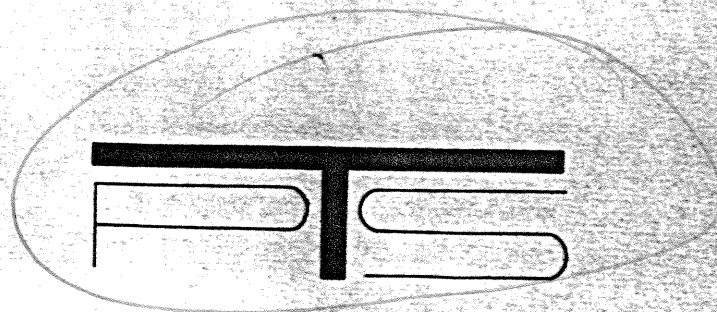


# **PTS 160 SYSTEM SECTION**



**PROGRAMMED TEST SOURCES, Inc.**

**Littleton, Massachusetts, USA.**

## TABLE OF CONTENTS

Introduction .....	1
Manual Organization .....	1
Specifications .....	2
Installation .....	3
Operation .....	5
Power Connection .....	5
Warm-Up .....	5
External-Internal Frequency Standard .....	5
Controls, Front Panel .....	5
Rear Panel Controls and Connectors .....	6
Remote Frequency/Level Control .....	8
Principles of Operation .....	9
General .....	9
Standard Frequency Section .....	9
Fine Resolution Section .....	10
10 MHz Step Section .....	10
Service .....	12
General .....	12
System Troubleshooting .....	12
Mainframe Components .....	15
Power Supply .....	15
Crystal Oscillators .....	15
Program Board PE 1021 .....	16
505 MHz Filter (390-1000) .....	16
Table 1. PTS 160 Remote Frequency/Level Control .....	17
Table 2. System Troubleshooting .....	18
Parts Lists .....	19
Figure 1 (Cabinet Dimensions) .....	21
Figure 2 (Front Panel) .....	22
Figure 3 (Rear Panel Controls) .....	23
Figure 4 (Block Diagram, PTS 160) .....	24
Figure 5 (Location of Test Points) .....	25
Figure 6 (Schematic, PS 1019) .....	26
Figure 7 (Schematic, PE 1021) .....	27
Figure 8 (Non-RF-Wiring, Deck) .....	28
Figure 9 (Module Location) .....	29

## INTRODUCTION

This manual covers the PTS 160 Frequency Synthesizer and contains information necessary to install, operate and service the instrument.

The PTS 160 is a precision frequency generator. It uses the accuracy and stability of a frequency standard operating at 5.0 or 10.0 MHz, either built-in or external, to produce output frequencies between 0.1 and 159.999 999 9 MHz, with up to 10 significant figures. All output frequencies are coherent with the standard frequency and reflect its stability and accuracy. Any frequency within the above band may be selected by manual dial or by remote control with resolution as fine as 0.1 Hz. The output from the levelled system is +3 to +13 dBm into 50 ohms and may be adjusted manually by the front panel control and meter or remotely by analog voltage.

The PTS 160 is a direct frequency synthesizer capable of providing signals for many uses requiring stable and accurate sine-wave signals with low attendant spurious outputs, low phase noise and fast transfer between selected frequencies. Typical applications include communications, spectrum analysis and surveillance, radar and automatic test systems with both narrow and wideband coverage.

### Manual Organization

The PTS 160 is a complete and integrated system using up to 13 modules installed on a deck inside the instrument mainframe. All data pertaining to the total instrument as a system are presented in the System Section of this manual. This section also covers items which are integral parts of the mainframe, such as power supply, front panel, rear panel and crystal oscillator. Modules which are mounted on the deck are covered in subsequent sections. The GPIB interface which mounts to the rear panel, like the PE 1021 board, is treated in a separate section.

## SPECIFICATIONS

### Frequency

Range:	0.1 MHz to 159.999 999 9 MHz
Resolution:	0.1 Hz to 10 KHz steps (optional)
Control:	Local by 10-position switches with dial; remote by TTL-Logic, 1,2,4,8; parallel-entry BCD; (hexadecimal for 0-15, 10 MHz steps). Neg true. 8-bit byte storage. IEEE 488 GPIB interface optional.
Switching Time:	20 microsec (within 0.1 rad at new frequency)

### Output

Level:	+3 to +13 dBm, (1V) into 50 $\Omega$ , metered in dBm and volt.
Flatness:	$\pm 0.5$ dB
Impedance:	50 $\Omega$
Control:	Manual by F/P-control, remote by voltage; RMS-output voltage into 50 $\Omega$ equals 1/2 positive DC-control voltage.
Settling Time:	50 microsec

### Spurious Outputs

Discrete:	-75 dB
Harmonics:	-35 dB at full output (improved at lower level)
S/N (phase):	-63 dBc (0.5 Hz to 15 KHz), incl. effects of int. std.
Noise Floor:	-135 dB/Hz

### Frequency Standard

Internal (option):	$3 \times 10^{-9}$ /day, or $1 \times 10^{-8}$ /day
External Drive:	5.000 or 10.000 MHz, 0.5V into 300 $\Omega$
Aux. Output:	10.000 MHz, 0.4V into 50 $\Omega$
Oper. Ambient:	0 to 55°C, 95% R.H.
Power:	105 to 125V, 50 to 400 Hz, 40 Watts (200-230V avail.)
Dimensions:	19x5-1/4x18" (Relay rack or bench cabinet)
Weight:	35 lbs



## INSTALLATION

**CAUTION:** Refer to Primary Power below, before connecting instrument to line.

### Unpacking

Your instrument has been built, tested and packed carefully and should reach you in perfect mechanical and electrical condition. Please inspect both the carton and the cabinet upon receipt for evidence of damage that might have occurred in transit. In case of damage or defect, a claim must be filed with the carrier immediately.

### Dimensions, Weight

Outside cabinet dimensions of the instrument for both the rack and bench versions are given in Figure 1.

### Primary Power

The PTS 160 is designed to operate from power lines with 115 or 220 VAC, +5%-10%, 50-400 Hz. Before operating your instrument, be certain that it has been connected and fused for your line voltage; this is indicated on the rear panel. Improper setting may lead to damage of the instrument.

Proper grounding of the mainframe to the neutral or ground of the power system is accomplished via the NEMA-approved receptacle and the 3-wire power cord supplied. For the safety of the operator, an approved adapter must be used with 2-wire outlets; such adapter must provide positive connection to the electrical conduit or other low resistance ground. Depending on module complement (resolution), the power consumption of the PTS 160 is approximately 40 Watts.

### **Bench Use**

For bench use the PTS 160 is equipped with a fold-down tilt stand. Stacking of the instrument is permissible, provided convection cooling of the heat-sink on the rear panel is not prevented by deep, overhanging cabinets.

### **Rack Mounting**

The instrument may be mounted to a standard 19-inch relay rack, if ordered with the rack mounting option. Where shock or vibration are encountered, it is suggested that rear or side supports be provided for the instrument.

## OPERATION

### Power Connection

Before attempting to connect the instrument to the primary power, verify proper line voltage connection and fusing; refer to **Primary Power** under **INSTALLATION**.

### Warm-Up

The PTS 160 is operative on turn-on. If the instrument is equipped with an oven-type crystal oscillator, a period of 20 minutes is required at 25°C ambient for the frequency to be within  $\pm 1 \times 10^{-7}$  of nominal. In general, it is desirable to operate the equipment continuously for best frequency stability.

### External-Internal Frequency Standard

The synthesizer may be operated from either the internal or an external frequency standard (5.0 or 10.0 MHz). If no external standard is used, the standard frequency selector switch (rear panel) has to be set to INT. STD.; otherwise no output is generated.

### Controls, Front Panel

Figure 2 identifies all controls provided on the front panel for local operation.

- (a) *Frequency Selector Switches with Dial* — A 2-position switch controls the 100 MHz step, and 10-position switches control the 10 MHz to 0.1 Hz steps. Instruments with less than full resolution have blank dial-switches for steps which are not equipped. The highest output frequency obtainable from the PTS 160 is 159.999 999 9 MHz. The first two dials can be set to numbers in excess of 15; these positions are not valid, however.

- (b) *Local/Remote Indicators* — LEDs indicate the mode in which the instrument is operated. The remote mode is enabled via the program connector on the rear panel; see **Rear Panel Controls and Connectors**, below. Manual dial settings indicate frequency only when operating in the local mode.
- (c) *Level* — Continuously variable control to set output to desired level between +3 and +13 dBm into 50 ohms, with the aid of the meter. (The fully ccw position disconnects this control for remote level setting.)
- (d) *Meter* — The meter indicates voltage or power in dBm delivered to a 50-ohm load. Voltage behind a 50-ohm source resistor is monitored, and the meter indicates one-half of this value. Calibration is valid for 50-ohm loads only.
- (e) *Output Connector* — BNC jack supplies instrument main output.
- (f) *Power Switch* — When non-continuous operation is desired, the primary power may be interrupted by this switch. Local/remote indicators serve as line-power indicators.

With these controls any frequency between 100 KHz and 159.999 999 9 MHz may be selected, subject to the resolution (option) of the instrument. When a power output of less than +3 dBm is desired, the use of 50-ohm attenuators is recommended.

#### **Rear Panel Controls and Connectors**

Figure 3 shows rear panel controls and connectors for programming and auxiliary inputs and outputs.

- (a) *Primary Power Receptacle, 3-wire* — Accepts power cord supplied with instrument.

- (b) *Fuse Holder* — Fuse rating and primary supply voltage for the instrument are indicated beside the fuse holder.
- (c) *Optional Location for Instrument Main Output Jack* — If equipped, the front panel output connector is inactive.
- (d) *External Frequency Standard Input* — Accepts 5.000 000 or 10.000 000 MHz of 0.4-0.6V into 300 ohms to control instrument in connection with the following slide switch.
- (e) *Slide Switch* — Selects the internal or an external frequency standard. It must be set to INT. STD if no external input is provided.
- (f) *10 MHz Standard Frequency Output of 0.4V into 50 ohms* — This output may be used to drive other synthesizers without internal standard as *slaves*.

NOTE: Either the 5/10 MHz input or the 10 MHz output can be used to synchronize a counter in a checkout of the instrument. For complete correspondence of dial settings and counter readings, synchronization is required or the difference in the two frequency standards will show up.

- (g) *Program Connector* — Amphenol 57-40500 requires 57-30500 to control. The pin-out of the connector is given in Table 1. All functions connect directly to 74 type ICs. For complete flexibility no internal pull-up or pull-down resistors are built in. Connection to ground will enable all functions, which are negative true. To set the instrument to the local control mode for front-panel frequency-selection, either remove the remote control connector or make certain that pin 42 is *high*. This connector, via pin 22 and associated ground pin 21, also permits control of the output amplitude.

## Remote Frequency/Level Control

Both frequency and amplitude of the output can be remotely programmed. Further, the mode of frequency control, local or remote, is also programmable. If it is desired to go to remote frequency control, but do this locally, a switch from ground to pin 42 in the program connector will permit it. Table 1 lists all pertinent data for remote programming by parallel entry.

Amplitude programming by analog voltage is under front panel potentiometer control, but pin 22 of the program connector is wired in parallel. The panel pot is disconnected when the ccw end-switch is actuated. Units without manual (front panel) controls are supplied with a deck-mounted screwdriver-adjust 10 K $\Omega$  potentiometer to pre-set level.

Frequency programming is BCD-parallel *transparent* if the Latch Enable lines are left *high*. A TTL *low* on these lines will store the last command. The full control word may be broken up into separate bytes, such that serial loading is feasible. (Also see Parallel Entry Board PE 1021, page 16.)

Frequency and amplitude programming via the IEEE 488 Bus is accomplished with the GPIB option, described in a separate section.

## PRINCIPLES OF OPERATION

### General

An overview of the system is presented here by discussing the block diagram in Figure 4. Detailed module descriptions are found in subsequent sections. This material is essential for efficient service, and familiarity with it is assumed in the service instructions.

All output frequencies of the PTS 160 are derived from the crystal oscillator by arithmetic operations and are fully coherent with the standard 10 MHz frequency. The instrument uses a simplified direct synthesis in which all auxiliary fixed frequencies are produced from a 10 MHz pulse. The final output frequency comes from a beat-frequency system, as follows:

A signal of 365 to 355 MHz, which carries all 0.1 Hz to 1 MHz steps, is subtracted from a 365 to 515 MHz signal which carries the 10 MHz steps. The resultant output ranges from 0.1 MHz to 160 MHz. The 0.1 MHz is the practical cutoff in the output amplifier; lower frequencies could otherwise be obtained. Strictly speaking, 160 MHz is not a settable output, but for simplicity in discussing bandwidths the 0.1 Hz difference is neglected.

The block diagram shows a crystal oscillator which is the prime reference in the system and three sections: a standard frequency section, a fine resolution section and a 10 MHz step section. An output amplifier completes the system.

### Standard Frequency Section

This section consists of the SGA and SGB modules; they provide all fixed standard frequencies needed and operate from an input of 10.000 MHz (or 5 MHz which is automatically doubled). For either input a filtered 10 MHz signal is fed to a pulse generator, where harmonics of 10 MHz up to 140 MHz are generated

with equal amplitude. This *picket fence* is the basis for all fixed standard frequencies. The SGA and SGB modules supply: 112 and 113 MHz; 14, 16, 18, 20 and 22 MHz for use in the fine resolution section. The 10 MHz picket fence from the SGA module is also fed to the 10 MHz step section. The above frequencies all come from arithmetic operations on the original 10 MHz multiples.

### Fine Resolution Section

This section may contain up to 7 DM modules ( $10^{-1}$  to  $10^5$  Hz steps), and most of the synthesis process is accomplished in these repetitive modules which are identical in design. They all operate *in series*, meaning that the output of a lower-order digit feeds the input of the next higher order digit-module. One further module is included in this section because it is nearly identical to the DM modules: The DMA module produces the 1 MHz steps. All DM modules use 112, 113 MHz and 14 to 22 MHz.

The function of the series-connected DM modules is to produce frequency increments on a 14 MHz *carrier* in accordance with dial settings (or remote program) up to the 100 KHz step. If, for instance, a frequency of 0.543 210 MHz has been selected, the output of the DM which feeds the DMA is 14.543 210 MHz. The DMA module adds the 1 MHz steps and also transfers the information to a frequency which can carry a 10 MHz bandwidth more readily. The *carrier* at the output of the DMA is 140 MHz, and, if the above selection is expanded to, say, 6.543 210 MHz, then the output of the DMA is 146.543 210 MHz. A more complete description of this process is found in the DM module section of the manual.

### 10 MHz Step Section

In this section frequencies are used which are not standard-frequency-derived. Frequencies mentioned in previous paragraphs were all as accurate as the standard 10 MHz frequency. In this section the VCO frequencies from 365 to 515 MHz (in 10 MHz steps) may differ from their nominal values by as much as



1 MHz; as will be shown, such deviation from the absolute value has no effect on the output frequency. The Stepped Oscillator operates in a drift cancelled loop which serves two functions:

1. Selection and filtering of one of fourteen 10 MHz pickets by a fixed 505 MHz filter.
2. Supply of frequencies high enough for the final mixer, with a high degree of coherence in the two mixer inputs.

The block diagram shows some of the VCO frequencies corresponding to certain 10 MHz steps as examples. These will be helpful in recognizing the complete synthesis process via a sample frequency.

If we return to our previously chosen sample frequency in the fine resolution section of 146.543 210 and assume that we have set the 10 MHz dials to 10, our complete frequency setting is 106.543 210 MHz. As shown in the block diagram for the 10 step the VCO will produce a frequency of 465 MHz, which is fed to two different mixers. In the mixer near the 505 MHz filter, the picket fence line of 40 MHz will add to the 465 MHz and feed 505 MHz through the filter and into the next mixer. After that mixer the lower sideband of 505 and 146.543 210 is filtered out by a 355 to 365 MHz bandpass filter; in this case the frequency is 358.456 790 MHz. This frequency enters the output mixer where it is subtracted from the VCO frequency of 465 MHz. The resultant difference is 106.543 210, our selected output frequency. After a low-pass filter the output frequency is amplified and fed to the output connector.

As can be seen, the VCO feeds both inputs to the final mixer, one directly and one after one intermediate mix. Therefore, if the VCO frequency deviates from nominal, *both* mixer inputs move up or down in frequency together by the same frequency increment. This obviously does not alter the difference of these two frequencies, which is the desired output frequency.

## SERVICE

### General

No preventive maintenance is required for the PTS 160 frequency synthesizer. For convenience of service all modules are easily removed from the deck and replaced. It is the purpose of this section to provide information which, in case of malfunction, permits the identification of a defective module.

The preferred service procedure is the exchange and factory-service of the module. The individual module sections provide information for module service, should spare modules not be available for exchange.

### System Troubleshooting

Test equipment recommended for troubleshooting:

RF-Voltmeter V	1-600 MHz, 10 mV - 1V, High Impedance Probe (3 pF, DC Res. 100 K $\Omega$ )
HF-Counter C	0-200 MHz or 0-20 MHz, 10 mV Sensitivity, High Impedance or 50 $\Omega$ input, 10 Hz Resolution; input for External Drive for Synchronization with 10 MHz, 0.5V into 50 $\Omega$
Spectrum - Analyzer SA	10-600 MHz, 50 $\Omega$ ; min. 60 dB on-screen dyn. range. Max. BW 1 MHz; min. Sensitivity -40 dBm
Multimeter	Analog or Digital, 0-15V; 0.1V Resolution; 0-2A; 0.1A Resolution

Test equipment is referenced in Table 2 as noted above (V, C, SA). The Voltmeter and Counter must have high DC input resistance since connection is made to points with +5.4V potential. The RF-Voltmeter probe connects directly to test points. The Counter is connected via a RG 174 or similar RF Cable equipped with small alligator clips.

If the instrument output is absent, proceed as follows. With instrument connected to line, power switch in the ON position, either the REMOTE or LOCAL indicator light should be on. Check fuse if no indication is obtained. Use only fuse of proper rating to replace. If indicator light is on, set instrument to the local mode (see **PRINCIPLES OF OPERATION**) and dial desired frequency; if no output is obtained, check rear panel output Standard Frequency, 10 MHz output. 0.4V into 50 ohms should be obtained. If no output is present (and the instrument is equipped with an internal standard and set to INT. STD.), the bottom cover of the instrument has to be removed. Disconnect unit from power line. Remove two screws holding the lip on the rear panel, two screws in the front of the case, and carefully withdraw cover. To fully withdraw from case, cover has to be deflected in the middle so that fold-down stand screws clear rear panel.

After unit is powered again, check for presence of supply voltages -12.4V (blue wire) and +5.4V (green wire) at the terminals of the power supply on the rear panel. If voltages are within  $\pm 0.2V$ , proceed; if voltage is absent or low, measure current in the leads from the supply. The proper 5.4V current is 1-1.25A; the proper 12.4V current is 0.8-1.0A, depending on resolution and crystal oven temperature. This test will isolate a faulty power supply, a short, or an overload in the instrument.

If the output is still absent or incorrect, the following tests are made with the aid of Table 2 which lists test points, signal frequencies and levels. Figure 5 shows location of test points.

To run a full diagnostic check, all test instruments with the upper frequency limits are required. It is possible, however, to test most of the instrument with the RF-Voltmeter and the 20 MHz Counter.

Proceeding from the crystal oscillator through the Standard Frequency Section and the Fine Resolution Section, most tests for presence of signal and proper frequency can be made *bridging*, without opening connections. These checks cover the bulk of the instrument. To check signals in the 10 MHz step section and the output amplifier, 50-ohm SMA connections will have to be made.

## MAINFRAME COMPONENTS

### Power Supply

The power supply, operating from commercial power lines, generates DC voltages of +5.4V and -12.4V. The former is used for TTL and MECL logic (fed by decoupling networks), and the 12.4V powers the transistor amplifiers. Total current is 1.25A at 5.4V and 1.0A at 12.4V, approximately.

Both regulators operate from capacitor input filters, fed by silicon rectifier bridges. The series-pass transistor, gain- and reference-elements are integrated in a TO-3 package which is heat-sunk to the rear-panel. Both supplies are short circuit-proof with fold-back.

The transformer uses paralleled primaries for 120V use and switch-selected 100V, 120V, 220V and 240V inputs.

In case of malfunction use the schematic which lists essential DC voltages for both supplies to locate the faulty component or replace the supply-board as a unit.

### Crystal Oscillator

The PTS 160 may be supplied with a built-in oven-type or TCXO crystal oscillator operating at 10 MHz. It is mounted on the instrument rear panel and has the following characteristics:

Type:	Oven Type	Moderate Stability TCXO
Frequency:	10.000 000 MHz	
Aging:	$3 \times 10^{-9}/\text{day}$	$1 \times 10^{-8}/\text{day}$
Temperature Coefficient:	$\pm 2 \times 10^{-10}/^{\circ}\text{C}$	$2 \times 10^{-8}/^{\circ}\text{C}$
Output:	1V RMS into 500 $\Omega$	1V RMS into 500 $\Omega$
Warm-Up Time:	24 hrs for $1 \times 10^{-8}$	—
DC Supply:	-12.4V, 250 mA (500 mA turn-on)	-12.4V, 20 mA

### Parallel Entry Board PE 1021

This board, which is mounted to the rear panel and directly connected with the Amphenol 57 type program input connector, contains circuitry to interface the outside programming signals for frequency control with the digit modules in the instrument. It also effects the transfer from local to remote frequency control with the remote enable command. The programming format is parallel entry, 1, 2, 4, 8 BCD for each digit. TTL logic levels are used and all commands are negative true. The 74LS373 type latches provide storage when this mode of operation is desired. To store a program input, Storage Enable pins must be brought to the *low* state. Table 1 indicates pin assignments in the last column. Note that enable lines "LE" are provided so that serial operation with separate bytes is possible. With reference to Figure 7, U5 is used to control a switch consisting of two transistors. U5 accepts the remote enable signal which is normally negative true. In the Local mode, latches are set to the "off" (third) state, and 5.1V is supplied to the front-panel switches. U14 is not used in normal operation. Pin assignment in the 57-40500 connector is shown in Table 1.

