SERVICE MANUAL

SM-1645 SERIES SYNTHESIZED MOBILE RADIOS

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NEUTEC A CELLTRONICS COMPANY

10400 MESA RIM RD., SAN DIEGO, CA 92121

CONTENTS

SPECIFICATIONS

SM-1645 Series
Mobiles and Mobile Repeater

This Equipment Meets or Exceeds the Following Specifications

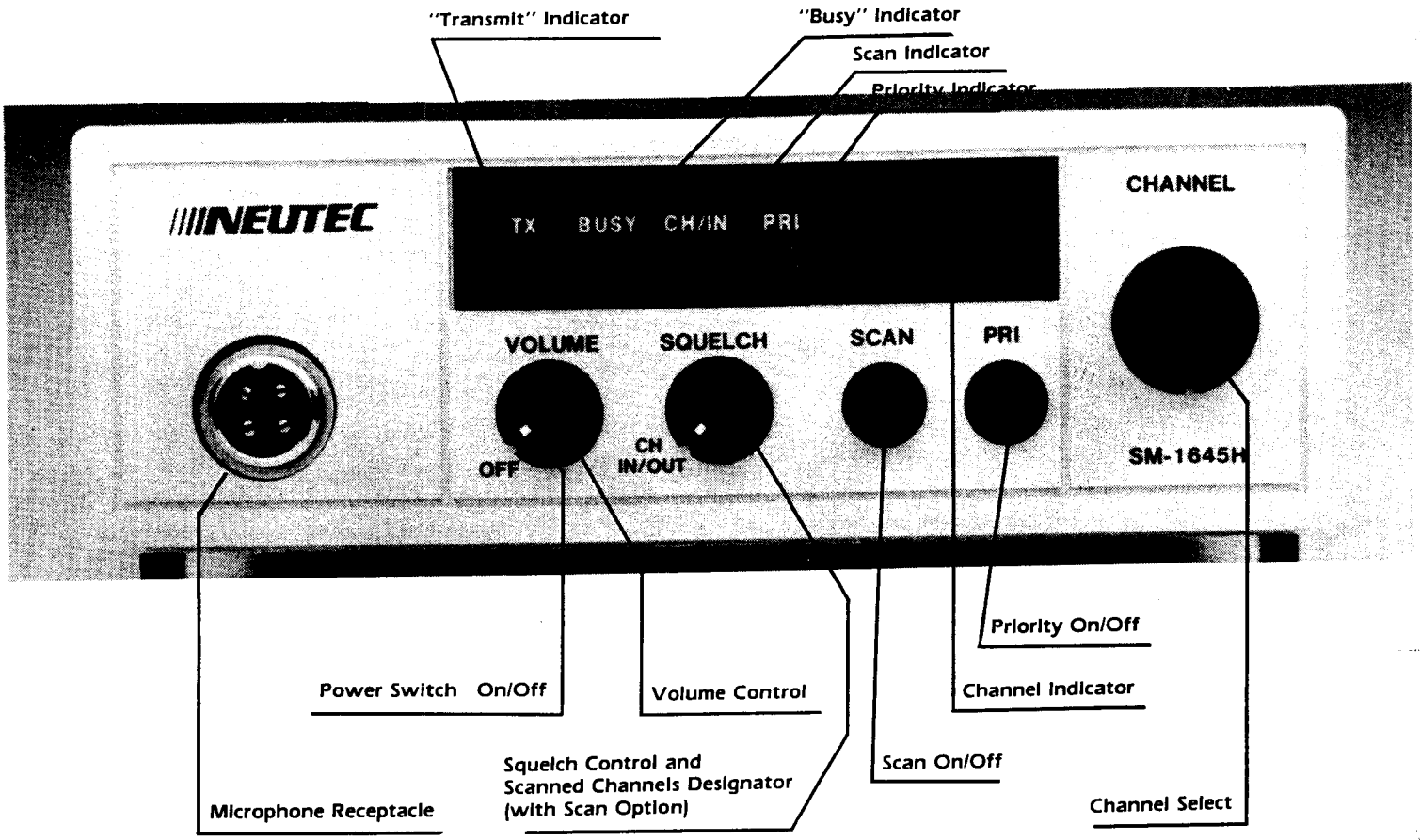
General	SM-1645H	SM-1645L	SM-1645HS
Frequency Range	136 - 174 MHz	30 - 50 MHz	144 - 174 MHz
Channels	16	16	16
Frequency Spread	12 MHz	2.5 MHz	12 MHz
Operating Temperature	- 30 to + 60C	- 30 to + 60C	- 30 to + 60C
Operating Voltage	13.8 VDC	13.8 VDC	13.8 VDC
Current Drain (TX)	8.5 amps	9.0 amps	9.1 amps
Current Drain (RX)	.8 amps	.8 amps	.98 amps
Antenna Impedance	50 ohms	50 ohms	50 ohms
Frequency Stability	5 PPM	5 PPM	5 PPM
Programming	EPROM	EPROM	Dual EPROMS
Channel Spacing	5 or 12.5 KHz	5 or 12.5 KHz	5 or 12.5 KHz
Size	7.2 x 2.6 x 10 inches	7.2 x 2.6 x 10 inches	11.7 x 7.2 x 2.6 inches
Weight	4 lbs. 2 ozs.	4 lbs. 2 ozs.	5 lbs. 4 ozs.

Transmitter			
RF Output Power	45 Watts (adj. 10 - 50)	45 Watts (adj. 10-50)	35 (adj.)
Modulation	16F3	16F3	16F3
Spurious and Harmonics	- 80 dB	- 80 dB	- 80 dB
Hum and Noise	- 50 dB	- 50 dB	- 50 dB
Audio Distortion	3%	3%	3%

Receiver			
Sensitivity	.25 uV (12 dB SINAD)	.25 uV (12 dB SINAD)	.25 uV (12 dB SINAD)
Selectivity	- 85 dB	- 85 dB	- 85 dB
Image and Spurious	- 85 dB	- 85 dB	- 85 dB
Intermodulation Rejection	- 75 dB	- 75 dB	- 75 dB
Hum and Noise	- 50 dB	- 50 dB	- 50 dB
Audio Output	5 Watts	5 Watts	5 Watts

Specifications subject to change without notice.

LOCATION OF CONTROLS



OPERATING PROCEDURE

1. Turn the "Volume Control" clockwise to apply power. The channel indicator will illuminate.
2. Set the "Channel Select" switch to the desired channel, as shown in the "Channel Indicator" window.
3. Rotate the "Squelch Control" counterclockwise.
4. Adjust the "Volume Control" for a normal listening level (background noise or a station if one is transmitting).
5. When the channel is clear (background noise only), rotate the "Squelch Control" clockwise until the receiver is silenced. Perform this step carefully. Do not go far beyond the silencing point or the receiver may not respond to weak signals.
6. After setting the receiver controls and selecting the proper channel, depress the microphone push-to-talk switch and speak across the face of the microphone in a normal voice when transmitting.

PRIORITY SCAN INSTRUCTIONS

1. Turn the radio on.
2. Select through the channels and use the "Delete/Add" switch (detent of squelch pot) to delete those channels that are to be skipped during the scan sequence. As channels are deleted the tone light will extinguish.
3. Set the "Squelch Control" to quiet the receiver. (This should be set on a non-active channel.)
4. Set the "Channel Selector" to the channel that is to be the priority channel.
5. Engage the priority monitor by depressing the "Priority" switch. (This step should only be included if the priority channel is to be monitored at all times.)
6. Activate the scan mode by depressing the "Scan" switch. At this time the channel display will indicate scanning of the channels in the scan list.
7. Verify the priority monitor by opening "Squelch" on a non-priority channel and noticing the "look-back" action to priority channel.
8. Reset the "Squelch" to threshold.
9. Remove the microphone from its bracket to assure priority channel switching.
10. Replace the microphone.

EPROM PROGRAMMING

General

Transmit and receive frequencies are determined from binary information stored in the EPROM, IC703. If the MT-20 Multi Tone option is installed, CTCSS Encode and Decode frequencies are also derived from binary information stored in the same EPROM. Data for each channel consists of 16 bytes or memory locations. The first 8 bytes control receive frequency and tone and the second block of 8 bytes control transmit frequency and tone. Each byte or memory location stores 8 bits of data. The upper four bits are tone information and the lower four bits are frequency information. If no CTCSS Encode or Decode is programmed, then the upper four bits of each memory location will remain all ones, or, as represented in Hex, "F." The transmit or receive frequency data is strobed into the synthesizer in eight-four bit blocks, via four data lines from the EPROM. This data sets the counters internal to the synthesizer so that the appropriate VCO oscillates at the desired frequency. The addresses of the data to be sent to the synthesizer are obtained from the Channel Select switch and the TX/RX mode input to the EPROM.

Computation of ROM Data:

Counter data can be determined mathematically using the formulas shown below. The result of the computations will consist of 8 figures in Hex format for each transmit or receive frequency.

The following example for channel 1 is based on a simplex frequency of 154.430 MHz without CTCSS. Note that the receive Hex code is computed for 21.6 MHz below the desired receive frequency. For low-band radios 21.6 MHz will be added to the receive frequency instead of subtracted. The eight data values for each transmit or receive frequency will be labeled D0 thru D7 and shown in Hex.

RECEIVER DATA:

VCO freq: 154.430 - 21.6 = 132.83 MHz

N = (132.830 x 1000) / 5 = 26566
(5 being the channel spacing)
26566 / 10240 = 2.5943359375 (*)
D4 = Integer value of above
D4 = 2.
Multiply figures to the right of the decimal by 16.
.5943359375 x 16 = 9.509375 (*)
D3 = Integer value of above
D3 = 9
Again multiply fractionary remainder by 16.
.509375 x 16 = 8.15
D2 = 8
Multiply fractionary remainder by 2.5
.150 x 2.5 = 0.375
D1 = 0
Multiply fractionary remainder by 16.
.375 x 16 = 6.0
D0 = nearest whole number (if a fraction) which in this case is 6
D0 = 6

So far we have values for D0 thru D4. The values for D5 thru D7 are determined by the channel spacing. Spacing can be 5 kHz (most U.S. frequencies) or 6.25 kHz spacing (mostly European). This is determined by whether the frequency is divisible by 5 or 6.25.

For 5 kHz steps:
D5 = 0 D6 = C D7 = 3
For 6.25 kHz steps:
D5 =0 D6 = 0 D7 = 3
The complete data load for 154.430 MHz (RX) then is:
D0 = 6, D1 = 0, D2 = 8, D3 = 9, D4 = 2, D5 = 0, D6 = C, C7 = 3 or (6 0 8 9 2 0 C 3)

TRANSMITTER DATA:

VCO freq: 154.430
N = (154.430 x 1000) / 5 = 30866
(5 being the channel spacing)
30866 / 10240 = 3.0162109375 (*)
D4 = 3
.0162109375 x 16 = .259375 (*)
D3 = 0
.259375 x 16 = 4.15
D2 = 4
.15 x 2.5 = .375
D1 = 0
.375 x 16 = 6.0
D0 = 6

As before, channel spacing being 5 kHz, then:
D5 = 0, D6 = C, D7 = 3
The complete data load for 154.430 MHz TX then is:
D0 = 6, D1 = 0, D2 = 4, D3 = 0, D4 = 3, D5 = 0, D6 = C, D7 = 3 or (6 0 4 0 3 0 C 3)

It must be remembered that in the hexadecimal system, numbers between 10 and 15 are represented by the letters A thru F.

If we were to program 154.430 TX/RX into channel 1, the complete data load for the first 16 addresses of the EPROM would then be:

F6 F0 F8 F9 F2, F0 FC F3, F6 F0 F4 F0 F3, F0 FC F3

Note that the upper 4 bits of each byte at each address will be filled with one's (F), as they are unused by the synthesizer. Also, the RX data is always entered first.

