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July 15, 2019

HID Global Corporation
6533 Flying Cloud Drive
Eden Prairie, MN 55344

Dear Robert Cresswell,

Enclosed is the EMC Wireless test report for compliance testing of the HID Global Corporation, OMNIKEY 5427 G2 as tested to the requirements of LP0002 Low-power Radio-frequency Devices Technical Regulations for Certification as an Intentional Radiator.

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.

Joel Huna
Documentation Department

Reference: (\\HID Global Corporation\\EMCA99143-LP0002BLE Rev. 2)

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Electromagnetic Compatibility Criteria Test Report

for the

**HID Global Corporation
OMNIKEY 5427 G2**

Tested under

LP0002 Low-power Radio-frequency Devices Technical Regulations
for Intentional Radiators

MET Report: EMCA99143-LP0002BLE Rev. 2

July 15, 2019

Prepared For:

**HID Global Corporation
6533 Flying Cloud Drive
Eden Prairie, MN 55344**

Prepared By:

MET Laboratories, Inc.
914 West Patapsco Avenue,
Baltimore, MD 21230

Electromagnetic Compatibility Criteria Test Report

for the

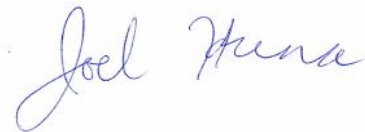
**HID Global Corporation
OMNIKEY 5427 G2**

Tested under

LP0002 Low-power Radio-frequency Devices Technical Regulations
for Intentional Radiators



Giuliano Messina, Project Engineer
Electromagnetic Compatibility Lab



Joel Huna
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 Rules Part 15.247 under normal use and maintenance.



John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	August 10, 2018	Initial Issue.
1	June 13, 2019	EUT model name change.
2	July 15, 2019	Marker Data Tables added to Emissions Plots

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
d	Measurement Distance
dB	Decibels
dBμA	Decibels above one microamp
dBμV	Decibels above one microvolt
dBμA/m	Decibels above one microamp per meter
dBμV/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
f	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
μH	microhenry
μ	microfarad
μs	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation OMNIKEY 5427 G2, with the requirements of LP0002 Low-power Radio-frequency Devices Technical Regulations. In accordance with LP0002, the following data is presented in support of the Certification of the OMNIKEY 5427 G2. HID Global Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the OMNIKEY 5427 G2, 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 LP0002, in accordance with HID Global Corporation, purchase order number 1110960151. All tests were conducted using measurement procedure ANSI C63.4-2014 and LP0002 Appendix.

LP0002 Reference	Description	Compliance
2.2	Antenna Requirement	Compliant
2.3	Conducted Emission Limits	Compliant
3.10.1.2	Peak Power Output	Compliant
3.10.1.5	Radiated Spurious Emissions Requirements	Compliant
3.10.1.5	RF Conducted Spurious Emissions Requirements	Compliant
3.10.1.6	Occupied Bandwidth	Compliant
3.10.1.6	Peak Power Spectral Density	Compliant
5.20	RF Exposure/Calculation	Compliant

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by HID Global Corporation to perform testing on the OMNIKEY 5427 G2, under HID Global Corporation's purchase order number 1110960151.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the HID Global Corporation, OMNIKEY 5427 G2.

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

Model(s) Tested:	OMNIKEY 5427 G2	
Model(s) Covered:	OMNIKEY 5427 G2	
EUT Specifications:	Primary Power: 5VDC USB, 100-240VAC laptop	
	Type of Modulations:	GFSK
	Equipment Code:	DTS
	Peak RF Output Power:	1.07 dBm
	EUT Frequency Ranges:	2402 – 2480 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Giuliano Messina	
Report Date(s):	July 15, 2019	

Table 2. EUT Summary Table

B. References

LP0002: 2015	Low-power Radio-frequency Devices Technical Regulations.
CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 13501 McCallen Pass, Austin, TX 78753. 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 10 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 HID Global Corporation OMNIKEY 5427 G2, Equipment Under Test (EUT), is designed to support any smart card for any application on any computer and connect via bluetooth. OMNIKEY devices support all relevant operating system from all windows platform to Linux and Mac OS.

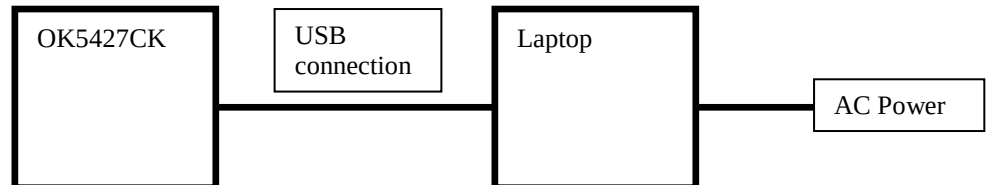


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
#3	N/A	Omnikey Reader	Omnikey 5027CK Gen 2	N/A	KJ0H4Q004R10622252	A
#5	N/A	Omnikey Reader	Omnikey 5027CK Gen 2	N/A	KJ0H4Q00B610622252	A
#6	N/A	Omnikey Reader	Omnikey 5027CK Gen 2	N/A	KJ0H4Q004K10622252	A

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
N/A	Laptop	Dell	Inspiron 15	N/A
N/A	Tablet	Samsung	SM-T230NU	N/A

The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer.

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
N/A	USB	USB connection to computer	1	1.5	1.5	N	Data/Power

Table 6. Ports and Cabling Information

H. Mode of Operation

The EUT was connected via USB to a laptop, providing both a power and data connection. An HF card was placed near the EUT to exercise the unit's transmitter. Putty was used to exercise the Bluetooth Low Energy connection.

