

Operating Manual

Garderos R-7800 Series

Ruggedized router (IP40) with

- 1 or 2 RJ-45 10/100/1000 BaseT Ethernet interfaces
- 4 Port RJ-45 10/100/1000 BaseT Ethernet switch
- 1 RJ-45 RS-232 serial interface (management) + RS-485
- 1 DSUB-9 female RS-232 (full)*
- 1 or 2 integrated WWAN modems (2/3G, 2/3/4G, CDMA)*
- 1 WLAN 802.11n a/b/g/ac*
- 1 RJ-45 ADSL2+ and VDSL2 modem (Annex A/B/J)*

* optional

1 Safety instructions



Read these safety instructions before handling or installing the device.

- Do not open the casing. Warranty shall be void if the warranty seal has been tampered with.
- Don't use or install the device in an explosive atmosphere!
- Don't touch any contacts with metallic or pointed items.
- This device has no power switch. Please disconnect the power before any operational work.
- In case of any damage to the device, it must not be put into operation.
- Do not install the device during a thunderstorm!
- Protect the device from heat sources and direct sunlight.
- Protect the device from aggressive fluids and vapors.
- The router emits electromagnetic waves. **To prevent other devices from being disturbed and to protect other people**, install the router only as described in this document and make sure to comply with safety distances.
 - Unauthorized persons must not get nearer than 60cm to the GSM/UMTS/LTE antennas.
 - Unauthorized persons must not get nearer than 7cm to the WLAN antennas.
 - Depending on the router type, the antenna and configured networks the safety distances may be smaller. Use the calculations in the Annex to calculate the minimum safety distance of your router.
- **Remove the power connector before performing any maintenance** or cleaning work near to the antennas or directly at the router.



Risk of burns! The device can operate in surroundings of more than 70 °C, so the surface can get very hot. Install the router inaccessible for unauthorized personnel. Before touching the router, remove the power supply and wait for 10 minutes for the router to cool down or wear protective gloves.

2 General information

2.1 Router type

The Garderos R-7800 routers are available as several different models with optional xDSL, WLAN, 2G/3G/4G and CDMA interfaces. This document is a general description for the following router types:

Type	Eth.	RS-232 (Mgmt.)	RS-232	RS-485	xDSL	WLAN	2/3G	2/3/4G	CDMA
R-7801	5 + 1 (opt.)	1	(opt.)	1		1			
R-7807	5 + 1 (opt.)	1	(opt.)	1					
R-7811	5	1		1	1	1			
R-7817	5	1		1	1				
R-7821	5 + 1 (opt.)	1	(opt.)	1		1	1		
R-7822	5 + 1 (opt.)	1	(opt.)	1		1		1	
R-7827	5 + 1 (opt.)	1	(opt.)	1			1		
R-7828	5 + 1 (opt.)	1	(opt.)	1				1	
R-7831	5	1		1	1	1			1
R-7837	5	1		1	1				1
R-7847	5 + 1 (opt.)	1	(opt.)	1			1		1
R-7848	5 + 1 (opt.)	1	(opt.)	1				1	1
R-7849	5 + 1 (opt.)	1		1					2
R-7857	5 + 1 (opt.)	1	(opt.)	1			1	1	
R-7858	5 + 1 (opt.)	1	(opt.)	1				2	
R-7859	5 + 1 (opt.)	1	(opt.)	1			2		
R-7861	5	1		1	1	1	1		
R-7862	5	1		1	1	1		1	
R-7867	5	1		1	1		1		
R-7868	5	1		1	1			1	
R-7871	5 + 1 (opt.)	1	(opt.)	1		1			1
R-7877	5 + 1 (opt.)	1	(opt.)	1					1

The router type can be identified by the serial number of the router. The type is coded into the first 5 characters of the serial number.

2.2 Included in delivery of Garderos R-7800

Standard scope:

- Garderos R-7800 router
- Phoenix 2-pin power connector
- Cable lug, washer and screw for grounding

Optional accessories:

