SERVICE MANUAL

PLL/SYNTHESIZED VHF/FM RADIOTELEPHONE

SPECIFICATIONS

GENERAL

Channel capacity	:	16
Frequency range	:	136 - 174 MHz
Power source	:	13.6V DC(negative ground) AC 110/240V (with an optional regulated Power Supply)
Communication system	:	Press-to-talk
Frequency stability	:	± 5ppm
Temperature range-operation	:	-30°C +60°C
Humidity	:	95%
Antenna impedance	:	50 ohms
Channel spacing	:	30/25/12.5 KHz
Dimensions (mm.)	:	58(H) x 180(W) x 200(D)
Weight	:	2.6 Kgs.

TRANSMITTER

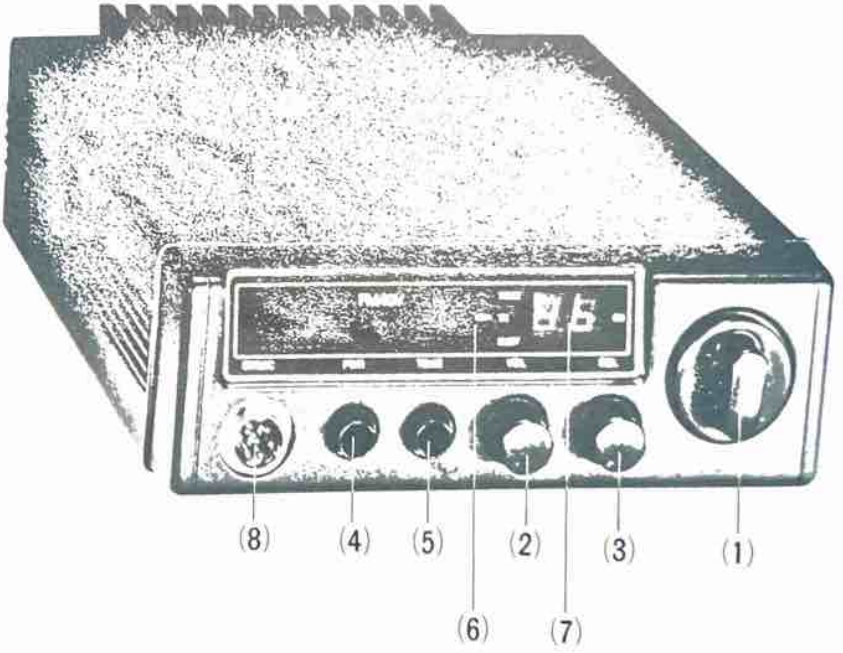
RF power output	:	40 watts (or 30 watts)
Modulation	:	16F3
FM Hum & Noise	:	45dB
Spurious & Harmonic emission	:	80dB
Tx bandwidth	:	6 MHz
Audio distortion	:	3%

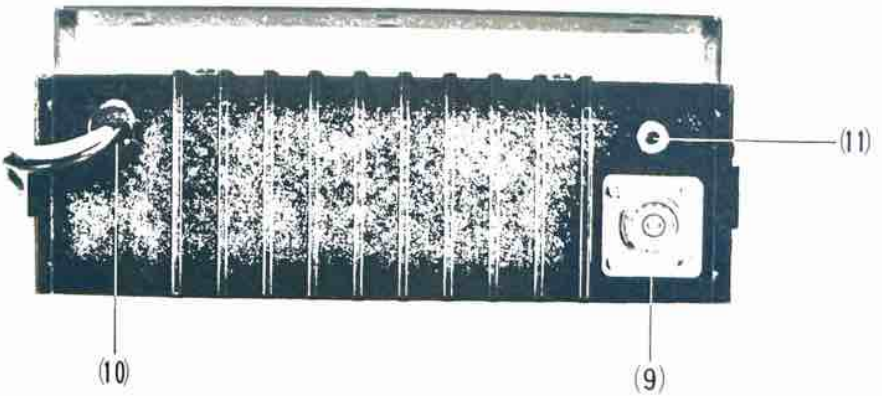
RECEIVER

Sensitivity	:	0.35uV (12dB SINAD) 0.5uV (20dB quieting)
Selectivity	:	75dB
Spurious & Image	:	85dB
Hum & Noise	:	45dB
Intermodulation	:	80dB
Receiver bandwidth	:	2 MHz (5 MHz -3dB)
Audio output with less than 3% distortion	:	4W/4 ohms
Modulation acceptance	:	7 KHz

CONTROLS / INDICATORS / CONNECTORS

(1) Channel selector - selects required channel.
(2) Volume control - adjusts the speech level at the speaker. Volume increases as knob turned clockwise.
(3) Squelch control - only works in receive mode. Selects threshold of background noise rejection.
(4) Power switch - for on-off.
(5) Tone (or RESET) switch
(6) 3 Light emitting diodes(green/yellow/red) - Lights when individual function on.
(7) Channel indicator
(8) Microphone (or Mike-Speaker) jack
(9) Antenna connector
(10) Power connector
(11) External speaker jack





OPERATION

RECEPTION

(1) Press On/Off switch. Check that channel indicator light appears.

(2) Select the required channel by channel selector switch.

(3) Set volume control to suitable listening level.

(4) Adjust the Squelch control clockwise until the background noise is just muted. This should be done when no signal being received. Important that this control be adjusted just to the threshold point, so that a weak signal still be audible. When a signal is received, it will trip the squelch circuit, allowing the signal to be heard.

TRANSMISSION

(1) To avoid interfering with other users on the same operating channel, first listed out to ensure that no transmissions are being made.

(2) Select your channel. If the channel is clear, operate the press-to-talk switch. Release the PTT bar for listening.

(3) When transmit, hold the microphone onr or two inches from your mouth and speak clearly in a normal conversational tone.

(4) Use correct operating procedure and keep transmissions short.

SWITCHING OFF

To switch off the set, press the On/Off switch again and check channel indicator lamp is extinguished.

CIRCUIT DESCRIPTIONS

RECEIVER SECTION

1-1
Receiver has a double superheterodyne circuit with 1st I.F. 21.6 and the 2nd I. F. 455 KHz. Has an excellent sensitivity, low noise level and high selectivity characteristics.

1-2 RF Amplifier
This circuit is represented by Q101 which is a low noise type dual gate Field Effect Transistor. At this stage, small radio signal received at the antenna terminal CN-101 is amplified and lead to next stage-1st mixer. RF coils L101-105 have an adequate bandwidth, which eliminates unnecessary input signal and at the same time, eliminates unnecessary leakage at the 1st local stage.

1-3 1st Mixer
This circuit is represented by Q101, F101, etc. and convert the received VHF mixed with the 1st local oscillator frequency into 1st I. F. Intermodulation characteristics are important at this stage and a high performance FET is adapted in this circuit to get the best function point.

1-4 1st I. F. Amplifier
This is consisted of Q104, L110 and other components which amplify the 21.6MHz element correctly picked up by the former stage crystal filter F101.

1-5 2nd Mixer
Consisted of Q106, F102 and other components. Mixed with the freq. from the 2nd local oscillator, 21.6MHz is converted into 455KHz 2nd I. F.

1-6 2nd I. F. Amplifier
Consisted of IC101 and other components. This circuit is to amplify the 455KHz element. IC101K includes the limiter circuit and eliminates the unnecessary Amplitude modulation elements.

1-7 Discriminator
This circuit consisting of part of IC101, F103 and other components picks up the voice signal included in the 2nd I. F. as an audio frequency.

1-8 AF Amplifier
This circuit is consisted of part of IC102 and other parts. Amplifies the voice signal in the former discriminator stage and the gain is adjusted by the volume control.

1-9 AF Power Amplifier
Consisted of IC104 and other parts. Amplifies the voice signal to the level where the power is enough to drive the speaker.

1-10 1st Local Oscillator (See the separate explanation)

1-11 2nd Local Oscillator
This is a crystal controlled oscillator(21.145MHz) represented by Q105. Fine tuning of this oscillator frequency is done by CV101. This oscillator frequency is put in the 2nd mixer(Q106) and works to help making the 455KHz 2nd I. F.

1-12 Squelch Control
This radio has a noise squelch system circuit. This uses the characteristics that the receiver reduces the internal noise when signal is received and

when there is no receiver signal, picks up the part of internal noise and make it to a DC element, amplified with the part of IC102/103 and rectified by Q107. Then, added to Schmidt Trigger circuit(consisted of the remaining part of IC-103)and ceases the amplifier function of AF Amplifier by IC102. When there is a receiver input and internal noise is reduced, there is no output of Noise Detector(Q107) which in turn makes the AF Amplifier IC102 function revived and voice is amplified. This squelch level setting is made by the variable resistor at the front of the set.

I-13 Busy Light

When the selective call system(CTCSS, etc) is used, it becomes necessary to confirm if the channel is occupied by other station. So, the set has a "BUSY" indicator. On this radio, this light is connected to Squelch circuit, namely when the radio receives the input signal with the squelch-on condition, Q108 works and "BUSY" lamp comes on.

1-14 Regulated Power Supply

In order not to have a bad influence to the performance from the variation of power supply, a regulated power is supplied to the important part such as Oscillator, Squelch, RF Amplifier, IF Amplifier, etc. from IC105.

1-15 Switching Circuit

When the push-to-talk switch is pushed in, the radio is on transmit position. This will cease receiver function. So, the circuit consisting of Q109, Q110, D105, D106 and other parts is there to stop the power supply to the receiver.

TRANSMITTER SECTION

2-1
This radio's oscillator part adopts a programmable phase lock loop circuit. This, at 150MHz band, will have the final output power of 40 watts and is consisted of Modulator Amplifier, APC(automatic power control), regulated power supply circuit, etc.

2-2 PLL, Exciter Board
This board is consisted of the following circuits.

A) PLL
B) Transmitter Exciter
C) Modulator Amplifier
D) Power Supply

PLL:
This circuit, with a reference of 4.8 MHz highly stable crystal oscillator frequency, generates an equally stable VHF frequency. Makes a direct transmit frequency at transmit and at receive, "RX Freq. - 1st IF freq" corresponding to the 1st local frequency.

Transmitter Exciter:
Tx frequency from PLL is amplified to 0.5W power and lead to TX driver stage.

Modulator Amplifier:
Process and amplifier part of the voice signal from the microphone, to get the adequate modulation characteristics and modulate the VCO in PLL.

Power Supply:
This makes 5V and 8V power for this board and supplies 5V power to display board.

2-3 PLL
Reference Freq Oscillator and Oven:
The circuit consted of Q204, X201 crystal oscillator, etc. generates 4.8MHz. In order to get a sufficient stability, each crystal is temperature-compensated for -10°C to +60°C with 5ppm tolerance. At below -10°C, the compensation circuit consisting of Q205, Q206, TH201, etc. will work. At -30°C, the set will work ±5ppm range in 3 minutes warm-up time after switched-on.

VCO:
There are Oscillator circuit by Q301, Buffer Amplifier by Q302 in the receiver and another oscillator by Q303 and buffer amplifier by Q304 for transmitter. Power to regulate the frequency is supplied to varicap diode D301/302/303. D303 is added to stabilize the modulation deviation in the wide transmit freq. band. Modulated signal is supplied to D304. In order to get the power for Tx VCO only at the Tx mode, power is supplied from Transmitter 8V line and the output is supplied to Tx Exciter and Buffer amplifier Q201.
Rx VCO works only at Rx and regulated by Q211. Oscillator output, as Rx Local, is supplied to Q302 and at the same time, supplied to Q201 through Q304 to operate PLL. These VCO circuits were designed to get a good carrier-to-noise ratio.

