

# **IC-RP1210**

 **ICOM** ICOM INCORPORATED

## FOREWORD

We thank you for your purchase of the ICOM IC-RP1210 Repeater, a unit designed for amateur radio communications on the 1200 MHz band. It was developed on the basis of both commercial communications technology and ICOM's own state-of-the-art computer technology.

Before use of this set, be sure to read this Operating Manual carefully to attain a thorough understanding of the IC-RP1210's workings and to ensure prolonged and reliable operation.

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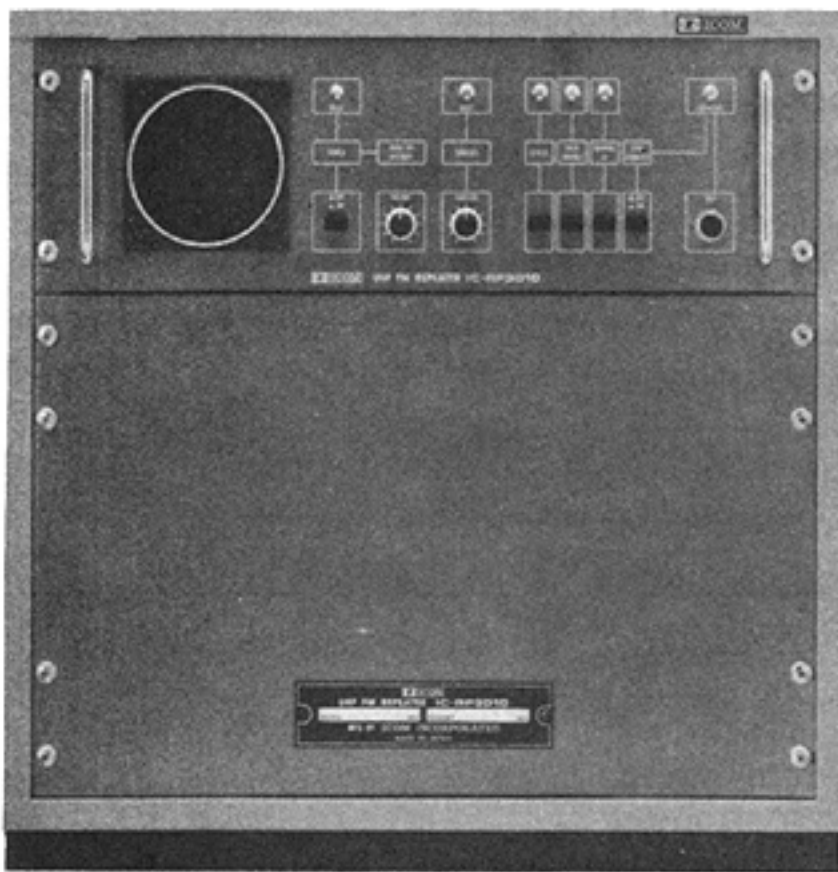
## GENERAL DESCRIPTION

### Outline

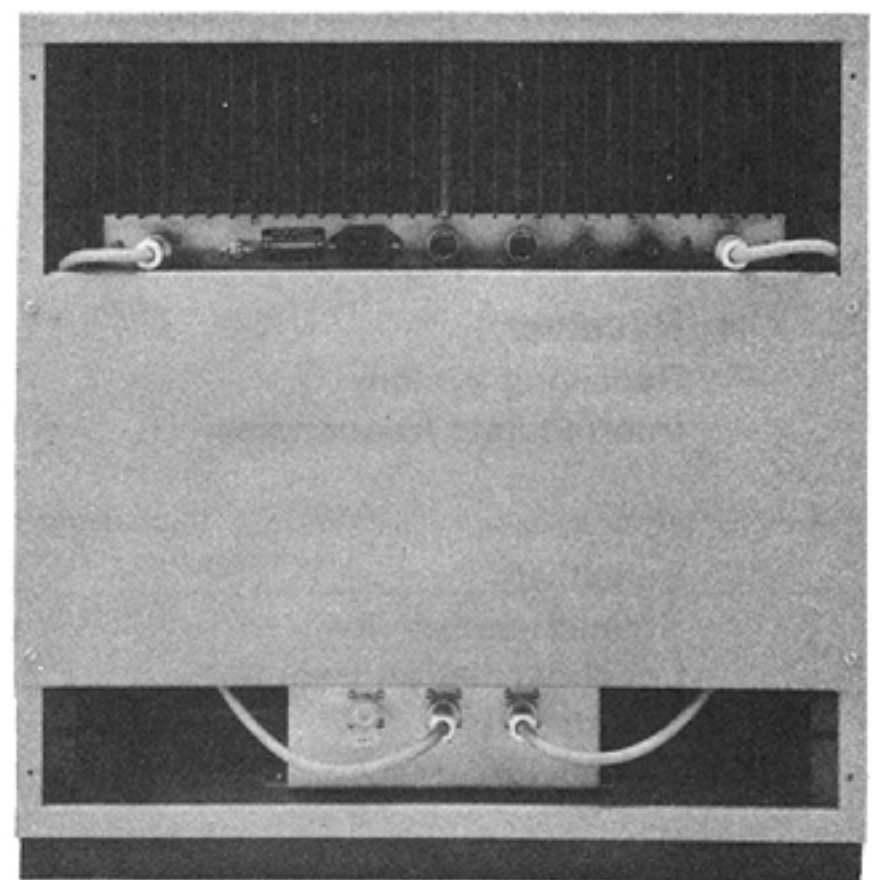
The IC-RP1210 is an FM repeater for amateur radio communications on the 1200 MHz band. The repeater system makes possible communications that were once impossible—between distant points, between points where obstacles stand in the way, etc. Making full use of its advanced technology, ICOM has introduced, both in the IC-RP1210's receiver and transmitter units, circuits that are generally employed in commercial radio applications. To enhance durability and service-life reliability, the components are housed in a sturdy steel frame.

The duplexer, the most important component for repeater functions, provides low insertion loss, ensuring sufficient transmission/receiving isolation. A microprocessor, Intel P8035L, is used in the repeater control unit to cover both internal and external control functions. With the ROM installed independently of the CPU, specifications (call sign, etc.) can be easily adapted to user requirements.

**Front panel**

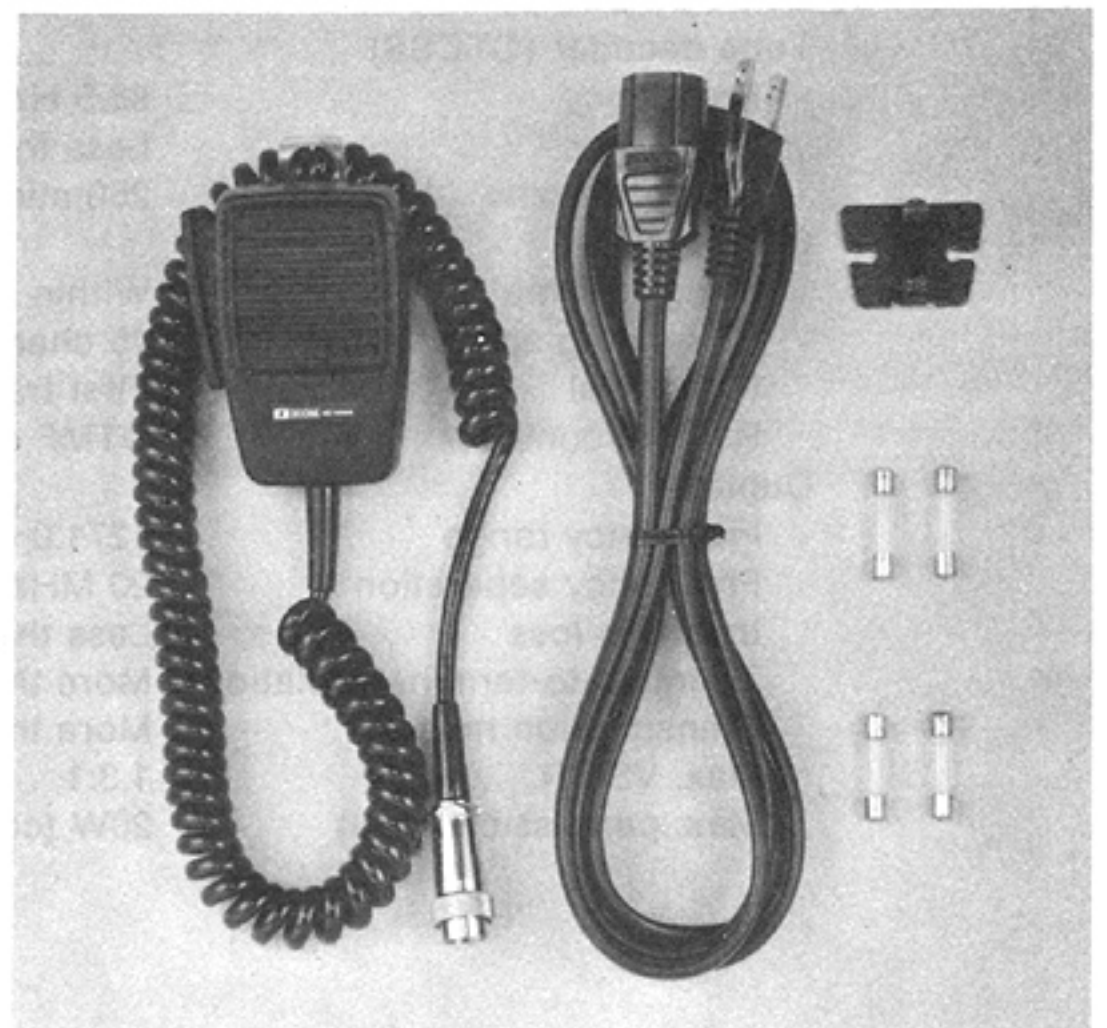


**Back panel**



### Standard Accessories

Microphone (IC-HM4) .....	1
AC power cable .....	1
Microphone hook .....	1
Spare fuse 2A (AC use) .....	2
Spare fuse 10A (DC use) .....	2



## Specifications

### • General

Frequency coverage	1271.02~1272.98 MHz (Reception), 1291.02~1292.98MHz (Transmission)
Mode	16F3 (16F2 for ID)
Number of channel	1 (PLL synthesizer system)
Repeater control system	Carrier/CTCSS operating system (switch selectable)
Power supply voltage	117V/240V AC or 13.8V DC
Rated input	120W
Ambient temperatures	-10°C to +50°C
Duty cycle	Continuous
Antenna impedance	50 ohms unbalanced
Dimensions	520(W) × 520(H) × 400(D) mm
Weight	Approx. 32.5 kg

### • Transmitter

RF output power	10W +20%, -50%
Frequency stability	Within $\pm 1 \times 10^{-6}$
Frequency multiplication	8 times (2×2×2)
Modulation system	Variable reactance phase modulation
Max. frequency deviation	±5 kHz
Modulation frequency response	6 dB/oct., +1 dB, -3 dB at 300 to 3000 Hz Less than -23 dB at 20 kHz (on 1000 Hz basis)
Overall distortion	Less than 10% for 60% modulation at 1000 Hz
S/N ratio	More than 40 dB for 60% modulation at 1000 Hz
Spurious emission	Less than -55 dB
Occupied bandwidth	Less than 16 kHz

### • Receiver

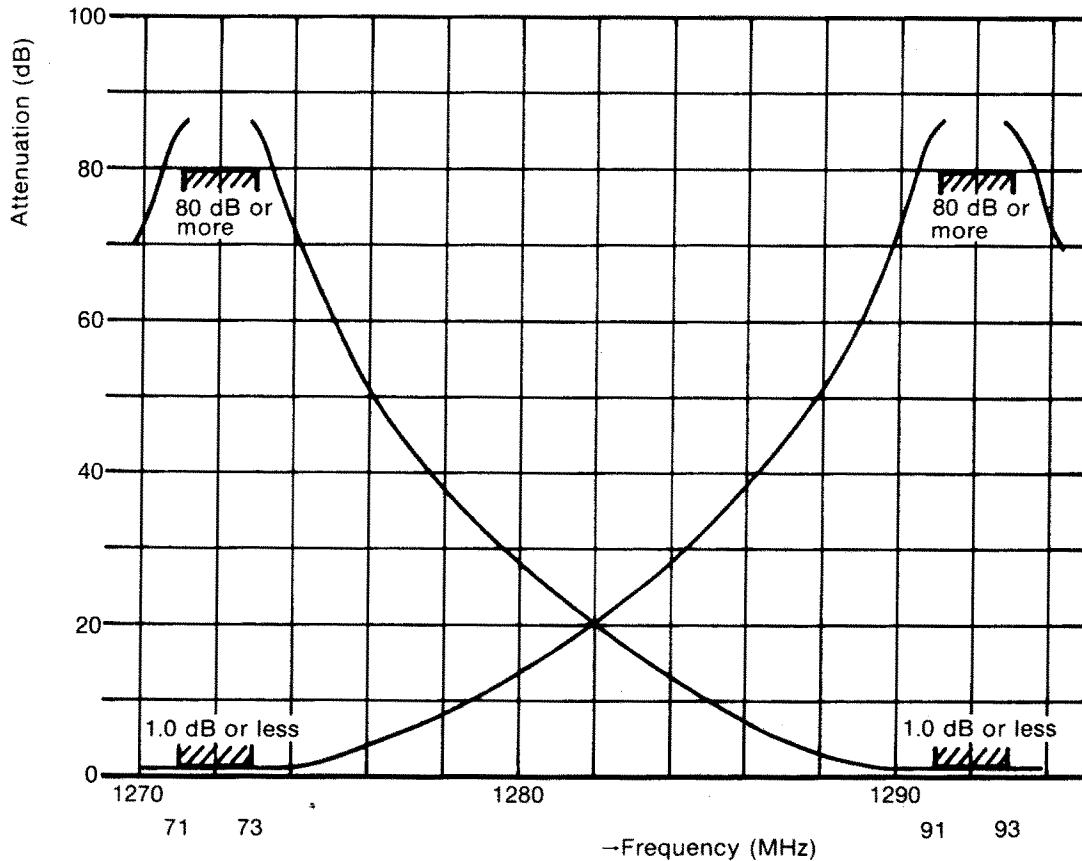
Receiving system	Triple-conversion superheterodyne
Intermediate frequencies	First IF: 131.4 MHz Second IF: 10.695 MHz Third IF: 455 kHz
Sensitivity	Less than 0.5 $\mu$ V for 12 dB SINAD
Squelch sensitivity	Less than 0.2 $\mu$ V
Local oscillation frequency stability	Within $\pm 1 \times 10^{-6}$
Selectivity	More than 12 kHz at -6 dB point Less than 25 kHz at -70 dB point
Spurious response rejection ratio	More than 60 dB
Desensitization	More than 60 dB
Intermodulation response	More than 50 dB
AF power output	2.0W (at 10% distortion with 8-ohm load)

### • Control Unit

Tone decoder (CTCSS)	
Frequency	88.5 Hz $\pm$ 0.5% (other frequency available)
Sensitivity	Less than 6 dB SINAD
Response time	250 microseconds or less
Control unit	
Hang-up time	Within 5 seconds (selectable)
ID sending speed	45 characters/min or 100 characters/min (at 800 Hz) (by ROM change)
ID interval	First transmission after 2~3 mins. transmission
Remote control	DTMF control
Duplexer	
Frequency range	1271.0~1273.0MHz (Reception), 1291.0~1293.0MHz (Transmission)
Frequency separation	20 MHz
Insertion loss	Less than 1.5 dB
Terminal-to-terminal isolation	More than 70 dB
Transmission noise	More than 75 dB below carrier power
Max. VSWR	1.3:1
Max. permissible input	20W (continuous duty)

## Duplexer Ratings and Characteristics

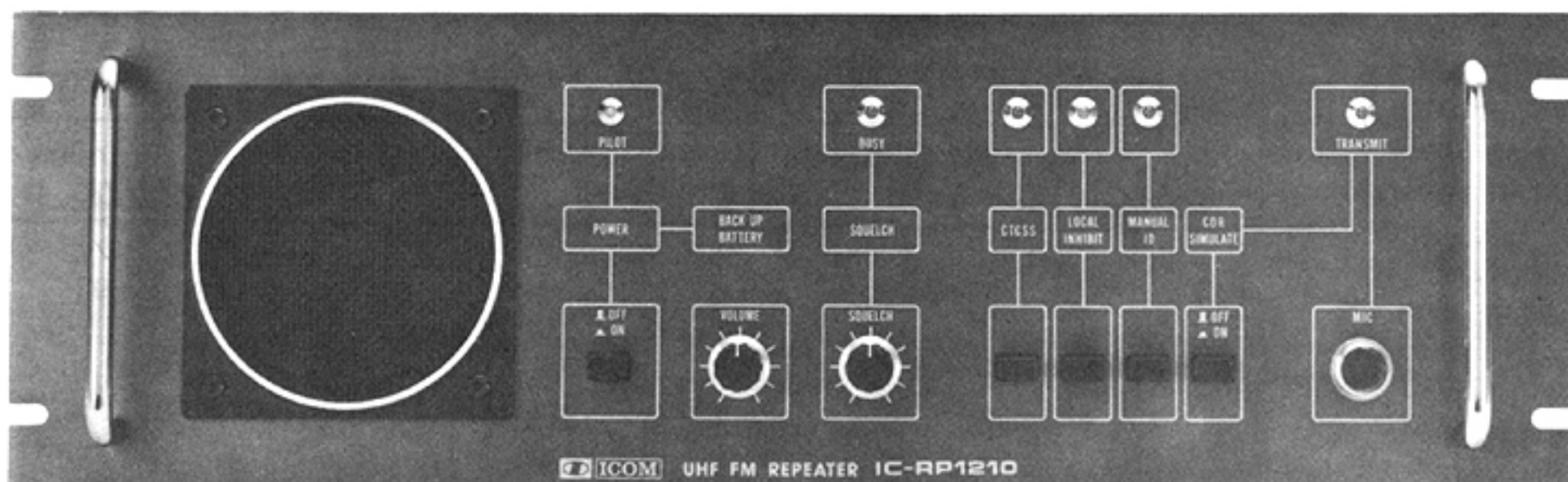
Received frequency	1271~1273 MHz (fr)
Transmitting frequency	1291~1293 MHz (fr)
Insertion loss	Less than 1.0 dB at fr Less than 1.0 dB at fr
Attenuation	80 dB or more at fr for receiver 80 dB or more at fr for transmitter
Impedance	50 ohms
VSWR	Less than 1.2 at fr and fr
Max. transmission power	20W
Connecting terminals	N-R
Ambient temperatures	-10°C to 50°C
Weight	Approx. 0.6 kg



## NAMES AND FUNCTIONS OF PARTS

### FRONT PANEL

- (1) **POWER switch**  
Turns ON/OFF the set. When the switch is depressed, the POWER LED lights up yellow for AC operation or red for DC operation, and the set is ready to operate.
- (2) **CTCSS (Continuous Tone Controlled Squelch System) switch**  
For selection of operation mode. Press it once for ON, and press it again for OFF. With the switch ON the CTCSS LED lights up green, and the continuous tone controlled squelch system is ready to operate for retransmitting signals which are modulated with the specified sub-audible tone.  
When the CTCSS switch is "OFF" the CTCSS LED remains off and the set functions as an open repeater that retransmits signals whenever received regardless of the specified sub-audible tone. This is mainly for testing purposes; the CTCSS switch should ordinarily be kept ON. This function can be remote-controlled.
- (3) **LOCAL/INHIBIT switch**  
Switches ON and OFF alternately every time the switch is pressed. With this switch ON the LOCAL/INHIBIT LED lights up yellow, the repeater operation is shut down, and the set functions as a transceiver. This switch also can be remote-controlled.
- (4) **COR (Carrier Operated Relay) SIMULATE switch**  
When this switch is pressed, the set is put in the transmit mode and the TRANSMIT LED will light up. This function is for checking the repeater's functions such as the hang-up time, time-out time, etc.
- (5) **MANUAL ID (Identifier) switch**  
Allows to send an identifier signal manually. An ID signal is sent every time this switch is pressed, and the ID LED remains green as long as this signal is being sent.
- (6) **VOLUME control knob**  
For volume control of the monitoring speaker. Turning it clockwise increases the volume without affecting transmission modulation.
- (7) **SQUELCH control knob**  
For setting the squelch threshold level of the receiver section. Turning it clockwise increases the squelch threshold.
- (8) **BUSY LED**  
When a signal is fed into the receiver and its strength exceeds the squelch threshold level, the squelch opens and the BUSY LED lights up green. Thus the presence or absence of a signal can be observed.
- (9) **TRANSMIT LED**  
Lights up red as long as the repeater is in operation:
  - while retransmitting received signals;
  - while the microphone PTT switch is pressed;
  - while the COR SIMULATE pushbutton is pressed;
  - while ID signal is sent with the MANUAL ID switch; and
  - during transmission in LOCAL/INHIBIT mode.
- (10) **IC-HM4 MIC connector**  
When the IC-HM4 microphone (supplied) is connected, the repeater is in the LOCAL/INHIBIT mode and the PTT switch is pressed, the IC-RP1210 functions as an ordinary transceiver. Speech can be inserted any time the repeater is ON by pressing the PTT switch; note at this time that the signal from the microphone is being superimposed on the incoming signals.





## REAR PANEL

There is a large opening at the lower rear of the set to allow an antenna to be connected without detaching the panel. There is another opening at the upper rear to provide adequate ventilation during long use of the set, and for easy connection of the AC power cable and other necessary cables.

### (1) Transmitter output connector (TX ANT)

RF output is put out from this terminal. Connect the supplied cable between this connector and the transmitter connector of the duplexer.

### (2) Receiver input connector (RX ANT)

An incoming signal from the antenna is applied to this connector (RX ANT) through the duplexer. Connect the supplied cable between this connector and the receiver connector of the duplexer.

