



OPERATING AND SERVICE MANUAL

IC-RP1510
VHF REPEATER

ICOM INCORPORATED

INTRODUCTION

The advanced **IC-RP1510** VHF REPEATER from **ICOM** is a highly reliable, heavy duty repeater built exclusively for commercial radio communications.

This manual contains information relative to the operational, theoretical, physical, mechanical, and electrical characteristics of the **IC-RP1510**.

ASSISTANCE

Four separate versions of the **IC-RP1510** are designed for use in different countries. This manual covers every version. When using the manual each model can be referred to by the following assigned version numbers:

VERSION NUMBER	FREQUENCY COVERAGE	CHANNEL SPACING
#01	138 ~ 150MHz	5kHz
#02	138 ~ 150MHz	12.5kHz
#03	150 ~ 174MHz	5kHz
#04	150 ~ 174MHz	12.5kHz

To thoroughly understand the capabilities of the **IC-RP1510**, please study this instruction manual carefully before attempting operation.

If you have additional questions regarding maintenance or the operation of the **IC-RP1510**, feel free to contact your nearest authorized **ICOM** Dealer or **ICOM** Service Center.

ORDERING PARTS

For the fastest service, supply all of the following information when ordering parts from your dealer or **ICOM** Service Center:

1. Equipment model and serial number (e.g., IC-RP1510, No. 0001)
2. Printed circuit board name and number (e.g., CONTROL UNIT B-670C)
3. Schematic part identifier (e.g., IC1)
4. Part number and name (e.g., μ PD2716, IC)
5. Quantity required (e.g., 2pcs.)

UNPACKING

Accessories included with the IC-RP1510:

	Qty.
① Microphone (IC-HM4)	1
② AC cord	1
③ Microphone hook	1
④ Spare fuses for AC line*	2
⑤ Spare fuses for DC line (10A)	2

*117V AC type 5A
220V, 240V AC type 3A

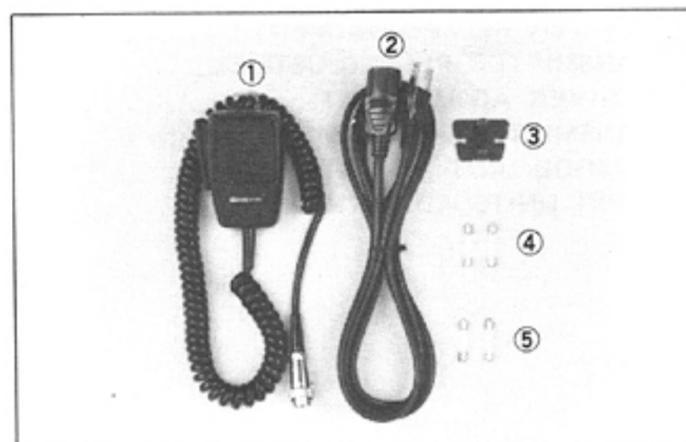


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1. FEATURES

- Built-in high stability crystal unit for ± 5 ppm to obtain steady transmit and receive output signals.
- Uses an external EPROM for programming an independent ID call sign for control functions, etc., and is adapted to user requirements.
- Components in the repeater's RF system are completely shielded in the RF shield case to prevent interference from other units.
- A heavy duty, large heatsink is installed on the rear panel to ensure steady, continuous 24 hour operation.
- Housed in a durable steel frame to ensure long-term reliability.
- Uses a high performance 8-bit CPU, Intel P8035L, for controlling the repeater.
- The repeater has two-way, AC and DC power source capability. If AC power to the repeater is interrupted, DC power can be connected as a backup power source.
- The IC-RP1510 has convenient rack mounting adaptability. Just use the front panel screw holes and handles for easy installation in a cabinet or suitable location.



The product name shown in the picture differs from the actual repeater name.

Some versions of the IC-RP1510 do not include the repeater metal cabinet as shown in the picture.

The cabinet is available as an option from ICOM. There is a space for installing a duplexer under the repeater body. The cabinet dimensions are 520(W) x 520(H) x 400(D) mm.

2. SPECIFICATIONS

■ GENERAL

- Frequency coverage:
136 ~ 150MHz, 150 ~ 174MHz
- Number of channels:
1
- Modes:
F3 (16K0F3E)
- Repeater control system:
Carrier or Tone squelch operating system
- Power supply voltage:
AC 117V, 220V, 240V DC 13.8V
- Power consumption:
Max. 125W
- Usable temperature range:
-10°C ~ +60°C
- Antenna impedance:
50Ω
- Frequency stability:
Less than ±0.0005% (±5ppm)
- Dimensions:
480(W)mm x 150(H)mm x 400(D)mm
- Weight:
19.0kg

■ TRANSMITTER

- RF output power:
25W
- Modulation system:
Variable reactance frequency modulation
- Max. frequency deviation:
±5kHz
- S/N ratio:
More than 40dB for 70% modulation at 1000Hz
- Spurious emissions:
Less than -60dB below carrier output power
- Occupied bandwidth:
Less than 16kHz

■ RECEIVER

- Receiver system:
Double-conversion superheterodyne
- Intermediate frequencies:
1st IF 21.8MHz 2nd IF 455kHz
- Sensitivity:
Less than 0.32μV (-117dBm) for 12dB SINAD
- Squelch sensitivity:
Less than 0.2μV
- Selectivity:
Less than 25kHz at -60dB
- Spurious response rejection ratio:
More than 70dB
- Desensitization:
More than 70dB
- Intermodulation response:
More than 60dB
- AF output power:
1.7W at 10% distortion with an 8Ω load

■ CONTROL UNIT

- Tone decoder (TONE SQUELCH)
 - Frequency:
88.5Hz ±0.5% (other frequencies available)
 - Sensitivity:
Less than 6dB SINAD
 - Response time:
250msec. or less
- Control function
 - Hang-up time:
Within 5sec. (selectable)
 - ID sending speed:
3wpm to 20wpm with 800Hz tone
 - ID interval time:
First transmission after 2 to 3min. transmission
 - Remote control system:
DTMF control

3-1 FRONT PANEL

① INTERNAL SPEAKER

This speaker is used for monitoring received signals.
(See item ⑨)

② PILOT INDICATOR

This indicator lights up when the POWER SWITCH is pushed IN.

- In AC operation : Lights up in yellow
- In DC operation : Lights up in red

③ BUSY INDICATOR

This indicator lights up when the repeater squelch is open.
(See item ⑩)

④ CTCSS INDICATOR

This indicator lights up when the TONE SQUELCH FUNCTION is ON. (See item ⑪)

⑤ LOCAL INHIBIT INDICATOR

This indicator lights up when the LOCAL INHIBIT FUNCTION is ON. (See item ⑫)

⑥ MANUAL ID INDICATOR

This indicator lights up while the ID signal is being transmitted. (See item ⑬)

⑦ TRANSMIT INDICATOR

This indicator lights up when the repeater is transmitting.
(See items ⑭ and ⑮)

⑧ POWER SWITCH

This switch turns the repeater ON and OFF. (See item ②)

⑨ VOLUME CONTROL

This control varies the audio output level from the MONITOR SPEAKER. Clockwise rotation increases the level.

⑩ SQUELCH CONTROL

This control sets the squelch threshold level for receive signals. Clockwise rotation increases the squelch threshold level. (See item ③)

⑪ CTCSS (Continuous Tone Controlled Squelch System) SWITCH

This switch turns the TONE SQUELCH FUNCTION ON and OFF alternately and can be remote-controlled.
(See item ④)

OFF condition:

The CTCSS INDICATOR does not light up. The repeater functions as an open repeater that transmits all received signals regardless of subaudible tones.

ON condition:

The CTCSS INDICATOR lights up. The repeater is set in TONE SQUELCH operation and opens when a signal with a specified subaudible tone superimposed on it is received, and transmits signals carrying the specified subaudible tone.

⑫ LOCAL INHIBIT SWITCH

This switch turns the repeater status alternately ON and OFF and can be remote-controlled. (See item ⑤)

OFF condition:

The LOCAL INHIBIT INDICATOR does not light up. The repeater functions as an ordinary repeater.

ON condition:

The LOCAL INHIBIT INDICATOR lights up. The repeater functions as an ordinary transceiver.

⑬ MANUAL ID (Identifier) SWITCH

This switch allows an identifier signal to be sent manually. Each push of the switch sends an ID signal. The MANUAL ID INDICATOR lights up while sending the ID out.
(See item ⑥)

⑭ COR (Carrier Operated Relay) SIMULATE SWITCH

This switch sets the repeater in transmit mode continuously, and can be used for checking repeater functions such as hang-up time, time-out timer, etc. (See item ⑦).

⑮ MIC CONNECTOR

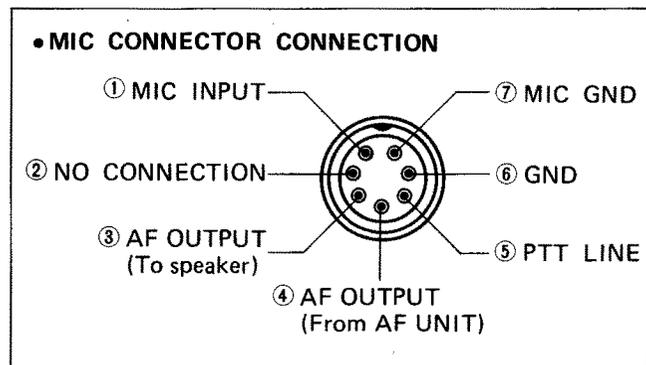
Connects the supplied IC-HM4 MICROPHONE.

When the [LOCAL INHIBIT] SWITCH is OFF:

Microphone signals are superimposed on receive signals when the PTT SWITCH is pushed.

When the [LOCAL INHIBIT] SWITCH is ON:

The PTT SWITCH on the microphone is pushed IN and the repeater functions as an ordinary transceiver when the microphone is used.



3-2 REAR PANEL

⑯ TRANSMIT ANTENNA CONNECTOR

This connector outputs RF output power. Connect a coaxial cable between the connector and the transmitter connector of the duplexer.

⑰ GROUND TERMINAL

Connect a ground cable to this terminal. Be sure to ground the repeater to a good earth point to protect the repeater and prevent electrical shocks.

⑱ AC POWER SOCKET

The AC POWER SOCKET connects the repeater to an AC outlet via the supplied AC cord.

⑲ AC LINE FUSE HOLDER

This holder contains the fuse for the AC power supply. Use the spare fuses provided to replace an old or damaged fuse.

- AC 117V type : 5A
- AC 220 or 240V type : 3A

⑳ DC LINE FUSE HOLDER

This holder contains the 10A fuse for the DC power supply. Use the spare fuses provided to replace an old or damaged fuse.

㉑ DC POWER INPUT TERMINALS

Connects a DC power source such as a 12V-type storage battery for DC operation. This battery is used for the repeater backup battery when power is interrupted during AC operation. See p. 4 - 1 for information regarding use of these terminals.

㉒ CONTROL SIGNAL INPUT JACK

This jack is used for controlling repeater functions such as TONE SQUELCH or LOCAL INHIBIT by DTMF tones from external equipment.

㉓ RECEIVER ANTENNA CONNECTOR

This connector receives incoming signals from the antenna sent through the duplexer. Connect a coaxial cable between this connector and the receive connector on the duplexer.

4. INSTALLATION

4-1 PLANNING

This repeater should be installed in a cabinet to protect it from dust, moisture, etc. The repeater has four screw holes and two handles on each side of the front panel for this installation purpose.

- **AVOID** using the IC-RP1510 in the following situations:
 - Where temperatures under -10°C or over $+60^{\circ}\text{C}$ are encountered. **DO NOT** use the repeater in areas exposed to direct sunlight for long periods.
 - In places subject to rain, humidity, strong winds, or excessive dust and moisture.
- To facilitate good ventilation and emergency maintenance, allow sufficient access between the repeater and the surrounding walls.

4-2 ANTENNA SYSTEM

CAUTION: Transmitting without an antenna may damage the transmitter of the repeater.

(1) ANTENNA

Antenna performance is crucial for reliable radio communications. For this reason, a 50Ω directional antenna is well worth the extra investment. Many high quality fixed location antennas are available from various manufacturers. Choose one most suited to your needs.

- Use heavy duty stainless steel mounting hardware to protect the antenna from bad weather and preserve it for longer periods of time.

(2) COAXIAL CABLE

We recommend using a coaxial cable, particularly in a fixed location installation where feed lengths are very long.

- Use a thick, low loss, all weather-type coaxial cable, and for best results make the connection between the antenna and repeater as short as possible.

4-3 DUPLEXER

This repeater does not include a duplexer. The duplexer must be purchased separately.

- The cables between the repeater and duplexer should be as short and thick as possible to reduce insertion loss.

4-4 GROUNDING

To prevent electrical shocks, interference from other stations, and other problems, be sure to ground the repeater through the GROUND TERMINAL.

- To ensure safety, use the heaviest gauge wire or strap available and make the connection as short as possible.
- **NEVER** use a gas pipe or electrical conduit pipe for grounding.

4-5 POWER SUPPLY

The IC-RP1510 can function with either an AC or DC power source. If AC power is interrupted when operating the repeater with an AC power source, power is automatically provided to the repeater when a 12V-type storage battery is connected to the DC POWER INPUT TERMINALS on the rear panel.

(1) IN AC OPERATION

- Extension cords should not be used unless absolutely necessary. Use of improper extension cords could result in fire risk.
- Use a proper power source from an AC outlet.

(2) IN DC OPERATION

CAUTION: Voltages greater than 16V DC will damage your repeater. Check the source voltage before connecting the power cable.

- Connect a battery with sufficient capacity such as a lead-acid battery. The current drain is approx. 8A during transmitting.
- Place the battery in a spot away from the repeater as gas leakage from the battery could cause corrosion when a lead-acid battery is used. Keep the battery cable long and install the battery more than 5 meters away from the repeater. Provide good ventilation.
- Charge the battery completely before connecting it to the repeater. Note the polarity: positive wire to the RED terminal; negative wire to the BLACK terminal.
- During AC operation a current of 100mA is fed from the repeater to recharge the battery as long as the repeater POWER SWITCH is ON. This is enough current to compensate for the battery's natural discharge. However, recharge the battery using an external charger.

5. GENERAL OPERATION

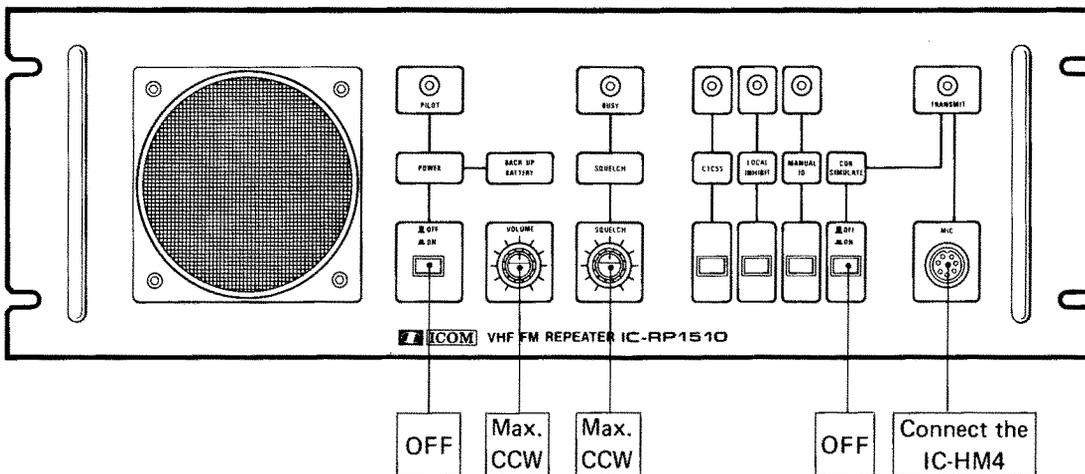
5-1 INITIAL SETTINGS

After all installation instructions have been followed in section 3, set the controls and switches as shown in the diagram below.

- 1) Make sure the [POWER] SWITCH is OFF, then plug the AC cord into a domestic AC outlet for AC operation, or apply 12V DC to the DC POWER TERMINALS for DC operation.
- 2) An antenna must be connected to the repeater through a duplexer. (See p. 4 - 1)

CAUTION: Transmitting without an antenna may damage the transmitter of the repeater.

- 3) A ground connection must be made through the GROUND TERMINAL. (See p. 4 - 1)
- 4) Connect the supplied IC-HM4 MICROPHONE to the MIC CONNECTOR.



5-2 BASIC OPERATION

- 1) Push the POWER SWITCH ON (IN).

The following indicators light up.

INDICATOR	LIGHT
[PILOT]	Lights up yellow*
[BUSY]	Lights up green
[LOCAL INHIBIT]	Lights up green

* The PILOT INDICATOR lights up yellow when the repeater is operating with an AC power source, and red when operating with a DC power source.

- 2) Rotate the [VOLUME] CONTROL clockwise to a suitable audio level if needed.
- 3) Rotate the [SQUELCH] CONTROL clockwise until noise from the speaker is quieted. The [BUSY] INDICATOR goes out.

- 4) Set repeater mode for either a private or open repeater.

For private repeaters:

Push the [CTCSS] SWITCH ON. The green [CTCSS] INDICATOR lights up and the repeater transmits only received signals with specified subaudible tones superimposed on them.

For open repeaters:

Push the [CTCSS] SWITCH to turn OFF the TONE SQUELCH FUNCTION if the [CTCSS] INDICATOR lights up. When the [CTCSS] INDICATOR does not light up the repeater transmits all received signals.

- 5) Push the [LOCAL INHIBIT] SWITCH to turn OFF the repeater. The yellow indicator goes out.

5-3 FREQUENCY PROGRAMMING

Both the receive and transmit frequencies can be set independently by dip switches on the N-CTRL UNIT. See p. 7 - 6 for detailed circuit description information and the diagram below for the N-CTRL UNIT location.

Following are the methods for programming both the receive and transmit frequencies.

(1) PROGRAMMING THE RECEIVE FREQUENCY

WARNING: TO PREVENT ELECTRIC SHOCKS, DISCONNECT ANY POWER CORD FROM THE REPEATER BEFORE PERFORMING WORK ON THE REPEATER.

- 1) Remove the bottom cover from the repeater.
- 2) Calculate an N-data value using the following formula. The values are different depending on the repeater's channel spacing.

$$N\text{-data} = \frac{\text{Receive frequency} - 1\text{st IF}}{\text{Channel spacing}}$$

- 3) Set dip switches using the value of the N-data got from the above formula.

Each dip switch has an independent N-data value. Set switches according to each value.

- 4) Check the dip switch setting before replacing the cover and trying to open the repeater.

● EXAMPLE FREQUENCY SETTING 1

Receive frequency : 164.00MHz
 1st IF : 21.8MHz
 Channel spacing : 5kHz (0.005MHz)

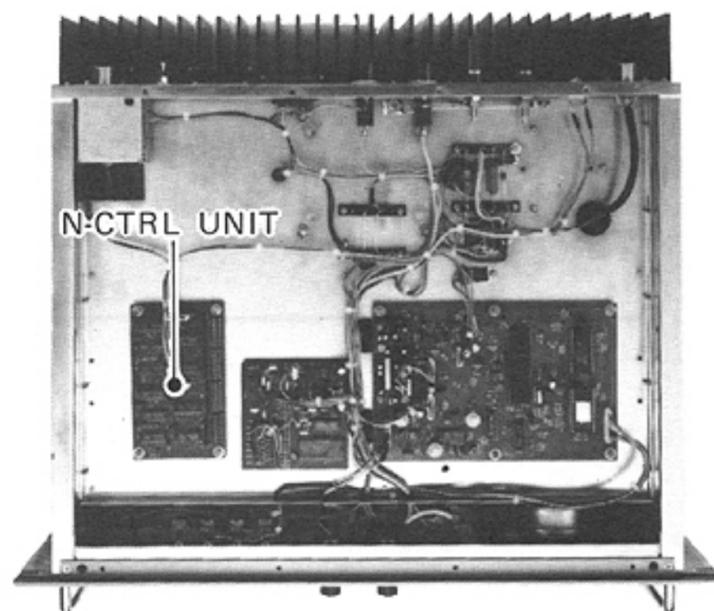
$$\begin{aligned}
 1) \text{ N-data} &= \frac{\text{Receive frequency} - 1\text{st IF}}{\text{Channel Spacing}} \\
 &= \frac{164.00 - 21.8}{0.005} \\
 &= 28440
 \end{aligned}$$

- 2) Set dip switches in the ON position according to their calculated N-data values.

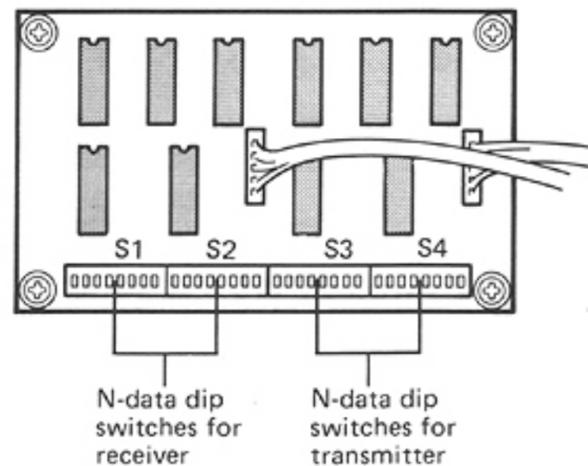
- 3) The following dip switches should be ON:

Dip switches	N-data value
S2-7 →	16384
S2-6 →	8192
S2-4 →	2048
S2-3 →	1024
S2-2 →	512
S2-1 →	256
S1-5 →	16
S1-4 →	8 (+)
Total	28440

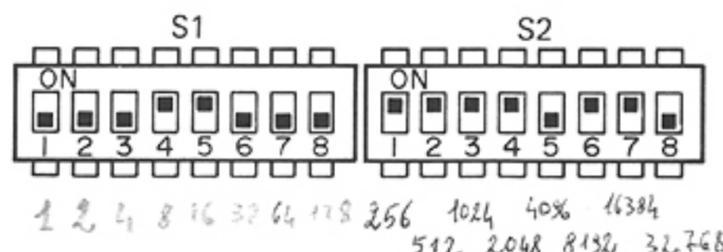
● BOTTOM VIEW



● N-CTRL UNIT



● DIP SWITCH SETTINGS



NOTE: Black areas indicate switch positions.

(2) PROGRAMMING THE TRANSMIT FREQUENCY

- 1) Remove the bottom cover from the repeater.
- 2) Calculate an N-data value using the following formula. Values are different depending on the repeater's channel spacing.

$$\text{N-data} = \frac{\text{Transmit frequency}}{\text{Channel spacing}}$$

- 3) Set dip switches using the value of the N-data got from formula at left.
- 4) Check the dip switch setting before replacing the cover and trying to open the repeater.

● EXAMPLE FREQUENCY SETTING 2

Transmit frequency : 164.60MHz
 Channel spacing : 5kHz (0.005MHz)

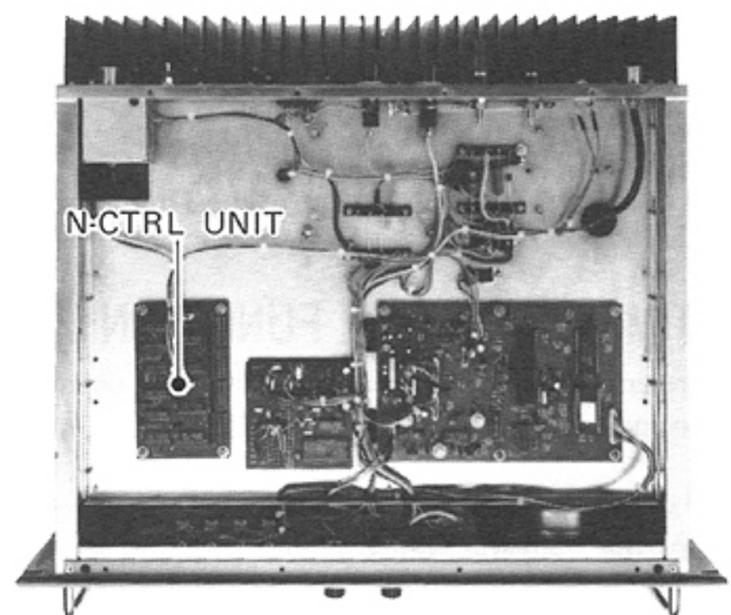
$$\begin{aligned} 1) \text{ N-data} &= \frac{\text{Transmit frequency}}{\text{Channel Spacing}} \\ &= \frac{164.60}{0.005} \\ &= 32920 \end{aligned}$$

- 2) Set dip switches in the ON position according to their calculated N-data values.

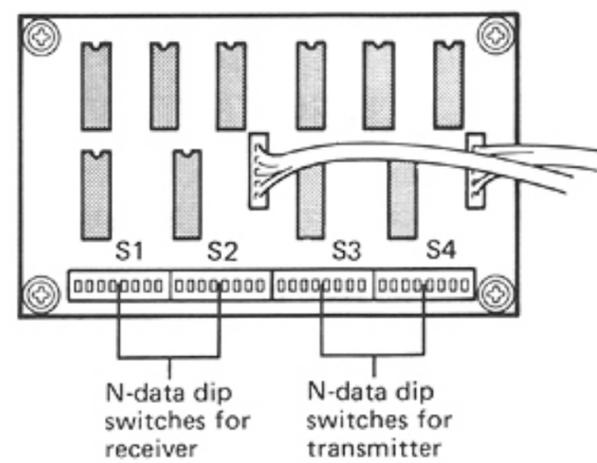
The following dip switches should be ON:

Dip switches	N-data value
S4-7 →	32768
S3-8 →	128
S3-5 →	16
S3-4 →	8 (+)
Total	32920

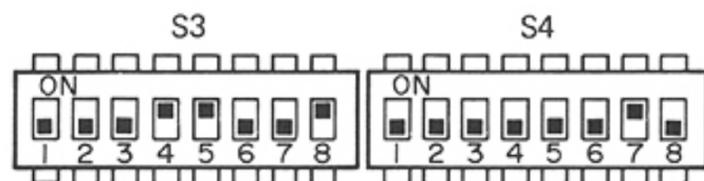
● IC-RP1510 (Bottom View)



● N-CTRL UNIT



● DIP SWITCH SETTINGS



NOTE: Black areas indicate switch positions.

6. FUNCTIONS DESCRIPTION

6-1 ID FUNCTION

The ID FUNCTION allows you to transmit an ID call sign for the repeater manually or automatically. The type of signal is CW (F2), and is sent out as described below.

(1) MANUAL ID FUNCTION

The ID call signal is sent out each time you push the [MANUAL ID] SWITCH on the front panel.

(2) AUTOMATIC ID FUNCTION

- The ID call sign is sent out when an incoming signal switches the repeater from standby condition to transmit mode.
- An ID call sign is sent out approx. every 3 minutes.

6-2 TIME-OUT TIMER FUNCTION

This function prevents the repeater from being occupied by a station for a long time.

If the access exceeds the preset time limit (approx. 3 minutes) the repeater shuts down automatically for 5 seconds.

If the access is still "ON" after 5 seconds, the repeater sends an ID call sign.

6-3 HANG-UP TIMER FUNCTION

The repeater is designed to retain the "transmit" condition for 5 seconds after an incoming signal is stopped.

If there is an access during this period of 5 seconds, the transmit operation starts immediately. The repeater is thus prevented from turning OFF during short pauses when stations are using the repeater.

This hang-up time can be changed by switches S1-1 and S1-2 on the CONTROL UNIT as shown below.

SET TIME	SWITCH POSITION	
	S1-1	S1-2
0sec.	ON	ON
1sec.	ON	OFF
3sec.	OFF	ON
5sec.	OFF	ON

6-4 MANUAL TRANSMIT FUNCTION

(1) INTERRUPT TRANSMIT FUNCTION

Push the PTT SWITCH on the microphone and speak into the microphone. Voice signals from the microphone are transmitted even if an incoming signal has accessed the repeater.

(2) FUNCTIONING AS AN ORDINARY TRANSCEIVER

Push the [LOCAL INHIBIT] SWITCH to turn ON the LOCAL INHIBIT FUNCTION. The [LOCAL INHIBIT] INDICATOR lights up green and the repeater functions as an ordinary transceiver.

Push the PTT SWITCH on the microphone to activate transmit mode; release the PTT SWITCH to activate receive mode.

6-5 REMOTE CONTROL FUNCTION

The IC-RP1510 repeater can be remote-controlled by the built-in DTMF decoder. This decoder employs 4-digit sequential signals as a control signal to prevent accidental control. The following functions can be remote-controlled.

- LOCAL INHIBIT MODE ON and OFF.
- TONE SQUELCH MODE ON and OFF.

(1) REMOTE-CONTROLLING THE REPEATER

1) Send a specified code consisting of 4 DTMF tones from a remote controller such as your transceiver keyboard to turn ON or OFF a function as shown in the table below.

(EXAMPLE)

Push keys [A], [1], [2] and [6] on the DTMF keyboard and the TONE SQUELCH FUNCTION of the repeater turns ON.

2) The DTMF decoder is set at the factory as shown below. However, the decoder can be reset to your own code. (See p. 6-2).

FUNCTIONS	KEY ENTRY (Specified code)
LOCAL INHIBIT ON	[A] [1] [2] [3]
LOCAL INHIBIT OFF	[A] [1] [2] [4]
TONE SQUELCH OFF	[A] [1] [2] [5]
TONE SQUELCH ON	[A] [1] [2] [6]

Factory default

(2) PROGRAMMING THE CONTROL NUMBER

A specified code consisting of 4 DTMF tones for the remote controller can be changed as follows:

- 1) Select the desired function you want to change from the table shown on p. 6 - 1.
- 2) Set a control code consisting of 4 digits. The first 3 digits of the code must be used for the other remote control functions. The last digit is used for each corresponding function. (See the table at right)

NOTE: Two functions can be remote-controlled using 4 different control codes. However, **REMEMBER** that the first 3 digits of 4 different codes must be the same. Only the last digit can be different.

- 3) Unscrew the 3 screws on the DTMF DECODER UNIT and lift up the unit.
- 4) Unsolder and disconnect jumper wires W11 (gray) through W17 (blue) from the programming area on the unit.

- 5) Insert the W11 (gray) jumper wire into the hole of the first digit selected and solder it from the bottom of the unit.
- 6) Insert the W12 (brown) and W13 (red) jumper wires into the hole of the second and third digits selected and solder them from the bottom of the unit.
- 7) Insert a jumper wire among the remaining wires W14 (orange) through W17 (blue) into the hole of the last digit and solder it. W14 through W17 have the following corresponding functions:

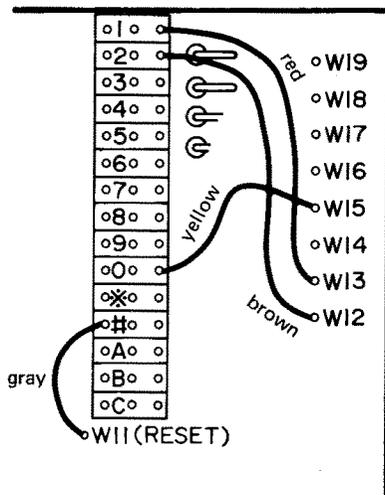
JUMPER WIRE	FUNCTION
W14 (orange)	LOCAL INHIBIT OFF
W15 (yellow)	LOCAL INHIBIT ON
W16 (green)	TONE SQUELCH OFF
W17 (blue)	TONE SQUELCH ON

- 8) There are 3 more jumper wires left without wiring. These wires correspond to the functions shown in the above table. Connect wires in the same manner as described in the wiring method above.

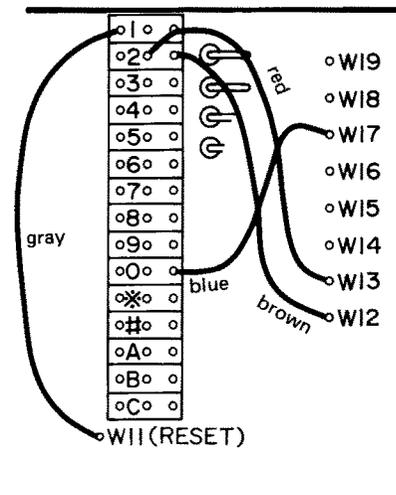
■ REMOTE CONTROL SETTING EXAMPLE

The following are examples for programming remote control codes. Programming should be made on the DTMF UNIT which is located on the bottom side of the repeater. (See p. 8 - 2 for the exact location.)

- (1) Programming code [#] [2] [1] [0] for the LOCAL INHIBIT ON function.



- (2) Programming code [1] [2] [2] [0] for the TONE SQUELCH ON function.



*The first three codes must be the same for the LOCAL INHIBIT ON, LOCAL INHIBIT OFF, and TONE SQUELCH OFF functions.

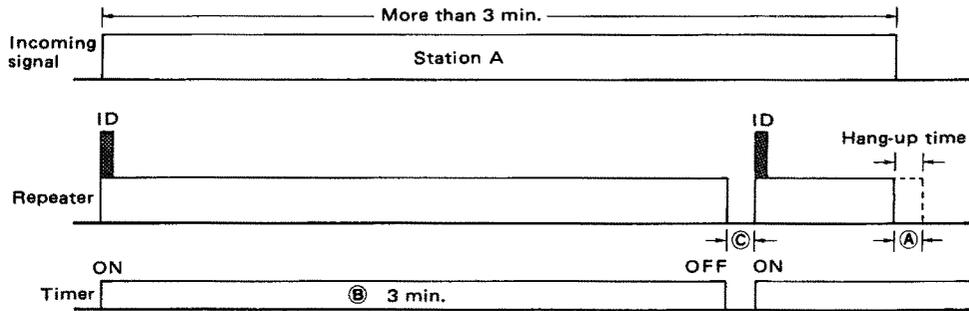
*The first three codes must be the same for the LOCAL INHIBIT OFF, TONE SQUELCH OFF, and TONE SQUELCH ON functions.

■ TIMING CHARTS OF TRANSMITTING AND ID EMISSIONS

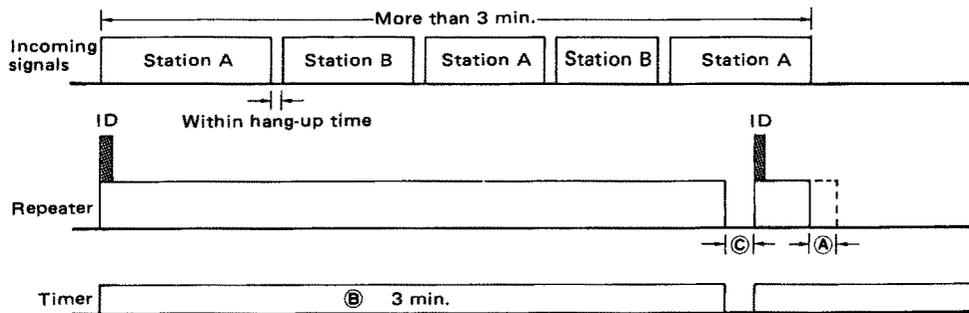
The functions listed below are represented in the diagrams by their assigned letters.

