HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

SYNTHESIZED SIGNAL GENERATOR 8660C

Including Options 001, 002 ,003, 004, 005 and 100

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1416A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

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Thanks

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NOTE

Although this is a Class 1 instrument, all warning, grounding, safety and voltage information is repeated here to ensure that all users of the instrument are aware of the safety and other precautions required to assure that the instrument is operated properly. The information is repeated at appropriate intervals throughout the manual.

WARNINGS

SAFETY

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

a. If this instrument is to be energized via an autotransformer for voltage reduction, make sure that the common terminal is connected to the earthed pole of the power source.

b. The power cable plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (grounding).

c. Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor of the power cord. This is accomplished by ensuring that the instrument's internal earth terminal is correctly connected to the instrument's chassis and that the power cord is wired correctly.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. Such equipment should be suitably tagged explaining the cause of malfunction, and include a warning that the equipment is not to be used until the malfunction is corrected.

Any interruption of the protective (grounding) conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

HIGH VOLTAGE

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, if inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

FUSES

Make sure that only fuses with the required rated current and of the specified type (normal blow time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

CAUTIONS

GROUNDING

Any interruption of the protective (grounding) conductor inside or outside the instrument is likely to cause damage, this instrument and all line powered devices connected to it must be connected to the same earth ground (see Section II).

LINE VOLTAGE

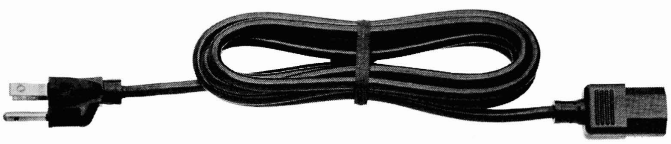
Be sure to select the correct fuse rating for the selected line voltage (see LINE VOLTAGE SELECTION in Section II); fuse ratings are listed on the fuse compartment.

To prevent damage to the instrument, make the line voltage selection BEFORE connecting line power. Also ensure that the line power cord is connected to a line power socket that is provided with a protective earth contact.

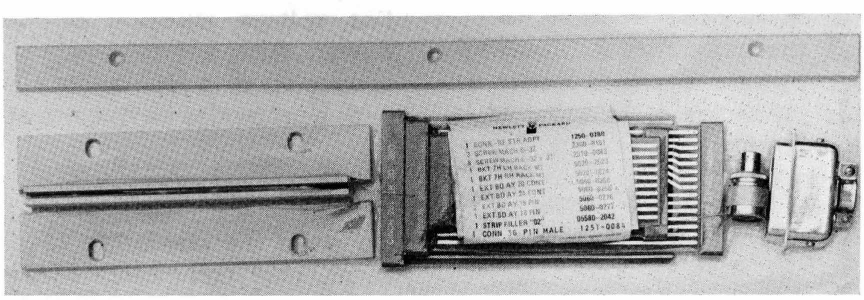
SAFETY

To avoid the possibility of damage to test equipment, read completely through each test before starting it. Make any preliminary control settings necessary for correct test equipment operation.

MODEL 8660C



LINE POWER CORD



RACK MOUNTING KIT

Figure 1-1. Model 8660C and Accessories Supplied

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains all information required to install, operate, test, adjust and service the Hewlett-Packard Model 8660C Synthesized Signal Generator mainframe. This section covers instrument identification, specifications and other basic information. Figure 1-1 shows a front view of the instrument and accessories supplied.

1-3. The other various sections of this manual provide information as follows:

a. SECTION II, INSTALLATION, provides information relative to incoming inspection, power requirements, mounting, packing for shipment, etc.

b. SECTION III, OPERATION, provides information relative to operating the instrument.

c. SECTION IV, PERFORMANCE TESTS, provides information required to ascertain that the instrument is performing in accordance with published specifications.

d. SECTION V, ADJUSTMENTS, provides information required to properly adjust and align the instrument after repairs are made.

e. SECTION VI, REPLACEABLE PARTS, provides ordering information for all replaceable parts and assemblies.

f. SECTION VII, MANUAL CHANGES, normally will contain no relevant changes in the original issue of a manual. This section is reserved to provide backdated and up-dated information in manual revision or reprints.

g. SECTION VIII, SERVICE, includes all information required to service the instrument when a malfunction occurs.

1-4. Packaged with this instrument is an Operating Information Supplement. This is simply a copy of the first three sections of this manual (less Table 1-2). This supplement should stay with the instrument for use by the operator. Additional copies of the Operating Information Supplement may be ordered separately through your nearest Hewlett-Packard office. The part number is listed on the inside title page of this manual below the Manual Part Number.

1-5. Also listed on the inside title page of this manual, below the manual part number, is a "Microfiche" part number. This number may be used to order 4 x 6 inch microfilm transparancies of the manual. Each microfiche contains up to 60 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes Supplement as well as all pertinent Service Notes.

1-6. SPECIFICATIONS

1-7. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument may be tested.

1-8. INSTRUMENTS COVERED BY MANUAL

1-9. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix(es) as listed under SERIAL NUMBERS on the inside title page.

1-10. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the inside title page. This unlisted serial prefix indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Changes supplement that contains "change information" that documents the differences.

1-11. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement for this manual. The supplement for this manual is keyed to this manual's print date and part number, both of

Table 1-1. Model 8660C Specifications (1 of 2)

SPECIFICATIONS

Frequency Selection:
Keyboard control panel allows selection of CW (or center frequency) by entry keys or synthesized tuning dial. Least significant digit either 1 Hz (standard) or 100 Hz (Option 004).*

Reference Oscillator:

Internal: 10 MHz quartz oscillator. Aging rate less than ±3 parts in 10^8 per 24 hours after 72 hour warmup (±3 parts in 10^9 per 24 hours after 30 day warmup, Option 001).

External: Rear panel switch allows operation from any 5 MHz or 10 MHz signal at a level between 0.2V and 2.0V rms into 170 ohms. Stability and spectral purity will be partially determined by characteristics of external reference oscillator.

Reference Output:
Rear panel BNC connector provides output of signal selected (INT. or EXT.) at the following levels into 170 ohms:

Internal Reference: 0.5V to 1V rms.

External Reference: Nominally equal to external input.

Display:
Ten-digit numerical LED display of CW frequency is active in either local or remote mode. Spring-loaded pushbuttons provide display of sweep width, selected step size, or characters being entered on the keyboard.

Synthesized Search:
Synthesized search dial changes the synthesized output frequency 180 steps per revolution (with the 86601A, the COARSE and STEP tuning are desensitized to 36 steps/revolution). Step sizes are 1 Hz, 1 kHz, 1 MHz, or any step size entered through the keyboard.

Digital Sweep:

Type: Symmetrical about CW/center frequency. Sweep width is divided into 100 synthesized steps for fastest sweep speed or 100 steps for slower speeds or Manual Sweep.

Sweep Width: Continuously adjustable over range of RF section installed. Smallest step size is equal to frequency resolution of mainframe.

Sweep End Point Accuracy: Same as reference oscillator accuracy.

Sweep Speed: Selectable 0.1 sec, 1 sec, or 50 sec per sweep (Auto or Single).

Sweep Output: 0 to +8V stepped ramp, 100 or 1000 equal steps depending on sweep speed.

Manual Sweep: Synthesized search dial allows manual sweep over width selected in 1000 steps (LED display follows output frequency during manual sweep).

Single Sweep: Initiated by momentary contact pushbutton.

Frequency Stepping:
After a step size has been entered on the keyboard, depressing STEP ↑ or STEP ↓ button will increment frequency up or down by the desired step size.

Step Accuracy: Same as reference oscillator accuracy.

REMOTE PROGRAMMING

CW frequency, frequency stepping (STEP ↑ or STEP ↓) and output level, and most modulation functions are programmable. Note: digital sweep is NOT programmable.

Frequency:
CW frequency is programmable over entire range with same resolution obtained in manual operation.

Frequency Step:
STEP ↑ or STEP ↓ may also be programmed to change output frequency by a previously selected step size.

Output Level:
Programmable in 1 dB steps over the output range of the RF section installed (for output level accuracy see RF section specifications).

Modulation: See specifications for modulation and RF section installed.

Programming Input:

Connector Type: 36 pin Cinch type (mating connector supplied). (Optional HP-IB interface; 24 pin Cinch type 57 (mating connector NOT supplied)).

Logic: TTL compatible (negative true)
"0" logic state corresponds to +2V or higher.
"1" logic state corresponds to +0.8V or lower.

Internal Fan-in from Programming Connector:
10; (required current approximately 15 mA per line in the "1" state).

*When using 86603A RF section above 1300 MHz least significant digit becomes either 2 Hz (standard) or 200 Hz (Option 004).

Table 1-1. Model 8660C Specifications (2 of 2)

GENERAL

Operating Temperature Range: 0° to +55°C.

Leakage: Meets radiated and conducted limits of MIL I-6181D.

Power: 100, 120, 200, or 240 volts +5%, −10%, 48—66 Hz. 400 VA maximum.

Weight: (Mainframe only): Net, 23.2 kg (51 lb), Shipping 28.6 kg (63 lb).

Options:
- Option 001: ±3 x 10^{-9} /day internal reference oscillator.
- Option 002: No internal reference oscillator.
- Option 003: Operation from 50 to 400 Hz line.
- Option 004: 100 Hz frequency resolution (200 Hz above 1300 MHz center frequency.)
- Option 005: HP-IB programming interface.
- Option 100: 11661B factory installed.

which appear on the inside title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-12. For information concerning a serial number prefix not listed on the inside title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-13. DESCRIPTION

1-14. The Model 8660C Synthesized Signal Generator Mainframe requires two plug-in sections to provide a useable RF output. The plug-ins required are an RF Section and a Modulation (or Auxiliary) Section. These plug-in sections are inserted into the front of the Model 8660C; all operating controls are on the front panels of the plug-in sections or on the mainframe panel.

1-15. An internal plug-in unit, the Frequency Extension Module (HP accessory number 11661) is required when any RF Section other than the HP Model 86601 is in use.

1-16. GENERAL OPERATING PRINCIPLES

1-17. All of the signals generated in the Model 8660C are phase locked, directly or indirectly, to a 100 MHz master oscillator in the reference section. The 100 MHz master oscillator is phase locked to an internal temperature controlled oscillator or to an external standard. Provisions are made for the internal oscillator to be used as a reference signal for other equipment.

1-18. The Model 8660C uses synthesizer techniques to provide digitally controlled, precise RF signals which are used in the RF Section output plug-ins to produce the selected output frequency. The output frequencies are exactly those selected in 1 Hz or 2 Hz increments in the standard instruments, or in 100 Hz or 200 Hz increments in Option 004 instruments.

1-19. Six phase locked loops, (four in Option 004 instruments), all phase locked to the 100 MHz master oscillator, are used to generate the RF signals used in the RF Section plug-ins to produce the final output signal.

1-20. The Model 8660C output frequency may be selected by front panel controls or by a remote programming device.

1-21. Operating of the plug-in sections may also be remotely programmed through the mainframe circuits.

1-22. Descriptions, operating instructions and service information for the various plug-in sections is provided in separate manuals.

NOTE

The 8660 family, and plug-ins available are described briefly on the first foldout Sheet.

1-23. OPTIONS

1-24. Option 001: Reference Oscillator with ± 3 x 10^{-9} / per day stability.

1-25. Option 002: No internal standard reference oscillator.

1-26. Option 003: 50 to 400 Hz ac operation.

1-27. Option 004: 100 Hz resolution below 1300 MHz, 200 Hz resolution above 1300 MHz.

1-28. Option 005: Hewlett-Packard Interface Bus installed instead of BCD interface. HP-IB utilizes some ASCII interface codes (also previously referred to as General Purpose Interface Bus).

1-29. Option 100: Adds an internal plug-in, the 11661 (for use with an 86602 or 86603 RF Section) before the instrument is shipped from the factory.

1-30. EQUIPMENT REQUIRED BUT NOT SUPPLIED

1-31. An RF Section and a Modulation or Auxiliary Section must be installed in the Model 8660C mainframe. In addition when an RF Section such as the 86602 or 86603, is used, the internal Frequency Extension Module (Model 11661) must be used.

1-32. EQUIPMENT AVAILABLE

1-33. A service kit, Hewlett-Packard accessory number 11672A, is recommended for servicing and adjusting the mainframe and the plug-in sections. Contents of the service kit are listed in Table 1-2. Individual items in the kit may be ordered separately if desired.

1-34. ACCESSORIES SUPPLIED

1-35. The following accessories are provided with the Model 8660C:

a. A detachable three-wire power cable. The type of power cord will be determined by the shipment destination.

b. A rack mounting kit part number 08660-60070, consisting of the following:

1	CONNECTOR: RF STRAIGHT ADAPTER	1250-0780
3	SCREW, MACHINE 6-32	2360-0180
8	SCREW, MACHINE 8-32 x 0.31	2510-0043
1	BRACKET 7H LEFT HAND RACK MOUNT	5020-7623
1	BRACKET 7H RIGHT HAND RACK MOUNT	5020-7624
1	EXTENSION BOARD ASSY 20 CONTACT	5060-0256
1	EXTENSION BOARD ASSY 24 CONTACT	5060-0258
2	EXTENDER BOARD ASSY 15 PIN	5060-0276
1	EXTENDER BOARD ASSY 18 PIN	5060-0277
1	STRIP, FILLER "02"	5580-2042
1	PLUG, 36 CONTACT MALE W/HOOD AND CLAMP	1251-0084

1-36. WARRANTY

1-37. Certification and warranty information for the Model 8660C appears on the inside front cover of this manual.

1-38. TEST EQUIPMENT AND ACCESSORIES

1-39. Table 1-2 lists the test equipment and accessories recommended to test, adjust and service the Model 8660C.

1-40. ELECTRICAL PROTECTION

1-41. The safety classification of this instrument is Safety Class I.

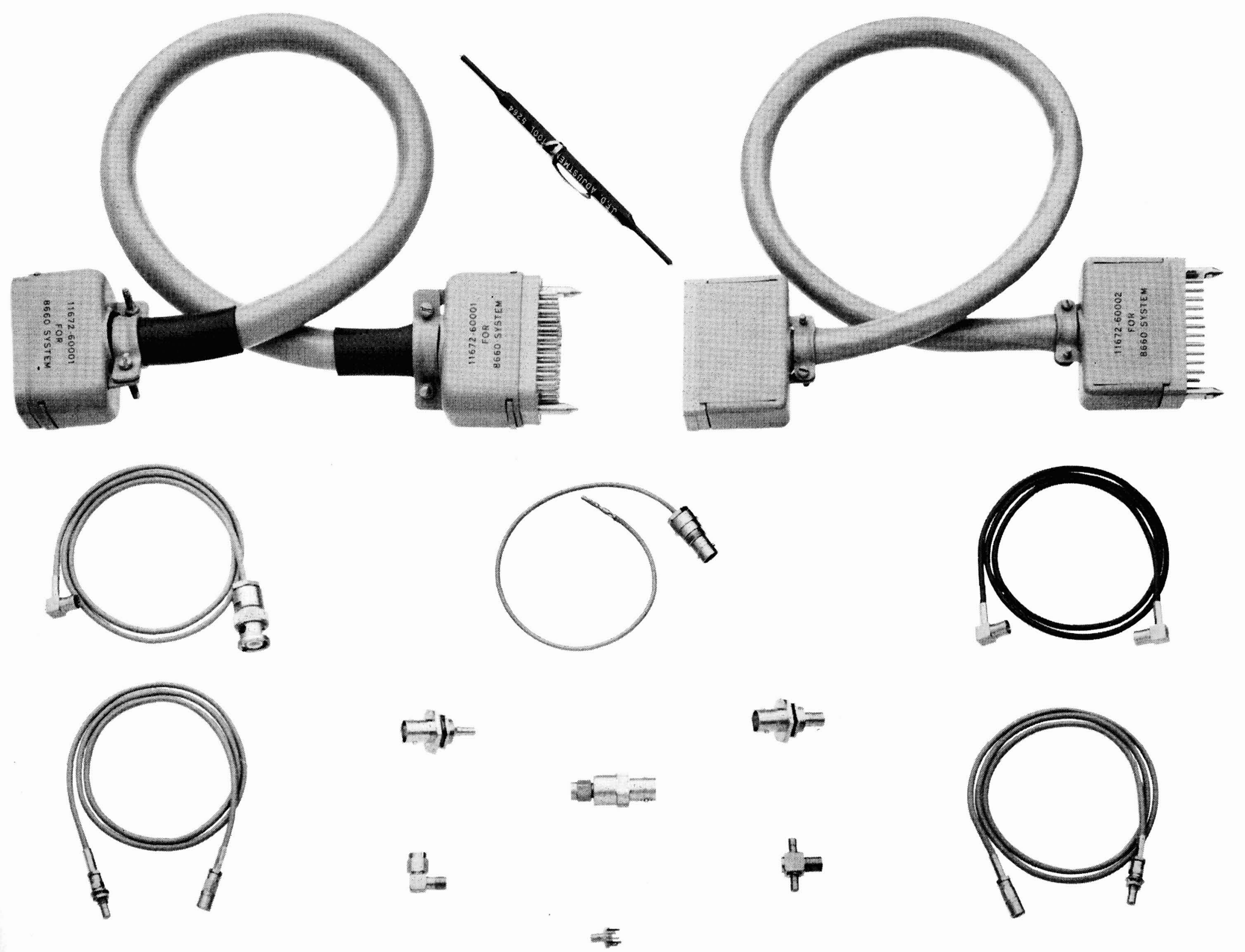
1-42. This apparatus has been designed and tested to operate in a safe manner. The Operating and Service Manual contains information, warnings and cautions which must be followed by the user to ensure safe operation and to retain safe operating conditions.

Table 1-2. Test Equipment and Accessories List (1 of 2)

Item	Minimum Specifications	Suggested Model	Use*
Digital Voltmeter	Voltage Accuracy ± 0.01% 0.000V to 8.0V	HP Model 3480 with 3482 plug-in	P, A, S
AC Microvoltmeter	3 μV to 3V Tuneable to 120 Hz	HP 3410A	A, S
Variable Voltage Transformer	Range 103 to 127 Vac Meter Range 103-127 Vac ± 1V	General Radio W4MT3A	A
VLF Comparator	Sensitivity 1 μV into 50 ohms; Compares 100 kHz input to NBS station WWVB	HP 117A	P, A
Oscilloscope	Frequency dc to 50 MHz Time base 10 ns to 1 s Time base accuracy 3%	HP 180A with HP 1801A and HP 1821A plug-ins	P, A, S
10:1 Divider Probes	10:1 Divider 10 Megohm 10 pF	HP 10004A (2)	
Spectrum Analyzer	Frequency Range 10 to 600 MHz, Response ± 1 dB, Measurement Accuracy ± 2.0 dB	HP 140/HP 8554B/ HP 8552	A, S
Frequency Counter	Range 0 - 50 MHz, 0 - 500 MHz with plug-in accuracy ± 1 count ± time base accuracy. External time base 10 MHz	HP 5245M with HP 5253 plug-in	P, A, S
Pulse Generator	Pulse rate 100 kHz Pulse width 0.035 μsec Amplitude 0.5V Polarity - Selectable	HP 222A	A
Signal Generator/ Sweeper	Frequency —1 - 110 MHz Output Range +20 to —20 dBm Output CW or swept	HP 8601A	P, A, S
RF Voltmeter	Range 0.1 to 2V Frequency Range 1 to 10 MHz	HP 411A	P
Test Oscillator	Freq. Range 10 Hz to 1 kHz Output Level +10 to —20 dBm	HP 651B	A, S
Frequency Synthesizer	Freq. Accuracy 0.001% Freq. Stability ± 10 parts in 10^6 per year	HP 3320B	P
Marked Card Programmer	Capable of programming either BCD or HP-IB bus data	HP 3260A	S
Logic Analyzer	Sequential display of 16 12-bit binary words	HP 1601 with HP 180 Oscilloscope	P, S

Table 1-2. Test Equipment and Accessories List (2 of 2)

Item	Minimum Specifications	Suggested Model	Use*
Service Kit	Consisting of:	HP 11672A	A, S
	Adapter: BNC female to OSM male	1250-1200	
	Adapter: BNC female, Sealectro female	1250-1236	
	Adapter: BNC female, Sealectro male	1250-1237	
	Adapter: Right angle OSM male/female	1250-1249	
	Sealectro jack (printed circuit mount)	1250-1255	
	Adapter: Sealectro Tee	1250-1391	
	Tool: Adjustment	8830-0024	
	Cable: Extender, 36 pin, gray	11672-60001	
	Cable: Extender, 42 pin, gray	11672-60002	
	Cable Assy: Sealectro male and female, 24 inches long, gray	11672-60003	
	Cable Assy: Sealectro male and female right angle connectors 24" long, red	11672-60004	
	Cable Assy: Sealectro right angle female, BNC male, 24" long, gray	11672-60005	
	Cable Assy: Sealectro male and female, 24" long, gray with blue stripe	11672-60006	
	Cable Assy: White	11672-60008	



SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section provides information on incoming inspection, selecting the input line voltage, operating environment, and information applicable to bench and rack mounted operation of the Model 8660C.

2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged it should be kept until the contents of the shipment have been checked mechanically and electrically. The contents of the shipment are shown in Figure 1-1, and the procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defects, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement without waiting for claim settlements.

2-5. The warranty statement for the instrument is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information relative to warranty claims.

2-6. PREPARATION FOR USE

2-7. Power Requirements

2-8. The Model 8660C Synthesized Signal Generator requires a power source of 100, 120, 220 or 240 Vac +5%, –10%, 48 to 66 Hz signal phase. Power consumption is 400 VA maximum.

2-9. Line Voltage Selection

CAUTION

To prevent damage to the instrument make the line voltage selection BEFORE connecting the line power. Also ensure the line power cord is connected to a line power circuit that is provided with a protective earth contact.

2-10. A rear panel line power module, (A7), permits operation from 100, 120, 220, or 240 Vac. The number visible in the window (located on the module) indicates the nominal line voltage to which the instrument must be connected.

2-11. To prepare the instrument for operation, slide the fuse compartment cover to the left (the line power cable must be disconnected). Pull the handle marked FUSE PULL and remove the fuse; rotate the handle to the left. Gently pull the printed circuit voltage selector card from its slot and orient it so that the desired operating voltage appears on the top-left side (see Figure 2-1). Firmly push the voltage selector card back into its slot. Rotate the FUSE PULL handle to the right, install a fuse of the correct rating, and slide the fuse compartment cover to the right.

WARNING

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

a. Note that the protection provided by grounding the instrument cabinet may be lost if any power cable other than the three-pronged type supplied is used to couple the ac line voltage to the instrument.

b. If this instrument is to be energized via an autotransformer to reduce or increase the line voltage, make sure that the common terminal is connected to the earthed pole of the power source.

c. The power cable plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (grounding).

d. Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor of the power cord. This is accomplished by ensuring that the instrument's internal earth terminal is correctly connected to the instrument's chassis and that the power cord is wired correctly.

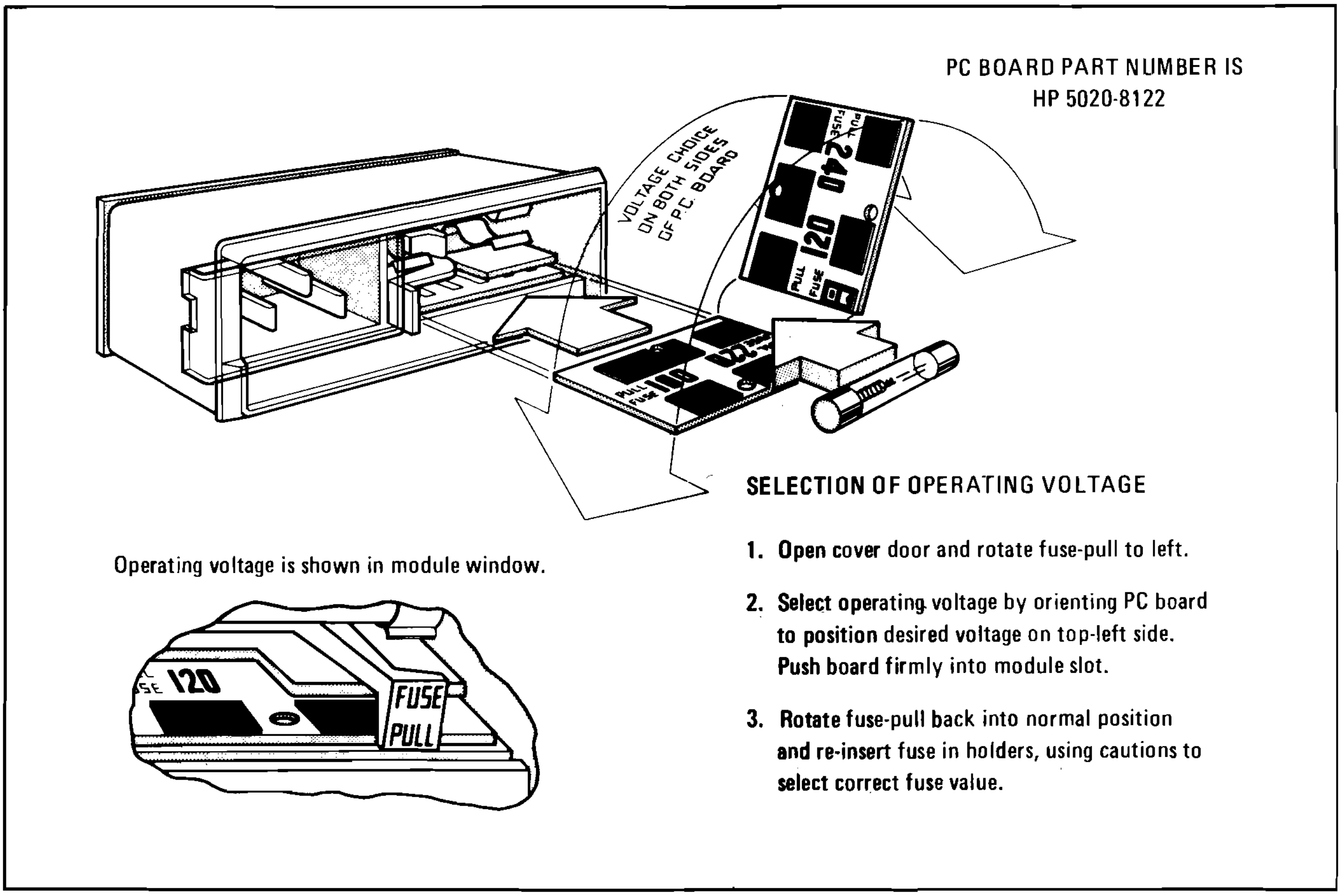


Figure 2-1. Line Voltage Selection

NOTE

The correct fuse rating for the line voltage selected is listed on the line power module. More information about fuses is given in the table of replaceable parts in Section VI (reference designation is A7F1).

2-12. Power Cable

2-13. In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of the power cable plugs available.

2-14. Mating Connectors

2-15. Internal mating connectors between the Model 8660C and the plug-in sections are in fixed positions. Refer to Figure 8-118 for plug-in connector information. Refer to Figure 8-106 for information relative to the remote control connector, J3.

2-16. Operating Environment

2-17. The operating environment should be within the following limitations:

Temperature	0 to 55°C
Humidity	<85% relative
Altitude	<15,000 feet

2-18. A forced air cooling system is used to maintain the operating temperature required by the instrument. The air exhaust fan is located on the rear panel of the instrument; the air intake is through the side panels of the instrument. When operating the instrument, choose a location that provides at least three inches of clearance at the rear and at least an inch of clearance for each side. The clearances provided by the plastic feet in bench stacking and the filler strip in rack mounting are adequate for the top and bottom cabinet surfaces.

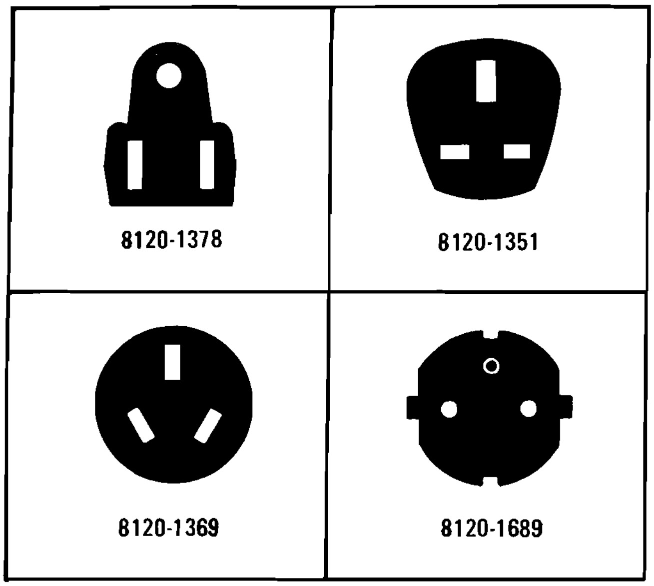


Figure 2-2. Power Cable HP Part Numbers

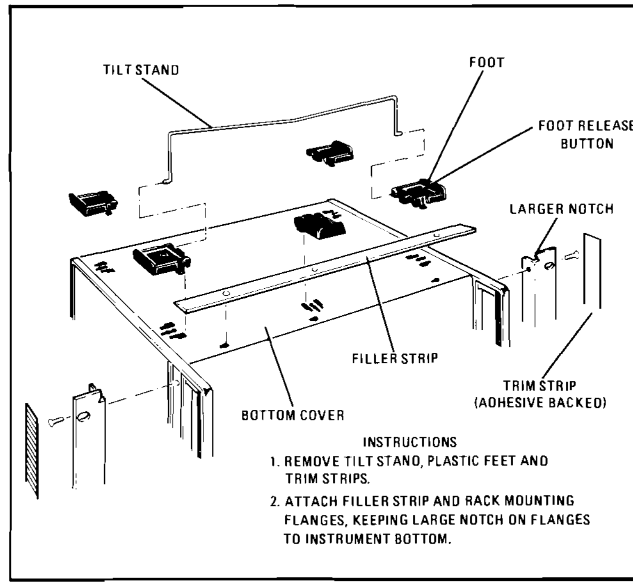


Figure 2-3. Preparation for Rack Mounting

2-19. Bench Operation

2-20. The instrument has plastic feet and a fold-away tilt stand for convenience in bench operation. The tilt stand raises the front of the instrument for easier viewing of the control panel and the plastic feet are shaped to make full width modular instruments self aligning when stacked.

2-21. Rack Mounting

2-22. This instrument is supplied with a rack mounting kit. This kit contains all the necessary hardware and installation instructions for mounting the instrument in a rack with 19 inch spacing (see Figure 2-3).

2-23. STORAGE AND SHIPMENT

2-24. Environment

2-25. The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature	−40°C to +75°C
Humidity	<95% relative
Altitude	<20,000 feet

2-26. Packaging

2-27. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-28. Other Packaging. The following general instructions should be used for re-packaging with commercially available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A doublewall carton made of 250-pound test material is adequate.

c. Use enough shock-absorbing material (3 to 4-inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides operating instructions for the Hewlett-Packard Model 8660C Synthesized Signal Generator mainframe for both the local and remote modes.

3-3. The Model 8660C is designed to provide precise digitally controlled signals for use in plug-in sections which provide the selected output frequency with the chosen modulation parameters. It will be necessary to have the operating manuals for the plug-in sections being used in order to efficiently operate the instrument.

NOTE

If a Modulation plug-in Section is not used it will be necessary to have an Auxiliary Section in place of the Modulation Section. The Auxiliary Section completes a signal path from the mainframe to the RF Section plug-in and also provides a means of modulating the RF Section from an external source.

3-4. PANEL FEATURES

3-5. Front and rear panel controls, indicators and connectors of the 8660C are shown, and their functions described, in Figure 3-1.

3-6. OPERATOR'S MAINTENANCE

3-7. Operator's maintenance of the Model 8660C Synthesized Signal Generator mainframe is limited to fuse replacement.

3-8. OPERATING PRINCIPLES

3-9. The Model 8660C may be operated by front panel controls in the local mode or externally programmed in the remote mode.

WARNING

The power requirements and safety precautions listed throughout this Manual must be observed to preserve the built-in safety features of the Model 8660C.

3-10. LOCAL OPERATION

3-11. In the local mode of operation, all functions of the mainframe are controlled by front panel controls, except when an external reference oscillator is used. When an external reference oscillator is used, the rear panel SELECTOR switch must be in the EXT position.

3-12. The 20-key keyboard may be used to:

a. Select any frequency within the range of the RF Section plug-in in 1 Hz increments (above 1300 MHz, 2 Hz increments) for standard instruments. Option 004 instruments are selectable in 100 Hz increments (above 1300 MHz, 200 Hz increments).

NOTE

Frequencies which are above the output frequency range of the RF Section, if selected, will be stored in the keyboard register, but the information will not be transferred to the center frequency register. The center frequency register and the readout will retain the last valid input. Frequencies below the output frequency range of the RF Section will be transferred to the center frequency register and the output register; the output frequency will be accurate but the output amplitude will be degraded. As an example, the Model 86601A RF Section has a specified lower frequency limit of 10 kHz, but typically will produce a useable RF output down to 3 kHz or lower.

b. When frequencies below the RF Section frequency range are selected, the OUT OF RNG lamp lights and remains lit.

c. Select any desired sweep width within the frequency range of the RF Section in use. See paragraph 3-14 for further details of sweep operation.

d. Select any incremental step within the frequency range of the RF Section in use. See

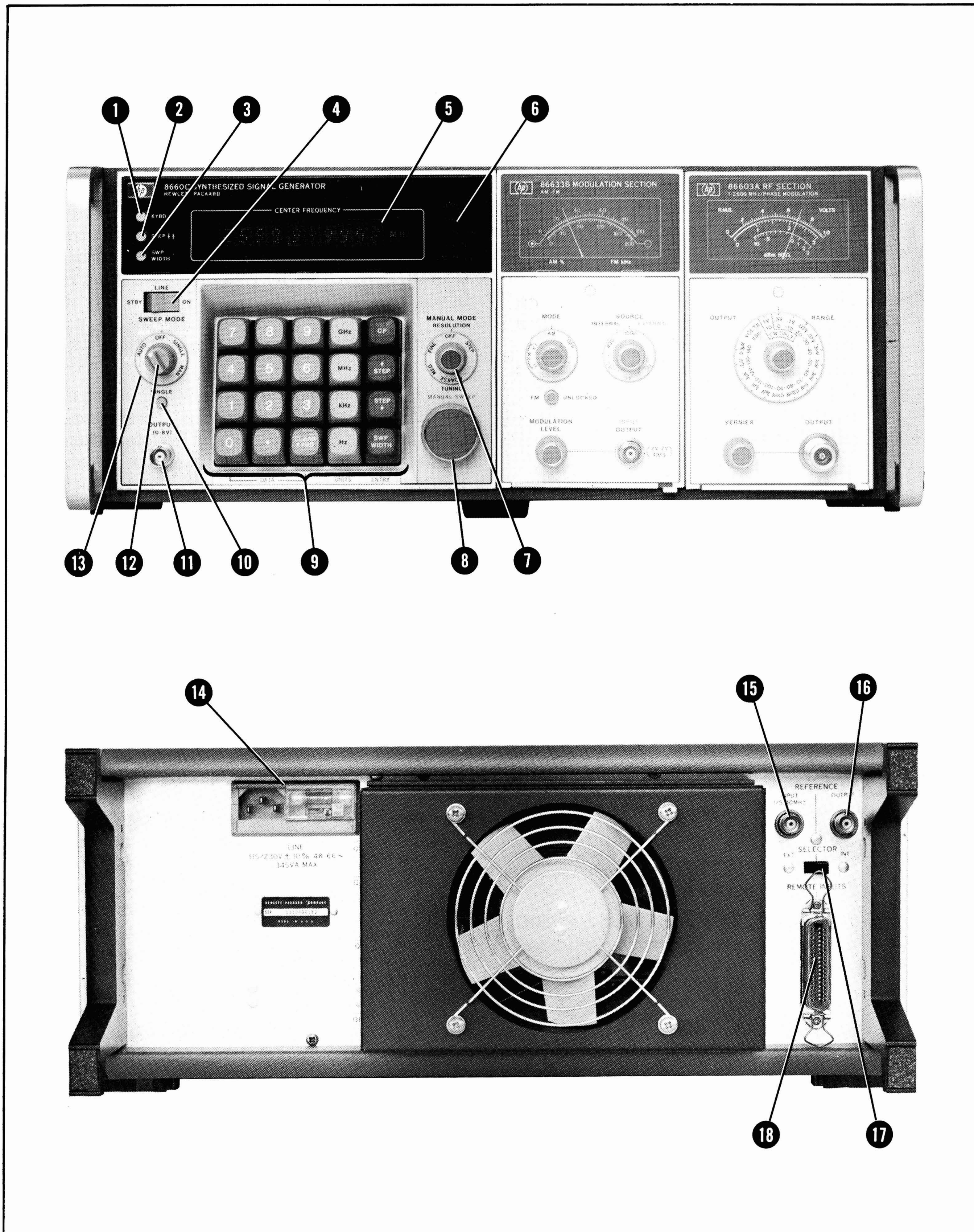


Figure 3-1. Front and Rear Panel Controls, Indicators and Connectors (1 of 2)

❶ **KYBD pushbutton.** When pressed, causes the information stored in the keyboard storage register to be displayed on the CENTER FREQUENCY readout.

❷ **STEP pushbutton.** When pressed, causes the information stored in the step storage register to be displayed on the CENTER FREQUENCY readout.

❸ **SWP WIDTH pushbutton.** When pressed, causes the information stored in the sweep width storage register to be displayed on the CENTER FREQUENCY readout.

❹ **LINE STBY – ON switch.** In the STBY position, with the instrument connected to the ac line source, the reference oscillator oven temperature is maintained at the operating temperature to avoid the necessity of allowing for a warm up period each time the instrument is used.

❺ **CENTER FREQUENCY readout.** Normally displays the output center frequency of the RF Section.

❻ **ANNUNCIATOR.** Provides visual display of mode of operation, crystal oven temperature and out of range frequency selection.

❼ **MANUAL MODE RESOLUTION.** Works in conjunction with the TUNING control to step the rf output in steps of 1 Hz (FINE), 1 kHz (MED) and 1 MHz (COARSE). In the STEP position the TUNING control steps the rf output frequency by the step stored in the step register.

❽ **TUNING – MANUAL SWEEP.** Works as specified in the MANUAL MODE RESOLUTION description. May also be used to set the rf output to any point within the limits stored in the sweep register when the SWEEP MODE switch is set to MAN.

❾ **Keyboard.** Contains 20 keys which are used to enter data or instructions as follows:

Numerals 0 through 9

Decimal Point (.)

CLEAR KYBD. Clears keyboard register (does NOT clear other registers).

GHz, MHz, kHz and Hz select frequency in conjunction with numeric keys.

CF. Transfers keyboard storage register data to the center frequency register.

STEP. ↑ Transfers keyboard storage register data to the step register and steps the center frequency up. May also be used to step the frequency up by the step stored in the step register without a new keyboard entry.
STEP. ↓ Same as STEP ↑ except that frequency is stepped down.
SWP WIDTH. Transfers the data in the keyboard storage register to the sweep register.

❿ **SINGLE pushbutton.** In the SINGLE mode, when pressed, causes the rf output to be swept, one time only, across the range stored in the sweep register, at a speed determined by the RATE switch.

⓫ **OUTPUT (0 to +8V).** Provides a sweep ramp for use in external equipment (oscilloscopes, X-Y recorders, etc.) when operating in the swept mode.

⓬ **RATE switch.** The rate switch selects sweep rates as follows: FAST — 100 steps at 1 millisecond per step, MED — 1000 steps at 1 millisecond per step, and SLO — 1000 steps at 50 milliseconds per step.

⓭ **SWEEP MODE switch.** With the sweep mode switch in the AUTO position sweep operation is automatic; the output rf is swept about the center frequency by the data stored in the sweep register at the rate selected by the RATE switch. In the SINGLE mode the rf output is swept once each time the SINGLE pushbutton is pressed. In the MAN mode the sweep is controlled by the MANUAL TUNE control and the data stored in the sweep register.

⓮ **LINE MODULE.** Contains a means of switching input line voltage to 100/120/220/240 Vac +5% −10%, fuse, line cable connector and filtering. NOTE: the cabinet (earth) ground is also applied through the line module.

⓯ **REFERENCE INPUT.** Used when an external standard of 5 or 10 MHz is used.

⓰ **REFERENCE OUTPUT.** Provides the capability of using the internal reference as a time base in external equipment.

⓱ **SELECTOR.** Selects INT or EXT reference.

⓲ **REMOTE INPUTS.** When the instrument is operated in the remote mode (pin 5 of this connector is grounded by the programming device), all functions of the instrument are controlled by the remote programming device. Front panel controls (except for LINE STBY-ON) have no effect on operation of the instrument.

Figure 3-1. Front and Rear Panel Controls, Indicators and Connectors (2 of 2) paragraph 3-18 for further details of incremental step operation.

3-13. Operating Modes

3-14. Sweep. In the sweep mode the sweep width is selected by the keyboard. The sweep width may be displayed on the CENTER FREQUENCY readout by pressing the SWP WIDTH pushbutton to the left of the readout. Only the center frequency is shown in the AUTO or SINGLE SWEEP modes. In the MAN sweep mode the actual RF output frequency of the RF Section will be displayed.

3-15. When the SWEEP MODE switch is placed in the AUTO position the output signal of the RF Section is swept about the selected center frequency by the selected sweep width. (Example: center frequency 50 MHz, sweep width 20 MHz, the RF output is swept from 40 to 60 MHz.) The sweep rate, selected by the RATE switch is as follows: FAST — 100 steps at 1 millisecond per step, MED — 1000 steps at 1 millisecond per step and SLO — 1000 steps at 50 milliseconds per step.

3-16. When the SWEEP MODE switch is placed in the SINGLE position, pressing the SINGLE pushbutton causes the output of the RF Section to be swept one time. When the single sweep is completed, the output of the RF Section returns to the selected center frequency. The sweep width and sweep rate are selected in the same manner as they are in the AUTO mode.

3-17. When the SWEEP MODE switch is placed in the MAN position the step rate of the output frequency of the RF Section may be manually controlled by the MANUAL SWEEP control. In this mode the sweep width is still controlled by the information in the sweep register. The selected sweep width, in this mode, is divided by 1000 and the output of the RF Section may be controlled in frequency steps that are 1/1000 of the sweep width. (Example: center frequency 50 MHz, sweep width 20 MHz, output may be swept manually from 40 to 60 MHz in 20 kHz steps.)

3-18. Step. The center frequency may be stepped up or down, in any increment within the frequency range of the RF Section in use. The increment selected, including units, must be entered in the keyboard before the STEP ↑ or STEP ↓ key is pressed. The step entered into the step register remains in the register until changed (or the instrument is place; in the standby mode) and may be displayed on the readout by pressing a STEP pushbutton.

3-19. When the MANUAL SWEEP control, a Rotary Pulse Generator, is used to control the STEP mode, the size of the step is determined by the information stored in the STEP register.

3-20. Manual. Manual mode operation is essentially the same as the step mode except that increments selected by the MANUAL MODE switch are 1 Hz (FINE), 1 kHz (MED) and 1 MHz (COARSE). These increments are controlled only by the TUNING control when the MANUAL MODE switch is placed in the selected position.

3-21. Combined. The sweep mode, step mode and manual mode may all be used simultaneously except for Manual Sweep which locks out the Manual Tuning Mode. This feature allows the user to quickly determine the frequency parameters of any device being tested.

3-22. Operator's Checks

3-23. During final checkout at the factory the Model 8660C Synthesized Signal Generator mainframe is adjusted for proper operation. No adjustments should be required when the instrument is received. The operator's checks listed in Table 3-1 are based on the assumption that properly operating RF Sections and Modulation Sections are in place during the tests. Refer to the manuals for the specific plug-ins for operating parameters.

3-24. The steps listed in Table 3-1 need not be followed in the sequence listed. Their purpose is to aid the operator in familiarizing himself with the instrument, and to provide assurance that all functions of the instrument are operating properly.

NOTES

1. Numbers shown in the "Result" column of Table 3-1 are those which should be displayed on the CENTER FREQUENCY readout.

2. Any operator's checks specified in the plug-in Manuals should also be performed.

3-25. Modulator Units

3-26. Since the modulator plug-ins are not affected by the mainframe except for digital control

Table 3-1. Operator's Checks (Local Operation) (1 of 4)

Step	Operation	Result
1	Initial Turn-on, all Models	
1-a	Set the rear panel line select in the power line Module to be compatible with the available line power.	
1-b	Connect the instrument to the power outlet; use ground pin adapter for electrical systems having no ground line. **NOTE** *The instrument should remain connected to the power source in the STBY (standby) mode when not in use. This will maintain constant temperature in the crystal oven and eliminate the need for a long warm-up period.*	
1-c	Place the LINE STBY/ON switch in the ON position.	Cooling fan starts. CF is 1.000000 MHz.
2	Keyboard Register and Readout Checks all Models	
2-a	Hold in KYBD pushbutton adjacent to CF readout and enter 1.23456789. Note that readout input steps from right to left.	Unit lights (GHz, MHz, kHz, Hz) are off. 1.234567890
2-b	With KYBD pushbutton held in : Press MHz key Press kHz key Press Hz key	1.234567 MHz 1.234 kHz 1 Hz
2-c	Release KYBD pushbutton	1.000000 MHz
2-d	Press KYBD pushbutton	1 Hz
2-e	With KYBD pushbutton held in: Press kHz key Press MHz key Press GHz key Press CLEAR KYBD key	1.000 kHz 1.000000 MHz 1.000000000 GHz Readout all zeroes
3	Step ↑ and step ↓ register and OUT OF RNG annunciator check (86601A).	
3-a	Enter 109.000000 MHz CF on the KYBD Enter 111111 Hz STEP ↑ on the keyboard	109.000000 MHz 109.111111 MHz
3-b	Press the KYBD pushbutton Release the KYBD pushbutton	111111 kHz 109.111111 MHz
3-c	Press the STEP ↑ key until the readout shows. Note that the readout has increased in steps of	109.999999 MHz 111111 Hz
3-d	Press the STEP ↑ key one more time.	110.111110 MHz OUT OF RNG light flashes once.
3-e	Place the MANUAL MODE switch in the STEP position and turn the TUNING control counterclockwise.	Readout decreases in 111111 Hz steps.

Table 3-1. Operator's Checks (Local Operation) (2 of 4)

Step	Operation	Result
3-f	Enter 10 kHz CF on the keyboard Enter 1 Hz STEP ↑ on keyboard Press STEP pushbutton adjacent to CF readout Press STEP ↓ key twice	10.000 kHz 10.001 kHz 1 Hz 9.999 kHz
	NOTE: With the Model 86601A RF Section the specified lower frequency limit is 10 kHz. **NOTE** *The Model 86601A RF Section lower frequency limit is specified at 10 kHz. However, the output frequency is accurate down to 1 Hz. The output power level is typically accurate down to 3 kHz or less.*	
3-g	Enter 3 kHz CF on the keyboard Enter 100 Hz STEP ↓ Repeatedly press the STEP ↓ key. Note that the frequency readout decreases in 100 Hz steps. The rf frequency level will typically start to drop below 2 kHz.	3.000 kHz 2.900 kHz
4	MANUAL MODE — MANUAL TUNING Check (86601A)	
4-a	Set the SWEEP MODE switch to OFF and enter 0 MHz CF	.000000 MHz
4-b	Set the MANUAL MODE switch to COARSE and rotate the TUNING CONTROL clockwise until the readout indicates : Note that the readout steps in 1 MHz increments.	109.000000 MHz
4-c	Set the MANUAL MODE switch to MED and rotate the TUNING control clockwise until the readout indicates : Note that the readout steps in 1 kHz increments.	109.999000 MHz
4-d	Set the MANUAL MODE switch to FINE and rotate the TUNING control clockwise until the readout indicates: Note that the readout steps in 1 Hz increments. The OUT OF RNG light flashes on when the RF Section upper frequency limit is passed. The system rejects overrange frequencies and the center frequency register retains the last valid entry.	109.999999 MHz
5	Sweep Mode Checks with the 86601A RF Section **NOTE** *Proper operation of the instrument in the sweep mode is best verified with a spectrum analyzer as described in step 5-c. However, operation of the sweep function can be verified by front panel indications as described in steps 5-a and 5-b.*	

Table 3-1. Operator's Checks (Local Operation) (3 of 4)

Step	Operation	Result
5-a	Set CF to 5 kHz and SWP WIDTH to 10 kHz. Place the SWEEP MODE switch in the AUTO position and the RATE switch in the SLO position.	SWEEP and OUT OF RNG lights on. RF output level drops every ten seconds.
5-b	Set CF to 10 kHz. Other functions as in step 5-a.	SWEEP LIGHT remains lit. OUT OF RNG light alternates, 25 seconds on, 25 seconds off.
5-c	Connect the rf output to the RF INPUT of the spectrum analyzer. Enter 10 MHz CF and 10 MHz SWP WIDTH and SWEEP MODE to AUTO. Position the RATE switch to MED and adjust the spectrum analyzer for a clear display. Enter 5 MHz STEP and step the frequency across the rf range.	Readout increases in 5 MHz steps. Sweep continues to be 5 MHz on each side of the center frequency.
6	Sweep Mode checks with the higher frequency RF Sections.	
6-a	Set the CF to 5 MHz, set SW WIDTH to 10 MHz. Set the SWEEP MODE switch to AUTO and RATE switch to SLO.	5.000000 MHz 5.000000 MHz OUT OF RNG light flashes ever 50 seconds. RF OUTPUT Meter also dips. SWEEP light remains on.
6-b	Set CF to 1 MHz	1.000000 MHz Sweep light on, OUT OF RNG light on 25 seconds; off 25 seconds.
6-c	Set CF to 5 MHz on keyboard. Set SWEEP RATE to MED.	5.000000 MHz 5.000000 MHz OUT OF RNG light flashes on at a 1 second rate.
7	MANUAL SWEEP Check	
7-a	Enter 50 MHz CF and 10 MHz SWP WIDTH. Place the SWEEP MODE switch in the MAN position. Rotate the MANUAL SWEEP control through its range.	Center frequency is tuneable from 45 to 55 MHz.

Table 3-1. Operator's Checks (Local Operation) (4 of 4)

Step	Operation	Results
8	SINGLE SWEEP Check	
8-a	Enter 50 MHz CF and 20 MHz SWP WIDTH and place the SWEEP MODE switch in the SINGLE position. Press SWP WIDTH pushbutton. Connect the rf output to the RF INPUT of the spectrum analyzer and tune the analyzer to display the 50 MHz signal. Press the SINGLE pushbutton.	50.000000 MHz 20.000000 MHz Spectrum analyzer displays is swept once from 40 to 60 MHz.
	Model 86602	
9	STEP ↑ and STEP ↓ register and OUT OF RNG annunciator check with the higher frequency RF Sections.	
9-a	Enter 1200.000000 MHz (86602) on the keyboard. Enter 11.111111 MHz STEP ↑ on the keyboard.	1200.000000 MHz 1211.111111 MHz
9-b	Press KYBD pushbutton Release KYBD pushbutton	11.111111 MHz 1211.111111 MHz
9-c	Continue pressing STEP ↑ key until readout displays:	1299.999999 MHz
9-d	Press the STEP ↑ key one more time	1299.999999 MHz OUT OR RNG light flashes once
9-e	Set the MANUAL MODE switch to the STEP position and turn the TUNING control counterclockwise	Readout decreases in 11.111111 MHz steps
9-f	Enter 1 MHz CF on the keyboard Enter 1 Hz STEP ↑ on the keyboard Press STEP pushbutton Press STEP ↓ on the keyboard twice	1.000000 MHz 1.000001 MHz 1 Hz .999999 MHz OUT OF RNG light stays on.
	NOTE *These checks will work with any of the RF Sections. It is only necessary to be aware of the frequency parameters and adjust the control settings accordingly.*	

voltages, operator's checks for the modulators are not included in Table 3-1. Refer to the individual manuals for the modulator plug-in in use for applicable operator's checks.

3-27. RF Units

3-28. Many of the tests specified in Table 3-1 do not apply specifically to an RF Section. Those checks which are not referred to a specific RF Section apply equally to the Model 86601, 86602, and the 86603. When procedures apply to specific RF Sections only, this information is conveyed following the procedure.

NOTE

Most of the programming tables in this section apply equally to local and remote modes.

3-29. REMOTE OPERATION

3-30. There are currently two means of remotely programming the Model 8660C. They are BCD (Binary Coded Decimal) and HP-IB (Hewlett-Packard Interface Bus). In the text which follows, programming and other requirements which are common to both means will be discussed first, then BCD requirements, and finally HP-IB requirements.

3-31. General Programming Requirements

3-32. There are several conventions which must be observed when remotely controlling the Model 8660C. Besides providing data with the least significant digit first, these conventions include:

a. All output levels are referenced to +13 dBm. This reference operation involves subtracting 13 from the desired output level.

b. There are three separate modulation parameters which may be programmed; source, type and %. Source and type are combined into one number (source is the least significant digit).

c. When in the remote mode, all front panel controls except the LINE STBY/ON and FM CAL controls are inhibited.

d. Digital sweep may not be operated in the remote mode of operation.

e. When changing from the local to the remote mode of operation the temporary storage register should be cleared before a remote entry is made.

f. The data level inputs to the Model 8660C are as follows: approximately 0 volts (TTL LOW) = 1 and approximately 2.8V (TTL HIGH) = 0 (sometimes referred to as negative or ground true logic).

3-33. BCD Remote Operation

3-34. The following information pertaining to BCD programming, does not apply to HP-IB programming.

3-35. In BCD remote operation two four-bit parallel codes are applied to the instrument circuits through a rear panel connector (J3). These inputs, if numeric data, are converted to BCD digit serial information and clocked into a temporary storage register. If the inputs are address information they are clocked into a temporary storage register. If the inputs are address information they are used to direct a clock to strobe the data from the temporary storage register into the desired final storage register.

3-36. When all of the significant data entries have been stored in the temporary storage registers, the least significant digit is stored in a position to allow it to be the first digit strobed out, then the next least significant digit, etc, so that the information will be stored in the appropriate register in the same sequence in which it was received.

3-37. Operation of the storage registers not located in the Model 8660C mainframe is detailed in the manuals for the plug-in sections. Table 3-3 provides examples of programming the registers which may be programmed when the Model 8660C mainframe is used.

3-38. Refer to Figures 3-2 and 3-3 for timing information and to Table 3-5 for interconnection information.

NOTE

Although it is not necessary to program frequency first, then modulation (if any), then attenuation, this sequence minimizes the time required for entering data.

3-39. Data Inputs. Data inputs (logic 1=0) must be referenced to the command pulse as shown in

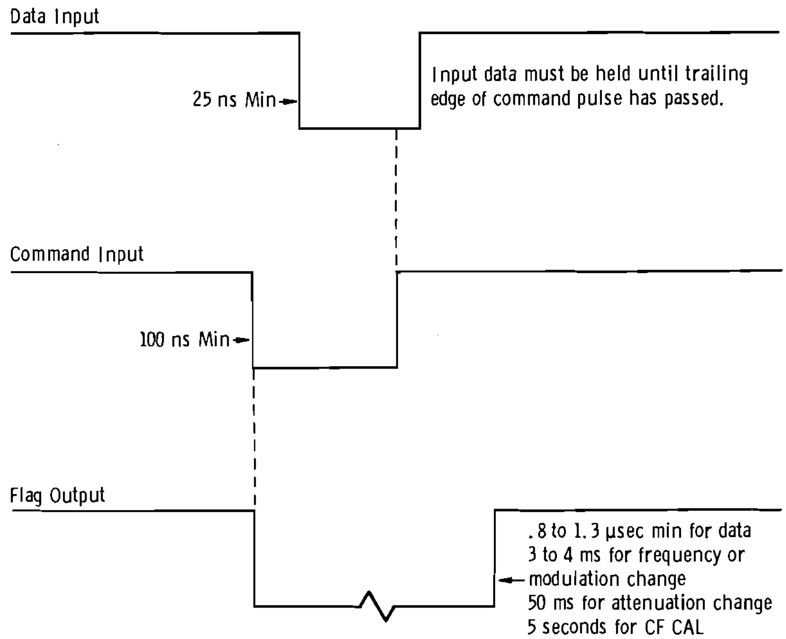


Figure 3-2. Model 8660C Data Input Timing

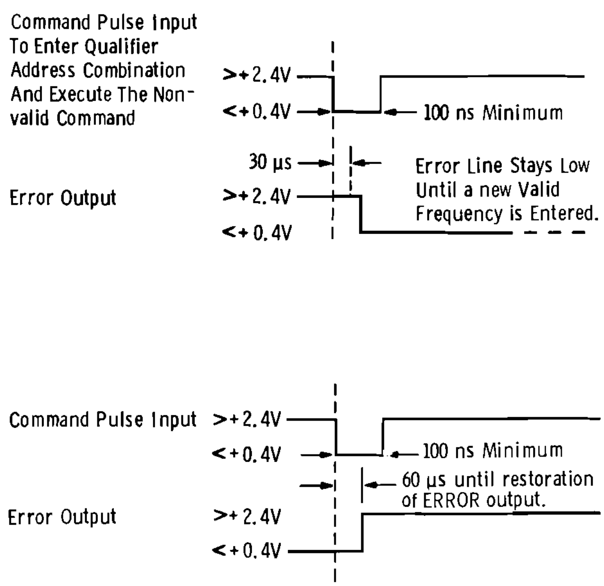


Figure 3-3. Model 8660C Error Output Timing

Figure 3-2. The data inputs may be terminated after the command pulse trailing edge.

3-40. The command pulse causes the input data to be stored in the temporary storage register or, if the data input is an address, to be stored in one of the final storage registers. These pulses are logic 1 (0V) pulses of 100 nanoseconds minimum width, maximum frequency of 500 kHz. Pulses for low transfer frequencies may be wider if consistent with the duty cycle. The leading edge must have a fall time of 100 nanoseconds or less. Transfer occurs on the leading edge of the pulse. Note that data must be held until the command pulse terminates. The flag signal is also initiated by the falling (leading) edge of the command pulse.

3-41. **Flag Signal.** The flag signal indicates receipt and execution of the command pulse from the remote programming device. The flag signal will be logic 1 (0V). Duration of the signal will depend on the function programmed.

3-42. **Error Signal.** Indicates frequency out of range or crystal oven temperature is not stabilized. The error signal will be at a logic 1 (0V) for the period of the function error (see Figure 3-3).

3-43. **Reset.** Controls the DCU circuits in the same manner as the DCU power detect circuit does when the instrument is first turned on. It also initializes circuitry and resets the data registers. Requires a logic 1 (0V) level which may be as short as 5 microseconds.

NOTE

When switching from remote to local operation clear the keyboard before making an entry.

3-44. HP-IB Remote Operation

3-45. HP-IB (Hewlett-Packard Interface Bus) is a general purpose interface system. Although the

Table 3-2. Storage Register Addresses

Name of Register	Address 0=High, 1=Low	Location	Function
Center Frequency	0000 (0)	Mainframe	To set Center Frequency
Step ↑	0001 (1)		To step center frequency up in any increment
Step ↓	0010 (2)	Mainframe DCU	To step center frequency down in any increment
Attenuator	0011 (3)	RF Section plug-in	Controls level of RF OUTPUT
AM-FM Function	0100 (4)	Modulation Section plug-in	Selects Modulation Function
AM-FM%	0101 (5)	Modulation Section plug-in	*Selects AM % of Modulation or FM Deviation
FM CAL 86635 or 86632 only	0110 (6)	Modulation Section plug-in	Phase locks 20 MHz FM oscillator to the reference loop 20 MHz

*The 86632B and the 86635A require inputs of one half of the desired deviation in remote mode.

Table 3-3. Model 8660C Programming Examples (1 of 3)

EXAMPLE 1. Set 100.000000 MHz Center Frequency (CF)

Input 0=High 1=Low	Temporary Register	CF Register
Data: D_1 0001 (1) D_2 0000 (0)	00 00 00 00 00	Last Input
Temporary Command	01 00 00 00 00	Last Input
Address: D_1 1111 (15) D_2 0000 (0)	01 00 00 00 00	Last Input
Transfer Command	00 00 00 00 00	01 00 00 00 00

EXAMPLE 2. Set 107.654321 MHz Center Frequency (CF)

Input 0=High 1=Low	Temporary Register	CF Register
Data: D_1 0001(1) D_2 0010 (2)	00 00 00 00 00	Last Input
Temporary Command	21 00 00 00 00	Last Input
Data: D_1 0011 (3) D_2 0100 (4)	21 00 00 00 00	Last Input
Temporary Command	43 21 00 00 00	Last Input
Data: D_1 0101 (5) D_2 0110 (6)	43 21 00 00 00	Last Input
Temporary Command	65 43 21 00 00	Last Input
Data: D_1 0111 (7) D_2 0000 (0)	65 43 21 00 00	Last Input
Temporary Command	07 65 43 21 00	Last Input
Address: D_1 1111 (15) D_2 0000 (0)	01 07 65 43 21	Last Input
Transfer Command	00 00 00 00 00	01 07 65 43 21

EXAMPLE 3. Set 120 dB Attenuation (RF SECTION) Below +13 dBm (1 volt)

Input 0=High 1-Low	Temporary Register	Atten Register
Data: D_1 0010 (2) D_2 0001 (1)	00 00 00 00 00	Last Input
Temporary Command	12 00 00 00 00	Last Input
Address: D_1 1111 (15) D_2 0011 (3)	12 00 00 00 00	Last Input
Transfer Command	00 00 00 00 00	120

NOTE

The attenuator is a three-digit register; only the three most significant digits are retained.

Table 3-3. Model 8660C Programming Examples (2 of 3)

EXAMPLE 4. Set 7 dB Attenuation (RF SECTION) Below +13 dBm (1 volt)

Input 0=High 1=Low	Temporary Register	Atten Register
Data: D_1 0000 (0) D_2 0111 (7)	00 00 00 00 00	Last Input
Temporary Command	70 00 00 00 00	Last Input
Data: D_1 0000 (0) D_2 0000 (0)	70 00 00 00 00	Last Input
Temporary Command	00 70 00 00 00	Last Input
Address: D_1 1111 (15) D_2 0011 (3)	00 70 00 00 00	Last Input
Transfer Command	00 00 00 00 00	007

See note for Example 3

EXAMPLE 5. Shut off Modulation (MODULATION SECTION)

Input 0=High 1=Low	Temporary Register	Function Register
Address: D_1 1111 (15) D_2 0100 (4)	00 00 00 00 00	Last Input
Transfer Command	00 00 00 00 00	00

NOTE: All digits are zero - no modulation

EXAMPLE 6. Set 3% AM Modulation, Internal 1 kHz (MODULATION SECTION)

Input 0=High 1=Low	Temporary Register	AM-FM % Register
Data: D_1 0011 (3) D_2 0000 (0)	00 00 00 00 00	Last Input
Temporary Command	03 00 00 00 00	Last Input
Address: D_1 1111 (15) D_2 0101 (5)	03 00 00 00 00	Last Input
Transfer Command	00 00 00 00 00	03 into % Storage
Data D_1 0001 (1) D_2 1000 (8)	00 00 00 00 00	
Temporary Command	81 00 00 00 00	
Address: D_1 1111 (15) D_2 0100 (4)	81 00 00 00 00	
Transfer Command	00 00 00 00 00	81 into AM-FM Function Register Sets AM and 1 kHz

NOTE: See Table 3-4. for AM-FM Function Register Codes

Table 3-3. Model 8660C Programming Examples (3 of 3)

EXAMPLE 7. Set 10 MHz STEP ↑		
Input 0=High 1 = Low	Temporary Register	INCR Register
Data: D_1 0000 (0) D_2 0001 (1)	00 00 00 00 00	Last Input
Temporary Command	10 00 00 00 00	Last Input
Data: D_1 0000 (0) D_2 0000 (0)	10 00 00 00 00	Last Input
Temporary Command	00 10 00 00 00	Last Input
Address: D_1 1111 (15) D_2 0001 (1)	00 10 00 00 00	Last Input
Transfer Command	00 00 00 00 00	00 10 00 00 00

Table 3-4. AM - FM Function Register Coding

DIGIT 2 (D_2) 0=High	1=Low	DIGIT 1 (D_1) 0=High	1=Low
ØM	1100 (12)	EXT. AC (UNLEVELED	1001 (9) 86633 only
FM X .1	0100 (4)	EXT. DC	0100 (4)
FM X 1	0010 (2)	INT. 400 Hz	0010 (2)
FM X 10	0001 (1)	INT. 1 kHz	0001 (1)
OFF	0000 (0)		

Table 3-5. Programming Connections to J3

J3 Pin No.	To A3XA5 Pin No.	Signal	Other
1			To J3 pin 18
3	2	Error	
5	5	LCL-RMT	
9	11	Command	
13	15	Digit 1 - 8	
14	16	Digit 1 - 4	
15	17	Digit 1 - 2	
16	18	Digit 1 - 1	
17	A	Flag (Busy)	
24	J	Reset	
28	S	Digit 2 - 8	
29	T	Digit 2 - 4	
30	U	Digit 2 - 2	
31	V	Digit 2 - 1	
36			Ground
J3 pins not listed are also wired to A3XA5. See the rear interface board schematic diagram for wiring information.			

HP-IB uses many of the operational parameters (coding, handshake, etc.), the terms HP-IB and ASCII should not be used interchangeably because they are not completely compatible.

3-46. The HP-IB interface systems use seventeen lines to effect the transfer of data between the instruments connected to the bus. Eight of these lines are used for the actual transfer of data, one line is ground and the remaining eight lines are used for control.

3-47. Table 3-6 illustrates the HP-IB bus interface line designations. The ground line, being self-explanatory, is not shown.

3-48. The structure and operation of the bus is analogous to an old-fashioned party line, and many of the conventions which apply to a party line apply to the HP-IB interface as well. For instance, at any given time only one person may talk on the party line, while many people may listen, and most will not be using the party line at all.

3-49. Similarly, on the HP-IB interface, only one instrument may talk (send data) at any given time, although many instruments may listen (receive data), and most instruments will not interact with the bus at all.

3-50. In order to determine which instruments are to "talk", which are to "listen", and which are to remain inactive, some sort of a controller is required. This controller, which might be a calculator, assigns functions to the various instruments by sending data over the eight lines to all instruments. Any instrument becomes a listener when its listen address is placed on the bus and remains a listener until the "unlisten" command is transmitted. Talkers, on the other hand, stop functioning as talkers whenever another talk address is put on the data lines. This prevents more than one device from talking at any given time.

3-51. In order for the instrument to distinguish between data and addresses, both of which are sent over the eight data lines, an "address mode/data mode" selector called the Multiple Response Enable (MRE) line is driven by the controller. When this line is low, all instruments listen to the eight data lines and interpret the information being transmitted by the controller as addresses. When the MRE line is high, information on the eight data lines is interpreted as data and the instruments talk, listen or remain inactive as determined during the time they were addressed when MRE was low.

3-52. Three-Wire Handshake. Information, whether addresses, measurement results, or other data is transferred on the data lines under control of a technique called the three-wire handshake. The handshake involves the use of three control lines, and operates as follows:

a. A listener indicates that it is ready to accept data by letting the Ready for Data (RFD) line go high. Listeners are connected to the RFD line in a logical AND configuration so the RFD line does not go high until all active listeners are ready for data.

b. After RFD has gone high, the talker indicates that it has placed a data byte on the eight data lines by setting the Data Valid (DAV) line low.

c. After DAV has gone low, each listener pulls RFD low, accepts the data, and then lets the data accepted (DAC) line go high. Again, all listeners are logically ANDed and DAC does not go high until all listeners have accepted the data.

d. After the DAC line has gone high, the talker can let DAV go high again and take the data off the lines. When DAV goes high, the listeners set DAC back to low and the sequence is ready to repeat with step 1 of Figure 3-4.

3-53. As can be seen from the description, data transfer is asynchronous, proceeding only as fast as the slowest active (addressed to talk or listen) device on the line.

NOTE

Figure 3-4 illustrates a flow chart of the three-wire handshake operation.

3-54. The four remaining control lines operate as follows:

a. The Remote Enable (REN) line allows the controller to put all instrument on the bus in the remote mode. When this line is low, all instruments will go into remote as soon as they are addressed, and remain in remote until the line goes high again.

b. The End Output (EOP) line, when pulled low by the system controller, will halt all activity on the bus and cause all instruments to unaddress themselves.

Table 3-6. HP-IB Interface Lines

	Name	Abbreviation	Description
DATA BUS	Data Input/Output 1 ↓ Data Input/Output 8	DI01 ↓ DI08	These lines carry address data, basic measurement data, control and program data, and status data.
TRANSFER BUS	Data Valid	DAV	These lines control the transfer of data over the DI01-DI08 lines.
	Ready for Data	RFD	
	Data Accepted	DAC	
MANAGEMENT BUS	Multiple Response Enable	MRE	Indicates whether information on DI01-DI08 should be interpreted as data common to all instruments (addresses) or data directed to selected instruments.
	Remote Enable	REN	Switches all instruments between remote and local mode.
	End Output	EOP	Allows controller to halt communication over the bus.
	Service Request	SRQ	Allows instruments on the bus to get the attention of the controller.
	End or Identify	EOI	Enables the controller to determine which instrument requested service through the SRQ line.

c. The Service Request (SRQ) line allows instruments to get the attention of the controller. The Model 8660C does not use this line, so its function will not be described here.

d. The End OR Identify (EOI) line is used to identify which instrument pulled the SRQ line low. The Model 8660C does not use this line.

3-55. When a standard Model 8660C is modified to accept the HP-IB interface the instructions contained in the modification kit must be followed to install the two new circuit boards.

3-56. In addition to following the modification instructions, special care should be taken to observe jumper positions on the HP-IB boards.

3-57. Before installing the HP-IB circuit boards check the address jumpers, and change if required. It should be noted that if more than one Model 8660C is used in a system, it is not likely that operational parameters will be the same for each, so different addresses will probably be required for each instrument.

3-58. When used in the Model 8660C, jumper J2 must not be connected.

3-59. Jumper J1 is installed at the operator's choice. With it in place the internally generated BUSY signal is used to delay the RFD response. Without it, the operator must make allowances in programming for the necessary settling time of the Model 8660C.

3-60. The information contained in this section of this manual applies only to Model 8660C Option 005 HP-IB instruments. Refer to Table 3-7 for HP-IB codes. Information contained in this section for other types of remote control does not apply to Option 005 instruments.

3-61. Local control operation of Option 005 instruments is the same as that described for the Model 8660C in other parts of this section.

3-62. Basically, the Model 8660C Option 005 instruments are the same as the standard Model 8660C instruments except that the capability of remote operation using the HP-IB interface is added and BCD interface is deleted. Basic information about HP-IB is included in the General Information Section of this manual.

3-63. Option 005 allows remote programming via the HP-IB interface of all 8660C front panel controls except LINE, (POWER), SWEEP MODE, and MANUAL MODE. All front panel controls except LINE AND FM CAL are locked out when the Model 8660C is in remote.

3-64. The Model 8660C HP-IB interface will recognize an internally preset "listen" address and accept bit-parallel, word serial HP-IB information. When addressed to listen, the Model 8660C shifts incoming data into a temporary storage register. This data must be presented to the interface least significant digit first to satisfy the internal logic requirements of the Model 8660C. When a programming code is detected in the input data, the contents of the temporary storage register are shifted into the register selected by the internal address character. The temporary register is then cleared to make way for more data.

3-65. There are three separate modulation parameters which may be programmed; source, type and %. Source and type are combined into one number (source is the least significant digit) and this number is followed by the address "$". To turn off the modulation section, code Ø for modulation type. When programming AM, % modulation refers to percentage of full scale. Thus the FM X 10 range is 1000 kHz full scale, and 20% would mean 200 kHz deviation. With this setup the deviation of the 86632B or the 86635A would be 400 kHz.

3-66. One last convention is that after the Model 8660C is placed in remote, the first output of the HP-IB interface should be a false address which serves to clear the temporary storage register. This can be accomplished by first addressing the Model 8660C to listen, then placing "/" on the HP-IB line.

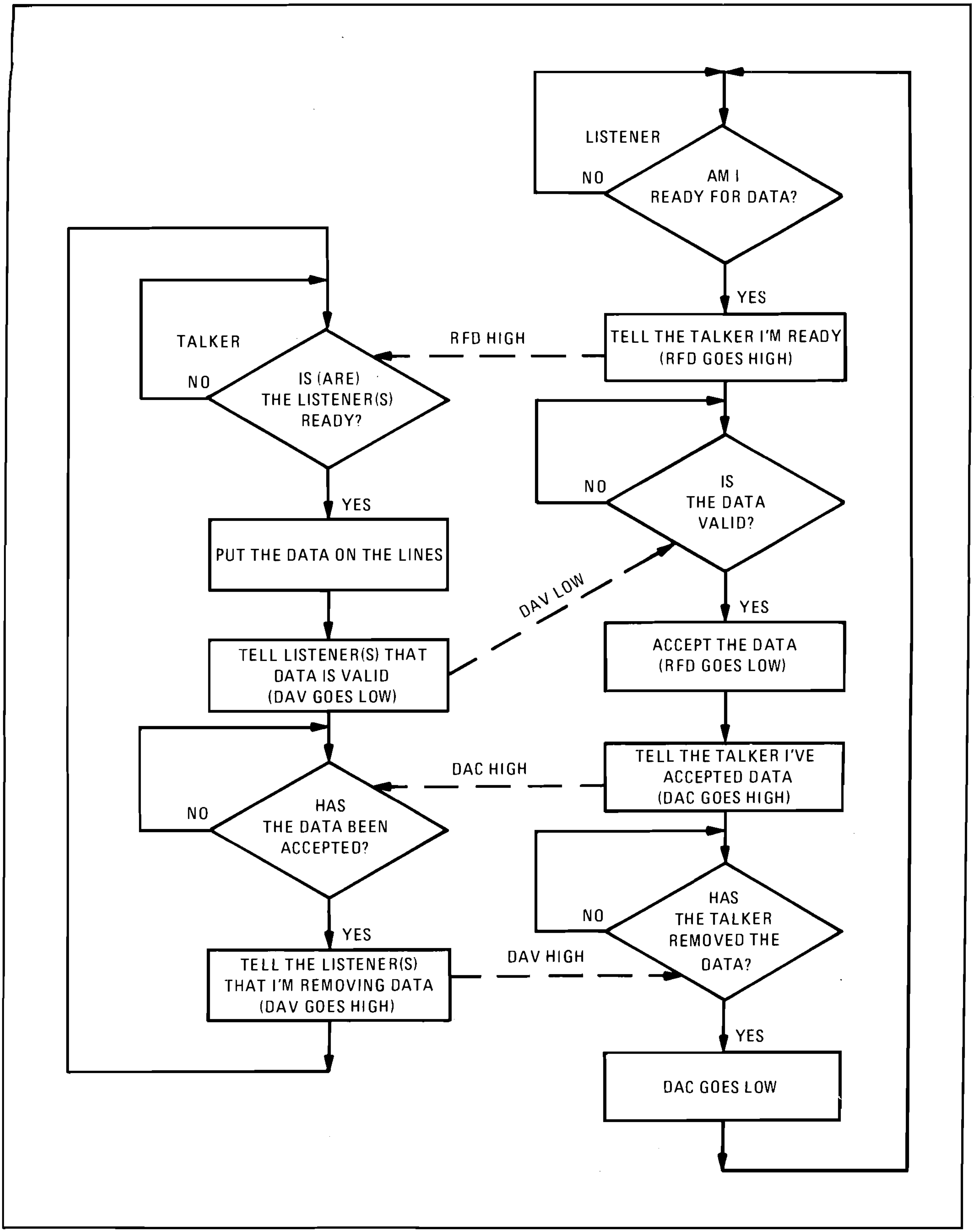


Figure 3-4. Handshake Flow Chart

Table 3-7. HP-IB Code Allocations

DIO LINES		UNIVERSAL BUS COMMANDS						DEVICE LISTEN ADDRESS						DEVICE TALK ADDRESS					
8 →		X			X			X			X			X			X		
7 →		H			H			H			H			L			L		
6 →		H			H			L			L			H			H		
5 →		H			L			H			L			H			L		
		COLUMN → 0			1			2			3			4			5		
4 3 2 1 ↓ ↓ ↓ ↓	ROW ↓	OCTAL	DECIMAL	BUS COMMAND	OCTAL	DECIMAL	BUS COMMAND	OCTAL	DECIMAL	SYMBOLIC ADDRESS	OCTAL	DECIMAL	SYMBOLIC ADDRESS	OCTAL	DECIMAL	SYMBOLIC ADDRESS	OCTAL	DECIMAL	SYMBOLIC ADDRESS
H H H H	0	0	0.		20	16.		40	32.	SP	60	48.	0	100	64.	@	120	80.	P
H H H L	1	1	1.		21	17.	*LLO	41	33.	!	61	49.	1	101	65.	A	121	81.	Q
H H L H	2	2	2.		22	18.	R*	42	34.	"	62	50.	2	102	66.	B	122	82.	R
H H L L	3	3	3.		23	19.	R*	43	35.	#	63	51.	3	103	67.	C	123	83.	S
H L H H	4	4	4.		24	20.	DCR	44	36.	$	64	52.	4	104	68.	D	124	84.	T
H L H L	5	5	5.	UNASSIGNED	25	21.	UNASSIGNED	45	37.	%	65	53.	5	105	69.	E	125	85.	U
H L L H	6	6	6.		26	22.		46	38.	&	66	54.	6	106	70.	F	126	86.	V
H L L L	7	7	7.		27	23.		47	39.	'	67	55.	7	107	71.	G	127	87.	W
L H H H	8	10	8.		30	24.	SPE	50	40.	(	70	56.	8	110	72.	H	130	88.	X
L H H L	9	11	9.		31	25.	SPD	51	41.	)	71	57.	9	111	73.	I	131	89.	Y
L H L H	10	12	10.		32	26.		52	42.	*	72	58.	:	112	74.	J	132	90.	Z
L H L L	11	13	11.		33	27.		53	43.	+	73	59.	;	113	75.	K	133	91.	[
L L H H	12	14	12.		34	28.	R*	54	44.	,	74	60.	<	114	76.	L	134	92.	\
L L H L	13	15	13.		35	29.	R*	55	45.	-	75	61.	=	115	77.	M	135	93.	]
L L L H	14	16	14.		36	30.		56	46.	.	76	62.	>	116	78.	N	136	94.	∧
L L L L	15	17	15.		37	31.		57	47.	/	77	63.	?	117	79.	O	137	95.	—
											UNLISTEN COMMAND						UNTALK COMMAND		

H = High State.
L = Low State.
X = Unused when MRE is low.

LLO = Local Lockout.
DCR = Device Clear.
R* = Reserved for future assignments.

SPE = Status Poll Enable.
SPD = Status Poll Disable.

[ ] = Control Bits.
DIO = Data Input Output Signal Lines, DIO1-8.

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedures in this section test the instruments electrical performance using the specifications of Table 1-1 as the performance standards. A simpler operations test is included in Section III under Operator's Checks.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for the performance tests is listed in the Recommended Test Equipment table in Section I. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4-5. TEST RECORD

4-6. Results of the performance tests may be tabulated on the Test Record at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

WARNING

Performance test 4-7 requires removal of the top instrument cover. This exposes the input line voltage and the dc voltage outputs of the power supply. Care should be exercised to avoid physical contact with these voltage points. In addition, the power source should be disconnected during cover removal. All required tests must be performed only by qualified service personnel.

PERFORMANCE TESTS

4-7. INTERNAL CRYSTAL OSCILLATOR AGING RATE

SPECIFICATION:

Reference Oscillator Internal: 10 MHz quartz oscillator. Aging rate less than ±3 parts in 10^8 per 24 hours after 72 hour warmup. (±3 parts in 10^9 per 24 hours after 30 day warmup, Option 001.)

DESCRIPTION:

This test verifies the reference oscillator aging rate by comparing it to the National Bureau of Standards signal from WWVB.

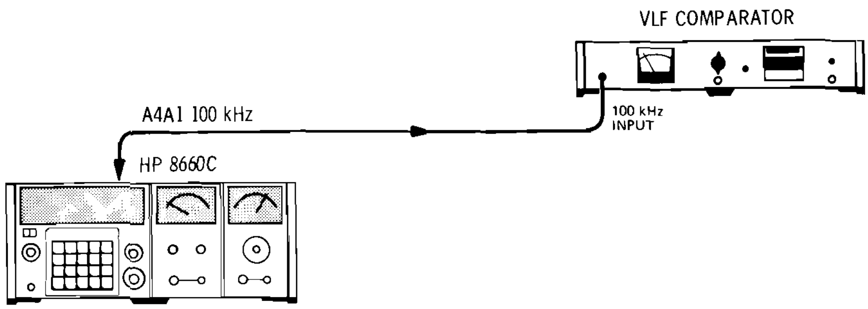


Figure 4-1. Crystal Oscillator Aging Rate Test Setup

EQUIPMENT:

VLF Comparator . . . . HP 117A

PERFORMANCE TESTS

4-7. INTERNAL CRYSTAL OSCILLATOR AGING RATE (Cont'd)

PROCEDURE:

1. Remove ac power and the Model 8660C top cover after the instrument has been connected to the ac line for 72 hours.

2. Connect a cable from the 100 kHz output of the A4A1 reference divider assembly to the VLF Comparator 100 kHz input. Reconnect ac power and switch power to ON.

3. Refer to the operating Section of the VLF Comparator Operating and Service Manual for Comparator operating instructions.

4. Aging rate is checked by noting the average offset between the two signals at two times several hours apart and dividing the offset difference by the hours between observations. The hourly offset is then converted to aging rate per day.

   Example:
   First reading +3 parts in 10^{10} at 10:00 AM

   Second reading +6 parts in 10^{11} at 4:00 PM

   The difference is 2.4 parts in 10^{10} in 6 hours

   $\frac{2.4}{6} \times 10^{10}$ = 0.4 parts in 10^{10} per hour

   Frequency change is 0.96 parts in 10^{9} per day.

4-8. REFERENCE TEST

SPECIFICATION:

About 1 Vrms, 10 MHz into 170 ohms.

DESCRIPTION:

This test verifies proper operation of the reference amplifier and relay switching circuits.

PERFORMANCE TESTS

4-8. REFERENCE TEST (Cont'd)

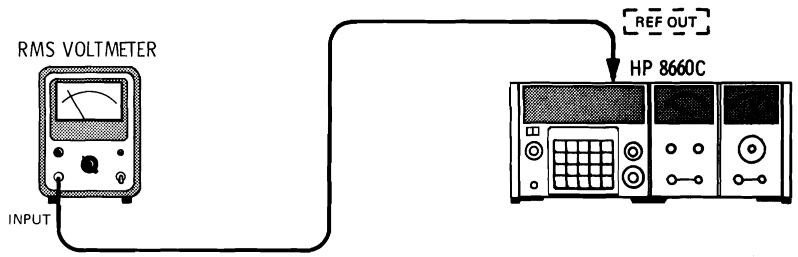


Figure 4-2. Internal Reference Test Setup

TEST EQUIPMENT:

RMS Voltmeter (with high impedance probe) . . . . **HP 411A**

PROCEDURE:

1. Connect the RMS Voltmeter to the REFERENCE OUTPUT (rear panel) jack and set the SELECTOR switch (rear panel) to the INT position.

2. The RMS Voltmeter should display a signal about 1 volt in amplitude.

Table 4-1. Performance Test Record

Hewlett-Packard Model 8660C Synthesized Signal Generator	Tests performed by ____________
Serial No. ____________	Date ____________
Crystal Oscillator Aging Rate	Actual ____________
OPT 001	Actual ____________
Output Reference Level	Actual ____________

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes adjustments and checks required to return the Model 8660C to peak operating capability when repairs have been made. Included in this section are test setups and procedures.

5-3. Except for the power supply adjustment procedures, which should be performed before repairs are made to any part of the instrument, the adjustment procedures are arranged in the same sequence as the service sheets to which they refer.

5-4. EQUIPMENT REQUIRED

5-5. Each adjustment procedure in this section contains a list of test equipment and accessories required to perform the procedure. Each test setup identifies test equipment and accessories by callouts.

5-6. Minimum specifications for test equipment used in the adjustment procedures are detailed in Table 1-2. Because the Model 8660C is an extremely accurate instrument, minimum specifications in Table 1-2 are particularly important in perfoming these adjustment procedures.

5-7. ADJUSTMENT AIDS

5-8. The HP 11672A Service Kit is an accessory item available from Hewlett-Packard for use in maintaining the Model 8660C Synthesized Signal Generator. Table 1-2 contains a detailed description of the Service Kit. Any item in the kit may be ordered separately.

5-9. FACTORY SELECTED COMPONENTS

5-10. Some component values are selected at the time of final checkout at the factory. Usually these values are not extremely critical; they are selected to provide optimum compatibility with associated components.

5-11. Factory selected components and suggested range of values are listed in Table 5-1.

5-12. The recommended procedure for replacing a factory selected component is as follows:

a. Try the original value, then perform the test specified in Section V of this manual for the circuit being repaired.

b. If the specified test cannot be satisfactorily performed, try the typical value shown in the parts list and repeat the test.

c. If the test results are still not satisfactory, substitute various values within the tolerances specified in Table 5-1 until the desired result is achieved.

5-13. RELATED ADJUSTMENTS

5-14. Most of the adjustments within any given phase lock loop are interrelated. This is especially true in digital-to-analog converters. Adjustments should be made in the order in which they appear for any given loop.

5-15. Generally, it will not be necessary to adjust any of the phase lock loops except the one in which the component failure occurred. An exception to this will be when adjustment to any phase lock loop has been attempted while the reference section is not functioning properly.

5-16. ADJUSTMENT LOCATIONS

5-17. Adjustment locations are identified pictorially on Section VIII foldout service sheets referred to in the individual procedures and in Figures listed in the individual procedures.

5-18. CHECKS AND ADJUSTMENTS

5-19. Data taken while following the adjustment procedures should be recorded in spaces provided. This information may then be used as reference in later tests.

Table 5-1. Factory Selected Components

Designation	Location	Purpose	Range of Values
A4A2C11	Reference Loop	To control 3 dB bandwidth of 40 to 70 kHz	38 to 72 pF
A4A4L12	Reference Loop	To control output level of 100 MHz	0.34 to 1.0 μH
A4A6R18	HF Loop	To center range of associated potentiometer	100 to 200 ohms
A4A6R26	HF Loop		60 to 250 ohms
A4A6R33	HF Loop		100 to 300 ohms
A4A6R38	HF Loop		100 to 500 ohms
A4A6R43	HF Loop		200 to 700 ohms
A4A6R47	HF Loop		200 to 900 ohms
A4A6R51	HF Loop		500 to 1500 ohms
A4A6R55	HF Loop		1.2K to 3.1K
A4A6R59	HF Loop		2K to 7K
A4A4Q7	Reference Loop	To optimize performance of 500 MHz tuned amplifier	
A4A4Q8	Reference Loop	To optimize performance of 100 MHz tuned amplifier.	
A8R18	N3 Oscillator	To aid in balancing Summing loop for Varactor tuning.	19.6K to 25K
A8R25	N3 Oscillator		4K to 6K
A19R55	SL1 Oscillator	To prevent oscillation in Q1	1K to 2K

NOTES

a. In the following tests it is assumed that at the start of the test the output frequency is set to 0.

b. An RF Section output plug-in section must be in place during the tests.

c. A Modulator Section or an Auxiliary Section must be in place in the modulator compartment.

d. All tests in which a counter is used should be made with the Model 8660C and the counter referenced to the same source. If the Hewlett-Packard Model 5245M Frequency Counter is used, the Model 8660C internal reference may be used as the source.

5-20. SAFETY CONSIDERATIONS

5-21. Although this instrument has been designed in accordance with international safety standards, this manual contains information and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition (see Section II). Service and adjustments should be performed only by qualified service personnel.

WARNING

Any interruption of the protective (grounding) conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

5-22. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazards involved. The opening of covers or removal of parts may expose live parts, and also accessible terminals may be live.

5-23. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

5-24. Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

5-25. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

NOTE

When repairs or adjustments to the instrument are required, such work should not be performed, even by a skilled technician, unless another person is in the same general area. This is not to be interpreted to mean that two persons are required to perform the necessary work, but only that another person should be available, should the need for assistance arise.

ADJUSTMENTS

5-26. POWER SUPPLY

REFERENCE:

Service Sheet 41

DESCRIPTION:

The power supplies in the Model 8660C provide regulated outputs of +20V, +5.25V, —10V and —40V. Unregulated supplies provide +30V, +19V, +4V and —19V. These checks verify proper operation of the power supply.

ADJUSTMENTS

5-26. POWER SUPPLY (Cont'd)

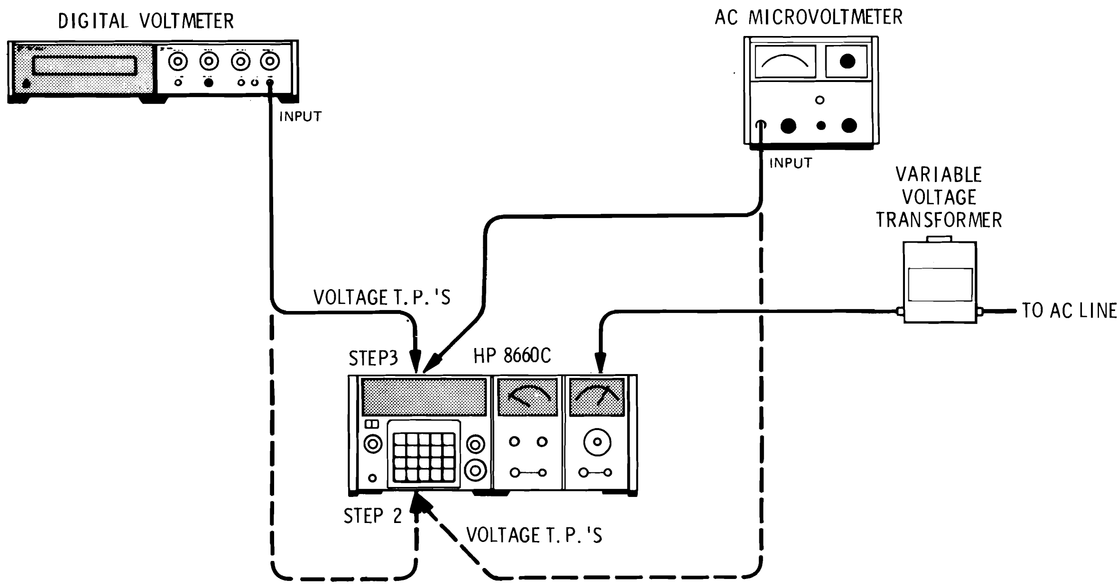


Figure 5-1. Power Supply Test Setup

TEST EQUIPMENT:

Digital Voltmeter	HP 3480/3482
AC Microvoltmeter	HP 3410A
Variable Voltage Transformer	General Radio W5MT3A

PROCEDURE:

1. Remove the top and bottom covers of the Model 8660C and connect the instrument to the ac line through the variable voltage transformer.

2. Use the digital voltmeter and the ac microvoltmeter to check voltages, tolerances and ripple at A20 test points specified in Table 5-2. Adjust the variable voltage transformer to check tolerance of the power supplies at ±10% line voltage variations.

3. Use the digital voltmeter and the ac microvoltmeter to check for voltages, tolerances and 120 Hz ripple at A5 test points specified in Table 5-3. Adjust the dc levels shown in Table 5-3 with controls specified in Table 5-3, then adjust the variable voltage transformer to check tolerance of the power supplies at ±10% of the normal line voltage.

ADJUSTMENTS

5-26. POWER SUPPLY (Cont'd)

Table 5-2. Unregulated Power Supplies

Test Location	Voltage at normal line	Tolerance high to low line (from normal line)	120 Hz Ripple (at normal line)
+ side of A20C7	Typical +3.67V	Specified ±0.6V	Typical .31Vrms
	Actual ______	Actual ______	Actual ______
+ side of A20C4	Typical +19.8V	Specified ±2.4V	Typical 1.1 Vrms
	Actual ______	Actual ______	Actual ______
— side of A20C5	Typical +19.8V	Specified ±2.4V	Typical 1.15 Vrms
	Actual ______	Actual ______	Actual ______
+ side of A20C1	Typical +33V	Specified ±4V	Typical .46 Vrms
	Actual ______	Actual ______	Actual ______

Table 5-3. Regulated Power Supplies

Test Point	Adjust Control	Voltage at Normal Line Specified	Tolerance High to Low Line Specified	RMS Ripple 120 Hz (Normal Line)
A5TP4	A5R24	+5.25V	±20 mV	125 μV
	+5.25 ADJ	Actual ______	Actual ______	Actual ______
A5TP2	A5R26	—10.0V	±5 mV	50 μV
	—10 ADJ	Actual ______	Actual ______	Actual ______
A5TP3	A5R21	+20.0V	±10 mV	50 μV
	+20 ADJ	Actual ______	Actual ______	Actual ______
A5TP1	A5R28	—40.0V	±20 mV	50 μV
	—40 ADJ	Actual ______	Actual ______	Actual ______

ADJUSTMENTS

5-27. REFERENCE SECTION

REFERENCE:

Service Sheets 2 and 3 and Figure 8-119.

DESCRIPTION:

The reference section contains a voltage controlled master oscillator from which all RF signals generated in the Model 8660C mainframe are derived. The master oscillator is phase locked to an internal temperature controlled crystal oscillator or to an external standard. The reference section provides outputs of 500 MHz, 100 MHz, 20 MHz, 10 MHz, 2 MHz, 400 kHz and 100 kHz. These checks verify proper operation of the circuits within the reference section.

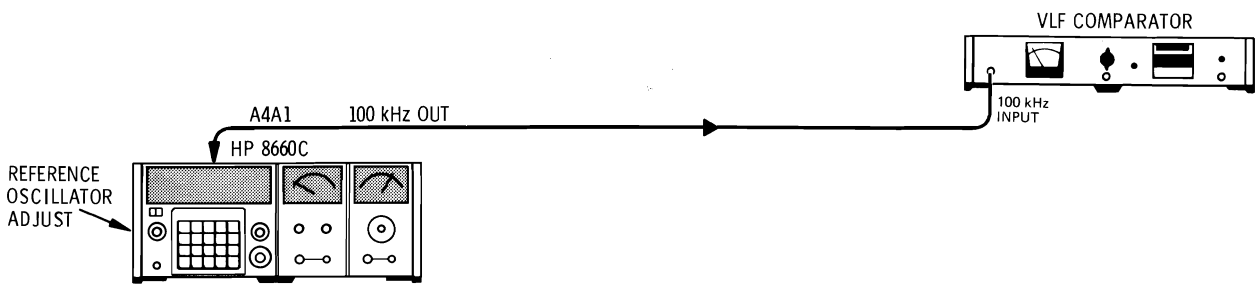


Figure 5-2. Reference Accuracy Adjustment Test Setup

EQUIPMENT:

VLF Comparator	HP 117A
Oscilloscope (with 10:1 divider probes)	HP 180A/1801A/1820A
Spectrum Analyzer	HP 140/8554L/8552
Frequency Counter	HP 5245M/5253B

PROCEDURE:

1. Internal Reference Accuracy Adjustment (see Figure 5-2). (Allow adequate warmup time.)

   a. Remove the Model 8660C top cover and connect the 100 kHz output from the A4A1 assembly to the 100 kHz input of the VLF Comparator.

   b. Remove the left side panel from the Model 8660C.

   c. Remove the cap screw to provide access to the adjustment point of the A21 Crystal oscillator assembly.

   d. Refer to Section III of the VLF Comparator Operating and Service Manual for operating instructions and align the Model 8660C A21 assembly.

ADJUSTMENTS

5-27. REFERENCE SECTION (Cont'd)

NOTE

If the VLF Comparator is not available, and an accurate signal source is, the reference oscillator may be adjusted by using an oscilloscope for comparison of the two signals.

2. Alternate Reference Accuracy Adjustment (see Figure 5-3)

   a. Use the signal source to trigger the oscilloscope at the SYNC INPUT and connect the reference output from the Model 8660C rear panel reference output to the oscilloscope vertical input.

   b. Observe the 10 MHz sine wave on the oscilloscope and adjust the A21 oscillator until the oscilloscope display stops drifting.

   c. Set the oscilloscope to sweep at 0.1 μSec/Division and the sweep magnifier to X10. If drift is observed readjust the A21 oscillator.

NOTE

When the oscilloscope display drift is less than 1 division in 10 seconds the Model 8660 reference oscillator is set within 1 part in 10^9 of the signal source.

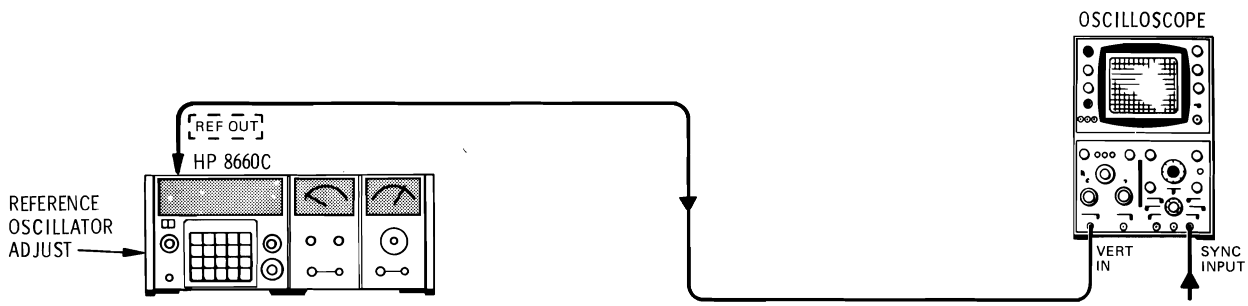


Figure 5-3. Alternate Reference Accuracy Adjustment Test Setup

3. 100 MHz Output Adjustment.

   a. Connect the frequency counter to the 100 MHz output on the A4A4 assembly (see Figure 5-4).

   b. If the internal reference is being used, place the rear panel INT/EXT switch in the EXT position to open to 100 MHz phase lock loop. (If an external reference is being used, disconnect the source.)

   c. Allow at least 15 minutes warmup time for the oscillator to stabilize and adjust A4A4C2 for a counter readout of 100.000 MHz ± 20 kHz. Disconnect the frequency counter.

ADJUSTMENTS

5-27. REFERENCE SECTION (Cont'd)

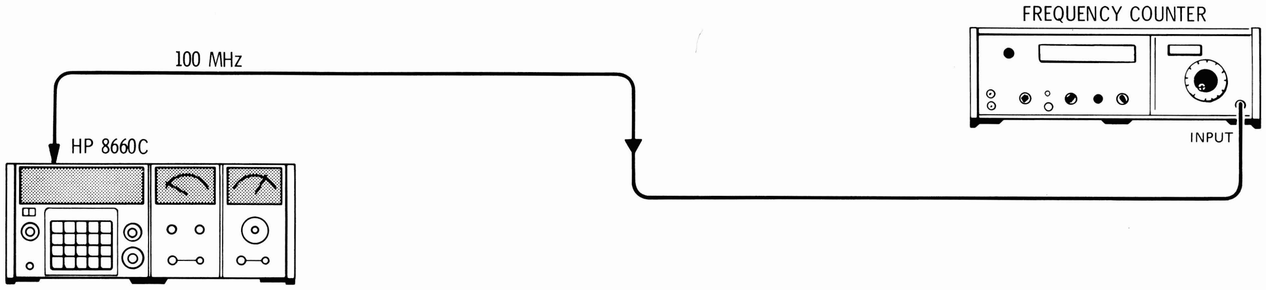


Figure 5-4. 100 MHz Adjustment Test Setup

d. Connect the Spectrum Analyzer RF INPUT to the 100 MHz output of the A4A4 assembly and tune the Spectrum Analyzer CENTER FREQUENCY to 100 MHz. The 100 MHz signal should be >+10 dBm (see Figure 5-5).

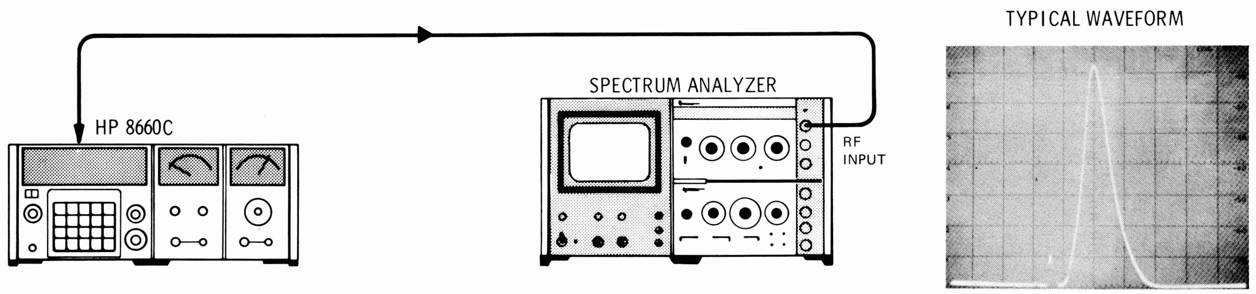


Figure 5-5. RF Level Checks Test Setup

e. Disconnect the Spectrum Analyzer and enable the 100 MHz phase lock loop by returning the INT/EXT switch to INT or by reconnecting the external standard.

4. 500 MHz Output Adjustment

a. Connect the Spectrum Analyzer RF INPUT to the 500 MHz output connector on the A4A4 assembly and tune the analyzer to 500 MHz. Set the analyzer scan width to 50 MHz per division and other analyzer controls for a clear display (see Figure 5-5).

b. Adjust A4A4C17, A4A4C23 and A4A4C31 for a peak amplitude of the 500 MHz signal. The 500 MHz signal amplitude should be >+3 dBm. The 400 MHz signal observed at the 500 MHz output is typically <−10 dBm. The 600 MHz signal observed at the 500 MHz output is typically <−20 dBm. Disconnect the analyzer.

500 MHz dBm ________
400 MHz dBm ________
600 MHz dBm ________

ADJUSTMENTS

5-27. REFERENCE SECTION (Cont'd)

5. 20 MHz Output Check

   a. Connect the Spectrum Analyzer RF INPUT to the 20 MHz output on the A4A4 assembly and tune the analyzer to 20 MHz. The 20 MHz signal should be >−6 dBm and <−2 dBm. Disconnect the analyzer.

20 MHz_______________dBm

6. Reference Section Outputs Not Previously Checked

   a. Check the outputs listed in Table 5-3 for the levels shown (see Figure 5-6).

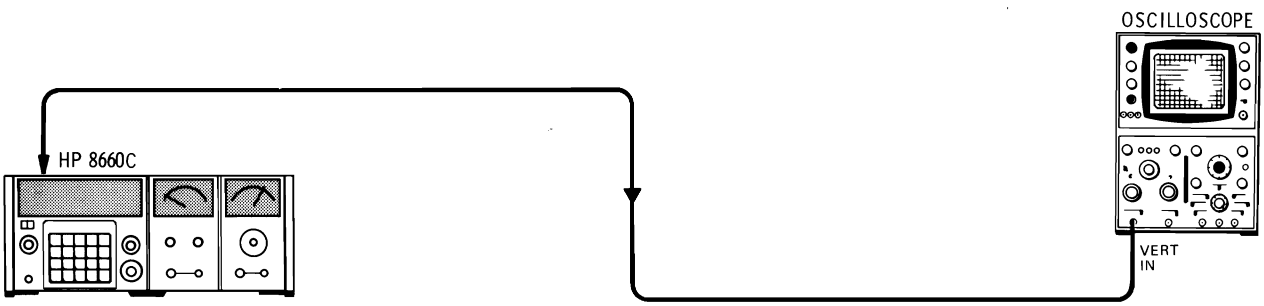


Figure 5-6. Oscilloscope Level Checks Test Setup

Table 5-4. Reference Section Output Levels

Test Point	Frequency	Specified Level	Actual Level
A4J6	10 MHz	>1 Vp-p	___________
A4J1	2 MHz	>2.2 Vp-p	___________
A4J3	400 kHz	>2.2 Vp-p <5.0V	___________
A4J2	100 kHz	>2.2 Vp-p <5.0V	___________
A4J4	100 kHz	>2.2 Vp-p <5.0V	___________

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION

REFERENCE:

Service Sheets 4, 5, and 6, and Figure 8-117.

DESCRIPTION:

The High Frequency Section contains a voltage controlled oscillator which provides eleven discrete output frequencies from 350 to 450 MHz in 10 MHz steps. The output of the voltage controlled oscillator is phase locked to a 10 MHz reference derived from the master oscillator in the reference section. The output from the HF section is used in the RF Section plug-in or in the internal frequency extension plug-in module. These checks verify proper operation of the High Frequency Section circuits.

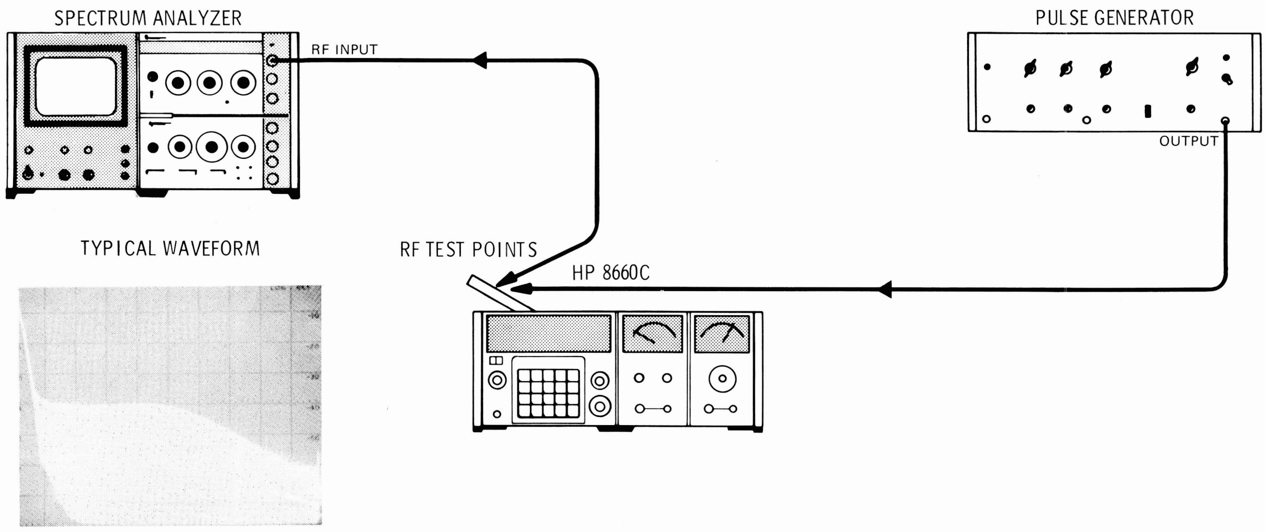


Figure 5-7. Phase Detector Response Adjustment Test Setup

TEST EQUIPMENT:

Frequency Counter	HP 5245M/5253B
Digital Voltmeter	HP 3480/3482
Pulse Generator	HP 222A
Spectrum Analyzer	HP 140/8554L/8552/8553
Oscilloscope (with 10:1 divider probes)	HP 180A/1801A/1821A
Signal Generator/Sweeper	HP 8601A

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

PROCEDURE:

1. Phase Detector Response Adjustments (see Figure 5-7)

   a. Disconnect the coaxial cable from VCO INPUT A4J11. Connect the PULSE OUTPUT of the Pulse Generator to A4J11. Set the Pulse Generator for 100 kHz pulse rate, 0.035 μSec pulse width, 0.5 volt amplitude and + polarity.

   b. Connect the Spectrum Analyzer RF INPUT to the "phase error" signal at A4TP1 outside A4A6. Set the analyzer controls as follows:

   CENTER FREQUENCY . . . . 5 MHz
   SCAN WIDTH PER DIVISION . . . . 1 MHz
   SCAN TIME PER DIVISION . . . . 1 ms
   Gain and Attenuation . . . . as required

   c. Adjust EFFiciency control A4A7R18 for a flat response to approximately 5 MHz with very slight peaking (1 dB ± 1 dB). See the waveform in Figure 5-7 for typical response.

   d. Disconnect the Pulse Generator and the Spectrum Analyzer.

2. Balance Adjustment

   a. Connect the digital voltmeter to "phase error" TP.

   b. Adjust the BALance control (A4A7R22) for a reading of 0 volts ± .05 volt. Disconnect the digital voltmeter.

3. Voltage Controlled Oscillator Adjustment (see Figure 5-8)

   a. Remove the A4A6 cover. With the output cable of the A4A5 assembly disconnected from the VCO OUTPUT (A4J10), connect the Digital Voltmeter to the A4A6 FREQuency control output (white lead).

   b. Adjust the A4A6 "0" control (A4A6R13) for a Digital Voltmeter reading of —34 volts (voltage should be adjustable from about —33 to —35 volts).

   c. Connect the Frequency Counter to the A4A5 voltage controlled oscillator output, A4J12. Replace the A4A6 assembly cover.

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

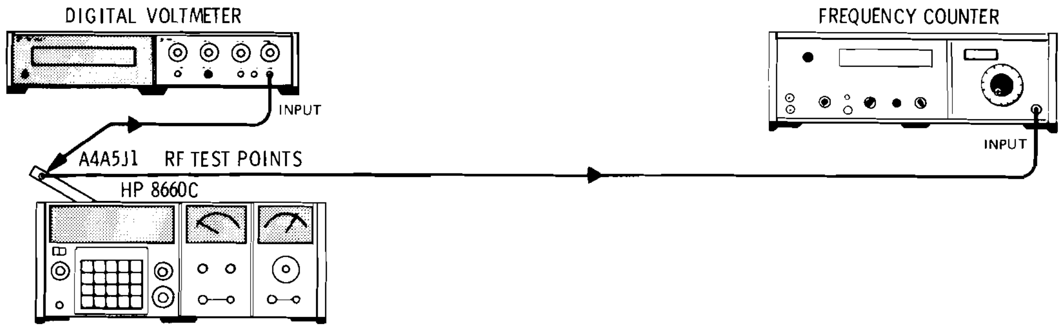


Figure 5-8. Voltage Controlled Oscillator Adjustments Test Setup

d. The Counter should display 450 MHz ± 1 MHz. If the correct reading is obtained proceed to step f. If the frequency reading is not correct, proceed to step e.

e. Remove the A4A5 cover and adjust A5A5C3 for a 450 MHz ± 1 MHz reading.

f. Disconnect the frequency counter and reconnect the voltage controlled oscillator output to the phase detector.

g. Connect the digital voltmeter to the "phase error" TP. Connect the frequency counter to A4A5J2 (350 − 450 MHz OUTPUT).

h. Set the center frequencies as shown in Table 5-4 and set the digital to analog controls on the A4A6 assembly for 0 ± 0.1 volt for each frequency listed. Note that the counter displays the output frequency listed for each center frequency setting.

NOTE

When the 86602 or 86603 is installed in the mainframe the 350 MHz output of the High Frequency Section is not used. When this situation exists, the adjustment procedure for A4A6R15 "10" is not valid and the following procedure should be substituted:

1. *Ground the collector for A4A6Q1.*

2. *Adjust A4A6R15 "10" for 350 MHz.*

3. *Remove the ground from the collector of A4A6Q1.*

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

Table 5-5. Pretune Adjustments

Center Frequency	Adjust Control	Counter Readout
0 MHz	A4A6R13 "0"	450.000000 MHz
10 MHz	A4A6R60 "1"	440.000000 MHz
20 MHz	A4A6R56 "2"	430.000000 MHz
30 MHz	A4A6R52 "3"	420.000000 MHz
40 MHz	A4A6R48 "4"	410.000000 MHz
50 MHz	A4A6R44 "5"	400.000000 MHz
60 MHz	A4A6R40 "6"	390.000000 MHz
70 MHz	A4A6R35 "7"	380.000000 MHz
80 MHz	A4A6R28 "8"	370.000000 MHz
90 MHz	A4A6R22 "9"	360.000000 MHz
100 MHz	A4A6R15 "10"	350.000000 MHz

NOTE

The adjustments shown in Table 5-5 should be made with the counter time base connected to the synthesizer REFERENCE OUTPUT.

i. If any of the controls listed in Table 5-4 cannot be adjusted to 0 volts, adjust A4A6R20 "profile" to obtain additional range. Repeat all pretune adjustments until satisfactory results are obtained. Disconnect the digital voltmeter and the frequency counter.

4. Loop Gain Adjustment (see Figure 5-9).

a. With the center frequency set to 0 MHz connect the Spectrum Analyzer RF INPUT to A4A5J2 (350 - 450 MHz OUTPUT) and set the analyzer controls as follows:

CENTER FREQUENCY . . . . 450 MHz
BANDWIDTH . . . . 30 kHz
SCAN WIDTH PER DIVISION . . . . 5 MHz
SCAN TIME PER DIVISION . . . . 5 ms

b. Disconnect the reference input to A4A7J2 and reconnect it together with the RF output of the Signal Generator/Sweeper.

c. Set the Signal Generator/Sweeper to 11.5 MHz CW at —35 dBm and symmetrical sweep width to 3 MHz. The analyzer display should be approximately as shown in the typical waveform shown in Figure 5-9. Adjust the A4A6 GAIN control (A4A6R2) for the response shown.

d. Disconnect the Analyzer and the Generator/Sweeper. Reconnect the reference signal to A4A7J2.

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

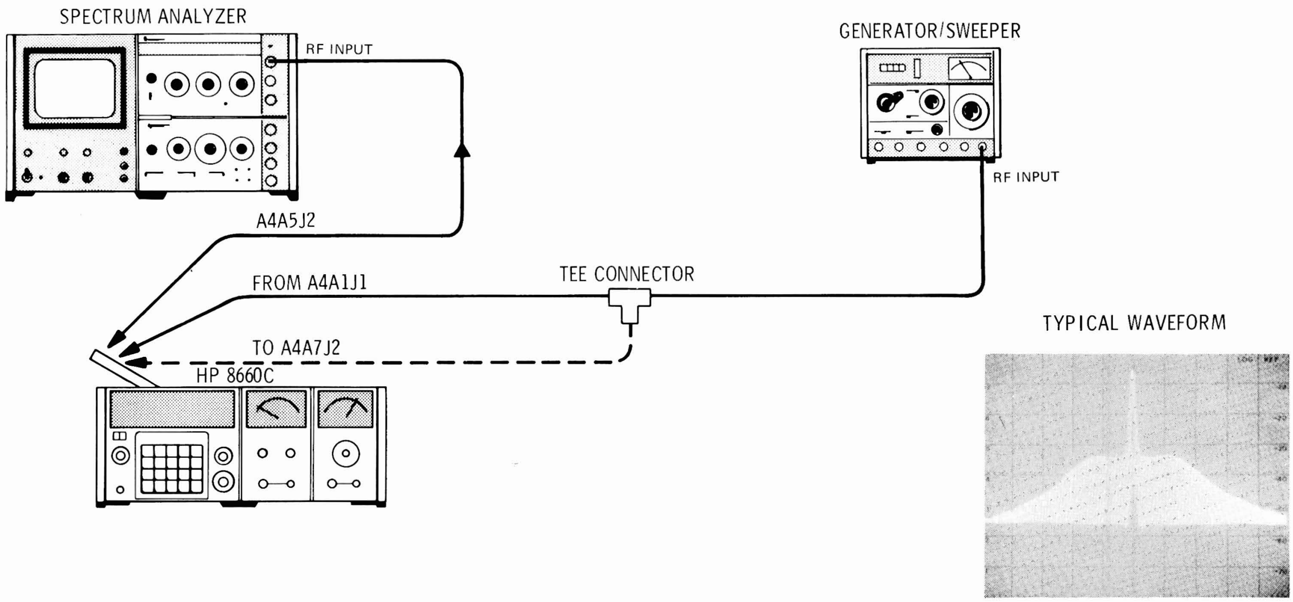


Figure 5-9. Loop Gain Adjustment Test Setup

5. 10 MHz Trap Adjustment (see Figure 5-10).

NOTE

This adjustment is necessary only if the A4A6 10 MHz trap has been repaired.

a. Disconnect the coaxial cable from A4J10 (350/450 MHz to Ø detector).

b. Disconnect the 10 MHz reference signal from A4J13 and reconnect it using a TEE connector. Connect the 10 MHz reference signal from the other TEE port to the Ø input of the A4A6 assembly (white wire from the A4A7 assembly).

c. Connect the Spectrum Analyzer RF INPUT to the A4A6 FREQuency control output (white-black-violet wire). Set the analyzer controls as follows:

CENTER FREQUENCY	10 MHz
BANDWIDTH	30 kHz
SCAN WIDTH PER DIVISION	200 kHz
VIDEO FILTER	OFF
INPUT ATTENUATION	0 dB
SCAN TIME PER DIVISION	1 Msec
REF LEVEL	—30 dBm

d. Adjust A4A6C5 trap for minimum 10 MHz amplitude.

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

e. Reconnect Ø input to A4A6.

f. Replace all High Frequency Section Covers.

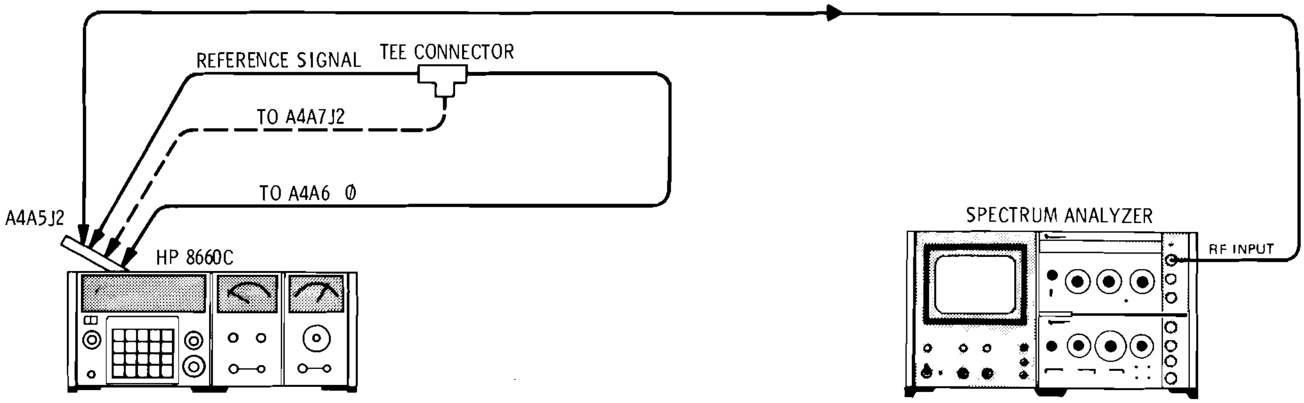


Figure 5-10. 10 MHz Trap Adjustment Test Setup

6. Output Frequency and Amplitude Check (see Figure 5-11).

a. Set the 8660C CF to 6 MHz.

b. Connect the Spectrum Analyzer RF INPUT to A4A5J2. Set the analyzer controls as required to view the 450 MHz signal. The output should be +13 dBm to +15 dBm.

__________ dBm

c. Switch digits 9 and 8 from 00 through 10. The frequency should decrease in 10 MHz steps (amplitude at +13 dBm minimum).

440 MHz __________ dBm	430 MHz __________ dBm	420 MHz __________ dBm
410 MHz __________ dBm	400 MHz __________ dBm	390 MHz __________ dBm
380 MHz __________ dBm	370 MHz __________ dBm	360 MHz __________ dBm
350 MHz __________ dBm		

ADJUSTMENTS

5-28. HIGH FREQUENCY SECTION (Cont'd)

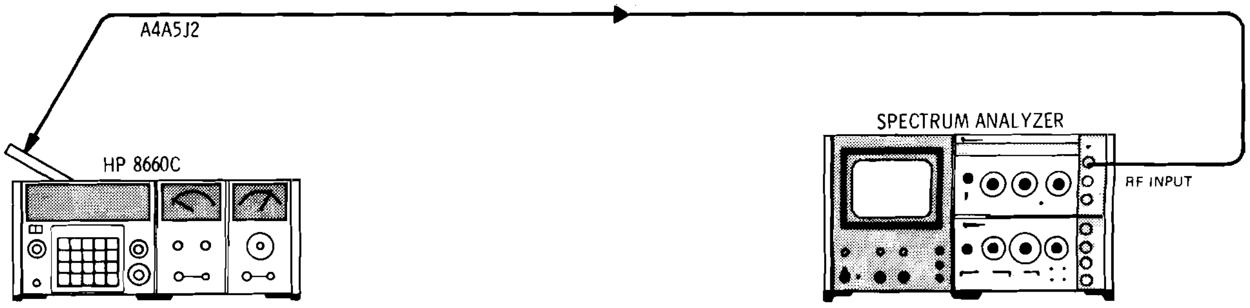


Figure 5-11. Output Amplitude Check Test Setup

5-29. N1 PHASE LOCK LOOP

REFERENCE:

Service Sheets 7 and 8 and Figure 8-120.

DESCRIPTION:

The N1 phase lock loop produces digitally controlled RF signals from 19.8 to 29.7 MHz in 100 kHz steps. The output frequency is selected by digits 6 and 7. These checks verify proper operation of the loop circuits.

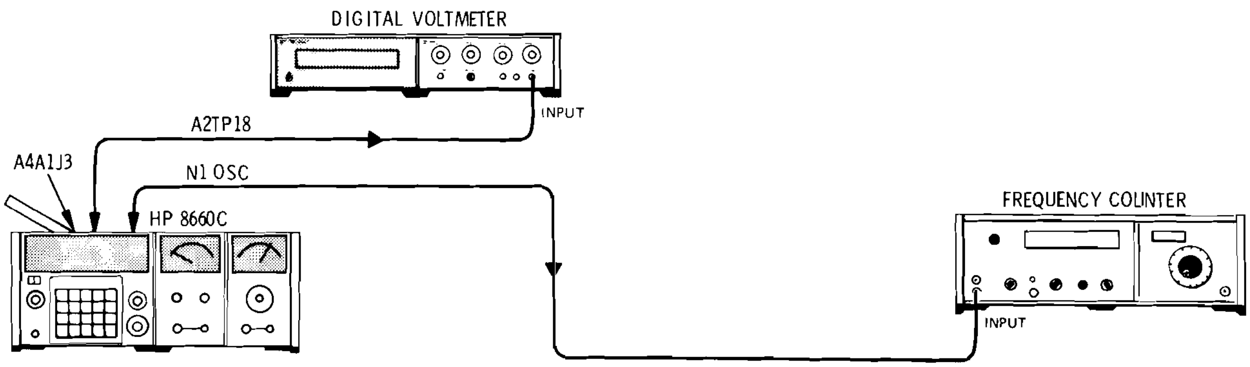


Figure 5-12. N1 Loop Test Setup

ADJUSTMENTS

5-29. N1 PHASE LOCK LOOP (Cont'd)

TEST EQUIPMENT:

Digital Voltmeter . . . . HP 3480/3482
Frequency Counter . . . . HP 5245M/5253B

PROCEDURE: (see Figure 5-12)

1. Enter 0 MHz center frequency and ground motherboard test point A2TP16 with one of the jumper plugs provided. Connect the digital voltmeter to A2TP18.

2. Adjust A17R31 or A17R28 for a voltmeter reading of −30 volts and disconnect the digital voltmeter.

3. Connect the frequency counter to the N1 oscillator output on the A2 mother board and adjust A17C17 for a counter reading as close as possible to 29.7 MHz (must be within ±200 kHz).

4. Enter 500 kHz center frequency and adjust A17R28 or A17R31 for a counter reading of 29.2 MHz.

5. Enter 9.5 MHz center frequency and record the counter readout.

   MHz ______________

6. Determine the frequency difference between the readout for step 5 and 20.2 MHz and record.

   MHz ______________

7. Enter 500 kHz center frequency.

   a. If the reading in step 5 was higher than 20.2 MHz adjust A17R28 for a counter readout of 29.2 MHz plus the difference frequency recorded in step 6.

   b. If the reading in step 5 was lower than 20.2 MHz adjust A17R28 for a counter readout of 29.2 MHz minus the difference frequency recorded in step 6.

8. Adjust A17R31 for an output frequency readout of 29.2 MHz.

9. Repeat steps 5 through 8 until the counter readout is 29.2 MHz ±20 MHz for a 500 kHz center frequency and 20.2 MHz ±20 kHz for a 9.5 MHz center frequency.

10. Remove the ground jumper from A2TP16.

11. Disconnect the 400 kHz reference signal by disconnecting the cable from A4A1J3 and connect the digital voltmeter to A2TP17. Adjust A16R38 for a digital voltmeter readout of 0V ± 10 mV. Reconnect the 400 kHz reference signal.

12. Enter center frequencies shown in Table 5-5. The counter readings should be as shown in the table.

ADJUSTMENTS

5-29. N1 PHASE LOCK LOOP (Cont'd)

Table 5-6. N1 Loop Output Frequency Checks

Center Frequency	Counter Readout
0	29.700000 MHz
1.1 MHz	28.600000 MHz
2.2 MHz	27.500000 MHz
3.3 MHz	26.400000 MHz
4.4 MHz	25.300000 MHz
5.5 MHz	24.200000 MHz
6.6 MHz	23.100000 MHz
7.7 MHz	22.000000 MHz
8.8 MHz	20.900000 MHz
9.9 MHz	19.800000 MHz

NOTE

The adjustments shown in Table 5-6 should be made with the counter time base connected to the synthesizer REFERENCE OUTPUT.

5-30. N2 PHASE LOCK LOOP

NOTE

Option 004 instruments use a different N2 programmable divider designated as N2a. In the following procedure the frequencies shown in parenthesis apply to N2a.

REFERENCE:

Service Sheets 9 and 10.

DESCRIPTION:

The N2 phase lock loop produces controlled RF signals from 19.80 to 29.79 MHz in 10 kHz increments. The output frequency selected by the 100 Hz, 1 kHz and 10 kHz steps. These checks verify proper operation of the loop circuits.

ADJUSTMENTS

5-30. N2 PHASE LOCK LOOP (Cont'd)

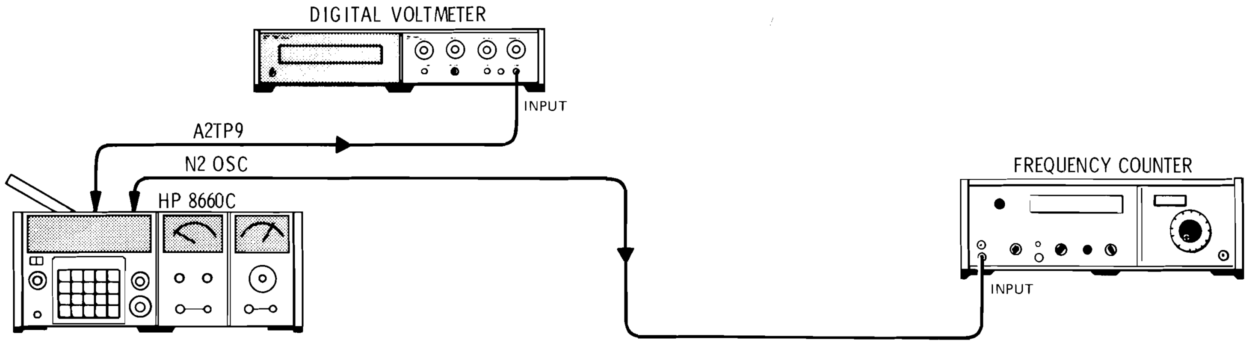


Figure 5-13. N2 Loop Test Setup

TEST EQUIPMENT:

Digital Voltmeter . . . . HP 3480/3482
Frequency Counter . . . . HP 5245M/5253B

PROCEDURE: (see Figure 5-13)

1. Set the center frequency to 0 MHz and ground A2TP12 on the mother board with one of the jumper plugs provided.

2. Connect the digital voltmeter to A2TP9 and adjust A13R37 or A13R39 to —30 volts. Disconnect the digital voltmeter.

3. Connect the frequency counter to the N2 oscillator output at XA13-1-4. Adjust A13C19 for a counter reading as close as possible to 29.79 MHz (N2a 30.00 MHz) must be within ±200 kHz.

4. Set the center frequency to 5.5 kHz. Adjust A13R37 or A13R39 for an output frequency reading of 29.250 MHz. (N2a 29.450 MHz.)

5. Set the center freuqency to 95.5 kHz and record the counter readout.

   MHz ______________

6. Determine the frequency difference between step 5 and 20.25 MHz (N2a 20.450 MHz) and record:

   MHz ______________

7. Set the center frequency to 5.5 kHz.

   a. If the reading in step 5 was more than 20.25 MHz (N2a 20.45 MHz) adjust A13R39 to 29.25 MHz (N2a 29.45 MHz) plus the difference frequency recorded in step 6.

ADJUSTMENTS

5-30. N2 PHASE LOCK LOOP (Cont'd)

b. If the reading in step 5 was less than 20.25 MHz (N2a 20.45 MHz) adjust A13R39 to 29.25 MHz (N2a 29.45 MHz) minus the difference frequency recorded in step 6.

8. Adjust A13R37 for an output frequency of 29.25 MHz (N2a 29.45 MHz).

9. Repeat steps 4 through 7 until the counter readout is 29.25 MHz (N2a 29.45 MHz) ±20 kHz for a center frequency of 20.25 MHz (N2a 20.45 MHz) ±20 kHz for a center frequency of 95.5 kHz.

10. Remove the ground from A2TP12.

11. Set center frequency as shown in Table 5-6. The counter readings should be as shown in the table.

Table 5-7. N2 Oscillator Output Frequency Checks

Center Frequency	Counter Readout N2	Counter Readout N2a
0	29.790000 MHz	30.000000 MHz
11.1 kHz	28.680000 MHz	28.890000 MHz
22.2 kHz	27.570000 MHz	27.780000 MHz
33.3 kHz	26.460000 MHz	26.670000 MHz
44.4 kHz	25.350000 MHz	25.560000 MHz
55.5 kHz	24.240000 MHz	24.450000 MHz
66.6 kHz	23.130000 MHz	23.340000 MHz
77.7 kHz	22.020000 MHz	22.230000 MHz
88.8 kHz	20.910000 MHz	21.120000 MHz
99.9 kHz	19.800000 MHz	20.010000 MHz

5-31. N3 PHASE LOCK LOOP

NOTE

Option 004 instruments do not include the N3 loop.

ADJUSTMENTS

5-31. N3 PHASE LOCK LOOP (Cont'd)

REFERENCE:

Service Sheets 11 and 12 and Figure 8-120.

DESCRIPTION:

The N3 phase lock loop produces digitally controlled RF signals from 2.001 to 2.100 MHz in 1 kHz increments. The output frequency is selected by 1 Hz and 10 Hz steps. These checks verify proper operation of the loop circuits.

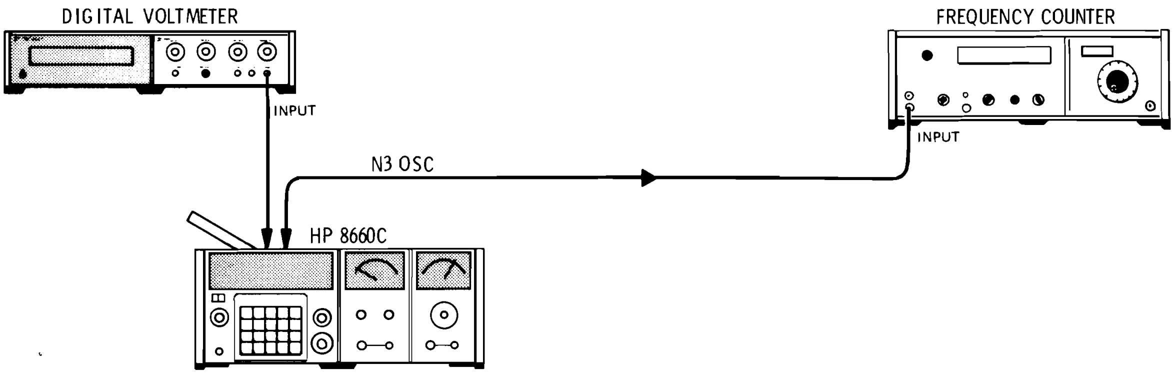


Figure 5-14. N3 Loop Test Setup

TEST EQUIPMENT:

Digital Voltmeter . . . . HP 3480/3482
Frequency Counter . . . . HP 5245M/5253B

PROCEDURE: (see Figure 5-14)

1. Set center frequency to 0 MHz and ground A2TP4 on the mother board with one of the jumper plugs provided.

2. Connect the counter to the N3 oscillator output at XA8-1-4 on the mother board. Adjust A8R26 or A8R24 for a counter readout of 2.100 MHz.

3. Set the center frequency to 5 Hz. Adjust A8R24 for a counter reading of 2.095 MHz. (must be within ±20 kHz.)

4. Set the center frequency to 95 Hz, and record the frequency displayed on the counter.

   MHz____________

5. Determine the frequency difference between that recorded in step 4 and 2.005 MHz and record.

   MHz____________

ADJUSTMENTS

5-31. N3 PHASE LOCK LOOP (Cont'd)

6. Set the center frequency to 5 Hz.

   a. If the reading in step 4 was less than 2.005 MHz adjust A8R24 to 2.095 MHz minus the frequency difference recorded in step 5.

   b. If the reading in step 4 was more than 2.005 MHz adjust A8R24 to 2.095 MHz plus the frequency difference recorded in step 5.

7. Adjust A8R26 for an output frequency of 2.095 MHz.

8. Repeat steps 3 through 6 until the counter readout is 2.095 MHz ± 20 kHz for a 5 Hz center frequency, and 2.005 MHz ± 20 kHz for a 95 Hz center frequency.

9. Remove the ground from A2TP4.

10. Set center frequencies as shown in Table 5-8. The counter readings should be as shown in the table.

Table 5-8. N3 Oscillator Output Frequency Checks

Center Frequency	Counter Readout
0 Hz	2.1000000 MHz
11 Hz	2.0890000 MHz
22 Hz	2.0780000 MHz
33 Hz	2.0670000 MHz
44 Hz	2.0560000 MHz
55 Hz	2.0450000 MHz
66 Hz	2.0340000 MHz
77 Hz	2.0230000 MHz
88 Hz	2.0120000 MHz
99 Hz	2.0010000 MHz

5-32. SUMMING LOOP 2 (SL2)

NOTE

Option 004 instruments do not include SL2.

ADJUSTMENTS

5-32. SUMMING LOOP 2 (SL2) (Cont'd)

REFERENCE:

Service Sheets 13 and 14 and Figure 8-120.

DESCRIPTION:

SL2 is a phase lock loop that provides a digitally controlled RF output to Summing Loop 1. This output, which is from 20.0001 to 30.000 MHz in 100 Hz steps, is controlled by 100 Hz, 1 kHz and 10 kHz steps, it is also indirectly controlled by 1 Hz and 10 Hz steps. These checks verify proper operation of the loop circuits.

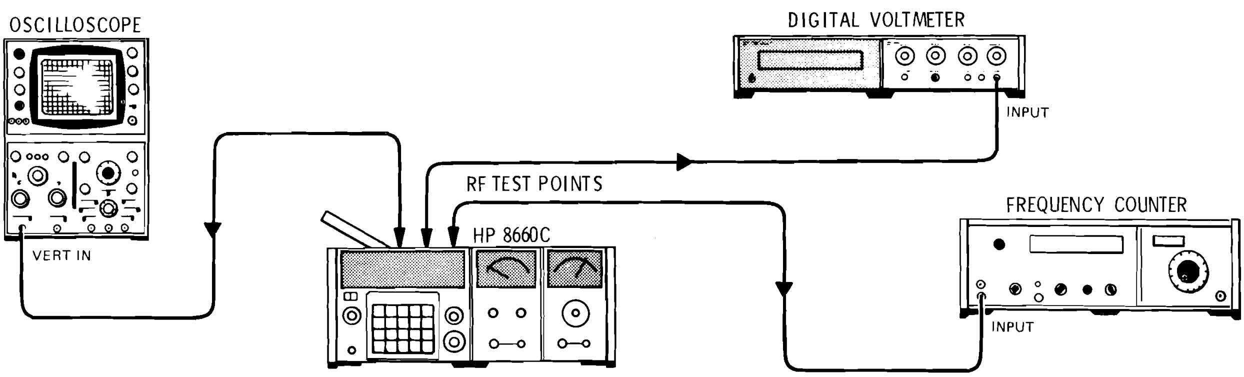


Figure 5-15. SL1 and SL2 Test Setup

TEST EQUIPMENT:

Digital Voltmeter . . . . HP 3480/3482
Frequency Counter . . . . HP 5245M/5253B
Oscilloscope (with 10:1 divider probes) . . . . HP 180A/1801A/1820A

PROCEDURE: (see Figure 5-15)

1. Set center frequency to 55.5 kHz.

   a. With the digital voltmeter connected to A2TP8, adjust A11R15 or A11R19 to 0.00 ± 10 millivolts.

   b. With the oscilloscope connected to A1TP7 adjust A12R37 for 50/50 symmetry.

   c. Disconnect the digital voltmeter and the oscilloscope.

2. Connect the digital voltmeter to varactor test point A2TP5, ground mother board test point A2TP8 with a clip lead, and set center frequency to 0 MHz.

ADJUSTMENTS

5-32. SUMMING LOOP 2 (SL2) (Cont'd)

a. Adjust A11R15 or A11R19 to read —30 volts on the digital voltmeter and then disconnect the digital voltmeter.

b. Connect the counter to test point A2TP6 and adjust A11C17 for a counter readout as close to 30 MHz as possible (must be within ±300 kHz).

3. Set center frequency to 4.5 kHz. Adjust A11R15 or A11R19 for a counter reading of 29.550 MHz.

4. Set center frequency to 94.5 kHz. Record the output at A2TP6 as read on the counter.

MHz ____________

5. Determine the difference frequency between that recorded in step 4 and 20.5500 MHz and record.

MHz ____________

a. Set center frequency to 4.5 kHz.

b. If the frequency readout in step 4 was higher than 20.5500 MHz adjust A11R15 to 29.550 MHz plus the difference frequency determined in step 5.

c. If the frequency readout in step 4 was lower than 20.5500 MHz adjust A11R15 to 29.550 MHz minus the difference frequency determined in step 5.

6. Reset the frequency to 29.550 MHz with A11R19.

7. Repeat steps 3, 4, 5 and 6 until the counter indicates 20.550 MHz ± 20 kHz for a center frequency of 94.5 kHz and 29.550 MHz ± 20 kHz for a center frequency of 4.5 kHz.

8. Set center frequency as shown in Table 5-9. Adjust the controls listed for counter readouts shown.

Table 5-9. SL2 Oscillator Output Frequency Adjustments

Center Frequency	Adjust	Counter Readout
84.5 kHz	A11R39 “8”	21.55 MHz ± 20 kHz
74.5 kHz	A11R54 “7”	22.55 MHz ± 20 kHz
64.5 kHz	A11R60 “6”	23.55 MHz ± 20 kHz
54.5 kHz	A11R67 “5”	24.55 MHz ± 20 kHz
44.5 kHz	A11R73 “4”	25.55 MHz ± 20 kHz
34.5 kHz	A11R77 “3”	26.55 MHz ± 20 kHz
24.5 kHz	A11R83 “2”	27.55 MHz ± 20 kHz
14.5 kHz	A11R90 “1”	28.55 MHz ± 20 kHz

ADJUSTMENTS

5-32. SUMMING LOOP 2 (SL2) (Cont'd)

9. Disconnect the counter, remove the ground from A2TP8 and connect the oscilloscope to A2TP7.

10. Set center frequencies as shown in Table 5-9 and adjust the associated potentiometers for 50/50 symmetry as seen on the oscilloscope (all must be within 40/60).

5-33. SUMMING LOOP 1 (SL1)

REFERENCE:

Service Sheets 15, 16 and 17 and Figure 8-130.

DESCRIPTION:

SL1 is a phase lock loop that provides a digitally controlled RF output to the RF Section plug-in. This output, which is from 20.000001 to 30.000000 MHz in 1 Hz steps is pretuned by 1 MHz, 100 kHz and 10 kHz steps and is also indirectly controlled by 1 kHz to 1 Hz steps. These checks verify proper operation of the loop circuits.

NOTE

In Option 004 instruments the SL1 output is 100 Hz steps.

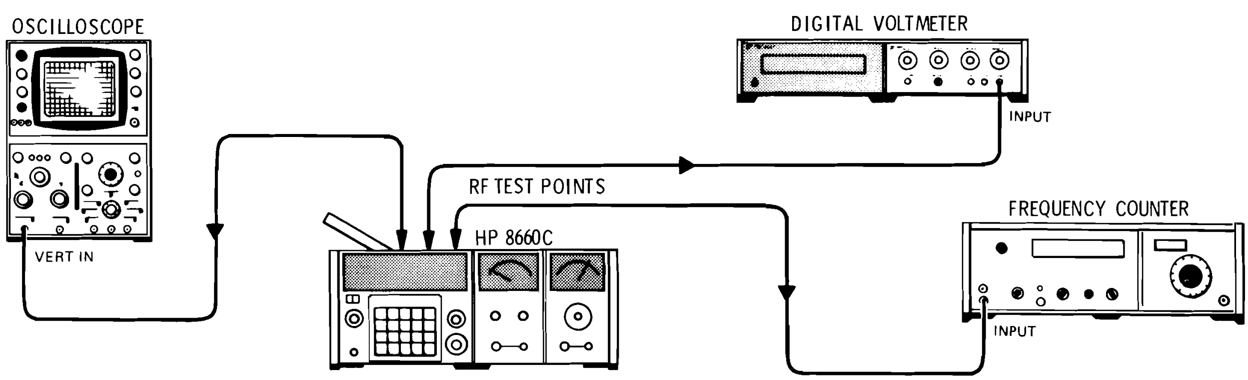


Figure 5-16. SL1 Test Setup

TEST EQUIPMENT:

Digital Voltmeter	HP 3480/3482
Frequency Counter	HP 5245M/5253B
Oscilloscope (with 10:1 divider probes)	HP 180A/1801A/1821A

ADJUSTMENTS

5-33. SUMMING LOOP 1 (SL1) (Cont'd)

PROCEDURE: (see Figure 5-16)

1. Set center frequency to 5.55 MHz.

   a. With the digital voltmeter connected to A2TP14, adjust A19R3 or A19R9 to 0.00 volt ± 10 millivolts.

   b. With the oscilloscope connected to A2TP13, adjust A15R14 for 50/50 symmetry.

   c. Disconnect the digital voltmeter and the oscilloscope.

2. Connect the digital voltmeter to varactor test point A2TP21, ground mother board test point A2TP14 with the jumper provided, and set center frequency to 0.

   a. Adjust A19R3 or A19R9 to —30 volts and disconnect the digital voltmeter.

   b. Connect the counter to SL1 OSC at XA19-1-2 and adjust A19C18 for a counter readout as close as possible to 30 MHz (must be within ±300 kHz).

3. Set center frequency to 450 kHz. Adjust A19R3 or A19R9 for a counter reading of 29.550 MHz.

4. Set center frequency to 9.45 MHz. Record frequency of output at SL1 OSC at XA19-1-2.

   MHz ____________

5. Determine the difference frequency between that recorded in step 4 and 20.550 MHz and record:

   MHz ____________

   a. Set center frequency to 450 kHz.

   b. If the frequency readout in step 4 was higher than 20.550 MHz adjust A19R3 to 29.550 MHz plus the difference frequency recorded in step 5.

   c. If the frequency readout in step 4 was lower than 20.550 MHz adjust A19R3 to 29.550 MHz minus the difference recorded in step 5.

6. Reset the frequency to 29.550 MHz with A19R9.

7. Repeat steps 3 through 6 until the counter indicates 20.550 MHz ± 20 kHz for a center frequency of 9.45 MHz and 29.550 MHz ± 20 kHz for a center frequency setting of 450 kHz.

8. Set center frequency as shown in Table 5-9. Adjust controls listed for counter readouts shown.

9. Disconnect the counter, remove the ground from A2TP14 and connect the oscilloscope to A2TP13.

10. Set center frequencies as shown in Table 5-9 and adjust the controls listed for 50/50 symmetry as seen on the oscilloscope. Disconnect the oscilloscope. (All settings must be within 40/60 symmetry.)

5-33. SUMMING LOOP 1 (SL1) (Cont'd)

Table 5-10. SL1 Oscillator Output Frequency Adjustments

Center Frequency	Adjust	Counter Readout
8.45 MHz	A18R35 "8"	21.550 MHz ± 20 kHz
7.45 MHz	A18R40 "7"	22.550 MHz ± 20 kHz
6.45 MHz	A18R44 "6"	23.550 MHz ± 20 kHz
5.45 MHz	A18R51 "5"	24.550 MHz ± 20 kHz
4.45 MHz	A18R55 "4"	25.550 MHz ± 20 kHz
3.45 MHz	A18R62 "3"	26.550 MHz ± 20 kHz
2.45 MHz	A18R67 "2"	27.550 MHz ± 20 kHz
1.45 MHz	A18R74 "1"	28.550 MHz ± 20 kHz

5-34. DCU SWEEP OUTPUT

REFERENCE:

Service Sheet

DESCRIPTION:

The Model 8660C sweep output may be used to drive the horizontal sweep of an oscilloscope while the RF output is used to determine the characteristics of a device being tested. This procedure provides information required to properly adjust the sweep ramp.

TEST EQUIPMENT:

Digital Voltmeter . . . . HP 3480B/3482

1. Remove the top and bottom covers from the 8660B. Remove the four DCU retaining screws (one at each corner inside).

2. With the 8660C inverted, gently slide the DCU out of the mainframe to the extent of connecting cables and connect the DVM to the 0 to +8V output.

3. Enter 1.000500 MHz center frequency and 1 kHz sweep width.

4. Set to manual sweep.

5. Using the MANUAL SWEEP control set frequencies shown in Table 5-11 and make the indicated adjustments. Adjustment locations are shown in Figure 5-17. All adjustments must be ±1 millivolt.

5-34. DCU SWEEP OUTPUT (Cont'd)

NOTE

Refer to Figure 8-50 for adjustment locations.

Table 5-11. Adjustments

Step	Frequency	Adjust
1	1.000799	Note DVM output reading typical 6.392V
2	1.000800	R29 for an output 8 mV greater than above reading is typically 6.4V
3	1.000999	R11 for an output of 7.992V
4	1.000000	R28 for an output of 0.000V
		Repeat steps 1 through 4
5	1.001000	R30 for an output of 8.000V

Table 5-12. Frequency Versus Exact Output Levels

Frequency	Output Level
1.000000 MHz	0.000V
1.000799 MHz	6.392V
1.000800 MHz	6.400V
1.000999 MHz	7.992V
1.001000 MHz	8.000V
Nominal step size - 8 mV/Hz	

ADJUSTMENTS

5-35. REMOTE PROGRAMMING

SPECIFICATIONS:

Specifications applying to operational tests in the LOCAL mode also apply to operational tests performed by remote programming (HP-IB or BCD interface).

DESCRIPTION:

All front panel frequency, output level, and modulation functions are programmable and can be tested using an HP 3260A Marked Card Programmer.

The standard remote cable for the 3260A is used with the HP-IB programming (OPT 005). The 3260A OPT 001 cable is used for standard BCD programming.

The Marked Card Programmer does not check the HP-IB Handshake Cycle.

TEST EQUIPMENT:

Frequency Counter . . . . HP 5340A
Spectrum Analyzer . . . . HP 140T/8555A/8552A
Marked Card Programmer . . . . HP 3260A OPT 001
Marked Card Programmer . . . . HP 3260A

PROCEDURE:

Center Frequency Test

1. Connect the Synthesizer 10 MHz Reference output to the Frequency Counter external reference input.

2. Program the RF Section for 0 dB attenuation and connect the RF output of the Synthesizer to the Frequency Counter input.

3. Program the mainframe for a center frequency within the RF Section frequency limits. The Frequency Counter should display a frequency reading of ± 1 digit of the programmed frequency.

Attenuation Test

4. Disconnect the Frequency Counter and connect the Spectrum Analyzer in its place.

5. Program the mainframe for a center frequency of 100 MHz.

6. Program the RF Section for 0 dB attenuation. The RF Section should be at maximum power output.

AM Test

7. Program mainframe for a center frequency of 50 MHz and RF Section for 10 dB of attenuation.

8. Program AM, 1 kHz Source, and 50% Modulation. Amplitude of sidebands should be —12 ± 0.5 dB with respect to carrier.

9. Program AM, Source, and 25% Modulation. Depth of sidebands should be —18.1 ± 0.5 dB with respect to carrier.

ADJUSTMENTS

5-35. REMOTE PROGRAMMING (cont'd)

FM Test

10. Program the mainframe for a center frequency of 100 MHz and RF Section for 0 dBm output.

11. Program in 1 kHz, FM Source, and 200 kHz peak deviation.

12. Set Spectrum Analyzer Controls for:

Center Frequency	100 MHz
Bandwidth	30 kHz
Scan Width	0.2 MHz/div.
Scan Time	5 ms

Display rising and falling edges should be 400 kHz pk-pk wide at top (200 kHz pk).

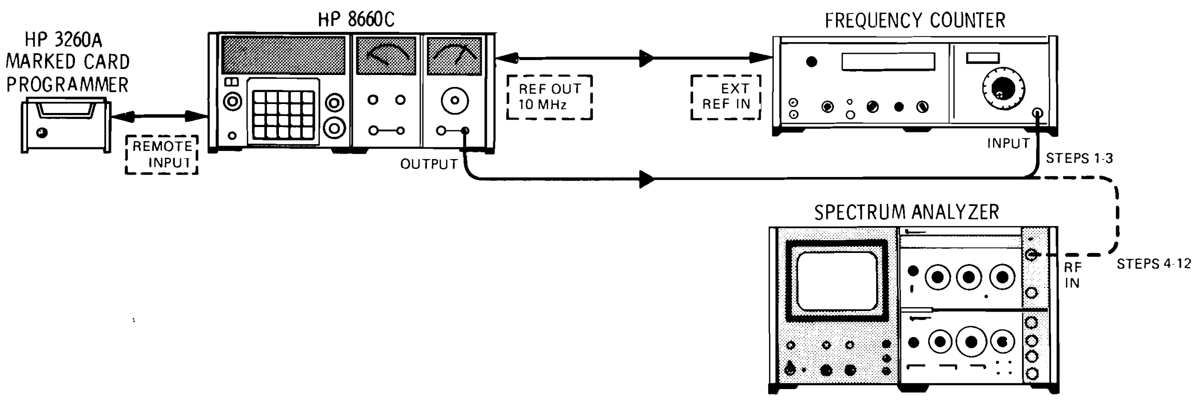


Figure 5-17. Typical Remote Programming Test Setup

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-2 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers.