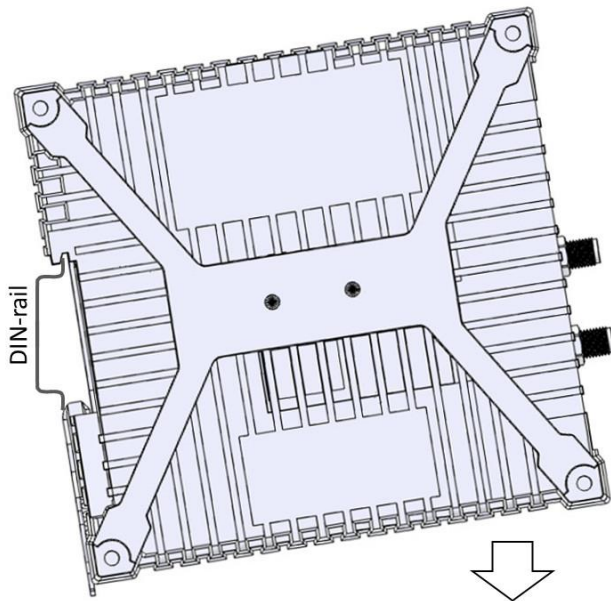
- Antennas (WLAN, 2G/3G/4G, CDMA)
- Antenna connector cables and adapters
- Industrial grade power supply
- Serial cables
- Holding angle and DIN rail clip

Please check the contents of the package after receipt.

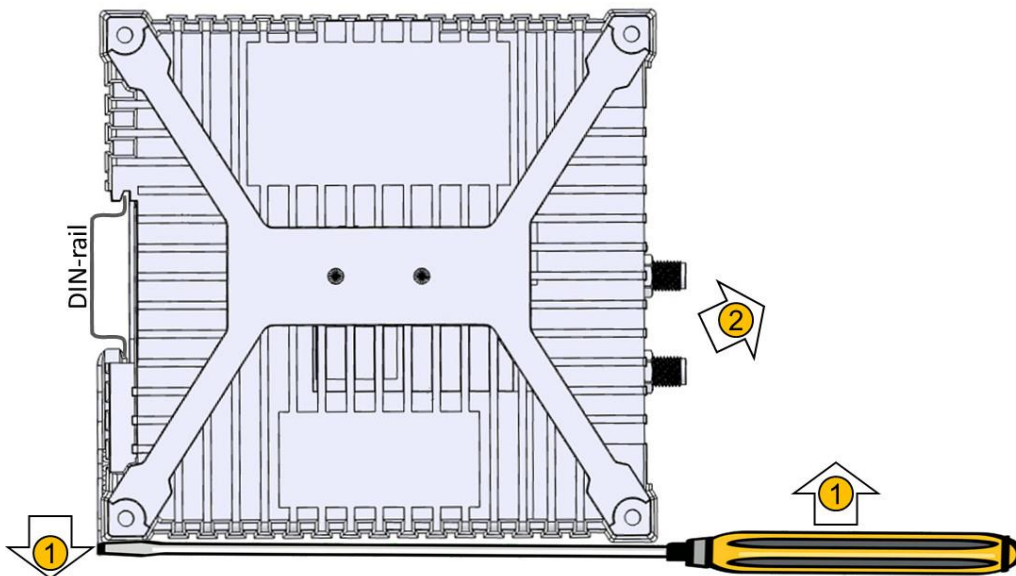
3 Hardware

3.1 Installation

The Garderos R-7800 has an integrated DIN rail mounting clip. Mount the router at a DIN rail as shown in the following drawing. The DIN rail clip has a spring that will automatically close the clip when the router fits to the rail.



For unmounting the router, use a screw driver with a long metal point and open the DIN rail clip as shown in the following drawing. Then push the router up to remove it from the DIN rail.



