



User Manual
DR-9200 DIGITAL REPEATER



SHENZHEN HQT SCIENCE & TECHNOLOGY CO., LTD.

For more information, please visit www.hqtsolutions.com

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if there is fluctuation, please take the material object as the standard.

Statement

HQT endeavors to achieve the accuracy and completeness of this manual. As for any inaccuracies and omissions that may possibly occur, the right to interpret is reserved to Shenzhen HQT Science & Technology Co., Ltd.

The design and specifications of this product are subject to being modified by Shenzhen HQT Science & Technology Co., Ltd. without prior notice.

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Hello

Thank you for purchasing HQT DMR digital repeater DR-9200. As a product built to the DMR standard, DR-9200 is endowed with ergonomic design, reliable performance and comprehensive digital functions to deliver an advanced communication solution. With DR-9200 you can make use of digital advantages to top the competitiveness! To get maximum benefits from the product, please read this manual carefully before use.

HQT On-line Service Center

More detailed product information



More professional technical support



HQT service network provides more information about on-line service of HQT two-way radio.

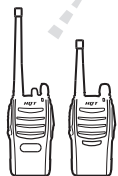
More detailed product information

To deepen your understanding of the functions of this radio.

More plentiful product models

To display more plentiful product models, so that you can understand the details of these products in advance and make decisions correctly according to the requirements of work.

For more details, please visit: www.hqtsolutions.com



More plentiful product models



More optional accessories

More Professional Technical Support

User Manual and Brochures

To provide downloading or on-line reading of the latest user manuals and brochures in covering detailed information of two-way radios.

Software Download

To provide downloading of the latest programming software from HQT website. You can connect your two-way radio to the computer with a programming cable to manage or edit the parameters of channel frequency and other items.

On-line Learning

To offer guidelines for detailed setting of the two-way radio.

More Optional Accessories

To provide various kinds of accessories which can offer more comfortable operation and more remarkable performance of the radio to you.

Safety Information

Please read the following safety guidelines. Nonobservance of these guidelines may cause danger or violation of law.



Warning

Don't transmit with antenna detached from the radio or don't damage or change antenna type. Strong electronic waves are emitted from the radio and damages or changes to the antenna may effect the performance of the radio, and it may cause the radio to be defective and not covered under warranty.



Warning

Don't use other manufacturers' accessories. Unknown or unauthorized accessories may cause the radio to be defective and not covered under warranty.



Warning

Don't disassemble the radio. Disassembly of the radio may cause a serious defect or malfunction and not be covered under warranty.



Warning

Don't give an excessive shock to the radio.
Don't place the radio where the direct sunlight or high temperature occurs.
Don't make a damage to the battery pack by sharp substance or an excessive shock.



Warning

Turn off the radio before boarding on an airplane.
Don't use the radio in the hospital without any pre-approval.
Don't use the radio at the place of where computer or other electronic devices are being used.



Warning

- Please keep the radio at least 1 inch away from the human body.
- Don't give any damage to antenna.
- When using earphone, please reduce the volume to a low level. If not, unexpected high sound may have harmful effect to your ear.
- Don't touch the conductive metal of the battery radio with wet hands. It may cause damage on your hands.
- Please be careful when putting the battery in a pocket or a bag.

FCC RF EXPOSURE COMPLIANCE REQUIREMENTS FOR OCCUPATIONAL USE ONLY

The Federal Communications Commission (FCC), with its action in General Docket 93-62, November 7, 1997, has adopted a safety standard for human exposure to Radio Frequency (RF) electromagnetic energy emitted by FCC regulated equipment. Proper operation of this radio will result in user exposure far below the Occupational Safety and Health Act (OSHA) and Federal Communications Commission limits.

- **DO NOT** transmit for more than 50% of total radio use time (50% duty cycle). Transmitting more than 50% of the time can cause FCC RF exposure compliance requirements to be exceeded.
- This radio is NOT approved for use by the general population in an uncontrolled environment. This radio is restricted to occupational use, work related operations only where radio operator must have the knowledge to control the user's exposure conditions for satisfying the higher exposure limit allowed for occupational use.
- When transmitting, hold the radio in a vertical position with its microphone 1 inch (2.5cm) away from your mouth.
- The radio is transmitting when the red LED on the front of the radio is illuminated. You can cause the radio to transmit by pressing the PTT bar on the radio.
- These are required operating configurations for meeting FCC RF exposure compliance. Failure to observe these restrictions mean violation.

