



**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*

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July 11, 2016

Grace Industries, Inc.  
305 Bend Hill Road  
Fredonia, PA 16124

Dear Bob Campman,

Enclosed is the EMC Wireless test report for compliance testing of the Grace Industries, Inc., MX / MS / Supercell / TPASS PAR as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,  
MET LABORATORIES, INC.

Jennifer Warnell  
Documentation Department

Reference: (\Grace Industries, Inc.\EMC88324C-FCC247 REV 1)

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## **Electromagnetic Compatibility Criteria Test Report**

for the

**Grace Industries, Inc.  
MX / MS / Supercell / TPASS PAR**

**Tested under**  
the FCC Certification Rules contained in  
Title 47 of the CFR, Part 15.247 Subpart C  
for Intentional Radiators

**MET Report: EMC88324C-FCC247 REV 1**

July 11, 2016

**Prepared For:**

**Grace Industries, Inc.  
305 Bend Hill Road  
Fredonia, PA 16124**

**Prepared By:**  
**MET Laboratories, Inc.**  
914 W. Patapsco Ave.  
Baltimore, MD 21230

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**Grace Industries, Inc.**  
**MX / MS / Supercell / TPASS PAR**

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Title 47 of the CFR, Part 15.247 Subpart C  
for Intentional Radiators



Hadid Jones, Project Engineer  
Electromagnetic Compatibility Lab



Jennifer Warnell  
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rule Part 15.247 under normal use and maintenance.



Asad Bajwa,  
Director, Electromagnetic Compatibility Lab



## Report Status Sheet

Revision	Report Date	Reason for Revision
∅	June 10, 2016	Initial Issue.
1	July 11, 2016	Engineer Corrections.

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## List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB $\mu$ A	Decibels above one <b>microamp</b>
dB $\mu$ V	Decibels above one <b>microvolt</b>
dB $\mu$ A/m	Decibels above one <b>microamp per meter</b>
dB $\mu$ V/m	Decibels above one <b>microvolt per meter</b>
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
$\mu$ H	microhenry
$\mu$	microfarad
$\mu$ s	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts <b>per meter</b>
VCP	Vertical Coupling Plane

# I. Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Grace Industries, Inc. MX / MS / Supercell / TPASS PAR, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the MX / MS / Supercell / TPASS PAR. Grace Industries, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the MX / MS / Supercell / TPASS PAR, has been **permanently** discontinued.

## B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Grace Industries, Inc., purchase order number 160201-2. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	20 dB Occupied Bandwidth	Compliant
	99% Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Number of RF Channels	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RF Channel Separation	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Conducted Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(g) & (h)	Declaration Statements for FHSS	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

**Table 1. Executive Summary of EMC Part 15.247 Compliance Testing**

## II. Equipment Configuration

## A. Overview

MET Laboratories, Inc. was contracted by Grace Industries, Inc. to perform testing on the MX / MS / Supercell / TPASS PAR, under Grace Industries, Inc.'s purchase order number 160201-2.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Grace Industries, Inc., MX / MS / Supercell / TPASS PAR.

The results obtained relate only to the item(s) tested.

<b>Model(s) Tested:</b>	MX / MS / Supercell / TPASS PAR	
<b>Model(s) Covered:</b>	MX / MS / Supercell / TPASS PAR	
<b>EUT Specifications:</b>	Primary Power: 3-5.5V Battery	
	FCC ID: J5XMXHEM	
	Type of Modulations:	GFSK
	Equipment Code:	DSS
	Peak RF Output Power:	22.87 dBm
	EUT Frequency Ranges:	905 – 925 MHz
<b>Analysis:</b>	The results obtained relate only to the item(s) tested.	
<b>Environmental Test Conditions:</b>	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
<b>Evaluated by:</b>	Hadid Jones	
<b>Report Date(s):</b>	July 11, 2016	

**Table 2. EUT Summary Table**

## B. References

<b>CFR 47, Part 15, Subpart C</b>	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
<b>ANSI C63.4:2014</b>	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
<b>ISO/IEC 17025:2005</b>	General Requirements for the Competence of Testing and Calibration Laboratories
<b>ANSI C63.10-2013</b>	American National Standard for Testing Unlicensed Wireless Devices
<b>KDB 447498 D01</b>	General RF Exposure Guidance v05r01

**Table 3. References**

## C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

## **D. Description of Test Sample**

The Grace Industries, Inc. MX / MS / Supercell / TPASS PAR, Equipment Under Test (EUT), devices portable transceiver devices used to monitor “Man-Down” safety alarms. They are used for alerting other personnel of a worker in distress.

## **E. Equipment Configuration**

The EUT was set up as outlined in **Error! Reference source not found.**

## **F. Mode of Operation**

There are two primary operating modes for these models:

Mode 1, Receive: The device receives periodic RF transmissions from certain compatible Grace products.

Mode 2, Transmit: By command from a monitoring person, these models can transmit an RF signal to a Grace compatible man-down alarm, for example for the purpose of signaling the user.

## **G. Method of Monitoring EUT Operation**

The devices contain LED indicator lights. The front LED lights flash Red when the unit is transmitting an RF signal. The front LED lights flash Green when the unit receives a signal from another device.

## **H. Modifications**

### **a) Modifications to EUT**

No modifications were made to the EUT.

### **b) Modifications to Test Standard**

No modifications were made to the test standard.

## **I. Disposition of EUT**

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Grace Industries, Inc. upon completion of testing.

### **III. Electromagnetic Compatibility Criteria for Intentional Radiators**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.203 Antenna Requirement

**Test Requirement:** § 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

**Results:** The EUT as tested is compliant the criteria of §15.203. The EUT has an integral antenna.

**Test Engineer(s):** Hadid Jones

**Test Date(s):** 05/02/16

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.207(a) Conducted Emissions Limits

**Test Requirement(s):** § 15.207 (a): For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50  $\Sigma$  line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dB $\mu$ V)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

**Table 4. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)**

**Test Procedure:** The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50  $\Omega$ /50  $\mu$ H Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50  $\Omega$ /50  $\mu$ H LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

