ICOM

OPERATING MANUAL

IC-RP1510

VHF REPEATER

ICOM INCORPORATED

INTRODUCTION

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 No.	VERSION	FREQUENCY COVERAGE		CHANNEL SPACING	TUNING STEP INCREMENT
		RECEIVER	TRANSMITTER		
#01	U.S.A.	138 ~ 174MHz	148 ~ 174MHz	25kHz	5kHz
#02	Europe	138 ~ 174MHz	148 ~ 174MHz	25kHz	12.5kHz
#03	CEPT	138 ~ 174MHz	148 ~ 174MHz	25kHz	12.5kHz
#04	CEPT Narrow	138 ~ 174MHz	148 ~ 174MHz	12.5kHz	12.5kHz

To thoroughly understand the capabilities of the **IC-RP1510**, please study this 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., LOGIC UNIT B-1638A)
3. Schematic part identifier (e.g., IC1)
4. Part number and name (e.g., μPD80C35C, IC)
5. Quantity required (e.g., 2pcs.)

UNPACKING

Accessories included with the IC-RP1510: **Qty.**

- ① Microphone (HM-4) 1
- ② AC cord*1 1
- ③ Microphone hook 1
- ④ Spare fuses for AC line*2 2
- ⑤ Spare fuses for DC line (20A) 2

*1 OPC-034 (#01)
OPC-048A (#02, #03, #04)

*2 117V AC type (#01) 5A
220V, 240V AC type
(#02, #03, #04) 3A

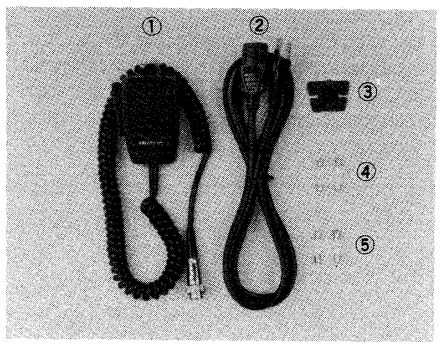


TABLE OF CONTENTS

1. FEATURES

- 50W high power, continuous 24-hour operation capability with a heavy-duty, large heatsink.
- Built-in high stability crystal unit for ±5ppm 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.
- Housed in a durable steel frame to ensure long-term reliability.
- Uses a high performance 8-bit CPU, μPC80C35C, 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:
  Receiver 138 ~ 174MHz
  Transmitter 148 ~ 174MHz

- Number of channels:
  1

- Modes:
  F3 (16K0F3E) (#01, #02, #03)
  F3 (8K50F3E) (#04)

- Repeater control system:
  Carrier or Tone squelch operating system

- Power supply voltage:
  117V, 220V, 240V AC 13.8V DC

- Power consumption:
  Max. 240W

- Usable temperature range:
  −30°C ~ +60°C

- Antenna impedance:
  50Ω

- Frequency stability:
  Less than ±0.0005% (±5ppm)

- Dimensions:
  480(W) x 150(H) x 400(D)mm

- Weight:
  19.0kg

■ TRANSMITTER

- RF output power:
  50W

- Modulation system:
  Variable reactance frequency modulation

- Max. frequency deviation:
  ±5kHz (#01, #02, #03)
  ±2.5kHz (#04)

- S/N ratio:
  More than 40dB for 70% modulation at 1000Hz

- Spurious emissions:
  Less than −60dB below carrier output power (#01, #02)
  Less than −80dB below carrier output power (#03, #04)

- Occupied bandwidth:
  Less than 16kHz (#01, #02, #03)
  Less than 8.5kHz (#04)

■ RECEIVER

- Receiver system:
  Double-conversion superheterodyne

- Intermediate frequencies:
  1st IF 21.8MHz 2nd IF 455kHz

- Sensitivity:
  Less than 0.32μV (−117dBm) for 12dB SINAD
  (#01, #02)
  Less than 0.56μV (−112dBm) for 20dB SINAD
  (#03, #04)

- Squelch sensitivity:
  Less than 0.2μV

- Adjacent channel selectivity:
  More than 70dB (#03)
  More than 60dB (#04)

- Spurious response rejection ratio:
  More than 70dB

- Desensitization:
  More than 70dB

- Intermodulation response:
  More than 70dB (#03)

- AF output power:
  1.7W at 10% distortion with an 8Ω load (#01, #02, #03)
  1.0W at 10% distortion with an 8Ω load (#04)

■ CONTROL UNIT

- Tone decoder CTCSS

  – Frequency:
  88.5Hz ±0.5% (other frequencies available)

  – Response time:
  250msec. or less

- Control function

  – Hang-up time:
  Within 5sec. (selectable)