FCC Notice

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

1. RF Radiation Information

This product must be restricted to operations in an Occupational/Controlled RF exposure Environment. Users must be fully aware of the hazards of the exposure and who are able to exercise control over their RF exposure to qualify for the higher exposure limits.

RF Radiation profile

Radio Frequency (RF) is a frequency of electromagnetic radiation in the range at which radio signals are transmitted. RF technology is widely used in communication, medicine food processing and other fields. It may generate radiation during use.

RF Radiation Safety

In order to ensure user health, experts from relevant industries including science, engineering, medicine and health work with international organizations to develop standards for safe exposure to RF radiation.

These standards consist of:

United States Federal Communications Commission, Code of Federal Regulations; 47 CFR part 2 sub-part J;

American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) C95.1-1992;

- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999;
- International Commission on Non-ionizing Radiation Protection (ICNIRP) 1998.

FCC Regulations

Federal Communication Commission (FCC) requires that all radio communication products should meet the requirements set forth in the above standards before they can be marketed in the U.S., and the manufacturer shall post a RF label on the product to inform users of operational instructions, so as to enhance their occupational health against exposure to RF energy.

Operational Instructions and Training Guidelines To ensure the optimal performance and the compliance with occupational controlled environment RF radiance limits in the above standards.

2. This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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Safety Matters

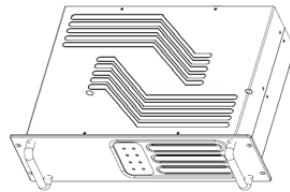
Please read the rules below. Nonobservance of these rules may cause danger or violation of law.

- The use of this radio must comply with regulations of local government.
- Turn off the radio before you enter places of potentially explosive or flammable environment.
- Do not replace or charge battery pack in places of potentially explosive or flammable environment.
- Turn off the radio before you approach blasting area and detonator area.
- Do not use the damaged antenna which may cause a minor burn on skin.
- Only qualified technicians are allowed to maintain this two-way radio. Do not disassemble the radio by yourself.
- To avoid problems caused by electromagnetic interference or electromagnetic compatibility, please turn off the radio in places with "Wireless Communication Transmit Equipment Prohibited" mark, such as hospitals or other health care places. When taking a plane, turn off the radio if required.
- In a car with air bag, do not place the radio within possibly involved area when air bag inflates.
- Do not expose the radio to direct sunlight or near heating devices for a long time.
- Keep the radio vertical and speak near the microphone during transmitting.
- Make sure that the antenna is 2.5 cm away from the body during transmitting if you wear the radio on your body.

Product Inspection

Please unpack carefully and check that all items listed below are received. If any item is missing or damaged, please contact your dealer.

1 Repeater



2 Power Cable



3 Data Kit



General Installation

Proper installation can ensure optimum performance and reliability of the HQT repeater and, therefore, pre-installation planning is required. This includes considering the mounting location of the equipment in relation to input power and antenna. Also to be considered are site environment conditions, the particular mounting method (several available), and the required tools and equipment.

If this is the first time installing this type of equipment, it is highly recommended that be sure to read the following installation requirements and instructions carefully before beginning the actual installation.

Pre-Installation Overview

The information below is an overview for installing the HQT repeater and auxiliary equipment.

- Pay particular attention to environment conditions at the site, ventilation requirements, and grounding and lightning protection in pre-installation.
- Unpack and inspect the equipment.
- Mechanically install the equipment at the site.
- Make necessary electrical and cabling connections, including the following:
 - AC input power cable.
 - Connect coaxial cables to TX and RX antenna.
- Perform a post-installation function check test of the equipment, to verify proper installation.

- Configure parameters (e.g. Working Frequency, PL, Code, Color Code etc.) of the repeater based on user's requirements

Environmental Conditions at Intended Installation Site

The repeater may be installed in any location suitable for electronic communications equipment, provided that the environmental conditions do not exceed the equipment specifications for temperature, humidity and air quality.

