



SERVICE MANUAL

114MHz FM TRANSCEIVER

IC-02A

IC-02AT

IC-02E

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SECTION 1 SPECIFICATIONS

GENERAL

Frequency Coverage	: IC-02A/AT; 144MHz ~ 148MHz IC-02E; 144MHz ~ 146MHz (Some versions cover 140MHz ~ 149.995MHz without specifications guaranteed)
Frequency Readout	: 6-digit 5KHz readout, LCD Display
Frequency Resolution	: IC-02A/AT; 5KHz steps (other steps such as 10KHz, 15KHz, 20KHz and 25KHz are programmable and available by pushing the UP/DOWN buttons) IC-02E; 12.5KHz steps (25KHz steps are programmable)
Frequency Control	: Digital PLL Synthesizer with key input
Frequency Stability	: Within 0.002% in range of $-10^{\circ}\text{C} \sim +60^{\circ}\text{C}$ ($+14^{\circ}\text{F} \sim +140^{\circ}\text{F}$)
Memory Channels	: 10 Channels
Scanning	: Programmed Scan and Memory Channel Scan available
Usable Temperature	: $-10^{\circ}\text{C} \sim +60^{\circ}\text{C}$ ($+14^{\circ}\text{F} \sim +140^{\circ}\text{F}$)
Antenna Impedance	: 50ohms unbalanced
Power Supply Requirement	: 12 ~ 15V DC for the EXTERNAL DC POWER JACK IC-BP2 ~ IC-BP8 BATTERY PACKS are acceptable.
Current Drain (with IC-BP3 or IC-BP8)	: Transmitting: HIGH (3W) Approx. 1.05A LOW (0.5W) Approx. 450mA Receiving: At max audio output Approx. 140mA Squelched Approx. 35mA
Dimensions	: 116.5mm(H) x 65mm(W) x 35mm(D) Without battery pack Attendant battery pack, IC-BP3 49mm(H) x 65mm(W) x 35mm(D)
Weight	: 515g (IC-02A; 495g) including battery pack, IC-BP3 and flexible antenna.

TRANSMITTER

Output Power	: HIGH: 3W with IC-BP3 or IC-BP8, 5W with IC-BP7 LOW: 0.5W with any ICOM battery pack
Emission Mode	: 16F ₃ (F3E 16K0)
Modulation System	: Variable reactance frequency modulation
Max. Frequency Deviation	: $\pm 5\text{KHz}$
Spurious Emission	: More than 60dB below carrier
Microphone	: Built-in Electret condenser microphone Optional Speaker-microphone (IC-HM9) and Headset (HS-10) can be used
Operating Mode	: Simplex Duplex (Any in-band frequency separation programmable)

RECEIVER

Receiving System	: Double-conversion superheterodyne
Modulation Acceptance	: 16F ₃ (F3E 16K0)
Intermediate Frequencies	: 1st: 16.9MHz 2nd: 455KHz
Sensitivity	: Less than 0.25 μV for 12dB SINAD Less than 0.3 μV for 20dB Noise quieting
Squelch Sensitivity	: Less than 0.1 μV
Spurious Response Rejection Ratio	: More than 60dB
Selectivity	: More than $\pm 7.5\text{KHz}$ at -6dB point Less than $\pm 15\text{KHz}$ at -60dB point
Audio Output Power	: More than 500mW (at 8 ohms 10% distortion)
Audio Output Impedance	: 8 ohms

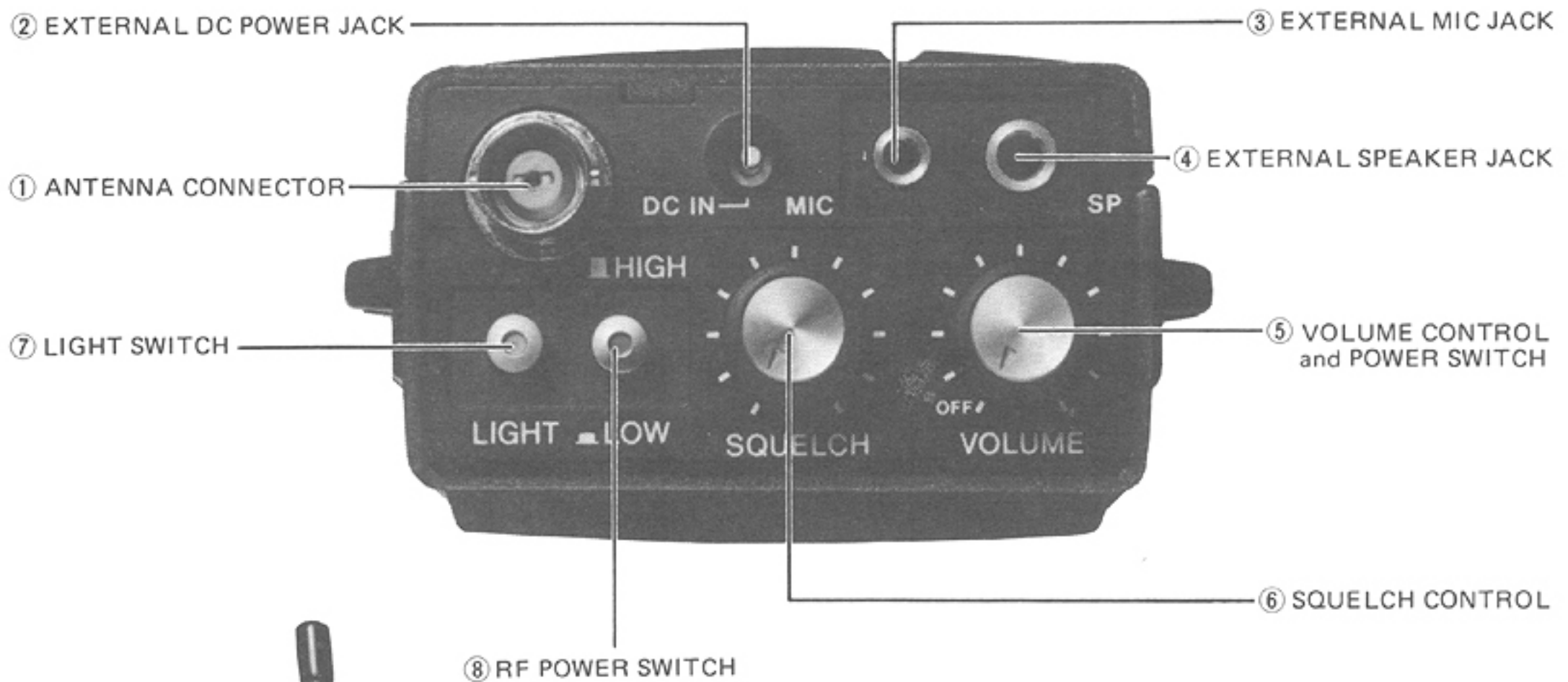
All stated specifications are subject to change without notice or obligation.

Version Table

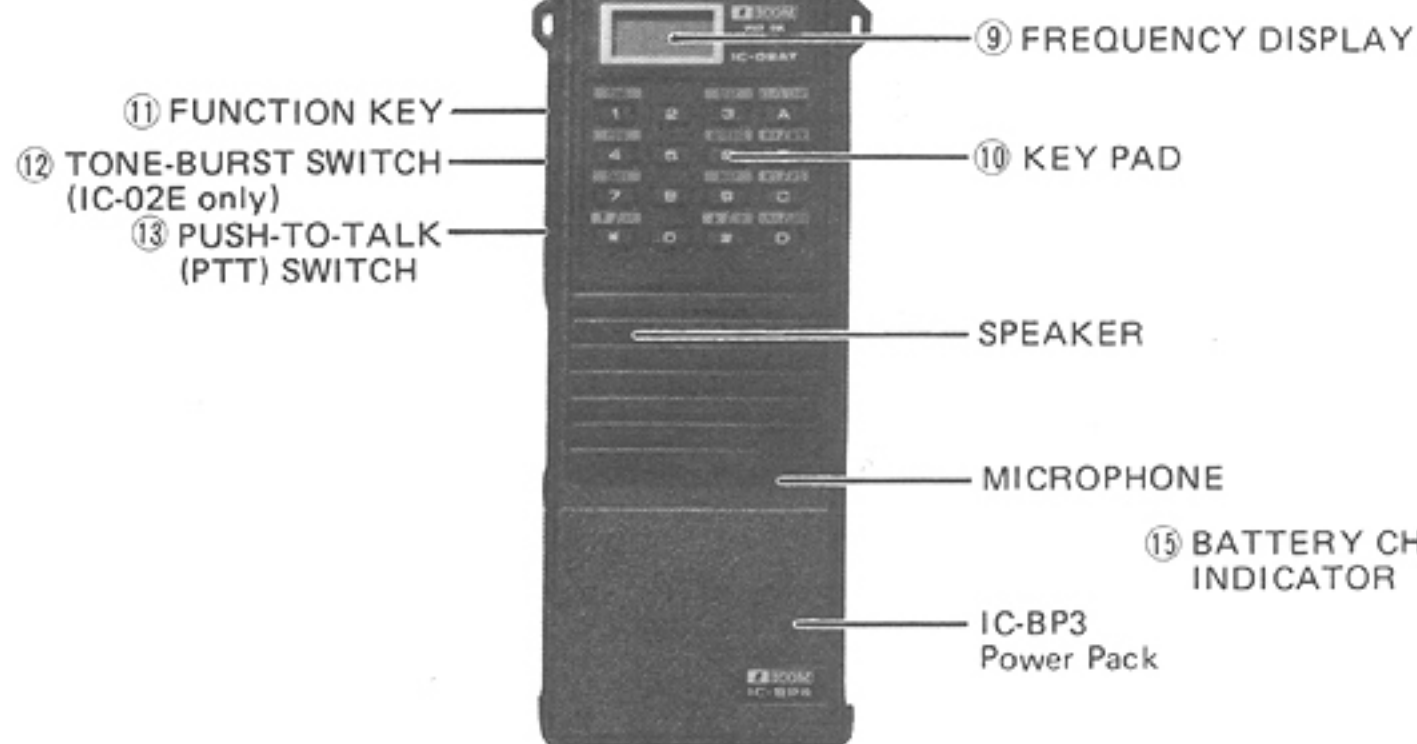
MODEL	Version Number	Frequency Coverage (MHz)	Frequency Resolution (KHz)	DTMF Encoder	CTCSS Encoder	1750Hz Tone	Included	
							Charger	Battery
IC-02E	02	144.000 ~ 145.9875	12.5, 25	No	No	Yes	BC-26E	IC-BP3
	04	140.000 ~ 149.9875	12.5, 25	No	No	Yes	BC-26E	IC-BP3
IC-02A	06	140.000 ~ 149.9875	5, 10, 15, 20, 25	No	No	No	BC-25U	IC-BP3
	07	144.000 ~ 147.995	5, 10, 15, 20, 25	No	No	No	—	IC-BP3
	08	140.000 ~ 149.995	5, 10, 15, 20, 25	No	No	No	—	IC-BP4
IC-02AT	05	140.000 ~ 149.995	5, 10, 15, 20, 25	Yes	Yes	No	BC-25U	IC-BP3
	09	140.000 ~ 149.995	5, 10, 15, 20, 25	Yes	Yes	No	—	IC-BP4

SECTION 2 OPERATING CONTROLS

TOP PANEL



FRONT PANEL



REAR PANEL



1 ANTENNA CONNECTOR

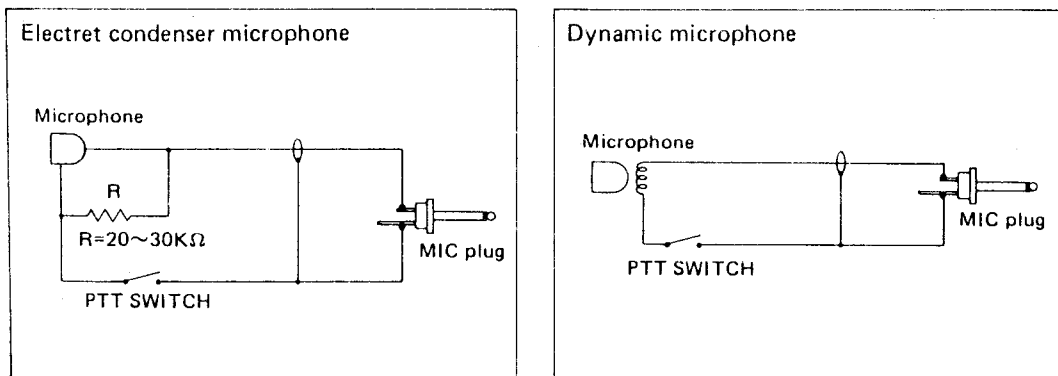
Connect the supplied flexible antenna. An external antenna can be used using a BNC connector.

2 EXTERNAL DC POWER JACK

A voltage regulated DC power supply with an output of 12volts ~ 15volts can be connected here, instead of using the battery pack attached. Inserting the power plug into this jack disables the attached power pack. (when using IC-BP3, IC-BP7 or IC-BP8, the battery pack will be charged in 0.1c rate.)

3. EXTERNAL MIC JACK

When an external microphone is used, connect it to this jack. See the schematic for the proper hookup. When the external microphone is connected, the built-in microphone does not function. The optional speaker-microphone, IC-HM9 and headset HS-10 with VOX unit, HS-10SA or PTT switch box, HS-10SB can be also used.



4. EXTERNAL SPEAKER JACK

When an external speaker (or an earphone) is used, connect it to this jack. Use a speaker with an impedance of 8ohms. When the external speaker is connected, the built-in speaker does not function.

5. VOLUME CONTROL and POWER SWITCH

When this control is turned completely counterclockwise, the power is OFF. By turning the control clockwise beyond the "click", the unit is turned ON and the audio level increases by further rotating it clockwise.

6. SQUELCH CONTROL

Sets the squelch threshold level. To turn OFF the squelch function, turn this control completely counterclockwise. To set the threshold level higher, turn the control clockwise.

7. LIGHT SWITCH

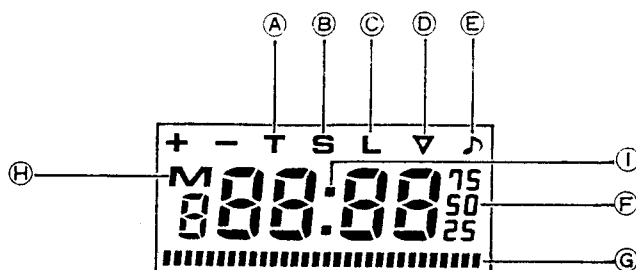
When this switch is in the locked in position, the frequency display is lit up and the displayed information can be seen in the dark. When using a battery power pack to power the IC-02A/AT/E, keep this switch in out position to save power.

8. RF POWER SWITCH

Switches the output power of the set HIGH and LOW. In the HIGH (out) position, the output power is 3 watts with IC-BP3 or IC-BP8 BATTERY PACK. In the LOW (locked-in) position, the output power is 0.5 watts with any ICOM battery pack.

9. FREQUENCY DISPLAY

Indicates not only the operating frequency but also several functions as follows;



- A: TRANSMIT INDICATOR: "T" is indicated when the set is in the transmit mode.
- B: SCAN INDICATOR: "S" is indicated when the set is in a scan mode.
- C: LOCK INDICATOR: "L" is indicated when the operating frequency is locked by pushing the "D" key while the "FUNC" key is depressed. At this time, any key pushing will be canceled except "FUNC" and "D" (LOCK) key pushed to clear the lock function.
- D: BATTERY CONDITION INDICATOR: "▽" is indicated just before the battery is exhausted in the transmit mode. When the "▽" is indicated, stop using the set and recharge the battery pack or replace the battery pack with a charged one. (When using IC-BP4 battery pack, replace the exhausted batteries in the pack with new batteries.)
- E: TONE ENCODER INDICATOR: "T" is indicated when the subaudible audio tone encoder is actuated by pushing "1" (TONE) key while the "FUNC" key is depressed. (IC-02AT only)
- F: FREQUENCY DISPLAY: Indicates the operating frequency with 5 digits between 100MHz and 10KHz, and a small "50" means 5KHz (IC-02E: "75" means 7.5KHz and "25" means 2.5KHz.) (In the memory channel mode, the 100MHz digit shows memory channel number.)
- G: S/RF INDICATOR: Indicates signal strength and RF output level with a dotted bar. The RF output level meter functions only as a relative output meter and does not indicate the wattage. These functions are switched automatically when T/R switching is made.
- H: MEMORY MODE INDICATOR: "M" is indicated when the set is in the memory mode and while memory writing.
- I: PRIORITY FUNCTION INDICATOR: "•" is indicated when the set is in the priority function.

10. KEY PAD

This key pad has 16 keys consisting of ten numerical keys and six code keys. Most keys have dual functions.

The primary functions are available by just pushing each key. The ten numerical keys function to set digit indicated on each key. The other keys function to set functions indicated above each key with letters on gray colored base.

The secondary functions are available by pushing each key while the "FUNC" key on the side is depressed. Each function is indicated above the key with letters on olive colored base.

KEY	PRIMARY FUNCTION		SECONDARY FUNCTION	
	SYMBOL	FUNCTION	SYMBOL	FUNCTION
1	1	Sets the digit of 1.	TONE	Sets a desired subaudible tone or turns off the tone. Push this key and then desired tone number keys. (To turn off the tone function, push "00" as the tone number.)
2	2	Sets the digit of 2.	----	-----
3	3	Sets the digit of 3.	STEP	Sets a desired frequency step. Push this key, and then one of the step keys which are the "1"–"5" keys.
4	4	Sets the digit of 4.	PRIO	Sets the priority function. To turn off this function, push the "A" key without depressing the "FUNC" key.
5	5	Sets the digit of 5.	----	-----
6	6	Sets the digit of 6.	REVERSE	In the duplex mode, the receive frequency and transmit frequency are exchanged with each other.
7	7	Sets the digit of 7.	SHIFT	Sets a desired receive/transmit frequency separation. Push this switch, "*" key for "–" duplex or "#" key for "+" duplex, and then enter the desired separation frequency in four digits.
8	8	Sets the digit of 8.	----	-----
9	9	Sets the digit of 9.	BEEP	Turns on and off the key pad beep tone.
0	0	Sets the digit of 0.	----	-----
*	▼	Decreases the operating frequency with specified steps, or operating channel number.	–	Sets the "–" duplex mode when pushed following the "SHIFT" (7) key.
#	▲	Increases the operating frequency with specified steps, or operating memory channel number.	+	Sets the "+" duplex mode when pushed following the "SHIFT" (7) key.
A	CL/SSTOP	Clears entered number, and recall previous frequency or clears previous number to "00". Clears the memory channel mode and enters the DIAL mode. Clears the priority function. Clears any scan function. The operating frequency, or memory channel stops on the displayed one.	----	-----
B	MR	Sets the radio in the memory channel mode. Push the key, and then a desired channel number "0" ~ "9"	MW	Writes the displayed frequency into a memory channel. Push the key, and then a desired channel number. The displayed frequency will be written.

C	MS	Sets the radio in the memory scan mode. Scans all memories.	PS	Sets the radio in the programmed scan mode. Scans frequency between the frequencies memorized in the channel 0 and channel 9 with specified steps.
D	CALL	Call the frequency memorized in the MEMORY CHANNEL 1. At this time, any key pushing is canceled except the "A" key to clear this function.	LOCK	Locks the key pad to prevent accidental key entry. To clear this function, push this key again while depressing the "FUNC" key.

11. FUNCTION KEY

By depressing this key, the secondary function of each key can be selected.

12. TONE-BURST SWITCH (IC-02E only)

Most repeaters require a 1750Hz tone-burst for initial access. Depressing this switch for the required period for a repeater puts the set in the transmit mode and the tone-burst generator actuates and you can access the repeater. (For the other versions, it functions as a Push-To-Talk switch.)

13. PUSH-TO-TALK (PTT) SWITCH

For transmission, press this switch and talk into the microphone with normal voice. The internal microphone is of the electret-condenser type and provides good pickup for all voice levels.

14. CHARGER CONNECTOR

Connects to the output plug of the supplied wall charger BC-25U/E or other suitable power source.

15. BATTERY CHARGE INDICATOR

Lights during battery charging.

NOTE:

- The last digit key enters frequencies according to the following chart.

KEY	1	2	3	4	5	6	7	8	9	0	REMARKS
IC-02A	/	/	/	/	5	/	/	/	/	0	KHz
IC-02AT	/	/	/	/	5	/	/	/	/	0	KHz
IC-02E	12.5	25.0	37.5	/	50.0	62.5	75.0	87.5	/	00.0	KHz

NOTE: Pushing a key where "/" is indicated causes the newly entered frequency to be canceled and the previous operating frequency is recalled.

- The frequency step rate defined to each key is shown in the following chart.

KEY/DISPLAY	1	2	3	4	5	6	7	8	9	0	REMARKS
IC-02A	5.0	10.0	15.0	20.0	25.0	/	/	/	/	/	KHz
IC-02AT	5.0	10.0	15.0	20.0	25.0	/	/	/	/	/	KHz
IC-02E	/	12.5	/	25.0	/	/	/	/	/	/	KHz

NOTE: Pushing a key where "/" is indicated causes the newly entered frequency to be canceled and the previous operating frequency is recalled.

3. The tone frequency for each number is shown in the following chart.

tone NO.	FREQUENCY (Hz)	tone NO.	FREQUENCY (Hz)	tone NO.	FREQUENCY (Hz)	tone NO.	FREQUENCY (Hz)
01	67.0	16	114.8	31	192.8	46	1700.0
02	71.9	17	118.8	32	203.5	47	1750.0
03	74.4	18	123.0	33	210.7	48	1800.0
04	77.0	19	127.3	34	218.1	49	1300.0
05	79.7	20	131.8	35	225.7	50	2000.0
06	82.5	21	136.8	36	233.6	51	2200.0
07	85.4	22	141.3	37	241.8	52	2975.0
08	88.5	23	146.2	38	250.3	53	2550.0
09	91.5	24	151.4	39	500.0	54	2295.0
10	94.8	25	156.7	40	600.0	55	2125.0
11	97.4	26	162.3	41	700.0	...	
12	100.0	27	167.9	42	800.0	...	
13	103.5	28	173.8	43	900.0	...	
14	107.2	29	179.9	44	1000.0	...	
15	110.9	30	186.2	45	1600.0	...	

To turn off the tone encoder, push the "0" key twice ("00") as the tone number.

If illegal number (a number that is not shown in the chart) has been entered, the number is canceled and the previous number (when the tone encoder is turned off, the number is "00") will be recalled.

SECTION 3 CIRCUIT DESCRIPTION

3 - 1 RECEIVER CIRCUITS

3 - 1 - 1 ANTENNA SWITCHING CIRCUIT

Input signals from the antenna connector are fed to the antenna switching circuit through Chebyshev low-pass filter consisting of L214, L213, C265, C264, C262, C260 and C258 in the PLL board.

The antenna switching circuit employs a quarter wave diode switching circuit through which current does not flow in the receive mode. In the receive mode, switching diodes D208 and D209 are turned OFF, and the incoming signals are fed to the RF amplifier circuit through low-pass filter consisting of C256, L212 and C259.

3 - 1 - 2 RF AMPLIFIER CIRCUIT

The signals from the switching circuit are amplified at Q206.

The signals amplified at Q206 are fed to the gate of the first mixer Q205 through the band-pass filter consisting of L204, L203, and L202, where interference and intermodulation from out of the band signals is reduced.

To the source of Q205, 127MHz local oscillator signals are applied from the PLL circuit. The mixer Q205 converts the RF signals into 16.9MHz first IF signals and puts out at L201.

3 - 1 - 3 THE FIRST LOCAL OSCILLATOR CIRCUIT

The 127MHz signals are generated by the VCO, Q211 and are applied to the source of Q205, through Q208, buffer amplifier and D203 switching diode.

3 - 1 - 4 IF AMPLIFIER CIRCUIT

The first IF signals from L201 are filtered further from out of band interference through the matched pair of monolithic crystal filters F1202 and are amplified at Q204 and Q203.

The signals amplified at Q203 are fed to IC201 IF circuit IC.

IC201 incorporates in one package the second local oscillation circuit, the second mixer, the limiter amplifier and quadrature detector circuit.

The second local oscillator circuit oscillates at 16.455MHz with crystal unit X202. The second local oscillator signal and the first IF signal fed to pin 16 of IC201 are mixed in the second mixer circuit. 455KHz second IF signals are put out from pin 3 of IC201.

The second IF signals are fed to pin 5 of IC201 through the high performance ceramic filter F1201 and a part of the signals is supplied simultaneously to the S-meter amplifiers, Q202 and Q201.

The signals fed to pin 5 of IC201 are amplified by the limiter amplifier, and are fed to the quadrature detector circuit inside IC201 and are put out from the pin 7. These signals are fed to pin 8 through the ceramic resonator, X201 to detect them and are put out from pin 9 as AF signals.

3 - 1 - 5 S-METER CIRCUIT

Q202 and Q201 are the S-meter amplifiers. The second IF signals are fed to the base of Q202 rectified with and put out from the collector of Q201. These signals are detected in a voltage-doubler D201 and D202 and used to charge C201 whose voltage is put out.

3 - 1 - 6 AF CIRCUITS

The AF signal output from pin 9 of IC201 is de-emphasised at 6dB/octave by integrator circuit consisting of R127 and C117, and fed to the AF amplifier Q105 through volume control R132 then to the base of Q116.

Q116, Q117, Q119, Q120 and Q122 are the AF power amplifier circuits and the input section functions as a differential amplifier to make the operation stable and suitable frequency response by the negative feedback network, R152 and R149. The power amplification circuit is the complementary SEPP circuit with the Darlington connection of Q119, Q120 and Q121, Q122, and drives the speaker with AF output of more than 500mV at 8 Ohms load.

In addition, in case of the power source voltage is more than 10V, D106 and Q106 (voltage regulator) stabilize the power supplied, limit the output power and make the bias stable.

3 - 1 - 7 SQUELCH CIRCUITS

Noise components from pin 9 of IC201 are fed to active filter IC101B through SQUELCH control, R126.

This active filter is a bypass filter, amplifying approx. 20KHz noise components. The noise components are rectified by D103 and converting to DC voltage at R120, C112, R119 and C111.

By this voltage through two inverters of IC103A and IC103B, Q105 AF amplifier is controlled to turn ON and OFF.

The output signals from pin 2 of IC103A are fed to MPU through D104.

In case that noise detection output voltage from D103 is high when no signal is received, pin 2 of IC103A becomes "HIGH", resulting in Q105 being OFF to cut off the AF output.

In the transmit mode, HIGH level voltage is applied to pin 9 of IC103B through D105, accordingly, pin 2 of IC103A is put to "HIGH" making Q105 OFF.

3 - 2 TRANSMITTER CIRCUITS

3 - 2 - 1 MIC AMPLIFIER CIRCUITS

Audio signals from the microphone are fed to the limiter amplifier, consisting of Q101, Q102, Q103 and Q104, which performs 6dB/octave pre-emphasis response between 300Hz and 3KHz.

The input of the limiter amplifier is a differential amplifier so that the output waveform of the limiter may be symmetrical. The output of the limiter amplifier is similar to rectangular waveform and includes harmonic components. Harmonic components of higher than 3KHz are attenuated by IC101A splatter filter, then they are fed to VCO to perform FM modulation.

3 - 2 - 2 MULTIPLIER AND DRIVER CIRCUITS

The 144MHz transmit frequency is generated by the VCO (Q211) and is buffered and amplified at Q208. And then it is amplified at Q209, and up to 150mW in a wide-band amplifier, Q210.

Due to the supply of the voltage from the APC circuit (described later) to the controller of Q210, the output power of Q210 can be reduced.

3 - 2 - 3 POWER AMPLIFIER CIRCUITS

IC203 is a small-sized power module giving a stable output power of more than 5W between 144MHz and 148MHz with the driving power of 150mW from Q210.

The driving signals from Q210 are fed to pin 1 of IC203, amplified to approx. 5W at 13.2V and output from pin 4.

In the transmit mode, Q215, D208 and D209 in the T/R switching circuit are turned ON, and L212 and C256 become a parallel resonance circuit. The output power from pin 4 of IC204 are fed to the antenna terminal through L210, D208 and C257, the low-pass filter, to reduce harmonic spurious radiation.

Q207 controls the bias voltage of Q209, Q210 and IC204 to prevent unwanted emission when switching from the receive mode to the transmit mode, or when PLL being unlocked due to possible failure.

3-2-4 APC AND POWER SET CIRCUITS

L210, C248, C250, C251, C252, C253, C254, D206 and D207 are the antenna mismatching detection circuit. When the antenna impedance is matched at 50 Ohms, voltage detected at D206 and D207 have a minimum value. However, when the antenna output is mismatched condition, the detected voltage becomes higher than the one in the matched condition.

Q216 and Q217 are the differential amplifier circuit. On the base of Q217, the bias voltage determined by R266, R267 and R265 are applied.

The voltage detected at D206 and D207 are combined by R239 and R240, and fed to the base of Q216.

If a mismatched condition occurs, the voltage at Q216 base will be higher than the one at Q217 base, Q216 collector current and Q214 base current will be reduced, resulting in the decrease of Q214 collector current. Accordingly, Q213 base current, namely, Q210 collector current is decreased.

As the result, Q210 output power is decreased, and that of IC204 is also reduced until the base voltage of Q216 becomes the same as the base voltage of Q217.

In a matched condition, the "HIGH" output power is determined by the value of R267. When the power switch in the "LOW" position, the series combination of R268 and R269 are connected in parallel with R265. R269 may then be used to set the low power.

The output voltages detected at D206 and D207 are taken out through R241 and connected to the comparator circuit (stated later) together with the detection output from the S-meter circuit.

3-3 PLL (Phase Locked Loop) CIRCUITS

PLL is so designed that the desired frequency is generated directly by the VCO, adopting the dual modulus pre-scaler system.

The PLL is composed of the pre-scaler, IC202 and PLL IC, IC203 and fed "divided by N" DATA from the MPU to decide the operation frequency.

N-DATA is number of times desired frequency is divided (the transmitting frequency in the transmit mode and the first local oscillator frequency in the receive mode) by the reference frequency.

$$N = \frac{\text{Desired frequency}}{\text{Reference frequency}}$$

The reference frequency of 5KHz is obtained by oscillator Q212 (crystal X203) and dividing the frequency with IC203.

The signals from the VCO, that are buffer-amplified at Q208, are divided "N" times at IC202 and IC203. The signals inside IC203 are phase-detected and detected signal is put out from pin 11 of IC203.

The output signals are applied to the varactor diodes D211 and D212 of the VCO through the loop filter to control the VCO frequency.

Due to a no multiplying and mixing circuitry, the circuit constitution is simple and leads a feature of less spurious.

3 - 3 - 1 DUAL MODULUS PRE-SCALER

IC202 is a dual modulus pre-scaler, that divides the signals from 127MHz to 151MHz generated by the VCO by either 1/64 or 1/65.

IC203 is a C-MOS LSI for use PLL in a frequency synthesizer. It incorporates a swallow-counter of binary 6 bits, a programmable counter of binary 11 bits, a phase comparator, a charge pump and a frequency divider for the reference frequency.

The reference frequency is obtained by crystal oscillator Q212 with crystal unit X203, and is fed to pin 17 of IC203. It divides the frequency by 1/1024, the reference frequency becomes 5KHz and is fed to pin 8 of IC203.

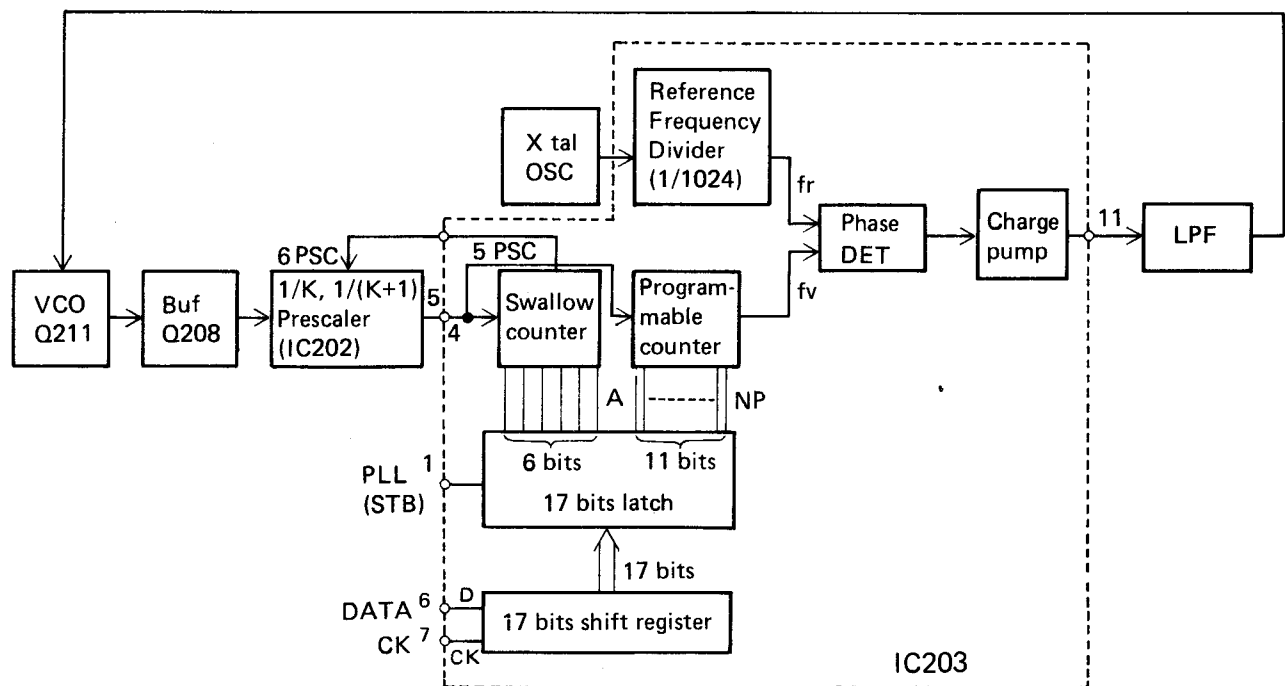


Fig. 3-1 Dual Modulus Prescaler System

3 - 3 - 2 UNLOCK CIRCUITS

When the PLL is unlocked, pin 10 of IC203 will be "LOW" level and the unlocked signal is fed to pin 8 of IC102A through the time constant circuit R254 and C283. As R+5V is applied to pin 9 of IC102A,

pin 10 of IC102A will be "HIGH" level in the receive mode. Due to pin 9 of IC102A being "LOW" in the transmit mode, pin 10 will be "LOW" when pin 8 is in "LOW" level, resulting in feeding to the MPU information that PLL has been unlocked to prevent unwanted signals are transmitted.

3 - 3 - 3 LOOP FILTER, VCO, MODULATION CIRCUITS

The output from pin 11 of IC203 determines the characteristics of PLL through the lag-lead type loop filter consisting of R253, R252 and C282, and controls varactor diodes D211 and D212 through the integrator circuit R249 and C273.

