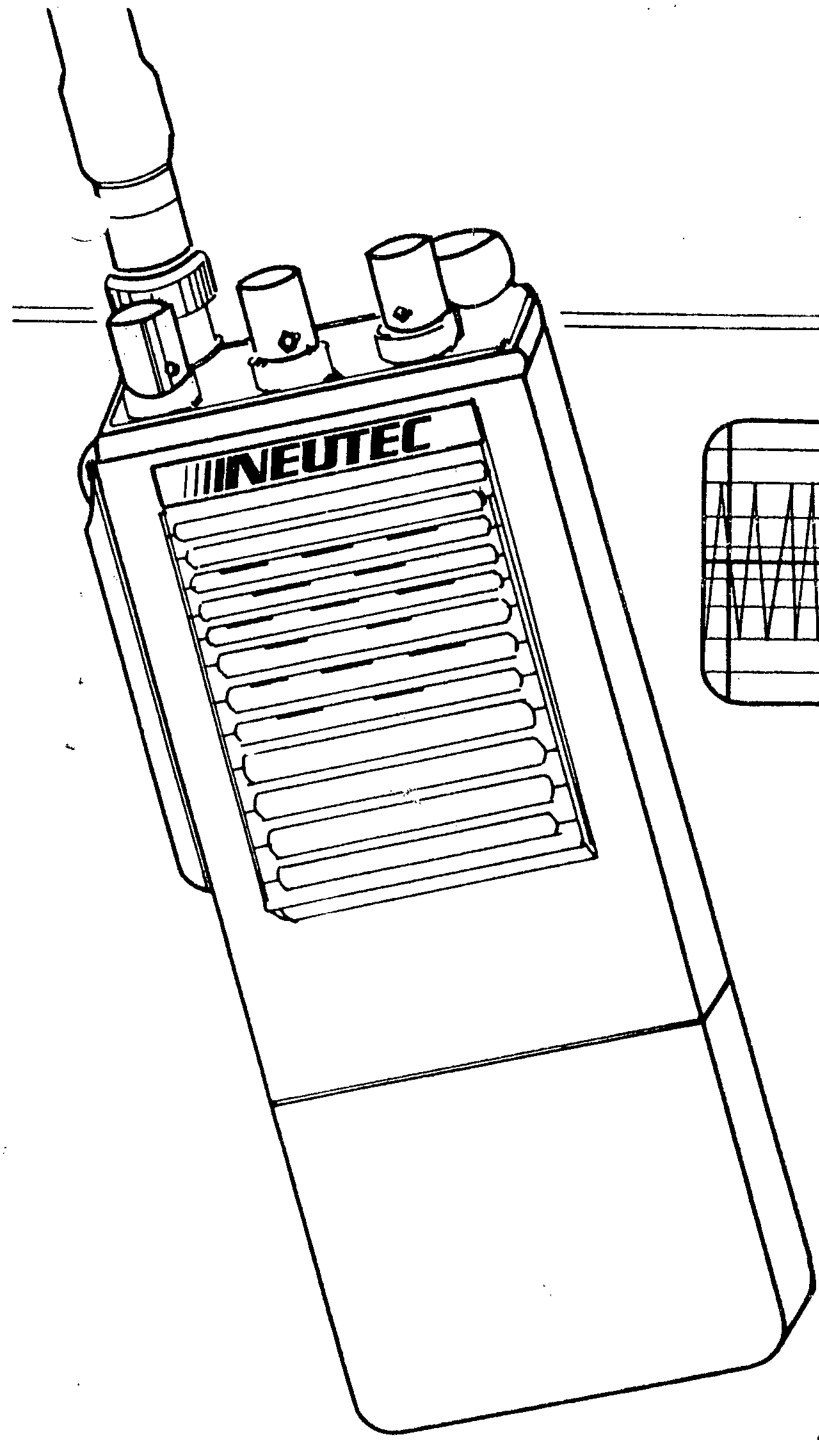
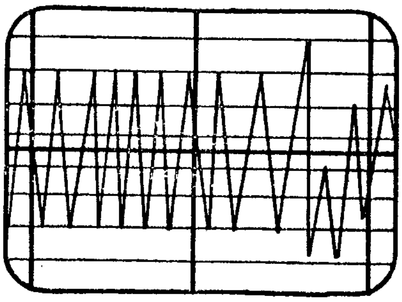
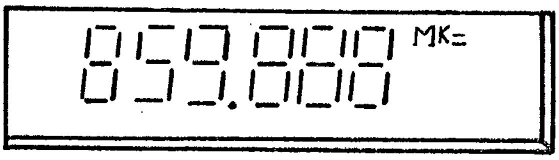
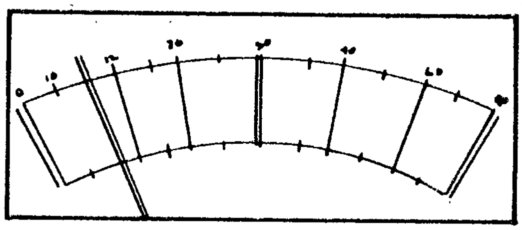


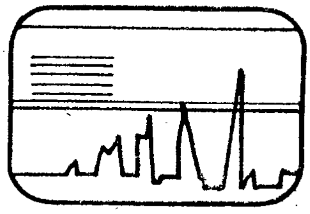
Service Manual

August 1984









SP-605H/SP-602H Synthesized VHF Portable Radio

TA2EI

Recep Aydın Çoteg

NEUTEC Communications

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10040 Mesa Rim Rd., San Diego, CA 92121
1-800-551 8551 • 1-800-424-8491 in California
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CHAPTER 1

Specifications

GENERAL

Frequency Ranges	SP-605H A		138-150 MHz
	SP-605H B		150-160 MHz
	SP-605H C		160-170 MHz
	SP-605H D		170-175 MHz
Number of Channels		6	
Programming		Synthesized	
Supply Voltage		12. VDC	
Current Drain (TX)		1100 mA	
(RX)		90 mA	
(Standby)		25 mA	

TRANSMITTER

RF Power Output	5/1 watt
Frequency Stability	5 PPM (−30°C to +60°C)
Duty Cycle	10%
Spurious & Harmonics	−60 dB
Transmitter Rise Time	40 ms
Audio Frequency Response (Pin 3)	+1, −3 dB from a 6 dB per octave pre-emphasis from 300-3000 Hz

RECEIVER

Sensitivity	.35 uV
(12 dB SINAD)	−70 dB
Selectivity	±7.5 KHz
Modulation Acceptance	±2.5 KHz
(with NBF Option)	−65 dB
Spurious Rejection	(unsquelched)
Receiver Attack Time	5 PPM (−30°C to +60°C)
Frequency Stability	+1, −3 dB from a 6 dB per octave
Audio Frequency Response (Pin 10)	de-emphasis from 300-3000 Hz
Audio Output	500 mW

OPTIONS

PT-10L	Single tone encoder/decoder (CTCSS)
NBFV	Narrow band filter for 12.5 KHz channel spacing

CHAPTER 2
BASIC OPERATING PROCEDURES

2.1 GENERAL INFORMATION

The SP-605H and SP-602H portable transceivers are the first all metal, synthesized, low-cost handhelds specifically designed for the professional land mobile user. These units operate in the VHF/FM band from 136 MHz to 174 MHz. The specific frequency of operation is determined by the diode-matrix board and the corresponding ranging crystal. By eliminating the need of frequency crystals for each channel, future channel additions are easily accommodated and the delay time of waiting for crystals is eliminated.