**Test Results:** The EUT was compliant with this requirement. Measured emissions were below applicable limits.

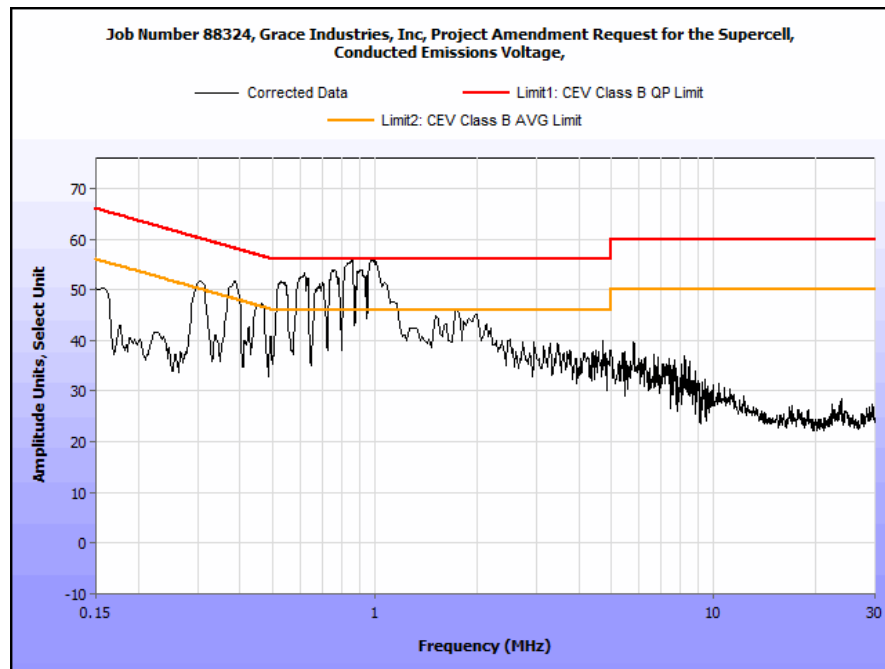
**Test Engineer(s):** Hadid Jones

**Test Date(s):** 03/18/16

### 15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dB $\mu$ V) QP	Cable Loss (dB)	Corrected Measurement (dB $\mu$ V) QP	Limit (dB $\mu$ V) QP	Margin (dB) QP	Uncorrected Meter Reading (dB $\mu$ V) Avg.	Cable Loss (dB)	Corrected Measurement (dB $\mu$ V) AVG	Limit (dB $\mu$ V) AVG	Margin (dB) AVG
0.998	54.38	-0.14	54.24	56	-1.76	42.99	-0.14	42.85	46	-3.15
0.868	51.43	0.26	51.69	56	-4.31	37.89	0.26	38.15	46	-7.85
0.981	45.95	-0.06	45.89	56	-10.11	25.81	-0.06	25.75	46	-20.25
0.788	49.89	0.19	50.08	56	-5.92	40.39	0.19	40.58	46	-5.42
0.718	47.13	0.26	47.39	56	-8.61	34.41	0.26	34.67	46	-11.33
0.632	51.98	0.31	52.29	56	-3.71	43.08	0.31	43.39	46	-2.61

Table 5. Conducted Emissions, 15.207(a), Phase Line, Test Results

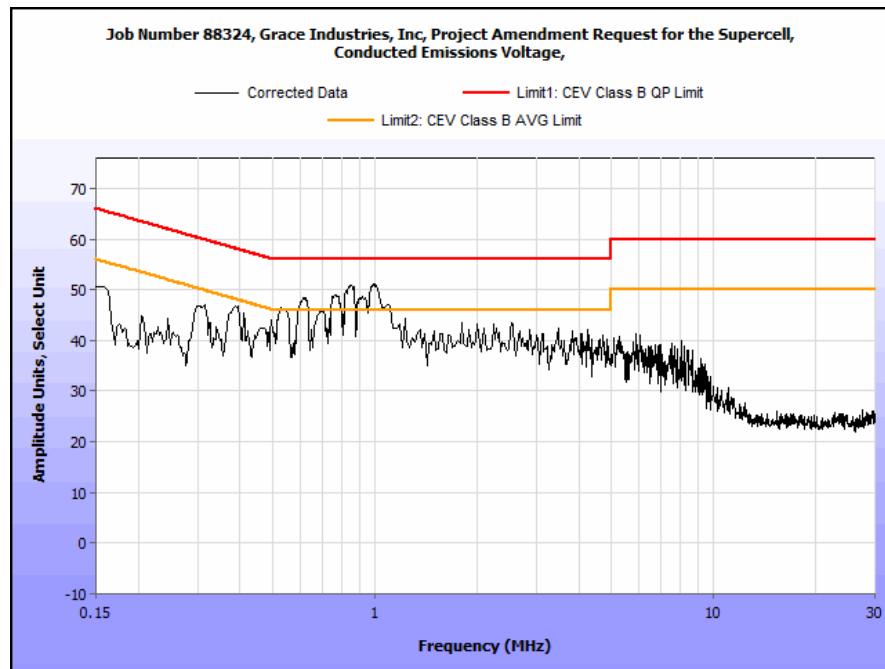


Plot 1. Conducted Emissions, 15.207(a), Phase Line

### 15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dB $\mu$ V) QP	Cable Loss (dB)	Corrected Measurement (dB $\mu$ V) QP	Limit (dB $\mu$ V) QP	Margin (dB) QP	Uncorrected Meter Reading (dB $\mu$ V) Avg.	Cable Loss (dB)	Corrected Measurement (dB $\mu$ V) AVG	Limit (dB $\mu$ V) AVG	Margin (dB) AVG
0.99	40.71	-0.1	40.61	56	-15.39	21.86	-0.1	21.76	46	-24.24
0.878	47.9	0.27	48.17	56	-7.83	36.36	0.27	36.63	46	-9.37
0.805	46.94	0.19	47.13	56	-8.87	34.89	0.19	35.08	46	-10.92
0.92	34.99	0.21	35.2	56	-20.8	19.85	0.21	20.06	46	-25.94
0.63	45.5	0.31	45.81	56	-10.19	31.88	0.31	32.19	46	-13.81
0.727	46.34	0.25	46.59	56	-9.41	32.37	0.25	32.62	46	-13.38

Table 6. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 2. Conducted Emissions, 15.207(a), Neutral Line

**Electromagnetic Compatibility Criteria for Intentional Radiators**

**§ 15.247(a)(1) 20 dB Occupied Bandwidth**

**Test Requirements:** § 15.247(a): Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

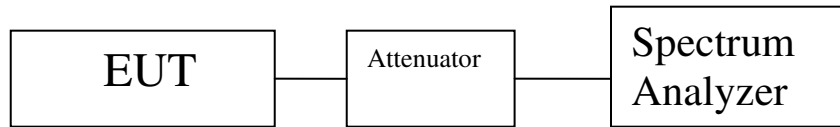
For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

