Engineering and Testing for EMC and Safety Compliance

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

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Model: Vehicular Repeater Base System (VRBS 7010)

FCC ID: OWDTR-0058-E
IC: 3636B-0058

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Table of Contents

1 MPE Measurements and Applicable Regulations

This test report presents the results of Maximum Permissible Exposure (MPE) measurements performed on the Harris Corporation Vehicular Repeater Base Station VRBS 7010, which operates in the 700 MHz frequency band (763-775 MHz). 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 10-1-09: "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 10-1-09: "Equipment Authorization Procedures." Specifically, Paragraph 2.1091: "Radiofrequency Radiation Exposure Evaluation: Mobile Devices",
- RSS-102, Issue 3, 2009: "Spectrum Management and Telecommunications Radio Standards Specification. Radiofrequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)".

2 Identification of the EUT

The EUT is a combination of a mobile radio and an antenna. The EUT was tested with two antennas which were placed on a metal plate during testing to simulate the vehicle mounting surface. The mounting plate acted as a determinable ground plane for the antenna. This MPE report covers the EUT with the antennas described below.

Manufacturer's Name	Harris Corporation
Manufacturer's Address	221 Jefferson Ridge Parkway Lynchburg, VA 24501, USA
Device Type	Vehicular Repeater Base System
Model of the EUT	VRBS 7010
Serial Number of the Radio	A4011E005390
FCC ID of the EUT	OWDTR-0058-E
IC ID of the EUT	3636B-0058
Operating Frequency Ranges (for the specific configuration in this report)	763-775 MHz
RF Max Conducted Power, Rated	4 W
TX Duty Cycle	50%
Antennas Tested	AN-225001-004 element with the following mounts: AN-125001-002 and AN-125001-008
Year of Manufacture	2009, 2010

3 Modifications

No modifications were made to the EUT during testing.

4 Test Laboratory

Testing was performed at the 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.

5 Test Dates

Testing was performed January 22 – 25, 2010

6 Antenna Information

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

Description	Gain	Mount Type	Antenna Element Part #	Mount Part #
Dual Band 700/800 MHz	3 dBd Gain	Roof Mount	AN-225001-004	AN-125001-002
Dual Band 700/800 MHz	3 dBd Gain	Roof Mount	AN-225001-004	AN-125001-008

7 Test Equipment, Accessories and Test Setup

Test equipment used for the measurements is shown in Table 7-1.

Table 7-1: Test Equipment

RTL Asset	Manufacturer	Model	Equipment Type	Serial Number	Calibration Due Date
901177	Narda	TYPE-9	Field Probe	N-0050	9/14/10
901183	Narda	EMC 200	Field Meter	AE-0024	9/14/10
901356	Agilent Technologies	E9323A	Power Sensor	31764-264	11/13/10
901184	Agilent Technologies	E4416A	EPM-P Power Meter, single channel	GB41050573	11/18/10
901358	Aeroflex/Weinschel	47-3-34	Attenuator, 3 dB 0.1 - 18 GHz	BS0146	3/12/10

Table 7-2: EUT and Accessories

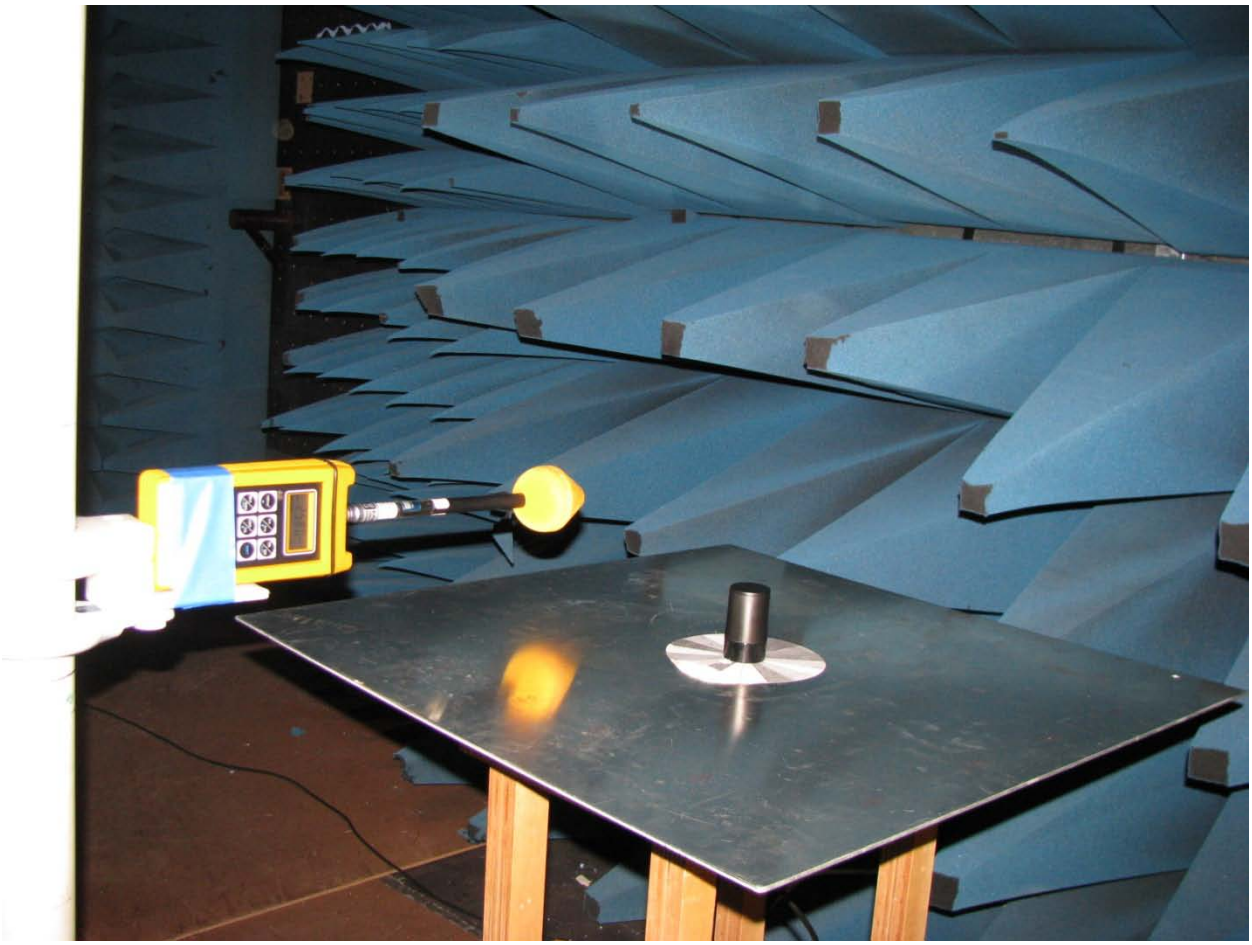
Part	Manufacturer	Model	Serial Number	FCC ID	IC ID	Barcode
Vehicular Repeater Base System	Harris Corporation	VRBS 7010	A4011E005390	OWDTR-0058-E	3636B-0058	19360
Antenna	Harris Corporation	AN-225001-004	N/A	N/A	N/A	19394
Antenna Mount	Harris Corporation	AN-125001-002	N/A	N/A	N/A	19395
Antenna Mount	Harris Corporation	AN-125001-008	N/A	N/A	N/A	19396