Digital Circuit part:
IC202 is made of reference Divider, Phase Comparator and programmable divider.

The reference driver generates the phase comparator frequency dividing the 4.8MHz reference frequency. PLL then can generates the frequencies equal to the phase comparator frequency which is multiplied by N, an integral number. Normally, this frequency is set at 12.5KHz but this can be available with 10, 15, 20, 25 and 30 KHz. However, it is not possible to get above 169.6MHz at 10KHz spacing. Programmable divider makes the divider with 2 modules divider IC20K for dividing(N). In order not to return the noise from dividing, signal VCO is supplied to IC201 through Q201 buffer.
This divided frequency is compared with phase comparator frequency by phase comparator and regulated signal is output to get the same phase and then regulates VCO through LPF. As a result, VCO oscillator frequency comes to multiple of N of comparator frequency. When PLL does not lock, Q202 outputs the unlocksignal with a signal from phase comparator. The frequency dividing-ratio-N to each channel is transferred to program divider from ROM IC203. The explanation about the ROM addresses and channel number is given later.

Tx Exciter:
Power supply will be made through the voltage regulator to every circuot of this PLL board, except for Exciter end and oven circuit. 5V output from IC206 will be supplied to every digital circuit and the display part.
Linear circuit is operated by 8V but the circuit which works in common at Tx and Rx will have a direct supply from IC205 8V output. The circuit works only at Tx will have a switching circuit by Q212 and power comes only when PTT is grounded.

Tx Driver and APC Board:
This part is to amplify about 500mW power from the Tx Exciter to about 10 watts by Q401 and to drive the Power Amplifier. This PCB includes the PAC circuit and prevents the variation of power output from the variation of power supply voltage or temperature changes. This circuit is consisted of Q402, Q403, Q404, Q405, D401, etc. V401 is a semi-fixed resistor set for output power about 15W to the maximum of about 45 watts. This circuit is well balanced with the regulated power circuit and PTT switch circuit.

Tx Power Amplifier Board:
This part is consisted of Q501 and other parts and amplifies about 10W power from the driver to about 50 watts, then supplies this power to antenna through a high performance Low Pass Filter consisted of switching diode D501, D502 and L504/505/506 and C522-528. Low Pass Filter effectively functions to Harmonics Emissions. Transmit/Receive switching is done by the circuit consists of D501/D508, Q502 and other choke coils, resistors and condensers.
In order to get the APC voltage, this PCB has a detector circuit consisting of D509, D510 and other parts. TH501 is a Thermal Compensator to cancel the temperature characteristics in PAC circuit.

DISPLAY BOARD

3-1
This PCB has 7-segment 2-digit channel display and 3 LED indicators separately.

3-2
Channel switch is designed to output positive logic 4-bit binary codes.
The code is for 16(0 to 15) in decimal expression. In order to convert this into 1-16, "1" is added to 4-bit code output with 4-bit parallel full adder, IC601. So that the 5-bit binary code from the adder may be converted into into 2-digit BCD codes, IC602 is placed.

The upper digits of BCD codes are 0 or 1, with 1 indicating Ch. 10 to Ch. 16. The 1-bit output of the upper digits is connected to Q601 and drives the segment that corresponds to "1" of the upper digits of the 7-segments LED.

The BCD codes at lower digits are connected to IC603, which is a BCD to 7-segment decoder driver and drives the lower digits of the 7-segments LED.

The 4-bit codes from the channel switch is fed to PLL, and the data necessary for particular channel is sent out from ROM to PLL.

The display board is mounted with Red, Green and Yellow LED's and these LED's are connected to 12V power line through anode resistors. For lighting LED's, cathode is connected to GND.

Transmit/Receive Frequencies & ROM Data

1.
T/R Frequencies and PLL Oscillating Frequency(F (osc)).
In Tx mode, the oscillating frequency is the same as transmit frequency, while in RX mode, because the oscillating output signal is used as first local freq., the oscillation is at the frequency that is obtainable from:

Rx Frequency - 1st Local Frequency(21.6 MHz)

2.
Frequency Dividing Ratio "N"- Oscillating Frequency and Programmable Divider.
In case where F is set as necessary channel spacing, it is usual that F is used for comparator frequency, however, on this radiotelephone, (F=12.5 KHz) is used regardless of 25 or 12.5 KHz channel spacing.
Considering (Oscillating Frequency F (osc) = N x F), it is then:

$$N = F(osc)/F$$

Example:

Oscillating frequency = 150.000 MHz
Channel spacing = 25 or 12.5 KHz
$N = 150 \times 10^3/12.5$ = 12000

3.
Frequency Dividing Ratio(N), PLL Control IC, Programming Number(M) into IC202.
The programmable range of N can be set up in two, with IC202's range selecting capability:

At range 0, N = 6720 - 16959 (Pin 1 to GND)
At range 1, N = 1600 - 11839 (Pin 1 to OPEN)
The relation between N and M is as follows:
M = N - 6720 ..... Range 0
M = N - 1600 ..... Range 1

On this radiotelephone, the range is set at 0 and therefore:

M = N - 6720

4.
Conversion of Programming Number(M) to Binary Number.
IC202 receives from PROM the programming number(M), as 14-bit binary data, four bits at a time for four times.
For a case where M is converted into four binary data, that is to say, "A" to "D", the explanations are given below, in an example in which the oscillating frequency is 154.275 and a channel spacing 12.5 KHz:

F (osc) = 154.275
F = 12.5 KHz
N = 154275/12.5 = 12342
M = 12342 - 6720 = 5622

a) Divide M by 640 = 5622/640 = 8.784375
b) Write down number before decimal place.
This number is word "D" - Word "D" = 8
c) Subtract this number from a) - 8.784375 - 8 = 0.784375
d) Multiply by 40 0.784375 x 40 = 12.55
e) Write down number before decimal place.
This number is word "C" - Word "C" = 12

f) Subtract this number from d) - 12.55 - 12 = 0.55
g) Multiply by 40 0.55 x 40 = 22
h) Divide by 16 22/16 = 1.375
i) Write down number before decimal place.
This number is word "B" - Word "B" = 1
j) Subtract this number from h) 1.375 - 1 = 0.375
k) Multiply by 16 0.375 x 16 = 6
l) Write down nearest whole number.
This number is word "A" Word "A" = 6

Results:
Word "A" = 6 ; Word "B" = 1 ; Word "C" = 12 ; Word "D" = 8

The results obtained here are decimal. The input data to IC202 must be in binary and are expressed in hexadecimalism, with 4-bit making up unit. The table is given to show relations between decimal, binary and hexadecimal, as per attached.

From the table, to hexadecimalize words A to D, it is as follows:
Word "A" = 6 ; Word "B" = 1 ; Word "C" = C ; Word "D" = 8

Note:
For calculating data for Rx frequencies, it is important that the following equation must be kept in mind:
F (osc) = Rx Frequency (FR) - 21.6 MHz

DECIMAL	HEXADECIMAL	BINARY
0	0	0 0 0 0
1	1	0 0 0 1
2	2	0 0 1 0
3	3	0 0 1 1
4	4	0 1 0 0
5	5	0 1 0 1
6	6	0 1 1 0
7	7	0 1 1 1
8	8	1 0 0 0
9	9	1 0 0 1
10	A	1 0 1 0
11	B	1 0 1 1
12	C	1 1 0 0
13	D	1 1 0 1
14	E	1 1 1 0
15	F	1 1 1 1

5. PROM, IC203 and Programming Numbers.

The PROM used is i2716 from Intel, which is made up of 8-bit x 2048 byte, the data IC203 reads in must have an architecture of 4-bit in parallel for four separate readings. This means that of 8-bit data (D0 - D7), the lower 4-bits (D0 - D3) are used and the upper 4-bits (D4 - D7) are ignored(or not used). In other words, to express any 8-bit data in hexadecimalism, it is 2-digit hexadecimal figures and the lower digits are used while the upper ones are ignored.
The ROM address to be used per channel is 4-byte for setting up Rx frequencies, 4-byte for Tx frequencies, 8-byte in total and 128 byte for all 16 channels.

Since i2716 ROM is capable of 2048 byte, it is capable of up to 256 channels. With the addition of BS201, a binary switch, this radiotelephone can be made compatible for 16 frequency groups, each being capable of 16-channels, allowing users to use any one of these 16 frequency groups.

The table given on this page shows the relations between ROM addresses and channel data.

Note from the table that the table after 0080 is for the case where Group Select is applied, others show the status of using 0000-00FF, the group 0(zero).

ROM Address VS. Channel Data

ROM ADDRESS			ROM DATA	EXAMPLE	F(osc)	
0 0 0 0			Word B	0 0	fR - 21.6MHz	Example:
0 0 0 1		Rx	" A	0 E		fT= fR =154.275
0 0 0 2			" C	0 1	Example"	
0 0 0 3			" D	0 6	132.675 MHz	
0 0 0 4	CH. 1		" B	0 1		fT
0 0 0 5		Tx	" A	0 6		
0 0 0 6			" C	0 C	Example:	
0 0 0 7			" D	0 8	154.275 MHz	
0 0 0 8			" B			
0 0 0 9	CH. 2	Rx	" A		fR - 21.6 MHz	
0 0 0 A			" C			
0 0 0 B			" D			
0 0 7 4			" B			
0 0 7 5			" A		fT	
0 0 7 6	Ch.15	Tx	" C			
0 0 7 7			" D			
0 0 7 8			" B			
0 0 7 9	Ch.16	Rx	" A		fR - 21.6 MHz	
0 0 7 A			" C			
0 0 7 B			" D			
0 0 7 C			" B		fT	
0 0 7 D		Tx	" A			
0 0 7 E			" C			
0 0 7 F			" D			
0 0 8 0			" B		fR - 21.6 MHz	
0 0 8 1		Rz	" A			Group 1
0 0 8 2	Ch. 1		" C			
0 0 8 3			" D			
0 0 8 4			" B		fT	

ALIGNMENT PROCEDURES

TUNE-UP PROCEDURES for PLL, Exciter Board

1.
Connect the radio to 13.6V source and switch power on. Switch channel to the center frequency channel in the pre-programmed frequencies.
Connect 1W power meter to CN201.

2.
Connect high input impedance DC voltmeter or oscilloscope with DC coupling to CP201. Rotate L301 core to get about 4V at CP201 in receiving condition. Again adjust L301 to get over 1.5V at the lowest frequency channel and under 7.5V at the highest frequency channel. Then, make it to transmit position with PTT switch pressed, and just L302 to get 1.5V - 7.5V as in the receiver adjustment. Power meter will show somewhere 0.5 - 0.8Watt.

3.
Feed a part of RF output into the frequency counter and adjust VC201 to obtain the correct frequency. This can be on any of the one channel selected.

4.
Connect a part of RF output into the FM Linear Detector, low frequency oscillator to microphone input through an attenuator and make the input level to the radio as -30dBm. Set mike sensitivity adjusted by VR201 and maximum deviation by VR202 at the center position and turn VR203 counter-clockwise until the end.
Change audio frequency from 300 to 3KHz and set the frequency at the point where maximum deviation obtained. Set VR202 to get ± 4.8KHz deviation.
Set audio frequency at 1KHz and obtain the level at the desirable microphone sensitivity. Adjust VR201 for 3KHz deviation.
Increase the input level by 3dB and adjust VR203 until the upper and lower wave form distortion comes to synmetric. Increase audio level 16dB more than mike input sensitivity level and again adjust VR202 to get 4.8KHz deviation in 300 to 3KHz. Those are for 25KHz channel spacing, so the deviation figures should be 1/2 at 12.5KHz spacing.

