



ICOM

OPERATING

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

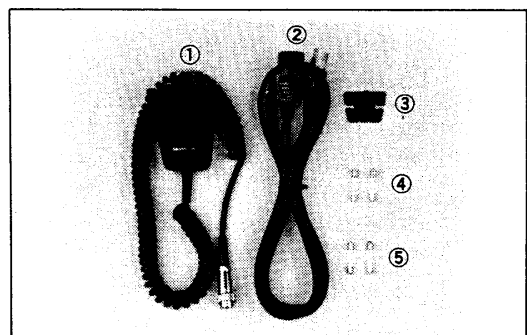
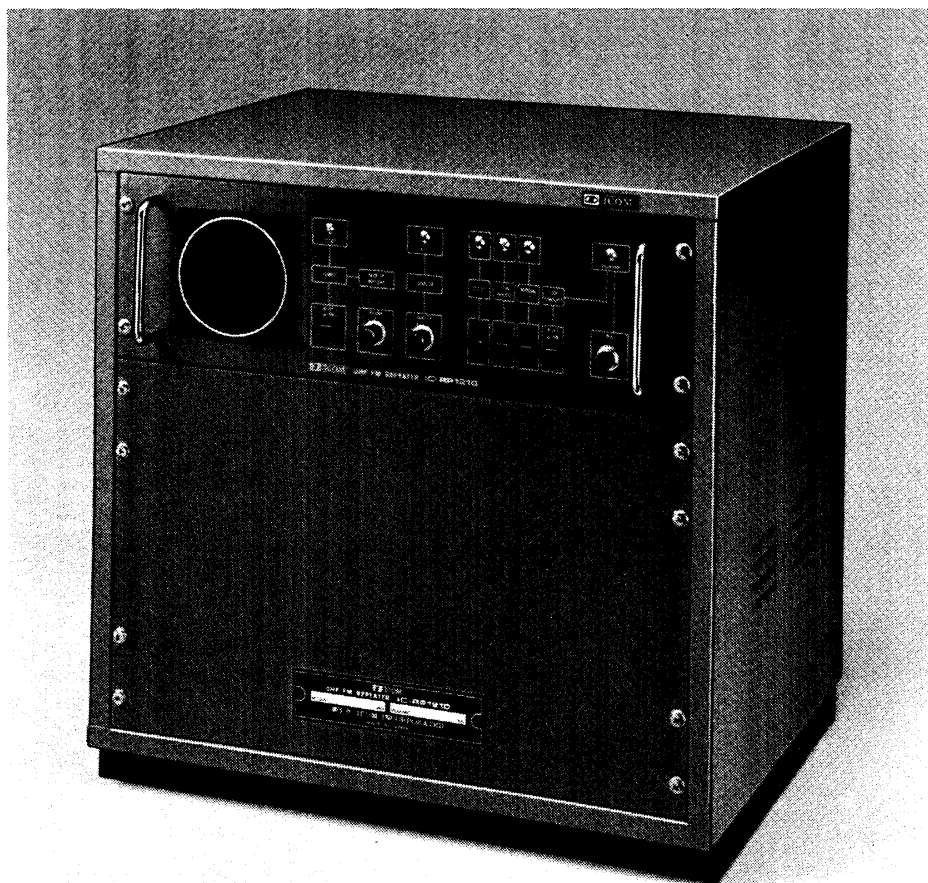