I. Method of Monitoring EUT Operation

The computer's user interface provided a visible output when the HF card was placed nearby and the transmitter was exercised. To monitor the transmitting frequency, a spectrum analyzer was used.

J. 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.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to HID Global Corporation upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§2.2 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 §2.2. The EUT utilizes a permanently attached antenna (integrated within the unit) and cannot be modified by the end user.

Test Engineer(s): Giuliano Messina

Test Date(s): June 7, 2018

Gain	Type
3.86 dBi	Chip

Table 7. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§2.3 Conducted Emissions Limits

Test Requirement(s): § 2.3: 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 μ H/50 Ω 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 μ V)	
	Quasi-Peak	Average
* 0.15 - 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from § 2.3

Note: (*) Decreases with the logarithm of the frequency.

Test Procedure: The EUT was placed on a 0.8 m-high wooden table above a ground plane. 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 Ω /50 μ 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 and LP0002 Appendix*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H LISN as the input transducer to an EMI receiver. Scans were performed with the transmitter on.

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

Test Engineer(s): Jonathan Tavira

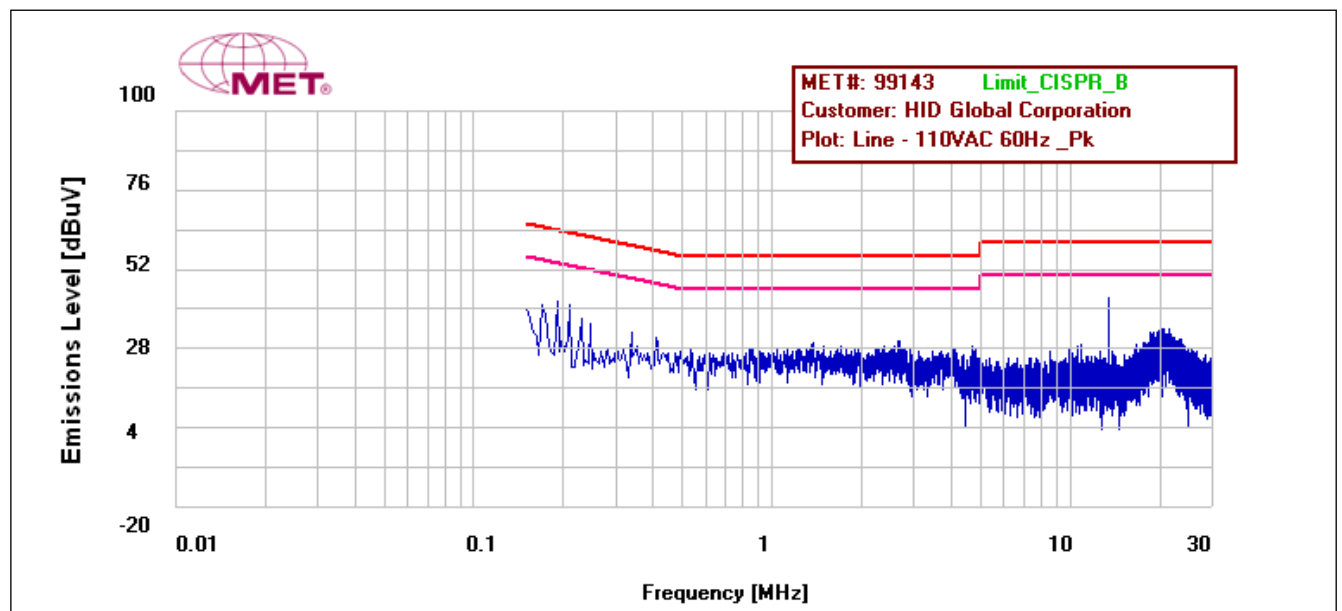
Test Date(s): June 5, 2018

Meas. Location	Meas. m	Limit	Pass/Fail
Bonding measurement from LISN ground to ground plane	0.624	< 2.5 mΩ	Pass

Table 9. Conducted Emissions, 110 VAC 60 Hz, Bonding Measurements

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line - 110VAC 60Hz	0.150	49.58	66	-16.42	Pass	31.48	56	-24.52	Pass
Line - 110VAC 60Hz	0.170	46.99	64.963	-17.973	Pass	31.23	54.963	-23.733	Pass
Line - 110VAC 60Hz	0.190	45.36	64.042	-18.682	Pass	30.01	54.042	-24.032	Pass
Line - 110VAC 60Hz	0.210	40.13	63.213	-23.083	Pass	25.98	53.213	-27.233	Pass
Line - 110VAC 60Hz	0.230	36.22	62.459	-26.239	Pass	24.06	52.459	-28.399	Pass
Line - 110VAC 60Hz	0.246	34.9	61.902	-27.002	Pass	23.26	51.902	-28.642	Pass
Line - 110VAC 60Hz	13.562	44.3	60	-15.7	Pass	47.4	50	-2.6	Pass

