MAINTENANCE SERVICE MANUAL FTC-2640

SAME AS SMC 2515L8

YAESU

YAESU MUSEN CO.,LTD.

MAINTENANCE SERVICE MANUAL FTC-2640

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PREFACE

The purpose of this manual is to provide information critical to the long-term operation and maintenance of the FTC-2640 VHF FM Mobile Transceiver. In the interest of clarity, descriptions have been kept brief and somewhat informal, while photographs and drawings are utilized liberally.

We believe the material presented herein to be correct and factual. However, should typographical or other errors be present, Yaesu assumes no liability for damage resulting from such errors. Your cooperation in pointing out any inconsistencies in the technical information would be appreciated.

The rugged, straightforward design of the FTC-2640 makes it unlikely that you will have frequent recourse to this manual. We hope and trust, however, that the material to follow will meet your service requirements.

Yaesu Musen Company, Ltd.
Tokyo, Japan

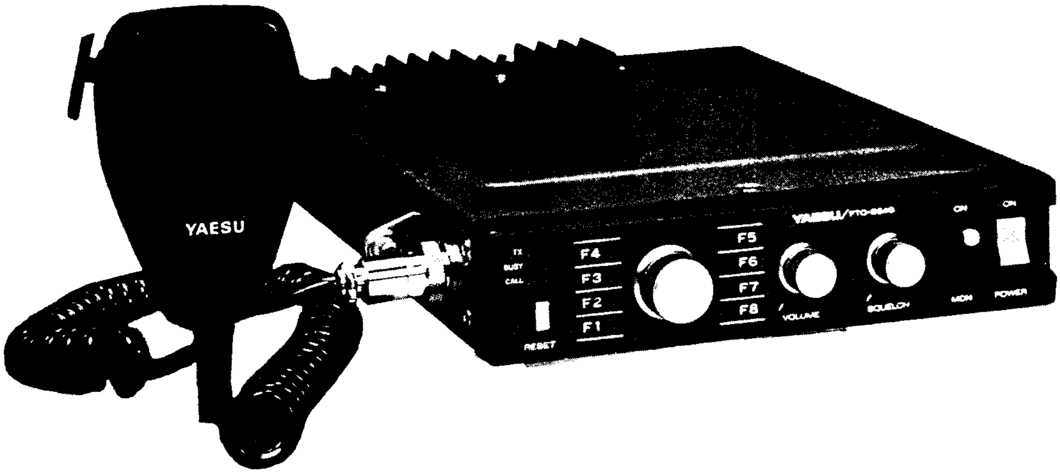
IMPORTANT NOTE

Any adjustments to the FTC-2640 which affect the transmitter characteristics or operating frequency must be performed only by an FCC licensed technician holding a Second Class (or higher) certificate.

CONTENTS

SECTION 4 – REPAIR PARTS

YAESU
FTC-2640
VHF LAND MOBILE TRANSCEIVER



GENERAL DESCRIPTION

The FTC-2640 is a compact, high-performance VHF FM transceiver for land mobile applications. Fully solid state, this transceiver provides operation within a 10 MHz range in the 134 – 174 MHz land mobile band. The transmitter section of the FTC-2640 puts out 40 watts. The receiver section provides high sensitivity, yet excellent rejection of intermodulation and cross modulation products.

Designed for use in a variety of land mobile applications, this transceiver is packaged in a heavy gauge metal case, thus minimizing the chance of damage from shock or vibration. The FTC-2640 is also protected against damage from high antenna SWR.

The FTC-2640 is supplied with all mounting hardware, cables, and connectors required for mobile installation.

PERFORMANCE SPECIFICATIONS

GENERAL

Frequency range:
8 desired spot frequencies within a 10 MHz spread within the range 134 – 174 MHz (5 Bands)
(A) 134 – 144 MHz, (*134.3 – 144.3 MHz)
(B) 144 – 154 MHz, (*144.3 – 154.3 MHz)
(C) 154 – 164 MHz, (*154.3 – 164.3 MHz)
(D) 164 – 174 MHz, (*164.3 – 174.3 MHz)
(E) 150 – 160 MHz (*150.3 – 160.3 MHz)

Oscillation system:
PLL control

External connections:
Push-to-talk microphone and mounting bracket furnished. External antenna jack and power supply connections in rear.

Weight:
Approx. 2.0 kg.

Dimensions:
40(50)mm (H) x 180(212)mm (W) x 252(295)mm (D)
(larger dimensions include heatsinks, knobs and jacks.)

Power requirements:
DC 13.6 volts (negative ground)

Power consumption (at 13.6 V)
Standby: Less than 0.3 A
Receive: Less than 1.0 A @ 1.5 W audio output
Transmit: 10 A

Number of channels:
8

TRANSMITTER

Power output:
40 watts

Frequency stability:
Better than ±5ppm

Modulation type:
16F3 (phase modulation)
(*11F3)

Transmitter audio deviation:
±5 kHz
(*±2.5 kHz)

Audio response:
+1, –3 dB/octave pre-emphasis characteristic from 300 Hz to 2500 Hz.

FM noise:
–40 dB @ ±3 kHz deviation w/1 kHz modulation.
(*–34 dB @±1.5 kHz deviation w/1 kHz modulation)

Spurious emissions:
At least 60 dB below carrier.

AF distortion:
10% or less @ 1 kHz, ±3 kHz deviation.
(*10% or less @ 1 kHz, ±1.5 kHz deviation)

Antenna impedance:
50 ohms

Microphone type:
Low impedance (600 ohm) dynamic

RECEIVER

Frequency stability:
Better than ±5ppm

Sensitivity:
Better than 0.5μV for 20 dB noise quieting
Better than 0.35μV for 12 dB SINAD

Adjacent channel selectivity:
Better than –70 dB.

Image rejection:
Better than –80 dB.

Intermodulation:
Better than –70 dB.

Squelch sensitivity:
0.2 μV.

AF output:
1.5 watts @ 10% THD (8 ohms)
3 watts for External Speaker @ 10% THD (4 ohms)

Specifications subject to change without notice or obligation.

* 12.5 kHz/step model

SEMICONDUCTORS

ICs	
AN315	1
HD74LS02AP	1
HD74LS74AP	1
MB3756	1
MC14504B	1
MC14568B	1
MLM2902	2
TC9122P	2
μPB551C (*μPB555C)	1
μPC577H	1
μPC14305	1

FETs	
2SK168D	1
3SK51-03	4
3SK59	1
3SK60	2

* 12.5 kHz/step model

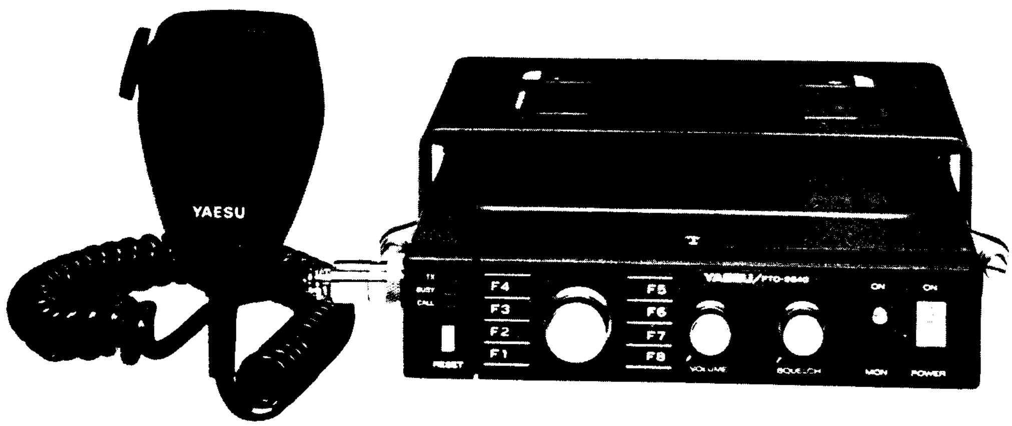
Transistors	
2SA628A(2SB856B)	1
2SC458B	5
2SC460B	7
2SC535B	8
2SC1209D	1
2SC1906	3
2SC2026	1
2SC2053	1
2SC2538	1
2SC2539	1
2SC2630	1

Silicon diodes	
1S1555	20
1SS97	3
V06C	1
15FD11	1

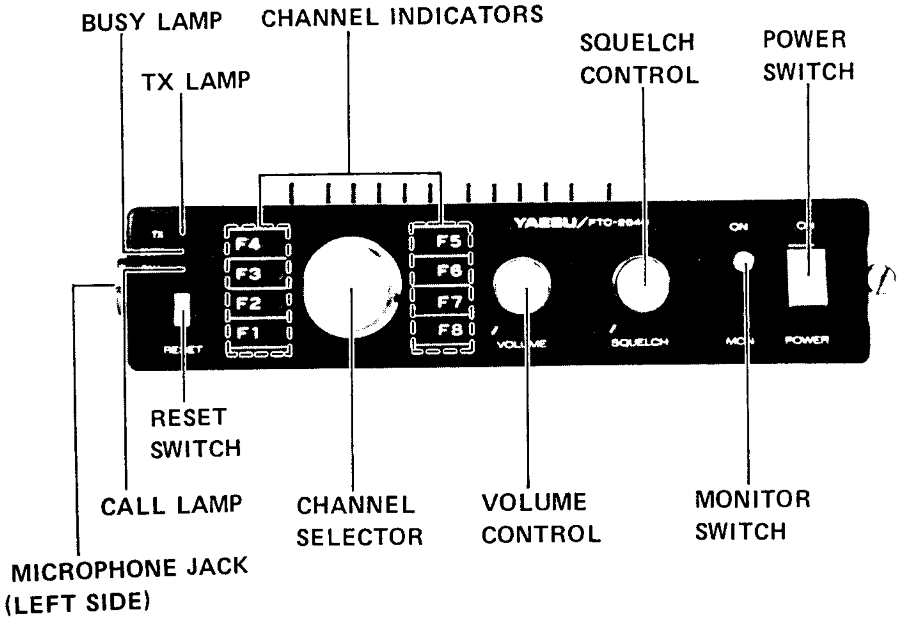
Varactor diodes	
1T25	13
FC52M	1

Light emitting diodes	
LN224RP	2
LN324GP	1
LN322GP	8

Zener diode	
WZ071	1



FRONT PANEL CONTROLS AND SWITCHES



(1) MICROPHONE JACK

This six-pin jack accepts the microphone input, as well as push-to-talk (PTT) control.

(2) VOLUME

The volume control varies the receiver audio output level. Clockwise rotation increases the volume.

(3) POWER

This is the main ON/OFF switch for the transceiver. When the switch is turned on, one channel indicator (LED) will become illuminated.

(4) SQUELCH

The squelch control quiets the audio output of the transceiver until a signal is received.

(5) CHANNEL

The 8-position channel selector switch selects the desired channel.

(6) CHANNEL INDICATORS (F1 – F8)

One of these LEDs lights up indicating the channel selected.

(7) INDICATOR LAMPS

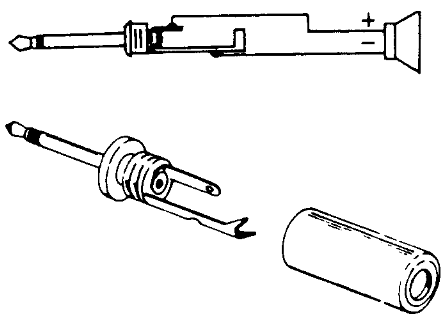
TX: This LED lights up during transmission.
BUSY: This LED lights up when the channel is occupied.
CALL: This LED lights up when the selective calling code for the transceiver is detected by the Two-Tone Decoder (optional unit).

(8) RESET

Press this button to reactivate the optional Two-Tone Decoder after responding to a call.

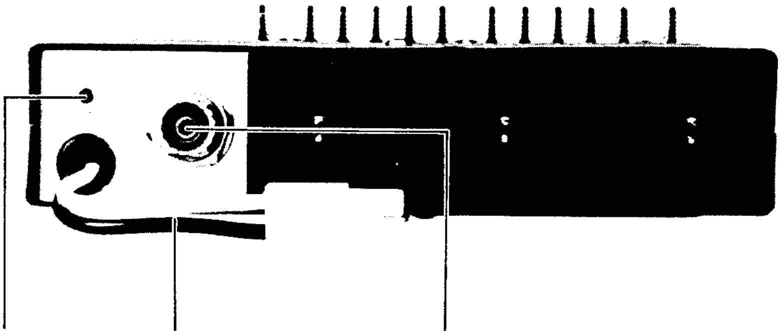
(9) MON ON/OFF

This switch allows monitoring during CTCSS operation.



Speaker Plug

REAR APRON CONNECTIONS



(1) ANT

This is an SO-239 coaxial receptacle for making connection to the antenna.

(2) EXT SP

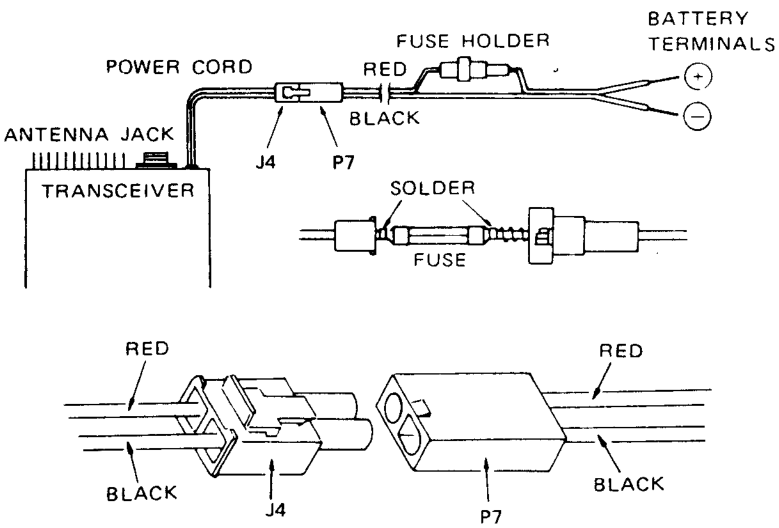
An external 4 or 8 ohm speaker may be connected at this point. Inserting a plug into this jack automatically disables the internal speaker.

(3) POWER CABLE/CONNECTOR

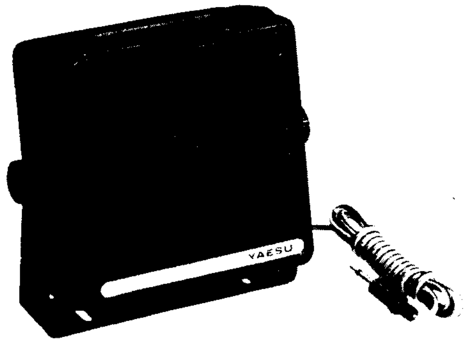
The main DC power cord from the power source is inserted in this sub-connector. Never apply AC voltage or any power voltage other than the type specified.

WARNING

DO NOT CONNECT AC POWER TO THE DC POWER RECEPTACLE. REPLACE FUSES ONLY WITH A 15 AMP FUSE. FAILURE TO OBSERVE THESE WARNINGS WILL VOID THE WARRANTY.



POWER CORD DIAGRAM



FSP-1/FSP-2
EXTERNAL SPEAKER

INSTALLATION

The FTC-2640 is designed primarily for mobile installation, requiring only an antenna and a 13.6 VDC power source for operation. The transceiver has been pretuned at the factory, and no adjustment is required for operation into a 50 ohm load.

For mobile installations, three basic factors must be considered. These are: the antenna system and feedline; the physical location of the transceiver; and the power connections. We will consider each of these individually in the following sections.

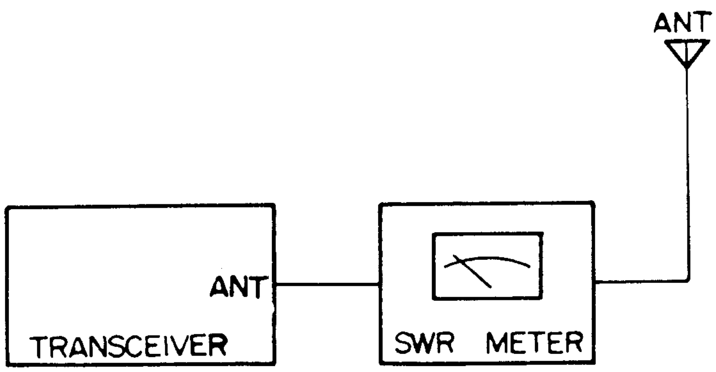
ANTENNA CONSIDERATIONS

The FTC-2640 is designed for operation into a 50 ohm antenna system. While variations of a few ohms from this figure are of no consequence, the automatic final amplifier protection circuitry will reduce the power output if the impedance presented to the antenna jack is below 25 ohms or above 100 ohms.

The antenna should be located away from the automobile engine, if possible, in order to avoid unnecessary noise pickup. Ideal locations are the center of the car roof or the center of the trunk lid. Where ground connections are made, they should be scraped clean of all paint and corrosion, so as to ensure adequate contact. Lossy ground connections can have seriously detrimental effects on the antenna system impedance and radiation pattern.

To minimize losses in the antenna system, the shortest possible length of coaxial cable should be used. For mobile installations, type RG-58A/U is suitable because of its small size. For base stations, however, larger sizes are to be preferred. Base station systems requiring more than 25 feet of coaxial cable should utilize type RG8A/U, and extremely long runs of many hundreds of feet generally require the use of type RG-17A/U, aluminum-jacketed "foamflex" coax, or air-dielectric "heliax" coax.

The antenna should be tuned for the center of the 10 MHz working band of the transceiver. To check the SWR, install a 50 ohm SWR meter between the transceiver antenna jack and the antenna. Place the selector switch into the FORWARD position on the meter, and transmit briefly (make certain that the channel is clear first). Rotate the FORWARD SET or SWR SET control for a full scale reading while transmitting. Now switch to REFLECTED on the meter, and read the SWR. If it is below 1.5, you are in good shape. If not, check the high and low band edges of the 10 MHz range of the transceiver to see if the antenna is detuned. If the SWR is very high (more than 3 : 1), there may be trouble in the coaxial cable. Check the SWR with the meter installed **at the antenna**, or test the coax by replacement with cable known to be good.



WHILE TRANSMITTING:

1. SWITCH TO FORWARD
2. SET METER FOR FULL SCALE
3. SWITCH TO REFLECTED
4. READ SWR ON METER.

TYPICAL SWR TEST SETUP

Figure 1-1

PHYSICAL LOCATION OF TRANSCEIVER

The FTC-2640 may be installed at any angle desired without loss of performance. Typical locations are atop the transmission tunnel, below or in the dash board, or overhead (in a truck, etc.).

When considering a possible location for the transceiver, several factors must be considered. First, there must be room for the transceiver cables, the microphone, and heat sink. We recommend that several inches of space be available around the heat sink to allow free air circulation. Also, we recommend that the transceiver not be located directly in the path of the output vent from the car heater.

Another consideration is the routing of cables to the desired installation location. If the power cable to the battery or the coaxial cable to the antenna must be extended greatly in order to meet aesthetic considerations, the resulting increased losses may degrade performance. Fortunately, the common under-dash installation lends itself well to efficient performance, as the power cable can easily be fed through the fire wall.

One final consideration is safety. The transceiver and its microphone must never be installed in a position that may interfere with driver vision or operation of the vehicle. Be especially wary of stick shifts in compact cars, and allow plenty of room for unobstructed manipulation of the controls. The FTC-2640 is a very compact unit, so there is no reason ever to compromise safety during installation.

POWER CONNECTIONS

For mobile installation, direct connection to the battery is to be preferred. If power connections are made at the ignition switch, unnecessary noise pickup may occur. Also, if power is taken from the automobile lighting, cigarette lighter, or other circuits, the circuit line fuse may blow because of insufficient capacity. A fuse (15 amp) is located in the DC power cord for the transceiver, protecting its circuitry.

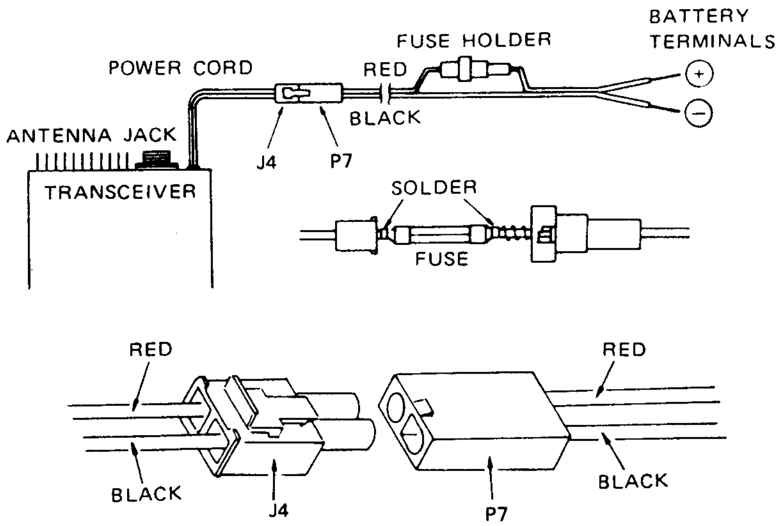
The power connection procedure is detailed below. Once the power connections are made, but before the power cord is connected to the transceiver, you should check the battery charging voltage with the engine running fast enough for the car ammeter to show a charge. If the voltage exceeds 15 volts, the car voltage regulator must be adjusted to limit the maximum voltage to less than 15 volts.

CAUTION

Be certain to observe proper polarity in the power cord when making connections to the vehicle battery.

CAUTION

Permanent damage may result if reversed polarity supply voltage is applied to this transceiver. Our warranty does not cover damage caused by reversed power supply connections.



POWER CORD DIAGRAM

INSTALLATION STEP-BY-STEP OUTLINE

1. Determine the optimum location for the transceiver, making certain that there is sufficient space for the transceiver, its cables and switches, and the microphone. Leave several inches of space around the heat sink, to permit free air flow.

2. A mounting bracket FMB-4-1 is supplied with the transceiver. Use the bracket as a template for positioning the mounting holes. Use a 3/16" diameter bit for drilling these holes, allowing clearance for the transceiver and all accessories and cables. Secure the mounting bracket with the screws, washers, and nuts supplied, as shown in the drawing.

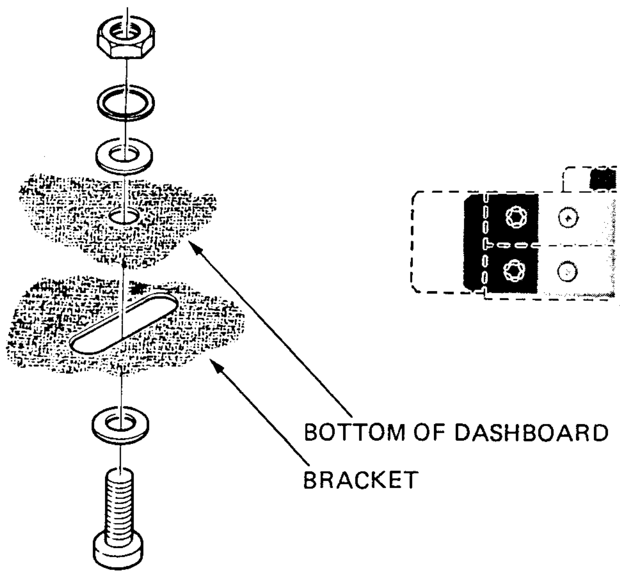
3. Ease the transceiver into the guide rail, and slide it into the desired position. Tighten the knobs on the outside of the mounting bracket to secure the transceiver.
   The optional mounting bracket key lock is available from your Yaesu dealer.

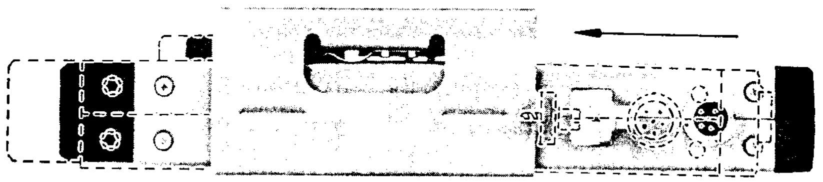
4. Confirm that the installation does not obstruct normal, safe operation of the vehicle.

5. Route the transceiver power cable through the fire wall to the battery. Avoid proximity to ignition cables if at all possible. Lay out the power cable so as not to have it interfere with the normal operation of the fan belt or other engine components.

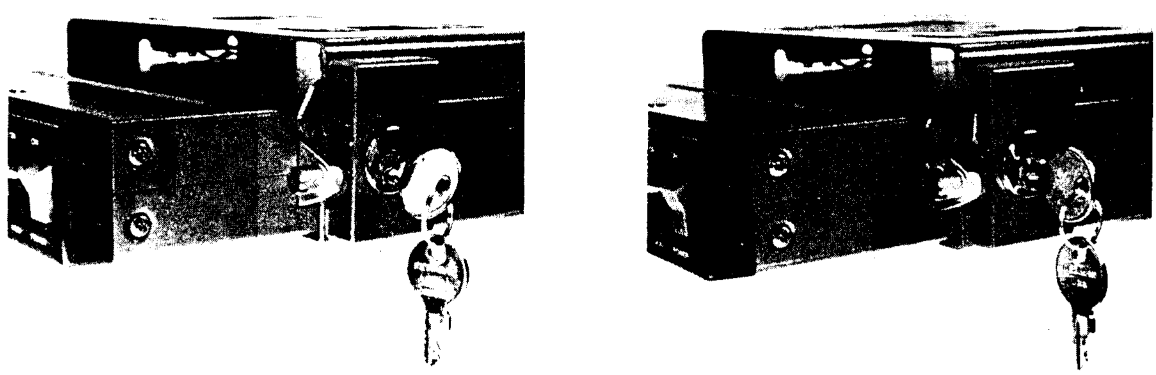
6. Connect the RED battery lead to the POSITIVE (+) side of the battery. Connect the BLACK lead to the NEGATIVE (−) side of the battery.

7. If the optional FSP-1 (8 ohm) or FSP-2 (4 ohm) external speaker is to be installed, it may be connected to the rear panel SP jack. The speaker can then be mounted wherever convenient for the operator. Insertion of the speaker plug into the jack on the rear apron automatically disables the internal speaker of the transceiver.





FMB-4-1



FMB-4 (With Optional Key Lock)

BASE STATION INSTALLATION

For base station installations, the FP-8 AC Power Supply option offers a convenient means of providing the required 13.6 VDC for the FTC-2640 transceiver.

Before commencing operation with the FP-8, be absolutely certain that the power transformer primary has been wired correctly for the local line voltage in your area. The FP-8 is marketed throughout the world, and a unit that you receive from a customer who recently has been abroad may be wired for a different voltage. Operation of the FP-8 from an improper supply voltage will void all warranties on the set.

Connect the RED power lead to the POSITIVE (+) terminal and connect the BLACK power lead to the NEGATIVE (−) terminal on the FP-8 rear apron.

CAUTION

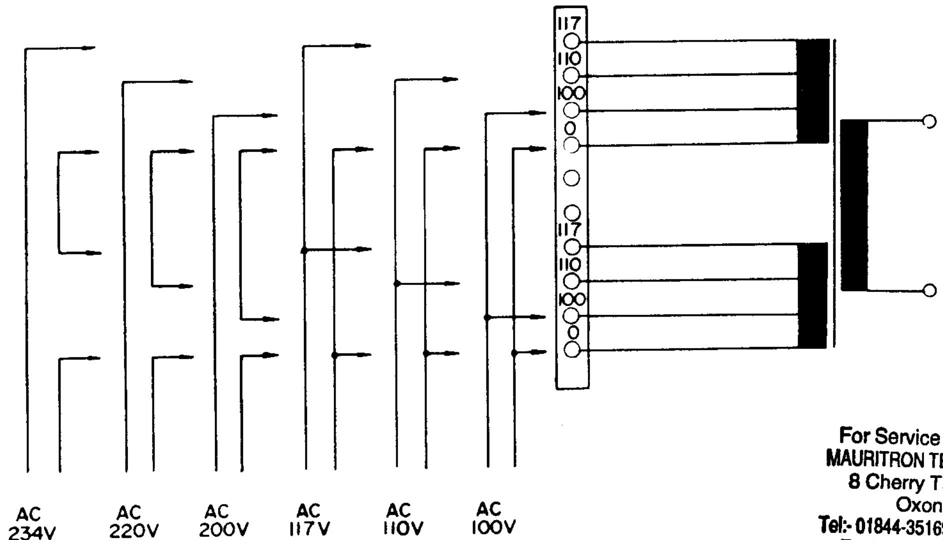
Our warranty does not cover damage caused by improper power supply connections, nor damage caused by the use of an incorrect fuse.

Connect the four pin plug on the cable from the FP-8 to J_1 on the FP-8 rear apron, and plug the FP-8 AC cable into the wall outlet. Now turn the FP-8 switch ON, and then turn the transceiver power switch ON. The radio will now be ready for operation, if you have the antenna and microphone connected.

The FP-8 contains a quality speaker for base station installation. Connect the miniature phone plug from the FP-8 to the SP jack on the rear apron of the transceiver.

NOTICE

The four pin plug must be connected to the J_1 on the FP-8 rear apron. Pin 1 and pin 2 of the four pin plug are used for the AC switching function.



POWER TRANSFORMER PRIMARY CONNECTIONS

THEFT GUARD INSTALLATION USING FHR-1

The Theft Guard feature of the FHR-1 Horn Relay box can be an effective deterrent to burglary. When the connection from the FHR-1 box to the FTC-2640 is interrupted, the horn will begin blaring on and off, and further tampering with the car will probably be discouraged.

In order to make it difficult for a thief to disable the Theft Guard, we recommend that the FHR-1 be installed under the hood of the automobile in a fairly dry location. Alternatively, it may be installed in some inaccessible location under the dash. The only time that ON/OFF switching should be needed is in the event of an attempted burglary, as the current drain is negligible in the standby mode. To quiet the horn, turn the FHR-1 power switch to OFF.

Installation Procedure:

(1) Refer to Figure 1-2, and mount the FHR-1 box in the desired location. The unit is not waterproof, so a position not exposed to moisture is recommended.

(2) Refer to the interconnection diagram (Page 2-10), and hook up the wires as shown. The two heavy red wires (bare ends, with no connector) should be wired in parallel with the main steering wheel horn switch of the car. The three leads from the molded connector are connected as follows: the white lead goes to the FTC-2640 HORN RELAY terminal (Figure 1-3); the red lead goes to an auxiliary post on the fuse block, if one is available (10 amp fuse is OK); the black lead goes to ground.

(3) Inside the FHR-1 are two miniature potentiometers, shown in Figure 1-4. VR_{101} controls the ON time of the beeping horn; while VR_{102} controls the OFF time. Either control provides an adjustment range of 2 to 25 seconds in the on and off times.

(4) The operator should be educated in the importance of being able to turn off the horn relay quickly, so as to minimize disturbance to others. Also discuss with the operator the importance of maintaining good connections to the HORN RELAY jack, etc., so as not to induce false triggering of the horn.

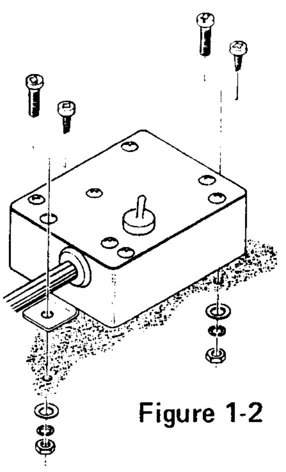


Figure 1-2

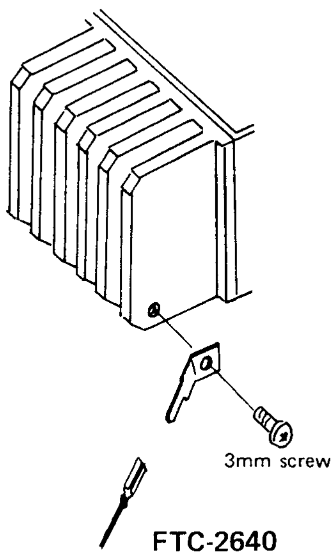


Figure 1-3

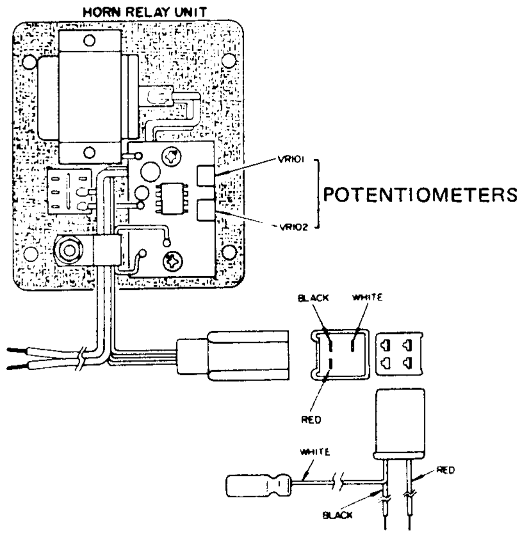
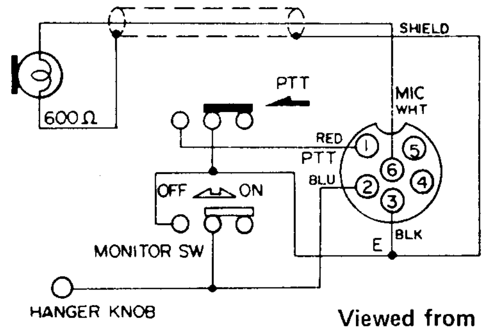


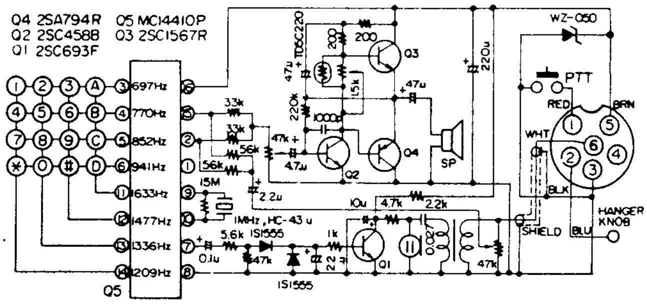
Figure 1-4

MICROPHONE CONNECTIONS



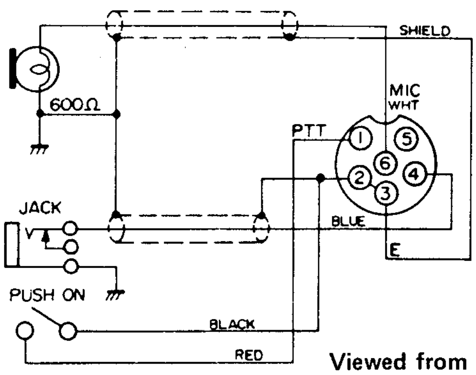
Viewed from "B" side

YM-31 MICROPHONE CONNECTIONS



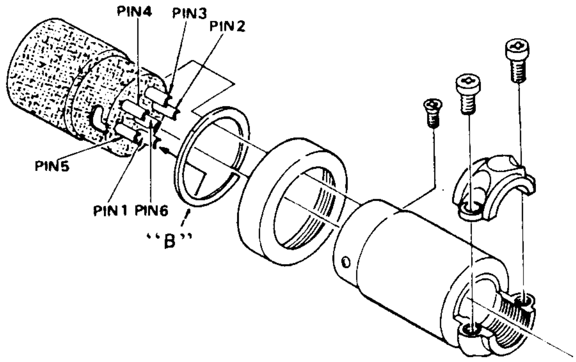
Viewed from "B" side

YM-28 MICROPHONE CONNECTIONS



Viewed from "B" side

YM-33 MICROPHONE CONNECTIONS



OPERATION

Operation of the FTC-2640 is extremely straightforward. Before commencing operation, confirm that power supply connections have been correctly made, and that a 50 ohm antenna is connected to the antenna jack.

(1) Place the POWER switch in the ON position. The channel indicator will become illuminated.

(2) Set the CHANNEL selector to the desired channel.

