VHF MARINE RADIOTELEPHONE

IC-M2

MAINTENANCE MANUAL

ICOM INCORPORATED

1-6-19, KAMI KURATSUKURI, HIRANO-KU, OSAKA, JAPAN
Phone: (06) 793-5301
Telex: ICOM TR J63649

ICOM AMERICA, INC.

2380 116th Avenue N.E.
Bellevue, WA 98004
Phone: (206) 454-8155
Telex: 230-152210 ICOM AMER BVUE

3331 Towerwood Dr., Suite 307
Dallas, Texas 75234
Phone: (214) 620-2781

ICOM EUROPE G.M.B.H.

Himmelgeister Strasse 100
4000 Duesseldorf 1
West Germany
Phone: 0211-346047
Telex: 41-8588082

ICOM CANADA LTD.

810 S.W. Marine Drive
Vancouver, BC Canada
Phone: (604) 321-1833
Telex: 21-454315

ICOM AUSTRALIA, PTY, LTD.

7 Duke Street, Windsor 3181
Victoria Australia
Phone: (03) 529-7582
Telex: 71-35521 ICOMAS AA35521

TABLE OF CONTENTS

SECTION 1 SPECIFICATIONS

GENERAL

Number of Semiconductors	Transistors	40
	FETs	3
	ICs	8
	Diodes	20
Number of Channels	All U.S.A. and International channels, 4 Weather and 4 Auxiliary Priority channels (U.K. version: All International and CH 37A) Operation Simplex, Semi-duplex	
Channel Spacing	25kHz	
Frequency Stability	0.0005 Percent	
Usable Temperature Range	−20°C to +60°C (−4°F to +140°F)	
Antenna Impedance	50 ohms unbalanced	
Power Supply Requirement	DC 8.4V; with attendant power pack, IC-CM3 DC 6 to 12V Negative ground is acceptable	
Current Drain at 8.4V	Transmitting	
	At 2 watts output	Approx. 700mA
	Receiving	
	At max audio output	Approx. 130mA
	Squelched	Approx. 25mA
Dimensions	116.5mm (H) × 65mm(W) × 45mm (D) without power pack Attendant power pack, IC-CM3: 49mm (H) × 65mm (W) × 35mm (D)	
Weight	510g including power pack, IC-CM3 and flexible antenna	

RECEIVER

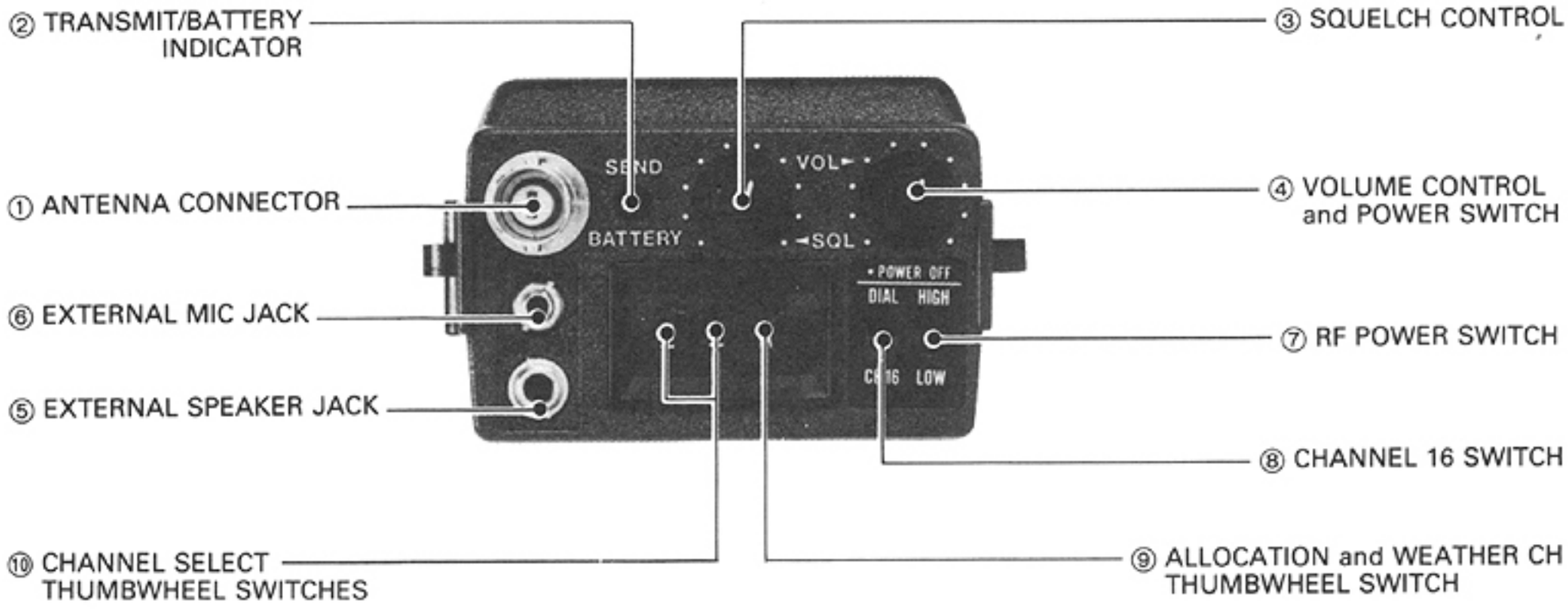
Frequency Range	156.025 ~ 157.425MHz and 160.625 ~ 162.550MHz
Receiving System	Double-conversion superheterodyne
Modulation Acceptance	16F3 ± 7.5kHz
Intermediate Frequency	1st: 10.695MHz (U.K. version: 16.9MHz) 2nd: 455kHz
Sensitivity	Less than 0.5μV for 20dB noise quieting Less than 0.4μV for 12dB SINAD
Squelch Sensitivity	Less than 0.4μV
Spurious Response Rejection Ratio	More than 60dB
Selectivity	More than 65dB at adjacent channel
Intermodulation Rejection Ratio	More than 60dB
Audio Output Power	More than 300mW at 10% distortion
Audio Output Impedance	8 ohms

TRANSMITTER

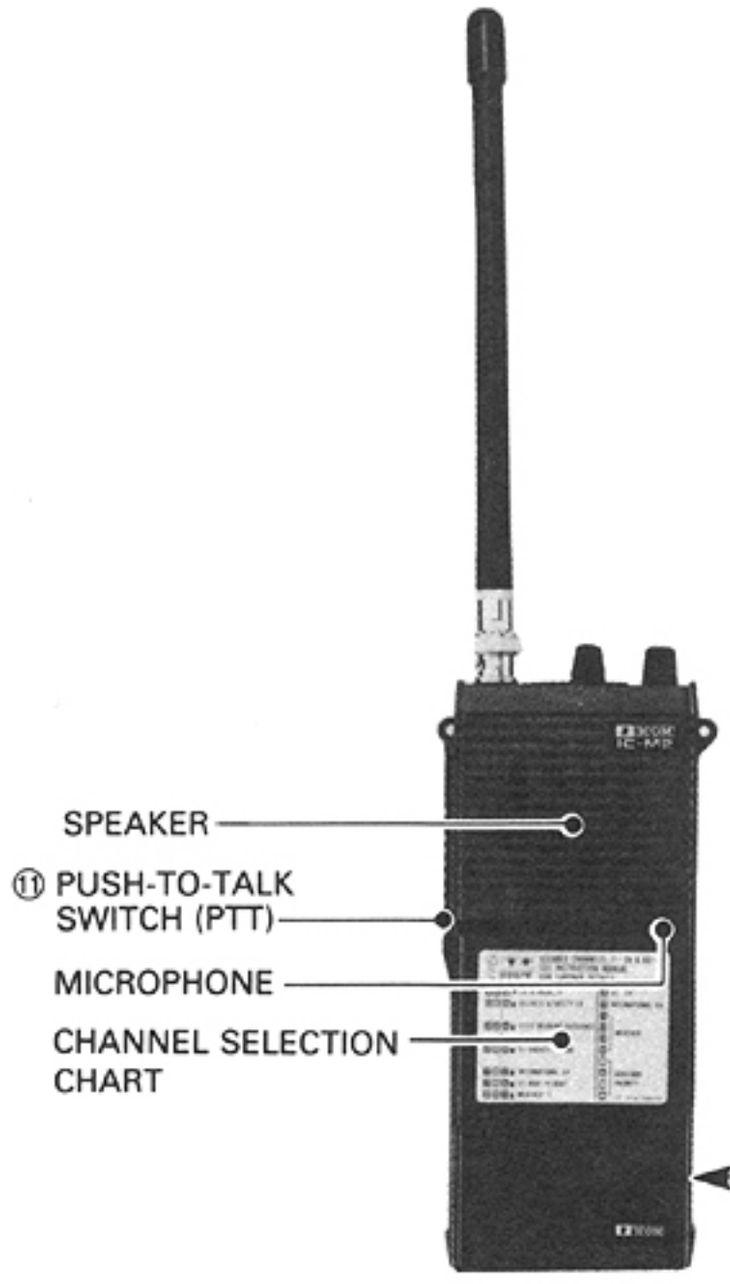
Frequency Range	156.025 ~ 157.425MHz
Output Power	High: 2 watts, Low: 0.4 watt (Australian version—High: 1 watt, Low: 0.1 watt) High: 5 watts, Low: 1 watt with IC-CM5 pack
Emission Mode	16F3
Modulation System	Variable reactance frequency modulation
Max. Frequency Deviation	±5kHz
Spurious Emission	More than 60dB below carrier
Microphone	Built-in electret condenser microphone Speaker-microphone (IC-CM9) optional

SECTION 2 OPERATING CONTROLS

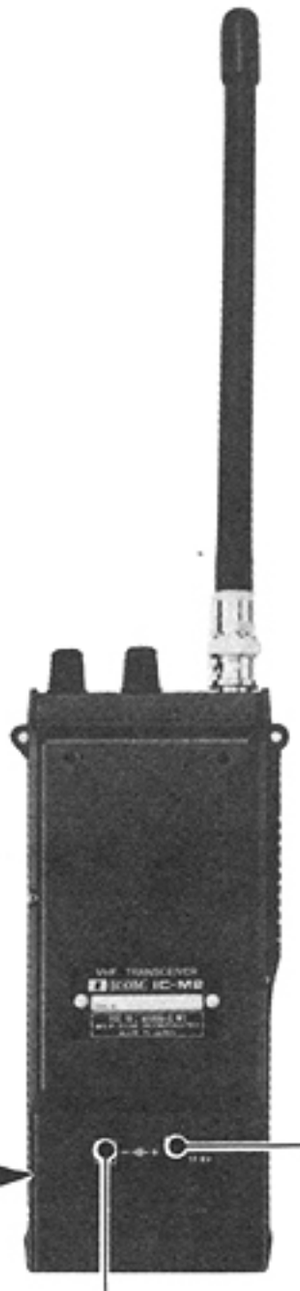
TOP PANEL



FRONT PANEL



REAR PANEL



IC-CM3
Power Pack

① **ANTENNA CONNECTOR**
Connect the supplied flexible antenna or an external antenna. The feedline must have a BNC connector.

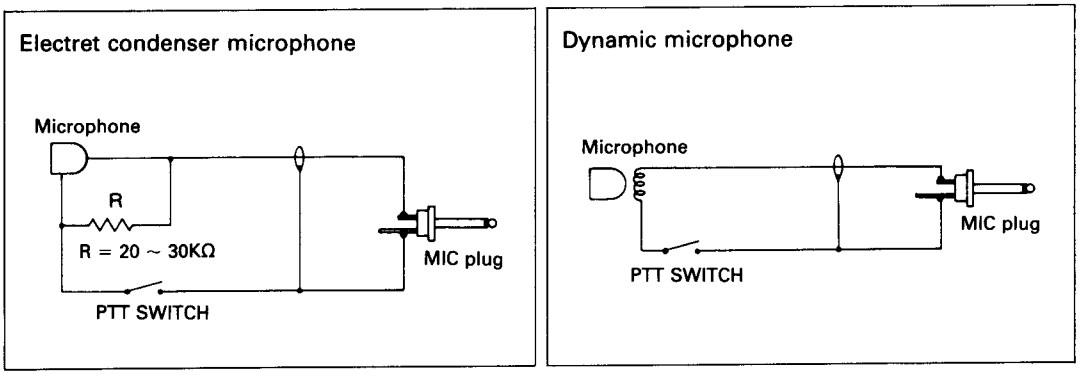
② **TRANSMIT/BATTERY INDICATOR**
Illuminates in the transmit mode. Also indicates the battery condition (while transmitting). The voltage of nickel-cadmium batteries drops rapidly just before they are exhausted. Be sure to immediately stop using the battery pack when this indicator goes out. Recharge the battery pack.

③ **SQUELCH CONTROL**
Sets the squelch threshold level. Rotate this control completely counterclockwise to turn OFF the squelch. Rotate the control clockwise to set the threshold level higher.

④ **VOLUME CONTROL and POWER SWITCH**
The power is OFF when this control is completely counterclockwise. Turn the control clockwise past the "click" to turn the radio ON. Rotate further clockwise to increase the audio level.

⑤ **EXTERNAL SPEAKER JACK**
Connect an external speaker or earphone, when required, to this jack. Use a speaker with an impedance of 8 ohms. The built-in speaker does not operate when an external speaker is connected.

⑥ **EXTERNAL MIC JACK**
Connect an external microphone, when required, to this jack. Refer to the schematic for the correct hookup. The built-in microphone does not function when the external microphone is connected. The IC-CM9 optional speaker-microphone may also be used.



⑦ **RF POWER SWITCH**
Selects the RF output power. 2 watts (HIGH) or 0.4 watt (LOW) at 8.4 volts is standard. 5 watts (HIGH) or 1 watt (LOW) at 10.8 volts is also available. The Australian version provides 1 watt (HIGH) or 0.1 watt (LOW) at 8.4 volts.

⑧ **CHANNEL 16 SWITCH**
Sets the radio to either Channel 16 or a channel selected by the CHANNEL SELECT and/or ALLOCATION and WEATHER CHANNEL thumbwheel switches.

⑨ **ALLOCATION and WEATHER CH. THUMBWHEEL SWITCH**
Selects the U.S. or International allocation, one of the weather channels or one of the auxiliary priority channels. U.K. version will not select the U.S. allocations or the weather channels.

⑩ **CHANNEL SELECT THUMBWHEEL SWITCHES**
Selects a channel from the U.S. or International allocation. U.K. version selects a channel from the International allocation or 37A.

⑪ **PUSH TO TALK (PTT) SWITCH**
Press this switch and speak into the microphone with a normal voice to transmit. The internal microphone is a sensitive electret-condenser type.

⑫ **CHARGER CONNECTOR**
Mates with the CM-25U/E wall charger output plug or other 12 volt DC power source.

⑬ **BATTERY CHARGE INDICATOR**
Lights while battery charges.

SECTION 3 CIRCUIT DESCRIPTION

3 - 1 RECEIVER CIRCUITS

3 - 1 - 1 Antenna Switching Circuit

The signals enter the antenna switching circuit from the antenna connector via a Chebyshev low-pass filter. L229, L230, C295, C297 and C298 on the PLL board form the filter.

The antenna switch employs a quarter wave switching circuit.

Switching diodes D216 and D217 turn OFF when in the receive mode. They provide isolation from both the transmitter and matching circuits. The incoming signals pass to the RF amplifier.

3 - 1 - 2 RF Amplifier and First Mixer

The signals from the switching circuit feed into the cascode amplifier composed of Q101 and Q102. The amplifier output passes to the gate of the first mixer Q103 through the band-pass filters L102, L103 and L104. This filter reduces interference and intermodulation from out-of-band signals.

The PLL circuit supplies a 145MHz (U.K. version: 139MHz) signal to the source of Q103 to convert the RF signal into the 10.695MHz (U.K. version: 16.9MHz) first IF.

The first IF then passes to the IF circuit from the drain of Q103.

3 - 1 - 3 IF Circuit

The first IF signal from Q103 feeds into the matched-pair crystal filter FI101. The filter output passes to IF amplifiers Q104 and Q105.

IC101 receives the amplified IF signal. The second local oscillator, second mixer, limiter amplifier, quadrature detector and active filter circuits are all within IC101.

X101 provides the 10.240MHz second local oscillator frequency (U.K. version: 16.445MHz). This frequency and the first IF signal mix to produce the 455kHz second IF. The second IF exits IC101 from pin 3 and passes to a highly selective external ceramic filter FI102. The filter output feeds back to IC101 pin 5 to be amplified and detected.

The detected AF signal exits from IC101 pin 9.

3 - 1 - 4 AF and Squelch Circuits

R117 and C126 form an integrating circuit to provide 6 dB/octave de-emphasis for the detected AF signal. The de-emphasized output passes to the AF power amplifier IC102 through the VOLUME control R1. IC102 supplies sufficient drive for the speaker.

Noise components output from IC101 pin 9 feed through the SQUELCH control R2 and back to IC101 pin 10. The SQUELCH control varies the squelch threshold level. IC101 filters the 20kHz noise signal and passes the output to pin 11.

Q113 rectifies the noise signal. R135, R136 and C136 integrate the output from Q113. Q114 turns ON and the AF power amplifier regulator turns OFF. D103, Q115 and Q116 form the regulator.

The squelch action reduces the current drain of the radio when in standby condition. A receive signal suppresses the noise and turns Q114 OFF. The regulator turns ON and supplies regulated voltage to the AF power amplifier. The incoming signal is heard from the speaker.

Q114 receives a voltage which turns it ON when the radio is in the transmit mode. This turns the regulator OFF (the same as in the standby condition).

3 - 1 - 5 Local Oscillator Circuit

Q207 and Q208 on the PLL board double the output from the VCO. The multiplied signal feeds to the base of the first mixer Q103 through a band-pass filter consisting of L217 and L218.

3 - 2 TRANSMITTER CIRCUITS

3 - 2 - 1 Mic Amplifier Circuit

The microphone audio signal feeds into the limiter amplifier. Q125, Q126, Q127 and Q128 compose this amplifier which has a 6dB/octave response between 300Hz and 3kHz.

The rectangular waveform from the output of the limiter amplifier contains many harmonics. Low-pass filter Q129 eliminates those which are 3kHz or higher. The filtered output modulates the VCO on the PLL board.

3 - 2 - 2 Multiplier and Driver Circuits

The VCO oscillates at half the transmit frequency. Multiplier Q208 and Q209 doubles the VCO output to obtain the 156MHz transmit frequency.

The 156MHz signal feeds into amplifiers Q211 and Q212 through band-pass filters L219/L220 and L221/L222. These amplifiers raise the power to 200 milliwatts. The voltage from C269 turns Q210 ON when the user switches from the receive to transmit mode. Q210 remains ON until C269 discharges. The action of Q210 cuts the bias voltage to Q211, Q212 and Q213 which prevents unwanted signals from being transmitted.

3 - 2 - 3 Power Amplifier Circuit

Power amplifier Q213 amplifies the Q212 output to 2 watts. D216 and D217 turn ON when the radio is in the transmit mode. D217 forces L228 to have a high impedance and D216 feeds the transmit signal to the antenna through the low-pass filter.

3 - 3 PLL CIRCUITS

3 - 3 - 1 Local Oscillator Circuit

The crystal oscillator Q216 oscillates at 34.970MHz (U.K. version: 33.419MHz) with X202 for receive and 37.644MHz with X203 for transmit. Q206 acts as a doubler. The doubled frequency feeds from the collector of Q206 to the PLL circuit mixer.

D210 receives R+5V through R223, L211 and R227 when the radio is in the receive mode. D210 turns ON and selects X202.

D211 receives T+5V through R224, L212 and R228 when the radio is in the transmit mode. D211 turns ON and selects X203.

3 - 3 - 2 Mixer, Low-Pass Filter and Amplifier Circuits

The output signal from the local oscillator circuit and the VCO signal from buffer amplifiers Q202 and Q203 combine in mixer Q204. The Q204 output feeds to a low-pass filter to remove only those signals below 7MHz. Q205 amplifies the filter output to provide the correct drive level for the programmable divider IC201. This level is more than 3Vp-p.

3 - 3 - 3 Programmable Divider Circuit

The BCD signals from the PROM board at IC201 pins 3 to 14 divide the input signal at IC201 pin 2.

The programmable divider is also called the 1/N counter and the BCD value is N. The value of N ranges from 218 to 479.

3 - 3 - 4 Reference Frequency Generator Circuit

Reference frequency generator IC203 consists of a crystal oscillator and a high-speed divider. X201 oscillates at 12.800MHz. This frequency is divided by 1024. The 12.5kHz reference frequency passes to phase detector IC202. This reference frequency determines the step variation of the PLL output frequency.

3 - 3 - 5 Phase Detector and Loop Filter Circuits

Digital phase detector IC202 detects the phase difference of the pulse signals of the 12.5kHz reference frequency and the output signal of the programmable divider. It proportionately feeds out pulse signals at pin 3 which becomes high impedance when the PLL locks.

Pin 4 detects lock failures. It changes to ground level according to the phase difference of the two pulse signals. R202 and C215 integrate the pulse signal from pin 4 when the lock fails. When the integrated voltage exceeds the junction voltage of the base of Q214; Q214 turns ON which turns ON Q107 on the MAIN board.

The base voltage of Q108 becomes ground level since the base is connected to the collector of Q107. Q108 and Q106 turn OFF to prevent unwanted emissions from being transmitted.

The loop filter, consisting of R204, R205, R206, C213 and C214, converts the pulse signal from pin 3 into a DC voltage. This voltage determines the response time of the entire loop.

The output signals feed to tuning diode D203 of the VCO circuit. These signals act as the control voltage to set the VCO frequency.

3 - 3 - 6 VCO Circuit

The VCO (Voltage Controlled Oscillator) is a Colpitts circuit which uses Q201 to oscillate in the 70MHz range.

A DC voltage supplied from the loop filter to varactor diode D203 controls the oscillator frequency.

The anode of D204 receives R+5 via L201 when the radio is in the receive mode. D204 turns ON and shunts C220. Thus, the free-run frequency of the VCO decreases.

The cathode of D204 receives T+5 via D205 and L202 when the radio is in the transmit mode. D204 turns OFF and inserts C220 in the oscillator circuit in series. Thus, the free-run frequency of the VCO increases.

The audio signals from the microphone frequency modulate the VCO signal at the same time. The audio applied to the gate of Q201 varies the mutual conductance of that transistor.

3 - 4 OTHER CIRCUITRY

3 - 4 - 1 Power Supply Circuit

The main circuits receive the regulated 5 volts which allows stable operation with as low a voltage as possible.

The power supply voltage feeds to the AF power amplifier through the squelch switching circuit. The power supply voltage also goes to the 5 volt regulator, consisting of Q117, Q118, Q119, Q120 and zener diode D104. The PLL circuit then receives the regulated 5 volts.

In the transmit mode, the Q123 base receives ground through R155, the microphone and the PTT switch. Q123 turns ON. Q106 and Q108 turn ON, T+5 develops and feeds to the transmitter circuits. T+5 also turns Q112 ON and the MIC amplifier circuit receives the power supply voltage via Q112.

In the receive mode, Q123 turns OFF and the Q109 bias voltage turns ON. R+5 develops and feeds to the PLL board to switch the local oscillator crystal and the driver transistors of the transmitter circuit.

Simultaneously, R+5 turns ON the voltage boost circuit consisting of Q110 and Q111. This circuit supplies +6 volts to the receiver circuits.

3 - 4 - 2 LED Indicator Circuit

The LED lights in the transmit mode. It does not light when the power supply voltage is lower than 5.5 volts.

R148 and R149 divide the power supply voltage and feed it to the base of Q121. The emitter of Q121 connects to the regulated 5 volt source. When the power supply voltage is more than 5.5 volts, Q121 turns OFF, Q122 turns ON and T+5 transfers to the LED through Q122 and R150. The LED lights.

3 - 5 PROM UNIT

IC-401 is a CMOS EPROM with a 16384 bit capacity (2048 words × 8 bits).

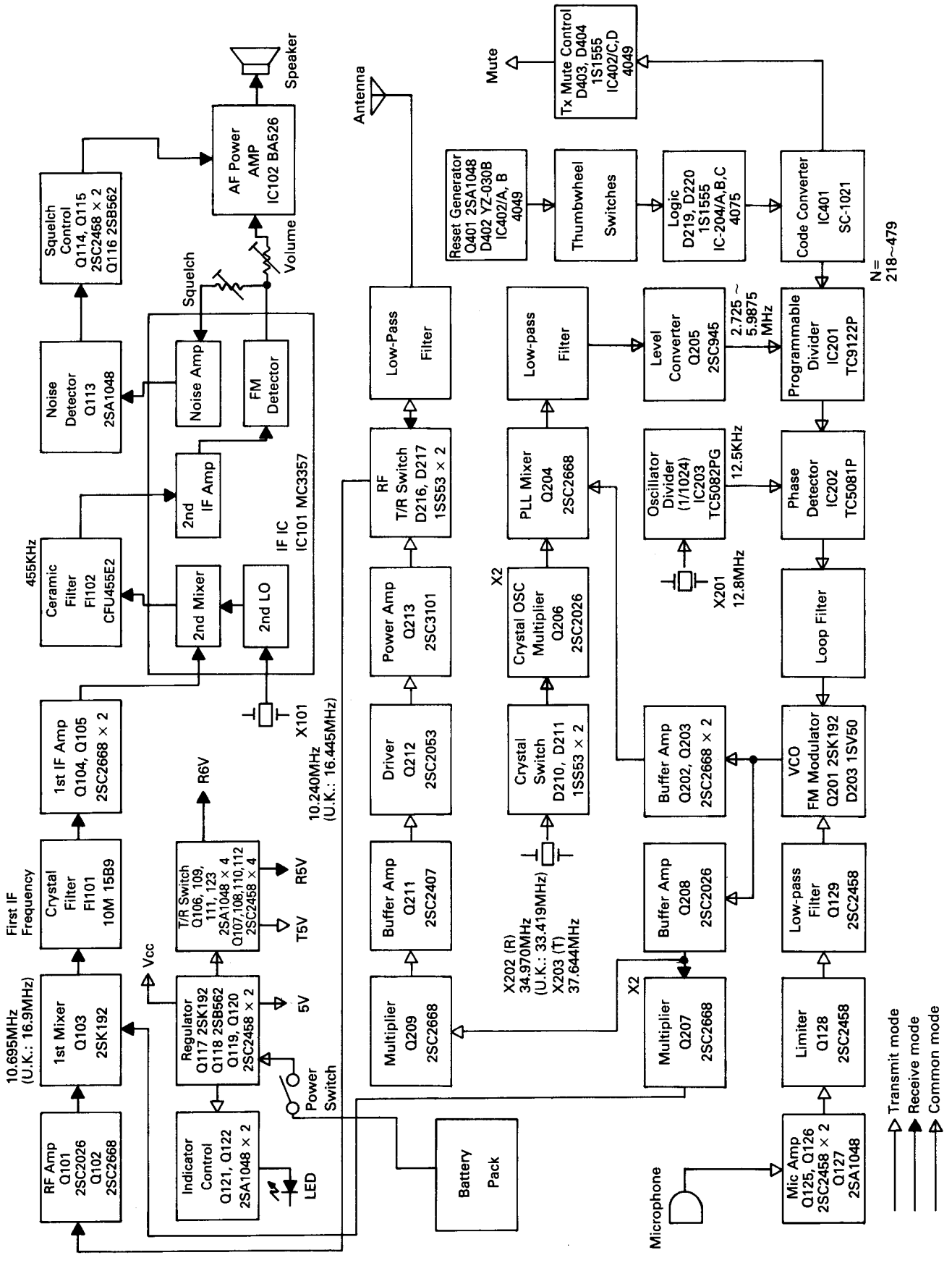
Addresses 000 through 3FF store the transmit and receive channel data for the WX and Auxiliary channels. Addresses 400 through 5FF contain the International channel data and addresses 600 through 7FF contain the U.S.A. channel data. Address data by means of the thumbwheel switches or the Channel 16 switch on the top panel. These switches control the programmable divider on the PLL board.

The output from IC401 pin 17 and the IC402 inverter controls the switching between simplex and duplex with a 4.6MHz frequency shift.

Addresses which contain no programmed data feed out FF so that the empty or WX channels are muted by the D403 and D404 detector circuit.