6-3. EXCHANGE ASSEMBLIES

6-4. Table 6-1 lists assemblies within the instrument that may be replaced on an exchange basis, thus affording a considerable cost saving. Exchange, factory-repaired and tested assemblies are available only on a trade-in basis; therefore, the defective assemblies must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number.

6-5. ABBREVIATIONS

6-6. Table 6-2 lists abbreviations used in the parts list, schematics and throughout the manual. In some cases, two forms of the abbreviation are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-7. REPLACEABLE PARTS LIST

6-8. Table 6-3 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alpha-numerical order by reference designation.

b. Chassis-mounted parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

6-9. The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. The total quantity (Qty) in the instrument.

c. The description of the part.

d. A typical manufacturer of the part in a five-digit code.

e. The manufacturer's number for the part.

6-10. The total quantity for each part is given only once - at the first appearance of the part number in the list.

NOTE

Total quantities for optional assemblies are totaled by assembly and not integrated into the standard list.

6-11. ORDERING INFORMATION

6-12. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-13. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

6-14. SPARE PARTS KIT

6-15. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a "Spare Parts Kit" available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the "Recommended Spares" list are based on failure reports and repair data, and parts support for one year. A complimentary "Recommended Spares" list for this instrument may be obtained on request and the "Spare Parts Kit" may be ordered through your nearest Hewlett-Packard office.

6-16. ILLUSTRATED PARTS BREAKDOWNS

6-17. Figure 6-1 provides a breakdown of Cabinet Parts. The parts are not identified by part numbers or descriptions. These parts are identified by MP (miscellaneous part) numbers which are further identified in Table 6-3 of this section.

6-18. Figure 6-2 provides a breakdown of DCU front panel parts. The parts are identified by MP numbers or assembly numbers which are further identified in Table 6-3 of this section.

Table 6-1. Part Numbers for Assembly Exchange Orders

	Assembly	New Part No.	Exchange No.
A1A1	Sw. Control	08660-60200	08660-60271
A1A2	Key Control	08660-60176	08660-60177
A1A3	Readout Control	08660-60191	08660-60265
A1A4	Rom Input	08660-60197	08660-60266
A1A6	Register Assy	08660-60198	08660-60267
A1A12	Numeric R/O	08660-60190	08660-60264
A1A17	Man. Mode Turner	08660-60123	08660-60251

Table 6-2. Reference Designations and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS

A	assembly
AT	attenuator; isolator; termination
B	fan; motor
BT	battery
C	capacitor
CP	coupler
CR	diode; diode thyristor; varactor
DC	directional coupler
DL	delay line
DS	annunciator; signaling device (audible or visual); lamp; LED
E	miscellaneous electrical part
F	fuse
FL	filter
H	hardware
HY	circulator
J	electrical connector (stationary portion); jack
K	relay
L	coil; inductor
M	meter
MP	miscellaneous mechanical part
P	electrical connector (movable portion); plug
Q	transistor: SCR; triode thyristor
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
U	integrated circuit; microcircuit
V	electron tube
VR	voltage regulator; breakdown diode
W	cable; transmission path; wire
X	socket
Y	crystal unit (piezo-electric or quartz)
Z	tuned cavity; tuned circuit

ABBREVIATIONS

A	ampere
ac	alternating current
ACCESS	accessory
ADJ	adjustment
A/D	analog-to-digital
AF	audio frequency
AFC	automatic frequency control
AGC	automatic gain control
AL	aluminum
ALC	automatic level control
AM	amplitude modulation
AMPL	amplifier
APC	automatic phase control
ASSY	assembly
AUX	auxiliary
avg	average
AWG	American wire gauge
BAL	balance
BCD	binary coded decimal
BD	board
BE CU	beryllium copper
BFO	beat frequency oscillator
BH	binder head
BKDN	breakdown
BP	bandpass
BPF	bandpass filter
BRS	brass
BWO	backward-wave oscillator
CAL	calibrate
ccw	counter-clockwise
CER	ceramic
CHAN	channel
cm	centimeter
CMO	cabinet mount only
COAX	coaxial
COEF	coefficient
COM	common
COMP	composition
COMPL	complete
CONN	connector
CP	cadmium plate
CRT	cathode-ray tube
CTL	complementary transistor logic
CW	continuous wave
cw	clockwise
cm	centimeter
D/A	digital-to-analog
dB	decibel
dBm	decibel referred to 1 mW
dc	direct current
deg	degree (temperature interval or difference)
...°	degree (plane angle)
°C	degree Celsius (centigrade)
°F	degree Fahrenheit
°K	degree Kelvin
DEPC	deposited carbon
DET	detector
diam	diameter
DIA	diameter (used in parts list)
DIFF AMPL	differential amplifier
div	division
DPDT	double-pole, double-throw
DR	drive
DSB	double sideband
DTL	diode transistor logic
DVM	digital voltmeter
ECL	emitter coupled logic
EMF	electromotive force
EDP	electronic data processing
ELECT	electrolytic
ENCAP	encapsulated
EXT	external
F	farad
FET	field-effect transistor
F/F	flip-flop
FH	flat head
FIL H	fillister head
FM	frequency modulation
FP	front panel
FREQ	frequency
FXD	fixed
g	gram
GE	germanium
GHz	gigahertz
GL	glass
GRD	ground(ed)
H	henry
h	hour
HET	heterodyne
HEX	hexagonal
HD	head
HDW	hardware
HF	high frequency
HG	mercury
HI	high
HP	Hewlett-Packard
HPF	high pass filter
HR	hour (used in parts list)
HV	high voltage
Hz	Hertz
IC	integrated circuit
ID	inside diameter
IF	intermediate frequency
IMPG	impregnated
in	inch
INCD	incandescent
INCL	include(s)
INP	input
INS	insulation
INT	internal
kg	kilogram
kHz	kilohertz
kΩ	kilohm
kV	kilovolt
lb	pound
LC	inductance-capacitance
LED	light-emitting diode
LF	low frequency
LG	long
LH	left hand
LIM	limit
LIN	linear taper (used in parts list)
lin	linear
LK WASH	lock washer
LO	low; local oscillator
LOG	logarithmic taper (used in parts list)
log	logrithm(ic)
LPF	low pass filter
LV	low voltage
m	meter (distance)
mA	milliampere
MAX	maximum
MΩ	megohm
MEG	meg (10^6) (used in parts list)
MET FLM	metal film
MET OX	metallic oxide
MF	medium frequency; microfarad (used in parts list)
MFR	manufacturer
mg	milligram
MHz	megahertz
mH	millihenry
mho	mho
MIN	minimum
min	minute (time)
...'	minute (plane angle)
MINAT	miniature
mm	millimeter

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-2. Reference Designations and Abbreviations (2 of 2)

Abbreviation	Meaning
MOD	modulator
MOM	momentary
MOS	metal-oxide semiconductor
ms	millisecond
MTG	mounting
MTR	meter (indicating device)
mV	millivolt
mVac	millivolt, ac
mVdc	millivolt, dc
mVpk	millivolt, peak
mVp-p	millivolt, peak-to-peak
mVrms	millivolt, rms
mW	milliwatt
MUX	multiplex
MY	mylar
μA	microampere
μF	microfarad
μH	microhenry
μmho	micromho
μs	microsecond
μV	microvolt
μVac	microvolt, ac
μVdc	microvolt, dc
μVpk	microvolt, peak
μVp-p	microvolt, peak-to-peak
μVrms	microvolt, rms
μW	microwatt
nA	nanoampere
NC	no connection
N/C	normally closed
NE	neon
NEG	negative
nF	nanofarad
NI PL	nickel plate
N/O	normally open
NOM	nominal
NORM	normal
NPN	negative-positive-negative
NPO	negative-positive zero (zero temperature coefficient)
NRFR	not recommended for field replacement
NSR	not separately replaceable
ns	nanosecond
nW	nanowatt
OBD	order by description
OD	outside diameter
OH	oval head
OP AMPL	operational amplifier
OPT	option
OSC	oscillator
OX	oxide
oz	ounce
Ω	ohm
P	peak (used in parts list)
PAM	pulse-amplitude modulation
PC	printed circuit
PCM	pulse-code modulation; pulse-count modulation
PDM	pulse-duration modulation
pF	picofarad
PH BRZ	phosphor bronze
PHL	Phillips
PIN	positive-intrinsic-negative
PIV	peak inverse voltage
pk	peak
PL	phase lock
PLO	phase lock oscillator
PM	phase modulation
PNP	positive-negative-positive
P/O	part of
POLY	polystyrene
PORC	porcelain
POS	positive; position(s) (used in parts list)
POSN	position
POT	potentiometer
p-p	peak-to-peak
PP	peak-to-peak (used in parts list)
PPM	pulse-position modulation
PREAMPL	preamplifier
PRF	pulse-repetition frequency
PRR	pulse repetition rate
ps	picosecond
PT	point
PTM	pulse-time modulation
PWM	pulse-width modulation
PWV	peak working voltage
RC	resistance-capacitance
RECT	rectifier
REF	reference
REG	regulated
REPL	replaceable
RF	radio frequency
RFI	radio frequency interference
RH	round head; right hand
RLC	resistance-inductance-capacitance
RMO	rack mount only
rms	root-mean-square
RND	round
ROM	read-only memory
R&P	rack and panel
RWV	reverse working voltage
S	scattering parameter
s	second (time)
..."	second (plane angle)
S-B	slow-blow (fuse) (used in parts list)
SCR	silicon controlled rectifier; screw
SE	selenium
SECT	sections
SEMICON	semiconductor
SHF	superhigh frequency
SI	silicon
SIL	silver
SL	slide
SNR	signal-to-noise ratio
SPDT	single-pole, double-throw
SPG	spring
SR	split ring
SPST	single-pole, single-throw
SSB	single sideband
SST	stainless steel
STL	steel
SQ	square
SWR	standing-wave ratio
SYNC	synchronize
T	timed (slow-blow fuse)
TA	tantalum
TC	temperature compensating
TD	time delay
TERM	terminal
TFT	thin-film transistor
TGL	toggle
THD	thread
THRU	through
TI	titanium
TOL	tolerance
TRIM	trimmer
TSTR	transistor
TTL	transistor-transistor logic
TV	television
TVI	television interference
TWT	traveling wave tube
U	micro (10^{-6}) (used in parts list)
UF	microfarad (used in parts list)
UHF	ultrahigh frequency
UNREG	unregulated
V	volt
VA	voltampere
Vac	volts, ac
VAR	variable
VCO	voltage-controlled oscillator
Vdc	volts, dc
VDCW	volts, dc, working (used in parts list)
V(F)	volts, filtered
VFO	variable-frequency oscillator
VHF	very-high frequency
Vpk	volts, peak
Vp-p	volts, peak-to-peak
Vrms	volts, rms
VSWR	voltage standing wave ratio
VTO	voltage-tuned oscillator
VTVM	vacuum-tube voltmeter
V(X)	volts, switched
W	watt
W/	with
WIV	working inverse voltage
WW	wirewound
W/O	without
YIG	yttrium-iron-garnet
Z_o	characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CABINET PARTS		
1	08660-00024	2	COVER, SIDE	28480	08660-00024
2	2360-0198	8	SCREW-MACH 6-32 100 DEG FL HD POZI REC	28480	2360-0198
3	08660-00026	1	COVER, TOP	28480	08660-00026
4	08660-00001	1	PANEL, REAR	28480	08660-00001
5	2510-0099	4	SCREW-MACH 8-32 PAN HD POZI REC SST-300	28480	2510-0099
6	5060-0222	2	HANDLE ASSY:5H SIDE	28480	5060-0222
7	08660-20057	2	GUIDE, MODULE PLUG IN	28480	08660-20057
8	08660-20058	2	GUIDE, RF PLUG-IN	28480	08660-20058
9	08660-20061	1	FRAME, FRONT	28480	08660-20061
10	08660-20076	2	FRAME, SIDE	28480	08660-20076
11	2360-0190	12	SCREW-MACH 6-32 100 DEG FL HD POZI REC	28480	2360-0190
12	2200-0164	8	SCREW-MACH 4-40 82 DEG FL HD POZI REC	28480	2200-0164
13	5060-0767	5	FOOT ASSY:FM	28480	5060-0767
14	1490-0030	1	SPRING WFRM .187-OD SST	28480	1490-0030
15	2510-0050	8	SCREW-MACH 8-32 82 DEG FL HD POZI REC	28480	2510-0050
16	2360-0111	8	SCREW-MACH 6-32 PAN HD POZI REC SST-300	28480	2360-0111
17	5060-8735	2	RETAINER HANDLE ASSY:OLIVE GRAY(STD)	28480	5060-8735
18	2510-0101	4	SCREW-MACH 8-32 PAN HD POZI REC SST-300	28480	2510-0101
19	08660-60070	1	KIT, RACK MOUNT	28480	08660-60070
20	08660-00025	1	COVER, BOTTOM	28480	08660-00025
	08660-20172	2	FOOT, EXTRUDED, REAR	28480	08660-20172
21	5000-0052	2	PLATE:FLUTED ALUMINUM	28480	5000-0052

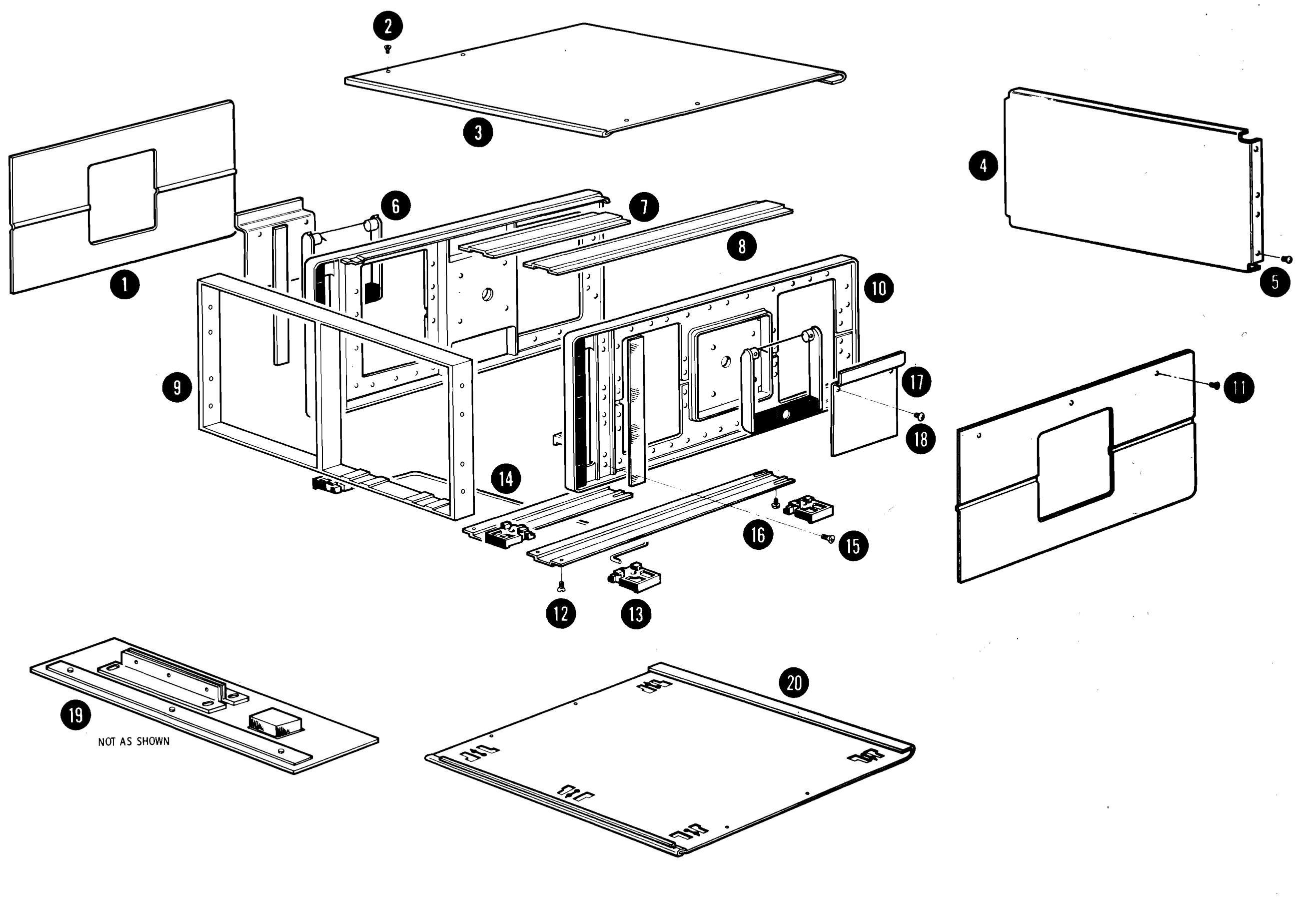


Figure 6-1. Cabinet Parts

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	0370-1131	1	KNOB; CONC; BAR AND PTR; .5 IN; JGK	28480	0370-1131
2	0370-2193	1	KNOB:MANUAL MODE SWITCH	28480	0370-2193
3	2950-0043	4	NUT-HEX-DBL CHAM 3/8-32-THD .094-THK	73743	2X 28200
4	1250-0118	1	CONNECTOR-RF BNC FEM SGL HOLE FR	90949	31-2221-1022
5	0370-2194	1	KNOB:SWEEP SWITCH	28480	0370-2194
6	0370-1303	1	KNOB; BASE; RND; 1.125 IN; JGK; SGI	28480	0370-1303
7	08660-20101	1	FRONT PANEL FRAME	28480	08660-20101
8	2190-0016	2	WASHER-LK INTL T .377 IN ID .507 IN OD	78189	1920-02
9	08660-60115	1	SWITCH ASSY, MANUAL MODE (A16)	28480	08660-60115
10	08660-60123	1	TUNER ASSY, MANUAL MODE (A17)	28480	08660-60123
11	08660-20154	1	RETAINER	28480	08660-20154
12	0520-0129	3	SCREW-MACH 2-56 PAN HD POZI REC SST-300	28480	0520-0129
13	08660-60113	1	SWITCH ASSY, KEYBOARD (A1A15)	28480	08660-60113
14	08660-20153	1	RETAINER, BRACKET	28480	08660-20153
15	9100-3354	1	COIL; FXD; AUDIO CHOKE; 4UH	28480	9100-3354
16	2200-0105	2	SCREW-MACH 4-40 PAN HD POZI REC SST-300	28480	2200-0105
17	2200-0141	4	SCREW-MACH 4-40 PAN HD POZI REC SST-300	28480	2200-0141
18	2190-0019	4	WASHER-LK HLCL NO. 4 .115 IN ID .226 IN	28480	2190-0019
19	3050-0023	1	WASHER-FL NM NO. 6 .144 IN ID .25 IN OD	28480	3050-0023
20	3050-0016	3	WASHER-FL MTLC NO. 6 .147 IN ID .281 IN	28480	3050-0016
21	08660-60111	1	BOARD ASSY, NUMERAL READOUT (A1A12)	28480	08660-60111
22	0520-0174	2	SCREW-MACH 2-56 PAN HD POZI REC SST-300	28480	0520-0174
23	3101-1655	1	SWITCH-TGL SUBMIN SPDT 5A 115VAC/DC	09353	7101-J1CX
24	08660-60114	1	SWITCH ASSY, SWEEP MODE (A15)	28480	08660-60114
25	08660-40107	1	SINGLE SWEEP PUSHBUTTON	28480	08660-40107
26	0360-1190	1	TERMINAL, SLDR LUG, 3/8 SCR, .38/.078	28480	0360-1190
27	08660-00106	1	FRONT PANEL, LEFT SIDE	28480	08660-00106
28	08660-20177	1	WINDOW, FRONT	28480	08660-20177
29	08660-00102	1	FRONT PANEL, RIGHT SIDE	28480	08660-00102
30	08660-40004	1	ANNUNCIATOR BLOCK	28480	08660-40004
31	08660-60159	1	ANNUNCIATOR CIRCUIT BOARD	28480	08660-60159
32	0510-1149	1	RETAINER; PUSH ON; .125 DIA; PHS STL	28480	0510-1149
33	2140-0356	1	LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
34	08660-40108	1	PUSHBUTTON, READOUT	28480	08660-40108

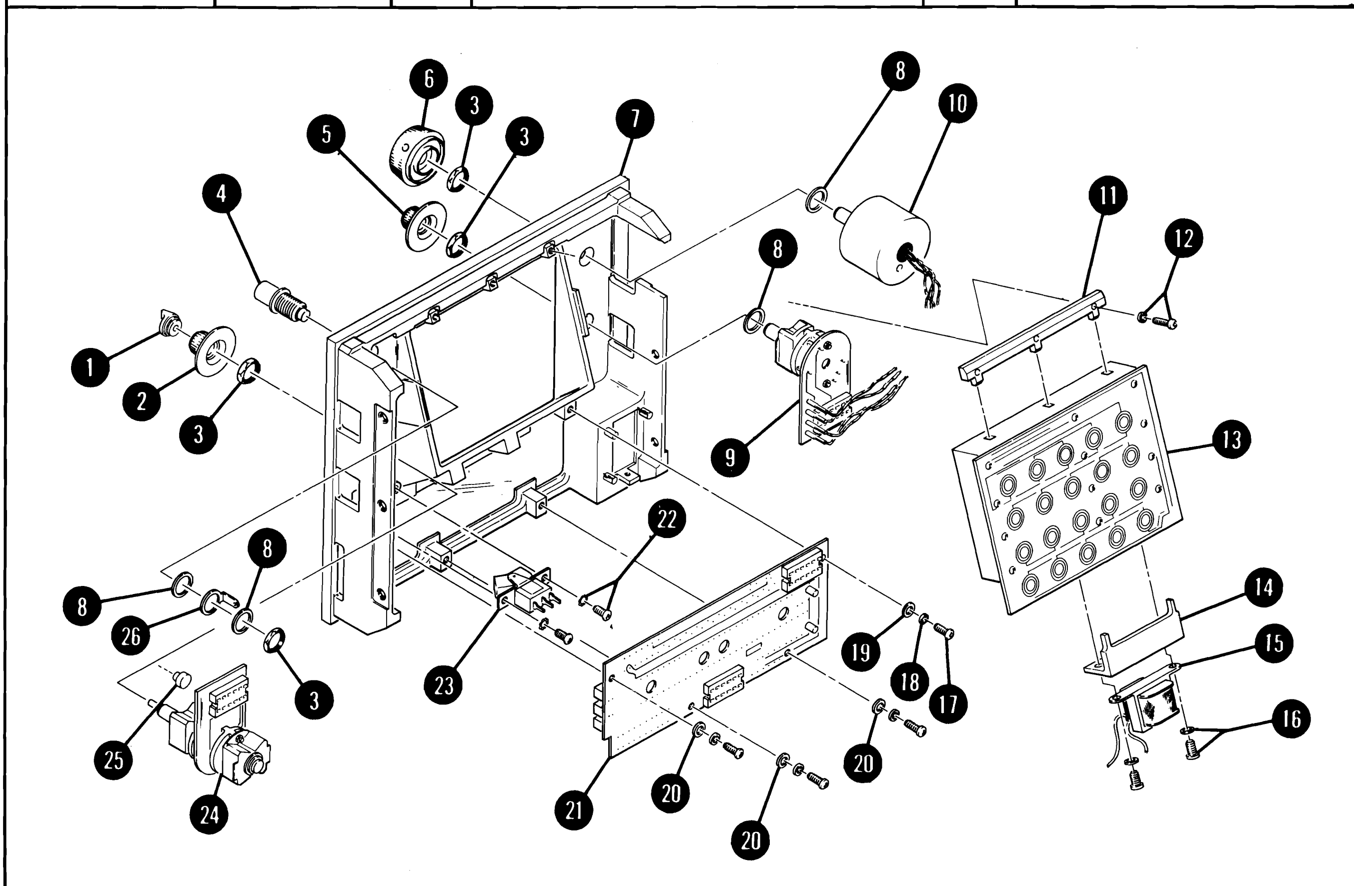


Figure 6-2. DCU Front Panel Parts

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	08660-60272	1	DIGITAL CONTROL ASSY	28480	08660-60272
A1C1	0160-3448	1	CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3448
A1J1	1250-0118	1	CONNECTOR-RF BNC FEM SGL HOLE FR	90949	31-2221-1022
A1L1	9100-3354	1	COIL; FXD; AUDIO CHOKE; 4UH	28480	9100-3354
A1W1	08660-60116	1	CABLE ASSY, SWITCH	28480	08660-60116
A1W2	08660-60117	1	CABLE ASSY, KEYBOARD	28480	08660-60117
A1W3	08660-60118	2	CABLE ASSY, READOUT	28480	08660-60118
A1W4	08660-60118		CABLE ASSY, READOUT	28480	08660-60118
A1W5	08660-60124	1	CABLE, D/A OUTPUT	28480	08660-60124
A1W6	08660-60126	1	WIRING HARNESS	28480	08660-60126
A1W7	08660-60129	1	CABLE ASSY, 4V FILTER	28480	08660-60129
			MISCELLANEOUS A1		
	0900-0023	1	"RING" 0.250" ID	07322	MR 8010
	08660-00069	1	SHIELD, R.F.I.	28480	08660-00069
	08660-00101	1	SUPPORT, DIGITAL TOP	28480	08660-00101
	08660-00103	1	SUPPORT, DIGITAL BOTTOM	28480	08660-00103
	08660-00110	1	INSULATOR, INTERCONNECT	28480	08660-00110
	08660-20121	1	SUB-PANEL, FRONT	28480	08660-20121
	08660-20152	1	FRONT PANEL, KEYBOARD	28480	08660-20152
	08660-20160	1	RETAINER, P.C. BOARD	28480	08660-20160
	08660-20161	1	SPACER, ROD	28480	08660-20161
	08660-40105	1	FREQUENCY RANGE INDICATOR	28480	08660-40105
	08660-40108	1	PUSHBUTTON, READOUT	28480	08660-40108
A1A1	08660-60200	1	BOARD ASSY, SWITCH CONTROL	28480	08660-60200
A1A1C1	0180-2206	4	CAPACITOR-FXD; 60UF+-10% 6VDC TA-SOLID	56289	150D606X9006B2
A1A1C2	0160-3536	1	CAPACITOR-FXD 620PF +-5% 100WVDC MICA	28480	0160-3536
A1A1C3	0180-1714	2	CAPACITOR-FXD; 330UF+-10% 6VDC TA-SOLID	56289	150D337X9006S2
A1A1C4	0180-0197	62	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1C6	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1C7	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1C8	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1C9	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A1CR1	1901-0040	70	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1A1R1	0698-7228	4	RESISTOR 464 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-464R-G
A1A1R2	0698-7272	1	RESISTOR 31.6K 2% .05W F TUBULAR	24546	C3-1/8-T0-3162-G
A1A1R3	0698-7253	16	RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R4	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R5	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R6	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R7	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R8	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R9	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R10	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R11	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R12	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R13	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R14	0698-7222	3	RESISTOR 261 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-261R-G
A1A1R15	0698-7228		RESISTOR 464 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-464R-G
A1A1R16	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R17	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R18	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R19	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R20	0698-7253		RESISTOR 5.11K 2% .05W F TUBULAR	24546	C3-1/8-T0-5111-G
A1A1R21	0698-7212	3	RESISTOR 100 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-100R-G
A1A1R22	0698-7212		RESISTOR 100 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-100R-G
A1A1R23	0698-7228		RESISTOR 464 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-464R-G
A1A1R24	0698-7228		RESISTOR 464 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-464R-G
A1A1TP1	0360-1514	15	TERMINAL; SLDR STUD	28480	0360-1514
A1A1TP2	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A1U1	1820-0913	3	IC DGTL SN74L 122 N MULTIVIBRATOR	01295	SN74L122N
A1A1U2	1820-0174	17	IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A1U3	1820-0256	3	IC DGTL MC 858P BUFFER	04713	MC858P
A1A1U4	1820-0600	6	IC DGTL DM85L 90N COUNTER	27014	DM74L90N
A1A1U5	1820-0600		IC DGTL DM85L 90N COUNTER	27014	DM74L90N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A1U6	1820-0600		IC DGTL DM85L 90N COUNTER	27014	DM74L90N
A1A1U7	1820-0600		IC DGTL DM85L 90N COUNTER	27014	DM74L90N
A1A1U8	1820-0600		IC DGTL DM85L 90N COUNTER	27014	DM74L90N
A1A1U9	1820-0600		IC DGTL DM85L 90N COUNTER	27014	DM74L90N
A1A1U10	1820-0054	63	IC DGTL SN74 00 N GATE	01295	SN7400N
A1A1U11	1820-0595	5	IC DGTL DM74L 73N FLIP-FLOP	27014	DM74L73N
A1A1U12	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A1U13	1820-0372	8	IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A1U14	1820-0587	5	IC DGTL DM74L 10N GATE	27014	DM74L10N
A1A1U15	1820-0596	5	IC DGTL DM74L 74N FLIP-FLOP	27014	DM74L74N
A1A1U16	1820-0595	1	IC DGTL FLIP FLOP	27014	DM74L73N
A1A1U17	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A1U18	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A1U19	1820-0374	1	IC DGTL SN74H 21 N GATE	01295	SN74H21N
A1A1U20	1820-0511	14	IC DGTL SN74 08 N GATE	01295	SN7408N
A1A1U21	1820-0077	7	IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A1A1U22	1820-0587		IC DGTL DM74L 10N GATE	27014	DM74L10N
A1A1U23	1820-0595		IC DGTL DM74L 73N FLIP-FLOP	27014	DM74L73N
A1A1U24	1820-0328	10	IC DGTL SN74 02 N GATE	01295	SN7402N
A1A1U25	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A1U26	1820-0495	4	IC DGTL DECODER	07263	9311DC
A1A1U27	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A1U28	1820-0596		IC DGTL DM74L 74N FLIP-FLOP	27014	DM74L74N
A1A1U29	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A1A1U30	1820-0661	11	IC DGTL SN74 32 N GATE	01295	SN7432N
A1A1U31	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A1U32	1820-0596		IC DGTL DM74L 74N FLIP-FLOP	27014	DM74L74N
A1A1U33	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A1XA1	1200-0507	10	SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A2	08660-60176	1	BOARD ASSY,KEY CONTROL	28480	08660-60176
A1A2C1	0160-0945	3	CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A1A2C2	0160-2204	13	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1A2C3	0160-0157	4	CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A1A2C4	0140-0199	2	CAPACITOR-FXD 240PF +-5% 300WVDC MICA	72136	DM15F241J0300WV1CR
A1A2C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C6	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C7	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C8	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C9	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C10	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C11	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2C12	0140-0199		CAPACITOR-FXD 240PF +-5% 300WVDC MICA	72136	DM15F241J0300WV1CR
A1A2C13	0160-3533	1	CAPACITOR-FXD 470PF +-5% 100WVDC MICA (OPT 004 ONLY)	28480	0160-3533
A1A2C14	0160-0161	6	CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A1A2C15	0160-0161		CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A1A2C16	0160-0161		CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A1A2C17	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A2Q1	1853-0020	4	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A1A2R1	0757-0419	2	RESISTOR 681 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-681R-F
A1A2R2	0757-0428	24	RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A1A2R3	0698-0082	36	RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A1A2R4	0757-0280	46	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1A2R5	0698-3430	9	RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R6	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R7	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1A2R8	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R9	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R10	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1A2R11	0757-0438	12	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A2R12	0757-0395	2	RESISTOR 56.2 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-56R2-F
A1A2R13	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R14	0698-3160	2	RESISTOR 31.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-3162-F
A1A2R15	0698-3160		RESISTOR 31.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-3162-F
A1A2R16	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A1A2R17	0698-3159	3	RESISTOR 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1A2R18	0698-3159		RESISTOR 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1A2R19	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A2R20	0698-3132	16	RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A1A2R21	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A2R22	0757-0288	7	RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A1A2R23	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1A2R24	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A1A2R25	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A2TP1	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A2TP2	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A2U1	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A2U2	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A2U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A2U4	1820-0709	10	IC DGTL REGISTER	07263	93L28DC
A1A2U5	1820-0659	17	IC DGTL REGISTER	07263	93L00DC
A1A2U6	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A2U7	1820-0281	1	IC DGTL SN74 107 N FLIP-FLOP	01295	SN74107N
A1A2U8	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A2U9	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A2U10	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A2U11	1820-0710	6	IC DGTL MULTIPLEXER	07263	93L22DC
A1A2U12	1820-0710		IC DGTL MULTIPLEXER	07263	93L22DC
A1A2U13	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A2U14	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A2U15	1820-0710		IC DGTL MULTIPLEXER	07263	93L22DC
A1A2U16	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A2U17	1820-0596		IC DGTL DM74L 74N FLIP-FLOP	27014	DM74L74N
A1A2U18	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A2U19	1820-0913		IC DGTL SN74L 122 N MULTIVIBRATOR	01295	SN74L122N
A1A2U20	1826-0055	1	IC DGTL COMPARATOR (ANALOG)	07263	711DC
A1A2U21	1820-0069	5	IC DGTL SN74 20 N GATE	01295	SN7420N
A1A2U22	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A2U23	1820-0214	7	IC DGTL SN74 42 N DECODER	01295	SN7442N
A1A2U24	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A2U25	1820-0055	4	IC DGTL SN74 90 N COUNTER	01295	SN7490N
A1A2U26	1820-0491	1	IC DGTL SN74 145 N DECODER	01295	SN74145N
A1A3	08660-60191	1	BOARD ASSY, READOUT CONTROL	28480	08660-60191
A1A3C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C6	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C7	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C8	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A3C9	0160-3534	2	CAPACITOR-FXD 510PF +-5% 100WVDC MICA	28480	0160-3534
A1A3C10	0160-0161		CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A1A3C11	0160-2208	3	CAPACITOR-FXD 330PF +-5% 300WVDC MICA	28480	0160-2208
A1A3C12	0140-0196	2	CAPACITOR-FXD 150PF +-5% 300WVDC MICA	72136	DM15F151J0300WV1CR
A1A3R1	0698-3447	22	RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R2	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R3	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R4	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R5	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R6	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R7	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R8	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R9	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R10	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R11	0698-3159		RESISTOR 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1A3R12	0757-0401	30	RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A1A3R13	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A1A3R14	0757-0346	16	RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A1A3R15	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A1A3U1	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A3U2			NOT ASSIGNED		
A1A3U3	1820-0725	1	IC DGTL SN74 170 J MEMORY	01295	SN74170J
A1A3U4	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U5	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U6	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A3U7	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A1A3U8	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A3U9	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U10	1820-0913		IC DGTL SN74L 122 N MULTIVIBRATOR	01295	SN74L122N
A1A3U11	1820-0904	1	IC DGTL COMPARATOR	07263	93L24DC
A1A3U12			NOT ASSIGNED		
A1A3U13	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A3U14	1820-0596		IC DGTL DM74L 74N FLIP-FLOP	27014	DM74L74N
A1A3U15	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A3U16	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U17	1820-0710		IC DGTL MULTIPLEXER	07263	93L22DC
A1A3U18	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A3U19	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A3U20	1820-0055		IC DGTL SN74 90 N COUNTER	01295	SN7490N
A1A3U21	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A3U22	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A3U23	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A3U24	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A3U25	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A3U26	1820-0256		IC DGTL MC 858P BUFFER	04713	MC858P
A1A3U27	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A3U28	1820-0903	8	IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A3U29	1820-0065	1	IC DGTL SN74 70 N FLIP-FLOP	01295	SN7470N
A1A3U30	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U31	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A3U32	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A3U33	1820-0069		IC DGTL SN74 20 N GATE	01295	SN7420N
A1A3U34	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A3U35	1820-0068	12	IC DGTL SN74 10 N GATE	01295	SN7410N
A1A3U36	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A3U37	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A3U38	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A3U39	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A4	08660-60197	1	BOARD ASSY, ROM INPUT	28480	08660-60197
A1A4C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A4C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A4C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A4C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A4C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A4CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1A4DS1	1990-0326	7	PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS2	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS3	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS4	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS5	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS6	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4DS7	1990-0326		PHOTO-DEVICE; SW PNP-SI 3V .05MW PD	28480	1990-0326
A1A4R1	0698-3153	17	RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R2	0698-3445	34	RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R3	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R4	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R5	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R6	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R7	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R8	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R9	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R10	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R11	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R12	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R13	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R14	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R15	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R16	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4R17	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A1A4R18	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A1A4S1	3101-0137	4	SWITCH-SENS SPDT SUBMIN .5A 28VDC	91929	1SX1-T
A1A4TP1	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP2	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP3	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP4	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP5	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP6	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP7	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP8	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP9	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4TP10	0360-1514		TERMINAL; SLDR STUD	28480	0360-1514
A1A4U1	1820-0070	5	IC DGTL SN74 30 N GATE	01295	SN7430N
A1A4U2	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A4U3	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A4U4	1820-0076	4	IC DGTL SN74 76 N FLIP-FLOP	01295	SN7476N
A1A4U5	1820-0076		IC DGTL SN74 76 N FLIP-FLOP	01295	SN7476N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A4U6	1820-0076		IC DGTL SN74 76 N FLIP-FLOP	01295	SN7476N
A1A4U7	1820-0076		IC DGTL SN74 76 N FLIP-FLOP	01295	SN7476N
A1A4U8	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A4U9	1820-0640	7	IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U10	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A1A4U11	1816-0421	1	IC DGTL MEMORY	28480	1816-0421
A1A4U12	1816-0422	1	IC DGTL MEMORY	28480	1816-0422
A1A4U13	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A4U14	1820-0595		IC DGTL DM74L 73N FLIP-FLOP	27014	DM74L73N
A1A4U15	1820-0595		IC DGTL DM74L 73N FLIP-FLOP	27014	DM74L73N
A1A4U16	1820-0595		IC DGTL DM74L 73N FLIP-FLOP	27014	DM74L73N
A1A4U17	1816-0423	1	IC DGTL MEMORY	28480	1816-0423
A1A4U18	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U19	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U20	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U21	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U22	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A4U23	1820-0640		IC DGTL SN74 150 N MULTIPLEXER	01295	SN74150N
A1A5	08660-60259	1	BOARD ASSY, ROM OUTPUT	28480	08660-60259
A1A5C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5C6	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A5U1	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A5U2	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A5U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A5U4	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A5U5	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A5U6	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A5U7	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A1A5U8	1820-0495		IC DGTL DECODER	07263	9311DC
A1A5U9	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A5U10	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A5U11	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A5U12	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A5U13	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A5U14	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A5U15	1820-0069		IC DGTL SN74 20 N GATE	01295	SN7420N
A1A5U16	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A1A5U17	1820-0495		IC DGTL DECODER	07263	9311DC
A1A5U18	1820-0716	1	IC DGTL SN74 161 N COUNTER	01295	SN74161N
A1A5U19	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A5U20	1820-0587		IC DGTL DM74L 10N GATE	27014	DM74L10N
A1A5U21	1820-0587		IC DGTL DM74L 10N GATE	27014	DM74L10N
A1A5U22	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A5U23	1820-0069		IC DGTL SN74 20 N GATE	01295	SN7420N
A1A5U24	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A1A5U25	1820-0495		IC DGTL DECODER	07263	9311DC
A1A6	08660-60198	1	BOARD ASSY, REGISTER	28480	08660-60198
A1A6C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C6	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C7	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C8	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A6C9	0180-1735	2	CAPACITOR-FXD; .22UF+-10% 35VDC TA	56289	150D224X9035A2
A1A6C10	0180-1735		CAPACITOR-FXD; .22UF+-10% 35VDC TA	56289	150D224X9035A2
A1A6R1	0698-7236	3	RESISTOR 1K 2% .05W F TUBULAR	24546	C3-1/8-T0-1001-G
A1A6R2	0698-7236		RESISTOR 1K 2% .05W F TUBULAR	24546	C3-1/8-T0-1001-G
A1A6U1			NOT ASSIGNED		
A1A6U2	1820-0379	1	IC DGTL SN74H 52 N GATE	01295	SN74H52N
A1A6U3	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A6U4	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A6U5	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A6U6	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A6U7	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U8	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U9	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U10	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A6U11	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A1A6U12	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A6U13	1820-0903		IC DGTL SN74L 164 N REGISTER	01295	SN74L164N
A1A6U14	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A6U15	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U16	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U17	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U18	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A6U19	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A6U20	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U21	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A6U22	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A6U23	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A6U24	1820-0583	4	IC DGTL DM74L 00N GATE	27014	DM74L00N
A1A6U25	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A6U26	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U27	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U28	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U29	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U30	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U31	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A6U32	1820-0583		IC DGTL DM74L 00N GATE	27014	DM74L00N
A1A6U33	1820-0587		IC DGTL DM74L 10N GATE	27014	DM74L10N
A1A6U34	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U35	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A6U36	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U37	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U38	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A6U39	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A6U40	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A7	08660-60151	1	BOARD ASSY, ALU	28480	08660-60151
A1A7C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A7C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A7C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A7R1	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A7R2	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A7R3	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A7R4	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A1A7R5	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A1A7R6	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A1A7U1	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A7U2	1820-0778	1	IC DGTL COUNTER	07263	93L16DC
A1A7U3	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A7U4	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A7U5	1820-0305	3	IC DGTL SN74 83 N ADDER	01295	SN7483N
A1A7U6	1820-0305		IC DGTL SN74 83 N ADDER	01295	SN7483N
A1A7U7	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A1A7U8	1820-0710		IC DGTL MULTIPLEXER	07263	93L22DC
A1A7U9	1816-0268	1	IC;DGTL;MEMORY	28480	1816-0268
A1A7U10	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A7U11	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A7U12	1820-0740	2	IC DGTL SN74H 87 N DGTL	01295	SN74H87N
A1A7U13	1820-0661		IC DGTL SN74 32 N GATE	01295	SN7432N
A1A7U14	1820-0740		IC DGTL SN74H 87 N DGTL	01295	SN74H87N
A1A7U15	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A7U16	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A7U17	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A7U18	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A7U19	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A1A7U20	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A7XA1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A8	08660-60180	1	BOARD ASSY, SWEEP COUNT	28480	08660-60180
A1A8C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A8C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A8C3	0180-0218	1	CAPACITOR-FXD; .15UF+-10% 35VDC TA	56289	150D154X9035A2
A1A8Q1	1854-0071	13	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1A8R1	0698-3154	21	RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R2	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R3	0757-1100	1	RESISTOR 600 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-601-F
A1A8R4	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R5	0757-0465	6	RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A8R6	0757-0472	6	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A1A8R7	0698-6248	3	RESISTOR 400K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4003-F
A1A8R8	0698-6248		RESISTOR 400K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4003-F
A1A8R9	0757-0439	12	RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A1A8R10	0698-7090	1	RESISTOR 4.5K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4502-F
A1A8R11	2100-3122	4	RESISTOR; VAR; TRMR; 100 OHM 10% C	32997	3006Y-1-101
A1A8R12	0698-6248		RESISTOR 400K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4003-F
A1A8R13	0757-0420	9	RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A1A8R14	0757-0274	8	RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A1A8R15	0757-0442	105	RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A1A8R16	0757-0449	3	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A1A8R17	0698-4008	1	RESISTOR 40K 1% .125W F TUBULAR	16299	C4-1/8-T0-4002-F
A1A8R18	0698-3201	1	RESISTOR 80K 1% .125W F TUBULAR	16299	C4-1/8-T0-8002-F
A1A8R19	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1A8R20	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R21	0757-0422	2	RESISTOR 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A1A8R22	0757-0283	1	RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A1A8R23	0698-5808	1	RESISTOR 4K 1% .125W F TUBULAR	24546	C4-1/8-T0-4001-F
A1A8R24	0698-3200	1	RESISTOR 8K 1% .125W F TUBULAR	16299	C4-1/8-T0-8001-F
A1A8R25	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A1A8R26	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R27	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A1A8R28	2100-3122		RESISTOR; VAR; TRMR; 100 OHM 10% C	32997	3006Y-1-101
A1A8R29	2100-3122		RESISTOR; VAR; TRMR; 100 OHM 10% C	32997	3006Y-1-101
A1A8R30	2100-3122		RESISTOR; VAR; TRMR; 100 OHM 10% C	32997	3006Y-1-101
A1A8U1	1826-0013	1	IC LIN AMPLIFIER	28480	1826-0013
A1A8U2	1820-0583		IC DGTL DM74L 00N GATE	27014	DM74L00N
A1A8U3	1820-0583		IC DGTL DM74L 00N GATE	27014	DM74L00N
A1A8U4	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A1A8U5	1820-0546	3	IC DGTL SN74 192 N COUNTER	01295	SN74192N
A1A8U6	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A1A8U7	1820-0577	3	IC DGTL SN74 16 N INVERTER	01295	SN7416N
A1A8U8	1820-0546		IC DGTL SN74 192 N COUNTER	01295	SN74192N
A1A8U9	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A8U10	1820-0546		IC DGTL SN74 192 N COUNTER	01295	SN74192N
A1A8U11	1820-0577		IC DGTL SN74 16 N INVERTER	01295	SN7416N
A1A8U12	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A1A8U13	1820-0577		IC DGTL SN74 16 N INVERTER	01295	SN7416N
A1A9	08660-60199	1	BOARD ASSY, REGISTER "A"	28480	08660-60199
A1A9C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A9C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A9C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A9C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A9U1	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A9U2	1820-0709		IC DGTL REGISTER	07263	93L28DC
A1A9U3	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A9U4	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A9U5	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A9U6	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A9U7	1820-0659		IC DGTL REGISTER	07263	93L00DC
A1A9U8	1820-0710		IC DGTL MULTIPLEXER	07263	93L22DC
A1A9U9	1820-0305		IC DGTL SN74 83 N ADDER	01295	SN7483N
A1A9U10	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A9U11	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A9U12	1820-0372		IC DGTL SN74H 11 N GATE	01295	SN74H11N
A1A9U13	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A9U14	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A9U15	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A9U16	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A1A10	08660-60128	1	BOARD ASSY, OUTPUT REGISTER	28480	08660-60128
A1A10C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A10C2	0140-0196		CAPACITOR-FXD 150PF +-5% 300WVDC MICA	72136	DM15F151J0300WV1CR
A1A10C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1A10R1	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A1A10R2	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A1A10U1	1820-0627	1	IC DGTL DECODER	07263	93L01DC
A1A10U2	1820-0535	1	IC DGTL SN75 451BP DRIVER	01295	SN75451BP
A1A10U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A1A10U4	1820-0614	5	IC DGTL LATCH	07263	93L08DC
A1A10U5	1820-0614		IC DGTL LATCH	07263	93L08DC
A1A10U6	1820-0614		IC DGTL LATCH	07263	93L08DC
A1A10U7	1820-0614		IC DGTL LATCH	07263	93L08DC
A1A10U8	1820-0614		IC DGTL LATCH	07263	93L08DC

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A11	08660-60257	1	BOARD ASSY, INTERCONNECT	28480	08660-60257
A1A11C1	0160-3452	1	CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3452
A1A11C2	0160-3879	4	CAPACITOR-FXD .01UF +-20% 100WVDC CER	28480	0160-3879
A1A11C3	0160-3879		CAPACITOR-FXD .01UF +-20% 100WVDC CER	28480	0160-3879
A1A11J1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A11J2	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A11J3	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A11J4	1250-1255	7	CONNECTOR-RF SMB M PC	98291	51-051-0000
A1A11J5	1251-2361	3	CONTACT, CONN, U/W POST TYPE SER, MALE	24995	86091-2
A1A11J6	1251-2361		CONTACT, CONN, U/W POST TYPE SER, MALE	24995	86091-2
A1A11TP1	0360-1514		TERMINAL; SLDR STUD'	28480	0360-1514
A1A11XA1-1	1251-2035	33	CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA1-2	1251-2026	10	CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA2-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA2-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA3-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA3-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA4-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA4-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA5-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA5-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA6-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA6-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA7-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA7-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA8-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA8-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA9-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA9-2	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A11XA10	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A1A11XA10	1251-2026		CONNECTOR; PC EDGE; 18-CONT; DIP SOLDER	71785	252-18-30-300
A1A12	08660-60190	1	BOARD ASSY, NUMERIC READOUT	28480	08660-60190
A1A12C1	0180-0228	16	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A1A12C2	0180-1714		CAPACITOR-FXD; 330UF+-10% 6VDC TA-SOLID	56289	150D337X9006S2
A1A12C3	0160-2055	152	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A1A12C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A1A12DS1	2140-0356	4	LAMP;INCAND BULB TI; 5V	71744	CM7-76B3
A1A12DS2	2140-0356		LAMP;INCAND BULB TI; 5V	71744	CM7-76B3
A1A12DS3	2140-0356		LAMP;INCAND BULB TI; 5V	71744	CM7-76B3
A1A12DS4	2140-0356		LAMP;INCAND BULB TI; 5V	71744	CM7-76B3
A1A12J1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A12J2	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A12Q1	1854-0492	20	TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q2	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q3	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q4	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q5	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q6	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q7	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q8	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q9	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q10	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q11	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q12	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q13	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q14	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q15	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q16	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q17	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q18	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q19	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12Q20	1854-0492		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A1A12R1	0698-7208	4	RESISTOR 68.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-68R1-G
A1A12R2	0698-7208		RESISTOR 68.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-68R1-G
A1A12R3	0698-7208		RESISTOR 68.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-68R1-G
A1A12R4	0698-7208		RESISTOR 68.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-68R1-G
A1A12S1	3101-0137		SWITCH-SENS SPDT SUBMIN .5A 28VDC	91929	1SX1-T
A1A12S2	3101-0137		SWITCH-SENS SPDT SUBMIN .5A 28VDC	91929	1SX1-T
A1A12S3	3101-0137		SWITCH-SENS SPDT SUBMIN .5A 28VDC	91929	1SX1-T
A1A12U1	1820-0571	2	IC DGTL GENERATOR	28480	1820-0571
A1A12U2	1820-0571		IC DGTL GENERATOR	28480	1820-0571
A1A12U3	1990-0311	2	DISPLAY NUM DOT MAT 6 CHAR .273 IN HIGH	28480	1990-0311
A1A12U4	1990-0311		DISPLAY NUM DOT MAT 6 CHAR .273 IN HIGH	28480	1990-0311
A1A12U5	1820-1060	1	IC DGTL SCANNER	28480	1820-1060

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A12XU3	1200-0481	2	SOCKET, ELEC, IC 36-CONT DIP SLDR TERM	28480	1200-0481
A1A12XU4	1200-0481		SOCKET, ELEC, IC 36-CONT DIP SLDR TERM	28480	1200-0481
	1251-1556	6	CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A13	08660-60159	1	BOARD ASSY, ANNUNCIATOR BLOCK	28480	08660-60159
A1A13DS1	2140-0356		LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
A1A13DS2	2140-0356		LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
A1A13DS3	2140-0356		LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
A1A13DS4	2140-0356		LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
A1A13DS5	2140-0356		LAMP; INCAND; BULB T1; 5V	71744	CM7-7683
A1A13TP1	0362-0063	6	TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13TP2	0362-0063		TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13TP3	0362-0063		TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13TP4	0362-0063		TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13TP5	0362-0063		TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13TP6	0362-0063		TERMINAL, CRP, QDISC FEM, 0.046 TAB,	91886	122-0192-019
A1A13XA1	1251-1556		CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A13XA2	1251-1556		CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A13XA3	1251-1556		CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A13XA4	1251-1556		CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A13XA5	1251-1556		CONNECTOR;1-CONT SKT .04 DIA	28480	1251-1556
A1A14	08660-60114	1	SWITCH ASSY, SWEEP	28480	08660-60114
A1A14J1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
A1A15	08660-60113	1	SWITCH ASSY, KEYBOARD	28480	08660-60113
A1A15J1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
			MISCELLANEOUS A1A15.		
	0570-0031	1	SCREW-MACH 4-40 RD HD SLT REC NYL-BLK	95987	N-440-1/2
	5040-0364	1	UPPER DECK	28480	5040-0364
	5001-0109	1	SPRING	28480	5001-0109
	5040-0365	1	LOWER DECK	28480	5040-0365
	5040-0366	1	FLIPPER	28480	5040-0366
	5040-0367	1	ACTUATOR	28480	5040-0367
	5040-6901	1	KEY:DEC POINT	28480	5040-6901
	5040-6902	1	KEY:NUMBER 1	28480	5040-6902
	5040-6903	1	KEY NUMBER 2	28480	5040-6903
	5040-6904	1	KEY NUMBER 3	28480	5040-6904
	5040-6905	1	KEY NUMBER 4	28480	5040-6905
	5040-6906	1	KEY NUMBER 5	28480	5040-6906
	5040-6907	1	KEY NUMBER 6	28480	5040-6907
	5040-6908	1	KEY NUMBER 7	28480	5040-6908
	5040-6909	1	KEY NUMBER 8	28480	5040-6909
	5040-6910	1	KEY NUMBER 9	28480	5040-6910
	5040-6911	1	KEY NUMBER 0	28480	5040-6911
	5040-6912	1	KEY:CLEAR KEYBOARD	28480	5040-6912
	5040-6913	1	KEY:STEP UP	28480	5040-6913
	5040-6914	1	KEY:STEP DOWN	28480	5040-6914
	5040-6915	1	KEY:SWEEP WIDTH	28480	5040-6915
	5040-6916	1	KEY:CONTROL FREQUENCY	28480	5040-6916
	5040-6917	1	KEY:HZ	28480	5040-6917
	5040-6918	1	KEY:MHZ	28480	5040-6918
	5040-6919	1	KEY:KHZ	28480	5040-6919
	5040-6920	1	KEY:GHZ	28480	5040-6920
A1A16	08660-60115	1	SWITCH ASSY, MANUAL MODE	28480	08660-60115
A1A16J1	1200-0507		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	06776	ICN-163-S3W
	0330-0187	1	INSULATOR, MYLAR 3" W X 4" LG	000BM	OBD
A1A17	08660-60123	1	TUNER ASSY, MANUAL MODE	28480	08660-60123
A2	08660-60020	1	BOARD ASSY, INTERCONNECTION	28480	08660-60020
A2C1	0160-3456	30	CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C2	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C3	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C4	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C5	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C6	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C7	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C8	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2C11	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C12	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C13	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C14	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C15	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C16	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C17	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C18	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C19	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C20	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C23	0160-2055		CAPACITOR-FXD .01UF, +80-20% 100WVDC CER	28480	0160-2055
A2C24	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C25	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C26	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C27	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C28	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C29	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C30	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C31	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C32	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C33	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C34	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C35	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C36	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C37	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C38	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C39	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C40	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A2C41	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C42	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C43	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2C44	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A2J1	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A2J2	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A2J3	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A2J4	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A2W2	08660-60080		CABLE ASSY, GRAY	28480	08660-60080
A2XA8-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA8-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA9-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA10-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA10-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA11-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA11-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA12-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA12-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA13-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA13-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA14-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA14-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA15-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA15-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA16-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA16-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA17-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA17-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA18-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA18-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA19-1	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A2XA19-2	1251-2035		CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-300
A3A1	08660-60028	1	BOARD ASSY, DIGITAL INTERFACE(FRONT)	28480	08660-60028
A3A1C1	0160-0154	3	CAPACITOR-FXD 2200PF +-10% 200WVDC POLYE	56289	292P22292
A3A1C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C5	0180-1746	3	CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A3A1C6	0180-0373	1	CAPACITOR-FXD; .68UF+-10% 35VDC TA	56289	150D684X9035A2
A3A1CR1	1902-3059	1	DIODE-ZNR 3.83V 5% DO-7 PD=.4W TC=	04713	SZ 10939-62
A3A1CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3A1Q1	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A3A1Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A1Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A1Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A1R1	0698-3157	5	RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A3A1R2	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A3A1R3	0698-3435	1	RESISTOR 38.3 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-38R3-F
A3A1R4	0757-0394	27	RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A3A1R5	0757-0279	31	RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A1R6	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R7	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R8	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R11	0757-0399	13	RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R12	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R13	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R14	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R15	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R16	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R17	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R18	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R19	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A3A1R20	0757-0278	4	RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A3A1U1	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A3A1U2	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A3A1U3	1820-0069		IC DGTL SN74 20 N GATE	01295	SN7420N
A3A1U4	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A3A1U5	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A3A1U6	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A3A1U7	1820-0328		IC DGTL SN74 02 N GATE	01295	SN7402N
A3A1U8	1820-0207	1	IC DGTL MULTIVIBRATOR	07263	9601PC
A3A1U9	1820-0072	2	IC DGTL SN74 50 N GATE	01295	SN7450N
A3A1U10	1820-0072		IC DGTL SN74 50 N GATE	01295	SN7450N
A3A1XA1	1251-1626	3	CONNECTOR; PC EDGE; 12-CONT; DIP SOLDER	71785	252-12-30-300
A3A1XA2	1251-2361		CONTACT, CONN, U/W POST TYPE SER, MALE (40 CONTACTS)	24995	86091-2
A3A1XA3	1251-2663	3	CONNECTOR; PC EDGE; 18-CONT; SOLDER EYE	05574	3VH18/1JN5
A3A1XA4	1251-1626		CONNECTOR; PC EDGE; 12-CONT; DIP SOLDER	71785	252-12-30-300
A3A1XA5	1251-2663		CONNECTOR; PC EDGE; 18-CONT; SOLDER EYE	05574	3VH18/1JN5

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

OPTION 005

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3A1	08660-60188	1	BOARD ASSY, HP IB OUTPUT	28480	08660-60188
A3A1C1	0180-0373	1	CAPACITOR-FXD; .68UF+-10% 35VDC TA	56289	150D684X9035A2
A3A1C2	0180-1746	1	CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A3A1C3	0180-0197	6	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C4	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A1C6	0160-0301	1	CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392
A3A1CR1	1901-0040	1	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3A1CR2	1902-3059	1	DIODE-ZNR 3.83V 5% DO-7 PD=.4W TC=	04713	SZ 10939-62
A3A1J1	1251-2194	2	CONNECTOR;1-CONT SKT .021 DIA	00779	3-331272-0
A3A1J2	1251-2194		CONNECTOR;1-CONT SKT .021 DIA	00779	3-331272-0
A3A1Q1	1853-0020	1	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A3A1Q2	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A1R1	0757-0442	4	RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R2	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R3	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R4	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3A1R5	0757-0279	1	RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A1R6	0757-0394	1	RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A3A1R7	0698-7210	9	RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R8	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R9	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R10	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R11	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R12	0757-0278	1	RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A3A1R13	0698-3435	1	RESISTOR 38.3 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-38R3-F
A3A1R14	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R15	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R16	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R17	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A3A1R18	0698-3160	1	RESISTOR 31.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-3162-F
A3A1U1	1820-0511	3	IC DGTL SN74 08 N GATE	01295	SN7408N
A3A1U2	1820-0134	1	IC DGTL REGISTER	07263	9300DC
A3A1U3	1820-0054	3	IC DGTL SN74 00 N GATE	01295	SN7400N
A3A1U4	1820-0214	1	IC DGTL SN74 42 N DECODER	01295	SN7442N
A3A1U5	1820-0328	1	IC DGTL SN74 02 N GATE	01295	SN7402N
A3A1U6	1820-0579	1	IC DGTL SN74 123 N MULTIVIBRATOR	01295	SN74123N
A3A1U7	1820-0076	1	IC DGTL SN74 76 N FLIP-FLOP	01295	SN7476N
A3A1U8	1820-0372	1	IC DGTL SN74H 11 N GATE	01295	SN74H11N
A3A1U9	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A3A1U10	1820-0174	3	IC DGTL SN74 04 N INVERTER	01295	SN7404N
A3A2	08660-60192	1	BOARD ASSY, HP IB INPUT	28480	08660-60192
A3A2C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C4	0160-0157	3	CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A3A2C5	0160-0157		CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A3A2C6	0160-0157		CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A3A2R1	0757-0403	3	RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A3A2R2	0757-0403		RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A3A2R3	0757-0403		RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A3A2U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A3A2U2	1820-0621	1	IC DGTL SN74 38 N BUFFER	01295	SN7438N
A3A2U3	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A3A2U4	1820-0070	3	IC DGTL SN74 30 N GATE	01295	SN7430N
A3A2U5	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A3A2U6	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A3A2U7	1820-1053	2	IC DGTL SN74 14 N SCHMITT TRIGGER	01295	SN7414N
A3A2U8	1810-0136	2	NETWORK-RES 10-PIN SIP .1-PIN-SPCG	28480	1810-0136
A3A2U9	1820-0077	1	IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A3A2U10	1820-0511		IC DGTL SN74 08 N GATE	01295	SN7408N
A3A2U11	1820-0174		IC DGTL SN74 04 N INVERTER	01295	SN7404N
A3A2U12	1820-0070		IC DGTL SN74 30 N GATE	01295	SN7430N
A3A2U13	1820-1053		IC DGTL SN74 14 N SCHMITT TRIGGER	01295	SN7414N
A3A2U14	1810-0136		NETWORK-RES 10-PIN SIP .1-PIN-SPCG	28480	1810-0136
J3A1	08660-60187	1	CABLE, ADAPTER, HP IB(INCLUDES MP1 THRU MP6)	28480	08660-60187
J3A1MP1	0380-1036	2	STANDOFF-HEX M/FEM .255-LG 6-32-THD	28480	0380-1036
J3A1MP2	1251-0483	2	CONNECTOR, 36-CONT, MALE, MICRO RIBBON	71785	57-10360-375
J3A1MP3	1251-3283	2	CONNECTOR; 24-CONT; FEM; MICRORIBBON	28480	1251-3283
J3A1MP4	08660-00060	2	MOUNT, HPIB CONNECTOR	28480	08660-00060
J3A1MP5	08660-20165	2	COVER, HPIB ADAPTER	28480	08660-20165
J3A1MP6	08660-20166	2	SPACER, CONNECTOR	28480	08660-20166

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3A2	08660-60029	1	BOARD ASSY, DIGITAL INTERFACE(REAR)	28480	08660-60029
A3A2C1	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C2	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C3	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3A2C4	0160-2219	1	CAPACITOR-FXD 1100PF +-5% 300WVDC MICA	28480	0160-2219
A3A2Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A2Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3A2R1	0757-0421	26	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R2	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R3	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R4	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R5	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R6	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R7	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R8	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R9	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R10	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R11	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R12	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R13	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R14	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R15	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R16	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R17	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R18	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R19	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R20	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R21	0757-0416	29	RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A3A2R22	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R23	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R24	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R25	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R26	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3A2R27	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R28	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3A2R29	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2R30	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A3A2U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A3A2U2	1820-0301	2	IC DGTL SN74 75 N LATCH	01295	SN7475N
A3A2U3	1820-0256		IC DGTL MC 858P BUFFER	04713	MC858P
A3A2U4	1820-0301		IC DGTL SN74 75 N LATCH	01295	SN7475N
A3A3	08660-60025	1	BOARD ASSY, DIGITAL INTERCONNECT	28480	08660-60025
A3A3J1	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A3A3J2	1250-1255		CONNECTOR-RF SMB M PC	98291	51-051-0000
A4	08660-60042	1	LOOP ASSY, H.F.	28480	08660-60042
A4C1	0160-2437	23	CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C2	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C3	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C4	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C5	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C6	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C7	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C8	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C9	0160-3744	6	CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C10	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C11	0160-3744		CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C12	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C13	0160-3744		CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C14	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C15	0160-3744		CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C16	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C17	0160-3744		CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C18	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C19	0160-3744		CAPACITOR-FXD 1000PF +80-20% 200WVDC CER	28480	0160-3744
A4C20	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C21	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C22	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A4C23	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4J1	1250-0901	18	CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J2	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J3	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J4	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J5	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J6	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J7	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J8	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J9	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J10	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J11	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J12	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J13	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4J14	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A4L1	9140-0144	4	COIL; FXD; MOLDED RF CHOKE; 4.7UH 10%	24226	10/471
A4W1	08660-60080		CABLE ASSY, GRAY	28480	08660-60080
A4W2	08660-60050	1	CABLE ASSY, GRAY	28480	08660-60050
A4W3	08660-60063	1	CABLE ASSY, GRAY	28480	08660-60063
A4W4	08660-60055	1	CABLE ASSY, GRAY	28480	08660-60055
			MISCELLANEOUS A4.		
	08660-00014	1	COVER, REF. OSC.	28480	08660-00014
	08660-00015	1	COVER, REF. DIVIDER	28480	08660-00015
	08660-00016	1	COVER, REF. PHASE DETECTOR	28480	08660-00016
	08660-00017	1	COVER, DIVIDE BY TWO.	28480	08660-00017
	08660-00018	1	COVER, PRETUNE	28480	08660-00018
	08660-00019	1	COVER, VCO	28480	08660-00019
	08660-00020	1	COVER, PHASE DETECTOR	28480	08660-00020
	08660-20063	1	HOUSING, H.F. LP	28480	08660-20063
A4A1	08660-60003	1	BOARD ASSY, REF. DIVIDER	28480	08660-60003
A4A1C1	0160-2201	1	CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A4A1C2	0180-0116	7	CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A4A1C3	0180-0229	11	CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A4A1C4	0160-2199	1	CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A4A1C5	0160-0154		CAPACITOR-FXD 2200PF +-10% 200WVDC POLYE	56289	292P22292
A4A1C6	0160-0154		CAPACITOR-FXD 2200PF +-10% 200WVDC POLYE	56289	292P22292
A4A1C7	0160-0297	2	CAPACITOR-FXD 1200PF +-10% 200WVDC POLYE	56289	292P12292
A4A1CR1	1902-0048	1	DIODE-ZNR 6.81V 5% DO-7 PD=.4W	28480	1902-0048
A4A1L1	9100-1642	2	COIL; FXD; MOLDED RF CHOKE; 270UH 5%	24226	19/273
A4A1L2	9100-1642		COIL; FXD; MOLDED RF CHOKE; 270UH 5%	24226	19/273
A4A1L3	9140-0144		COIL; FXD; MOLDED RF CHOKE; 4.7UH 10%	24226	10/471
A4A1Q1	1854-0019	15	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A1Q2	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A1Q3	1854-0045	4	TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0045
A4A1R1	0757-0444	13	RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4A1R2	0698-3622	1	RESISTOR 120 OHM 5% 2W MO TUBULAR	24546	FP42-2-T00-120R-J
A4A1R3	0698-0083	40	RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A1R4	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A1R5	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A1R6	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A1R7	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A1R8	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A1R9	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A1R10	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A1R11	0698-3441	17	RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A1R12	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A1R13	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A1R14	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A1U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A4A1U2	1820-0055		IC DGTL SN74 90 N COUNTER	01295	SN7490N
A4A1U3	1820-0055		IC DGTL SN74 90 N COUNTER	01295	SN7490N
A4A2	08660-60002	1	BOARD ASSY,REF. PHASE DETECTOR	28480	08660-60002
A4A2C1	0180-0100	1	CAPACITOR-FXD; 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A4A2C2	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A4A2C3	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A4A2C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C5	0180-1746		CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A4A2C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C8	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C9	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A4A2C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A2C11*	0140-0191	1	CAPACITOR-FXD 56PF +-5% 300WVDC MICA * FACTORY SELECTED PART	72136	DM15E560J0300WV1CR
A4A2C12	0160-2308	1	CAPACITOR-FXD 36PF +-5% 300WVDC MICA	28480	0160-2308
A4A2C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C16	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C18	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C20	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A4A2C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2C22	0180-1743	1	CAPACITOR-FXD; .1UF+-10% 35VDC TA-SOLID	56289	150D104X9035A2
A4A2C23	0160-3537	2	CAPACITOR-FXD 680PF +-5% 100WVDC MICA	28480	0160-3537
A4A2C24	0160-2205	3	CAPACITOR-FXD 120PF +-5% 300WVDC MICA	28480	0160-2205
A4A2C25	0160-2218	3	CAPACITOR-FXD 1000PF +-5% 300WVDC MICA	28480	0160-2218
A4A2C26	0180-2205	1	CAPACITOR-FXD; .33UF+-10% 35VDC TA	56289	150D334X9035A2
A4A2C27	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A2CR1	1902-0041	7	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A2CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A4A2CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A4A2CR4	1901-0179	6	DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A4A2CR5	1901-0179		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A4A2L1	9100-1629	28	COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A4A2L2	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A4A2L3	9100-2260	2	COIL; FXD; MOLDED RF CHOKE; 1.8UH 10%	76493	9230-26
A4A2L4	9140-0129	2	COIL; FXD; MOLDED RF CHOKE; 220UH 5%	24226	15/223
A4A2L5	9140-0237	1	COIL; FXD; MOLDED RF CHOKE; 200UH 5%	24226	15/203
A4A2Q1	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2Q2	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2Q3	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2Q4	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2Q5	1853-0015	6	TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A4A2Q6	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2Q7	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A4A2Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4A2Q9	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4A2Q10	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4A2Q11	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A2R1	0698-3440	24	RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A2R2	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-100R-F
A4A2R3	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A2R4	0757-0441	17	RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A2R5	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A2R6	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A2R7	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A2R8	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A2R9	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A4A2R10	0698-3156	8	RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A4A2R11	0757-1090	1	RESISTOR 261 OHM 1% .5W F TUBULAR	19701	MF7C1/2-T0-261R-F
A4A2R12	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A2R13	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A2R14	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A2R15	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A2R16	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A4A2R17	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A2R18	0698-0084	12	RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A2R19	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A2R20	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A4A2R21	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A2R22	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A2R23	0698-3438	9	RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A2R24	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A2R25	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A2R26	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A2R27	0757-0418	6	RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F
A4A2R28	0698-3158	3	RESISTOR 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A4A2R29	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A4A2R30	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A4A2R31	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A2R32	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A2R33	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A2R34	0698-3453	1	RESISTOR 196K 1% .125W F TUBULAR	16299	C4-1/8-T0-1963-F
A4A2R35	0698-3260	1	RESISTOR 464K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4643-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A2R36	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A4A2R37	0757-0290	6	RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A4A2R38	0698-3444	20	RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A2R39	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A4A2R40	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A2R41	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A4A2R42	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A2R43	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A4A2R44	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A2R45	0757-0419		RESISTOR 681 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-681R-F
A4A2R46	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A2R47	0698-3446	6	RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A4A2U1	1820-0370	1	IC DGTL SN74H 00 N GATE	01295	SN74H00N
			MISCELLANEOUS A4A2.		
	9170-0029	1	CORE, MAG, SHIELDING BEAD, .138 OD .047	02114	56-590-65A2/4A
A4A3	08660-60004	1	BOARD ASSY, REF. DIVIDE BY TWO.	28480	08660-60004
A4A3C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C2	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A4A3C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C4	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A4A3C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C8	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C11	0160-0978	1	CAPACITOR-FXD 1500PF +-1% 500WVDC MICA	28480	0160-0978
A4A3C12	0160-2534	1	CAPACITOR-FXD 300PF +-1% 300WVDC MICA	28480	0160-2534
A4A3C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C15	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A4A3C16	0140-0197	1	CAPACITOR-FXD 180PF +-5% 300WVDC MICA	72136	DM15F181J0300WV1CP
A4A3C17	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A4A3C18	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A3C19	0140-0194	1	CAPACITOR-FXD 110PF +-5% 300WVDC MICA	72136	DM15F111J0300WV1CR
A4A3CR1	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A3L1	9100-0348	2	COIL, FXD, MOLDED RF CHOKE, 1UH 1%	24226	9378
A4A3L2	9100-0348		COIL, FXD, MOLDED RF CHOKE, 1UH 1%	24226	9378
A4A3Q1	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A3Q2	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A3Q3	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A3Q4	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A3Q5	1854-0345	8	TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A4A3R1	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A3R2	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4A3R3	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A3R4	0757-0814	1	RESISTOR 511 OHM 1% .5W F TUBULAR	19701	MF7C1/2-T0-511R-F
A4A3R5	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A3R6	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A4A3R7	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A3R8	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A3R9	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A3R10	0698-3434	2	RESISTOR 34.8 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-34R8-F
A4A3R11	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A3R12	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4A3R13	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A3R14	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A3R15	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A4A3R16	0698-3429	1	RESISTOR 19.6 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-19R6-F
A4A3R17	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A3R18	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4A3R19	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A3R20	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A3R21	0757-0418		RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F
A4A3R22	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A3R23	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4A3R24	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A3R25	0757-0397	5	RESISTOR 68.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-68R1-F
A4A3R26	0757-0418		RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A3U1	1820-0469	3	IC DGTL SN74H 102 N FLIP-FLOP	01295	SN74H102N
A4A4	08660-60001	1	BOARD ASSY,REF. VCO	28480	08660-60001
A4A4C1	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A4A4C2	0121-0451	3	CAPACITOR; VAR; TRMR; AIR; 1.7/11PF	74970	187-0106-005
A4A4C3	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A4A4C4	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A4A4C5	0160-0214	1	CAPACITOR-FXD 10PF +-5% 500WVDC CER	28480	0160-0214
A4A4C6	0160-2266	10	CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A4C7	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A4A4C8	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C10	0160-2306	1	CAPACITOR-FXD 27PF +-5% 300WVDC MICA	28480	0160-2306
A4A4C11	0140-0190	4	CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A4A4C12	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A4A4C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C16	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C17	0121-0046	1	CAPACITOR; VAR; TRMR; CER; 9/35PF	73899	DV11PS350
A4A4C18	0160-3879		CAPACITOR-FXD .01UF +-20% 100WVDC CER	28480	0160-3879
A4A4C19	0160-2327	4	CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-2327
A4A4C20	0140-0190		CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A4A4C21	0140-0190		CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A4A4C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C23	0121-0451		CAPACITOR; VAR; TRMR; AIR; 1.7/11PF	74970	187-0106-005
A4A4C24	0160-2327		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-2327
A4A4C25	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C27	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C28	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C29	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C30	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C31	0121-0451		CAPACITOR; VAR; TRMR; AIR; 1.7/11PF	74970	187-0106-005
A4A4C32	0160-2327		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-2327
A4A4C33	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C34	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C35	0140-0190		CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A4A4C36	0160-2307	1	CAPACITOR-FXD 47PF +-5% 300WVDC MICA	28480	0160-2307
A4A4C37	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C38	0160-2205		CAPACITOR-FXD 120PF +-5% 300WVDC MICA	28480	0160-2205
A4A4C39	0160-2205		CAPACITOR-FXD 120PF +-5% 300WVDC MICA	28480	0160-2205
A4A4C40	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A4C41	0121-0448	1	CAPACITOR; VAR; TRMR; CER; 2.5/5PF	0086S	5S-TRIKO-03, 2.5 -
A4A4CR1	0122-0287	1	DIO-VVC 10PF 5% C2/C20=2000000 MIN	04713	SMV389-287
A4A4CR2	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A4L1	9100-1623	1	COIL; FXD; MOLDED RF CHOKE; 27UH 5%	24226	15/272
A4A4L2	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A4A4L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A4A4L4	08660-80002	1	INDUCTOR	28480	08660-80002
A4A4L5	08660-80009	3	INDUCTOR	28480	08660-80009
A4A4L6	9100-2247	3	COIL; FXD; MOLDED RF CHOKE; .1UH 10%	24226	10/100
A4A4L7	9100-2247		COIL; FXD; MOLDED RF CHOKE; .1UH 10%	24226	10/100
A4A4L8			PART OF PRINTED CIRCUIT BOARD		
A4A4L9			PART OF PRINTED CIRCUIT BOARD		
A4A4L10	9100-2247		COIL; FXD; MOLDED RF CHOKE; .1UH 10%	24226	10/100
A4A4L11	9140-0158	1	COIL, FXD, MOLDED RF CHOKE, 1UH 10%	24226	10/101
A4A4L12	9100-2254	2	COIL; FXD; MOLDED RF CHOKE; .39UH 10%	24226	10/390
A4A4Q1	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A4Q2	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A4A4Q3	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A4A4Q4	1854-0431	9	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A4Q5	1854-0540	3	TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0540
A4A4Q6	1854-0540		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0540
A4A4Q7	1854-0540		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0540
A4A4Q8	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A4Q9	1854-0404	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A4A4R1	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A4R2	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A4R3	0757-0418		RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F
A4A4R4	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A4R5	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A4R6	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A4R7	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A4A4R8	0757-0278		RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A4A4R9	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A4R10	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A4A4R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A4R12	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A4R13	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A4R14	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A4R15	0757-0422		RESISTOR 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A4A4R16	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A4R17	0757-1094	8	RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A4R18	0698-3434		RESISTOR 34.8 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-34R8-F
A4A4R19	0757-0398	3	RESISTOR 75 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-75R0-F
A4A4R20	0764-0033	1	RESISTOR 33 OHM 5% 2W MO TUBULAR	24546	FP42-2-T00-3302-J
A4A4R21	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A4R22	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A4A4R23	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A4R24	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A4R25	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A4A4R26	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A4R27	0698-3155	16	RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A4A4R28	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A4A4R29	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A4R30	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-100R-F
A4A4R31	0757-0422		RESISTOR 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A4A4R32	0698-7195	1	RESISTOR 19.6 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-19R6-G
A4A4U1	1820-0714	1	IC DGTL PRESCALER	28480	1820-0714
A4A5	08660-60005	1	BOARD ASSY, VCO & AMPLIFIERS	28480	08660-60005
A4A5C1	0160-3878	21	CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C2	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C3	0121-0452	2	CAPACITOR; VAR; TRMR; AIR; 1.3/5.4PF	74970	187-0103-005
A4A5C4	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C5	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C6	0160-2250	2	CAPACITOR-FXD 5.1PF +-.25PF 500WVDC CER	28480	0160-2250
A4A5C7	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C8	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C9	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C10	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C11	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C12	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C13	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C14	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C15	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C16	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C17	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C18	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C19	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C20	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A5C21	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C22	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C23	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5C24	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A5CR1	0122-0248	1	DIO-VVC 1N5140A 10PF 5% C4/C60=2800000	04713	1N5140A
A4A5CR2	1901-1034	1	DIODE-STABISTOR 90V	03508	MPD400
A4A5FL1	08660-20038	1	FILTER, L.P. 600MHZ	28480	08660-20038
A4A5L1			PART OF PRINTED CIRCUIT BOARD		
A4A5L2	9100-2250	7	COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L3	08660-80006	4	INDUCTOR	28480	08660-80006
A4A5L4	08660-80006		INDUCTOR	28480	08660-80006
A4A5L5	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L6	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L7	08660-80006		INDUCTOR	28480	08660-80006
A4A5L8	08660-80006		INDUCTOR	28480	08660-80006
A4A5L9	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L10	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L11	08660-80009		INDUCTOR	28480	08660-80009
A4A5L12	08660-80009		INDUCTOR	28480	08660-80009
A4A5L13	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5L14	9100-2250		COIL; FXD; MOLDED RF CHOKE; .18UH 10%	24226	10/180
A4A5Q1	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A5Q2	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A5Q3	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A5Q4	1854-0540		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0540
A4A5Q5	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A5Q6	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A5Q7	1854-0431		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02735	2N5179
A4A5R1	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A5R2	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A5R3	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A5R4	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A5R5	0698-7205	2	RESISTOR 51.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-51R1-G
A4A5R6	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A5R7	0698-7205		RESISTOR 51.1 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-51R1-G
A4A5R8	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A5R9	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5R10	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5R11	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R12	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R13	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R14	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R15	0698-3442	12	RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A4A5R16	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A4A5R17	0698-3428	4	RESISTOR 14.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-14R7-F
A4A5R18	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A4A5R19	0698-3428		RESISTOR 14.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-14R7-F
A4A5R20	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A4A5R21	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R22	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R23	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R24	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R25	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A5R26	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A5R27	0698-3428		RESISTOR 14.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-14R7-F
A4A5R28	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A5R29	0698-3428		RESISTOR 14.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-14R7-F
A4A5R30	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A5R31	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R32	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R33	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A4A5R34	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A5R35	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A5R36	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A5R37	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5R38	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5R39	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A5R40	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A5R41	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5R42	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A5T1	08660-80003	1	TRANSFORMER, ISOLATOR	28480	08660-80003
A4A6	08660-60007	1	BOARD ASSY, PRETUNE	28480	08660-60007
A4A6C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A4A6C2	0180-0183	6	CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A4A6C3	0180-0183		CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A4A6C4	0180-0141	5	CAPACITOR-FXD; 50UF+75-10% 50VDC AL	56289	30D506G050DD2
A4A6C5	0121-0452		CAPACITOR; VAR; TRMR; AIR; 1.3/5.4PF	74970	187-0103-005
A4A6C6	0160-2264	2	CAPACITOR-FXD 20PF +-5% 500WVDC CER 0+	28480	0160-2264
A4A6C7	0160-0174	15	CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A4A6C8	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4A6C9	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A6C10	0180-0183		CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A4A6C11	0160-3537		CAPACITOR-FXD 680PF +-5% 100WVDC MICA	28480	0160-3537
A4A6CR1	1901-0033	2	DIODE-GEN PRP 180V 200MA	28480	1901-0033
A4A6L1	9140-0178	1	COIL; FXD; MOLDED RF CHOKE; 12UH 10%	24226	15/122
A4A6L2	9100-1643	1	COIL; FXD; MOLDED RF CHOKE; 300UH 5%	24226	19/303
A4A6Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4A6Q2	1853-0007	67	TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q3	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q4	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q5	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q6	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q7	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q9	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q10	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A6Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q12	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q13	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A6Q14	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4A6R1	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A6R2	2100-2216	2	RESISTOR; VAR; TRMR; 5KOHM 10% C	30983	ET50W502
A4A6R3	0757-0418		RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F
A4A6R4	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A6R5	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A6R6	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A6R7	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A6R8	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A6R9	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A4A6R10	0757-0405	6	RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A4A6R11	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A6R12	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A6R13	2100-2497	2	RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50W202
A4A6R14	0757-0200	23	RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A4A6R15	2100-1984	3	RESISTOR; VAR; TRMR; 100 OHM 10% C	30983	ET50W101
A4A6R16	0698-3439	6	RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A4A6R17	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A4A6R18	0757-0405		RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A4A6R19	0698-3443	10	RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A4A6R20	2100-1984		RESISTOR; VAR; TRMR; 100 OHM 10% C	30983	ET50W101
A4A6R21	0698-3409	1	RESISTOR 2.37K 1% .5W F TUBULAR	19701	MF7C1/2-T0-2371-F
A4A6R22	2100-1984		RESISTOR; VAR; TRMR; 100 OHM 10% C	30983	ET50W101
A4A6R23	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A6R24	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A6R25	0757-0278		RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A4A6R26	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A6R27	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A6R28	2100-2061	2	RESISTOR; VAR; TRMR; 200 OHM 10% C	30983	ET50W201
A4A6R29	0757-0836	1	RESISTOR 7.5K 1% .5W F TUBULAR	19701	MF7C1/2-T0-7501-F
A4A6R30	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A6R31	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A6R32	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A4A6R33	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A6R34	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A6R35	2100-2061		RESISTOR; VAR; TRMR; 200 OHM 10% C	30983	ET50W201
A4A6R36	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A4A6R37	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A6R38	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A4A6R39	0757-0440	5	RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A4A6R40	2100-1788	2	RESISTOR; VAR; TRMR; 500 OHM 10% C	30983	ET50W501
A4A6R41	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A4A6R42	0698-3150	6	RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A4A6R43	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A4A6R44	2100-1788		RESISTOR; VAR; TRMR; 500 OHM 10% C	30983	ET50W501
A4A6R45	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A4A6R46	0698-0085	13	RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A4A6R47	0757-0417	2	RESISTOR 562 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-562R-F
A4A6R48	2100-1986	4	RESISTOR; VAR; TRMR; 1KOHM 10% C	30983	ET50W102
A4A6R49	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A4A6R50	0698-3151	8	RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A4A6R51	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A6R52	2100-1986		RESISTOR; VAR; TRMR; 1KOHM 10% C	30983	ET50W102
A4A6R53	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A4A6R54	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A4A6R55	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A6R56	2100-2497		RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50W202
A4A6R57	0698-3446		RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A4A6R58	0698-3152	2	RESISTOR 3.48K 1% .125W F TUBULAR	16299	C4-1/8-T0-3481-F
A4A6R59	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A4A6R60	2100-2216		RESISTOR; VAR; TRMR; 5KOHM 10% C	30983	ET50W502
A4A6R61	0757-0447	4	RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A4A6R62	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A4A6R63	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A6R64	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A6R65	0698-7284	1	RESISTOR 100K 2% .05W F TUBULAR	24546	C3-1/8-T0-1003-G
A4A6U1	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A4A7	08660-60006	1	BOARD ASSY, PHASE DETECTOR	28480	08660-60006
A4A7C1	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A7C2	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A7C3	0180-2214	5	CAPACITOR-FXD; 90UF+75-10% 16VDC AL	56289	30D906G016CC2
A4A7C4	0160-3879		CAPACITOR-FXD .01UF +-20% 100WVDC CER	28480	0160-3879
A4A7C5	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A7C6	0180-2214		CAPACITOR-FXD; 90UF+75-10% 16VDC AL	56289	30D906G016CC2
A4A7C7	0180-0049	8	CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A4A7C8	0160-3878		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-3878
A4A7C9	0160-0839	1	CAPACITOR-FXD 110PF +-1% 300WVDC MICA	28480	0160-0839
A4A7C10	0160-3064	1	CAPACITOR-FXD 1000PF +-5% 300WVDC MICA	28480	0160-3064
A4A7C11	0160-0182	2	CAPACITOR-FXD 47PF +-5% 300WVDC MICA	28480	0160-0182
A4A7C12	0160-0182		CAPACITOR-FXD 47PF +-5% 300WVDC MICA	28480	0160-0182
A4A7C13	0160-2250		CAPACITOR-FXD 5.1PF +-.25PF 500WVDC CER	28480	0160-2250
A4A7C14	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A7C15	0180-1745	1	CAPACITOR-FXD; 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A4A7C16	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A7C17	0160-2264		CAPACITOR-FXD 20PF +-5% 500WVDC CER 0+	28480	0160-2264
A4A7C18	0180-0291	16	CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A4A7C19	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A4A7C20	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A4A7C21	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4A7C22	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A4A7C23	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4A7C24	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A4A7C25	0180-0183		CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A4A7C26	0160-2266		CAPACITOR-FXD 24PF +-5% 500WVDC CER 0+	28480	0160-2266
A4A7CR1	1901-0189	1	DIODE-STEP RCVY 20V	28480	1901-0189
A4A7CR2	5080-0271	4	DIODE:SILICON MATCHED QUAD	28480	5080-0271
A4A7CR3	5080-0271		DIODE:SILICON MATCHED QUAD	28480	5080-0271
A4A7CR4	5080-0271		DIODE:SILICON MATCHED QUAD	28480	5080-0271
A4A7CR5	5080-0271		DIODE:SILICON MATCHED QUAD	28480	5080-0271
A4A7CR6	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A7CR7	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A7CR8	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A7CR9	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A4A7CR10	1901-0033		DIODE-GEN PRP 180V 200MA	28480	1901-0033
A4A7J1	1250-0836	1	CONNECTOR-RF SMC M PC	2K497	CD-700141
A4A7L1	9140-0144		COIL; FXD; MOLDED RF CHOKE; 4.7UH 10%	24226	10/471
A4A7L2	9140-0210	2	COIL; FXD; MOLDED RF CHOKE; 100UH 5%	24226	15/103
A4A7L3	9140-0210		COIL; FXD; MOLDED RF CHOKE; 100UH 5%	24226	15/103
A4A7L4	9100-2260		COIL; FXD; MOLDED RF CHOKE; 1.8UH 10%	76493	9230-26
A4A7L5	9100-2254		COIL; FXD; MOLDED RF CHOKE; .39UH 10%	24226	10/390
A4A7L6	08660-80005	2	INDUCTOR	28480	08660-80005
A4A7L7	08660-80005		INDUCTOR	28480	08660-80005
A4A7Q1	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A7Q2	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A4A7Q3	1853-0034	9	TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A4A7Q4	1855-0049	3	TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0049
A4A7Q5	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A4A7Q6	1854-0023	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0023
A4A7R1	0757-0398		RESISTOR 75 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-75R0-F
A4A7R2	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A7R3	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A7R4	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A4A7R5	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A7R6	0698-3437	5	RESISTOR 133 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-133R-F
A4A7R7	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A4A7R8	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A4A7R9	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4A7R10	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A7R11	0757-0276	1	RESISTOR 61.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-6192-F
A4A7R12	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A4A7R13	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R14	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R15	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R16	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A7R17	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A4A7R18	2100-1986		RESISTOR; VAR; TRMR; 1KOHM 10% C	30983	ET50W102
A4A7R19	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R20	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R21	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A7R22	2100-1986		RESISTOR; VAR; TRMR; 1KOHM 10% C	30983	ET50W102
A4A7R23	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A7R24	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A7R25	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4A7R26	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A4A7R27	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7R28	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4A7R29	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A4A7R30	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4A7R31	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A4A7R32	0698-3101	1	RESISTOR 2.87K 1% .5W F TUBULAR	03888	PME65-1/2-T0-2871-F
A4A7R33	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A4A7R34	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A4A7T1	08660-80011	1	TRANSFORMER, TRIFILAR	28480	08660-80011
A4A7T2	08660-80010	1	TRANSFORMER, BIFILAR	28480	08660-80010
A5	08660-60023	1	BOARD ASSY, REGULATOR	28480	08660-60023
A5C1	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C2	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C3	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C4	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C5	0160-2207	1	CAPACITOR-FXD 300PF +-5% 300WVDC MICA	28480	0160-2207
A5C6	0180-1704	7	CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A5C7	0180-0374	5	CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A5C8	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C9	0160-2208		CAPACITOR-FXD 330PF +-5% 300WVDC MICA	28480	0160-2208
A5C10	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A5C11			NOT ASSIGNED		
A5C12	0160-2218		CAPACITOR-FXD 1000PF +-5% 300WVDC MICA	28480	0160-2218
A5C13	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C14	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A5C15	0180-0269	2	CAPACITOR-FXD; 1UF+75-10% 150VDC AL	56289	30D105G150BA2
A5C16			NOT ASSIGNED		
A5C17	0160-2218		CAPACITOR-FXD 1000PF +-5% 300WVDC MICA	28480	0160-2218
A5C18	0180-0269		CAPACITOR-FXD; 1UF+75-10% 150VDC AL	56289	30D105G150BA2
A5C19	0180-0058	14	CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A5CR1	1902-3104	2	DIODE-ZNR 5.62V 5% DO-7 PD=.4W	04713	SZ 10939-110
A5Q1	1853-0037	5	TRANSISTOR PNP SI CHIP TO-39 PD=1W	28480	1853-0037
A5Q2	1853-0050	17	TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A5Q3	1853-0037		TRANSISTOR PNP SI CHIP TO-39 PD=1W	28480	1853-0037
A5Q4	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A5Q5	1853-0037		TRANSISTOR PNP SI CHIP TO-39 PD=1W	28480	1853-0037
A5Q6	1853-0326	1	TRANSISTOR PNP SI CHIP PD=1W FT=50MHZ	28480	1853-0326
A5R1	0757-0397		RESISTOR 68.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-68R1-F
A5R2	0757-0346		RESISTOR 10 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-10R0-F
A5R3	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A5R4	0757-0397		RESISTOR 68.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-68R1-F
A5R5	0757-0397		RESISTOR 68.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-68R1-F
A5R6	0757-0398		RESISTOR 75 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-75R0-F
A5R7	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A5R8	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A5R9	0757-0397		RESISTOR 68.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-68R1-F
A5R10	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A5R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A5R12	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A5R13	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A5R14	0698-3161	1	RESISTOR 38.3K 1% .125W F TUBULAR	16299	C4-1/8-T0-3832-F
A5R15	0757-0424	15	RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A5R16	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A5R17	0698-3150		RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A5R18	0698-3150		RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A5R19	0698-3136	4	RESISTOR 17.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1782-F
A5R20	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A5R21	2100-1973	1	RESISTOR; VAR; TRMR; 200 OHM 10% WW	32997	3005P-1-201
A5R22	0757-0278		RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A5R23	0698-3152		RESISTOR 3.48K 1% .125W F TUBULAR	16299	C4-1/8-T0-3481-F
A5R24	2100-1799	1	RESISTOR-VAR TRMR 500 OHM 10% WW SIDE	32997	3005P-1-501
A5R25	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A5R26	2100-2852	1	RESISTOR-VAR TRMR 1KOHM 10% WW SIDE ADJ	32997	3005P-1-102
A5R27	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A5R28	2100-1739	1	RESISTOR-VAR TRMR 5KOHM 10% WW SIDE ADJ	32997	3005P-1-502
A5R29	0698-3136		RESISTOR 17.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1782-F
A5U1	1826-0016	1	IC LIN LM204H REGULATOR	27014	LM204H
A5U2	1826-0004	1	IC LIN LM304H REGULATOR	27014	LM304H
A5U3	1820-0247	2	IC LIN LM305 REGULATOR	27014	LM305
A5U4	1820-0247		IC LIN LM305 REGULATOR	27014	LM305
A6	08660-60276	1	FAN ASSY, 400HZ (OPTION 003 ONLY)	28480	08660-60276
A6	08660-60275	1	FAN ASSY, 60HZ (STANDARD INSTRUMENT)	28480	08660-60275
A6A1	08660-60024	1	BOARD ASSY, PRE-REGULATOR	28480	08660-60024

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6A1C1	0180-0141		CAPACITOR-FXD; 50UF+75-10% 50VDC AL	56289	30D506G050DD2
A6A1C2	0180-0141		CAPACITOR-FXD; 50UF+75-10% 50VDC AL	56289	30D506G050DD2
A6A1C3	0180-0089	1	CAPACITOR-FXD; 10UF+50-10% 150VDC AL	56289	30D106F150DD2
A6A1C4	0150-0121	48	CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C9	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A6A1C10	0160-3679	2	CAPACITOR-FXD 1UF +-10% 220WVAC MET (OPT 003 ONLY)	56289	439P1059220
A6A1CR1	1902-3262	1	DIODE-ZNR 24.9V 5% DO-7 PD=.4W	04713	SZ 10939-296
A6A1CR2	1902-3203	1	DIODE-ZNR 14.7V 5% DO-7 PD=.4W	04713	SZ 10939-230
A6A1CR3	1902-3333	1	DIODE-ZNR 46.4V 5% DO-7 PD=.4W	04713	SZ 10939-374
A6A1Q1	1854-0072	1	TRANSISTOR NPN 2N3054 SI PD=25W	02735	2N3054
A6A1Q2	1853-0052	1	TRANSISTOR PNP 2N3740 SI CHIP PD=25W	04713	2N3740
A6A1Q3	1853-0037		TRANSISTOR PNP SI CHIP TO-39 PD=1W	28480	1853-0037
A6A1Q4	1854-0063	3	TRANSISTOR NPN 2N3055 SI PD=115W	28480	1854-0063
A6A1Q5	1853-0059	1	TRANSISTOR PNP 2N3791 SI CHIP PD=150W	04713	2N3791
A6A1Q6	1853-0037		TRANSISTOR PNP SI CHIP TO-39 PD=1W	28480	1853-0037
A6A1Q7	1854-0063		TRANSISTOR NPN 2N3055 SI PD=115W	28480	1854-0063
A6A1Q8	1854-0063		TRANSISTOR NPN 2N3055 SI PD=115W	28480	1854-0063
A6A1Q9	1854-0003	1	TRANSISTOR NPN SI TO-39 PD=800MW	28480	1854-0003
A6A1Q10	1854-0313	1	TRANSISTOR NPN 2N3771 SI PD=150W	02735	2N3771
A6A1R1	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A6A1R2	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A6A1R3	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A6A1R4	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A6A1R5	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A6A1R6	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A6A1R7	0812-0014	1	RESISTOR .5 OHM 3% 5W PW TUBULAR	28480	0812-0014
A6A1R8	0812-0019	2	RESISTOR .33 OHM 5% 3W PW TUBULAR	91637	CW2B-1
A6A1R9	0812-0019		RESISTOR .33 OHM 5% 3W PW TUBULAR	91637	CW2B-1
A6A1R10	0812-0020	1	RESISTOR .39 OHM 5% 3W PW TUBULAR	91637	CW2B1-3-T2-39/100-J
A6A1R11	0811-1670	1	RESISTOR 2.2 OHM 5% 2W PW TUBULAR	75042	BWH2-2R2-J
A6A1XA20-1	1251-1388	1	CONNECTOR; PC EDGE; 15-CONT; DIP SOLDER	71785	252-15-30-008
			MISCELLANEOUS A6A1.		
	1200-0043	1	INSULATOR; XSTR; TO- 3; .02 THK	28480	1200-0043
	0340-0162	1	INSULATOR; XSTR; TO- 66; .02 THK	28480	0340-0162
	08660-20173	1	HEAT SINK	28480	08660-20173
A6A2	3160-0056	1	FAN-TBAX 115-CFM 115V 50/60-HZ 1.5-THK (EXCEPT OPT 003)	28480	3160-0056
A6A2	3160-0087	1	FAN-TBAX 95-CFM 115V 50/60/400-HZ 1.5 (OPT 003 ONLY)	28480	3160-0087
A6A2C1	0160-3679		CAPACITOR-FXD 1UF +-10% 220WVAC MET (OPT 003 ONLY)	56289	439P1059220
			MISCELLANEOUS A6A2.		
	08660-00063	1	FAN, SHIELD	28480	08660-00063
	08660-00064	1	HEAT SINK COVER	28480	08660-00064
	0403-0026	2	GLIDE:NYLON	28480	0403-0026
A7	5060-9409	1	POWER LINE MODULE/FILTER	28480	5060-9409
A7C1	0160-4065	1	CAPACITOR, FXD 0.1UF+-20% 250WVAC PAPER	0057R	PME 271 M 610
A7F1	2110-0029	1	FUSE, 3A SLO-BLO (FOR 100/120 VAC)	71400	MDX-3
A7F1	2110-0304	1	FUSE, 1.5A SLO-BLO (FOR 220/240 VAC)	71400	MDX-1-1/2A
A7R1	0839-0006	1	THERMISTOR, NEG TC, 10 OHM DISC	83186	115212
A8	08660-60014	1	BOARD ASSY, N3 OSCILLATOR (EXCEPT OPT 004)	28480	08660-60014
A8C1	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A8C2	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A8C3	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A8C4	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A8C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A8C6	0160-3459	6	CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A8C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A8C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A8C9	0160-3459		CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A8C10	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8C11	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C12	0160-0386	15	CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A8C13	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A8C14	0170-0082	7	CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A8C15			NOT ASSIGNED		
A8C16	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A8C17	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A8C18	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A8CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A8CR3	0122-0299	1	DIO-VVC 82PF 5% C2/C20=2000000 MIN	04713	SMV389-299
A8L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A8L2	9140-0114	10	COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A8L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A8L4	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A8L5	9100-2815	5	COIL; FXD; NON-MOLDED RF CHOKE; .7UH 5%	28480	9100-2815
A8L6	9140-0179	25	COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A8L7	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A8Q1	1854-0092	32	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A8Q2	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A8Q3	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A8Q4	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A8Q5	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A8Q6	1854-0087	8	TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A8Q7	1855-0081	5	TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A8Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A8Q9	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A8Q10	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A8Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A8Q12	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A8R1			NOT ASSIGNED		
A8R2	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A8R3	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A8R4	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A8R5	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A8R6	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R7	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R8	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R10	0757-0479	5	RESISTOR 392K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3923-F
A8R11	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A8R12	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A8R13	0698-3228	5	RESISTOR 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T0-4991-F
A8R14			NOT ASSIGNED		
A8R15	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A8R16	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R17	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A8R18	0757-0199	7	RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A8R19	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A8R20	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A8R21	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A8R22	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A8R23	0698-4037	3	RESISTOR 46.4 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-46R4-F
A8R24	2100-1760	6	RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A8R25	0698-4002	3	RESISTOR 5K 1% .125W F TUBULAR	16299	C4-1/8-T0-5001-F
A8R26	2100-1759	5	RESISTOR; VAR; TRMR; 2KOHM 5% WW	GB027	CT-106-4
A8R27	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A8R28	0698-3158		RESISTOR 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A8R29			NOT ASSIGNED		
A8R30	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A8R31	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A8R32	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A8R33	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A8R34	0757-0443	2	RESISTOR 11K 1% .125W F TUBULAR	24546	C4-1/8-T0-1102-F
A8R35	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A8R36	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R37			NOT ASSIGNED		
A8R38	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A8R39	0683-8245	5	RESISTOR 820K 5% .25W CC TUBULAR	01121	CB8245
A8R40	0698-3243	13	RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8R41	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A8R42	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A8R43	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A8R44	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A8R45	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A8R46	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A8R47	0757-0403	4	RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A8R48	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A8R49	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A8R50	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A8U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A8U2	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A8U3	1820-0450	12	IC DGTL N8290A COUNTER	18324	N8290A
A9	08660-60045	1	CABLE ASSY, LOOP BOX	28480	08660-60045
A9W1	8120-1614	1	CABLE, UNSHLD 28-COND 28AWG	75037	3401
A9A1	08660-60037	1	BOARD ASSY, DIGITAL PROGRAM	28480	08660-60037
A9A1E1	0360-1636	1	TERMINAL	76381	3402
A9A1R1	0698-7210	28	RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R2	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R3	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R4	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R5	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R6	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R7	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R8	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R9	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R10	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R11	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R12	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R13	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R14	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R15	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R16	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R17	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R18	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R19	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R20	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R21	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R22	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R23	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R24	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R25	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R26	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R27	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A9A1R28	0698-7210		RESISTOR 82.5 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-82R5-G
A10	08660-60013	1	BOARD ASSY, N3 PHASE DETECTOR (EXCEPT OPT 004)	28480	08660-60013
A10C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C3	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A10C4	0180-2206		CAPACITOR-FXD; 60UF+-10% 6VDC TA-SOLID	56289	150D606X900682
A10C5	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X901582
A10C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C8	0160-0157		CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A10C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C10	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C12	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C13	0140-0172	2	CAPACITOR-FXD 3000PF +-1% 100WVDC MICA	72136	DM19F302F0100WV1CR
A10C14	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A10C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C17	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C18	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A10C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A10C22	0160-3539	3	CAPACITOR-FXD 820PF +-5% 100WVDC MICA	28480	0160-3539
A10C23	0160-2453	2	CAPACITOR-FXD .22UF +-10% 80WVDC POLYE	84411	HEW-238T
A10C24	0170-0040	2	CAPACITOR-FXD .047UF +-10% 200WVDC POLYE	56289	292P47392

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A10CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A10CR3	1901-0179		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A10CR4	1901-0179		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A10L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A10L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A10L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A10L4	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A10L5	9100-1650	2	COIL; FXD; MOLDED RF CHOKE; 680UH 5%	24226	19/683
A10L6	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A10L7	9100-1652	3	COIL; FXD; MOLDED RF CHOKE; 820UH 5%	24226	19/823
A10Q1	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A10Q2	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A10Q3	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A10Q4	1855-0049		TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0049
A10Q5	1854-0045		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0045
A10Q6	1853-0015		TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A10Q7	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A10R1	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A10R2	0757-0289	5	RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A10R3	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A10R4	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A10R5	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A10R6	0698-3446		RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A10R7	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A10R8	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A10R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A10R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A10R11	0698-3450	4	RESISTOR 42.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4222-F
A10R12	0757-0447		RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A10R13	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A10R14	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A10R15	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A10R16	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A10R17	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A10R18	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A10R19	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A10R20	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A10R21	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A10R22	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A10R23	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A10R24	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A10R25	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A10R26	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A10R27	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A10R28	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A10R29	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A10R30	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A10R31	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A10R32	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A10R33	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A10R34	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A10R35	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A10R36	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A10T1	08660-80001	3	TRANSFORMER, SAMPLER	28480	08660-80001
A10U1	1820-0451	6	IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A10U2	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A10U3	1820-0204	3	IC DGTL MC 3006P GATE	04713	MC3006P
A10U4	1820-0751	11	IC DGTL SN74196N COUNTER	01295	SN74196N
A10U5	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A10U6	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A10U7	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A11	08660-60019	1	BOARD ASSY, SL2 OSCILLATOR (EXCEPT OPT 004)	28480	08660-60019
A11	08660-20040		BOARD ASSY, N2 LOOP-SL1 LOOP COUPLER (OPT 004 ONLY)	28480	08660-20040
A11C1	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A11C2	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A11C3	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A11C4	0180-2214		CAPACITOR-FXD; 90UF+75-10% 16VDC AL	56289	30D906G016CC2
A11C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11C6	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A11C7	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A11C8	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A11C9	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11C10	0180-2210	2	CAPACITOR-FXD; 2UF+50-10% 150VDC AL	56289	30D205F150BB2
A11C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A11C12	0180-0374		CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A11C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A11C14	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A11C15	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A11C16	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A11C17	0121-0059	4	CAPACITOR; VAR; TRMR; CER; 2/8PF	73899	DV11PR8A
A11C18	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A11C19	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A11C20	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A11C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A11C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A11C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A11C24	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A11C25	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A11C26	0180-2207	4	CAPACITOR-FXD; 100UF+-10% 10VDC TA	56289	150D107X9010R2
A11C27	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11C28	0160-2228	1	CAPACITOR-FXD 2700PF +-5% 300WVDC MICA	28480	0160-2228
A11CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR8	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR9	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR10	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR11	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR12	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR13	0122-0264	4	DIO-VVC 1N5148A 47PF 5% C4/C60=3200000	04713	1N5148A
A11CR14	0122-0262	4	DIO-VVC 1N5147A 39PF 5% C4/C60=3200000	04713	1N5147A
A11CR15	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A11CR16	1901-0518	2	DIODE-SCHOTTKY	28480	1901-0518
A11L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A11L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A11L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A11L4	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A11L5	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A11L6	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A11L7	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A11L8	9100-2815		COIL; FXD; NON-MOLDED RF CHOKE; .7UH 5%	28480	9100-2815
A11L9	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A11L10	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A11L11	9140-0129		COIL; FXD; MOLDED RF CHOKE; 220UH 5%	24226	15/223
A11L12	9100-0368	1	COIL; FXD; MOLDED RF CHOKE; .33UH 10%	24226	10/330
A11Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A11Q2	1855-0081		TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A11Q3	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A11Q4	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A11Q5	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A11Q6	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A11Q7	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q9	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q10	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q12	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q13	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q14	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q15	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A11Q16	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q17	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q18	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q19	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11Q20	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A11R1	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R2	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R3	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R4	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R5	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11R6	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R7	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R8	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R9	0757-0479		RESISTOR 392K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3923-F
A11R10	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A11R11	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A11R12	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T0-4991-F
A11R13	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A11R14	0757-0460	2	RESISTOR 61.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-6192-F
A11R15	2100-1760		RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A11R16	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A11R17	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R18	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R19	2100-1759		RESISTOR; VAR; TRMR; 2KOHM 5% WW	GB027	CT-106-4
A11R20	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A11R21	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A11R22	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R23	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A11R24	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A11R25	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R26	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R27	0757-0458	4	RESISTOR 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A11R28	0757-0461	4	RESISTOR 68.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-6812-F
A11R29	0757-0464	4	RESISTOR 90.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-9092-F
A11R30	0757-0467	4	RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A11R31	0757-0466	4	RESISTOR 110K 1% .125W F TUBULAR	24546	C4-1/8-T0-1103-F
A11R32	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A11R33	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A11R34	0698-3266	8	RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A11R35	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A11R36	0698-3459	4	RESISTOR 383K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3833-F
A11R37	0698-3162	5	RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A11R38	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A11R39	2100-2574	4	RESISTOR; VAR; TRMR; 500 OHM 10% C	19701	ET50X501
A11R40	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A11R41	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R42	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R43	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A11R44	0698-3437		RESISTOR 133 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-133R-F
A11R45	0757-0405		RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A11R46	0698-3439		RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A11R47	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A11R48	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A11R49	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A11R50	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A11R51	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A11R52	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A11R53	0757-0317	4	RESISTOR 1.33K 1% .125W F TUBULAR	24546	C4-1/8-T0-1331-F
A11R54	2100-2574		RESISTOR; VAR; TRMR; 500 OHM 10% C	19701	ET50X501
A11R55	0698-3258	2	RESISTOR 5.36K 1% .125W F TUBULAR	16299	C4-1/8-T0-5361-F
A11R56	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A11R57	0757-0834	4	RESISTOR 5.62K 1% .5W F TUBULAR	19701	MF7C1/2-T0-5621-F
A11R58	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R59	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R60	2100-2633	6	RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A11R61	0757-0290		RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A11R62	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A11R63	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R64	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R65	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A11R66	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R67	2100-2633		RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A11R68	0757-0440		RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A11R69	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A11R70	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R71	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R72	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A11R73	2100-2521	4	RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50X202
A11R74	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A11R75	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R76	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R77	2100-2521		RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50X202
A11R78	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A11R79	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R80	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11R81	0683-8245		RESISTOR 820K 5% .25W CC TUBULAR	01121	CB8245
A11R82	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A11R83	2100-2489	2	RESISTOR; VAR; TRMR; 5KOHM 10% C	19701	ET50X502
A11R84	0698-3136		RESISTOR 17.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1782-F
A11R85	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A11R86	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A11R87	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A11R88	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R89	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A11R90	2100-2522	2	RESISTOR; VAR; TRMR; 10KOHM 10% C	19701	ET50X103
A11R91	0757-0123	2	RESISTOR 34.8K 1% .125W F TUBULAR	24546	C5-1/4-T0-3482-F
A11R92	0757-0403		RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A11R93	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A11R94	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A11R95	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A11R96	0757-0402	1	RESISTOR 110 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-111-F
A11R97	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A11R98	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A11R99	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A11R100	0757-0395		RESISTOR 56.2 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-56R2-F
A11R101	0698-3439		RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A11R102	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A11R103	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A11R104	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A11R105	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A11R106	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A11R107	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A11U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A11U2	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A11U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12	08660-60018	1	BOARD ASSY, SL2 DETECTOR (EXCEPT OPT 004)	28480	08660-60018
A12	08660-20040		BOARD ASSY, N2 LOOP-SL1 LOOP COUPLER (OPT 004 ONLY)	28480	08660-20040
A12C1	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C2	0180-2207		CAPACITOR-FXD; 100UF+-10% 10VDC TA	56289	150D107X9010R2
A12C3	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C4	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C5	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C6	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A12C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A12C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A12C9	0160-0301	5	CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392
A12C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A12C11	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392
A12C12	0160-2261	4	CAPACITOR-FXD 15PF +-5% 500WVDC CER 0+	28480	0160-2261
A12C13	0160-2261		CAPACITOR-FXD 15PF +-5% 500WVDC CER 0+	28480	0160-2261
A12C14	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C15	0180-2141	1	CAPACITOR-FXD; 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A12C16	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A12C17	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A12C18	0160-0299	2	CAPACITOR-FXD 1800PF +-10% 200WVDC POLYE	56289	292P18292
A12C19	0160-0939	1	CAPACITOR-FXD 430PF +-5% 300WVDC MICA	28480	0160-0939
A12C20	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A12C21	0160-0299		CAPACITOR-FXD 1800PF +-10% 200WVDC POLYE	56289	292P18292
A12C22	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A12C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A12C24	0160-3534		CAPACITOR-FXD 510PF +-5% 100WVDC MICA	28480	0160-3534
A12C25	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A12E1	10534C	2	MIXER:200 MHZ	28480	10534C
A12L1	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A12L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A12L3	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A12L4	9100-1621	2	COIL; FXD; MOLDED RF CHOKE; 18UH 10%	24226	15/182
A12L5	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A12L6	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A12L7	9100-1658	1	COIL; FXD; MOLDED RF CHOKE; 1.6MH 5%	24226	22/164
A12Q1	1853-0015		TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A12Q2	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12Q3	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12Q4	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12Q5	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A12Q6	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12Q7	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A12Q9	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A12Q10	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A12Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A12Q12	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A12R1	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A12R2	0757-0400	3	RESISTOR 90.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-90R9-F
A12R3	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A12R4	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A12R5	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A12R6	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A12R7	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A12R8	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A12R9	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A12R10	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A12R11	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A12R12	0757-0440		RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A12R13	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A12R14			NOT ASSIGNED		
A12R15	0757-0294	2	RESISTOR 17.8 OHM 1% .125W F TUBULAR	19701	MF4C1/8-T0-17R8-F
A12R16	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R17	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R18	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A12R19	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R20	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A12R21	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A12R22	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A12R23	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A12R24	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A12R25	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A12R26	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A12R27	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A12R28	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A12R29	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A12R30	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A12R31	0683-3955	2	RESISTOR 3.9M 5% .25W CC TUBULAR	01121	CB3955
A12R32	0683-2055	2	RESISTOR 2M 5% .25W CC TUBULAR	01121	CB2055
A12R33	0683-1055	2	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A12R34	0698-3263	2	RESISTOR 500K 1% .125W F TUBULAR	19701	MF5C1/8-T0-5003-F
A12R35	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A12R36	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A12R37	2100-2633		RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A12R38	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A12R39	0698-3150		RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A12R40	0757-0418		RESISTOR 619 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-619R-F
A12R41	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A12R42	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R43	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A12R44	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A12R45	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A12R46	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A12R47	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R48	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12R49	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A12R50	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A12R51	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A12U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U2	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A12U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U4	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U5	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A12U6	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U7	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U8	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A12U9	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A13	08660-60012	1	BOARD ASSY, N2 OSCILLATOR	28480	08660-60012
A13C1	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A13C2	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A13C3	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A13C4	0180-2207		CAPACITOR-FXD; 100UF+-10% 10VDC TA	56289	150D107X9010R2
A13C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A13C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A13C8	0160-3459		CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A13C9			NOT ASSIGNED		
A13C10	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A13C11	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A13C12	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A13C13	0180-2210		CAPACITOR-FXD; 2UF+50-10% 150VDC AL	56289	30D205F150BB2
A13C14	0180-0374		CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A13C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C16	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A13C17	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A13C18	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PF1030R5W1
A13C19	0121-0059		CAPACITOR; VAR; TRMR; CER; 2/8PF	73899	DV11PR8A
A13C20			NOT ASSIGNED		
A13C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C22	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A13C23	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A13C24	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C25	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C27	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A13C28	0160-3459		CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A13C29	0160-0163	1	CAPACITOR-FXD .033UF +-10% 200WVDC POLYE	56289	292P33392
A13CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR2			NOT ASSIGNED		
A13CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR8	0122-0264		DIO-VVC 1N5148A 47PF 5% C4/C60=3200000	04713	1N5148A
A13CR9	0122-0262		DIO-VVC 1N5147A 39PF 5% C4/C60=3200000	04713	1N5147A
A13CR10			NOT ASSIGNED		
A13CR11	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR12	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR13	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR14	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR15	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13CR16	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A13L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A13L2	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A13L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A13L4	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A13L5	9100-2815		COIL; FXD; NON-MOLDED RF CHOKE; .7UH 5%	28480	9100-2815
A13L6	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A13L7	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A13L8	9100-1674	1	COIL; FXD; MOLDED RF CHOKE; 7.5MH 5%	24226	24-754
A13Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A13Q2	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A13Q3	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A13Q4	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A13Q5	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q6	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q7	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q9	1855-0081		TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A13Q10	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A13Q11	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A13Q12	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A13Q13	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q14	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q15	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13Q16	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A13R1	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R2	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R3	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R4	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R5	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R6	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R7	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R8	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A13R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R12	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R13	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R14	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R15	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R16	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R17	0757-0479		RESISTOR 392K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3923-F
A13R18	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A13R19	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A13R20	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T0-4991-F
A13R21	0757-0124	2	RESISTOR 39.2K 1% .125W F TUBULAR	24546	C5-1/4-T0-3922-F
A13R22	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A13R23	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R24	0698-4002		RESISTOR 5K 1% .125W F TUBULAR	16299	C4-1/8-T0-5001-F
A13R25	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R26	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A13R27	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A13R28	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A13R29	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A13R30	0757-0290		RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A13R31	0698-3162		RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A13R32	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A13R33	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A13R34	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A13R35	0698-4037		RESISTOR 46.4 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-46R4-F
A13R36	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A13R37	2100-1759		RESISTOR; VAR; TRMR; 2KOHM 5% WW	GB027	CT-106-4
A13R38			NOT ASSIGNED		
A13R39	2100-1760		RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A13R40	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A13R41	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A13R42	0757-0317		RESISTOR 1.33K 1% .125W F TUBULAR	24546	C4-1/8-T0-1331-F
A13R43	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A13R44	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R45	0757-0834		RESISTOR 5.62K 1% .5W F TUBULAR	19701	MF7C1/2-T0-5621-F
A13R46	0698-3459		RESISTOR 383K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3833-F
A13R47	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A13R48	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A13R49	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A13R50	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A13R51			NOT ASSIGNED		
A13R52	0757-0443		RESISTOR 11K 1% .125W F TUBULAR	24546	C4-1/8-T0-1102-F
A13R53	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A13R54	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A13R55	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A13R56	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A13R57	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A13R58	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A13R59	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A13R60	0757-0466		RESISTOR 110K 1% .125W F TUBULAR	24546	C4-1/8-T0-1103-F
A13R61	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A13R62	0683-8245		RESISTOR 820K 5% .25W CC TUBULAR	01121	CB8245
A13R63	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A13R64	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A13R65	0757-0467		RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A13R66	0698-3439		RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A13R67	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A13R68	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A13R69	0757-0464		RESISTOR 90.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-9092-F
A13R70	0757-0405		RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A13R71	0757-0461		RESISTOR 68.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-6812-F
A13R72	0698-3437		RESISTOR 133 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-133R-F
A13R73	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A13R74	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A13R75	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A13R76	0757-0403		RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A13R77	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A13R78	0757-0458		RESISTOR 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A13R79	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A13R80	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A13R81	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A13R82	0757-0400		RESISTOR 90.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-90R9-F
A13R83	0698-3438		RESISTOR 147 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-147R-F
A13R84	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A13R85	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A13U2	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A13U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A14	08660-60011	1	BOARD ASSY, N2 PHASE DETECTOR (EXCEPT OPT 004)	28480	08660-60011
A14	08660-60039	1	BOARD ASSY, N2 PHASE DETECTOR (OPT 004 ONLY)	28480	08660-60039
A14C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C2			NOT ASSIGNED		
A14C3	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A14C4	0180-2206		CAPACITOR-FXD; 60UF+-10% 6VDC TA-SOLID	56289	150D606X9006B2
A14C5	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A14C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C7	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A14C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C9	0160-0157		CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A14C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C12	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C14	0140-0172		CAPACITOR-FXD 3000PF +-1% 100WVDC MICA	72136	DM19F302F0100WV1CR
A14C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C17	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C18	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C22	0160-3539		CAPACITOR-FXD 820PF +-5% 100WVDC MICA	28480	0160-3539
A14C23	0160-2453		CAPACITOR-FXD .22UF +-10% 80WVDC POLYE	84411	HEW-238T
A14C24	0170-0040		CAPACITOR-FXD .047UF +-10% 200WVDC POLYE	56289	292P47392
A14C25	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A14C26	0180-0374		CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A14CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A14CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A14CR3	1901-1066	2	DIODE-SWITCHING 750PS 15V 50MA	28480	1901-1066
A14CR4	1901-1066		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-1066
A14L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A14L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A14L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A14L4	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A14L5	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A14L6	9100-1614	2	COIL; FXD; MOLDED RF CHOKE; .82UH 10%	24226	15/820
A14L7	9100-1650		COIL; FXD; MOLDED RF CHOKE; 680UH 5%	24226	19/683
A14L8	9100-1652		COIL; FXD; MOLDED RF CHOKE; 820UH 5%	24226	19/823
A14Q1	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q2	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q3	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q4	1855-0049		TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0049
A14Q5	1854-0045		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0045
A14Q6	1853-0015		TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A14Q7	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A14R1	0757-0289		RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A14R2	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A14R3	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A14R4	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A14R5	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R6	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R7	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R8	0698-3446		RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A14R9	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R11	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R12	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R13	0698-3450		RESISTOR 42.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4222-F
A14R14	0757-0447		RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A14R15	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A14R16	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R17	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A14R18	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A14R19	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A14R20	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A14R21	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A14R22	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A14R23	0757-0290		RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A14R24	0698-3150		RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A14R25	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A14R26	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A14R27	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R28	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R29	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A14R30	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R31	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A14R32	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A14R33	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A14R34	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R35	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A14R36	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14T1	08660-80001		TRANSFORMER, SAMPLER	28480	08660-80001
A14U1	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A14U2	1820-0204		IC DGTL MC 3006P GATE	04713	MC3006P
A14U3	1820-0469		IC DGTL SN74H 102 N FLIP-FLOP	01295	SN74H102N
A14U4	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A14U5	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A14U6	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A14U7	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A14U8	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A14	08660-60039	1	BOARD ASSY, N2A PHASE DETECTOR (OPT 004 ONLY)	28480	08660-60039
A14C1	0160-2055	8	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C2	0180-0059	1	CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A14C3	0180-2206	1	CAPACITOR-FXD; 60UF+-10% 6VDC TA-SOLID	56289	150D606X9006B2
A14C4	0180-0228	1	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A14C5	0150-0121	7	CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C9	0160-0157	1	CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A14C10	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C12	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C13	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C15	0140-0172	1	CAPACITOR-FXD 3000PF +-1% 100WVDC MICA	72136	DM19F302F0100WV1CR
A14C16	0180-0229	2	CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A14C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C18	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A14C19	0180-0374	1	CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A14C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14C22	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D335X9010B2
A14C23	0160-3539	1	CAPACITOR-FXD 820PF +-5% 100WVDC MICA	28480	0160-3539
A14C24	0160-2453	1	CAPACITOR-FXD .22UF +-10% 80WVDC POLYE	84411	HEW-238T
A14C25	0170-0040	1	CAPACITOR-FXD .047UF +-10% 200WVDC POLYE	56289	292P47392
A14C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A14CR1	1901-0040	2	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A14CR2	1901-1066	2	DIODE-SWITCHING 75 OPS 15V 50MA	28480	1901-1066
A14CR3	1901-1066		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-1066
A14L1	9100-1629	2	COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A14L2	9140-0114	2	COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A14L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A14L4	9100-1650	1	COIL; FXD; MOLDED RF CHOKE; 680UH 5%	24226	19/683
A14L5	9100-1652	1	COIL; FXD; MOLDED RF CHOKE; 820UH 5%	24226	19/823
A14L6	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A14Q1	1853-0034	3	TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q2	1854-0210	2	TRANSISTOR NPN 2N2222 SI PD=500MW	04713	2N2222
A14Q3	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q4	1853-0015	1	TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A14Q5	1854-0210		TRANSISTOR NPN 2N2222 SI PD=500MW	04713	2N2222
A14Q6	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A14Q7	1855-0049	1	TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0049
A14R1	0757-0440	1	RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A14R2	0757-0421	2	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A14R3	0757-0280	3	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A14R4	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A14R5	0757-0442	3	RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R6	0698-3446	1	RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A14R7	0698-0082	1	RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A14R8	0757-0289	1	RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A14R9	0757-0439	1	RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A14R10	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A14R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R12	0757-0424	4	RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R13	0757-0416	4	RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R14	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R15	0698-3430	1	RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A14R16	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R17	0698-3450	1	RESISTOR 42.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4222-F
A14R18	0757-0447	1	RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A14R19	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A14R20	0698-3447	1	RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A14R21	0757-0279	3	RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A14R22	0698-3155	2	RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A14R23	0757-0290	1	RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A14R24	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A14R25	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A14R26	0698-3150	1	RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A14R27	0757-1094	1	RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A14R28	0757-0394	2	RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A14R29	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A14R30	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R31	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R32	0757-0438	1	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A14R33	0757-0200	1	RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A14R34	0757-0278	1	RESISTOR 1.78K 1% .125W F TUBULAR	24546	C4-1/8-T0-1781-F
A14R35	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A14R36	0757-0444	2	RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A14R37	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A14R38	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A14R39	0698-0085	1	RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A14R40	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A14R41	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A14T1	08660-80001	1	TRANSFORMER, SAMPLER	28480	08660-80001
A14U1	1820-0451	2	IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A14U2	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A14U3	1820-0204	1	IC DGTL MC 3006P GATE	04713	MC3006P
A14U4	1820-0450	3	IC DGTL N8290A COUNTER	18324	N8290A
A14U5	1820-0450		IC DGTL N8290A COUNTER	18324	N8290A
A14U6	1820-0450		IC DGTL N8290A COUNTER	18324	N8290A
A14U7	1820-0374	1	IC DGTL SN74H 21 N GATE	01295	SN74H21N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A15	08660-60016	1	BOARD ASSY, SL1 DETECTOR	28480	08660-60016
A15C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A15C2	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A15C3	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A15C4	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A15C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A15C6	0160-3456		CAPACITOR-FXD 1000PF +-10% 1000WVDC CER	28480	0160-3456
A15C7	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A15C8	0180-2207		CAPACITOR-FXD; 100UF+-10% 10VDC TA	56289	150D107X9010R2
A15C9	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A15C10	0160-2261		CAPACITOR-FXD 15PF +-5% 500WVDC CER 0+	28480	0160-2261
A15C11	0160-2261		CAPACITOR-FXD 15PF +-5% 500WVDC CER 0+	28480	0160-2261
A15C12	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A15C13	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A15C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A15C15	0160-0298	2	CAPACITOR-FXD 1500PF +-10% 200WVDC POLYE	56289	292P15292
A15C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A15C17	0160-0298		CAPACITOR-FXD 1500PF +-10% 200WVDC POLYE	56289	292P15292
A15C18	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A15C19	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A15C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A15C21	0160-2208		CAPACITOR-FXD 330PF +-5% 300WVDC MICA	28480	0160-2208
A15C22	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A15L1	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A15L2	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A15L3	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A15L4	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A15L5			NOT ASSIGNED		
A15L6	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A15L7	9100-1659	1	COIL; FXD; MOLDED RF CHOKE; 1.8MH 5%	28480	9100-1659
A15L8	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A15Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A15Q2	1853-0015		TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A15Q3	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A15Q4	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A15Q5	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A15Q6	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A15R1	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A15R2	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A15R3	0757-0379	1	RESISTOR 12.1 OHM 1% .125W F TUBULAR	19701	MF4C1/8-T0-12R1-F
A15R4			NOT ASSIGNED		
A15R5	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R6	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R7	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A15R8	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A15R9	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A15R10	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A15R11	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R12	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A15R13	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A15R14	2100-2633		RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A15R15	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A15R16	0698-3150		RESISTOR 2.37K 1% .125W F TUBULAR	16299	C4-1/8-T0-2371-F
A15R17	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R18	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A15R19	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R20	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A15R21	0757-0417		RESISTOR 562 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-562R-F
A15R22	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A15R23	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A15R24	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A15R25	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A15R26	0698-7236		RESISTOR 1K 2% .05W F TUBULAR	24546	C3-1/8-T0-1001-G
A15R27	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A15U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A15U2	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A15U3	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A15U4	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A15U5	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A15U6	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A15U7	1820-0068		IC DGTL SN74 10 N GATE	01295	SN7410N
A15U8	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A15U9	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A15U10	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A16	08660-60009	1	BOARD ASSY, N1 PHASE DETECTOR	28480	08660-60009
A16C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C2	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A16C3	0180-2206		CAPACITOR-FXD; 60UF+-10% 6VDC TA-SOLID	56289	150D606X9006B2
A16C4	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A16C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C8	0160-0297		CAPACITOR-FXD 1200PF +-10% 200WVDC POLYE	56289	292P12292
A16C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C10	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C12	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C13	0160-0937	1	CAPACITOR-FXD 1000PF +-2% 300WVDC MICA	28480	0160-0937
A16C14	0160-3459		CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A16C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C16	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A16C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C18	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A16C19	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A16C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A16C22	0160-3539		CAPACITOR-FXD 820PF +-5% 100WVDC MICA	28480	0160-3539
A16C23	0180-1746		CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A16C24	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A16C25	0160-3459		CAPACITOR-FXD .02UF +-20% 100WVDC CER	28480	0160-3459
A16C26	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A16C27	0160-0134	2	CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A16C28	0160-0134		CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A16C29	0160-0302	1	CAPACITOR-FXD .018UF +-10% 200WVDC POLYE	56289	292P18392
A16C30	0160-0945		CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A16C31	0140-0200	1	CAPACITOR-FXD 390PF +-5% 300WVDC MICA	72136	DM15F391J0300WV1CR
A16CR1	1902-3104		DIODE-ZNR 5.62V 5% DO-7 PD=.4W	04713	SZ 10939-110
A16CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A16CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A16CR4	1901-0179		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A16CR5	1901-0179		DIODE-SWITCHING 750PS 15V 50MA	28480	1901-0179
A16CR6	1902-0025	1	DIODE-ZNR 10V 5% DO-7 PD=.4W TC=+.06%	04713	SZ 10939-182
A16L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A16L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A16L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A16L4	9100-1614		COIL; FXD; MOLDED RF CHOKE; .82UH 10%	24226	15/820
A16L5	9100-2564	2	COIL; FXD; MOLDED RF CHOKE; 150UH 10%	06560	15S-151K
A16L6	9100-2564		COIL; FXD; MOLDED RF CHOKE; 150UH 10%	06560	15S-151K
A16Q1	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A16Q2	1853-0034		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0034
A16Q3	1855-0082	1	TRANSISTOR; J-FET P-CHAN, D-MODE SI	28480	1855-0082
A16Q4	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A16Q5	1853-0015		TRANSISTOR PNP SI CHIP PD=200MW	28480	1853-0015
A16Q6	1854-0045		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0045
A16R1	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A16R2	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A16R3	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A16R4	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A16R5	0757-1092	1	RESISTOR 287 OHM 1% .5W F TUBULAR	19701	MF7C1/2-T0-287R-F
A16R6	0757-0289		RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A16R7	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A16R8	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A16R9	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A16R10	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A16R11	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A16R12	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A16R13	0698-3446		RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A16R14	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A16R15	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A16R16	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A16R17	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A16R18	0698-3450		RESISTOR 42.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4222-F
A16R19	0757-0447		RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A16R20	0698-3430		RESISTOR 21.5 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-21R5-F
A16R21	0757-0424		RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1101-F
A16R22	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A16R23	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A16R24	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A16R25	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A16R26	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A16R27	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A16R28	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A16R29	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A16R30	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A16R31	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A16R32	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A16R33	0698-3162		RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A16R34	0698-3450		RESISTOR 42.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4222-F
A16R35	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A16R36	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A16R37	0757-0289		RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A16R38	2100-1760		RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A16R39	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A16R40	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A16R41	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A16R42	0757-1094		RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A16R43	0698-3158		RESISTOR 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A16R44	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A16R45	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A16R46	0757-0440		RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A16R47	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A16T1	08660-80001		TRANSFORMER, SAMPLER	28480	08660-80001
A16TP1	0360-0124	8	TERMINAL STUD .040"	28480	0360-0124
A16TP2	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP3	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP4	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP5	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP6	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP7	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16TP8	0360-0124		TERMINAL STUD .040"	28480	0360-0124
A16U1	1820-0058	1	IC LIN AMPLIFIER	07263	709HC
A16U2	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A16U3	1820-0451		IC DGTL MC 3062P FLIP-FLOP	04713	MC3062P
A16U4	1820-0469		IC DGTL SN74H 102 N FLIP-FLOP	01295	SN74H102N
A16U5	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A16U6	1820-0751		IC DGTL SN74196N COUNTER	01295	SN74196N
A16U7	1820-0204		IC DGTL MC 3006P GATE	04713	MC3006P
			MISCELLANEOUS A16.		
	08660-20155	2	SHIELD, INDUCTOR	28480	08660-20155
	08660-20155		SHIELD, INDUCTOR	28480	08660-20155
A17	08660-60010	1	BOARD ASSY, N1 OSCILLATOR	28480	08660-60010
A17C1	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A17C2	0180-2215	1	CAPACITOR-FXD; 170UF+75-10% 15VDC AL	56289	30D177G015DD2
A17C3	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A17C4	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A17C5	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A17C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A17C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C8	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A17C9	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A17C10	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A17C11	0180-0183		CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A17C12	0180-0374		CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A17C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C14	0160-3047	1	CAPACITOR-FXD 3280PF +-1% 100WVDC MICA	28480	0160-3047
A17C15	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A17C16	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A17C17	0121-0059		CAPACITOR; VAR; TRMR; CER; 2/8PF	73899	DV11PR8A
A17C18	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A17C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C20	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A17C21	0160-3092	1	CAPACITOR-FXD 1600PF +-1% 100WVDC MICA	28480	0160-3092
A17C22			NOT ASSIGNED		
A17C23	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A17C24	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A17C25	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C27	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C28	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C29	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C30	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C31	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C32	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A17C33	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C34	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C35	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C36	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17C37	0160-0162	1	CAPACITOR-FXD .022UF +-10% 200WVDC POLYE	56289	292P22392
A17C38	0140-0210	1	CAPACITOR-FXD 270PF +-5% 300WVDC MICA	72136	DM15F271J0300WV1CR
A17C39	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A17CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR6	0122-0264		DIO-VVC 1N5148A 47PF 5% C4/C60=3200000	04713	1N5148A
A17CR7	0122-0262		DIO-VVC 1N5147A 39PF 5% C4/C60=3200000	04713	1N5147A
A17CR8	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR9	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR10	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR11	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR12	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR13	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR14	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR15	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR16	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17CR17	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A17L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A17L2	9100-2562	2	COIL; FXD; MOLDED RF CHOKE; 100UH 10%	06560	15S-101K
A17L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A17L4	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A17L5	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A17L6	9100-2815		COIL; FXD; NON-MOLDED RF CHOKE; .7UH 5%	28480	9100-2815
A17L7	9100-1652		COIL; FXD; MOLDED RF CHOKE; 820UH 5%	24226	19/823
A17L8	9100-2566	1	COIL; FXD; MOLDED RF CHOKE; 270UH 10%	06560	15S-271K
A17L9	9100-2568	1	COIL; FXD; MOLDED RF CHOKE; 390UH 10%	06560	15S-391K
A17Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A17Q2	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A17Q3	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A17Q4	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A17Q5	1855-0081		TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A17Q6	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A17Q7	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A17Q8	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A17Q9	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A17Q10	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A17Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q12	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q13	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q14	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q15	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A17Q16	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q17	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q18	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17Q19	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A17R1	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R2	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R3	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R4	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R5	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R6	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R7	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R8	0757-0428		RESISTOR 1.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-1621-F
A17R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A17R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R12	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R13	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R14	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R15	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R16	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R17	0757-0479		RESISTOR 392K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3923-F
A17R18	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A17R19	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A17R20	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T0-4991-F
A17R21	0757-0124		RESISTOR 39.2K 1% .125W F TUBULAR	24546	C5-1/4-T0-3922-F
A17R22	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A17R23	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R24	0698-4002		RESISTOR 5K 1% .125W F TUBULAR	16299	C4-1/8-T0-5001-F
A17R25	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R26	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A17R27	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A17R28	2100-1760		RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A17R29	0698-3156		RESISTOR 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A17R30	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A17R31	2100-1759		RESISTOR; VAR; TRMR; 2KOHM 5% WW	GB027	CT-106-4
A17R32	0757-0290		RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A17R33	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A17R34	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A17R35	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A17R36	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A17R37	0698-4037		RESISTOR 46.4 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-46R4-F
A17R38	0698-3162		RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A17R39	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A17R40	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A17R41	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A17R42	0757-0834		RESISTOR 5.62K 1% .5W F TUBULAR	19701	MF7C1/2-T0-5621-F
A17R43	0757-0317		RESISTOR 1.33K 1% .125W F TUBULAR	24546	C4-1/8-T0-1331-F
A17R44	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A17R45	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R46	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A17R47	0698-3459		RESISTOR 383K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3833-F
A17R48	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A17R49	0757-0835	1	RESISTOR 6.81K 1% .5W F TUBULAR	19701	MF7C1/2-T0-6811-F
A17R50	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A17R51	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A17R52	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A17R53	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A17R54	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A17R55	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A17R56	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A17R57	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A17R58	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A17R59	0757-0466		RESISTOR 110K 1% .125W F TUBULAR	24546	C4-1/8-T0-1103-F
A17R60	0683-8245		RESISTOR 820K 5% .25W CC TUBULAR	01121	CB8245
A17R61	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A17R62	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A17R63	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A17R64	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A17R65	0757-0467		RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A17R66	0698-3439		RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A17R67	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A17R68	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A17R69	0757-0464		RESISTOR 90.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-9092-F
A17R70	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A17R71	0757-0405		RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A17R72	0757-0461		RESISTOR 68.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-6812-F
A17R73	0757-0403		RESISTOR 121 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-121R-F
A17R74	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A17R75	0698-3437		RESISTOR 133 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-133R-F
A17R76	0757-0458		RESISTOR 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A17R77	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A17R78	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A17R79	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A17R80	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A17R81	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A17R82	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A17R83	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A17R84	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A17R85	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A17R86	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A17R87	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A17R88	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A17R89	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A17R90	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A17R91	0698-3433	2	RESISTOR 28.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-28R7-F
A17R92	0698-3432	1	RESISTOR 26.1 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-26R1-F
A17R93	0698-3433		RESISTOR 28.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-28R7-F
A17R94	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A17R95	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A17R96	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A17R97	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A17R98	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A17R99	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A17U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A17U2	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A18	08660-60015	1	BOARD ASSY, SL1 MIXER	28480	08660-60015
A18C1	0180-1704		CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A18C2			NOT ASSIGNED		
A18C3	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A18C4			NOT ASSIGNED		
A18C5	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A18C6			NOT ASSIGNED		
A18C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A18C8	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A18C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A18C10	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392
A18C11	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC POLYE	56289	292P12392
A18C12	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A18C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A18C14	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A18C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A18C16	0180-2214		CAPACITOR-FXD; 90UF+75-10% 16VDC AL	56289	30D906G016CC2
A18C17	0160-2327		CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-2327
A18C18			NOT ASSIGNED		
A18C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A18C20	0180-0141		CAPACITOR-FXD; 50UF+75-10% 50VDC AL	56289	30D506G050DD2
A18C21	0180-1819	1	CAPACITOR-FXD; 100UF+75-10% 50VDC AL	56289	30D107G050DH2
A18C22	0180-0141		CAPACITOR-FXD; 50UF+75-10% 50VDC AL	56289	30D506G050DD2
A18CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A18CR2	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A18E1	10534C		MIXER:200 MHZ	28480	10534C
A18L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A18L2	9140-0114		COIL; FXD; MOLDED RF CHOKE; 10UH 10%	24226	15/102
A18L3	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A18L4	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A18L5	9100-1621		COIL; FXD; MOLDED RF CHOKE; 18UH 10%	24226	15/182
A18L6	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A18Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A18Q2	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A18Q3	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A18Q4	1854-0087		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0087
A18Q5	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q6	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q7	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q8	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q9	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q10	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q11	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q12	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q13	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q14	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A18Q15	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A18Q16	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q17	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q18	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A18Q19	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q20	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q21	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q22	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q23	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251
A18Q24	1853-0007		TRANSISTOR PNP 2N3251 SI CHIP	04713	2N3251

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A18R1	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R2	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R3	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R4	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R5	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R6	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R7	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R8	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R9	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R10	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R11	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R12	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R13	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R14	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R15	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R16	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R17	0757-0479		RESISTOR 392K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3923-F
A18R18	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A18R19	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A18R20	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T0-4991-F
A18R21	0683-3955		RESISTOR 3.9M 5% .25W CC TUBULAR	01121	CB3955
A18R22	0683-2055		RESISTOR 2M 5% .25W CC TUBULAR	01121	CB2055
A18R23	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A18R24	0698-3263		RESISTOR 500K 1% .125W F TUBULAR	19701	MF5C1/8-T0-5003-F
A18R25	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R26	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R27	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A18R28	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A18R29	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A18R30	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A18R31	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A18R32	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A18R33	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R34	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R35	2100-2574		RESISTOR; VAR; TRMR; 500 OHM 10% C	19701	ET50X501
A18R36	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A18R37	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A18R38	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R39	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R40	2100-2574		RESISTOR; VAR; TRMR; 500 OHM 10% C	19701	ET50X501
A18R41	0698-3258		RESISTOR 5.36K 1% .125W F TUBULAR	16299	C4-1/8-T0-5361-F
A18R42	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R43	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R44	2100-2633		RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A18R45	0757-0290		RESISTOR 6.19K 1% .125W F TUBULAR	19701	MF4C1/8-T0-6191-F
A18R46	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A18R47	0757-0400		RESISTOR 90.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-90R9-F
A18R48	0757-0399		RESISTOR 82.5 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-82R5-F
A18R49	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R50	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R51	2100-2633		RESISTOR; VAR; TRMR; 1KOHM 10% C	19701	ET50X102
A18R52	0757-0440		RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A18R53	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R54	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R55	2100-2521		RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50X202
A18R56	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A18R57	0757-0394		RESISTOR 51.1 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-51R1-F
A18R58	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A18R59	0698-3151		RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A18R60	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R61	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R62	2100-2521		RESISTOR; VAR; TRMR; 2KOHM 10% C	19701	ET50X202
A18R63	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A18R64	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A18R65	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A18R66	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R67	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R68	2100-2489		RESISTOR; VAR; TRMR; 5KOHM 10% C	19701	ET50X502
A18R69	0698-3136		RESISTOR 17.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1782-F
A18R70	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A18R71	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A18R72	0698-0083		RESISTOR 1.96K 1% .125W F TUBULAR	16299	C4-1/8-T0-1961-F
A18R73	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A18R74	2100-2522		RESISTOR; VAR; TRMR; 10KOHM 10% C	19701	ET50X103
A18R75	0757-0123		RESISTOR 34.8K 1% .125W F TUBULAR	24546	C5-1/4-T0-3482-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A18R76	0757-0420		RESISTOR 750 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-751-F
A18R77	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A18R78	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A18R79	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A18R80	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A18R81	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A18R82	0698-0085		RESISTOR 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A18R83	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A18R84	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A18R85	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A18R86	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A18R87	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A18U1	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A18U2	1820-0054		IC DGTL SN74 00 N GATE	01295	SN7400N
A18U3	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A19	08660-60017	1	BOARD ASSY, SL1 OSCILLATOR	28480	08660-60017
A19C1	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A19C2	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A19C3	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A19C4	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A19C5	0160-0945		CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A19C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A19C7	0180-2214		CAPACITOR-FXD; 90UF+75-10% 16VDC AL	56289	30D906G016CC2
A19C8	0160-0174		CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A19C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C10	0160-0161		CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A19C11	0160-2220	1	CAPACITOR-FXD 1200PF +-5% 300WVDC MICA	28480	0160-2220
A19C12	0160-0161		CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A19C13	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A19C14	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A19C15	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A19C16	0180-0183		CAPACITOR-FXD; 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A19C17	0170-0082		CAPACITOR-FXD .01UF +-20% 50WVDC POLYE	84411	601PE1030R5W1
A19C18	0121-0059		CAPACITOR; VAR; TRMR; CER; 2/8PF	73899	DV11PR8A
A19C19	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A19C20	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A19C21	0160-0386		CAPACITOR-FXD 3.3PF +-.25PF 500WVDC CER	28480	0160-0386
A19C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C24	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C25	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C27	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C28	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C29	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C30	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C31	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C32	0140-0195	1	CAPACITOR-FXD 130PF +-5% 300WVDC MICA	72136	DM15F131J0300WV1CR
A19C33	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A19C34	0160-2202	1	CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A19C35	0160-2200	1	CAPACITOR-FXD 43PF +-5% 300WVDC MICA	28480	0160-2200
A19C36	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D335X9010B2
A19C37	0160-0157		CAPACITOR-FXD 4700PF +-10% 200WVDC POLYE	56289	292P47292
A19C38	0160-0164	1	CAPACITOR-FXD .039UF +-10% 200WVDC POLYE	56289	292P39392
A19C39	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A19CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR8	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR9	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR10	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR11	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR12	0122-0264		DIO-VVC 1N5148A 47PF 5% C4/C60=3200000	04713	1N5148A
A19CR13	0122-0262		DIO-VVC 1N5147A 39PF 5% C4/C60=3200000	04713	1N5147A
A19CR14	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR15	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A19CR16	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A19L1	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A19L2	9100-2562		COIL; FXD; MOLDED RF CHOKE; 100UH 10%	06560	15S-101K
A19L3	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A19L4	9100-1629		COIL; FXD; MOLDED RF CHOKE; 47UH 5%	24226	15/472
A19L5	9100-2572	1	COIL; FXD; MOLDED RF CHOKE; 820UH 10%	06560	15S-821K
A19L6	9100-2815		COIL; FXD; NON-MOLDED RF CHOKE; .7UH 5%	28480	9100-2815
A19L7	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A19L8	9140-0179		COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A19L9	9100-1611	2	COIL; FXD; MOLDED RF CHOKE; .22UH 20%	24226	15/220
A19L10	9100-1611		COIL; FXD; MOLDED RF CHOKE; .22UH 20%	24226	15/220
A19Q1	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A19Q2	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A19Q3	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A19Q4	1855-0081		TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A19Q5	1854-0345		TRANSISTOR NPN 2N5179 SI PD=200MW	04713	2N5179
A19Q6	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A19Q7	1853-0050		TRANSISTOR PNP SI CHIP TO-18 PD=360MW	28480	1853-0050
A19Q8	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A19Q9	1854-0092		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A19Q10	1854-0022	1	TRANSISTOR NPN SI TO-39 PD=700MW	07263	S17843
A19R1	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A19R2	0698-3442		RESISTOR 237 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-237R-F
A19R3	2100-1760		RESISTOR; VAR; TRMR; 5KOHM 5% WW	GB027	CT-106-4
A19R4	0757-0458		RESISTOR 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A19R5	0698-3437		RESISTOR 133 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-133R-F
A19R6	0757-0460		RESISTOR 61.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-6192-F
A19R7			NOT ASSIGNED		
A19R8	0757-0461		RESISTOR 68.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-6812-F
A19R9	2100-1759		RESISTOR; VAR; TRMR; 2KOHM 5% WW	GB027	CT-106-4
A19R10	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-T0-6811-F
A19R11	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A19R12	0757-0405		RESISTOR 162 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-162R-F
A19R13	0757-0464		RESISTOR 90.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-9092-F
A19R14	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A19R15	0698-3439		RESISTOR 178 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-178R-F
A19R16	0757-0467		RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A19R17	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A19R18	0757-0466		RESISTOR 110K 1% .125W F TUBULAR	24546	C4-1/8-T0-1103-F
A19R19	0757-0834		RESISTOR 5.62K 1% .5W F TUBULAR	19701	MF7C1/2-T0-5621-F
A19R20	0698-3132		RESISTOR 261 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-2610-F
A19R21	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A19R22	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A19R23	0757-0441		RESISTOR 8.25K 1% .125W F TUBULAR	24546	C4-1/8-T0-8251-F
A19R24	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A19R25	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A19R26	0698-3445		RESISTOR 348 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-348R-F
A19R27	0757-0279		RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A19R28	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A19R29	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A19R30	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A19R31	0698-3266		RESISTOR 237K 1% .125W F TUBULAR	16299	C4-1/8-T0-2373-F
A19R32	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R33	0757-0444		RESISTOR 12.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A19R34	0698-3459		RESISTOR 383K 1% .125W F TUBULAR	19701	MF4C1/8-T0-3833-F
A19R35	0698-3162		RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A19R36	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A19R37	0757-0288		RESISTOR 9.09K 1% .125W F TUBULAR	19701	MF4C1/8-T0-9091-F
A19R38	0698-3155		RESISTOR 4.64K 1% .125W F TUBULAR	16299	C4-1/8-T0-4641-F
A19R39	0757-0317		RESISTOR 1.33K 1% .125W F TUBULAR	24546	C4-1/8-T0-1331-F
A19R40	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A19R41	0683-8245		RESISTOR 820K 5% .25W CC TUBULAR	01121	CB8245
A19R42	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A19R43	0698-3446		RESISTOR 383 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-383R-F
A19R44	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R45	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A19R46	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A19R47	0698-3441		RESISTOR 215 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-215R-F
A19R48	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A19R49	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A19R50	0698-3440		RESISTOR 196 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-196R-F
A19R51	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A19R52	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A19R53	0757-0200		RESISTOR 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A19R54	0698-3154		RESISTOR 4.22K 1% .125W F TUBULAR	16299	C4-1/8-T0-4221-F
A19R55	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A19R56	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A19R57	0698-3447		RESISTOR 422 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-422R-F
A19R58	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R59	0698-3444		RESISTOR 316 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-316R-F
A19R60	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R61	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R62	0698-0082		RESISTOR 464 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4640-F
A19R63	0757-0130	1	RESISTOR 31.6 OHM 1% .125W F TUBULAR	24546	C5-1/4-T0-3136-F
A19R64	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A19R65	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A19R66	0757-0294		RESISTOR 17.8 OHM 1% .125W F TUBULAR	19701	MF4C1/8-T0-17R8-F
A19R67	0698-3443		RESISTOR 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A19R68	0757-0289		RESISTOR 13.3K 1% .125W F TUBULAR	19701	MF4C1/8-T0-1332-F
A19R69	0757-0274		RESISTOR 1.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A19R70	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A19R71	0698-3153		RESISTOR 3.83K 1% .125W F TUBULAR	16299	C4-1/8-T0-3831-F
A19R72	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A20	08660-60021	1	BOARD ASSY, RECTIFIER	28480	08660-60021
A20C1	0180-2369	2	CAPACITOR-FXD; 3600UF+75-10% 40VDC AL	56289	36D362G040AB2B
A20C2	0180-1968	1	CAPACITOR-FXD; 18000UF+75-10% 15VDC AL	28480	0180-1968
A20C3	0180-2369		CAPACITOR-FXD; 3600UF+75-10% 40VDC AL	56289	36D362G040AB2B
A20C4	0180-0094	2	CAPACITOR-FXD; 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A20C5	0180-0094		CAPACITOR-FXD; 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A20C6	0180-2334	1	CAPACITOR-FXD; 3900UF+75-10% 75VDC AL	56289	36D392F075BB2B
A20C7	0180-2154	1	CAPACITOR-FXD; 1900UF+75-10% 15VDC AL	56289	39D198G015GL4
A20C8	0180-0058		CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A20C9	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A20C10	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A20C11	0180-0049		CAPACITOR-FXD; 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A20CR1	1901-0638	4	DIODE; MULT; FULL WAVE BRIDGE RECTIFIER	28480	1901-0638
A20CR2			NOT ASSIGNED		
A20CR3	1901-0638		DIODE; MULT; FULL WAVE BRIDGE RECTIFIER	28480	1901-0638
A20CR4	1901-0638		DIODE; MULT; FULL WAVE BRIDGE RECTIFIER	28480	1901-0638
A20CR5	1901-0364	1	DIODE-MULT FULL WAVE BRIDGE RECTIFIER	04713	SDA 10185-4
A20CR6	1901-0638		DIODE; MULT; FULL WAVE BRIDGE RECTIFIER	28480	1901-0638
A20CR7	1884-0024	1	THYRISTOR; SCR	28480	1884-0024
A20F1	2110-0051	1	FUSE 10A 250V	28480	2110-0051
A20F2	2110-0332	1	FUSE 3A 125V	71400	GMW 3
A20F3	2110-0047	3	FUSE 1A 125V	71400	TYPE GMW-1/2
A20F4	2110-0047		FUSE 1A 125V	71400	TYPE GMW-1/2
A20F5	2110-0047		FUSE 1A 125V	71400	TYPE GMW-1/2
A20K1	0490-0908	2	RELAY, 24VDC, CONT 5A 115VAC FORM 4C	77342	R40-E1-X4-V800
A20K2	0490-0908		RELAY, 24VDC, CONT 5A 115VAC FORM 4C	77342	R40-E1-X4-V800
A20MP1	0490-0861	2	SPRING RLY RTNR .031-OD SST	77342	R40-P33
A20MP2	0490-0861		SPRING RLY RTNR .031-OD SST	77342	R40-P33
A20MP3	4040-0554	1	COVER, CAPACITOR	28480	4040-0554
A20R1	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R2	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R3	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R4	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R5	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R6	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A20R7	0757-0198	1	RESISTOR 100 OHM 1% .5W F TUBULAR	19701	MF7C1/2-T0-101-F
A20XA1	1251-2313	6	CONNECTOR;1-CONT SKT .04 DIA	00779	3-332070-5
A20XA5	1251-1626		CONNECTOR; PC EDGE; 12-CONT; DIP SOLDER	71785	252-12-30-300
A20XAK1	0490-0907	2	SOCKET; ELEC; RELAY 15-CONT DIP SLDR	28480	0490-0907
A20XAK2	0490-0907		SOCKET; ELEC; RELAY 15-CONT DIP SLDR	28480	0490-0907
A21	0960-0151	1	CRYSTAL OSCILLATOR:10 MHZ (EXCEPT OPT'S 001 AND 002)	28480	0960-0151
A21	0960-0150	1	CRYSTAL OSCILLATOR:10 MHZ (OPT 001 ONLY) (OMIT A21 ASSY FOR OPT 002)	28480	0960-0150
A22	08660-60043	1	SWITCH ASSY, REFERENCE	28480	08660-60043
	08660-20051	1	HOUSING, REF. SWITCH	28480	08660-20051
A22C1	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A22C2	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A22C3	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A22C4	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A22C5	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A22C6	0160-2437		CAPACITOR-FXD 5000PF +80-20% 200WVDC CER	28480	0160-2437
A22J1	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A22J2	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A22J3	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A22J4	1250-0901		CONNECTOR-RF SMB M SGL HOLE FR	2K497	700166
A22L1	9100-1648	1	COIL; FXD; MOLDED RF CHOKE; 560UH 5%	24226	19/563
A22A1	08660-60027	1	BOARD ASSY, REFERENCE SWITCH	28480	08660-60027
A22A1C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A1C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A1C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A1C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A1K1	0490-0916	6	RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A1K2	0490-0916		RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A1K3	0490-0916		RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A2	08660-60026	1	BOARD ASSY, REFERENCE AMPLIFIER SWITCH	28480	08660-60026
A22A2C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C6	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A22A2C7	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A22A2C8	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22A2CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A22A2CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A22A2K1	0490-0916		RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A2K2	0490-0916		RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A2K3	0490-0916		RELAY; REED; 1A .5A 50V CONT; 5V COIL	28480	0490-0916
A22A2L1	9140-0118	1	COIL; FXD; MOLDED RF CHOKE; 500UH 5%	24226	19/503
A22A2L2	9140-0144		COIL; FXD; MOLDED RF CHOKE; 4.7UH 10%	24226	10/471
A22A2Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A22A2Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A22A2Q3	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A22A2R1	0698-7227	1	RESISTOR 422 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-422R-G
A22A2R2	0698-7222		RESISTOR 261 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-261R-G
A22A2R3	0698-7240	1	RESISTOR 1.47K 2% .05W F TUBULAR	24546	C3-1/8-T0-1471-G
A22A2R4	0698-7248	1	RESISTOR 3.16K 2% .05W F TUBULAR	24546	C3-1/8-T0-3161-G
A22A2R5	0698-7222		RESISTOR 261 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-261R-G
A22A2R6	0698-7212		RESISTOR 100 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-100R-G
A22A2R7	0698-7229	1	RESISTOR 511 OHM 2% .05W F TUBULAR	24546	C3-1/8-T0-511R-G
A22A2R8	0698-7188	2	RESISTOR 10 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-10R-G
A22A2R9	0698-7188		RESISTOR 10 OHM 2% .05W F TUBULAR	24546	C3-1/8-T00-10R-G
A23	08660-60044	1	WIRING HARNESS, MAIN	28480	08660-60044
A23J3	1251-0085	1	CONNECTOR, 36-CONT, FEM, MICRO RIBBON	71785	57-40360-375
A23J3	1251-1908	1	CONTACT, CONN, U/W RECTANGULAR SER,	81312	100-1022P
A23J3	1251-0545	1	CONTACT, R & P CONNECTOR	81312	III-17054P
A23J3	1251-1910	1	CONTACT, CONN, U/W RECTANGULAR SER,	81312	100-1016P
A23J4	1251-2663		CONNECTOR; PC EDGE; 18-CONT; SOLDER EYE	05574	3VH18/1JN5
A23J4	1251-0544	2	BODY, R & P CONNECTOR,42-MALE CONTACTS	81312	MPAC42PG-4192
A23J5	1251-0544		BODY, R & P CONNECTOR,42-MALE CONTACTS	81312	MRAC42PG-4192
A23J6	1251-0547	1	BODY, R & P CONNECTOR,66-MALE CONTACT	81312	MRAC66PG-4193
A23J7	1251-1017	2	CONNECTOR, 4-CONT, WINCH JF	81312	JF2S-2P-5B
A23W1			"UNDER CHASSIS PARTS"		
A23W2			"UNDER CHASSIS PARTS"		
A23W3	08660-60054	1	CABLE ASSY, WHITE	28480	08660-60054
A23W4			"UNDER CHASSIS PARTS"		
A23W5			"UNDER CHASSIS PARTS"		
A23W6	08660-60056	1	CABLE ASSY, ORANGE	28480	08660-60056
A23W7	08660-60058	1	CABLE ASSY, WHITE/RED	28480	08660-60058
A23W8	08660-60057	1	CABLE ASSY, WHITE/GREEN	28480	08660-60057
A23W9	08660-60071	1	CABLE ASSY, WHITE/BROWN	28480	08660-60071
A23W10	08660-60052	1	CABLE ASSY, RED	28480	08660-60052
A23W11	08660-60053	1	CABLE ASSY, BROWN	28480	08660-60053
A23W12	08660-60075	1	CABLE ASSY, GREEN	28480	08660-60075
A23W13	08660-60067	1	CABLE ASSY, WHITE/RED	28480	08660-60067
A23W14	08660-60066	1	CABLE ASSY, WHITE/BLUE	28480	08660-60066
A23W15	08660-60059	1	CABLE ASSY, WHITE/YELLOW	28480	08660-60059

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A23W16	08660-60081	1	CABLE ASSY, WHITE/RED	28480	08660-60081
A23W17	08660-60074	1	CABLE ASSY, WHITE/BROWN	28480	08660-60074
A23W18	08660-60072	1	CABLE ASSY, WHITE/ORANGE	28480	08660-60072
A23W19	08660-60073	1	CABLE ASSY, WHITE/YELLOW	28480	08660-60073
A23W20	08660-60076	1	CABLE ASSY, WHITE/BLACK	28480	08660-60076
A23W21	08660-60077	1	CABLE ASSY, WHITE/GRAY	28480	08660-60077
A23W22	08660-60062	1	CABLE ASSY, WHITE (EXCEPT OPT 004)	28480	08660-60062
A23W23	08660-60060	1	CABLE ASSY, WHITE/ORANGE	28480	08660-60060
A23W24	08660-60093	1	CABLE ASSY	28480	08660-60093
A23W25	08660-60094	1	CABLE ASSY	28480	08660-60094
A23W26	08660-60095	1	CABLE ASSY	28480	08660-60095
A23W27	08660-60175	1	CABLE, VIOLET	28480	08660-60175
			MISCELLANEOUS A23.		
	08660-20052	3	PIN, GUIDE	28480	08660-20052
A24	08660-60064		WIRING HARNESS	28480	08660-60064
A24P7	1251-1017		CONNECTOR, 4-CONT, WINCH JF	81312	JF2S-2P-AB
A24S1	3101-1536	1	SWITCH-TGL DPDT 3A 125VAC	28480	3101-1536
			CHASSIS PARTS		
F1			PART OF A7 (PRIMARY FUSE)		
F1			PART OF A20		
F2			PART OF A20.		
F3			PART OF A20.		
F4			PART OF A20.		
F5			PART OF A20.		
S1	3101-1235	1	SWITCH-SL DPDT-NS 3A 125VAC (INT/EXT REFERENCE SWITCH)	22753	SW 322
T1	9100-3543	1	COIL, FXD	28480	9100-3543
T1CR1	1901-1001	1	DIODE, MULT, SILICON, DUAL	28480	1901-1001
W1	08660-60061	2	CABLE ASSY, GRAY	28480	08660-60061
W2	08660-60061		CABLE ASSY, GRAY	28480	08660-60061
W3			PART OF A23.		
W4	08660-60046	1	CABLE ASSY, INTERFACE	28480	08660-60046
W5	08660-60065	1	CABLE ASSY, ORANGE	28480	08660-60065
			MISCELLANEOUS PARTS		
	8120-1348	1	CABLE: UNSHLD 3-COND 18AWG	28480	8120-1348
	5040-1485	3	CONDUCTOR ASSEMBLY:PLUG-IN JUMPER	28480	5040-1485
	8150-008272	6	WIRE, RED #18.	28480	8150-008272
	08660-00003	1	SUPPORT, 66-PIN CONNECTOR	28480	08660-00003
	08660-00004	1	SUPPORT, 42-PIN CONNECTOR	28480	08660-00004
	08660-00005	1	BRACKET, LEFT INTERFACE	28480	08660-00005
	08660-20167	1	BRACKET, RIGHT INTERFACE	28480	08660-20167
	08660-00007	1	SUPPORT, REFERENCE OSCILLATOR	28480	08660-00007
	08660-00027	1	SUPPORT, LOOP BOX, REAR	28480	08660-00027
	08660-00028	1	CLAMP, REF. OSC. (OPT 002)	28480	08660-00028
	08660-00029	1	BRACKET, L.P. BOX, LT SD	28480	08660-00029
	08660-00030	1	COVER, SL1 OSCILLATOR	28480	08660-00030
	08660-00031	1	COVER, SL1 PHASE DETECTOR	28480	08660-00031
	08660-00058	1	GASKET, SL1-N1	28480	08660-00058
	08660-00032	1	COVER, N1	28480	08660-00032
	08660-00033	1	COVER, N2 (OPT 004)	28480	08660-00033
	08660-00034	1	COVER, N3 (OPT 004)	28480	08660-00034
	08660-00035	1	COVER, SL2 (OPT 004)	28480	08660-00035
	08660-00036	1	SUPPORT, H.F. LOW PASS BOX	28480	08660-00036
	08660-00037	1	COVER, BOTTOM 1.3GHZ MOD.	28480	08660-00037
	08660-00038	1	LATCH, H.F. LOW PASS BOX	28480	08660-00038
	08660-00041	1	COVER, WIRING HARNESS	28480	08660-00041
	08660-00042	1	COVER, N2A (OPT 004)	28480	08660-00042
	08660-00043	1	COVER, COUPLING BOARD (OPT 004)	28480	08660-00043
	08660-00044	1	COVER, BLANK (OPT 004)	28480	08660-00044
	08660-00061	1	BRACKET, CONNECTOR	28480	08660-00061
	08660-20040	3	BOARD, P.C. (OPT 004)	28480	08660-20040
	08660-20050	1	HEAT SINK	28480	08660-20050

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	08660-20052		PIN, LATCH	28480	08660-20052
	08660-20054	2	PIN, PIVOT	28480	08660-20054
	08660-20055	1	SCREW, SHOULDER	28480	08660-20055
	08660-20056	2	END PLATE, L.P.BOX	28480	08660-20056
	08660-20062	11	EXTRACTOR, SHIELD	28480	08660-20062
	08660-20170	2	HEAT SINK, .75 X .18"	28480	08660-20170
	08660-20183	2	HEAT SINK, .75 X .38"	28480	08660-20183
	08660-60080	2	CABLE ASSY, GRAY	28480	08660-60080
	08660-60083	1	CABLE ASSY, GRAY	28480	08660-60083
	1251-0084	1	CONNECTOR, 36-CONT, MALE, MICRO RIBBON	71785	57-30360-375
	1250-0780	1	ADAPTER-COAX; STRAIGHT BNC UG 201A/U	90949	31-216-1020
	5020-7623	1	BRACKET:7H L.H. RACK MOUNT	28480	5020-7623
	5020-7624	1	BRACKET:7H R.H. RACK MOUNT	28480	5020-7624
	5060-0256	1	EXT. BOARD ASSY:24 CONTACT	28480	5060-0256
	5060-0276	2	EXT. BOARD ASSY:15 PIN	28480	5060-0276
	5060-0258	1	EXT. BOARD ASSY:24 CONTACT	28480	5060-0258
	5060-0277	1	EXT. BOARD ASSY:18 PIN	28480	5060-0277
	05580-2042	1	STRIP, FILLER	28480	05580-2042
	08660-00065	1	CORK PAD	28480	08660-00065
	08660-20168	1	HEAT SINK	28480	08660-20168
	08660-20169	1	HEAT SINK	28480	08660-20169

Table 6-4. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
GB027	NEOHM	ENGLAND	
0057R	RIFA		
00779	AMP INC	HARRISBURG PA	17105
00865	STETTNER-TRUSH INC	CAZENOVIA NY	13035
0089M	MABI CO THE		
01121	ALLEN BRADLEY CO	MILWAUKEE WI	53212
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75231
02114	FERROXCUBE CORP	SAUGERTIES NY	12477
02735	RCA CORP SOLID STATE DIV	SOMMERVILLE NJ	08876
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE NY	13201
03888	PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
05574	VIKING INDUSTRIES INC	CHATSWORTH CA	91311
06560	AIRCO SPEER ELEK DIV AIR RDCN CO	NOGALES AZ	85621
06776	ROBINSON NUGENT INC	NEW ALBANY IN	47150
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94040
07322	MINNESOTA RUBBER CO	MINNEAPOLIS MN	55416
07716	TRW INC BURLINGTON DIV	BURLINGTON IA	52601
09353	C AND K COMPONENTS INC	WATERTOWN MA	02172
16299	CORNING GL WK ELEC CMPNT DIV	RALEIGH NC	27604
18324	SIGNETICS CORP	SUNNYVALE CA	94086
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
2K497	CABLEWAVE SYSTEMS INC	NORTH HAVEN CT	06473
22753	U I D ELECTRONICS CORP	HOLLYWOOD FL	33021
24226	GOWANDA ELECTRONICS CORP	GOWANDA NY	14070
24546	CORNING GLASS WORKS	BRADFORD PA	16701
24995	ENVIRONMENTAL CONTAINER SYSTEMS INC	PALO ALTO CA	94304
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
30983	MEPCO/ELECTRA CORP	SAN DIEGO CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE CA	92507
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
71400	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS MO	63017
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO IL	60640
71785	TRW ELEK COMPONENTS CINCH DIV	ELK GROVE VILLAGE IL	60007
72136	ELECTRO MOTIVE MFG CO INC	WILLIMANTIC CT	06226
73743	FISCHER SPECIAL MFG CO	CINCINNATI OH	45206
73899	J F D ELECTRONICS CORP	BROOKLYN NY	11219
74970	JOHNSON E F CO	WASECA MN	56093
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA PA	19108
76381	3M COMPANY	ST PAUL MN	55101
76493	BELL INDUSTRIES INC MILLER JW DIV	COMPTON CA	90224
77342	POTTER & BRUMFIELD DIV AMF INC	PRINCETON IN	47570
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF	ELGIN IL	60126
81312	WINCHESTER ELEK DIV LITTON IND INC	OAKVILLE CT	06779
83186	VICTORY ENGINEERING CORP	SPRINGFIELD NJ	07081
84411	TRW CAPACITOR DIV	OGALLALA NE	69153
90949	AMPHENOL SALES DIV OF BUNKER-RAMO	HAZELWOOD MO	63042
91637	DALE ELECTRONICS INC	COLUMBUS NE	68601
91886	MALCO MFG CO INC	CHICAGO IL	60650
91929	HONEYWELL INC MICRO SWITCH DIV	FREEPORT IL	61032
95987	WECKESSER CO INC	CHICAGO IL	60641
98291	SEALECTRO CORP	MAMARONECK NY	10544

See introduction to this section for ordering information

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section will be used in future issues or revisions of this manual to provide back-dating information.