### (3) Antenna connector (Antenna terminal of the duplexer)

This is used to connect an antenna to the repeater. Its impedance is 50 ohms and connects with an N (UG-21/U) connector.

### (4) AC power cable connector (AC)

Connects the supplied AC power cable.

### (5) CONTROL INPUT jack

- The input jack for remote control of the repeater. Input a DTMF (Dual Tone Multi Frequency) signal to this jack, and the CTCSS and LOCAL/INHIBIT operations can be remote-controlled.
- When this terminal is not used, the repeater can be controlled by an incoming signal modulated with a DTMF signal. The optional IC-HM14 (with DTMF encoder), or transceiver with built-in DTMF encoder can be used to control the repeater.

### (6) FUSE (AC) holder

Holds a 2A AC power source fuse.

### (7) FUSE (DC) holder

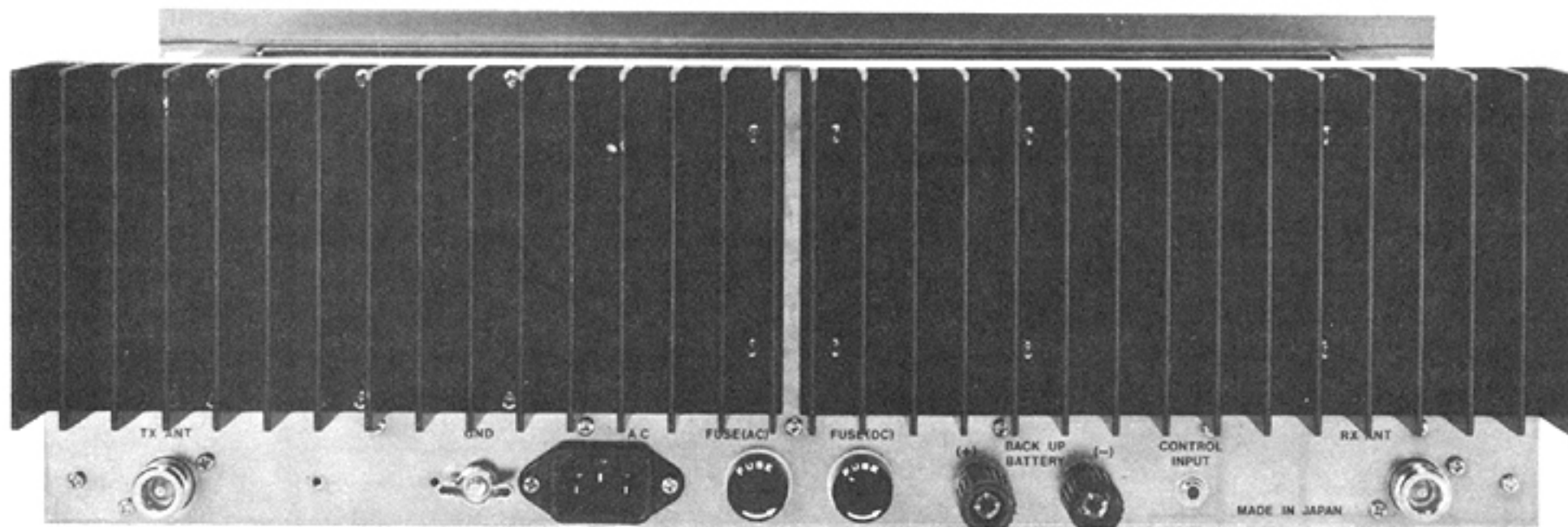
Holds a 10A DC power source fuse (1/4" standard fuse). The fuse will blow if the batteries are connected to the reverse polarity.

### (8) GND (ground) terminal

Connect a grounding cable to this terminal. This MUST be done to prevent electrical shock and protect the set.

### (9) BACK-UP BATTERY terminals (emergency power supply)

Terminals for DC input, e.g. battery. Connect the battery, positive to the red terminal; and negative to the black one.



## PRECAUTIONS FOR USE

### (1) Antenna

The antenna impedance for the IC-RP1210 is designed at 50 ohms. Employ an antenna and feeder of impedance of 50 ohms. There are many types of coaxial cables available on the market that fulfill the above requirement; choose the one with as low loss as possible, and run it so that the cable length is as short as possible. In selecting the antenna, try to match it for the transmitting frequency; and choose the one with wider band width.

### (2) Installation location

Choose the installation location for the repeater where temperatures fluctuate within the required range,  $-10^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Avoid placing the set in extremely cold and hot places, rain, wind, or direct sunshine for a long time. To facilitate good ventilation and emergency maintenance, allow sufficient access between the set and the surrounding walls.

### (3) Installation

(Read the following only if you bought a duplexer separately.)

- Install the main unit on top, and the duplexer at bottom. Secure the duplexer to the bottom plate of the frame with four tapping screws. Then attach the auxiliary panel in front.
- Remove the rear panel by unscrewing the four screws, and connect cables between the repeater and the duplexer in the manner shown in the illustration below.

- (4) When connecting the AC power cable and a back-up battery (emergency power supply) to the repeater, check to see that the POWER switch is kept OFF.

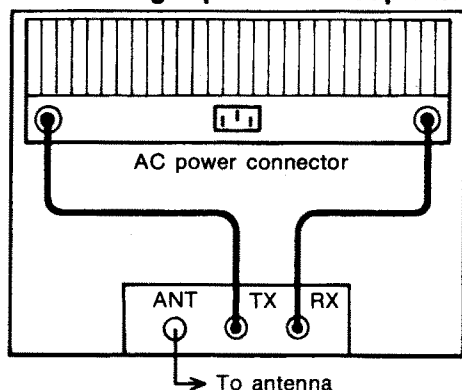
#### • Back-up battery

By connecting a battery of 12V DC to the BACK-UP BATTERY terminals, the repeater can continue operating without interruption should AC power fail. Because the battery is constantly recharged by a small current during normal operation, it will not discharge, even if not used for a long time.

#### Precautions for connecting battery

- Keep the battery away from the set. Gas from the battery can corrode the set parts. Strong gas will be generated especially if a lead storage battery is employed: keep the battery cable long and install the battery more than 5 meters away from the repeater. Provide good ventilation.
- Be sure to recharge the battery completely before connecting it to the repeater. Note polarity: positive wire to the red terminal, negative to the black one.
- After connection, a current of 100 mA is fed from the repeater to recharge the battery as long as the repeater POWER switch is ON. This is just enough to compensate for the battery's natural discharge. If the repeater should cease to operate during DC operation, recharge the battery with a charger. For periods of long operation it should be kept in mind that current consumption is about 3.2A when the set is transmitting.

Connecting repeater and duplexer





# OPERATION

## ■ Before turning POWER switch ON

1. Check to see that the COR SIMULATE switch is OFF. Otherwise, transmit mode is activated when the POWER switch is turned on.
2. Turn the VOLUME control knob to the extreme counterclockwise position.
3. Turn the SQUELCH control knob to the extreme counterclockwise position.
4. Connect the supplied microphone (IC-HM4) to the MIC connector.

## ■ Operation

1. Turn the POWER switch ON. This is indicated by the following:

POWER LED	Lights up yellow*
BUSY LED	Lights up green
CTCSS LED	Lights up green

\*Red LED indicates that the set is being operated by the back-up battery. This indicates a problem in the AC power supply. Check to see that the power cable is connected properly.

2. Turn the CTCSS switch ON. Check to see that the CTCSS LED is lit green. With the switch OFF, the repeater is in the open mode and retransmits all received signals.
3. Turn the VOLUME control knob clockwise until noise from the built-in speaker is at the proper level.
4. Turn the SQUELCH control knob clockwise until BUSY LED and the noise from the speaker go off (this knob functions in the same manner as the squelch function for the normal FM transceiver). Thus the level of the input signal to be retransmitted can be set with the SQUELCH control knob. At any specified setting of this control, the repeater will retransmit only signals stronger than this level.

## ■ Functions of Repeater

### 1. Classification of operating modes and functions

- (1) Functions available in retransmit mode

#### • Automatic functions

- ① ID function
- ② Time-out timer function
- ③ Hang-up timer function

#### • Manual functions

- ④ Interrupt transmitting function
- ⑤ External control function
- ⑥ Manual ID function

- (2) Function available in LOCAL/INHIBIT mode Duplex transceiver function.

### 2. Description of Functions

#### (1) ID function

ID function provides automatic emission of the call sign of the repeater. The type of the signal is CW(F2), and it is sent out in the following manner:

- (a) With the repeater in standby condition, an ID is sent when the set receives an incoming signal to turn into the retransmit state.
- (b) The repeater sends out an ID about every three minutes.

#### (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 prescribed time limit (about three minutes), the repeater shuts down automatically for five seconds. If the access is still "on" after the five seconds, the repeater sends an ID.

#### (3) Hang-up timer function

The repeater is designed to retain the "retransmit" condition for five seconds, after incoming signal is stopped. If there is an access during this period of five seconds, retransmit operation is started immediately. Thus, the repeater is prevented from turning off by a short pause of the stations using the repeater.

Setting of this hang-up timer is possible with the switches S1 and S2 inside the control unit; available settings are 0, 1, 3 and 5 seconds.

#### Combinations of switches and time settings

Set time	S1	S2
0 sec.	ON	ON
1 sec.	ON	OFF
3 sec.	OFF	ON
5 sec.	OFF	OFF

**(4) Interrupt transmitting function**

Press the PTT switch on the microphone, and signals from the microphone can be transmitted even if an incoming signal has accessed the repeater (refer to "FRONT PANEL (10) IC-HM4 MIC connector" in NAMES AND FUNCTIONS OF PARTS on page 5).

**(5) External control function**

This is the function that permits external control of the repeater by means of a DTMF signal (refer to "REAR PANEL (5) CONTROL INPUT jack" in NAMES AND FUNCTIONS OF PARTS on page 6). Operations that can be controlled by the above are:

- (a) Inhibit repeater transmission and switch to LOCAL/INHIBIT mode, and vice versa.

- (b) Tone access (CTCSS) circuit ON/OFF operation.

Control function	Signal (Through DTMF keypad)
CTCSS ON	By 4-character keyed signals
CTCSS OFF	(refer to the LOCAL/INHIBIT ON "DTMF Tone Decode Unit").
LOCAL/INHIBIT ON	
LOCAL/INHIBIT ON	

**(6) MANUAL ID function**

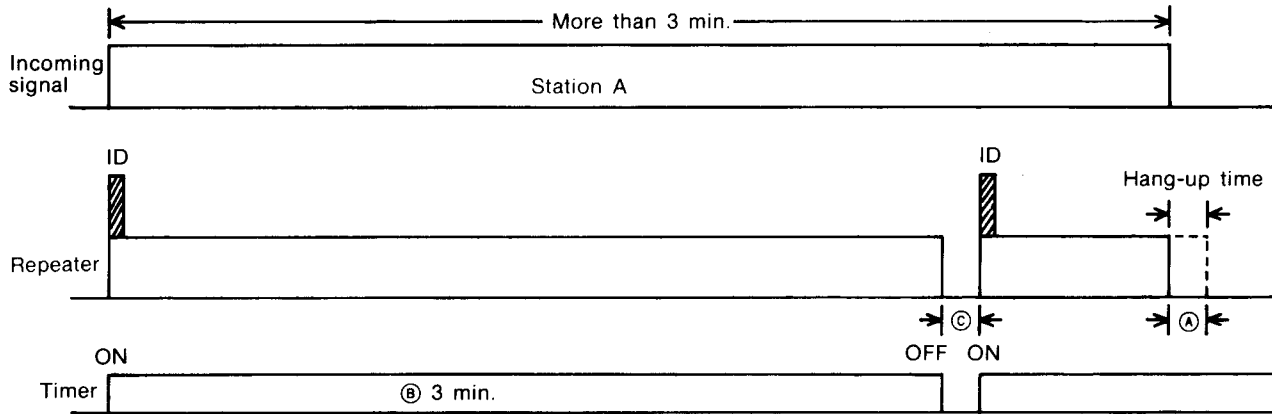
Allows sendout of call sign (ID) manually (refer to "FRONT PANEL (5) MANUAL ID switch" in NAMES AND FUNCTIONS OF PARTS on page 5.)

**Timing Charts of Retransmitting and ID Emission**

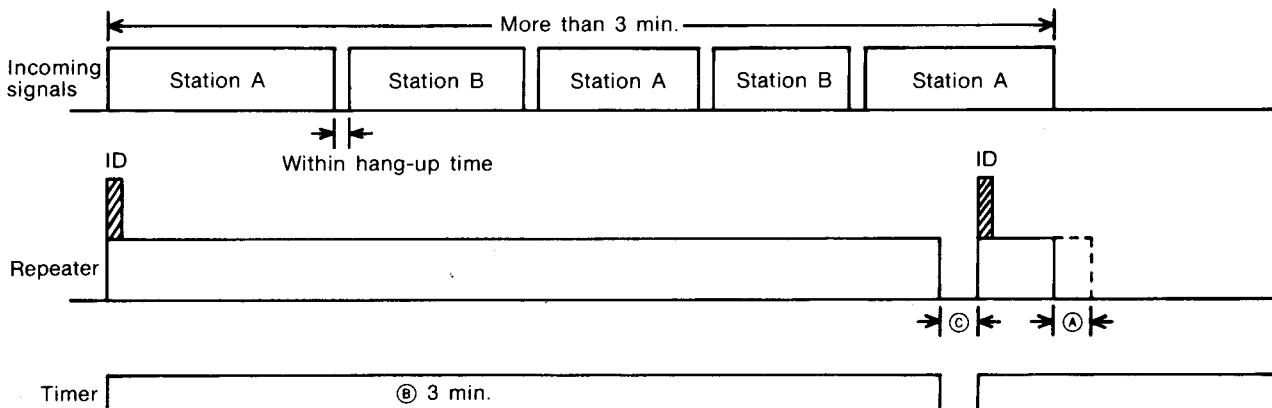
**\*Timers**

- Ⓐ Hang-up timer                                      Settable to 0, 1, 3 and 5 sec. with switches S1 and S2.
- Ⓑ Time-out timer                                    3 min.
- Ⓒ Repeater stop timer                            5 sec. (after expiration of time-out timer)
- Ⓓ Basic communication timer                    2 min. (minimum communication time set to 2 min.)

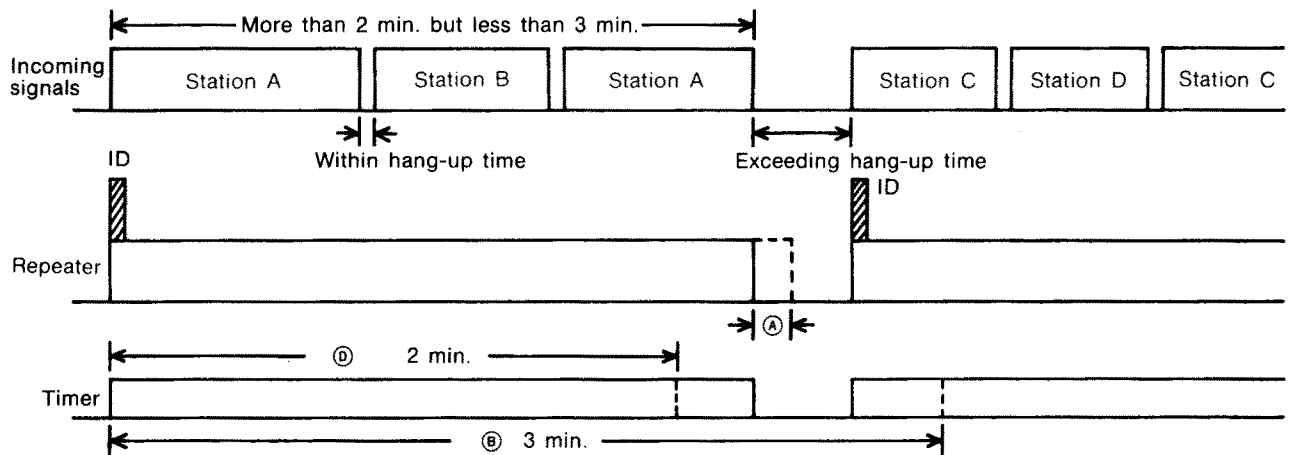
**① If one station occupies the repeater for more than 3 min.:**



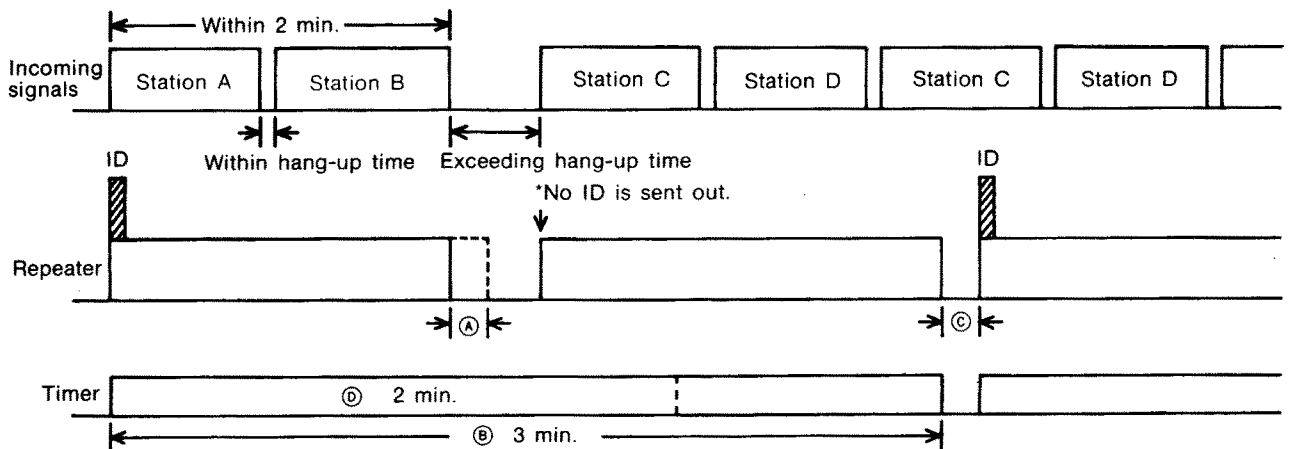
**② If two stations communicate with each other for more than 3 min. without an interruption of 5 sec. or more:**



- ③ If communication between two stations is completed between 2 and 3 min. and after that a third station uses the repeater:

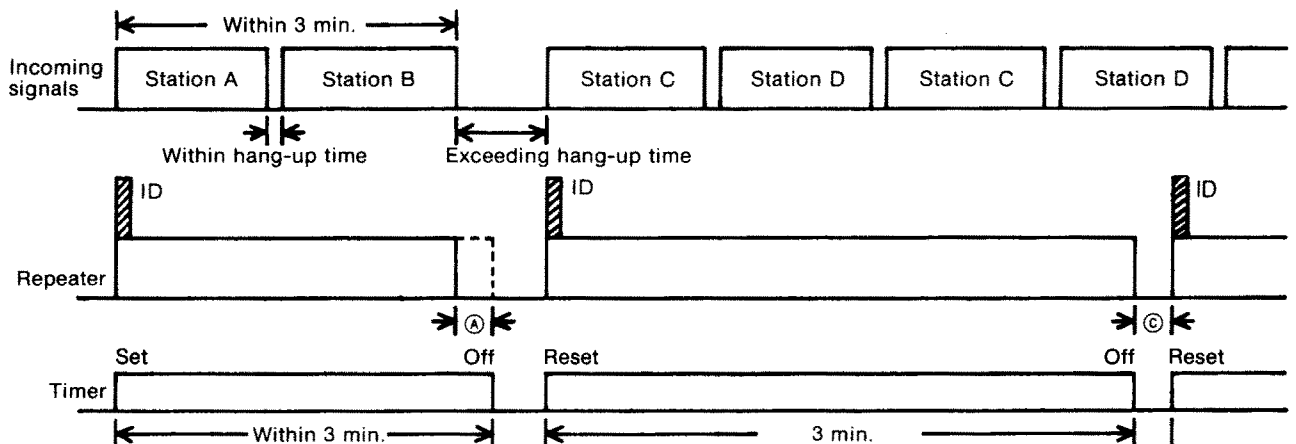


- ④ If communication between two stations is completed within 2 min., and after that other stations use the repeater:



\* In cases ① through ④ above, the timers and ID sending interval are shown as standard-set. By replacing the P-ROM, it is possible to change their functions as shown below.

- ⑤ If communication between two stations is completed within 3 min., 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 min., the case is the same ① or ②.

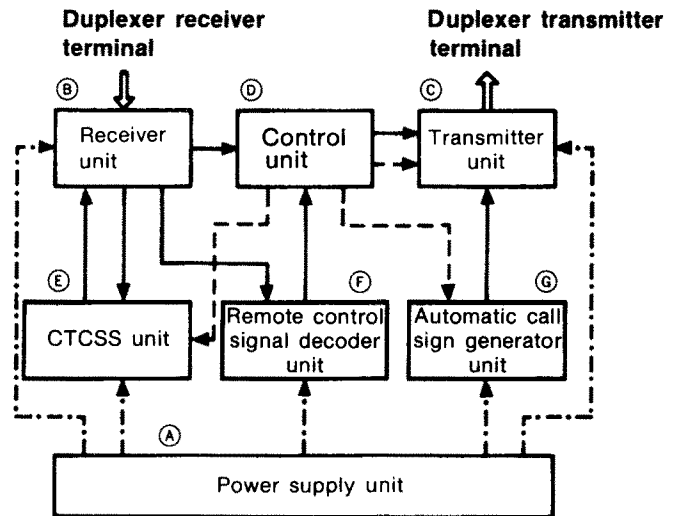


\* ID sending speed is 100 characters per min. with this system.