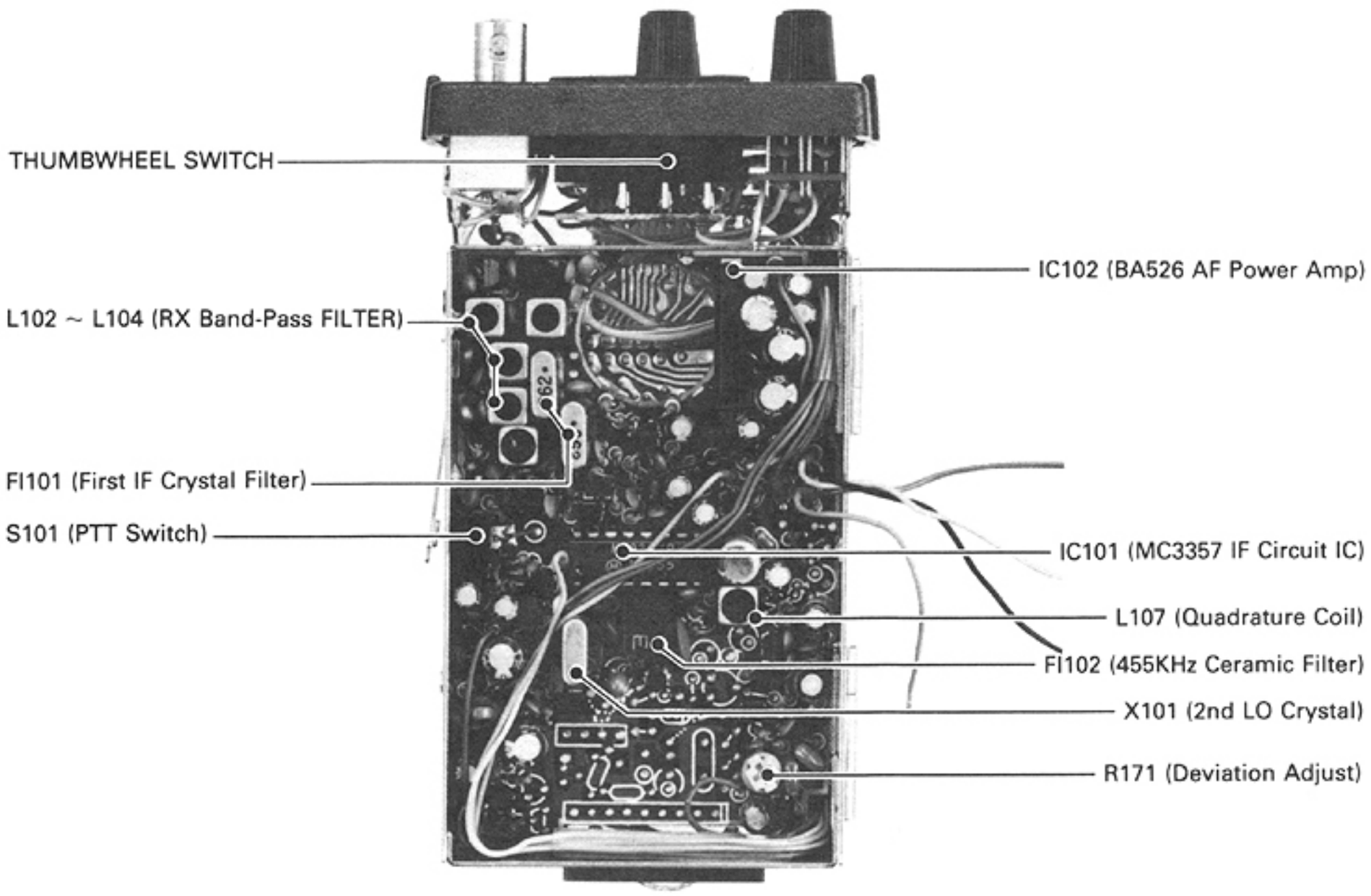
D402 and Q401 are the reset circuit for initialization.

SECTION 4 BLOCK DIAGRAM

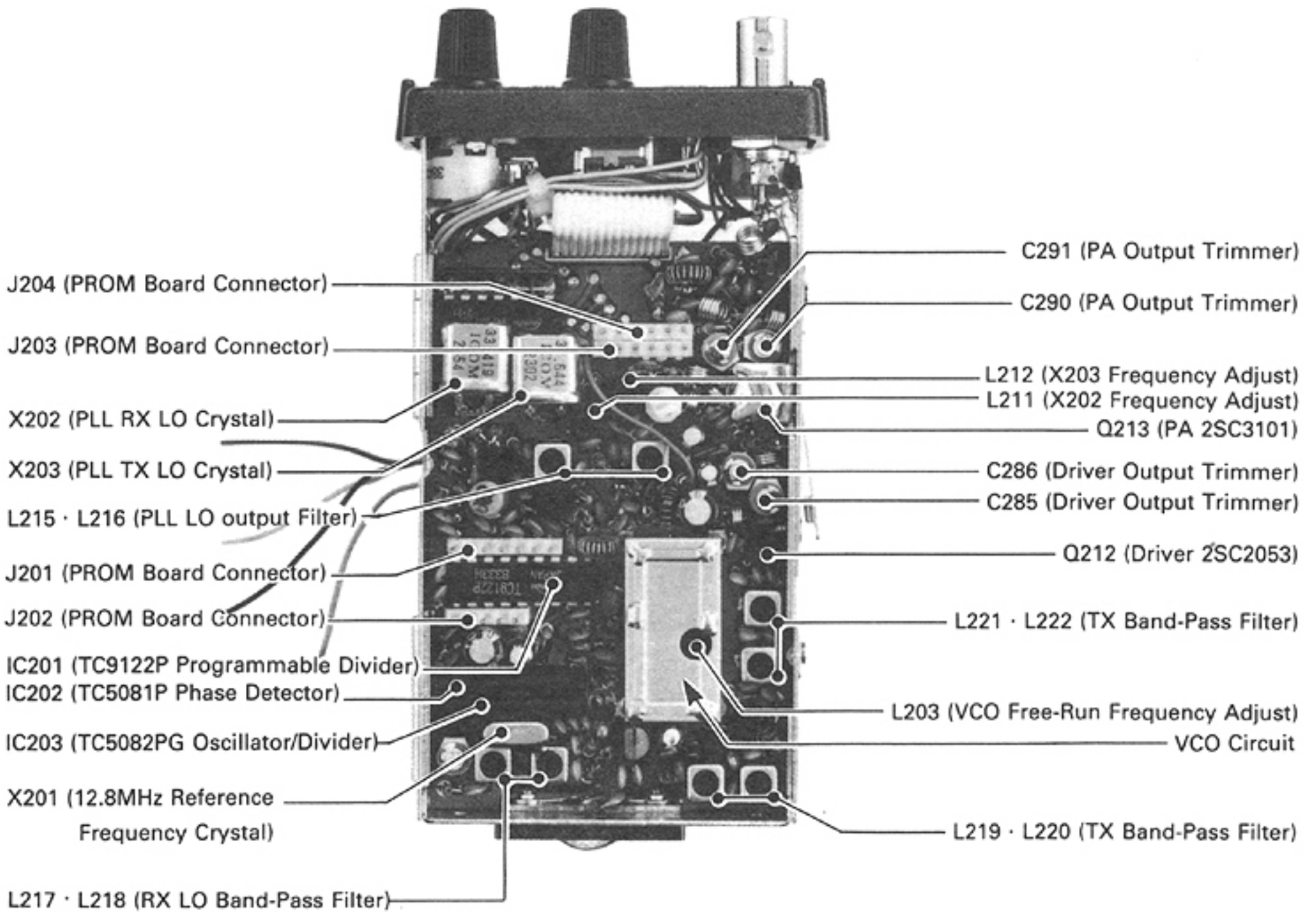


SECTION 5 INSIDE VIEWS

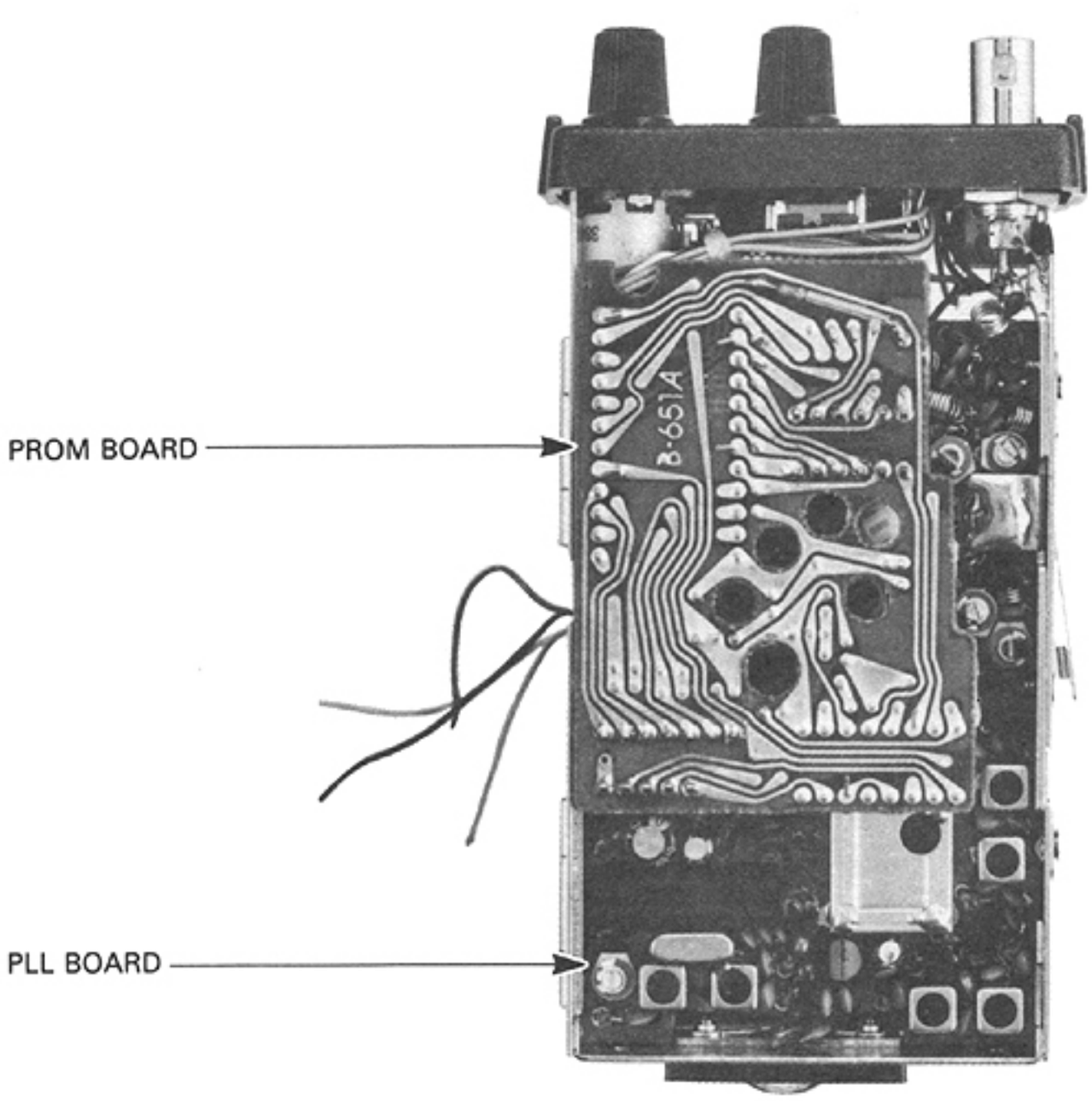
MAIN UNIT



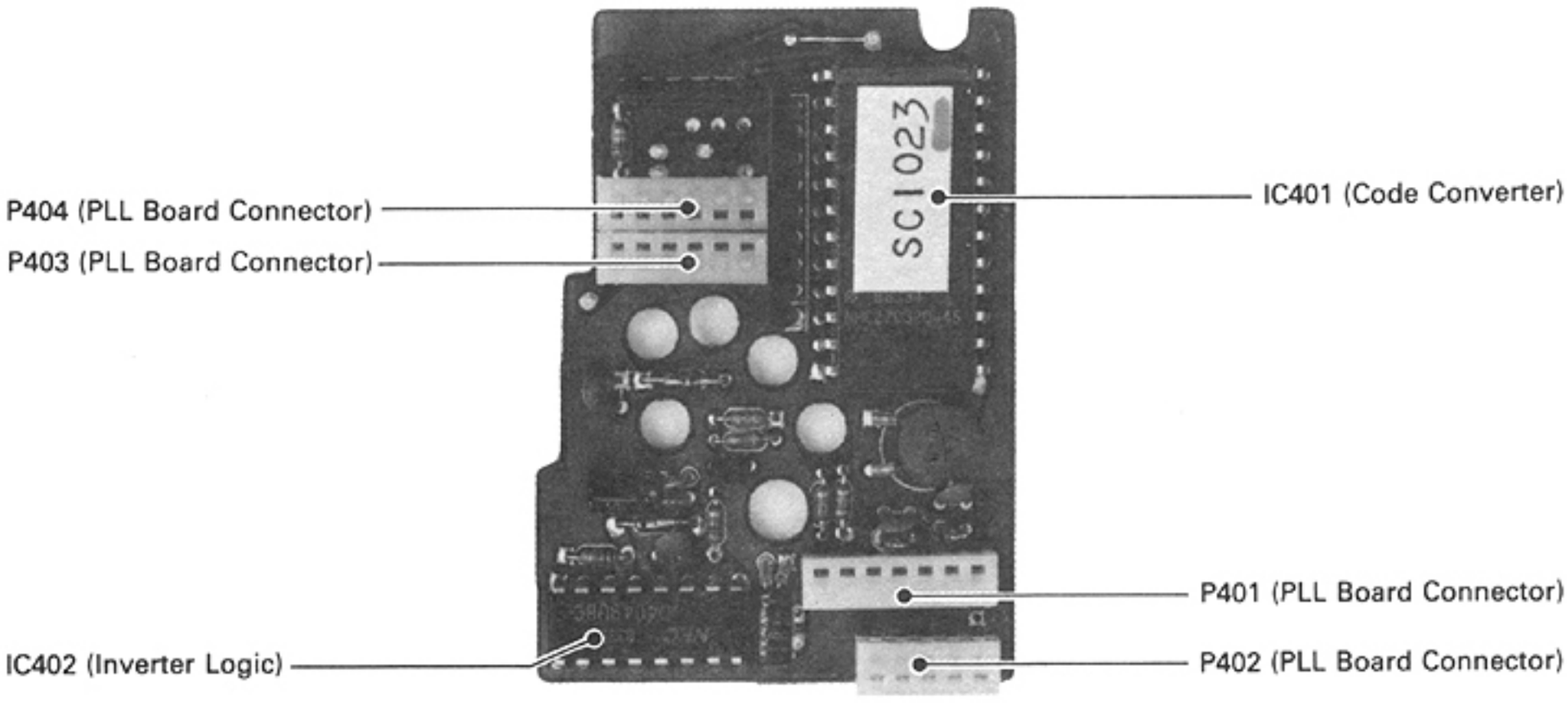
PLL UNIT



PROM UNIT
(P.C. SIDE)



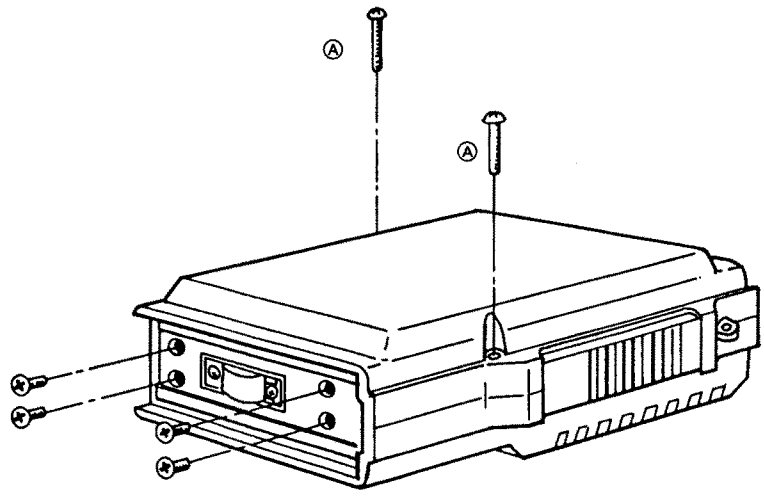
PROM UNIT
(COMPONENT SIDE)



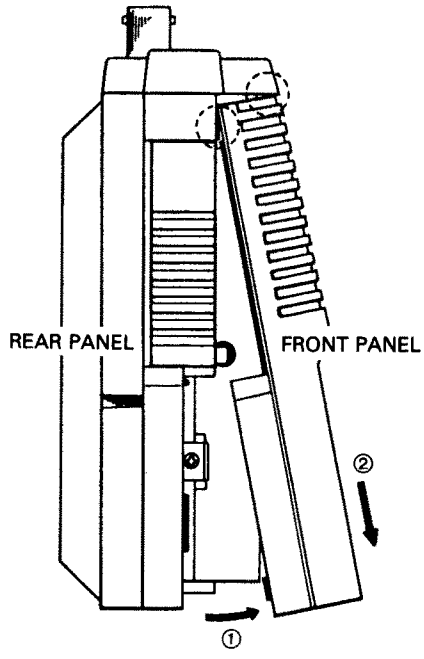
SECTION 6 MECHANICAL PARTS AND DISASSEMBLY

6 - 1 DISASSEMBLY OF THE CASE

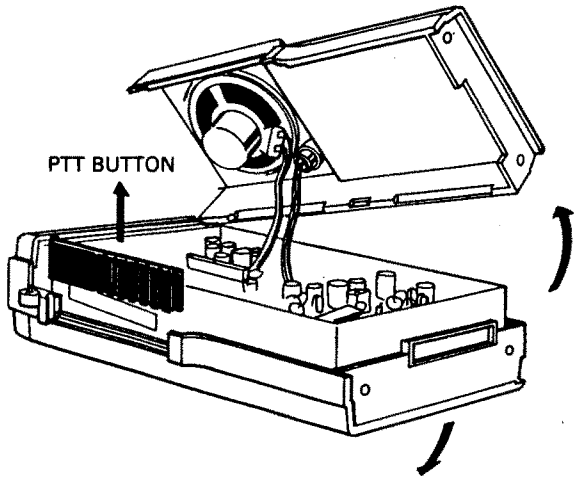
1. Turn the power switch off and remove the power pack.
2. Remove two screws Ⓐ on the rear panel and four screws on the bottom as shown in the figure.



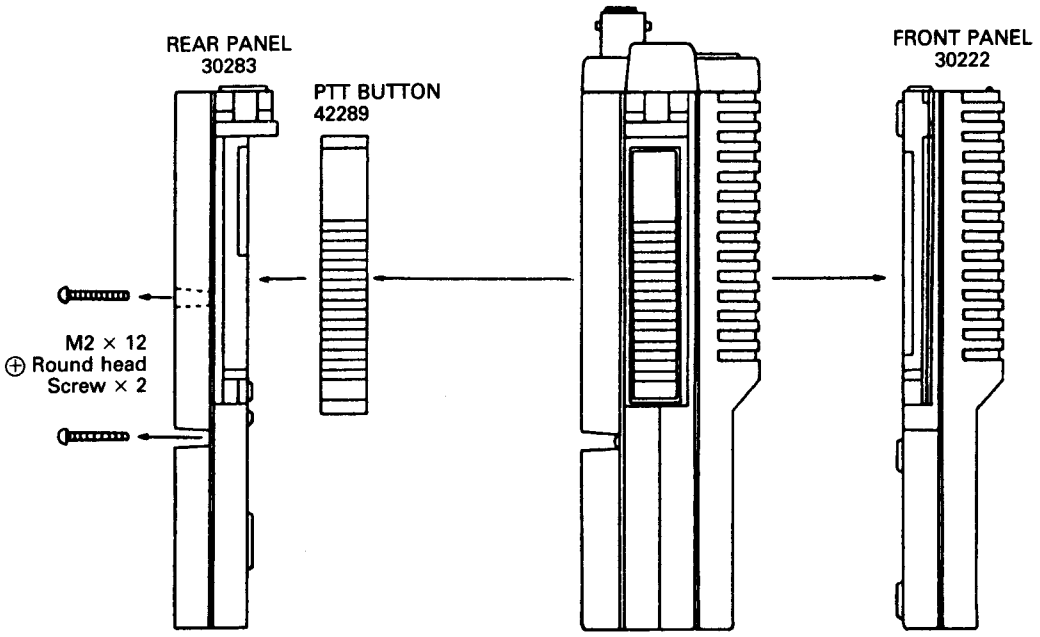
3. Remove the front panel as shown in the figure. At this time, be sure not to damage the engaged parts at the top (circled with dotted lines).
   ① open the bottom slightly and ② slide the front panel downwards.



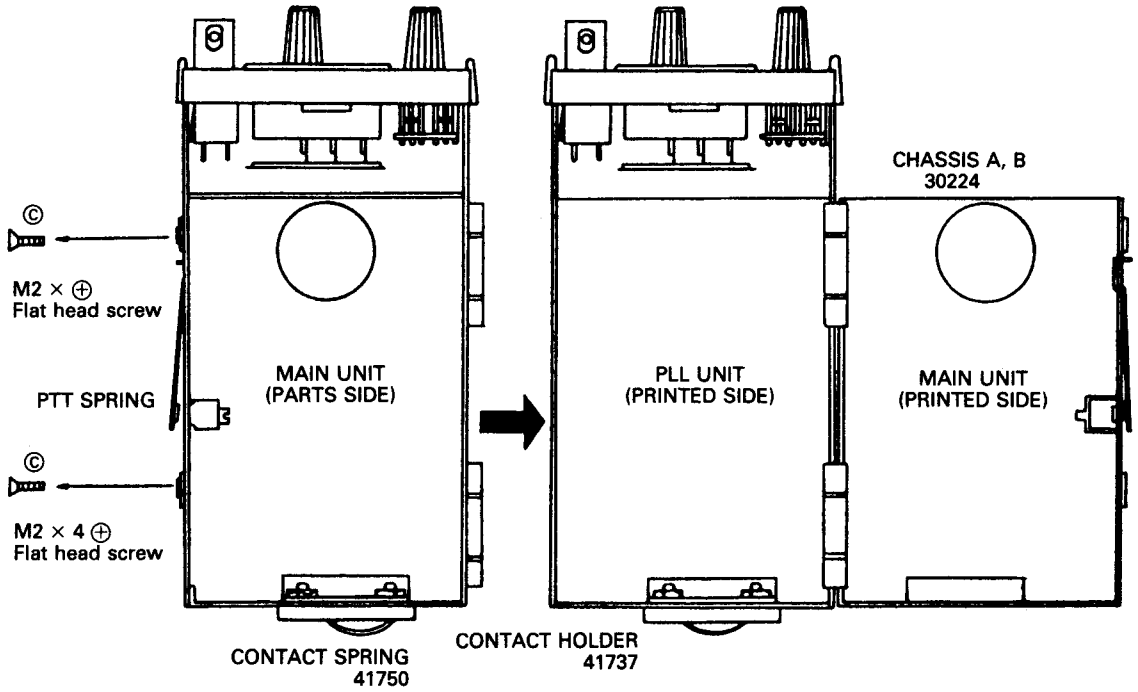
4. Slide the PTT Button upward, and then remove the rear panel.



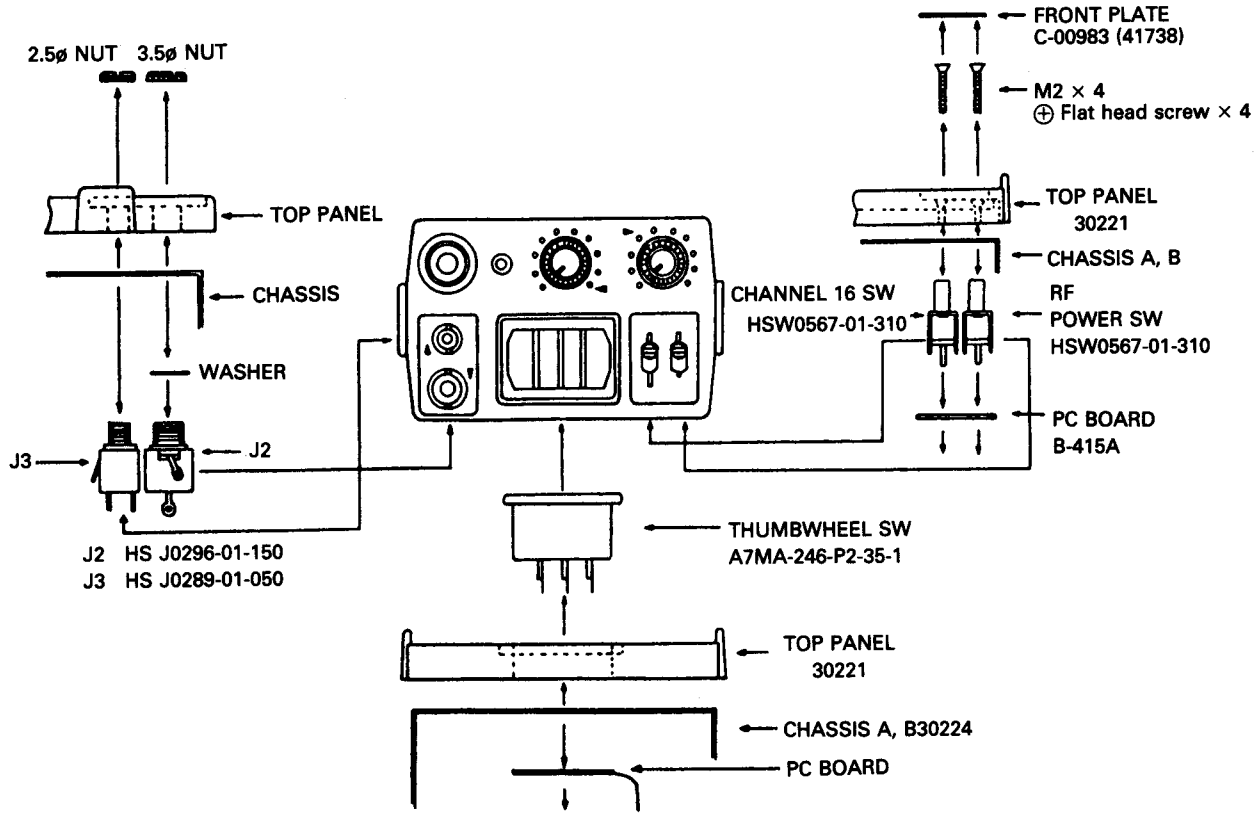
6 - 2 BOARD ACCESS



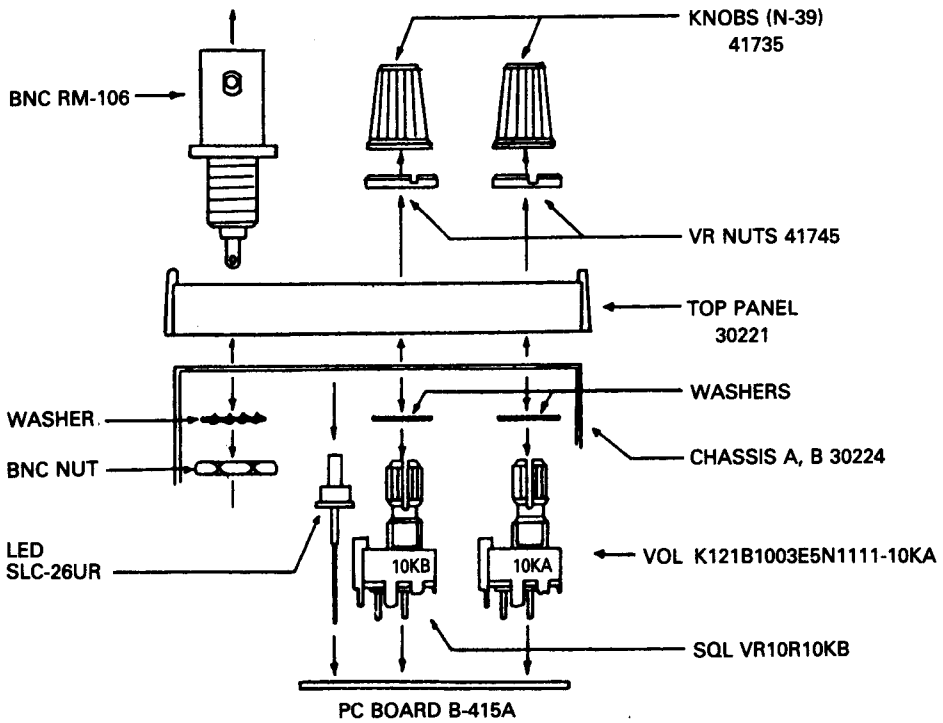
To see the printed sides of the PC boards, open the chassis by removing two screws © located above and below the PTT spring.