EXAMPLE DATA CHART

EPROM ADDRESS	DATA	LOAD	FUNCTION	REMARKS
00	D0	F6		F(RX)=154.430 MHz
01	D1	F0		F(VCO)=154.430-21.6
02	D2	F8		=132.830 MHz
03	D3	F9		
04	D4	F2	CH 1	
05	D5	F0	RX	
06	D6	FC		
07	D7	F3		
08	D0	F6		F(TX)=154.430 MHz
09	D1	F0		F(VCO)=154.430
0A	D2	F4		
0B	D3	F0		
0C	D4	F3	CH 1	
0D	D5	F0	TX	
0E	D6	FC		
0F	D7	F3		

(*) The division of N by 10240 and subsequent multiplication of the fractional part by 16 should be done by hand or computer with appropriate accuracy as these numbers can sometimes extend 12 decimal places and must be carried rather than rounded off so as to maintain accuracy.

CIRCUIT DESCRIPTION
RECEIVER

General
The SM-1645's double superheterodyne design emphasizes high sensitivity, low noise level and excellent selectivity. The first IF frequency is 21.5 MHz and the second IF frequency is 455 kHz.

RF Amplifier
A low-noise, dual-gate FET (Q101) amplifies low-level signals from the antenna terminal and feeds the next stage (1st Mixer). RF coils L101-L105 affect the bandwidth, filter incoming signals and prevent undesirable radiation of the 1st local oscillator frequency.

1st Mixer
This function, performed by Q102, serves to mix the incoming signal and that of the 1st local oscillator, resulting in the 1st IF of 21.6 MHz. This stage is important in achieving a high level of intermodulation rejection.

1st IF Amplifier
This circuit, consisting of Q104, amplifies the 21.6 MHz signal.

2nd Mixer
This function, performed by Q106, serves to mix the frequency of the 2nd local oscillator, and to convert 21.6 MHz to the 2nd IF of 455 Khz.

2nd IF Amplifier
This stage, contained within IC101, amplifies the 455 KHz 2nd IF. It also performs the limiting function.

Audio Detector
This circuit, consisting of IC101 and F103, recovers the audio signal from the 2nd IF.

AF Amplifier
IC104 amplifies the audio signal from the previous stage to the power level needed to drive the loud speaker.

1st Local Oscillator
See "PLL/Frequency Generation".

2nd Local Oscillator
Q105 is a crystal-controlled oscillator at 21.145 MHz, with the frequency fine adjusted by CV101. This signal is fed into the 2nd mixer (Q106).

Squelch Control Circuit
In a noise squelch circuit, the internal noise of the receiver decreases when a signal is present. When there is no incoming signal, noise is picked up and amplified by half of IC102 and part of IC103. It is then rectified by Q107 and converted to a DC level.

The DC signal is fed to a Schmitt Trigger Circuit (comprised of the other parts of IC103), which stops the amplification function of IC102 (DC-Controlled Attenuator).

When there is incoming signal, and the internal noise decreases, the Noise Detector (Q107) loses its output and pin 10 of IC103 goes high, enabling IC102. The squelch point is controlled by the squelch potentiometer, which varies the gain of IC102 at the DC level.

Busy Light
Where tone squelch systems are incorporated into the radio, it is necessary to check for other signals before transmitting. The busy light indicator serves that purpose.

The busy light functions off the high or low DC level at pin 10 of IC103 via LED driver transistor Q108.

Regulated Power Supply
To keep fluctuations in power source voltage from influencing the receiver characteristics, IC105 feeds regulated voltage to the primary circuits, including oscillator, squelch, RF amplifier and IF amplifier.

Switching Circuit
In the TX mode, the receiver supply voltage is removed by Q109-Q110 and D105-D106.

CIRCUIT DESCRIPTION
TRANSMITTER

General

The oscillator uses a programmable Phase Locked Loop (PLL). The resultant VCO frequency is the same as the channel frequency on transmit and 21.6 MHz below channel frequency on receive. In the transmit mode, the VCO output is modulated, amplified and fed to the antenna.

PLL, Exciter Boards

The circuits that make up the transmitter are:

- PLL
- Transmitter Exciter
- Modulator
- Power Supply

PLL/Frequency Generation

Transmitter drive at the carrier frequency and the receiver 1st local oscillator signal (21.6 MHz below the desired receive frequency) are generated respectively by independent VCOs Q203 and Q201. The signal from transmit VCO Q203 is buffered by Q204 before being fed to the TX exciter and PLL buffer Q205. The output from receive VCO Q201 is buffered by Q202 before being fed to the receiver 1st mixer. In the receive mode, Q201 output is also fed to the PLL buffer Q205 via Q204.

The frequency of the respective VCOs are controlled by a DC voltage derived by the PLL circuitry. The DC voltage results from a phase/frequency comparison between the divided-down frequency from the reference oscillator controlled by 4.8 MHz crystal X201 and the divided-down output from the VCO. These functions are performed by the dual-modulus synthesizer IC202.

XTAL heaters R267 and R268 stabilize the temperature of the reference oscillator. The heating is controlled by Q214 and Q215, and is proportional to the ambient temperature as sensed by the thermistor TH201. The resultant VCO control voltage (and hence frequency) is determined by the divide ratio of the counters internal to IC202. The VCO voltage will vary between 1.5 volts at the lowest frequency and 7.5 volts at the highest. This voltage is generated by Q206, Q207 and Q208 based on phase data from the synthesizer IC202. Digital data, which sets the internal counters (or divide-by ratios) in IC202, is stored in an Erasable Programmable Read-Only Memory (EPROM) IC203.

The synthesizer, IC202, requires 32 bits for frequency determination. Data is transferred or "strobed" into IC202 in eight 4-bit "words" in order to simplify interconnection and package size. Strobing is done by clocking the addresses to the EPROM and IC202. The data entering IC202 via data pins D0-D3 is stored in internal latches as determined by the address present.

Address strobing is accomplished by clock IC205, which drives counter IC204. IC204 converts the serial clock pulses from IC205 to 3-line binary addresses between 0 and 7 (decimal) at outputs Q0-Q2.

PLL unlock protection is provided by Q212 and Q213. This circuit will disable the TX exciter in the absence of lock detect at IC202. A high or "1" is supplied to EPROM IC203 address line 3 (pin 5) during TX in order to switch strobing up by eight addresses. This allows receive data to be stored in the first 8 addresses and transmit data within the next 8 addresses of any given 16 address "channel block" selected by the channel select circuitry. Channel select addressing takes place at address lines A4-A7 of the EPROM.

It is conceivable that up to eight 16-channel blocks could be addressed via unused lines A8-A10 for a total of 128 channels.

(The 2716 EPROM stores up to 2048 bytes. Each channel requires 16 bytes, which provides room for 128 16-byte "groups".)

IC201 is a dual modulus counter controlled by IC202. The dual modulus method simplifies overall design by providing a selected division ratio on the input of IC202.

Operating frequency versus VCO voltage is determined by Varicaps D201-D202 at the receive VCO and D203-D204 at the transmit VCO. Modulation of the transmit VCO is determined by applying the audio signal to Varicap D205.

Transmitter Exciter
Q209, Q210 and Q211 amplify the transmitter VCO signal to a suitable input level for the driver stage (0.5 W). The stages are broadband transformer coupled and do not require tuning.

Modulator
This stage consists of Dual Op-Amp IC207. One half acts half as a speech amplifier and the other half provides pre-emphasis and limiting. Appropriate high frequency roll off is accomplished by a low-pass filter on the output of the second stage. Microphone sensitivity is set by VR201 and deviation by VR202.

Power Circuits
TX/RX switching is accomplished by Q217 and Q216. In the receive mode, Q217 saturates as a result of base drive from 8 V regular IC206. Saturation of Q217 provides a ground path for RX VCO Q201, thereby enabling it.

Shortening the PTT line to ground shunts base drive to Q217, which prevents it from conducting. This, in turn, disables RX VCO Q201. In this condition, base current flows through Q216, causing it to saturate and to provide +8 V DC to the modulator, TX VCO and RF predriver Q209 via Q213, which is part of the lock detection circuit.

Voltage regulation is provided by IC208 (+5 V DC for the logic) and IC206 (+8 V DC for modulator and TX VCO).

Display Board
A 7-segment 2-digit LED is used to display the channel being used. Four additional LEDs serve to indicate various functions of the radio.

The channel select switch sends out positive logic 4-bit binary codes representing 0 to 15 decimal. To convert this to 1 to 16, "1" is added to the 4-bit code output by 4-bit parallel full adder IC601.

IC602 converts the 5-bit binary code from the adder to 2-digit BCD for the display. The upper digits are 0 to 1, with 1 indicating Ch. 10 to Ch. 16. The 1-bit output of the upper digits is connected to Q601, which drives the segment that corresponds to "1" on the first digit of the 7-segment display.

BCD codes for the lower digits are connected to IC602, which drives the second digit of the 7-segment display.

The 4-bit codes from the channel select switch are also fed to the EPROM on the synthesizer board.

CIRCUIT DESCRIPTION
ADDITIONAL RECEIVER PLL/REPEATER CONTROL PCB
(SCHEMATIC ON PAGE 41)
SM-1645HS Duplex Mobile Repeater

The receiver PLL PCB has two functions. It must separate the first local oscillator signal for the receiver independently of the transmitter VCO so as to allow duplex operation, and it controls operation of the transceiver in the duplex mode or as a repeater.

The VCO/synthesizer circuitry is identical to the transmitter VCO/synthesizer which was previously described and which is contained within the exciter PCB. In the receiver PLL section, the VCO function is performed by Q701. The output of Q701, which is 21.6 MHz below the desired carrier (channel) frequency, is fed to buffers Q703 and Q702. The output of Q703 is fed to the Rx first mixer on the Rx PCB. The output of Q702 is fed to PLL buffer Q704. The output of Q704 is fed to IC 701. IC 701 is programmable N/N÷1 variable modulus counter whose countins ratio is controlled by synthesizer IC 702. The output of IC 702 is used to control the VCO as determined by the binary data loaded into receive EPROM IC 703. The binary data in IC 703 is clocked into the internal counters of the synthsizer IC. Prom addressing data, in 3 line binary form, is provided by counter IC 704 which is driven by free running clock consisting IC 705.

The Rx PLL PCB contains additional circuitry which controls if the radio is to operate in the duplex mode or repeater mode, and also provides an audio path between the Tx and Rx when in the repeat mode. Control is accomplished by IC 706 and IC 707. Repeater/duplex selection is determined by the level of J701 pin 9. A high at this point selects repeater while a low selects duplex. Q 708 provides audio feed to the Tx by amplifying and de-emphasizing the Rx discriminator signal from the Rx PCB. Deviation in the repeat mode is controlled by VR 701, audio path from the microphone (duplex mode) or the Rx PCB (repeater mode) is selected by analog switches in IC 708.

Tx activation in the repeater mode is controlled by the squelch level from the Rx PCB (COR). Additional circuits on the PLL PCB are voltage regulation as provided by IC 708, IC 709. Reference oscillator xtal X 701 is temperature stabilized by proportional heater circuit consisting of Q 710 and Q 711.

MT-10 CTCSS SINGLE TONE ENCODE/DECODE OPTION

(SCHEMATIC ON PAGE 43)

General Theory

Neutec's MT-10 Single Tone option equips the SM-1645 series of mobile radios for operation in CTCSS environments. With this option, the radio can encode or decode any of the 38 EIA standard tones. Programming of tone information is accomplished via dip switches. MT-10 Single Tone option can not be used with SC-10 Scan Option

Input/Output Functions:

DECODE ENABLE (J901-4) - This input disables the audio gate on carrier channels until a carrier signal is detected. For tone channels, this input is ignored and audio is allowed to pass only after the proper tone is detected.

