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Project Number: 01078-10

Prepared for:

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**TYPE CERTIFICATION TEST REPORT**

**UNIVERSAL TRANSEIVER MODULE**

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THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF PROFESSIONAL TESTING (EMI), INC.

## 1. EUT Description

The Equipment Under Test (EUT) is the **Lester Electrical, Inc., Universal Transceiver Module**. The **Universal Transceiver Module** is used together with one or more Data Collection Modules and Temperature Sensor Units for gathering battery performance and vehicle utilization data. The EUT operates in the 902 - 928 MHz band and is designed for compliance with 47 CFR 15.249 of the FCC rules.

The **Universal Transceiver Module/Base Station** consists of a DC to DC converter power supply, microprocessor and RF transceiver constructed entirely of surface mount components attached to a 2.4" X 2.4" PC board, mounted in a metal enclosure with an external, permanently attached antenna. The serial port of the small personal computer to which it is attached powers it. The device employs a bi-directional RF data link to gather data from Data Collection Modules attached to batteries. The device operates at a frequency of 916.5 MHz and employs on-off keying as the modulation method. Data is Manchester encoded and transmitted at an approximate rate of 12Khz. The device operates autonomously and is normally in the receive mode. Periodically, it may transmit a 200-millisecond burst of data to convey status information to Data Collection Modules or to request specific data from them.

The Personal computer is a model ILH386V with a 386 processor operating at 25 MHz. The PC contains an internal hard disk drive, a floppy disk drive, a flash disk drive.

Specific test requirements for this device include the following:

47 CFR 15.249	Fundamental Transmit Power
47 CFR 15.249 & 15.205	Spurious Radiated Power
47 CFR 15.249 15.231 & 2.989	Occupied Bandwidth (2.989 used as Procedural Reference)
47 CFR 15.203	Antenna Requirement
47 CFR 15.207	Conducted Emissions

**The system tested consisted of the following:**

<b>Manufacturer &amp; Model</b>	<b>FCC ID #</b>	<b>Description</b>
Lester Electrical, Inc.	OBH22220	Universal Transceiver Module

### 1.1. EUT Operation

The **Universal Transceiver Module** was tested with the wireless link active and fully modulated. Setup and operational modes cover worst case configuration and operational modes for the device.

## 2. Radiated Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. Radiated emission measurements were made of the Fundamental and Spurious Emission levels for the **Universal Transceiver Module**. Measurements of the occupied bandwidth were also made for the equipment.

Measurements of the maximum emission levels for the fundamental and the spurious/harmonic emissions of the **Universal Transceiver Module** were made at the Professional Testing "Open Field" Site 3, located in Round Rock, Texas to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

Tests of the fundamental for the device were performed to determine the worst case polarization of the devices. The fundamental emissions of the device were measured with the antennas of the devices vertical and horizontal to the ground plane.

### 2.1. Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. For spurious/harmonic measurements above 1GHz, the measurement antenna was placed 1 meter from the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. A drawing showing the test setup is given as Figure 1.

### 2.2. Test Criteria

The FCC Part 15.249 radiated limits are given below for an intentional radiator operating in the 902 to 928 MHz band. The reference distance for each limit is also shown in this table.

Signal Type	Test Distance	Field Strength	
		$\mu\text{V/m}$	$\text{dB } \mu\text{V/m}$
Fundamental	3	50,000	93.9
Spurious/Harmonics	3	500	53.9
Spurious/Harmonics	1	1,500	63.5

In addition to these requirements, the EUT must meet the restricted emission band requirements of §15.205. For this frequency range, the unintentional radiated emission limits of §15.249 for a 902 to 928 MHz radiator and the restricted band limits of §15.205 are identical. Measurements of the harmonic were performed to the 10<sup>th</sup> harmonic of the fundamental.

### 2.3. Test Results

The radiated test data is included as Appendix B. The emissions were maximized at each frequency and the highest emissions identified were measured using peak detection. The radiated emissions generated by the **Universal Transceiver Module** are below the FCC Part 15.249 maximum emission criteria.

## 3. Occupied Bandwidth Measurements

Measurements of the occupied bandwidth for the fundamental signals of the of the **Universal Transceiver Module** were made at the Professional Testing's Round Rock, Texas laboratory. All measurements were made in a controlled indoor environment in a configuration which did not present measurement distortion or ambient interference.