**Test Procedure:** The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

**Test Results** The EUT was compliant with § 15.247 (a)(2).

**Test Engineer(s):** Hadid Jones

**Test Date(s):** 03/17/16

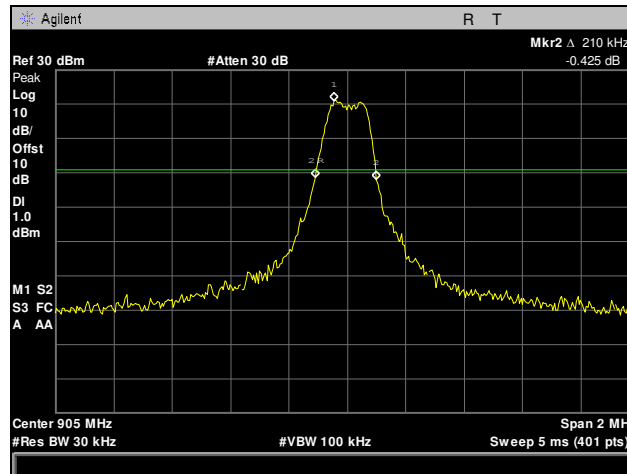


**Figure 1. Block Diagram, Occupied Bandwidth Test Setup**

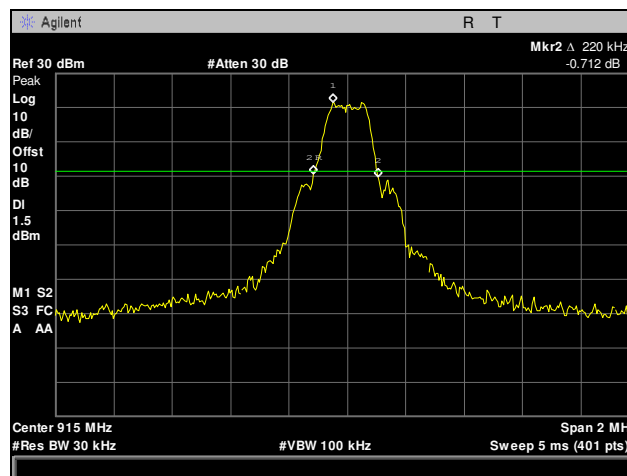
OBW FCC	
Frequency (MHz)	-20db bw (kHz)
905	210
915	220
925	210

**Table 7. Occupied Bandwidth, Test Reports**

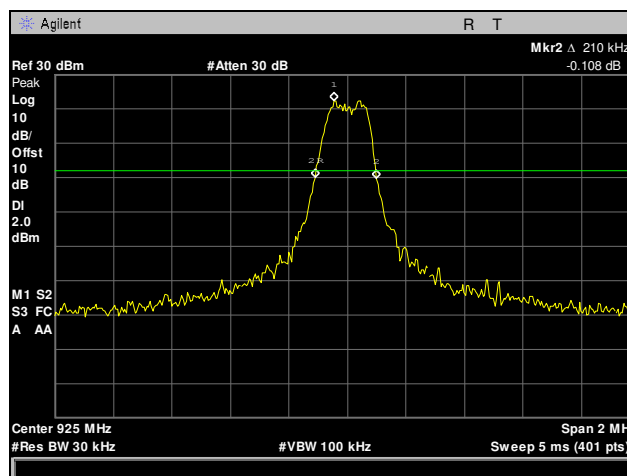
## 20 dB Occupied Bandwidth Test Results



Plot 3. 20 dB Occupied Bandwidth, Low Channel



Plot 4. 20 dB Occupied Bandwidth, Mid Channel



Plot 5. 20 dB Occupied Bandwidth, High Channel

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(a)(1) Average Time of Occupancy (Dwell Time)

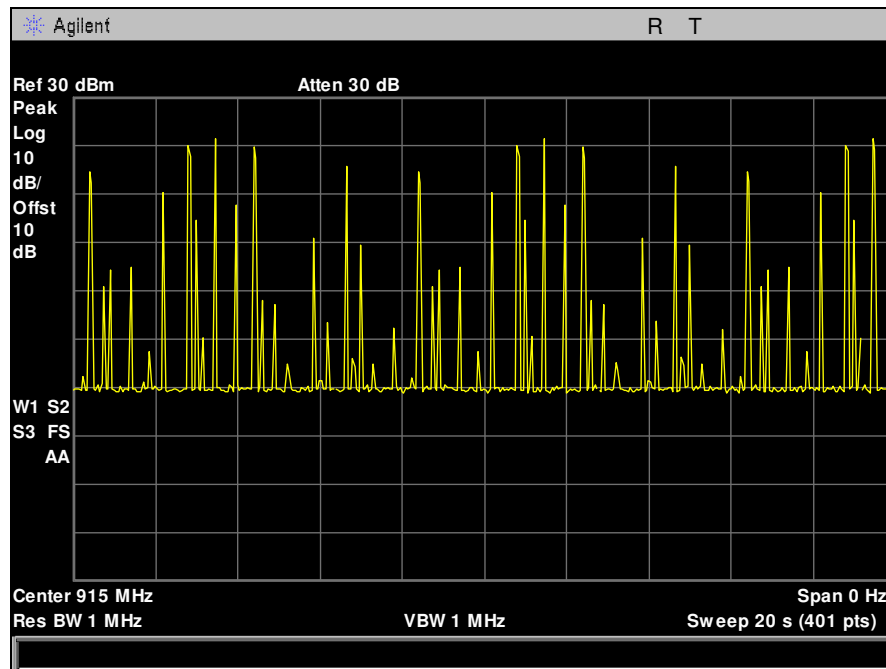
**Remarks:** The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Total hopping channels is 50. The EUT meets the specifications of Section 15.247(a) (1) (i) for Number of Hopping Channels.

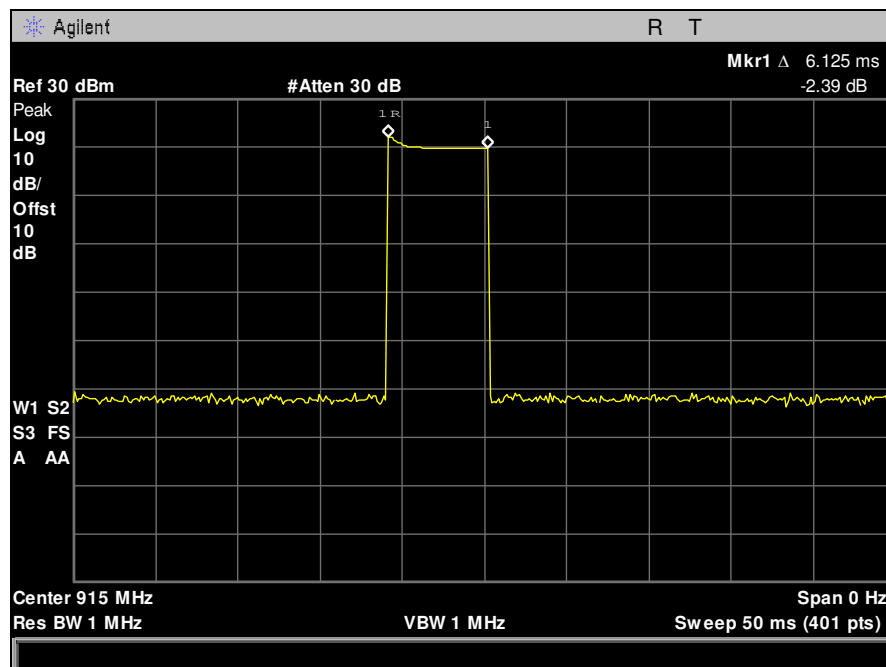
Dwell Time						
frequency range (MHz)	# of channels	hopping period (s)	# of Bursts per Hopping Period	Total Time of Occupancy (s)	Limit (s)	margin (s)
902-928	50	20	8	0.049	0.4	-0.351