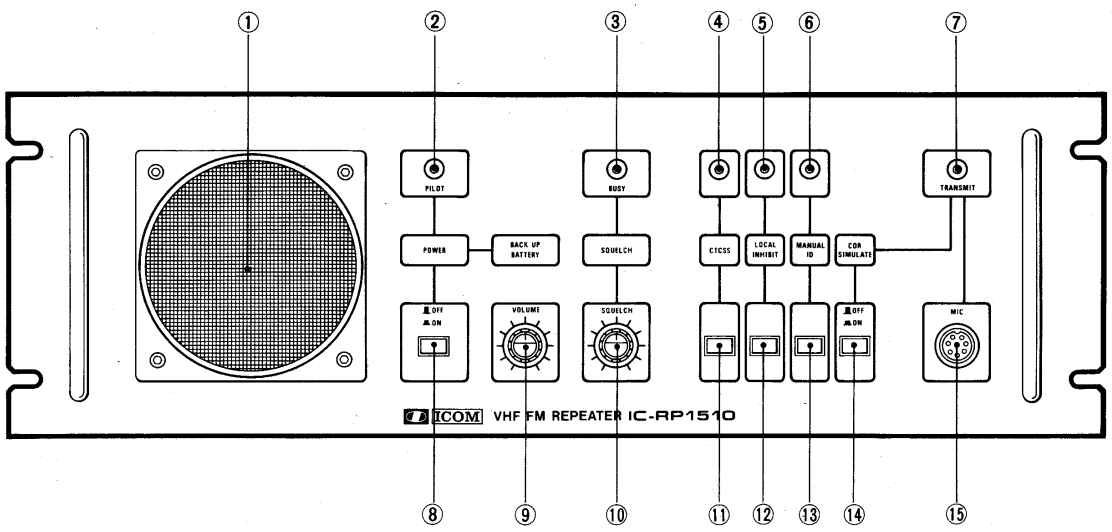
  – ID sending speed:
  3wpm to 20wpm with 800Hz tone

  – ID interval time:
  First transmission after 2 to 3min. transmission

  – Remote control system:
  DTMF control

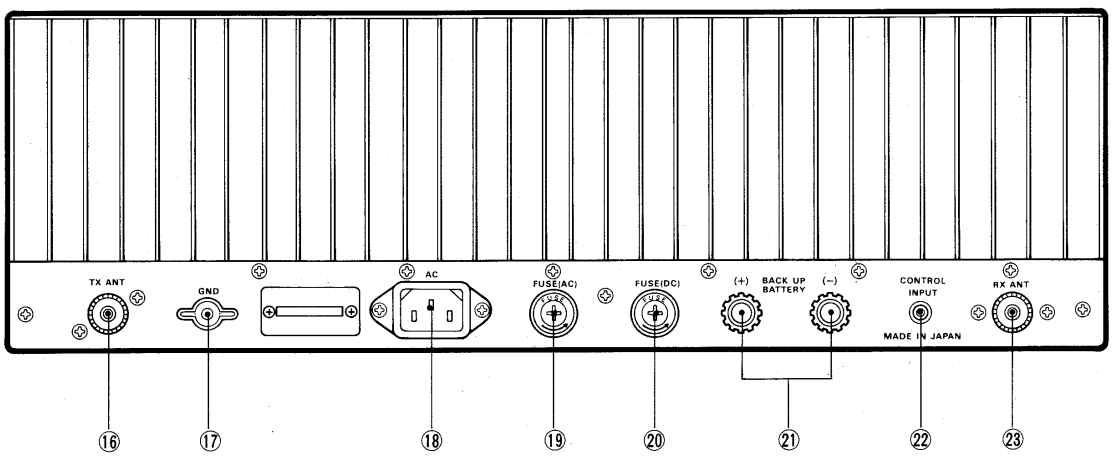
3. CONTROL FUNCTIONS

■ FRONT PANEL



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

■ REAR PANEL



⑯ TRANSMIT ANTENNA CONNECTOR
⑰ GROUND TERMINAL
⑱ AC POWER SOCKET
⑲ AC LINE FUSE HOLDER
⑳ DC LINE FUSE HOLDER
㉑ DC POWER INPUT TERMINALS
㉒ CONTROL SIGNAL INPUT JACK
㉓ 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 CTCSS 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 INTERNAL 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 CTCSS 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 CTCSS 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)

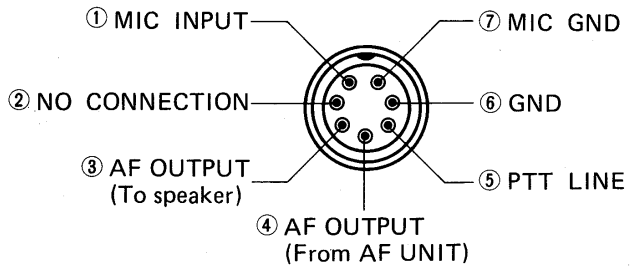
⑭ COR (Carrier Operated Relay) SIMULATE SWITCH
This switch sets the repeater in transmit mode continuously, and can be used for checking repeater functions such as hang-up time, time-out timer, etc. (See item ⑦).

⑮ MIC CONNECTOR
Connects the supplied HM-4 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.

• MIC CONNECTOR CONNECTION
[Front panel view]



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 (#01) : 5A
- AC 220 or 240V type (#02, #03, #04) : 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 CTCSS 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 −30°C or over +60°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 important for reliable radio communications. For this reason, a 50Ω omnidirectional 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. 13A while 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.