7-3. In the interim, any necessary changes to the information contained in this manual will be documented in Manual Change Sheets shipped with the manual.

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section of the manual is designed to aid the technician in returning the instrument to proper operating condition in the shortest time possible should a malfunction occur in any of the operating circuits.

8-3. PRINCIPLES OF OPERATION

8-4. Operation of the various circuits within the 8660C mainframe are explained beginning with paragraph 8-87. Each of the phase locked loops, the interface circuits and the Digital Control Unit are briefly explained. These circuits are also graphically shown in the System Block Diagram and Service Sheet 1.

8-5. TROUBLESHOOTING

8-6. In general, this section is designed to aid in isolating the assembly, circuit or Plug-in Section which is causing faulty operation, by a series of tables identified in Table 8-1. The tables listed in Table 8-1 identify the source of trouble and also provide information relative to the location of the schematic (Service Sheet, abbreviated SS) of the defective circuit. These Service Sheets provide the schematic, a pictorial display of component locations and technical data about the circuits in the assembly.

8-7. Due to the digital design of the Model 8660C, two major troubleshooting aids in this manual are an ASM diagram (Algorithmic State Machine, sometimes called a flow chart) located on the last foldout page of this manual and a system of mnemonics (basically a system of abbreviated terms) which serve to reduce clutter in the ASM diagram and in the circuits of the Digital Control Unit (DCU) and interface units. The basic principles of ASM diagrams and an example of ASM diagram use appears beginning in paragraph 8-36. Figure 8-5 illustrates a basic ASM diagram (actually a part of the Model 8660C ASM diagram) and describes the use of an ASM diagram in isolating the cause of a malfunction. Mnemonics are described beginning with paragraph 8-71 and listed in Table 8-4. An explanation of the use of

Table 8-1. 8660C Troubleshooting Tables

No.	Title
8-6	Power Supply Troubleshooting
8-7	Troubleshooting DCU by Assembly Replacement
8-8	DCU and Interface Troubleshooting Guide
8-9	Incorrect Initial Readout
8-10	Center Frequency Readout Faulty
8-11	BCD Data to Mainframe Incorrect
8-12	Readout is Partially Displayed or Incorrect
8-13	Only 1 or 2 Half-Digits Displayed
8-14	Center Frequency Readout Does Not Justify Correctly
8-15	Readout Does Not Justify with only One Units Key
8-16	Either STEP ↑ or STEP ↓ Operation Defective
8-17	Both STEP ↑ and STEP ↓ Defective at the RF Output
8-18	Manual STEP Defective
8-19	Manual Tune Mode Inoperative
8-20	Manual Tune Defective on One Range, Fine, Medium, or Coarse
8-21	Either Up or Down Manual Tune Defective
8-22	Auto Sweep Defective at all Sweep Rates
8-23	Auto Sweep Defective at One Rate
8-24	Single Sweep Defective
8-25	Manual Sweep Defective
8-26	Out-of-Range Indicator Inoperative
8-27	KYBD Pushbutton Readout Defective
8-28	STEP Pushbutton Readout Defective
8-29	Sweep Width Pushbutton Readout Defective
8-30	Remote Control Problems
8-31	Harmonics Excessive Below 1.3 GHz
8-32	Output Frequency is Half Indicated Frequency Above 1.3 GHz
8-33	Troubleshooting Option 005 Interface Problems
8-34	Troubleshooting the Reference Section
8-35	High Frequency Loop Troubleshooting
8-36	Summing Loop 1 Troubleshooting
8-37	Summing Loop 2 Troubleshooting
8-38	N3 Loop Troubleshooting
8-39	N2 Loop Troubleshooting
8-40	N1 Loop Troubleshooting
8-41	Low Frequency Loops Notes

mnemonics is included in the first part of Table 8-4.

8-8. RECOMMENDED TEST EQUIPMENT

8-9. Test equipment and accessories required to maintain the Model 8660C are listed in Table 1-2. If the equipment listed is not available, equipment that meets the minimum specifications shown may be substituted.

8-10. Also listed in Table 1-2 is Service Kit HP Model 11672A. This kit consists of extension cables, cable adapters and an alignment tool. The items within the kit are listed individually in Table 1-2. The entire kit, or any part within the kit may be ordered separately.

8-11. REPAIR

8-12. Factory Selected Components

8-13. Some component values are selected at the time of final checkout at the factory (see Table 5-1). Usually these values are not extremely critical, they are selected to provide optimum compatibility with associated components. These components are identified on individual schematics by an asterisk (*). The recommended procedure for replacing a factory-selected component is shown in Section V of this manual.

8-14. Board Repair.

8-15. Etched Circuits. The etched circuit boards in the Synthesized Signal Generator are of the plated-through type consisting of metallic conductors bonded to both sides of insulating material. The metallic conductors are extended through the component mounting holes by a plating process. Soldering can be done from either side of the board with equally good results. Table 8-2 lists recommendations and precautions pertinent to etched circuit repair work.

a. Avoid unnecessary component substitution; it can result in damage to the circuit board and/or adjacent components.

b. Do not use a high-power soldering iron on etched boards. Excessive heat may lift a conductor or damage the board.

c. Use a suction device (Table 8-2) or wooden toothpick to remove solder from component mounting holes. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL FOR THIS PURPOSE. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR.

d. After soldering, remove excess flux from the soldered areas and apply a protective coating to prevent contamination and corrosion. (Avoid getting flux remover on the printed circuit board extractors.) See Table 8-2 for recommendations.

8-16. Etched Conductor Repair. A broken or burned section of conductor can be repaired by bridging the damaged section with a length of tinned copper wire. Allow adequate overlay and remove any varnish from etched conductor before soldering wire into place.

8-17. Component Replacement. Remove defective component from board.

NOTE

Although not recommended on boards with high-frequency signals or where both sides of a board are accessible, axial lead components, such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads neare body of defective component, remove component and straighten leads left in board. Wrap leads of replacement component one turn around original leads. Solder wrap connection and clip off excess lead.

8-18. If component was unsoldered, remove solder from mounting holes, and position component as original was positioned. DO NOT FORCE LEADS INTO MOUNTING HOLES: sharp lead ends may damage plated-through conductor.

8-19. Transistor Replacement. Transistors are packaged in many physical forms. This sometimes results in confusion as to which lead is the collector, which is the emitter, and which is the base. Figure 8-1 shows typical epoxy and metal case transistors and the means of identifying the leads.

8-20. To replace a transistor, proceed as follows:

a. Do not apply excessive heat; see Table 8-2 for recommended soldering tools.

b. If possible, use long-nose pliers between transistor and hot soldering tools.

c. When installing replacement transistors, ensure sufficient lead length to dissipate soldering heat by using about the same length of exposed lead as used for the original transistor.

d. Integrated circuit replacement instructions are the same as for transistors.

8-21. Some transistors are mounted on heat sinks for good heat dissipation. This requires good thermal contact with mounting surfaces. To assure good thermal contact for a replacement transistor, coat both sides with Dow Corning No. 5 silicone compound or equivalent before fastening the transistor to the chassis. Dow Corning No. 5 compound is available in 8 oz. tubes from HP; order HP Part No. 9500-0059.

8-22. Diode Replacement. Solid state diodes have many different physical forms. This sometimes results in confusion as to which lead is the anode (positive), since all diodes are not marked with the standard symbols. Figure 8-1 shows examples of some diode marking methods. If doubt exists as to polarity, an ohmmeter may be used to determine the proper connection. It is necessary to know the polarity of the ohms lead for the ohmmeter used. (For the HP Model 410B Vacuum Tube Voltmeter, the ohms lead is negative with respect to the common; for the HP Model 412A DC Vacuum Tube Voltmeter, the ohms lead is positive with respect to the common.) When the ohmmeter indicates the least diode resistance, the cathode of the diode is connected to the ohmmeter lead which is negative with respect to the other lead.

NOTE

Replacement instructions for diodes are the same as those listed for transistors.

8-23. Illustrated Parts Breakdown (IPB's). Figure 6-1 and Figure 6-2 show IPB's for the Cabinet Parts and the inside of the DCU front panel.

8-24. MODULE EXCHANGE

8-25. Some of the assemblies within the Mainframe Digital Control Unit are available on an exchange-for-credit basis. These assemblies and the special exchange numbers are listed in Table 6-1. When ordering an exchange module be sure to use the special exchange module numbers shown in Table 6-1 and refer to Figure 8-2 for the procedure to be followed.

8-26. SAFETY REQUIREMENTS

8-27. Safety requirements are listed on page vii (directly preceding Section I). They are also called out where required in the Manual.

8-28. SERVICE AIDS

8-29. Posidriv Screwdrivers. Many of the screws in the instrument appear to be Phillips, but are not. To avoid damage to the screw slots, Pozidriv screwdrivers should be used.

8-30. Extender Boards. Extender boards are furnished with the rack mounting kit (accessory part number 08660-60070). These boards and other furnished assemblies are listed in Section I of this Manual. The extender boards may be used to extend any plug-in board free of the chassis for maintenance except the A3 Interface boards. Figure 8-3 shows a typical use of the extender board for maintenance purposes.

8-31. Part Locator Aids. The locations of chassis mounted parts and assemblies are shown in Figure 8-113. The locations of individual components mounted on printed circuit boards or other assemblies are shown on the appropriate schematic page or the page opposing it. The part reference designator is the assembly number followed by the schematic reference designator (for example, A6R9 is R9 on the A6 assembly). For specific component description and ordering information refer to the parts list in Section VI.

8-32. Assembly Adjustment Locations. Near the rear cover of this Manual is a series of Figures which locate the adjustments for all assemblies. These Figures are referred to in each of the adjustment procedures in Section V.

8-33. Servicing Aids on Printed Circuit Boards. The servicing aids include test points, transistor and integrated circuit designations, adjustment call-outs and assembly stock numbers.

8-34. Table 8-3 (two sheets) Schematic Diagram Notes, provides information relative to symbols and values shown on the schematic diagrams.

8-35. Figure 8-4 illustrates the method used to number the connectors used on the printed circuit boards.

8-36. ALGORITHMIC STATE MACHINES (ASM's)

8-37. ASM diagrams, sometimes called flow graphs, are the most practical approach to under-

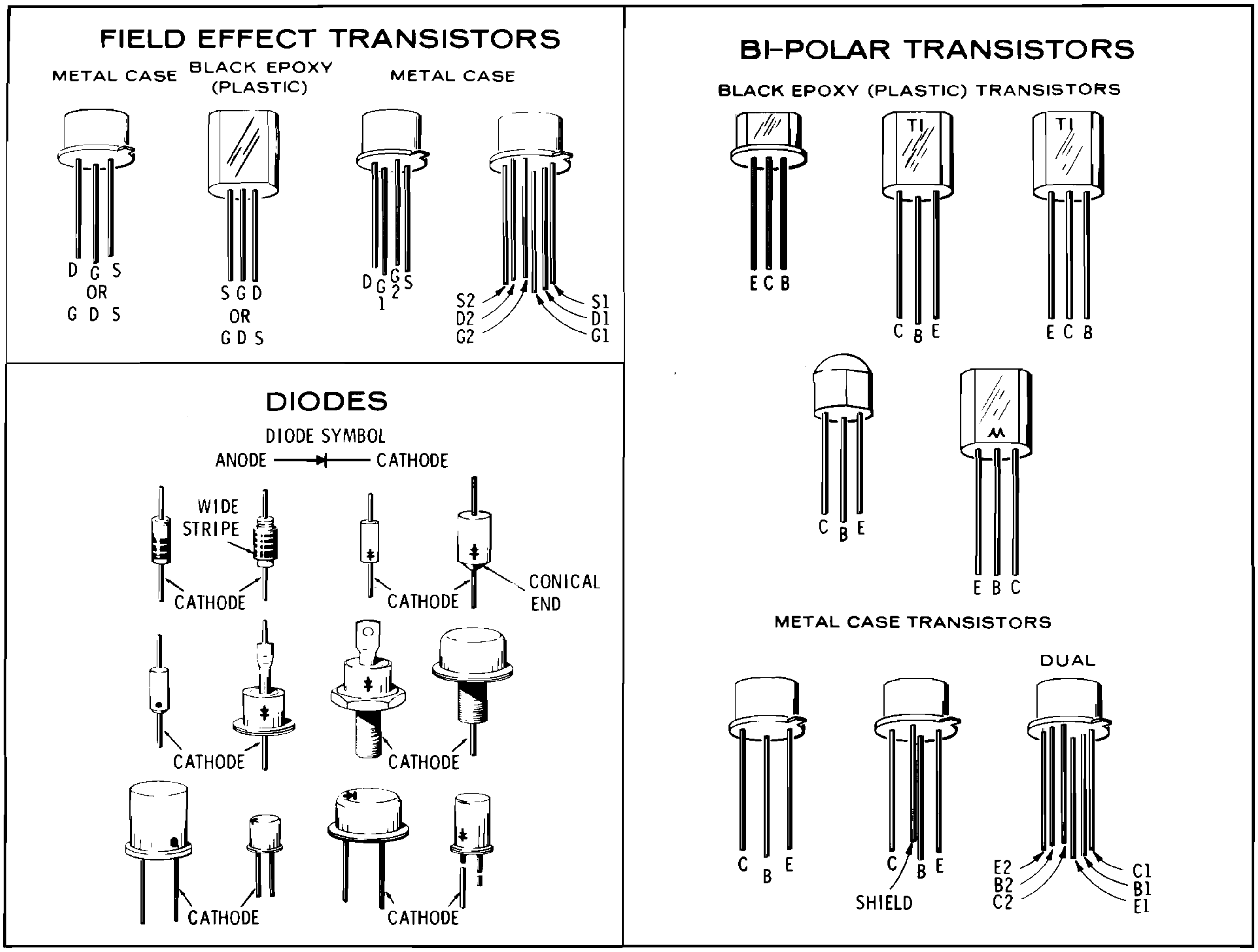


Figure 8-1. Examples of Diode and Transistor Marking Methods

Table 8-2. Etched Circuit Soldering Equipment

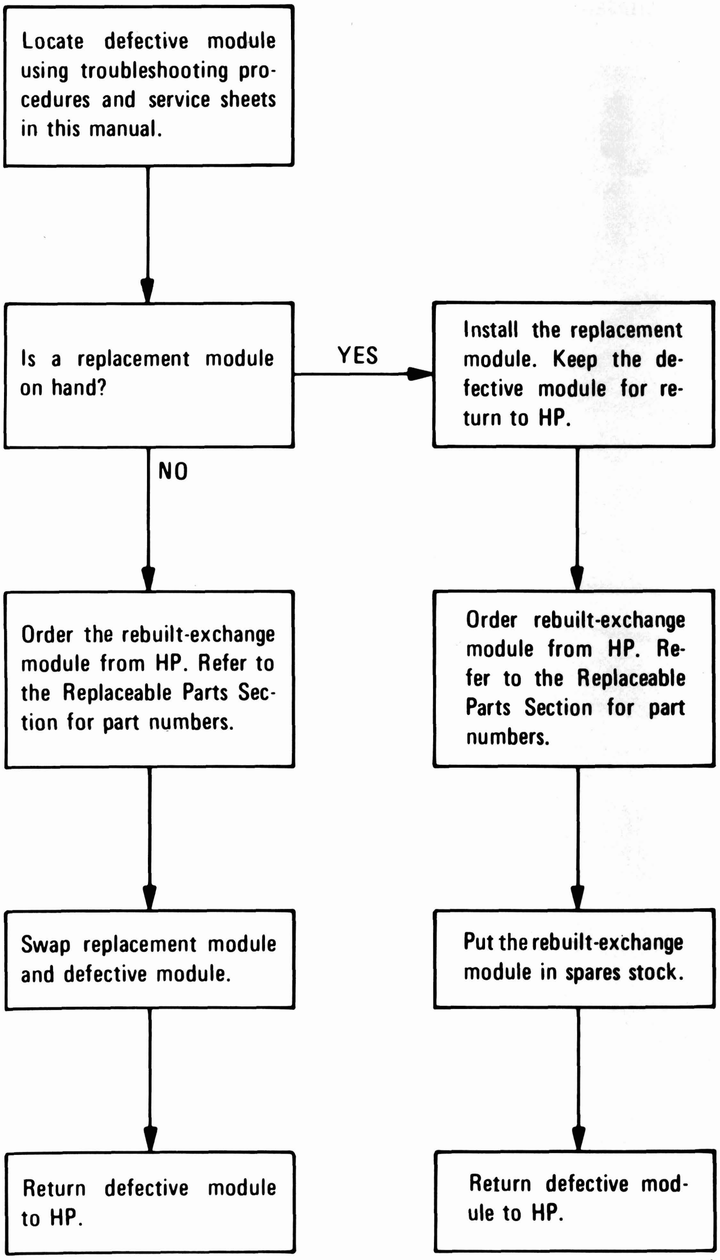
Item	Use	Specification	Item Recommended
Soldering Tool	Soldering, unsoldering	Wattage range: 37-50; Tip Temp: 750-800°	Unger #766 handle w/*Ungar #1237 heating unit
Soldering Tip	Soldering, unsoldering	*Shape: pointed	*Unger #PL111
De-soldering Aid	To remove molten solder from connection	Suction device	Soldapult by Edsyn Co., Arleta, California
Resin (flux) Solvent	Remove excess flux from from soldered area before application of protective coating	Must not dissolve etched circuit base board	Freon; Acetone; Lacquer Thinner
Solder	Component replacement. Circuit board repair. Wiring.	Resin (flux) core, high tin content (60/40 tin/lead), 18 gauge (AWG) preferred	
Protective	Contamination, corrosion protection	Good electrical insulation; corrosion-prevention properties	Silicone Resin such as GE DRI-FILM**88

* For working on circuit boards; for general purpose work, use Ungar No. 4037 Heating Unit (47½—56½ W) tip temperature of 850-900 degrees and Ungar No. PL113 1/8" chisel tip.

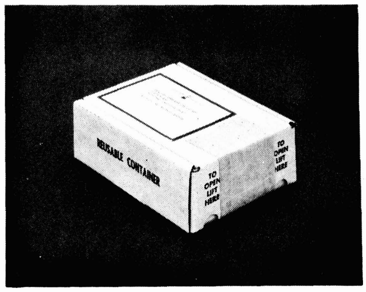
** General Electric Co., Silicone Products Dept. Waterford, New York, U.S.A.

Module Exchange Repair Program

The module exchange program described here is a method of keeping your Hewlett-Packard instrument in service without repairing the instrument to the component level.



A.



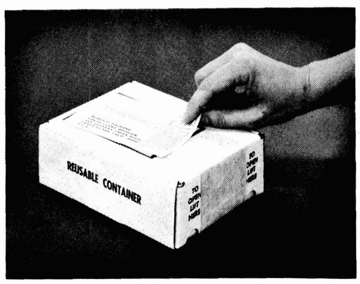
Rebuilt-exchange modules are shipped individually in boxes like this. In addition to the circuit module, the box contains:

- Module repair report
- Return address label
- Tape for resealing box

B.

Open box carefully - it will be used to return defective module to HP. Complete repair report. Place it and defective module in box. Be sure to remove enclosed return address label.

C.



Seal box with tape provided. Inside U.S.A.*, stick preprinted return address label over label already on box, and return box to HP. Outside U.S.A., do not use address label: instead, address box to the nearest HP office.

*HP pays postage on boxes mailed in U.S.A.

Figure 8-2. Modular Exchange Procedure

Figure 8-3. Model 8660C With Circuit Board Extended for Maintenance

Table 8-3. Schematic Diagram Notes (1 of 2)

SCHEMATIC DIAGRAM NOTES

Inductance is in microhenries, Resistance is in ohms and Capacitance is in microfarads unless otherwise noted.

P/O	part of
(screwdriver symbol)	Screwdriver Adjustment
(circle)	Panel Control
(solid rectangle)	Encloses Front Panel designations
(dashed rectangle)	Encloses Rear Panel designations
—— - - ——	Circuit assembly borderline
– – – – – – –	Other assembly borderline
CW	Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.
(star with 1)	Numbers in stars on circuit assemblies show locations of test points.
(oval)	Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number identifies the base color, second number the wider stripe, and the third number the narrower stripe. Example: (947) denotes white base, yellow wide stripe, violet narrow stripe.
(A) 2	Indicates an output from a schematic that goes to an input identified as (A) on Service Sheet 2.
6 (K)	Indicates an input to a schematic that comes from an output identified as (K) on Service Sheet 6.

NOTE

When the above two symbols appear within the borderline of a schematic, they indicate a connection within the borderline of the referenced schematic.

(ground symbol)	Indicates circuit ground.

Table 8-3. Schematic Diagram Notes (2 of 2)

Test point symbols. Stars are numbered or lettered for easy correlation of schematic diagrams, procedures, and locator illustrations.

Arrow connecting star to measurement point signifies no measuring aid provided.

Star shown electrically connected to circuit signifies measuring aid (metal post, circuit pad, etc.) provided.

Interconnection information.

Circled letter indicates circuit path continues on another schematic diagram. Look for same circled letter on service sheet indicated by adjacent bold number (3, in this example).

Plug-in connection information. Socket designation for A2 assembly.

Number indicates pin of socket (XA2).

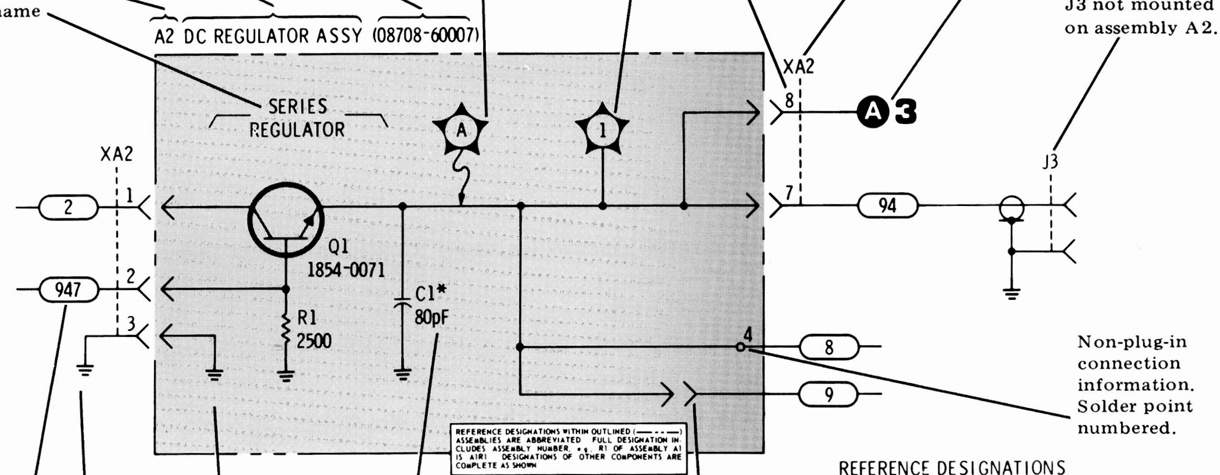
Assembly part number

Assembly name

Assembly designation

Stage name

J3 not mounted on assembly A2.



Non-plug-in connection information. Solder point numbered.

REFERENCE DESIGNATIONS

NO PREFIX	A2 ASSY
A2 J3 XA2	C1 Q1 R1

DELETED:

2
A2

Circuit board common.

Conducting connection to chassis or frame.

Value selected for best operation. Value shown is average or most commonly selected value.

Connector symbols within the borderlines of circuit assemblies signify connections to the assembly which are separate from those made through the integral plug part of the assembly.

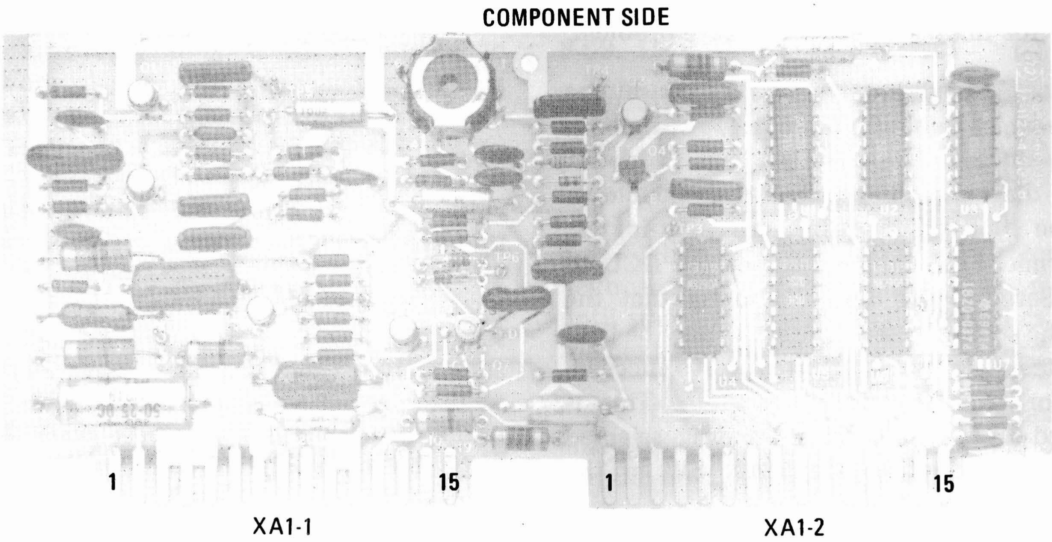
Assembly reference designator(s).

Large numbers in lower right corners of schematic diagrams are service sheet numbers. They are provided for convenience in tracing interconnections.

Wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number identifies the base color, second number the wider stripe, and the third number the narrower stripe. Example, (947) denotes white base, yellow wide stripe, violet narrow stripe.

Reference designators deleted by circuit changes are listed here.

List of all the reference designations on the diagram.



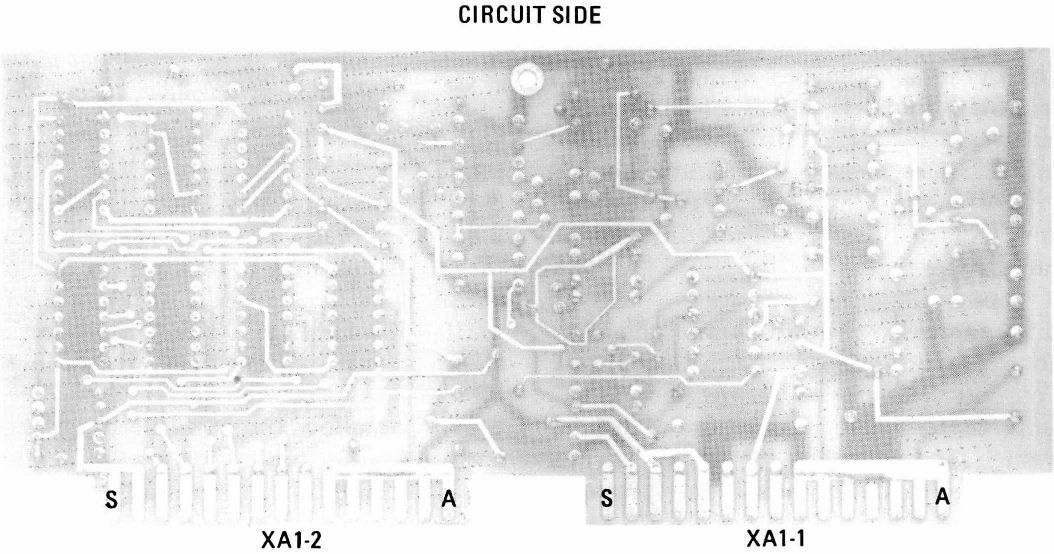


Figure 8-4. Printed Circuit Board Connector Identification

standing circuitry as complex as that in the Model 8660C DCU.

DEFINITIONS:

Algorithm: A fixed step-by-step procedure for finding the solution to a problem.

State: A condition, or a set of conditions which exist at a given point in time.

8-38. ASM diagrams are particularly valuable in servicing the Model 8660C because built-in test features permit the technician to set the DCU to any state. Seven LED's verify or deny that the DCU is in the state selected. The DCU may be held in the selected state, manually stepped to succeeding states or reset to any other state. This is accomplished by temporarily grounding selected Test Points or operating the MAN SW in the self-test facilities.

8-39. Figure 8-5 represents a portion of the overall DCU ASM which is shown in its entirety in Figure 8-122. The following description of the information shown in Figure 8-5 is equally applicable to the overall ASM diagram.

8-40. The mnemonics (Table 8-4) in the state (rectangular) boxes and the qualifier (diamond shaped) boxes are not truly representative of specific electrical points in the circuit; the function represented by the mnemonic may appear at many points in the DCU. Table 8-4, mnemonics information, will enable the technician to quickly locate the points in the DCU where the function appears. The —H (>+2.8V) or the —L (<+0.8V) following the mnemonics indicates that the function is High or Low in the assertive (active) state.

8-41. The lines connecting the qualifiers and the states are not representative of electrical connections. Their purpose is to provide information as to what the next state will be. Usually the qualifier determines which of two states is next. In some cases however, the qualifier holds the present machine state for a predetermined period of time.

8-42. In the Model 8660C there are about 112 machine states. Some of these states are used in many operations (see Table 8-4 and the overall ASM diagram). Seven "state" flip-flops determine present machine state by their logic conditions. The outputs of these flip-flops are designated as $A_{\emptyset}$ through A_6 and their binary weighting determines the state number. Take, for instance, the state of 5/11; A_6 and A_4, with weighting of 4 and 1 provides the binary number 5, or BCD 1 0 1 for the first part of the number and A_3 A_1 and $A_{\emptyset}$ with weighting of 8, 2 and 1 provide the binary number of 11 or BCD 1 0 1 1 for the second part of the number. Breaking the number into two parts is for convenience only — it is shown in both numerals and BCD format for each state in the box (in the example it would be 5-11 - 1 0 1 1 0 1 1).

8-43. Refer to Figure 8-5. The starting point for this ASM diagram is in the upper left hand corner.

8-44. State 7/15 is an invalid state. It is representative of ROM addresses which are not normally addressable. There is a remote possibility that one of these addresses might be randomly selected at initial turn on, in which case state 7/15 would force the machine state to 0/0, the normal starting point.

8-45. Figure 8-5 illustrates the state path for an entry of a number or a decimal point. It also illustrates the start of the state path for justification (decimal point placement) when a decimal point is entered.

NOTE

The seven "state" LED's, test points and the stepping microswitch (MAN SW) are shown in Figure 8-118 to the left of the ASM. This foldout sheet may be folded out for ready reference while going through the state sequences.

8-46. Numeral Entry State Path (heavy line). When the first entry is made with the keyboard (JF10)—L (J input to flip-flop 10 goes low) is active. Qualifier F10 goes high and the next state is 4/10. (JSW1)—L is a sweep function and has no effect on entries other than sweep functions.

8-47. To follow the state path through the DCU for a numerical entry, remove the cabinet bottom cover and temporarily ground the MAN. TP. All of the LED's should be extinguished, indicating state 0/0 (if they are not, temporarily ground the STATE 0/0 TP).

8-48. Press and hold in a numeric keyboard key until state 4/10 is reached. Note that pressing a numeric key does not (by itself) cause a change in state. The MAN. TP. must be pressed each time the state is changed for any operation.

8-49. In order to reach state 4/0 or any other succeeding state, it is necessary to press the MAN. TP. microswitch. (It is suggested that the MAN. TP. be pressed with the eraser end of a pencil. This switch is very sensitive and the least amount of nervousness may cause a progression through more than one state.)

8-50. Qualifier F7-H is active only in sweep functions so pressing the MAN. TP. when the instrument is in state 4/40 should cause the next state to be 5/0.

8-51. Qualifier DP-L is active only when a decimal point has been entered, so pressing the MAN. TP. one time when in state 5/0 should cause the next state to be 6/0.

8-52. Qualifier NUM-H is active when a numeric entry is made. Pressing the MAN. TP. one time when the state is at 6/0 should cause the next state to be 6/1.

8-53. Qualifier F2-H is active for only the first key entry of any new keyboard entry. In this case the first entry is a numeral, so pressing the MAN. TP. one time should cause the next machine state to be 1/5. State 1/5 includes instructions (RF2, RJCT)-L.

8-54. Qualifier NUM-H following state 1/5 is active, so pressing the MAN. TP. one time should cause the next state to be 0/2 which contains instruction ETKØ-L. This instruction causes the number BCD (format) to be stored in a 1 digit shift register KØ.

8-55. Pressing the MAN. TP. one time now causes the next state to be 0/3 which contains instructions KØTK-L and CK10. Qualifier CKB-H is low and the state remains at 0/3 until the BCD data from the KØ register is clocked into the least significant digit of the keyboard shift register (10 clock pulses).

8-56. When CKB-H again goes high the path is directly through states 6/14, 1/1, 4/1, 1/9 and 4/9 to state 4/10. (Once again, the MAN TP must be pressed one time for each state progression.)

8-57. Qualifier KDN-H is active only when a keyboard key is pressed. Since it takes only a few microseconds to reach state 4/0, KDN-H is active and the high output holds the machine state in state 4/10 until the key is released and KDN-H goes low.

8-58. When KDN-H goes low (and the MAN. TP. is pressed), the next state is 5/10. Since this is a local operation, RMT-H is low and the next state, when the MAN. TP. is pressed, is 0/0. The instrument is now ready for the next keyboard entry.

8-59. Decimal Entry State Path

8-60. Note that for a decimal entry in the manual step mode the decimal point key must remain pressed in and the MAN. TP. must be pressed one time for each state change.

8-61. When a decimal point is entered on the keyboard, the path is the same as the numeral path until state 5/0 is reached. Since DP-L is now active, the next state is 5/1.

8-62. If the decimal point is the first keyboard entry, qualifier F2-H following state 5/1 is active and the next state is 1/5.

8-63. State 1/5, which contains instructions RF2-L, RKB-L and RJCT-L is followed by NUM-H. Since the entry was not a number, the next state is 3/5 which contains instruction SJCT-L. The state path from this point back to state 0/0 is the same as it was for a numeric entry.

8-64. If the decimal point was not the first entry, qualifier F2-H following state 5/1 is low and state 1/5 is bypassed.

8-65. Units Entry State Path.

8-66. As with a numeric or decimal entry, the keyboard key for the unit selected (Hz, kHz, MHz, or GHz) must remain pressed in and the MAN. TP. must be pressed one time for each state change.

8-67. When a units key (Hz, kHz, MHz, or GHz) is pressed the state path is the same as it is for a numeral until state 6/0 is reached. When state 6/0 is reached, qualifier NUM-H is low and the next state is 0/4.

8-68. State 0/4 which contains instruction RKO-L is followed by qualifier QU1-H. Since a units entry has been made, QU1-H is active and the next state is 1/5.

8-69. State 1/6 which contains instructions JUS-L, JF2-L, KF3-L and a clock, CK10J, is followed by qualifier QJO-H. QJO-H is active until the keyboard entry is justified (decimal point is positioned properly for the units selected).

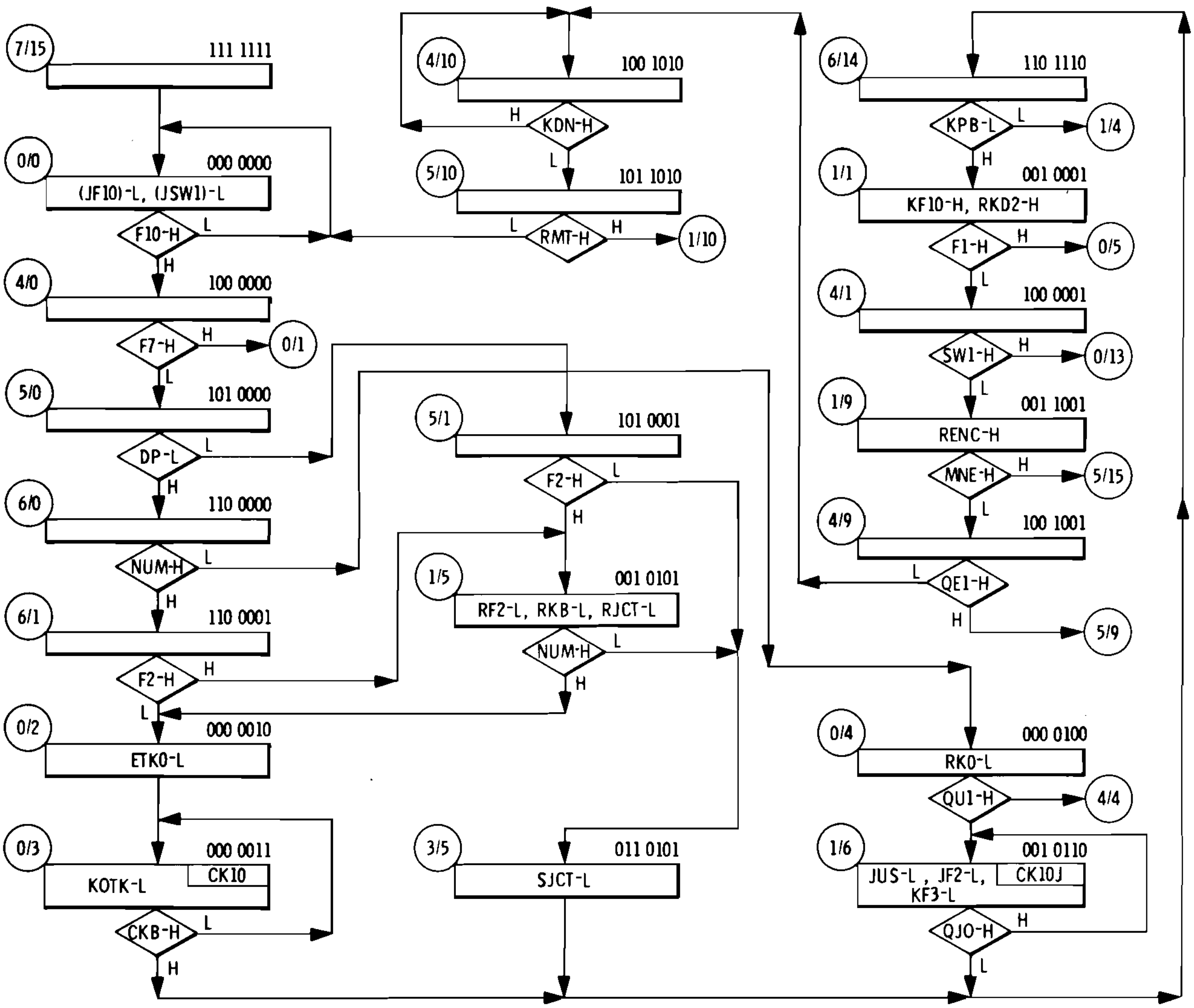


Figure 8-5. Part of the Algorithmic State Machine for Model 8660C DCU

8-70. When QJO-H goes low the remaining state path is the same as it was for a numeric or decimal point entry until state 0/0 is again reached.

8-71. MNEMONICS

8-72. Many of the terms used to describe functions of the DCU, ASM and interface circuits would take up entirely too much room if they were spelled out each time they were used. Most of these terms are abbreviated by the use of mnemonics and shown in Table 8-4. Also shown in the mnemonics table is a definition of such terms, locations where the terms are used, the point of origination of the terms, and information as to whether the mnemonics are high or low in the assertive (active) state (illustrated by an H or an L that follows the mnemonics).

8-73. Note that the mnemonics do not follow normal dictionary type identifications, but are identified by function.

8-74. LOGIC SYMBOLS AND DESCRIPTIONS

8-75. Table 8-5 shows some of the "basic building blocks" of logic symbols with the equivalent electronics circuits.

8-76. Figure 8-6 illustrates gates and inverters which are used throughout the instrument. These integrated circuits are shown to avoid repeating details on each schematic.

8-77. Other, more complex, integrated circuits are explained in the supporting text for the schematic on which they appear.

8-78. TROUBLESHOOTING

8-79. Mnemonics. Before proceeding with troubleshooting this instrument the technician should become familiar with the use and meaning of mnemonic terms. These terms appear throughout the Algorithmic State Machine (flow graph) and the schematics. The terms are defined in Table 8-2.

8-80. Algorithmic State Machine (ASM). The ASM which appears on a foldout page (Figure 8-119) covers all of the functions of the DCU within the instrument. A partial ASM for the DCU appears in Figure 8-5. The paragraphs directly preceding Figure 8-5 provide information relative to the basic use of the ASM in troubleshooting the instrument.

8-81. Troubleshooting Procedures. Basically there are three troubleshooting methods defined in this manual. They are:

a. A logical procedure for replacement of circuit boards in the Digital Control Unit for those who have a spare set of assemblies on hand. This procedure is to be followed in the sequence shown when a malfunction has been traced to the DCU. Some of these assemblies are available on an exchange basis (see Section VI for more information regarding this procedure.

b. Repair to the assembly level. With this procedure, assemblies are ordered to replace the known defective assembly. This procedure eliminates the requirement to repair to the component level. Information is provided in tabular format to assist the technician in locating the cause of the malfunction.

c. Repair to the component level. In this procedure, the cause of a malfunction is localized to an assembly and reference is then made to the applicable Service Sheet to provide additional information required to repair to the component level.

8-82. The troubleshooting tables which follow serve a dual purpose. These tables identify the circuit board or assembly which is the cause of the malfunction; if it is not desired to make repairs to the component level, a replacement assembly may be ordered from the part numbers which appear in Section VI of this manual. If repairs are to be made to the component level, the tables also refer to the appropriate schematic diagram and additional technical data to aid the technician in making such repairs.

NOTE

If symptoms of the cause of the malfunction indicate that the trouble is in a given assembly or circuit, the technician may proceed directly to the applicable table, and perform the specified tests without going through the preceding tests. Each table refers to the assembly and the Service Sheet for the assembly which is most likely to be causing the malfunction.

8-83. The troubleshooting tables are arranged in the most likely cause of the malfunction order. This order is as follows:

a. Table 8-6, Power Supply Troubleshooting.

b. Table 8-7, DCU Repair by Replacement. (To be used only if DCU trouble is suspected and a spare set of compatible assemblies are on hand.

c. Table 8-8 is a guide designed to lead the technician to the defective assembly within the DCU.

d. Table 8-9 through Table 8-30, DCU and interface troubleshooting tables.

e. Table 8-31 through 8-40, Mainframe RF loops troubleshooting.

NOTE

When a malfunction has been found and corrected in any circuit containing adjustable components, the adjustment procedures specified in Section V of this manual for the repaired circuit should be performed.

8-84. Each of the troubleshooting tables list the test equipment required to perform the tests in the Table and refer the technician to the appropriate Service Sheet which contains additional information about the circuit.

8-85. In Table 8-8, , the steps referred to in the prior steps column must have been observed and found to be operating properly before proceeding to the next function of any step.

8-86. The following notes apply to all of the troubleshooting Tables:

a. Always check qualifiers or instructions in the machine state with which they are listed.

b. Refer to Table 8-4 for descriptions of mnemonics and "where used" information.

c. When an instruction or qualifier which should be high is found to be low, the source is listed as the faulty assembly. However, it is possible that the load may be shorted to a low level. Circuit trace and isolate before ordering a replacement assembly.

Table 8-4. Mnemonics Information (1 of 13)

How to use this table:

When the mnemonic has been found and identified, the remaining three columns provide the following information:

The Assy No. column identifies the assembly where the mnemonics appear. The * indicates the assembly where the mnemonic originates.

The "Where Used SS No." column identifies the Service Sheet(s) on which the mnemonic appears. The * identifies the Service Sheet on which the mnemonic originates.

Prefix all assembly numbers with A1 except those which are prefixed in the assembly number column as A3A(x).

The ASM State column indicates the state(s) in which the mnemonics appear. When followed by a "Q" the mnemonic is a qualifier following the state shown.

The mnemonics are also used on all DCU Service Sheets(SS), the Interface Service Sheets and the ASM, Figure 8-122.

Mnemonic	Description	Assy No.	Where Used SS. No.	ASM State
+20V	+20V regulated	A8, A11, A2	33, 21	
+4V	+4V unregulated	A12	36	
+5V	+5V regulated	A1, A2, A3, A4 A5, A6, A7, A8, A9, A10, A12, A3A1, A3A2, A3A1-a,A3A2-a	19, 20, 22, 24, 25, 27, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40	
−10V	−10V regulated	A8, A2, A11	21, 33	
	Note: *All voltages generated in mainframe power supply.*			
100KCK	100 kHz Clock to keyboard	A1*, A2	20*, 21	
13GL-L	1.3 GHz select for 86602	A7*, A6	32*, 31	
16LIM-L	160 MHz limits (special only)	A7*, A6	32*, 31	
AØ	State flip-flop AØ output	A4*, A1, A5	26*, 19, 25, 28	
A2	State flip-flop A2 output	A4*, A1, A5	26*, 19, 25, 28	
A2TR-H	A2 register to A bus	A5*, A9	27*, 34	3/1
A3	State flip-flop A3 output	A4*, A1, A5	26*,19,25,28	
A3TR-H	A3 register to A bus	A5*, A9	28*, 34	2/13, 2/12, 3/0

Table 8-4. Mnemonics Information (2 of 13)

Mnemonic	Description	Assy No.	Where Used SS. No.	ASM State
A4	State flip-flop A4 output	A4*, A1, A5	26*, 19, 25, 28	
A5	State flip-flop A5 output	A4*, A1, A5	26*, 19, 25, 28	
A6	State flip-flop A6 output	A4*, A1, A5	26*, 19, 25, 28	
ADD-H	Add command to ALU	A5*, A7	28*, 32	2/12, 3/10, 3/1,2/1,1/15, 3/4
ADD-L	Subtract command to ALU	A5*, A7	28*, 32	2,0,2/13, 1/14, 2/15
ADDCK-H	ALU clock control	A6*, A3, A7	29*, 24, 32	
ADOF-L	Add offset (special)	A5	28	3/2, 2/6, 1/10, 1/7
ALU1	ALU1 Binary 1	A7*, A6	32*, 29	
ALU2	ALU Binary 2	A7*, A6	32*, 29	
ALU4	ALU Binary 4	A7*, A6	32*, 29	
ALU8	ALU Binary 8	A7*, A6	32*, 29	
AREGCK-H	A register clock	A6*, 9	29*, 34	
ATR-H	A register to R bus	A5*, A9	28*, 34	3/2, 2/15, 2/6, 3/7, 3/4, 0/9
AT01	A Register to output 1	A9*, A10	34*, 35	
AT02	A Register to output 2	A9*, A10	34*, 35	
AT04	A Register to output 4	A9*, A10	34*, 35	
AT08	A Register to output 8	A9*, A10	34*, 35	
B0-L	9 clock gate signal	A5*, A3, A5	24*, 36	
BR-L	Brightness control of readout	A3*, A12	24*, 26	
CDN-L	[See (KIUP-CPN)-L]			
CF-H	Center Frequency	A2*, A4	21*, 25	6/8Q, 4/3Q, 6/3Q, 6/10Q
CFR-H	Center Frequency Readout	A1*, A4	19*, 25	6/6Q, 6/15Q

Table 8-4. Mnemonics Information (3 of 13)

Mnemonic	Description	Assy No.	Where Used SS. No.	ASM State
CK	1 MHz System Clock	A1*, A2, A3, A4, A5, A6, A7, A8, A9, A10, A3A1	20*, 22, 24 26, 27, 29, 32, 33, 34, 35, 37, 39	
CK10-L	Clock 10. Instruction for ten clock pulses.	A4*, A5, A6	26*, 27, 29	2/13, 3/2, 2/12, 3/0, 3/1, 2/15, 2/9, 2/1, 1/15, 2/0, 0/9, 1/13, 1/14, 2/7, 1/12, 3/8, 2/5, 2/6, 0/3, 1/11, 3/7, 1/2, 1/3, 1/4, 3/4, 1/8, 0/1, 1/7, 1/10
CK10CK-H	Gated control for chain of 10 clock pulses	A6*, A3	29*, 23	
CK10J-L	Decimal point justification clock	A3*, A5, A6	23*, 27, 29	1/6
CK1213-L	Instruction for 12 or 13 clock pulse train	A5*, A6	27*, 29	2/13, 2/12, 3/0, 3/1
CKA-H	Clock A ANDED with CKB, signifies completion of 12 or 13 clock pulses	A5*, A4, A6, A8	27*, 25, 29, 33	2/13Q, 2/12Q, 1/10Q, 3/0Q, 3/1Q
CK12-L				
CK13-L				
CKB-H	Clock B, signifies completion of 10 clock pulses	A5*, A4, A3, A6, A8	27*, 25, 23, 29, 33	3/2Q, 2/13Q, 2/12Q, 3/0Q, 3/1Q, 2/15Q, 1/15Q, 2/1Q, 2/9Q, 2/0Q, 0/9Q, 1/13Q, 1/14Q, 2/7Q, 0/1Q, 1/4Q, 3/4Q, 1/3Q, 1/12Q, 3/8Q, 2/5Q, 0/3Q, 1/11Q, 2/6Q, 3/7Q, 1/2Q, 1/3Q, 1/8Q, 1/10Q, 1/7Q
CMND P-L	Permanent command from external programming interface	A3A1*, A2	39*, 21	

Table 8-4. Mnemonics Information (4 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS. No.	ASM State
CMND T-L	Temporary command from external programming interface	A3A1*, A2	39*, 21	
CNT1	Parallel dump count, binary 1	A5*, A10	27*, 35	
CNT2	Parallel dump count, binary 2	A5*, A10	27*, 35	
CNT4	Parallel dump count, binary 4	A5*, A10	27*, 35	
CNT8	Parallel dump count, binary 8	A5*, A10	27*, 35	
COAXCK	2 MHz clock input from interface board	A1	20	
CODE 1 CODE 2	These are bias levels that are used to aid in leveling the output of the RF Section. See RF Section Manual.	A6*	31*	
CTR-H	Center Frequency register to R bus	A5*, A6	28*, 29	2/1, 2/0, 1/7 1/15, 1/14
CTT-H	Center Frequency register to T bus	A5*, A6	28*, 29	2/9, 2/7, 3/8, 1/8
CUP-H	Count up instruction to sweep	A5*, A8	28*, 33	2/12, 3/0, 3/1
D1-1 D1-2 D1-4 D1-8	Digit 1 BCD 1 Digit 1 BCD 2 Digit 1 BCD 4 Digit 1 BCD 8	A10* A10* A10* A10*	35*, 37 35*, 37 35*, 37 35*, 37	
	Note *Repeat for digits 2 through 9. Note that digits proceed in numerical sequency from right to left.*			
D10-1	Digit 10 BCD 1	A10*	35*, 37	
	Note *Digit 10 BCD 2, 4 and 8 are not used.*			
DAOUT	Digital to Analog output (sweep ramp)	A8*, J1	33*	
DBL-L	Double Frequency Output	A6*, A3, A9, A11		
DP-L	Decimal point qualifier	A2*, A4	35*, 37	5/0Q

Table 8-4. Mnemonics Information (5 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
DP1-L thru DP9-L	Readout decimal points. Numbered from right to left.	A3*, A12	23*, 36	
ETKØ-L	Encoder to KØ register	A1*, A2	19*, 22	0/2
F LIM-L	Frequency Limits. Out of range annunciator.	A1*	19*, 37	
F1-H	Interrupt sweep for new entry, flip-flop.	A1*, A4	19*, 25	3/12Q, 1/1Q
F2-L	Keyboard initial entry, flip-flop.	A4*, A3	26*, 23	5/1Q, 6/1Q
F3-L	Prevents entry of information before justification, flip-flop.	A2*, A4	21*, 25	5/6Q, 6/9Q
F7-H	Sweep function flip-flop (also functions as plug-in remote flip-flop).	A4*	26*, 25	2/8Q, 2/4Q, 2/3Q, 4/0Q
F8-H	Sweep ramp flip-flop	A4*	26*, 25	6/11Q, 4/11Q
F10-H	Start flip-flop	A1*, A4	19*, 25	0/0Q
FM MODE-L	Lights FM MODE lamp in annunciator	A1*	19*	
FM-H	Frequency modulation instruction	MOD* A1	19	
FPB-L	Causes sweep width register data to be displayed on center frequency readout	A1*, A3 A4	19*, 23	6/4Q
FTS-H	Sweep width register to S bus	A5*, A7	28*, 32	2/13, 2/12, 3/0, 3/1, 2/15, 1/3
G2Ø	Gate 2 to Code Ø instruction selector	A5*, A1	27*, 19	
Hz-H	Hertz	A2*, A3	21*, 23	
IDN-H	Inhibit down	A4*		4/12Q
INC-H	Incremental step	A2*, A4	21*, 25	5/9Q
IPB-L	Causes STEP register data to be displayed on center frequency readout	A1*, A3, A4	19*, 23, 25	5/4Q
ITS-H	Increment (step) register to S bus	A5*, A7	28*, 32	1/15, 1/14, 1/2

Table 8-4. Mnemonics Information (6 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
IUP-H	Inhibit up	A4*		6/12Q
JCFR-L	See KPBR-JOFR-L			
JF1-H	J input to FF1	A1*		0/10
JF2-H	J input to flip-flop 2	A1*, A4	19*, 26	0/7, 1/6
JF3-L	J input to flip-flop 3	A5*, A2	28*, 21	1/0, 1/11, 1/10 1/13
(JF7A, ILD)-L	J input to flip-flop 7, and Input Load (presets swp counter)	A1*, A4, A8	19*, 26, 33	0/13
JF7B-L	J input to flip-flop 7	A2*, A4	21*, 26	
(JF8, IRS)-L	J input to flip-flop 8, and input reset to sweep increment counter	A5*, A8, A4	28*, 33, 26	0/13, 2/15, 2/9 0/0
JF9-H				0/14, 0/15
JF10-L				0/0
JIDN-L	J input inhibit down flip-flop	A5*, A4	28*, 26	2/11
JIUP-L	J input inhibit up flip-flop	A5*, A4	28*, 26	2/10
(JUS, KF3, (JF2)-L	Justification (DP justify), K input to flip-flop 3, J input to flip-flop 2	A5*, A1, A1 A2, A3	28*, 19, 21, 23	1/6
JSW1-L	JF3-L (1/12)			0/0, 0/8
KØ- K9	Keyboard key pairs	A12*, A2	21*	
KØTK-L	KØ to Keyboard Register	A2	22	0/3
KA	Keyboard register output A BCD 1	A2*, A6	22*, 29	
KB	Keyboard register output B BCD 2	A2*, A6	22*, 29	
KC	Keyboard register output C BCD 4	A2*, A6	22*, 29	
KD	Keyboard register output D BCD 8	A2*, A6	22*, 29	
KCFR-L	K input to Center Frequency Read-out flip-flop	A5*, A1	28*, 19	1/8
KCK-L	Keyboard register clock	A3*, A2	23*, 22	

Table 8-4. Mnemonics Information (7 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
KD2-L	Keydown 2	A2*, A1	21*, 19	
KDN-H	Keydown	A2*, A4	21*, 25	4/10Q
KF2-H				0/5
KF3-L				1/6
KF7-H	K input to flip-flop 7	A5*, A4	28*, 26	2/9, 1/0
KF8-H				2/9
KF9-H				0/0
KF10-H				1/1, 1/0, 3/6
KHZ-H	Kilohertz	A2*, A3	21*, 23	
KIDN-H	K input to inhibit down flip-flop	A5*, A4	28*, 26	2/12
(KIUP, CDN)-L	K input of increment up flip-flop Count down instruction to sweep	A5*, A4, A8	28*, 26	2/13
KPB-L	Causes keyboard register data to be displayed on center frequency readout	A1*, A3, A4	19*, 23, 25	6/14Q
(KPBR, JCFR)-L	K input to pushbutton readout flip-flop, J input to center frequency readout flip-flop	A5*, A1	29*, 19	3/6
KSW1-H				0/10
(KTR, CTS)-H				1/10
KTT-H	Keyboard register to T bus	A5*, A6	28*, 29	1/3, 1/12, 2/5, 1/11, 1/4, 1/13
KYBCK1 KYBCK2	These are separate keyboard strobe lines which join at a common point in the A2 assy.	A2*	21*	
LCL-H	Local/remote input	A3A1*, A1, A2, A3	39*, 37, 20, 21, 23	
LD-L	Load resets the A2 and A3 registers on the A9 assy.	A8*, A9	33*, 34	

Table 8-4. Mnemonics Information (8 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
MHZ-H	Megahertz	A2*, A3	21*, 23	
MNE-H	Manual entry	A1*, A4	20*, 25	3/13Q, 6/13Q, 1/9Q, 5/14Q
NTS-L	Manual tune increment n to S bus	A5*, A7	28*, 21	2/1, 2/0
NUM-H	Numeral	A2*, A4	21*, 25	6/0Q, 1/5Q
OFS-L	Offset frequency (special)	A4	25, 37	4/2Q, 3/10Q 5/5Q, 5/7Q, 3/3Q
OPID1	Output plug-in digit 1 BCD 1	J6 pin 33*, A6, A7	31, 32	
OPID2	Output plug-in digit 2 BCD 2	J6 pin 34*, A7	32	
OPID4	Output plug-in digit 4 BCD 4	J6 pin 35*,A7	32	
OPR-L	Option reset. Option 004-100 Hz resolution.	A5*, A3	27*, 24	
OPRO-L	Option readout. Option 004 - 100 Hz resolution	A1*, A3	19*, 24	
OTS-L	Offset frequency to S bus	A5*, A7	28*, 32	2/6, 1/10, 1/7, 3/2
OVEN-L	Oven signal (oven not at temperature when lamp is lit). (Annunciator)	A21*	2*, 19	
OVRNG-L				
PBCOM-L	Pushbutton common	A1*	28*, 19	
PBF-L	Sweep width readout pushbutton	A1*	19*	
PBI-L	Increment (step) readout pushbutton	A1*	19*	
PBK-L	Keyboard readout pushbutton	A1*	19*	
PD-H	Parallel dump	A5*, A10	28*, 35	2/9, 3/7
PDN-L				3/7, 2/9, 0/9
PDS-L	Parallel dump sweep	A1*, A5, A9	19*, 28, 34	0/9
PI1	Data to plug-in section, binary 1	A6*, A11	29*, 37	

Table 8-4. Mnemonics Information (9 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
PI2	Data to plug-in sections, binary 2	A6*, A11	29*, 37	
PI4	Data to plug-in sections, binary 4	A6*, A11	28*, 37	
PI8	Data to plug-in sections, binary 8	A6*, A11	29*, 37	
PICK-L	Plug-in clock for remote data transfer	A6*, A11	29*, 37	0/1
PILIM-L	110 MHz limit select for 86601A	A7*, A6, A1	32*, 31, 20	
PLS-H	Plus (manual tune sense)	A1*, A4	20*, 25	0/12Q, 5/15Q
PRDT-L	Power detect (DCU)	A2*, A1, A4, A6	22*, 37, 20, 26, 29	
PWRDT-L	Power detect from mainframe	A3A1*, A2	39*, 37, 22	
Q100-H	Qualifier 100 (100 step sweep)	A1*, A4, A8	20*, 25, 33	5/12Q
QA-H	Qualifier A. Frequency above limits.	A6*, A4	31*, 25	2/2Q
QAD-H	Qualifier add	A2*, A4	21*, 25	5/13Q
QB-H	Qualifier B. Frequency below limits.	A7*, A4, A6	32*, 25, 31	4/13Q, 6/7Q, 4/15Q, 5/2Q, 5/7Q
QCTM-H	Qualifier count maximum. Sweep Count.	A8*, A4	33*, 25	4/14Q, 5/11Q
QCTZ-H	Qualifier count zero. Sweep count.	A8*, A4	33*, 25	4/7Q
QEI-H	Qualifier enter 1 (any entry key)	A2*, A4	21*, 25	4/9Q, 4/4Q
QJØ -H	Justification operation	A3*, A4	23*, 25	1/6Q
QMSW-H	Qualifier, manual sweep	A1*, A4	20*, 25	0/15Q, 5/8Q, 0/11Q, 0/14Q
QSP-H	Qualifier sweep pulse	A1*, A4	20*, 25	0/10Q
QSS-H	Qualifier single sweep	A1*, A4	20*, 25	3/15Q
QU1-H	Qualifier units 1 (any units key)	A2*, A4	21*, 25	0/4Q
RBUS A1	A register to R bus BCD 1	A9*, A7	34*, 32	

Table 8-4. Mnemonics Information (10 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
RBUS A2	A register to R bus BCD 2	A9*, A7	34*, 32	
REBUS A4	A register to R bus BCD 4	A9*, A7	34*, 32	
REBUS A8	A register to R bus BCD 8	A9*, A7	34*, 32	
RBUS C1	CF register to R bus BCD 1	A6*, A7	29*, 32	
REBUS C2	CF register to R bus BCD 2	A6*, A7	29*, 32	
RBUS C4	CF register to R bus BCD 4	A6*, A7	29*, 32	
RBUS C8	CF register to R bus BCD 8	A6*, A7	29*, 32	
RBUS K1	M register to R bus BCD 1	A6*, A7	29*, 32	
RBUS K2	M register to R bus BCD 2	A6*, A7	29*, 32	
RBUS K4	M register to R bus BCD 4	A6*, A7	29*, 32	
RBUS K8	M register to R bus BCD 8	A6*, A7	29*, 32	
RENC-H	Reset encode counter	A5*, A7	28*, 32	2/13, 2/12, 2/8, 3/4, 2/4, 2/3, 1/9, 3/3
RERR-L				0/4
RF1-L				0/8
(RF2, RJCT)-L	Reset flip-flop 2 and reset justification counter.	A2*, A3, A4	22*, 23 26	1/5
RF9-L				0/9
RKB-L	Reset keyboard register	A5*, A2	28*, 22	1/5, 1/0
(RKD2, KF1Ø)-H	Reset keydown flip-flop 2, and K input to flip-flop 10.	A5*, A2, A1	28*, 21, 19	3/6, 1/1, 1/0
RKØ-L	Reset KØ register	A3*, A2	23*, 22	0/4
RMT STEP DN-L	Remote step down (increment)	A3A1*, A2	39*, 21	
RMT STEP UP-L	Remote step up (increment)	A3A1*, A2	39*, 21	
RMT-H	Remote Qualifier	A3*, A4	23*, 25	5/10Q

Table 8-4. Mnemonics Information (11 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
RMT1-L	Remote data input binary 1	A3A1*, A2	39*, 37, 22	
RMT2-L	Remote data input binary 2	A3A1*, A2	39*, 37, 22	
RMT4-L	Remote data input binary 4	A3A1*, A2	39*, 37, 22	
RMT8-L	Remote data input binary 8	A3A1*, A2	39*, 37, 22	
RMTCF-L	Remote center frequency command	A3A1*, A2	39*, 22	
RMTL-L	Readout remote lamp (annunciator)	A1*, lamp	20*	
ROCK	Readout clock (10 kHz)	A1*, A12	20*, 36	
ROGHZ-L	Readout GHz	A3*, A12	23*, 36	
ROMHZ-L	Readout MHz	A3*, A12	23*, 36	
ROKHZ-L	Readout kHz	A3*, A12	23*, 36	
ROHZ-L	Readout Hertz	A3*, A12	23*, 36	
ROI-L	Readout inhibit (option 004)	A1*, A3	19*, 24	
ROM A1 ROM A2 ROM A4 ROM A8	To read-only-memory A on A1A12. Controls readout digits 7, 8 and 9.	A3*, A12	24*, 36	
ROM B1 ROM B2 ROM B4 ROM B8	To read-only-memory B on A1A12. Controls readout digits 1 thru 6. Digit 1 is least significant digit.	A3*, A12	24*, 36	
RQB-L	Reset qualifier B flip-flop in ALU	A5*, A7	28*, 32	2/8, 2/4, 2/2,
RQSP-L				0/11, 0/9
(RQSS, KF8, RSW1)-H	Reset QSS flip-flop, K input to flip-flop 8, reset SW1 flip-flop.	A5*, A4, A1	28*, 26, 20	2/0, 0/7
RSCAN-H	Reset readout scanner circuit	A3*, A12	24*, 36	
RSWON-L				0/8
RZER-L	Reset zero flip-flop	A5*, A7	28*, 32	2/2, 2/12
S1, S2	Sense lines from keyboard	A15*, A2	21	

Table 8-4. Mnemonics Information (12 of 13)

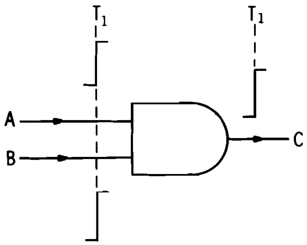
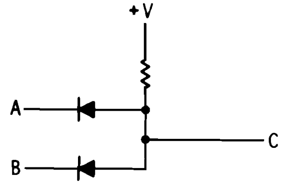
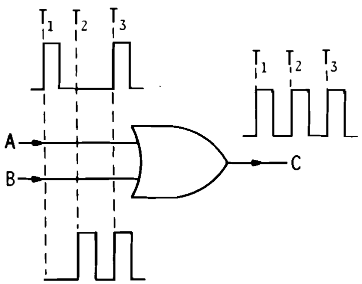
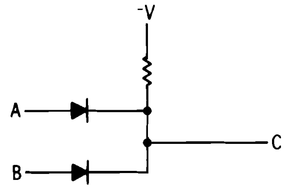
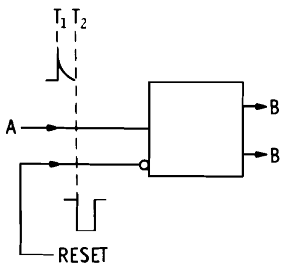
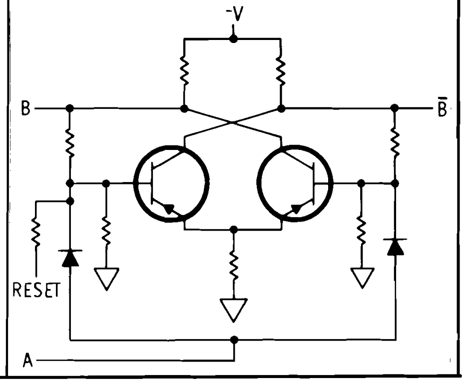
Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
SBUS F1	Sweep register to S bus BCD 1	A6*, A7	30*, 32	
SBUS F2	Sweep register to S bus BCD 2	A6*, A7	30*, 32	
SBUS F4	Sweep register to S bus BCD 4	A6*, A7	30*, 32	
SBUS F8	Sweep register to S bus BCD 8	A6*, A7	30*, 32	
SBUS I1	Step register to S bus BCD 1	A6*, A7	30*, 32	
SBUS I2	Step register to S bus BCD 2	A6*, A7	30*, 32	
SBUS I4	Step register to S bus BCD 4	A6*, A7	30*, 32	
SBUS I8	Step register to S bus BCD 8	A6*, A7	30*, 32	
SCAN CK	5 kHz clock to readout control	A1*, A3	20*, 24	
SCDP-L	Set center frequency decimal point (Stores DP)	A5*, A3	28*, 23	2/5
(SFDP, TTF)-L	Set sweep width decimal point (stores DP), T bus to sweep width register	A5*, A3, A6	28*, 23, 30	1/11
(SIDP, TTI)-L	Set step decimal point (stores DP) T bus to step register	A5*, A3, A6	28*, 23, 30	1/13
SIND1, 4	Set error lamp driver	A5*, A1, A2	28*, 19, 21	2/8, 2/3
SIND2-L				
SJCT-L	Set justification counter	A5*, A3	28*, 23	3/5
SQB-H	Set qualifier B flip-flop	A5*, A7	28*, 32	2/13, 3/2, 2/15, 2/0, 1/7, 1/10 1/14, 2/6
STØ1-L	Machine state 0/1	A1*, A6	19*, 29	
STØ4-L	Machine state 0/4	A1*, A3	19*, 23	
STEP-L	Manual tune switch to A1A4	A1*, A4	20*, 25	5/3Q, 4/8Q
SW1-H	Sweep 1 qualifier flip-flop	A1*, A4	20*, 25	3/14Q, 4/1Q, 0/6Q
SWL-L	Sweep lamp (annunciator)	A1*, A13	20*	

Table 8-4. Mnemonics Information (13 of 13)

Mnemonic	Description	Where Used		
		Assy No.	SS No.	ASM State
SWON-H	Sweep on	A1*, A4	20*, 25	3/9Q, 4/6Q
SZER-L	Set zero flip-flop	A5*, A7	28*, 32	2/14
TBUS 1 TBUS 2 TBUS 4 TBUS 8	T bus BCD 1 T bus BCD 2 T bus BCD 4 T bus BCD 8	A6*, A9 A10, A3	29*, 30, 31, 34, 35, 24	
TRØ-L	Tuning Range zero	A1*, A2, A3 A7	20*, 21, 23, 32	
TR1-L	Tuning range 1 coarse	A1*, A7	20*, 32	
TR2-L	Tuning range 2 medium	A1*, A7	20*, 32	
TR3-L	Tuning range 3 fine	A1*, A7	20*, 32	
TTA-L	T bus to A register	A4*, A9	26*, 34	2/13, 2/12, 3/0. 3/1, 2/15, 2/9, 2/7, 2/5, 2/6
TTC-H	T bus to center frequency register	A5*, A6	28*, 29	2/15, 1/14, 2/0, 2/1, 2/5, 1/15,
TTF-L				1/11
TTI-L				1/13
TTM-L	T bus to M register	A4*, A6	26*, 31	2/13, 2/12, 3/0, 1/15, 3/1, 2/1, 2/15, 2/0, 1/14, 1/12, 3/8, 1/10, 1/7, 2/9
TTRO-L	T bus to readout register	A4*, A3	26*, 24	2/13, 3/2, 2/12, 2/9, 2/7, 2/5, 1/4, 1/2, 3/4, 1/8, 1/3
UTT-H	ALU to T bus	A4*, A7	26*, 32	2/13, 3/2, 2/12, 1/10, 3/0, 3/1, 2/15, 2/1, 1/15, 2/0, 0/9, 1/14, 2/6, 1/7, 3/7, 1/3, 3/4, 1/2
XOR-H	Exclusive OR; ALU does not change data	A5*, A7	28*, 32	1/2, 1/3
ZER-H	Zero qualifier flip-flop	A7*, A4	32*, 25	6/5Q

Table 8-5. Logic Symbology

1 indicates true signal	○ on symbol indicates logical inversion (not necessarily electrical) of the input or output signal(s). The logic indicated within the symbol remains the same.
0 indicates false signal.	→ indicates direction of signal flow.

Designation	Logic Symbol	Description	Truth Table	Typical Circuit
AND Gate (Positive True)		Both input signals (A and B) must be true simultaneously to produce a true output at C.	A | B | C 0 | 0 | 0 0 | 1 | 0 1 | 0 | 0 1 | 1 | 1	
OR Gate (Positive True)		If either input signal (A or B) or both is true, the output at C is true	A | B | C 0 | 0 | 0 0 | 1 | 1 1 | 0 | 1 1 | 1 | 1	
Time Delay		Input signal delayed by the time indicated. True input at A produces a true output at B after a 15 ms delay		RC and FL Coupling
Trigger		The binary is a flip-flop which changes state with every true input pulse at A. Since A is applied to the bases of both transistors, it is shown centered in the symbol. The negative pulse produces the same effect as a positive pulse applied to the opposite base. To preserve the positive logic, the reset pulse is shown inverted and applied to the opposite side. A reset pulse sets B true.		

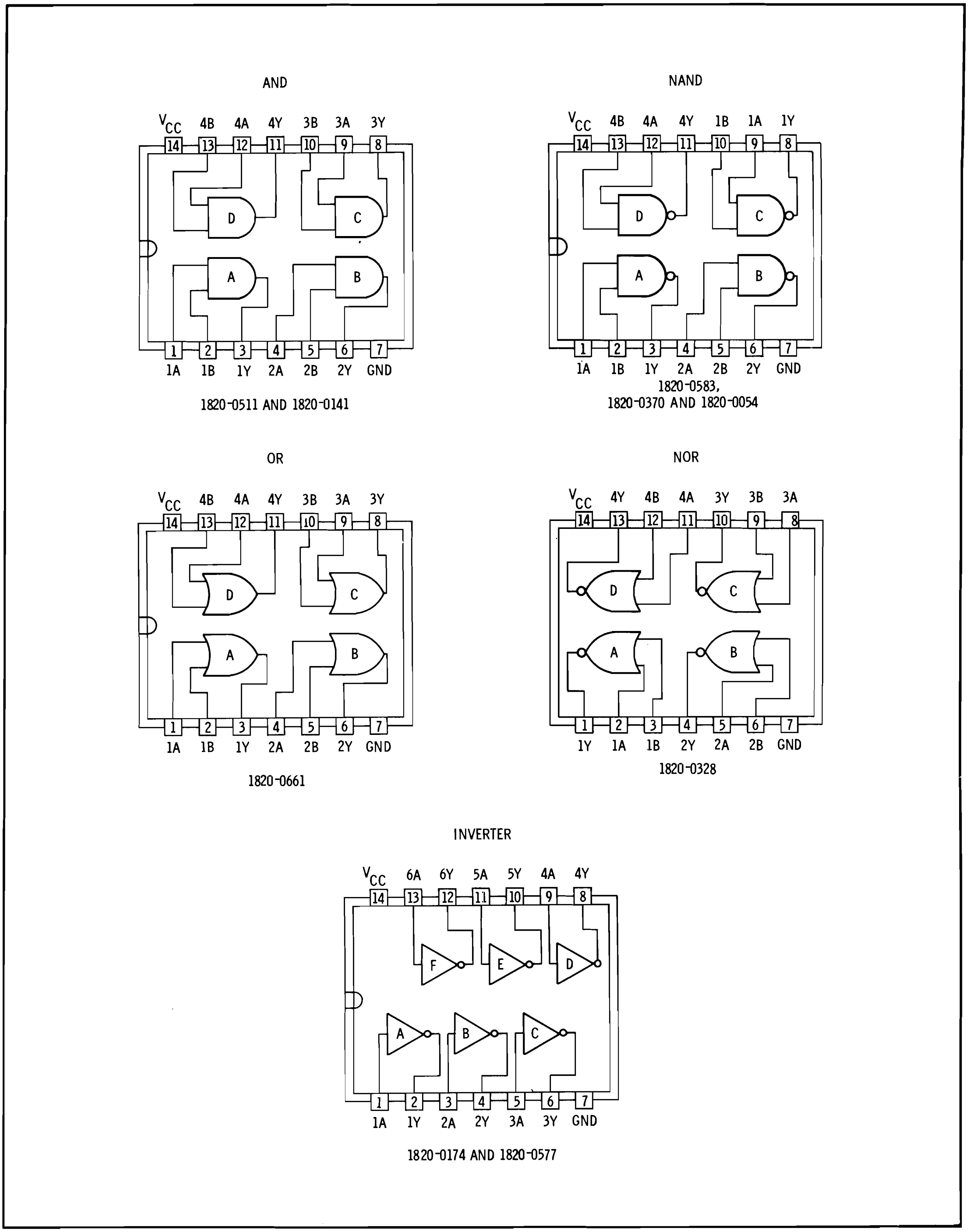


Figure 8-6. Common Gates and Inverters Used in the Model 8660C

Table 8-6. Power Supply Troubleshooting (1 of 3)

Test Equipment Required:

Voltmeter
AC Microvoltmeter
Variable Voltage Transformer

Step	Symptom and Procedure	Take the following action or proceed to step shown
1	Fan does not come on.	
1a	Unplug the instrument and check the main fuse (A7F1)	Replace the fuse if defective. If fuse is good, proceed to next step.
1b	With the instrument unplugged, remove the mainframe bottom cover and check the dc resistance from tie point SW/9 (located close to the front of the A20 assembly).	Proceed to Step 1c.
1c	With the instrument unplugged, check the dc resistance with the LINE switch ON.	The ohmmeter should read 0 ohms. If it does not, A1S1 or an associated component is probably defective. Refer to Service Sheet 41 and make necessary tests. Proceed to Step 1d.
1d	With the instrument unplugged, check the dc resistance with the LINE switch in the STBY position.	The ohmmeter should read a charging capacitor with an ultimate value of about 10K ohms. If it does not, refer to Service Sheet 41 and make necessary repairs.
1e	Check the voltage applied to the fan motor (should be 115 Vac).	If the voltage is present, but fan does not work, check the fan.
1f	If the voltage is not present at the fan:	Check A20K1, then refer to Service Sheet 41 and repair as required.
2	OVEN light does not illuminate when instrument is first turned on.	Refer to step 2a.
2a	Turn off and unplug the instrument for 10 minutes.	Proceed to step 2b.
2b	Remove the mainframe top cover, raise the A4 assembly and disconnect the wire from tie point 6 on A21.	Measure the resistance from A21 tie point 6 to ground. The resistance should be 0 ohms. If it is, proceed to step 2d, if not, proceed to step 2c.
2c	If the dc resistance from A21 is about 50 ohms.	The lamp is good and A21, the interface board, interconnecting wiring may be defective. Refer to Service sheet 41 and locate the cause of trouble.
2d	Reconnect wire to A21. Plug in and turn on instrument. OVEN lamp should extinguish after 10-15 minutes. **Note:** If conditions are not as shown, refer to Service Sheet 41.	If lamp does not extinguish as it should, refer to Service Sheet 41 and repair as required.

Table 8-6. Power Supply Troubleshooting (2 of 3)

Symptom	Take the following action or proceed to step shown
All supplies defective, fan does not come on.	Check line module, power cord, T1,CR1 and line fuse.
The instrument is inoperative, but fan operates.	Check A20K2
Instrument appears inoperative, fan does not work but oven supply is OK.	Check A20K1, A20K2, A1S1 and associated wiring.
All regulated supplies are inoperative, but unregulated supplies are OK.	Check A20K2.
Regulated supplies are OK but unregulated supplies are inoperative and fan does not work.	Check A20K1
+20V power inoperative.	Check A5Q5, A5U3, A6A1Q7, A6A1Q8, A20K1, A20 CR1 and T1.
+5.25V power inoperative.	Check A20F1*, A6A1Q10*, A20K2, A5Q6, A5U4, and A20C2 (*common failure mode).
+5.25V supply low but not inoperative.	A5R24 defective or incorrectly adjusted (do not readjust until it is clear that something else is not pulling the supply down). Output load resistance is too low – should be 6 ohms or greater. Check line module and T1. Check A6A1Q10 for collector to emitter short.
+5.25V supply is noisy but not inoperative.	Check line module for dirty or intermittent contacts, check A20C2, A5U4, and A6A1Q10.
+20V supply low, noisy, or unregulated.	Check line module for dirty or intermittent contacts. Check A20C1, A6CR1, A5U3, A6A1C1, A6Q5, A6A1R1, A6A1Q9, and A6A1Q8.
–10V supply inoperative.	Check A20CR3, A6A1Q5, A6A1Q4, A10C3, T1, A20K2. Load should be nominally 60 ohms.
–10V supply low, noisy or unregulated.	Check line module, A5U2, A6A1Q6, A6A1Q4, A5Q3, A6A1Q5 and A6A4.
–40V supply inoperative.	Check A20CR5 (nominally 570 ohms), A6A1Q1, A6A1Q2, A20C11, A6C15, and A20K2.
–40V supply low, noisy, or unregulated.	Check A6A1CR3, line module, A5U1, A5Q1, A5Q2, A6A1R3, and A20C6.

Table 8-6. Power Supply Troubleshooting (3 of 3)

Symptom	Take the following action or proceed to step shown
+21 and −21V supplies inoperative.	Check A20CR4, A20F4 and A20F3, T1, A20C4 and A20C5.
+21V supply inoperative but −21V supply OK.	Check A20C4 and A20F4.
−21V supply inoperative but +21V supply OK.	Check A20C5 and A20F3.

Table 8-7. Digital Control Unit Troubleshooting by Replacement (1 of 2)

Note: Where the procedure column lists several assemblies, replace them in the order shown.

Test	Result	Procedure
1. Perform operator's checks 1 through 1-c.	Readout does not display 1.000000 MHz.	Check the 2 MHz and power supply inputs to the DCU. If present, proceed to step 1-a.
1-a. Ground the connector pin labeled PWR DET on the mother board.	Readout displays 1.000000 MHz. Readout display is not correct.	Trouble is in A3 interface assembly. A2, A1, A7, A4, A5, A6, A12.
2. Enter a center frequency (within the limits of the RF Section in use) in Hz. With the 86603A RF Section set to 1300 MHz the DCU output data is ½ the RO. DBL-L on A1A6 pin 1c is also activated.	Readout correct. (It has been determined that the data out of the DCU is incorrect or Readout incorrect, but RF output is correct.)	A9, A10, A1, A5, A4, A7. A3, A2, A1, A12.
3. Enter center frequencies in GH, MHz, kHz (stay within limits of the RF Section in use).	Readout is not positioned properly.	A3, A2, check wiring from the keyboard to the A1A11 mother board.
4. Perform operator's checks 2-a and 2-b.	Readout is not positioned properly.	A3, A2, check wiring from the keyboard to the A1A11 mother board.
5. Perform operator's check 2-c.	Readout incorrect.	A1, A4, A5.
6. Perform operator's checks 2-d and 2-e.	Readout isn't all zeroes when CLEAR KYBD is pressed.	A2, check wiring between keyboard and A1A11 mother board.
7. Perform operator's check 3-a with 86601A ; 4-a with 86602A; 5-a with the 86603A.	STEP ↑ operation does not function properly.	A2, A4, A5, A6, A7, check wiring between keyboard and A1A11 mother board.

Table 8-7. Troubleshooting by Replacement (2 of 3)

Test	Result	Procedure
7-a. Check STEP ↓ operation.	STEP ↓ operation does not function properly.	Same as step 7.
8. Perform operator's check 3-b with 86601A; 4-b with 86602A; 5-b with the 86603A.	STEP readout incorrect.	A1, A4, A5, A7, check STEP push-button switch and wiring.
9. Perform operator's checks 3-c and 3-d with the 86601A, and 4-d with the 86602A; 5-d with 86603A.	OUT OF RNG light does not flash.	A6, A1, light bulb, A4, A5, A7. Check OPID lines as follows: Extend the A1A7 assembly and check the following lines on connector −1. **RF Sec. 86601 86602 86603** Pin 3 H L H Pin C H H L Pin B H H H Pin 2 not used (open) line on A1A7. **NOTE** If proper levels are present, trouble is in the A1A7 assembly or associated wiring. If proper levels are not present, trouble is in the cabling to the plug-in unit.
10. Perform operator's check 3-e with the 86601A; 4-e with the 86602A; 5-e with the 86603A.	Readout does not decrease in 111111 Hz steps.	A1, A4, A5, A6, A7. Check MANUAL switch and wiring. Check TUNING control and wiring. Extend the A1A1 assy on two extender boards and use an oscilloscope to check for pulses at A1A1U12 pins 4 and 5. If pulses are present, the A1A1 assembly is probably defective. If the pulses are not present the TUNING control, A1A17, is probably defective.
11. Perform operator's check 3-f with 86601A; 4-f with 5-f with the 86603A.	OUT OF RNG light doesn't stay on below lower frequency limit.	A6, A1 lightbulb, A4, A5, A7. Check OPID lines on the A1A7 assembly as shown in step 9. Results are the same.
12 Perform operator's checks 6-a through 6-d.	Manual tune mode not operating properly	A1, A4, A5, A6, A7. Check MANUAL switch A1A17 TUNING CONTROL. Extend the A1A1 assembly on two extender boards and check as in step 10. Results are the same.
13. Perform operator's checks 7-a through 7-c for 86601A. 8-a thru 8-c with the 86602A or 86603A.	Does not perform as specified in Table 3-5.	A4, A5, A6, A7, A8, A1, A9, A10, A12. Check lightbulbs, sweep switches and wiring.

Table 8-7. Troubleshooting by Replacement (3 of 3)

Test	Result	Procedure
14. Perform operator's check 9-a.	Readout and/or output is incorrect.	A1, A4, A5, A6, A7, A8, A9, A10, A12. Check sweep switches and TUNING control. Extend the A1A1 Assembly on two extender boards and check as in step 10. Results are the same.
15. Perform operator's check 9b through 9f.	Incorrect output.	A4, A5, A6, A7, A8, A1, A9, A10, A12. Check SINGLE switch and wiring.

Table 8-8. DCU and Interface Troubleshooting Guide (1 of 3)

NOTES

1. The steps referred to in the Prior Steps Required column must have been observed and found to be operating properly before proceeding to the table referred to in any step.
2. The following notes apply to all of the troubleshooting tables:
   a. Always check qualifiers or instructions in the machine state with which they are listed.
   b. Refer to Table 8-4 for descriptions of mnemonics and "where used" information.
   c. When an instruction or qualifier which should be high is found to be low, the source is listed as a faulty assembly. However, it is possible that the load may be shorted to a low level. Circuit trace and isolate before ordering a replacement assembly.

Step	Instruction or Fault	Prior Steps Req'd
1	When the power is turned on the CENTER FREQUENCY readout should display 1.000000 MHz. If the readout is correct proceed to step 2. If the readout is not correct, refer to Table 8-9.	
2.	Enter a new frequency with the keyboard. The CENTER FREQUENCY readout should display the selected frequency; if it does, proceed to step 3, if it does not, refer to Table 8-10.	1
3	If the CENTER FREQUENCY readout is correct, but BCD data to the mainframe is not, refer Table 8-11. If both are correct, proceed to step 4. If the selected frequency is above 1.3 GHz, the BCD output will be one-half that shown on the readout.	1
3.	**NOTE** The BCD data to the mainframe may be checked at several points. The most readily accessible is at the top of the DCU at connectors A1A11XA11-1 and A1A11XA11-2. See Service Sheet 42 for pin number identification. The logic at these pins is positive HIGH=1, LOW = 0.	

Table 8-8. DCU and Interface Troubleshooting Guide (2 of 3)

Steps	Instruction or Fault	Prior Steps Required
4	Enter a CENTER FREQUENCY in Hz. The CENTER FREQUENCY readout should display the selected frequency; if it does proceed to step 5. If it does not, refer to Table 8-10. At frequencies above 1.3 GHz the least significant digit is always even.	1
5	If the CENTER FREQUENCY readout displays only one or two half-digits (other digits are blank) refer to Table 8-12. Otherwise, proceed to step 6.	1
6	If CENTER FREQUENCY readout is not properly positioned when units (decimal point not properly placed) of GHz, MHz, kHz or Hz are entered, and/or associated annunciator lamp does not light, refer to Table 7-14. If only one entry is not properly positioned, proceed to step 7.	1-5
7	If CENTER FREQUENCY readout does not position properly for only one units entry (GHz, MHz, kHz, or Hz), refer to Table 8-15. Otherwise, proceed to step 8.	1-5
8	If STEP ↑ or STEP ↓ do not function properly, refer to Table 8-16. If both STEP ↑ and STEP ↓ do not function properly, proceed to step 9. If both are functioning properly, proceed to step 10. At frequencies above 1.3 GHz, the STEP is also divided by two.	1-7
9	STEP ↑ and STEP ↓ are both defective, refer to Table 8-17. If both function properly, proceed to step 10.	1-7
10	Manual step does not function properly. If true, refer to Table 8-18. If manual step functions properly proceed to step 11. At frequencies above 1.3 GHz the manual step is divided by two.	1-9, 11, 12
11	If all manual tune ranges do not function properly refer to Table 8-19. If only one range COARSE, MED or FINE does not function properly, proceed to step 12.	1-9
12	If only one RESOLUTION range (COARSE, MED, or FINE) is defective in the MANUAL MODE refer to Table 8-20. If the frequency can be set only in one direction (up or down) proceed to step 13.	1-9
13	Set the MANUAL MODE switch to COARSE, MED, FINE or STEP. Rotating the TUNING control clockwise should cause an increase in frequency; counter-clockwise rotation should cause a decrease in frequency. If the frequency does now change in one direction refer to Table 8-21. If operation is normal proceed to step 14.	1-9
14	Set the SWEEP MODE switch to AUTO. If all rates (SLO, MED and FAST) are defective refer to Table 8-22. If only one rate is defective proceed to step 15.	1-7
15	If only one sweep rate in the auto sweep mode is defective proceed to Table 8-23. If all sweep rates function properly, proceed to step 16.	1-7

Table 8-8. DCU and Interface Troubleshooting Guide (3 of 3)

Step	Instruction or Fault	Prior Steps Required
16	If only single sweep is defective in the sweep mode refer to Table 8-24. If single sweep is not defective proceed to step 17.	1-7, 14, 15
17	If only the manual sweep mode is defective refer to Table 8-25. At frequencies above 1.3 GHz manual sweep is divided by two. If manual sweep functions normally proceed to step 18.	1-7, 11, 12
18	D/A sweep ramp output is defective. Repair or replace the A1A8 assembly. For repair information see Service Sheet 33.	1-7, 14, 15
19	If the out of range lamp does not function correctly refer to Table 8-26. If lamp does not function at all proceed to step 20.	1-7
20	If code 1 or Code 2 information to the RF section is not correct repair or replace the A1A6 assembly. For repair information see Service Sheet 31.	1-7
21	Press the KYBD pushbutton. The CENTER FREQUENCY readout should display the information stored in the keyboard register. If the display is correct, proceed to step 22. If the display is not correct refer to Table 8-27. Leading zeros should not be blanked.	1-7
22	Press the STEP pushbutton. The CENTER FREQUENCY readout should display the information stored in the step register. If the display is correct, proceed to step 23. If the display is not correct refer to Table 8-28. Check the DBL-L line on SS31 when using the 86603 RF Section.	1-10
23	Press the SWP WIDTH pushbutton. The CENTER FREQUENCY readout display should display the information stored in the sweep register. If the display is correct proceed to step 24. If the display is not correct refer to Table 8-29.	1-7, 14, 15
24	CENTER FREQUENCY readout visible but dim. Check the mainframe +4V supply.	
25	Some CENTER FREQUENCY readout digits not complete or a random display appears. Repair or replace A1A12 assembly. For repair information see Service Sheet 36.	
26	Remote operation is defective. All local functions are correct. Refer to Table 8-30.	1-25
27	Harmonics excessive below 1.3 GHz or output frequency is twice that programmed. If true, refer to Table 8-31.	1
28	Output frequency is half that programmed when operating above 1.3 GHz. If true, refer to Table 8-32.	1

Table 8-9. Incorrect Initial Readout (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Readout incorrect on initial turn-on.							
2	Enter 123 kHz on keyboard. Instrument responds correctly.						A1A7	
3	If the instrument does not respond to 2, use a Logic Pulser to pulse (or momentarily ground) pin 30 of A1A11XA11-2 marked PWR DET.							
4	If instrument responds correctly, (displays 1.000000 MHz. **NOTE** There is a possibility that trouble is a broken trace or an open pull-up resistor on A3A2. The trouble is more likely to be a short in the wiring harness to J3.		RESET		A3XA5-J	H	A3A1	NOTE
5	If the instrument did not respond to 3, check power supplies (+20V, +5V and –10V) on the A1A11 test points. Check 2 MHz clock.						cont.*	Main-frame
6	Set the instrument to Manual Test Mode by momentarily grounding the MAN TP on the bottom of the DCU. Set states as follows: Set to Sequence presets conditions Set to for following tests Set to Set to	0/0 0/6 0/0 3/6						A1A4
7	Set the instrument to the automatic test mode by momentarily grounding the AUTO TP on the bottom of the DCU. If the state indicators do not go to 0/0, proceed to Table 8-6.							

*Continue to next step

Table 8-9. Incorrect Initial Readout (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location		Logic Level	Repair or Replace	
								If OK	If Wrong
8	If the state indicators went to 0/0 in step 7, clear and then enter 123 kHz on the keyboard. The CENTER FREQUENCY readout indicates 123 kHz. Pulse or momentarily ground pin 30 of A1A11XA11-2 marked PWR DET.		PRDT		A1A1XA1-2	F	Pulses H – L	A1A1	A1A2
9	If state indicators do not go to 0/0 afer step 8		F10		A1A4XA4-2	M	L	A1A4	cont.
10	Extend the A1A1 assembly on an extender board and set the instrument to manual test mode. Set to state	1/1	KF10		A1A1XA1-2	H	H	cont.	A1A5
	Set to state	0/0							
	Set to state	0/6	RMNE		A1A1XA1-2	10	L	A1A1	A1A1

Table 8-10. Center Frequency Readout Faulty (1 of 5)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next state wrong - check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Key in a valid center frequency. Check the RF Section output with a frequency counter. If the frequency is correct, but the readout is not, proceed to Table 8-12.							
2	If the output frequency and the readout are both faulty, hold in the KYBD key while entering a few frequency. If the readout is correct, but the decimal point is not properly justified, proceed to Table 8-14.							

Table 8-10. Center Frequency Readout Faulty (2 of 5)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
3	If the readout was correct and justified in step 2 proceed to Test I of this table.							
4	If the readout and justification were both incorrect in step 2 proceed to Test II of this table.							
TEST I	Check manual tune in fine range. If the readout does not add and subtract properly proceed to part 2 of this test. **NOTE:** Above 1.3 GHz the frequency increments in 2 Hz steps.							
PART 1 1	In auto test mode key in kHz. Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	4/1						
	Manually Clock	1/9						
2	Hold CTR FREQ key down			MNE	A1A4XA4-2 7	L	A1A4	A1A1
	NOTE If the 'next state' does not appear as shown in the succession column reset to the previous state before making test shown. Manually clock	4/9		QE1	A1A4XA4-1 M	H	A1A4	A1A2
	Manually clock	5/9		INC	A1A4XA4-1 F	L	A1A4	A1A2
	Manually clock	6/9	INC	F3	A1A4XA4-1 A	L	A1A4	A1A2
	Manually clock	6/10		CF	A1A4XA4-1 D	H	A1A4	A1A2
	Manually clock	5/7		OFS	A1A4XA4-26	H	A1A4	NOTE
	Release CTR FREQ key while checking instructions. Manually clock	1/12	KTT		A1A5XA5-2 P	H	cont.	A1A5
			TTM		A1A4XA4-2 14	L	cont.	A1A4
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			JF3		A1A4XA4-1 A	L	cont.	A1A2
	NOTE: Check for short in wiring to RF Section J6 Pin 9.							

Table 8-10. Center Frequency Readout Faulty (3 of 5)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
3	Hold CTR FREQ key down			CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	2/2		QA	A1A4XA4-1 3	L	A1A4	A1A6
	Manually clock	2/4		F7			A1A4	A1A4
	Manually clock	4/3		CF	A1A4XA4-1 D	H	A1A4	A1A2
	Release CTR FREQ Manually clock	2/5	KTT		A1A5XA5-2 P	H	cont.	A1A5
	key while checking		TTA		A1A4XA4-1 14	L	cont.	A1A4
	instructions		TTC		A1A5XA5-1 E	H	cont.	A1A5
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			SCDP		A1A5XA5-1 12	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/5					A1A6	
PART 2								
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	0/4		QUI	A1A4XA4-2 10	L	A1A4	A1A2
	Manually clock	4/4						
2	Set to state	0/0						
	Set to state	6/14		KPB	A1A4XA4-1 8	H	A1A4	A1A1
	Manually clock	1/1		F1	A1A4XA4-2 H	L	A1A4	A1A1
	Manually clock	4/1		SWI	A1A4XA4-1 N	L	A1A4	A1A1
	Manually clock	1/9		MNE	A1A4XA4-2 7	L	A1A4	A1A1
	Manually clock	4/9		QEI	A1A4XA4-1 M	L	A1A4	A1A2
	Manually clock	4/10						
3	Set to state	0/0						
	Set to state	2/2		QA	A1A4XA4-1 3		A1A4	A1A6
	Manually clock	2/4		F7			A1A4	A1A4
	Manually clock	4/3		CF	A1A4XA4-1 D	L	A1A4	A1A2
	Manually clock	4/5		NINC	A1A4XA4-1 11	L	A1A4	A1A3
	Manually clock	2/7		CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/5		OFS	A1A4XA4-2 6	H	A1A4	NOTE
	Manually clock	6/6		CFR	A1A4XA4-1 J	L	A1A4	A1A1
	Manually clock	3/7					A1A6	
	NOTE If OFS is wrong, check wiring to and through A1A11 to RF Section J6 Pin 9.							

Table 8-10. Center Frequency Readout Faulty (4 of 5)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
TEST II	Check manual tune in fine range. If the readout does not add and subtract properly proceed to part 2 of this test.							
PART 1								
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	6/0		NUM	A1A4XA4-1 C	H	A1A4	A1A2
	Hold in any numbered key. Manually clock	6/1		F2	A1A4XA4-2 18	L	A1A4	A1A4
	Manually clock	1/5	RKB		A1A5XA5-2 L	L	cont.	A1A5
	Release numbered key while checking instructions		RF2		A1A4XA4-2 8	L	cont.	A1A2
				NUM	A1A4XA4-1 C	H	A1A4	A1A2
	Manually clock	0/2						
2	Set to state	0/0						
	Set to state	6/1		F2	A1A4XA4-2 18	H	A1A4	A1A4
	Manually clock	0/2		no check				A1A4
	Manually clock	0/3	CK10		A1A4XA4-2 17	L	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	6/14						
3	Set to state	0/0						
	Set to state	5/10		RMT	A1A4XA4-1 6	L	A1A4	A1A3
	Manually clock	0/0						
4	Extend A1A1 on an extender board. Set to manual test mode by momentarily grounding the MAN TP. Set to state	0/2	ETKØ		A1A1XA1-2 15	L	cont.	A1A1
	Manually clock	0/3	KØTK		A1A1XA1-2 S	L	A1A2	A1A1
PART 2								
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	0/0		F10	A1A4XA4-2 M	H	cont.	A1A1

Table 8-10. Center Frequency Readout Faulty (5 of 5)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next state wrong - check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
1	(Cont'd) Hold in any numbered key.							
	Manually clock	4/0		F7			A1A4	A1A4
	Manually clock	5/0		DP	A1A4XA4-1 2	H	A1A4	A1A2
	Manually clock	6/0		NUM	A1A4XA4-1 C	H	A1A4	A1A2
	Manually clock	6/1						
2	Extend A1A1 on an extender board. Set to manual test mode by momentarily grounding the MAN TP Set to state	0/0	KD2		A1A1XA1-1 12	L	A1A1	A1A2
	NOTE Hold in a numbered key while checking KD2.							

Table 8-11. BCD Data to Mainframe Incorrect (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next state wrong - check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
	Center frequency DCU output data to main-frame loops is incorrect. Center frequency readout is correct.							
	NOTE: BCD data to the mainframe should be 1/2 of the CF readout.							
1	Press STEP ↑ key repeatedly and observe PD.		PD		A1A5XA5-1 4	Flash L to H	con't	A1A5
2	Enter CLEAR KYBD, Hz, & CF (CF readout is blank).							
3	Enter 11.111111 MHz STEP ↑;							

Table 8-11. BCD Data to Mainframe Incorrect (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next state wrong - check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
4	Check mainframe output frequency with counter. If frequency is not the same as entered frequency, switch Sweep Mode from OFF to AUTO and back to OFF. Check output frequency again. *Possibly one or two digits only are faulty. Continue with Step 5 to detect faulty digit. IC corresponding to faulty digit on A10 may be replaced.						A1A9	A1A10*
5	Enter STEP ↑. Check for counter reading 22.222222 MHz. Repeat STEP ↑ and check with counter. Faulty digit will give incorrect reading.							

Table 8-12. Readout is Partially Displayed or Incorrect (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next state wrong - check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Check readout with the following entries: 11 111 111 Hz 44 444 444 Hz 22 222 222 Hz 88 888 888 Hz If ALL digits show any other number, or an odd character, repair or replace A1A3.							
2	If the readout if incorrect but not as defined in step 1, connect a frequency counter to the RF Section output. Enter If the counter reading is not the same as the frequency entered, refer to Table 8-10.							

Table 8-12. Readout is Partially Displayed or Incorrect (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
3	When the counter reading in step 2 is the same as the keyboard entry: a. If the readout right hand six digits is defective replace A1A12U2. b. If the readout of the remaining digits is defective replace A1A12U1. c. If both sides of the readout are faulty refer to Table 8-13.							

Table 8-13. Only 1 or 2 Half-Digits Displayed

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Use extender boards to extend A1A3		RSCAN		A1A3XA3-2 5	Square wave 1.2 ms	Step 2	Step 4
2	Use extender boards to extend A1A1		ROCK		A1A1XA1-2 E	10 kHz Clock	A1A12	A1A1
3	Check cabling to A1A12							
4			SCANCK		A1A1XA1-2 5	5 kHz Clock	A1A3	A1A1

Table 8-14. Center Frequency Readout Does Not Justify Correctly

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Hold KYBD pushbutton and enter 10 MHz, then 10 kHz, then 10 Hz. If the readout justifies correctly refer to Table 8-14.							
2	If justification was incorrect in step 1 Hold in the Hz key		QU1		A1A4XA4-2 10	H	cont.	A1A2
3	Press Hz key several times		JUS		A1A5XA5-2 H	H→L	A1A3	cont.
4	Set to manual mode by momentarily grounding the MAN TP and hold the Hz key down. Set to state	0/4						
	Manually clock	1/6					A1A5	A1A4

Table 8-15. Readout Does Not Justify with Only One Units Key (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Use extender boards to extend A1A2 and press the units key that does not respond		GHz		A1A2U21 pin 8	H	A1A3	cont.
			MHz		A1A2XA2-1 L	H	A1A3	cont.
			kHz		A1A2XA2-1 K	H	A1A3	cont.
			Hz		A1A2XA2-1 13	H	A1A3	cont.
2	Use a Logic Probe (or an oscilloscope) to check for a clock while pressing the units key which does not respond		GHz		A1A2U26 pin 11	L	A1A2	cont.
			MHz		A1A2U26 pin 7	L	A1A2	cont.
			kHz		A1A2U26 pin 5	L	A1A2	cont.
			Hz		A1A2U26 pin 4	L	A1A2	cont.

Table 8-15. Readout Does Not Justify with Only One Units Key (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
3	Verify presence of dc voltages -10V				A1A2XA2-2 L	-10V	cont.	Power Supply
	+20V				A1A2XA2-2 11	+20V	cont.	Power Supply
			100 KCK		A1A2XA2-1 9		A1A2	A1A1
	NOTE Check the interconnections between the keyboard and A1A11.							

Table 8-16. Either STEP ↑ or STEP ↓ Operation Defective (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
	If STEP ↑ is defective proceed to step 1 If STEP ↓ is defective proceed to step 2							
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/13						
	Hold STEP ↑ key in			QAD	A1A4XA4-1 7	H	A1A4	A1A2
	Manually clock	1/15	ADD		A1A5XA5-1 6	H	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/3					A1A5 NOTE	
	NOTE If the manual tune up is also defective, repair or replace A1A7, not A1A5.							

Table 8-16. Either STEP ↑ or STEP ↓ Operation Defective (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
2	Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/13						
	Hold STEP ↓ key in			QAD	A1A4XA4-1 7	L	A1A4	A1A2
	Manually clock	1/14	ADD		A1A5XA5-1 6	L	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/2		QB	A1A4XA4-1 5	L	A1A4	A1A5
	Manually clock	3/3					A1A5 NOTE	
	NOTE If the manual tune down is also defective, repair or replace A1A7, not A1A5.							

Table 8-17. Both STEP ↑ and STEP ↓ Defective at the RF Output (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Enter 10 MHz CF and 1 kHz STEP ↑. Press STEP display pushbutton. Does the readout display show 9 digits with the same character for most; If yes, repair or replace A1A6.							
2	Key in Hz on the keyboard and set to manual mode by momentarily grounding the MAN TP. Hold in STEP ↑ key.							
	Set to state	5/9		INC	A1A4XA4-1 F	H	A1A4	A1A2
	Manually clock	5/6		F3	A1A4XA4-1 A	L	A1A4	A1A2
	Manually clock	1/13	KTT		A1A5XA5-2 P	H	cont.	A1A5
			TTI		A1A5XA5-2 9	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/13		QAD	A1A4XA4-1 7	H	A1A4	A1A2

Table 8-17. Both STEP ↑ and STEP ↓ Defective at the RF Output (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
2 (cont)	Manually clock	1/15	CTR		A1A5XA5-1 K	H	cont.	A1A5
			ITS		A1A5XA5-1 D	H	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/3						
	Set to state	0/0						
	Set to state	4/3		CF	A1A4XA4-1 D	L	A1A4	A1A2
	Manually clock	2/7	CTT		A1A5XA5-1 10	H	cont.	A1A5
			TTA		A1A4XA4-1 14	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/5					A1A6	

Table 8-18. Manual STEP Defective

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Select manual step		STEP		A1A4XA4-2 D	L	A1A4	cont.
			STEP		A1A1XA1-1 R	L	SEE NOTE	
	NOTE Check continuity between A1A1, mother board, cabling and the switch.							

Table 8-19. *Manual Tune Mode Inoperative*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Select fine tune. While turning the manual sweep tuning knob		MNE		A1A4XA4-2 7	Flashes	Step 2	cont.
	Use extender boards to extend A1A1. While turning the tuning knob		CW		A1A1U12 pin 4	Flashes	A1A1	A1A17
			CCW		A1A1U12 pin 5	Flashes	A1A1	A1A17
2	Set to manual mode by momentarily grounding MAN TP and turn manual tune a part of a turn. Set to state	1/9	RENC		A1A5XA5-1 F	H	cont.	A1A5
	Manually clock			MNE	A1A4XA4-2 7	H	A1A4	A1A1
		5/15						
	Set to state	0/0						
	Set to state	4/8		STEP	A1A4XA4-2 D	H	A1A4	A1A1
	Manually clock	2/1	NTS		A1A5XA5-2 T	L	cont.	A1A5
	Use extender boards to extend A1A7 and set to manual mode by momentarily grounding the MAN TP. Set to state	2/1	PRENC		A1A7XA7-1 5	H	cont.	A1A5
			OTS		A1A7U7 pin 12	H	cont.	A1A5
			MTR		A1A7U1 pin 1	L	cont.	A1A5
			TRØ		A1A7U3 pin 13	H	cont.	A1A1
			TR1		A1A7U3 pin 2	H	cont.	A1A1
	NOTE If TRØ, TR1, TR2, or TR3 are not as shown in the logic level column refer to Table 8-20.		TR2		A1A7U16 pin 5	H	cont.	A1A1
			TR3		A1A7U16 pin 4	L	cont.	A1A1

Table 8-20. Manual Tune Defective on One Range, Fine, Medium or Coarse

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Extend A1A7 on extender board check the defective range as shown							
	COARSE		TR1		A1A7XA7-1 6	L	A1A7	cont.
	MEDIUM		TR2		A1A7XA7-1 7	L	A1A7	cont.
	FINE		TR3		A1A7XA7-1 H	L	A1A7	cont.
	Re-install A1A7							
2	Extend A1A1 on extender boards and check as shown		TR1		A1A1J1 pin 7	L	SEE NOTE	
			TR2		A1A1J1 pin 6	L		
			TR3		A1A1J1 pin 5	L		
	NOTE Check continuity of A1A11 (mother board), A1A1, cabling and switch.							

Table 8-21. Either Up or Down Manual Tune Defective (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Select fine manual tune and turn the manual tune knob		PLS		A1A4XA4-1 K	Flash	Step 2 or 3	cont.
	Extend A1A1 on the extender boards and rotate the manual tune knob		CCW		A1A1J1 pin 10	Flash	A1A1	A1A17
			CW		A1A1J1 pin 11	Flash	A1A1	A1A17
	If up tune is defective proceed to step 2 If down tune is defective proceed to step 3							

Table 8-21. *Either Up or Down Manual Tune Defective (2 of 2)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
2	Turn manual tune knob to set PLS level		PLS		A1A4XA4-1 K	H		
	Set to manual mode by momentarily grounding MAN TP — Set to state	5/15		PLS	A1A4XA4-1 K	H	A1A4	cont.
	Manually clock	4/8		STEP	A1A4XA4-2 D	H	A1A4	A1A1
	Manually clock	2/1	ADD		A1A5XA5-1 6	H	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/3					A1A5 NOTE	
	NOTE If STEP ↓ is also defective repair or replace A1A7, not A1A5							
3	Turn manual tune knob to set PLS level		PLS		A1A4XA4-1 K	L		
	Set to manual mode by momentarily grounding the MAN TP — Set to state	5/15		PLS	A1A4XA4-1 K	L	A1A4	cont.
	Manually clock	5/3		STEP	A1A4XA4-2 D	H	A1A4	A1A1
	Manually clock	2/0	ADD		A1A5XA5-1 6	L	cont.	A1A5
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	5/2		QB	A1A4XA4-1 S	L	A1A4	A1A7
	Manually clock	3/3					A1A5 NOTE	
	NOTE If STEP ↑ is also defective repair or replace A1A7, not A1A5.							

Table 8-22. *Auto Sweep Defective at All Sweep Rates (1 of 2)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Enter 10 MHz CF and 10 kHz SWP WIDTH. Press sweep width display pushbutton. If the display is correct proceed to step 3. If not, proceed to step 2.							
2	Set to manual test mode by momentarily grounding the MAN TP Set to state	6/10		CF	A1A4XA4-1 D	L	A1A4	A1A2
	Manually clock	1/11	KTT		A1A5XA5-2 P	H	cont.	A1A5
			TTF		A1A5XA5-2 N	L	cont.	A1A5
			JF3		A1A5XA5-2 2	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	6/6					A1A6	
3	Switch to Auto sweep and fast rate. Set to manual test mode by momentarily grounding the MAN TP. Set to state	4/1		SW1	A1A4XA4-1 N	H	A1A4	A1A1
	Manually clock	0/13	JF7A		A1A4XA4-2 L	L	cont.	A1A1
				No check			A1A4	
	Manually clock	3/14		SW1	A1A4XA4-1 N	H	A1A4	A1A1
	Manually clock	3/12		F1	A1A4XA4-2 H	L	A1A4	A1A1
	Manually clock	0/10		QSP	A1A4XA4-2 12	H	A1A4	A1A1
	Manually clock	0/11		QMSW	A1A4XA4-2 13	L	A1A4	A1A1
	Manually clock	5/11		QCTM	A1A4XA4-1 9	L	A1A4	A1A8
	Manually clock	5/12		Q100	A1A4XA4-1 H	H	A1A4	A1A1
	Manually clock	3/1	FTS		A1A5XA5-1 5	NOTE	cont.	A1A5
			A2TR		A1A5XA5-1 M	H	cont.	A1A5
	NOTE		ADD		A1A5XA5-1 6	H	cont.	A1A5
	Flashes high when going from state 5/12 to state 3/1 only.		CUP		A1A5XA5-1 13	H	cont.	A1A5
			CK1213		A1A5XA5-1 1	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTM		A1A4XA4-2 14	L	cont.	A1A4
			TTA		A1A4XA4-1 14	L	cont.	A1A4
				CKA	A1A5XA5-1 R	H	A4 if both OK	A1A5
				CKB	A1A5XA5-1 P	H		A1A5

Table 8-22. Auto Sweep Defective at All Sweep Rates (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
3	Cont'd							
	Manually clock	6/5		ZER	A1A4XA4-1 E	L	A1A4	A1A7
	Manually clock	2/2		QA	A1A4XA4-13	L	A1A4	A1A6
	Manually clock	2/4		F7			A1A4	A1A4
	Manually clock	4/11		F8			A1A4	A1A4
	Manually clock	0/9	PDS		A1A5XA5-2 6	L	cont.	A1A1
			ATR		A1A5XA5-1 L	H	cont.	A1A5
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/14						
	Set to auto mode. Enter 10 MHz CF and 10 kHz SWP WIDTH. Switch to manual sweep and tune manual sweep until the output frequency exactly equals 10.005 MHz.							
	Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/11		QCTM	A1A4XA4-1 9	H	A1A4	A1A8
	Manually clock	6/11		F8			A1A4	A1A4
	Manually clock	2/15	ATR		A1A5XA5-1 L	H	cont.	A1A5
			FTS		A1A5XA5-1 5	H	cont.	A1A5
			ADD		A1A5XA5-1 6	L	cont.	A1A5
			SQB		A1A5XA5-1 9	H	cont.	A1A5
			JF8		A1A5XA5-2 K	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTM		A1A4XA4-2 14	L	cont.	A1A4
			TTA		A1A4XA4-1 14	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	4/15		QB	A1A4XA4-1 5	L	A1A4	A1A7
	Manually clock	2/2						
	Set to state	0/0						
	Set to state	0/10		QSP	A1A4XA4-2 12	L	A1A4	A1A1
	Manually clock	3/14					A1A9	

Table 8-23. Auto Sweep Defective at One Sweep Rate (1 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
1	Enter 10 MHz CF and 10 kHz SWP WIDTH. If fast rate is defective proceed to step 2. If slow or medium rates are defective proceed to step 3.							
2	Set to auto sweep and fast rate. Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/12		Q100	A1A4XA4-1 H	H	A1A4	A1A1
	Manually clock	2/12		CKA	A1A5XA5-1 R	H	A1A4	A1A5
				CKB	A1A5XA5-1 P	H	If both OK	A1A5
	Manually clock	6/2					cont.	A1A4
	Manually clock	3/4	ATR		A1A5XA5-1 L	H	cont.	A1A5
	Manually clock		UTT		A1A4XA4-2 16	H	cont.	A1A4
	Manually clock		CK10		A1A4XA4-2 17	L	cont.	A1A4
	Manually clock		TTRO		A1A4XA4-12 15	L	cont.	A1A4
	Manually clock		ADD		A1A5XA5-1 6	H	cont.	A1A5
	Manually clock		RENC		A1A5XA5-1 F	H	cont.	A1A5
	Manually clock			CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Set to auto mode. Switch to manual sweep and tune manual sweep until the output frequency exactly equals 10.005 MHz.							
	Set to manual test mode by momentarily grounding the MAN TP.						A1A4	A1A8
	Manually clock	4/14		QCFM	A1A4XA4-1 9	L	A1A4	A1A8
3	Switch to auto sweep and medium or slow rate. Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/12		Q100	A1A4XA4-1 H	L	A1A4	A1A1
	Manually clock	3/0	A3TR		A1A5XA5-1 8	H	cont.	A1A5
			FTS		A1A5XA5-1 5	H	cont.	A1A5
			ADD		A1A5XA5-1 6	H	cont.	A1A5

Table 8-23. Auto Sweep Defective at One Rate (2 of 2)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
3	Cont'd		CUP		A1A5XA5-1 13	H	cont.	A1A5
			CK1213		A1A5XA5-1 1	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTM		A1A4XA4-2 14	L	cont.	A1A4
			TTA		A1A4XA4-1 15	L	cont.	A1A4
				CKA	A1A5XA5-1 R	H }	A1A4 if both OK	A1A5
				CKB	A1A5XA5-1 P	H }		A1A5
	Manually clock	6/5						
	Set to auto mode. Switch to manual sweep and tune manual sweep until center frequency exactly equals 10.005 MHz. Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/11		QCTM	A1A4XA4-1 9	H	A1A4	A1A8
	Manually clock	6/11					A1A9	

Table 8-24. Single Sweep Defective

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point - Check	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
1	Enter 10 MHz CF and 5 MHz SWP WIDTH. Switch to single sweep and any sweep rate. Set to manual test mode by momentarily grounding the MAN TP. Press single sweep pushbutton once. Set to state	3/15		QSS	A1A4XA4-2 B	H	A1A4	A1A1
	Manually clock	2/9	RQSS		A1A5XA5-2 F	H	A1A1	A1A5
	NOTE Check cabling to switches before replacing A1A1.							

Table 8-25. Manual Sweep Defective (1 of 4)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Extend A1A4 on extender boards. Enter 10.000500 CF and 1 kHz SWP WIDTH. Switch to manual sweep. If manual sweep up is defective proceed to step 3. If manual sweep down is defective proceed to step 4.							
2	Turn manual sweep to set PLS at A1A4XA4-1 pin K to the high level (very sensitive setting). Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	0/15		QMSW	A1A4XA4-2 13	H	A1A4	A1A1
	Manually clock	2/13						
	Set to state	0/0						
	Set to state	0/14		QMSW	A1A4XA4-2 13	H	A1A4	A1A1
	Manually clock	2/12						
	Set to state	0/0						
	Set to state	0/11		QMSW	A1A4XA4-2 13	H	A1A4	A1A1
	Manually clock	0/12		PLS	A1A4XA4-1 K	H	A1A4	A1A1
	Manually clock	6/12		IUP	A1A4U14 pin 9	L	A1A4	cont.
	Manually clock	2/12		CKA	A1A5XA5-1 R	H	A1A4 if both OK	A1A5
				CKB	A1A5XA5-1 P	H		A1A5
	Manually clock	4/14		QCTM	A1A4XA4-1 9	L	A1A4	A1A8
	Manually clock	4/7		QCTZ	A1A4XA4-1 L	L	A1A4	A1A8
	Manually clock	4/2		OFS	A1A4XA4-2 6	H	A1A4	NOTE
	Manually clock	2/2						
	NOTE If OFS is wrong, check wiring to A1A11.							
2	Set to auto mode. Rotate manual sweep to maximum frequency, exactly 10.001000 MHz. Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	4/14		QCTM	A1A4XA4-1 9	H	A1A4	A1A8
	Manually clock	2/10	JIUP		A1A4XA4-2 3	L	cont.	A1A5
				No check			A1A4	A1A4
	Manually clock	4/2						

Table 8-25. Manual Sweep Defective (2 of 4)

Step	Symptom or Instruction		State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
								If OK	If Wrong
2	Cont'd	Set to state	0/0						
		Set to state	6/12		IUP	A1A4U14 pin 9	H	A1A4	A1A4
		Manually clock	3/14						
		Set to state	0/0						
		Set to state	2/13	KIUP		A1A4XA4-2 E	L	cont.	A1A5
		Set to state	0/0						
		Set to state	6/12		IUP	A1A4U14 pin 9	L	A1A4	A1A4
		Manually clock	2/12						
	Set to auto mode. Rotate manual sweep to minimum frequency, exactly 10.000000 MHz. Set to manual test mode by momentarily grounding the MAN TP.								
		Set to state	4/7		QCTZ	A1A4XA4-1 L	H	A1A4	A1A8
		Manually clock	2/11	JIDN		A1A4XA4-2 C	L	cont.	A1A5
					No check			A1A4	A1A4
		Manually clock	4/2						
		Set to state	0/0						
		Set to state	4/12		IDN	A1A4U14 pin 12	H	A1A4	A1A4
		Manually clock	3/14						
		Set to state	0/0						
		Set to state	2/12	KIDN		A1A5XA5-2 5	L	cont.	A1A5
		Set to state	0/0						
		Set to state	4/12		IDN	A1A4U14 pin 12	L	A1A4	A1A4
		Manually clock	2/13					A1A1	
3	Sweep up is defective. Turn Manual sweep and set PLS at A1A4XA4-1 pin K to the high level (very sensitive setting). Set to manual test mode by momentarily grounding the MAN TP.	Set to state	2/13	KIUP		A1A4XA4-2 E	L	cont.	A1A5
		Set to state	0/0						
		Set to state	0/12		PLS	A1A4XA4-1 K	H	A1A4	A1A1
		Manually clock	6/12		IUP	A1A4U14 pin 9	L	A1A4	A1A4
		Manually clock	2/12	A3TR		A1A5XA5-1 8	H	cont.	A1A5
				FTS		A1A5XA5-1 5	H	cont.	A1A5
				ADD		A1A5XA5-1 6	H	cont.	A1A5

Table 8-25. Manual Sweep Defective (3 of 4)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
3	Cont'd							
			CUP		A1A5XA5-1 13	H	cont.	A1A5
			KIDN		A1A5XA5-2 5	H	cont.	A1A5
			RZER		A1A5XA5-2 S	L	cont.	A1A5
			CK1213		A1A5XA5-1 1	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			TTM		A1A4XA4-1 14	L	cont.	A1A4
			TTA		A1A4XA4-1 14	L	cont.	A1A4
				CKA	A1A5XA5-1 R	H	A1A4 if both OK	A1A5
				CKB	A1A5XA5-1 P	H		A1A5
	Manually clock	6/2						
	Set to auto mode. Rotate manual sweep to maximum frequency, exactly 10.001000 MHz. Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	4/14		QCTM	A1A4XA4-1 9	H	A1A4	A1A8
	Manually clock	2/10	JIUP		A1A4XA4-2 3	L	cont.	A1A5
				No check			A1A4	A1A4
	Manually clock	4/2						
	Set to state	0/0						
	Set to state	6/12		IUP	A1A4U14 pin 9	H	A1A4	A1A4
	Manually clock	3/14					A1A1	
4	Sweep down is defective. Turn manual sweep and set PLS at A1A4XA4-1 pin K to the low level (very sensitive setting). Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	2/12	KIDN		A1A5XA5-2 5	L	cont.	A1A5
	Set to state			QCT2	A1XA4-1 L	H	A1A4	A1A8
	Set to state	0/0						
	Set to state	0/12		PLS	A1A4XA4-1 K	L	A1A4	A1A1
	Manually clock	4/12		IDN	A1A4U14 pin 12	L	A1A4	A1A4
	Manually clock	2/13	A3TR		A1A5XA5-1 8	H	cont.	A1A5

Table 8-25. Manual Sweep Defective (4 of 4)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
			FTS		A1A5XA5-1 5	H	cont.	A1A5
			ADD		A1A5XA5-1 6	L	cont.	A1A5
			RENC		A1A5XA5-1 F	H	cont.	A1A5
			CDN		A1A5XA5-2 E	L	cont.	A1A5
			SQB		A1A5XA5-1 9	H	cont.	A1A5
			CK1213		A1A5XA5-1 1	L	cont.	A1A5
			CK10		A1A4XA4-2 17	L	cont.	A1A4
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			TTM		A1A4XA4-2 14	L	cont.	A1A4
			TTA		A1A4XA4-1 14	L	cont.	A1A4
				CKA	A1A5XA5-1 R	H }	A1A4 if both OK	A1A5
				CKB	A1A5XA5-1 P	H }		A1A5
	Manually clock	4/13		QB	A1A4XA4-1 5	L	A1A4	A1A7
	Manually clock	4/14						
	Set to auto mode. Rotate manual sweep to minimum frequency (exactly 10.000000 MHz). Set to manual test mode by momentarily grounding the MAN TP.							
	Set to state	4/7		QCTZ	A1A4XA4-1 L	H	A1A4	A1A8
	Manually clock	2/11	JIDN		A1A4XA4-2 C	L	cont.	A1A5
				No check			A1A4	A1A4
	Manually clock	4/2						
	Set to state	0/0						
	Set to state	4/12		IDN	A1A4U14 pin 12	H	A1A4	A1A4
	Manually clock	3/14					A1A1	

Table 8-26. *Out of Range Indicator Inoperative (1 of 2)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
1	Use a frequency counter to count the output rf frequency. If the center frequency stops at the upper frequency limit, proceed to step 3.							
	Observe the dc level on the test point while tuning the center frequency above the upper limit.					Flash H	A1A4	cont.
2	If 86601A is being used: Extend A1A7 on the extender board		PILIM		A1A7XA7-1 D	L	A1A6	cont.
			13GL		A1A7XA7-1 4	H	A1A6	cont.
			16LIM		A1A7XA7-2 K	H	A1A6	cont.
			OPID1		A1A7XA7-1 3	H	A1A7	cont.
			OPID2		A1A7XA7-1 C	H	A1A7	cont.
			OPID4		A1A7XA7-1 B	H	A1A7	cont.
	If 86602A is being used: Extend A1A7 on the extender board							
			PILIM		A1A7XA7-1D	H	A1A6	cont.
			13GL		A1A7XA7-1 4	L	A1A6	cont.
			16LIM		A1A7XA7-2 K	H	A1A6	cont.
			OPID 1		A1A7XA7-1 3	L	A1A7	cont.
			OPID2		A1A7XA7-1 C	H	A1A7	cont.
			OPID4		A1A7XA7-1 B	H	A1A7	cont.

Table 8-26. *Out of Range Indicator Inoperative (2 of 2)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
2 cont.	If 86603A is being used Extend A1A7 on extender board							
			PILIM		A1A7XA7-1 D	L	A1A6	cont.
			13GL		A1A7XA7-1 4	H	A1A6	cont.
			16LIM		A1A7XA7-2 K	L	A1A6	cont.
			OPID1		A1A7XA7-1 3	H	A1A7	cont.
			OPID2		A1A7XA7-1 C	L	A1A7	cont.
			OPID4		A1A7XA7-1 B	H	A1A7	cont.
	NOTE If any of the above checks are wrong repair interconnections.							
3	Check OUT OF RNG lamp at upper frequency limit					Blinks	A1A6	cont.
	At upper frequency limit check		SIND2		A1A1XA1-1 4	Flash L	cont.	A1A6
	If lamp is on continuously						A1A1	cont.
	Ground ERR pin at front of mother board. If the out of range lamp lights						A1A1	
	If the out of range lamp does not light, check the lamp and wiring.							

Table 8-27. KYBD Pushbutton Readout Defective

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Set to manual test mode Set to state	6/14						
	Press KYBD pushbutton			KPB	A1A4XA4-1 8	L	A1A4	A1A1
	Manually clock	1/4	KTT		A1A5XA5-2 P	H	cont.	A1A5
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/6					A1A7	
	NOTE If KPB is wrong, check A1A11 and cabling.							

Table 8-28. STEP Pushbutton Readout Defective

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	5/4						
	Hold in STEP pushbutton			IPB	A1A4XA4-1 B	L	A1A4	NOTE
	Manually clock	1/2	ITS		A1A5XA5-1 D	H	cont.	A1A5
	NOTE If wrong, check A1A1 and interconnections.		XOR		A1A4XA4-2 R	H	cont.	A1A5
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/6					A1A7	

Table 8-29. Sweep Width Pushbutton Readout Defective

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Set to manual test mode by momentarily grounding the MAN TP. Set to state	6/4						
	Hold in the SWP WIDTH pushbutton			FPB	A1A4XA4-1 4	L	A1A4	NOTE
	Manually clock	1/3	FTS		A1A5XA5-1 5	H	cont.	A1A5
	NOTE							
	If FPB is wrong, check A1A1 and wiring		XOR		A1A5XA5-2 R	H	cont.	A1A5
			UTT		A1A4XA4-2 16	H	cont.	A1A4
			TTRO		A1A4XA4-2 15	L	cont.	A1A4
			CK10		A1A4XA4-2 17	L	cont.	A1A4
				CKB	A1A5XA5-1 P	H	A1A4	A1A5
	Manually clock	3/6					A1A7	

Table 8-30. Remote Control Problems (1 of 7)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
1	Verify that the mainframe and the plug-ins operate properly in the local operating mode. Refer to Section III of this manual and verify that programming procedures are correct. If the flag signal is faulty in remote operation proceed to step 2, otherwise proceed to step 3.							
2	Measure voltage		FLAG		A3A1U3 pin 10	⩾3.0V	cont.	cont.

Table 8-30. *Remote Control Problems (2 of 7)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace: If OK	Repair or Replace: If Wrong
2	Cont'd Use a logic probe or an oscilloscope to monitor		FLAG		A3A1U3 pin 10	H	cont.	cont.
	Use a pulser probe to pulse		COMMAND		A3A1U3 pin 1	H→L Flash	cont.	A3A1
	Use a pulser probe to pulse		COMMAND		J3 pin 9	H→L Flash	NOTE 1	Check Cable
	NOTE 1 Tests indicate that external command source is defective.							
3	If remote control is completely inoperative proceed to step 4; if partially operative continue. Is remote control of CTR FREQ or STEP inoperative? If yes, proceed to step 3-a, if no, proceed to step 3-B.							
3-a	**NOTE 2** Checks that follow include various cables that should be checked for continuity before exchanging the indicated assembly. Use a pulser probe (or momentarily ground) J3 pin 9 to pulse the command line.							
	Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	L	cont.	A3A2
			D2-2		A3A2U4 pin 11	L	cont.	A3A2
			D2-1		A3A2U4 pin 8	L	cont.	A3A2
			CF		A1A11XA11-2 33	L	cont.	A3A1
			STEP ↑		A1A11XA11-2 34	H	cont.	A3A1
			STEP ↓		A1A11XA11-2 36	H	cont.	A3A1

Table 8-30. Remote Control Problems (3 of 7)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
3-a	Cont'd							
	Ground J3 pin 31 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	L	cont.	A3A2
			D2-2		A3A2U4 pin 11	L	cont.	A3A2
			D2-1		A3A2U4 pin 8	H	cont.	A3A2
			CF		A1A11XA11-2 33	H	cont.	A3A1
			STEP ↑		A1A11XA11-2 34	L	cont.	A3A1
			STEP ↓		A1A11XA11-2 36	H	cont.	A3A1
	Remove the ground from J3 pin 31.							
	Ground J3 pin 30 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	L	cont.	A3A2
			D2-2		A3A2U4 pin 11	H	cont.	A3A2
			D2-1		A3A2U4 pin 8	L	cont.	A3A2
	Check		CF		A1A11XA11-2 33	H	cont.	A3A1
			STEP ↑		A1A11XA11-2 34	H	cont.	A3A1
			STEP ↓		A1A11XA11-2 36	L	cont.	A3A1
	If all check OK						A1A2	
3-b	See NOTE 2 If any modulation or rf output plug-in functions can be correctly programmed, continue; if not, proceed to step 3-c.							
	Perform the following checks for the particular function which has failed.							
	Ground J3 pins 13, 14, 15 and 16.							
	ATTENUATION							
	Ground J3 pins 30 and 31. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	L	cont.	A3A2
			D2-2		A3A2U4 pin 11	H	cont.	A3A2
			D2-1		A3A2U4 pin 8	H	cont.	A3A2

Table 8-30. Remote Control Problems (4 of 7)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace If OK	Repair or Replace If Wrong
3-b	Cont'd							
	Pulse command J3 Pin 9		Atten		J6 pin 24	Pulses L→H	cont.	A3A1
	AM-FM FCTN							
	Ground J3 pin 29 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	H	cont.	A3A2
			D2-2		A3A2U4 pin 11	L	cont.	A3A2
	Check		D2-1		A3A2U4 pin 8	L	cont.	A3A2
	Pulse command		AM-FM		J5 pin V	Pulses L→H	cont.	A3A1
	AM-FM %							
	Ground J3 pins 29 and 31 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	H	cont.	A3A2
			D2-2		A3A2U4 pin 11	L	cont.	A3A2
			D2-1		A3A2U4 pin 8	H	cont.	A3A2
	Pulse command		AM-FM %		J5 pin U	Pulses L→H	cont.	A3A2
	FM CAL							
	Ground J3 pins 29 and 30 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	H	cont.	A3A2
			D2-2		A3A2U4 pin 11	H	cont.	A3A2
			D2-1		A3A2U4 pin 8	L	cont.	A3A2
	Pulse command		FM CAL		J5 pin Z	Pulses L→H	cont.	A3A1
	RF FCTN							
	Ground J3 pins 29, 30 and 31 and pulse (or momentarily ground) J3 pin 9. Check		D2-8		A3A2U4 pin 1	L	cont.	A3A2
			D2-4		A3A2U4 pin 14	H	cont.	A3A2

Table 8-30. *Remote Control Problems (5 of 7)*

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair Replace: If OK	Repair Replace: If Wrong
3-b	Cont'd							
			D2-2		A3A2U4 pin 11	H	cont.	A3A2
			D2-1		A3A2U4 pin 8	H	cont.	A3A2
	Pulse command		RF RCTN		J6 pin 26	Pulses L→H	cont.	A3A1
	If all checks are OK the problem is in the plug-in sections.							
3-c	See NOTE 2 Following pulse check occurs only once for each sequence of 1) and 2).							
	1). Ground J3 pins 28, 29, 30 and 31 and pulse (or momentarily ground) J3 pin 9.							
	2). Ground J3 pins 13, 14, 15 and 16. Check Pulse J3 pin 9		PI-1		A1A11XA11-2 3	Pulses L→H	A3A1	A1A6
	Repeat 1) and 2). Check Pulse J3 pin 9		PI-2		A1A11XA11-2 37	Pulses L→H	A3A1	A1A6
	Repeat 1) and 2). Check Pulse J3 pin 9		PI-4		A1A11XA11-2 22	Pulses L→H	A3A1	A1A6
	Repeat 1) and 2). Check Pulse J3 pin 9		PI-8		A1A11XA11-2 28	Pulses L→H	A3A1	A1A6
4	Remote control system is completely inoperative.							
	Ground J3 pin 5. Check		LCL		A3A1U1 pin 5	L	cont.	A3A2
	Check		LCL		A1A11XA11-2 29	L	cont.	A3A1
			RMT		A1A4XA4-1 6	H	cont.	A1A3

Table 8-30. Remote Control Problems (6 of 7)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
4	Cont'd If the front panel remote indicator is not on and panel controls are functional Pulse J3 pin 9							A1A1
	Check		CMND T		A3A2U1 pin 13	Pulses H→L	cont.	A3A2
			CMND T		A3A11XA11-2 32	Pulses H→L	cont.	A3A1
	Remove the ground from J3 pin 5. Press STEP ↑ one time. Ground J3 pin 5 again Check		F3		A1A4XA4-1 A	H		
	Pulse J3 pin 9					H→L	cont.	A1A2
	Ground J3 pins 13, 14, 15 and 16 and Pulse J3 pin 9. Check		D1-8		A3A1U2 pin 1	H	cont.	A3A2
			D1-4		A3A1U2 pin 14	H	cont.	A3A2
			D1-2		A3A1U2 pin 11	H	cont.	A3A2
			D1-1		A3A1U2 pin 8	H	cont.	A3A2
			CMND P		A1A11XA11-2 35	H		
	Pulse J3 pin 9					Pulses H→L	cont.	A3A1
			F10		A1A4XA4-2 M	L		
	Pulse J3 pin 9					Pulses L→H	cont.	A1A2
	Ground J3 pins 28, 29, 30 and 31 and pulse J3 pin 9		D2-8		A3A1U4 pin 1	H	cont.	A3A1
			D2-4		A3A1U4 pin 14	H	cont.	A3A1
			D2-2		A3A1U4 pin 11	H	cont.	A3A1
			D2-1		A3A1U4 pin 8	H	cont.	A3A1
	Pulse J3 pin 9 for each of the following checks		RMT 8		A1A11XA11-2 24	Pulses H→L	cont.	A3A1
			RMT 4		A1A11XA11-2 27	Pulses H→L	cont.	A3A1

Table 8-30. Remote Control Problems (7 of 7)

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
4	Cont'd							
			RMT 2		A1A11XA11-2 23	Pulses H→L	cont.	A3A1
			RMT 1		A1A11XA11-2 20	Pulses H→L	cont.	A3A1
	Remove grounds from J3 pins 28, 29, 30 and 31. Ground J3 pins 13, 14, 15 and 16 and pulse J3 pin 9 for each of the following checks.		RMT 8		A1A11XA11-2 24	Pulses H→L	cont.	A3A1
			RMT 4		A1A11XA11-2 27	Pulses H→L	cont.	A3A1
			RMT 2		A1A11XA11-2 23	Pulses H→L	cont.	A3A1
			RMT 1		A1A11XA11-2 20	Pulses H→L	cont.	A3A1
	If all above checks are OK						A1A2	

Table 8-31. Harmonics Excessive Below 1300 MHz

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
	Check Doubler line				A1A11XA11-1 26	H	A1A6*	86603A
	*Check continuity of line to plug-in.							