## CIRCUIT DESCRIPTION

### Repeater Circuits

- Ⓐ Power supply unit
- Ⓑ Receiver unit
- Ⓒ Transmitter unit
- Ⓓ Control unit
- Ⓔ CTCSS unit
- Ⓕ Remote control signal decoder unit
- Ⓖ Automatic call sign generator unit



### RECEIVER UNIT

The receiver unit employs a PLL-controlled, triple-conversion superheterodyne with first IF of 131.4MHz, second IF of 10.695MHz and third IF of 455KHz. The unit housing is shielded to prevent interference. The connection to the other sections of the set are made by a JC-1J for RF and PLL input, and by feedthrough capacitors for power supply, squelch control and discriminator output.

#### • RF circuit

An incoming signal of the 1270MHz band from J3 is fed to J1 of the RF unit, amplified by Q1 and Q2, and then fed to D1. At the same time, a signal of 1139 to 1141MHz from the PLL unit fed through J4, and J2 of the RF unit, is amplified at Q3, and fed to D1. The signal from the PLL and the incoming signal are mixed at D1. As a result a signal of 131.4MHz is obtained to be fed to J1 of the main unit.

#### • IF circuit

The signal fed to J1 is amplified by IF amplifier Q1, and then filtered by the band-pass filter comprising L3, C5, C7, L4, C6, C8, L5 and C9 to reduce image response and other interference. Then, the signal is applied to L6 primary side of the double-balanced mixer (DBM). On the other hand, to the L6 secondary side, a 120.705MHz signal is applied as the second local oscillator signal. This signal is generated by Q3 and X1 of the second local oscillator circuit, then tripled by Q3 itself and filtered by a band-pass filter consisting of L12, C20, C19, L11, C18, C17, L10 and C16, then amplified by Q2.

The second IF signal of 10.695MHz obtained by the DBM consisting of L6, IC1 and L7 is removed of out-of-the-band component while passing through the crystal filter F11. This signal is amplified by Q4, and then fed to pin 16 of the third mixer IC2.

The IC2 is a multi-functional IC incorporating mixer, crystal oscillator (with crystal installed externally), IF limiter, amplifier, detector (quadrature type) and OP amplifier circuits.

The signal fed to pin 16 of IC2 is mixed with the frequency generated by the crystal X2 (10.24MHz) connected between pin 1 and pin 2. As a result, the third IF of 455KHz is obtained to be fed out of pin 3. The third IF from pin 3 passes through FI2, which has excellent selectivity, reaches pin 5 where it is clipped of its AM component by the IF limiter and then is fed to the detector circuit inside the IC. The signal is detected therein, and then fed out from pin 9. This signal passes through the de-emphasis circuit consisting of R43 and C41 and is fed to the AF and squelch circuit.

#### • Squelch circuit

IC3 functions as electronic controlled AF attenuators responsible for control of squelch threshold level and switching the AF signals for squelch function.

For squelch control, the signal fed to pin 1 of IC3 is passed through the AF attenuator and put out from pin 3. The output from pin 3 is controlled logarithmically by the DC voltage at pin 13.

The output from pin 3 is applied to pin 10 of IC2, sent to OP amplifier to be amplified, and then put out from pin 11. Further, the signal is rectified at D2, D3 and C46, and then fed to DC amplifier Q5 in order to control the voltage at pin 6 of IC3. The Q5 collector applies a signal to the Q6 base to turn ON or OFF the BUSY LED.

#### • AF circuit

The detected AF signal passes through the de-emphasis circuit, is fed to pin 8 of IC3, and then output from pin 10. This AF signal is turned ON or OFF by the squelch switching voltage at pin 6, and is output only when it is ON.

The AF signal from pin 10 of IC3 contains a sub-audible tone signal to access the repeater. After removal of this subaudible tone signal with the band-pass filter of IC4, the AF signal is fed to pin 1 of IC4.

The P1 connector connections are as follows:

Pin 1 GND	}	Shielded wire (fed to the CTCSS unit)
Pin 2 Discriminator Output		

Pin 3 GND	} Shielded wire
Pin 4 AF Output	
Pin 5 13.8V DC (input)	(AF AMP, control unit)
Pin 6 SQUELCH Control (input)	
Pin 7 BUSY LED (output)	
Pin 8 SQUELCH switching signal	
	(fed to control unit)
Pin 9 NC	

Pin 1 MIC PTT output	
Pin 2 Output to control PTT	
Pin 3 13.8VDC input	
Pin 4 T9V output	
Pin 5 GND	} Shielded wire (fed
Pin 6 MIC AF	
Pin 7 GND	} to microphone)
Pin 8 MOD	
	} Shielded wired (fed
	} to control unit)

## TRANSMITTER UNIT

The transmitter unit consists of the TX MAIN unit and the RF amplifier unit, and is shielded in a housing. The transmitter unit obtains a signal of 1290MHz by mixing with a 1140MHz band signal from the PLL unit and a 151.4MHz signal from the TX MAIN unit, at the RF amplifier unit.

### • Oscillator and multiplier circuits

By mixing signals from the LO and modulator circuits, a transmitting signal is obtained, which is fed into the RF amplifier circuit. The signal from the LO circuit is generated by X1 and Q3, and a tripled signal is filtered at C10 and L2. The signal is then amplified at Q4, and filtered at L5 and C18 to obtain a signal of 140.65MHz, which is fed to the DBM consisting of IC1, L7 and L8.

### • Modulator circuits

The signal from the microphone passes through pin 6 of P1 and is fed to pin 6 of IC2(B). This signal is amplified and output from pin 7, then fed to pin 3 of IC2(A). ID signal and MOD signal, on the other hand, pass through C35 and R23, and are also fed to pin 3 of IC2(A).

When the PTT switch on the microphone is not pressed, pin 6 of IC2(B) is pulled up by R1, and IC2(B) remains in "OFF" condition.

The above signal fed to pin 3 is amplified and is output from pin 1. The signal is further passed through a low-pass filter consisting of R35 through R37, C41 through C43 and Q6, and fed to the modulator circuit comprising D5 and L14, thereby modulating the signal at the oscillator circuit of X2 and Q7. The modulated 10.75MHz signal is clipped of remaining AM component while passing through the limiter amplifier of IC3, and is fed to the DBM.

### • Mixer circuit

At the DBM, addition of the 140.65MHz signal from the LO circuit to the 10.75MHz from the modulator circuit generates a signal of 151.4MHz. To remove unnecessary signal component, this signal passes through the band-pass filter consisting of L9 through L12 and C22 through C28, and then is applied to the first gate of Q5. The signal is then amplified at Q5 and Q8, passes through the low-pass filter of F11 to reduce harmonics, and is finally input to the RF amplifier.

### • RF amplifier circuit

The 151.4MHz signal from the TX MAIN unit is fed to the RF circuit and the 1140MHz signal from the PLL unit are mixed at Q4, and the resultant signal passes through the band-pass filter consisting of L9, L10, C13 and C14 to reduce spurious components. Then it is amplified at Q1 through Q3, and then again fed through the band-pass filter before being output. The P1 connector connections are as follows:

### • PLL unit

Parallel/serial comparator that determines N for PLL is generated at IC10 to serve as clock pulses. At IC9, 4-bit BCD up counter output is generated, which is converted into a decimal numeral at IC8, and then N is output in the range of 21802 and 21998 by D5 through D16 and DIP switches. The highest two digits (21) are fixed and the third digit can be changed between 8 and 9, and the lowest two are variable with DIP switches. Changing the third digit to 8 causes changes to 1271MHz band (RX) and 1291MHz band (TX), and that to 9 to 1272MHz band (RX) and 1292MHz band (TX). BCDs in the lowest two digits are read in the decimal manner (see Table 1).

VCO is a modified Clapp oscillator of Q1 and its frequency is determined by D1, C2 through C4 and L2. The signal is buffered and amplified at Q2, and then fed to the prescaler, IC3. The output signal from IC3 is then fed to the PLL IC IC4 and compared with the signal divided by N (described above), and outputs a PD signal according to the result of comparison. This output passes through the loop filter comprising Q4 and Q5, and its voltage is fed to D1 of VCO in order to determine the PLL frequency.

The output from Q2 passes through C15, and then through the low-pass filter of F11 to be reduced of harmonics, and is finally input to the DBM.

LO (local oscillation) is generated at X1 and Q9, and is input to IC5 through C62. It is then divided to one-tenth (5.12MHz) and clamped at D2 and D3 to be employed as PLL reference frequency. X1 employs a highly stable crystal of 0.5ppm for this purpose.

The signal generated at Q9 is first tripled by itself and filtered by L16 and C60, then again tripled by Q8 to 460.8MHz, amplified by Q7 and Q6, and applied to the DBM.

The DBM puts out a signal which is the sum of the PLL and LO frequencies. This signal is amplified at Q12 and Q13, divided by C77 and C78, and each component is then input to Q1 of DOUBLER 1 and 2 respectively.

Each component signal is doubled at Q1, and is sent through C5, C6, L2 and L3 during which harmonics and sub-harmonics are reduced. Finally the two signals are fed to the transmitter and receiver unit respectively.

**(Reference) Table 1**

N	PLL OUT (MHz)	RX (MHz)	TX (MHz)
21802	1139.62	1271.02	1291.02
04	1139.64	1271.04	1291.04
06	1139.66	1271.06	1291.06
08	1139.68	1271.08	1291.08
10	1139.70	1271.10	1291.10
12	1139.72	1271.12	1291.12
92	1140.52	1271.92	1291.92
94	1140.54	1271.94	1291.94
96	1140.56	1271.96	1291.96
98	1140.58	1271.98	1291.98
21900	1140.60	1272.00	1292.00
02	1140.62	1272.02	1292.02
04	1140.64	1272.04	1292.04
06	1140.66	1272.06	1292.06
08	1140.68	1272.08	1292.08
10	1140.70	1272.10	1292.10
12	1140.72	1272.12	1292.12
88	1141.48	1272.88	1292.88
90	1141.50	1272.90	1292.90
92	1141.52	1272.92	1292.92
94	1141.54	1272.97	1292.94
96	1141.56	1272.96	1292.96
98	1141.58	1272.98	1292.93

## CONTROL UNIT

This unit mainly consists of COR (Carrier Operated Relay—for start control) circuitry, and as additional circuitry, it has an AF oscillator circuit for ID sendout and remote control signal decoder circuit. The unit can be divided into the following systems:

1. AF system (retransmitting AF signal line)
2. Transmission control system (start of TX unit)
3. Timer system (hang-up timer, time-out timer, ID and ID interval timer).

The AF system consists of filters, buffer amplifiers, mixer, etc., and sends a detected incoming signal to the transmitter unit. The circuitry is mainly operated by operational amplifiers and switching diodes.

In the transmission control system, signals from the simulate and tone squelch circuits are fed into the microcomputer, then the microcomputer puts out control signals to the transmitter unit. A microcomputer is employed for the timers, too. Standard settings are 3 minutes for the time-out timer, and 5 seconds for the hang-up timer. The settings for the hang-up timer can be changed with a combination of switches to 0, 1, 3 and 5 sec. as required.

### 1. AF system

An AF input signal from the receiver unit via pin 3 of J4, and the ID signal from the CPU (IC3) are mixed and amplified approximately 10 dB by IC6(A), and the mixed signal is sent out to the transmitter unit.

The ID signal from the CPU (IC3, pin 24) switches an AF signal generated by IC7. To reduce tone distortion, the AF signal is divided in half at IC4, and then passes through the low-pass filter comprising R6, R7, C2, C3 and IC6(B), then fed to the mixer IC6(A). In the LOCAL/INHIBIT mode, IC6(A) is cut off by D4, and detected incoming signals are not fed to the transmitter unit.

### 2. Transmission control system

There are two inputs for the transmission control system. One is a signal (pin 5 of J2 is HIGH-level when a subaudible tone is present) from the tone unit, and the other is the squelch signal (pin 2 of J4 is HIGH-level when a carrier is received). The signal from the tone unit is fed to pin 5 of J2 and passes through the Schmitt trigger circuit consisting of R15, R16 and IC5(A). Meanwhile, the squelch signal is fed to pin 4 of J4 and passes through another Schmitt trigger circuit of R13, R14 and IC5(B). Then, these two input signals pass through the NAND gate of IC7, to be consequently fed to the CPU (IC3 pin 10) as BUSY signal.

### 3. Timer system

The timers employed are: ① time-out timer, ② ID and ID interval timer and ③ hang-up timer. ① and ② are programmed in the IC1 ROM, while ③ is selectively set to 0, 1, 3 and 5 sec. by the combinations of the two switches S1 and S2 that are connected to the input terminals of pins 16 and 17 of the CPU.

### 4. Others

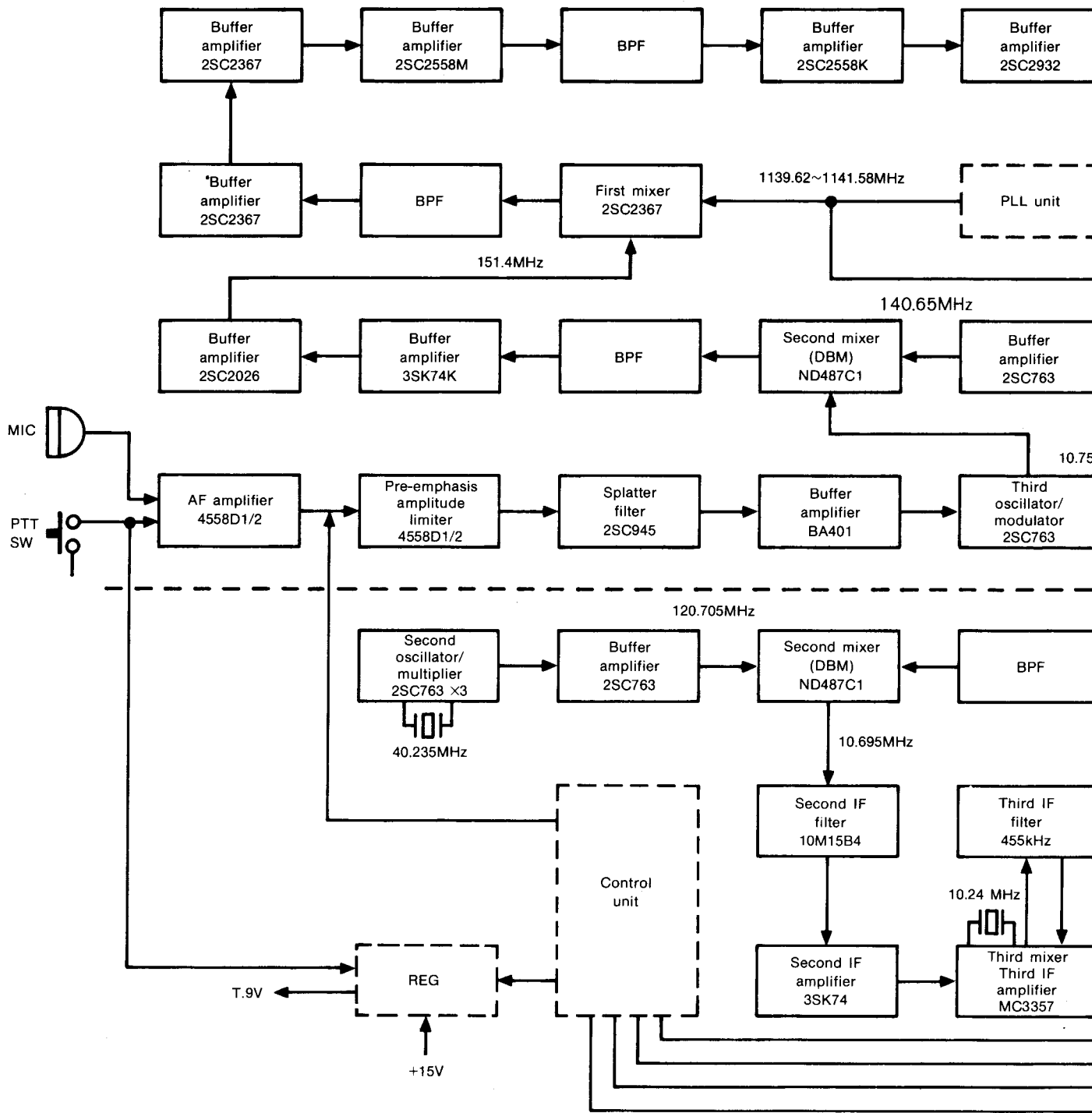
The ON/OFF signal of the LOCAL/INHIBIT switch is latched at IC8(A), passes through Q3 and is fed to the CPU (pin 11). It also turns ON Q4 to light up LOCAL/INHIBIT LED. Data from CTCSS switch is latched at IC8(B) to send a LOW-level signal at pin 13, and passes through pin 4 of J2 to turn the tone unit ON.

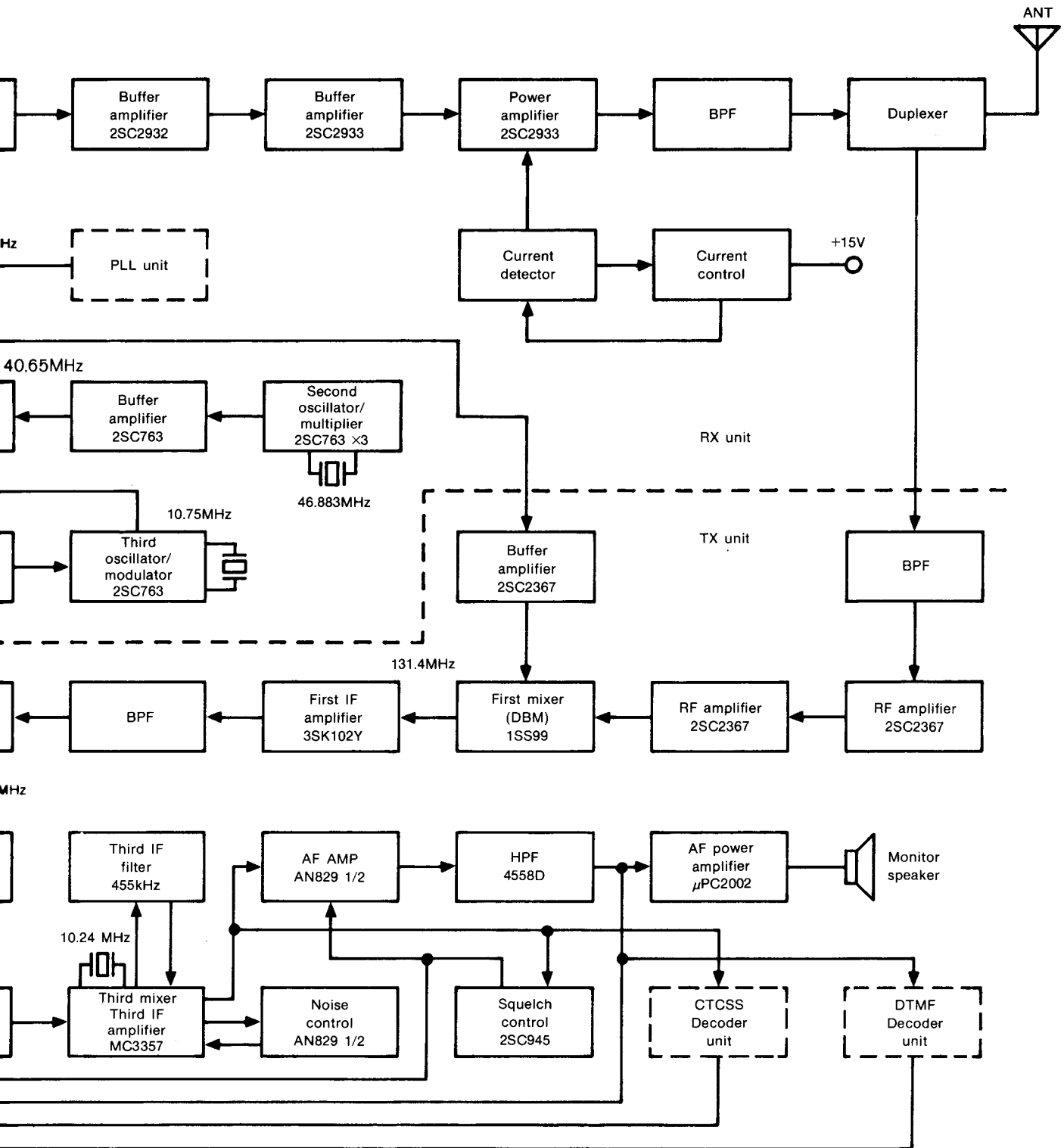
The two latch circuits in IC8 receive a signal from the DTMF Decoder Unit via J3, for set or reset operation.

Data of COR SIMULATE MANUAL ID switch is directly applied to the INT terminal of the CPU.