RECEIVER TUNE-UPS

1.
Switch power , rotate SQ VR counter clockwise until the end and set the channel switch to the middle of the preprogrammed channels. Connect coaxial cable from standard signal generator to antenna terminal and an external speaker to radio's speaker terminal. Also connect Oscilloscope, AF Voltmeter and distortion meter to speaker terminals.

2.
Make input of 1st local signal from PLL CN202 to CN102. PLL adjustment must be completed prior to this.

3.
Connect Frequency Counter to CP101 and adjust frequency to 21.145MHz by CV101.

4.
SSG frequency should be precisely adjusted to Rx freq. and obtain SINAD of receiver output to about 12dB with an adjustment of output level. Repeat the adjustment of L101-L112 cores to get the maximum sensitivity, while decreasing the SSG output. Then, fine tune L101-L107 to get the necessary sensitivity at the highest and lowest frequencies.

5.
Turn SQ clockwise until the end with SSG output level set at +3dB.
Set threshold of SQ on-off by the tight squelch adjustment by VR101.

TX, DRIVER, PA AND PAC TUNE-UPS

1.
After PLL, Exciter boards tuned-up, connect Exciter output terminal CN201 to driver input terminal CX401 and connect Power Meter(15W) to driver output terminal CN401. Set frequency in the middle of programmed frequencies.

2.
Push PTT switch to make it to transmit position and adjust VC401 and VC402 until the power meter indicates maximum. Over 8W output should be obtained.

3.
Power amplifier input CX501 to be connected to CN401. Connect over 50W Power Meter to antenna terminal. APC adjustment VR401 to be rotated clockwise until the end. Obtain the maximum output by VC501 and VC502 and see if over 40W power is obtained on every channel.

4.
Set the output power to 40W by APC VR401.

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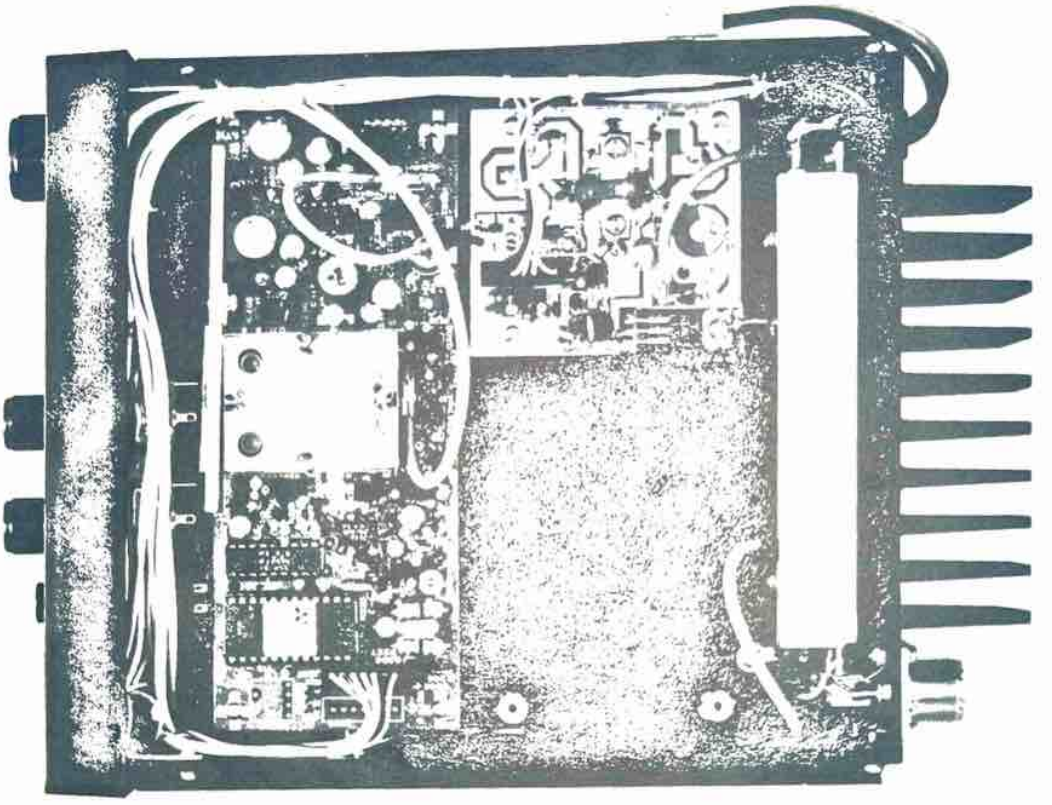
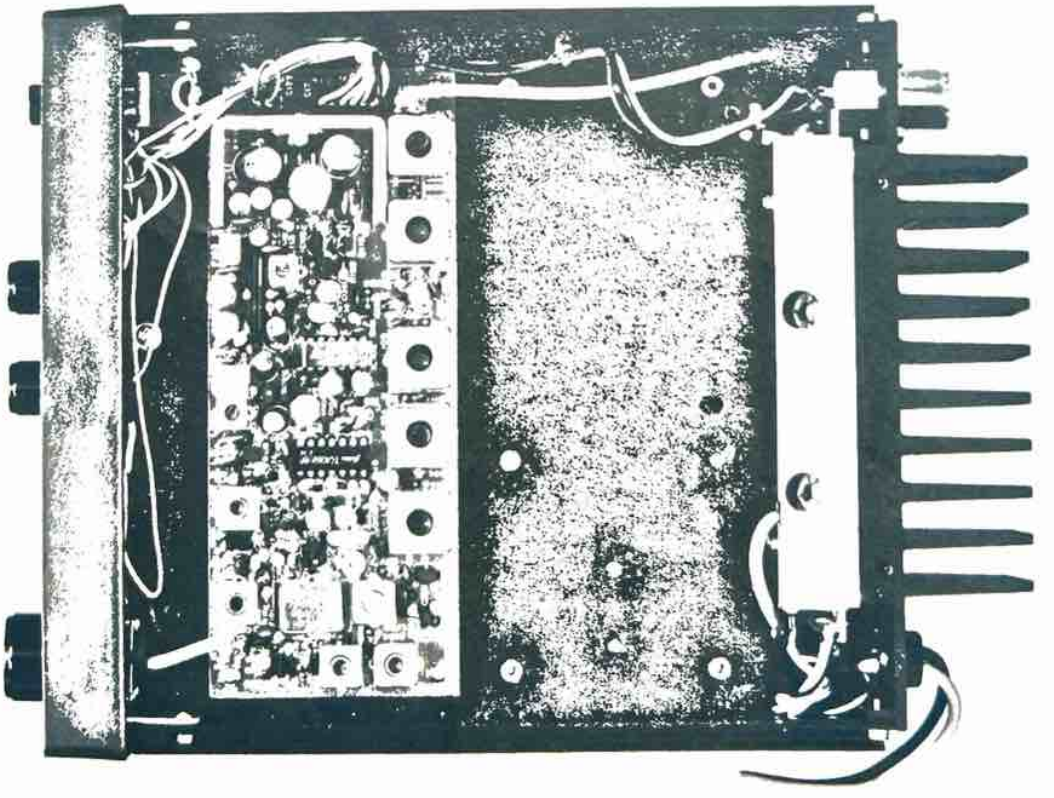
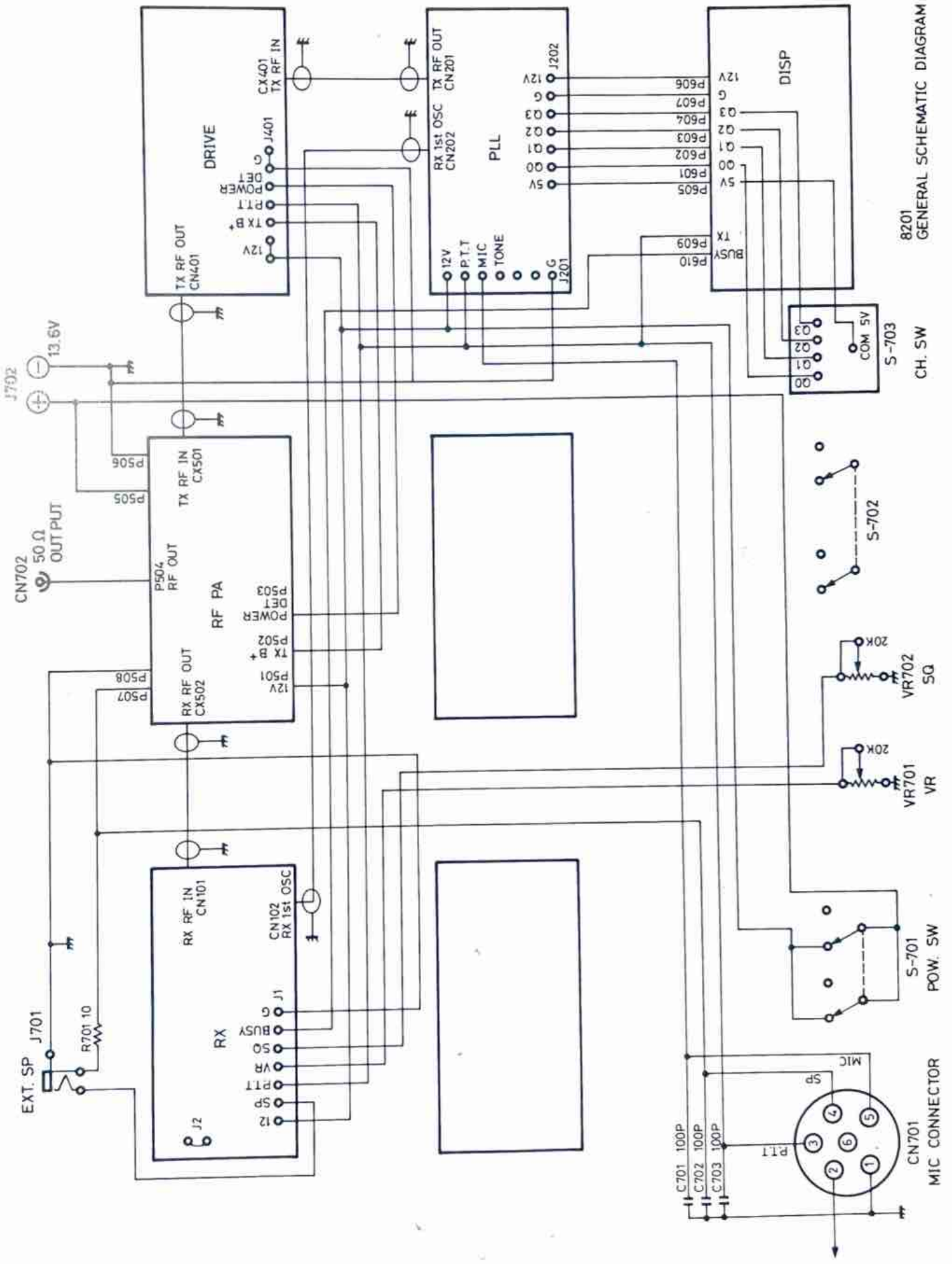
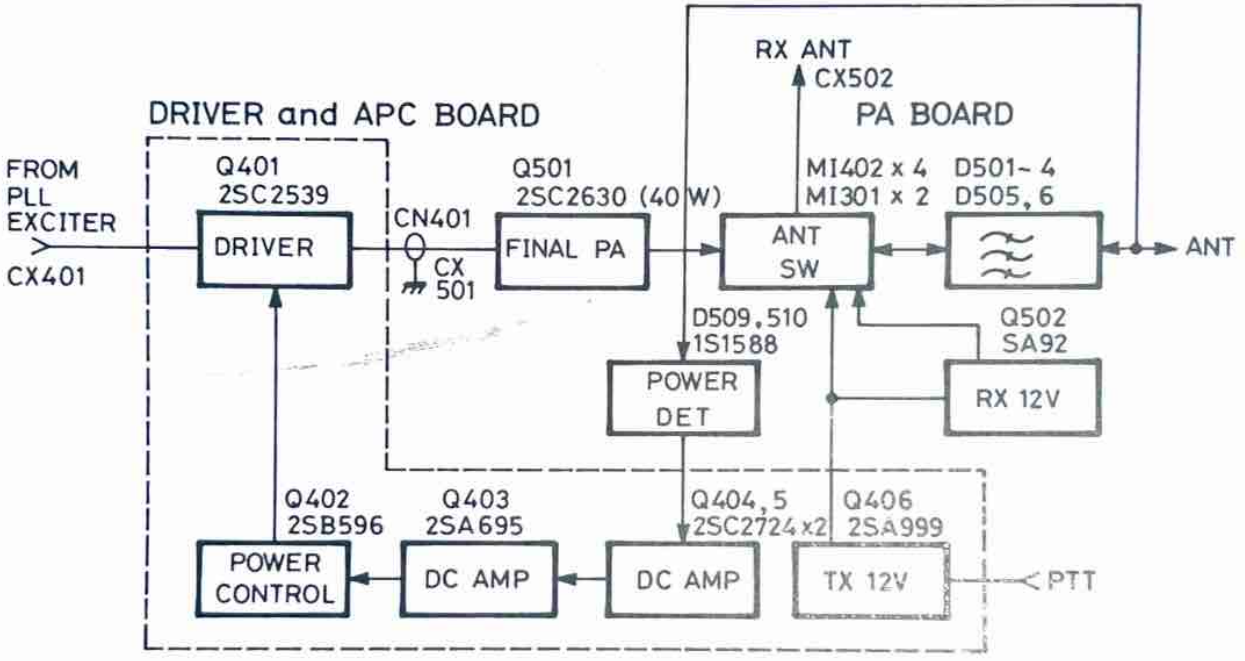
ACTUAL INSIDE VIEW