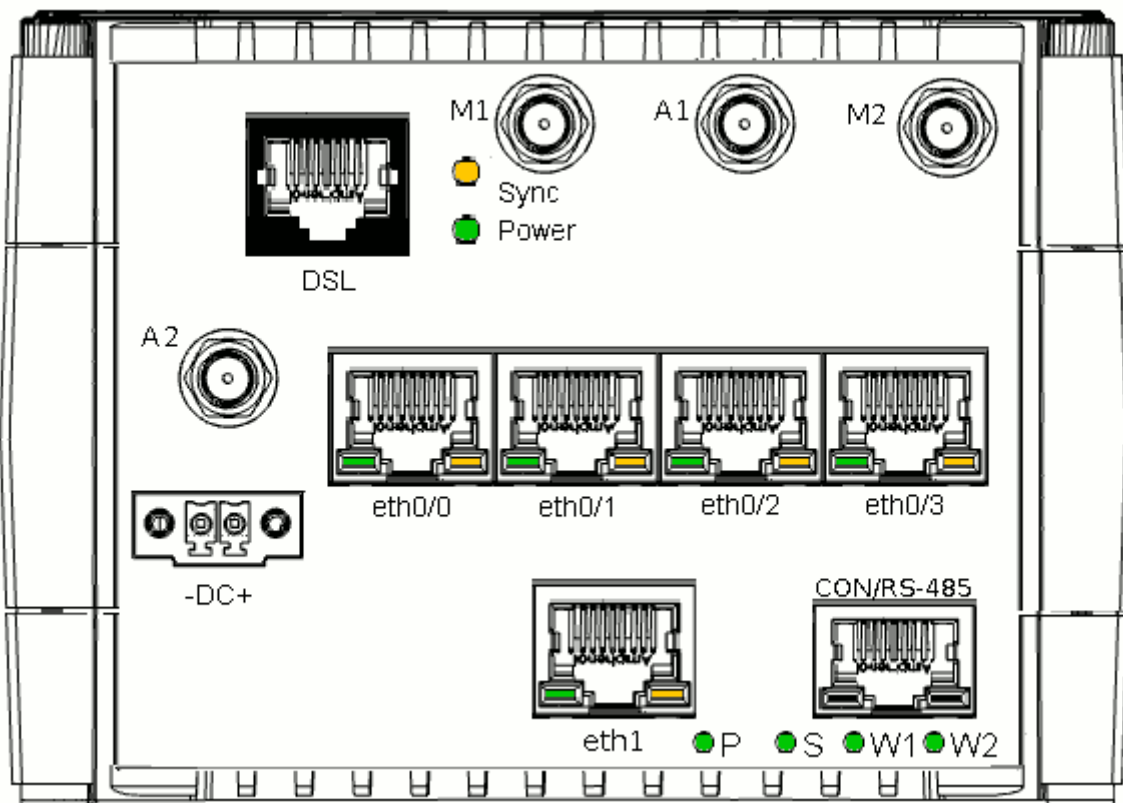
3.2 Grounding

For grounding crimp a 1.5mm² ground cable to the grounding lug that is included in the router delivery. Fix the grounding cable with the washer between the M4 screw and the cable lug to any of the screw holes in router case. See the following picture for an example:



3.3 Status LEDs

The Garderos R-7800 has LEDs on the front, showing its operational status. All LEDs, except from the Ethernet LEDs that are integrated into the RJ-45 Ethernet sockets, are clearly marked on the casing:



P (green)

Shows the status of the router's power supply and is lit during the entire period of operation.

S (green)

Shows the current state of the router operating system. The LED blinks during fetching and executing the router

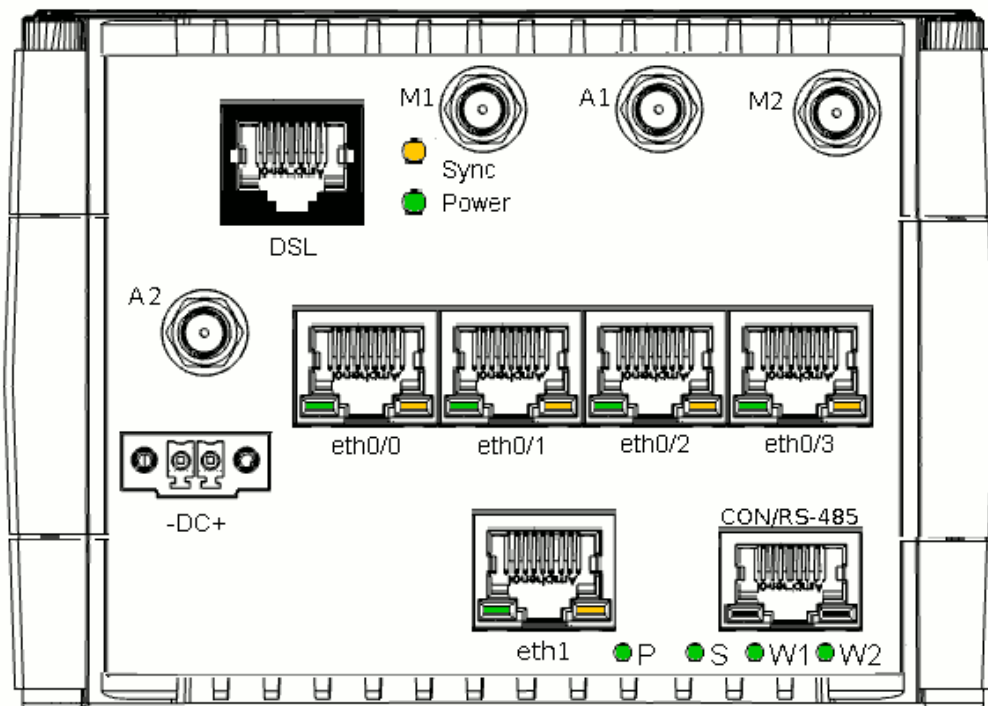
configuration and is permanently lit when the configuration of the device has been completed.