- Operating Temperature Range
 - -30°C (-22°F) to +60°C (+140°F) – the temperature surrounding the repeater. (It refers to the temperature in the cabinet if the repeater is mounted in a cabinet.)
- Humidity
 - At or below RH of 95%, non-condensing at 50°C (122°F).
- Air Quality
 - Air quality (rack mount): Airborne particulates level must not exceed 25µg/m³ in environmental control capable environment.
 - Air quality (rack mount): Airborne particulates level must not exceed 90µg/m³ in environmental control incapable environment.

Proper filtrating equipment must be in use to cool the air surround the repeater, if the intended installation environment is dirty, dusty or does not accord with the requirements of air quality. As

the dirt or dust in the internal PCB and module is difficult to clean, and may cause problems such as superheating and discontinuously electrical connection etc.

Ventilation Requirements

The repeater is equipped with a cooling fan to provide forced convection cooling. So please comply with the ventilation requirements below in pre-installation.

- Cabinets must be equipped with ventilation slots or openings in the front (for air entry) and back or side panels (for air to exit). If several repeaters are installed in a single cabinet, be sure ventilation openings surround each repeater to allow for adequate cooling.
- All cabinets must have at least 15cm (6 inch) of open space between the air vents and any wall or other cabinets to allow for adequate air flow.
- When several cabinets (several repeaters in each cabinet) are installed in a closed area, adequate ventilation must be ensured, also to be considered are air condition or other environmental control devices, to meet the operating temperature requirements of the equipment.

AC Input Power Requirements

The repeater is equipped with a switching-mode power supply of which the working range is 100 – 240VAC (47 – 63Hz AC input power). Besides, a standard 3-core cable is provided to connect

the power supply to AC power supply.

A grounding socket-outlet with standard 3-core cable is recommended to connect the AC power supply.

The socket-outlet must be connected to the AC power supply which can provide a maximum power of 280W. For nominal 110/120 VAC input, the AC power supply must be with 5A current supply and protected by a circuit breaker with 15A rated current. For nominal 220/240 VAC input, the AC power supply must be with 3A current supply and protected by a circuit breaker with 10A rated current.

- Circuit Overloading
Overloading of the overcurrent protective device and effects of the power supply circuit must be considered. To be considered is the rated value of equipment for solving such problem.

Mounting Methods

HQT repeater can be mounted in a rack, bracket or cabinet (So can the accessories).

Grounding and Lightning Protection

One of the most important issues to be considered is grounding and lightning protection system in designing communication site. Correct grounding technology is closely related to lightning protection, and the common types of site grounding are listed as below:

- **Electrical Grounding**

Ground cable used for transmitting the current from site circuit or devices belongs to Electrical Grounding. It includes the AC or DC power supply used for site power device, and lines or cables for connecting site alarm or sensor.

- **RF Grounding**

This type involves the grounding of useless RF energy. One example of RF Grounding is to use shielding object to avoid or minimize the harmful RF energy from communication devices and cables.

The device must be installed in places which are easily accessible.

- **Lightning Protection Grounding**

Providing adequate lightning protection is vital for ensuring a safe and reliable communication site. RF cable, and AC or DC power cables must be protected in case of the lightning strikes when lightning enters the site.

Even though the contents covered in site grounding technology and lightning protection are not in the range of this manual, several excellent industrial power supplies complied with the requirements of grounding and lightning protection exist in communication site.

- **Device Grounding**

The repeater is equipped with ground screw which is on the rear of the power supply module and used for connecting the repeater to the site ground. Correct grounding and lightning protection should be made for all antenna cable, AC and DC power cables, to accord with the rules and requirements above. If not, permanent damages to the radio equipments may be caused.

Mechanical Installation

This section introduces mechanical installation steps of HQT repeater. Various mounting methods vary depending on different types of rack or cabinet selected for fixing the repeater.

Mounting the Repeater in a Rack or Cabinet

The repeater is shipped in a box; it must be moved to a rack or cabinet from the packing container once arrived.

Note: The rack or cabinet must have guide rails and hole spacing, with EIA 48.3 cm (19 inch) configuration.

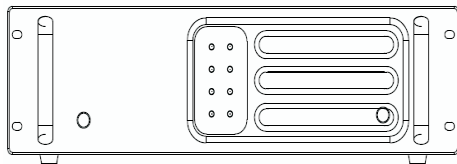
The cabinet must have adequate ventilation and comply with the minimum standards listed below:

- Depth: 41.3 cm (16.25 inch)
- Width: 48.3 cm (19 inch)
- Height: 13.4 cm (5.25 inch)
- The two installation rails are 5 cm (2 inch) away from the front of the cabinet, and front installation hole spacing is 2.25 inch (from center to center).