MONITOR ENABLE (J901-6) — When the microphone is removed from its bracket, this input is removed from ground. This opens the audio gate, allowing the selected channel to be monitored for activity.

TX TONE OUT (J901-7) — The programmed CTCSS tone is sent to the exciter via this output. (Adjustment allows for proper deviation control.)

TX ENABLE (J901-8) — This input provides transmit enable to the tone chip. This will cause the tone signal to be sent to the transmitter circuitry.

Tone Programming:

Tone selection is accomplished by setting the dip switches on the Tone Board as indicated in Tone Data Table.

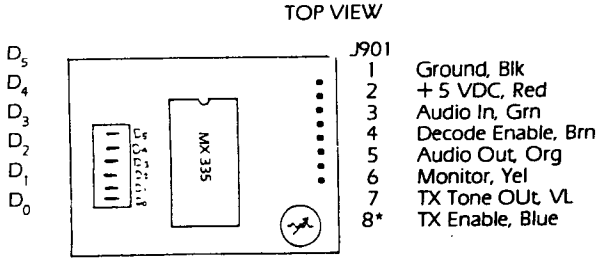
Installation:

1. A wiring harness for scan and tone options is incorporated in Neutec mobiles to facilitate field installation or exchange.
2. Locate and secure MT-10 Tone Board in the space provided next to the internal speaker, on top side of radio.
3. Remove green jumper from Receiver Board J102 and connect two pin plug from wiring harness.
4. Connect eight pin plug from wiring harness to J901 of MT-10 Tone Board.
5. On bottom side of radio, connect four pin plug from wiring harness to four pin plug provided. Solder opposite end of wire to J401 pin 4 on Driver Board.

Alignment:

TX TONE LEVEL (R7) — With the transmitter keyed on a tone channel, adjust R7 for proper sub-audible deviation of the transmitter signal. (Typically ±500 Hz deviation.)

MT-10 Single Tone CTCSS Installation Diagram:



MT-10 Interconnect Table:

Pin:	Function:	Destination:
J901		
1	Ground	Grounding junction at volume pot.
2	+5 VDC	+5 VCD output from PLL Bd. (P2027)
3	Audio In	Receiver Bd. Detector (P102-1) Pin closest to front of unit.
4	Decode Enable	Receiver Bd. Sq. Detect (IC103-10)
5	Audio Out	Receiver Bd. Audio Amp (P102-2) Pin farthest from front of unit.
6	Monitor Enable	Mic Hook-Switch
7	TX Tone Out	PLL/Exciter Bd. (VR202 wiper)*
8	TX Enable	Solder to gray wire on J401 of driver board (PTT).

Tone Data Table:

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

*NOTE: 1 = OFF 0 = ON

MT-20 CTCSS MULTITONE ENCODE/DECODE OPTION

(SCHEMATIC ON PAGE 45)

General Theory

Neutec's MT-20 MultiTone option equips the SM-1645 series of mobile radios for operation in CTCSS environments. With this option, the radio can encode or decode any of the 38 EIA standard tones. Tone information is stored in the single EPROM; along with frequency data. Any given channel can be programmed to encode the transmitter, decode incoming signals for proper tone, or operate in a carrier squelch mode. This universal capability enhances the versatile features of the Neutec product line.

Input/Output Functions:

DECODE ENABLE (J901-4) — This input disables the audio gate on carrier channels until a carrier signal is detected. For tone channels, this input is ignored and audio is allowed to pass only after the proper tone is detected.

MONITOR ENABLE (J901-6) — When the microphone is removed from its bracket, this input is removed from ground. This opens the audio gate, allowing the selected channel to be monitored for activity.

TX TONE OUT (J901-7) — The programmed CTCSS tone is sent to the exciter via this output. (Adjustment allows for proper deviation control.)

TONE DECODE OUT (J901-8) — This output is only used on radios equipped with the SC-10, Priority Scan Option. When used, this output causes the scanner to halt when the proper tone is detected.

TONE CHANNEL (J902-1) — This output is only used on radios equipped with the SC-10, Priority Scan Option. When used, this output informs the Scan Board that a tone channel has been selected. The Scan Board then extends the sample time to allow for sufficient decode time.

DATA IN (J902-2) — Incoming memory data from the EPROM is input to the Tone Board at this point. The serial data is then latched and fed to the tone chip in a parallel fashion. This data acquaints the tone processor with the programmed tone and options that have been selected.

WRITE DISABLE (J902-3) — Data is allowed to enter into the Tone Board only during periods when the write disable line is in the low state. This action allows the serial data to be clocked into the Tone Board for instruction processing.

A0 - A2 (J902-4, 5, 6) — These inputs to the Tone Board set-up the proper addressing of incoming data.

Tone Programming:

CTCSS Encode and Decode information is stored in EPROM IC203, on the PLL Board. Each channel assignment consists of 16 bytes or memory locations. The first eight bytes are for receive and the second block of eight bytes are for transmit. Each byte contains eight bits of data. The upper four bits are tone information and the lower four bits are frequency information.

When loading an EPROM with the Stand Alone programmer, obtain data D0 thru D5 from the Tone Data Table. Obtain data D6 and D7 from the Tone Function Table below.

Tone Function Table:

	Rx		Tx	
Mode	D6	D7	D6	D7
Rx Decode Only	0	F	0	F
Tx Encode Only	F	F	F	0
Carrier Squelch	F	F	F	F
Encode & Decode	0	F	0	0

The following example for channel 1 is based on a simplex frequency of 154.350 MHz with a CTCSS Encode and Decode tone of 67.0 MHz.

From the Tone Data Table D0-D5 are as follows:
D0 = 1 D1 = 1 D2 = 1 D3 = 1 D4 = 1 D5 = 1

From the Tone Function Table, receive values are:
D6 = 0 D7 = F

Also from the Tone Function Table, transmit values are:
D6 = 0 D7 = 0

The complete example data appears below.

EXAMPLE DATA CHART

EPROM ADDRESS	DATA	LOAD	FUNCTION	REMARKS
00	D0	16		
01	D1	10		
02	D2	18		
03	D3	19		
04	D4	12	CH 1	
05	D5	10	Rx	
06	D6	OC		
07	D7	F3		
08	D0	16		
09	D1	10		
0A	D2	14		
0B	D3	10		
0C	D4	13	CH 1	
0D	D5	10	Tx	
0E	D6	0C		
0F	D7	03		
	(Tone Information			Freq. Information)

Installation:

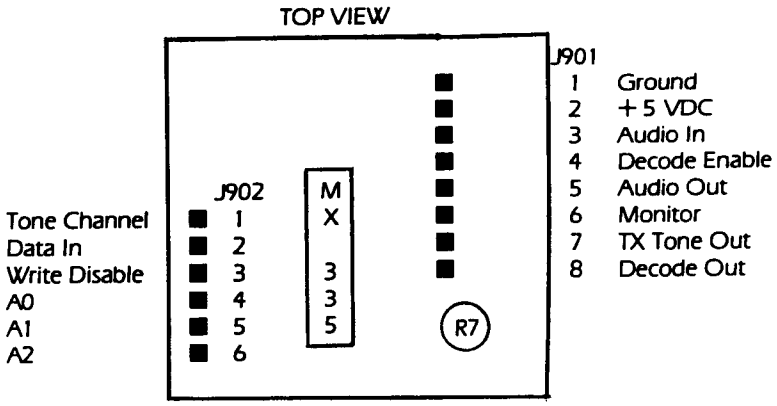
1. A wiring harness for Scan and Tone Options is incorporated in Neutec mobiles to facilitate field installation or exchange.
2. Locate and secure MT-20 Tone Board in the space provided next to the internal speaker on top side of radio.
3. Remove green jumper from Receiver Board J102 and connect two pin plug from wiring harness.
4. Connect wiring harness eight pin plug to J901 of MT-20 Tone Board. Connect wiring harness six pin plug to J902 of MT-20 Tone Board.

MT-20 CTCSS MULTITONE ENCODE/DECODE OPTION

MT-20 Interconnect Table:

Pin:	Function:	Destination:
J901		
1	Ground	Grounding junction at volume pot.
2	+ 5 VDC	+ 5 VDC output from PLL Bd. (P202-7)
3	Audio In	Receiver Bd. Detector (P102-1) Pin closest to front of unit.
4	Decode Enable	Receiver Bd. Sq. Detect (IC103-10)
5	Audio Out	Receiver Bd. Audio Amp (P102-2) Pin farthest from front of unit.
6	Monitor Enable	Mic Hook-Switch.
7	TX Tone Out	PLL/Exciter Bd. (VR202 wiper)*
8	Tone Decode Out	Scan Bd. (J803-2) Only used with Scan Board option.
J902		
1	Tone Channel	Scan Bd. (J803-3) Only used with Scan Board option.
2	Data In	PLL Bd. (J205-1)
3	Write Disable	PLL Bd. CK1 (J203-2)
4	A0	PLL Bd. EPROM (IC203-8)
5	A1	PLL Bd. EPROM (IC203-7)
6	A2	PLL Bd. EPROM (IC203-6)

MT-20 Multitone Option Installation Diagram:



Alignment:

TX TONE LEVEL (R7) — With the transmitter keyed on a tone channel, adjust R7 for proper sub-audible deviation of the transmitter signal. (Typically ±500 Hz deviation.)

SC-10 PRIORITY SCANNER OPTION

(SCHEMATIC ON PAGE 47)

General Theory

The SC-10 Priority Scanner Option for the SM-1645 Series of mobile radios allows scanning of all, or any portion of, programmed channels. Designed to offer simple, effective operation, the SC-1 option will automatically stop scanning whenever activity is detected on an enabled channel.

Channels are enabled in two methods. First, the initial scan list length is established by a jumper on the scan board. This jumper may be installed to establish a scanning list for 2 to 16 channels. Secondly, once the scan list is set, the user can delete/add channels via a switch on the front panel. Addition or detection of a channel is accomplished by turning the squelch control in to and out of the CH IN/OUT position. the CH/IN light indicates whether the channel is in the scan list.

Priority channel monitoring is accomplised by activation of the priority on/off push button. this feature assures that the priority channel is always monitored — even during activity on non-priority channels. A "priority-check" monitor constantly samples the priority channel to detect activity. If activity is detected, the scanner will immediately revert to the priority channel and maintain that channel until activity is concluded.

Input/Output Functions:

D0 - D3 INPUTS — Channel selection is input to the scan board at U2. When the scan option is disabled the input data is passed to the output via the data bus. When the scan mode is engaged the data is clocked to artificially advance the channel selection. Whenever the priority channel monitor detects activity on the priority channel, U2 again passes the direct data information as output to the display and synthesizer boards.

BIT 0 - BIT 3 OUTPUTS — These outputs control the display logic and synthesizer. When the scan mode is off, these outputs follow the D0 - D3 inputs. Upon scan activation, these outputs are artificially advanced by the scan clock circuitry.

CH/IN LIGHT OUTPUT — To indicate scan list selection the tone light is illuminated on channels that have been selected active. As channels are deleted the tone light is extinguished.

SCAN ON/OFF INPUT — The "Scan" switch applies a ground to the scan enable input. This enables the scan mode and allows U2 to pass the clocked artificial channel data.

PRIORITY ON/OFF INPUT — When the "Priority" switch is closed the priority monitor is enabled. During priority monitor condition U2 periodically reverts to manual mode to allow the synthesizer to momentarily lock-on to the priority channel. If activity is detected the scan sequence is halted until activity concludes. If the priority channel is inactive, the scan sequence resumes at the previous channel.