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1. FEATURES

- 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

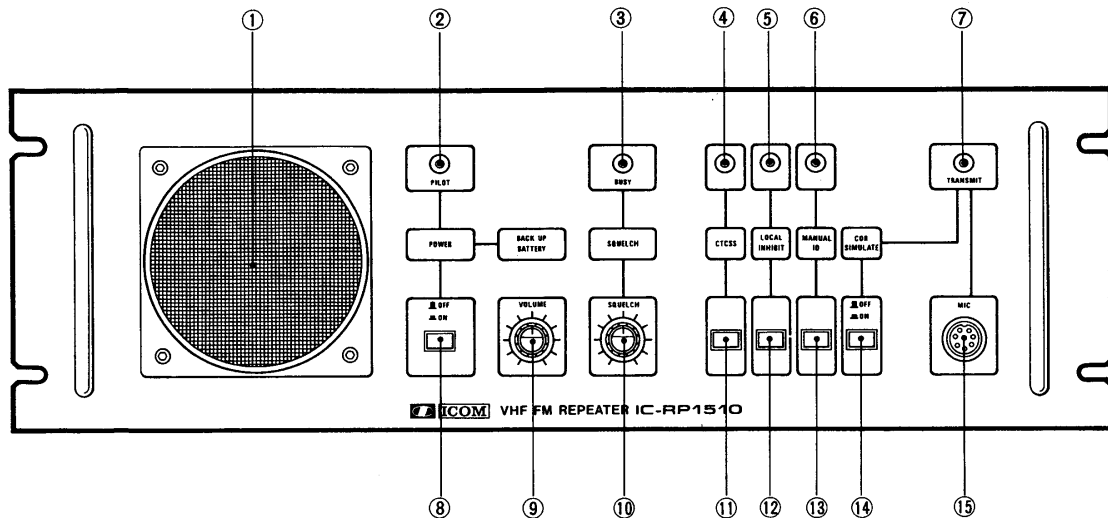
- Receiver system:
Double-conversion superheterodyne
- Intermediate frequencies:
1st IF 21.8MHz 2nd IF 455kHz
- Sensitivity:
Less than 0.32μV (-117dBm) for 12dB SINAD
- Squelch sensitivity:
Less than 0.2μV
- Selectivity:
Less than 25kHz at -60dB
- Spurious response rejection ratio:
More than 70dB
- Desensitization:
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

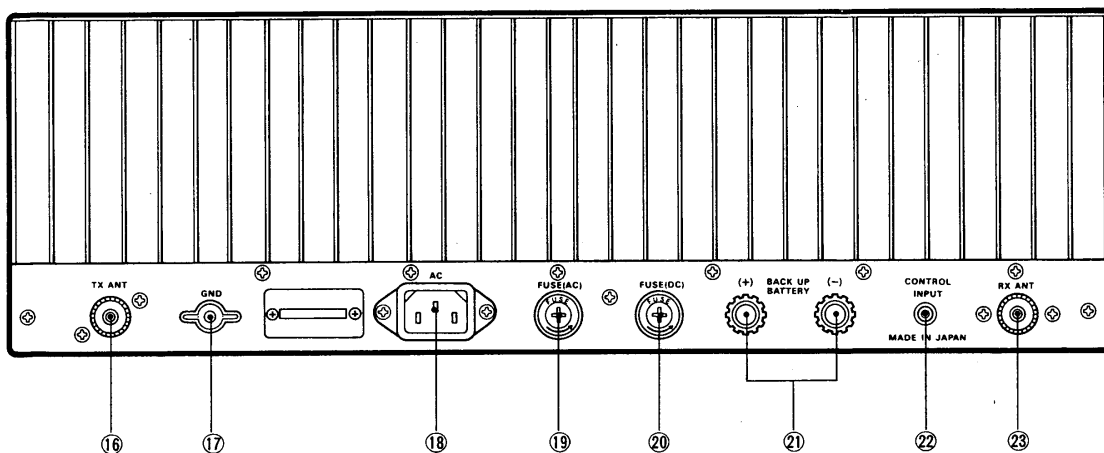
3. CONTROL FUNCTIONS

FRONT PANEL



- | | |
|---------------------------|------------------------|
| ① INTERNAL SPEAKER | ⑨ VOLUME CONTROL |
| ② PILOT INDICATOR | ⑩ SQUELCH CONTROL |
| ③ BUSY INDICATOR | ⑪ CTCSS SWITCH |
| ④ CTCSS INDICATOR | ⑫ LOCAL INHIBIT SWITCH |
| ⑤ LOCAL INHIBIT INDICATOR | ⑬ MANUAL ID SWITCH |
| ⑥ MANUAL ID INDICATOR | ⑭ COR SIMULATE SWITCH |
| ⑦ TRANSMIT INDICATOR | ⑮ MIC CONNECTOR |
| ⑧ POWER SWITCH | |