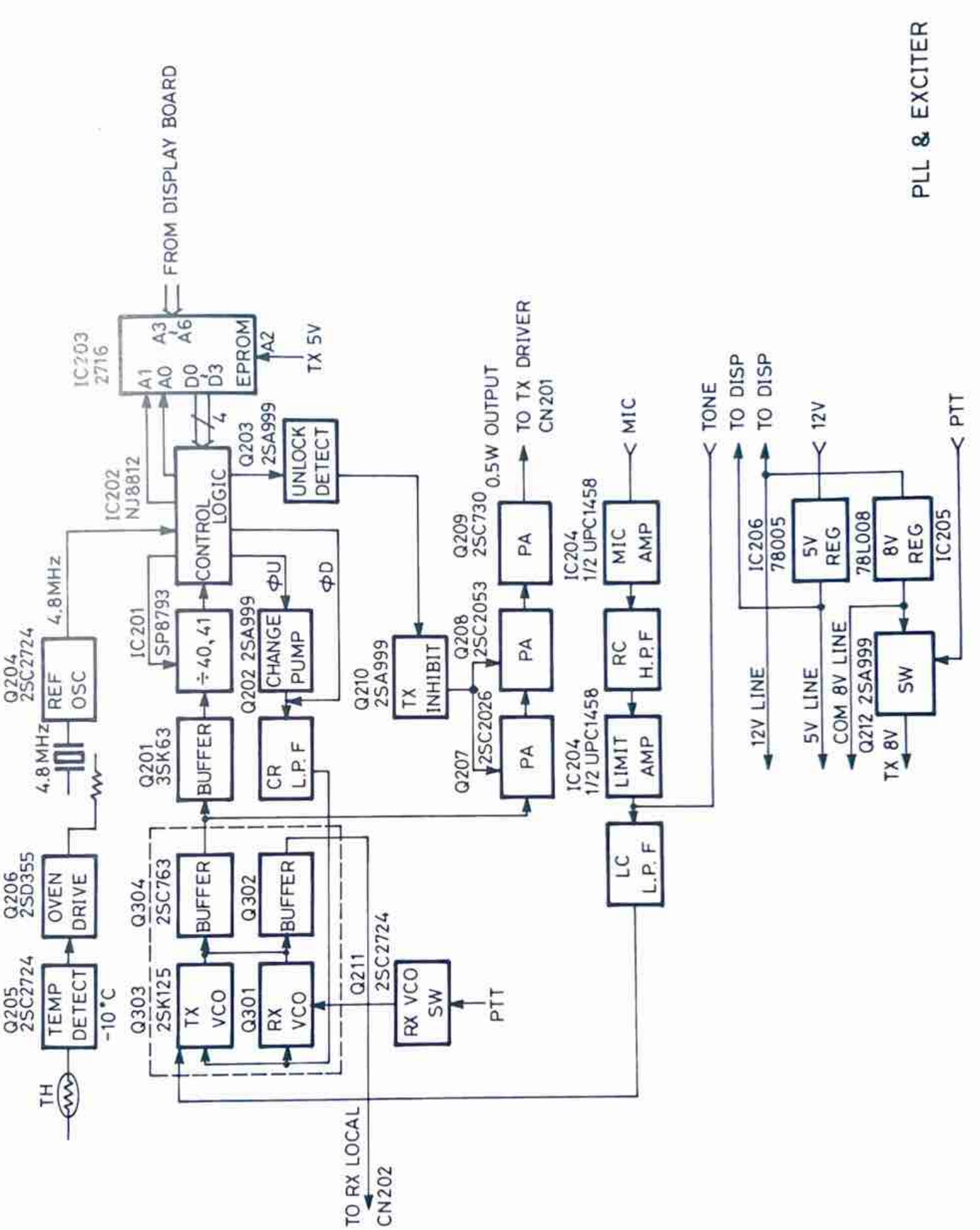


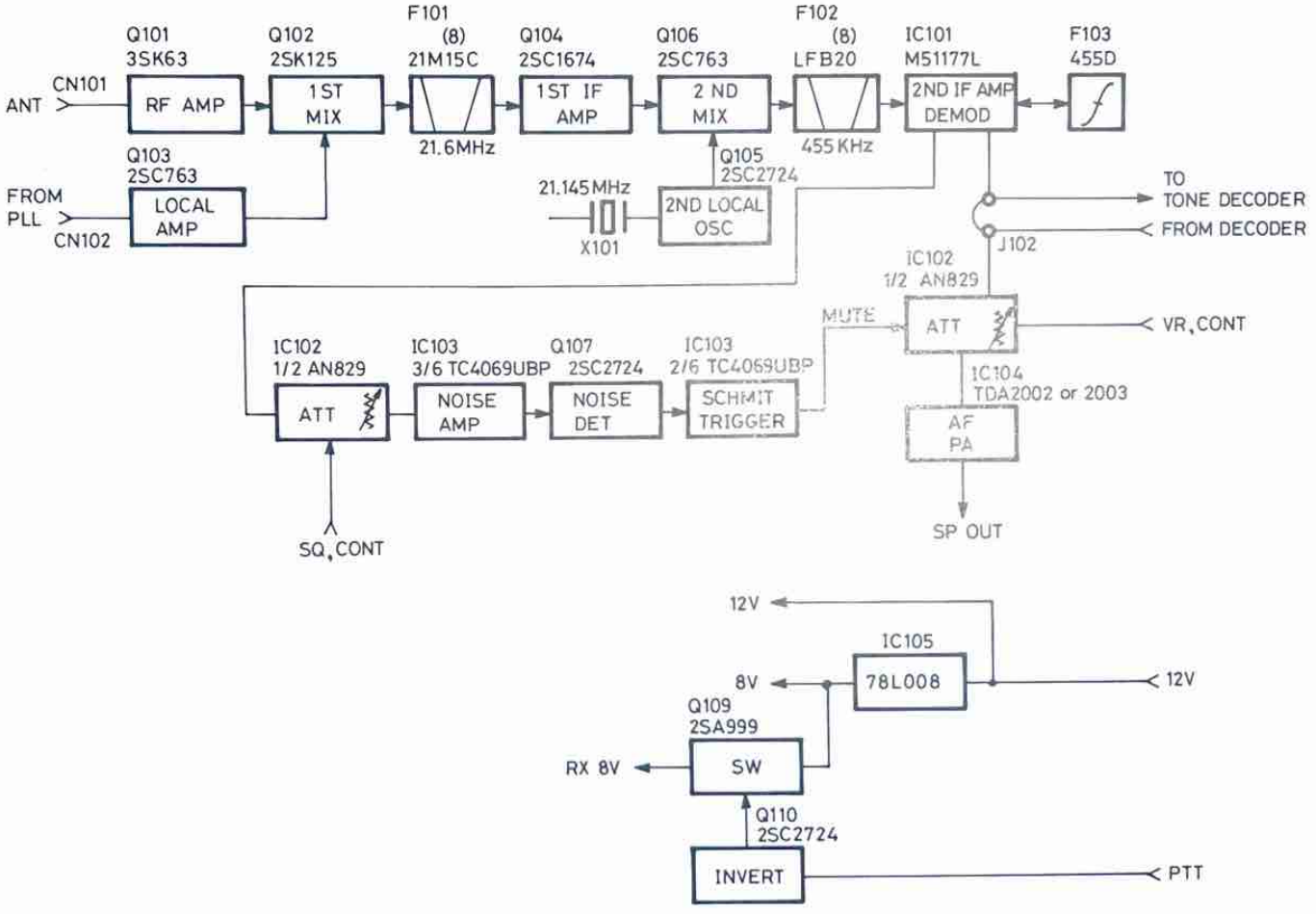






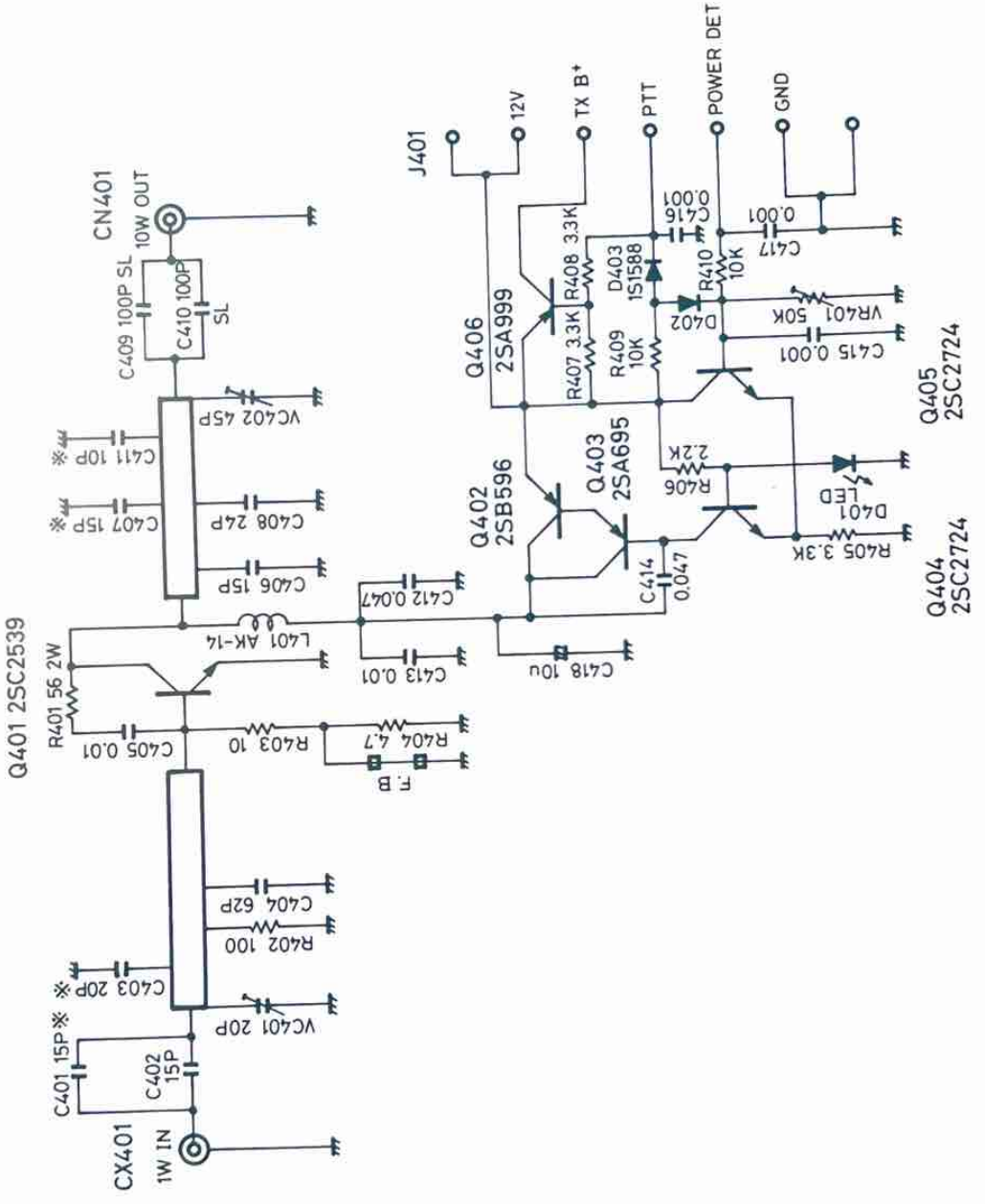
TX DRIVE, PA, APC, ANT SW