### 505 MHz Filter (390-1000)

This 5-section cavity filter forms part of the 10 MHz step section. It is fixed-tuned and cannot be retuned in the field. The 390-1000 is bolted to the back lip of the deck.

TABLE 1. PTS 160 REMOTE FREQUENCY/LEVEL CONTROL

Amphenol 57-40500—On Equipment

Amphenol 57-30500—Required to Control

		Weight:	1	2	4	8	Latch Enable
Digit			Pin Numbers				
10	MHz (0-15, Hexadecimal)		15	16	40	41	23
1	MHz		17	18	19	20	24
100	KHz		1	2	26	27	24
10	KHz	(0-9, BCD; 10-15 Invalid)	3	4	28	29	25
1	KHz		5	6	30	31	25
100	Hz		7	8	32	33	46
10	Hz		9	10	34	35	46
1	Hz		11	12	36	37	47
0.1	Hz		13	14	38	39	47

Remote Enable = Pin 42

Ground = Pin 50

All functions are negative true, TTL.

Levels: Low, + 0.7V max

High, + 2.0-5.0V

#### ANALOG LEVEL CONTROL

Remote-Level = Pin 22

(Ground = Pin 21)

RMS output =  $0.5 \times \text{pos. DC Control voltage}$

(e.g. 1VRMS output + 2.0VDC)

NOTE: Remote level input will sink or source current depending on voltage applied.

Impedance : >3K (Unit with Front Panel controls)

>1K (Remote-only unit)

TABLE 2. SYSTEM TROUBLESHOOTING

Step	Test Point	Frequency (MHz)	Level	Test Equipment	Module Checked	Notes
1	SGA, 51	10.000	0.4V	V, C	Freq. Std. Drive	
2	SGA, 49	10.000	0.4V	V, C	SGA	
3	SGA, 20	18.000	0.1V	V, C	SGA	
4	SGA, 43	20.000	0.1V	V, C	SGA	
5	SGA, 6	22.000	0.1V	V, C	SGA	
6	SGA, 2	33.000	90 mV	V, C	SGA	
7	SO, J1	10-140	-17 dBm	SA	SGA	4
8	SGB, 10	14.000	0.1V	V, C	SGB	
9	SGB, 24	16.000	0.1V	V, C	SGB	
10	DMA, 1	112.000	0.1V	V, C	SGB	2
11	DMA, 10	113.000	0.1V	V, C	SGB	3
12	DM, 50 (all)	14.000	0.25V	V, C	DM	2
13	DMA, 50	140.000	0.40V	V, C	DMA	2
14	Filter-Output	505 $\pm$ 1	-35 dBm	SA	SO, F	5
15	IM, J3	355 $\pm$ 1	-16 dBm	SA	IM	2
16	SO, J3	100.000	-25 dBm	SA	SO	2
17	OA, J1	100.000	+13 dBm	SA	OA	2

## Notes:

1. Test point designations show the module type and the pin number (position) of the board-edge connector, as used on the module schematic and Figure 5.
2. Set instrument to 100.000 000 0 MHz
3. Set instrument to 101.000 000 0 MHz - 1V output (set-level volt. = +2 VDC)
4. Remove SO module, connect SA in place of SO, J1. Each 10 MHz multiple from 10 to 140 MHz to be displayed.
5. Set instrument to all 10 MHz steps (0 - 150 or 190 MHz).



# PS-1019 PARTS LIST

Schem. Desig.	Description	PTS P/N
------------------	-------------	---------

## CAPACITORS

C1	4,700 $\mu$ F, 25V	31-5104
C2	6.8 $\mu$ F, 16V	30-5101
C3	6.8 $\mu$ F, 16V	30-5101
C4	10,000 $\mu$ F, 16V	31-5102
C5	6.8 $\mu$ F, 16V	30-5101
C6	6.8 $\mu$ F, 16V	30-5101

## RESISTORS

R1	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0152
R2	243 $\Omega$ , 1%, $\frac{1}{4}$ W	14-5105
R3	1 K $\Omega$ , Pot., 10%, .75W	17-5104
R4	590 $\Omega$ , 1%, $\frac{1}{4}$ W	14-5112
R5	243 $\Omega$ , 1% $\frac{1}{4}$ W	14-5105
R6	500 $\Omega$ , Pot., 10%, .75W	17-5103

## DIODES

CR1	3A, 100V	74-5100
CR2	3A, 100V	74-5100
CR3	3A, 100V	74-5100
CR4	3A, 100V	74-5100
CR5	3A, 100V	74-5100
CR6	3A, 100V	74-5100
CR7	3A, 100V	74-5100
CR8	3A, 100V	74-5100

## INTEGRATED CIRCUITS

U1	LM350K	64-0350K
U2	LM350K	64-0350K

## TRANSFORMERS

T1	50-400 Hz	83-5102
----	-----------	---------

# PE-1021 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	6.8 $\mu$ F, 20%, 16V (tant.)	30-5101
C2-C6	50 nF, 80/20, 50V, Z5V	23-0503
RESISTORS		
R1	1 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0100
R2-R6	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R7	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R8, R9	2.2 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1220
R11-R42	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
TRANSISTORS		
Q1, Q2	2N 2905	42-2905
INTEGRATED CIRCUITS		
U1-U4	74 LS 04	63-0004
U5	74 LS 05	63-0005
U6, U7	74 LS 04	63-0004
U8-U13	74 LS 373	63-0373
CONNECTORS		
J1	50 pos. conn. (series 57 compatible)	78-1050
HEADER STRIP		
P1	25 pos., single row	79-1003

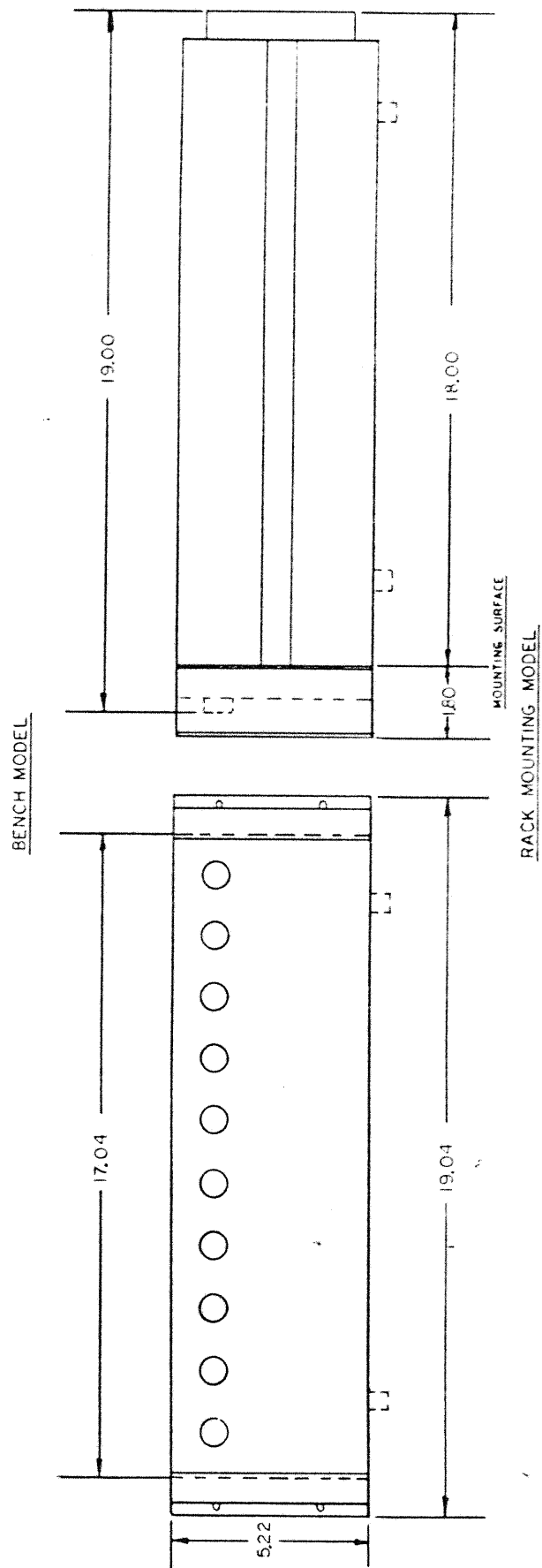


Figure 1

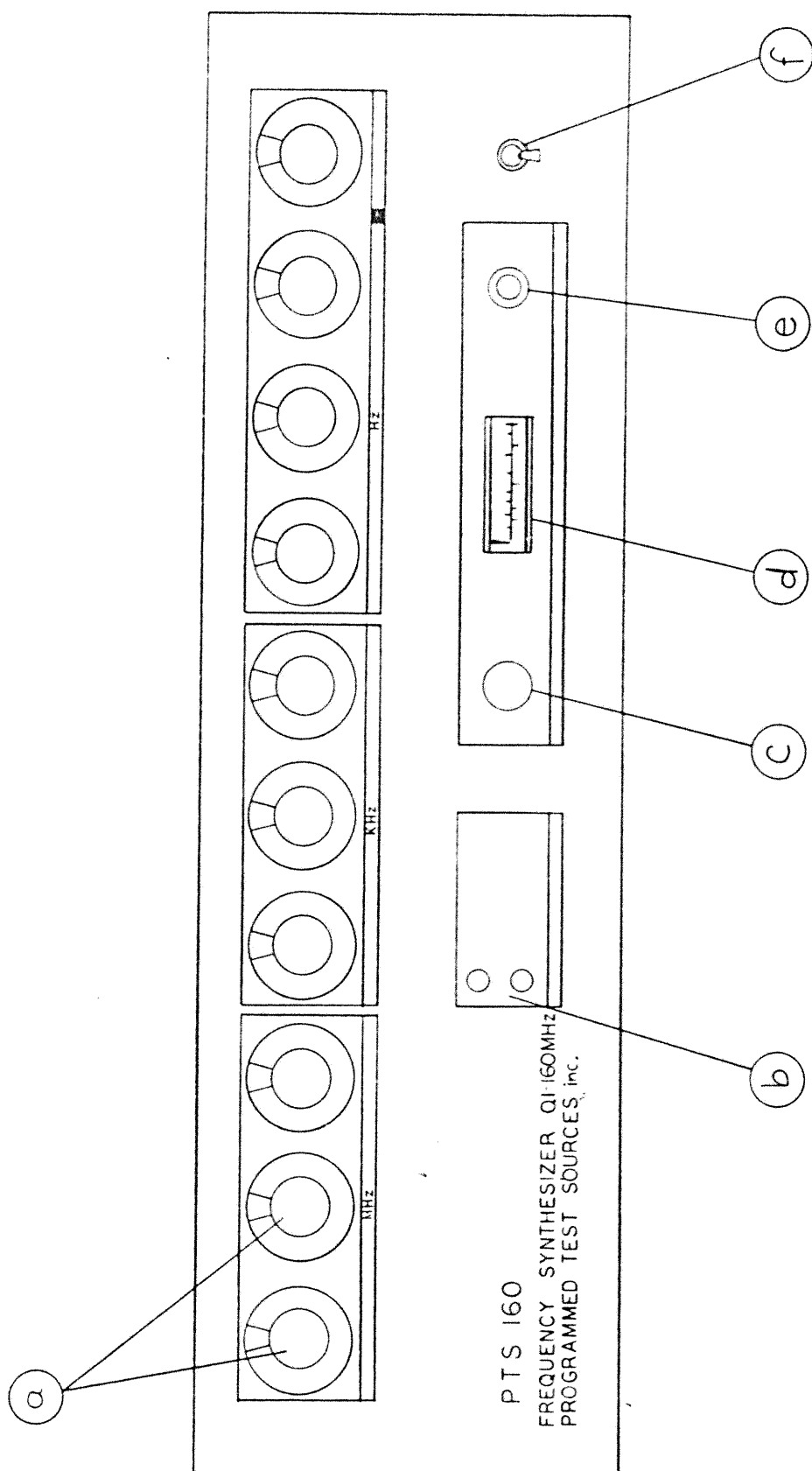


Figure 2

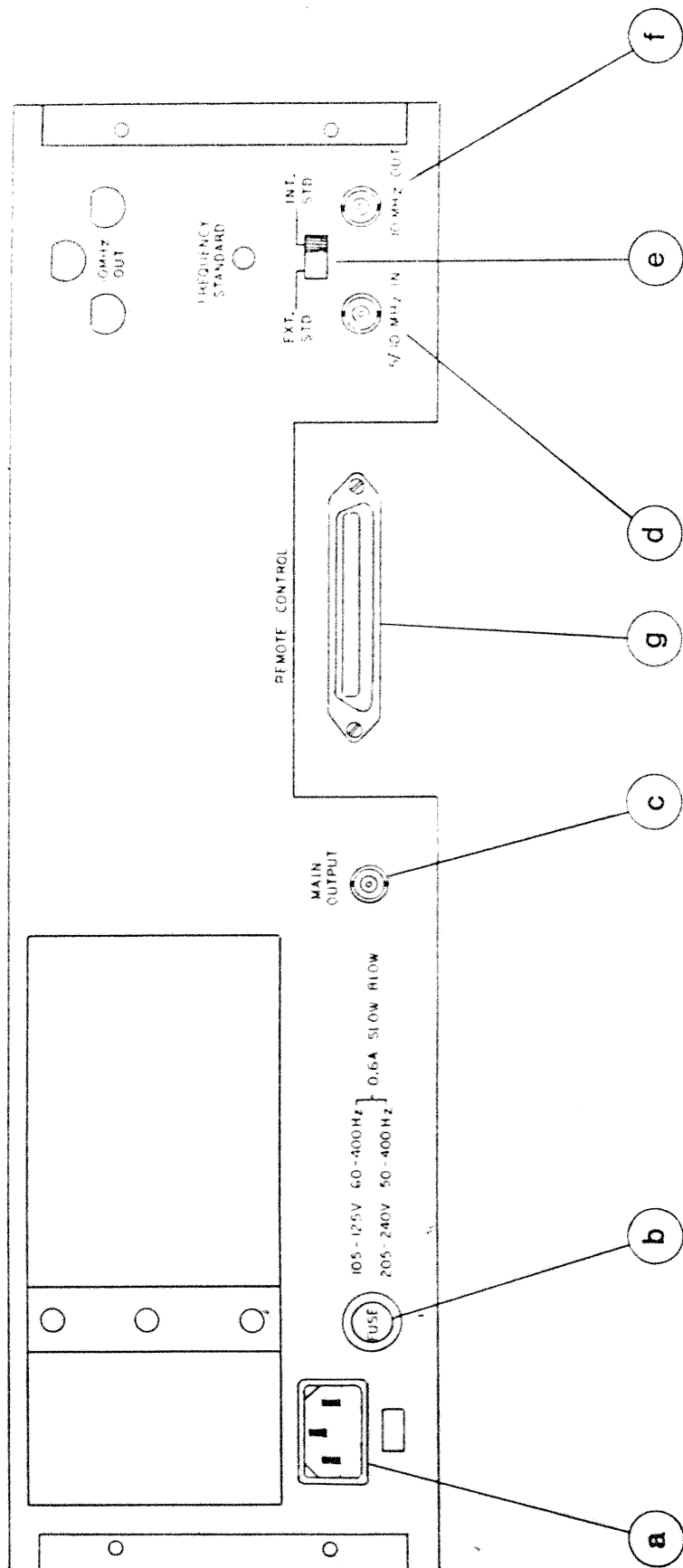


Figure 3

# BLOCK DIAGRAM, PTS 160

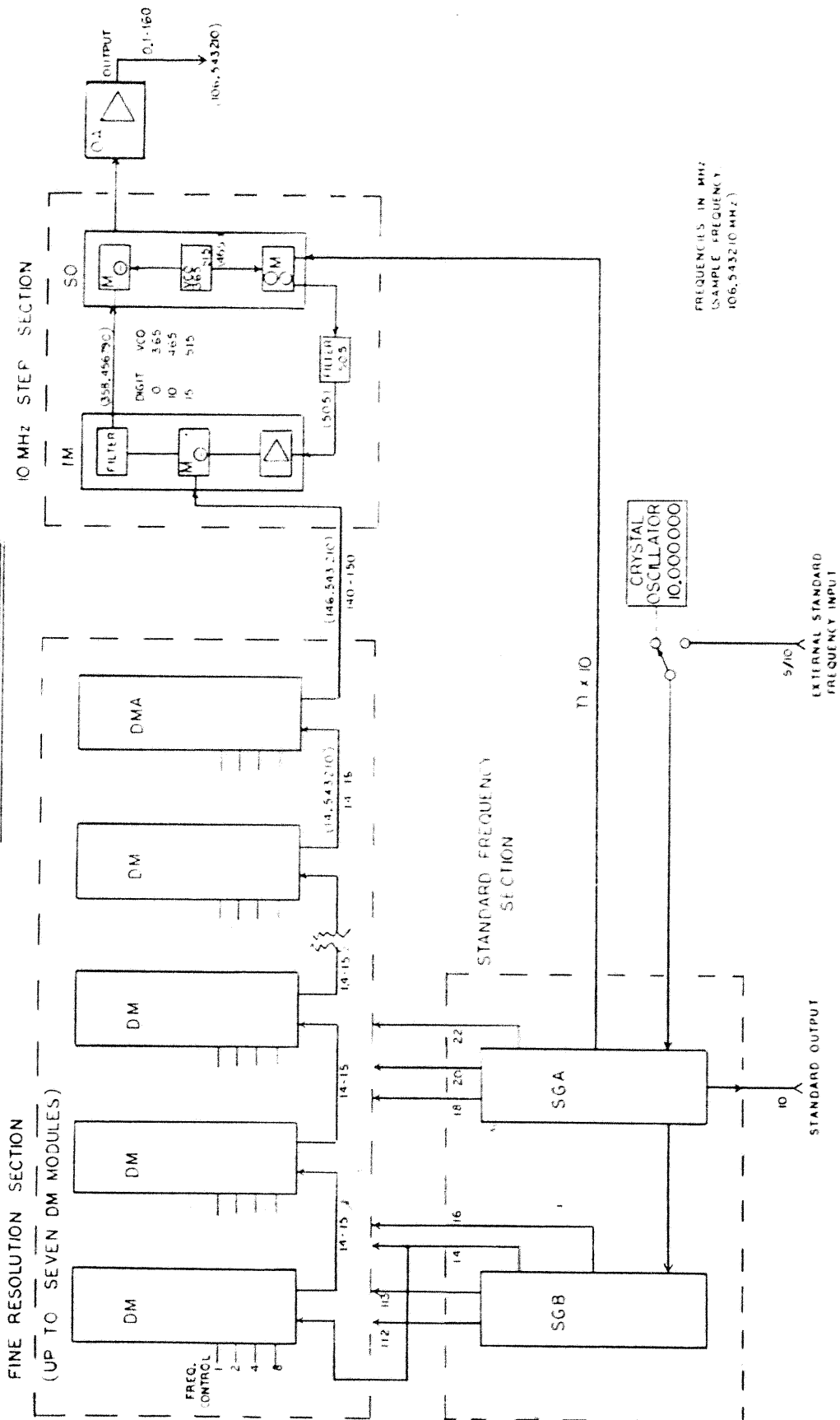


Figure 4

LOCATION OF TEST POINTS  
(BOTTOM VIEW OF DECK)

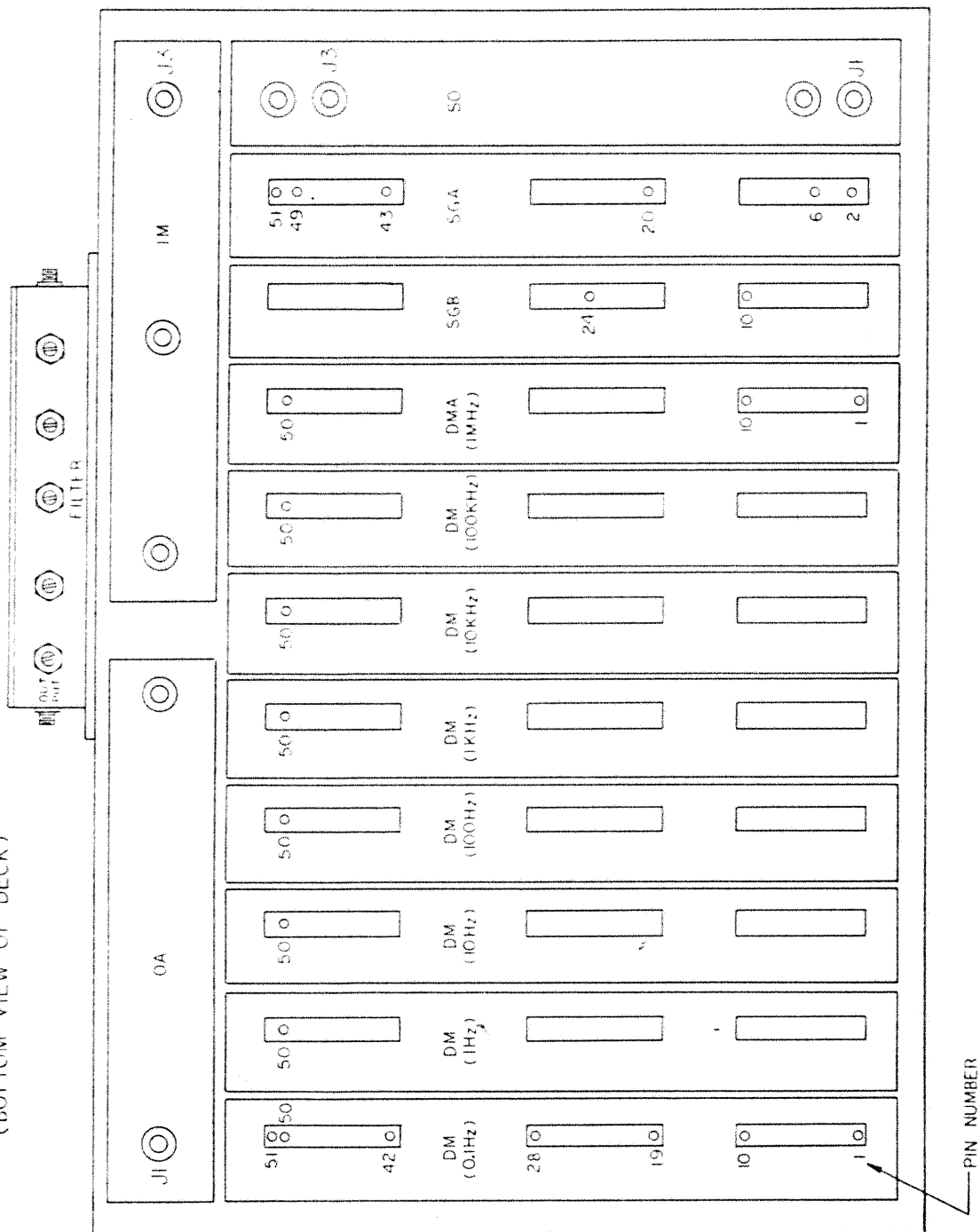


Figure 5







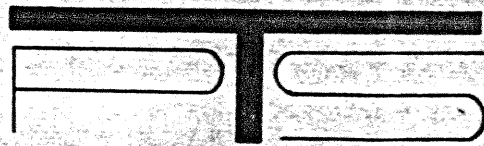
**Figure 7**



- 29 -

**DM-1000**

**SECTION**



**PROGRAMMED TEST SOURCES, inc.**

Littleton, Massachusetts, USA.