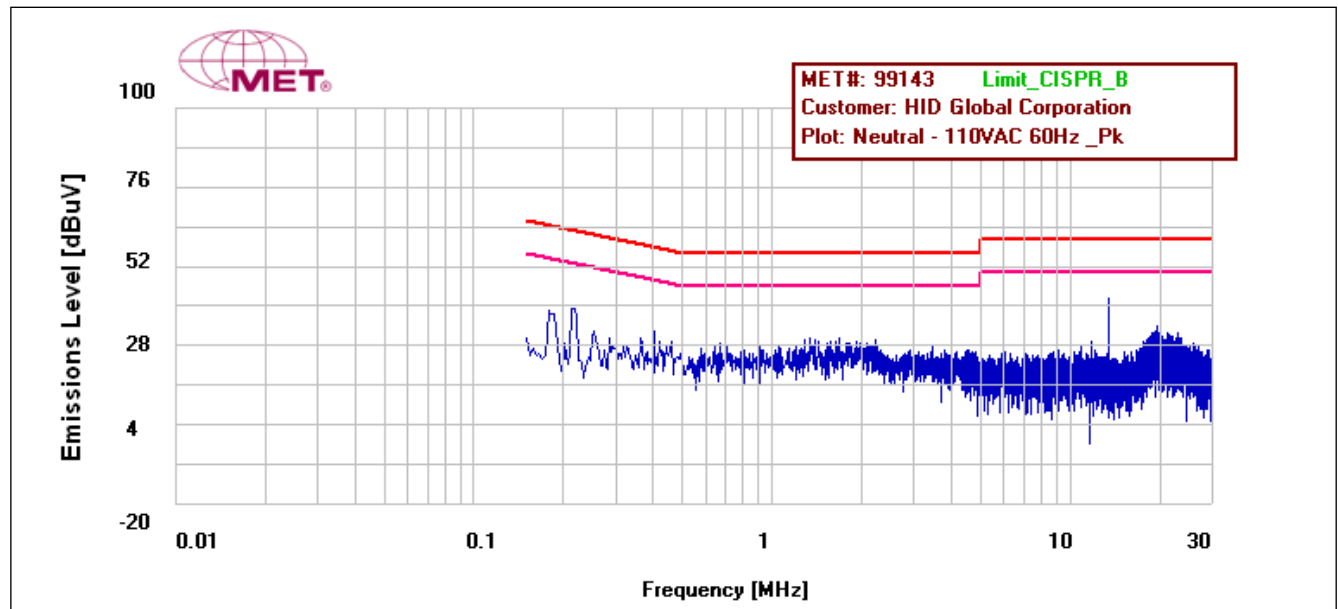
Table 10. Conducted Emissions, 110 VAC 60 Hz, Phase Line, Test Results



Plot 1. Conducted Emissions, 110 VAC 60 Hz, Phase Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral - 110VAC 60Hz	0.178	47.62	64.582	-16.962	Pass	27.99	54.582	-26.592	Pass
Neutral - 110VAC 60Hz	0.214	41.36	63.057	-21.697	Pass	25.1	53.057	-27.957	Pass
Neutral - 110VAC 60Hz	0.254	35.15	61.637	-26.487	Pass	23.26	51.637	-28.377	Pass
Neutral - 110VAC 60Hz	0.286	32.36	60.654	-28.294	Pass	21.99	50.654	-28.664	Pass
Neutral - 110VAC 60Hz	0.402	27.78	57.834	-30.054	Pass	20.24	47.834	-27.594	Pass
Neutral - 110VAC 60Hz	13.558	37.5	60	-22.5	Pass	40.1	50	-9.9	Pass
Neutral - 110VAC 60Hz	19.786	29.45	60	-30.55	Pass	23.1	50	-26.9	Pass

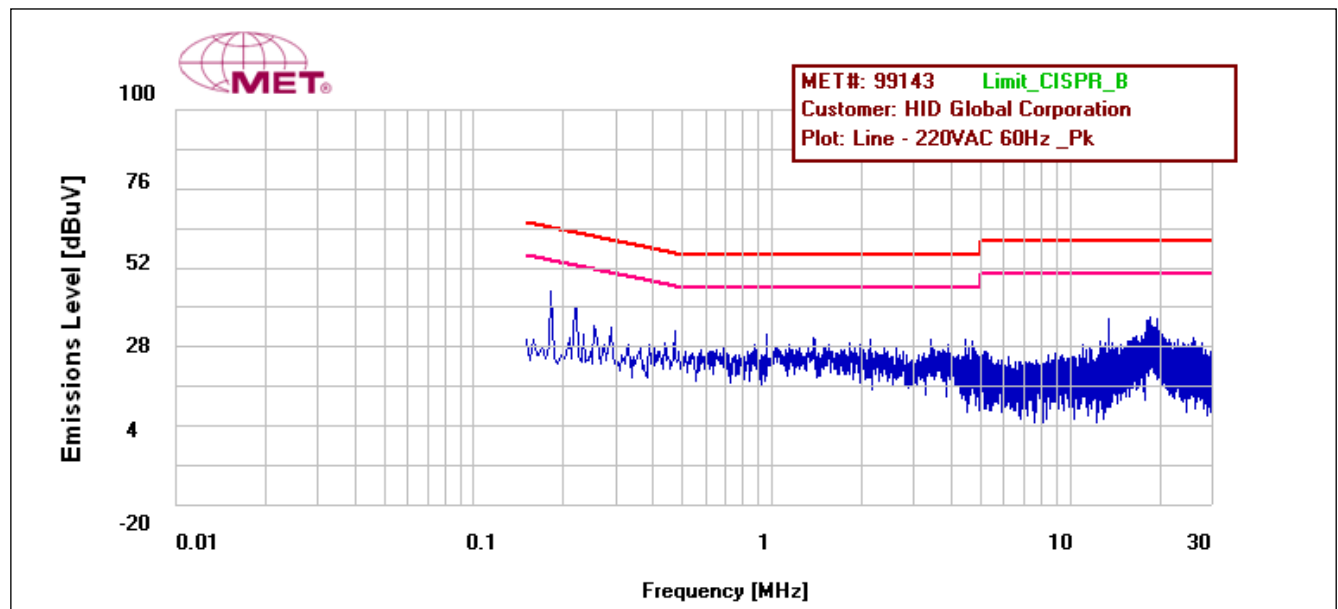
Table 11. Conducted Emissions, 110 VAC 60 Hz, Neutral Line, Test Results