REAR PANEL



- | | |
|------------------------------|-----------------------------|
| ⑬ AC LINE FUSE HOLDER | ⑮ DC LINE FUSE HOLDER |
| ⑭ GROUND TERMINAL | ⑯ DC POWER INPUT TERMINALS |
| ⑮ TRANSMIT ANTENNA CONNECTOR | ⑰ CONTROL SIGNAL INPUT JACK |
| ⑯ RECEIVER ANTENNA CONNECTOR | |

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

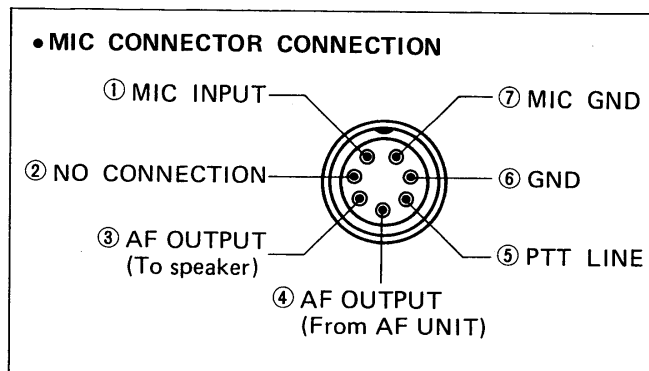
Connects the supplied IC-HM4 MICROPHONE.

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

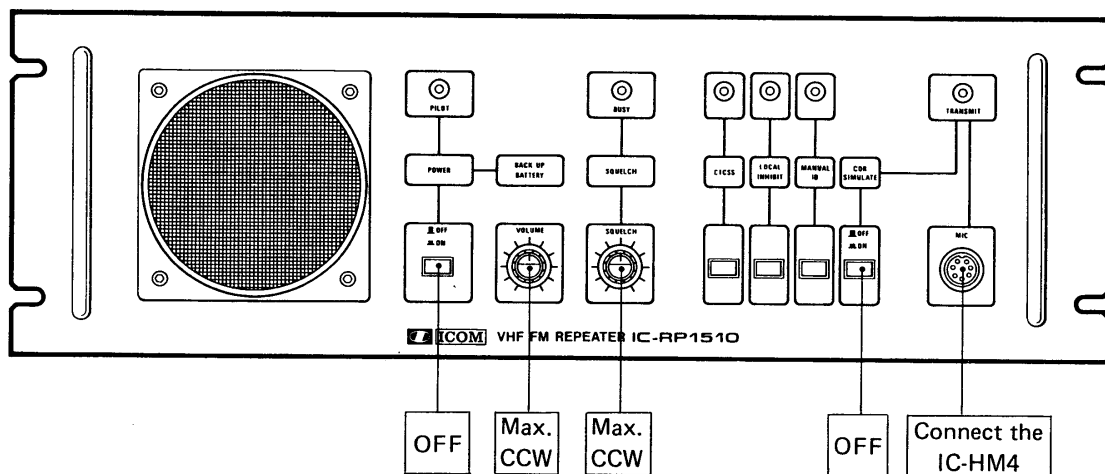
5-1 INITIAL SETTINGS

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 Transmitter without an antenna will damage the transistor 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)

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

$$= \frac{164.00 - 21.8}{0.005}$$

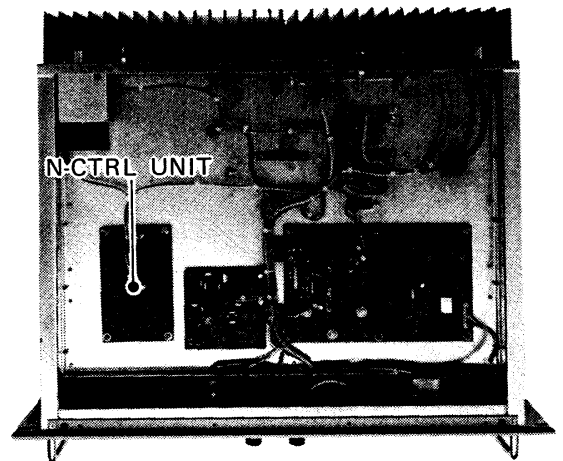
$$= 28440$$

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

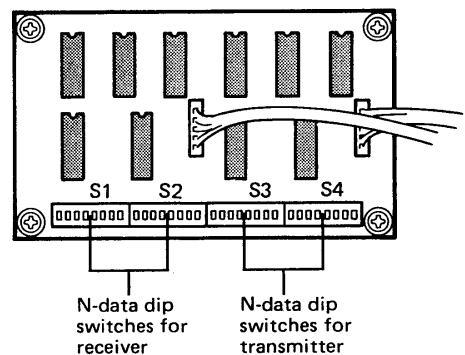
- 3) The following dip switches should be ON:

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

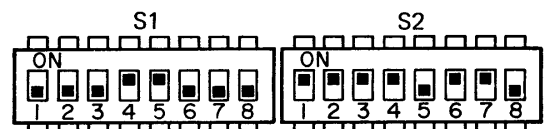
• BOTTOM VIEW



• 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.

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

- 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)

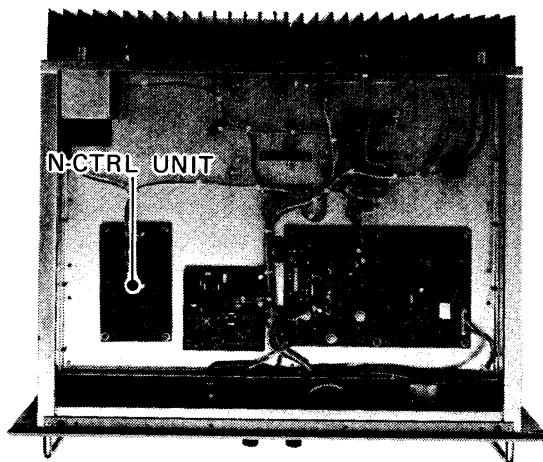
$$\begin{aligned}
 1) \ N\text{-data} &= \frac{\text{Transmit frequency}}{\text{Channel Spacing}} \\
 &= \frac{164.60}{0.005} \\
 &= 32920
 \end{aligned}$$

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

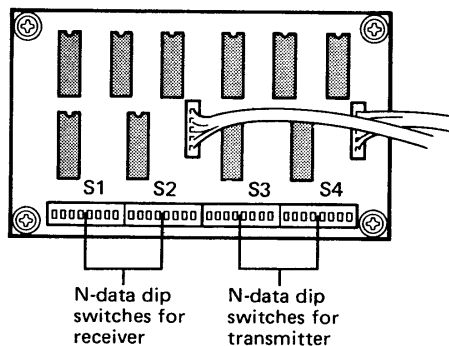
The following dip switches should be ON:

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

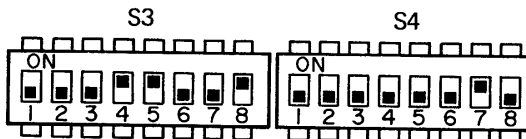
● IC-RP1510 (Bottom View)



● 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:

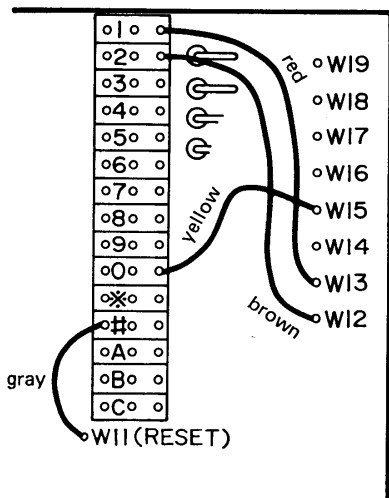
JUMPER WIRE	FUNCTION
W14 (orange)	LOCAL INHIBIT OFF
W15 (yellow)	LOCAL INHIBIT ON
W16 (green)	TONE SQUELCH OFF
W17 (blue)	TONE SQUELCH ON

- 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.