## TABLE OF CONTENTS

Introduction .....	1
Principles of Operation .....	2
Module Specifications .....	4
Service .....	5
Maintenance .....	5
Alignment .....	5
Troubleshooting Procedure .....	5
Parts List .....	8
Figure 1 (Block Diagram) .....	13
Figure 2 (Block Diagram) .....	14
Figure 3 (Schematic) .....	15
Figure 4 (PC Assembly) .....	16

## INTRODUCTION

The DM-1000 is used repetitively, up to seven times per instrument, to synthesize, according to external command, all digits from the 0.1 Hz to the 100 KHz step. The actual number of DMs used is dependent on the resolution option (smallest frequency step) of the synthesizer: For 0.1 Hz steps seven DMs are needed; for reduced resolution the number decreases by one DM for each digit.

All DMs in the instrument operate in series; each module restores the signal to a normal output level independent of the level of input signals above a threshold. Although all DMs are identical and produce at their output 100 KHz steps, these steps are reduced to the proper significance by the repeated division in the chain. The module combines analog, VHF and digital techniques. It is programmed through four parallel lines in BCD. All inputs and outputs are fed through card-edge connectors with multiple low-inductance grounds provided for the RF signals. All DM-1000s are interchangeable; however, they are not interchangeable with the DMA-1005 or any other module in the synthesizer.

The digit module is of plug-in design and uses three ten-pin connectors with asymmetric spacing assuring proper orientation; it is secured with three 6-32 screws from the bottom of the deck. Housed in a frame and U-cover enclosure, the DM-1000 can be removed as a complete unit after releasing the 6-32 pan-head screws. The printed-circuit board may also be removed separately from the enclosure, after the four cover screws (4-40) on top have been released and the cover has been lifted off. Holes near the top corners of the board facilitate prying the board up and free of the connectors by using a small tool alternately on both sides. *and 2 (2-56)* ?

## PRINCIPLES OF OPERATION

The block diagram of Figure 1 shows a series-string of DM modules, which produce digit steps in a PTS synthesizer. The direction of signal flow in this string of modules is from the least significant to the most significant digit. The input to the first DM in the chain is 14.000 MHz from the 14 MHz bus in the deck; as the frequency is processed, it always remains between 14 and 15 MHz passing from one DM to the next.

The DM module has the following arithmetic capabilities: When receiving a frequency of 14.xyz . . . MHz from the predecessor, it will produce an output frequency of 14.axyz . . . MHz, where "a" directly corresponds to the dial setting (digit control) of the module. In other words, all digits behind the decimal point are moved to the right by one position (reduced in significance by ten), and a new 100 KHz step, as selected by the digit control (manual or remote), is placed ahead of the received digits.

The block diagram of Figure 2 shows the DM-1000 module. Apart from the input and output, the module is connected to the following fixed bus frequencies: 112 MHz, 113 MHz, 14, 16, 18, 20, 22 MHz, which are all crystal-oscillator-derived and coherent. For any one digit selection, the DM uses either 112 or 113 MHz and one of the five lower frequencies. 112 or 113 MHz is used to make even or odd digits; 14 MHz is used with digits 0,1; 16 MHz with digits 2,3; 18 MHz with digits 4,5, and so on.

To illustrate the operation, the block diagram (Figure 2) shows as a sample all frequencies which are internally produced in a DM, if it receives an input of 14.210 MHz and is set to digit "3". With the aid of the schematic of Figure 3, the circuitry used to effect the arithmetic may be traced.

14.210 MHz as received on pin 3 is fed to the base of Q10, an additive mixer. Digit control pins 5 and 6 (weight 1 and 2) are "high" if a "3" is selected, and decoder-ICs U1 and U2 furnish two DC outputs: "3" being odd, Q2, the 113

MHz switch, is turned on; and, since "3" belongs to the second pair of ten frequencies (2,3), Q5, which controls 16 MHz, is turned on.

113 MHz reaches the base of Q10 via C28. The upper sideband (sum) of the two inputs to Q10, 14.210 MHz and 113 MHz, is 127.210 MHz. Two double-tuned filters and amplifier Q11, which have a passband of 126-128 MHz, deliver this frequency to the input of the second mixer Q8/Q9.

T1 is connected to the output of switch-transistors Q3 to Q7, and, since Q5 is turned on, 16 MHz is the other input to the second mixer. Again, the circuits following are tuned to select the upper sideband, which is between 140 and 150 MHz. Our specific sample signal is 127.210 MHz plus 16 MHz, or 143.210 MHz. The filters suppress the lower sideband and other unwanted products. After amplification, the signal reaches U3, which is a digital divide-by-ten IC. The output is filtered by a tuned circuit, and a signal of 14.3210 MHz is fed to pin 50. As we see, a "3" has been placed ahead of "210", and the latter digits have moved one position to the right. In this fashion, a multi-digit number is synthesized.



## MODULE SPECIFICATIONS

Inputs:	14 - 15 MHz	0.20 - 0.35V
	112, 113 MHz	0.10 - 0.17V
	14,16,18,20,22 MHz	90 - 125 mV
Output:	14 - 15 MHz	0.25 - 0.31V nominal
		0.20V minimum
		Load: 1.3 K $\Omega$ parallel 30 pF
Programming:	1,2,4,8 BCD, positive true	
	High: 3.0V minimum	Low: 0.5V maximum
Spurious Outputs:	-75 dB	
Power:	+5.4V, 100 mA $\pm$ 10%	-12.4V, 38 mA $\pm$ 10%
Operating Temp:	0 - 60°C	

## SERVICE

### Maintenance

No preventive maintenance is required for DM modules. The presence of an output signal of correct frequency and level indicates that the module is operating properly. The output of the module is produced directly by an IC divider. A 10 dB window exists at the divider input, and minor aging effects will, therefore, not impair operation.

Replacement of faulty components requires careful use of printed-circuit repair techniques as applicable to double-sided boards with plated-through holes.

### Alignment

Complete alignment of this module is made at the factory with a special test-set. Restoring the alignment after replacement of individual parts in the field is possible. It is recommended that voltages given in the Troubleshooting Procedure be used and that, in general, touch-up alignment be performed only on those tuned circuits which may have been altered by the parts replacements. Replacement of semiconductors will not necessitate realignment of tuned circuits in general.

### Troubleshooting Procedure

The System Section of this manual provides information to isolate faulty modules. It is important to follow the procedure given in detail to ensure that all the common supply frequencies are present before attempting to repair modules.

If a DM module has been isolated as faulty, the preferred service mode is exchange and factory repair. When immediate service is needed, the following procedure may be used.

#### Test Equipment Required:

RF Voltmeter      1 - 300 MHz, 10 mV - 1V, High Impedance Probe  
(3 pF, DC Res 100 K $\Omega$ )

HF Counter        0 - 200 MHz, 10 mV Sensitivity, High Impedance or  
50  $\Omega$  Input

The output of the DM module is on pin 50, which is also the test point designation used in the System Section and the running number of the board-edge connector as shown on the schematic (Figure 3). The module produces 14.000 MHz at a level of 0.2 - 0.35V into the next DM module if all instrument dials have been set to zero. As the dial of the module under test is changed through successive numbers 0 to 9, the output frequency should change in 100 KHz steps from 14.000 MHz to 14.900 MHz. If the output is of the proper frequency but low in level, the output tank L10/C62 or the tuning should be checked. C62 is peaked at a setting of 5 (14.500 MHz). Only the voltmeter probe must remain connected to pin 50 for final tuning.

Absence of output for some dial settings points to specific causes:

1. No output on *two* successive even-odd digits (e.g., 2,3) indicates that the second mixer, Q8, Q9 does not receive one of the low bus frequencies from 14 to 22 MHz, and the fault is likely located in the switch section (Q3 to Q7). 14 MHz is used for digit 0,1; 16 MHz for digit 2,3, and so on.
2. No output on either *all odd* or *all even* digits will result from failure in the 112/113 MHz switches Q1 or Q2, since 112 MHz is used to produce all even digits and 113 MHz to make the odd digits.
3. If no output is obtained on any digit, if random digits are missing, or if an unsteady counter reading (noise) is present, the divider (U3) is

faulty or the input on pin 7 is low. 0.2V minimum is to be read at this point with only the voltmeter connected. If the above checks (1 and 2) were positive, then part of the circuitry that is used on all digits must be faulty. The active devices are Q10, Q11, Q8, Q9 and Q12. DC operating conditions on all of these transistors are such that 1.1 to 1.5V should be measured across their emitter resistors R40, R45, R34 and R48.

RF voltages at various stages are given to permit further localization of the trouble. The previously indicated level of 0.2V into pin 7 of the divider is a minimum; other voltages may differ from normal by  $\pm 3$  dB.

Base Q10	0.10V
Base Q11	0.05V
C23/C24	0.50V
Base Q12	0.07V
U3, Pin 7	0.28V

The 126-128 MHz signal at C23/C24 peaks at digit setting "5" and drops approximately 2 dB for settings "0" and "9" on the preceding DM module (less significant digit). Voltage at pin 7 of U3 responds to digit settings on the DM under test, and the minimum voltage must be obtained for all settings.

## PARTS LIST

Schem. Desig.	Description	PTS P/N
<b>CAPACITORS</b>		
C1	1 nF, 10%, 500V, X5F	22-0102
C2	220 pF, 10%, 500V, X5F	22-0221
C3	50 nF, 80/20%, 50V, Z5V	23-0503
C4	1 nF, 10%, 500V, X5F	22-0102
C5	1 nF, 10%, 500V, X5F	22-0102
C6	50 nF, 80/20%, 50V, Z5V	23-0503
C7	50 nF, 80/20%, 50V, Z5V	23-0503
C8	220 pF, 10%, 500V, X5F	22-0221
C9	1 nF, 10%, 500V, X5F	22-0102
C10	1 nF, 10%, 500V, X5F	22-0102
C11	1 nF, 10%, 500V, X5F	22-0102
C12	1 nF, 10%, 500V, X5F	22-0102
C13	1 nF, 10%, 500V, X5F	22-0102
C14	1 nF, 10%, 500V, X5F	22-0102
C15	1 nF, 10%, 500V, X5F	22-0102
C16	1 nF, 10%, 500V, X5F	22-0102
C17	220 pF, 10%, 500V, X5F	22-0221
C18	220 pF, 10%, 500V, X5F	22-0221
C19	220 pF, 10%, 500V, X5F	22-0221
C20	220 pF, 10%, 500V, X5F	22-0221
C21	220 pF, 10%, 500V, X5F	22-0221
C22	68 pF, 5%, 500V, N750	21-0680
C23	22 pF, 5%, 500V, NPO	20-0220
C24	22 pF, 5%, 500V, NPO	20-0220
C25	10 nF, 80/20%, 50V, Z5V	23-0103
C26	27 pF, 5%, 500V, NPO	20-0270
C27	1-10 pF, Trimmer	26-5100
C28	5 pF, .25 pF, 500V, NPO	20-1500
C29	10 nF, 80/20%, 50V, Z5V	23-0103
C30	10 nF, 80/20%, 50V, Z5V	23-0103
C31	47 pF, 5%, 500V, NPO	20-0470
C32	22 pF, 5%, 500V, NPO	20-0220
C33	1-10 pF, Trimmer	26-5100
C34	0.68 pF, .25 pF, 500V, NPO	24-2680
C35	22 pF, 5%, 500V, NPO	20-0220
C36	1-10 pF, Trimmer	26-5100
C37	5 pF, .25%, 500V, NPO	20-1500
C38	5 pF, .25 pF, 500V, NPO	20-1500
C39	10 nF, 80/20%, 50V, Z5V	23-0103

## PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
CAPACITORS (continued)		
C40	10 nF, 80/20%, 50V, Z5V	23-0103
C41	22 pF, 5%, 500V, NPO	20-0220
C42	1-10 pF, Trimmer	26-5100
C43	0.68 pF, .25 pF, 500V, NPO	24-2680
C44	1-10 pF, Trimmer	26-5100
C45	22 pF, 5%, 500V, NPO	20-0220
C46	15 pF, 5%, 500V, NPO	20-0150
C47	1-10 pF, Trimmer	26-5100
C48	3.3 pF, 5%, 500V, NPO	20-1330
C49	10 pF, 5%, 500V, NPO	20-0100
C50	1-10 pF, Trimmer	26-5100
C51	5 pF, .25 pF, 500V, NPO	20-1500
C52	10 nF, 80/20%, 50V, Z5V	23-0103
C53	10 nF, 80/20%, 50V, Z5V	23-0103
C54	10 pF, 5%, 500V, NPO	20-0100
C55	1-10 pF, Trimmer	26-5100
C56	2.2 pF, .25 pF, 500V, NPO	20-1220
C57	10 pF, 5%, 500V, NPO	20-0100
C58	1-10 pF, Trimmer	26-5100
C59	10 pF, 5%, 500V, NPO	20-0100
C60	50 nF, 80/20%, 50V, Z5V	23-0503
C61	10 pF, 5%, 500V, NPO	20-0100
C62	1-10 pF, Trimmer	26-5100
C63	10 pF, 5%, 500V, NPO	20-0100
C64	68 pF, 5%, 500V, N750	21-0680

## INDUCTORS

L1	50 nH, nom.	35-5100
L2	50 nH, nom.	35-5100
L3	50 nH, nom.	35-5100
L4	50 nH, nom.	35-5100
L5	50 nH, nom.	35-5100
L6	50 nH, nom.	35-5100
L7	50 nH, nom.	35-5100
L8	50 nH, nom.	35-5100
L9	50 nH, nom.	35-5100
L10	5.6 $\mu$ H, 20%	36-5100

# PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS		
R1	10 K $\Omega$ , 5%, 1/4W	10-0103
R2	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R3	15 $\Omega$ , 5%, 1/4W	10-0150
R4	680 $\Omega$ , 5%, 1/4W	10-0681
R5	47 $\Omega$ , 5%, 1/4W	10-0470
R6	1 K $\Omega$ , 5%, 1/4W	10-0102
R7	10 K $\Omega$ , 5%, 1/4W	10-0103
R8	15 $\Omega$ , 5%, 1/4W	10-0150
R9	680 $\Omega$ , 5%, 1/4W	10-0681
R10	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R11	1 K $\Omega$ , 5%, 1/4W	10-0102
R12	47 $\Omega$ , 5%, 1/4W	10-0470
R13	47 $\Omega$ , 5%, 1/4W	10-0470
R14	680 $\Omega$ , 5%, 1/4W	10-0681
R15	10 K $\Omega$ , 5%, 1/4W	10-0103
R16	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R17	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R18	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R19	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R20	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R21	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R22	1 K $\Omega$ , 5%, 1/4W	10-0102
R23	1 K $\Omega$ , 5%, 1/4W	10-0102
R24	1 K $\Omega$ , 5%, 1/4W	10-0102
R25	1 K $\Omega$ , 5%, 1/4W	10-0102
R26	1 K $\Omega$ , 5%, 1/4W	10-0102
R27	330 $\Omega$ , 5%, 1/4W	10-0331
R28	330 $\Omega$ , 5%, 1/4W	10-0331
R29	330 $\Omega$ , 5%, 1/4W	10-0331
R30	330 $\Omega$ , 5%, 1/4W	10-0331
R31	330 $\Omega$ , 5%, 1/4W	10-0331
R32	47 $\Omega$ , 5%, 1/4W	10-0470
R33	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R34	220 $\Omega$ , 5%, 1/4W	10-0221
R35	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R36	15 $\Omega$ , 5%, 1/4W	10-0150
R37	680 $\Omega$ , 5%, 1/4W	10-0681
R38	1.5 K $\Omega$ , 5%, 1/4W	10-0152

# PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R39	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R40	330 $\Omega$ , 5%, 1/4W	10-0331
R41	Not Used	-----
R42	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R43	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R44	15 $\Omega$ , 5%, 1/4W	10-0150
R45	150 $\Omega$ , 5%, 1/4W	10-0151
R46	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R47	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R48	150 $\Omega$ , 5%, 1/4W	10-0151
R49	4.7 $\Omega$ , 5%, 1/4W	10-1470
R50	2.2 K $\Omega$ , 5%, 1/4W	11-0222
R51	4.7 $\Omega$ , 5%, 1/4W	10-1470
R52	680 $\Omega$ , 5%, 1/4W	11-0681
R53	470 $\Omega$ , 5%, 1/4W	10-0471
R54	470 $\Omega$ , 5%, 1/4W	10-0471
R55	15 $\Omega$ , 5%, 1/4W	10-0150
R56	15 $\Omega$ , 5%, 1/4W	10-0150
R57	15 $\Omega$ , 5%, 1/4W	10-0150
R58	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R59	100 $\Omega$ , 5%, 1/4W	10-0101
R60	100 $\Omega$ , 5%, 1/4W	10-0101
R61	100 $\Omega$ , 5%, 1/4W	10-0101
R62	1.0 K $\Omega$ , 5%, 1/4W	10-0102
R63	470 $\Omega$ , 5%, 1/4W	10-0471

Note: 10-xxxx carbon composition  
11-xxxx carbon film

## TRANSISTORS

Q1	2N 3250	41-3250
Q2	2N 3250	41-3250
Q3	2N 3250	41-3250
Q4	2N 3250	41-3250
Q5	2N 3250	41-3250
Q6	2N 3250	41-3250
Q7	2N 3250	41-3250
Q8	2N 2369	40-2369



# PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
TRANSISTORS (continued)		
Q9	2N 2369	40-2369
Q10	2N 2369	40-2369
Q11	2N 5179	40-5179
Q12	2N 5179	40-5179
TRANSFORMERS		
T1	Transformer, RF	84-5100
DIODES		
CR1	BA 244	71-0244
CR2	BA 244	71-0244
CR3	BA 244	71-0244
CR4	BA 244	71-0244
CR5	BA 244	71-0244
CR6	BA 244	71-0244
INTEGRATED CIRCUITS		
U1	74L20	61-5101
U2	74L00	61-5100
U3	MC10138	62-5100

