



INSTRUCTION MANUAL

VHF dPMR REPEATER

IC-FR5100
IC-FR5100H

UHF dPMR REPEATER

IC-FR6100
IC-FR6100H



IMPORTANT

READ THIS INSTRUCTION MANUAL CAREFULLY before attempting to operate the repeater.

SAVE THIS INSTRUCTION MANUAL— This manual contains important safety and operating instructions for the IC-FR5100 and IC-FR5100H VHF dPMR REPEATERS, and the IC-FR6100 and IC-FR6100H UHF dPMR REPEATERS.

FORWARD

Thank you for purchasing this Icom repeater. The IC-FR5100/H and the IC-FR6100/H are designed and built with Icom's state of the art technology and craftsmanship. With proper care, this product should provide you with years of trouble-free operation.

We appreciate you making the IC-FR5100/H and IC-FR6100/H your repeater of choice, and hope you agree with Icom's philosophy of "technology first." Many hours of research and development went into the design of your IC-FR5100/H and IC-FR6100/H.

◆ FEATURES

○ Up to 2 channel operation (IC-FR5100/IC-FR6100 only)

You can install an optional UR-FR5100/UR-FR6100 channel extension module into a repeater. 2 channels can be utilized when a channel extension module is installed.

○ Built-in 5-Tone, DTMF encoder & decoder

Multiple signaling systems are included as standard. These systems are fully compatible with Icom F-series radios.

○ DTMF remote control capability

You can control the repeater from a remote location over the air, or over a phone line with DTMF.

○ D-Sub 25 pin ACC port equipped

You can use optional equipment connected to the D-sub 25 pin ACC port on the repeater's rear panel.

○ Other features

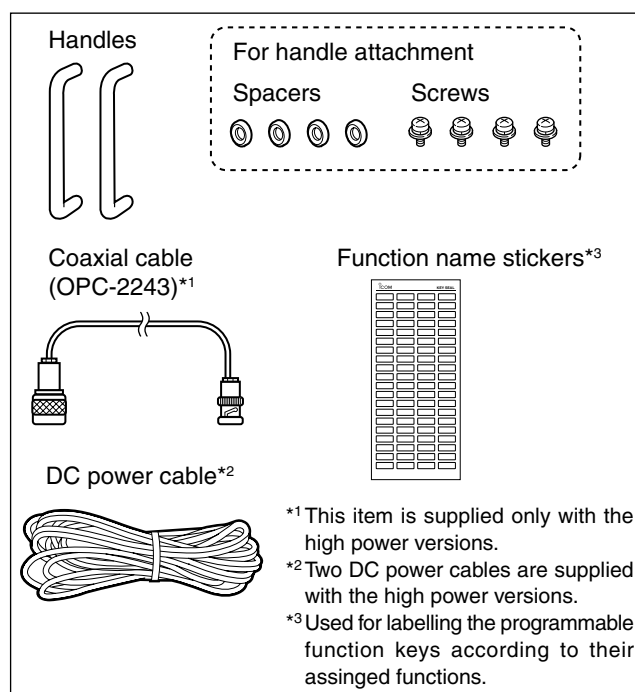
- Wide 136 to 174 MHz, 400 to 470 MHz frequency coverage
- PC programmable
- 19 inch rack mountable
- Optional UT-109R/UT-110R Voice Scrambler Unit for base operation

EXPLICIT DEFINITIONS

WORD	DEFINITION
⚠ WARNING!	Personal injury, fire hazard or electric shock may occur.
CAUTION	Equipment damage may occur.
NOTE	If disregarded, inconvenience only. No risk of personal injury, fire or electric shock.

SUPPLIED ACCESSORIES

The following accessories are supplied.



*1 This item is supplied only with the high power versions.

*2 Two DC power cables are supplied with the high power versions.

*3 Used for labelling the programmable function keys according to their assigned functions.

PRECAUTIONS

⚠ **WARNING HIGH VOLTAGE! NEVER** attach an antenna or internal antenna connector while transmitting. This may result in an electrical shock or burn.

⚠ **WARNING HIGH VOLTAGE! NEVER** install the antenna in a place where a person could easily touch the antenna while transmitting. This could result in an electrical shock or burn.

⚠ **WARNING! NEVER** apply AC to the DC power receptacle on the repeater rear panel. This could cause a fire or damage the repeater.

⚠ **WARNING! NEVER** apply more than 16 V DC to the DC power receptacle on the repeater rear panel. This could cause a fire or damage the repeater.

⚠ **WARNING! NEVER** reverse the DC power cable polarity when connecting to a power source. This could cause a fire or damage the repeater.

CAUTION: NEVER let metal, wire or other objects touch any internal part or connectors on the rear panel of the repeater. This may result in an electric shock.

CAUTION: NEVER expose the repeater to rain, snow or any liquids.

DO NOT operate or place the repeater in areas with temperatures below -25°C or above $+55^{\circ}\text{C}$. Be aware that temperatures can exceed $+80^{\circ}\text{C}$, resulting in permanent damage to the repeater if left there for extended periods.

DO NOT place the repeater in excessively dusty environments or in direct sunlight.

DO NOT put anything on top of the repeater. This will obstruct heat dissipation. Place the repeater in a secure place to avoid inadvertent use by children.

BE CAREFUL: The heatsink will become hot when operating the repeater continuously for long periods.

BE CAREFUL: If a linear amplifier is connected, set the repeater's RF output power to less than the linear amplifier's maximum input level, otherwise, the linear amplifier will be damaged.

USE only the specified microphone. Other microphones have different pin assignments and may damage the repeater.

Place the repeater in a secure place to avoid inadvertent access by children.

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VOICE CODING TECHNOLOGY

The AMBE+2™ voice coding Technology embodied in this product is protected by intellectual property rights including patent rights, copyrights and trade secrets of Digital Voice Systems, Inc. This voice coding Technology is licensed solely for use within this Communications Equipment. The user of this Technology is explicitly prohibited from attempting to extract, remove, decompile, reverse engineer, or disassemble the Object Code, or in any other way convert the Object Code into a human-readable form. U.S. Patent Nos. #8,595,002, #8,359,197, #8,315,860, #8,200,497, #7,970,606, #6,912,495 B2.