- W1 (green)** Depending on the type of the WWAN link this LED signals the state of the link. The LED is off when no WWAN connection is active and is lit while at least 1 WWAN connection is active.
- W2 (green)** Is lit when the integrated WLAN interface is active.
- Sync (yellow)** Shows the xDSL modem synchronization status. The LED is off after boot, blinks when the modem tries to synchronize and is lit while the modem is synchronized.
- Power (green)** Shows the power state of the xDSL modem. The LED is lit during the entire period of operation.
- Eth link (green)** Is lit when an Ethernet link was detected.
- Eth activity (orange)** Blinks during Ethernet activity.

In normal operation mode the LEDs **Power**, **P** and **S** are on, as well as the **green LEDs** of all connected Ethernet ports.

3.4 Connectors

Depending on the type, the Garderos R-7800 routers have different connectors on the front. All possible connectors are described below; the image shows the front panel of an R-7831 as an example. The R-7800 routers have 2 SIM card slots on the back:



- DC+** Power connection. – (0V/GND) and + (VCC) are marked on the casing.

CON/RS-485	RJ-45 jack for RS-232 serial console (Settings: 115200 / 8 / N / 1 / none) and RS-485 half duplex serial interface for connection to industrial components.
eth0/0	RJ-45 jack for 10/100/1000 BaseT Ethernet switch port 0
eth0/1	RJ-45 jack for 10/100/1000 BaseT Ethernet switch port 1
eth0/2	RJ-45 jack for 10/100/1000 BaseT Ethernet switch port 2
eth0/3	RJ-45 jack for 10/100/1000 BaseT Ethernet switch port 3
eth1	RJ-45 jack for 10/100/1000 BaseT Ethernet
eth2	RJ-45 jack for 10/100/1000 BaseT Ethernet (optional)
DSL	RJ-45 jack for xDSL
M1	Main 1 antenna connector. See 3.4.4 for description.
A1	Auxiliary 1 antenna connector. See 3.4.4 for description.
M2	Main 1 antenna connector. See 3.4.4 for description.
A2	Auxiliary 1 antenna connector. See 3.4.4 for description.
M3	Main 2 antenna connector. See 3.4.4 for description
RS-232	Optional: RS-232 connector.



Select an antenna for the correct band to get the best performance on the network. Depending on the router type the WWAN supports different frequencies. WWAN capabilities can be shown by the command „show hardware wwan wwan0 information”. See below for more information about login and command line interface.

3.4.1 DC power connection

GND and VCC are marked. The allowed power range is 12-60V DC. Make sure to correctly connect 0V/GND (-) and VCC (+) to power as marked on the front plate.

3.4.2 CON/RS-485

The RJ-45 connector's pins are assigned to an RS-232 serial console and an RS-485 half duplex industrial serial interface. Pin assignment is:

PIN no.	Description
1	RS-232 console port RTS
2	RS-485 half duplex B
3	RS-232 console port TX
4	GND
5	GND
6	RS-232 console port RX
7	RS-485 half duplex A
8	RS-232 console port CTS

Serial cables can be ordered from Garderos.

3.4.3 DSL

RJ-45 connector for connection to a DSL line. Port assignment is:

PIN no.	Description
1	Not assigned
2	Not assigned
3	Not assigned
4	DSL
5	DSL
6	Not assigned
7	Not assigned
8	Not assigned

3.4.4 Antenna connectors

Depending on the router type the antenna connectors M1, A1, M2, A2 and M3 are used for different antenna connections, e.g. a 3G or a WiFi card. The connectors are always SMA female when being used for 2G/3G/4G/CDMA radio networks and RP-SMA female when being used for WiFi. Login to the router and use the command:

```
R7800# show hardware connector
```

to show the assignment of the antenna connectors.

3.4.5 Optional RS-232 connector

The R-7800 series routers can be equipped with an additional fully allocated DSUB-9 connector for RS-232. This must be ordered as a special option and will result in less antenna connectors.

The DSUB-9 socket is allocated in the following way:

PIN no.	Description
1	RS-232 DCD, data carrier detect
2	RS-232 TX, transmit data
3	RS-232 RX, receive data
4	RS-232 DSR, data set ready
5	Ground (GND)
6	RS-232 DTR, data terminal ready
7	RS-232 CTS, clear to send
8	RS-232 RTS, request to send
9	RS-232 RI, ring indicator

4 Software

The Garderos R-7800 routers run the Garderos Router Software (GRS) operating system.