- A Hang-up timer : Selectable to 0, 1, 3 and 5 seconds with S1 switch.
- B Time-out timer : 3 minutes
- C Repeater stop timer : 5 seconds
- D Basic communication timer : 2 minutes

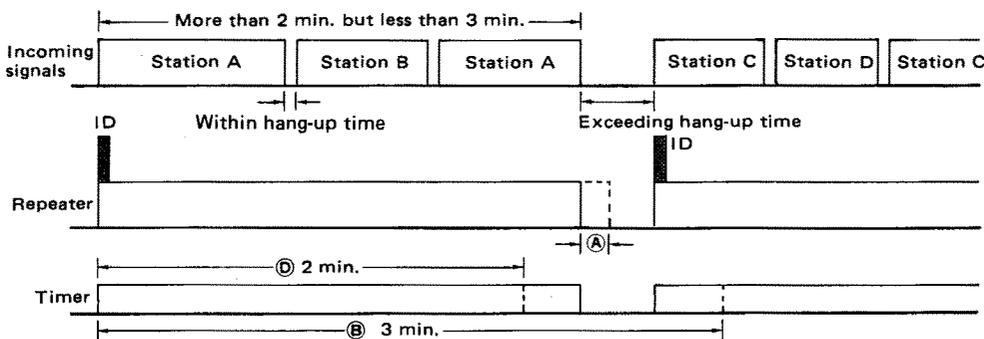
(1) If one station occupies the repeater for more than 3 minutes.



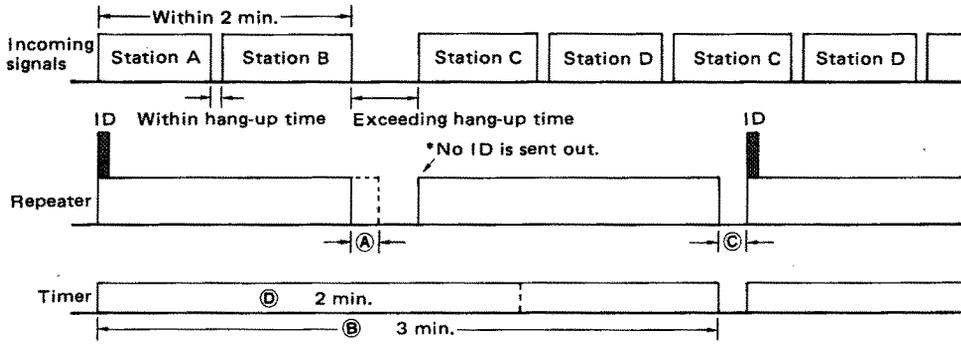
(2) If two stations communicate with each other for more than 3 minutes without an interruption of 5 seconds or more:



(3) If communication between two stations is completed between 2 and 3 minutes and then a third station uses the repeater:

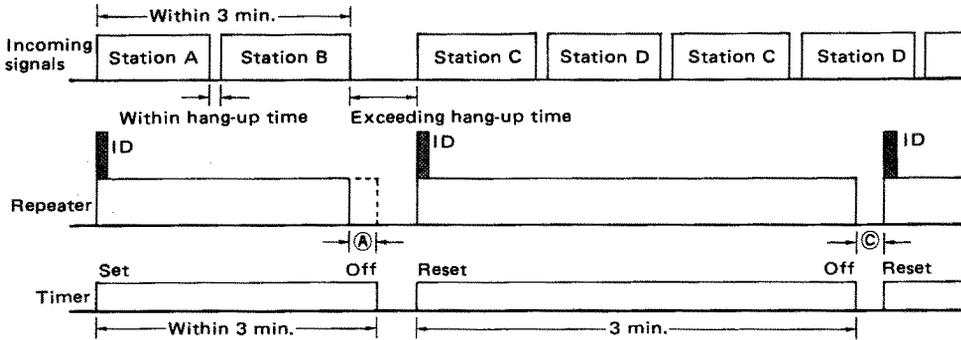


(4) If communication between two stations is completed within 2 minutes, and then other stations use the repeater:



* In cases (1) through (4) above, the timers and ID sending interval are shown as default settings. By replacing the EP ROM, it is possible to change their functions as shown below.

(5) If communication between two stations is completed within 3 minutes, the timer is OFF, and the moment there is an access from a third station, an ID signal is sent and at the same time the timer is reset. If the first communication duration exceeds 3 minutes, the case is the same as (1) or (2).



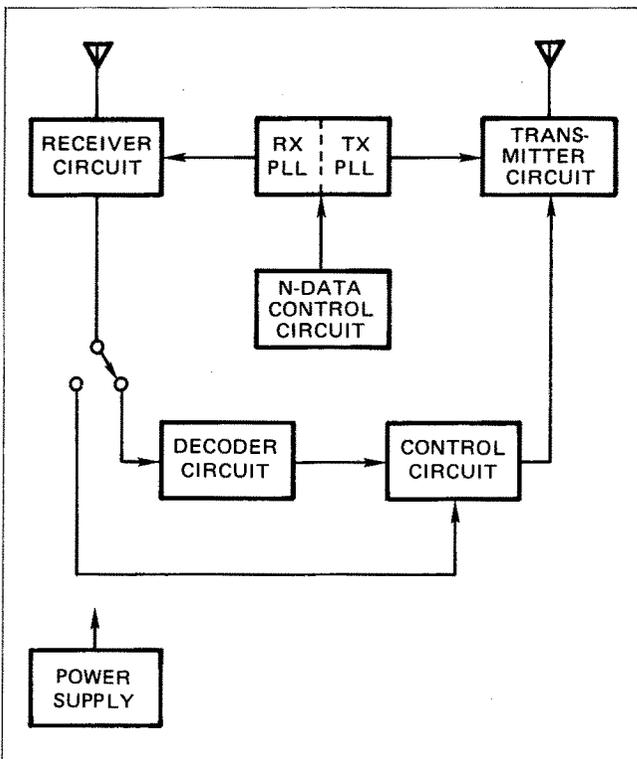
* ID sending speed is 20wpm with this system.

7. CIRCUIT DESCRIPTION

7-1 SYSTEM CONFIGURATION

The IC-RP1510 consists of the following circuits:

- ① RECEIVER CIRCUIT
- ② TRANSMITTER CIRCUIT
- ③ PLL CIRCUIT
- ④ N-DATA CONTROL CIRCUIT
- ⑤ CONTROL CIRCUIT
- ⑥ DECODER CIRCUIT
- ⑦ POWER SUPPLY CIRCUIT



7-2 RECEIVER CIRCUIT

The receiver unit employs a PLL-controlled, double-conversion superheterodyne with 1st IF signals of 21.8MHz and 2nd IF signals of 455kHz. The unit housing is shielded to prevent interference. A BNC connector and feedthrough capacitors are also used for reducing RF loss and interference.

(1) RF CIRCUIT

Incoming signals fed from J1 pass through a bandpass filter consisting of varicaps D1 to D4 and pattern coils to eliminate unwanted signals from the band. Signals passing through the bandpass filter are amplified by Q1 (2SK241) for high-gain and low-noise amplification.

Signals amplified by Q1 pass through a bandpass filter consisting of varicaps D5 to D12 and pattern coils, then enter the 1st gate of 1st mixer Q2 (3SK74). The local oscillator output from the PLL UNIT is injected into the 2nd gate of this FET. The output signals are mixed with this signal and converted to 1st IF (21.8MHz) signals.

The center frequency of the BPFs is shifted as capacitance of varicaps (D1 ~ D12) and is varied by the control voltage from the VCO UNIT.

(2) IF CIRCUIT

1st IF signals converted to 21.8MHz are turned into a necessary band by the crystal filter of F11 and then amplified by the IF amplifier of Q3 (3SK122). The amplified signals are applied to IC1 through the matching transformer of L6.

IC1 is an IC chip for FM-IF. The amplifier for the 2nd local oscillator, the 2nd mixer, the limiter amplifier, the quadrature detector, and the active filter are collected in one package.

Signals entered at pin 16 of IC1 are mixed with a 2nd local oscillator consisting of C26, C27 and crystal unit X1 (21.345MHz), and are output from pin 3 as 2nd IF signals of 455kHz. The signals pass through a high-performance ceramic filter of F12, enter pin 5, and are detected by the limiter amplifier. A phase delay element (X2) is used in the detection circuit to improve temperature characteristics.

Detected AF signals are output from pin 9. The signals pass through a deemphasis circuit consisting of R32 and C43, then through the AF circuit. Output signals from pin 9 are also applied to the squelch circuit and the tone squelch circuit.

(3) SQUELCH CIRCUIT

IC2(b) functions as an electronically controlled AF attenuator for control of a squelch threshold level, switching the AF signals for the squelch function.

For squelch control, signals are fed to pin 1 of IC2(b), pass through the AF attenuator, and are output from pin 3. Output signals from pin 3 are controlled logarithmically by the DC voltage from pin 13, and are applied to pin 10 of IC1. Noise components in the output signal are selected by the active filter of IC1.

Signals are rectified at D16, D17 and C36, and are then fed to DC amplifier Q4 in order to control the voltage at pin 6 of IC2(a).

The collector of Q4 is connected to the base of Q5 and turns ON and OFF the BUSY INDICATOR.

(4) AF CIRCUIT

Detected AF signals from pin 9 pass through a deemphasis circuit consisting of R32 and C43, are fed to pin 8 of IC2(a), and then are output from pin 10. These AF signals are turned ON and OFF by the squelch signal at pin 6.

AF signals from pin 10 of IC2(a) contain a subaudible tone signal to access repeaters. After removing subaudible tone signals by a BPF consisting of IC3, the signals are output from pin 1 and applied to the AF UNIT located behind the front panel.

IC1 on the AF UNIT amplifies low level AF signals from IC3 on the RECEIVER UNIT and drives an internal speaker.

(5) P1 CONNECTOR CONNECTIONS

PIN NUMBER	CONNECTION
Pin 1	Ground
Pin 2	Discriminator output
Pin 3	Ground
Pin 4	AF output
Pin 5	13.8V DC input
Pin 6	SQUELCH CONTROL input
Pin 7	BUSY INDICATOR output
Pin 8	Squelch switching signal output
Pin 9	No connection

7-3 TRANSMITTER CIRCUIT

(1) MIC AMP CIRCUIT

Audio signals from the microphone are applied to IC3(a) and IC3(b) through a preemphasis circuit consisting of C52 and R50, and are amplified. Components over 3kHz of the audio signal are eliminated from the splatter filter of IC4(a) and the expansion of unnecessary bands is inhibited. The signal enters the TRANSMITTER VCO UNIT in the TRANSMITTER UNIT for generating an FM modulation signal.

(2) MODULATION CIRCUIT (TX-VCO UNIT)

The modulation signal is applied to varicap D5, and FM modulation is carried out as it enters the gate of Q1 through C4 in the direct modulation system.

(3) DRIVER AMPLIFIER CIRCUIT

Output signals from the TX VCO UNIT are amplified by Q9 for the predriver, and then are amplified by a wide-band amplifier circuit consisting of Q10, Q11 and Q12. Signals then enter the PA UNIT.

VCO output signals are also applied to the transmitter PLL loop through an isolation circuit consisting of L1, R1 ~ R4 and R31 ~ R33.

(4) POWER AMPLIFIER CIRCUIT (PA UNIT)

The PA UNIT is located behind the rear panel heat sink, and is shielded by a metal case.

IC1 is an RF power module that can output 25W with an input of 200mW. Steady output power over a broad band can be continuously obtained since a large-sized heat sink is installed.

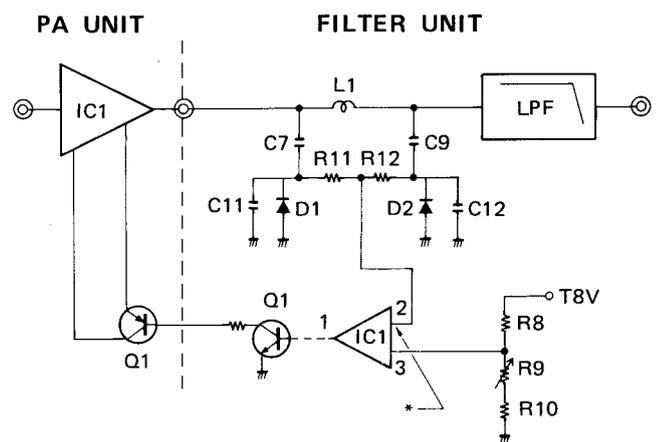
(5) LOW-PASS FILTER CIRCUIT (FILTER UNIT)

Spurious high harmonic emissions are fully suppressed by a 3-stage low-pass filter consisting of L2 ~ L4 and C14 ~ C20.

An SWR detector circuit is installed in the repeater. SWR is detected by D1 and D2 and detected voltage is used for the ALC control voltage.

(6) ALC CONTROL CIRCUIT (FILTER UNIT)

Voltage detected by D1 and D2 enters a comparator circuit consisting of IC1 (op-amp). The ALC control voltage is applied to Q1 on the PA UNIT through Q1 on the FILTER UNIT and P2 connector.



*When this voltage is higher than the voltage of pin 3, pin 1 becomes "LOW" and reduces output power in the PA UNIT.

(7) P2 CONNECTOR CONNECTIONS

PIN NUMBER	CONNECTION
Pin 1	Mic PTT output
Pin 2	PTT control output
Pin 3	13.8V DC input
Pin 4	T8V output
Pin 5	Ground
Pin 6	Connected to mic amp
Pin 7	Ground
Pin 8	Mic input

7-4 RECEIVER PLL CIRCUIT

Each receiver and transmitter circuit has an independent PLL circuit for controlling frequencies. Each PLL circuit is shielded and installed in the RECEIVER and TRANSMITTER UNIT.

(1) RECEIVER VCO CIRCUIT (RX-VCO UNIT)

The receiver VCO UNIT (RX-VCO UNIT) utilizes a strip line and varicaps D1 ~ D4 for wide-band oscillation. A junction-type FET (Q1) performs the oscillation.

Oscillation output signals are buffer-amplified at Q2 for improving C/N (Carrier to Noise ratio) characteristics.

(2) PLL CIRCUIT (RECEIVER UNIT)

VCO output signals are buffer-amplified by Q7 and are divided by 1/64 and 1/65 by a dual modulus prescaler, IC5. In addition, divided signals are applied to IC4 and are divided by N-data from the N-CTRL UNIT.

IC1 includes a phase detector circuit. Divided signals are compared with the reference oscillator frequency. Detector signals are output from pins 12 and 13 on IC4.

Output signals are received at the charge pump circuit of Q8 and Q9 and are supplied with high DC voltage (+20V). By using this method, the PD (Phase Detector) voltage expands and the VCO covers a very wide frequency range. R68, R69, R70 and C82 make a LPF for the loop filter of this PLL circuit. D23 and D24 reduce lock-up time.

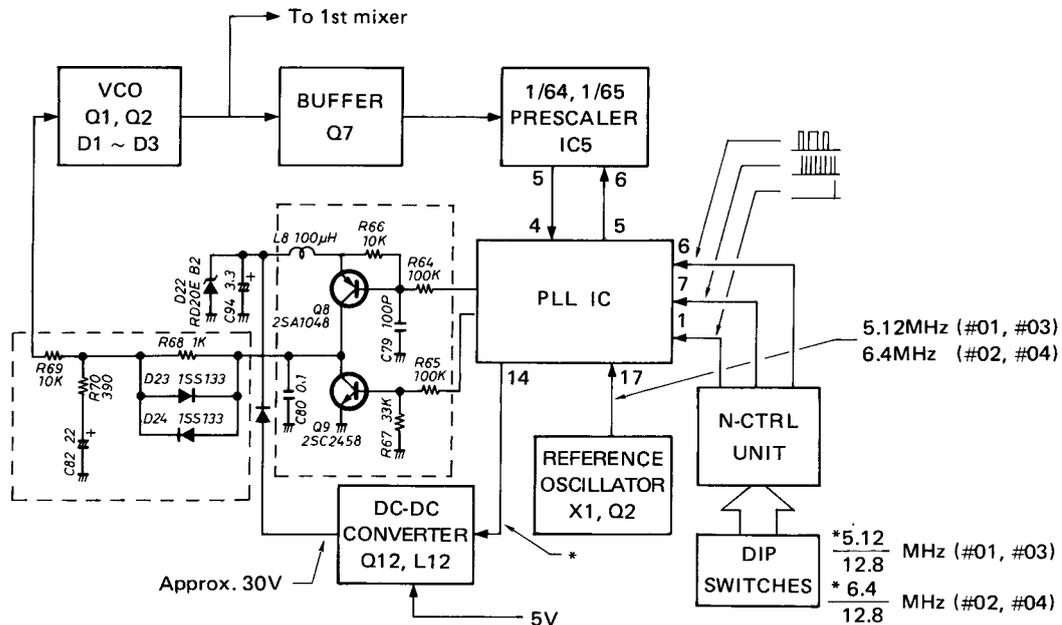
N-data can be obtained using the formula below.

$$N\text{-data} = \frac{\text{Receive frequency} - 1\text{st IF}}{\text{Channel spacing}}$$

(3) REFERENCE FREQUENCY OSCILLATOR CIRCUIT

The oscillator circuit consists of crystal unit X3, transistor Q6, thermistors R56 and R59, varicap D21 and other parts. The oscillation circuit is made from a reference oscillator circuit which is highly stable within a wide temperature range. The reference oscillation is divided inside IC4 to obtain 12.5kHz or 5kHz.

A part of the frequency from pin 14 of IC4 enters a booster circuit consisting of Q12, D25, L12 and the other parts. The output voltage of Q12 is at a high voltage (+20V) and is used in the charge pump circuit.



7-5 TRANSMITTER PLL CIRCUIT

(1) TRANSMITTER VCO CIRCUIT (TX-VCO UNIT)

See SECTION 7 - 4 (1) RECEIVER VCO CIRCUIT for detailed circuit description.

(2) PLL CIRCUIT (TRANSMITTER UNIT)

The VCO output signal is buffer amplified by Q1 and is divided by 1/64 and 1/65 at dual modulus prescaler IC2. In addition, divided signals are applied to IC1 and divided by N-data from the N-CTRL UNIT.

IC1 includes a phase detector circuit. The divided signal is compared with the reference oscillator frequency. Detector signals are output from pins 12 and 13 on IC1.

These output signals are received at a charge pump circuit of Q6 and Q7, and are supplied with high DC voltage (+20V). Using this method, the swing of the PD (Phase Detector) voltage expands and the VCO covers a very wide frequency range. R22, R23, R24 and C22 comprise a LPF for the loop filter of this PLL circuit. D2 and D3 reduce lock-up time.

N-data, as previously stated, is the value obtained by dividing the object frequency by channel spacing as shown in the formula below.

$$N\text{-data} = \frac{\text{Transmit frequency}}{\text{Channel spacing}}$$

(3) REFERENCE FREQUENCY OSCILLATOR CIRCUIT

The oscillator circuit consists of crystal unit X1, transistor Q2, thermistors R13 and R16, varicap D1 and other parts. The oscillation circuit consists of a reference oscillator circuit which is highly stable in a wide temperature range. The reference oscillation is divided inside IC1 to attain 12.5kHz or 5kHz.

A part of the frequency from pin 14 of IC1 enters a booster circuit consisting of Q8, D5, L4 and the other parts. The output voltage of Q8 is a high voltage (+20V) and is used in the charge pump circuit.

(4) UNLOCK DETECTOR CIRCUIT (TRANSMITTER UNIT)

When the PLL circuit is unlocked, pin 10 of IC1 is at a LOW level and the unlock detector circuit composed by Q3 outputs a HIGH level of the unlock (MUTE) signal to Q4. Q4 turns ON and Q5 turns OFF. The base bias voltages of Q10, Q11 and Q12 are removed, and thus transmit output signals are muted.

7-6 CONTROL CIRCUIT (CONTROL UNIT)

This circuit consists mainly of COR circuitry (Carrier Operated Relay) for start control. An AF oscillator circuit and a remote control signal decoder are also included for ID sendout. This control unit can be divided into the following control categories:

1. AF line control:

Transmitting an AF signal.

2. Transmission control:

Start of transmitter circuit.

3. Timer control:

Hang-up timer, time-out timer, ID interval timer.

(1) AF LINE CONTROL (CONTROL UNIT)

ID signals from pin 35 of IC3 (CPU) switch AF signals generated by IC7. To reduce tone distortion, signals are passed through a low-pass filter consisting of IC6(b) and other parts, then fed to mixer IC6(a).

AF output signals that pass through pin 4 of J4 in the RECEIVER UNIT and ID signals from IC6(b) are mixed and amplified at approximately 10dB at IC6(a). They are then mixed and signals are sent out to the TRANSMITTER UNIT through pin 4 of J5 on the CONTROL UNIT.

When the LOCAL INHIBIT FUNCTION is turned ON, IC6(a) is cut off by D4, and no signal is output from IC6(a).

(2) TRANSMISSION CONTROL (CONTROL UNIT)

When the repeater receives a signal and the [BUSY] INDICATOR lights up, the repeater starts transmitting. Following are explanations for controlling the transmitter of the repeater.

The CONTROL UNIT has two signal inputs for controlling the transmitter: one is a signal from the TONE UNIT on the CONTROL UNIT through pin 5 of J2; the other is the squelch signal from pin 4 of J4 on the CONTROL UNIT.

Pin 5 (J2): HIGH level with presence of access tone.

Pin 4 (J4): HIGH level with reception of carrier.

Both signals are fed to the NAND gate of IC7 through a Schmitt trigger circuit consisting of two inverters in each circuit as BUSY signals.

When the [BUSY] INDICATOR lights up, IC3 sends out a signal for transmit through the PTT line on pin 5 of J5.

(3) TIMER CONTROL (CONTROL UNIT)

Three timers are used in this unit: (1) Time-out timer, (2) ID interval timer, and (3) Hang-up timer.

The time-out timer and ID interval timer are programmed in the EPROM IC chip, IC1 on the CONTROL UNIT. The hang-up timer can be selected for 0, 1, 3 and 5 seconds by combinations of switches S1 and S2. These are connected to the input terminals of pins 33 and 34 of IC3 (CPU).

(4) OTHERS

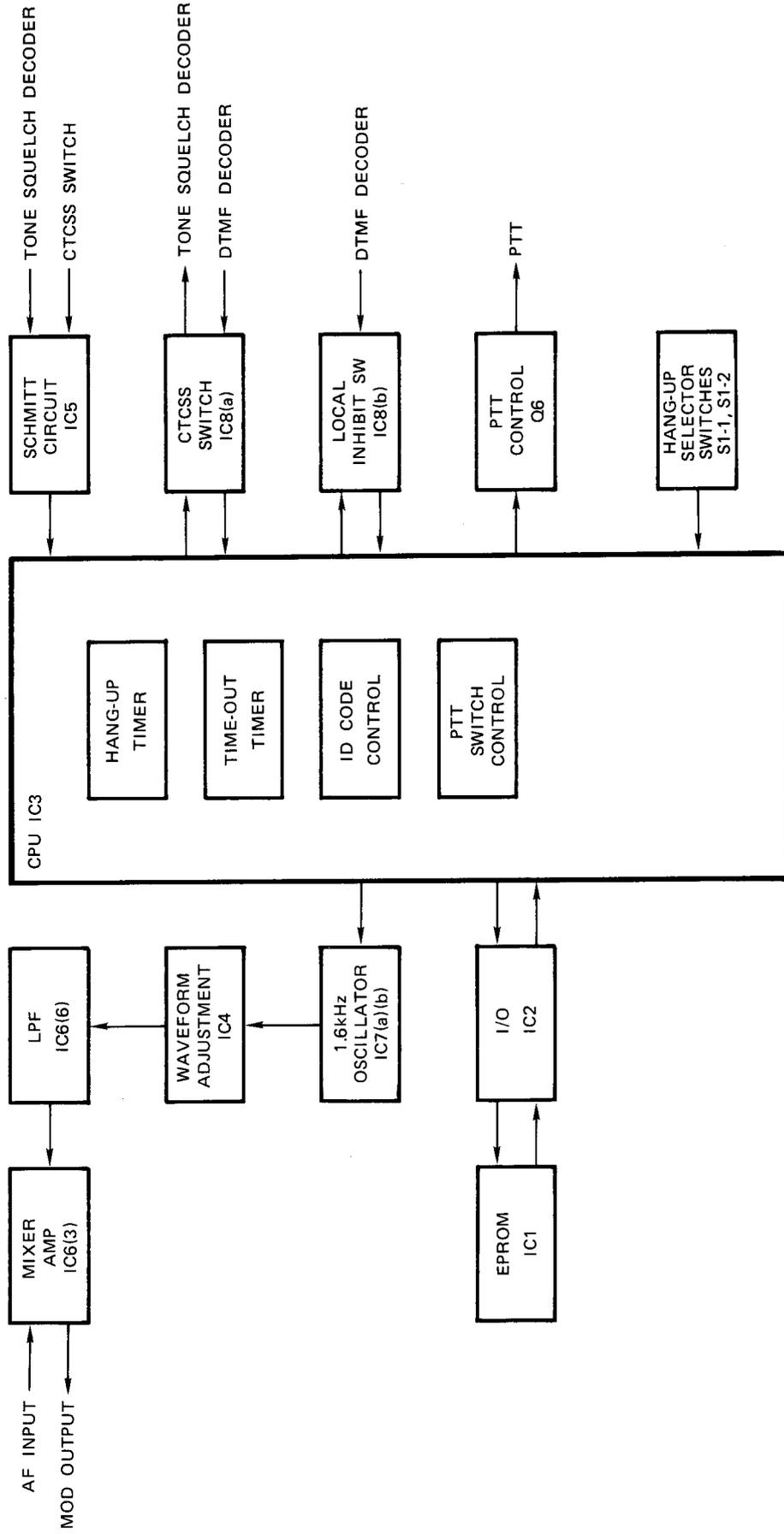
The ON-OFF signal of the [LOCAL INHIBIT] SWITCH is latched at IC8(b) through pin 1 of J1 and passes to IC3 (CPU) through Q3. The output signal also controls the [LOCAL INHIBIT] INDICATOR.

The ON-OFF signal of the [CTCSS] SWITCH is latched at IC8(a). When the [CTCSS] SWITCH is pushed and the [CTCSS] INDICATOR lights up, pin 13 of IC8(a) is at a LOW level and the TONE SQUELCH UNIT is turned ON. In addition, the output signal from IC8(a) controls the [CTCSS] INDICATOR through Q1.

The two latch circuits in IC8 receive a signal from the DTMF DECODER UNIT via J3 on the CONTROL UNIT for setting or resetting operations.

The signal from the [COR SIMULATE] SWITCH is directly applied to the INT (interrupt) terminal on IC3 (CPU).

■ CONTROL UNIT BLOCK DIAGRAM



7-7 TONE SQUELCH CIRCUIT

The TONE SQUELCH UNIT consists of an amplifier circuit, decoder circuit, switching circuit, and regulator circuit.

The discriminated AF signal from pin 2 of IC1 on the RECEIVER UNIT is fed to Q1 on the TONE SQUELCH UNIT through pin 7 of J2 and is amplified.

IC1 is a high performance encoder/decoder IC chip. However, the encoder function is not used. The tone decoder frequency is determined by resistor element R17. The decoder frequency is available for the following 33 frequencies:

GROUP-A		GROUP-B	
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
A-1	107.2	B-1	179.9
A-2	114.8	B-2	167.9
A-3	123.0	B-3	156.7
A-4	131.8	B-4	146.2
A-5	141.3	B-5	136.5
A-6	151.4	B-6	127.3
A-7	162.2	B-7	118.8
A-8	173.8	B-8	110.9
A-9	186.2	B-9	103.5
A-10	203.5	B-10	94.8
A-11	218.1	B-11	82.5
A-12	233.6	B-12	71.9
A-13	250.3	B-13	241.8
A-14	67.0	B-14	225.7
A-15	77.0	B-15	210.7
A-16	88.5	B-16	192.8
A-17	100.0		

Unit : Hz

7-8 DTMF DECODER CIRCUIT (DTMF UNIT)

AF signals from the RECEIVER UNIT are fed to Q1 on the DTMF UNIT through J1 and signals are amplified.

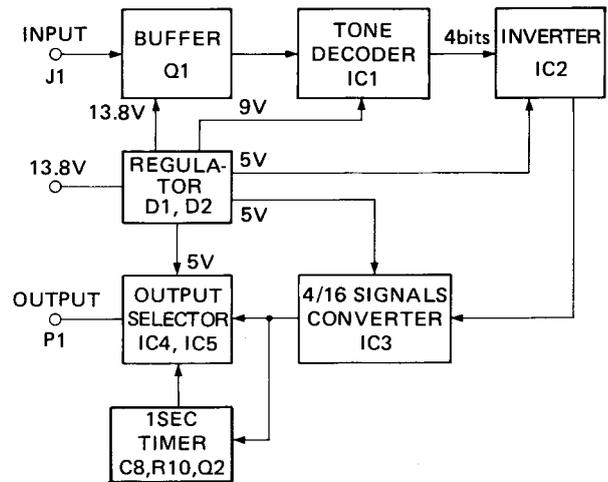
IC1 is an IC chip for the DTMF detector. An applied double-tone signal is detected at IC1 and outputs signals as a 4-bit binary code.

IC2 reverses the output signals and converts the signals from 9Vp-p to 5Vp-p.

IC3 converts the input signals to signals of hexadecimals and the signals are fed to IC4 and IC5.

A group of signals is checked for its combination at IC4 or IC5, and is output from pin 9 or pin 13 via IC4, or from pin 1 or pin 10 through IC5.

These signals are then sent to the CONTROL UNIT through J3 on the CONTROL UNIT to activate their respective functions.



7-9 N-CONTROL CIRCUIT (N-CTRL UNIT)

This unit has two independent generators for the receiver and transmitter PLL circuits which generate N-data, clock, and strobe signals.

Following is a description for the generator used in the RECEIVER UNIT (identical to the generator used in the PLL UNIT).

IC1 functions as a clock generator.

IC2 functions as a clock counter and strobe generator. When IC2 counts 17 clocks, pin 11 of IC3 outputs a strobe signal.

IC4 and IC5 function as a parallel-serial converter and convert parallel signals for PLL N-data which is set by dip switches S1 and S2 for serial N-data.

IC5 outputs N-data signals as a binary code.

8. MAINTENANCE AND ADJUSTMENT

8-1 MAINTENANCE

DANGER: HIGH VOLTAGE

The regulator circuit in the IC-RP151D contains high voltages that are potentially **LETHAL** when operating the repeater with an AC power source. A DC power source (13.8V) should be used if the repeater case is removed for servicing.

(1) FUSE REPLACEMENT

If the fuse blows or the transceiver stops functioning, track down the source of the problem, and replace the damaged fuse with a new, rated fuse.

WARNING: Disconnect the AC cord from the AC outlet to prevent electric shocks when changing the fuse.

- AC line fuse : 5A for 117V AC type
3A for 220V, 240V AC type

- DC line fuse : 10A for all versions

(2) PERIODICAL CHECKING

Since the IC-RP151D contains high voltages and is a powerful full duplex repeater, the unit is liable to become hot while operating.

The following items should be checked periodically to ensure steady repeater operations:

- ① AC cord connection
- ② DC power cable connection
- ③ Antenna connectors connection
- ④ Antenna system
- ⑤ Backup battery life
- ⑥ Burning smell from the repeater
- ⑦ Heat from the repeater

8-2 PREPARATION BEFORE SERVICING

- 1) Detach the power cord and turn OFF the [POWER] SWITCH before performing any work on the repeater.
- 2) **DO NOT** short circuit components while making adjustments.
- 3) Use an insulated tuning tool for all adjustments.

- 4) **DO NOT** force any of the variable components. Tune them slowly and smoothly.

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

- 6) Check the condition of connectors, solder joints and screws when adjustments are complete. Make sure components do not touch each other.

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

- 8) Use the correct tools and test equipment.

- 9) For transmission problems, connect a dummy load to the transmitter antenna connector.

For reception problems, connect an antenna or signal generator to the receiver antenna connector.

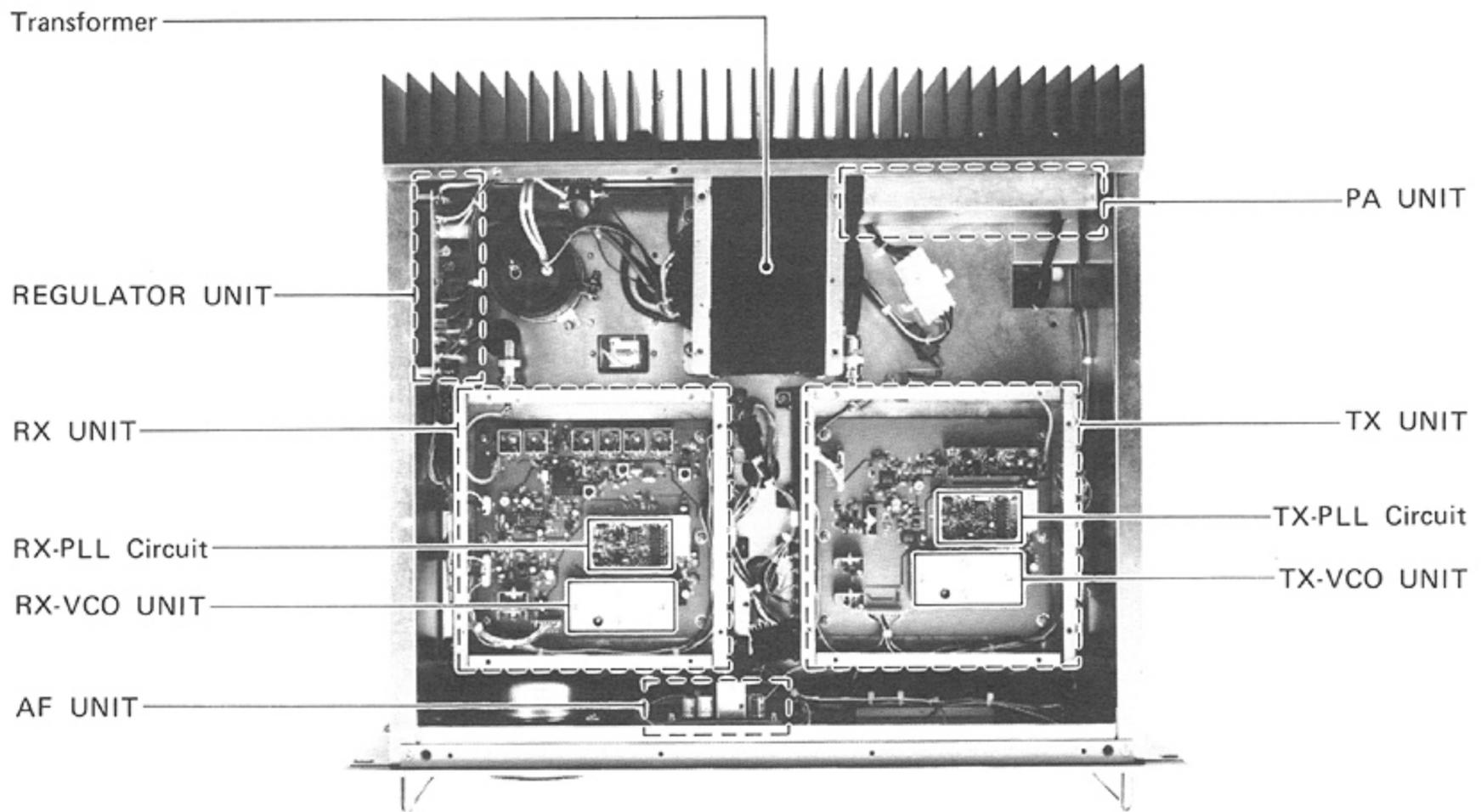
- 10) Recheck for the suspected malfunction with the POWER SWITCH ON.

