RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

RF Maximum Permissible Exposure (MPE) Report
for
Controlled and Uncontrolled Environments

Harris Corporation
221 Jefferson Ridge Parkway
Lynchburg, VA 24501
Contact: Fred Shabestar

Model: XL-200M Mobile Radio

FCC ID: OWDTR-0161-E
IC: 3636B-0161

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Report Prepared by: Richard B. McMurray, P.E.

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1 MPE Measurements and Applicable Regulations

This test report presents the results of Maximum Permissible Exposure (MPE) measurements performed on the Harris Corporation XL-200M Mobile Radio, which operates in the VHF-L, VHF, UHF, 700 MHz, 800 MHz and 900 MHz frequency bands. The tests contained in this report are MPE measurements in the 800 and 900 MHz bands. The tests were performed in accordance with TCB training material and the following FCC Rules and Regulations and Industry Canada Radio Standard Specifications:

- IEEE Std C95.1: 2005: "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz",
- IEEE Std C95.3: 2002: "IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz – 300 GHz",
- FCC OET Bulletin 65, Edition 97-01: "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields",
- FCC Supplement C to OET Bulletin 65, Edition 01-01: "Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emission",
- Subpart I, Part 1 of 47 CFR FCC Rules and Regulations, Edition 10-01-18: "Procedures Implementing the National Environmental Policy Act of 1969." Specifically, Paragraph 1.1310: "Radiofrequency Radiation Exposure Limits",
- Subpart J, Part 2 of 47 CFR FCC Rules and Regulations, Edition 10-01-18: "Equipment Authorization Procedures." Specifically, Paragraph 2.1091: "Radiofrequency Radiation Exposure Evaluation: Mobile Devices",
- RSS-102, Issue 5: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

2 Modifications

No modifications were made to the EUT during testing.

3 Test Laboratory

Testing was performed at the Rhein Tech Laboratories (RTL) test facility located at 360 Herndon Parkway, Suite 1400, Herndon, VA, 20170, by RTL personnel. Various regulatory bodies, including the FCC and IC, approved this facility for conducting tests and measurements on a contractual basis.

4 Test Dates

Testing was performed October 2 – 3, 2019.

5 Antenna Information

The following antenna/mounts were tested for the MPE investigation.

Description	Gain (dBi)	Antenna Part #
Antenna, Element, 700/800	5.15	AN-225001-001
Antenna, Element, 800/900	7.15	14050-6611-01
Antenna, Yagi, 800 MHz	12.15	AN-025137-008
Antenna, Yagi, 900 MHz	12.15	AN-025137-009

6 Test Equipment, Accessories and Test Setup

Test equipment used for the measurements is shown in Table 6-1.

Table 6-1: Test Equipment

RTL Asset	Manufacturer	Model	Equipment Type	Serial Number	Calibration Due Date
901676	ETS Lindgren	HI-6053	Electric Field Probe	00200468	3/26/2022
901355	JFW Industries	50FH-003-300	300 W Attenuator	N/A	10/09/2019
901727	Insulated Wire Inc.	KPS-1503-360-KPS	cable	N/A	8/20/2020
901583	Agilent	N9010A	EXA Signal Analyzer	MY51250846	2/06/2020

Table 6-2: EUT and Accessories

Part	Manufacturer	Model/ HVIN	Serial Number	FCC ID	RTL Bar Code
Vehicular Communication Hub (VCH)	Harris Corporation	XL-200M/ XZ-MPM1M	048	OWDTR-0161-E	23081
Control Head	Harris Corporation	XL-CH Mobile Control Head/ N/A	085	OWDTR-0161-E	23080

Details of the test setup are as follows:

- The EUT was mounted on a wood table 80 cm tall.
- The antenna was mounted on a metal plate (roof mount only) with azimuth indicators and placed in the middle of a separate table.
- The control unit and power supply were located at a distance of at least 1.5 meters from the EUT's antenna to minimize interference.
- The test probe was solidly connected to the radiation meter, and then attached to the plastic mast in front of the EUT's antenna.
- During the MPE measurements, the EUT was set to transmit at maximum RF power with a 50% duty cycle.