Table 8-32. Output Frequency is Half Indicated Frequency Above 1300 MHz

Step	Symptom or Instruction	State Succession	Check Instruction	If Next State Wrong - Check	Test Point Location	Logic Level	Repair or Replace	
							If OK	If Wrong
	Check DBL				A1A11XA11-1 26	L	A1A6	cont.
	Put A1A7 on Extender Board		PILIM		A1A7XA7-1 D	L	A1A6	cont.
			13GL		A1A7XA7-1 4	H	A1A6	cont.
			16LIM		A1A7XA7-2 P	L	A1A6	cont.
			OPID-1		A1A7XA7-1 3	H	*	A1A7
			OPID-2		A1A7XA7-1 C	L	*	A1A7
			OPID-4		A1A7XA7-1 B	H	*	A1A7
	*Plug-in or wiring from DCU to Plug-in.							

Table 8-33. Troubleshooting Option 005 Interface Circuits (1 of 2)

Step	Procedure	Take the following action or proceed to step shown
1	Check the instrument in the LOCAL mode as shown in Section III.	If the instrument does not operate properly proceed to Step 2. If the instrument operates properly proceed to Step 4.
2	Check LCL/RMT line on A3A2U9 pin 9.	If the level is high refer to the RF Section Troubleshooting. If level is low proceed to Step 3.
3	Check REN-H at A3XA5 pin 5.	If the level is high A3A2 is defective. If the level is low check the external controller or cabling.
4	Check +5V at A3XA4 pin L.	If the voltage is not correct, refer to Table 8-6. If the voltage is correct proceed to Step 5.
5	Check the 2 MHz input clock on A3A1.	If the 2 MHz clock is not present refer to the reference section troubleshooting tables. If the clock is present proceed to Step 6.
6	Check Center Frequency programming for both the mainframe and Plug-in.	If just Plug-in programming is defective, proceed to Step 7. If all programming modes are defective, proceed to Step 8.
7	Check to see if only Plug-in programming is defective.	If just Plug-in programming is bad proceed to Step 7-a. Otherwise proceed to Step 7-b, then Step 7-c.
7-a	Check PICK-L on A3A1U5 pin 8 for a burst of clock pulses when the Plug-in is addressed.	If the clock pulses are present proceed to Step 7-d. If the clock pulses are not present, trouble is in the DCU.
7-b	If only CF is defective, program a CF and check RMT CF-L at A3A1U4 pin 10.	If RMT CF-L steps low, trouble is in the DCU. If RMT CF-L does not step low, A3A1 is defective.
7-c	If only CF is defective program a CF Step ↑ and check level at A3A1U4 pin 3. Program a CF Step ↓ and check level at A3A1U4 pin 2.	If Step ↑ goes low, continue with test. If Step 7-c does not go low, A3A1 is defective. If Step ↓ goes low, trouble is in the DCU. If Step 7-c does not go low, trouble is in A3A1 assembly.
7-d	Check the output clocks to the plug-ins. A burst of clock pulses should appear on A3A1U5 pins as listed below: U5 pin 10 — FM CAL U5 pin 13 — AM/FM% U5 pin 4 — AM/FM Function U5 pin 1 — RF Attenuator	If any of the clocks do not appear verify that programming is correct. If the burst of address pulses does not appear for any function, A3A1 is defective.
8	If all programming modes are defective, remove the A3A2 assy and check the jumper pins for the following configuration: 1 — H 2 — H 3 — L 4 — L 5 — H } Normal Code for 8660 (HP-IB)	If jumper pins are not as shown repair and replace the A3A2 Assy. If the jumper pins are correctly placed proceed to Step 9.

Table 8-33. Troubleshooting Option 005 Interface Circuits (2 of 2)

Step	Procedure	Take the following action or proceed to step shown
9	With an external controller enter a correct call-up address. Check A3A2U12 pin 8 MLA-L for correct action (Refer to SS 39).	If the circuit does not function properly, A3A2 is defective. If the circuit functions properly proceed to Step 10.
10	With an external controller program the 8660 to unlisten. Make the following checks on A3A2U9: Address F/F pin 9 — H pin 8 — L Remote F/F pin 5 — RMT-H pin 6 — RMT-L	If the address flip-flop is not functioning properly check A3A2U9 pin 13-H. If A3A2U9 pin 13 is high proceed to Step 10-a, if low, proceed to step 10-b. If checks are OK proceed to Step 11
10-a	Check A3A2U3 pins 4, 5-H.	If pin 5 is low, A3A1 is defective.
10-b	Same as 10-a.	If the Remote F/F is not functioning properly in Step 10, or if Step 10-a pin 4 is not functioning properly, A3A2 or the EOP-L input from the controller is defective.
11	Same as Step 10	If the tests in Step 10 are as shown, check A3A2 U2 pin 6-L and pin 11-H. If either or both checks are bad, proceed to Step 11-a. If both checks are good proceed to Step 11-b.
11-a	Check A3A2U3 pin 3 (ADR-H). It should go high after the Synthesizer address command.	If ADR-H does not go high, A3A2 is defective.
11-b	If Step 11-a checks properly check A3A2U1 pin 3 (INSL-L). It should go high during Synthesizer address and data commands.	If INSL-L does not go high when it should, A3A2 is defective. If INSL-L functions properly, proceed to Step 12.
12	Check A3A1U9 pin 6 CMDT-L. It should go low during the data transfer address command.	If this point does not switch low, A3A1 is defective. If it does switch low, proceed to Step 12-b.
12-b	Check A3A1U4 pin 10 for the RMT CF-L when CF is addressed and during the transfer command.	If this point does not switch low, A3A1 is defective. If it does switch low, trouble is in the DCU.

Table 8-34. Troubleshooting the Reference Section (1 of 2)

Test Equipment Required:

Oscilloscope (with 10:1 divider probes) . . .	HP180A/1801A/1821A
VLF Comparator	HP 117A
Spectrum Analyzer	HP 140/8554L/8552
Electronic Counter	

PROCEDURE:

1. Internal Reference Accuracy Adjustment (see Figure 5-3), (allow adequate warmup time).

2. Use the Digital Voltmeter to verify the presence of dc operating voltages at all assemblies before beginning tests. Proceed to next step.

3. Disconnect the REF INPUT cable from A4A2. Use the Spectrum Analyzer and the counter to verify the presence of the reference signal at the cable output (10 MHz, at least +5 dBm).

4. Set the rear panel REFERENCE switch to EXT and apply a 1 Vrms 10 MHz signal to the reference INPUT. Recheck the signal at the end of the cable to the A4A2 assembly.

5. Signal is present — A22 assembly is defective. Order replacement or refer to Service Sheet and repair as necessary.

6. Set the rear panel REFERENCE switch to INT and check the output of the A21 reference oscillator — signal is present (check cable to A21) — signal is not present — A21 is defective. Order a replacement unit.

7. Use the Spectrum Analyzer and the Counter to verify the presence of the 100 MHz signal at the A4Q4 100 MHz output. Should be exactly 100 MHz, at least +10 dBm. Amplitude not as specified, A4A4 Assembly is defective. Order replacement assembly or refer to Service Sheet 3 and repair as required.

7-a. Frequency is not as specified. Remove the covers from A4A3 and A4A2. Use an oscilloscope and a Counter to verify the presence of the 20 MHz input to A4A3. Should be 20 MHz ± 1 MHz and at least 300 mV p-p. A4A4 assembly is defective. Order replacement assembly or refer to Service Sheet 3 and repair as required.

7-b. Use an oscilloscope and a counter to verify the presence of the 20 MHz output from the A4A3 assembly. Should be 20 MHz ± 1 MHz and at least 2V p-p — frequency or level is not as specified. A4A3 assembly is defective. Order a replacement assembly or refer to Service Sheet 3 and repair as required.

7-c. Connect the oscilloscope to A4TP1. The oscilloscope should display a 20 nanosecond pulse at least 2V p-p. Pulse is present as specified.

7-d. Use the DVM to check the dc level at the A4A2 "VCO" lead. Voltage should be about +12 to +14 volts. Voltage is as specified.

7-e. Connect the counter to the 20 MHz OUTPUT from the A4A4 assembly. Verify that A4A4C2 can be adjusted to 20 MHz ± 5 kHz.

NOTE

If the outputs from the A4A2 assemblies as specified in 7-c, 7-d and 7-e are not as specified, order replacement assemblies or refer to Service Sheet 3 and repair as required.

7-f. Adjustment called for in step 7-e cannot be made as per specifications called for in test 7-e — A4A4 assembly is defective. Order replacement assembly or refer to Service Sheet 3 and repair as required.

Table 8-34. Troubleshooting the Reference Section (2 of 2)

8-a.	If the amplitude and frequency are as specified in test 7 use the Spectrum Analyzer and the Counter to check the 500 MHz output from the A4A4 assembly. Should be exactly 500 MHz and at least +3 dBm. — Frequency or level is not as specified. A4A4 assembly is defective. Order an A4A4 assembly or refer to Service Sheet 3 and repair as required.
8-b.	If the signal is as specified in step 8-a, use the Spectrum Analyzer and the Counter to check the 20 MHz output from the A4A4 assembly. Should be exactly 20 MHz and at a level between —3 and —6 dBm.
8-c.	Frequency or level is not as specified. A4A4 assembly is defective. Order a replacement assembly or refer to Service Sheet 3 and repair as required.
8-d.	If the signal is as specified use the Oscilloscope to check the 10 MHz output from the A4A4 assembly. Level should be greater than 1.5 V p-p. Use the counter to check the frequency. Frequency should be exactly 10 MHz. If frequency or level is not as specified, A4A3 assembly is defective. Order a replacement assembly or refer to Service Sheet 3 and repair as required.
8-e.	If the signal is as specified in 8-d, use the oscilloscope and counter to check the reference outputs from the A4A1 assembly. The 2 MHz, 400 kHz, and both 100 kHz signals should be greater than 2V p-p.
8-f.	Frequency or level is not as specified. Use an oscilloscope to check 10 MHz input to the A4A1 assembly from the A4A3 assembly. Level should be greater than 1.5V p-p. Signal is not as specified — A4A3 assembly is defective. Order replacement assembly or refer to Service Sheet 4 and repair as required. Signal is defective — order replacement assembly or refer to Service Sheet 2 and repair as required.
8-g.	All signals from A4A1 assembly are correct. Reference loop is functioning properly.

NOTE

If a malfunction is found and corrected in the Reference Section, perform all of the alignment instructions for the Reference Section which appear in Section V.

Table 8-35. High Frequency Loop Troubleshooting (1 of 3)

Test Equipment Required:

- Frequency Counter
- Digital Voltmeter
- Pulse Generator
- Spectrum Analyzer
- Signal Generator/Sweeper
- Oscilloscope (with 10:1 divider probes)
- Logic Analyzer

NOTE

The HP Analyzer may not be readily available. If it is not, other instruments may be substituted from Table 1-2 at the expense of additional funds and "out-of-service" time.

Table 8-35. High Frequency Loop Troubleshooting (2 of 3)

PROCEDURE:

1. Check that keyboard digit information is reaching the remote input and the HF Loop input. The MAN TP. should be grounded to enable using a single clock pulse until KDN-H is released. This enables the KDN-H to be held until adequate time has elapsed to complete the specified test.

   Use the Spectrum Analyzer and a Counter to verify that the output at the rear (remote) connector of the A4A5 assembly is about +13 to +15 dBm at the frequencies shown.

Center Frequency Settting in MHz	Center Output MHz	Input Logic Level EDCBA pins
0 0 0	450.000000	00000
0 1 0	440.000000	00001
0 2 0	430.000000	00010
0 3 0	420.000000	00011
0 4 0	410.000000	00100
0 5 0	400.000000	00101
0 6 0	390.000000	00110
0 7 0	380.000000	00111
0 8 0	370.000000	01000
0 9 0	360.000000	01001
1 0 0	*350.000000	10000

*This frequency not used when RF Section with >110 MHz maximum Center Frequency is used.

   If the frequencies are not correct use the DVM to check the logic levels at the A4A6 "A", "B", "C", "D" and "E" inputs. For frequencies shown in this Table logic levels should be as shown in the level column. 1 = high, about +3V.

2. All frequencies and levels are as specified. HF Loop is functioning properly.

3. Output is low or there is no output. A4A5 is defective. Order replacement assembly or refer to Service Sheet 3 and repair as required.

4. Input logic levels are not as specified. Check interconnections to the interface circuit. If connections are good, trouble is in the interface circuits of the DCU. Refer to Table 8-8.

5. Levels are as specified in test 1 but frequencies are not. Use the Oscilloscope and Counter to check the 10 MHz input to the A4A7 assembly. Should be greater than 1-5V p-p. If all frequencies and levels are as specified in Test 1 the HP Loop circuits are functioning properly. Proceed to Table 8-35.

6. If frequencies or levels are not as specified, trouble is in the Reference Section or cable A4W2. Check the cable, then return to the beginning of this test. If the cable is good, recheck the Reference Section.

7. If frequency and level is as specified, open the HF phase lock loop by removing the cable from the A4A5 350–450 MHz VCO OUTPUT. Use the Oscilloscope or the DVM to check the dc level on the lead marked ∅ between the A4A6 and A4A7 assemblies, the level should be 0V ± 0.1V. If the dc level is not as specified, the A4A7 assembly is defective. Order a replacement assembly or refer to Service Sheet 5 and repair as required.

8. If dc level is as specified, refer to the first step in the HF Loop procedure and repeat the frequency portion of the test. Frequencies shown should be within ± 500 kHz. If the frequencies are not as specified, use the DVM to check the dc on the lead marked "freq" between the A4A5 and A4A6 assemblies. With

Table 8-35. High Frequency Loop Troubleshooting (3 of 3)

	center frequencies at 0 MHz reading should be −34 Vdc. At 100 MHz it should be approximately −7 Vdc. If levels are not as specified, refer to Section V and perform the adjustment procedure.
8-a.	If the adjustment procedure does not correct the problem, use the DVM to measure the lead "comp" in the A4A6 assembly. Should be about −37V to −38V.
8-b.	If the levels are correct from test 8 or the voltage is not as specified in 8-a, the A4A5 assembly is defective. Order a replacement assembly or refer to Service Sheet 6 and repair as required.
8-c.	If the voltage is as specified in 8-a the A4A6 assembly is defective. Order a replacement assembly or refer to Service Sheet 4 and repair as required.
9.	Frequencies are as specified in test 8. Close the HF Loop by reconnecting the cable between the A4A6 and A4A7 assemblies. Use the Oscilloscope to check 2 to 3V p-p beat note at the lead labeled Ø on the A4A7 assembly. **NOTE** The beat frequency depends on how far the high frequency is out of lock.
9-a.	The beat note is present. The A4A6 assembly is defective. Order a replacement assembly or refer to Service Sheet 5 and repair as required.
9-b.	The beat note is present. The A4A7 assembly is defective. Order a replacement assembly or refer to Service Sheet 5 and repair as required. **NOTE** If repairs are required in any portion of the HF Loop perform the adjustment procedures outlined in Section V of this manual.

NOTES

1. The following five troubleshooting tables are arranged in the sequence of the output to the RF Section back to the inputs from the Reference Section. These Loops are commonly referred to as the LF (Low Frequency) Loops; all are physically mounted on the A2 Mother Board Assembly.

2. Since some of these notes are used in several places, they appear in Table 8-39 to avoid repetition.

3. Locations of the assemblies within these loops are shown in Figure 8-114.

Table 8-36. Summing Loop 1 Troubleshooting

Reference: Service Sheets 15, 16 and 17.

Test Equipment Required (from Table 1-2):
- Digital Voltmeter
- Oscilloscope (with 10:1 probes)
- Frequency Counter

Step	Procedure	Take the following action or proceed to step shown
1	Use the Oscilloscope and the Frequency Counter to check the N1 output at A2XA17-1 pin 2. Level should be greater than 0.4V p-p. For formula to calculate frequency see Note 5 of Table 8-39.	If the frequency is not as specified see Note 2 of Table 8-39 and proceed to Step 2. If the frequency and level are as specified, proceed to Step 3.
2	Proceed to Table 8-38 N1 Loop Trouble-shooting.	Perform tests shown in Table 8-38.
3	Use the plug provided to ground A2TP14. Use the Frequency Counter to check the SL1 output at A2TP22.	See Note 6 of Table 8-39 to calculate frequency output. Frequency should be as calculated, ± 150 kHz. If frequency is not as calculated, proceed to Step 4 (also see Note 2 of Table 8-39). If frequency is as calculated, proceed to Step 5.
4	Use the DVM to check the dc levels at A2XA18-2 pin R. The level is controlled by digits 5, 6 and 7. With the digits set to 000, the level should be −25.5V (typical). With the digits set to 999, the level should be about −5.4V. Intermediate steps should be about .02V.	If the level is not as specified the A18 assembly is defective. Order a replacement assembly or refer to Service Sheet 16 and repair as required. If the levels are as specified the A19 assembly is defective. Order a replacement or refer to Service Sheet 16 and repair as required.
5	Use the Frequency Counter to check the frequency at A2XA19 −1 pin 2. The frequency should be as calculated for Step 3.	If frequency is not as calculated the A19 assembly is defective. Order a replacement or refer to Service Sheet 17 and repair as required. If the frequency is correct, proceed to Step 6.
6	Use the Frequency Counter to check the frequency at A2TP19. The frequency should be the difference frequency between the N1 and SL1 outputs. If the frequency is as specified, trouble is in the Frequency Extension Module or the RF Section.	If the frequency is not as specified the A18 assembly is defective. Order a replacement or refer to Service Sheet 16 and repair as required. If the frequency is as specified, the A15 assembly is defective. Order a replacement or refer to Service Sheet 15 and repair as required.

Table 8-37. Summing Loop 2 Troubleshooting

Reference: Service Sheets 13 and 14

Test Equipment Required (from Table 1-2):
Oscilloscope (with 10:1 probes)
Frequency Counter

Step	Procedure	Take the following action or proceed to step shown
1	Use the Oscilloscope and the Frequency Counter to check the SL2 output at A2TP6. Level should be greater than 1V p-p. For the formula to calculate frequency see Note 1 of Table 8-39.	If the frequency and level are as specified, recheck Summing Loop 1 (Table 8-34). If the frequency and level are correct proceed to Step 2.
2	Use the Oscilloscope and the Frequency Counter to check the N2 output at A2XA13-1 pin 4. Level should be greater than 275 mV p-p. Refer to Note 3 of Table 8-39 for formula to calculate frequency.	If the frequency and level are not as specified, proceed to the N2 Loop Troubleshooting, Table 8-37. If the frequency and level are as specified, proceed to Step 3.
3	Use the Oscilloscope and the Frequency Counter to check the N3 output at A2XA8-1 pin 4. Level should be greater than 2V p-p. Refer to note 4 of Table 8-39 for formula to calculate frequency.	If the frequency and level are not as specified, proceed to the N3 Loop Troubleshooting, Table 8-38. If the frequency and level are as specified proceed to Step 4.
4	Use the plug provided to ground A2TP8. Use the Frequency Counter to check the SL2 output at A2XA11-1 pin 2. Refer to Note 1 of Table 8-39 for formula to calculate frequency. Should be ± 150 kHz.	If the frequency is as specified the A12 assembly is defective. Order a replacement assembly or refer to Service Sheet 13 and repair as required. If the frequency is not correct proceed to Step 5.
5	Use the Frequency Counter to check the output at A2TP6.	If the frequency is as specified in Step 4 the A11 assembly is defective. If the frequency is not as specified in Step 4 proceed to Step 6.
6	Remove the A12 assembly and repeat the test. The frequency should be the same as that calculated for Step 4.	If the frequency is as specified the A12 assembly is defective. Order a replacement assembly or refer to Service Sheet 13 and repair as required. If the frequency is not as specified the A11 assembly is defective. Order a replacement assembly or refer to Service Sheet 14 and repair as required.

Table 8-38. N3 Loop Troubleshooting

Reference: Service Sheets 11 and 12.

Test Equipment Required (from Table 1-2):
Oscilloscope (with 10:1 probes)
Frequency Counter

Step	Procedure	Take the following action or proceed to step shown
1	Use the Oscilloscope and the Frequency Counter to check the N3 output at A2XA8-1 pin 6. The level should be greater than 0.5V p-p. Frequency should be the same as that in Table 8-35 X 10.	If the frequency and level are as specified, the A8 assembly is defective. Order a new assembly or refer to Service Sheet 12 and repair as required. If the frequency is not as specified, proceed to step 2.
2	Use the plug provided to ground A2TP4. Use Frequency Counter to check the frequency at A2XA8-1 pin 6. The frequency should be the same as Step 1 ± 250 kHz. Remove the ground plug.	If the frequency is not as specified the A8 assembly is defective. Order a replacement or refer to Service Sheet 12 and repair as required. If the frequency is as specified proceed to Step 3.
3	Use the Oscilloscope and the Frequency Counter to check the 100 kHz input at A2XA10-1 pin 2. The signal should be exactly 100 kHz at about 2.5V p-p.	If the frequency is not as specified check the interconnection to the reference section. If the frequency is as specified the A10 assembly is defective. Order a replacement assembly or refer to Service Sheet 11 and repair as required.

Table 8-39. N2 Loop Troubleshooting (1 of 2)

Reference: Service Sheets 9 and 10.

Test Equipment Required (from Table 1-2):
Oscilloscope (with 10:1 probes)
Frequency Counter

Step	Procedure	Take the following action or proceed to step shown
1	If the frequency was not as specified in Step 2 of Table 8-35 use the plug provided to ground A2TP12 and use the Frequency Counter to check the N2 output at A2XA13-1 pin 4. The frequency should be as specified in the step shown above ± 250 kHz.	If the frequency is not as specified the A13 assembly is defective. Order a replacement assembly or refer to Service Sheet 10 and repair as required. If the frequency is as specified proceed to Step 2.
2	Use the Oscilloscope and the Frequency Counter to check the frequency and level at A2XA13-1 pin 6. The frequency should be as shown for step 1. The level should be about 0.4V p-p.	If the frequency is not as specified the A13 assembly is defective. Order a replacement assembly or refer to Service Sheet 10 and repair as required. If the frequency is as specified proceed to Step 3.

Table 8-39. N2 Loop Troubleshooting (2 of 2)

Step	Procedure	Take the following action or proceed to step shown
3	Use the Oscilloscope and the Frequency Counter to check the frequency and level at A2XA14-1 pin 2. The frequency should be exactly 100 kHz and the level should be about 2V p-p.	If the frequency is not as specified check the interconnection wiring to the reference section. If the frequency and level are as specified the A14 assembly is defective. Order a new assembly or refer to Service Sheet 9 and repair as required.

Table 8-40. N1 Loop Troubleshooting

Reference: Service Sheets 7 and 8.

Test Equipment Required (from Table 1-2):
- Oscilloscope (with 10:1 probes)
- Frequency Counter

Step	Procedure	Take the following action or proceed to step shown
1	If the frequency was not as calculated in Step 1 of Table 8-34 use the Frequency Counter to check the output at A2XA17-1 pin 2. Frequency should be as calculated in Step 1 of Table 8-34 ± 250 kHz.	If the frequency is not as specified the A17 assembly is defective. Order a replacement assembly or refer to Service Sheet 8 and repair as required. If the frequency is correct proceed to Step 2.
2	Use the Frequency Counter to check the frequency at A2XA17-1 pin D. Should be the same as calculated for Step 1.	If frequency is not as specified the A17 assembly is defective. Order a replacement assembly or refer to Service Sheet 8 and repair as required. If the frequency is as specified proceed to Step 3.
3	Use the Oscilloscope and the Frequency Counter to check the input at A2XA16-1 pin 2. The input should be exactly 400 kHz at about 2.5V p-p.	If the frequency is not as specified check the interconnection wiring to the reference section. If the signal is as specified the A16 assembly is defective. Order a replacement assembly or refer to Service Sheet 7 and repair as required.

Table 8-41. Low Frequency Loops Notes (1 of 2)

1. The output frequency of the SL2 loop may be determined by adding the N2 output frequency to the divider-by-ten output of the N3 loop assembly. EXAMPLE: Programmed frequency is 107.654321 MHz. 24.36 + 0.2079 = 24.5679. Output frequency is 24.5679 MHz.
2. If there is no RF output, or if the RF level is low, the trouble is in the circuit board containing the voltage controlled oscillator and output circuits.
3. The output frequency of the N2 loop is equal to 29.79 MHz less the setting of center frequency digits 5, 4, and 3. EXAMPLE: center frequency set to 107.654321 MHz, 29.79 − 5.43 = 24.36. Output frequency is 24.36 MHz.

Table 8-41. Low Frequency Loops Notes (2 of 2)

4. The output frequency of the N3 loop is equal to 2.100 MHz less the setting of center frequency digits 2 and 1. EXAMPLE: center frequency set to 107.654321 MHz (2.100 — .021 = 2.079). Output frequency is 2.079 MHz.

5. The output frequency of the N1 loop is equal to 29.7 MHz less the setting of center frequency digits 7 and 6. EXAMPLE: center frequency set to 107.654321 MHz, 29.7 — 7.6 = 22.1. Output frequency is 22.1 MHz.

6. The output frequency of the SL1 loop may be determined by subtracting the last seven digits of the programmed frequency from 30.000000 — 7.654321 = 22.345679. Output frequency is 22.345679 MHz.

Table 8-42. Index to Assembly Illustrations (1 of 2)

Assy No.	Description	SS No.	(Photo) Fig. 8-
A1	Digital Control Unit	18 thru 36	50, 114
A1A1	P/O Switch Control Assy (1 of 2)	19	52
A1A1	P/O Switch Control Assy (2 of 2)	20	54
A1A2	P/O Key Control Assy (1 of 2)	21	58
A1A2	P/O Key Control Assy (2 of 2)	22	60
A1A3	P/O Readout Control Assy (1 of 2)	23	62
A1A3	P/O Readout Control Assy (2 of 2)	24	64
A1A4	P/O ROM Input Assy (1 of 2)	25	66
A1A4	P/O ROM Input Assy (2 of 2)	26	68
A1A5	P/O ROM Output Assy (1 of 2)	27	70
A1A5	P/O ROM Output Assy (2 of 2)	28	72
A1A6	P/O Register Assy (1 of 3)	29	74
A1A6	P/O Register Assy (2 of 3)	30	76
A1A6	P/O Register Assy (3 of 3)	31	78
A1A7	Arithmetic Logic Unit	32	80
A1A8	Sweep Count Assy	33	82
A1A9	A Register Assy	34	84
A1A10	Output Register Assy	35	86
A1A11	DCU Mother Board		110
A1A12	Numeric Readout Assy	36	80
A1A13	Board Assy Annunciator Block	Various	107
A1A14	Switch Assy Sweep	Various	
A1A15	Switch Assy Keyboard	21	56, 57
A1A16	Switch Assy Manual Mode	20	
A1A17	Tuner Assy Manual Mode	20	
A2	Board Assy Interconnection	—	108, 109

Table 8-42. Index to Assembly Illustrations (2 of 2)

Assy No.	Description	SS No.	(Photo) Fig. 8-
A3	Interface Assy	41	114
A3A1	Front Interface Assy	37, 41	92, 98
A3A2	Read Interface Assy	38, 41	94, 96
A4	Loop Assy RF	2, 3, 4, 5, 6	2, 3, 4, 5, 6, 23, 24, 119
A4A1	Reference Divider Assy	2	13
A4A2	Reference Phase Detector	2	12
A4A3	Reference Divide-by-Two	3	16
A4A4	Reference VCO Assy	3	15
A4A5	VCO and Amplifiers	6	22
A4A6	Pretuning Assy	4	18
A4A7	Phase Detector Assy	5	20
A5	Board Assy Rectifier	41	103
A6	Fan Assy, 400 Hz (Opt. 003)	—	100
A6	Fan Assy, 60 Hz STD	—	100
A6A1	Pre-Regulator Assy	41	101, 102
A7	Power Line Module/Filter	41	114
A8	N3 Oscillator Assy (except Opt 004)	12	38
A9	Cable Assy Loop Box	42	114, 111
A10	N3 Phase Detector	11	36
A11	SL2 Oscillator Assy	14	42
A12	SL2 Detector	13	40
A13	N2 Oscillator	10	34
A14	N2 Phase Detector	9, 9a	30, 32
A15	SL1 Detector	15	44
A16	N1 Phase Detector	7	26
A17	N1 Oscillator	8	28
A18	SL1 Mixer	16	46
A19	SL1 Oscillator	17	48
A20	Rectifier Assy	41	104
A21	Crystal Oscillator	2	10
A22	Switch Assy Reference	2	11
A23	Wiring Harness	Various	114

8-87. PRINCIPLES OF OPERATION

8-88. The following discussion illustrates the basic principles of operation of the Model 8660 System. More detailed information about principles of operation for the phase lock loops and the Digital Control Unit appears on Service Sheets 1 and 18 respectively. In addition, detailed information to the circuit level is provided on individual Service Sheets.

8-89. General. The Model 8660 was designed to provide precise digitally controlled output frequencies utilizing indirect synthesizer techniques. Unlike conventional signal generators, the output frequency is not ± some percentage factor: the output frequency of the Model 8660 is exactly that selected (the only factor which must be considered here is the accuracy and stability of the reference source). The output frequency range is determined by the RF Section plug-in being used.

8-90. All of the phase lock loops are phase locked, directly or indirectly, to a very stable temperature controlled internal 10 MHz source or to an external reference source. (The term "indirect synthesis" as used in paragraph 8-89 refers to a synthesizer that derives all frequencies from a single source, as opposed to a "direct synthesizer" which uses different crystal oscillators for each frequency generated.)

8-91. Reference Section. A 100 MHz voltage controlled oscillator which is phase locked to an internal reference, or to an external reference source, serves as a master oscillator. The internal reference is a 10 MHz standard temperature controlled crystal oscillator. The external reference source may be 4 or 10 MHz at 0.2 to 2V rms. All of the outputs from the reference section are derived from the 100 MHz master oscillator.

8-92. The reference section provides the following outputs:

a. 500 MHz to the RF Output Section.

b. 100 MHz to the RF Output Section. This 100 MHz is coupled out of the RF Section for use in other circuits.

c. 20 MHz to the Modulator Section. This 20 MHz is coupled out of the Modulator Section for use in the RF Section and the Frequency Extension Module.

d. 10 MHz to the High Frequency Loop phase detector for use as a reference signal.

e. 2 MHz to the Digital Control Unit to be used as a clock.

f. 400 kHz to the N1 loop for a reference signal.

g. Separate 100 kHz signals to the N2 and N3 loops for reference signals.

NOTE

In the following discussion the terms digit 1, digit 2, through digit 10 are used to refer to the 10 digits of frequency selection. Digit 1 refers to the least significant digit (1 Hz increments). Digit numbers progress from right to left until digit 10 refers to the most significant digit (1 GHz increments).

8-93. High Frequency Loop. The HF loop contains a voltage controlled oscillator which provides eleven discrete outputs between 350 and 450 MHz in 10 MHz increments when the Model 86601A RF Section is used. When other RF Sections are used the output of the HF loop will still step in 10 MHz increments, but there will be more than, or less than, eleven steps.

8-94. Pretuning tunes the voltage controlled oscillator to a point within the capture range of the phase lock loop and the phase detector then causes the loop to be phase locked to the 10 MHz reference signal at the exact frequency selected.

8-95. When a 0.01 to 110 MHz RF Section such as the HP Model 86601A is used, the output of the HF loop is applied to the RF Section. When a higher frequency RF Section is used, the output of the HF loop is applied to the Frequency Extension Module.

8-96. N1 Phase Lock Loop. The N1 loop provides an output to Summing Loop 1 (SL1) that is between 19.8 and 29.7 MHz in 100 kHz steps. The N1 voltage controlled oscillator is roughly pretuned by a digital to analog converter which is controlled by digits 6 and 7.

8-97. The N1 sampling phase detector is driven by pulses derived from the N1 voltage controlled oscillator through a programmable divider and a pulse shaper. The programmable divider is controlled by digits 6 and 7. When the loop is phase locked the 400 kHz reference input is sampled at a 100 kHz rate. The error voltage from the phase detector is summed with the digital to analog converter output to precisely control the voltage controlled oscillator frequency.

NOTE

In Option 004 instruments the N2A programmable divider is used. The N2 loop output is then between 20.01 and 30.00 MHz.

8-98. N2 Phase Lock Loop. The N2 loop provides an output to Summing Loop 2 (SL2) that is between 19.80 and 29.79 MHz in 10 kHz steps. The N2 voltage controlled oscillator is roughly pretuned by a digital to analog converter which is controlled by digits 4 and 5.

8-99. The N2 sampling phase detector is driven by pulses derived from the N2 voltage controlled oscillator through a programmable divider and a pulse shaper. The programmable divider is controlled by digits 3, 4, and 5. When the loop is phase locked the 100 kHz reference signal input is sampled at a 10 kHz rate. The error voltage from the phase detector is summed with the digital to analog converter output to precisely control the voltage controlled oscillator.

8-100. N3 Phase Lock Loop. The N3 loop provides an output to Summing Loop 2 (SL2) that is between 2.001 and 2.100 MHz in 1 kHz steps. The N3 voltage controlled oscillator is roughly pretuned by a digital to analog converter which is controlled by digit 2.

8-101. The N3 sampling phase detector is driven by pulses derived from the N3 voltage controlled oscillator through a programmable divider and a pulse shaper. The programmable divider is controlled by digits 1 and 2. When the loop is phase locked the 100 kHz reference signal is sampled at a 10 kHz rate. The error voltage from the phase detector is summed with the digital to analog converter output to precisely control the voltage controlled oscillator frequency.

NOTE

In Option 004 instruments Summing Loop 2 (SL2) is not used.

8-102. Summing Loop 2. SL2 provides an output to SL1 that is between 20.0001 and 30.0000 MHz in 100 Hz steps. The SL2 voltage controlled oscillator is roughly pretuned by a digital-to-analog converter which is controlled by digits 3, 4, and 5.

8-103. The output from the SL2 voltage controlled oscillator is also applied to a mixer where it is mixed with the output of the N2 loop. The output of this mixer is applied to one input of a digital phase detector through a pulse shaper. The other input to the digital phase detector is the divided by ten output of the N3 loop assembly in pulse form. When SL2 is phase locked the frequency ratio of the two inputs to the phase detector is always 1:1; the mixer output frequency must exactly match the divided by ten output of the N2 loop assembly (the pulses are received alternately).

NOTE

In Option 004 instruments the Summing Loop 1 output is from 20.0001 to 30 MHz.

8-104. Summing Loop 1. SL1 provides an output to the RF Section that is between 20.000001 and 30 MHz in 1 Hz steps. The SL1 voltage controlled oscillator is roughly pretuned by a digital to analog converter which is controlled by digits 5, 6, and 7.

8-105. The output from the SL1 voltage controlled oscillator is also applied to a mixer where it is mixed with the output of the N1 loop. The output of this mixer is applied to one input of a digital phase detector through a pulse shaper. The other input to the digital phase detector is the divided-by-one hundred output of the SL2 voltage controlled oscillator in pulse form. When SL2 is phase locked the frequency ratio of the two inputs to the phase detector is 1:1; the mixer output frequency must exactly match the divided by one hundred output of the SL2 voltage controlled oscillator (the pulses are received alternately).

8-106. Digital Control Unit (DCU). In the local mode all functions of the Model 8660 are controlled by the DCU. These functions are itemized and described in Section III of this manual.

8-107. Interface Circuits. The interface circuits provide the capability of operating the Model 8660 with the front panel controls (local mode), or by a remote programming device via a rear panel connector (remote mode).

8-108. RF Section. An RF Section plug-in is required to produce a useable rf output. Figure 8-11 shows a block diagram of the Model 8660. All plug-in sections are covered by separate manuals.

8-109. Modulation Section. If a modulation section is not available, it will be necessary to have an auxiliary section in the modulator compartment to complete necessary connections.

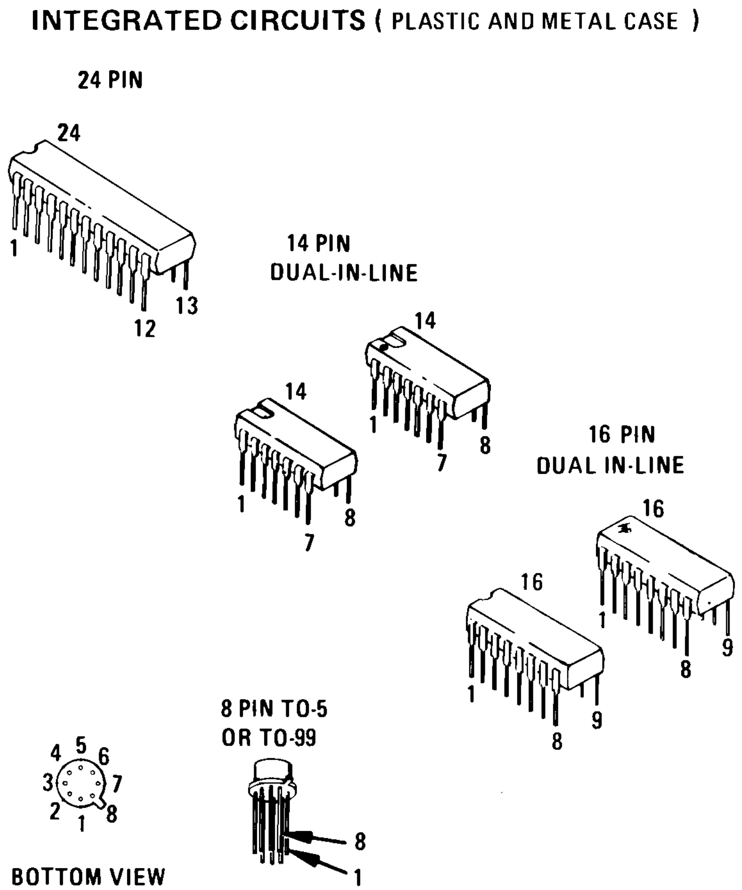


Figure 8-7. Integrated Circuit Packaging

Table 8-43. 8660 System

Mainframes	
8660A	Thumbwheel Frequency Control — Fully Programmable
8660B/C	Keyboard Frequency Control — Fully Programmable
Modulation Sections	
86631	External AM and Pulse
86632	AM/FM — Fully Programmable
86633	AM/FM (Phase-Locked FM Carrier) — Fully Programmable
86634	Phase Modulation — High Rates to 10 MHz
86635	Phase Modulation/FM — Fully Programmable
RF Sections	
86601	10 kHz to 110 MHz +13 dBm
86602	1 MHz to 1300 MHz +10 dBm
86603	1 MHz to 2600 MHz +7 dBm
Frequency Extension Module	
11661	Required for operation of the 86602 and 86603 RF Sections. Is installed internally in the mainframe. (Mainframe Option 100)

NOTE

This table and Figure 8-8 do not cover the entire 8660 system. The intent is to cover only the general capabilities of the system

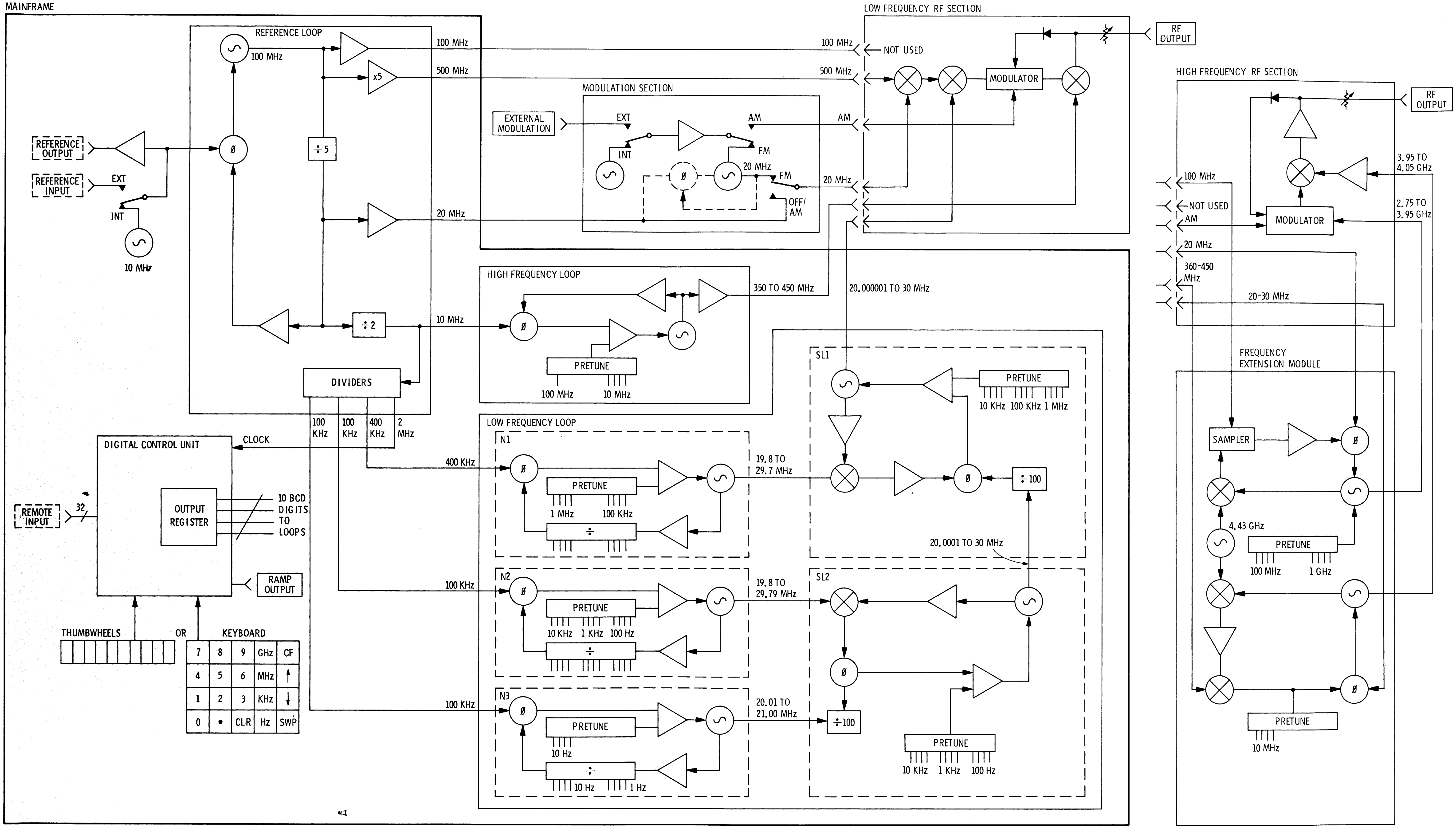


Figure 8-8. Model 8660C System Block Diagram

BLOCK DIAGRAM

General

The Hewlett-Packard Model 8660C is a signal generator which utilizes synthesizer techniques to produce precise RF output signals. These signals may be selected in increments as small as one Hz.

Each step in the generation of the output frequency is controlled by phase lock loops. This ensures that the output frequency is exactly that selected by front panel (or remote) controls.

All of the seven phase lock loops (five loops in option 004) are referenced to a single source. This source may be the internal temperature controlled crystal oscillator or an external frequency standard of 5 or 10 MHz.

The Model 8660C mainframe does not provide a direct RF output, except for the reference signal which may be used as a time base for external equipment. The signals generated within the mainframe are used in plug-in modules which utilize mixing techniques to provide the selected output RF signals.

Reference Loop

The reference loop consists of four circuit boards mounted in the A4 assembly. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 2 and 3.

All of the signals generated within the Model 8660C mainframe are derived from the 100 MHz master oscillator in the reference loop. The master oscillator is a voltage controlled oscillator which is phase locked to a stable reference (the 10 MHz INT or an EXT standard). The 100 MHz oscillator is located in the A4A4 assembly.

Also included in the A4A4 assembly are divide-by-five and multiply-by-five circuits. The outputs from the A4A4 assembly are 500 MHz, 100 MHz, and 20 MHz. The 20 MHz output from the A4A4 assembly is sampled in the reference loop phase detector to provide a phase correction signal to the master oscillator. The 20 MHz signal is also applied to the A4A3 assembly where it is divided by two to provide a 10 MHz signal for use in the A4A1 reference dividers and in the high frequency phase lock loop.

The reference loop input circuit (A4A2) converts the signal from the reference oscillator into sharp short-duration pulses to open a sampler gate which samples the 20 MHz signal from the A4A4 assembly. The sampled signal is used to generate an error signal which biases the varactor in the 100 MHz voltage controlled oscillator in the A4A4 assembly to maintain the phase locked condition.

The A4A1 assembly divides the 10 MHz input from the A4A3 assembly by five to provide a 2 MHz clock for the digital control unit. The 2 MHz signal is divided by five to provide a 400 kHz signal to the phase detector in the N1 loop. The 400 kHz is twice divided by two to provide 100 kHz signals to the phase detectors in the N2 and N3 loops.

High Frequency Loop

The HF loop consists of three circuit boards mounted in the A4 assembly. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 4, 5 and 6.

The HF loop provides digitally controlled RF signals between 350 and 450 MHz in precisely selected 10 MHz increments.

The sampling phase detector (A4A7) compares the voltage controlled oscillator (A4A5) output to a 10 MHz signal from the reference loop and provides an output to phase lock the voltage controlled oscillator to the reference signal. The phase detector assembly contains a pulse generator, a sampler and a signal processing circuit.

The frequency of the voltage controlled oscillator (A4A5) is roughly pretuned by a digital to analog converter located in the A4A6 assembly. The error signal from the A4A7 assembly is summed with the output of the digital to analog converter to maintain the phase locked condition. The A4A5 assembly also contains two identical three-stage amplifiers. These amplifiers serve as buffers to isolate any extraneous signals at their outputs from the oscillator. One of the amplifiers provides an output to the RF plug-in; the other output goes to the HF loop sampling phase detector.

The A4A6 pretuning circuit consists of a digital to analog converter which roughly pretunes the voltage controlled oscillator to the 10 MHz increment between 350 and 450 MHz selected by CF digits 8 and 9 of the front panel (or remote) controls. The pretuning cannot, by itself, set the voltage controlled oscillator frequency accurately; it does set the frequency within the capture range of the loop.

The A4A6 assembly also contains a summing circuit which sums the negative dc level from the digital to analog converter with the current from a +20 volt source and the output of the phase detector. The output from the summing circuit precisely controls the frequency of the voltage controlled oscillator.

Divide By N Loop N1

The purpose of the N1 loop is to generate digitally controlled RF signals in the range of 19.8 to 29.7 MHz in selectable 100 kHz increments. The voltage controlled oscillator is phase locked to a 400 kHz reference signal which is derived from the master oscillator in the reference loop. The output of the N1 loop is applied to summing loop 1.

The N1 loop circuits are mounted on two circuit boards, A16 and A17. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 7 and 8.

The A16 phase detector assembly contains a programmable divider, a sampling phase detector and a signal processing circuit.

The programmable divider divides by a number determined by CF digits 6 and 7 of the front panel (or remote) controls. The terminal count of the programmable divider is always 297. The actual number of cycles counted is determined by the count programmed into the divider prior to the start of each count cycle. The output of the programmable divider is always 100 kHz when the loop is locked.

The output frequency of the N1 loop may be determined by subtracting the CF digits 7 and 6 information from 29.7 MHz. As an example, if CF digits 7 and 6 are set for 3.4 MHz, the N1 output frequency will be 26.3 MHz (29.7 - 3.4).

The sampling phase detector uses the 100 kHz pulses from the programmable divider to sample the 400 kHz reference signal and provides an error output to the summing circuit in the A17 assembly.

The signal processing circuit consists of an operational amplifier with lead and lag compensation.

The A17 assembly contains a digital to analog converter, a voltage controlled oscillator and a summing circuit.

The digital to analog converter converts the digital inputs from CF digits 6 and 7 to a dc level which roughly pretunes the voltage controlled oscillator to a frequency within the capture range of the loop.

The summing circuit sums the current from the negative digital to analog converter source with current from a +20 volt source and the error signal from the phase detector to precisely control the voltage controlled oscillator frequency.

Divide By N Loop N2

The purpose of the N2 loop is to generate digitally controlled RF signals in the range of 19.80 to 29.79 MHz in selected 10 kHz increments.

NOTE

In option 004 instruments the N2 loop output is from 20.01 to 30.00 MHz in 10 kHz increments.

The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The output of the N2 loop is applied to summing loop 2 (summing loop 1 in option 004 instrument).

kHz reference signal which is derived from the master oscillator in the reference loop. The output of the N1 loop is applied to summing loop 1.

The N1 loop circuits are mounted on two circuit boards, A16 and A17. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 7 and 8.

The A16 phase detector assembly contains a programmable divider, a sampling phase detector and a signal processing circuit.

The programmable divider divides by a number determined by CF digits 6 and 7 of the front panel (or remote) controls. The terminal count of the programmable divider is always 297. The actual number of cycles counted is determined by the count programmed into the divider prior to the start of each count cycle. The output of the programmable divider is always 100 kHz when the loop is locked.

The output frequency of the N1 loop may be determined by subtracting the CF digits 7 and 6 information from 29.7 MHz. As an example, if CF digits 7 and 6 are set for 3.4 MHz, the N1 output frequency will be 26.3 MHz (29.7 - 3.4).

The sampling phase detector uses the 100 kHz pulses from the programmable divider to sample the 400 kHz reference signal and provides an error output to the summing circuit in the A17 assembly.

The signal processing circuit consists of an operational amplifier with lead and lag compensation.

The A17 assembly contains a digital to analog converter, a voltage controlled oscillator and a summing circuit.

The digital to analog converter converts the digital inputs from CF digits 6 and 7 to a dc level which roughly pretunes the voltage controlled oscillator to a frequency within the capture range of the loop.

The summing circuit sums the current from the negative digital to analog converter source with current from a +20 volt source and the error signal from the phase detector to precisely control the voltage controlled oscillator frequency.

Divide By N Loop N2

The purpose of the N2 loop is to generate digitally controlled RF signals in the range of 19.80 to 29.79 MHz in selected 10 kHz increments.

NOTE

In option 004 instruments the N2 loop output is from 20.01 to 30.00 MHz in 10 kHz increments.

The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The output of the N2 loop is applied to summing loop 2 (summing loop 1 in option 004 instrument).

SERVICE SHEET 1 (Cont'd)

The N2 loop circuits are mounted on two circuit boards, A13 and A14. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 9 (9A for option 004 instruments) and 10.

Operation of the N2 loop is virtually the same as operation of the N1 loop. The reference input is 100 kHz and the output of the programmable divider is always 10 kHz when the loop is locked. The digital inputs are from CF digits 3, 4 and 5 (or remote controls) and range from 000 to 999.

The programmable divider count always terminates in a count of 2979 (3000 in option 004 instruments). The output frequency in MHz of the oscillator may be calculated by subtracting the programmed digital input from CF digits 5, 4 and 3 from 2979 (3000 for option 004 instruments) and dividing the results by 100. Example: with CF digits 5, 4 and 3 set to 222 the output frequency will be 27.57 MHz ($\frac{2979\text{-}222}{100}$). (Option 004 $\frac{3000\text{-}222}{100}$ = 27.78 MHz.)

Divide By N Loop N3

NOTE

The N3 loop is not included in option 004 instruments.

The purpose of the N3 loop is to generate digitally controlled RF signals in the range of 20.01 to 21.00 MHz in selectable 10 kHz increments. The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The output from the N3 phase lock loop is divided by ten and the resulting 2.001 to 2.100 MHz (1 kHz steps) signal is applied to summing loop 2.

The N3 loop circuit is mounted on 2 circuit boards, A8 and A10. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 11 and 12.

Operation of the N3 loop is virtually identical to operation of the N1 and N2 loops. The reference signal is 100 kHz and the output of the programmable divider is always 10 kHz when the loop is phase locked. The digital inputs are from CF digits 1 and 2, and range from 00 to 99.

The programmable divider count always terminates in a count of 2100. The output frequency in MHz of the voltage controlled oscillator may be calculated by subtracting the programmed digital input from CF digits 2 and 1 from 2100 and dividing the result by 100. Example; with CF digits 2 and 1 set to 34, the output frequency of the voltage controlled oscillator will be 20.66 MHz ($\frac{2100\text{-}34}{100}$). Since the voltage controlled oscillator output is divided by 10, the output to summing loop 2 will be 2.066 MHz.

SERVICE SHEET 1 (Cont'd)

Summing Loop 2

NOTE

Summing Loop 2 is not included in option 004 instruments.

The purpose of SL2 is to generate digitally controlled RF signals in the range of 20.0001 to 30.0000 MHz in selectable 100 Hz increments. The output frequency of the SL2 voltage controlled oscillator is equal to the sum of the N2 output and the divided-by-ten output of the N3 assembly. The inputs to the digital phase detector are the divided-by-ten output of the N3 assembly and the output from a mixer which detects the difference frequency of the N2 output and the SL2 voltage controlled oscillator. The output of SL2 is applied to SL1.

The SL2 circuits are mounted on two circuit boards, A11 and A12. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided by Service Sheets 13 and 14.

The SL2 phase detector A12 is completely digital; it compares the relative positions (in time) of two sets of pulses and provides an error signal to correct phase errors or a dc level to correct frequency errors. One of the inputs to the phase detector is the divided by ten output of the N3 A8 assembly. The other input to the phase detector is the difference frequency between the N2 loop output and the SL2 voltage controlled oscillator output. When the loop is locked, both phase detector input signals are at the same frequency (1:1 ratio). When the ratio between the two signals is not 1:1 the difference is detected by a sense circuit which disables the phase detector. The phase detector output goes low if the SL2 voltage controlled oscillator frequency is low; the output goes high if the SL2 voltage controlled oscillator frequency is high. The pretuning circuit and the voltage controlled oscillator are contained in the A11 assembly.

The pretuning circuit is a digital to analog converter controlled by CF digits 3, 4 and 5. The digital to analog converter for the CF digit three is physically located on the A12 assembly. The pretuning circuit roughly presets the voltage controlled oscillator to a frequency within the capture range of the loop. A summing circuit sums the negative current from the digital to analog converter circuit with a current from a +20 volt source and the output of the SL2 digital phase detector to precisely set the output frequency of the voltage controlled oscillator. The output from the voltage controlled oscillator is applied to SL1 and to a mixer in the A12 assembly.

The output frequency of SL2 is equal to the N2 frequency plus the divided by ten input from the N3 circuit.

Summing Loop 1

The purpose of SL1 is to generate digitally controlled RF signals in the range of 20.000001 to 30.0 MHz in selectable increments as small as

◀ Model 8660 System Block Diagram

SERVICE SHEET 1 (Cont'd)

1 Hz. The output frequency of the SL1 voltage controlled oscillator is equal to the sum of the N1 output and the divided-by-one hundred output of SL2. The inputs to the digital phase detector are the divided-by-one hundred output of the SL2 assembly and the output from a mixer which detects the difference frequency of the N1 output and the SL1 voltage controlled oscillator. The output of SL1 is applied to the RF Section plug-in.

NOTE

In option 004 instruments the output is from 20.0001 to 30.0 MHz in selectable increments as low as 100 Hz. The voltage controlled oscillator is phase locked to the divided by one hundred output of the N2 loop.

The SL1 circuits are mounted on three circuit boards, A15, A18 and A19. Schematics, a more comprehensive circuit analysis, and troubleshooting information are provided on Service Sheets 15, 16 and 17.

Operation of SL1 is the same as operation of SL2 except that the phase detector inputs are the divided by one hundred output of SL2 and the difference frequency between the output of N1 and the SL1 oscillator. The output frequency is equal to $N1 + \frac{SL2}{100}$ or $N1 + \frac{N2}{100} + \frac{N3}{1000}$.

NOTE

In option 004 instruments the phase detector inputs are the divided by one hundred output of N2 and the difference frequency between the N1 output and the frequency of the SL1 voltage controlled oscillator output. The output frequency is equal to $N1 + \frac{N2}{100}$.

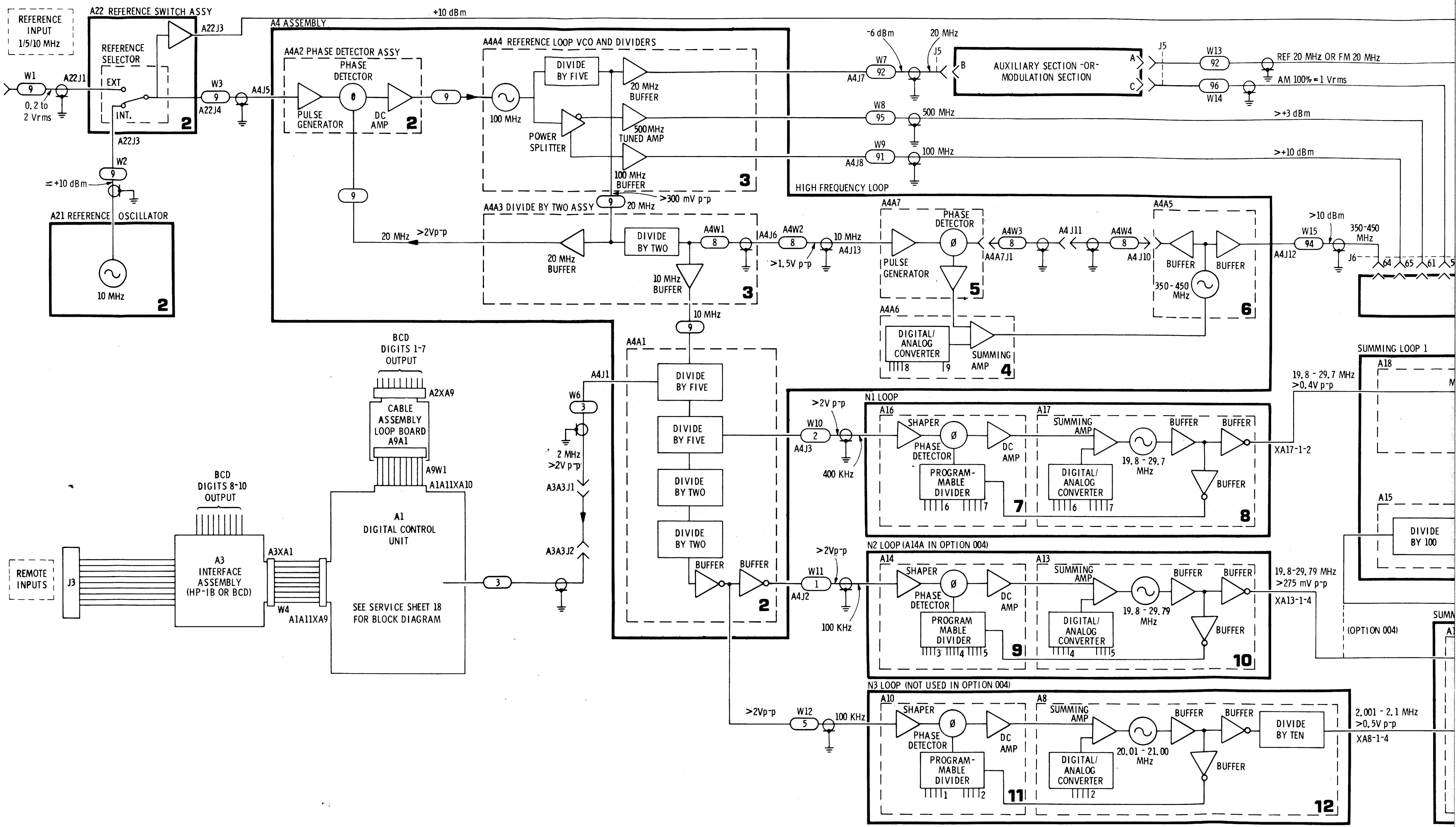
RF Section

The RF Section plug-in processes the outputs from the mainframe to provide the desired output frequency.

Information relative to operation and service of the RF Section is provided in a separate manual.

Digital Control Unit

Service Sheet 18 provides a logic diagram of the digital control unit.


REFERENCE INPUT 1/5/10 MHz
A22 REFERENCE SWITCH ASSY
REFERENCE SELECTOR
EXT
INT.
A22J1
A22J3
A22J4
0.2 to 2 Vrms
+10 dBm
A4 ASSEMBLY
A4A2 PHASE DETECTOR ASSY
PHASE DETECTOR
PULSE GENERATOR
DC AMP
A4A4 REFERENCE LOOP VCO AND DIVIDERS
DIVIDE BY FIVE
20 MHz BUFFER
100 MHz
POWER SPLITTER
500MHz TUNED AMP
100 MHz BUFFER
>300 mV p-p
20 MHz
A4A3 DIVIDE BY TWO ASSY
DIVIDE BY TWO
20 MHz BUFFER
10 MHz BUFFER
20 MHz >2Vp-p
A21 REFERENCE OSCILLATOR
10 MHz
-6 dBm
AUXILIARY SECTION -OR- MODULATION SECTION
REF 20 MHz OR FM 20 MHz
AM 100% = 1 Vrms
500 MHz
>+3 dBm
100 MHz
>+10 dBm
HIGH FREQUENCY LOOP
A4A7
PHASE DETECTOR
PULSE GENERATOR
A4A6
DIGITAL/ ANALOG CONVERTER
SUMMING AMP
A4A5
BUFFER
350-450 MHz
>10 dBm
>1.5V p-p
10 MHz
A4A1
DIVIDE BY FIVE
DIVIDE BY TWO
BUFFER
BCD DIGITS 1-7 OUTPUT
CABLE ASSEMBLY LOOP BOARD A9A1
A2XA9
A9W1
A1A11XA10
BCD DIGITS 8-10 OUTPUT
REMOTE INPUTS
A3 INTERFACE ASSEMBLY (HP-IB OR BCD)
A1 DIGITAL CONTROL UNIT
SEE SERVICE SHEET 18 FOR BLOCK DIAGRAM
A1A11XA9
2 MHz >2V p-p
A3A3J1
A3A3J2
N1 LOOP
A16
SHAPER
PHASE DETECTOR
PROGRAM-MABLE DIVIDER
A17
SUMMING AMP
19.8 - 29.7 MHz
400 KHz
XA17-1-2
19.8 - 29.7 MHz >0.4V p-p
N2 LOOP (A14A IN OPTION 004)
A14
A13
19.8 - 29.79 MHz
100 KHz
19.8-29.79 MHz >275 mV p-p
XA13-1-4
N3 LOOP (NOT USED IN OPTION 004)
A10
A8
20.01 - 21.00 MHz
DIVIDE BY TEN
2.001 - 2.1 MHz >0.5V p-p
XA8-1-4
SUMMING LOOP 1
A18
A15
DIVIDE BY 100
(OPTION 004)

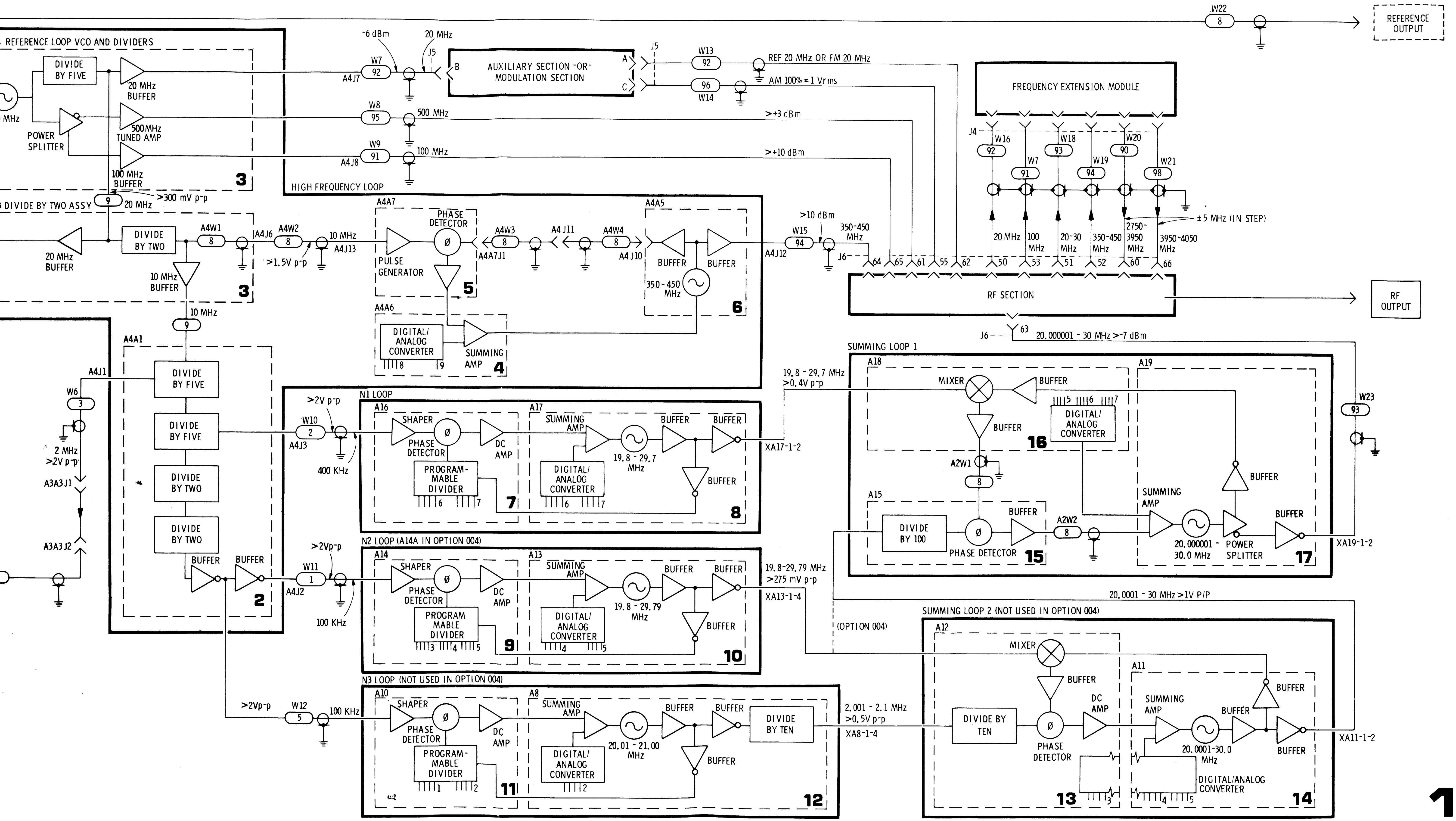


Figure 8-9. Model 8660C Block Diagram

SERVICE SHEET 2

PART OF REFERENCE LOOP CIRCUITS

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

When repairing the reference loop only one of the four covers should be removed at any given time. Operating the instrument with the voltage controlled oscillator cover removed may cause faulty or erratic performance after required repairs have been completed.

NOTE

After making repairs in any part of the reference loop circuits the adjustment procedures specified in Section V paragraph 5-27 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Test Oscillator
10:1 Oscilloscope probes (2)
Oscilloscope
Frequency Counter

REFERENCE LOOP GENERAL

The reference loop consists of four circuit boards located in the A4 assembly. This service sheet provides information about circuit operation and test procedures for the reference oscillator, reference amplifier and relays, the phase detector and the divide-by-five and divide-by-two circuits. Schematic diagrams, text and troubleshooting information for the voltage controlled oscillator and divide-by-two circuits appear on Service Sheet 3.

The accuracy and stability of all the signals generated in the Model 8660C mainframe are traceable to the reference loop outputs.

The reference loop provides output frequencies of 500 MHz, 100 MHz, 20 MHz, 10 MHz, 2 MHz, 400 kHz, and 100 kHz. These signals are used in other circuits in the mainframe and in the plug-in sections. All of the reference section outputs are derived from a 100 MHz master oscillator which is phase locked to a stable reference source. The reference signal may be supplied by the internal reference oscillator or by an external reference standard. The reference signal may be 5 or 10 MHz at a level of 0.2 to 2 volts rms.

1 REFERENCE OSCILLATOR, AMPLIFIER AND RELAYS

The Model 8660C (except for option 002 instruments) contains a 10 MHz temperature controlled crystal oscillator which is used as a reference source. Also included are switching relays and a buffer amplifier. The buffer amplifier serves to isolate the reference oscillator when its output is used as a reference source for external equipment.

TEST PROCEDURE 1

Test 1-a. Connect the oscilloscope to the Model 8660C rear panel REFERENCE OUTPUT connector. If the internal reference is being used the oscilloscope should display a 10 MHz signal at about 4 volts peak to peak. If an external reference is used the oscilloscope should display the reference frequency at about the same level as the reference signal input.

If the signal is present proceed to test 1-b. If the signal is not present proceed to test 1-c.

Test 1-b. Disconnect the coaxial cable from A4J5 (REF INPUT) and connect the oscilloscope to the end of the cable. If the internal reference is being used the oscilloscope should display a 10 MHz signal at about 5 volts peak to peak. If an external reference is used the oscilloscope should display the input reference signal.

If the signal appeared in test 1-a, but does not appear in test 1-b, the cable between the A4A2 assembly and the reference relay/amplifier is probably defective.

If the correct signal is observed in test 1-b, proceed to TEST PROCEDURE 2.

Test 1-c. If the signal was not present in test 1-a, tilt the A4 assembly out of the frame, disconnect the coaxial cable from the reference oscillator assembly and connect the reference oscillator output to the oscilloscope. The oscilloscope should display a 10 MHz signal at about 7 volts peak to peak.

If the signal is not present, check for dc levels as follows: terminal 1, +20 volts, terminal 2, +35 volts (oven voltage) and terminal 6, +5.2 volts (when present indicates thermostat is open, temperature stabilized). If the voltages are correct the reference oscillator assembly (A21) is defective.

NOTE

The reference oscillator assembly is not considered a field repairable unit. Replacement is recommended.

If the signal is present at the reference oscillator output check the SELECTOR switch, the relay assembly (A22A1) and the reference amplifier (A22A2).

PHASE DETECTOR ASSEMBLY (A4A2) GENERAL:

The phase detector consists of three basic circuits; a pulse generator, a sampler and a circuit to process the error signal.

The pulse generator converts the reference signal to very sharp, short duration pulses. These pulses are used to forward bias the sampler gate diodes.

The sampler gate provides a means of comparing the pulses generated from the reference signal to the 20 MHz signal from the A4A3 assembly. An error signal is developed to control the voltage controlled oscillator in the A4A4 assembly when a phase error exists.

2 PULSE GENERATOR

The pulse generator consists of Q1 through Q5, U1, T1 and associated components.

The reference input to Q1 may be 5 or 10 MHz. Q1 and Q2 act as an amplifier for low level signals and as a limiter for high level signals. Q3 acts as a limiter to ensure that the input to NAND gate U1A is always the same when the input reference signal is 0.2 to 2 volts rms. The output from Q3 is essentially a square wave with a slow rise time and a fast fall time; it is clipped, top and bottom, and it is approximately 5 volts peak to peak.

U1, C11 and R20 are used as a pulse shaper. The output of U1A is differentiated by C11 and R20 and inverted by U1B. The sharp pulses (20 to 25 nanoseconds) are inverted by U1D to provide positive-going pulses to drive Q4/Q5.

Q4/Q5 comprise a complementary emitter-follower pair; its purpose is to provide a low impedance drive to T1.

TEST PROCEDURE 2

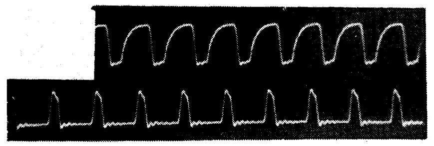
Test 2-a. Composite waveform SS2-1 and trace 2 of composite waveform SS2-2 illustrate the development of the 10 MHz pulses derived from the internal reference signal. These pulses are used to drive the sampling phase detector diode gates. Observing the individual waveforms on an oscilloscope should enable the technician to quickly isolate a malfunction in the circuit to an individual stage or to the reference oscillator/switching circuits.

There are no loops or feedback circuits in the pulse generator circuit. It is safe to assume when a correct waveform is observed that all preceding portions of the circuit are operating properly.

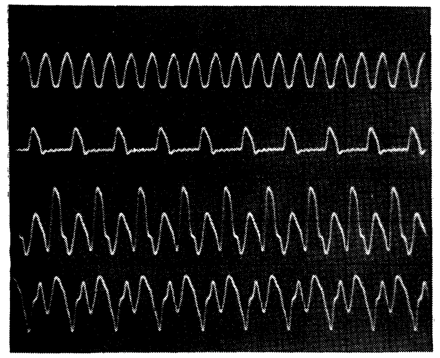
SERVICE SHEET 2 (Cont'd)

3 SAMPLER

Sampler diodes CR4 and CR5 are normally reverse biased. When the sampling pulse appears across the secondary of T1 it is coupled through C18 and C19 to forward bias CR4 and CR5. Since the gate pulses are equal in amplitude but opposite in polarity, they will cancel at the junction of R32, R33, R34, and C20.



Composite Waveform SS2-1



Composite Waveform SS2-2

While CR4 and CR5 are forward biased the sampling gate is open and the 20 MHz signal from the A4A3 assembly is sampled. If the 20 MHz input from the A4A3 assembly is not phase locked to the pulses derived from the reference signal an ac signal will appear on the base of Q7. The polarity of the signal at any given time depends on the polarity of the 20 MHz signal from the A4A3 assembly when the last sample was taken. The amplitude of the ac signal at any given time depends on what portion of the 20 MHz sine wave the last sample was taken from.

Each time CR4 and CR5 are forward biased the charge on C20 will change unless the phase relationship is the same as it was in the previous sample. The time constant of C20 and R34 is long and since the time between samples is never more than one microsecond, C20 cannot discharge appreciably between sampling pulses.

The reverse bias levels for CR4 and CR5 are maintained at the same levels (opposite polarities) by voltage divider networks.

SERVICE SHEET 2 (Cont'd)

TEST PROCEDURE 3

Test 3-a. An oscilloscope loads the sampling circuit at TP3 and TP4 to a point where accurate analysis of the signal is not possible. However, observing the waveforms and comparing them to the typical waveforms shown in composite waveform SS2-2 will provide an adequate indication that the circuit is, or is not, functioning properly. The important points to observe are the two-to-one frequency ratio between the 20 MHz signal and the pulses, and the time coincidence of the positive-going and negative-going pulses at TP3 and TP4 with the pulses at TP1.

4 ERROR SIGNAL AMPLIFIER

When a phase difference between the reference signal and the 20 MHz input exists, a signal appears on C20. This signal is amplified and used to correct the frequency of the voltage controlled oscillator in the A4A4 assembly.

Q7 and Q9 provide a high impedance input for the sampler output. Q8 and Q10 comprise a differential amplifier. Emitter-follower Q11 provides the output to the A4A4 assembly.

TEST PROCEDURE 4

Test 4-a. Connect an oscilloscope to the A4A2 output labeled VCO. With the input 10 MHz reference disconnected from A4J5, (REF INPUT) connect a test oscillator (output 0 dBm, 3 kHz) to A4A2TP2. (The exact frequency is unimportant - 3 kHz was chosen arbitrarily.)

Vary the output level of the test oscillator and note that the A4A2 output level displayed on the oscilloscope varies.

NOTE

If the A4A2 output does not vary when the test oscillator output is varied, use the oscilloscope to check back through the stages for a point in the circuit where the level does change with a change in the output level of the test oscillator. The following stage is probably defective.

5 REFERENCE DIVIDE-BY-FIVE AND DIVIDE-BY-TWO ASSEMBLY A4A1

The A4A1 assembly divides the 10 MHz input from the A4A3 assembly four times; two times by five and two times by two. The assembly provides a 2 MHz clock signal to the digital control unit, 100 kHz signals to the N2 and N3 loops and 400 kHz to the N1 loop.

Block Diagram
SERVICE SHEET 1

SERVICE SHEET 2 (Cont'd)

Q3 and CR1 reduce the +20 volt input to +5 volts for operation of all circuits in the assembly. This method of providing power is used to minimize the effect of ac ripple on the power supply.

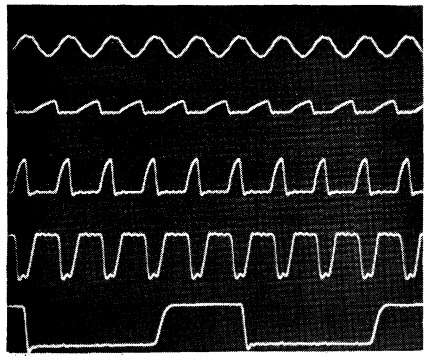
Q1 isolates the circuit from the 10 MHz source. Q2 amplifies the 10 MHz input and NAND gate U1A shapes it into pulses to drive U2. U2 provides a divided-by-five 2 MHz output at pin 8 which is used as a clock signal in the digital control unit. The 2 MHz output is also available at pin 11 of U2 and is used to drive U3.

U3 divides the 2 MHz input from pin 11 of U2 by five and provides outputs of 400 kHz at pins 8 and 11. The 400 kHz output at U3 pin 8 is used as the phase detector reference in the N1 loop. The 400 kHz at pin 11 of U3 is coupled to U3 pin 14 and divided by two. The 200 kHz output of U3 at pin 12 is coupled back to U2 pin 14 through NAND gate U1C and again divided by two. The 100 kHz output from U2 pin 12 is coupled through NAND gate U1B to the phase detector in the N3 loop. The 100 kHz signal is also coupled through NAND gate U1D to the phase detector in the N2 loop.

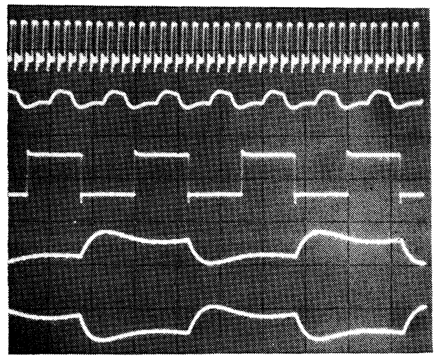
TEST PROCEDURE 5

Composite waveform SS2-3 illustrates the development of pulses from the 10 MHz reference input and the 2 MHz clock output to the digital control unit.

Composite waveform SS2-4 illustrates the development of the 400 kHz and 100 kHz N loop reference signals from the 2 MHz clock signals.



Composite Waveform SS2-3



Composite Waveform SS2-4

There are no loops or feed back paths in the circuit. It is safe to assume that when the proper waveform is observed at any point that preceding stages are functioning properly.

Observing the waveforms at the test points specified should enable the technician to quickly isolate the cause of a malfunction to a specific stage or component.

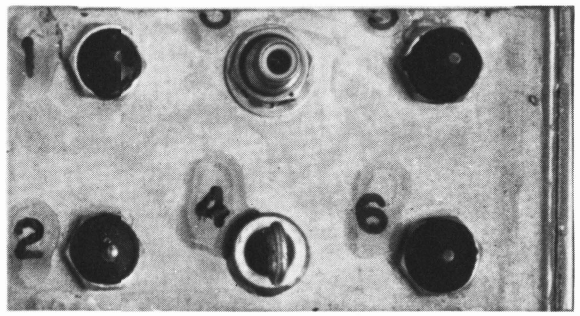


Figure 8-10. A21 Reference Oscillator Assembly

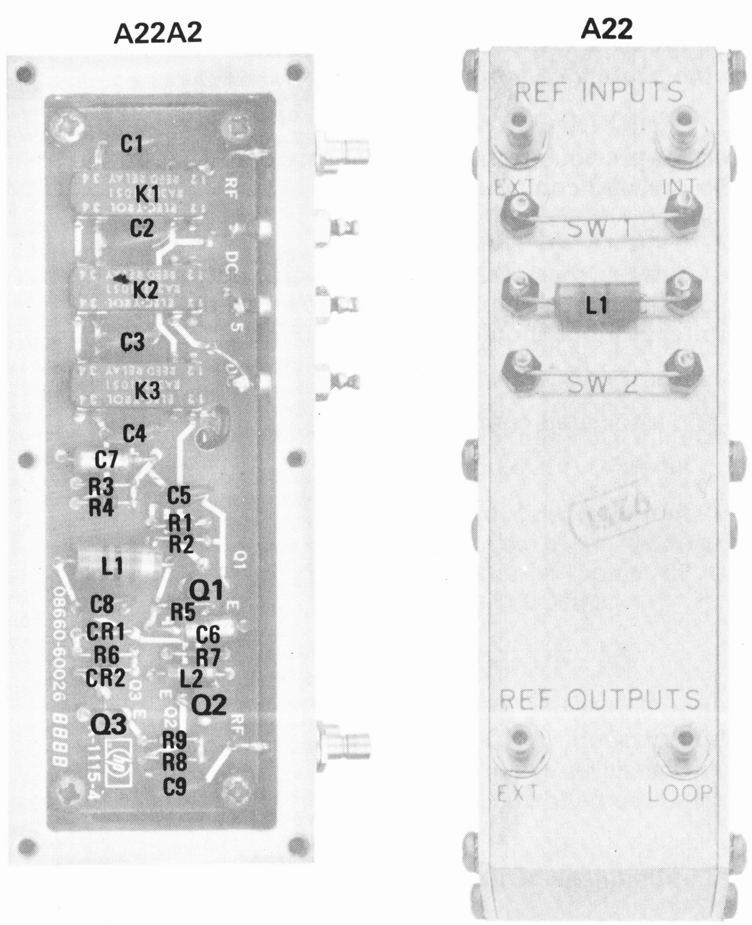


Figure 8-11. A22 Assembly Component Locations

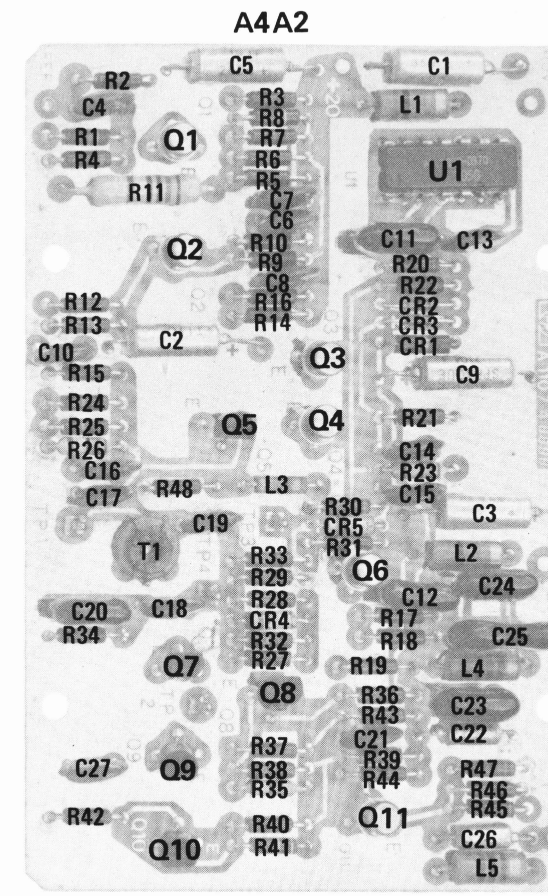


Figure 8-12. A4A2 Reference Phase Detector Component Locations

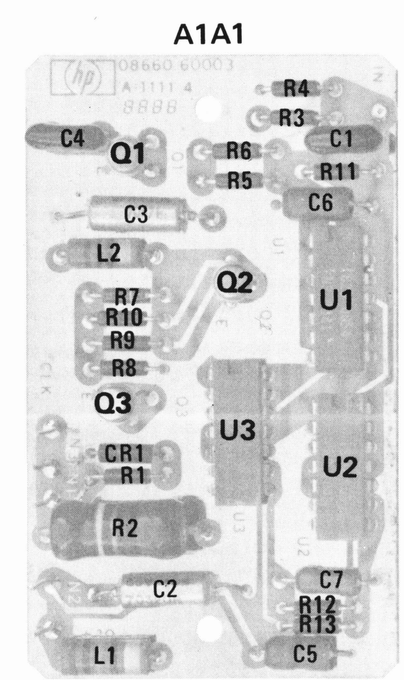
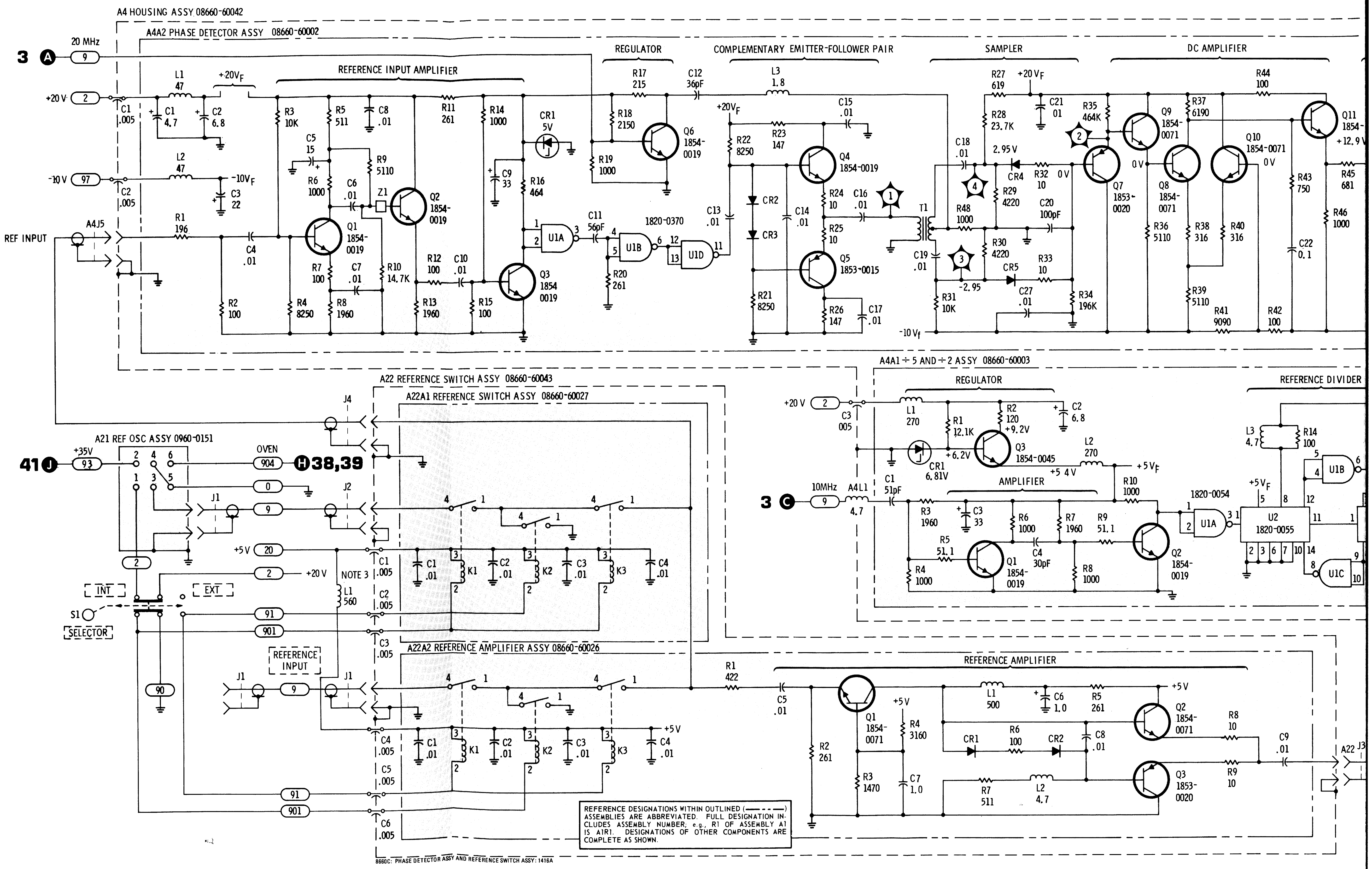
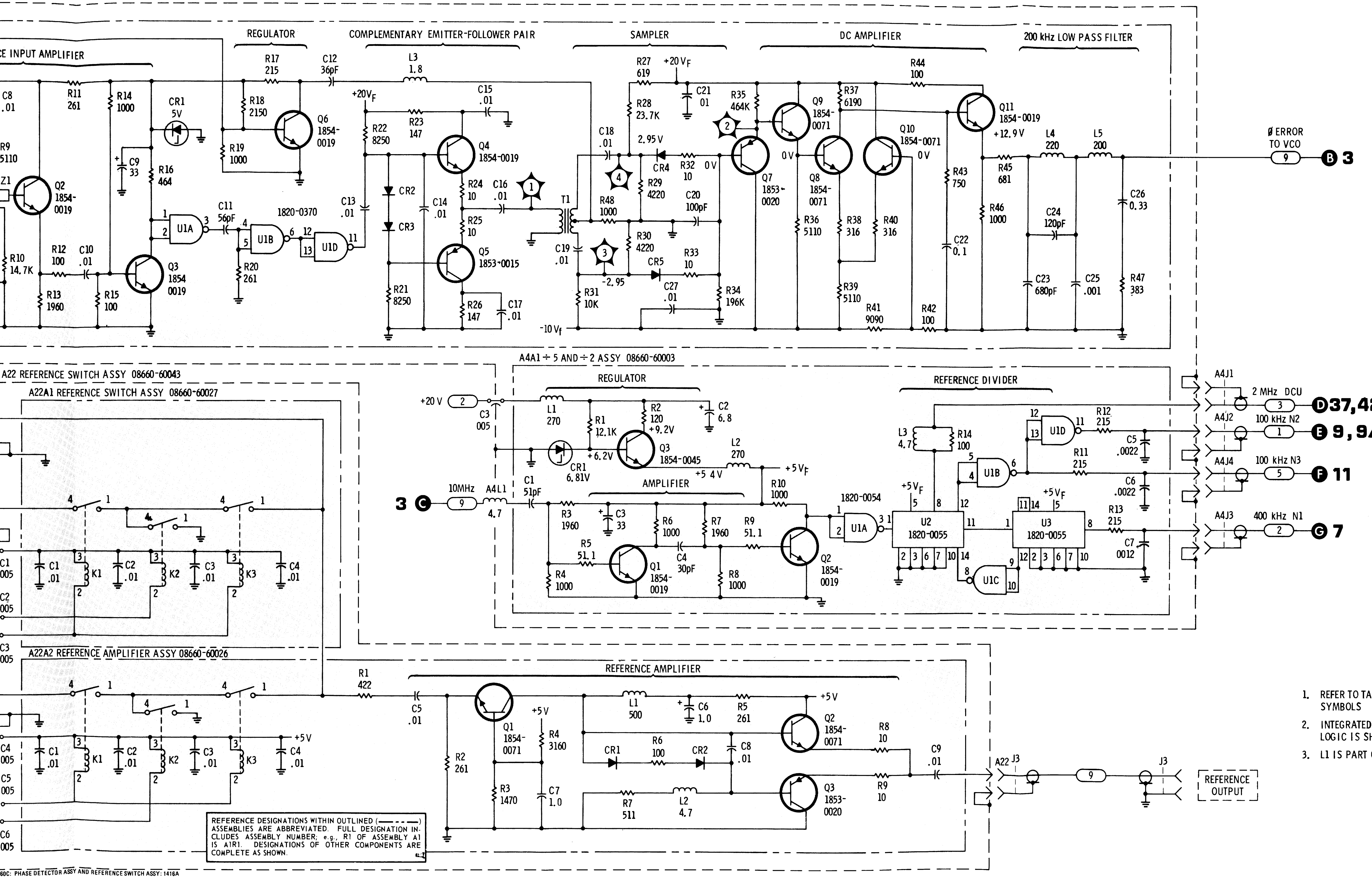


Figure 8-13. A4A1 Reference Divider Component Locations



A4 HOUSING ASSY 08660-60042
A4A2 PHASE DETECTOR ASSY 08660-60002
20 MHz
REFERENCE INPUT AMPLIFIER
REGULATOR
COMPLEMENTARY EMITTER-FOLLOWER PAIR
SAMPLER
DC AMPLIFIER
REF INPUT
A4J5
A4A1 ÷ 5 AND ÷ 2 ASSY 08660-60003
REGULATOR
AMPLIFIER
REFERENCE DIVIDER
10MHz
A22 REFERENCE SWITCH ASSY 08660-60043
A22A1 REFERENCE SWITCH ASSY 08660-60027
A21 REF OSC ASSY 0960-0151
OVEN
38,39
NOTE 3
INT
EXT
S1
SELECTOR
REFERENCE INPUT
A22A2 REFERENCE AMPLIFIER ASSY 08660-60026
REFERENCE AMPLIFIER
REFERENCE DESIGNATIONS WITHIN OUTLINED (— - — - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.
8660C: PHASE DETECTOR ASSY AND REFERENCE SWITCH ASSY: 1416A



REFERENCE DESIGNATIONS

A4	A21
C1-3, J1-5, L1	**A22** C1-6, J1-4
A4A1 C1-7, CR1, L1, 2, Q1-3, R1-13, U1-3	**A22A1** C1-4, K1-3
A4A2 C1-27, CR1-5, L1-5, Q1-11, R1-48, T1, U1	**A22A2** C1-9, CR1, 2, K1-3, L1, 2, Q1-3, R1-9
	CHASSIS J1, 3, S1

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6
3. L1 IS PART OF THE A22 ASSY.

2

Figure 8-14. Reference Circuit Schematics

SERVICE SHEET 3

PART OF REFERENCE LOOP CIRCUITS

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

When repairing the reference loop only one of the four covers should be removed at any given time. Operation of the instrument with the voltage controlled oscillator cover removed may cause faulty or erratic performance after required repairs have been completed.

NOTE

After making repairs in any part of the reference loop circuits the adjustment procedures specified in Section V paragraph 5-27 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Oscilloscope
Frequency Counter
10:1 Oscilloscope probes (2)

REFERENCE LOOP GENERAL

The reference loop consists of four circuit boards located in the A4 assembly. Service Sheet 2 provides information about circuit operation and test procedures for the reference oscillator, reference amplifier and relays, the phase detector and the divide-by-five and divide-by-two circuits. Schematic diagrams, text and troubleshooting information for the voltage controlled oscillator and divide-by-two circuits appear on this service sheet.

The accuracy and stability of all the signals generated in the Model 8660C mainframe are traceable to the reference loop circuits.

The reference loop provides output frequencies of 500 MHz, 100 MHz, 20 MHz, 10 MHz, 2 MHz, 400 kHz, and 100 kHz. These signals are used in other circuits in the mainframe and in the plug-in sections. All of the reference section outputs are derived from a 100 MHz master oscillator which is phase locked to a stable reference source. The reference signal may be supplied by the internal reference oscillator or by an external reference standard. The reference signal may be 5 or 10 MHz at a level of 0.2 to 2 volts rms.

1 OSCILLATOR, POWER SPLITTER, 500 MHz AMP and 100 MHz AMP

Q3 and associated components comprise a 100 MHz voltage controlled oscillator. Varactor CR1 is biased by the output of the

A4A2 phase detector to assure that the oscillator is phase locked to the reference signal at 100 MHz.

The oscillator output is capacitively coupled to the base of Q4 which functions as a power splitter.

Q9 and associated components provide isolation from the +20 volt power supply for the oscillator and power splitter to minimize effects of ac power supply ripple or line variations.

The collector output of Q4 is capacitively coupled to A8, a 100 MHz tuned amplifier which functions as a buffer stage. The times five function is accomplished by Q7 which is tuned to 500 MHz. The 500 MHz output from the Q7 tank circuit is capacitively coupled to Q6, another 500 MHz tuned amplifier which also provides isolation.

The emitter output of Q4 is capacitively coupled to the base of Q5 which functions as a 100 MHz tuned amplifier buffer stage. This output is used in the Frequency Extension Module (accessory number 11661A).

TEST PROCEDURE 1

NOTE

If the signal frequency is close to that specified in the following tests but is erratic, or not exact, the trouble is probably in the Phase Detector circuit. Refer to Service Sheet 2.

Test 1-a. With the A4A4 assembly cover removed use the counter and spectrum analyzer (separately) to check the 500 MHz output. The counter should indicate exactly 500 MHz and the oscilloscope should display a sine wave at about >+3 dBm.

If the signal is present proceed to test 1-d. If the signal is not present proceed to test 1-b.

Test 1-b. Connect the oscilloscope and the counter (separately) to Q4-c. The counter should indicate exactly 100 MHz and the oscilloscope should display a sine wave at about 2.5V p-p.

If the signal is present, but was not present in test 1-a, check Q6, Q7, Q8 and associated components. If the signal is not present, proceed to test 1-c.

Test 1-c. Connect the oscilloscope and the counter (separately) to Q4-b. The counter should indicate exactly 100 MHz and the scope should display a sine wave at about 0.4 volts.

If the signal is present, but was not present in previous tests, Q4 is probably defective. If the signal is not present check Q3, Q9 and associated components.

Test 1-d. Use the oscilloscope and the counter (separately) to check the 100 MHz output. The counter should indicate exactly 100 MHz and the oscilloscope should display a sine wave at about 0.5 volts.

If the signal is not present, but was present in test 1-a, check Q5 and associated components. If the signal is present, proceed to Test Procedure 2.

2 20 MHz OUTPUTS

A third 100 MHz signal is capacitively coupled from the oscillator tank circuit to the base of 100 MHz tuned amplifier Q2. The output of Q2 is used to drive a divide-by-five circuit (U1) which provides the 20 MHz output. The 20 MHz output is used to drive the divide-by-two circuit in the A4A3 assembly. The 20 MHz signal is also coupled to 20 MHz tuned amplifier Q1 for use in circuits external to the reference loop.

TEST PROCEDURE 2

Test 2-a. Connect the oscilloscope to the 20 MHz output from Q1. The display should be similar to that shown in the center trace of composite waveform SS3-1. Proceed to test 2-b.

Test 2-b. Connect the oscilloscope to the 20 MHz output which goes to the A4A3 assembly. The display should be similar to that shown in the lower trace of composite waveform SS3-1.

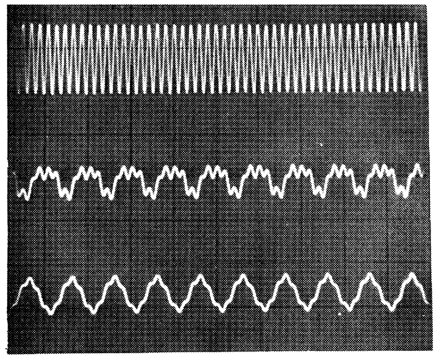
If the correct signal is present, but was not present in test 2-a, check Q1 and associated components.

If the signal is not present proceed to test 2-c.

Test 2-c. Connect the oscilloscope to Q2-c. The oscilloscope display should be similar to the top trace in composite waveform SS3-1. If the signal is present, but was not present in test 2-b, U1 is probably defective.

If the signal is not present at Q2-c, Q2 is probably defective.

SERVICE SHEET 3 (cont'd)



Composite Waveform SS3-1

3 DIVIDE-BY-TWO CIRCUIT A4A3

The A4A3 assembly provides 10 MHz outputs to the HF Loop (A4A7) phase detector, and to the divide-by-five and divide-by-two circuits (A4A1). It also provides a 20 MHz output for use in the reference loop phase detector A4A2.

Q1 and Q2 amplify the 20 MHz signal from the A4A4 assembly and applies it to U1 which divides by two. The +5 volts required for operation of U1 is derived from the +20 volt supply by R4 and CR1 to minimize effects of power supply ac ripple and line variations.

The output from U1 is capacitively coupled out to the HF loop as a reference signal. It is also coupled through Q3 to 10 MHz tuned amplifier Q5. The 10 MHz output from the Q5 is used in the divide-by-five and divide-by-two circuits (A4A1).

The 20 MHz output of Q2 is also coupled through tuned amplifier Q4 to the A4A2 phase detector assembly.

TEST PROCEDURE 3

Test 3-a. Connect the oscilloscope to the 10 MHz output to the A4A1 assembly. The oscilloscope display should be about as shown in the bottom trace of composite waveform SS3-2. Verify that the frequency is exactly 10 MHz with the counter.

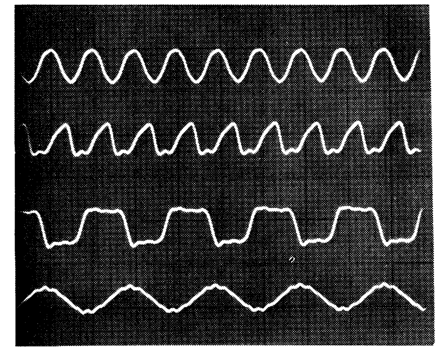
If the signal is not present proceed to test 3-b. If the signal is present, proceed to test 3-d.

Test 3-b. Connect the oscilloscope to the 10 MHz output which goes to the A4A4 assembly. The oscilloscope display should be about as shown in the next-to-the-bottom trace of composite waveform SS3-2. Verify that the frequency is exactly 10 MHz with the counter.

If the signal is present, but was not present in test 3-a, check Q3, Q5 and associated components. If the signal is not present proceed to test 3-c.

Reference Loop
SERVICE SHEET 2

SERVICE SHEET 3 (Cont'd)



Composite Waveform SS3-2

Test 3-c. Connect the oscilloscope to U1 pin 12. The oscilloscope display should be similar to the second from the top trace in composite waveform SS3-2.

NOTE

The counter may be used to verify that the frequency is approximately 20 MHz. However, this point in the circuit is critical; the additional load on the circuit will probably disturb the phase lock loop balance.

If the display is correct, but was not correct in previous tests, U1 is probably defective. If the display is not correct, check Q1, Q2 and associated components.

Test 3-d. Connect the oscilloscope and the counter (separately) to the 20 MHz output to the A4A2 assembly. The oscilloscope display should be similar to that shown in the top trace of composite waveform SS3-2. The counter readout should be exactly 20 MHz.

If the correct signal is not present check Q4 and associated components.

A4A4

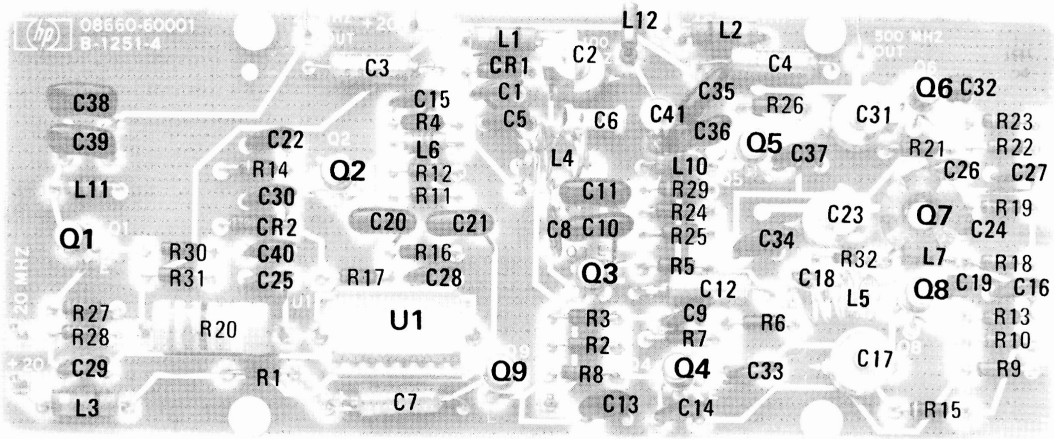


Figure 8-15. A4A4 Reference VCO Component Locations

A4A3

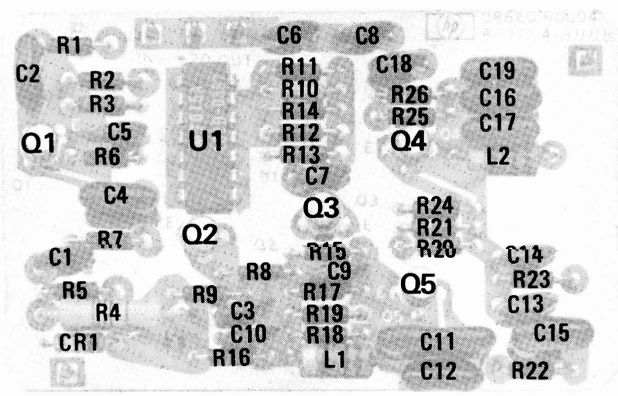


Figure 8-16. A4A3 Reference Divide-by-Two Component Locations

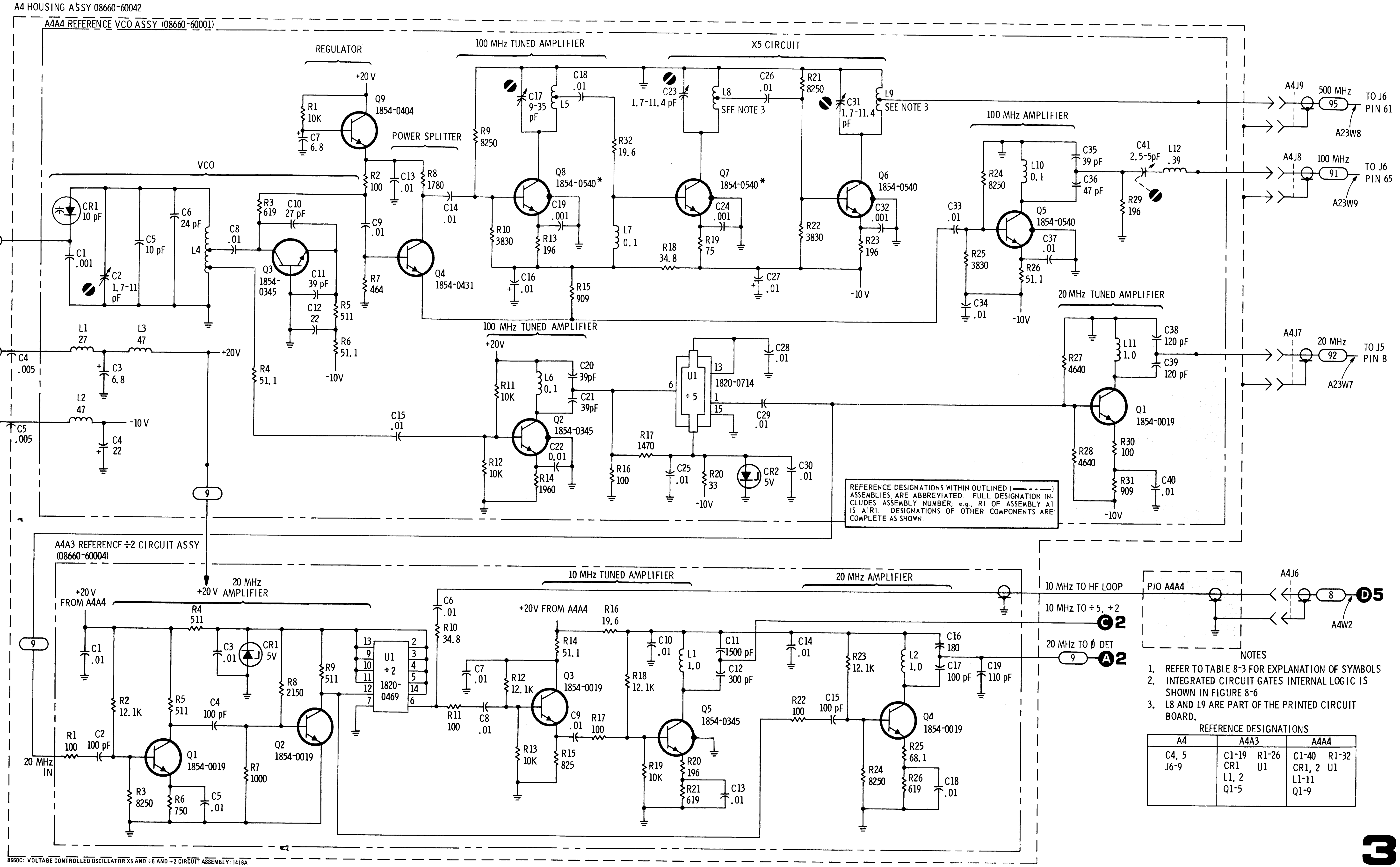


Figure 8-17. Reference VCO and Divider Schematic

SERVICE SHEET 4

PRETUNING ASSEMBLY (A4A6)

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A4A6 assembly, a part of the three-assembly High Frequency Loop, is shown schematically and described on this service sheet. The other two assemblies, A4A5 and A4A7, are shown schematically and described on Service Sheets 5 and 6.

NOTE

After making repairs in any parts of the HF Loop circuits the adjustment procedure specified in Section V paragraph 5-28 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter

HIGH FREQUENCY LOOP GENERAL INFORMATION

The purpose of the HF loop is to provide a precise digitally controlled output frequency between 350 and 450 MHz in 10 MHz increments. This output is used in the internal extension module and in the plug-in RF Sections to provide the desired output signal.

1 PRETUNING CIRCUIT

Q1 through Q11, U1 and associated components comprise a digital to analog converter which pretunes the A4A5 voltage controlled oscillator. The pretuning circuit cannot, by itself, set the oscillator frequency precisely; it does set the frequency within the capture range of the loop.

Integrated circuit U1 is a decoder which converts the BCD input from CF digit 8 to individual select lines which turn on one of nine transistors connected in a resistive network. The transistor which is turned on effectively grounds one point in the resistive network. The voltage level output to the voltage controlled oscillator depends on which transistor is turned on. The voltage varies from about —7 volts (350 MHz) to about —34 volts (450 MHz).

A single input line, representative of BCD '1' from CF digit 9 drives Q1 to turn on Q11. Q11, the tenth transistor switch in the pretuning network, grounds the lowest resistance point in the network; it pretunes the voltage controlled oscillator to 350 MHz.

TEST PROCEDURE 1

Test 1-a. With the digital voltmeter connected to the junction of R15, R18 and R19 set the CF as shown in table 8-28. The voltages shown in the table are typical; the actual voltage levels will depend on the characteristics of the varactor used in the voltage controlled oscillator.

If changing the setting of CF digit 8 through its range does not result in a change in the dc level at the junction of R15, R18 and R19, U1 may be defective.

Test 1-b. Use the digital voltmeter to check the A, B, C and D inputs to U1 from CF digit 8. These inputs are binary 1 2 4 8 positive true logic. (Example: with CF digit 8 set to a 3, U1 pins 15 and 14 should be high, about +4 volts, and pins 12 and 13 should be low, about 0.3 volt). If the A, B, C and D inputs to U1 are correct, use the digital voltmeter to check the U1 output. (Example: if thumbwheel digit 8 is set to a 3, Inputs A and B will be high and U1 pin 4 will go low.)

Operation of transistors Q2 through Q11 may be checked by checking the dc level at their collectors which are connected to the transistor shell. The numbers plated on the circuit board next to the potentiometers correspond to CF digits 8 and 9. CF digit 8 controls Q2 through Q10 and CF digit 9 drives Q1 to control Q11. The metallic shell (collector) of the transistor selected goes low (0.1 volt or less).

Reference Loop VCO
◀ SERVICE SHEET 3

SERVICE SHEET 4 (Cont'd)

2 SUMMING CIRCUIT

Common base current source Q13 sums the output of the digital to analog converter, current from a +20 volt source (R13) and the error signal from the A4A7 sampling phase detector. The output of the digital to analog converter is partially controlled by common base current source Q14. Conduction of Q14 is controlled by a temperature sensitive stabistor diode on the voltage controlled oscillator circuit board. The current from Q14 is injected into the pretuning network to provide correct compensation for the voltage controlled oscillator drift characteristics. Q12 provides a means of coupling the error signal from the phase detector through C7 to the voltage controlled oscillator in the A4A5 assembly.

TEST PROCEDURE 2

Test 2-a. Connect the digital voltmeter to the A4A6 output labeled FREQ on the circuit board. Set the CF digits as shown in Table 8-28. The voltages shown are typical; actual voltage levels depend on the characteristics of the varactor in the voltage controlled oscillator.

If the voltages were correct in test 1-a, but are not in test 2-a, check Q12, Q13 and associated components.

Table 8-44. Pretuning DC Levels

Center Frequency	Test 1-a DC Level	Test 2-a DC Level
0000.010000 MHz	—34.7 volts	—34.5 volts
0010.010000 MHz	—28.3 volts	—29.3 volts
0020.010000 MHz	—23.1 volts	—25.0 volts
0030.010000 MHz	—18.7 volts	—21.4 volts
0040.010000 MHz	—14.9 volts	—18.4 volts
0050.010000 MHz	—11.6 volts	—15.7 volts
0060.010000 MHz	—8.9 volts	—13.5 volts
0070.010000 MHz	—6.5 volts	—11.6 volts
0080.010000 MHz	—4.5 volts	—9.9 volts
0090.010000 MHz	—2.6 volts	—8.4 volts
0100.010000 MHz	—1.1 volts	—7.2 volts

A4A6

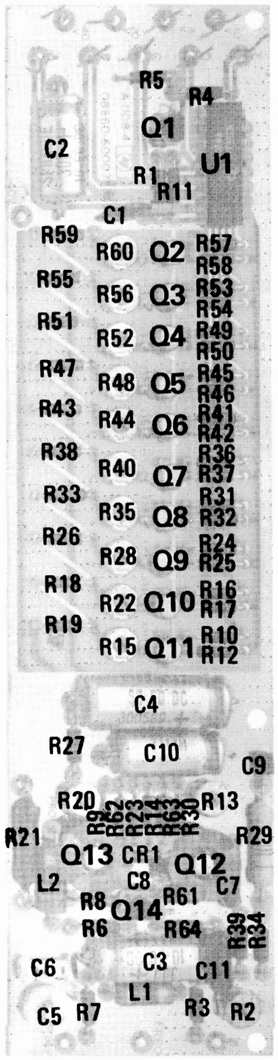
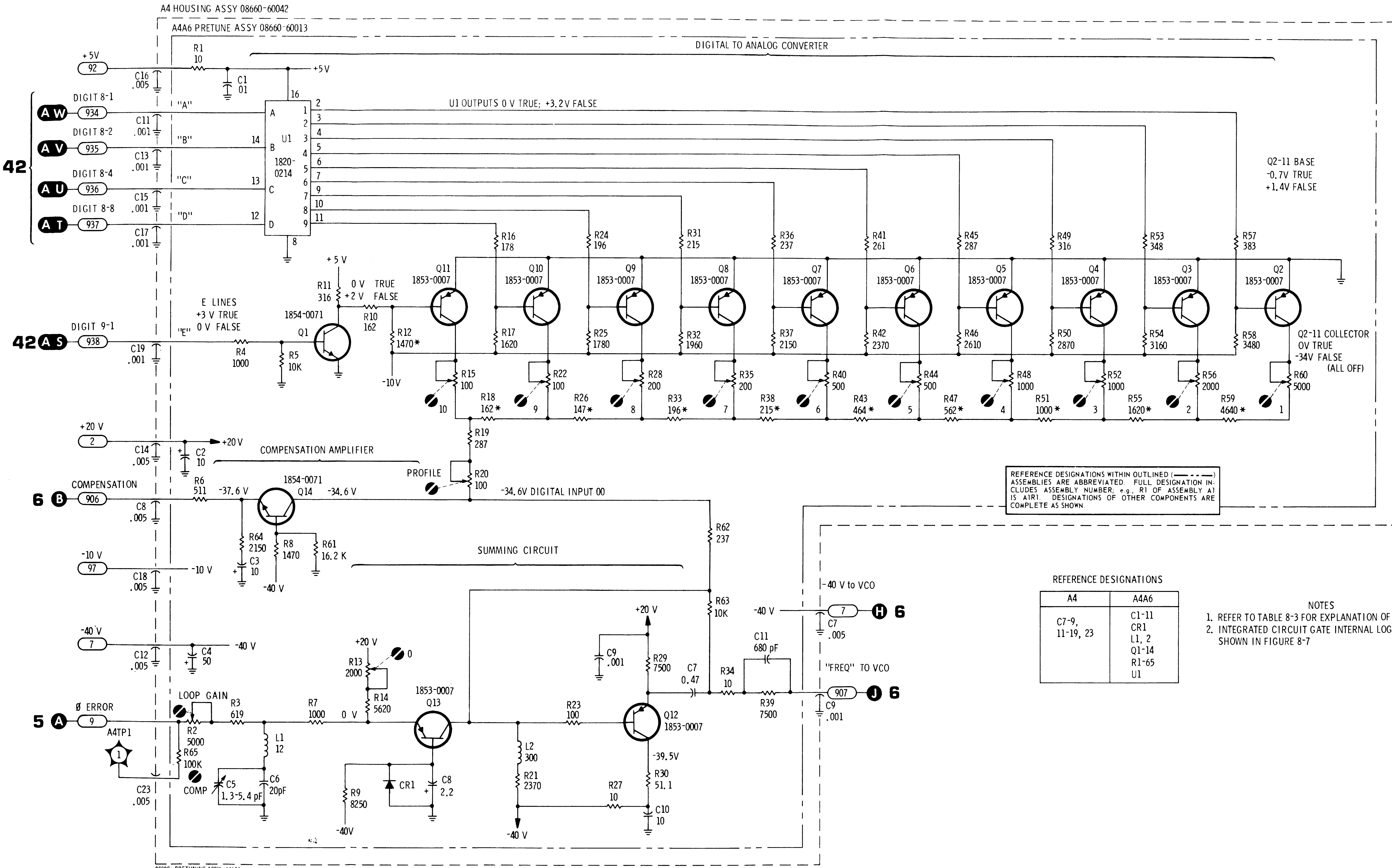


Figure 8-18. A4A6 HF Loop Pretuning Component Locations



REFERENCE DESIGNATIONS

A4	A4A6
C7-9, 11-19, 23	C1-11 CR1 L1, 2 Q1-14 R1-65 U1

NOTES
1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-7

Figure 8-19. HF Loop Pretuning Circuit Schematic

SERVICE SHEET 5

SAMPLING PHASE DETECTOR (A4A7)

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A4A7 assembly, a part of the three-assembly High Frequency Loop, is shown schematically and described on this service sheet. The other two assemblies, A4A5 and A4A6, are shown schematically and described on Service Sheets 4 and 6.

NOTE

After making repairs in any part of the HF Loop circuits the adjustment procedure specified in Section V paragraph 5-28 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Test Oscillator
Digital Voltmeter

HIGH FREQUENCY LOOP GENERAL INFORMATION

The purpose of the HF loop is to provide a precise digitally controlled output frequency between 350 and 450 MHz in 10 MHz increments. This output is used in the internal extension module and in the plug-in RF Sections to provide the desired output signal.

The sampling phase detector compares the voltage controlled oscillator output to a 10 MHz signal from the reference section. The output of the phase detector circuit is a beat note or a varying dc level. The phase detector assembly contains a pulse generator, a sampler, and a signal processing circuit.

1 PULSE GENERATOR

Q1 and Q2 comprise a non-saturating, limiting amplifier. It provides a constant amplitude square wave (about 6 volts) derived from the 10 MHz reference signal. The circuit is designed to minimize the sensitivity of the output ac swing to power supply ripple.

The output of Q2 is applied to Q3 which converts the signal to a stable current waveform. A two-to-one stepdown transformer (T1) is used in conjunction with Q3 to provide the additional current required to drive the step-recovery diode CR1.

When Q3 conducts heavily CR1 is reverse biased by the signal which appears across the secondary winding of T1. When Q3 is turned off the collapsing inductive field of the T1 primary winding and the resonant circuit of L5 and C10 cause a flyback action which drives CR1 into conduction. L4 and C9 also enhance the flyback action.

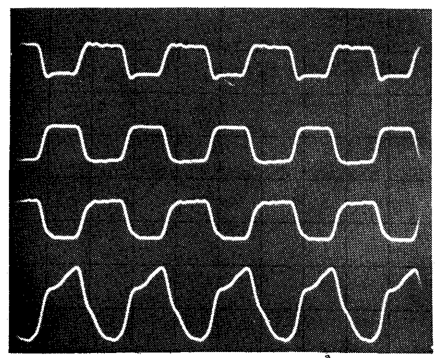
NOTE

One of the characteristics of a step-recovery diode, also called a charge-storage diode, is that the junction transition capacitance accumulates a charge while the diode is forward biased.

When the pulse which forward biased CR1 has ended, CR1 is again reverse biased; however, current will flow in the reverse direction until the charge stored in CR1 is depleted. When the charge stored in CR1 is depleted current flow stops abruptly; the sharp current transition causes L6 and L7 to develop large narrow voltages spikes of about 6 volts amplitude and one nanosecond in duration. The pulse is positive-going at L7 and negative-going at L6. These pulses are coupled through C10, C11 and balun T2 to forward bias the diodes in the sampler bridge. Balun T2 improves amplitude balance of the pulses.

TEST PROCEDURE 1

Test 1-a. Composite waveform SS5-1 illustrates the correct waveforms for the three stages of the pulse generator.



Composite Waveform SS5-1

NOTE

Since an oscilloscope would load the remainder of the pulse generator circuit, and due to the short duration of the gate pulse, waveform analysis is not practicable. If the waveforms are as shown in SS5-1 and the loop does not phase lock, proceed to test procedure 2 .

2 SAMPLER AND SIGNAL PROCESSOR

The sampler is a matched quad diode gate which is normally reverse biased. When the step-recovery diode generates the gate pulse all four of the sampler gate diodes are simultaneously forward biased. When the sampler gate diodes are forward

HF Loop Pretuning
SERVICE SHEET 4

A4A7)

in the Model 8660C will be isolated to a circuit
: of performing the tests specified in the

three-assembly High Frequency Loop, is shown
s service sheet. The other two assemblies, A4A5
y and described on Service Sheets 4 and 6.

NOTE

ıny part of the HF Loop circuits the
ecified in Section V paragraph 5-28
o ensure proper operation of the

See Table 1-2)

ıbes)

RAL INFORMATION

ɔ provide a precise digitally controlled output
ɪHz in 10 MHz increments. This output is used
and in the plug-in RF Sections to provide the

ıares the voltage controlled oscillator output to
ıce section. The output of the phase detector
c level. The phase detector assembly contains a
ɡnal processing circuit.

.ting, limiting amplifier. It provides a constant
ɔlts) derived from the 10 MHz reference signal.
the sensitivity of the output ac swing to power

} which converts the signal to a stable current
transformer (T1) is used in conjunction with
ent required to drive the step-recovery diode

is reverse biased by the signal which appears
T1. When Q3 is turned off the collapsing

SERVICE SHEET 5 (Cont'd)

inductive field of the T1 primary winding and the resonant circuit of L5 and C10 cause a flyback action which drives CR1 into conduction. L4 and C9 also enhance the flyback action.

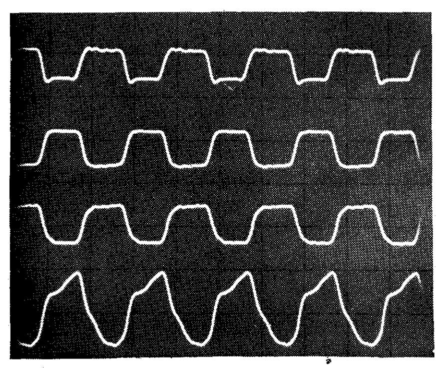
NOTE

One of the characteristics of a step-recovery diode, also called a charge-storage diode, is that the junction transition capacitance accumulates a charge while the diode is forward biased.

When the pulse which forward biased CR1 has ended, CR1 is again reverse biased; however, current will flow in the reverse direction until the charge stored in CR1 is depleted. When the charge stored in CR1 is depleted current flow stops abruptly; the sharp current transition causes L6 and L7 to develop large narrow voltages spikes of about 6 volts amplitude and one nanosecond in duration. The pulse is positive-going at L7 and negative-going at L6. These pulses are coupled through C10, C11 and balun T2 to forward bias the diodes in the sampler bridge. Balun T2 improves amplitude balance of the pulses.

TEST PROCEDURE 1

Test 1-a. Composite waveform SS5-1 illustrates the correct waveforms for the three stages of the pulse generator.



Composite Waveform SS5-1

NOTE

Since an oscilloscope would load the remainder of the pulse generator circuit, and due to the short duration of the gate pulse, waveform analysis is not practicable. If the waveforms are as shown in SS5-1 and the loop does not phase lock, proceed to test procedure 2.

2 SAMPLER AND SIGNAL PROCESSOR

The sampler is a matched quad diode gate which is normally reverse biased. When the step-recovery diode generates the gate pulse all four of the sampler gate diodes are simultaneously forward biased. When the sampler gate diodes are forward

SERVICE SHEET 5 (Cont'd)

biased a sample of the signal from the A4A5 voltage controlled oscillator is taken and stored in C13.

Q4 and Q5 comprise a differential amplifier. The non-inverting input (G2) is derived from the sampling circuit. The output is applied to emitter-follower Q6 which provides a low impedance phase error output. The output of Q6 is also fed back to the differential amplifier inverting input (G1) to close the loop at unity gain. The holding capacitor, C13 is connected directly between the two inputs to Q4; this bootstraps C13 to extend the sampler's frequency response.

CR8 and CR9 provide reverse bias voltages for the sampling gate diodes. These bias voltages are balanced and centered on the output signal to improve sampler efficiency.

R18 controls the response of the sampler by varying the amount of back-bias for the bridge; it is adjusted for maximum frequency response with minimum peaking.

R22 controls the quiescent output level to the summing circuit in A4A6; it should be adjusted for zero output with the input from the voltage controlled oscillator disconnected.

If the voltage controlled oscillator output is harmonically related to the reference signal the output of the phase detector is proportional to the sine of the difference in phase of the two signals. If the voltage controlled oscillator frequency is not harmonically related to the reference signal, the output of the phase detector is a beat note at the difference frequency.

TEST PROCEDURE 2

Test 2-a. Disconnect the input to the sampler gate from the A4A5 voltage controlled oscillator and substitute a 1 MHz, 10 dBm signal from the test oscillator. Connect the oscilloscope to the phase error output (labeled Ø on the circuit board). Varying the output level of the test oscillator should cause the oscilloscope display to follow the amplitude change.

If the oscilloscope display is not as specified proceed to test 2-b.

If the display is correct and the display for test 1-b was correct, check the step-recovery diode and associated components.

Test 2-b. With the oscilloscope connected as it was in test 2-a, inject the 1 MHz signal at Q4-G2. If the signal is now displayed on the oscilloscope and varies as the output of the test oscillator is varied, check the step-recovery diode, the sampler gate diodes and associated components.

If the signal is not displayed check Q4, Q5, Q6 and associated components.

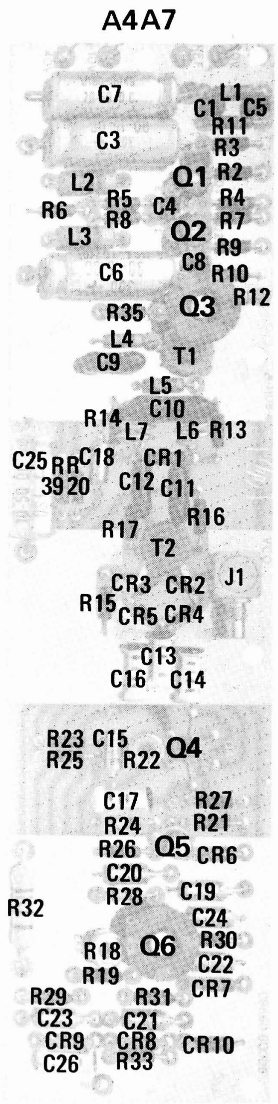
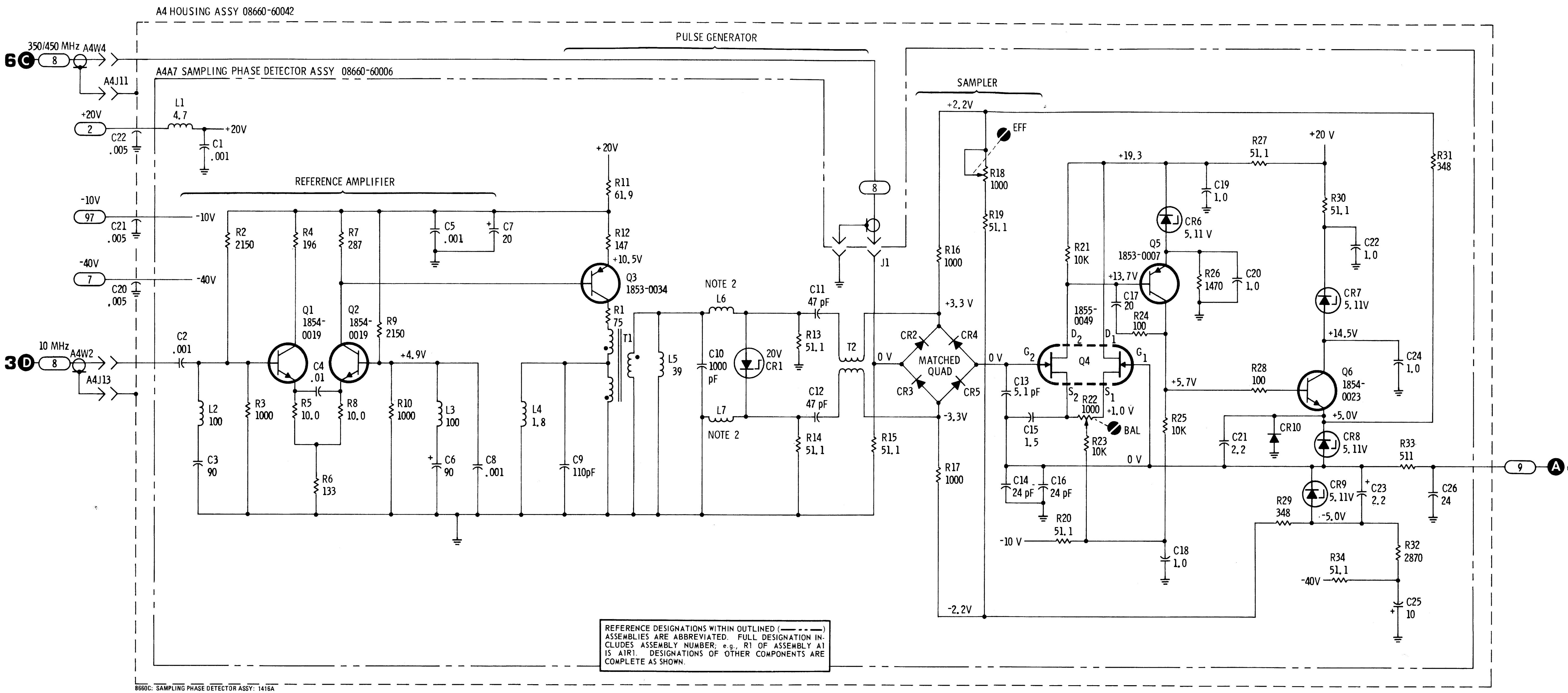


Figure 8-20. A4A7 HF Loop Phase Detector Component Locations



REFERENCE DESIGNATIONS

A4	A4A7
C20-22 J11, 13	C1-26 CR1-10 L1-7 Q1-6 R1-34 T1, 2

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. P/O PRINTED CIRCUIT BOARD.

5

Figure 8-21. Sampling Phase Detector Schematic

SERVICE SHEET 6

VCO AND AMPLIFIERS (A4A5)

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A4A5 assembly, a part of the three-assembly HF Loop, is shown schematically and described on this service sheet. The other two assemblies, A4A6 and A4A7, are shown schematically and described on Service Sheets 4 and 5.

NOTE

After making repairs to any part of the HF Loop circuits the adjustment procedures specified in Section V paragraph 5-28 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Spectrum Analyzer
Frequency Counter

1 HIGH FREQUENCY LOOP GENERAL INFORMATION

The purpose of the HF Loop is to provide a precise digitally controlled output frequency between 350 and 450 MHz in 10 MHz increments. This output is used in the Frequency Extension Module and in the plug-in RF Section to provide the desired output signal.

VCO AND AMPLIFIERS

Transistor A4 and associated components comprise a voltage controlled oscillator. The output frequency, when the loop is phase locked, is always a 10 MHz harmonic between 350 and 450 MHz. C3 is adjusted to set the high frequency end of the band. C1 is part of the loop filter in the control path and also provides an ac ground for the varactor at the bias point.

The oscillator output (about .5 volts rms) is coupled through an isolation transformer to two identical three-stage buffer amplifiers. The isolation transformer splits the power equally to the two amplifiers and also eliminates feedthrough of extraneous signals from one amplifier to the other. The amplifiers provide outputs that are about 1 volt rms into 50 ohms.

Additional isolation from extraneous signals is provided by separate power supply inputs to the two amplifiers, extensive decoupling between stages, multiple grounding points for individual stages and separation of ground planes for individual stages.

CR2 is a stabistor used for temperature compensation for the voltage controlled oscillator. The forward voltage drop of the stabistor changes with the voltage controlled oscillator temperature and controls a current source (A4A6Q14) in the pretuning assembly.

HF Loop Phase Detector
SERVICE SHEET 5

A4A5

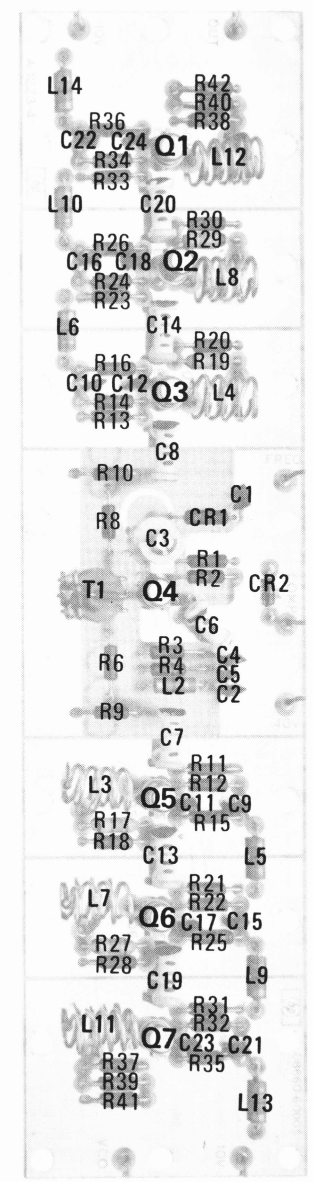


Figure 8-22. A4A5 HF Loop VCO Component Locations

A4 TOP VIEW

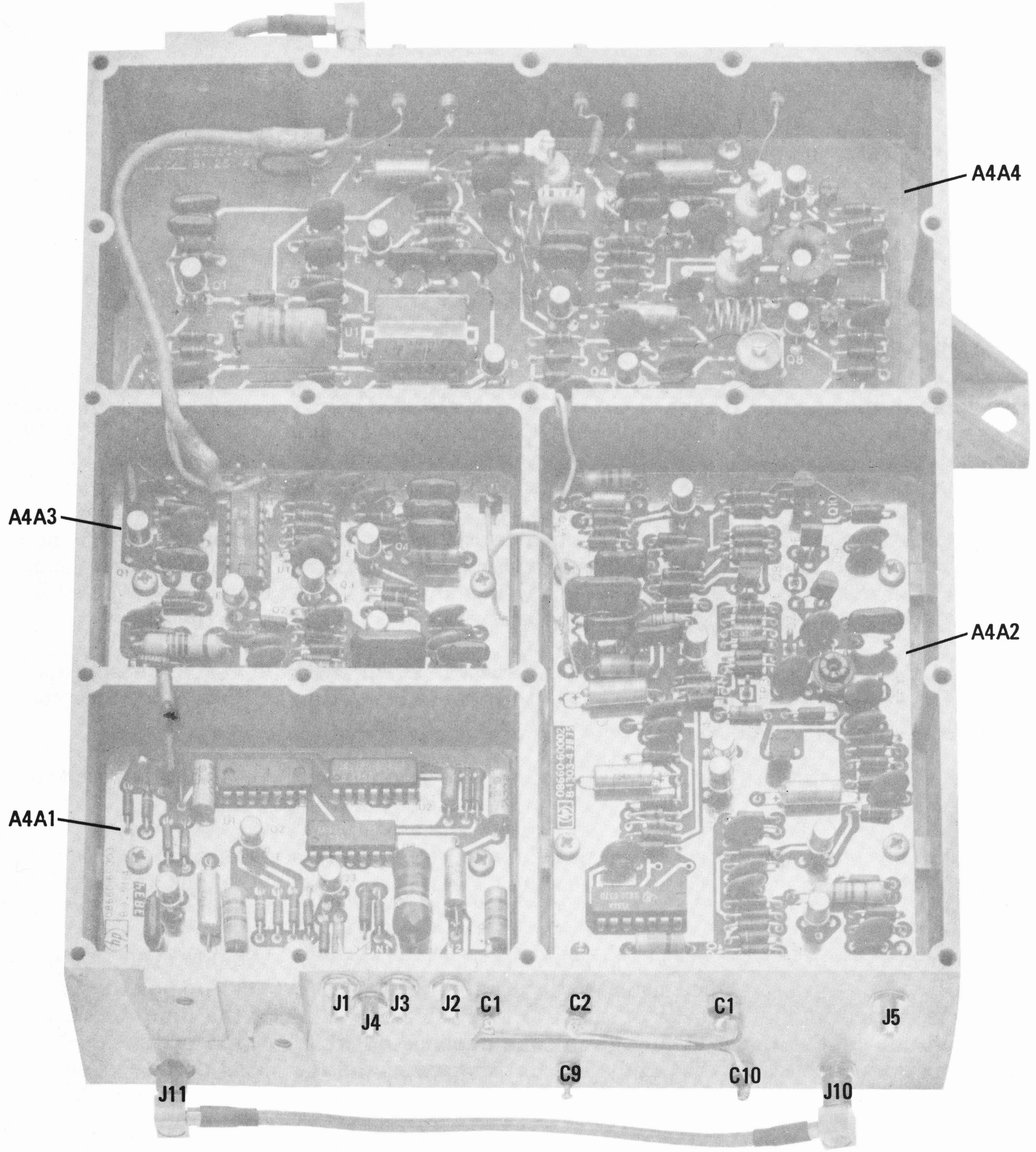


Figure 8-23. A4 Assembly Top View

A4 BOTTOM VIEW

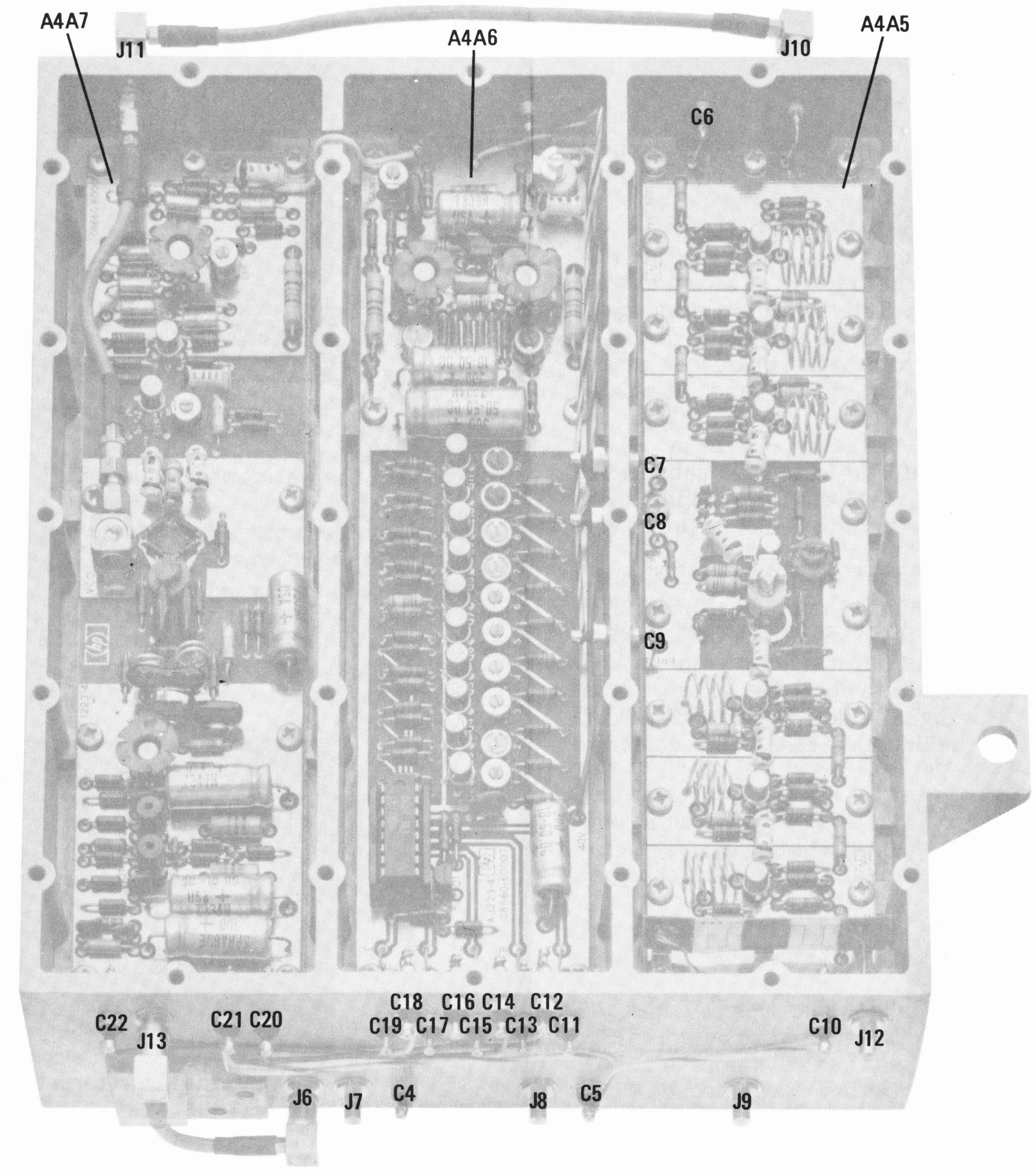
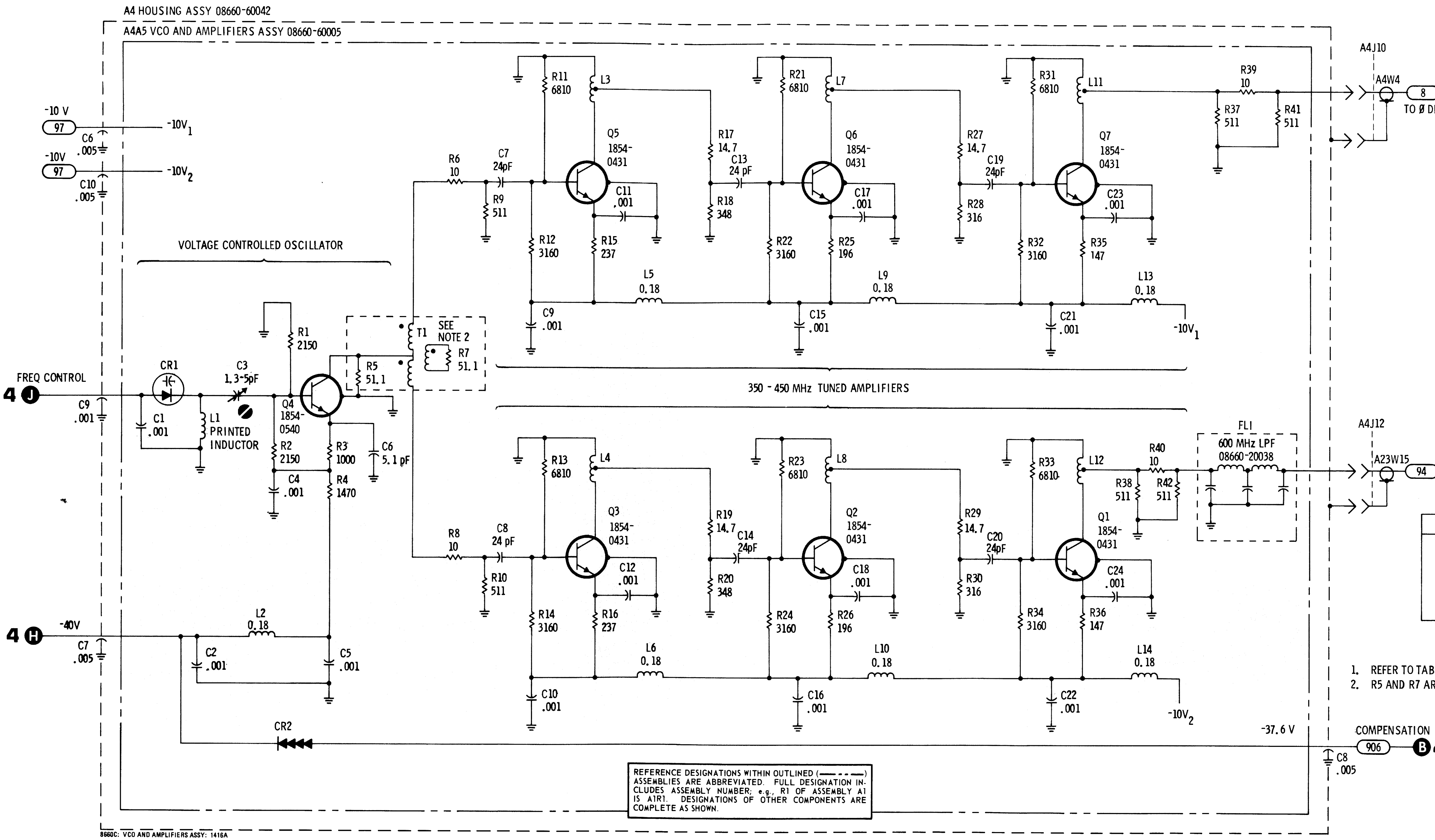


Figure 8-24. A4 Assembly Bottom View



REFERENCE DESIGNATIONS

A4	A4A5
C6-10 J10, 12	C1-24 CR1 L1-14 Q1-7 R1-42 T1

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. R5 AND R7 ARE PART OF THE T1 ASSEMBLY.

6

Figure 8-25. VCO and Amplifiers Schematic

SERVICE SHEET 7

N1 PHASE DETECTOR ASSEMBLY A16

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A16 assembly, a part of the two-assembly N1 phase lock loop is shown schematically and described on this service sheet. The N1 Oscillator assembly, A17, is shown schematically and described on Service Sheet 8.

When trouble has been isolated to the A16 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs in any part of the N1 loop circuits the adjustment procedures specified in Section V paragraph 5-29 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (see Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

N1 LOOP GENERAL INFORMATION

The purpose of the N1 loop is to generate digitally controlled RF signals in the range of 19.8 to 29.7 MHz in selectable 100 kHz increments. The voltage controlled oscillator is phase locked to a 400 kHz reference which is derived from the master oscillator in the reference section. The RF output from the N1 loop is applied to Summing Loop 1.

1 PROGRAMMABLE DIVIDER CIRCUIT

The integrated circuits in the A16 assembly, except for U1, are all used to count down the input from the N1 voltage controlled oscillator. When there is no BCD input (all inputs low) and the loop is locked, the input from the voltage controlled oscillator will be 29.7 MHz; the programmable divider will divide by 297 and provide a 100 kHz output at TP3. U5 and U6 are preset by CF digits 6 and 7 and programmed to vary between start counts of 00 to 99. Operation of the circuit is as follows:

Assume that initially there are no BCD input to decade dividers U5 and U6 and they have been preset to zero. Assume also that U2A pin 6 ($\overline{Q}$) and U2B pin 8 ($\overline{Q}$) are both low. U4 pin 6 ($\overline{Q}$), U3A pin 6 ($\overline{Q}$) and U3B pin 8 ($\overline{Q}$) are all high.

AND gate U7A functions as a Schmitt trigger to change the incoming positive half cycles of the sine wave from the voltage controlled oscillator to positive-going pulses. These pulses clock U5 when AND gate U7B is enabled. U5 pin 12 provides a divided-by-ten output to clock U6 and also provides A and B (BCD 1 and 2) outputs. The A and B outputs of U5 have no effect on U4 until AND gate U7C pin 8 goes high (AND gate U7C will be discussed later in this text).

U6 pin 12 provides a divided-by-one hundred output to clock U2A and also provides A and D (BCD 1 and 8) outputs to AND gate U7C. The A and D outputs have no effect on AND gate U7C until after U2B pin 8 ($\overline{Q}$) goes high at the count of 200.

The D output of U6 (pin 12) goes high on the count of 8 (80 input pulses to U5). This output has no effect on U2A because U2A is clocked on negative-going pulses only.

The D output of U6 (pin 12) goes low at the count of 10 (100 input pulses to U5) and clocks U2A. This causes U2A pin 6 ($\overline{Q}$) to go high. When the D output of U6 (pin 12) again goes low at the count of 10 (200 input pulses to U5), U2A is again clocked and the $\overline{Q}$ output goes low to clock U2B. When U2B pin 8 ($\overline{Q}$) goes high it provides a high input to AND gate U7C pin 11.

SERVICE SHEET 7 (Cont'd)

Ninety input cycles after U2B pin 8 ($\overline{Q}$) goes high (290 input cycles), U6 A and D outputs (BCD 1 and 8) go high and enable AND gate U7C and provide a high to J input 3 of U4, U4 still cannot be clocked because U4 J pins 4 and 5 are still low.

Three input cycles after U4 pin 3 goes high (293 input cycles), the A and B outputs of U5 (BCD 1 and 2) go high and enable the J input to J-K flip-flop U4.

The 294th input cycle will clock U4 at pin 12 because all J and K inputs are high. When clocked, U4 $\overline{Q}$ goes low and AND gate U7B is no longer enabled; the count, as far as U5, U6 and U2 are concerned, is ended. When U4 $\overline{Q}$ goes low it also sets U3A and U3B; the $\overline{Q}$ outputs go low and the Q outputs go high. When U3A pin 6 ($\overline{Q}$) goes low it is used to preset U5 and U6 to the start count programmed by CF digits 6 and 7 or by remote control; U2A and U2B $\overline{Q}$ outputs are set low. When U5, U6, U2A and U2B are preset the J input to U4 is no longer enabled since the count is no longer at the 'sense' count of 293.

When U3B pin 9 (Q) goes high the leading edge is used to generate the sampling pulse. The first pulse to the sampling phase detector is initiated by the 294th input cycle. Since three more cycles are required to restart the count cycle, following sampler pulses are 297 cycles apart.

The 295th input cycle will clock U4 and since U4 K is high, U4 $\overline{Q}$ will go high. This $\overline{Q}$ high is applied to the K input of U3A (pin 2) and to pin 4 of AND gate U7B. AND gate U7B will not be enabled because U3B pin 8 ($\overline{Q}$) is holding AND gate U7B pin 5 low.