The VCO, Q211, employs Clapp oscillator circuit. By shunting C276 and C275 in receive mode. The VCO free-run frequency is shifted lower from one in the transmit mode. Thus a stable oscillation can be achieved over the wide range frequency.

In the transmit mode, the frequency shift is turned OFF as TS5 is at 5V and RS5 is at 0V, thus D214 is turned off. Accordingly, C275 and C276 are connected in series with L218, thus the free-run frequency will be higher.

In the transmit mode, D214 is reverse biased. When modulation signals are applied on the anode, the capacitance between D214's terminals is changed and performs frequency modulation.

The deviation is adjusted by changing the modulation signal level with R243.

3 - 4 POWER SUPPLY CIRCUITS

3 - 4 - 1 INTERNAL/EXTERNAL POWER SWITCHING CIRCUIT

When using a battery pack, RL101 is OFF and the power switch is connected to the battery pack. When a power source having 10–16V is connected to the external power terminal (EXT), RL101 will be ON and the power switch will be connected to the external power source.

In case of the erroneous connection to the external power terminal with reverse polarity, D117 will be reversely biased, preventing in RL101 being ON to protect the transceiver.

3 - 4 - 2 VOLTAGE REGULATOR CIRCUITS

In the voltage regulator circuit, a C-MOS three-terminal regulator IC104 is utilized, so that the output voltage is kept 5V constantly even with the input voltage from 5.1V to 16V.

Noise components are eliminated from the output of IC104 through filter circuit R165 and C138. The outputs after noise components have been eliminated are fed to the current amplifier circuit consisting of Q130 and Q129.

Q129 and Q130 are connected in a complementary circuit to acquire a higher current amplification factor. Accordingly, the base voltage of Q130 is nearly equal to the output voltage of IC104. Also, the collector voltage of Q29 is approx. 5V. As the temperature coefficient of the junction voltage of D114 are nearly equal to VBE of Q130, the output voltage is kept constant against any change in temperature.

The regulated 5V at Q129 collector is fed to common circuits through Q114 and Q115 current amplifier circuits and also fed to the transmit/receive switching circuits of Q108 and Q109.

In the receive mode, pin 3 of IC102 is "LOW" level, Q108 is turned ON to feed RS5, and also R+5 through Q110, Q111 current amplifier circuits. At this time, Q109 will be OFF.

In the transmit mode, pin 3 of IC102 is "HIGH" level which pin 4 of IC103 is "LOW" level, resulting Q108 is turned OFF and Q109 ON. Thus, Q109 feeds TS5 and T+5 through current amplifiers Q112 and Q113.

3 - 4 - 3 POWER SOURCE CIRCUIT FOR COMPUTER

MPU includes memory elements to memory operating frequency, memory channels, etc. Usually memories will be erased when the power source of the MPU fails. In order to avoid this, the memory unit has an internal lithium battery for memory backup when the power source is turned OFF.

Due to higher resistances of R161, R162 and R163, power consumption in this circuit is very little and the battery can back up the memories for approx. four years.

3 - 4 - 4 VOX POWER SOURCE CIRCUITS

This is a current limiter to supply a voltage to the external VOX unit, HS-10SA. Current drain of up to 5mA is acceptable.

In the case of a normal load current, the voltage drop through R271 is small, approx. 5V is fed to the VOX unit. The increase of load current leads to the increase of the voltage drop at R271. When the voltage, which is obtained by adding the voltage between emitter and base of Q218 to it, is equal to the voltage between R272 and D216 cathode, the load current is limited.

3 - 5 COMPARATOR, REDUCED VOLTAGE DETECTION CIRCUITS

3 - 5 - 1 COMPARATOR CIRCUIT

The voltage detected in the S-meter circuits and APC circuits are input to pin 3 of IC105A. Moreover, D/A signals are fed to pin 2 of IC105A.

The voltage of D/A signals is divided at R166 and is changed at 16 steps between 0.12V and 1.258V by providing bias at R167.

When the voltage at pin 2 of IC105A is less than that at pin 3, the output at pin 1 is "HIGH" level. When the voltage at pin 2 is higher and exceeds that at pin 3, pin 1 will be in "LOW" and the voltage is fed into the MPU.

In the MPU, depending on the condition of the D/A, S is indicated in the receive mode and RF-output in the transmit mode.

3 - 5 - 2 REDUCED VOLTAGE DETECTING CIRCUITS

The reduced voltage detecting circuits are composed of IC105B, R168, R169, R170 and R171.

The regulated 5V is divided at R168 and R169, by which the voltage of approx. 1.03V is applied to pin 6 of IC105B. The voltage of Vcc is divided by R170 and R171 which is applied to pin 5. The voltage division ratio is selected so that the voltage at pin 5 is 1.03V when Vcc is approx. 5.6V.

If Vcc is greater than 5.6V, the voltage at pin 5 of IC105B will be higher than that at pin 6, resulting pin 7 is "HIGH" level. If the Vcc voltage decreases to less than 5.6V, the voltage at pin 5 will be less than that at pin 6 and the output voltage at pin 7 and the output of IC105B will be "LOW". This information is fed to the MPU causing the BATTERY CONDITION indicator to come "ON".

3 - 6 LOGIC CIRCUITS

The main part of the LOGIC CIRCUIT is a one-chip microcomputer IC401, which includes 2K word ROM, 128 word pattern ROM, 160 bit RAM and a circuit to drive the LCD (liquid crystal display).

Here is the explanation of operation mainly in connection with respective I/O ports.

3 - 6 - 1 D0 (Pin 78) SEND

This is an input port and is pulled up inside the MPU.

When this input is "LOW" level, transmit mode is selected and input from KEY entry is inhibited. At each leading edge and trail edge, the MPU puts out frequency control data, CTCSS and/or DTMF data, and makes MUTE processing.

3 - 6 - 2 D1 (Pin 79) MUTE

This is an output port and will be the "HIGH" level for approx. 60 milliseconds when changing from receive to transmit.

If the transmit frequency will be OUT OF BAND in the DUPLEX mode, it remains at the LOW level.

3 - 6 - 3 D2 (Pin 80) CK

This pin outputs clock pulses for serial data transferring in synchronously with N-data for the PLL and data for the CTCSS encoder.

These serial data are converted into parallel data with shift registers respectively. The shift registers shift the data respectively at each leading edge of the clock pulses.

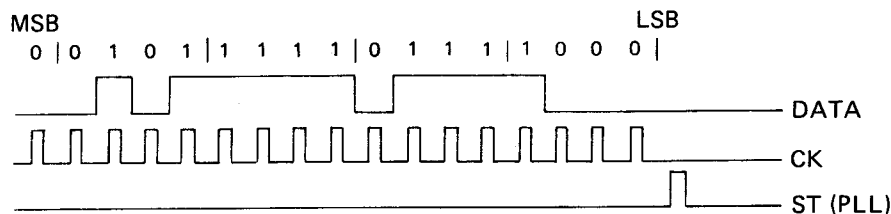
3 - 6 - 4 D3 (Pin 1) DATA

This is an output port, where the PLL N-data and CTCSS encoder data are output serially.

The serial transfer begins with the most significant bit (MSB) and ends with the least significant bit (LSB).

N-data for PLL are transferred in binary code.

For 144MHz, 5F78H (Hexadecimal of $144,000 \div 5 = 28,800$) is put out.



CTCSS encoder data are transferred in binary code after the N-data for PLL.

3 - 6 - 5 D4 (Pin 2) COMP

This is an input port and is pulled up inside the MPU. When this pin becomes "LOW" level, the MPU sends the count number of output at the R3-port to the LCD to indicate the S/Rf indicator.

3 - 6 - 6 D5 (Pin 3) UNLOCK

This is an input port and is pulled up inside the MPU. This becomes active at "LOW" level and the MPU makes D1-port "LOW". Further, this causes the LCD flashing to indicate the PLL is unlocked.

3 - 6 - 7 D6 (Pin 4) PLL

This is an output port and puts out a strobe pulse after the PLL N-data have been transferred. The PLL IC reads the N-data from the shift register (inside the PLL IC) at the leading edge and latches them at the trail edge of this pulse.

3 - 6 - 8 D7 (Pin 5) CTCSS

This is an output port and puts out a strobe pulse after the CTCSS encoder data have been transferred.

The latch buffers (inside the shift register IC) read the data at the leading edge and latch them at the trail edge respectively, then the latched data are fed to the CTCSS encoder IC.

3 - 6 - 9 D8 (Pin 6) SQL

This is an input port and is pulled up inside the MPU. When this pin becomes "LOW" level, the MPU functions to indicate one dot (actually it looks like two dots) at the left end of the LCD S/RF indicator. At the same time the MPU stops the program scan or memory scan if any.

3 - 6 - 10 D9 (Pin 7) HALT CONT

This is an output port and becomes "LOW" level for a moment to store the program execution address of the MPU when the set is turned off. The address is used later when the set is turned on again.

3 - 6 - 11 D11 (Pin 8) BEEP

This is an output port and puts out a "HIGH" level pulse of approx. 40 milliseconds after a key has been entered. The pulse controls the BEEP tone oscillator on the main unit.

3 - 6 - 12 D11 (Pin 9) FUNC

This is an input port and is pulled up inside the MPU.

When the function key is depressed, this pin becomes "LOW" level, and the secondary functions of the key pad can be selected.

3 - 6 - 13 D12 ~ D15 (Pins 10 ~ 13) KEY SCAN

This is an output port consisting of four lines and each terminal is open drain. These lines are connected to the columns of the key pad, and each line is turned on sequentially to find pushed key.

3 - 6 - 14 R0 (Pins 14 ~ 17) KEY RETURN

This is an input port consisting of four lines and each line is pulled up by R414 to R417 respectively. Each line is active low, and finds which key has been pushed.

3 - 6 - 15 R1 (Pins 66 ~ 69) INITIAL KEY RETURN

This is an input port consisting of four lines and each terminal is pulled up. Each line is active low, and reads the preset specifications such as frequency range, frequency steps, etc, when the MPU is initialized.

3 - 6 - 16 R2 (Pins 70 ~ 73) INITIAL KEY SCAN

This is an output port consisting of four lines and each terminal is open drain. These lines are connected to the matrix circuit which presets specifications such as frequency range, frequency steps, etc., and each line is turned on sequentially to read the matrix.

3 - 6 - 17 R3 (Pins 74 ~ 77) D/A

This is an output port consisting of four lines and puts out loop counter number in hexadecimal. The number is increased every time when the program of the MPU has executed the main routine. When the COMP terminal becomes LOW level, the counter is cleared and starts to count again.

This output is converted a DC voltage by the D/A converter consisting of R409 ~ R412. This voltage is compared with the S-meter voltage or RF-meter voltage. When this voltage becomes higher than the S-meter or RF-meter voltage the COMP terminal becomes LOW.

3 - 6 - 18 INT 0 (Pin 64) POWER DOWN

This is an input port and is pulled up by R405 and R406 outside the MPU.

This is active low. When the set is turned off or the power supply voltage goes down, the MPU makes backup procedure, then the HALT CONT terminal is set HIGH level and the MPU is set in HALT state.

3 - 6 - 19 INT 1 (Pin 65) BAT

This is an input port and is pulled up inside the MPU and is active low. When the battery voltage becomes less than the normal one, this terminal becomes LOW level and the "▽" battery condition indicator is displayed on the LCD.

3 - 6 - 20 PRESET (Pin 18)

This is a terminal for the MPU resetting and is pulled down by R421.

This is active high. The MPU is reset by pushing S102 (Reset switch) on the MAIN unit, during the power switch is ON.

3 - 6 - 21 COM 1 – 2 SEG 1 – 32 (Pins 27 ~ 62)

These are output terminals for driving the LCD and the segments on the LCD are displayed with 1/2 bias and 1/2 duty conditions.

LCD is driven at 3V. The bias voltage is generated with the dividing resistors consisting of R418, R419 and R404, resistor between Vcc and V1, and resistor between V2 and V3 inside the MPU.

3 - 6 - 22 OSC1, OSC2 (Pin 20 and 21)

These are terminals for the MPU clock oscillator and clock frequency is determined with R413 at approx. 200KHz.

3 - 7 OTHER CIRCUITS

3 - 7 - 1 LAMP CIRCUIT

The lamp circuit consists of Q131, D115, D116 etc. and drives the lamp at the constant current so that the brightness is not changed with different power supply voltage (Vcc).

When S106 is pushed ON, the current flows into R173, resulting in Q131 base voltage being approx. Vcc–1.2V as determined by D115 and D116. Accordingly, the emitter voltage of Q131 will be Vcc–0.6V and the voltage at the both ends of R172 is kept constant, resulting in acquiring the constant current even with a change of Vcc.

3 - 7 - 2 BEEP CIRCUIT

This is a phase shift oscillator, consisting of IC103F, R155, R156, R157, C131, C132, and C134, and oscillates when a "HIGH" level voltage is applied to the cathode of D113. The oscillating frequency is set at approx. 2500Hz.

3 - 7 - 3 TRANSMIT/RECEIVE SWITCHING CIRCUIT

When S101 is pushed ON, Q107 will be turned ON and pin 13 of IC103C and pin 1 of IC102 will be at HIGH level. Then pin 3 of IC102C will be "HIGH" level. Thus Q108 is turned OFF and Q109 is turned ON, and T+5 and TS5 lines become 5V, and R+5 and RS5 lines 0V. Further, as pin 19 of IC103C is at LOW level. "Transmit mode" is informed to the MPU through D107.

Pin 4 of IC102B will be LOW approx. 20ms after S101 has been pushed caused by R138 and C122 time constant. The MUTE signal from the MPU remains "HIGH" for approx. 60ms. Accordingly, pin 11 of IC102D will be "LOW" approx. 60ms after the S101 has been pushed, resulting Q207 is turned ON and the set transmits signals.

When S101 is released, Q107 is turned OFF and at the same time pin 13 of IC103C and pin 1 of IC102C will become LOW.

Pin 3 of IC102C will become LOW approx. 20ms later caused by R138 and C122 time constant, and Q108 is turned ON and Q109 is turned ON. Thus the R+5 and RS5 lines become 5V, and T+5 and TS5 line 0V. Further, pin 12 of IC103C will be "HIGH" to inform that the set is receive mode to the MPU. Almost at the same time, pin 11 of IC102D will be "HIGH" to turn Q207 OFF.

3 - 7 - 4 TONE UNIT (IC-02AT only)

DTMF encorder and a CTCSS encoder are both incorporated in the tone circuit board to control the repeater system.

– DTMF ENCODER –

IC105, DTMF encoder, generates the tone signals matched to DTMF telephone dialing tones. While transmitting, Q505 will be turned ON, applying the voltage on IC501.

At this time, when there is any input from the keypad, the proper frequency dividing ratio which is dividing X501 (3.58MHz) is selected to output one set of audio frequencies, corresponding to ROW input and COL input, from pin 16.

Further, a "HIGH" level is applied from pin 10 when the keypad is actuated. This level has a time constant (approx. 1sec) to turn Q506 ON for approx. one second. Thus key entries can be enable without holding the PTT switch down.

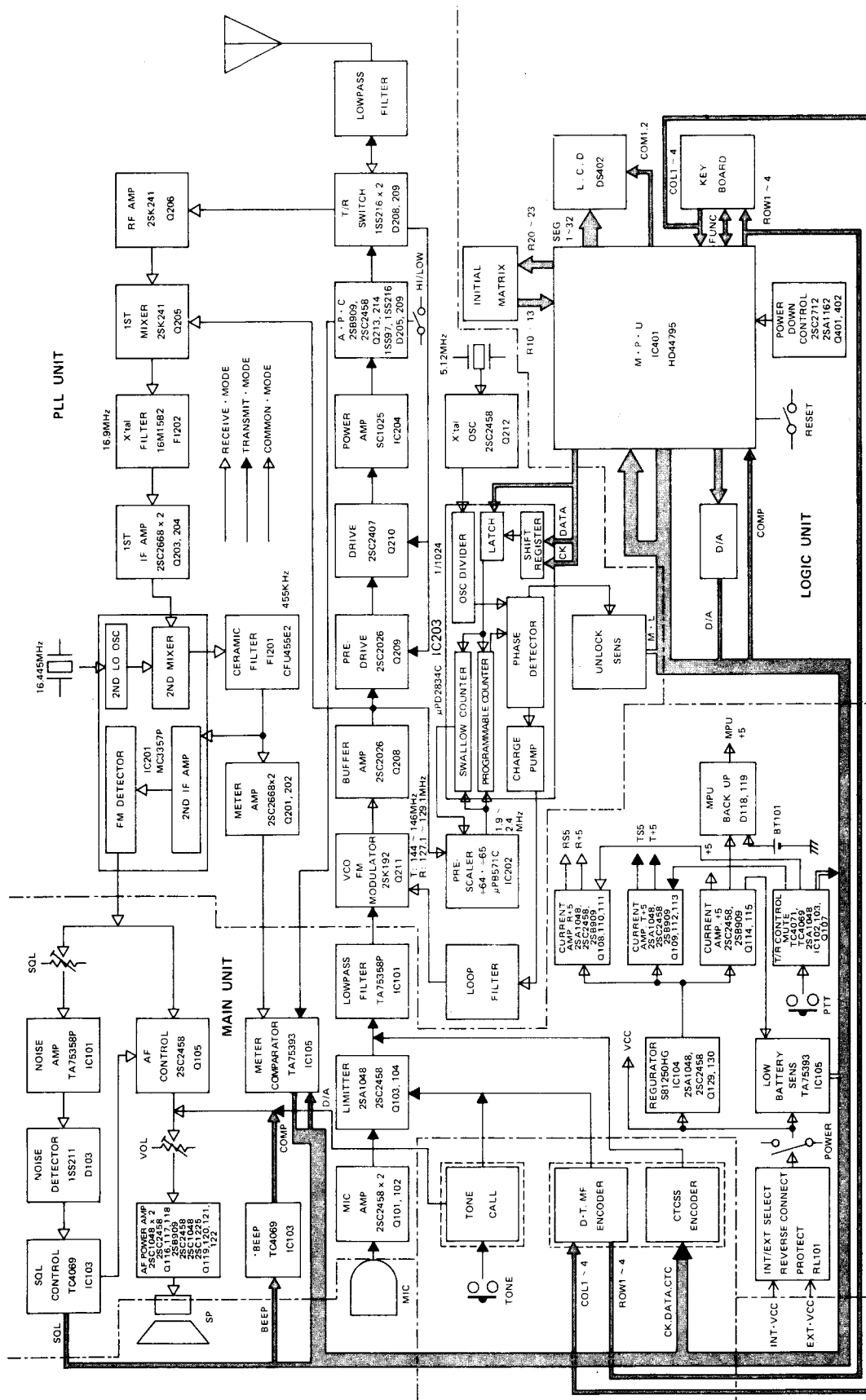
– CTCSS ENCODER –

When a tone number is set, data is sent to IC502 from the MPU. IC502 carries out serial/parallel conversion data from the MPU and feeds it to IC503. IC503 divides the frequency of X502 (3.579545 MHz) corresponding to data, and is output from pin 1.

3 - 7 - 5 TONE CALL UNIT (IC-02E only)

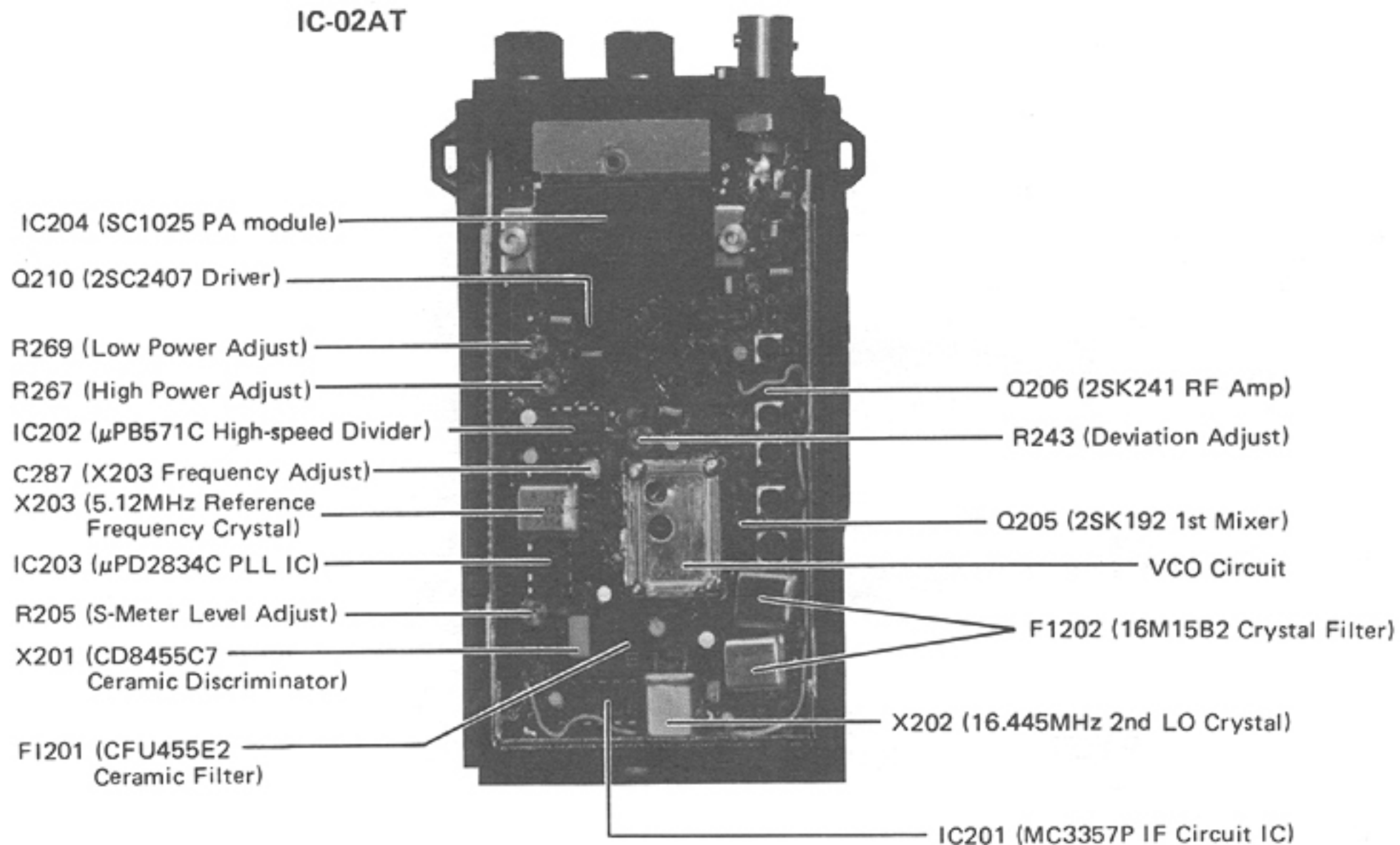
The tone call generates the tone of 1750Hz used in duplex transmit (repeater operation). When TONE-BURST switch is being depressed, Q601 is turned ON and the voltage is applied to IC601. IC601 divides the frequency of 7.1680MHz by 1/4096 to output 1750Hz tone from pin 4.

SECTION 4 BLOCK DIAGRAM

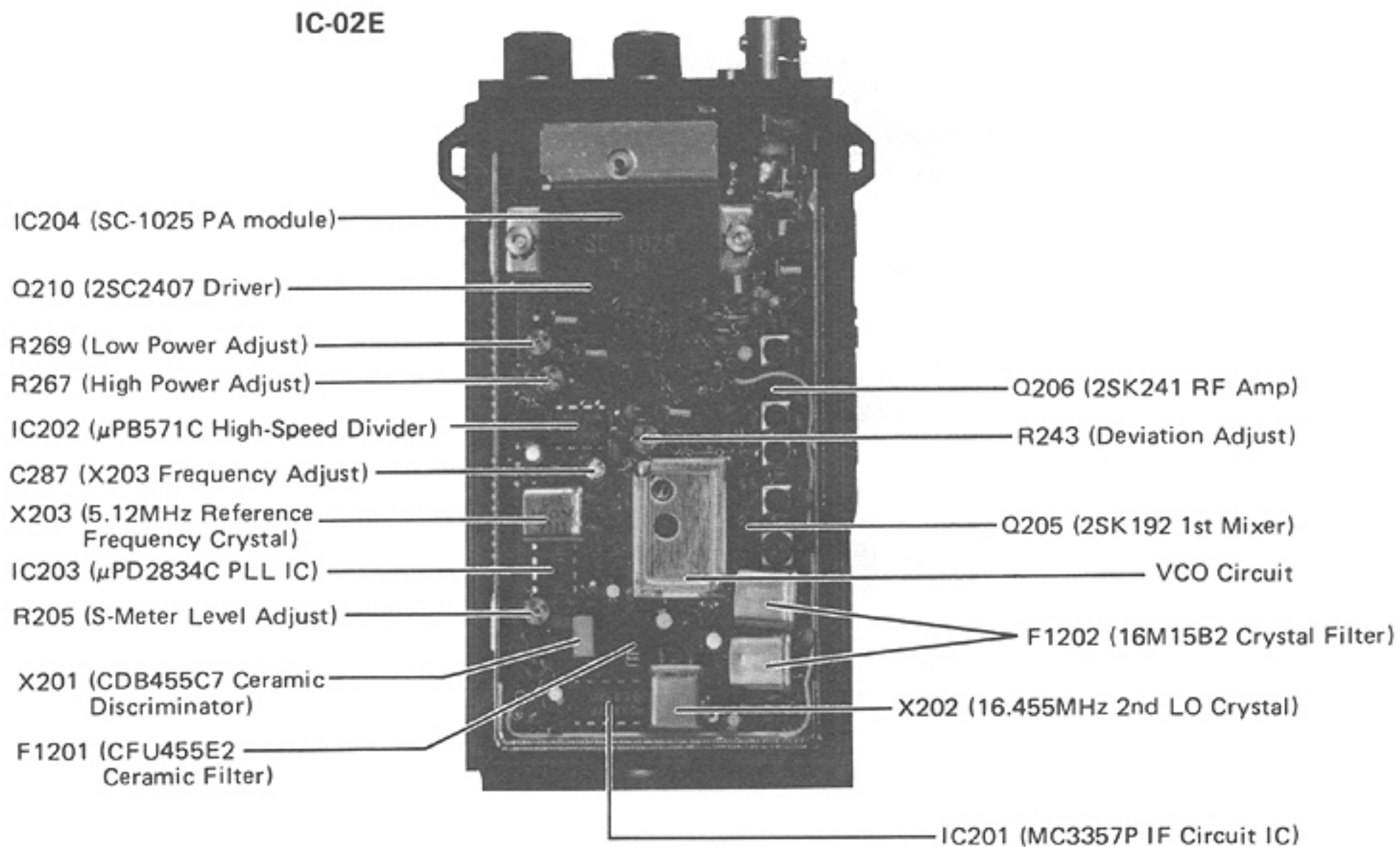


SECTION 5 INSIDE VIEWS

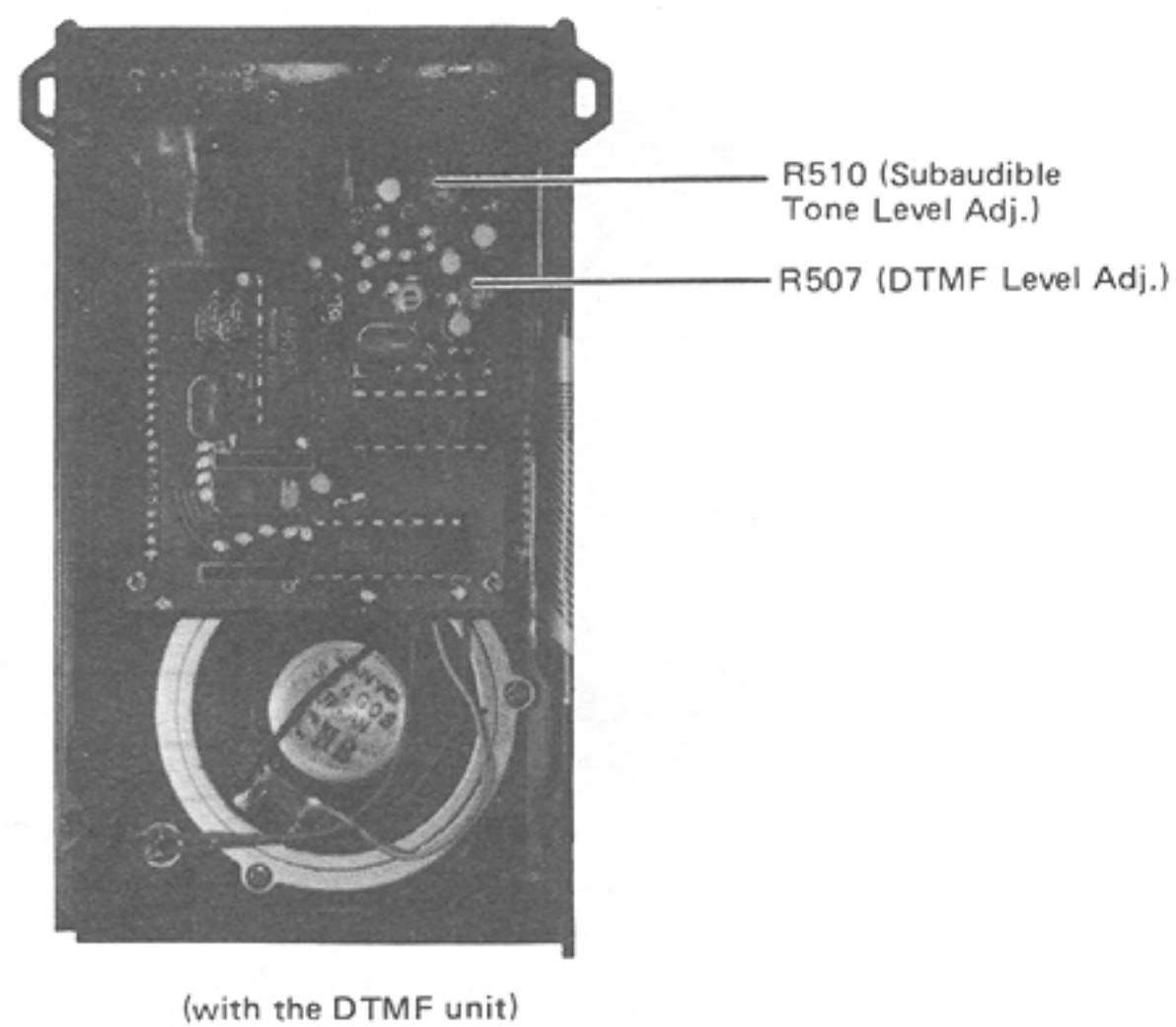
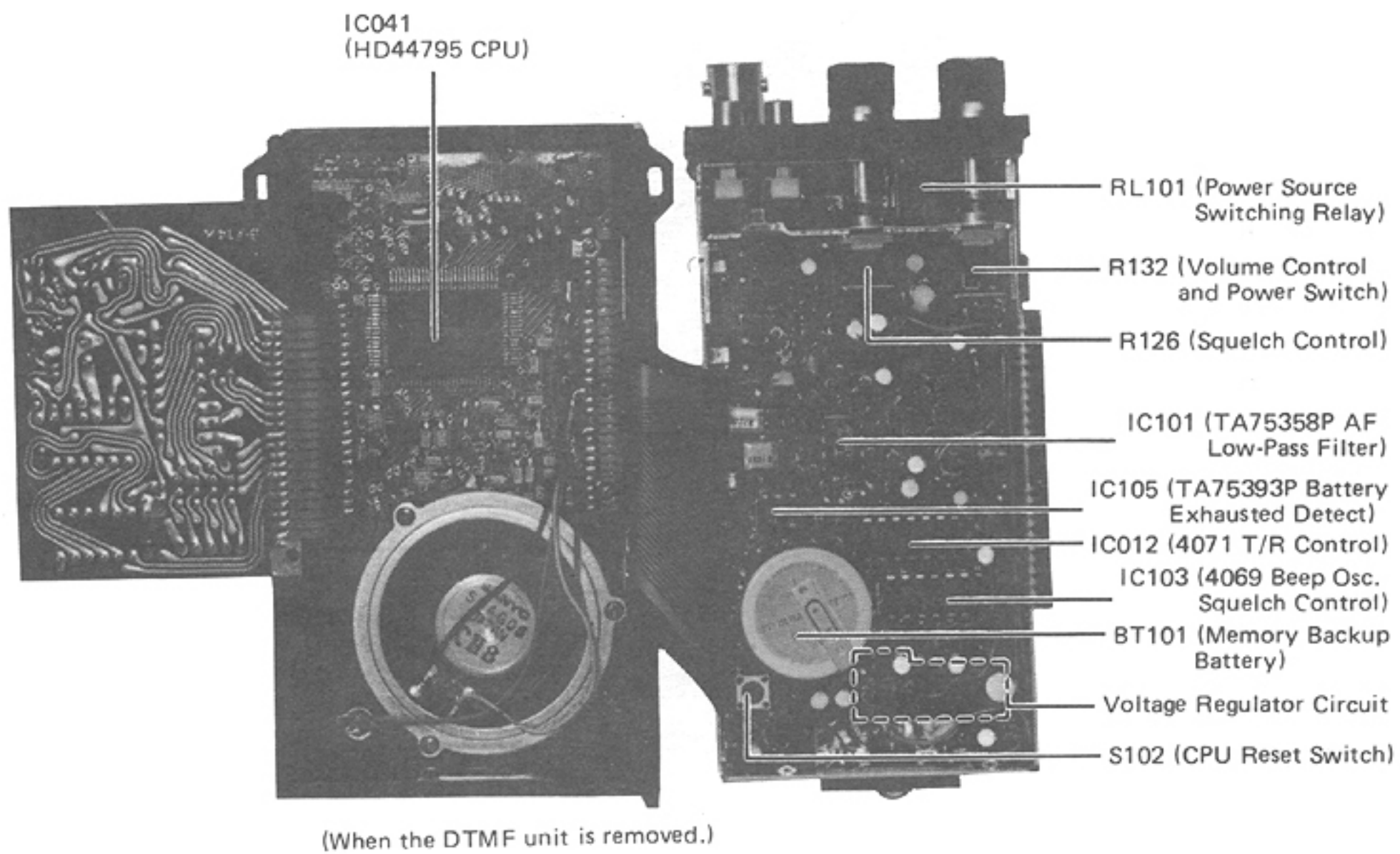
IC-02AT