Plot 2. Conducted Emissions, 110 VAC 60 Hz, Neutral Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line - 220VAC 60Hz	0.182	42.05	64.398	-22.348	Pass	25.65	54.398	-28.748	Pass
Line - 220VAC 60Hz	0.222	39.06	62.753	-23.693	Pass	25.02	52.753	-27.733	Pass
Line - 220VAC 60Hz	0.230	39.64	62.459	-22.819	Pass	24.84	52.459	-27.619	Pass
Line - 220VAC 60Hz	0.254	36.63	61.637	-25.007	Pass	23.79	51.637	-27.847	Pass
Line - 220VAC 60Hz	0.290	33.71	60.539	-26.829	Pass	22.25	50.539	-28.289	Pass
Line - 220VAC 60Hz	13.562	38.08	60	-21.92	Pass	39.7	50	-10.3	Pass
Line - 220VAC 60Hz	18.666	30.64	60	-29.36	Pass	26.29	50	-23.71	Pass

Table 12. Conducted Emissions, 220 VAC 60 Hz, Phase Line, Test Results

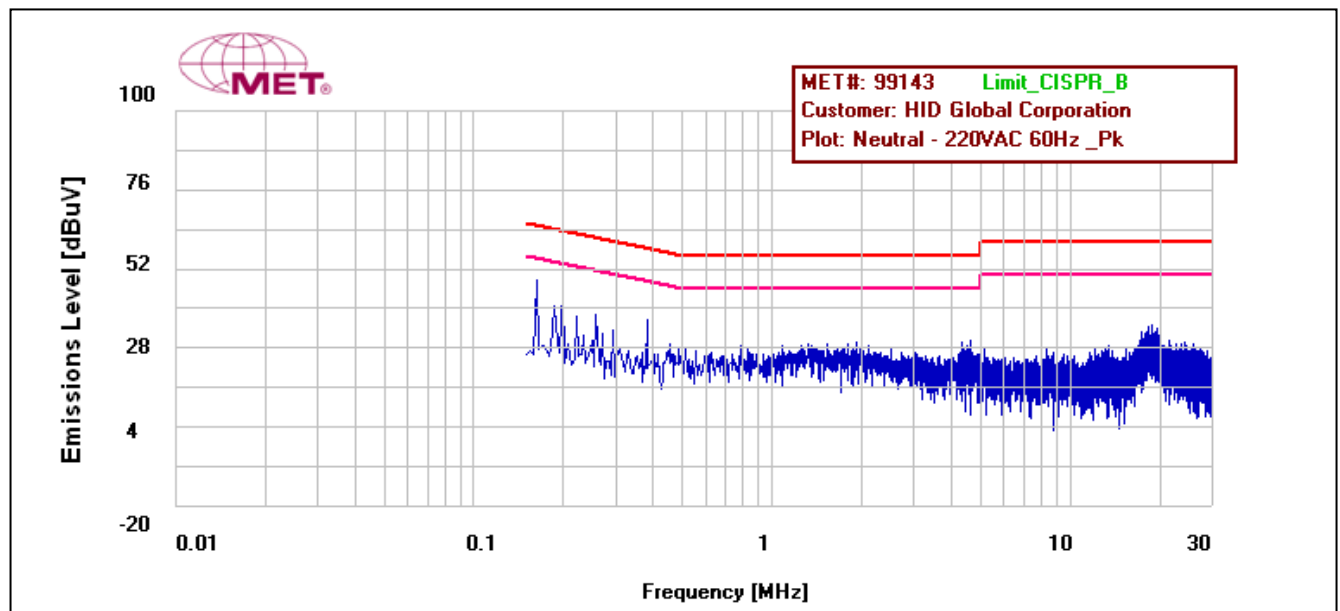


Plot 3. Conducted Emissions, 220 VAC 60 Hz, Phase Line

2.2 Conducted Emissions Test Results

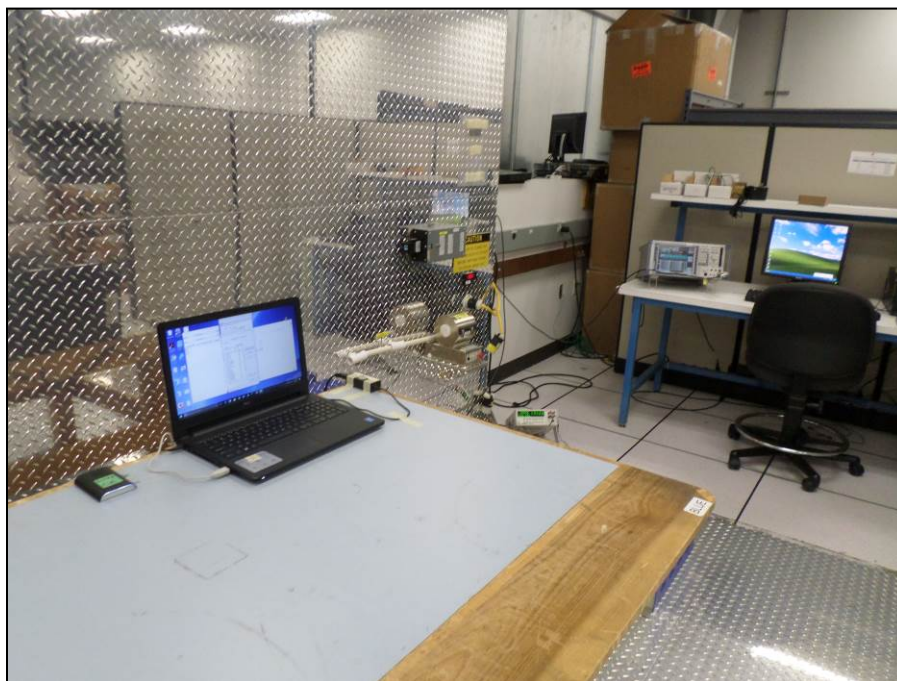
Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral - 220VAC 60Hz	0.162	45.13	65.363	-20.233	Pass	27.94	55.363	-27.423	Pass
Neutral - 220VAC 60Hz	0.186	43.04	64.218	-21.178	Pass	26.22	54.218	-27.998	Pass
Neutral - 220VAC 60Hz	0.198	41.1	63.7	-22.6	Pass	25.17	53.7	-28.53	Pass
Neutral - 220VAC 60Hz	0.222	39.87	62.753	-22.883	Pass	23.73	52.753	-29.023	Pass
Neutral - 220VAC 60Hz	0.230	39.56	62.459	-22.899	Pass	24.26	52.459	-28.199	Pass
Neutral - 220VAC 60Hz	0.258	36.6	61.508	-24.908	Pass	22.97	51.508	-28.538	Pass
Neutral - 220VAC 60Hz	0.382	30.23	58.257	-28.027	Pass	25.23	48.257	-23.027	Pass