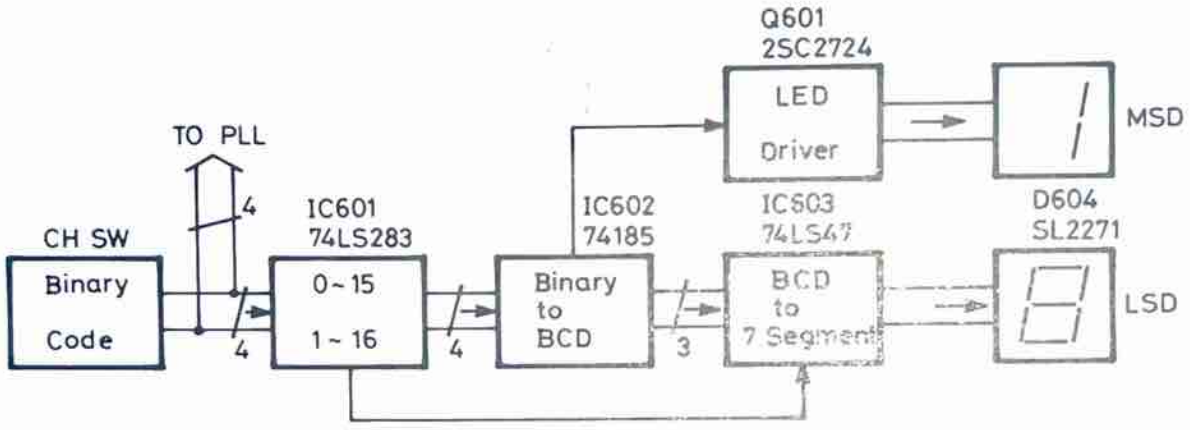


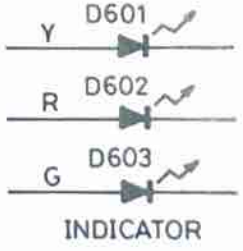


RX

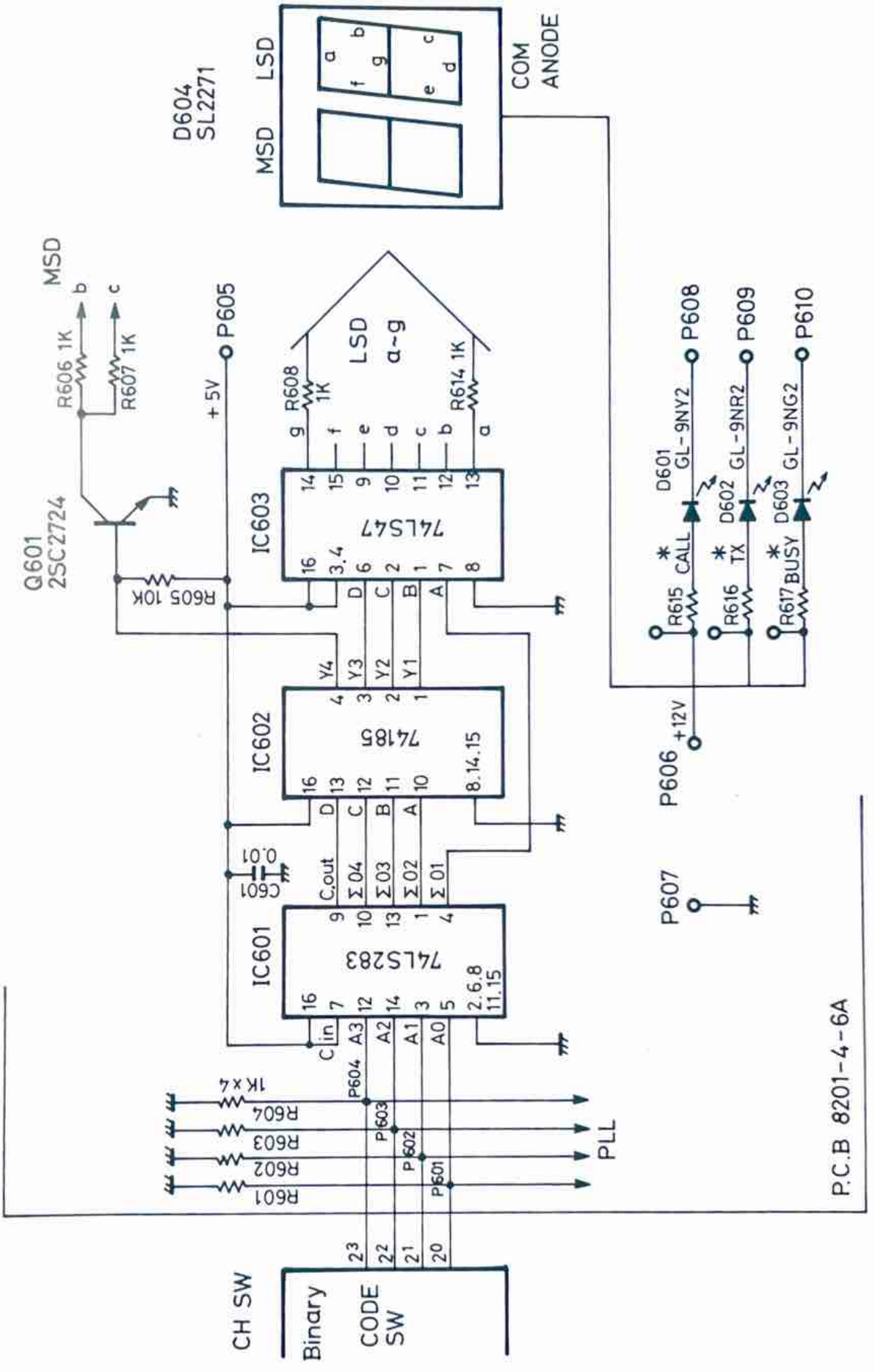
TX DRIVER & APC BOARD SCHEM.
PCB 8201-4-4A