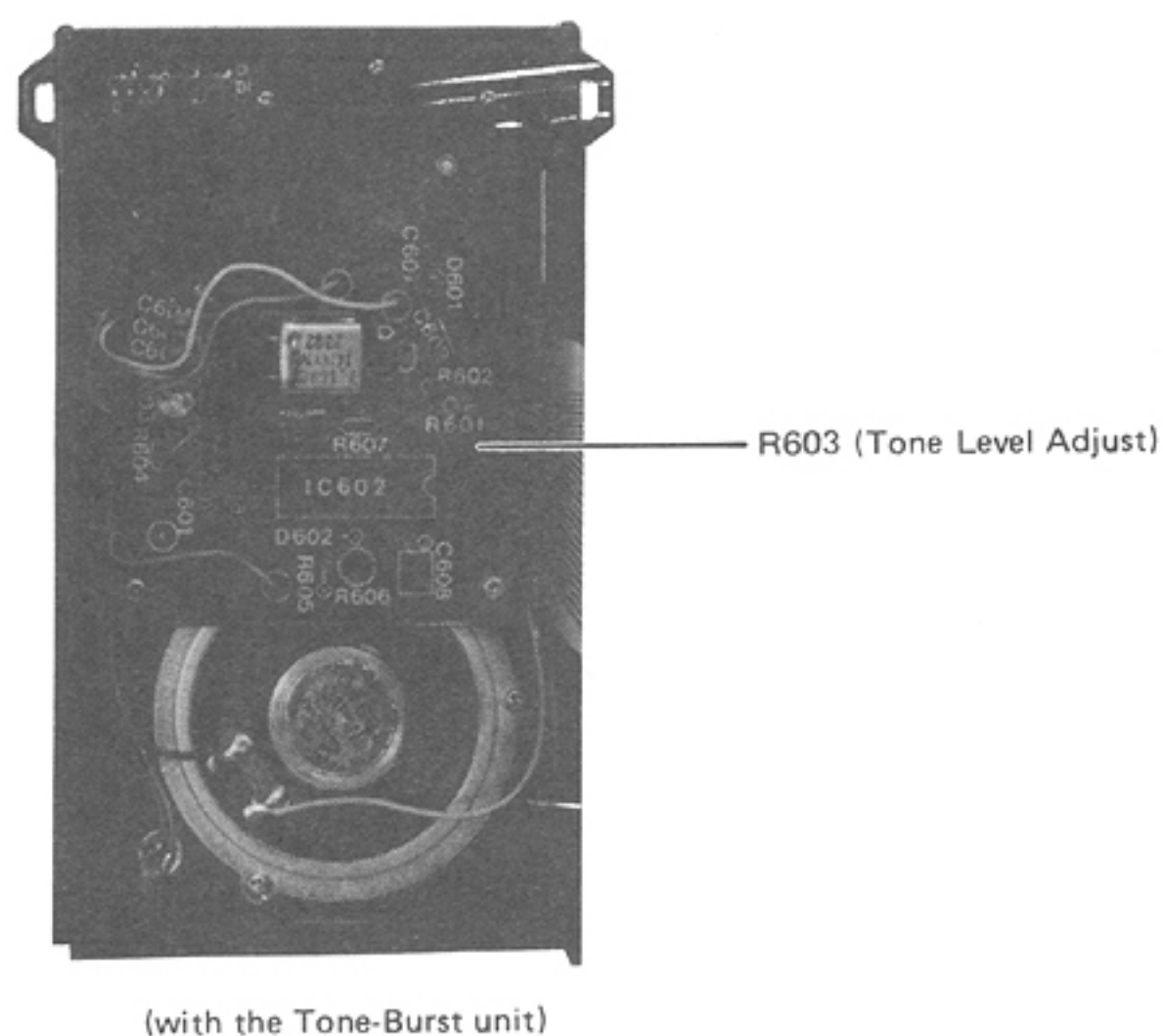
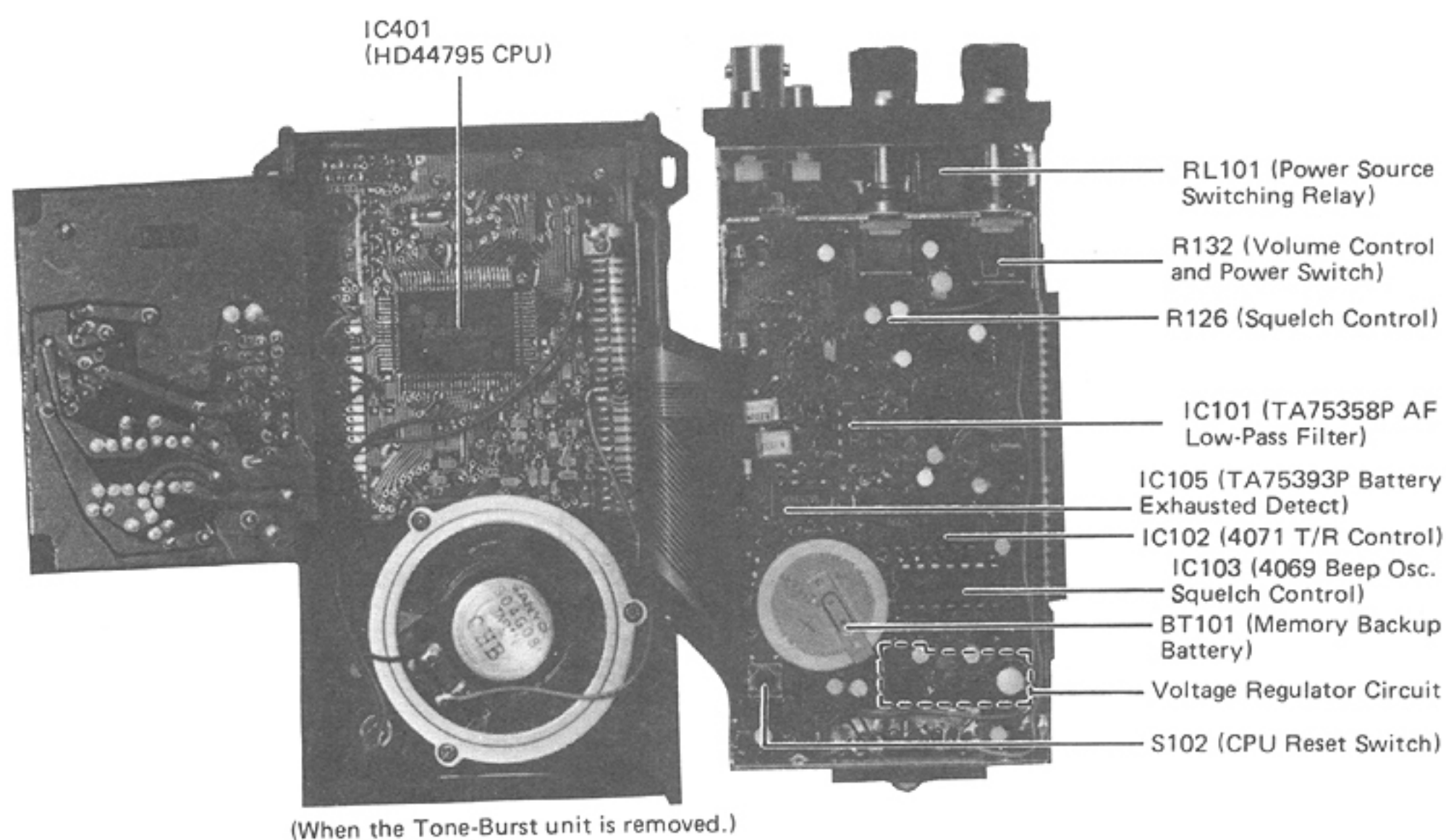
IC-02E



IC-02AT



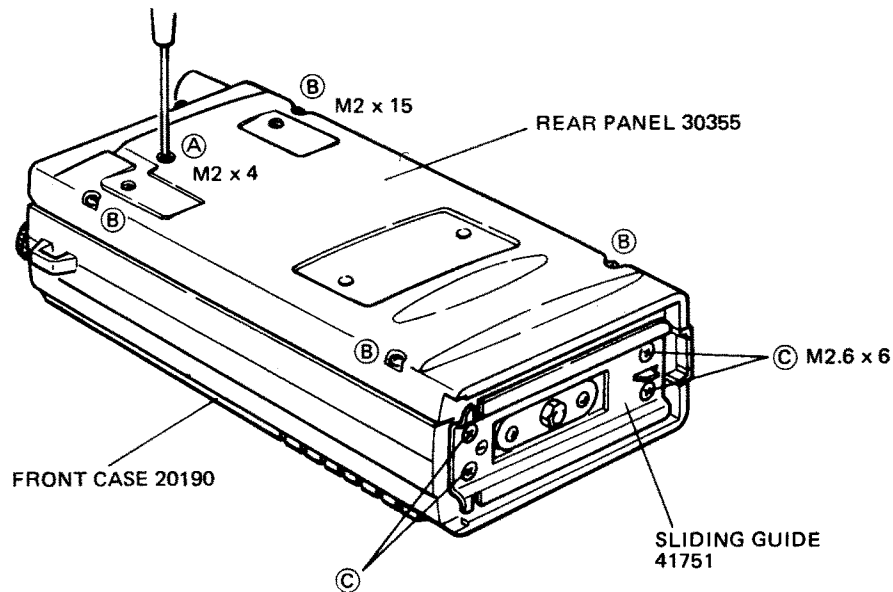
IC-02E



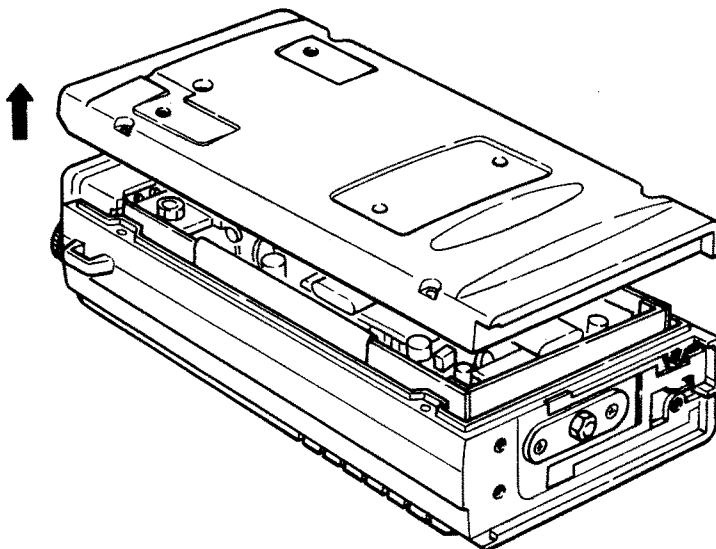
SECTION 6 MECHANICAL PARTS AND DISASSEMBLY

6 - 1 DISASSEMBLY OF THE CASES

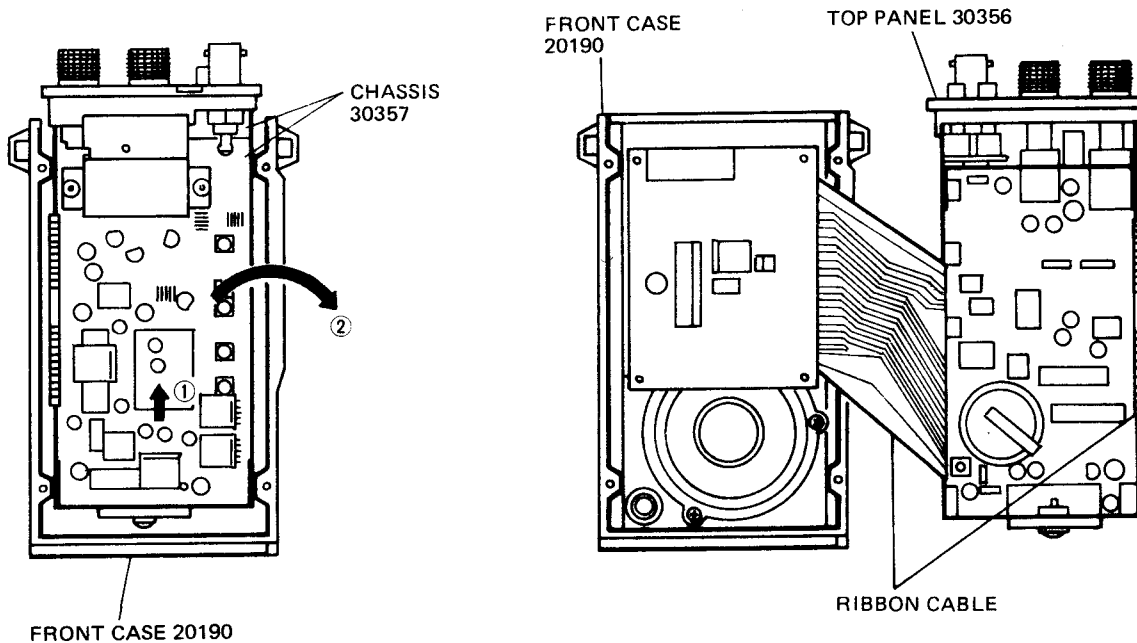
1. Turn the power switch off and remove the power pack.
2. Remove a screw (A) and four screws (B) on the rear panel and four screws (C) on the bottom as shown in the figure.



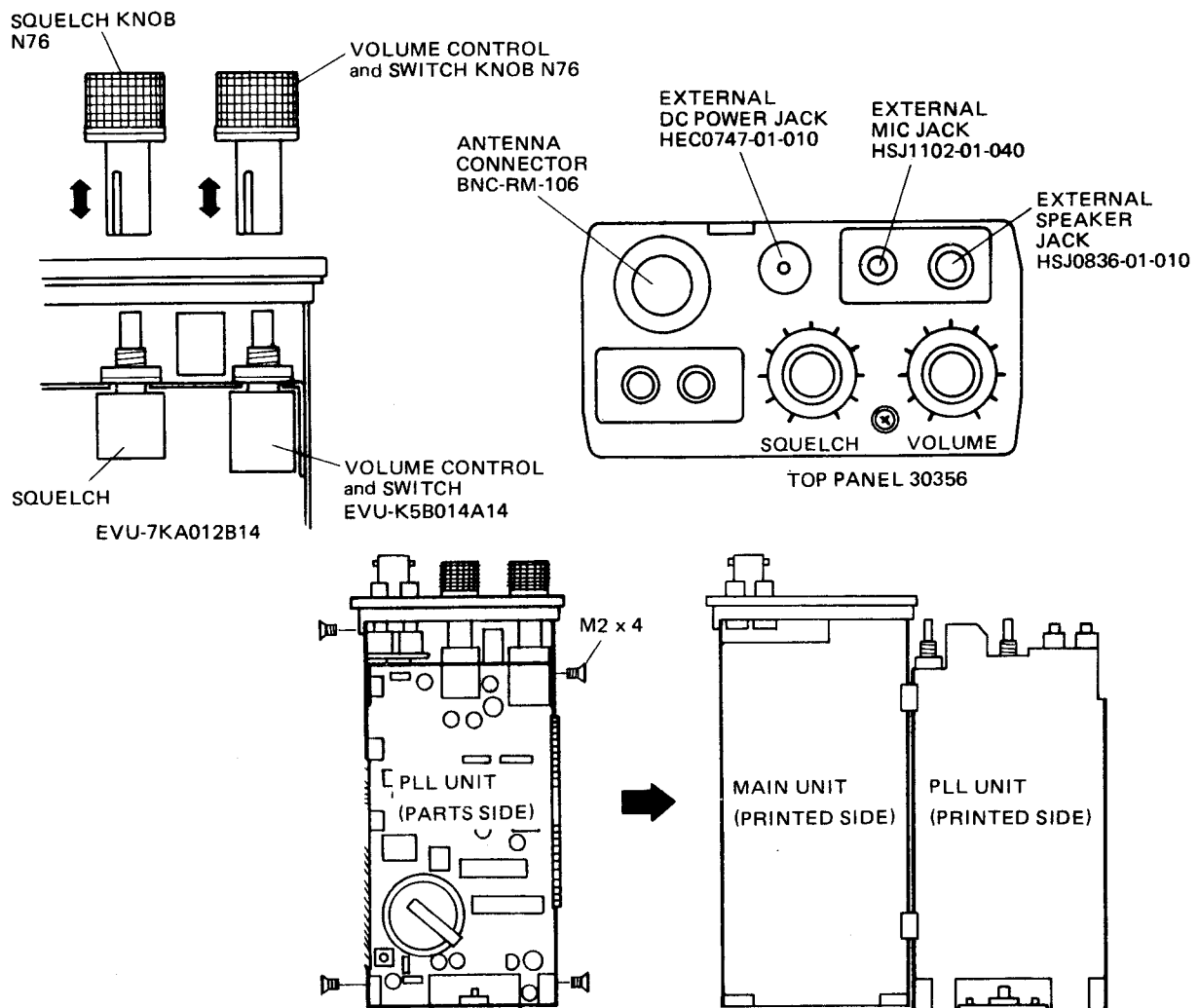
3. Remove the rear panel as shown in the figure.



- Slide the inner frame upward slightly as shown in the figure, and turn it clockwise. At this time, be sure not to damage the ribbon cable.



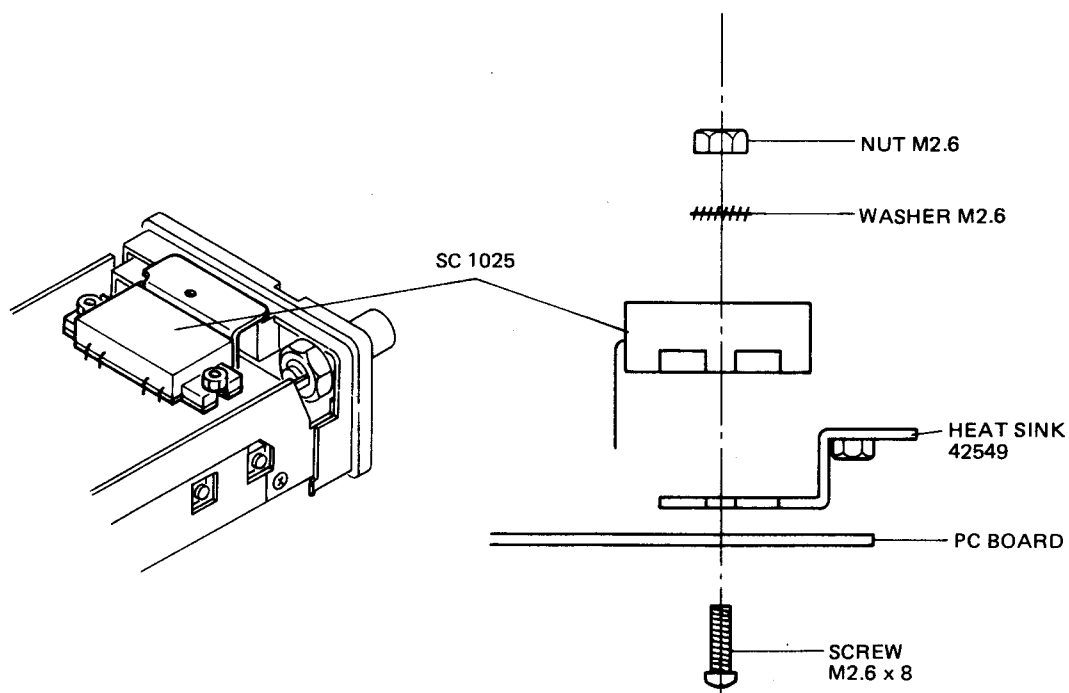
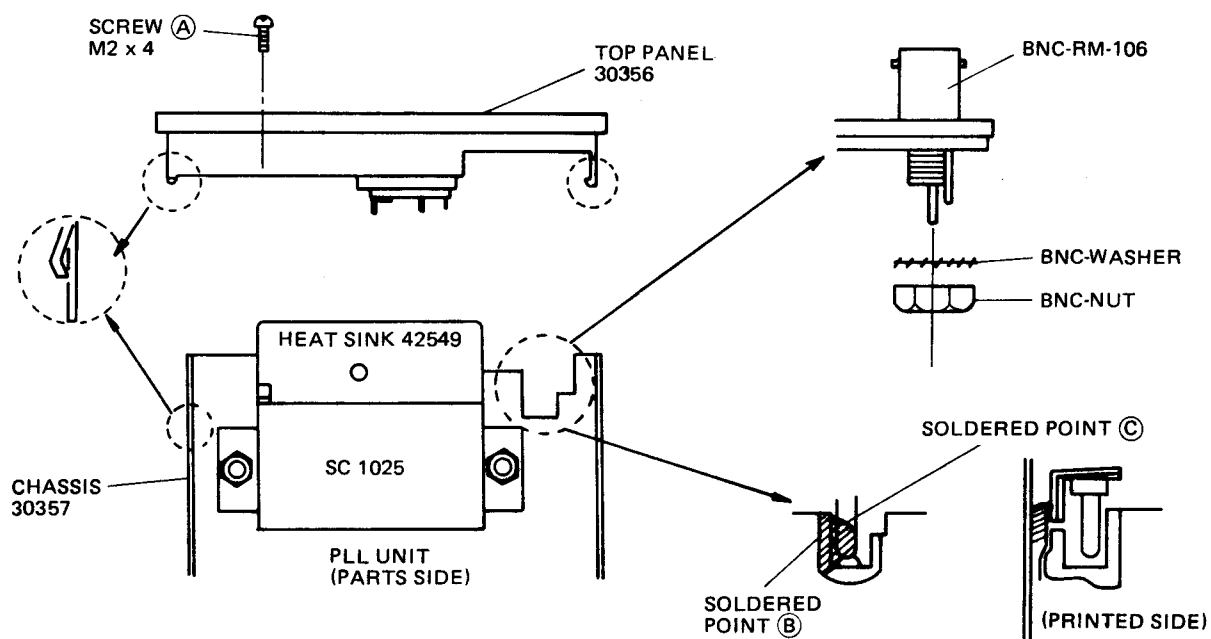
- To see the printed sides of the MAIN and PLL boards, remove the SQUELCH knob and VOLUME CONTROL and POWER SWITCH knob, then remove the four screws on the sides of the inner frame.



6 - 2 DISASSEMBLY OF THE TOP PANEL

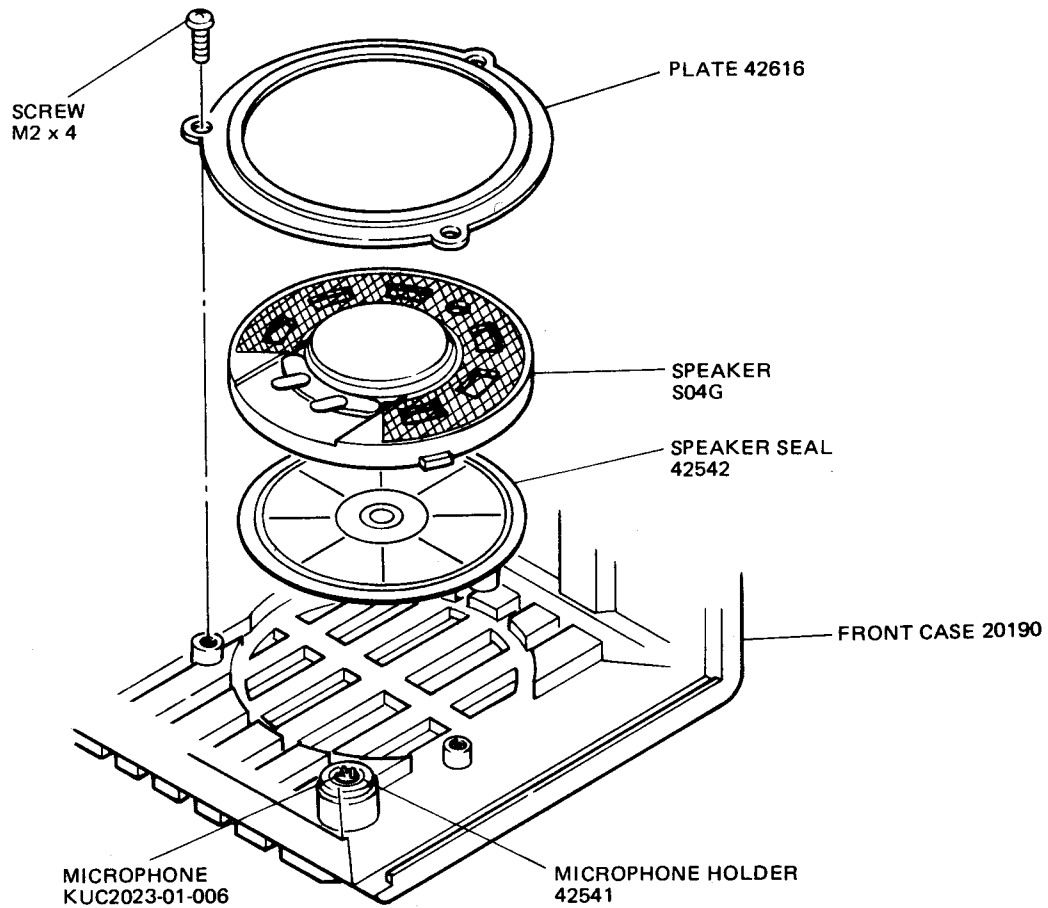
Remove the screw (A)

1. Remove the BNC-NUT and the BNC-WASHER.
2. Remove the BNC-RM by desoldering point (B) on the parts side and point (C) on the printed side of the PLL board.
3. Remove the TOP PANEL by slightly opening the both sides of the TOP PANEL edges.



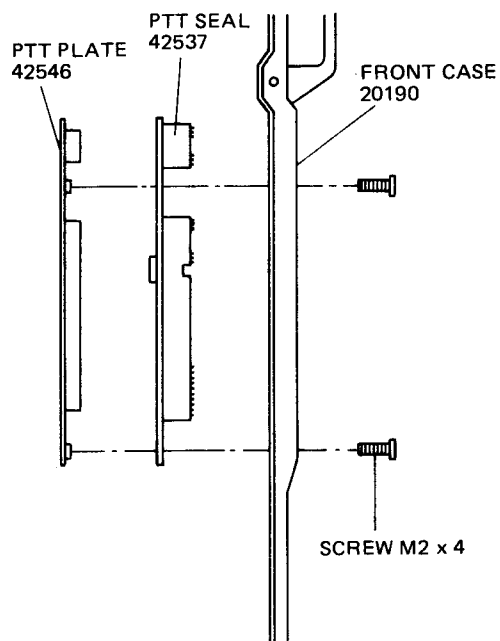
6 - 3 SPEAKER/MICROPHONE ASSEMBLY

(HOW TO REPLACE THE SPEAKER/MICROPHONE)



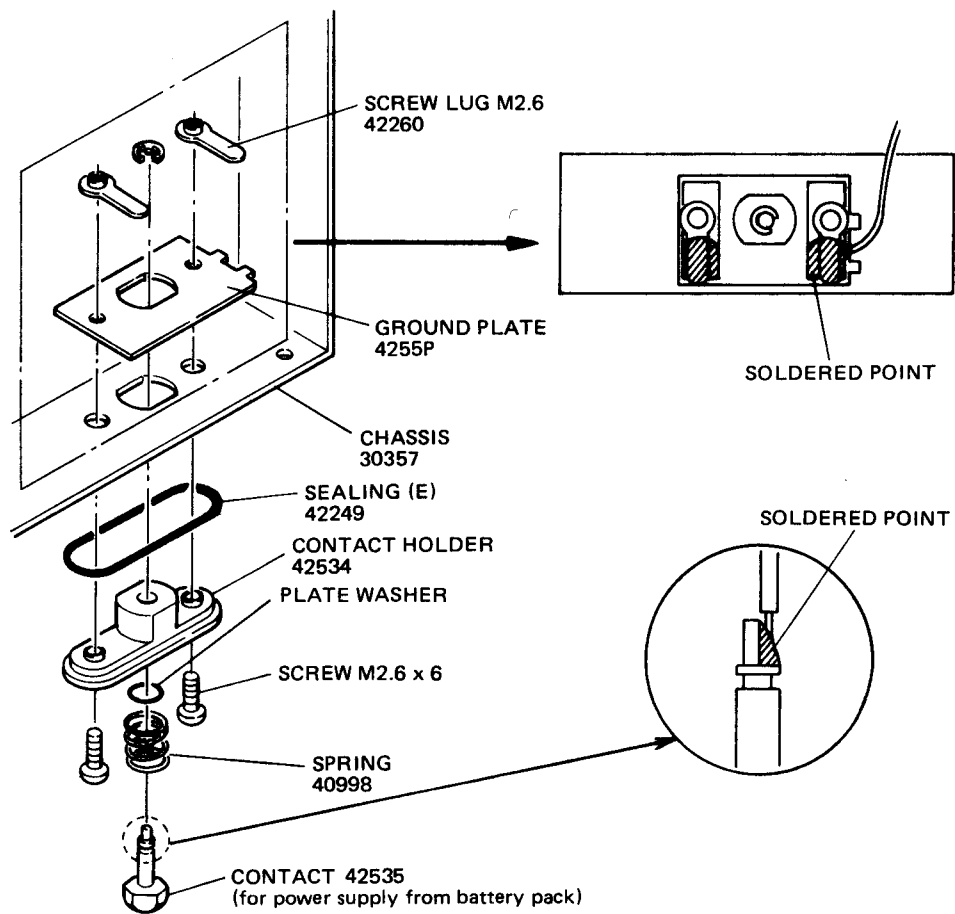
6 - 4 PTT SPRING ASSEMBLY

(HOW TO REPLACE PTT SPRING)



6 - 5 UNIT BOTTOM ASSEMBLY

(BOTTOM VIEW)



SECTION 7 MAINTENANCE AND ADJUSTMENT

7 - 1 MEASURING INSTRUMENTS REQUIRED FOR ADJUSTMENT

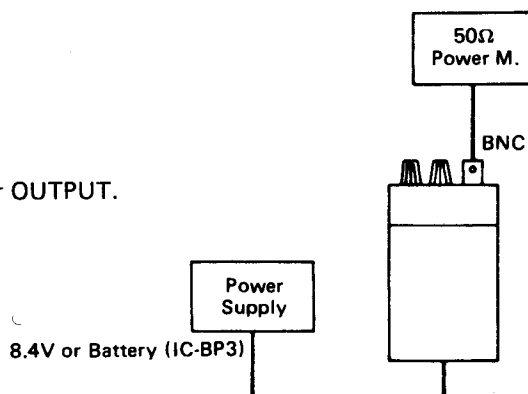
(1) FREQUENCY COUNTER	FREQUENCY RANGE	0.1 - 160MHz
	ACCURACY	BETTER THAN ± 1 ppm
	SENSITIVITY	100mV or BETTER
(2) SIGNAL GENERATOR	FREQUENCY RANGE	0.1MHz - 160MHz
	OUTPUT VOLTAGE	-20 - 90dB (0dB = 1 μ V)
(3) MULTIMETER		50K Ω /Volt or better
(4) AC MULTIVOLTMETER	MEASURING RANGE	10mV - 2V
(5) RF VOLTMETER	FREQUENCY RANGE	0.1 - 160MHz
	MEASURING RANGE	0.01 - 10V
(6) RF WATTMETER (Terminated Type)	MEASURING RANGE	5 Watts
	FREQUENCY RANGE	140 - 160MHz
	IMPEDANCE	50 OHMS
	SWR	LESS THAN 1.1
(7) AF OSCILLATOR	OUTPUT FREQUENCY	200 - 3000Hz
	OUTPUT VOLTAGE	0 - 100mV
	DISTORTION	LESS THAN 0.1%
(8) OSCILLOSCOPE	FREQUENCY RANGE	DC - 10MHz
	MEASURING RANGE	0.01 - 10V
(9) FM DEVIATION METER	FREQUENCY RANGE	140 ~ 160MHz
	MEASURING RANGE	0 ~ ± 10 KHz
(10) DIRECTIONAL COUPLER	FREQUENCY RANGE	140 ~ 160MHz
(11) AMPERMETER	MEASURING RANGE	0 ~ 2A DC
(12) DUMMY LOAD OR EXTERNAL SPEAKER	IMPEDANCE	8 OHMS
(13) VOLTAGE REGULATED POWER SUPPLY	OUTPUT VOLTAGE	5 ~ 15V DC (Adjustable)
	CAPACITY	1.5A OR MORE

7 - 2 PRELIMINARY CHECKS

7 - 2 - 1 TRANSMITTER OUTPUT CHECKS

1. Connect a 50 ohm RF wattmeter to the ANT connector.
2. Set the frequency as follows. And observe the RF power OUTPUT.

Verson No.	Frequency
-02	145MHz
-04, -06, -07	146MHz
-05, -08, -09	148MHz



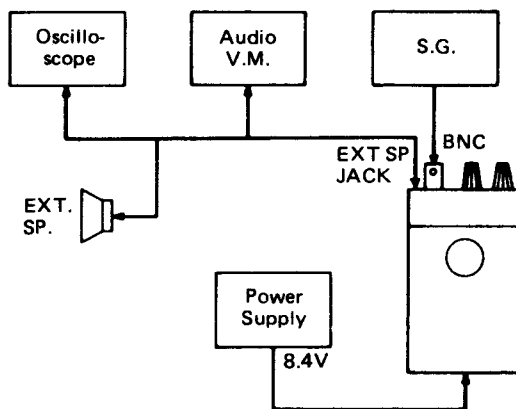
3. Power output should be 3 watts at HIGH or 0.5 watt at LOW position.

7 - 2 - 2 RECEIVER CHECKS

Make all checks at 8.4V DC

1. Settings of controls and switches

Power switch	ON
Squelch Control	Fully counterclockwise
Frequency	Same as the case of transmitter check.



2. Connect an AF voltmeter to the SP jack and set the SQL control fully counterclockwise.
3. Connect the RF output of a VHF signal generator (no modulation) to the ANT connector.
4. Adjust the VOL control and the AF voltmeter range.
Adjust the VOL control for a full scale reading on the AF voltmeter. Don't change the VOL control setting after this adjustment.
5. Set the signal generator to the receiving frequency and adjust the output level of the signal generator until the AF voltmeter shows a 20dB decrease in reading.
6. The signal generator output voltage at this point is the 20dB quieting sensitivity.

7 - 3 PREPARATION AND PROCEDURE BEFORE SERVICING

1. Confirm defective operation and check to make sure setup or external sources are not the cause of the problem.
2. Proper tools and measuring instruments are required for repair and adjustment. Don't try to repair or modify without them.
3. Remove the transceiver case as shown on Page 6 - 1. Use a screw driver that fits the screw.
4. To open the hinge chassis, remove the four screws as shown on Page 6 - 2.
5. Attach an 8.0 ~ 10.0V DC external power source to the battery clip or screw. Be sure to check the polarity.
6. In the case of a transmission problem, a dummy load should be connected to the antenna connector. In the case of a receiving problem, an antenna or signal generator is connected to the antenna connector. Be careful not to transmit into the signal generator.
7. Recheck for the suspected malfunction with the power switch on.
8. Check the defective circuit and measure the DC voltages of the collector, base and emitter of each transistor.
9. When checking a transmission problem, it is convenient to shortcircuit an accessory mic connector plug and insert it, turning on the transmitter.