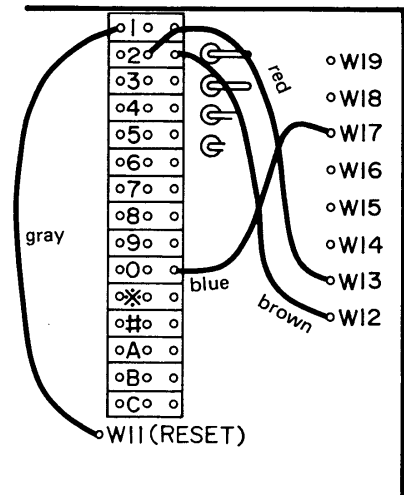
■ REMOTE CONTROL SETTING EXAMPLE

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.

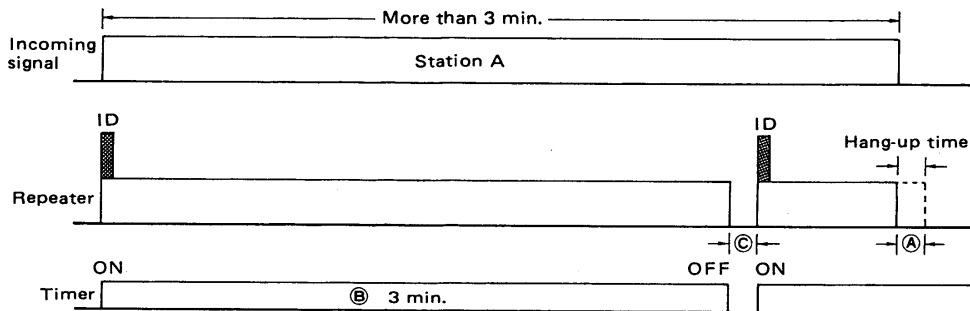
*The first three codes must be the same for the LOCAL INHIBIT OFF, TONE SQUELCH OFF, and TONE SQUELCH ON functions.

■ TIMING CHARTS OF TRANSMITTING AND ID EMISSIONS

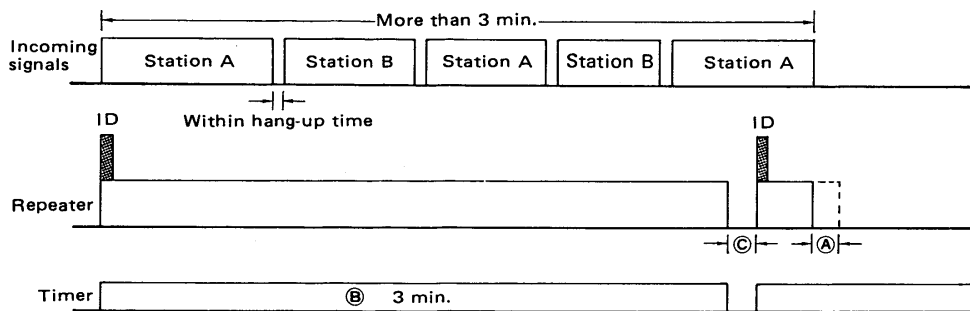
The functions listed below are represented in the diagrams by their assigned letters.

- 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

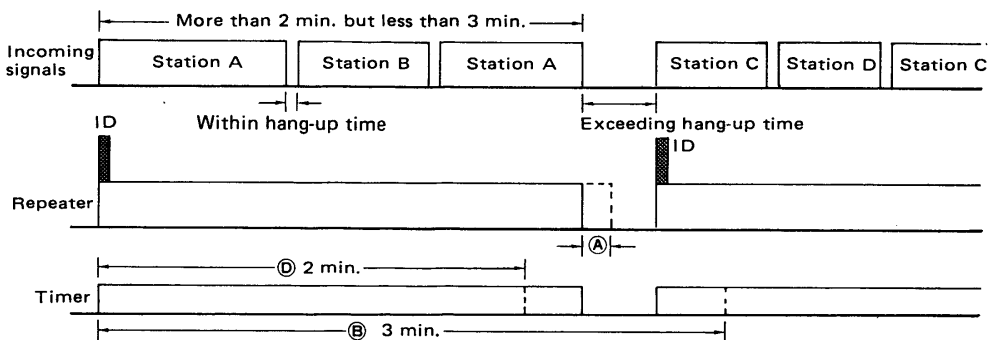
(1) If one station occupies the repeater for more than 3 minutes.