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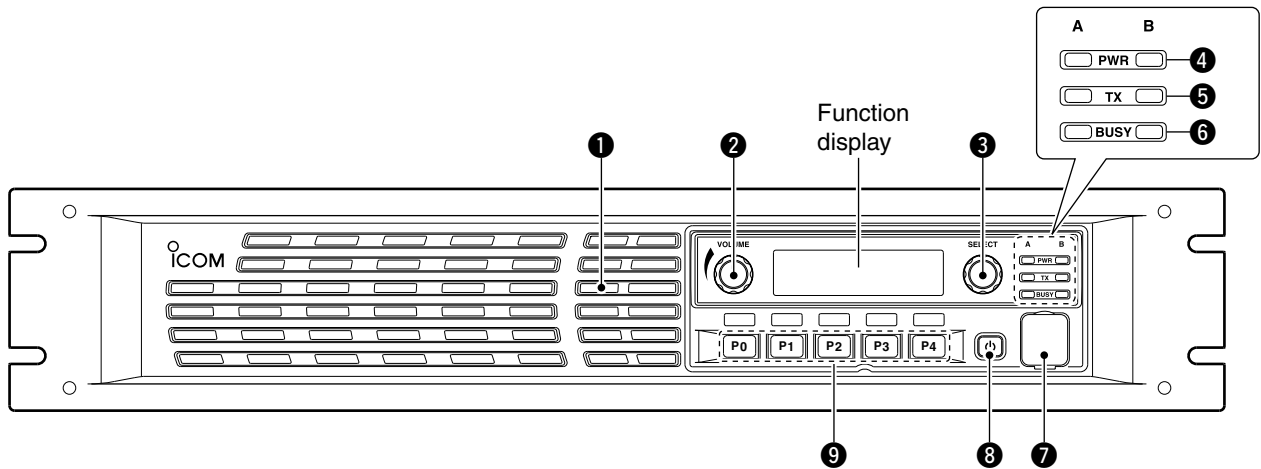
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Front panel



1 INTERNAL SPEAKER

Received audio is heard.

2 VOLUME CONTROL [VOLUME] (p. 8)

Adjusts the audio output level.

3 SELECTOR DIAL [SELECT]

Rotate to adjust the squelch threshold level, or select the operating channel, depending on the pre-programming.

4 POWER INDICATOR [POWER]

➔ Lights green on 'A' module's indicator while the repeater power is ON.

When a channel extension module is installed (For IC-FR5100/IC-FR6100):

- ➔ Lights green on the selected module indicator, 'A' or 'B,' while the repeater power is ON.
- ➔ Lights orange on the un-selected module indicator, 'A' or 'B,' while the repeater power is ON.

5 TRANSMIT INDICATOR [TX]

Lights red while transmitting.

6 BUSY INDICATOR [BUSY]

Lights green while receiving a signal, or when the noise squelch is open.

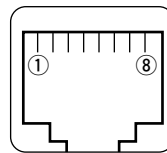
About [PWR], [TX] and [BUSY] indicators (For IC-FR5100/IC-FR6100):

'A' module's indicator corresponds to the original module, and 'B' module's indicator corresponds to the extended module.

7 MICROPHONE CONNECTOR [MIC]

This 8-pin modular jack accepts an optional microphone.

KEEP the [MIC] connector cover attached to the repeater when the microphone is not used.



- ① +8 V DC output (15 mA maximum)
- ② Output port for PC programming
- ③ NC
- ④ M PTT (Input port for TX control)
- ⑤ Microphone ground
- ⑥ Microphone input
- ⑦ Ground
- ⑧ Input port for PC programming

8 POWER SWITCH [POWER]

- ➔ Push to turn ON the repeater power.
- ➔ Hold down for 3 seconds to turn OFF the repeater power.

When a channel extension module is installed (For IC-FR5100/IC-FR6100):

- ➔ While the repeater power is turned ON, push to select the desired module to operate the repeater as a base station.
 - The power indicator of the selected module unit lights green.

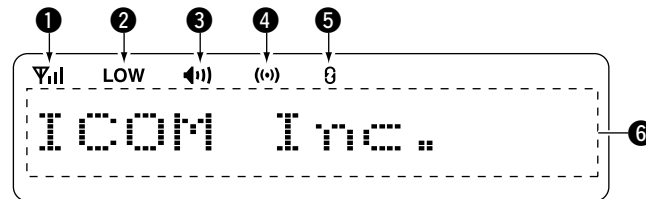
9 DEALER-PROGRAMMABLE KEYS

Desired functions can be programmed for each key by your dealer.

Ask your dealer for details.

- Because these keys are programmable, their functions are unique to each unit.

◇ Function display



1 SIGNAL STRENGTH INDICATOR

Indicates the relative signal strength level.

2 LOW POWER INDICATOR

Appears when low output power is selected.

3 AUDIBLE INDICATOR

Appears when the channel is in the 'audible' (un-mute) mode.

4 COMPANDER INDICATOR

Appears when the compander function is activated.

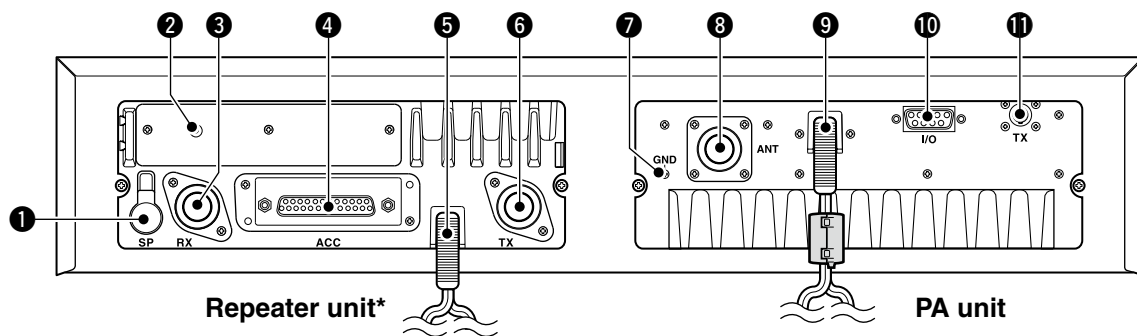
5 SCRAMBLER/ENCRYPTION INDICATOR

Appears when the voice scrambler/encryption function is activated.