The 296th input cycle will clock U3A because the K input is now high. U3A pin 6 ($\overline{Q}$) will go high. This high $\overline{Q}$ output is applied to AND gate U7B pin 5 and the next count cycle is enabled through AND gate U7B.

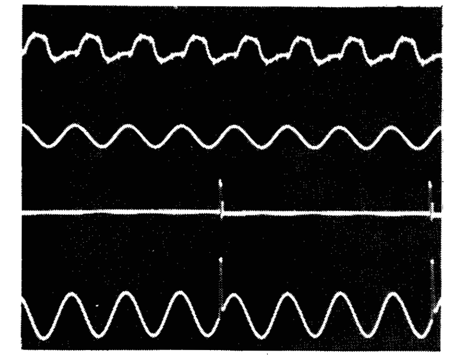
When there is a preset input programmed into U5 and U6 pins 3, 4, 10 and 11 the terminal count is still 297. However, the count starts at the number programmed into the BCD inputs. As an example, if the BCD input into U5 and U6 is 99, the first cycle would cause the same digital circuit changes that the 100th cycle caused in the discussion above (U2A would be clocked). The frequency division would be 297 - 99, equal to division by 198. The phase lock loop operation would result in an input frequency to the programmable divider of 19.8 MHz. When divided by 198, the divider output at TP3 would again be 100 kHz.

The output from U3B at TP3 is always 100 kHz when the voltage controlled oscillator is phase locked to the reference signal.

Q6 and CR1 provide Vcc to U3 to minimize the effect of power supply ac ripple and line variations.

TEST PROCEDURE 1

Composite waveform SS7-1 illustrates the proper timing relationship between the 400 kHz reference input, the pulse output from the pulse generator and the sampling point on the 400 kHz reference signal when the loop is phase locked.



Composite Waveform SS7-1

NOTE

In the following tests the CF is set to 0 unless otherwise noted.

Test 1-a. Use the frequency counter to check for 400.000 kHz at TP5.

If the 400.000 kHz signal is displayed on the counter, verify that the sine wave at TP5 is as shown in trace 2 of composite waveform SS7-1. If the signal is as shown proceed to test 1-b.

If the 400 kHz signal cannot be counted or does not appear as shown on the composite waveform for TP5, check the reference input at XA16-1-2. The reference input signal should be about 4 volts peak-to-peak and 400 kHz as shown in trace 1 of composite waveform SS7-1. If the correct waveform is observed, but was not observed at TP5, check Q1, Q2 and associated components. If the correct waveform is not present, check the cabling to the reference loop and, if necessary, the reference loop (See Service Sheet 3).

If trouble is found and corrected, perform the adjustment procedures specified in paragraph 5-16 to verify proper operation of the loop.

Test 1-b. Connect one oscilloscope channel and the counter to TP4 and the other oscilloscope channel to the junction of C20, R24 and T1. If the loop is locked the waveforms will be as shown in traces 3 and 4 of composite waveform SS7-1 and the counter will display 100.000 kHz.

Note that the waveform shown by trace 3 of the composite waveform may appear as shown even if the counter does not indicate 100.000 kHz. This is because the frequency sensitivity of the oscilloscope is not as exacting as the frequency sensitivity of the counter.

If the programmable divider and the pulse shaper are working properly but the loop is not locked, trace 4 as shown in composite waveform SS7-1 may still show the pulses, but the signal between the pulses will be erratic.

Test 1-c. If the pulses are not present at TP4 or the junction of C20, R24 and T1 and the counter counts randomly or not at all, connect the oscilloscope to TP3. The oscilloscope should display a waveform similar to that shown in trace 3 of the composite waveform SS7-1 at about half the amplitude.

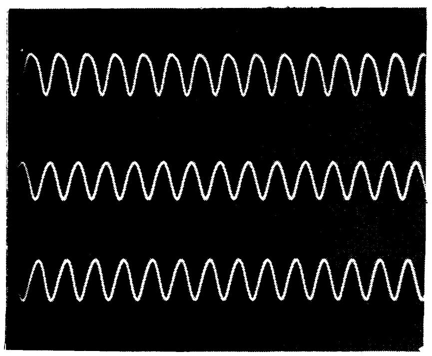
If the pulses are not present at TP3 proceed to test 1-d.

If the pulses are present at TP3 but were not present at TP4, check Q4, Q5 and associated components. After repairs are made recheck test procedure 1-b.

If the pulses are now present at TP4 and the junction of C20, R24 and T1, but the four-cycle sine wave is not present as shown in trace 4 of composite waveform SS7-1, rotate R38 through its range to see if the proper waveform can be obtained. If the frequency displayed on the counter does change as R38 is rotated but phase lock cannot be achieved, check Q3, the sampling diodes and associated components.

Test 1-d. If the pulse is not present at TP3 in test 1-c connect the oscilloscope to AND gate U7B pin 6. The waveform should be as shown in the top trace of composite waveform SS7-2. If the correct signal is observed proceed to test 1-e.

If the correct signal is not observed connect the oscilloscope to TP1. The waveform should be as shown in the center trace of composite waveform SS7-2. If the signal is present, but was not present at AND gate U7B pin 6, use the digital voltmeter to check the voltage at pins 4 and 5 of AND gate U7B. The digital voltmeter should indicate about 4 volts. If the voltages are present AND gate U7B is defective.



Composite Waveform SS7-2

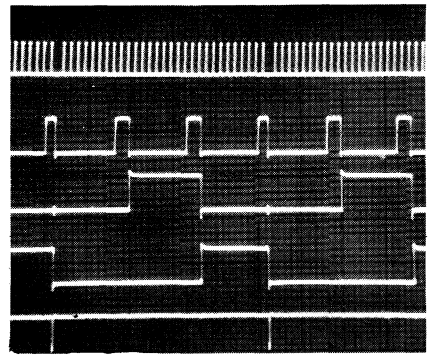
If the voltages are not present at AND gate U7B pins 4 and 5, ground pin 2 of U4. If the signal now appears at AND gate U7B pin 6, U3 and U7B are functioning properly. The trouble is probably in the gating circuit to U4. Proceed to test 1-e.

If the signal is not present at TP1, use the oscilloscope to check the input from the voltage controlled oscillator at XA16-2-15. The signal should be as shown in the lower trace in composite waveform SS7-2.

SERVICE SHEET 7 (Cont'd)

If the signal is present AND gate U7A is probably defective. If the signal is not present, the A17 assembly or interconnections are defective.

Test 1-e. It is assumed in this test that the signal from the N1 voltage controlled oscillator is present at U5 pin 8. Composite waveform SS7-3 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts.

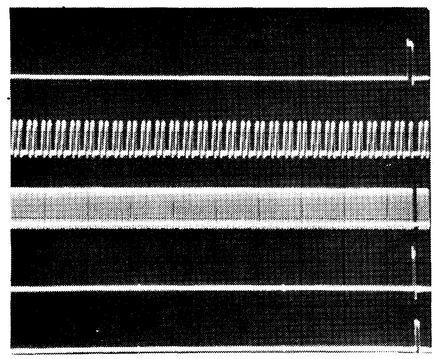


Composite Waveform SS7-3

If none of the waveforms are present, U5 is probably defective.

Note that the reset pulse in trace 5 is in time coincidence with the 'missing' pulse in trace 1 and that the reset pulse resets traces 2 and 4.

Test 1-f. Composite waveform SS7-4 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts in amplitude. Sync the oscilloscope to TP3 for this test.



Composite Waveform SS7-4

Note that U4 pin 8 goes high only when all of the J inputs (U4 pins 3, 4 and 5) are high.

If the waveforms for traces 2 and/or 3 are not present, U5 is probably defective.

If the waveforms for traces 1, 4 and 5 are not present, proceed to test 1-g.

Test 1-g. Composite waveform SS7-5 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts in amplitude. Sync the oscilloscope to TP3 for this test.

HF Loop VCO
◀ SERVICE SHEET 6

7 (Cont'd)

nay still show the pulses, but the signal between the
tic.

ulses are not present at TP4 or the junction of C20,
the counter counts randomly or not at all, connect
o TP3. The oscilloscope should display a waveform
own in trace 3 of the composite waveform SS7-1 at
plitude.

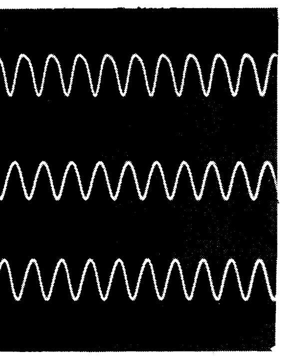
ot present at TP3 proceed to test 1-d.

present at TP3 but were not present at TP4, check
ciated components. After repairs are made recheck
).

now present at TP4 and the junction of C20, R24
four-cycle sine wave is not present as shown in trace
raveform SS7-1, rotate R38 through its range to see
eform can be obtained. If the frequency displayed
oes change as R38 is rotated but phase lock cannot
heck Q3, the sampling diodes and associated

pulse is not present at TP3 in test 1-c connect the
ND gate U7B pin 6. The waveform should be as
trace of composite waveform SS7-2. If the correct
proceed to test 1-e.

nal is not observed connect the oscilloscope to TP1.
ould be as shown in the center trace of composite
If the signal is present, but was not present at AND
use the digital voltmeter to check the voltage at pins
) gate U7B. The digital voltmeter should indicate
the voltages are present AND gate U7B is defective.



te Waveform SS7-2

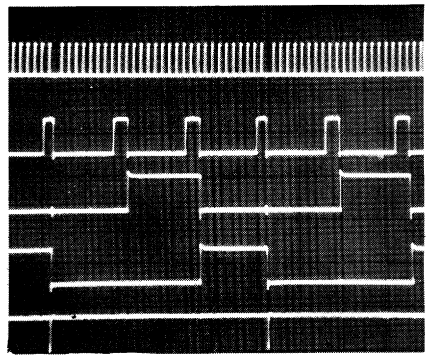
e not present at AND gate U7B pins 4 and 5, ground
he signal now appears at AND gate U7B pin 6, U3
ctioning properly. The trouble is probably in the
J4. Proceed to test 1-e.

ot present at TP1, use the oscilloscope to check the
oltage controlled oscillator at XA16-2-15. The signal
wn in the lower trace in composite waveform SS7-2.

SERVICE SHEET 7 (Cont'd)

If the signal is present AND gate U7A is probably defective. If the signal is not present, the A17 assembly or interconnections are defective.

Test 1-e. It is assumed in this test that the signal from the N1 voltage controlled oscillator is present at U5 pin 8. Composite waveform SS7-3 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts.

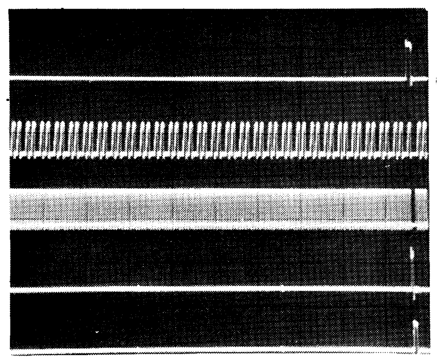


Composite Waveform SS7-3

If none of the waveforms are present, U5 is probably defective.

Note that the reset pulse in trace 5 is in time coincidence with the 'missing' pulse in trace 1 and that the reset pulse resets traces 2 and 4.

Test 1-f. Composite waveform SS7-4 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts in amplitude. Sync the oscilloscope to TP3 for this test.



Composite Waveform SS7-4

Note that U4 pin 8 goes high only when all of the J inputs (U4 pins 3, 4 and 5) are high.

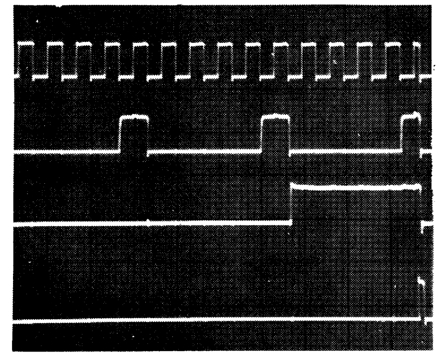
If the waveforms for traces 2 and/or 3 are not present, U5 is probably defective.

If the waveforms for traces 1, 4 and 5 are not present, proceed to test 1-g.

Test 1-g. Composite waveform SS7-5 illustrates the correct waveforms at the points shown. All signals are about 4.5 volts in amplitude. Sync the oscilloscope to TP3 for this test.

HF Loop VCO
SERVICE SHEET 6

SERVICE SHEET 7 (Cont'd)



Composite Waveform SS7-5

If the inputs to AND gate U7C are not as shown, U6 or U2 may be defective.

If the inputs are as shown but there is no output at AND gate U7C pin 8, U7 is defective.

2 PULSE AMPLIFIER

The positive-going output from U3B pin 9 is used to generate the pulse required to open the sampler gate. Common base amplifier Q5 and emitter follower Q4 amplifies and couples the pulse to T1. CR2 and CR3 are used to minimize flyback action. CR3 also bypasses the negative-going pulse around the transformer primary to ensure that only the positive-going pulse is coupled to the transformer secondary.

A 400 kHz signal from the reference loop is applied to the secondary center tap of T1. L5 and C8 (along with C7 in the reference loop A4A1 assembly) comprise a low pass filter with a cut off frequency of about 500 MHz. The TTL input from the reference loop is reshaped into a sine wave by the low pass filter. L6 and C13 comprise a tuned circuit which bypasses unwanted signals and further filters the sine wave.

Sampler diodes CR4 and CR5 are normally reverse biased. When the sampling pulse appears across the secondary of T1 it is coupled through C20 and C21 to forward bias CR4 and CR5. Since the gate pulses are equal in amplitude but opposite in polarity, they will cancel at TP6.

While CR4 and CR5 are forward biased the sampling gate is open and the 400 kHz reference signal is sampled.

This type of sampling phase detector may be phase locked at virtually any point on the sine wave curve. Ideally, the zero crossover point of the sine wave should be used to improve the lock and hold-in capability of the loop.

If the divided down output of the voltage controlled oscillator in the A17 assembly (100 kHz pulses) is not phase locked to the 400 kHz reference signal an ac signal is developed at TP6. The polarity of the signal at any given time depends on the polarity of the 400 kHz reference signal at the time the last sample was taken. The amplitude of the signal at any given time depends on what portion of the sine wave the last sample was taken from. Each time CR4 and CR5 are forward biased the signal derived from the 400 kHz reference signal at T1 terminals 4 and 6 are coupled through the sampling gate to control the charge on C22.

When the sampling gate pulse ends, CR4 and CR5 are again reverse biased and the sampling gate is closed. Since Q3 is a high impedance device, the charge will remain on C22 until the next sampling pulse. The error signal from Q3 is applied to the summing amplifier in the A17 assembly through operational amplifier U1.

Test point 8 may be grounded to open the phase lock loop. Since the emitter of A17Q4 in the A17 assembly is also almost exactly at dc ground level, grounding this test point will not affect the pretuning circuit. With the loop open both the pretuning and the error signal may be checked.

SERVICE SHEET 7 (Cont'd)

TEST PROCEDURE 2

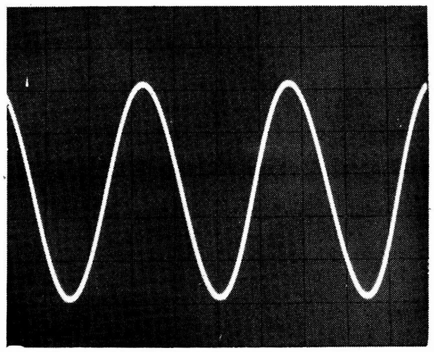
Test 2-a. Connect the oscilloscope to TP6. If the 400 kHz signal is present one of the sampling gate diodes (CR4 or CR5) is probably shorted. If the gate pulses are present one of the sampling gate diodes is probably open (negative-going pulses CR5, positive-going pulses, CR4). Proceed to test 2-b.

Test 2-b. With the oscilloscope connected to TP6, ground TP8. The signal displayed should be similar to that shown in waveform SS7-6, at about 3 volts. The frequency of the signal will be determined by the difference detected by the sampling gate (typically 200 to 400 Hz).

If the signal is present at TP6, connect the oscilloscope to U1 pin 6. The sine wave should be about the same as that shown for TP6 except that the sampling points will not be as obvious.

If the signal is present at U1 pin 6 the error amplifier and the sampling circuits are functioning properly.

If the signal is not present at U1 pin 6, but was present at TP6, check U1 and associated components. After repairs are made repeat the test and remove the ground from TP8.



Waveform SS7-6

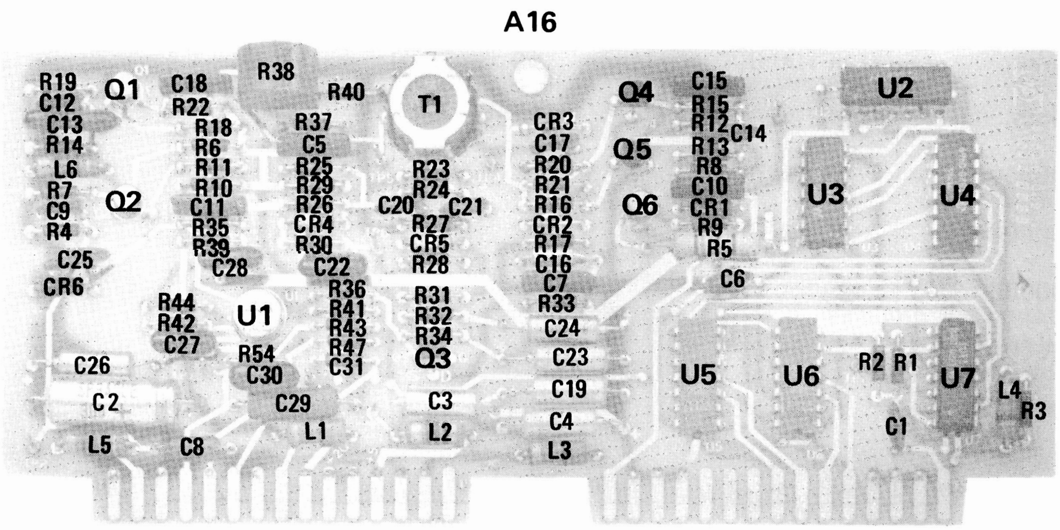
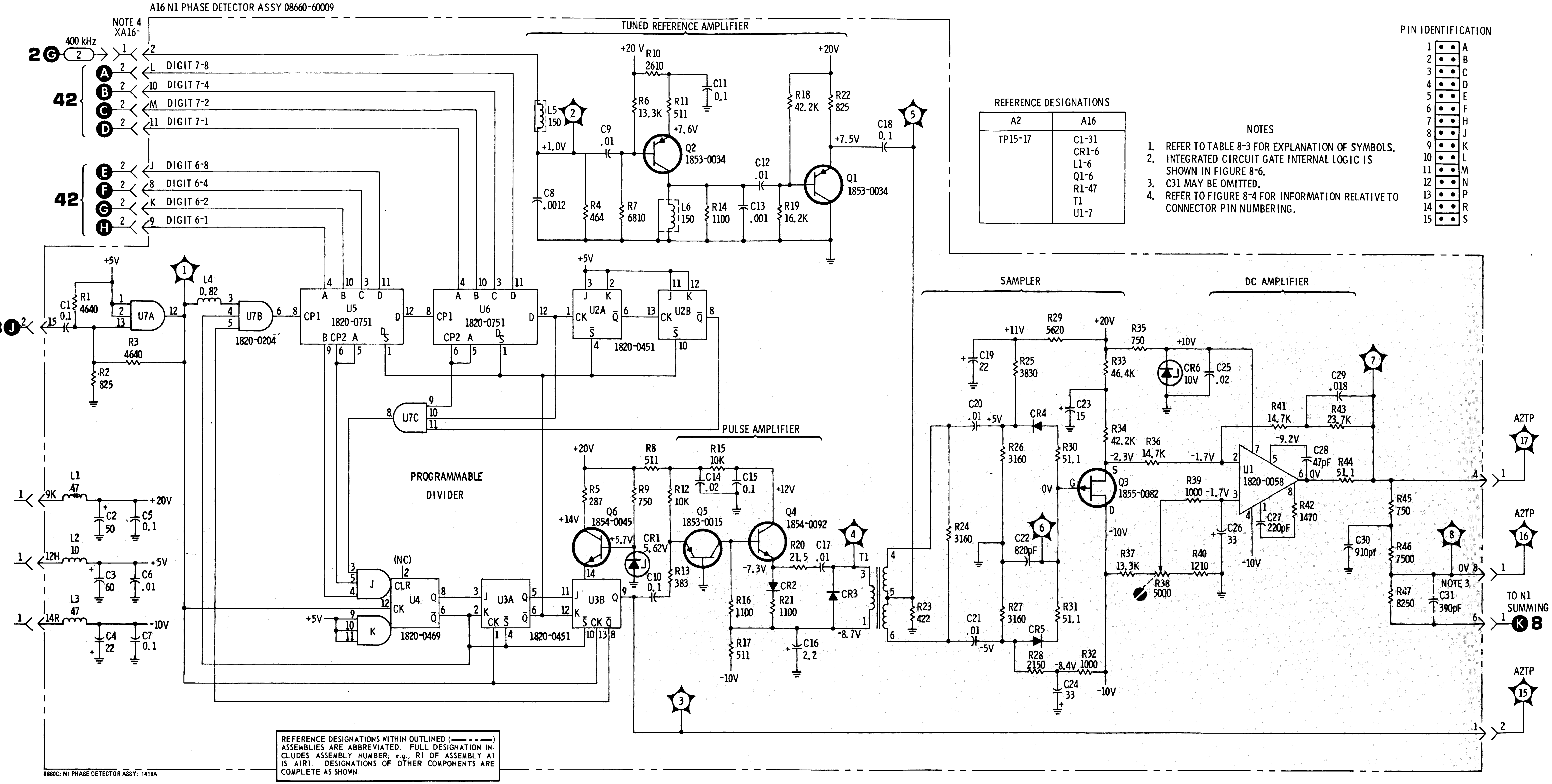


Figure 8-26. A16 N1 Phase Detector Component Locations



7

Figure 8-27. N1 Phase Detector Schematic

SERVICE SHEET 8

N1 PRETUNING AND OSCILLATOR ASSEMBLY A17

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A17 assembly, a part of the two-assembly N1 phase lock loop is shown schematically and described on this service sheet. The N1 Phase Detector Assembly, A16, is shown schematically and described on Service Sheet 7.

When trouble has been isolated to the A17 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs in any part of the N1 loop circuits the adjustment procedures specified in Section V paragraph 5-29 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Frequency Counter
Oscilloscope (with 10:1 divider probes)

N1 LOOP GENERAL INFORMATION

The purpose of the N1 loop is to generate digitally controlled RF signals in the range of 19.8 to 29.7 MHz in selectable 100 kHz increments. The voltage controlled oscillator is phase locked to a 400 kHz reference which is derived from the master oscillator in the reference section. The RF output from the N1 loop is applied to Summing Loop 1.

1 VOLTAGE CONTROLLED OSCILLATOR

Q3, Q5 and associated components comprise a voltage controlled oscillator. Two varactors (CR6 and CR7) are used in parallel to provide a high Q as well as the wide capacitance range required.

FET Q5 acts as a source follower in the feedback circuit; it provides high impedance at the gate and a low impedance at the source. The gain of the FET is held at less than unity to minimize the Miller effect which might reflect capacitance back into the oscillator tank circuit.

Q1 amplifies the signal from the FET and applies it to two separate amplifiers. Q10 and Q15 provide the output to drive the SL1 mixer and Q8 drives the programmable divider in the A16 assembly.

SERVICE SHEET 8 (Cont'd)

TEST PROCEDURE 1

Test 1-a. Connect the frequency counter to XA17-1-2 and set CF as shown in table 8-4. The counter readout should be as shown in the table. (Make allowances for counter accuracy).

If the counter does not display a frequency at, or close to, that specified, connect the oscilloscope to TP3. The oscilloscope should display a sine wave at about .3 volts peak-to-peak. If the sine wave is present at TP3 but there is no signal at XA17-1-2, check Q10, Q15 and associated components.

If there is no signal at TP3 check the bias level at TP2. The bias level should be about as shown in Table 8-4 for the front panel frequency setting. If the bias level is within the range of approximately −3.4 to −30 volts, and there is no signal at TP3 check Q1, Q3, Q5 and associated components. If the bias voltage is not within the range shown, proceed to 2-b.

If the counter displays the correct readout for some, but not all, of the front panel settings, proceed to 2-a.

2 PRETUNING CIRCUIT

The frequency of the voltage controlled oscillator is roughly preset by the digital to analog converter (U1, U2, Q11 through Q14 and Q16 through Q19). The digital to analog converter cannot, by itself, set the oscillator frequency precisely; it does set the frequency within the capture range of the phase lock loop, The inputs to U1 and U2 are BCD bits coded 8, 4, 2 and 1. When any of the BCD inputs are high they cause the output of the NAND gate to which they are connected to go low; the transistor connected to the NAND gate output is switched on.

When all of the BCD inputs are low Q9 is biased to provide approximately −25 volts at TP1 (Q7-e). With this dc level at TP1 the oscillator is roughly preset to 29.7 MHz.

When any one or more of the BCD inputs go high the transistor associated with it saturates and the current through Q9 is reduced. The reduction in current flow through Q9 changes the bias on Q7 and causes the voltage at TP1 to go less negative (closer to dc ground level). Finally, when the BCD input is 99, the voltage at TP1 is approximately −5.2 volts and the oscillator frequency is roughly preset to 19.8 MHz.

Q4 is a summing amplifier which combines the output of the digital to analog converter and the signal from the N1 phase detector. The summing point (Q4-e) sums the current from three sources; a current source from the +20 volts supply through R31, R32 and R33, a negative source from the digital to analog converter (TP1) and the error signal from the N1 phase detector. The voltage at the summing point is always zero volts.

When TP1 is at approximately −25 volts (all inputs low), most of the current from the +20 volts source flows through Q7; very little current flows through Q4. Under these conditions the voltage at Q4-c is about −30 volts. As the voltage at TP1 decreases (gets closer to dc ground level), less current flows through Q7, more current flows through Q4, and the Q4 collector voltage goes less negative.

SERVICE SHEET 8 (Cont'd)

CR3 through CR5, CR8 through CR15 and associated resistors are used to s
the voltage applied to the voltage controlled oscillator so that the frequenc
be linear with the applied voltage. When all BCD inputs are low, Q4-c is at a
−30 volts, the junction of R43 R48 is about −27.5 volts and all of the dio
the resistive network are reverse biased. As the voltage at TP1 decreases
closer to −5.2 volts), current through Q4 increases and the Q4 collector v
goes less negative. As the Q4 collector voltage decreases first CR3, then CR
are forward biased. As the diodes are forward biased resistors are added in pa
with R38 and R39 to shape the rate at which the voltage decreases at Q4-c.

Q2 and Q5 are emitter followers which couple the output of Q4 to the vara
Q2 provides a high impedance for the output of the summing amplifier colle
R46, L7 and C14 comprise a 400 kHz trap to attenuate (15 to 20 dB) any
kHz ripple which may be present from the reference signal used in the p
detector. R51, L8, C20 and C21 comprise a low pass filter with a c
frequency of about 200 kHz.

TEST PROCEDURE 2

Table 8-29 represents typical voltage levels for test points 1 and 2 and
frequencies at XA17-1-2 for given settings of CF digits six and seven whe
loop is locked.

NOTE

While the voltages shown for TP2 are typical (they will vary from instrument to instrument due to differences in varactor characteristics), they are representative of normal ratio of TP2 to TP1 voltages.

Test 2-a. With the digital voltmeter connected to TP1 select CF's shown in T
8-4. The voltage level should approximately follow those shown in Table 8-4.

If the voltage at TP1 does not vary at all, first verify the presence of input d
information to the NAND gates, then check Q7, Q9 and associated compon

If the voltage at TP1 does not vary as shown, or some CF (or CF's) d
produce a change, first verify the presence of the input to the N
gate/transistor combination affected, then check the NAND gate and
transistor.

If the voltages at TP1 are approximately as shown in Table 8-29 proceed to
2-b.

Test 2-b. Connect the digital voltmeter to TP2 and the counter to XA17-1
the voltage at TP2 does not change about as shown in Table 8-29 for spe
CF's, or does not change at all, check Q2, Q4, Q6 and associated components

If the voltage at TP2 varies approximately as shown in Table 8-19, bu
frequency at XA17-12 does not step (or there is no RF output), refer to
Procedure 1 and check the oscillator circuits.

N1 Phase Detec
SERVICE SHE

SERVICE SHEET 8 (Cont'd)

CR3 through CR5, CR8 through CR15 and associated resistors are used to shape the voltage applied to the voltage controlled oscillator so that the frequency will be linear with the applied voltage. When all BCD inputs are low, Q4-c is at about —30 volts, the junction of R43 R48 is about —27.5 volts and all of the diodes in the resistive network are reverse biased. As the voltage at TP1 decreases (gets closer to —5.2 volts), current through Q4 increases and the Q4 collector voltage goes less negative. As the Q4 collector voltage decreases first CR3, then CR4 etc. are forward biased. As the diodes are forward biased resistors are added in parallel with R38 and R39 to shape the rate at which the voltage decreases at Q4-c.

Q2 and Q5 are emitter followers which couple the output of Q4 to the varactors. Q2 provides a high impedance for the output of the summing amplifier collector. R46, L7 and C14 comprise a 400 kHz trap to attenuate (15 to 20 dB) any 400 kHz ripple which may be present from the reference signal used in the phase detector. R51, L8, C20 and C21 comprise a low pass filter with a cutoff frequency of about 200 kHz.

TEST PROCEDURE 2

Table 8-29 represents typical voltage levels for test points 1 and 2 and exact frequencies at XA17-1-2 for given settings of CF digits six and seven when the loop is locked.

NOTE

While the voltages shown for TP2 are typical (they will vary from instrument to instrument due to differences in varactor characteristics), they are representative of normal ratio of TP2 to TP1 voltages.

Test 2-a. With the digital voltmeter connected to TP1 select CF's shown in Table 8-4. The voltage level should approximately follow those shown in Table 8-4.

If the voltage at TP1 does not vary at all, first verify the presence of input digital information to the NAND gates, then check Q7, Q9 and associated components.

If the voltage at TP1 does not vary as shown, or some CF (or CF's) do not produce a change, first verify the presence of the input to the NAND gate/transistor combination affected, then check the NAND gate and the transistor.

If the voltages at TP1 are approximately as shown in Table 8-29 proceed to Test 2-b.

Test 2-b. Connect the digital voltmeter to TP2 and the counter to XA17-1-2. If the voltage at TP2 does not change about as shown in Table 8-29 for specified CF's, or does not change at all, check Q2, Q4, Q6 and associated components.

If the voltage at TP2 varies approximately as shown in Table 8-19, but the frequency at XA17-12 does not step (or there is no RF output), refer to Test Procedure 1 and check the oscillator circuits.

N1 Phase Detector
SERVICE SHEET 7

SERVICE SHEET 8 (Cont'd)

If the voltage at TP2 varies approximately as shown in Table 8-29 and the frequency readout of the counter approximately follows the table (± 20-30 kHz) check Q8 and associated components.

Table 8-45. N1 Oscillator Test Point Measurements

Center Frequency MHz	Frequency At TP3 kHz	Voltage at TP1	Voltage at TP2
0000.100000	29600.000	—25.2v	—29.2v
0000.100000	29600.000	—25.0v	—28.7v
0000.200000	29500.000	—24.8v	—28.2v
0000.300000	29400.000	—24.6v	—27.7v
0000.400000	29300.000	—24.4v	—27.1v
0000.500000	29200.000	—24.2v	—26.6v
0000.600000	29100.000	—24.0v	—26.2v
0000.700000	29000.000	—23.8v	—25.7v
0000.800000	28900.000	—23.6v	—25.2v
0000.900000	28800.000	—23.4v	—24.7v
0001.000000	28700.000	—23.2v	—24.3v
0002.000000	27700.000	—21.2v	—20.2v
0003,000000	26700.000	—19.2v	—16.6v
0004,000000	25700.000	—17.2v	—13.6v
0005.000000	24700.000	—15.2v	—11.9v
0006.000000	23700.000	—13.2v	—8.9v
0007.000000	22700.000	—11.2v	—7.1v
0008.000000	21700.000	—9.2v	—5.6v
0009.000000	20700.000	—7.1v	—4.3v
0009.900000	19800.000	—5.3v	—3.4v

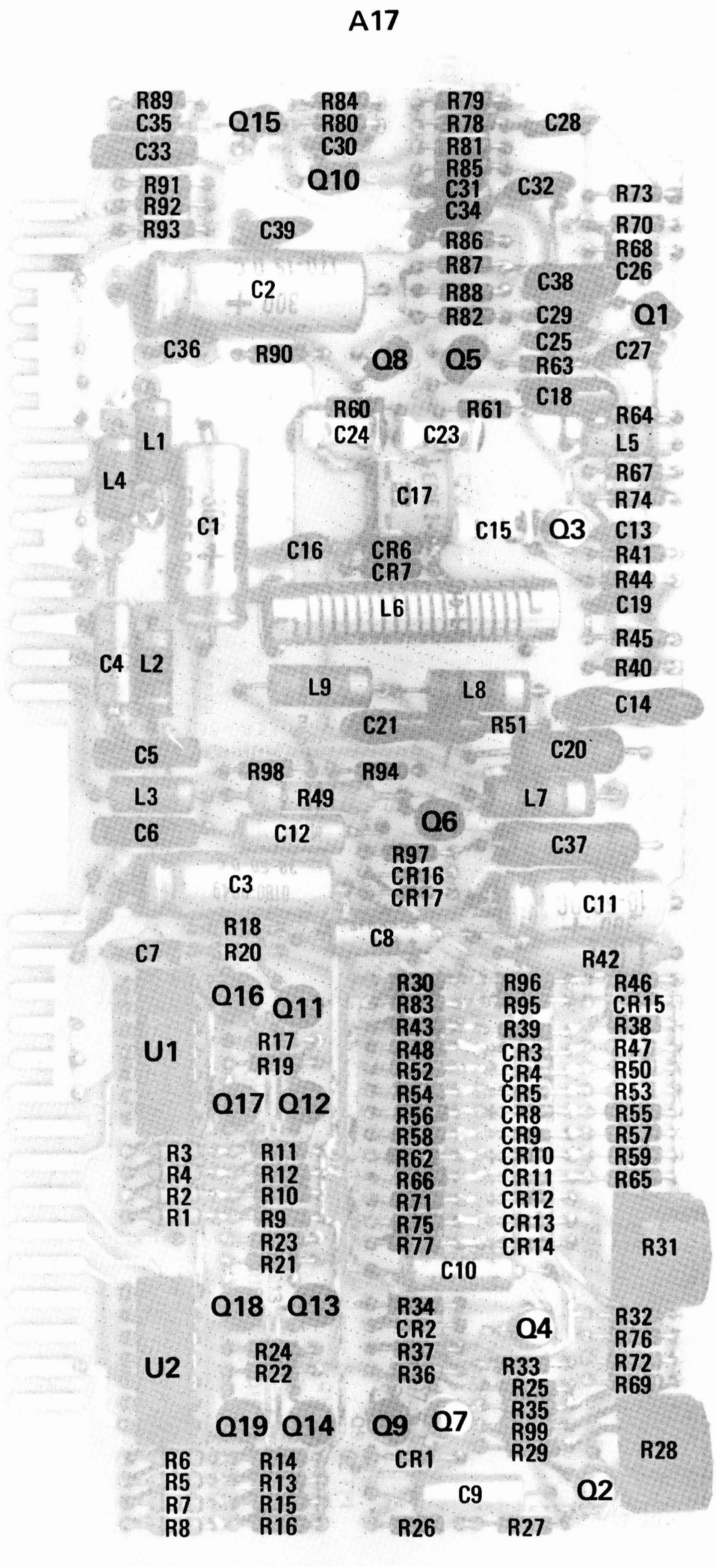


Figure 8-28. A17 N1 VCO Component Locations

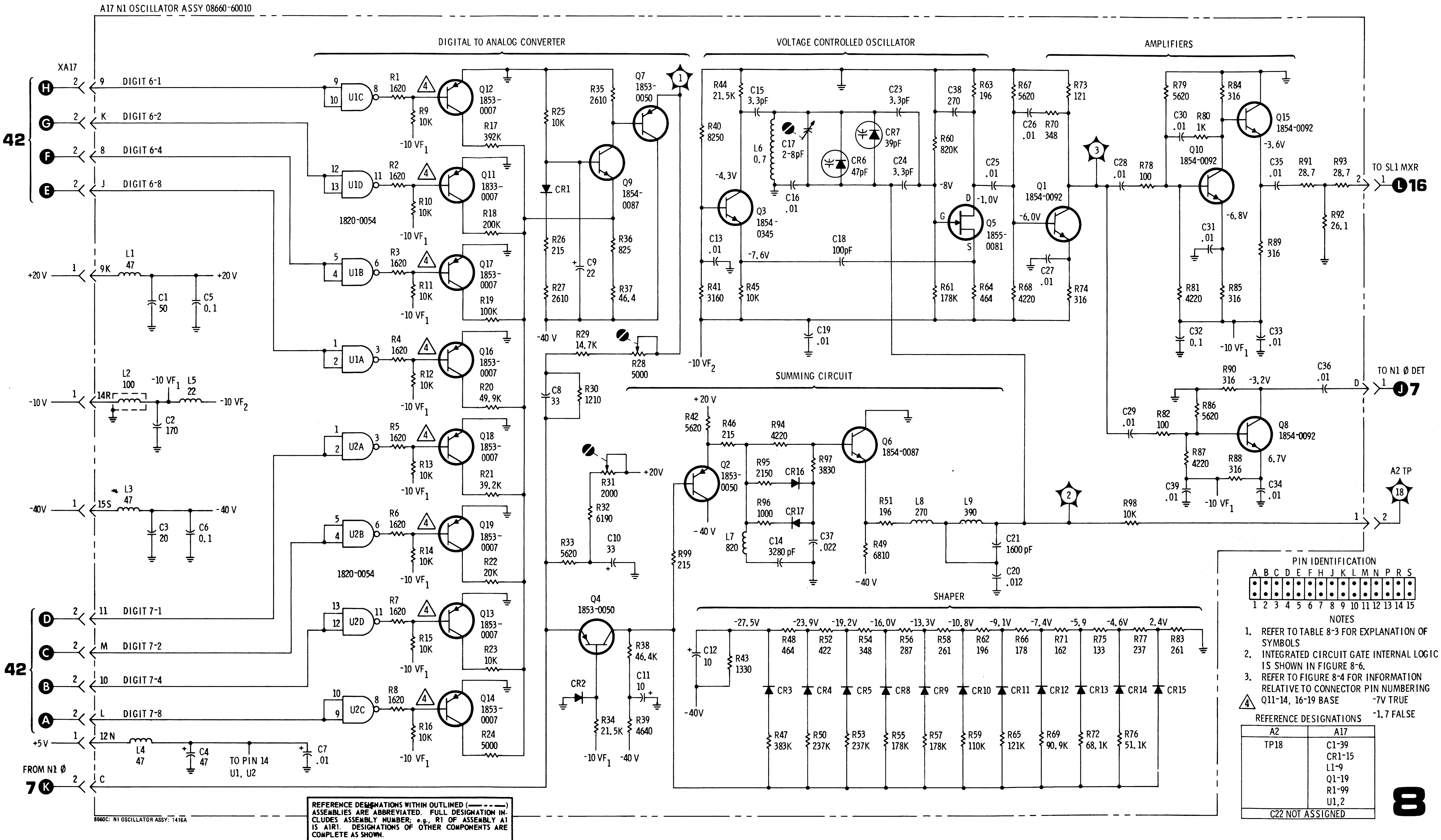


Figure 8-29. N1 VCO Schematic

SERVICE SHEET 9

N2 PHASE DETECTOR ASSEMBLY A14

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A14 assembly, a part of the two-assembly N2 phase lock loop is shown schematically and described on this Service Sheet. The N2 Oscillator assembly, A13, is shown schematically and described on Service Sheet 10.

When trouble has been isolated to the A14 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs in any part of the N2 loop circuits the adjustment procedures specified in Section V paragraph 5-30 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

N2 LOOP GENERAL INFORMATION

The purpose of the N2 loop is to generate digitally controlled RF signals in the range of 19.80 to 29.79 MHz in selectable 10 kHz increments. The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The RF output from the N2 loop is applied to Summing Loop 2.

1 PROGRAMMABLE DIVIDER CIRCUIT

All of the integrated circuits in the A14 assembly are used to count down the input from the N2 voltage controlled oscillator.

When there is no BCD input to U5, U6 and U7 (all inputs low) the input from the oscillator will be 29.79 MHz; the programmable divider will divide by 2979 to provide a 10 kHz output. U5, U6 and U7 may be preset by CF digits 3, 4 and 5 and programmed to vary between counts of 1980 and 2979. Operation of the circuit is as follows:

Assume that initially there are no BCD inputs to U5, U6 and U7 (divide-by-ten decades) and they have all been preset to zero.

At the start of every count cycle, regardless of the BCD input, U1A pin 6 ($\overline{Q}$) and U1B pin 8 ($\overline{Q}$) are both low; U3 pin 6 ($\overline{Q}$), U4A pin 6 ($\overline{Q}$) and U4B pin 8 ($\overline{Q}$) are all high.

NAND gate U8C functions as a Schmitt trigger and provides pulses derived from the N2 voltage controlled oscillator output to clock U7 when AND gate U2B is enabled. U7 provides a divide-by-ten output to clock U6 and also provides A and C (binary 1 and 4) outputs to J inputs of JK flip-flop U3. The A and C outputs have no effect on U3 until the count down reaches 2975.

U6 provides a divide-by-ten output to clock U5 and also provides A, B and C (binary 1, 2 and 4) outputs to AND gates U2A and U2C. The A, B and C outputs have no effect on the circuit until the count down of 2970 is reached.

U5 provides a divide-by-ten output to clock U1A and also provides A and D outputs to NAND gate U8A. The A and D (binary 1 and 8) outputs have no effect on the circuit until the count down has reached 2900.

The D output of U5 (pin 12) goes low on the 1000th pulse input to U7 pin 8 and clocks U1A. One thousand input cycles later U1A is again clocked and the negative-going $\overline{Q}$ output

SERVICE SHEET 9 (Cont'd)

of U1A (pin 6) clocks U1B. When U1B $\overline{Q}$ goes high it provides a high to AND gate U2A. The count down has reached 2000.

When the count down reaches 2900,U5 A and D outputs are high. NAND gate U8A pin 3 goes low and NAND gate U8B pin 6 goes high.

When the count down reaches 2970, U6 A, B and C outputs are high. The B and C outputs are applied to AND gate U2C pins 10 and 11, and since U2C pin 9 has been high since the count of 2900, U2C pin 8 goes high. The U6A output is applied to AND gate U2A, and since the other two inputs to U2A are high, U2A pin 12 goes high and is applied to U3 J input pin 3.

When the count down reaches 2975, U7 A and C high outputs are applied to U3 J input pins 4 and 5. Since U3 J pin 3 is now held high, the next input pulse from U8C will clock U3. Count coincidence at 2975 cycles has been achieved.

When the count down reaches 2976, U3 is clocked and the U3 $\overline{Q}$ output goes low. When U3 $\overline{Q}$ goes low, AND gate U2B is no longer enabled; the count, as far as U7, U6, U5 and U1 are concerned is ended. When U3 $\overline{Q}$ goes low it also sets U4A and U4B; the $\overline{Q}$ outputs go low and the Q outputs go high. When the $\overline{Q}$ output of U4B goes low it presets U7, U6, U5 and U1. When U7, U6, U5 and U1 are preset the J inputs to U3 are inhibited since the count is no longer at the coincident count of 2975.

When the U4B Q output goes high the leading edge of the pulse is used to generate the sampler pulse. The first pulse to the sampling phase detector is initiated by the 2976th input cycle. Since three more cycles are required to restart the count cycle, following sampler pulses will be 2979 cycles apart.

When the count down reaches 2977, U3 is again clocked and since the K input is high and the J input is low, $\overline{Q}$ will go high. This $\overline{Q}$ high is applied to the K input of U4A and to pin 4 of AND gate U2B. U2B will not be enabled because U4B $\overline{Q}$ is holding AND gate U2B pin 5 low.

When the count down reaches 2978 U4A is clocked because the K input is high. U4A $\overline{Q}$ goes high and is applied to the K input of U4B.

On the 2979th input cycle, U4B is clocked and the $\overline{Q}$ output goes high. When U4B $\overline{Q}$ goes high the preset pulse is ended and AND gate U2B is enabled. The next input cycle will initiate the count cycle.

When there is a preset input programmed into U7, U6 and U5, the terminal count is still 2979. However, the count down starts at the number programmed into the BCD inputs. As an example, if the binary input to U7, U6 and U5 is 999, the first input cycle would cause the same digital circuit changes that the 1000th input cycle caused in the discussion above (U1A would be clocked for the first time). The frequency division would be 2979 minus 999, equal to division by 1980. The phase lock loop operation would result in an input frequency to the programmable divider of 19.80 MHz. When the 19.80 MHz is divided by 1980 the divider output would again be 10 kHz.

The output from U4B is always 10 kHz when the oscillator is phase locked.

SERVICE SHEET 9 (Cont'd)

TEST PROCEDURE 1

Composite Waveform SS9-1 illustrates the proper timing relationship between the 100 kHz reference input, the pulse output from the pulse generator and the sampling point on the 100 kHz reference signal when the loop is phase locked.

NOTE

Center frequency is initially set to zero.

Test 1-a. Use the counter and the oscilloscope to check for a 100.000 kHz sine wave at approximately 5 volts p/p at TP5. The display should be similar to that shown in the second trace from the top in composite waveform SS9-1.

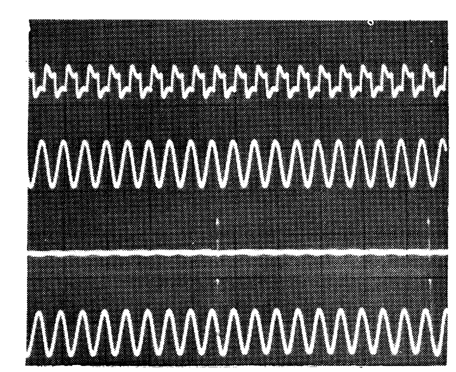
If the correct signal is present, proceed to test 1-b.

If the counter readout is 100.000 kHz but the sine wave is distorted, check Q1, Q2 and associated components.

If the signal is not present, connect the counter and the oscilloscope to XA14-1-2. The counter readout should be 100.000 kHz and the oscilloscope display should be similar to that shown in the top trace of composite waveform SS9-1.

If the correct signal is observed but was not observed at TP5, check Q1, Q2 and associated components.

If the signal is not present at XA14-1-2 check interconnections to the reference loop and, if necessary, the reference loop.



Composite Waveform SS9-1

Test 1-b. Connect the oscilloscope and the counter to TP4. The counter readout should be 10.000 kHz and the oscilloscope should display positive-going pulses as shown in composite waveform SS9-1 at about 7 volts amplitude.

SERVICE SHEET 9 (Cont'd)

If the signal is not present proceed to test 1-c. If the signal is present, connect the oscilloscope to the junction of R19 and C21. The oscilloscope display should be similar to that shown in the lower trace of composite waveform SS9-1.

If the programmable divider and the pulse generator are working properly but the loop is not phase locked, the oscilloscope may still show the signals, but the relationship between the pulses and the sine wave will not be the same as shown in composite waveform SS9-1. If the voltage controlled oscillator and the summing circuits in the A13 assembly are known to be functioning properly proceed to test procedure **2** .

Test 1-c. If the pulses are not present at TP5, and the counter counts randomly or not at all, connect the oscilloscope to TP3. The oscilloscope should display pulses at approximately 10 kHz and about 3.5 v p/p.

If the pulses are present at TP3, but were not present at TP4, check Q6, Q7 and associated components.

If the pulses are not present at TP3 proceed to test 1-d.

Test 1-d. If the pulse is not present at TP3 connect the oscilloscope to U2B pin 6. The waveform should be similar to that shown in the top trace of composite waveform SS9-2. If the signal is as shown proceed to test 1-e.

If there is no signal present at AND gate U2B pin 6 connect the oscilloscope to TP1. The waveform should be similar to that shown in the center trace of composite waveform SS9-2. If the signal is now present, use the digital voltmeter to check the voltage at AND gate U2B pins 4 and 5. The digital voltmeter should indicate about +3.7 volts; if it does, U2B is defective.

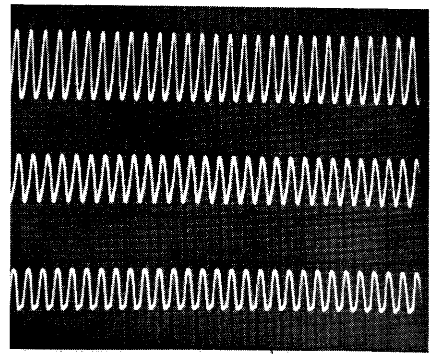
If the voltages are not present at AND gate U2B pins 4 and 5, ground U3B pin 2. If the voltages now appear at AND gate U2B pins 4 and 5 and the signal appears at U2B pin 6, U2B is functioning properly; the trouble is probably in the gating circuits to U3.

If the voltage is present at AND gate U2B pin 4 with U3 pin 2 grounded, but is not present at U2B pin 5, U4 is probably defective.

If the voltages are not present at AND gate U2B pins 4 or 5 with U3 pin 2 grounded, U3 is probably defective.

If the signal is not present at TP1, use the oscilloscope to check the voltage controlled oscillator input at XA14-2-15. The display should be similar to the lower trace in composite waveform SS9-2. If the signal is present NAND gate U8C is probably defective. If the signal is not present check interconnections to the A13 assembly and, if necessary, the A13 assembly.

SERVICE SHEET 9 (Cont'd)



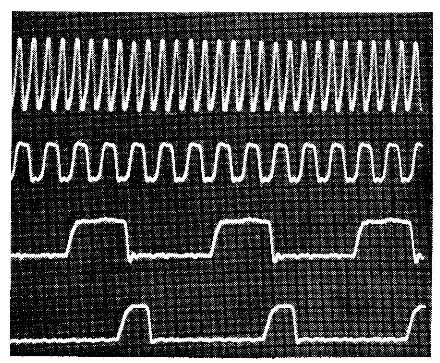
Composite Waveform SS9-2

Test 1-e. It is assumed in this test that the signal input is present at U7 pin 8 only because U3 pin 2 is grounded. Composite waveforms SS9-3 through SS9-7 illustrate the correct waveforms for the integrated circuits in the programmable divider loop. All waveforms are about 4.5 volts in amplitude. Follow the numerical sequence of the waveforms; when an IC output is missing the trouble is found. Replace the defective component, remove the ground from U3 pin 2, and repeat test 1-b.

Composite waveform SS9-8 illustrates the proper waveforms for U3 under normal operating conditions.

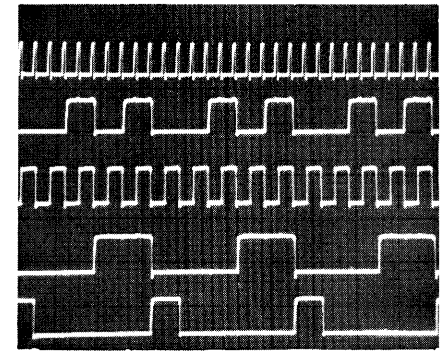
NOTE

Composite waveforms SS9-7 and SS9-8 waveform pictures were taken with the oscilloscope being triggered from TP3 and the oscilloscope sweep magnified X10.

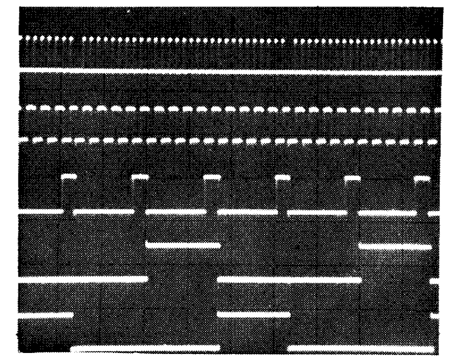


Composite Waveform SS9-3

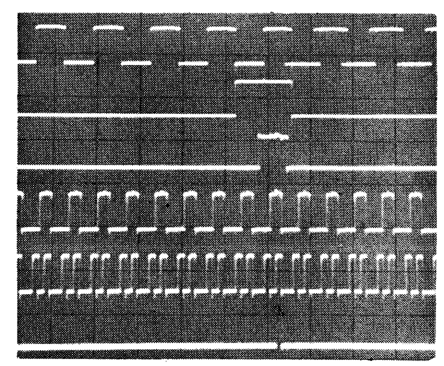
SERVICE SHEET 9 (Cont'd)



Composite Waveform SS9-4



Composite Waveform SS9-5



Composite Waveform SS9-6

Continued on Page 8-1

N1 VCO
SERVICE SHEET 8

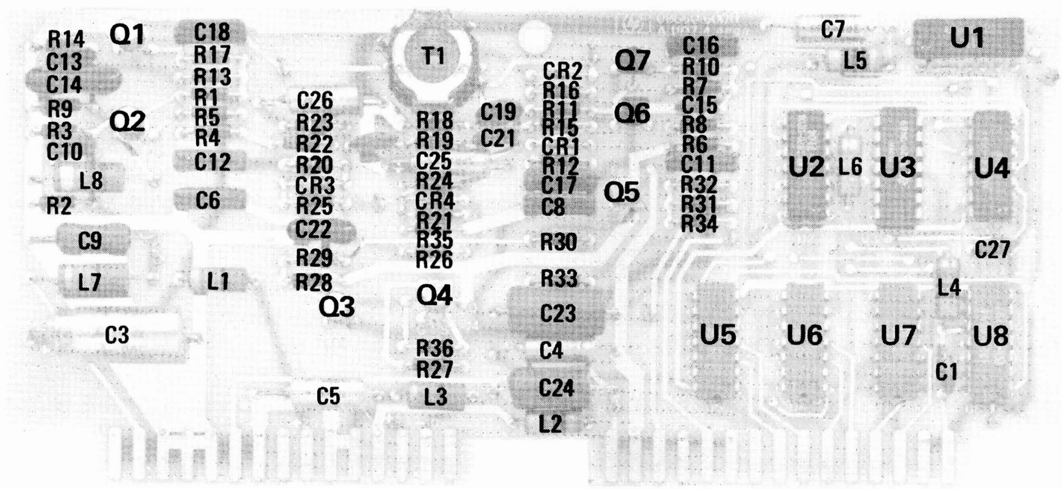
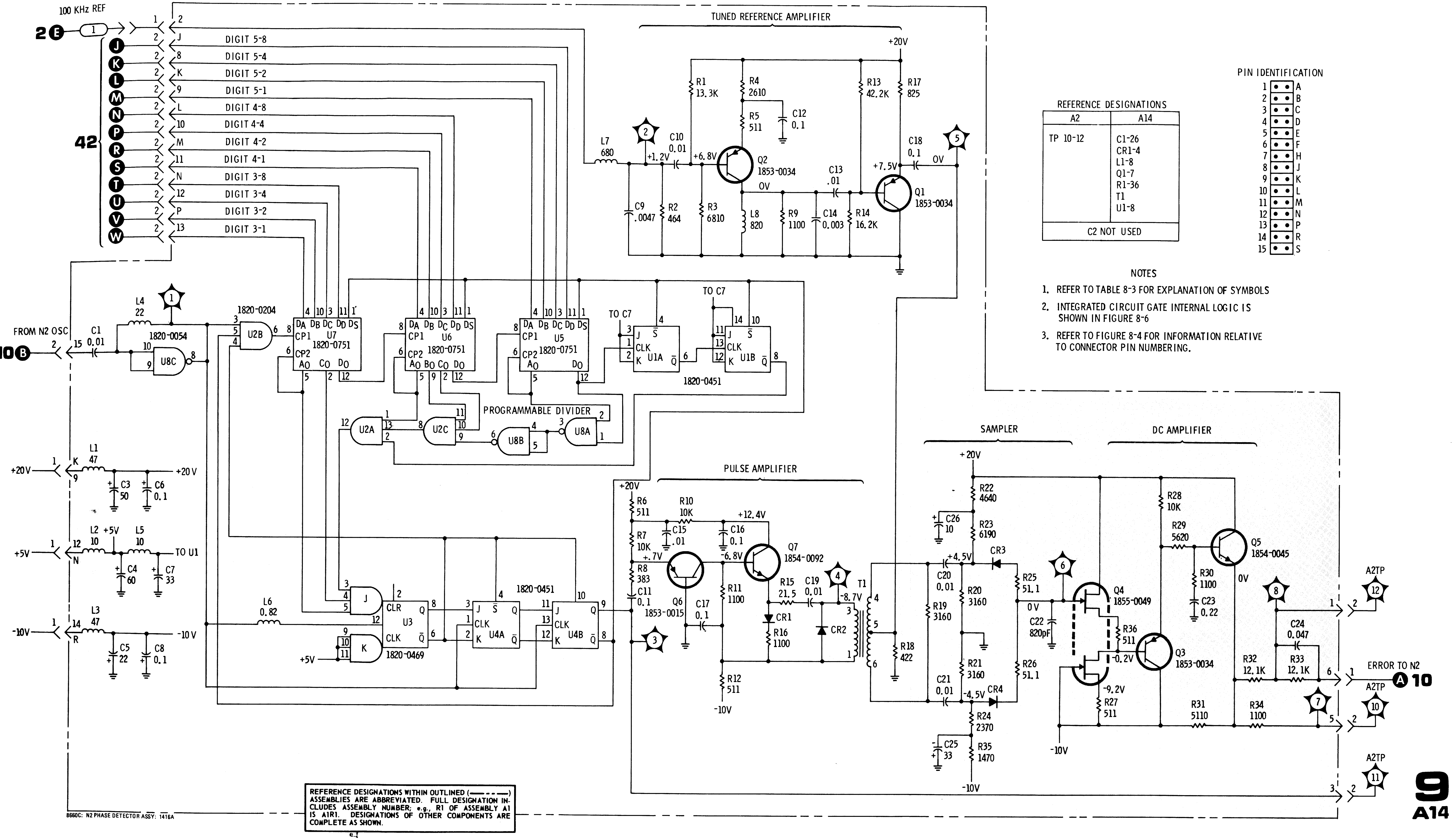


Figure 8-30. A14 N2 Phase Detector Component Locations



REFERENCE DESIGNATIONS

A2	A14
TP 10-12	C1-26 CR1-4 L1-8 Q1-7 R1-36 T1 U1-8
C2 NOT USED	

PIN IDENTIFICATION

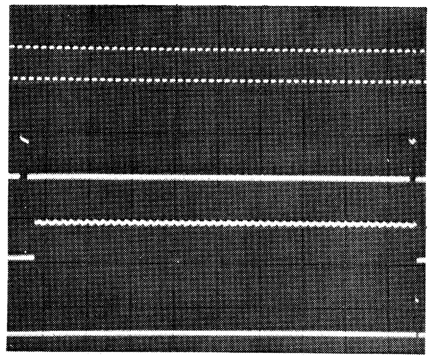
1	A
2	B
3	C
4	D
5	E
6	F
7	H
8	J
9	K
10	L
11	M
12	N
13	P
14	R
15	S

NOTES

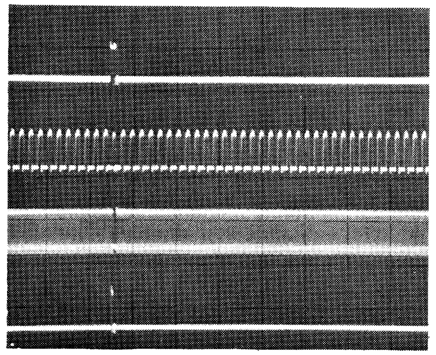
1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.

Figure 8-31. N2 Phase Detector Schematic

SERVICE SHEET 9 (Cont'd)



Composite Waveform SS9-7



Composite Waveform SS9-8

2 SAMPLING PHASE DETECTOR

The positive-going output from U4B pin 9 is used to generate the pulse required to open the sampler gate. Common base amplifier Q6 and emitter follower Q7 amplifies and couples the pulse to T1. CR1 and CR2 are used to minimize transformer flyback action. CR2 also bypasses the negative-going pulse around the transformer primary to ensure that only the positive-going pulse is coupled to the transformer secondary.

A 100 kHz signal from the reference loop is applied to the secondary center tap of T1. L7 and C9 (along with C3 in the reference loop A4A1 assembly) comprise a low pass filter; it has an impedance of about 450 ohms and a cutoff frequency of about 150 kHz. The TTL input from the reference loop is reshaped into a sine wave by the low pass filter. L8 and C14 comprise a tuned circuit which bypasses unwanted high frequency signals and further filters the sine wave.

Sampler diodes CR3 and CR4 are normally reverse biased. When the sampling pulse appears across the secondary of T1 it is coupled through C20 and C21 to forward bias CR3 and CR4. Since the gate pulses are equal in amplitude but opposite in polarity, they will cancel at TP6.

While CR3 and CR4 are forward biased the sampling gate is open and the 100 kHz reference signal is sampled.

SERVICE SHEET 9 (Cont'd)

This type of sampling phase detector may be phase locked at virtually any point on the sine wave curve. Ideally, the zero volt crossover point of the sine wave should be used to improve the lock and hold in capability of the loop.

If the divided down output of the voltage controlled oscillator in the A13 assembly (10 kHz pulses) is not phase locked to the 100 kHz reference signal an ac signal is developed at TP6. The polarity of the signal at any given time depends on the polarity of the 100 kHz sine wave at the time the last sample was taken. The amplitude of the signal at any given time depends on what portion of the sine wave the last sample was taken from. Each time CR3 and CR4 are forward biased the signal derived from the 100 kHz reference signal at T1 terminals 4 and 6 are coupled through the sampling gate to control the charge on C22.

When the sampling gate pulse ends, CR3 and CR4 are again reverse biased and the sampling gate is closed. Since Q4 is a high input impedance device, the charge will remain in C22 until the next sampling pulse. The error signal from Q4 is applied to the summing amplifier in the A13 assembly through emitter followers Q3 and Q5.

Test Point 8 may be grounded to open the phase lock loop. Since the emitter of A13Q12 in the A13 assembly is also exactly at dc ground level, grounding this test point will not affect the pretuning circuit. With the loop open both the pretuning and the error signal may be checked.

TEST PROCEDURE 2

Test 2-a. Connect the oscilloscope to TP6. If the 100 kHz reference signal is present one of the sampling gate diodes (CR3 or CR4) is probably shorted. If the gate pulses are present one of the sampling gate diodes is probably open (Negative-going pulses CR4 - positive going pulses CR3). Proceed to test 2-b.

Test 2-b. With the oscilloscope connected to TP6, ground TP8. The signal displayed should be similar to that shown in Composite Waveform SS9-9, at about 4 volts. The frequency of the signal will be determined by the frequency difference detected by the sampling gate (typically 200 to 400 Hz).

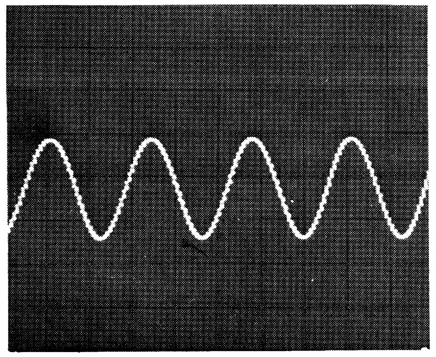
If the signal is present at TP6, connect the oscilloscope to Q5-e. The sine wave should be about the same as that shown for TP6 except that the sampling points will not be as obvious.

If the signal is present at Q5-e the error amplifier and the sampling circuits are functioning properly.

If the signal is not present at Q5-e and was present at TP6, check Q3, Q4, Q5 and associated components. After repairs are made repeat the test and remove the ground from TP8.

NOTE

Operation of the circuit shown on Service Sheet 9-a is essentially the same as that shown on Service Sheet 9. Reference designations differ. The count down is always 3000.



Waveform SS9-9

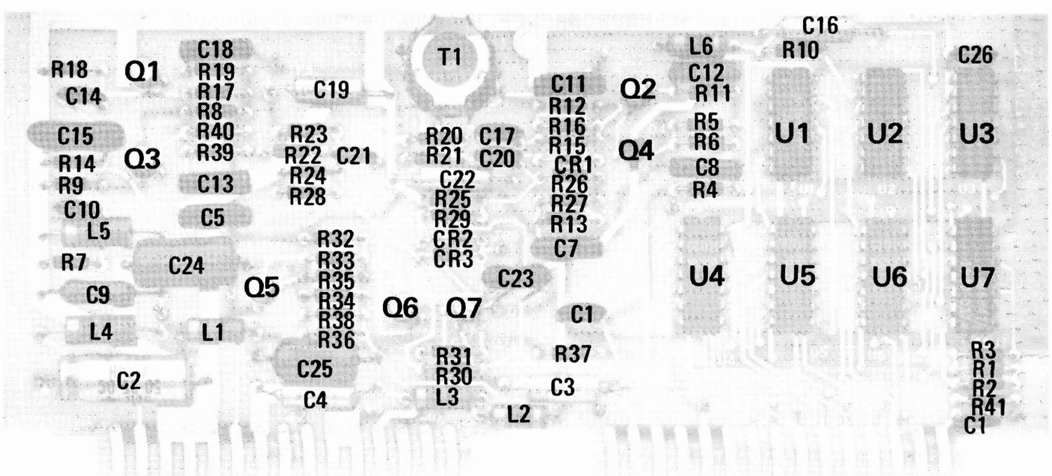
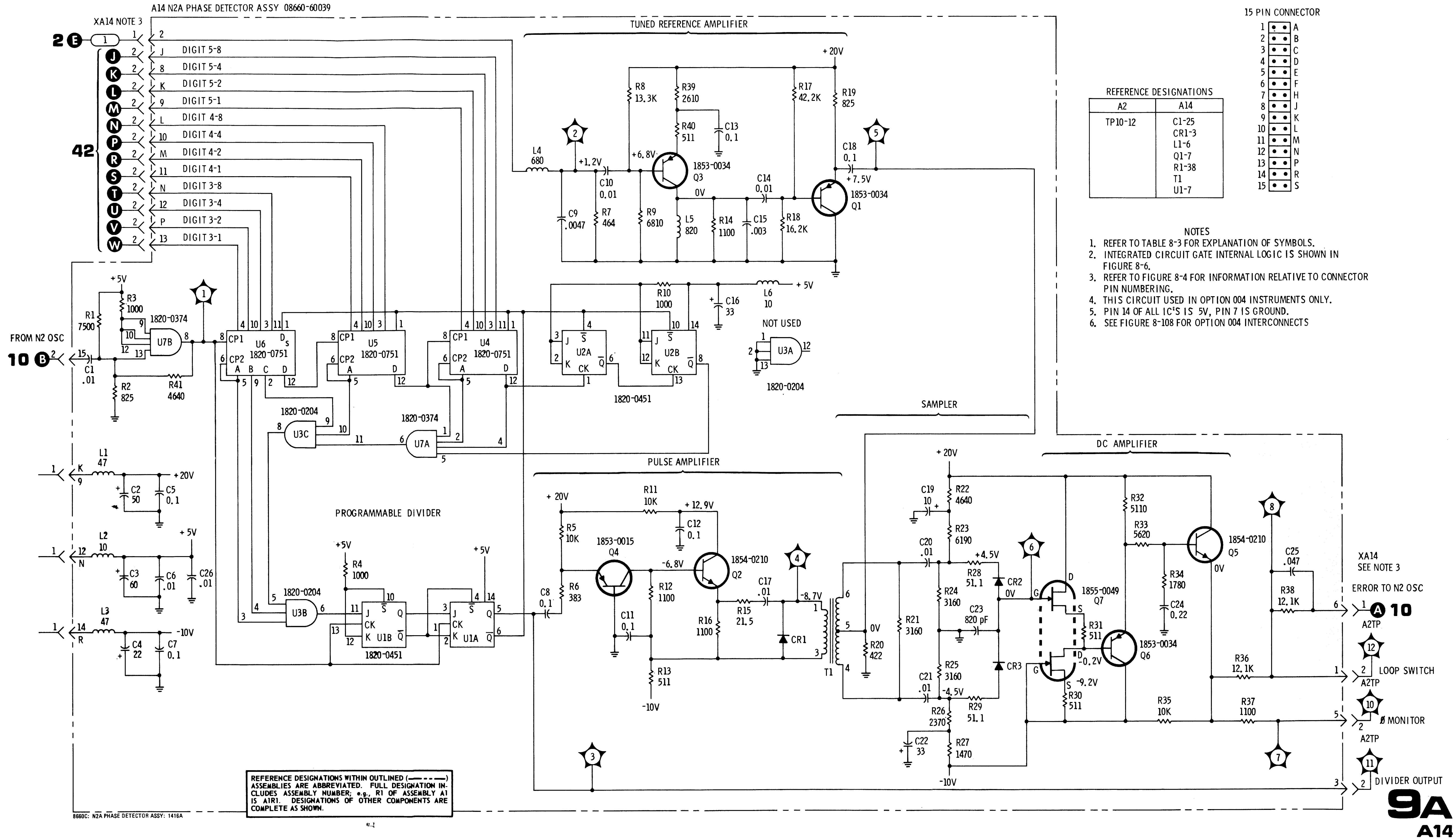


Figure 8-32. A14a N2a Phase Detector Component Locations



REFERENCE DESIGNATIONS

A2	A14
TP10-12	C1-25 CR1-3 L1-6 Q1-7 R1-38 T1 U1-7

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.
4. THIS CIRCUIT USED IN OPTION 004 INSTRUMENTS ONLY.
5. PIN 14 OF ALL IC'S IS 5V, PIN 7 IS GROUND.
6. SEE FIGURE 8-108 FOR OPTION 004 INTERCONNECTS

Figure 8-33. N2a Phase Detector Schematic

SERVICE SHEET 10

N2 OSCILLATOR ASSEMBLY A13

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A13 assembly, a part of the two-assembly N2 phase lock loop is shown schematically and described on this service sheet. The N2 Phase Detector assembly, A14, is shown schematically and described on Service Sheet 9.

When trouble has been isolated to the A13 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the N2 loop circuits the adjustment procedures specified in Section V paragraph 5-30 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Frequency Counter

N2 LOOP GENERAL INFORMATION

The purpose of the N2 loop is to generate digitally controlled RF signals in the range of 19.80 to 29.79 MHz in selectable 10 kHz increments. The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The RF output of the N2 loop is applied to Summing Loop 2.

1 VOLTAGE CONTROLLED OSCILLATOR

Varactors CR8 and CR9, transistors Q2 and Q9 and associated components comprise a voltage controlled oscillator. Two varactors are used in parallel to provide high Q as well as the wide capacitance range required. C18 provides isolation for the dc levels required to bias the varactors. C17 provides the feedback required to sustain oscillation. The resonant tank circuit is coupled to Q9 by means of capacitive divider C22 and C23. The FET acts as a source follower in the feedback circuit; it provides a high impedance at the gate and a low impedance at the source. The gain of the FET amplifier for the output signal is less than one; this minimizes the Miller effect which might otherwise reflect capacitance back into the oscillator tank circuit.

Q1 amplifies the signal and applies it to U1A which functions as a Schmitt trigger. U1D inverts the output from U1A and applies it to the programmable divider in the A14 assembly. U1C inverts the output from U1A and applies it to the divide-by-one hundred circuit in Summing Loop 2.

TEST PROCEDURE 1

NOTE

Do not use long coax leads from the counter to TP3. The capacitive loading may attenuate the signal below a useable level.

SERVICE SHEET 10 (Cont'd)

Test 1-a. Connect the counter to TP3 and set Center Frequencies as shown in Table 8-5. The counter readout should be as shown in the table. (Make allowances for counter accuracy.)

NOTE

If the frequency readouts listed in Table 8-30 are not approximately as shown check the voltage levels shown for TP2 in Table 8-30. If the voltage levels are incorrect proceed to test procedure 2

If the signal is present use the oscilloscope to check the outputs at XA13-1 pins 4 and 6 with center frequency set to zero. The signal at XA13-1-4 should be about 0.8 volt p/p and the signal at XA13-1-6 should be about 0.3 volt.

If the signal is present at TP3 but is not present at XA13-1 pins 4 and 6 check U1.

Test 1-b. If the signal is not present at TP3 use the oscilloscope to check the signal at the collector of Q1. The signal should be about 1 volt in amplitude.

If the signal is not present at Q1-c use the oscilloscope to check the signal at the Q1 base. If the signal is now present (about 0.3 volt), Q1 is probably defective.

If the signal is not present at Q1 base, check Q2, Q9 and associated components.

2 PRETUNING CIRCUIT

The frequency of the voltage controlled oscillator is roughly preset by the digital to analog converter (U2, U3, transistors connected to the outputs of the NAND gates and associated components). The digital to analog converter cannot, by itself, set the oscillator frequency precisely; it does set the frequency within the capture range of the loop. The inputs to U2 and U3 are BCD bits coded 8, 4, 2 and 1. When any of the BCD inputs are high they cause the output of the NAND gate with which they are associated to go low; the transistor associated with the NAND gate is switched on.

When all of the BCD inputs are low Q4 is biased to provide approximately −25 volts at TP1 (Q3-e). With this dc level at TP1 the oscillator is roughly preset to 29.79 MHz.

When any one or more of the BCD inputs go high the transistor associated with it saturates and draws current through R34 and R35. The change in bias for Q4 causes the voltage at TP1 to go less negative (closer to ground level). Finally when the binary input is 99, the voltage at TP1 is approximately −5.2 volts and the oscillator frequency is roughly preset to 19.80 MHz.

Q12 is a summing amplifier which combines the output of the digital to analog converter and the signal from the N2 phase detector. The summing point (Q12-e) sums the current from three sources; a current source from the +20 volt supply through R28, R30 and R37, a negative source from the digital to analog converter (TP1) and the signal from the N2 phase detector. The voltage at the summing point is always zero volts.

When TP1 is at approximately −25 volts (no BCD input), most of the current from the +20 volt supply flows through Q4 and Q3; very little flows through Q12. Under these conditions the voltage at Q12-c is about −30 volts. As the voltage at TP1 decreases (gets closer to ground level) less current flows through Q4 and Q3, more current flows through Q12, and the Q12 collector voltage decreases.

◀ N2a Phase Detector
SERVICE SHEET 9A

SERVICE SHEET 10 (Cont'd)

Test 1-a. Connect the counter to TP3 and set Center Frequencies as shown in Table 8-5. The counter readout should be as shown in the table. (Make allowances for counter accuracy.)

NOTE

If the frequency readouts listed in Table 8-30 are not approximately as shown check the voltage levels shown for TP2 in Table 8-30. If the voltage levels are incorrect proceed to test procedure **2**

If the signal is present use the oscilloscope to check the outputs at XA13-1 pins 4 and 6 with center frequency set to zero. The signal at XA13-1-4 should be about 0.8 volt p/p and the signal at XA13-1-6 should be about 0.3 volt.

If the signal is present at TP3 but is not present at XA13-1 pins 4 and 6 check U1.

Test 1-b. If the signal is not present at TP3 use the oscilloscope to check the signal at the collector of Q1. The signal should be about 1 volt in amplitude.

If the signal is not present at Q1-c use the oscilloscope to check the signal at the Q1 base. If the signal is now present (about 0.3 volt), Q1 is probably defective.

If the signal is not present at Q1 base, check Q2, Q9 and associated components.

2 PRETUNING CIRCUIT

The frequency of the voltage controlled oscillator is roughly preset by the digital to analog converter (U2, U3, transistors connected to the outputs of the NAND gates and associated components). The digital to analog converter cannot, by itself, set the oscillator frequency precisely; it does set the frequency within the capture range of the loop. The inputs to U2 and U3 are BCD bits coded 8, 4, 2 and 1. When any of the BCD inputs are high they cause the output of the NAND gate with which they are associated to go low; the transistor associated with the NAND gate is switched on.

When all of the BCD inputs are low Q4 is biased to provide approximately −25 volts at TP1 (Q3-e). With this dc level at TP1 the oscillator is roughly preset to 29.79 MHz.

When any one or more of the BCD inputs go high the transistor associated with it saturates and draws current through R34 and R35. The change in bias for Q4 causes the voltage at TP1 to go less negative (closer to ground level). Finally when the binary input is 99, the voltage at TP1 is approximately −5.2 volts and the oscillator frequency is roughly preset to 19.80 MHz.

Q12 is a summing amplifier which combines the output of the digital to analog converter and the signal from the N2 phase detector. The summing point (Q12-e) sums the current from three sources; a current source from the +20 volt supply through R28, R30 and R37, a negative source from the digital to analog converter (TP1) and the signal from the N2 phase detector. The voltage at the summing point is always zero volts.

When TP1 is at approximately −25 volts (no BCD input), most of the current from the +20 volt supply flows through Q4 and Q3; very little flows through Q12. Under these conditions the voltage at Q12-c is about −30 volts. As the voltage at TP1 decreases (gets closer to ground level) less current flows through Q4 and Q3, more current flows through Q12, and the Q12 collector voltage decreases.

N2a Phase Detector
◀ SERVICE SHEET 9A

SERVICE SHEET 10 (Cont'd)

CR4 through CR7, CR11 through CR16 and associated resistors are used to shape the voltage applied to the varactors in the voltage controlled oscillator circuit so that the frequency will be linear with the voltage change. The voltage at the junction of R42 and R47 is about −27.5 volts. When there is no BCD input (Q12-c is about −30 volts) all of the diodes in the shaper are reverse biased. As the voltage at TP1 decreases (gets closer to −5.2 volts) current through Q12 increases and the Q12 collector voltage also decreases. As the Q12-c voltage decreases first CR4, then CR5, etc. are forward biased. As the diodes are forward biased resistors are added in parallel with R31 and R32 to shape the voltage curve to the varactors.

Q11 and Q10 are emitter followers which couple the output of Q12 to the varactors. Q11 provides a high impedance for the output of the summing amplifier, Q12.

TEST PROCEDURE 2

Test 2-a. Use the digital voltmeter to check the voltages at TP1 and TP2. These dc levels should be about as shown in Table 8-30 for the center frequencies shown.

If the voltages at TP1 are about right, but those at TP2 are not, check Q12, Q11, Q10 and associated components.

If the voltages at TP1 are not approximately as shown in Table 8-46, check the components in the digital to analog converter.

NOTE

Also check the BCD input lines for the correct levels. With CF digits 4 and 5 set to a zero all eight input lines should be low. With CF digits 4 and 5 set to a 1 inputs at XA13-2 pins 11 and 9 should be high, etc.

Table 8-46. N2 Frequency Versus Voltage Chart

Center Frequency	Counter Readout	TP1 Volts	TP2 Volts
00000 Hz	29.790000 MHz	−25	−31
11100 Hz	28.680000 MHz	−23	−26
22200 Hz	27.570000 MHz	−21	−21
33300 Hz	26.460000 MHz	−18.5	−16.8
44400 Hz	25.350000 MHz	−16.4	−13.4
55500 Hz	24.240000 MHz	−14.2	−10.6
66600 Hz	23.130000 MHz	−12	−8.3
77700 Hz	22.020000 MHz	−9.8	−6.4
88800 Hz	20.910000 MHz	−7.7	−4.8
99900 Hz	19.800000 MHz	−5.4	−3.6

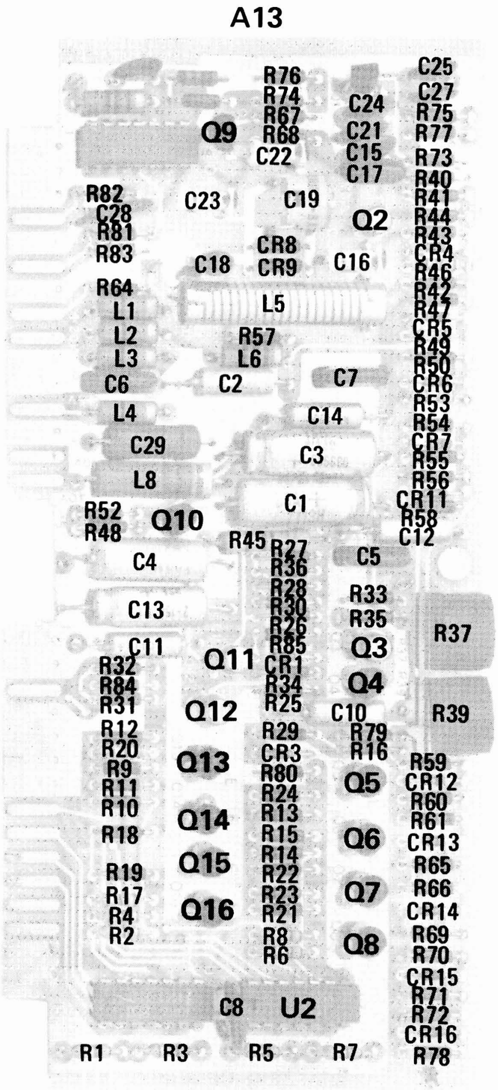


Figure 8-34. A13 N2 VCO Component Locations

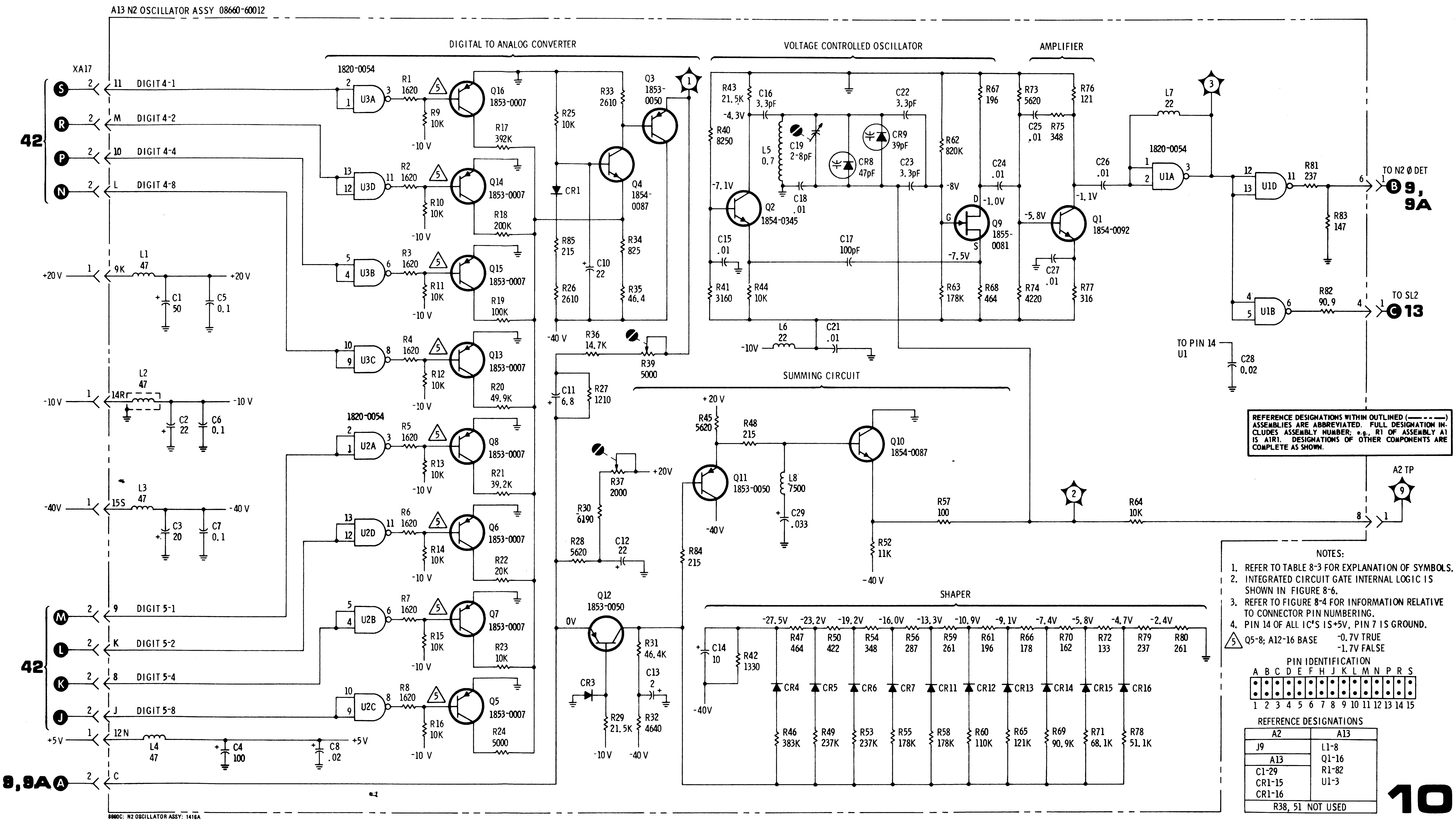


Figure 8-35. N2 VCO Schematic

SERVICE SHEET 11

N3 PHASE DETECTOR ASSEMBLY A10

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A10 assembly, a part of the two-assembly N3 phase lock loop is shown schematically and described on this service sheet. The N3 oscillator assembly, A8, is shown schematically and described on Service Sheet 12.

When trouble has been isolated to the A10 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the N3 loop circuits the adjustment procedures specified in Section V paragraph 5-31 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

N3 LOOP GENERAL INFORMATION

The purpose of the N3 loop is to generate digitally controlled RF signals in the range of 20.01 to 21.00 MHz in selectable 10 kHz increments. The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section.

The RF output of the N3 voltage controlled oscillator is divided by ten before being applied to the SL2 assembly. The output to SL2 is 2.001 to 2.100 MHz in 1 kHz increments.

1 N3 PROGRAMMABLE DIVIDER CIRCUIT

All of the integrated circuits in the A10 assembly are used to count down the input from the N3 voltage controlled oscillator.

When there are no BCD inputs to U5 and U6 (all inputs low), the input from the oscillator will be 21.00 MHz when the oscillator is phase locked; the programmable divider will divide by 2100 to provide a 10 kHz output at TP3. U5 and U6 are preset by CF digits 1 and 2 and programmed to vary between start counts of 00 and 99. Operation of the circuit is as follows:

Assume that initially all BCD inputs are low and U4, U5 and U6 have been preset to zero. Assume also that U2A pin 6 ($\overline{Q}$) and U2B pin 8 ($\overline{Q}$) are both low. U1B pin 8 ($\overline{Q}$) and U1A pin 6 ($\overline{Q}$) are both high.

NAND gate U7C couples the input from the N3 oscillator to the clock input of U5. U5 provides a divided-by-ten output to clock U6 and also provides A, B and C (BCD 1, 2 and 4) outputs. The A, B and C outputs are not used until the count of 2097 has been reached.

U6 provides a divided-by-ten output to clock U4 and also provides A and D (BCD 1 and 8) outputs to AND gates U3A and U3C. The A and D outputs are not used until the count has reached 2090.

U4 provides a divided-by-ten output to clock U2A. At the count of 1000 U4 clocks U2A and the U2A $\overline{Q}$ output at pin 6 goes high. At the count of 2000 U4 again clocks U2A and the negative-going $\overline{Q}$ output at pin 6 clocks U2B. When U2B is clocked $\overline{Q}$ at pin 8 goes high and is applied to pins 2 and 13 of AND gate U3A.

At the count of 2090 the high A and D outputs of U6 are applied to AND gates U3A and U3C. Since U3A pins 2 and 13 are both high, U3A is enabled and it places a high on pin 11 of AND gate U3C.

SERVICE SHEET 11 (Cont'd)

At the count of 2097 the high A, B and C outputs of U5 are applied to AND gates U3B and U3C to provide a high at the J input of U1B at pin 11.

At the count of 2098 U1B is clocked, U1B $\overline{Q}$ (pin 8) goes low and sets U1A. U1A $\overline{Q}$ (pin 6) goes low and presets U2, U4, U5 and U6; they are held in preset until the count is completed.

When U1A is set Q (pin 5) goes high and initiates the sampling pulse. The first pulse to the sampling phase detector is initiated by the 2098th input cycle. Since two more cycles are required to restart the count cycle, following sampler pulses are 2100 cycles apart when there is no BCD input.

At the count of 2099 U1B is again clocked and $\overline{Q}$ (pin 8) goes high. The high at pin 8 is applied to the K input of U1A (pin 2).

At the count of 2100 U1A is clocked and pin 6 $\overline{Q}$ goes high to end the preset pulse. The next input to U5 initiates the next count cycle.

When there is a BCD input programmed into U5 and U6 pins 3, 4, 10 and 11 the terminal count is still 2100. However, the count starts at the number programmed into the BCD inputs. As an example, if the BCD input to U5 and U6 is 99, the first input cycle would cause the same digital circuit changes that the 100th input cycle caused in the discussion above (U4 would be clocked). The frequency division would be 2100-99, equal to division by 2001. The phase lock loop operation would result in an input frequency to the programmable divider of 20.01 MHz. When divided by 2001, the divider output at TP3 would again be 10 kHz.

The output from U1A pin 5 is always 10 kHz when the oscillator is phase locked regardless of the oscillator frequency.

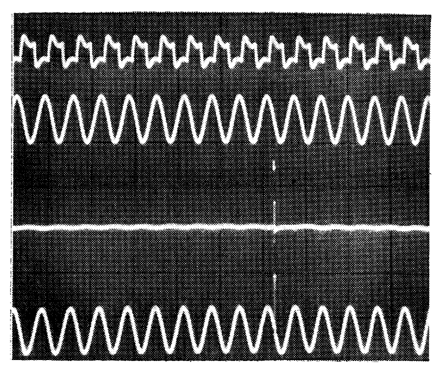
TEST PROCEDURE 1

Composite Waveform SS11-1 illustrates the proper timing relationship between the 100 kHz reference input, the pulse output from the pulse generator and the sampling point on the 100 kHz reference signal when the loop is locked.

NOTE

Center Frequency is initially set to zero.

Test 1-a. Use the counter and the oscilloscope to check for a 100.000 kHz sine wave at approximately 5 volts p/p at TP5. The display should be similar to that shown in the second trace from the top of composite waveform SS11-1.



Composite Waveform SS11-1

SERVICE SHEET 11 (Cont'd)

If the counter readout is 100,000 kHz but the sine wave is distorted, check Q1, Q2 and associated components.

If the signal is not present, connect the counter and the oscilloscope to XA10-1-2. The counter readout should be 100.000 kHz and the oscilloscope display should be similar to that shown in the top trace of composite waveform SS11-1.

If the correct signal is present at XA10-1-2, but was not present at TP5, check Q1, Q2 and associated components.

If the signal is not present at XA10-1-2 check interconnections to the reference loop and, if necessary, the reference loop.

Test 1-b. Connect the oscilloscope and the counter to TP4. The counter readout should be 100.000 kHz and the oscilloscope should display positive-going pulses as shown in composite waveform SS11-1 at about 7 volts amplitude. If the signal is not present, proceed to test 1-c.

If the signal is present, connect the oscilloscope to the junction of R19 and C20. The oscilloscope display should be similar to that shown in the lowest trace of composite waveform SS11-1.

If the programmable divider and the pulse generator are working properly but the loop is not phase locked, the oscilloscope may still display the signals at the junction of R19 and C20, but the relationship between the pulses and the sine wave will not be the same as shown in composite waveform SS11-1. If the voltage controlled oscillator and the summing circuit in the A8 assembly are known to be functioning properly, proceed to test procedure 2.

Test 1-c. If the pulses are not present at TP4, and the counter counts randomly or not at all, connect the oscilloscope to TP3. The oscilloscope display should be a series of pulses at approximately 10 kHz and about 4 volts in amplitude.

If the pulses are present at TP3, but were not present at TP4, check Q6, Q7 and associated components.

If the pulses are not present at TP3, proceed to test 1-d.

Test 1-d. If the pulse is not present at TP3 connect the oscilloscope to NAND gate U7C pin 8. The oscilloscope should display a slightly distorted sine wave at about 21 MHz and about 3 volts in amplitude.

If the signal is not present at U7C pin 8, connect the oscilloscope to XA10-2-15. The 21 MHz signal should be about 0.06 volt in amplitude. If the signal is present, U7 is probably defective. If the signal is not present check interconnections to the A8 assembly and, if necessary the A8 assembly.

Test 1-e. It is assumed in this test that the signal input is present at U5 pin 8. Composite waveforms SS11-2 through SS11-6 illustrate the correct waveforms for the integrated circuit points shown.

NOTE

These waveforms were taken with the oscilloscope triggered from TP3.

SERVICE SHEET 11 (Cont'd)

If the counter readout is 100,000 kHz but the sine wave is distorted, check Q1, Q2 and associated components.

If the signal is not present, connect the counter and the oscilloscope to XA10-1-2. The counter readout should be 100.000 kHz and the oscilloscope display should be similar to that shown in the top trace of composite waveform SS11-1.

If the correct signal is present at XA10-1-2, but was not present at TP5, check Q1, Q2 and associated components.

If the signal is not present at XA10-1-2 check interconnections to the reference loop and, if necessary, the reference loop.

Test 1-b. Connect the oscilloscope and the counter to TP4. The counter readout should be 100.000 kHz and the oscilloscope should display positive-going pulses as shown in composite waveform SS11-1 at about 7 volts amplitude. If the signal is not present, proceed to test 1-c.

If the signal is present, connect the oscilloscope to the junction of R19 and C20. The oscilloscope display should be similar to that shown in the lowest trace of composite waveform SS11-1.

If the programmable divider and the pulse generator are working properly but the loop is not phase locked, the oscilloscope may still display the signals at the junction of R19 and C20, but the relationship between the pulses and the sine wave will not be the same as shown in composite waveform SS11-1. If the voltage controlled oscillator and the summing circuit in the A8 assembly are known to be functioning properly, proceed to test procedure **2**.

Test 1-c. If the pulses are not present at TP4, and the counter counts randomly or not at all, connect the oscilloscope to TP3. The oscilloscope display should be a series of pulses at approximately 10 kHz and about 4 volts in amplitude.

If the pulses are present at TP3, but were not present at TP4, check Q6, Q7 and associated components.

If the pulses are not present at TP3, proceed to test 1-d.

Test 1-d. If the pulse is not present at TP3 connect the oscilloscope to NAND gate U7C pin 8. The oscilloscope should display a slightly distorted sine wave at about 21 MHz and about 3 volts in amplitude.

If the signal is not present at U7C pin 8, connect the oscilloscope to XA10-2-15. The 21 MHz signal should be about 0.06 volt in amplitude. If the signal is present, U7 is probably defective. If the signal is not present check interconnections to the A8 assembly and, if necessary the A8 assembly.

Test 1-e. It is assumed in this test that the signal input is present at U5 pin 8. Composite waveforms SS11-2 through SS11-6 illustrate the correct waveforms for the integrated circuit points shown.

NOTE

These waveforms were taken with the oscilloscope triggered from TP3.

Follow the numerical sequence of the waveforms shown; when an IC output is missing the trouble is found. Replace the defective component and repeat test 1-b.

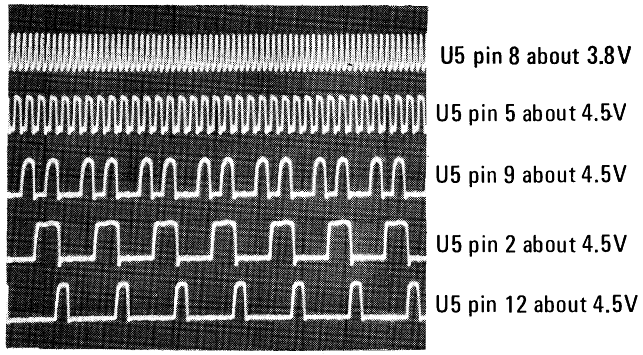
NOTE

If the output from U5 is not present proceed to test 1-f before replacing U5.

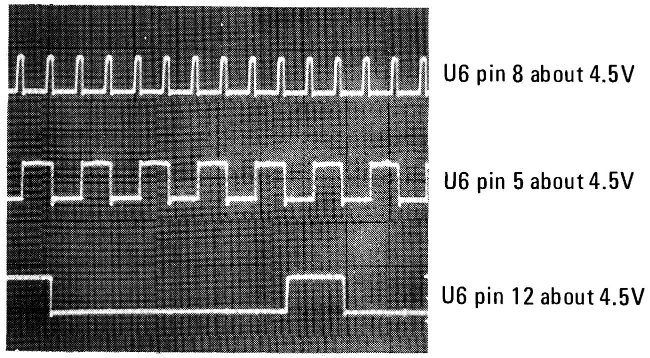
Test 1-f. Composite waveform SS11-7 illustrates correct waveforms for a properly operating U1. In this test the oscilloscope was again triggered by TP3 and the sweep delay of the oscilloscope was used to center the pulses shown.

If the waveforms in composite waveform SS11-7 cannot be observed (because an adequate oscilloscope is not available or other reasons) measure the voltage at U1 pin 6, it should be about +3.7 volts; U1 pin 5 should be at about +100 millivolts. If the voltages are not as specified, ground U1 pin 10. The voltages should then be; U1 pin 6 about +130 millivolts and U1 pin 5 about +3.8 volts. If the voltages are as specified in either case and there is no output from U5, U5 is probably defective.

If there is no change in the dc levels at U1 pins 5 and 6 with U1 pin 10 grounded U1 is probably defective.

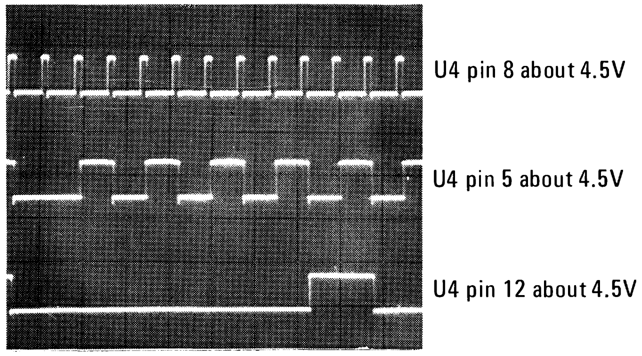


Composite Waveform SS11-2

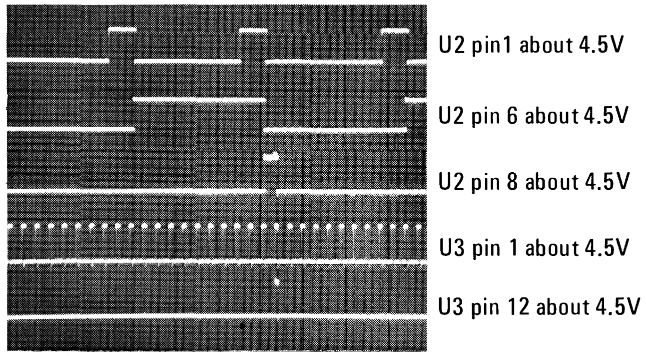


Composite Waveform SS11-3

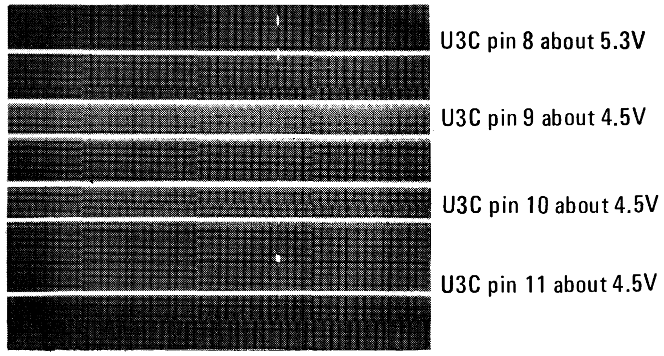
SERVICE SHEET 11 (Cont'd)



Composite Waveform SS11-4

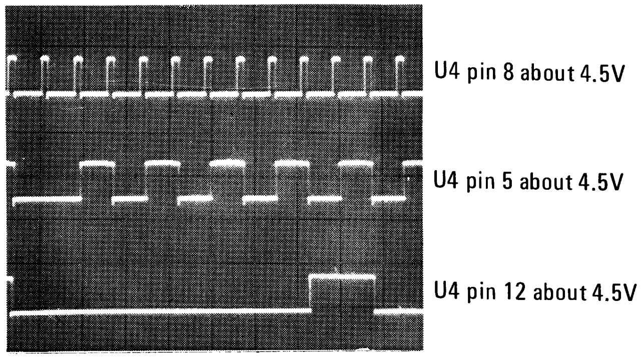


Composite Waveform SS11-5

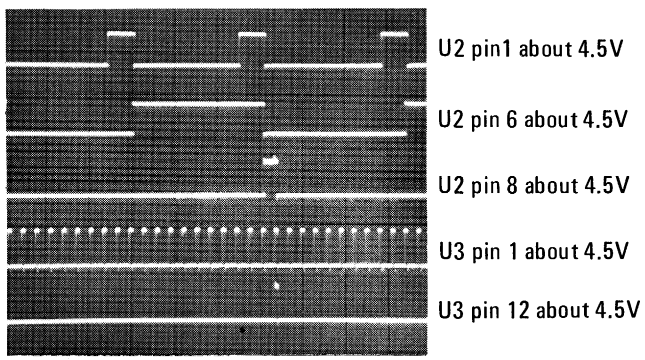


Composite Waveform SS11-6

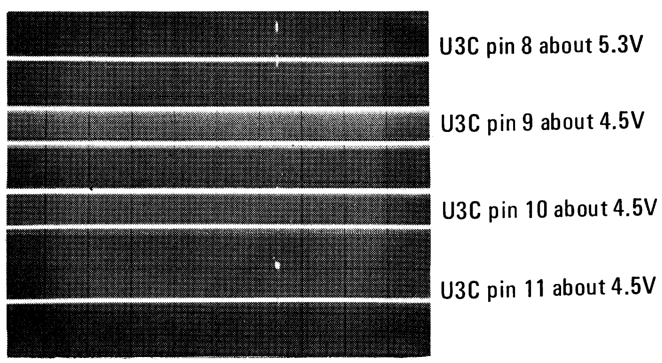
SERVICE SHEET 11 (Cont'd)



Composite Waveform SS11-4



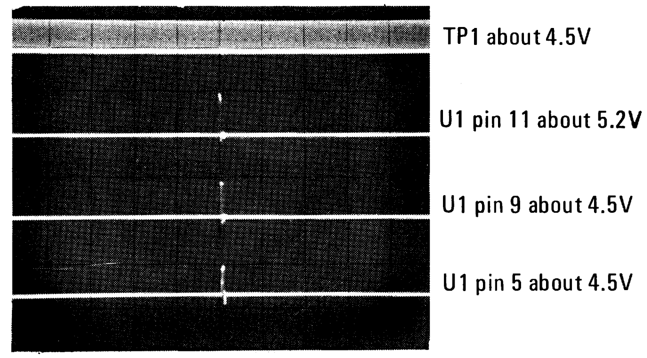
Composite Waveform SS11-5



Composite Waveform SS11-6

N2 VCO
SERVICE SHEET 10

SERVICE SHEET 11 (Cont'd)



Composite Waveform SS11-7

2 SAMPLING PHASE DETECTOR

The positive-going output from U1A Q (pin 5) is used to generate the pulse required to open the sampler gate. Common base amplifier Q6 and emitter follower Q7 amplifies and couples the pulse to T1. CR1 and CR2 are used to minimize transformer flyback action. CR2 also bypasses the negative-going pulse around the transformer primary to ensure that only the positive-going pulse is coupled to the transformer secondary.

A 100 kHz signal from the reference loop is applied through Q2 and Q1 to the secondary center tap of T1. L5 and C8 (along with C4 in the reference loop A4A1 assembly) comprise a low pass filter; it has an impedance of about 450 ohms and a cutoff frequency of about 150 kHz. The TTL input from the reference loop is reshaped into a sine wave by the low pass filter. Q2 and Q1 amplify the signal to the level required in the sampling phase detector. L7 and C13 comprise a tuned circuit which bypasses unwanted high frequency signals and further filters the sine wave.

Sampler diodes CR3 and CR4 are normally reverse biased. When the sampling pulse appears across the secondary of T1 it is coupled through C20 and C21 to forward bias CR3 and CR4. Since the gate pulses are equal in amplitude but opposite in polarity, they will cancel at TP6.

While CR3 and CR4 are forward biased the sampling gate is open and the 100 kHz reference input signal is sampled.

This type of sampling phase detector may be phase locked to virtually any point on the sine wave slope. Ideally, the zero crossover point of the sine wave should be used to improve the lock and lock hold capabilities of the loop.

If the divided down output of the voltage controlled oscillator (10 kHz pulses) is not phase locked to the 100 kHz reference signal an ac error signal will be developed at TP6. The polarity of the error signal at any given point in time depends on the polarity of the 100 kHz reference signal at the time the last sample was taken. The amplitude of the error signal at any given time depends on what part of the sine wave the last sample was taken from. Each time CR3 and CR4 are forward biased the 100 kHz reference signal at T1 terminals 4 and 6 are coupled through the sampling gate to control the charge on C22.

When the sampling gate pulse ends CR3 and CR4 are again reverse biased and the sampling gate is closed. Since Q4 is a high impedance input device, the charge will remain on C22 until the next sampling pulse. The current through Q4 is controlled by the difference in Gate-source voltage of the lower FET. Operation of the dual FET sets the output level at the lower FET drain to exactly the level at the upper FET gate. The output is coupled through two emitter followers to the summing amplifier in the A8 assembly.

SERVICE SHEET 11 (Cont'd)

TEST PROCEDURE

Test 2-a. Connect the oscilloscope to TP6. If the 100 kHz reference signal is present one of the sampling gate diodes (CR3 or CR4) is probably shorted. If the gate pulses are present one of the sampling gate diodes is probably open (Negative-going pulses CR4 - positive-going pulses CR3). Proceed to test 2-b.

Test 2-b. With the oscilloscope connected to TP6, ground TP8. The oscilloscope should display a low frequncy sine wave (about 4 volts) that varies in frequency. The frequency of the signal will be the difference frequency detected by the sampling gate.

If the signal is present at TP6, connect the oscilloscope to Q5-e. The sine wave should be the same as seen at TP6.

If the signal is present at Q5-e the error amplifier and the sampler circuit are functioning properly.

If the signal is not present at Q5-e and was present at TP6, check Q3, Q4, Q5 and associated components.

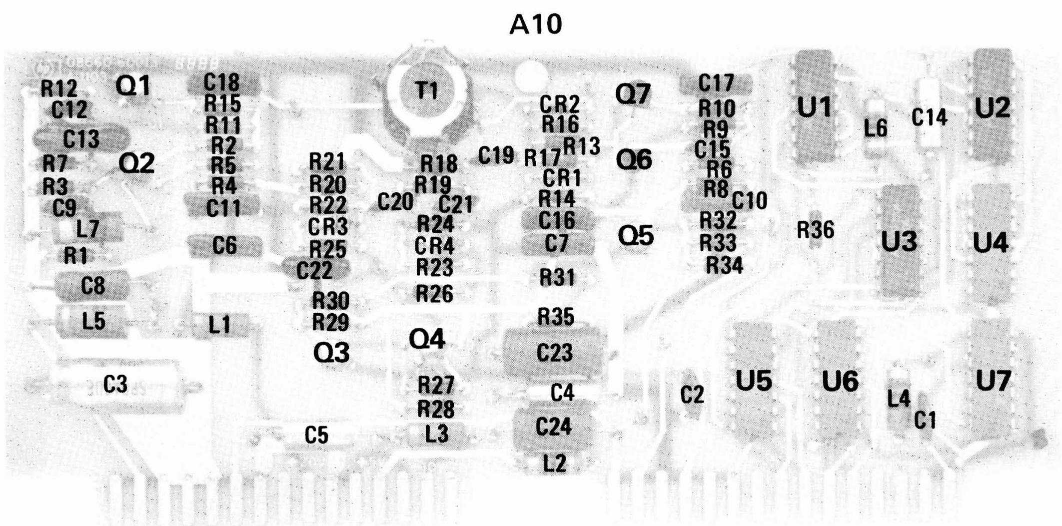
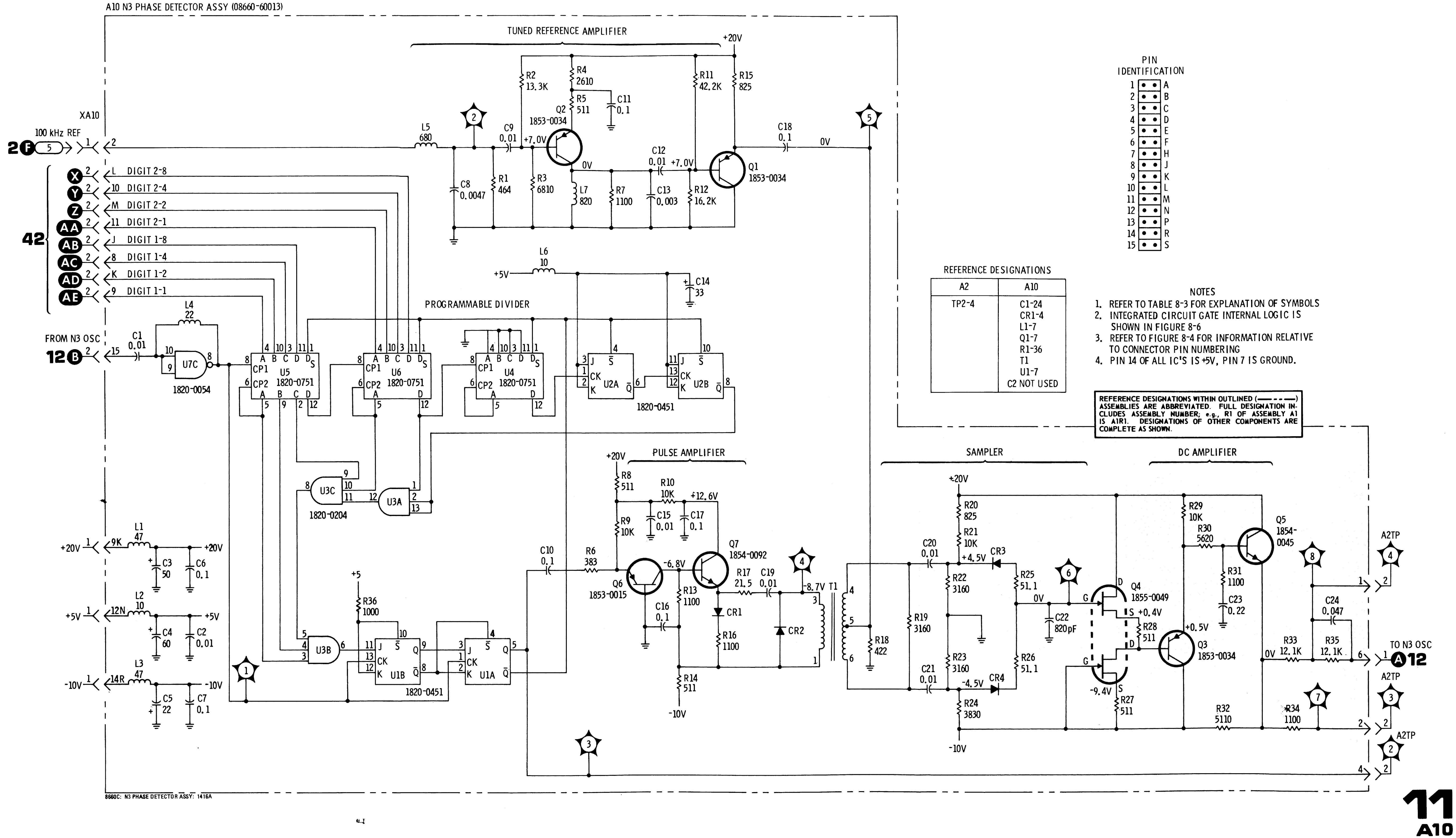


Figure 8-36. A10 N3 Phase Detector Component Locations



REFERENCE DESIGNATIONS

A2	A10
TP2-4	C1-24 CR1-4 L1-7 Q1-7 R1-36 T1 U1-7 C2 NOT USED

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING
4. PIN 14 OF ALL IC'S IS +5V, PIN 7 IS GROUND.

Figure 8-37. N3 Phase Detector Schematic

SERVICE SHEET 12

N3 OSCILLATOR ASSEMBLY A8

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A8 assembly, a part of the two-assembly N3 phase lock loop is shown schematically and described on this service sheet. The N3 Phase Detector assembly, A10, is shown schematically and described on Service Sheet 11.

When trouble has been isolated to the A8 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the N3 loop circuits the adjustment procedures specified in Section V paragraph 5-31 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Digital Voltmeter
Frequency Counter

N3 LOOP GENERAL INFORMATION

The purpose of the N3 loop is to generate digitally controlled RF signals in the range of 20.01 to 21.00 MHz in selectable 10 kHz increments. The voltage controlled oscillator is phase locked to a 100 kHz reference which is derived from the master oscillator in the reference section. The RF output of the N3 voltage controlled oscillator is divided by ten before it is applied to summing Loop 2. The output from the N3 assembly to SL2 is 2.001 to 2.100 MHz in selectable 1 kHz increments.

1 VOLTAGE CONTROLLED OSCILLATOR

Q2, Q7 and associated components comprise a voltage controlled oscillator. C14 and C17 provide isolation for the dc levels required to bias the varactor. C13 provides the feedback required to sustain oscillation. The resonant tank is coupled to Q7 by capacitive divider C16 and C17. The FET acts as a source follower in the feedback circuit; it provides a high impedance at the gate and a low impedance at the source. The gain of the FET for the output signal at the drain is held at less than unity to minimize the Miller effect which might otherwise reflect capacitance back into the oscillator tank circuit.

Q1 amplifies the voltage controlled oscillator output and applies it to U1A which functions as a Schmitt trigger. U1D provides the output to the N3 programmable divider in the A10 assembly. U1B and U3 provide a divided by ten output to Summing Loop 2.

SERVICE SHEET 12 (Cont'd)

TEST PROCEDURE

NOTE

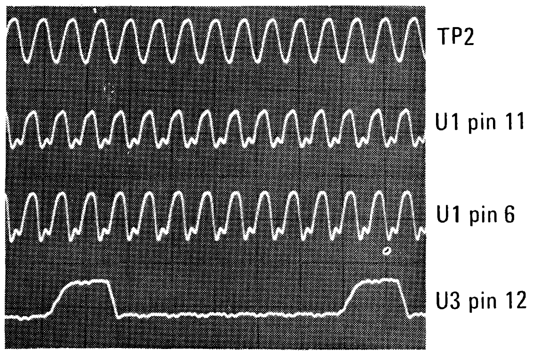
Do not use long coax leads from the counter to N3 test points. The capacitive loading may attenuate the signal below a useable level.

Test 1-a. Connect the counter to TP2. With the center freuqency set to zero the counter readout should be 21.00 MHz. Set CF digits 1 and 2 to the settings specified in Table 8-31. Frequency readouts on the counter should follow those specified in the table. (Make allowances for counter accuracy).

NOTE

If the frequency readouts listed in Table 8-31 are not approximately as shown, check the voltage levels shown for TP3 in the table. If the voltage levels are incorrect proceed to test procedure 2 .

If the signal is present use the oscilloscope to check the signal at points shown in composite waveform SS12-1. Signals shown are about 4 volts in amplitude.



Composite Waveform SS12-1

If the signal is present at TP2 but is not present at U1 pin 11, U1 is probably defective; if the signal is not present at U3 pin 12, U1 or U3 may be defective.

If the signal is not present at TP2 use the oscilloscope to check for the signal at Q1-b. If the signal is present at Q1-b check Q1 and NAND gate U1A. If the signal is not present check Q2, Q7 and associated components.

2 PRETUNING CIRCUIT

The frequency of the voltage controlled oscillator is roughly preset by the digital to analog converter (U2 and Q8 through Q11). The digital to analog converter

SERVICE SHEET 12 (Cont'd)

cannot, by itself, set the oscillator frequency precisely; it does set the frequency within the capture range of the phase lock loop. The inputs to U2 are BCD bits coded 1, 2, 4 and 8. When any one of the BCD inputs are high they cause the output of the NAND gate to which they are connected to go low; the transistor connected to the NAND gate output is switched on.

When all of the BCD inputs are low Q6 is biased to provide approximately −8.5 volts at TP1 (Q5-e). With this dc level at TP1 the oscillator is roughly preset to 21 MHz (how close depends on adjustment of R24 and R26).

When any one or more BCD inputs go high the transistor associated with it saturates and the current through Q6 is reduced. The reduction of current through Q6 changes the bias on Q5 and causes the voltage at TP1 to go less negative (closer to dc ground level). Finally, when the BCD input is 9, the voltage at TP1 is approximately −6.7 volts and the oscillator is roughly preset to 20.01 MHz (again depending on adjustment of R24 and R26).

Q3 is a summing amplifier which combines the output of the digital to analog converter and the error signal from the N3 Phase Detector. The summing point (Q3-e) sums the current from three sources; a current source from the +20 volt power supply through R19, R25 and R26, a negative source from the digital to analog converter (TP1), and the error signal from the phase detector. The voltage at the summing point is always zero volts when the loop is locked.

The output from Q3 is coupled through Q4 and Q12 to control the bias on varactor CR5 and the frequency of the voltage controlled oscillator.

TEST PROCEDURE 2

Test 2-a. Use the digital voltmeter to check the voltages at TP1 and TP3. These dc levels should be about as shown in Table 8-31 for the center frequencies shown.

NOTE

These voltages are typical. They will vary from instrument to instrument because of differences in individual varactor characteristics.

If the voltages at TP1 are about right, but those at TP3 are not, check Q3, Q4, Q12 and associated components.

If the voltages at TP1 are not approximately as shown in Table 8-31, check the components in the digital to analog converter.

NOTE

Also check the dc levels at the BCD input lines.

◀ N3 Phase Detector
SERVICE SHEET 11

SERVICE SHEET 12 (Cont'd)

Table 8-47. N3 Frequency Versus Voltage Chart

Center Frequency	Counter Readout	TP1 Voltage	TP3 Voltage
00 Hz	21.000000 MHz	−8.5 V	−3.7 V
11 Hz	20.890000 MHz	−8.3 V	−3.6 V
22 Hz	20.780000 MHz	−8.1 V	−3.5 V
33 Hz	20.670000 MHz	−7.9 V	−3.4 V
44 Hz	20.560000 MHz	−7.7 V	−3.3 V
55 Hz	20.450000 MHz	−7.5 V	−3.2 V
66 Hz	20.340000 MHz	−7.3 V	−3.1 V
77 Hz	20.230000 MHz	−7.1 V	−3.0 V
88 Hz	20.120000 MHz	−6.9 V	−2.9 V
99 Hz	20.010000 MHz	−6.7 V	−2.8 V

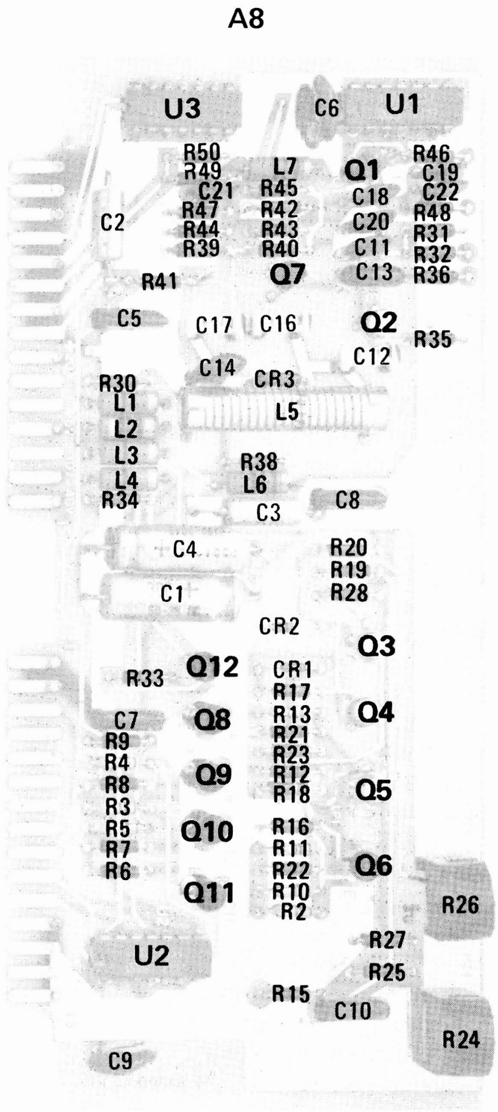
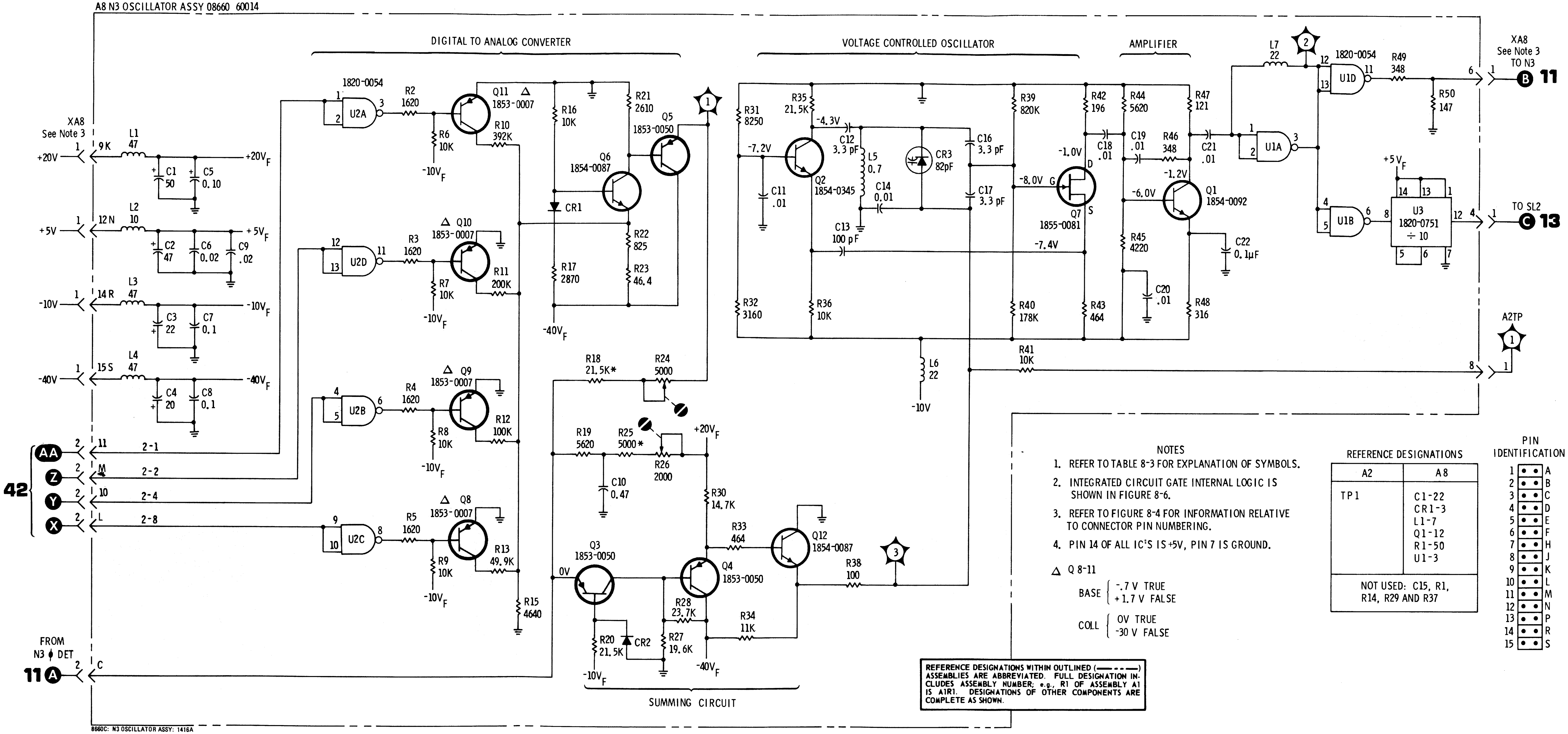


Figure 8-38. A8 N3 VCO Component Locations



12
A8

Figure 8-39. N3 VCO Schematic

SERVICE SHEET 13

SUMMING LOOP 2 PHASE DETECTOR A12

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A12 assembly, a part of the two-assembly SL2, is shown schematically and described on this Service Sheet. The SL2 Oscillator Assembly (A11) is shown schematically and described on Service Sheet 14.

When trouble has been isolated to the A12 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the SL2 circuits the adjustment procedures in Section V paragraph 5-32 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

SUMMING LOOP 2 GENERAL

The purpose of Summing Loop 2 (SL2) is to generate digitally controlled RF signals in the range of 20.0001 to 30.0000 MHz in selectable 100 Hz increments. The difference frequency between the SL2 voltage controlled oscillator and the input from the N2 loop is phase locked to the divided-by-ten output of the N3 assembly. The output of SL2 is applied to SL1.

The portion of the pretuning circuit that appears on service sheet 13 (U8 and Q8 through Q11) is explained in the text for service sheet 14.

1 PHASE DETECTOR

There are three signal inputs to the phase detector assembly. They are the output of the N2 voltage controlled oscillator, the divided by ten output of the N3 voltage controlled oscillator and the output of the SL2 voltage controlled oscillator.

The N2 and SL2 signals are mixed and the difference frequency is used as one input to the digital phase detector. The second input to the digital phase detector is the divided by ten input from the N3 assembly.

The output of the N3 voltage controlled oscillator is divided by ten in the N3 assembly and again divided by ten by U9. Q12 and NAND gate U7A shape the resulting pulses which vary in frequency (depending on programming to the N3 loop) from 0.2001 to 0.2100 MHz. The pulses at TP2 are negative-going.

SERVICE SHEET 13 (Cont'd)

The inputs from the N2 loop and the SL2 voltage controlled oscillator are applied to double balanced mixer E1 R and L ports. The difference signal from the X port is amplified by Q5 and Q4 and shaped by Q3, Q7 and NAND gates U4B and U4C. When the loop is phase locked the negative-going pulses at TP3 are at the same frequency as those at TP2. The pulses do not appear in time coincidence; they are received alternately.

U7B, U7D, U4A and U4D comprise a coincidence gate which inhibits signals that appear simultaneously at TP2 and TP3. Normally, when signals are not present, TP2 and TP3 are both high. When a signal appears at TP2, U7B pin 6 and U4D pin 13 go high. If there is no signal at TP3 U5D pin 12 is also high; U4D pin 11 goes low, and U1B pin 6 goes high. The positive pulse at TP5 drives the clock generator and the sense circuit or phase detector. When a signal appears at TP3, U4A pin 3 and U7D pin 12 go high. If there is no signal at TP2, U7D pin 13 is also high; U7D pin 11 goes low, and U7C pin 8 goes high. The positive pulse at TP9 drives the clock generator and the sense circuit or the phase detector. When signals appear at TP2 and TP3 at the same time U7D pin 13 and U4D pin 12 go low, U7D pin 11 and U4D pin 11 remain high, and the signals cannot reach TP5 or TP9.

U1A, U1C, U1D and U5C comprise a clock generator which clocks U2A and U2B each time a signal appears at TP5 or TP9. With no signals present TP5 and TP9 are low. When a positive pulse appears at TP9 U1A pin 3 goes low, U1D pin 11 goes high and a negative-going pulse appears at TP6. When a positive pulse appears at TP5 operation of the circuit is the same except that U1C pin 8 goes low (rather than U1A pin 3). Since a clock pulse is generated for each input, the pulse frequency at TP6 is the sum of the frequencies at TP5 and TP9.

Since the sense circuit does not function when the loop is locked, operation of the phase detector will be discussed first.

When the loop is phase locked U2A $\overline{Q}$ is held high to enable U3A and U3D. Assume that initially U2B $\overline{Q}$ is high, U3B pin 6 is low and U3C pin 8 is high. When a positive-going signal from TP9 appears at U3A pin 1, U3A pin 3 goes low and causes a change in state of flip-flop U3B/U3C; U3B pin 6 goes high and U3C pin 8 goes low. The high at U2B pin 12 sets the flip/flop and the positive-going trailing edge of the clock pulse causes U2B Q to go high. The following positive pulse from TP5 is applied to U3D pin 12, U3D pin 11 goes low and changes the state of flip/flop U3B/U3C. U3B pin 6 goes low and the clock pulse causes U2B $\overline{Q}$ to again go high. This sequence continues as long as the signals at TP5 and TP9 are received alternately.

The signals at TP5 and TP9 are applied to the sense circuit even when the loop is phase locked. They have no effect on the circuit because of the relationship of the Q and $\overline{Q}$ outputs of U2B to the incoming signals.

SERVICE SHEET 13 (Cont'd)

When U2B Q is high NAND gates U6A and U6C are enabled. When the signal from TP5 appears at U6C pin 9, U6C pin 8 goes low; flip/flop U5A/U5B does not change state because U5B pin 3 is low. The signal at U6B has no effect because U2B $\overline{Q}$ and U6B pin 4 are low.

When U2B $\overline{Q}$ is high NAND gates U6B and U6D are enabled. When the signal at TP9 appears at U6D pin 13, U6D pin 11 goes low; flip/flop U5A/U5B does not change state becuase U5B pin 3 is low. The signal at pin 1 of U6A has no effect on the circuit because U2B Q and pin 2 of U6A are low.

When two or more consecutive pulses from either input (TP5 or TP9) occur between pulses from the other input the sense circuit functions to disable the phase detector until the frequency error is corrected.

As an example of circuit operation assume that two pulses from TP9 (SL2 signal) are received between two pulses from TP5 (N3 signal) indicating that the SL2 frequency is high. When the first pulse from TP9 is received U3A pin 3 goes low, U3B pin 6 goes high to set U2B and the clock pulse causes U2B Q to go high. When the second consecutive pulse is received from TP9 U6A has been enabled by the high Q output of U2B. U6A pin 3 goes low and causes flip/flop U5A/U5B to change state. When the D input of U2A goes low the clock pulse causes U2A $\overline{Q}$ to go low and inhibit U3A and U3D. If a third SL2 signal is received prior to receipt of an N3 signal U6A pin 3 will again go low but will have no effect on flip/flop U5A/U5B because U5A pin 13 is low.

When an N3 pulse is received U2B Q is still high and U6C pin 8 will go low to change the state of flip/flop U5A/U5B. When the D input of U2A goes low the clock pulse causes U2A $\overline{Q}$ to go high and enable U3A and U3D. The propagation time of the signal through the sense circuit is long enough for the pulse from N3 (TP5) to have ended before U3D is enabled so the state of flip/flop U3B/U3C does not change.

The next pulse from SL2 will again cause U6A pin 3 to go low and change the state of flip/flop U5A/U5B. With the D input to U2A high again, the clock pulse again causes U2A $\overline{Q}$ to go low and inhibit U3A and U3D. The signal applied to U3A has no effect on flip/flop U3B/U3C because U3B pin 5 is low.

The sense circuit continues operation in the manner described above until two constecutive N3 pulses are received between two SL2 signals. When this occurs the first pulse causes U6C pin 8 to go low and change the state of flip/flop U5A/U5B. With the D input to U2A low the clock pulse will cause U2A $\overline{Q}$ to go high and enable U3A and U3D. Again, because of propagation time through the sense circuit

SERVICE SHEET 13 (Cont'd)

the pulse will have ended before U3D in enabled. The second consecutive N3 pulse again causes U6C pin 8 to go low but, because U5B pin 3 is low, no change in state occurs in flip/flop U5A/U5B. Since U3D is now enabled, U3D pin 11 goes low and causes flip/flop U3B/U3C to change state. With the D input to U2B low, the clock pulse causes U2B $\overline{Q}$ output to go high. Phase lock has been achieved and the loop will remain locked as long as pulses at the same frequency appear alternately at TP5 and TP9.

When the SL2 frequency is low U2B Q is low. When the SL2 frequency is high U2B Q is high.

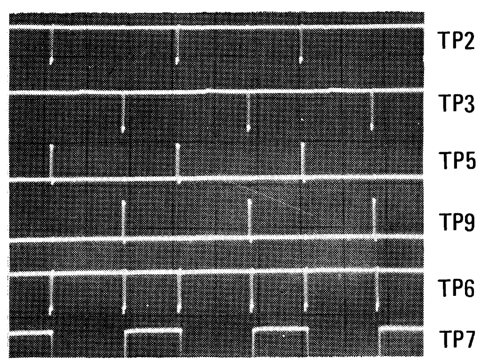
DC amplifier Q2, Q1, Q6 and associated components filter the Q output of U2B and applies it to a summing circuit in the A11 assembly to precisely control the voltage controlled oscillator.

TEST PROCEDURE 1

Test 1-a. Connect the oscilloscope input to test points shown by composite waveform SS13-1. This composite waveform illustrates correct waveforms and timing relationships for the points tested. All signals are about 4 volts in amplitude.

NOTE

The oscilloscope was triggered from TP1 for these tests.



Composite Waveform SS13-1

If the pulses are not present at TP2 proceed to test 1-b.

If the pulses are not present at TP3 proceed to test 1-c.

If the pulses are present at TP2 and TP3, but opposite polarity pulses are not present at TP5 and/or TP9, check the NAND gates between TP2 and TP5 or TP3 and TP9 as appropriate.

SERVICE SHEET 13 (Cont'd)

If the positive-going pulses are present at TP5 and TP9, but negative-going pulses are not present at TP6 for each of the pulses, check NAND gates U1A, U1C, U1D and U5C as appropriate.

If the pulses are approximately as shown in the top five traces of composite waveform SS13-1 but there is no square wave at TP7, use the oscilloscope to check the signal at NAND gate U3B pin 6. The display should be the same as that shown for TP7. If the signal is present, U2B is probably defective.

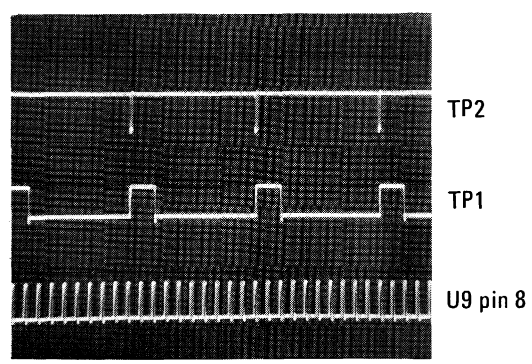
If the signal is not present at U3B pin 6 use the oscilloscope to check the signals at NAND gates U3D pin 11 and U3A pin 3. The signals should appear as they did at TP5 and TP9 except that they are inverted. If the signals are present U3B or U3C may be defective. If the signal is present at one of the NAND gate outputs but not at the other, replace U3.

If the signal is not present at U3D pin 11 or U3A pin 3, use the digital voltmeter to check the dc level at U2A pin 6. The dc level should be about +4 volts. If U2A pin 6 is at about +4 volts, U3 is defective.

If the +4 volts is not present at U2A pin 6, ground U2A pin 1. If the voltage at U2A pin 6 does not go to about +4 volts, U2 is defective.

If trouble still has not been found, connect the counter to TP3 and the digital voltmeter and the oscilloscope to NAND gate U5A pin 12. The counter readout should be about 210 kHz and U5A pin 12 should be low (about +60 millivolts). If the counter readout is lower or higher than 210 kHz and U5A pin 12 is high, slowly rotate A11R19 through its range while observing the counter and the oscilloscope. As the counter readout passes through the 210 kHz point the oscilloscope display should show a change in dc level; if it does not, U5 or U6 is probably defective.

Test 1-b. If there is no signal at TP2, or the signal is not approximately as shown in the top trace of composite waveform SS13-2, connect the oscilloscope first to TP1, then to U9 pin 8. TP1 and U9 pin 8 signals should be as shown in composite waveform SS13-2. All signal levels are about 4 volts.



Composite Waveform SS13-2

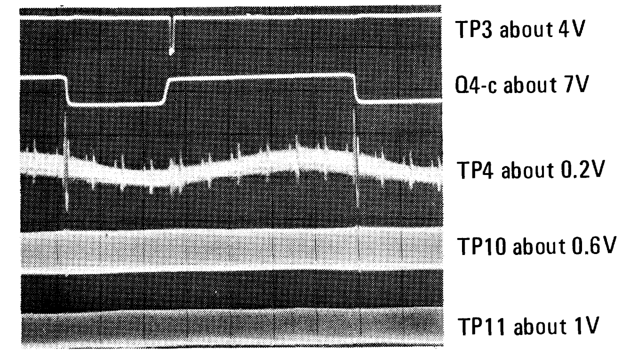
SERVICE SHEET 13 (Cont'd)

If the signal is as shown at TP1, U7A or Q12 may be defective.

If the signal is as shown at U9 pin 8 but does not appear at TP1, U9 is probably defective.

If the signal does not appear at U9 pin 8 check the interconnections to the N3 loop and, if necessary, the N3 loop.

Test 1-c. If there is no signal at TP3, or the signal is not approximately as shown in the top trace of composite waveform SS13-3, connect the oscilloscope, in turn, to the points shown in composite waveform SS13-3.



Composite Waveform SS13-3

If the signal shown in the second trace from the top of composite waveform SS13-3 is not as shown check Q3, Q7, U4B, U4C and associated components.

If the signal does not appear at Q4-c but the signal at TP4 is present check Q5, Q4 and associated components.

If the signal is not present at TP4 check for signals shown at TP10 and TP11. If both signals are present mixer E1 is probably defective. If either TP10 or TP11 signals are not present, trouble is in the N2 Loop or the SL2 voltage controlled oscillator.

Test 1-d. To check operation of the dc amplifier connect the digital voltmeter to TP8 and rotate A11R19 through its range. The digital voltmeter readout should vary from about —1.5 volt to about +1.5 volt. If the voltage does not vary as A11R19 is adjusted, check Q2, Q1, Q6 and associated components.

N3 VCO
◀ SERVICE SHEET 12

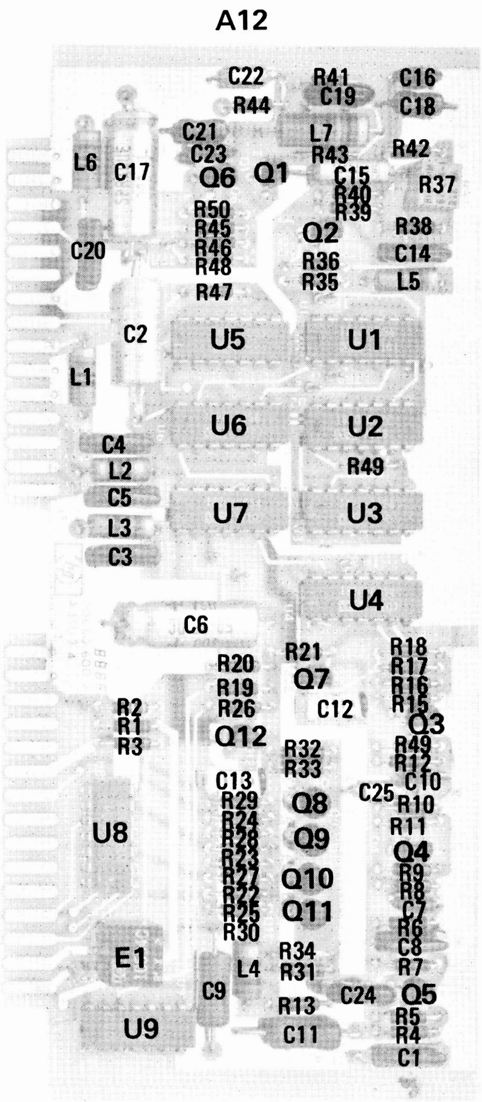
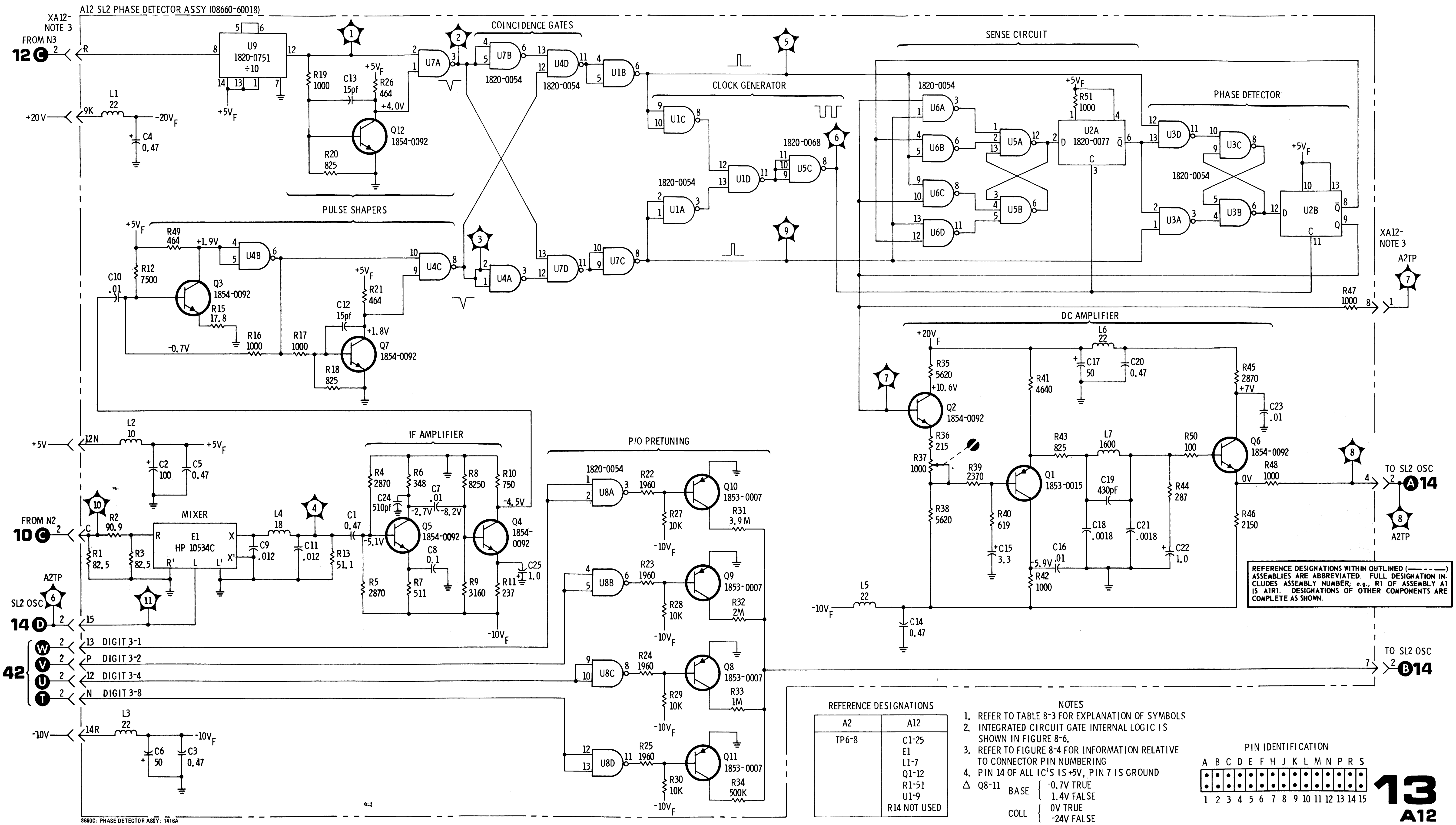


Figure 8-40. A12 SL2 Phase Detector Component Locations



REFERENCE DESIGNATIONS

A2	A12
TP6-8	C1-25 E1 L1-7 Q1-12 R1-51 U1-9 R14 NOT USED

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING
4. PIN 14 OF ALL IC'S IS +5V, PIN 7 IS GROUND

△ Q8-11 BASE { -0.7V TRUE, 1.4V FALSE }; COLL { 0V TRUE, -24V FALSE }

Figure 8-41. SL2 Phase Detector Schematic

SUMMING LOOP 2 OSCILLATOR A11

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A11 assembly, a part of the two-assembly SL2, is shown schematically and described on this service sheet. The SL2 Phase Detector assembly (A12) is shown schematically and described on service sheet 13.

When trouble has been isolated to the A11 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the SL2 circuits the adjustment procedures in Section V paragraph 5-32 should be perform to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

SUMMING LOOP 2 GENERAL

The purpose of Summing Loop 2 (SL2) is to generate digitally controlled RF signals in the range of 20.0001 to 30.0000 MHz in selectable 100 Hz increments. The difference frequency between the SL2 voltage controlled oscillator and the input from the N2 loop is phase locked to the divided-by-ten output of the N3 assembly. The output of SL2 is applied to SL1.

1 PRETUNING AND OSCILLATOR

The A11 assembly contains a voltage controlled oscillator, a digital to analog converter and a circuit to combine the pretuning dc level with the output from the phase detector. The frequency of the voltage controlled oscillator is roughly preset by the pretuning signal from the digital to analog converter circuit. The pretuning signal cannot, by itself, set the oscillator precisely; it does set the frequency within the capture range of the phase lock loop.

U2 is a decoder which converts the BCD information from digit 5 to turn on one of nine transistors in a resistive network. Quad NAND gate U3 turns on one or more transistors (Q17 through Q20) when there is a BCD input from digit 4. Quad NAND gate U8 in the A12 assembly turns on one or more transistors (A12Q8 through A12Q11 also in the A12 assembly) when there is a BCD input from digit 3.

When there is no BCD input (all inputs low), the voltage at TP3 is approximately —25 volts and the oscillator is roughly preset to 30.0000 MHz. As the digital to

analog transistors are switched on the voltage at TP3 decreases (becomes less negative). When the BCD inputs are at 999 the voltage at TP3 is about —5 volts and the oscillator is roughly preset to 20.0001 MHz.

Q4 is a summing amplifier which combines the output of the digital to analog converter and the signal from the SL2 phase detector. The summing point (Q4-e) sums the current from three sources; a current source from the +20 volt supply through R19, R20 and R21, a negative source from the digital to analog converter (TP3) and the signal from the SL2 phase detector. The voltage at the summing point is always zero volts.

When TP3 is at approximately —25 volts (all BCD inputs low), most of the current from the +20 volt source flows through Q5, very little flows through Q4. Under these conditions the voltage at Q4-c is about —30 volts. As the voltage at TP3 decreases (gets closer to dc ground level) less current flows through Q5, more flows through Q4 and the voltage at Q4-c decreases.

CR2 through CR11 and associated resistors are used to shape the voltage curve applied to the voltage controlled oscillator tuning varactors to ensure that the frequency change is linear with the applied voltage. The voltage at the junction of R52 and R53 is about —27.5 volts. When all BCD inputs are low (Q4-c is at about —30 volts) all of the diodes in the shaper are reverse biased. As the voltage at TP3 decreases (gets closer to —5 volts), current through Q4 increases and the Q4 collector voltage decreases. As the Q4-c voltage decreases first CR11, then CR10, etc are forward biased. As the diodes are forward biased resistors are added in parallel with R37 and R38 to shape the voltage curve to the varactors. Q15 provides a low impedance output to drive the varactors.

Q1 drives U1A which functions as a Schmitt trigger. U1B inverts the signal and applies it to the SL1 phase detector. U1D also inverts the signal and applies it to the SL2 phase detector.

TEST PROCEDURE 1

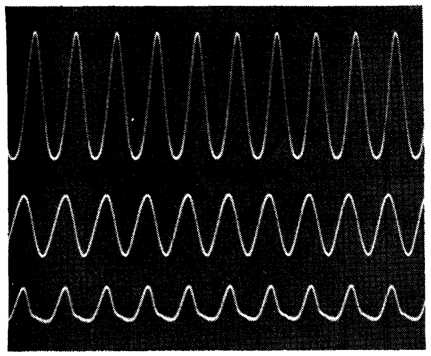
Test 1-a. Connect the counter to TP4. With the center freuqency set to zero the counter readout should be 30.000000 MHz. Set CF to the settings specified in Table 8-32. Frequency readouts should follow those specified in the table. (Make allowances for counter accuracy).

NOTE

If the frequency readouts listed in Table 8-32 are not as shown, check the voltage levels shown for TP5 in the table. If the voltages are incorrect proceed to test procedures 2.

If the signal is present use the oscilloscope to check the signals at points shown by composite waveform SS14-1.

SERVICE SHEET 14 (Cont'd)



Composite Waveform SS14-1

If the signal is present at TP4 but is not present at XA11-1-2 or XA11-1-6, U1 is probably defective.

If the signal is not present at TP4, use the oscilloscope to check for the signal at Q1-b. If the signal in present at Q1-b, check Q1 and NAND gate U1A. If the signal is not present at Q1-b check Q2, Q3 and associated components.

TEST PROCEDURE 2

Test 2-a. Use the digital voltmeter to check the voltages at TP3, TP2 and TP5. These dc levels should be about as shown in Table 8-32 for the center frequencies shown.

NOTE

These voltages are typical. They will vary from instrument to instrument because of differences in individual varactor characteristics.

If the voltage at TP3 does not change when CF digit 5 is changed to any position, U2 is probably defective. (Verify presence of BCD inputs). If the voltage at TP3 reaches about −25 volts when any CF digit 5 position is set (other than 0) the transistor associated with that number is probably open.

When the voltage at TP3 does not change with a change of the setting of CF digit 4, U3 or the associated transistors may be defective.

When the voltage at TP3 does not change with a change in the setting of CF digit 3, A12U8 or associated transistors may be defective. (This portion of the digital to analog converter is located in the A12 assembly).

SL2 Phase Detector
SERVICE SHEET 13

SERVICE SHEET 14 (Cont'd)

If the voltages are approximately correct at TP3 but are not correct at either TP2 or TP5, check Q4, Q15 and associated components.

The counter is connected to TP4 for readouts specified in Table 8-48.