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

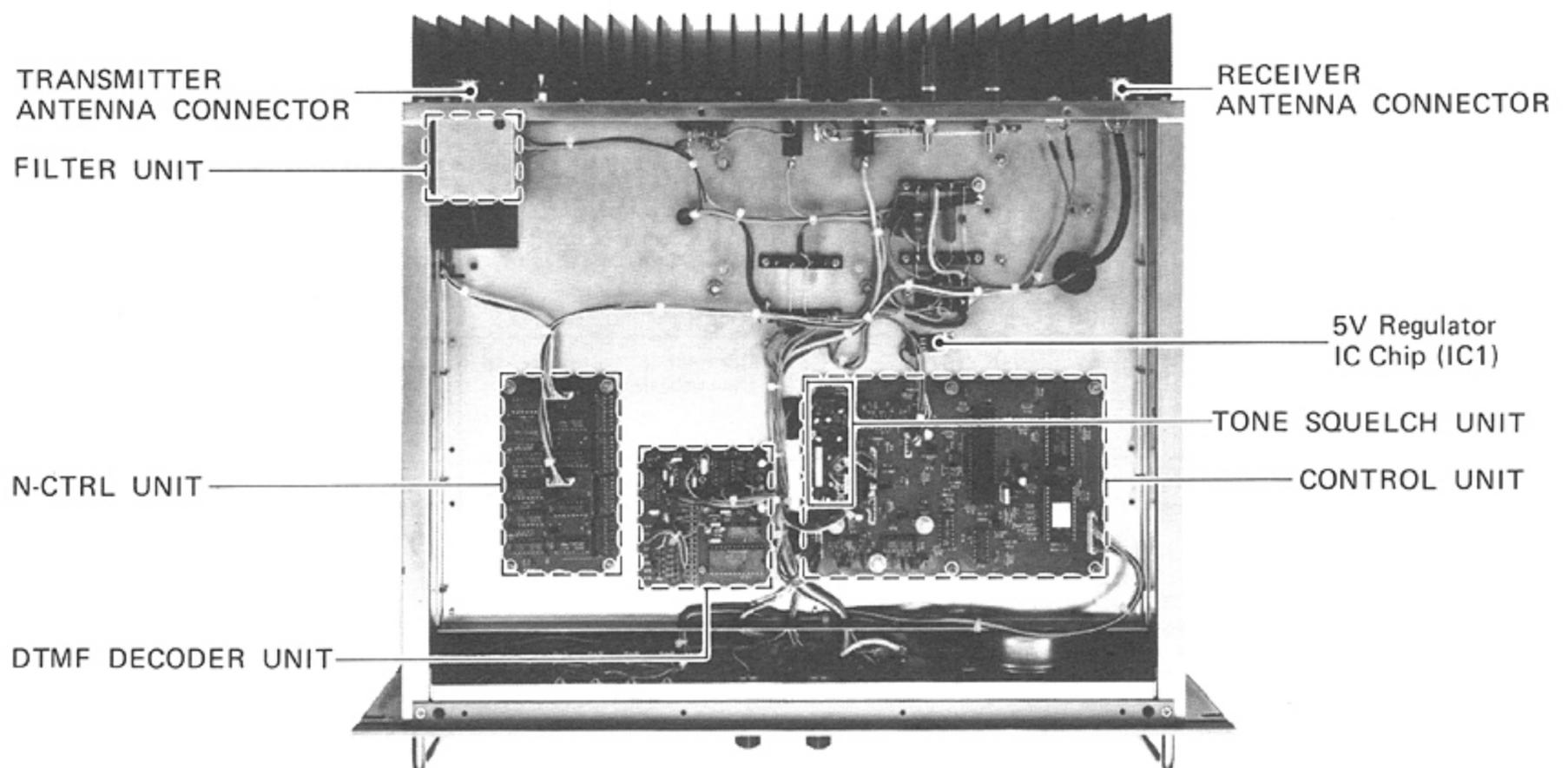
The voltage between the base and emitter should be 0.6V when the transistor is activated.

8-3 INSIDE VIEWS

● TOP VIEW



● BOTTOM VIEW

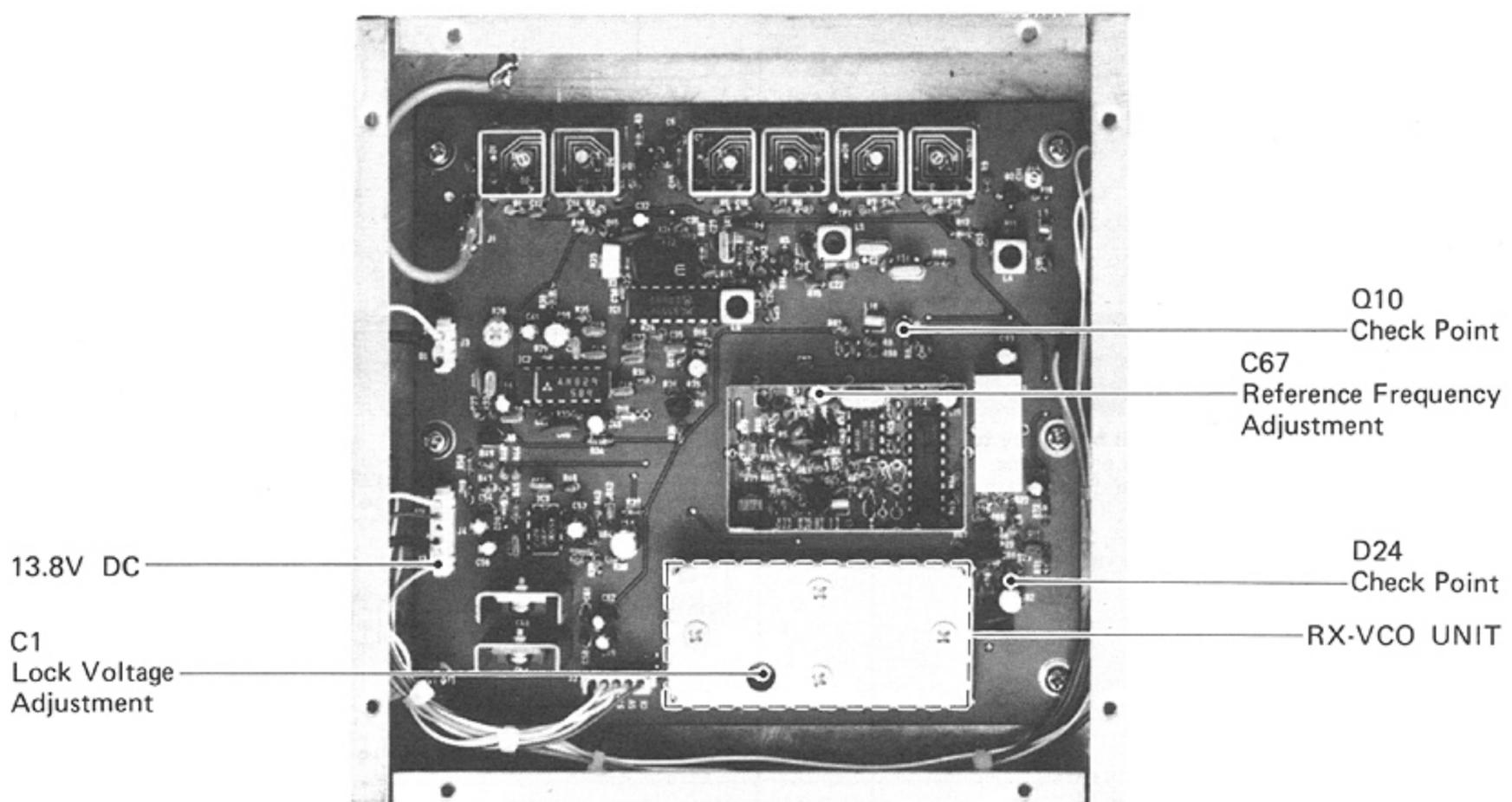


8-4 RECEIVER PLL ADJUSTMENT

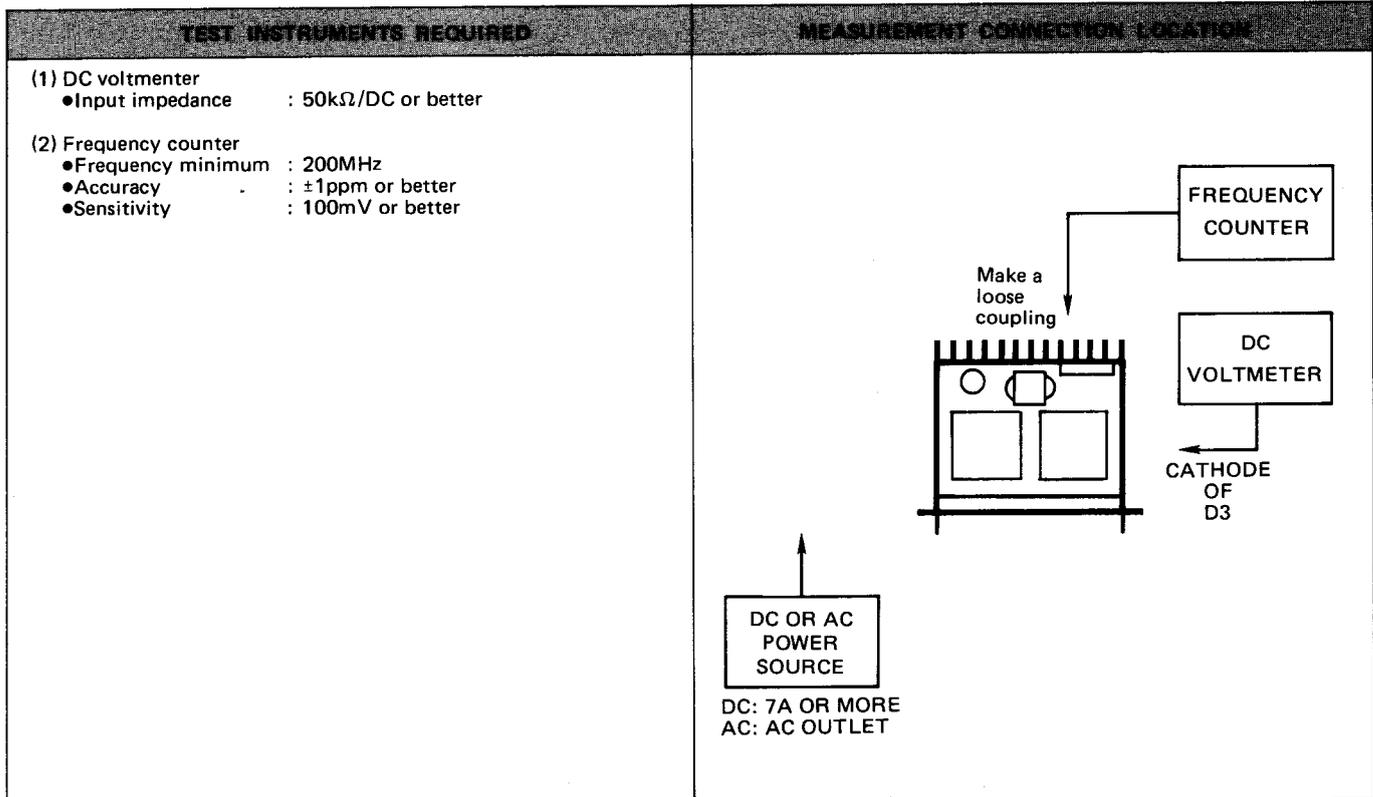
TEST INSTRUMENTS REQUIRED	MEASUREMENT CONNECTION LOCATION
<p>(1) DC voltmeter</p> <ul style="list-style-type: none"> ●Input impedance : 50kΩ/DC or better <p>(2) Frequency counter</p> <ul style="list-style-type: none"> ●Frequency minimum : 200MHz ●Accuracy : ±1ppm or better ●Sensitivity : 100mV or better 	<p>DC OR AC POWER SOURCE DC: 7A OR MORE AC: AC OUTLET</p> <p>FREQUENCY COUNTER</p> <p>DC VOLTmeter</p> <p>CATHODE OF D24</p> <p>Make a loose coupling</p>

ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
LOCK VOLTAGE	1	N-CTRL	<p>N-CTRL UNIT</p> <p>Receive frequency setting</p>	<p>#01 (N-data = 22840)</p> <p>#02 (N-data = 9136)</p> <p>#03 (N-data = 25640)</p> <p>#04 (N-data = 10256)</p>		
	2	●Receive mode	RX	Connect a voltmeter to the cathode of D24.	#01, #02 1.5V #03, #04 4.0V	RX-VCO
REFERENCE FREQUENCY	1	RX	Make a loose coupling between a frequency counter and Q10.	#01, #02 114.20MHz #03, #04 128.20MHz	RX (PLL)	C67

● RX UNIT

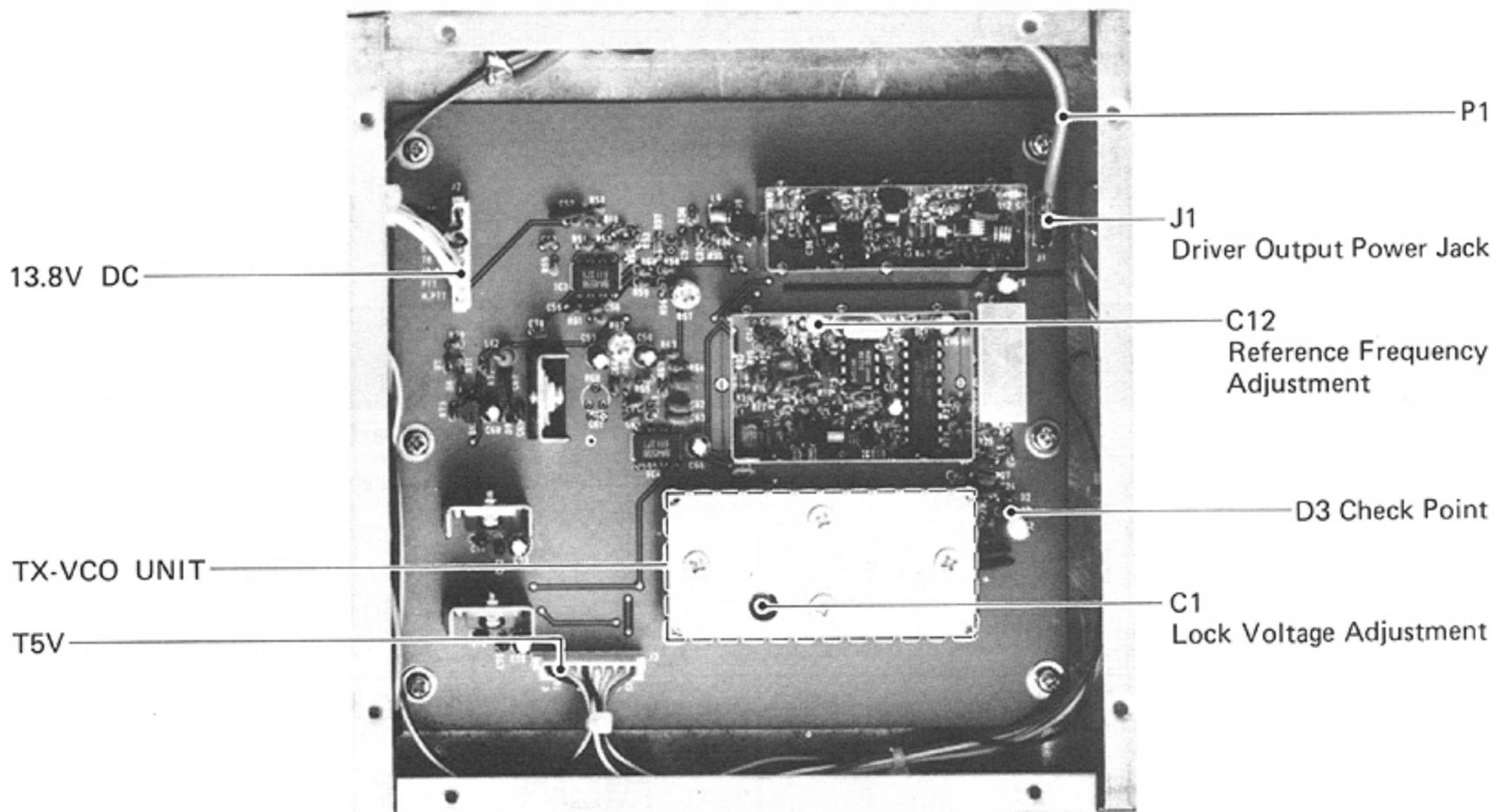


8-5 TRANSMITTER PLL ADJUSTMENT

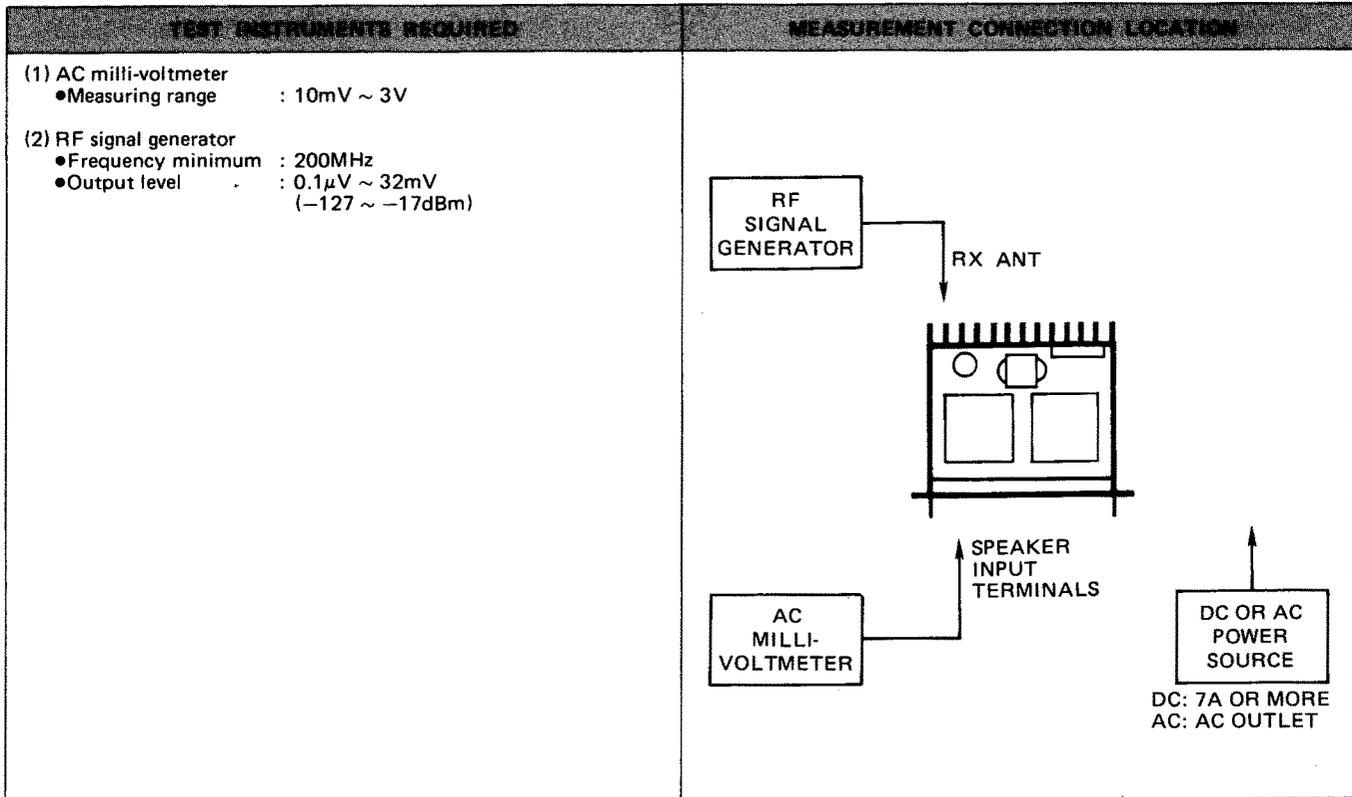


ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
LOCK VOLTAGE	1	N-CTRL	N-CTRL UNIT Transmit frequency set	#01, #03 (N-data = 30000) #02, #04 (N-data = 12000) 		
	2	TX	Connect a voltmeter to the cathode of D3.	All versions 8.5V	TX-VCO	C1
REFERENCE FREQUENCY	●Transmit mode ●Frequency : 150.00MHz ●Remove P1 from J1	TX	Make a loose coupling between a frequency counter and J1.	150.000MHz	TX	C12
	NOTE: Re-plug P1 to J1 after the adjustment is finished.					

● TX UNIT

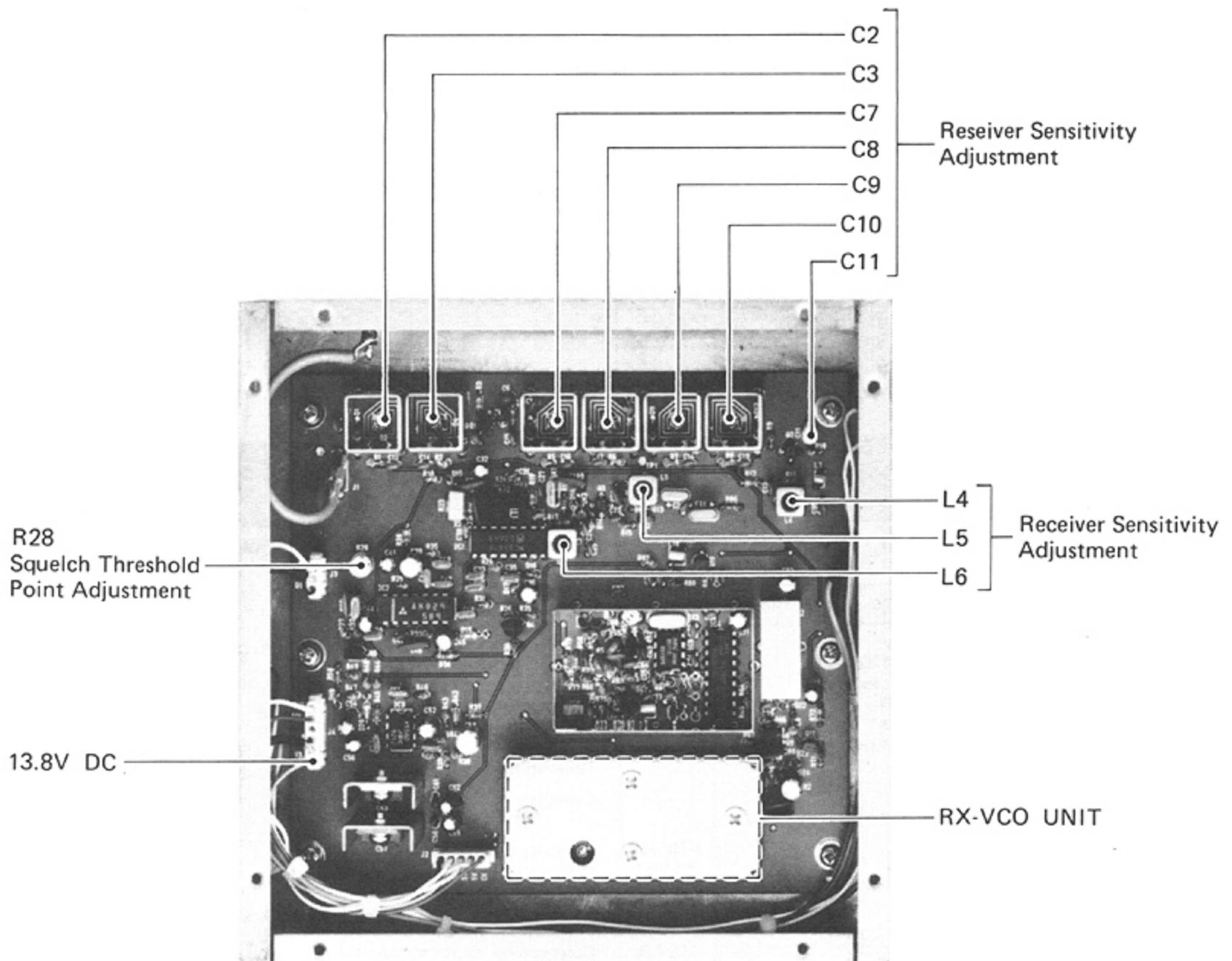


8-6 RECEIVER ADJUSTMENT

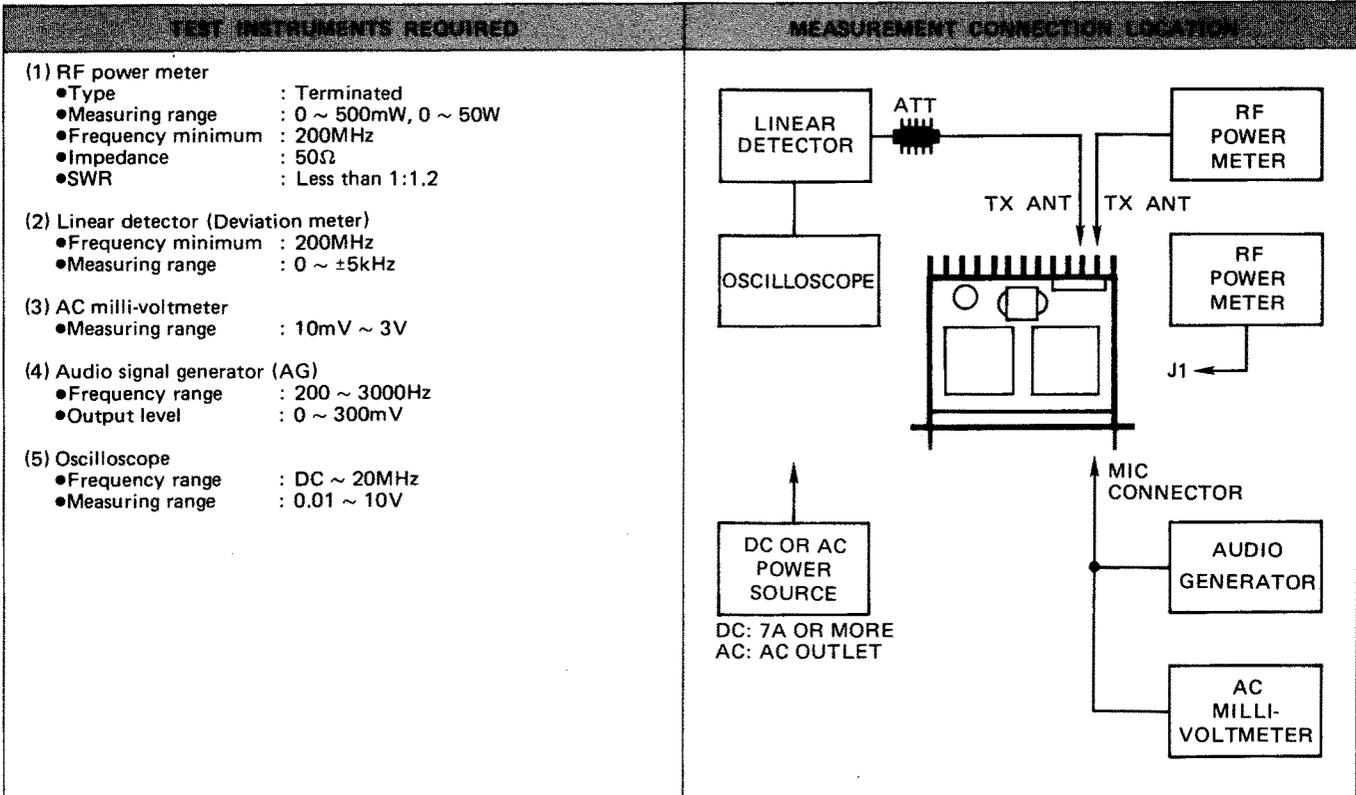


ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
SENSITIVITY	1	FRONT	Connect an AC milli-voltmeter to the input terminals of the internal speaker.	Maximum level More than -117dBm for 12dB SINAD.	RX	C2, C3, C7, C8, C9, C10, C11, L4, L5, L6
	<p>●Receive mode</p> <p>●Apply an RF signal to the RX ANT CONNECTOR.</p> <p style="margin-left: 20px;">Level : 10μV (-87dBm)</p> <p style="margin-left: 20px;">Deviation : ±3.5kHz</p> <p style="margin-left: 20px;">Modulation : 1kHz</p> <p style="margin-left: 20px;">Frequency : 150.00MHz</p> <p>NOTE: Repeat this adjustment several times to obtain maximum receiver sensitivity.</p>					
SQUELCH THRESHOLD POINT	1	FRONT		10 o'clock	FRONT PANEL	
	2					

● RX UNIT

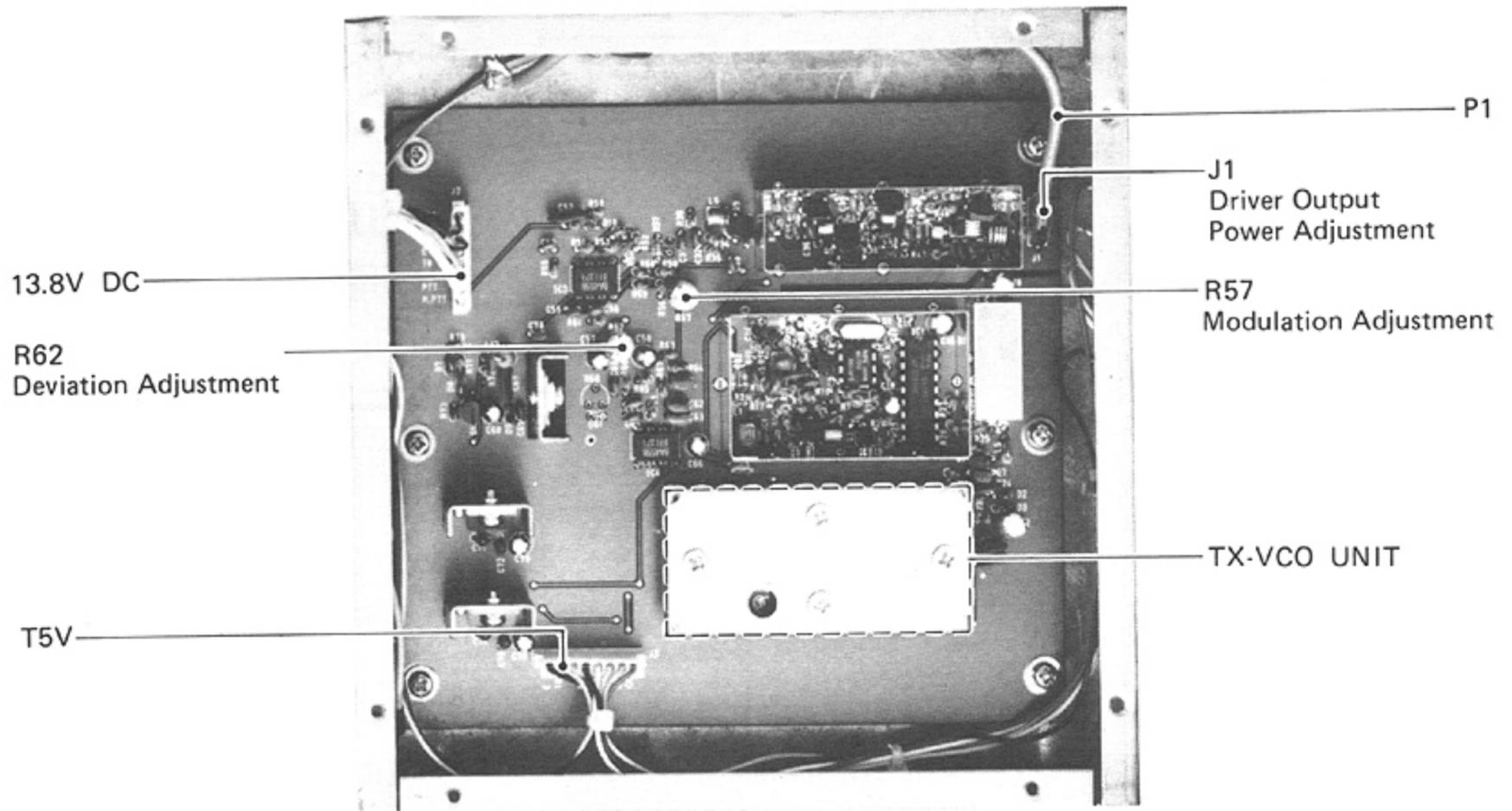


8-7 TRANSMITTER ADJUSTMENT

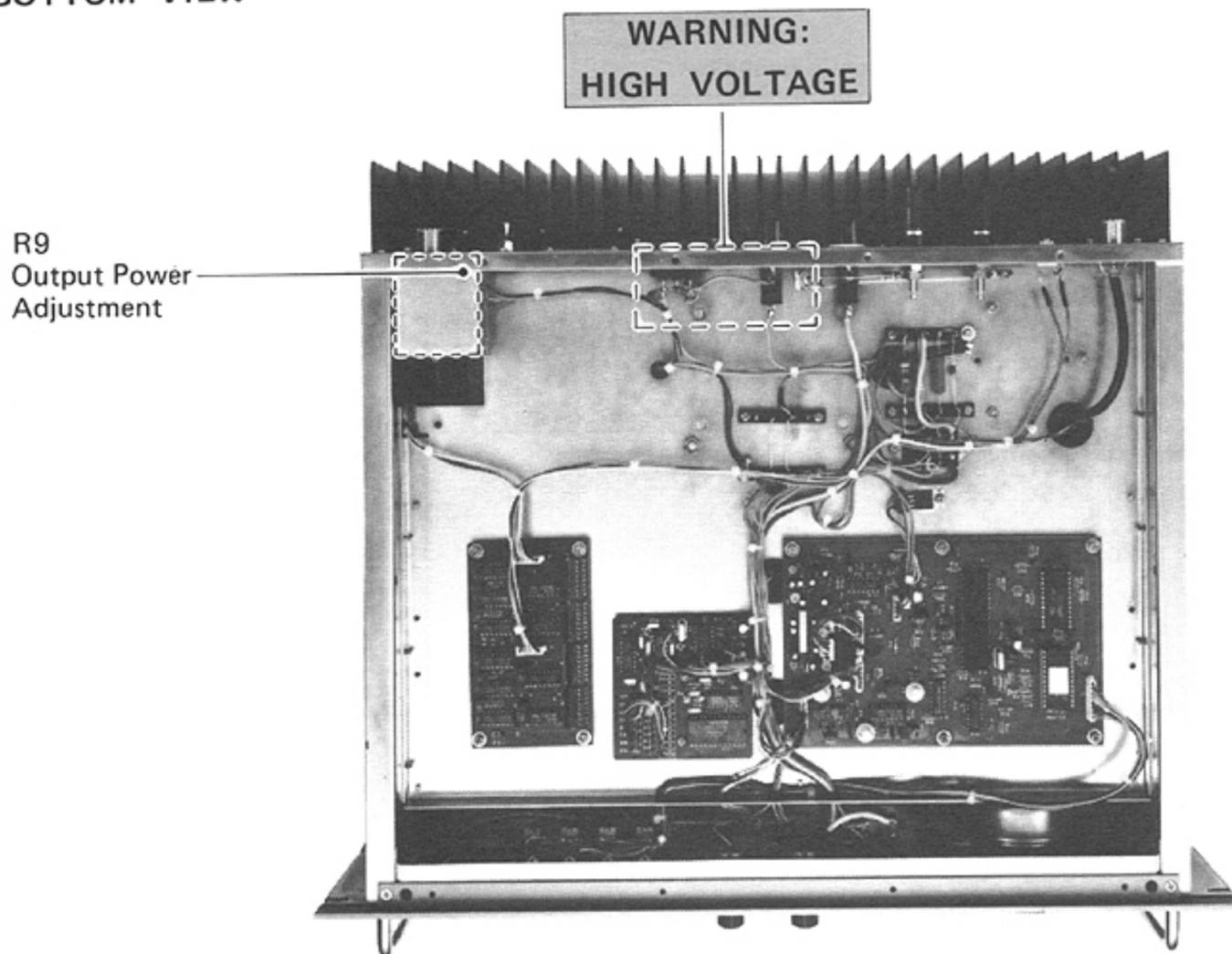


ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
DRIVER OUTPUT	1 <ul style="list-style-type: none"> Remove P1 from J1 Transmit mode 	TX	Connect a power meter to J1.	300mW	TX	Verify
NOTE: Re-plug P1 to J1 after the adjustment is finished.						
MODULATION	1 <ul style="list-style-type: none"> Transmit frequency: 150.00MHz Apply an AF signal to the MIC CONNECTOR. Level : 40mV Frequency : 1000Hz 	REAR PANEL	Connect a linear detector to the TX ANT CONNECTOR through an attenuator. LPF : 20kHz HPF : OFF De-emphasis : OFF Detector : $\frac{P-P}{2}$	±4.5kHz	TX	R62
	2 <ul style="list-style-type: none"> Transmit frequency Apply an AF signal to the MIC CONNECTOR. Level : 4mV Frequency : 1000Hz 	FRONT PANEL	Connect an AC milli-voltmeter to the audio generator in parallel.			
		REAR PANEL	Connect an oscilloscope to the output terminals on the linear detector.	<p>Same waveforms</p>	TX	R57
OUTPUT POWER	1 <ul style="list-style-type: none"> Transmit mode 	REAR PANEL	Connect a power meter.	25W	FILTER	R9