Power output for the SP-605H is five watts in the HI position and one watt in the LO position. The SP-602H provides two watts of RF output in the HI position and 0.5 watts in the LO setting. By utilizing the LO power position whenever possible, the battery consumption is reduced to allow longer use between battery charges.

Battery power for the SP-605H is provided by a slip-on 12.0 volt pack. The SP-602H uses a smaller pack of the same style with a voltage of 7.2 volts. Both of these battery packs are easily changed by the user. For optimum performance, these nickel cadmium packs should be completely discharged periodically prior to recharges. This allows the battery to take on a deeper charge which offers a longer use before minimum operating voltage is reached.

2.2 OPERATING PROCEDURES

2.21 ANTENNA
The helical whip (50 ohm) antenna is secured to the portable at the BNC connector. To install the antenna the connectors should be mated and the connector turned clockwise until locked.

2.22 VOLUME CONTROL
When the volume control is in the full counter-clockwise position the unit is in the OFF position. To turn the unit ON the control should be turned clockwise until the desired volume level is reached. To assure the proper setting, the squelch control should be set to its full clockwise position to allow noise to be heard from the speaker.

2.23 SQUELCH CONTROL
Once the desired volume level is set, the squelch control should be rotated counter-clockwise until the background noise just disappears. Rotation beyond this point will elevate the squelch threshold and weak transmissions may be missed. By periodically adjusting the squelch control clockwise (referred to as "breaking squelch") the user can

perform an operational check of the receiver and speaker system.

2.24 PTT SWITCH
To transmit from the portable the press-to-talk (PTT) switch on the side of the unit must be pressed. This action engages the transmitter and disables the receiver. When transmitting, the user should speak across the face of the unit within a few inches of the speaker. At the end of the transmission the PTT switch must be released to enable the receiver.

2.25 HI/LO POWER SWITCH
For extended battery life it is recommended that the radio be operated in the LO power position, whenever possible. This reduces the output power of the transmitter and saves battery drain during transmissions. However, if the LO setting does not provide sufficient range the switch can be placed in the HI position. This allows maximum output power from the transmitter.

2.26 TRANSMITTER INDICATOR
When the transmitter is engaged the transmitter light will illuminate to indicate transmitter power. If the light fails to come on during transmissions the unit should be checked by a technician for proper operation.

2.27 BATTERY INDICATOR
When the battery pack is nearing a discharged condition the battery indicator light will illuminate. When this occurs the battery pack should be replaced or recharged.

CHAPTER 3

Theory of Operation

RECEIVER

Antenna Switching — Received signal enters the antenna connector and passes through the low-pass filter network into the RF amplifier stage TR221. When the unit is in the transmit mode, the transmitted signal is prevented from entering the RF amplifier stage by the antenna switch diodes D103 and D104. In the receive mode, these diodes are non-conductive and decouple the TX final stage.

RF Amplifier — L201 and L202 allow input filtering and impedance matching to the first amplifier stage of TR221. TR221 is a dual-gate MOSFET which provides amplification of the incoming signal.

First Mixer — After amplification, the receive signal enters the first mixer stage of TR222 where an injection signal at 21.4 MHz offset is provided. This FET helps assure minimum intermodulation interference and maximum linearity. After mixing with the received signal, the resultant 21.4 MHz signal (with accompanying modulation) is fed to the first IF stage of crystal filter FL201.

First IF Amplifier — FL201 reduces any incoming harmonics and provides impedance matching to the IF amplifier stages of TR223 and TR224.

Second Mixer, Second Local Oscillator, Limiter, Detector — The circuitry centered around multifunction IC201 constitute the second mixer stage, second local oscillator, limiter and detector. An internal oscillator signal of 21.945 MHz is mixed with the incoming signal of 21.4 MHz. The resultant 455 kHz signal is routed outboard to FL202 which reduces any harmonics and provides a clean signal for return into IC201. Upon entering IC201, the 455 kHz signal is limited to assure stable output. This limited signal is then fed through a quadrature detector to strip the modulation and provide audio output from IC201. Discriminator output (pin 2 of the interface connector) is obtained from pin 4 of IC201.

Squelch Circuit — Squelch threshold is established by control of an active filter within IC201. This threshold is determined by the position of squelch potentiometer VR301. When no carrier is present, allowing high frequency noise to be received, the internal filter passes this high frequency signal into rectifier diode D208. The resultant voltage is used to control the gating transistors of TR225-TR227. This action reduces the power output of the audio stage IC202. When a carrier is present, the gating circuit enables the final audio stage.

Audio Amplifier — The output from IC201 is routed through volume potentiometer VR302 to the audio amplifier stage of IC202. The output of this stage is available through pin 4 of the interface connector or J303.

TRANSMITTER

Transmit Audio Amplifier — Transmit audio (pin 12 of the interface connector) is preamplified by TR205, TR203, and TR203. The amplified audio is then fed to limiter TR202 which prevents overmodulation. After limiting, the audio is then routed to low-pass filter TR201. This integrator circuit prevents splatter into the transmitter.

Modulator — Audio from the speech amplifier is applied to the VCO FET, TR110, which causes the carrier frequency to be shifted proportionally to the audio rate. This action causes frequency modulation of the transmitter. Audio level is controlled by deviation control VR201. Transmit data input (pin 7 of the interface connector) is fed to the base of TR110 through R123.

Buffer, Multiplier, Driver, Final — Isolation for the VCO injection signal is provided by buffer TR102. The VCO frequency at this point is half the channel frequency. The multiplier circuit of TR103 doubles the input frequency and passes the transmitter signal into buffer TR104. Preamplifier TR105 amplifies the signal to an adequate level to drive the final power amplifier TR106. During transmit mode the antenna switch diodes D103 and D104 are forward biased to allow passage of the transmitter RF. Also during transmit condition, light emitting diode D301 is forward biased to indicate transmitter operation.

SYNTHESIZER

The primary function of the synthesizer is to provide transmitter injection signal, and local oscillator signal to the receiver. This design allows a single crystal oscillator to provide stable frequency generation without the need for tuning crystals for each channel. By dividing the reference oscillator signal by an amount respective of the selected channel, the synthesizer can provide a range of frequencies.

Programming of the synthesizer is accomplished via the diode matrix board, located at the back of the unit. These diodes determine the proper divide ratio for the synthesizer. (Refer to diode programming instructions in chapter 4.)

The design used in the SP-605H/TM is a premix PLL configuration which allows a lower frequency output from the VCO. This is desired to allow accurate division by the digital divider circuitry.

Voltage Controlled Oscillator (VCO) — The VCO consists of oscillator TR110 and varactor diode D106. The effective capacitance of D106 is controlled by the DC tuning voltage. As the tuning voltage is changed, the oscillator frequency of the VCO follows. The output of the VCO is applied to the doubler circuits of TR101 and TR103. TR101 feeds the receiver, and TR103 provides signal into the transmitter. The VCO output is also applied to cascaded buffer stages TR111 and TR112 which feed the mixer circuit for the phased-locked-loop (PLL).