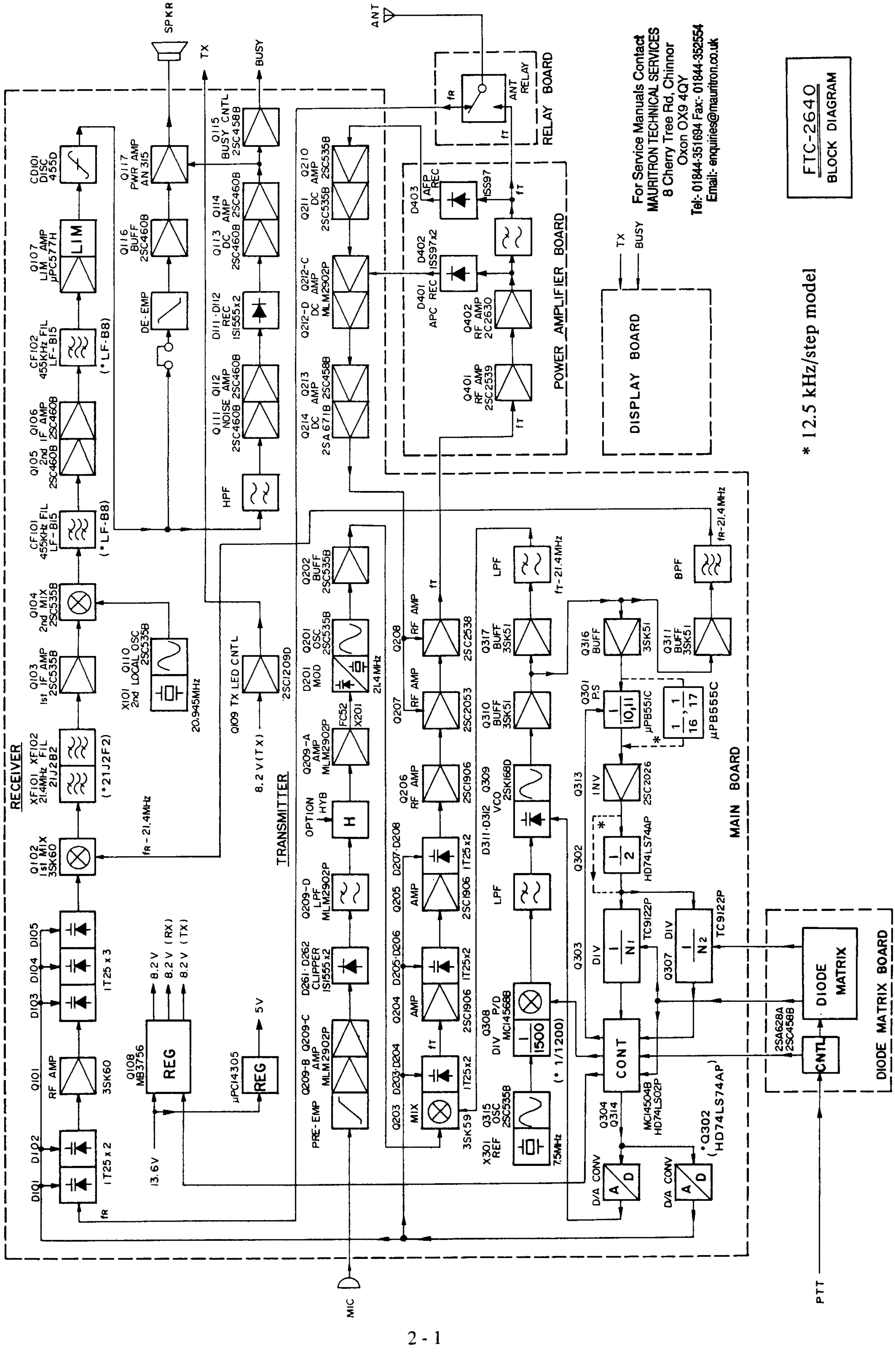
(3) Rotate the SQUELCH control fully counterclockwise.

(4) Adjust the VOLUME control for a normal listening level on the background noise or incoming signal.

(5) When the channel is clear, rotate the SQUELCH control carefully in a clockwise direction, to the point where the background noise is just silenced. If you go much beyond the point where the noise just disappears the receiver will not respond to weak signals.

(6) After setting the receiver controls and selecting the proper channel, depress the microphone push-to-talk switch to activate the transmitter. Hold the microphone a short distance from your mouth, and speak in a clear normal voice across the face of the microphone (sideways).

(7) When the optional tone squelch unit is installed and tone squelch operation is desired, a subaudible tone will be superimposed on the output signal when transmitting. On receive, when the MON switch is in the OFF position, a similar subaudible tone will be required to trip the receiver squelch. If a station is using the channel but is not using a subaudible tone generator, the BUSY lamp will light up, alerting the operator to the fact that the channel is in use.


FTC-2640
BLOCK DIAGRAM
* 12.5 kHz/step model
For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk
RECEIVER
TRANSMITTER
MAIN BOARD
POWER AMPLIFIER BOARD
RELAY BOARD
DISPLAY BOARD
DIODE MATRIX BOARD
ANT
SPKR
TX
BUSY
MIC
PTT
D101 D102 1T25x2
Q101 RF AMP 3SK60
D103 D104 D105 1T25x3
Q102 1st MIX 3SK60
XF101 XF102 21.4MHz FIL 21J2B2
(*21J2F2)
Q103 1st IF AMP 2SC535B
Q104 2nd MIX 2SC535B
Q110 2nd LOCAL OSC 2SC535B
X101 20.945MHz
CF101 455KHz FIL LF-B15
(*LF-B8)
Q105 Q106 2nd IF AMP 2SC460B
CF102 455KHz FIL LF-B15
Q107 LIM AMP μPC577H
LIM
CD101 DISC 455D
Q117 PWR AMP AN315
Q116 BUFF 2SC460B
DE-EMP
HPF
Q111 Q112 NOISE AMP 2SC460B
D111·D112 REC 1S1555x2
Q113 Q114 DC AMP 2SC460B
Q115 BUSY CNTL 2SC458B
Q109 TX LED CNTL 2SC1209D
8.2V(TX)
Q108 MB3756
REG
8.2V
8.2V (RX)
8.2V (TX)
μPC14305
5V
13.6V
PRE-EMP
Q209-B Q209-C AMP MLM2902P
D261·D262 CLIPPER 1S1555x2
Q209-D LPF MLM2902P
OPTION HYB
H
Q209-A AMP MLM2902P
FC52 X201
D201 MOD
Q201 OSC 2SC535B
21.4MHz
Q202 BUFF 2SC535B
Q203 MIX 3SK59
D203·D204 1T25x2
Q204 AMP 2SC1906
D205·D206 1T25x2
Q205 AMP 2SC1906
D207·D208 1T25x2
Q206 RF AMP 2SC1906
Q207 RF AMP 2SC2053
Q208 RF AMP 2SC2538
Q214 DC 2SA671B
Q213 AMP 2SC458B
Q212-D DC AMP MLM2902P
Q212-C AMP MLM2902P
Q211 DC AMP 2SC535B
Q210 AMP 2SC535B
Q401 RF AMP 2SC2539
Q402 RF AMP 2C2630
D401 APC REC
D402 1SS97x2
D403 AFP REC
1SS97
ANT RELAY
X301 REF 7.5MHz
Q315 OSC 2SC535B
Q308 DIV P/D MC14568B
1/1500
(*1/1200)
LPF
D311·D312 VCO
Q309 2SK168D
Q310 BUFF 3SK51
Q317 BUFF 3SK51
LPF
fT-21.4MHz
Q316 BUFF 3SK51
Q311 BUFF 3SK51
BPF
fR-21.4MHz
Q301 P.S
1/10,11
μPB551C
1/16, 1/17
μPB555C
Q313 INV 2SC2026
Q302 1/2 HD74LS74AP
Q303 DIV 1/N1 TC9122P
Q307 DIV 1/N2 TC9122P
CONT
Q304 Q314 MC14504B HD74LS02P
(*Q302 HD74LS74AP)
D/A CONV
A D
DIODE MATRIX
CNTL
2SA628A 2SC458B

CIRCUIT INFORMATION

The block diagram and circuit description to follow will provide you with a better understanding of this transceiver. Please refer to the schematic diagram for specific circuit details.

PARTS DESIGNATIONS ON CIRCUIT BOARDS

Each circuit board has a code number assigned to it, and each part within the transceiver has a part number assigned to it (e.g. Q_{102}).

Part numbers 01–99 (e.g. R_{12}) are located on the main chassis. Other parts, located on the circuit boards, are assigned a three or four digit part number; the last two figures represent the part number for the particular board, while the first one or two digits are the code number for that board.

Thus, Q_{101} is transistor number 01, located on circuit board number 1, which is the RX Unit. Refer to the accompanying chart for a tabulation of the code numbers assigned to the FTC-2640 circuit boards.

Please note that the designation "Q" is applied to transistors as well as to integrated circuits. The "U" nomenclature for IC's is not used in Yaesu diagrams.

Code #	Unit	Board Designation
1	RX circuit	PB-2330A
2	TX circuit	PB-2330A
3	PLL circuit	PB-2330A
4	POWER AMPLIFIER	PB-2332
5	DIODE MATRIX BOARD	PB-2333
6	LED BOARD	PB-2334
7	RELAY BOARD	PB-2331

FUNCTIONS OF CIRCUIT COMPONENTS

Part No.	Device	Type	Function
Q101	3SK60	Dual Gate MOSFET	RX RF Amplifier
102	"	"	RX 1st Mixer
103	2SC535B	Transistor	RX 1st IF Amplifier
104	"	"	RX 2nd Mixer
105	2SC460B	"	RX 2nd IF Amplifier
106	"	"	"
107	μPC577H	IC	"
108	MB3756	"	DC Limiter Regulator
109	2SC1209D	Transistor	Relay Driver
110	2SC535B	"	RX 2nd Oscillator
111	2SC460B	"	RX Squelch Amplifier
112	"	"	"
113	"	"	"
114	"	"	"
115	2SC458B	"	RX Busy LED Driver
116	2SC460B	"	RX Audio Buffer
117	AN315	IC	RX Audio Amplifier

Part No.	Device	Type	Function
Q201	2SC535B	Transistor	TX Modulation Oscillator
202	〃	〃	TX Buffer
203	3SK59	Dual Gate MOSFET	TX Mixer
204	2SC1906	Transistor	TX Amplifier
205	〃	〃	〃
206	〃	〃	TX RF Amplifier
207	2SC2053	〃	TX RF Amplifier
208	2SC2538	〃	〃
209	MLM2902P	IC	TX Microphone Amplifier
210	2SC535B	Transistor	AFP DC Amplifier
211	〃	〃	〃
212	MLM2902P	IC	Differential Amplifier
213	2SC458B	Transistor	Power Control DC Amplifier
214	2SB856B	〃	〃
Q301	μPB551C (*μPB555C)	IC	PLL Prescaler
302	HD74LS74AP	〃	PLL D Flip-Flop
303	TC9122P	〃	PLL Divider
304	HD74LS02P	〃	PLL Quad 2-input NOR Gate
305	2SC458B	Transistor	TX Control
306	〃	〃	〃
307	TC9122P	IC	PLL Divider
308	MC14568B	〃	PLL Phase Comparator
309	2SK168D	Junction FET	PLL VCO
310	3SK51	Dual Gate MOSFET	PLL VCO Buffer
311	〃	〃	PLL Output Buffer (RX)
312	μPC14305	IC	DC Regulator
313	2SC2026	Transistor	PLL Inverter
314	MC14504B	IC	PLL Level Shifter
315	2SC535B	Transistor	PLL Reference Oscillator
316	3SK51-03	Dual Gate MOSFET	PLL Buffer
317	〃	〃	PLL Output Buffer (TX)
Q401	2SC2539	Transistor	TX RF Amplifier
402	2SC2630	〃	〃
Q501	2SC458B	Transistor	Diode Matrix Control
502	2SA628A	〃	〃
D101	1T25	Varactor Diode	RX Auto Tune
102	〃	〃	〃
103	〃	〃	〃
104	〃	〃	〃
105	〃	〃	〃
106	1S1555	Si Diode	Discriminator
107	〃	〃	〃
111	〃	〃	Noise Rectifier
112	〃	〃	〃
113	〃	〃	Switch
114	〃	〃	〃
115	〃	〃	〃
116	〃	〃	〃

* 12.5 kHz/step model

Part No.	Device	Type	Function
D201	FC52M	Varactor Diode	TX Modulator
202	1S1555	Si Diode	Switch
203–208	1T25	Varactor Diode	TX Auto Tune
261	1S1555	Si Diode	Modulation Limiter
262	″	″	″
D301	1S1555	Si Diode	Switch
302	″	″	″
303	″	″	″
304	″	″	″
305	″	″	″
306	″	″	″
307	″	″	″
308	WZ071	Zener Diode	DC Regulator
309	1S1555	Si Diode	″
311	1T25	Varactor Diode	PLL OSC
312	″	″	″
313	1S1555	Si Diode	Switch
D401	1SS97	Schottky Barrier Diode	APC Rectifier
402	″	″	″
403	″	″	AFP ″
D501		Diode Array	Diode Matrix
D601	LN224RP	LED	Call Indicator
602	LN324GP	″	Busy Indicator
603	LN224RP	″	TX Indicator
604–611	LN322GP	″	CH Indicator
D701	V06C	Si Diode	Surge Protector
702	15FD11	″	Reversed Polarity Supply Protector
X101		Crystal	RX 2nd local Osc.
201		″	TX Modulation Osc.
301		″	PLL Reference Osc.
XF101	21J2B2 (*21J2F2)	Crystal Filter	RX 1st IF Filter
102	″	″	″
CF101	LF-B15 (*LF-B8)	Ceramic Filter	RX 2nd IF Filter
102	″	″	″
CD101	455D	Discriminator	Ceramic Discriminator

* 12.5 kHz/step model

CIRCUIT DESCRIPTION

RECEIVER

The incoming RF signal from the antenna connector is fed through an antenna relay to the RF amplifier, Q_{101} **(3SK60)**. The signal passes through input and output auto-tune filters to eliminate unwanted signals which may cause intermodulation and cross-modulation. The center frequencies of these filters are automatically adjusted by a control preset voltage in 1 MHz steps from the PLL circuit. After amplification, the signal is fed to 1st mixer Q_{102} **(3SK60)**, where it is mixed with the first local signal delivered from the PLL local oscillator, resulting in a 21.4 MHz first IF signal. This signal passes through monolithic crystal filters XF_{101} and XF_{102} to amplifier Q_{103} **(2SC535B)**, and is then fed to 2nd mixer Q_{104} **(2SC535B)** where it is mixed with a 20.945 MHz second local signal. As a result, the second IF of 455 kHz is obtained.

The 2nd local frequency of 20.945 MHz is generated by Q_{110} **(2SC535B)** and fed to the second mixer. The 2nd IF signal is fed through a ceramic filter, CF_{101}, to 2nd IF amplifiers Q_{105} and Q_{106} **(2SC460B)**, where the signal is amplified and again fed through a ceramic filter, CF_{102}, cutting off unwanted signals. This signal is then fed to limiter /amplifier IC Q_{107} (μPC577H), where the IF signal is amplified to a level sufficient to drive the discriminator. Amplitude variation of the IF signal is rejected by the limiter, and then the signal is fed to the discriminator consisting of ceramic discriminator elements CD_{101}, D_{106} and D_{107}. From this circuit an audio output is provided in response to the corresponding frequency shift of the IF signal.

The audio output signal from the discriminator is fed to a notch filter to reject the 455 kHz signal on the audio output. The signal is then fed through pin 4 of J_{101} to the tone squelch unit (optional). When the tone squelch unit is not installed, the signal is fed via jumper to the de-emphasis network consisting of R_{140} and C_{154}. The de-emphasized audio output is fed through audio volume control VR_1 to audio buffer Q_{116} **(2SC460B)**, and then fed to audio power amplifier IC Q_{117} **(AN315)**, which delivers 1.5 watts of audio output power to the speaker.

The squelch circuit consists of noise amplifier Q_{111} and Q_{112} **(2SC460B)**, and DC amplifier Q_{113} and Q_{114} **(2SC460B)**. When no carrier is present in the 455 kHz IF signal, the high frequency noise present at the discriminator output is amplified by Q_{111} and Q_{112}, and then detected by D_{113} and D_{114} **(1S1555)**, producing a DC voltage. The voltage is amplified by Q_{113} and Q_{114} and fed to pin 10 of Q_{117}, cutting off the audio amplifier. A portion of the DC voltage from Q_{114} is delivered to Q_{115} **(2SC458B)**, which turns the BUSY LED on when a carrier is present in the 455 kHz IF. When a carrier is present the noise is removed from the discriminator output, and the audio amplifier operates normally.

TRANSMITTER

The speech input signal from the microphone passes through a pre-emphasis network consisting of C_{263} and R_{263}. This signal is amplified by Q_{209} (B) and Q_{209} (C)**(MLM2902P)** and fed to the IDC (Instantaneous Deviation Control) circuit, which consists of R_{268}, R_{269}, R_{270}, D_{261} and D_{262} **(1S1555)**. Here, the amplified speech signal is limited in amplitude so as not to produce over-deviation from the higher speech levels. Next, the signal passes through an active lowpass filter, Q_{209} (D), and its associated circuits. Here, the frequency spectrum above the speech range is rejected. This signal is buffered by amplifier Q_{209} (A) and delivered to the frequency modulator circuit.

The 21.4 MHz TX MOD/OSC circuit, Q_{201} **(2SC535B)** and D_{201} **(FC52)**, modulates its oscillating frequency with the AF signal delivered from Q_{209} (A), which is then amplified by buffer Q_{202} **(2SC535B)** and fed to mixer Q_{203} **(3SK59)**. The signal is there mixed with the local signal delivered from the PLL local oscillator, and as a result, the output signal at the TX frequency is obtained. This heterodyned signal passes through a double auto-tune filter consisting of D_{203} and D_{204} **(1T25)** and associated circuits, resulting in rejection of unwanted spurious. The center frequency of this filter is varied to correspond with the operating frequency with the help of the auto-tune control voltage from the PLL circuit.

Next, this signal is amplified by two stages of amplifier/filter, Q_{204} and Q_{205} **(2SC1906)** and D_{205} – D_{208} **(1T25)**, which also make up the other stage of the auto-tune filter, to reject spurious caused by mixer Q_{203}. Spurious products are thus suppressed more than 70 dB.

This signal is delivered to a pre-driver stage consisting of Q_{206} **(2SC1906)**, Q_{207} **(2SC2053)** and Q_{208} **(2SC2538)**, where the clean low level TX signal is amplified to a level sufficient to drive the power amplifier.

The power amplifier unit is composed of two stages of transistors. The output from Q_{208} is coupled through a matching network to the base of Q_{401} **(2SC2539)** and then fed through another matching network to final amplifier Q_{402} **(2SC2630)**. Here, the signal is amplified up to 40 watts. It then passes through a low pass three-section pi filter, which reduces the harmonic spurious of the carrier signal more than 60 dB. Finally, the signal is fed through a directional coupler and the antenna relay to the antenna connector.

AUTOMATIC FINAL PROTECTION CIRCUIT

The reflected voltage when a load other than 50 ohms is connected to the ANT connector is sensed by the directional coupler and rectified by D_{403} **(1SS97)**. This provides a control voltage which is fed to the DC amplifier consisting of Q_{210}, Q_{211} **(2SC535B)**, Q_{212} (D), Q_{212} (C) **(MLM2902P)**, Q_{213} **(2SC458B)**, and Q_{214} **(2SB856B)**. This signal reduces the VCC voltage fed to RF amplifier Q_{207} and Q_{208}, thus reducing the drive level for the final amplifier to protect the transistors from high SWR load conditions at the ANT connector.

AUTOMATIC POWER CONTROL CIRCUIT

A portion of the RF signal from driver Q_{402} is rectified by D_{401} and D_{402} **(1SS97)** and delivered to Q_{212} (C), where the DC voltage controls the DC amplifier stage, thus reducing the VCC voltage to the pre-driver stage.

* 12.5 kHz/step model

DC VOLTAGE CHANGEOVER CIRCUIT

The PTT line from Q_{304} **(HD74LS02P)** is fed to DC voltage control IC Q_{108} **(MB3756)**, which provides 8.2 volts for either the TX or RX circuits.

PLL LOCAL SIGNAL OSCILLATOR

The PLL local signal oscillator consists of a VCO (voltage controlled oscillator), a reference crystal oscillator, a programmable divider, a phase comparator and a lowpass filter, all of which work to generate the TX or RX frequency minus 21.4 MHz.

The VCO; Q_{309} **(2SK168D)**, D_{311} and D_{312} **(1T25)**; generates the desired local signal. The oscillator frequency is controlled by varactor diode D_{311}, which varies the capacitance of the tuned circuit in accordance with the DC voltage supplied through a lowpass filter from phase comparator Q_{308} **(MC14568B)**. The center frequency of the VCO is preset by another varactor diode, D_{312}, whose control voltage is delivered in 1 MHz steps from the Digital-to-Analog converter. This Digital-to-Analog converter provides a preset voltage corresponding to the programmed data for the operating frequency.

The output from Q_{309} is fed through buffer amplifiers Q_{310} and Q_{317} **(3SK51-03)** and a lowpass filter to TX mixer Q_{203}. A portion of the RF signal from Q_{310} is fed to buffer amplifier Q_{311} **(3SK51-03)**, and then passes through a lowpass filter to RX 1st mixer Q_{102}.

Another portion of the RF signal from Q_{310} is amplified by buffer Q_{316} **(3SK51-03)** and fed to a programmable counter circuit, which consists of 10/11 (*16/17) prescaler Q_{301} **(μPB555C)** **(*μPB555C)**, inverter Q_{313} **(2SC2026)**, 1/2 divider Q_{302} **(HD74LS74AP)**, and programmable dividers Q_{303} and Q_{307} **(TC9122P)**, where the VCO frequency is divided by the number programmed into the diode matrix, and thus produces a 5 kHz PLL signal. This signal is then fed through a control circuit to the phase detector part of Q_{308} **(MC14568B)**, where the signal is compared with its reference signal. As a result, the difference of both signals produces a DC voltage which is delivered through a lowpass filter to the VCO circuit.

The programmed data from the diode matrix sets the dividing ratio of programmable counters Q_{303} and Q_{307}. Also, the 1 MHz step programming data from the diode matrix is delivered to D/A converters, which produce the preset voltage for the VCO and the control voltage for the auto-tune circuits.

Reference oscillator Q_{315} **(2SC535B)** generates a 7.5 MHz signal which is delivered to the divider section of Q_{308}, where the signal is divided by 1500, providing a 5 kHz reference signal for the phase comparator section.

When any phase difference is present between the divided VCO signal and its reference signal, the DC voltage from the phase comparator compensates to lock the PLL circuit. While the PLL circuit is locked, the DC voltage from the phase comparator remains constant.

If the PLL loop is unlocked, an unlock signal from phase comparator Q_{308} appears, and is fed to gate circuit Q_{304} **(HD74LS02P)** and also to the PTT line, so as to open the PTT line and disable the transmitter.

Spurious Suppression at Antenna Jack

Spurious radiation from the antenna terminal is suppressed by: (1) a lowpass filter consisting of C_{421} – C_{427} and L_{410} – L_{412} in a three section pi configuration, providing more than 60 dB of harmonic suppression, and (2) T_{206}, C_{225}, D_{205}, T_{207}, C_{226} – C_{229}, D_{206}, T_{208}, C_{233}, D_{207}, T_{209}, C_{234} – C_{237}, D_{208}, T_{204}, C_{216}, D_{203}, T_{205}, C_{218} – C_{221} and D_{204}, which attenuate non-harmonic spurious signals more than 60 dB.

Spurious Radiation from the Case, Power Cable, etc.

The following capacitors ensure maximum attenuation of spurious signals from the case, power cable and other areas: C_{211}, C_{222}, C_{230}, C_{238}, C_{239}, C_{240}, C_{243}, C_{246}, C_{293}, C_{294}, C_{141}, C_{336}, C_{337}, C_{368}, C_{357}, C_{413}, C_{415} and C_{405}, Coils are sealed where they could cause spurious radiation.

Deviation Circuit

The Instantaneous Deviation Control circuit (IDC) consists of D_{261}, D_{262}, R_{268}, R_{269} and R_{270}, which control the deviation level and limit the maximum deviation.

Audio Filtering

An active audio filter, consisting of Q_{209}(D), R_{271} – R_{274} and C_{267} – C_{269}, provides attenuation of audio frequencies above 3 kHz @ –18 dB/octave referenced to 1 kHz.

Frequency Stability/Adjustment/Channel Selection

The operation frequencies for both transmit and receive are determined by the diode matrix circuit. The programmed codes of each channel control the dividing ratio of the programmable counter in the PLL local signal oscillator.

The diode matrix circuit can program the programmable dividing ratio for any eight TX and eight RX frequencies desired as follows:

Frequency Coverage: 134 MHz – 174 MHz
Frequency TX: Frequency PLL + Frequency MOD/OSC
Frequency MOD/OSC: 21.4 MHz

The frequency stability of the transmitter is determined by the frequency stability of PLL reference oscillator Q_{315}/X_{301} and the modulation oscillator Q_{201}/X_{201}. These oscillators' components have been carefully selected for cancelling reactance variation due to temperature change, for the purpose of temperature compensation.

Final Device Information

2SC2630 transistor:
Collector 13.6V, 4.7A
Base 0V
Emitter 0V

CRYSTAL DATA

Function	RX Second Local	⋆TX Carrier/Modulator	Reference
Symbol Number	X101	X201	X301
Part Number	H0102050	H0102442	H0102384
Type of Holder	HC-18/U	HC-18/T	HC-18/U
Frequency	20.945 MHz	⋆ 21.400 MHz	7.500 MHz
Oscillation Frequency	20.945 MHz	⋆ 21.400 MHz	7.500 MHz
Load Capacity	30pF ± 0.3pF	Series Resonance	30pF
Drive Level	1mW ± 0.2mW	1mW ± 0.2mW	5mW
Shunt Capacity	7pF	7pF	4.8pF ± 0.3pF
Frequency Tolerance	± 20ppm	± 10ppm	± 20ppm
Frequency Stability	± 20ppm	± 10ppm	± 30ppm
Equivalent Resistance	Less than 50 ohms	Less than 25 ohms	Less than 40 ohms
Operation Mode	Fundamental	Fundamental	Fundamental

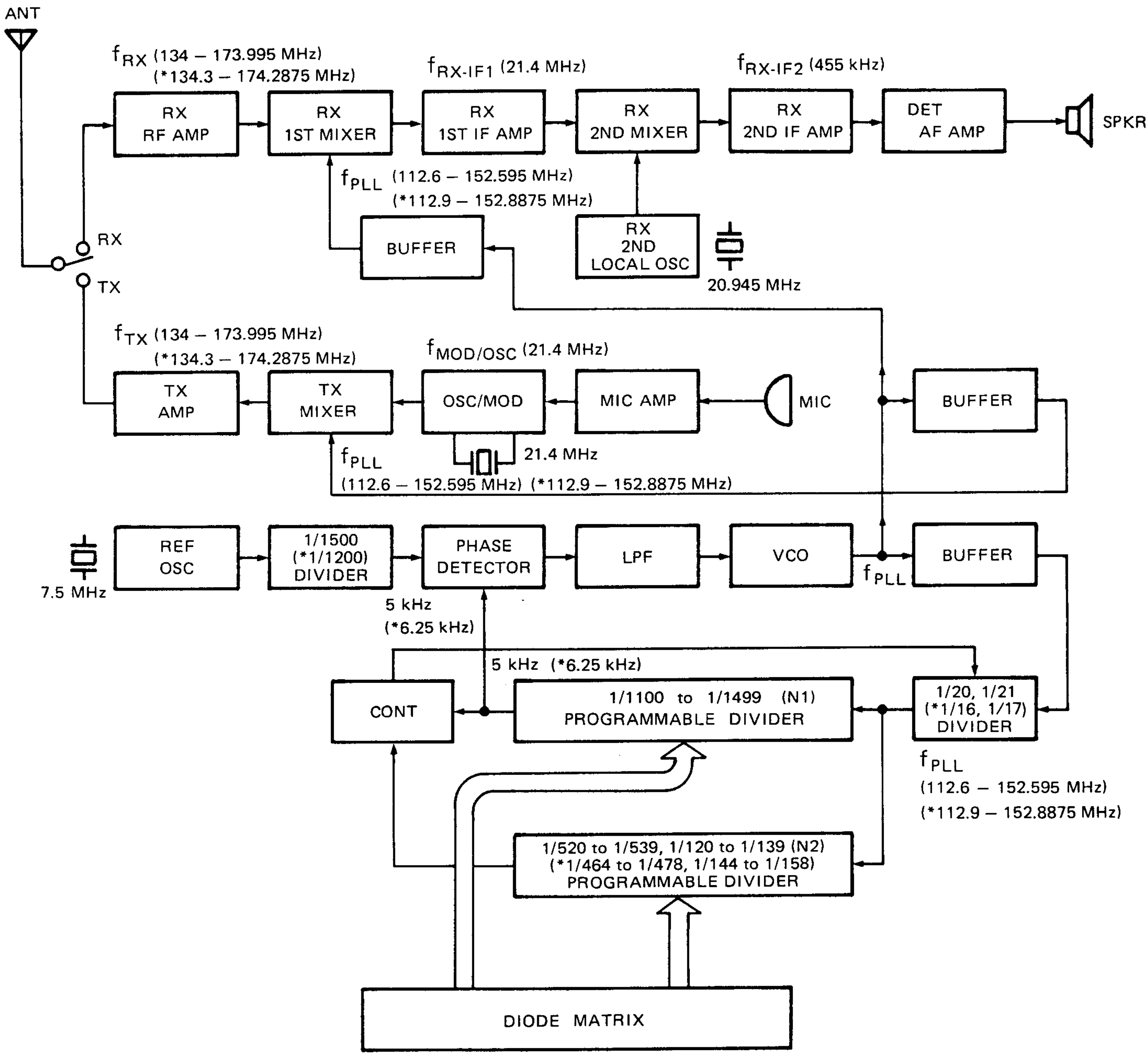
⋆ Actual Frequency: 21.4064 MHz with CI meter.
(Determined by circuit)

		BAND A	BAND B	BAND C	BAND D	BAND E
f_{RX}/f_{TX}		MHz 134.000 – 143.995 (*134.300 – 144.2875)	MHz 144.000 – 153.995 (*144.300 – 154.2875)	MHz 154.000 – 163.995 (*154.300 – 164.2875)	MHz 164.000 – 173.995 (*164.300 – 174.2875)	MHz 150.000 – 159.995 (*150.300 – 160.2875)
f_{PLL}		112.600 – 122.595 (*112.900 – 122.8875)	122.600 – 132.595 (*122.900 – 132.8875)	132.600 – 142.595 (*132.900 – 142.8875)	142.600 – 152.595 (*142.900 – 152.8875)	128.600 – 138.595 (*128.900 – 138.8875)
Divider Ratio	N1 Preset	1000	1200	1200	1400	1200
	N1 Matrix	100 – 199	0 – 99	100 – 199	0 – 99	80 – 179
	N2 Preset	520 (*460)	520 (*460)	520 (*460)	520 (*460)	120 (*140)
	N2 Matrix	0 – 19 (*4 – 18)	0 – 19 (*4 – 18)	0 – 19 (*4 – 18)	0 – 19 (*4 – 18)	0 – 19 (*4 – 18)
	N	1100x16+520=22520 to 1199x20+529=24519 (*1100x16+464=18064) to (*1199x16+478=19662)	1200x20+520=24520 to 1299x20+539=26519 (*1200x16+464=19664) to (*1299x16+478=21262)	1300x20+520=26520 to 1399x20+539=28519 (*1300x16+464=21264) to (*1399x16+478=22862)	1400x20+520=28520 to 1499x20+539=30519 (*1400x16+464=22864) to (*1399x16+478=22862)	1280x20+120=25720 to 1379x20+139=27719 (*1280x16+144=20624) to (*1379x16+158=22222)

* for 12.5 kHz/step model $N = \frac{f_{PLL(MHz)}}{0.005(MHz)} = 20N1 + N2$

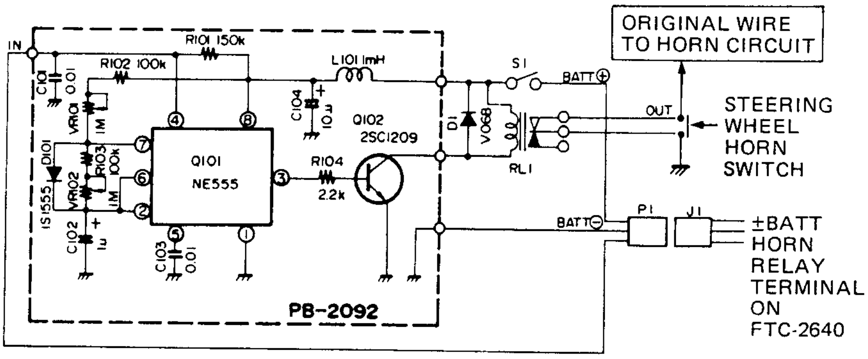
$f_{PLL} = f_{TX(RX)} - 21.4(MHz)$

FTC-2640 FREQUENCY RELATIONSHIPS

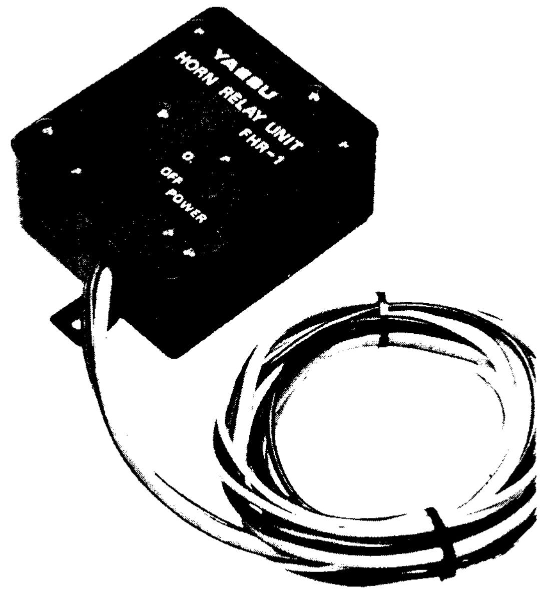


(* 12.5 kHz/step model)

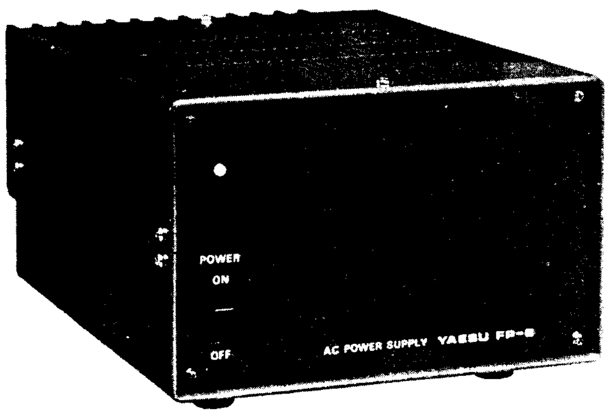
HORN RELAY UNIT
FHR-1

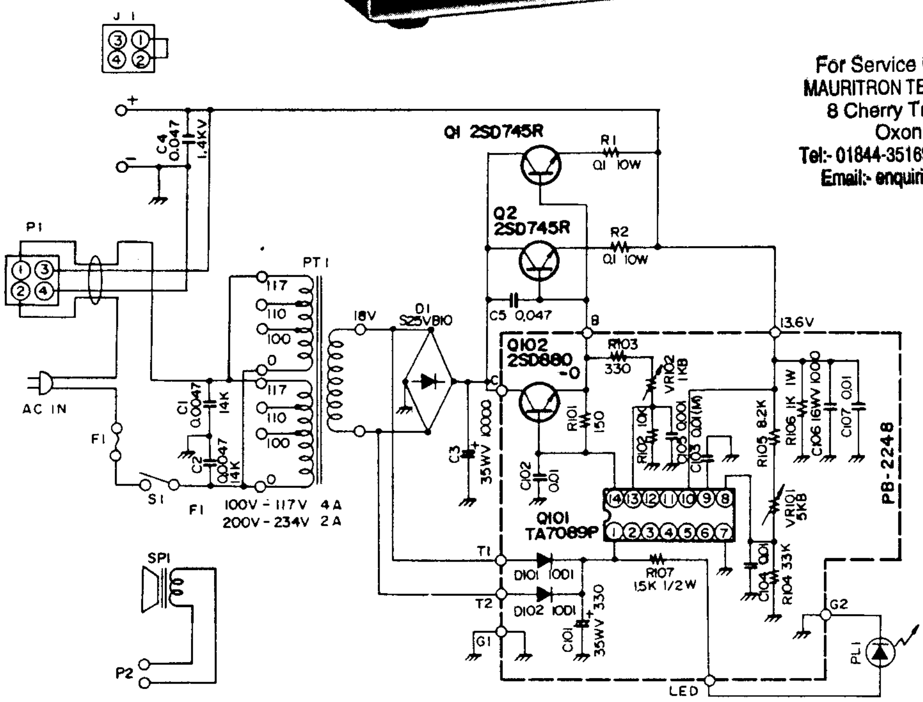


FHR-1
HORN RELAY UNIT



AC POWER SUPPLY
FP-8





FP-8
CIRCUIT DIAGRAM

BAND PROGRAMMING

1. Select the 10 MHz band to be used for operation, and note its corresponding letter:

134 – 144 MHz	BAND A
*134.3 – 144.3 MHz	BAND A (12.5 kHz)
144 – 154 MHz	BAND B
*144.3 – 154.3 MHz	BAND B (12.5 kHz)
154 – 164 MHz	BAND C
*154.3 – 164.3 MHz	BAND C (12.5 kHz)
164 – 174 MHz	BAND D
*164.3 – 174.3 MHz	BAND D (12.5 kHz)
150 – 160 MHz	BAND E (RCC)
*150.3 – 160.3 MHz	BAND E (12.5 kHz)

2. Referring to Figure 2-2, install the jumpers as shown for the band selected. For example, if you are programming the FTC-2640 to operate within the range of 154 to 164 MHz (*154.3 to 164.3 MHz), you noted in step 1 that this is BAND C (*BAND C–12.5 kHz). So from Figure 2-2 you see that you must jumper TP_{301} to TP_{303}, TP_{306} to TP_{308} and TP_{304} to TP_{305}.