7 Justification of Transmitting Mode and Frequency

The EUT is able to transmit with a non-modulated carrier and with various types of modulations at a maximum rated power of 35 W in the 800 and 900 MHz bands. Power was adjusted 50% as it is a PTT radio, then increased by 20% per FCC Part 90.205(s) to allow for manufacturing tolerances. Analog modulation was chosen to represent worst-case for the MPE measurements. The MPE distance measurements were conducted at two representative carrier frequencies since there are two bands of operation for this radio. The frequencies chosen had the highest actual measured conducted powers in each of the bands.

8 MPE Limits for the EUT

The FCC and IC MPE limits, are shown below for uncontrolled and controlled environments in Tables 8-1 and 9-2 respectively. The limits are based on the recommended MPE Guidelines published by the National Council on Radiation Protection and Measurements in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields."

Table 8-1: FCC MPE Limit and Averaging Time in an Uncontrolled Environment

Frequency Range, MHz	Power Density (S), mW/cm^2	Averaging Time, min
300-1500	f/1500, where "f" is the frequency in MHz	30

Table 8-2: FCC MPE Limit and Averaging Time in a Controlled Environment

Frequency Range, MHz	Power Density (S), mW/cm^2	Averaging Time, min
300-1500	f/300, where "f" is the frequency in MHz	6

Table 8-3: ISED MPE Limit and Averaging Time in an Uncontrolled Environment

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Table 8-4: ISED MPE Limit and Averaging Time in a Controlled Environment

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[23]	170	180	-	Instantaneous*
0.1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	$129.8/f^{0.25}$	$0.3444/f^{0.25}$	$44.72/f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60\,f^{0.25}$	$0.04138\,f^{0.25}$	$0.6455f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354\,f^{0.5}$	$9.40 \times 10^{-4}\,f^{0.5}$	$3.33 \times 10^{-4}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

The MPE limits for the EUT are shown in Table 8-5.

Table 8-5: MPE Limits for the Investigated Frequencies

Transmit Frequencies (MHz)	Uncontrolled Exposure		Controlled Exposure	
	FCC Limit (mW/cm^2)	ISED Limit (mW/cm^2)	FCC Limit (mW/cm^2)	ISED Limit (mW/cm^2)
815.0000	0.54	0.25	2.7	1.8
935.0125	0.60	0.27	3.0	1.9

9 Calculating the Safe Distance from the EUT's Antenna

Before starting MPE measurements, we calculated the safe distance, R_{safe} using the following formula:

$$\text{Rsafe} = \sqrt{\frac{P\max \cdot Gn \cdot \eta}{4\pi \cdot S}}$$

G_n: antenna gain (numeric)
P_{max}: maximum power input to the antenna (W)
S: power density limit (W/m^2) respectively
η: duty cycle (decimal number), for these measurements $\eta = 0.5$

The cable loss of the RF cable connecting the EUT and the antenna under test decreases the RF power delivered to the antenna and influences the value of the safe distance.

Based on the specification for the cable supplied with these antennas, the cable loss in the frequency range of interest is approximately 0.6 dB; the cable loss is assumed to be zero in the calculations below.

The calculated safe distances serve as a starting point for the MPE measurements, though it is acknowledged that the measured safe distances will be smaller.

Table 9-1 presents the results of **R_{safe}** calculations:

Table 9-1: Calculated Rsafe

Calculated Minimum Safe Distance from LMR Antenna (based on maximum gain of non-Yagi/non-log periodic antennas)

Antenna Gain (dBi)	Transmit Frequencies (MHz)	Uncontrolled Exposure		Controlled Exposure	
		United States (cm)	Canada (cm)	United States (cm)	Canada (cm)
5.15	815.0000	101	148	45	56
7.15	935.0125	121	178	54	68

Calculated Minimum Safe Distance from LMR Antenna (based on maximum gain of Yagi/log periodic antennas) – Mobile Command Center applications

Antenna Gain (dBi)	Transmit Frequencies (MHz)	Uncontrolled Exposure		Controlled Exposure	
		United States (cm)	Canada (cm)	United States (cm)	Canada (cm)
12.15	815.0000	226	332	101	124
12.15	935.0125	214	319	96	121

10 Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were fulfilled during the testing:

1. ANSI C63.4 requires the ambient temperature and relative humidity to be within the ranges of 10°C to 40°C and 10% to 90%, respectively. With respect to the narrower ranges recommended for the power meter used for the measurements, ambient conditions shall be in line with the power meter ranges. Actual values of ambient temperature and relative humidity are shown in Section 13 of this test report.

2. Measurement results presented in Section 13, Test Results, unless otherwise noted, show the highest measured level of MPE.