6 ALPHANUMERIC DISPLAY

Shows a variety of text and code information.

■ Rear panel



*For the IC-FR5100/IC-FR6100, the repeater unit is installed in the right side (back view).

1 EXTERNAL SPEAKER JACK [SP]

Connects to the optional external speaker.

2 IF SIGNAL OUT CONNECTOR

Connects to a dPMR control unit to output an IF signal.

3 RECEIVE ANTENNA CONNECTOR [RX]

Connects to a 50 Ω antenna to receive.

4 ACCESSORY CONNECTOR [ACC]

See page 3 for accessory connector information.

(For IC-FR5100/IC-FR6100)

Connects to an external equipment.

(For IC-FR5100H/IC-FR6100H)

Connects to the [I/O] connector on the PA unit and/or to an external equipment.

5 DC POWER RECEPTACLE

Connect the supplied DC power cable from this connector to an external 13.2 V DC power source.

6 TRANSMIT ANTENNA CONNECTOR [TX]

(For IC-FR5100/IC-FR6100)

Connects to a 50 Ω antenna to transmit.

(For IC-FR5100H/IC-FR6100H)

Connects to the [TX] connector on the PA unit through the supplied coaxial cable (OPC-2243) to output the repeater's transmit signal to the PA unit.

7 GROUND TERMINAL [GND]

Connect this terminal to ground to prevent electrical shocks, TVI, BCI and other problems.

8 ANTENNA CONNECTOR [ANT]

Connects to a 50 Ω antenna to transmit.

9 DC POWER RECEPTACLE

Connects the supplied DC power cable from this connector to an external 13.2 V DC power source.

10 INPUT/OUTPUT CONNECTOR [I/O]

Connects to the [ACC] connector on the repeater unit through the optional OPC-2202 or OPC-2203.

• See page 6 for the repeater unit connection details.

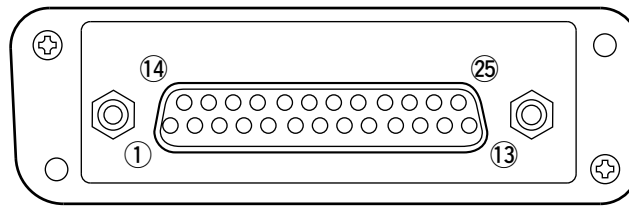
11 RF IN CONNECTOR [TX]

Connects to the [TX] connector on the repeater unit through the supplied coaxial cable to input the repeater's transmit signal.

1 PANEL DESCRIPTION

■ Rear panel (Continued)

◇ Accessory connector



Pin No.	Pin Name	Description	Specification
1	NC	No connection	—
2	TXD	Output terminal for serial communication data.	—
3	RXD	Input terminal for serial communication data.	—
4	RTS	Output terminal for request-to-send data.	—
5	CTS	Input terminal for clear-to-send data.	—
6	NC	No connection	—
7	GND	Serial/digital signal ground	—
8	MOD IN	Modulator input from an external terminal unit.	Input impedance: 2.7 k Ω Input level: 85 mV rms (for 60% deviation) NOTE: If the input impedance is changed to 27 k Ω , a 300 mV rms input level is needed for 60% deviation signal.
9	DISC OUT	Buffer output terminal for AF signals from the AF detector circuit. The output level simultaneously changes with the modulation level of the received signal, regardless of the [AF] control setting.	Output level: 300 mV rms ^{*2} ^{*2} Received 60% deviation signal
10	EXT. D/A	The desired function can be assigned. ^{*1}	—
11	VCC	13.2 V DC output	Output current: Less than 1 A
12	EXT. A/D	Customize A/D input	—
13	NC	No connection	—
14	GND	Ground	—
15	EXT. I/O 15	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
16	EXT. I/O 16	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
17	EXT. I/O 17	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
18	EXT. I/O 18	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
19	EXT. I/O 19	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
20	DATA IN	Input terminal for data. The signals from this terminal bypass the pre-emphasis circuit.	Input impedance: 47 k Ω Input level: 300 mV rms (for 60% deviation)
21	EXT. I/O 21	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
22	AF OUT	Buffer output terminal for AF signals through the de-emphasis circuit from the AF detector circuit. The output level simultaneously changes with the modulation level of the received signal, regardless of the [AF] control setting.	Output level: 300 mV rms ^{*4} ^{*4} Received 60% deviation signal
23	EXT. I/O 23	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
24	EXT. I/O 24	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}
25	EXT. I/O 25	The desired function can be assigned. ^{*1}	+5 V pull up, Active=L ^{*3}

^{*1} The desired function can be assigned using the optional CS-FR5000(dPMR) CLONING SOFTWARE. Ask your dealer for details. The default settings are shown to the right.

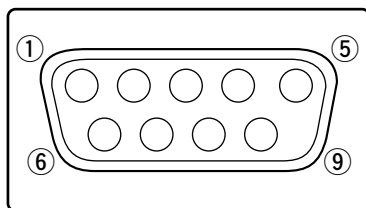
^{*3} The active logic can be set to High using the optional CS-FR5000(dPMR) CLONING SOFTWARE. Ask your dealer for details.

The list shows the default functions that are assigned to the pins 10, 12, 15, 16, 17, 18, 19, 21, 23, 24 and 25.