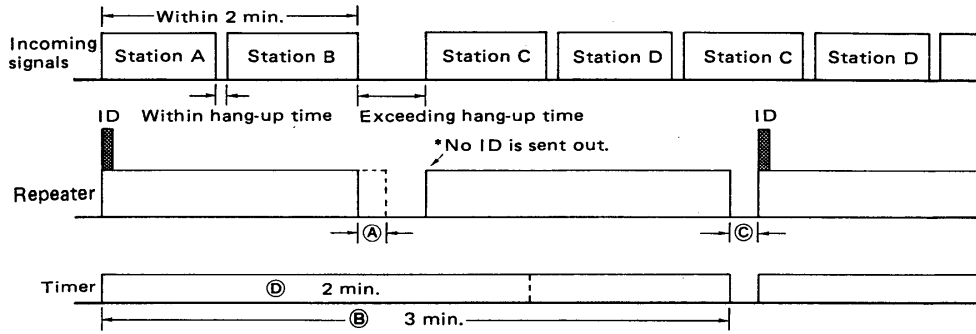
(2) If two stations communicate with each other for more than 3 minutes without an interruption of 5 seconds or more:



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

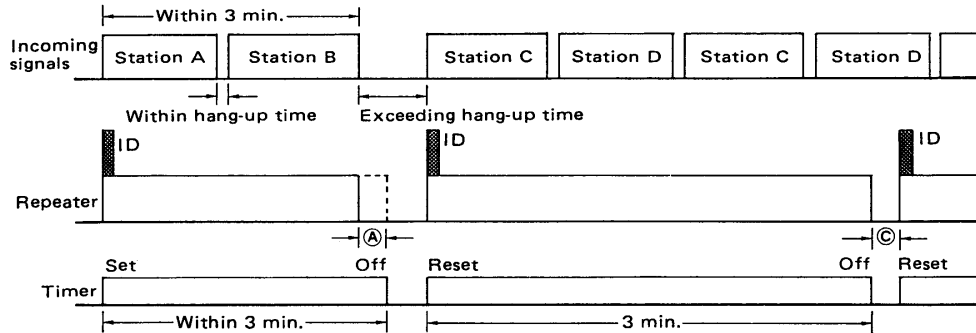


(4) If communication between two stations is completed within 2 minutes, and then other stations use the repeater:



* 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).



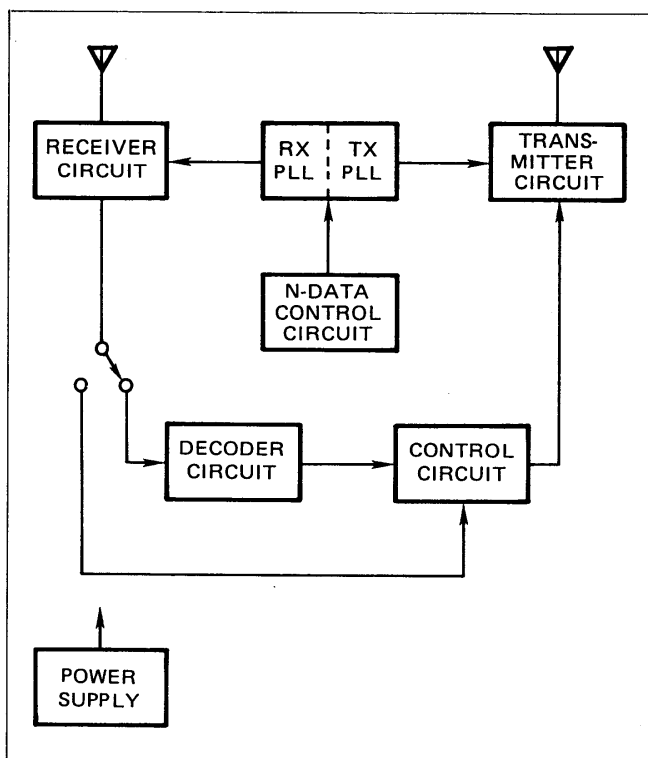
* ID sending speed is 20wpm with this system.

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.