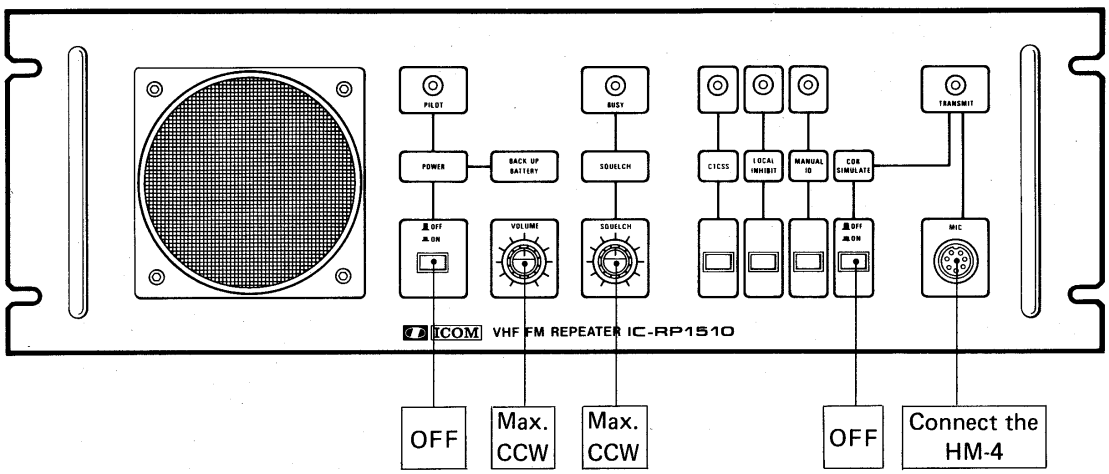
1) Make sure the [POWER] SWITCH is OFF, then plug the AC cord into a domestic AC outlet for AC operation, or apply 12V DC to the DC POWER INPUT TERMINALS for DC operation.

2) An antenna must be connected to the repeater through a duplexer. (See p. 4 - 1)

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

3) A ground connection must be made through the GROUND TERMINAL. (See p. 4 - 1)

4) Connect the supplied HM-4 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 CTCSS 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.

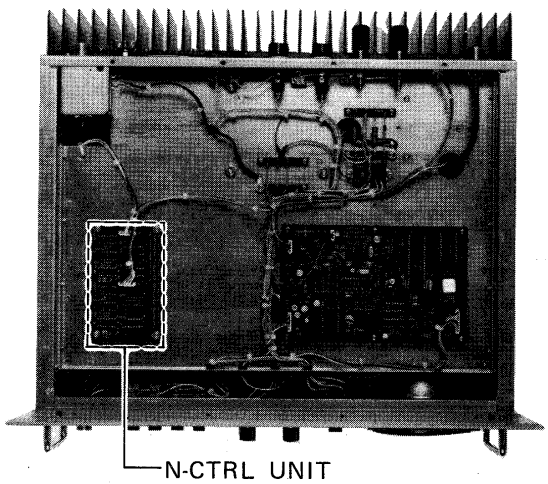
5-3 FREQUENCY PROGRAMMING

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.

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

• BOTTOM VIEW



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.

• RECEIVE FREQUENCY:

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

• TRANSMIT FREQUENCY:

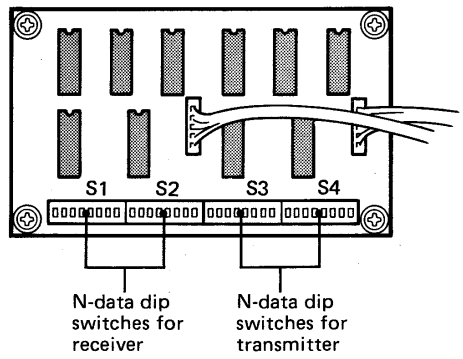
$$\text{N-data} = \frac{\text{Transmit frequency}}{\text{Channel spacing}}$$

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.

• N-CTRL UNIT



• EXAMPLE FREQUENCY SETTING (RECEIVE)

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

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

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

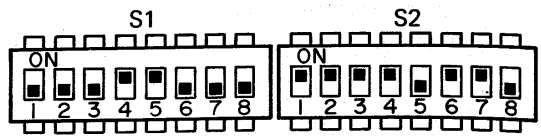
$= 28440$

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

• DIP SWITCH SETTINGS



NOTE: Black areas indicate switch positions.

•EXAMPLE FREQUENCY SETTING 2

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

1) N-data = $\frac{\text{Transmit frequency}}{\text{Channel Spacing}}$

$= \frac{164.60}{0.005}$

$= 32920$

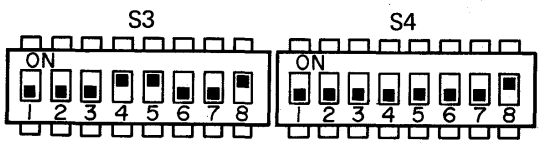
2) Set dip switches in the ON position according to their calculated N-data values.

The following dip switches should be ON:

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

• DIP SWITCH SETTINGS

NOTE: Black areas indicate switch positions.



5-4 CTCSS FREQUENCY PROGRAMMING

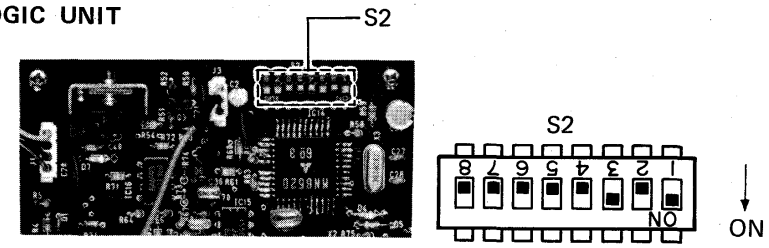
One of 37 kinds of CTCSS decoder frequencies can be set by S2 dip switches on the LOGIC UNIT. See the diagram below for S2 locations.