CARRIER INPUT — The not carrier input enables the scan clock oscillator. When a carrier is detected this line is forced low causing the scan clock to be disabled. The scan sequence will then continue when the carrier is removed.

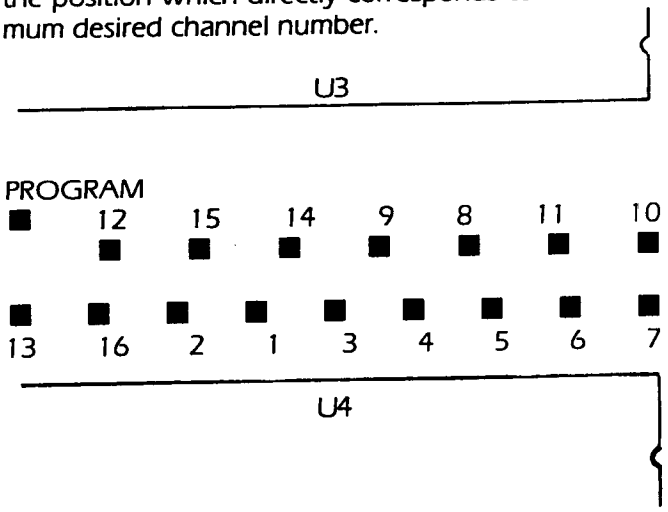
TONE CHANNEL INPUT — The not tone line is input from the tone board (TS-2). This line is forced low whenever a tone channel is scanned. When a tone channel is scanned (and a carrier is present) the scan cycle time is increased to allow sufficient time for the tone board to detect tone information. If the proper tone is detected by the tone board, the scan sequence is halted until the tone is removed. (When this input is unused the line should be connected to +5 volts.)

DECODE INPUT — When the tone board detects the proper CTCSS tone, the not decode line is forced low. This disables the scan sequence until the tone is removed.

DELETE/ADD SWITCH — This input is momentarily grounded to toggle the selected channel in or out of the scan list.

Scan List Length Programming:

The SC-1 can be programmed to scan from 2 to 16 channels. Programming is accomplished by installing jumper J1. Install the jumper to the program point and the position which directly corresponds to the maximum desired channel number.



SC-10 PRIORITY SCANNER OPTION

Installation:

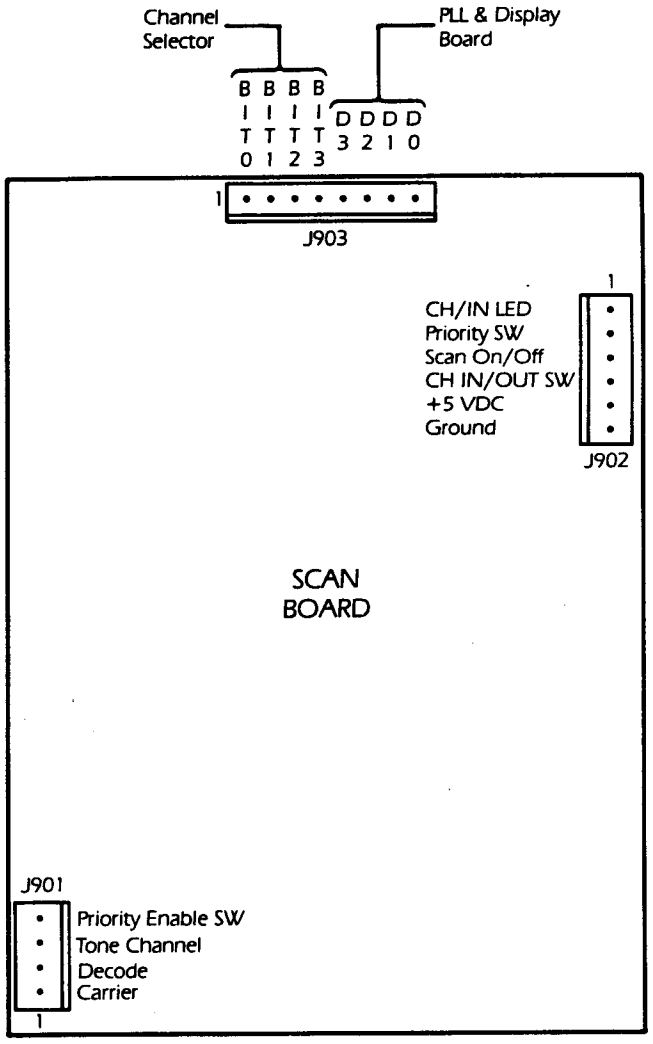
1. A wiring harness for Scan and Tone Options is incorporated in Neutec mobiles to facilitate field installation or exchange.
2. Locate and secure SC-10 Scan Board in the space provided on bottom side of radio.
3. Remove jumper from wiring harness eight pin plug and connect eight pin plug to Scan Board J903. Connect wiring harness six pin plug to Scan Board J902. Connect wiring harness four pin plug to Scan Board J901.
4. If MT-20 Multi Tone Board is not installed J803 pin 3, tone channel, must be connected to +5 VDC.

Scan Board Interconnect Table:

Pin:	Function:	Destination:
J903		
1	D0	Channel Selector
2	D1	Channel Selector
3	D2	Channel Selector
4	D3	Channel Selector
5	Bit 3	Orange/White wire from channel selector
6	Bit 2	Red/White wire from channel selector
7	Bit 1	Brown/White wire from channel selector
8	Bit 0	Black/White wire from channel selector
J902		
1	In List LED	Amber Tone Light cathode
2	Priority Sw.	Priority Switch (center contact)
3	Scan On/Off	Scan Switch (top contact)
4	Delete Sw.	Switch contact at back of Squelch Sw.
5	+ 5 VDC	+ 5 VDC output from PLL Board (J202-7)
6	Ground	Ground lead from PLL Board (J202-2)
J901		
1	Carrier	Receiver Board IC103 pin 8
2	Decode	MultiTone Board (J901 pin 8)*
3	Tone Chan.	MultiTone Board (J902 pin 1)**
4	Priority Sw.	Priority Switch (top contact)

Notes: *1. For units without MultiTone, J901 is unused.
**2. For units without MultiTone, J901 should be connected to +5 VDC.

SC-10 Priority Scanner Board Installation Diagram:



Parts Variation vs Frequency Chart
30 - 50 MHz

Receiver	30 - 35 MHz	35 - 40 MHz	40 - 45 MHz	45 - 50 MHz
C-101	33P CH	33P CH	33P CH	20P CH
C-105	33P CH	33P CH	25P CH	20P CH
C-110	33P CH	33P CH	25P CH	20P CH
C-113	33P CH	33P CH	25P CH	20P CH
C-116	33P CH	33P CH	25P CH	20P CH
C-120	25P CH	20P CH	15P CH	12P CH
C-123	25P CH	20P CH	15P CH	12P CH
PLL & Exciter				
C-201	20P CH	20P CH	15P CH	15P CH
C-218	82P CH	62P CH	62P CH	62P CH
C-215	39P CH	30P CH	30P CH	20P CH
Driver & APC				
C-402	0.01 uF		—	
C-402A	—		39P CH	
C-403A	—		0.01 uF	
C-412	0.001 uF		—	
R-401	4.7 ohms ¼W		1 ohms ¼W	
R-402	20 ohms 2W		—	
R-402A	—		100 ohms 2W	
R-410	10 K ¼W		82 K ¼W	
Power Amplifier				
C-502	200P SL	100P CH	—	51P CH
C-503	150P CH	150P CH	150P CH	51P CH
C-504	300P SL	300P SL	300P SL	220P SL
C-505	300P SL	300P SL	300P SL	220P SL
C-10	300P SL	300P SL	300P SL	200P SL
C-510A	—	—	—	220P SL
C-511	100P CH	100P CH	100P CH	—
C-514	1P CH	1P CH	1P CH	—
C-515	36P CH	36P CH	36P CH	33P CH
C-517	3P CH	3P CH	3P CH	—
C-518	39P CH	39P CH	39P CH	33P CH
C-519	5P CH	5P CH	5P CH	—
C-522	5P CH	5P CH	5P CH	—
C-523	39P CH	39P CH	39P CH	33P CH
C-525	3P CH	3P CH	3P CH	—
C-526	36P CH	36P CH	36P CH	33P CH
C-527	1P CH	1P CH	1P CH	—

Parts Variation vs Frequency Chart
138 - 174 MHz

The following components should be changed to the indicated values when the frequency spread is other than 148-165 MHz.

Receiver	138 - 148 MHz	148 - 165 MHz	160 - 174 MHz
C102 C104 C109 C112 C115 C121 C124	4pF cer.	1pF cer.	not used
Driver & APC			
C401	not used	not used	not used
C403	20pF cer.	not used	
C407	not used	not used	
C411	not used	not used	
others	*Note 1.	*Note 1.	
Power Amplifier			
C506	not used	not used	not used
C507	39pF cer.		
others	*Note 2.		

Note. 1 Shunt a 220 ohm ¼ watt resistor between C402 input side and ground.
Note 2. Shunt a 30pF ceramic capacitator between the collector of Q501 and ground.

ALIGNMENT AND ADJUSTMENT PROCEDURES

VCO

Connect a wattmeter and a dummy load of suitable dissipation to the antenna connector. Connect a high impedance voltmeter to test point CP201, which is located next to the shielded area (VCOs) on the synthesizer/exciter board.

(NOTE: With the PLL/exciter board upright and while facing the front of the radio, you will see the RX VCO coil on your left and the TX VCO coil on your right within the VCO shielded area. CP201 is to the right of the coils.)

Adjust the RX VCO (L201) for about 4 V DC while on a channel which is approximately in the center of the desired frequency range. Readjust L201 to obtain no less than 1.0 V DC on the lowest operating frequency and no more than 7.5 V DC on the highest.

(NOTE: It is important that the VCO coils be adjusted carefully and with the proper tuning tool to avoid damaging the core. It is also important that the friction locking rubber piece inserted between the core and the coil be in place to eliminate the possibility of the VCO falling outside the 1.0 to 7.2 volt range during vibration or movement.)

After adjusting the RX VCO, activate the transmitter and adjust the TX VCO coil (L202) in the same manner.

Adjust the reference oscillator trimmer VC201 for the correct carrier frequency at the selected channel.

Transmitter

Begin transmitter alignment by setting VR401 to its full clockwise position. Then transmit on a frequency that is near the center of the radio's assigned frequency range, and adjust the driver's input and output tuning capacitors, (VC401, VC402) for maximum output.

Now adjust the input and the output tuning capacitors for the final stage (VC501 and VC502) for maximum output. These can be reached through holes on the final P.A. shield. Alternate tuning VC401, VC402, VC501 and VC502 for maximum output power. After adjusting transmitter to maximum power, adjust VR401 counter-clockwise until power drops slightly. (Note: To ensure proper power output, use a power supply capable of supplying 13.8 VDC at 10 amps and heavy power cables.)

While modulating the transmitter, set deviation to 4.8 Khz by adjusting VR202 (located on the PLL board at the end opposite the synthesizer and the PROM ICs). Next, adjust mike gain potentiometer VR201 for proper deviation while holding the microphone at the desired speaking distance.