Note that in the case of the BAND E (RCC BAND), *BAND E–12.5 kHz, diodes D_{306} and D_{307} must be removed (or simply cut) in addition to the illustrated jumper installation.

SIMPLEX/DUPLEX PROGRAMMING

1. If you intend that all channels be simplex, simply install a jumper between pins 2 and 3 of J_{501}, as shown in Figure 2-1.

2. If some channels are to be semi-duplex, determine which of channels 1 through 8 are to be simplex channels. Referring to Figure 2-1, locate Matrix Column C on the circuit board and install jumpers in Column C between the Transmit Row and the Receive Row for each simplex channel. For example; if Channel 1 is to be simplex, connect a jumper from Row T1 (nearest P_{501}) to Row R1 (middle Row) in Column C (end column near J_{501}).

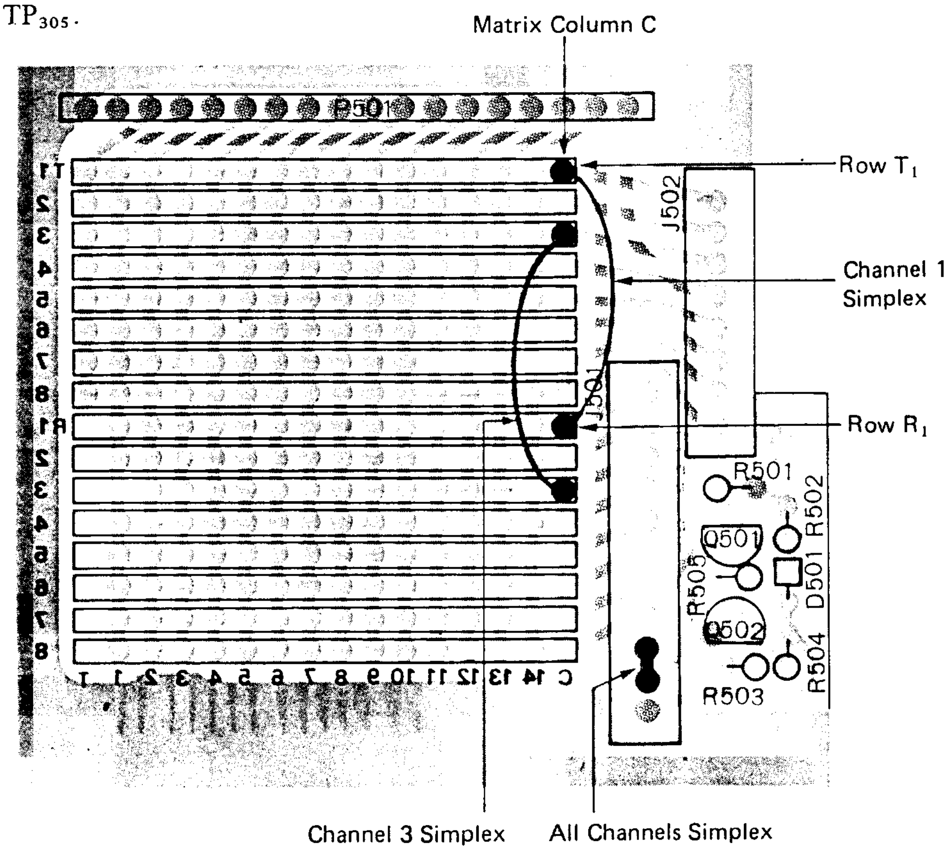
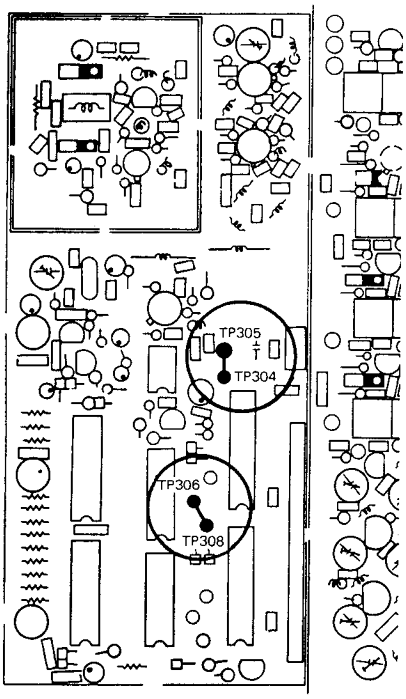
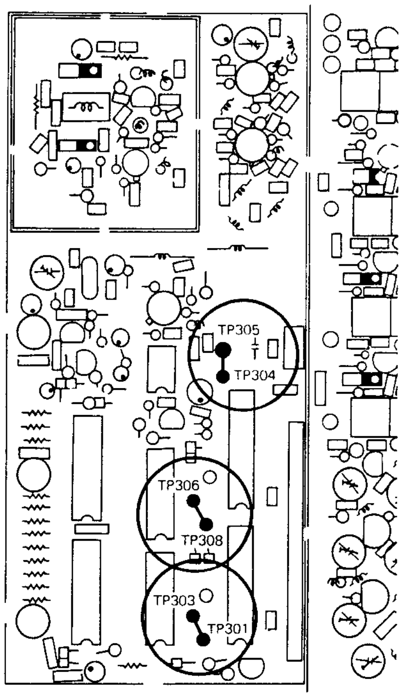


Figure 2-1
Viewed from solder side

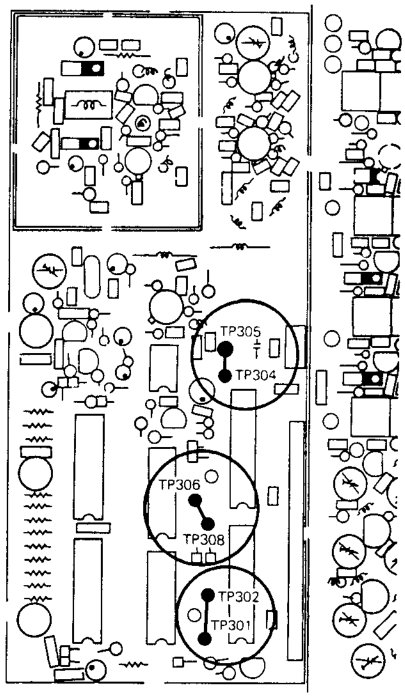
BAND SELECT JUMPER CONNECTIONS



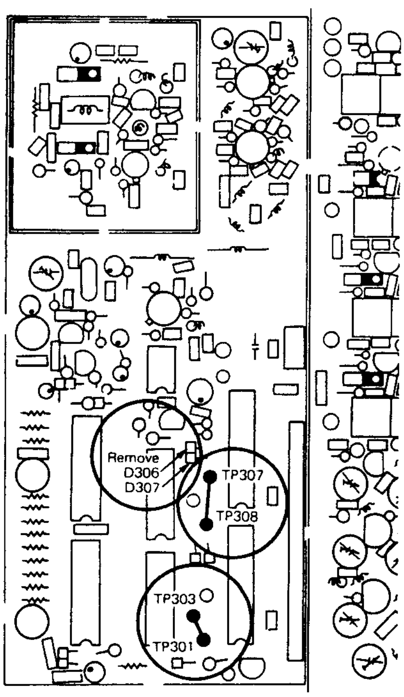
BAND A, A(12.5 kHz)



BAND B, B(12.5 kHz) and C(12.5 kHz)



BAND D, D(12.5 kHz)



BAND E, E(12.5 kHz)

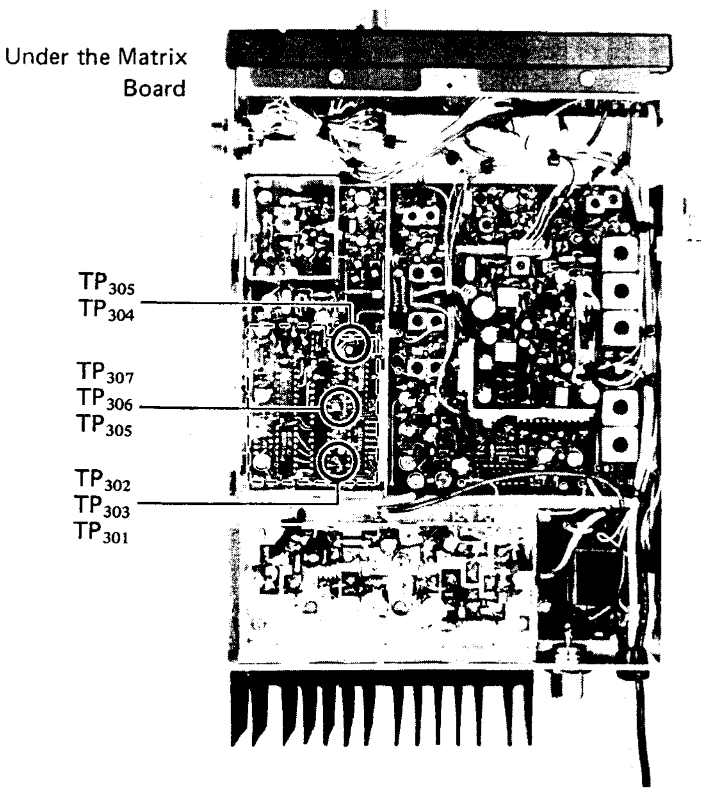


Figure 2-2

MAIN BOARD PLL SECTION (UNDER THE MATRIX BOARD)

CHANNEL FREQUENCY PROGRAMMING* FOR 5 kHz/STEP MODEL

Note: Simplex channels are fully programmed by installing diodes in the Transmit Row of the Diode Matrix only. The Receive Row is not used for simplex channels. Those diodes in Column T (nearest the edge of the circuit board) enable the Transmit function. If you intend to install a channel for Receive only you must install the jumpers as described in the simplex channel programming step and install the diode Row in the Transmit section of the Matrix, cutting the diode in the Column T position to disable Transmit. Be careful not to cut this diode when programming the channel frequency, unless you intend to disable transmit on that channel.

1. Separate the desired chânnel frequency into 5 and 10 kHz, 100 kHz, and MHz segments as follows:

```
1  6  2        9    7  5
└──┬──┘        │    └─┬┘
  MHz          │   5 & 10 kHz
Col. 5 – 9     │   Col. 10 – 14
           100 kHz
           Col. 1 – 4
```

   Matrix Columns 1** through 4 are used to program the 100 kHz digit.

   Matrix Columns 5 through 9 program the MHz digits.

   Matrix Columns 10 through 14 program the 5 and 10 kHz digits.

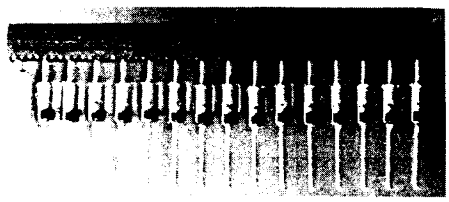
* For RCC (Radio Common Carrier) operation, install the jumpers and cut the diodes as shown in Figure 2-2 BAND E. Then program the channel frequencies according to Figure 2-6 on page 2-16.

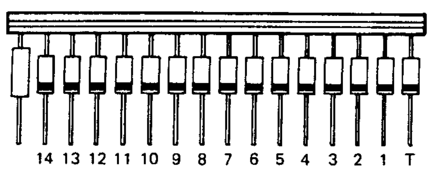
** Notice that Column position 1 in the array is not the edge position, but second from the edge, since the T Column position is the first diode at the edge.

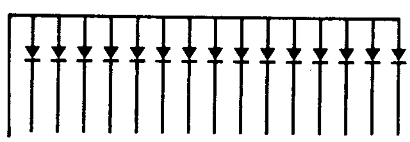
2. Referring to Table 2-1 and the Example Tables, program the 5 and 10 kHz digits of your channel frequency by removing the diodes in Column positions 10 through 14 corresponding with the 0s shown on the Line for your frequency.
   For example, using the above frequency of 162.975 MHz, the 5 and 10 kHz digits are 75 (0.075 MHz). Now referring to Table 2-1, the 75 kHz line indicates that the diodes in Column positions 11 and 13 must be cut.

3. Program the 100 kHz digit in the same manner from the data in Table 2-3, cutting the appropriate diodes in Columns 1 through 4. Thus for the above frequency, the 100 kHz digit is 9, and from Table 2-3 we see that the diodes in Column positions 2 and 3 must be cut.

4. To program the MHz digits repeat the same procedure as with the other digits, this time referring to Table 2-2. Note that this Table is divided into sections A, B, C, D and E corresponding with the BAND selected by the jumpers installed during Band Programming. For our example of 162.975 MHz, the MHz digits are 162, and in the Table we see that this frequency is in Section C, corresponding with the BAND programmed via the jumpers in an earlier example. We also see from the Table that the diodes in Column







	5 and 10 kHz digits				
DIODE NO.	14	13	12	11	10
kHz	50	5x2³	5x2²	5x2¹	5x2⁰
00	0	0	0	0	0
05	0	0	0	0	1
10	0	0	0	1	0
15	0	0	0	1	1
20	0	0	1	0	0
25	0	0	1	0	1
30	0	0	1	1	0
35	0	0	1	1	1
40	0	1	0	0	0
45	0	1	0	0	1
50	1	0	0	0	0
55	1	0	0	0	1
60	1	0	0	1	0
65	1	0	0	1	1
70	1	0	1	0	0
75	1	0	1	0	1
80	1	0	1	1	0
85	1	0	1	1	1
90	1	1	0	0	0
95	1	1	0	0	1

Table 2-1

	134 – 173 MHz (BAND A, B, C, D)					150 – 159 MHz (BAND E)				
DIODE NO.	9	8	7	6	5	9	8	7	6	5
MHz	*	$+2^3$	$+2^2$	$+2^1$	$+2^0$	*	$+2^3$	$+2^2$	$+2^1$	$+2^0$
134	1	0	0	0	0					
135	1	0	0	0	1					
136	1	0	0	1	0					
137	1	0	0	1	1					
138	1	0	1	0	0					
139	1	0	1	0	1					
140	1	0	1	1	0					
141	1	0	1	1	1					
142	1	1	0	0	0					
143	1	1	0	0	1					
144	0	0	0	0	0					
145	0	0	0	0	1					
146	0	0	0	1	0					
147	0	0	[illegible]	1	1					
148	0	0	1	0	0					
149	0	0	1	0	1					
150	0	0	1	1	0	0	1	0	0	0
151	0	0	1	1	1	0	1	0	0	1
152	0	1	0	0	0	1	0	0	0	0
153	0	1	0	0	1	1	0	0	0	1
154	1	0	0	0	0	1	0	0	1	0
155	1	0	0	0	1	1	0	0	1	1
156	1	0	0	1	0	1	0	1	0	0
157	1	0	0	1	1	1	0	1	0	1
158	1	0	1	0	0	1	0	1	1	0
159	1	0	1	0	1	1	0	1	1	1
160	1	0	1	1	0					
161	1	0	1	1	1					
162	1	1	0	0	0					
163	1	1	0	0	1					
164	0	0	0	0	0					
165	0	0	0	0	1					
166	0	0	0	1	0					
167	0	0	0	1	1					
168	0	0	1	0	0					
169	0	0	1	0	1					
170	0	0	1	1	0					
171	0	0	1	1	1					
172	0	1	0	0	0					
173	0	1	0	0	1					

* BAND A 1 → 134
BAND B 0 → 144
BAND C 1 → 154
BAND D 0 → 164
BAND E 0 → 150
BAND E 1 → 152

Table 2-2

	100 kHz digits			
DIODE NO.	4	3	2	1
kHz	100 x2³	100 x2²	100 x2¹	100 x2⁰
000	0	0	0	0
100	0	0	0	1
200	0	0	1	0
300	0	0	1	1
400	0	1	0	0
500	0	1	0	1
600	0	1	1	0
700	0	1	1	1
800	1	0	0	0
900	1	0	0	1

Table 2-3

	DIODE NO.	14	13	12	11	10
		5 and 10 kHz digits				
	kHz	50	$5x2^3$	$5x2^2$	$5x2^1$	$5x2^0$
	00	0	0	0	0	0
	05	0	0	0	0	1
	10	0	0	0	1	0
	15	0	0	0	1	1
F2(T) →	20	0	0	1	0	0
	25	0	0	1	0	1
	30	0	0	1	1	0
	35	0	0	1	1	1
	40	0	1	0	0	0
	45	0	1	0	0	1
F3(R) →	50	1	0	0	0	0
	55	1	0	0	0	1
F2(R) →	60	1	0	0	1	0
	65	1	0	0	1	1
	70	1	0	1	0	0
F1 →	75	1	0	1	0	1
	80	1	0	1	1	0
	85	1	0	1	1	1
	90	1	1	0	0	0
	95	1	1	0	0	1

	DIODE NO.	9	8	7	6	5	9	8	7	6	5
		134 – 173 MHz (BAND A, B, C, D)					150 – 159 MHz (BAND E)				
	MHz	*	$+2^3$	$+2^2$	$+2^1$	$+2^0$	*	$+2^3$	$+2^2$	$+2^1$	$+2^0$
	134	1	0	0	0	0					
	135	1	0	0	0	1					
	136	1	0	0	1	0					
	137	1	0	0	1	1					
	138	1	0	1	0	0					
	139	1	0	1	0	1					
	140	1	0	1	1	0					
	141	1	0	1	1	1					
	142	1	1	0	0	0					
	143	1	1	0	0	1					
	144	0	0	0	0	0					
	145	0	0	0	0	1					
	146	0	0	0	1	0					
	147	0	0	0	1	1					
	148	0	0	1	0	0					
	149	0	0	1	0	1					
	150	0	0	1	1	0	0	1	0	0	0
	151	0	0	1	1	1	0	1	0	0	1
	152	0	1	0	0	0	1	0	0	0	0
	153	0	1	0	0	1	1	0	0	0	1
	154	1	0	0	0	0	1	0	0	1	0
F2(R) →	155	1	0	0	0	1	1	0	0	1	1
	156	1	0	0	1	0	1	0	1	0	0
	157	1	0	0	1	1	1	0	1	0	1
F2(T) →	158	1	0	1	0	0	1	0	1	1	0
	159	1	0	1	0	1	1	0	1	1	1
	160	1	0	1	1	0					
	161	1	0	1	1	1					
F1 →	162	1	1	0	0	0					
F3(R) →	163	1	1	0	0	1					
	164	0	0	0	0	0					
	165	0	0	0	0	1					
	166	0	0	0	1	0					
	167	0	0	0	1	1					
	168	0	0	1	0	0					
	169	0	0	1	0	1					
	170	0	0	1	1	0					
	171	0	0	1	1	1					
	172	0	1	0	0	0					
	173	0	1	0	0	1					

* BAND A 1 → 134
BAND B 0 → 144
BAND C 1 → 154
BAND D 0 → 164
BAND E 0 → 150
BAND E 1 → 152

DIODE NO.	4	3	2	1	
	100 kHz digits				
kHz	$100 x2^3$	$100 x2^2$	$100 x2^1$	$100 x2^0$	
000	0	0	0	0	← F2(R)
100	0	0	0	1	
200	0	0	1	0	
300	0	0	1	1	
400	0	1	0	0	
500	0	1	0	1	← F2(T)
600	0	1	1	0	
700	0	1	1	1	
800	1	0	0	0	
900	1	0	0	1	← F1, F3(R)

EXAMPLE TABLES

EXAMPLE 2. Channel 3; 163.950 MHz Receive Only (Figures 2-5 and 2-9, and Example Tables).

Note again that this frequency is located within the 154 – 164 MHz C BAND, since all channels programmed into the FTC-2640 must be within the same band. Recalling the NOTE at the beginning of the Channel Frequency Programming section, we will first begin the Receive Only programming by wiring Channel 3 as for Simplex operation.

1. Referring to Figure 2-1, install a jumper between Matrix Row T3 and Row R3 in Matrix Column C.

2. Now for frequency programming, separate the frequency into the three segments: 163 MHz, 900 kHz and 50 kHz.

3. Referring to the respective programming Tables for these frequency segments, cut diodes in Column positions 2, 3, 6, 7, 10, 11, 12 and 13.

4. Again recalling the NOTE at the beginning of the Channel Frequency Programming section, we must also cut the diode in the Column T position to disable Transmit (if we leave this diode in place the channel will be an ordinary simplex channel).

5. Install this diode assembly into the circuit at Row T3, and solder the remaining diodes of the assembly into place.

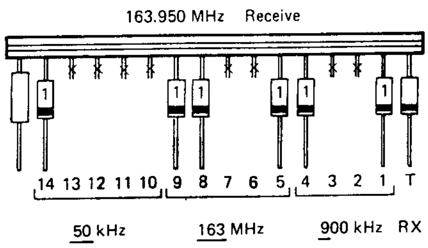


Figure 2-9 (X ····· cut)

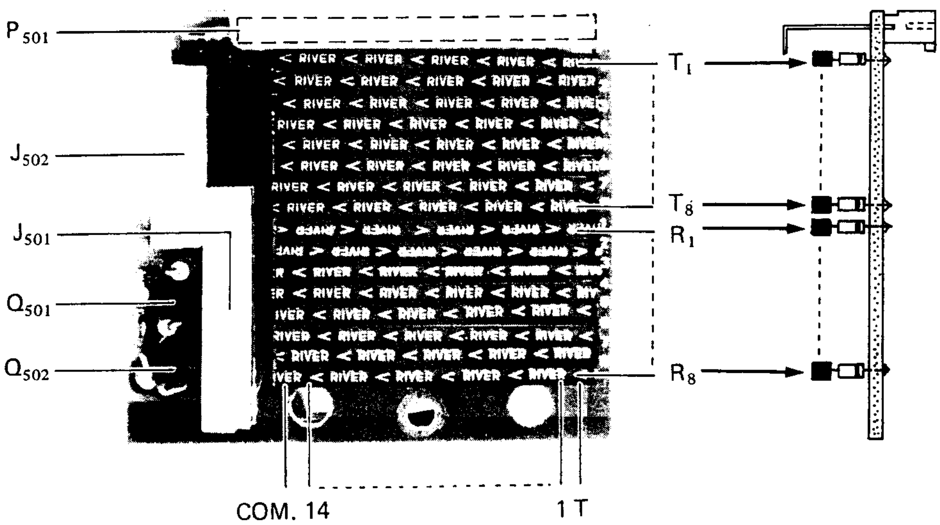


Figure 2-10

CHANNEL FREQUENCY PROGRAMMING FOR 12.5 kHz/STEP MODEL

Note: Simplex channels are fully programmed by installing diodes in the Transmit Row of the Diode Matrix only. The Receive Row is not used for simplex channels. Those diodes in Column T (nearest the edge of the circuit board) enable the Transmit function. If you intend to install a channel for Receive only you must install the jumpers as described in the simplex channel programming step and install the diode Row in the Transmit section of the Matrix, cutting the diode in the Column T position to disable Transmit. Be careful not to cut this diode when programming the channel frequency, unless you intend to disable transmit on that channel.

1. Separate the desired channel frequency into 0.5, 1 & 10 kHz; 100 kHz; and MHz range segments as follows:

   1 6 4 — MHz range, Col. 5 – 9
   2 — 100 kHz, Col. 1 – 4
   7 5 0 — 0.5, 1 & 10 kHz, Col. 10 – 14

   Matrix Columns 1** through 4 are used to program the 100 kHz digit.

   Matrix Columns 5 through 9 program the MHz range, each of which has a lower limit of X + .3000 MHz and an upper limit of (X + 1) + .2875 MHz. (X is any whole number of MHz within the operating band).

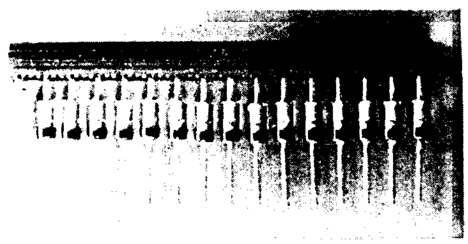
   Matrix Columns 10 through 14 program the 0.5, 1 & 10 kHz digits. (The 0.5 kHz digit can be only zero or 0.5.)

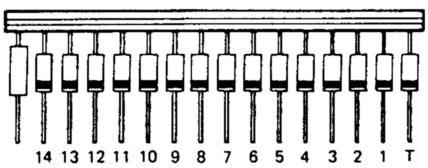
**Notice that Column position 1 in the array is not the edge position, but second from the edge, since the T Column position is the first diode at the edge.

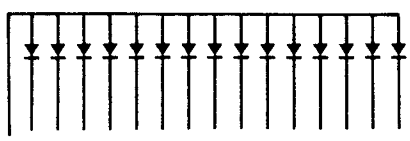
2. Referring to Table 2-4 and the Example Tables, program the 0.5, 1 & 10 kHz digits of your channel frequency by removing the diodes in Column positions 10 through 14 corresponding with the 0s shown on the Line for your frequency.
   For example, using the above frequency of 164.2750 MHz, the 0.5, 1 & 10 kHz digits are 75.0. Now referring to Table 2-4, the 75.0 kHz line indicates that the diodes in Column positions 10 and 13 must be cut.

3. Program the 100 kHz digit in the same manner from the data in Table 2-6, cutting the appropriate diodes in Columns 1 through 4. Thus for the above frequency, the 100 kHz digit is 2 (200 kHz), and from Table 2-6 we see that the diodes in Column positions 2 and 3 must be cut.

4. To program the MHz range repeat the same procedure as with the other digits, this time referring to Table 2-5. Note that this Table is divided into sections A, B, C, D and E corresponding with the BAND selected by the jumpers installed during Band Programming. For our example of 164.275 MHz, the MHz range is 163.3 – 164.2, and in the Table we see that this frequency is in Section C, corresponding with the BAND programmed via the jumpers in an earlier example. Notice that, although the desired frequency is above 164.2 MHz, the 163.3 – 164.2 MHz range is used for programming. This is because it is the 100 kHz digit that sets the limit of the MHz range (in this case 200 kHz), and the







next higher range can not be used for any frequencies below 164.3 MHz. We see from the Table that the diodes in Column positions 6 and 7 must be cut. The diode assembly should now match the program shown in Channel F1 on Figures 2-10 and 2-11.

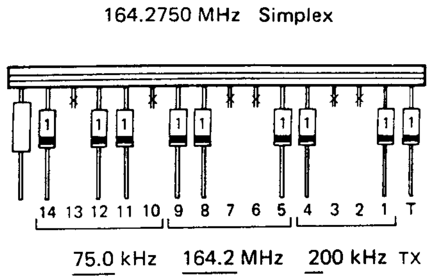


Figure 2-10 (X ... cut)

FTC-2640 PROGRAM BAND C (12.5 kHz)

CHANNEL		FREQUENCY (MHz)	COLUMN POSITION (DIODE) NO.															
DISPLAY	MATRIX BOARD (ROW)		14	13	12	11	10	9	8	7	6	5	4	3	2	1	T	
F 1	T 1	164.2750	1	0	1	1	0	1	1	0	0	1	1	0	0	1	1	
	R 1																	
F 2	T 2	159.8000	0	0	1	0	0	1	0	1	0	1	0	1	0	1	1	Example 1.
	R 2	156.3500	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	
F 3	T 3																	Example 2.
	R 3	163.2250	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	
F 4	T 4																	
	R 4																	
F 5	T 5																	
	R 5																	
F 6	T 6																	
	R 6																	
F 7	T 7																	
	R 7																	
F 8	T 8																	
	R 8																	

Figure 2-11

ADDITIONAL FREQUENCY PROGRAMMING EXAMPLES

EXAMPLE 1. Channel 2 Duplex; 159.8000 Transmit, 156.3500 Receive (Figures 2-11, 2-12 and 2-13; and Example Tables).

For this example we will again assume that the FTC-2640 is already programmed with the jumpers described in the Band Programming section to operate in the 154.3 – 164.28 MHz band (BAND C) (12.5 kHz). Since Channel 2 is to be duplex, we do not install a jumper as described in the Simplex/Duplex Programming section.

1. To program the transmit frequency, we will first separate the frequency into the components we will need:
   159.8 is the MHz range,
   8 is the 100 kHz segment, and
   00.0 is the 0.5, 1 & 10 kHz segment.

2. Now to program the 0.5, 1 & 10 kHz segment first; referring to Table 2-4, we find on the 00.0 kHz line that we must cut the diodes in Column positions 10, 11, 13, and 14.

3. To program the 100 kHz segment; referring to Table 2-6, we find on the 800 kHz line that we must cut the diodes in Column positions 2 and 4.

4. Similarly, for the MHz range segment; referring now to Table 2-5, we find on the 159.3 – 160.2 MHz line (Part E of the Table) that we must cut the diodes in Column positions 6 and 8.

5. Now install the diode assembly into the circuit at Row T2 (marked on the circuit board), and solder the remaining diodes of the assembly into place.

6. To program the receive frequency we again separate it into three segments:
   156.3 is the MHz range segment,
   3 is the 100 kHz segment, and
   50.0 is the 0.5, 1 & 10 kHz segment.

7. For the 0.5, 1 & 10 kHz segment we again refer to Table 2-4, and on the 50.0 kHz line we see that we must cut the diodes in positions 10, 12, and 13.

8. For the 100 kHz segment we see in Table 2-6 that we cut all of the diodes in positions 1 through 4 (remember that position 1 is not the first diode in the row, but the second, since the T position is the first diode at the end of the row).

9. For the MHz range segment we see in Table 2-5 (Part C) on the 156.3 – 157.2 MHz line that we must cut the diodes in positions 5, 7 and 8.

10. Finally, install this diode assembly into the circuit at Row R2, and solder the remaining diodes of the assembly into place.

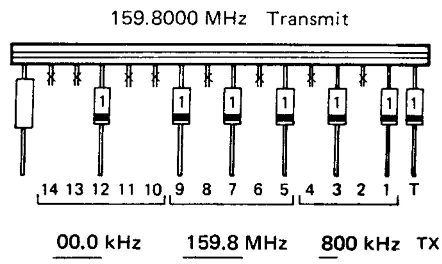


Figure 2-12 (X ... cut)

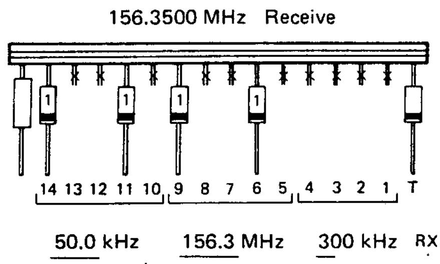


Figure 2-13 (X ... cut)

EXAMPLE 2. Channel 3; 163.2250 MHz Receive Only (Figures 2-11 Example Tables).

Note again that this frequency is located within the 154.3 – 164.3 MHz C(12.5 kHz) BAND, since all channels programmed into the FTC-2640 must be within the same band. Recalling the NOTE at the beginning of the Channel Frequency Programming section, we will first begin the Receive Only programming by wiring Channel 3 as for Simplex operation.

1. Referring to Figure 2-1, install a jumper between Matrix Row T3 and Row R3 in Matrix Column C.

2. Now for frequency programming, separate the frequency into the three segments: 163.2 MHz, 200 kHz and 25.0 kHz.

3. Referring to the respective programming Tables for these frequency segments, cut diodes in Column positions 2, 3, 5, 6, 7, 10, 11, 12 and 14.

4. Again recalling the NOTE at the beginning of the Channel Frequency Programming section, we must also cut the diode in the Column T position to disable Transmit (if we leave this diode in place the channel will be an ordinary simplex channel).

5. Install this diode assembly into the circuit at Row T3, and solder the remaining diodes of the assembly into place.

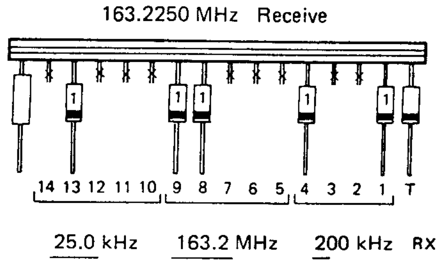


Figure 2-14 (X ... cut)

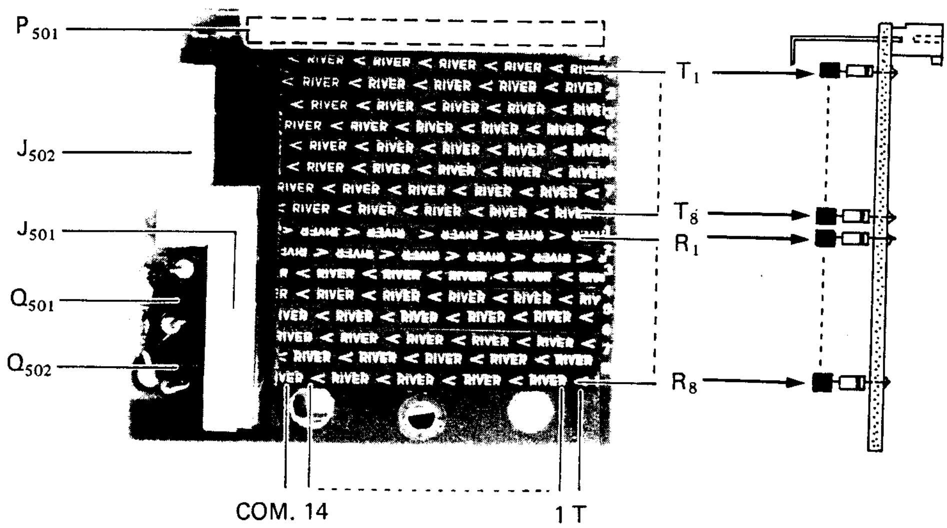
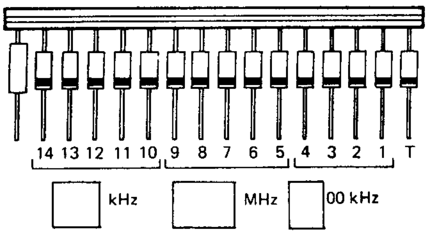


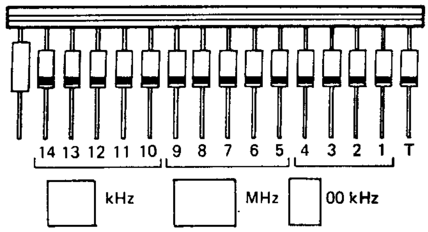
Figure 2-15

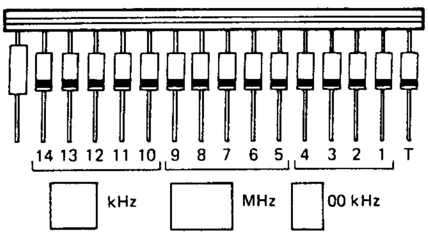
Use these blank diagrams for programming practice.