Use the S2-7 and S2-8 dip switches for fine tuning of CTCSS decoder frequency. See diagram below.

• Example: If the S2-7 and S2-8 dip switches are set in the ON position, and the other switches are set as shown in the figure below, the CTCSS decoder frequency is approximately:

88.5 x (1 + 0.015) = 89.8 [Hz]

• LOGIC UNIT



TONE FREQ. [Hz]	SWITCHES 1	2	3	4	5	6	TONE FREQ. [Hz]	SWITCHES 1	2	3	4	5	6	TONE FREQ. [Hz]	SWITCHES 1	2	3	4	5	6
67.0	1	0	0	0	0	0	110.9	0	1	0	1	0	0	173.8	1	1	1	0	1	0
71.9	0	1	0	0	0	0	114.8	1	1	0	1	0	0	179.9	0	0	0	1	1	0
74.4	0	0	1	0	0	1	118.8	0	0	1	1	0	0	186.2	1	0	0	1	1	0
77.0	1	1	0	0	0	0	123.0	1	0	1	1	0	0	192.8	0	1	0	1	1	0
79.7	0	1	1	0	0	1	127.3	0	1	1	1	0	0	203.5	1	1	0	1	1	0
82.5	0	0	1	0	0	0	131.8	1	1	1	1	0	0	210.7	0	0	1	1	1	0
85.4	0	0	0	1	0	1	136.5	0	0	0	0	1	0	218.1	1	0	1	1	1	0
88.5	1	0	1	0	0	0	141.3	1	0	0	0	1	0	225.7	0	1	1	1	1	0
91.5	0	1	0	1	0	1	146.2	0	1	0	0	1	0	233.6	1	1	1	1	1	0
94.8	0	1	1	0	0	0	151.4	1	1	0	0	1	0	241.8	0	0	0	0	0	1
100.0	1	1	1	0	0	0	156.7	0	0	1	0	1	0	250.3	1	0	0	0	0	1
103.5	0	0	0	1	0	0	162.2	1	0	1	0	1	0	–	–					
107.2	1	0	0	1	0	0	167.9	0	1	1	0	1	0	–	–					

0 : OFF
1 : ON

FINE TUNING [%]	SWITCHES 7	8
+1.5	1	1
+1.0	1	0
+0.5	0	1
0	0	0

0 : OFF
1 : ON

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 LOGIC 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.
- CTCSS 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 CTCSS 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 6 screws on the LOGIC UNIT and lift up the unit.

4) Unsolder and disconnect jumper wires W1 (brown) through W6 (blue) and W9 (white) from the programming area on the unit.

5) Insert the W9 (white) jumper wire into the hole of the first digit selected and solder it from the foil side of the unit.

6) Insert the W1 (brown) and W2 (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 W3 (orange) through W6 (blue) into the hold of the last digit and solder it. W3 through W6 have the following corresponding functions:

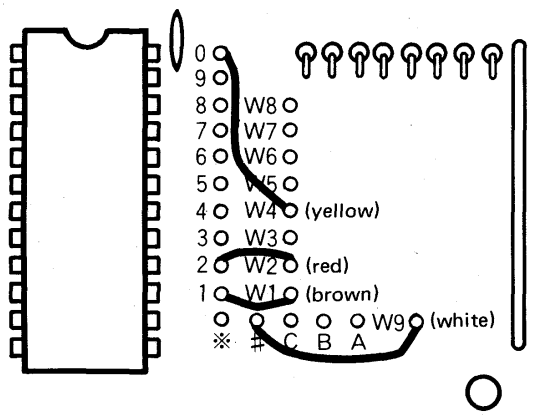
JUMPER WIRE	FUNCTION
W3 (orange)	LOCAL INHIBIT OFF
W4 (yellow)	LOCAL INHIBIT ON
W5 (green)	CTCSS OFF
W6 (blue)	CTCSS ON

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

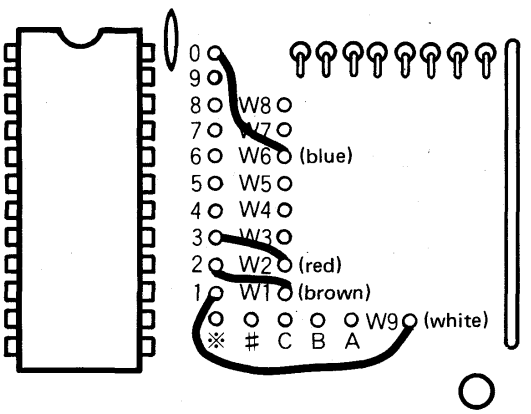
The following are examples for programming remote control codes. Programming should be made on the LOGIC UNIT which is located on the bottom side of the repeater. (See p. 8 - 2 for the exact location.)

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



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

(2) Programming code [1] [2] [3] [0] for the CTCSS ON function.