6 - 3 TOP PANEL CONSTRUCTION AND PART NAMES

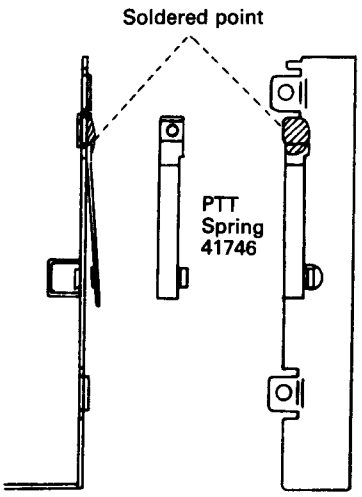


6 - 4 VOL/SQL CONTROLS AND BNC CONNECTOR ASSEMBLY

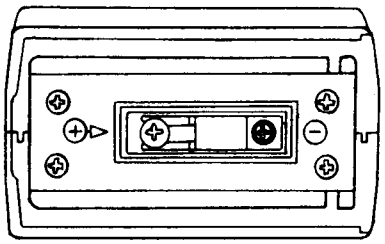


6 - 5 PTT SPRING ASSEMBLY (HOW TO REPLACE PTT SPRING)

1. The PTT spring is soldered at its top as shown in the figure.
2. Remove the old spring by heating the soldered point.
3. Solder the hole at the top of the new spring.
4. Make sure the new spring is soldered on parallel to the chassis.

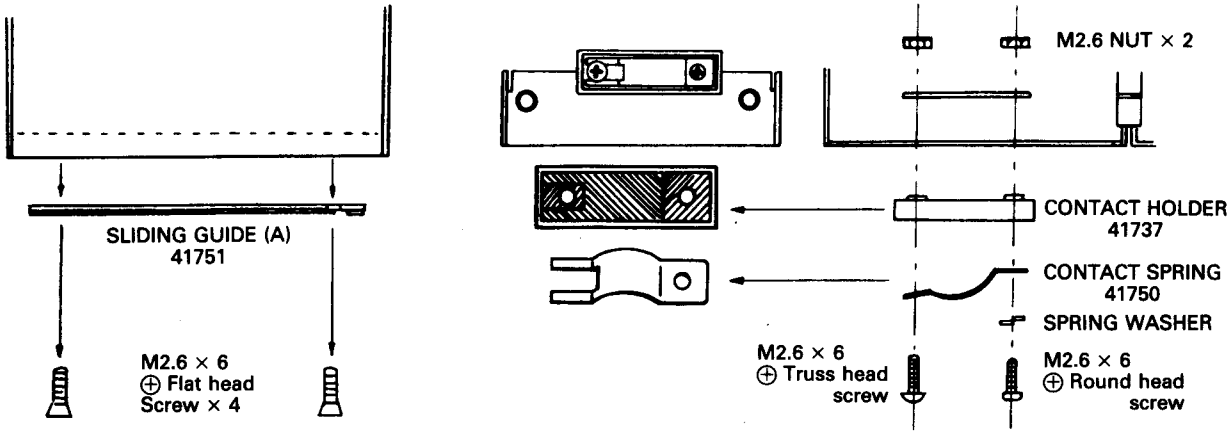


6 - 6 UNIT BOTTOM ASSEMBLY (BOTTOM VIEW)



(HOW TO REPLACE CONTACT SPRING)

1. Remove round head screws at contact spring.
2. Remove the old contact spring and set the new contact spring.
3. When setting the new contact spring, make sure the split end of the spring is on the positive side and the other end on the negative side.



SECTION 7 MAINTENANCE AND ADJUSTMENT

7 - 1 PREPARATION BEFORE SERVICING

1. Detach the power cord and turn off the power switch before performing any work on the radio.

2. Do not short circuit components while making adjustments.

3. Use an insulated tuning tool for all adjustments.

4. Do not force any of the variable components. Tune them slowly and smoothly.

5. Follow the instructions exactly. If an indicated result is not obtained, repeat the instruction until the correct result is obtained.

6. Check the condition of connectors, solder joints and screws when adjustments are complete. Confirm that components do not touch each other.

7. There are several versions of this radio. Adjustment procedures and results may differ for each version. Be certain to follow the correct procedure for the radio you have.

8. Confirm defective operation of the radio first when checking an out-of-service unit. Verify that external sources do not cause the problem.

9. Use the correct tools and test equipment.

10. Remove the transceiver case as shown on Page 6–1.
NOTE: Do not break the speaker or microphone wires when removing the front cover.

11. Remove the two screws to open the hinged chassis as shown on Page 6–2.

12. Attach an 8.0 ~ 11.0 volt DC external power source to the battery clip or screw. Be sure to check the polarity.

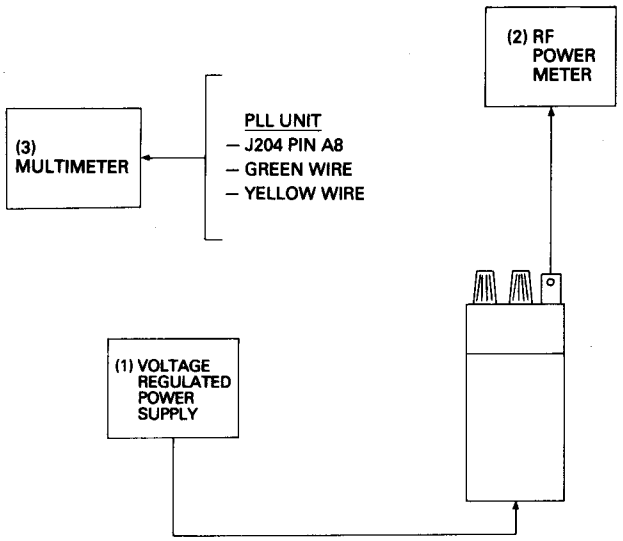
13. For transmission problems, attach a dummy load to the antenna connector. For reception problems, attach an antenna or signal generator to the antenna connector. Do not transmit into the signal generator.

14. Recheck for the suspected malfunction with the power switch on.

15. Check the defective circuit. Measure the DC voltages of the collector, base and emitter of each transistor.

16. It is convenient to short circuit an accessory mic connector plug and insert it into the microphone jack when troubleshooting the transmitter.

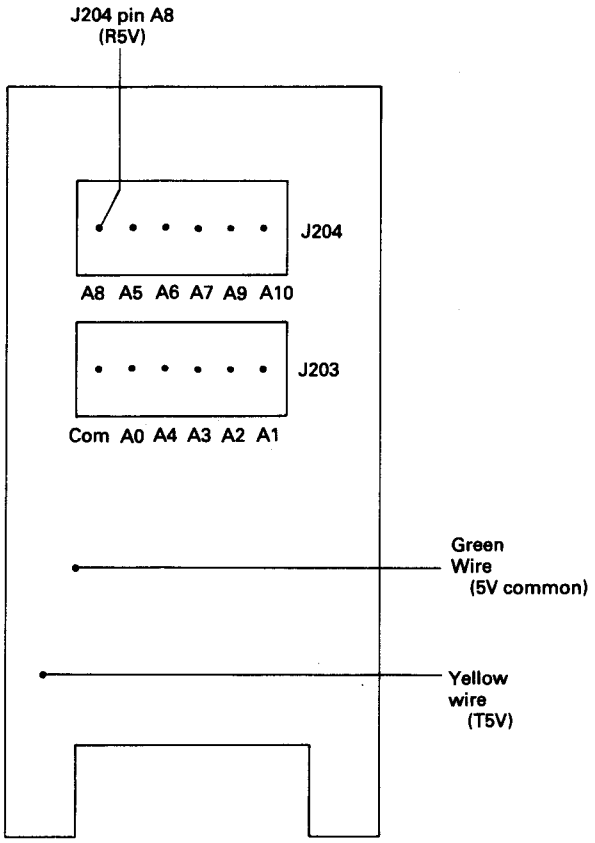
7 - 2 POWER SUPPLY CHECKS

INSTRUMENTS REQUIRED	CONNECTIONS
(1) VOLTAGE REGULATED POWER SUPPLY OR ATTENDANT POWER PACK : OUTPUT VOLTAGE DC 8.4V : CURRENT CAPACITY 1A (2) RF POWER METER (TERMINATED TYPE) : MEASURING RANGE 5W : FREQUENCY RANGE 140 ~ 170MHz : IMPEDANCE 50Ω : SWR Less Than 1 : 1 (3) MULTIMETER : INPUT IMPEDANCE 50kΩ/VOLT OR BETTER	

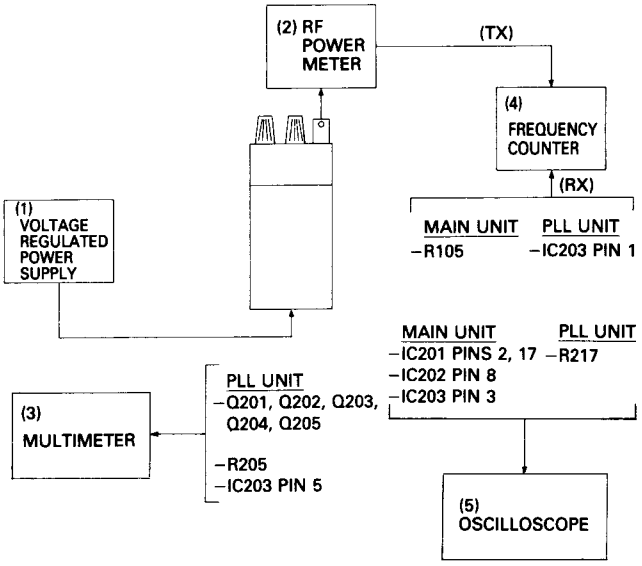
Adjustment		Adjustment conditions	Unit	Adjustment location	Adjustment value	Unit	Adjustment point
R5V	1.	• Receive mode	PLL	Connect the multimeter to J204 pin A8.	5.2V		
5V Common Supply	1.	• Receive mode	PLL	Connect the multimeter to the green wire from the MAIN unit.	5.2V		
T5V	1.	• Transmit mode	PLL	Connect the multimeter to the yellow wire from the MAIN unit.	5.2V		

PLL Unit

(Printed Circuit Side)

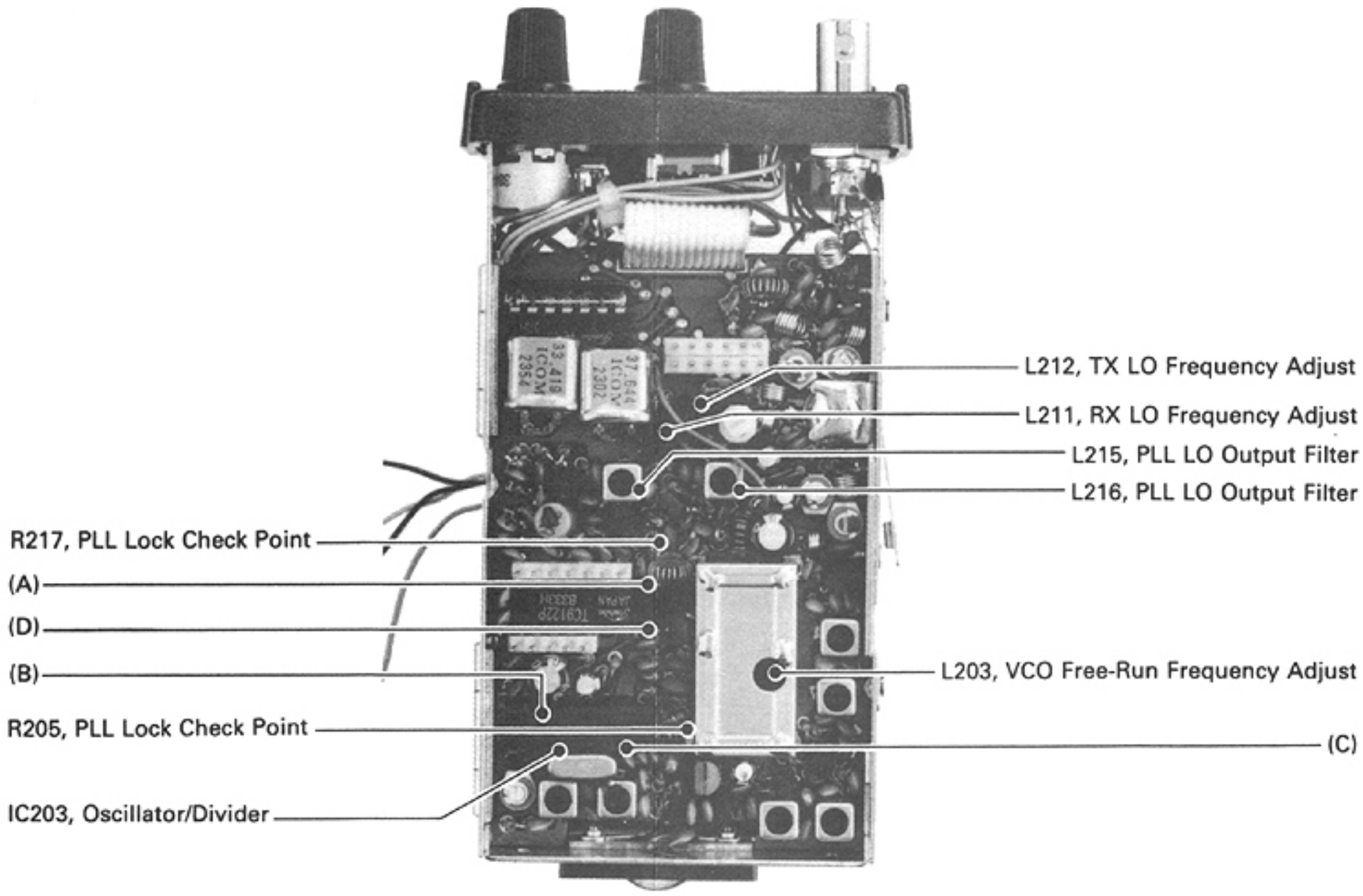


7 - 3 PLL ADJUSTMENT

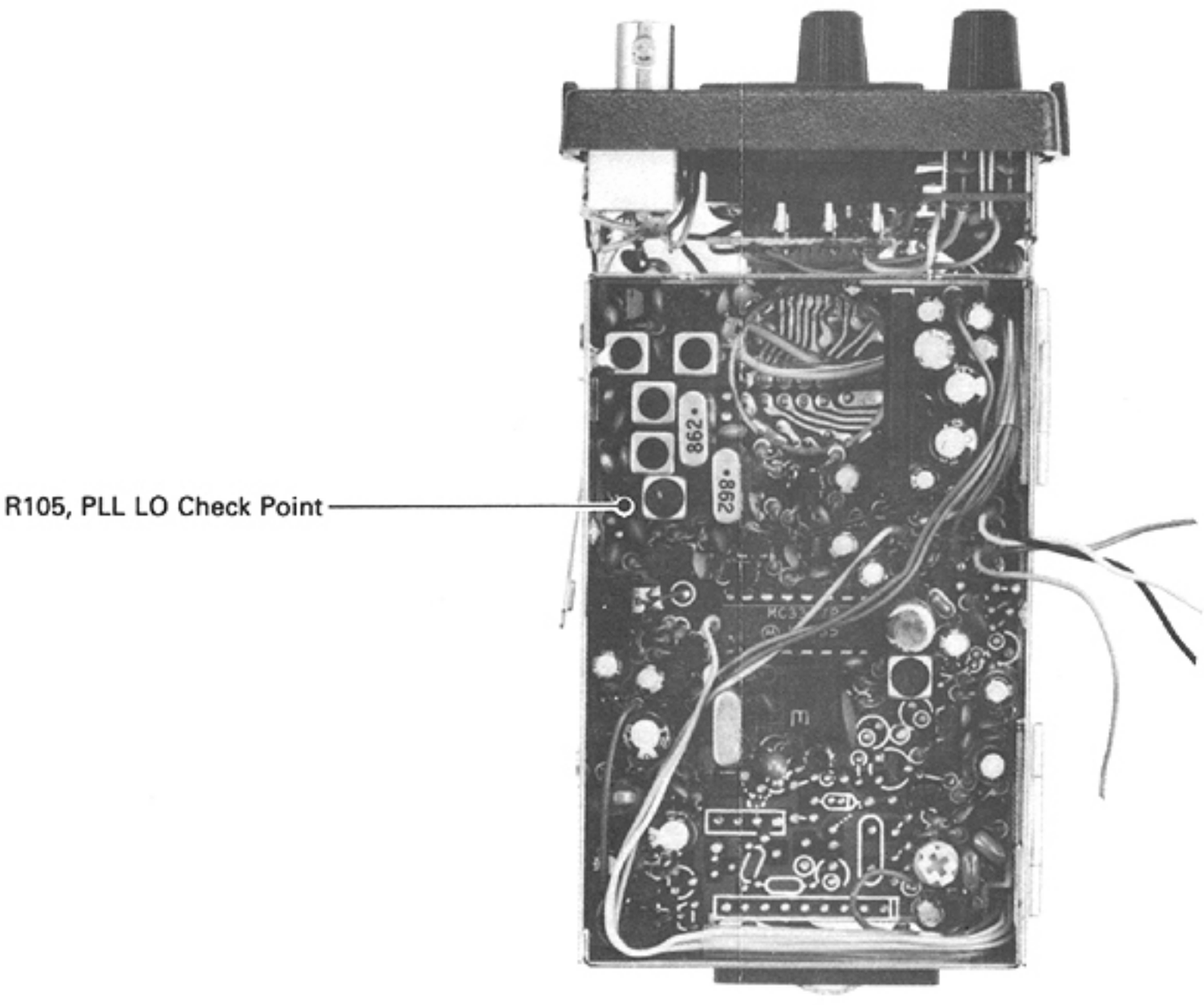
INSTRUMENTS REQUIRED		CONNECTIONS
(1) VOLTAGE REGULATED POWER SUPPLY OR ATTENDANT POWER PACK		
: OUTPUT VOLTAGE	DC 8.4V	
: CURRENT CAPACITY	1A	
(2) RF POWER METER (TERMINATED TYPE)		
: MEASURING RANGE	5W	
: FREQUENCY RANGE	140 ~ 170MHz	
: IMPEDANCE	50Ω	
: SWR	LESS THAN 1 : 1	
(3) MULTIMETER		
: INPUT IMPEDANCE	50kΩ/VOLT OR BETTER	
(4) FREQUENCY COUNTER		
: FREQUENCY RANGE	0.1 ~ 170MHz	
: ACCURACY	BETTER THAN ±1PPM	
: SENSITIVITY	100mV OR BETTER	
(5) OSCILLOSCOPE		
: FREQUENCY RANGE	DC ~ 20MHz	
: MEASURING RANGE	0.01 ~ 10V	

Adjustment		Adjustment conditions	Unit	Adjustment location	Adjustment value	Unit	Adjustment point
PRELIMINARY	1.	• Check the programmable divider input.	PLL	Connect the oscilloscope to point (A). [IC201 PIN 2]	Unstable or no waveform indicates lock failure.		
	2.	• Check the divided reference frequency.		Connect the oscilloscope to point (B). [IC202 PIN 8]	12.5kHz 5Vp-p squarewave.		
	3.	• Perform this step if a squarewave is not observed above.		Connect the multimeter to IC203 PIN 5. (DC 10V range)	5.2V		
	4.	• Check the Master Oscillator frequency.		Connect the oscilloscope to point (C). [IC203 PIN 3]	Check for a 12.8MHz signal.		
	5.	• Check the programmable divider output.		Connect the oscilloscope to point (D). [IC201 PIN 17]	Check for a waveform.		
	6.	• Check transistor voltages.		Connect the multimeter to Q201, Q202, Q203, Q204 and Q205.	See voltage information in Section 9.		
PLL LOCK	1.	• The PLL is locked under normal conditions. The voltage range is 0 ~ 5V.	PLL	Connect the multimeter to R205.	1VDC	PLL	L203
	2.	• Receive mode. • CHANNEL SELECTOR: CH16		Connect the oscilloscope to R217.	Maximum peak-to-peak value on the oscilloscope.		L216
	3.	• Transmit mode.					L215
	4.	• Reset CHANNEL SELECTOR switch to CH26. Repeat steps 2 and 3 several times.					L216, L215
	5.	• Reset CHANNEL SELECTOR switch to CH16.		Connect the multimeter to R205.	1.0 ± 0.3VDC		
	6.	• Receive and transmit modes.		Connect the oscilloscope to R217.	Over 2Vp-p over radio's frequency range.		
		NOTE: If PLL does not lock, check R5V, T5V, 5V common, and the PLL L.O. and reference frequency oscillator. Refer to Sections 7-2 and 7-3.					
REFERENCE FREQUENCY OSCILLATOR	1.	• Use a capacitor between the counter probe and circuit.	PLL	Connect the counter to IC203 PIN 1.	12.800MHz ± 250Hz		
PLL L.O. FREQUENCY	1.	• CHANNEL SELECTOR: CH16. • Receive mode.	MAIN	Connect the counter to R105.	146.105MHz (U.K. version: 139.900MHz)	PLL	L211
	2.	• Transmit mode.			156.800MHz		L212
	3.	• Repeat steps 1 and 2 several times.			±500Hz		L211, L212

PLL UNIT



MAIN UNIT



7 - 4 TRANSMITTER ADJUSTMENT

INSTRUMENTS REQUIRED

(1) VOLTAGE REGULATED POWER SUPPLY OR ATTENDANT POWER PACK
: OUTPUT VOLTAGE — DC 8.4V
: CURRENT CAPACITY — 1A

(2) RF POWER METER (TERMINATED TYPE)
: MEASURING RANGE — 5W
: FREQUENCY RANGE — 140 ~ 170MHz
: IMPEDANCE — 50Ω
: SWR — LESS THAN 1 : 1

(3) RF VOLTMETER
: FREQUENCY RANGE — 0.1 ~ 170MHz
: MEASURING RANGE — 0.01 ~ 10V

(4) MULTIMETER
: INPUT IMPEDANCE — 50kΩ/VOLT OR BETTER

(5) AF OSCILLATOR
: OUTPUT FREQUENCY RANGE — 200 ~ 3,000Hz
: OUTPUT VOLTAGE — 0 ~ 200mV
: DISTORTION — LESS THAN 0.1%

(6) OSCILLOSCOPE
: FREQUENCY RANGE — DC ~ 20MHz
: MEASURING RANGE — 0.01 ~ 10V

(7) AMMETER
: MEASURING RANGE — 0 ~ 1 A DC

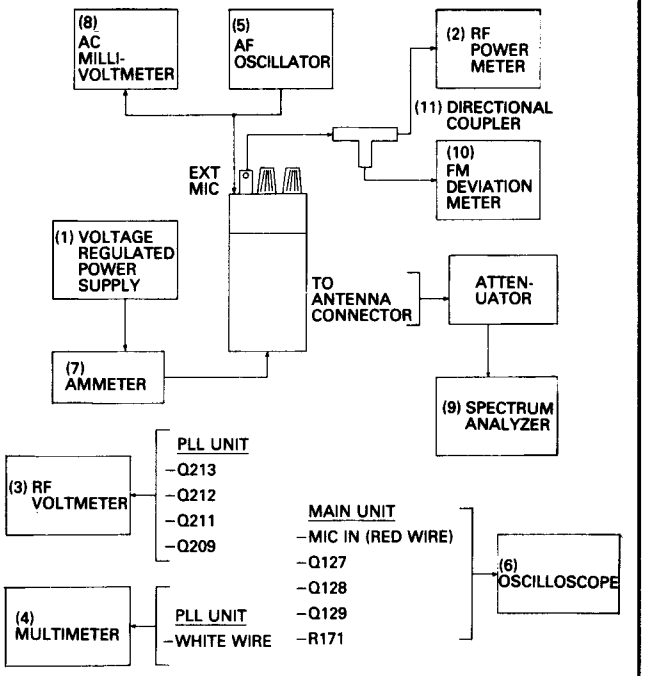
(8) AC MILLIVOLTMETER
: MEASURING RANGE — 10mV ~ 2V

(9) SPECTRUM ANALYZER
: FREQUENCY RANGE — 0.1 ~ 170MHz

(10) FM DEVIATION METER
: FREQUENCY RANGE — 140 ~ 170MHz
: MEASURING RANGE — 0 ~ ±10kHz

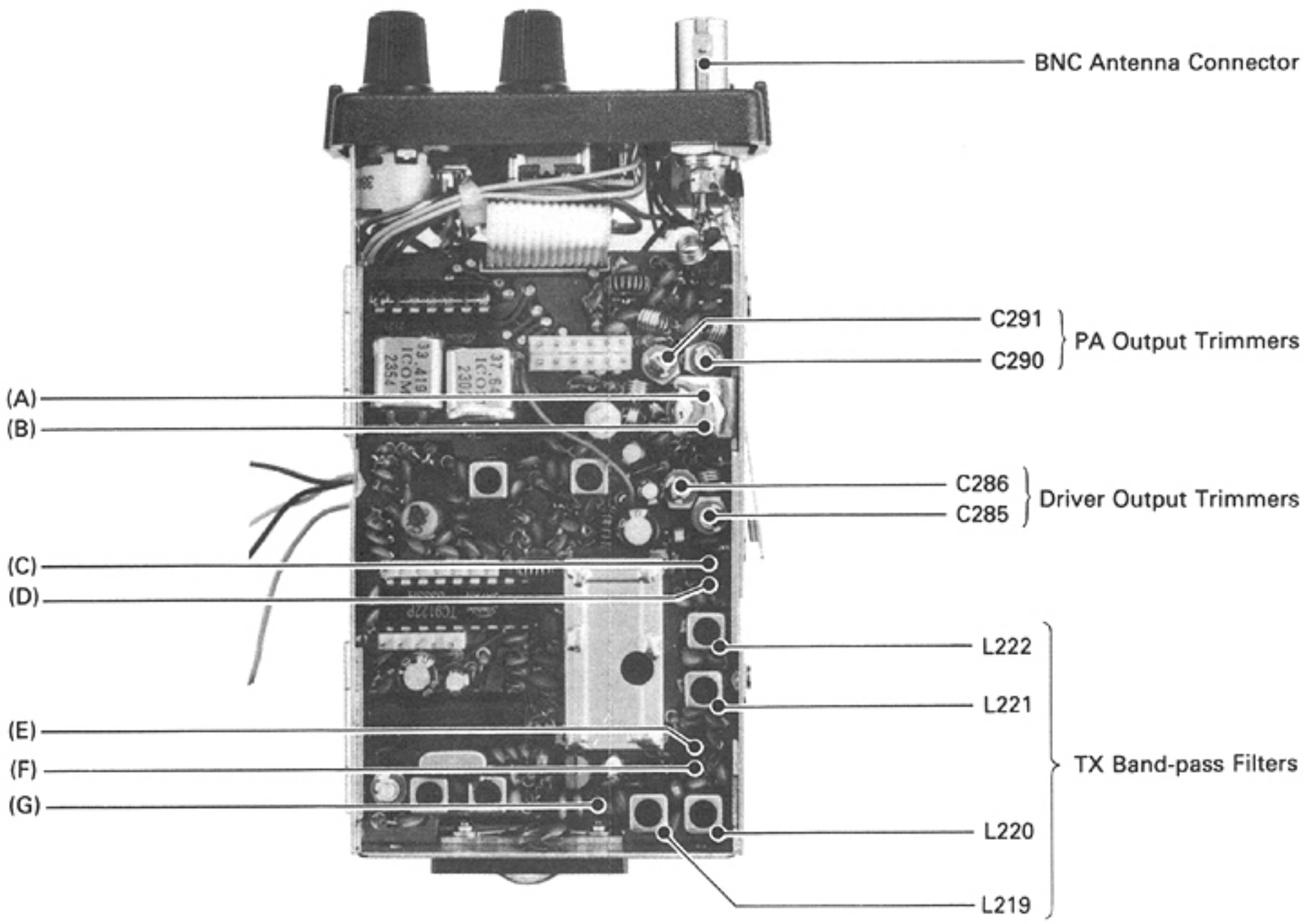
(11) DIRECTIONAL COUPLER
: FREQUENCY RANGE — 140 ~170MHz