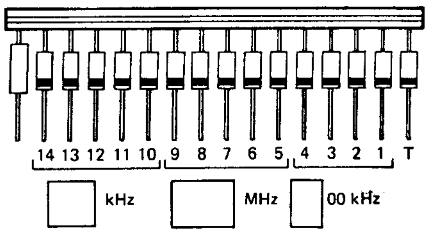
FTC-2640 PROGRAM BAND (   )

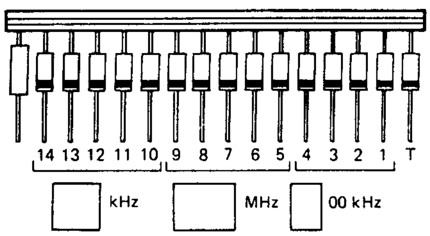
CHANNEL		FREQUENCY (MHz)	COLUMN POSITION (DIODE) NO.														
DISPLAY	MATRIX BOARD (ROW)		14	13	12	11	10	9	8	7	6	5	4	3	2	1	T
F 1	T 1																
	R 1																
F 2	T 2																
	R 2																
F 3	T 3																
	R 3																
F 4	T 4																
	R 4																
F 5	T 5																
	R 5																
F 6	T 6																
	R 6																
F 7	T 7																
	R 7																
F 8	T 8																
	R 8																

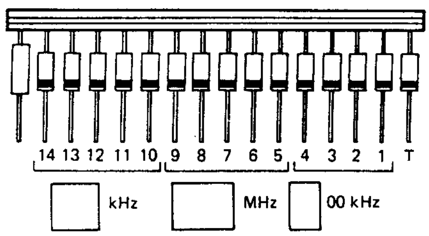


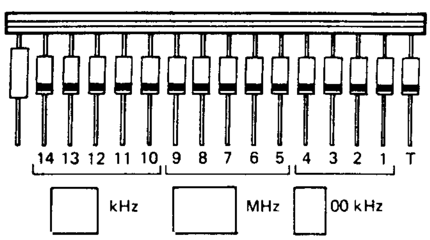


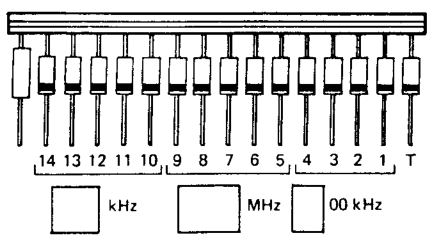


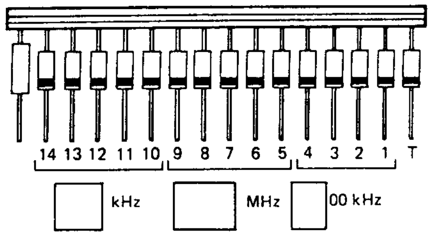


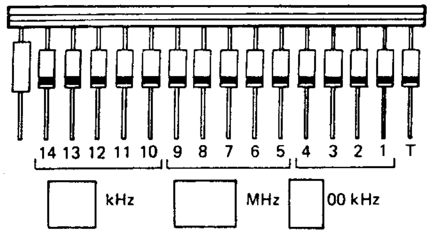


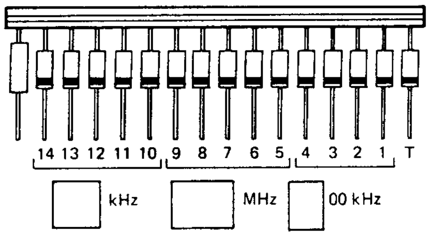







14 13 12 11 10 9 8 7 6 5 4 3 2 1 T
kHz
MHz
00 kHz


14 13 12 11 10 9 8 7 6 5 4 3 2 1 T
kHz
MHz
00 kHz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MHz
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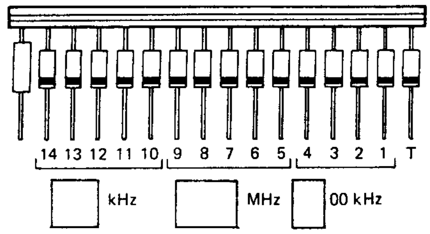
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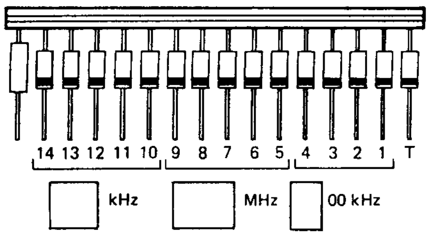
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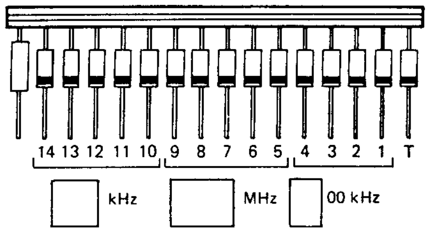
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MHz
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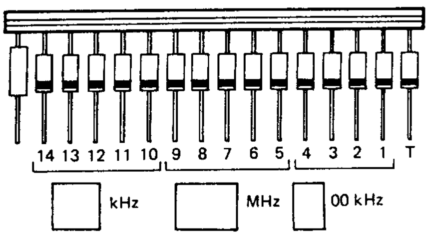
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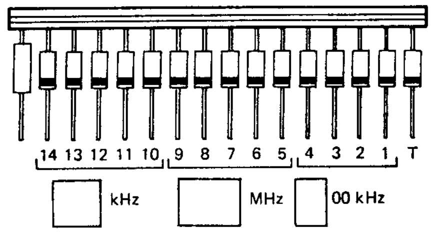
MHz
00 kHz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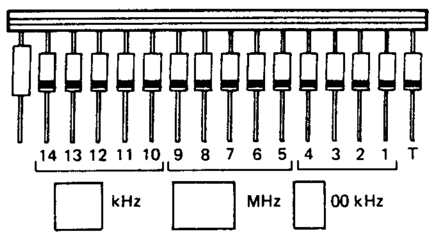
kHz
MHz
00 kHz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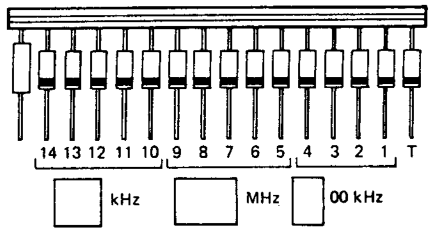
MHz
00 kHz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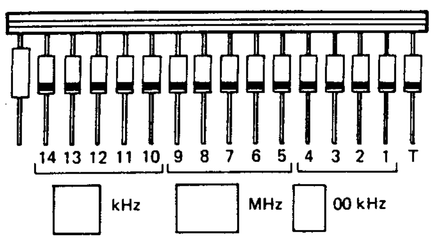
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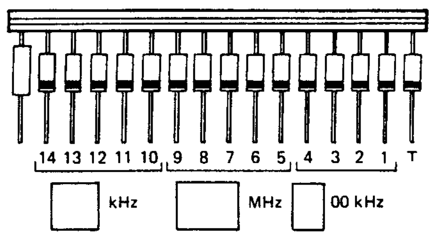
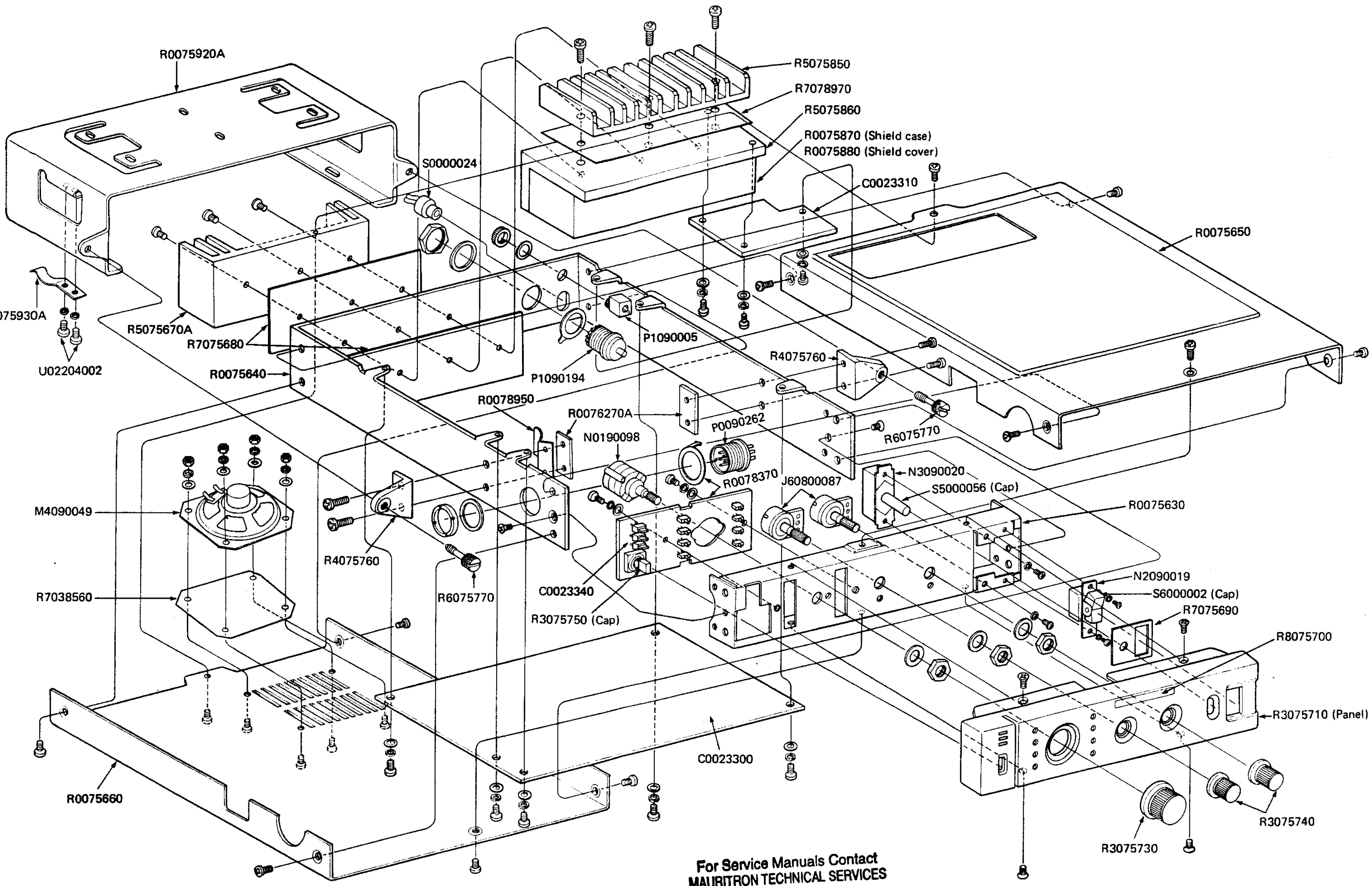

14 13 12 11 10 9 8 7 6 5 4 3 2 1 T
kHz
MHz
00 kHz

BAND TABLE (TUNING CAPACITORS)

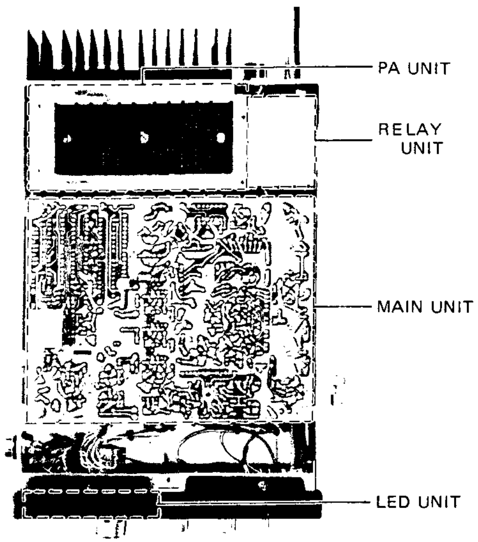
	134 – 154 MHz (A, B) (134.3 – 154.3 MHz)		150 – 164 MHz (C, E) (150.3 – 164.3 MHz)		164 – 174 MHz (D) (164.3 – 174.3 MHz)	
	Part No.	Description	Part No.	Description	Part No.	Description
C102	K02182020	Ceramic CH 2pF (RD870-1CG 020C 63V)	–	Not used	–	Not used
C103	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183070	Ceramic UJ 7pF (RD870-1UJ 070D 63V)	K06183070	Ceramic UJ 7pF (RD870-1UJ 070D 63V)
C106	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)
C107	K06183090	〃 UJ 9pF (RD870-1UJ 090D 63V)	K06182040	〃 UJ 4pF (RD870-1UJ 040C 63V)	K06182040	〃 UJ 4pF (RD870-1UJ 040C 63V)
C111	K02182030	〃 CH 3pF (RD870-1CG 030C 63V)	K02182010	〃 CH 1pF (RD870-1CG 010C 63V)	K02182010	〃 CH 1pF (RD870-1CG 010C 63V)
C113	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)
C115	K02182040	〃 CH 4pF (RD870-1CG 040C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)
C116	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)
C118	K06185120	〃 UJ 12pF (RD870-1UJ 120J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C119	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)	K06183070	〃 UJ 7pF (RD870-1UJ 070D 63V)
C120	K06182040	〃 UJ 4pF (RD870-1UJ 040C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)
C0201	K05183100	〃 RH 10pF (RD870-1RG 100D 63V)	K05183050	〃 RH 5pF (RD870-1RG 050C 63V)	K05183050	〃 RH 5pF (RD870-1RG 050C 63V)
C0202	K02182010	〃 CH 1pF (RD870-1CG 010C 63V)	K02182059	〃 CH 0.5pF (RD870-1CG 0R5C 63V)	K02182059	〃 CH 0.5pF (RD870-1CG 0R5C 63V)
C0203	K05182050	〃 RH 5pF (RD870-1RG 050C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)	K05182020	〃 CH 2pF (RD870-1CG 020C 63V)
C216	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C217	K02182020	〃 CH 2pF (RD870-1CG020C 63V)	–	Not used	–	Not used
C219	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C223	K02182040	〃 CH 4pF (RD870-1CG 040C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)
C225	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C227	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C231	K02182040	〃 CH 4pF (RD870-1CG 040C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)	K02182020	〃 CH 2pF (RD870-1CG 020C 63V)
C233	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C235	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)	K06183100	〃 UJ 10pF (RD870-1UJ 100D 63V)
C311	K06185470	〃 UJ 47pF (RD870-1UJ 470J 63V)	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)	K06185150	〃 UJ 15pF (RD870-1UJ 150J 63V)
C312	K06185330	〃 UJ 33pF (RD870-1UJ 330J 63V)	K06185180	〃 UJ 18pF (RD870-1UJ 180J 63V)	K06185180	〃 UJ 18pF (RD870-1UJ 180J 63V)
C315	K06185220	〃 UJ 22pF (RD870-1UJ 220J 63V)	K06185120	〃 UJ 12pF (RD870-1UJ 120J 63V)	K06185120	〃 UJ 12pF (RD870-1UJ 120J 63V)
C363	K02183100	〃 CH 10pF (RD870-1CG 100D 63V)	K02182050	〃 CH 5pF (RD870-1CG 050C 63V)	K02182050	〃 CH 5pF (RD870-1CG 050C 63V)
C366	K02185390	〃 CH 39pF (RD871-1CG 390J 63V)	K02185390	〃 CH 39pF (RD871-1CG 390J 63V)	K02185560	〃 CH 56pF (RD872-2CG 560J 63V)
C409	K02185560	〃 CH 56pF (RD872-2CG 560J 63V)	K02185560	〃 CH 56pF (RD872-2CG 560J 63V)	K02185330	〃 CH 33pF (RD871-1CG 330J 63V)
C410	K02185680	〃 CH 68pF (RD873-2CG 680J 63V)	–	Not used	–	Not used
C421	K02185560	〃 CH 56pF (RD872-2CG 560J 63V)	K02185560	〃 CH 56pF (RD872-2CG 560J 63V)	–	Not used
C427	K02185150	〃 CH 15pF (RD870-1CG 150J 63V)	K02183090	〃 CH 9pF (RD870-1CG 090D 63V)	K02183070	〃 CH 7pF (RD870-1CG 070D 63V)
C434	K02185220	〃 CH 22pF (RD871-1CG 220J 63V)	–	Not used	–	Not used
C443	K02185220	〃 CH 22pF (RD871-1CG 220J 63V)	K02185180	〃 CH 18pF (RD870-1CG 180J 63V)	K02185180	〃 CH 18pF (RD870-1CG 180J 63V)
C445	K02185220	〃 CH 22pF (RD871-1CG 220J 63V)	K02185180	〃 CH 18pF (RD870-1CG 180J 63V)	K02185180	〃 CH 18pF (RD870-1CG 180J 63V)

MEMO

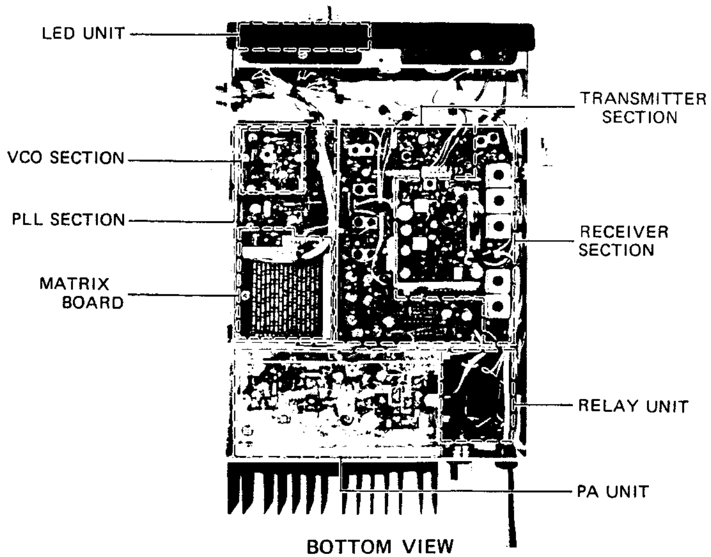
EXPLODED VIEW



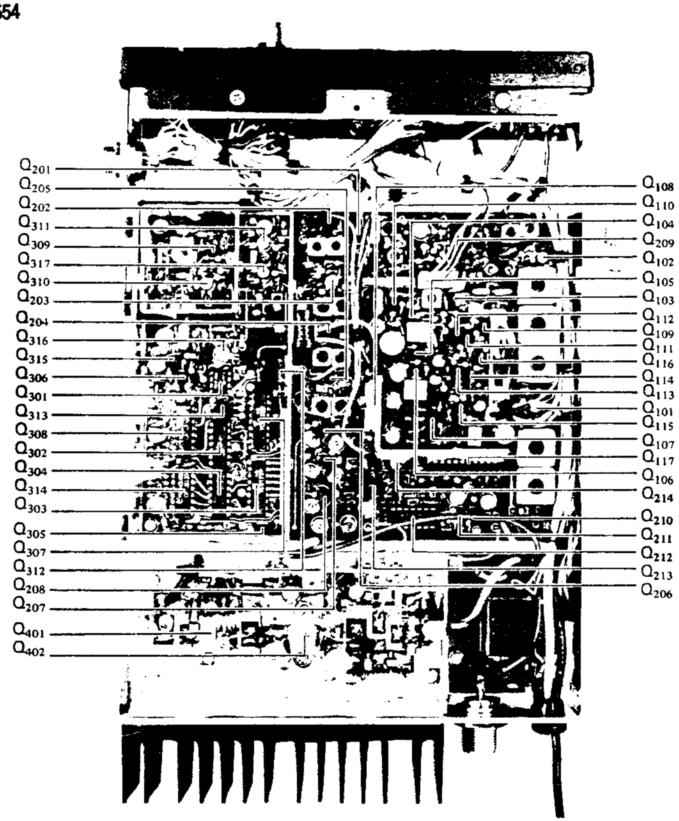
BOARD LAYOUT



TOP VIEW

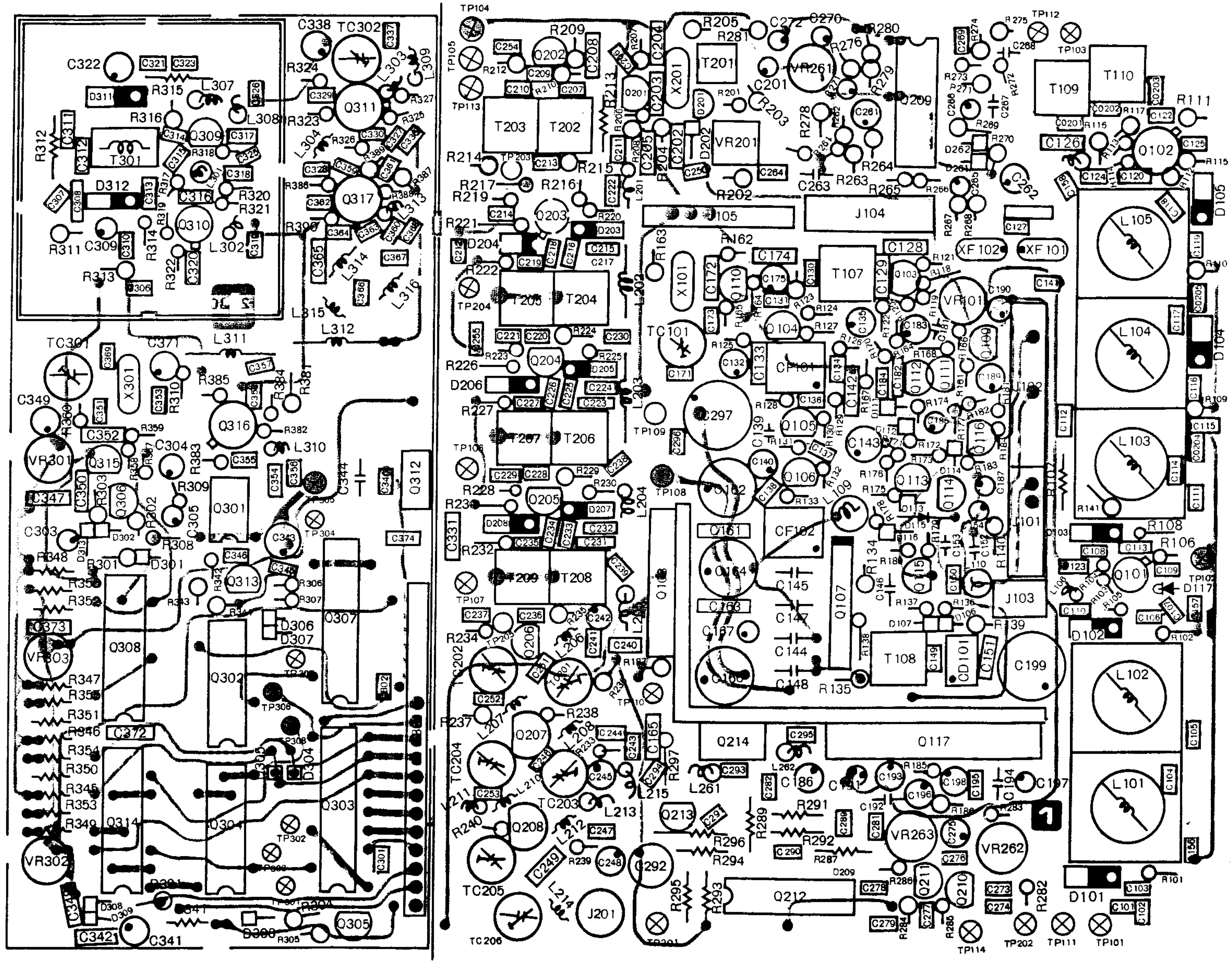


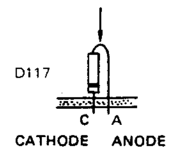
BOTTOM VIEW



SEMICONDUCTOR LOCATIONS

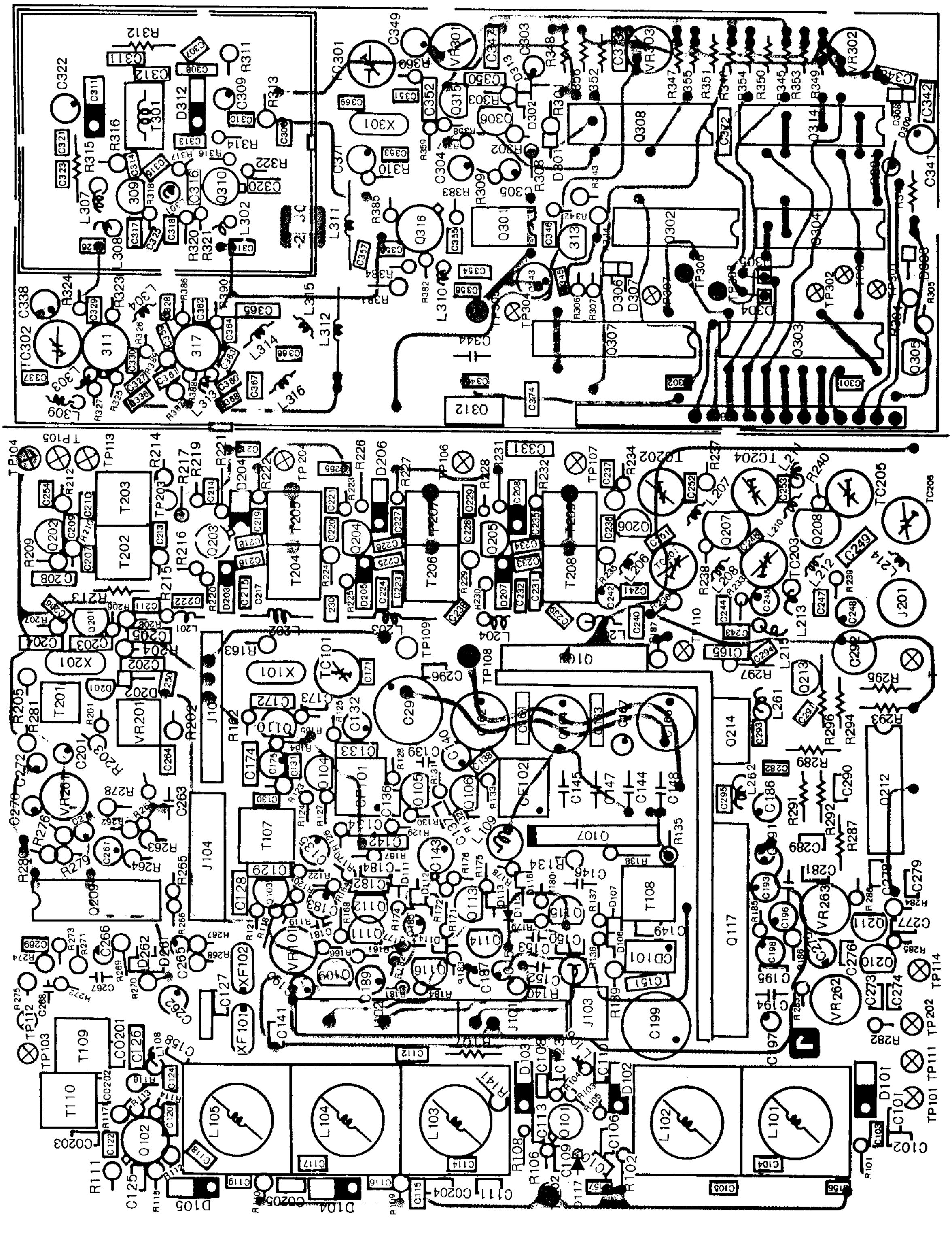
MAIN BOARD PARTS LAYOUT





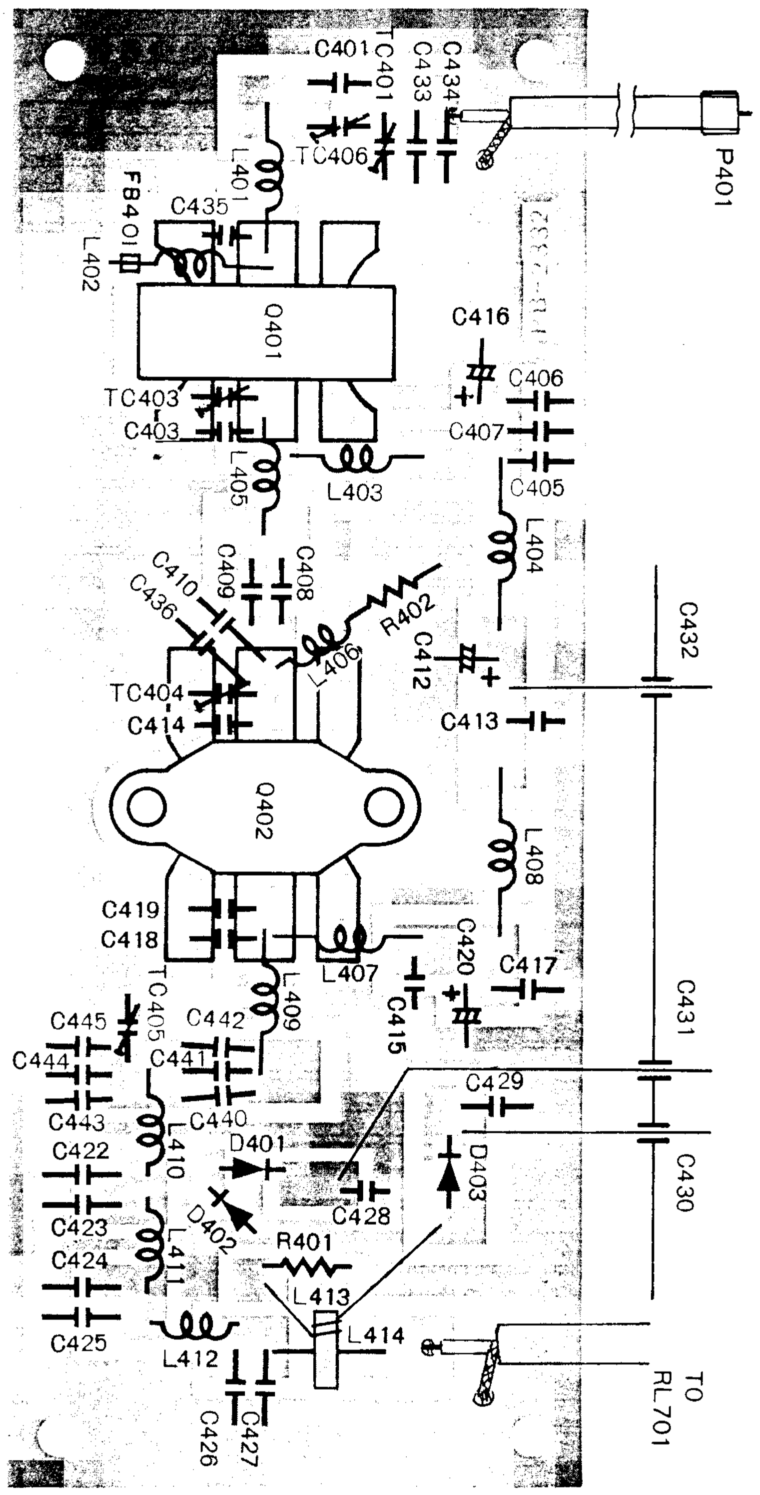
Viewed from component side

MAIN BOARD PARTS LAYOUT

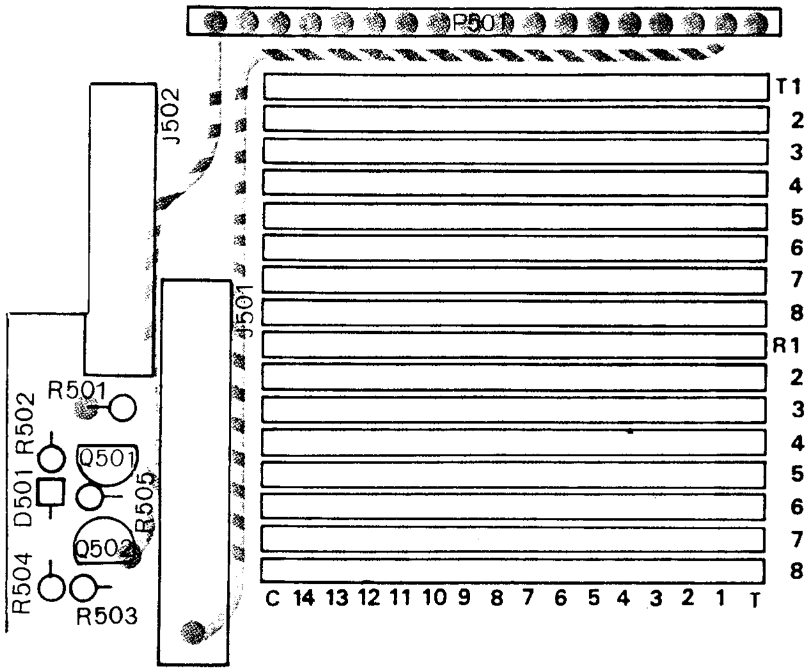


Viewed from solder side

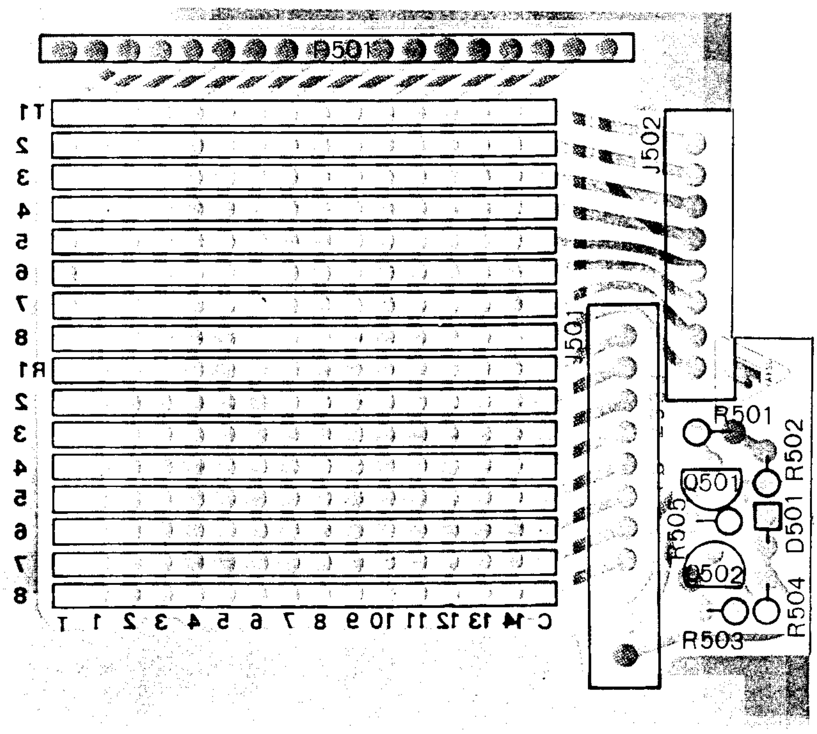
POWER AMPLIFIER BOARD PARTS LAYOUT



DIODE MATRIX BOARD PARTS LAYOUT

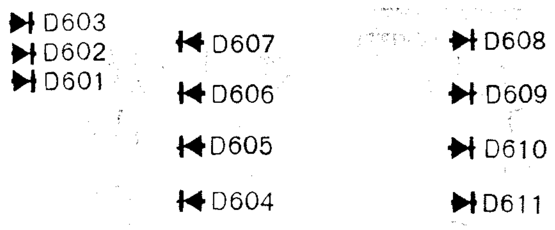


Viewed from component side

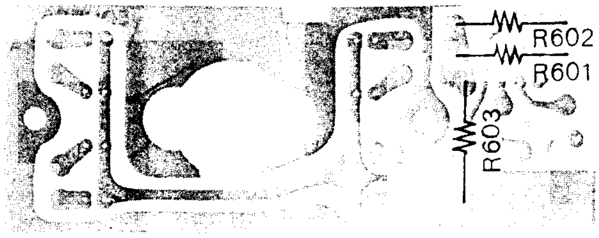


Viewed from solder side

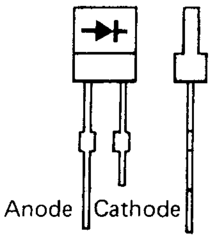
LED BOARD PARTS LAYOUT



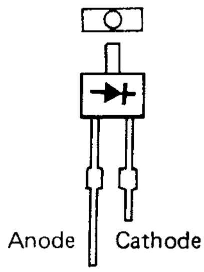
Viewed from LED side



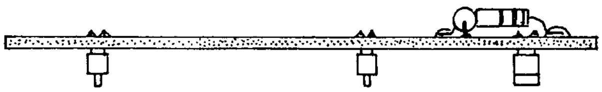
Viewed from resistor side



D_{601} – D_{603}

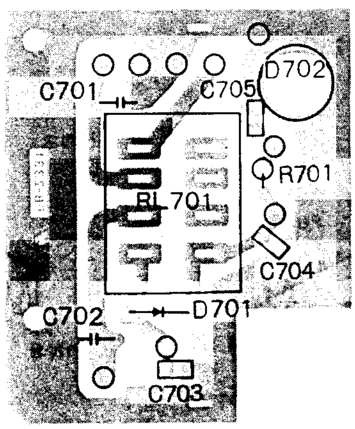


D_{604} – D_{611}

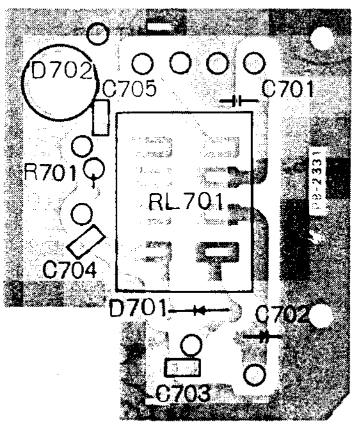


D_{608} – D_{611} D_{604} – D_{607} D_{601} – D_{603}

RELAY BOARD PARTS LAYOUT



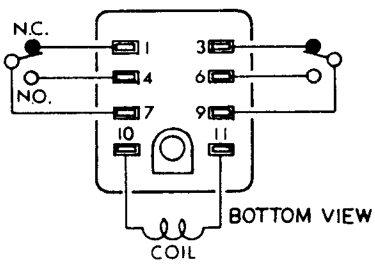
Viewed from component side



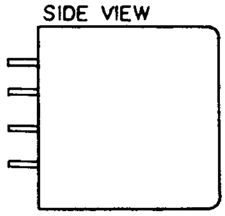
Viewed from solder side

Should the need for replacement of relays become necessary, or if you are trying to verify proper relay operation, these diagrams should help you.