11 Measurement Procedure

1. The test setup was as described in Section 7 of this test report.
2. Polarization of the EUT's antenna was vertical, which is its polarization in actual use.
3. The EUT was set to transmit at the chosen frequency at maximum RF power and at 50% duty cycle (50% duty cycle is simulated either by lowering the radio's power by 3 dB or by using a 3 dB pad on the output of the radio) and *X 1.20 (per Part 90.205(s)).* During preliminary measurements, we set the distance between the power density probe and the investigated EUT's antenna equal to the average calculated R_{safe} (Table 10-1) applicable either for controlled or uncontrolled environments.
4. Power density measurements were taken at different heights of the probe from the ground (0.1 to 2 meters) while rotating versus azimuth (from 0° to 360°) the antenna.
5. The azimuth between the probe and the antenna position corresponding to the highest MPE level was chosen as the "worst case" position for the final measurements.
6. For the final measurements, we adjusted the distance between the test probe and the tested antenna to the real safe distance, R_{real}, such that the measured highest power density in the "worst case" position was the same or slightly less than the test limit.
7. The measurement results of final measurements conducted at the chosen azimuth and different heights of the probe above the ground are shown in Section 13.
8. Average values of power density were calculated for the imaginary whole human body (0.1–2.0 m), for the lower part of the body (0.1–0.9 m) and for the upper part of the body (1.0–2.0 m). The results of calculations are shown in Section 13.

12 Test Results

Ambient conditions during the MPE investigation were as follows:

- Temperature: 24°C
- Relative humidity: 38%

The MPE measurement procedure was performed per the description in Section 12. Tables 12-1 through 12-2 demonstrate the test results.

Table 12-1: MPE Data General Population/ Uncontrolled Environment

Measuring Antenna Height (cm)	FCC 5.15 dBi, 815 MHz 58 cm (mW/cm^2)	FCC 7.15 dBi, 935.0125 MHz, 50 cm (mW/cm^2)	FCC 12.15 dBi, 815 MHz, 174 cm (mW/cm^2)	FCC 12.15 dBi, 935.0125 MHz, 134 cm (mW/cm^2)	ISED 5.15 dBi, 815 MHz, 96 cm (mW/cm^2)	ISED 7.15 dBi, 935.0125 MHz, 85 cm (mW/cm^2)	ISED 12.15 dBi, 815 MHz, 309 cm (mW/cm^2)	ISED 12.15 dBi, 935.0125 MHz, 265 cm (mW/cm^2)
10	0.0210	0.0153	0.3651	0.2595	0.0210	0.0095	**0.2356**	0.0357
20	0.0149	0.0201	0.3534	0.1941	0.0183	0.0059	0.1909	0.0435
30	0.0369	0.0292	0.1528	0.4527	0.0229	0.0045	0.1150	0.0898
40	0.0351	0.0229	0.2889	0.5267	0.0339	0.0092	0.0426	0.0679
50	0.0705	0.0304	**0.4996**	0.3102	0.0414	0.0095	0.0602	0.0215
60	0.0637	0.0491	0.4459	0.3770	0.0581	0.0315	0.2071	0.0597
70	0.1249	0.1050	0.2468	**0.5506**	0.0938	0.0550	0.1722	0.1415
80	0.2632	0.2308	0.1203	0.4820	0.1502	0.1379	0.2461	0.2050
90	0.4905	0.4546	0.1948	0.3917	0.1782	0.2170	0.2065	**0.2615**
100	**0.5300**	**0.5785**	0.3534	0.3752	**0.2489**	**0.2632**	0.1331	0.2231
110	0.3419	0.2802	0.4524	0.4557	0.2293	0.2340	0.0869	0.1645
120	0.1553	0.0662	0.3612	0.4342	0.1962	0.1343	0.0542	0.1355
130	0.0918	0.0161	0.2889	0.3768	0.1115	0.0803	0.0408	0.0918
140	0.1029	0.0201	0.1991	0.2989	0.0722	0.0428	0.0794	0.1203
150	0.1137	0.0145	0.1618	0.2406	0.0535	0.0064	0.1148	0.1226
160	0.1137	0.0072	0.1766	0.1863	0.0550	0.0134	0.1502	0.1261
170	0.0859	0.0075	0.1807	0.1342	0.0573	0.0205	0.1415	0.1137
180	0.0731	0.0086	0.1863	0.0956	0.0558	0.0229	0.1226	0.0908
190	0.0428	0.0105	0.1541	0.0787	0.0469	0.0244	0.0869	0.0621
200	0.0408	0.0066	0.1148	0.0548	0.0395	0.0192	0.0597	0.0527
Limit	**0.54**	**0.60**	**0.54**	**0.60**	**0.25**	**0.27**	**0.25**	**0.27**