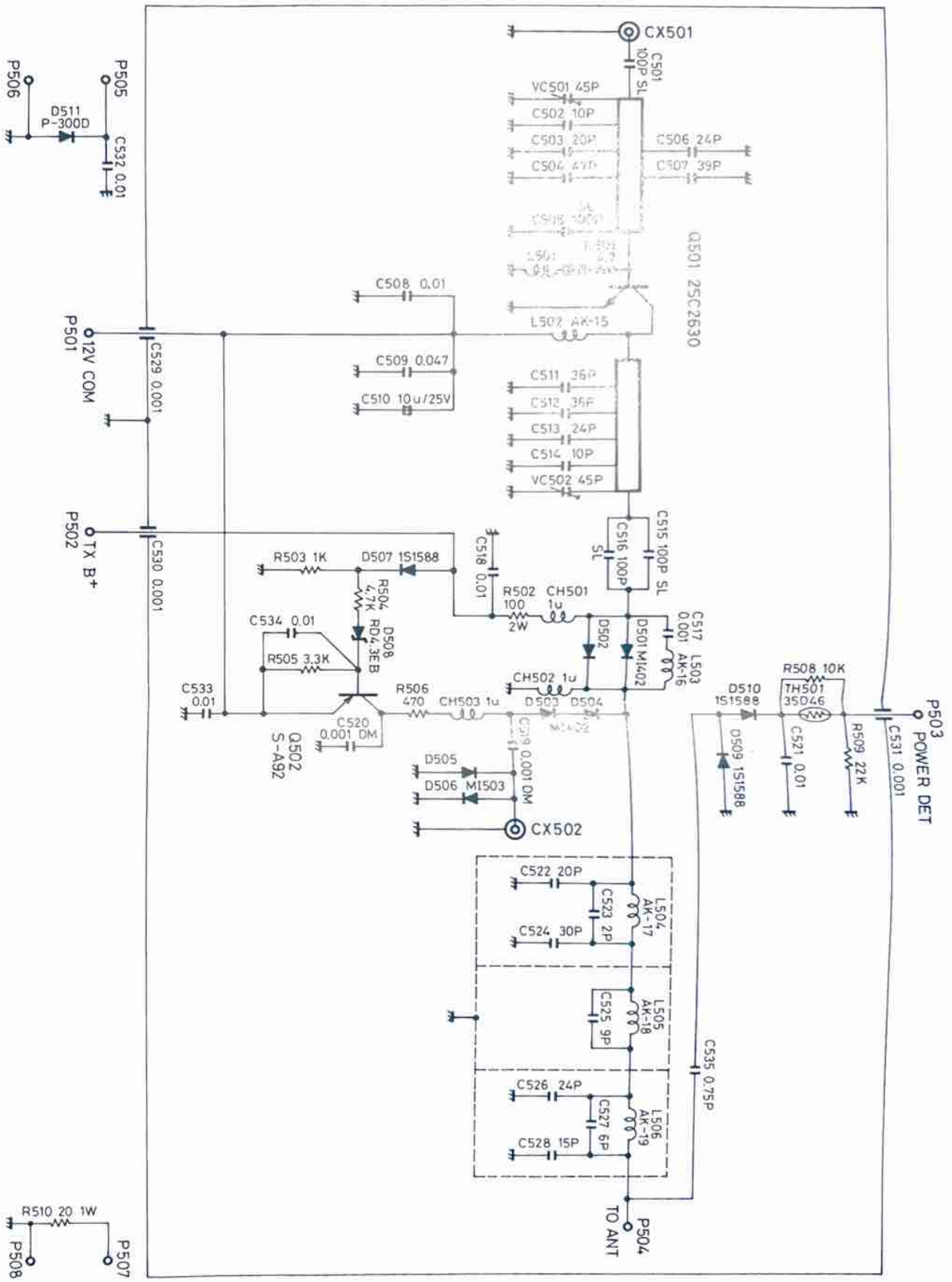




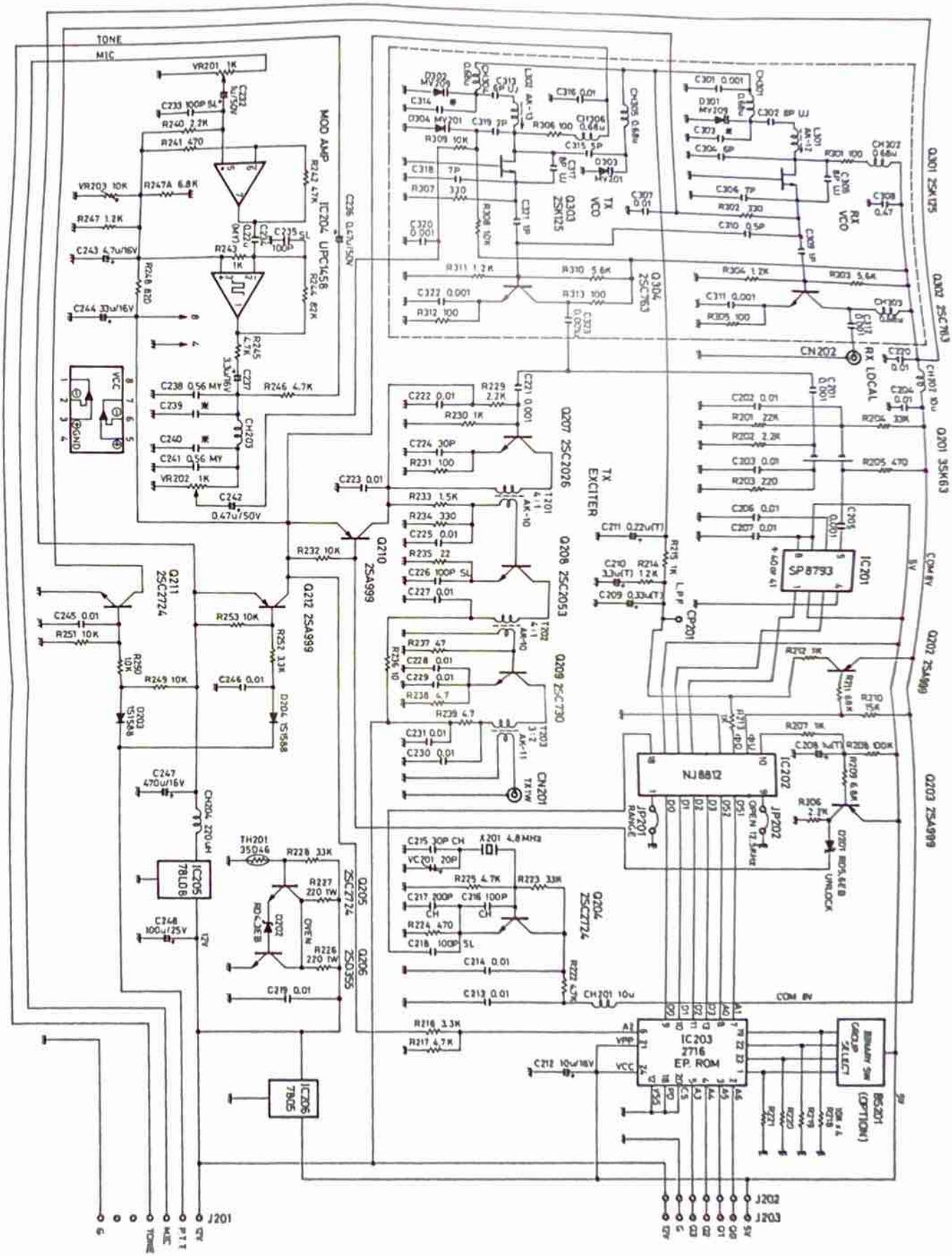


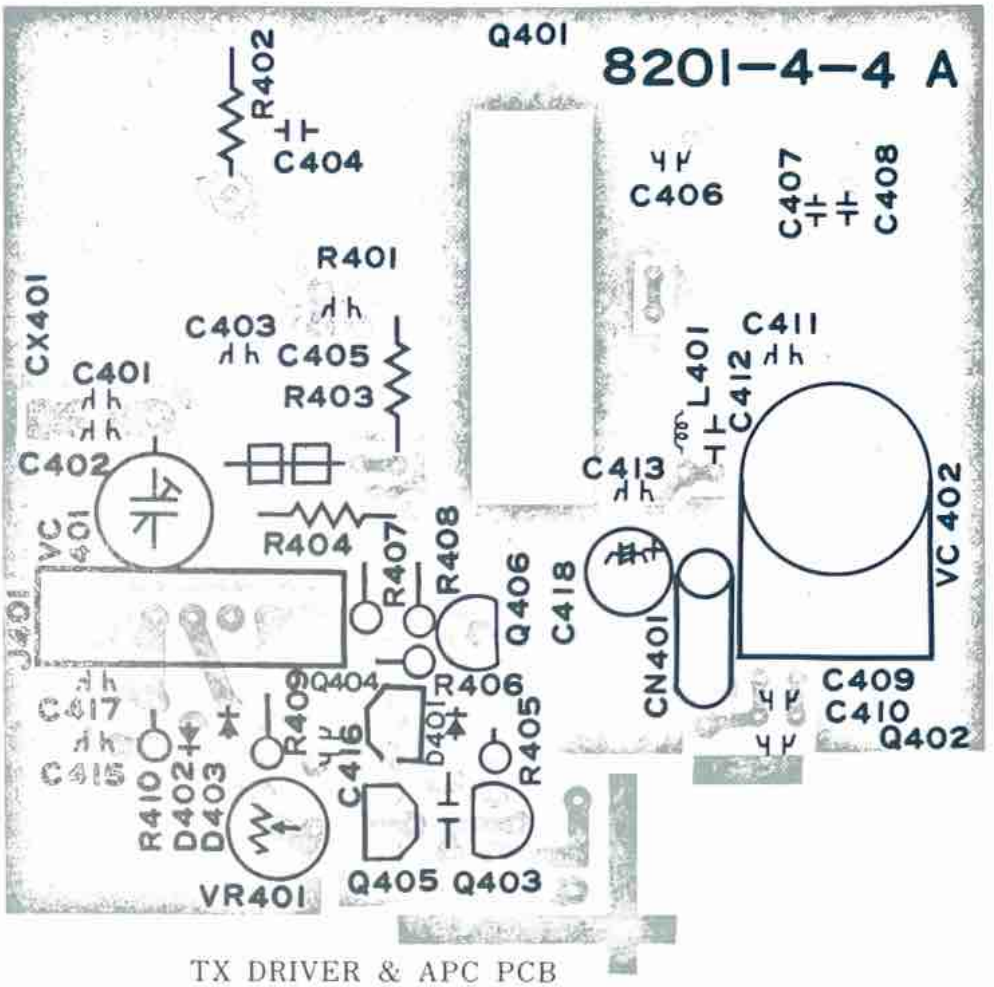
DISPLAY





TX PA BOARD SCHEM.
P.C.B 8201-4-5A

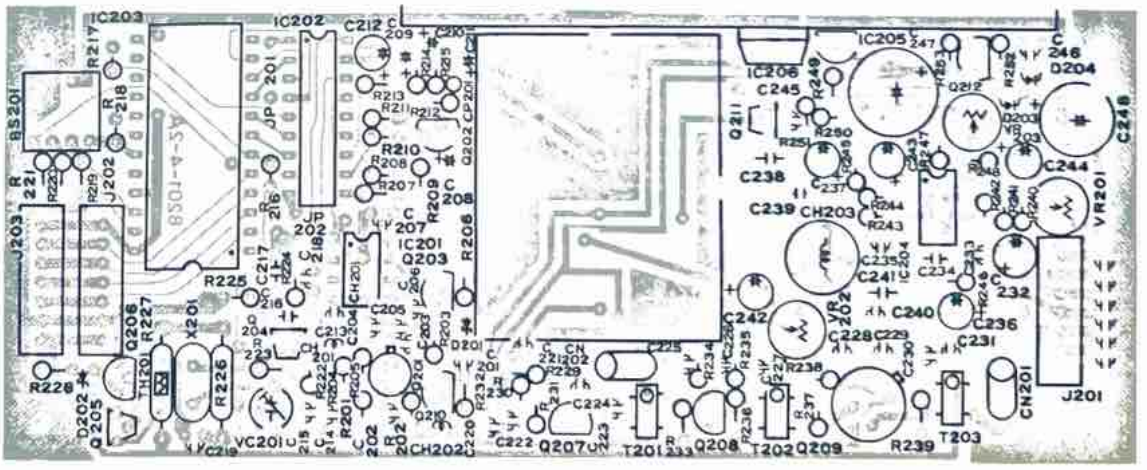




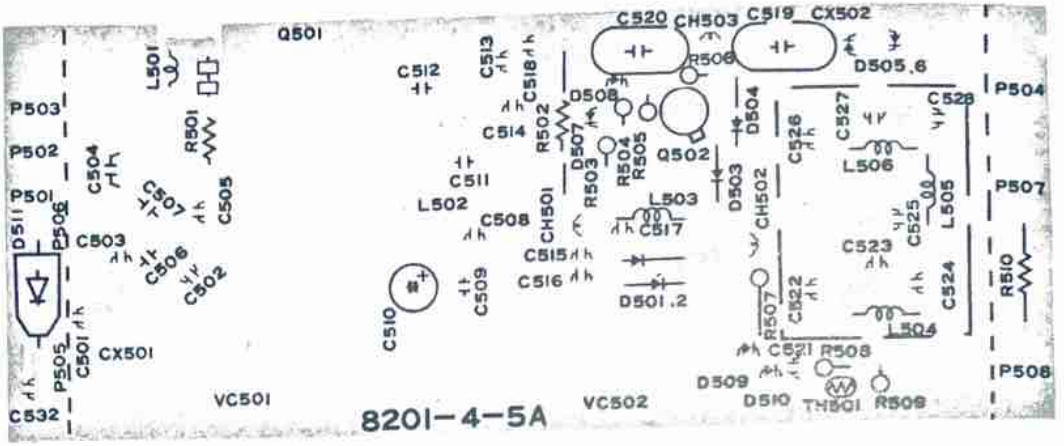
TX DRIVER & APC PCB

8201-4-4A

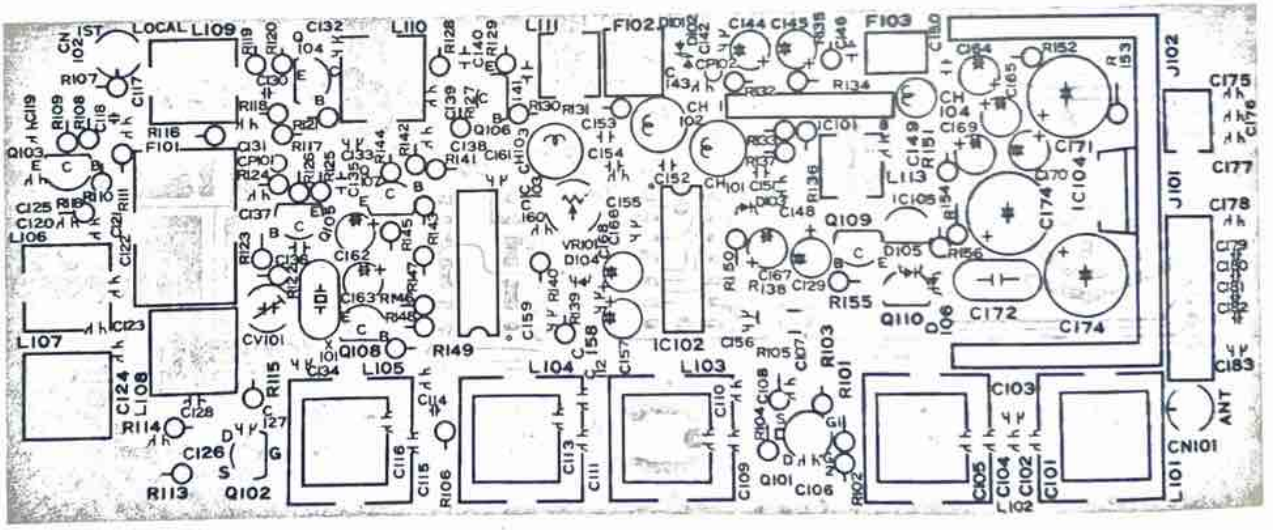
8201-4-2A



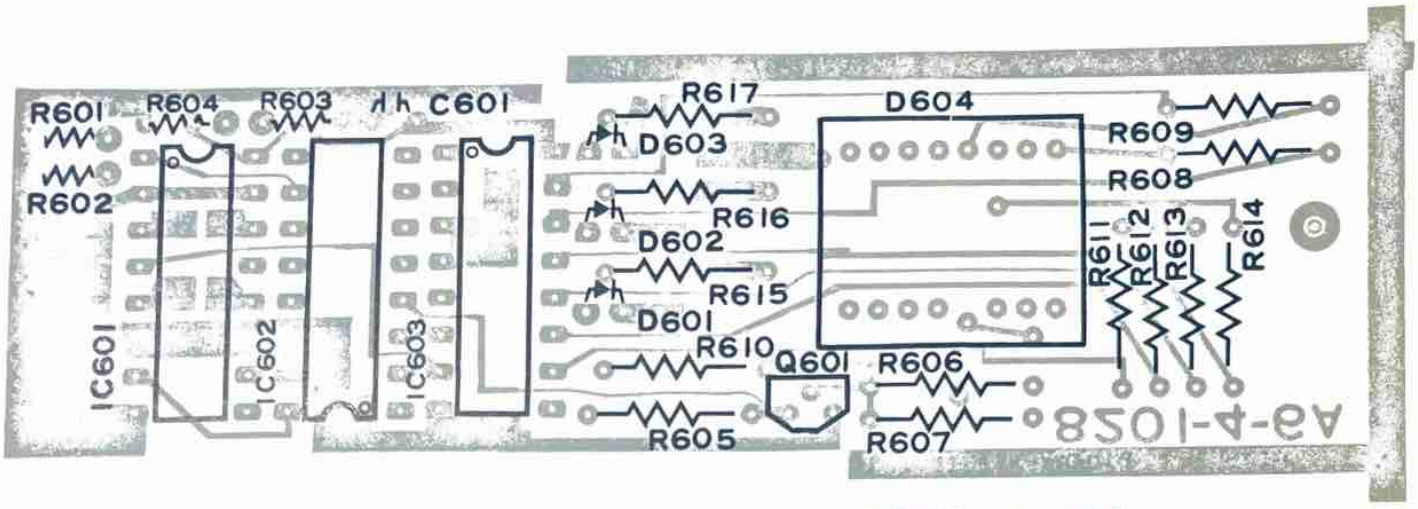
PLL PCB



TX PA BOARD PCB

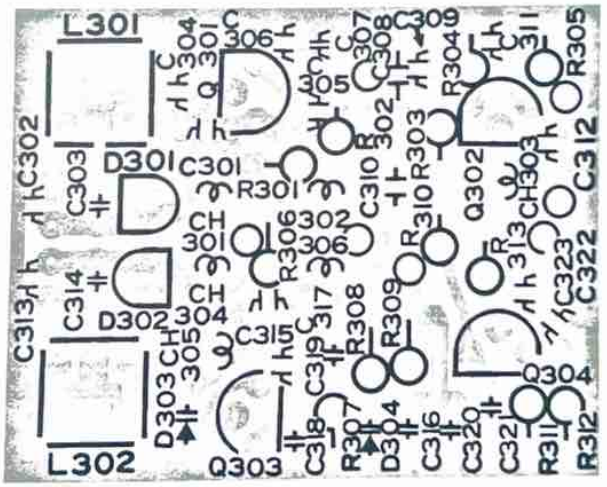


RX PCB



8201-4-6A

DISPLAY BOARD PCB



8201-4-3B

VCO PCB

PARTS LIST

= RX BOARD = 1/2

Symbol No.	Items	
Q101	Transistor	3SK63GR
Q102	"	2SK125
Q103	"	2SC763
Q104	"	2SC1674
Q105	"	2SC2724
Q106	"	2SC763
Q107	"	2SC2724
Q108	"	"
Q109	"	2SA999
Q110	"	2SC2724
IC101	IC	M51177L
IC102	"	AN829
IC103	"	4069UBP
IC104	"	TDA2002(or 2003)
IC105	"	78L09
D101	Diode	1S1588
D102	"	"
D103	"	"
D104	"	"
D105	"	"
D106	"	"
R101	Resistor-carbon	33K
R102	"	15k
R103	"	47
R104	-	
R105	"	100
R106	"	1.5k
R107	"	47
R108	"	1.2k
R109	"	150
R110	"	3.3k
R111	"	100
R112	"	"
R113	"	330
R114	"	1.5k
R115	"	100
R116	"	1.5k
R117	"	100
R118	"	22k
R119	"	6.8k
R120	"	470
R121	"	100
R122	"	10k
R123	"	22k
R124	"	100
R125	"	1k
R126	"	2.2k
R127	"	33k
R128	"	4.7k
R129	"	470
R130	"	100
R131	"	1k
R132	Resistor-carbon	2.2k
R133	"	4.7k
R134	"	100
R135	"	1k
R136	"	470
R137	"	2.2k
R138	"	4.7k
R139	"	2.2k
R140	"	2.2m
R141	"	10k
R142	-	
R143	"	47k
R144	"	10k
R145	"	"
R146	"	33k
R147	"	220k
R148	"	10k
R149	"	100
R150	"	3.3k
R151	"	15k
R152	"	2.2
R153	"	470
R154	"	1
R155	"	4.7k
R156	"	10k
C101	Capacitor-ceramic	8p
C102	"	2p
C103	"	1p
C104	"	2p
C105	"	6p
C106	"	0.01u
C107	"	0.001u
C108	"	0.01u
C109	"	2p
C110	"	3p
C111	"	0.5p
C112	"	2p
C113	"	6p
C114	"	0.5p
C115	"	5p
C116	"	4p
C117	"	0.01u
C118	"	"
C119	"	"
C120	"	6p
C121	"	2p
C122	"	0.5p
C123	"	6p
C124	"	2p
C125	"	0.01u
C126	"	"
C127	"	"
C128	"	82p
C129	" Electrolytic	10u 16v

=RX BOARD = 2/2

Symbol No.	Items	
C130	Capacitor-ceramic	24p
C131	"	0.01u
C132	"	"
C133	"	"
C134	"	47p
C135	"	100p
C136	"	"
C137	"	0.01u
C138	"	1p
C139	"	100p
C140	"	0.047u
C141	"	"
C142	"	0.01u
C143	"	"
C144	" electrolytic	4.7u 16v
C145	"	"
C146	" ceramic	0.047u
C147	" electrolytic	10u 16v
C148	" ceramic	0.01u
C149	" Myler	0.0047u
C150	"	"
C151	"	0.01u
C152	"	"
C153	"	0.022u
C154	"	0.01u
C155	" ceramic	0.01u
C156	"	0.001u
C157	" electrolytic	0.47u 50v
C158	" ceramic	0.01u