GRS provides the following functions:

- Router operating system
- Automatic management of the configuration:
 - Local configuration (startup configuration) to configure the router locally.
 - Remote configuration that can be downloaded from a web server for central configuration management.
- Interfaces to other systems via APIs:
 - HTTPS Configuration API
 - RADIUS authentication
 - NTP
 - SNMP
 - ...

The GRS documentation is available online at:

<https://www.garderos.com/techsup>

Username and password for login to the support web are available from your Garderos sales representative.

The documentation contains a detailed description of all GRS features. This operating manual is limited to the basic steps for starting the router so that it can be commissioned.

5 Commissioning

5.1 Installation

Connect the antennas before powering on the router. Connect antennas at least to the M1, M2 and M3 connectors of the wireless interfaces which will be used. Ethernet cables can be connected / disconnected at any time.

5.2 Handling of the SIM-card

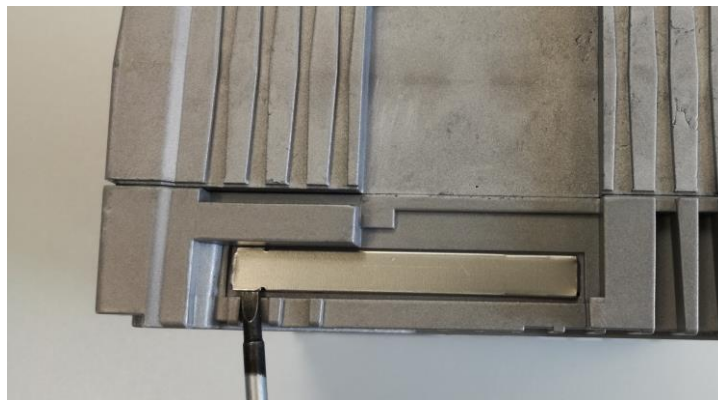
Insert and remove SIM cards from the router only when the power is disconnected.

5.2.1 Removing a SIM card tray

The R-7800 router has 2 SIM card slots for Mini-SIM format. For routers with 1 WWAN modem (e.g. R-7827) the SIM card must always be inserted into slot "SIM 1", which is intended for the modem "wwan0". For routers with 2 WWAN modems (e.g. R-7857) the SIM card for the WWAN modem called "wwan0" must be inserted into "SIM 1", the SIM card for the modem "wwan1" into slot "SIM 2".

To access the SIM-card slot remove the cover using a screwdriver. Always put back the SIM-card cover after inserting the SIM-card to prevent the SIM card from moving when the router is exposed to shock or vibration.

Remove the SIM-card cover by using a screwdriver.



Remove the SIM tray by pressing the yellow button with a screw driver:

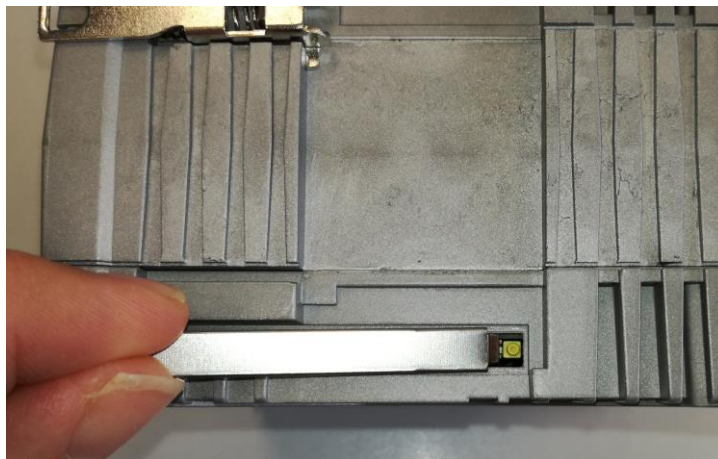


5.2.2 Inserting the SIM-card

Insert the SIM card into the SIM tray and push the SIM tray back into the router. Take care to correctly push the SIM tray into the SIM card tray holder. The SIM card tray fits below the tray holder and may slip into the router, if not put into the right position:



Put back the SIM slot cover to keep IP40 ingress protection:



Remove the WWAN settings of the router before inserting a new SIM card. Otherwise the router might try to establish the WWAN connection with the previous settings, and an incorrect PIN might cause the SIM-card to be locked.