### 3.1. Test Procedure

1. The EUT was placed on a non-conductive table 0.8 meters above the floor. The table was rotated to an angle that presented the highest signal level.
2. The Spectrum Analyzer was set to a resolution bandwidth of 100 kHz. Peak detection was used for all tests. The display was set with the maximum amplitude near the displayed center frequency and with a display width sufficient to view the occupied bandwidth.
3. The occupied bandwidth was measured based on a 20 dB criteria (20 dB down either side of the emission from the nominal center of the emission).

A drawing showing the test setup is given as Figure 1.

### 3.2. Test Criteria

While the FCC rules do not state a specific limit of occupied bandwidth for 47 CFR 15.249 devices, submission of the emission bandwidth is normally required during the Certification procedure. The only implication regarding an occupied bandwidth requirement is that the emission cannot exceed 80% of the band authorized under §15.249 (902 to 928 MHz for this device). Measurement of the occupied bandwidth was performed to verify that the emission bandwidth did not change beyond what is typically seen for Universal Transceiver module. The typical occupied bandwidth for the module is 100 kHz. Data from these tests was also used to verify compliance with the main frequency range requirement of §15.249. For this device, the lowest allowed center frequency of the intended emission is 902 MHz and the highest allowed center frequency of the intended emission is 928 MHz.

### 3.3. Test Results

The occupied bandwidth test data is included in Appendix C. The occupied bandwidth for the fundamental frequency (916.5 MHz) is 450 kHz. The figure is typical for the Universal Transceiver module.

The intended center frequency for the EUT was centered at 916.5 MHz. The center frequency is within the allowed band. The fundamental signal generated by **Universal Transceiver Module** is within the band allowed under FCC Part 15.249 emission band criteria.

## 4. Antenna Requirement

An analysis of the **Universal Transceiver Module** was performed to determine compliance with Section 15.203 of the Rules. This section requires specific handling and control of antennas used for devices subject to regulation under the Intentional Radiator portions of Part 15.

### 4.1. Evaluation Procedure

The structure and application of the **Universal Transceiver Module** were analyzed with respect to the rules. The antenna for this unit permanently attached to the unit and is not accessible by the user and an auxiliary antenna port is not present.

### 4.2. Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

- (a) Antenna be permanently attached to the unit.
- (b) Antenna must use a unique type of connector to attach to the EUT.

(c) Unit must be professional installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

#### **4.3. Evaluation Results**

The **Universal Transceiver Module** meets the criteria of this rule by virtue of having an antenna permanently attached to the unit. The EUT is therefore compliant with §15.203.

### **5. Conducted Emissions Testing**

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. Conducted emission measurements were made of the AC power to the Base Station (PC) attached to the **Universal Transceiver Module**.

Measurements of the conducted emission levels for the Base Station attached to the **Universal Transceiver Module** were made at the Professional Testing laboratory, located in Round Rock, Texas to determine the radio noise conducted from the EUT.

Tests of both the phase and neutral of the AC power feeding the device were performed to determine the emissions coming from the device.

#### **5.1. Test Procedure**

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The AC power cord was connected to a LISN. The test setup, cable placement and relative distances were configured per ANSI C63.4.

A Spectrum Analyzer with quasi-peak detection was used to find the maximums of the conducted emissions during the testing.

#### **5.2. Test Criteria**

The FCC Part 15.207 conducted limits are given below for emissions in the 0.45 to 30.0 MHz band.

<b>Frequency Range</b>	<b>Field Strength</b>	
	<b>μV</b>	<b>dB μV</b>
0.45 – 1.705	1000	60.0
1.705 – 30.0	3000	69.5

### 5.3. Test Results

The conducted test data is included as Appendix D. The highest emissions were identified and measured using quasi-peak detection. The conducted emissions generated by the Base Station and **Universal Transceiver Module** are below the FCC Part 15.207 criteria.

### 6. Modifications to Equipment

There were no modifications made on the **Universal Transceiver Module** during the performance of the test program in order to meet the FCC criteria.

### 7. List of Test Equipment

A list of the test equipment utilized to perform the testing is given below. The date of calibration is given for each.