Pre-Mix Local Oscillator — In order to reduce the VCO to a frequency suitable for division by the low speed logic, the VCO output is mixed with the output of the oscillator/doubler TR115. In the receive mode, the VCO output must be offset from the transmit frequency by half of the first IF frequency. This, and a semi-duplex split is accomplished by using a different crystal frequency at the pre-mix oscillator.

Mixer and Low Pass Filter — The mixer circuit of TR113 mixes the VCO frequency with the output of the pre-mix oscillator TR115. The desired resultant, which is the difference frequency (or lower frequency component) is passed by the low pass filter consisting of CH108, C177, and C178.

Pre-Mix Local Oscillator — In order to reduce the VCO to a frequency suitable for division by the low speed logic, the VCO output is mixed with the output of the oscillator/doubler TR115. In the receive mode, the VCO output must be offset from the transmit frequency by half of the first IF frequency. This, and a semi-duplex split is accomplished by using a different crystal frequency at the pre-mix oscillator.

Divider Buffer — The output of the low pass filter is buffered and amplified by TR114 to the level reqired by programmable divider IC101.

Programmable Divider — Division of the buffered pre-mix output is accomplished by programmable divider IC101. The division ratio is set by the programming diodes on the diode matrix board. This division process determines the output of the VCO.

Phase Comparator, Reference Oscillator/Divider — By comparing the divided VCO frequency to the reference oscillator, the synthesizer can determine if the VCO is on the proper operating frequency, as determined by the programming diodes. If a difference is detected, the DC tuning voltage will be changed to drive the VCO to the correct output.

The DC tuning voltage is derived from the filtered output of phase comparator IC103. Output from IC103 represents the difference between the divided output of programmable divider IC101, and the 2.5 kHz output from the reference oscillator/divider IC102. The 2.5 kHz reference signal is derived from the 10.240 Mhz reference oscillator and a fixed division ratio in the reference divider of 4096. Any detected difference will alter the DC tuning voltage to bring the VCO output to the correct frequency.

CHAPTER 4

Frequency Programming

GENERAL INFORMATION

Frequency programming for the SP-605H is accomplished by the proper installation of diodes on the diode-matrix board, located in the back of the unit. Each unit is shipped with a sufficient supply of diodes to program all six channels.

In addition to diode programming, each unit must have the proper ranging crystals installed. There are two RX crystals (X103) and (X104), and one TX crystal (X102).

RANGING CRYSTAL SELECTION

The following chart provides the proper frequency for the RX and TX crystals:

Frequency Band (MHz)	RX (X103 & X104)	TX (X102)
135-140	24.75	30.10
140-145	26.00	31.35
145-150	27.25	32.60
150-155	28.50	33.85
155-160	29.75	35.10
160-165	31.00	36.35
165-170	32.25	37.60
170-175	33.50	38.85
153-158	29.25	34.6

Note: SP-605H units are shipped from the factory with RX1 (X103) and RX2 (X104) installed per order, if specified. Should ranging changes be necessary, the above values should be installed according to the desired frequency ranges. To order additional crystals, specify the desired frequency from the above chart.

DIODE-MATRIX PROGRAMMING

Programming the desired frequency requires installation of diodes in the proper positions on the matrix board (located at the back of the unit). Matrix sections A through L correspond to the following channels:

Section A = RX Channel 1
Section B = RX Channel 2
Section C = RX Channel 3
Section D = RX Channel 4
Section E = RX Channel 5
Section F = RX Channel 6

Section G = RX Channel 1
Section H = RX Channel 2
Section I = RX Channel 3
Section J = RX Channel 4
Section K = RX Channel 5
Section L = RX Channel 6

TRANSMITTER PROGRAMMING

Diode positioning for transmitter channels can be calculated using the following formula:

$N = (TX \times .5 - ftx \times 2) \times 400$

where:
- N = diode programming position
- TX = transmit frequency (MHz)
- ftx = ranging crystal frequency (per chart 4.2 above)

Example: Desired transmit frequency = 155.00 MHz

$$
\begin{aligned}
N &= (TX \times .5 - ftx \times 2) \times 400 \\
&= (155.00 \times .5 - 35.10 \times 2) \times 400 \\
&= (77.5 - 70.2) \times 400 \\
&= (7.3) \times 400 \\
&= 2920
\end{aligned}
$$

This resultant four digit number is then subjected to one of the following charts:

Chart 1
3000 > N > 2900

B3	2000
D2	800
C2	400
B2	200
A2	100
D1	80
C1	40
B1	20
A1	10
D0	8
C0	4
B0	2
A0	1

Chart 2
3999 > N > 3000

B3	2000
A3	1000
D2	800
C2	400
B2	200
A2	100
D1	80
C1	40
B1	20
A1	10
D0	8
C0	4
B0	2
A0	1

Locations B3 - A0 refer to diode locations on the diode matrix board. By installing the proper diodes, according to the calculated number, the synthesizer provides the proper divide ratio, allowing the VCO to operate on the proper frequency.

Example: Calculated number for N = 2920

The binary equivalent for 2920 is determined as follows:

B3 - A3	D2 - A2	D1 - A1	D0 - A0
2	9	2	0

Diode programming would then then be determined as:

(B3) (D2, A2) (B1)

Installation of the above diodes will program the transmit frequency of 155.00 MHz.

RECEIVER PROGRAMMING

Programming of the receiver diodes is similar to the transmitter. The only difference in the procedure is the applied formula. For receiver programming the following formula is used:

N = [(RX − 21.4) × .5 − (frx × 2)] × 400

where: N = diode programming position
RX = receive frequency (MHz)
frx = ranging crystal frequency (per chart 4.2 above)

Example: Desired receive frequency = 157.750 MHz

N = [(RX − 21.4) × .5 − (frx × 2) × 400
= [(157.750 − 21.4) × .5 − (29.75 × 2)] × 400
= [(136.35) × .5 − (59.50)] × 400
= [68.175 − 59.50] × 400
= 8.675 × 400
= 3470

By referring to the above charts, the programming diodes needed would be:

3	4	7	0
(B3, A3)	(C2)	(C1, B1, A1)	

Installation of diodes B3, A3, C2, C1, B1, and A1, will program the receive frequency of 157.750 MHz.

RANGING CRYSTAL SWITCHING

An additional diode location exists in each section of the matrix board. These locations (next to the A0 position of each section) are for the purpose of crystal switching into operationRX1 or RX2. Location A corresponds to channel 1; B corresponds to channel 2, etc... If all locations are left empty, RX1 will be switched into the circuitry. Whenever a channel assignment requires the ranging of crystal RX2, a diode should be installed into the proper location/channel assignment.