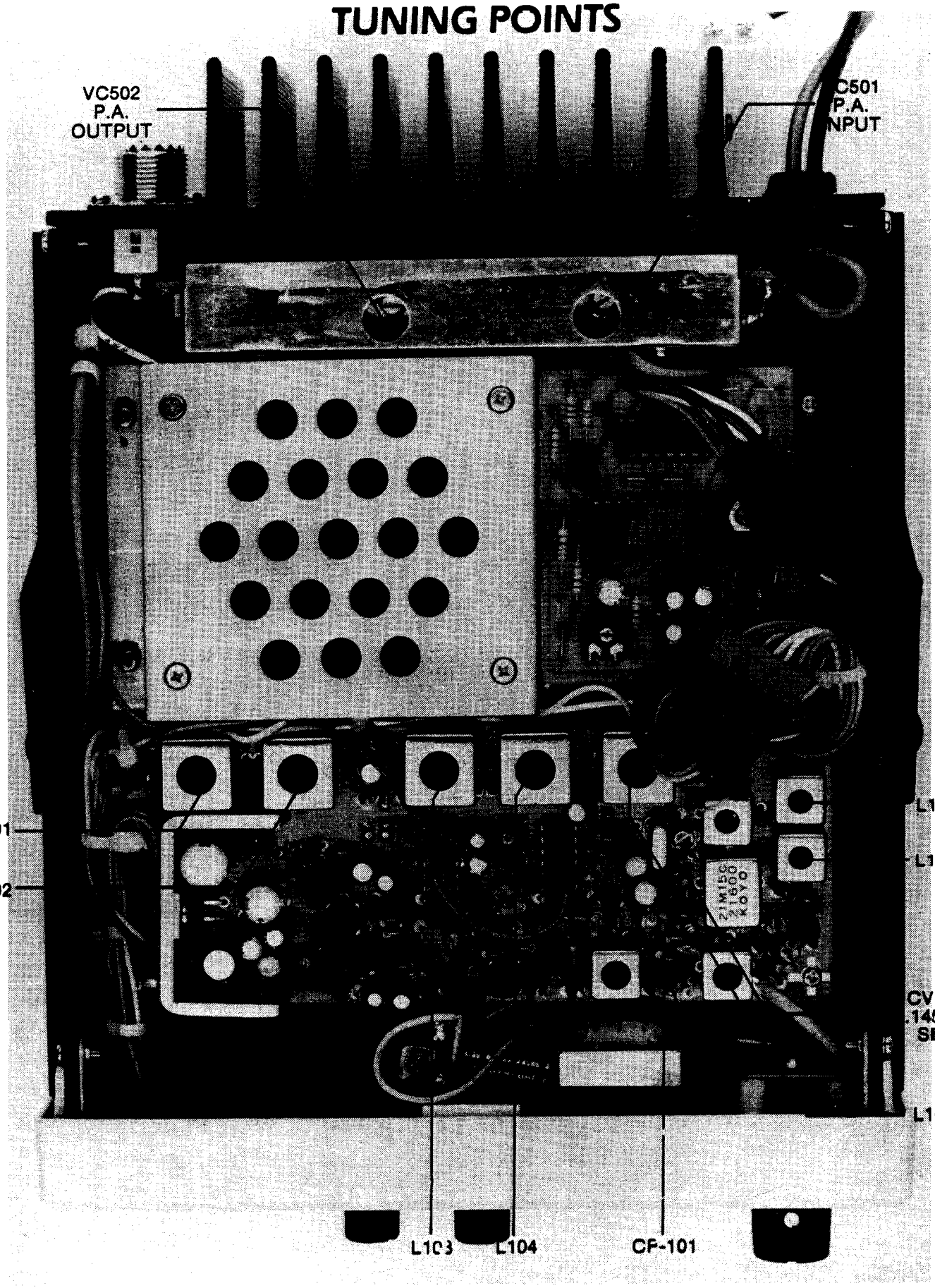
Receiver

Select a channel on the approximate center of the desired operating range. To the antenna connector, connect a signal generator modulated by a 1 Khz tone set for 3.3 Khz deviation. Connect a SINAD meter to the external speaker jack on the rear of the radio. Turn squelch control fully counterclockwise. Adjust L101 through L107 for best SINAD while maintaining the output of the generator close to the 12 dB point. Readjust coils as necessary for proper receiver response over the operating range.

IF coils L108 through L112 come properly tuned from the factory. It is not advisable to tamper with the tuning. If it becomes necessary, however, follow the SINAD method described above for front-end tuning.

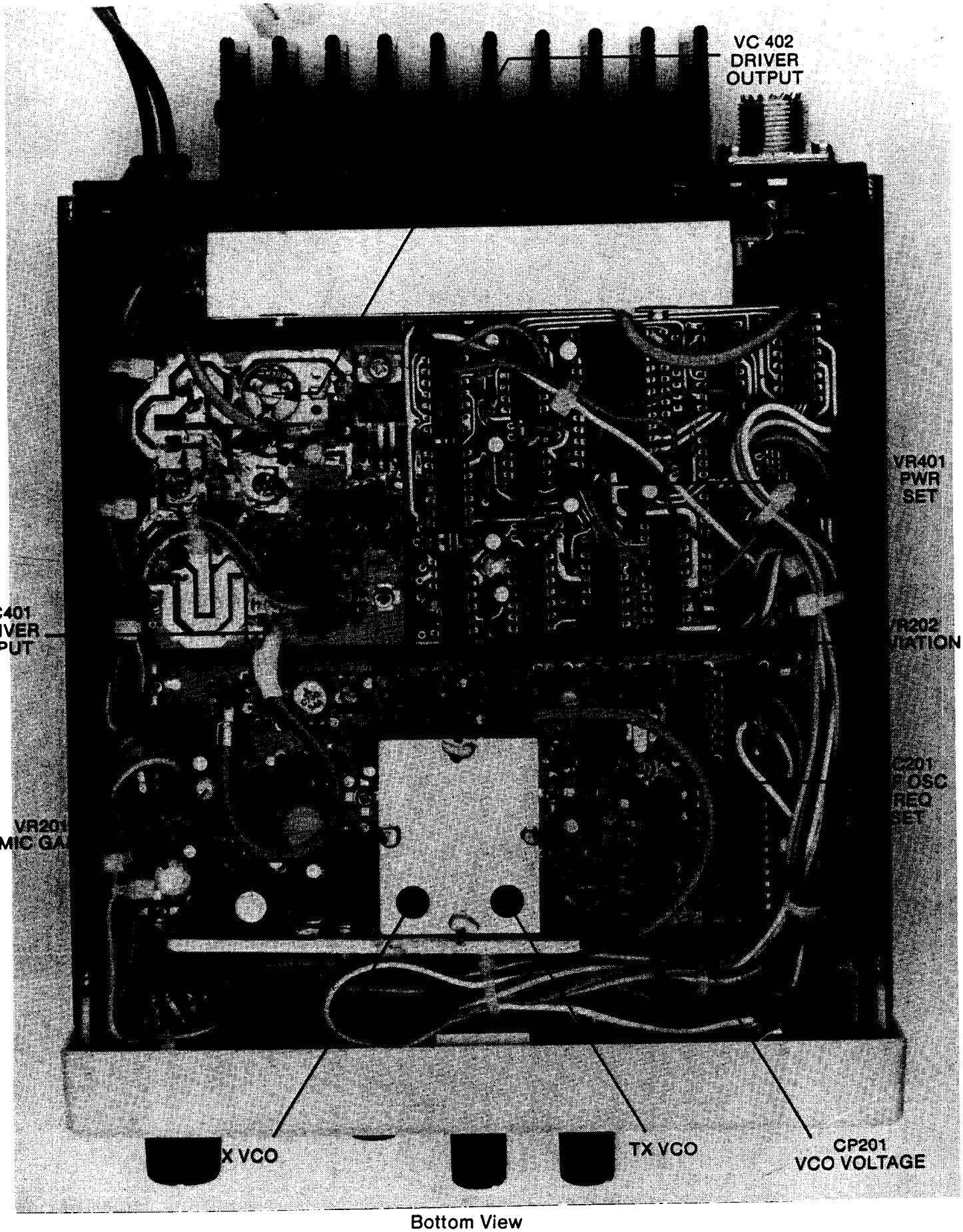
The 2nd local oscillator, although not usually necessary, can be set by connecting a high sensitivity frequency counter to test point CP101 on the RX PCB and adjusting CV101 for 21.145 MHz.

TUNING POINTS



Top View

TUNING POINTS



Bottom View

TROUBLESHOOTING AND SUGGESTED TEST EQUIPMENT

It is recommended that maintenance of the radio be done at the board exchange level. Service facilities can take maximum advantage of the board exchange program by stocking a set of replacement boards and by returning defective boards to the factory.

The transceiver is composed of five boards that contain all of the circuitry. Any malfunction should be isolated to a board and verified by an exchange. The five boards are:

- PLL Synthesizer/TX Exciter
- Receiver
- RF driver
- RF power output
- Display

Except for the Display and RF P.A., these boards can be removed and replaced with a screwdriver and some care.

General

The PLL Synthesizer/TX exciter board contains the modulator, RX and TX VCO, TX predrivers and synthesizer circuits. As such, a receive malfunction could be an RX VCO problem on the PLL board. Proper VCO operation can easily be verified by checking for 1.0 to 7.2 volts at the VCO test point CP201. If the RX VCO is operating, then most RX malfunctions would be a result of a problem on the receive board.

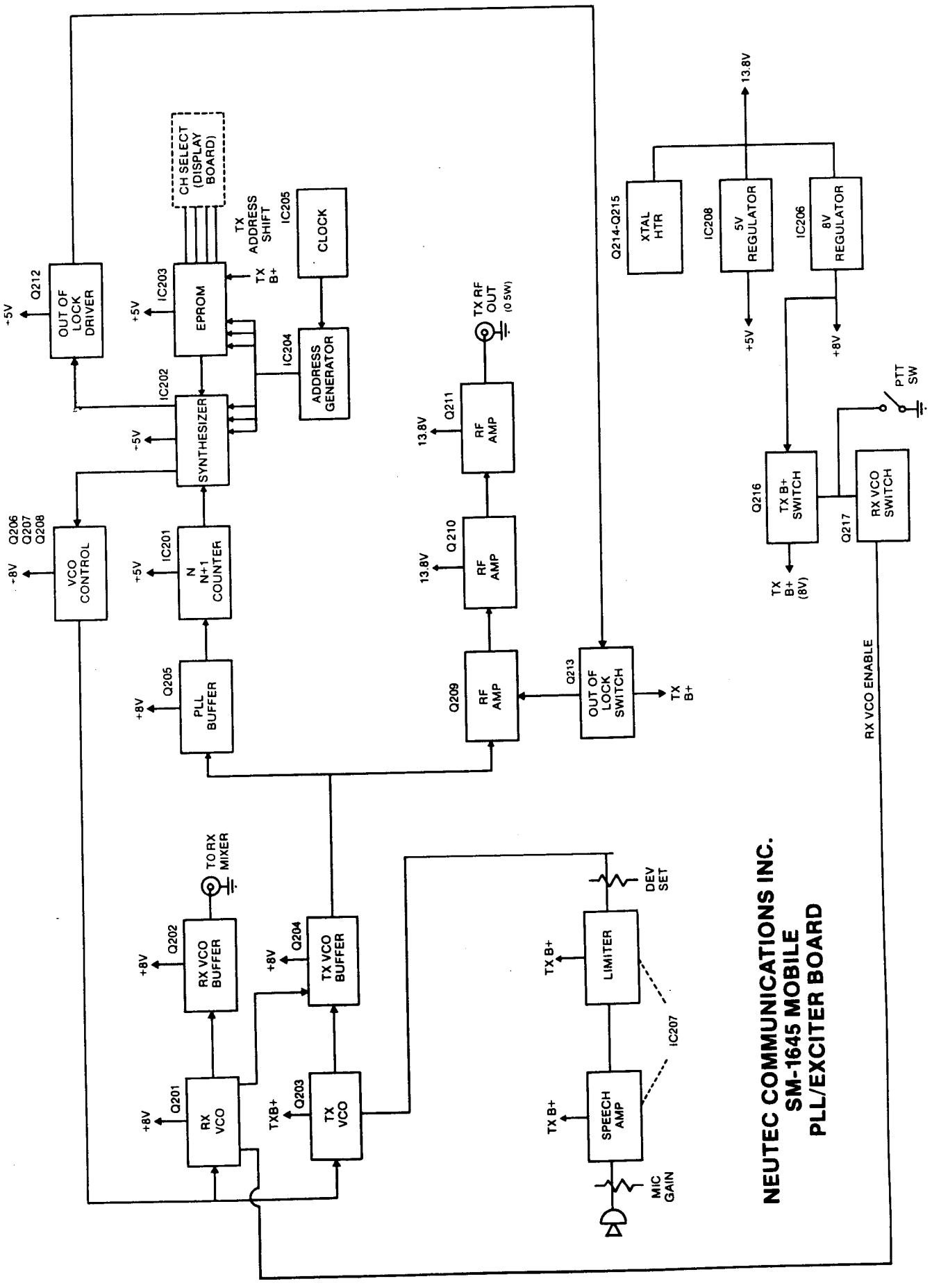
Transmitter malfunctions could be on any one of three boards. As with the receiver, the first place to check would be the TX VCO voltage at CP201 while in the TX mode. If this voltage is correct, the problem could be in the predriver, driver or power amplifier stages.