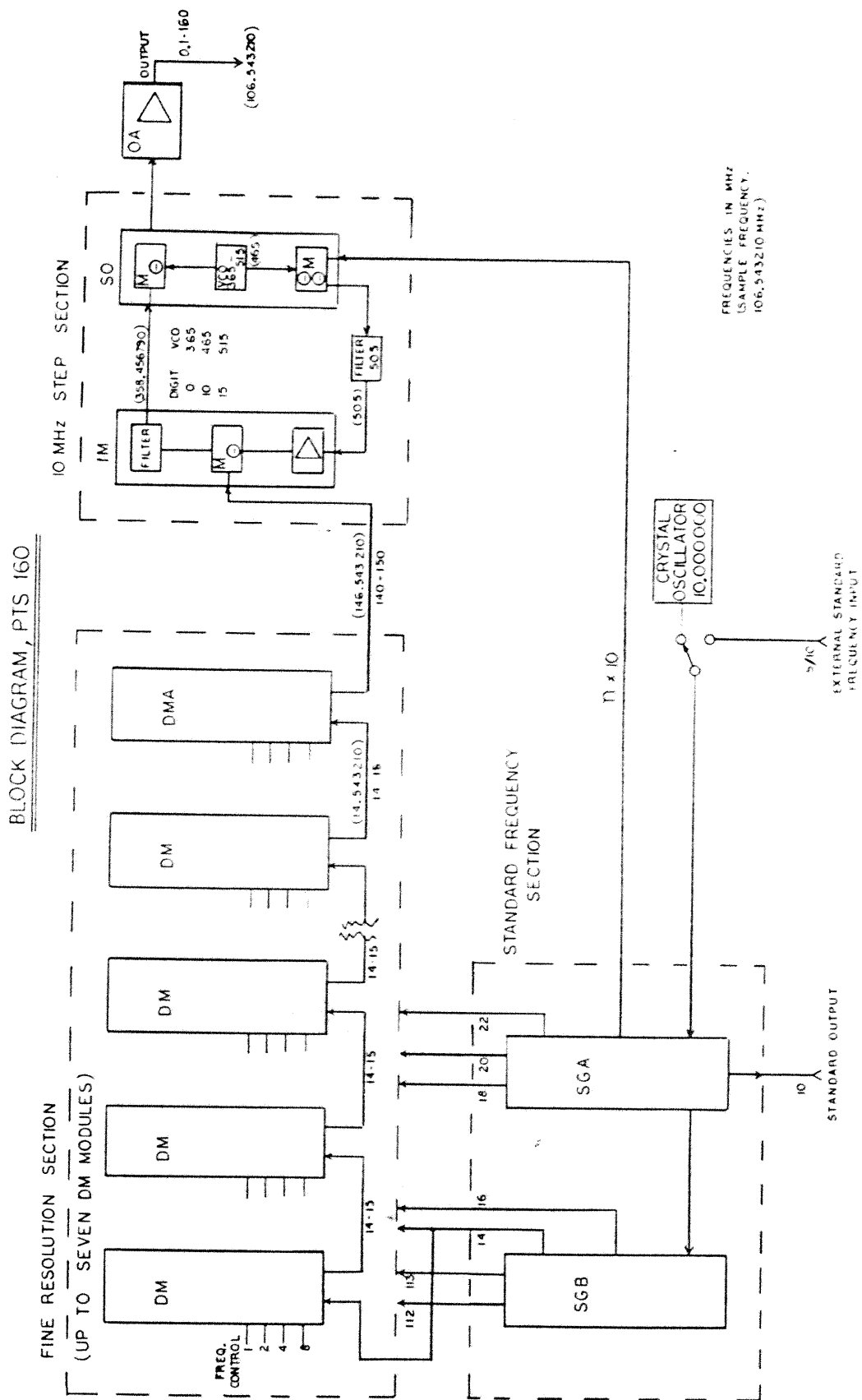


Figure 1



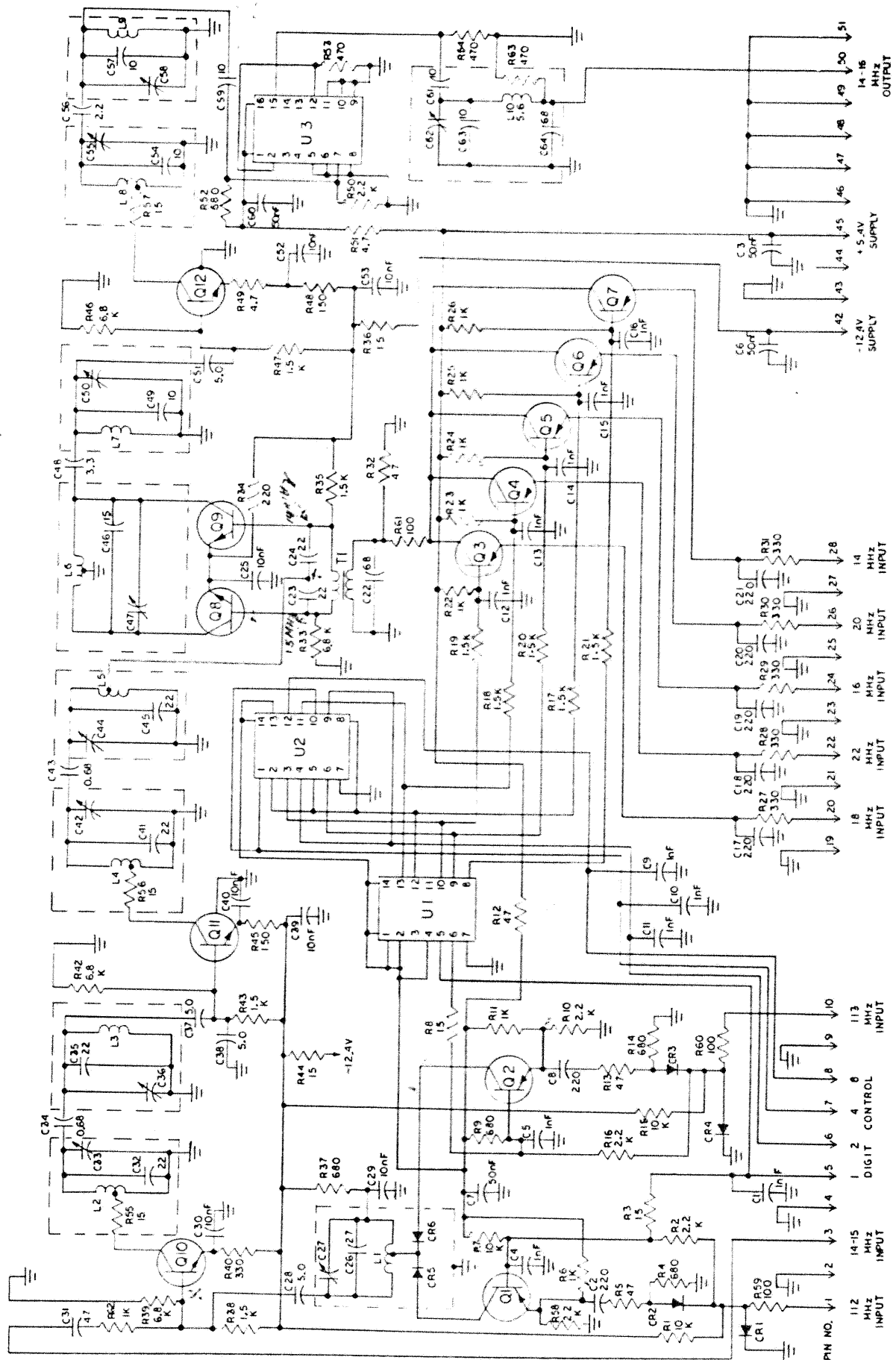


Figure 3

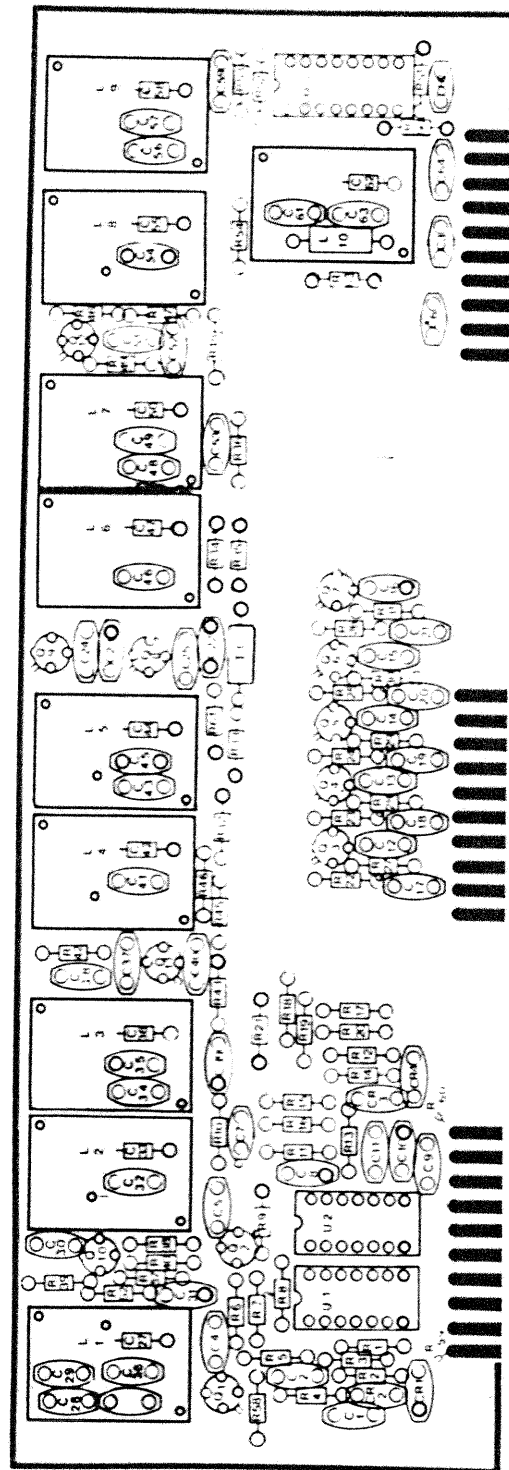


Figure 4

# **DMA-1005 SECTION**



**PROGRAMMED TEST SOURCES, inc.**

Littleton, Massachusetts, USA.

## TABLE OF CONTENTS

Introduction .....	1
Principles of Operation .....	2
Service .....	3
Maintenance .....	3
Alignment .....	3
Troubleshooting Procedure .....	3
Parts List .....	6
Figure 1 (Block Diagram, PTS 160) .....	11
Figure 2 (Schematic) .....	12
Figure 3 (PC Assembly) .....	13

## INTRODUCTION

The DMA-1005, digit module-A, is used once per instrument and generates the 1 MHz steps. It is very similar to the DM-1000 module and is fed by the string of all DMs in the instrument. As the last unit of this series, it's output at 140-150 MHz contains the 1 MHz steps and all finer steps for which the instrument is equipped, down to 0.1 Hz.

This manual should be seen as supplemental and must be used in conjunction with the DM-1000 portion.

This digit module is of plug-in design and uses three 10-pin connectors with asymmetric spacing assuring proper orientation; it is secured with three 6-32 screws from the bottom of the deck. Housed in a frame and U-cover enclosure, the DMA-1005 can be removed as a complete unit after releasing the 6-32 pan-head screws. To gain access to the PC board, 4-40 top screws and all 2-56 side screws must be removed from the module U-cover. The PC board cannot be removed without first removing the module from the deck.



## PRINCIPLES OF OPERATION

The main difference between the DM and DMA modules is the absence of the final division-by-ten in the DMA. As a result, the arithmetic function of the DMA-1005 can be described as follows:

When receiving a frequency of 14.xyz from the preceding DM, it will produce an output frequency of 14A.xyz MHz, where A directly corresponds to the DMA dial setting. In other words, all digits behind the decimal point are retained, and a 1 MHz step, as selected by the digit control (manual or remote), is placed ahead of the received digits.

All other observations made in the DM *Principles of Operation* apply here as well, and the frequencies shown in the block diagram (Figure 1) at the output of the DMA, namely 146.543210, would be obtained if the DMA had been instructed to produce a "6" digit.

Figure 2 shows the schematic of the DMA-1005, and, apart from the absence of the final divider, it may be noted that there are additional components used in the execution of the 14 to 22 MHz selection switch. This added, switched selectivity removes unwanted frequencies before they can enter the balanced mixer. These frequencies are not attenuated by division or a narrow-band output as they are in the DM-1000 module. All input levels to the DMA are identical with the levels for the DM modules. The output level of the DMA, however, at 140-150 MHz is +2 to +6 dBm into a 50 ohm load. The module feeds a mixer in the IM-1007 module through a 50 ohm pad.

## SERVICE

### Maintenance

No preventive maintenance is required for DMA modules. The presence of an output signal of correct frequency and level indicates that the module is operating properly. The output of the module is included in the leveling loop, and minor aging effects will, therefore, not impair operation.

Replacement of faulty components requires careful use of printed-circuit repair techniques as applicable to double-sided boards with plated-through holes.

### Alignment

Complete alignment of this module is made at the factory with a special test-set. Restoring the alignment after replacement of individual parts in the field is possible. It is recommended that voltages given in the Troubleshooting Procedure be used and that, in general, touch-up alignment be performed only on those tuned circuits which may have been altered by the parts replacements. Replacement of semiconductors will not necessitate realignment of tuned circuits in general.

### Troubleshooting Procedure

The System Section of this manual provides information to isolate faulty modules. It is important to follow the procedure given in detail to ensure that all the common supply frequencies are present before attempting to repair modules.

If a DMA module has been isolated as faulty, the preferred service mode is exchange and factory repair. When immediate service is needed, the following procedure may be used.

Test Equipment Required:

RF Voltmeter	1 - 300 MHz, 10 mV - 1V, High Impedance Probe (3 pF, DC Res 100 K $\Omega$ )
HF Counter	0 - 200 MHz, 10 mV Sensitivity, High Impedance or 50 $\Omega$ Input

The output of the DMA module is on pin 50, which is also the test point designation used in the System Section and the running number of the board-edge connector as shown in the schematic (Figure 2). The module produces 140.000 MHz at a level of +2 to +6 dBm into the IM module if all instrument dials have been set to zero. As the dial of the DMA module is changed through successive numbers 0 to 9, the output frequency should change in 1 MHz steps from 140.000 MHz to 149.000 MHz. If the output is of the proper frequency but low in level, the fault is in the 14-22 MHz switch, the mixer (M1), or the 140-150 MHz output filters L6 to L10 and transistor Q11. Alignment of this section cannot be restored in the field, but active devices are generally replaceable without need for realignment. See DC operating conditions listed below.

Absence of output for some dial settings points to specific causes:

1. No output on *two* successive even-odd digits (e.g., 2,3) indicates that the second mixer, M1, does not receive one of the low bus frequencies from 14 to 22 MHz, and the fault is likely located in the switch section (Q3 to Q7). 14 MHz is used for digit 0,1; 16 MHz for digit 2,3; and so on.
2. No output on either *all odd* or *all even* digits will result from failure in the 112/113 MHz switches Q1 or Q2, since 112 MHz is used to produce all even digits and 113 MHz to make the odd digits.

3. If no output is obtained on any digit, if random digits are missing, or if an unsteady counter reading (noise) is present, part of the circuitry that is used on all digits must be faulty. The active devices are Q8, Q9, Q10 and Q11. DC operating conditions on all of these transistors are such that 1.1 to 1.5V should be measured across their emitter resistors R40, R45, R69 and R48. Bases of switch transistors Q3 to Q7 are at +5.2V when inactive and at +3.3V when turned on.

RF voltages at various stages are given to permit further localization of the trouble. Voltages may differ from nominal by  $\pm 3$  dB.

Base Q8	0.20V
Base Q9	0.05V
Tap, L5	0.30V
Base Q11	0.10V

The 126-128 MHz signal at the tap of L5 peaks at digit setting "5" and drops approximately 2 dB for settings "0" and "9" on the preceding DM module (less significant digit).

# DMA-1005 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	1 nF, 10%, 500V, X5F	22-0102
C2	220 pF, 10%, 500V, X5F	22-0221
C3	10 nF, 80/20%, 50V, Z5V	23-0103
C4	1 nF, 10%, 500V, X5F	22-0102
C5	1 nF, 10%, 500V, X5F	22-0102
C6	10 nF, 80/20%, 50V, Z5V	23-0103
C7	10 nF, 80/20%, 50V, Z5V	23-0103
C8	220 pF, 10%, 500V, X5F	22-0221
C9	1 nF, 10%, 500V, X5F	22-0102
C10	1 nF, 10%, 500V, X5F	22-0102
C11	1 nF, 10%, 500V, X5F	22-0102
C12	1 nF, 10%, 500V, X5F	22-0102
C13	1 nF, 10%, 500V, X5F	22-0102
C14	1 nF, 10%, 500V, X5F	22-0102
C15	1 nF, 10%, 500V, X5F	22-0102
C16	1 nF, 10%, 500V, X5F	22-0102
C17	47 pF, 5%, 500V, NPO	20-0470
C18	47 pF, 5%, 500V, NPO	20-0470
C19	47 pF, 5%, 500V, NPO	20-0470
C20	47 pF, 5%, 500V, NPO	20-0470
C21	47 pF, 5%, 500V, NPO	20-0470
C23	10 nF, 80/20%, 50V, Z5V	23-0103
C24	1.5 nF, 10%, 500V, X5F	22-0152
C26	27 pF, 5%, 500V, NPO	20-0270
C27	1-10 pF, Trimmer	26-5100
C28	5 pF, .25 pF, 500V, NPO	20-1500
C29	10 nF, 80/20%, 50V, Z5V	23-0103
C30	10 nF, 80/20%, 50V, Z5V	23-0103
C31	47 pF, 5%, 500V, NPO	20-0470
C32	22 pF, 5%, 500V, NPO	20-0220
C33	1-10 pF, Trimmer	26-5100
C34	0.68 pF, .25 pF, 500V	24-2680
C35	22 pF, 5%, 500V, NPO	20-0220
C36	1-10 pF, Trimmer	26-5100
C37	5 pF, .25 pF, 500V, NPO	20-1500
C38	15 pF, 5%, 500V, NPO	20-0150
C39	10 nF, 80/20%, 50V, Z5V	23-0103
C40	1 nF, 10%, 500V, X5F	22-0102
C41	22 pF, 5%, 500V, NPO	20-0220
C42	1-10 pF, Trimmer	26-5100
C43	0.68 pF, .25 pF, 500V	24-2680
C44	1-10 pF, Trimmer	26-5100
C45	22 pF, 5%, 500V, NPO	20-0220
C46	12 pF, 5%, 500V, NPO	20-0120

# DMA-1005 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
CAPACITORS (continued)		
C47	1-10 pF, Trimmer	26-5100
C48	2.2 pF, .25 pF, 500V, NPO	20-1220
C49	10 pF, 5%, 500V, NPO	20-0100
C50	1-10 pF, Trimmer	26-5100
C51	6.8 pF, .25 pF, 500V, NPO	20-1680
C52	10 nF, 80/20%, 50V, Z5V	23-0103
C53	10 nF, 80/20%, 50V, Z5V	23-0103
C54	15 pF, 5%, 500V, NPO	20-0150
C55	1-10 pF, Trimmer	26-5100
C56	1.5 pF, .25 pF, 500V, NPO	24-1150
C57	12 pF, 5%, 500V, NPO	20-0120
C58	1-10 pF, Trimmer	26-5100
C59	1.5 pF, .25 pF, 500V, NPO	24-1150
C60	47 pF, 5%, 500V, NPO	20-0470
C61	47 pF, 5%, 500V, NPO	20-0470
C62	1-10 pF, Trimmer	26-5100
C63	15 pF, 5%, 500V, NPO	20-0150
C65	2.2 pF, .25 pF, NPO	20-1220
C66	91 pF, 5%, 500V, N750	21-0910
C67	15 pF, 5%, 500V, NPO	20-0150
C68	56 pF, 5%, 500V, NPO	20-0560
C69	5 pF, .25 pF, 500V, NPO	20-1500
C70	33 pF, 5%, 500V, NPO	20-0330
C71	3-13 pF, Trimmer	26-5101
C72	3-13 pF, Trimmer	26-5101
C73	3-13 pF, Trimmer	26-5101
C74	3-13 pF, Trimmer	26-5101
C75	3-13 pF, Trimmer	26-5101
C76	27 pF, 5%, 500V, NPO	20-0270
C77	150 pF, 10%, 500V, X5F	22-0150

## INDUCTORS

L1	50 nH, nom.	35-5100
L2	50 nH, nom.	35-5100
L3	50 nH, nom.	35-5100
L4	50 nH, nom.	35-5100
L5	50 nH, nom.	35-5100
L6	50 nH, nom.	35-5100
L7	50 nH, nom.	35-5100
L8	50 nH, nom.	35-5100
L9	50 nH, nom.	35-5100
L10	50 nH, nom.	35-5100
L11	1.0 $\mu$ H, 5%	36-5105

# DMA-1005 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS		
R1	10 K $\Omega$ , 5%, 1/4W	10-0103
R2	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R3	15 $\Omega$ , 5%, 1/4W	10-0150
R4	680 $\Omega$ , 5%, 1/4W	10-0681
R5	47 $\Omega$ , 5%, 1/4W	10-0470
R6	1 K $\Omega$ , 5%, 1/4W	10-0102
R7	10 K $\Omega$ , 5%, 1/4W	10-0103
R8	15 $\Omega$ , 5%, 1/4W	10-0150
R9	680 $\Omega$ , 5%, 1/4W	10-0681
R10	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R11	1 K $\Omega$ , 5%, 1/4W	10-0102
R12	47 $\Omega$ , 5%, 1/4W	10-0470
R13	47 $\Omega$ , 5%, 1/4W	10-0470
R14	680 $\Omega$ , 5%, 1/4W	10-0681
R15	10 K $\Omega$ , 5%, 1/4W	10-0103
R16	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R17	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R18	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R19	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R20	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R21	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R22	1 K $\Omega$ , 5%, 1/4W	10-0102
R23	1 K $\Omega$ , 5%, 1/4W	10-0102
R24	2.2 K $\Omega$ , 5%, 1/4W	10-0222
R25	1 K $\Omega$ , 5%, 1/4W	10-0102
R26	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R27	470 $\Omega$ , 5%, 1/4W	10-0471
R28	470 $\Omega$ , 5%, 1/4W	10-0471
R29	470 $\Omega$ , 5%, 1/4W	10-0471
R30	470 $\Omega$ , 5%, 1/4W	10-0471
R31	330 $\Omega$ , 5%, 1/4W	10-0331
R32	220 $\Omega$ , 5%, 1/4W	10-0221
R33	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R34	220 $\Omega$ , 5%, 1/4W	10-0221
R35	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R36	15 $\Omega$ , 5%, 1/4W	10-0150
R37	680 $\Omega$ , 5%, 1/4W	10-0681
R38	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R39	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R40	470 $\Omega$ , 5%, 1/4W	10-0471
R42	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R43	1.5 K $\Omega$ , 5%, 1/4W	10-0152

NOTE: 10-xxxx Carbon Composition

## DMA-1005 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
------------------	-------------	---------

## RESISTORS (continued)

R44	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R45	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R46	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R47	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R48	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R49	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R50	68 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0680
R55	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R56	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R57	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R58	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R59	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R60	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R62	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R63	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R64	22 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R65	22 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R66	22 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R67	22 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R68	22 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223

## TRANSISTORS

Q1	2SA 711	41-0711
Q2	2SA 711	41-0711
Q3	2N 3250	41-3250
Q4	2N 3250	41-3250
Q5	2N 3250	41-3250
Q6	2N 3250	41-3250
Q7	2N 3250	41-3250
Q8	2N 5179	40-5179
Q9	2N 5179	40-5179
Q10	2N 5179	40-5179
Q11	2N 5179	40-5179



## DMA-1005 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
DIODES		
CR2	BA 244	71-0244
CR3	BA 244	71-0244
CR5	IN 4151	70-4151
CR6	IN 4151	70-4151
CR7	BA 244	71-0244
CR8	BA 244	71-0244
CR9	BA 244	71-0244
CR10	BA 244	71-0244
CR11	BA 244	71-0244
INTEGRATED CIRCUITS		
U1	74L20N	61-5101
U2	74L00N	61-5100
M1	MD108	65-5102