Table 13. Conducted Emissions, 220 VAC 60 Hz, Neutral Line, Test Results

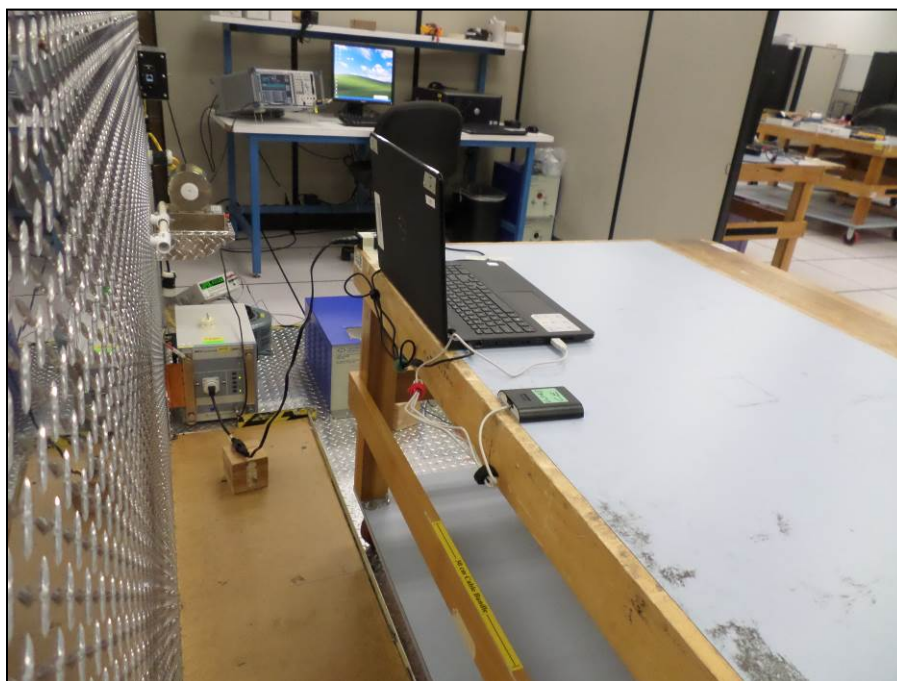


Plot 4. Conducted Emissions, 220 VAC 60 Hz, Neutral Line

15.207(a) Conducted Emissions Test Setup Photo



Photograph 1. Conducted Emissions, Test Setup, Front



Photograph 2. Conducted Emissions, Test Setup, Rear

Electromagnetic Compatibility Criteria for Intentional Radiators

§3.10.1.2 Peak Power Output

Test Requirements: §3.10.1.2: The maximum peak output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (Watts)
2400–2483.5	1.000

Table 14. Output Power Requirements from §3.10.1.2

§3.10.1.3: If transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 14, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

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 at the maximum power level.

Test Results: The EUT was compliant with the Peak Power Output limits of §3.10.1.2.

Test Engineer(s): Giuliano Messina

Test Date(s): June 7, 2018

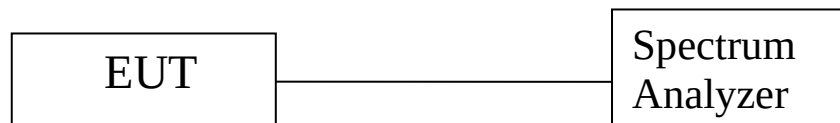
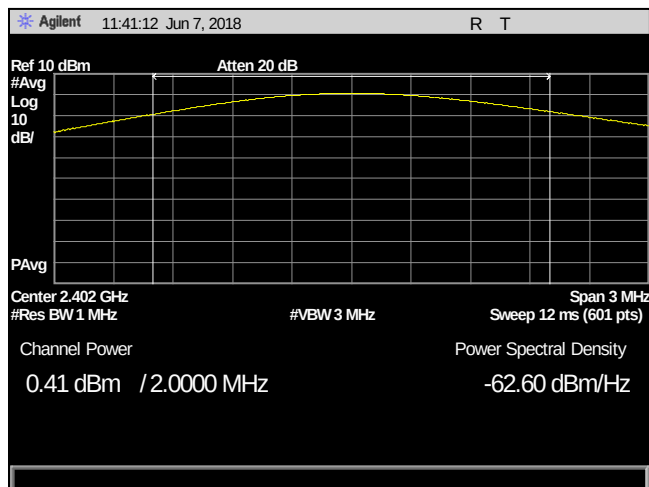
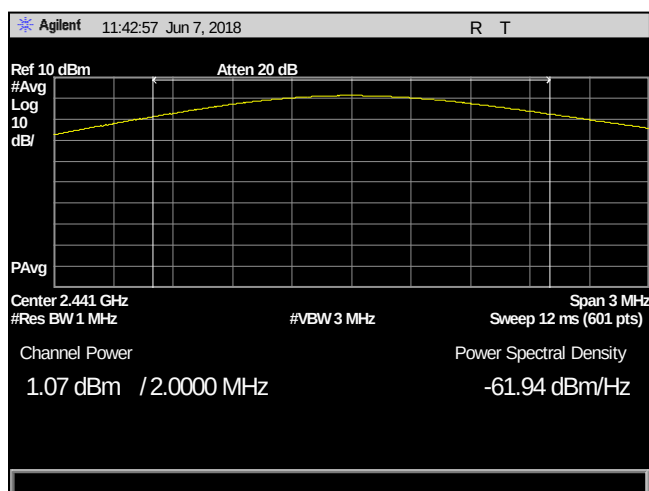