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

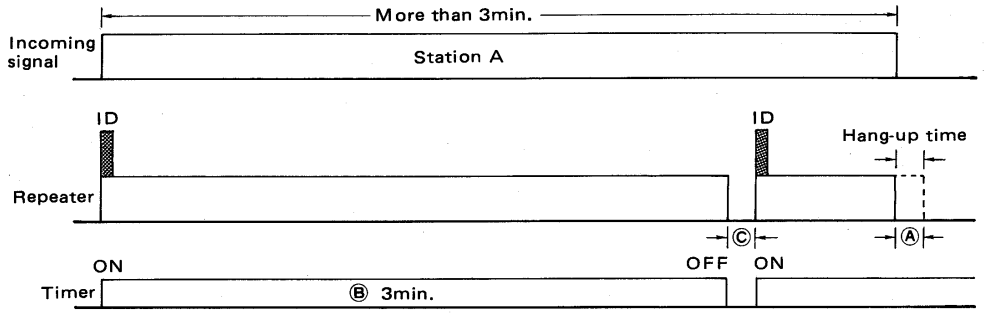
*The first three codes must be the same for the LOCAL INHIBIT ON, LOCAL INHIBIT OFF, and TONE SQUELCH OFF functions.

■ TIMING CHARTS OF TRANSMITTING AND ID EMISSIONS

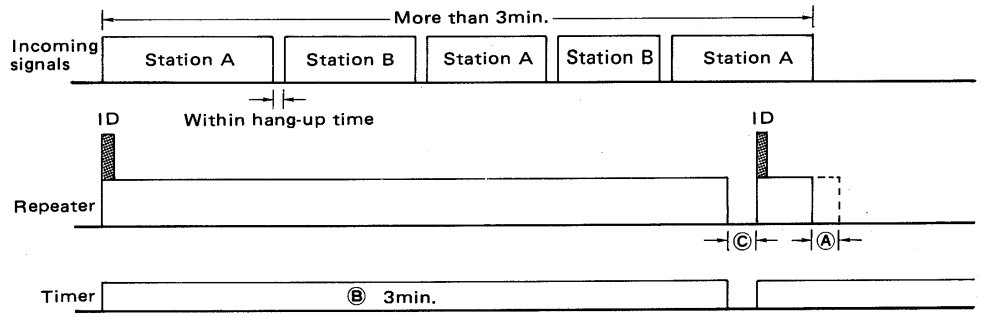
The functions listed below are represented in the diagrams by their assigned letters.

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

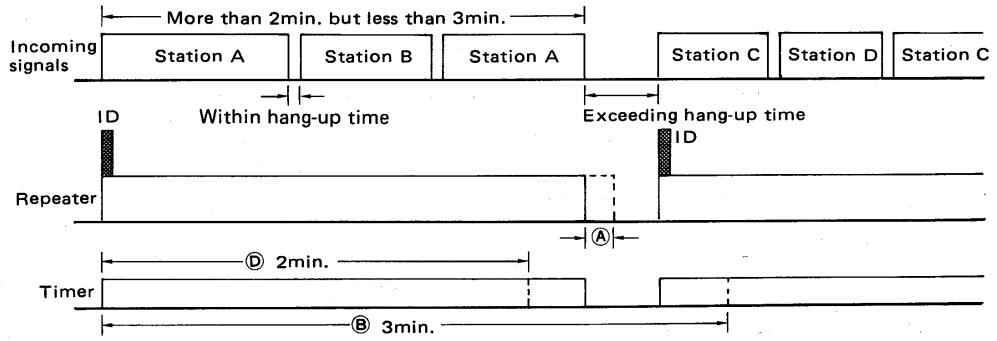
(1) If one station occupies the repeater for more than 3 minutes.



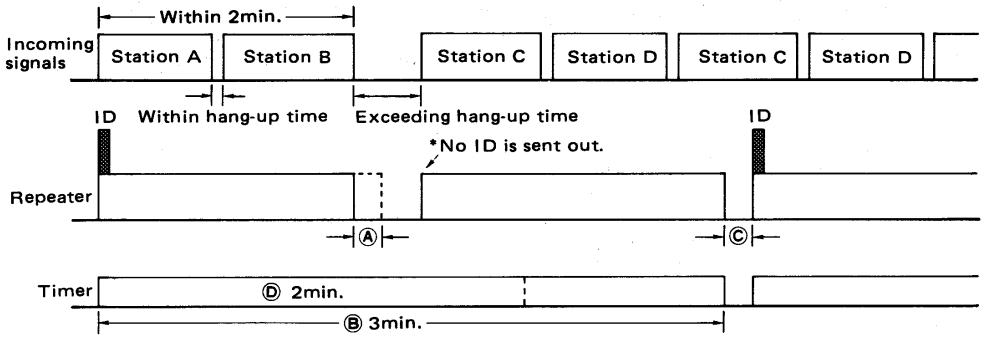
(2) If two stations communicate with each other for more than 3 minutes without an interruption of 5 seconds or more:



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

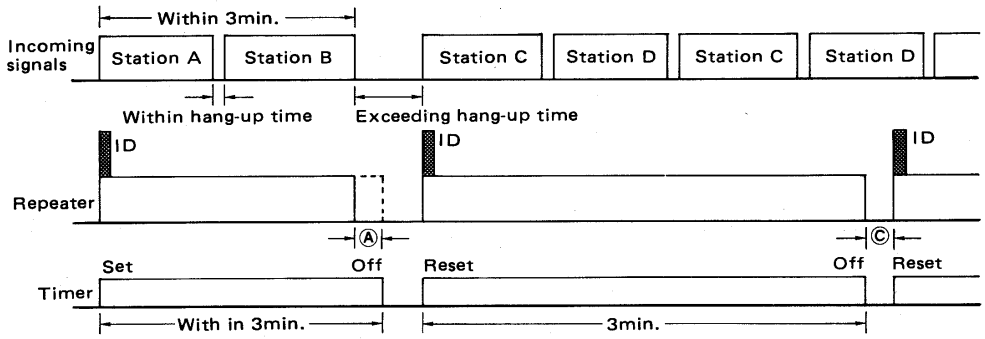


(4) If communication between two stations is completed within 2 minutes, and then other stations use the repeater:



*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).