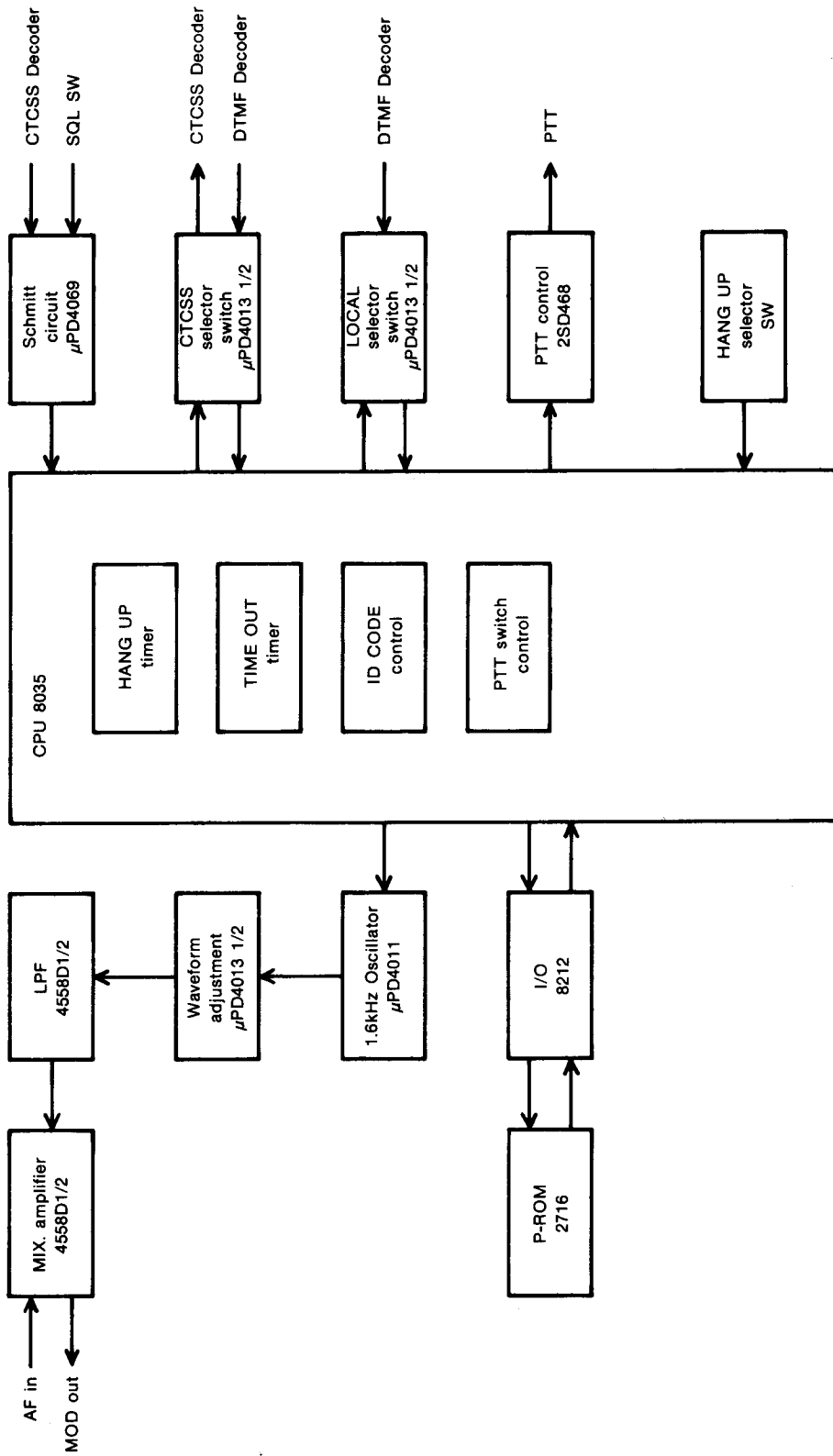


# IC-RP1210 BLOCK DIAGRAM

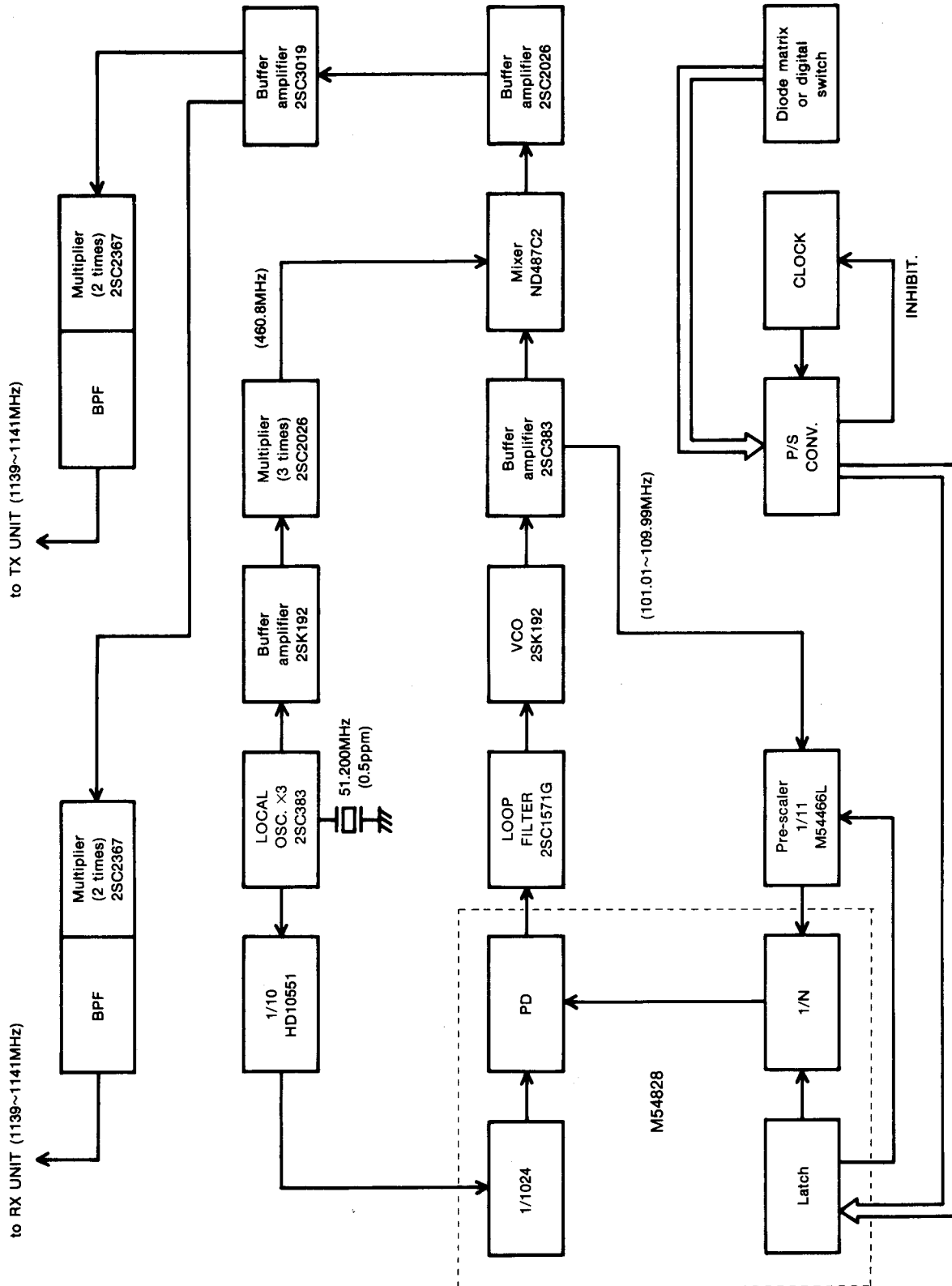




# CONTROL UNIT BLOCK DIAGRAM

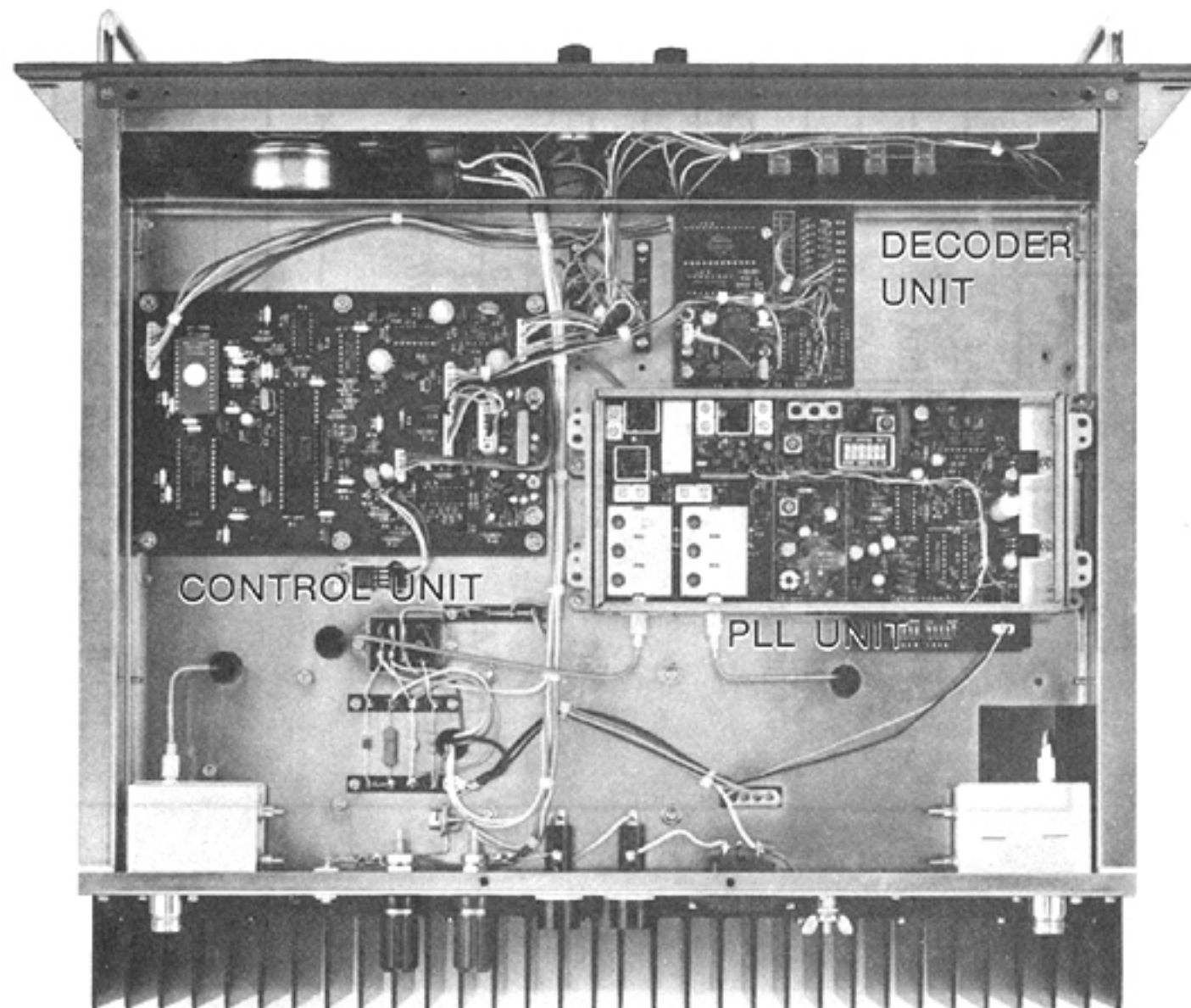
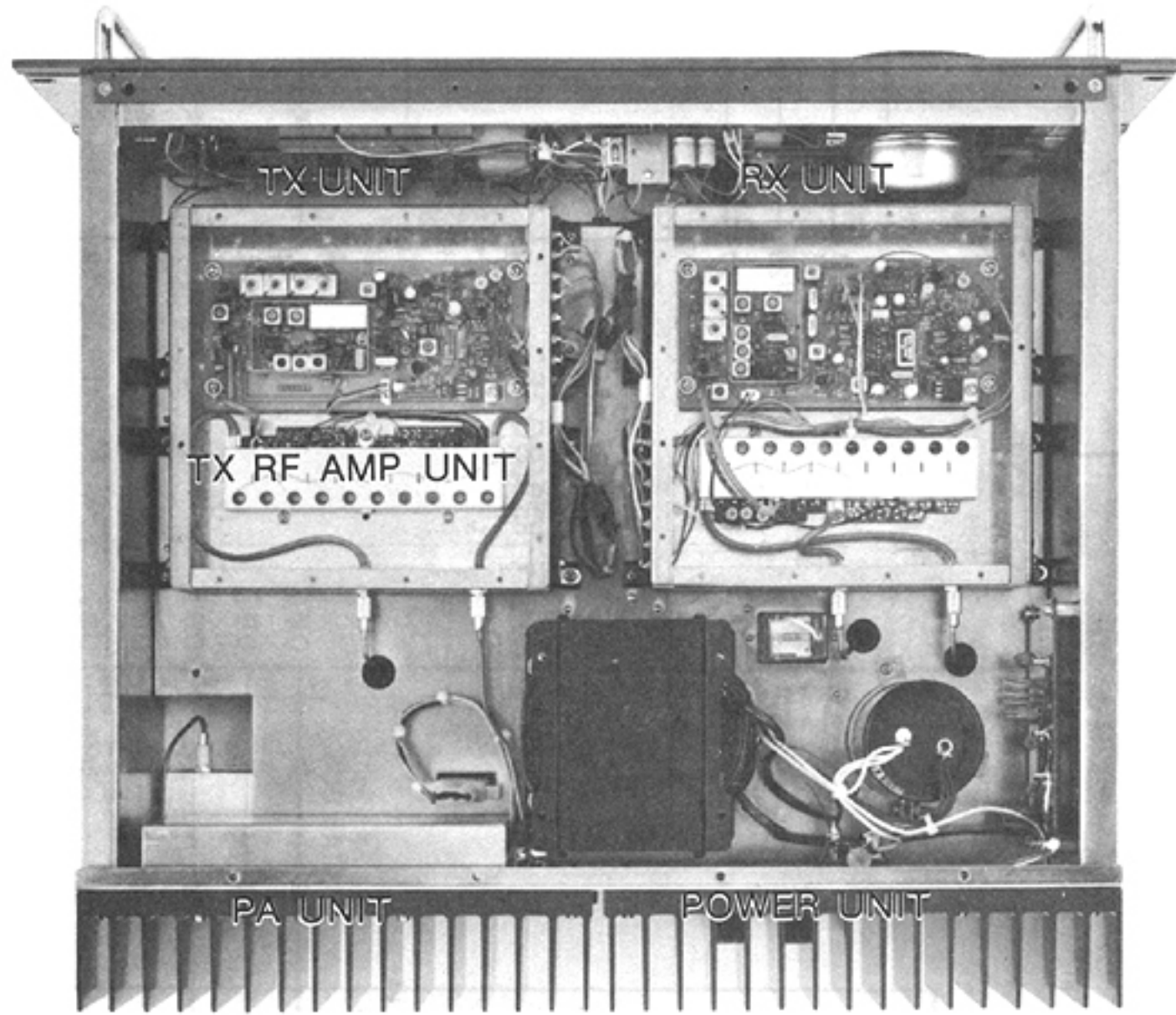


# PLL UNIT BLOCK DIAGRAM





# INSIDE VIEWS



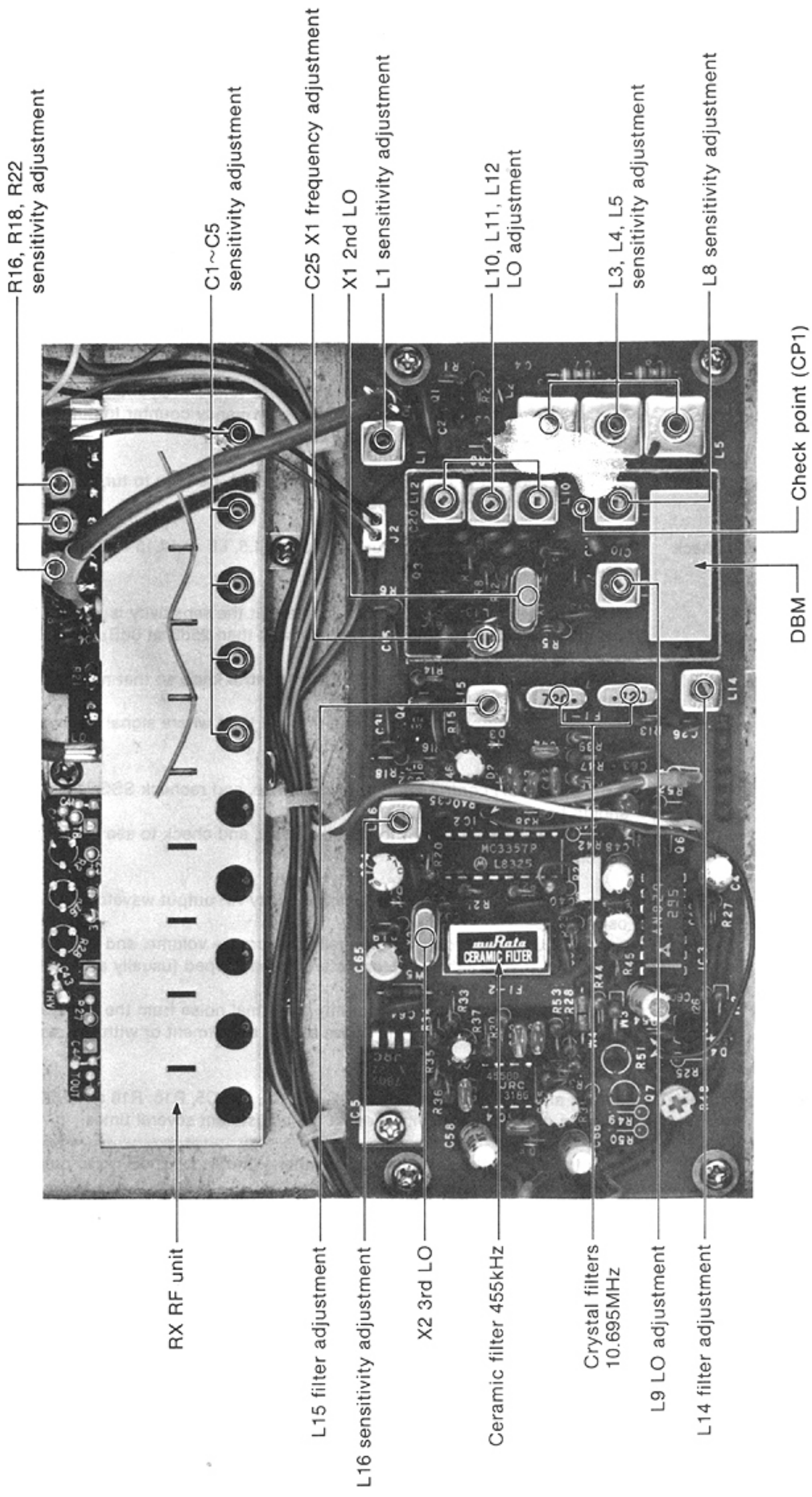


# ADJUSTING PROCEDURES

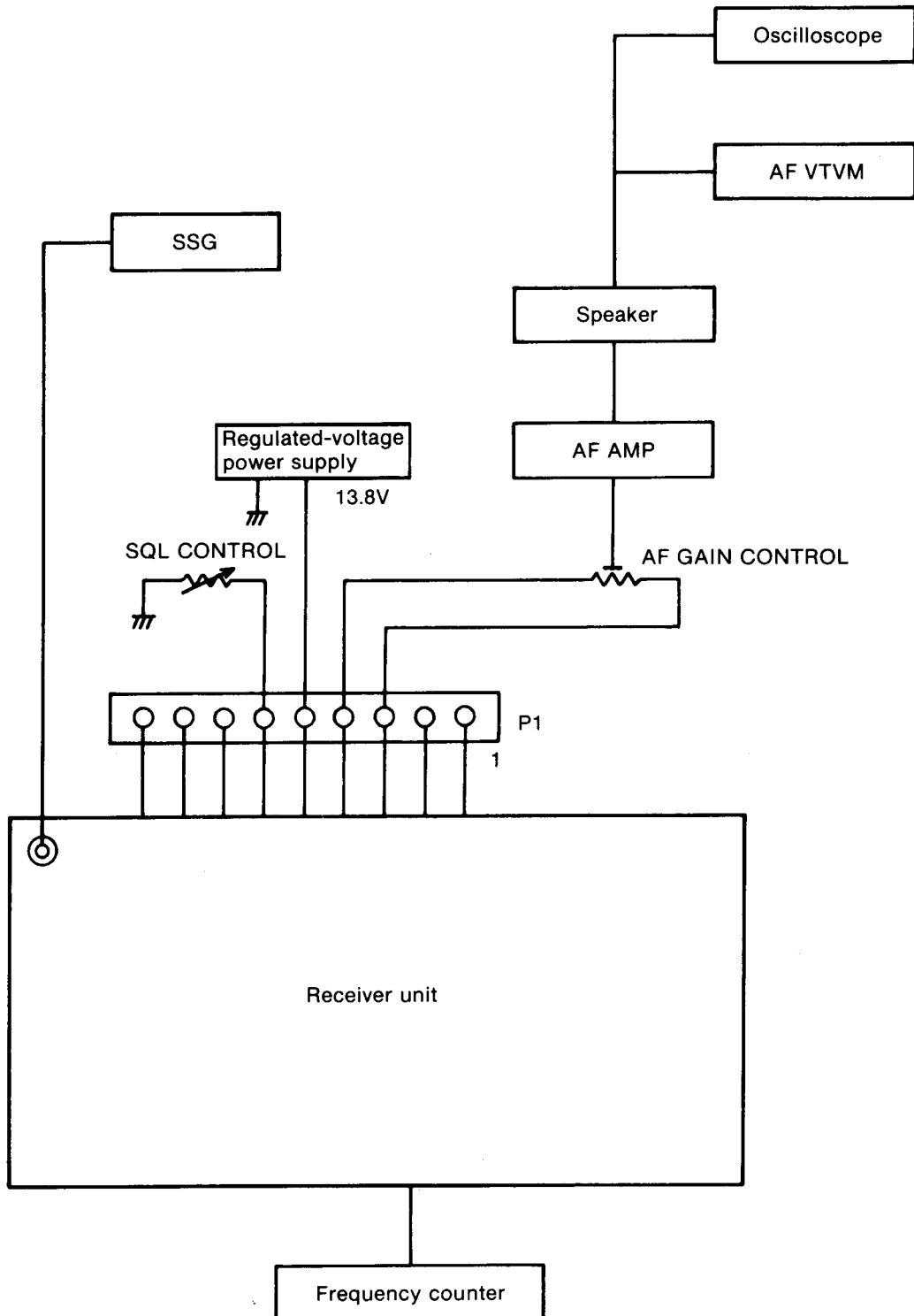
## RECEIVER UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	LO adjustment	Connect an RF voltmeter to CP1, and adjust L9, L10, L11 and L12 to get maximum reading.	L9, L10, L11, L12
2	X1 frequency adjust	Connect a frequency counter to CP1, and adjust C25 for 120.705MHz.	C25
3	Second local oscillator check	Set SSG output maximum and its frequency at 10.695MHz, and couple the output near the second local oscillator. Connect a frequency counter to pin 7 of IC2 and check to see that reading is 455kHz $\pm$ 200 Hz.	
4	Filter adjustment	Adjust L14 and L15 to get maximum noise output. Be sure to turn SQUELCH control knob fully counterclockwise beforehand.	L14, L15
5	Sensitivity check	Connect an SSG to J1, and adjust L1, L3, L4, L5, L8 and L16 to get maximum quieting sensitivity. Repeat this several times.	L1, L3, L4, L5
"	"	After the above is completed, check to see that the sensitivity is less than $-13\text{dB}\mu$ for 20dB noise quieting and the S/N ratio is more than 25dB at $0\text{dB}\mu$ input.	L8, L16
6	Squelch check	<ul style="list-style-type: none"> <li>• Shut off SSG output, and set SQUELCH control knob so that no noise is heard (use R48 for control positioning).</li> <li>• Increase SSG output gradually, and find the level where signal starts to be audible (the level should be less than <math>-13\text{dB}\mu</math>).</li> </ul>	
"	"	<ul style="list-style-type: none"> <li>• Turn SQUELCH control knob fully clockwise, and recheck SSG level (the level should be more than <math>8\text{dB}\mu</math>).</li> <li>• Then, increase SSG output to about <math>100\text{dB}\mu</math>, and check to see that the squelch does not close.</li> </ul>	
7	Output waveform check	<ul style="list-style-type: none"> <li>• Keep SSG output at 20 to <math>40\text{dB}\mu</math>, and display AF output waveform on an oscilloscope.</li> <li>• Turn VOLUME control knob gradually to increase volume, and find the output voltage level where the waveform starts to be clipped (usually about 4V).</li> </ul>	
"	"	<ul style="list-style-type: none"> <li>• In the above condition, check for any abnormal noise from the speaker.</li> <li>• If any abnormality or problem arises during adjustment or with the results, repeat the adjustment.</li> </ul>	
8	Sensitivity check	Connect an SSG to J3 and adjust C1, C2, C3, C4, C5, R16, R18 and R22 to get maximum quieting sensitivity. Repeat the adjustment several times.	
"	"	Check to see that the sensitivity is less than $-13\text{dB}\mu$ for 20dB noise quieting. If not, readjust.	C1, C2, C3, C4, C5, R16, R18, R22