Example:

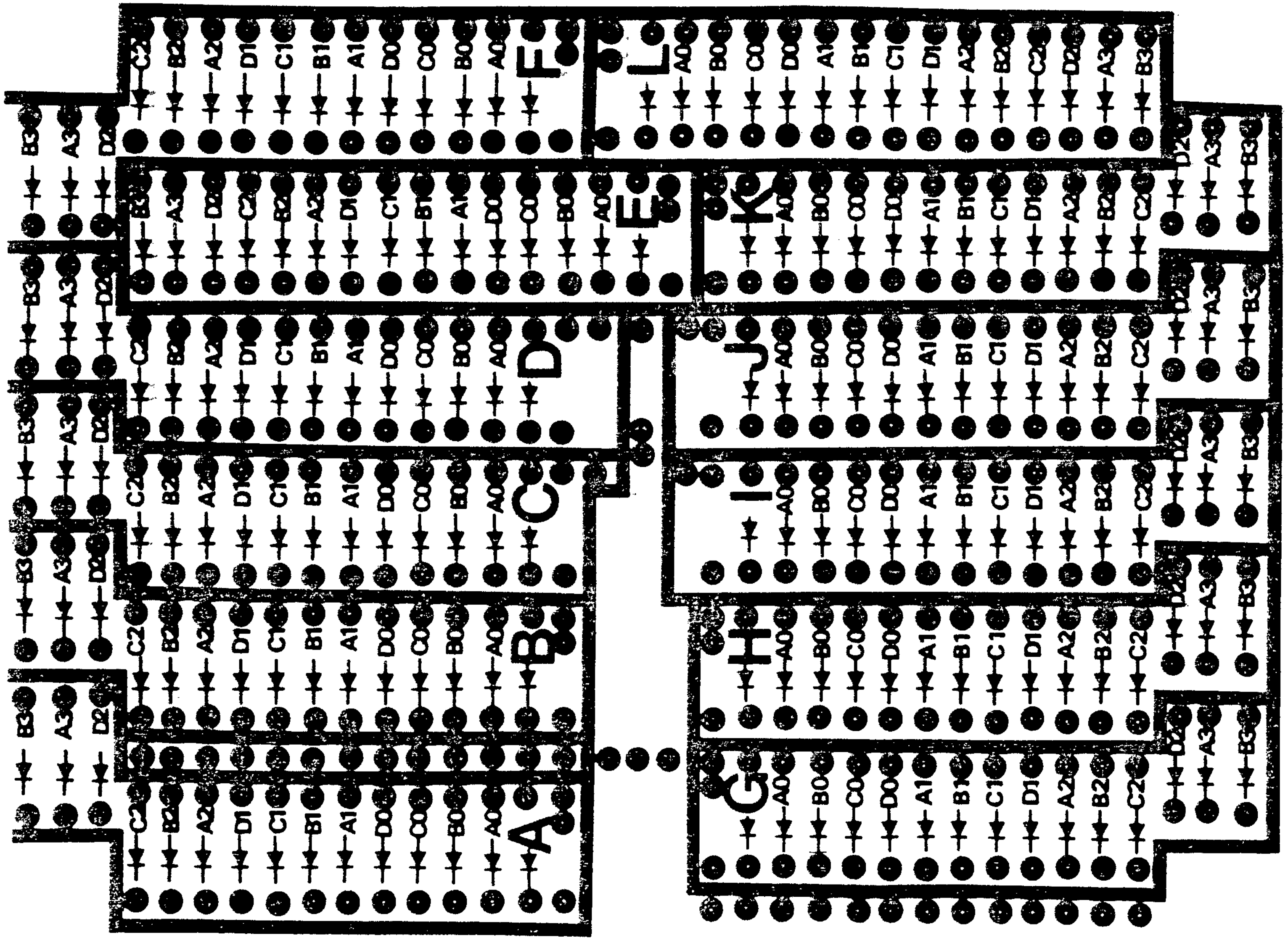
Location:	Diode Installed?:	Crystal Used:
A (CH 1)	NO	RX1
B (CH 2)	NO	RX1
C (CH 3)	YES	RX2
D (CH 4)	YES	RX2
E (CH 5)	NO	RX1
F (CH 6)	YES	RX2

Note: Locations G through L are unused.

DIODE INSTALLATION

The programming diodes should be carefully formed and installed with a low temperature soldering iron. As many diodes must be housed in a small location, care must be taken to assure that all diodes are installed neatly and with equal spacing.

MATRIX BOARD LAYOUT



A – 1CH RX

B – 2CH RX

C – 3CH RX

D – 4CH RX

E – 5CH RX

F – 6CH RX

G – 1CH TX

H – 2CH TX

I – 3CH TX

J – 4CH TX

K – 5CH TX

L – 6CH TX

CHAPTER 5

Alignment Procedures

PRELIMINARY

Alignment of the SP-605H should be performed by qualified technicians only. Warranty may be void if technical repair is attempted by anyone that is not trained and familiar with portable communications equipment.

Alignment of the SP-605H can easily be accomplished with standard test equipment. However, the equipment should be within calibration standards to assure accurate alignment of the radio equipment.

PHASE-LOCKED LOOP (PLL)

Connect an oscilloscope to TP101 and adjust L118 for maximum signal (in receive mode) at this point. Once this is accomplished, turn the core of the coil down one turn to broaden the adjustment. (This adjustment should be accomplished on the lowest frequency that the unit is programmed to operate.)

With the unit on the lowest programmed receive frequency, connect a DC voltmeter to TP103 (top of R120) and adjust L114 for 1.28 VDC. Connect a wattmeter to the antenna jack. Then key the transmitter on the lowest frequency and increase this voltage until the transmit power appears.

Connect an oscilloscope to TP104 and adjust L119 for 1.0 to 1.6 volts peak-to-peak in the transmit mode. After this adjustment, recheck the DC voltage at TP103 to assure that the voltage is less than 3.0 VDC in the transmit mode. If the reading is greater, perform the above procedure for L114 again.

Connect a frequency counter to TP105 and adjust the following variable capacitors to obtain the proper frequency (+/− 200 Hz) according to the following calculation:

$RX = (Fo - 21.4) \times .5$
$TX = Fo \times .5$

Where Fo = selected frequency
For frequencies in the lower 5 MHz receive band, adjust VC107 to obtain the proper frequency.
For frequencies in the upper 5 MHz receive band, adjust VC108 to obtain the proper frequency.
For frequencies in the upper 3 MHz transmit band, adjust VC106 to obtain the proper frequency.

RECEIVER ALIGNMENT

Local Oscillator — Connect an RF voltmeter to the source of receiver mixer TR222. Adjust L101 and L102 for maximum level. If an RF voltmeter is not available, L101 and L102 can be adjusted for best SINAD while feeding a high level, on-channel signal to the receiver.

Receiver Front-End Alignment — Input an on-channel signal into the receiver and adjust L201-L204 for best SINAD. (This adjustment should be started on the center frequency of the programmed channels. After setting L201-L204, the outside channels should be checked for proper specifications. If outside the specified limits, readjust L201-L204 for proper readings.)

IF/Detector Alignment — These circuits are normally factory tuned and should not be retuned unless absolutely necessary. If retuning is required, adjust L205 and L206 for best SINAD.

Squelch Threshold Adjustment — Connect a signal generator to the receiver and modulate the selected frequency with a 1 kHz tone, set for 3.3. kHz deviation. Set the ouptut level of the generator at 0.25μV. Adjust the squelch control to maximum squelch position and adjust VR202 to open squelch. After adjustment, remove the input signal to the receiver and rotate the squelch control to assure that the radio is squelched within the first quarter turn of the control.