CONNECTIONS

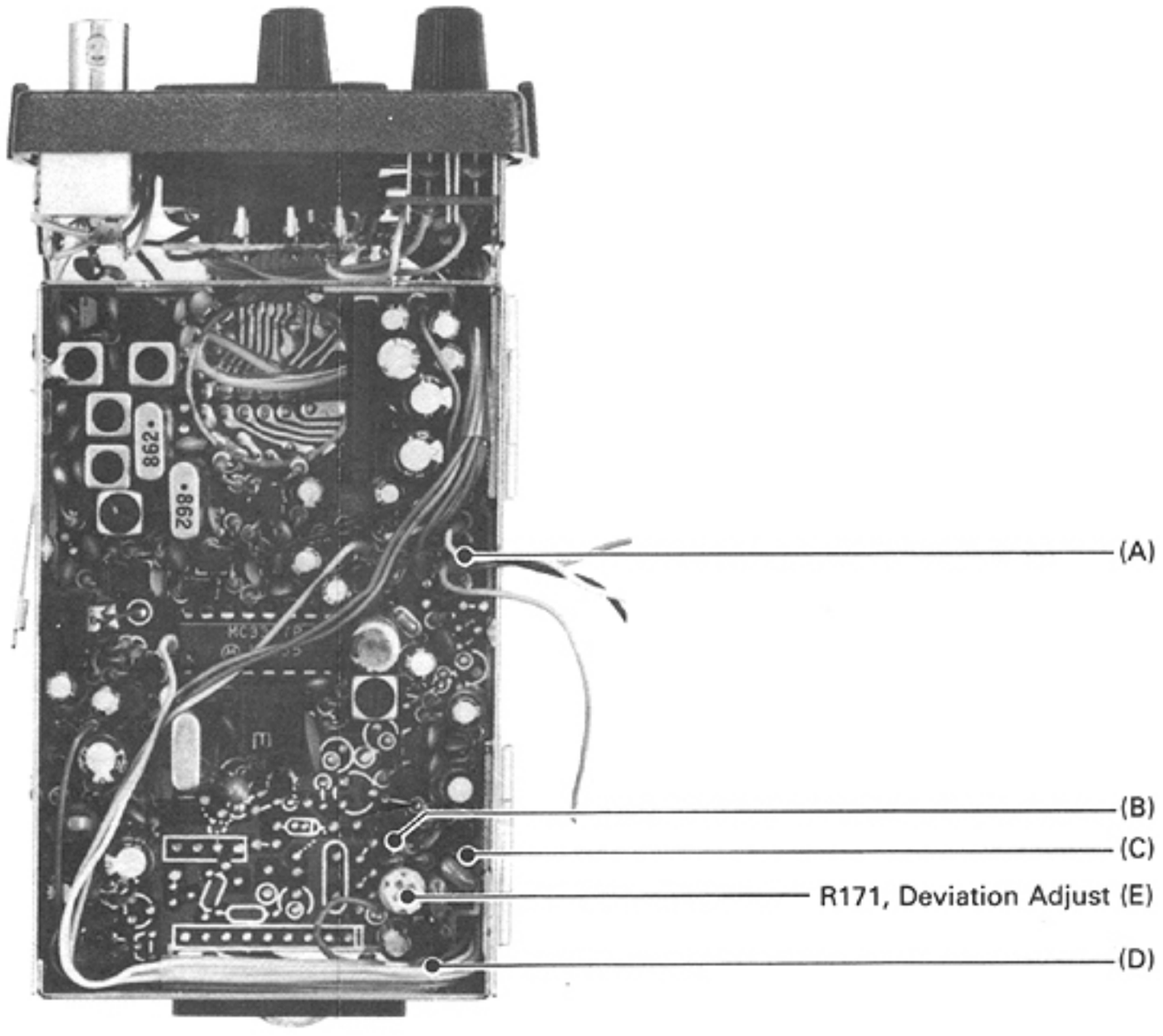


Adjustment		Adjustment conditions	Unit	Adjustment location	Adjustment value	Unit	Adjustment point
PRELIMINARY	1.	• Check the RF output power with RF POWER switch in HIGH position. • Transmit mode.		Connect the RF power meter to the ANTENNA CONNECTOR.	2W (Australia: 1W)		
	2.	• Check the main points in the transmission path. • Transmit mode.	PLL	Connect the RF voltmeter to: (A) Q213 collector (B) Q213 base (C) Q212 collector (D) Q212 base (E) Q211 collector (F) Q211 base (G) Q209 emitter	Verify RF is present.		
	3.	• If the output power is low, check the regulated power supply voltage. • Do not adjust the coils.		Connect the multimeter to the white wire. (DC 10V range)	5.2V		
		NOTE: It is not possible to measure the DC voltage accurately with a multimeter when RF is present.					
	4.	• Check main audio voltages. • Transmit mode.	MAIN	Connect a 1kHz 40mV signal to EXT MIC connector. Connect the oscilloscope to: (A) MIC IN (Red wire) (B) Q127 base (C) Q128 base (D) Q129 base (E) R171	Verify AF is present.		
OUTPUT POWER	1.	• RF POWER SWITCH: HIGH • CHANNEL SELECTOR: CH16 • Transmit mode.		Connect the RF power meter to the ANTENNA CONNECTOR.	Maximum power.	PLL	L219 ~ L222 C285, C286, C290, C291
	2.	• Perform this step if the current drain is more than 500mA. • Transmit mode.		Connect the ammeter in series between the power supply and the radio.	500mA maximum		C291
	3.	• Repeat step 1.					
	4.	• Confirm correct power and current. • Transmit mode.		RF power meter: ANTENNA CONNECTOR Ammeter: In series between power supply and radio.	2W (Australia: 1W) 500mA maximum		
	5.	• Transmit mode.		Vary the voltage from 5.5V to 10.8V	No change from step 4.		
DEVIATION, MODULATION SENSITIVITY, S/N RATIO	1.	• Deviation meter deemphasis: OFF • CHANNEL SELECTOR: CH16 • Transmit mode.		Connect a 1kHz 120mV RMS signal to the EXT MIC jack. Connect the RF power meter and the deviation meter to the ANTENNA CONNECTOR using a directional coupler.	4.5kHz deviation ±10%	MAIN	R171
	2.	• Check the modulation sensitivity.		Adjust the AF oscillator to 1kHz 12mV ± 3dB.	3.5kHz deviation		
	3.	• Check the transmit signal-to-noise ratio. • No audio input. • Transmit mode.		Remove the oscillator signal. Connect the millivoltmeter to the deviation meter output.	Record the reading.		
	4.	• Transmit mode.		Connect a 1kHz 40mV RMS signal to the EXT MIC jack. Connect the millivoltmeter to the deviation meter output.	Record the reading.		
		NOTE: The ratio of the readings taken in steps 3 and 4 must be greater than 40dB.					
SPURIOUS EMISSIONS	1.	• Measure the spurious signals. • Transmit mode.		Connect the spectrum analyzer to the ANTENNA CONNECTOR.	Greater than 60dB below the fundamental frequency level.		
HARMONIC OUTPUT	1.	• Measure the harmonic levels. • Transmit mode.		Connect the spectrum analyzer to the ANTENNA CONNECTOR.	Greater than 60dB below the fundamental frequency level.		

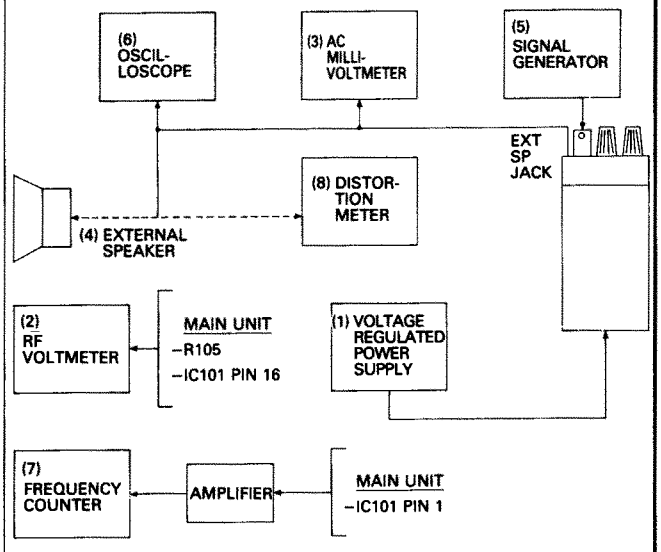
PLL UNIT



MAIN UNIT

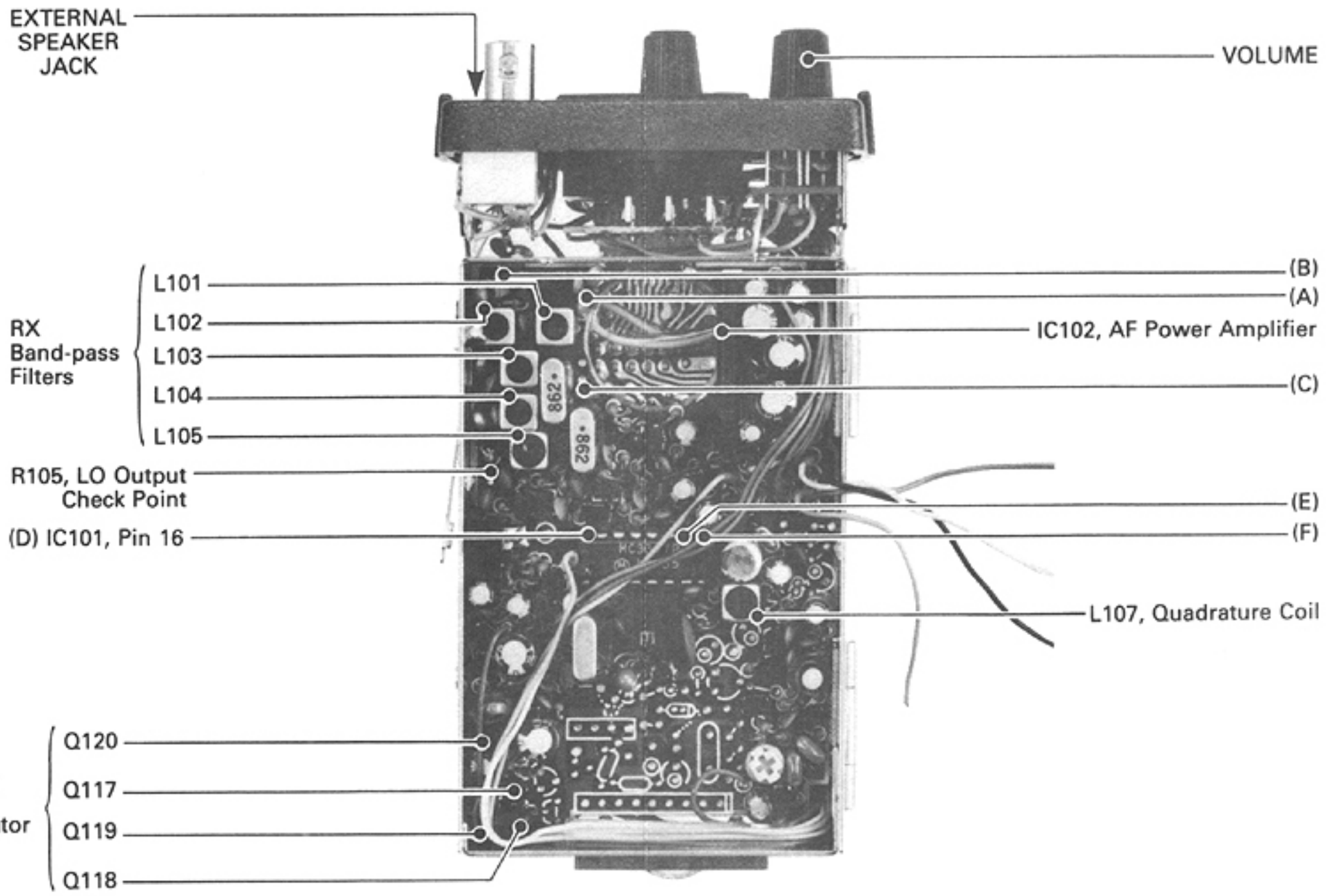


7 - 5 RECEIVER ADJUSTMENT

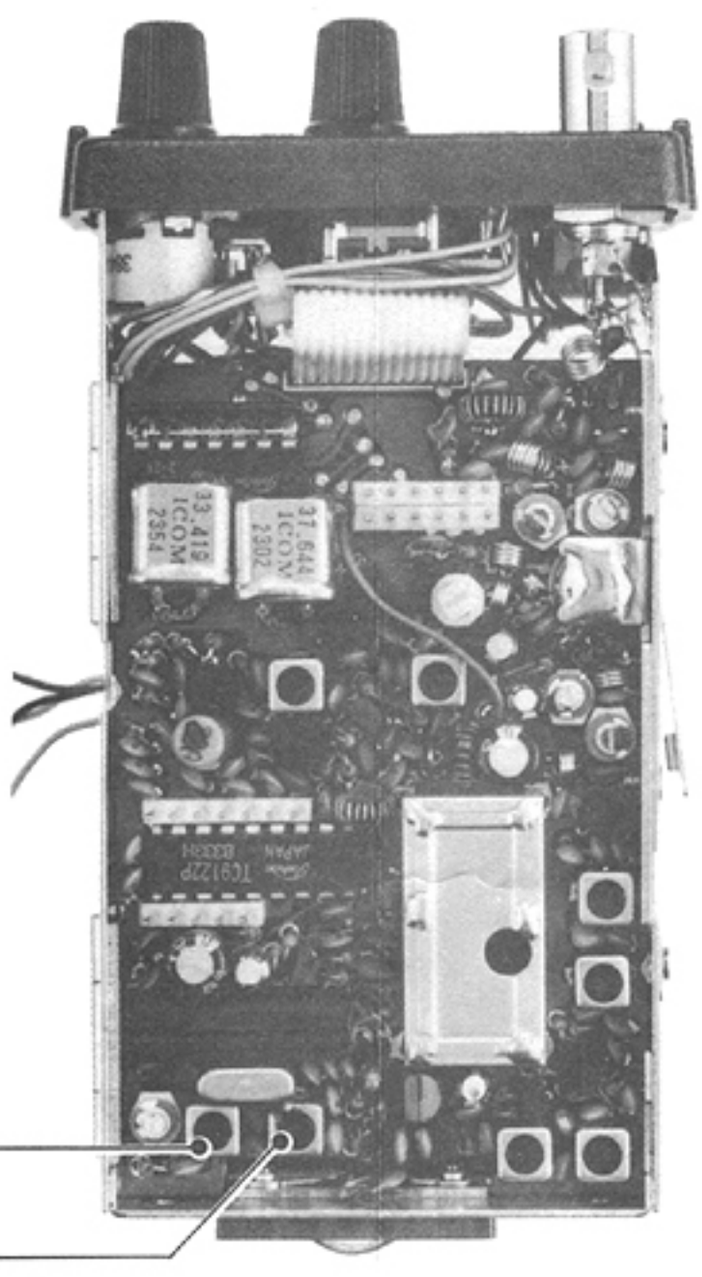
INSTRUMENTS REQUIRED		CONNECTIONS
(1) VOLTAGE REGULATED POWER SUPPLY OR ATTENDANT POWER PACK		
: OUTPUT VOLTAGE	DC 8.4V	
: CURRENT CAPACITY	1A	
(2) RF VOLTMETER		
: FREQUENCY RANGE	0.1 ~ 170MHz	
: IMPEDANCE	50Ω	
: SWR	LESS THAN 1 : 1	
(3) AC MILLIVOLTMETER		
: MEASURING RANGE	10mV ~ 2V	
(4) EXTERNAL SPEAKER		
: IMPEDANCE	8Ω	
(5) SIGNAL GENERATOR		
: FREQUENCY RANGE	0.1 ~ 170MHz	
: OUTPUT VOLTAGE	−20 to +90dB (0dB = 1μV)	
(6) OSCILLOSCOPE		
: FREQUENCY RANGE	DC ~ 20MHz	
: MEASURING RANGE	0.01 ~ 10V	
(7) FREQUENCY COUNTER		
: FREQUENCY RANGE	0.1 ~ 170MHz	
: ACCURACY	BETTER THAN ± 1PPM	
: SENSITIVITY	100mV or BETTER	
(8) DISTORTION METER		

Adjustment		Adjustment conditions	Unit	Adjustment location	Adjustment value	Unit	Adjustment point
PRELIMINARY	1.	• Check the 20dB noise quieting. • CHANNEL SELECTOR: CH16 • SQUELCH: CCW • No audio input to the ANTENNA JACK from the signal generator.		Bridge the AC millivoltmeter to the EXT SPEAKER jack. Connect the external speaker.	Full Scale.		VOLUME
		NOTE: Do not readjust the VOLUME after this step.					
	2.	• Set the signal generator to 156.8MHz		Connect the signal generator to the ANTENNA CONNECTOR.	20dB decrease in level.		Generator level
		NOTE: The signal generator output voltage is the 20dB quieting sensitivity.					
	3.	• Confirm the PLL works correctly.		See Section 7-3 PLL PRELIMINARY.			
	4.	• Check the receive path continuity. • Set the oscillator for an FM test signal with 1kHz modulation. • Use a 0.01μF capacitor between the generator output and the test points (A) to (D). (A) Q101 base-Inject CH FREQUENCY. (B) Q102 collector-Inject CH FREQUENCY. (C) C114-Inject 1st IF. (D) IC101 pin 16-Inject 1st IF.	MAIN	Monitor the receiver speaker. Connect the oscilloscope to test points (E) and (F). (E) IC101 pin 10 (F) IC101 pin 9	Check for an AF output.		
LOCAL OSCILLATOR OUTPUT	1.	• CH SELECTOR: CH16	MAIN	Connect the RF voltmeter to R105.	Maximum output.	PLL	L217, L218
	2.	• CH SELECTOR: CH26					
		NOTE: Repeat steps 1 and 2 to obtain the same readings on either CH 16 or 26. The final output voltage should be about 200mV.					
RF/IF STAGES	1.	• Set the signal generator for 156.8MHz. • Reduce the output level so the RF voltmeter reads just above the noise.	MAIN	Connect the RF voltmeter to IC101 pin 16. Connect the signal generator to the ANTENNA CONNECTOR.	Maximum RF voltmeter reading.	MAIN	L101 ~ L105
	2.	• Vary the generator ±10kHz. • Check for ripple at the output.			Ripple must be less than 3dB.		L105
	3.	• Inject a −80 to −90dBm signal with 3.5kHz deviation. • Tune the generator frequency to obtain the maximum output from the speaker.			Maximum RF voltmeter reading.		L107
		NOTE: Final settings should produce 20dB quieting for a −8dBμ (0.4μV) signal. See PRELIMINARY section for method of measuring 20dB quieting level.					
2ND LOCAL OSCILLATOR FREQUENCY	1.	• Loosely couple the frequency counter. • Use an amplifier between the counter and the test point.	MAIN	Connect the frequency counter to IC101 pin 1. (X101 frequency)	10.240MHz ± 400Hz. (U.K. version: 16.445MHz)		
RECEIVER SPURIOUS RESPONSE	1.	• Measure the spurious across the entire frequency band. • Terminate the ANTENNA CONNECTOR with a 50Ω load.		Bridge the AC millivoltmeter onto the EXT SPEAKER jack. Connect the external speaker.	All spurious should be more than 60dB down from a typical receive signal.		
RECEIVE AUDIO OUTPUT	1.	• Set the signal generator for −80 to −90dBm with 3.5kHz deviation. • Increase VOLUME for 10% distortion on AF signal.		Connect the signal generator to the ANTENNA CONNECTOR. Connect the oscilloscope, distortion meter and AC millivoltmeter in parallel with the EXT SPEAKER jack.		1.55V minimum	VOLUME

MAIN UNIT

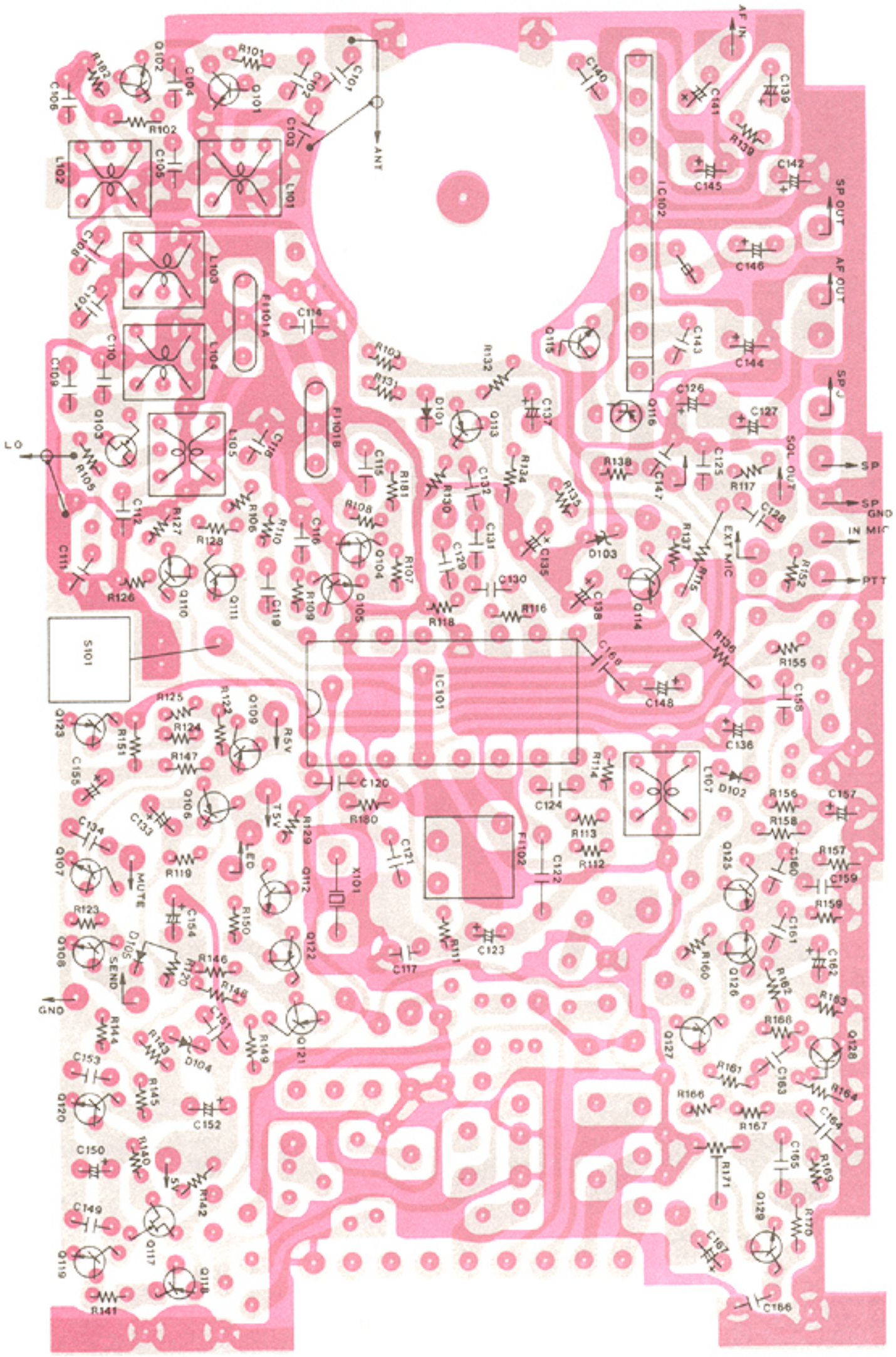


PLL UNIT

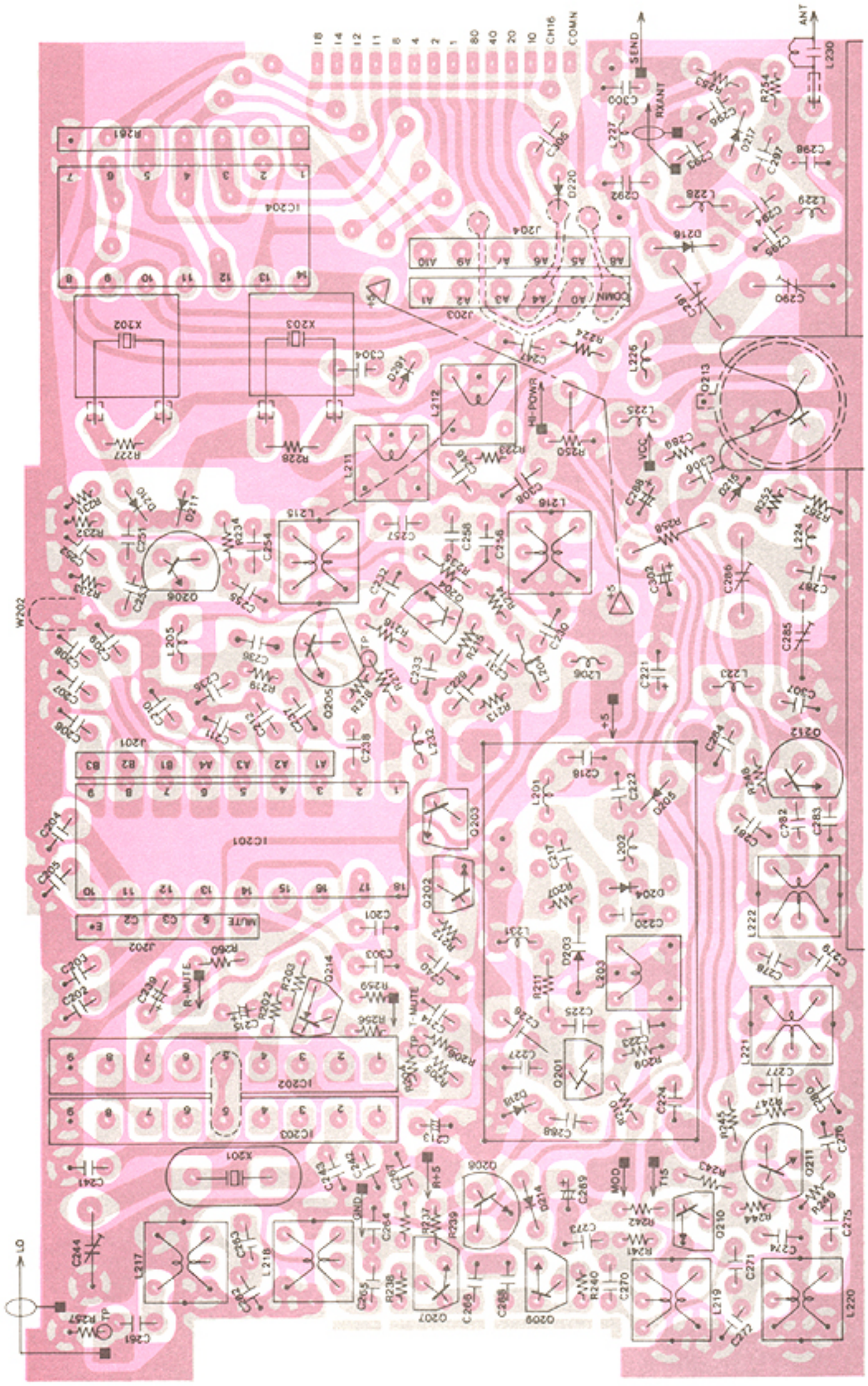


SECTION 8 BOARD LAYOUTS

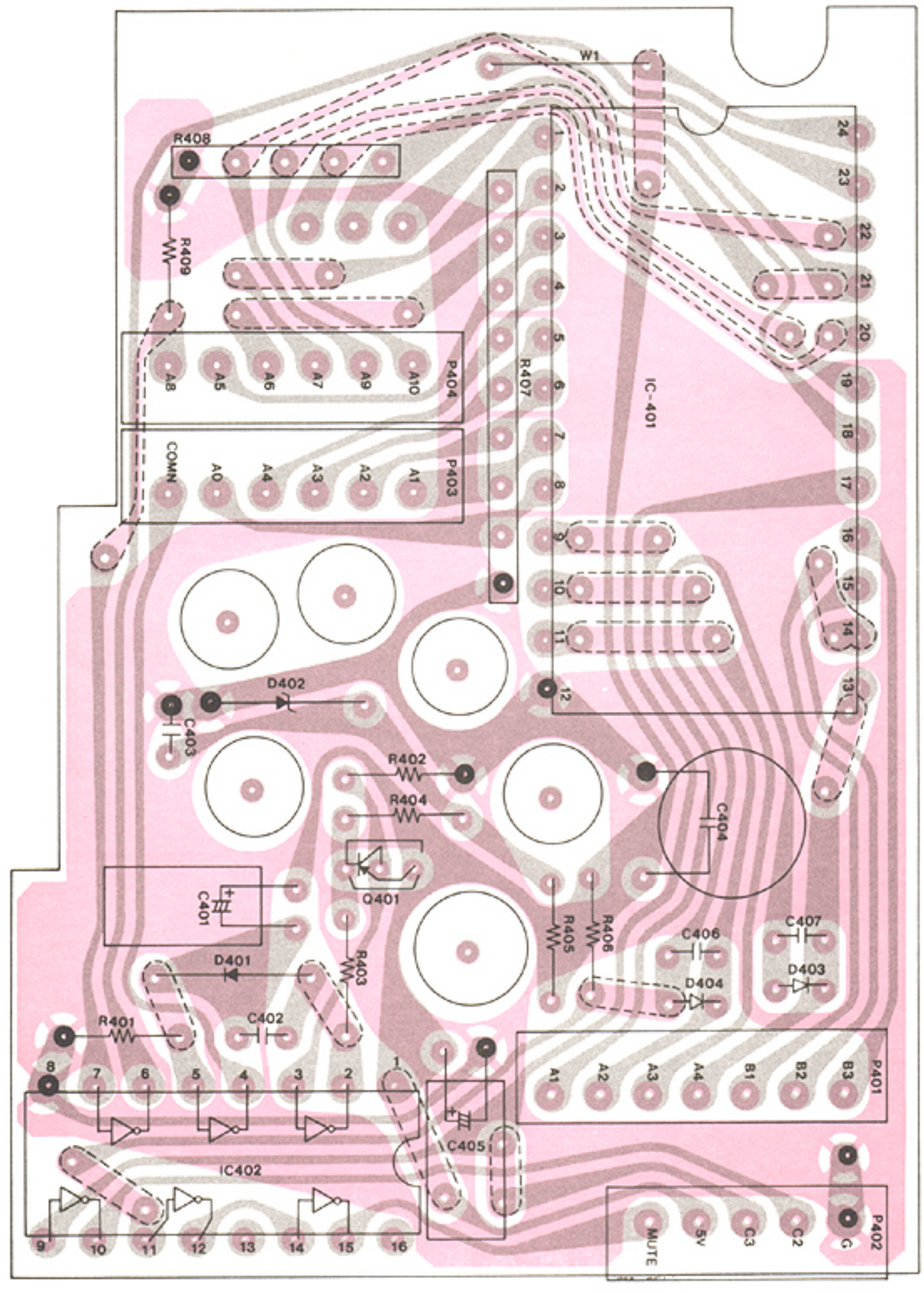
MAIN UNIT

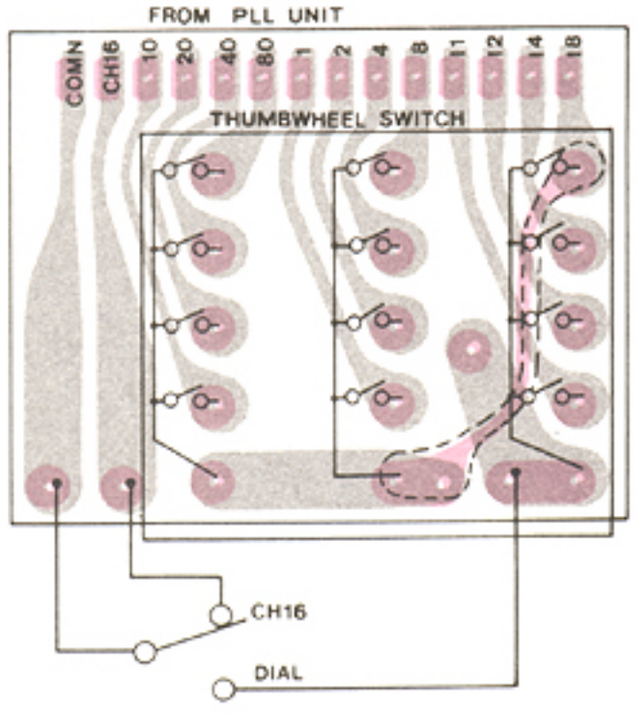


PLL UNIT



PROM UNIT


W1
R408
R409
P404
P403
COMN
A8
A5
A6
A7
A9
A10
A0
A4
A3
A2
A1
R407
IC-401
D402
C403
R402
R404
Q401
C401
C404
R405
R406
C406
C407
D403
D404
D401
R403
R401
C402
C405
IC402
P401
P402
MUTE
5V
C3
C2
G
B3
B2
B1
A4
A3
A2
A1