# Receiver Unit



## Instrument connections



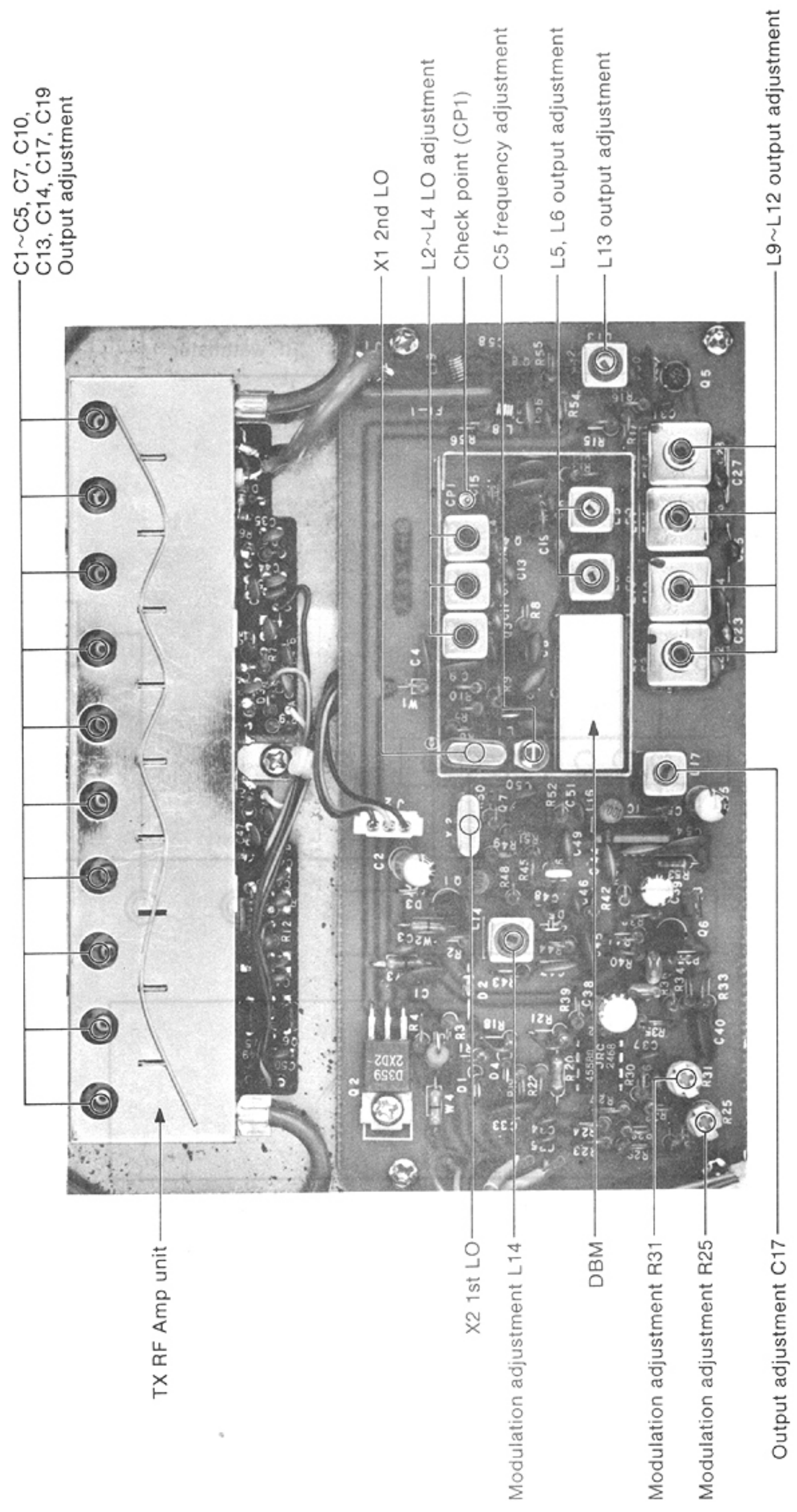
## TRANSMITTER UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	LO adjustment	Connect an RF voltmeter to CP1 and adjust L2, L3 and L4 to get maximum reading.	L2, L3, L4
2	X1 frequency adjustment	Connect a frequency counter to CP1, and adjust C5 to get the reading of 46.830MHz.	C5
3	Output adjustment	Connect an RF wattmeter to J1, and adjust L5, L6, L9, L10, L11, L12, L13 and L17 to get maximum reading (20mW or more).	L5, L6, L9, L10, L11, L12, L13, L17
4	Frequency adjustment	Turn R31 fully counterclockwise, locate the frequency counter near the RF wattmeter, and adjust C5 to 151.400MHz ( $\pm 200$ Hz or less).	C5, R31
5	Modulation stage adjustment	Set R25 and R31 at the center of the respective range. Apply a 1 kHz signal from an audio generator to the microphone circuit, connect an oscilloscope to pin 1 of IC2, and change AG output level. Adjust R24 so that the waveform on the scope is clipped at top and bottom symmetrically.	
"	"	Adjust L14 so that deviation is maximum. Then adjust R31 for 4.8kHz deviation at $-3.5$ dBm AG output.	L14, R31
"	"	Set AG output at $-55$ dBm, and check that deviation is about 3.5kHz. Adjust L14 so that distortion is minimal (10% or less).	L14
6	Others	If any abnormality or problem arises during adjustment or with the results, repeat the adjustment.	

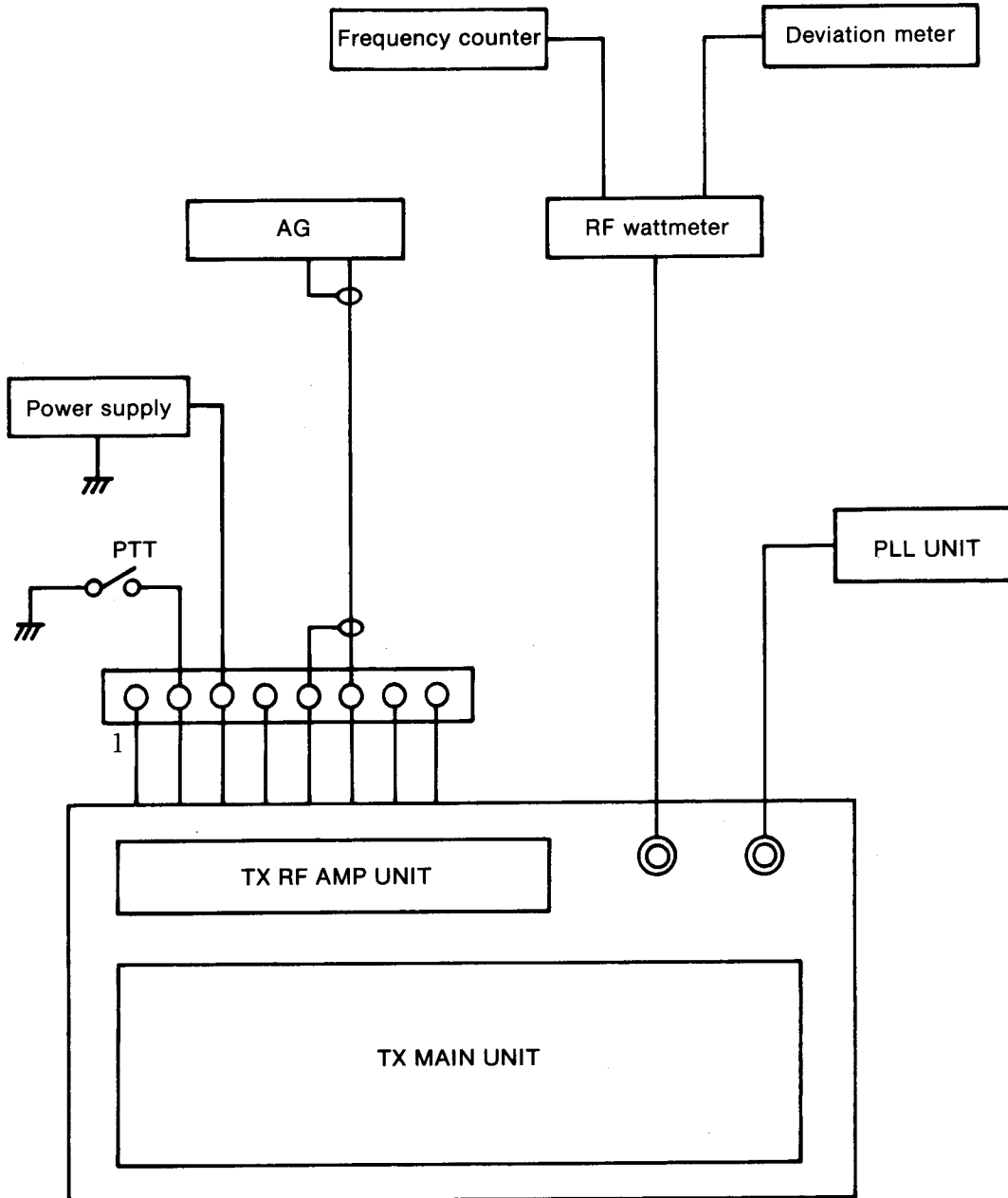
## TX RF AMP UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	Output adjustment	Connect an RF wattmeter to J3, and adjust C1, C2, C3, C5, C7, C10, C13, C14, C17 and C19 to get maximum reading.	C1, C2, C3, C5, C7, C10, C13, C14, C17, C19
"	"	Repeat the above adjustment several times so that the reading is 300mW or more. Switch upper and lower PLL frequencies, and check to see that there is no difference in output.	
2	Others	If any abnormality or problem arises during adjustment or with the results, repeat the adjustment.	

# Transmitter Unit



## Transmitter Unit connections

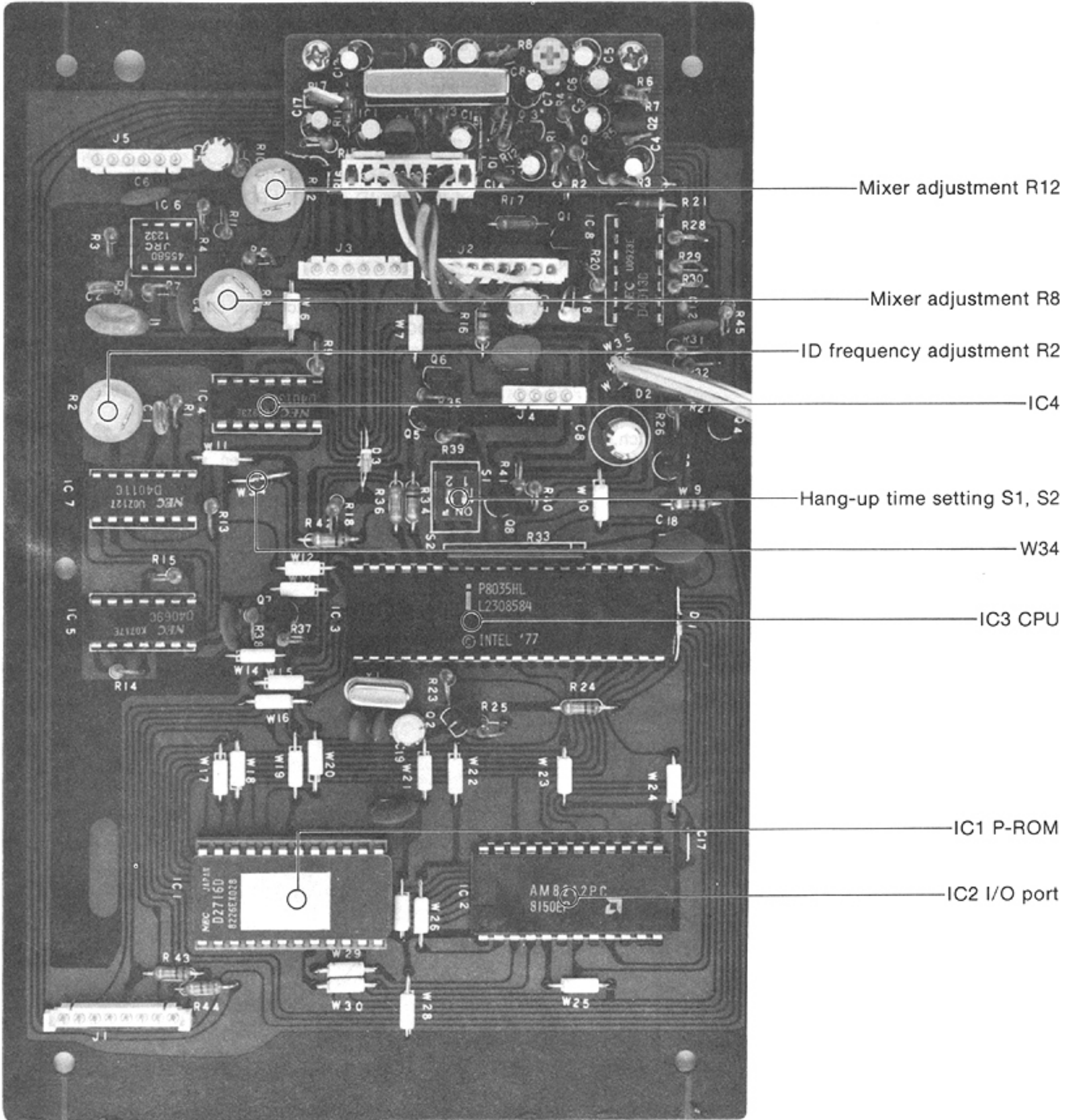




## CONTROL UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	ID frequency adjustment	<ul style="list-style-type: none"> <li>• Connect a frequency counter to pin 1 of IC4, and adjust R2 so that the ID frequency is 800 Hz.</li> <li>• Disconnect W34 after the above.</li> </ul>	R2
2	CTCSS check	<ul style="list-style-type: none"> <li>• Press CTCSS switch, and check to see that the CTCSS LED lights up.</li> <li>• Keep the CTCSS LED on after the above.</li> </ul>	
3	Mixer adjustment	<ul style="list-style-type: none"> <li>• Connect an AF oscillator to pin 3 of J4, an AF millivoltmeter to pin 4 of J5, generating 1 kHz, 250 mV signal, and adjust R12 so that output is 750 mV.</li> <li>• Turn off the output of the AF oscillator, reconnect W34, and adjust R8 so that the output is 200 mV.</li> <li>• Disconnect W34 after the above.</li> </ul>	R12  R8
4	MANUAL ID check	<ul style="list-style-type: none"> <li>• Connect an oscilloscope to pin 4 of J5, press MANUAL ID switch, and check to see that ID waveform is proper and that the ID and TX LED's are ON.</li> </ul>	
5	COR SIMULATE check	After ID LED goes OFF, press COR SIMULATE switch, and check to see that the ID and TX LED's are ON.	
6	LOCAL/INHIBIT check	After the ID LED goes OFF, press LOCAL/INHIBIT switch, and check to see that the ID and TX LED's go OFF and the LOCAL LED lights up. Press switch again, and check to see that the LOCAL LED goes OFF, and the ID and TX LED's light up.	
7	S1, S2 check	After the ID LED goes off with S1 and S2 set to OFF, turn OFF the COR SIMULATE switch, and check to see that the TX LED goes OFF in about 5 sec. Further, check to see that the TX LED turns OFF in about 3 sec. with S1 OFF and S2 ON, in about 1 sec. with S1 ON and S2 OFF, and at once with S1 and S2 ON.	

# Control Unit



Mixer adjustment R12

Mixer adjustment R8

ID frequency adjustment R2

IC4

Hang-up time setting S1, S2

W34

IC3 CPU

IC1 P-ROM

IC2 I/O port

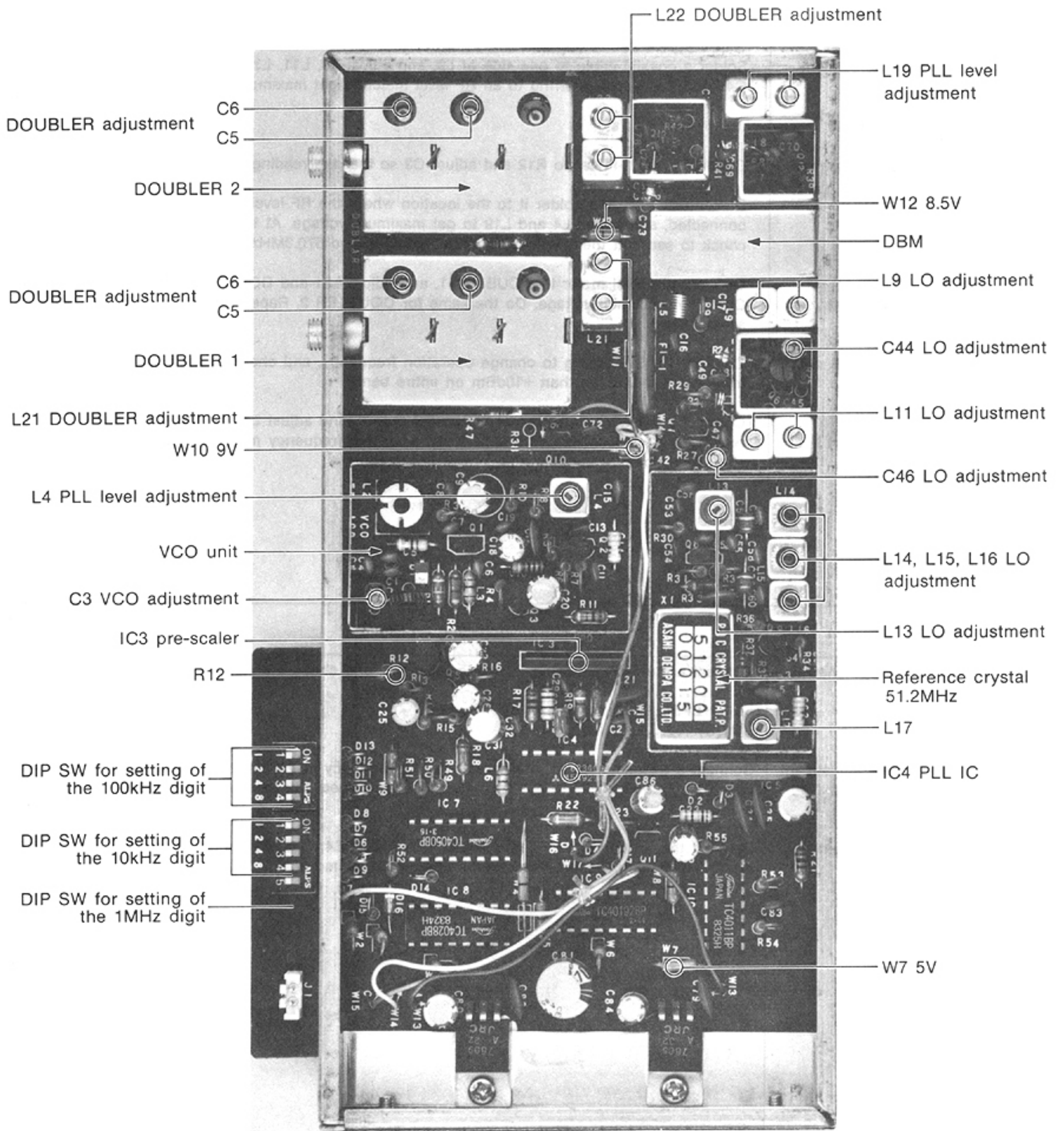
## PLL UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	Voltage check	<ul style="list-style-type: none"> <li>Connect a multi-meter to the following locations, and check the voltage:  W7.....5V  W10 .....9V  W12 .....8.5V</li> </ul>	
2	LO adjustment	<ul style="list-style-type: none"> <li>Solder a coaxial cable to one side of L9, and adjust L9, L11, L13, L14, L15, L16, C46 and C44 while referring to an RF level meter to get maximum voltage.</li> </ul>	L9, L11, L13, L14, L15, L16, C44, C46
3	VCO adjustment	<ul style="list-style-type: none"> <li>Connect a multi-meter to R12 and adjust C3 so that the reading is 4V.</li> </ul>	C3
4	PLL level adjustment	<ul style="list-style-type: none"> <li>Disconnect R45, and solder it to the location where the RF level meter was connected, and adjust L4 and L19 to get maximum voltage. At the same time, check to see that the frequency counter reads around 570.3MHz.</li> </ul>	L4, L19
5	DOUBLER adjustment	<ul style="list-style-type: none"> <li>Connect the level meter to DOUBLER 1, and adjust L21 and DOUBLER 1 C5 and C6 to get maximum voltage. Do the same for DOUBLER 2. Repeat this step several times.</li> </ul>	L21, L22, C5, C6
6	DOUBLER check	<ul style="list-style-type: none"> <li>Change DIP SW setting to change operation frequency, and check to see that RF level remains at more than +10dBm on entire band.</li> </ul>	
7	Frequency adjustment	<ul style="list-style-type: none"> <li>Connect a frequency counter to DOUBLER output, and adjust L17 so that the reading is 1149.600MHz (<math>\pm 200</math>Hz or less). Note that frequency measurement should be done 20 minutes after power is turned on.</li> </ul>	L17