TRANSMITTER ALIGNMENT

Preliminary — Connect a wattmeter of suitable range to the antenna connector. Adjust VC104 and VC105 to mid-position. Check air coils L106, L108, and L110, to assure that none of the coils are shorted.

Transmitter Buffer Alignment — Set the channel selector to center frequency of the programmed frequencies. Connect a DC voltmeter to TP102 and adjust L103 and L104 to peak voltage reading in transmit mode. (Continue this procedure until maximum voltage is obtained. However, the cores should not be above the top of the cans. If this occurs, reset the cores to mid-position and readjust.) Adjust VC101 to maximum voltage at TP102. Retrim adjustments L103, L104, and VC101 to obtain maximum voltage.

Driver and Final Power AMP Alignment — Activate the transmitter on the radio's center frequency and adjust VC102, VC103, VC104, and VC105, for maximum power output. If power output degrades on outside channels, decrease VC105 (slightly) and retune VC102-VC104.

"LO" Power Setting Adjustment — Set the "LO" power switch (SW301) to the LO position and adjust VR101 to the desired output (factory set for 1 watt).

Modulator Alignment — Set the transmitter in the "HI" position and modulate the transmitter. Adjust VR201 for 4.8 kHz of deviation. Check the "LO" power setting to assure that the modulation remains the same.

Power Supply Check — To assure proper operation, the SP-605H/TM should not exceed the following current drain specifications:

Model	Supply Voltage	Mode	Maximum Current
SP-605H	12.0 VDC	TX "HI"	1.2 A
SP-605H	12.0 VDC	TX "LO"	450 mA
SP-605H	12.0 VDC	RX	90 mA

In the event that current drain is substantially greater than the above values, the unit should be retuned and/or checked for defect.

CHAPTER 6

Parts List

GENERAL INFORMATION

The schematics in Chapter 8 incorporate all component values along with the schematic identification number. These values, or manufacturer part numbers, should be used when replacing defective parts.

ORDERING INFORMATION

When ordering replacement parts from the factory,simply use the following nomenclature:

	Model	Schematic Identification
Example:	SP-605H	TR106

This part number would coordinate to the final transistor (TR106) in the transmitter of a model SP-605H/
Any changes in component values or manufacturer's part numbers will be coordinated at the factory to assure that the proper part is replaced.

CHAPTER 7

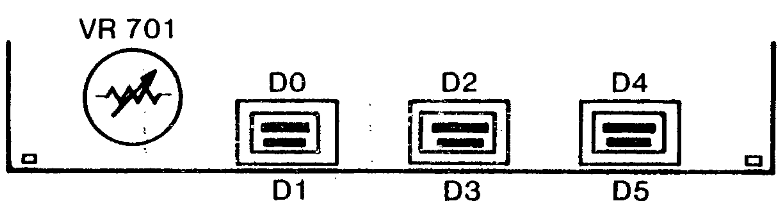
Options

SINGLE TONE CTCSS ENCODER/DECODER (PT-10L)

Tone Data Chart

Tone #	Tone Freq. (Hz)	Data D0	D1	D2	D3	D4	D5
1	67.0	1	1	1	1	1	1
2	71.9	1	1	1	1	1	0
3	74.4	0	1	1	1	1	1
4	77.0	1	1	1	1	0	0
5	79.7	1	0	1	1	1	1
6	82.5	0	1	1	1	1	0
7	85.4	0	0	1	1	1	1
8	88.5	0	1	1	1	0	0
9	91.5	1	1	0	1	1	1
10	94.8	1	0	1	1	1	0
11	97.4	0	1	0	1	1	1
12	100.0	1	0	1	1	0	0
13	103.5	0	0	1	1	1	0
14	107.2	0	0	1	1	0	0
15	110.9	1	1	0	1	1	0
16	114.8	1	1	0	1	0	0
17	118.8	0	1	0	1	1	0
18	123.0	0	1	0	1	0	0
19	127.3	1	0	0	1	1	0
20	131.8	1	0	0	1	0	0
21	136.5	0	0	0	1	1	0
22	141.3	0	0	0	1	0	0
23	146.2	1	1	1	0	1	0
24	151.4	1	1	1	0	0	0
25	156.7	0	1	1	0	1	0
26	162.2	0	1	1	0	0	0
27	167.9	1	0	1	0	1	0
28	173.8	1	0	1	0	0	0
29	179.9	0	0	1	0	1	0
30	186.2	0	0	1	0	0	0
31	192.8	1	1	0	0	1	0
32	203.5	1	1	0	0	0	0
33	210.7	0	1	0	0	1	0
34	218.1	0	1	0	0	0	0
35	225.7	1	0	0	0	1	0
36	233.6	1	0	0	0	0	0
37	241.8	0	0	0	0	1	0
38	250.3	0	0	0	0	0	0