**Table 8. Average Time of Occupancy (Dwell Time), Test Results**

## Dwell Time



Plot 6. Dwell Time, Number of Bursts



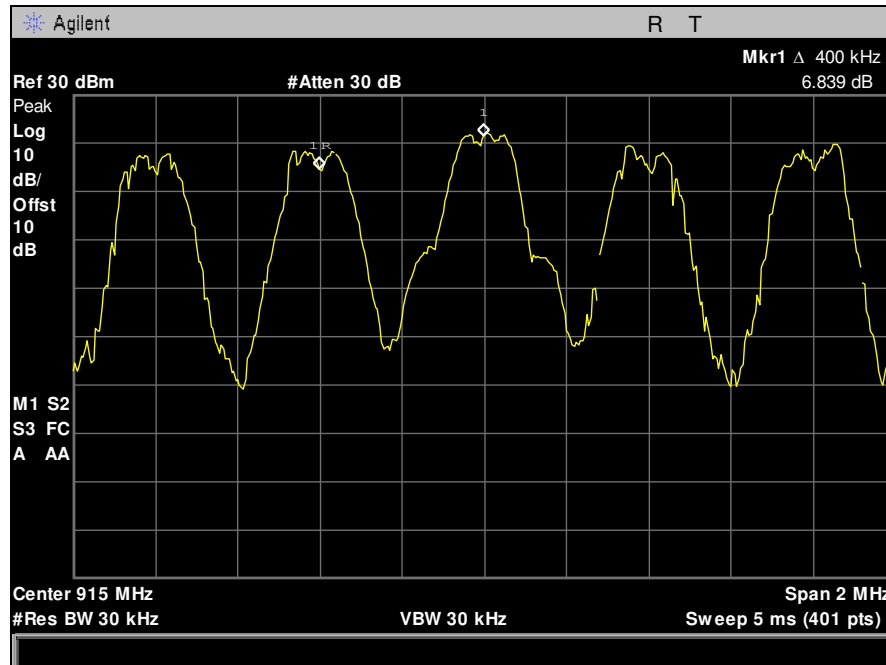
Plot 7. Dwell Time, Burst Duration



## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(a)(1) RF Channel Separation

**Requirement:** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.



Plot 9. Channel Separation

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(b) Peak Power Output

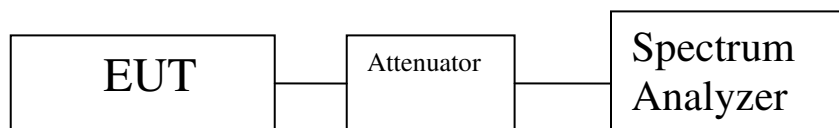
**Test Requirements:** §15.247(b)(1): The maximum peak output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

**Test Procedure:** The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band. The EUT utilizes a 0dBi Omni Antenna, so the maximum power allowed is 30dBm.

**Test Results:** The EUT was compliant with the Peak Power Output limits of §15.247(b).

**Test Engineer(s):** Hadid Jones

**Test Date(s):** 03/17/16



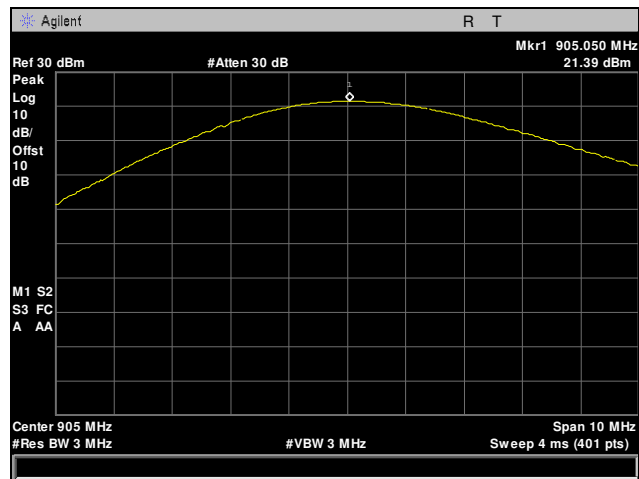
**Figure 2. Peak Power Output Test Setup**

## Peak Power Output Test Results

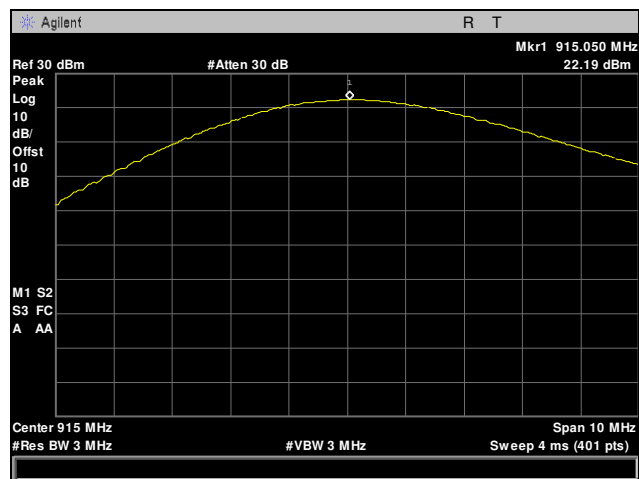
Output Power				
Frequency (MHz)	Power (dBm)	Limit (dBm)	Margin	Antenna Gain (dBi)
905	21.39	30	-8.61	0
915	22.19	30	-7.81	0
925	22.87	30	-7.13	0

**Table 9. Peak Power Output, Test Results**

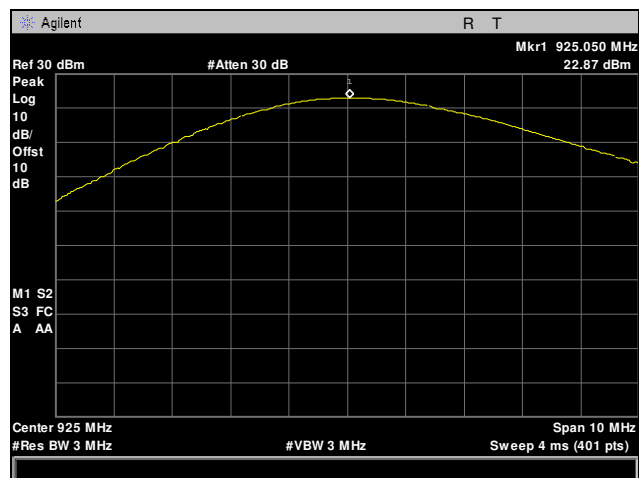
## Peak Power Output Test Results



Plot 10. Peak Power Output, Low Channel



Plot 11. Peak Power Output, Mid Channel



Plot 12. Peak Power Output, High Channel

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

**Test Requirements:** §15.247(d); §15.205: Emissions outside the frequency band.

**§15.247(d):** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

**§15.205(a):** Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110-----	16.42–16.423	399.9–410	4.5–5.15
<sup>1</sup> 0.495–0.505-----	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905-----	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128-----	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775-----	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775-----	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218-----	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825-----	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225-----	123–138	2200–2300	14.47–14.5
8.291–8.294-----	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366-----	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675-----	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475-----	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293-----	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025-----	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725-----	322–335.4	3600–4400	( <sup>2</sup> )

**Table 10. Restricted Bands of Operation**

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

<sup>2</sup> Above 38.6

**Test Requirement(s):** § 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 11.

Frequency (MHz)	§ 15.209(a), Radiated Emission Limits (dB $\mu$ V) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