Figure 2. Peak Power Output Test Setup

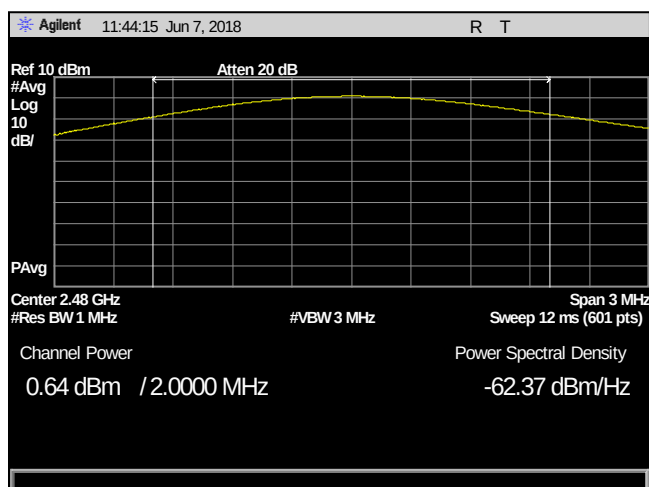
Peak Power Output Test Results



Plot 5. Peak Power Output, 2402 MHz



Plot 6. Peak Power Output, 2441 MHz



Plot 7. Peak Power Output, 2480 MHz



Photograph 3. Peak Output Power, Conducted Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§3.10.1.5 Spurious Radiated Emissions

Test Requirements: §3.10.1.5; §2.7: Emissions outside the frequency band.

§3.10.1.5: 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below:

- (1) The attenuation shall be at least 20dB when the conducted power is measured according to Appendix II of this section, based on either an RF conducted or a radiated measurement.
- (2) The attenuation shall be at least 30dB when the conducted power is measured according to the paragraph (1) (C) of this section 3.10.1.2.

In addition, radiated emissions that fall under Section 2.7 the restricted bands must also comply with the radiated emission limit specified in Section 2.8.

§2.7: Except as shown in 3.10.1.5 of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110	149.9–150.05	1805–1865	9.0–9.2
0.490–0.510	156.7–156.9	1885–1900	9.3–9.5
2.172–2.198	162.01–167.17	1905–1985	10.6–12.7
4.115–4.198	167.72–173.2	2015–2025	13.25–13.4
5.670–5.690	240–285	2125–2165	14.47–14.5
6.2–6.3	322–335.4	2200–2300	15.35–16.2
8.230–8.4	399.9–410	2310–2390	17.7–21.4
12.265–12.600	485–510	2483.5–2900	22.01–23.12
13.340–13.430	608–614	3260–3267	23.6–24.0
14.965–15.020	703–748	3332–3339	31.2–31.8
16.700–16.755	758–803	3345.8–3358	36.43–36.5
19.965–20.020	825–915	3500–4400	Above 38.6
25.5–25.70	930–1240	4500–5250	
37.475–38.275	1300–1427	5350–5460	
73.5–75.4	1435–1626.5	7250–7750	
108–138	1660–1770	8025–8500	

Table 15. Restricted Bands of Operation

Test Requirement(s): § 3.2.1.2: The field strength of unwanted emissions shall not exceed the general radiated emissions limits in LP0002 § 2.8

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
30 (included) – 88 (included)	100	3
88 (excluded) – 216 (included)	150	3
216 (excluded) – 960 (included)	200	3
Above 960 (excluded)	500	3

Table 16. General Radiated Emissions Limits of §2.8

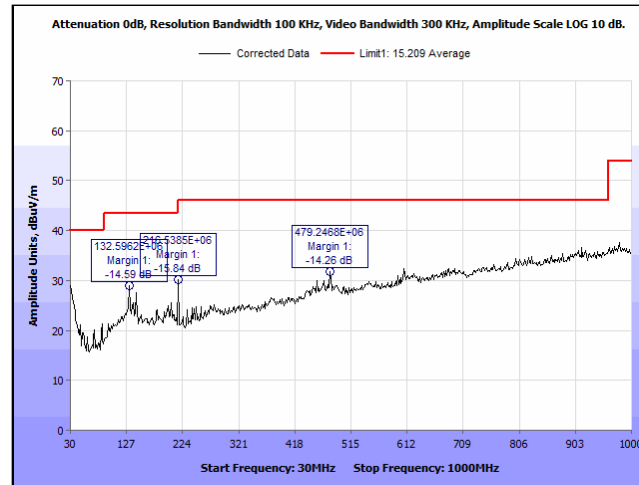
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of §3.10.1.5. Measured emissions were within applicable limits.