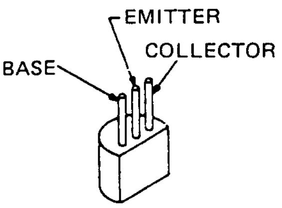
RL701



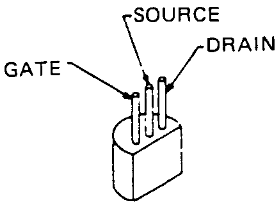
SIDE VIEW



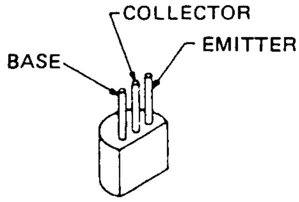
TRANSISTOR & IC PINOUTS



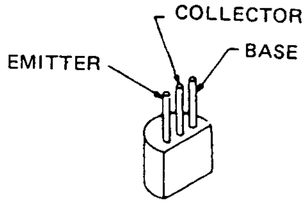
2SC2026



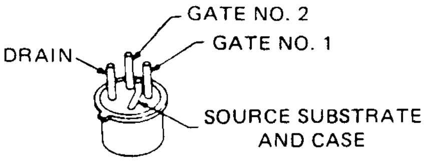
2SK168D



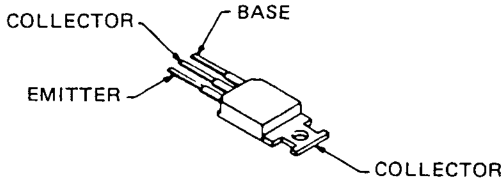
2SC458B*
2SC1906



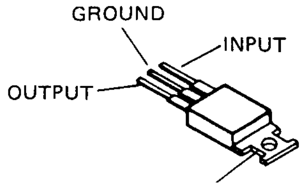
2SC1209
2SC2053
2SC2538
2SA628



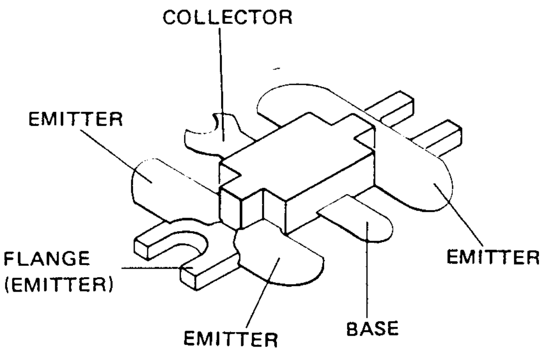
3SK51
3SK59
3SK60



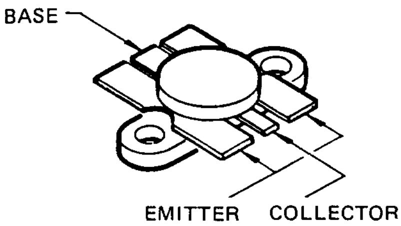
2SB856B



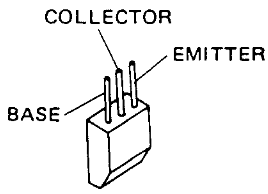
μPC14305



2SC2539

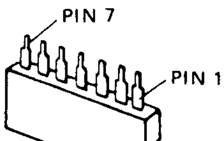


2SC2630

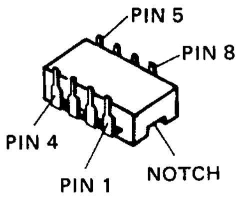


2SC535A/B
2SC458B*
2SC460B

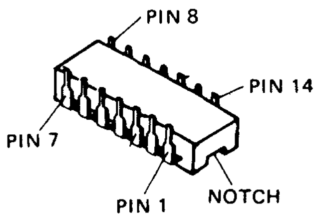
PIN 8



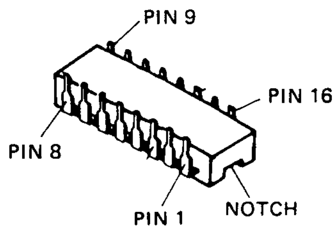
μPC577H



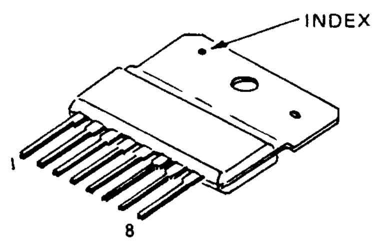
μPB551C



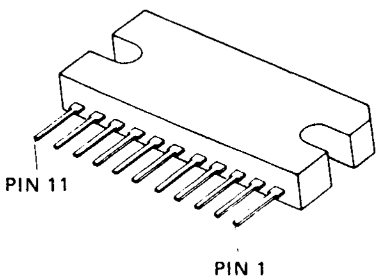
HD74LS02P
HD74LS74AP



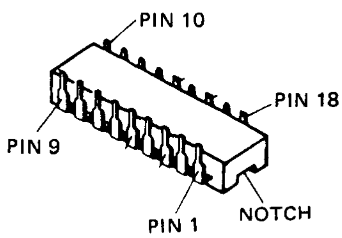
MC14504B
MC14568B



MB3756



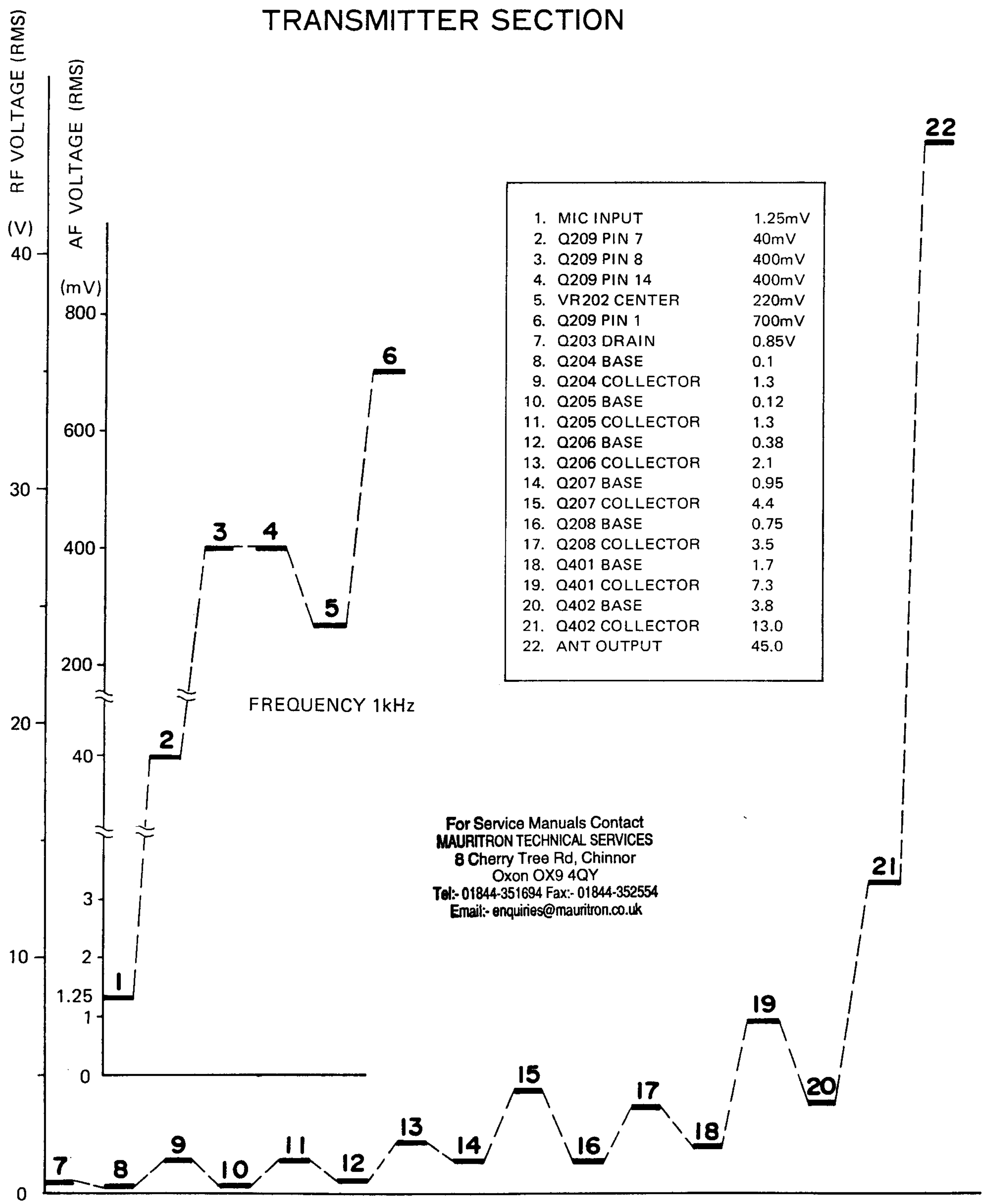
AN315



TC9122

LEVEL DIAGRAM

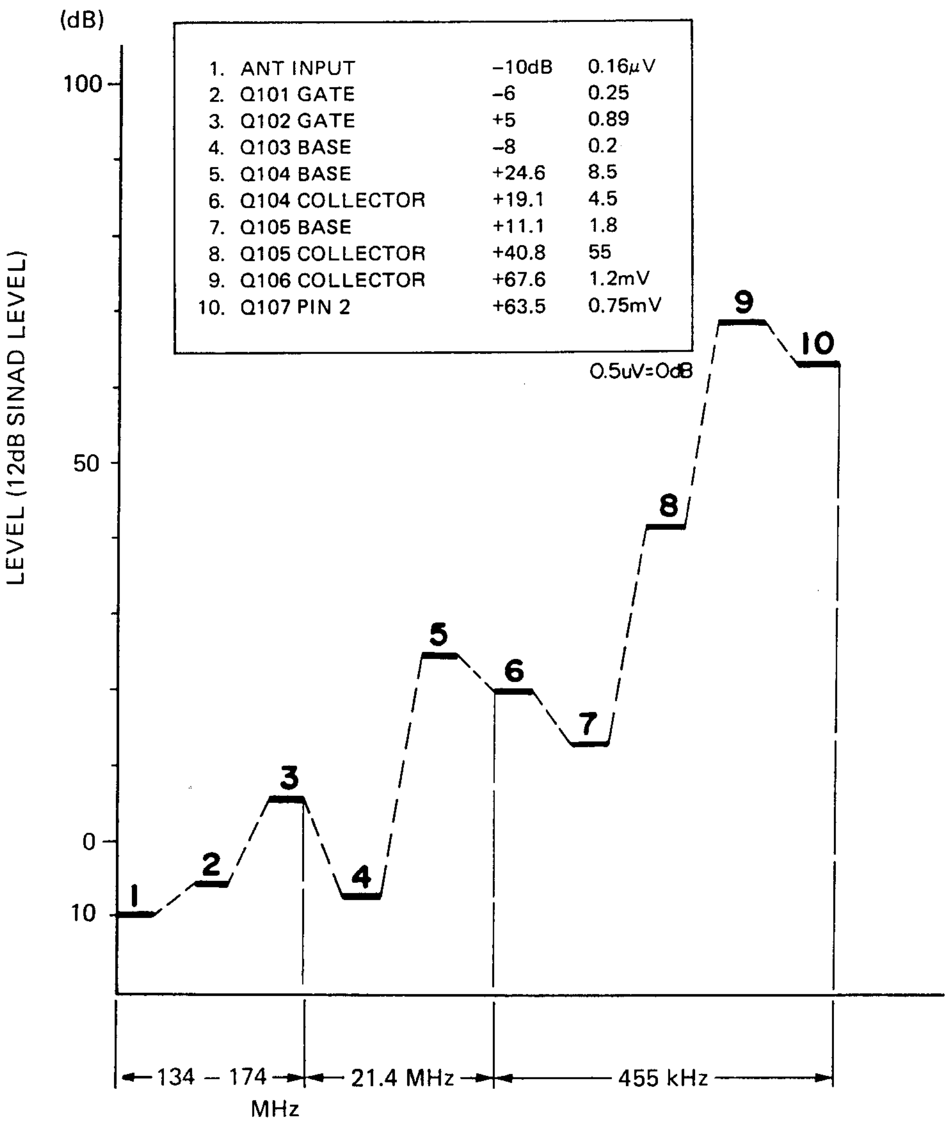
FTC-2640
TRANSMITTER SECTION



1.	MIC INPUT	1.25mV
2.	Q209 PIN 7	40mV
3.	Q209 PIN 8	400mV
4.	Q209 PIN 14	400mV
5.	VR202 CENTER	220mV
6.	Q209 PIN 1	700mV
7.	Q203 DRAIN	0.85V
8.	Q204 BASE	0.1
9.	Q204 COLLECTOR	1.3
10.	Q205 BASE	0.12
11.	Q205 COLLECTOR	1.3
12.	Q206 BASE	0.38
13.	Q206 COLLECTOR	2.1
14.	Q207 BASE	0.95
15.	Q207 COLLECTOR	4.4
16.	Q208 BASE	0.75
17.	Q208 COLLECTOR	3.5
18.	Q401 BASE	1.7
19.	Q401 COLLECTOR	7.3
20.	Q402 BASE	3.8
21.	Q402 COLLECTOR	13.0
22.	ANT OUTPUT	45.0

LEVEL DIAGRAM

FTC-2640
RECEIVER SECTION



1.	ANT INPUT	−10dB	0.16μV
2.	Q101 GATE	−6	0.25
3.	Q102 GATE	+5	0.89
4.	Q103 BASE	−8	0.2
5.	Q104 BASE	+24.6	8.5
6.	Q104 COLLECTOR	+19.1	4.5
7.	Q105 BASE	+11.1	1.8
8.	Q105 COLLECTOR	+40.8	55
9.	Q106 COLLECTOR	+67.6	1.2mV
10.	Q107 PIN 2	+63.5	0.75mV

VOLTAGE CHART

	B (G)	E (S)	C (D)	REMARKS		B (G)	E (S)	C (D)	REMARKS
Q_{101}	G_1 0.3 V G_2 2.0	0.7 V	8.0 V		Q_{206}	0.3 V	0 V	4.4 V	
Q_{102}	G_1 0.4 G_2 0.9	0.2	2.6		Q_{207}	0.3	0	11.1	
Q_{103}	1.3	0.6	7.4		Q_{208}	0.03	0	13.6	
Q_{104}	1.4	0.7	7.5		Q_{210}	0.1	0	4.7	APC: OPEN
Q_{105}	0.7	0	2.1		Q_{211}	4.7	3.9	8.3	APC: OPEN
Q_{106}	4.8	4.1	6.4		Q_{213}	0.8	0	0.1	APC: OPEN
Q_{110}	1.3	0.7	8.1		Q_{214}	12.7	13.5	13.4	APC: OPEN
Q_{111}	0.7/0.7	0	1.9/1.8	SQ: OFF/ON	Q_{309}	−0.3	0.1	7.9	
Q_{112}	1.9/1.8	1.2/1.1	4.3/4.4	SQ: OFF/ON	Q_{310}	G_1 0 G_2 4.2	0.4	8.4	
Q_{113}	0.8/1.1	0.1/0.5	0.3/1.8	SQ: OFF/ON	Q_{311}	G_1 0 G_2 2.7	0.5	7.7	
Q_{114}	0.2/1.2	0.1/0.5	13.2/0.7	SQ: OFF/ON	Q_{315}	3.4	4.1	8.1	
Q_{115}	0.7/0.5	0/0	0.06/12.0	SQ: OFF/ON	Q_{316}	G_1 0 G_2 2.1	0.3	7.8	
Q_{116}	2.7	2.1	2.9		Q_{317}	G_1 0 G_2 2.4	0.4	7.8	
Q_{201}	1.9	1.2	8.3		Q_{401}	0	0	13.6	RX
Q_{202}	1.7	0.5	7.3		Q_{402}	0	0	13.6	RX
Q_{203}	G_1 0.06 G_2 0.3	0.15	8.1			IN	E	OUT	
Q_{204}	0.7	0	6.6		Q_{312}	13.6	0	5.0	
Q_{205}	0.6	0	5.8						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	REMARKS
Q_{107}	5.3	1.8	1.8	0	6.7	2.9	8.4								
Q_{108}	8.4 /8.4	13.6 /13.5	8.4 /8.4	0/0	13.5 /0.3	8.4 /−0.03	0/0	0.1 /8.4							RX/TX
Q_{117}	5.5 /0.2	0/0	1.2 /0	6.7 /0.2	10.4 /0.2	5.4 /0.2	0/0	5.5 /0.4	5.4 /0.4	13.2 /0.7	13.6 /13.6				SQ: OFF/ON
Q_{209}	4.2	4.2	4.2	8.4	4.2	4.2	4.2	4.3	4.2	4.2	0	4.2	4.2	4.1	
Q_{212}	*	*	*	8.4	*	*	*	4.0	4.0	3.9	0	4.0	3.7	6.8	

Measured with VTVM.
Values are in VOLTS DC.

$Q_{101} \sim Q_{117}$ .... Transmit 0V
$Q_{201} \sim Q_{214}$ .... Receive 0V

SOLDERING AND DESOLDERING TECHNIQUE ON PRINTED CIRCUIT BOARDS

The FTC-2640 circuit boards are tough, but mis-handling during soldering can cause circuit traces to "lift." While this does not cause permanent damage to the board, much servicing trouble can result, because of the tendency for this lifted trace to break. A few simple precautions will keep your circuit boards in A-1 condition.

1. Use only a 12 to 30 watt chisel-tip soldering iron. Yes, some "repairmen" have been known to use small blowtorches on cards.

2. Use only a soldering iron equipped with a three-wire cord, with the tip grounded. Also acceptable is a soldering iron isolated through a transformer. An old soldering iron or gun may have 117 volts on the tip, and will certainly cause more damage than it repairs!

3. USE ONLY 60/40 ROSIN CORE SOLDER. Acid core solder should be thrown away if you find it in your radio shop!

4. Use a solder sucker and solder tape to ensure a professional repair job.

5. If you **do** lift a trace, don't worry! Read on to find out how to repair traces like a pro.

NOTES ON USE OF CMOS COMPONENTS:

As CMOS devices are extremely sensitive to damage from static electricity, special precautions must be observed.

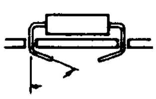
In storage, use only sponge specially designed for CMOS components.

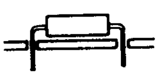
When installing a CMOS part in a socket, or on a circuit board, be certain that the power is off. In addition, the technician should rest his hand on the chassis as the component is inserted, so as to place his hand at the same potential as the chassis (better to discharge small amounts of static electricity through your fingers than through a $5 IC !).

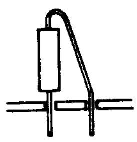
When soldering a CMOS part onto a circuit board, use a low wattage iron, and be sure to ground the tip with a clip lead, if the tip is not grounded through a three-wire power cord.

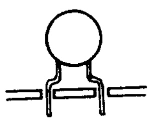
INSERTION OF PARTS ON CIRCUIT BOARDS

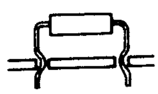
All of the below are acceptable ways of inserting components into circuit board mounting holes.


(a) Bend leads slightly

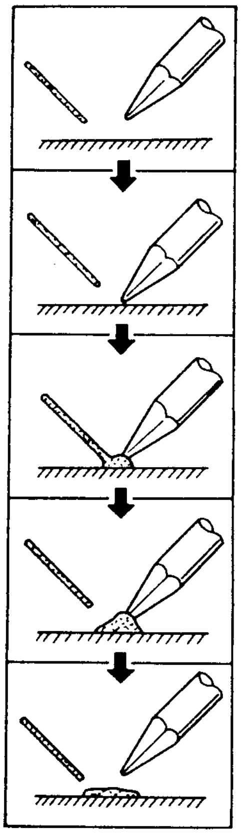

(b) Straight-in mounting


(c) Vertical mounting


(d) Preformed disc ceramic capacitor


(e) Preformed resistor, diode, etc.

BASIC SOLDERING PRACTICE



(1) Prepare soldering iron and solder.

(2) Apply soldering iron to surface to be soldered.

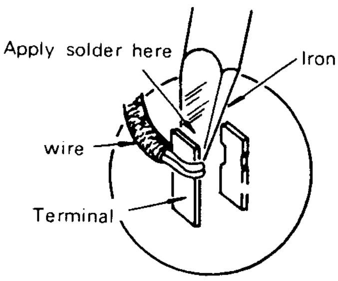
(3) Apply solder to heated surface.

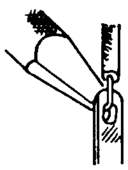
(4) When enough solder is applied, remove solder. Continue to apply heat until solder flows cleanly.

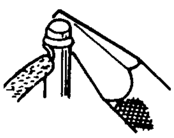
(5) Remove iron from work. Do not apply more heat than necessary for good solder flow.

Soldering to terminal posts:

(Be certain to apply heat to both post and wire.)

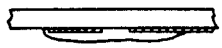




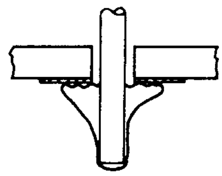


EXAMPLES OF POOR SOLDERING PRACTICE

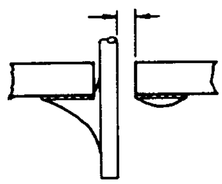
Solder bridge (caused by use of too much solder)



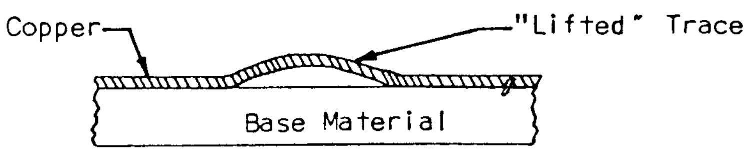
"Cold joint" (caused by insufficient heat to part of work, resulting in poor solder flow)

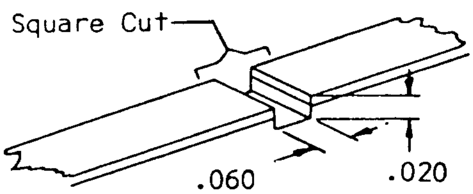


Unstable joint (caused by insufficient heat or solder)



If you have previously lifted a trace, make an etch cut on each side of the lifted trace, and install a wire bridge as shown in the drawing.





Coat Cut Area With Eastman 910

FAULT LOCALIZATION

While the process of fault localization is highly individualistic, it is generally agreed that there is no substitute for a logical, step-by-step diagnostic check.

Begin your troubleshooting procedure with a visual inspection of the radio. Use your nose, too: burned resistors smell differently than do transformers, etc. Check for charred or loose components inside the cabinet.

If the preliminary inspection turns up nothing, connect a dummy load to the antenna jack, and a 13.6 VDC bench supply to the power cord. The supply should be capable 8 amperes continuous for the FTC-2640.

Turn the power switch on, and begin a systematic check. Do the lamps light up? If not, check the fuse. Is the trouble not apparent? Perhaps it only happens on transmit. Check for noises, pops, sparks, or smoke inside the cabinet – these are unmistakable declarations by the radio that something is awry!

TYPICAL PART FAILURES, CAUSES, AND SYMPTOMS

PARTS	CAUSE OF TROUBLE	SYMPTOMS
Semiconductors (IC, FET, TR)	High supply voltage Open circuit Excessive drive High temperature	Short or open circuit Output decreases to 1/2 at 80°C Internal noise Instability
MOS FET MOS IC	Static electricity	Total failure
Crystal Crystal filter	Shock High temperature	Crystal destroyed Frequency drift Filter bandpass change
Resistor	Excessive power Aging High temperature	Component burned Value changed Open circuit
Potentiometer	Excessive power Shock	Component burned Open circuit Noise Unsmooth rotation
Capacitor	Excess voltage High temperature Excess power	Shorted Leakage Open/decreased capacitance
Variable capacitor Trimmer capacitor	Ratings exceeded Dust between plates Shock, forced rotation	Shorted Leakage Unsmooth rotation
Coils	Ratings exceeded Variation	Open or short circuit Leakage or shorted turns Detuned
Switch	Ratings exceeded Aging	Poor contact Unsmooth operation Open circuit
Relay	Ratings exceeded Humidity	Poor contact Noise Coil open

MAINTENANCE AND SERVICING

REGULAR MAINTENANCE PLAN

Because of the rugged design and construction of the FTC-2640, little maintenance should be required if the radio is not abused. As a Yaesu dealer, though, you are best in a position to determine the individual needs of your customers. Operation in extremely harsh environments may warrant more frequent checks of transceiver performance.

We recommend that your customers return their sets to your service facility once every two years for routine checks of the transmitter power output and the receiver sensitivity. In the meantime, keep in frequent touch with your customers regarding their expanding communications requirements. Not only will this give you the opportunity to introduce new Yaesu products, but your customers' particular service requirements will become evident.

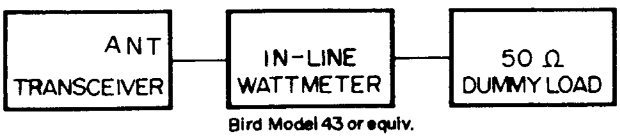
PERFORMANCE CHECKS

Make all performance checks at 13.6 volts DC under load.

Check the transmitter power output as follows:

a) Connect a suitable dummy load/wattmeter to the antenna jack.

b) Set the channel selector to any channel. Close the push-to-talk switch, and observe the power output. The output should be at least 40 watts.



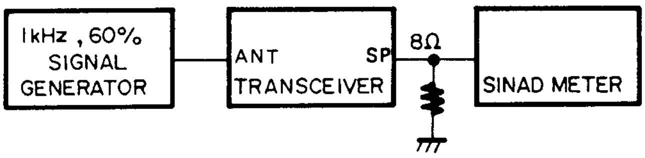
PO TEST SETUP

Check the receiver sensitivity as follows:

a) Connect an 8 ohm dummy load and a SINAD meter to the SP jack. Set the SQUELCH control fully counterclockwise.

b) Connect the RF output of a precision VHF signal generator to the antenna jack, and set the output to 1 mV with 60% deviation at 1 kHz. Adjust the VOLUME Control to 150 mW AF output.

c) Now reduce the output of the signal generator to the point where the deflection of the SINAD meter indicates 12 dB. Check to see that the signal generator reads 12 dB SINAD sensitivity. The nominal value of the output from the signal generator should be approximately 0.35 μV.



RX SENSITIVITY TEST SETUP

If the above checks are both OK, then clean out the transceiver by applying moderate-force compressed air throughout the chassis area. This will remove any dust that may be present. If there is accumulated dirt inside the cabinet, a soft brush may be used to loosen it. Wipe the outer cabinet of the transceiver with a damp cloth, and use the compressed air to dislodge accumulated dust present in the corners of the radio.

ALIGNMENT

Internal adjustments should, under most circumstances, be limited to those described in the paragraphs to follow.

Remove the four screws from the top cover, then the four screws from the bottom cover, in order to provide full access to the transceiver circuitry.

RECOMMENDED ALIGNMENT EQUIPMENT

Frequency Counter (8-digit, ±0.02 PPM)	YC-500E (Yaesu), or equivalent		
DC Voltmeter	HP 4304B (Hewlett-Packard)		″
VTVM with 500 MHz RF Probe	HP 3406A	″	″
Sweep Generator	HP 8620	″	″
Spectrum Analyzer	HP 141T, 8552B, or 8554B (Hewlett-Packard)		″
Standard Signal Generator	HP 8640B	″	″
AF VTVM	HP 400E	″	″
Distortion Meter	HP 334A	″	″
SINAD Meter	S101 (Helper Instr. Co.)		″
X-Y Oscilloscope	HP 1222A (Hewlett-Packard)		″
In-line Wattmeter	Bird 43		″
Power Attenuator (20dB)	Bird 8343-200		″
Attenuator (20dB)	HP 8491A (Hewlett-Packard)		
Linear Detector	HP 8901A	″	″
Audio Generator	HP 200CD	″	″

ALIGNMENT FREQUENCIES AND MATRIX PROGRAMMING CHART

CH	BAND A	BAND C	COLUMN POSITION (DIODE) NO.														
	134–143.995MHz	154–163.995MHz	14	13	12	11	10	9	8	7	6	5	4	3	2	1	T
F 1	143.500MHz	163.500 MHz	0	0	0	0	0	1	1	0	0	1	0	1	0	1	1
F 2	134.500	154.500	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1
F 3	139.500	159.500	0	0	0	0	0	1	0	1	0	1	0	1	0	1	1
F 4	139.000	159.000	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1
F 5	139.995	159.995	1	1	0	0	1	1	0	1	0	1	1	0	0	1	1
F 6	143.995	163.995	1	1	0	0	1	1	1	0	0	1	1	0	0	1	1
F 7	143.000	163.000	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1
F 8	134.000	154.000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

CH	BAND A*	BAND C*	COLUMN POSITION (DIODE) NO.													
			14	13	12	11	10	9	8	7	6	5	4	3	2	1
F 1	143.800MHz	163.800MHz	0	0	1	0	0	1	1	0	0	1	0	1	0	1
F 2	134.800	154.800	0	0	1	0	0	1	0	0	0	0	0	1	0	1
F 3	139.800	159.800	0	0	1	0	0	1	0	1	0	1	0	1	0	1
F 4	139.300	159.300	0	0	1	0	0	1	0	1	0	1	0	0	0	0
F 5	140.2875	160.2875	1	1	0	0	0	1	0	1	0	1	1	0	0	1
F 6	144.2875	164.2875	1	1	0	0	0	1	1	0	0	1	1	0	0	1
F 7	143.300	163.300	0	0	1	0	0	1	1	0	0	1	0	0	0	0
F 8	134.300	154.300	0	0	1	0	0	1	0	0	0	0	0	0	0	0

CH	BAND B	BAND D	COLUMN POSITION (DIODE) NO.														
	144–153.995MHz	164–173.995MHz	14	13	12	11	10	9	8	7	6	5	4	3	2	1	T
F 1	153.500MHz	173.500MHz	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1
F 2	144.500	164.500	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
F 3	149.500	169.500	0	0	0	0	0	0	0	1	0	1	0	1	0	1	1
F 4	149.000	169.000	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1
F 5	149.995	169.995	1	1	0	0	1	0	0	1	0	1	1	0	0	1	1
F 6	153.995	173.995	1	1	0	0	1	0	1	0	0	1	1	0	0	1	1
F 7	153.000	173.000	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1
F 8	144.000	164.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

CH	BAND B*	BAND D*	COLUMN POSITION (DIODE) NO.													
			14	13	12	11	10	9	8	7	6	5	4	3	2	1
F 1	153.800MHz	173.800MHz	0	0	1	0	0	0	1	0	0	1	0	1	0	1
F 2	144.800	164.800	0	0	1	0	0	0	0	0	0	0	0	1	0	1
F 3	149.800	169.800	0	0	1	0	0	0	0	1	0	1	0	1	0	1
F 4	149.300	169.300	0	0	1	0	0	0	0	1	0	1	0	0	0	0
F 5	150.2875	170.2875	1	1	0	0	0	0	0	1	0	1	1	0	0	1
F 6	154.2875	174.2875	1	1	0	0	0	0	1	0	0	1	1	0	0	1
F 7	153.300	173.300	0	0	1	0	0	0	1	0	0	1	0	0	0	0
F 8	144.300	164.300	0	0	1	0	0	0	0	0	0	0	0	0	0	0

CH	BAND E	COLUMN POSITION (DIODE) NO.														
	150–159.995MHz	14	13	12	11	10	9	8	7	6	5	4	3	2	1	T
F 1	159.500MHz	0	0	0	0	0	1	0	1	1	1	0	1	0	1	1
F 2	150.500	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1
F 3	155.500	0	0	0	0	0	1	0	0	1	1	0	1	0	1	1
F 4	155.000	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1
F 5	155.995	1	1	0	0	1	1	0	0	1	1	1	0	0	1	1
F 6	159.995	1	1	0	0	1	1	0	1	1	1	1	0	0	1	1
F 7	159.000	0	0	0	0	0	1	0	1	1	1	0	0	0	0	1
F 8	150.000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1

CH	BAND E*	COLUMN POSITION (DIODE) NO.													
		14	13	12	11	10	9	8	7	6	5	4	3	2	1
F 1	159.800MHz	0	0	1	0	0	1	0	1	1	1	0	1	0	1
F 2	150.800	0	0	1	0	0	0	1	0	0	0	0	1	0	1
F 3	155.800	0	0	1	0	0	1	0	0	1	1	0	1	0	1
F 4	155.300	0	0	1	0	0	1	0	0	1	1	0	0	0	0
F 5	156.2875	1	1	0	0	0	1	0	0	1	1	1	0	0	1
F 6	160.2875	1	1	0	0	0	1	0	1	1	1	1	0	0	1
F 7	159.300	0	0	1	0	0	1	0	1	1	1	0	0	0	0
F 8	150.300	0	0	1	0	0	0	1	0	0	0	0	0	0	0

* 12.5 kHz/step model

1. PLL CIRCUIT

Alignment frequencies (F1 through F8) are shown in the Chart on Page 3-16. Use an Alignment Matrix programmed for these frequencies when performing alignment. Alignment points are illustrated on Page 3-18.

A. PLL VCV (Varactor Control Voltage)

1) Connect the DC voltmeter to the high end of R_{310}.
2) Set the Channel Selector to F1 and adjust T_{301} for 4V on the meter.
3) Set the Channel Selector to F2 and adjust VR_{301} for 4V on the meter, and then check the DC voltage across C_{347} for at least 2V.
4) Reconnect the meter to R_{310} and set the Channel Selector to each of positions F3 through F8 while checking to see that the voltage at R_{310} remains between 2 and 6V.

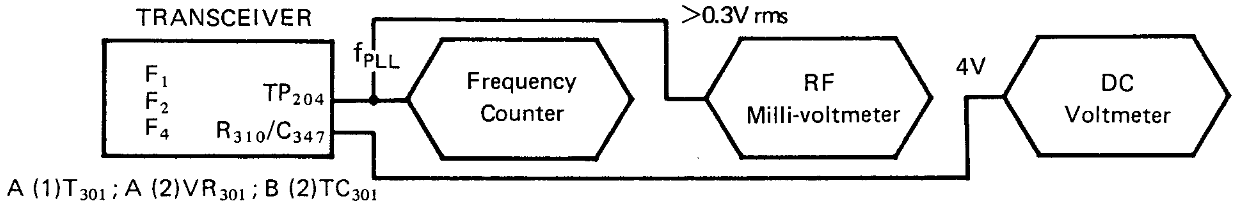
B. PLL Frequency

1) Connect the frequency counter to TP_{204} and set the Channel Selector to F4.
2) Adjust TC_{301} for a frequency of $*f_{PLL}$ ±50 Hz.

$*f_{PLL}$ ——	BAND (A)	117.6 MHz
	BAND (B)	127.6 MHz
	BAND (C)	137.6 MHz
	BAND (D)	147.6 MHz
	BAND (E)	133.6 MHz

C. PLL Level

1) Connect the RF probe of the voltmeter to TP_{204}.
2) With the Channel Selector set to F1, F2 and F3 check that more than 0.3V (+2.5 dBm) is shown on the meter.