For more information about mounting the equipment in a cabinet, please contact the Technical Support Department of Shenzhen HQT Science & Technology Co., Ltd.

Repeater Overview

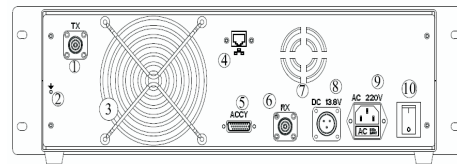
Front Panel



LED Indicators

LED	Status	Description
Power	Red LED glows	AC power supply
	LED off	Power off
Disable	Red LED glows	Repeater Disable
	Red LED flashes	Self-checking mode
	LED off	Normal working mode
Digital	Green LED glows	Digital mode
Analog	Green LED glows	Analog mode
Tx A	Red LED glows	Transmitting (analog)
	Red LED glows	The repeater in slot A is transmitting (digital).
Rx A	Green LED glows	Receiving (analog)
	Green LED glows	The repeater in slot A is receiving (digital).
Tx B	Red LED glows	The repeater in slot B is transmitting (digital).
Rx B	Green LED glows	The repeater in slot B is receiving (digital).

Rear Panel



NO.	Item	Description
1	Tx Connector	N Type (Roll Pass)
2	Ground Screw	Must be connected to system grounding.
3	Main Fan	Change speed. Stops at room temperature. Rotation speed increases when repeater works for a long time.
4	Ethernet Connector	100Base-TX (RJ45)
5	Rear Accessory Connector	For plugging programming cable.
6	Rx Connector	BNC (Roll Pass)
7	Power Fan	Continuously working to cool the repeater.
8	Backup Battery Connector (DC Input)	Backup battery is an optional accessory and provides backup power for the repeater. It can be charged slowly by the repeater, but it is recommended to be charged with an external charger after it is in use for a long time. Standard repeater power supply can automatically toggle from AC power to battery power when AC power supply is cut off, and automatically switch to AC power when the AC power supply recovers. Front panel power LED turns red from green when battery power supply is connected.
9	Main Power Supply Connector (AC Input)	100-240V
10	Power On/Off Switch	Switch on or off the AC power supply to the repeater.

Rear Accessory Connectors

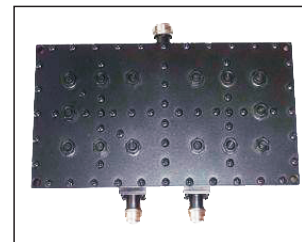
Pin No.	Pin Name	Pin Function	Pin No.	Pin Name	Pin Function
1	USB_VBUS	USB External Power Supply	14	EMERGENCY_IN	External Emergency On/Off Switch
2	GND		15	ACC_ID3	External ID Recognition Matrix 3
3	MAP_GPIO_3	External Programmable Input Trigger Control Connector	16	EXT_PTT	External PTT
4	EXT_SWB+	13.8V External Power Supply Switch	17	GND	
5	ALARM	Alarm Power Output (13.8V)	18	EXT_SPK+	External Speaker Voice Output+
6	GND		19	USB_DP	USB
7	EXT_MIC+	External MIC/Audio Input Connector	20	MAP_GPIO_8	External Programmable Input Trigger Control Connector
8	RX_AUDIO	RX Audio External Output Connector	21	GND	
9	EXT_SPK-	External Speaker Voice Output-	22	MAP_GPIO_7/MDIO_CLOCK	External Programmable Input Trigger Control Connector
10	USB_DM	USB	23	MAP_GPIO_6	External Programmable Input Trigger Control Connector
11	GND		24	PUB_ADDRESS1	Signal Public Output Address 1
12	MAP_GPIO_2	External Programmable Input Trigger Control Connector	25	PUB_ADDRESS2	Signal Public Output Address 2
13	ACC_ID2	External ID Recognition Matrix 2	26	IGN_SENSE_IN	External Sense On Switch

Optional Accessories

The main optional accessories of the repeater are listed below. For more information, please contact your dealer or HQT.