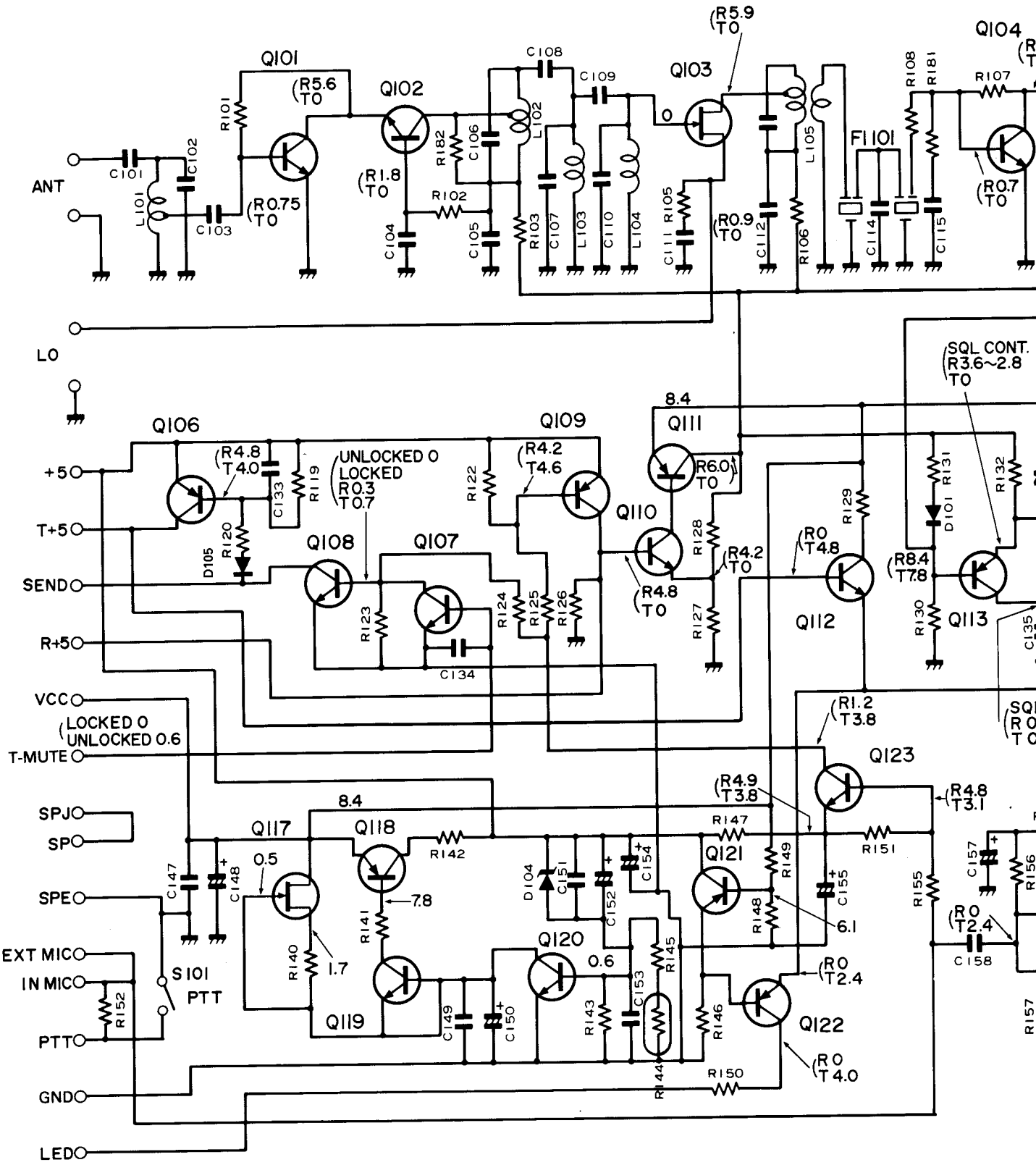

FROM PLL UNIT
COMN
CH16
10
20
40
80
1
2
4
8
11
12
14
18
THUMBWHEEL SWITCH
CH16
DIAL

SECTION 9 VOLTAGE DIAGRAMS

MAIN UNIT VOLTAGE DIAGRAM

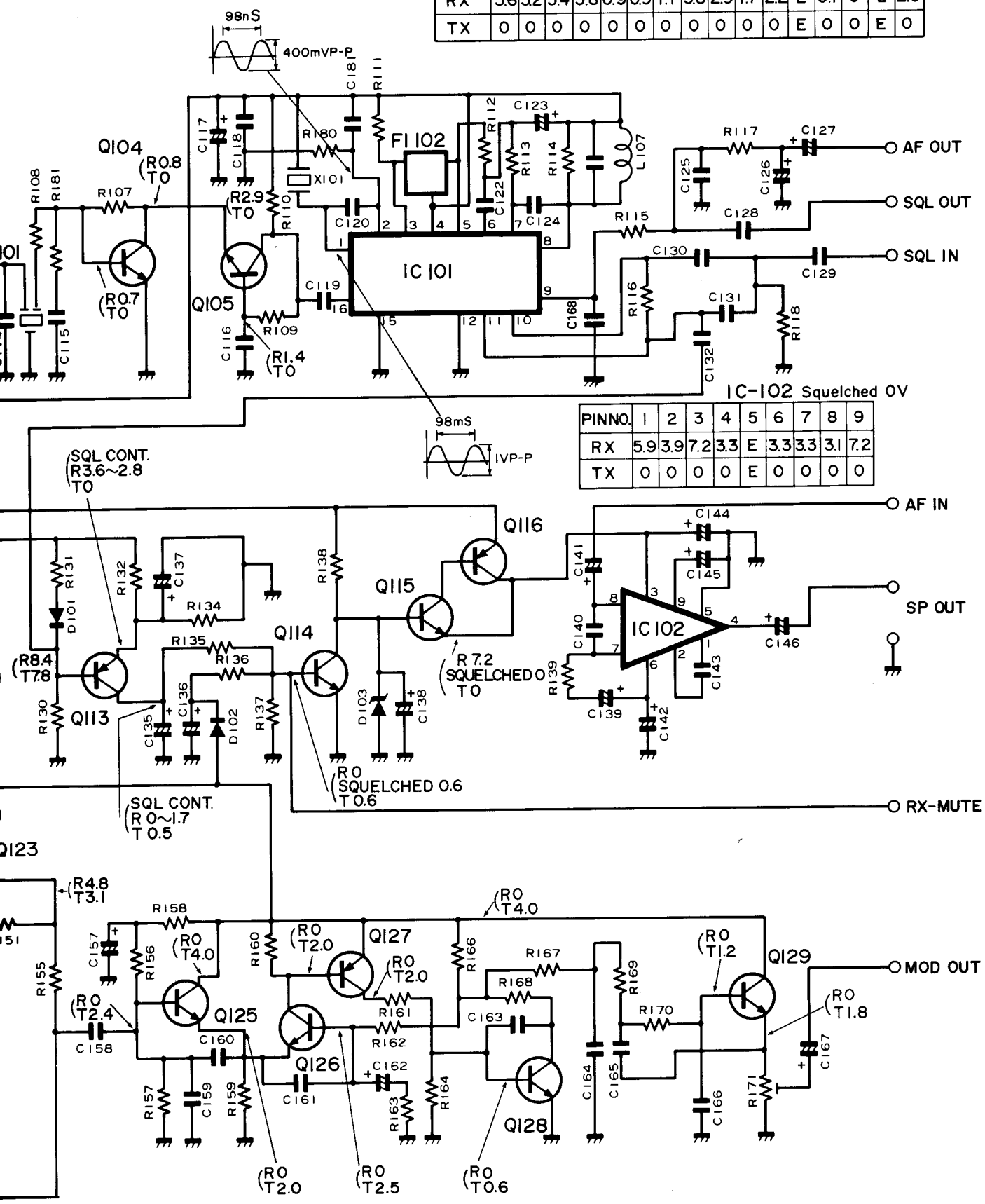
Set channel selector to channel "1,6,I".

TEST EQUIPMENT
DC V. 50KΩ/V MULTIMETER
RF V. 150MHz OSCILLOSCOPE



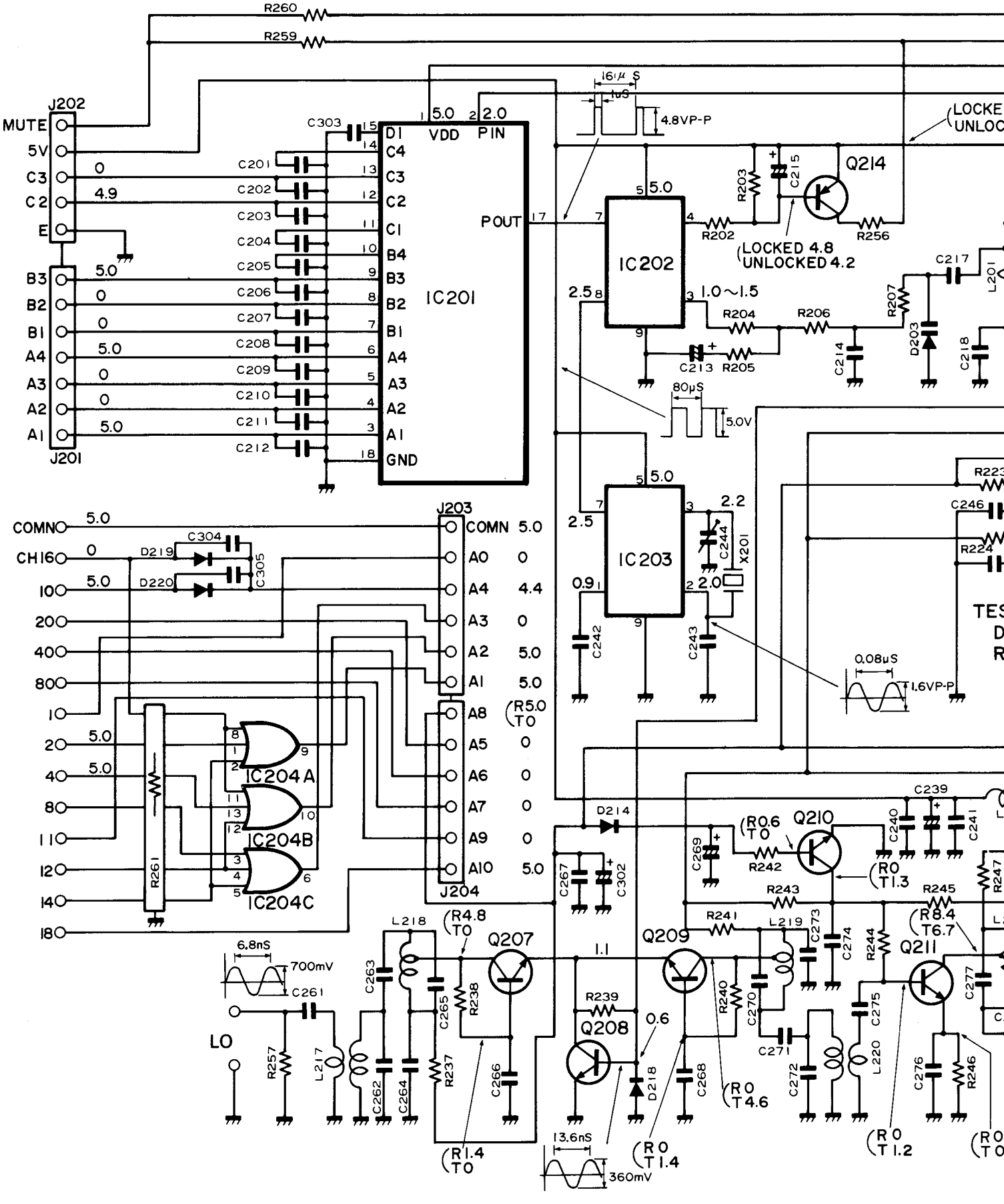
IC-101

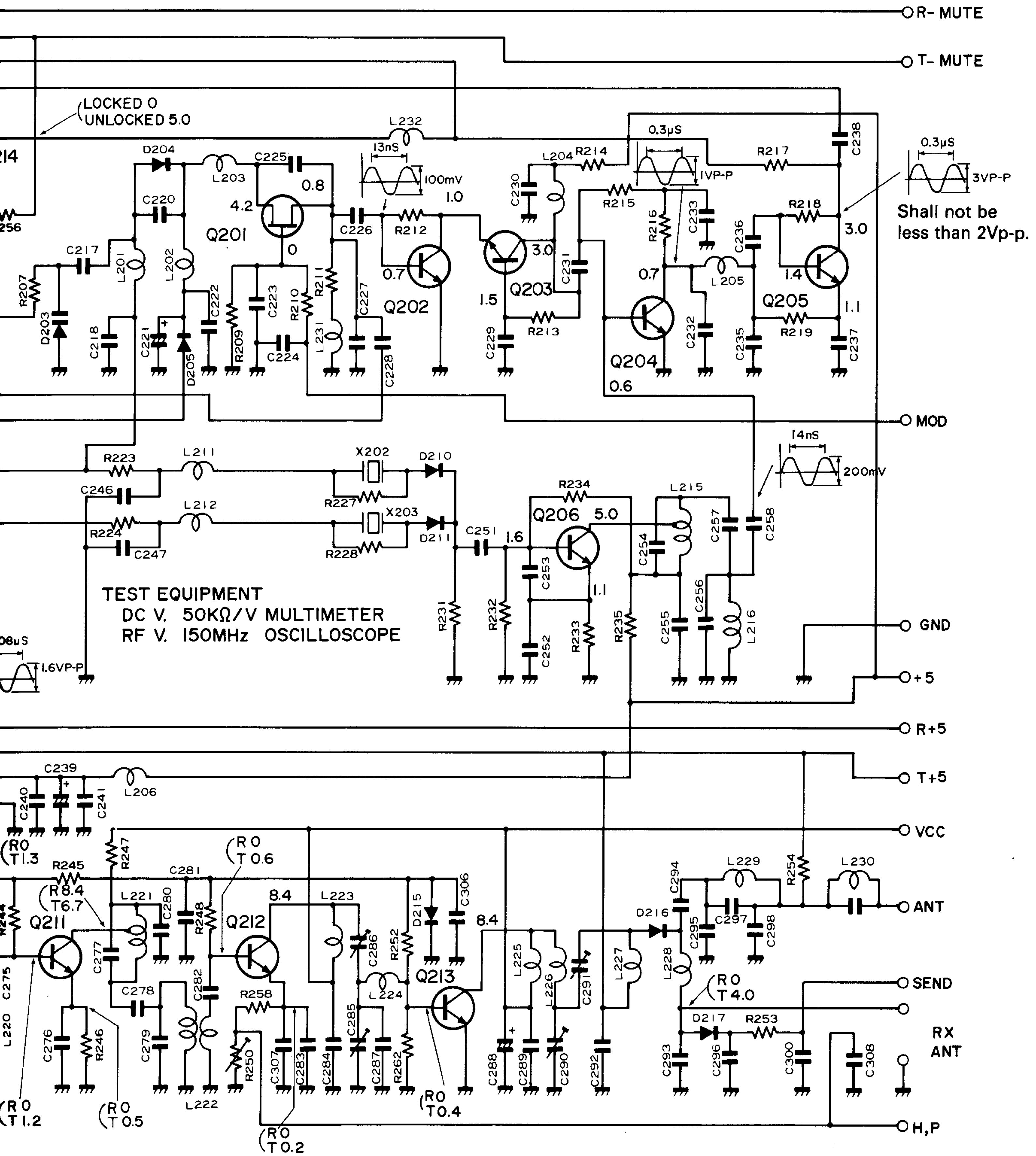
PIN NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
RX	5.6	5.2	5.4	5.8	0.9	0.9	1.1	5.8	2.9	1.7	2.2	E	5.1	0	E	2.0
TX	0	0	0	0	0	0	0	0	0	0	0	E	0	0	E	0



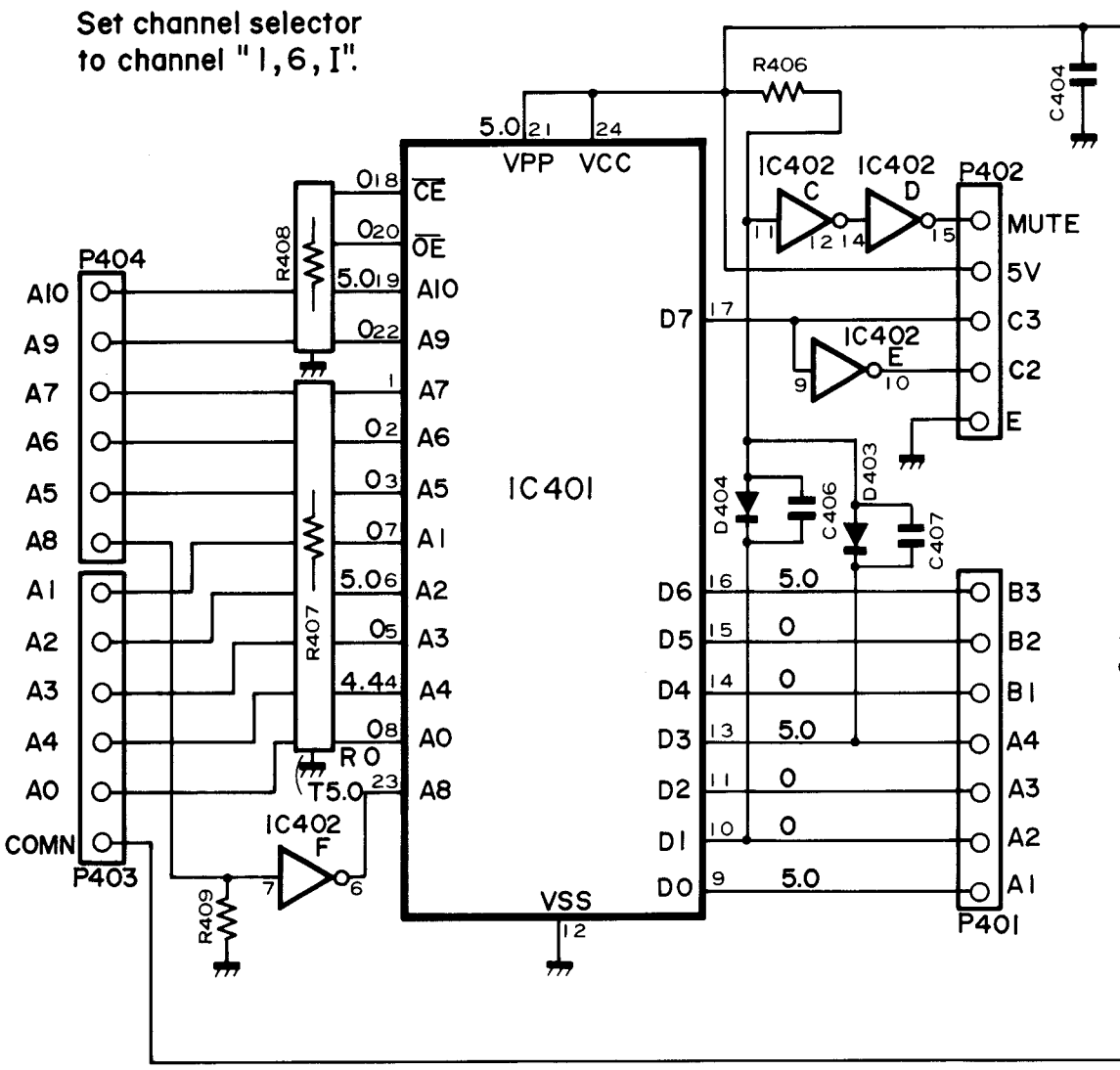
PLL UNIT VOLTAGE DIAGRAM

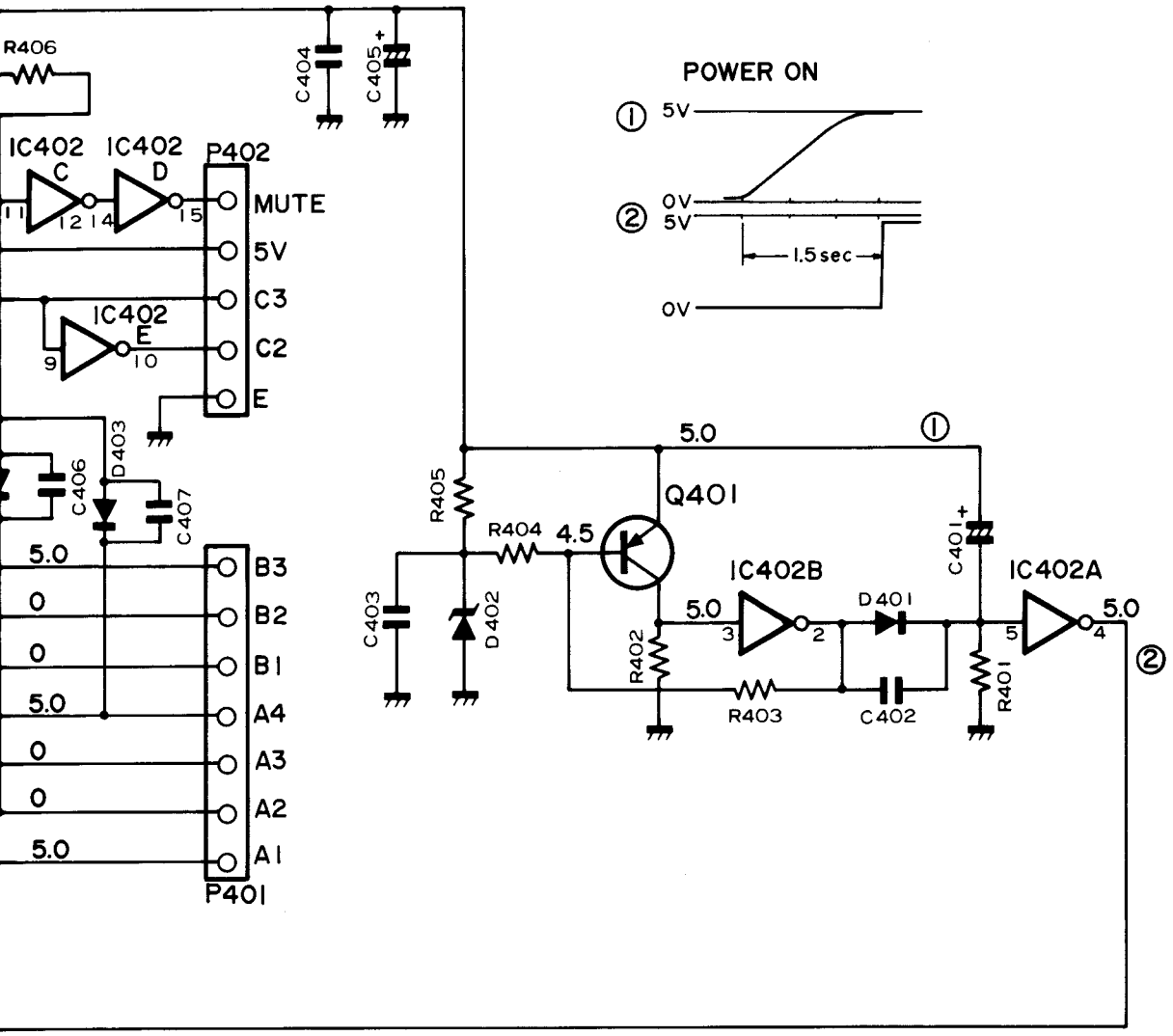
Set channel selector
to channel "1, 6, I".