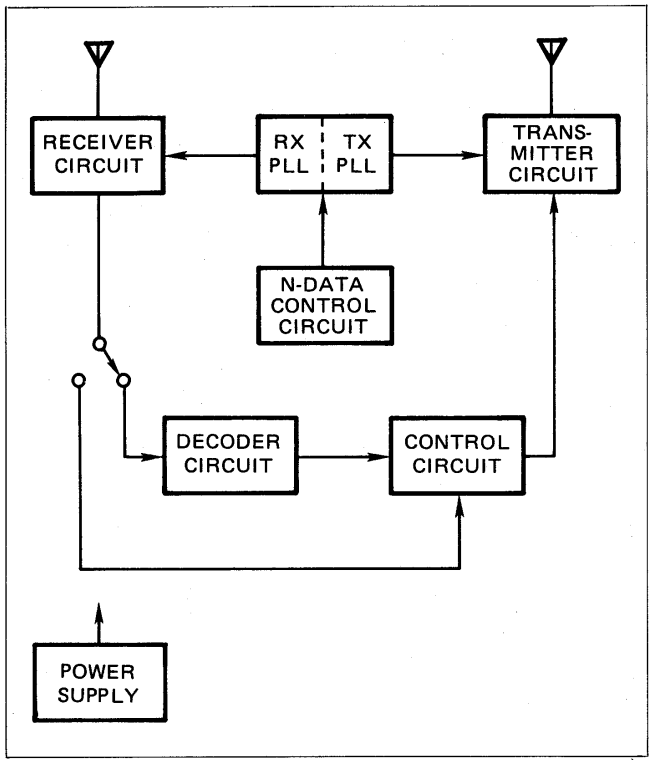
*ID sending speed is 20wpm with this system.

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 (RX UNIT)

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 circuit 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 RX-VCO UNIT.

(2) IF CIRCUIT (RX UNIT)

1st IF signals converted to 21.8MHz are turned into a necessary band by the crystal filter of FI1 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 FI2, 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 (RX UNIT)

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 (RX UNIT)

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 RX UNIT and drives an internal speaker.

(5) P2 CONNECTOR CONNECTIONS

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

7-3 TRANSMITTER CIRCUIT

(1) MIC AMP CIRCUIT (TX UNIT)

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 TX-VCO UNIT in the TX 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 (TX UNIT)

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(1) 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(1) AND PA(2) UNITS)

The PA(1) and PA(2) UNITS are located behind the rear panel heat sink, and is shielded by a metal case.

RF signals from the TX UNIT enter the PA (1) UNIT, are attenuated 10dB by R1 ~ R3, and are amplified at IC1 driver to approx. 2W. Output signals are then amplified at IC2 power amplifier in the PA (2) UNIT to 50W or more.

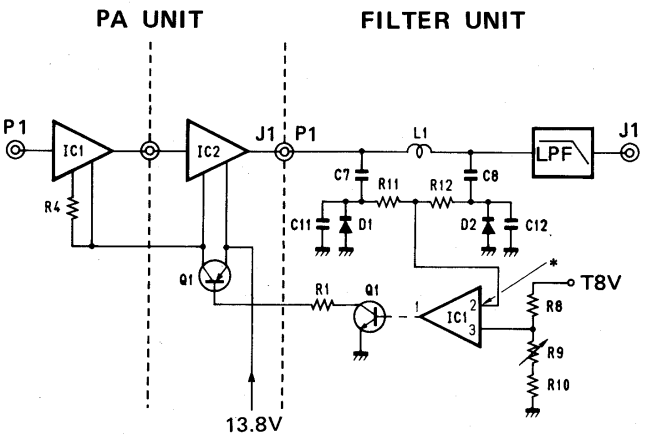
(5) LOW-PASS FILTER CIRCUIT (FILTER UNIT)

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) P10 CONNECTOR CONNECTIONS

PIN NUMBER	CONNECTION
Pin 1	Mic PTT output
Pin 2	PTT control output
Pin 3	13.8V DC input
Pin 4	T8 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 RX and TX UNIT.

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

The receiver VCO Circuit (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 (RX 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.

IC4 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 lockup time.