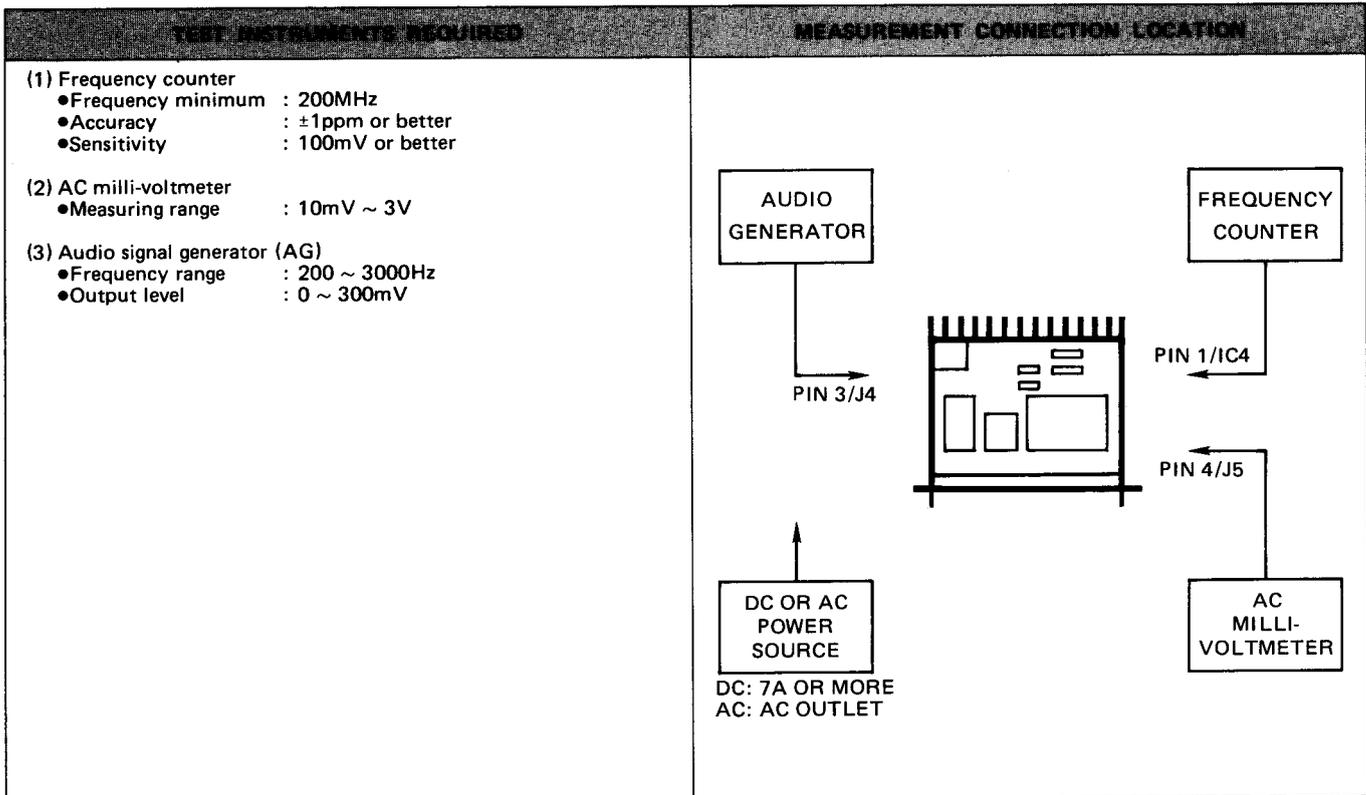
● TX UNIT



● BOTTOM VIEW

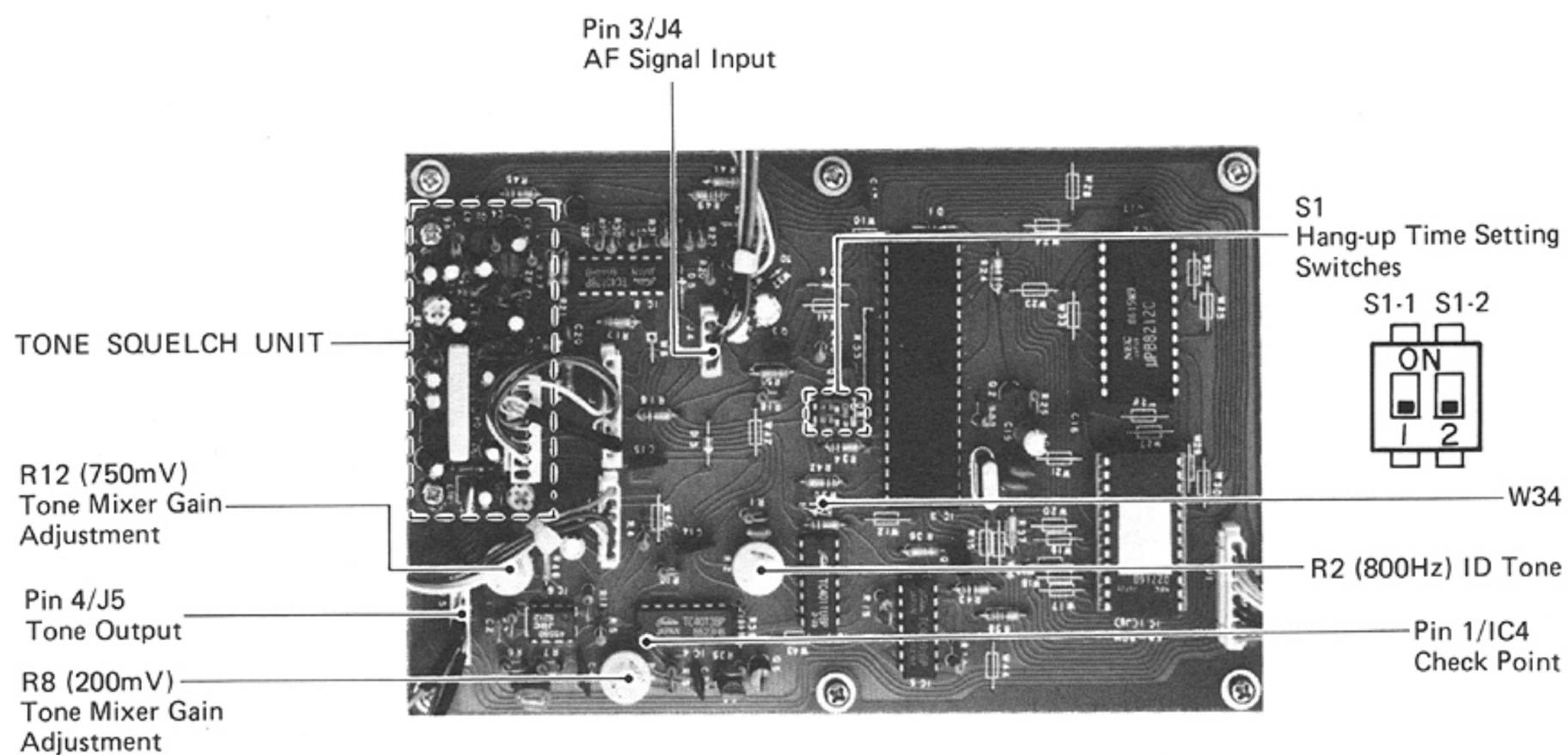


8-8 CONTROL UNIT ADJUSTMENT

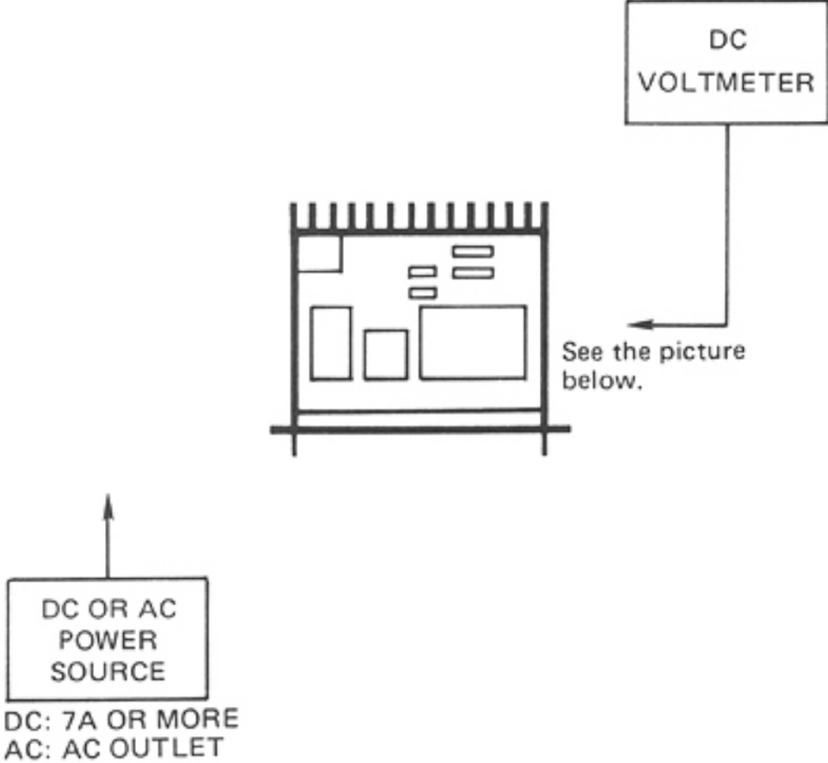


ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT					
		UNIT	LOCATION		UNIT	ADJUST				
ID TONE FREQUENCY	1	●Re-connect W34 before adjusting if the wire is cut.	CONTROL	Connect a frequency counter to pin 1 of IC4.	800Hz	CONTROL	R2			
	NOTE: Disconnect W34 after the adjustment is finished.									
TONE MIXER GAIN	1	●Connect W34 before adjusting if the wire is cut. ●Apply an AF signal to pin 3 of J4 on the CONTROL UNIT Level : 250mV Frequency : 1000Hz	CONTROL	Connect an AC milli-voltmeter to pin 4 of J5.	750mV	CONTROL	R12			
	2							●Re-connect W34 before adjusting if the wire is cut. ●Apply no signal.	200mV	R8
	NOTE: Disconnect W34 after the adjustment is finished.									
HANG-UP TIMER	1	●See p. 6 - 1 for further information.			HANG-UP TIME SETTING					
					SET TIME	SWITCH POSITION				
						S1-1	S1-2			
					0sec.	ON	ON			
					1sec.	ON	OFF			
					3sec.	OFF	ON			
5sec.	OFF	OFF								

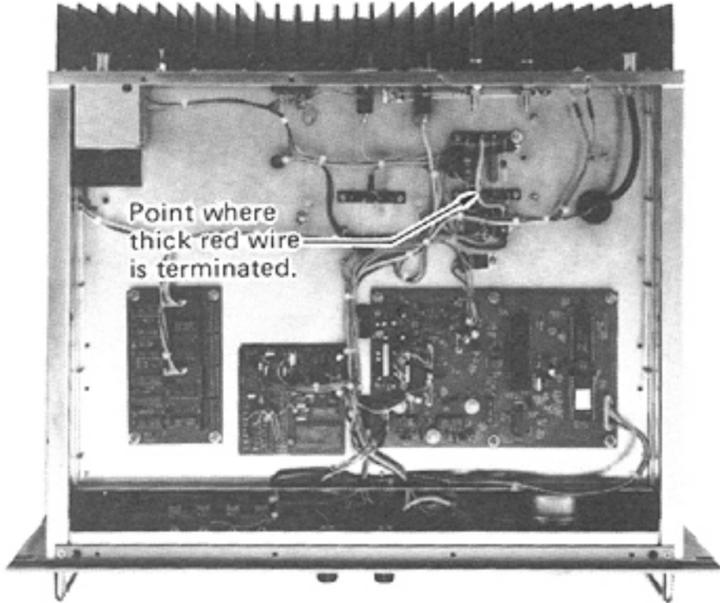
● CONTROL UNIT



8-9 OTHER UNITS ADJUSTMENT

TEST INSTRUMENTS REQUIRED	MEASUREMENT CONNECTION LOCATION
(1) DC voltmeter •Input impedance : 50kΩ/DC or better	 <p>DC OR AC POWER SOURCE DC: 7A OR MORE AC: AC OUTLET</p> <p>DC VOLTMETER</p> <p>See the picture below.</p>

ADJUSTMENT	ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
		UNIT	LOCATION		UNIT	ADJUST
TONE SQUELCH	1 •[VOLUME] CONTROL : Max. CCW •[SQUELCH] CONTROL : Max. CCW •[CTCSS] SWITCH : ON •OTHER SWITCHES : OFF •Rotate R8 on the TONE SQUELCH UNIT max. CW. •Rotate R8 CCW.	FRONT PANEL	[TRANSMIT] INDICATOR	The point when the [TRANSMIT] INDICATOR lights up steadily.	TONE SQUELCH	R8
REGULATOR OUTPUT VOLTAGE	1 •Rotate R6 max. CCW.		Connect a voltmeter at the point shown in the picture below.	14.0V	REGULATOR	R4



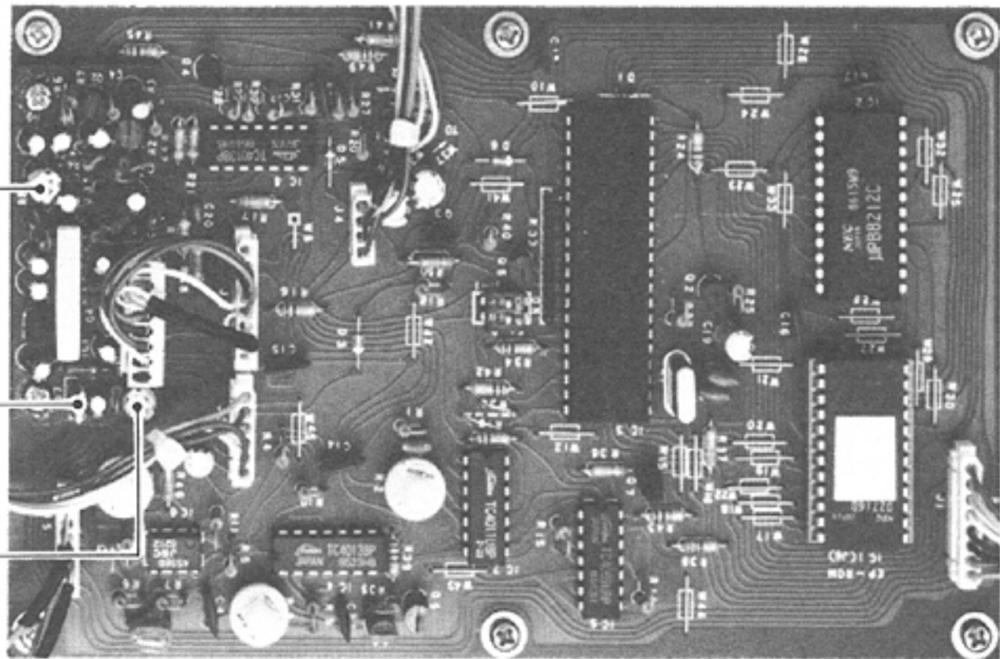
Point where thick red wire is terminated.

● CONTROL UNIT

R8
Tone Squelch
Adjustment

R17
Tone Frequency Setting
Resistor Element

R16 (No Function)