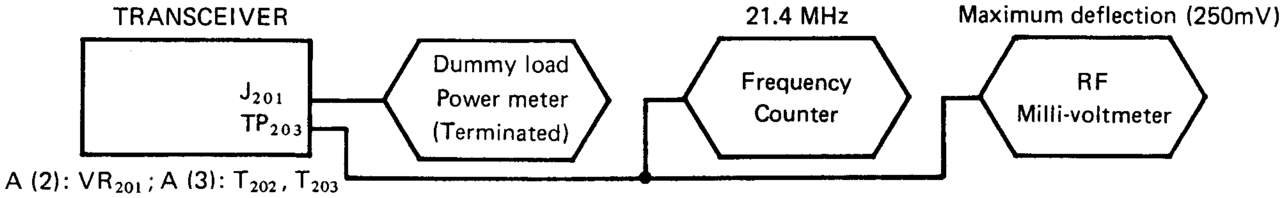


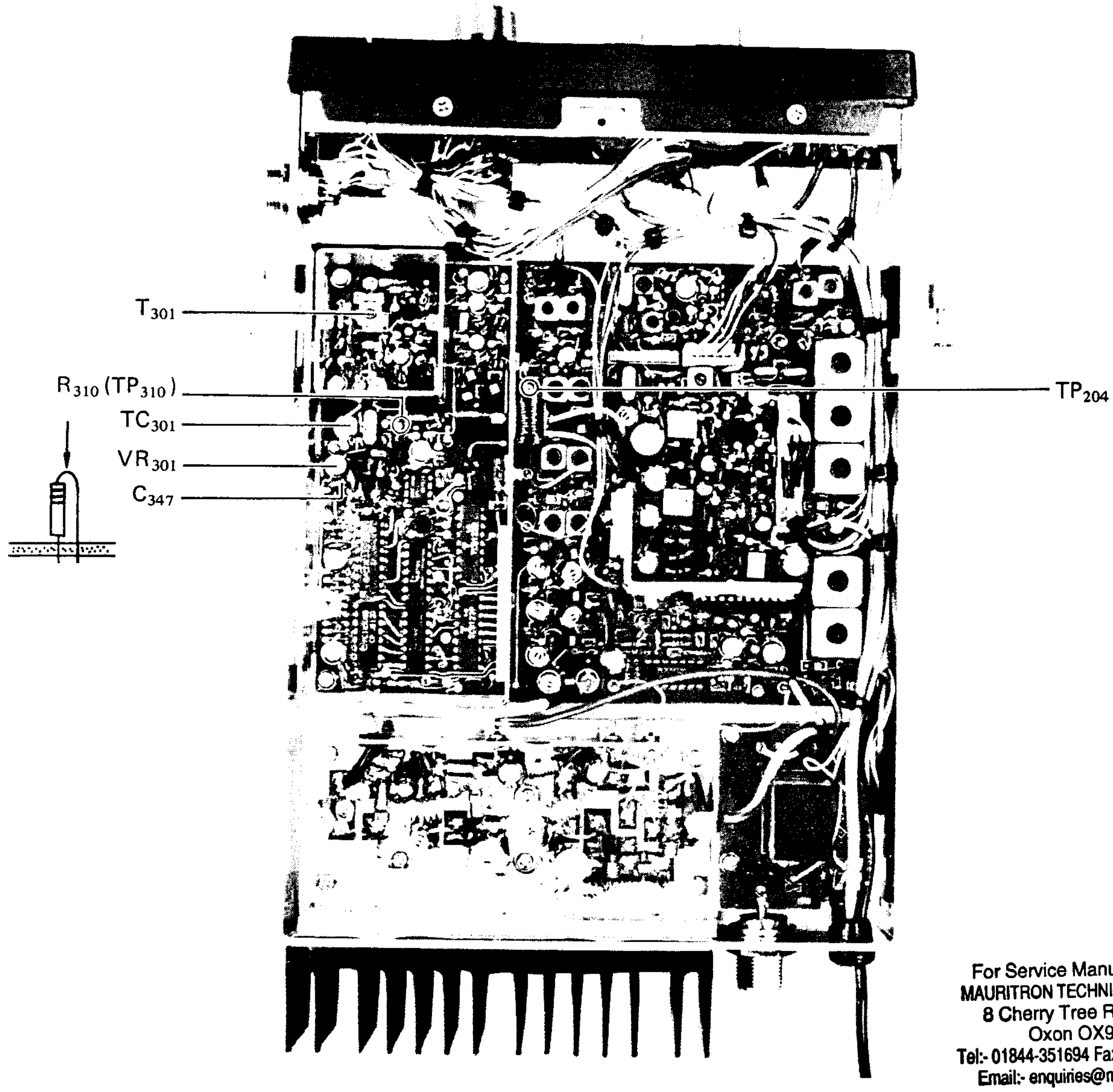
2. TRANSMITTER CIRCUITS

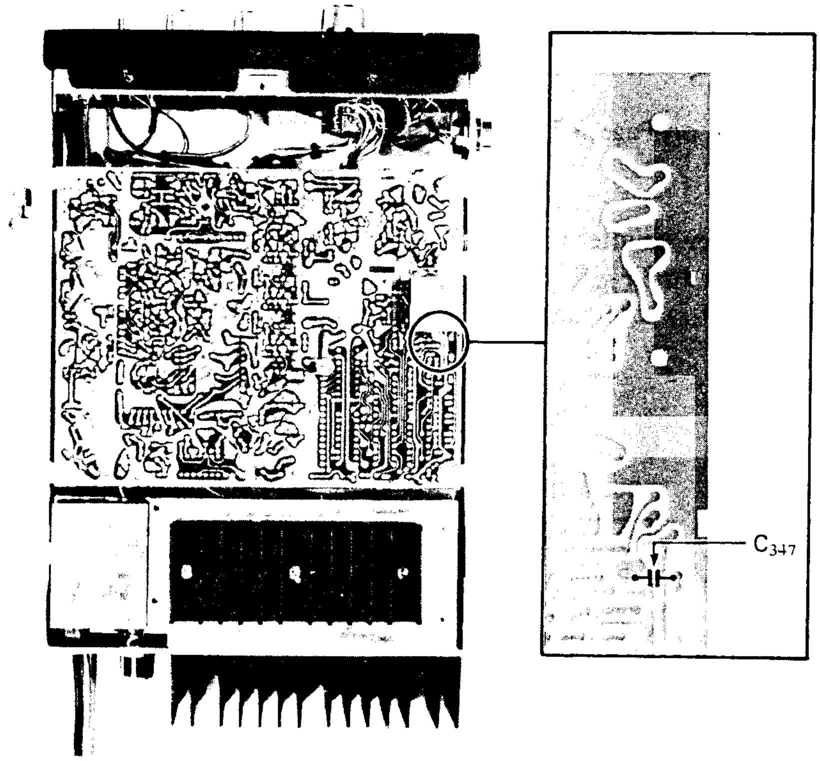
Alignment points are illustrated on Page 3-20.

A. 21.4 MHz Oscillator

1) Connect both the frequency counter and the RF probe of the voltmeter to TP_{203}, and the 50 ohm dummy load to J_{201} after removing plug P_{401}.
2) Adjust VR_{201} for a frequency of 21.4 MHz ±10 Hz on the counter. (If the signal level at TP_{203} is insufficient, perform the following step first.)
3) Adjust T_{202} and T_{203} for a maximum reading on the voltmeter (approx. 250 mV).



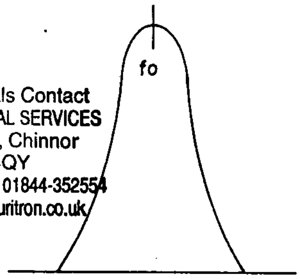


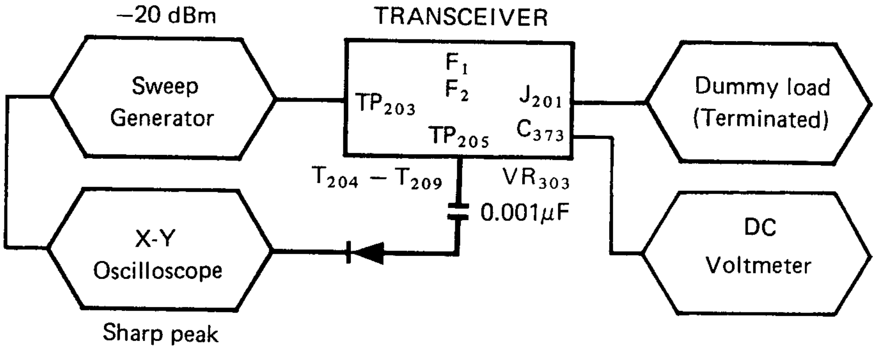


PLL SECTION ALIGNMENT POINTS

B. Auto Tune

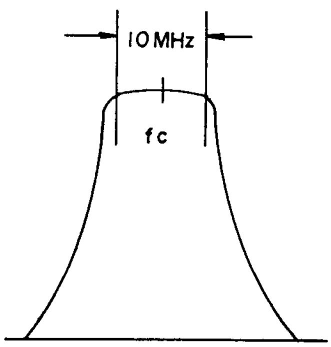
1) Connect the Sweep Generator to TP_{203}, the oscilloscope through a detector to TP_{205}, and the 50 ohm dummy load to J_{201} (P_{401} removed).
2) Short across the terminals of R_{389} and L_{206} to unlock the VCO, in order to provide a clear scope pattern during the following steps.
3) Set the Channel Selector to F1 and depress the PTT switch.
4) Adjust T_{204} through T_{209} to obtain a sharp peak on the pattern shown at the right at $f_O (= f_{max} - 0.5$ MHz).
5) Switch the Channel Selector to F2 and adjust VR_{303} for the peak at $f_O (= f_{min} + 0.5$ MHz).
6) Check that the voltage across C_{373} is more than 2V.

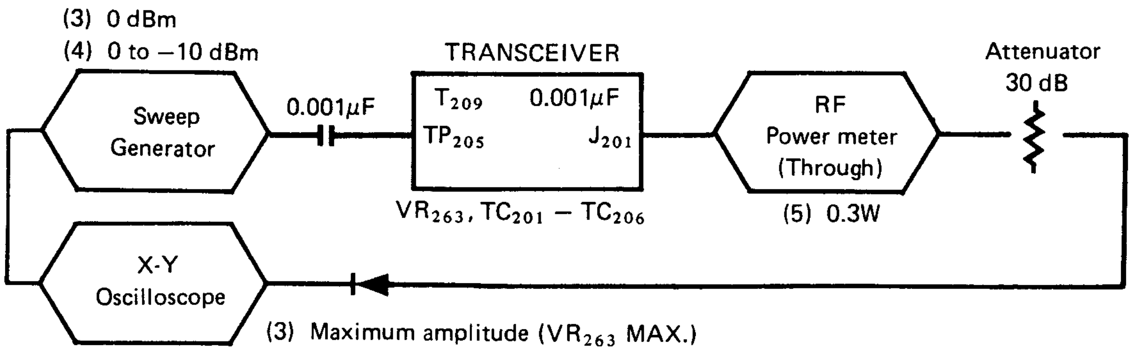


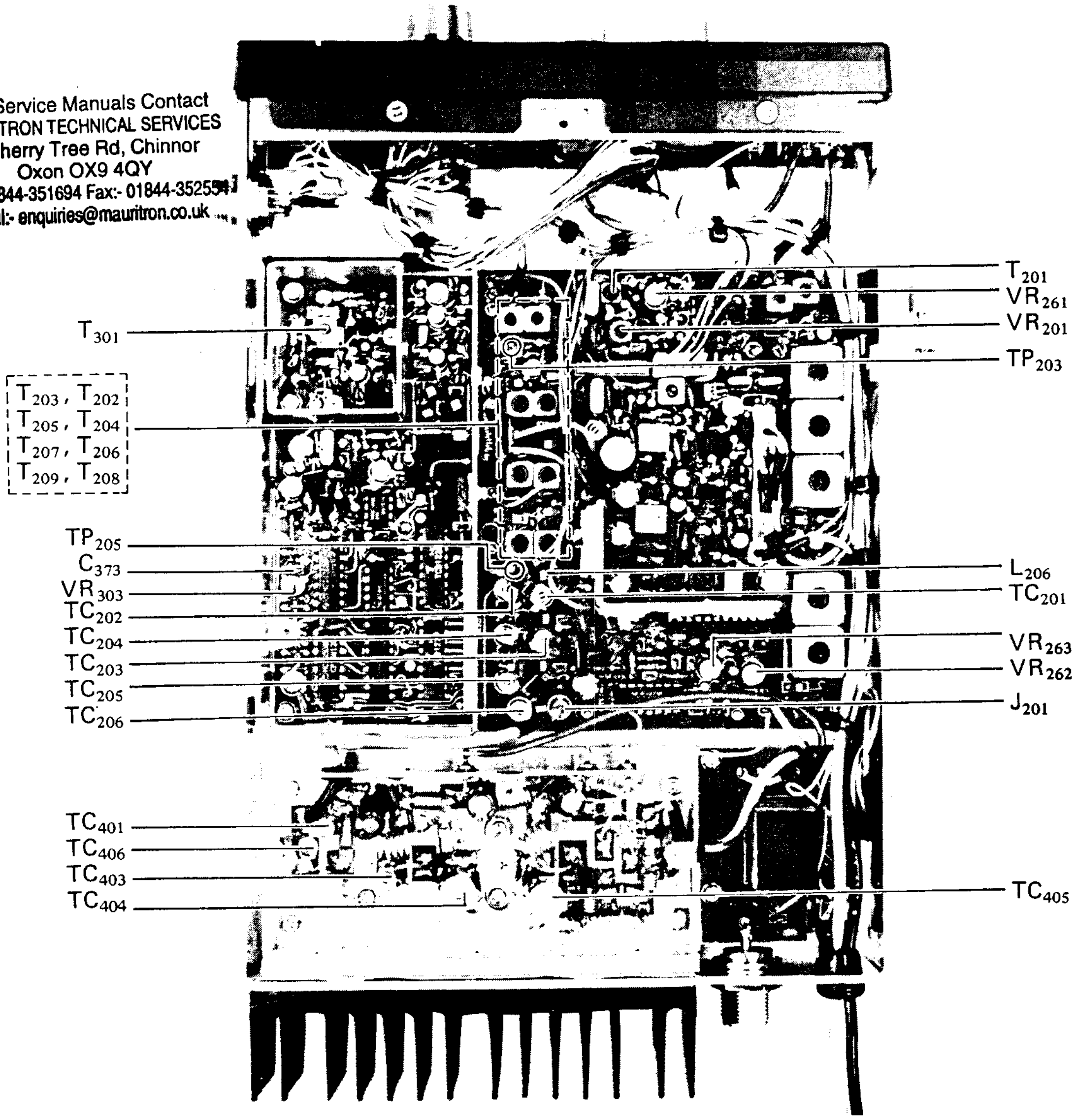


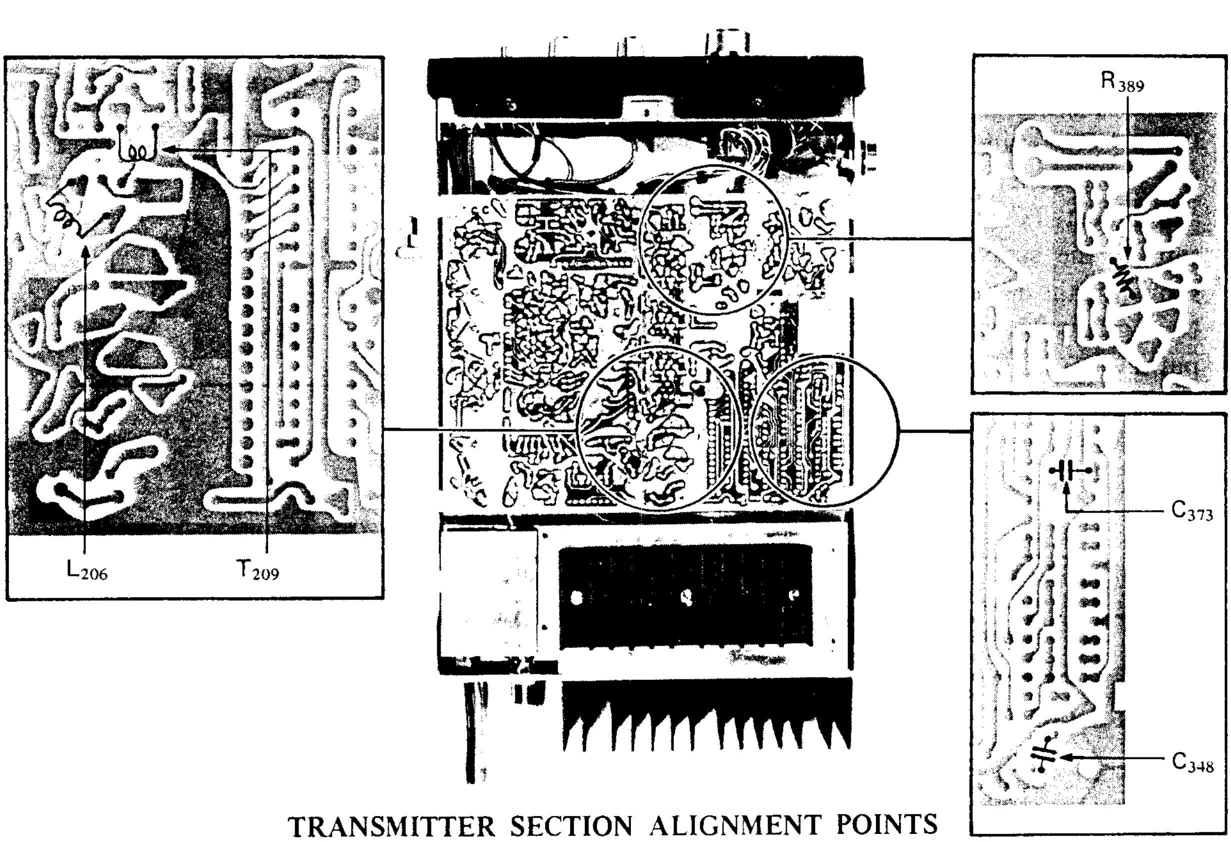
C. Exciter

1) Connect the sweep generator through a 1000pF capacitor to TP_{205}, and the in-line wattmeter (1 or 5 watts) to J_{201}, and to a 30 dB attenuator to a detector and the oscilloscope.
2) Connect a 1000pF capacitor across the terminals of T_{209}.
3) Preset VR_{263} fully clockwise (maximum), set the sweep generator output level to 0 dBm, and adjust TC_{201} through TC_{206} for a flat top on the scope pattern at $f_C \pm 5$ MHz as shown in the Figure.
4) Now gradually vary the sweep generator output level from 0 to −10 dBm while watching the waveform to check that the amplitude varies smoothly.
5) Disconnect the sweep generator and the 1000pF capacitors, and check that the wattmeter shows at least 0.3 watts in all channels (F1 through F8).





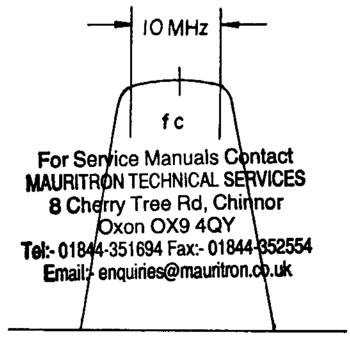


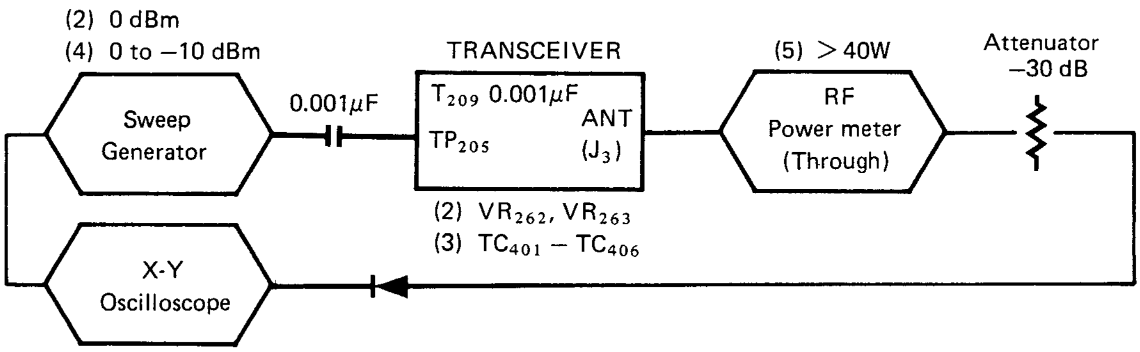


TRANSMITTER SECTION ALIGNMENT POINTS

D. Power Amplifier

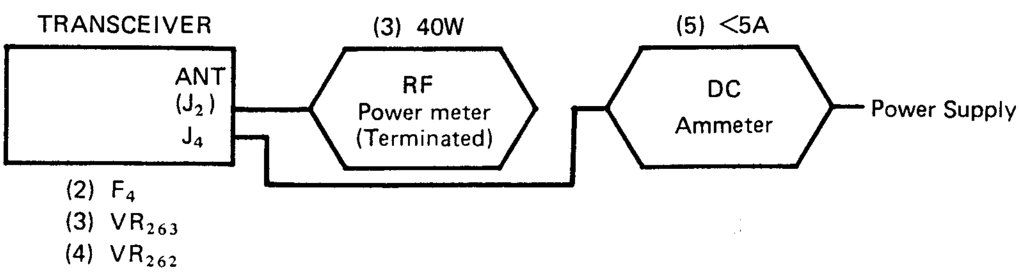
1) Connect the in-line wattmeter (50 watts) to the ANT terminal and to the 30 dB attenuator to the diode detector to the oscilloscope. Connect the sweep generator through a 1000pF capacitor to TP_{205} and another 1000pF capacitor across T_{209} as in the previous Exciter alignment.
2) Preset VR_{262} fully counter-clockwise, VR_{263} fully clockwise and the sweep generator output level to 0 dBm.
3) Adjust TC_{401} through TC_{406} to obtain at least 40 watts output through the 10 MHz range of the transceiver ($f_C \pm$ 5 MHz) with a smooth, symmetrical curve peaking at f_C, as illustrated. DO NOT PEAK power output at one frequency, since the trimmer capacitors in the final amplifier may be destroyed.
4) Vary the supply voltage between 10 and 16.5V while also varying the sweep generator output level between 0 and −10 dBm. Ensure that the power output changes smoothly during these variations.
5) Remove the sweep generator and the 1000pF capacitors and check that the output is at least 40 watts in all channels (F1 through F8).





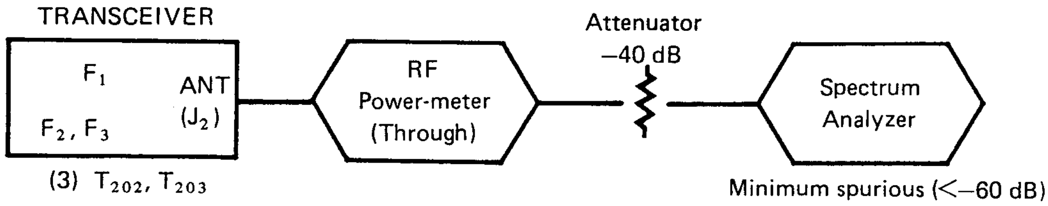
E. APC (Automatic Power Control) and AFP (Automatic Final Protection)

1) Connect the dummy load and wattmeter (50 watts) to the ANT terminal and the DC ammeter in the DC supply line.
2) Set the Channel Selector to F4 (the center of the band).
3) Adjust VR_{263} for 40 watts on the wattmeter, and check channels F1 and F2 for 40 watts ±3 watts.
4) Rotate VR_{262} clockwise just to the point where output power begins to decrease, and then rotate it back 30 degrees counter-clockwise from this point. If output power does not decrease at any point, set VR_{262} fully clockwise.
5) Remove the dummy load and briefly depress the PTT switch. Check that the total DC current is less than 5A.



F. Spurious Check with Supply Voltage Variation

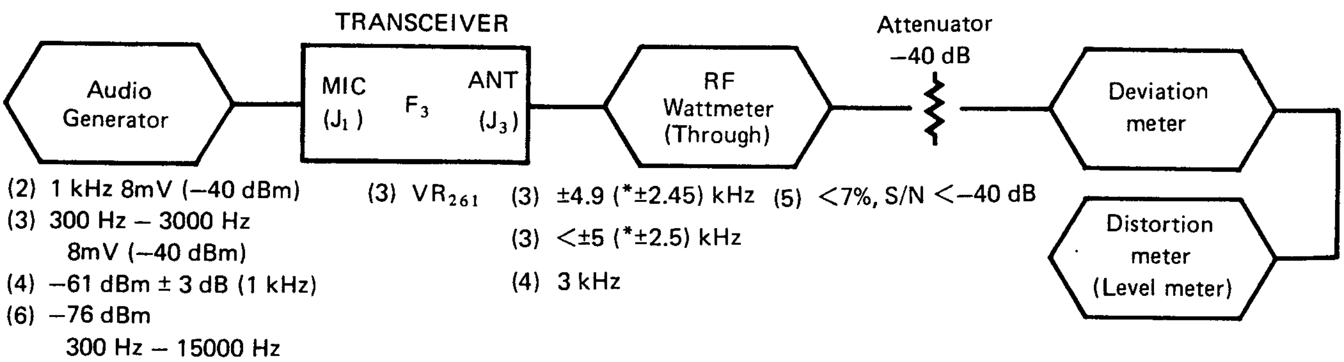
1) Connect the in-line wattmeter (50 watts) to the spectrum analyzer (through an attenuator) and to the ANT terminal. Connect the DC voltmeter so as to measure the supply voltage.
2) First in channel F1, vary the supply voltage over the range of 13.6V ± 15% while ensuring that spurious radiation is below −60 dB from the output power level.
3) Repeat the previous step for channels F2 and F3, and adjust T_{202} and T_{203} if spurious radiation exceeds −60 dB.



G. Modulation and Deviation

1) Connect the audio generator and level meter to pin 6 of MIC jack J_1, and the in-line wattmeter with 40 dB power attenuator to the ANT terminal. Connect the deviation meter and distortion meter with level meter to the attenuator output.
2) Set the Channel Selector to F3 and the audio generator output level to −40 dBm at 1 kHz.
3) Adjust VR_{261}, if necessary, to obtain ±4.9 kHz (*±2.45 kHz) deviation on the meter, and then check that the deviation remains under ±5 kHz (*±2.5 kHz) while varying the audio generator output from 300 to 3000 Hz.
4) Reduce the audio generator input level so that the deviation meter indicates 3(*1.5) kHz deviation (1 kHz audio frequency), and check that the audio input level is −61 dBm ±3 dB.
5) Check that the THD is less than 7% and the S/N less than −40 dB.
6) Now reduce the audio generator output level 15 dB from −61 dBm (−76 dBm). While tuning the audio frequency from 300 to 15000 Hz observe that the deviation remains constant as the level meter shows the following values:

0.3 kHz	$-10.5\ \text{dB}\ ^{+1}_{-3}\ \text{dB}$
1 kHz	0 dB
3 kHz	$+9.5\ \text{dB}\ ^{+1}_{-4.5}\ \text{dB}$
15 kHz	−25 dB or less



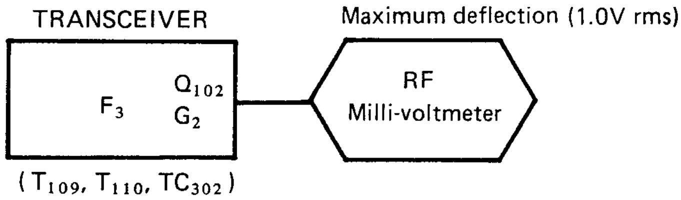
* 12.5 kHz/step model

3. RECEIVER CIRCUITS

Alignment points are illustrated on Page 3-24.

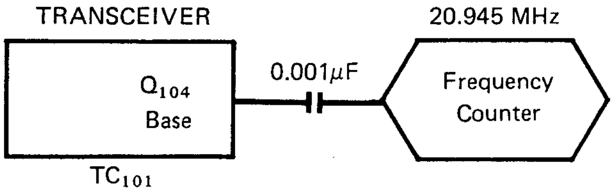
A. First Local PLL

1) Connect the RF probe of the voltmeter to gate two of Q_{102}. Set the Channel Selector to F3.
2) Adjust T_{109}, T_{110} and TC_{302} located in the PLL shield case for a maximum deflection on the voltmeter (about 1.0Vrms).
3) Check that the signal level at gate two of Q_{102} is at least 1 volt in channel positions F1, F2 and F3.



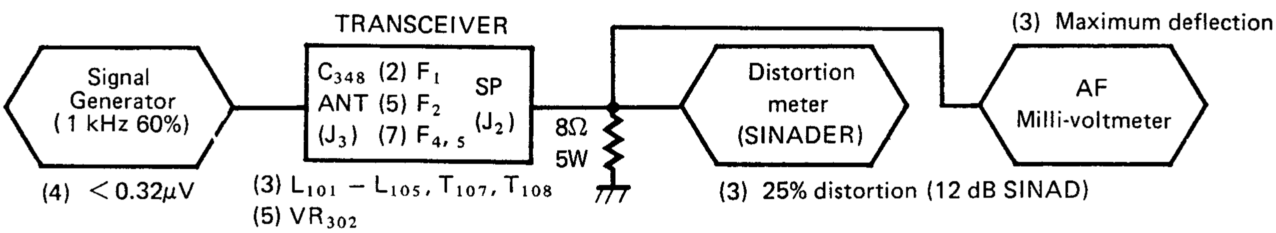
B. Second Local

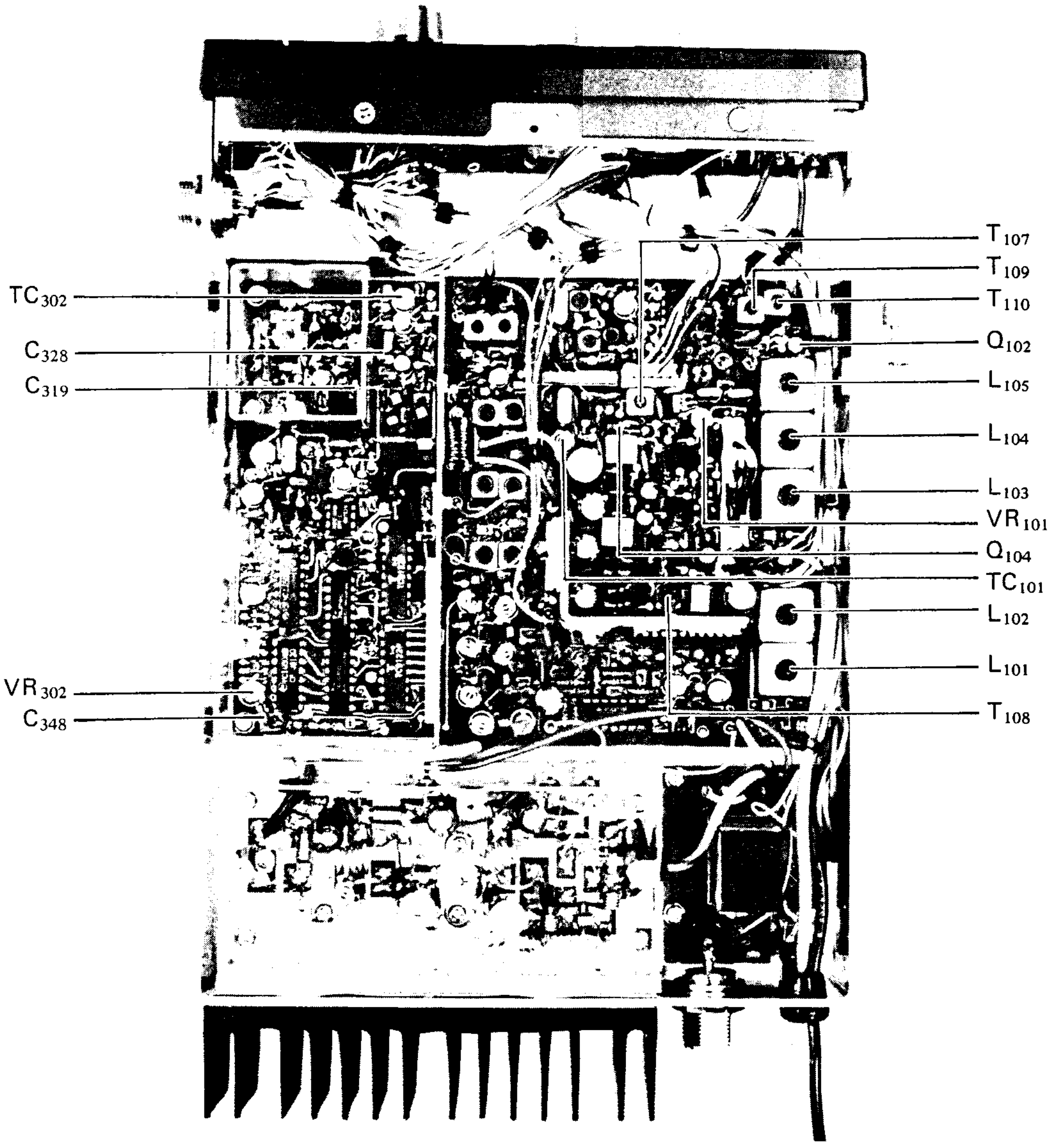
1) Connect the frequency counter through a 1000pF capacitor to the base of Q_{104} (2SC535B).
2) Adjust TC_{101} if necessary to achieve a reading of 20.945 MHz ±20 Hz on the counter.

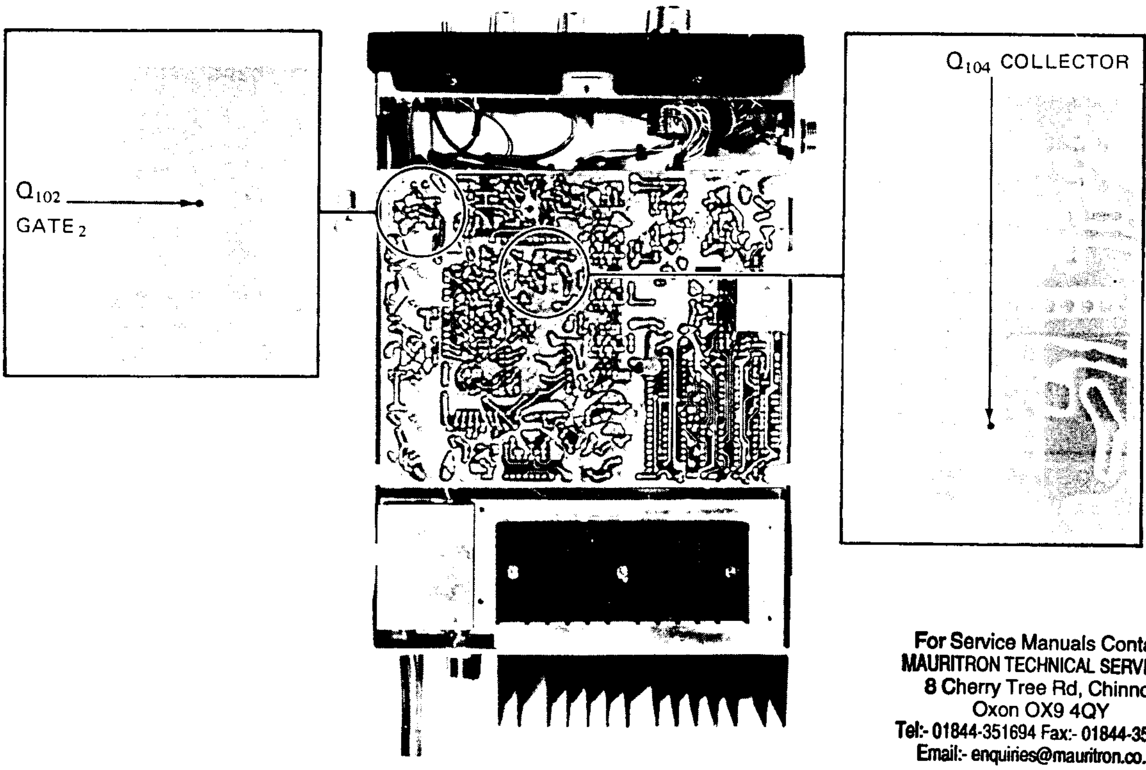


C. Sensitivity

1) Connect the SSG (standard signal generator) to the ANT terminal, and an 8 ohm, 5 watt resistor across EXT SP jack J_2. Connect the distortion meter and level meter to the EXT SP jack.
2) Set the Channel Selector to F1, and tune the SSG to the F1 receive frequency with 60% modulation at 1 kHz.
3) Adjust the SSG output level to obtain a 12 to 15 dB reading on the distortion meter, and then adjust L_{101} through L_{105} and T_{107} for minimum distortion on the meter. Now adjust T_{108} for maximum indication on the level meter.
4) Again adjust the SSG output level to obtain 12 dB of distortion, and check that the SSG level is less than 0.32 μV (−4 dBμ).
5) Set the Channel Selector to F2 and repeat the SSG set up procedure in steps 2 and 3, adjusting VR_{302} on the PLL unit for minimum distortion on the meter.
6) Check that the voltage across C_{348} on the PLL unit is less than 2V.
7) Set the Channel Selector to F4 (band center +0.5 MHz) and check sensitivity, then repeat the check for F5 (band center −0.5 MHz).

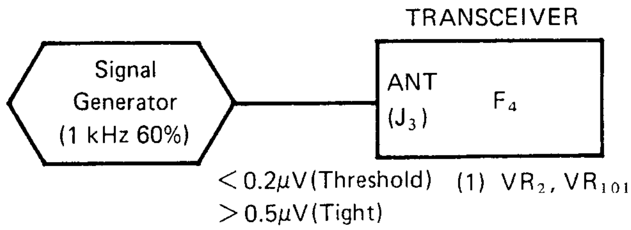



TC_{302}
C_{328}
C_{319}
VR_{302}
C_{348}
T_{107}
T_{109}
T_{110}
Q_{102}
L_{105}
L_{104}
L_{103}
VR_{101}
Q_{104}
TC_{101}
L_{102}
L_{101}
T_{108}


Q_{102}
$GATE_2$
Q_{104} COLLECTOR

D. Squelch

1) Connect the SSG to the ANT terminal with its output OFF. Preset SQ VR_2 to the 9 o'clock position and adjust VR_{101} just to the threshold point where the BUSY lamp switches OFF.
2) Set the Channel Selector to F4, and the SSG output frequency to the F4 receive frequency. Now gradually increase the SSG output level. The squelch threshold should occur at 0.2 μV, and be tight at 0.5 μV.