## PA UNIT

No.	Item	Adjusting procedure	Location for adjustment
1	Voltage check	Connect a multi-meter to the following locations, and check the voltage: EP1 .....0.6V EP2~EP5 .....approx. 13V Q1(C) .....approx. 13V	
2	Drive adjustment	Connect a wattmeter to J1, and set operating frequency at 1292.0MHz. Adjust C17, C19, C21, C25 and C26 to get maximum reading. Repeat this several times. (3W or more)	C17, C19, C21, C25, C26
3	Final adjustment	Connect the wattmeter to P4, and adjust C28, C33, C34, C35, C40 and C41 to get maximum reading. Repeat this several times. (12W or more)	C28, C33, C34, C35, C40, C41

# PLL Unit



## RECEIVE OVERALL ADJUSTING PROCEDURE

No.	Item	Adjusting procedure	Location for adjustment
1	Sensitivity adjustment	<ul style="list-style-type: none"> <li>Connect an SSG and set its frequency and operating frequency at 1272MHz, and adjust RF trimmers, RX MAIN coils, DOUBLER 2 trimmers and filter 2 to get maximum quieting sensitivity (<math>-10\text{dB}\mu</math> or less).</li> </ul>	R48
2	Squelch adjustment	<ul style="list-style-type: none"> <li>Turn off SSG output, and set R48 so that the squelch closes with SQL control knob set at 10 o'clock position.</li> </ul>	
3	Squelch check	<ul style="list-style-type: none"> <li>Increase SSG output gradually, and check for the level where the squelch opens. With the output less than <math>-13\text{dB}\mu</math>, turn SQUELCH control knob fully clockwise, and check for SSG output level in the same manner as above. With the output more than <math>-8\text{dB}\mu</math>, increase SSG output to about <math>100\text{dB}\mu</math>, and check to see that the squelch does not close.</li> </ul>	
4	Output waveform check	<ul style="list-style-type: none"> <li>Keep SSG output about <math>20\text{dB}\mu</math>, check for no distortion or abnormal noise in AF waveform. Then, turn the volume control knob fully clockwise, and check to see that the output voltage is 4V or more.</li> </ul>	

## TRANSMITTER OVERALL ADJUSTING PROCEDURE

No.	Item	Adjusting procedure	Location for adjustment
1	Power adjustment	<ul style="list-style-type: none"> <li>Press COR SIMULATE switch, and adjust RF amplifier and filter 1 to get maximum wattage (10W or more).</li> </ul>	
2	Power check	<ul style="list-style-type: none"> <li>Switch upper and lower PLL frequencies, and check to see that the difference in output is 1W or less.</li> </ul>	
3	frequency check	<ul style="list-style-type: none"> <li>Check to see that output frequency fluctuation is within 500Hz.</li> </ul>	
4	Deviation check	<ul style="list-style-type: none"> <li>Apply 1kHz audio signal, and check to see that transmit deviation is 4.8kHz. Press MANUAL ID switch, and check to see that ID signal is 1kHz deviation.</li> </ul>	
5	Spurious emission check	<ul style="list-style-type: none"> <li>Check to see that spurious emission is <math>-60\text{dB}</math> or less at 10MHz span, and that harmonics and sub-harmonics are <math>-60\text{dB}</math> or less at 1000MHz span. (Check this with both AC power supply and DC power supply)</li> </ul>	

## REGULATOR

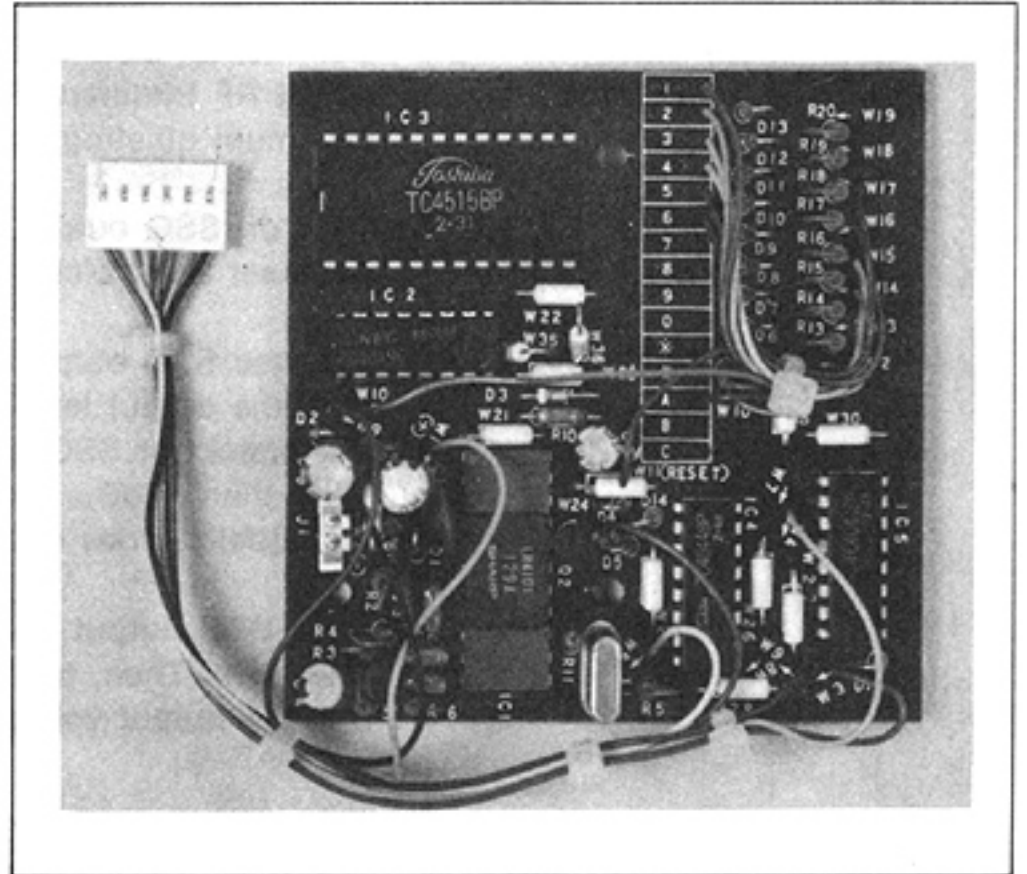
No.	Item	Adjusting procedure	Location for adjustment
1	Voltage adjustment	<ul style="list-style-type: none"> <li>Connect an external transistor to pins 2, 3 and 4, and apply input of about 17VDC to pins 1 and 7. Adjust R4 so that the voltage at pin 5 and 6 is 13.8V.</li> </ul>	R4
2	Current	<ul style="list-style-type: none"> <li>Connect load to pins 5 and 6, and adjust R6 so that voltage starts to drop at a load current of 6.5A (with current constant).</li> </ul>	R6



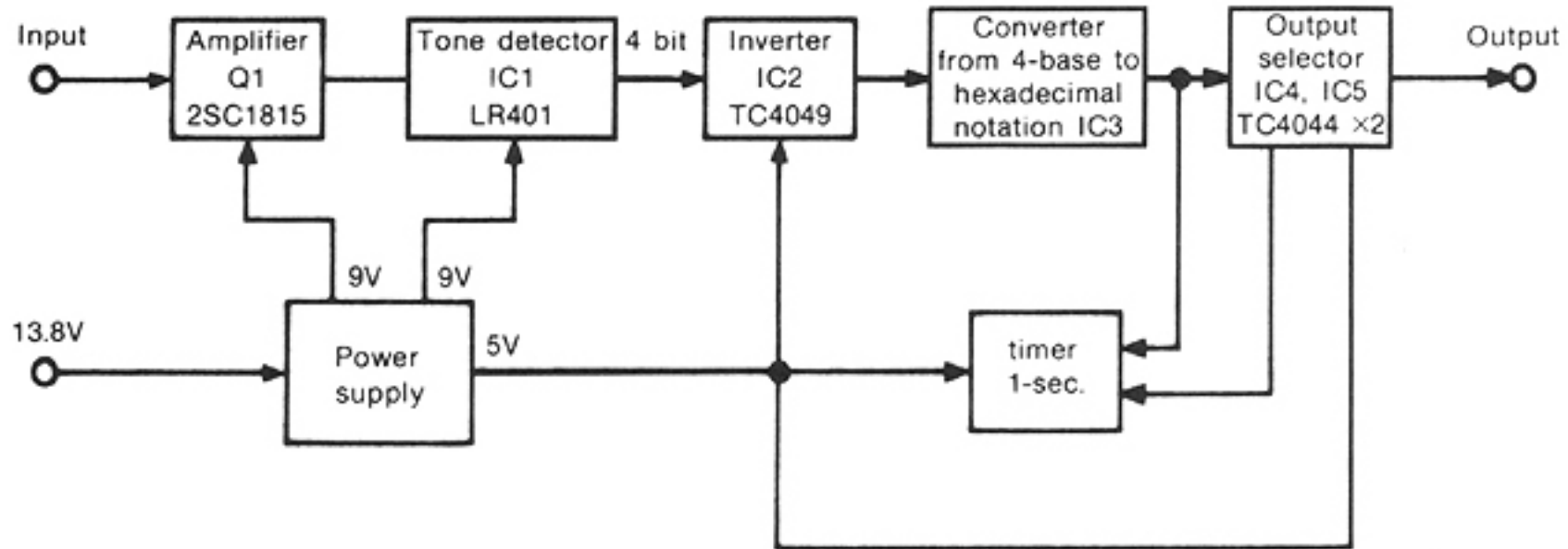
# DTMF DECODER Unit

## 1. Outline

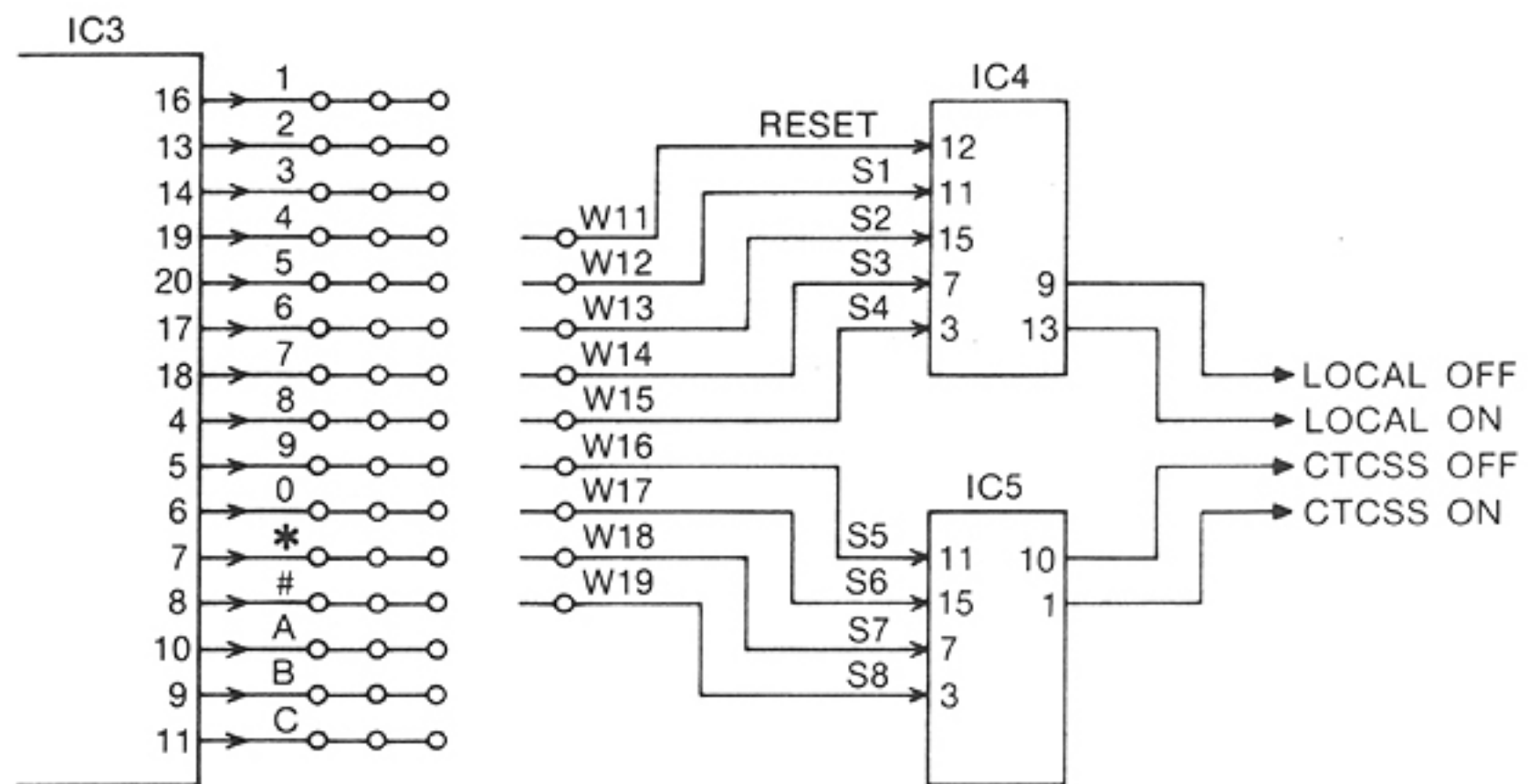
The IC-RP1210 Repeater can be remote controlled with the built-in tone decoder. This DTMF decoder employs three-digit sequential signal as a control signal to prevent accidental controlling. Remote-controlled functions are (1) LOCAL/INHIBIT mode ON/OFF operation, and (2) CTCSS mode ON/OFF operation.



**Block diagram**



2. The DTMF Decoder unit circuit is shown on p. 31. Below is the section where signals are combined.



Signals (15 of them: 0/9, \*, #, A, B and C) from an external controller (DTMF) are fed to IC3, and then output to the respective signal output terminals. A group of signals is checked for its combination at IC4 or IC5, and is output from pin 9 or pin 13 by way

of IC4, or from pin 10 or pin 1 through IC5. After that, these signals are sent to the control unit by way of the P1 connector to activate the respective function.



IC4 pin 9 → LOCAL/INHIBIT mode OFF  
 pin 13 → LOCAL/INHIBIT mode ON  
 IC5 pin 10 → CTCSS mode OFF  
 pin 1 → CTCSS mode ON

The correlations between input combinations and output are as shown below:

**Table 1**

Input combination	Output	Function
S1, S2, S3	IC4 pin 9	LOCAL mode OFF
S1, S2, S4	IC4 pin 13	LOCAL mode ON
S1, S2, S5	IC5 pin 11	CTCSS mode OFF
S1, S2, S6	IC5 pin 15	CTCSS mode ON
S1, S2, S7	IC5 pin 7	Spare
S1, S2, S8	IC5 pin 3	Spare

S1 through S8 are connected to W12 through W18, which are connected to IC3 output terminals. By changing these W12 - W18 connections, it is possible to determine the remote control functions respectively.

### 3. How to Combine Signals

The control signal should consist of 3 digits and 1-character reset signal; and they should be sequential as follows: reset signal → S1 → S2 → S3~S6.

Reset → S1 → S2 → S3.....LOCAL OFF  
 Reset → S1 → S2 → S4.....LOCAL ON  
 Reset → S1 → S2 → S5.....CTCSS OFF  
 Reset → S1 → S2 → S6.....CTCSS ON

The DTMF Decoder Unit is factory-wired as follows:

W11	(RESET)	Gray	A
W12	(S1)	Brown	1
W13	(S2)	Red	2
W14	(S3)	Orange	3
W15	(S4)	Yellow	4
W16	(S5)	Green	5
W17	(S6)	Red	6

By using the above wiring as it is, control signals serve as follows:

LOCAL OFF → A, 1, 2, 3  
 LOCAL ON → A, 1, 2, 4  
 CTCSS OFF → A, 1, 2, 5  
 CTCSS ON → A, 1, 2, 6

As a result, it is necessary for the user of this unit to determine the 4-digit signals as control signals before starting operation. To change the control signals, disconnect the W11 through W18 jumper wires, and connect them to IC3 output terminals (0~9, \*, #, A, B and C) as desired.

### • Examples of control signals and how to change them

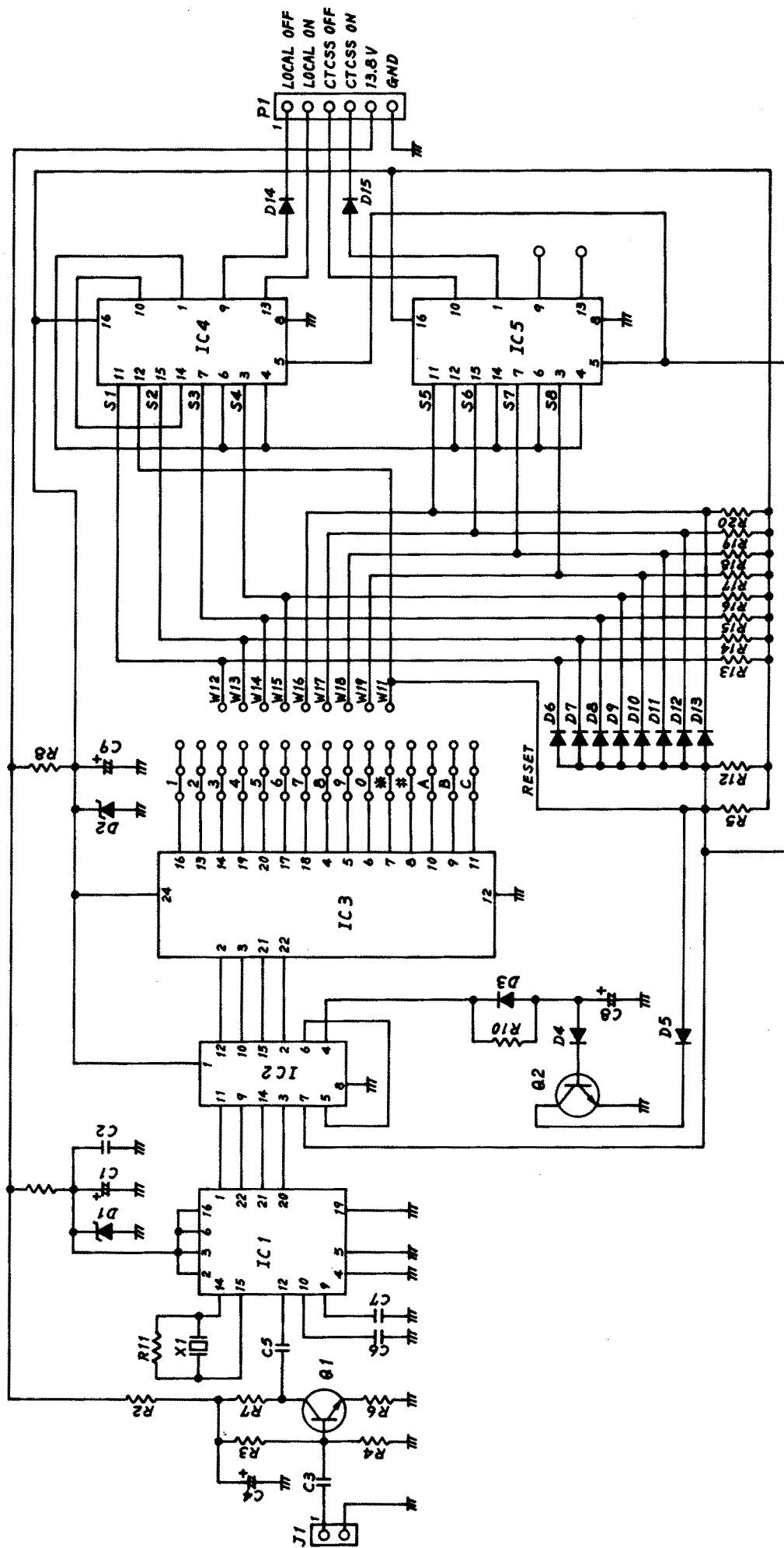
To change control signal for LOCAL OFF to C, 4, 3, 0:

Connect W11 to C, W12 to 4, W13 to 3 and W14 to 0 so that C is input to RESET, 4 to S2, 3 to S2 and 0 to S3. Now that the control signal for LOCAL OFF is C, 4, 3, 0, the leading three digits of the remaining control signals (LOCAL ON, CTCSS ON/OFF) should be C, 4, 3 (see Table 1). For the last digit, connect the desired wire to the corresponding terminal.

