

RADIO FREQUENCY EXPOSURE REPORT

FOR THE

**Device: Generation 5 Repeater
Model: RHK-G5RL10**

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Purpose:

To demonstrate compliance with United States RF Exposure requirements for Portable equipment (devices used $\leq 20\text{cm}$ from the body) or Mobile equipment (devices used $> 20\text{cm}$ from the body) with power output below exemption levels and Mobile equipment, where Maximum Permissible Exposure (MPE) Calculations apply.

United States Compliance Requirements (1.1310):

***RF Exposure Evaluation Limits
Occupational / Controlled Exposure***

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-3.0	614	1.63	*(100)	6
3.0-30	$1842/f$	$4.89/f$	*($900/f^2$)	6
30-300	61.4	0.163	1	6
300-1500	---	---	$f/300$	6
1500-100,000	---	---	5.0	6

***RF Exposure Evaluation Limits
General Population / Uncontrolled Exposure***

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	$824/f$	$2.19/f$	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	---	---	$f/1500$	30
1500-100,000	---	---	1.0	30

* Plane wave equivalent power density

Limit is calculated based on the mid-band frequency used in the operating frequency range.

Exemption Level: Power output $< 60/f_{\text{GHz}}$ (mW)

Canadian Compliance Requirements (RSS-102):

RF Exposure Evaluation Limits Occupational / Controlled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1.0	600	4.9	---	6
1.0-10	600/f	4.9/f	---	6
10-30	60	4.9/f	---	6
30-300	60	0.163	10	6
300-1500	$3.54 f^{0.5}$	$0.0094 * f^{0.5}$	f/3	6
1500-15,000	137	0.364	50	6
15,000-150,000	137	0.364	50	$616000/f^{1.2}$

RF Exposure Evaluation Limits General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1.0	280	2.19	---	6
1.0-10	280/f	2.19/f	---	6
10-30	28	2.19/f	---	6
30-300	28	0.073	2	6
300-1500	$1.585 * f^{0.5}$	$0.0042 * f^{0.5}$	f/150	6
1500-15,000	61.4	0.163	10	6
15,000-150,000	61.4	0.163	10	$616000/f^{1.2}$

**Power density limit applicable >100MHz*

Exemption Level:

Frequency Range (MHz)	Maximum Output Power (Conducted or EIRP)
0.003-1000	≤ 200 mW
1000-2200	≤ 100 mW
2200-3000	≤ 20 mW
3000-6000	≤ 10 mW

European Union Compliance Requirements (ICNIRP):

RF Exposure Evaluation Limits Occupational / Controlled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m ²)	Averaging Time (minutes)
0.00082-0.065	610	24.4	---	6
0.065-1.0	610	1.6/f	---	
1.0-10	610/f	1.6/f	---	6
10-400	61	0.16	10	6
400-2000	$3.0 * f^{0.5}$	$0.008 * f^{0.5}$	f/40	6
2000-300,000	137	0.36	50	6

RF Exposure Evaluation Limits General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-0.150	87	5.0	---	6
0.150-1.0	87	0.73/f	--	6
1.0-10	$87/f^{0.5}$	0.73/f	---	6
10-400	28	0.073	2	6
400-2000	$1.375 f^{0.5}$	$0.0037 * f^{0.5}$	f/200	6
2000-300,000	61	0.16	10	6

**Power density limit applicable >100MHz*

Exemption Level: Power output < 20mW¹

¹ May vary by product type

Device and Antenna Operating Configuration:

Device operating at maximum output power with continuous transmission of modulated data.

Device Operation:

The Ethernet port is connected to a remote laptop via unshielded twisted pair.

The Remote laptop is running test software to exercise the intended functionalities. The device has two identical radios installed with three chains each. For each radio, only two chains are transmitting, Chain 0 and Chain 2. Each radio connects to one antenna with one chain connected to the horizontal element in the antenna and the other chain connected to the vertical element of the antenna. The second radio is connected to a second antenna in the same fashion. The system firmware/software does not allow the two radios to transmit on the same frequency band at the same time.

The system tested is the Digital Path Generation 5 Repeater Model RHK-G5RL10. The Generation 5 Repeater has multiple configurations that are defined in the table below with Product Codes.

The different configurations cover the two main chassis for the Generation 5 Repeater plus the different options available. The 5GHZ Tri-Sector is a metal chassis using 17dBi Sector antennas. The 5GHz Panel is a plastic chassis with an integrated 18dBi Panel and either an integrated Omi Directional Antenna or external connectors to connect an external antenna to. The remaining differences in the configurations are if the device has GPS installed or not and for the Tri-Sector version, if there is a heater included or if the antennas are directed using shims.