Switch Settings

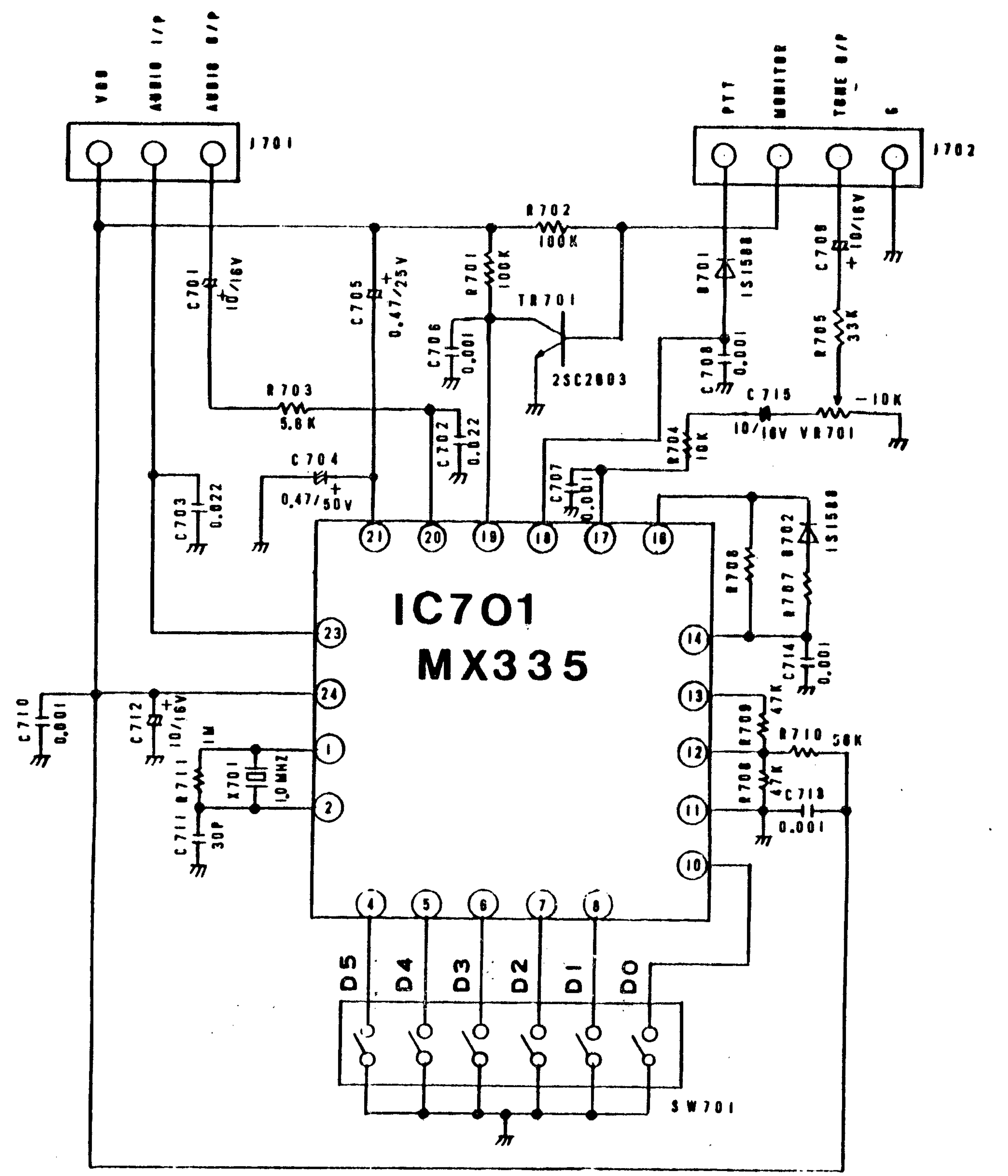


OFF= 1

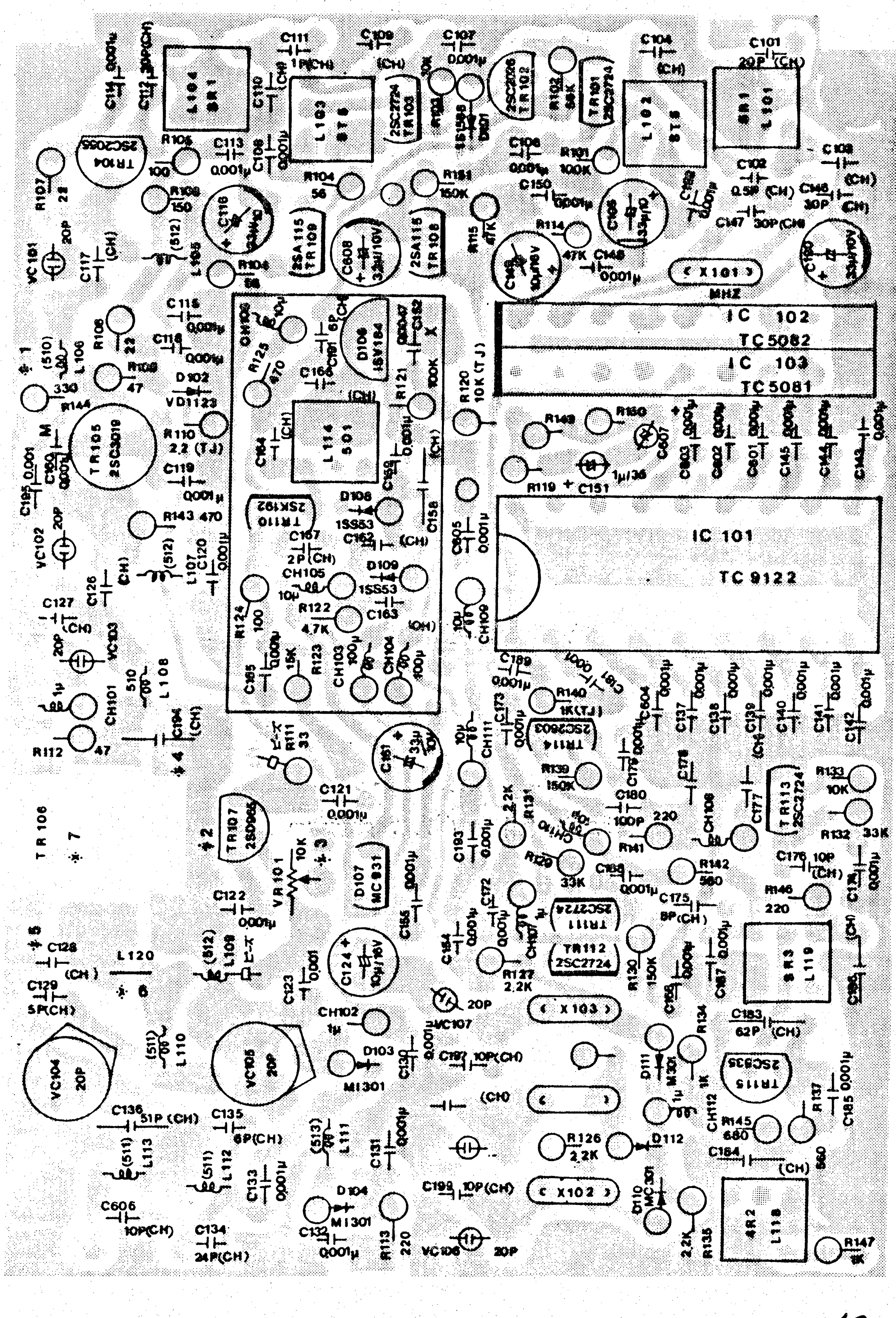
ON= 0

Tone Encode Level Adjust — Key transmitter and adjust VR701 for 500 - 575 Hz CTCSS tone deviation. (Check all frequencies and average accordingly.)