Table 8-48. SL2 Frequency Versus Voltage Chart

Center Frequency	Counter Readout	TP3	TP2	TP5
00000 Hz	30.000000 MHz	−25.1 V	−31.6 V	−30.9 V
11100 Hz	28.890000 MHz	−22.8 V	−25.5 V	−24.8 V
22200 Hz	27.780000 MHz	−20.5 V	−20.5 V	−19.9 V
33300 Hz	26.670000 MHz	−18.3 V	−16.4 V	−15.7 V
44400 Hz	25.560000 MHz	−16. V	−13. V	−12.4 V
55500 Hz	24.450000 MHz	−13.8 V	−10.3 V	−9.6 V
66600 Hz	23.340000 MHz	−11.7 V	−8. V	−7.3 V
77700 Hz	22.230000 MHz	−9.5 V	−6.2 V	−5.5 V
88800 Hz	21.120000.MHz	−7.3 V	−4.6 V	−4. V
99900 Hz	20.010000 MHz	−5.3 V	−3.4 V	−2.8 V

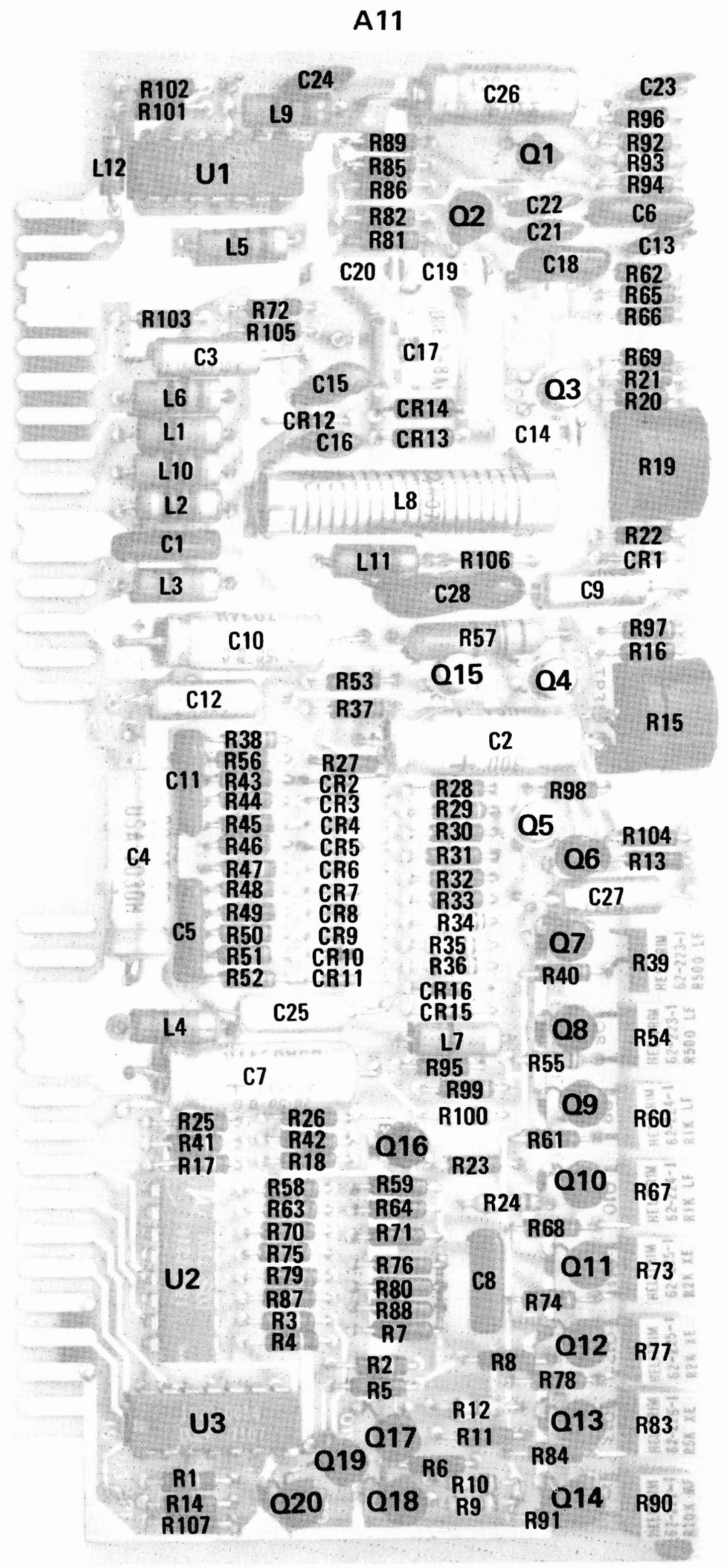


Figure 8-42. A11 SL2 VCO Component Locations

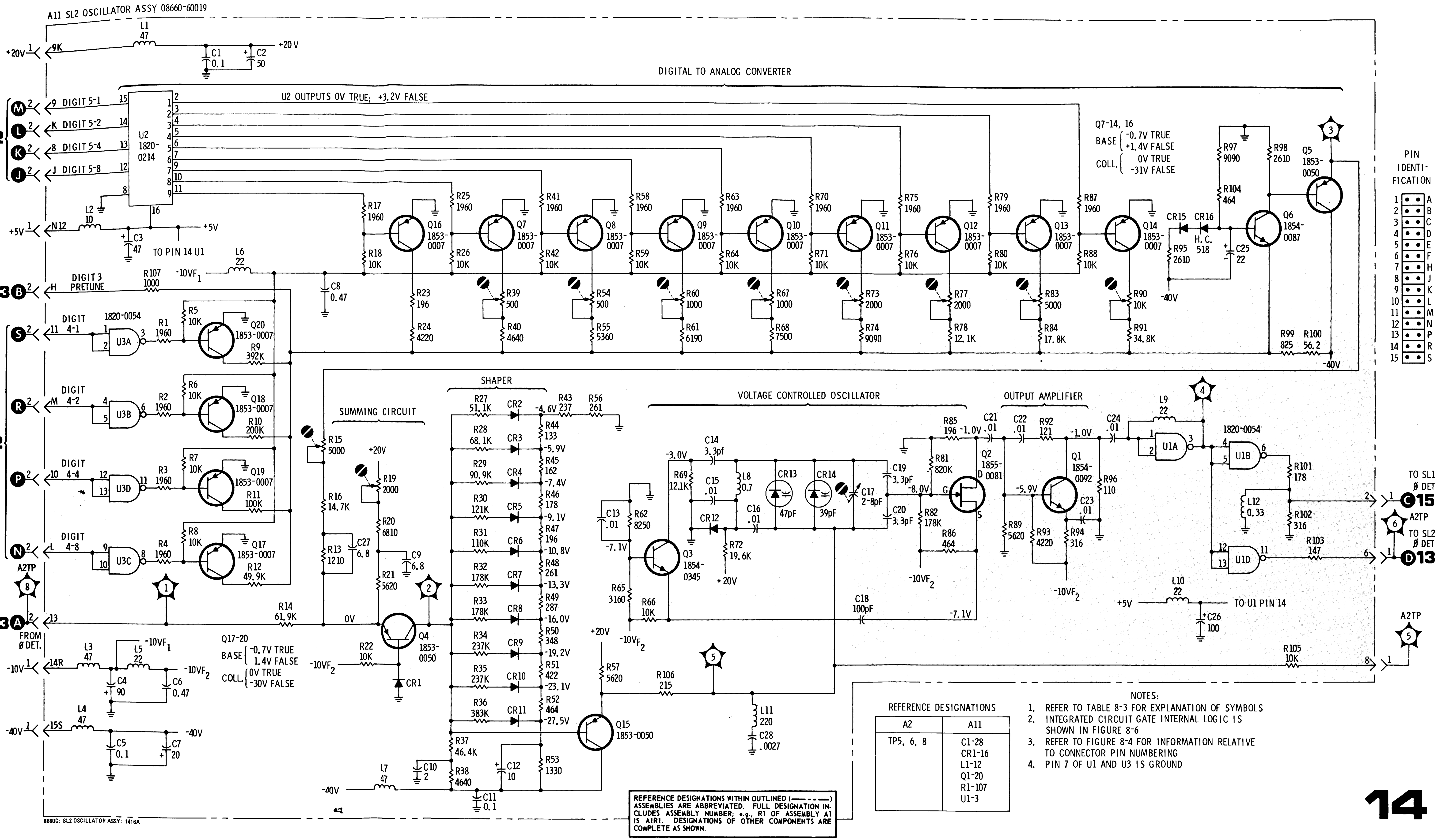


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Figure 8-43. SL2 VCO Schematic

SERVICE SHEET 15

SUMMING LOOP 1 PHASE DETECTOR A15

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A15 assembly, a part of the three-assembly SL1, is shown schematically and described on this Service Sheet. The SL1 Oscillator Assembly (A19) is shown schematically and described on Service Sheet 17. The SL1 Mixer and D/A Converter Assembly (A18) is shown schematically and described on Service Sheet 16.

When trouble has been isolated to the A15 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the SL1 circuits the adjustment procedures in Section V paragraph 5-33 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

SUMMING LOOP 1 GENERAL

The purpose of Summing Loop 1 (SL1) is to generate digitally controlled RF signals in the range of 20.000001 to 30.000000 MHz in selectable increments as low as 1 Hz. The SL1 voltage controlled oscillator is phase locked to the divided by one hundred output of the SL2 loop and the difference frequency of the N1 loop and the SL1 oscillator. The output of SL1 is applied to the RF Section plug-in.

1 PHASE DETECTOR ASSEMBLY A15

There are two signal inputs to the phase detector assembly. One is the input from the SL2 loop which is shaped by U10D and divided by 100 by U6 and U5. The output of U5 is again shaped by Q5 and U4A to provide negative-going pulses at TP2. The other input to the phase detector is from the SL1 mixer and is the difference frequency between the N1 oscillator and the SL1 voltage controlled oscillator. Q6, U4B, Q4 and U4C shape the signal and provides negative-going pulses at TP3.

The pulse frequency at TP2 and TP3 varies (depending on programming) from 0.200001 to 0.300000 MHz. When the phase lock loop is locked the pulse frequency is the same at TP2 and TP3. The sampling ratio is 1:1.

U9A, U3B, U4D and U9B comprise coincidence gates which inhibit signals which appear simultaneously at TP2 and TP3. Normally, when signals are not present, TP2 and TP3 are both high.

When a signal appears at TP2, U9A pin 3 and U3B pin 4 go high. If there is no signal at TP3, U3B pin 5 is also high; U3B pin 6 goes low and U3C pin 8 goes high. The positive pulse at TP4 drives the clock generator and the sense circuit or the phase detector.

When a signal appears at TP3, U4D pin 11 and U9B pin 5 go high. If there is no signal at TP2, U9B pin 4 is also high; U9B pin 6 goes low and U9D pin 11 goes high. The positive pulse at TP8 drives the clock generator and the sense circuit or the phase detector.

When signals appear simultaneously at TP2 and TP3, U9B pin 4 and U3B pin 5 go low: U9B pin 6 and U3B pin 6 remain high and the signals cannot reach TP4 or TP8.

U7C, U9C, U3D and U3A comprise a clock generator which clocks U2A and U2B each time a signal appears at TP4 or TP8. With no signals present TP4 and TP8 are low. When a positive pulse appears at TP8, U9C pin 8 goes low, U3D pin 11 goes high and a negative-going pulse appears at TP5. When a positive pulse appears at TP4 operation of the circuit is the same except that U7C pin 8 (rather than U9C pin 8 goes low). Since a clock

SERVICE SHEET 15 (Cont'd)

pulse is generated for each input, the clock pulse frequency at TP5 is the sum of the pulse frequencies at TP4 and TP8. U2A and U2B are clocked by the positive-going trailing edge of the negative clock pulses.

Since the sense circuit does not function when the loop is locked, operation of the phase detector will be described first.

When the loop is phase locked U2A $\overline{Q}$ is held high to enable U1A and U1B. Assume that initially U2B $\overline{Q}$ is high U1D pin 11 is low and U1C pin 8 is high. When a positive pulse from TP8 appears at U1A pin 1, U1A pin 3 goes low and causes a change in state of flip/flop U1D/U1C: U1D pin 11 goes high and U1C pin 8 goes low. The high at U1D pin 11 sets the D input to U2B and the clock pulse causes U2B Q to go high. The following positive pulse at TP4 is applied to U1B pin 5, U1B pin 6 goes low and changes the state of flip/flop U1D/U1C. U1D pin 11 goes low and the clock pulse causes U2B $\overline{Q}$ to again go high. This sequence continues as long as the pulses at TP4 and TP8 alternate.

The signals at TP4 and TP8 are applied to the sense circuit even when the loop is phase locked. They have no effect on the circuit because of the relationship between the Q and $\overline{Q}$ outputs of U2B to the incoming signals.

When U2B is high, NAND gates U8A and U8C are enabled. When the signal from TP4 appears at U8C pin 9, U8C pin 8 goes low; flip/flop U7A/U7B does not change state because U7B pin 3 is low. The signal at U8B pin 4 has no effect because U2B $\overline{Q}$ and U8B pin 5 are low.

When two or more consecutive pulses from either input (TP4 or TP8) occur between pulses from the other input, the sense circuits function to disable the phase detector until the frequency error has been corrected.

As an example of circuit operation, assume that two pulses from TP8 are received between two pulses from TP4, indicating that the SL1 frequency is too high. When the first pulse from TP8 is received U1A pin 3 goes low, U1D pin 11 goes high to set the D input to U2B and the clock pulse causes U2B Q to go high. When the second consecutive pulse is received from TP8, U8A has been enabled by the high Q output of U2B. U8A pin 3 goes low and causes flip/flop U7A/U7B to change state. When the D input to U2A goes high, the clock pulse causes U2A $\overline{Q}$ to go low and inhibit NAND gates U1A and U1B. If a third pulse from TP8 is received prior to receipt of a signal from TP4, U8A pin 3 will again go low but will not affect flip/flop U7A/U7B because U7A pin 13 is low.

When a pulse is received from TP4, U2B Q is still high and U8C pin 8 will go low and change the state of flip/flop U7A/U7B. When the D input to U2A goes low the clock pulse will cause U2A $\overline{Q}$ to go high and enable U1A and U1B. The propagation time of the signal through the sense circuit is long enough for the pulse from TP4 to have ended before U1B is enabled so the state of flip/flop U1D/U1C does not change.

The next pulse from TP8 will again cause U8A pin 3 to go low and change the state of flip/flop U7A/U7B. With the D input of U2A high again, the clock pulse causes U2A $\overline{Q}$ to go low and inhibit U1A and U1B. The signal applied to U1A has no effect on flip/flop U1D/U1C because U1D pin 12 is low.

The sense circuit continues operation in the manner described above until two consecutive pulses are received at TP4 between two pulses at TP8. When this occurs the first pulse causes U8C pin 8 to go low and change the state of flip/flop U7A/U7B. With the D input to U2A low the clock pulse will cause U2A $\overline{Q}$ to go high and enable NAND gates U1A and U1B. Because of the propagation time through the sense circuit, the pulse will have ended before U1B is enabled. The second consecutive pulse from TP4 again causes U8C pin 8 to go low, but because U7B pin 3 is now low, no change in state occurs in flip/flop U7A/U7B. Since U1B is enabled, U1B pin 6 goes low and causes flip/flop U1D/U1C to change state. With the D input of U2B low, the clock pulse will cause U2B $\overline{Q}$ output to go high.

SERVICE SHEET 15 (Cont'd)

Phase lock has been achieved and the loop will remain locked as long a
the same frequency are received alternately at TP4 and TP8.

When the SL1 frequency is too low, U2B Q is low. When the SL1 frequ
high, U2B Q is high.

DC amplifier Q1, Q2, Q3 and associated components filter the Q outp
and applies it to a summing circuit in the A19 assembly to precisely c
voltage controlled oscillator.

TEST PROCEDURE 1

Test 1-a. Connect the oscilloscope input to test points shown by
waveform SS15-1. This composite waveform illustrates correct wave
timing relationships for the points tested. All signals are about
amplitude.

NOTE

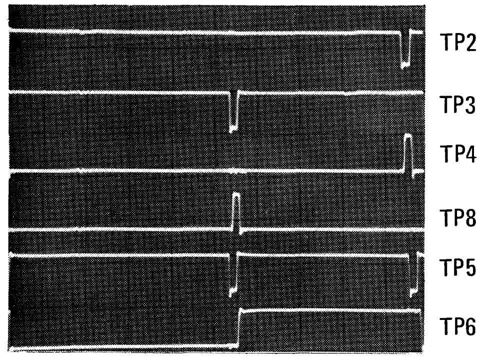
The oscilloscope was triggered from TP1 for all waveforms.

If the pulses are not present at TP2 proceed to test 1-b.

If the pulses are not present at TP3 proceed to test 1-c.

If the pulses are present at TP2 and TP3, but opposite polarity puls
present at TP4 and/or TP8, check the NAND gates between TP2 and T
and TP8 as appropriate.

If the positive-going pulses are present at TP4 and TP8, but negative-g
are not present at TP5 for each of the pulses, check NAND gates U3A,
and U9C as appropriate.



Composite Waveform SS15-1

If the pulses are approximately as shown in the top five traces of
waveform SS15-1 but there is no square wave at TP6, use the oscil
check the signal at NAND gate U1D pin 11. The display should be t
that shown for TP6. If the signal is present, U2B is probably defective.

If the signal is not present at U1D pin 11 use the oscilloscope to check
at NAND gates U1A pin 3 and U1B pin 6. The signals should appear as
TP4 and TP8 except that they are inverted. If the signals are present, U
may be defective. If the signal is present at one of the NAND gates but
other, replace U1.

If the signal is not present at U1A pin 3 or U1B pin 6, use the digital vo
check the dc level at U2A pin 6. If U2A pin 6 is about +4 volts, U1 is de

If the +4 volts is not present at U2A pin 6, ground U2A pin 1. If the
U2A pin 6 does not go to about +4 volts, U2 is defective.

SL2 VCO
SERVICE

ılse frequency at TP5 is the sum of
A and U2B are clocked by the
pulses.

n the loop is locked, operation of

ld high to enable U1A and U1B.
11 is low and U1C pin 8 is high.
A pin 1, U1A pin 3 goes low and
U1D pin 11 goes high and U1C pin
) input to U2B and the clock pulse
ve pulse at TP4 is applied to U1B
ite of flip/flop U1D/U1C. U1D pin
Q to again go high. This sequence
lternate.

sense circuit even when the loop is
ircuit because of the relationship
oming signals.

are enabled. When the signal from
low; flip/flop U7A/U7B does not
signal at U8B pin 4 has no effect

either input (TP4 or TP8) occur
se circuits function to disable the
n corrected.

t two pulses from TP8 are received
t the SL1 frequency is too high.
pin 3 goes low, U1D pin 11 goes
k pulse causes U2B Q to go high.
from TP8, U8A has been enabled
low and causes flip/flop U7A/U7B
s high, the clock pulse causes U2A
U1B. If a third pulse from TP8 is
U8A pin 3 will again go low but
pin 13 is low.

till high and U8C pin 8 will go low
hen the D input to U2A goes low
and enable U1A and U1B. The
nse circuit is long enough for the
enabled so the state of flip/flop

A pin 3 to go low and change the
of U2A high again, the clock pulse
1B. The signal applied to U1A has
n 12 is low.

nanner described above until two
en two pulses at TP8. When this
w and change the state of flip/flop
lock pulse will cause U2A $\overline{Q}$ to go
Because of the propagation time
nded before U1B is enabled. The
U8C pin 8 to go low, but because
in flip/flop U7A/U7B. Since U1B
p/flop U1D/U1C to change state.
ll cause U2B $\overline{Q}$ output to go high.

SERVICE SHEET 15 (Cont'd)

Phase lock has been achieved and the loop will remain locked as long as pulses at the same frequency are received alternately at TP4 and TP8.

When the SL1 frequency is too low, U2B Q is low. When the SL1 frequency is too high, U2B Q is high.

DC amplifier Q1, Q2, Q3 and associated components filter the Q output of U2B and applies it to a summing circuit in the A19 assembly to precisely control the voltage controlled oscillator.

TEST PROCEDURE 1

Test 1-a. Connect the oscilloscope input to test points shown by composite waveform SS15-1. This composite waveform illustrates correct waveforms and timing relationships for the points tested. All signals are about 4 volts in amplitude.

NOTE

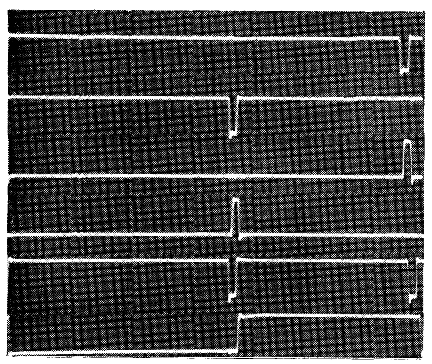
The oscilloscope was triggered from TP1 for all waveforms.

If the pulses are not present at TP2 proceed to test 1-b.

If the pulses are not present at TP3 proceed to test 1-c.

If the pulses are present at TP2 and TP3, but opposite polarity pulses are not present at TP4 and/or TP8, check the NAND gates between TP2 and TP4 or TP3 and TP8 as appropriate.

If the positive-going pulses are present at TP4 and TP8, but negative-going pulses are not present at TP5 for each of the pulses, check NAND gates U3A, U3D, U7C, and U9C as appropriate.



Composite Waveform SS15-1

If the pulses are approximately as shown in the top five traces of composite waveform SS15-1 but there is no square wave at TP6, use the oscilloscope to check the signal at NAND gate U1D pin 11. The display should be the same as that shown for TP6. If the signal is present, U2B is probably defective.

If the signal is not present at U1D pin 11 use the oscilloscope to check the signals at NAND gates U1A pin 3 and U1B pin 6. The signals should appear as they did at TP4 and TP8 except that they are inverted. If the signals are present, U1C or U1D may be defective. If the signal is present at one of the NAND gates but not at the other, replace U1.

If the signal is not present at U1A pin 3 or U1B pin 6, use the digital voltmeter to check the dc level at U2A pin 6. If U2A pin 6 is about +4 volts, U1 is defective.

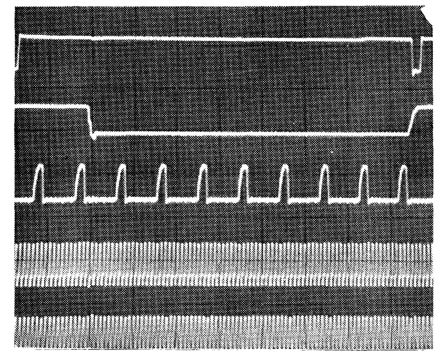
If the +4 volts is not present at U2A pin 6, ground U2A pin 1. If the voltage at U2A pin 6 does not go to about +4 volts, U2 is defective.

◀ SL2 VCO
SERVICE SHEET 14

SERVICE SHEET 15 (Cont'd)

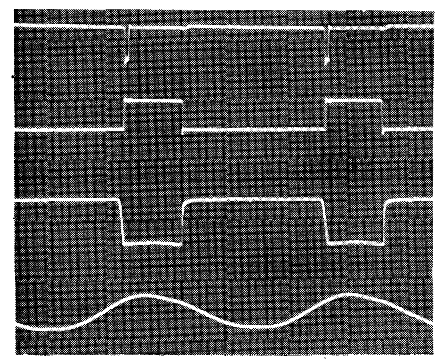
If the cause of trouble still has not been found, connect the counter to TP3 and the digital voltmeter and oscilloscope to NAND gate U7A pin 12. The counter readout should be about 300.000 kHz (center frequency set to zero) and U7A pin 12 should be low (about +70 millivolts). If the counter readout is lower or higher than 300 kHz and U5A pin 12 is high, slowly rotate A15R14 through its range while observing the counter and the oscilloscope. As the counter readout passes through the 300 kHz point the oscilloscope display should show a change in level; if it does not, U7 or U8 is probably defective.

Test 1-b. If there is no signal at TP2 or the signal is not approximately as shown in the top trace of composite waveform SS15-2, connect the oscilloscope first to TP2, then U6 pin 12, U6 pin 8 and finally to XA15-2-14. In making the checks in the order shown, the point at which the correct signal is first observed is followed by the defective circuit. If the signal is not present at XA15-2-14, check the interconnections to the SL2 loop and, if necessary, the SL2 loop.



Composite Waveform SS15-2

Test 1-c. If there is no signal at TP3 or the signal is not approximately as shown in the top trace of composite waveform SS15-3 connect the oscilloscope first to U4 pin 6, then to U4 pin 4 or 5 and finally to XA15-2-C.



Composite Waveform SS15-3

In making the checks in the order shown, the point at which the signal is first observed is followed by the defective circuit. If the signal is not present at XA15-2-C check the interconnections to the A18 assembly and, if necessary, the A18 assembly.

Test 1-d. To check operation of the dc amplifier connect the digital voltmeter to Q3-e, ground TP7, and rotate A15R14 through its range. The digital voltmeter readout should vary from about −1.5 volts to about +1.5 volts. If the voltage does not vary as A15R14 is adjusted, check Q1, Q2, Q3 and associated components.

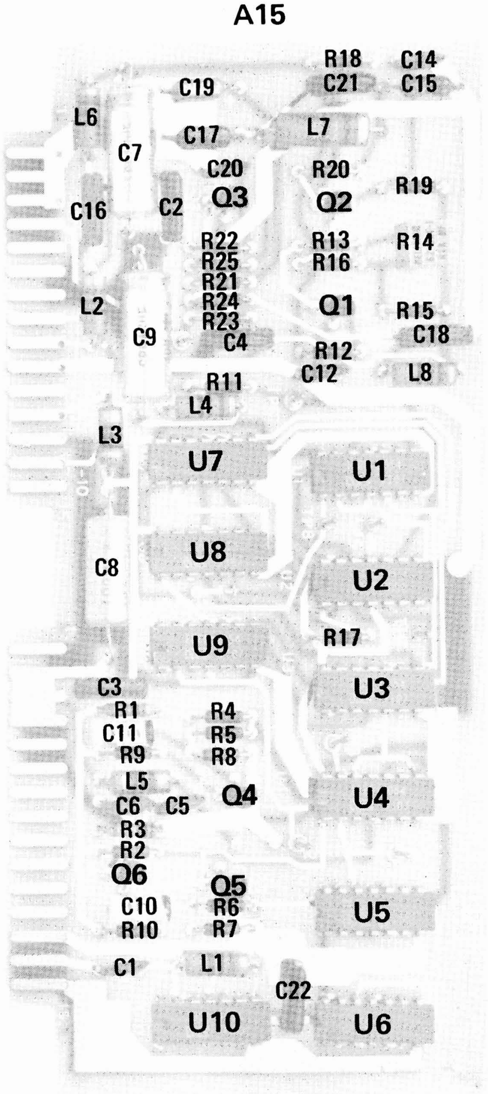
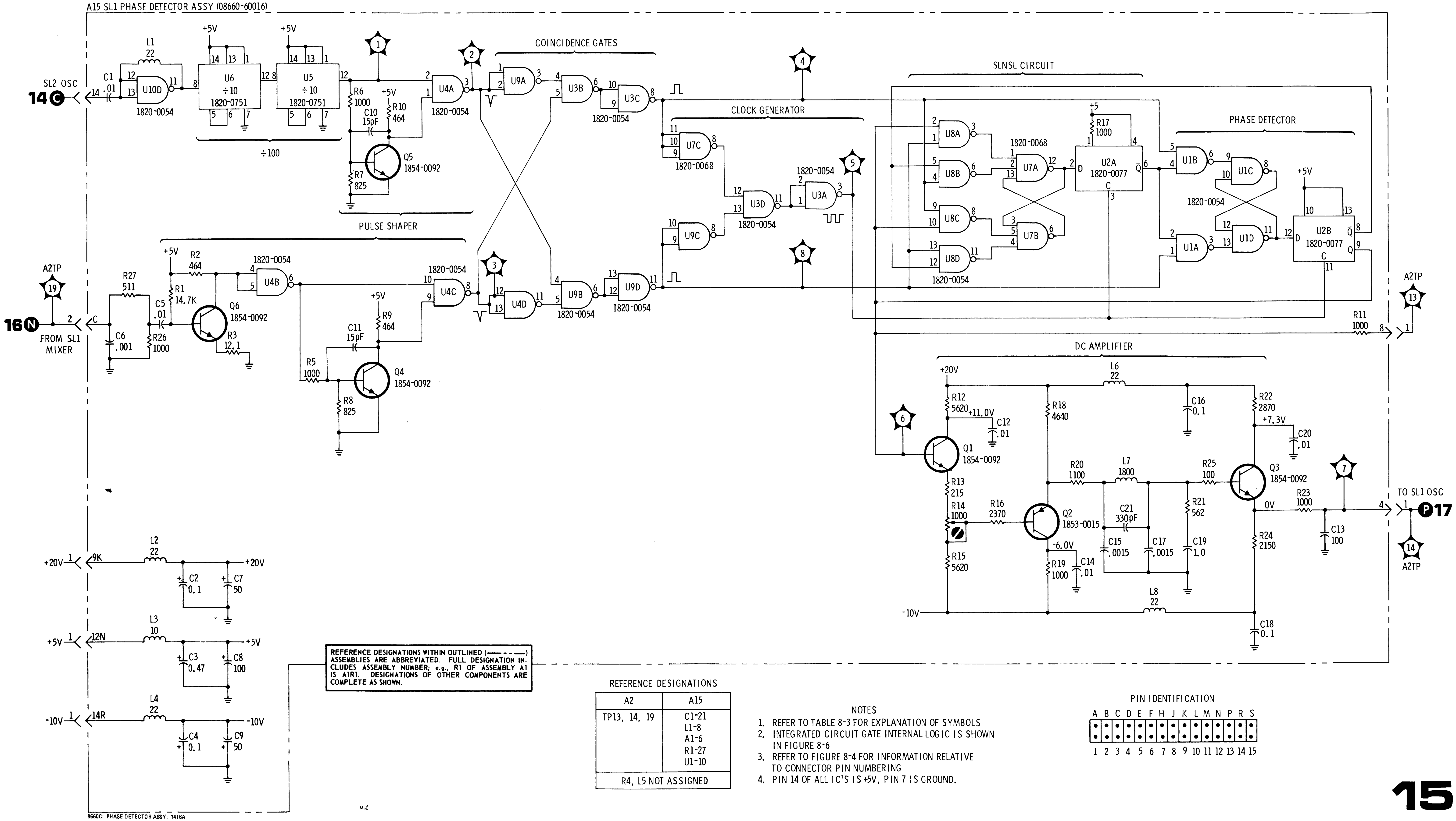


Figure 8-44. A15 SL1 Phase Detector Component Locations



REFERENCE DESIGNATIONS

A2	A15
TP13, 14, 19	C1-21 L1-8 A1-6 R1-27 U1-10
R4, L5 NOT ASSIGNED	

NOTES
1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING
4. PIN 14 OF ALL IC'S IS +5V, PIN 7 IS GROUND.

PIN IDENTIFICATION

A	B	C	D	E	F	H	J	K	L	M	N	P	R	S
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

15

Figure 8-45. SL1 Phase Detector Schematic

SERVICE SHEET 16

SUMMING LOOP 1 MIXER AND D TO A CONVERTER A18

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A18 assembly, a part of the three-assembly SL1, is shown schematically and described on this Service Sheet. The SL1 Phase Detector Assembly (A15) is shown schematically and described on Service Sheet 15. The SL1 Oscillator Assembly (A19) is shown schematically and described on Service Sheet 17.

When trouble has been isolated to the A18 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the SL1 circuits the adjustment procedures in Section V paragraph 5-33 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

SUMMING LOOP 1 GENERAL

The purpose of Summing Loop 1 (SL1) is to generate digitally controlled RF signals in the range of 20.000001 to 30.000000 MHz in selectable increments as low as 1 Hz. The SL1 voltage controlled oscillator is phase locked to the divided by one hundred output of the SL2 loop and the difference frequency of the N1 loop and the SL1 oscillator. The output of SL1 is applied to the RF Section output plug-in.

1 MIXER AND AMPLIFIERS

E1 is a double balanced mixer which mixes the output of the SL1 voltage controlled oscillator with the output of the N1 loop and provides an output which is the difference frequency of the two inputs.

Q14 and Q1 amplify the input from the SL1 voltage controlled oscillator.

Q2, Q15, Q18 and associated components amplify the output from the mixer before applying it to the phase detector circuit in the A15 assembly.

TEST PROCEDURE 1

Test 1-a. With the center frequency set to zero use the counter and the oscilloscope to check for the following (approximately sine wave) signals:

TP5 300.000 kHz at about 4 volts p/p
TP4 (oscilloscope only) 300 kHz at about 0.1 volt p/p
TP3 29.700000 MHz at about 0.5 volt p/p
Q1-e 30.000000 MHz at about 1.1 volt p/p
TP2 30.000000 MHz at about 0.5 volts p/p

SL1 Phase Detector
◄ SERVICE SHEET 15

SERVICE SHEET 16 (Cont'd)

2 DIGITAL TO ANALOG CONVERTER

U3 is a decoder which converts the BCD inputs from digit 7 to an output that will turn on one of nine transistors in a resistive network. Quad NAND gates U2 and U1 turn on one or more transistors connected to their outputs in a resistive network. U2 and U1 are controlled by digits 6 and 5 respectively.

The current flow through Q4 and the bias for Q3 is determined by which of the transistors in the resistive network are saturated. The dc level at TP1 is determined by which transistors are on. This dc level is applied to a summing circuit in the A19 assembly and used to roughly pretune the voltage controlled oscillator. When the BCD input is 000 the dc level at TP1 is about —25 volts. When the BCD input is 999 the dc level is about —5 volts.

TEST PROCEDURE 2

Test 2-a. Connect the digital voltmeter to TP1 and the counter to TP5. Refer to Table 8-33 for CF settings, counter readouts, and approximate voltage levels.

NOTE

The voltage readings are typical and may vary greatly from that shown due to differences in varactor characteristics. The important point to note is the ratio of change as the center frequency is changed.

If the voltage ratio changes about as shown but the frequency requirements are not met, trouble is probably in the oscillator assembly or the phase detector assembly.

Table 8-49. SL1 Frequency Versus Voltage Chart

Center Frequency	Frequency TP5	Voltage TP1
0000000 Hz	300.000 kHz	—25.5 V
1110000 Hz	290.000 kHz	—23.4 V
2220000 Hz	280.000 kHz	—21.0 V
3330000 Hz	270.000 kHz	—18.8 V
4440000 Hz	260.000 kHz	—16.6 V
5550000 Hz	250.000 kHz	—14.3 V
6660000 Hz	240.000 kHz	—12.1 V
7770000 Hz	230.000 kHz	—9.9 V
8880000 Hz	220.000 kHz	—7.7 V
9990000 Hz	210.000 kHz	—5.4 V
9999999 Hz	200.000 kHz	—5.4 V

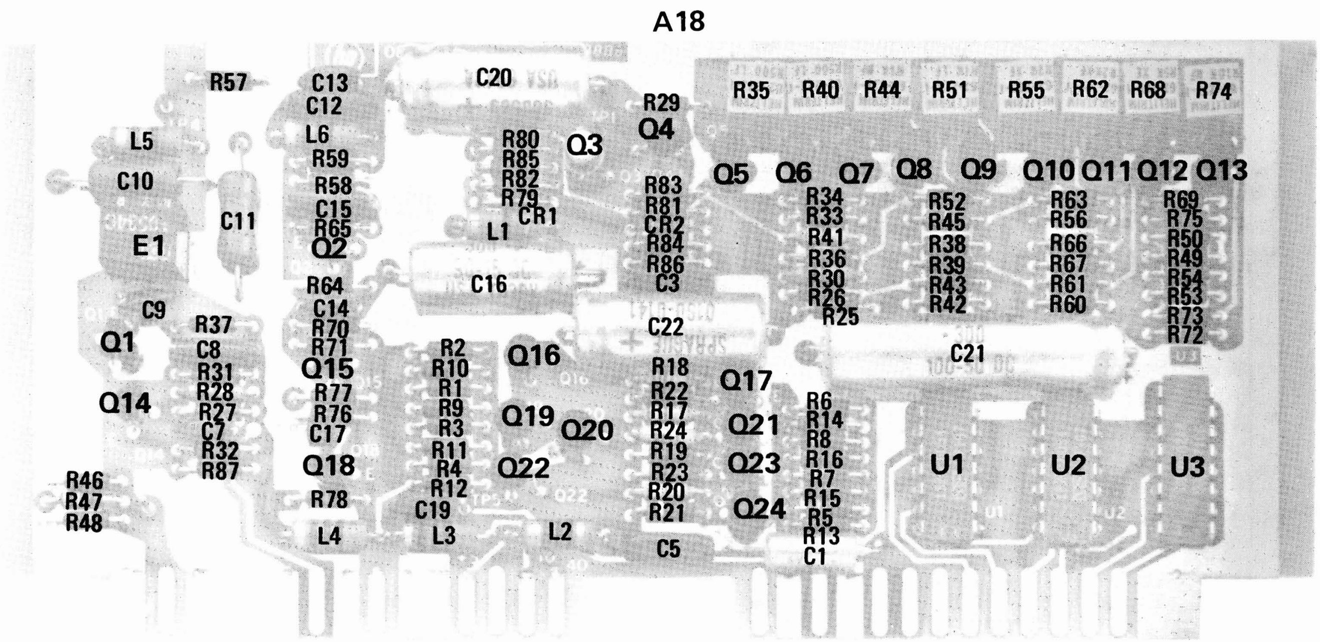
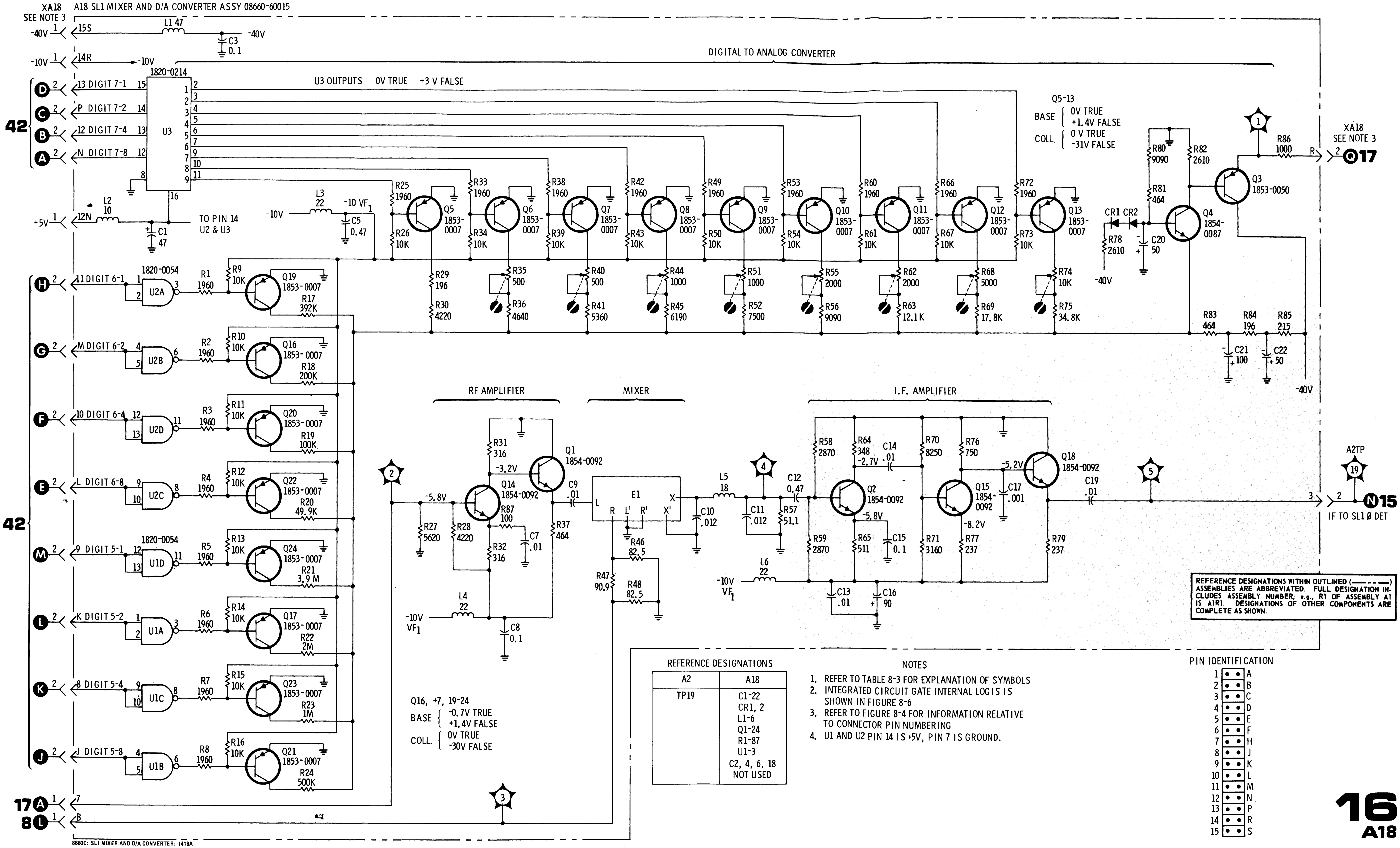


Figure 8-46. A18 SL1 Mixer and D/A Converter Component Locations



REFERENCE DESIGNATIONS

A2	A18
TP19	C1-22 CR1, 2 L1-6 Q1-24 R1-87 U1-3 C2, 4, 6, 18 NOT USED

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIS IS SHOWN IN FIGURE 8-6
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING
4. U1 AND U2 PIN 14 IS +5V, PIN 7 IS GROUND.

16
A18

Figure 8-47. SL1 Mixer and D/A Converter Schematic

SERVICE SHEET 17

SUMMING LOOP 1 OSCILLATOR A19

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

The A19 assembly, a part of the three-assembly SL2, is shown schematically and described on this Service Sheet. The SL1 Mixer and D/A Converter Assembly (A18) is shown schematically and described on Service Sheet 16. The SL1 Phase Detector Assembly (A15) is shown schematically and described on Service Sheet 15.

When trouble has been isolated to the A19 assembly it should be removed and reinstalled using two extender boards. This will provide easy access to test points and components.

NOTE

After making repairs to any part of the SL1 circuits the adjustment procedures in Section V paragraph 5-33 should be performed to ensure proper operation of the instrument.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter
Frequency Counter

SUMMING LOOP 1 GENERAL

The purpose of Summing Loop 1 (SL1) is to generate digitally controlled RF signals in the range of 20.000001 to 30.000000 MHz in selectable increments as low as 1 Hz. The SL1 voltage controlled oscillator is phase locked to the divided by one hundred output of the SL2 loop and the difference frequency of the N1 loop and the SL1 oscillator. The output of SL1 is applied to the RF Section plug-in.

1 SUMMING AMPLIFIER

Q6 is a summing amplifier which combines the output of the digital to analog converter and the signal from the SL1 phase detector. The summing point (Q6-e) sums the current from three sources; a current source from the +20 volt supply through R9, R10 and R11, a negative source from the digital to analog converter through R3, R7 and R68, and the signal from the SL1 phase detector through R6. The dc level at the summing point is held at zero volts.

When the input at XA19-2-J is about —25 volts (all BCD inputs to A18 low) most of the current from the +20 volt source flows through A18Q3; very little flows through Q6. Under these conditions the voltage at Q6-c is about —30 volts. As the voltage at XA19-2-J decreases (becomes less negative), less current flows through A18Q3, more flows through Q6, and the voltage at Q6-c decreases (becomes less negative).

SERVICE SHEET 17 (Cont'd)

CR1 through CR10 and associated resistors are used to shape the voltage curve applied to the voltage controlled oscillator tuning varactors to ensure that frequency change is linear with voltage change. The voltage at the junction of R32 and R39 is about —27.5 volts. When all BCD input to the A18 assembly are low, Q6-c is about —30 volts and all of the diodes in the shaper are reverse biased. As the voltage from the digital to analog converter decreases (gets closer to —5 volts) current through Q6 increases and the Q6 collector voltage decreases. As the Q6-c voltage decreases first CR10, then CR9, etc. are forward biased. As the diodes are forward biased resistors are added in parallel with R35 and R38 to shape the voltage curve to the varactors. Q7 provides a low impedance output to drive the varactors.

TEST PROCEDURE 1

Test 1-a. Connect the digital voltmeter to TP1 and set the center frequency as shown in Table 8-34.

NOTE

The voltage readings are typical and may vary greatly from that shown due to differences in varactor characteristics. The important point to note is the ratio of change as the center frequency is changed.

If the voltage at TP1 does not change as the CF are changed check the input from the digital to analog converter (A18) at XA19-2-J. If the voltage levels at this point do not change as the CF is changed, trouble is probably in the A18 assembly.

If the voltage level from the digital to analog converter does change, but the level at TP1 does not, check Q6, Q7 and associated components.

2 VOLTAGE CONTROLLED OSCILLATOR AND AMPLIFIERS

Q5, Q4 and associated components comprise a voltage controlled oscillator. C17, C20 and C21 provide isolation for the dc levels required to bias the varactors. C19 provides the feedback necessary to sustain oscillation. The resonant tank circuit is coupled to Q4 by capacitive divider C20 and C21. The FET acts as a source follower in the feedback circuit; it provides a high impedance at the gate and a low impedance at the source.

Q3 is a power splitter which drives two two-stage amplifiers. One amplifier output is applied to the RF Section plug-in and the other is applied to the mixer in the A18 assembly.

TEST PROCEDURE 2

Test 2-a. Connect the oscilloscope to TP3 then to TP4. The sine wave at both test points should be about 0.3 volts p/p.

SL1 Mixer and D/A
SERVICE SHEET 16

SERVICE SHEET 17 (Cont'd)

CR1 through CR10 and associated resistors are used to shape the voltage curve applied to the voltage controlled oscillator tuning varactors to ensure that frequency change is linear with voltage change. The voltage at the junction of R32 and R39 is about —27.5 volts. When all BCD input to the A18 assembly are low, Q6-c is about —30 volts and all of the diodes in the shaper are reverse biased. As the voltage from the digital to analog converter decreases (gets closer to —5 volts) current through Q6 increases and the Q6 collector voltage decreases. As the Q6-c voltage decreases first CR10, then CR9, etc. are forward biased. As the diodes are forward biased resistors are added in parallel with R35 and R38 to shape the voltage curve to the varactors. Q7 provides a low impedance output to drive the varactors.

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Test 1-a. Connect the digital voltmeter to TP1 and set the center frequency as shown in Table 8-34.

NOTE

The voltage readings are typical and may vary greatly from that shown due to differences in varactor characteristics. The important point to note is the ratio of change as the center frequency is changed.

If the voltage at TP1 does not change as the CF are changed check the input from the digital to analog converter (A18) at XA19-2-J. If the voltage levels at this point do not change as the CF is changed, trouble is probably in the A18 assembly.

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Q5, Q4 and associated components comprise a voltage controlled oscillator. C17, C20 and C21 provide isolation for the dc levels required to bias the varactors. C19 provides the feedback necessary to sustain oscillation. The resonant tank circuit is coupled to Q4 by capacitive divider C20 and C21. The FET acts as a source follower in the feedback circuit; it provides a high impedance at the gate and a low impedance at the source.

Q3 is a power splitter which drives two two-stage amplifiers. One amplifier output is applied to the RF Section plug-in and the other is applied to the mixer in the A18 assembly.

TEST PROCEDURE 2

Test 2-a. Connect the oscilloscope to TP3 then to TP4. The sine wave at both test points should be about 0.3 volts p/p.

SERVICE SHEET 17 (Cont'd)

If the signal is not present at either TP3 or TP4 connect the oscilloscope to Q3-b. The signal level should be about 0.2 volts p/p. If the signal is present at Q3-b but was not present at TP3 or TP4, Q3 is probably defective. If the signal is not present at Q3-b, check Q5, Q4 and associated components.

Test 2-b. Connect the counter to TP3 or TP4 and check for correct frequencies at the CF shown in Table 8-47.

Table 8-50. Varactor Bias Versus Frequency SL1

Center Frequency	Frequency TP3 or TP4	Voltage TP1
0000000 Hz	30.000000 MHz	—30.7 V
1110000 Hz	28.890000 MHz	—25.3 V
2220000 Hz	27.780000 MHz	—21.2 V
3330000 Hz	26.670000 MHz	—17.2 V
4440000 Hz	25.560000 MHz	—13.4 V
5550000 Hz	24.450000 MHz	—10.6 V
6660000 Hz	23.340000 MHz	—8.2 V
7770000 Hz	22.230000 MHz	—6.3 V
8880000 Hz	21.120000 MHz	—4.7 V
9990000 Hz	20.010000 MHz	—3.3 V
9999999 Hz	20.000001 MHz	—3.2 V

SL1 Mixer and D/A
SERVICE SHEET 16

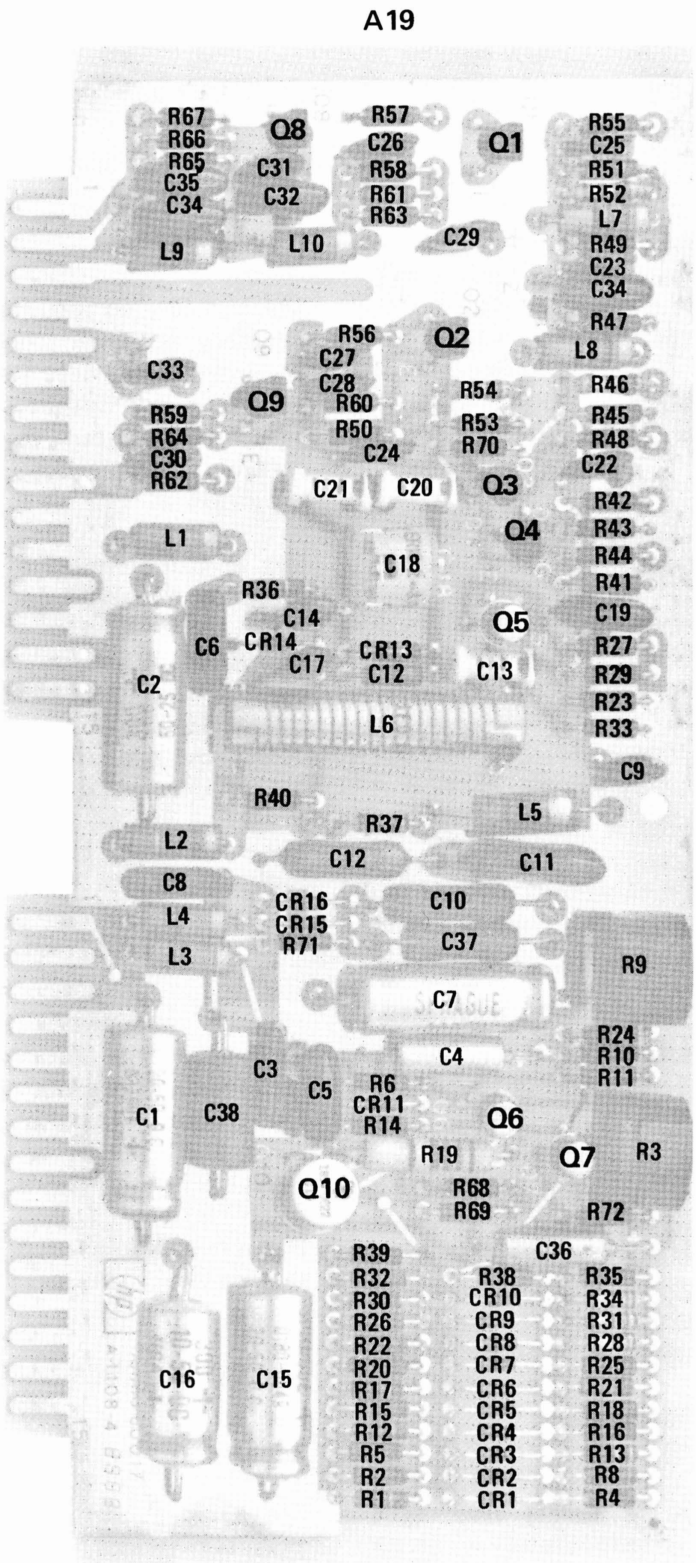
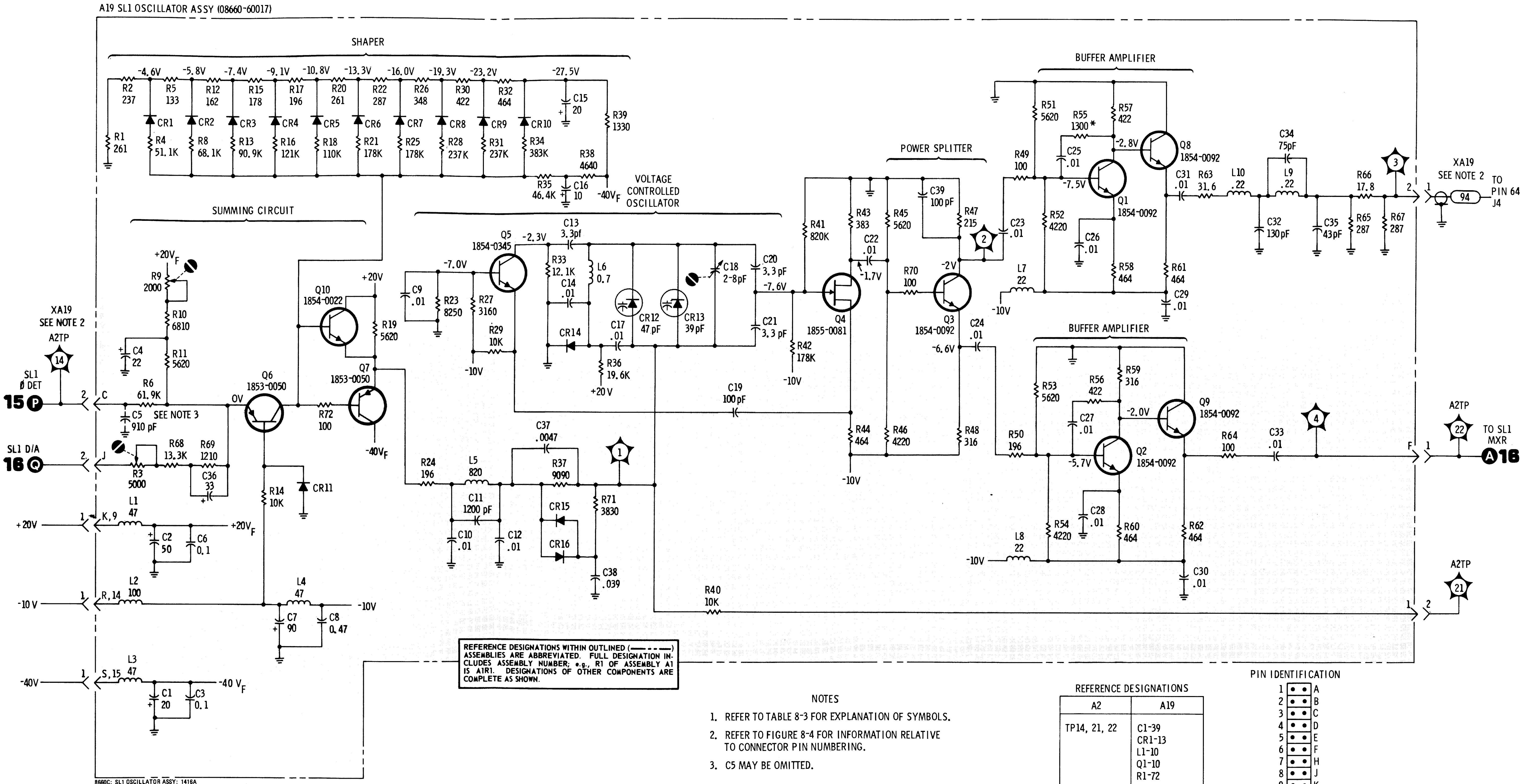


Figure 8-48. A19 SL1 VCO Component Locations



NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.
3. C5 MAY BE OMITTED.

REFERENCE DESIGNATIONS

A2	A19
TP14, 21, 22	C1-39 CR1-13 L1-10 Q1-10 R1-72
R7 NOT USED	

PIN IDENTIFICATION

1	A
2	B
3	C
4	D
5	E
6	F
7	H
8	J
9	K
10	L
11	M
12	N
13	P
14	R
15	S

17

Figure 8-49. SL1 VCO Schematic

DCU BLOCK DIAGRAM

GENERAL

The DCU (Digital Control Unit) controls all functions of the mainframe in the local mode of operation. In addition, in the remote mode of operation, the DCU displays the selected center frequency (CF) and processes the programming data to control all functions of the mainframe and the plug-in sections.

The DCU is a bus oriented system with three major buses.

All of the data from the keyboard shift register (KYBD SR), the Arithmetic Logic Unit (ALU) and the CF register is routed through the T bus to their destination(s).

The R bus couples the outputs of the CF and A registers to the ALU on command.

The S bus couples the outputs of the step and sweep width registers, and the output of a read-only-memory (ROM) to the ALU on command.

The following information describes, in general terms, the overall operation of the various functions of the DCU. More detailed information to the circuit level appears on the foldout page opposing the schematic diagrams of the individual circuits.

KEYBOARD

The keyboard (KYBD) assembly consists of 20 non-contacting keys and a circuit board containing 20 printed circuit transformers. The transformer secondaries are series connected and the primaries are connected in series pairs. The transformer windings in each pair are oppositely paired. Each pair of the transformers are controlled by one numeral (0-9) key and one function (D.P., CF, MHz, etc.) key. A 100 kHz clock controls scanning of the transformer pairs.

When a key is pressed, a spring loaded, metal disc closely coupled to the transformer changes the mutual inductance between the primary and secondary of the corresponding transformer. The key detect and encode circuit in the A1A2 keyboard control assembly then determines which key of the pair has been pressed.

The keyboard is shown schematically on Service Sheet 21.

KEYBOARD CONTROL ASSEMBLY

Key Detect and Encode. The keyboard control assembly provides a train of 100 kHz pulses to the ten key-pair transformers on the keyboard. The keyboard pairs are strobed successively in the scanning process. When a key is pressed the scanning is stopped until the key is released.

During the period of time that scanning is stopped, the key detect and encode circuit determines which key of the pair has

been pressed and furnishes outputs to MPX I (multiplexer I) or to the qualifier select circuits on the A1A4 assembly. Numerical information goes to MPX I and all other information goes to A1A4.

Keyboard Register and Multiplexers. In order to simplify the following discussion the multiplexers in the keyboard control assembly are referred to as MPX I, MPX II and MPX III. Each of the multiplexers has four-line inputs to points labeled I_0 and I_1. The input to be used is determined by the level at the I_S selector line, i.e., a high level, logic 1, would select the I_1 inputs.

In the local mode, KØ register and the KYBD SR function as a four-bit, eleven digit, recirculating shift register. The purpose of recirculating the BCD information is to ensure that when all data is stored in the KYBD SR, the least significant digit is stored in a position to be the first digit shifted out of the register.

Operation of the circuit is as follows (example entry is 12.345678 MHz); KYBD key 1 is pressed first and the BCD information (0001) is coupled through MPX I to be stored in KØ. The KYBD SR is then clocked by a burst of ten clock pulses and the BCD information is shifted to the least significant digit position in the KYBD SR.

The second KYBD entry, a 2 (0010) is clocked into KØ. A burst of ten clock pulses again transfers the KØ data to the least significant digit of the KYBD SR. Now, however, there is an input to MPX I, I_1, which is clocked into KØ; this entry, BCD 0001, follows the BCD 0010 information through to the KYBD SR. When the burst of ten clock pulses ends, the BCD 0010 data is stored in the KYBD SR least significant storage and the BCD 0001 data is stored in the next least significant digit storage.

The third keyboard entry, for the example used, is a decimal point (DP) which does not directly affect the KYBD SR. The DP information is applied to the qualifier select circuit in the A1A4 assembly.

The fourth keyboard entry, for the example used, a 3 (0011) is processed in the same manner as the first and second entries. At the end of the burst of ten clock pulses the information stored in the KYBD SR is 0000000123.

NOTE

If the KYBD pushbutton is now pressed the CF readout will display 12.3.

The remaining keyboard entries are processed in the same manner as entries 1, 2 and 4. When all information has been entered the KYBD SR data will be 0012345678. If the KYBD pushbutton is pressed the CF readout will display 12.345678.

The last keyboard entry (in the example an 8, BCD1000), will be the first digit clocked out when the data is transferred to another shift register.

When information is clocked out of the KYBD SR it is also recirculated through MPX III and clocked back into the KYBD SR. In the local mode the information is retained in the KYBD SR until the keyboard is cleared or a new data entry is made.

In the remote mode, MPX III I_0 inputs are enabled by the RMT CMND-L line which goes low on command. Information from the mainframe interface circuits is applied to MPX III I_0 inputs with the least significant digit first. Data is entered in the KYBD SR until all required data is entered.

It should be noted that when the information in the KYBD SR is clocked out in the remote mode, it is again coupled back to MPX I and MPX III. This feedback is coupled through MPX I to KØ but cannot affect the KYBD SR because MPX II I_1 is selected. Since MPX III I_S is low only when remote data is being programmed in from an external source, the feedback flows through MPX III and MPX II to recirculate the information in the KYBD SR. When the data is stored in a final register the KYBD SR is cleared.

The output from the KYBD SR is applied to the A1A6 register assembly.

Refer to Service Sheets 19,20, and 32 for more detailed information regarding these circuits.

REGISTER ASSEMBLY

The A1A6 assembly contains the CF, STEP, SWEEP WIDTH and M registers.

The data inputs to the A1A6 assembly consist of inputs from the KYBD SR and the ALU. Most instructions are received from the A1A5 ROM output assembly.

The BCD inputs from the KYBD SR are applied to two sets of gates. If these BCD inputs are data inputs for the plug-in sections, the gates are enabled by the input ST01-H, and the data is transferred to the appropriate register in the addressed plug-in section.

If the information stored in the KYBD SR is not for the plug-in sections, gates may be enabled by KTT-H to couple the information to the T bus. Simultaneously, the information on the T bus is clocked into one, or more, of the shift registers on the A1A3 or A1A9 assembly as well as the A1A6 assembly.

Most of the registers are preceeded by multiplexers. These multiplexers may be an integral part of the register integrated circuit or a separate integrated circuit.

When new information is present on the T bus, one set of multiplex gates is enabled to couple the information to the

SERVICE SHEET 18 (Cont'd)

register. When information is being clocked out of a register, the other set of multiplexer gates are enabled to recirculate the information to the register. This ensures that register information is retained for future use without re-programming.

Center Frequency (CF) Register

The CF register is the only register that feeds its output back to the T bus. This output to the T bus, which is coupled through gates enabled by CTT-H occurs when:

1. Entry of an out-of-range frequency has been attempted (state 3/8).
2. A frequency increment (STEP) has been added to or subtracted from, the center frequency (state 2/7).
3. The instrument has been switched from the sweep mode to the fixed frequency mode (state 2/9).
4. The readout is to display CF again after the readout has been used to display KYBD, STEP, or SWP WIDTH (state 1/8).

Refer to Service Sheet 29 for more detailed information about the CF register.

Step Register

Any frequency (within the range of the RF Section in use) may be stored in the step register and added to, or subtracted from, the center frequency by the ALU. Since the step register is a recirculating register, the stored information may be used as many times as desired.

Refer to Service Sheet 30 for more detailed information about the step register.

Sweep Width Register

Any sweep width within the range of the RF Section in use may be stored in the sweep width register. In the sweep mode the sweep width is centered on the center frequency. Example; CF 50 MHz, SWP WIDTH 50 MHz, RF output is swept from 25 to 75 MHz.

Refer to Service Sheet 30 for more detailed information about the sweep width register.

M Register and Limits

When CF data from the KYBD SR is first clocked to the T bus it is applied only to the M register. The M register and the frequency limits decoder then determined if the programmed frequency is within the limits of the RF Section in use.

The M register is a six digit register. Only the six most significant digits are required for limit detection.

SERVICE SHEET 18 (Cont'd)

The frequency limits decoder, in addition to the BCD inputs from the M register, has 16LIM and 13GL inputs. The 16LIM and 13GL inputs are decoded inputs from the RF Section plug-in which are used to select the frequency limits.

The frequency limits decoder controls operation of the OUT OF RNG lamp and also provides Code 1 and Code 2 dc levels to the RF Section power amplifiers to operate two transistor switches to change the response time for output leveling.

After the M register and the frequency limits decoder have determined that the CF data is valid, the KYBD SR data is again clocked via the T bus into the CF, readout (RO) and A registers. The data is then clocked from the A register through the ALU via the R bus to the T bus and to A1A10, the output register.

Refer to Service Sheet 31 for a more detailed description of the M register and frequency limits circuit.

ARITHMETIC LOGIC UNIT (ALU)

The ALU, as the name implies, arithmetically manipulates the inputs from the other registers. The ALU may add, subtract, or allow the data to flow through without change. It also has a ROM (read-only-memory) which contains incrementing numbers used for the manual tune operation. The ROM may be used to cause the selected center frequency to be offset by any frequency within the range of the RF Section in use.

NOTE

Offset is a special option. The frequency offset must be specified, and the ROM programmed at the factory.

Refer to Service Sheet 32 for a more complete description of the ALU circuits.

OUTPUT REGISTER

The output register converts the serial BCD data from the T bus or the A register to parallel BCD data. This is referred to as parallel dump. The advantage of parallel dump over serial dump is that only those mainframe phase lock loops which are programmed for a different rf output lose phase lock. This improves switching time and avoids generation of unwanted frequencies.

Refer to Service Sheet 35 for a more detailed explanation of the output register circuit.

SWEEP COUNT ASSEMBLY

Shown directly under the ALU block is the sweep count assembly. The major function of this assembly is to keep track of the number of steps which have been taken in the sweep operation. The three UP/DN counters have the capability of counting to 1000 steps. When the sweep is set to 100 steps the first UP/DN counter is bypassed and the count is 100.

When the sweep mode is selected, the sweep always starts at the center frequency. In the AUTO mode the frequency steps are always to a higher frequency. When the upper limit of the sweep range is reached, the sweep starts at the lower limit of the range and is stepped up in frequency until the upper limit is again reached.

In the manual (MAN) sweep mode the sweep may be stepped either up or down by use of the manual tuning control.

The D/A (digital to analog) output (0 to +8V) may be used as an input to X-Y recorders, oscilloscopes, etc.

For more complete details about the sweep count assembly refer to Service Sheet 33.

SWITCH CONTROL ASSEMBLY

The switch control assembly is shown at the far left side of the block diagram. This assembly provides seven clocks for use in various parts of the DCU. It also generates and stores qualifiers for all of the front panel controls except the keyboard numbers.

For a more complete description of the switch control assembly refer to Service Sheets 19 and 20.

ROM INPUT AND ROM OUTPUT ASSEMBLIES

The outputs of the seven state flip-flops control the qualifier select and seven of the address bits of the ROMs. When the eighth address bit is provided to the ROMs, the seven state flip/flops are set to the next state by the outputs of ROMs 1 and 2. ROM 2 also provides 1 output instruction and ROM 3 provides 4 output instructions.

Circuits are also provided to manually clock (single step) the DCU. When this feature is used, light emitting diodes verify the machine state.

SERVICE SHEET 18 (Cont'd)

The frequency limits decoder, in addition to the BCD inputs from the M register, has 16LIM and 13GL inputs. The 16LIM and 13GL inputs are decoded inputs from the RF Section plug-in which are used to select the frequency limits.

The frequency limits decoder controls operation of the OUT OF RNG lamp and also provides Code 1 and Code 2 dc levels to the RF Section power amplifiers to operate two transistor switches to change the response time for output leveling.

After the M register and the frequency limits decoder have determined that the CF data is valid, the KYBD SR data is again clocked via the T bus into the CF, readout (RO) and A registers. The data is then clocked from the A register through the ALU via the R bus to the T bus and to A1A10, the output register.

Refer to Service Sheet 31 for a more detailed description of the M register and frequency limits circuit.

ARITHMETIC LOGIC UNIT (ALU)

The ALU, as the name implies, arithmetically manipulates the inputs from the other registers. The ALU may add, subtract, or allow the data to flow through without change. It also has a ROM (read-only-memory) which contains incrementing numbers used for the manual tune operation. The ROM may be used to cause the selected center frequency to be offset by any frequency within the range of the RF Section in use.

NOTE

Offset is a special option. The frequency offset must be specified, and the ROM programmed at the factory.

Refer to Service Sheet 32 for a more complete description of the ALU circuits.

OUTPUT REGISTER

The output register converts the serial BCD data from the T bus or the A register to parallel BCD data. This is referred to as parallel dump. The advantage of parallel dump over serial dump is that only those mainframe phase lock loops which are programmed for a different rf output lose phase lock. This improves switching time and avoids generation of unwanted frequencies.

Refer to Service Sheet 35 for a more detailed explanation of the output register circuit.

SWEEP COUNT ASSEMBLY

Shown directly under the ALU block is the sweep count assembly. The major function of this assembly is to keep track of the number of steps which have been taken in the sweep

SL1 VCO
SERVICE SHEET 17

SERVICE SHEET 18 (Cont'd)

operation. The three UP/DN counters have the capability of counting to 1000 steps. When the sweep is set to 100 steps the first UP/DN counter is bypassed and the count is 100.

When the sweep mode is selected, the sweep always starts at the center frequency. In the AUTO mode the frequency steps are always to a higher frequency. When the upper limit of the sweep range is reached, the sweep starts at the lower limit of the range and is stepped up in frequency until the upper limit is again reached.

In the manual (MAN) sweep mode the sweep may be stepped either up or down by use of the manual tuning control.

The D/A (digital to analog) output (0 to +8V) may be used as an input to X-Y recorders, oscilloscopes, etc.

For more complete details about the sweep count assembly refer to Service Sheet 33.

SWITCH CONTROL ASSEMBLY

The switch control assembly is shown at the far left side of the block diagram. This assembly provides seven clocks for use in various parts of the DCU. It also generates and stores qualifiers for all of the front panel controls except the keyboard numbers.

For a more complete description of the switch control assembly refer to Service Sheets 19 and 20.

ROM INPUT AND ROM OUTPUT ASSEMBLIES

The outputs of the seven state flip-flops control the qualifier select and seven of the address bits of the ROMs. When the eighth address bit is provided to the ROMs, the seven state flip/flops are set to the next state by the outputs of ROMs 1 and 2. ROM 2 also provides 1 output instruction and ROM 3 provides 4 output instructions.

Circuits are also provided to manually clock (single step) the DCU. When this feature is used, light emitting diodes verify the machine state.

NOTE

The term "machine state" refers to a given set of conditions at a given point in time. These states are shown in logical succession on the Algorithmic State Machine (ASM) Flow Chart on the last foldout sheet of this manual.

For a more complete description of circuit operation refer to Service Sheet 26.

The box labeled qualifier select in the ROM input assembly is shown schematically on Service Sheet 25. Multiple devices form a large selector circuit providing one output selected from 34 qualifier inputs. Seven inputs from the seven state flip-flops control the selection. The single output provides the eighth address bit to ROMs 1, 2 and 3.

For a more detailed description of circuit operation refer to Service Sheet 25.

The ROM output assembly contains a clock burst control which selects the number of pulses in the clock train, and a state decoder which converts the coded outputs of the seven state flip-flops to instructions.

For a more detailed description of the circuits refer to Service Sheets 27 and 28.

READOUT CONTROL ASSEMBLY

The major function of the A1A3 readout control assembly is to justify (position) the decimal point in the readout. The assembly also contains a 10 digit readout register which controls the ROMs in the readout assembly. Blanking of the leading zeros, and scanning of the register for the readout assembly is also provided.

For a more detailed description of the cirucits in the readout control assembly refer to Service Sheets 23 and 24.

READOUT ASSEMBLY

The readout assembly contains two side by side solid state readouts. Both are 6 digit readouts.

For a more complete description of the readout assembly circuits refer to Service Sheet 36.

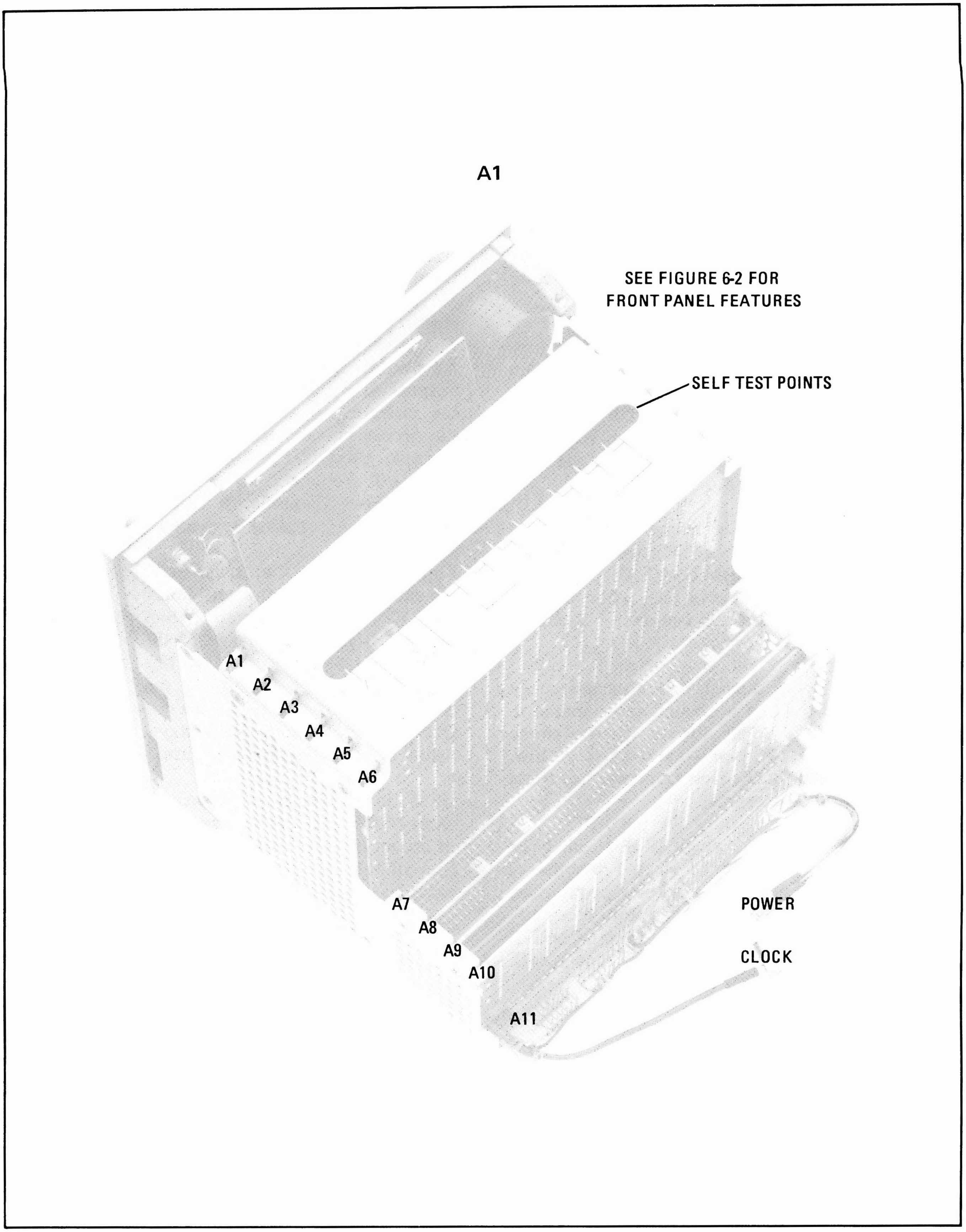
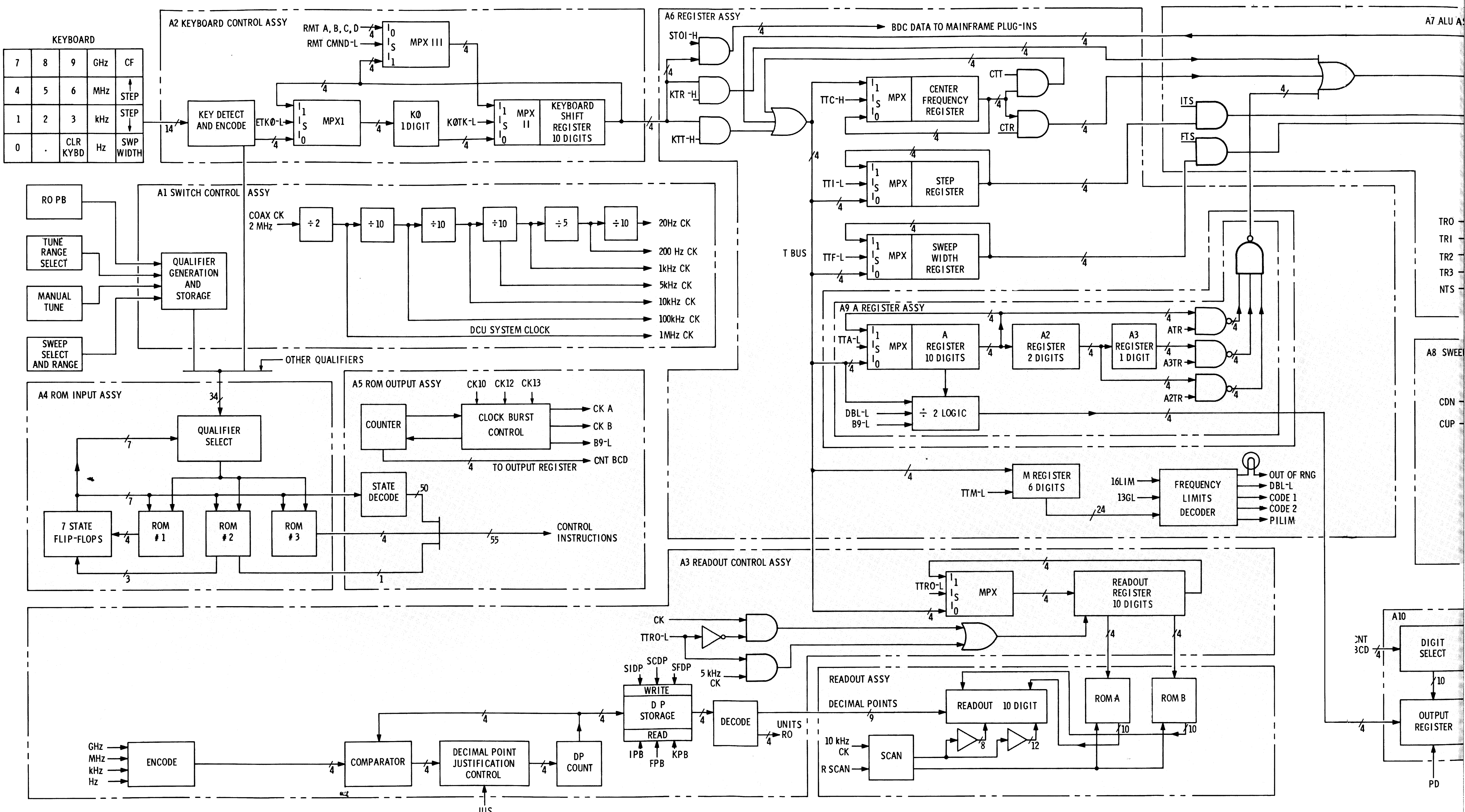


Figure 8-50. 8660B DCU (A1)


KEYBOARD
7 8 9 GHz CF
4 5 6 MHz STEP
1 2 3 kHz STEP
0 . CLR KYBD Hz SWP WIDTH
A2 KEYBOARD CONTROL ASSY
KEY DETECT AND ENCODE
RMT A, B, C, D
RMT CMND-L
MPX III
MPX1
ETKØ-L
KØ 1 DIGIT
KØTK-L
MPX II
KEYBOARD SHIFT REGISTER 10 DIGITS
A6 REGISTER ASSY
STOI-H
KTR-H
KTT-H
BDC DATA TO MAINFRAME PLUG-INS
TTC-H
CENTER FREQUENCY REGISTER
CTT
CTR
TTI-L
STEP REGISTER
TTF-L
SWEEP WIDTH REGISTER
T BUS
A7 ALU A
ITS
FTS
TRO
TRI
TR2
TR3
NTS
RO PB
TUNE RANGE SELECT
MANUAL TUNE
SWEEP SELECT AND RANGE
A1 SWITCH CONTROL ASSY
QUALIFIER GENERATION AND STORAGE
COAX CK 2 MHz
÷2
÷10
÷5
20Hz CK
200 Hz CK
1kHz CK
5kHz CK
10kHz CK
100kHz CK
DCU SYSTEM CLOCK
1MHz CK
OTHER QUALIFIERS
A9 A REGISTER ASSY
TTA-L
A REGISTER 10 DIGITS
A2 REGISTER 2 DIGITS
A3 REGISTER 1 DIGIT
ATR
A3TR
A2TR
DBL-L
B9-L
÷ 2 LOGIC
A8 SWEE
CDN
CUP
A4 ROM INPUT ASSY
QUALIFIER SELECT
7 STATE FLIP-FLOPS
ROM #1
ROM #2
ROM #3
A5 ROM OUTPUT ASSY
CK10 CK12 CK13
COUNTER
CLOCK BURST CONTROL
CK A
CK B
B9-L
CNT BCD
TO OUTPUT REGISTER
STATE DECODE
CONTROL INSTRUCTIONS
M REGISTER 6 DIGITS
TTM-L
16LIM
13GL
FREQUENCY LIMITS DECODER
OUT OF RNG
DBL-L
CODE 1
CODE 2
PILIM
A3 READOUT CONTROL ASSY
TTRO-L
MPX
READOUT REGISTER 10 DIGITS
CK
TTRO-L
SIDP SCDP SFDP
5 kHz CK
WRITE
D P STORAGE
READ
IPB FPB KPB
DECODE
UNITS RO
READOUT ASSY
DECIMAL POINTS
READOUT 10 DIGIT
ROM A
ROM B
10 kHz CK
R SCAN
SCAN
GHz
MHz
kHz
Hz
ENCODE
COMPARATOR
DECIMAL POINT JUSTIFICATION CONTROL
JUS
DP COUNT
A10
CNT BCD
DIGIT SELECT
OUTPUT REGISTER
PD

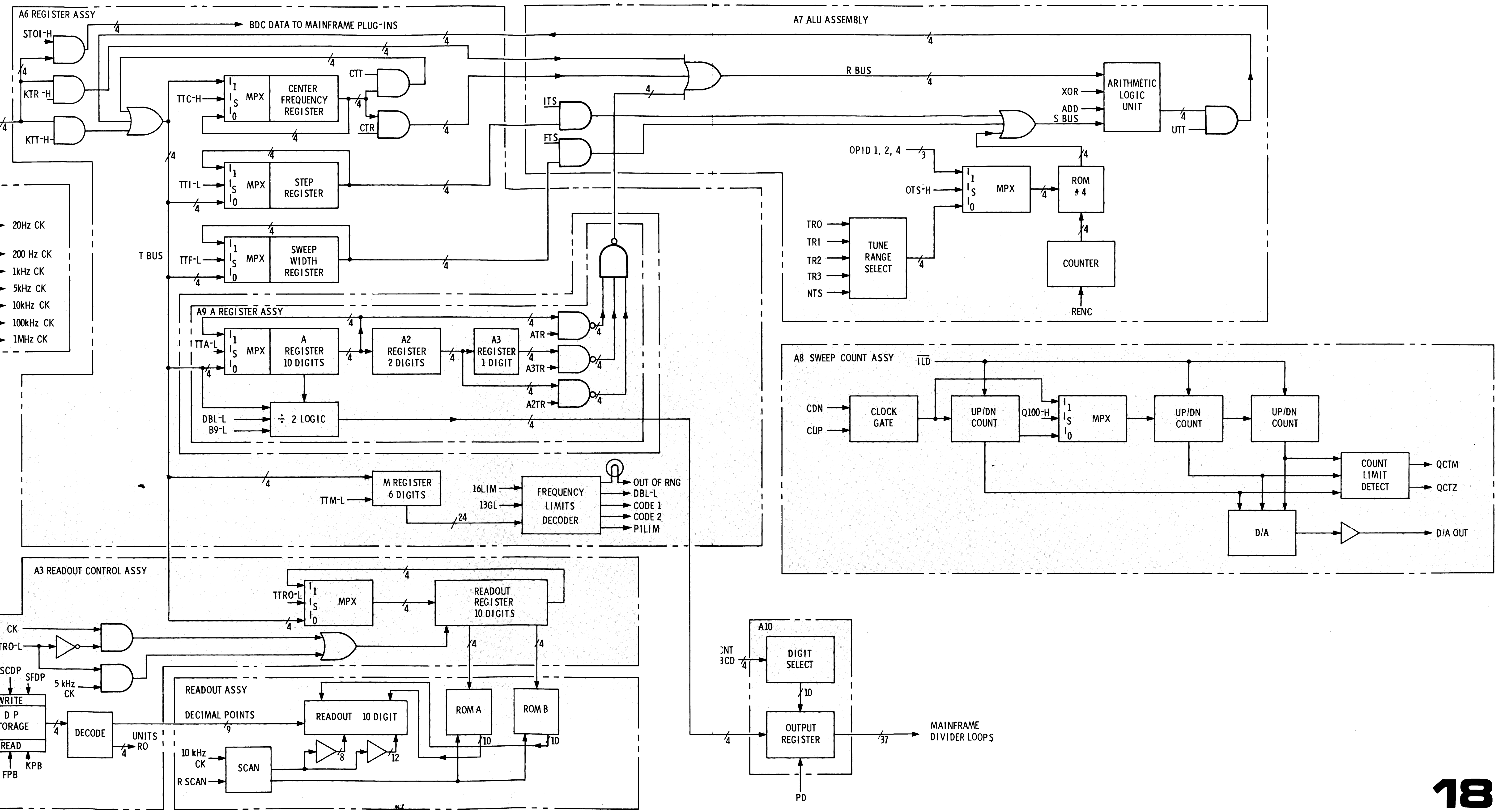


Figure 8-51. DCU Block Diagram, A1

SERVICE SHEET 19

P/O SWITCH CONTROL ASSEMBLY A1A1

Service sheets 19 and 20 provide schematic diagrams for the circuits on the A1A1 assembly and some of the front panel operating controls.

The pushbutton switches shown in the upper left hand corner of Service Sheet 19 labeled KYBD, STEP and SWP WIDTH, when pressed, cause the information stored in the KYBD SR (keyboard shift register), STEP (step register), or the SWP WIDTH (sweep width register) to be displayed on the CENTER FREQUENCY readout.

The PBCOM (pushbutton common line) is low when the instrument is in the local mode and the power detect requirements have been met. When any one of the pushbuttons is pressed the D input of the associated D type flip-flop goes low. The Q output of the associated flip-flop goes low and remains low until the pushbutton is released. On release the Q output goes high on the next clock pulse. The clock pulse to these flip-flops are operated by a 200 Hz clock.

The Q outputs of the pushbutton flip-flops U21B, U29B and U29A are used in the readout control assembly, A1A3 and the ROM Input assembly A1A4. These Q outputs also control the output of NAND gate U22B. When any one of the Q outputs go low, the output of NAND gate U22B goes high.

Normally, the pushbutton readout (PBR) flip-flop, U11A and the center frequency (CFR) flip-flop, U11B, are in the reset state.

When one of the pushbuttons is pressed and the output of U22B goes high, both inputs to AND gate U20C are high, the J input to U11A is high and U11A Q will go high on the first clock pulse. The Q output of U11A goes high to enable U20B.

When U11A $\overline{Q}$ goes low, AND gates U19A and U13C are inhibited. The low level at U13C pin 8 enables NOR gate U24C. When the instrument is in state 0/0 the output of U24 is also low so the J input of flip-flop F10 goes high. The next clock pulse causes U16B Q to go high. When qualifier F10-H goes high the state machine is enabled to proceed from state 0/0 to state 4/0.

When state 3/6 is reached, KPBR and JCFR go low, KF10 and RKD2 go high. The KPBR-JCFR input is inverted and applied to the K input of U11A and, through AND gate U20B to the J input of U11B. Simultaneously the KF10-H level is applied to the K input of the F10 flip/flop U16B. The next clock pulse causes U11A Q to go low, U11B $\overline{Q}$ to go high and U16B Q to go low.

DCU Block Diagram
SERVICE SHEET 18

SERVICE SHEET 19 (Cont'd)

The state progression then flows back to state 0/0 where it remains until the pushbutton is released. On release of the pushbutton the Q output of the associated pushbuttton flip-flop again goes high and the output of NAND gate U22B goes low.

Both inputs to NOR gate U24A are now low so the output goes high and is inverted to inhibit AND gates U19A and U13C. The next clock pulse causes the Q output of the F10 flip-flop, U16B, to go high. The state machine again proceeds from state 0/0, state 4/0 and on.

When machine state 1/8 is reached the instructions cause the Center Frequency readout to again display the center frequency. Instruction KCFR-L occurs in state 1/8. This input is inverted and applied to the K input of U11B which is then clocked to drive the Q output terminating the CFR flip-flop function.

When any keyboard key is pressed, input KD2-L goes low. This inhibits NAND gates U19A and U13C and enables NOR gate U24C. The J input to the F10 flip-flop, U16B, goes high when in state 0/0 and the next clock pulse causes the Q output to go high.

The F10 flip-flop Q output also is caused to go high at state 0/0 when a manual tune operation causes U19A pin 4 to go low or when a sweep operation causes U13C pins 10 and 11 to go low. In each case, the F10 flip-flop is set and this starts the state to state progression.

The F1 flip-flop, U16A, which is also called the interrupt flip-flop, is set in state 0/0 when a keyboard entry, a manual entry, or a pushbutton entry is made during a sweep operation. When any of these entries are made, the output of NAND gate U19A goes low to enable NOR gate U24D. When state 0/10 is reached, the J input of U16A goes high, and the next clock pulse causes the Q output to go high.

When a keyboard entry is made while in the sweep mode, the sweep is interrupted while the entry is being executed. During execution U15A K input goes high in state 0/5 enabling the reset of the F1 flip-flop. The sweep is resumed when the entry is completed.

U26 is a 4-line to 16-line selector. The A, B, C and D inputs are in binary format. Inputs G1 and G2 are enabling inputs which must both be low to enable the selector. U26 is the code 0 selector; whenever it is active the state is 0/0, 0/1, 0/2, etc. All outputs are high except the one selected. The outputs of the selector are instructions. Some of the instructions are qualified; they do not affect the circuits unless certain conditions are met. As an example, the F10 flip-flop, U16B will not be set in state 0/0 unless a front panel control, switch or key has been manipulated. Some instructions such as JF9-H, are generated by more than one state.

Flip-flop U1 in the lower left corner of the schematic performs the sole function of operating the OUT OF RNG lamp. When the frequency selected is above the range of the RF Section in use, the data is rejected and the OUT OF RNG lamp flashes once (about 0.5 second). When the frequency selected is below the specified limits, the OUT OF RNG lamp light stays lit (frequencies below the specified limits are useable).

U28B, in conjunction with cross-connected NAND gates U18A and U18B serve to speed up detection of an out of range frequency to provide an FLIM-L (out of range) signal for programming equipment external to the 8660C.

Flip-flop U28A controls the SWON-H (sweep on) line.

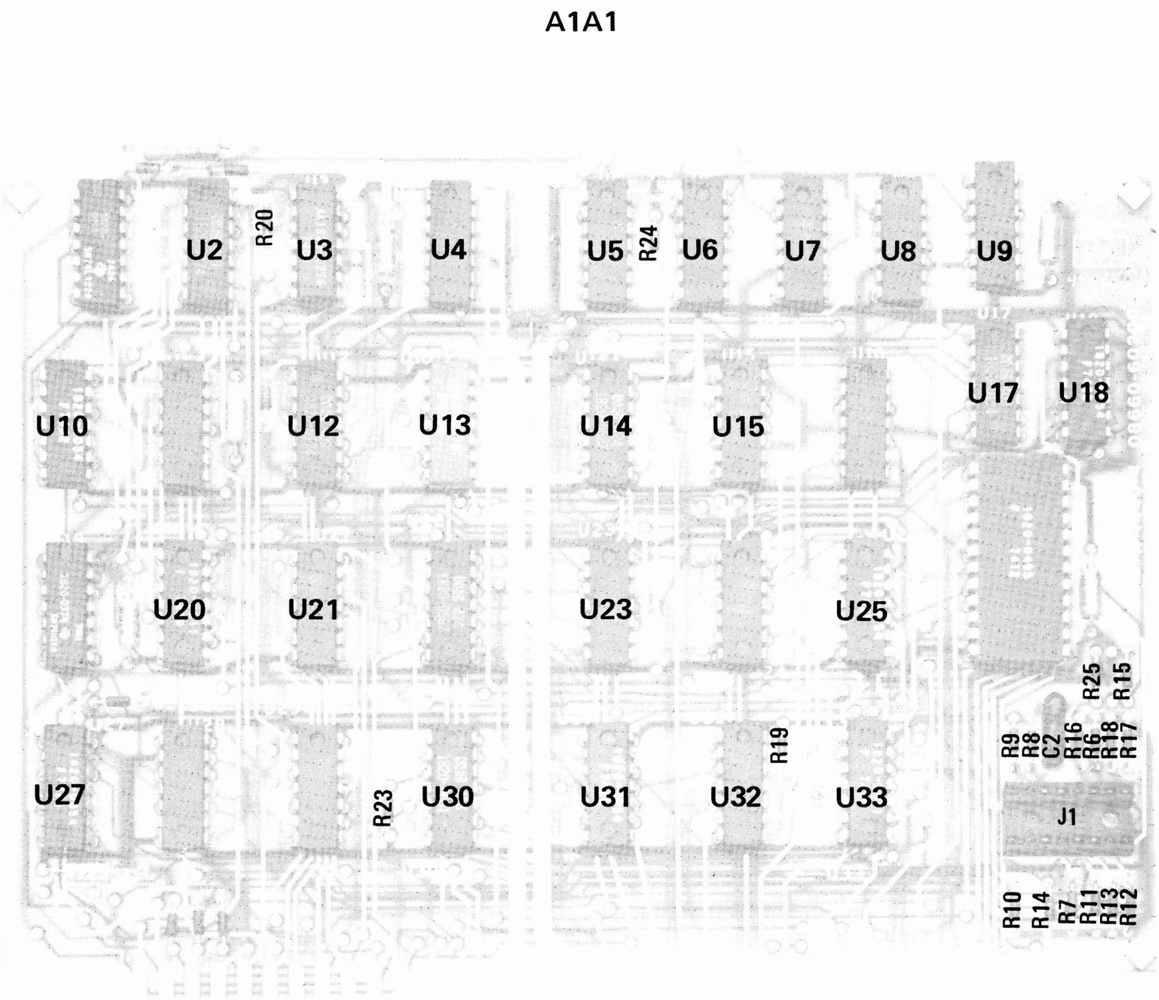
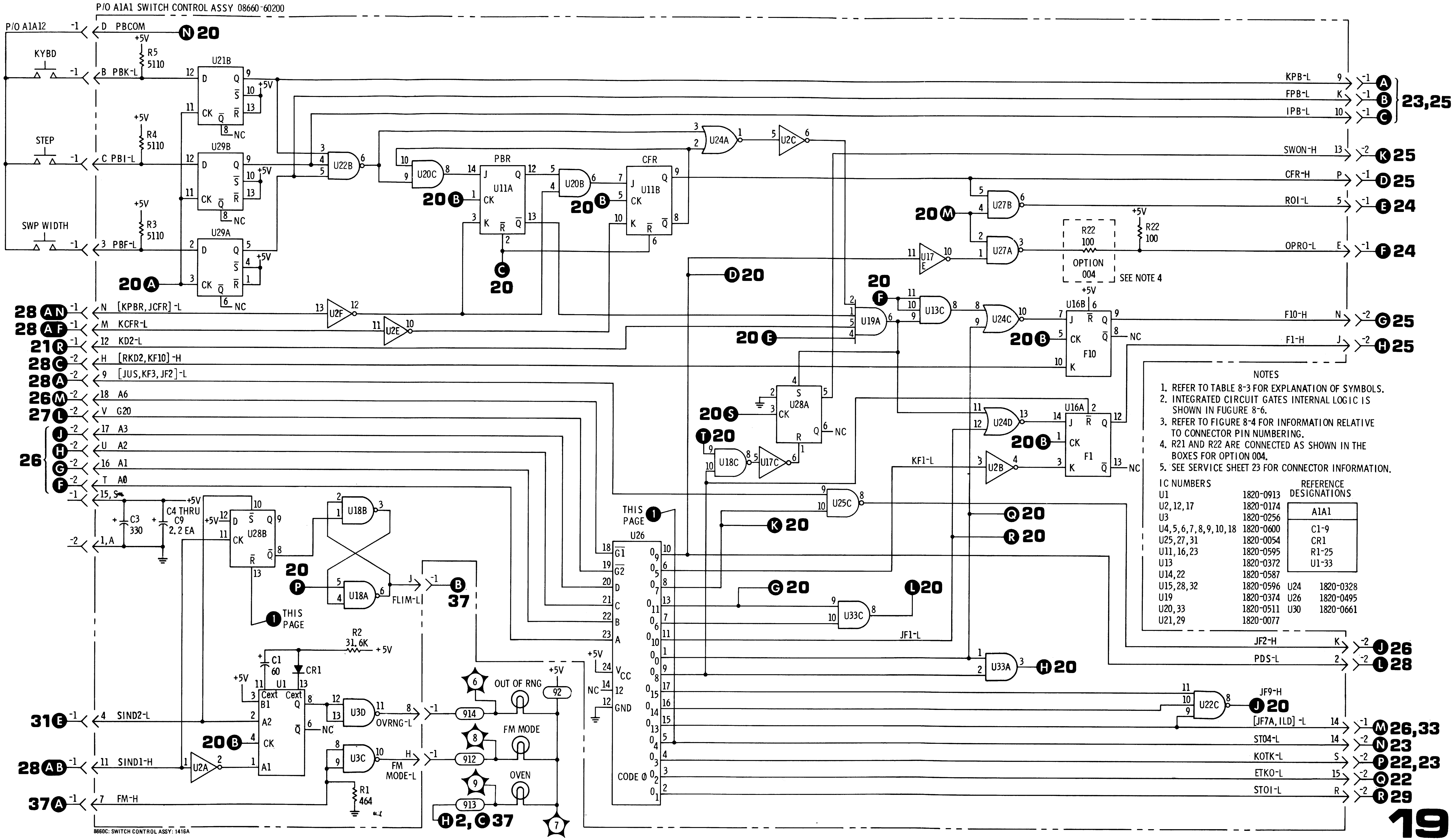


Figure 8-52. P/O A1A1 Switch Control Assy Component Locations (Part 1)



NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FUGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.
4. R21 AND R22 ARE CONNECTED AS SHOWN IN THE BOXES FOR OPTION 004.
5. SEE SERVICE SHEET 23 FOR CONNECTOR INFORMATION.

IC NUMBERS	
U1	1820-0913
U2, 12, 17	1820-0174
U3	1820-0256
U4, 5, 6, 7, 8, 9, 10, 18	1820-0600
U25, 27, 31	1820-0054
U11, 16, 23	1820-0595
U13	1820-0372
U14, 22	1820-0587
U15, 28, 32	1820-0596
U19	1820-0374
U20, 33	1820-0511
U21, 29	1820-0077
U24	1820-0328
U26	1820-0495
U30	1820-0661

REFERENCE DESIGNATIONS
A1A1
C1-9
CR1
R1-25
U1-33

19

Figure 8-53. A1A1 Switch Control Assy (Part 1)

SERVICE SHEET 20

P/O SWITCH CONTROL ASSEMBLY A1A1

Service Sheets 19 and 20 show the circuits of the A1A1 assembly schematically.

The circuits receive inputs from all front panel switches except the keyboard. These inputs serve to set (or reset) certain flip/flops or may simply flow through the assembly for use in other assemblies.

A principal output is qualifier F10-H from flip/flop U15 shown on SS19. When qualifier F10-H is set the state machine will go through the various states to set up the operation selected by the operator. Principal inputs to the F10 flip/flop are from the keyboard via input KD2-L, the readout pushbutton switches, the sweep control switches or the manual mode tuning dial.

A second principal circuit is the 4-to-16 selector U26 (shown on SS19) which is one of four such selectors in the DCU. Selector U26, which is designated as CODE Ø, is a part of this assembly because many of the outputs are directly used in other circuits in the assembly. The other three selectors are located on the A1A5 assembly which appears on Service Sheet 28.

A third principal circuit is the clock dividers which provide seven different check outputs used in various DCU circuits.

The first divider, D type flip-flop U32B, divides the 2 MHz coax clock by two. The 1 MHz output of U32B drives divide-by-ten U9 and is also used as the system clock.

The second divider, U9, divides by ten. The 100 kHz output drives divide-by-ten U8 and is also used as the keyboard clock.

The third divider, U8, divides by ten. The 10 kHz output drives U6 and is also used in the readout assembly.

The fourth divider, U6, provides two outputs. The first, a divide-by-two, 5 kHz clock is used in the readout control assembly. The second output is a divided-by-ten 1 kHz clock used in controlling the sweep. The 1 kHz output also drives U7. The fifth divider, U7, divides by 5. The 200 Hz output is used in the sweep control circuits and to clock the pushbutton flip-flops (see SS19). This output also drives U7.

The sixth divider, U5, divides by ten. The 20 Hz output is used in the sweep control circuits.

In the upper left hand corner of the schematic is a block labeled ROTARY PULSE GENERATOR (abbreviated RPG). The RPG is enabled by the MANUAL MODE RESOLUTION switch in any position except OFF. The RPG is also enabled when the SWEEP MODE switch is placed in the MAN position. The SWEEP MODE switch takes precedence over the MANUAL MODE RESOLUTION switch.

SERVICE SHEET 20 (Cont'd)

The RPG contains a light source and two photocells which are used to generate two square waves. These two square waves have a quadrature relationship — they are 90 degrees out of phase.

The circuits following the RPG CW and CCW outputs must detect when a manual entry has been made and also whether the input is an increase or a decrease in frequency.

AND gate U33D is driven by the CW and CCW inputs from the RPG.

Assume that the RPG is to be turned in the CW direction and that initially the CW output is low. The CCW output is low when the CW output goes high. When the CCW output goes high AND gate U33D is enabled and its output is high. When the CW output goes low, PLS-H goes high to cause an add operation and the low output of AND gate U33D clocks U32A through NAND gate U31D to cause the Q output (MNE-H) to go high.

When the RPG is turned CCW, the CCW output will go high at a time when the CW output is low. 90° later CW goes high and AND gate U33D output goes high. When, 90° later, CCW goes low, U33D output goes low and clocks U32A through U31D. The CW output is still high so the output of NAND gate U21A, PLS-H, is low. A subtraction operation is directed rather than an addition operation.

The enabling input to NAND gate U28A is from a cross-connected pair flip-flop, U31B/C. TRØ-L is low only during the power detect operation when the instrument is first turned on. TRØ-L is also coupled back to NAND gate U25B and U3A to inhibit the front panel manual controls during power detect.

Divide-by-five counter U4 is used when the HF RF output unit is in use and the 1 MHz (COARSE) step increment is selected. This is done to provide a fine control over the 1 MHz COARSE operation. Only every fifth input from the RPG can clock the MNE-H flip-flop, and control is improved.

Option 004 instruments have a 100 Hz resolution rather than 1 Hz resolution. Part of the changes required for this change is to shift R18 from its location shown on the schematic to a point between U30D pin 13 to ground. The step increments in OPT 004 instruments are 100 Hz, 10 kHz and 1 MHz.

SWEEP ENABLE CIRCUITS

The SW1 flip-flop, U23A, Q output (SW1-H) and SWON-H go high for all sweep operations. Selection of AUTO or MAN sweep controls the J input fo U23A through AND gate U23A and U22B when enabled by state 0/0 at 19 (H). Selection of SWEEP OFF controls the K inputs for reset of U23A through NAND gate U22A.

Flip-flop U23B, also referred to as the F9 flip-flop, is the sweep rate control. When the instrument is first turned on the K input to U23B is high due to the state of the TRØ flip-flop (U31B/U32C), so the $\overline{Q}$ output is set high.

When state 0/13, 0/14 or 0/15 is reached the J input to U23 goes high and the system clock causes the Q output to go high. When U23B Q output is

P/O A1A1 Switch Control Assy (Part 1)
SERVICE SHEET 19

SERVICE SHEET 20 (cont'd)

high, NAND gate U25D is enabled and the system clock is coupled through to NAND gate U14C. These three states enable the sweep to step at the maximum clock rate (1 MHz) during certain parts of the sweep operation.

The $\overline{Q}$ output of the single sweep flip-flop, U21A, is high in the quiescent state. Since both inputs to AND gate U20A are high the level at the S input to U21A does not affect the flip-flop.

When the SWEEP MODE switch is placed in the SINGLE mode and the SINGLE pushbutton is pressed, the output of AND gate U20A goes low to set the Q output of U21A high. The Q output of U21A (QSS-H) stays high for the period of one sweep width. The inverted system clock at the pin 2 input of OR gate U30A cannot reset U21A because instructions RQSS-H is low during the single sweep operation.

When the single sweep operation is concluded, instruction RQSS-H goes high, is inverted by U2D and enables OR gate U21A. The next inverted system clock resets both U21A and U23A (Q goes low and $\overline{Q}$ goes high).

When the single sweep was initiated, U21A $\overline{Q}$ went low to cause the output of AND gate U13A to go low. The pin 6 input to NOR gate U24B is also low so the J input is high at U23A, the SW1 flip-flop. The next clock pulse will cause the Q output of U23A (SW1-H) to go high. SWON-H is also high during the time the output of U21A is low as controlled by the QSS flip-flop U21A.

While the Q output of U23B is high the system clock is coupled through NAND gate U25D to pin 10 of NAND gate U14C. Pins 9 and 11 of U14C are high because U23B $\overline{Q}$ is low. The system clock is coupled through NAND gate U14C to U15A. Since the D input to U15A is held high the Q output goes high on the clock pulse. The inverted system clock then causes the Q output of U15B (QSP-H) to go high. When state 0/11 is reached pin 9 of U30C goes low to permit the inverted system clock to reset U15A and U15B (Q outputs go low) to make them ready for the next system clock.

When one of the three other clock sources is to be used to drive U15A, state 0/9 is reached, pin 12 of OR gate U30D goes low, the inverted system clock at OR gate U30D pin 11 resets U23B and the output of AND gate U20D resets U15A and U15B.

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MNE-H input is sync
clock and provides QSP

Y A1A1

the circuits of the A1A1 assembly

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h takes precedence over the MANUAL

SERVICE SHEET 20 (Cont'd)

The RPG contains a light source and two photocells which are used to generate two square waves. These two square waves have a quadrature relationship — they are 90 degrees out of phase.

The circuits following the RPG CW and CCW outputs must detect when a manual entry has been made and also whether the input is an increase or a decrease in frequency.

AND gate U33D is driven by the CW and CCW inputs from the RPG.

Assume that the RPG is to be turned in the CW direction and that initially the CW output is low. The CCW output is low when the CW output goes high. When the CCW output goes high AND gate U33D is enabled and its output is high. When the CW output goes low, PLS-H goes high to cause an add operation and the low output of AND gate U33D clocks U32A through NAND gate U31D to cause the Q output (MNE-H) to go high.

When the RPG is turned CCW, the CCW output will go high at a time when the CW output is low. 90° later CW goes high and AND gate U33D output goes high. When, 90° later, CCW goes low, U33D output goes low and clocks U32A through U31D. The CW output is still high so the output of NAND gate U21A, PLS-H, is low. A subtraction operation is directed rather than an addition operation.

The enabling input to NAND gate U28A is from a cross-connected pair flip-flop, U31B/C. TRØ-L is low only during the power detect operation when the instrument is first turned on. TRØ-L is also coupled back to NAND gate U25B and U3A to inhibit the front panel manual controls during power detect.

Divide-by-five counter U4 is used when the HF RF output unit is in use and the 1 MHz (COARSE) step increment is selected. This is done to provide a fine control over the 1 MHz COARSE operation. Only every fifth input from the RPG can clock the MNE-H flip-flop, and control is improved.

Option 004 instruments have a 100 Hz resolution rather than 1 Hz resolution. Part of the changes required for this change is to shift R18 from its location shown on the schematic to a point between U30D pin 13 to ground. The step increments in OPT 004 instruments are 100 Hz, 10 kHz and 1 MHz.

SWEEP ENABLE CIRCUITS

The SW1 flip-flop, U23A, Q output (SW1-H) and SWON-H go high for all sweep operations. Selection of AUTO or MAN sweep controls the J input fo U23A through AND gate U23A and U22B when enabled by state 0/0 at 19 (H). Selection of SWEEP OFF controls the K inputs for reset of U23A through NAND gate U22A.

Flip-flop U23B, also referred to as the F9 flip-flop, is the sweep rate control. When the instrument is first turned on the K input to U23B is high due to the state of the TRØ flip-flop (U31B/U32C), so the $\overline{Q}$ output is set high.

When state 0/13, 0/14 or 0/15 is reached the J input to U23 goes high and the system clock causes the Q output to go high. When U23B Q output is

P/O A1A1 Switch Control Assy (Part 1)
SERVICE SHEET 19

SERVICE SHEET 20 (cont'd)

high, NAND gate U25D is enabled and the system clock is coupled through to NAND gate U14C. These three states enable the sweep to step at the maximum clock rate (1 MHz) during certain parts of the sweep operation.

The $\overline{Q}$ output of the single sweep flip-flop, U21A, is high in the quiescent state. Since both inputs to AND gate U20A are high the level at the S input to U21A does not affect the flip-flop.

When the SWEEP MODE switch is placed in the SINGLE mode and the SINGLE pushbutton is pressed, the output of AND gate U20A goes low to set the Q output of U21A high. The Q output of U21A (QSS-H) stays high for the period of one sweep width. The inverted system clock at the pin 2 input of OR gate U30A cannot reset U21A because instructions RQSS-H is low during the single sweep operation.

When the single sweep operation is concluded, instruction RQSS-H goes high, is inverted by U2D and enables OR gate U21A. The next inverted system clock resets both U21A and U23A (Q goes low and $\overline{Q}$ goes high).

When the single sweep was initiated, U21A $\overline{Q}$ went low to cause the output of AND gate U13A to go low. The pin 6 input to NOR gate U24B is also low so the J input is high at U23A, the SW1 flip-flop. The next clock pulse will cause the Q output of U23A (SW1-H) to go high. SWON-H is also high during the time the output of U21A is low as controlled by the QSS flip-flop U21A.

While the Q output of U23B is high the system clock is coupled through NAND gate U25D to pin 10 of NAND gate U14C. Pins 9 and 11 of U14C are high because U23B $\overline{Q}$ is low. The system clock is coupled through NAND gate U14C to U15A. Since the D input to U15A is held high the Q output goes high on the clock pulse. The inverted system clock then causes the Q output of U15B (QSP-H) to go high. When state 0/11 is reached pin 9 of U30C goes low to permit the inverted system clock to reset U15A and U15B (Q outputs go low) to make them ready for the next system clock.

When one of the three other clock sources is to be used to drive U15A, state 0/9 is reached, pin 12 of OR gate U30D goes low, the inverted system clock at OR gate U30D pin 11 resets U23B and the output of AND gate U20D resets U15A and U15B.

When U23B is reset the Q output goes high and NAND gate U25D is inhibited to prevent further system clock pulses from reaching U15A. The high output from U25D is also used to partially enable NAND gate U14C.

When the SWEEP MODE switch is set to AUTO and the SWEEP RATE swtich is set to MED, the output of NAND gate U10A goes high to enable NAND gate U10D which supplies the 1 millisecond (1 kHz) clock to U10B. The pin 5 input to U10B is high because the high output of U10A is inverted and used to inhibit U10C.

Pins 2 and 13 of NAND gate U14A are high so the clock path is completed through to NAND gate U14C. Pins 9 and 10 of U14C are both high so U15A is clocked and its Q output goes high.

The next inverted system clock causes QSP-H to go high. This signal instructs the system to advance another sweep step. Using the inverted system clock to clock U15B ensures that the 1 millisecond clock is synchronized to the system clock. The 1 millisecond clock is derived from the system clock. However, the dividers are low power devices and the propagation delay may result in excessive phase shift. Also, during manual sweep, asynchronous pulses are received through U14B and U14C which must be synchronized.

When the FAST sweep rate is selected, operation of the circuit is the same as in the MED mode except that the output of AND gate U33B (Q100-H) is high. In this mode the sweep is 100 steps at the 1 kHz rate.

When the SLO sweep rate is selected, operation is similar to the MED mode except that the output of U10 is low, U10C is enabled, and the 10 millisecond (20 Hz) clock is used.

When the SWEEP MODE switch is set to MAN, the RPG is enabled. Operation of the RPG and associated circuits is essentially the same as it was in the MANUAL TUNE RESOLUTION mode. MNE-H is applied to the pin 5 input of NAND gate U14B; U14B pin 3 is held high by U23B $\overline{Q}$ and U14B pin 4 is held high by QMSW-H so MNE-H is coupled through to NAND gate U14C. The other two inputs to U14C are high so U15A is clocked by MNE-H. U15B is then clocked by the next inverted system clock. This ensures that the MNE-H input is synchronized with the system clock and provides QSP-H.

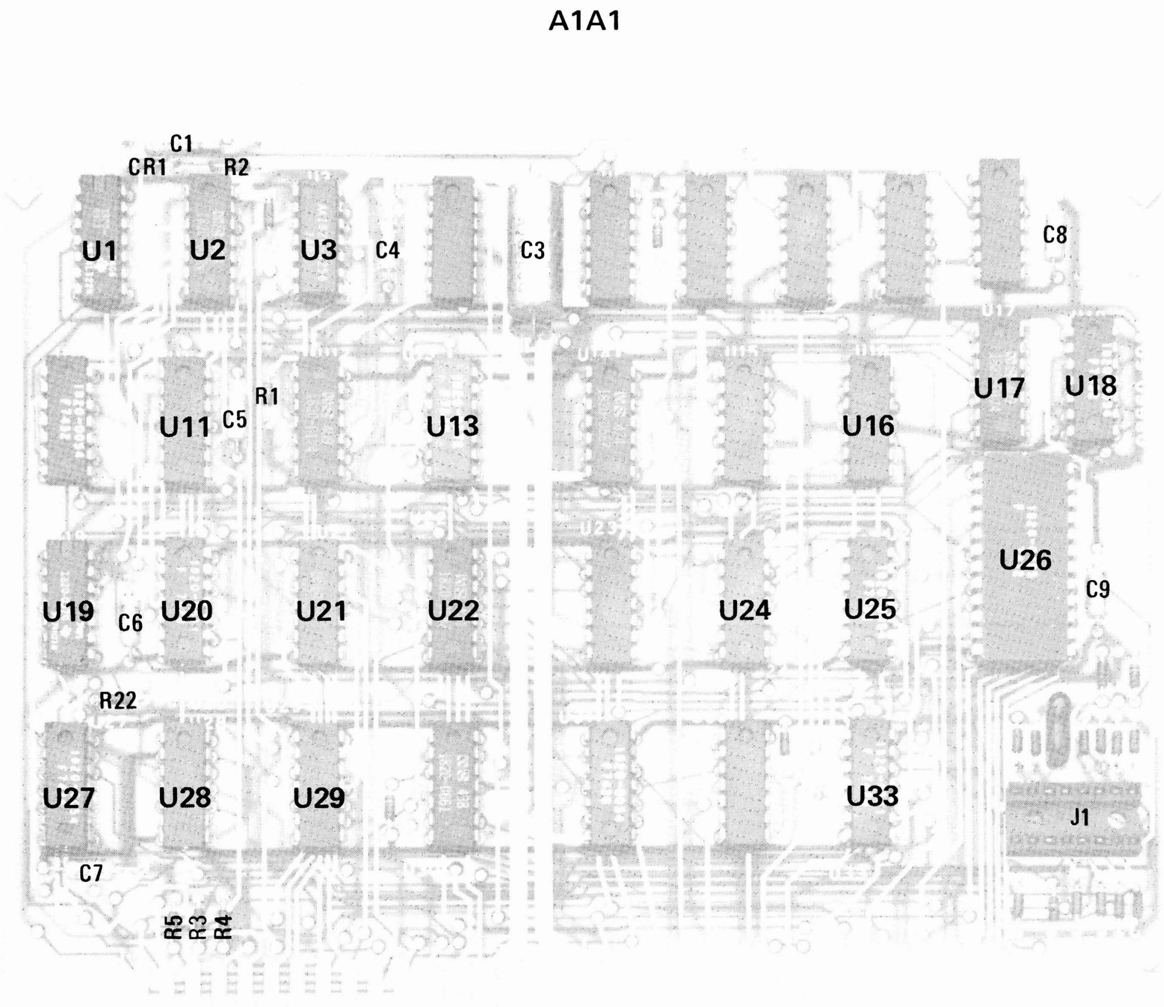


Figure 8-54. P/O A1A1 Switch Control Assembly Component Locations (Part 2)

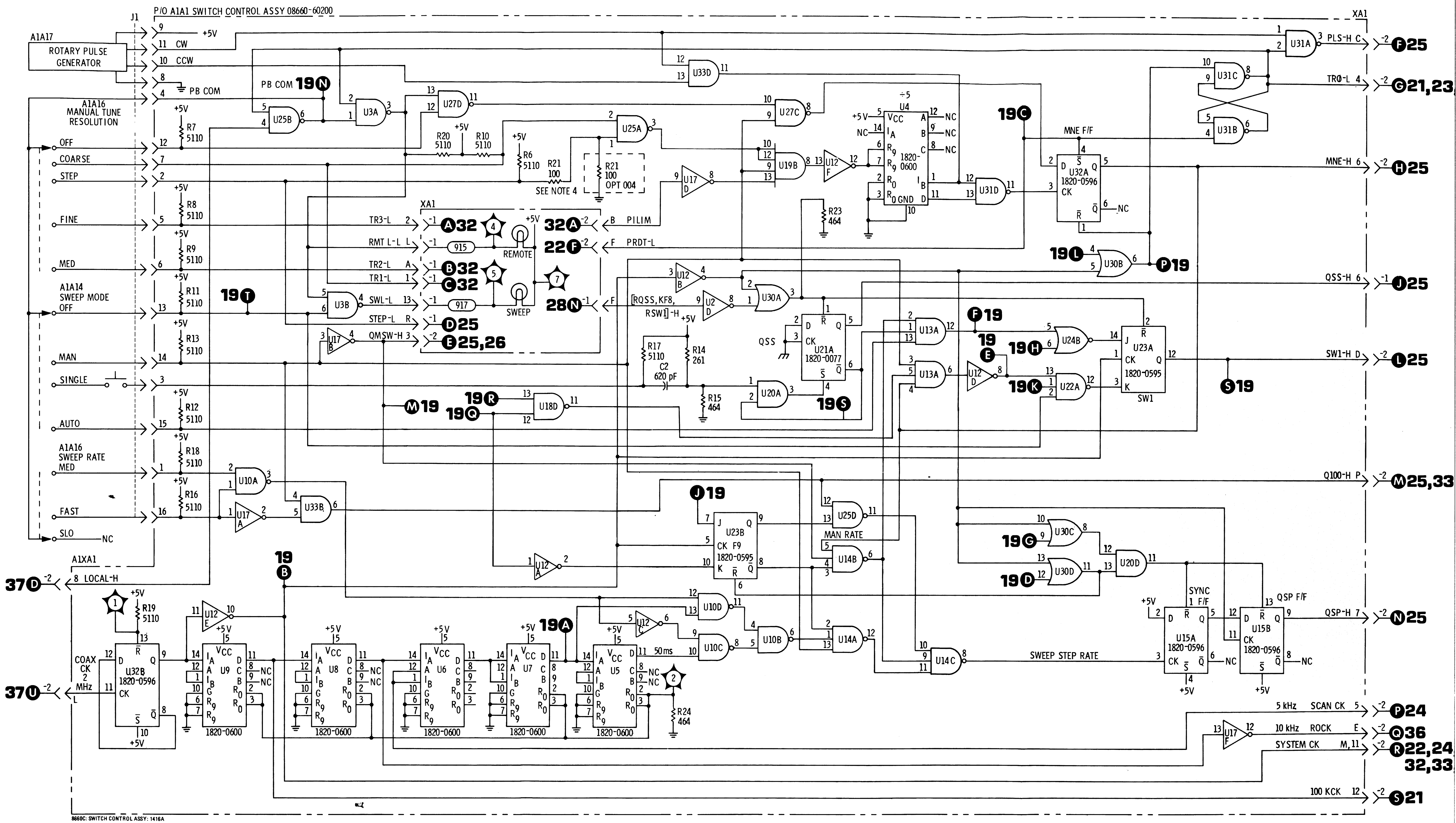


Figure 8-55. A1A1 Switch Control

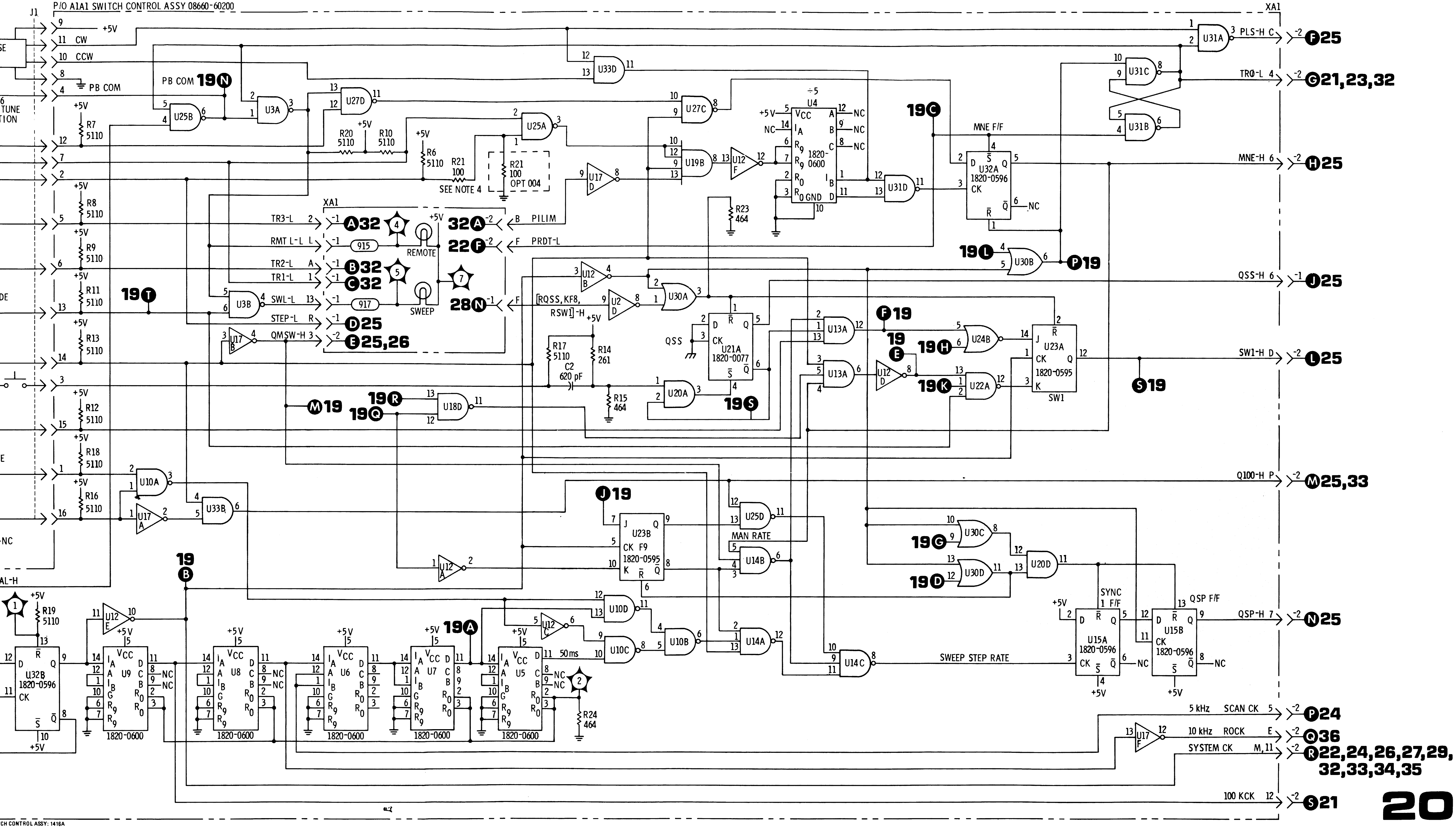


Figure 8-55. A1A1 Switch Control Assy (Part 2)

SERVICE SHEET 21

P/O A1A2 KEY CONTROL ASSEMBLY AND KEYBOARD

The circuits in the A1A2 assembly are shown schematically on Service Sheets 21 and 22. The keyboard scan, encoding circuits and the keyboard shift register are all contained in this assembly. Also shown on Service Sheet 21 is the keyboard printed circuit board schematic.

The Model 8660C keyboard is unique in that there are no mechanical contacts. Basically the keyboard consists of ten pairs of printed circuit pulse transformers with metallic spring leafs suspended adjacent to them. When a key is pressed the associated pulse transformer is inductively shorted.

The pulse transformer primaries are connected in series pairs between the 100 kHz clock pulses and a 1 of 10 selector, U26. The pulse transformer secondaries are connected in series between the inputs of a dual comparator, U20. The pulse transformer pairs are connected so that secondary currents cancel until a key is pressed.

The keyboard clock (KYB CK) is connected to all of the transformer pairs. However, only one transformer pair is selected at any given time by U26. The keys are scanned sequentially, 10 times for numeric data, then 10 times for non-numeric data. This is accomplised by clocking flip/flop U17B every time the D output of divide-by-ten U25 is active. The Q and $\overline{Q}$ outputs of U17B determine which of the U20 comparators is being strobed. The lower comparator is the numeric key detector.

When the lower U20 comparator is being strobed, if a numeric key is pressed a positive going pulse appears at U20 E_O output. This causes the one-shot U19 to change states ($\overline{Q}$ goes low). The low output of U19 $\overline{Q}$ inhibits the clock gate (U16C) to the divider (U25). U25A, B, C and D outputs retain the binary number of the key pressed. The numeric data is applied to multiplexer U12 which is shown on Service Sheet 22. Numeric data cannot affect the non-numeric data circuits because OR gates U24A, B, C and D outputs are held high by NAND gate U16B.

U19 is a monostable multivibrator which may be re-triggered during its period of about 15 microseconds. The period of U19 will be extended as long as the key is pressed since re-triggering pulses are received from U20 every 10 microseconds.

Operation when a non-numeric key is pressed is essentially the same as it is for a numeric key. The upper U20 comparator is enabled by U17B Q and both U16B inputs are high. The low level at the output of U16B enables U24A, B, C and D to couple the data through to one-of-ten selector, U23. The outputs of U23 correspond to the input binary weighted code.

U15 is a multiplexer which processes data from U23 in the local mode or from external programming circuits in the remote mode. The only data functions processed through U15 are the step up, step down and center frequency. In the local mode U15 pin 1 (select) selects inputs 1A, 1B, and 1C because the LOCAL-H line is high. In the remote mode the select line (U15 pin 1) is low so inputs 0A, 0B and 0C are selected. In either case, the Z_A, Z_B and Z_C outputs correspond to the A, B and C inputs.

SERVICE SHEET 21 (Cont'd)

The gating circuits to the right of U15 and U23 generate various qualifiers and instructions. As an example, if the CF key is pressed (code 8, 1000) the 0_8 output of U23 is low, $U15Z_C$ is low and the output of U22D is high. At all other times, when the CF function has not been initiated, qualifier CF-H is low.

Flip/flop U7B functions in the microprogram to prevent an entry operation from being made before a unit key is pressed. A unit key must be pressed to complete the justification process. The F3 flip/flop (U7B) K input goes high when qualifier QU1 (U21B pin 8) is high and instruction KF3-L is low which occurs in state 1/6. The next clock pulse resets U7B and qualifier F3 goes low. The F3 J input must go high in order to make the Q output go high to complete the cycle. This is accomplished when the JF3-L input (pin 11) becomes active when the machine is active in any one of four states, 1/11, 1/12, 1/13 or 1/0 and U7B is clocked. The Q output will also go high if the CLEAR KYBD key is pressed generating output 0_2 from U23. U17A $\overline{Q}$ (KD2-L) provides a signal to the F10 flip/flop on the A1A1 assembly when a key has been pressed or when CMND-P-L goes low in the remote mode.

J-K flip/flop U7A is used in a synchronizing process; it is connected as a "D" type flip/flop. The "D" input from U19 is asynchronous since it is a response to manual press and release of a key. The synchronized KDN-H output ensures correct machine state action.

P/O A1A1 Switch Control Assy (Part 2)
◀ SERVICE SHEET 20

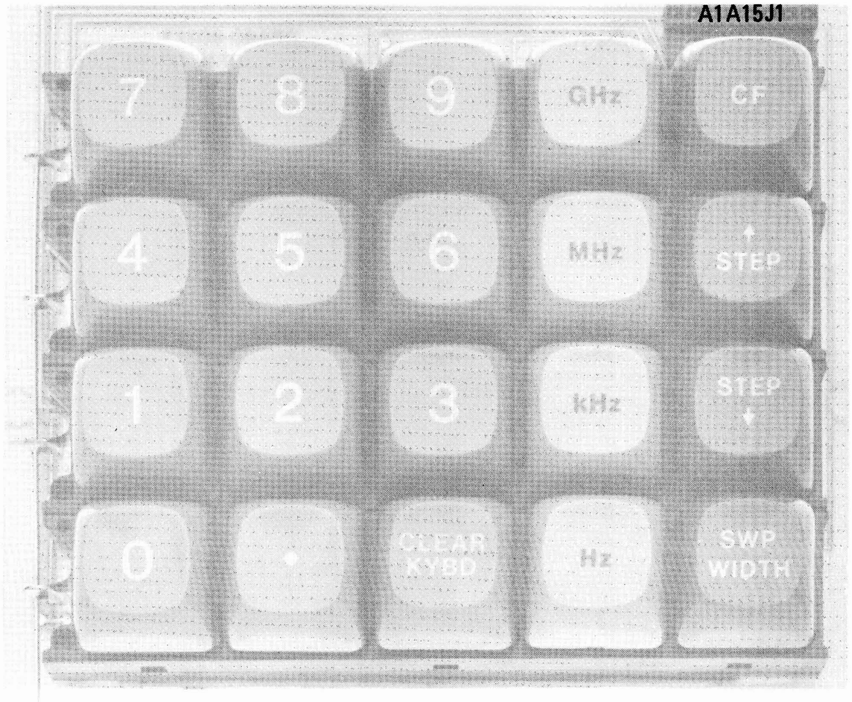


Figure 8-56. Keyboard Assembly Front View

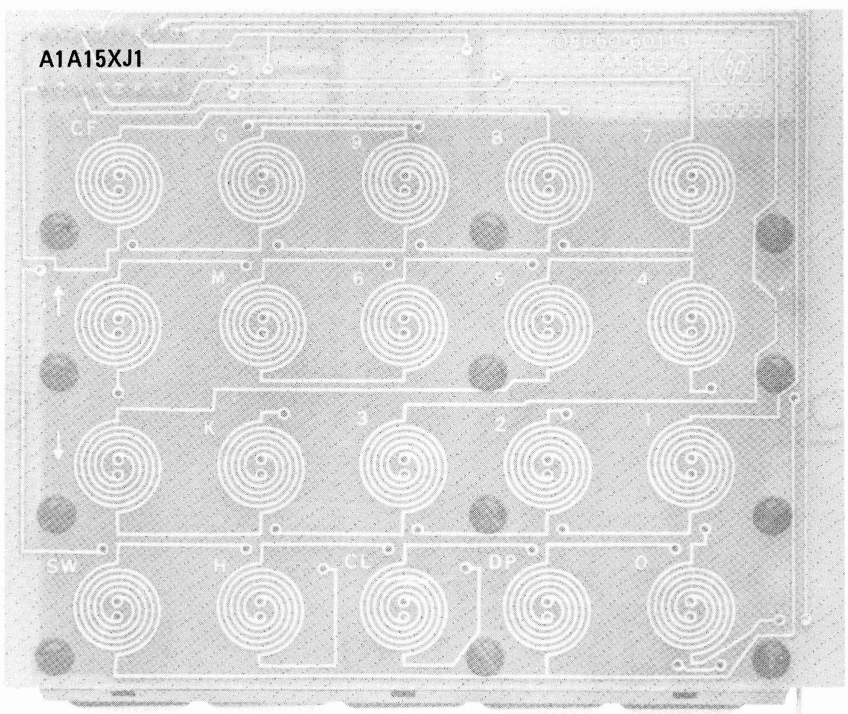


Figure 8-57. Keyboard Assembly Rear View

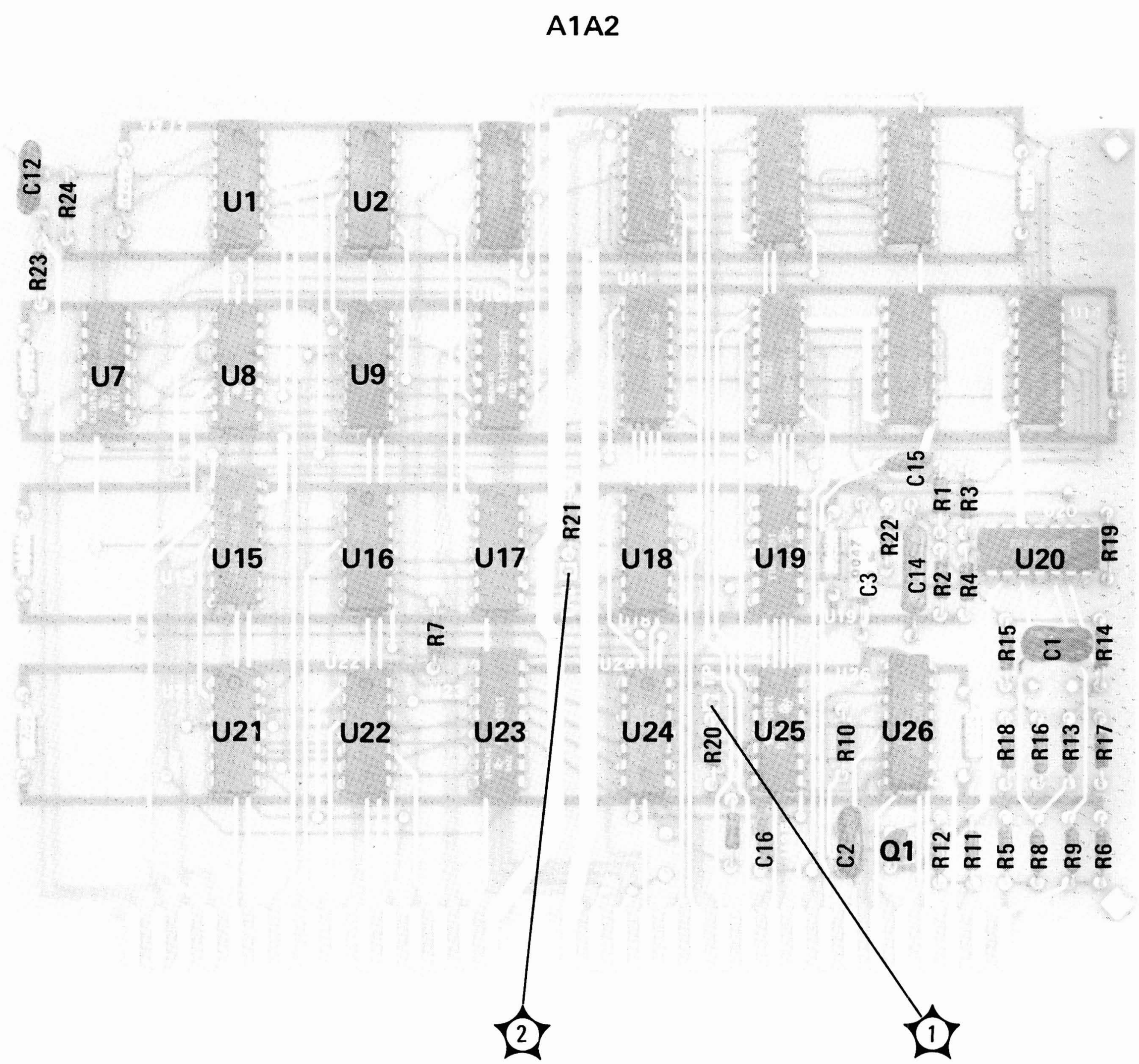
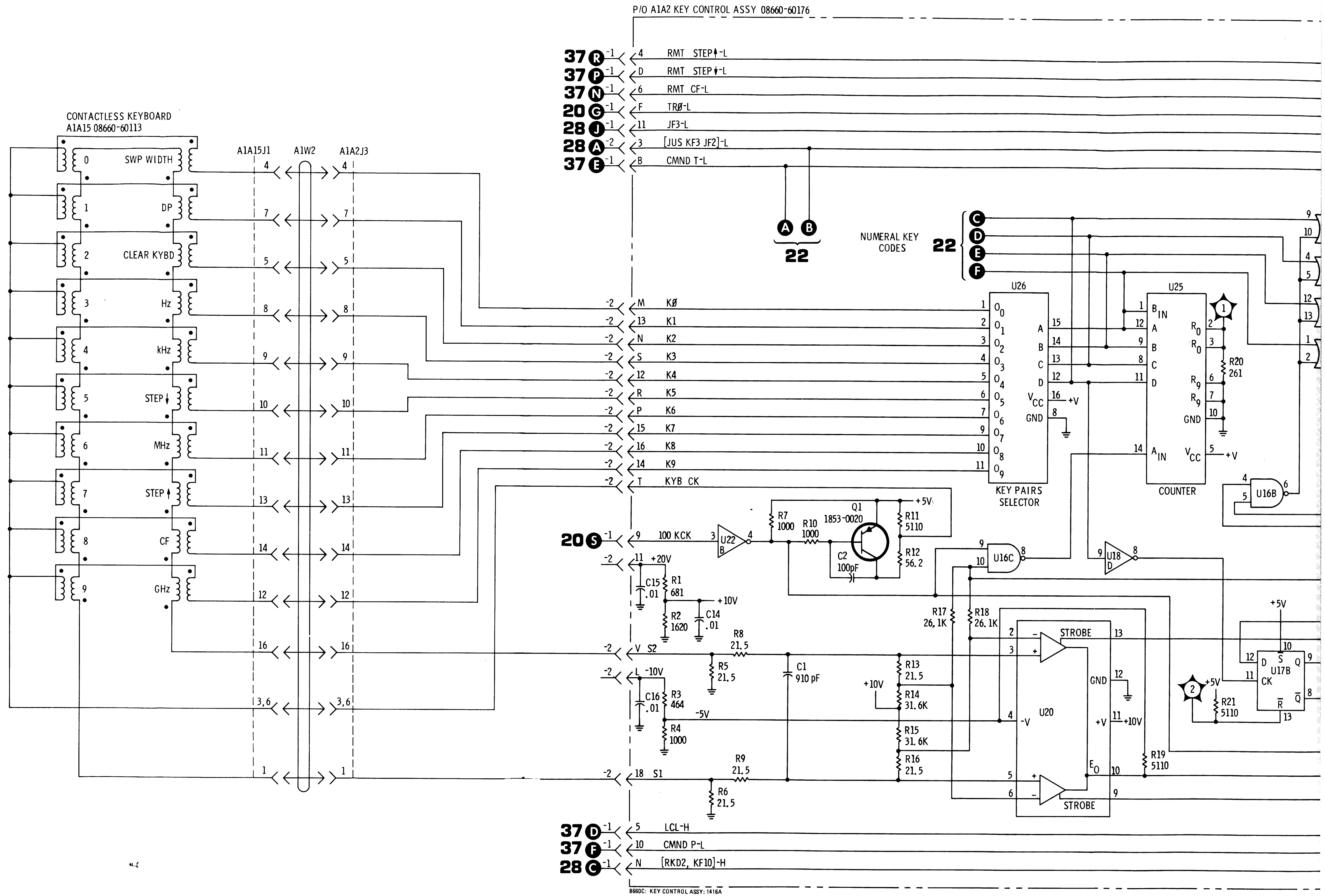


Figure 8-58. P/O A1A2 Key Control Assy Component Locations (Part 1)


P/O A1A2 KEY CONTROL ASSY 08660-60176
CONTACTLESS KEYBOARD
A1A15 08660-60113
SWP WIDTH
DP
CLEAR KYBD
Hz
kHz
STEP
MHz
CF
GHz
A1A15J1
A1W2
A1A2J3
RMT STEP-L
RMT CF-L
TRØ-L
JF3-L
[JUS KF3 JF2]-L
CMND T-L
NUMERAL KEY CODES
KØ
K1
K2
K3
K4
K5
K6
K7
K8
K9
KYB CK
100 KCK
S2
-10V
S1
LCL-H
CMND P-L
[RKD2, KF10]-H
U26
KEY PAIRS SELECTOR
U25
COUNTER
U16B
U16C
U18
U22
Q1 1853-0020
U20
STROBE
U17B
R1 681
R2 1620
R3 464
R4 1000
R5 21.5
R6 21.5
R7 1000
R8 21.5
R9 21.5
R10 1000
R11 5110
R12 56.2
R13 21.5
R14 31.6K
R15 31.6K
R16 21.5
R17 26.1K
R18 26.1K
R19 5110
R20 261
R21 5110
C1 910 pF
C2 100pF
C14 .01
C15 .01
C16 .01
8660C: KEY CONTROL ASSY: 1416A

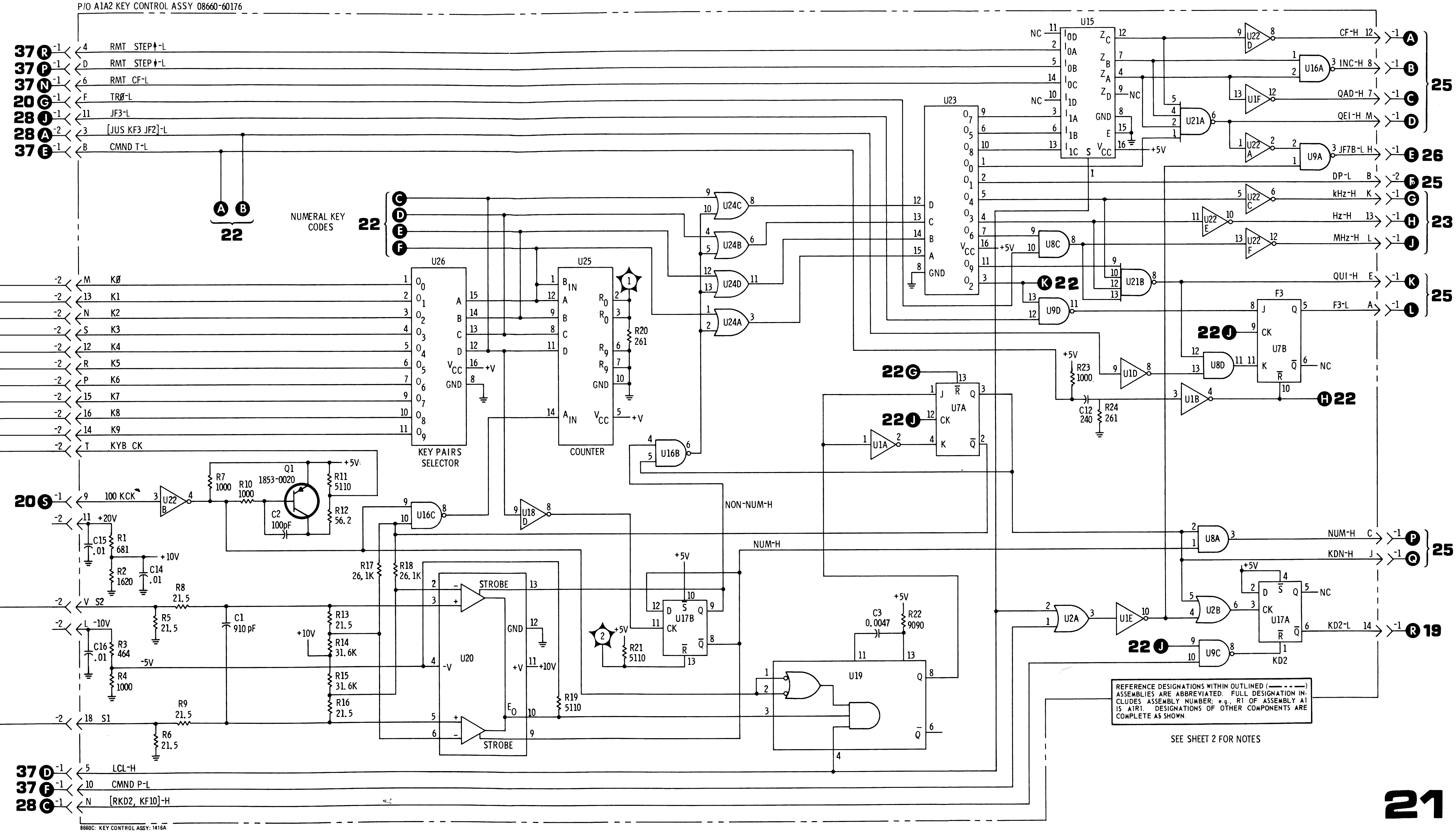


Figure 8-59. P/O A1A2 Key Control Assy (Part 1)

SERVICE SHEET 22

P/O A1A2 KEY CONTROL ASSEMBLY

The A1A2 key control assembly circuits are shown schematically on Service Sheets 21 and 22. The circuits shown on this Service Sheet consist of the recirculating keyboard register and the circuits which control it.

Multiplexer U12, when a keyboard numeral is being entered (ETKØ-L is active), couples the data to U5 which is a one digit, 4 bit-register (referred to as the KØ register).

After the data is stored in KØ a train of 10 clock pulses transfer the data to the main keyboard shift register consisting of U4, U6, U14 and U13.

U6 and U4 are dual 8 bit registers. Data bits 1 and 2 for digits 3 through 10 are stored in U6 and data bits 4 and 8 for digits 3 through 10 are stored in U4. U14 and U13 are one digit four bit registers. U14 stores digit 2 and U13 stores digit 1.

Note that the output of the main keyboard register is coupled back to U5 thorugh U12 while the train of 10 clock pulses is present. This is true because ETKØ-L is now in the quiescent (high) state. The cycle continues until all of the required numeric entries are made. When the last digit has been entered (the least significant digit) it will be so positioned in the register that it will be the first digit clocked out. The first digit clocked in will be the last digit clocked out.

In the local mode when the keyboard data is clocked out, it is also clocked back into the main keyboard register, through multiplexer U11. U12 and U5 are bypassed.

The control gates for the keyboard register are conventional.

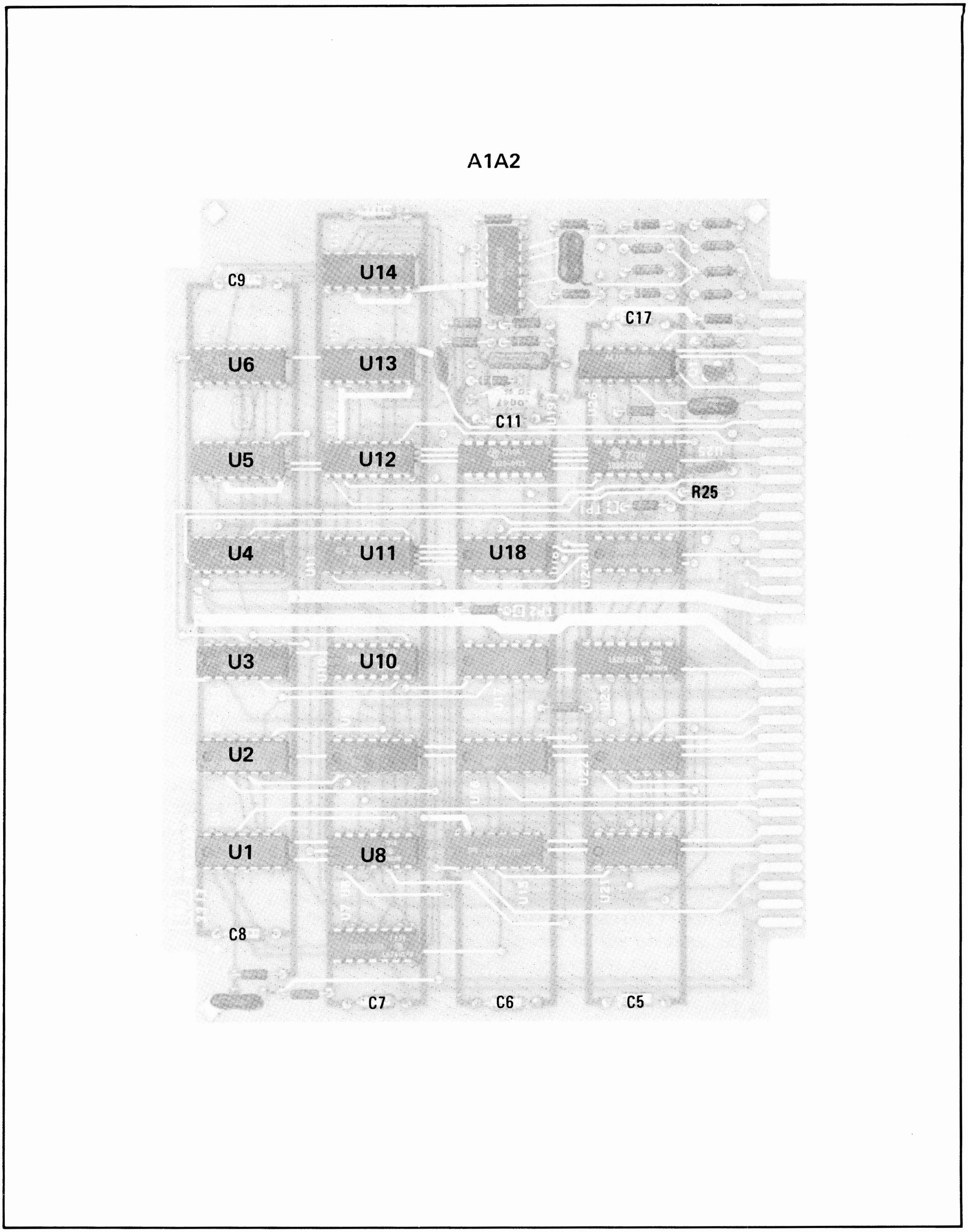
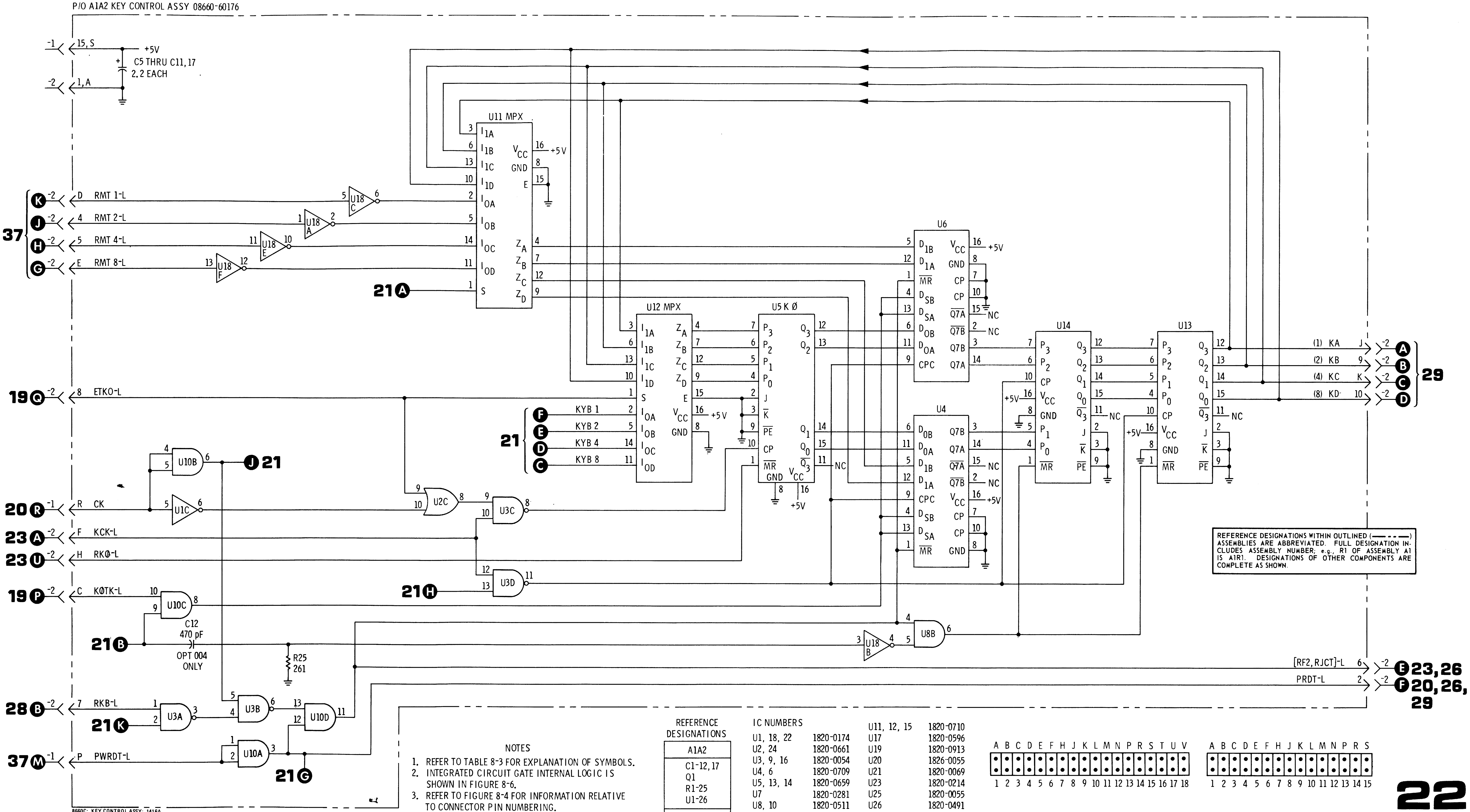


Figure 8-60. P/O A1A2 Key Control Assy Component Locations (Part 2)



NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.