Pin No.	Pin Name	Default	
		IC-FR5100/IC-FR6100	IC-FR5100H/IC-FR6100H
10	EXT. D/A	Null	Null
12	EXT. A/D	Null	UR-PA5000 Temperature Input* (Connects to Pin 1 of the I/O connector.)
15	EXT. I/O 15	Null	External Alert1 Input* (Connects to Pin 2 of the I/O connector.)
16	EXT. I/O 16	P0 Monitor Output	External Alert2 Input* (Connects to Pin 4 of the I/O connector.)
17	EXT. I/O 17	Busy Output	Busy Output
18	EXT. I/O 18	Null	TX Output* (Connects to Pin 5 of the I/O connector.)
19	EXT. I/O 19	EPTT Input	EPTT Input
21	EXT. I/O 21	Analog Audible Output	50W/100W Output* (Connects to Pin 3 of the I/O connector.) • Depending on the repeater's version, the output power is restricted to 50 W.
23	EXT. I/O 23	Mic Mute Output	Mic Mute Output
24	EXT. I/O 24	Null	Alert Output
25	EXT. I/O 25	Mic Hanger Output	Mic Hanger Output

*When the PA unit is used, these functions must be assigned to the specified pin. Ask your dealer for details.

◇ I/O connector (for the PA unit)



Pin No.	Pin Name	Description	Specification
1	PA TEMP	Output terminal for the PA unit temperature data.	—
2	FAN ALM	Output terminal for the cooling fan data.	H: Normal, L: Fan stops or decreases to half speed.
3	50 W/100 W	Input terminal for the output power selection.	H: 50 W, L: 100 W • Depending on the repeater's version, the output power is restricted to 50 W.
4	RF ALM	Output terminal for the low output power level.	H: Normal, L: Low output power
5	PTT	Input terminal. When grounded, transmit.	H: Standby, L: Transmit
6	NC	No connection	—
7	GND	Connects to the [GND] terminal of the PA unit.	—
8	NC	No connection	—
9	NC	No connection	—

■ Unpacking

After unpacking, immediately report any damage to the delivering carrier or your dealer. Keep the shipping cartons.

For a description and a diagram of accessory equipment included with the repeater, see 'SUPPLIED ACCESSORIES' on page i of this manual.

■ Selecting a location

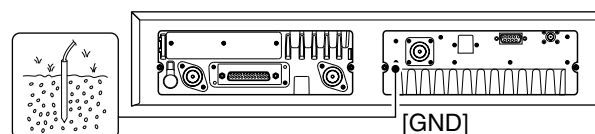
Select a location for the repeater that allows adequate air circulation, free from extreme heat, cold, or vibrations, and away from TV sets, TV antenna elements, radios and other electromagnetic sources.

■ Grounding

To prevent electrical shock, television interference (TVI), broadcast interference (BCI) and other problems, ground the transceiver using the GROUND terminal on the rear panel.

For best results, connect a heavy gauge wire or strap to a long ground rod. Make the distance between the [GND] terminal and ground rod as short as possible.

⚠ WARNING! NEVER connect the [GND] terminal to a gas or electric pipe, since the connection could cause an explosion or electric shock.



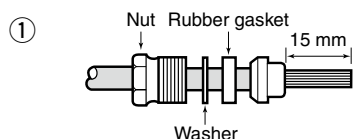
■ Antenna connection

For radio communications, the antenna is a critical component, along with output power and sensitivity. Select antenna(s) such as a well-matched 50 Ω antenna, and feedline. A Voltage Standing Wave Ratio (VSWR) of 1.5:1 or better for the desired band is recommended. Of course, a coaxial cable should be used.

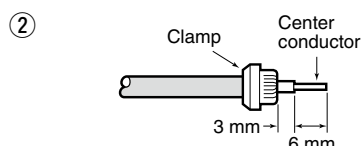
⚠ CAUTION: Protect the repeater from lightning by using a lightning arrestor.

⚠ NOTE: There are many publications that describe proper antennas and their installation. Check with your local dealer for more information and recommendations.

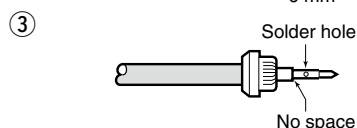
TYPE-N CONNECTOR INSTALLATION EXAMPLE



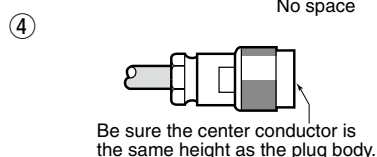
Slide the nut, flat washer, rubber gasket and clamp over the coaxial cable, then cut the end of the cable evenly.



Strip the cable and fold the braid back over the clamp.

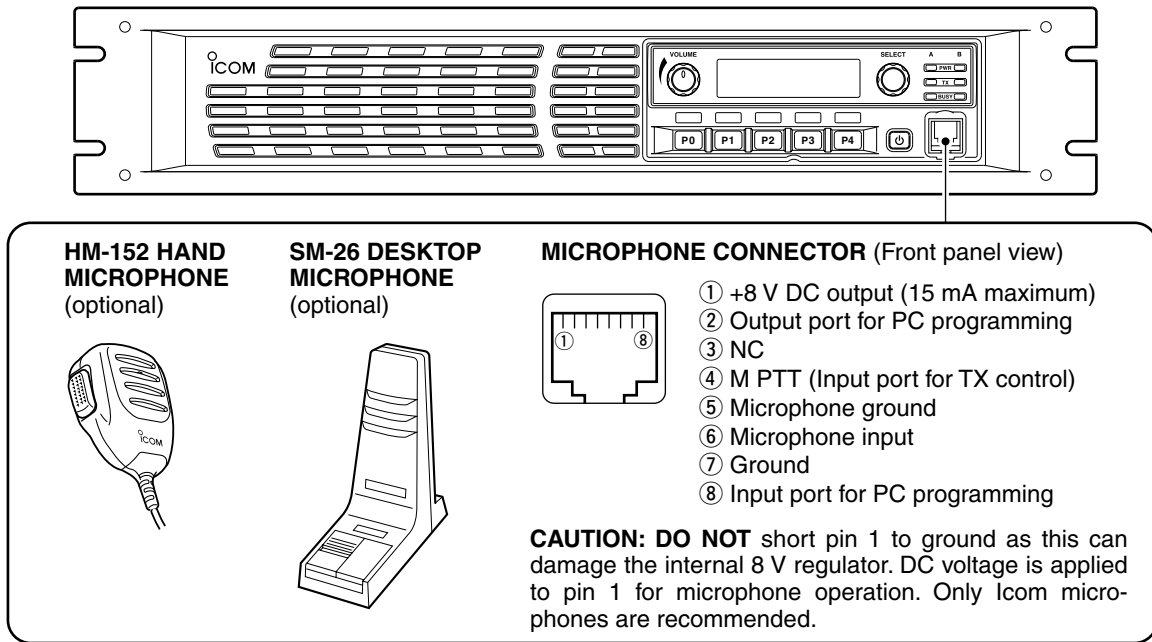


Tin the center conductor. Install the center conductor pin and solder it in place.