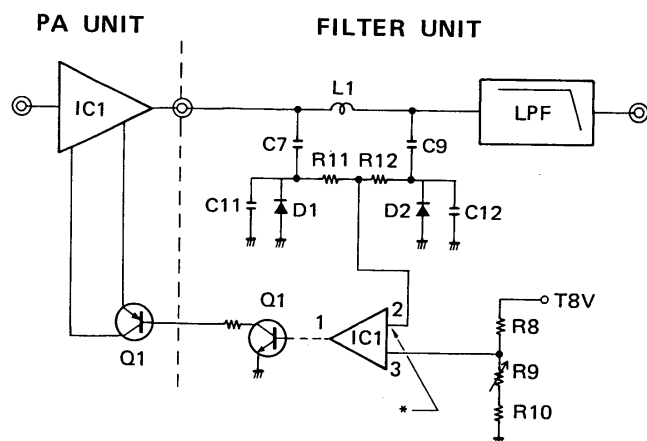
(5) LOW-PASS FILTER CIRCUIT (FILTER UNIT)

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.

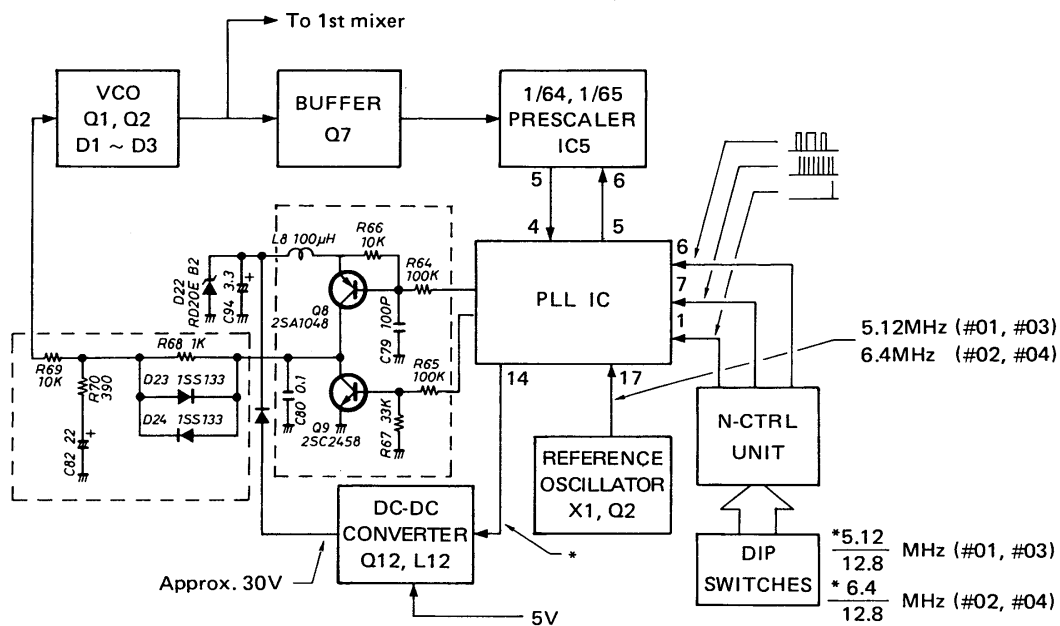
N-data can be obtained using the formula below.