REFERENCE DESIGNATIONS
A1A2
C1-12, 17 Q1 R1-25 U1-26
C13 NOT USED

IC NUMBERS

U1, 18, 22	1820-0174	U11, 12, 15	1820-0710
U2, 24	1820-0661	U17	1820-0596
U3, 9, 16	1820-0054	U19	1820-0913
U4, 6	1820-0709	U20	1826-0055
U5, 13, 14	1820-0659	U21	1820-0069
U7	1820-0281	U23	1820-0214
U8, 10	1820-0511	U25	1820-0055
		U26	1820-0491

22

Figure 8-61. P/O A1A2 Key Control Assy (Part 2)

SERVICE SHEET 23

P/O A1A3 READOUT CONTROL ASSEMBLY

Most of the circuitry shown on this service sheet is used to justify (properly locate) the decimal point in the readout. Following entry of a multidigit number, units are selected and the number is shifted left or right in the keyboard register as controlled by the following circuitry which determines position of the decimal point.

The MHz, kHz and Hz inputs are applied to the B inputs of comparator U11. The A inputs to comparator U11 are from justification counter, U20. The purpose of U11 is to detect when A=B.

The justification counter, U20, is a decade counter which operates only after a decimal point or a units entry has been made.

Referring to the Algorithmic State Machine, (flow graph), assume that the first keyboard entry is a numeral and follow the machine states from 0/0 through states 4/0, 5/0, 6/0 and 6/1 to state 1/5. State 1/5 contains the first instruction that directly affects the circuits shown on Service Sheet 23.

The instructions in state 1/5 are RF2-L which resets FF2, RKB-L which resets the keyboard and RJCT-L which resets the justification flip-flop, U14A. RJCT-L is also inverted by U31C to reset the counter, U20, to nine (1001).

The next state, 0/2, contains the instruction ETKØ-L. This causes the numeric data to be stored in the KØ register.

The next state, 0/3, contains instruction KØTK-L (KØ to keyboard register) and a train of 10 clock pulses. These clock pulses transfer the data from the single digit KØ register to the least significant storage in the ten digit keyboard storage register.

NOTE

See Service Sheets 21 and 22 for a more complete analysis of the keyboard register.

When a decimal point is entered after a numeric entry the machine state path is from state 0/0 through states 4/0, 5/0 and 5/1 to state 3/5.

In state 3/5 instruction SJCT-L (set justification counter) appears. This instruction, which has a low assertive state, is applied to NOR gate U13A pin 3. The second input to NOR gate U13A is the inverted system clock which is high when SJCT-L appears. When the inverted system clock at U13A pin 2 goes low the clock input to U14A goes high and causes the Q output to go high.

SERVICE SHEET 23 (Cont'd)

When U14A Q goes high NAND gate U33A is enabled. Pin 4 of U33A is high because B9-L is not active at this time. The system clock at NAND gate U35B pin 3 is applied to U33A pin 5 when CK10 CK is high and JUS or QJO are high. Pin 2 of U33A is high because KØTK is low.

The output of NAND gate U33B is high since QJO is low and NAND gate U30D is enabled for a period of nine clock pulses. The train of clock pulses ends when B9-L goes low and inhibits U33A.

The justification counter, U20, starts at a count of 9 in the local mode. The 9 clock pulses it receives cause it to stop one count lower than where it started. In other words, the first entry after a decimal point would cause the counter output to be an 8, the next entry a 7, etc.

The output of NAND gate U35B pin 6 is also used to clock the keyboard register via line KCK-L. The output burst of 10 clock pulses shifts the new entry to the correct sequential position as described in Service Sheets 21 and 22.

So far, justification has not taken place; the justification counter has merely deducted the number of entries after the decimal point from 9. Flip/flop U14B has not yet been clocked because the JUS-L high level has been inverted by U31E to inhibit AND gate U32B.

As an example of circuit operation assume that 12.34 has been entered and the output is to be 12.34 kHz. Referring to the Algorithmic State Machine it can be seen that the UNITS path is the same as the numeral path until state 6/0 is reached. The qualifier following state 6/0, NUM-H, is not active so the next state is 0/4 which contains instruction RKØ-L (reset KØ register).

RKØ-L is the output of AND gate U32D. The inputs to U32D are from OR gate U21C which is high because JUS-L is not active and from AND gate U9A. ST04-L is active by virtue of being an output of state 0/4 and the low level is inverted by U24E to enable U9A. The system clock is then coupled to AND gate U32D to produce RKØ-L.

Qualifier QU1-H is active for state 0/4 so the next state is 1/6 which contains instructions JUS-L, KF3-L and CK10J-L.

When JUS-L goes low it is inverted by U31E and applied to AND gates U25A and U32B. The second input to U32B is from OR gate U21D. The output of OR gate U21D is high because input pin 13 is connected to B9-L which is high.

The low to high output transition of U32B clocks U14B. Since the B inputs to U11 are a 6 (0110) and the A inputs are a 7 (0111), both A=B and A<B are low. The D input to U14B is low and clocking U14B causes the Q output to go low.

The low Q output of U14B is applied to one input of NOR gate U13B. The second input to U13B is CKB-H which is also low. The high input to OR gate U21A at pin 1 is coupled through to pin 10 of AND gate U32C. Pin 2 of OR gate U21A is also held high by the inverted low A=B level.

The second input to AND gate U32C is from AND gate U25A. U25A pin 2 is held high by the inverted JUS-L level and pin 1 is held high by the local line. The high output of U25A enables AND gate U32C and QJØ-H goes high.

SERVICE SHEET 23 (Cont'd)

When QJØ-H goes high it holds the instrument in state 1/6 until justification requirements are met. QJØ-H enables NAND gate U35B throu OR gate U23A. QJØ-H also enables NAND gate U33B which then clocks U through U30D.

The clock train is again stopped after nine clock pulses by the action of B and the outputs of U20 and U2 are compared by U11. Since both of inputs to U11 are now 6 (0110), A=B goes high to cause the D input U14B to go high.

When U11 A=B is a high the justification requirements are satisfi However, several things must happen before state 1/6 may be left.

The A=B high level is inverted by U31A and applied to pin 2 of OR g U21A. This does not immediately affect the output of U21A because output of NOR gate U13B is held high by the low Q output of U14B and CKB-H level which is low.

U14B is clocked by AND gate U32B as follows: U32B pin 5 is still held h by the inverted JUS-L low level. The second input to U32B is from OR g U21D. When B9-L goes low, pin 13 of U21D is also low. The inverted syst clock at pin 12 of U21D is high so the output of U32B remains high. On t next clock the inverted clock goes low and the output of U32B goes lo This does not clock U14B because a D type flip/flop may be triggered o on a positive going pulse. The next time the inverted clock goes high is at t beginning of the tenth clock; this clocks U14B and causes the Q output to high.

The high Q output of U14B inhibits NOR gate U13B. Since both inputs OR gate U21A are now low AND gate U32C is inhibited and QJØ-H go low. The machine state progression is now through states 6/14, 1/1, 4/1, 1 4/9, 4/10 and 5/10 to 0/0. The instrument is now ready for the next ent (function).

Now assume that 12.34 kHz was entered by accident, it should have be 12.34 MHz. 12.340 is still stored in the keyboard register so all that necessary to start the justification process over is to press the MHz key.

Operation of the justification circuit is the same as it was for kHz exce that now the input to 011 is a 3 (0011) and the output of U20 is a 6 (011 QJØ-H goes high as it did in the previous example. QJØ-H stays high u three trains of clock pulses cause the output of U20 to reach 3 (0011) a once again U11 A=B is high. QJØ-H is caused to go low in the same man as in the previous example.

For a third example assume it is decided that 12.340 kHz was, after all, t desired output frequency.

Initiation of the justification cycle is the same as it was in the previous t examples. How, however, the A inputs to U11 are a 3 (0011) and the inputs are a 6 (0110) so A<B is high. This high level at pin 10 of NOR g U13C holds the D input of U14B high and U14B is clocked as it was bef but no output change results since the Q output was already high.

P/O A1A2 Key Control Assy (Part
SERVICE SHEET 22

SERVICE SHEET 23 (Cont'd)

When QJ∅-H goes high it holds the instrument in state 1/6 until the justification requirements are met. QJ∅-H enables NAND gate U35B through OR gate U23A. QJ∅-H also enables NAND gate U33B which then clocks U20 through U30D.

The clock train is again stopped after nine clock pulses by the action of B9-L and the outputs of U20 and U2 are compared by U11. Since both of the inputs to U11 are now 6 (0110), A=B goes high to cause the D input to U14B to go high.

When U11 A=B is a high the justification requirements are satisfied. However, several things must happen before state 1/6 may be left.

The A=B high level is inverted by U31A and applied to pin 2 of OR gate U21A. This does not immediately affect the output of U21A because the output of NOR gate U13B is held high by the low Q output of U14B and the CKB-H level which is low.

U14B is clocked by AND gate U32B as follows: U32B pin 5 is still held high by the inverted JUS-L low level. The second input to U32B is from OR gate U21D. When B9-L goes low, pin 13 of U21D is also low. The inverted system clock at pin 12 of U21D is high so the output of U32B remains high. On the next clock the inverted clock goes low and the output of U32B goes low. This does not clock U14B because a D type flip/flop may be triggered only on a positive going pulse. The next time the inverted clock goes high is at the beginning of the tenth clock; this clocks U14B and causes the Q output to go high.

The high Q output of U14B inhibits NOR gate U13B. Since both inputs to OR gate U21A are now low AND gate U32C is inhibited and QJ∅-H goes low. The machine state progression is now through states 6/14, 1/1, 4/1, 1/9, 4/9, 4/10 and 5/10 to 0/0. The instrument is now ready for the next entry (function).

Now assume that 12.34 kHz was entered by accident, it should have been 12.34 MHz. 12.340 is still stored in the keyboard register so all that is necessary to start the justification process over is to press the MHz key.

Operation of the justification circuit is the same as it was for kHz except that now the input to 011 is a 3 (0011) and the output of U20 is a 6 (0110). QJ∅-H goes high as it did in the previous example. QJ∅-H stays high until three trains of clock pulses cause the output of U20 to reach 3 (0011) and once again U11 A=B is high. QJ∅-H is caused to go low in the same manner as in the previous example.

For a third example assume it is decided that 12.340 kHz was, after all, the desired output frequency.

Initiation of the justification cycle is the same as it was in the previous two examples. How, however, the A inputs to U11 are a 3 (0011) and the B inputs are a 6 (0110) so A<B is high. This high level at pin 10 of NOR gate U13C holds the D input of U14B high and U14B is clocked as it was before but no output change results since the Q output was already high.

P/O A1A2 Key Control Assy (Part 2)
SERVICE SHEET 22

SERVICE SHEET 23 (Cont'd)

The low A=B output of U11 is again inverted and applied to OR gate U21A to enable AND gate U32C and again cause QJ∅-H to go high (U32C pin 9 is caused to go high in the same manner as in the previous examples).

U11 is continually comparing the outputs from U20, U1B and U21B. The first clock to U20 causes the output to go to 4 (0100), the second to 5 (0101) and the third to 6 (0110). Justification has been accomplished, A=B is high, U21A is inhibited and QJ∅-H immediately goes low. The state progression back to state 0/0 is the same as it was in the previous examples.

During all of these justification counts, outputs from KCK-L to the keyboard register cause the entry to be shifted to positions consistent with units and decimal point.

It may be seen from the foregoing examples that left shifting (from kHz to MHz) takes three trains of clock pulses, while right shifting (from MHz to kHz) takes only three clock pulses.

The decimal point storage, U3, is a 4 x 4 file. It stores 4 four-bit words. These words are selected by the outputs of U22A and U22B as follows: word 1, center frequency 00; word 2, sweep width 01; word 3, step (increment) 10 and word 4, keyboard 11.

The inverted system clock is applied to pin 12 (G_W) of U3 where it is used as the write clock. W_A and W_B (write) inputs are controlled by AND gates U22A and U22B which are, in turn, controlled by the KYBD, STEP or SWP WIDTH pushbuttons in the local mode. When these pushbuttons are all inactive the center frequency is selected.

When operating in the remote mode only the center frequency is displayed. It is displayed in MHz only. In the remote mode the LOCAL-H line is low. This low level is inverted by U31F and used to reset the justification counter, U20, to zero. OR gates U1C and U1D provide the inputs to U3 in the remote mode. Pin 10 of U1C and Pin 12 of U1D are connected directly to the output of U22A AND gate. Normally, in the local mode, the output of U22A is low.

When the remote mode is selected and LOCAL-H goes low it is applied to INVERTER U6 and AND gate U30A. The output of AND gate U32A goes low, is inverted and applied to AND gate U25B. The second input to AND gate U25B is QHF-H which is low.

Decoder U7 is one-of-ten selector. All outputs of the decoder are high except the one selected. The outputs of the decoder directly drive the decimal point LED's in the readout (the series resistors are for current limiting).

The gates shown to the right of decoder U7 are used to drive the Hz, kHz, M (M and Hz are both used to display MHz) and GHz lamps. NAND gates U26A, B, C and D are open collector lamp drivers. The common input to these gates is controlled by the combined functions of F2 and KPB. During the time when keyboard entries are being made, the KYBD pushbutton is pressed for readout of the entries, the units lamps are inhibited. When the entry is justified, F2-L goes low and the units lamps are then enabled.

A1A3

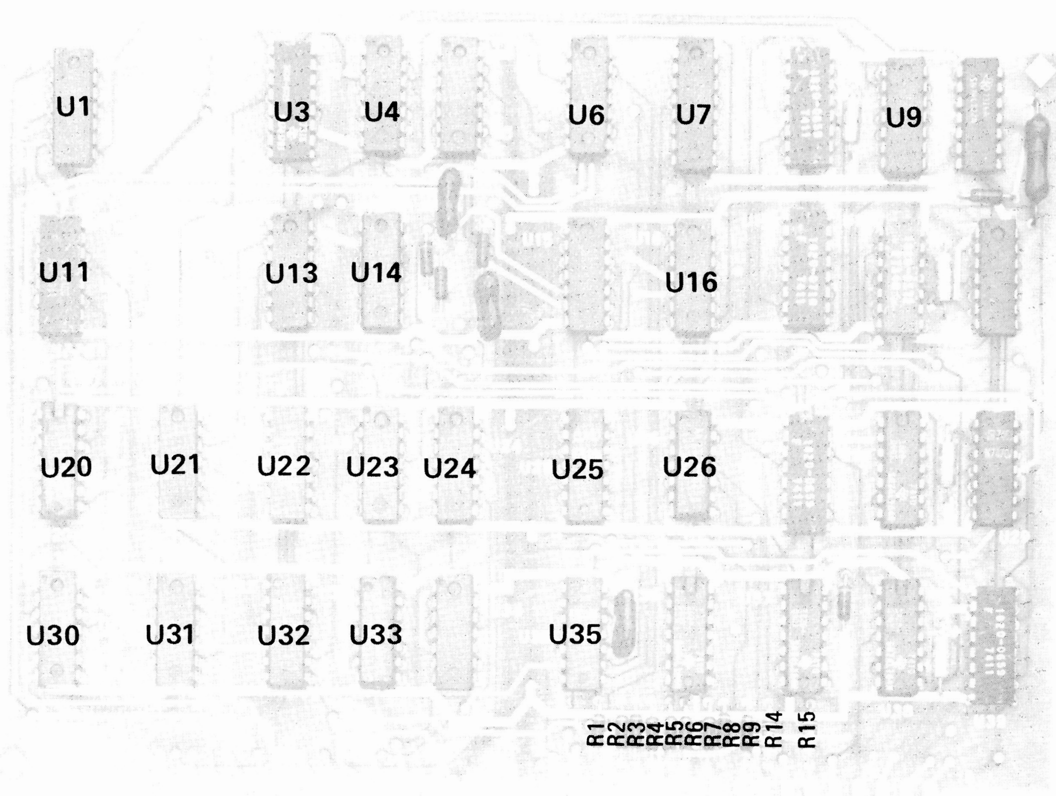


Figure 8-62. P/O A1A3 Readout Control Assembly Component Locations (Part 1)

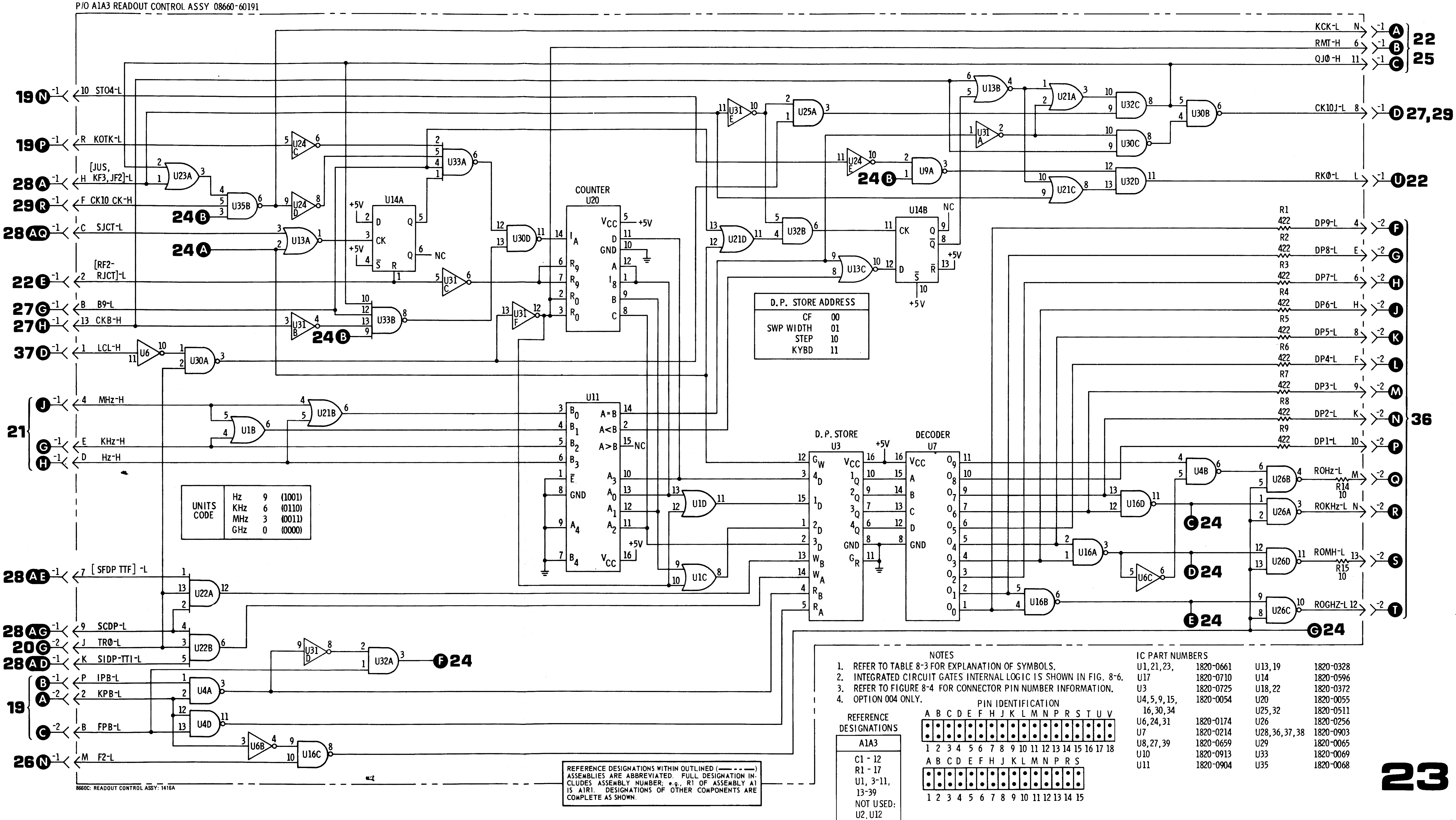


Figure 8-63. P/O A1A3 Readout Control Assy (Part 1)

SERVICE SHEET 24

P/O READOUT CONTROL ASSEMBLY A1A3

The A1A3 assembly is shown schematically on Service Sheets 23 and 24.

The circuits shown on SS24 consist of the ten digit recirculating readout register, scan control for the readout and a blanking control for the readout.

When new information is to be clocked into the readout register from the T bus, TTRO-L goes low at pin 4 of NAND gate U5B and U5B output goes high. OPRO-L and ROI-L are normally high, so the output of AND gate U25B goes high to select the I_1 inputs of multiplexer U17.

The outputs of multiplexer U17 are applied to U8, U27, U36, U37, U38 and U28. The last five IC's comprise the ten digit register which, in conjunction with other circuits shown on SS24 control operation of the readout.

While the output of AND gate U25 is high the preset enable (PE) to the sync register, U39, is also high. The register will function as a shift register, and, with the J input high, the first four clock pulses will cause the Q outputs of U39 to go high. These outputs of U39, a 15, (1 1 1 1) is the scan synchronizing code.

The output of AND gate U25B also is used to partially control clock inputs to the readout and synch registers.

Many of the gates shown in the lower left of the schematic function to control the clocks. The output of NAND gate U15D clocks the recirculating register including U39, the synch register.

The inputs to NAND gate U15D are from three-input NAND gate U35C and U22C/U24F which function together as a three-input NAND gate. One or the other of these inputs to U15D will be high at any given time and the other input provides the clock pulses.

When new data is being clocked in NAND gate U35C drives NAND gate U15D to clock the recirculating readout register at the system clock rate, 1 MHz. NAND gate U35C is enabled by the output of U34D and the ADDCK-H input which remains high for the period of ten clock pulses required to clock in the information. The system clock pulses are coupled through AND gate U25C and inverted by U6D. C9 and R10 form a one-shot which effectively delays the clock while TTRO is going low. Inverter U24A again inverts the clock before it is applied to NAND gate U34B. Since NAND gate U5D output is high the output of NAND gate U34B goes low with the positive clock pulse to trigger flip/flop U34C/U34D. The output of U34D then goes high to complete the enabling process for NAND gate U35C.

SERVICE SHEET 24 (Cont'd)

When the output of NAND gate U5D goes high the next system clock triggers one-shot U10 and the $\overline{Q}$ output at pin 6 goes low, typically for a period of 105 microseconds. The low level at U10 $\overline{Q}$ sets the Q output of flip/flop U29 high and holds it high. The low output from U20 $\overline{Q}$ also inhibits U4C and blanks the readout through the brightness control.

When NAND gate U4C is inhibited the output goes high and enables one input to AND gate U22C. Since the Q output of flip/flop U29 is high, the inverted system clock is coupled through NAND gate U15B back to the pin 10 input of AND gate U22C.

The third input to AND gate U22C is enabled when TTRO-L goes high and causes the output of NAND gate U5D to go low. Flip/flop U34C/U34D changes state, AND gate U22C is enabled, and the system clock is coupled through inverter U24F and NAND gate U15D to clock the recirculating data. Note that the MSD register, U8, is not being clocked.

As long as the $\overline{Q}$ output of one-shot U10 is low, (approximately 100 microseconds) AND gate U22C is enabled and the system clock drives the recirculating portion of the register including the sync register, U39. During this portion of the cycle insignificant leading zeros are blanked.

Whenever a leading zero reaches the sync register, U39, all of its outputs are low so the inputs to NOR gates U13D and U19D are low and their outputs are high. The low output of NAND gate U15A is applied to pin 5 of NOR gate U19B. Pin 6 of NOR gate U19B is also low since the Q_H outputs of U38 and U28 are high. The sync code (1111) has recirculated to the Q_H digit of the register. These two high levels are applied to NAND gate U9C which provides the low input to NOR gate U19B. The pin 10 input to AND gate U18C is high. Assume for the time being that the other two inputs to AND gate U18C and the output are all high (these inputs will be discussed later in this text). The high inputs to OR gates U23B, C and D cause the outputs to go high. The output of U18C is inverted by U6F to drive the output of AND gate U25D low. These outputs comprise the blanking code, 14 (1 1 1 0) which will recirculate in the position of a leading zero.

The information in the readout register continues to recirculate until the $\overline{Q}$ output of U10 returns to a high state. Pin 13 ($\overline{S}$) of flip/flop U29 also goes high to allow U29 to function as a J-K flip/flop. U29 Q remains high and the data continues to recirculate until the sync code (15) reaches the sync register, U39.

When the sync code reaches U39 all of the outputs go high to enable the K input to flip/flop U29. The next system clock causes the $\overline{Q}$ output of U29 to go high. The scan cycle is not initiated.

SERVICE SHEET 24 (Cont'd)

When the $\overline{Q}$ output of flip/flop U29 goes high, NAND gate U9B output goes low to enable the one-of-twelve selector, U5, on the readout assembly (SS36). The second input to NAND gate U9B at pin 4 is high because command TTRO-L is high.

The high level at the $\overline{Q}$ output of flip/flop U10 enables NAND gate U4C to allow the 5 kHz SCANCK to be applied to AND gate U22C. The input to pin 9 of U22C is held high by flip/flop U34C/U34D and the pin 10 input is held high by the output of NAND gate U15B. The clock output of AND gate U22C is inverted and applied to NAND gate U15D. The second input to U15D is held high because flip/flop U34C/U34D inhibits NAND gate U35C.

It takes only six clock pulses at the 5 kHz rate (SCANCK) to clock the information in the readout register to the ROM's in the readout assembly.

When the six clock, 5 kHz train has clocked the nine data digits to the readout assembly the sync code (15) has recirculated to the Q_E output of the eight-bit registers. These outputs all go high to enable the J input of flip/flop U29. The next clock pulse causes the Q output of U29 to go high and couple the system clock through NAND gate U15B back to input pin 10 of AND gate U22C. The input to pin 11 of AND gate U22C is high because the 5 kHz clock is low. The system clock continues the recirculating process for four system clock periods at which time the sync code (15) again reaches U39. The K input to flip/flop U29 causes the $\overline{Q}$ output of U29 to go high and restart the scan cycle.

The scan cycle continues without interruption until the readout register contents are changed by a new entry.

Blanking AND gate U18C is inhibited in several different ways in conjunction with selected frequency units.

When GHz is selected, input pin 9 of NOR gate U19C goes high, the output goes low and AND gate U18C is inhibited. Blanking of the MSD still occurs if the MSD is a zero because the low Q_3 output of U8 turns off transistor switch Q1 in the readout assembly.

When MHz is selected all leading insignificant zeros are blanked until the sync code (15) reaches Q_E in the 8-bit registers. All inputs to AND gate U18A are high and the output also goes high. The high input to NOR gate U19A causes the output to go low and inhibit AND gate U18C. Blanking of zeros following the MHz decimal point is prevented.

When kHz is selected all leading zeros are blanked until a number is reached or the sync code reaches Q_B of the 8-bit registers. All inputs to AND gate U18B go high and the output goes high. The high input to NOR gate U19A causes the output

SERVICE SHEET 24 (Cont'd)

to go low and inhibit AND gate U18C. Blanking of zeros following the kHz decimal point is prevented.

When Hz is selected all leading zeros are blanked.

Inputs OPR-L and OPRO-L are used only in option 004, 100 Hz resolution to 1.3 GHz resolution (200 Hz to 2.6 GHz resolution)instruments. These inputs last for two clock pulses and they force the two least significant digits to zero.

Input ROI-L establishes priority for the readout during manual sweep.

When one of the pushbuttons is pressed to call up the contents of a given register it takes priority and is displayed regardless of any change in manual sweep. When the pushbutton is released the readout will again display the manual sweep frequency.

Whenever the selected output frequency of the RF Section is 1.3 GHz or higher the DBL-L line goes low. When the DBL-L line goes low it is inverted and applied to NAND gate U35A. This signal, in conjunction with other inputs to U35A cause flip-flop U5A/U5C to change states. The output of NAND gate U5A goes low and inhibits AND gate U25C. U25C then prevents BCD 1 from being clocked into U8. The next inverted clock pulse then causes the state of flip-flop U5C/U5A to again change state. This action prevents the least significant digit from being an odd number.

In Option 004 instruments operating above 1.3 GHz, the lowest increment is 200 Hz. In this configuration, the output of U5A remains high for the first three BC inputs to the readout control register. This is accomplished by moving R16 to the boxed in area and control-line the reset of flip-flop U5C/U5A by means of U39, U19D and the Q_H outputs of U36, U37, U38 and U28. When the Q_2 and Q_3 outputs of U39 go high, the output of U19D goes low to reset flip-flop U5C/U5D to enable AND gate U25C. The fourth input and all higher digits may be odd numbers.

SERVICE SHEET 24 (Cont'd)

Table 8-51. Readout Register Leading Zero Blanking

			ROM A ↑						ROM B ↑		
MSD		Q_A	Q_B	Q_C	Q_D	Q_E	Q_F	Q_G	Q_H	S	
U8	U27	U36	U37	U38	U28	U36	U37	U38	U28	U39	
B	0	0	0	1	2	3	4	5	6	S	Initial state Hz
S	0	0	0	0	1	2	3	4	5	6	
6	S	0	0	0	0	1	2	3	4	5	
5	6	5	0	0	0	0	1	2	3	4	
4	5	6	S	0	0	0	0	1	2	3	
3	4	5	6	S	0	0	0	0	1	2	
2	3	4	5	6	S	0	0	0	0	1	
1	2	3	4	5	6	S	0	0	0	0	
0	1	2	3	4	5	6	S	0	0	0	
0	0	1	2	3	4	5	6	S	0	0	
0	0	0	1	2	3	4	5	6	S	B	Detect zero
B	0	0	0	1	2	3	4	5	6	S	Blank (code 14)
S	B	0	0	0	1	2	3	4	5	6	
6	S	B	0	0	0	1	2	3	4	5	
5	6	S	B	0	0	0	1	2	3	4	
4	5	6	S	B	0	0	0	1	2	3	
3	4	5	6	S	B	0	0	0	1	2	
2	3	4	5	6	S	B	0	0	0	1	
1	2	3	4	5	6	S	B	0	0	0	
0	1	2	3	4	5	6	S	0	B	0	
0	0	1	2	3	4	5	6	S	B	B	Detect zero
	Continue to final state.										Blank (code 14)
	B	B	B	1	2	3	4	5	6	S	Final state.

SERVICE SHEET 24 (Cont'd)

Table 8-52. Readout Register Significant Zero Blanking Inhibit

			ROM A ↑						ROM B ↑		
		Q_A	Q_B	Q_C	Q_D	Q_E	Q_F	Q_G	Q_H	S	
U8	U27	U36	U37	U38	U28	U36	U37	U38	U28	U39	
B	B	B	B	.0	5	4	3	2	1	S	Initial state (MHz)
S	B	B	B	B	.0	5	4	3	2	1	
1	S	B	B	B	B	.0	5	4	3	2	
2	1	S	B	B	B	B	.0	5	4	3	
3	2	1	S	B	B	B	B	.0	5	4	
4	3	2	1	S	B	B	B	B	.0	5	
5	4	3	2	1	S	B	B	B	B	.0	Detect zero Inhibit blanking
.0	5	4	3	2	1	S	B	B	B	B	Q_D outputs binary
B	.0	5	4	3	2	1	S	B	B	B	4 and 8 along with MHz line drives U19
B	B	.0	5	4	3	2	1	S	B	B	output low to inhibit blanking
B	B	B	B	.0	5	4	3	2	1	S	Final state (MHz)

Table 8-53. Readout Register Recirculating Cycle

			ROM A ↑						ROM B ↑		
		Q_A	Q_B	Q_C	Q_D	Q_E	Q_F	Q_G	Q_H	S	
U8	U27	U36	U37	U38	U28	U36	U37	U38	U28	U39	
0	0	0	0	1	2	3	4	5	6	S	Initial State
S	0	0	0	0	1	2	3	4	5	6	
6	S	0	0	0	0	1	2	3	4	5	
5	6	S	0	0	0	0	1	2	3	4	5 kHz clock
4	5	6	S	0	0	0	0	1	2	3	
3	4	5	6	S	0	0	0	0	1	2	
2	3	4	5	6	S	0	0	0	0	1	Detects code 15
1	2	3	4	5	6	S	0	0	0	0	
0	1	2	3	4	5	6	S	0	0	0	1 MHz clock
0	0	1	2	3	4	5	6	S	0	0	
0	0	0	1	2	3	4	5	6	S	0	Return to initial state
0	0	0	0	1	2	3	4	5	6	S	

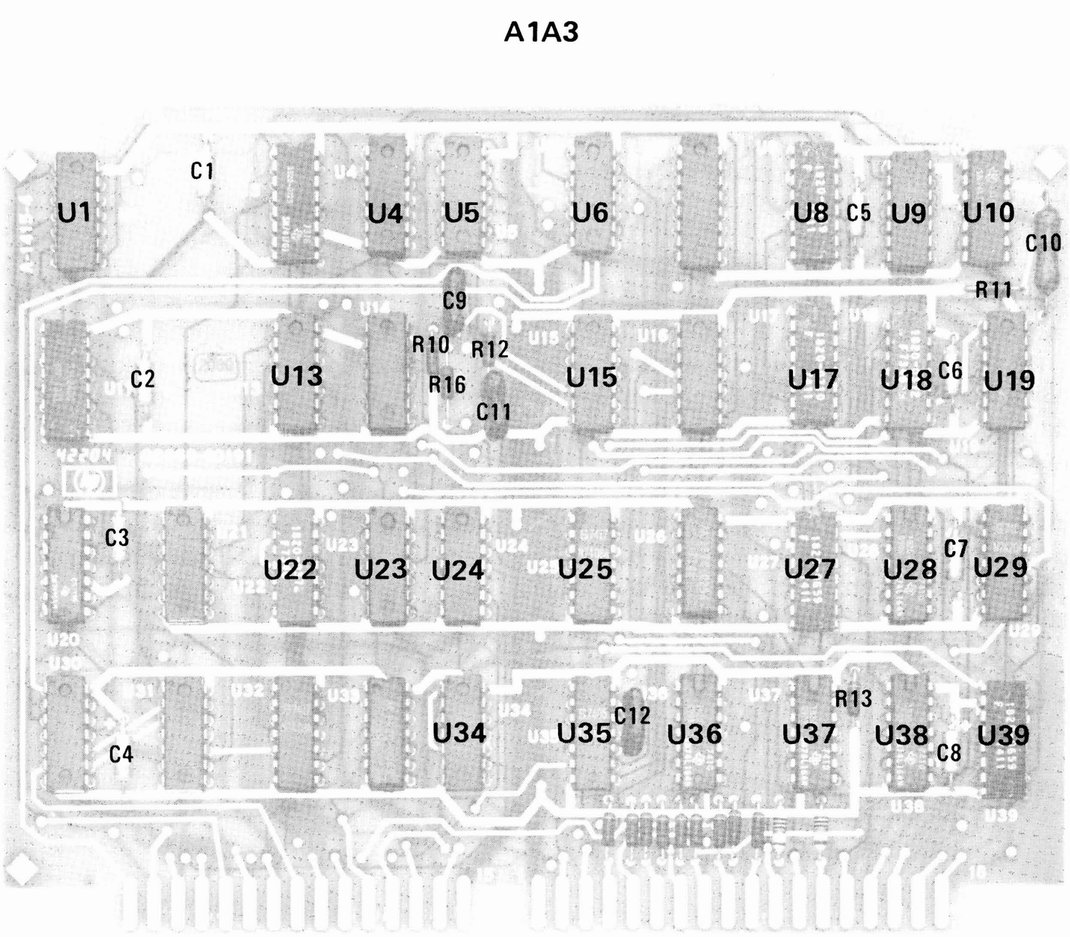


Figure 8-64. P/O A1A3 Readout Control Assembly Component Locations (Part 2)

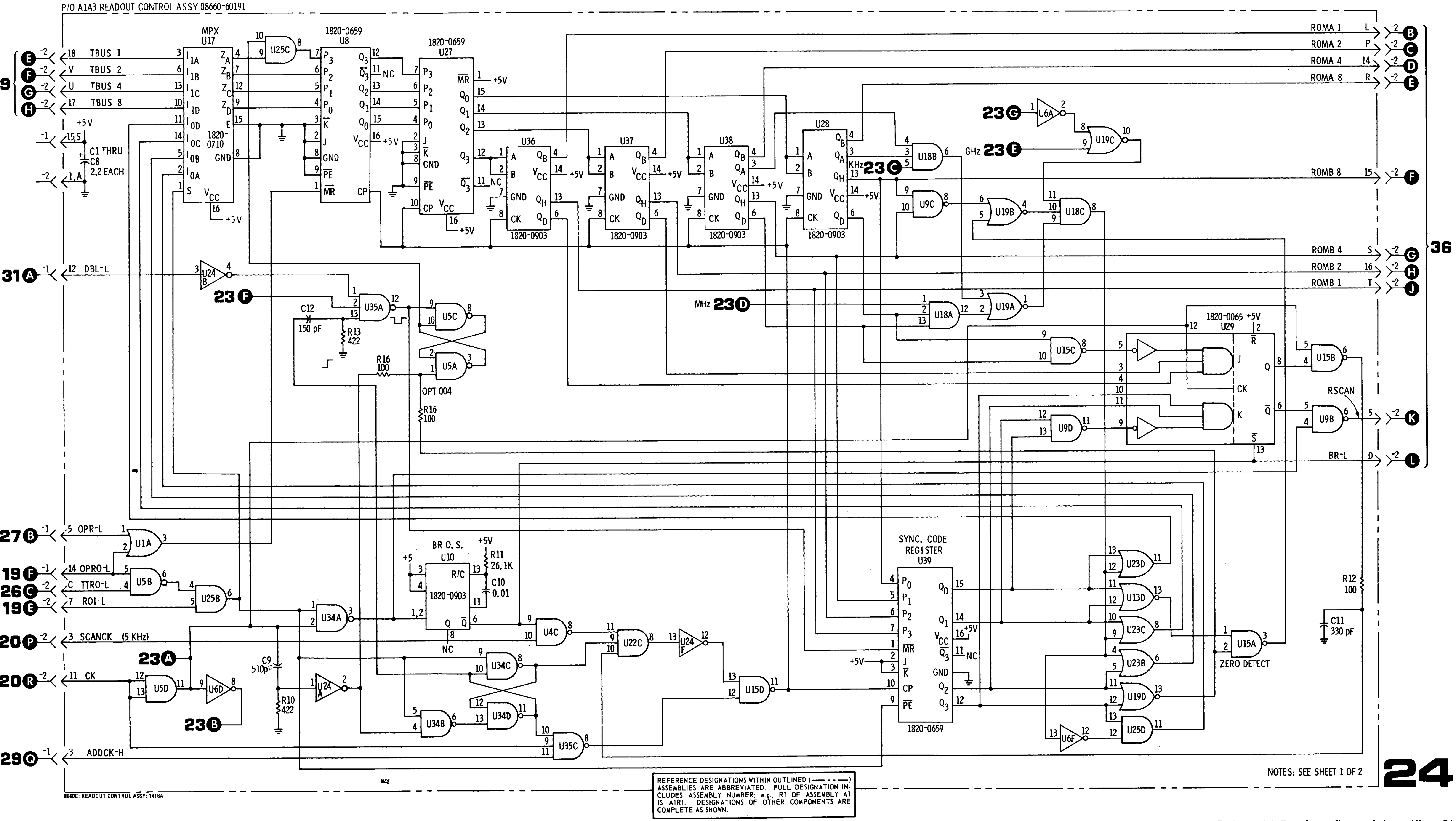


Figure 8-65. P/O A1A3 Readout Control Assy (Part 2)

SERVICE SHEET 25

P/O ROM INPUT ASSEMBLY A1A4

The A1A4 (SS25 and 26) and the A1A5 (SS27 and 28) assemblies contain most of the micro-programming circuits that control the entire instrument.

The A1A4 assembly contains the qualifier select circuit shown on SS25 and the seven flip/flops, ROMs and qualifier flip/flops shown on SS26.

Because of the number of inputs from other assemblies to the circuit shown on SS25 the inputs are shown at the bottom of the page. The only output on SS25 is the output of U1 labeled A 26. This output provides the eighth address bit for the ROMs shown on SS26.

U18, U9, U19, U20, U21, U22 and U23 are four input one-of-sixteen selectors. The A, B, C and D inputs are positive logic binary 1 2 4 8 format from the A_0, A_1, A_2 and A_3 outputs of the seven state flip/flops shown on SS26. These inputs are applied to all of the selectors in parallel. However, only one of the selectors is active at any given time.

One-of-ten selector U10 (only 7 outputs are used) is controlled by the A_4, A_5 and A_6 outputs of the seven state flip/flops shown on SS26. All of the U10 outputs are high except the one selected. The D input to U10 is grounded because only three data bits are required to select the output (BCD 4, 2 and 1).

It is readily apparent from the circuit configuration that the state for any of the inputs to the code selectors is easily detected. As an example, assume that the inputs from the seven state flip/flops are all low. The U10 0_0 output is low and U23 (code 0) is selected. Since the A, B, C and D inputs to U23 are all low, input E_0 is selected. The E_0 input is qualifier F10-H. If an Entry has not been made, F10-H is low the $\overline{W}$ output of U23 is high and the instrument is held in state 0/0. If the F10-H input is high, the $\overline{W}$ output of U23 goes low, the output of U1 goes high and the next state is selected.

In the foregoing example, assume that qualifier F10-H was high. Referring to the ASM chart it may be seen that the next state is 4/0 (100 0000). Since the input to U10 is now a 4 (100) U19 is selected. The A, B, C and D inputs to U19 are all low so once again E_0 input is selected. The input to E_0 is from the F7-H flip/flop shown on SS26. It may be seen on the algorithm that if F7 is high the next state is 0/1, if low, 5/0.

AND gate U2C combines CKA-H and CKB-H when they are both high to provide inputs to U20 and U21. These inputs are used in states 3/1, 3/0, 2/13 and 2/12.

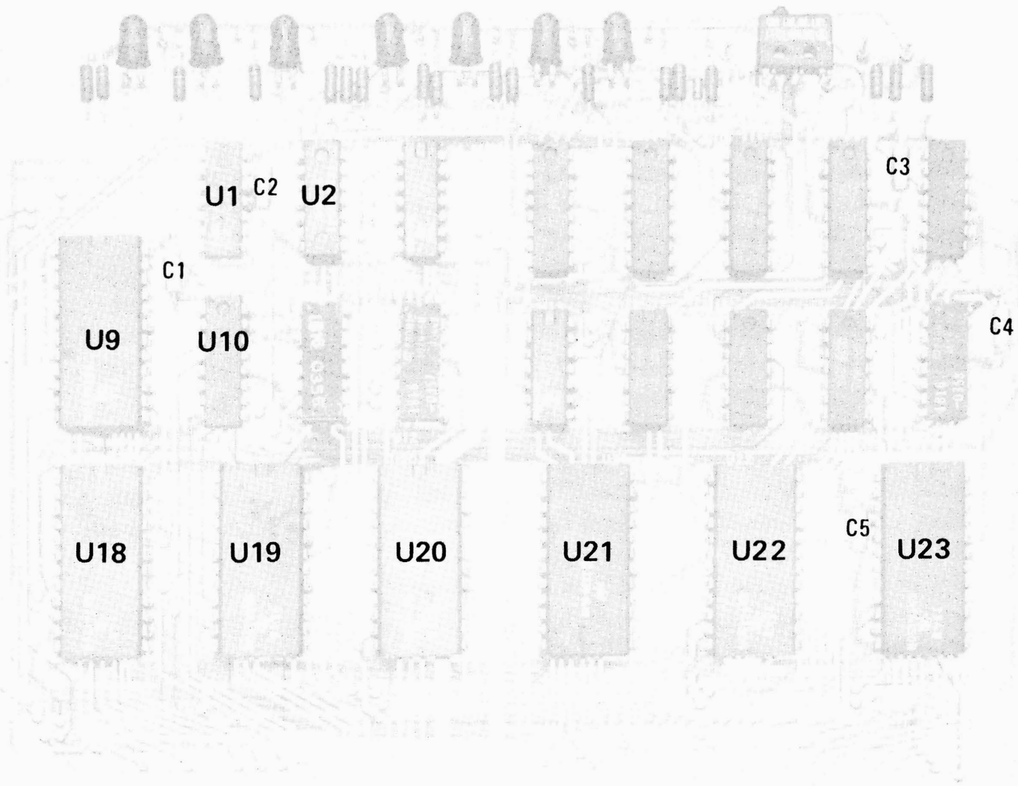
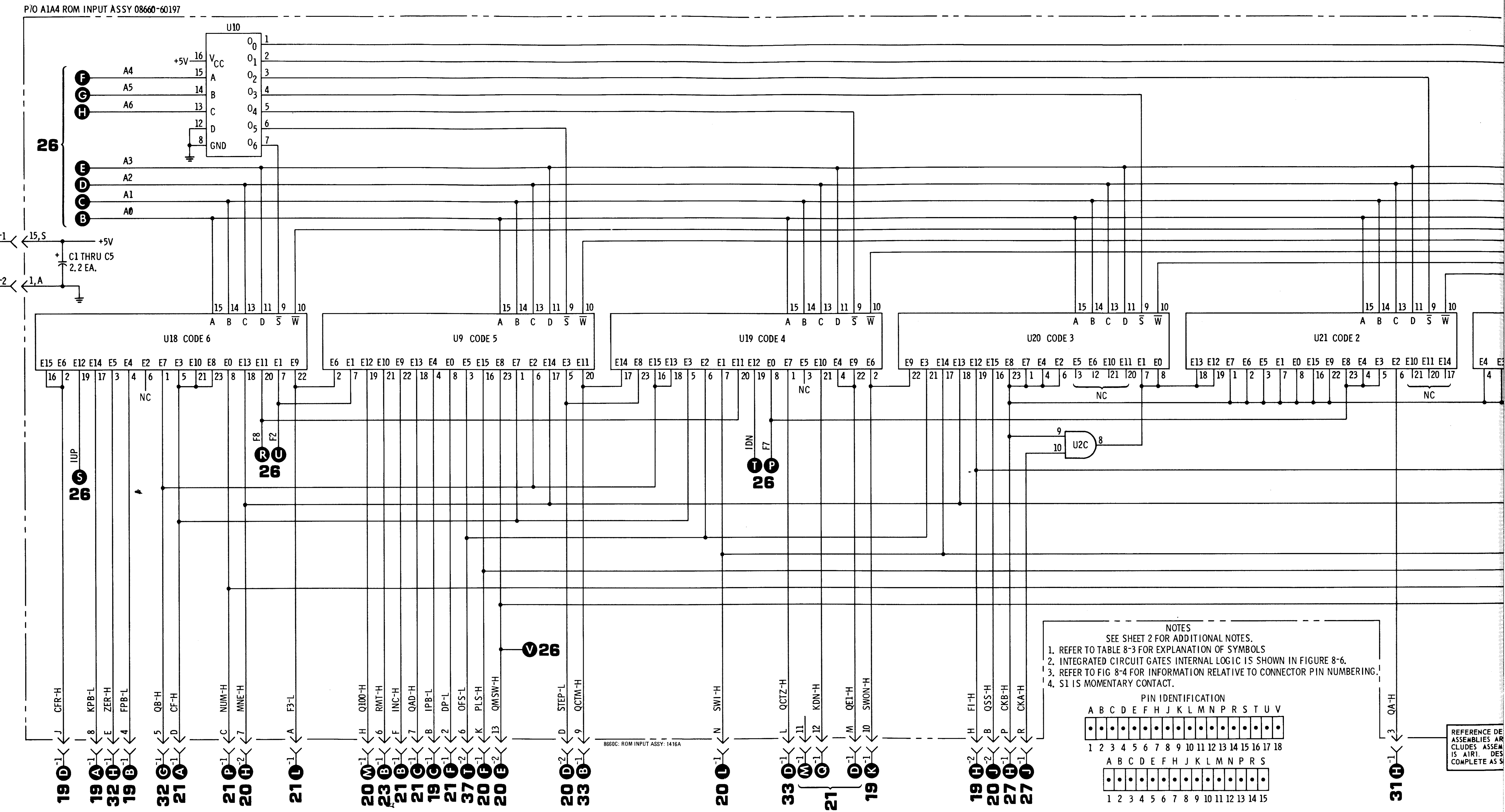


Figure 8-66. P/O A1A4 ROM Input Assembly Component Locations (Part 1)



NOTES

SEE SHEET 2 FOR ADDITIONAL NOTES.

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIG 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.
4. S1 IS MOMENTARY CONTACT.

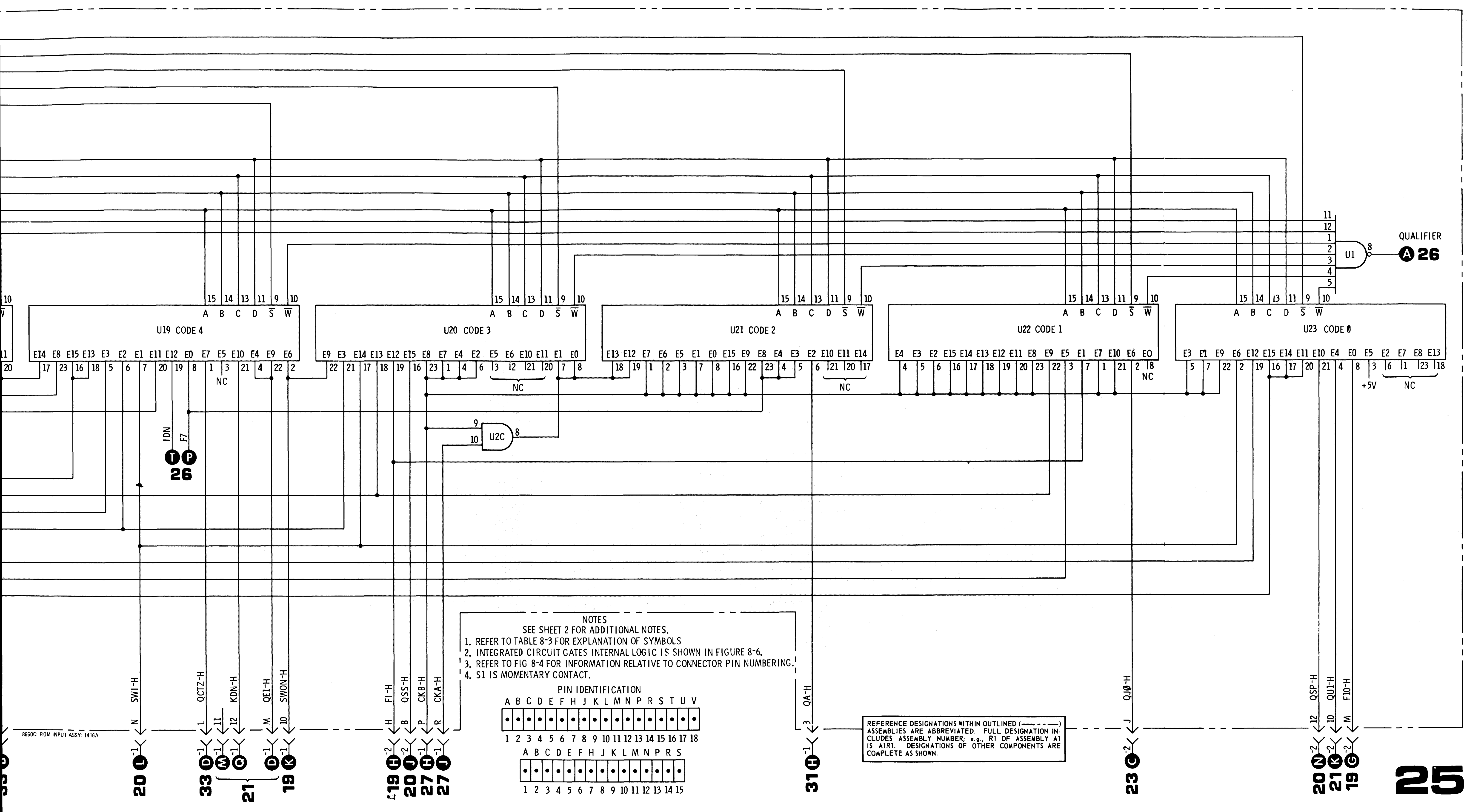


Figure 8-67. P/O A1A4 ROM Input Assy (Part 1)

SERVICE SHEET 26

P/O ROM INPUT ASSEMBLY A1A4

The A1A4 (SS25 and 26) and the A1A5 (SS27 and 28) assemblies contain most of the micro-programming circuits that control the entire instrument.

The A1A4 assembly contains the qualifier select circuit shown on SS25. The seven-state flip/flops, ROM's, and qualifier flip/flops are shown on SS26.

Seven J-K flip/flops, U6A, U5A, U4A, U7B, U5B, U6B and U4B form the seven-state flip/flops. The outputs of these flip/flops provide seven of the eight address bits required to control the next state outputs of ROM's U11, U12 and U17. The outputs also control the qualifier selector circuits shown on SS25 and the output instruction selectors on SS28 and SS19.

The eighth address bit to the ROM's is supplied by the selector circuit shown on SS25. When the seven-state flip/flops are clocked all four of the outputs from ROM U11 and three of the outputs from ROM U12 determine the next machine state. The remaining output of ROM U12 and all four of the outputs from ROM U17 are used directly as output instructions.

The light emitting diodes (LED's) connected between the $\overline{Q}$ outputs of the seven-state flip/flops and +5V indicate the machine state. These LED's light when the $\overline{Q}$ outputs of the flip/flops go low. Proper utilization of these LED's in the manual test mode will enable the technician to quickly isolate the cause of a problem to the assembly or even the circuit level. In the automatic mode of operation the machine states change so rapidly that the LED's serve no useful purpose.

At the far left of the schematic, U7, a J-K flip/flop is used to set the manual test mode. When TP9 is momentarily grounded $\overline{Q}$ goes low to inhibit the clock gate, U8A. Momentarily grounding TP8 will reset the flip/flop causing the $\overline{Q}$ output to go high and enable the clock gate, U8A. This returns the instrument to the automatic mode. The PRDT-L (power detect) input, which is low when the instrument is first turned on ensures that the automatic mode of operation is selected.

In order to use the manual test mode facilities it is necessary to momentarily ground or pulse the manual test point, TP9. The machine state may be 0/0 (all LED's out) or may be any state in an operation sequence. If state 0/0 test point, is desired, momentarily ground or pulse the state 0/0 test point, TP10. Any machine state may now be set by momentarily grounding or pulsing the appropriate seven-state flip/flop test points.

P/O A1A4 ROM Input Assy (Part 1)
◄ SERVICE SHEET 25

SERVICE SHEET 26 (Cont'd)

If, for instance, TP7, TP4 and TP1 were momentarily grounded or pulsed, the machine state would be 4/9 (100 1001). The ASM chart shows the qualifier QEI (qualifier entry instruction) following state 4/9. If an entry instruction (CF, STEP or SWP) is being made (key held down), pressing the MAN SW microswitch should cause the next state to be 5/9 (101 1001) as shown by the LED's. If the state 5/9 is not present, the operation was incorrect. Refer to Table 8-2, Mnenmonics Information, locate qualifier QEI, read across the page to determine where the qualifier originates and refer to the applicable service sheet to effect necessary repairs.

When NAND gate U8A pin 1 goes low pin 3 goes high to enable AND gate U2B. The clock pulse source is now flip/flop U15B. Normally, the $\overline{R}$ and CK inputs to U15B are held low by R2 and the $\overline{Q}$ output is high. As soon as SW1 NC contacts are opened the $\overline{R}$ input to U15B goes high. When the SW1 NO contacts are closed the U15B CK goes high but this does not affect the output since J-K flip/flops are triggered by a negative-going transition. When SW1 is released it is returned to the NC position. The negative-going transition at the CK input causes U15B $\overline{Q}$ to go low. The output of AND gate U2B goes low and the outputs of inverters U13C and U13F go high. When the NC contacts of SW1 are again closed, the $\overline{R}$ input to U15B again goes low to cause the $\overline{Q}$ output to go high, AND gate U2B output goes high and the outputs of inverters U13C and U13F go low to clock the seven-state flip/flops.

AND gates U2A and U2D are used to reset the seven-state flip/flops to state 0/0 when PRDT-L is low or when TP10 is momentarily grounded or pulsed.

The J-K flip/flops shown in the lower part of the schematic provide qualifiers; most of which are used in the selector circuits shown on SS25. These flip/flops are all clocked by the system (1 MHz) clock. They are also reset ($\overline{Q}$ goes high) when PRDT-L is active or TP10 is momentarily grounded or pulsed.

Flip/flop U16A generates the F7 qualifier. The K inputs is an instruction (KF7-H) which appears in states 2/9 and 1/0. The J input goes high whenever JF7B-L or (JF7A, ILD)-L goes low. F7 is fundamentally the sweep flip/flop but it also functions in the remote mode.

U15A is the sweep ramp qualifier flip/flop F8. It appears in states 6/11 and 4/11.

U14B (IUP) inhibits the sweep up operation when QCTM-H (qualifier count maximum) on the sweep count assembly A1A8 goes high.

U14A (IDN) inhibits the sweep down operation when QCTZ (qualifier count zero) on the sweep count assembly A1A8 goes high.

U16B (F2) is active ($\overline{Q}$ low) only for the first keyboard entry.

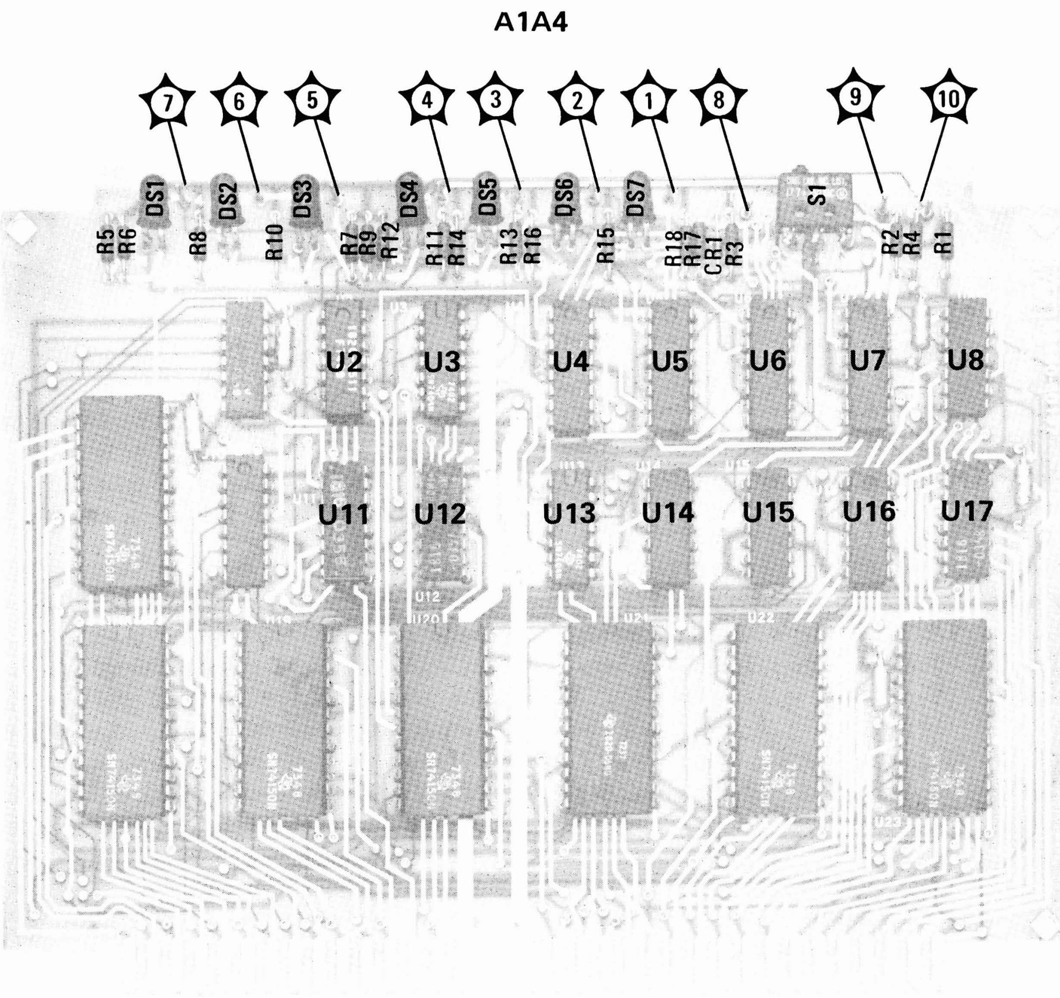


Figure 8-68. P/O A1A4 ROM Input Assembly Component Locations (Part 2)

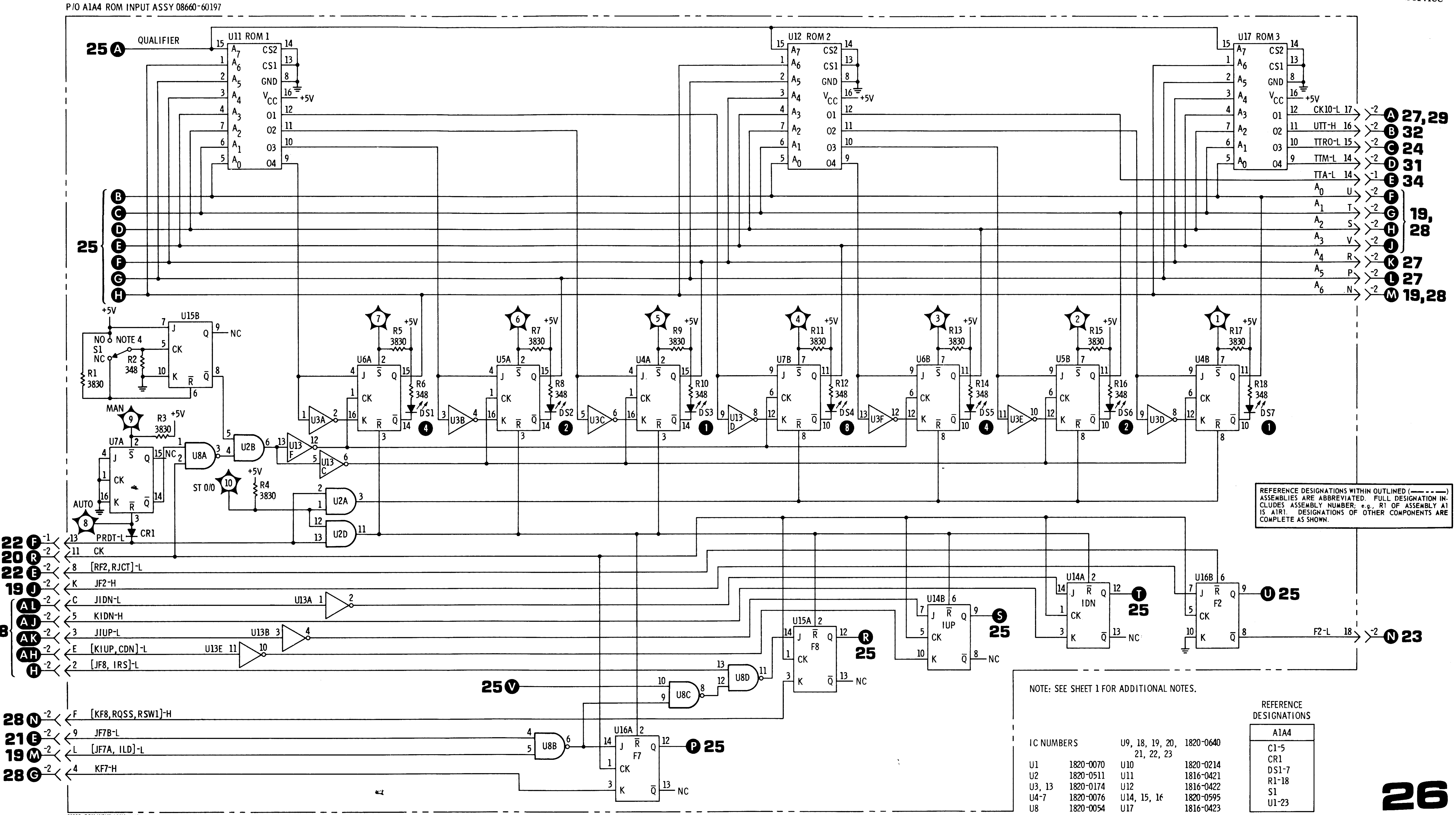


Figure 8-69. P/O A1A4 ROM Input Assy (Part 2)

SERVICE SHEET 27

P/O ROM OUTPUT ASSEMBLY A1A5

The A1A4 (SS25 and 26) and the A1A5 (SS27and 28) assemblies contain most of the micro-programming circuits that control operation of the entire instrument.

U17, shown in the center of the schematic, is the major control element for most of the circuits shown on this service sheet. It is a preset counter but is used only as a binary counter. When U17 is not active the master reset, $\overline{MR}$, input is low and all of the Q outputs are held low.

Any of the clock inputs, except the system clock, will inhibit NAND gate U9B and enable binary counter U17 by removing the reset input.

As an example of circuit operation, assume that the CK12-L input goes low. The output of AND gate U11A goes low to cause the output of NAND gates U9A and U9B to go high. This inhibits the $\overline{MR}$ input to U17. Since the output of U20A is low at this time, the output of inverter U10C is high and the clock is coupled through NAND gate U9C to U17.

When CK12-L went low it was inverted by U4E and used to enable NAND gate U19A. U19A, U19B, U19C and U20A form a detect circuit which provides the CKA-H output for the binary number selected.

In the case of CK12-L, when the output of U17 reaches 12 (1100), the output of U19A goes low and causes the output of U20A to go high.

While U19 and U20A were detecting a specific binary number, U18 was also detecting counts of 10, 11, and 12. When the count of 10 (1010) is reached the output of NAND gate U18C goes low and causes the output of U18D to go high. When the count of 11 (1011) is reached the CKB-H output remains high because NAND gate U18C is still enabled. When the count of 12 is reached NAND gate U18A is enabled so CKB-H is still high. The outputs of U20A (CKA) and U18D (CKB) are ANDed together in the system, and when the 12 count is reached, the combined signal enables the state machine to go to the next state. In doing so, the CK12-L input goes high again, causing reset of U17 through U11A and U9B.

NAND gate U18B produces the B9-L output which goes low on the 9th clock pulse. It is used in the readout control assembly to limit a normal ten-clock train to 9 clocks.

The output labeled OPR-L is used in the readout control assembly to set the two least significant readout digits to 0 in Option 004 instruments.

Output A2TR-H enables output gates for the 12 digit portion of the A register assembly.

The A4 and A5 inputs are from the seven-state flip/flops in the switch control assembly, A1A4. The 2-bit code on these inputs is decoded by the gates shown in the lower right corner of the schematic to produce one of four outputs. Output G20 enables the code 0 instruction decoder on A1A1. The outputs labeled 28, E, F and G enable the code 1, 2 and 3 instruction decoders shown on SS28.

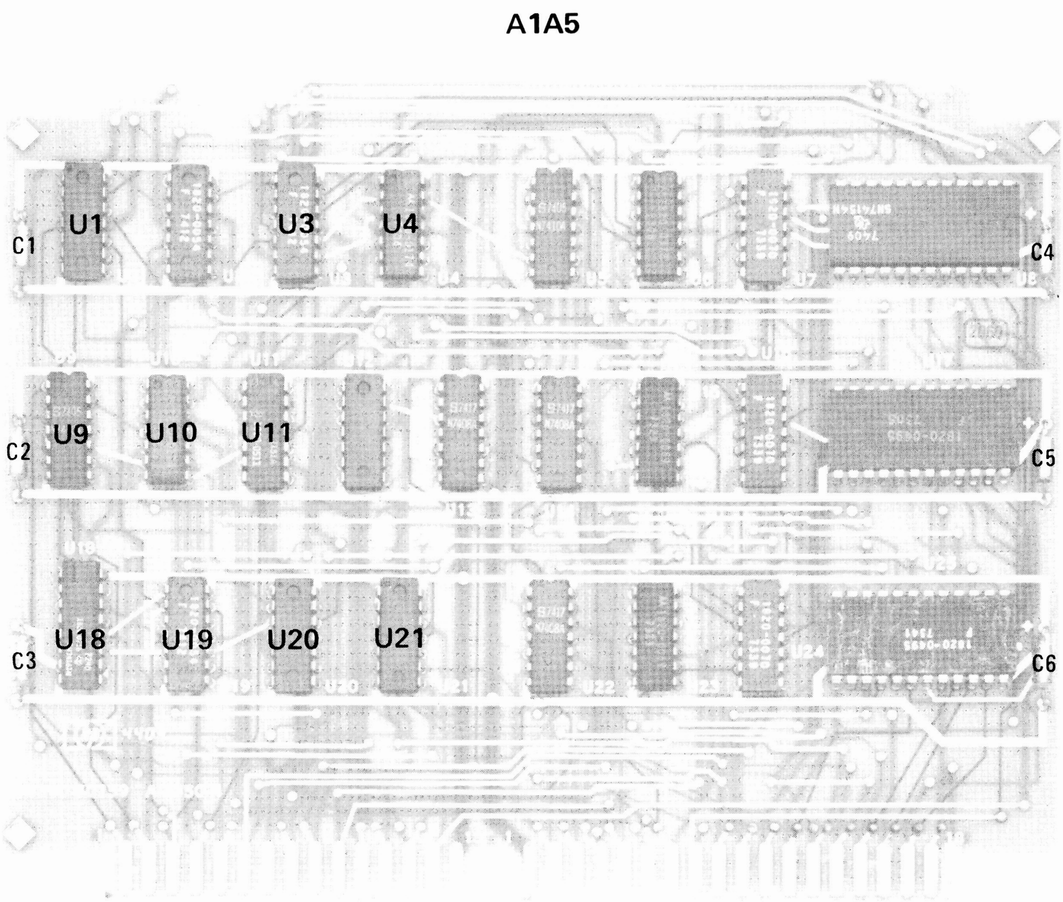
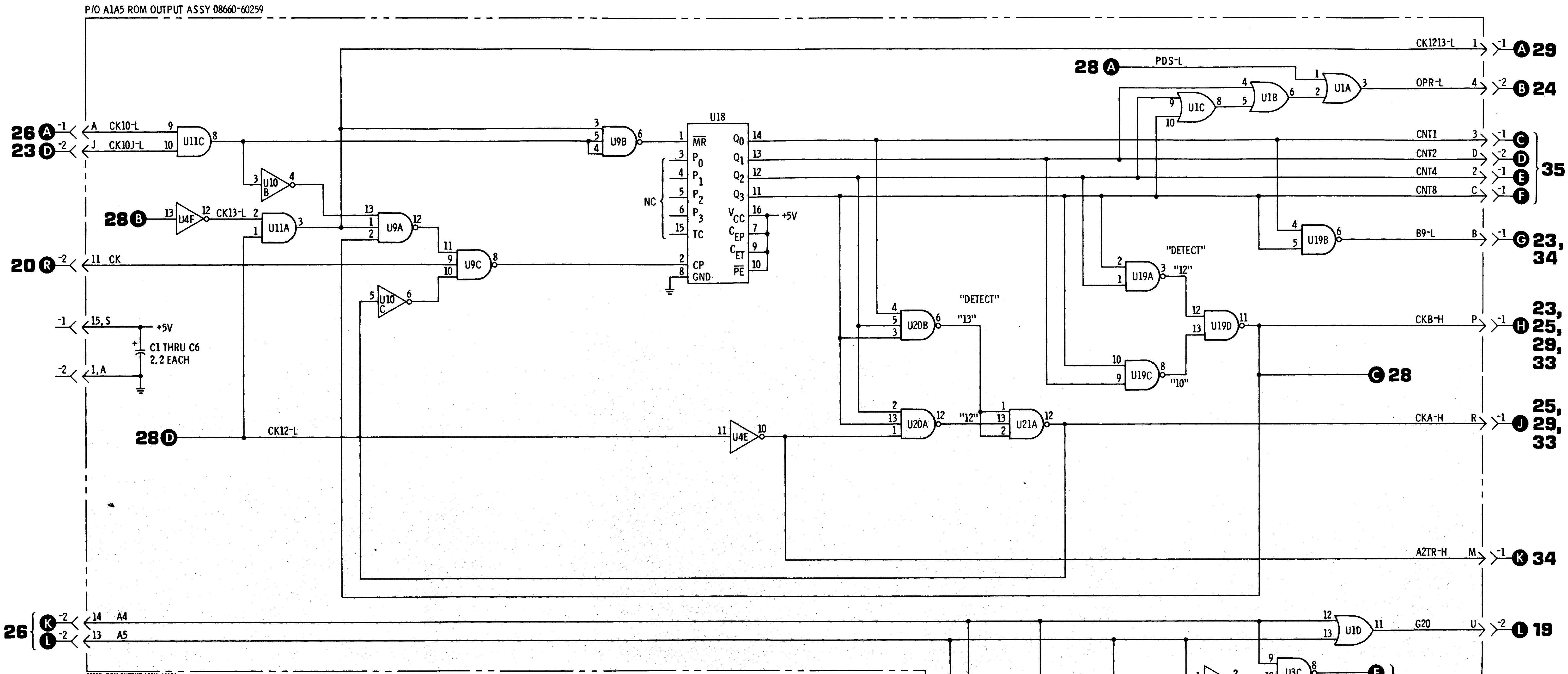


Figure 8-70. P/O A1A5 ROM Output Assembly Component Locations (Part 1)



NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING

REFERENCE DESIGNATIONS

A1A5
C1-6 U1-25

IC NUMBERS

U1, 12	1820-0661
U2, 3, 19	1820-0054
U4, 10	1820-0174
U5, 9	1820-0068
U6	1820-0372
U7, 16, 24	1820-0070
U8, 17, 25	1820-0495
U11, 13, 14, 22	1820-0511
U15, 23	1820-0069
U18	1820-0716
U20, 21	1820-0587

REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

27

Figure 8-71. P/O A1A5 ROM Output Assy (Part 1)

SERVICE SHEET 28

P/O ROM OUTPUT ASSEMBLY A1A5

The A1A4 (SS25 and 26) and the A1A5 (SS27 and 28) assemblies contain most of the micro-programming circuits that control operation of the entire instrument.

All of the gates shown on SS28 are controlled by the 4-line-to-16-line instruction decoders U25, U17 and U8. These decoders have six inputs, all of which are required to decode to the single output. All outputs are high except the one decoded.

Note that the decoders are labeled CODE 1, CODE 2 and CODE 3. These code numbers and the output numbers of the decoders quickly reveal the machine state code as shown on the algorithm, which is the state of the seven-state flip/flops in the ROM input assembly.

The gates shown combine the decoder outputs to provide the desired instruction.

As an example, assume that output 6 of U25 is low. Decoder U25 is labeled CODE 1 (001) and the decoded output is 6 (0110). The state code is 1/6 and the outputs of the seven-state flip/flops is 001 0110. Instructions (JUS, KF3, JF2)-L are low.

The example quoted for the instructions in state 1/6 is very simple. Generation of many of the instructions is more complex when the instruction is decoded from several machine states.

Take, as an example, state 2/5 (output 5 of U16). Following the line across the schematic leads to instruction SCDP-L, set center frequency decimal point - assertive state low. The state 2/5 low output from U16 is applied to inverter U4C and its high output causes TTC-H, T bus to center frequency register - assertive state high, to go high. The state 2/5 output from U17 is also applied to AND gate U13B, the pin 12 input to NAND gate U2D goes low and KTT-H keyboard to T bus - assertive state high, goes high.

The instruction SCDP-L occurs only in state 2/5. However, some of the other instructions generated in state 2/5 are also generated in other states.

Instruction TTC-H is also made to go high when NAND gate U23B pin 8 CTR-H goes high. This occurs when any one of the inputs to U23B goes low in states 1/15, 1/14, 2/0 or 2/1.

Instruction KTT-H also goes high when the pin 5 input to U13B goes low in state 1/4. KTT-H goes high and JF3-L goes low when any of the inputs to AND gate U6A go low in states 1/13, 1/12 or 1/11. Input pin 5 of U21B also causes JF3-L to go low in state 1/0, but does not affect KTT-H.

Any of the instruction paths may be quickly checked by setting the instrument to the manual test mode and to the state to be checked. The machine state block in the algorithm indicates all instructions required in the set state.

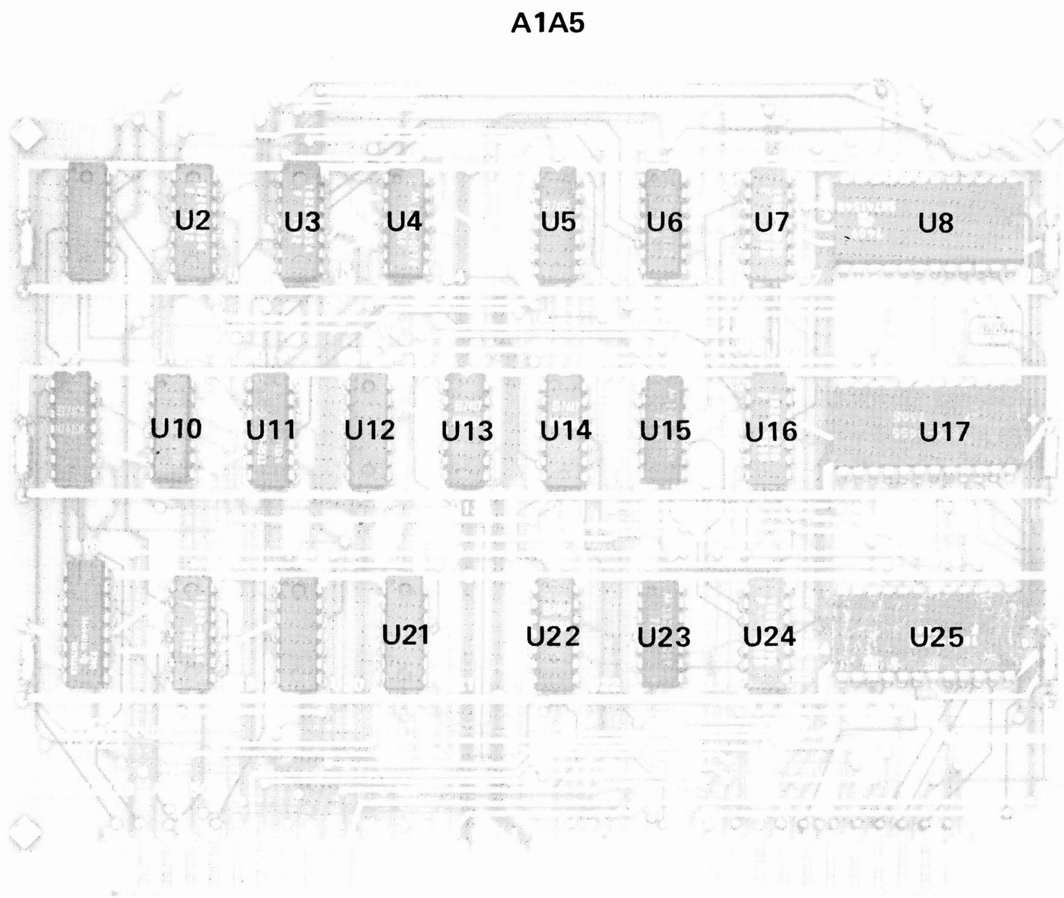
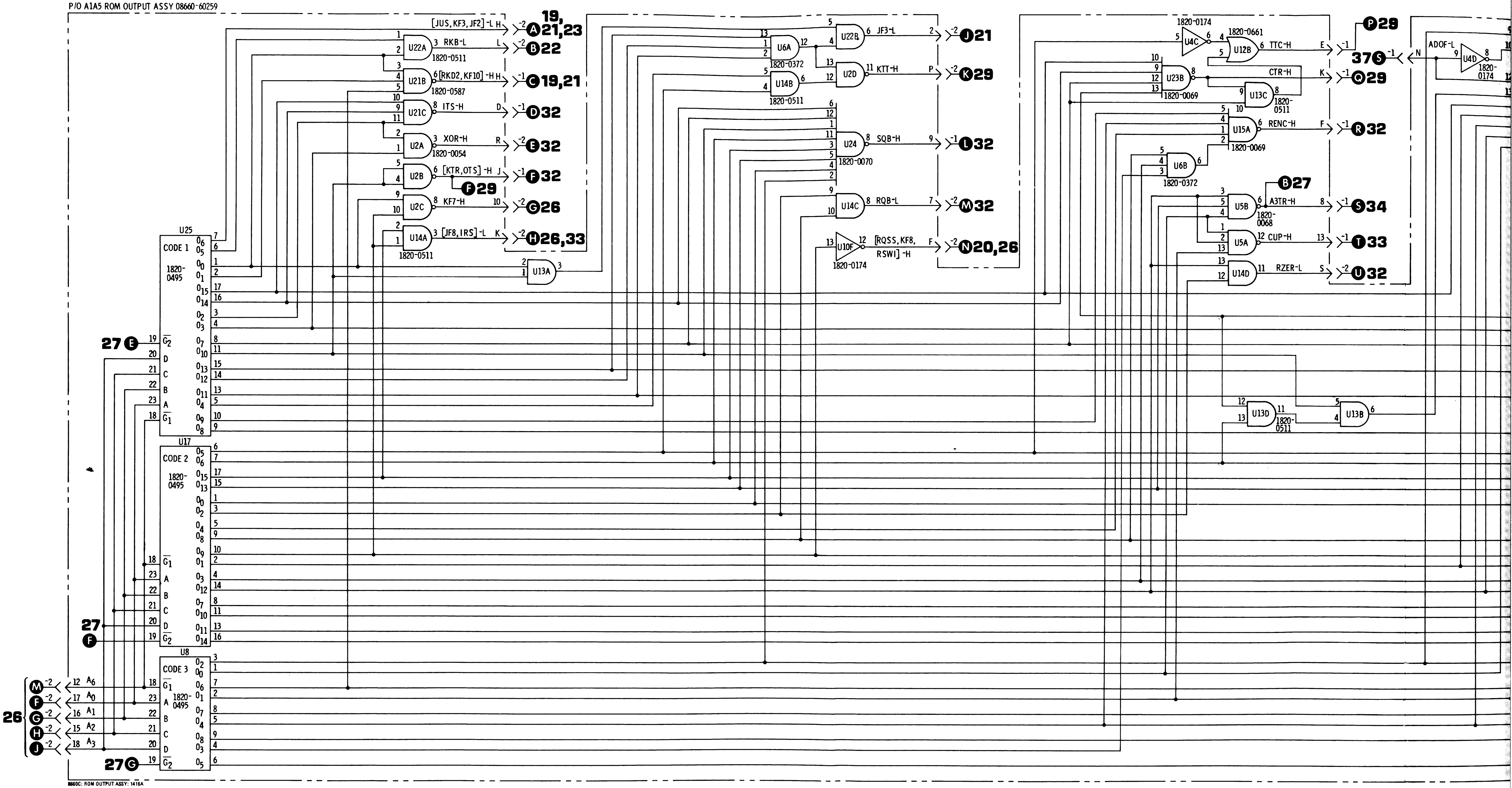


Figure 8-72. P/O A1A5 ROM Output Assembly Component Locations (Part 2)

P/O A1A5 ROM OUTPUT ASSY 08660-60259



8660C: ROM OUTPUT ASSY: 1416A

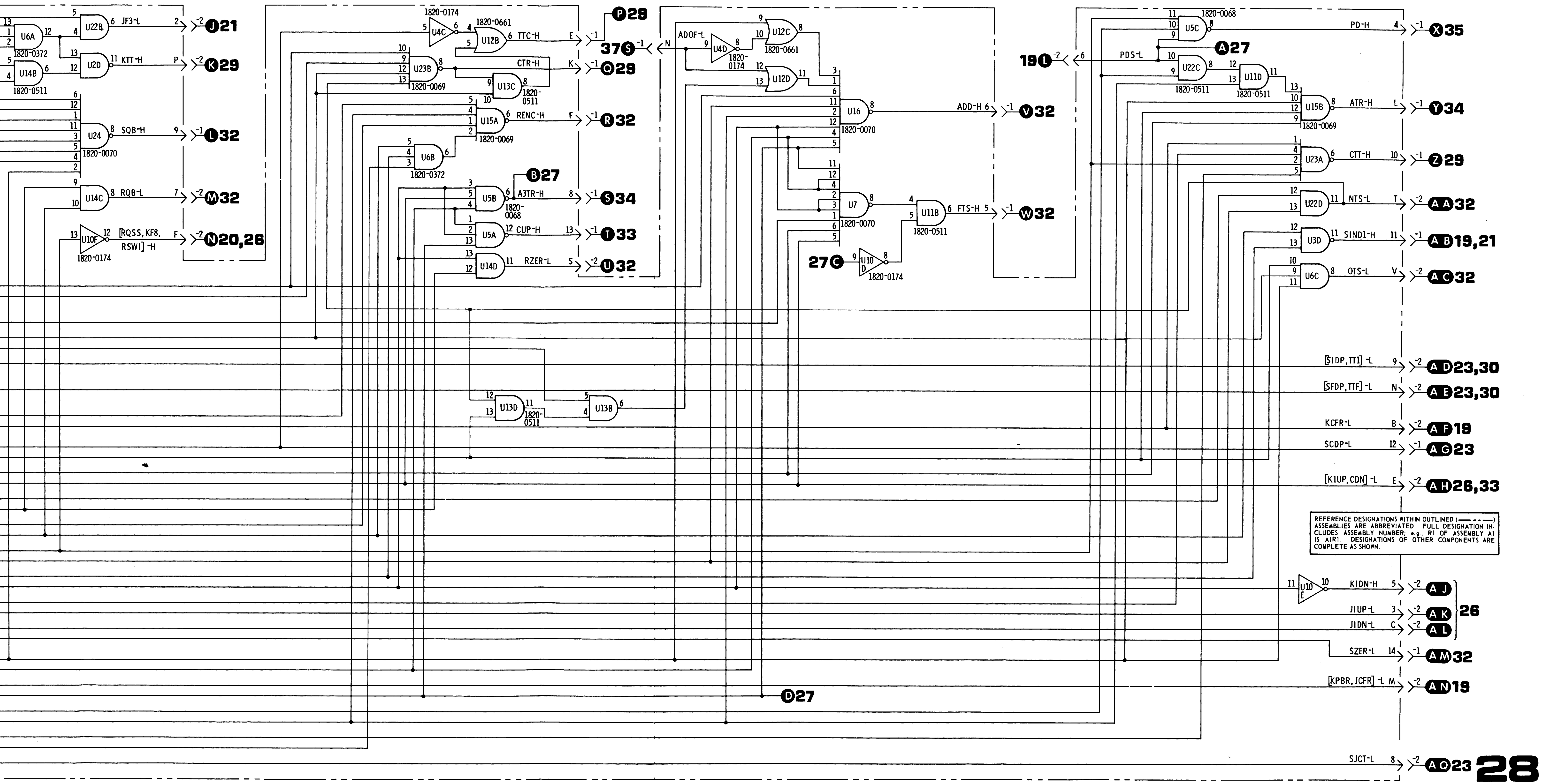


Figure 8-73. P/O A1A5 ROM Output Assy (Part 2)

SERVICE SHEET 29

P/O REGISTER ASSEMBLY A1A6

A1A6 register assembly circuits are shown schematically on Service Sheets 29, 30 and 31.

Service Sheet 29 shows the center frequency register and some clock control gating circuits.

The center frequency register, consisting of U9, U18, U28 and U38, is a ten digit recirculating shift register. U9 and U18 are dual 8-bit registers with built-in multiplexers. U28 and U38 are single-digit four-bit registers; they store the least significant digits (U38 digit 1 and U28 digit 2). U9 stores BCD 1 and 2 data and U18 stores BCD 4 and 8 data.

When the instrument is first turned on PRDT-L is low, the $\overline{MR}$ inputs to the registers are low and the register is held in the reset state until the power supply is stabilized.

When a new center frequency is entered on the keyboard and transferred to the T bus, it is not immediately entered into the center frequency register. It is, instead, first entered in the M register (SS31). If the M register and associated gates determine that the center frequency selected is within the output range of the RF Section installed, KTT-H and TTC-H both go high and the contents of the keyboard shift register is transferred to the center frequency register. If the center frequency entered is out of range it is rejected and the center frequency register retains the last valid entry.

When CTR-H goes high, the U33 NAND gates are enabled and the data stored in the center frequency register is clocked out to the R bus. The data is also clocked back into the center frequency register for future use. While the data is being clocked out TTC-H is low so the D_{OB} and D_{OA} inputs of U7 and U16 are selected and the data recirculates.

The data stored in the center frequency register may also be transferred back to the T bus when desired. This occurs when CTT-H goes high.

The input lines labeled KA, KB, KC and KD are the inputs from the keyboard register. When these inputs carry data to be used in the plug-in sections, ST01-L is low and is inverted by U40B to enable the U39 AND gates. NAND gate U19A is also enabled to provide a burst of ten clock pulses (PICK-L) to the appropriate plug-in register. This operation occurs in the remote mode of operation.

The clock pulses for the center frequency, step and sweep registers are provided by AND gate U8B. A train of ten clock pulses is provided when the following conditions exist:

1. The low CKB-H level is inverted and applied to pin 5 of AND gate U10B.
2. The low CK10-L level is inverted by U40E and applied to pin 4 of AND gate U10B.
3. The system clock is present at U10B pin 3.

Input CK10-L initiates the clock burst when it goes low. The input CKB-H from the clock generator portion of A1A5 (SS27) goes high on the 10th clock and inhibits further output from U8B.

AND gate U10C provides a train of 10, 12 or 13 clock pulses to drive the M register (SS31), when TTM-L at 31 B goes low. The CK10-L and CKB-H will enable and inhibit respectively a clock burst of ten pulses by their drive through U20A and U10A to U10C. The clock pulses are then coupled through U10C to the M register.

Three other clocks originate in the gating circuits shown on SS29. They are:

1. CK10CK-H used in the A1A3 readout control assembly, 10 clock pulses long.
2. ADDCK-H used in the A1A7 ALU assembly and A1A3 readout control assembly, may be 10, 12 or 13 clock pulses long.
3. AREGCK-H used in the A1A9 A register assembly, may be 10, 12 or 13 clock pulses long.

These are similarly generated when enabled by CK1213-L, or CK10-L, or CK10J-L and inhibited by combined sequential operation of CKB-H and CKA-H. The latter two limit clock bursts to 10, 12 or 13 pulses.

The U15 NAND gates permit passage of BCD data from the keyboard SR to the A6U.

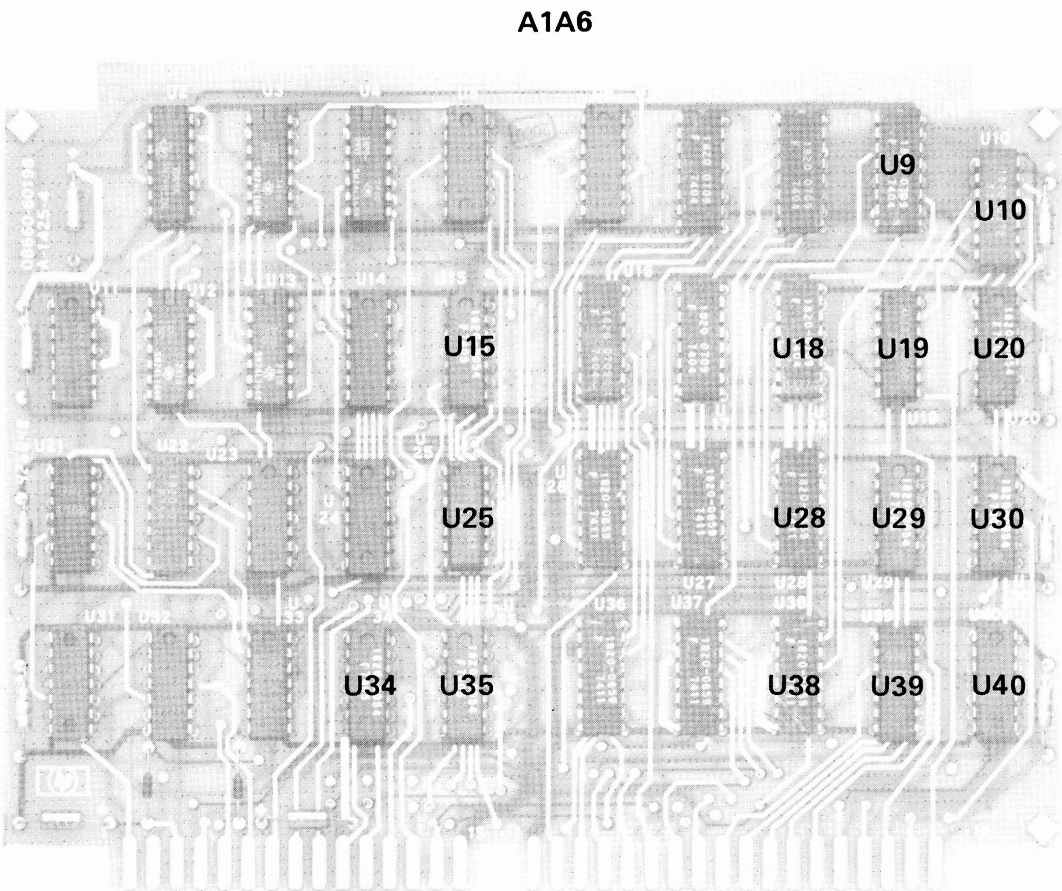
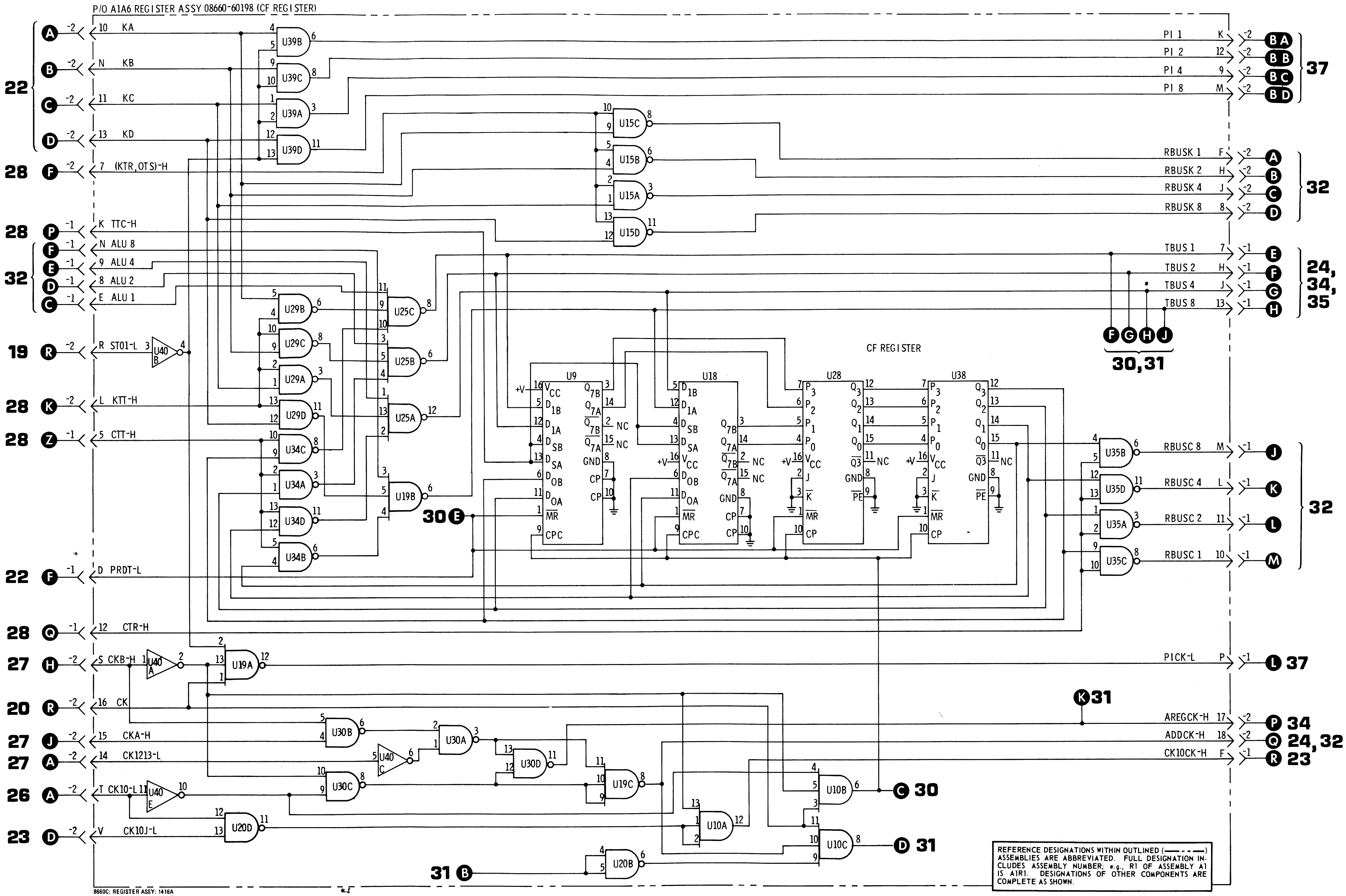


Figure 8-74. P/O A1A6 Register Assembly Component Locations (Part 1)



NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR CONNECTOR PIN NUMBERING.

REFERENCE DESIGNATIONS

A1A6
C1-10 R1, 2 U2-10, 12-40 NOT USED U1, 11

IC PART NUMBERS

U3,4,12,13	1820-0903
U5,31	1820-0661
U6,14,23	1820-0328
U7,8,9,16,17,18	1820-0709
U10,22	1820-0372
U15,20,29,30,34,35	1820-0054
U19,25	1820-0068
U21,39	1820-0511
U24,32	1820-0583
U26,27,28,36,37,38	1820-0659
U33	1820-0587
U40	1820-0174
U2	1820-0379

PIN IDENTIFICATION

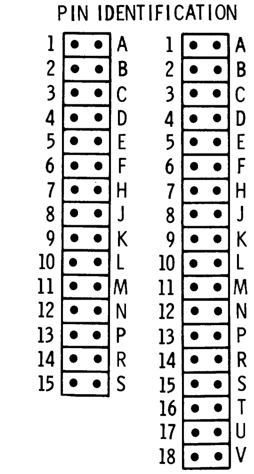


Figure 8-75. P/O A1A6 Register Assy (Part 1)

SERVICE SHEET 30

P/O REGISTER ASSEMBLY A1A6

A1A6 register assembly circuits are shown schematically on Service Sheets 29, 30 and 31.

The sweep and step registers, which operate identically, are shown schematically on Service Sheet 30. The configuration of these registers is the same as the center frequency register shown on Service Sheet 29. They each consist of two dual 8 bit registers with built in multiplexers and two 4 bit registers.

When new data is to be entered into the sweep register the input labeled (SFDP, TTF)-L goes low and this level at U8 and U17 pins 4 and 13 (D_S) selects the D_{0A} and D_{0B} inputs. A train of ten clock pulses clock the sweep width information off the T bus into the sweep register where it is stored until called for.

When the data in the sweep register is to be clocked to the S bus, the train of ten clock pulses again appears at the CPC and CP inputs. During this cycle (SFDP, TTF)-L are high and the data from the register output is recirculated back into the register through the D_{1A} and D_{1B} inputs to U6 and U15.

Operation of the step register is the same as operation of the sweep register except that the inputs are selected by (SIDP, TTI)-L.

PRDT-L at 29 Ⓔ holds the registers in the reset when the instrument is first turned on until the mainframe power supplies are stabilized.

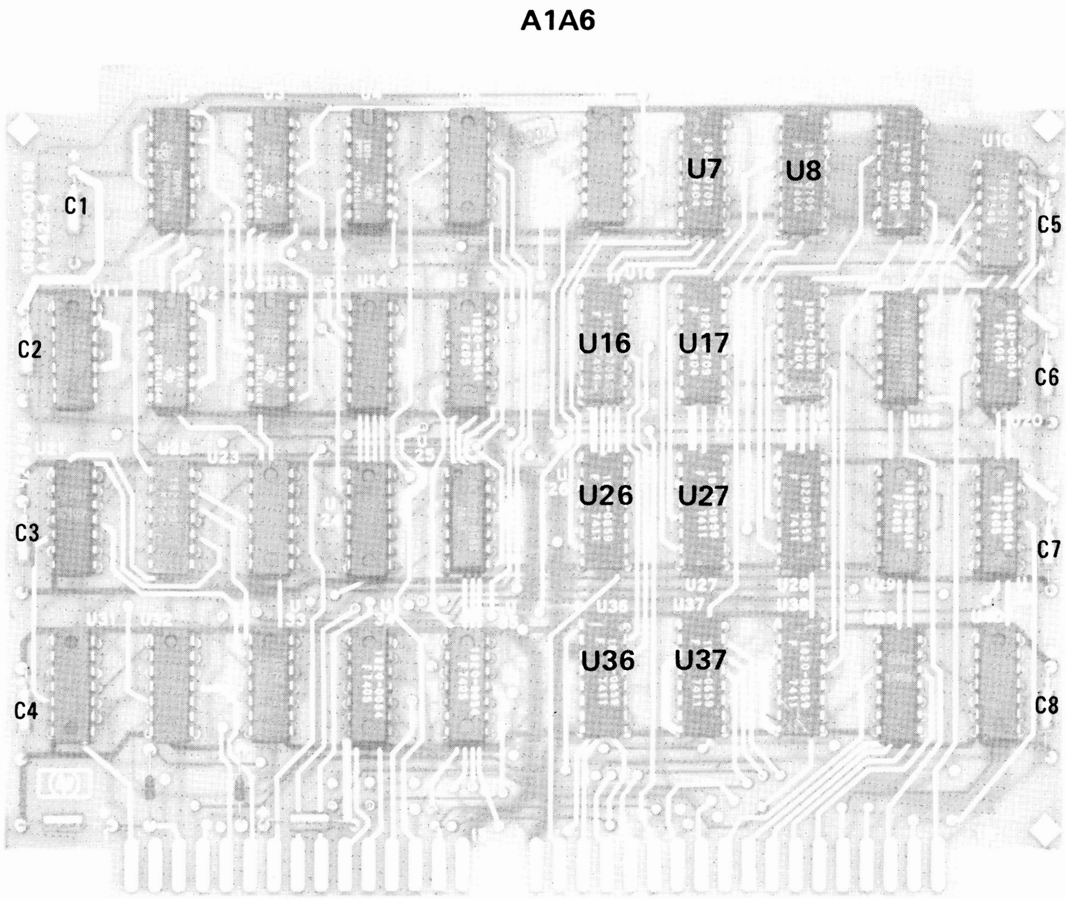


Figure 8-76. P/O A1A6 Register Assembly Component Locations (Part 1)

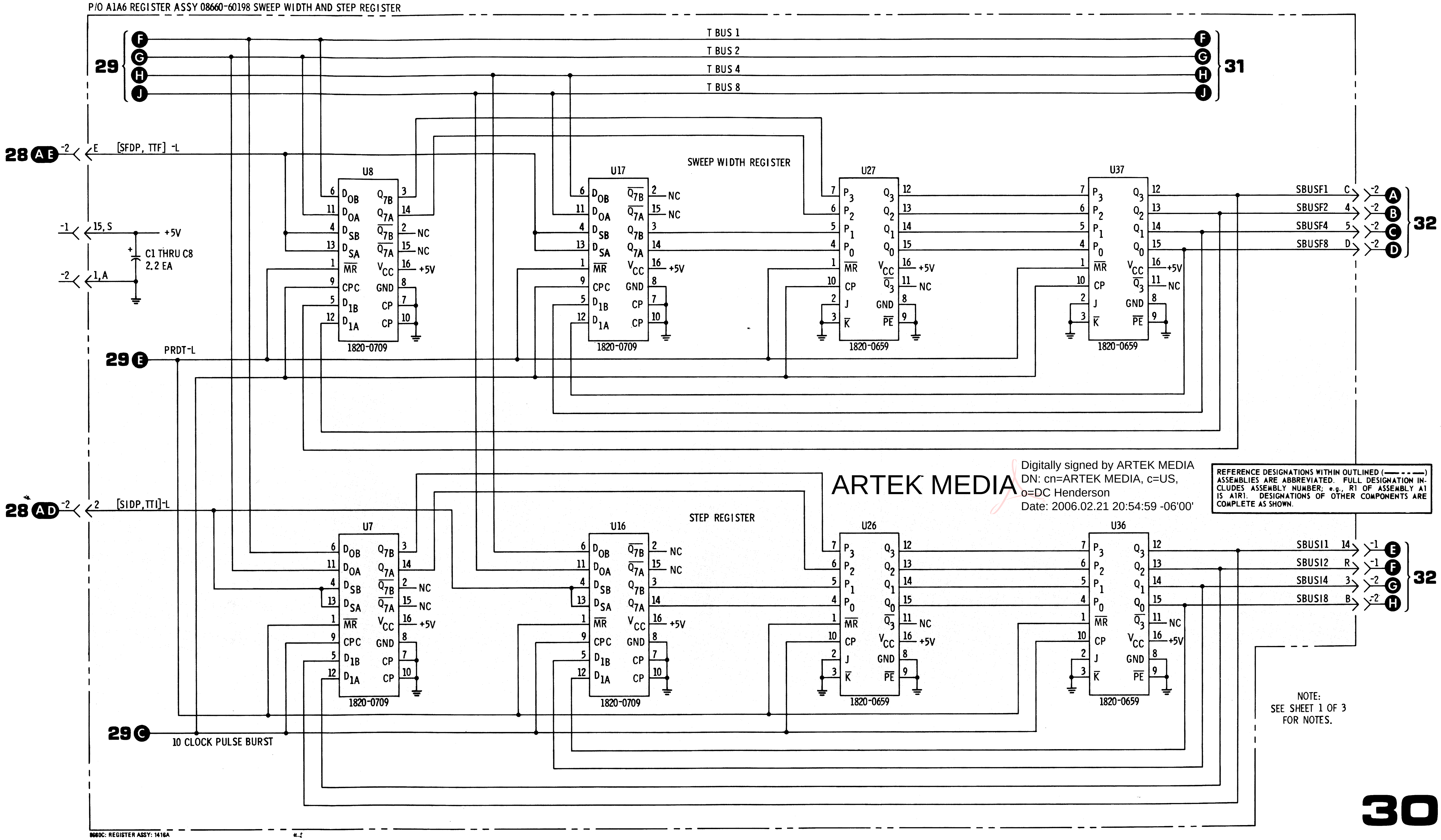


Figure 8-77. P/O A1A6 Register Assy (Part 2)

SERVICE SHEET 31

P/O REGISTER ASSEMBLY A1A6

A1A6 register assembly circuits are shown schematically on Service Sheets 29, 30 and 31.

Service Sheet 31 shows the M register and the frequency limits detect gates.

The M register differs considerably from the other registers in the A1A6 assembly. U10 (BCD 1), U11 (BCD 2), U1 (BCD 4) and U2 (BCD 8) are all eight bit shift registers. Only six of the 8 bit locations are used (6 most significant digits). Data is clocked into the M register by a train of ten clock pulses, and digits 1, 2, 3 and 4 are discarded. They are not needed because 10 kHz is the lowest detected frequency limit for any of the plug in RF Sections available.

All of the gates, except U13, to the right of the M register are used to detect and provide frequency limit information.

Two inputs, PILIM and 13GL, shown in the lower left corner of the schematic enable selected gates that correspond to the limits of the RF Section in use.

The output of U31C, qualifier QA-H, signifying an above range frequency, is processed through A1A4 (ROM input assembly) and A1A5 (ROM output assembly) to a one-shot on the A1A1 switch control assembly. When QA-H goes high the (SIND1, JNINC)-H input to A1A1 goes high and causes the OUT OF RNG light to flash for about 1 second. The entered frequency will not be transferred to the center frequency register.

The output of U30B, SIND2 (lower frequency limit), is applied directly to A1A1 U14; it causes the OUT OF RNG light to light and remain lit. The instrument is capable of producing frequencies considerably lower than those specified as the lower frequency limit. However, the output level may be degraded.

The Code 1 and Code 2 outputs are used to change time constants in the RF Section plug in power amplifier to aid in output leveling.

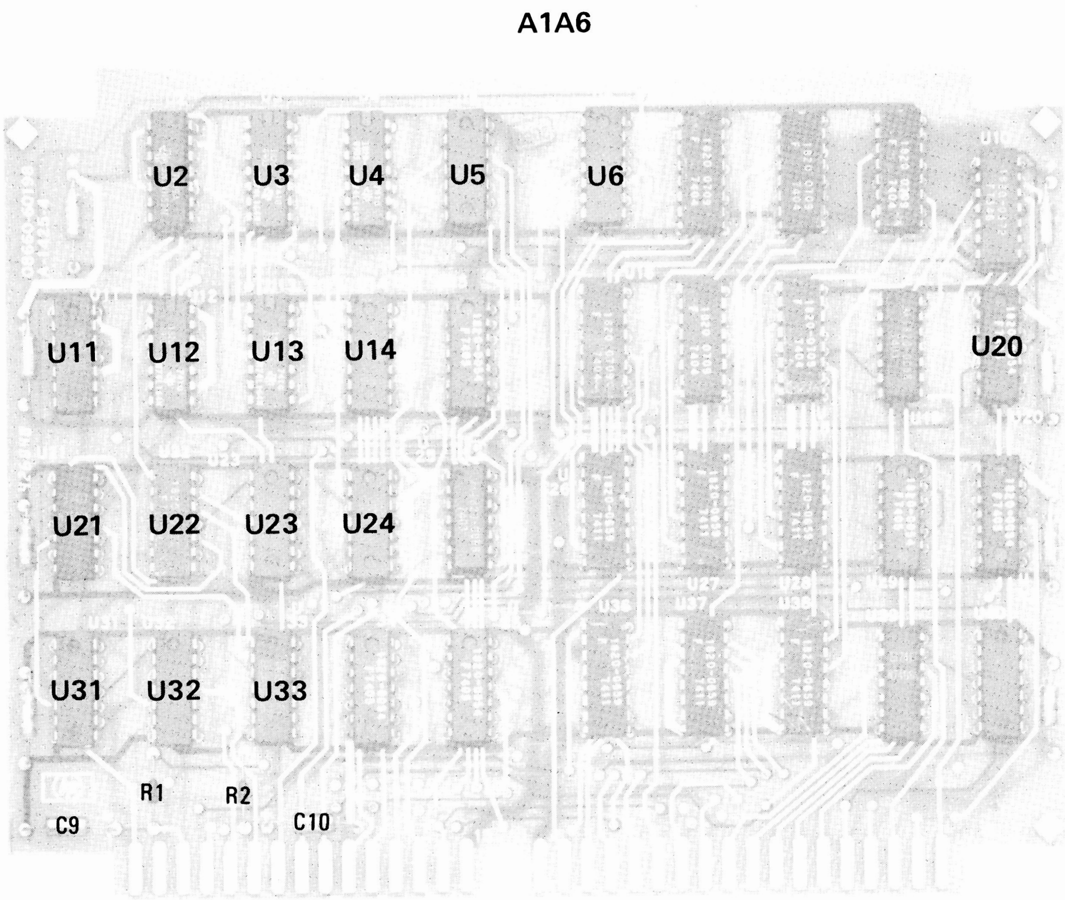


Figure 8-78. P/O A1A6 Register Assembly Component Locations (Part 3)

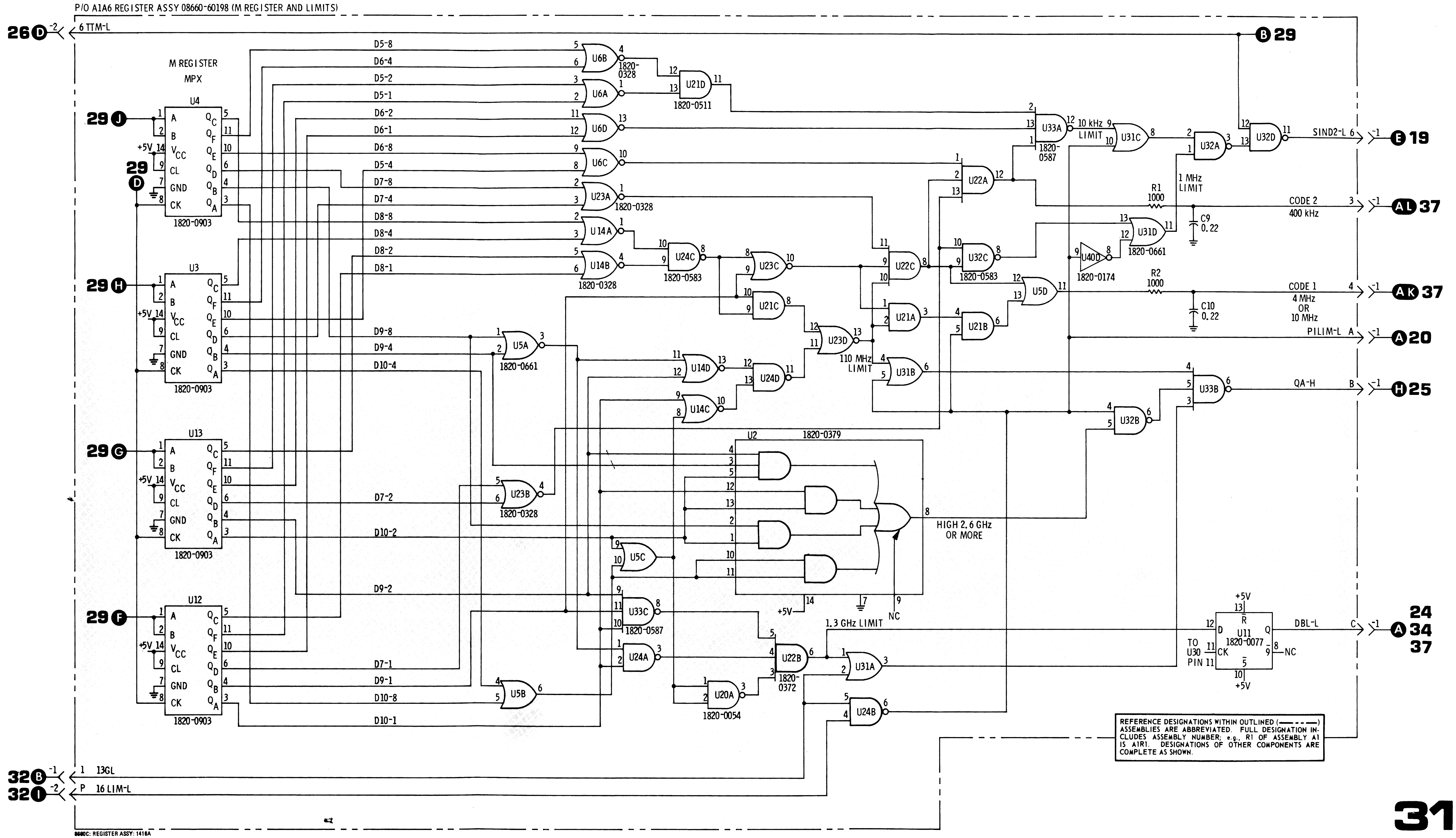


Figure 8-79. P/O A1A6 Register Assy (Part 3)

SERVICE SHEET 32

ARITHMETIC LOGIC UNIT (ALU) A1A7

The ALU processes input data from the A, Center Frequency, Sweep Width and Step registers as well as data from ROM #4 (U9) and associated circuitry.

U5 and U6 are four-bit full adders; they can accept two four-bit inputs and produce an output which is the binary sum of the inputs.

In a sense, U5 is the focal point of the ALU. It is here that the ALU inputs are initially combined.

U12 and U14 are complementers which may be operated in four different modes. The mode is selected by the dc levels on control inputs B and C as follows:

1. B and C both low - the Y outputs are the complements of the A inputs - subtract function.
2. B is low and C is high (ADD-H is active) - the Y outputs follow the A inputs - add function.
3. B and C both high (XOR-H is active) - all Y outputs are low - the B inputs to U5 are processed through U5 without change.
4. B is high and C is low - all Y outputs are high. This mode is not used in the 8660B.

At the top center of the schematic are four three-input NAND gates (U18A, B, C and U3C). The inputs to these NAND gates are from the A, M, or CF registers. The output lines of the NAND gates are the R bus. The Y outputs of U12 are applied to the A inputs of ADDER U5.

The second input to ADDER U5 is from the S bus. The inputs to the S bus are from the sweep width register via NAND gates U10A, B, C and D, the increment register via NAND gates U17A, B, C and D and ROM U9.

In the arithmetic process the A and B inputs to ADDER U5 are summed and appear at the Σ summation outputs in binary format. Whenever the U5 Σ outputs are greater than 9 (1001) U6 adds 6 (0110) to the output of U5 to convert the binary sum to a BCD sum.

When ADD-H is high NAND gates U4B and U4C are enabled. U4B detects an output of 10 or 11 (1010 or 1011) at the output of U5. U4C detects an output of 12, 13, 14 or 15 at the output of U5. U16D detects a carry, C4 from U5. A low output from any of these NAND gates will drive the output of NAND gate U4A high. With U6 inputs B_2 and B_3 high, U6 will add 6 (0110) to the inputs from U5.

In the subtraction process, the subtrahend is 1's complemented, added to the minuend, and the sum is 1's complemented to get the difference. The binary sum is converted to BCD by adding 6

SERVICE SHEET 32 (Cont'd)

(0110) whenever a carry (borrow) is generated. The C_4 output is the carry from the fourth bit. Whenever there is a carry from $U5C_4$, U16D output goes low, U4A output goes high and U6 again adds 6 to the U5 output. Note that U4B and U4C are inhibited during the subtraction process because input ADD-H is low.

In the subtraction operation XOR-H and ADD-H are both low so the B and C inputs of U12 and U14 are also low. The Y outputs of U12 and U14 are the complements of the A inputs.

Following are a few examples of binary addition and subtraction which may be helpful to the technician who has had little experience in the techniques involved.

Add 75 + 38

```
BCD  5   0101
BCD  8   1000
         1101     > 9    (13)
         0110     + 6
         0011     = 3    + carry
BCD  7   0111
         0001            add carry
         1000     = 8
BCD  3   0011
         1011     > 9    (11)
         0110     + 6
         0001     = 1    + carry
= BCD 0001 0001 0011  =  DECIMAL 113
```

Add 456+82

```
BCD  6   0110
BCD  2   0010
         1000     = 8

BCD  5   0101
BCD  8   1000
         1101     > 9    (13)
         0110     + 6
         0011     = 3    + carry
BCD  4   0100            add carry
         0001
         0101     = 5
= BCD 0101 0011 1000  =  DECIMAL 538
```

SERVICE SHEET 32 (Cont'd)

The subtraction process is really an addition process with numbers which have been complemented, summed, manipulated and again complemented to convert the binary sum to BCD.

Subtract 86 from 275

```
BCD  5   0101               complement
         1010
BCD  6   0110
         0000               carry
         0110     + 6
         0110               complement
         1001     = 9
BCD  7   0111               complement
         1000
         0001               add carry (borrow)
         1001
BCD  8   1000
         0001               carry
         0110     + 6
         0111               complement
         1000     = 8
BCD  2   0010               complement
         1101
         0001               add carry (borrow)
         1110               complement
         0001     = 1
= BCD 0001 1000 1001 =      DECIMAL 189
```

Subtract 45 from 92

```
BCD  2   0010               complement
         1101
BCD  5   0101
         0010               carry
         0110     + 6
         1000               complement
         0111     = 7
BCD  9   1001               complement
         0110
         0001               add carry (borrow)
         0111
BCD  4   0100
         1011
         0100     = 4       complement
= BCD 0100 0111 = DECIMAL 47
```

SERVICE SHEET 32 (Cont'd)

Subtract 40 from 00036

BCD	6	0110		complement
		1001		
BCD	0	0000		
		1001		complement
		0110	= 6	
BCD	3	0011		complement
		1100		
BCD	4	0100		
		0000		carry
		0110	+ 6	
		0110		complement
		1001	= 9	
BCD	0	0000		complement
		1111		
		0001		add carry (borrow)
		0000		carry
		0110	+ 6	
		0110		complement
		1001	= 9	
BCD	0	0000		complement
		1111		
		0001		add carry (borrow)
		0000		carry
		0110	+ 6	
		0110		complement
		1001	= 9	
BCD	0	0000		complement
		1111		
		0001		add carry (borrow)
		0000		carry
		0110	+ 6	
		0110		complement
		1001	= 9	

= BCD 1001 1001 1001 1001 0110 =
DECIMAL 99996 + carry (borrow)

This subtraction result indicates a number less than zero. In the synthesizer it implies a negative frequency, which is impossible. In a following paragraph on ZER - FF, U19B, the impossibility is explained.

Shown in the lower right corner of the schematic are two D type flip/flops, U19A and U19B. These flip/flops provide two qualifier outputs, QB-H and ZER-H. The QB flip/flop also provides the carry bit storage during add and subtract operations. The U19A D input is connected to the C_4 (carry) outputs of both adders through OR gate U13D. If a clock pulse appears at a time when either carry is high, U19A Q will go high. The QB-H output may change state several times during an operation to store the carry bit. The QB-H output logic sense is important only for the last clock in the operation. The clock train may last for 10, 12 or 13 pulses depending on the operation being performed. When the D input to U19A is high at the time the last clock pulse is received, QB-H goes high. It will stay high until the reset input, RQB-L is generated.

Flip/flop U19B retains the information occasionally generated during subtraction, that the difference number is effectively less than zero (minus). The ZER-H output will go high if the U19B D input is high during the last clock. Following this event a sequence of additions take place until the sum is no longer minus, and input RZER-L will enable the reset of U19B.

The 13 clock pulse train is used in the sweep mode when the 1000 step sweep is selected. It is possible to set the sweep width wide enough to go below 0 Hz (minus frequency). When this happens the sweep increment is repeatedly added to the A register content until the A register is 0 or +.

As an example, assume that the center frequency is 1 MHz and a sweep width of 4 MHz is entered. The sweep range is arithmetically —1 MHz to +3 MHz. Since the sweep starts initially at the center frequency, the sweep output is accurate until the frequency reaches 3 MHz. Then, when the sweep step count is reset to zero, the arithmetic circuit is calling for an output frequency of —1 MHz. Since this is impossible, it is necessary to add, for the example quoted, 4.000 kHz to the A register content 250 times (250 X 4 kHz = 1 MHz), before there is an rf output and sweep is resumed. During the process of returning the A register content to zero or a + frequency, the sweep step clock is replaced with system clock to decrease dead time.

For the example quoted, 1 MHz center frequency, 4 MHz sweep width and 1000 step sweep the input from the A register is 13 digits long. The input from the sweep register is 10 digits long. The arithmetic process is as follows:

A register input to ALU	0001.000000000
Sweep input to ALU	0000004.000000
Next A register content	0001.004000000

It may be seen from the foregoing that the sweep width is effectively divided by 1000, for the example quoted, by adding a ten digit sweep width to an extended 13 digit A register number. Each step adds 4.000 kHz to the A register.

NOTE

See SS34 for details on the A register.

SERVICE SHEET 32 (Cont'd)

After the adding process the information in the ten digit portion of the A register is 1.004000 MHz. This information is then clocked back through the ALU, without change, and returned to the T bus and the output register for use in the mainframe RF circuits.

When it is desired to display the contents of the increment or sweep width register on the center frequency readout the data is passed through the ALU without change. This is accomplished by causing the XOR-H input to go high. When XOR-H is high, both the B and C inputs to U12 are high so the Y outputs are held low. UTT-H is high so the data is coupled thorugh NAND gates U20A, B, C and D to the T bus.

Manual tune operation. ROM #4, U9, provides the B inputs to ADDER U5 when a manual tune or offset operation has been initiated.

When a manual tune operation is initiated, multiplexer U8 I_S is high, so the I_1 inputs are selected. The Z outputs follow the I_1 inputs (note that I_{1A} is held high and I_{1D} is held low). NAND gates U3A and U16B control the I_{1B} and I_{1C} inputs to multiplexer U8. The inputs to NAND gates U3A and U16A are:

1. TRØ is a function of the power detect circuit and selects coarse resolution mode (1 MHz steps).
2. TR1 is the coarse resolution mode (1 MHz steps). When it is active the I_{1B} input to multiplexer U8 is high.
3. TR2 is the medium resolution mode (1 kHz steps). When it is active the I_{1C} input to multiplexer U8 is high.
4. TR3 is the fine resolution mode (1 Hz steps). When it is active, both the I_{1B} and I_{1C} inputs to multiplexer U8 are high.

When a manual entry is made NTS-L goes low and the output of NAND gate U16C goes high to enable counter U2. The high output of U16C is inverted by U1E to enable the ROM, U9.

SERVICE SHEET 32 (Cont'd)

at a time when either carry is high, U19A Q will go high. The QB-H output may change state several times during an operation to store the carry bit. The QB-H output logic sense is important only for the last clock in the operation. The clock train may last for 10, 12 or 13 pulses depending on the operation being performed. When the D input to U19A is high at the time the last clock pulse is received, QB-H goes high. It will stay high until the reset input, RQB-L is generated.

Flip/flop U19B retains the information occasionally generated during subtraction, that the difference number is effectively less than zero (minus). The ZER-H output will go high if the U19B D input is high during the last clock. Following this event a sequence of additions take place until the sum is no longer minus, and input RZER-L will enable the reset of U19B.

The 13 clock pulse train is used in the sweep mode when the 1000 step sweep is selected. It is possible to set the sweep width wide enough to go below 0 Hz (minus frequency). When this happens the sweep increment is repeatedly added to the A register content until the A register is 0 or +.

As an example, assume that the center frequency is 1 MHz and a sweep width of 4 MHz is entered. The sweep range is arithmetically −1 MHz to +3 MHz. Since the sweep starts initially at the center frequency, the sweep output is accurate until the frequency reaches 3 MHz. Then, when the sweep step count is reset to zero, the arithmetic circuit is calling for an output frequency of −1 MHz. Since this is impossible, it is necessary to add, for the example quoted, 4.000 kHz to the A register content 250 times (250 X 4 kHz = 1 MHz), before there is an rf output and sweep is resumed. During the process of returning the A register content to zero or a + frequency, the sweep step clock is replaced with system clock to decrease dead time.

For the example quoted, 1 MHz center frequency, 4 MHz sweep width and 1000 step sweep the input from the A register is 13 digits long. The input from the sweep register is 10 digits long. The arithmetic process is as follows:

A register input to ALU	0001.000000000
Sweep input to ALU	0000004.000000
Next A register content	0001.004000000

It may be seen from the foregoing that the sweep width is effectively divided by 1000, for the example quoted, by adding a ten digit sweep width to an extended 13 digit A register number. Each step adds 4.000 kHz to the A register.

NOTE

See SS34 for details on the A register.

P/O A1A6 Register Assy (Part 3)
SERVICE SHEET 31

SERVICE SHEET 32 (Cont'd)

After the adding process the information in the ten digit portion of the A register is 1.004000 MHz. This information is then clocked back through the ALU, without change, and returned to the T bus and the output register for use in the mainframe RF circuits.

When it is desired to display the contents of the increment or sweep width register on the center frequency readout the data is passed through the ALU without change. This is accomplished by causing the XOR-H input to go high. When XOR-H is high, both the B and C inputs to U12 are high so the Y outputs are held low. UTT-H is high so the data is coupled thorugh NAND gates U20A, B, C and D to the T bus.

Manual tune operation. ROM #4, U9, provides the B inputs to ADDER U5 when a manual tune or offset operation has been initiated.

When a manual tune operation is initiated, multiplexer U8 I_S is high, so the I_1 inputs are selected. The Z outputs follow the I_1 inputs (note that I_{1A} is held high and I_{1D} is held low). NAND gates U3A and U16B control the I_{1B} and I_{1C} inputs to multiplexer U8. The inputs to NAND gates U3A and U16A are:

1. TRØ is a function of the power detect circuit and selects coarse resolution mode (1 MHz steps).
2. TR1 is the coarse resolution mode (1 MHz steps). When it is active the I_{1B} input to multiplexer U8 is high.
3. TR2 is the medium resolution mode (1 kHz steps). When it is active the I_{1C} input to multiplexer U8 is high.
4. TR3 is the fine resolution mode (1 Hz steps). When it is active, both the I_{1B} and I_{1C} inputs to multiplexer U8 are high.

When a manual entry is made NTS-L goes low and the output of NAND gate U16C goes high to enable counter U2. The high output of U16C is inverted by U1E to enable the ROM, U9.

When ADDCK-H goes high it enables AND gate U7B which couples the clock to counter U2. The Z outputs of U8 and the Q outputs of U2 select sequentially, 10 ROM addresses as the counter is clocked from 0 to a count of 9. The data in the ROM ripples through NAND gates U11A, B, C and U3B to the B inputs of ADDER U5. Simultaneously, complimenter U12 applies the contents of the center frequency register to the A inputs of ADDER U5. The sum of the two inputs to U5 is then processed as previously described to provide a new center frequency incremented, or decremented, by the selected fine, medium or coarse step.

Offset is a special feature which allows the center frequency to be offset by fixed amount. This is accomplished when OTS-L is active. The select input to multiplexer U8 is low and the inputs labeled OPID 8-L, OPID 4-L, OPID 2-L and OPID 1-L are selected. The fixed code from these inputs address that part of the ROM where the offset number is stored. The Z outputs of U8 are applied to the most significant ROM address bits. When AND gate U7D pin 11 goes low, NAND gate U16C pin 8 goes high to enable counter U2. The high at U16C pin 8 is inverted by U1E to enable U9. When ADDCK-H is active the clock is coupled through AND gate U7B to the CP input of counter U2. The data stored in the 10 ROM addresses is then coupled through U11A, B, C and U3B to the B inputs of ADDER U5 as the counter is clocked from Ø to a count of 9. Simultaneously, complimenter U12 applies the contents of the center frequency register into the A inputs of ADDER U5. The sum of the two inputs is then processed as previously described to provide a frequency offset by a fixed amount.

NOTE

ROM #4 (U9) must be set up at the factory before offset can be used. The offset amount may be either plus or minus when referenced to the center frequency.

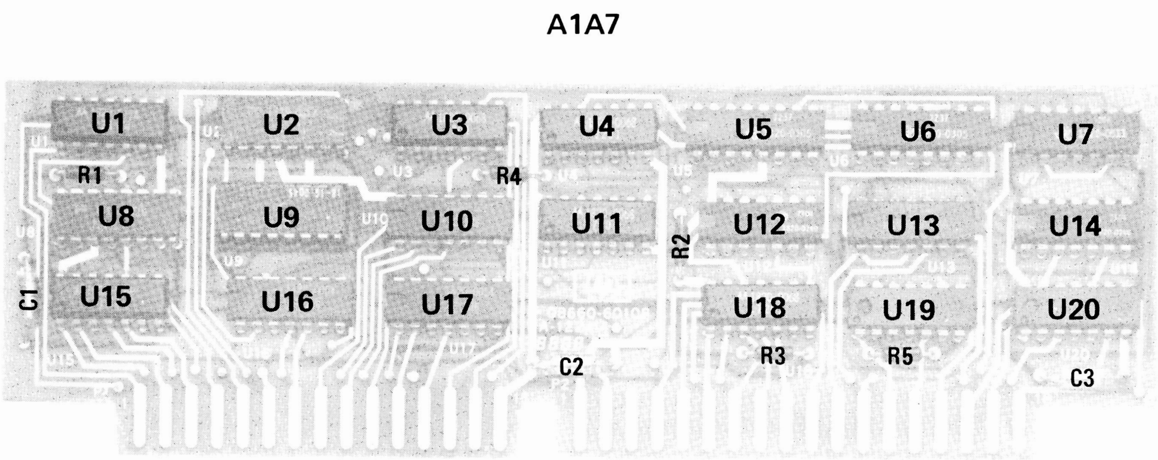


Figure 8-80. A1A7 Arithmetic Logic Unit Component Locations

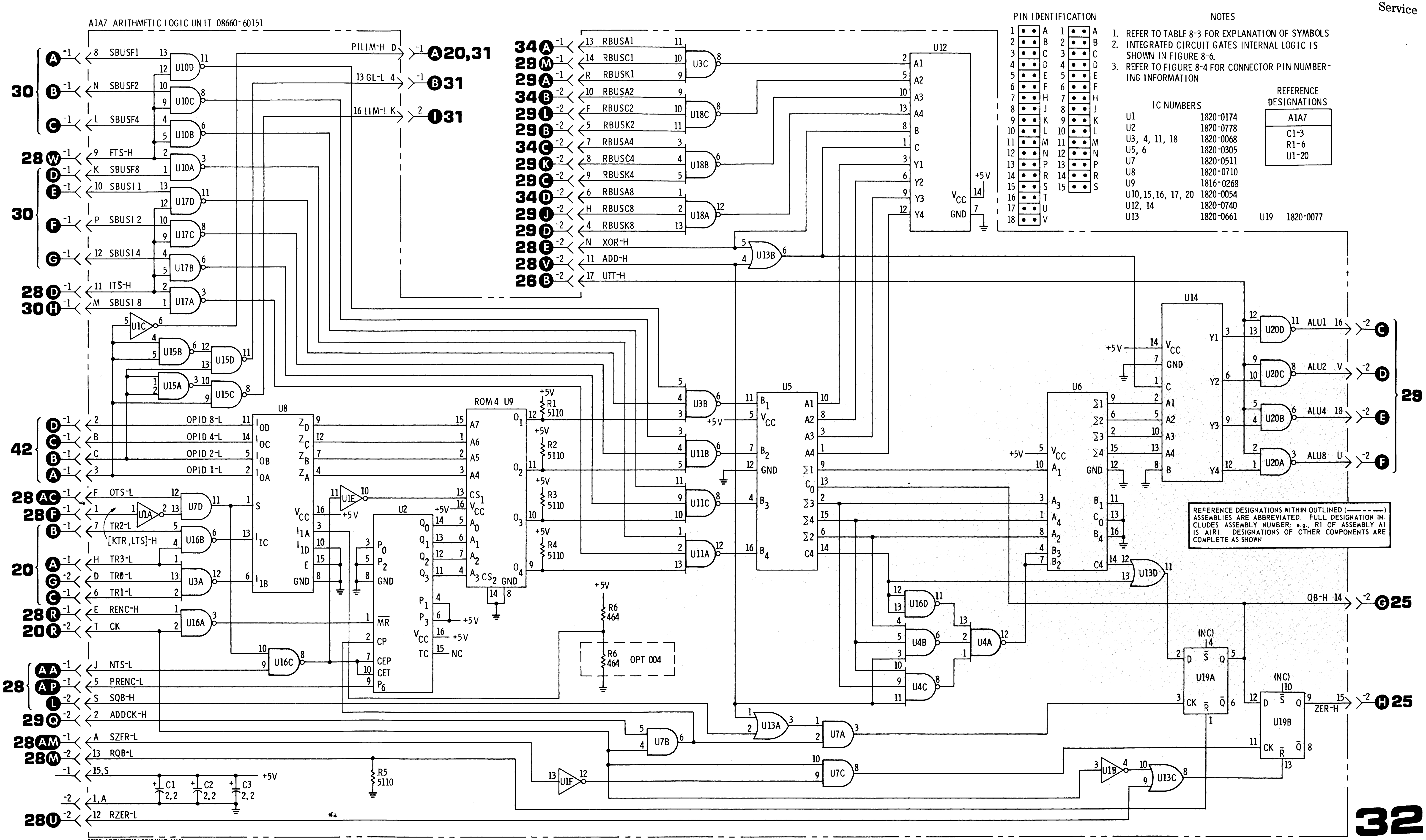


Figure 8-81. A1A7 Arithmetic Logic Unit

SERVICE SHEET 33

SWEEP COUNT ASSEMBLY A1A8

The sweep count assembly performs two major functions. It keeps trace of the number of sweep steps which have occurred and it also provides a D/A voltage output (0 to +8V) which is proportional to the sweep ramp.

The principle elements of the circuits are the presettable up/down counters U8, U10 and U5. The reason up/down counters are required is that in manual sweep mode the output frequency may be set up or down to any point within the sweep width range.

Note that the center frequency and the sweep frequency have no effect on the sweep count circuit. The counter tracks and counts the number of steps that have taken place on the sweep ramp. In the AUTO sweep and SINGLE sweep modes the count is always up. In the MANUAL sweep mode the count may be either up or down.

Since U8, U10 and U5 comprise a three digit counter, it is capable of reaching a count of 999. Essentially, the final count is 1000 because the input following 999 creates a carry at U5 pin 12 which causes flip/flop U3C/U3D to change state and cause QCTM-H (qualifier count maximum) to go high.

The count may be 1000 or 100. When the count is 1000 all three up/down counters are used. When the count is 100, U8 is bypassed.

When the count of 100 is selected Q100-H goes high to clear U8. U8 is held cleared as long as Q100-H is high. The Q100-H level enables NAND gates U2C and U2D. The Q100-H level is inverted by U13F and is used to inhibit NAND gates U2A and U2B which then enable NAND gates U3A and U3B. With the CDN output of NAND gate U6A connected to pin 13 of NAND gate U2D and the CUP output of NAND gate U6B connected to pin 10 of U2C, U8 is effectively bypassed and the terminal count will be 100.

The $\overline{\text{LD}}$ inputs to U8, U10 and U5 are preset inputs. When ILD-L (input load) goes low it is inverted by U7D to enable NAND gate U6C. The system clock then presets U8, U10 and U5. Since the A, B, C and D inputs of U8 and U10 are grounded, the outputs will be preset to zero.

Since the sweep operation starts initially at the center frequency, U5 must be preset to the center of its range, a 5. Note that the D_B and D_D inputs are grounded but the D_A and D_C inputs are high; the preset output of U5 is a 5 (0101).

When the selected sweep is 1000 steps the up/down counter is effectively preset to 500; it will take 500 CUP inputs for the count to reach maximum. All sweep ramps following the first will start at 000 and require 1000 steps to reach maximum.

When the selected sweep is 100 steps, U5 is preset to 5, U10 is preset to zero and U8 is bypassed.

The CUP and CDN inputs to U8 (or U10 when 100 step sweep is selected) are coupled through NAND gates U6A and U6B. Operation of the gates is essentially the same except that input CND-L must be inverted because its assertive state is low.

NOTE

The CDN-L and CUP-H inputs are in their assertive states for a period of 12 or 13 clock pulses. During this period the output of U6A or U6B is low. When the period ends the output of U6A or U6B goes high. This positive going excursion is the input to trigger U10 or U8.

At the bottom right of the schematic is the output QCTZ-H (qualifier count zero). This qualifier performs no useful function in the AUTO mode. In the manual sweep mode when manual sweep control is rotated CCW and the lower end of the sweep width range is reached, all of the outputs from U8, U10 and U5 are low and QCTZ goes high. Further rotation of the manual sweep control will not change the output frequency.

The digital-to-analog (D/A) output is a voltage proportional to the number of steps which have occurred during the sweep operation. U1 functions as a summing circuit; it sums the currents from 12 inverters and one transistor switch, Q1. It is important to note that the inverters are open collector inverters. When their inputs are high, the outputs are low and they provide a current which is proportional to their load resistors, to a common point. When the inverter inputs go low their outputs do not go high; they seek the voltage level at their common point. When QCTM-H (qualifier count maximum) goes high, Q1 is supplying all of the current to the summing circuit and the D/A output is +8V.

A8A8

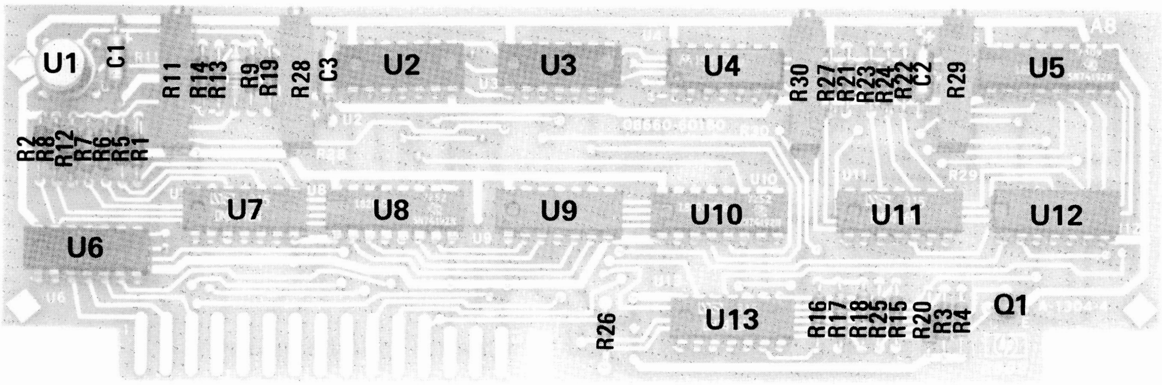
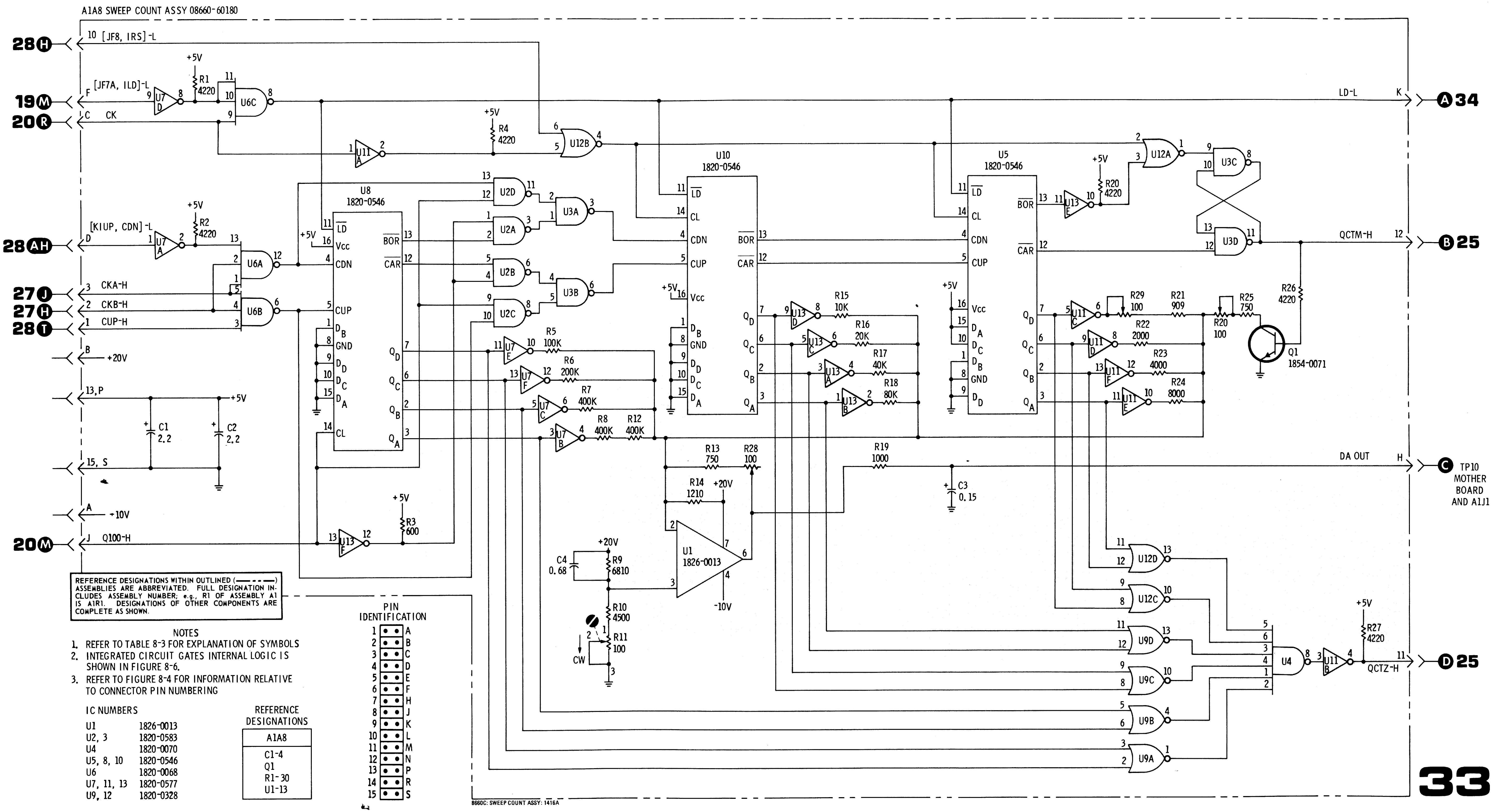


Figure 8-82. A1A8 Sweep Count Assy Component Locations



REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING

IC NUMBERS	
U1	1826-0013
U2, 3	1820-0583
U4	1820-0070
U5, 8, 10	1820-0546
U6	1820-0068
U7, 11, 13	1820-0577
U9, 12	1820-0328

REFERENCE DESIGNATIONS
A1A8
C1-4 Q1 R1-30 U1-13

PIN IDENTIFICATION

1	A
2	B
3	C
4	D
5	E
6	F
7	H
8	J
9	K
10	L
11	M
12	N
13	P
14	R
15	S

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Figure 8-83. A1A8 Sweep Count Assy

SERVICE SHEET 34

A REGISTER ASSEMBLY A1A9

The major difference between the A register and other registers in the instrument is that it may be 10, 12 or 13 digits long.

The 12 and 13 digit data is used in sweep operation. The 12 digit register is used when the sweep is to be 100 steps. The 13 digit register is used when the sweep is to be 1000 steps.

When the instrument is operated in the CW mode the final output to the mainframe through the ALU and the output register is from the ten-digit A register (U1, U2, U3 and U4). U1 and U2 are dual 8-bit shift registers. U3 and U4 are four-bit registers. U3 and U4 are four-bit registers. The ten-digit register is a recirculating shift register when not in the sweep mode. The information in the ten-digit register is clocked to the ALU when ATR-H goes high to enable NAND gates U11A, B, C and D.

When a sweep operation is initiated for 100 steps, the register is lengthened to 12 digits by use of four-bit registers U5 and U6. The 12-digit data is clocked to the ALU when A2TR-H goes high to enable NAND gates U12A, B, C and D.

When a sweep operation is initiated for 1000 steps, the register is lengthened to 13 digits by use of four-bit register U7. The 13 digit data is clocked to the ALU when A3TR-H goes high to enable NAND gates U13A, B, C and D.

When the 12 or 13 digit data is clocked into the ALU and manipulated, it is clocked back into the A register via the T bus. In the AUTO sweep mode the ALU normally adds one hundredth or one thousandth of the sweep width until QCTM-H goes high in the sweep count assembly.

NOTE

It may be necessary for the technician to review the text for the sweep count assembly and the ALU to understand this operation.

Two of the three inputs to AND gates U10A, B, C and U9B are always high. The outputs are controlled by the selected NAND gates which precede them.

The gates shown in the lower left corner of the schematic control the clock inputs to the registers.

The instruction TTA-L or ATR-H enable the clock gate, U9A. The period of instruction AREGCK-H, determines whether 10, 12 or 13 clock pulses will drive the combined registers. The instructions PDS-L inhibits clocking the three add-on registers U5, U6 and U7 at times during sweep when stored information is to be preserved.