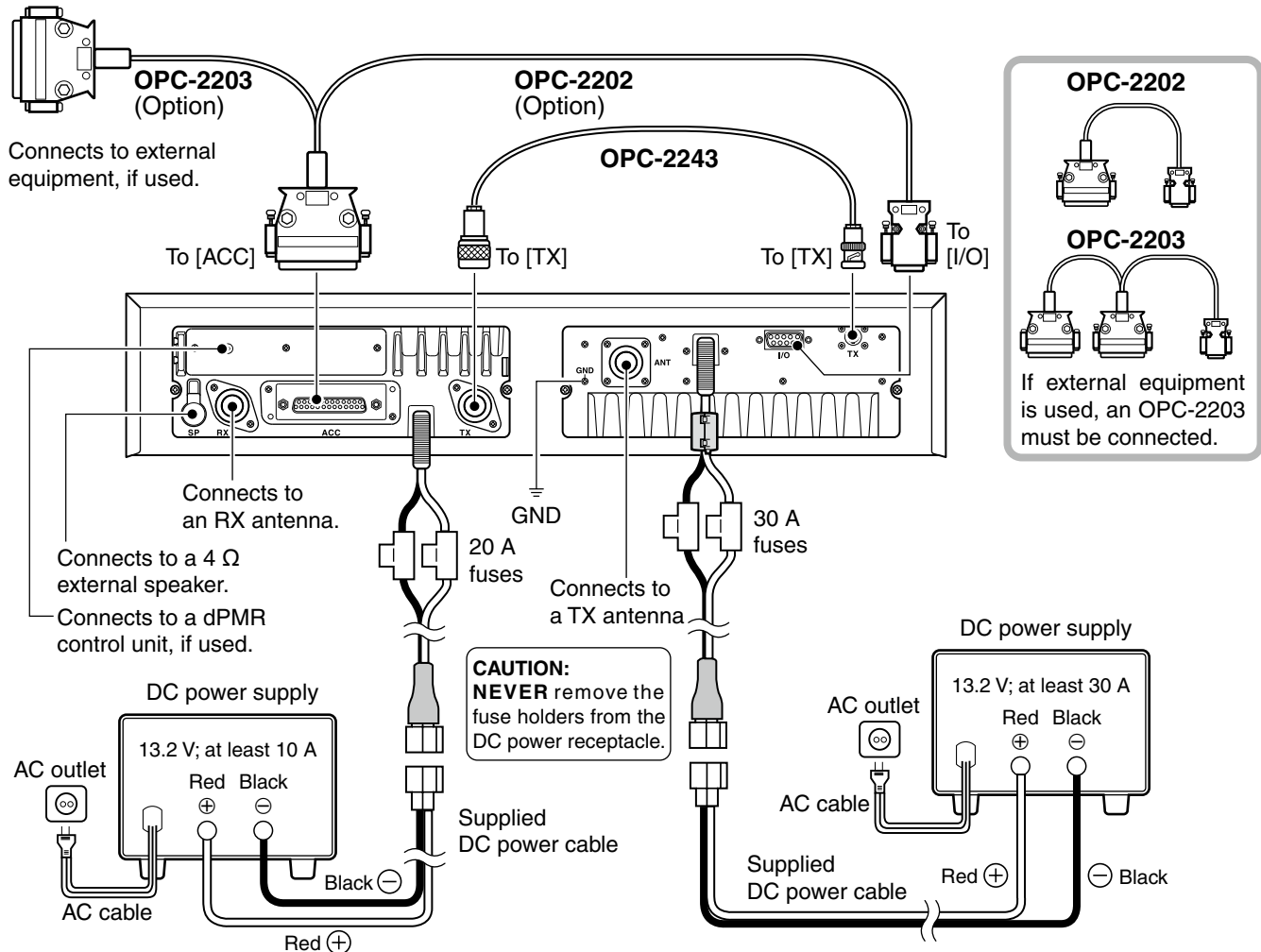


Carefully slide the plug body into place, aligning the center conductor pin on the cable. Tighten the nut onto the plug body.