7-4 HOW TO CHECK

7-4-1 RECEIVER

1. Check the frequency of P.L.L. unit when you are unable to receive with a strong signal present and noise present when turning up the VOLUME control.
2. When no noise is present at the speaker, check audio frequency amplifier or 5V regulator first.
3. Inject RF through a $0.01\mu\text{F}$ capacitor from an FM signal generator modulated with 1KHz audio modulation (FM), to points (A) through (D) in order, check for receiver output.

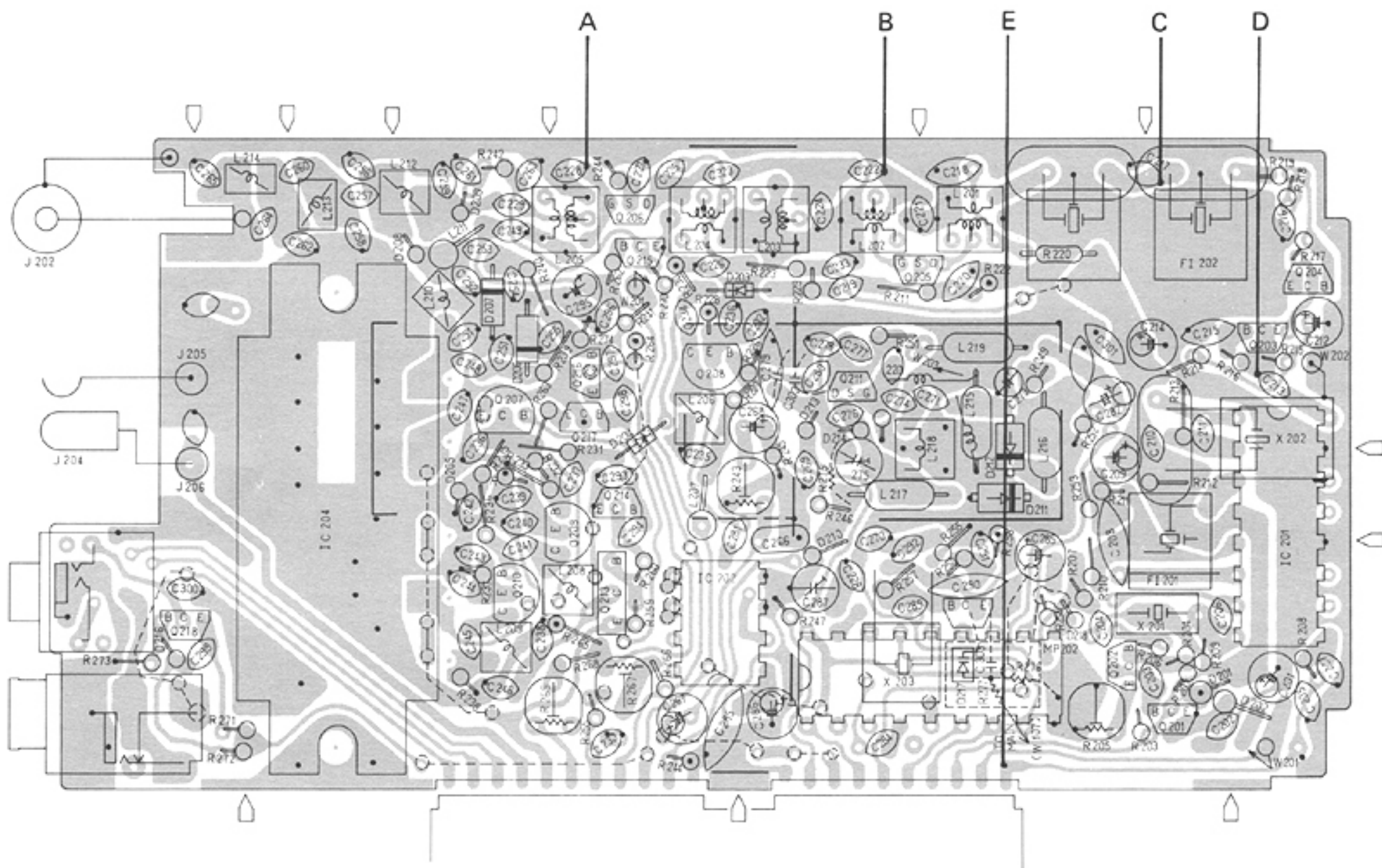
(A) and (B) =

Version No.	Frequency
-02	145MHz
-04, -06, -07	146MHz
-05, -08, -09	148MHz

(C) = 16.9MHz

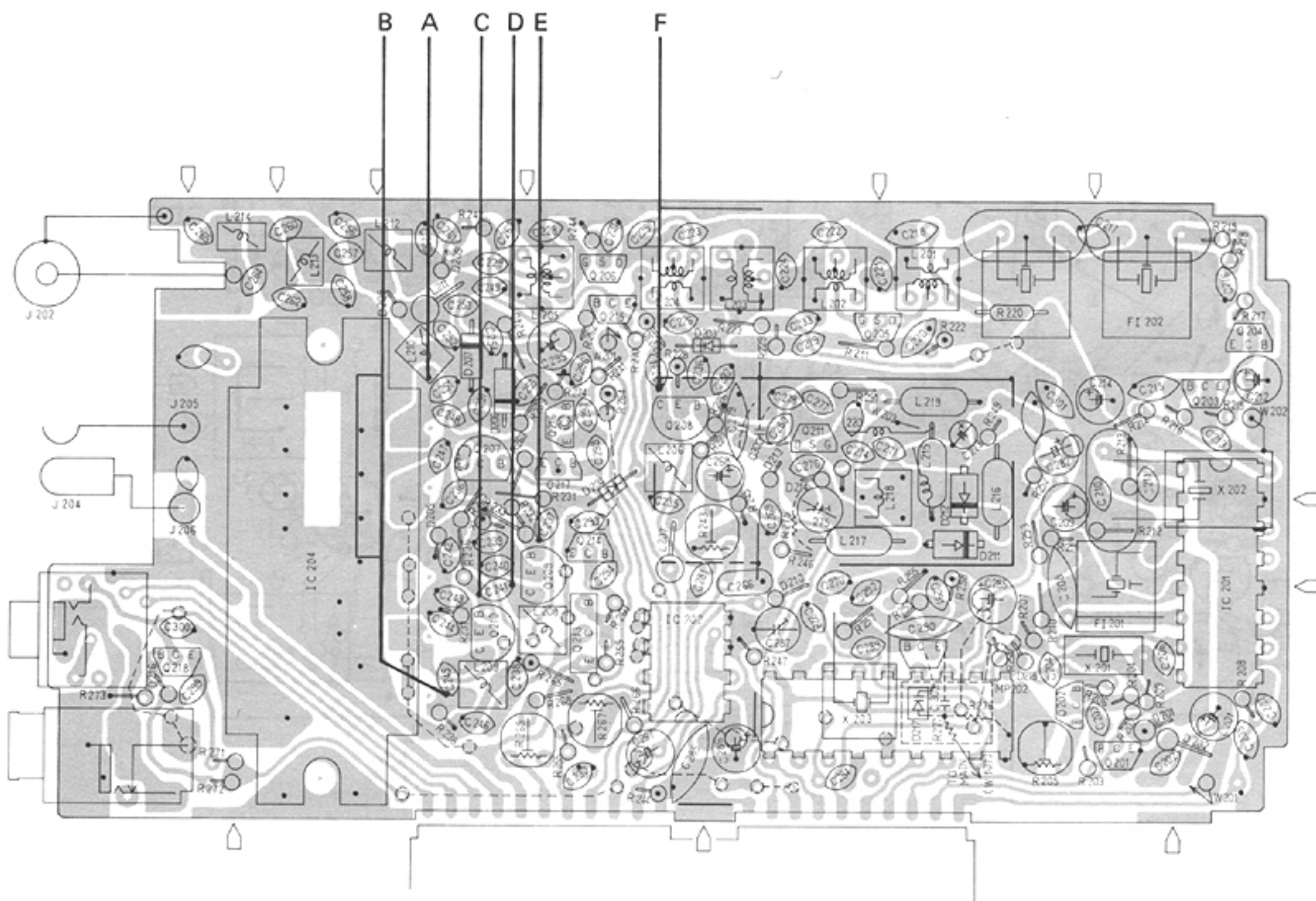
(D) = 16.9MHz

4. Check (E) with an oscilloscope, for demodulated output in the audio frequency range.



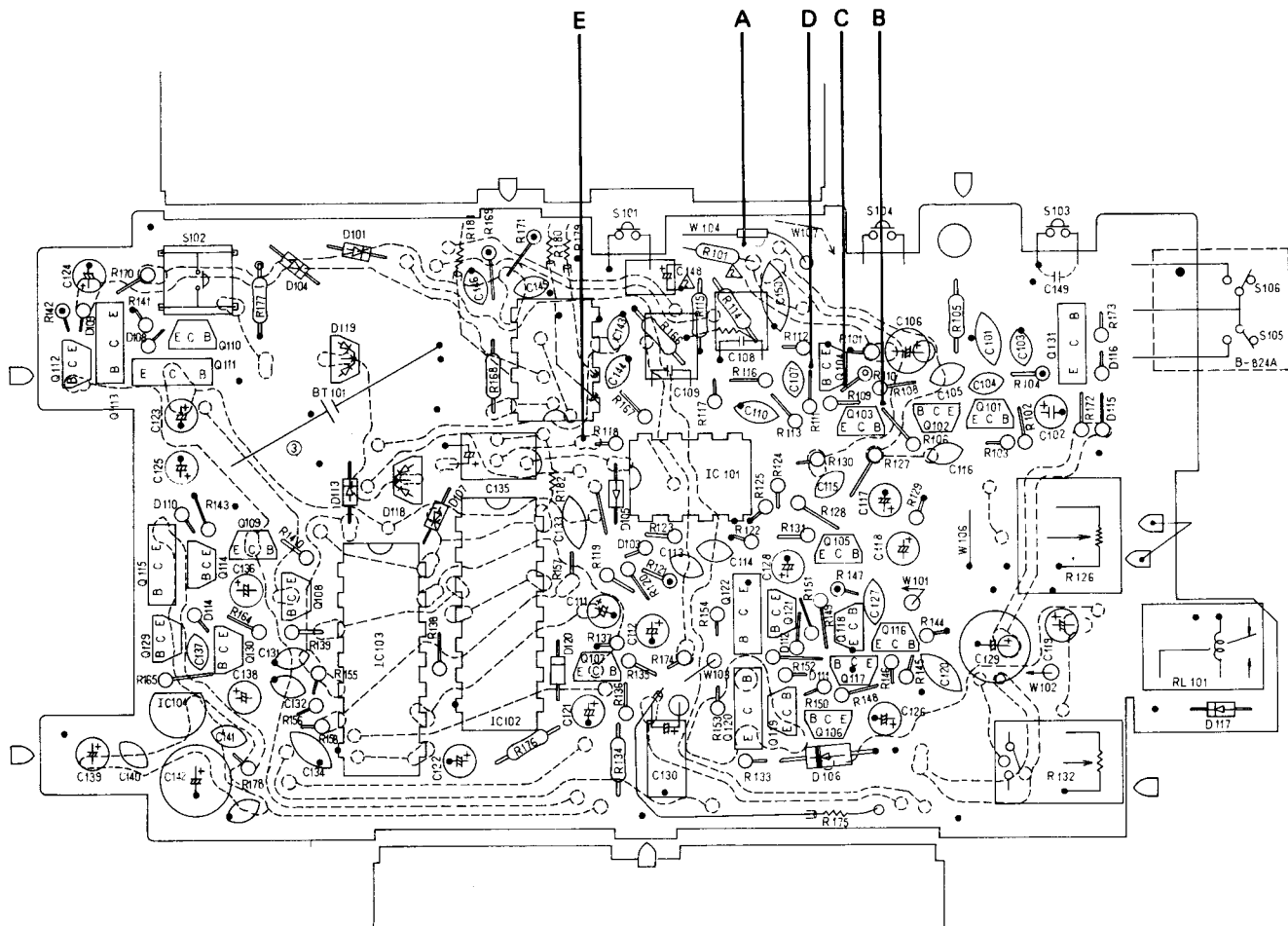
7-4-2 TRANSMITTER

1. Check (A) through (F) in order with RF voltmeter.
2. When the transmitter output is low, check regulated power supply voltage first, and do not turn coil trimmers.
3. When transmission is normal, RF is present and it is not possible to measure the DC voltage accurately with a voltmeter.



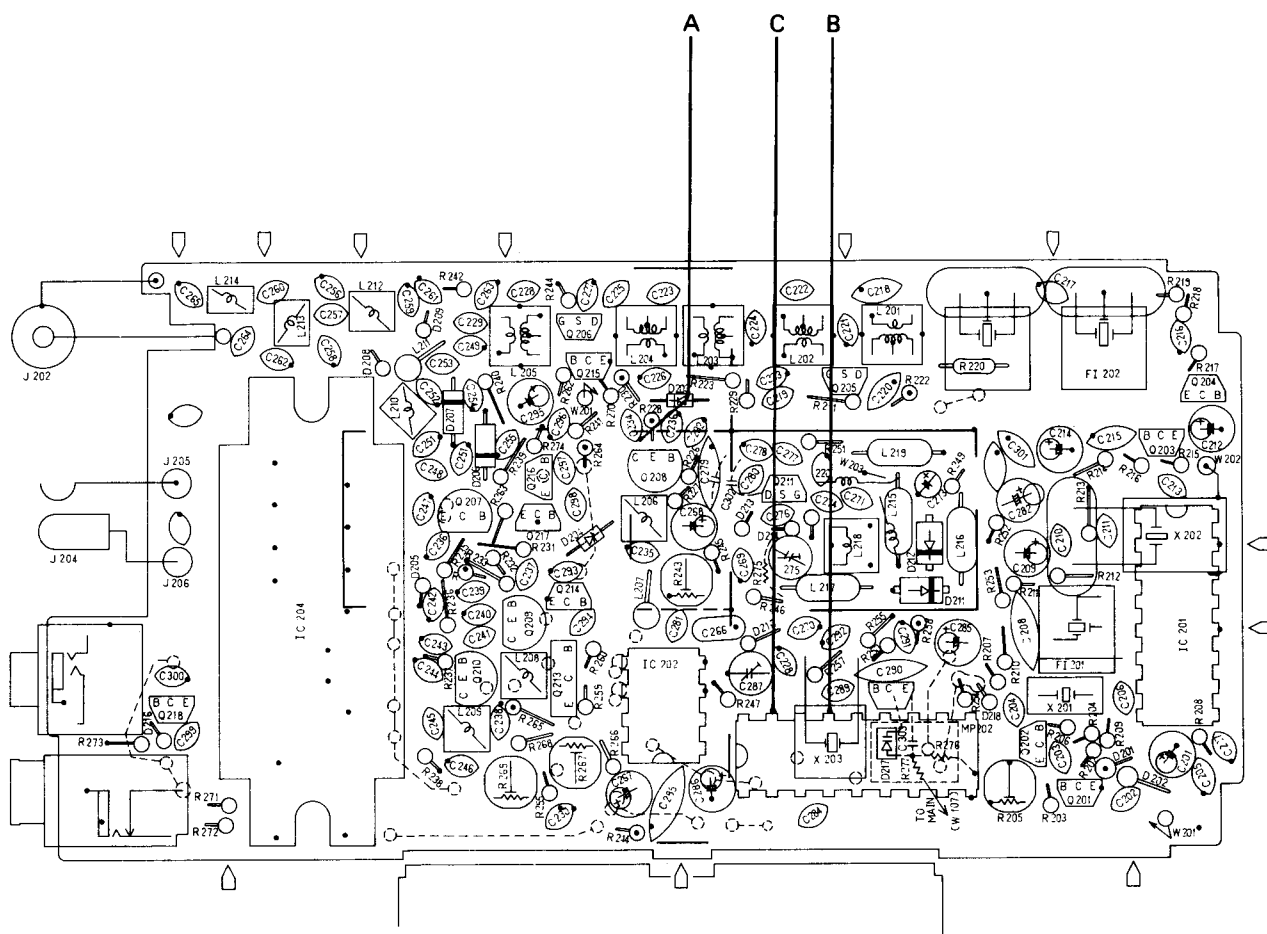
7-4-3 MODULATION

1. Put a signal into the EXT MIC connector (1KHz 40mV) with an AF oscillator or an external mic.
2. Check the AF voltage (A) through (E) in order with an oscilloscope.



7-4-4 P.L.L.

1. Check (A) with an oscilloscope. A lock failure is indicated by an instability or absence of the waveform. Check as follows:
2. Check the Frequency of the master oscillator (5.12MHz). If a 5KHz 5Vp-p squarewave is not observed at (B), measure DC voltage on Pin 18 of IC203 if no oscillation.
3. Wave measure the output of (C) with an oscilloscope.
4. Measure DC voltage of Q208, Q211 and Q212.
5. If the transmit or receive frequency differs from the display, check the signal "DATA".



7 - 5 BASIC ALIGNMENT PROCEDURE

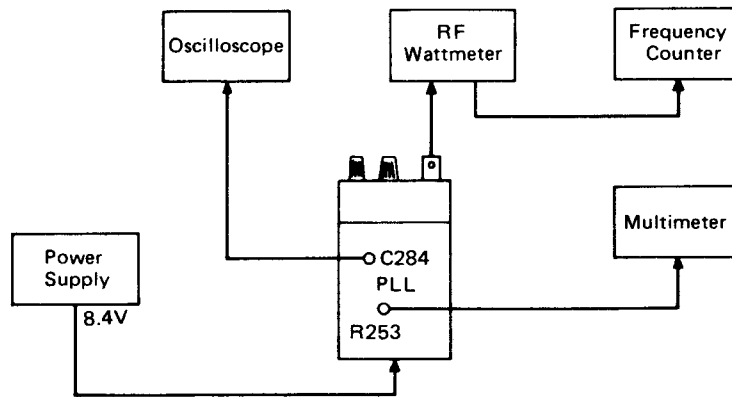
7 - 5 - 1 P.L.L. CIRCUIT

A. Lock Adjustment

1. Connect the measuring instrument as follows:

- Connect an oscilloscope (10MHz bandwidth) to C284.
- Connect voltmeter between R253 and ground.
- Set the frequency as below in accordance with Adjustment and Confirmation.

Version No.	Adjustment		Confirmation	
	Frequency [MHz]	Voltage [V]	Frequency [MHz]	Voltage [V]
-02	144.000	1.5	145.9875	≤ 2.5
-04	144.000	1.5	147.9875	≤ 3.0
-07	144.000	1.5	147.995	≤ 3.0
-05, -06, -08, -09	140.000	1.0	149.995	≤ 4.0



2. Procedure

When the circuit is operating normally, adjust coil L218 in the receive mode. The P.L.L. will be locked.

- Adjust coil L218, and the voltage of R253 varies between 0 ~ 5V, and P.L.L. should be locked.
- Then, in the confirmed frequency on the list, check that the same voltage is less than the confirmed voltage.

If the P.L.L. won't lock, check voltages on lines RS5, TS5, R+5, T+5 and +5 and the P.L.L. LO and reference frequency oscillator for oscillation. Connect a counter to R238, and check the oscillation frequency of the V.C.O. during transmission.

If unlocked, check that L218 can be adjusted as follows:

- Adjust L218 to 115MHz when the voltage of R253 is 0V.
- Adjust L218 to 139MHz when the voltage of R253 is 5V.

B. Reference Frequency Oscillator Adjustment

Deviation of transmitting and receiving frequency is determined by this reference oscillating frequency. Accordingly, the adjustment would be carried out carefully.

1. Connect a counter through a capacitor to R221 (Source side of Q205).
2. Adjust C287 and set the frequency as follows:

Version No.	Operating Frequency	Setting Frequency
-02, -04, -06, -07	144.00MHz	127.1MHz $\pm$ 400Hz
-05, -08, -09	140.00MHz	123.1MHz $\pm$ 400Hz

Cf: When transmitting, couple a counter loosely with a powermeter, the indication of which may be adjusted to the same value of the indication frequency.

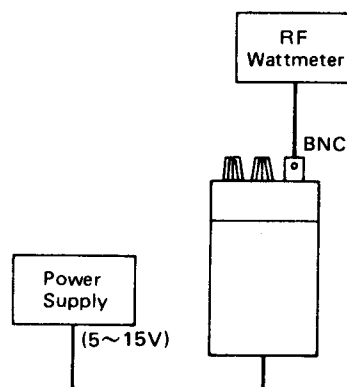
7 - 5 - 2 TRANSMISSION

A. Power Adjustment

1. Connection of measuring instruments and setting of the knobs

- Connect a 50 ohm powermeter to ANT connector.
- Connect a voltmeter and variable power supply to the set.
Set a power supply at 13.2V.
- Power SW should be HIGH.
- Set the frequency as follows:

Version No.	Frequency
-02	145MHz
-04, -06, -07	146MHz
-05, -08, -09	148MHz



2. Procedure

- Adjust L206 though L209, L213 and L214 of the PLL unit for maximum RF power output while pushing PTT SW.
- Adjust R267 and set output power at 5 watts.
- Then, set the RF Power SW at LOW. Adjust R269 and set output power at 0.5 watts.

3. Confirmation

Confirm output power and current drain at the edge frequency for each version:

RF Power SW	Power supply voltage	Confirmation	
		RF output power	Current drain
HIGH	13.2V	5W $\pm$ 10%	less than 1.45A
	9V	more than 3W	less than 1.3A
	8.4V	more than 2.5W	less than 1.25A
LOW	8.4 ~ 13.2V	0.5W $\pm$ 20%	less than 0.55A

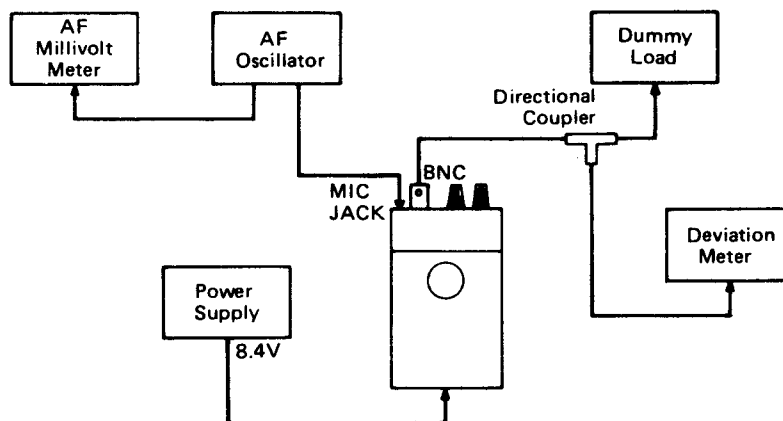
B. Modulation Adjustment

1. Connecting the measuring instrument and the settings of the controls.

Connect a deviation meter to the ANT connector through a directional coupler or attenuator.

Deviation meter filter shall be a High Pass Filter 50Hz, L.P.F. 20KHz. De-emphasis OFF.

- The frequency shall be the same as the case of power adjustment.
- Set Power SW to HIGH.
- Connect an AF oscillator, with a millivoltmeter in parallel, to the mic input.
(Insert a switch in series to allow on/off transmit switching.)



2. Procedure

Mic input shall be as follows in accordance with a version. During transmit, adjust R243 on the main unit for 5KHz deviation.

Version No.	Mic input voltage
-02, -04, -07 -08, -09	1KHz 75mV RMS
-05, -06	1KHz 170mV RMS

3. Modulation check

Maximum deviation: With the above, input shall be 5KHz $\pm 10\%$.

Modulation sensitivity: When deviation is 3.5KHz,

Version No.	Modulation sensitivity
-02, -04, -07 -08, -09	7.5mV ± 3 dB
-05, -06	17mV ± 3 dB

S/N Ratio:

Connect an AC millivoltmeter to the output terminal of the deviation meter. With no audio input to the mic input, take the voltmeter reading. Now apply 1 kHz 40mV audio into the mic connector and it's level is for 3.5KHz deviation. Take the voltmeter reading. The ratio should be greater than 40dB.

4. Spurious Emission

Connect a spectrum analyzer with appropriate attenuator. Confirm nearby random spurious signals are less than -60dB below the fundamental signal.

Measure the harmonic output, adjust RF-ATT until noise level just appears.

Should be less than -60dB below the fundamental signal.

7 - 5 - 3 RECEIVER

A. LO Output Adjustment

- Adjust the frequency as follows:

Version No.	Frequency
-02	Approx. 145MHz
-04, -06, -07	Approx. 146MHz
-05, -08, -09	Approx. 148MHz

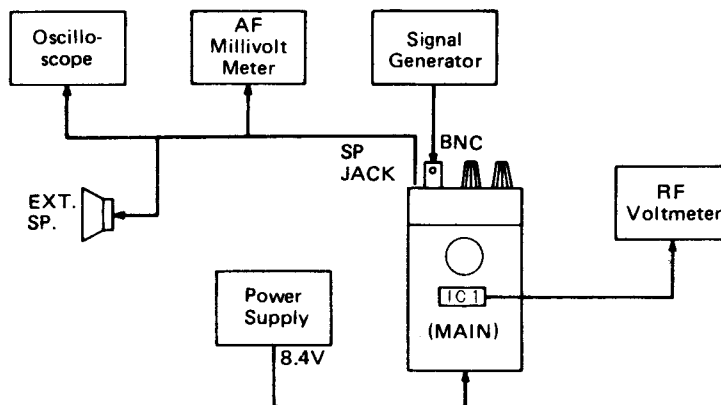
- Adjust L206, for maximum output on an RF voltmeter attached to the source of Q205 in the main unit. Output voltage should be about 180mV.

B. RF IF DET Coil Adjustment.

Using a ceramic discriminator in this set, no adjustment of DET is needed.

1. The connecting point of measuring instrument and the setting of the knob.

- Connect a signal generator to the ANT connector.
- Connect an external speaker and AF millivoltmeter to the external speaker jack.



2. Procedure

Set RF voltage meter (minimum range) to the cathode of D201, adjust L201 through L205 maximum output while setting the input from the signal generator as low as possible. Then vary the input frequency from the signal generator $\pm 10\text{KHz}$. Check if rippling (change in output level) occurs. If rippling is over 3dB, readjust L201.

3. Confirmation

Sensitivity should be less than $-10\text{dB}\mu$ for 20dB quieting.

C. 2nd LO Frequency Check

Connect a 16.445MHz amplifier to the counter, check the frequency of X202 (2nd OSC) with loose coupling the amplifier to X202. It should be: $16.445\text{MHz} \pm 500\text{Hz}$.

D. Receiver Spurious Response

Connect a speaker and millivoltmeter to the EXT SP jack. Connect a 50 ohm dummy load to the antenna terminal. Noise suppression should be less than 3dB with any spurious response over entire frequency range.

E. Receiver Audio Output

Connect a millivoltmeter, oscilloscope, and a distortion meter to the EXT SP jack. To the ANT terminal, connect the signal generator and set the signal generator to 20 to 30dB μ and deviation to 3.5KHz. Turn up AF VOL control. Read the millivoltmeter when the distortion is 10%. Audio output should be more than 2V R.M.S.

F. S-meter

Connect a signal generator to the ANT connector and set the signal generator to +8dB μ . Adjust R205 for 8-dot lighting on the LCD meter. After that, check the full scale as rising the output level of the signal generator.

7 - 5 - 4 OTHERS

A. Tone call (version -02 and -04 only)

- Adjust the frequency at approx. 145MHz for version -02 or at approx. 146MHz for version -04.
- Connect a 7.168MHz amplifier to the counter, press the tone call SW and check the frequency of X601 with loose coupling the amplifier to X601. It should be $7.168\text{MHz} \pm 500\text{Hz}$.
- Connect a deviation meter to the ANT connector through a directional coupler. Adjust R603 for the deviation of $3.5\text{KHz} \pm 10\%$.

B. Dual Tone (version -05 and -09 only)

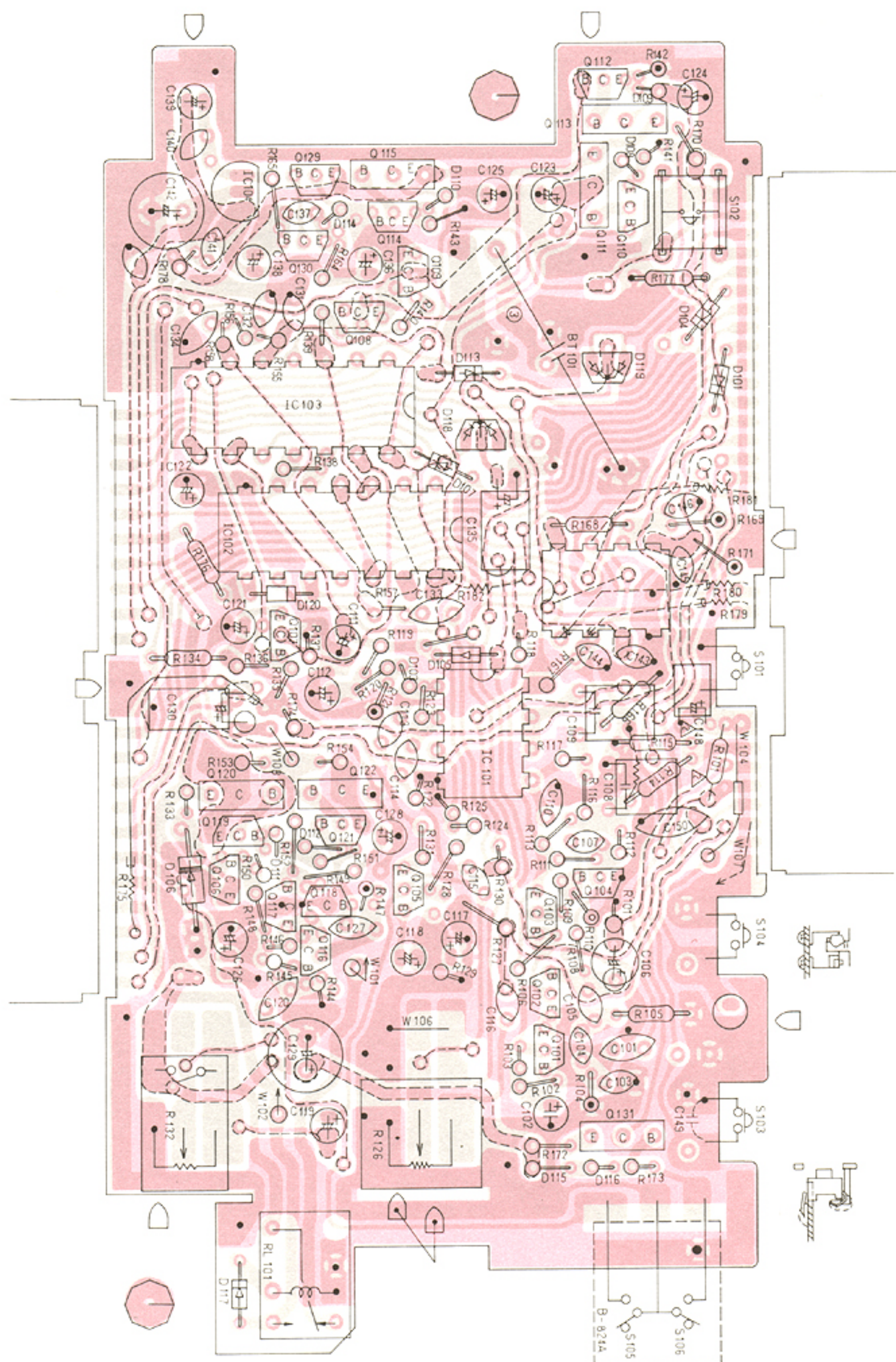
- Adjust the frequency at approx. 146MHz.
- Connect a 3.58MHz amplifier to the counter, press the PTT SW and any button on the key pad, and check the frequency of X501 with loose coupling the amplifier to X501. It should be $3.578\text{MHz} \pm 14\text{KHz}$.
- Connect a deviation meter to the ANT connector through a directional coupler or attenuator. Press the PTT SW and a button D on the key pad, and adjust R507 for the deviation of $3.5\text{KHz} \pm 10\%$.

C. CTCSS Encoder (version -05 and -09 only)

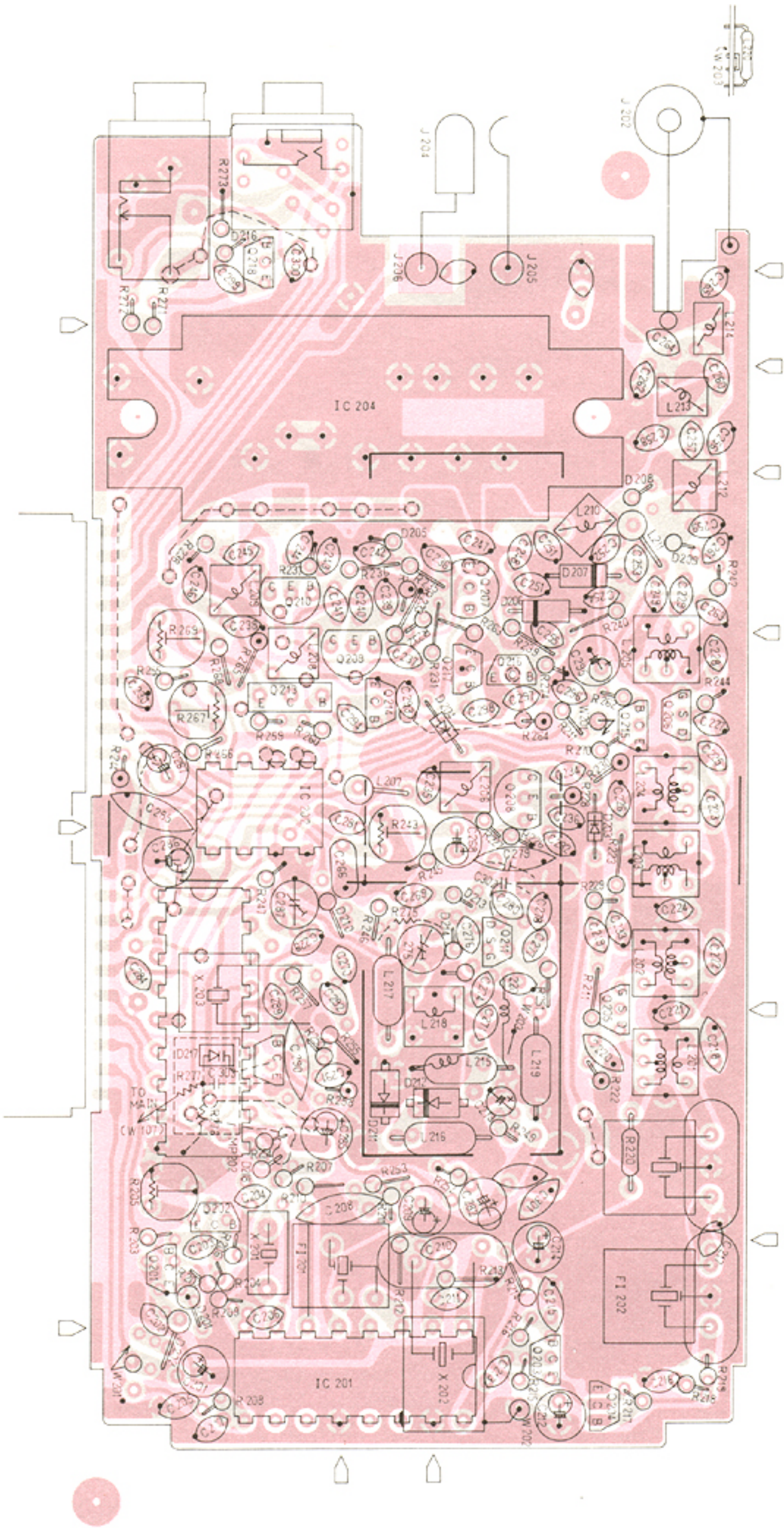
- Adjust the frequency at approx. 146MHz.
- Set Tone number previously with the key pad, and select Tone number 1 (67Hz). Connect a 3.58MHz amplifier to the counter, press the PTT SW and check the frequency of X502 with loose coupling the amplifier to X502. Adjust C509 for the frequency of $3.58\text{MHz} \pm 10\text{KHz}$.
- Connect a deviation meter to the ANT connector through a directional coupler or attenuator. Because of low frequencies of Tone carrier, the HPF of a deviation meter shall be off and the LPF 20KHz. Press the PTT SW and adjust R510 for the deviation of $0.5\text{KHz} \pm 10\%$.