**Table 11. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedure:** The transmitter was set to the mid channel at the highest output power and placed on a 0.8 m high wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurement were repeated the measurement at the low and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor

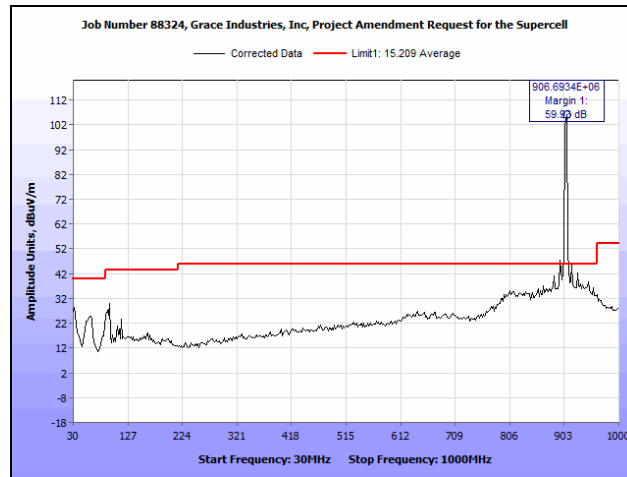
**Test Results:** The EUT was compliant with the Radiated Spurious Emission limits of §15.247(d).

Note: For the 1-10GHz band, the worse-case was reported

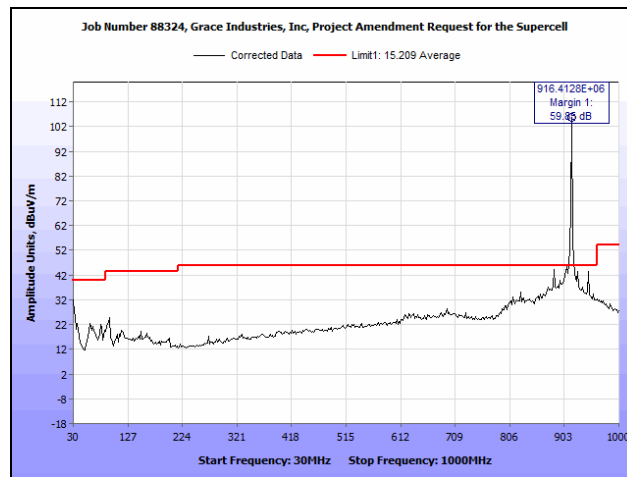
**Test Engineer(s):** Hadid Jones

**Test Date(s):** 05/02/16

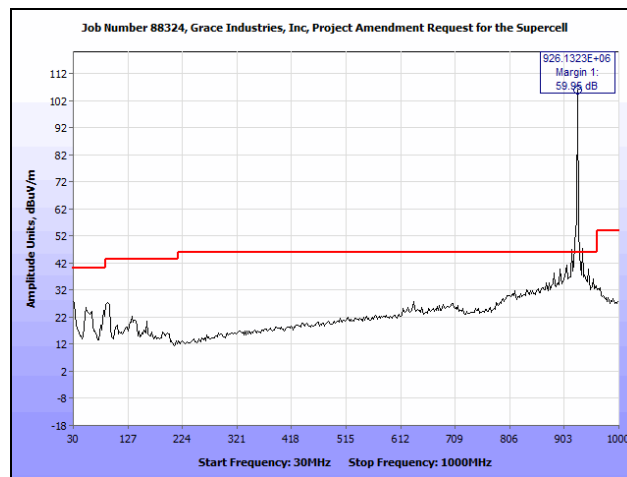
## Radiated Spurious Emissions Test Results



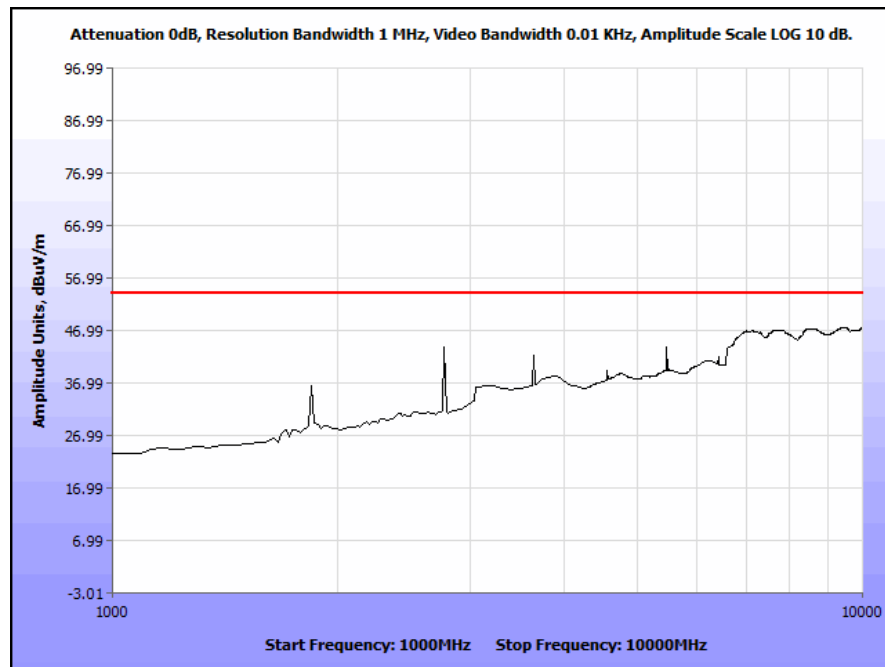
**Plot 13. Radiated Spurious Emissions, 30 MHz – 1 GHz, Low Channel**



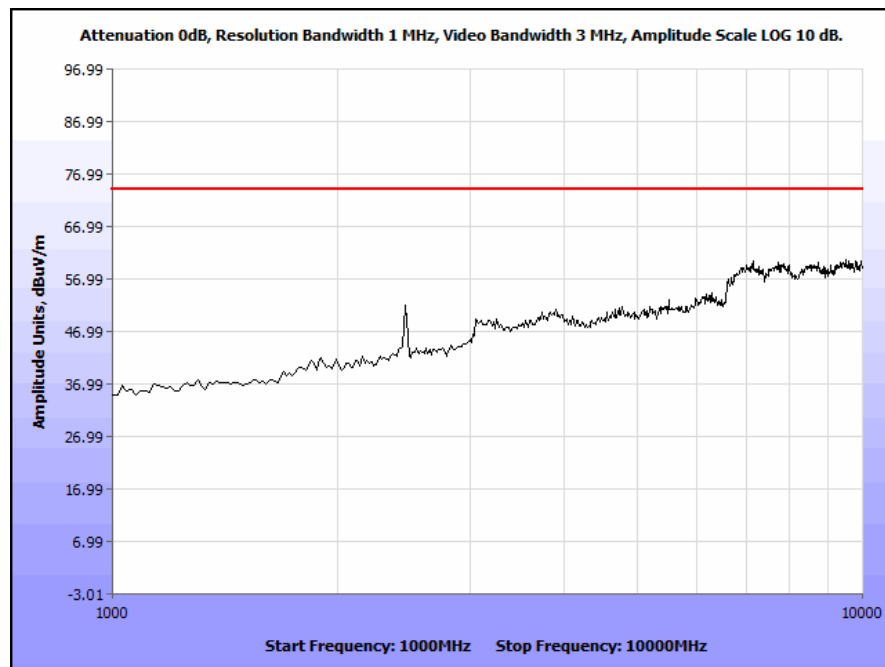
**Plot 14. Radiated Spurious Emissions, 30 MHz – 1 GHz, Mid Channel**