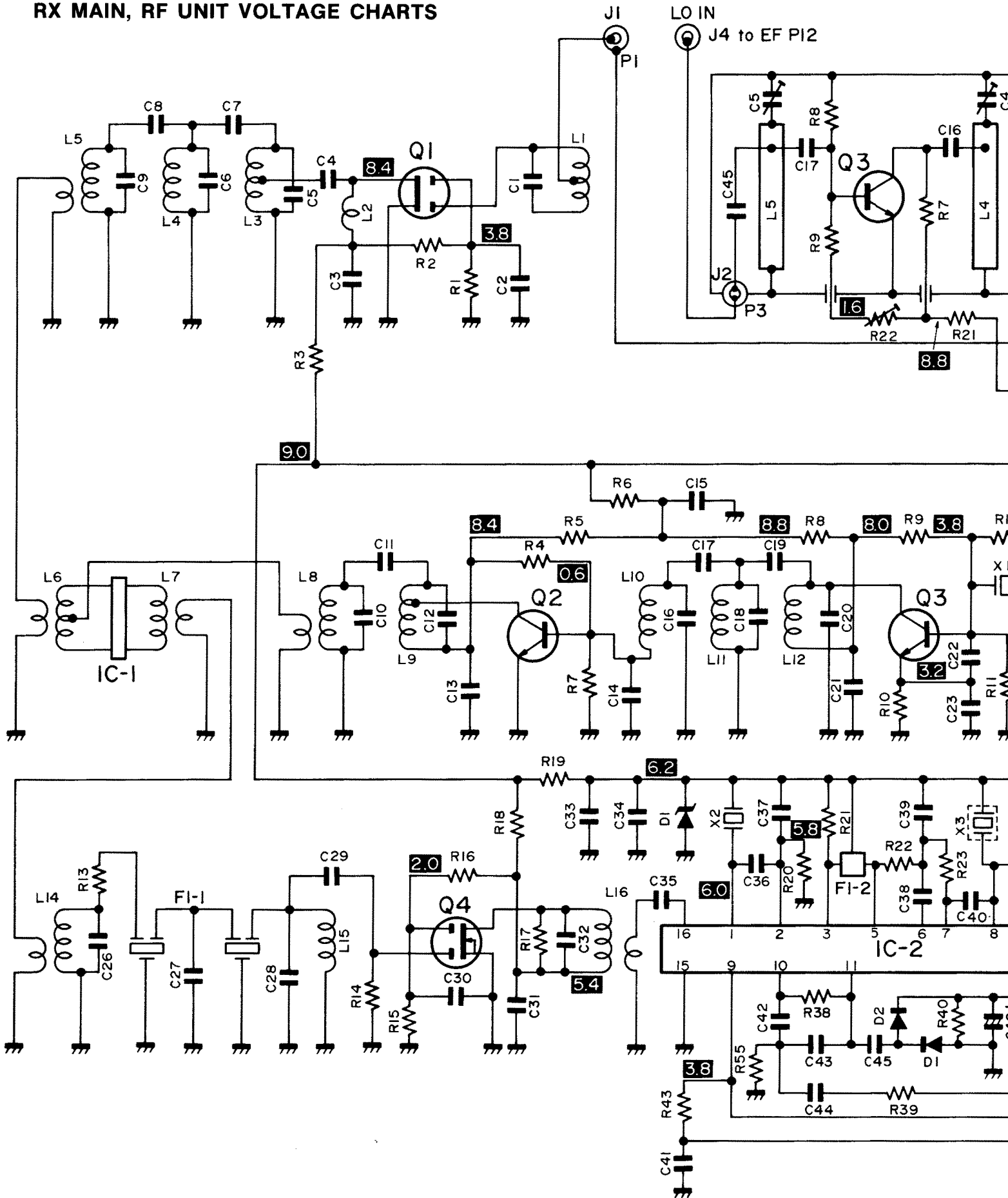
\* When changing wiring, disconnect the jumper wires by unsoldering the connection on the back side of the board.

Note: Unsolder the connection on the signal terminal side (0~9, \*, #, A, B and C).

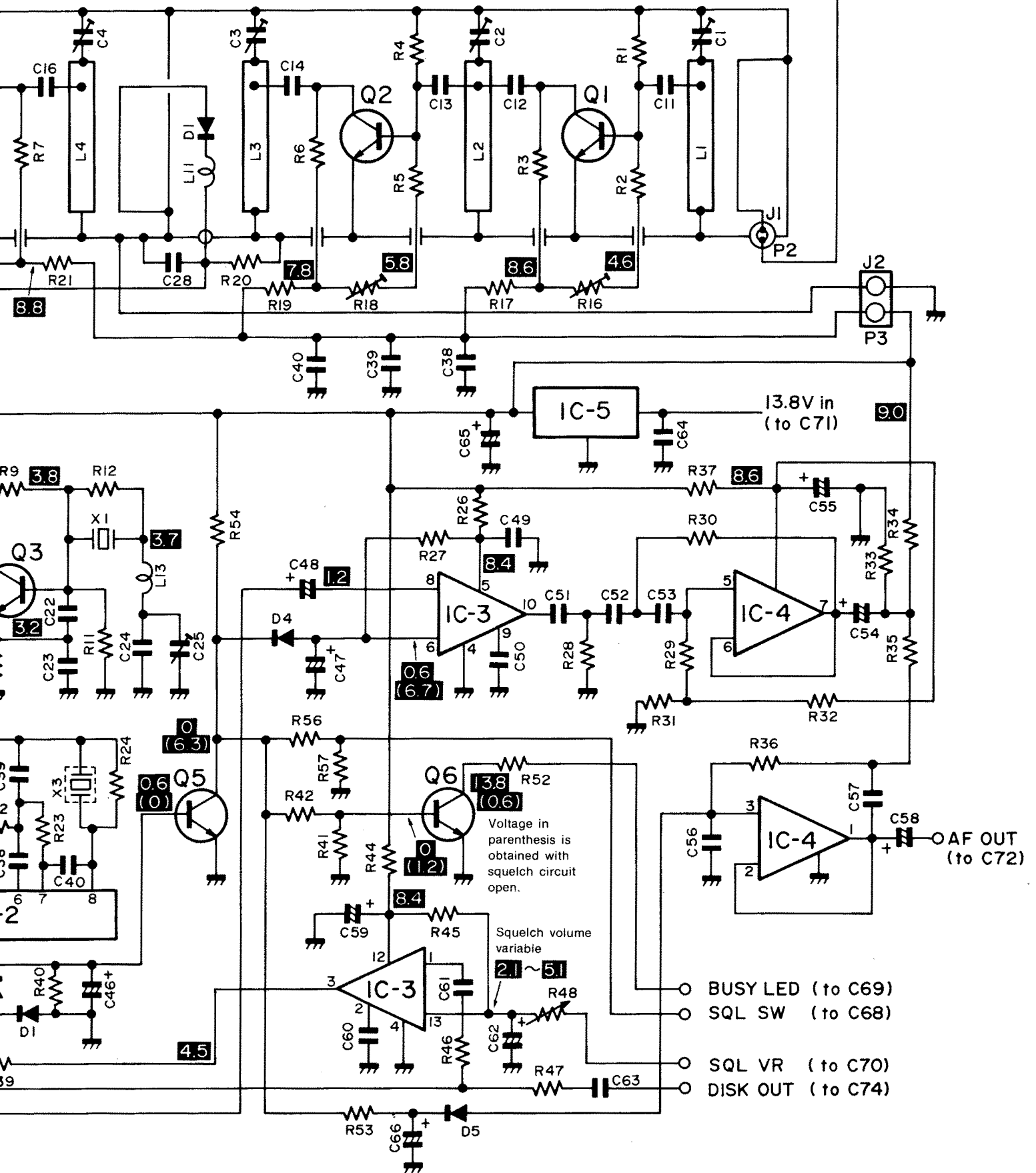
# Decoder unit



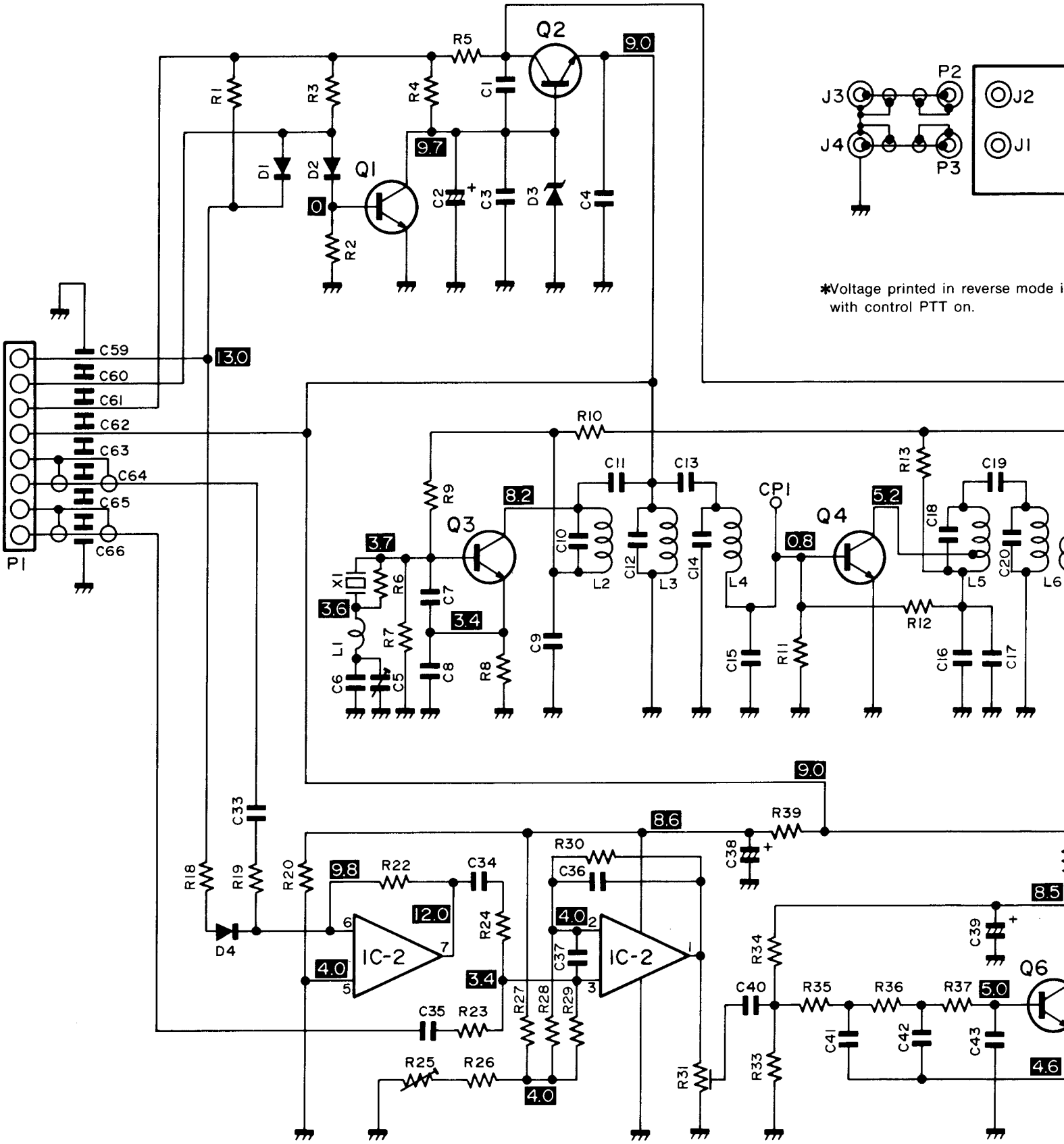
# RX MAIN, RF UNIT VOLTAGE CHARTS

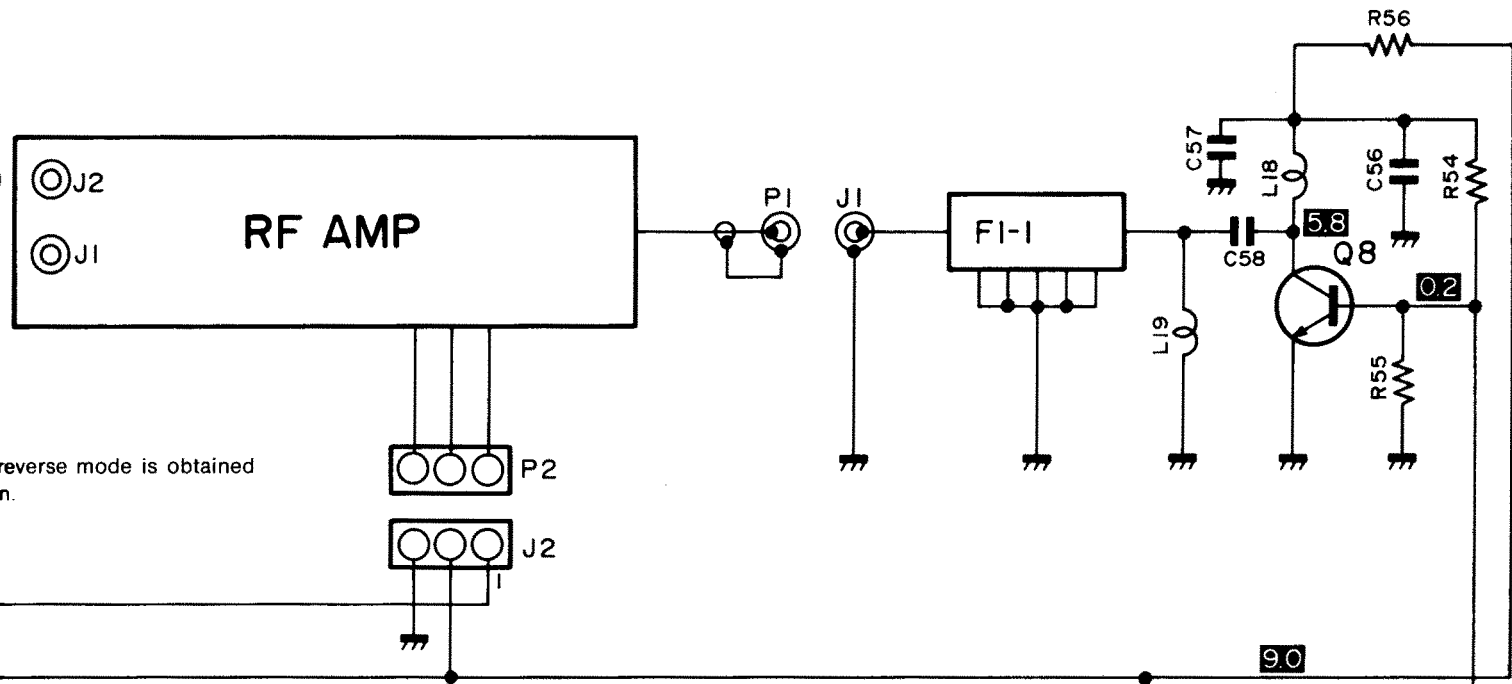


J3 to EF PI5

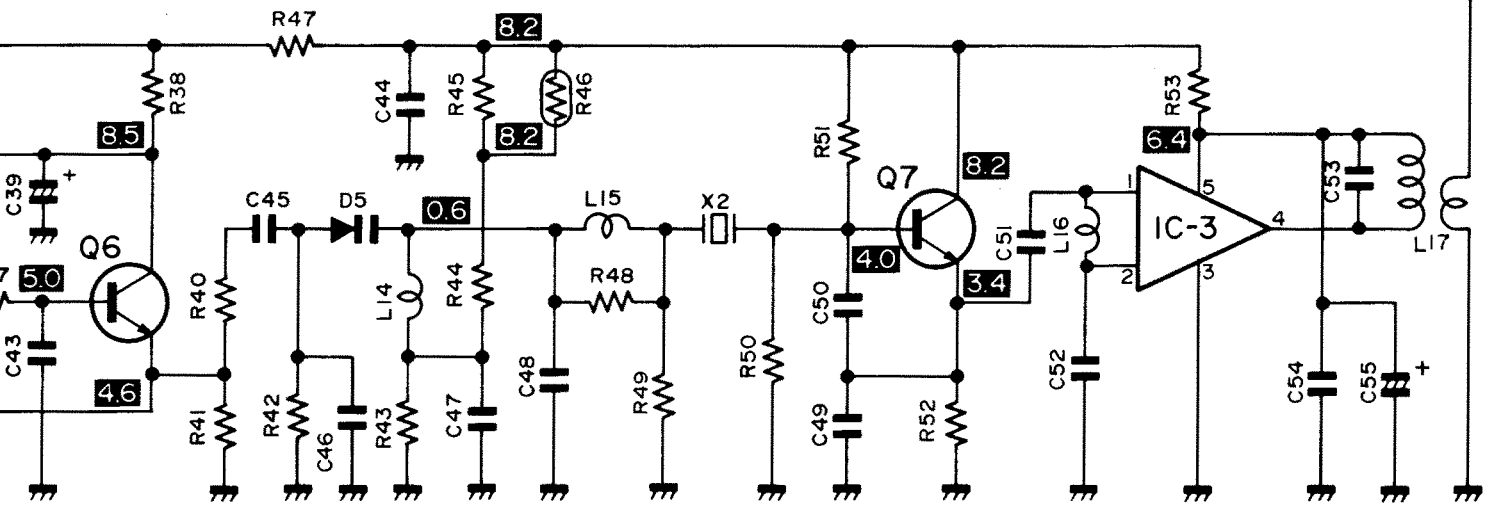
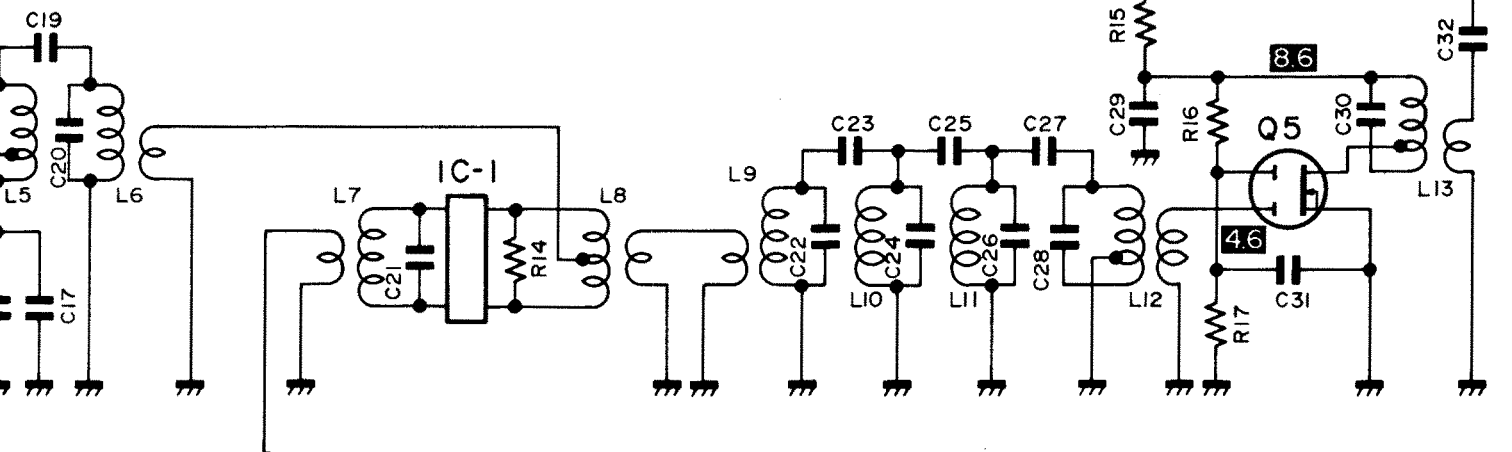


# TX MAIN UNIT

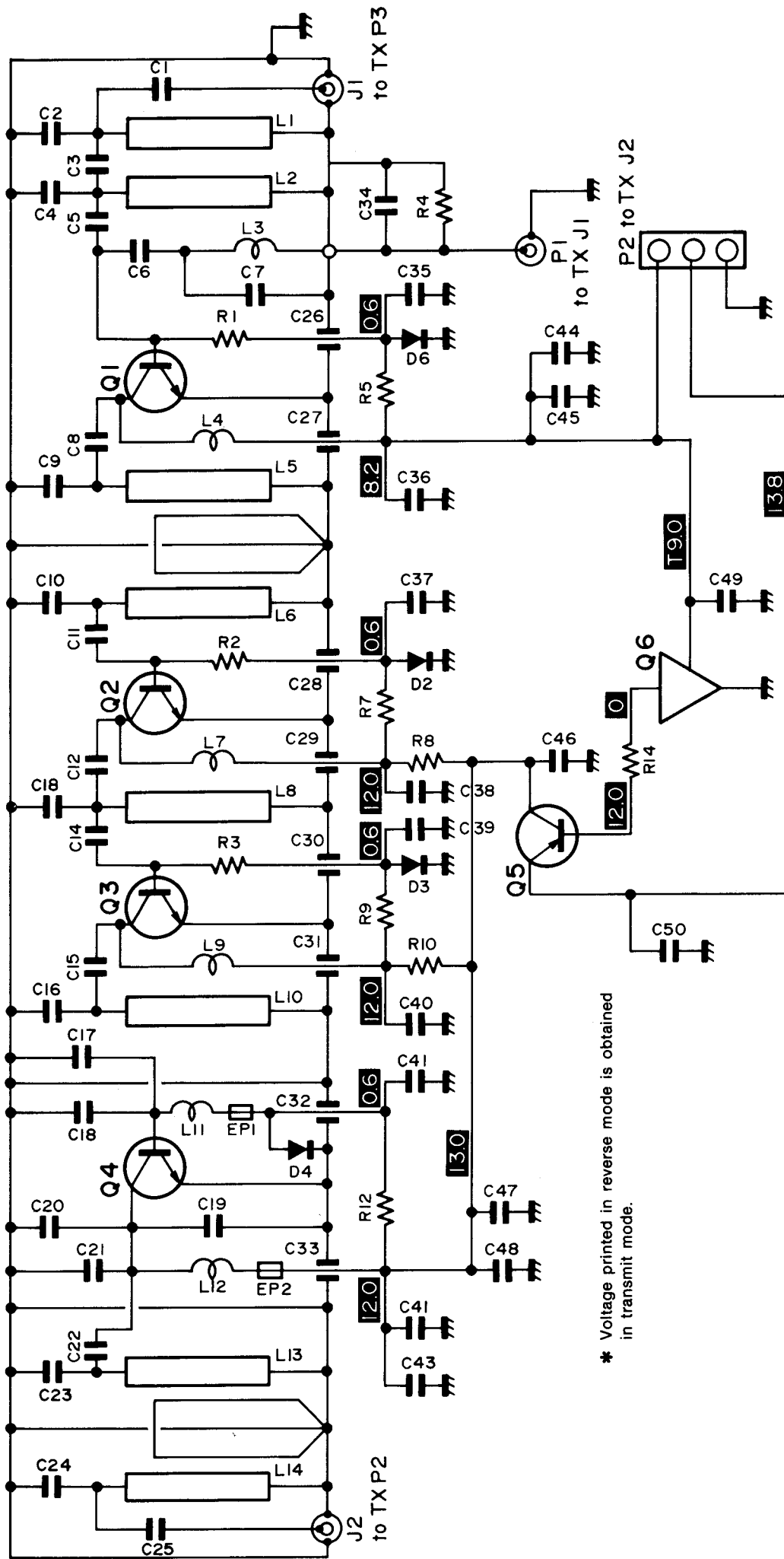




reverse mode is obtained  
n.