SECTION 8 BOARD LAYOUT

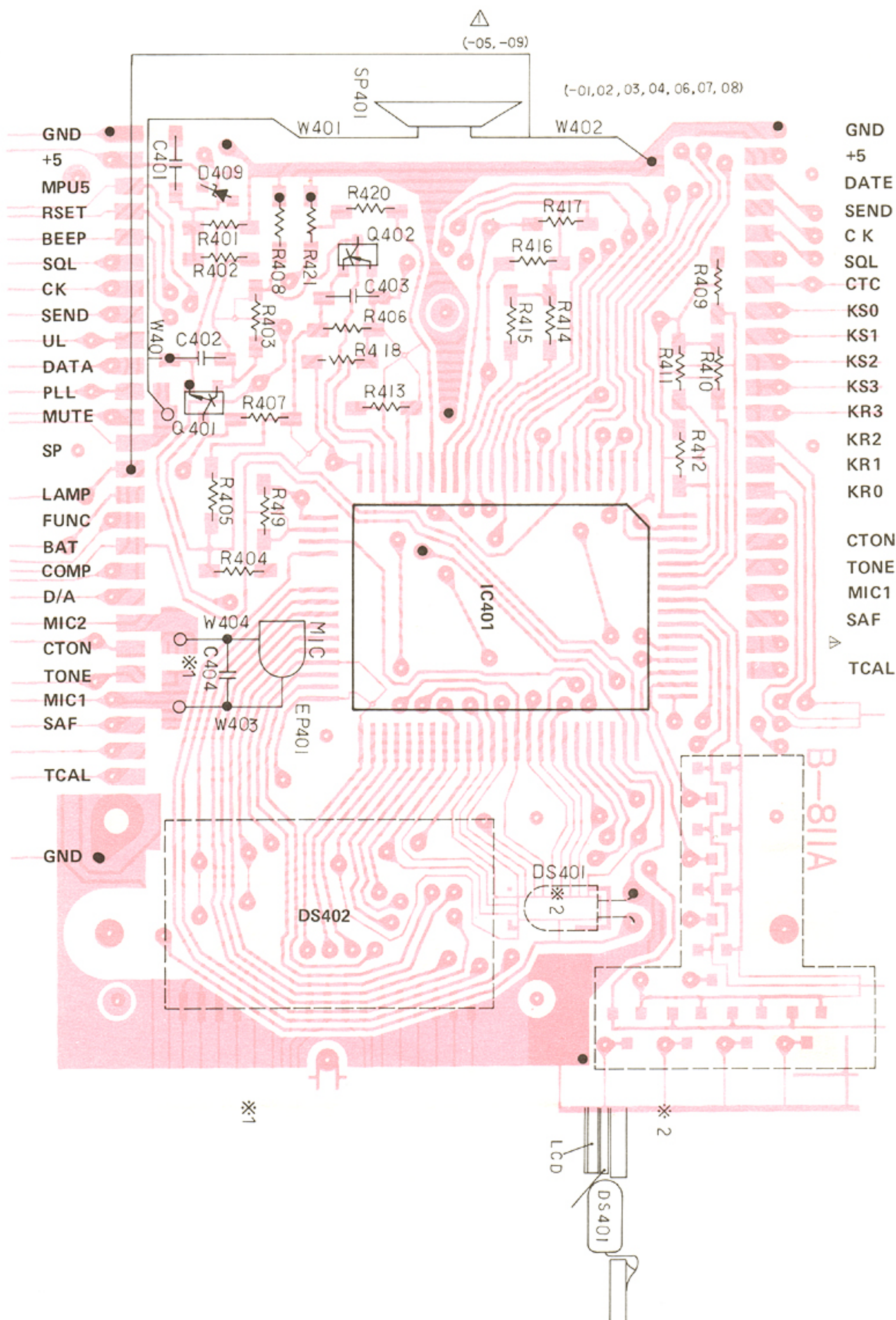
MAIN UNIT



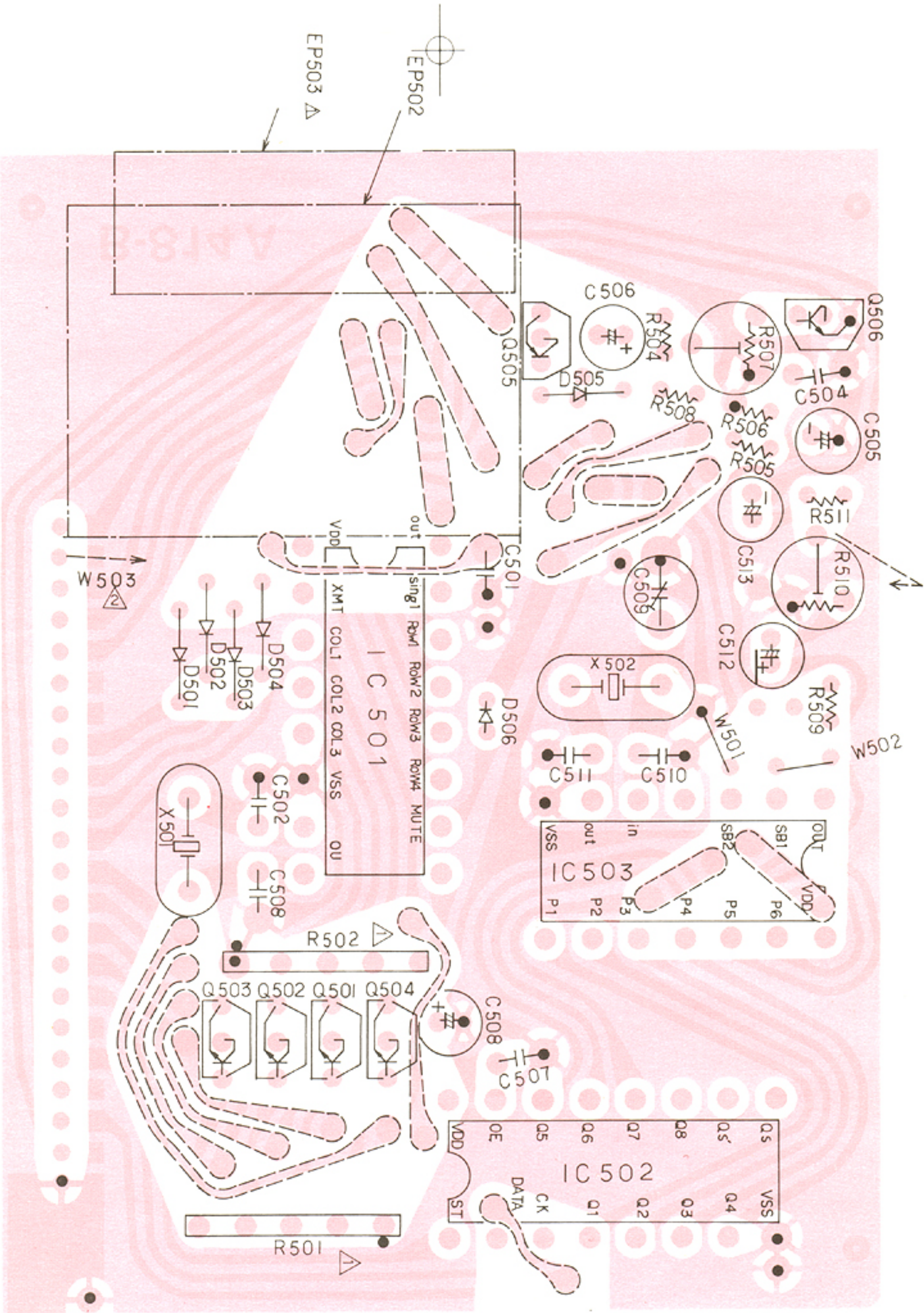
PLL UNIT



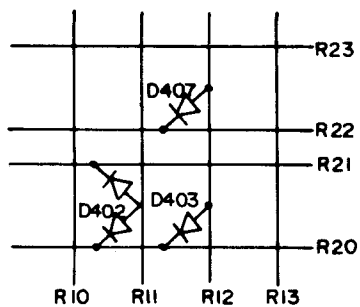
LOGIC UNIT



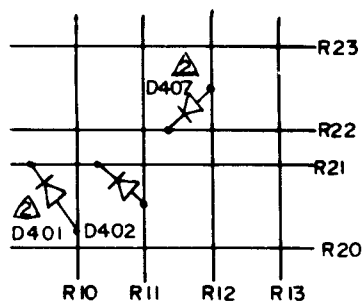
TONE UNIT (IC-02AT only)



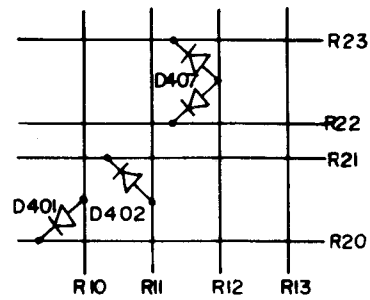
DIODE MATRIX for each version



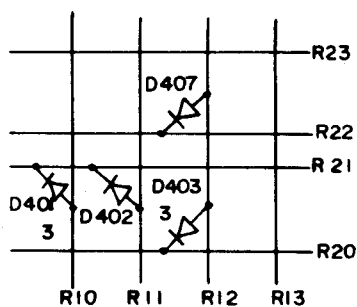
- 01



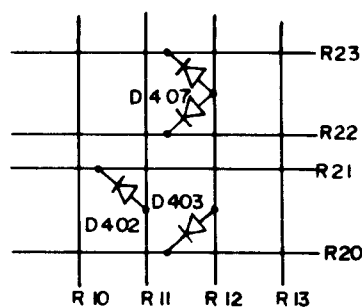
- 02



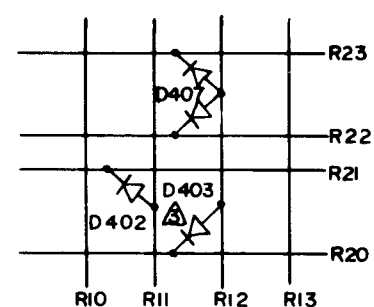
- 03



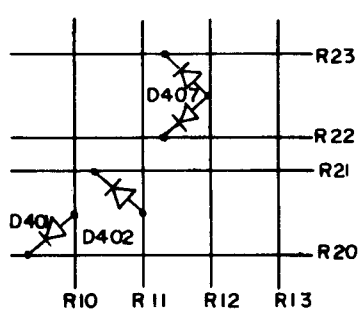
-04



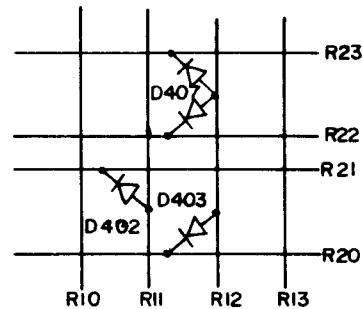
- 05



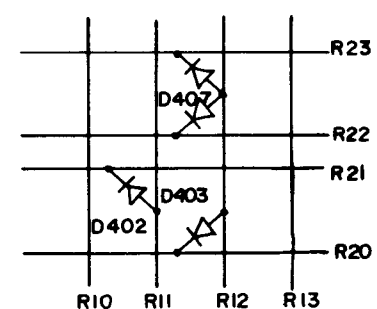
-06



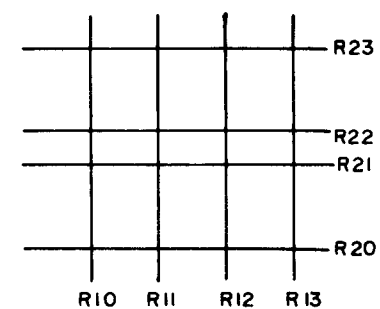
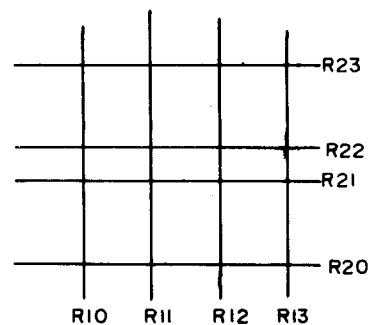
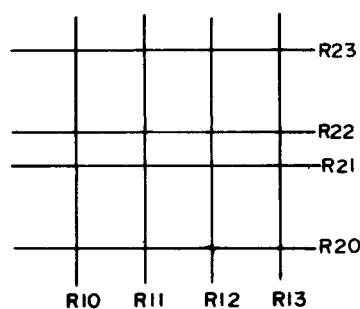
-07



- 08



- 09



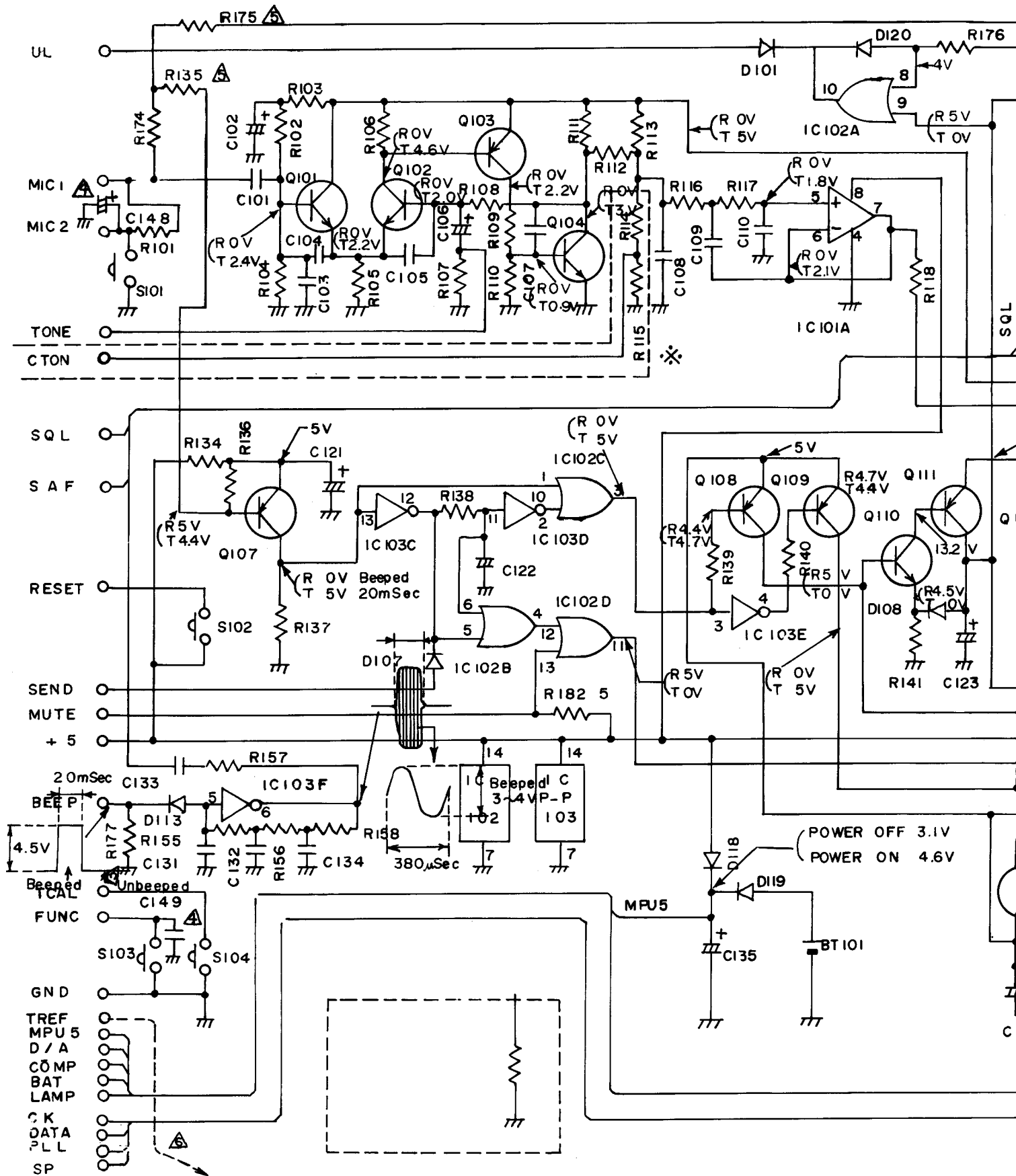
SECTION 9 VOLTAGE CHARTS

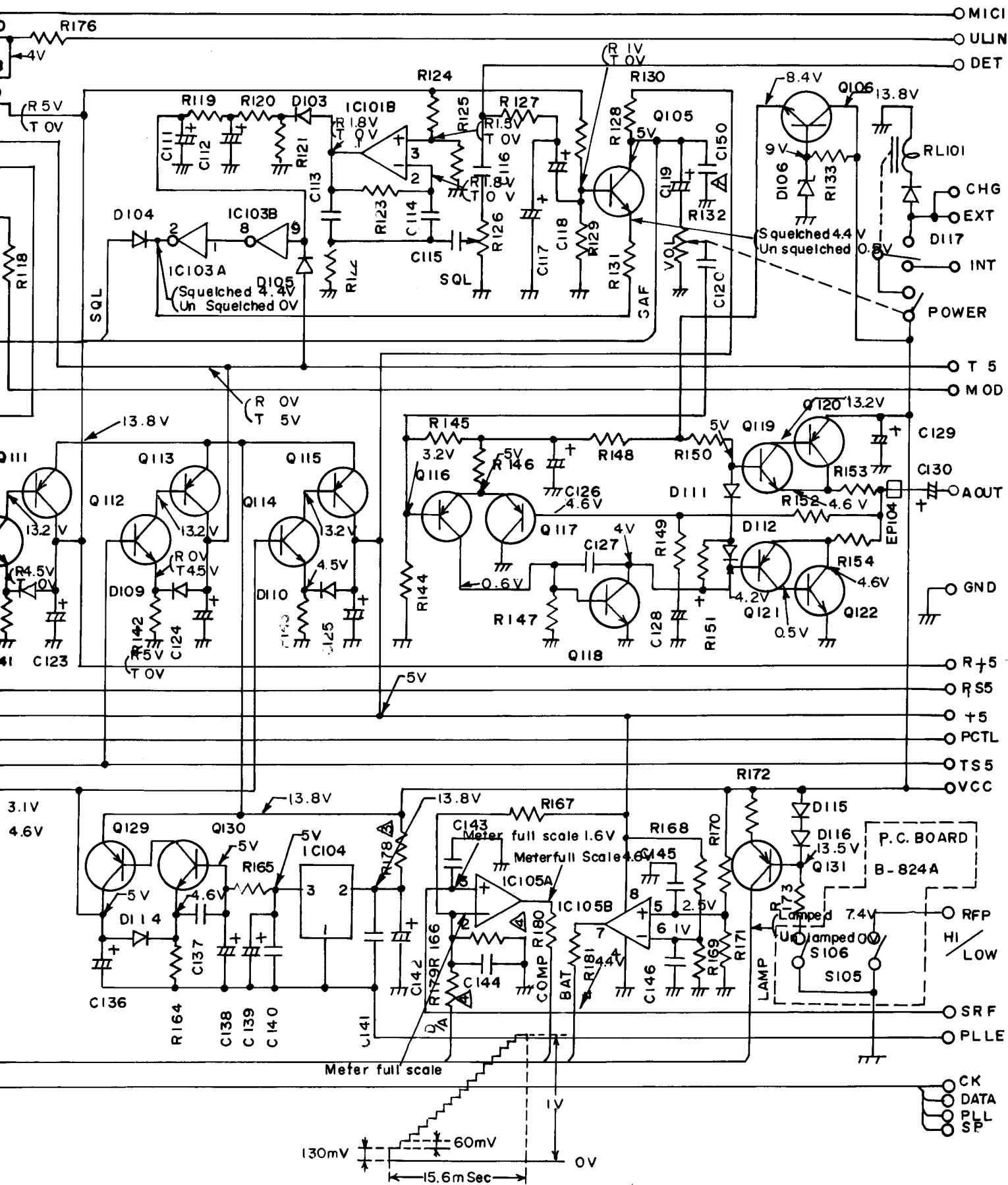
TRANSISTORS VOLTAGE CHART

UNIT	NO.	TRANSMIT			RECEIVE			REMARKS
		BASE or GATE	COLLECTOR or DRAIN	EMITTER or SOURCE	BASE or GATE	COLLECTOR or DRAIN	EMITTER or SOURCE	
MAIN	Q101	2.4	5	2.2	0	0	0	Squelch closed/open *Depend on power voltage
	Q102	2.0	4.6	2.2	0	0	0	
	Q103	4.6	2.2	5	0	0	0	
	G104	0.9	3	GND	0	0	GND	
	G105	0	5	4.4/0.5	1	5	4.4/0.5	
	G106	9	13.8*	8.4	9	13.8*	8.4	
	G107	4.4	5	5	5	0	5	
	Q108	4.7	0	5	4.4	5	5	
	Q109	4.4	5	5	4.7	0	5	
	Q110	0	13.2	0	5	13.2	4.5	
	Q111	13.2	0	13.8	13.2	5	13.8	
	Q112	5	13.2	4.5	0	13.2	0	
	Q113	13.2	5	13.8	13.2	0	13.8	
	Q114	5	13.2	4.5	5	13.2	4.5	
	Q115	13.2	5	13.8	13.2	5	13.8	
	Q116	3.2	0.6	5	3.2	0.6	5	
	Q117	4.6	0.6	5	4.6	0.6	5	
	Q118	0.6	4	GND	0.6	4	GND	
	Q119	5	13.2	4.6	5	13.2	4.6	
	Q120	13.2	4.6	13.8	13.2	4.6	13.8	
	Q121	4.2	0.5	4.6	4.2	0.5	4.6	
	Q122	0.5	4.6	GND	0.5	4.6	GND	
	Q129	13.2	5	13.8	13.2	5	13.8	
	Q130	5	13.2	4.6	5	13.2	4.6	
	Q131	13.5	7.4/0	13.8	13.5	7.4/0	13.8	Lamp ON/Lamp OFF
PLL	Q201	0	0	GND	0.6	2.4	GND	
	Q202	0	0	0	0.6	2.8	0	
	Q203	0	0	0	1.5	2.9	0.9	
	Q204	0	0	GND	0.7	0.9	GND	
	Q205	0	0	0	0	5	1	
	Q206	0	0	0	0	4.6	1	
	Q207	0.5	5	5	5	0	0	
	Q208	2.2	5	1.5	2.2	5	1.5	
	Q209	1.7	6.4	1.1	0	0	0	
	Q210	0.7	6.4	0.6	0	0	0	
	Q211	0	4.5	0.5	0	3.8	0.5	
	Q212	2	5	2.2	2	5	2.2	
	Q213	13	6.4	13.8	13.8	0	13.8	
	Q214	0.8	8.9	GND	0	13.8	GND	
	Q215	0.7	0.3	GND	0	0.6	GND	
	Q216	2.8	0.8	2.5	0	0	0	
	Q217	2.5	GND	3.2	0	GND	0	
	Q218	4.5	5	5	4.5	5	5	

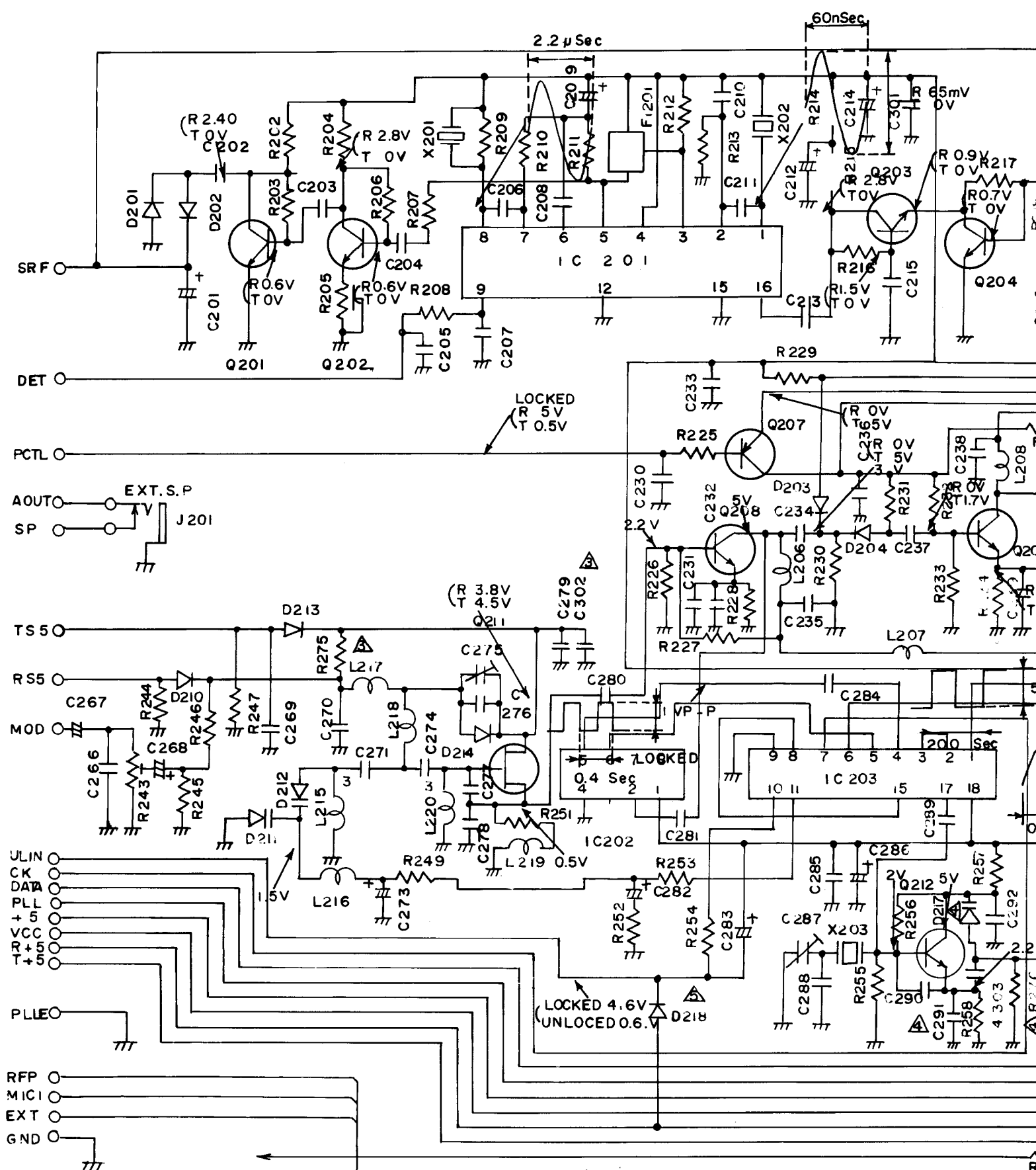
UNIT	NO.	TRANSMIT			RECEIVE			REMARKS
		BASE or GATE	COLLECTOR or DRAIN	EMITTER or SOURCE	BASE or GATE	COLLECTOR or DRAIN	EMITTER or SOURCE	
LOGIC	Q401	0.7	0.1/2.9	GND	0.7	0.1/2.9	GND	Power OFF/Power ON
	Q402	2.8/4	0/4.6	3.1/4.6	2.8/4	0/4.6	3.1/4.6	Power OFF/Power ON
TONE	Q501	0/2.2	0/2.3		0	0		T/DTMF
	Q502	0/2.2	0/2.3		0	0		T/DTMF
	Q503	0/2.2	0/2.3		0	0		T/DTMF
	Q504	0/2.2	0/2.3		0	0		T/DTMF
	Q505	0.6	5	5	4.4	0	5	
	Q506	0/0.6	1.8/0	GND	0	4.8	GND	T/DTMF
TONE CALL	Q601	4.8/4.2	0/5	5	4.8	0	5	T/TCAL

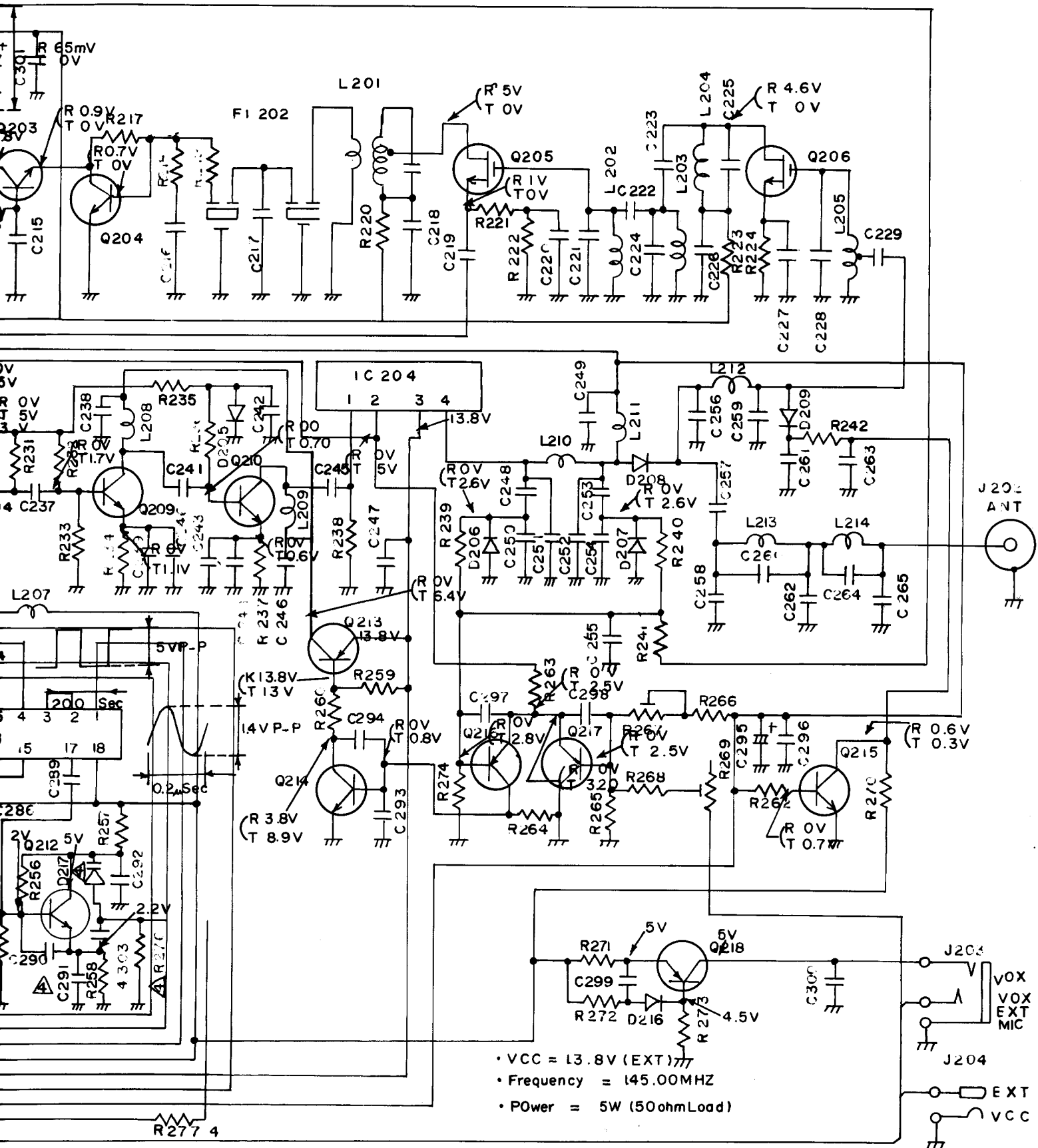
MAIN UNIT VOLTAGE DIAGRAM



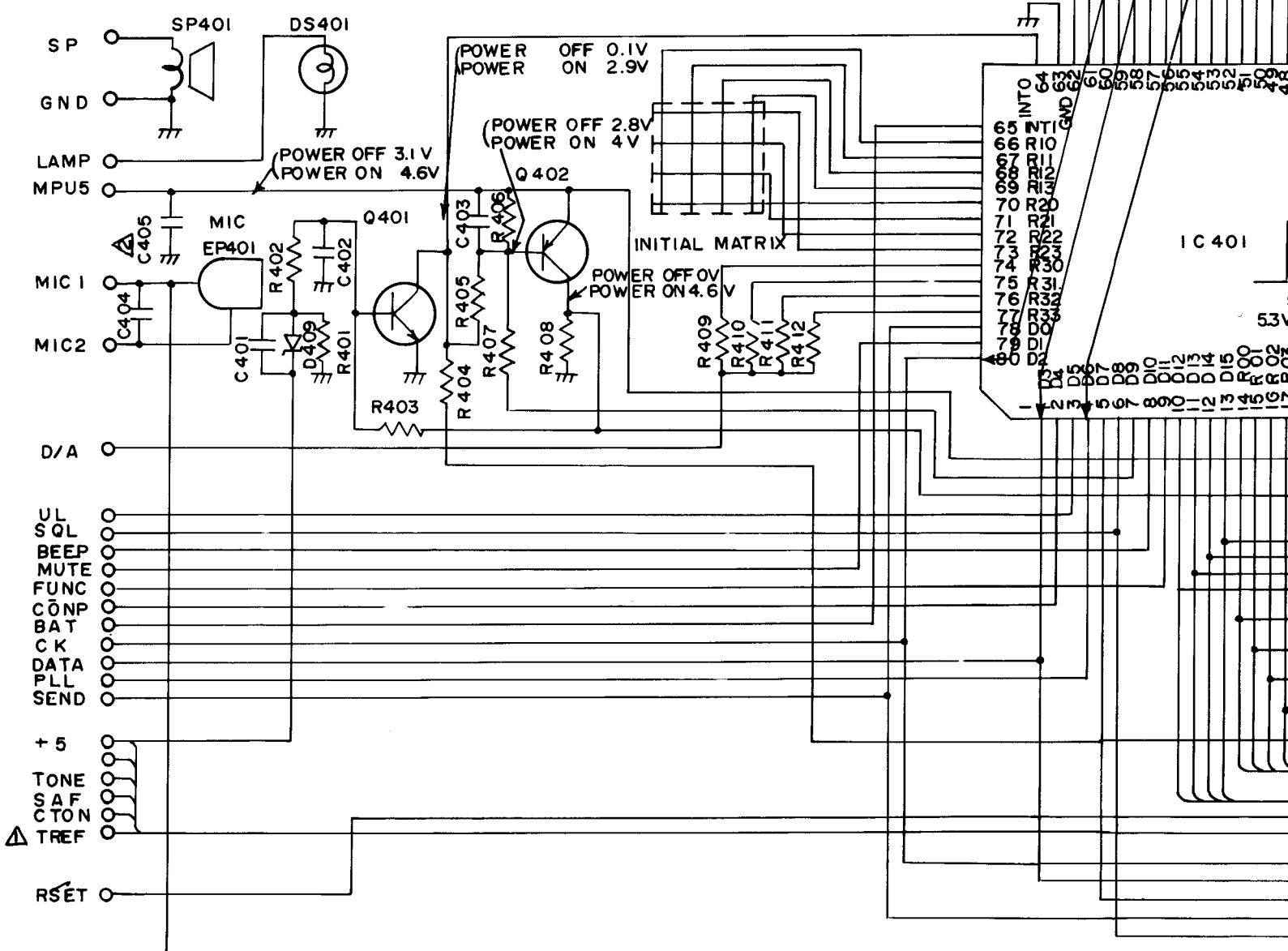
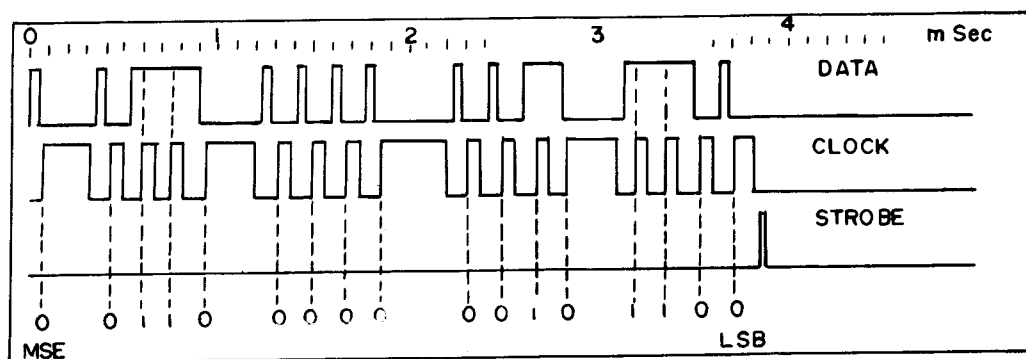