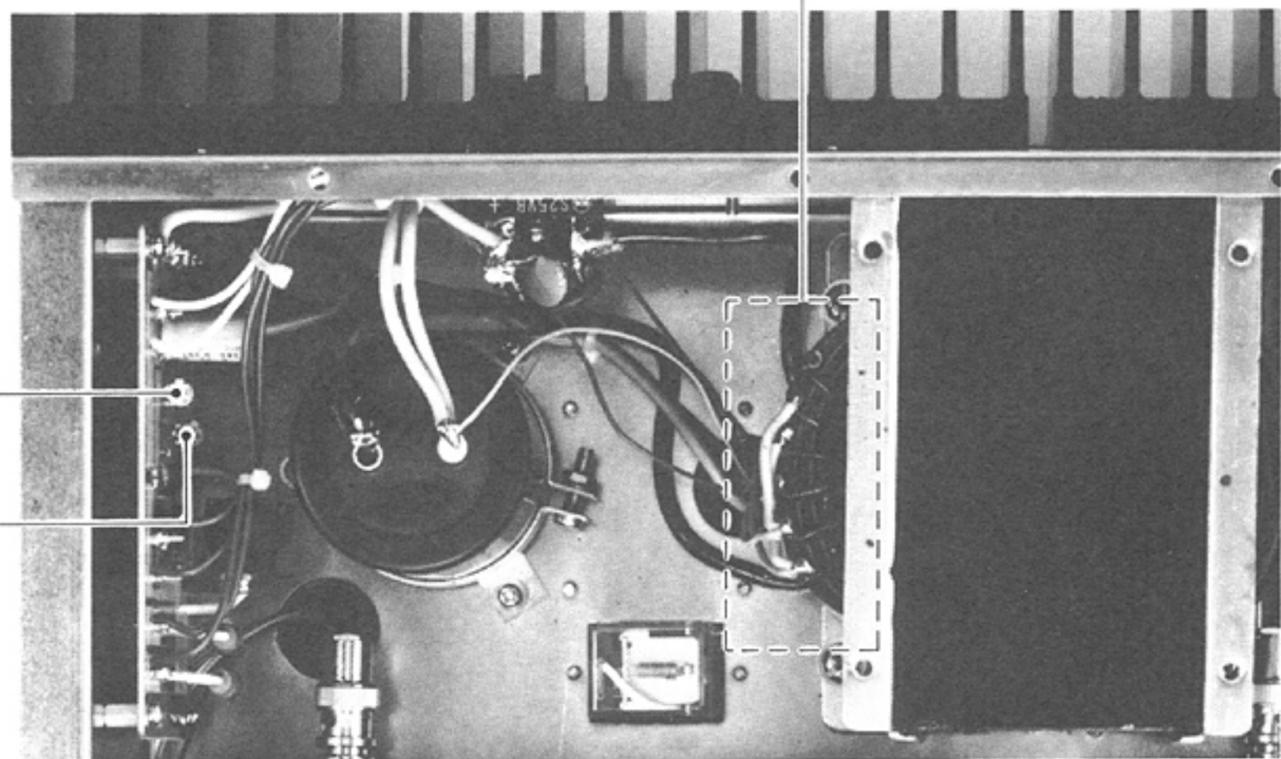


● REGULATOR UNIT

WARNING:
HIGH VOLTAGE

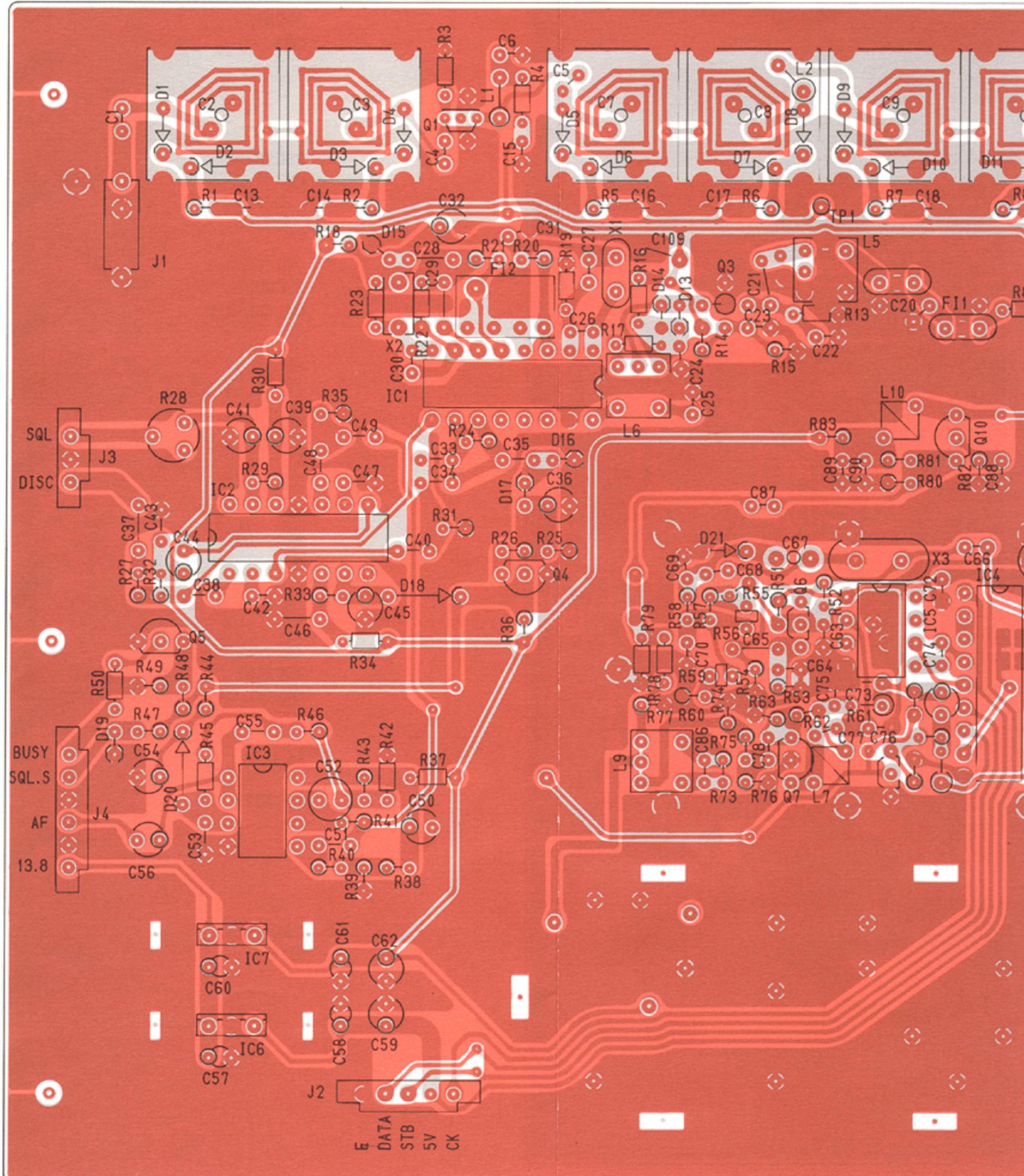
R6
Current Limiter
Adjustment

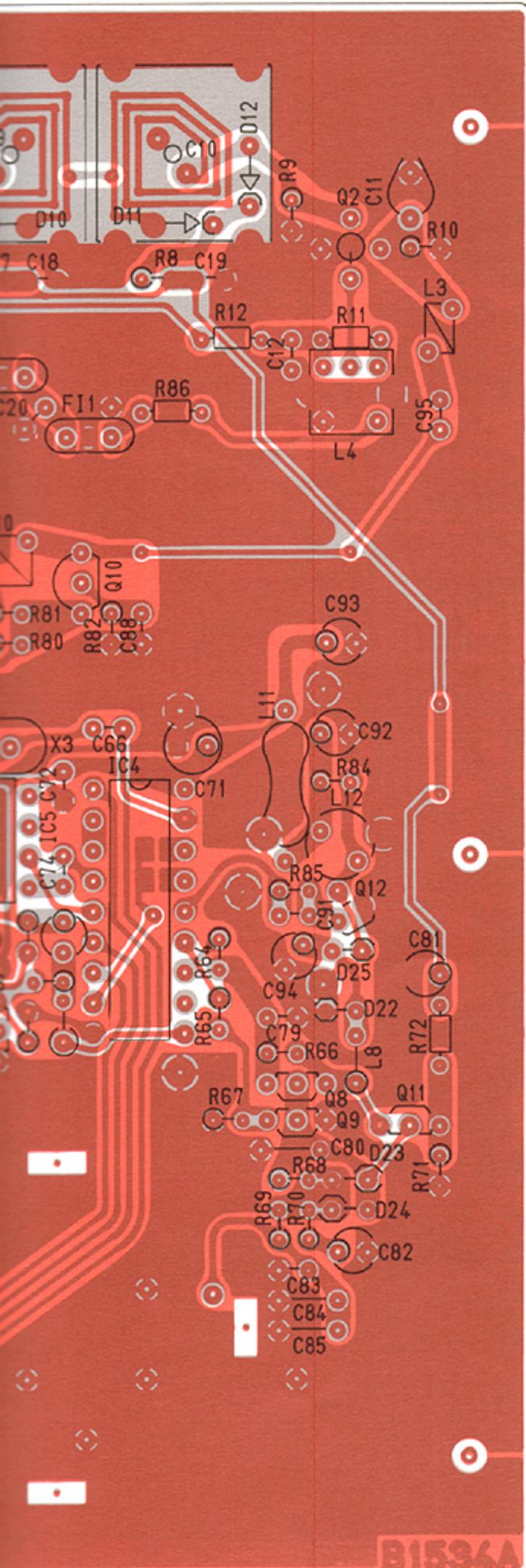
R4
Regulator Output
Voltage Adjustment



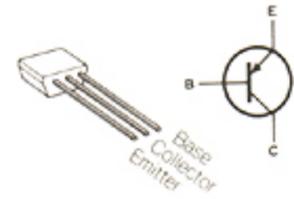
9. BOARD LAYOUTS

9-1 RX UNIT

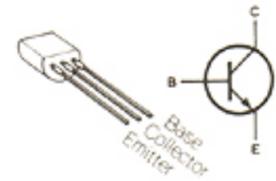




2SA1048
Q8



2SC945
Q4



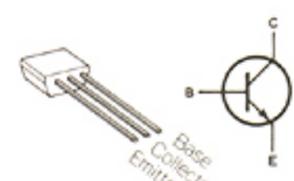
2SC1645
Q5



2SC2026
Q7, Q10



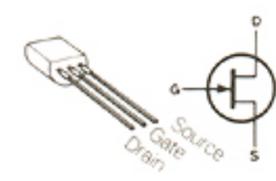
2SC2458
Q6, Q9



2SC3327
Q12



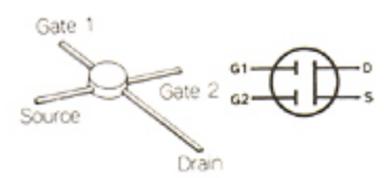
2SK184
Q11



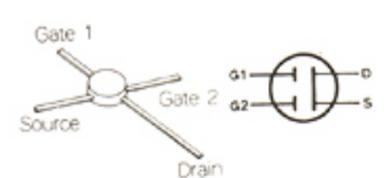
2SK241
Q1



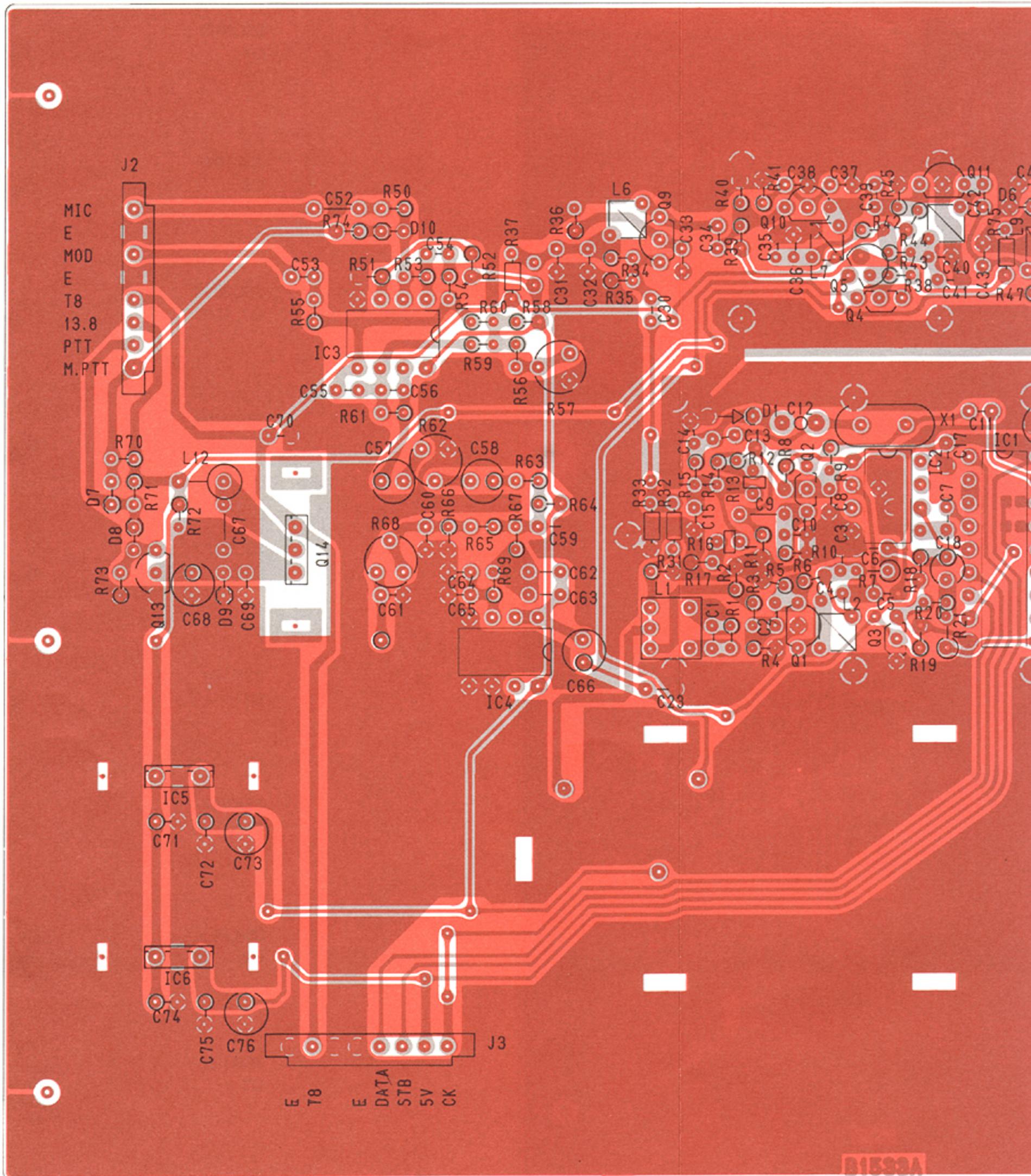
3SK74
Q2

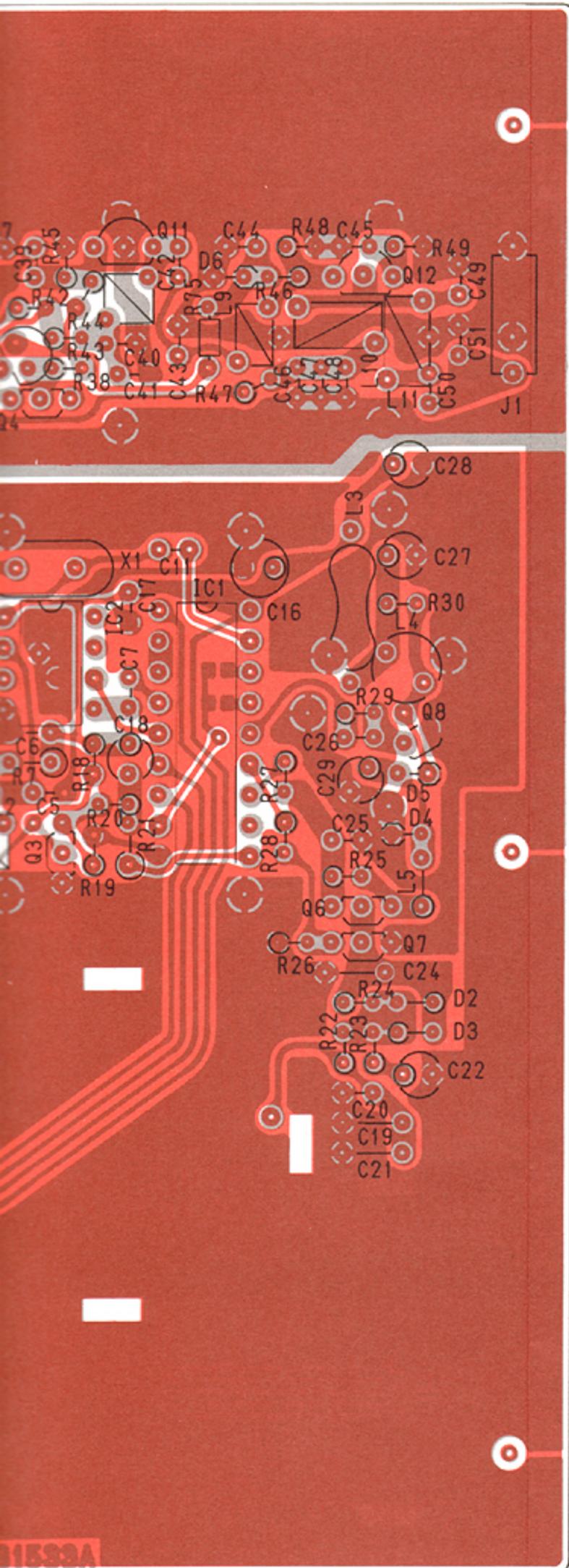


3SK122
Q3

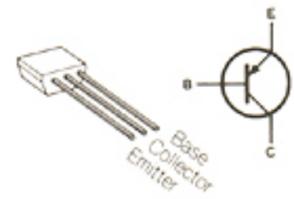


9-2 TX UNIT

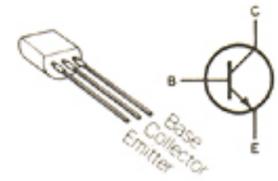




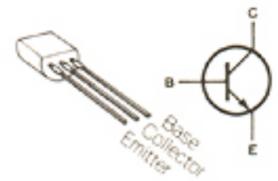
2SA1048
Q6



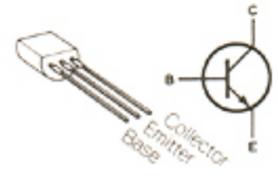
2SC945
Q13



2SC1815
Q5



2SC2026
Q1, Q9, Q10



2SC2053
Q12



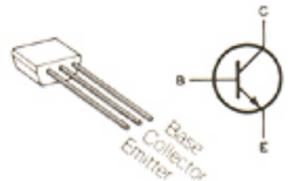
2SC2407
Q11



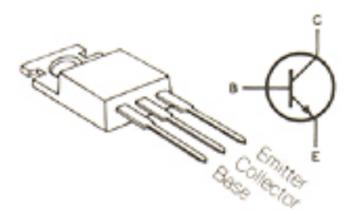
2SC2458
Q2, Q3, Q4, Q7



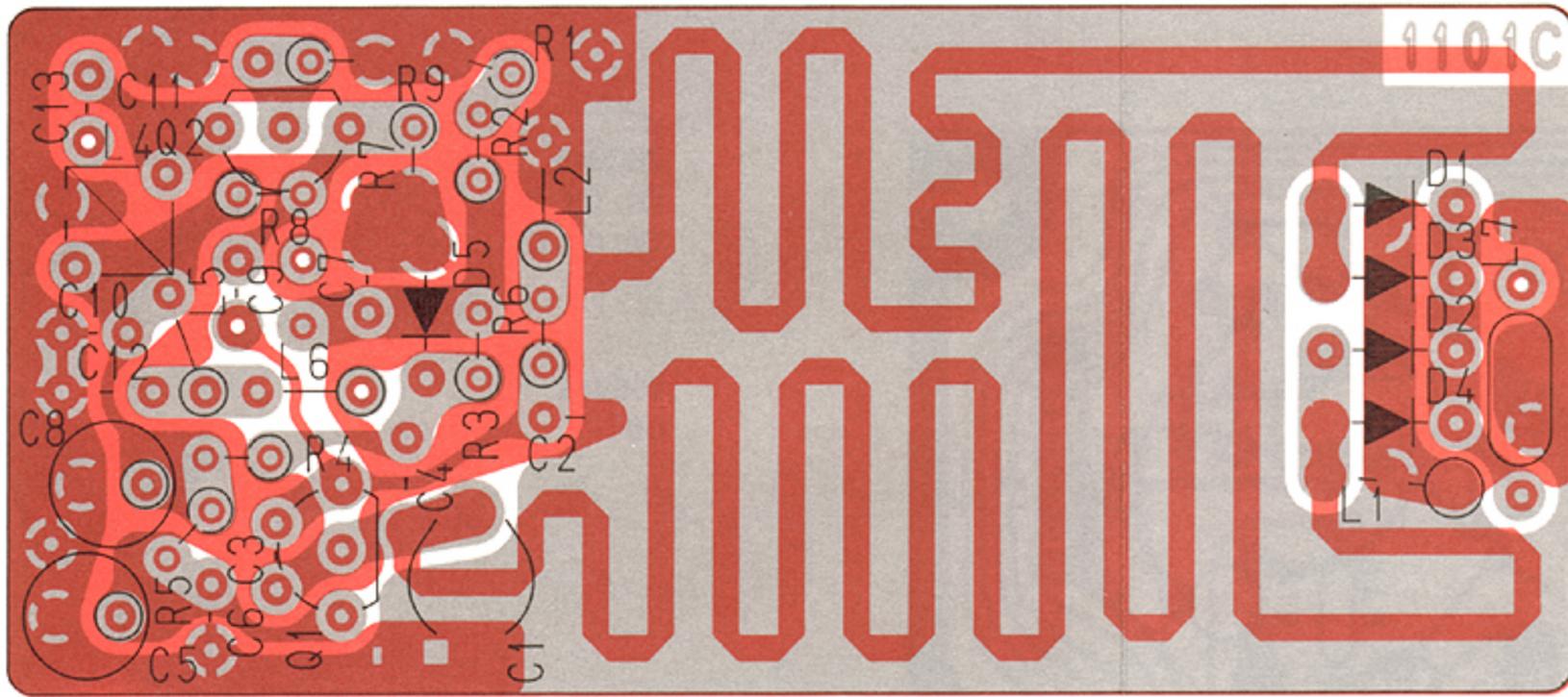
2SC3327
Q8



2SD880
Q14



9-3 RX-VCO AND TX-VCO UNITS



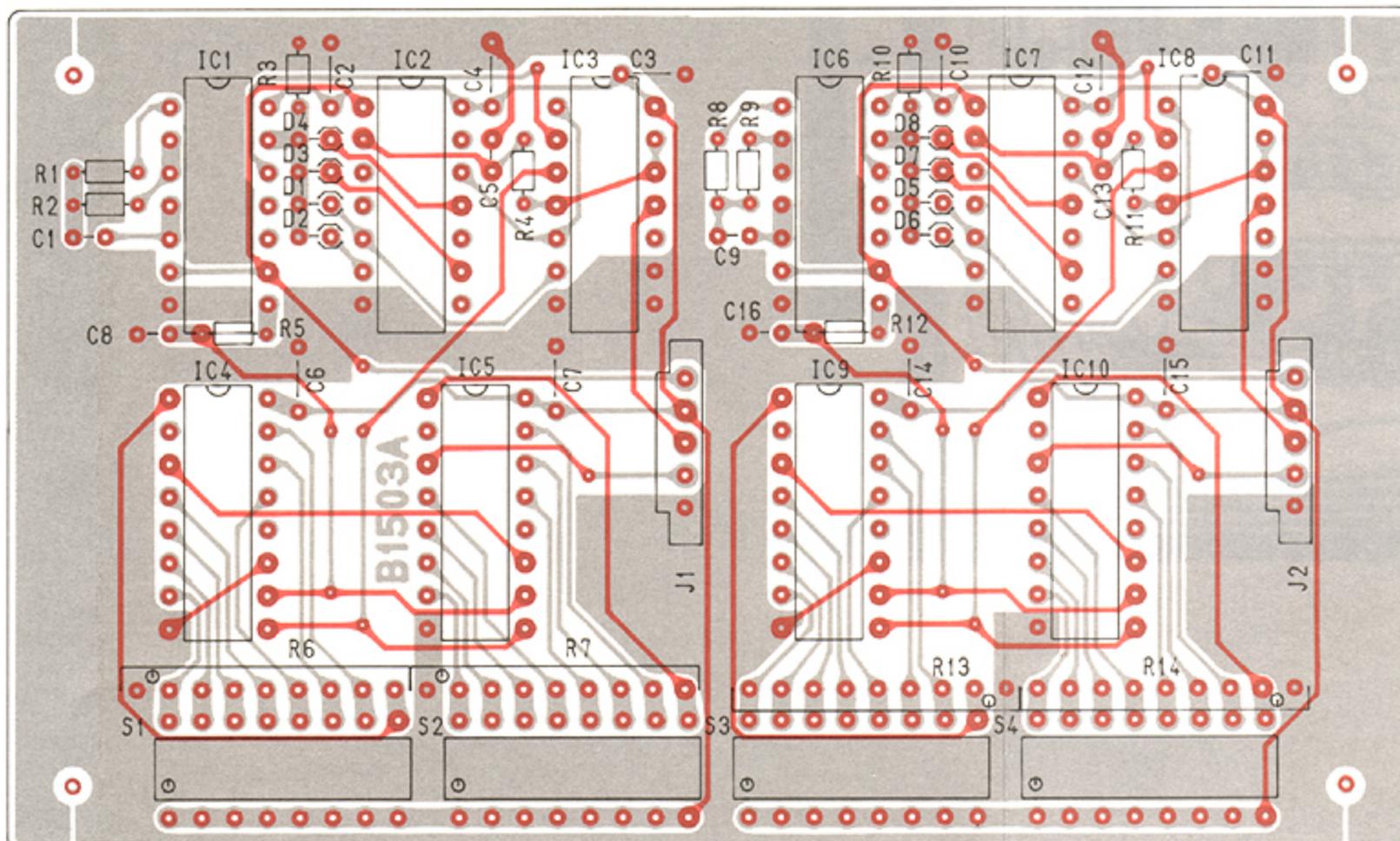
2SK125
Q1



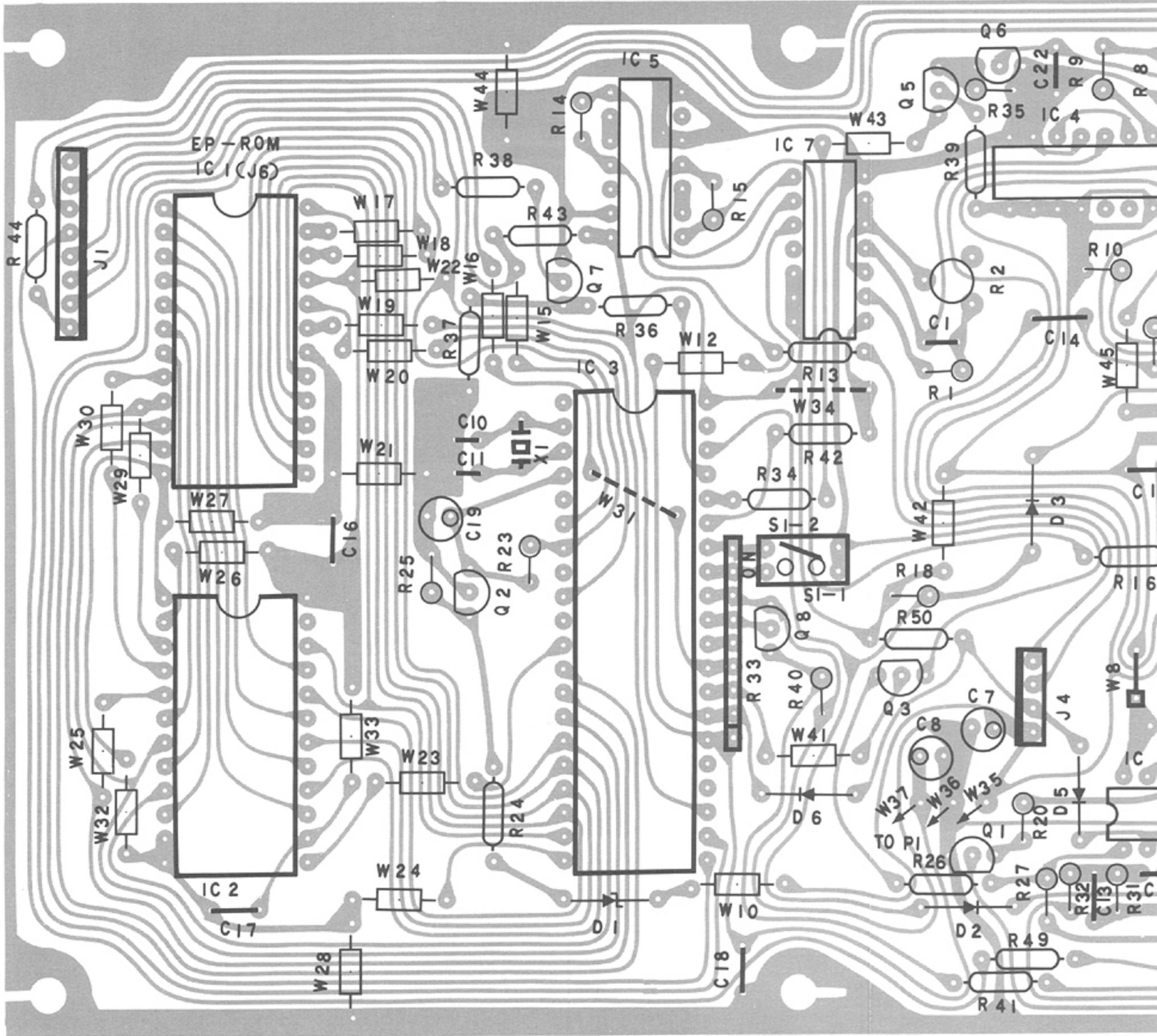
2SC2026
Q2

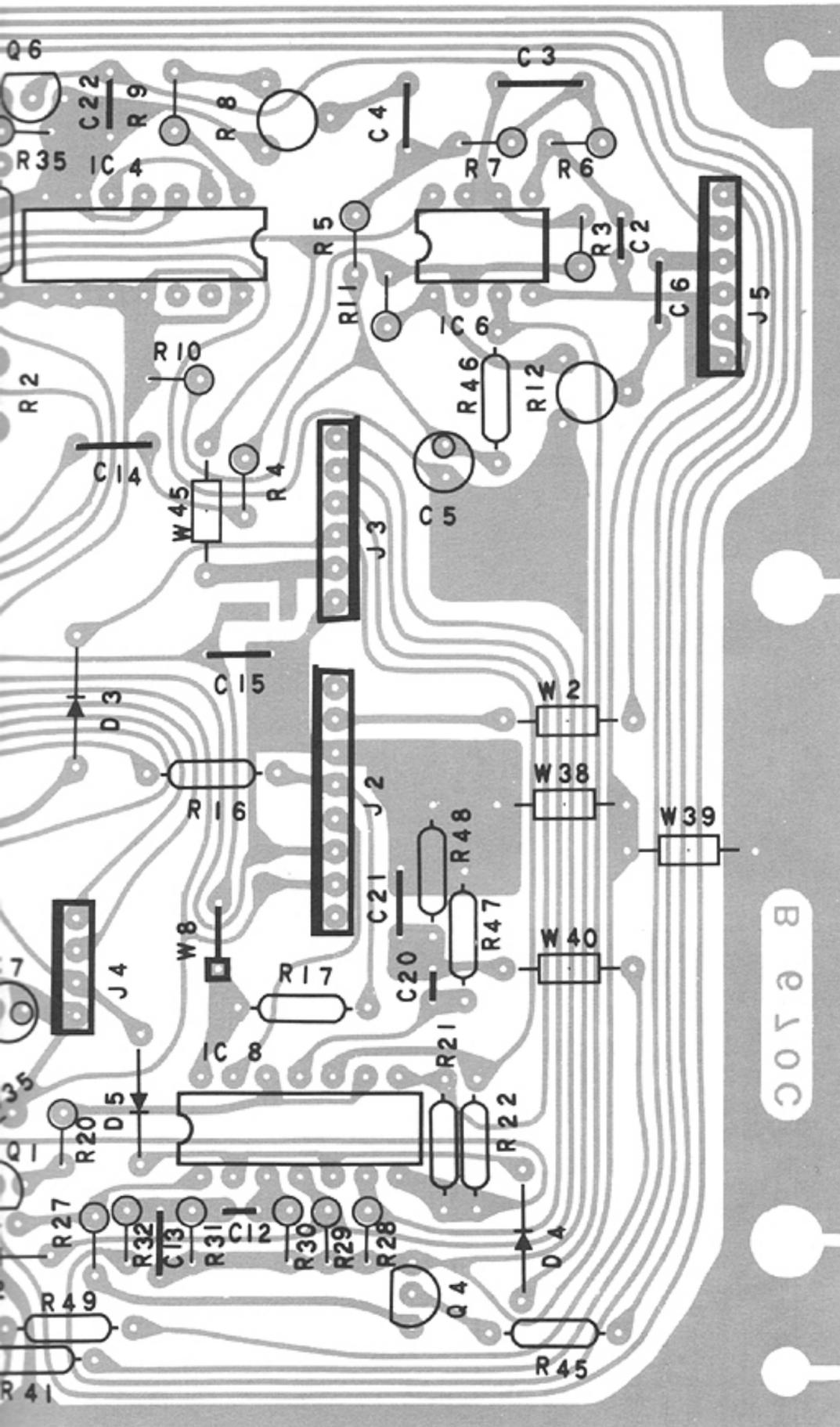


9-4 N-CTRL UNIT

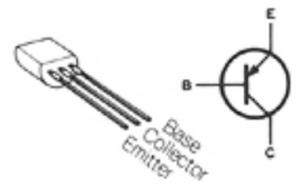


9-8 CONTROL UNIT

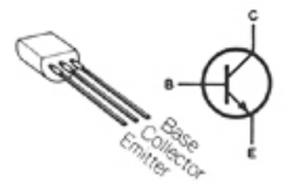




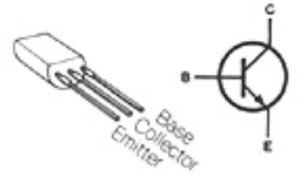
2SA1015
Q2



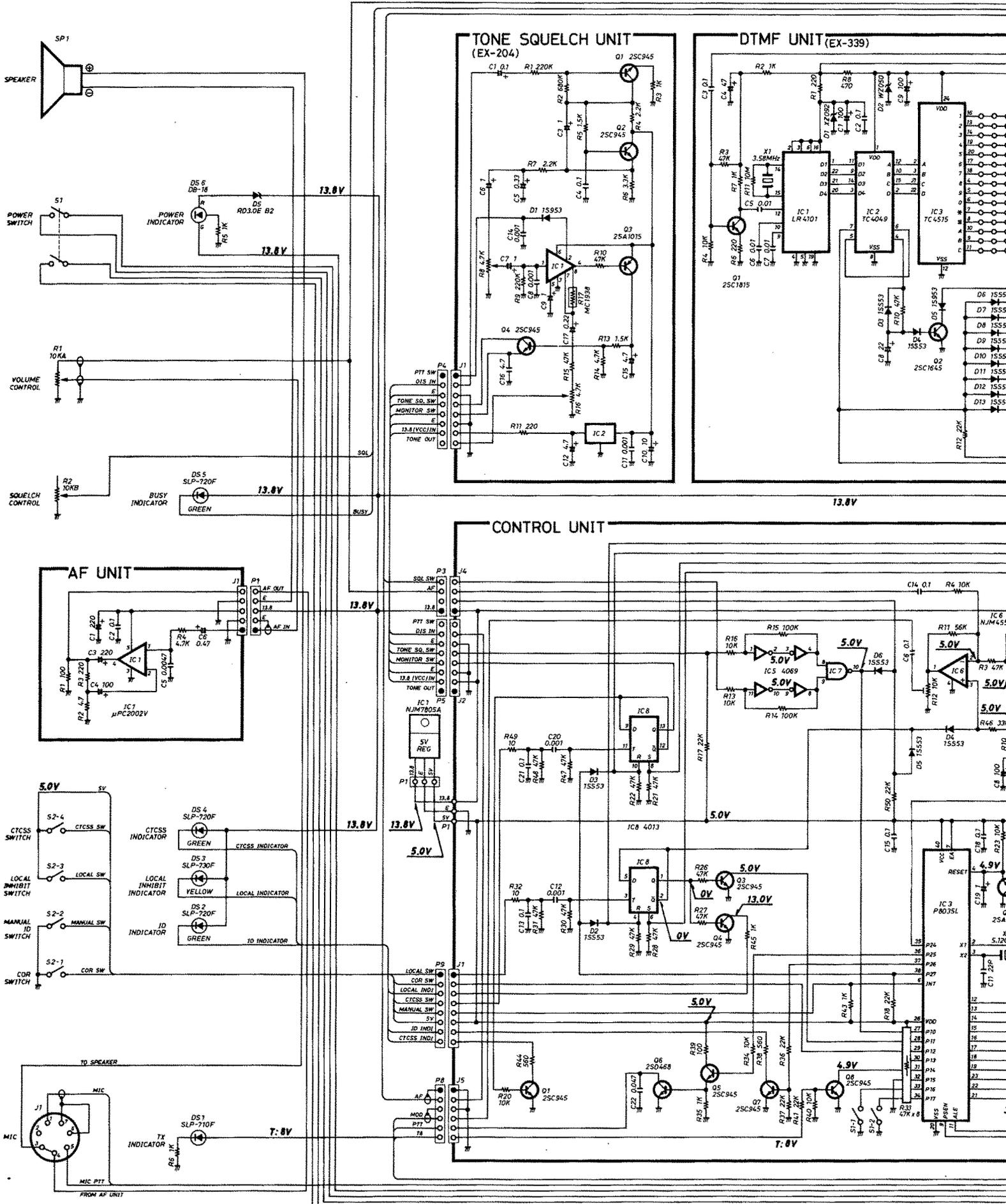
2SC945
Q1, Q3, Q4,
Q5, Q7, Q8

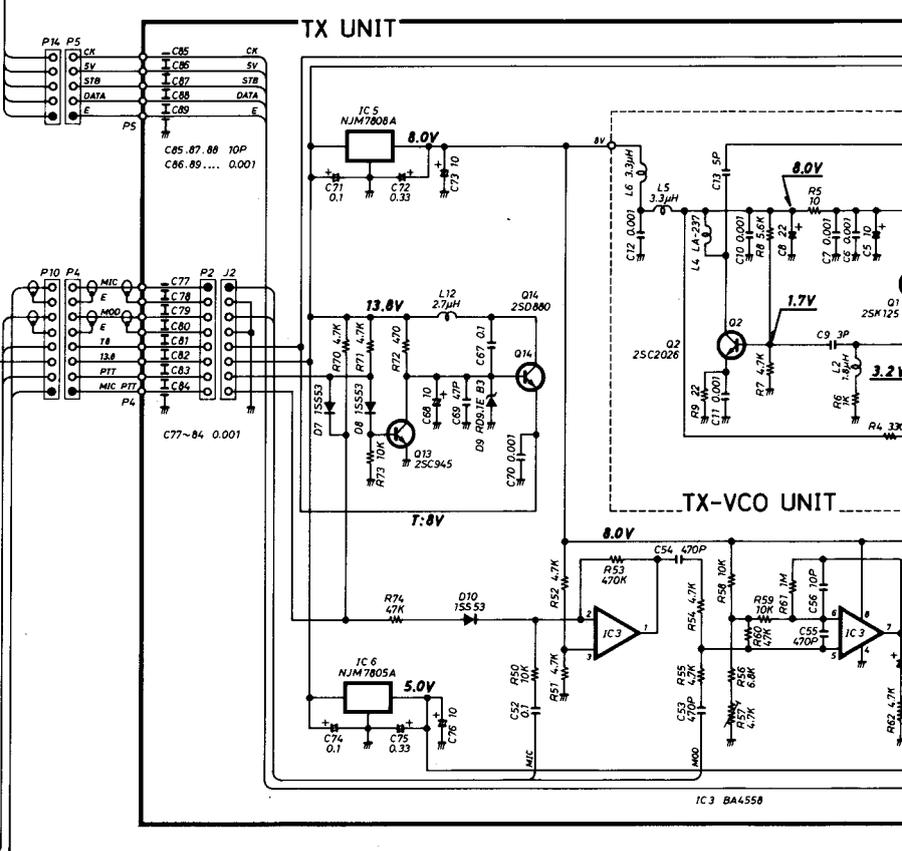
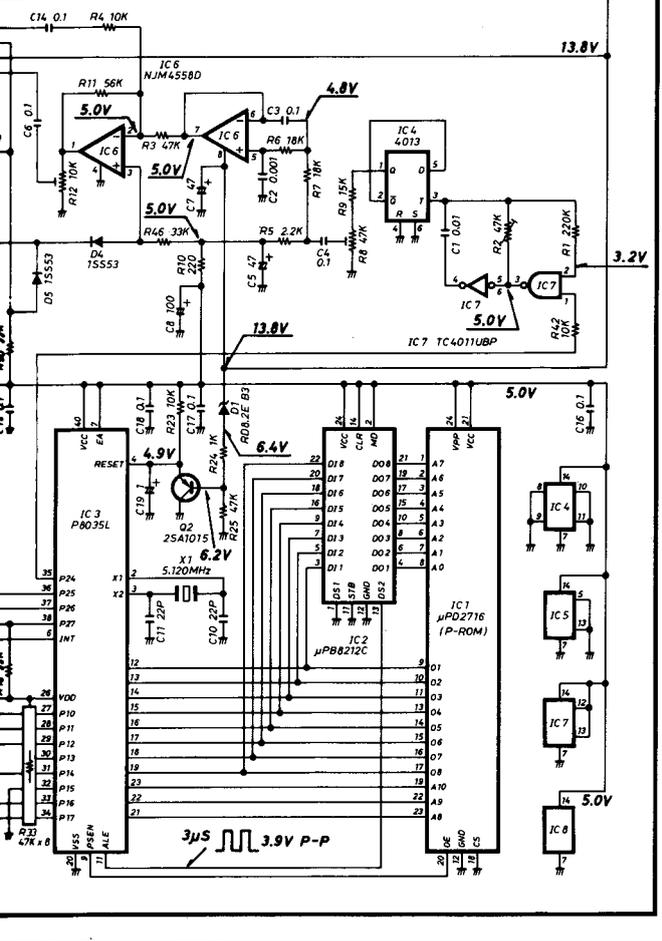
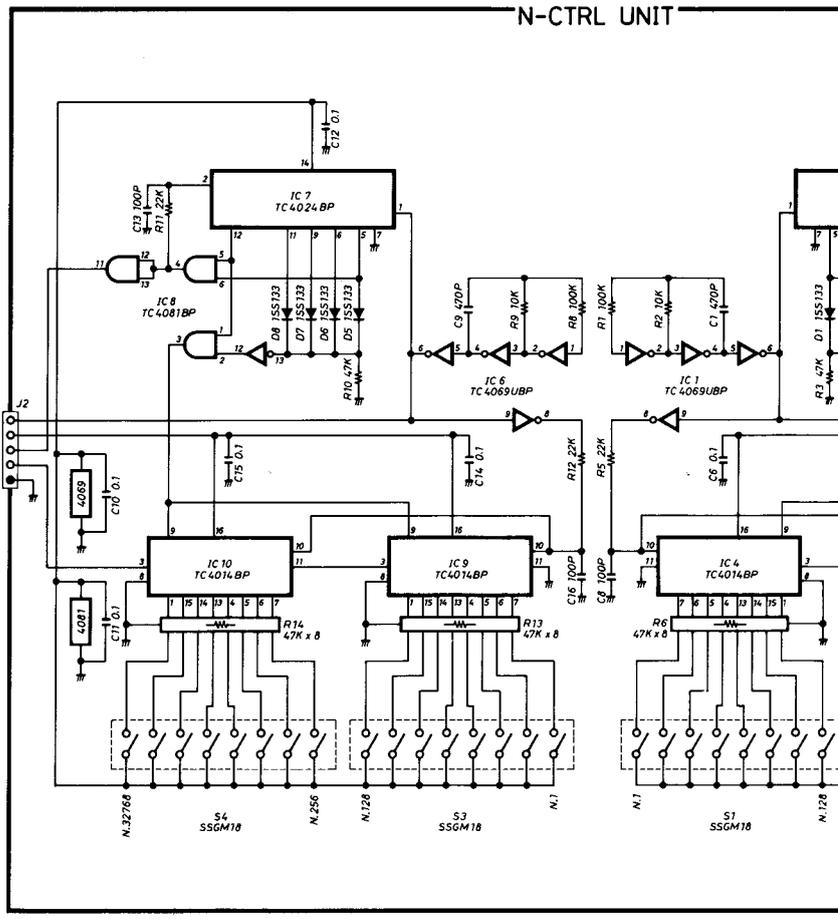
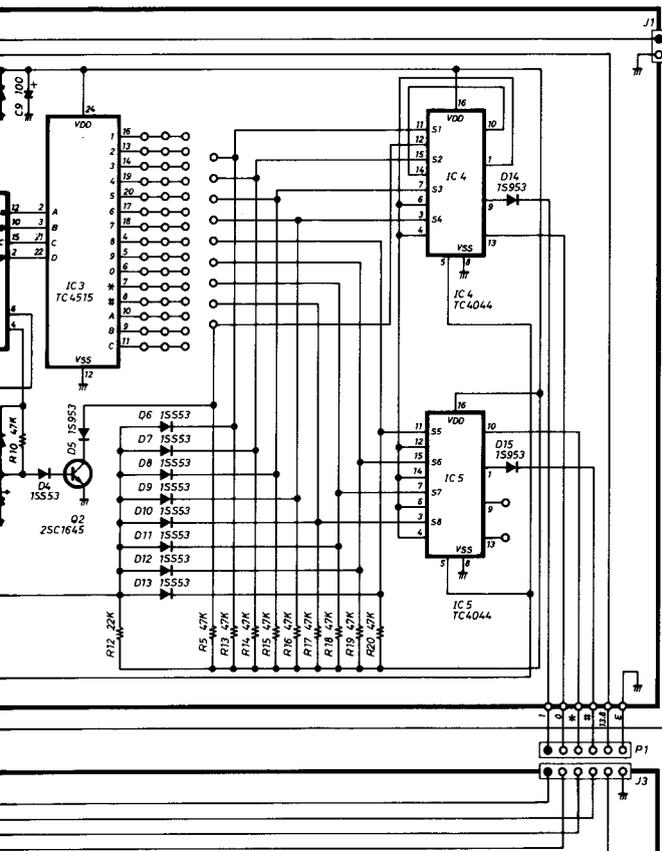