# BLOCK DIAGRAM, PTS 160

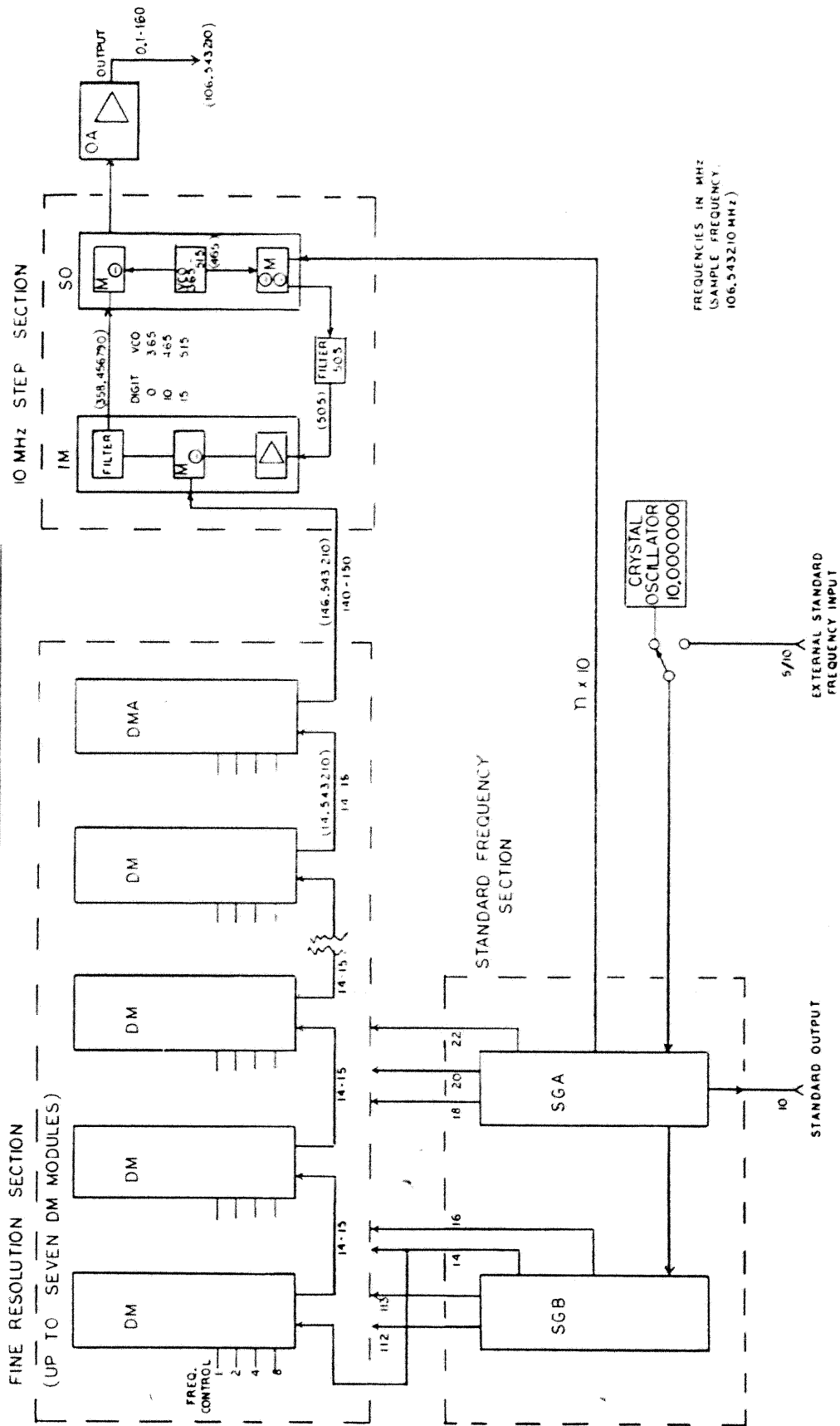
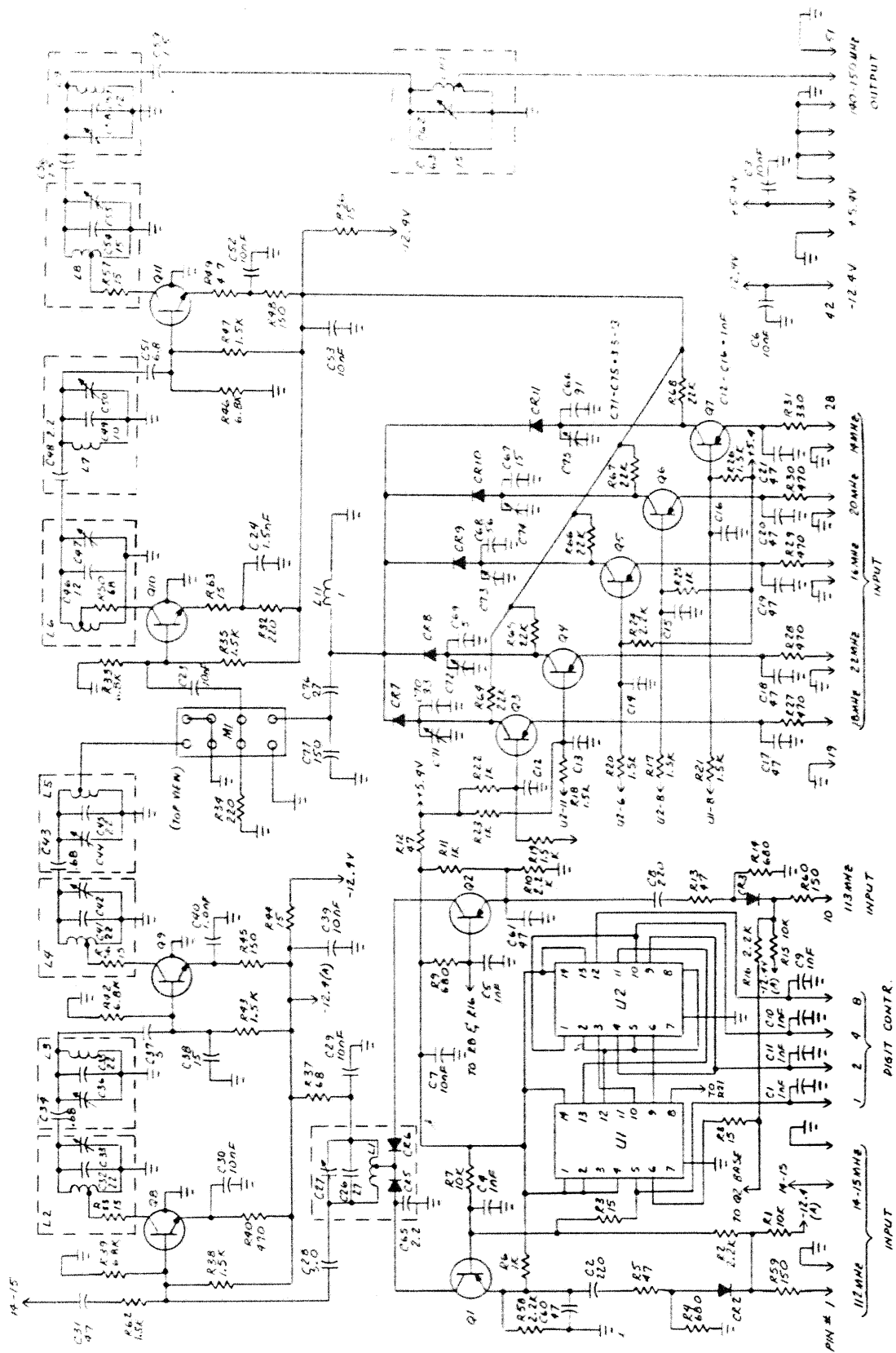


Figure 1



PM1005

Figure 2

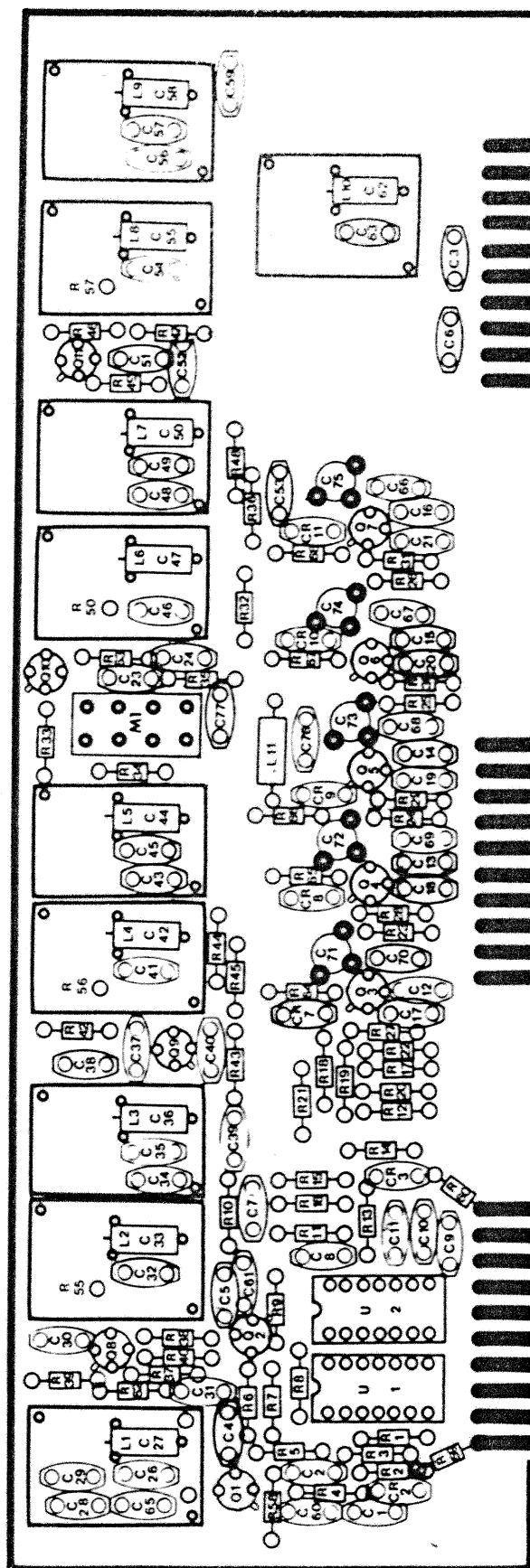
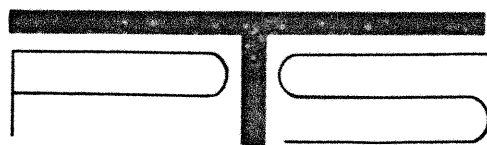


Figure 3

**SGA-1002**

**SGB-1003**

**SECTION**



**PROGRAMMED TEST SOURCES, inc.**

Littleton, Massachusetts

## TABLE OF CONTENTS

Introduction .....	1
Principles of Operation .....	2
Service. ....	4
Maintenance .....	4
Alignment .....	4
Troubleshooting .....	4
Parts List. ....	7
Figure 1 (Block Diagram) .....	13
Figure 2 (Schematic SGA-1002) .....	14
Figure 3 (Schematic SGB-1003) .....	15
Figure 4 (PC Assembly, SGA-1002) .....	16
Figure 5 (PC Assembly, SGB-1003). ....	17

## INTRODUCTION

The SGA-1002 and SGB-1003 are standard generators used in PTS synthesizers. They operate together from a crystal-oscillator input and, by direct arithmetic operations, produce common supply frequencies. These standard frequencies are distributed in the deck and used by most other modules in the synthesizer.

The SGA module can operate from either 5 or 10 MHz, and with this input it produces: discrete frequencies of 18, 20, 22 and 33 MHz on separate outputs; further all harmonics of 10MHz from 10 to 140 MHz with equal amplitude on one output. These frequencies are used by the SGB, DMs, DMA and SO modules in the synthesis process.

The SGB receives the 10 to 140 MHz *picket fence* from the SGA module and produces 14 and 16 MHz, 112 and 113 MHz, all on separate outputs. These frequencies are used by the DMs and DMA modules.

The SGA and SGB modules use DC power at +5.4V and -12.4V; since the outputs are constant and not subject to selection or control, no programming inputs are provided. These modules combine analog, VHF and digital techniques. All inputs and outputs are fed through card-edge connectors with multiple grounds provided for the RF signals.

These modules are unique; they are not interchangeable with any other module in the synthesizer. Both units are of plug-in design using three 10-pin connectors with asymmetric spacing, which assure proper orientation.

They are secured with three 6-32 pan-head screws from the bottom of the deck. Housed in a frame and U-cover enclosure, the SGA-1002 and SGB-1003 can be removed after releasing the three 6-32 screws.

To gain access to the PC boards, 4-40 top screws and 2-56 side screws have to be removed from the module U-cover. Printed circuit boards cannot be removed without first removing the modules from the deck.

## PRINCIPLES OF OPERATION

The SGA-1002 and SGB-1003, standard generators which operate together, are depicted in the block diagram of Figure 1.

An input of 5 or 10 MHz and a level of 0.4V is received from an external or internal frequency standard and fed to the input amplifier/multiplier. This block is followed by a narrow crystal filter. The pulse generator receives its input from this crystal filter and produces a spectrum, which is the basis for *all* fixed or standard frequencies in the synthesizer. Of these, the five low frequencies of 14, 16, 18, 20 and 22 MHz are all produced by division of a specific spectrum-line through an amplifier-filter circuit, a digital divider, and a filter at the output frequency. The two higher standard frequencies of 112 and 113 MHz also use one specific spectrum line each. Mixers (M) add derivatives of certain low standard frequencies, as shown, to obtain the final frequencies. Thus, by multiplication, division and addition, the SGA and SGB produce seven standard frequencies which are completely coherent with the input frequency of 5 or 10 MHz.

According to Schematic 1002-S (Figure 2), the 5/10 MHz input signal drives Q7, which amplifies or multiplies, and a 10 MHz single-pole crystal filter Y1 follows, which removes noise (and attenuates 5 MHz). The resulting 10 MHz signal can be used externally (to drive slave instruments) from the output of emitter-follower Q6. It is applied internally to pulse generator Q5/Q4.

At the output of the pulse generator (R23/R24) a spectrum of  $n \times 10$  MHz multiples from 10 to 140 MHz is available. These frequencies are the source of all standard frequencies in the instrument. Three of the lower frequencies are produced in the SGA.

Since the three sections are identical, a description of one — the 20 MHz generator — shall suffice to illustrate the process. Loosely coupled to the *spectrum bus* by C16, transistor Q3 amplifies the 100 MHz line, and this signal, after filtering in L16, C17, C18, reaches the divider U3. The divide-by-five section of U3 is used, and a 20 MHz signal from pin 4 is connected to a tuned circuit. A low impedance output, taken across C35 is fed to pin 43 and then to the 20 MHz bus in the deck.



A frequency of 33 MHz is needed to produce 113 MHz in the SGB module. This signal is produced by U1, where the 22 MHz output is divided by 2 and the third harmonic, after filtering, is fed to pin 2 and then to the SGB module.

As shown on Schematic 1003-S (Figure 3), the SGB receives the 10 to 140 MHz spectrum from the SGA module on pin 20. The schematic shows, starting from the middle, on the left-hand side the generation of 14 MHz and 112 MHz signals, and in the right half the generation of 16 MHz and 113 MHz. The low frequencies are produced by the same divide-by-five process which is used in the SGA module: The 70 MHz line is pre-filtered, amplified and filtered in L4, C13, C14, from where it enters divider U1; the resulting 14 MHz signal, after filtering, reaches pin 10, the output.

The same IC also supplies a third harmonic of 14 MHz to Q3. After amplification this 42 MHz signal serves as injection to Q1, which is the final mixer producing 112 MHz by adding a 70 MHz input from Q2.

The 16 MHz generation is identical to the 14 MHz circuits, and 80 MHz is filtered and amplified further to drive mixer Q7 on the 113 MHz side. The 33 MHz signal, coming from the SGA, is amplified in Q8 and then fed to the mixer. Double-tuned filters are employed on both sides to filter the 112 and 113 MHz mixer outputs.

Test Equipment Required:

RF Voltmeter	1 - 300 MHz, 10 mV - 1V, High Impedance Probe (3 pF, DC Res. 100 K $\Omega$ )
HF Counter	0 - 200 MHz, 10 mV Sensitivity, High Impedance or 50 $\Omega$ Input
Spectrum Analyzer	10 - 600 MHz, 50 $\Omega$ Input, 60 dB min Dynamic Range, Resolution 1 MHz

System Section troubleshooting isolates failure in the SGA and SGB to specific outputs. In addition, the block diagram (Figure 1) and schematics (Figure 2 and 3) are structured such that individual circuit-sections are recognizable, and this will aid in the search for the failure.

DC checks of suspected active devices are the proper first step. Voltage drops across the emitter-resistors of the transistors are all 1.2 - 1.5V, except in the SGA across R36 and R25, where 1.9 - 2.3V are normal (R25 with RF drive).

Basic to all output signals is the presence of the *picket fence* of 10 - 140 MHz. The spectrum analyzer connected in place of the SO module (J1) must show each frequency with a level of -16 to -19 dBm. Instruments *not* using an SO module will have a termination on pin 45 (SGA); the S/A connected in place of the termination will show -8 to -11 dBm of spectrum signals.

**Note:** Avoid S/A signal overloads.

The active devices in the pulse generation are Q7, Q5, Q4. Crystal-filter Y1 output is 0.4 - 0.5V across R31.

If the picket fence is normal, low level or absence of a specific frequency may be traced as follows: Connect the S/A to the output in question. Total absence of output in a 14 to 22 MHz frequency generally indicates that the divider is not triggered. All injection voltages, which are connected to pin 7 of the IC (MC-10138), are accessible to the voltmeter probe from the component side of the

## SERVICE

### Maintenance

No preventive maintenance is required for the SGA or SGB modules. The presence of standard output signals of correct frequency and level indicates that the modules are operating properly.

All outputs of the SGA and SGB modules, with the exception of the 112 and 113 MHz signals, are produced directly by IC digital dividers. A 10 dB window exists at the divider inputs and minor aging effects will, therefore, not impair operation.

Replacement of faulty components requires careful use of PC repair techniques as applicable to double-sided boards with plated-through holes.

### Alignment

Complete alignment of this module is made at the factory with a special test set. Restoring the alignment after replacement of individual parts in the field is possible. It is recommended that voltages given in the Troubleshooting procedure be used, and that in general touch-up alignment be performed only on those tuned circuits which may have been altered by the parts replacements. Replacement of semiconductors will not generally necessitate realignment of tuned circuits.

### Troubleshooting

The System Section of this manual provides information necessary to isolate faulty modules. It is important to follow the procedure step by step to ensure proper identification of failure before attempting to repair modules.

If an SGA or SGB module has been isolated as faulty, the preferred service mode is exchange and factory repair. When immediate service is needed, the following procedure may be used.

board. A minimum level of 0.3V is required there. The input and output trimmer capacitors may be identified and retuned (e.g., the trimmers for the 90 MHz circuits feeding the 18 MHz divider are C10 and C12).

If a specific low frequency (14 to 22 MHz) is displayed on the S/A, but the level is low, output circuits are defective or detuned. Every output circuit is tuned by a single trimmer (e.g., C42 tunes the 18 MHz output).

The 112 and 113 MHz outputs are the result of mixing two frequencies. In both cases the first step in tracing trouble is checking the 14 or 16 MHz outputs as detailed before. If these low frequencies are present, connect the S/A to the faulty output (112 or 113 MHz) and attempt to tune: C9, C19, C4, C1 for the 112 MHz output and C46, C53, C56, C60 for the 113 MHz output. At the bases of Q1 and Q7, 0.4V min should be obtained; this is a composite of both injections. This level and its variation with tuning both injections will locate the fault in either one of the mixer inputs or the output circuits following the mixer.