C159	"	"
C160	"	0.001u
C161	"	0.01u
C162	" electrolytic	1u 50v
C163	"	"
C164	"	"
C165	"	"
C166	" ceramic	0.001u
C167	" electrolytic	0.47u 50v
C168	"	10u 16v
C169	"	0.47u 50v
C170	" tantalum	0.1u 6.3v
C171	" electrolytic	220u 6.3v
C172	" myler	0.1u
C173	" electrolytic	100u 25v
C174	"	220u 16v
C175	" ceramic	0.001u
C176	"	"
C177	"	"
C178	"	"
C179	"	"
C180	"	"
C181	"	"
C182	"	"
C183	"	"

Symbol No.	Items	
L101	Coil	AK-01
L102	"	AK-02
L103	"	AK-03
L104	"	AK-03
L105	"	AK-04
L106	"	AK-05
L107	"	AK-06
L108	"	AK-07
L109	"	AK-08
L110	"	AK-09
L111	"	BH169E
L112	"	"
CV101	Capacitor-variable	20P 53
VR101	Resistor-variable	
X101	Xtal 21.145 MHz	
F101	Xtal filter 21M15C 21.6	
F102	Ceramic filter LFB20	
F103	Discriminator 455D	
CN101	RF connector V1	
CN102	"	
J101	Connector R41 3614	
J102	"	
CP101	Check point pin	
CP102	"	
CH101	Ferri inductor 1mH	
CH102	"	
CH103	"	
Ch104	"	220uH
	Heat sink 8201-4-8	

=PLL BOARD = 1/2

Symbol No.	Items	
Q201	Transistor	3SK63GR
Q202	"	2SA999
Q203	"	"
Q204	"	2SC2724
Q205	"	"
Q206	"	2SD355
Q207	"	2SC2026
Q208	"	2SC2053
Q209	"	2SC730
Q210	"	2SA999
Q211	"	2SC2724
Q212	"	2SA999
IC201	IC	SP8793
IC202	"	NJ8812
IC203	"	2716
IC204	"	uPC1458
IC205	"	78L08
IC206	"	7805
R201	Resistor-carbon	22k
R202	"	2.2k
R203	"	220
R204	"	33k
R205	"	470
R206	"	2.2k
R207	"	1k
R208	"	100k
R209	"	6.8k
R210	"	15k
R211	"	68k
R212	"	1k
R213	"	"
R214	"	1.2k
R215	"	1k
R216	"	3.3k
R217	"	4.7k
R218	"	10k
R219	"	"
R220	"	"
R221	"	"
R222	"	4.7k
R223	"	33k
R224	"	470
R225	"	4.7k
R226	" metal film	220
R227	"	"
R228	" carbon	33k
R229	"	2.2k
R230	"	1k
R231	"	100
R232	"	10k
R233	"	1.5k
R234	"	330

Symbol No.	Items	
R235	Resistor-carbon	22 ohms
R236	"	10
R237	"	47
R238	"	4.7
R239	"	"
R240	"	2.2k
R241	"	470
R242	"	47k
R243	"	1k
R244	"	82k
R245	"	4.7k
R246	"	"
R247	"	1.2k
R248	"	820
R249	"	10k
R250	"	"
R251	"	"
R252	"	3.3k
R253	"	10k
R247A	"	6.8k
C201	Capacitor-ceramic	0.001u
C202	"	0.01u
C203	"	"
C204	"	"
C205	"	0.001u
C206	"	0.01u
C207	"	"
C208	" tantalum	1u 16V
C209	"	0.33u 16v
C210	"	"
C211	"	0.22u 16v
C212	" electrolytic	10u 16v
C213	" ceramic	0.01u
C214	"	"
C215	"	30p
C216	"	100p
C217	" mica	200p
C218	" ceramic	100p
C219	"	0.01u
C220	"	"
C221	"	0.001u
C222	"	0.01u
C223	"	"
C224	"	30p
C225	"	0.01u
C226	"	100p
C227	"	0.01u
C228	"	"
C229	"	"
C230	"	"
C231	"	"
C232	" electrolytic	1u 50v
C233	" ceramic	100p