R- MUTE
T- MUTE
LOCKED 0
UNLOCKED 5.0
L232
13nS
100mV
1.0
0.3μS
1VP-P
0.3μS
3VP-P
Shall not be less than 2Vp-p.
D204
L203
C225
0.8
4.2
Q201
0
C220
C217
C226
R212
0.7
Q202
L204
R214
R217
C238
C230
R215
R216
C233
R218
C236
3.0
Q203
1.5
C231
R213
C229
0.7
L205
1.4
Q205
1.1
C232
C235
R219
C237
Q204
0.6
R207
L201
L202
C222
R210
R211
C227
D203
C218
C221
D205
R209
C223
C224
L231
C228
MOD
14nS
200mV
R223
L211
X202
D210
C246
L212
R227
X203
R224
C247
R228
D211
C251
1.6
R234
Q206
5.0
L215
C257
C258
C254
C253
1.1
C255
C256
L216
TEST EQUIPMENT
DC V. 50KΩ/V MULTIMETER
RF V. 150MHz OSCILLOSCOPE
1.6VP-P
R231
R232
C252
R233
R235
GND
+5
R+5
C239
L206
C240
C241
T+5
VCC
R0
T1.3
R247
R0
T0.6
R245
C281
R8.4
T6.7
L221
C280
R248
8.4
L223
C306
D215
8.4
Q211
Q212
C277
C286
R252
Q213
C278
C282
R258
L224
C285
C276
R246
C279
L222
R250
C307
C283
C284
C287
R262
R0
T1.2
R0
T0.5
R0
T0.2
R0
T0.4
L229
R254
L230
C294
C297
ANT
D216
C295
C298
L225
L226
C291
L227
L228
R0
T4.0
SEND
D217
R253
C288
C289
C290
C292
C293
C296
C300
C308
RX
ANT
H,P

PROM UNIT VOLTAGE DIAGRAM

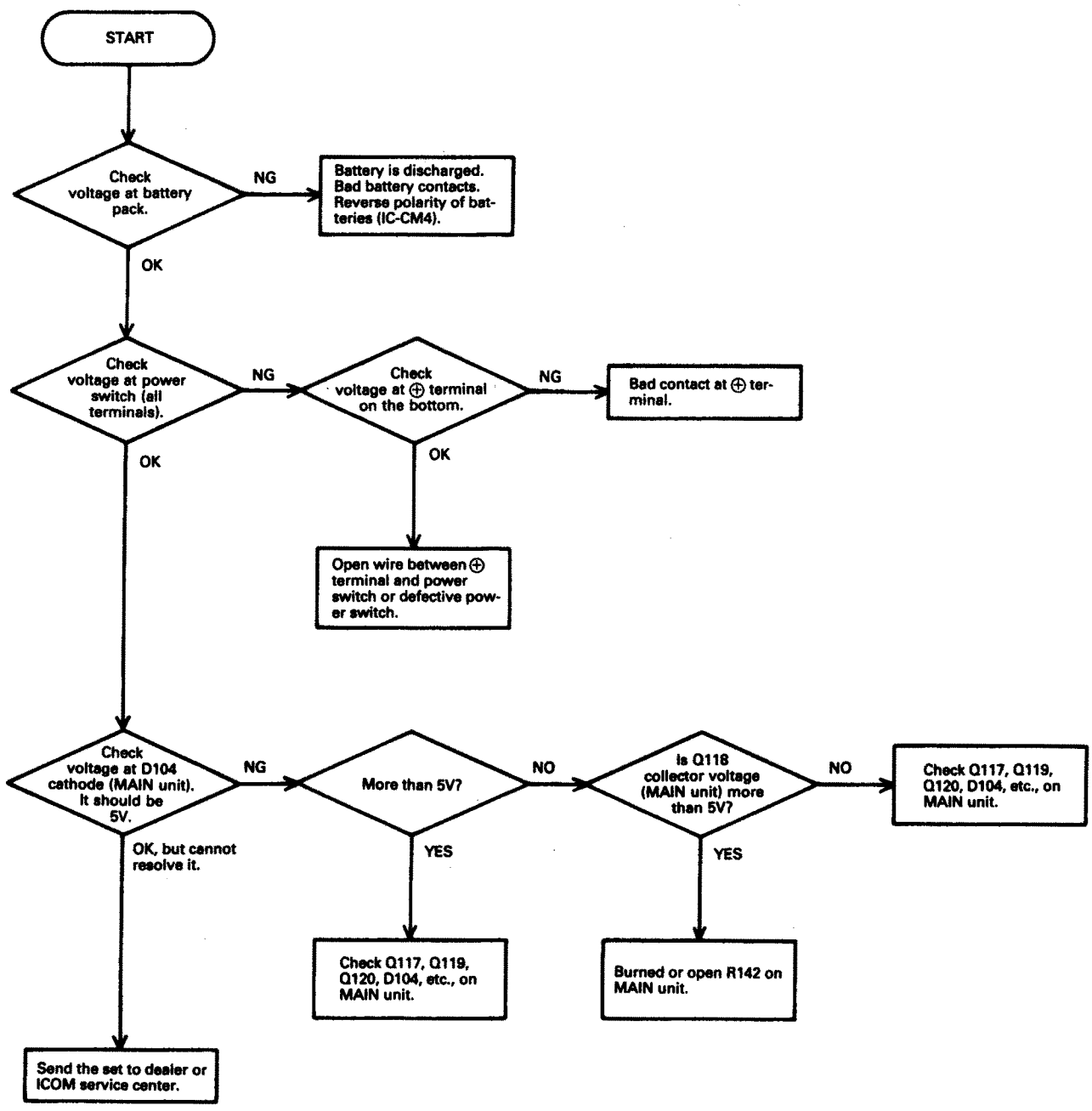




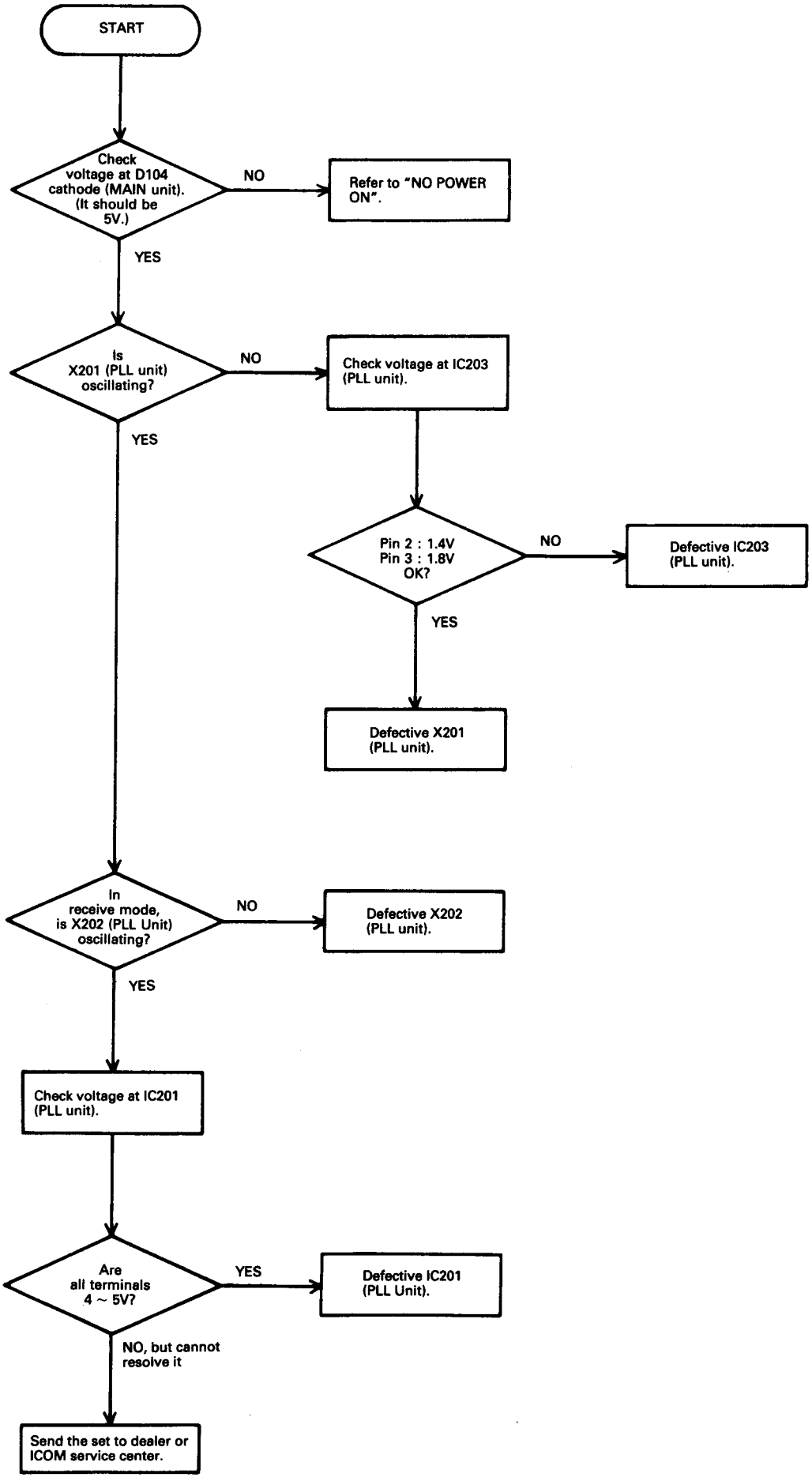
TEST EQUIPMENT
DC V. 50KΩ/V MULTIMETER
RF V. 150MHz OSCILLOSCOPE

SECTION 10 TROUBLESHOOTING

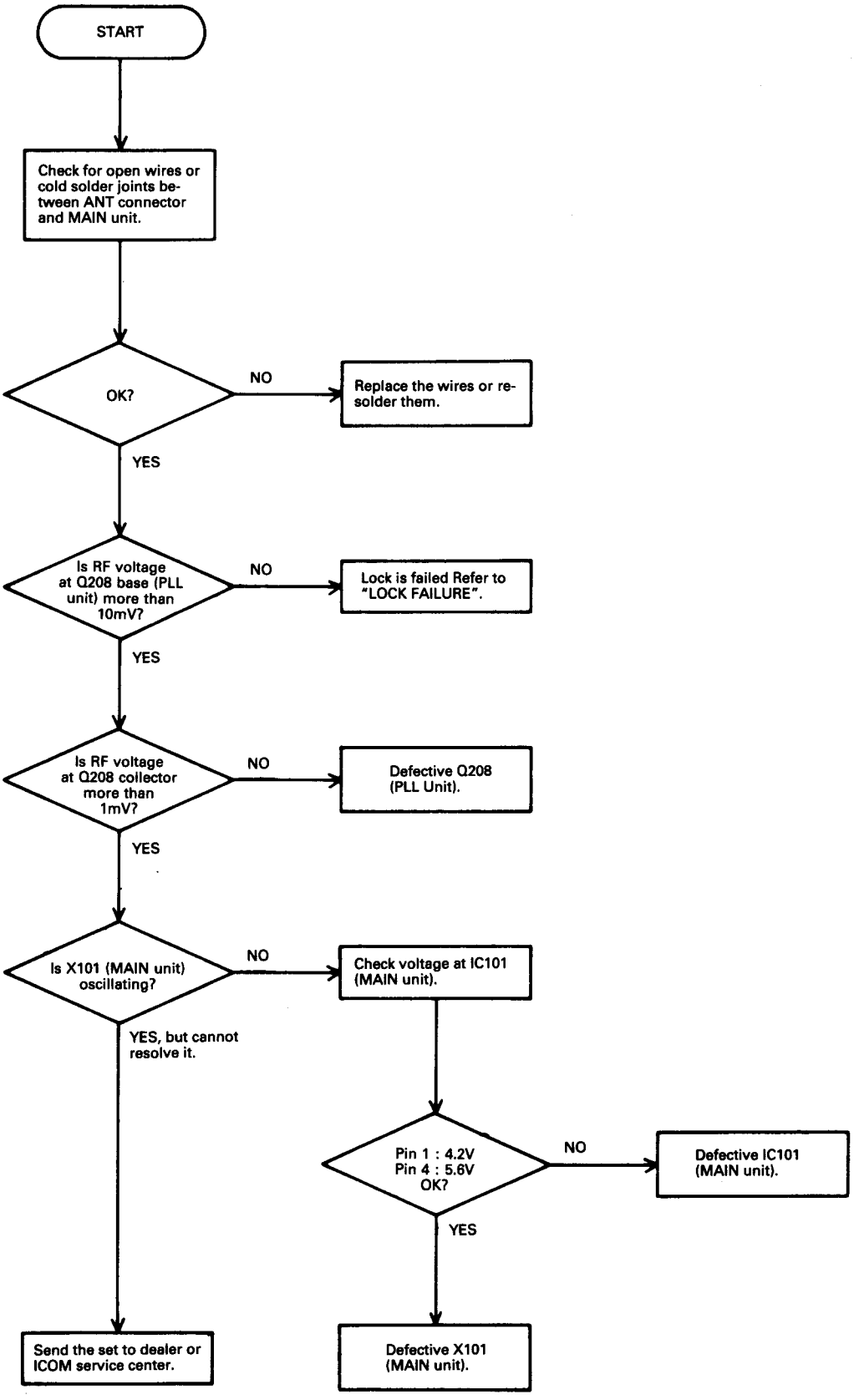
NO POWER ON



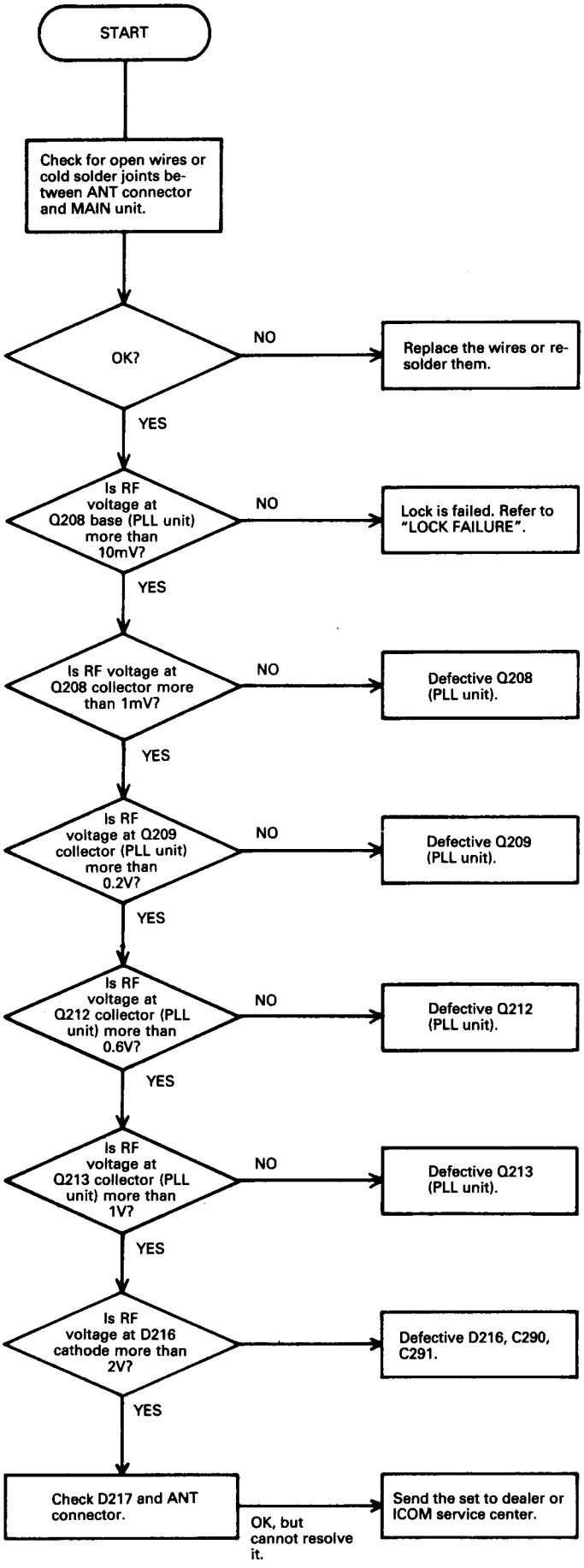
LOCK FAILURE



NO RECEPTION



NO TRANSMIT RF POWER



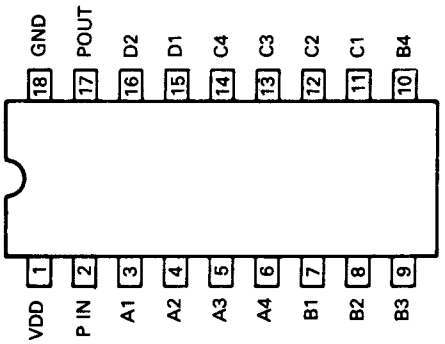
SECTION 11 IC SPECIFICATIONS

TC-9122P (BCD PROGRAMMABLE COUNTER)

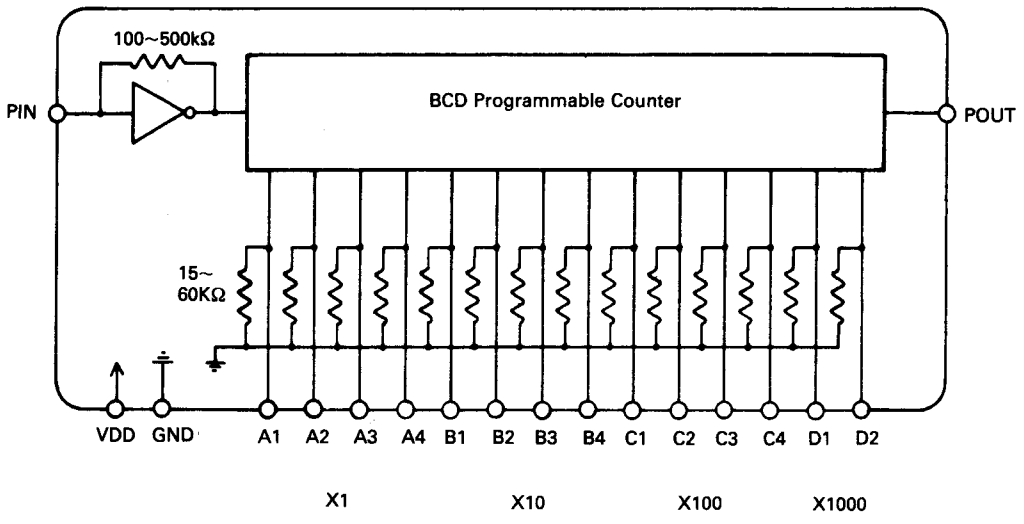
MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V_{DD}	Supply Voltage	10	V
V_{IN}	Input Voltage	−0.3~V_{DD}+0.3	V
T_{OPR}	Operating Temperature	−30~75	°C
T_{STR}	Storage Temperature	−55~125	°C

PIN CONNECTION



BLOCK DIAGRAM

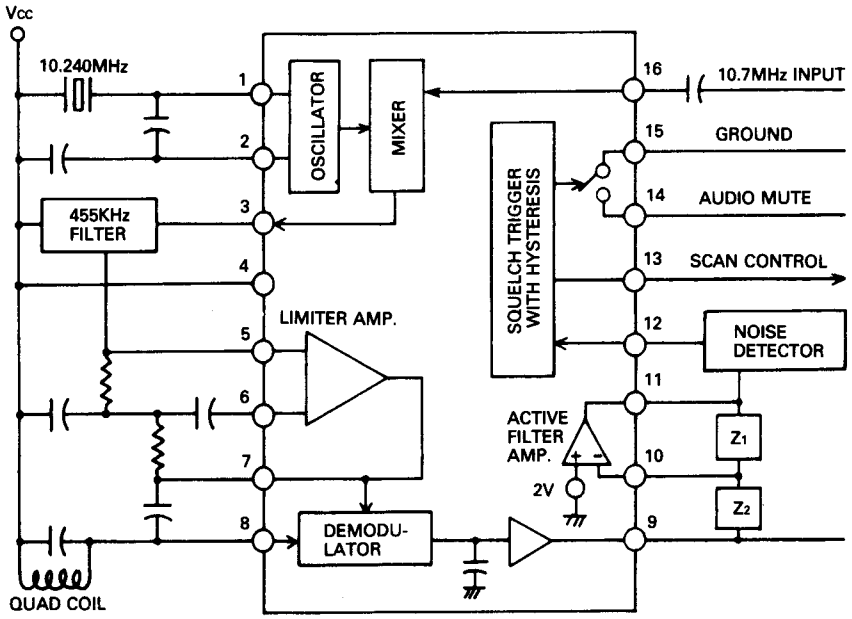


MC-3357 (LOW POWER FM IF)

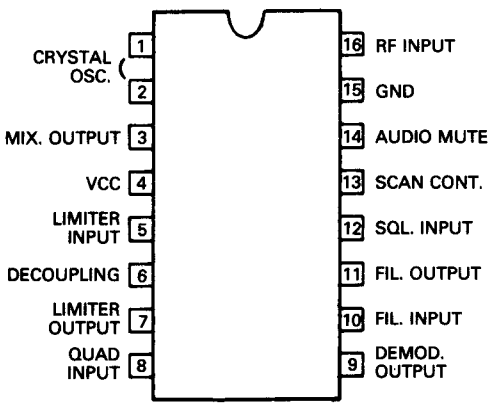
MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V_{CC}	Supply Voltage (MAX)	12	V_{DC}
V_{CC}	Operating Supply Voltage	4 to 8	V_{DC}
V_{IN}	Input Voltage	1.0	V_{RMS}
T_{OPR}	Operating Temperature	−30~+70	°C
T_{STG}	Storage Temperature	−65~+150	°C

BLOCK DIAGRAM



PIN CONNECTION

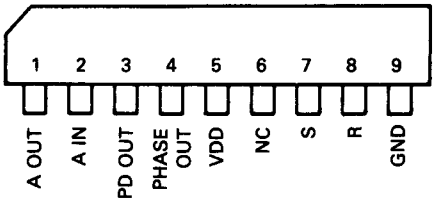


TC-5081 (PHASE COMPARATOR)

MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V_{DD}	Supply Voltage	10	V
V_{IN}	Input Voltage	−0.3~V_{DD}+0.3	V
T_{OPR}	Operating Temperature	−30~ 75	°C
T_{STR}	Storage Temperature	−55~125	°C

PIN CONNECTION

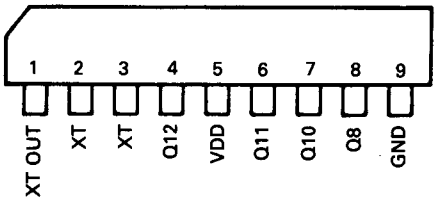


TC-5082 (OSCILLATOR AND 10 STAGE DIVIDER)

MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V_{DD}	Supply Voltage	10	V
V_{IN}	Input Voltage	−0.3~V_{DD}+0.3	V
T_{OPR}	Operating Temperature	−30~ 75	°C
T_{STR}	Storage Temperature	−55~125	°C

PIN CONNECTION

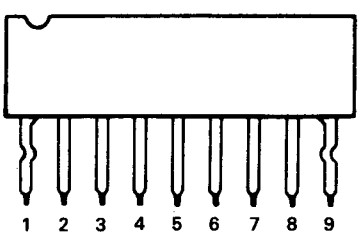


BA-526 (700mW AMPLIFIER)

MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
Vcc	Supply Voltage	9	V
Pd	Permissible Dissipation	700	mW
T_{OPR}	Operating Temperature	−10~+65	°C
T_{STG}	Storage Temperature	−30~+125	°C

PIN CONNECTION



SECTION 12 PARTS LIST

EF PARTS

REF. NO.	DESCRIPTION	PART NO.
D1	LED	SLC-26UR
R1	Variable Resistor	K121B1003E5N
		1111-10KA
R2	Variable Resistor	VR10R10KB
C1	Ceramic	470pF/50V
C2	Ceramic	470pF/50V
C3	Ceramic	15pF/50V
J1	Connector	BNC-RM-106
J2	Connector	HSJ0296-01-150
J3	Connector	HSJ0289-01-050
S1	Switch	A7MA-246-P2-35-1
S2	Switch	HSW0567-01-310
S3	Switch	HSW0567-01-310
SP1	Speaker	45P30S
MC1	Microphone	EM-80
B1	P.C. Board (Contact Board)	B-415A

MAIN UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
IC101	IC	MC3357
IC102	IC	BA526
Q101	Transistor	2SC2026
Q102	Transistor	2SC2668-O
Q103	FET	2SK192-Y
Q104	Transistor	2SC2668-O
Q105	Transistor	2SC2668-O
Q106	Transistor	2SA1048-Y
Q107	Transistor	2SC2458-GR
Q108	Transistor	2SC2458-GR
Q109	Transistor	2SA1048-Y
Q110	Transistor	2SC2458-GR
Q111	Transistor	2SA1048-Y
Q112	Transistor	2SC2458-GR
Q113	Transistor	2SA1048-Y
Q114	Transistor	2SC2458-GR
Q115	Transistor	2SC2458-GR
Q116	Transistor	2SB562-C
Q117	FET	2SK192-Y
Q118	Transistor	2SB562-C
Q119	Transistor	2SC2458-GR
Q120	Transistor	2SC2458-GR
Q121	Transistor	2SA1048-Y
Q122	Transistor	2SA1048-Y
Q123	Transistor	2SA1048-Y
Q125	Transistor	2SC2458-GR
Q126	Transistor	2SC2458-GR
Q127	Transistor	2SA1048-Y
Q128	Transistor	2SC2458-GR

MAIN UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
Q129	Transistor	2SC2458-GR
D101	Diode	1S1555
D102	Diode	1S1555
D103	Zener Diode	WZ-081
D104	Zener Diode	RD4.7JS B3
D105	Diode	1S1555
FI101	Crystal Filter	10M15B9
	Crystal Filter (U.K.)	16M15B2
FI102	Ceramic Filter	CFU455E2
X101	Crystal	CR-17 HC-18/T
	Crystal (U.K.)	16.445MHz HC-18/T
L101	Inductor	LS-160
L102	Inductor	LS-160
L103	Inductor	LS-160
L104	Inductor	LS-160
L105	Inductor	LS-159
	Inductor (U.K.)	LS-221
L107	Inductor	LS-158
R101	Resistor	10KΩ -J ELR10
R102	Resistor	100KΩ-J ELR10
R103	Resistor	100Ω -J ELR10
R105	Resistor	56Ω -J ELR10
R106	Resistor	220Ω -J ELR10
R107	Resistor	47KΩ -J ELR10
R108	Resistor	2.7KΩ -J ELR10
	Resistor (U.K.)	1.2KΩ -J ELR10
R109	Resistor	330KΩ-J ELR10
R110	Resistor	10KΩ -J ELR10
R111	Resistor	1.5KΩ -J ELR10
R112	Resistor	1.5KΩ -J ELR10
R113	Resistor	47KΩ -J ELR10
R114	Resistor	22KΩ -J ELR10
R115	Resistor	470Ω -J R10
R116	Resistor	330KΩ-J ELR10
R117	Resistor	4.7KΩ -J ELR10
R118	Resistor	5.6KΩ -J ELR10
R119	Resistor	1KΩ -J ELR10
R120	Resistor	2.2KΩ -J ELR10
R122	Resistor	3.3KΩ -J ELR10
R123	Resistor	1KΩ -J ELR10
R124	Resistor	3.3KΩ -J ELR10
R125	Resistor	10KΩ -J ELR10
R126	Resistor	10KΩ -J ELR10
R127	Resistor	10KΩ -J ELR10
R128	Resistor	4.7KΩ -J ELR10
R129	Resistor	47Ω -J ELR10
R130	Resistor	47KΩ -J ELR10
R131	Resistor	22KΩ -J ELR10
R132	Resistor	10KΩ -J ELR10
R134	Resistor	15KΩ -J ELR10
R135	Resistor	10KΩ -J ELR10
R136	Resistor	47KΩ -J R10
R137	Resistor	22KΩ -J ELR10
R138	Resistor	22KΩ -J ELR10

MAIN UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
R139	Resistor	330Ω -J ELR10
R140	Resistor	3.3KΩ -J ELR10
R141	Resistor	4.7KΩ -J ELR10
R142	Resistor	2.2Ω -J ELR10
R143	Resistor	2.7KΩ -J ELR10
R144	Thermistor	33D28
R145	Resistor	470Ω -J ELR10
R146	Resistor	22KΩ -J ELR10
R147	Resistor	470Ω -J ELR10
R148	Resistor	220KΩ-J ELR10
R149	Resistor	56KΩ -J ELR10
R150	Resistor	330Ω -J ELR10
R151	Resistor	10KΩ -J ELR10
R152	Resistor	33KΩ -J ELR10
R155	Resistor	2.2KΩ -J ELR10
R156	Resistor	68KΩ -J ELR10
R157	Resistor	120KΩ-J ELR10
R158	Resistor	470Ω -J ELR10
R159	Resistor	4.7KΩ -J ELR10
R160	Resistor	3.3KΩ -J ELR10
R161	Resistor	2.2KΩ -J ELR10
R162	Resistor	10KΩ -J ELR10
R163	Resistor	33Ω -J ELR10
R164	Resistor	1KΩ -J ELR10
R166	Resistor	2.2KΩ -J ELR10
R167	Resistor	22KΩ -J ELR10
R168	Resistor	1KΩ -J ELR10
R169	Resistor	82KΩ -J ELR10
R170	Resistor	100KΩ-J ELR10
R171	Trimmer	10KΩ H0651A
R180	Resistor	47KΩ -J ELR10
R181	Resistor	1KΩ -J ELR10
R182	Resistor	470Ω -J ELR10
C101	Ceramic	8pF/50V
C102	Ceramic	2pF/50V
C103	Ceramic	100pF/50V
C104	Ceramic	470pF/50V
C105	Ceramic	470pF/50V
C106	Ceramic	8pF/50V
C107	Ceramic	8pF/50V
C108	Ceramic	0.35pF/50V
C109	Ceramic	0.35pF/50V
C110	Ceramic	5pF/50V
C111	Barrier Lay	0.0047μF/50V TBDO5V472K
C112	Barrier Lay	0.0047μF/50V TBDO5V472K
C114	Ceramic	4pF/50V
	Ceramic (U.K.)	5pF/50V
C115	Ceramic	0.001μF/50V
C116	Barrier Lay	0.0047μF/50V TBDO5V472K
C117	Tantalum	10μF/6.3V ECSF6E 10
C118	Barrier Lay	0.0047μF/50V TBDO5V472K
C119	Ceramic	0.001μF/50V
C120	Ceramic	47pF/50V
	Ceramic (U.K.)	22pF/50V
C121	Ceramic	120pF/50V
C122	Barrier Lay	0.1μF/16V UAEO8X 104M-L45AE
C123	Electrolytic	0.1μF/50V MS7