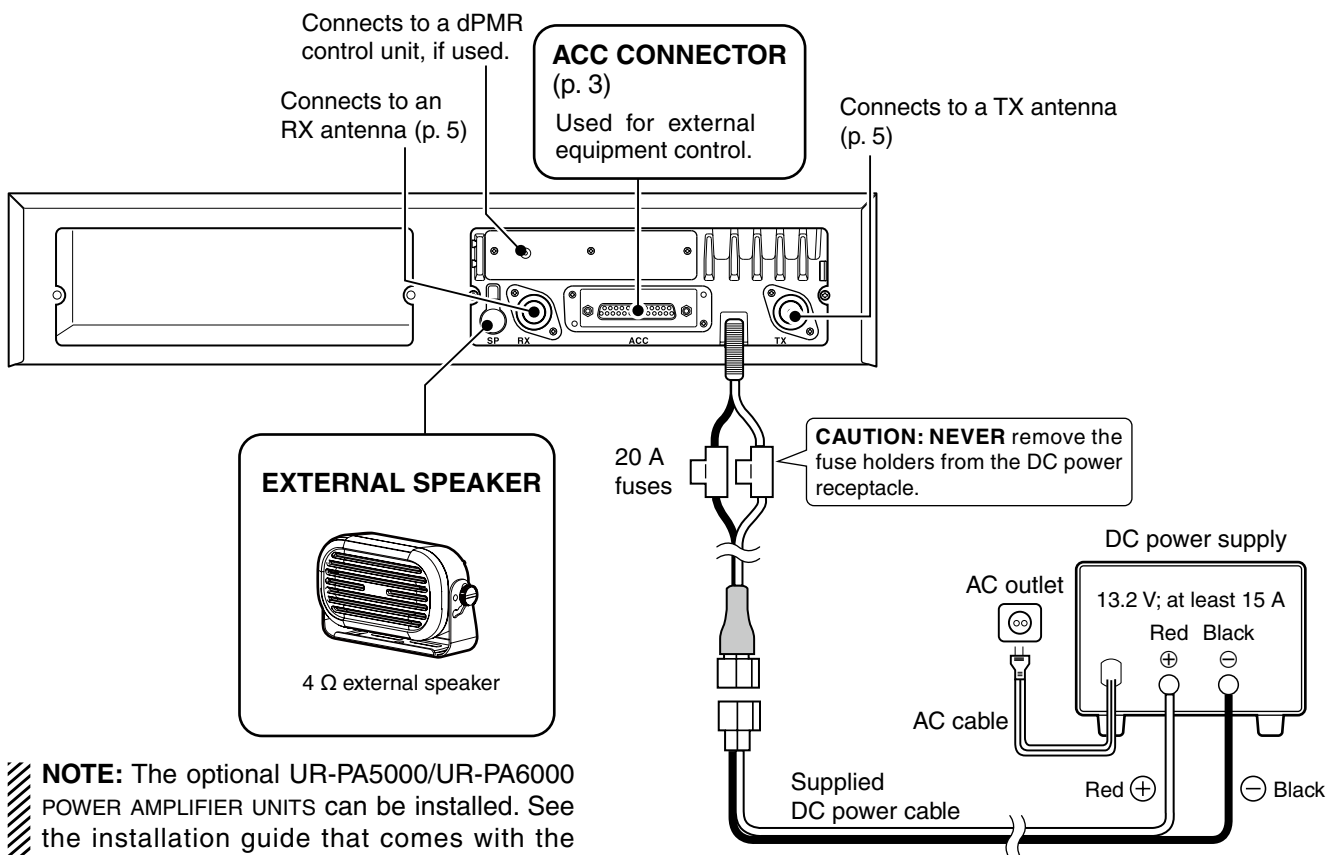
■ Front panel connection



■ Rear panel connection— For the IC-FR5100H/IC-FR6100H



■ Rear panel connection— For the IC-FR5100/IC-FR6100



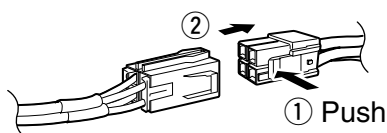
NOTE: The optional UR-PA5000/UR-PA6000 POWER AMPLIFIER UNITS can be installed. See the installation guide that comes with the UR-PA5000/UR-PA6000 for details.

■ Power supply connection

Make sure the repeater's power is turned OFF when connecting a DC power cable.

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

⚠ When you disconnect the DC power cable, take care to not break your fingernail.

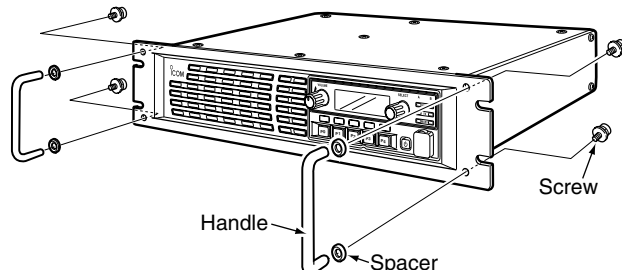


■ Mounting the repeater

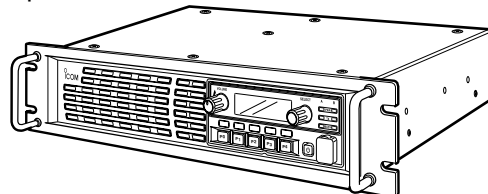
◇ Using the supplied handle

The supplied handles are useful when mounting the repeater into a 19 inch rack. The handles are installed on the repeater's front panel.

- ① Attach the supplied handles to both sides of the repeater's front panel with the spacers, then tighten the screws as shown below.



- ② The completed installation should look like this.



■ Receiving and transmitting

◇ Repeater operation

Ask your dealer for details of the repeater's programming.

- ➔ When the power is turned ON, the **[PWR]** indicator lights green. (p. 1)
- ➔ The **[TX]** and **[BUSY]** indicators light simultaneously while transmitting and receiving a signal.
 - The **[TX]** indicator lights red.
 - The **[BUSY]** indicator lights green.

NOTE: A power amplifier protector is built-in to the repeater. When the repeater temperature becomes extremely high due to the frequently access to the repeater, the protector is activated to reduce the transmit output power level. The output power will return to its normal level when the repeater has cooled down.

◇ Base station operation

Receiving

- ① Push **[POWER]** to turn ON the power.
- ② Set the audio and squelch levels.
 - ➔ Rotate **[SELECT]***¹ fully counterclockwise first.
 - ➔ Rotate **[VOLUME]** to adjust the audio output level.
 - ➔ Rotate **[SELECT]***¹ clockwise until the noise just disappears.
- ③ Push **[CH Up]***² or **[CH Down]***² to select the desired channel.
 - When receiving a signal, the **[BUSY]** indicator lights green and audio is heard from the speaker.
 - Further adjustment of **[VOLUME]** to a comfortable listening level may be necessary at this point.

*¹ When the [SQL Level Up/Down] key function is assigned to [SELECT].

*² When the [CH Up]/[CH Down] key functions are assigned.

Transmitting

- ① Take the microphone off the hook.
- ② Wait for the channel to become clear.
- ③ Hold down **[PTT]** to transmit, then speak into the microphone at your normal voice level.
- ④ Release **[PTT]** to receive.

IMPORTANT:

To maximize the audio quality of the transmitted signal:

- (1) Pause briefly after pushing **[PTT]** before you begin speaking.
- (2) Hold the microphone 5 to 10 cm (2 to 4 inch) from your mouth, then speak at a normal voice level.