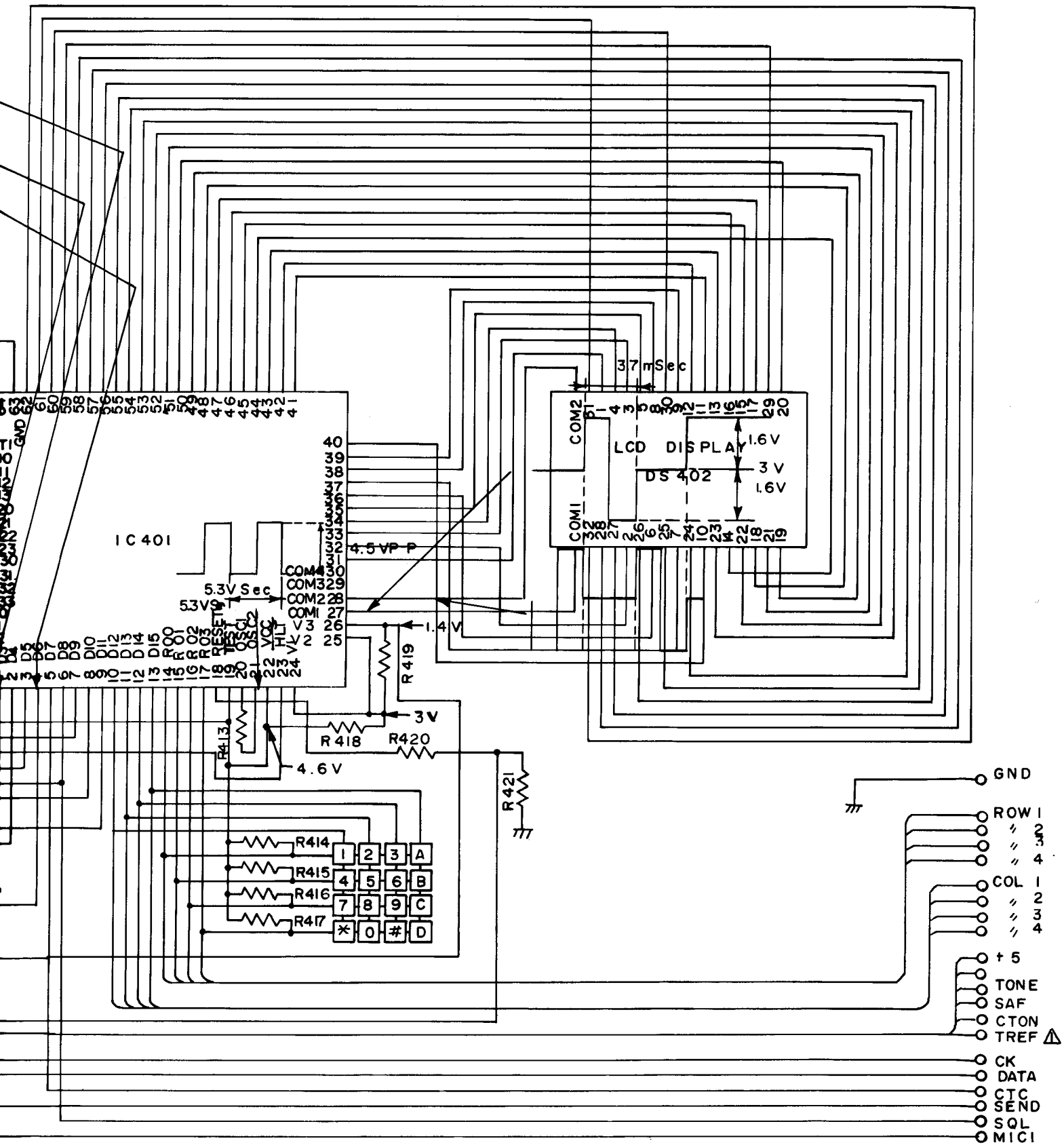
PLL UNIT VOLTAGE DIAGRAM



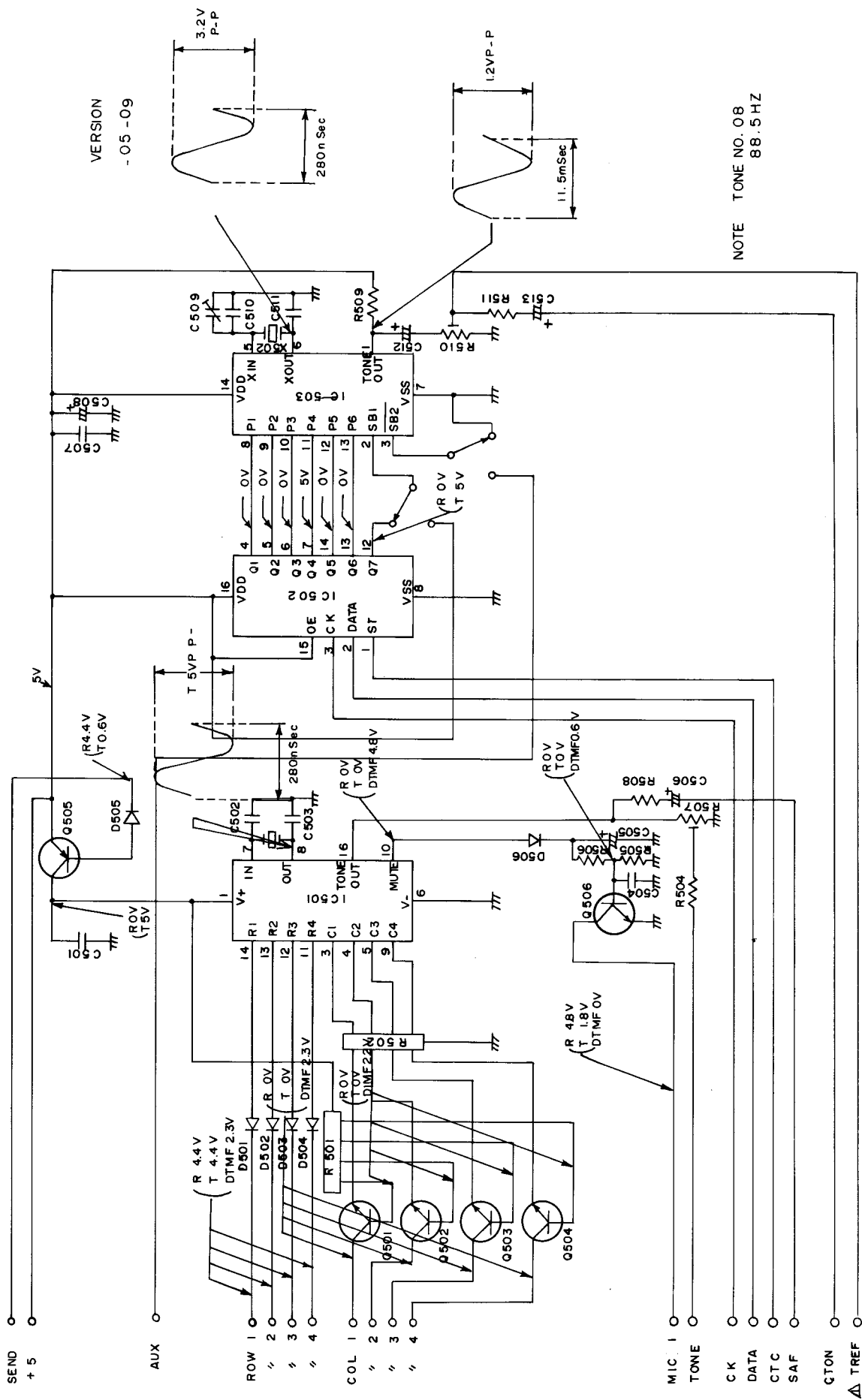


LOGIC UNIT VOLTAGE DIAGRAM



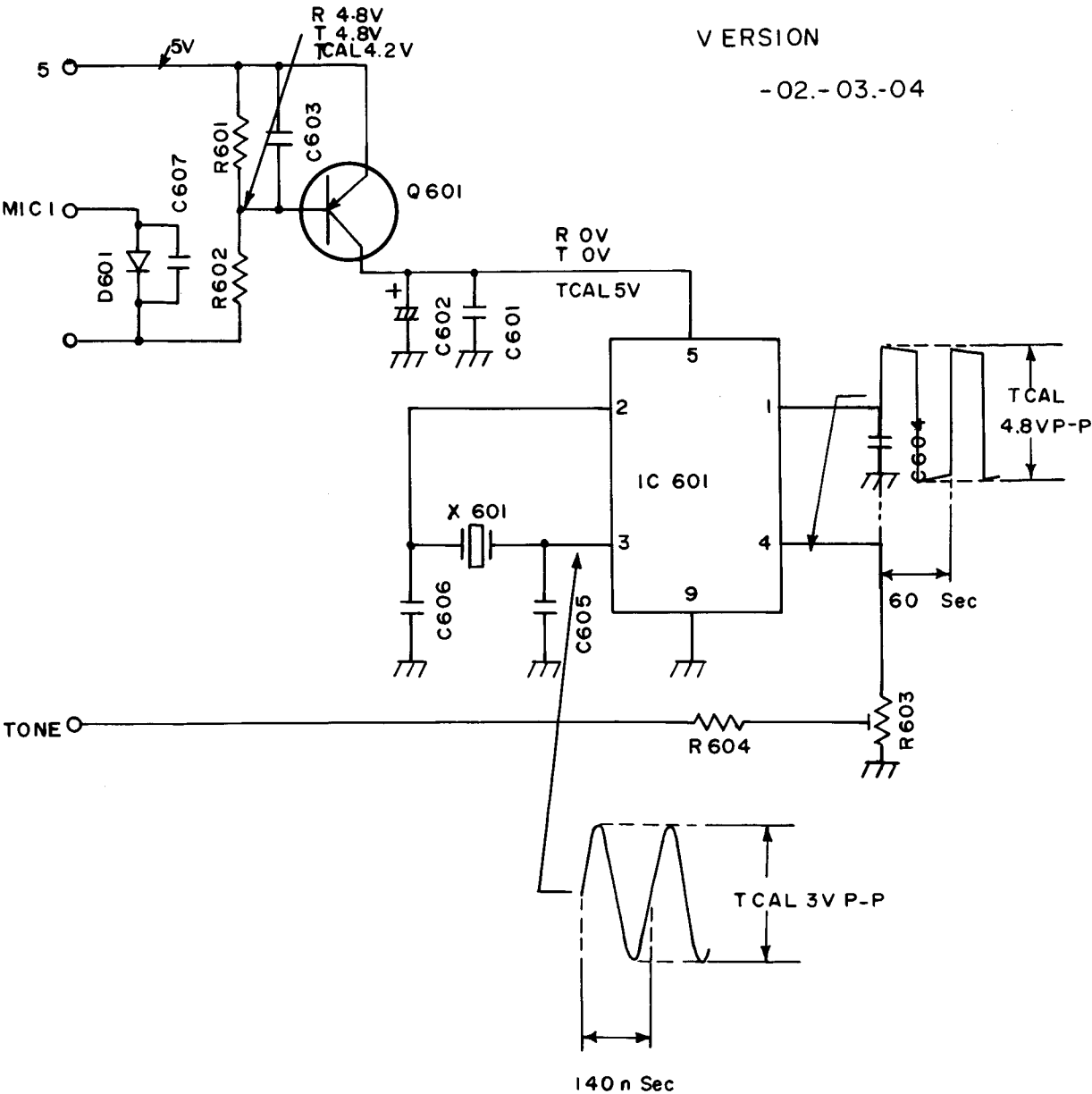


TONE UNIT VOLTAGE DIAGRAM (IC-02AT only)



TONE-CALL UNIT VOLTAGE DIAGRAM (IC-02E only)

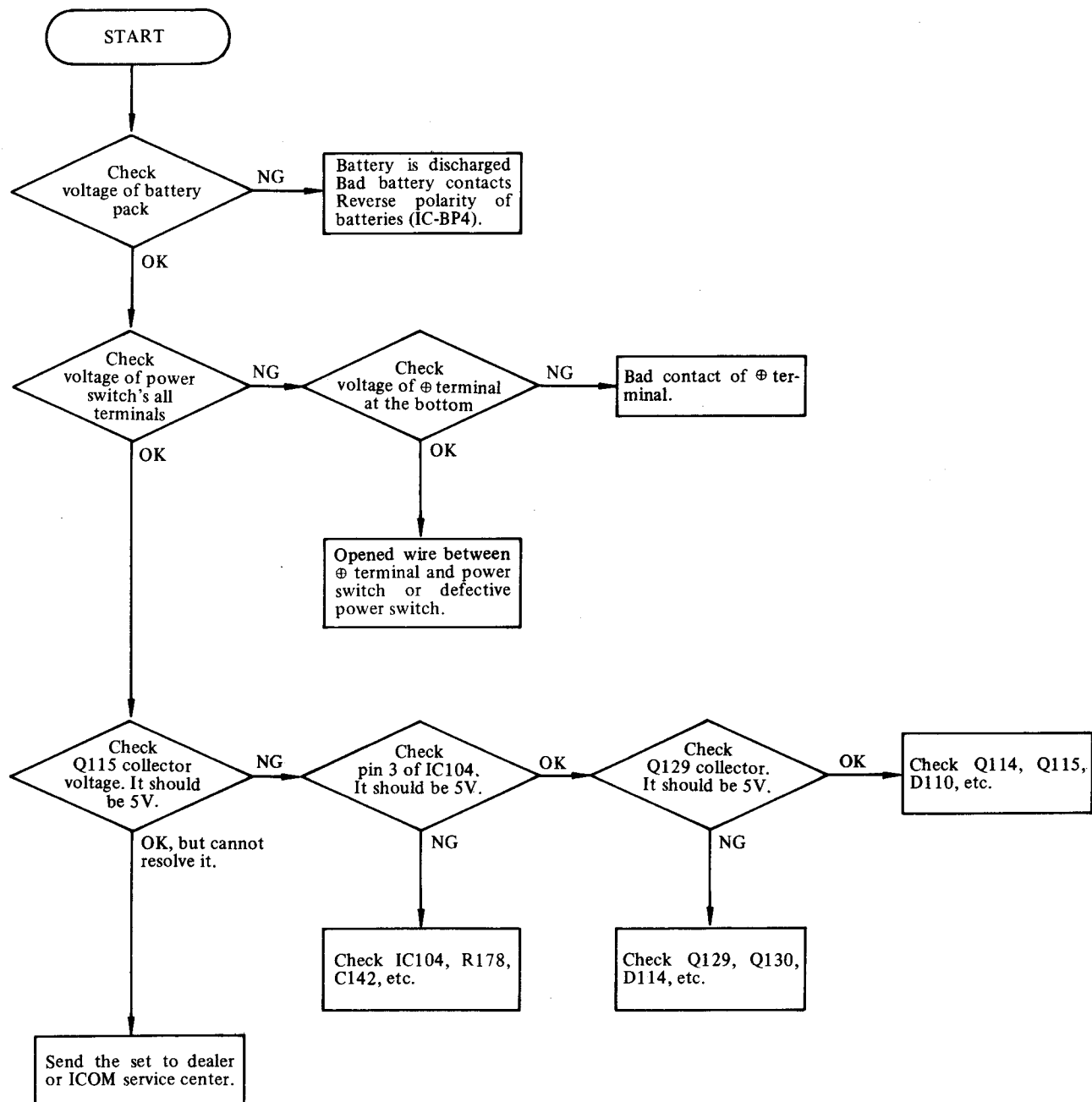
VERSION
-02.-03.-04



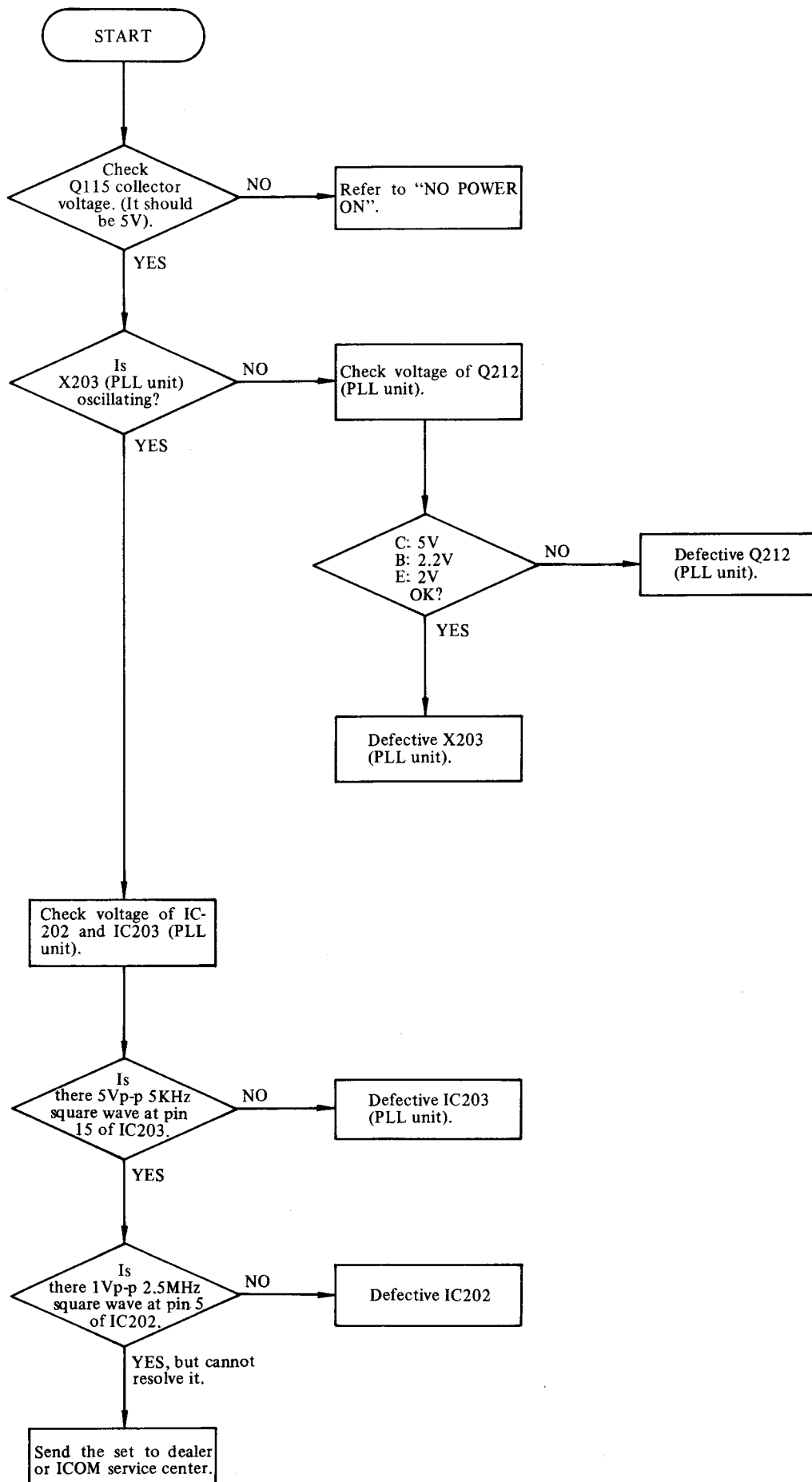
NOTE .. TCAL TONE CALL MODE

SECTION 10 TROUBLESHOOTING

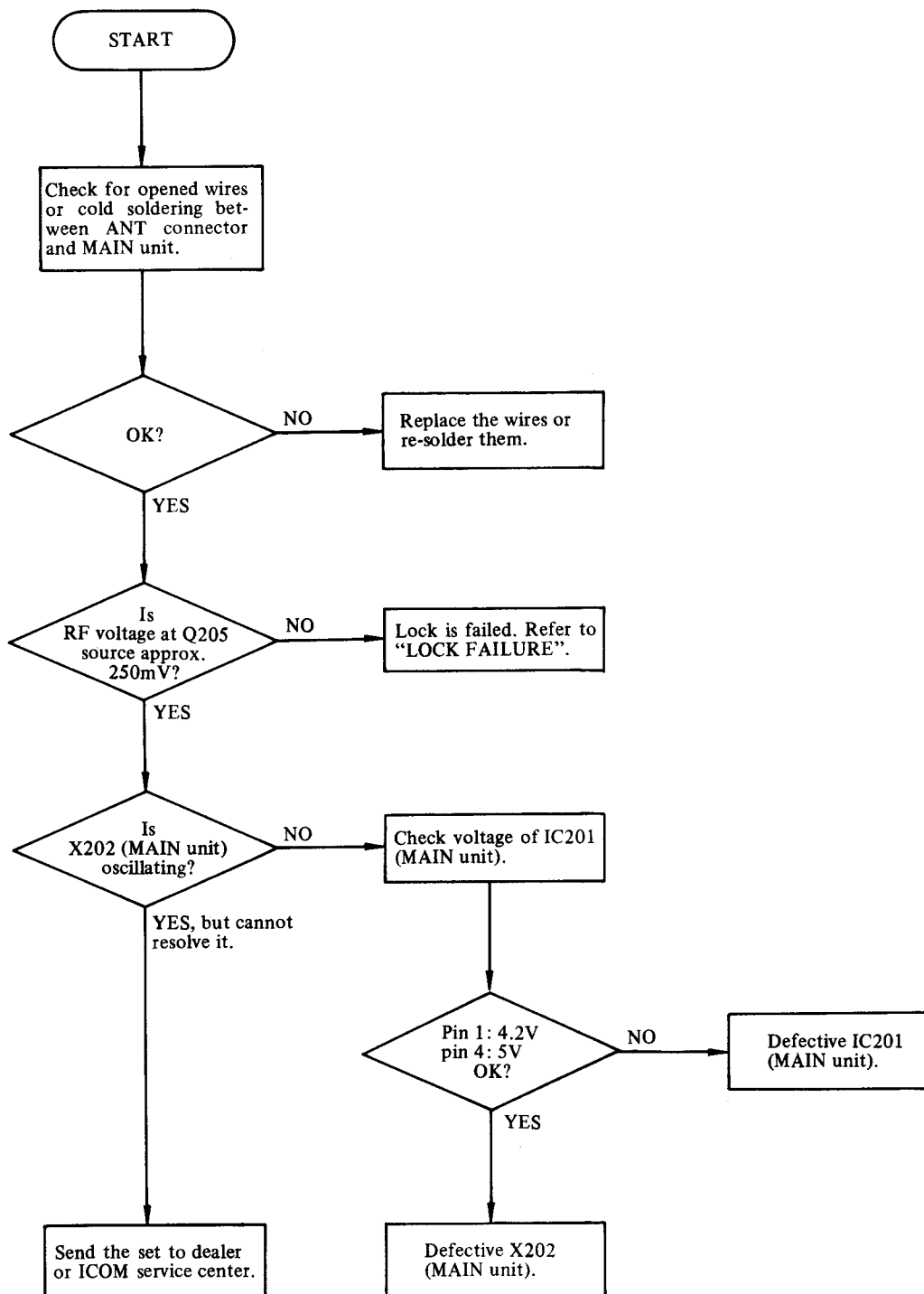
NO POWER ON



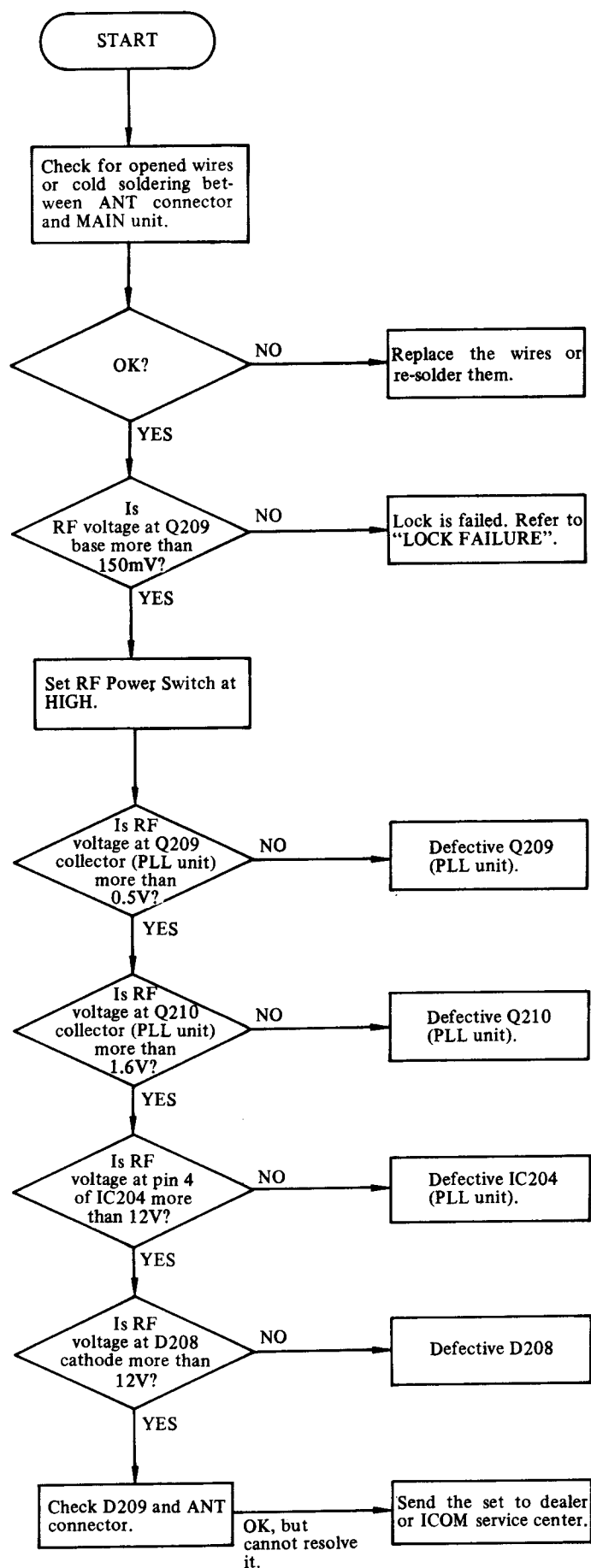
LOCK FAILURE



NO RECEPTION



NO TRANSMIT RF POWER



SECTION 11 IC SPECIFICATIONS

HD 44795 (MPU)

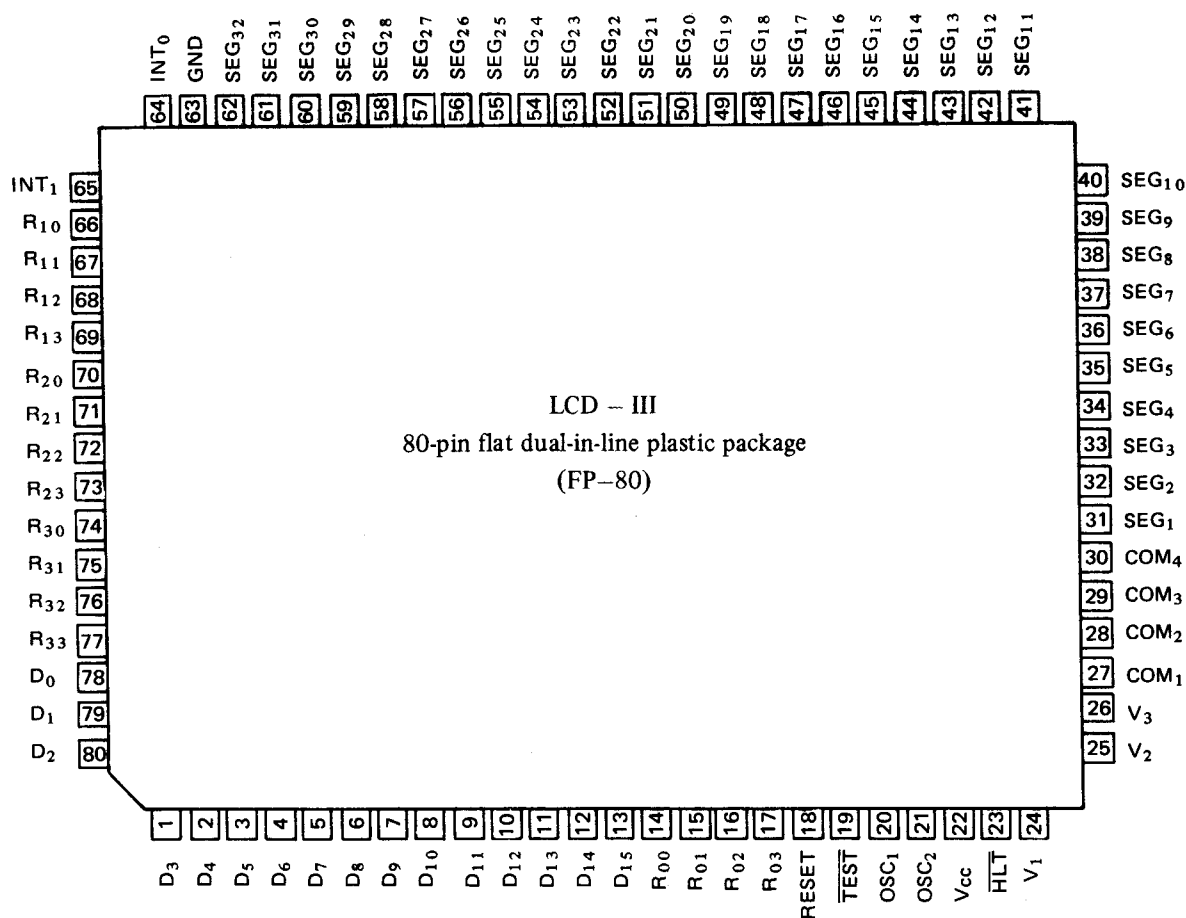
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT	REMARKS
V _{CC}	Supply Voltage	- 0.3 ~ + 7.0	V	
V _{T1}	Lead Voltage (1)	- 0.3 ~ V _{CC} + 0.3	V	Note 1)
V _{T2}	Lead Voltage (2)	- 0.3 ~ + 10.0	V	Note 2)
-ΣI _{O1}	Maximum Output Current (1)	45	mA	
ΣI _{O2}	Maximum Output Current (2)	45	mA	
TOPR	Operating Temperature	- 20 ~ + 75	°C	
TSTG	Storage Temperature	- 55 ~ + 125	°C	

Note 1): Use all pins except V_{r1}.

Note 2): Use open drain output pins and input and output pins.