MAIN UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
C124	Ceramic	10pF/50V
C125	Barrier Lay	0.0033μF/50V TBDO5V332K
C126	Electrolytic	0.22μF/50V MS7
C127	Electrolytic	0.22μF/50V MS7
C128	Ceramic	0.001μF/50V
C129	Ceramic	0.001μF/50V
C130	Ceramic	0.001μF/50V
C131	Ceramic	33pF/50V
C132	Ceramic	0.001μF/50V
C133	Electrolytic	4.7μF/25V MS7
C134	Ceramic	470pF/50V
C135	Electrolytic	1μF/50V MS7
C136	Electrolytic	0.47μF/50V MS7
C137	Electrolytic	1μF/50V MS7
C138	Electrolytic	3.3μF/50V MS7
C139	Electrolytic	10μF/16V MS7
C140	Ceramic	0.001μF/50V
C141	Electrolytic	0.47μF/50V MS7
C142	Electrolytic	10μF/16V MS7
C143	Ceramic	0.001μF/50V
C144	Electrolytic	100μF/10V MS9
C145	Electrolytic	47μF/10V MS9
C146	Electrolytic	100μF/10V MS9
C147	Ceramic	0.001μF/50V
C148	Electrolytic	47μF/25V MS9
C149	Ceramic	470pF/50V
C150	Electrolytic	0.22μF/50V MS7
C151	Ceramic	470pF/50V
C152	Electrolytic	100μF/10V MS9
C153	Ceramic	470pF/50V
C154	Electrolytic	100μF/10V MS9
C155	Electrolytic	10μF/16V MS7
C157	Electrolytic	10μF/16V MS7
C158	Barrier Lay	0.01μF/50V TBDO5103K
C159	Ceramic	470pF/50V
C160	Ceramic	470pF/50V
C161	Ceramic	470pF/50V
C162	Electrolytic	1μF/50V MS7
C163	Ceramic	0.001μF/50V
C164	Mylar	0.0027μF/50V
C165	Mylar	0.0047μF/50V
C166	Ceramic	120pF/50V
C167	Electrolytic	1μF/50V MS7
C168	Ceramic	0.001μF/50V
B101	P.C. Board	B-391C
S101	Switch	TWN 0301
	Beads Core	DL-20P2.6-3-1.2H

PLL UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
IC201	IC	TC9122P
IC202	IC	TC5081P
IC203	IC	TC5082PG
IC204	IC	4075
Q201	FET	2SK192A-Y
Q202	Transistor	2SC2668-O

PLL UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
Q203	Transistor	2SC2668-O
Q204	Transistor	2SC2668-O
Q205	Transistor	2SC945-R
Q206	Transistor	2SC2026
Q207	Transistor	2SC2668-O
Q208	Transistor	2SC2026
Q209	Transistor	2SC2668-O
Q210	Transistor	2SC2458-GR
Q211	Transistor	2SC2407
Q212	Transistor	2SC2053
Q213	Transistor	2SC3101
Q214	Transistor	2SA1048-Y
D203	Varactor Diode	1SV50
D204	Diode	1SS53
D205	Diode	1S1555
D210	Diode	1SS53
D211	Diode	1SS53
D214	Diode	1S1555
D215	Diode	1S1555
D216	Diode	1SS53
D217	Diode	1SS53
D218	Diode	1S1555
D219	Diode	1S1555
D220	Diode	1S1555
X201	Crystal	12.800MHz HC-18/T
X202	Crystal	34.970MHz HC-18/T
	Crystal (U.K.)	33.419MHz HC-18/T
X203	Crystal	37.644MHz HC-18/T
L201	Inductor	LR-125
L202	Inductor	LR-79
L203	Inductor	LB-88
L204	Inductor	LW-20
L205	Inductor	L4-220
L206	Inductor	LR-79
L211	Inductor	LB-91
L212	Inductor	LB-134
L215	Inductor	LS-160
L216	Inductor	LS-160
L217	Inductor	LS-160
L218	Inductor	LS-160
L219	Inductor	LS-160
L220	Inductor	LS-160
L221	Inductor	LS-160
L222	Inductor	LS-160
L223	Inductor	LA-134
L224	Inductor	LA-134
L225	Inductor	LA-134
	Inductor (Aus.)	LA-126
L226	Inductor	LA-135
L227	Inductor	LR-78
L228	Inductor	LA-121
L229	Inductor	LA-135
L230	Inductor	LA-143
L231	Inductor	LR-77
L232	Inductor	LR-118
R202	Resistor	47KΩ -J ELR10
R203	Resistor	47KΩ -J ELR10
R204	Resistor	10KΩ -J ELR10
R205	Resistor	470Ω -J R10
R206	Resistor	10KΩ -J ELR10

PLL UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
R207	Resistor	100KΩ-J ELR10
R209	Resistor	220Ω -J ELR10
R210	Resistor	22KΩ -J ELR10
R211	Resistor	470Ω -J ELR10
R212	Resistor	33KΩ -J ELR10
R213	Resistor	120KΩ-J ELR10
R214	Resistor	2.2KΩ -J ELR10
R215	Resistor	22Ω -J ELR10
R216	Resistor	10KΩ -J ELR10
R217	Resistor	2.2KΩ -J R10
R218	Resistor	220KΩ-J ELR10
R219	Resistor	470Ω -J ELR10
R223	Resistor	2.2KΩ -J ELR10
R224	Resistor	2.2KΩ -J ELR10
R227	Resistor	2.2KΩ -J ELR10
R228	Resistor	2.2KΩ -J ELR10
R231	Resistor	22KΩ -J ELR10
R232	Resistor	22KΩ -J ELR10
R233	Resistor	1KΩ -J ELR10
R234	Resistor	33KΩ -J ELR10
R235	Resistor	47Ω -J ELR10
R237	Resistor	47Ω -J ELR10
R238	Resistor	82KΩ -J ELR10
R239	Resistor	10KΩ -J ELR10
R240	Resistor	82KΩ -J ELR10
R241	Resistor	47Ω -J ELR10
R242	Resistor	10KΩ -J ELR10
R243	Resistor	100Ω -J ELR10
R244	Resistor	220Ω -J ELR10
R245	Resistor	18Ω -J ELR10
R246	Resistor	15Ω -J ELR10
R247	Resistor	47Ω -J ELR10
R248	Resistor	47Ω -J ELR10
R250	Trimmer	EVN5AC101K
R252	Resistor	22Ω -J ELR10
R253	Resistor	330Ω -J ELR10
R254	Resistor	15KΩ -J ELR10
R256	Resistor	100KΩ-J ELR10
R257	Resistor	2.2KΩ -J R10
R258	Resistor	2.2Ω -J ELR10
R259	Resistor	100KΩ-J ELR10
R260	Resistor	100KΩ-J ELR10
R261	Array	RM-6 104
R262	Resistor	100Ω -J ELR10
C201	Ceramic	0.001ΩF/50V
C202	Ceramic	0.001ΩF/50V
C203	Ceramic	0.001ΩF/50V
C204	Ceramic	0.001μF/50V
C205	Ceramic	0.001μF/50V
C206	Ceramic	0.001μF/50V
C207	Ceramic	0.001μF/50V
C208	Ceramic	0.001μF/50V
C209	Ceramic	0.001μF/50V
C210	Ceramic	0.001μF/50V
C211	Ceramic	0.001μF/50V
C212	Ceramic	0.001μF/50V
C213	Tantalum	2.2μF/16V
C214	Barrier Lay	0.01μF/50V
		TBDO5V103K
C215	Electrolytic	10μF/16V MS7
C217	Ceramic	470pF/50V
C218	Ceramic	470pF/50V
C220	Ceramic	56pF/50V

PLL UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
	Ceramic (U.K.)	33pF/50V
C221	Electrolytic	100μF/10V MS9
C222	Ceramic	470pF/50V
C223	Ceramic	470pF/50V
C224	Ceramic	470pF/50V
C225	Ceramic	10pF/50V TH
C226	Ceramic	1pF/50V
C227	Ceramic	33pF/50V TH
C228	Ceramic	3pF/50V
C229	Ceramic	0.001μF/50V
C230	Ceramic	0.001μF/50V
C231	Ceramic	12pF/50V
C232	Ceramic	22pF/50V
C233	Barrier Lay	0.0047μF/50V
		TBDO5V472K
C235	Ceramic	22pF/50V
C236	Ceramic	0.001μF/50V
C237	Barrier Lay	0.0047μF/50V
		TBDO5V472K
C238	Ceramic	0.001μF/50V
C239	Electrolytic	100μF/10V MS9
C240	Barrier Lay	0.0047μF/50V
		TBDO5V472K
C241	Ceramic	0.001μF/50V
C242	Ceramic	15pF/50V
C243	Ceramic	10pF/50V
C244	Trimmer	12pF
		CVO5C1201
C246	Ceramic	0.001μF/50V
C247	Ceramic	0.001μF/50V
C251	Ceramic	0.001μF/50V
C252	Ceramic	56pF/50V
C253	Ceramic	22pF/50V
C254	Ceramic	47pF/50V
C255	Ceramic	0.001μF/50V
C256	Ceramic	39pF/50V
C257	Ceramic	5pF/50V
C258	Ceramic	5pF/50V
C261	Ceramic	47pF/50V
C262	Ceramic	10pF/50V
C263	Ceramic	0.5pF/50V
C264	Ceramic	0.001μF/50V
C265	Ceramic	10pF/50V
C266	Ceramic	0.001μF/50V
C267	Ceramic	470pF/50V
C268	Ceramic	0.001μF/50V
C269	Electrolytic	4.7μF/25V MS7
C270	Ceramic	8pF/50V
C271	Ceramic	0.35pF/50V
C272	Ceramic	8pF/50V
C273	Ceramic	0.001μF/50V
C274	Ceramic	470pF/50V
C275	Ceramic	47pF/50V
C276	Ceramic	470pF/50V
C277	Ceramic	8pF/50V
C278	Ceramic	0.5pF/50V
C279	Ceramic	8pF/50V
C280	Ceramic	470pF/50V
C281	Ceramic	470pF/50V
C282	Ceramic	47pF/50V
C283	Barrier Lay	0.01μF/50V
		TBDO5103K
C284	Ceramic	470pF/50V
C285	Trimmer	20pF
		CVO5D2001

PLL UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
C286	Trimmer	12pF
		CVO5D2001
C287	Ceramic	5pF/50V
C288	Electrolytic	1μF/50V MS7
C289	Ceramic	470pF/50V
C290	Trimmer	12pF
		CVO5C1201
C291	Trimmer	20pF
		CVO5D2001
C292	Ceramic	470pF/50V
C293	Ceramic	22pF/50V
C294	Ceramic	100pF/50V
C295	Ceramic	33pF/50V
C296	Ceramic	100pF/50V
C297	Ceramic	2pF/50V
C298	Ceramic	27pF/50V
C300	Ceramic	470pF/50V
C302	Electrolytic	0.47μF/50V MS7
C303	Ceramic	0.001μF/50V
C304	Ceramic	0.001μF/50V
C305	Ceramic	0.001μF/50V
C306	Ceramic	0.001μF/50V
C307	Ceramic	0.001μF/50V
C308	Ceramic	0.001μF/50V
C309	Ceramic	470pF/50V
J201	Connector	SB7P-HVQ-22
J202	Connector	SB5P-HVQ-22
J203	Connector	SB6P-HVQ-22
J204	Connector	SB6P-HVQ-22
B201	P.C. Board	B-653A
	Beads Core	DL-20P2.6-3-1.2H

PROM UNIT PARTS

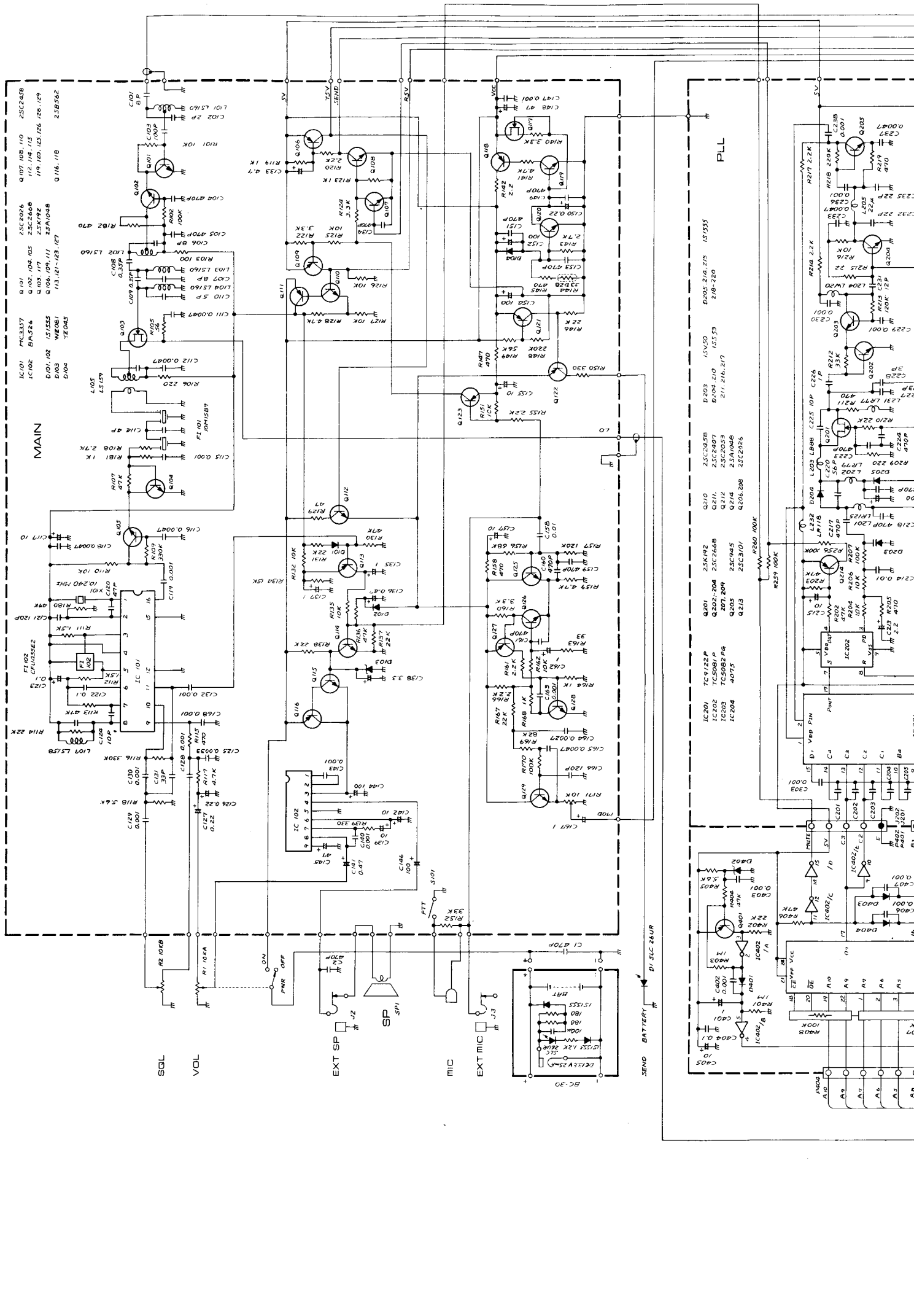
REF. NO.	DESCRIPTION	PART NO.
IC401	IC	SC-1021
	IC (U.K.)	SC-1023
IC402	IC	4049
Q401	Transistor	2SA1048-Y
D401	Diode	1S1555
D402	Zener	YZ-030B
D403	Diode	1S1555
D404	Diode	1S1555
R401	Resistor	1MΩ -J R10
R402	Resistor	22KΩ -J R10
R403	Resistor	1MΩ -J R10
R404	Resistor	47KΩ -J R10
R405	Resistor	5.6KΩ-J R10
R406	Resistor	47KΩ -J R10
R407	Array	RM8 104
R408	Array	RM4 104
R409	Resistor	100KΩ-J R10
C401	Electrolytic	1μF/50V MS7
C402	Ceramic	0.001μF/50V
C403	Ceramic	0.001μF/50V
C404	Barrier Lay	0.1μF/16V
	UAE08X	104M-L45AE

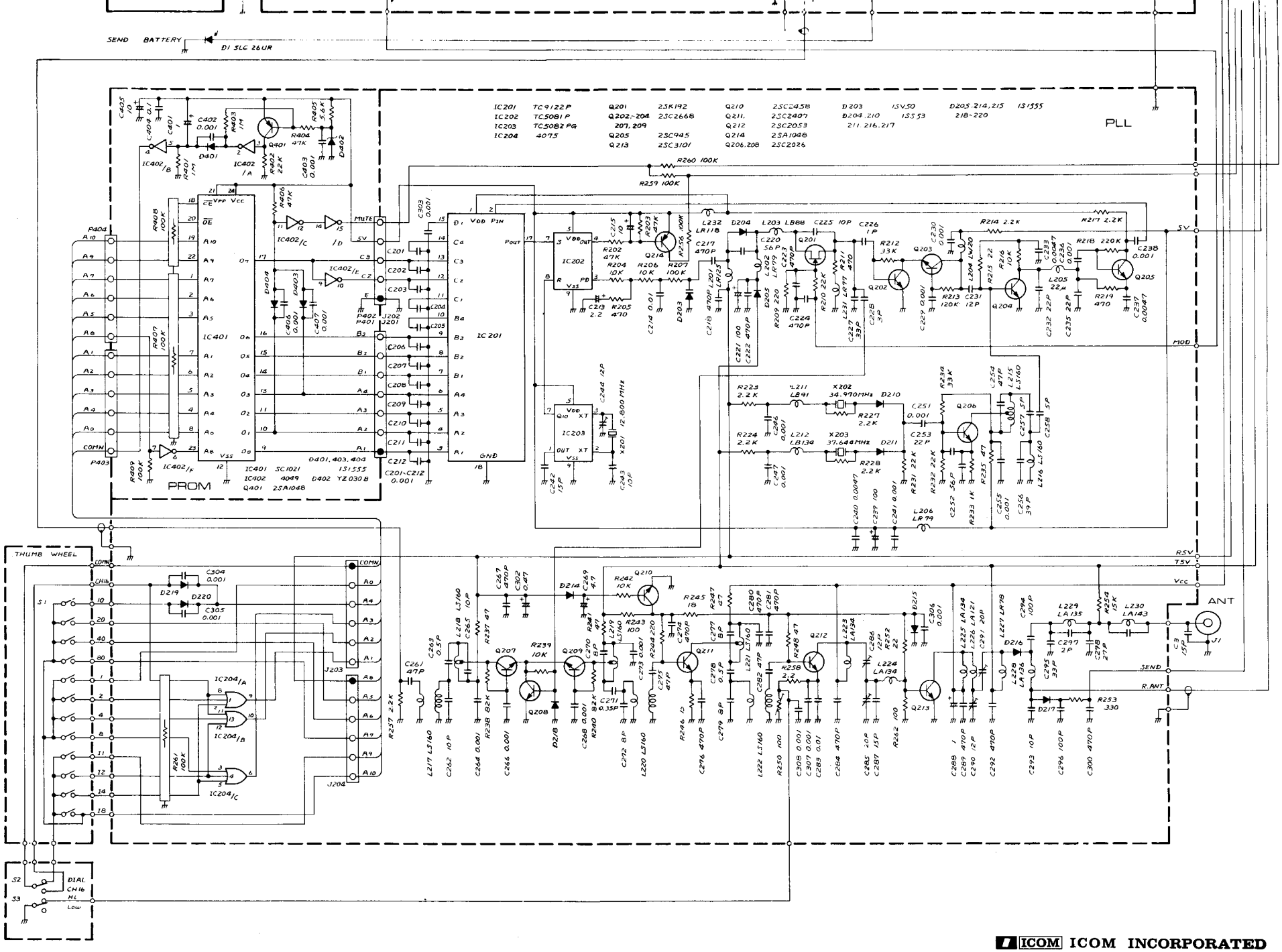
PROM UNIT PARTS

REF. NO.	DESCRIPTION	PART NO.
C405	Electrolytic	10μF/16V MS7
C406	Ceramic	0.001μF/50V
C407	Ceramic	0.001μF/50V
P401	Connector	F7P-HVQ-K
P402	Connector	F5P-HVQ-K
P403	Connector	F6P-HVQ-K
P404	Connector	F6P-HVQ-K
B401	P.C. Board	B-651A

IC-M2

SCHEMATIC DIAGRAM





ICOM ICOM INCORPORATED

AC BATTERY CHARGER

CM-35

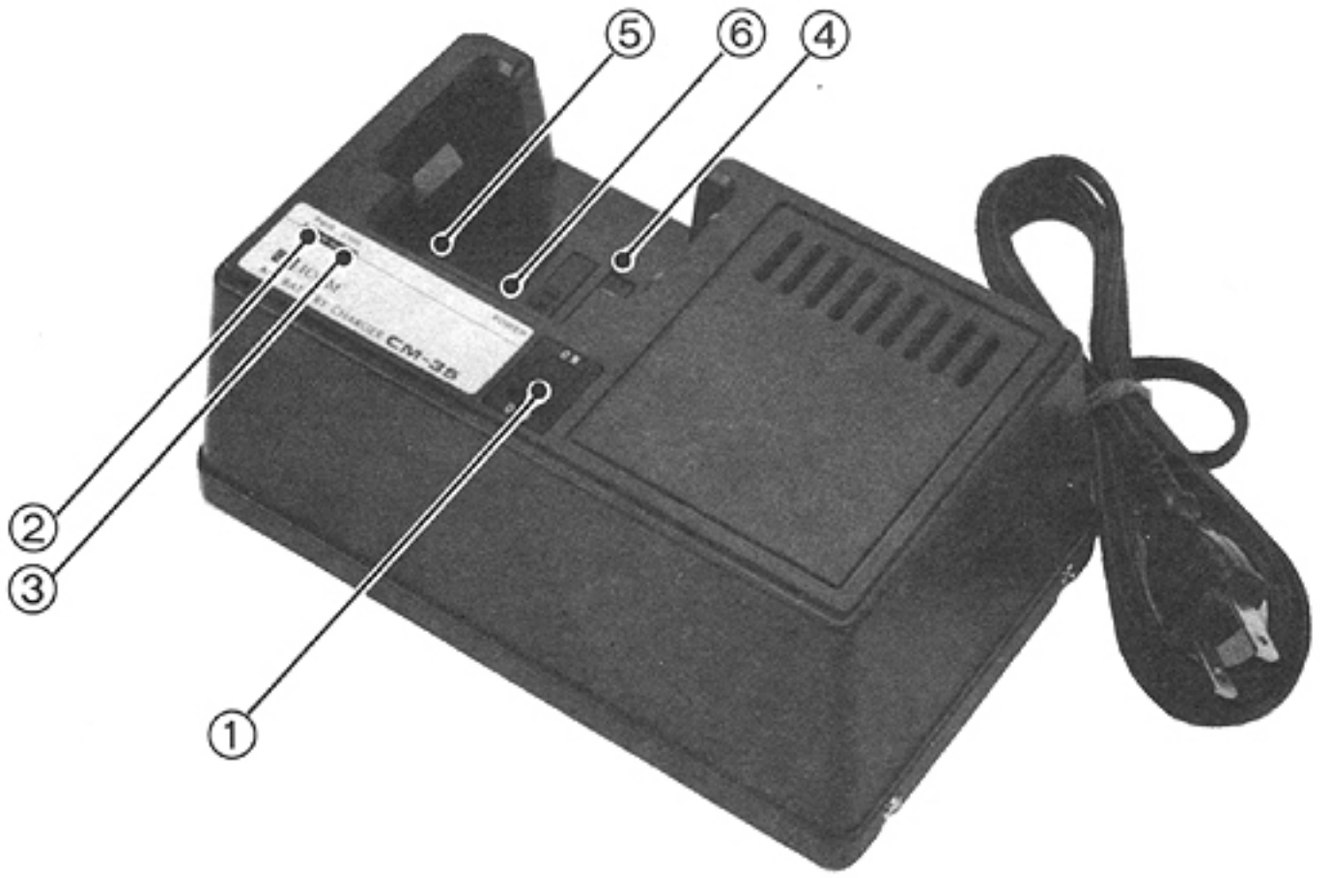
MAINTENANCE MANUAL

TABLE OF CONTENTS

SPECIFICATIONS

Applicable Battery Packs	IC-CM2, IC-CM3, IC-CM5, IC-CM7, IC-CM8 IC-CM4 (only with nickel-cadmium batteries inserted)
Number of Semiconductors	Transistors 9 ICs 2 Diodes 14
Power Supply Requirement	Japanese version (−01): 100V, 50/60Hz American version (−02): 117V, 50/60Hz European version (−03): 240V, 50/60Hz German version (−04): 220V, 50Hz
Charging Current	600mA for IC-CM2, IC-CM5, IC-CM7 and IC-CM8 25mA for IC-CM3 45mA for IC-CM4 (nickel-cadmium inserted)
Usable Temperature	0°C ~ +45°C for IC-CM3 and IC-CM4 +10°C ~ +40°C for IC-CM2, IC-CM5, IC-CM7 and IC-CM8
Dimensions	72mm (H) × 172mm (W) × 104mm (D)
Weight	Approx. 1.0kg

DESCRIPTION OF CONTROLS



① Power Switch

Turns on the charger after the charger is plugged into the wall.

② Power Lamp

Indicates power is on.

③ Charge Lamp

Indicates charging is underway. Goes out when rapid-charge packs are fully charged.

④ Insertion slot for battery packs

⑤ Charging terminal

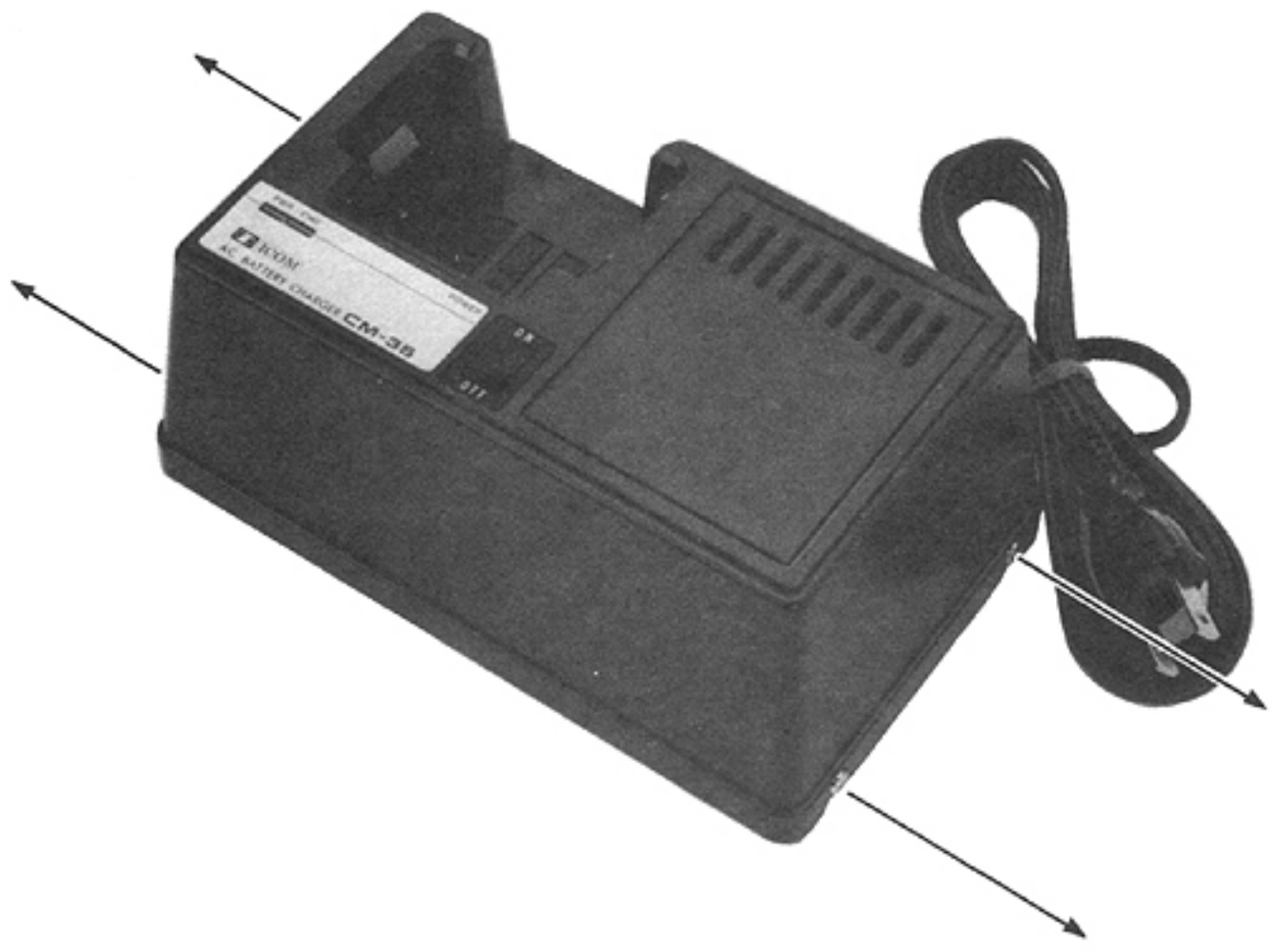
Corresponds to the terminals on the bottom of the battery packs.