■ Troubleshooting

The following chart is designed to help correct problems which are not equipment malfunctions.

If you are unable to locate the cause of a problem or solve it through the use of this chart, contact the nearest Icom Dealer or Service Center.

PROBLEM	POSSIBLE CAUSE	SOLUTION	REF.
Power does not come on when [POWER] is pushed.	<ul style="list-style-type: none"> The power supply is turned OFF. DC power cable is improperly connected. Fuse is blown. 	<ul style="list-style-type: none"> Turn ON the power supply. Reconnect the DC power cable correctly. Check the cause, repair it, and then replace the fuse with a compatible one. 	— pp. 6, 7 p. 9
No sounds are heard from the speaker.	<ul style="list-style-type: none"> Volume level is too low. The squelch is closed. The audio mute function is activated. A selective call or squelch function such as 5 tone call or tone squelch is activated. The front speaker is turned OFF. The function assigned to the pins of the ACC connector is wrong. 	<ul style="list-style-type: none"> Rotate [VOLUME] clockwise to obtain a suitable listening level. While in the base operating mode, rotate [SELECT] counterclockwise to open the squelch. (When the [SQL Level Up/Down] key function is assigned to [SELECT].) Push [MONI] (if assigned) to turn OFF the audio mute function. Turn OFF the appropriate function. Turn ON the front speaker using the CS-FR5000(dPMR) CLONING SOFTWARE. Ask your dealer for details. Assign the correct function using the CS-FR5000(dPMR). Ask your dealer for details. 	p. 8 p. 8 — — — p. 4
Sensitivity is low and only strong signals are audible.	<ul style="list-style-type: none"> Antenna feedline or the antenna connector has poor contact or is shorted. 	<ul style="list-style-type: none"> Check the antenna cable or connector and then reconnect, or replace if necessary. 	pp. 6, 7
Received signal cannot be understood.	<ul style="list-style-type: none"> Optional voice scrambler is turned OFF. Scrambler code is not correctly set. 	<ul style="list-style-type: none"> Turn ON the optional voice scrambler. Reset the scrambler code. 	— —
Output power is too low.	<ul style="list-style-type: none"> Output power is set to Low. Power amplifier protection circuit is activated. The function assigned to the pins of the ACC connector is wrong. 	<ul style="list-style-type: none"> Push [HIGH/LOW] (if assigned) to select High power. Cool down the repeater or stop accessing the repeater until it has cooled down. Assign the correct function using the CS-FR5000(dPMR). Ask your dealer for details. 	— — p. 4
No contact possible with another station.	<ul style="list-style-type: none"> The other station is using tone squelch. While operating in the base mode, the repeater is set to duplex. 	<ul style="list-style-type: none"> Turn the tone squelch function ON. Set the repeater to simplex, when the other transceiver is set to simplex. 	— —
The transmit signal is not output from the PA unit.	<ul style="list-style-type: none"> Power amplifier protection circuit is activated because the repeater unit's output power level is set too high, or too low. 	<ul style="list-style-type: none"> Adjust the repeater's output power level to 5 W. 	—
The PA unit temperature data cannot be detected.	<ul style="list-style-type: none"> The function assigned to the pins of the ACC connector is wrong. 	<ul style="list-style-type: none"> Assign the correct function using the CS-FR5000(dPMR). Ask your dealer for details. 	p. 4

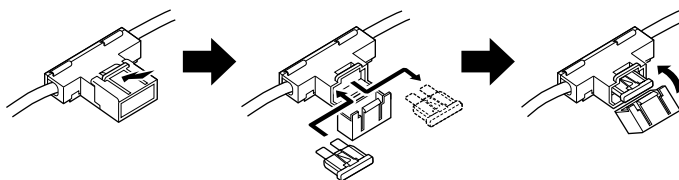
■ Fuse replacement

If a fuse blows, and the repeater stops functioning, find the source of the problem, repair it, and then replace the damaged fuse with a new matching rated fuse.

CAUTION: DISCONNECT the DC power cable from the repeater. Otherwise, there is danger of an electric shock and/or equipment damage.

◇ Line fuse replacement

Fuse rating: 20 A (for the repeater unit),
30 A (for the PA unit)
USE the specified fuse only.

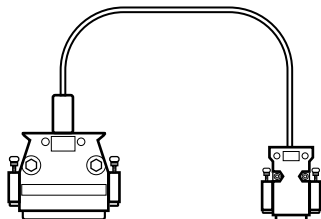


- **SP-22/SP-35** EXTERNAL SPEAKERS
Compact and easy-to-install.
Input impedance : 4 Ω
Maximum Input power : 7 W maximum

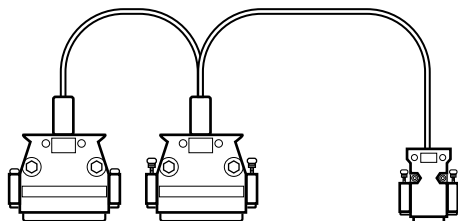
- **HM-152** HAND MICROPHONE

- **SM-26** DESKTOP MICROPHONE

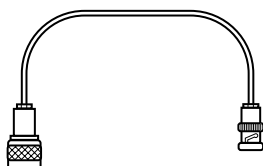
- **OPC-2202** CONNECTION CABLE
Connects between the repeater unit and the PA unit.



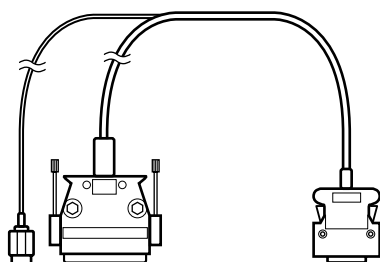
- **OPC-2203** CONNECTION CABLE
Connects between the repeater unit, the PA unit and the dPMR control unit.



- **OPC-2243** COAXIAL CABLE
Connects between the [TX] connectors of the repeater unit and the PA unit.



- **OPC-2311** CONNECTION CABLE
Connects between the repeater unit and the dPMR control unit.
*OPC-2203 is additionally required for the IC-FR5100H/IC-FR6100H.