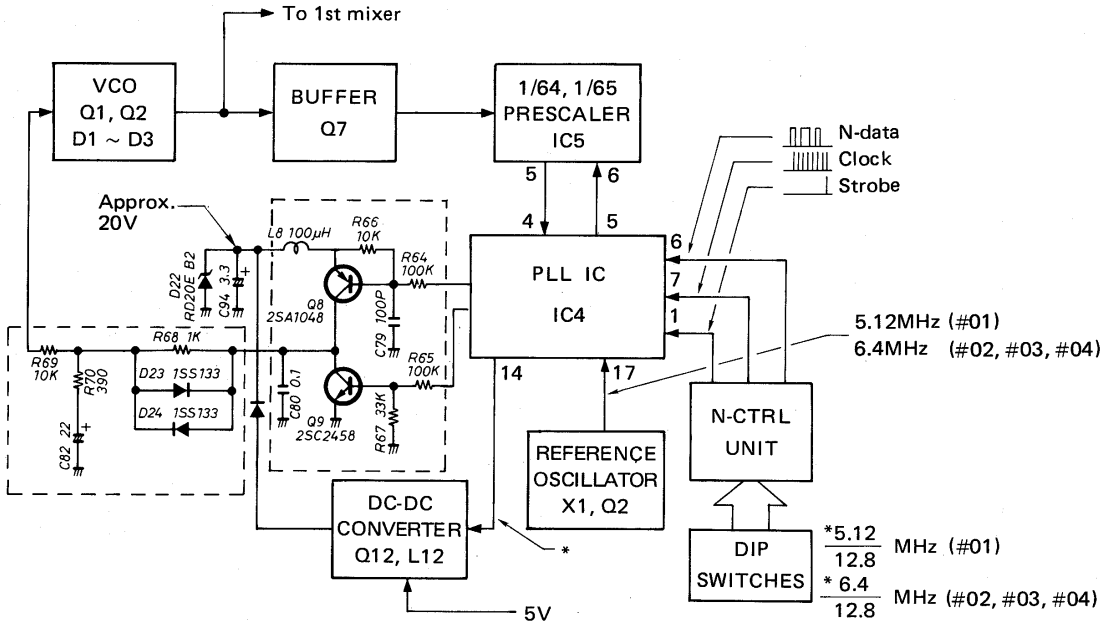
N-data can be obtained using the formula below.

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

(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 5kHz (#01) or 12.5kHz (#02, #03, #04).

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 (TX 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.

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

(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 5kHz (#01) or 12.5kHz (#02, #03, #04).

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 (TX 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 turn 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 circuit 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

ID signals from pin 35 of IC1 (CPU) switch AF signals generated by IC6. To reduce tone distortion, signals are divided by IC7, passed through a low-pass filter consisting of IC8(b) and other parts, then fed to mixer IC8(a).

AF output signals that pass through pin 4 of J4 in the RX UNIT and ID signals from IC8(b) are mixed and amplified at approximately 10dB at IC8(a). They are then mixed and signals are sent out to the TX UNIT through pin 4 of J2 on the LOGIC UNIT.

When the LOCAL INHIBIT FUNCTION is turned ON, IC8(a) is cut off by D8, and no signal is output from IC8(a).

(2) TRANSMISSION CONTROL

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 transmit control circuit is activated while two signals are input: Squelch signals from pin 4 of J1 and the CTCSS decoder signal from pin 23 of IC14.

Both signals are fed to pins 8 and 9 of IC6 through a Schmitt trigger circuit consisting of two inverters in each circuit as BUSY signals.

When the [BUSY] INDICATOR lights up, IC1 sends out a signal for transmit through the PTT line on pin 5 of J2.

(3) TIMER CONTROL

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 IC3. The hang-up timer can be selected for 0, 1, 3 and 5 seconds by combinations of switches S1-1 and S1-2. These are connected to the input terminals of pins 33 and 34 of IC1 (CPU).

(4) OTHERS

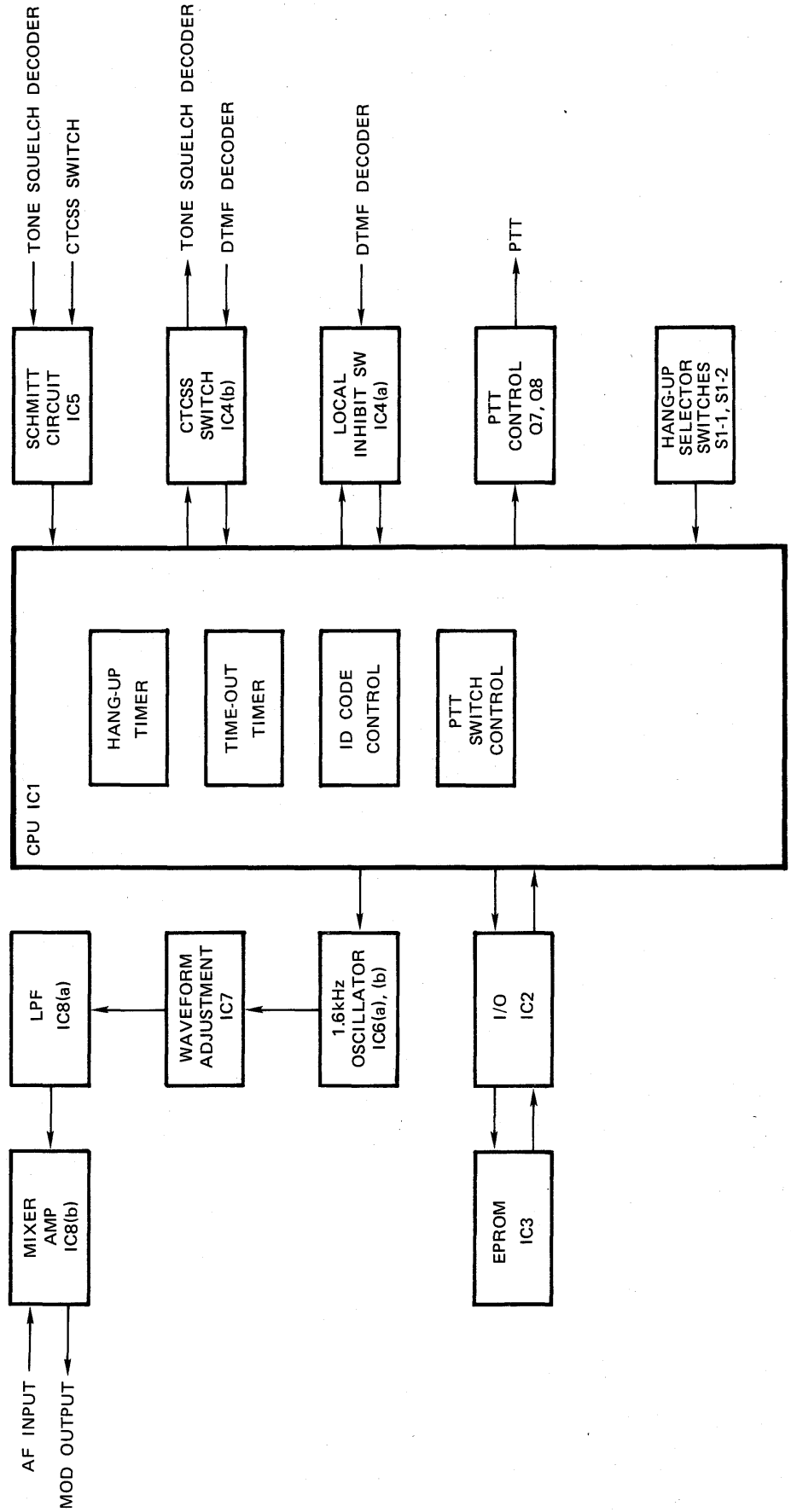
The ON-OFF signal of the [LOCAL INHIBIT] SWITCH is latched at IC4(a) through pin 1 of J4 and passes to IC1 (CPU) through Q2. The output signal also controls the [LOCAL INHIBIT] INDICATOR.