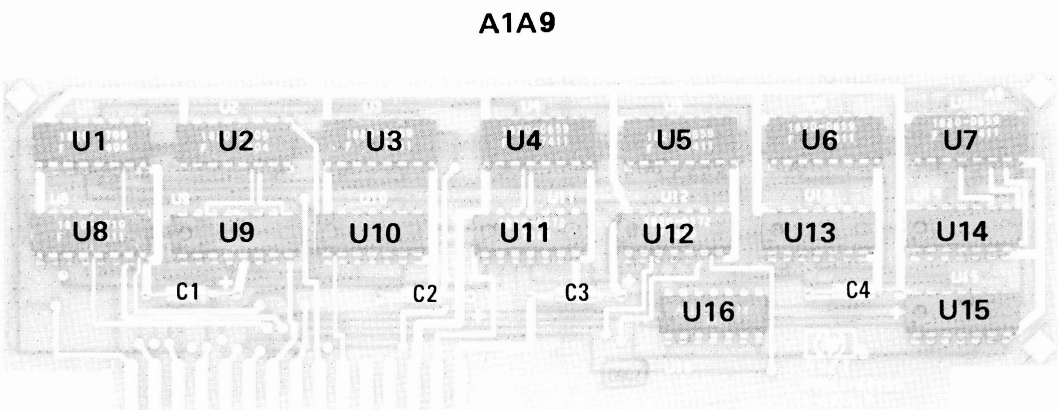

Figure 8-84. A1A9 A Register Assembly Component Locations

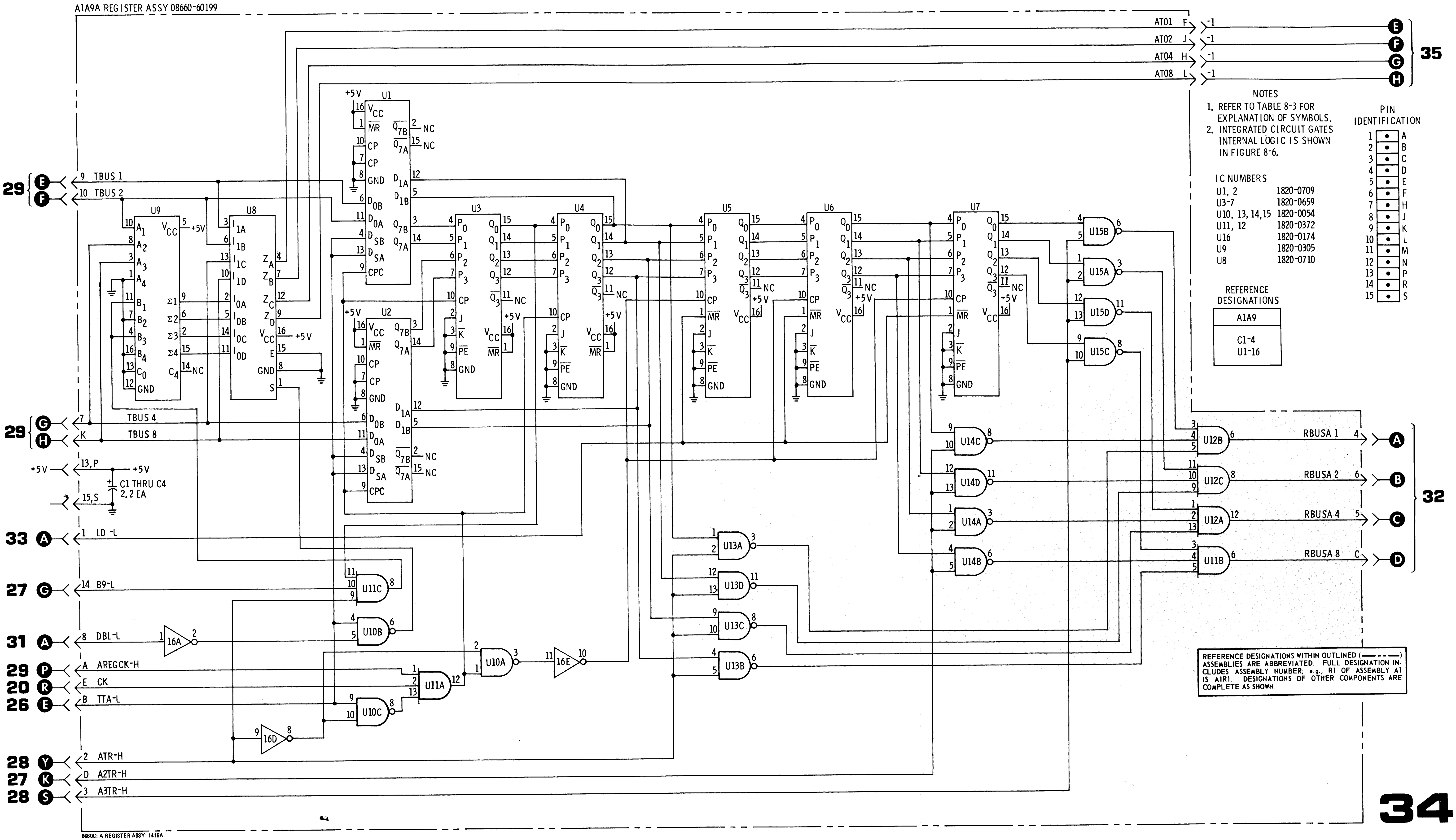

Figure 8-85. A1A9 A Register Assy

SERVICE SHEET 35

OUTPUT REGISTER ASSEMBLY A1A10

The output register assembly contains the final DCU register. From this register the data goes to the mainframe RF loops through the A9 Cable Loop Assembly or the A3 Interface Assembly.

U4 through U8 function to provide serial to parallel data storage. Each of them are dual four-bit latches. One of the characteristics of this type of latch is that the Q outputs follow the D inputs when the latch is enabled. These latches are not clocked directly by the system clock; they are enabled by a combination of the output of one-of-ten selector U1, the system clock and the PD-H input. This type of register is commonly termed a parallel dump register.

A parallel dump register has a distinct advantage over serial dump registers, in that only the BCD bits that require change, are changed. In serial dump registers, all of the RF phase lock loops lose lock each time the frequency is changed, even if the frequency change is as low as 1 Hz. The result of losing lock in all of the RF loops is longer switching time and temporary generation of many undesired frequencies. These problems are particularly troublesome in the sweep mode of operation.

Assume that the RF output has been 1.000000 MHz and is changed to 1.100000 MHz. The Q_{0A} output (binary 1 of digit 6) of U8 goes high and all other outputs remain unchanged.

U1, a one-of-ten selector, enables the gates in the dual four-bit latches sequentially. They are enabled at a point in time when the data of the T bus applies only to their output digit number (D1 through D10). All outputs are high except the one selected. The sequential BCD inputs on CNT 1, 2, 4 and 8 originates in a counter U17 on the A1A5 assembly (see Service Sheet 27).

All of the enable latch gates are connected to the output of NAND gate U3D. One of the inputs to U3D is PD-H which is high in the assertive state. The other input is derived from the system clock. This second input to U3D is delayed approximately 0.1 microsecond to ensure that the latches are not enabled while a change is taking place on the T bus.

A1A10

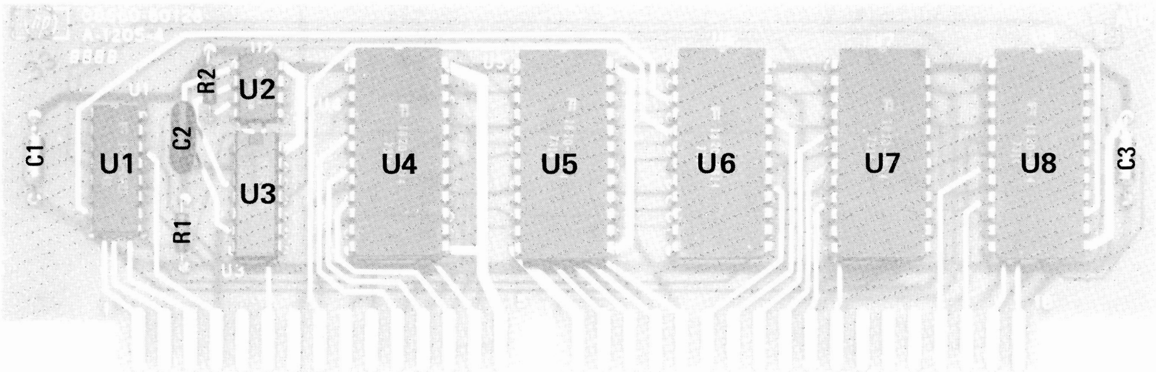

Figure 8-86. A1A10 Output Register Component Locations

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. INTEGRATED CIRCUIT GATES INTERNAL LOGIC IS SHOWN IN FIGURE 8-6.
3. REFER TO FIGURE 8-4 FOR INFORMATION RELATIVE TO CONNECTOR PIN NUMBERING.

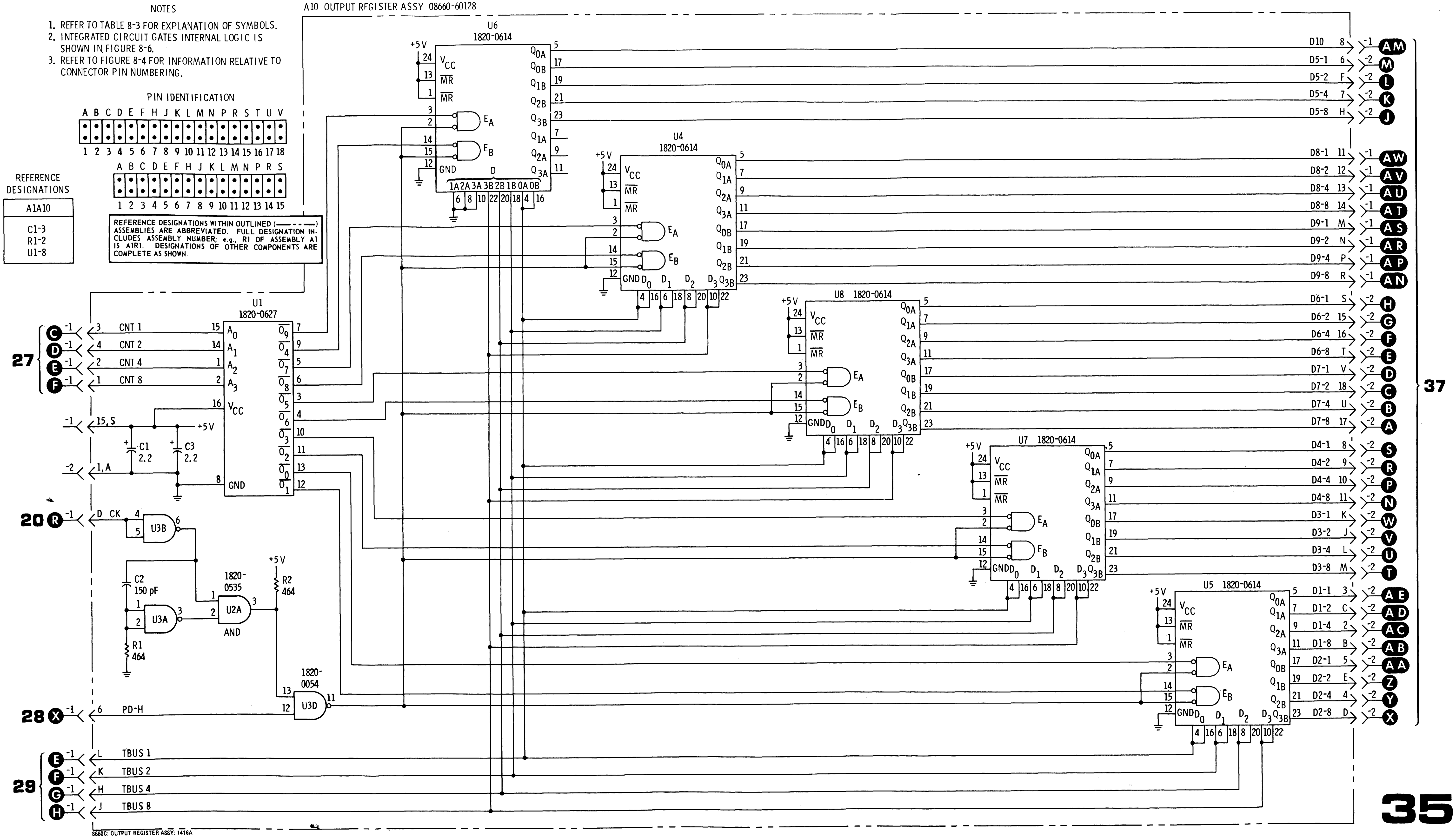

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Figure 8-87. A1A10 Output Register Assy

SERVICE SHEET 36

NUMERIC READOUT ASSEMBLY A1A2

The numeric readout assembly consists of two readout units, U3 and U4, and the circuits required to drive them. U4 displays the least significant digits, 1 through 6. U3 displays the 4 most significant digits, 7, 8, 9 and 10. The most significant digit, digit 10, is always a 1, 2 or 0. U3 is also a six-digit display, but only the four least significant digits are displayed.

The readout display creates the illusion that the LEDs (light emitting diodes) are lit continuously. They are actually scanned at a 10 kHz rate and therefore each half digit is illuminated for 100 microseconds for each scan cycle.

Referring to Figure 8-88 it may be seen that each digit is made up of 20 LEDs that are divided into two 10 LED half digits. During the scanning cycle the half digits are scanned, first right half, then left half. The LEDs require approximately 50 milliamperes each so the transistor drivers are heavy duty types capable of delivering about 400 milliamperes each.

Referring back to the schematic it is readily seen that one-of-twelve selector U5, the transistor drivers and ROMs U1 and U2 jointly control the readout.

It is important to understand the relationship of the ROCK (10 kHz), RSCAN-H and ROM (read only memory) inputs.

The 10 kHz ROCK input clocks U5 only during the time that RSCAN-H is low, i.e., when not in reset. RSCAN-H stays low for the period of six clock pulses at a 5 kHz rate. The 5 kHz clock drives the ten-digit register on the A1A3 assembly, Service Sheet 24, during the period of time that the readout is being displayed. The BCD inputs to ROMs A and B are BCD data which is clocked in at a 5 kHz rate.

It may be seen from the foregoing that U5 provides two outputs to the transistor drivers for each BCD input to the ROMs. U5 also provides an R/L (right/left) output which is used as the fifth address bit to the ROMs. This R/L output determines, in conjunction with the other ROM inputs, which LEDs of the half digit being displayed are illuminated.

As the scanning cycle starts U5 output OR (output 0, right half) turns on Q20 and Q8 to apply about +4 volts to the right hand half of digits 1 and 7. Simultaneously the R/L output of U5 provides the fifth address bit to ROMs A and B. ROMs A and B then provide ground returns for the LEDs which are to be illuminated in the right half of digits 1 and 7. When U5 output OL goes high Q19 and Q7 drive the left half of digits 1 and 7. The R/L output of U5 again provides the fifth address bit to ROMs A and B which then provide the ground returns to light the appropriate LEDs in the left half of digits 1 and 7. Next, digits 2 and 8, then digits 3 and 9, then digits 4 and 10, and finally digits 5 and 6 are scanned in order.

It can be seen that the scanning cycle has effectively scanned 10 digits with 12 inputs clocks at a 10 kHz rate. At this point in time RSCAN-H goes high to reset U5.

SERVICE SHEET 36 (Cont'd)

In the A1A3 assembly the ten digit recirculating register contains a sync register. At the end of the readout scan cycle, four more clock pulses are required to re-position the data in the register before the data can again be used in the readout scanning cycle. During the readout scanning cycle the recirculating register is clocked at a 5 kHz rate. If this rate were continued, it would be 800 microseconds before the next readout scanning could start. However, a detect circuit driven from the sync register detects the sync code at the sixth 5 kHz clock and switches to the system clock of 1 MHz for the next four clock pulses. Using this system assures that there are only four microseconds between readout scan cycles. See Service Sheet 24 for expanded details of this operation.

All controls for the numeric readout, except for the 10 kHz ROCK, originate in the A1A3 Readout Control Assembly.

The assembly also has the drive circuits for the four incandescent lamps, which display GHz, MHz, kHz and Hz units.

The pushbuttons select SWP WIDTH, STEP and KYBD readout instructions for the A1A1 Switch Control Assembly.

A1A10 Output Register Assy
SERVICE SHEET 35

SERVICE SHEET 36 (Cont'd)

In the A1A3 assembly the ten digit recirculating register contains a sync register. At the end of the readout scan cycle, four more clock pulses are required to re-position the data in the register before the data can again be used in the readout scanning cycle. During the readout scanning cycle the recirculating register is clocked at a 5 kHz rate. If this rate were continued, it would be 800 microseconds before the next readout scanning could start. However, a detect circuit driven from the sync register detects the sync code at the sixth 5 kHz clock and switches to the system clock of 1 MHz for the next four clock pulses. Using this system assures that there are only four microseconds between readout scan cycles. See Service Sheet 24 for expanded details of this operation.

All controls for the numeric readout, except for the 10 kHz ROCK, originate in the A1A3 Readout Control Assembly.

The assembly also has the drive circuits for the four incandescent lamps, which display GHz, MHz, kHz and Hz units.

The pushbuttons select SWP WIDTH, STEP and KYBD readout instructions for the A1A1 Switch Control Assembly.

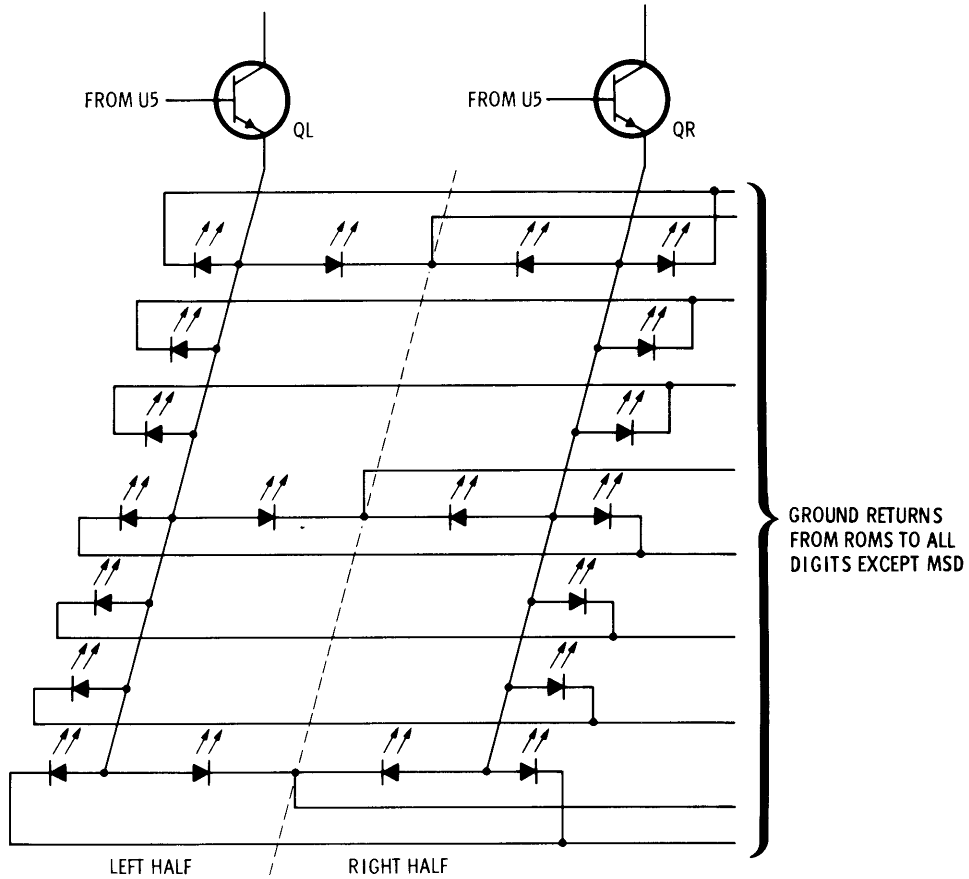


Figure 8-88. Readout Digit Schematic

A1A10 Output Register Assy
SERVICE SHEET 35

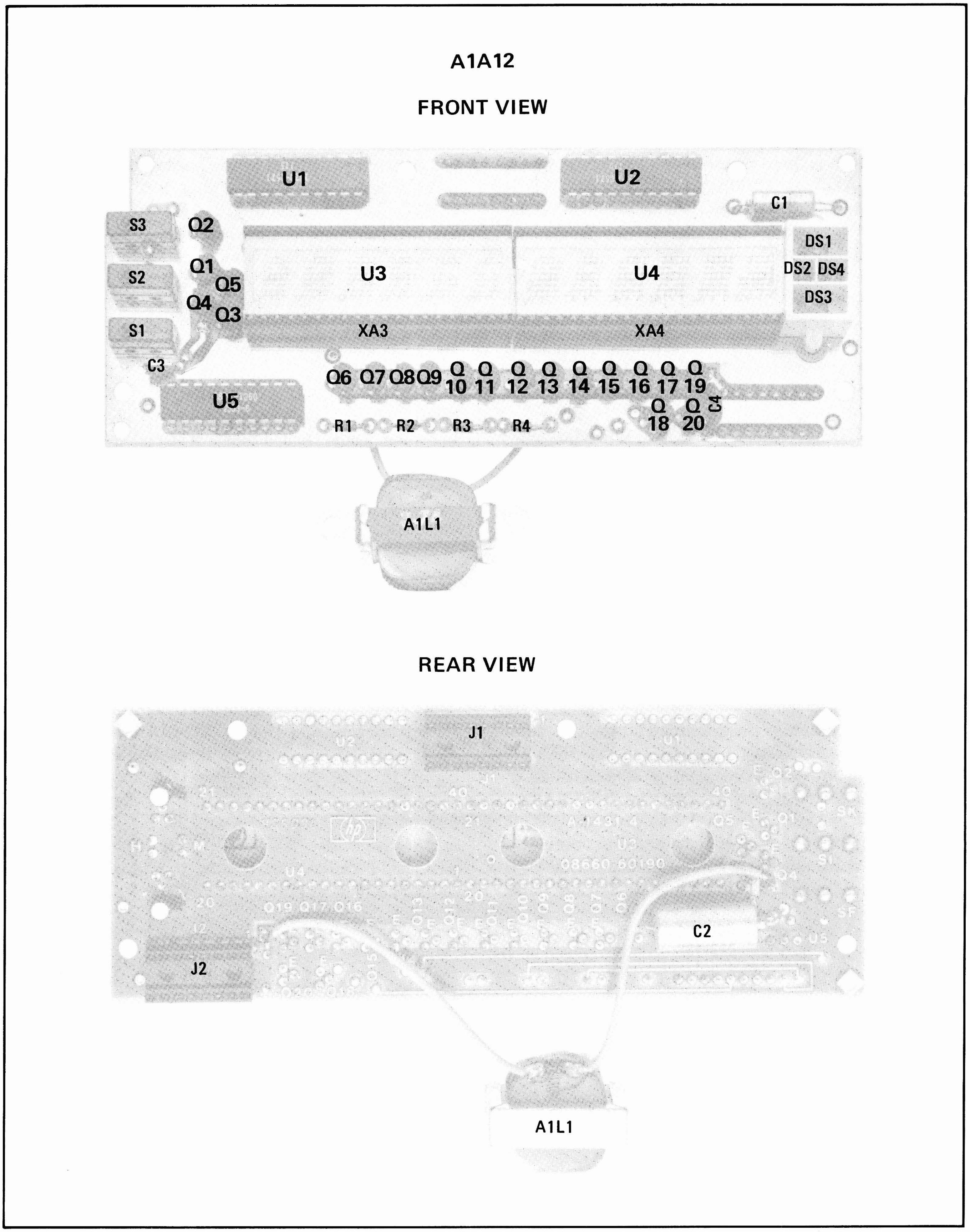


Figure 8-89. A1A12 Numeric Readout Assembly Component Locations

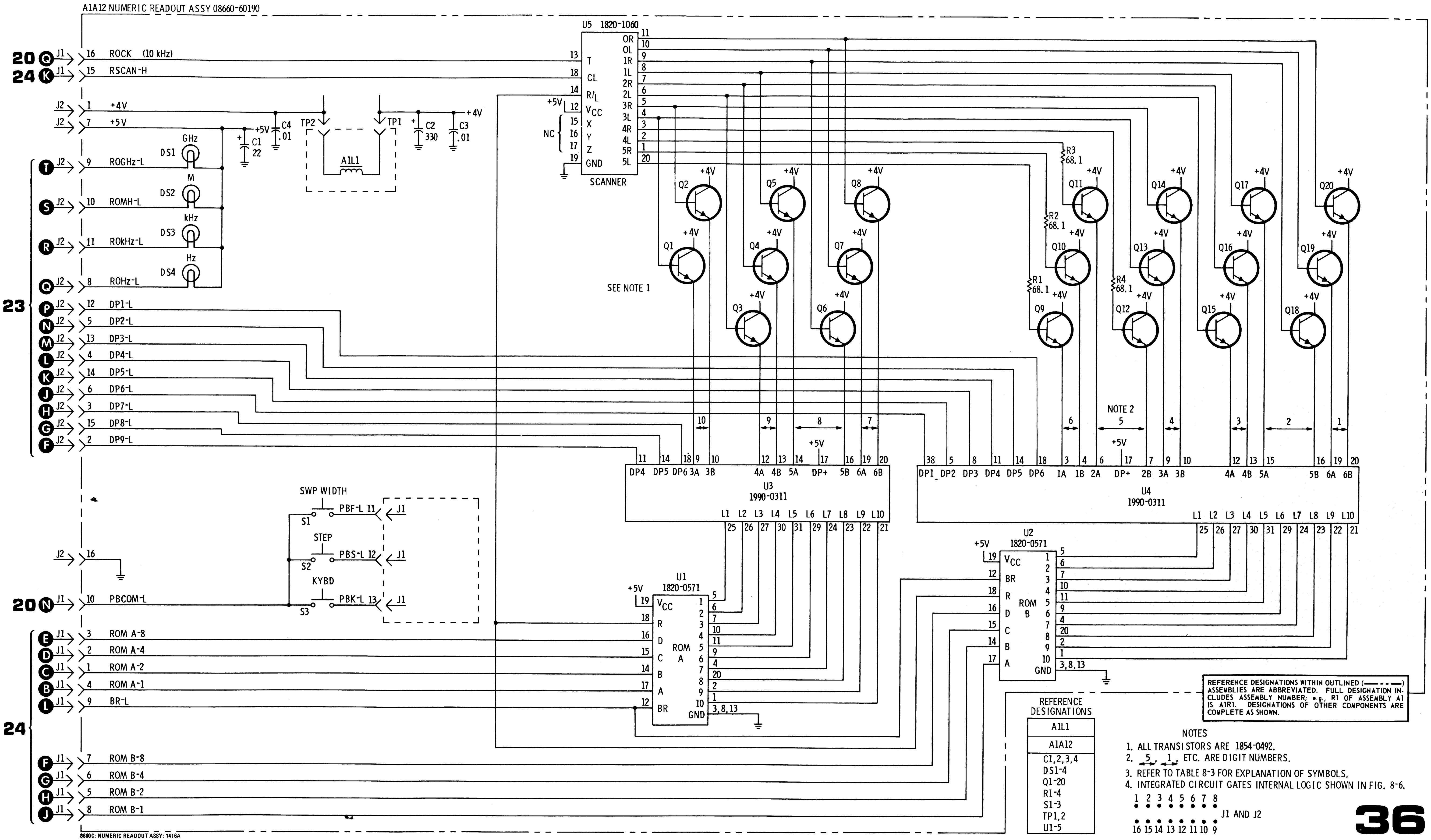


Figure 8-90. A1A12 Numeric Readout Assy

SERVICE SHEET 37

FRONT INTERFACE CIRCUIT BOARD

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

When the defect has been traced to the front interface board, access to the component side of the circuit board may be improved by removing the four screws which hold the digital control unit in place and sliding it forward to the extent of the interconnecting cables.

TEST EQUIPMENT REQUIRED (See Table 1-3)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter

GENERAL

The major purpose of the interface circuits is to assure compatability between the digital control unit, the phase lock loops, the plug-in sections and the programming information from the remote programming device (via J3).

FRONT INTERFACE CIRCUIT - REMOTE MODE

DATA INPUT

The multiplexer, U9 and U10, converts the eight-line two-digit parallel BCD input to four-line serial information. The serial BCD data is stored in the temporary storage register in the digital control unit.

When a command pulse is received at A3XA1 pin 1 it is inverted by U1F and applied to the "D" input of flip/flop U2A. Pin 1 of U2A is held high by the inverted low AUTO-MAN input at A3XA1 pin B so U2A is enabled. (A low at U2A pin 1 would hold the Q output high regardless of other inputs).

The 2 MHz clock, which is always present is inverted and applied to the clock input of U2A. Since the inverted command pulse is high the first clock pulse to U2A will cause the Q output to go high. The Q output enables the upper AND gates in U10A, U10B, U9A and U9B. The outputs of the multiplexer follow the selected inputs (in this case, digit 1). Several other circuits function simultaneously with this change of state to determine where and how the input will be used.

If the BCD inputs are data (BCD 0 - 9), the output of NAND gate U3A is high because at least one of the inputs is low. U1D inverts the output of U3A to inhibit U4D which is the permanent command gate. The high output of U3A enables U4C which is the temporary command gate.

When U2A $\overline{Q}$ output goes low with the clock pulse it presets U2B; U2B Q goes high and $\overline{Q}$ goes low. The low at U2B $\overline{Q}$ resets the one-shot (U1A and U1B) on the rear interface board to end the command pulse. This assures that the command pulse will end and the "D" input to U2A will go low before the next clock pulse appears.

SERVICE SHEET 37 (Cont'd)

When U2B Q goes high it enables NAND gate U4A. NAND gate U4A provides a negative-going clock pulse to NOR gate U6A which provides, in turn, a positive pulse to NAND gate U4C. Since NAND gate U4C pin 9 is held high by the output of NAND gate U3A, the output of NAND gate U4C clocks the digit 1 BCD information into the temporary storage register.

When the next clock pulse appears the "D" input to U2A is low. The Q output goes low and the $\overline{Q}$ output goes high. The lower AND gates in U10A, U10B, U9A and U9B are now enabled and the upper AND gates are inhibited. The multiplexer outputs are the same as the digit 2 inputs.

When U2A Q goes low the output of NOR gate U6B goes high to enable NAND gate U4B. Since the Q output of U2B is still high when the second clock pulse appears this clock is coupled through U4A, U6A and U4C to clock digit 2 into the temporary storage unit in the digital control unit.

Since NAND gate U4B pin 5 is now held high by NOR gate U6B the clock pulse at U4B pin 4 causes the output of U4B to go low and clear flip/flop U2B. When U2B is cleared the Q output goes low to inhibit U4A, the $\overline{Q}$ output goes high to enable the command one-shot on the rear interface board, and the circuit is quiescent until the next command pulse is received.

ADDRESS INPUT

When all four digit 1 lines are high (BCD 15), NAND gate U3A output is low. This low level inhibits the temporary command gate U4C; through inverter U1D it also enables the permanent (transfer) command gate U4D. When the input command pulse appears (U2A "D" input goes low), the first clock pulse will cause U2A Q to go high and $\overline{Q}$ to go low. The high Q output causes the output of NAND gate U4D to go low.

The digit 2 inputs have been simultaneously applied to BCD to decimal decoder U5. When the digit 2 address is 0000 (center frequency) pin 1 of U5 goes low to address the information stored in the temporary storage register to the center frequency register.

The outputs from U5 pins 2 and 3 are not used in the Model 8660A.

When the digit 2 address data causes U5 to produce a low to the input of one of the NOR gates connected to the U5 outputs, a train of ten clock pulses transfer the data stored in the temporary storage register to the selected final register.

The outputs from the multiplexer are not used during the address function.

Operation of U2B is the same during the address function as it is during the data function.

When the next clock pulse appears the state of U2A and U2B will change and the circuit is quiescent until the next command pulse appears.

SERVICE SHEET 37 (Cont'd)

POWER DETECT CIRCUIT

Q3 and U7D comprise a power detect circuit. The pin 11 input to NOR gate U7D is low unless the reset input to Q4 is grounded. When the +5V power supply is below about +4.75 volts Q3 is turned off, the pin 12 input to NOR gate U7D is high, and the output from U7D is low. When the PWR DET output is low the center frequency register and the modulation register are cleared. This prevents incorrect programming when the instrument is first turned on before the power supplies have stabilized. When a ground is applied to the remote reset line Q4 is turned off, pin 11 of NOR gate U7D goes high and the U7D output goes low. The result is the same as when the +5V power supply is low.

FLAG CIRCUIT

The flag circuit provides a busy signal to the remote programming device. Whenever any one or more of the inputs to U3B are low the output is high. This output is inverted on the rear interface board and applied to rear panel connector J3 pin 17.

There are several factors which determine the duration of the flag signal.

When data is being programmed into the temporary storage register in the digital control unit the duration of the flag signal is a maximum of about 1.5 microseconds. It starts when the command pulse causes U3B pin 12 to go low. U2B $\overline{Q}$ almost immediately goes low to end the command pulse. The command line now goes high, but U2B $\overline{Q}$ is now holding U3B pin 13 low so the flag pulse

A1A12 Numeric Readout Assy
◀SERVICE SHEET 36

SERVICE SHEET 37 (Cont'd)

When U2B Q goes high it enables NAND gate U4A. NAND gate U4A provides a negative-going clock pulse to NOR gate U6A which provides, in turn, a positive pulse to NAND gate U4C. Since NAND gate U4C pin 9 is held high by the output of NAND gate U3A, the output of NAND gate U4C clocks the digit 1 BCD information into the temporary storage register.

When the next clock pulse appears the "D" input to U2A is low. The Q output goes low and the $\overline{Q}$ output goes high. The lower AND gates in U10A, U10B, U9A and U9B are now enabled and the upper AND gates are inhibited. The multiplexer outputs are the same as the digit 2 inputs.

When U2A Q goes low the output of NOR gate U6B goes high to enable NAND gate U4B. Since the Q output of U2B is still high when the second clock pulse appears this clock is coupled through U4A, U6A and U4C to clock digit 2 into the temporary storage unit in the digital control unit.

Since NAND gate U4B pin 5 is now held high by NOR gate U6B the clock pulse at U4B pin 4 causes the output of U4B to go low and clear flip/flop U2B. When U2B is cleared the Q output goes low to inhibit U4A, the $\overline{Q}$ output goes high to enable the command one-shot on the rear interface board, and the circuit is quiescent until the next command pulse is received.

ADDRESS INPUT

When all four digit 1 lines are high (BCD 15), NAND gate U3A output is low. This low level inhibits the temporary command gate U4C; through inverter U1D it also enables the permanent (transfer) command gate U4D. When the input command pulse appears (U2A "D" input goes low), the first clock pulse will cause U2A Q to go high and $\overline{Q}$ to go low. The high Q output causes the output of NAND gate U4D to go low.

The digit 2 inputs have been simultaneously applied to BCD to decimal decoder U5. When the digit 2 address is 0000 (center frequency) pin 1 of U5 goes low to address the information stored in the temporary storage register to the center frequency register.

The outputs from U5 pins 2 and 3 are not used in the Model 8660A.

When the digit 2 address data causes U5 to produce a low to the input of one of the NOR gates connected to the U5 outputs, a train of ten clock pulses transfer the data stored in the temporary storage register to the selected final register.

The outputs from the multiplexer are not used during the address function.

Operation of U2B is the same during the address function as it is during the data function.

When the next clock pulse appears the state of U2A and U2B will change and the circuit is quiescent until the next command pulse appears.

A1A12 Numeric Readout Assy
◀SERVICE SHEET 36

SERVICE SHEET 37 (Cont'd)

POWER DETECT CIRCUIT

Q3 and U7D comprise a power detect circuit. The pin 11 input to NOR gate U7D is low unless the reset input to Q4 is grounded. When the +5V power supply is below about +4.75 volts Q3 is turned off, the pin 12 input to NOR gate U7D is high, and the output from U7D is low. When the PWR DET output is low the center frequency register and the modulation register are cleared. This prevents incorrect programming when the instrument is first turned on before the power supplies have stabilized. When a ground is applied to the remote reset line Q4 is turned off, pin 11 of NOR gate U7D goes high and the U7D output goes low. The result is the same as when the +5V power supply is low.

FLAG CIRCUIT

The flag circuit provides a busy signal to the remote programming device. Whenever any one or more of the inputs to U3B are low the output is high. This output is inverted on the rear interface board and applied to rear panel connector J3 pin 17.

There are several factors which determine the duration of the flag signal.

When data is being programmed into the temporary storage register in the digital control unit the duration of the flag signal is a maximum of about 1.5 microseconds. It starts when the command pulse causes U3B pin 12 to go low. U2B $\overline{Q}$ almost immediately goes low to end the command pulse. The command line now goes high, but U2B $\overline{Q}$ is now holding U3B pin 13 low so the flag pulse continues. When the second clock pulse causes U2B to be cleared, U2B $\overline{Q}$ goes high and the flag pulse is ended. One/shot U8 cannot be triggered because the high output of U3A is inverted and applied to pins 3 and 4 of U8.

When the plug-in programmable attenuator in the RF Section plug-in is being addressed one-shot U8 is triggered when U2B $\overline{Q}$ goes low on the second clock pulse (U8 pins 3 and 4 are now held high by the inverted low at U3A pin 6). One-shot U8 pin 6 goes low and the flag signal is extended to about 50 milliseconds. The low output from U5 pin 4 turns off Q2 and the Q2 high output turns off Q1. The time constant of one-shot U8 is determined by R10, C5 and C6.

When any address other than the programmable attenuator is programmed, one-shot U8 extends the flag signal to about 3 or 4 milliseconds. Operation of the circuit is the same as when the attenuator is addressed except that Q1 and Q2 are on and the time constant of the one-shot is determined by R9 and C6.

When the FM modulator is being calibrated a 5 second pulse appears at A3XA3 pin 15 which is applied to U3B pin 9 to produce an output pulse that is 5 seconds in duration.

LOCAL MODE

In the local mode the AUTO-MAN input is high. Inverter U1C inverts this level to hold the clear input to U2A low and the Q output high. This inhibits all of the circuits on the front interface board except U1C, U1A and U1B. U1A and U1B again invert the AUTO-MAN input to provide a LCL-RMT fan-out of ten to the plug-ins and the digital control unit.

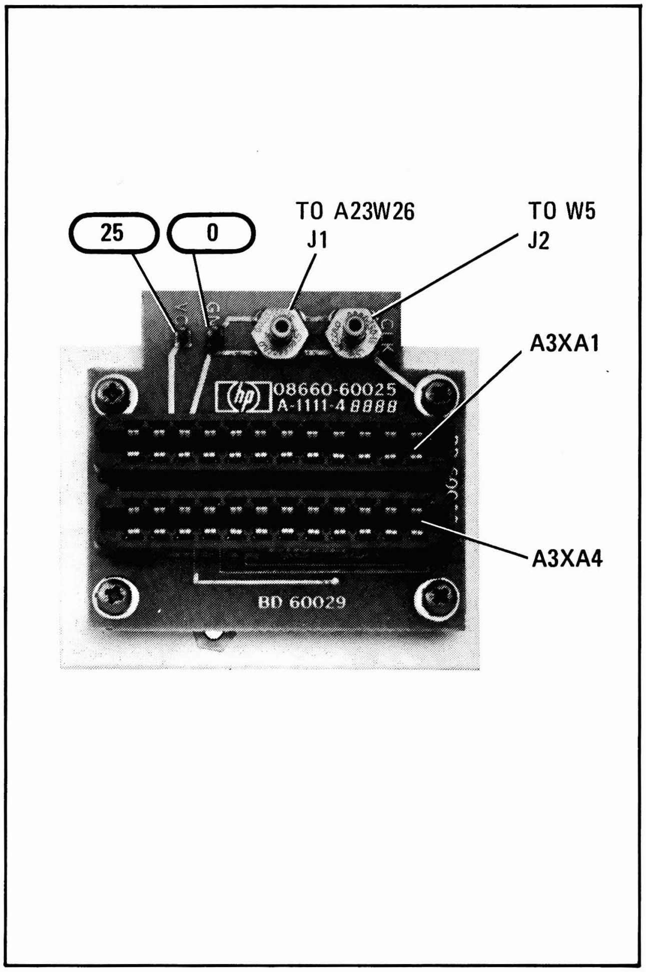


Figure 8-91. Interface Mother Board

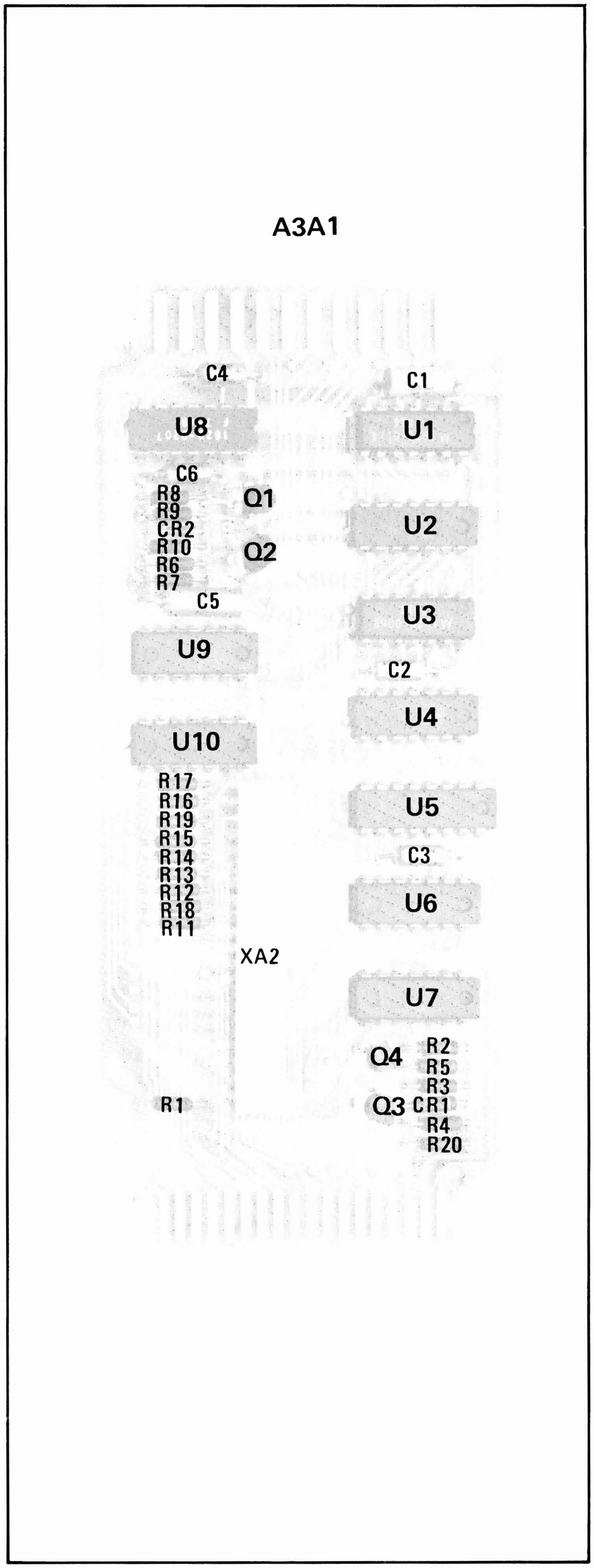


Figure 8-92. A3A1 Front Interface Board Component Locations

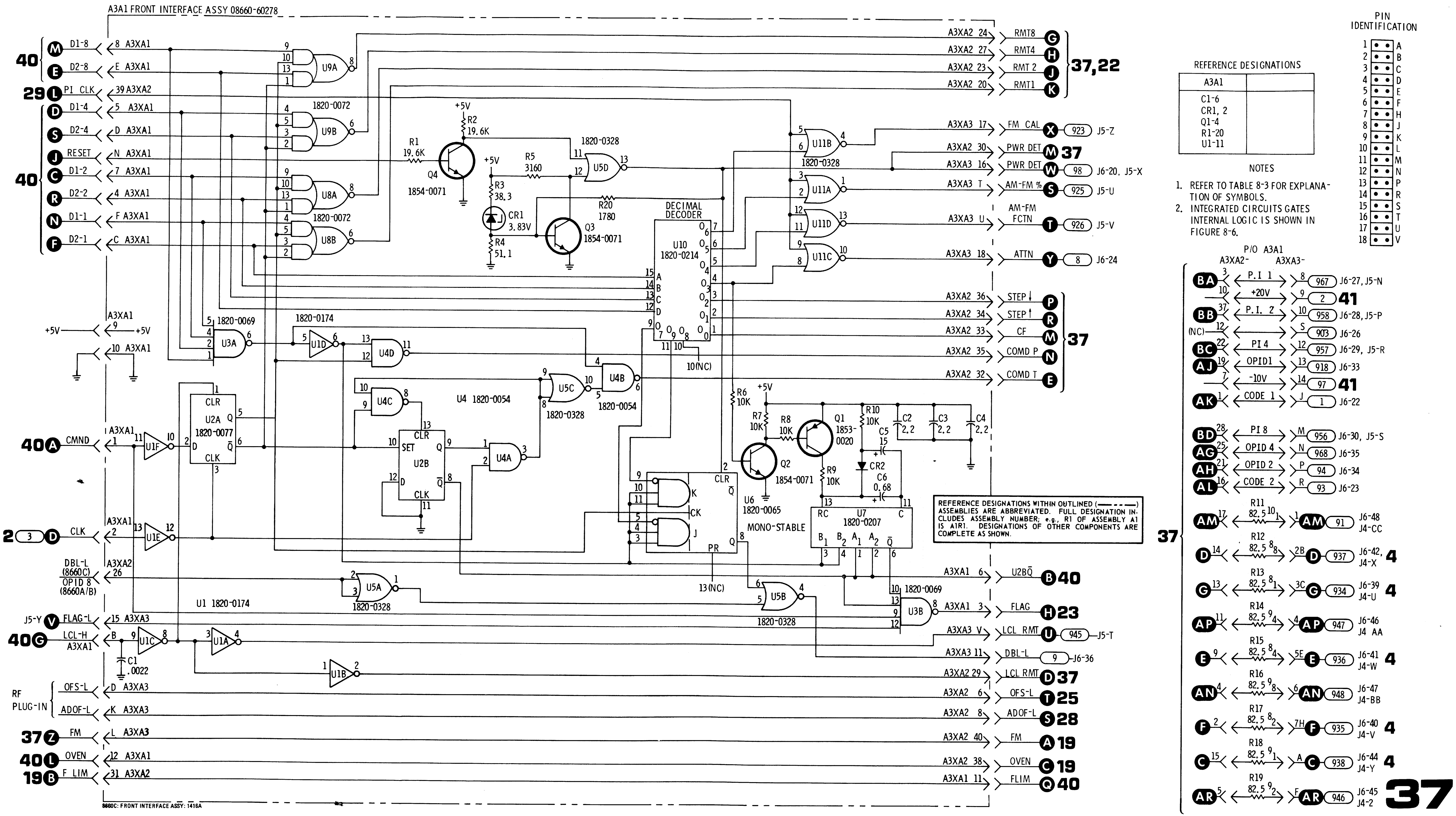


Figure 8-93. A3A1 Front Interface Board Schematic

SERVICE SHEET 38

REAR INTERFACE CIRCUIT BOARD

Normally, causes of malfunctions in the Model 8660C will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting trees.

When trouble has been traced to the rear interface circuit board it will be necessary to swing the A4 assembly out of the frame to provide access to the wiring side of the circuit board.

TEST EQUIPMENT REQUIRED (See Table 1-2)

Oscilloscope (with 10:1 divider probes)
Digital Voltmeter

GENERAL

The major purpose of the interface circuits is to assure compatability between the digital control unit, the phase lock loops, the plug-in sections and the programming information from the remote programming device (via J3).

REAR INTERFACE CIRCUIT

The BCD inputs from the remote input (J3) are applied to the "D" inputs of two quad latch flip/flops (U2 and U4). When a negative-going command pulse appears at the input to U3A the outputs of U1D and U1C clock U2 and U4.

Since the $\overline{Q}$ outputs of U2 and U4 provide the front interface drive signals the negative-true input BCD data (low = 1, high = 0) is inverted. This data is stored in U2 and U4 until the next command pulse.

NAND gates U1A and U1B comprise a one-shot with a maximum time constant of 0.75 microsecond. Normally NAND gate U1B pin 6 is high because R21 is holding pin 4 of U1B low and pin 1 of NAND gate U1A is held high by the command line. Pin 5 of NAND gate U1B is normally held high by the $\overline{Q}$ output of the flip/flop U2B on the front interface board. When a negative-going command pulse appears the output of NAND gate U1A at pin 3 goes high and is coupled through C4 to cause the output (pin 6) of NAND gate U1B to go low. The time constant of C4/R21 limits the negative-going pulse to a maximum duration of 0.75 microseconds to allow adequate time for a flip/flop in the front interface circuit to be clocked once by the 2 MHz clock (0.5 microsecond time base). To assure that two or more clock pulses do not appear in the front interface circuit while the command pulse is present, the inputs to NAND gate U1B pin 5 is caused to go low (output, pin 6 goes high) when the first clock pulse is received in the front interface circuit.

Q1, Q2 and NAND gate U3D comprise an error detect circuit. The input to NAND gate U3D pin 12 is from the reference oscillator (A21) assembly. When the oven temperature has not stabilized this level will be low. When either input to U3D is low the output will be high, Q1 will be turned on, and an error signal (low) will be applied to J3 pin 3 to inform the remote

SERVICE SHEET 38 (Cont'd)

programming device that the Model 8660C is not ready to receive data. The input to pin 12 of NAND gate U3D is also applied to the digital control unit to light a lamp on the annunciator block when the oven temperature has not stabilized.

The input to pin 13 of U3D is from one of two sources. The F LIM input from A3XA4 pin 11 originates in the digital control unit center frequency circuit and is a low when the selected output frequency is not within the range of the RF Section in use. The second input to control NAND gate U3D pin 13 is the "GHz" input at A3XA5 pin D. This input is a high when selected frequency is not within the range of the 1.3 GHz RF Section or the internal Frequency Extension Module. A high input to the base of Q2 will cause Q2 to turn on the output of NAND gate U3D will again go high to turn on Q1.

NAND gate U3C inverts the FLAG signal, which is generated in the front interface circuit, and applies it to J3 pin 17 as a busy signal to the remote programming device.

R25 and R29 hold the AUTO line (A3XA5 pin 5) high when the instrument is operated in the local mode. When J3 pin 5 is grounded by the remote programming device, this line goes low and the instrument is in the remote mode.

R26 and R30 hold the RESET line (A3XA5 pin J) high when no error is present in the remote programming device. When an error is present J3 pin 24 goes low and causes the PWR DET circuit on the front interface board to clear the center frequency storage register and shut off the modulation.

A3A1 Front Interface Board
SERVICE SHEET 37

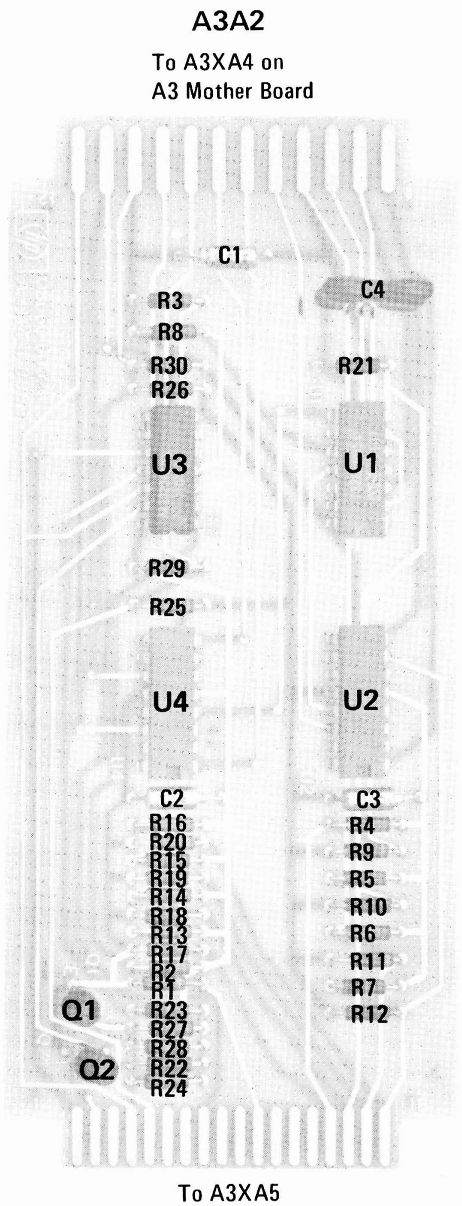
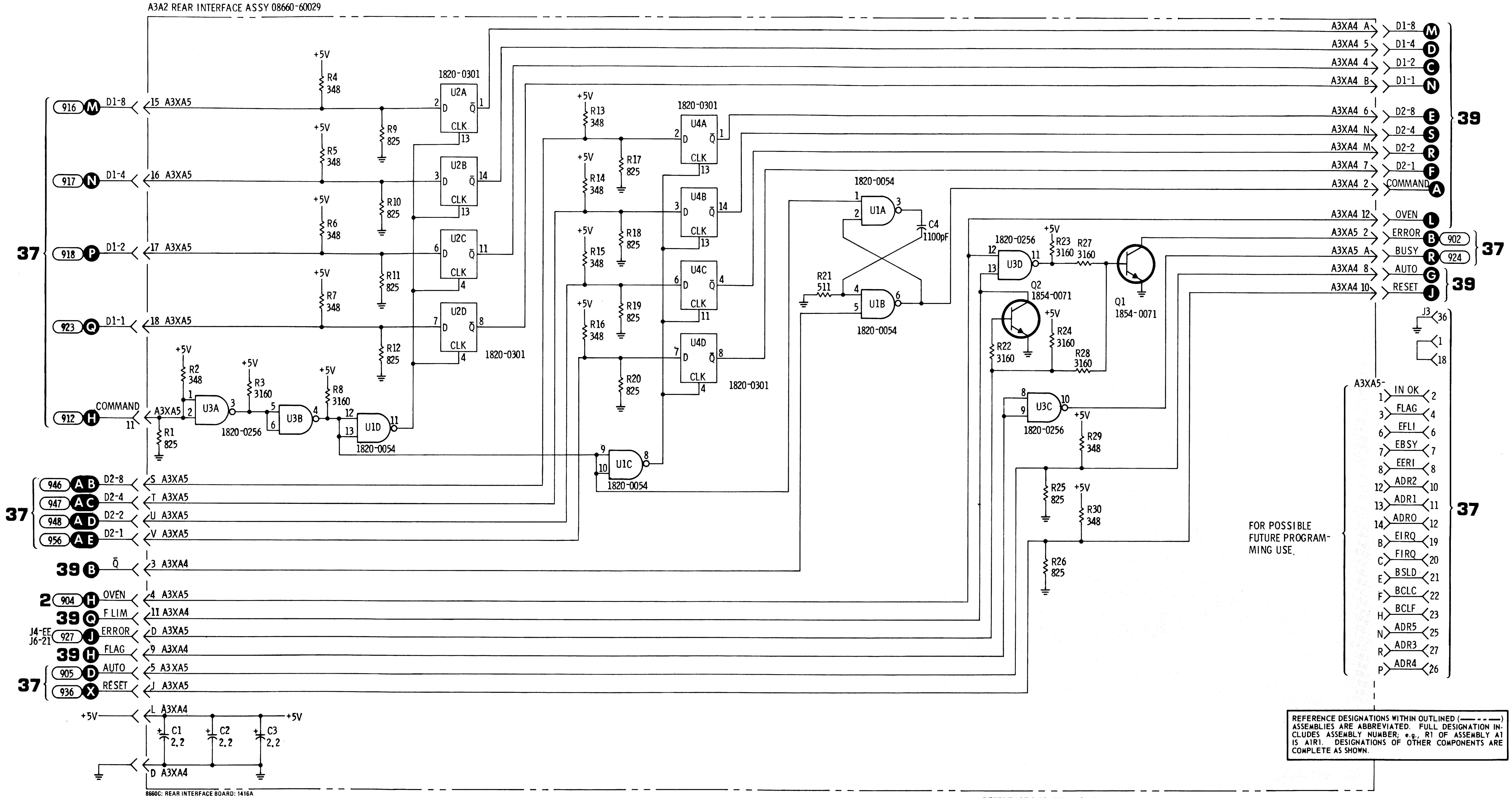


Figure 8-94. A3A2 Rear Interface Board Component Locations



PIN IDENTIFICATION

A B C D E F H J K L M N P R S T U V

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

REFERENCE DESIGNATIONS

A3A2	
C1-3 Q1, 2 R1-30 U1-4	

NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS.
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6

Figure 8-95. A3A2 Rear Interface Board Schematic

SERVICE SHEET 39

HP-IB INPUT ASSEMBLY A3A2 (08660-60192)

General

Basically the HP-IB input assembly accepts the data from the bus, detects the programming action taking place and provides outputs that determine the operational parameters for the Model 8660.

Voltage Dividers (U8, U14) and Schmitt Triggers (U7, U13)

U8 and U14 are resistive arrays which contain eight two-resistor voltage dividers each. Each voltage divider consists of (typical values) 3000 ohms to +5V and 6200 ohms to ground. These dividers bias the input lines to about +3V when the lines are not being driven by data. These dividers are used to keep the load on the bus, which is wire ANDed to all instruments, constant. Note that the lines which are not used in the Model 8660 (DI 08, E0I-L and SRQ-L) are also terminated in loads to preserve the constant loading of the HP-IB bus.

The HP-IB input lines are negative true logic. These lines are high in the quiescent state and are pulled low in the assertive state (0V = H). One of the reasons for using negative true logic is that TTL "sees" an open circuit as a high. If positive true logic were used, a discontinuity or a disconnected connector would simulate a high and the inputs lines would see this as the assertive state.

U7 and U13 are Schmitt Triggers. These Schmitt Triggers improve the quality of the data inputs, provide buffering and invert the input logic levels. Buffering is required to limit the load on the controller to one standard load (approx. 1.6 milliamperes sink current) for each controlled instrument. Following the data lines it may be seen that they are again inverted to negative true logic. Again, the data bits cannot be directly used from the inputs lines because of excessive loading.

Address Decoder U12

One of the characteristics of a NAND gate is that all of the inputs must be high in order for the output to be low. Therefore, all of the inputs to U12 must be high before the output MLA-L (My Local Address-Low) can be in the assertive state. As may be seen by evaluating the circuits which provide the inputs to U12, only one set of input data bits will cause the output of U12 (MLA-L) to go to the assertive state. For the Model 8660 this is an HP-IB characters 3.

If more than one Model 8660 is used in the system, each additional 8660's would require a different address. This involves a different set of address bits from the controller and changing the address jumpers to accept the new HP-IB character.

SERVICE SHEET 39 (Cont'd)

Remote Flip/Flop U9A

When the REN (Remote Enable) input line goes low the input is inverted by Schmitt Trigger U13A and applied to the "D" input of U9A.

U9A, however, cannot change state until it is clocked by a combination of MLA-L, DAC-H, DAV-L and MRE-L. This is because it is desired to keep the Model 8660 in the local mode until it is addressed by the bus. U9A is clocked as follows:

1. When MLA-L goes low it is inverted by U11F and applied to one input of AND gate U10D.
2. The second input to AND gate U10D is the inverted DAC-H output of NAND gate U2B which is low until the data is accepted.
3. The high output of AND gate U10D is applied to one input of AND gate U10B. The second input to U10B is from AND gate U10A.
4. The inputs to AND gate U10A are the inverted MRE-L (Multiple Response Enable) and the inverted DAV-L (Data Valid) inputs.
5. MRE is an address function so it goes low first.
6. Finally, DAV goes low, is inverted and applied to the clock input of U9A. It is the negative-going DAV signal which supplies the positive-going pulse to clock U9A.

When MLA-L is low and U9A is clocked the U9A Q output goes high and the $\overline{Q}$ output goes low. Note that the $\overline{Q}$ output of U9A is labeled LCL-H. When the LCL line goes low the Model 8660 goes to the remote mode and the front panel controls (except for STBY/ON) are inhibited.

Address Flip/Flop U9B

When MLA-L goes low it is also used to set the "D" input to U9B high. This is accomplished as follows: the pin 10 input of U3C is high, and until an "unlisten" command appears, so is the pin 9 input. The high output of U3C enables the "D" input of U9B.

U9B is clocked in the same manner as U9A, by a combination of MRE and DAV.

The Q output of U9B is applied to one input of AND gate U3A. The second input to U3A is MRE, which is now in the quiescent state (high), so the output of U3A (ADR-H) is also high.

Unlisten Gate U5

When all of the inputs to U5 go high the address flip/flop is reset and the incoming data has no effect on the Model 8660.

DCR-L Gate U4 (Device Clear)

When all of the inputs to U4 go high the output goes low. The low output has the same effect on the Model 8660 as the power detect circuit. The instrument is initialized with frequency (8660C) and attenuation set to predetermined values.

The remaining gates and inverters are conventional and should pose no problem to the average technician.

A3A2 Rear Interface Board
SERVICE SHEET 38

A3A2

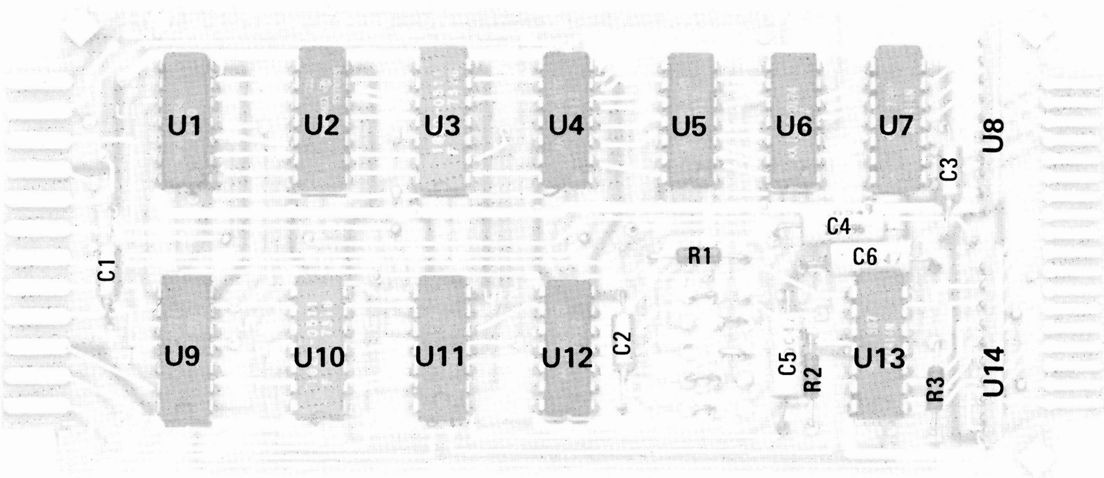


Figure 8-96. A3A2 Component Locations

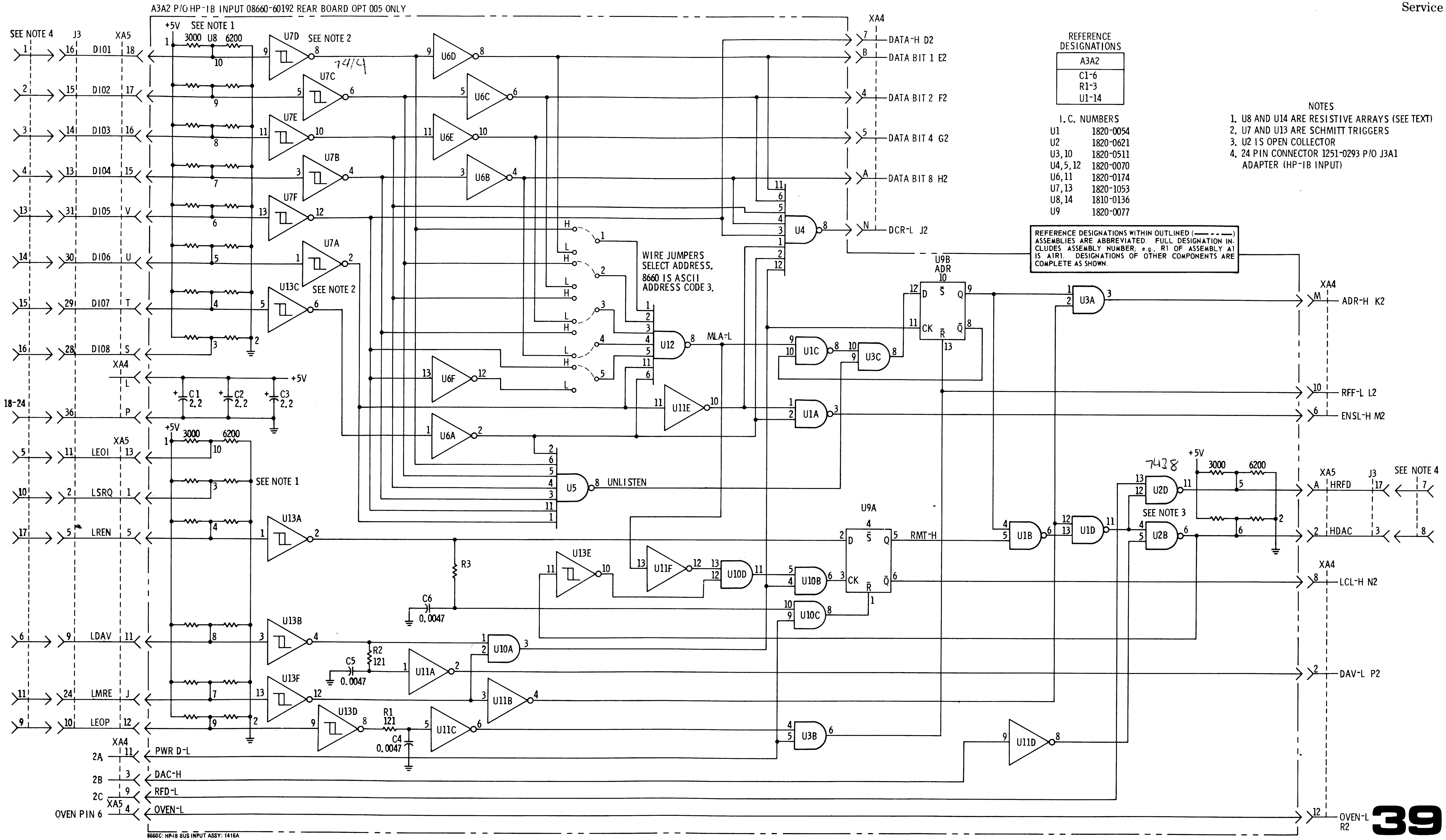


Figure 8-97. HP-IB Input Assembly, Schematic

SERVICE SHEET 40

HP-IB OUTPUT ASSEMBLY A3A1 (08660-60188)

General

The HP-IB Output Board accepts inputs from the HP-IB Input Board, the DCU and the mainframe and converts these inputs to data which is used to program the mainframe, the plug-in sections and the HP-IB Input assembly.

Four-State Macine U7A/B

Located at the lower left side of Service Sheet 2 is a schematic representation of the four-state machine designated as U7A and U7B. Located outside of the schematic image area is an algorithmic state machine graph (ASM or flow chart) which graphically illustrates the operation of flip/flops U7A and U7B.

Each of the four states of the ASM are labeled at the upper right hand corner with the machine state (11, 10, 00 and 01). Each of the states refer to the state of the Q outputs of the flip/flops with the 1 representing a high. For example, the top box, labeled state 11, indicates that the Q outputs of both U7A and U7B are high. Note that in each case the first digit is for U7B and the second digit is for U7A.

Initially, with U7A/B in the quiescent state (state 11), the flip/flops are ready for DAV (Data Valid) to go low signifying that there is a data input. When DAV goes low it is inverted by U10E and applied to AND gate U1A. The other input to U1A is held high at this time by U7B Q, so the K input of U7A goes high.

The next clock pulse causes U7A to change state; Q goes low and $\overline{Q}$ goes high and the ASM proceeds to state 10. In state 10 the incoming data is stored in U2 and the RFD state remains active.

Since there is no qualifier following state 10, the next clock pulse moves the ASM to state 00. In state 00 the command pulse to transfer the data is generated.

Like state 10, there is no qualifier following state 00, so the next clock pulse moves the ASM to state 01, which is the DAC (Data Accepted) state.

Following state 01 is qualifier DAV-H and BUSY-L. When the output of qualifier DAV-H and BUSY-L is low, the ASM is held in state 01. When the qualifier output goes high the ASM (and the flip/flops), return to state 11 and are ready for the next data input.

Flip/flops U7A/B control the three-wire handshake procedure within the instrument.

Jumper J1, when in place, is used to couple the internally generated BUSY signal to delay the RFD response. Without J1 the operator must make allowances in programming for the necessary settling time delays of the Model 8660.

HP-IB Input Assembly, Schematic
◀ SERVICE SHEET 39

SERVICE SHEET 40 (Cont'd)

Delay One Shot U6

U6, in conjunction with Q1 and associated components, comprise a delay circuit which inhibits the start of the RFD period when certain programming steps are initiated. This is required because the programming time required for different functions varies.

As an example of circuit operation assume that a change in frequency is programmed. Q1 is turned on and R1 and C2 determine the 5 millisecond operating time of the one-shot. One-shot output is from pin 4 to U1 and pin 12.

When an attenuation function is programmed, Q1 is turned off and R2, C1 and C2 determine the 50 millisecond operating time of the one-shot.

There is also a 5 second delay built into the Model 8660 DCU for use in the FM CAL operation. The HP-IB interface utilizes this signal to delay RFD for 5 seconds when FM CAL is programmed. This delay input is the FLAG-L (BUSY) signal.

Shift Register U2

U2 is a conventional 4-bit shift register which is operated in the preset mode. U2 functions as a temporary storage register.

When the inputs to U2 are data the U2 outputs are directly applied to the DCU.

When the inputs to U2 are an address, ENSL-H (Enable Select) goes high to enable the U3 NAND gates and the address data is coupled to one-of-ten selector U4. When the U2 register is processing an address, the clock input, CP, at pin 10 is inhibited for 100 microseconds by one-shot U6 pin 12 output. This prevents controller change of address until after sufficient time has passed for the Model 8660C state machine process. Jumper J2 may be installed to disable this operation for a Model 8660A.

One-of-Ten Selector U4

U4 determines which programming function (address) has been selected, and, in conjunction with PICK-L (Plug-in Clock) couples the address data to the appropriate register.

Power Detect Circuit

Q2 and associated components comprise a power detect circuit which inhibits circuit operation on initial turn-on until the power supply has reached a stable condition. Initialization follows removal of the low level pulse, setting frequency to 1 MHz (8660C) and attenuation to −140 dB.

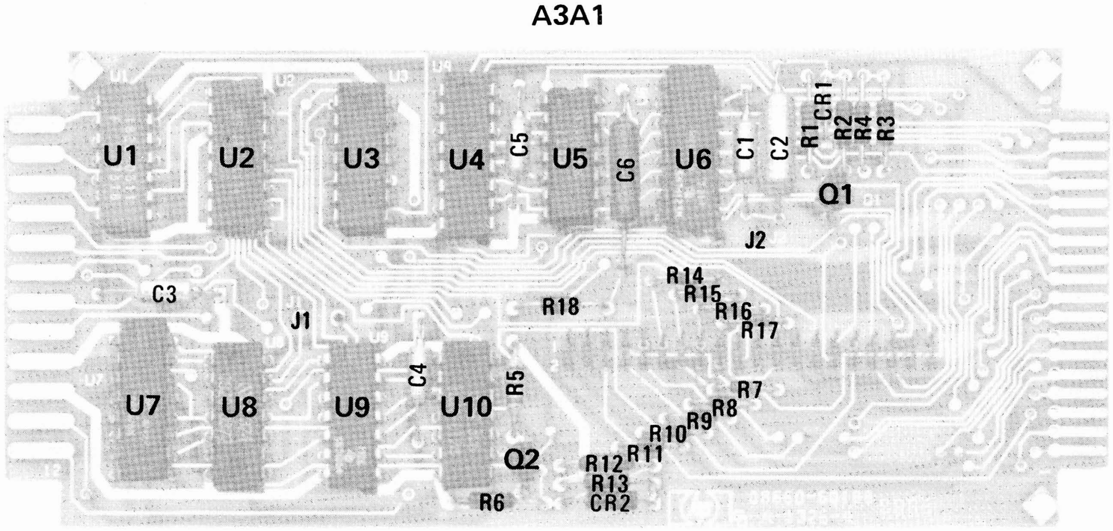
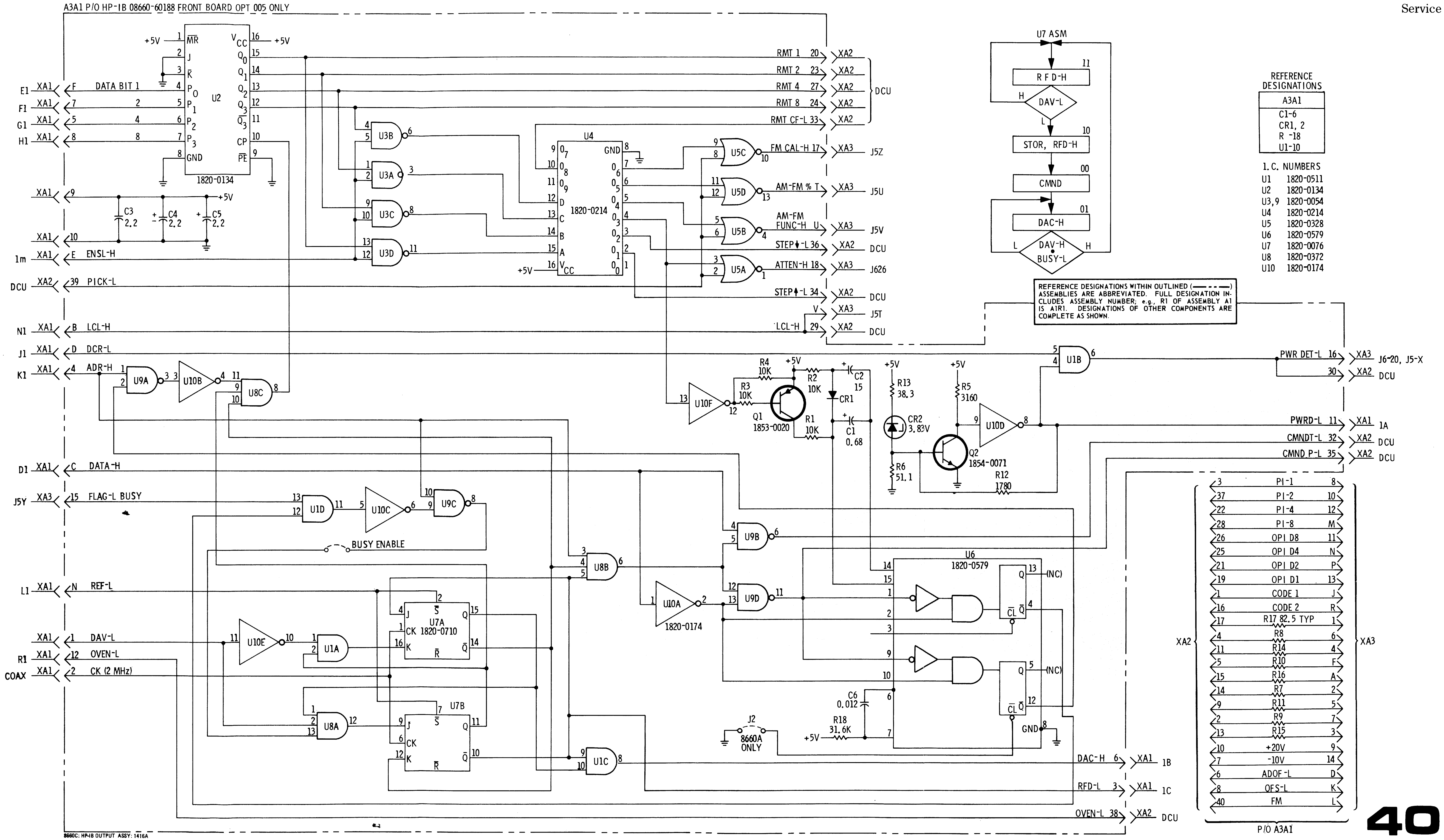


Figure 8-98. Opt 005 A3A1 Component Locations



40

Figure 8-99. HP-IB Output Assembly, Schematic

Figure 8-100. A6 Assembly Open View

A6A1 FRONT VIEW

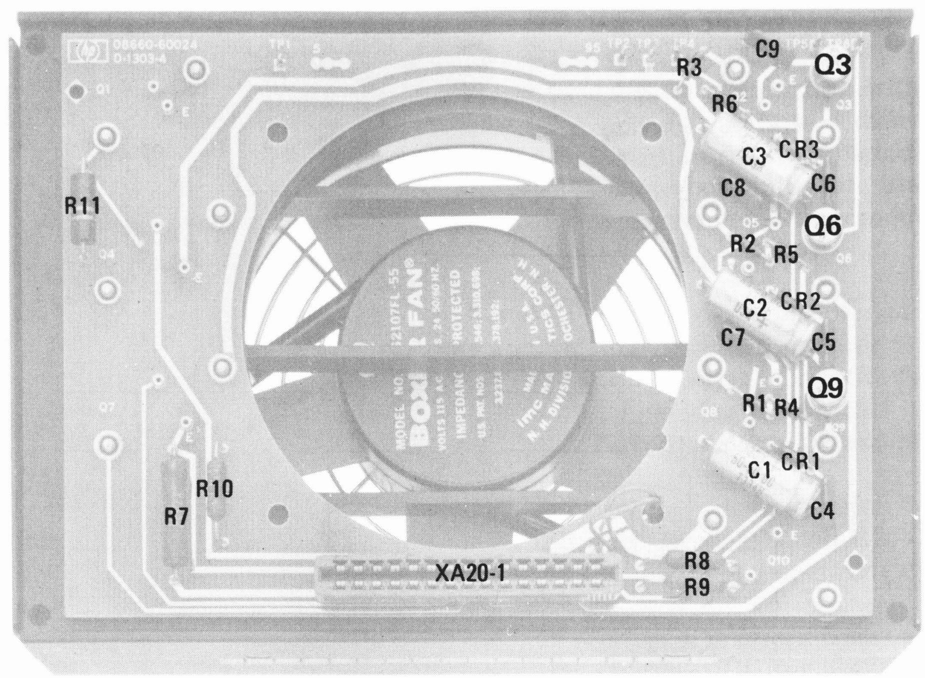


Figure 8-101. A6A1 Assy Component Locations Front View

A6A1 REAR VIEW

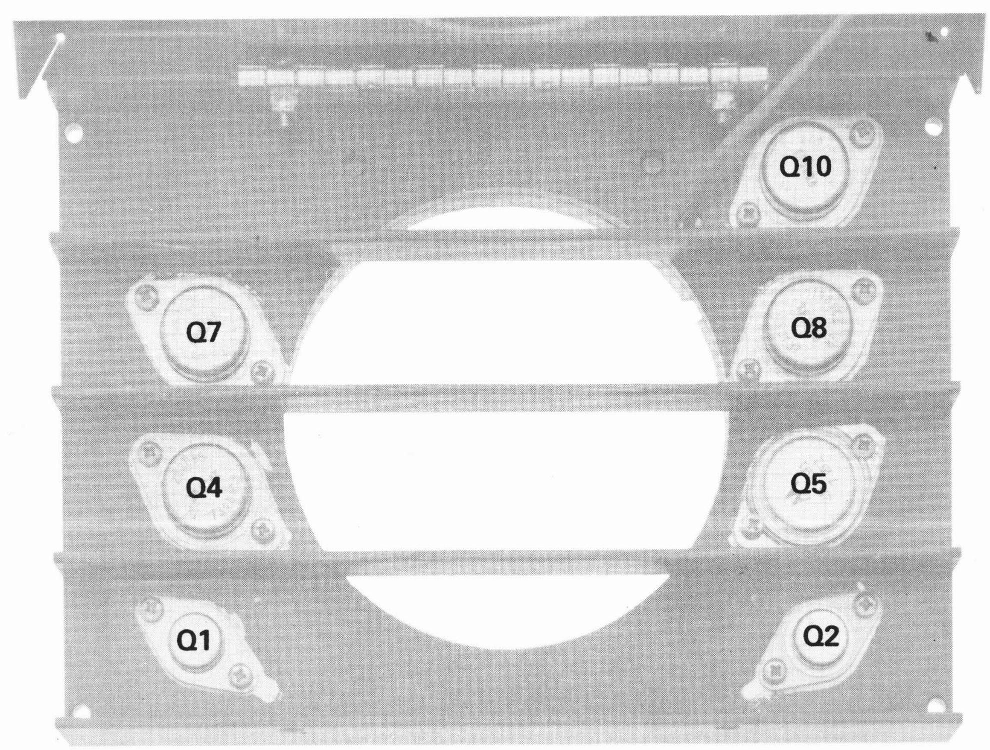


Figure 8-102. A6A1 Assy Component Locations Rear View

◀ HP-IB Output Assembly, Schematic
SERVICE SHEET 40

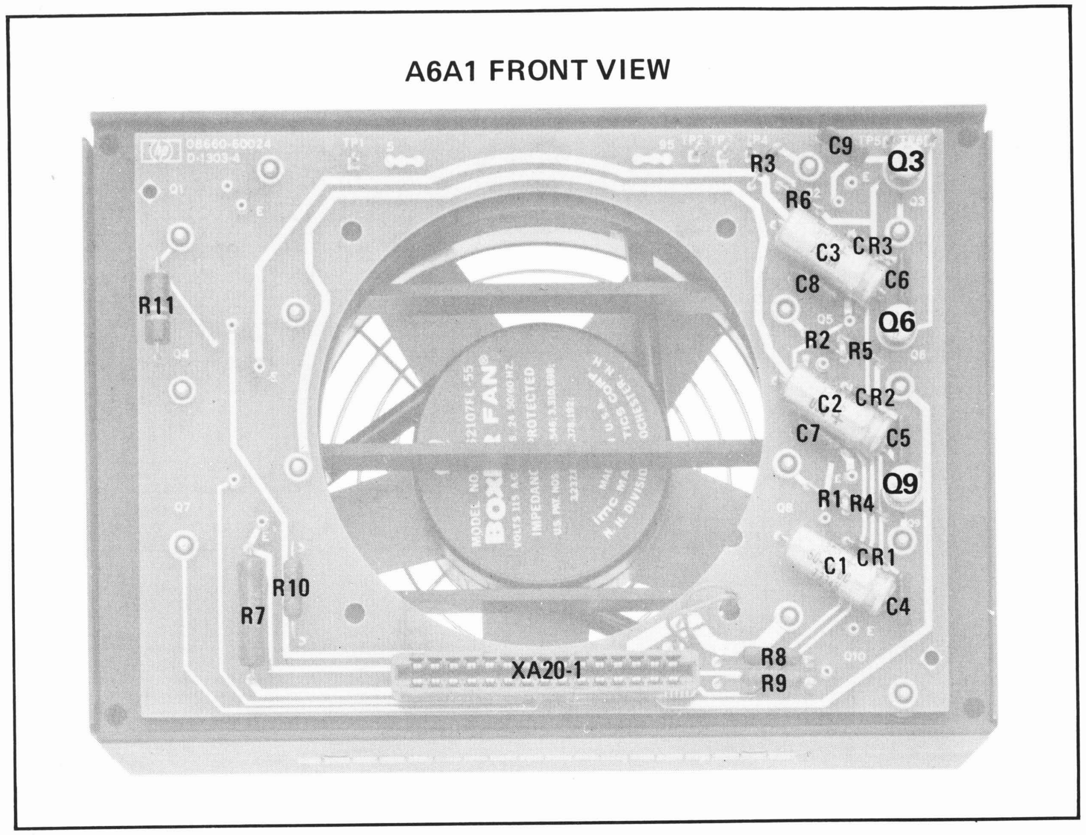


Figure 8-101. A6A1 Assy Component Locations Front View

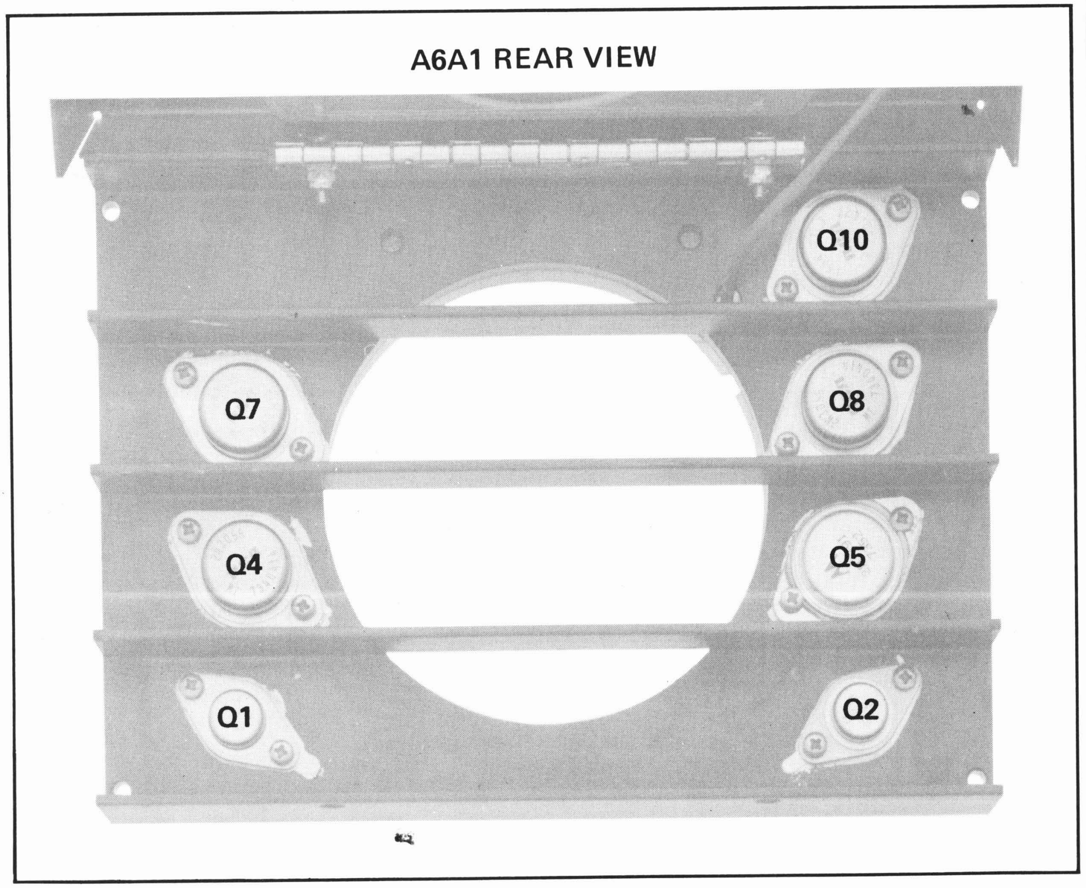


Figure 8-102. A6A1 Assy Component Locations Rear View

HP-IB Output Assembly, Schematic
SERVICE SHEET 40

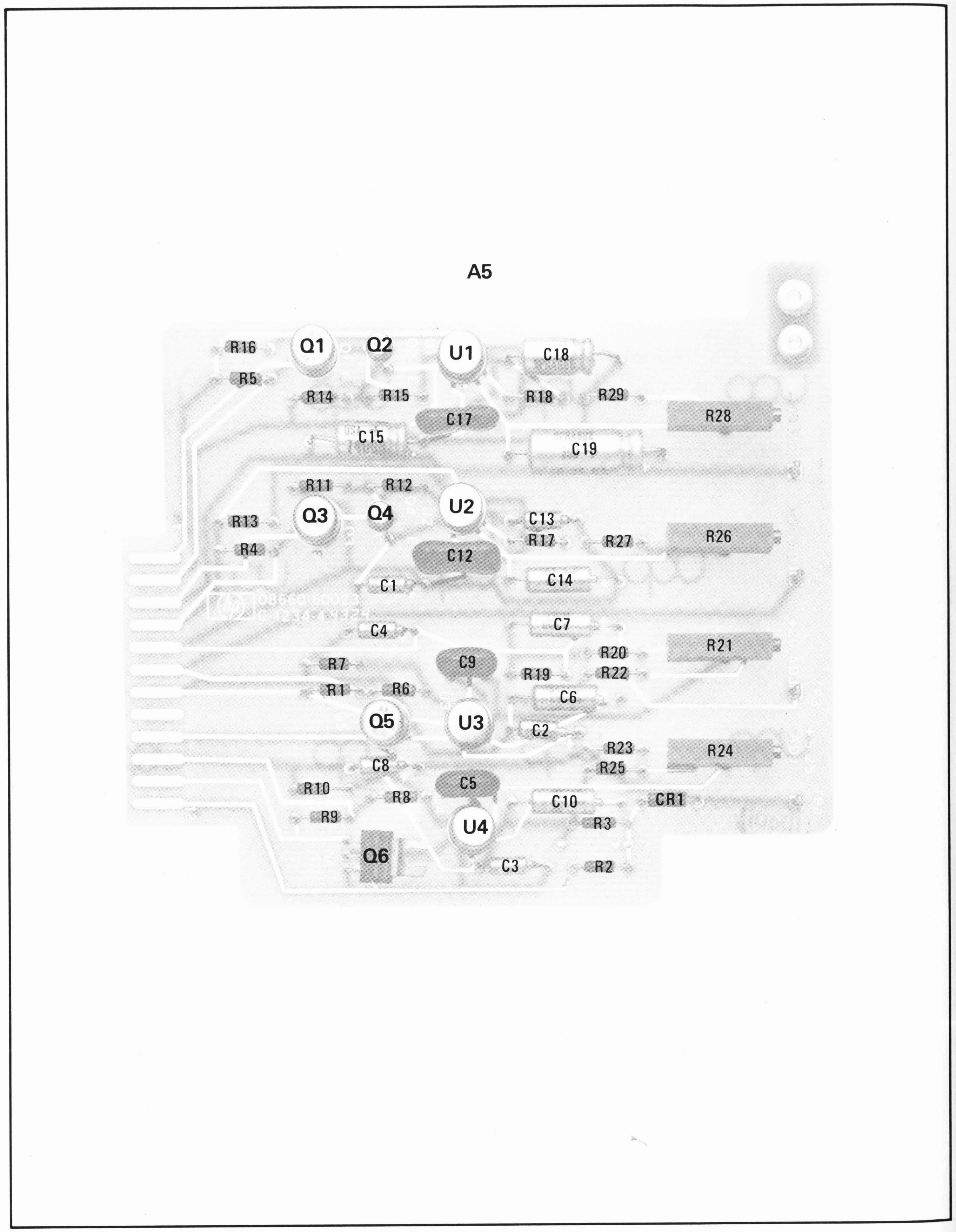


Figure 8-103. A5 Component Locations

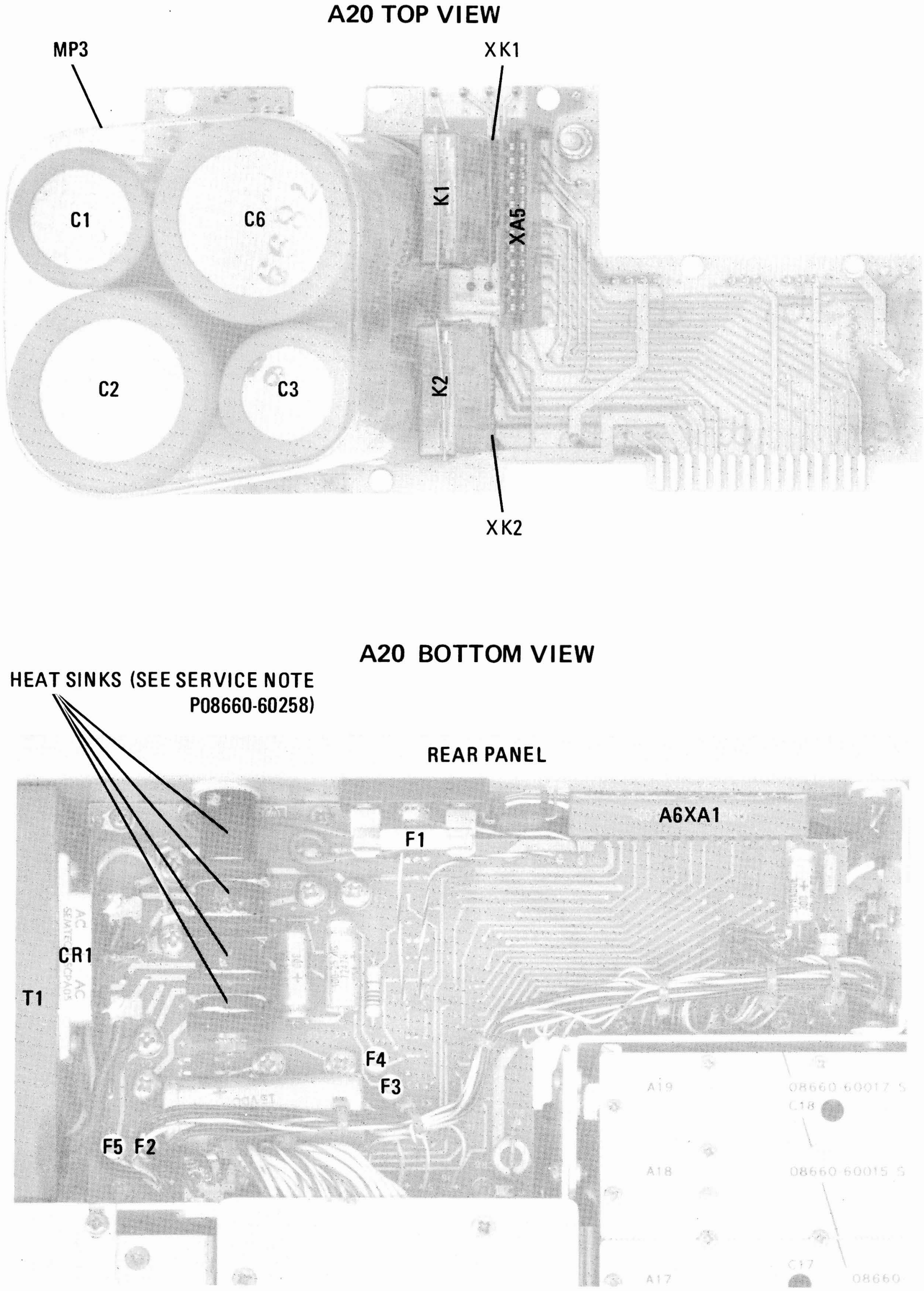
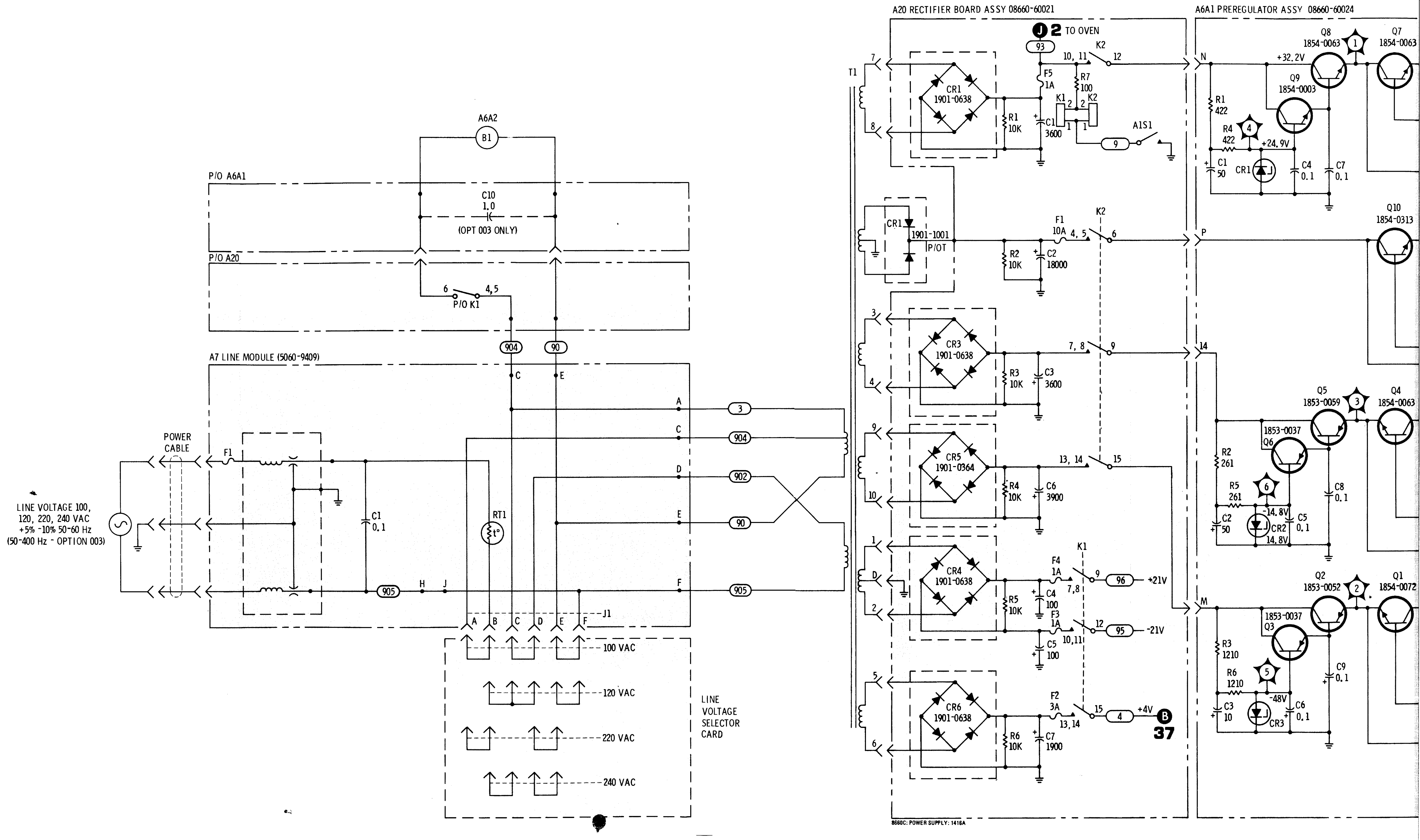
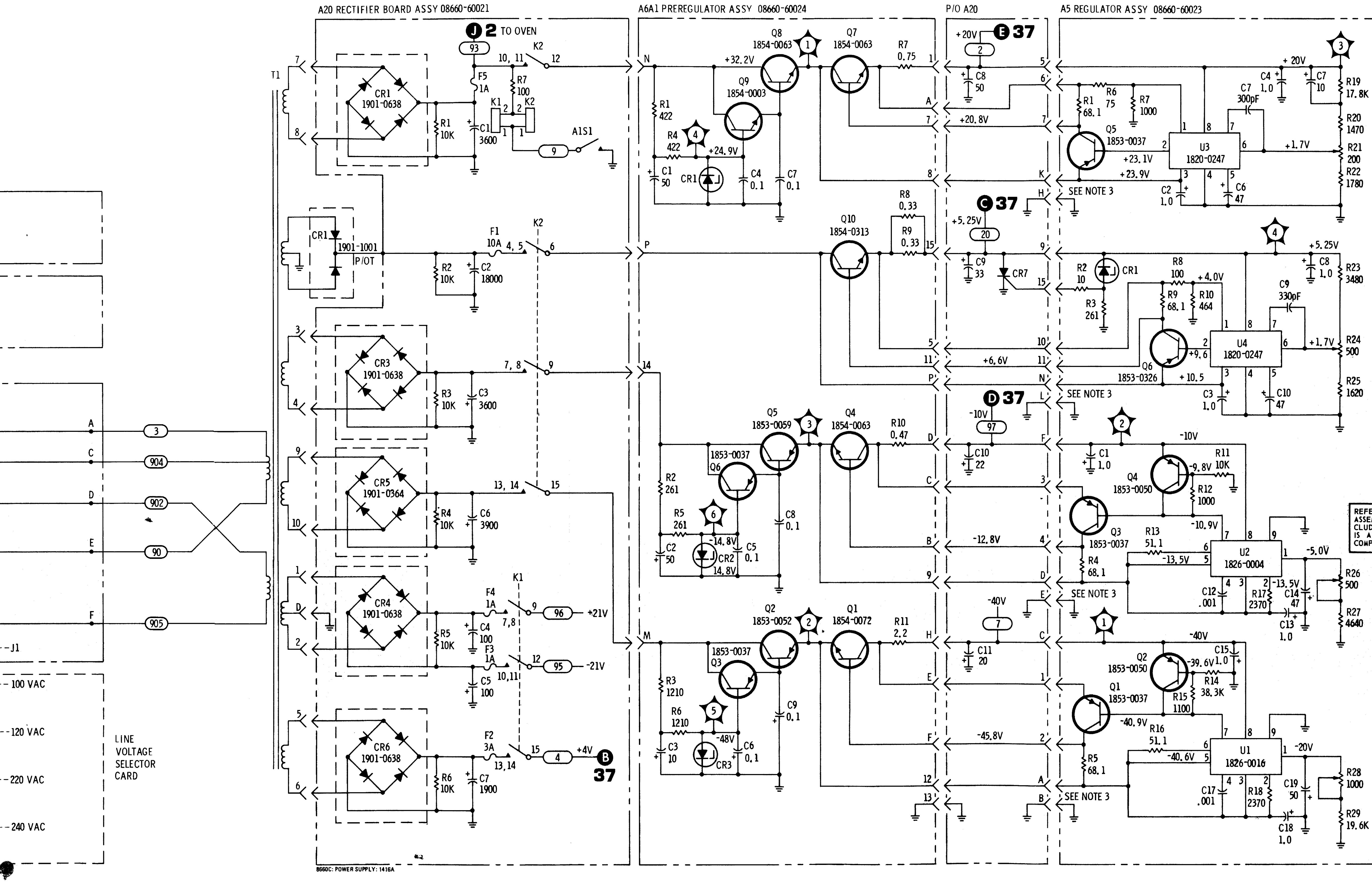
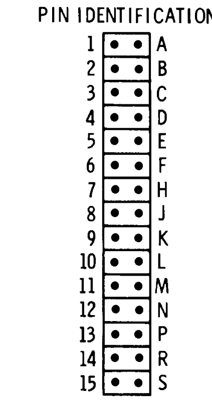


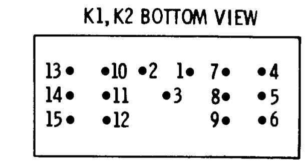
Figure 8-104. A20 Top and Bottom Component Locations



A20 RECTIFIER BOARD ASSY 08660-60021
A6A1 PREREGULATOR ASSY 08660-60024
A6A2
P/O A6A1
P/O A20
A7 LINE MODULE (5060-9409)
LINE VOLTAGE 100, 120, 220, 240 VAC +5% -10% 50-60 Hz (50-400 Hz - OPTION 003)
POWER CABLE
C10 1.0 (OPT 003 ONLY)
P/O K1
LINE VOLTAGE SELECTOR CARD
100 VAC
120 VAC
220 VAC
240 VAC
TO OVEN
CR1 1901-0638
CR3 1901-0638
CR5 1901-0364
CR4 1901-0638
CR6 1901-0638
+21V
-21V
+4V
37
Q8 1854-0063
Q7 1854-0063
Q9 1854-0003
Q10 1854-0313
Q5 1853-0059
Q4 1854-0063
Q6 1853-0037
Q2 1853-0052
Q1 1854-0072
Q3 1853-0037
+32.2V
+24.9V
-14.8V
14.8V
-48V
8660C: POWER SUPPLY: 1416A







NOTES

1. REFER TO TABLE 8-3 FOR EXPLANATION OF SYMBOLS
2. INTEGRATED CIRCUIT GATE INTERNAL LOGIC IS SHOWN IN FIGURE 8-6
3. EACH REGULATOR CIRCUIT ON A5 HAS ITS OWN GROUND. THESE GROUNDS ARE NOT COMMON ON THE A5 ASSEMBLY.

REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

REFERENCE DESIGNATIONS

CHASSIS	A6A1
T1	C1-10 CR1-3 Q1-10 R1-11
A5	
C1-19 CR1 Q1-6 R1-29 U1-4	A7
	A20
	C1-11 CR1-7 F1 K1, 2 R1-7

41

8660C: POWER SUPPLY: 1416A

Figure 8-105. Power Supply Schematic

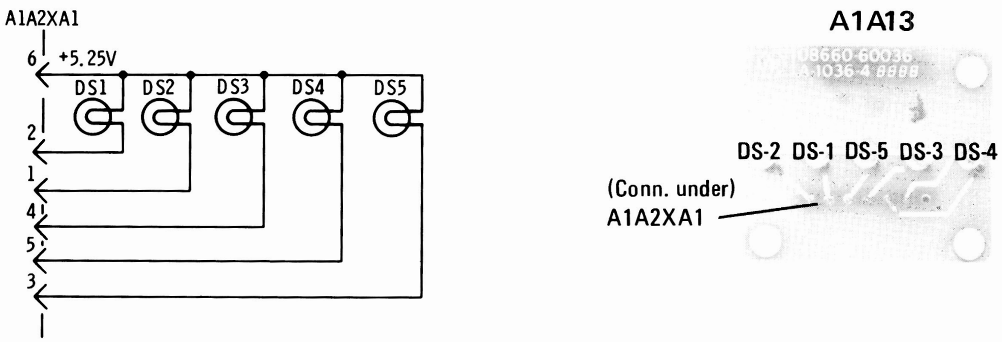


Figure 8-106. A1A2 Annunciator Assembly and Schematic

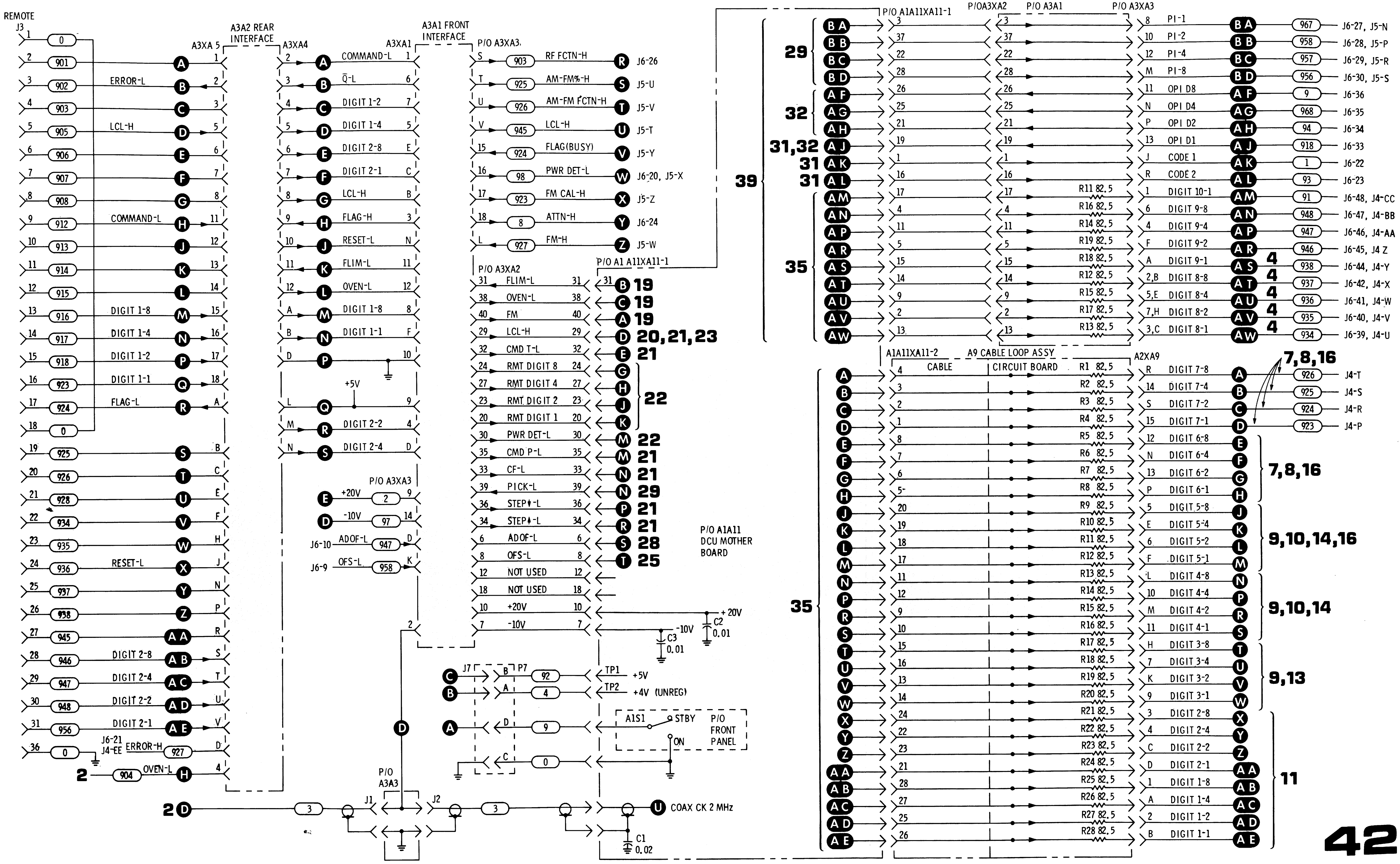


Figure 8-107. DCU and Interface Wiring Diagram

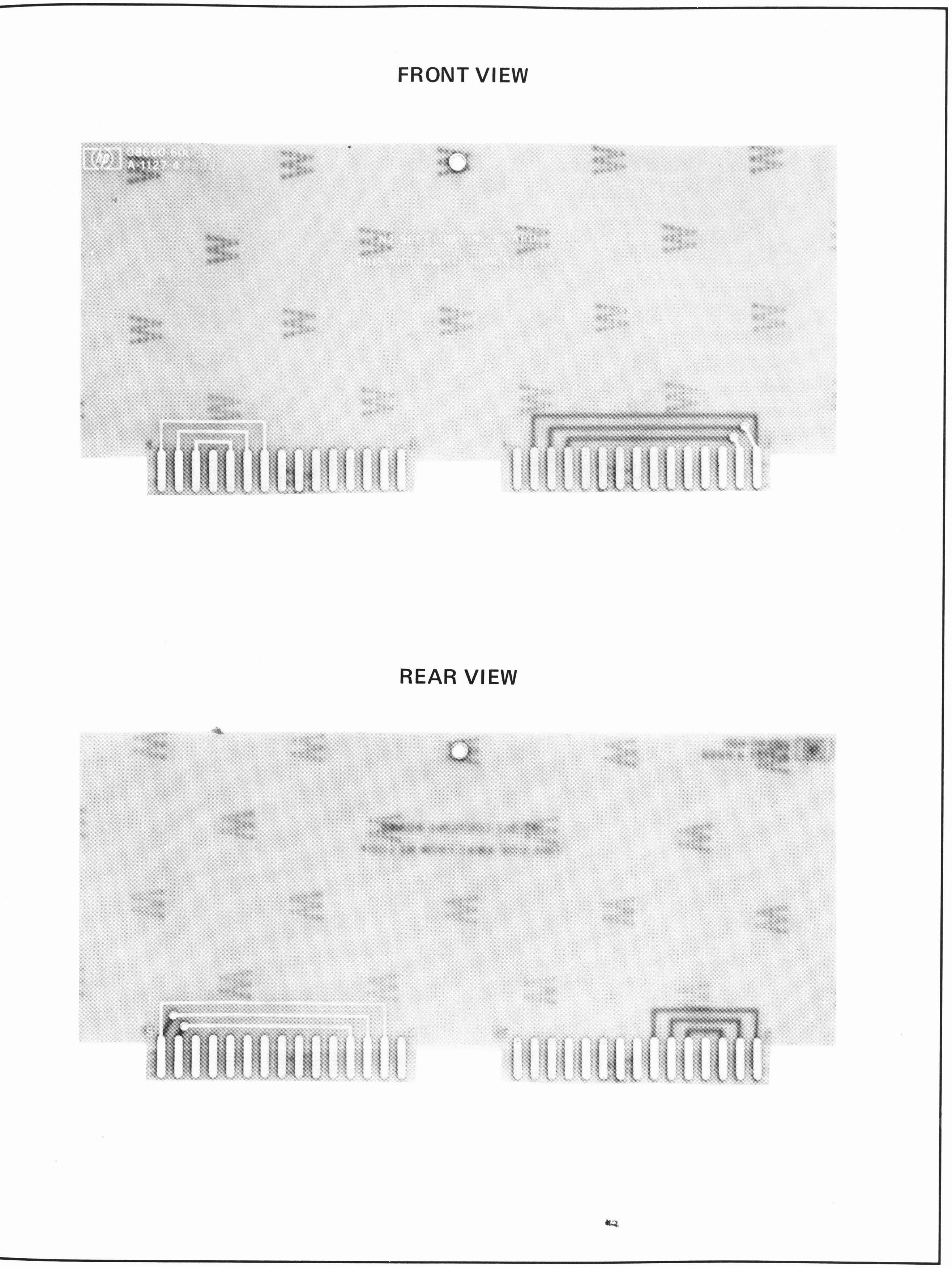


Figure 8-108 Interconnection Assembly (Opt. 004)

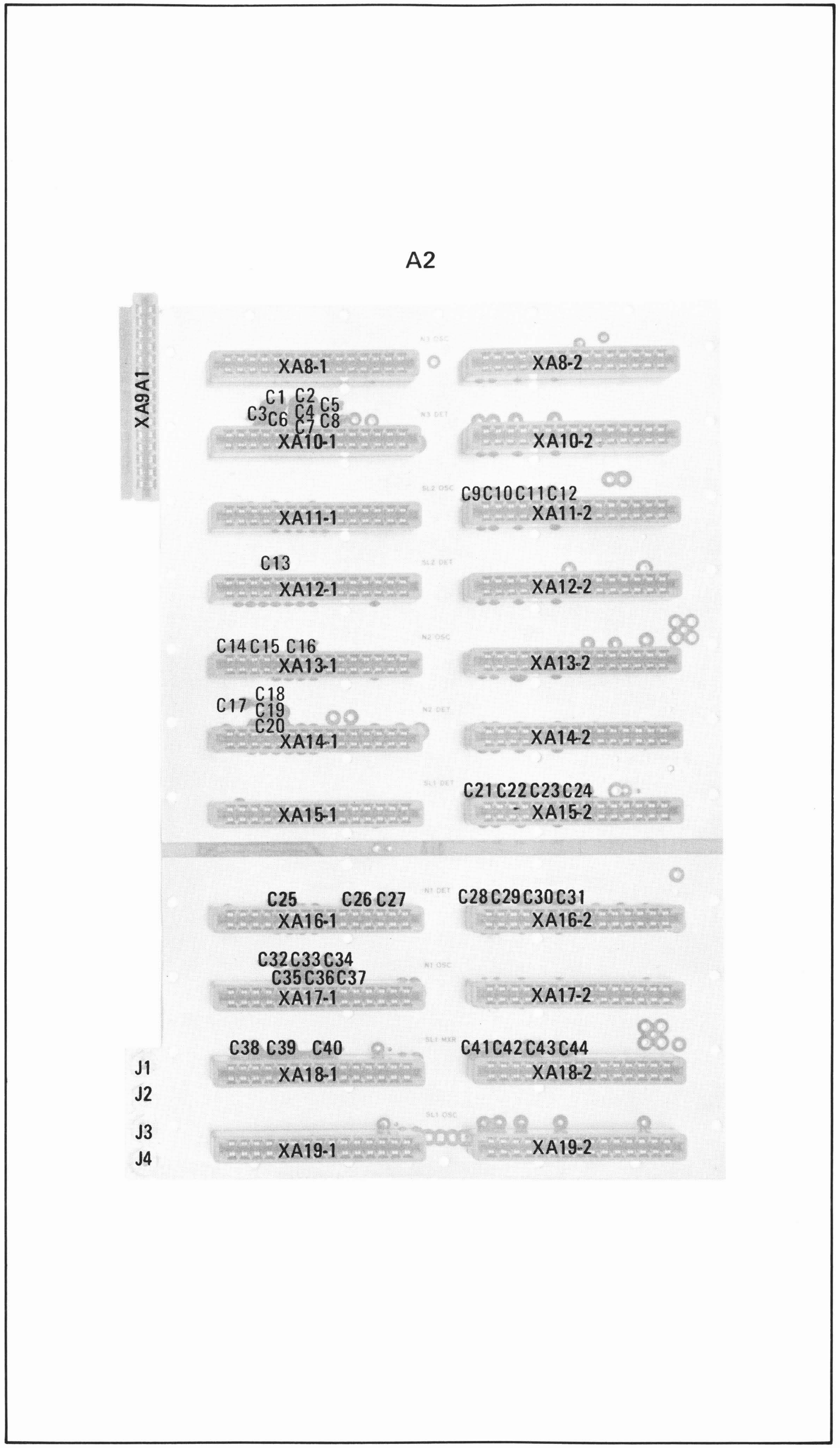


Figure 8-109. A2 Mother Board Component Locations

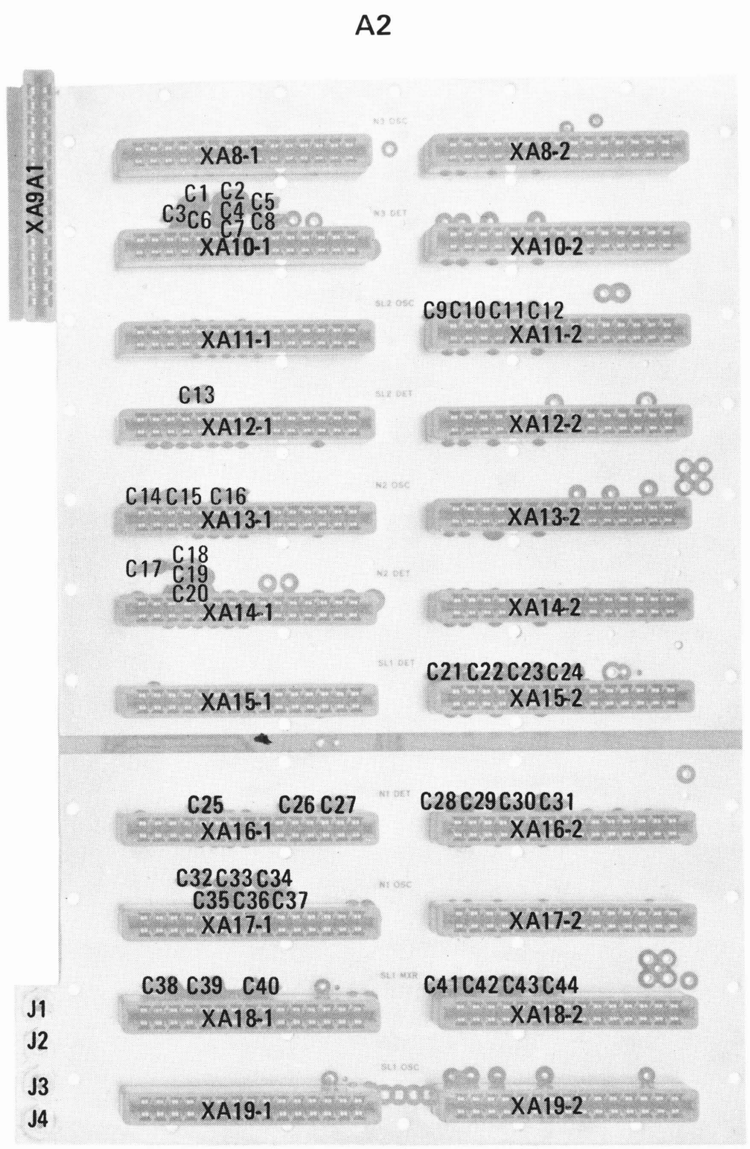


Figure 8-109. A2 Mother Board Component Locations

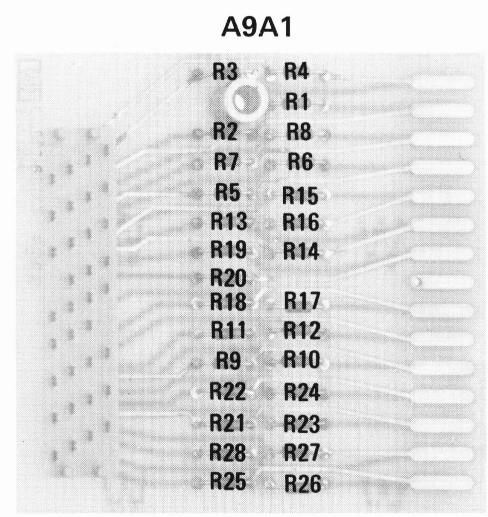


Figure 8-110. A9A1 Cable Loop Assembly

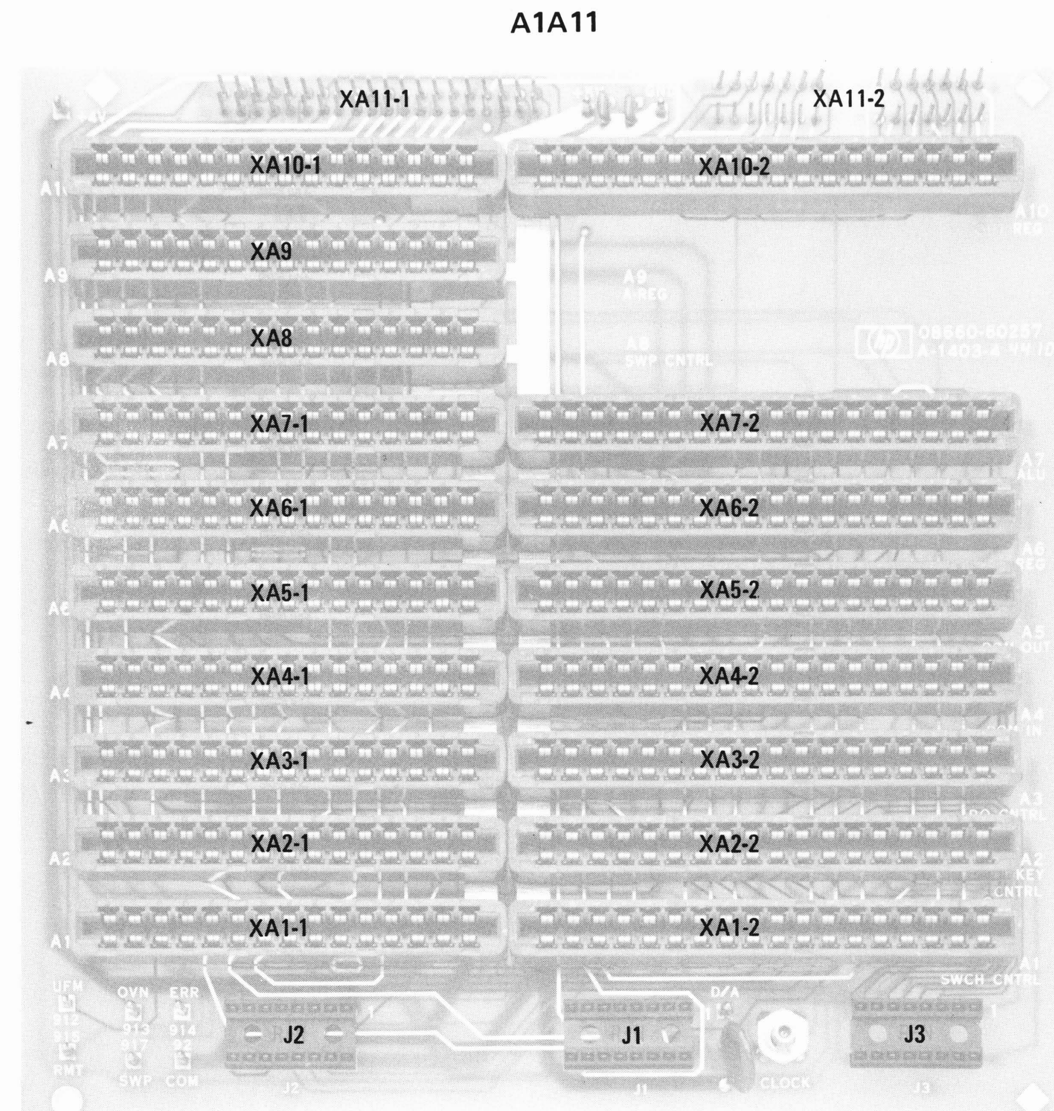


Figure 8-111. A1A11 DCU Mother Board Component Locations

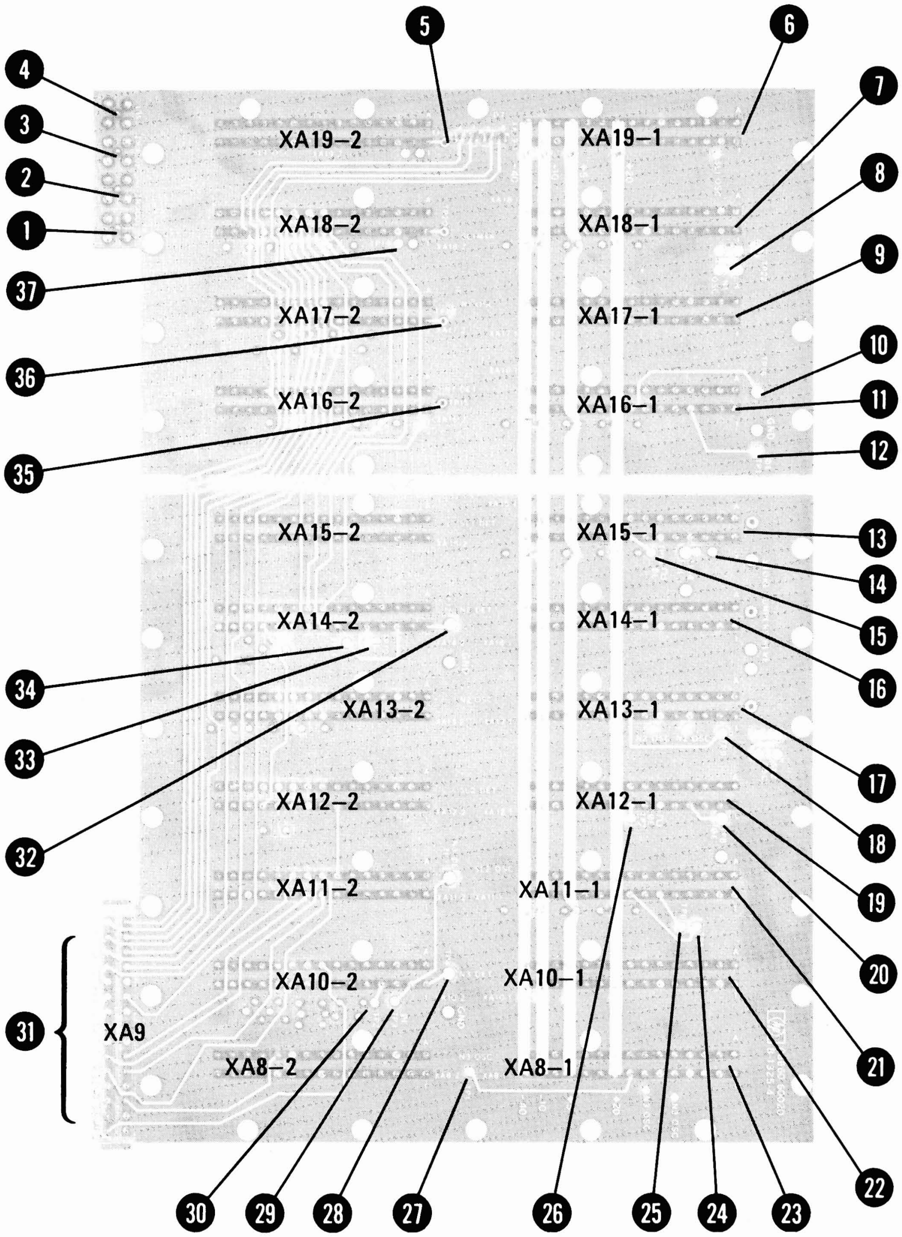


Figure 8-112. Mainframe Mother Board Test Points (1 of 2)

Test Points	Assemblies	Mother Board Inputs and Outputs
(27) TP1 N3 Oscillator	(9) N1 Oscillator (A17)	(1) 100 kHz Reference Input to N2
(30) TP2 N3 10 kHz	(11) N1 Phase Detector (A16)	(2) 100 kHz Reference Input to N3
(29) TP3 N3 Phase Error	(17) N2 Oscillator (A13)	(3) 400 kHz Reference Input to N1
(28) TP4 N3 Phase Error Grounding	(16) N2 Phase Detector (A14)	(4) SL1 Output
(24) TP5 SL2 Tuning	(23) N3 Oscillator (A5)	(31) BCD Frequency Data Digits 1 through 7
(25) TP6 SL2 Oscillator	(22) N3 Phase Detector (A10)	
(26) TP7 SL2 Pulse Phase Error	(21) SL2 Oscillator (A11)	
(20) TP8 SL2 Phase Error	(19) SL2 Phase Detector (A12)	
(18) TP9 N2 Oscillator	(6) SL1 Oscillator (A19)	
(33) TP10 N2 Phase Error	(13) SL1 Phase Detector (A15)	
(34) TP11 N2 10 kHz	(7) SL1 Mixer (A18)	
(32) TP12 N2 Phase Error Grounding		
(15) TP13 SL1 Pulse Phase Error		
(14) TP14 SL1 Phase Error		
(35) TP15 N1 100 kHz		
(10) TP16 N1 Phase Error Grounding		
(12) TP17 N1 Phase Error		
(30) TP18 N1 Oscillator		
(37) TP19 SL1 Mixer Output		
TP20 Not Connected		
(5) TP21 SL1 Driver		
(8) TP22 SL1 Oscillator		

Figure 8-112. Mainframe Mother Board Test Points (2 of 2)

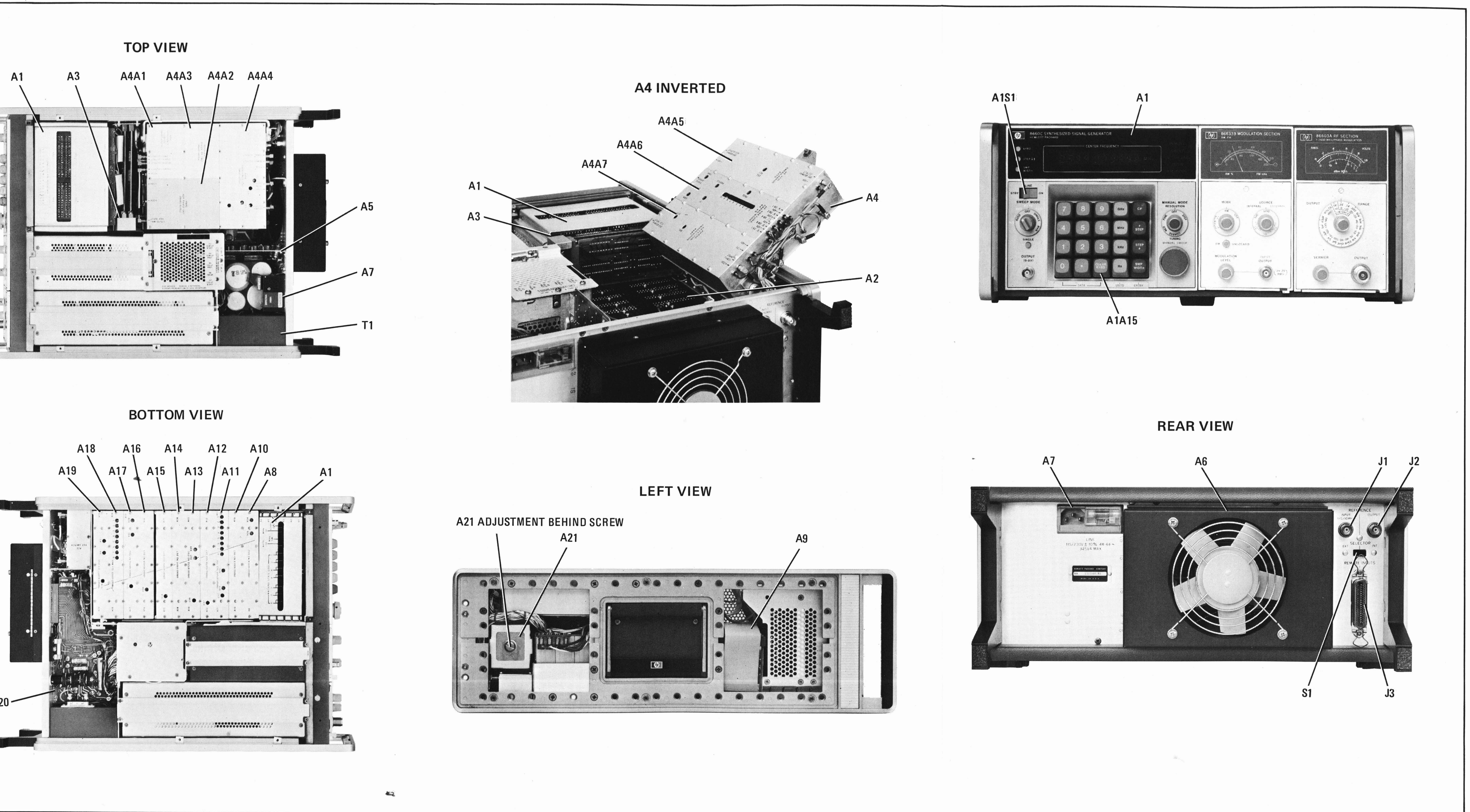
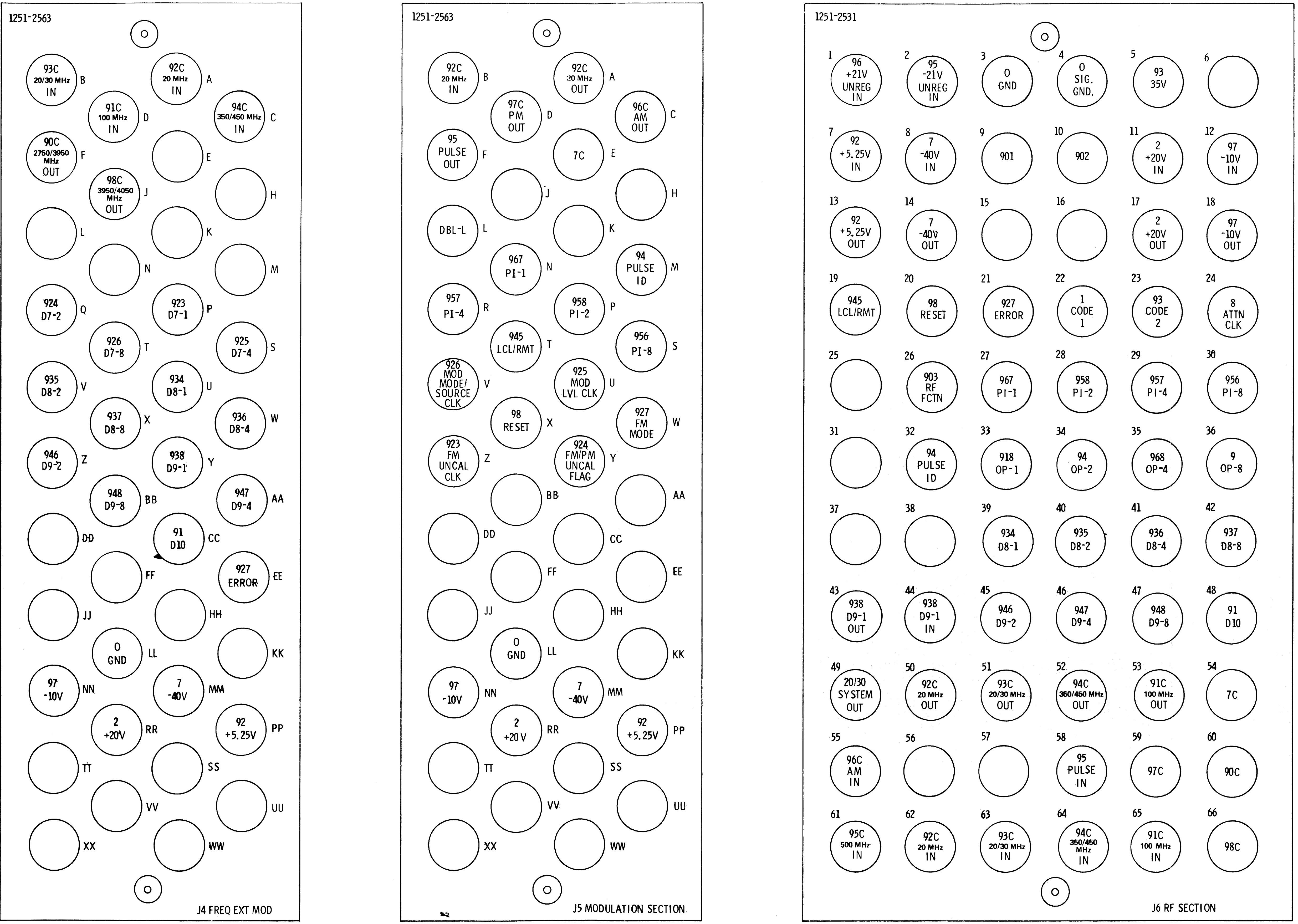


Figure 8-113. Model 8660C Internal Views



NOTES:

1. PART NUMBERS SHOWN FOR CONNECTORS DO NOT INCLUDE PINS.
2. COAX PINS ARE HP PART NUMBER 1251-2041 REGULAR PINS ARE HP PART NUMBER 1251-1908
3. A TOOL KIT, WINCHESTER CATALOG NUMBER 107K4 IS REQUIRED TO INSTALL THE REGULAR PINS.
4. A TOOL KIT, WINCHESTER CATALOG NUMBER 107-0600 AND A TOOL LOCATOR WINCHESTER CATALOG NUMBER 107-0602 IS REQUIRED TO INSTALL COAX PINS.

Figure 8-114. Plug-In Connectors Details

Internal Views

Table 8-54. Low Frequency Adjustment Identification

A8 (N3)	R24, R26 →	Frequency Range Adjustment Pots
A11 (SL2) Osc.	R15, R19 → R39, 54, 60, 67, 73, 77, 83, 90 → C17 →	Frequency Range Adjustment Pots Oscillator Pretune Pots 30 MHz Oscillator Trimmer Adjustment
A12 (SL2 Det)	R37 →	Phase Error Adjustment Pot
A13 (N2 Osc)	R37, R39 → C19 →	Frequency Range Adjustment Pots 29.79 MHz Oscillator Trimmer Adjustment
A15 (SL1) Phase Det	R14 →	Phase Error Adjustment Pot
A16 (N1 Det)	R38 →	Phase Error Adjustment Pot
A17 (N1 Osc)	R24, R31 → C17 →	Frequency Range Adjustment Pots 29.7 MHz Oscillator Trimmer Adjustment
A18 (SL1 Mixer)	R35, 40, 44, 51, 55, 62, 68, 74 →	Oscillator Pretune Pots
A19 (SL1 Osc)	R3, R9 → C18 →	Frequency Range Adjustment Pots 30 MHz Oscillator Trimmer Adjustment

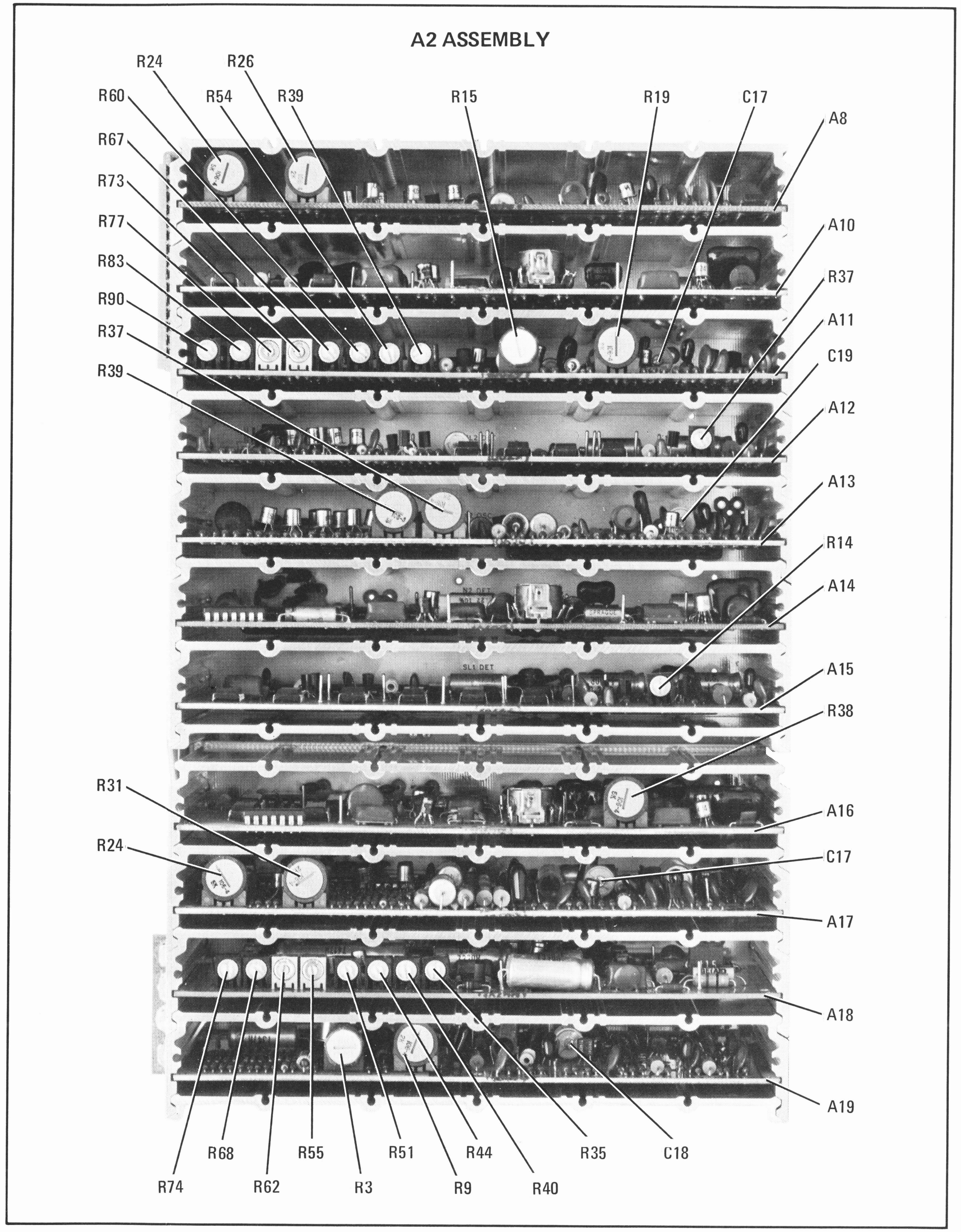


Figure 8-115. LF Loops Adjustment Locations

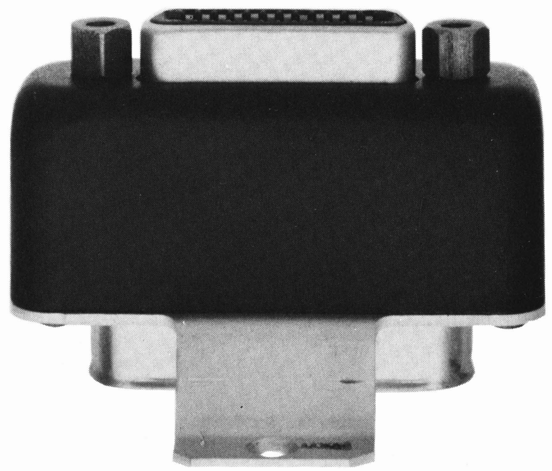


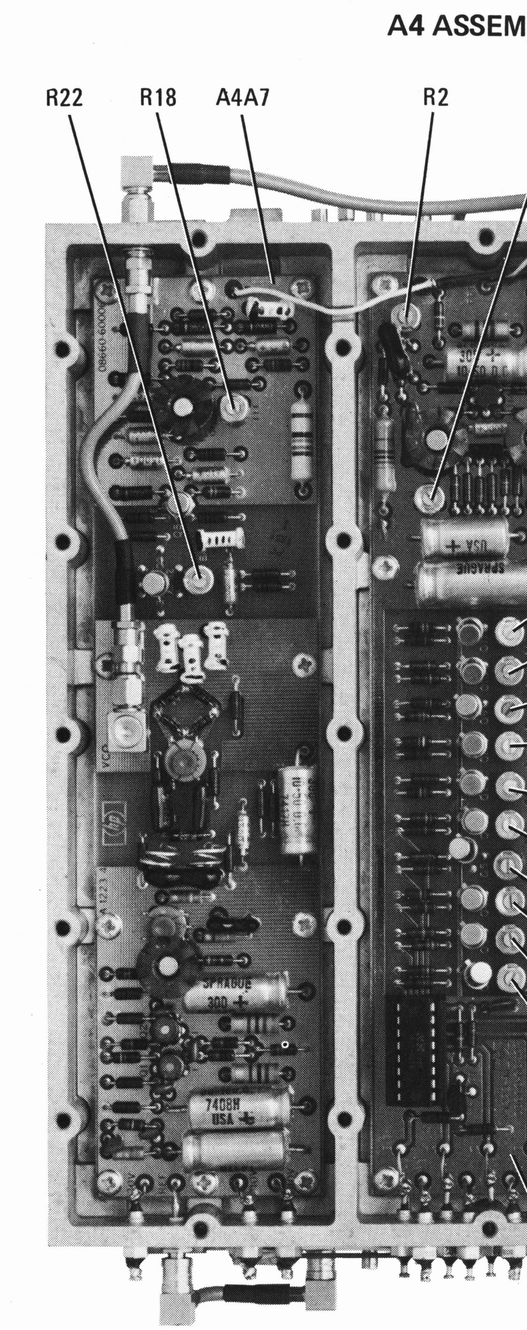
Figure 8-116. HP-IB Adapter

Table 8-55. High Frequency Loop Adjustment Identification

A4A5 (H.F. Osc.)	C3 →	350 — 450 MHz Oscillator Adjustment
A4A6 (H.F. Pretune)	R2 →	Loop Gain Adjustment
	R13	"0" (Zero) Adjustment
	R20 →	Profile Pot
	C5 →	10 MHz Trap Adjustment
	R15, 22, 28, 35, 40, 44, 48, 52, 56, 60 →	Oscillator Pretune Pots
A4A7 (Phase Det.)	R18 →	Efficiency Adjustment
	R22 →	Balance Adjustment

Table 8-56. Reference Loop Adjustment Identification

A4A4 (Ref Loop VCO)	C2 →	100 MHz Oscillator Adjustment
	C41 →	100 MHz Power Level Adjustment
	C17, C23, C31 →	500 MHz Power Level Adjustment



ble 8-55. High Frequency Loop Adjustment Identification

	C3 →	350 — 450 MHz Oscillator Adjustment
	R2 →	Loop Gain Adjustment
ne)	R13	"0" (Zero) Adjustment
	R20 →	Profile Pot
	C5 →	10 MHz Trap Adjustment
	R15, 22, 28, 35, 40, 44, 48, 52, 56, 60 →	Oscillator Pretune Pots
	R18 →	Efficiency Adjustment
)	R22 →	Balance Adjustment

Table 8-56. Reference Loop Adjustment Identification

C2 →	100 MHz Oscillator Adjustment
C41 →	100 MHz Power Level Adjustment
C17, C23, C31 →	500 MHz Power Level Adjustment

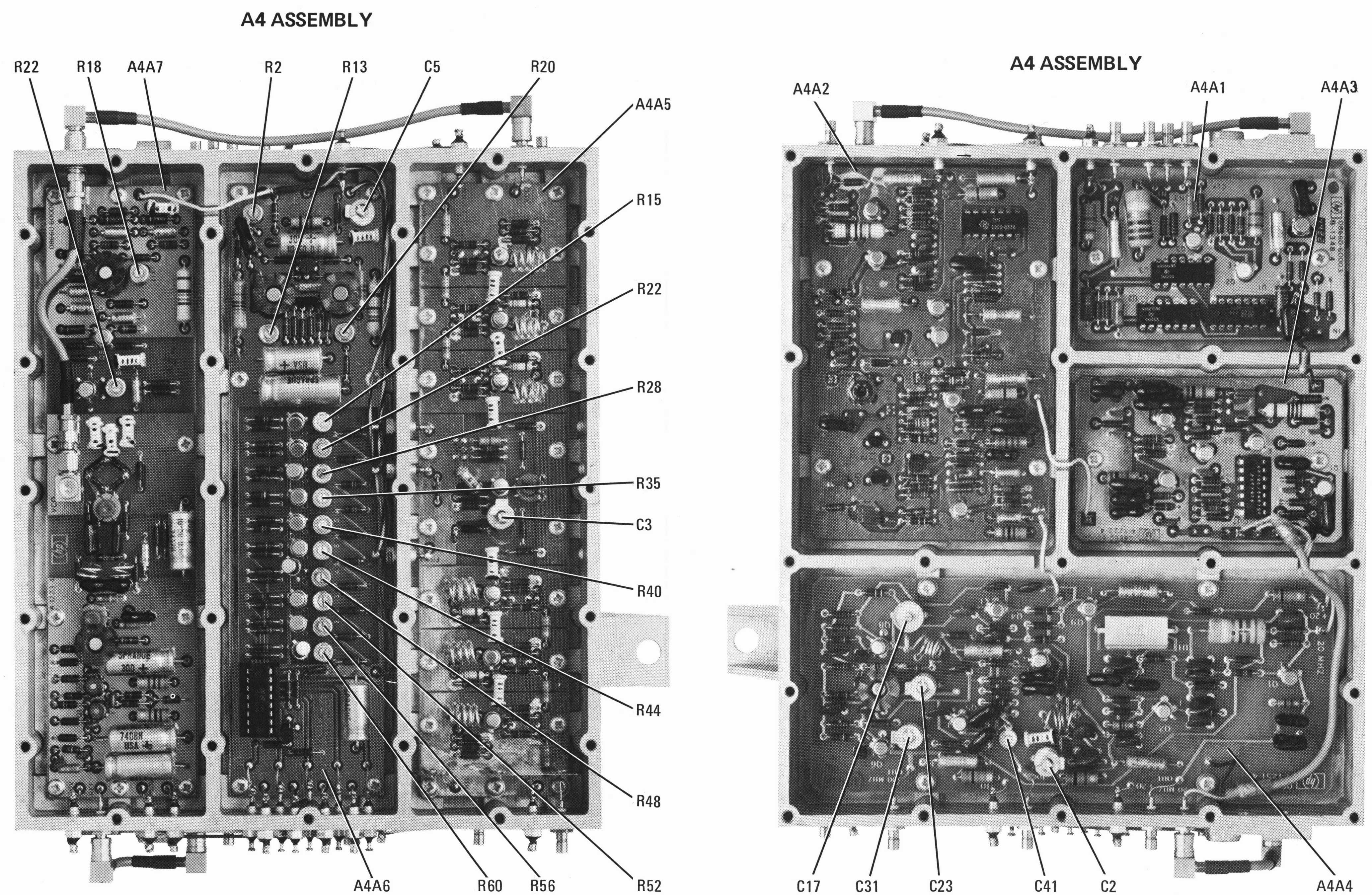


Figure 8-117. HF Loop and Reference Loop Adjustment Locations

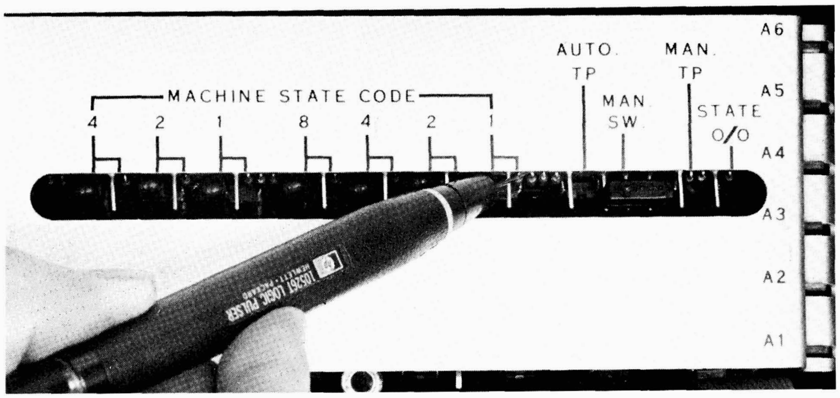


Figure 8-118. Self Test Features