2SD468
Q6



10. VOLTAGE DIAGRAM



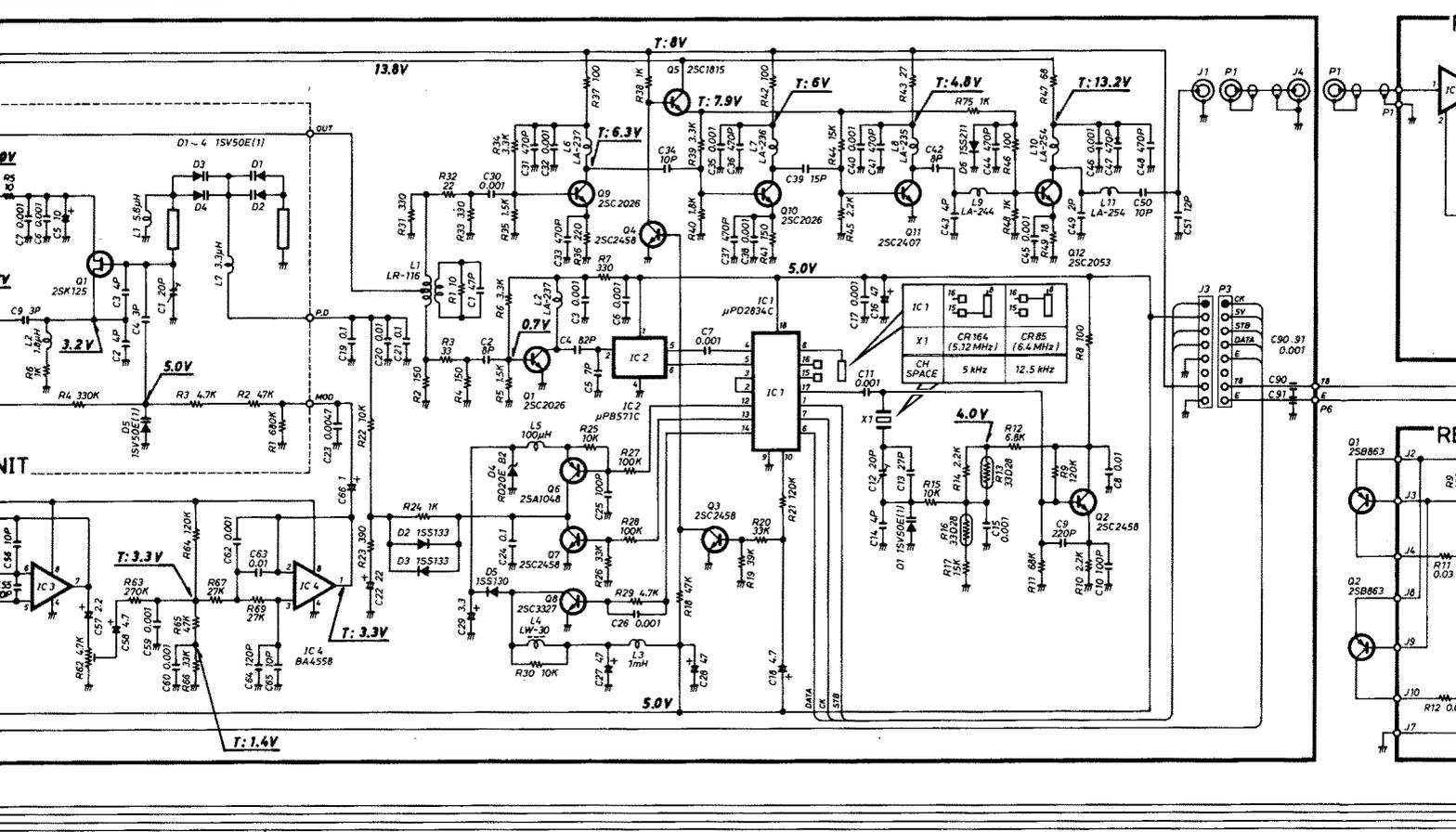
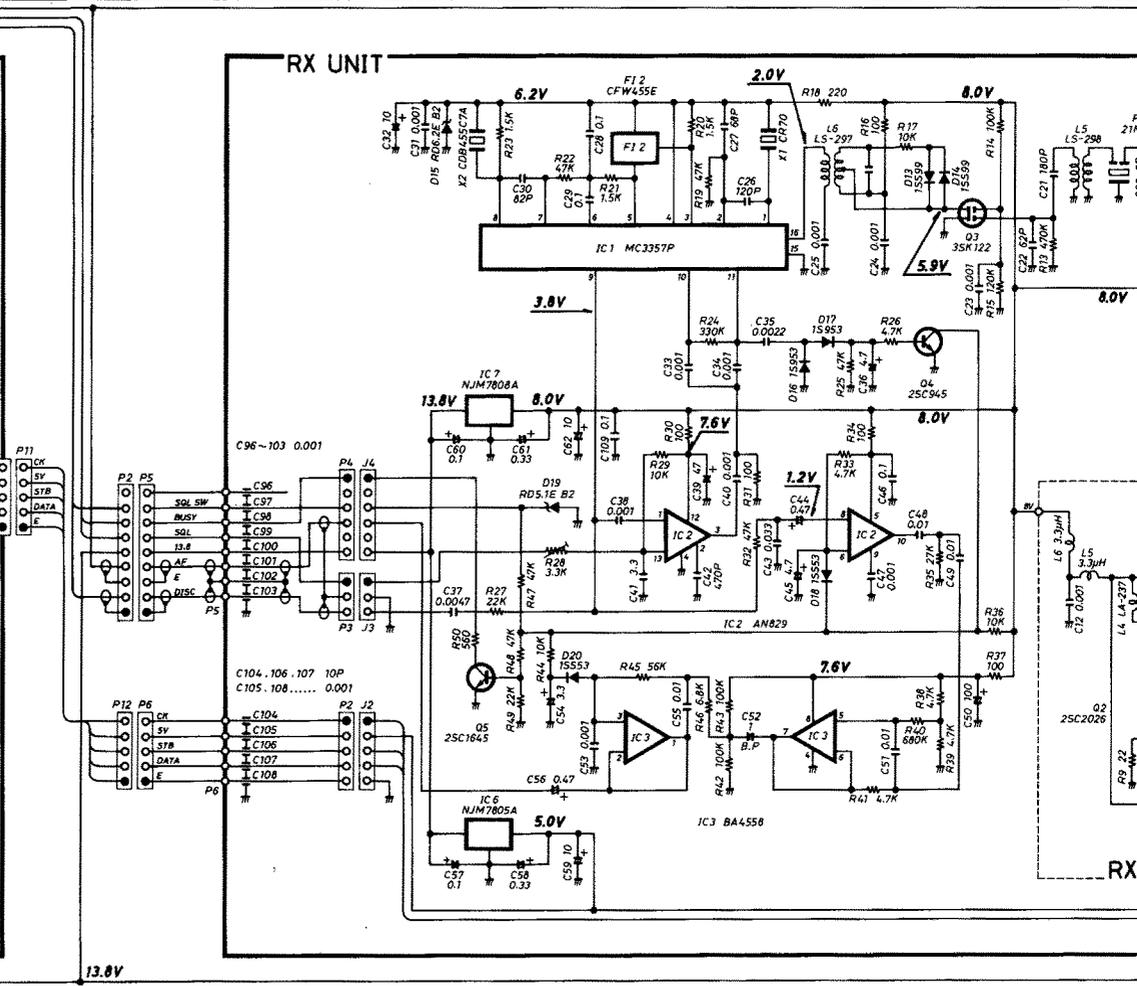
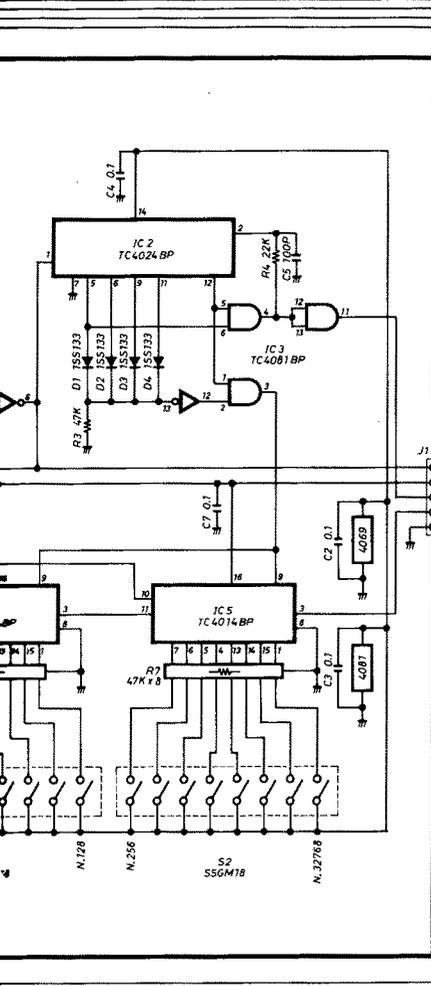


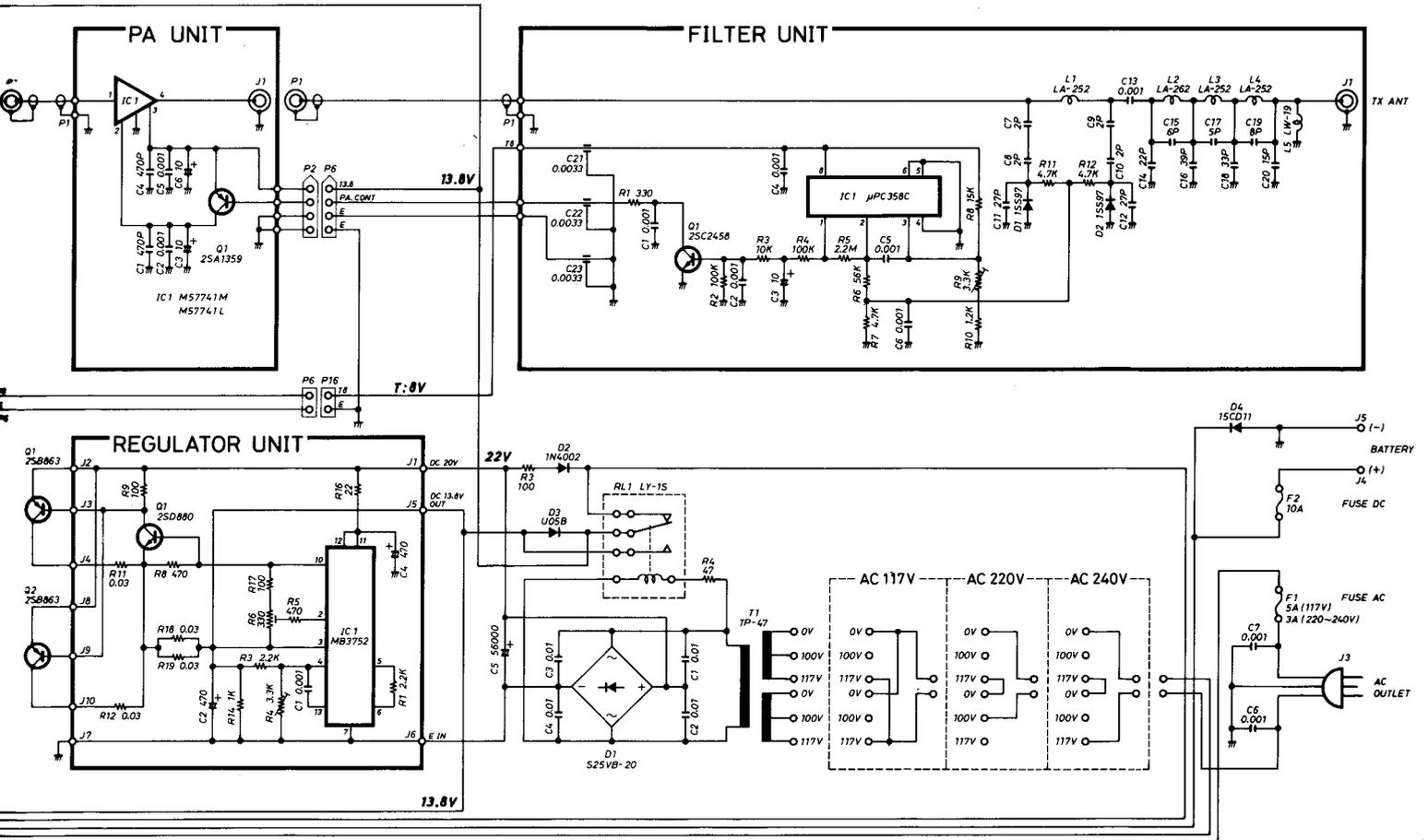
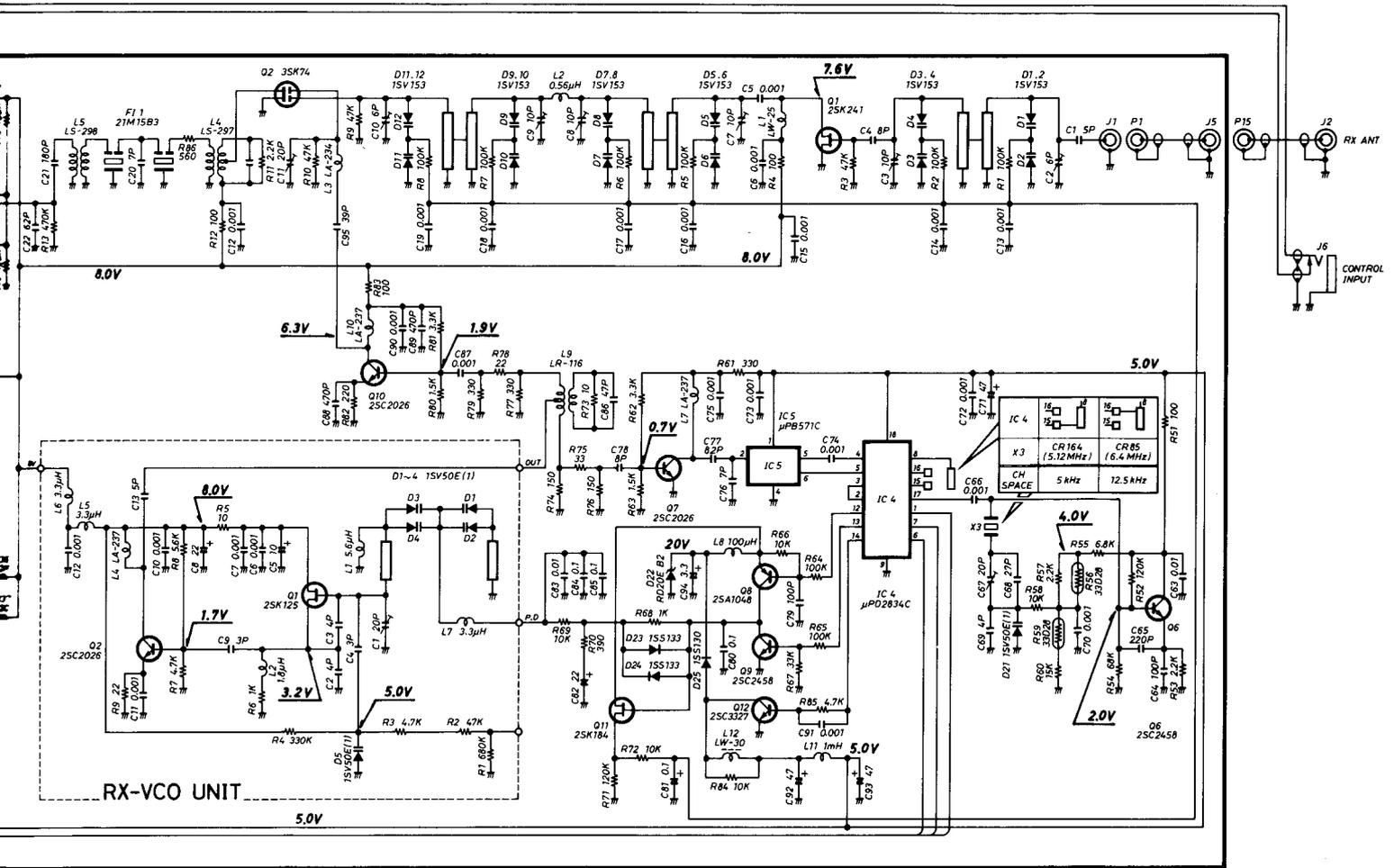
N-CTRL UNIT

TX UNIT

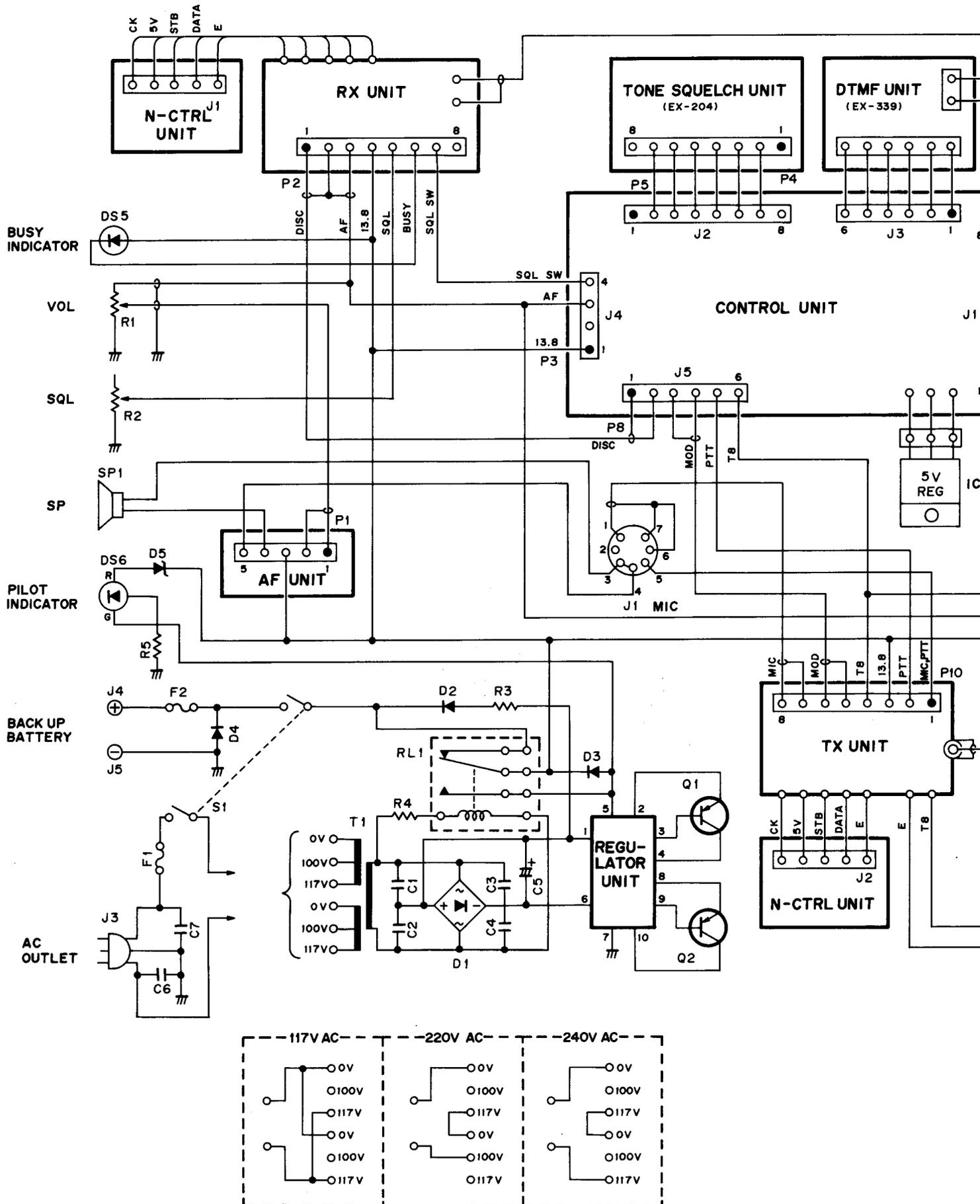
TX-VCO UNIT

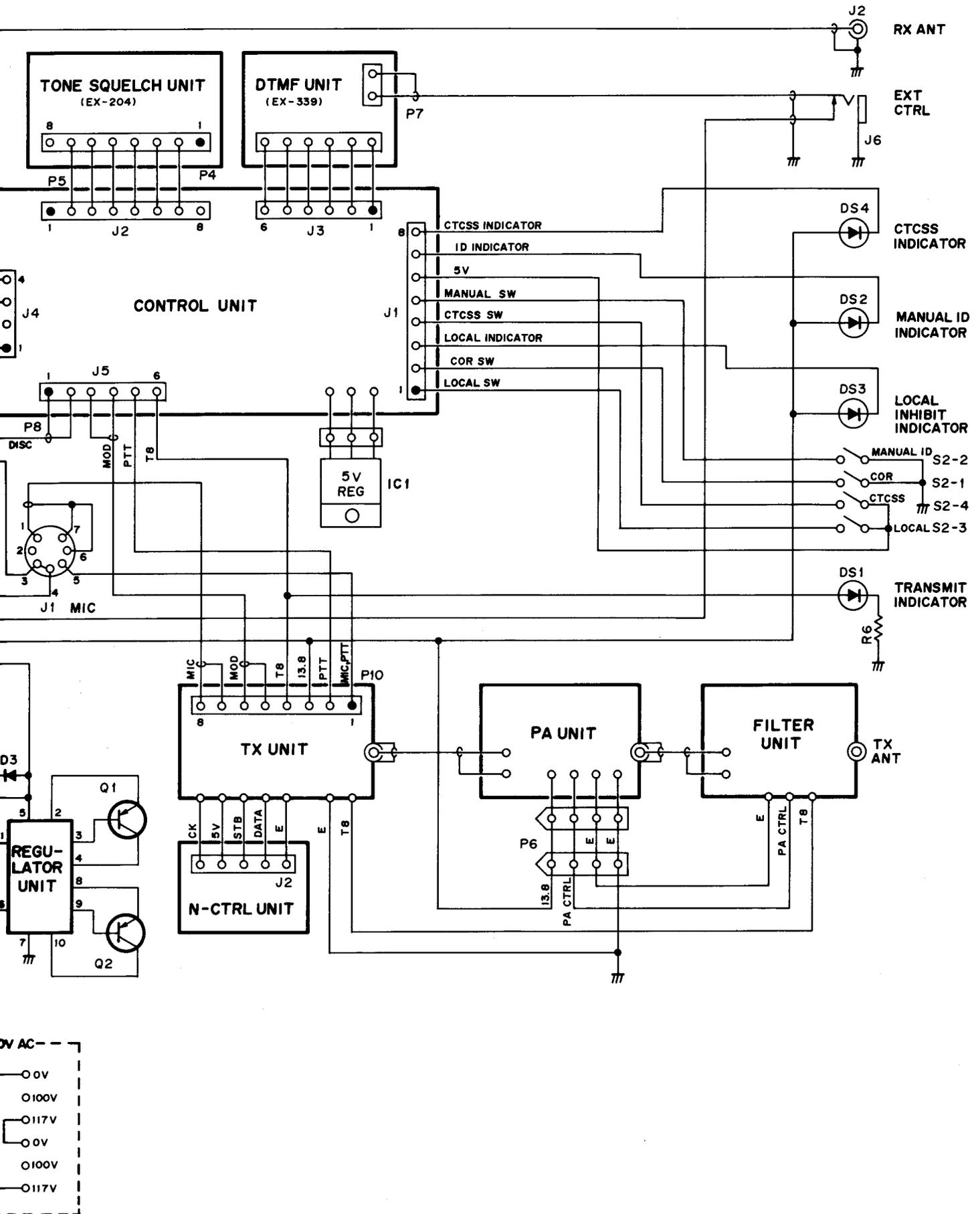
IC 3 BA4558



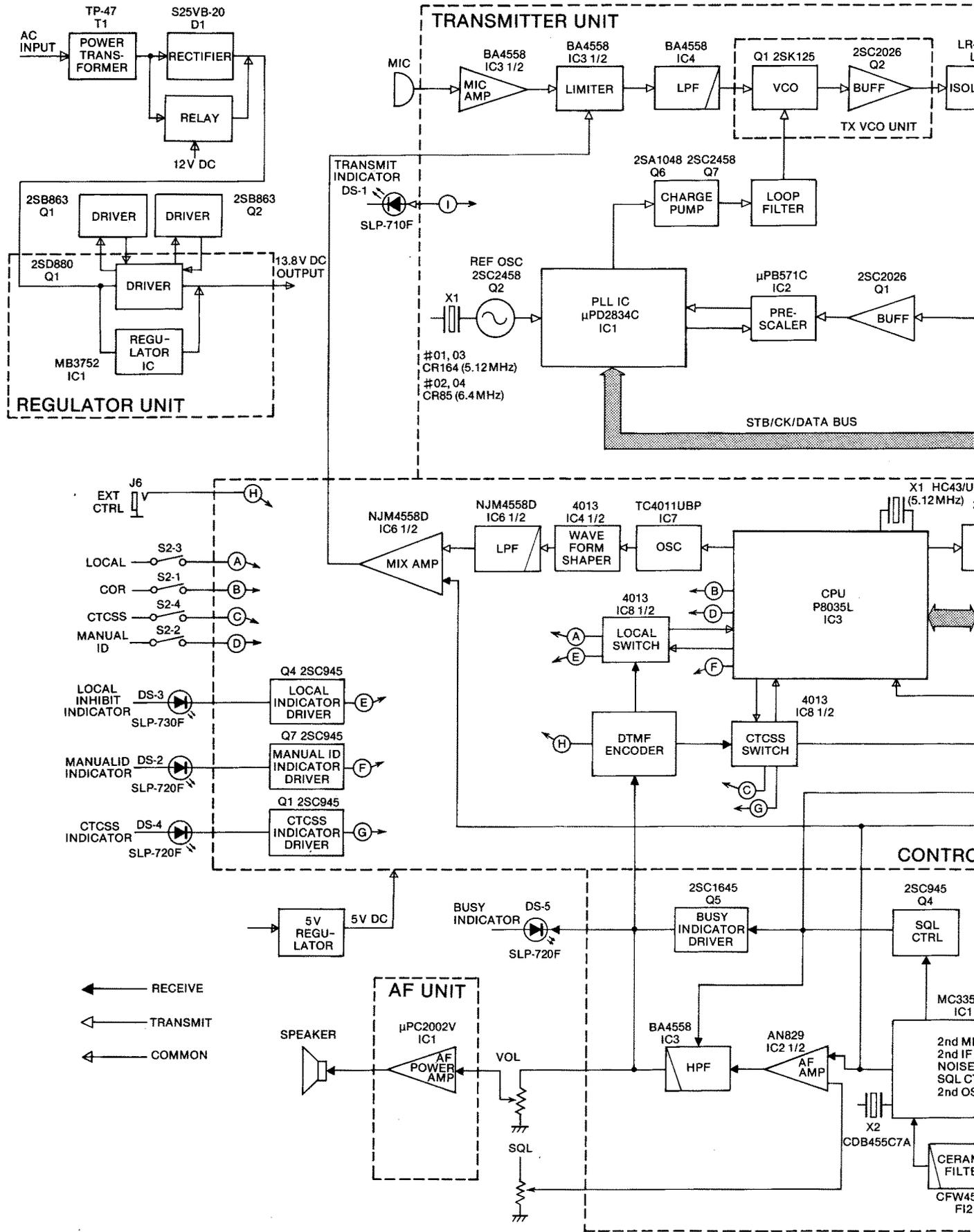


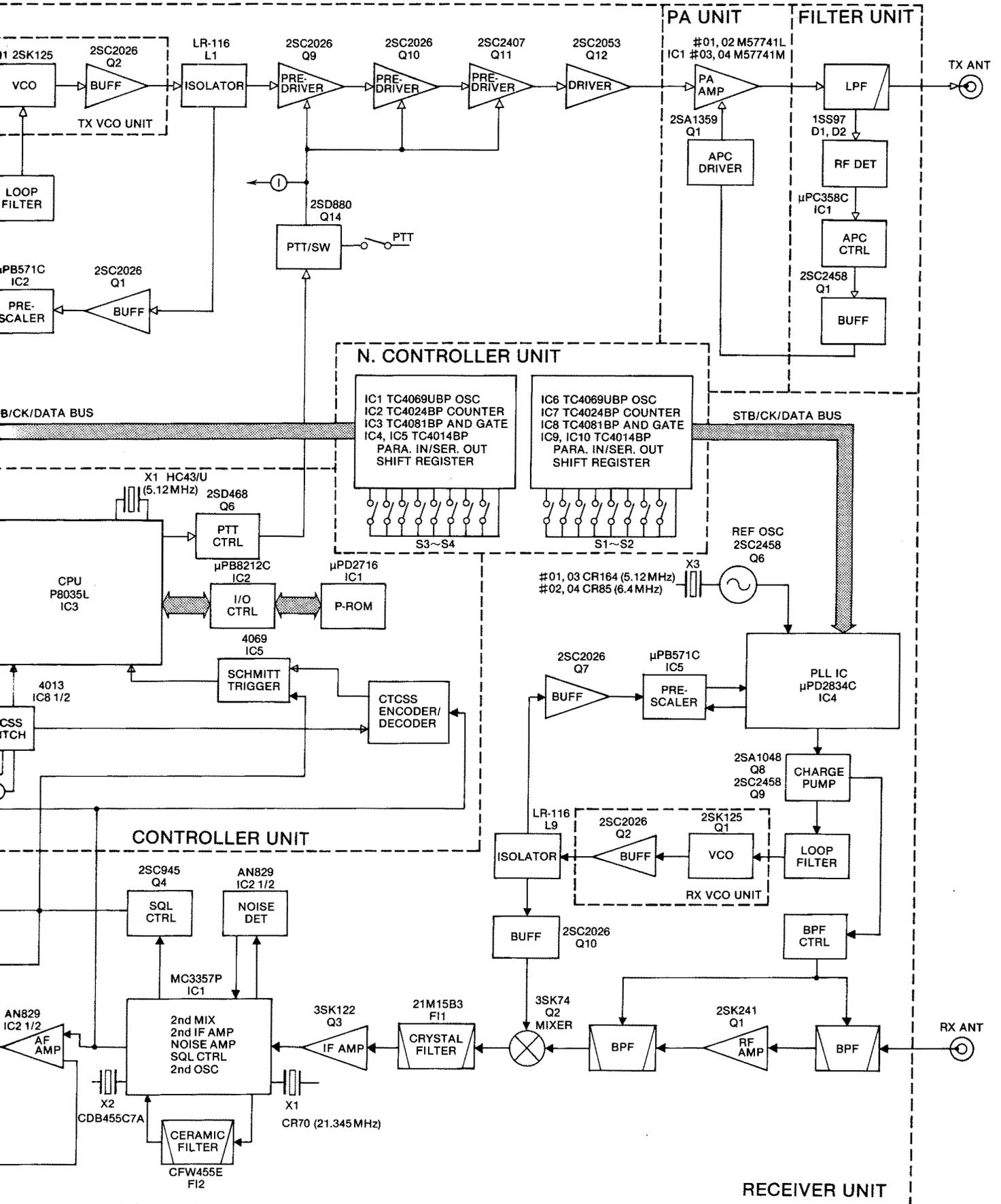
11. UNIT INTERCONNECTIONS DIAGRAM





12. BLOCK DIAGRAM





13. PARTS LIST

13-1 RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
IC1	IC	MC3357P
IC2	IC	AN829
IC3	IC	BA4558
IC4	IC	μPD2834C
IC5	IC	μPB571C
IC6	IC	NJM7805A
IC7	IC	NJM7808A
Q1	FET	2SK241 GR
Q2	FET	3SK74 M
Q3	FET	3SK122 K
Q4	Transistor	2SC945 K
Q5	Transistor	2SC1645 B
Q6	Transistor	2SC2458 GR
Q7	Transistor	2SC2026
Q8	Transistor	2SA1048 GR
Q9	Transistor	2SC2458 GR
Q10	Transistor	2SC2026
Q11	FET	2SK184 Y
Q12	Transistor	2SC3327 B
D1	Varicap	1SV153
D2	Varicap	1SV153
D3	Varicap	1SV153
D4	Varicap	1SV153
D5	Varicap	1SV153
D6	Varicap	1SV153
D7	Varicap	1SV153
D8	Varicap	1SV153
D9	Varicap	1SV153
D10	Varicap	1SV153
D11	Varicap	1SV153
D12	Varicap	1SV153
D13	Diode	1SS99
D14	Diode	1SS99
D15	Zener	RD6.2E B2
D16	Diode	1S953
D17	Diode	1S953
D18	Diode	1SS53
D19	Zener	RD5.1E B2
D20	Diode	1SS53
D21	Varicap	1SV50E (1)
D22	Zener	RD20E B2
D23	Diode	1SS133
D24	Diode	1SS133
D25	Diode	1SS130
FI1	Crystal	21M15B3
FI2	Ceramic	CFW455E
X1	Crystal	CR70
X2	Discriminator	CDB455C7A
X3	Crystal	CR164 (5.12MHz) (#01, #03)
	Crystal	CR85 (6.4MHz) (#02, #04)
L1	Coil	LW-25
L2	Coil	LAL03NA R56M

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
L3	Coil	LA-234
L4	Coil	LS-297
L5	Coil	LS-298
L6	Coil	LS-297
L7	Coil	LA-237
L8	Coil	LAL03NA 101K
L9	Coil	LR-116
L10	Coil	LA-237
L11	Coil	LAL04NA 102K
L12	Coil	LW-30
R1	Resistor	100k ELR20
R2	Resistor	100k ELR20
R3	Resistor	47k R20
R4	Resistor	100 R20
R5	Resistor	100k ELR20
R6	Resistor	100k ELR20
R7	Resistor	100k ELR20
R8	Resistor	100k ELR20
R9	Resistor	47k ELR20
R10	Resistor	47k ELR20
R11	Resistor	2.2k R20
R12	Resistor	100 R20
R13	Resistor	470k R20
R14	Resistor	100k ELR20
R15	Resistor	120k ELR20
R16	Resistor	100 R20
R17	Resistor	10k R20
R18	Resistor	220 ELR20
R19	Resistor	47k R20
R20	Resistor	1.5k ELR20
R21	Resistor	1.5k ELR20
R22	Resistor	47k R20
R23	Resistor	1.5k R20
R24	Resistor	330k ELR20
R25	Resistor	47k ELR20
R26	Resistor	4.7k ELR20
R27	Resistor	22k ELR20
R28	Trimmer	3.3k RH0651CN3J01A
R29	Resistor	10k ELR20
R30	Resistor	100 R20
R31	Resistor	100 ELR20
R32	Resistor	47k ELR20
R33	Resistor	4.7k ELR20
R34	Resistor	100 R20
R35	Resistor	27k ELR20
R36	Resistor	10k ELR20
R37	Resistor	100 R20
R38	Resistor	4.7k ELR20
R39	Resistor	4.7k ELR20
R40	Resistor	680k ELR20
R41	Resistor	4.7k ELR20
R42	Resistor	100k R20
R43	Resistor	100k ELR20
R44	Resistor	10k ELR20
R45	Resistor	56k R20
R46	Resistor	6.8k ELR20

RX UNIT

REF. NO. DESCRIPTION TYPE (PART NO.)

R47	Resistor	47k	ELR20
R48	Resistor	47k	ELR20
R49	Resistor	22k	ELR20
R50	Resistor	560	R20
R51	Resistor	100	ELR20
R52	Resistor	120k	ELR20
R53	Resistor	2.2k	ELR20
R54	Resistor	68k	ELR20
R55	Resistor	6.8k	ELR20
R56	Thermistor	33D28	
R57	Resistor	2.2k	ELR20
R58	Resistor	10k	ELR20
R59	Thermistor	33D28	
R60	Resistor	15k	ELR20
R61	Resistor	330	ELR20
R62	Resistor	3.3k	ELR20
R63	Resistor	1.5k	ELR20
R64	Resistor	100k	ELR20
R65	Resistor	100k	ELR20
R66	Resistor	10k	ELR20
R67	Resistor	33k	ELR20
R68	Resistor	1k	ELR20
R69	Resistor	10k	ELR20
R70	Resistor	390	ELR20
R71	Resistor	120k	ELR20
R72	Resistor	10k	R20
R73	Resistor	10	ELR20
R74	Resistor	150	ELR20
R75	Resistor	33	ELR20
R76	Resistor	150	ELR20
R77	Resistor	330	ELR20
R78	Resistor	22	R20
R79	Resistor	330	R20
R80	Resistor	1.5k	ELR20
R81	Resistor	3.3k	ELR20
R82	Resistor	220	ELR20
R83	Resistor	100	ELR20
R84	Resistor	10k	ELR20
R85	Resistor	4.7k	ELR20
R86	Resistor	560	R20
C1	Ceramic	5P	50V
C2	Trimmer	6P	CV38B0601
C3	Trimmer	10P	CV38D1001
C4	Ceramic	8P	50V
C5	Ceramic	0.001	50V
C6	Ceramic	0.001	50V
C7	Trimmer	10P	CV38D1001
C8	Trimmer	10P	CV38D1001
C9	Trimmer	10P	CV38D1001
C10	Trimmer	6P	CV38B0601
C11	Trimmer	20P	CV38D2001
C12	Ceramic	0.001	50V
C13	Ceramic	0.001	50V
C14	Ceramic	0.001	50V
C15	Ceramic	0.001	50V
C16	Ceramic	0.001	50V
C17	Ceramic	0.001	50V
C18	Ceramic	0.001	50V
C19	Ceramic	0.001	50V

RX UNIT

REF. NO. DESCRIPTION TYPE (PART NO.)