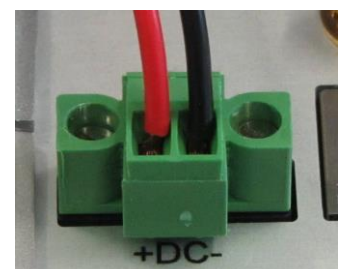
Only insert/remove the SIM-card when the router is powered off! Use thermo resistant Mini-SIM-cards for up to 80°C (ask your cellular operator for industrial SIM-cards).

5.3 Powering up the router

This device has no power switch. To power it on, just connect DC power (12-60V) to the router.



Connect VCC to + and 0V/GND to - as marked on the front plate. Otherwise the router might be damaged!





Before starting the R-7800 antennas must be connected to the M1 and M2 connectors of all wireless interfaces which will be used, otherwise the router may be damaged.

The LEDs (see chapter 0) show the operational mode of the device:

- P** Shows the status of the power supply and is lit during the entire period of operation.
- S** Shows the current state of the router operating system. The LED blinks during fetching and executing the router configuration and is permanently lit when the configuration of the router has been completed.
- W1** Is lit when at least 1 WWAN interface is active.
- W2** Is lit when at least 1 WLAN interface is active.

5.4 Login

The Garderos R-7800 can be managed via a serial console. Connect your computer to the router's **CON/RS-485** port using an RJ-45 serial console cable. Use the following settings:

Bits per second	115200
Data bits	8
Parity	N
Stop	1
Flow control	None

Log in with the following credentials:

User name	root
Password	g42pnuMN

Find online documentation about initial configuration of the factory default Garderos router at <https://www.garderos.com/techsup> in the chapter "Getting Started". The online documentation also contains detailed descriptions for more than 600 configuration parameters.

6 Annex

6.1 Technical Data

Dimensions (WxHxD)	80.5x111x116mm die cast aluminum 80.5x111x122mm including connectors
Weight	~0.75kg
Input voltage	12-60VDC
Power consumption	~5-16W
Operating temperature range	-40°C to +75°C *)
Transport temperature range	Same as operating temperature range.
Storage temperature range	Same as operating temperature range.
WWAN (optional)	2G, 3G, 4G, CDMA (see datasheet for details)
WAN	ADSL2+, VDSL2, Annex A, B, J, PTM/ATM, Vectoring
Network interfaces	1 or 2 RJ-45, 10/100/1000 BaseT Ethernet, autosensing, auto-MDI-X 4 Rj-45, 10/100/1000 BaseT Ethernet switch ports, autosensing, auto-MDI-X
WLAN (optional)	802.11ac a/b/g/n
Serial ports	1 * RS-232 (mgmt), 1* RS-485, 1* RS-232 (optional)
Ingress protection	IP40
IEC protection class	3
Conformity	CE, FCC, EN 61000-6-2 (2005), RoHS

*) Max. temperature range. The temperature range may differ depending on the router variant.

6.2 WiFi radio settings

6.2.1 TX-power

The Garderos R-7800 uses the unregulated bands in the 2.4GHz and 5.5GHz range. Depending on the country the maximum radiated power is limited by law to e.g. 100mW (20dBm) in Germany and 400mW (26dBm) in the US. By default the Garderos routers are configured to comply with the German regulatory domain (DE).

The radiated power also depends on the antenna. To comply with the regulatory limitations, the maximum radiated power must be configured in the R-7800 for the antenna used with the router.

By default the Garderos R-7800 router will set the radiated power lower than 100mW (20dBm) for both bands, meaning that it complies with all restrictions when being used together with an antenna without gain. When using an antenna with a gain, the power may need to be reduced in the configuration file.

To change the WLAN TX-power see the online documentation for the configuration parameter:

```
hardware.wifi.*.tx-power
```

The following calculation shows how to calculate the TX-power that must be configured in the router to comply with the regulatory restrictions.

- Calculate the total antenna gain. The antenna gain consists of:
 - Losses inside the router. This is a static value of -0.3dB.
 - Antenna gain taken from the data sheet of the antenna.
 - Optional: Losses by extension cables.

```
Total antenna gain = -0.3dB + Antenna gain + Losses
```

- The maximum value for the TX-power that can be configured on the router to stay inside the regulatory limitations is calculated from:
 - Maximum output power allowed in the regulatory domain, e.g. 20dBm for DE.
 - The total antenna gain.

```
tx-power max = 20dBm - Total antenna gain
```

- Example:
 - Static value for losses in the router: -0.3dB
 - Antenna has a gain of 4dBi in the configured band 2.4GHz (channel 1-14).
 - No extension cable.
 - Regulatory domain Germany (DE) allows max. 20dBm output power.
 - The TX-power must be set to a value less or equal 16dBm.

$$\text{tx-power max} = 20\text{dBm} - (-0.3\text{dB} + 4\text{dBi} + 0\text{dB}) = 16.3\text{dBm}$$

Calculate maximum TX-power as described above and round down the value. Set the TX-power on the router to that value to stay in the regulatory limits (16dBm in the example above).