Antenna



Duplexer

Note: Please use HQT approved accessories, or users must bear all the consequences caused by using unauthorized accessories.

Troubleshooting

Phenomena	Analysis	Solution
The repeater can not be powered on.	<ul style="list-style-type: none"> a. Power cord is not connected or is not securely connected to the outlet. b. Power cord fuse is damaged. 	<ul style="list-style-type: none"> a. Properly connect the power cord and ensure secure connection. b. Check if the DC fuse has blown, and if yes, replace it with a new one.
Group members can not talk to each other, or the repeater can not communicate with a subscriber radio.	<ul style="list-style-type: none"> a. TX/RX frequency of the repeater is inconsistent with that of portable/mobile terminals. b. Failed to repeat useful signal due to strong interference signal. c. The group member is out of the coverage of the repeater. 	<ul style="list-style-type: none"> a. Re-set frequencies. b. If you can not remove or by pass the interference source, change to operate on other frequencies. c. Go within the coverage of the repeater.
Group members can not talk to each other, even though RX indication is given.	<ul style="list-style-type: none"> a. Your ID is inconsistent with that of other group members. b. Inconsistent CTCSS/CDCSS. 	<ul style="list-style-type: none"> a. Set your ID to the same as that of other members. b. Re-set CTCSS/CDCSS.
Short communication range or poor audio	<ul style="list-style-type: none"> a. Leakage of signal energy due to damaged connection cable. b. Loose connection between antenna connector and the cable, or loss of connection. c. Invisible damage of cable. d. Duplexer is not properly set (if duplexer is mounted). 	<ul style="list-style-type: none"> a. Replace the cable with a new one if necessary. b. Secure the connection or replace cable plug with a new one if necessary. c. Replace the cable with a new one. d. Contact the manufacturer or your dealer to re-set the duplexer.

If the above solutions can not fix your problems, or you may have some other queries, please contact us or your local dealer for more technical support.

Care and Cleaning

To guarantee optimal performance as well as a long service life of your repeater, please follow the tips below.

Repeater Care

Keep the repeater at a place of good ventilation and heat dissipation to facilitate normal work. Do not place irrelevant articles on top of the repeater to ensure optimal heat dissipation. Do not place the repeater in corrosive agents, solutions or water.

Repeater Cleaning

Clean up the dust and fine particles on the repeater parts with a clean and dry lint-free cloth or a brush regularly.

Use a non-woven cloth with neutral cleanser to clean after long-time use.

Do not use chemical preparations such as stain removers, alcohol, sprays or oil preparations.

Make sure the repeater is completely dry before use.

Caution: Power off the repeater before cleaning.

Service and Support

Shenzhen HQT Science & Technology Co., Ltd. ("HQT") provides long-term support for its products, including repair and supply of the radio and its parts and accessories.

Service Commitment

1. HQT two-way radio body has an 18-month warranty; accessories (battery, adapter, charger and antenna) 6 months; earphone 3 months.
2. Free repair is available and subject to the fully-filled warranty card or valid original invoice of purchase in the case that the radio or accessories can not work normally due to non-human factor during the warranty period.
3. Replacement or repair is available and subject to the fully-filled warranty card or valid original invoice of purchase in the case that the radio or accessories can not work normally because of non-human factor within 30 days from the date of purchase.
4. Repaired parts are warranted for the balance of the original applicable warranty period or 90 days from the date of repair. The longer one is valid.

Warranty

1. The warranty is only valid for products under normal use, defects or damages that result from human factors are excluded from the warranty coverage. Such as: disassembling or modifications, damages caused by outside force, water penetration, burns, use of HQT unapproved accessories, using against the user manual and so on.
2. The warranty period starts from the date of purchase on the invoice.
3. Free repair is unavailable if the HQT mark or serial number label is torn off.
4. Only the fully-filled warranty card and valid original invoice of purchase with HQT's seal or authorized dealer's seal affixed are valid for receiving the warranty service.

Cautions

1. Read the user manual before use.
2. Do not use the radio with damaged antenna, only HQT approved antenna is applicable.
3. Turn off the radio in potentially explosive or flammable environments.
4. Avoid the contact between the battery and metal, oily or corrosive objects.
5. Do not immerse the radio or battery into liquids or discard them in fire.
6. Use the radio only with standard battery, adapter, charger and earphone.