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 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.

The typical test setup is shown in photograph 7-1.

Photograph 7-1: Typical Test Setup



8 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 4 W, and is capable of transmitting with "P25 Random" modulation. This type of modulation was chosen to represent worst-case for the MPE measurements. The MPE distance measurements were conducted at one carrier frequency since there is only one band of operation for this radio. The lowest frequency of operation was chosen as it represents the most conservative power density limit.

9 MPE Limits for the EUT

The FCC and IC have the same MPE limits, which are shown below for uncontrolled and controlled environments in Tables 9-1 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 9-1: FCC/IC 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 9-2: FCC/IC 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

The MPE limits for the EUT transmitting at 763 MHz are shown in Table 9-3.

Table 9-3: MPE Limits for the Investigated Frequencies

Frequency (MHz)	MPE Limit (S) Controlled Environment (mW/cm^2)	MPE Limit (S) Uncontrolled Environment (mW/cm^2)
763	2.5	0.5

10 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 1.5 dB; but based on the power of this radio, cable loss is assumed to be zero in the calculations below since the distance is so close to the FCC minimum of 20 cm.

Note that the assumed antenna gain is the same for both mounts for the basis of these calculations and measurements. Both mounts were tested to ensure there was no significant difference.

Table 10-1 presents the results of **R_{safe}** calculations:

Table 10-1: Calculated Rsafe

Antenna Gain (dBi)	R_{safe}, Controlled Environment (cm)	R_{safe}, Uncontrolled Environment (cm)
4.15	13 (which defaults to 20 cm minimum)	28

11 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.

12 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 at the chosen modulation 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). 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.

Note: The calculated distance in Section 10 is generally used to determine a starting distance for the MPE measurements. Due to the calculated distance for controlled environments being less than 20 cm and some engineering investigation measurements, it was felt that all measurement could be made at 20 cm and the final measurements would be less than the limits for both controlled and uncontrolled environments. This indeed turned out to be the case, and is why only one set of data (representing both controlled and uncontrolled environments) is being reported per antenna/mount combination in the following section.

13 Test Results

Ambient conditions during the MPE investigation were as follows:

- Temperature: 23.8°C
- Relative humidity: 28%

The MPE measurement procedure was performed per the description in Section 12. Tables 13-1 through 13-4 demonstrate the test results.

Table 13-1: MPE – Magnetic Mount

MPE, mW/cm^2, measured at the distance of **20 cm** between the probe and the antenna at the height (cm) shown below																			
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
0.00	0.01	0.01	0.01	0.01	0.01	0.03	0.33	0.21	0.13	0.07	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00

Table 13-2: MPE for Body Parts - Magnetic Mount

Part of the body / averaging points	Averaged Power Density at R_{real} = 20 cm, mW/cm^2
Whole body (0.1 m to 2.0 m)	0.04
Lower body (0.1 m to 0.9 m)	0.07
Upper body (1.0 m to 2.0 m)	0.03

Table 13-3: MPE – Non-Magnetic Mount

MPE, mW/cm^2, measured at the distance of **20 cm** between the probe and the antenna at the height (cm) shown below																			
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
0.00	0.00	0.01	0.00	0.01	0.02	0.02	0.37	0.25	0.14	0.08	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00

Table 13-4: MPE for Body Parts – Non-Magnetic Mount

Part of the body / averaging points	Averaged Power Density at R_{real} = 20 cm, mW/cm^2
Whole body (0.1 m to 2.0 m)	0.05
Lower body (0.1 m to 0.9 m)	0.07
Upper body (1.0 m to 2.0 m)	0.03

14 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 the EUT antennas with different gains and a user.

2. As is shown in Section 13, the measured MPE are below the maximum allowed limits.

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

Safe Distance, R_{safe}, (cm)		
Antenna	**Controlled Environment**	**Uncontrolled Environment**
AN-225001-004 w/ AN-125001-002 (4.15 dBi)	20	20
AN-225001-004 w/ AN-125001-008 (4.15 dBi)	20	20