# SGA-1002 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	10 nF, 80/20%, 50V, Z5V	23-0103
C2	22 pF, 5%, 500V, NPO	20-0220
C3	3-13 pF, Trimmer	26-5101
C4	1.0 pF, .25 pF, 500V, NPO	24-1100
C5	1-10 pF, Trimmer	26-5100
C6	27 pF, 5%, 500V, NPO	20-0270
C7	10 nF, 80/20%, 50V, Z5V	23-0103
C8	10 nF, 80/20%, 50V, Z5V	23-0103
C9	22 pF, 5%, 500V, NPO	20-0220
C10	3-13 pF, Trimmer	26-5101
C11	1.0 pF, .25 pF, 500V, NPO	24-1100
C12	1-10 pF, Trimmer	26-5100
C13	47 pF, 5%, 500V, NPO	20-047
C14	10 nF, 80/20%, 50V, Z5V	23-0103
C15	22 pF, 5%, 500V, NPO	20-0220
C16	1.0 pF, .25 pF, 500V, NPO	24-1100
C17	1-10 pF, Trimmer	26-5100
C18	33 pF, 5%, 500V, NPO	20-0330
C19	3-13 pF, Trimmer	26-5101
C20	10 nF, 80/20%, 50V, Z5V	23-0103
C21	3-13 pF, Trimmer	26-5101
C22	10 nF, 80/20%, 50V, Z5V	23-0103
C23	10 nF, 80/20%, 50V, Z5V	23-0103
C24	100 pF, 10%, 500V, X5F	22-0101
C25	110 pF, 5%, MICA	27-5100
C26	1-10 pF, Trimmer	26-5100
C27	6.8 $\mu$ F, El., Tant., 16V	30-5101
C28	10 nF, 80/20%, 50V, Z5V	23-0103
C29	33 pF, 5%, 500V, NPO	20-0330
C30	120 pF, 10%, 500V, X5F	22-0121
C31	3-13 pF, Trimmer	26-5101
C32	10 nF, 80/20%, 50V, Z5V	23-0103
C33	10 nF, 80/20%, 50V, Z5V	23-0103
C34	10 nF, 80/20%, 50V, Z5V	23-0103
C35	1 nF, 10%, 500V, X5F	22-0102
C36	3-13 pF, Trimmer	26-5101
C37	50 nF, 80/20%, 50V, Z5V	23-0503
C38	50 nF, 80/20%, 50V, Z5V	23-0503
C39	50 nF, 80/20%, 50V, Z5V	23-0503
C40	5 pF, .25 pF, 500V, NPO	20-1500
C41	1 nF, 10%, 500V, X5F	22-0102
C42	3-13 pF, Trimmer	26-5101
C43	5 pF, .25 pF, 500V, NPO	20-1500
C44	50 nF, 80/20%, 50V, Z5V	23-0503
C45	1 nF, 10%, 500V, X5F	22-0102

## SGA-1002 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
<b>CAPACITORS (continued)</b>		
C46	3-13 pF, Trimmer	26-5101
C47	5 pF, .25 pF, 500V, NPO	20-1500
C48	5 pF, .25 pF, 500V, NPO	20-1500
C49	3-13 pF, Trimmer	26-5101
C50	10 pF, 5%, 500V, NPO	20-0100
C51	560 pF, 10%, 500V, X5F	22-0561
C52	50 nF, 80/20%, 50V, Z5V	23-0503
C53	10 nF, 80/20%, 50V, Z5V	23-0103
C54	10 nF, 80/20%, 50V, Z5V	23-0103
C55	5 pF, .25 pF, 500V, NPO	20-1500
<b>INDUCTORS</b>		
L1	0.33 $\mu$ H, 10%	36-5104
L2	0.33 $\mu$ H, 10%	36-5104
L3	0.33 $\mu$ H, 10%	36-5104
L4	0.20 $\mu$ H, nom.	35-5101
L5	2.2 $\mu$ H, 10%	36-5103
L6	1.0 $\mu$ H, 10%	36-5105
L7	22 $\mu$ H, 10%	36-5106
L8	5.6 $\mu$ H, 10%	36-5100
L9	22 $\mu$ H, 10%	36-5106
L10	5.6 $\mu$ H, 10%	36-5100
L11	22 $\mu$ H, 10%	36-5106
L12	5.6 $\mu$ H, 10%	36-5100
L13	5.6 $\mu$ H, 10%	36-5100
L14	50 nH, nom.	35-5106
L15	50 nH, nom.	35-5106
L16	50 nH, nom.	35-5106
<b>RESISTORS</b>		
R1	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R2	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R3	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R4	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R5	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R6	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R7	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R8	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R9	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R10	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0222
R11	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R12	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R13	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R14	680 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0681
R15	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0222
R16	680 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0681

Note: 10-XXXX carbon composition  
11-XXXX carbon film

## SGA-1002 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R17	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R18	680 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0681
R19	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0222
R20	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R21	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R22	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R23	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R24	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R25	1 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R26	1 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R27	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R28	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R29	680 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0681
R30	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R31	68 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0680
R32	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R33	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R34	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R35	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R36	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R37	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R38	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R39	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R40	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R41	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R42	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R43	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R44	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
TRANSISTORS		
Q1	2N 5179	40-5179
Q2	2N 5179	40-5179
Q3	2N 5179	40-5179
Q4	2N 5179	40-5179
Q5	2N 3250	41-3250
Q6	2N 2369	40-2369
Q7	2N 2369	40-2369
DIODES		
CR1	1N 4151	70-4151
INTEGRATED CIRCUITS		
U1	MC10138	62-5100
U2	MC10138	62-5100
U3	MC10138	62-5100
Y1	Crystal, Filter (or Resistor)	85-5100 (10-0150)

# SGB-1003 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	1-10 pF, Trimmer	26-5100
C2	33 pF, 5%, 500V, NPO	20-0330
C3	33 pF, 5%, 500V, NPO	20-0330
C4	1-10 pF, Trimmer	26-5100
C5	0.5 pF, .25 pF, 500V, NPO	24-2500
C6	22 pF, 5%, 500V, NPO	20-0220
C7	2.2 pF, 5%, 500V, NPO	20-1220
C8	56 pF, 5%, Mica	27-5101
C9	1-10 pF, Trimmer	26-5100
C10	10 nF, 80/20%, 50V, Z5V	23-0103
C11	10 pF, 5%, 500V, NPO	20-0100
C12	1.5 pF, .25 pF, 500V, NPO	24-1150
C13	47 pF, 5%, 500V, NPO	20-0470
C14	1-10 pF, Trimmer	26-5100
C15	10 nF, 80/20%, 50V, Z5V	23-0103
C16	3.3 pF, 5%, 500V, NPO	20-1330
C17	10 nF, 80/20%, 50V, Z5V	23-0103
C18	27 pF, 5%, 500V, NPO	20-0270
C19	3-13 pF, Trimmer	26-5101
C20	33 pF, 5%, 500V, NPO	20-0330
C21	10 nF, 80/20%, 50V, Z5V	23-0103
C22	15 pF, 5%, 500V, NPO	20-0150
C23	560 pF, 10%, 500V, X5F	22-0561
C24	12 pF, 5%, 500V, NPO	20-0120
C25	5 pF, .25 pF, 500V, NPO	20-1500
C26	3-13 pF, Trimmer	26-5101
C27	1.5 nF, 10%, 500V, X5F	22-0152
C28	50 nF, 80/20%, 50V, Z5V	23-0503
C29	10 nF, 80/20%, 50V, Z5V	23-0103
C30	6.8 pF, 5%, 500V, NPO	20-1680
C31	3-13 pF, Trimmer	26-5101
C32	1.5 pF, .25 pF, 500V, NPO	24-1150
C33	50 nF, 80/20%, 50V, Z5V	23-0503
C34	50 nF, 80/20%, 50V, Z5V	23-0503
C35	2.2 pF, 5%, 500V, NPO	20-1220
C36	3-13 pF, Trimmer	26-5101
C37	47 pF, 5%, 500V, NPO	20-0470
C38	22 pF, 5%, 500V, NPO	20-0220
C39	10 nF, 80/20%, 50V, Z5V	23-0103
C40	1-10 pF, Trimmer	26-5100
C41	33 pF, 5%, 500V, NPO	20-0330
C42	3.3 pF, 5%, 500V, NPO	20-1330
C43	10 pF, 5%, 500V, NPO	20-0100
C44	3.3 pF, 5%, 500V, NPO	20-1330
C45	10 nF, 80/20%, 50V, Z5V	23-0103



# SGB-1003 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
CAPACITORS (continued)		
C46	1-10 pF, Trimmer	26-5100
C47	47 pF, 5%, 500V, NPO	20-0470
C48	22 pF, 5%, 500V, NPO	20-0220
C49	3.3 pF, 5%, 500V, NPO	20-1330
C50	10 nF, 80/20%, 50V, Z5V	23-0103
C51	10 nF, 80/20%, 50V, Z5V	23-0103
C52	50 nF, 80/20%, 50V, Z5V	23-0503
C53	3-13 pF, Trimmer	26-5101
C54	47 pF, 5%, 500V, NPO	20-0470
C55	10 nF, 80/20%, 50V, Z5V	23-0103
C56	1-10 pF, Trimmer	26-5100
C57	33 pF, 5%, 500V, NPO	20-0330
C58	0.5 pF, .25 pF, 500V, NPO	24-2500
C59	33 pF, 5%, 500V, NPO	20-0330
C60	1-10 pF, Trimmer	26-5100
C61	27 pF, 5%, 500V, NPO	20-0270
C62	3-13 pF, Trimmer	26-5101
C63	12 pF, 5%, 500V, NPO	20-0120
C64	1.5 nF, 10%, 500V, X5F	22-0152
C65	1 nF, 10%, 500V, X5F	22-0102
C66	50 nF, 80/20%, 50V, Z5V	23-0503
INDUCTORS		
L1	50 nH, nom.	35-5100
L2	50 nH, nom.	35-5100
L3	90 nH, nom.	35-5107
L4	90 nH, nom.	35-5107
L5	90 nH, nom.	35-5107
L6	90 nH, nom.	35-5107
L7	50 nH, nom.	35-5100
L8	50 nH, nom.	35-5100
L9	.33 $\mu$ H, 10%	36-5104
L10	5.6 $\mu$ H, 10%	36-5100
L11	.33 $\mu$ H, 10%	36-5104
L12	.33 $\mu$ H, 10%	36-5104
L13	5.6 $\mu$ H, 10%	36-5100
L14	22 $\mu$ H, 5%	36-5106
L15	22 $\mu$ H, 5%	36-5106
L16	.33 $\mu$ H, 10%	36-5104
L17	1.0 $\mu$ H, 5%	36-5105
RESISTORS		
R1	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R2	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R3	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682
R4	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R5	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R6	6.8 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0682

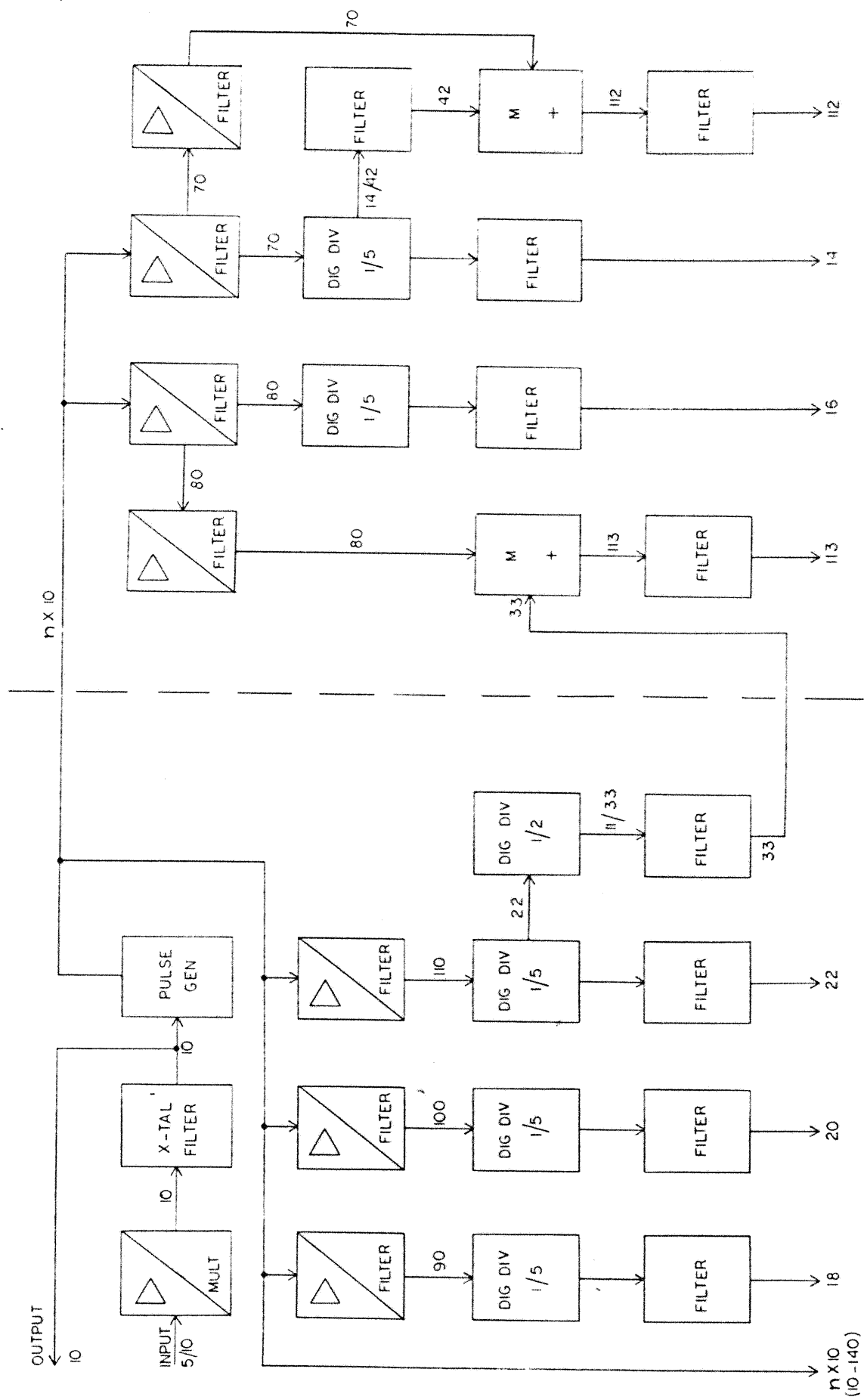
Note: 10-XXXX carbon composition  
11-XXXX carbon film

# SGB-1003 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R7	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R8	470 $\Omega$ , 5%, 1/4W	10-0471
R9	680 $\Omega$ , 5%, 1/4W	11-0681
R10	2.2 K $\Omega$ , 5%, 1/4W	11-0222
R11	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R12	680 $\Omega$ , 5%, 1/4W	10-0681
R13	15 $\Omega$ , 5%, 1/4W	10-0150
R14	220 $\Omega$ , 5%, 1/4W	10-0221
R15	220 $\Omega$ , 5%, 1/4W	10-0221
R16	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R17	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R18	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R19	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R20	220 $\Omega$ , 5%, 1/4W	10-0221
R21	2.2 K $\Omega$ , 5%, 1/4W	11-0222
R22	680 $\Omega$ , 5%, 1/4W	11-0681
R23	220 $\Omega$ , 5%, 1/4W	10-0221
R24	150 $\Omega$ , 5%, 1/4W	10-0151
R25	15 $\Omega$ , 5%, 1/4W	10-0150
R26	680 $\Omega$ , 5%, 1/4W	10-0681
R27	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R28	150 $\Omega$ , 5%, 1/4W	10-0151
R29	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R30	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R31	220 $\Omega$ , 5%, 1/4W	10-0221
R32	1.5 K $\Omega$ , 5%, 1/4W	10-0152
R33	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R34	6.8 K $\Omega$ , 5%, 1/4W	10-0682
R35	15 $\Omega$ , 5%, 1/4W	10-0150
R36	15 $\Omega$ , 5%, 1/4W	10-0150
R37	15 $\Omega$ , 5%, 1/4W	10-0150
R38	15 $\Omega$ , 5%, 1/4W	10-0150
R39	15 $\Omega$ , 5%, 1/4W	10-0150
R40	15 $\Omega$ , 5%, 1/4W	10-0150
R41	15 $\Omega$ , 5%, 1/4W	10-0150
TRANSISTORS		
Q1	2N 5179	40-5179
Q2	2N 5179	40-5179
Q3	2N 5179	40-5179
Q4	2N 5179	40-5179
Q5	2N 5179	40-5179
Q6	2N 5179	40-5179
Q7	2N 5179	40-5179
Q8	2N 5179	40-5179
INTEGRATED CIRCUITS		
U1	MC10138	62-5100
U2	MC10138	62-5100

SGA

SGB

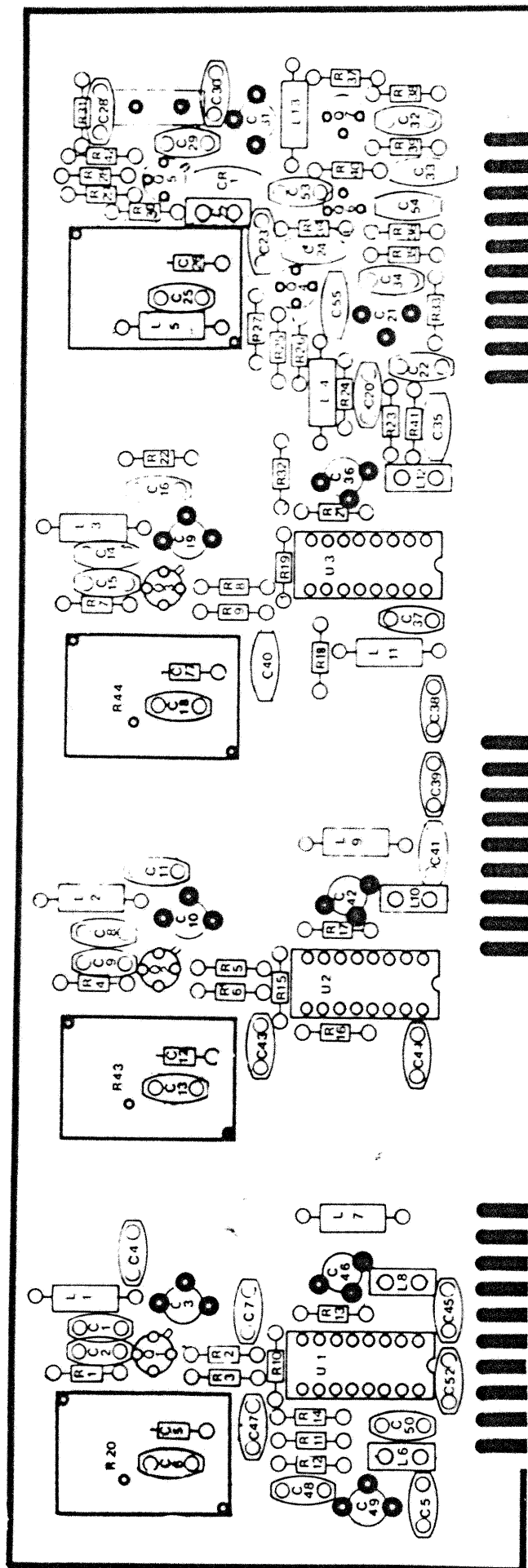


ALL FREQUENCIES IN MHz

Figure 1

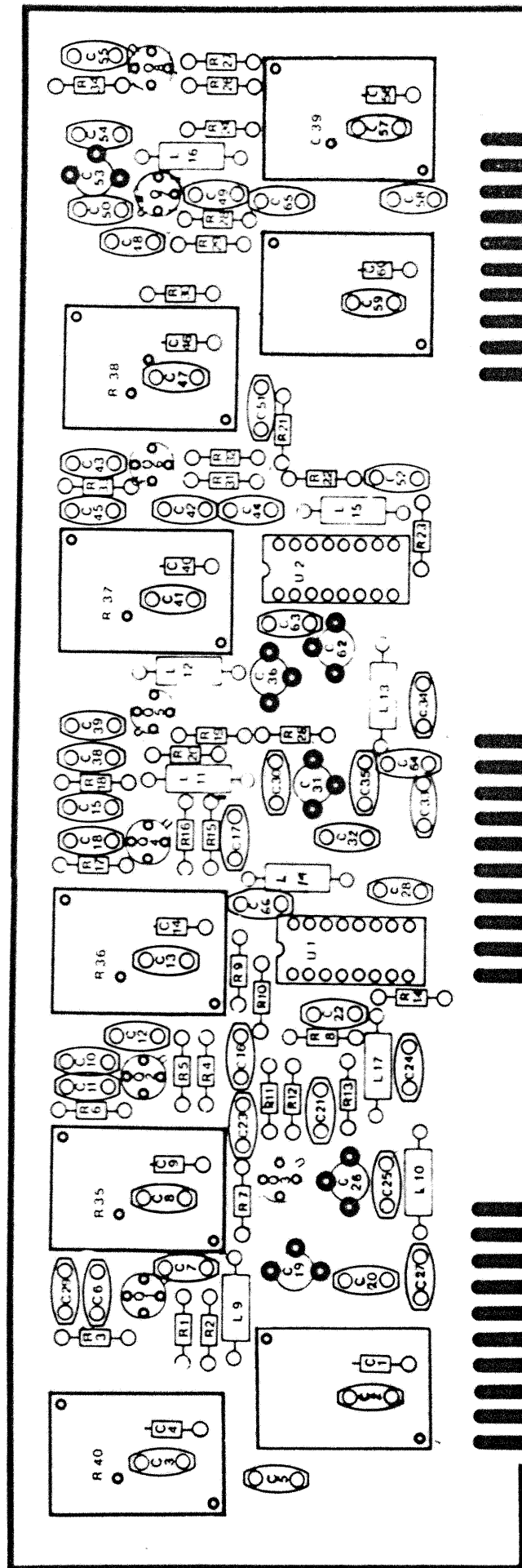






SGA-1002

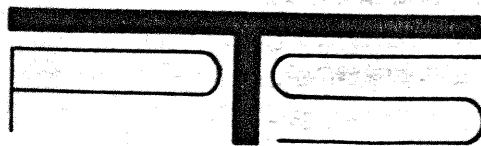
Figure 4



SGB-1003

Figure 5

**SO-1001  
IM-1007  
OA-1006  
SECTION**



**PROGRAMMED TEST SOURCES, inc.**

Littleton, Massachusetts, USA.



## TABLE OF CONTENTS

Introduction .....	1
Principles of Operation .....	2
10 MHz Step Function .....	2
Output Amplification and Level Control. ....	4
Service. ....	5
Maintenance .....	5
Alignment/Calibration. ....	5
Troubleshooting .....	6
Module Checks .....	7
Parts Lists .....	10
Figure 1 (Block Diagram) .....	20
Figure 2 (Schematic SO-1001) .....	21
Figure 3 (Schematic IM-1007). ....	22
Figure 4 (Schematic OA-1006) .....	23
Figure 5 (PC Assembly SO-1001) .....	24
Figure 6 (PC Assembly IM-1007) .....	25
Figure 7 (PC Assembly OA-1006) .....	26

## INTRODUCTION

The 10 MHz Step Section consists of three separate modules, the SO-1001, the IM-1007 and the OA-1006. They work in conjunction with the 505 MHz band-pass filter (390-1000) as the final functional block of the synthesizer. This block performs frequency translations to obtain the selected 10 MHz decade within the 160 MHz range and also provides the desired output level over a 10 dB range up to +13 dBm.

The heart of the 10 MHz Step Section is the SO-1001, switched oscillator, whose digitally controlled frequency spans a 150 MHz range in 10 MHz increments. Together with the intermediate mixer module, IM-1007, it performs a drift-cancelling double-conversion process, which negates any frequency fluctuations of this oscillator but adds or subtracts the appropriate 10 MHz harmonic from the basic reference source picket-fence to the signal supplied by the DMA module (140-150 MHz). The end result is simply expressed by: Output Frequency = DMA Frequency + (n x 10 MHz) with n = -14 through 0 to +1 depending on the selected 10 MHz multiple. The output amplifier, OA-1006 brings this signal to a level of 20 mW. Level control is accomplished through a feedback loop involving a "PIN"-diode modulator in the IM module as the variable gain element. The controlling signal is derived from a level-sensing detector and comparator in the OA module.

The modules of this section are unique, not interchangeable with each other or other modules in the synthesizer. All three modules employ coax connectors which must be released before removal from the deck is possible. In addition, the IM and SO modules use push-on connectors for various supply and programming inputs. The OA module uses a 10-pin card-edge connector. The modules are secured from the bottom of the deck by 6-32 pan-head screws; the SO uses three, the OA and IM two each. The PC boards of these modules are not accessible without removal of the module from the deck and subsequent removal of the covers. The 505 MHz filter is permanently mounted to the deck structure.