PIN CONNECTION

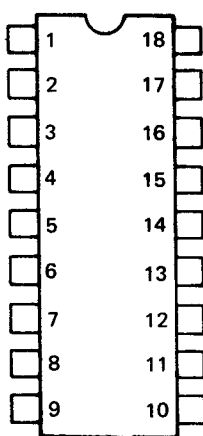


μPD 2834C (PLL FREQUENCY SYNTHESIZER)

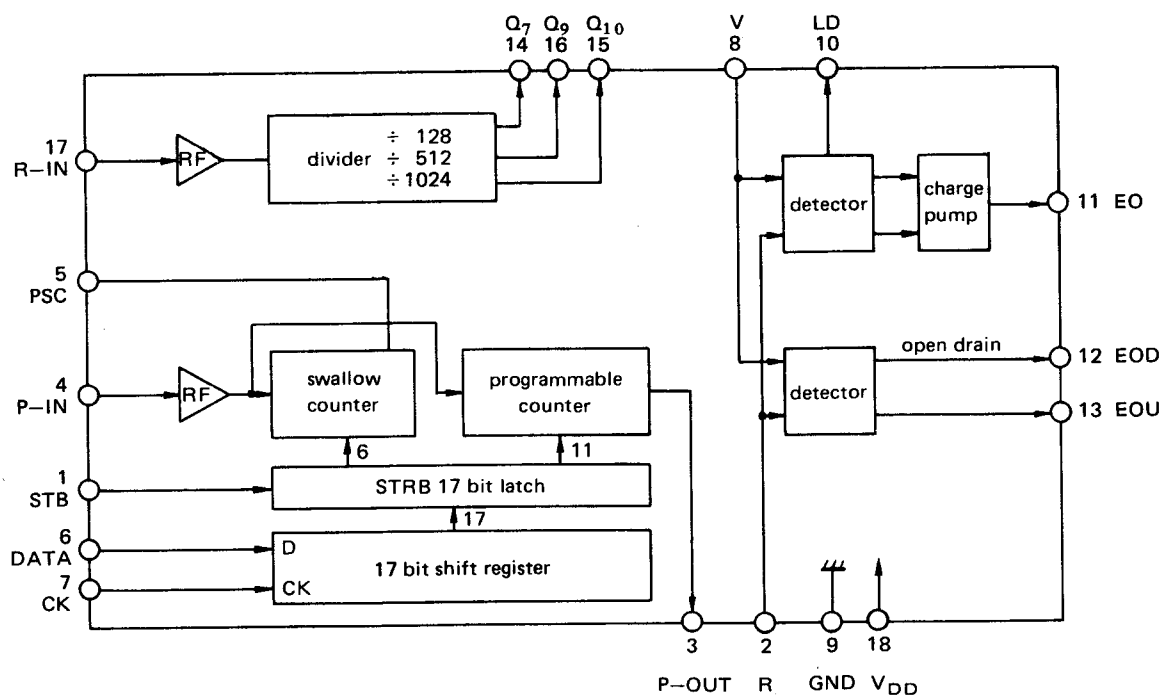
MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT	REMARKS
V _{DD}	Supply Voltage	− 0.3 ~ + 7.0	V	
V _{IN}	Input Voltage	− 0.5 ~ + V _{DD} + 0.5	V	
V _{OUT}	Output Voltage	− 0.5 ~ + V _{DD} + 0.5	V	
V _{OUT}	Output Voltage	− 0.5 ~ + V _{DD} + 3.0	V	EOU pins only
TOPR	Operating Temperature	− 40 ~ + 85	°C	
TSTR	Storage Temperature	− 65 ~ + 150	°C	

PIN CONNECTION



BLOCK DIAGRAM

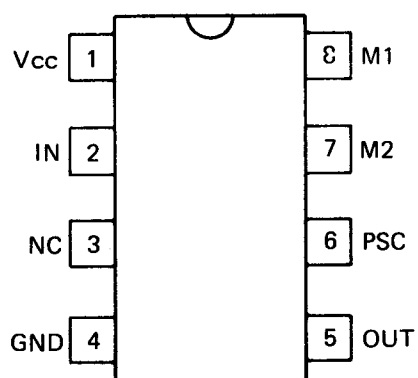


μPD571C (LOW POWER PRESCALER)

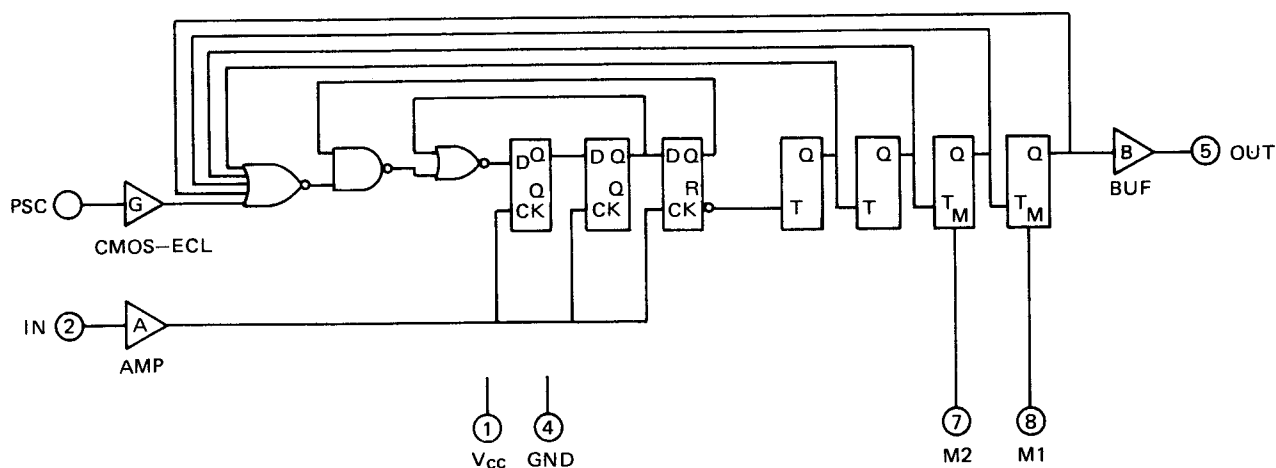
MAXIMUM RATINGS (ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{CC}	Supply Voltage (MAX)	− 0.5 ~ + 6.0	V
V _{IN}	Input Voltage	− 0.5 ~ + V _{CC} + 0.5	V
I _O	Output Current	− 10	mA
T _{STG}	Storage Temperature	− 55 ~ + 125	°C

PIN CONNECTION



BLOCK DIAGRAM



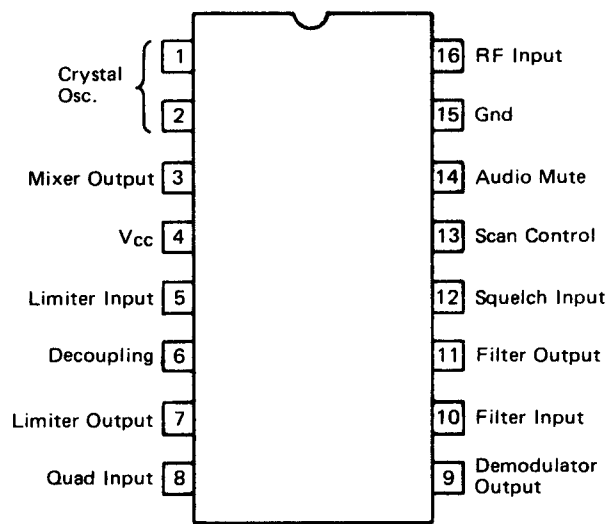
when M1 and M2 are Hi (V_{CC}), FF is equal to buffer.

MC3357 (LOW POWER FM IF)

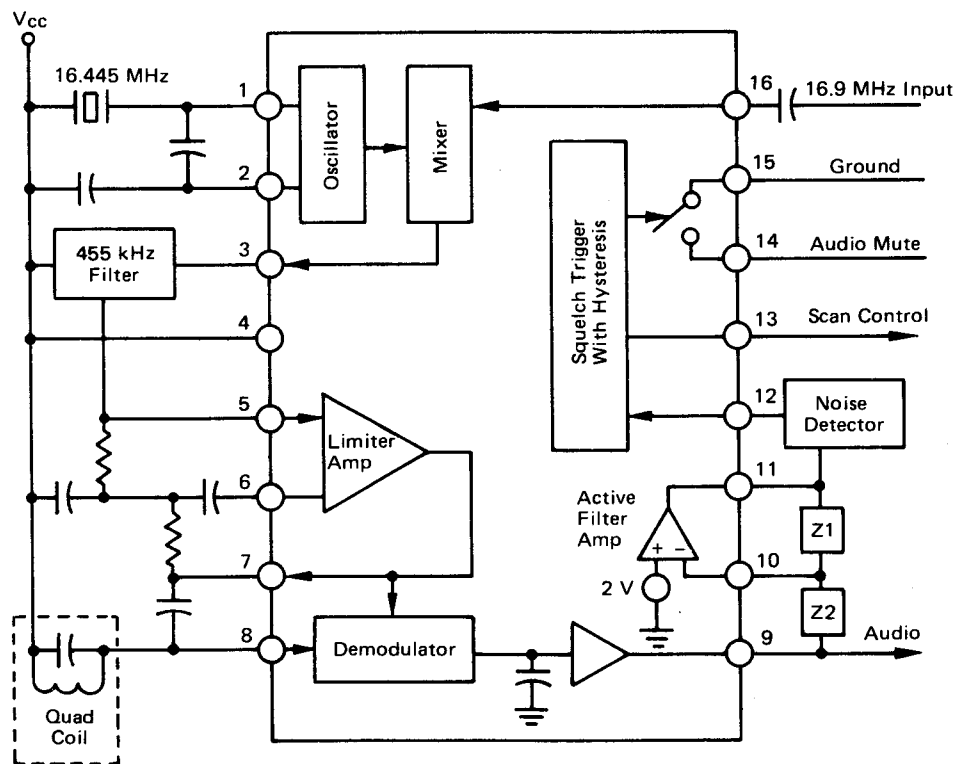
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{CC} (max)	Power Supply Voltage	12	V _{dc}
V _{CC}	Operating Supply Voltage	4 or 8	V _{dc}
—	Detector Input Voltage	1.0	V _{p-p}
V ₁₆	Input Voltage (V _{CC} ≥ 6.0 Volts)	1.0	V _{RMS}
V ₁₄	Mute Function	− 0.5 to 5.0	V _{pk}
T _J	Junction Temperature	150	°C
T _A	Operating Ambient Temperature Range	− 30 to + 70	°C
T _{STG}	Storage Temperature Range	− 65 to + 150	°C

PIN CONNECTION



BLOCK DIAGRAM

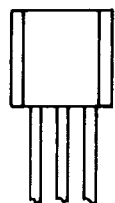


S-81250HG (C-MOS VOLTAGE REGULATOR)

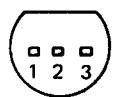
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
V_{IN}	Input Voltage	18	V
I_{OUT}	Output Current	100	mA
V_{OUT}	Output Voltage	$V_{in} + 0.3 \sim V_{SS} - 0.3$	V
P_d	Permissible Dissipation	200	mW
T_{OPR}	Operating Temperature	$-20 \sim +70$	°C
T_{STG}	Storage Temperature	$-40 \sim +125$	

PIN CONNECTION

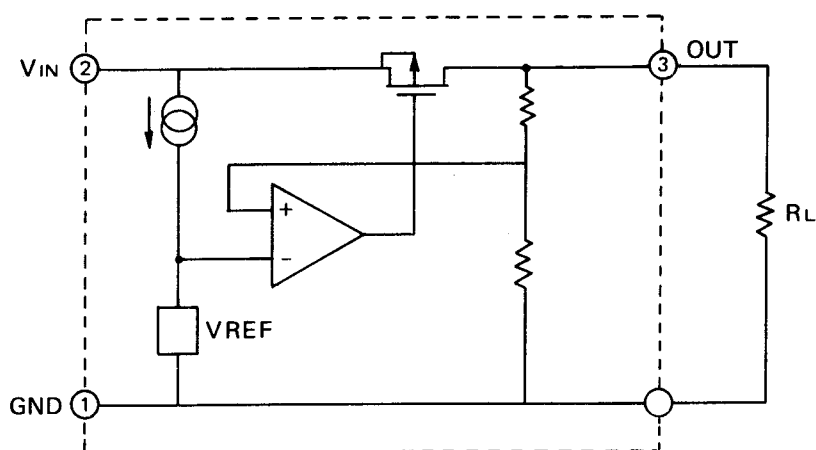


1 GND
2 V_{IN}
3 V_{OUT}



BOTTOM VIEW

BLOCK DIAGRAM

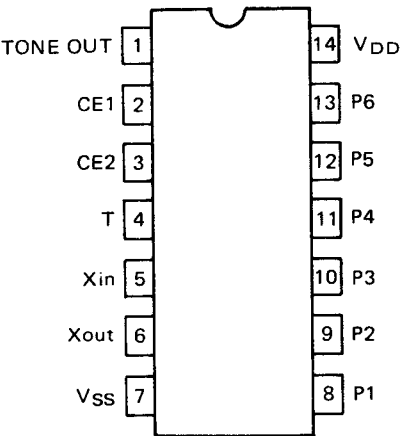


S-7116A TONE GENERATOR C-MOS LSI

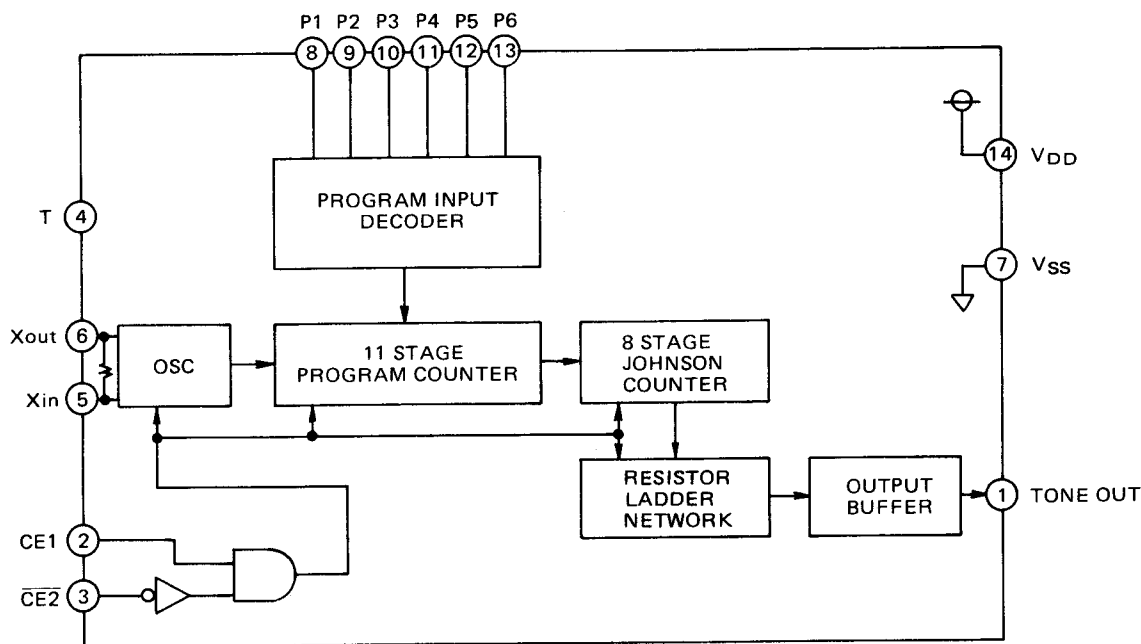
MAXIMUM RATING

SYMBOL	DESCRIPTION	RATINGS		UNIT
		Min.	Max.	
$V_{DD} - V_{SS}$	Supply Voltage		12.0	
V_{IN}	Input Voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	V
V_{OUT}	Output Voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
T_{OPR}	Operating Temperature	- 25	+ 70	°C
T_{STG}	Storage Temperature	- 40	+ 125	
P_d	Permissible Dissipation		300	mW

PIN CONNECTION



BLOCK DIAGRAM



* Program Input Pin; CE1 includes a pull-down resistor, CE2 includes a pull-up resistor.
* T = Test pin

Code and Tone Frequency of P₁ ~ P₆

fosc = 3.579545 MHz

TONE NO.	FREQUENCY (Hz)		DIVIDING RATIO	P1 P2 P3 P4 P5 P6						TONE NO.	FREQUENCY (Hz)		DIVIDING RATIO	P1 P2 P3 P4 P5 P6					
	NOMINAL	ACTUAL									NOMINAL	ACTUAL							
01	67.0	66.98	1670	1						39	500	499.4	224	1	1	1			1
02	71.9	71.89	1556		1					40	600	601.4	186				1		1
03	74.4	74.38	1504	1	1					41	700	699.1	160	1			1		1
04	77.0	76.99	1453			1				42	800	799.0	140		1		1		1
05	79.7	79.67	1404	1		1				43	900	902.1	124	1	1		1		1
06	82.5	82.49	1356		1	1				44	1000	998.8	112			1	1		1
07	85.4	85.39	1310	1	1	1				45	1600	1598.0	70	1		1	1		1
08	88.5	88.50	1264				1			46	1700	1694.9	66		1	1	1		1
09	91.5	91.46	1223	1			1			47	1750	1747.8	64	1	1	1	1		1
10	94.8	94.80	1180		1		1			48	1800	1804.2	62					1	1
11	97.4	97.44	1148	1	1		1			49	1300	1300.7	86	1				1	1
12	100.0	99.96	1119			1	1			50	2000	1997.5	56		1			1	1
13	103.5	103.48	1081	1		1	1			51	2200	2193.3	51	1	1			1	1
14	107.2	107.25	1043		1	1	1			52	2975	2943.7	38			1		1	1
15	110.9	110.86	1009	1	1	1	1			53	2550	2542.3	44	1		1		1	1
16	114.8	114.85	974				1			54	2295	2282.9	49		1	1		1	1
17	118.8	118.75	942	1			1			55	2125	2110.6	53	1	1	1		1	1
18	123.0	123.06	909		1		1			56	1275	1271.1	88				1	1	1
19	127.3	127.26	876	1	1		1			57	1445	1452.7	77	1			1	1	1
20	131.8	131.76	849			1	1												
21	136.5	136.58	819	1		1	1												
22	141.3	141.24	792		1	1	1												
23	146.2	146.22	765	1	1	1	1												
24	151.4	151.37	739				1	1											
25	156.7	156.67	714	1			1	1											
26	162.2	162.12	690		1		1	1											
27	167.9	167.96	666	1	1		1	1											
28	173.8	173.70	644			1	1	1											
29	179.9	179.84	622	1		1	1	1											
30	186.2	186.12	601		1	1	1	1											
31	192.8	192.86	580	1	1	1	1	1											
32	203.5	203.38	550						1										
33	210.7	210.66	531	1					1										
34	218.1	218.50	513		1				1										
35	225.7	225.53	496	1	1				1										
36	233.6	233.53	479			1			1										
37	241.8	241.60	463	1		1			1										
38	250.3	250.25	447		1	1			1										

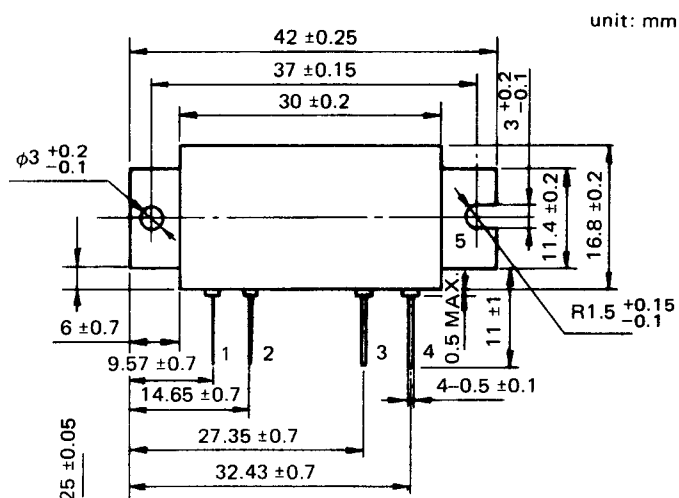
Note: Input voltage of P₁ ~ P₆; 1 = V_{DD}, blank = V_{SS} or open.

SC-1025 (VHF POWER AMPLIFIER MODULE)

MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{CC}	Supply Voltage	16	V
V _{BB}	Bias Voltage	6	V
P _i	Input Power	300	mW
T _{C(OP)}	Operating Temperature	− 30 ~ 100	°C
T _{STG}	Storage Temperature	− 40 ~ 110	°C

PIN CONNECTOR

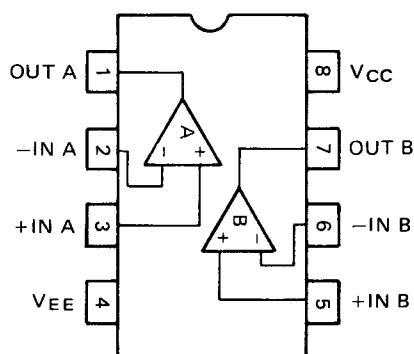


TA75358P (DUAL DRIVER)

MAXIMUM RATINGS (T_a = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{CC} , V _{EE}	Supply Voltage	± 18, 36	V
DV _{IN}	Drive Input Voltage	± 36	V
V _{IN}	Input Voltage	− 0.3 ~ 36	V
P _D	Permissible Dissipation	500	mW
T _{OPR}	Operating Temperature	− 40 ~ 85	°C
T _{STG}	Storage Temperature	− 55 ~ 125	°C

PIN CONNECTION

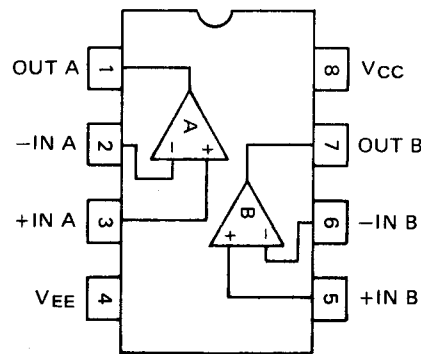


TA75393P (DUAL COMPARATOR)

MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
VCC	Supply Voltage	± 18 ~ 36	V
DVIN	Drive Input Voltage	± 36	V
CMVIN	Compare Input Voltage	− 0.3 ~ VCC	V
PD	Permissible Dissipation	500	mW
TOPR	Operating Temperature	− 40 ~ 85	°C
TSTG	Strage Temperature	− 55 ~ 125	°C

PIN CONNECTION

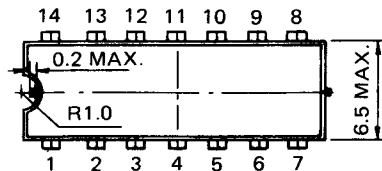


TC4069UBP (HEX INVERTER)

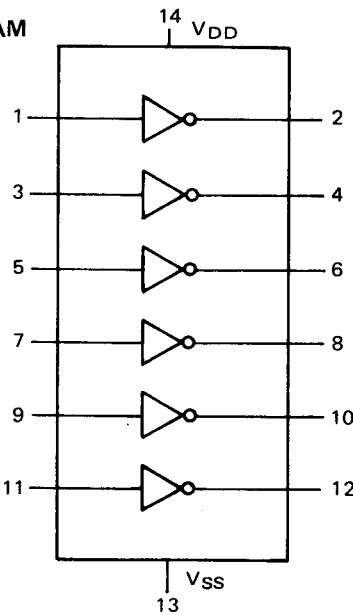
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
VDD	Supply Voltage	VSS − 0.5 ~ VSS + 20	V
VIN	Input Voltage	VSS − 0.5 ~ VDD + 0.5	V
VOUT	Output Voltage	VSS − 0.5 ~ VDD + 0.5	V
IIN	Input Current	± 10	mA
PD	Permissible Dissipation	300	mW
TSTG	Strage Temperature	− 65 ~ 150	°C
TSOL	Soldering Temperature and Time	260°C · 10 sec	

PIN CONNECTION



BLOCK DIAGRAM

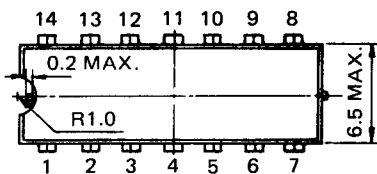


TC4071BP (QUAD 2-INPUT POSITIVE OR GATE)

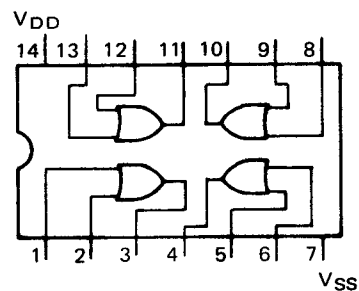
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{DD}	Supply Voltage	V _{SS} - 0.5 ~ V _{SS} + 20	V
V _{IN}	Input Voltage	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
V _{OUT}	Output Voltage	V _{SS} - 0.5 ~ V _{DD} ¼ 0.5	V
I _{IN}	Input Current	± 10	mA
P _D	Permissible Dissipation	300	mW
T _{STG}	Storage Temperature	- 65 ~ 150	°C
T _{SOL}	Soldering Temperature and Time	260°C • 10 sec	

PIN CONNECTION



BLOCK DIAGRAM

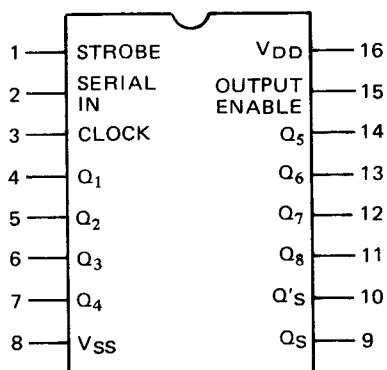


TC4094BP (8-STAGE SHIFT-AND-STORE BUSREGISTER)

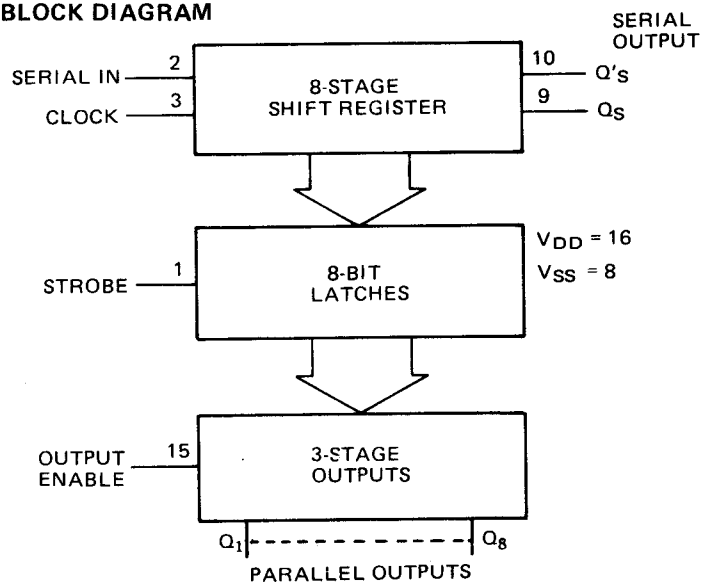
MAXIMUM RATINGS

SYMBOL	DESCRIPTION	RATINGS	UNIT
V _{DD}	Supply Voltage	V _{SS} - 0.5 ~ V _{SS} + 20	V
V _{IN}	Input Voltage	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
V _{OUT}	Output Voltage	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
I _{IN}	Input Current	± 10	mA
P _D	Permissible Dissipation	300	mW
T _{STG}	Storage Temperature	- 65 ~ 150	°C
T _{SOL}	Soldering Temperature and Time	260°C • 10 sec	

PIN CONNECTION



BLOCK DIAGRAM

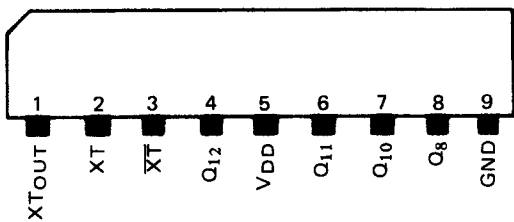


TC5082P (OSCILLATOR AND 12 STAGE DIVIDER)

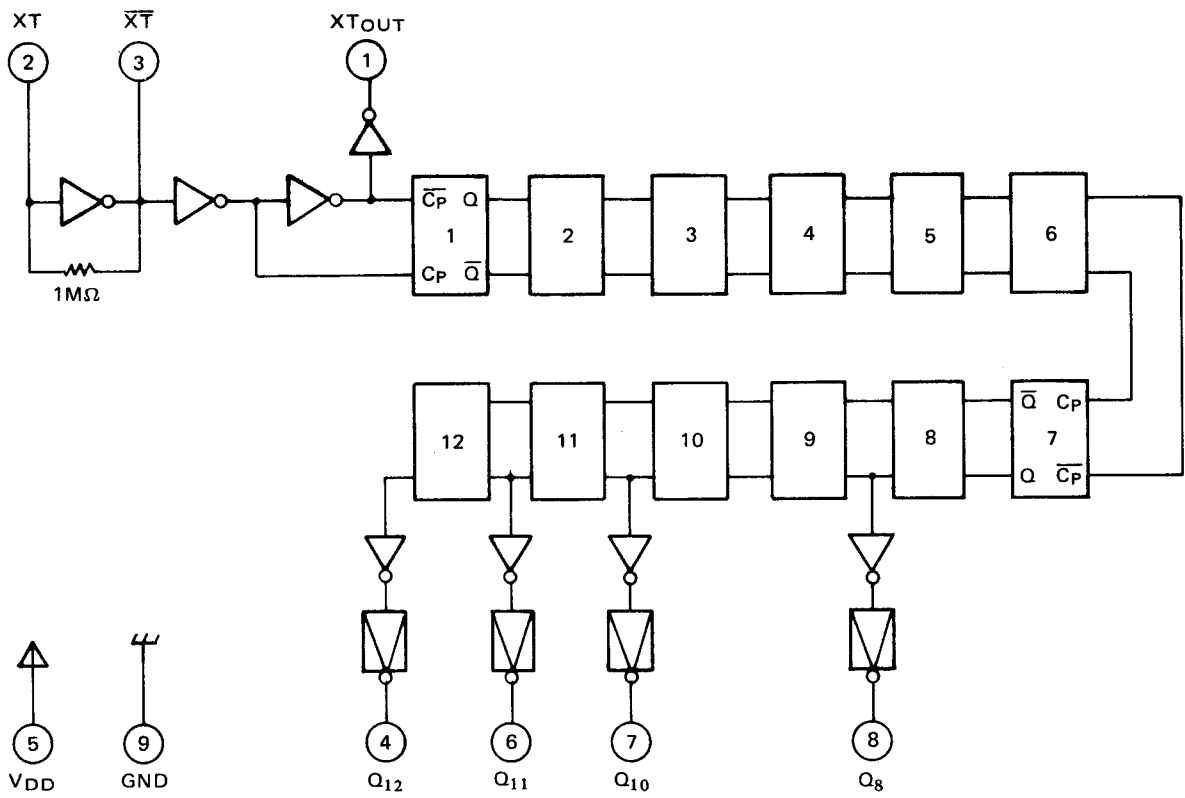
MAXIMUM RATINGS (Ta = 25°C)

SYMBOL	DESCRIPTION	RATINGS	UNIT
VDD	Supply Voltage	10	V
VIN	Input Voltage	− 0.3 ~ VDD + 0.3	V
TOPR	Operating Temperature	− 30 ~ 75	°C
TSTG	Storage Temperature	− 55 ~ 125	°C

PIN CONNECTION



BLOCK DIAGRAM



SECTION 12 PARTS LIST

[MAIN UNIT]

[MAIN UNIT]

REF. NO.	DESCRIPTION (PART NO.)	
IC101	IC	TA75358P
IC102	IC	TC4071BP
IC103	IC	TC4069UBP
IC104	IC	S81250HG
IC105	IC	TA75393P
Q101	Transistor	2SC2458-GR
Q102	Transistor	2SC2458-GR
Q103	Transistor	2SA1048-GR
Q104	Transistor	2SC2458-GR
Q105	Transistor	2SC2458-GR
Q106	Transistor	2SC2458-GR
Q107	Transistor	2SA1048-GR
Q108	Transistor	2SA1048-GR
Q109	Transistor	2SA1048-GR
Q110	Transistor	2SC2458-GR
Q111	Transistor	2SB909M-R
Q112	Transistor	2SC2458-GR
Q113	Transistor	2SB909M-R
Q114	Transistor	2SC2458-GR
Q115	Transistor	2SB909M-R
Q116	Transistor	2SA1048-GR
Q117	Transistor	2SA1048-GR
Q118	Transistor	2SC2458-GR
Q119	Transistor	2SC2458-GR
Q120	Transistor	2SB909M-R
Q121	Transistor	2SA1048-GR
Q122	Transistor	2SD1225M-R
Q123		
Q124		
Q125		
Q126		
Q127		
Q128		
Q129	Transistor	2SA1048-GR
Q130	Transistor	2SC2458-GR
Q131	Transistor	2SB909M-R
D101	Diode	1SS211
D102		
D103	Diode	1SS211
D104	Diode	1SS211
D105	Diode	1SS211
D106	Zener	RD9.1EB3
D107	Diode	1SS211
D108	Diode	1SS211
D109	Diode	1SS211
D110	Diode	1SS211
D111	Diode	1SS211
D112	Diode	1SS211
D113	Diode	1SS211
D114	Diode	1SS211
D115	Diode	1SS211
D116	Diode	1SS211
D117	Diode	1SS211
D118	Diode	1SS233
D119	Diode	1SS233
D120	Diode	1SS211
D121	Diode	1SS211

REF. NO.	DESCRIPTION (PART NO.)		
R101	Resistor	33K	R10
R102	Resistor	120K	ELR10
R103	Resistor	470	ELR10
R104	Resistor	120K	ELR10
R105	Resistor	12K	R10
R106	Resistor	5.6K	ELR10
R107	Resistor	120	ELR10 (for -01, -02, -03, -04, -07, -08, -09)
		270	ELR10 (for -05, -06)
R108	Resistor	470K	ELR10
R109	Resistor	2.2K	ELR10
R110	Resistor	1K	ELR10
R111	Resistor	3.3K	ELR10
R112	Resistor	100K	ELR10
R113	Resistor	220K	ELR10
R114	Resistor	82K	R10 (for -01, -02, -03, -04, -06, -07, -08)
		27K	R10 (for -05, -09)
R115	Resistor	56K	R10 (for -05, -09)
R116	Resistor	39K	ELR10
R117	Resistor	39K	ELR10
R118	Resistor	12K	ELR10
R119	Resistor	220K	ELR10
R120	Resistor	1K	ELR10
R121	Resistor	100K	ELR10
R122	Resistor	5.6K	ELR10
R123	Resistor	1M	ELR10
R124	Resistor	300K	ELR10
R125	Resistor	180K	ELR10
R126	Variable	K09110019-10KB	
R127	Resistor	4.7K	ELR10
R128	Resistor	300K	ELR10
R129	Resistor	100K	ELR10
R130	Resistor	6.8K	ELR10
R131	Resistor	1.2K	ELR10
R132	Variable	K0911100A-5R1111-10KA	
R133	Resistor	22K	ELR10
R134	Resistor	470	R10
R135	Resistor	1.2K	ELR10
R136	Resistor	10K	ELR10
R137	Resistor	100K	ELR10
R138	Resistor	180K	ELR10
R139	Resistor	33K	ELR10
R140	Resistor	33K	ELR10
R141	Resistor	10K	ELR10
R142	Resistor	10K	ELR10
R143	Resistor	10K	ELR10
R144	Resistor	470K	ELR10
R145	Resistor	330K	ELR10
R146	Resistor	27K	ELR10
R147	Resistor	22K	ELR10
R148	Resistor	6.8K	ELR10
R149	Resistor	12K	ELR10
R150	Resistor	8.2K	ELR10
R151	Resistor	1.5K	ELR10
R152	Resistor	390K	ELR10
R153	Resistor	1	ELR10
R154	Resistor	1	ELR10

[MAIN UNIT]