The default value for tx-power is set to 20dBm. If an antenna with gain is used, the value must be set to a value from the table above, to comply with the regulatory limitations. It is the operator's responsibility to comply with the regulatory limitations.

6.2.2 Safety distance

The router's antennas should be installed in such a way that they are not accessible for unauthorized persons. The following tables show the minimum safety distance based on the harmonized EU standards EN 50385:2017 and EN 50383:2010, taking into account the reference values of the Council recommendations 1999/519/EG:

Calculate the output power on the antenna from the configured TX-power on the router and the total antenna gain:

$$\text{Output power} = \text{Configured tx-power} + \text{Total antenna gain}$$

Output power for the example above:

$$\text{Output power} = 16\text{dBm} + (-0.3\text{dB} + 4\text{dBi} + 0\text{dB}) = 19.7\text{dBm}$$

Round up the value (20dBm) and select the safety distance from the table below.

2.4GHz

Output power	Safety dist.
18dBi	2.2cm
20dBi	2.8cm
22dBi	3.6cm
24dBi	4.5cm
26dBi	5.7cm
28dBi	7.2cm

5.5GHz

Output power	Safety dist.
18dBi	2.2cm
20dBi	2.8cm
22dBi	3.6cm
24dBi	4.5cm
26dBi	5.7cm
28dBi	7.2cm

6.3 WWAN radio settings

Based on the harmonized EU standards EN 50385:2017 and EN 50383:2010, taking into account the reference values of the Council recommendations 1999/519/EG the safety distances for the 2G/3G/4G antennas can be calculated. The calculation is based on the output power of the router and the gain and losses inside the antenna and extension cables.

The R-7800 routers are delivered with different WWAN modems depending on the router type. To find out the modem type used in the router, login to the router, then execute the command:

```
router# show hardware wwan
```

This command also shows the bands that the modem is active in.

The following tables show the maximum output power for all WWAN modems depending on the supported technology:

WWAN modem type	2G	3G	4G	CDMA450
EG25-G	35dBm	25dBm	25dBm	
HE910-D	33.5dBm	24dBm		
LE910-EU V2	33.5dBm	24.5dBm	24dBm	
LE910-EU1	33.5dBm		24dBm	
LE910-EUG	33.5dBm	25dBm	25dBm	
MC7430		24dBm	24dBm	
MPN200				25dBm
WPD-600N			23dBm	

The gain and loss in the antenna and antenna cables also need to be taken into account to get the output power relevant for the safety distance.

Calculate the total output power on the antenna. This value is calculated from:

- Output power for each technology supported by the WWAN modem taken from the table above.
- Losses inside the router. This is a static value of -0.3dB.
- Antenna gain taken from the data sheet of the antenna. If the gain depends on the frequency, the calculation has to be done for each different gain.
- Optional: Losses by extension cables.

$$\text{Output power} = \text{Modem power} - 0.3\text{dB} + \text{Antenna gain} + \text{Losses}$$

Example:

- Output power of the LE910-EU1 WWAN modem for 2G (GSM) is 33.5dBm, for 4G (LTE) it is 24dBm.
- Losses inside the router are -0.3dB.
- Antenna has a gain of 4dBi in all frequencies for 2G and 4G.
- No extension cable.

$$\text{Output power}_{4G} = 24\text{dBm} - 0.3\text{dB} + 4\text{dBi} = 26.7\text{dBi}$$

$$\text{Output power}_{2G} = 33.5\text{dBm} - 0.3\text{dB} + 4\text{dBi} = 37.2\text{dBi}$$

6.3.1 Safety distance per frequency

The safety distance depends on the output power and the frequency. Generally the safety distance needs to be higher for lower frequencies.