## PRINCIPLES OF OPERATION

The two main functions of the 10 MHz step section are:

1. Generation of the final 10 MHz step in the synthesis process.
2. Output amplification and level control.

A detailed description of how these functions are implemented follows. Use block diagram PTS 160 (Figure 1), schematic SO-1001 (Figure 2), schematic IM-1007 (Figure 3) and schematic OA-1006 (Figure 4) for reference.

### The 10 MHz Step Function

In order to obtain the desired output frequency, a 10 MHz multiple must be added or subtracted from the 140-150 MHz signal provided by the DMA module. This is done in a drift cancelled loop involving the SO and the IM modules and a narrow bandpass filter centered at 505 MHz. A major element in this scheme is the switched oscillator in the SO module, which can be set to one of 16 frequencies spaced 10 MHz by a 4-bit control word.

The program input in hexadecimal code and TTL level is first transposed by zener diodes CR1-4 by approximately -12V. The 1-of-16 decoder (U1, U2, Q8) operates from -6.8V to -11.4V; the latter is a stabilized and filtered voltage, produced by regulator CR8, Q9/Q10, Q11. Stabilization and low ripple are needed since this voltage is eventually applied to the oscillator varactors. The output of the decoder, by connecting one of the divider-resistors R1-R16 to -11.4V, produces proper voltages to set oscillator Q7 to frequencies from 365-515 in 10 MHz steps.

The oscillator frequency is changed by means of varactor diodes CR6, CR7. Control voltage ranges from -1.9V (365 MHz) to -11.0V (515 MHz), approximately.

The oscillator output is fed to two separate three-stage amplifiers for gain and isolation; at both mixers M1 and M2 this signal is used as the switching (LO) signal with a level of +10 to +16 dBm. M1 is connected through an attenuator in the deck and a low-pass filter (L1, L2, L3 and capacitors) to the picket fence signal ( $n \times 10$  MHz, 10-140 MHz). At each setting of the VCO one of the sum or difference frequencies equals 505 MHz. This signal is filtered by the bandpass filter connected to J2. The output of the filter feeds the IM module.

Mixer M2 produces the instrument output signal, which is amplified in the OA module. The low level input to M2 at J4 (365-355 MHz), which carries all digits except the 10 MHz steps, comes from the IM module. Any frequency drift of the VCO affects the two inputs to M2 in the same direction and by the same amount which cancels completely in the final output (0.1 to 160 MHz), which is the difference between the two mixer inputs.

The IM-1007 module contains the other elements of the drift cancelled loop. It consists of a 505 MHz broadly tuned amplifier, a mixer, a pin-diode attenuator and a 3-pole bandpass filter for 365-355 MHz.

The unit receives a 505 MHz signal from the SO module via the 505 MHz band-pass filter located in the deck. Five-stage amplifier Q1-5 increases this signal to drive mixer M1 at approximately +15 dBm.

The low-level signal to M1 is the 140-150 MHz input which comes from the DMA through a matching pad. Mixer M1 produces 365-355 MHz, the difference between 505 MHz and 140-150 MHz. It is fed to the pin-modulator CR1-CR4, which is driven from the OA and is a part of the output levelling loop. Minimum attenuation is obtained with a -11.5V input. The signal is then filtered in the 3-pole filter (L1, L2, L3) and fed back to the SO via J3, thereby closing the drift cancelling loop.

## Output Amplification and Level Control

The final output (0.1-160 MHz) from M2 in the SO module is a low-level signal of nominally -24 dBm. The output amplifier OA module provides the necessary wideband gain and levelling of amplitude to produce instrument outputs up to +13 dBm across the band from a 50 ohm source-impedance with substantially flat response. See schematic 1006-S (Figure 4).

The RF gain portion from input J2 to output J1 provides insertion gain in a 50-ohm system of approximately 40 dB from 100 KHz to 160 MHz, if the "level set" voltage on pin 22 is 2.0 VDC. The four-stage amplifier uses emitter degeneration at low frequencies to obtain a flat response. Two stages of pre-amplification are followed by a TO-5 driver and a PNP-NPN push-pull output stage. The module input, which is connected to the final mixer output in the SO module, contains a matching pad and a low-pass filter to reduce levels of signals above 165 MHz.

Between the first and second stage a PIN-diode attenuator is used to effect a reduction in gain by some 8 dB for a "set-level" voltage reduction from 2.0V to 0.63V. This reduces the overall loop gain without substantial loss of signal-to-noise ratio.

To operate the levelling loop, the RF output signal is detected by CR1/CR2. The resulting DC voltage, after suitable amplification, is compared to the "set-level" voltage in the differential pair Q9/Q10. The output of this amplifier through Q11 regulates the current of the PIN-diode attenuator in the IM module, which controls the amplifier input signal such that only a minute error-voltage exists between the "set-level" voltage and the collector voltage of Q8. This means that the RF voltage at the detector is stabilized at a constant set level. The actual output voltage into a matched load impedance (50 ohms) is one-half of the detector voltage with R26 providing the 50 ohm source impedance. The unterminated output can reach a level of twice the voltage shown by the meter on the front panel.

## SERVICE

### Maintenance

No preventive maintenance is required for the three modules of this section. The presence of output signals of correct frequency and level indicates that the modules are operating properly. Minor aging effects will not impair performance. Detailed verification of systems and module operation is made with the system troubleshooting table in the system section.

### Alignment/Calibration

Modules are tested and calibrated at the factory in special test fixtures. Complete alignment of the SO and IM modules is beyond the scope of this manual; most active and passive components of these modules, however, can be replaced if they become defective, without any recalibration. The only calibration in the OA module is the adjustment of the meter circuit, described below.

#### OA Module, Meter Calibration

Remove module from deck after carefully releasing coax connectors and 6-32 screws. Remove cover, reinstall module without cover, connect power or level meter (50 ohm terminated) directly to the output jack, i.e., the level sensing head should see no additional attenuation. Set frequency to 100 MHz and adjust level control to obtain +13 dBm reading on front panel meter. If necessary, readjust R36 to obtain +13 dBm on power or level meter. Reset level to +3 dBm on panel meter. Adjust R41 if needed to match reading on power meter. Repeat sequence several times to eliminate effects of interaction. Reinstall cover and recheck.

## Troubleshooting

The system section of this manual has the necessary information to isolate a faulty module in the 10 MHz Step Section. It is important to follow the procedure in detail to ensure proper identification of the faulty module. Further tests here require the same test equipment as detailed under System Troubleshooting.

Aspects of the generation of the proper frequency are all covered in the system troubleshooting chart. This leaves the checks concerning the levelling loop. Meter recalibration in the OA module is detailed above.

A normally functioning instrument will produce a PIN-modulator voltage (orange lead, OA pin 20) of  $-4$  to  $-11.0\text{V}$  at an output setting of  $+13\text{ dBm}$  into a  $50\text{ ohm}$  load. This voltage (PIN-voltage) is an easily accessible monitor for loop problems. It permits diagnosis of most troubles. If it saturates to  $-11.5\text{V}$ , insufficient gain is available to produce the output demanded.

The first step in the system troubleshooting chart that involves the PIN-voltage is No. 15. To obtain  $-16\text{ dBm}$  output from the IM requires a PIN-voltage of  $11.5\text{V}$ ; since the loop is open (SA connected to IM output), the OA will produce this voltage unless it is faulty. The OA, however, must see  $+2.0\text{V}$  at its pin 22. This voltage comes from the front panel level pot. A built-in voltage divider or an external feed through programming connector pin 22 supplies this voltage in instruments without front panel controls. If no positive voltage is available on OA pin 22, check these sources.

An *apparent* lack of output can obviously result from a failure of the meter or the meter resistor R40 in the OA. If the spectrum analyzer or level meter record output, but no meter indication is obtained, a check of the  $1\text{ mA}$ ,  $100\text{ ohm}$ , front panel meter or the resistor is in order. The PIN-voltage will not indicate post-detector faults in the system. If the voltage is normal, but no output is available, check output coax cable, connectors and R26, C23 in the OA module.

## Module Checks

After one of the three modules has been found suspect or defective, it is recommended to return the module to the factory for repair. In emergency situations a number of checks are detailed below, which may enable a skilled technician to locate the specific fault.

Most failures of active devices result in drastic changes of the DC voltages of the semiconductor. For this reason DC checks are always the proper first step. Further, a careful examination of the PC board may reveal overheated components, bad solder joints, broken track, etc.

Replacement of faulty components requires careful use of printed-circuit repair techniques as applicable to double-sided boards with plated-through holes.

## OA Module Tests

Carefully remove module after releasing 6-32 screws and coax connectors below the deck. Remove cover from module. To perform DC tests, the module has to be powered, preferably through a 10-pin, card-edge connector (0.156 spacing) with: -12.4V at pin 28, current 120mA; +5.4V at pin 26, current 90 mA. Ground return is pin 19.

Transistor currents in the RF part of the OA are best checked by measuring the drop across the emitter resistors.

Q	Res	Voltage
1	R5+6	0.8V
2	R9+10	0.6V
3	R16+17	2.3V
4	R28	1.3V
5	R24	1.3V

Deviations of over 20% are not normal. Replacement of any of the above transistors will not require recalibration. Part or transistor replacement in the detector-op-amp part of the OA calls for recalibration of the meter circuit; see page 5.



### SO Module Tests

Check -12.4V current with ammeter (in blue lead). Normal values are 180-200 mA for digit 10 MHz; and 230-250 mA for digit 150 MHz. Any significant deviation confirms some component or wiring fault, which might be detectable by careful inspection of the open module.

Unplug bottom connections, coax and feed-through clips, remove module and remove cover. Do not change any pot settings. Power module with -12.4V through C44 and check:

1. -11.4V regulator voltage at pin 8-U1. Non-compliance indicates trouble in regulator section around Q9-Q11.
2. Verify mixer input levels at L4, R82 for M1 and L10, R81 for M2 to be +13 dBm. (Use RF voltmeter.) If both are off, oscillator section is suspect. If only one is off, associated amplifier section is suspect, Q1-Q3 or Q4-Q6. Emitter resistor voltage drops across R21, R27, R32, R55, R60, R66 are 1.7 -2.3V.

Generally no recalibration is required after replacement of transistors and components in the amplifier and regulator sections.

### IM Module Tests

Check -12.4V current with ammeter (in blue lead). Normal value is 65 mA. Reconnect blue lead, remove orange lead and apply -12.4V through ammeter to this capacitor, normal current is 10 mA. Any significant deviation confirms a major component or wiring fault. Release coax connector and remove module after releasing the 6-32 screws; remove cover. If inspection does not provide any clues, power module with -12.4V through C41 and measure voltage drops in the emitter resistors:

Q	Res.	Voltage
1	R33	1.3V
2	R27	1.3V
3	R22	1.3V
4	R16	1.3V
5	R13	1.5V

Replacements of transistors or components in the amplifier section Q1-Q5 can be done without recalibration.

# SO-1001 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	220 pF, 10%, 500V, X5F	22-0221
C2	1 nF, 10%, 500V, X5F	22-0102
C3	10 pF, 5%, 500V, NPO	20-0100
C4	220 pF, 10%, 500V, X5F	22-0221
C5	10 pF, 5%, 500V, NPO	20-0100
C6	220 pF, 10%, 500V, X5F	22-0221
C7	10 pF, 5%, 500V, NPO	20-0100
C8	1 nF, 10%, 500V, X5F	22-0102
C9	1 nF, 10%, 500V, X5F	22-0102
C10	27 pF, 5%, 500V, NPO	20-0270
C11	12 pF, 5%, 500V, NPO	20-0120
C12	33 pF, 5%, 500V, NPO	20-0330
C13	6.8 pF, 5%, 500V, NPO	24-1680
C14	15 pF, 5%, 500V, NPO	20-0150
C15	10 nF, 80/20%, 50V, Z5V	23-0103
C16	5 pF, 5%, 500V, NPO	20-1500
C17	1.0 pF, 5%, 500V, NPO	24-1100
C18	1 nF, 10%, 500V, X5F	22-0102
C19	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C20	10 pF, 5%, 500V, NPO	20-0100
C21	3.3 pF, 5%, 500V, NPO	20-1330
C22	10 pF, 5%, 500V, NPO	20-0100
C23	2.2 pF, 5%, 500V, NPO	20-1220
C24	10pF, 5%, 500V, NPO	20-0100
C25	1.5 nF, +50-20%, 500V	28-5100
C26	1 nF, 10%, 500V, X5F	22-0102
C27	220 pF, 10%, 500V, X5F	22-0221
C28	10 pF, 5%, 500V, NPO	20-0100
C29	220 pF, 10%, 500V, X5F	22-0221
C30	10 pF, 5%, 500V, NPO	20-0100
C31	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C32	220 pF, 10%, 500V, X5F	22-0221
C33	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C34	10 pF, 5%, 500V, NPO	20-0100
C35	1 nF, 10%, 500V, X5F	22-0102
C36	10 nF, 80/20%, 50V, Z5V	23-0103
C37	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C38	1.5 nF, +50-20%, 500V	28-5100
C39	1.5 nF, +50-20%, 500V	28-5100
C40	1.5 nF, +50-20%, 500V	28-5100
C41	1 nF, 10%, 500V, X5F	22-0102
C42	1 nF, 10%, 500V, X5F	22-0102
C43	10 pF, 5%, 500V, NPO	20-0100
C44	1.5 nF, +50-20%, 500V	28-5100

# SO-1001 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
INDUCTORS		
L1	50 nH, nom.	35-5104
L2	50 nH, nom.	35-5103
L3	50 nH, nom.	35-5104
L4	50 nH, nom.	35-5105
L5	50 nH, nom.	35-5105
L6	50 nH, nom.	35-5105
L7	25 nH, nom.	35-5112
L8	30 nH, nom.	38-5100
L9	80 nH, nom.	35-5122
L10	50 nH, nom.	35-5105
L11	50 nH, nom.	35-5105
L12	50 nH, nom.	35-5105
L13	20 nH, nom.	35-5121
L14	20 nH, nom.	35-5120
RESISTORS		
R1	500 $\Omega$ , 10%, 1W	17-5103
R2	500 $\Omega$ , 10%, 1W	17-5103
R3	500 $\Omega$ , 10%, 1W	17-5103
R4	1.0 K $\Omega$ , 10%, 1W	17-5104
R5	1.0 K $\Omega$ , 10%, 1W	17-5104
R6	1.0 K $\Omega$ , 10%, 1W	17-5104
R7	1.0 K $\Omega$ , 10%, 1W	17-5104
R8	1.0 K $\Omega$ , 10%, 1W	17-5104
R9	1.0 K $\Omega$ , 10%, 1W	17-5104
R10	2.0 K $\Omega$ , 10%, 1W	17-5100
R11	2.0 K $\Omega$ , 10%, 1W	17-5100
R12	2.0 K $\Omega$ , 10%, 1W	17-5100
R13	5.0 K $\Omega$ , 10%, 1W	17-5102
R14	5.0 K $\Omega$ , 10%, 1W	17-5102
R15	5.0 K $\Omega$ , 10%, 1W	17-5102
R16	5.0 K $\Omega$ , 10%, 1W	17-5102
R17	1.0 K $\Omega$ , 1%, $\frac{1}{4}$ W	14-5103
R18	1.5 K $\Omega$ , 1%, $\frac{1}{4}$ W	14-5104
R19	1.0 K $\Omega$ , 1%, $\frac{1}{4}$ W	14-5103
R20	511 $\Omega$ , 1%, $\frac{1}{4}$ W	14-5102
R21	220 $\Omega$ , 5%, $\frac{1}{4}$ W	*10-0221
R22	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R23	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R24	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R25	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R26	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R27	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R28	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R29	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R30	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471

# SO-1001 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R31	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R32	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R33	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R34	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R35	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R36	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R37	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R38	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R39	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R40	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R41	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R42	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R43	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R44	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R45	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R46	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R47	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R48	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R49	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R50	3.3 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0332
R51	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0102
R52	47 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0470
R53	470 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0471
R54	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R55	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R56	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R57	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R58	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R59	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R60	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R61	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R62	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R63	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R64	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R65	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R66	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R67	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R68	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R69	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R70	2.0 K $\Omega$ , 10%, 1W	17-5100
R71	150 $\Omega$ , 5%, $\frac{1}{4}$ W	11-0151
R72	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R73	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R74	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R75	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R76	2.2 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1220

# SO-1001 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R77	15 K $\Omega$ , 5%, 1/4W	10-0153
R78	15 K $\Omega$ , 5%, 1/4W	10-0153
R79	15 K $\Omega$ , 5%, 1/4W	10-0153
R80	15 K $\Omega$ , 5%, 1/4W	10-0153
R81	22 $\Omega$ , 5%, 1/4W	10-0220
R82	22 $\Omega$ , 5%, 1/4W	10-0220
R83	1.5 K $\Omega$ , 5%, 1/4W	11-0152
TRANSISTORS		
Q1	2N 5179	40-5179
Q2	2N 5179	40-5179
Q3	2N 5179	40-5179
Q4	2N 5179	40-5179
Q5	2N 5179	40-5179
Q6	2N 5179	40-5179
Q7	2N 5179	40-5179
Q8	2N 2369	40-2369
Q9	2N 3250	41-3250
Q10	2N 3250	41-3250
Q11	2N 2218	42-2218
DIODES		
CR1	1N 963BF	73-0963
CR2	1N 963BF	73-0963
CR3	1N 963BF	73-0963
CR4	1N 963BF	73-0963
CR5	1N 3829A	73-3829
CR6	BB 141B	72-0141
CR7	BB 141B	72-0141
CR8	1N 751A	73-0751
CR9	1N 4151	70-4151
INTEGRATED CIRCUITS		
U1	74145	60-5101
U2	74145	60-5101
M1	SRA-1H	65-5100
M2	SRA-1H	65-5100

\*NOTE: 10-xxxx carbon composition  
11-xxxx carbon film

# IM-1007 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	1-6 pF, Trimmer	26-5102
C2	1.0 pF, .25 pF, 500V, NPO	24-1100
C3	1-6 pF, Trimmer	26-5102
C4	1.0 pF, .25 pF, 500V, NPO	24-1100
C5	1-6 pF, Trimmer	26-5102
C6	220 pF, 10%, 500V, X5F	22-0221
C7	220 pF, 10%, 500V, X5F	22-0221
C8	220 pF, 10%, 500V, X5F	22-0221
C9	220 pF, 10%, 500V, X5F	22-0221
C10	10 pF, 5%, 500V, NPO	20-0100
C11	3-13 pF, Trimmer	26-5101
C12	12 pF, 5%, 500V, NPO	20-0120
C13	220 pF, 10%, 500V, X5F	22-0221
C14	10 nF, 80/20%, 50V, Z5V	23-0103
C15	220 pF, 10%, 500V, X5F	22-0221
C16	22 pF, 5%, 500V, NPO	20-0220
C17	12 pF, 5%, 500V, NPO	20-0120
C18	220 pF, 10%, 500V, X5F	22-0221
C19	220 pF, 10%, 500V, X5F	22-0221
C20	12 pF, 5%, 500V, NPO	20-0120
C21	12 pF, 5%, 500V, NPO	20-0120
C22	220 pF, 10%, 500V, X5F	22-0221
C23	220 pF, 10%, 500V, X5F	22-0221
C24	22 pF, 5%, 500V, NPO	20-0220
C25	10 pF, 5%, 500V, NPO	20-0100
C26	220 pF, 10%, 500V, X5F	22-0221
C27	10 nF, 80/20%, 50V, Z5V	23-0103
C28	220 pF, 10%, 500V, X5F	22-0221
C29	12 pF, 5%, 500V, NPO	20-0120
C30	5 pF, .25 pF, 500V, NPO	20-1500
C31	220 pF, 10%, 500V, X5F	22-0221
C32	220 pF, 10%, 500V, X5F	22-0221
C33	22 pF, 5%, 500V, NPO	20-0220
C34	10 nF, 80/20%, 50V, Z5V	23-0103
C35	220 pF, 10%, 500V, X5F	22-0221
C36	1.0 pF, .25 pF, 500V, NPO	24-1100
C37	1.5 pF, .25 pF, 500V, NPO	24-1150
C38	3.3 pF, .25 pF, 500V, NPO	20-1330
C39	2.2 pF, .25 pF, 500V, NPO	20-1220
C40	1.5 nF, +50-20%, 500V	28-5100
C41	1.5 nF, +50-20%, 500V	28-5100
C42	3-13 pF, Trimmer	26-5101
C43	5 pF, .25 pF, 500V, NPO	20-1500
C44	5 pF, .25 pF, 500V, NPO	20-1500
C45	5 pF, .25 pF, 500V, N750	21-1500
C46	5 pF, .25 pF, 500V, NPO	20-1500

# IM-1007 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
INDUCTORS		
L1	20 nH, nom.	35-5114
L2	20 nH, nom.	35-5113
L3	20 nH, nom.	35-5113
L4	.33 $\mu$ H, 10%	36-5104
L5	.33 $\mu$ H, 10%	36-5104
L6	50 nH, nom.	35-5104
L7	40 nH, nom.	35-5111
L8	40 nH, nom.	35-5110
RESISTORS		
R1	10 K $\Omega$ , 5%, $\frac{1}{4}$ W	*10-0103
R2	10 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0103
R3	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R4	10 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0103
R5	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R6	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R7	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R8	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R9	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R10	220 $\Omega$ , 5% $\frac{1}{4}$ W	10-0221
R11	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R12	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R13	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R14	220 $\Omega$ , 5% $\frac{1}{4}$ W	10-0221
R15	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R16	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R17	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R18		
R19	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R20	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R21	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R22	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R23	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R24	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R25	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R26	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R27	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R28	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R29	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R30	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R31	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R32	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R33	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R34	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R35	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R36	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R37	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471



# IM-1007 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
TRANSISTORS		
Q1	2SC 1260	40-1260
Q2	2SC 1260	40-1260
Q3	2SC 1260	40-1260
Q4	2SC 1260	40-1260
Q5	2N 5179	40-5179
DIODES		
CR1	5082-3080	71-3080
CR2	5082-3080	71-3080
CR3	5082-3080	71-3080
CR4	5082-3080	71-3080
INTEGRATED CIRCUITS		
M1	SRA 1H	65-5100