To isolate a transmitter problem, first check the power supply current during transmit. As the driver draws approximately 2 amps, failure of the final stage would show some increase in current during transmit (about 2 amps more than while receiving). Little change in current between TX and RX would indicate problems in the predrivers (PLL board) or driver (assuming the TX VCO was operational, which should be the first test). An additional test could be made with an RF probe or an RF voltmeter at the input to the driver stage (about 5 volts RMS should be present here). Output of driver stage should be 8.0 W or more (10-12 W typical).

Modular construction of the transceiver was intended to simplify servicing at your facility as this can be a hidden cost associated with other transceivers where troubleshooting must be pursued to the component level.

Test Instrument	Required Specifications	Suggested Type
DC Power Supply	Voltage: 13.8 VDC Current: 10 Amps Cont.	Astron RS-12
RF Watt Meter	Frequency: 136-174 MHz Power: 0-100 Watts Impedance: 50 Ohms	Bird Model 43 With 10 C Element
RF Dummy Load	Impedance: 50 Ohms Power: 50 W	Bird Model 8085 or Model 8341-200
DC Voltmeter	Range: 0-15 V DC Input Resistance 10 Meg Ohm	Simpson 260 and Data Precision 1351
AC Voltmeter	Range: 3 mV-10 V	Leader LMV 181 A
Deviation Meter	Range: 0-5 KHz +/- Deviation Capability	Marconi TF 2304
Frequency Counter	Range: 136-174 MHz Accuracy: +2 ppm/yr	HP 5383 A or Data Precision 5000-TB8
RF Signal Generator	Range: 136-174 MHz Level: 0.1-1000 uv Modulation: Internal/External Deviation: 0-5 kHz	Wavetek 3005
Speaker Load	Impedance: 8 Ohm Power: 7.5 Watts Min. With Switch Selectable Int. 8 Ohm Speaker	Shop Fabricated

BLOCK DIAGRAM



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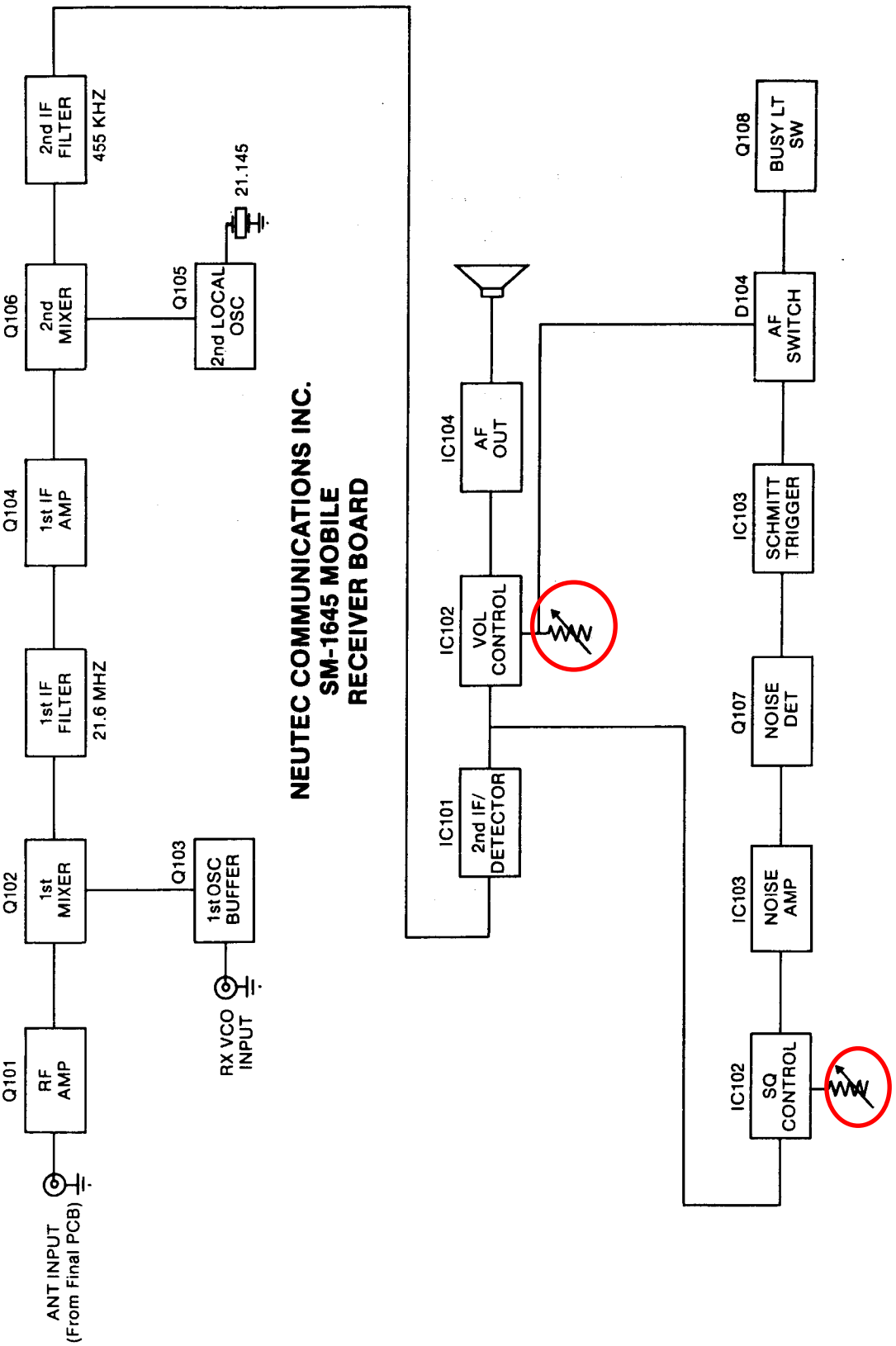
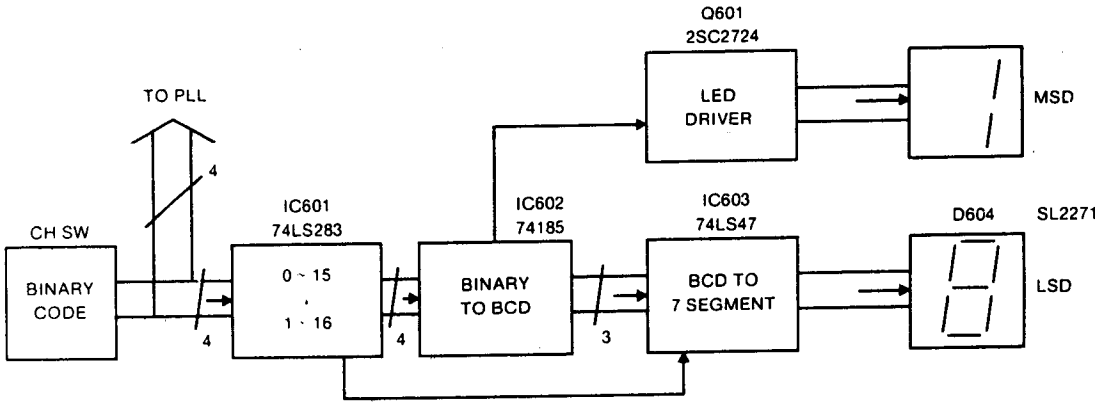
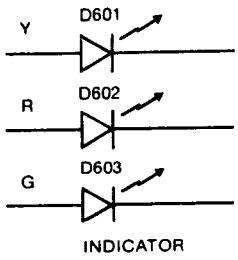