You can see the frequencies supported by the WWAN modem by using the command:

```
router# show hardware wwan
```

The following table shows the frequencies for the supported bands:

2G (GSM)	
Band	Frequency
GSM-850	850 MHz
GSM-E-900	900 MHz
DCS-1800	1800 MHz
PCS-1900	1900 MHz

3G (UMTS)	
Band	Frequency
B1	2100 MHz
B2	1900 MHz
B4	1700 MHz
B5	850 MHz
B6	800 MHz
B8	900 MHz
B9	1700 MHz
B19	800 MHz

4G (LTE)	
Band	Frequency
B1	2100 MHz
B3	1800 MHz
B5	850 MHz
B7	2600 MHz
B8	900 MHz
B18	850 MHz
B19	850 MHz
B20	800 MHz
B21	1500 MHz
B28	700 MHz
B31	450 MHz
B38	2600 MHz
B39	1900 MHz
B40	2300 MHz
B41	2500 MHz

CDMA 450	
Band	Frequency
450	450 MHz

To find out the correct safety distance, first calculate the output power for your router/antenna setup for all frequencies. Then read the safety distances from the following table for each of them. Round up the output power and round down the frequency to one of the values from the table. The highest value shown in the table is the safety distance that you should comply to:

Output power	450MHz	700MHz	800MHz	900MHz	1500MHz	1800MHz	>=2GHz
20dBi	6.0cm	4.8cm	4.5cm	4.2cm	3.3cm	3.0cm	2.9cm
22dBi	7.5cm	6.0cm	5.6cm	5.3cm	4.1cm	3.8cm	3.6cm
24dBi	9.5cm	7.6cm	7.0cm	6.7cm	5.2cm	4.7cm	4.5cm
26dBi	11.9cm	9.6cm	8.9cm	8.4cm	6.5cm	6.0cm	5.7cm
28dBi	15.0cm	12.0cm	11.2cm	10.6cm	8.2cm	7.5cm	7.2cm
30dBi	18.8cm	15.1cm	14.1cm	13.3cm	10.2cm	9.4cm	9.0cm
32dBi	23.7cm	19.0cm	17.8cm	16.8cm	13.0cm	11.9cm	11.3cm
34dBi	29.8cm	23.9cm	22.4cm	21.0cm	16.3cm	14.9cm	14.3cm
36dBi	37.6cm	30.2cm	28.2cm	26.6cm	20.6cm	18.8cm	18.0cm
38dBi	47.2cm	37.9cm	35.4cm	33.4cm	25.9cm	23.6cm	22.6cm
40dBi	59.4cm	47.7cm	44.6cm	42.0cm	32.6cm	29.7cm	28.4cm
42dBi	74.8cm	60.0cm	56.1cm	52.9cm	41.0cm	37.4cm	35.8cm
44dBi	94.2cm	75.5cm	70.6cm	66.6cm	51.6cm	47.1cm	45.0cm

6.3.2 Safety distance per modem type

Based on the calculations from above a safe value can be taken from the table below, if the gain of the antenna connected to the router is known.



This simplified calculation can only be used, if the antenna gain is equal for all frequencies, or if the gain is higher for lower frequencies. In that case choose the higher gain. This table can not be used, if the gain of the antenna is higher for the high frequencies!

Antenna gain	EG25-G	HE910-D	LE910-EU V2	LE910-EU1	LE910-EUG	MC7430	MPN200	WPD-600N
-4dB	17.8cm	14.1cm	13.3cm	13.3cm	13.3cm	4.6cm	7.5cm	6.0cm
-2dB	22.4cm	17.8cm	16.8cm	16.8cm	16.8cm	6.0cm	9.5cm	7.5cm
0dB	28.2cm	22.4cm	21.0cm	21.0cm	21.0cm	7.6cm	11.9cm	9.5cm
2dB	35.4cm	28.2cm	26.6cm	26.6cm	26.6cm	9.6cm	15.0cm	11.9cm
4dB	44.6cm	35.4cm	33.4cm	33.4cm	33.4cm	12.0cm	18.8cm	15.0cm
6dB	56.1cm	44.6cm	42.0cm	42.0cm	42.0cm	15.1cm	23.7cm	18.8cm

6.4 Warranty

The conditions of warranty for the Garderos products are described in the Garderos General Terms and Conditions in the section entitled „Warranty“.

6.5 Declaration of conformity

Garderos GmbH declares that the Garderos R-7800 product conforms to CE. The complete statement of conformity can be downloaded at:

<https://www.garderos.com/conformity>

6.6 Disposal information

Please consider the following when disposing of the device:

- This device must not be disposed together with household waste.
- The Garderos R-7800 contains a CR-2032 battery, which must be removed before disposal. The battery can be removed in the following way:
 - Disconnect the device from the power supply.
 - Open the device by using a screw driver.
 - Remove the screws of the router main board (the one with the serial CON/RS-485 connector) by using a screw driver.
 - The battery is located in a battery holder on the back of the main board. Push out the battery using a screw driver.
 - Dispose of the battery at an official collection point for batteries.
- Now dispose of the device at an official collection point for electronic waste.



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