Test Engineer(s): Giuliano Messina

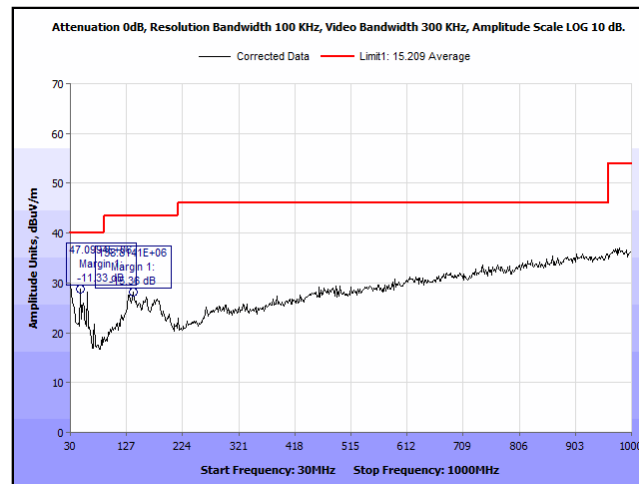
Test Date(s): June 7, 2018

Radiated Spurious Emissions Test Results



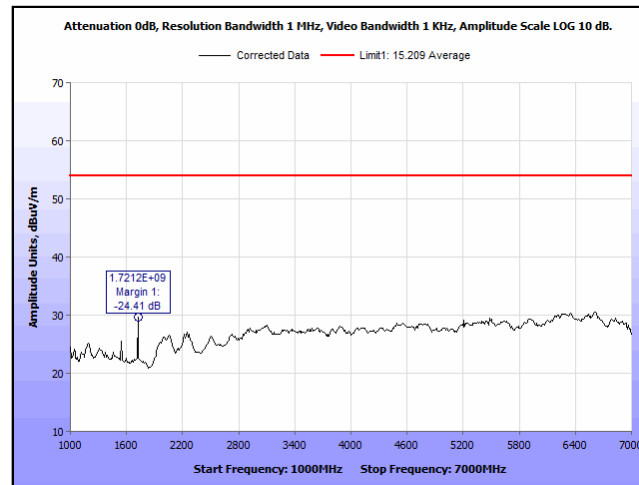
Frequency (MHz)	Meter Reading (dBuV)	RBW (kHz)	Distance Correction Factor (dB)	Measurement Sensor Factor Amplitude (dBuV)	Preamplifier Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
216.5385	31.5	100	10.46	11.04	-22.85	30.16	46	-15.84
132.5962	29.06	100	10.46	12.86	-23.47	28.91	43.5	-14.59
479.2468	25.2	100	10.46	17.8	-21.72	31.74	46	-14.26

Plot 8. Radiated Spurious Emissions, BLE, 30 MHz – 1 GHz, Horizontal



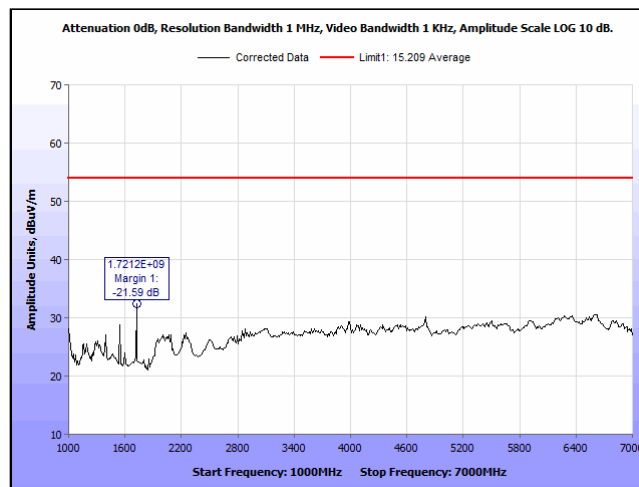
Frequency (MHz)	Meter Reading (dBuV)	RBW (kHz)	Distance Correction Factor (dB)	Measurement Sensor Factor Amplitude (dBuV)	Preamplifier Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
138.8141	27.79	100	10.46	13.3	-23.41	28.14	43.5	-15.36
47.0994	33.67	100	10.46	8.94	-24.41	28.67	40	-11.33

Plot 9. Radiated Spurious Emissions, BLE, 30 MHz – 1 GHz, Vertical



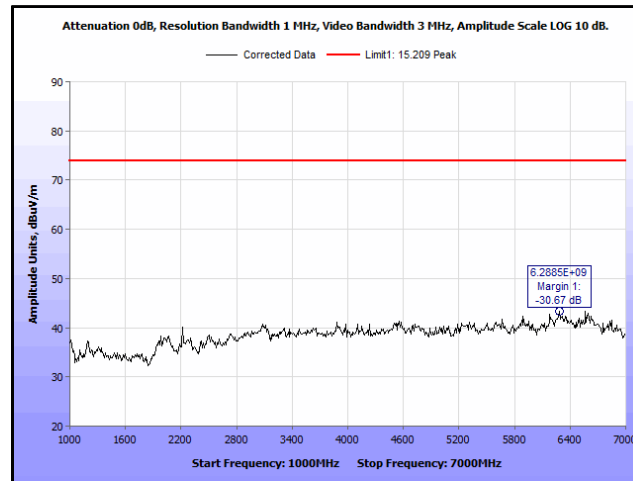
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
1.7212	32.76	1	29.12	-32.28	29.59	54	-24.41

Plot 10. Radiated Spurious Emissions, BLE, 1 – 7 GHz, Average, Horizontal



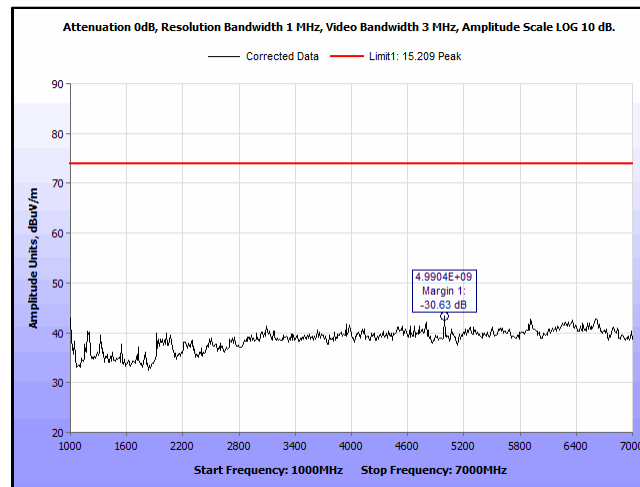
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
1.7212	35.58	1	29.12	-32.28	32.41	54	-21.59