**Plot 15. Radiated Spurious Emissions, 30 MHz – 1 GHz, High Channel**



**Plot 16. Radiated Spurious Emissions, 1 GHz – 10 GHz, Average**

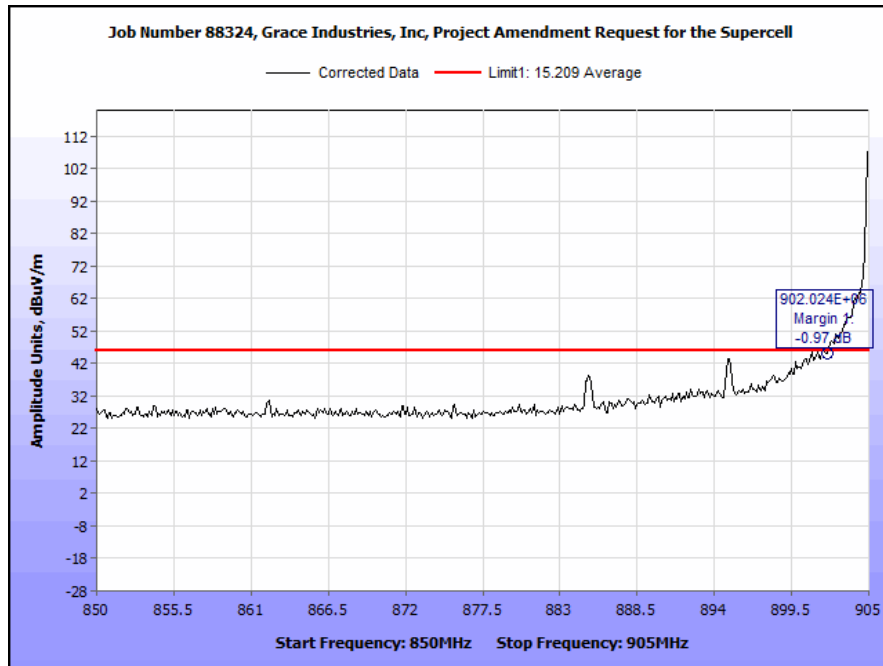


**Plot 17. Radiated Spurious Emissions, 1 GHz – 10 GHz, Peak**

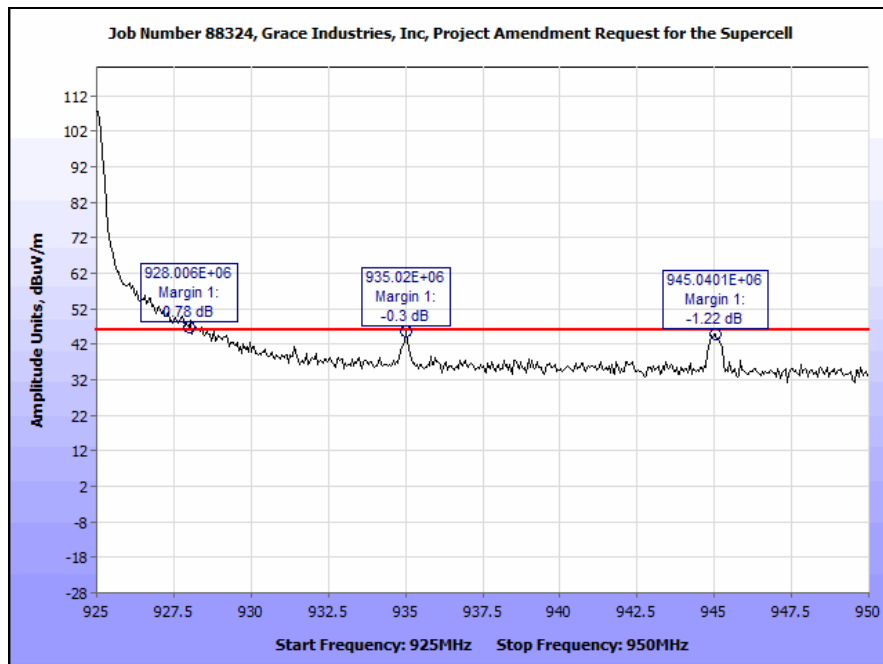
## Radiated Band Edge Measurements

### Test Procedures:

The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.



Plot 18. Radiated Restricted Band Edge, Low Channel



Plot 19. Radiated Restricted Band Edge, High Channel

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected EMI Meter Reading (dB $\mu$ V)	Antenna Correction Factor (dB/m) (+)	Cable Loss/Pre-amp (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
928	214	H	1.2695	12.01	23.20	2.85	0	38.06	46	-7.94
928	98	V	1	14.09	23.20	2.85	0	40.14	46	-5.86
902	33	H	2.7204	10.96	23.02	2.84	0	36.82	46	-9.18
902	94	V	1	13.98	23.02	2.84	0	39.84	46	-6.16

**Table 12. Radiated Band Edge, Quasi-Peak Data**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

**Test Requirement:** 15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

**Test Procedure:** For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10<sup>th</sup> harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

See following pages for detailed test results with RF Conducted Spurious Emissions.