REF. NO.	DESCRIPTION (PART NO.)		
R155	Resistor	1M	ELR10
R156	Resistor	220K	ELR10
R157	Resistor	270K	ELR10
R158	Resistor	39K	ELR10
R159			
R160			
R161			
R162			
R163			
R164	Resistor	33K	ELR10
R165	Resistor	10K	ELR10
R166	Resistor	6.8K	R10
R167	Resistor	180K	ELR10
R168	Resistor	150K	R10
R169	Resistor	39K	ELR10
R170	Resistor	120K	ELR10
R171	Resistor	27K	ELR10
R172	Resistor	12	ELR10
R173	Resistor	5.6K	ELR10
R174	Resistor	1K	ELR10
R175	Resistor	1K	R10
R176	Resistor	100K	R10
R177	Resistor	470K	R10
R178	Resistor	470	R10
R179	Resistor	1K	R10
R180	Resistor	4.7K	R10
R181	Resistor	4.7K	R10
R182	Resistor	470K	R10
C101	Barrier Lay	0.01	50V
C102	Electrolytic	10	16V RC3
C103	Ceramic	470P	50V
C104	Ceramic	470P	50V
C105	Ceramic	470P	50V
C106	Tantalum	CS15E1VR22 (for -01, -02,-03,-04,-07,-08, -09) CS15E1VOR1 (for -05, -06)	
C107	Ceramic	0.001	50V
C108	Mylar	0.0022	50V
C109	Mylar	0.01	50V
C110	Ceramic	120P	50V
C111	Electrolytic	0.22	50V RC3
C112	Electrolytic	0.22	50V RC3
C113	Ceramic	10P	50V
C114	Ceramic	0.001	50V
C115	Ceramic	0.001	50V
C116	Ceramic	0.001	50V
C117	Electrolytic	0.22	50V RC3
C118	Electrolytic	0.22	50V RC3
C119	Electrolytic	1	50V RC3
C120	Barrier Lay	0.01	50V
C121	Electrolytic	10	16V RC3
C122	Electrolytic	0.22	50V RC3
C123	Electrolytic	22	6.3V RC3
C124	Electrolytic	22	6.3V RC3
C125	Electrolytic	22	6.3V RC3
C126	Electrolytic	10	16V RC3
C127	Ceramic	100P	50V
C128	Electrolytic	0.22	50V RC3
C129	Electrolytic	47	25V MS7
C130	Electrolytic	100	10V MS7
C131	Ceramic	100P	50V
C132	Ceramic	470P	50V
C133	Barrier Lay	0.0033	50V

[MAIN UNIT]

REF. NO.	DESCRIPTION (PART NO.)		
C134	Barrier Lay	0.0027	50V
C135	Electrolytic	47	6.3V RC3
C136	Electrolytic	22	6.3V RC3
C137	Ceramic	470P	50V
C138	Electrolytic	22	6.3V RC3
C139	Electrolytic	22	6.3V RC3
C140	Ceramic	470P	50V
C141	Ceramic	470P	50V
C142	Electrolytic	33	25V RC3
C143	Ceramic	0.001	50V
C144	Ceramic	0.001	50V
C145	Ceramic	0.001	50V
C146	Ceramic	0.001	50V
C147			
C148	Tantalum	0.1	50V (for -05, -09)
C149	Ceramic	470P	50V
C150	Barrier Lay	0.018	50V
RL101	Relay	OUC-SS-114D	
S101	Switch	KHH	10906
S102	Switch	KHH	10906
S103	Switch	KHH	10906
S104	Switch	KHH	10906
S105	Switch	SPH	221B
S106	Switch	SPH	221B
BT101	Lithium Cell	BR2325-1HC	

[PLL UNIT]

REF. NO.	DESCRIPTION (PART NO.)	
IC201	IC	MC 3357P
IC202	IC	μPB571C
IC203	IC	μPD2834C
IC204	IC	SC-1025
Q201	Transistor	2SC2668-O
Q202	Transistor	2SC2668-O
Q203	Transistor	2SC2668-O
Q204	Transistor	2SC2668-O
Q205	FET	2SK241-Y
Q206	FET	2SK241-Y
Q207	Transistor	2SB561-C
Q208	Transistor	2SC2026
Q209	Transistor	2SC2026
Q210	Transistor	2SC2407
Q211	FET	2SK192A-Y
Q212	Transistor	2SC2458-GR
Q213	Transistor	2SB909M-R
Q214	Transistor	2SC2458-GR
Q215	Transistor	2SC2458-GR
Q216	Transistor	2SA1048-GR
Q217	Transistor	2SA1048-GR
Q218	Transistor	2SA1048-GR
D201	Diode	1SS99
D202	Diode	1SS97
D203	Diode	1SS216
D204	Diode	1SS216
D205	Diode	1SS211
D206	Diode	1SS97

[PLL UNIT]

REF. NO.	DESCRIPTION (PART NO.)	
D207	Diode	1SS97
D208	Diode	1SS216
D209	Diode	1SS216
D210	Diode	1SS211
D211	Varactor Diode	1T25
D212	Varactor Diode	1T25
D213	Diode	1SS211
D214	Diode	1SS216
D215		
D216	Diode	1SS211
D217	Varactor Diode	1SV100 (for -05, -09)
D218	Diode	1SS211
F1201	Ceramic Filter	CFU455E2
F1202	Crystal Filter	16M15B2
X201	Discriminator	CDB455C7
X202	Crystal	HC-18/T 16.445MHz
X203	Crystal	HC-18/T 5.12MHz (except -04) HC-18/T CR9 (-04 only)
L201	Coil	LS262
L202	Coil	LS265
L203	Coil	LS265
L204	Coil	LS265
L205	Coil	LS265
L206	Coil	LA237
L207	Choke	LAL03NA221K
L208	Coil	LA237
L209	Coil	LA237
L210	Coil	LA236
L211	Choke	LAL03BA4R7K
L212	Coil	LA237
L213	Coil	LA235
L214	Coil	LA234
L215	Choke	LAL03NA4R7K
L216	Choke	LAL03NA4R7K
L217	Choke	LAL03NA4R7K
L218	Coil	LB162
L219	Choke	LAL03NA4R7K
L220	Choke	LAL03NA4R7K
R201		
R202	Resistor	12K ELR10
R203	Resistor	680K ELR10
R204	Resistor	15K ELR10
R205	Resistor	3.3K H0521A
R206	Resistor	1M ELR10
R207	Resistor	4.7K ELR10
R208	Resistor	470 ELR10
R209	Resistor	1.5K ELR10
R210	Resistor	47K ELR10
R211	Resistor	1.5K ELR10
R212	Resistor	1.5K ELR10
R213	Resistor	82K ELR10
R214	Resistor	2.2K ELR10
R215	Resistor	4.7K ELR10
R216	Resistor	330K ELR10
R217	Resistor	47K ELR10
R218	Resistor	1K ELR10
R219	Resistor	1.2K ELR10
R220	Resistor	100 R10
R221	Resistor	56 R10
R222	Resistor	2.2K ELR10
R223	Resistor	100 ELR10

[PLL UNIT]

REF. NO.	DESCRIPTION (PART NO.)	
R224	Resistor	18 ELR10
R225	Resistor	6.8K ELR10
R226	Resistor	4.7K ELR10
R227	Resistor	5.6K ELR10
R228	Resistor	470 ELR10
R229	Resistor	10K ELR10
R230	Resistor	22K ELR10
R231	Resistor	10K ELR10
R232	Resistor	1.2K ELR10
R233	Resistor	560 ELR10
R234	Resistor	68 ELR10
R235	Resistor	1K ELR10
R236	Resistor	100 ELR10
R237	Resistor	10 ELR10
R238	Resistor	220 ELR10
R239	Resistor	4.7K R10
R240	Resistor	4.7K ELR10
R241	Resistor	150K R10
R242	Resistor	330 ELR10
R243	Resistor	100K H0521A
R244	Resistor	220K ELR10
R245	Resistor	100K ELR10
R246	Resistor	47K ELR10
R247	Resistor	100K ELR10
R248		
R249	Resistor	10K ELR10
R250		
R251	Resistor	100 ELR10
R252	Resistor	1.5K ELR10
R253	Resistor	1.8K R10
R254	Resistor	470K ELR10
R255	Resistor	220K ELR10 (for -01, -02, -03, -04, -06, -07, -08) 39K ELR10 (for -05, -09)
R256	Resistor	220K ELR10 (for -01, -02, -03, -04, -06, -07, -08) 39K ELR10 (for -05, -09)
R257	Resistor	100 ELR10
R258	Resistor	5.6K ELR10
R259	Resistor	5.6K ELR10
R260	Resistor	15K ELR10
R261		
R262	Resistor	47K ELR10
R263	Resistor	120K R10
R264	Resistor	560K ELR10
R265	Resistor	22K R10
R266	Resistor	8.2K ELR10
R267	Trimmer	22K H0521A
R268	Resistor	2.2K R10
R269	Trimmer	2.2K H0521A
R270	Resistor	1M ELR10
R271	Resistor	27 ELR10
R272	Resistor	5.6K ELR10
R273	Resistor	47K ELR10
R274	Resistor	22K R10
R275	Resistor	220K R10
R276	Resistor	470K R10 (for -05, -09)
R277	Resistor	390K R10 (for -05, -09)

[PLL UNIT]

REF. NO.	DESCRIPTION (PART NO.)			
C201	Electrolytic	1	50V	RC2
C202	Ceramic	470P	50V	
C203	Ceramic	470P	50V	
C204	Ceramic	15P	50V	
C205	Barrier Lay	0.0033	50V	
C206	Ceramic	82P	50V	
C207	Ceramic	0.001	50V	
C208	Barrier Lay	0.1	16V	
C209	Electrolytic	0.1	50V	RC2
C210	Ceramic	120P	50V	
C211	Ceramic	22P	50V	
C212	Electrolytic	1	50V	RC2
C213	Ceramic	0.001	50V	
C214	Electrolytic	10	16V	RC2
C215	Barrier Lay	0.0047	50V	
C216	Ceramic	0.001	50V	
C217	Ceramic	5P	50V	
C218	Barrier Lay	0.0047	50V	
C219	Ceramic	10P	50V	
C220	Barrier Lay	0.0047	50V	
C221	Ceramic	12P	50V	
C222	Ceramic	1P	50V	
C223	Ceramic	1P	50V	
C224	Ceramic	12P	50V	
C225	Ceramic	12P	50V	
C226	Ceramic	470P	50V	
C227	Ceramic	470P	50V	
C228	Ceramic	10P	50V	
C229	Ceramic	8P	50V	
C230	Ceramic	0.001	50V	
C231	Ceramic	0.001	50V	
C232	Ceramic	0.001	50V	
C233	Ceramic	470P	50V	
C234	Ceramic	22P	50V	
C235	Ceramic	0.001	50V	
C236	Ceramic	0.001	50V	
C237	Ceramic	33P	50V	
C238	Ceramic	0.001	50V	
C239	Ceramic	0.001	50V	
C240	Ceramic	0.001	50V	
C241	Ceramic	18P	50V	
C242	Ceramic	0.001	50V	
C243	Ceramic	0.001	50V	
C244	Ceramic	0.001	50V	
C245	Ceramic	22P	50V	
C246	Ceramic	0.001	50V	
C247	Ceramic	0.001	50V	
C248	Ceramic	1P	50V	
C249	Ceramic	470P	50V	
C250	Ceramic	5P	50V	
C251	Ceramic	20P	50V	
C252	Ceramic	20P	50V	
C253	Ceramic	1P	50V	
C254	Ceramic	5P	50V	
C255	Ceramic	470P	50V	
C256	Ceramic	15P	50V	
C257	Ceramic	0.001	50V	
C258	Ceramic	18P	50V	
C259	Ceramic	15P	50V	
C260	Ceramic	2P	50V	
C261	Ceramic	100P	50V	
C262	Ceramic	27P	50V	
C263	Ceramic	470P	50V	
C264	Ceramic	7P	50V	
C265	Ceramic	15P	50V	
C266	Mylar	0.0022	50V	

[PLL UNIT]

REF. NO.	DESCRIPTION (PART NO.)			
C267	Electrolytic	0.47	50V	RC2
C268	Electrolytic	0.47	50V	RC2
C269	Ceramic	470P	50V	
C270	Ceramic	470P	50V	
C271	Ceramic	68P	50V	
C272				
C273	Tantalum	CS15E1V0R1		
C274	Ceramic	33P	50V	
C275	Trimmer	ECR. GA015E30		
C276	Ceramic	43P	50V	
C277	Ceramic	4P	50V	
C278	Ceramic	5P	50V	
C279	Ceramic	0.001	50V	
C280	Ceramic	1P	50V	
C281	Ceramic	4P	50V	
C282	Tantalum	CS15E0J100		
C283	Electrolytic	1	50V	RC2
C284	Ceramic	0.001	50V	
C285	Barrier Lay	0.1	16V	
C286	Electrolytic	22	6.3V	RC2
C287	Trimmer	ECR. GA010D30		
C288	Ceramic	22P	50V	
C289	Ceramic	0.001	50V	
C290	Ceramic	220P	50V	
C291	Ceramic	100P	50V	
		(for -01, -02, -03, -04, -06, -07, -08)		
C292	Barrier Lay	0.01	50V	
C293	Ceramic	0.001	50V	
C294	Barrier Lay	0.0027	50V	
C295	Electrolytic	10	16V	RC2
C296	Ceramic	0.001	50V	
C297	Ceramic	0.001	50V	
C298	Ceramic	0.001	50V	
C299	Ceramic	0.001	50V	
C300	Ceramic	0.001	50V	
C301	Barrier Lay	0.0047	50V	
C302	Ceramic	0.001	50V	
C303	Ceramic	0.001	50V	
		(for -05, -09)		
J201	Connector	HSJ0836-01-010		
J202	Connector	BNC-RM-106		
J203	Connector	HSJ1102-01-040		
J204	Connector	HEC0747-01-010		
J205	Connector	RT-01T-1.3A		
J206	Connector	RT-01T-1.3A		

[LOGIC UNIT]

REF. NO.	DESCRIPTION (PART NO.)	
IC401	IC	HD44795A61
Q401	Transistor	2SC2712-Y
Q402	Transistor	2SA1162-Y
D401	Diode	1SS190 (for -03, -07) 1SS187 (-04 only)
D402	Diode	1SS181 (-01 only) 1SS187 (except -01)
D403	Diode	1SS190 (-01, -04, -05, -06, -08, -09)
D404		
D405		

[LOGIC UNIT]

REF. NO.	DESCRIPTION (PART NO.)			
D406	Diode	1SS190	(for -01,-04)	
D407		1SS181	(for -02,-03,-05,-06,-07,-08,-09)	
D408				
D409	Zener	RD4.7MB3		
R401	Resistor	6.8K	MCR18	
R402	Resistor	15K	MCR18	
R403	Resistor	1M	MCR18	
R404	Resistor	15K	MCR18	
R405	Resistor	100K	MCR18	
R406	Resistor	100K	MCR18	
R407	Resistor	100K	MCR18	
R408	Resistor	100K	MCR18	
R409	Resistor	270K	MCR18	
R410	Resistor	120K	MCR18	
R411	Resistor	68K	MCR18	
R412	Resistor	33K	MCR18	
R413	Resistor	270K	MCR18	
R414	Resistor	47K	MCR18	
R415	Resistor	47K	MCR18	
R416	Resistor	47K	MCR18	
R417	Resistor	47K	MCR18	
R418	Resistor	22K	MCR18	
R419	Resistor	22K	MCR18	
R420	Resistor	100K	MCR18	
R421	Resistor	100K	MCR18	
C401	Monolithic	470P	50V	GR42-6
C402	Monolithic	470P	50V	GR42-6
C403	Monolithic	470P	50V	GR42-6
C404	Ceramic	470P	50V	
DS401	Lamp	8V	50mA	
DS402	LCD	LP156-E		
SP401	Speaker	S04G08		
EP401	Microphone	KUC2023-01-006		

[TONE UNIT] (IC-02AT only)

REF. NO.	DESCRIPTION (PART NO.)		
IC501	IC	LR4087	
IC502	IC	TC4094BP	
IC503	IC	S-7116A	
Q501	Transistor	2SC2458-GR	
Q502	Transistor	2SC2458-GR	
Q503	Transistor	2SC2458-GR	
Q504	Transistor	2SC2458-GR	
Q505	Transistor	2SA1345	
Q506	Transistor	2SC2458-GR	
D501	Diode	1SS211	
D502	Diode	1SS211	
D503	Diode	1SS211	
D504	Diode	1SS211	
D505	Diode	1SS211	
D506	Diode	1SS211	
X501	Ceralock	CSA3.58MG18	
X502	Ceralock	CSA3.58MG18	

[TONE UNIT]

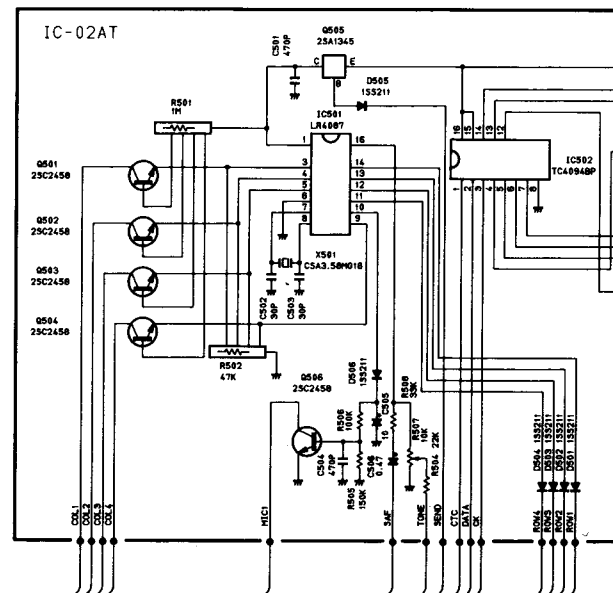
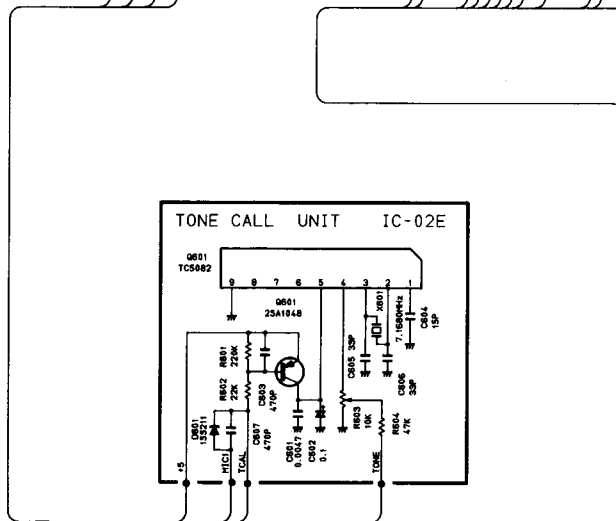
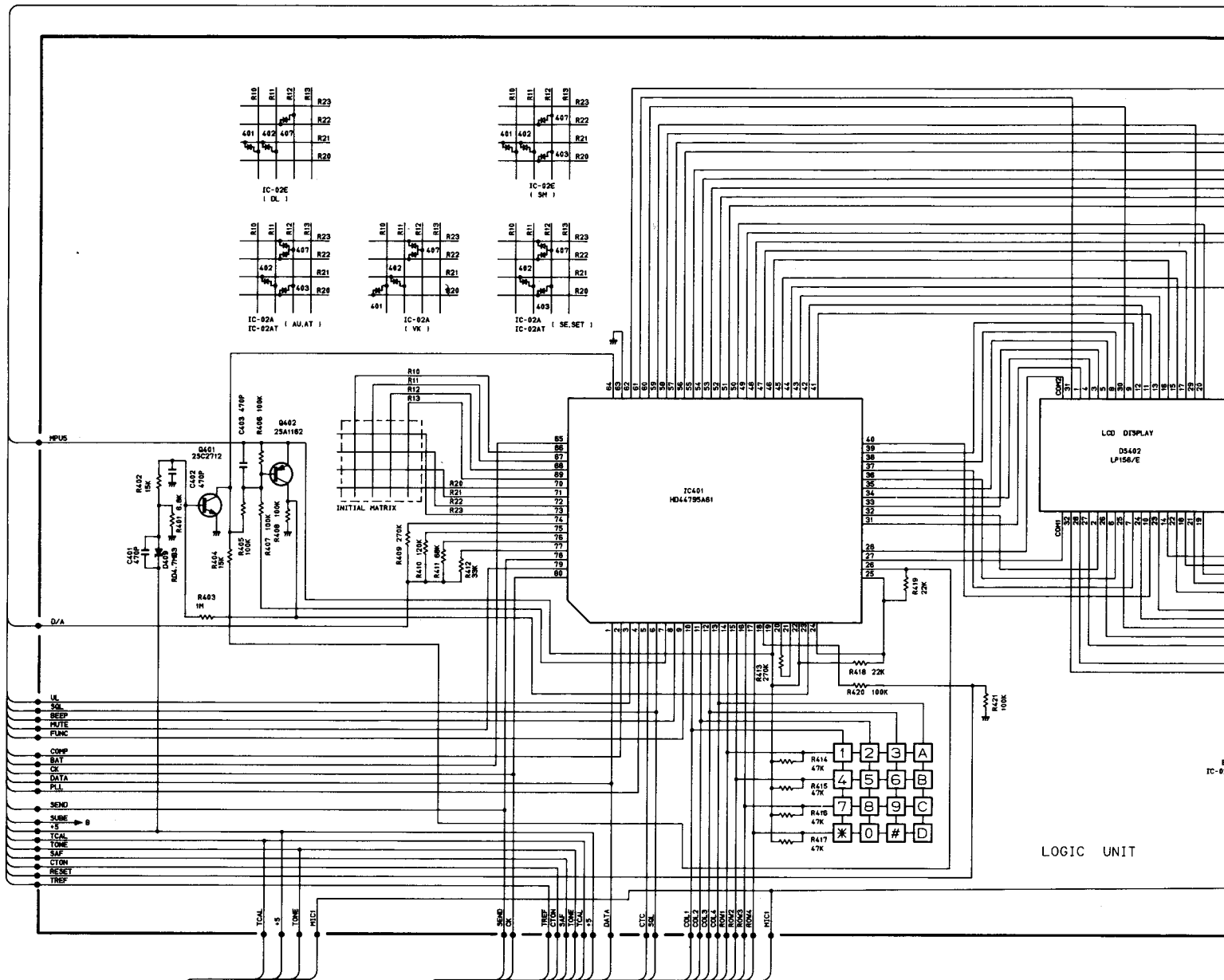
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R501	Array	RKL5S105J		
R502	Array	RKL5S473J		
R503	Resistor	22K	ELR10	
R504		150K	ELR10	
R505		100K	ELR10	
R506	Resistor	10K	H0521A	
R507	Trimmer	33K	ELR10	
R508	Resistor	47K	ELR10	
R509	Resistor	100K	H0521A	
R510	Trimmer	120K	ELR10	
R511	Resistor			
C501	Ceramic	470P	50V	
C502	Ceramic	30P	50V	
C503	Ceramic	30P	50V	
C504	Ceramic	470P	50V	
C505	Electrolytic	10	16V	RC3
C506	Electrolytic	0.47	50V	RC3
C507	Ceramic	470P	50V	
C508	Electrolytic	22	6.3V	RC3
C509	Trimmer	ECR-GA020E30		
C510	Ceramic	39P	50V	
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C512	Electrolytic	0.47	50V	RC3
C513	Electrolytic	0.22	50V	RC3

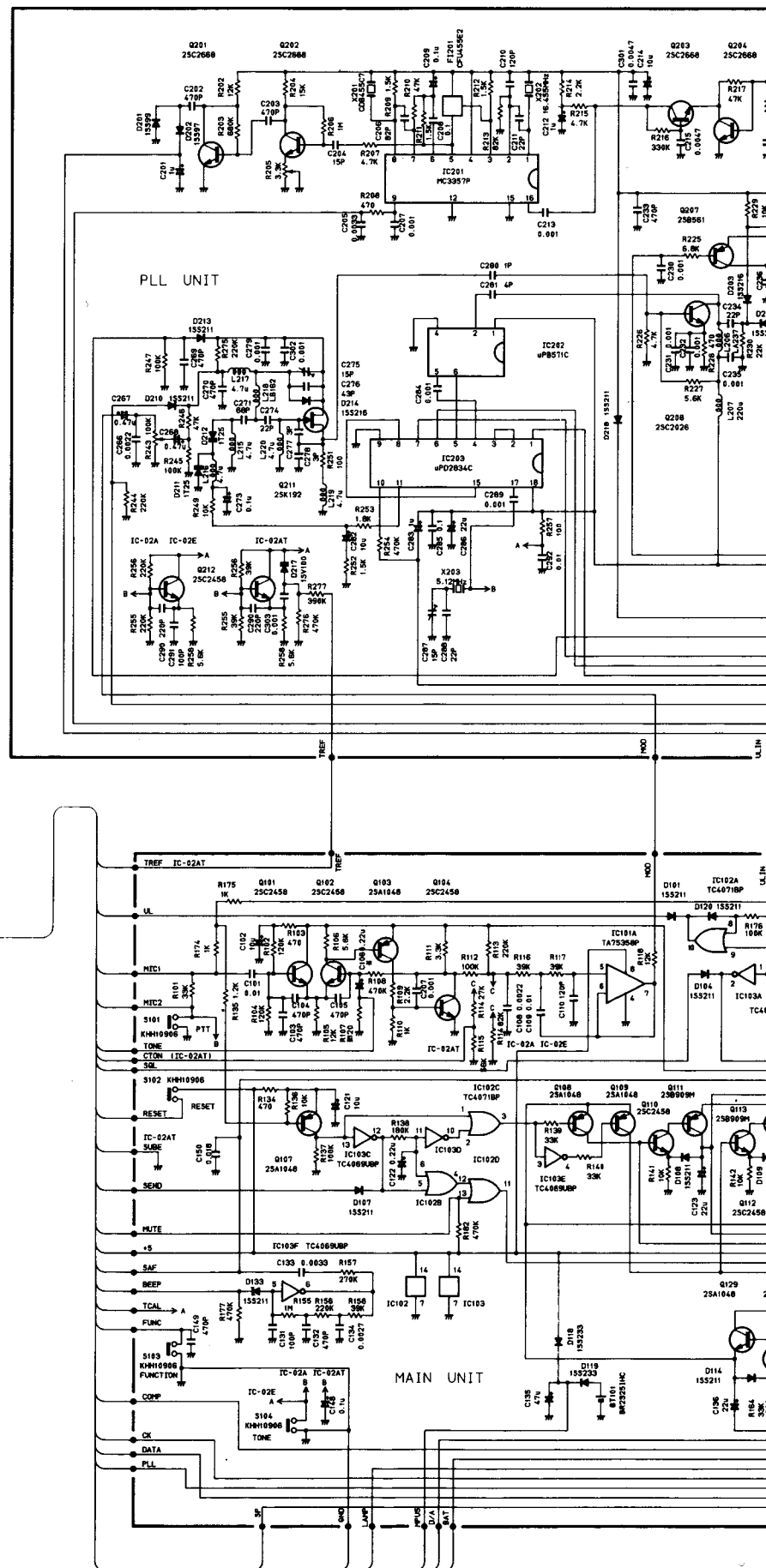
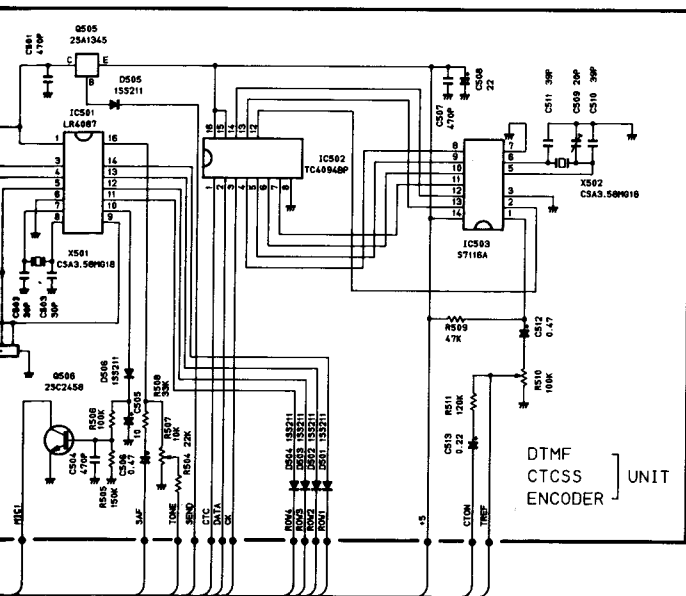
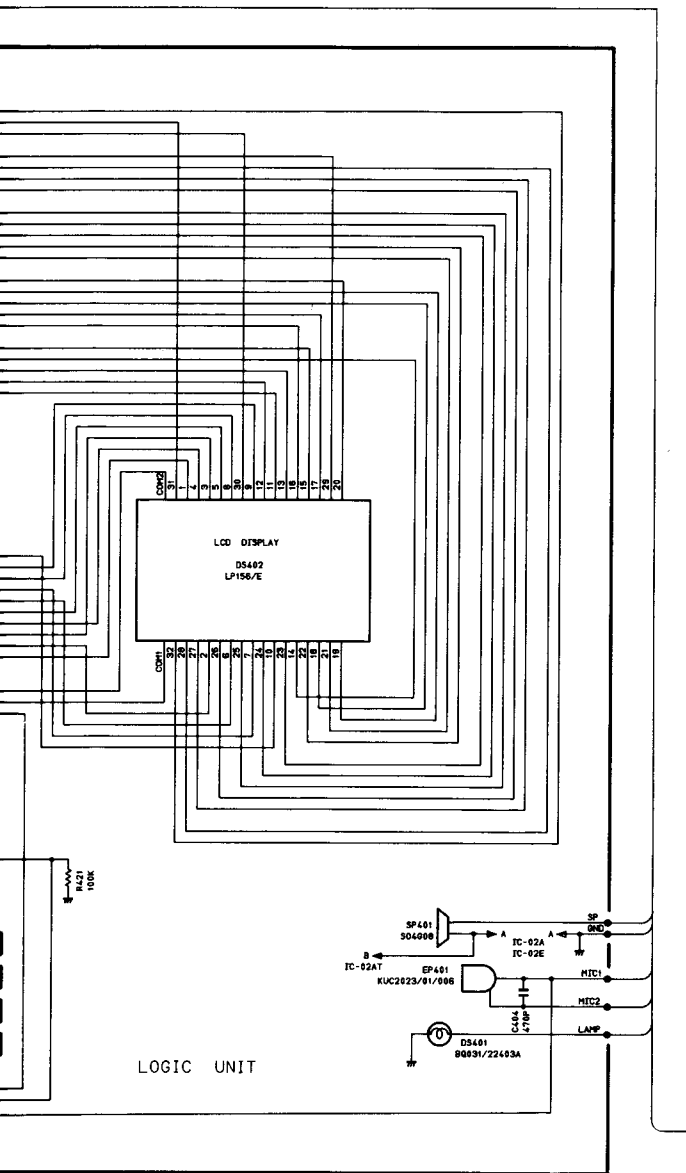
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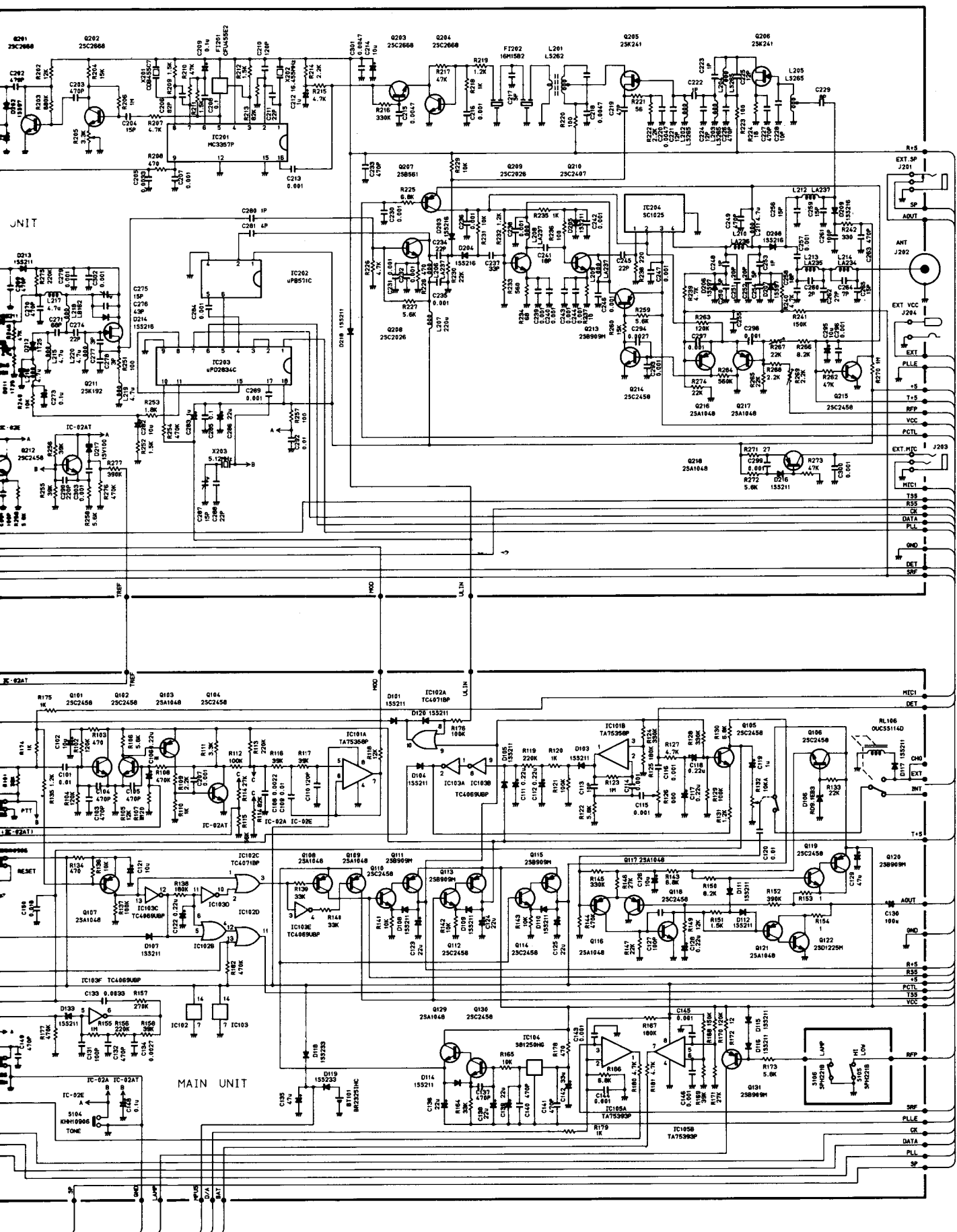
REF. NO.	DESCRIPTION (PART NO.)		
IC601	IC	TC 5082P	
Q601	Transistor	2SA1048-GR	
D601	Diode	1SS211	
X601	Crystal	HC-18/T 7.1680MHz	
R601	Resistor	220K	ELR10
R602	Resistor	22K	ELR10
R603	Trimmer	10K	H0521A
R604	Resistor	47K	ELR10

IC-02A IC-02E IC-02AT

SCHEMATIC DIAGRAM







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