C20	Ceramic	7P	50V
C21	Ceramic	180P	50V
C22	Ceramic	62P	50V
C23	Ceramic	0.001	50V
C24	Ceramic	0.001	50V
C25	Ceramic	0.001	50V
C26	Ceramic	120P	50V
C27	Ceramic	68P	50V
C28	Barrier Layer	0.1	16V
C29	Barrier Layer	0.1	16V
C30	Ceramic	82P	50V
C31	Ceramic	0.001	50V
C32	Electrolytic	10	16V RC2
C33	Mylar	0.001	50V
C34	Ceramic	33P	50V
C35	Mylar	0.0022	50V
C36	Electrolytic	4.7	25V RC2
C37	Ceramic	0.0047	50V
C38	Mylar	0.001	50V
C39	Electrolytic	47	10V RC2
C40	Mylar	0.001	50V
C41	Electrolytic	3.3	50V RC2
C42	Ceramic	470P	50V
C43	Mylar	0.033	50V
C44	Electrolytic	0.47	50V RC2
C45	Electrolytic	4.7	25V RC2
C46	Barrier Layer	0.1	16V
C47	Mylar	0.001	50V
C48	Mylar	0.01	50V
C49	Mylar	0.01	50V
C50	Electrolytic	100	10V MS9
C51	Mylar	0.01	50V
C52	Electrolytic	1	50V B.P
C53	Mylar	0.001	50V
C54	Electrolytic	3.3	50V RC2
C55	Mylar	0.01	50V
C56	Electrolytic	0.47	50V RC2
C57	Tantalum	0.1	35V DN
C58	Tantalum	0.33	35V DN
C59	Electrolytic	10	16V RC2
C60	Tantalum	0.1	35V DN
C61	Tantalum	0.33	35V DN
C62	Electrolytic	10	16V RC2
C63	Barrier Layer	0.01	25V
C64	Ceramic	100P	50V
C65	Ceramic	220P	50V
C66	Ceramic	0.001	50V
C67	Trimmer	20P	CV38D2001
C68	Ceramic	27P	50V CH
C69	Ceramic	4P	50V CH
C70	Ceramic	0.001	50V
C71	Electrolytic	47	6.3V RC2
C72	Ceramic	0.001	50V
C73	Ceramic	0.001	50V
C74	Ceramic	0.001	50V
C75	Ceramic	0.001	50V
C76	Ceramic	7P	50V
C77	Ceramic	82P	50V
C78	Ceramic	8P	50V
C79	Ceramic	100P	50V

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
C80	Barrier Layer	0.1	16V
C81	Electrolytic	0.1	50V RC2
C82	Electrolytic	22	25V TW
C83	Barrier Layer	0.01	25V
C84	Barrier Layer	0.1	16V
C85	Barrier Layer	0.1	16V
C86	Ceramic	47P	50V
C87	Ceramic	0.001	50V
C88	Ceramic	470P	50V
C89	Ceramic	470P	50V
C90	Ceramic	0.001	50V
C91	Ceramic	0.001	50V
C92	Electrolytic	47	6.3V RC2
C93	Electrolytic	47	6.3V RC2
C94	Electrolytic	3.3	50V RC2
C95	Ceramic	39P	50V
C96	Feed Through	TF318-450E102GMV50	
C97	Feed Through	TF318-450E102GMV50	
C98	Feed Through	TF318-450E102GMV50	
C99	Feed Through	TF318-450E102GMV50	
C100	Feed Through	TF318-450E102GMV50	
C101	Feed Through	TF318-450E102GMV50	
C102	Feed Through	TF318-450E102GMV50	
C103	Feed Through	TF318-450E102GMV50	
C104	Feed Through	TF318-450SL100G50	
C105	Feed Through	TF318-450E102GMV50	
C106	Feed Through	TF318-450SL100G50	
C107	Feed Through	TF318-450SL100G50	
C108	Feed Through	TF318-450E102GMV50	
C109	Barrier Layer	0.1	16V
J1	Connector	TMP-J101X-A2	
J2	Connector	TL-25P-05-V1	
J3	Connector	TL-25P-03-V1	
J4	Connector	TL-25P-06-V1	
J5	Connector	BNC-RM-106	
P1	Connector	TMP-P01X-A1	
P2	Connector	TL-25H-05-B1	
P3	Connector	TL-25H-03-B1	
P4	Connector	TL-25H-06-B1	
P5	Connector	SMR-09-VB	
P6	Connector	SMP-05-VB	
EP1	P.C. Board	B-1534A	

13-2 TX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	μPD2834C	
IC2	IC	μPB571C	
IC3	IC	BA4558	
IC4	IC	BA4558	
IC5	IC	NJM7808A	
IC6	IC	NJM7805A	
Q1	Transistor	2SC2026	
Q2	Transistor	2SC2458	GR
Q3	Transistor	2SC2458	GR
Q4	Transistor	2SC2458	GR
Q5	Transistor	2SC1815	Y
Q6	Transistor	2SA1048	GR
Q7	Transistor	2SC2458	GR
Q8	Transistor	2SC3327	B
Q9	Transistor	2SC2026	
Q10	Transistor	2SC2026	
Q11	Transistor	2SC2407	
Q12	Transistor	2SC2053	
Q13	Transistor	2SC945	P
Q14	Transistor	2SD880	Y
D1	Varicap	1SV50E (1)	
D2	Diode	1SS133	
D3	Diode	1SS133	
D4	Zener	RD20E	B2
D5	Diode	1SS130	
D6	Diode	1SS211	
D7	Diode	1SS53	
D8	Diode	1SS53	
D9	Zener	RD9.1E	B3
D10	Diode	1SS53	
X1	Crystal	CR164 (5.12MHz)	
X1	Crystal	CR85 (6.4MHz)	
L1	Coil	LR-116	
L2	Coil	LA-237	
L3	Coil	LAL04NA	102K
L4	Coil	LW-30	
L5	Coil	LAL03NA	101K
L6	Coil	LA-237	
L7	Coil	LA-236	
L8	Coil	LA-235	
L9	Coil	LA-244	
L10	Coil	LA-254	
L11	Coil	LA-254	
L12	Coil	LAL04NA	2R7M
R1	Resistor	10	ELR20
R2	Resistor	150	ELR20
R3	Resistor	33	ELR20
R4	Resistor	150	ELR20
R5	Resistor	1.5k	ELR20
R6	Resistor	3.3k	ELR20
R7	Resistor	330	ELR20
R8	Resistor	100	ELR20
R9	Resistor	120k	ELR20
R10	Resistor	2.2k	ELR20
R11	Resistor	68k	ELR20
R12	Resistor	6.8k	ELR20

TX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
R13	Thermistor	33D28
R14	Resistor	2.2k ELR20
R15	Resistor	10k ELR20
R16	Thermistor	33D28
R17	Resistor	15k ELR20
R18	Resistor	47k ELR20
R19	Resistor	39k ELR20
R20	Resistor	33k ELR20
R21	Resistor	120k ELR20
R22	Resistor	10k ELR20
R23	Resistor	390 ELR20
R24	Resistor	1k ELR20
R25	Resistor	10k ELR20
R26	Resistor	33k ELR20
R27	Resistor	100k ELR20
R28	Resistor	100k ELR20
R29	Resistor	4.7k ELR20
R30	Resistor	10k ELR20
R31	Resistor	330 ELR20
R32	Resistor	22 R20
R33	Resistor	330 R20
R34	Resistor	3.3k ELR20
R35	Resistor	1.5k ELR20
R36	Resistor	220 ELR20
R37	Resistor	100 R20
R38	Resistor	1k ELR20
R39	Resistor	3.3k ELR20
R40	Resistor	1.8k ELR20
R41	Resistor	150 ELR20
R42	Resistor	100 ELR20
R43	Resistor	27 ELR20
R44	Resistor	15k ELR20
R45	Resistor	2.2k ELR20
R46	Resistor	100 ELR20
R47	Resistor	68 R50X
R48	Resistor	1k ELR20
R49	Resistor	18 ELR20
R50	Resistor	10k ELR20
R51	Resistor	4.7k ELR20
R52	Resistor	4.7k ELR20
R53	Resistor	470k ELR20
R54	Resistor	4.7k ELR20
R55	Resistor	4.7k ELR20
R56	Resistor	6.8k ELR20
R57	Trimmer	4.7k RH0651CS3J2KA
R58	Resistor	10k ELR20
R59	Resistor	10k ELR20
R60	Resistor	47k ELR20
R61	Resistor	1M ELR20
R62	Trimmer	4.7k RH0651CS2J2KA
R63	Resistor	270k ELR20
R64	Resistor	120k ELR20
R65	Resistor	47k ELR20
R66	Resistor	33k ELR20
R67	Resistor	27k ELR20
R69	Resistor	27k ELR20
R70	Resistor	4.7k ELR20
R71	Resistor	4.7k ELR20
R72	Resistor	470 ELR20
R73	Resistor	10k ELR20
R74	Resistor	47k ELR20
R75	Resistor	1k R20

TX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
C1	Ceramic	47P 50V
C2	Ceramic	8P 50V
C3	Ceramic	0.001 50V
C4	Ceramic	82P 50V
C5	Ceramic	7P 50V
C6	Ceramic	0.001 50V
C7	Ceramic	0.001 50V
C8	Barrier Layer	0.01 25V
C9	Ceramic	220P 50V
C10	Ceramic	100P 50V
C11	Ceramic	0.001 50V
C12	Trimmer	20P CV38D2001
C13	Ceramic	27P 50V CH
C14	Ceramic	4P 50V CH
C15	Ceramic	0.001 50V
C16	Electrolytic	47 6.3V RC2
C17	Ceramic	0.001 50V
C18	Electrolytic	4.7 25V RC2
C19	Barrier Layer	0.1 16V
C20	Barrier Layer	0.01 25V
C21	Barrier Layer	0.1 16V
C22	Electrolytic	22 25V
C23	Mylar	0.0047 50V
C24	Barrier Layer	0.1 16V
C25	Ceramic	100P 50V
C26	Ceramic	0.001 50V
C27	Electrolytic	47 6.3V RC2
C28	Electrolytic	47 6.3V RC2
C29	Electrolytic	3.3 50V RC2
C30	Ceramic	0.001 50V
C31	Ceramic	470P 50V
C32	Ceramic	0.001 50V
C33	Ceramic	470P 50V
C34	Ceramic	10P 50V
C35	Ceramic	0.001 50V
C36	Ceramic	470P 50V
C37	Ceramic	470P 50V
C38	Ceramic	0.001 50V
C39	Ceramic	15P 50V
C40	Ceramic	0.001 50V
C41	Ceramic	470P 50V
C42	Ceramic	8P 50V
C43	Ceramic	4P 50V
C44	Ceramic	470P 50V
C45	Ceramic	0.001 50V
C46	Ceramic	0.001 50V
C47	Ceramic	470P 50V
C48	Ceramic	470P 50V
C49	Ceramic	2P 50V
C50	Ceramic	10P 50V
C51	Ceramic	12P 50V
C52	Barrier Layer	0.1 16V
C53	Ceramic	470P 50V
C54	Ceramic	470P 50V
C55	Ceramic	470P 50V
C56	Ceramic	10P 50V
C57	Electrolytic	2.2 50V RC2
C58	Electrolytic	4.7 25V RC2
C59	Mylar	0.001 50V
C60	Ceramic	0.001 50V
C62	Mylar	0.001 50V
C63	Mylar	0.01 50V

TX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
C64	Ceramic	120P	50V	
C65	Ceramic	10P	50V	
C66	Electrolytic	1	50V	RC2
C67	Barrier Layer	0.1	16V	
C68	Electrolytic	10	16V	RC2
C69	Ceramic	47P	50V	
C70	Ceramic	0.001	50V	
C71	Tantalum	0.1	35V	DN
C72	Tantalum	0.33	35V	DN
C73	Electrolytic	10	16V	RC2
C74	Tantalum	0.1	35V	DN
C75	Tantalum	0.33	35V	DN
C76	Electrolytic	10	16V	RC2
C77	Feed Through	TC318-450E102GMV50		
C78	Feed Through	TF318-450E102GMV50		
C79	Feed Through	TF318-450E102GMV50		
C80	Feed Through	TF318-450E102GMV50		
C81	Feed Through	TF318-450E102GMV50		
C82	Feed Through	TF318-450E102GMV50		
C83	Feed Through	TF318-450E102GMV50		
C84	Feed Through	TF318-450E102GMV50		
C85	Feed Through	TF318-450SL100G50		
C86	Feed Through	TF318-450E102GMV50		
C87	Feed Through	TF318-450SL100G50		
C88	Feed Through	TF318-450SL100G50		
C89	Feed Through	TF318-450E102GMV50		
C90	Feed Through	TF318-450E102GMV50		
C91	Feed Through	TF318-450E102GMV50		
J1	Connector	TMP-J01X-A2		
J2	Connector	TL-25P-08-V1		
J3	Connector	TL-25P-08-V1		
J4	Connector	BNC-RM-106		
P1	Connector	TMP-P01X-A1		
P2	Connector	TL-25H-08-B1		
P3	Connector	TL-25H-08-B1		
P4	Connector	SMR-08-VB		
P5	Connector	SMP-05-VB		
P6	Connector	SMP-03-VB		
EP1	P.C. Board	B-1533A		

13-3 RX-VCO UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
Q1	FET	2SK125		
Q2	Transistor	2SC2026		
D1	Varicap	1SV50E (1)		
D2	Varicap	1SV50E (1)		
D3	Varicap	1SV50E (1)		
D4	Varicap	1SV50E (1)		
D5	Varicap	1SV50E (1)		
L1	Coil	LAL03NA 5R6M		
L2	Coil	LAL03NA 1R8M		
L4	Coil	LA-237		
L5	Coil	LAL03NA 3R3M		
L6	Coil	LAL03NA 3R3M		
L7	Coil	LAL03NA 3R3M		
R1	Resistor	680k	ELR20	
R2	Resistor	47k	ELR20	
R3	Resistor	4.7k	ELR20	
R4	Resistor	330k	ELR20	
R5	Resistor	10	ELR20	
R6	Resistor	1k	ELR20	
R7	Resistor	4.7k	ELR20	
R8	Resistor	5.6k	ELR20	
R9	Resistor	22	ELR20	
C1	Trimmer	20P	CV05D2001	
C2	Ceramic	4P	50V	
C3	Ceramic	4P	50V	
C4	Ceramic	3P	50V	
C5	Electrolytic	10	16V	RC3
C6	Ceramic	0.001	50V	
C7	Ceramic	0.001	50V	
C8	Electrolytic	22	16V	RC3
C9	Ceramic	3P	50V	
C10	Ceramic	0.001	50V	
C11	Ceramic	0.001	50V	
C12	Ceramic	0.001	50V	
C13	Ceramic	5P	50V	
EP1	P.C. Board	B-1101C		

13-4 TX-VCO UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
Q1	FET	2SK125	
Q2	Transistor	2SC2026	
D1	Varicap	1SV50E (1)	
D2	Varicap	1SV50E (1)	
D3	Varicap	1SV50E (1)	
D4	Varicap	1SV50E (1)	
D5	Varicap	1SV50E (1)	
L1	Coil	LAL03NA 5R6M	
L2	Coil	LAL03NA 1R8M	
L4	Coil	LA-237	
L5	Coil	LAL03NA 3R3M	
L6	Coil	LAL03NA 3R3M	
L7	Coil	LAL03NA 3R3M	
R1	Resistor	680k	ELR20
R2	Resistor	47k	ELR20
R3	Resistor	4.7k	ELR20
R4	Resistor	330k	ELR20
R5	Resistor	10	ELR20
R6	Resistor	1k	ELR20
R7	Resistor	4.7k	ELR20
R8	Resistor	5.6k	ELR20
R9	Resistor	22	ELR20
C1	Trimmer	20P	CV05D2001
C2	Ceramic	4P	50V
C3	Ceramic	4P	50V
C4	Ceramic	3P	50V
C5	Electrolytic	10	16V RC3
C6	Ceramic	0.001	50V
C7	Ceramic	0.001	50V
C8	Electrolytic	22	16V RC3
C9	Ceramic	3P	50V
C10	Ceramic	0.001	50V
C11	Ceramic	0.001	50V
C12	Ceramic	0.001	50V
C13	Ceramic	5P	50V
EP1	P.C. Board	B-1101C	

13-5 CONTROL UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	μPD2716	
IC2	IC	μPB8212C	
IC3	IC	P8035L	
IC4	IC	4013	
IC5	IC	4069	
IC6	IC	NJM4558D	
IC7	IC	TC4011UBP	
IC8	IC	4013	
Q1	Transistor	2SC945	P/Q/R
Q2	Transistor	2SA1015	Y
Q3	Transistor	2SC945	P/Q/R
Q4	Transistor	2SC945	P/Q/R
Q5	Transistor	2SC945	P/Q/R
Q6	Transistor	2SD468	
Q7	Transistor	2SC945	P/Q/R
Q8	Transistor	2SC945	P/Q/R
D1	Zener	RD8.2E	B3
D2	Diode	1SS53	
D3	Diode	1SS53	
D4	Diode	1SS53	
D5	Diode	1SS53	
D6	Diode	1SS53	
X1	Crystal	5.120MHz	HC43/U
R1	Resistor	220k	ELR25
R2	Trimmer	47k	RH1051DS4J06A
R3	Resistor	47k	ELR25
R4	Resistor	10k	ELR25
R5	Resistor	2.2k	ELR25
R6	Resistor	18k	ELR25
R7	Resistor	18k	ELR25
R8	Trimmer	47k	RH1051DS4J06A
R9	Resistor	15k	ELR25
R10	Resistor	220	ELR25
R11	Resistor	56k	ELR25
R12	Trimmer	10k	RH1051D14J09A
R13	Resistor	10k	R25
R14	Resistor	100k	ELR25
R15	Resistor	100k	ELR25
R16	Resistor	10k	R25
R17	Resistor	22k	R25
R18	Resistor	22k	ELR25
R20	Resistor	10k	ELR25
R21	Resistor	47k	R25
R22	Resistor	47k	R25
R23	Resistor	10k	ELR25
R24	Resistor	1k	R25
R25	Resistor	47k	ELR25
R26	Resistor	47k	R25
R27	Resistor	47k	ELR25
R28	Resistor	47k	ELR25
R29	Resistor	47k	ELR25
R30	Resistor	47k	ELR25
R31	Resistor	47k	ELR25
R32	Resistor	10	ELR25
R33	Array	47k	RMX-8 473
R34	Resistor	10k	R25
R35	Resistor	1k	ELR25

CONTROL UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
R36	Resistor	22k	R25
R37	Resistor	22k	R25
R38	Resistor	560	R25
R39	Resistor	100	R25
R40	Resistor	10k	ELR25
R41	Resistor	22k	R25
R42	Resistor	10k	R25
R43	Resistor	1k	R25
R44	Resistor	560	R25
R45	Resistor	1k	R25
R46	Resistor	33k	R25
R47	Resistor	47k	R25
R48	Resistor	47k	R25
R49	Resistor	10	R25
R50	Resistor	22k	R25
C1	Mylar	0.01	50V
C2	Mylar	0.001	50V
C3	Mylar	0.1	50V
C4	Barrier Layer	0.1	16V
C5	Electrolytic	47	16V
C6	Barrier Layer	0.1	16V
C7	Electrolytic	47	16V
C8	Electrolytic	100	10V
C10	Dip mica	22P	50V
C11	Dip mica	22P	50V
C12	Ceramic	0.001	50V
C13	Barrier Layer	0.1	16V
C14	Barrier Layer	0.1	16V
C15	Barrier Layer	0.1	16V
C16	Barrier Layer	0.1	16V
C17	Barrier Layer	0.1	16V
C18	Barrier Layer	0.1	16V
C19	Electrolytic	1	50V
C20	Ceramic	0.001	50V
C21	Barrier Layer	0.1	16V
C22	Barrier Layer	0.047	25V
J1	Connector	TL-25P-08-V1	
J2	Connector	TL-25P-08-V1	
J3	Connector	TL-25P-06-V1	
J4	Connector	TL-25P-04-V1	
J5	Connector	TL-25P-06-V1	
J6	Socket	IC-30-2406-G4	
P1	Connector	SMP-03-VB	
S1	Dip Switch	SSGM12	
EP1	P.C. Board	B-670C	

13-6 N-CTRL UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	TC4069UBP	
IC2	IC	TC4024BP	
IC3	IC	TC4081BP	
IC4	IC	TC4014BP	
IC5	IC	TC4014BP	
IC6	IC	TC4069UBP	
IC7	IC	TC4024BP	
IC8	IC	TC4081BP	
IC9	IC	TC4014BP	
IC10	IC	TC4014BP	
D1	Diode	1SS133	
D2	Diode	1SS133	
D3	Diode	1SS133	
D4	Diode	1SS133	
D5	Diode	1SS133	
D6	Diode	1SS133	
D7	Diode	1SS133	
D8	Diode	1SS133	
R1	Resistor	100k	R20
R2	Resistor	10k	R20
R3	Resistor	47k	R20
R4	Resistor	22k	R20
R5	Resistor	22k	R20
R6	Array	47k	RMX-8 473
R7	Array	47k	RMX-8 473
R8	Resistor	100k	R20
R9	Resistor	10k	R20
R10	Resistor	47k	R20
R11	Resistor	22k	R20
R12	Resistor	22k	R20
R13	Array	47k	RMX-8 473
R14	Array	47k	RMX-8 473
C1	Ceramic	470P	50V
C2	Barrier Layer	0.1	16V
C3	Barrier Layer	0.1	16V
C4	Barrier Layer	0.1	16V
C5	Ceramic	100P	50V
C6	Barrier Layer	0.1	16V
C7	Barrier Layer	0.1	16V
C8	Ceramic	100P	50V
C9	Ceramic	470P	50V
C10	Barrier Layer	0.1	16V
C11	Barrier Layer	0.1	16V
C12	Barrier Layer	0.1	16V
C13	Ceramic	100P	50V
C14	Barrier Layer	0.1	16V
C15	Barrier Layer	0.1	16V
C16	Ceramic	100P	50V
J1	Connector	TL-25P-05V1	
J2	Connector	TL-25P-05V1	
S1	Switch	SSGM18	
S2	Switch	SSGM18	
S3	Switch	SSGM18	
S4	Switch	SSGM18	
EP1	P.C. Board	B-1503A	

13-7 PA UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	M57741M (#03, #04) M57741L (#01, #02)	
Q1	Transistor	2SA1359Y	
C1	Ceramic	470P	50V
C2	Ceramic	0.001	50V
C3	Tantalum	10	35V DN
C4	Ceramic	470P	50V
C5	Ceramic	0.001	50V
C6	Electrolytic	10	16V MS7
J1	Connector	BNC-RM-106	
P1	Cable	OPC-035B	
P2	Connector	1460-4P1	
EP1	P.C. Board	B-1495	

13-8 FILTER UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	μPC358C	
Q1	Transistor	2SC2458 GR	
D1	Diode	1SS97	
D2	Diode	1SS97	
L1	Coil	LA-252	
L2	Coil	LA-262	
L3	Coil	LA-252	
L4	Coil	LA-252	
L5	Coil	LW-19	
R1	Resistor	330	R20
R2	Resistor	100k	R20
R3	Resistor	10k	R20
R4	Resistor	100k	R20
R5	Resistor	2.2M	R20
R6	Resistor	56k	R20
R7	Resistor	4.7k	R20
R8	Resistor	15k	R20
R9	Trimmer	3.3K RH0651CN3J01A	
R10	Resistor	1.2k	R20
R11	Resistor	4.7k	R20
R12	Resistor	4.7k	R20
C1	Ceramic	0.001	50V
C2	Ceramic	0.001	50V
C3	Electrolytic	10	16V MS7
C4	Ceramic	0.001	50V
C5	Ceramic	0.001	50V
C6	Ceramic	0.001	50V
C7	Ceramic	2P	50V
C8	Ceramic	2P	50V
C9	Ceramic	2P	50V
C10	Ceramic	2P	50V
C11	Ceramic	27P	50V
C12	Ceramic	27P	50V
C13	Ceramic	0.001	500V
C14	Ceramic	22P	500V
C15	Ceramic	6P	500V
C16	Ceramic	39P	500V
C17	Ceramic	5P	500V
C18	Ceramic	33P	500V
C19	Ceramic	8P	500V
C20	Ceramic	15P	500V
C21	Feed Through	TF240-602SS332Z50V	
C22	Feed Through	TF240-602SS332Z50V	
C23	Feed Through	TF240-602SS332Z50V	
J1	Connector	MR-DS	
P1	Cable	OPC-035E	
EP1	P.C. Board	B-1502A	

13-9 DTMF UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	LR4101	
IC2	IC	TC4049	
IC3	IC	TC4515	
IC4	IC	TC4044	
IC5	IC	TC4044	
Q1	Transistor	2SC1815	
Q2	Transistor	2SC1645B	
D1	Zener	XZ092	
D2	Zener	WZ050	
D3	Diode	1SS53	
D4	Diode	1SS53	
D5	Diode	1SS53	
D6	Diode	1SS53	
D7	Diode	1SS53	
D8	Diode	1SS53	
D9	Diode	1SS53	
D10	Diode	1SS53	
D11	Diode	1SS53	
D12	Diode	1SS53	
D13	Diode	1SS53	
D14	Diode	1SS53	
D15	Diode	1SS53	
R1	Resistor	220	ELR25
R2	Resistor	1k	ELR25
R3	Resistor	47k	ELR25
R4	Resistor	10k	ELR25
R5	Resistor	47k	ELR25
R6	Resistor	1k	ELR25
R7	Resistor	1k	ELR25
R8	Resistor	470	ELR25
R10	Resistor	47k	R25
R11	Resistor	10M	ELR25
R12	Resistor	22k	ELR25
R13	Resistor	47k	ELR25
R14	Resistor	47k	ELR25
R15	Resistor	47k	ELR25
R16	Resistor	47k	ELR25
R17	Resistor	47k	ELR25
R18	Resistor	47k	ELR25
R19	Resistor	47k	ELR25
R20	Resistor	47k	ELR25
C1	Electrolytic	100	10V
C2	Barrier Layer	0.1	16V
C3	Barrier Layer	0.1	16V
C4	Electrolytic	47	10V
C5	Mylar	0.01	50V
C6	Mylar	0.01	50V
C7	Mylar	0.01	50V
C8	Electrolytic	22	10V
C9	Electrolytic	100	10V
P1	Connector	TL-25H-06-B1	
J1	Connector	TL-25P-02-V1	
X1	Crystal	3.58MHz	HC43/U
EP1	P.C. Board	B-732	

13-10 TONE SQUELCH UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
IC1	IC	MC4138		
IC2	IC	NJM78L08		
Q1	Transistor	2SC945	P	
Q2	Transistor	2SC945	P	
Q3	Transistor	2SA1015		
Q4	Transistor	2SC945	P	
D1	Diode	1S953		
R1	Resistor	220k	ELR25	
R2	Resistor	680k	ELR25	
R3	Resistor	1k	ELR25	
R4	Resistor	2.2k	ELR25	
R5	Resistor	1.5k	ELR25	
R6	Resistor	3.3k	ELR25	
R7	Resistor	2.2k	ELR25	
R8	Trimmer	4.7k	H0651A	
R9	Resistor	220k	ELR25	
R10	Resistor	47k	ELR25	
R11	Resistor	220	R25	
R12	Resistor	10k	ELR25	
R13	Resistor	1.5k	ELR25	
R14	Resistor	4.7k	ELR25	
R15	Resistor	4.7k	ELR25	
R16	Trimmer	4.7k	H0651A	
R17	Resistor	MC1938		
C1	Electrolytic	0.1	50V	RC2
C2	Ceramic	0.001	50V	B
C3	Electrolytic	1	50V	RC2
C4	Electrolytic	0.1	50V	RC2
C5	Electrolytic	0.33	50V	RC2
C6	Electrolytic	1	50V	RC2
C7	Electrolytic	1	50V	RC2
C8	Ceramic	0.001	50V	B
C9	Electrolytic	1	50V	RC2
C10	Electrolytic	1	50V	RC2
C11	Ceramic	0.001	50V	B
C12	Electrolytic	4.7	35V	RC2
C14	Ceramic	0.001	50V	B
C15	Electrolytic	4.7	35V	RC2
C16	Electrolytic	4.7	35V	RC2
C17	Electrolytic	0.22	50V	RC2
J1	Connector	5045-08A		
EP1	P.C. Board	B-460		

13-11 AF UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	μ PD2002V	
R1	Resistor	100	ELR20
R2	Resistor	4.7	ELR20
R3	Resistor	220	ELR20
R4	Resistor	4.7k	ELR20
C1	Electrolytic	220	16V
C2	Barrier Layer	0.1	16V
C3	Electrolytic	220	16V
C4	Electrolytic	100	16V
C5	Ceramic	0.0047	50V
C6	Electrolytic	0.47	50V
J1	Connector	TL-25P-05-V1	
EP1	P.C. Board	B-667B (or B-1611)	

13-12 REGULATOR UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	MB3752	
Q1	Transistor	2SD880Y	
R1	Resistor	2.2k	R20
R3	Resistor	2.2k	R20
R4	Trimmer	3.3k RH0652CN3J05A	
R5	Resistor	470	R20
R6	Trimmer	330 RH0652CN2J04A	
R8	Resistor	470	R20
R9	Resistor	100	R20
R11	Resistor	0.03	SRW3P0.03-J
R12	Resistor	0.03	SRW3P0.03-J
R14	Resistor	1k	R20
R16	Resistor	22	R20
R17	Resistor	100	R20
R18	Resistor	0.03	SRW3P0.03-J
R19	Resistor	0.03	SRW3P0.03-J
C1	Ceramic	0.001	50V
C2	Electrolytic	470	16V
C4	Electrolytic	470	25V
J1	Connector	RT-01T-1.3B	
J2	Connector	RT-01T-1.3B	
J3	Connector	RT-01T-1.3B	
J4	Connector	RT-01T-1.3B	
J5	Connector	RT-01T-1.3B	
J6	Connector	RT-01T-1.3B	
J7	Connector	RT-01T-1.3B	
J8	Connector	RT-01T-1.3B	
J9	Connector	RT-01T-1.3B	
J10	Connector	RT-01T-1.3B	
EP1	P.C. Board	B-688D	

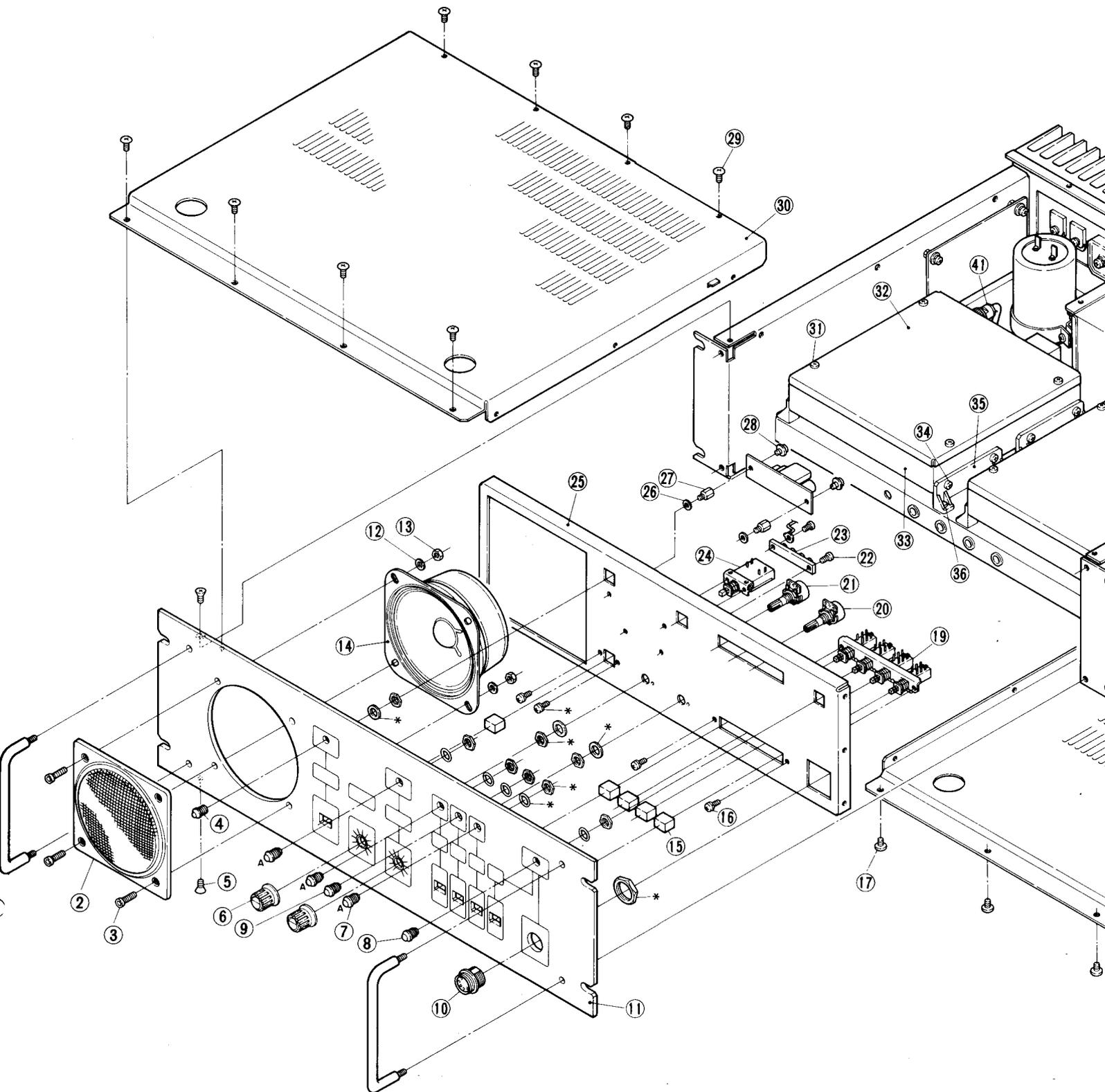
13-13 FRONT UNIT

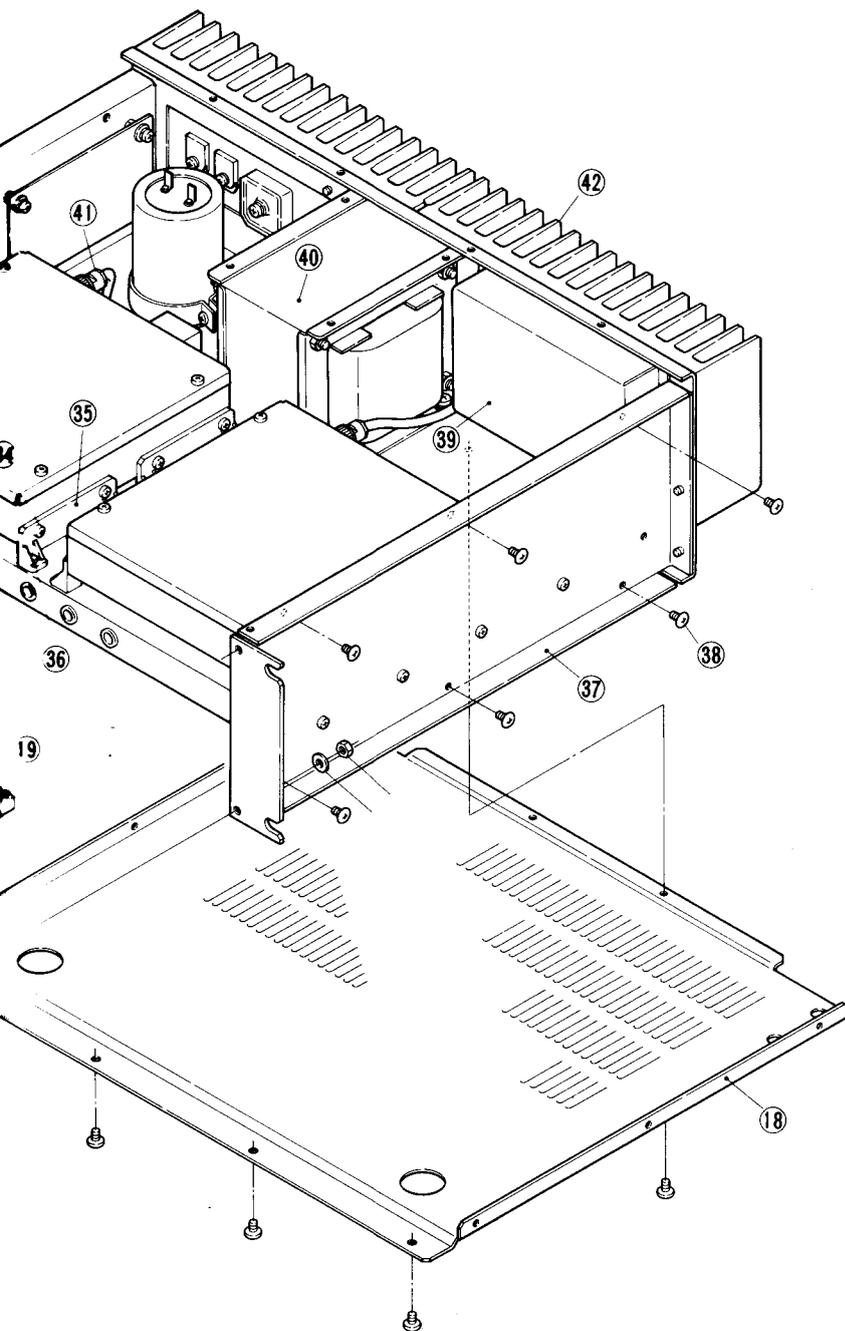
REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	NJM7805A	
Q1	Transistor	2SB863 O/Y	
Q2	Transistor	2SB863 O/Y	
D1	Diode	S25VB-20	
D2	Diode	1N4002	
D3	Diode	U05B	
D4	Diode	15CD11	
D5	Zener	RD3.0E B2	
R1	Variable	10k RK1631110D9DA 10KA	
R2	Variable	10k RK1631110D9CA 10KB	
R3	Resistor	SRW2P100-J	
R4	Resistor	SRW1P47J	
R5	Resistor	1k	R20
R6	Resistor	1k	R20
C1	Ceramic	0.01	50V
C2	Ceramic	0.01	50V
C3	Ceramic	0.01	50V
C4	Ceramic	0.01	50V
C5	Electrolytic	56000	25V
C6	Ceramic	DE709B102KAC400	0.001
C7	Ceramic	DE709B102KAC400	0.001
RL1	Relay	LY-1S	AC12V
J1	Connector	FM14RS-7H	
J2	Connector	MR-DSE-02	
J3	Connector	CM-3	
J4	Terminal	T-3830	RED
J5	Terminal	T-3830	BLACK
J6	Connector	HSJ-296	
P1	Connector	TL-25H-05-B1	
P2	Connector	SMP-09-VB	
P3	Connector	TL-25H-04-B1	
P4	Connector	5250-08	
P5	Connector	TL-25H-08-B1	
P6	Connector	1490-4R	
P7	Connector	TL-25H-02-B1	
P8	Connector	TL-25H-06-B1	
P9	Connector	TL-25H-08-B1	
P10	Connector	SMP-08-VB	
P11	Connector	TL-25H-05-B1	
P12	Connector	SMR-05-VB	
P13	Connector	TL-25H-05-B1	
P14	Connector	SMR-05-VB	
P15	Connector	OPC-035F	
P16	Connector	SMR-03-VB	
F1	Fuse Holder	FH-032C	
F2	Fuse Holder	FH-032C	
DS1	LED	SLP-710F (red)	
DS2	LED	SLP-720F (green)	
DS3	LED	SLP-730F (yellow)	
DS4	LED	SLP-720F (green)	
DS5	LED	SLP-720F (green)	