**Test Results:** The EUT was compliant with the Conducted Spurious Emission limits of §15.247(d).

**Test Engineer(s):** Hadid Jones

**Test Date(s):** 03/17/16

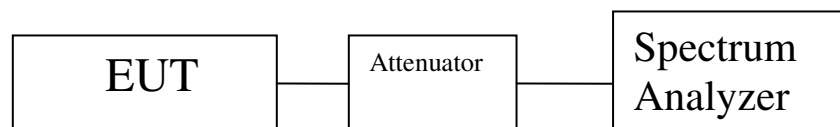
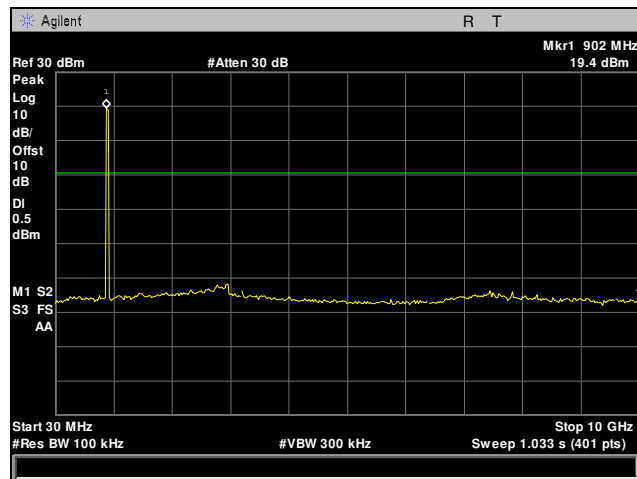
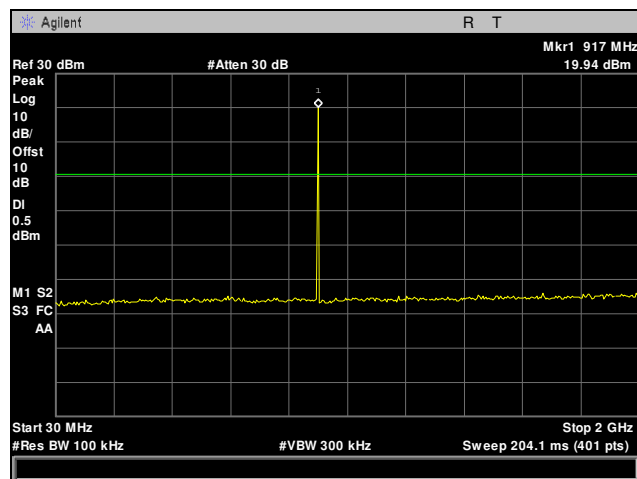


Figure 3. Block Diagram, Conducted Spurious Emissions Test Setup

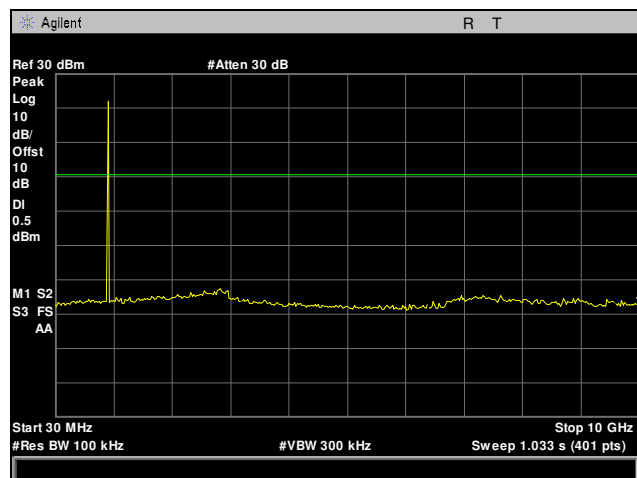
## Conducted Spurious Emissions Test Results



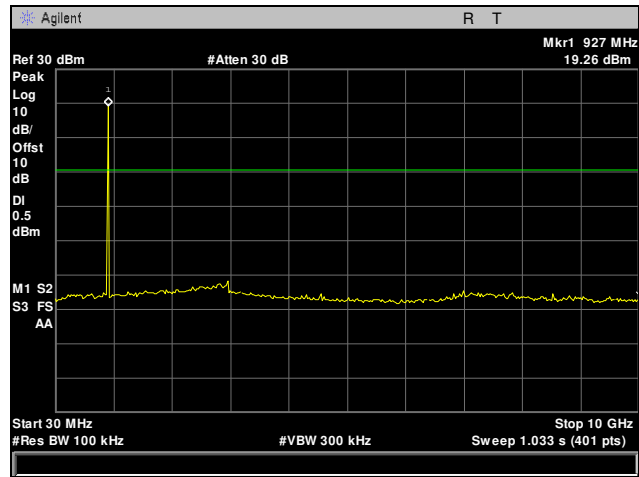
Plot 20. Conducted Spurious Emissions, Low Channel



Plot 21. Conducted Spurious Emissions, Mid Channel (a)

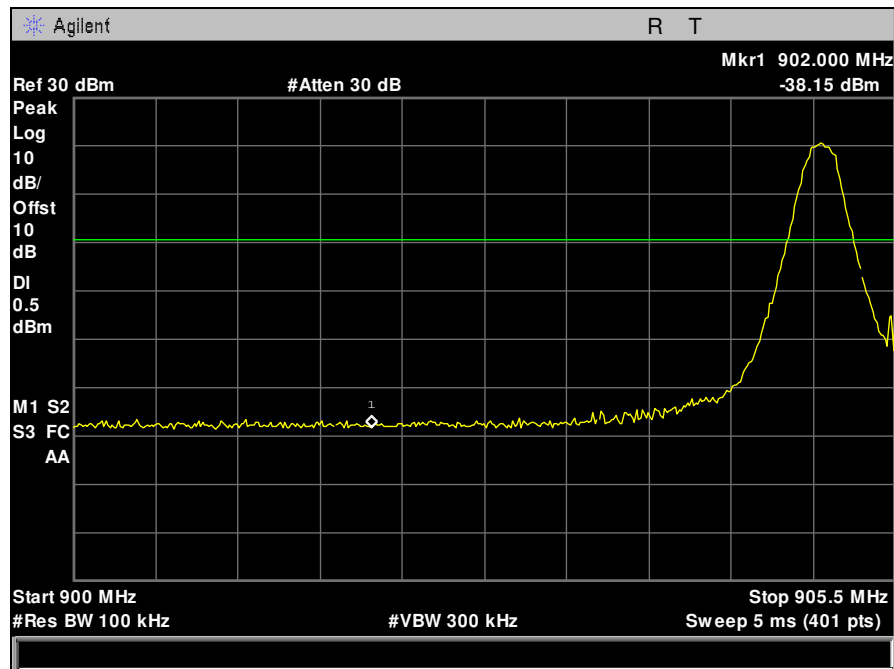


Plot 22. Conducted Spurious Emissions, Mid Channel (b)