- **UC-FR5000** TRUNKING/NETWORK CONTROLLER

- **UT-109R** VOICE SCRAMBLER UNIT
Non-rolling type (32 codes maximum).

- **UT-110R** VOICE SCRAMBLER UNIT
Rolling type (1020 codes maximum).

NOTE: The scrambler systems of the UT-109R and UT-110R are not compatible with each other.

For only the IC-FR5100 and IC-FR6100:

- **UR-PA5000/UR-PA6000** POWER AMPLIFIER UNITS

- **UR-FR5100/UR-FR6100** CHANNEL EXTENSION MODULES

Approved Icom optional equipment is designed for optimal performance when used with an Icom transceiver. Icom is not responsible for the destruction or damage to an Icom transceiver in the event the Icom transceiver is used with equipment that is not manufactured or approved by Icom.

Some options may not be available in some countries. Please ask your dealer for details.

INSTALLATION NOTES

• Compliance of base station transmitter installations with EN50385

The installation of this equipment and its associated antenna should be made in such a manner as to respect the EC recommended electromagnetic (EM) field exposure limits. (1999/519/EC)

In order not to exceed these exposure limits it is necessary to determine the 'Compliance Boundary,' that means the volume within which the EM field radiated by the transmitter/antenna installation may exceed the 1999/519/EC limits. You will then need to ensure that members of the general public do not have access within this area. The actual Compliance Boundary for this repeater will be totally dependant on the antenna, feeder, RF amplifier and other passive or active devices used in the installation.

The RF output power of this repeater is 25 watts.

The figures contained in this guide are based on the recommended limits for the general public and are obtained by 'worst case' numerical analysis. For a definitive evaluation of any given installation, measurements should be made with an EM field meter and a broad-band calibrated probe.

• Installation

The antenna should be installed as high as possible for maximum efficiency and minimum EM field at ground-level. The evaluation of radiated field should take into account any additional RF amplifiers used, any loss in the antenna feeder cable and the gain of the antenna used as well as its polar radiation pattern.

If there are any objects or structures larger than half a wavelength close to the antenna, or within the clearance distances specified, then these can cause reflections which will have an effect on the overall radiation pattern.

For any installation you need to consider 'height clearance' (i.e. the height above any place where persons may have access) and 'front clearance' (i.e. the distance in front of the antenna where the radiated field may exceed the recommended limits). Normally with an antenna installed on a reasonably high mast or tower, there will not be any access point directly in front but care should be exercised when there are other buildings higher than the antenna within the vicinity.

• Installation with a vertical type antenna at VHF-UHF

You need to consider the distances between the antenna and any point where persons may have access. Allowing an average height of 1.8 m for a person in the vicinity of the antenna the clearance distances can be evaluated as follows. For the antenna a forward gain of 1.6 and downward gain of unity has been assumed.

Power	EIRP	Distance	Height clearance	Front clearance
1 watt	1.6 watts	0.32 m	2.1 m	0.4 m
10 watts	16 watts	1 m	2.8 m	1.3 m
25 watts	40 watts	1.6 m	3.4 m	2 m
100 watts	160 watts	3.2 m	5 m	4 m
1 kW	1600 watts	10 m	12 m	13 m

• Installation with a Yagi or directive type antenna

Exposure distance assumes that the predominant radiation pattern is forwards and that radiation vertically downwards is at unity gain (sidelobe suppression is equal to main lobe gain). This is true of almost every gain antenna today. Exposed persons are assumed to be beneath the antenna array and have a typical height of 1.8 m.

The figures assume the worst case emission of constant carrier.

RF power Clearance heights by frequency band

Watts	10–2 m	70 cm	23 cm	13 cm and above
1	2.1 m	2 m	2 m	2 m
10	2.8 m	2.7 m	2.5 m	2.3 m
25	3.4 m	3.3 m	2.7 m	2.5 m
100	5 m	4.7 m	3.6 m	3.2 m
1000	12 m	11.5 m	7.3 m	6.3 m

EIRP Forward clearance, EIRP by frequency band

Watts	10–2 m	70 cm	23 cm	13 cm and above
100	2 m	2 m	1.1 m	0.7 m
1000	6.5 m	6 m	3.5 m	3 m
10,000	20 m	18 m	11 m	7 m
100,000	65 m	60 m	35 m	29 m

• Typical installation example

A UHF base station transmitter is to be installed on the roof of an office.

The transmit power is 25 watts, there is 20 m of RG-213 coaxial cable and the antenna is a vertically polarised dipole.

The specification of the RG-213 cable gives a loss of 1.5 dB/10 m. There will be 3 dB loss for the 20 m length used.

The RF power at the antenna input will be 12.5 watts.

The dipole antenna has a forward gain of 0 dBd or 1.6, giving an EIRP of 20 watts.

Referring to the table above for VHF/UHF vertical antennas, this gives a front clearance distance of approx. 1.5 m and a height clearance of 3 m.

The antenna installation needs to ensure that the lowest part of the antenna is at least 3 m above any point where the general public may gain access and that they cannot pass within 1.5 m in front of the antenna.

If there is no general public access to the roof in question then the antenna could be mounted on a short stub mast. If there is such access to the roof then the antenna could be mounted on top of a short mast of 3.2 m high. The mast position should be such that the antenna can radiate clearly i.e. no other object or structure is within 1.5 m (preferably more).

It should be relatively easy to fulfil all these recommendations.

If for any reason such minimum distances are impossible to guarantee then some type of access control fence or barrier around the antenna installation should be provided.

Should a Yagi type antenna be used then you will have to obtain a 3 dimensional polar plot of the radiation characteristic from the manufacturer and evaluate the clearance distances in both vertical and horizontal planes.

• Operating Notes

All of the above comments on RF safety assume that the radio is transmitting continuously in a constant carrier mode such as FM or RTTY etc.

The RF exposure limits recommended by the EC are based on the mean power averaged over a 6 minute period.

Therefore if the total transmit time during any 6 minute period is reduced, then the installation will be even further within the recommended limits.

Count on us!