The ON-OFF signal of the [CTCSS] SWITCH is latched at IC4(b). When the [CTCSS] SWITCH is pushed and the [CTCSS] INDICATOR lights up, pin 12 of IC4(b) is at a LOW level and the CTCSS decoder circuit is turned ON. In addition, the output signal from IC4(b) controls the [CTCSS] INDICATOR through Q4.

The two latch circuits in IC4 receive a signal from the IC11 and IC13 for setting or resetting operations.

The signal from the [COR SIMULATE] SWITCH is directly applied to pin 29 of IC1 (CPU).

■ CONTROL CIRCUIT BLOCK DIAGRAM



7-7 CTCSS DECODER CIRCUIT (LOGIC UNIT)

The CTCSS decoder circuit consists of IC15, IC14, IC4(b) Q11 and Q12.

Discriminated AF signals from pin 2 of J2 on the LOGIC UNIT pass through low-pass filter IC15 and are fed to pin 29 of IC14.

IC14 is a tone encoder/decoder IC chip. However, the encoder function is not used. The tone decoder frequency is determined by the S2 dip switches.

When IC14 acknowledges input signals, pin 23 of IC14 becomes "HIGH", turning Q11 and Q12 ON.

IC4 is flip-flop IC chip that controls Q12 emitter voltage using the front panel CTCSS SWITCH or DTMF signal control.

7-8 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.

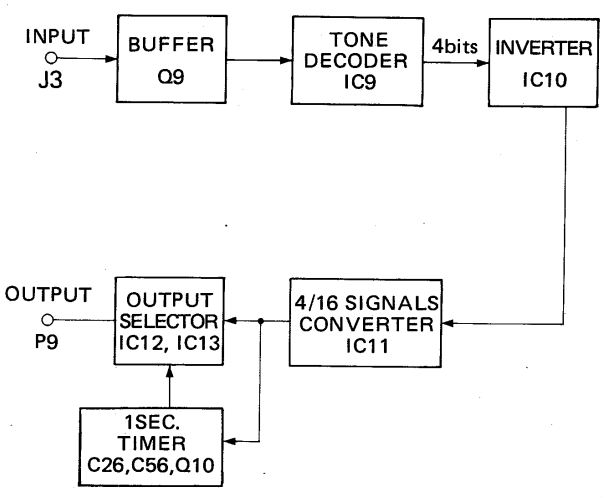
Following is a description for the generator used in the RX UNIT (identical to the generator used in the PLL UNIT).

IC6 functions as a clock generator.

IC7 functions as a clock counter and strobe generator. When IC7 counts 17 clocks, pin 11 of IC8 outputs a strobe signal.

IC9 and IC10 function as a parallel-serial converter and convert parallel signals for PLL N-data which is set by dip switches S3 and S4 for serial N-data.

IC10 outputs N-data signals as a binary code.



7-9 DTMF DECODER CIRCUIT (LOGIC UNIT)

AF signals from the RX UNIT are fed to Q9 on the LOGIC UNIT through J3 and signals are amplified.

IC9 is an IC chip for the DTMF detector. An applied double-tone signal is detected at IC9 and outputs signals as a 4-bit binary code.

IC10 reverses the output signals and converts the signals from 9Vp-p to 5Vp-p.

IC11 converts the input signals to signals of hexadecimals and the signals are fed to IC12 and IC13.

A group of signals is checked for its combination at IC12 or IC13, and is output from pin 9 or pin 10 via IC12, or from pin 9 or pin 10 through IC13.

These signals are then sent to CTCSS switch circuit IC4(b) or local inhibit switch circuit IC4(a) to activate their respective functions.

A-1000
Printed in Japan