# RF AMP UNIT

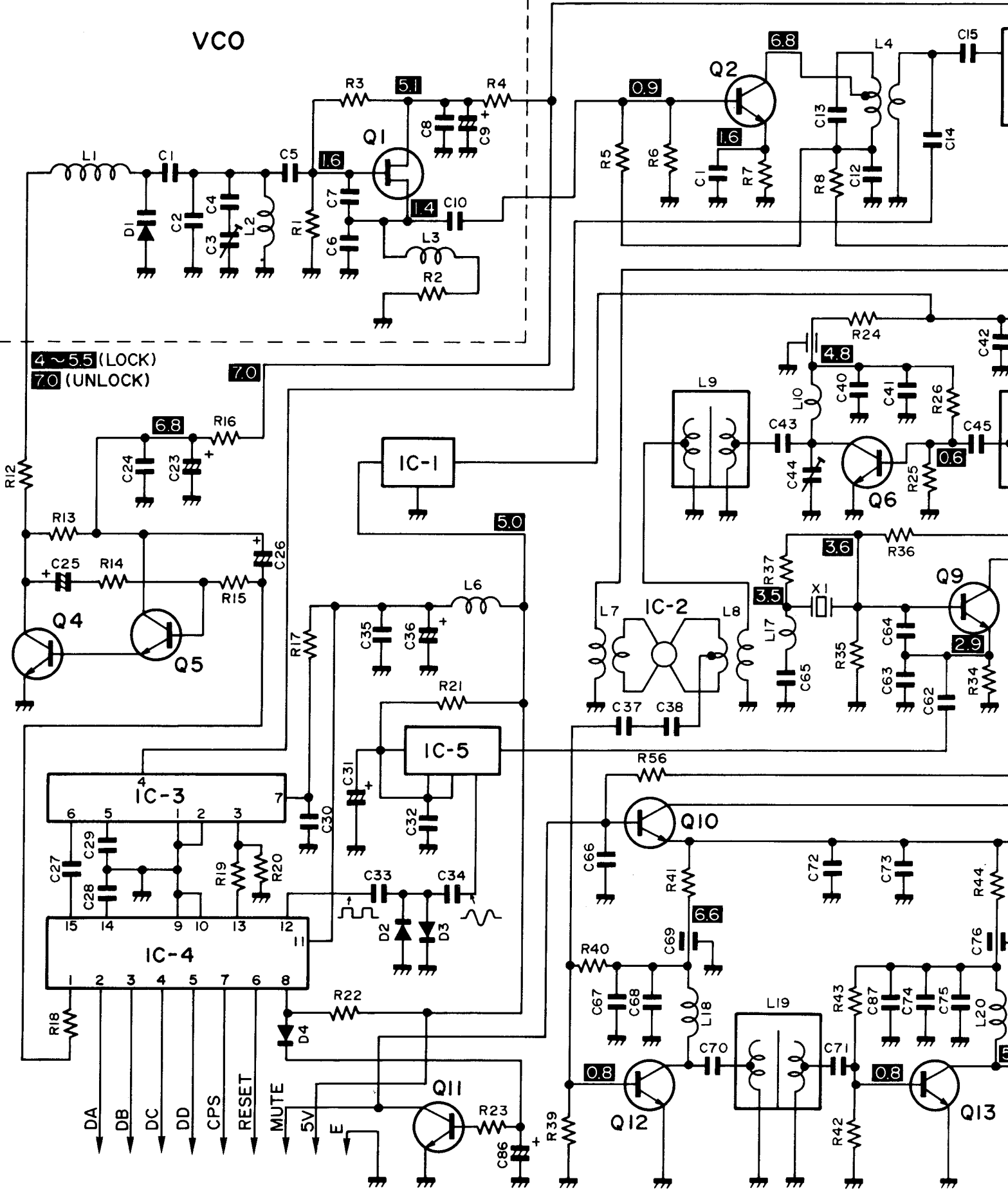


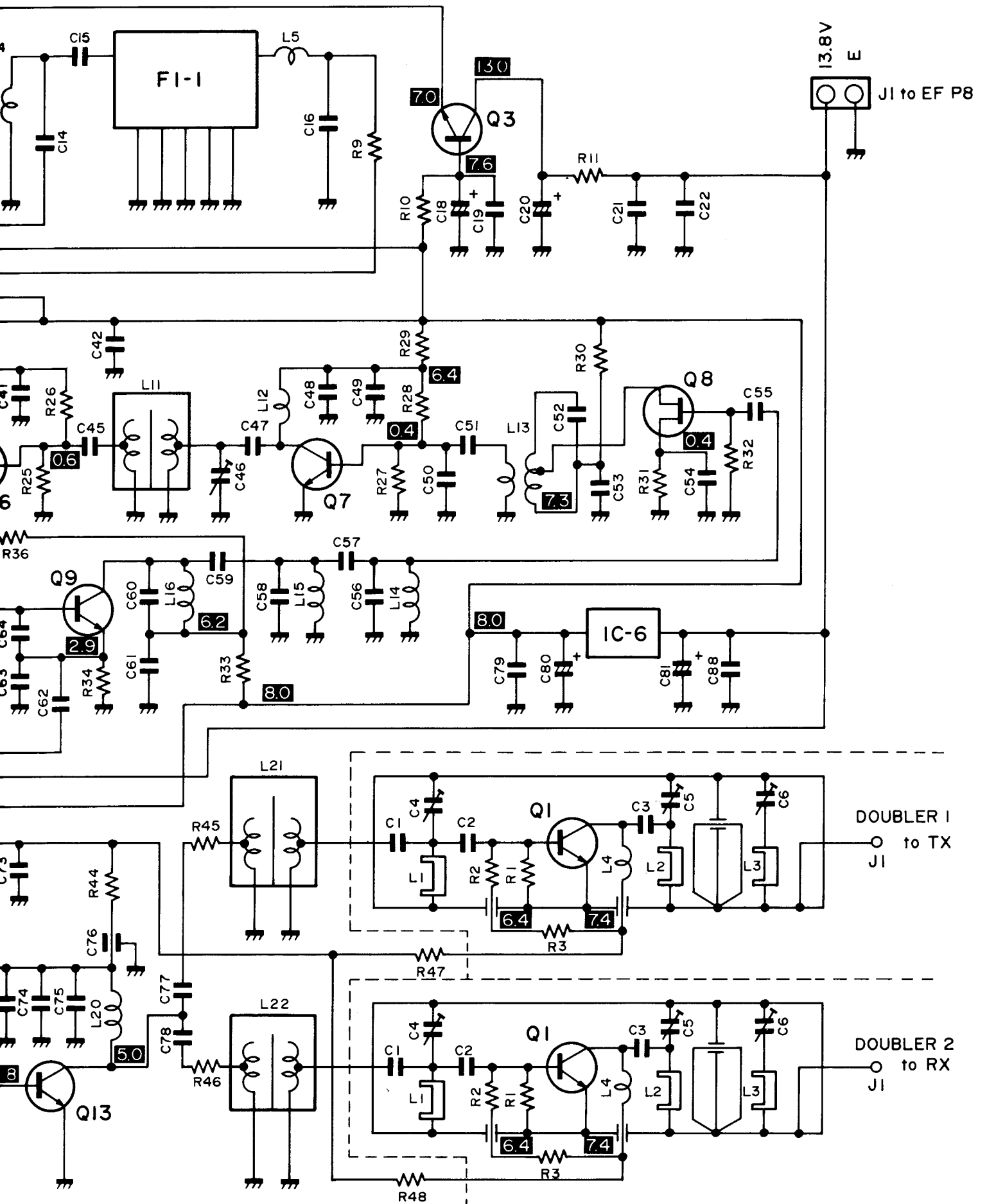
\* Voltage printed in reverse mode is obtained in transmit mode.



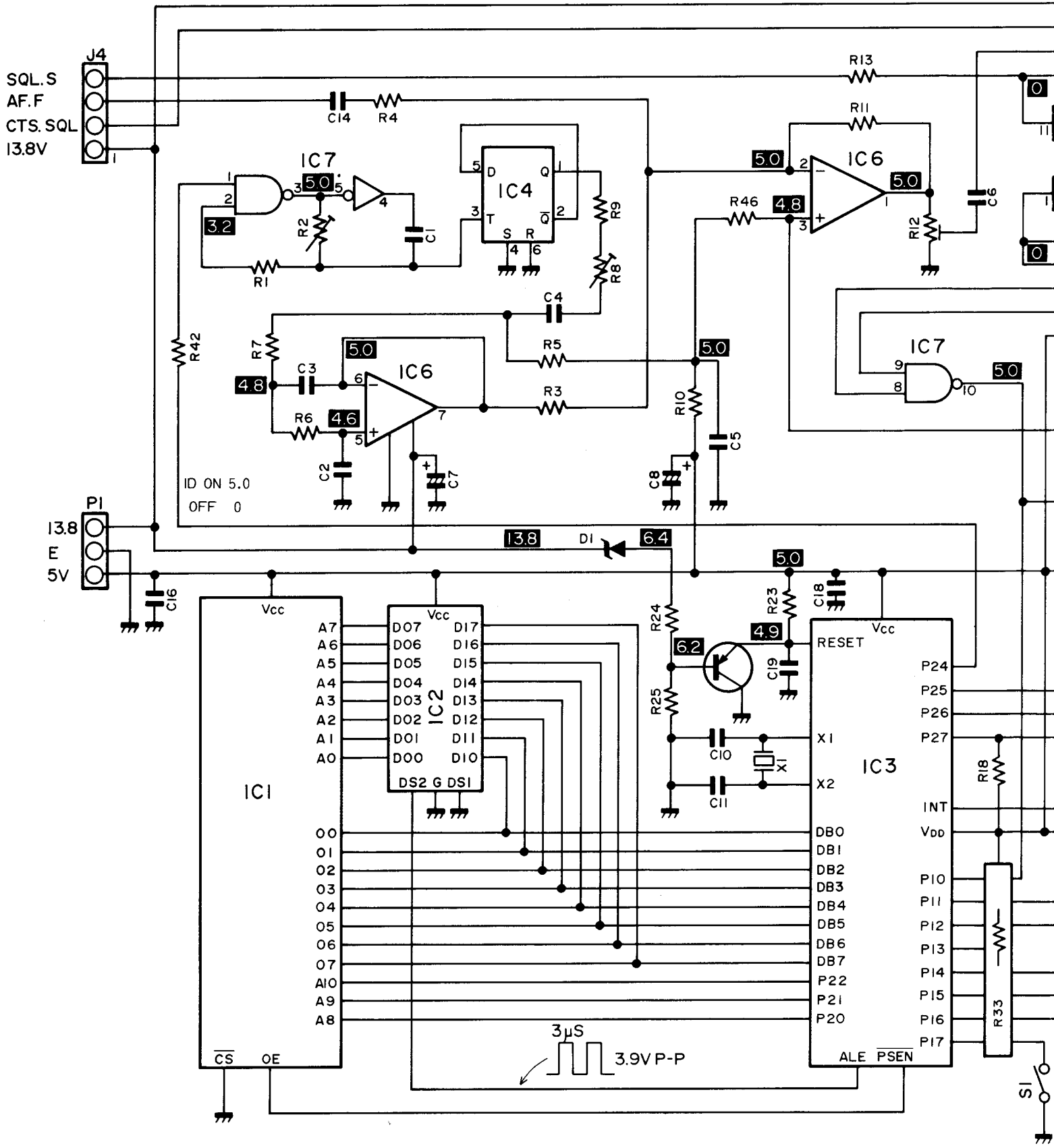
# PLL, DOUBLER UNIT

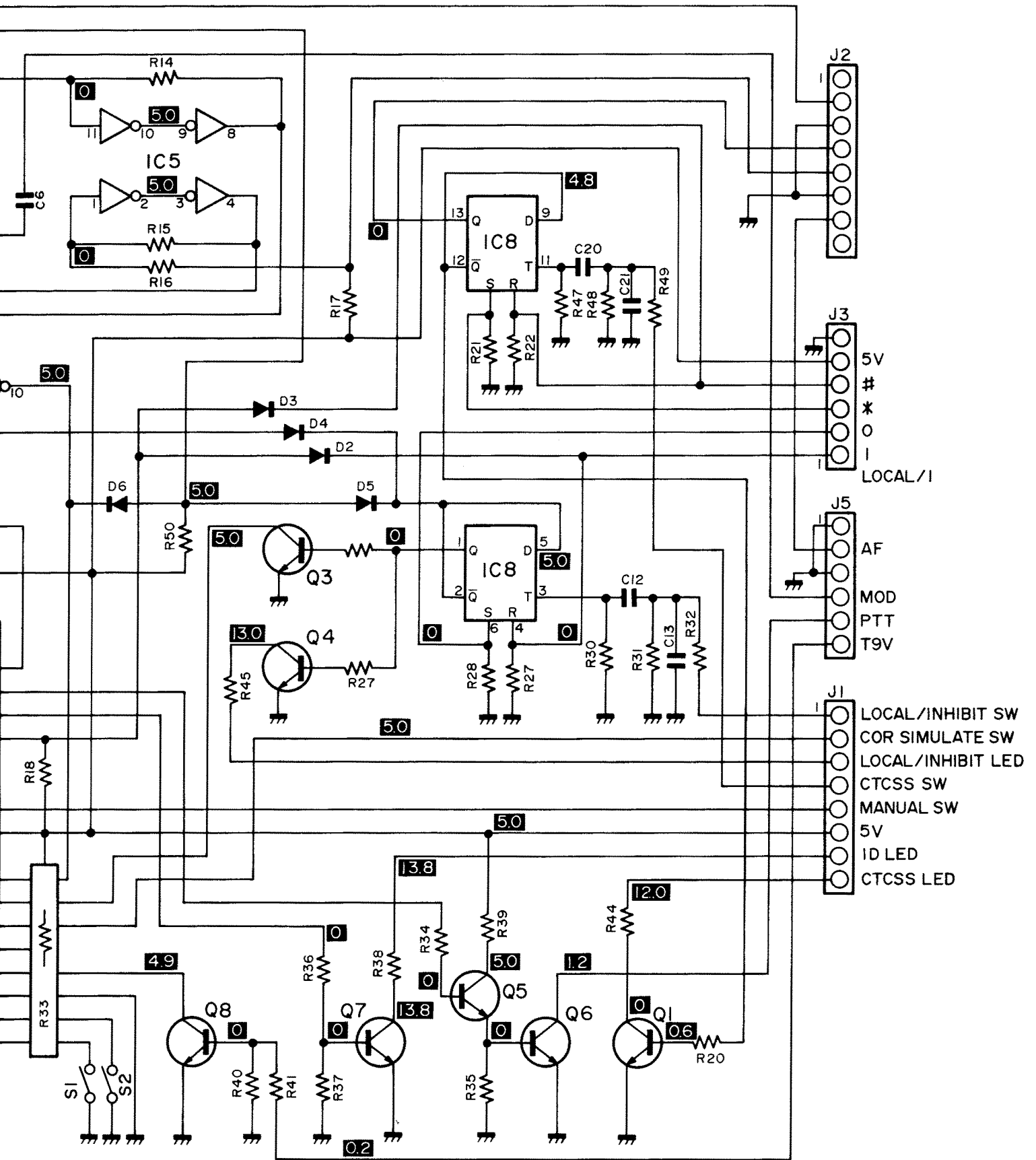
## VCO



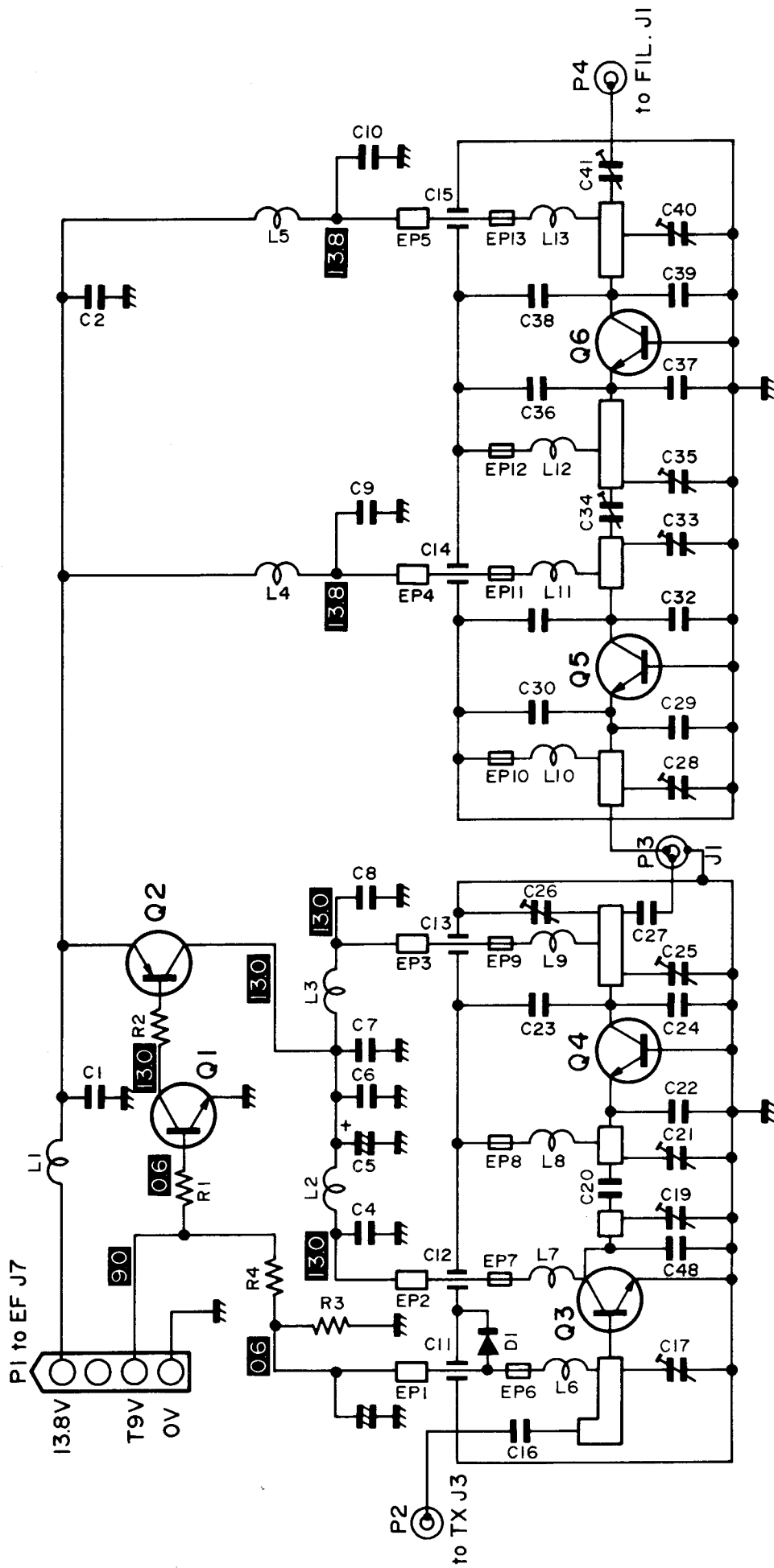


# CONTROL UNIT





PA UNIT



# EF UNIT