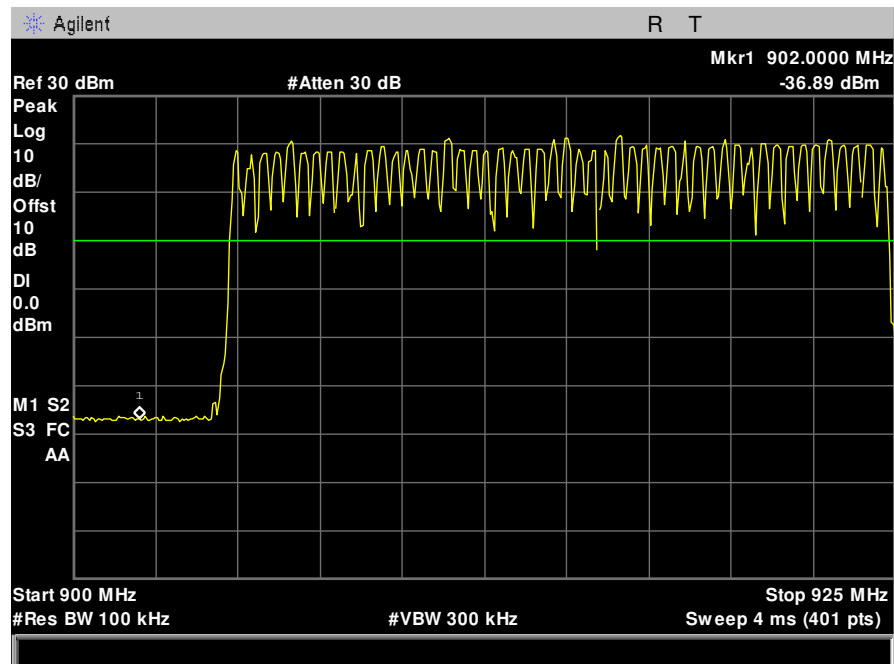


Plot 23. Conducted Spurious Emissions, High Channel

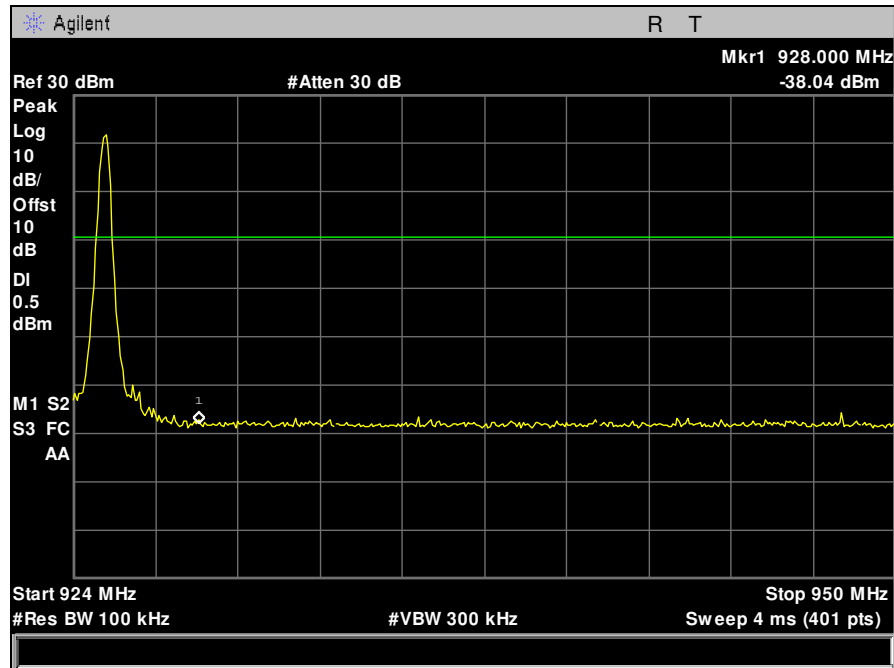
### Conducted Band Edge Test Results



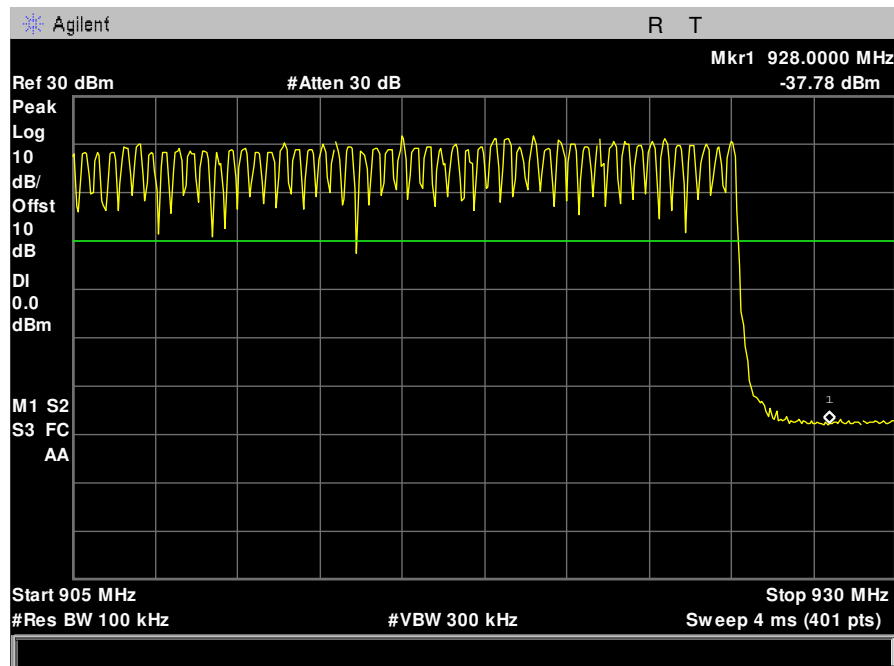
Plot 24. Conducted Band Edge, Low Channel



Plot 25. Conducted Band Edge, Lower, Hopping Mode



Plot 26. Conducted Band Edge, High Channel



Plot 27. Conducted Band Edge, Upper, Hopping Mode

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(g)(h) Declaration Statements for FHSS

**Customer declared.**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(i) Maximum Permissible Exposure

**RF Exposure Requirements:** §1.1307(b)(1) and §1.1307(b)(2): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

**RF Radiation Exposure Limit:** §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

The end products are personal worker safety 'man-down' alarms typically attached to the end-user within 20cm of the human body. Based upon the very low duty cycle and maximum RF transmit power, the module is below the SAR exclusion limits as defined in KDB 447498 D01. The exclusion power level at 925 MHz (highest operating channel of the device) is 15.6 mW based on KDB 447498 D01, section 4.3.1 (1).

Time averaged maximum power level of the device:

RF message length = 7mS (total time of each message emitting RF energy)

RF radiated power from antenna is  $\leq 200\text{mW}$  (maximum)

Maximum, momentary transmit message rate is 1 message (7ms in length) every 100mS.

SAR calculated power =  $(7\text{mS}/100\text{mS}) \times 200\text{mW} = 14\text{mW}$  (under 15.6 mW requirement)

The maximum duty cycle as described above, will not change and is controlled by firmware and the manufacturing and programming of the device, done at manufacturing facility..

Therefore, SAR is not required based on low duty cycle per KDB 447498 D01.

## IV. Test Equipment

## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	10/29/2014	10/29/2016
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	9/1/2015	3/1/2017
1T4300A	SEMI-ANECHOIC CHAMBER # 1 (FCC)	EMC TEST SYSTEMS	NONE	1/31/2014	1/31/2017
1T4483	ANTENNA; HORN	ETS-LINDGREN	7/13/1908	10/8/2015	4/8/2017
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY PROOF	3/21/1900	NOT REQUIRED	
1T4564	LISN (24 AMP)	SOLAR ELECTRONICS COMPANY	9252-50-R-24-BNC	7/1/2015	7/1/2016

**Table 13. Test Equipment List**

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

## **V. Certification & User's Manual Information**

## Certification & User's Manual Information

### A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

#### § 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

#### § 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
  - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
  - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing*;
  - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
  - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

## Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

### § 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.<sup>1</sup> *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.*
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

### § 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

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<sup>1</sup> In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

## Certification & User's Manual Information

### § 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
- (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
- (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
- (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
- (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

## Certification & User's Manual Information

### 1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

#### § 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

*This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

#### § 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

### § 15.105 Information to the user.

- (a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

- (b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.



# End of Report