<b>Electromagnetic Emissions Test Equipment</b>		
<b>Device Description</b>	<b>Date Last Calibration</b>	<b>Date Calibrated Due</b>
HP 8566B Spectrum Analyzer	07/22/00	07/22/01
HP 85650A Quasi Peak Adapter	07/22/00	07/22/01
HP 8447E Preamp	11/11/99	11/11/00
EMCO 3146 Log Antenna	12/21/99	12/21/00
EMCO 3115 Microwave Antenna	5/21/00	5/21/01
MITEQ Preamp 1-20 GHz	5/10/00	5/10/01
Advantest R3265 Spectrum Analyzer	11/5/00	11/5/01
Tektronix 2706 Preselector	11/5/00	11/5/01
Compliance Design B-100 Biconical Antenna	11/5/00	11/5/01



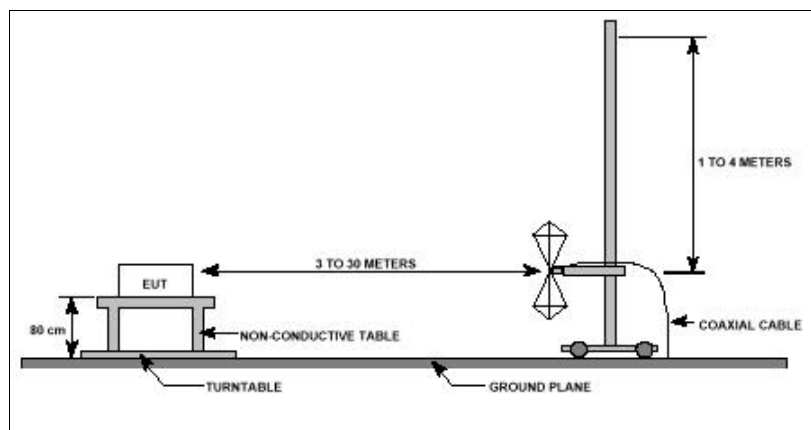


FIGURE 1: Radiated Emissions Test Setup

**8. Appendix A: Fundamental Radiated Emissions Data**

**Grantee:** Lester Electrical, Inc.  
**Model:** Universal Transceiver Module  
**M/N:** OBH 22220  
**S/N:** 001  
**Project:** 01078-10

**Date:** 8/14/00  
**Measurement Distance (m):** 3  
**Detector Function:** Quasi-Peak

*Antenna Polarization - Vertical*

<b>Frequency</b>	<b>EUT Dir.</b>	<b>Ant. Height</b>	<b>Rec. Level</b>	<b>Ant. Factor</b>	<b>Cable Loss</b>	<b>Corrected Level</b>	<b>Limit</b>	<b>Margin</b>
<b>MHz</b>	<b>Deg.</b>	<b>m</b>	<b>dB ìV</b>	<b>dB/m</b>	<b>dB</b>	<b>dB ìV/m</b>	<b>dB ìV /m</b>	<b>dB</b>
<b>916.54</b>	<b>355</b>	<b>1.5</b>	<b>59.3</b>	<b>21.7</b>	<b>9.0</b>	<b>90.0</b>	<b>93.9</b>	<b>3.9</b>

## 9. Appendix B: Spurious Radiated Emissions

**Grantee:** Lester Electrical, Inc.  
**Model:** Universal Transceiver Module  
**M/N:** OBH 22220  
**S/N:** 001  
**Project:** 01078-10

**Date:** 8/15/00  
**Measurement Distance (m):** 3  
**Detector Function:** Peak

### *Antenna Polarization - Horizontal*

Frequency	EUT Dir.	Ant. Height	Rec. Level	Ant. Factor	Cable Loss	Corrected Level	Limit	Margin
MHz	Deg.	m	dB ÷V	dB/m	dB	dB ÷V/m	dB ÷V /m	dB
48.01	180	2.6				5.0	49.5	44.5
72.017	170	2.5				29.6	49.5	19.9
120.04	215	2.0				13.0	53.9	40.9
127.94	180	1.5				26.5	53.9	27.4
128.04	80	1.5				25.2	53.9	28.7
144.03	75	2.0				37.1	53.9	16.8
168.037	185	2.0				47.0	53.9	6.9