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

(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

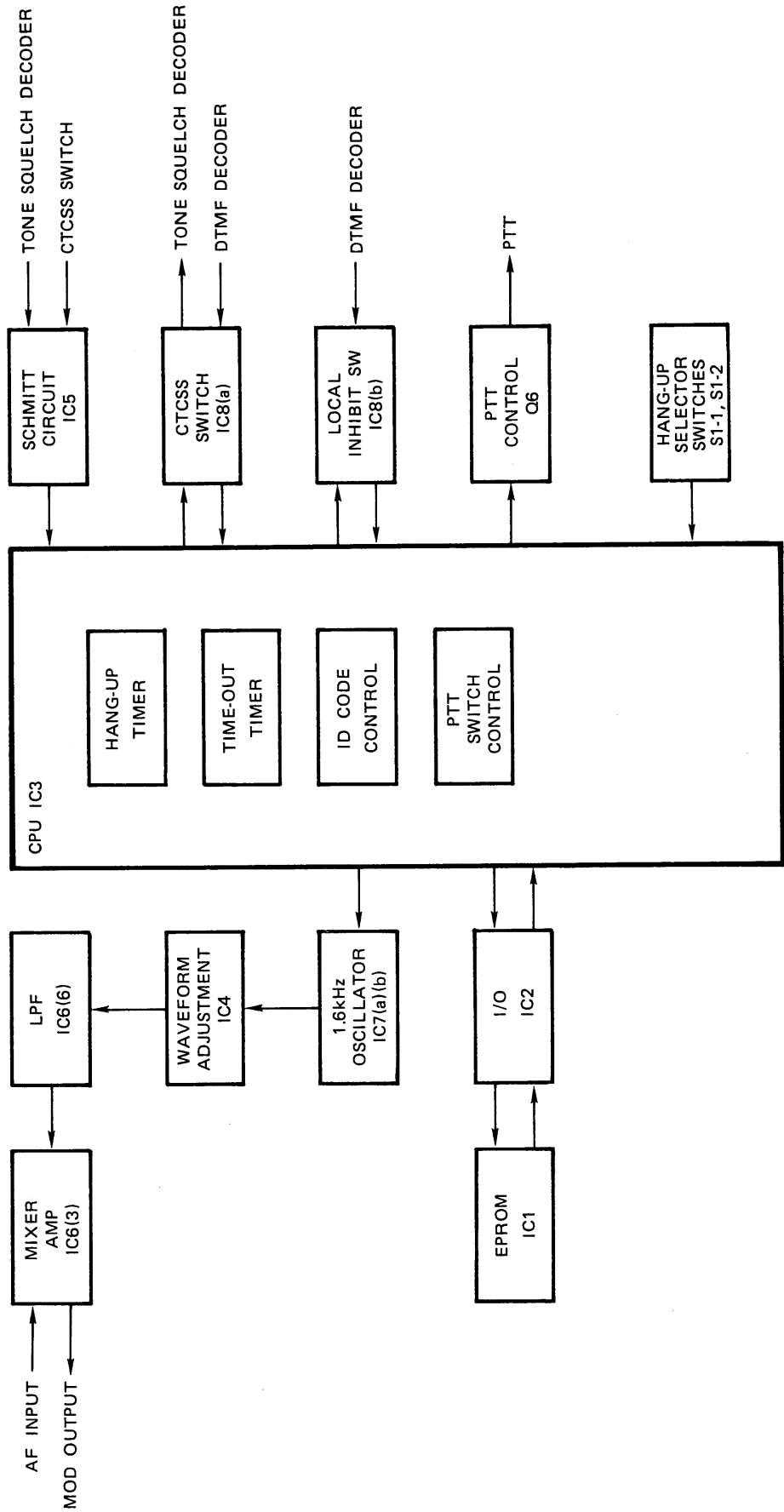
The ON-OFF signal of the [LOCAL INHIBIT] SWITCH is latched at IC8(b) through pin 1 of J1 and passes to IC3 (CPU) through Q3. The output signal also controls the [LOCAL INHIBIT] INDICATOR.

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.

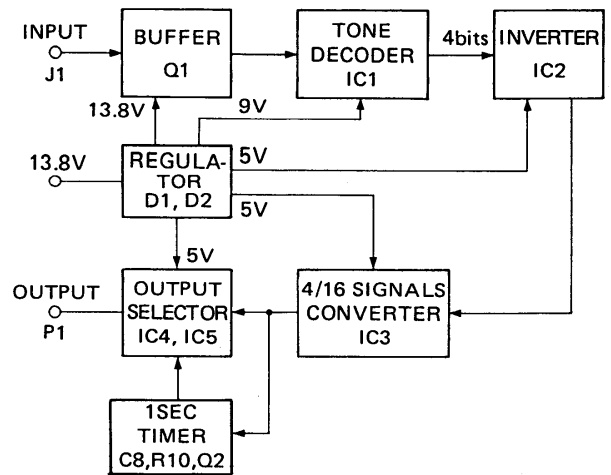
IC1 is an IC chip for the DTMF detector. An applied double-tone signal is detected at IC1 and outputs signals as a 4-bit binary code.

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.