\*NOTE: 10-xxxx carbon composition  
11-xxxx carbon film

# OA-1006 PARTS LIST

Schem. Desig.	Description	PTS P/N
CAPACITORS		
C1	15 pF, 5%, 500V, NPO	20-0150
C2	6.8 pF, 5%, 500V, NPO	24-1680
C3	15 pF, 5%, 500V, NPO	20-0150
C4	15 pF, 5%, 500V, NPO	20-0150
C5	22 pF, 5%, 500V, NPO	20-0220
C6	50 nF, 80/20%, 50V, Z5V	23-0503
C7	50 nF, 80/20%, 50V, Z5V	23-0503
C8	68 pF, 5%, 500V, N750	21-0680
C9	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C10	50 nF, 80/20%, 50V, Z5V	23-0503
C11	68 pF, 5%, 500V, N750	21-0680
C12	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C13	47 pF, 5%, 500V, NPO	20-0470
C14	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C15	50 nF, 80/20%, 50V, Z5V	23-0503
C16	50 nF, 80/20%, 50V, Z5V	23-0503
C17	150 pF, 10%, 500V, X5F	22-0151
C18	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C19	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C20	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C21	150 pF, 10%, 500V, X5F	22-0151
C22	1 nF, 10%, 500V, X5F	22-0102
C23	1 $\mu$ F, $\pm$ 20%, 50V	29-5101
C24	220 pF, 10%, 500V, X5F	22-0221
C25	1 nF, 10%, 500V, X5F	22-0102
C26	50 nF, 80/20%, 50V, Z5V	23-0503
C27	1 nF, 10%, 500V, X5F	22-0102
C28	10 nF, 80/20%, 50V, Z5V	23-0103
C29	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C30	6.8 $\mu$ F, El.-Tant. 16V	30-5101
C31	10 nF, 80/20%, 50V, Z5V	23-0103
C32	10 nF, 80/20%, 50V, Z5V	23-0103
C33	50 nF, 80/20%, 50V, Z5V	23-0503
C34	50 nF, 80/20%, 50V, Z5V	23-0503
C35	22 pF, 5%, 500V, NPO	20-0220
C36	220 pF, 10%, 500V, X5F	22-0221
C37	10 nF, 80/20%, 50V, Z5V	23-0103
INDUCTORS		
L1	50 nH, nom.	35-5109
L2	50 nH, nom.	35-5111
L3	50 nH, nom.	35-5110
L4	50 nH, nom.	35-5109
L5	22 $\mu$ H, 5%	36-5106
L6	22 $\mu$ H, 5%	36-5106
L7	150 $\mu$ H, 10%	36-5121

# OA-1006 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS		
R1	100 $\Omega$ , 5%, $\frac{1}{4}$ W	*10-0101
R2	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R3	470 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0471
R4	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R5	33 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0330
R6	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R7	3.3 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0332
R8	680 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0681
R9	22 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0220
R10	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R11	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R12	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R13	220 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0221
R14	1.5 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0152
R15	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R16	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R17	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R18	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R19	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R20	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R21	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R22	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R23	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R24	33 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0330
R25	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	10-1470
R26	47 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0470
R27	150 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0151
R28	33 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0330
R29	4.7 $\Omega$ , 5%, $\frac{1}{4}$ W	11-1470
R30	100.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0104
R31	33.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0333
R32	15.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0153
R33	22.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R34	10.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0103
R35	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R36	10.0 K $\Omega$ , 20%, $\frac{1}{2}$ W	16-5101
R37	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R38	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R39	10 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0103
R40	2.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0202
R41	10.0 K $\Omega$ , 20%, $\frac{1}{2}$ W	16-5101
R42	33.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	11-0333
R43	22.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R44	22.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0223
R45	1.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R46	1 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0102
R47	10.0 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0103

# OA-1006 PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
RESISTORS (continued)		
R48	33 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0330
R49	10.0 K $\Omega$ , 20%, $\frac{1}{2}$ W	16-0101
R50	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R51	15 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0150
R52	330 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0331
R53	4.7 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0472
R54	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R55	680 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0681
R56	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
R57	100 $\Omega$ , 5%, $\frac{1}{4}$ W	10-0101
R58	2.2 K $\Omega$ , 5%, $\frac{1}{4}$ W	10-0222
TRANSISTORS		
Q1	2N 5179	40-5179
Q2	2N 5179	40-5179
Q3	2N 5109	42-5109
Q4	2N 5160	42-5160
Q5	2N 5109	42-5109
Q6	2N 3250	41-3250
Q7	2N 3250	41-3250
Q8	2N 2369	40-2369
Q9	2N 3250	41-3250
Q10	2N 3250	41-3250
Q11	2N 2369	40-2369
DIODES		
CR1	1N 4151	70-4151
CR2	1N 4151	70-4151
CR3	1N 4151	70-4151
CR4	BA 379	71-0379
CR5	BA 379	71-0379

\*NOTE: 10-xxxx carbon composition  
11-xxxx carbon film

# BLOCK DIAGRAM, PTS 160

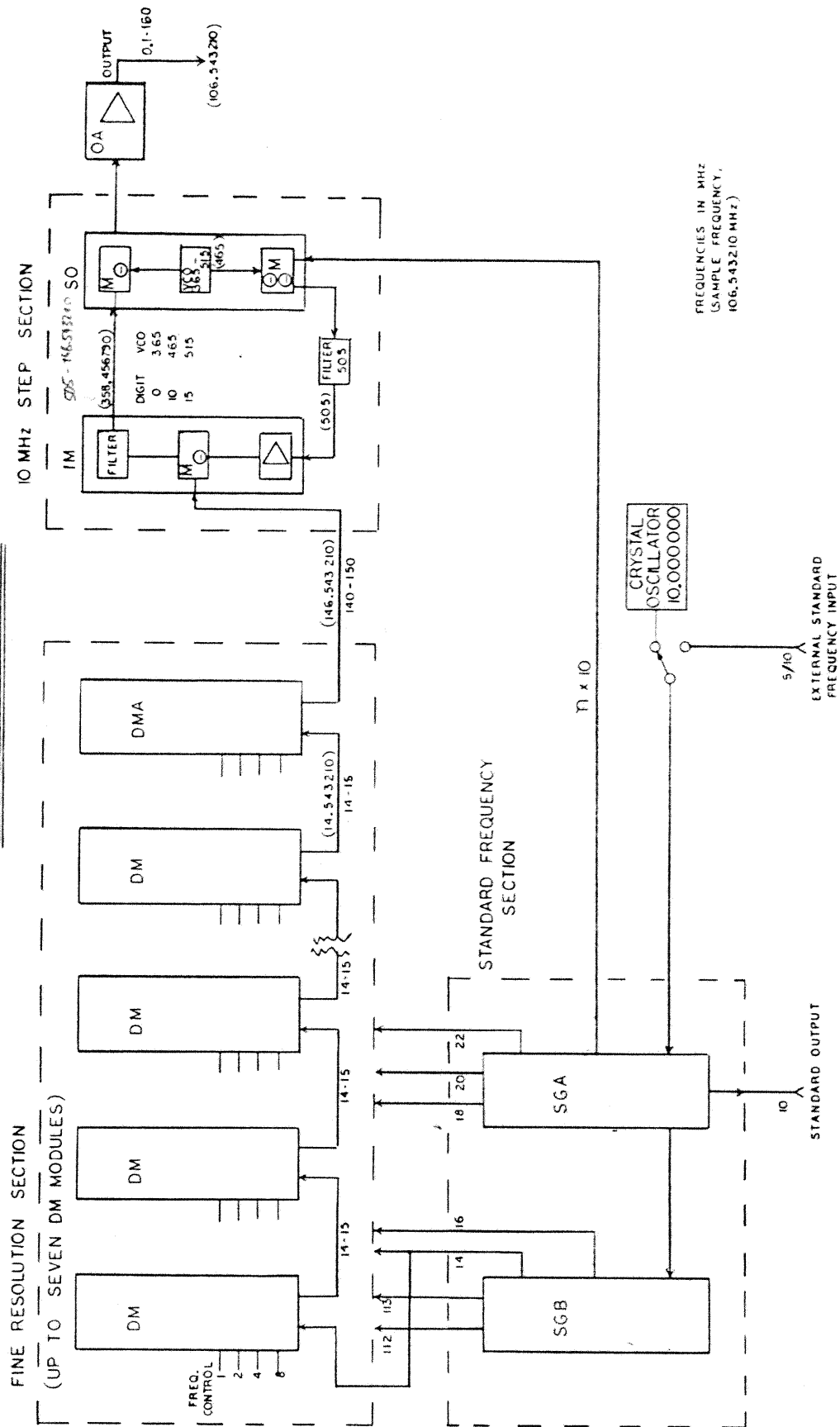


Figure 1



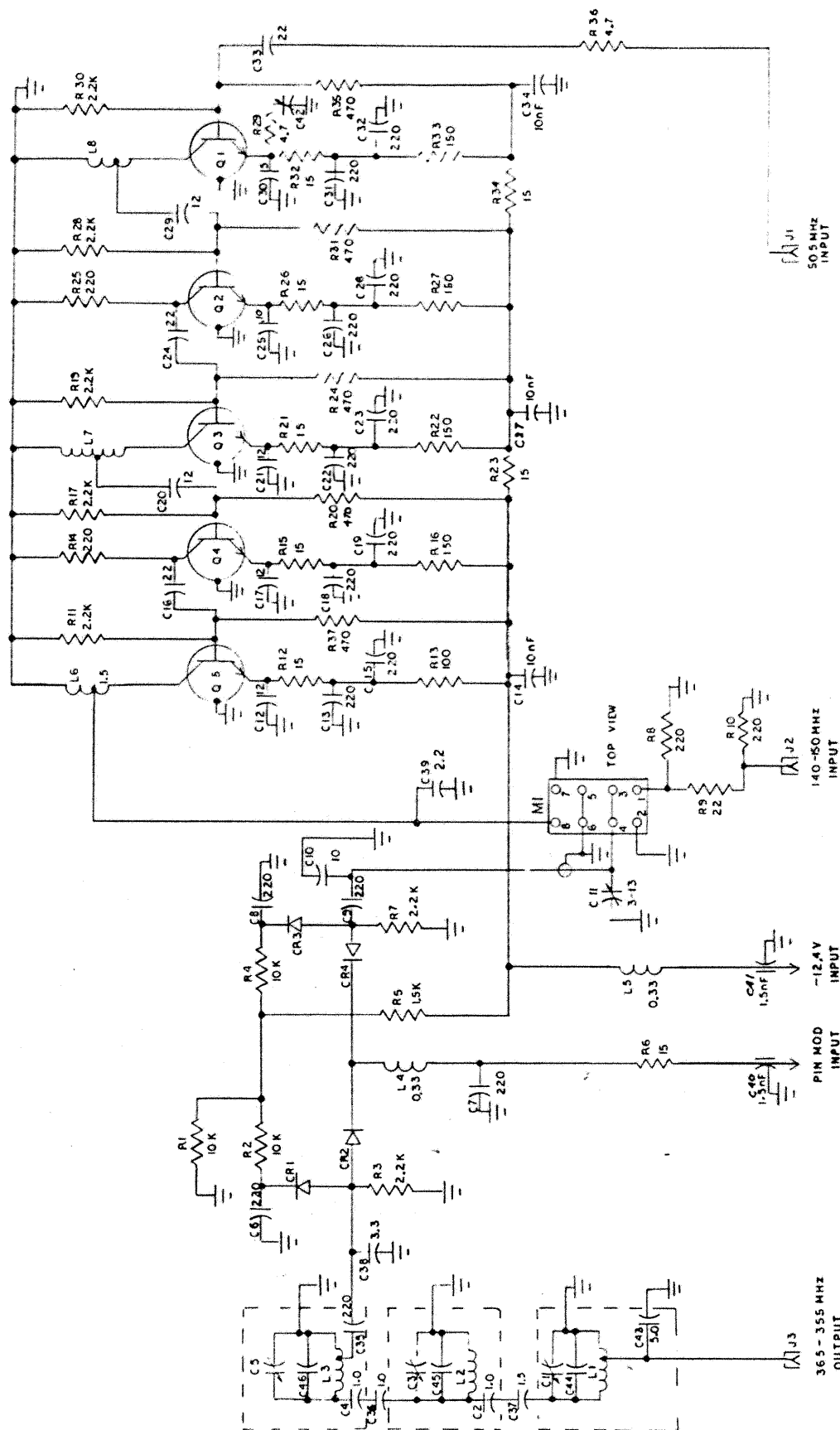


Figure 3

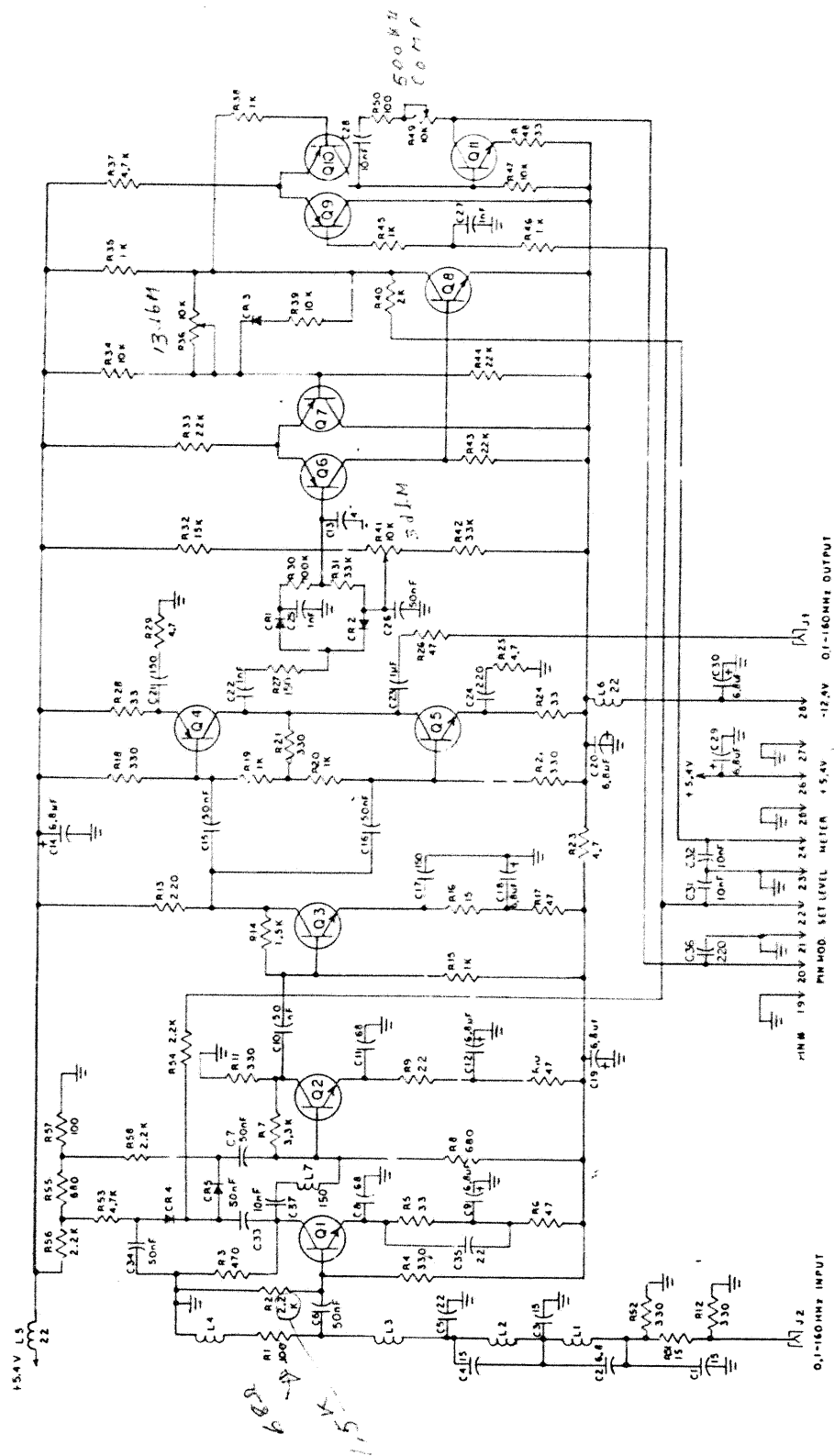


Figure 4

0A1006



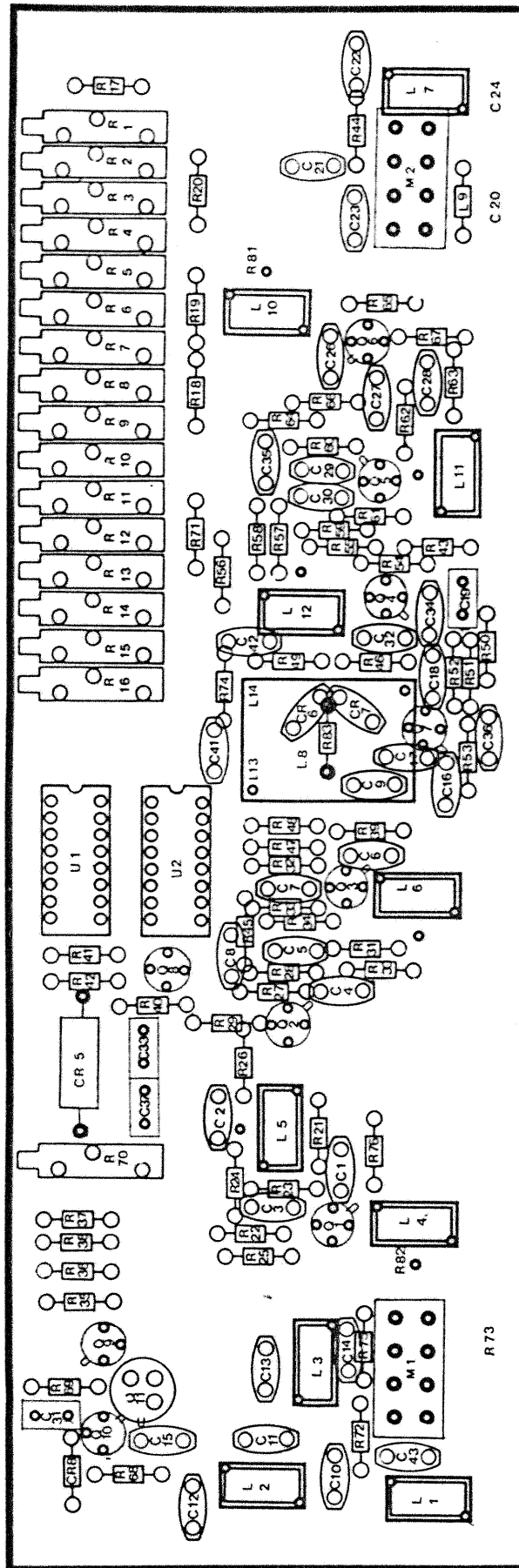


Figure 5

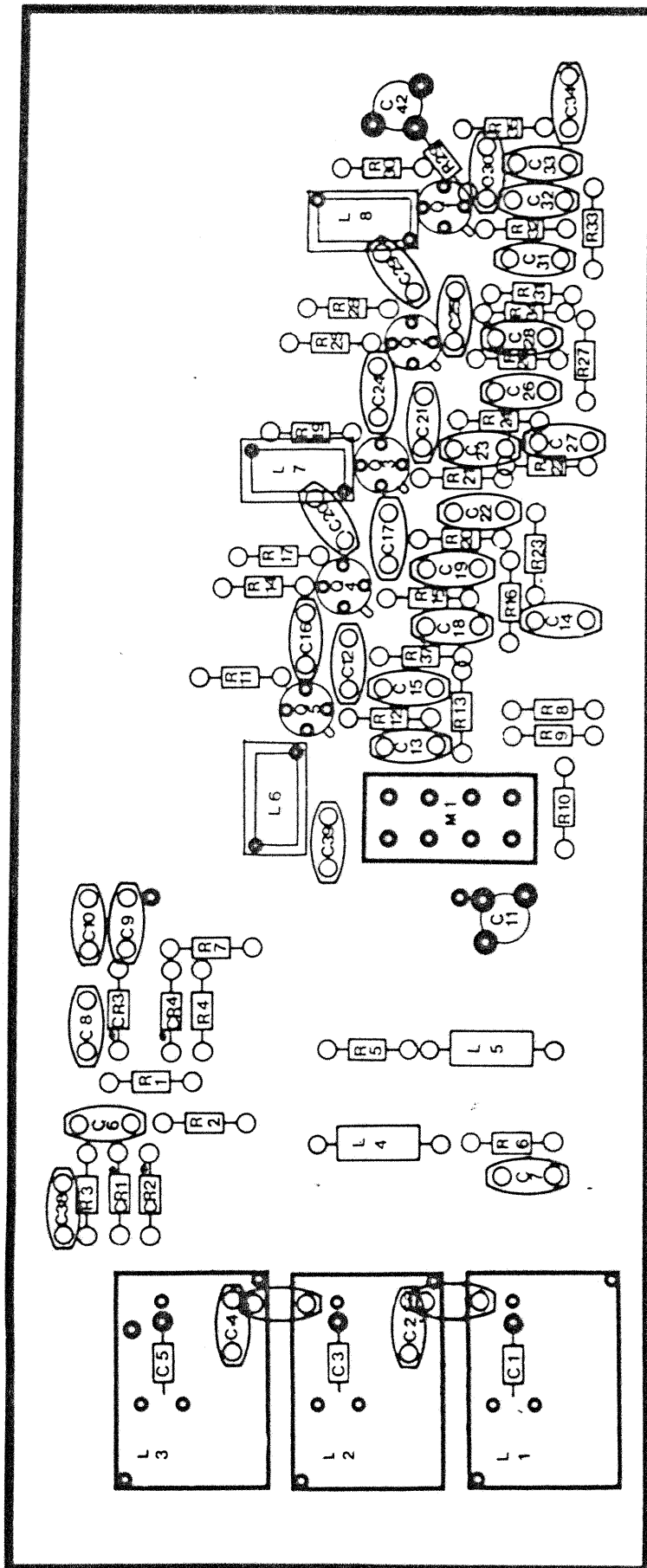


Figure 6