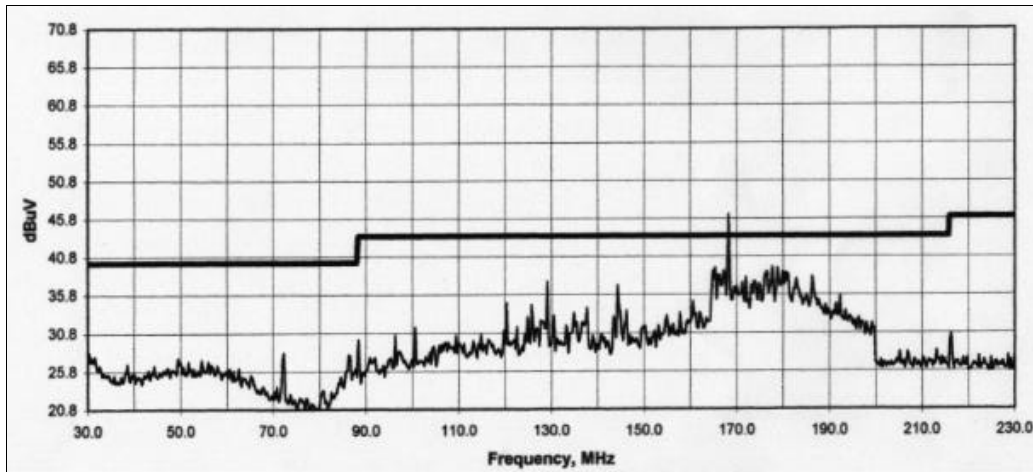
**Date:** 8/14/00  
**Measurement Distance (m):** 1  
**Detector Function:** Peak

### *Antenna Polarization - Vertical*

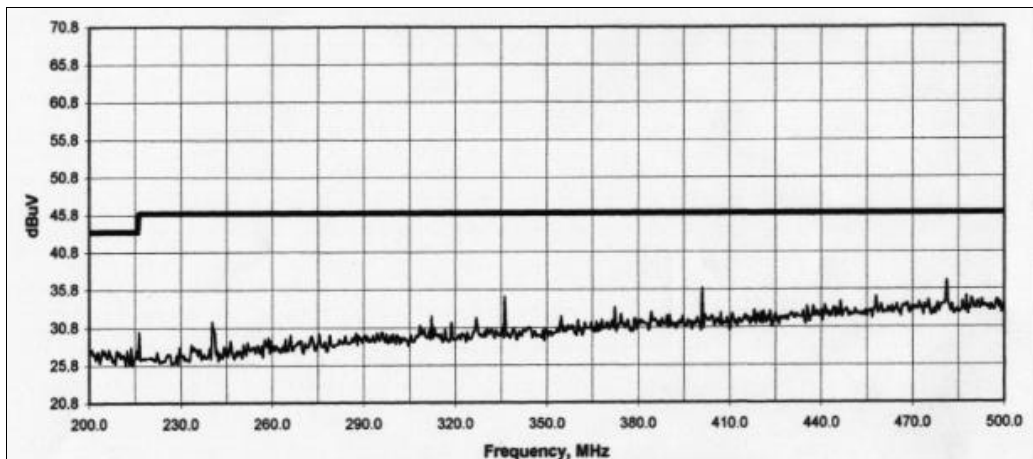
Frequency	EUT Dir.	Rec. Level	Ant. Factor	Amp Gain	Cable Loss	Corrected Level	Limit	Margin
MHz	Deg.	dB ÷V	dB/m	dB	dB	dB ÷V/m	dB ÷V /m	dB
1833.2	355	30.1	27.3	-23.4	1.5	26.0	53.9	27.9

NOTE: 9.5 dB was subtracted from the corrected level in order to properly compare the 1 m reading with the 3 m limit.