Table 12-2 MPE Data Occupational/Controlled Environment

Measuring Antenna Height (cm)	FCC 5.15 dBi, 815 MHz 18 cm (mW/cm^2)	FCC 7.15 dBi, 935.0125 MHz, 17 cm (mW/cm^2)	FCC 12.15 dBi, 815 MHz, 39 cm (mW/cm^2)	FCC 12.15 dBi, 935.0125 MHz, 39 cm (mW/cm^2)	ISED 5.15 dBi, 815 MHz, 30 cm (mW/cm^2)	ISED 7.15 dBi, 935.0125 MHz, 18 cm (mW/cm^2)	ISED 12.15 dBi, 815 MHz, 56 cm (mW/cm^2)	ISED 12.15 dBi, 935.0125 MHz, 71 cm (mW/cm^2)
10	0.0327	0.0357	0.2035	0.1104	0.0157	0.0170	0.1790	0.1948
20	0.0428	0.0483	0.2699	0.1631	0.0201	0.0327	0.2220	0.2682
30	0.0662	0.0215	0.4287	0.3139	0.0731	0.0220	0.3794	0.3139
40	0.0292	0.0428	0.5711	0.6526	0.0304	0.0183	0.4782	0.4459
50	0.0840	0.0542	0.7908	1.1978	0.0550	0.0740	0.6597	0.6658
60	0.0589	0.0448	1.3942	1.8538	0.0869	0.0621	1.1957	1.2193
70	0.0908	0.1272	2.0916	2.4349	0.1515	0.2308	1.5845	1.2410
80	**2.6472**	**2.9691**	**2.6685**	**2.8745**	**1.7292**	0.2533	1.4992	1.1589
90	2.1105	2.1966	2.6685	2.7705	1.3865	**1.7575**	1.6790	**1.6722**
100	1.0000	0.9870	2.3288	2.2892	0.8739	1.020	1.7710	1.4291
110	0.3249	0.3066	1.9801	1.6554	0.3139	0.2959	**1.7827**	1.0461
120	0.2170	0.0958	1.2592	0.9109	0.1343	0.0850	1.5040	0.8618
130	0.2246	0.0888	0.8831	0.4244	0.1991	0.0696	1.0226	0.6765
140	0.1284	0.0351	0.6035	0.1991	0.1849	0.0210	0.7440	0.4502
150	0.0498	0.0157	0.3495	0.0812	0.1226	0.0075	0.4719	0.3249
160	0.0192	0.0123	0.2356	0.0520	0.0688	0.0066	0.3012	0.1698
170	0.0080	0.0095	0.1238	0.0327	0.0333	0.0042	0.2387	0.0469
180	0.0072	0.0042	0.0758	0.0234	0.0225	0.0032	0.1721	0.0304
190	0.0099	0.0049	0.0395	0.0196	0.0153	0.0032	0.1355	0.0178
200	0.0126	0.0059	0.0276	0.0059	0.0138	0.0025	0.0928	0.0174
Limit	**2.7**	**3.0**	**2.7**	**3.0**	**1.8**	**1.9**	**1.8**	**1.9**

13 Conclusion

1. The MPE measurements for controlled and uncontrolled environments shown in this report were conducted per the applicable FCC/IC Rules, Regulations and Guidance, and determined the minimum safe distances between a user and the EUT antennas with different gains.

2. As is shown in Section 12, the measured MPE are below the maximum allowed limits.

3. The User Manual shall include RF radiation safety warnings and the following table:

Antenna	Gain (dBi)	Part #	Band (MHz)	Uncontrolled Exposure		Controlled Exposure	
				United States (cm)	Canada (cm)	United States (cm)	Canada (cm)
Antenna, Element, 700/800	5.15	AN-225001-001	800	58	96	18	30
Antenna, Element, 800/900	7.15	14050-6611-01	900	50	85	17	18
Antenna, Yagi, 800 MHz	12.15	AN-025137-008	800	174	309	39	56
Antenna, Yagi, 900 MHz	12.15	AN-025137-009	900	134	265	39	71