BLOCK DIAGRAM

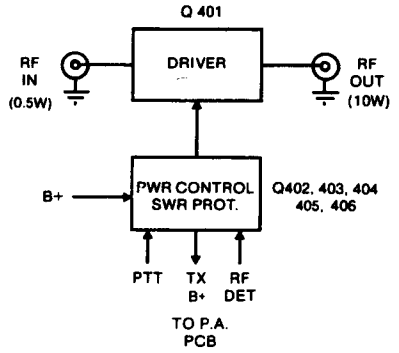
NEUTEC COMMUNICATIONS INC.
SM-1645 MOBILE
DISPLAY BOARD

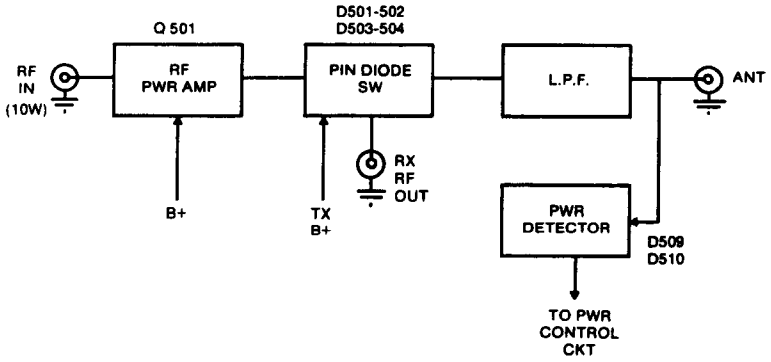




BLOCK DIAGRAM

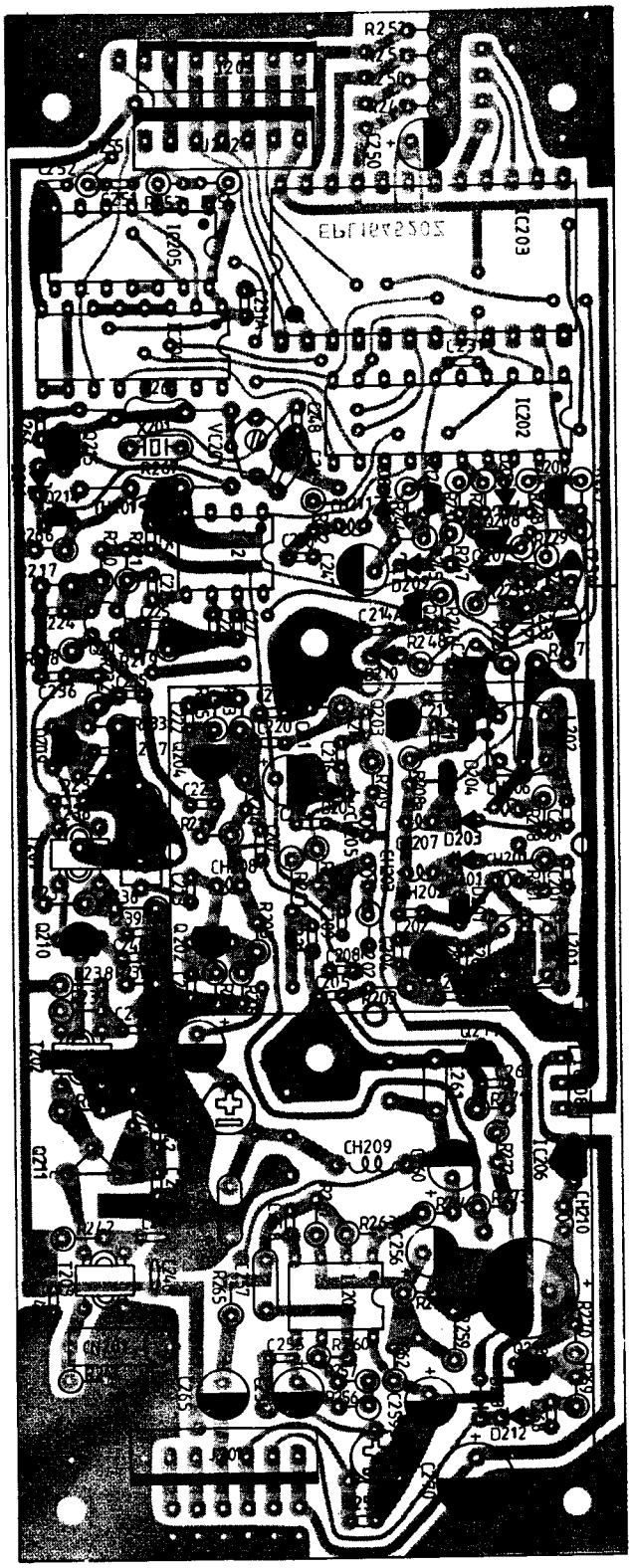
NEUTEC COMMUNICATIONS INC.
SM-1645 MOBILE
DRIVER BOARD





FINAL PWR AMP BOARD

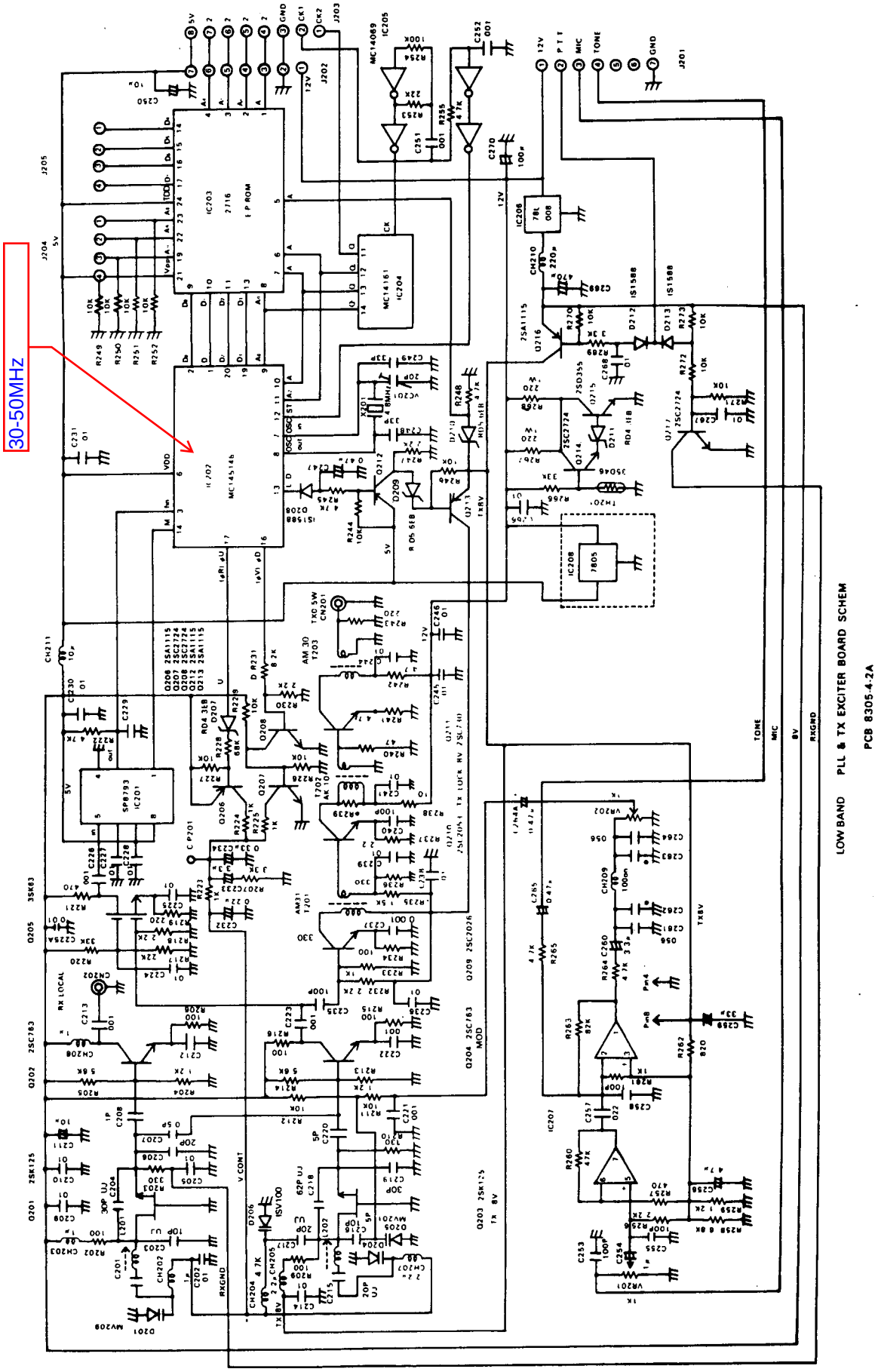
LAYOUT PLL/EXCITER BOARD



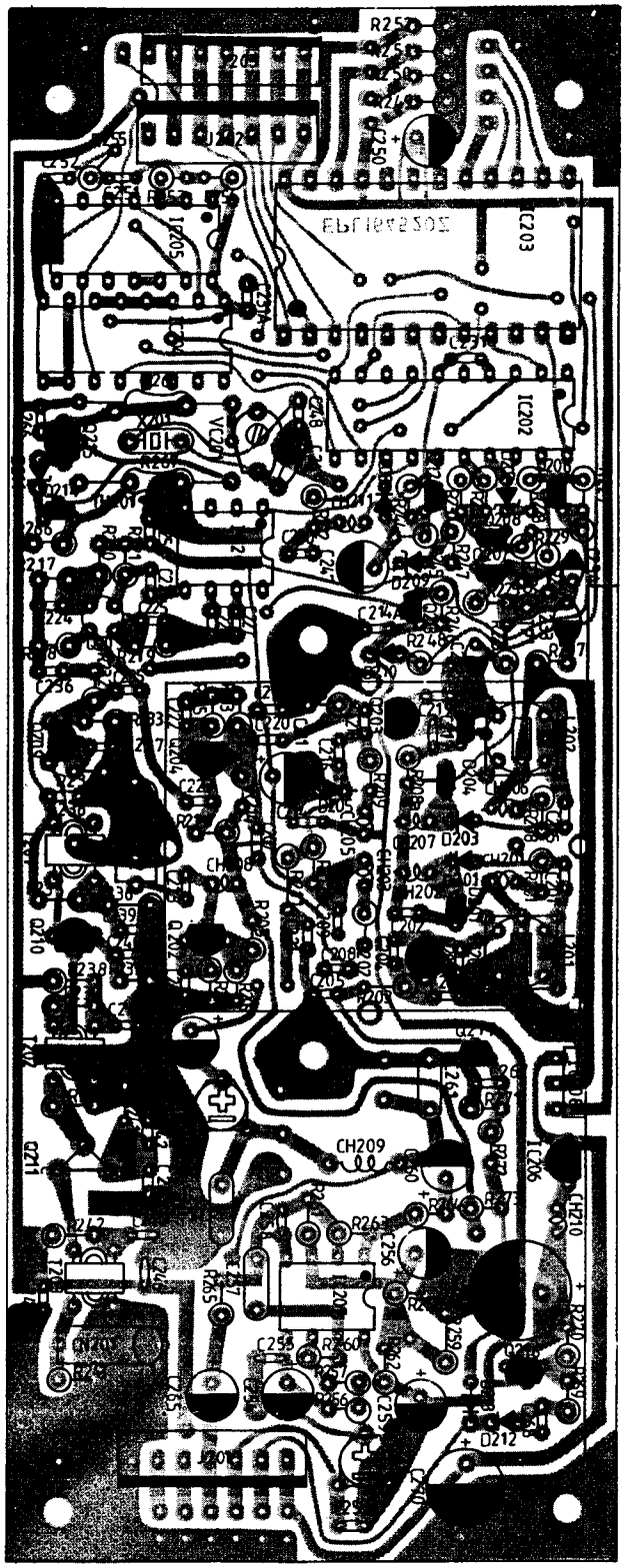
PCB 8305-4-2A