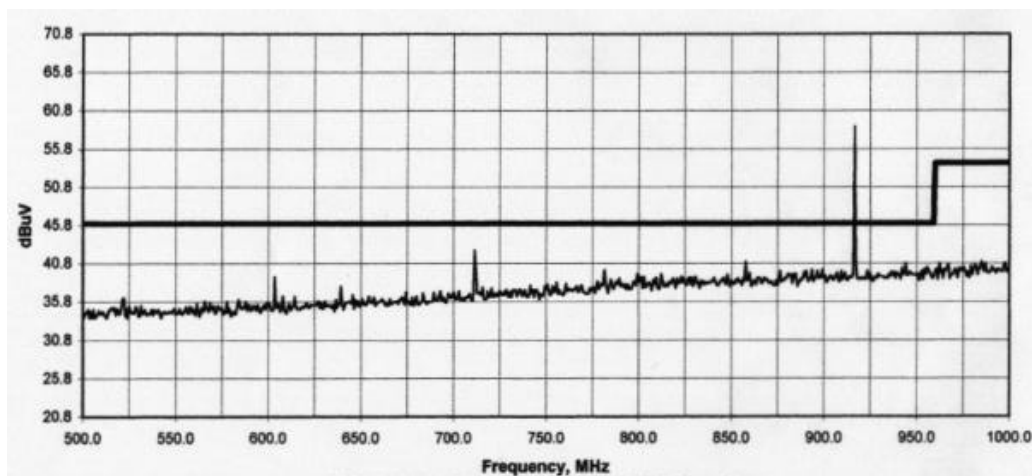
## 9.1. Pre-Scan Graphs



**FCC 15.109(a): Radiated, 3M, Class B Limit**  
**100 kHz RBW, Peak Detection, 100 ms Sweep**



**FCC 15.109(a): Radiated, 3M, Class B Limit**  
**100 kHz RBW, Peak Detection, 100 ms Sweep**



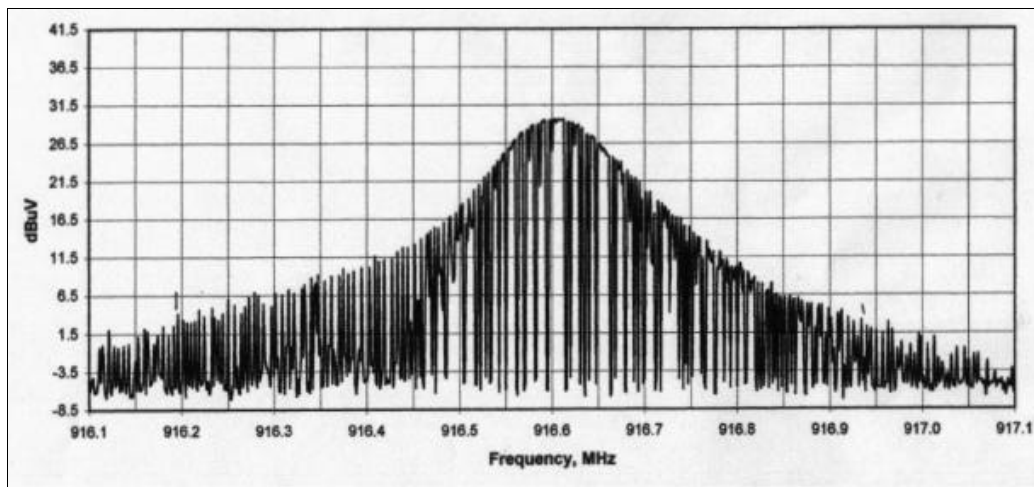
**FCC 15.109(a): Radiated, 3M, Class B Limit**  
**100 kHz RBW, Peak Detection, 100 ms Sweep**

**10. Appendix C: Occupied Bandwidth**

**Grantee:** Lester Electrical, Inc.  
**Model:** Universal Transceiver Module  
**M/N:** OBH 22220  
**S/N:** 001  
**Project:** 01078-10

**Date:** 8/15/00  
**Resolution Bandwidth:** 100 kHz  
**Detection Function:** Peak  
**Sweep Time:** 50 mS

**20 dB Bandwidth:** 450 kHz



100 kHz RBW, Peak Detection, 50 ms Sweep

**11. Appendix D: Conducted Emissions**

**Grantee:** Lester Electrical, Inc.  
**Model:** Universal Transceiver Module  
**M/N:** OBH 22220  
**S/N:** 001  
**Project:** 01078-10