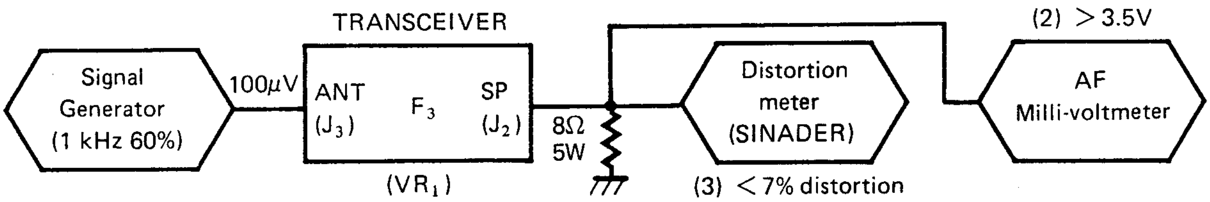


E. Audio Output Distortion and S/N

1) Connect the test equipment as in section C (Sensitivity).
2) Check that the audio output power is at least 1.5W (3.5V).
3) Check that the audio output distortion is less than 7% at 1.5 watts.
4) Check that the audio frequency response conforms to the following:

300 Hz	+10.5 dB $^{+2}_{-8}$ dB
1 kHz	0 dB
3 kHz	−9.5 dB $^{+2}_{-8}$ dB

5) Check that the signal-to-noise ratio is better than 40 dB.

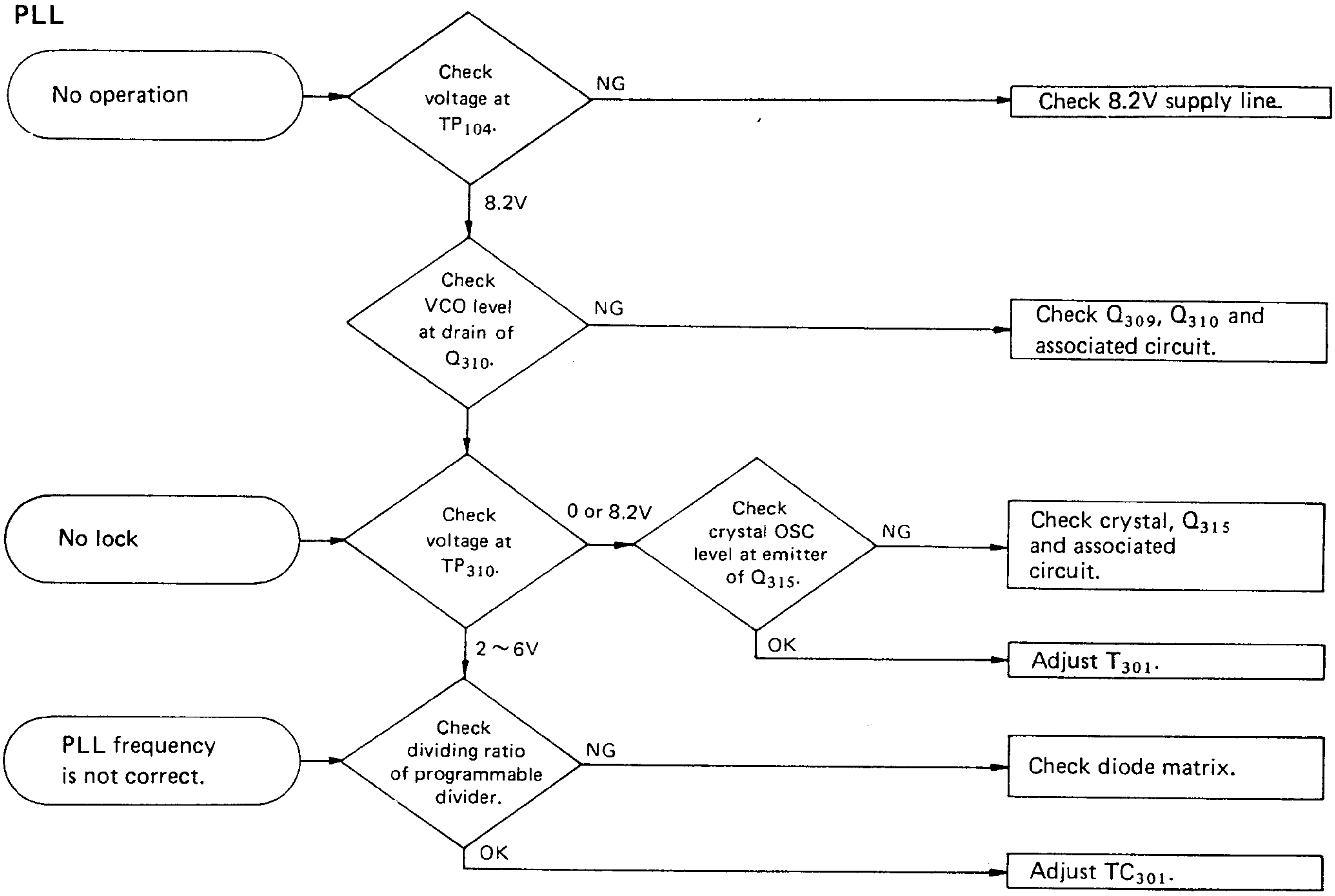


F. Spurious Response

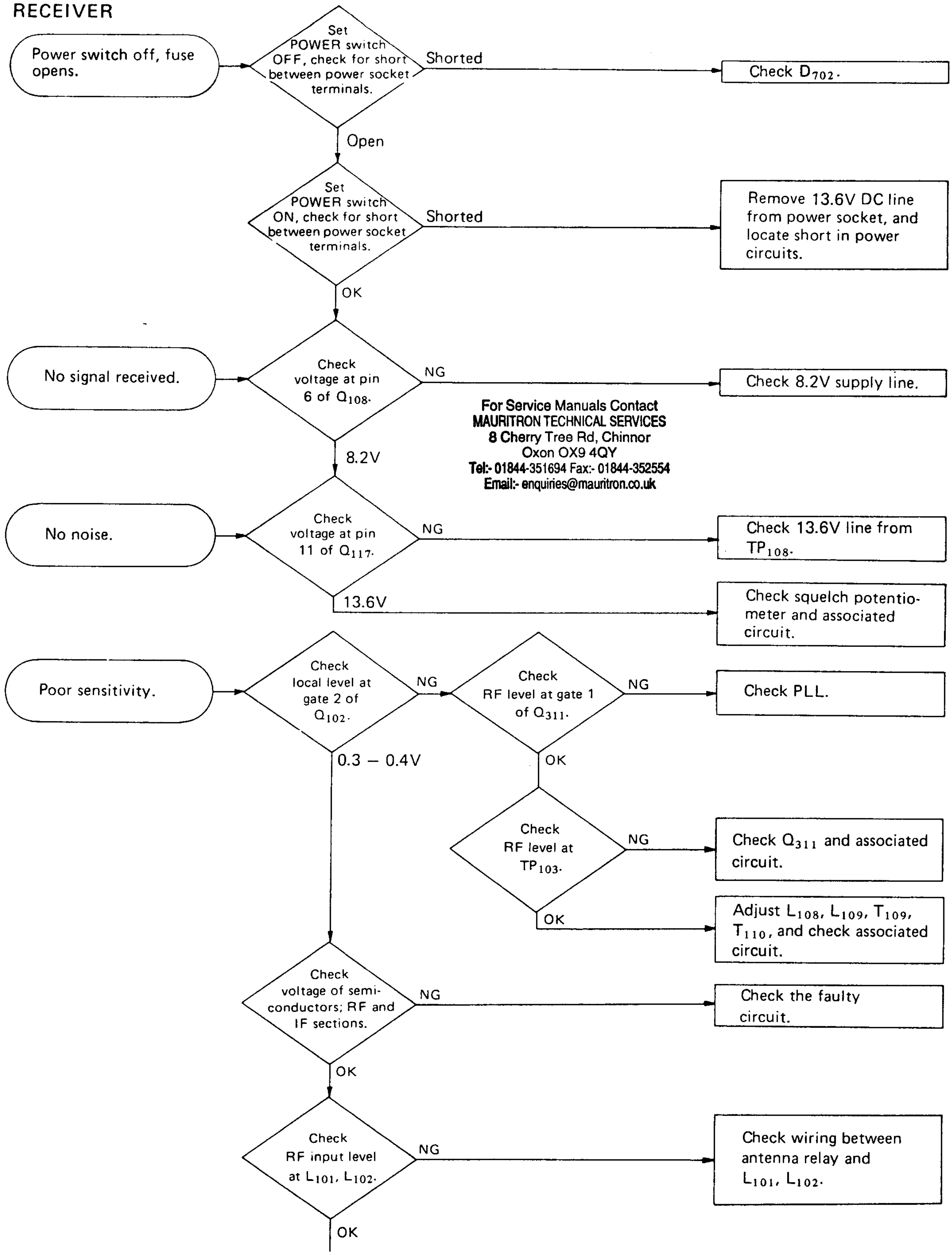
1) Connect the test equipment as in section C and E.
2) Check that spurious response is less than 80 dB for all channels.

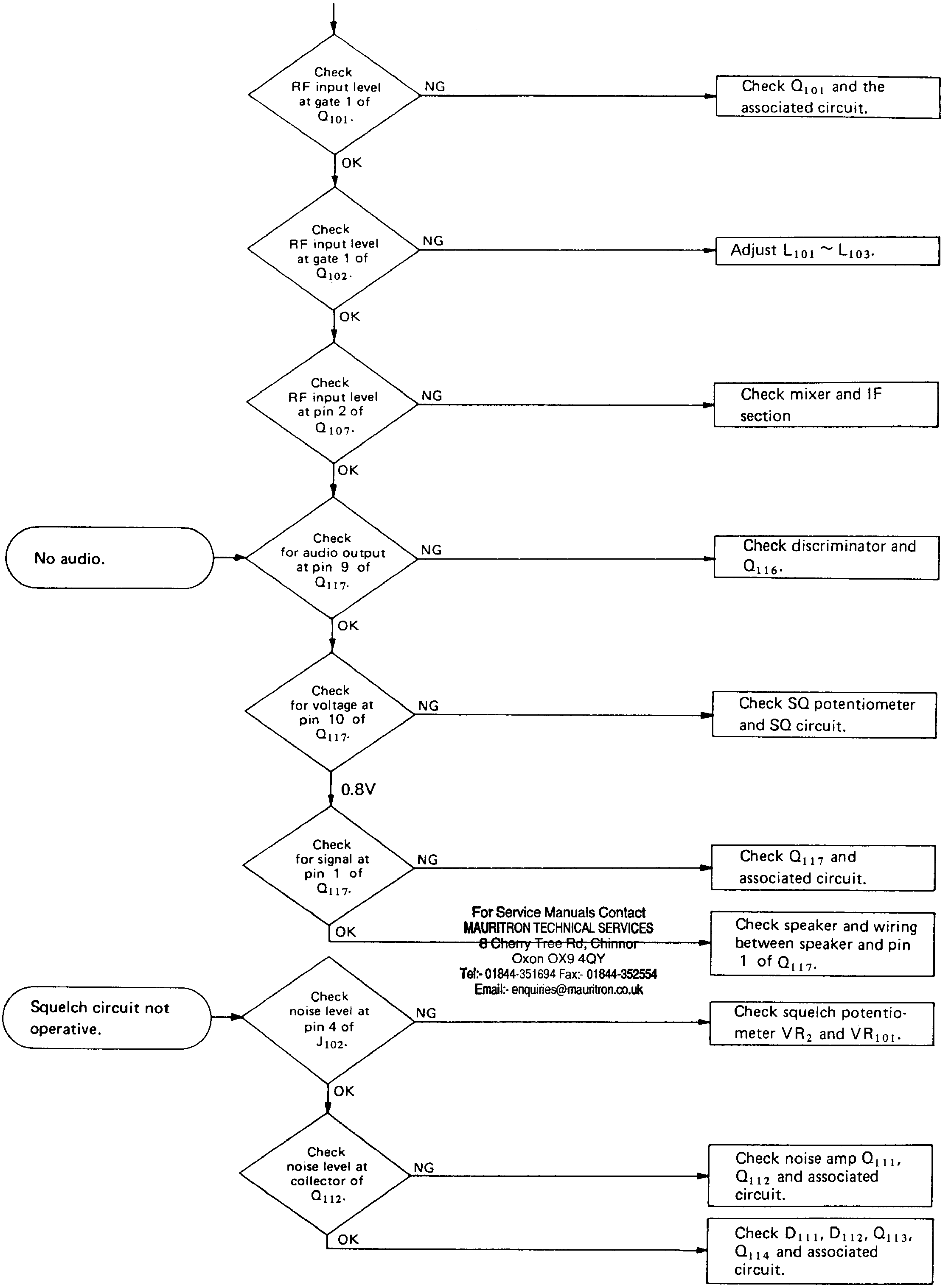
TROUBLESHOOTING

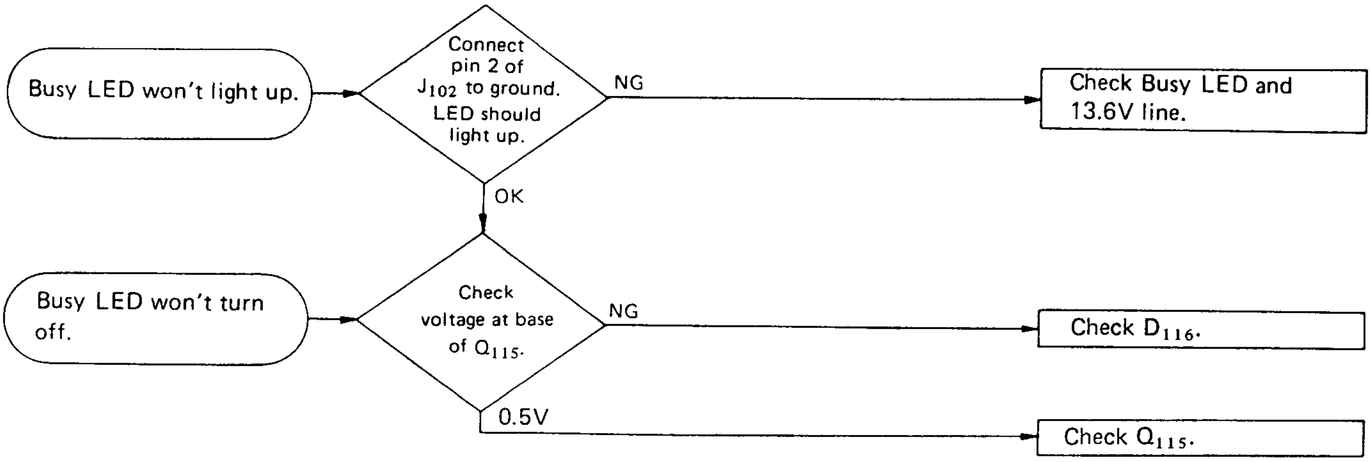
PLL



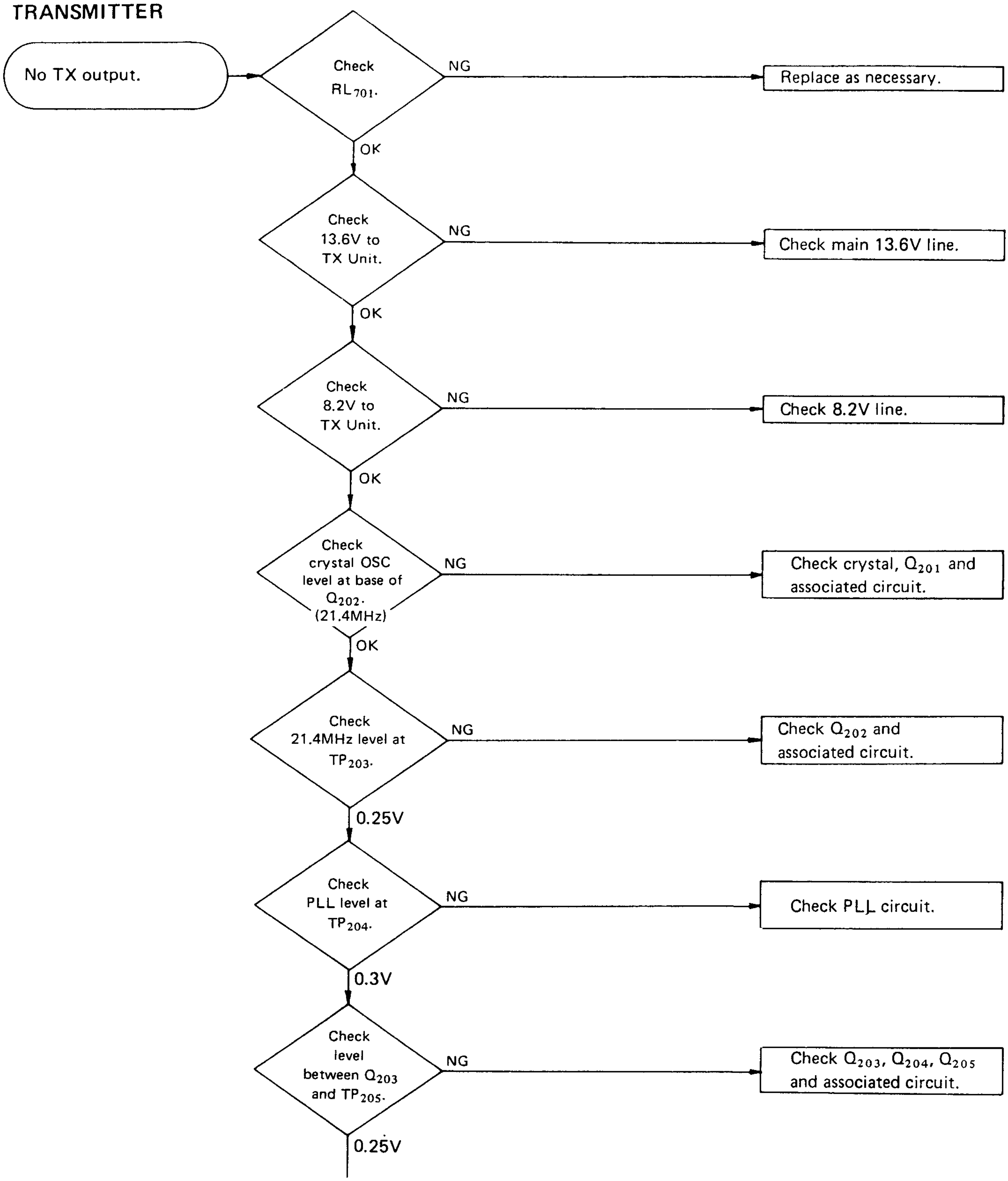
RECEIVER

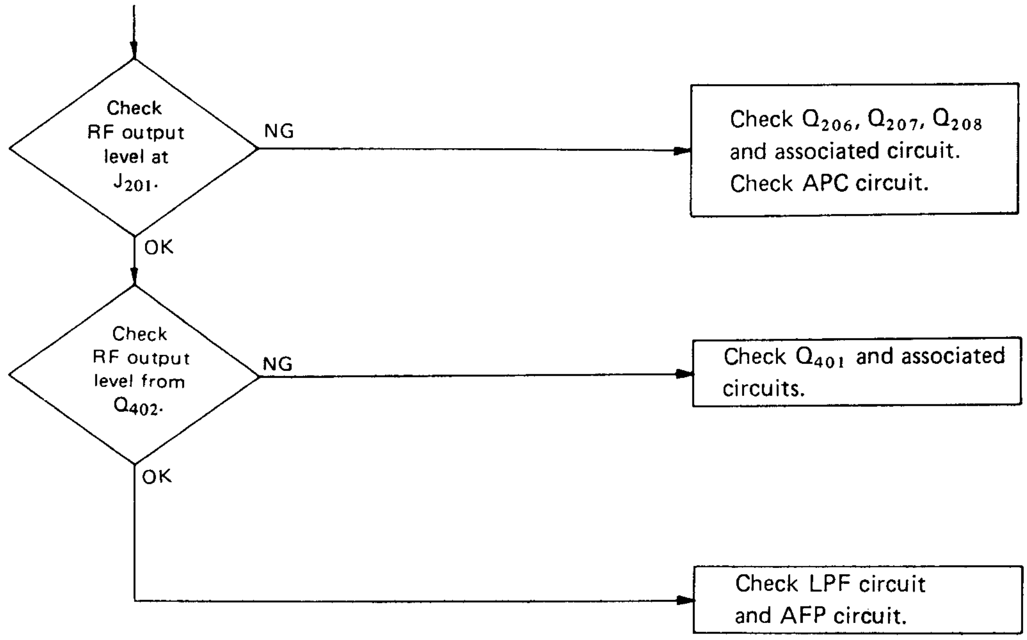

Power switch off, fuse opens.
Set POWER switch OFF, check for short between power socket terminals.
Shorted
Check D_{702}.
Open
Set POWER switch ON, check for short between power socket terminals.
Shorted
Remove 13.6V DC line from power socket, and locate short in power circuits.
OK
No signal received.
Check voltage at pin 6 of Q_{108}.
NG
Check 8.2V supply line.
8.2V
No noise.
Check voltage at pin 11 of Q_{117}.
NG
Check 13.6V line from TP_{108}.
13.6V
Check squelch potentiometer and associated circuit.
Poor sensitivity.
Check local level at gate 2 of Q_{102}.
NG
Check RF level at gate 1 of Q_{311}.
NG
Check PLL.
0.3 – 0.4V
OK
Check RF level at TP_{103}.
NG
Check Q_{311} and associated circuit.
OK
Adjust L_{108}, L_{109}, T_{109}, T_{110}, and check associated circuit.
Check voltage of semiconductors; RF and IF sections.
NG
Check the faulty circuit.
OK
Check RF input level at L_{101}, L_{102}.
NG
Check wiring between antenna relay and L_{101}, L_{102}.
OK

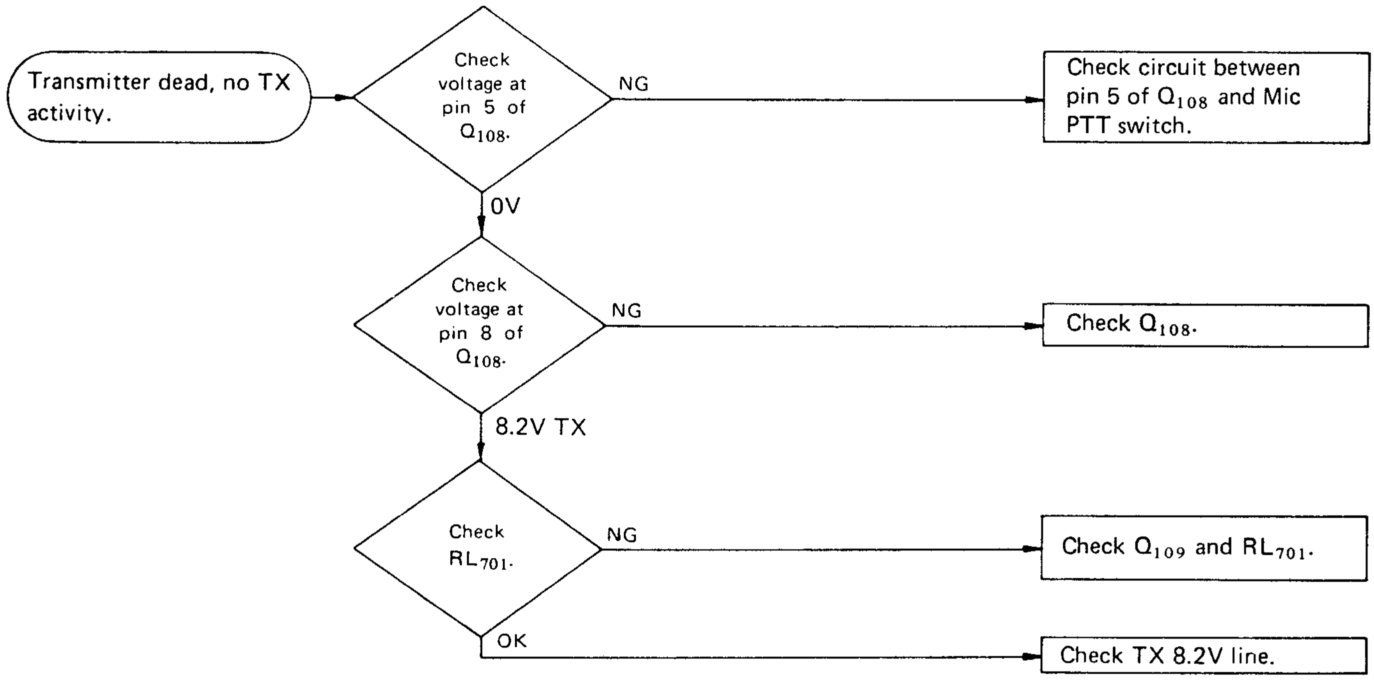

Check RF input level at gate 1 of Q_{101}.
NG
Check Q_{101} and the associated circuit.
OK
Check RF input level at gate 1 of Q_{102}.
NG
Adjust $L_{101} \sim L_{103}$.
OK
Check RF input level at pin 2 of Q_{107}.
NG
Check mixer and IF section
OK
No audio.
Check for audio output at pin 9 of Q_{117}.
NG
Check discriminator and Q_{116}.
OK
Check for voltage at pin 10 of Q_{117}.
NG
Check SQ potentiometer and SQ circuit.
0.8V
Check for signal at pin 1 of Q_{117}.
NG
Check Q_{117} and associated circuit.
OK
Check speaker and wiring between speaker and pin 1 of Q_{117}.
Squelch circuit not operative.
Check noise level at pin 4 of J_{102}.
NG
Check squelch potentiometer VR_2 and VR_{101}.
OK
Check noise level at collector of Q_{112}.
NG
Check noise amp Q_{111}, Q_{112} and associated circuit.
OK
Check D_{111}, D_{112}, Q_{113}, Q_{114} and associated circuit.

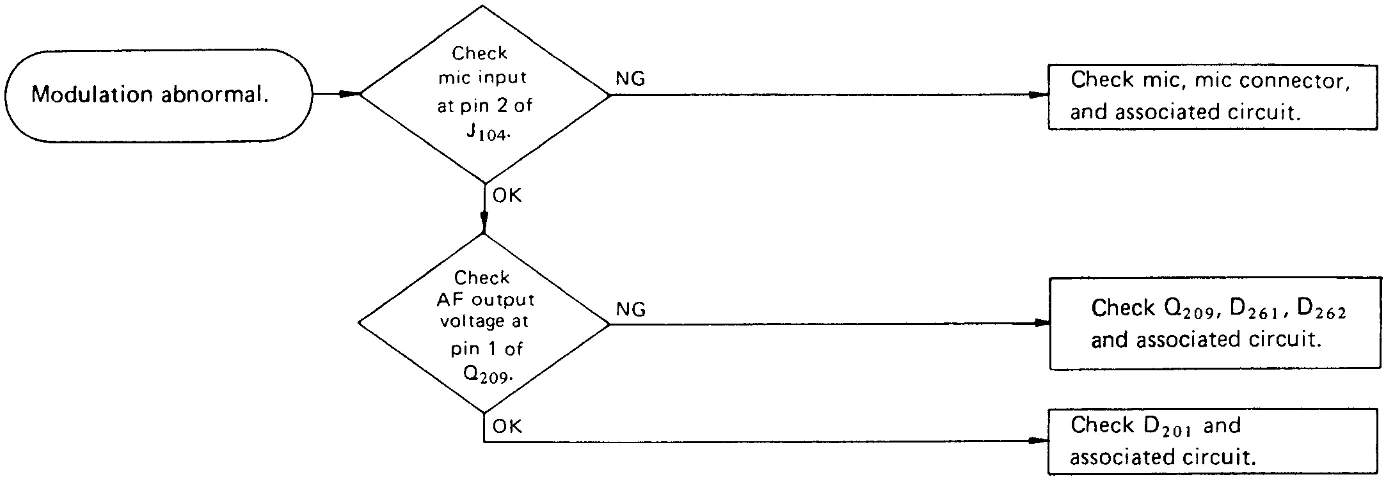

Busy LED won't light up.
Connect pin 2 of J_{102} to ground. LED should light up.
NG
Check Busy LED and 13.6V line.
OK
Busy LED won't turn off.
Check voltage at base of Q_{115}.
NG
Check D_{116}.
0.5V
Check Q_{115}.

TRANSMITTER




Check RF output level at J_{201}.
NG
Check Q_{206}, Q_{207}, Q_{208} and associated circuit. Check APC circuit.
OK
Check RF output level from Q_{402}.
NG
Check Q_{401} and associated circuits.
OK
Check LPF circuit and AFP circuit.


Transmitter dead, no TX activity.
Check voltage at pin 5 of Q_{108}.
NG
Check circuit between pin 5 of Q_{108} and Mic PTT switch.
0V
Check voltage at pin 8 of Q_{108}.
NG
Check Q_{108}.
8.2V TX
Check RL_{701}.
NG
Check Q_{109} and RL_{701}.
OK
Check TX 8.2V line.


Modulation abnormal.
Check mic input at pin 2 of J_{104}.
NG
Check mic, mic connector, and associated circuit.
OK
Check AF output voltage at pin 1 of Q_{209}.
NG
Check Q_{209}, D_{261}, D_{262} and associated circuit.
OK
Check D_{201} and associated circuit.

PARTS LIST

MAIN CHASSIS

Symbol No.	Part No.	Description
		POTENTIOMETER
VR1, 2	J60800087	K1611008TE10KB 10KΩ
		CAPACITOR
C1	K10179015	Ceramic 0.01μF (CK45B1H103MYS)
		SWITCH
S1	N3090020	SLP622014
	S5000056	(Switch Lever)
S2	N2090019	8M3011
	S6000002	8Z0034 (Switch Lever)
S3	N0190098	SRN3038
		RECEPTACLE
J1	P0090262	FM214(2)-6S
J3	P1090194	FM-MR-M2'
J2	P1090005	SG8050
J4 (with wire)	T9204365A	3191-02R1
		SPEAKER
SP1	M4090049	SM-77KY-2 8Ω
	T9100302	Speaker Connection Cable
P1 (with wire)	T9204364	XHP-05
P2 (")	T9204363	XHP-08
P3 (")	T9204362	XHP-02
P4 (")	T9204361	XHP-06
P5 (")	T9204360	XHP-11
P6 (")	T9204359	XHP-08
		KNOB
	R3075730	FT-24SK (Channel)
	R3075740	FT-15SK (VOL, SQL)

MAIN UNIT

Symbol No.	Part No.	Description
PB-2330D	F0002330D	Printed Circuit Board
	C0023300	P.C.B. with Components
		IC
Q117	G1090218	AN315
Q108	G1090222	MB3756
Q314	G1090312	MC14504B
Q308	G1090347	MC14568B
Q209, 212	G1090220	MLM2902P
Q304	G1090180	HD74LS02P
Q302	G1090196	HD74LS74AP
Q303, 307	G1090247	TC9122P
Q301	G1090292	μPB551C
Q107	G1090072	μPC577H
Q312	G1090299	μPC14305
		TRANSISTOR
Q115, 213, 305 306	G3304580B	2SC458B
Q105, 106, 112–114, 116	G3304600B	2SC460B
Q111	G3304600C	2SC460C
Q103, 104, 110 201, 202, 210 211, 315	G3305350B	2SC535B
Q214	G3208560B	2SB856B 2SA671B
Q109	G3312090D	2SC1209D
Q204–206	G3319060	2SC1906
Q313	G3320260	2SC2026
Q207	G3320530	2SC2053
Q208	G3325380	2SC2538
		FET
Q310, 311, 316 317	G4800510C	3SK51-03
Q203	G4800590	3SK59
Q101, 102	G4800600	3SK60
Q309	G3801680D	2SK168D
		DIODE
D106, 107, 111–117 202, 209, 261 262, 301–307 309, 313	G2015550	Si 1S1555
D201	G2090073	Varactor FC52M
D101–105, 203–208, 311, 312	G2090107	" 1T25
D308	G2090008	Zener WZ071
		CRYSTAL FILTER
XF101	H1101990	21J2B2 (½) (Matched Pair)
XF102	H1101990	" "
		CERAMIC FILTER
CF101, 102	H3900030	LF-B15
		CERAMIC DISCRIMINATOR
CD101	H7900010	455D
		CRYSTAL
X101	H0102050	HC-18/U 20.945MHz
X201	H0102442	HC-18/T 21.4MHz
X301	H0102384	HC-18/U 7.5MHz

		RESISTOR
R241	J20306220	Metallic Film 1W 22Ω
R317	J02245220	Carbon Film ¼W SJ 22Ω
R115, 219, 383	J02245470	" " " " 47Ω
R239, 322, 326 390	J02245680	" " " " 68Ω
R176, 185	J02245820	" " " " 82Ω
R107, 310	J01245101	" " " TJ 100Ω
R116, 126, 164 208, 214, 220 233, 240, 318 327, 357, 381 387	J02245101	" " " SJ 100Ω
	J01245100	" " " " 120Ω
R212, 342	J02245221	" " " " 220Ω
R106	J02245271	" " " " 270Ω
R341	J01245271	" " " TJ 270Ω
R297	J02245331	" " " SJ 330Ω
R308	J02245391	" " " " 390Ω
R263	J02245471	" " " " 470Ω
R213	J01245471	" " " TJ 470Ω
R215, 344	J02245561	" " " SJ 560Ω
R225, 230, 236	J02245681	" " " " 680Ω
R117, 118, 121 122, 125, 127 129, 135, 165 169, 181, 207 309	J02245102	" " " " 1KΩ
R286, 296	J01245102	" " " TJ 1KΩ
R128, 131, 133 134, 184, 267 281, 360	J02245222	" " " SJ 2.2KΩ
R223, 228, 314	J02245272	" " " " 2.7KΩ
R139, 141, 161 170, 178, 179 217, 234, 237	J02245332	" " " " 3.3KΩ
R315	J01245103	" " " TJ 10KΩ
R119, 123, 173 180, 182, 209	J02245472	" " " SJ 4.7KΩ
R167, 268, 269	J02245562	" " " " 5.6KΩ
R163, 175, 283 389	J02245682	" " " " 6.8KΩ
R324, 384	J02245822	" " " " 8.2KΩ
R105, 136, 137 166, 204, 205 238, 261, 262 275, 276, 278 279, 284	J02245103	" " " " 10KΩ
R287, 291, 292 294, 295	J01215103	" " 1/8WTJ 10KΩ
R112	J02245123	" " ¼W SJ 12KΩ
R187, 201, 202 216, 271, 285 302, 304, 311 325, 359, 388	J02245153	" " " " 15KΩ
R347, 351, 355	J01215153	" " 1/8W TJ 15KΩ
R282, 358	J02245183	" " ¼W SJ 18KΩ

R120, 124, 140 177, 183, 210 224, 229, 235 306, 307, 382 391	J02245223	Carbon Film ¼W SJ 22KΩ
R111, 270	J02245273	" " " " 27KΩ
R346, 348, 350 352, 354, 356	J01215303	" " 1/8W TJ 30KΩ
R162, 172, 186 206, 265, 280 301, 313	J02245333	" " ¼W SJ 33KΩ
R312	J01245333	" " " TJ 33KΩ
R103, 138, 168 203, 320, 321 343	J02245473	" " " SJ 47KΩ
R345, 349, 353	J01215623	" " 1/8W TJ 62KΩ
R293	J01215683	" " " " 68KΩ
R101, 102, 108– 110, 221, 222 226, 227, 231 232	J00215104	" " " SJ 100KΩ
R174, 305, 316 319, 323, 385 386	J02245104	" " ¼W " 100KΩ
R273	J02245124	" " " " 120KΩ
	J01215154	" " 1/8W TJ 150KΩ
R130, 132, 303	J02245154	" " ¼W SJ 150KΩ
R104	J02245184	" " " " 180KΩ
R113, 114, 171 264, 272	J02245224	" " " " 220KΩ
R289	J01215333	" " 1/8W TJ 33KΩ
R266	J02245334	" " ¼W SJ 330KΩ
R274	J02245474	" " " " 470KΩ
		POTENTIOMETER
VR101, 261– 263	J51745103	H0651A013-10KB 10KΩ
VR201	J51724103	PN822H 103H 10KΩ
VR301–303	J51745473	H0651A017-47KB 47KΩ
		CAPACITOR
C226, 234	K08179003	Ceramic Disc AK 0.35pF (RAU04AK0R35C)
C104, 114, 117 0204, 0205	K02182010	" " 63WV CH 1pF (RD870-1CG010C63V)
C101, 105, 209	K02182030	" " " " 3pF (RD870-1CG030C63V)
C246, 251, 316	K02182050	" " " " 5pF (RD870-1CG050C63V)
C220, 228, 236	K02183060	" " " " 6pF (RD870-1CG060D63V)
C127	K02183070	" " " " 7pF (RD870-1CG070D63V)
C131	K02183100	" " " " 10pF (RD870-1CG100D63V)
C314	K06183100	" " " UJ 10pF (RD870-1UJ100D63V)