⑥ Microswitches

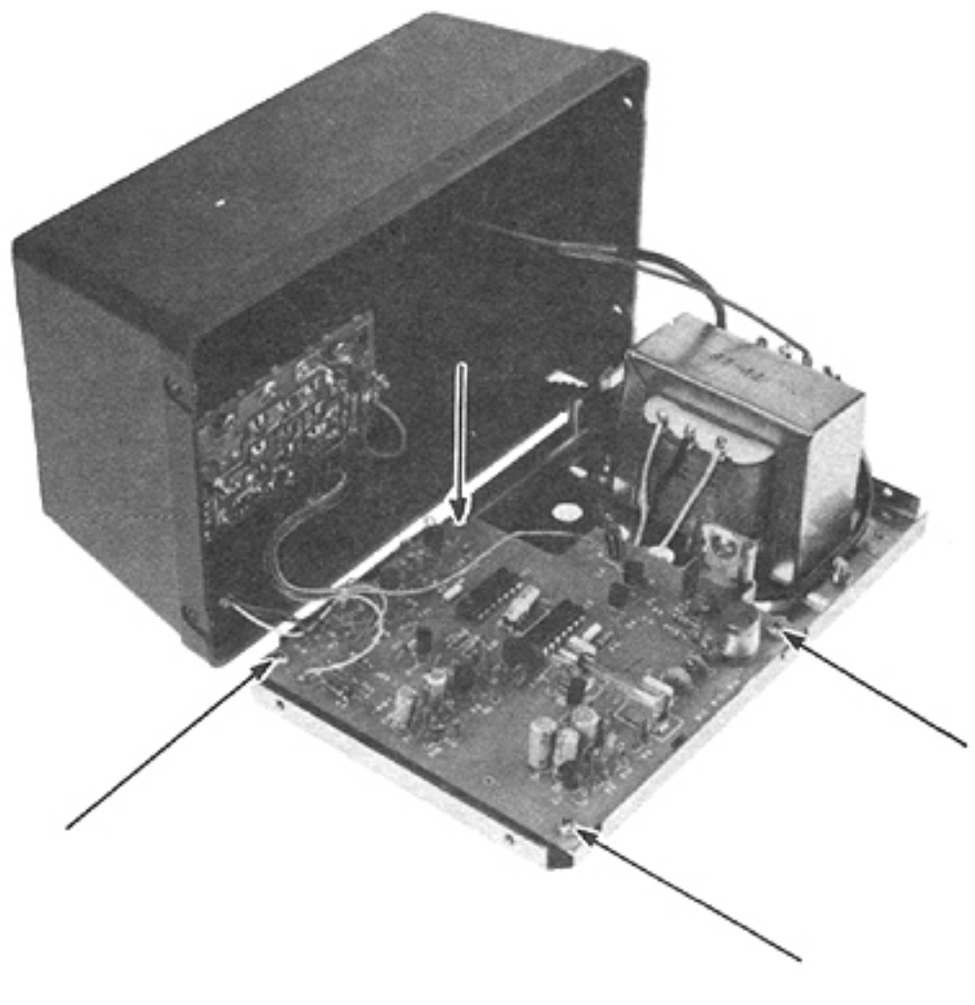
These microswitches select different circuits which provide the correct charging current for each type of battery pack.

DISASSEMBLY

1. Remove the four retaining screws from the cover of the unit as shown.



2. Remove the cover from the chassis taking care not to damage the internal wiring. Remove the four screws to release the PC board from its mounting.



CIRCUIT DESCRIPTION

This unit provides the correct charging current for various battery packs. The bottom of each pack has a coded strip which activates microswitches within the charger. The position of these microswitches determine the charging current supplied to the battery pack.

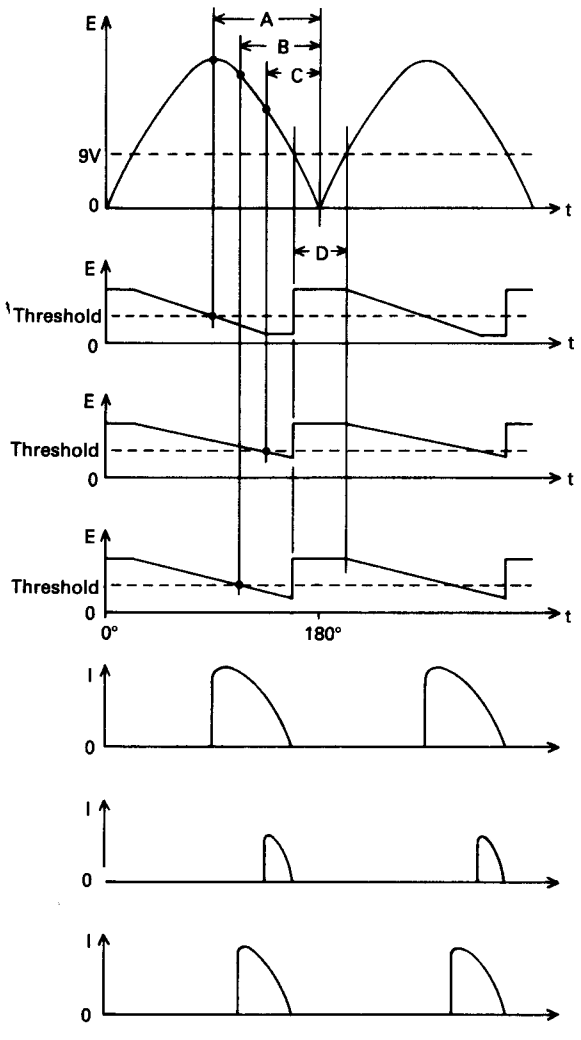
The charger provides a constant charging current independent of the battery pack voltage. It accomplishes this by controlling the conducting phase angle of an SCR.

1. Conducting Angle Control Circuit

A gate pulse controls the thyristor (SCR) D6 in the circuit. This gate pulse is part of a full-wave rectified signal. A saw tooth pulse, synchronized with this signal, controls the gate pulse phase angle.

The actual charging current controls the saw tooth pulse falltime. The falltime then determines the gate pulse phase angle which may vary between 40 and 160 degrees.

The saw tooth pulse generator circuit consists of Q2, Q5 and C9.



The Q2 base receives the full-wave rectified voltage via R4. This voltage turns Q2 ON near its base line (D portion in the figure below). Regulator Q1 charges C9 to +9V. When the rectified voltage exceeds +9V. (outside of the D portion), Q2 turns OFF. The C9 voltage discharges through Q5 and a saw tooth waveform develops across C9. This saw tooth pulse feeds to IC2 pin 12.

When the pulse voltage decreases lower than the gate's threshold level, IC2 pin 11 outputs a HIGH. This turns Q3 and Q4 ON, and a portion of the full-wave rectified signal feeds to the SCR D6 gate through Q3. D6 turns ON.

Once the SCR is ON, it locks in this state until the power source voltage becomes zero or the SCR is reverse biased. Thus, the SCR turns OFF when the full-wave rectified voltage drops to less than +9V. (D portion in the figure).

R37 to R42 determine the output charging current. S3, S4 and S5 select the particular resistors used. The battery pack's charging current selector strip on the bottom of the pack selects the different combinations of these switches. The switches are in series with the charging battery.

R14 and C16 integrate the voltage that appears across R37, R38 or R39 to R42. The integrated result feeds to the Q6 base. Q5 and Q6 form a differential amplifier. R11 and R12 divide +9V. down to a reference voltage and apply this reference to the Q5 base. The Q6 base voltage, therefore, varies the Q5 collector current and controls the C9 discharge time.

For example, when the charging current increases more than the specified amount, Q6 collector current increases and Q5 collector current decreases. The C9 discharge time becomes longer which delays the D6 gate pulse phase angle. That is, the pulse width becomes narrower. The charging current decreases.

If the current drops lower than the specified current, the circuit functions the opposite way. Overall, the charging current remains constant.

2. Logic Circuit

Current select switches S3, S4 and S5 and the charging detector Q10 control the logic circuit.

The charging current selector strip on the battery pack turns S5 ON when charging IC-CM2, IC-CM5, IC-CM7 or IC-CM8. The 600mA charging current flows through R39 to R42, and the Q10 base receives the voltage across these resistors. Q10 turns ON. IC2 pins 1 and 2 become LOW and pin 3 HIGH. This causes IC1 pin 4 to be HIGH. This gate combined with an IC2 gate form a flipflop. IC1 pin 10 outputs a HIGH and IC2 pin 10 a LOW.

This grounds the Q4 emitter through R10 and IC2 pin 10. Q3 turns ON while IC2 pin 11 is HIGH and charges the battery pack.

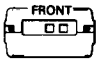
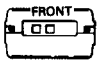
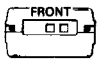
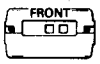
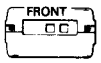
The built-in thermal switch in the pack turns OFF and cuts the current from the minus charging terminal when the battery pack reaches full charge. IC2 pins 1 and 2, and IC1 pin 5 receive a HIGH level which turns the flip-flop to the reverse condition. IC1 pin 4 becomes LOW. IC2 pin 10 is HIGH which turns Q4 OFF. No charging current flows even if the thermal switch closes after the battery pack cools.

Removal of the battery pack from the charger turns S5 OFF. S5 then grounds IC1 pin 5. This action resets the flip-flop for another charging.

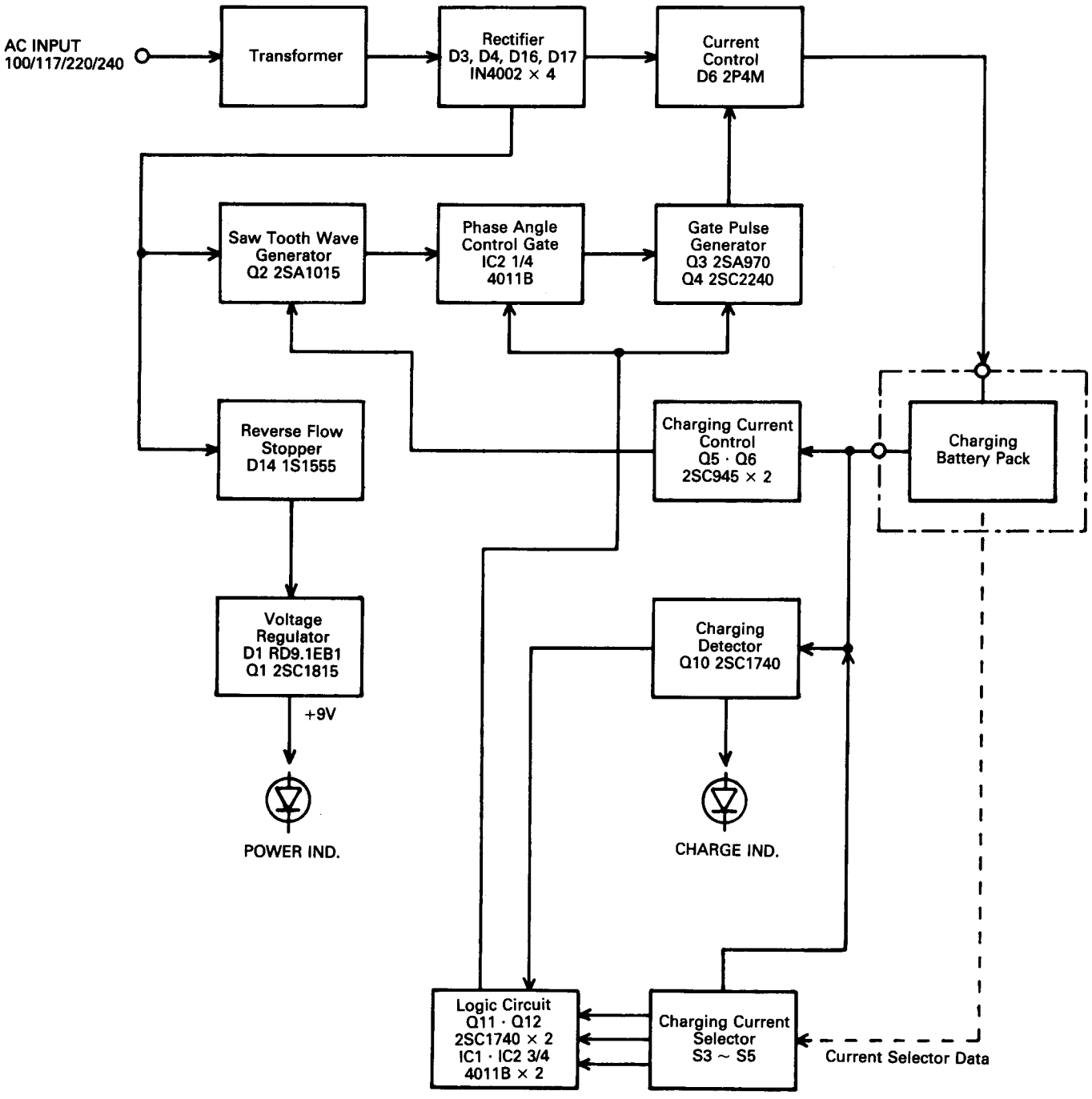
The battery pack current selector strip turns S3 ON when IC-CM3 packs are charged. The charging current (25mA) flows through R37. S5 grounds IC1 pins 5 and 8. IC2 pin 10 is LOW and R10 grounds the Q4 emitter. The charging current flows until the battery pack is removed from the charger.

The current selector strip turns S4 ON and the charging current (45mA) flows through R38 when charging IC-CM4 packs equipped with nickel-cadmium batteries. The logic circuit works the same as when charging an IC-CM3.

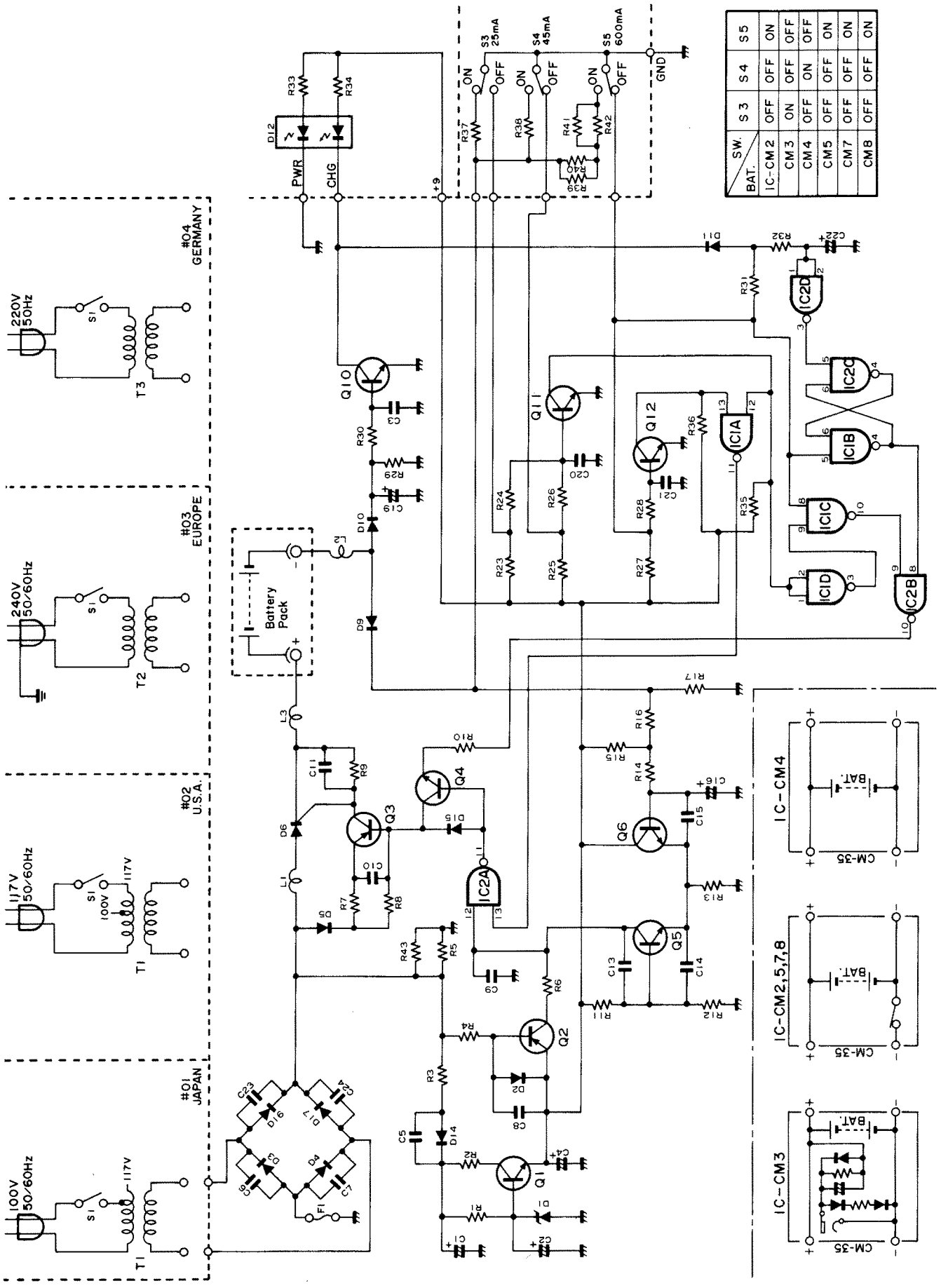
POWER PACK SPECIFICATIONS

	IC-CM2	IC-CM3	IC-CM4	IC-CM4	IC-CM5	IC-CM7	IC-CM8
Cells [Capacity]	N-425A R (× 6) [400mAH]	N-250A A (× 7) [250mAH]	AA Size Alkaline (× 6)	AA Size Nickel-Cadmium (× 6)	N-425A R (× 9) [400mAH]	N-450AR × 11 [450mAH]	N-800AR × 7 [800mAH]
Voltage	7.2V	8.4V	9.0	7.2V	10.8V	13.2V	8.4V
RF Output	1.5W	2.0W	2.0W	1.5W	4.0W	5.0W	2.0W
Charging	Rapid	Normal		Normal	Rapid	Rapid	Rapid
Charging Time	1 ~ 1.5H	15H		15H	1 ~ 1.5H	1 ~ 1.5H (600mA) [CM-35] 15H (90mA) [CM-16U/E]	2 ~ 3H (600mA) [CM-30/35] 15H (80mA) [CM-16U/E]
Suitable Charger	CM-30/35	CM-30/35 CM-25U/E IC-CM1		CM-30/35	CM-30/35		
Charging Current	600mA	25mA		45mA	600mA		
Ambient Temp	+10°C~+40°C	0°C~+45°C		0°C~45°C	+10°C~+40°C	+10°C~+40°C	+10°C~+40°C
Overcharge Protected	YES	NO		NO	YES	YES	YES
Current Selector							
Height	39m/m	39m/m	49m/m	49m/m	60m/m	80m/m	80m/m
Replaceable Batteries	NO	NO	YES	YES	NO	NO	NO

BLOCK DIAGRAM

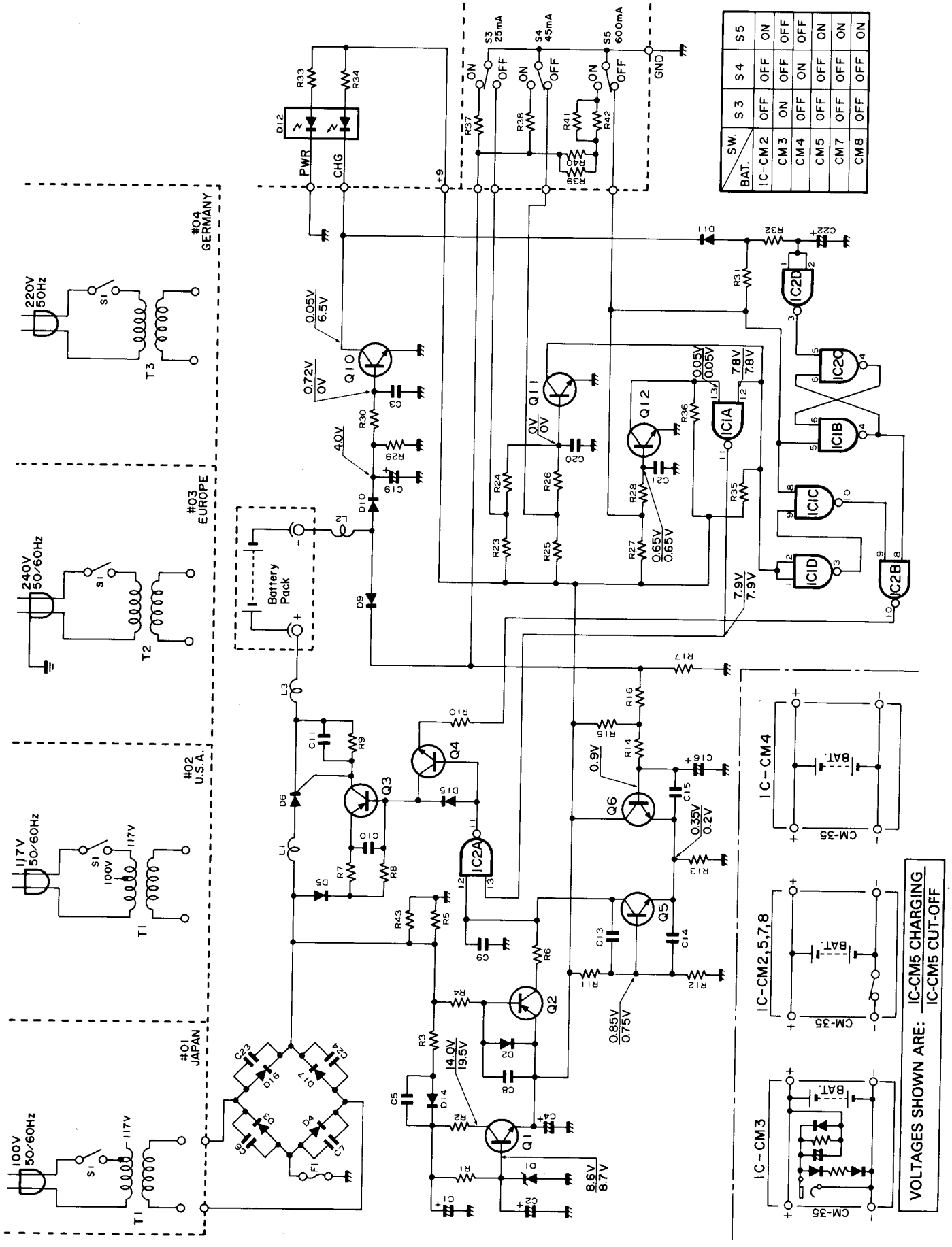


SCHEMATIC DIAGRAM



SW. / BAT.	S3	S4	S5
IC-CM2	OFF	OFF	ON
CM3	ON	OFF	OFF
CM4	OFF	ON	OFF
CM5	OFF	OFF	ON
CM7	OFF	OFF	ON
CM8	OFF	OFF	ON

VOLTAGE DIAGRAM



SW. / BAT.	S3	S4	S5
IC-CM2	OFF	OFF	ON
CM3	ON	OFF	OFF
CM4	OFF	ON	OFF
CM5	OFF	OFF	ON
CM7	OFF	OFF	ON
CM8	OFF	OFF	ON

PARTS LIST

REF. NO.		DESCRIPTION	
IC1	IC	4011B	
IC2	IC	4011B	
Q1	Transistor	2SC1815-O, Y, GR, BL	
Q2	Transistor	2SA1015-Y	
Q3	Transistor	2SA970-GR,BL	
Q4	Transistor	2SC2240-GR, BL	
Q5	Transistor	2SC945-P	
Q6	Transistor	2SC945-P	
Q10	Transistor	2SC1740-Q, R, S, E	
Q11	Transistor	2SC1740-Q, R, S, E	
Q12	Transistor	2SC1740-Q, R, S, E	
D1	Zener	RD9.1EB1	
D2	Diode	1S1555	
D3	Diode	1N4002	
D4	Diode	1N4002	
D5	Diode	1S1555	
D6	SCR	2P4M	
D9	Diode	1N4002	
D10	Diode	1S1555	
D11	Diode	1S1555	
D12	LED	LD-002R	
D14	Diode	1S1555	
D15	Diode	1S1555	
D16	Diode	1N4002	
D17	Diode	1N4002	
L1	Inductor	LW-16	
L2	Inductor	LW-9	
L3	Inductor	LW-9	
R1	Resistor	1.5K	ELR25
R2	Resistor	220	ELR25
R3	Resistor	100	ELR25
R4	Resistor	22K	ELR25
R5	Resistor	2.2K	ELR25
R6	Resistor	3.3K	ELR25
R7	Resistor	1K	R25
R8	Resistor	10K	R25
R9	Resistor	1K	ELR25
R10	Resistor	47K	R25
R11	Resistor	22K	ELR25
R12	Resistor	2.7K	ELR25
R13	Resistor	1.5K	ELR25
R14	Resistor	22K	ELR25
R15	Resistor	15K	ELR25
R16	Resistor	560	ELR25
R17	Resistor	820	ELR25
R23	Resistor	10K	ELR25
R24	Resistor	100K	ELR25
R25	Resistor	10K	ELR25
R26	Resistor	100K	ELR25
R27	Resistor	10K	R25
R28	Resistor	100K	ELR25
R29	Resistor	100K	R25
R30	Resistor	5.6K	R25
R31	Resistor	470K	R25

REF. NO.		DESCRIPTION		
R32	Resistor	22K	R25	
R33	Resistor	680	R25	
R34	Resistor	680	R25	
R35	Resistor	10K	ELR25	
R36	Resistor	10K	ELR25	
R37	Resistor	27	R25	
R38	Resistor	15	R25	
R39	Resistor	1	R25	
R40	Resistor	1	R25	
R41	Resistor	1	R25	
R42	Resistor	1	R25	
R43	Surge Absorber	ERZ-C05DK390		
C1	Electrolytic	47	25V	MS
C2	Electrolytic	10	16V	MS
C3	Ceramic	470P	50V	
C4	Electrolytic	100	10V	MS
C5	Ceramic	0.0047	50V	
C6	Ceramic	0.0047	50V	
C7	Ceramic	0.0047	50V	
C8	Ceramic	470P	50V	
C9	Barrier Lay	0.047	25V	
C10	Ceramic	470P	50V	
C11	Ceramic	470P	50V	
C12	Ceramic	470P	50V	
C13	Ceramic	470P	50V	
C14	Ceramic	470P	50V	
C15	Ceramic	470P	50V	
C16	Electrolytic	47	10V	MS
C19	Electrolytic	22	16V	MS
C20	Ceramic	470P	50V	
C21	Ceramic	470P	50V	
C22	Electrolytic	2.2	50V	MS
C23	Ceramic	0.0047	50V	
C24	Ceramic	0.0047	50V	
S1	Switch	SDJ2S		
S3	Switch	D2MS		
S4	Switch	D2MS		
S5	Switch	D2MS		
P1	Connector (yellow spring) (Germany)			
B1	PC Board	B-439D		
MP1	HEATSINK	41912		
F1	Fuse	2A		
F2	Fuse Holder	S-N5051		
F3	Fuse Holder	S-N5051		
T1	Transformer	TP-34 (Japan, USA)		
T2	Transformer	TP-36 (Europe)		
T3	Transformer	TP-35 (Germany)		
EP1	Power Cord	OPC-013 (Japan, USA)		
EP2	Power Cord	OPC-019 (Europe)		
EP3	Power Cord	OPC-029 (Germany)		