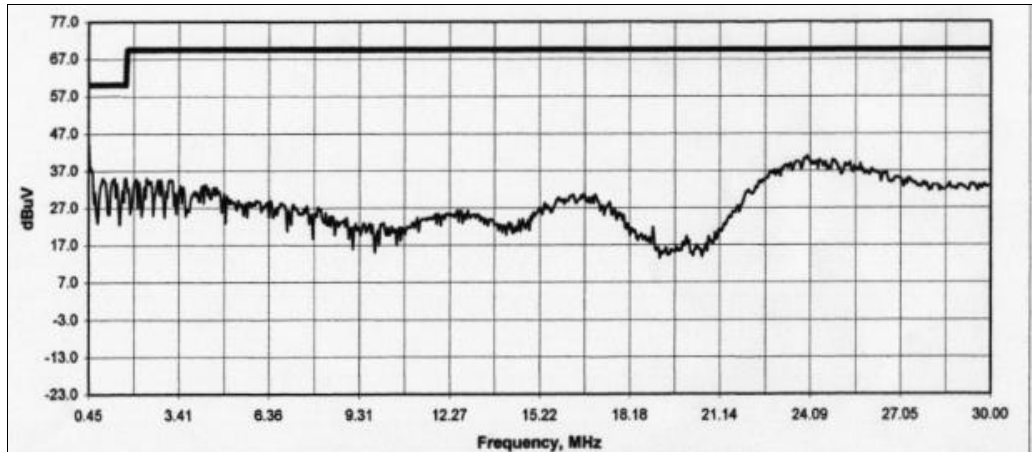
**Date:** 8/15/00  
**Detector Function:** Peak

*Line Tested - Phase*

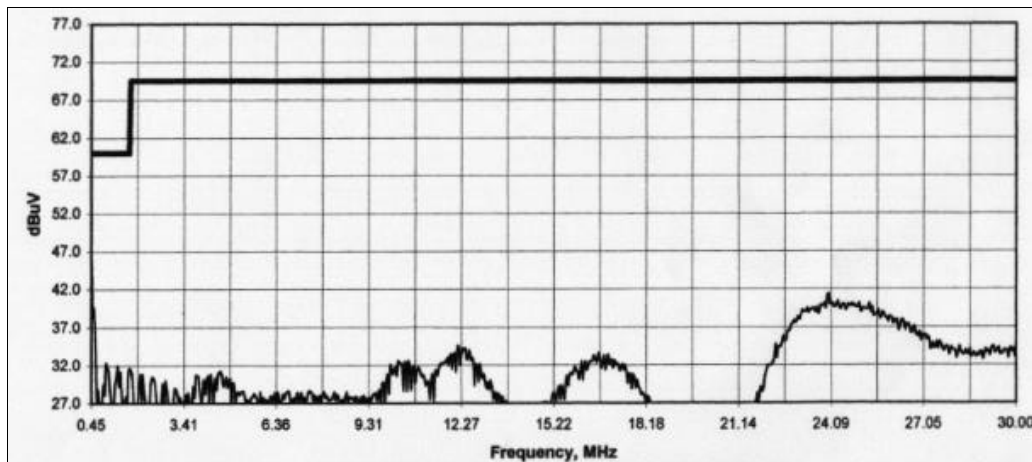
Frequency	Rec. Level	Cable Loss	LISN Factor	Corrected Level	QP Limit	Margin
MHz	dB ÷V	dB	dB	dB ÷V	dB ÷V	dB
.45	35.0	.1	.2	35.3	60.0	24.7
.4571	46.2	.1	.2	46.5	60.0	13.5
12.285	30.4	.8	.1	31.3	69.5	38.2
17.0	22.9	.9	.1	23.9	69.5	45.6
24.01	37.9	1.1	.2	39.2	69.5	30.3

*Line Tested - Neutral*

Frequency	Rec. Level	Cable Loss	LISN Factor	Corrected Level	QP Limit	Margin
MHz	dB ÷V	dB	dB	dB ÷V	dB ÷V	dB
.45654	44.2	.1	.2	45.5	60.0	15.5
.91513	35.4	.2	.2	35.8	60.0	24.2
4.181	32.8	.4	.1	33.3	69.5	36.2
16.788	26.9	.9	.1	27.9	69.5	41.6
24.01	38.9	1.1	.2	40.2	69.5	29.3

*Line Tested - Phase*

**FCC 15.107(b): Conducted, Q-Pk, Class A Limit  
10 kHz RBW, Peak Detection, 600 ms Sweep**

*Line Tested – Neutral*

**FCC 15.107(b): Conducted, Q-Pk, Class A Limit  
10 kHz RBW, Peak Detection, 600 ms Sweep**