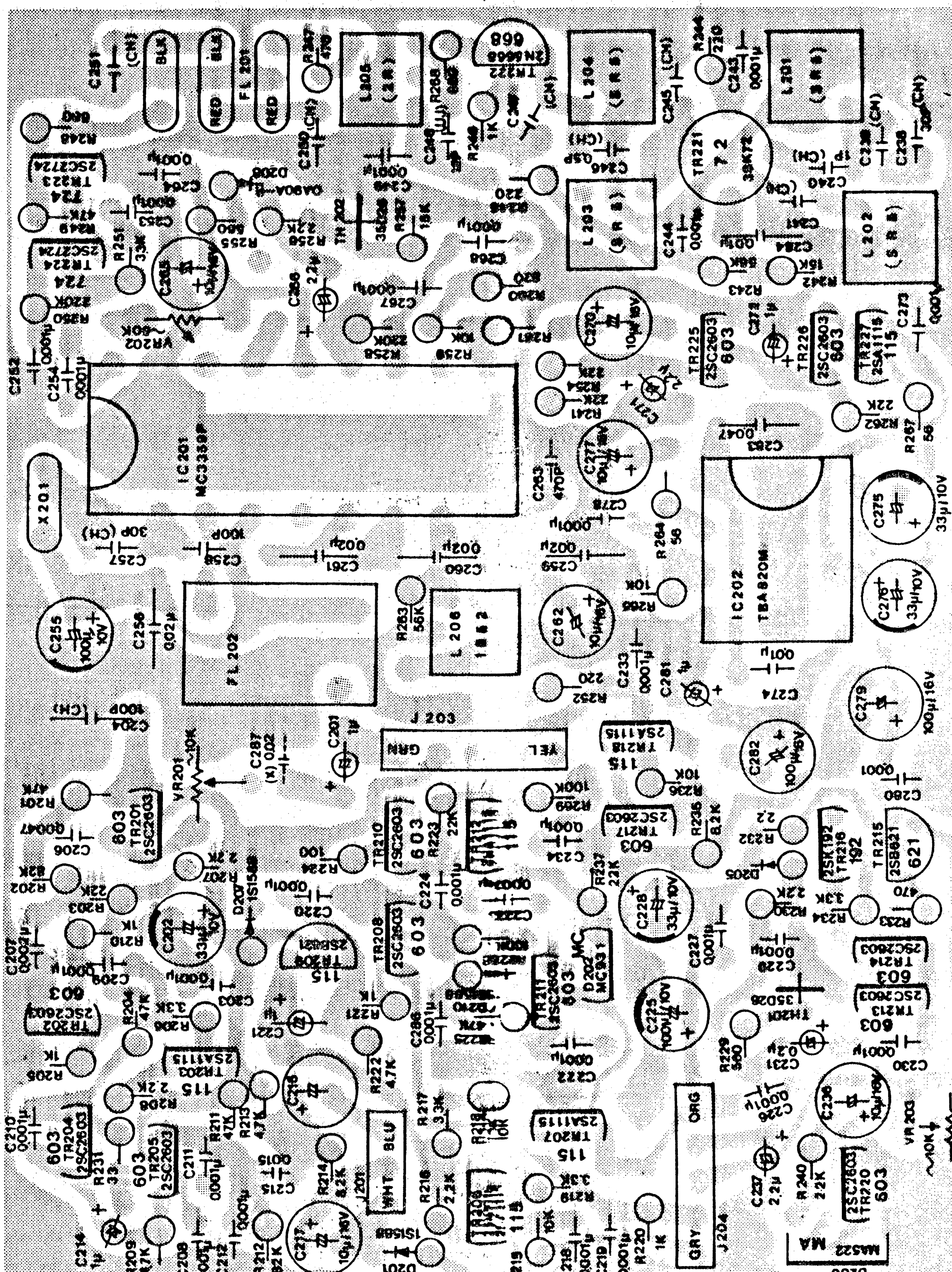
PT-10L Schematic



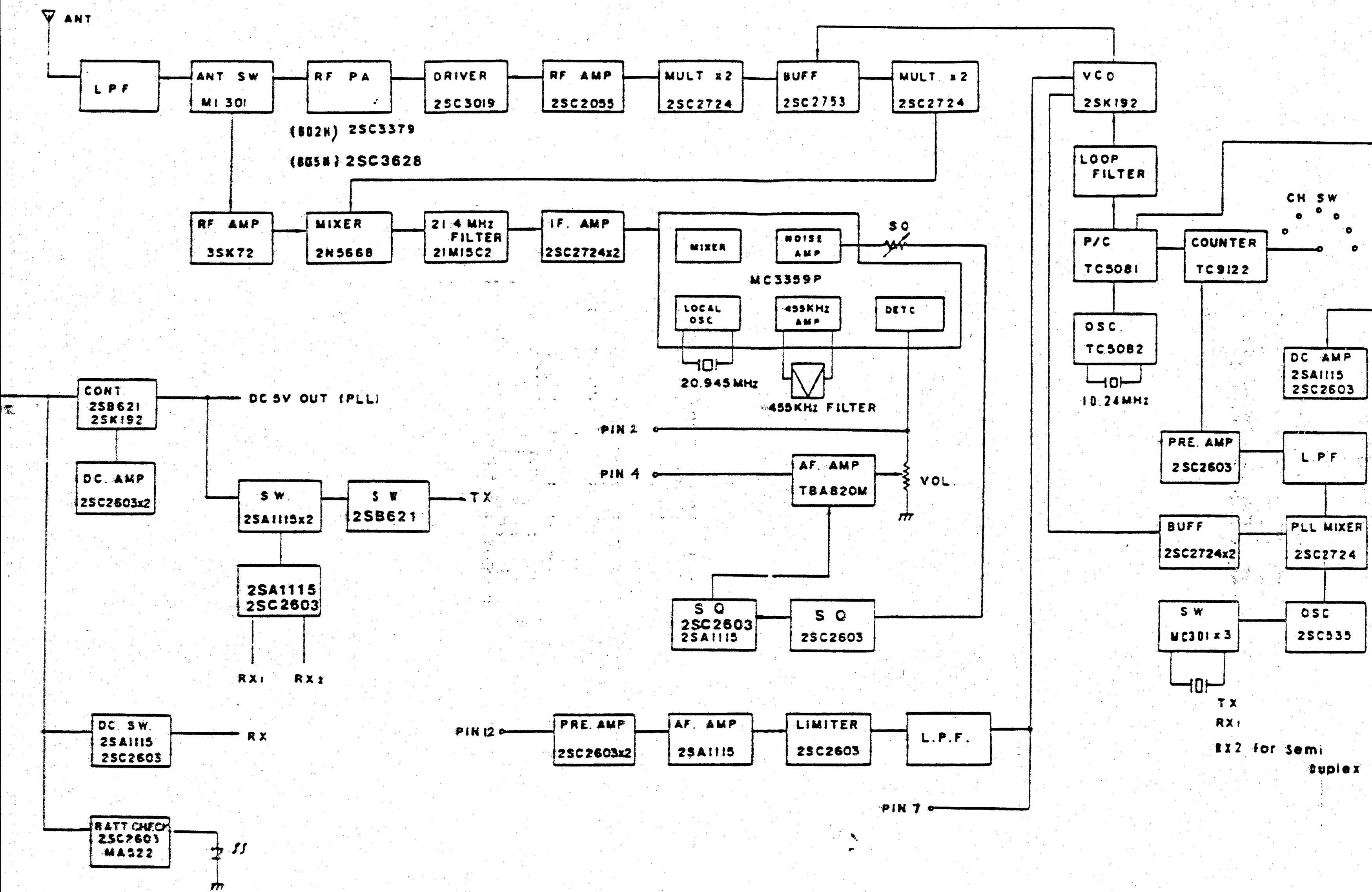
PLL/Transmitter Board Layout



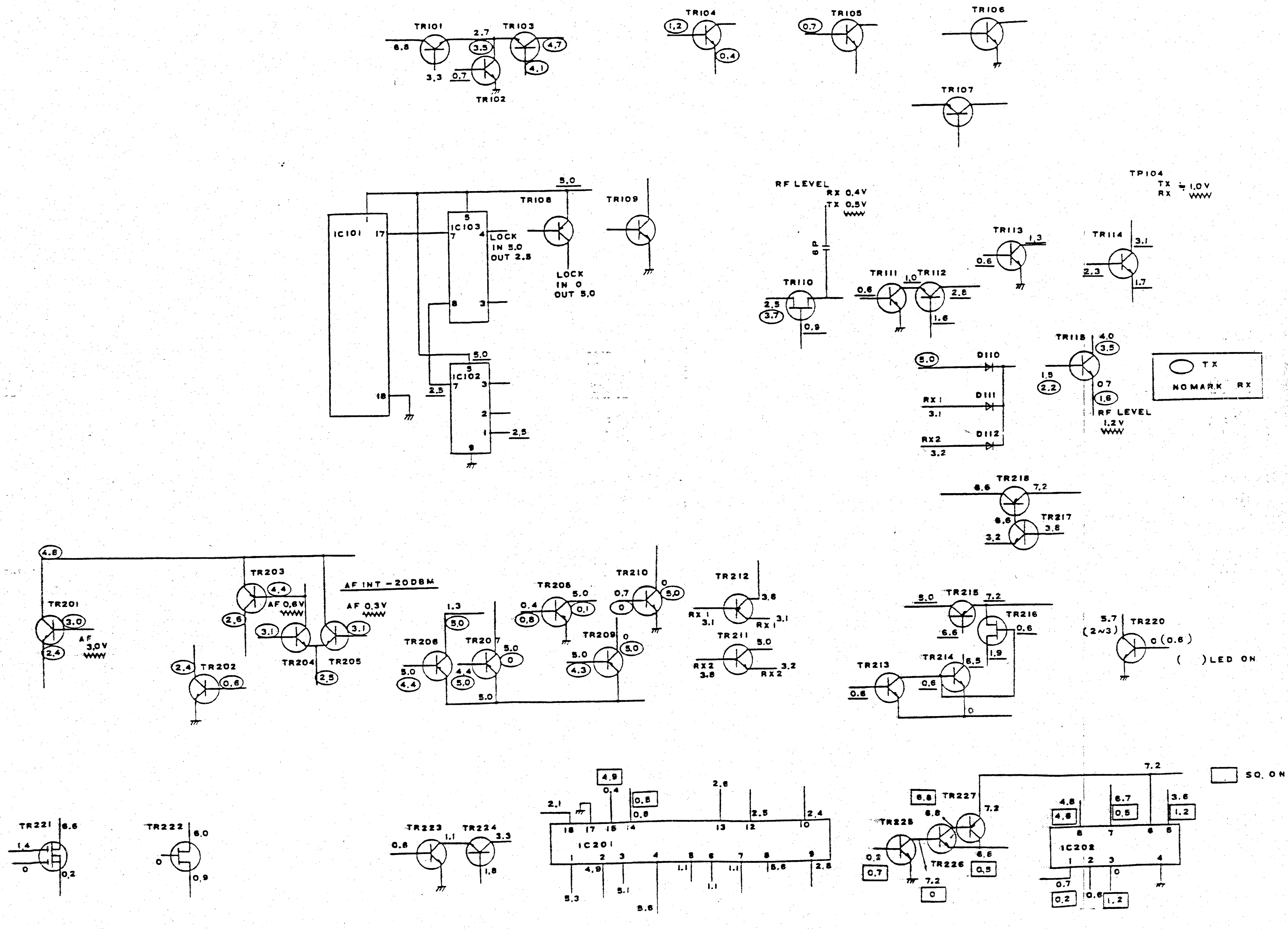
Receiver Board Layout



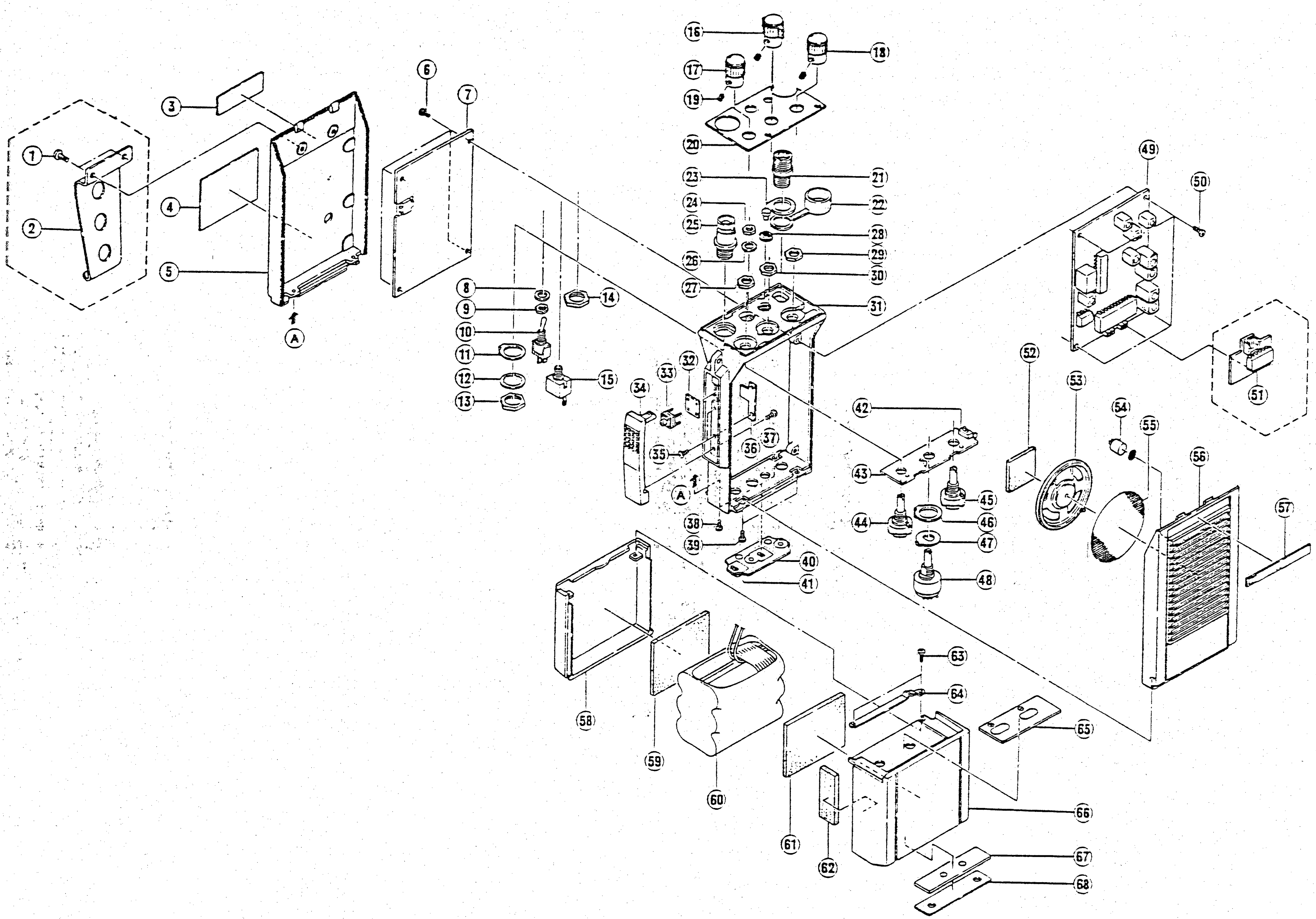
Block Diagram



FREQ. BAND	RX1	TX
135 — 140	24 75	30.10
140 — 145	26.00	31.35
145 — 150	27.25	32.60
150 — 155	28.50	33.85
155 — 160	29.75	35.10
160 — 165	31.00	36.35
165 — 170	32.25	37.60
170 — 175	33.50	38.85
153 — 158	28.25	34.60



VOLTAGE CHART



MECHANICAL PARTS EXPLOSION