SCHEMATIC PLL/EXCITER BOARD

30 - 50 MHz



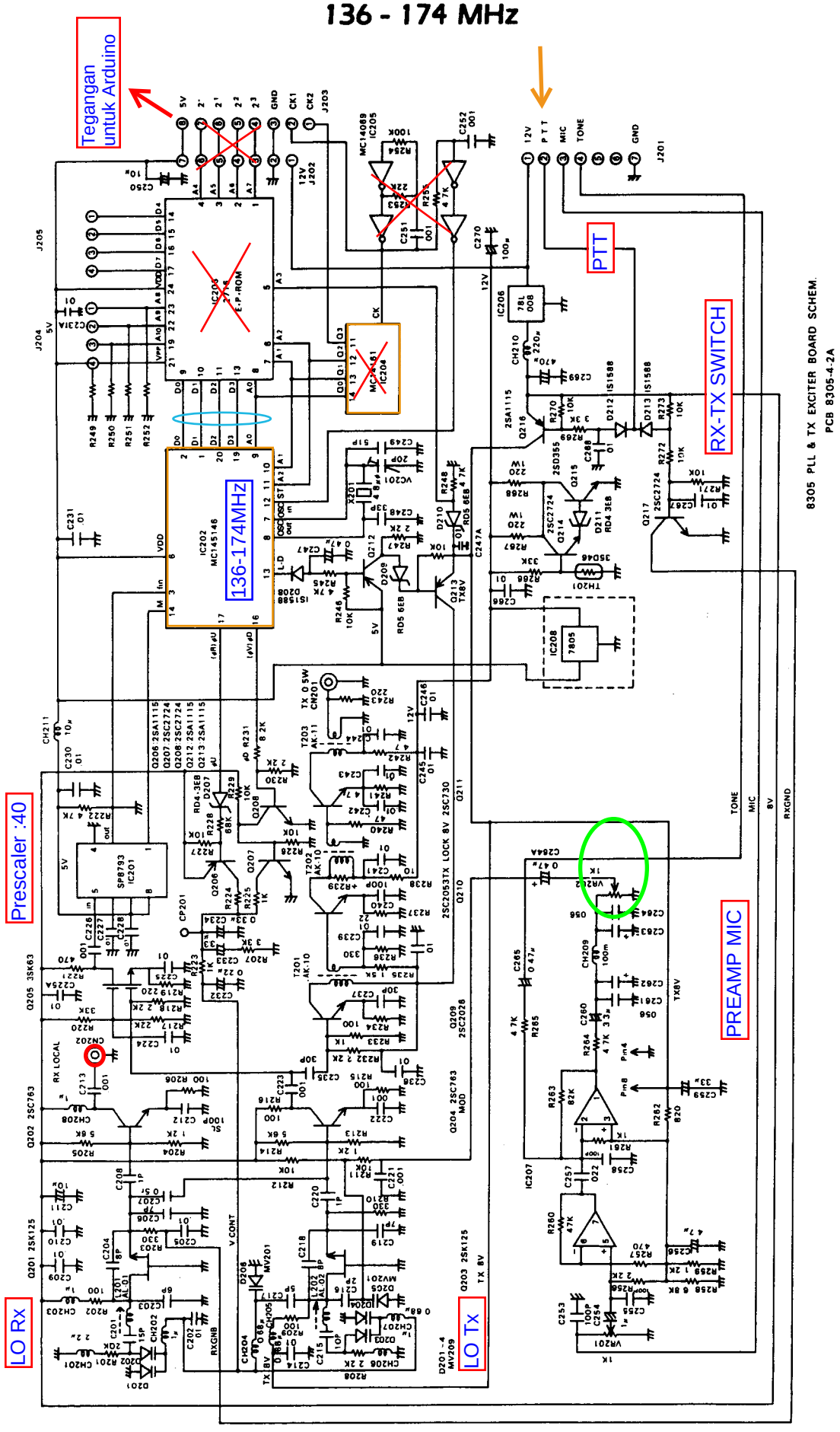
LAYOUT PLL/EXCITER BOARD



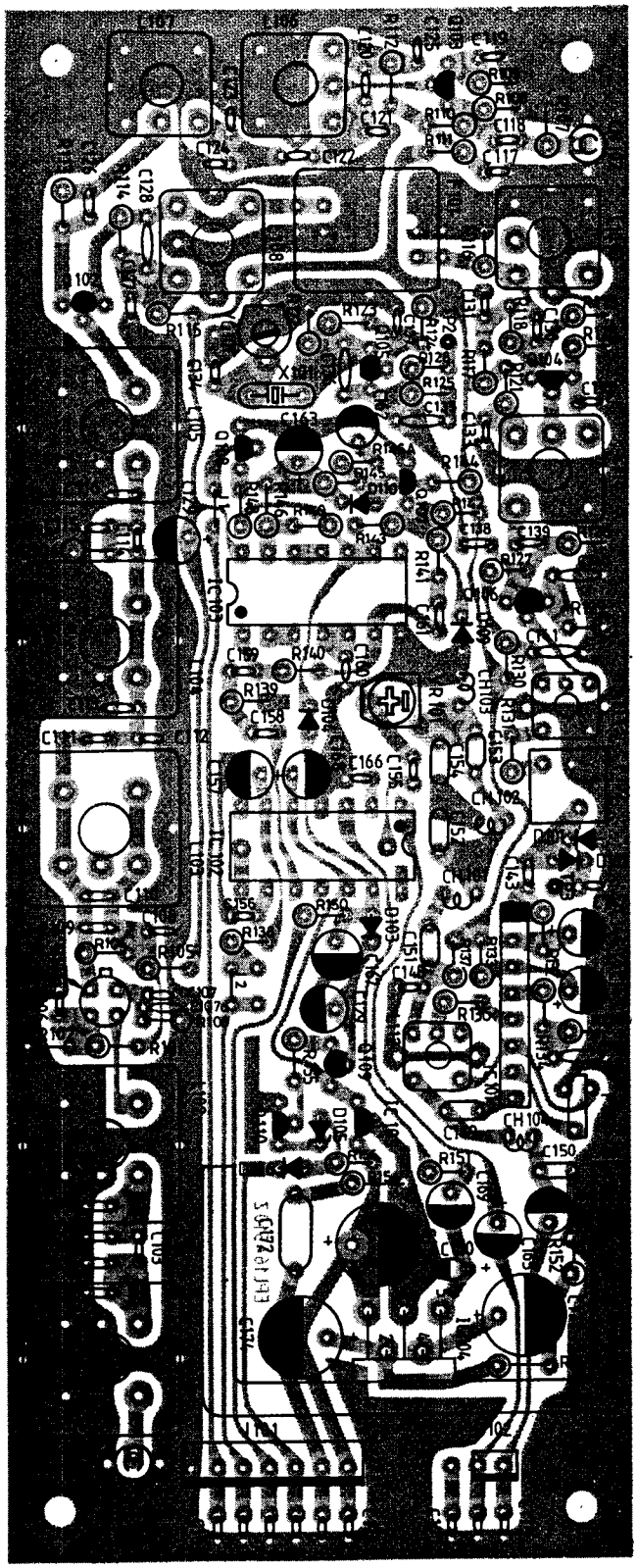
PCB 8305-4-2A

SCHEMATIC PLL/EXCITER BOARD

136 - 174 MHz



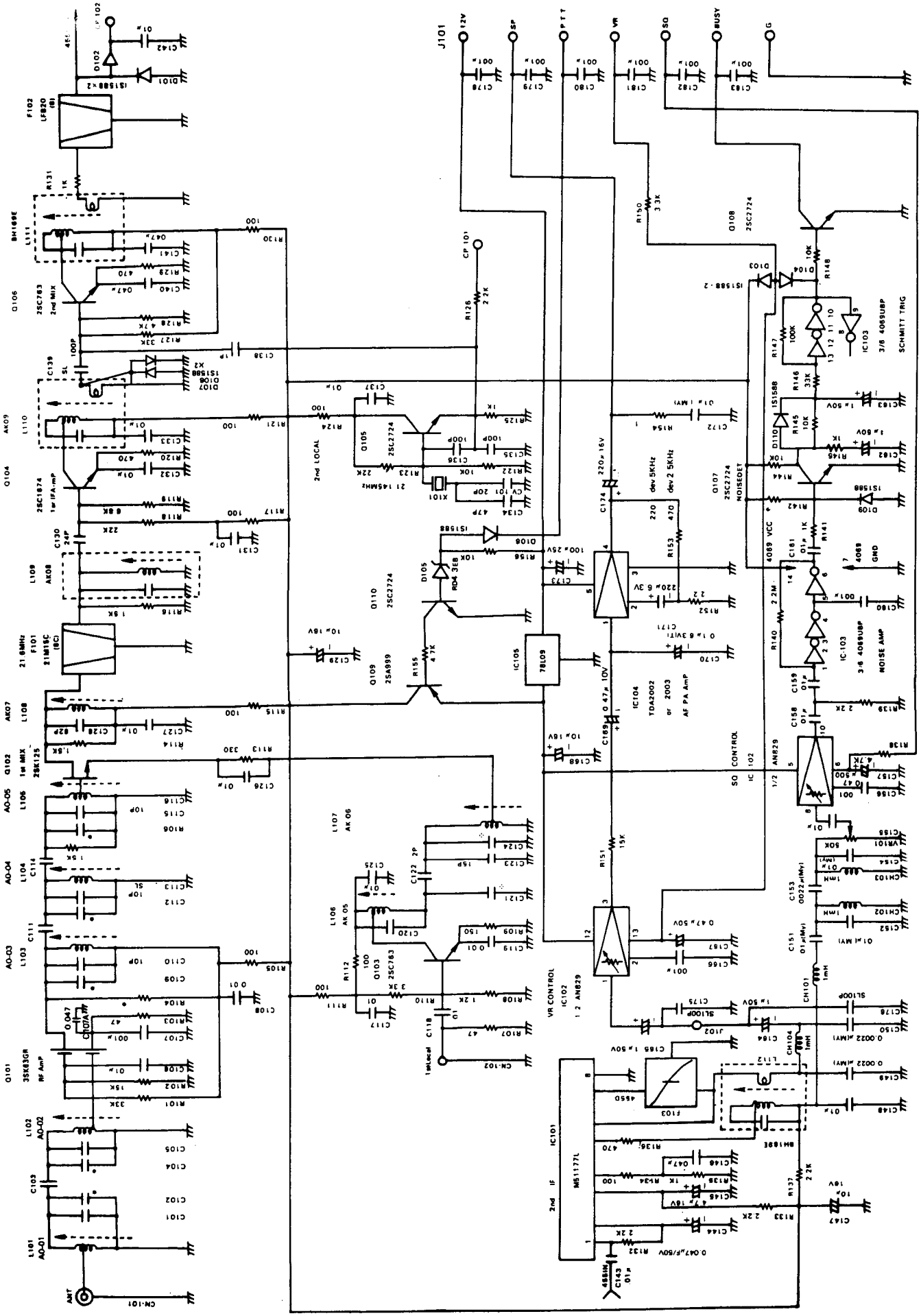
LAYOUT RECEIVER BOARD



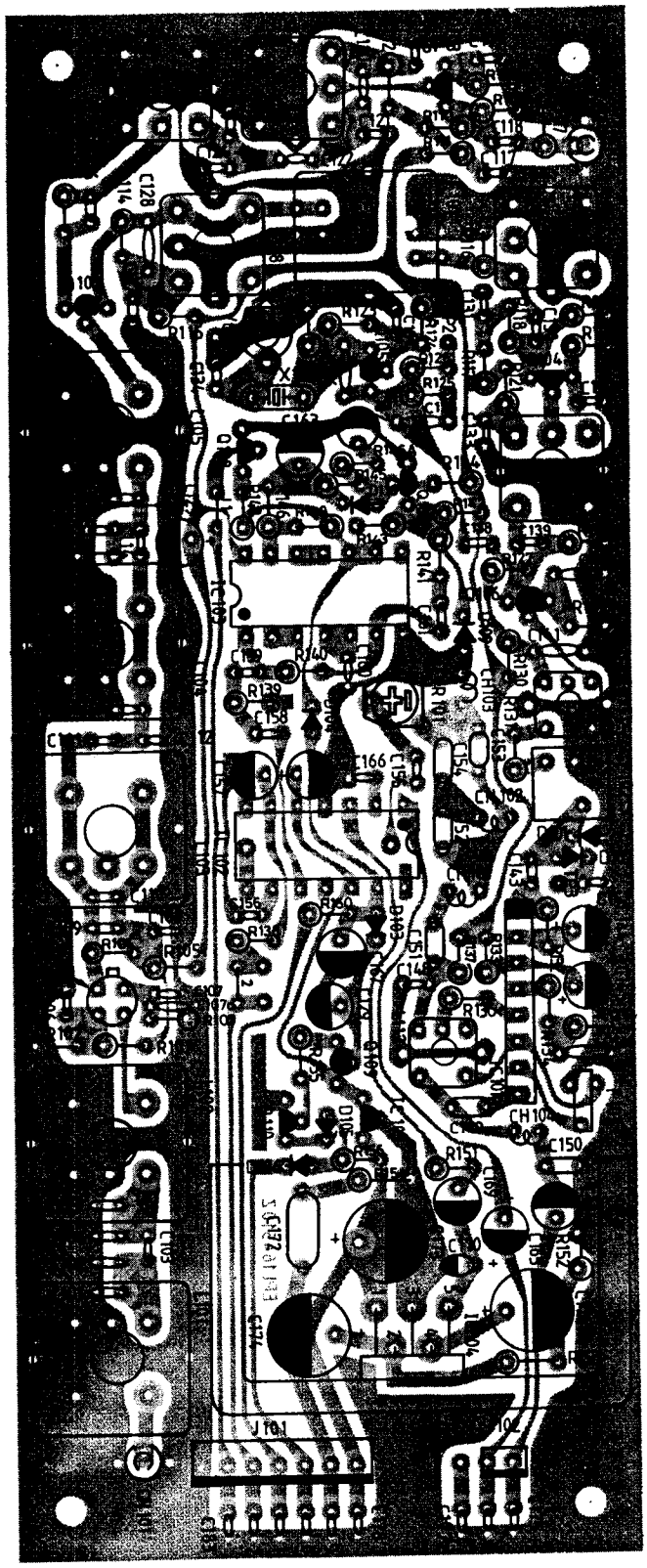
PCB 8305-4-2A

SCHEMATIC RECEIVER BOARD

30 - 50 MHz



LAYOUT RECEIVER BOARD



SCHEMATIC RECEIVER BOARD

136 - 174 MHz