Terms of Warranty

1. HQT two-way radio body has an 18-month warranty; accessories (battery, adapter, charger and antenna) 6 months; earphone 3 months.
2. Only the fully-filled warranty card and valid original invoice of purchase with HQT's seal or authorized dealer's seal affixed are valid as proofs for identifying the warranty period. (The invoice should give clear indication of radio, accessories, serial number, date of purchase, purchase price and so on.)
3. If the radio body goes wrong during the warranty period, it should be ensured working normally over 30 days after the repair.
4. Replacement or repair is available and subject to the fully-filled warranty card and valid original invoice of purchase in the case that the radio can not work normally as the instructions list within 30 days from the date of purchase. (Note that there must not be abrasions on radio body and accessories.)
5. Replacement of the same model is available and subject to the 3 repair receipts in the case that the radio body still works abnormally after 3-time-or-above repairs during the warranty period.
6. Repair of the radio and accessories (battery, adapter, charger and antenna) is available and subject to the valid original invoice of purchase.
7. The costs of materials and repair are covered during the warranty period.
8. No warranty service is provided if the HQT mark and/or serial number label on the product are/is torn off.
9. Exclusions from warranty coverage:
 - 1) Beyond the valid warranty period;
 - 2) Defects or damages that result from use of the product in other than its normal and customary manner;
 - 3) Defects or damages resulting from misuse, accident, water penetration or neglect;
 - 4) Defects or damages caused by improper testing, operation, repair, installation, reconfiguration or adjustment;
 - 5) Defects or damages to antenna unless caused by material or processing problems;
 - 6) Product which has the serial number removed or illegible;
 - 7) Product with unclear date of purchase;
 - 8) Defects or damages because of unauthorized repair or disassembling;
 - 9) Rechargeable battery if:
 - (1) there is any damage or any sign of unsealing to it;
 - (2) the defect or damage is caused by charging the battery with improper equipment or using it beyond specified maintenance condition;
 - 10) Abrasions under normal use.

Note: This warranty will be adjusted or modified properly according to the market, and it is subject to change without notice. If adjusted or modified, the warranty is subject to the latest version issued by HQT service center in HQT official channels.

FCC Caution:

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Your radio radiates measurable RF energy only while it is transmitting(during talking), not when it is receiving(listening)or in standby mode. Antenna gain must not exceed 6.5dBi.The antenna installation comply with the requirements of manufacturer or supplier, and at least 3.8m from any body part of the user or nearby persons.

Your Shenzhen HQT Science & Technology CO.,LTD. 2-way radio is designed and tested to comply with a number of national and international standards and guidelines (listed below) for human exposure to radio frequency electromagnetic. This radio complies with the IEEE and ICNIRP exposure limits for occupational/controlled RF exposure environment at operating duty factors of up to 50% transmitting and is authorized by the FCC for occupational use only. In terms of measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode.

Note: The approved batteries supplied with this radio are rated for a 5-5-90 duty factor (5% talk -5% listen -90% standby) even though this radio complies with the FCC occupational RF exposure limits and may operate at duty factors of up to 50% talk.

Your Shenzhen HQT Science & Technology CO.,LTD. Two-way radio complies with the following RF energy exposure standards and guidelines:United States Federal Communications Commission, Code of Federal Regulations; 47CFR §§1.1.307,1.1310,

- 2.1091 and 2.1093
- American National Standards Institute(ANSI)/ Institute of Electrical and Electronic Engineers (IEEE) C95.1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition

The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2.

Table 2—450-470MHz—Maximum ERP/Reference HAAT for a specific Service Area Radius.

	Service area radius(km)									
	3	8	13	16	24	32	40 ⁴	48 ⁴	64 ⁴	80 ⁴
Maximum ERP(W) ¹	2	100	² 500	² 500	² 500	² 500	² 500	² 500	² 500	² 500
Up to reference HAAT(m) ³	15	15	15	27	63	125	250	410	950	2700

³When the actual antenna HAAR is greater than the reference HAAT, the allowable EEP will be reduced in accordance with the following.

$$\text{Equation: } \text{ERP}_{\text{allow}} = \text{ERP}_{\text{max}} \times (\text{HAAT}_{\text{ref}} / \text{HAAT}_{\text{actual}})^2$$