PRODUCT CODE	DESCRIPTION
G5RL10	5GHz Panel (18dBi) w/ integrated 10dBi Omni Directional Antenna
G5RL10E	5GHz Panel w/ external connectors
G5RL10G	5GHz Panel (18dBi) w/ integrated 10dBi Omni Directional Antenna w/ GPS
G5RL10EG	5GHz Panel w/ external connectors w/ GPS
G5RL10T	5GHz Tri-Sector (17dBi)
G5RL10TG	5GHz Tri-Sector (17dBi) w/ GPS
G5RL10TH	5GHz Tri-Sector (17dBi) w/ 48v Heater
G5RL10THG	5GHz Tri-Sector (17dBi) w/ GPS and 48v Heater
G5RL10TS	5GHz Tri-Sector (17dBi) w/ shims
G5RL10TGS	5GHz Tri-Sector (17dBi) w/ GPS and shims
G5RL10THS	5GHz Tri-Sector (17dBi) w/ 48v heater / shims
G5RL10TGHS	5GHz Tri-Sector (17dBi) w/ GPS / 48v heater / shims

Antenna Options:

17 Sector (UBNT)
20 Sector (UBNT)
11 Omni
18 Directional Panel

Test Procedure:

This equipment is evaluated in accordance with the guidelines set forth in OET Guide 65 & ANSI C95.1 for the US and Health Canada Safety Code 6 & RSS 102 for Canada.

Other Considerations:

None

MPE Calculations

Applicability:

<i>Limit Used</i>	X	General Population / Uncontrolled Exposure
		Occupational / Controlled Exposure
<i>RF Exposure Exemption</i>	No	United States
	NA	Canada
	NA	Europe

NA – only testing to US regulations

Equipment operational details:

<i>Config #</i>	<i>Operating Frequency (GHz)</i>	<i>Measured Output Power (dBm)</i>	<i>Antenna Gain (dBi)</i>	<i>Antenna Type / Configuration</i>	<i>EIRP (dBm)</i>
1	5.25-5.35	10.50	20	Sector	30
2	5.25-5.35	19.00	11	Omni	30
3	5.25-5.35	12.50	18	Directional panel	30
4	5.47-5.725	14.00	20	Sector	30
5	5.47-5.725	19.00	11	Omni	30
6	5.47-5.725	13.50	18	Directional panel	30

Measurements based from EMC Test Report(s): 92682-15

MPE Calculation:

$$\text{Power Density} = \frac{\text{EIRP}}{4\pi d^2} \quad \text{Given: EIRP in mW or W and } d \text{ in cm or m}$$

<i>Config #</i>	<i>Distance (cm)</i>	<i>US (1.1310)</i>		<i>Canada (RSS-102)</i>		<i>EU (ICNIRP)</i>	
		<i>Power Density (mW/cm²)</i>	<i>Limit (mW/cm²)</i>	<i>Power Density (W/m²)</i>	<i>Limit (W/m²)</i>	<i>Power Density (W/m²)</i>	<i>Limit (W/m²)</i>
1	20	0.22	1.0	NA	--	NA	--
2	20	0.20	1.0	NA	--	NA	--
3	20	0.22	1.0	NA	--	NA	
4	20	0.50	1.0	NA	--	NA	
5	20	0.20	1.0	NA	--	NA	
6	20	0.28	1.0	NA	--	NA	

NA – only testing to US regulations

Performed calculations based the worst case (highest gain) of each antenna type

Summary:*Exemptions:*

In the case the equipment meets compliance requirements by exemption the product is approved for use under mobile or portable conditions without further testing under the condition that any additional collocation or simultaneous transmission requirements (including necessary separation distances) have been met.

MPE Calculation Results:

Calculations are based on assuming omni-directional antennas to generate the absolute worst case MPE levels or antenna separation distances.

In the case the equipment meets compliance by MPE Calculations the product is approved for use under mobile conditions without further testing under the condition that any additional collocation or simultaneous transmission requirements (including necessary separation distances) have been met. It is assumed that the manufacturer shall design the equipment such that the minimum separation distance of 20cm (or greater, as listed above) is met or that the manufacturer provides a protection guide (or installation instructions) to the end user such that the antenna(s) may be installed in accordance with the manufacturer's instructions in such a manner to maintain the minimum separation distance.

The antennas are intended for fixed mounting in permanent outdoor structures.

The Absorption and distribution of Electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape and physiological condition of the body; the orientation of the body with respect to the fields; and, the electrical properties of the body and the environment. Variables that may play a substantial role in possible biological effects are those that characterize the environment (including but not limited to: ambient temperature, air velocity, relative humidity and body insulation); and those that characterize the individual (including but not limited to: age, gender, activity level and existing debilitation or disease). Because innumerable factors may interact to determine specific biological effects of exposure to electromagnetic fields, any protection guide should consider both intended and unintended operational environments and provide guidance for installation and use of the product such that proper separation distances can be maintained. (ANSI C95.1)

References

Federal Communications Commission Knowledge Database (KDB) Publication 447498, "What are the RF exposure requirements and procedures for mobile and portable devices?" As in effect on the issue date of this report.

Federal Communications Commission Bulletin OET 65 Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields" June 2001.

Title 47 Code of Federal Regulations, Part 1.1310, "Radiofrequency radiation exposure limits." As in effect on the issue date of this report.

Title 47 Code of Federal Regulations, Part 2.1091, "Radiofrequency radiation exposure evaluation: mobile devices." As in effect on the issue date of this report.

Health Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, 2009.

Health Canada Safety Code 6 Technical Guide, 2009

Industry Canada RSS-102 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) Issue 4, March 2010 (including update December, 2010).

International Commission on Non-Ionizing Radiation Protection. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). Health Physics 74 (4): 494-522; 1998.

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European Committee for Electrotechnical Standardization. European Normative, EN 50371 Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz) 2002.