=PLL BOARD = 2/2

Symbol No.	Items	
C234	Capacitor-Myler	0.022u
C235	" - ceramic	100p
C236	" - electrolytic	0.47u 50v
C237	"	3.3u 50v
C238	" Myler	0.056u
C239	-	
C240	-	
C241	" myler	0.056u
C242	" electrolytic	0.47u 50v
C243	"	4.7u 16v
C244	"	33u 16v
C245	" ceramic	0.01u
C246	"	"
C247	" electrolytic	470u 16v
C248	"	100u 25v
D201	Zener diode	RD5.6EB
D202	"	RD4.3EB
D203	Diode	1S1588
D204	"	"
T201	Transformer	AK10
T202	"	"
T203	"	AK11
CH201	Ferri inductor	10uH
CH202	"	"
CH203	"	100m
CH204	"	220u
VC201	Variable capacitor	20p53
VR201	Variable resistor	EVN38CA
VR202	"	
X201	Xtal 4.8MHz	
	Heat Sink 8201-1-9	
CN201	RF connector	
CN202	"	
J201	Connector-Jack	
J202	"	
CP201	Check point pin	
TH201	Thermistor	35D46

= VCO BOARD =

Symbol No.	items	
Q301	Transistor	2SK125
Q302	"	2SC763
Q303	"	2SK125
Q304	"	2SC763
D301	Diode	MV209
D302*	"	"
D303	"	MV201
D304	"	"
R301	Resistor-carbon	100 ohms
R302	"	330
R303	"	5.6k
R304	"	1.2k
R305	"	100
R306	"	"
R307	"	330
R308	"	10k
R309	"	"
R310	"	5.6k
R311	"	1.2k
R312	"	100
R313	"	"
C301	Capacitor-ceramic	0.001u
C302	"	8p
C303	"	-
C304	"	6p
C305	"	8p
C306	"	7p
C306	"	0.01u
C308	"	0.047u
C309	"	1p
C310		0.5p
C311	"	0.001u
C312	"	"
C313	"	6p
C315	"	5p
C316	"	0.01u
C317	"	8p
C318	"	7p
C319	"	2p
C320	"	0.001u
C321	"	1p
C322	"	0.001u
C323	"	"
L301	Coil	AK12
L302	"	AK13
CH301	Ferri inductor	0.68uH
CH302	"	"
Ch303	"	"
CH304	"	"
CH305	"	"
CH306	"	"
	VCO case 1(8201-1-6)	
	VCO case 2(8201-1-7)	
	Lead pin	

= TX DRIVER & APC BOARD =

Symbol No.	items	
Q401	Transistor	2SC2539
Q402	"	2SB596
Q403	"	2SA695
Q404	"	2SC2724
Q405	"	"
Q406	"	2SA999
D401	LED	GL-9NR2
D402	Diode	1S1588
D403	"	"
R401	Resistor-metal	56 ohms
R402	" - carbon	100
R403*	"	10
R404	"	4.7
R405	"	3.3k
R406	"	2.2k
R407	"	3.3k
R408	"	"
R409	"	10k
R410	"	"
C401	Capacitor-ceramic	15p
C402	"	"
C403	"	20p
C404	"	62p
C405	"	0.01u
C406	"	15p
C407	"	"
C408	"	24p
C409	"	100p
C410	"	"
C411	"	10p
C412	"	0.047u
C413	"	0.01u
C414	"	0.047u
C415	"	0.001u
C416	"	"
C417	"	"
C418	" electrolytic	10u 16v
VC401	Variable capacitor	2op 32
VC402	"	45p
VR401	Variable resistor	EVN38CA
L401	Voil	AK14
CX401	Coaxial cable 110mm	
CN401	RF connector	
J401	Connector R413614	
F. B.	Ferrite beads	FB101
	TR Spacer 8201-1-11A	
	Plastic washer	

= TX PA BOARD =

Symbol No.	Items	
Q501	Transistor	2SC2630
Q502	"	S-A92
D501	Diode	MI402
D502	"	"
D503	"	"
D504	"	"
D505	"	MI301
D506	"	"
D507	"	1S1588
D508	"	RD4.3EB
D509	"	1S1588
D510	"	"
D511	"	P-300D
R501	Resistor-carbon	4.7 ohms
R502	" metal film	100
R503	" carbon	1k
R504	"	4.7k
R505	"	3.3k
R506	"	470
R507	"	-
R508	"	10k
R509	"	22k
R510	" metal film	20
C501	Capacitor-ceramic	100p
C502	"	10p
C503	"	20p
C504	"	47p
C505	"	100p
C506	"	24p
C507	"	39p
C508	"	0.01u
C509	"	0.047u
C510	" electrolytic	10u 25v
C511	" ceramic	36p
C512	"	"
C513	"	24p
C514	"	10p
C515	"	100p
C516	"	"
C517	"	0.001u
C518	"	0.01u
C519	"	0.001u
C520	"	"
C521	"	0.01u
C522	"	22p
C523	"	2p
C524	"	30p
C525	"	9p
C526	"	24p
C527	"	6p
C528	"	15p
C529	" feed-thru	0.001u
C530	"	"

Symbol No.	Items	
C531	Capacitor-feed thru	0.001u
C532	" ceramic	0.01u
C533	"	"
C534	"	"
C535	"	0.75p
VC501	Variable capacitor	CV01C450
VC502	"	"
TH501	Thermistor	35D46
CX501	Coaxial cable	140mm
CX502	"	220mm
CH501	Ferri inductor	1u
CH502	"	
CH503	"	
L501	Coil	HF3LR35J
L502	"	AK-15
L503	"	AK-16
L504	"	AK-17
L505	"	AK-18
L506	"	AK-19
	LPF case 1	8201-1-1
	" 2	8201-1-2
	" 3	8201-1-2
	PA shield 1	8201-1-4
	" 2	8201-1-5
	Ferrite beads	FB101
	Rage washer	M3
	TR spacer	8201-1-10

= DISPLAY BOARD =

Symbol No.	Items	
IC601	IC	78LS283
IC602	"	74185
IC603	"	74LS47
Q601	Transistor	2SC2724
D601	Diode	GL-9NY2
D602	"	GL-9NR2
D603	"	GL-9NG2
D604	"	SL-2271
R601	Resistor-carbon	1k
R602	"	"
R603	"	"
R604	"	"
R605	"	10K
R606	"	1K
R607	"	"
R608	"	"
R609	"	"
R610	"	"
R611	"	"
R612	"	"
R613	"	"
R614	"	"
R615	"	"
R616	"	"
R617	"	"
C601	Capacitor-ceramic	0.01u

= PARTS OUT OF PCB =

Symbol No.	Items	
S701	Switch	8N2011
S702	"	8N2021
S703	" -digital	SRS101G
VR701	Resistor-variable	K1611
VR702	"	
CN701	Mike connector	6PF146S
CN702	'M' type connector	MR-SQ
J701	Ext. speaker jack	
J702	Power jack	
R701	Resistor-metal film	10 ohms
C701	Capacitor-ceramic	100p
C702	"	"
C703	"	"
	Bushing SP-4L-4	
	Main-frame, aluminum	
	Heat sink	
	Front sub-chassis	
	Lid-upper	
	" -bottom	
	Front mould piece	
	Aclyric plate	
	Knob-channel	
	" Vol. Sque.	
	Bracket	
	Freq. indication paper	
	Plastic cover for above	
	Specification plate	
	Microphone	
	Speaker	
	Fuse 10A	
	Owner's manual	
JR201	2.5mm socket	M36-07-SA
JR202	"	
JR402	"	
JR101	"	
280A	Coax cable with connector	
	Shorting wire	

= RX PLL BOARD = 1/2

Symbol No.	Items	
Q701	Transistor	2SK125
Q702	"	2SC763
Q703	"	"
Q704	"	3SK63GR
Q705	"	2SA999
Q706	"	2SC2724
Q707	"	2SC1312
Q708	"	2SC2724
Q709	"	"
Q710	"	2SD355
IC701	IC	SP8793
IC702	"	NJ8812
IC703	"	2716
IC704	"	MC14016BP
IC705	"	MC14001BP
IC706	"	78L8
IC707	"	7805
D701	Diode	MV209
D702	"	1S1588
IC704	"	RD4.3EB
R701	Resistor-carbon	100 ohms
R702	"	330
R703	"	1.2k
R704	"	5.6k
R705	"	100
R706	"	"
R707	"	5.6k
R708	"	1.2k
R709	"	100
R710	"	2.2k
R711	"	22k
R712	"	33k
R713	"	220
R714	"	470
R715	"	10k
R716	"	15k
R717	"	1k
R718	"	"
R719	"	10k
R720	"	"
R721	"	"
R722	"	"
R723	"	1.2k
R724	"	1k
R725	"	4.7k
R726	"	33k
R727	"	4.7k
R728	"	470
R729	"	22k
R730	"	330k
R731	"	470k

Symbol No.	Items	
R732	Resistor-carbon	1k
R733	"	100
R734	"	10k
R735	"	"
R736	"	"
R737	"	"
R738	"	"
R739	"	"
R740	"	"
R741	"	"
R742	"	"
R743	"	"
R744	"	33k
R745	" metal film	220
R746	"	"
C701	Capacitor-ceramic	0.001u
C702	"	8p
C703	"	6p
C704	"	8p
C705	"	7p
C706	"	0.5p
C707	"	1p
C708	"	0.047u
C709	"	0.001u
C710	"	"
C711	"	"
C712	"	"
C713	"	"
C714	"	"
C715	"	"
C716	"	"
C717	"	"
C718	"	"
C719	" tantalum	0.33u
C720	"	3.3u
C721	"	0.22u
C722	" electrolytic	10u 16v
C723	" ceramic	0.001u
C724	"	"
C725	"	"
C726	"	"
C727	"	"
C728	"	"
C729	"	0.01u
C730	"	100p
C731	"	"
C732	" mica	200p
C733	" ceramic	30p
C734	" myler	0.1u
C735	" electrolytic	1u 50v
C736	"	"
C737	"	10u 16v
C738	"	"

Symbol No.	Items	
C739	Capacitor-electrolytic	10u 16v
C740	"	470y 16v
C741	"	100u 25v
C742	" ceramic	0.001u
C743	"	"
C744	"	"
C745	"	"
C746	"	"
C747	"	"
C748	"	"
C749	"	"
C750	"	"
C751	"	"
C752	"	"
C753	"	"
C754	"	"
C755	"	"
CH701	Ferri inductor	0.68uH
CH702	"	"
CH703	"	"
CH704	"	220u
L701	Coil	AK-12
X701	Xtal 4.8 MHz	
VC701	Trim cap	20pf
CN701	RF connector A1	
VR701	Resistor-Variable	B54
VR702	"	B24
CP701	Check point pin	
CH702	"	
J701	Connector M36-15-30-114p	
J702	" M36-07-30-114p	
	Shield case 8201-1-13A/14A	
	RX shield case 8201-1-17/18	