FRONT UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)
DS6	LED	DB-18
S1	Switch	TWA-0068-01-233
S2	Switch	SPUE44F05A
T1	Transformer	TP-47
SP1	Speaker	C100P21A001

13-14 MECHANICAL PARTS

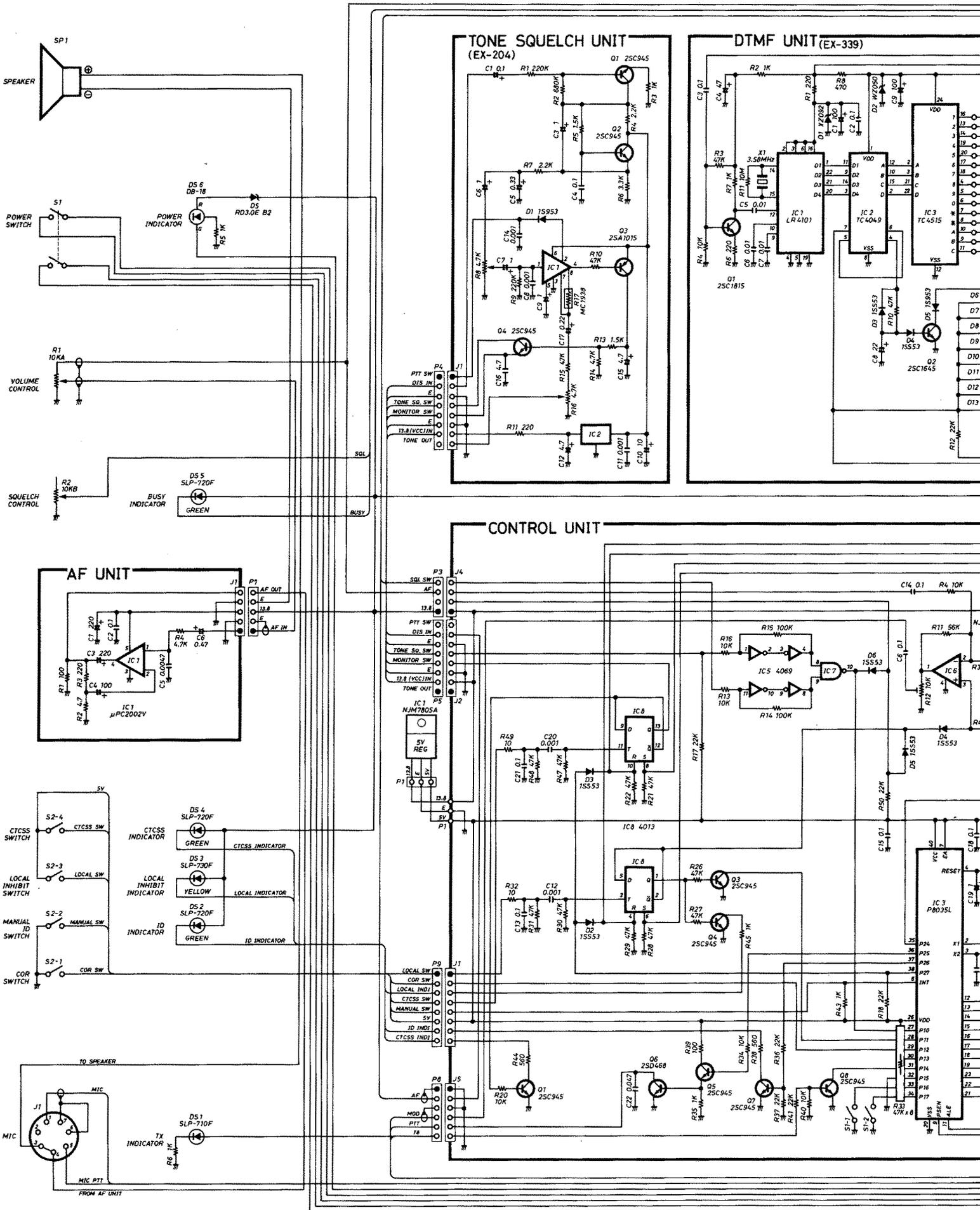


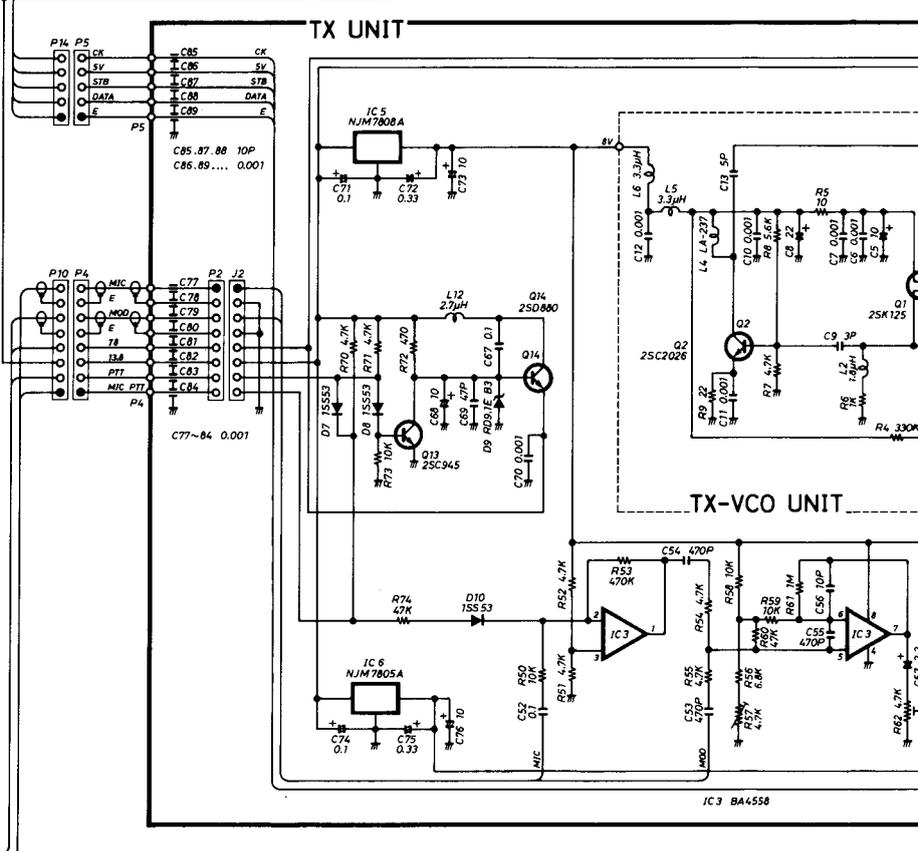
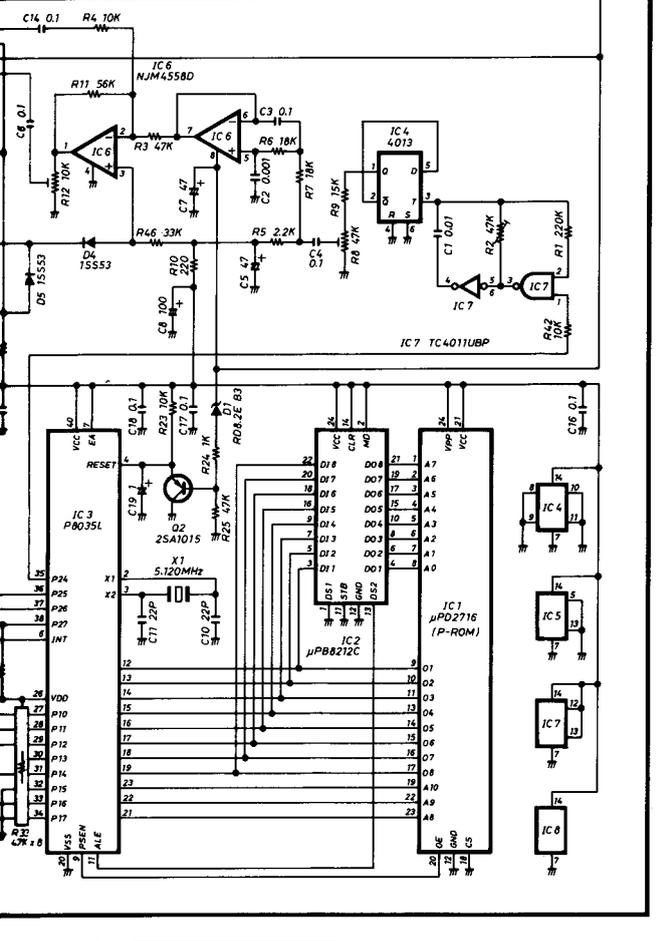
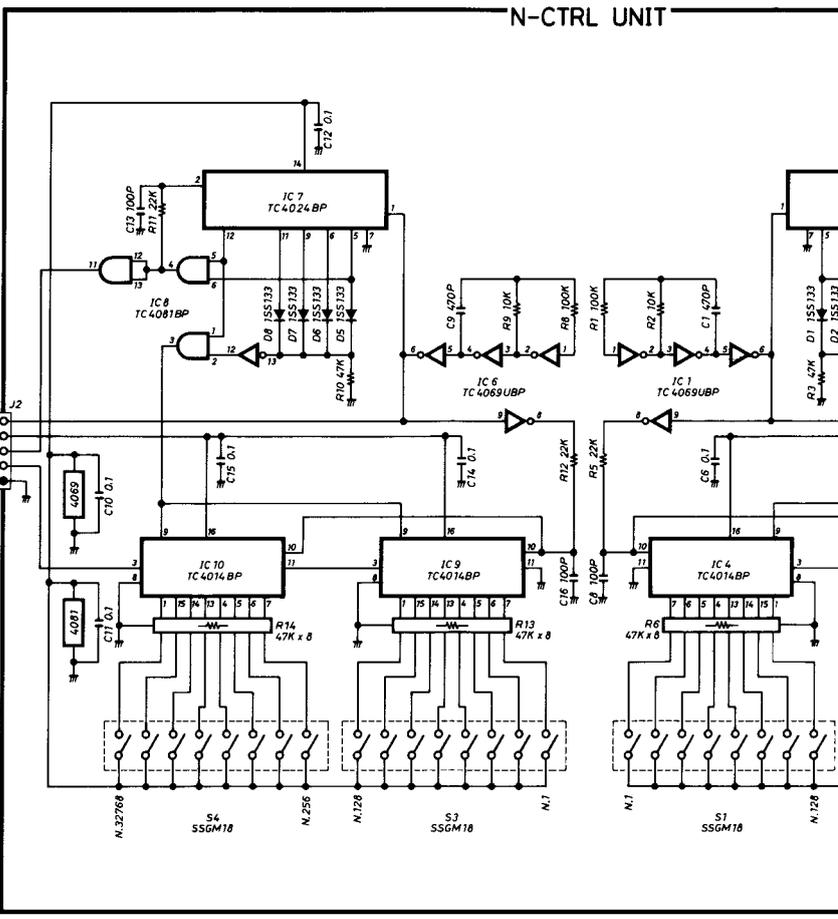
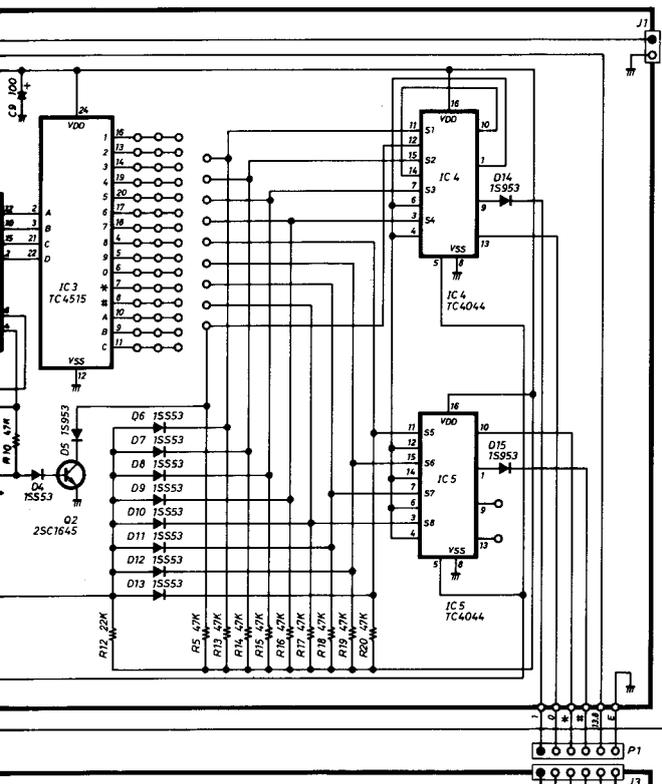


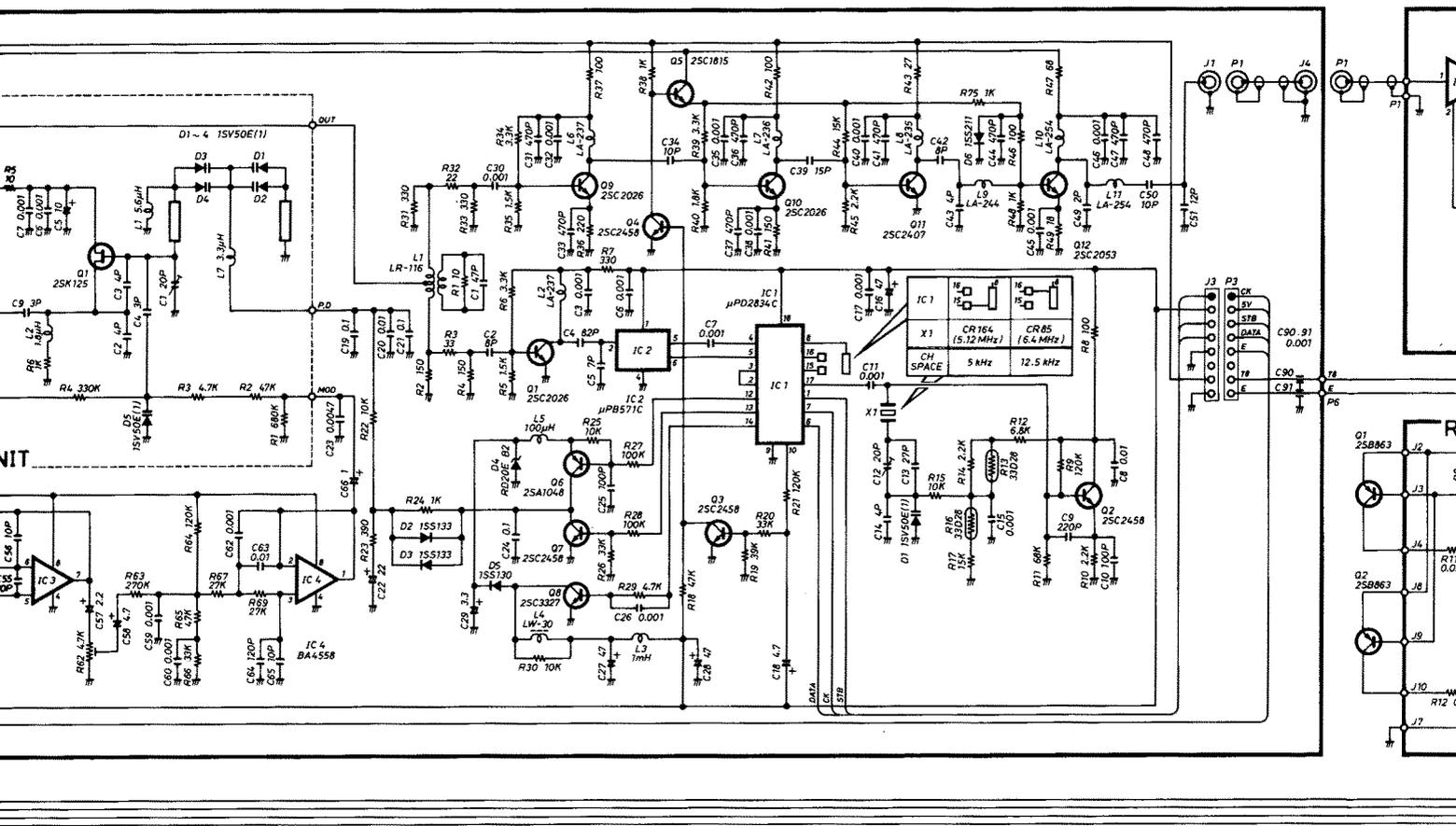
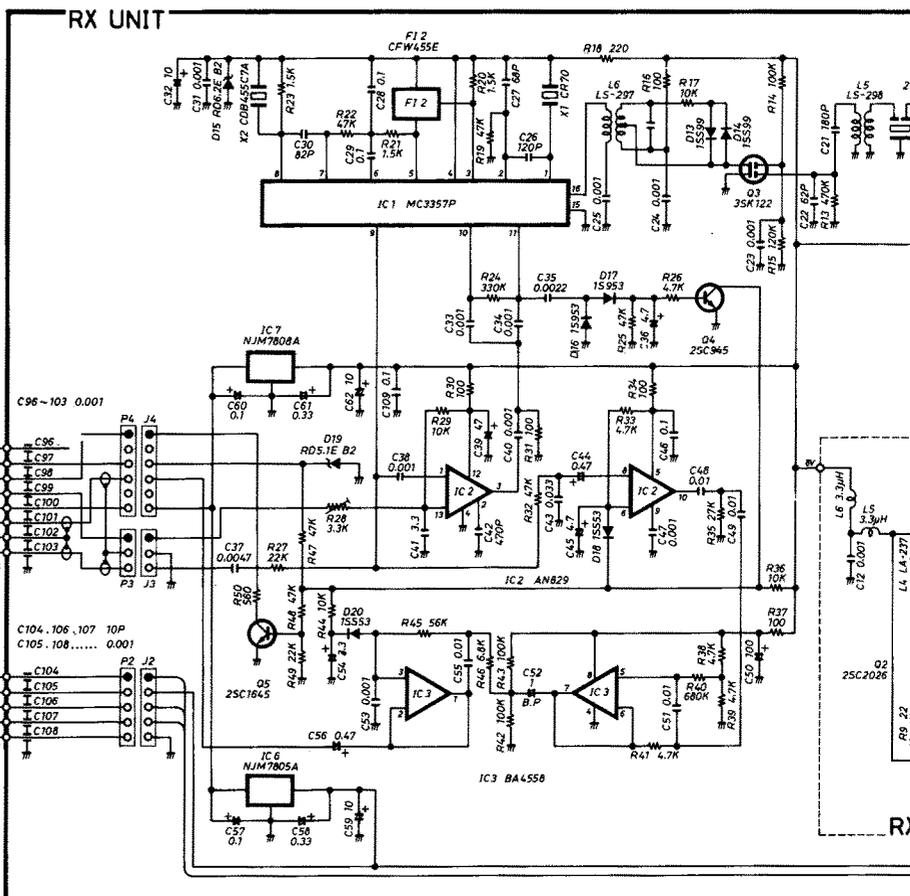
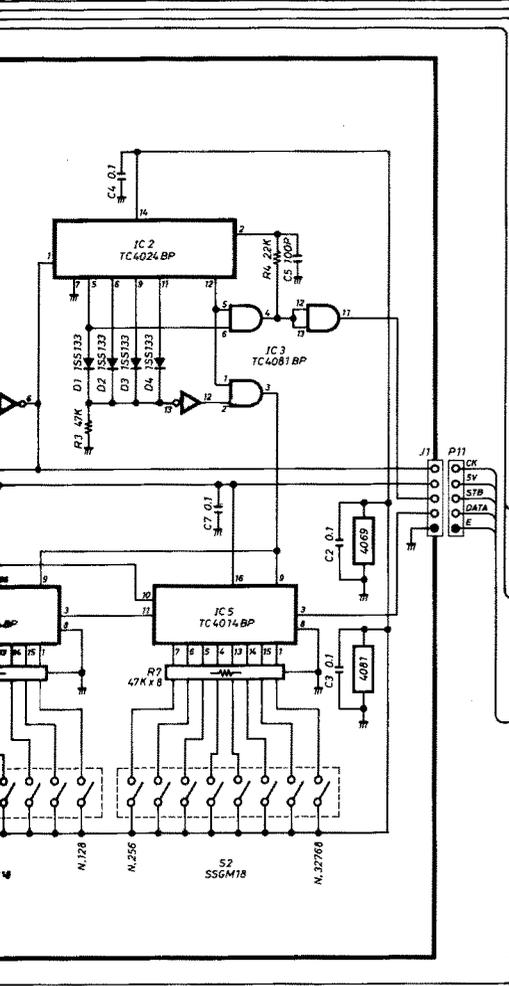
No.	PARTS NAME	PARTS NUMBER
1	Rack mounting handle	PH-110-8M
2	Speaker net	41925
3	Hex socket screw	M4 x 14 BLACK
4	LED	DB-18
5	Flat head screw	M3 x 6
6	Knob	N-66
7	LED	SLP-720F (green)
8	LED	SLP-710F (red)
9	LED	SLP-730F (yellow)
10	Mic connector	FM14RS-7H
11	Front panel (B)	C-02383
12	Flat washer	M4
13	Nut	M4
14	Speaker	C100P21A001
15	Pan head screw	(A) 3 x 6
16	Pan head screw	(A) 3 x 6
17	Button head screw	(A) 3 x 4
18	Bottom cover	20179
19	Switch	SPUE44F05A
20	Variable resistor	RK1631110D9CA 10KB
21	Variable resistor	RK1631110D9DA 10KA
22	Pan head screw	(A) 3 x 6
23	T-terminal	ML-3182 4P
24	Switch	TWA-0068-01-233
25	Sub-chassis	20162
26	Spring lock washer	M3
27	Stand-off (H)	L=7.5
28	Set screw	(C)
29	Button head screw	(A) 3 x 4
30	Top cover	20178
31	Pan head self-tapping	M3 x 6
32	Shield case cover	42338
33	Shield case (A)	41699
34	Pan head self-tapping	M3 x 8
35	Support angle	41204
36	Set screw	(A) 3 x 8
37	Side panel (R)	20163
38	Button head screw	(A) 3 x 4
39	PA shield cover	41818
40	Transformer	TP-47
41	BNC connector	BNC plug (Male)
42	PA heatsink	30322

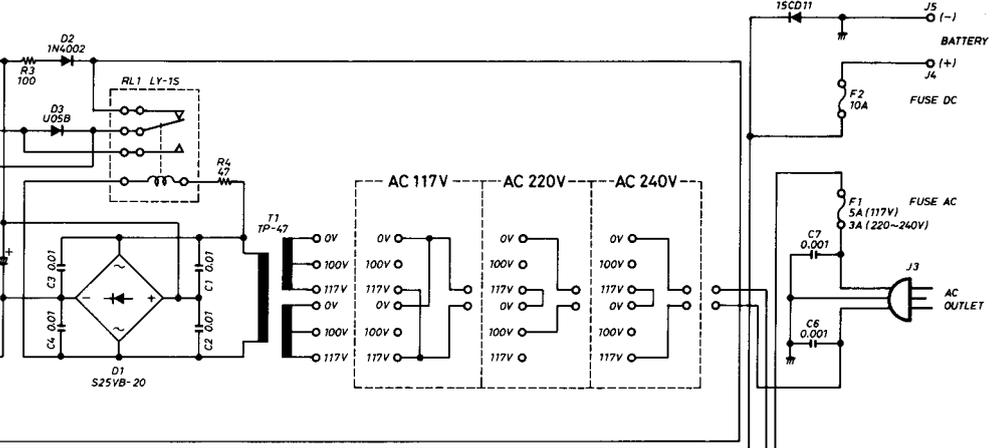
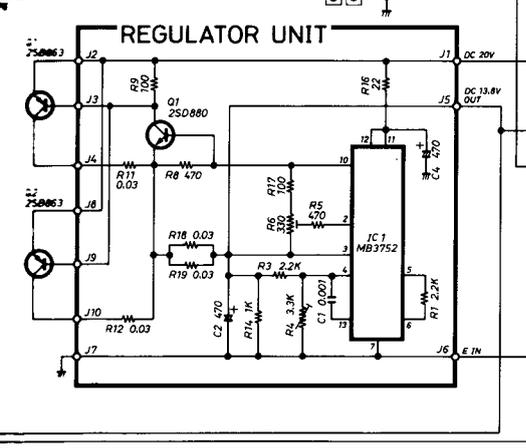
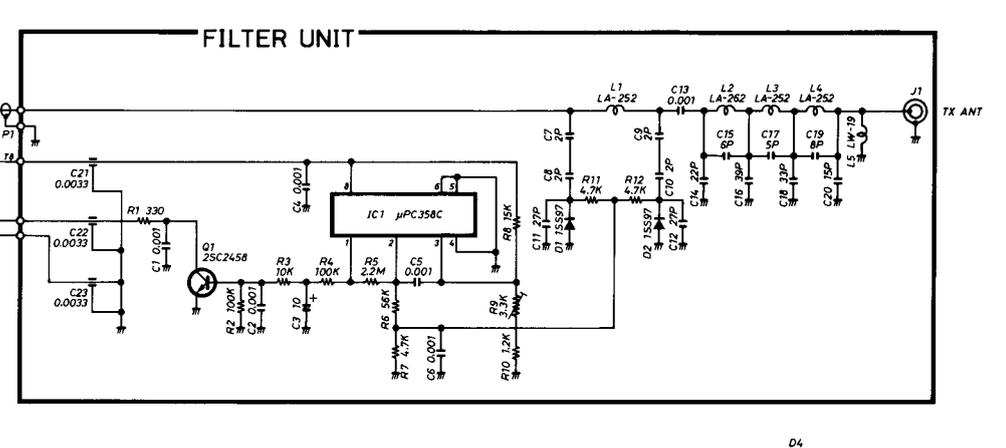
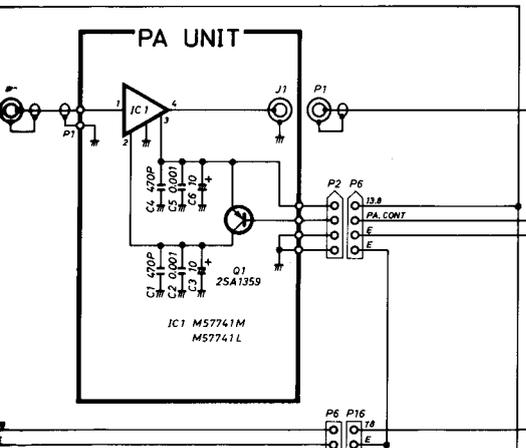
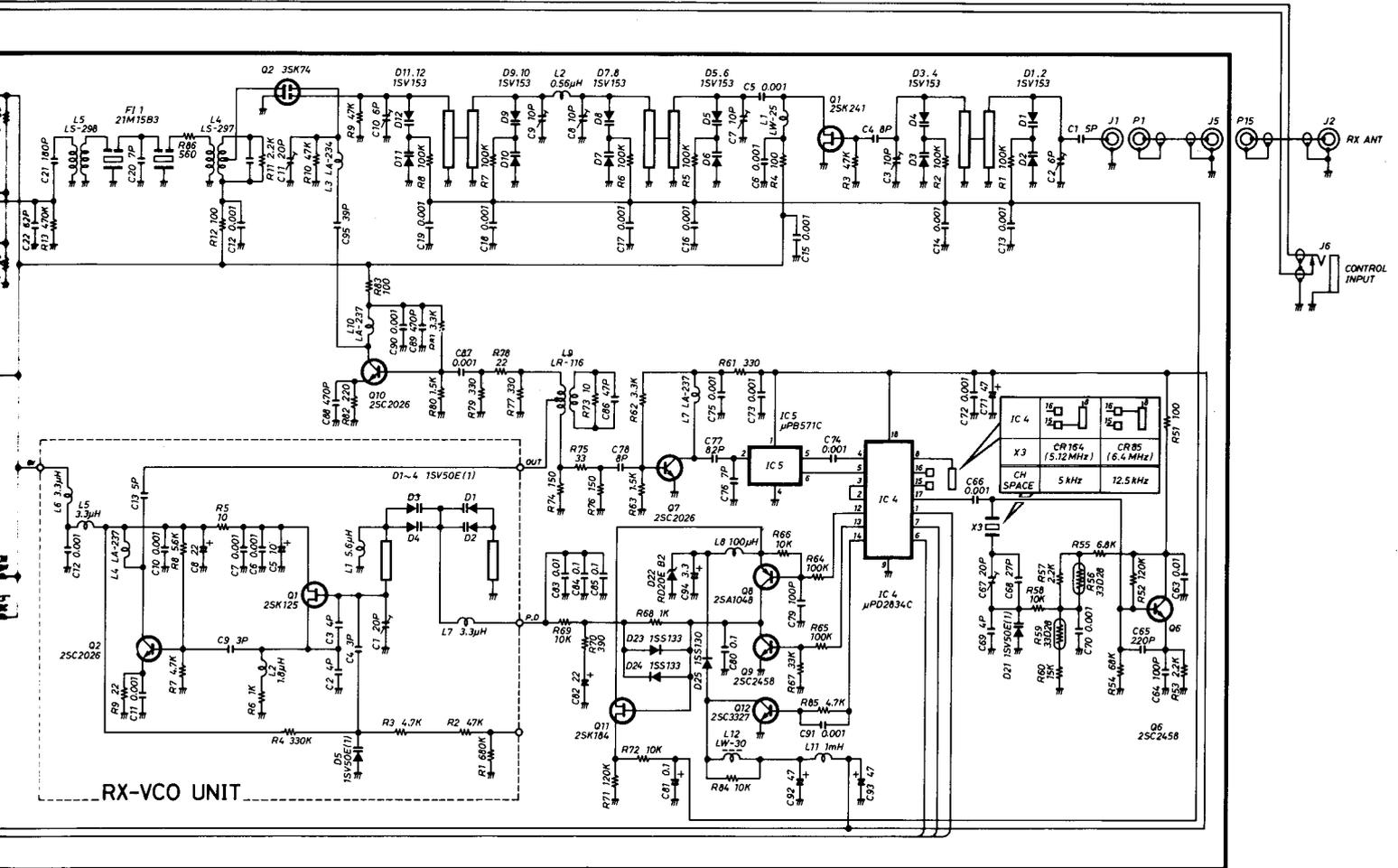
* Parts marked with "*" are included with various assemblies (i.e., control pot, switch, LED, etc.).

14. GENERAL SCHEMATIC DIAGRAM











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