C367	K02185180	Ceramic Disc 63WV CH 18pF (RD870-1CG180J63V)
C122	K05185220	" " " RH 22pF (RD870-1RG220J63V)
C364	K02185330	" " " CH 33pF (RD871-1CG330J63V)
C171	K06185330	" " " UJ 33pF (RD870-1UJ330J63V)
C207, 210	K05185390	" " " RH 39pF (RD871-1RG390J63V)
C206, 229, 237 252, 253, 269 369	K02185390	" " " CH 39pF (RD871-1CG390J63V)
C221, 249, 365	K02185560	" " " " 56pF (RD872-2CG560J63V)
C173, 351	K06185101	" " " UJ 100pF (RD870-1CG010C63V)
C182, 308	K02185101	" " " CH 100pF (RD874-2CG101J63V)
C172, 352	K06185221	" " " " 220pF (RD873-2UJ221J63V)
C203, 204	K06185271	" " " " 270pF (RD874-2UJ271J63V)
C195	K10186331	" " " B 330pF (RD870-1B331K63V)
C150	K10186471	" " " " 470pF (RD870-1B471K63V)
C184	K10186821	" " " " 820pF (RD870-1B821K63V)
C108–110, 112 123–125, 130 134, 136–138 141, 149, 156– 158,0206,0207 211–215, 222 224, 230, 232 238–241, 243 244, 247, 250 254, 255, 264 273, 274, 276–279, 281 282, 289–291 293–296, 301 302, 306, 307 310, 317–321 323, 325–330 336, 337, 345 346, 353–362 368, 374	K10186102	" " " " 0.001μF (RD870-1B102K63V)
C126, 128, 129 133, 142, 151 161, 163, 165 174, 202, 205 208, 331, 340 342, 347, 348 350, 372, 373	K10179015	" " " " 0.01μF (CK45B1H103MYS)
C154, 197	K70167104	Tantalum 35WV 0.1μF (CS15E1V0R1M1S)
C305	K70167154	" " 0.15μF (CS15E1VR15M1S)

C309	K70167334	Tantalum 35WV 0.33μF (CS15E1VR33M1S)
C167, 185, 191 265, 266, 270 271, 303, 304	K70147105	" 25WV 1μF (CS15E1E010M1S)
C187, 190, 201 272	K70127225	" 16WV 2.2μF (CS15E1C2R2M1S)
C132, 183, 261	K70127475	" " 4.7μF (CS15E1C4R7M1S)
C242, 245, 248	K70127685	" " 6.8μF (CS15E1C6R8M1S)
C135, 140, 175 186, 189, 193 196, 198, 262 275, 322, 338 341, 343, 349 371	K70127106	" " 10μF (CS15E1C100M1S)
C194, 268	K50177102	Mylar 0.001μF (50F2U102M)
C139, 152, 153	K50177222	" 0.0022μF (50F2U222M)
C192	K50177332	" 0.0033μF (50F2U332M)
C181, 267	K50177472	" 0.0047μF (50F2U472M)
C263	K50177223	" 0.022μF (50F2U223M)
C144–148	K50177473	" 0.047μF (50F2U473M)
C344	K50177104	" 0.1μF (50F2U104M)
C143	K40129008	Electrolytic 16WV 33μF (16RE33)
C162, 164, 166 292	K40129007	" " 100μF (16RE100)
C199, 297	K40129006	" " 470μF (16RE470)
		TUNING CAPACITOR
C101, 102, 106 107, 111, 113 115, 116, 118 119, 120, 0201 0202, 0203 C216, 217, 219 225, 227, 233 235 C311, 312, 313 315		(See Band Table, page 2-27)
		TRIMMER CAPACITOR
TC302	K91000028	ECV-1ZW 10x53 10pF
TC101, 201, 203 205, 206, 301	K91000029	ECV-1ZW 20x53 20pF
TC202, 204	K91000030	ECV-1ZW 40x53 40pF

		INDUCTOR
L101−105	L0020706	
	L9190015	Shield Case (for L101−L105)
L106, 108, 201−205, 215, 307−309, 311, 312	L1020081A	
L109	L1190017	FL5H-102K 1mH
L110	L1190038	FL5H-271K 270μH
L206, 208, 212 214, 314−316	L0020342	
L207, 210	L0020886	
L261, 262	L1020079A	
L263	L2030060	
L301	L1190119	FL3H-1R5M 1.5μH
L304	L0020724	
L211, 302, 303 310, 313	L1020469	
		TRANSFORMER
T107	L0020647	119CC-11114N
T108	L0020649	7MC-5896Y
T109, 110	L0020345	113SN-6146F
T201	L0021153	
T202, 203	L0020919	
T204−209	L0020429	113SN-4530Y
T301	L0021157	L-1S6-B
		CONNECTOR
J103	P0090191	B02B-XH
J101	P0090194	B05B-XH
J104	P0090195	B06B-XH
J102	P0090197	B08B-XH
J105	P0090092	3022-08A
J301	P0090242	3022-18A
J201	P1090210	TMP-JV
		TERMINAL POST
	Q5000036	TP-G
	R0075780	HEAT SINK
	R0075790	HEAT SINK SPACER
	R0075800	SHIELD PLATE (S)
	R0078940	SHIELD PLATE (L)
	R0075810	PLL SHIELD CASE
	R0075820	PLL SHIELD CASE COVER
	R0075830	VCO CASE
	R0075840	VCO CASE COVER

P.A. UNIT

Symbol No.	Part No.	Description
PB-2332	F0002332	Printed Circuit Board
	C0023320	P.C.B. with Components
		TRANSISTOR
Q401	G3325390	2SC2539
Q402	G3326300	2SC2630
		DIODE
D401−403	G2090118	Schottky Barrier 1SS97
		RESISTOR
R402	J02245100	Carbon Film ¼W TJ 10Ω
R401	J01245121	" " " SJ 120Ω
		CAPACITOR
C426	K02183090	Ceramic Disc 63WV CH 9pF (RD870-1CG090D63V)
C422−425, 444	K02185180	" " " " 18pF (RD870-1CG180J63V)
C433	K02185390	" " " " 39pF (RD871-1CG390J63)
C440−442	K02185121	" " " " 120pF (RD874-2CG121J63V)
C403, 409, 418 419	K02185560	" " " " 56pF (RD872-2CG560J63V)
C401	K02185680	" " " " 68pF (RD873-2CG680J63V)
C408	K02185330	" " " " 33pF (RD871-1CG330J63V)
C406, 414, 436	K02185101	" " " " 100pF (RD874-2CG101J63V)
C405, 413, 415 428, 429	K10186102	" " " B 0.001μF (RD870-1B102K63V)
C435	K02185220	" " " CH 22pF (RD871-1CG220J63V)
C407, 417	K10179024	" " " " 0.01μF (CK45B1H103MYS)
C430−432	K21170002	Feed Through 0.001μF (ECKY1H-102WE)
C412, 416, 420	K40129029	Electrolytic 16WV 100μF (16RJ2100)
		TUNING CAPACITOR
C404, 410, 426 427, 434, 443 445		(See Band Table, page 2-27)
		TRIMMER CAPACITOR
TC401,403,406	K91000030	ECV-1ZW 40x53 40pF
TC405	K91000047	2222-808-32409 40pF
TC404	K91000057	2222-808-32809 80pF
		INDUCTOR
L401	L0021151A	
L402, 406	L1020079A	
L403, 407	L0021148A	

L404	L1020080A	
L405, 409	L0021150A	
L410-412	L0021149	
L413	L0020355A	
L414	L0020354A	
L408	L0021160	
		FERRITE BEADS
FB401	L9190001	Ri 3x3x1
		PLUG
P401 (with wire)	T9204366	TMP1.5DP
	R5075670	HEAT SINK (Rear Panel)
	R5075850	HEAT SINK (Top Fin)
	R5075860	HEAT SINK (Block)
	R0075870	PA SHIELD CASE
	R0075880	PA SHIELD CASE COVER

DIODE MATRIX BOARD

Symbol No.	Part No.	Description
PB-2333	F0002333	Printed Circuit Board
	C0023330	P.C.B. with Components (without Diode Array)
		TRANSISTOR
Q501	G3304580B	2SC458B
Q502	G3106280A	2SA628A
		DIODE
D501	G2015550	Si 1S1555
		RESISTOR
R501, 505	J02245101	Carbon Film ¼W SJ 100Ω
R502	J02245332	" " " " 3.3KΩ
R503	J02245822	" " " " 8.2KΩ
R504	J02245223	" " " " 22KΩ
		CONNECTOR
J502	P0090197	B08B-XH 8P
J501	P0090200	B11B-XH 11P
P501	P1090232	3024-18C 18P
	R0075890	MATRIX BOARD RETAINER STRIP

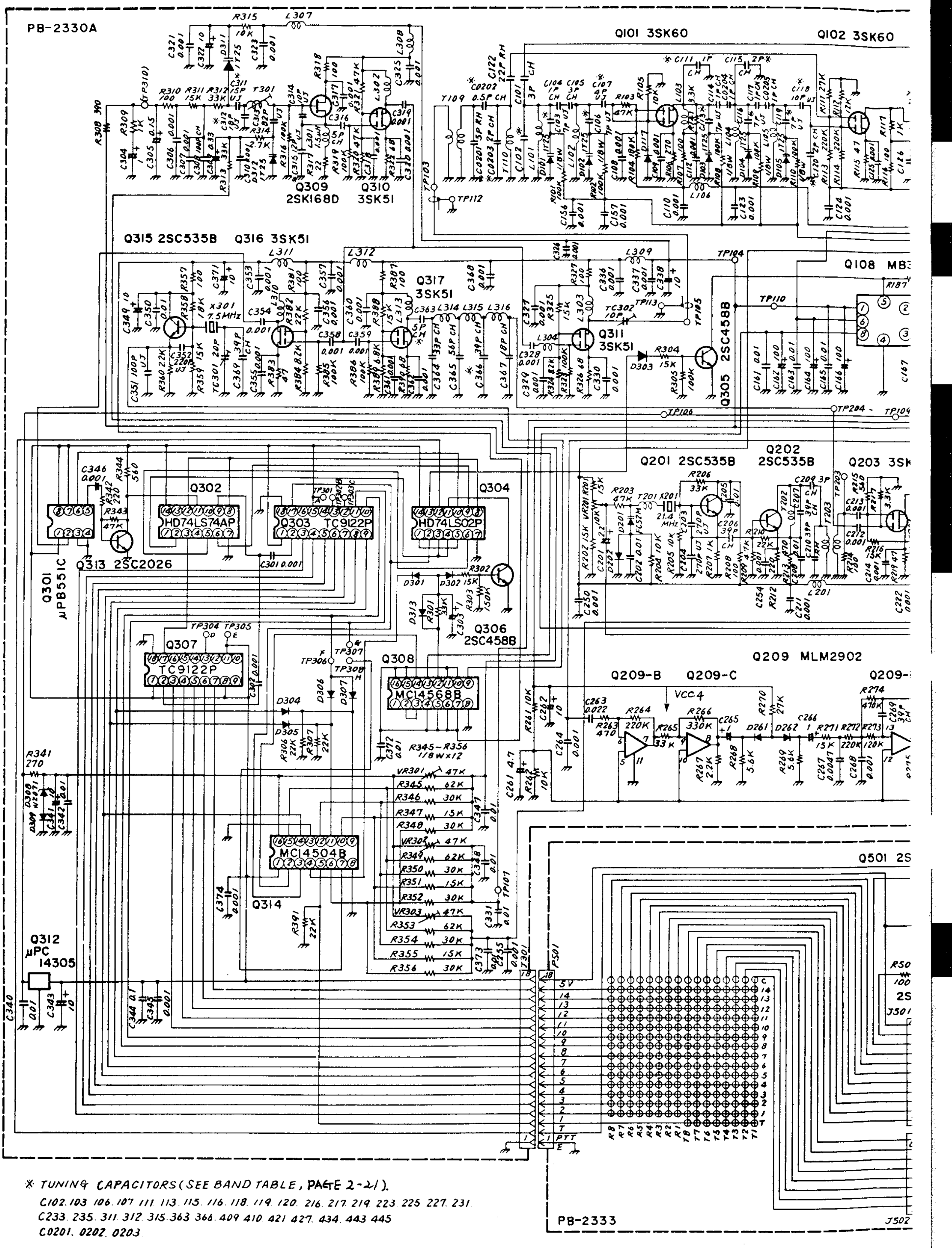
LED UNIT

Symbol No.	Part No.	Description
PB-2334	F0002334	Printed Circuit Board
	C0023340	P.C.B. with Components
		SWITCH
S601	N4090049	KHC10901
		LED
D601, 603	G2090094	LN224RP
D604-611	G2090071	LN322GP
D602	G2090212	LN324GP
		RESISTOR
R601-603	J10276102	Carbon Composition ½WV GK 1KΩ

RELAY UNIT

Symbol No.	Part No.	Description
PB-2331	F0002331	Printed Circuit Board
	C0023310	P.C.B. with Components
		DIODE
D701	G2090211	Si V06C
D702	G2090072	Si 15FD11
		RESISTOR
R701	J10276471	Carbon Composition ½WV GK 470Ω
		CAPACITOR
C701	K30279063	Dipped Mica 500WV 5pF (DM15D050J)
C702	K30279064	" " " 10pF (DM15D100J)
C703-705	K10186102	Ceramic Disc 63WV B 0.001μF (RD870-1B102K63V)
		RELAY
RL701	M1090002	MX2P
		TERMINAL POST
	Q5000037	TP-H
	Q5000036	TP-G
	R0075900	SHIELD PLATE

ACCESSORIES		
Symbol No.	Part No.	Description
	M3090020	MICROPHONE (YM-31)
	P1090021	(Microphone Plug FM-146P)
	T9013415	DC POWER CORD
	P1090124	(Plug 3191-02P1)
	Q2000001	(Fuse Holder SN1101)
		FUSE
	Q0000008	15A
		MOUNT BRACKET
	D6000024	FMB-4-1 (with Mount Screws)
		DIODE ARRAY
	G2090213	03-0042 (Not programmed)

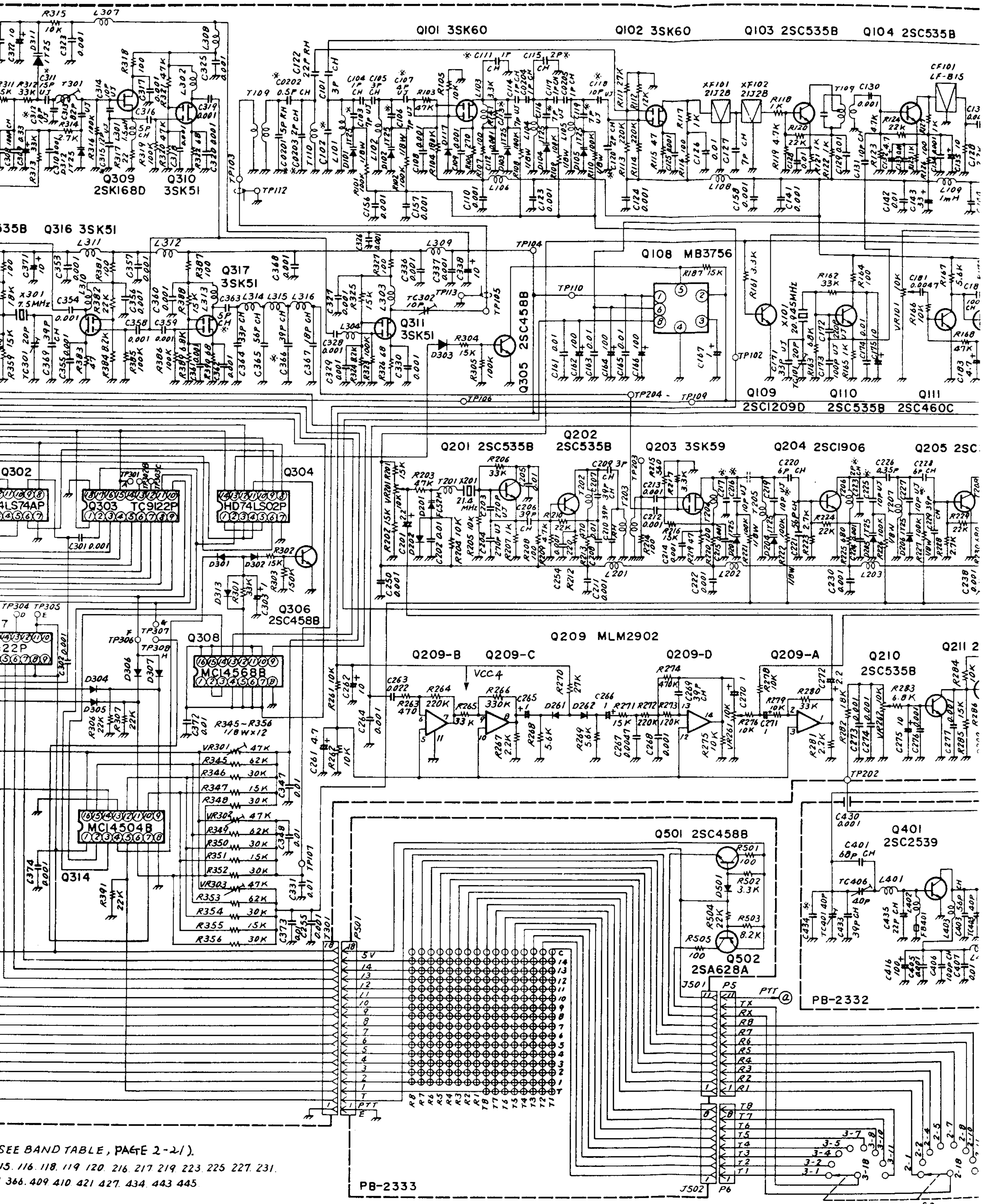


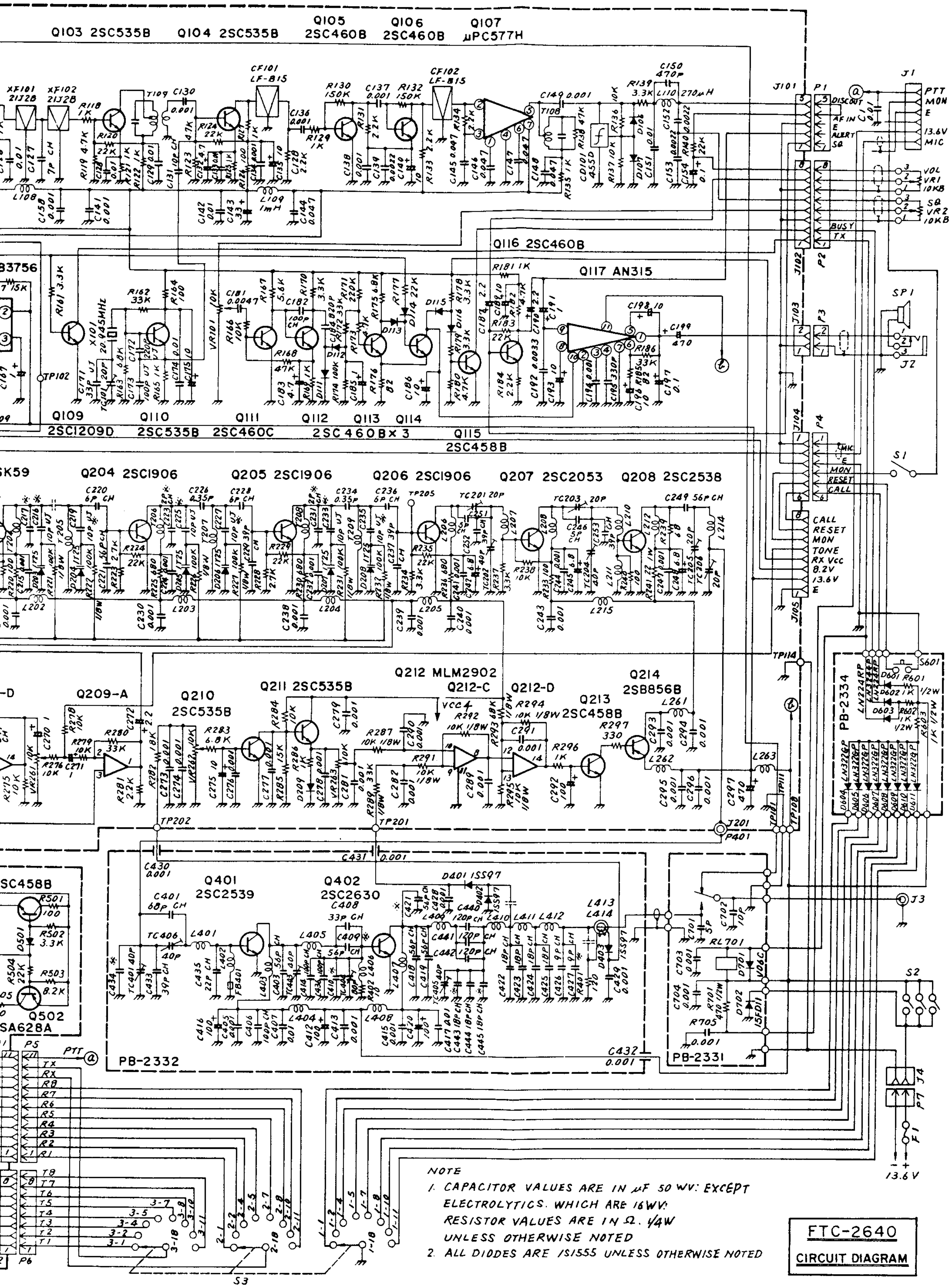
※ TUNING CAPACITORS (SEE BAND TABLE, PAGE 2-21).

C102. 103 106. 107. 111 113. 115. 116. 118. 119 120. 216. 217. 219. 223. 225 227. 231

C233. 235. 311 312. 315. 363 366. 409 410. 421 427. 434. 443 445

C0201. 0202. 0203


Q101 3SK60
Q102 3SK60
Q103 2SC535B
Q104 2SC535B
Q309 2SK168D
Q310 3SK51
Q316 3SK51
Q317 3SK51
Q311 3SK51
Q305 2SC458B
Q108 MB3756
Q109 2SC1209D
Q110 2SC535B
Q111 2SC460C
Q201 2SC535B
Q202 2SC535B
Q203 3SK59
Q204 2SC1906
Q302
Q303 TC9122P
Q304 HD74LS02P
Q306 2SC458B
Q308 MC14568B
Q314 MC14504B
Q209 MLM2902
Q209-B
Q209-C
Q209-D
Q209-A
Q210 2SC535B
Q501 2SC458B
Q502 2SA628A
Q401 2SC2539
XF101 21J2B
XF102 21J2B
CF101 LF-B15
X301 7.5MHz
X101 20.945MHz
X201 21.4MHz
R345~R356 1/8W×12
PB-2332
PB-2333
S3
SEE BAND TABLE, PAGE 2-21).
15. 116. 118. 119. 120. 216. 217. 219. 223. 225. 227. 231.
366. 409. 410. 421. 427. 434. 443. 445

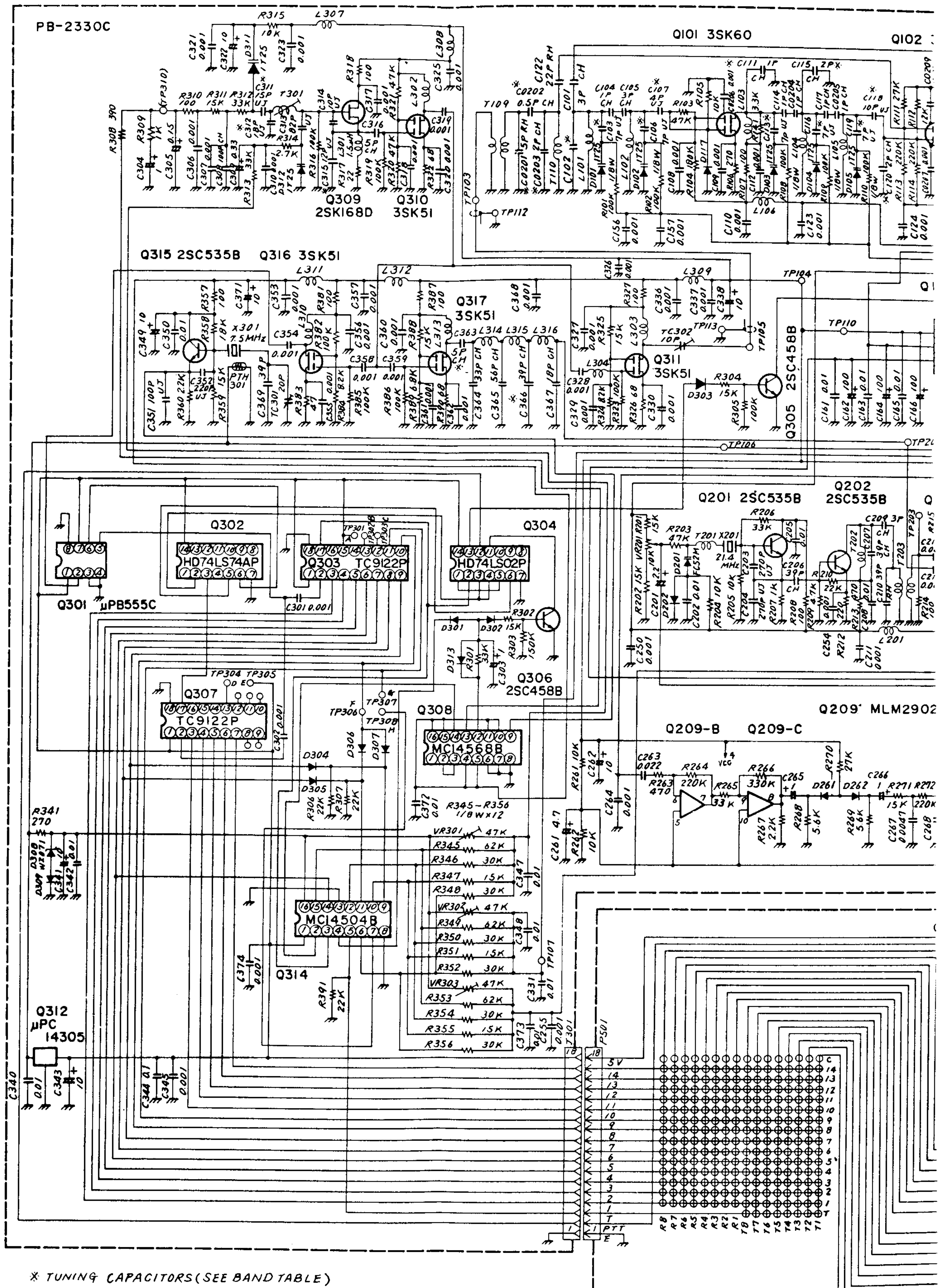


NOTE

1. CAPACITOR VALUES ARE IN µF 50 WV: EXCEPT ELECTROLYTICS. WHICH ARE 16WV: RESISTOR VALUES ARE IN Ω. 1/4W UNLESS OTHERWISE NOTED
2. ALL DIODES ARE 1S1555 UNLESS OTHERWISE NOTED

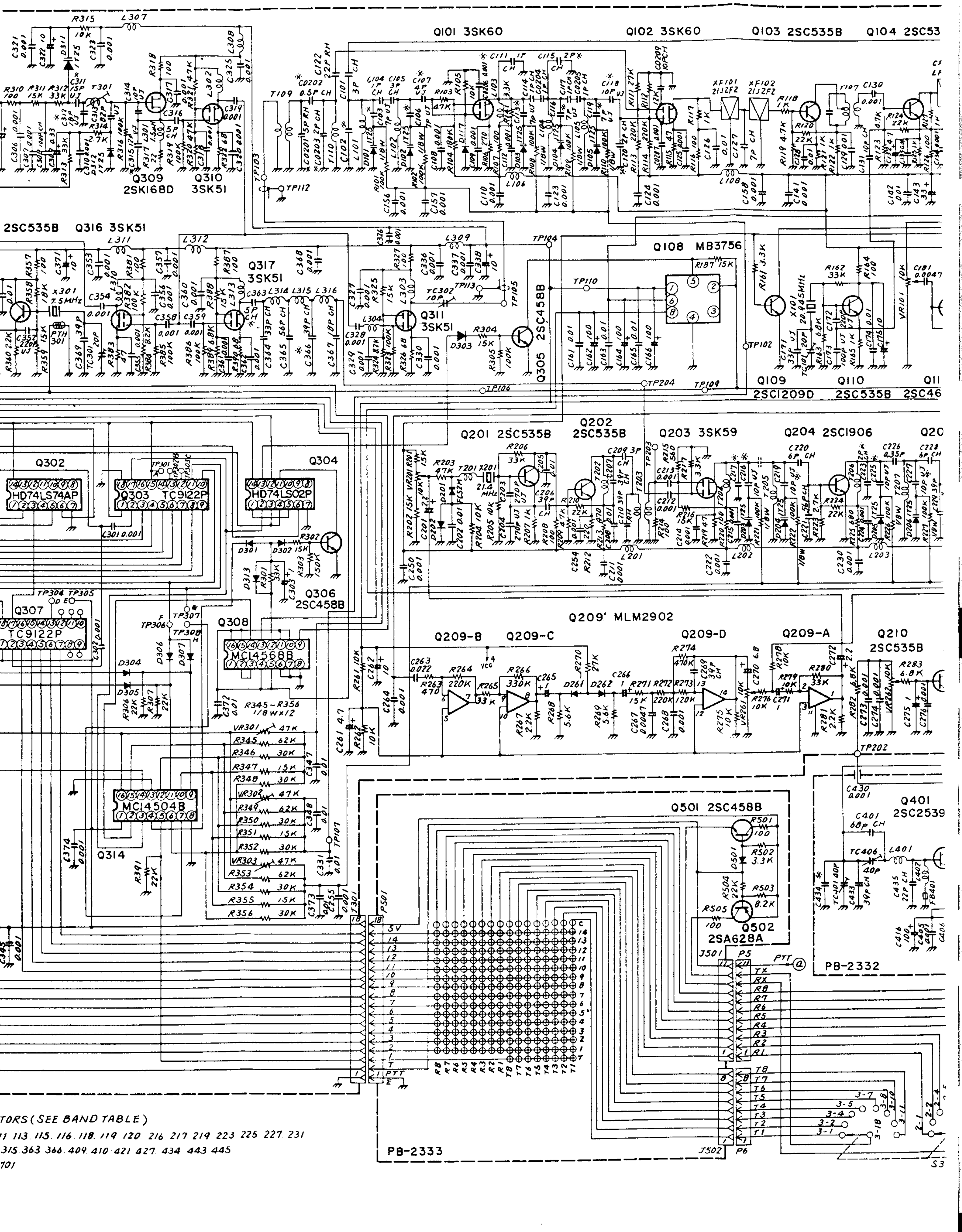
FTC-2640

CIRCUIT DIAGRAM

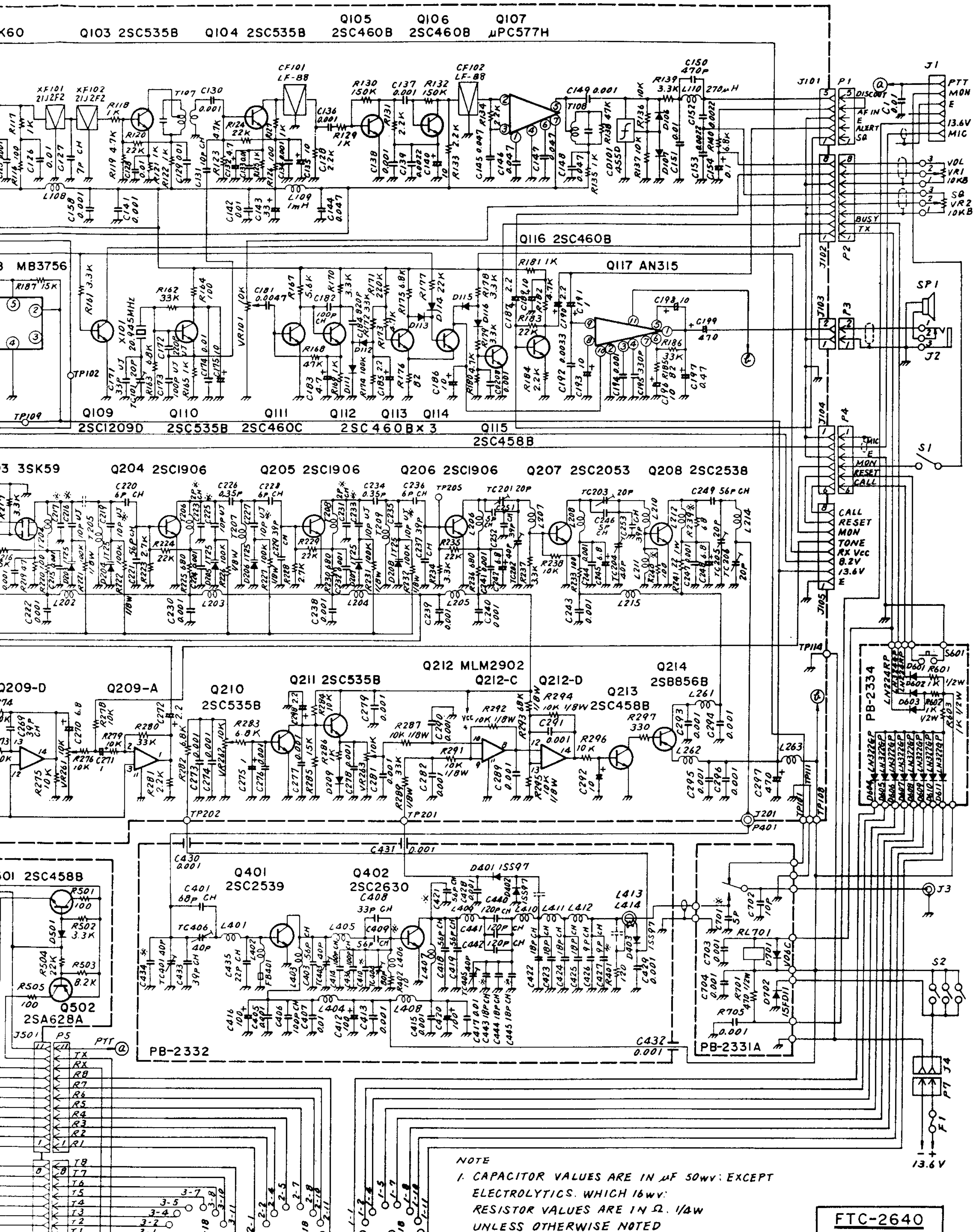


※ TUNING CAPACITORS (SEE BAND TABLE)

C102. 103. 106. 107. 111. 113. 115. 116. 118. 119. 120. 216. 217. 219. 223. 225. 227. 231.
C233. 235. 311. 312. 315. 363. 366. 409. 410. 421. 427. 434. 443. 445
C0201. 0202. 0203. 701



Q101 3SK60
Q102 3SK60
Q103 2SC535B
Q104 2SC53
Q309 2SK168D
Q310 3SK51
2SC535B Q316 3SK51
Q317 3SK51
X301 7.5MHz
Q311 3SK51
Q305 2SC458B
Q108 MB3756
X101 20.945MHz
Q109 2SC1209D
Q110 2SC535B
2SC46
Q201 2SC535B
Q202 2SC535B
Q203 3SK59
Q204 2SC1906
X201 21.4 MHz
Q302 HD74LS74AP
Q303 TC9122P
Q304 HD74LS02P
Q306 2SC458B
Q307 TC9122P
Q308 MC14568B
Q314 MC14504B
R345~R356 1/8W×12
Q209 MLM2902
Q209-B
Q209-C
Q209-D
Q209-A
Q210 2SC535B
Q401 2SC2539
Q501 2SC458B
Q502 2SA628A
PB-2332
PB-2333
J301 P501 J501 P5 J502 P6
PTT
TP101 TP102 TP103 TP104 TP105 TP106 TP107 TP109 TP110 TP112 TP113 TP202 TP204 TP301 TP304 TP305 TP306 TP307 TP308
TORS (SEE BAND TABLE)
11 113. 115. 116. 118. 119 120. 216 217. 219 223 225 227. 231
315. 363 366. 409 410 421 427 434 443 445
701



NOTE

1. CAPACITOR VALUES ARE IN µF 50wv; EXCEPT ELECTROLYTICS. WHICH 16wv. RESISTOR VALUES ARE IN Ω. 1/4W UNLESS OTHERWISE NOTED
2. ALL DIODES ARE 1S1555 UNLESS OTHERWISE NOTED

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CIRCUIT DIAGRAM

12.5kHz/STEP MODEL