Plot 11. Radiated Spurious Emissions, BLE, 1 – 7 GHz, Average, Vertical



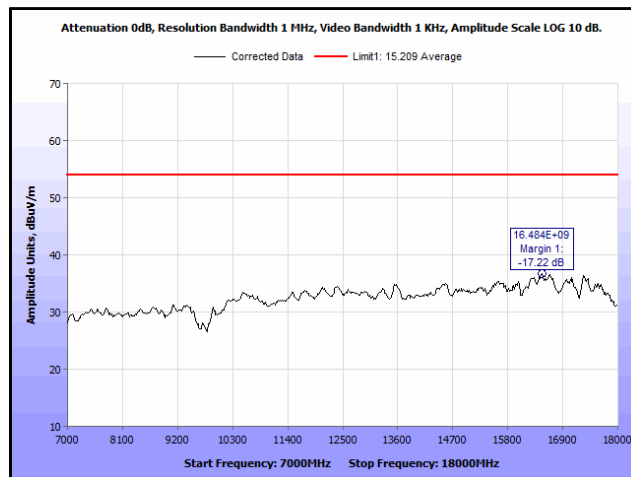
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
6.2885	47.43	1	35.49	-39.59	43.33	74	-30.67

Plot 12. Radiated Spurious Emissions, BLE, 1 – 7 GHz, Peak, Horizontal



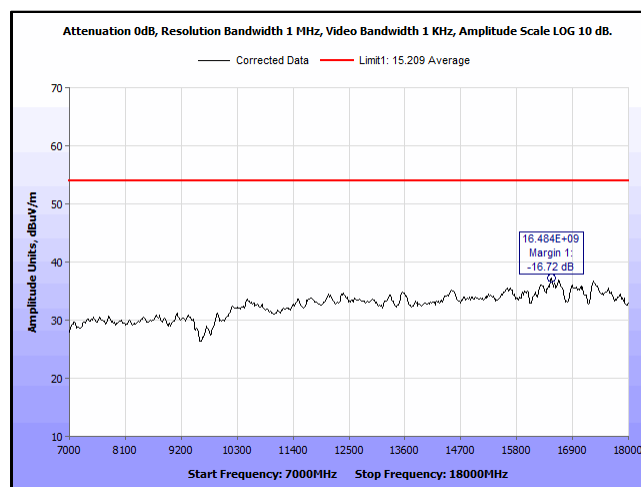
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
4.9904	48.22	1	33.97	-38.82	43.37	74	-30.63

Plot 13. Radiated Spurious Emissions, BLE, 1 – 7 GHz, Peak, Vertical



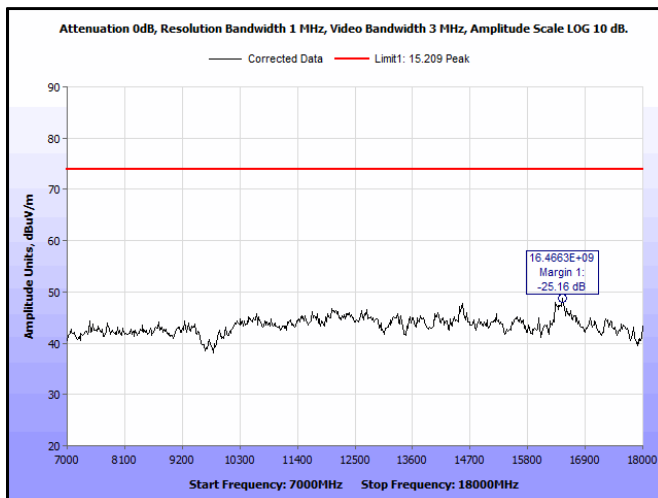
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
16.484	36.83	1	40.88	-40.93	36.78	54	-17.22

Plot 14. Radiated Spurious Emissions, BLE, 7 – 18 GHz, Average, Horizontal



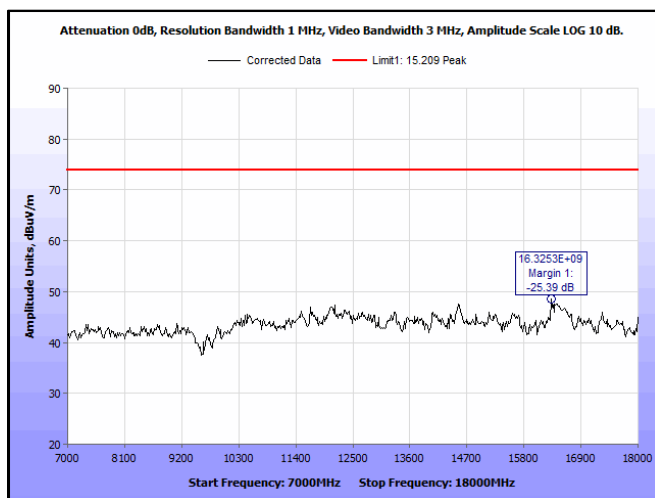
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
16.484	37.33	1	40.88	-40.93	37.28	54	-16.72

Plot 15. Radiated Spurious Emissions, BLE, 7 – 18 GHz, Average, Vertical



Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamplifier Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
16.4663	48.94	1	40.84	-40.94	48.84	74	-25.16

Plot 16. Radiated Spurious Emissions, BLE, 7 – 18 GHz, Peak, Horizontal



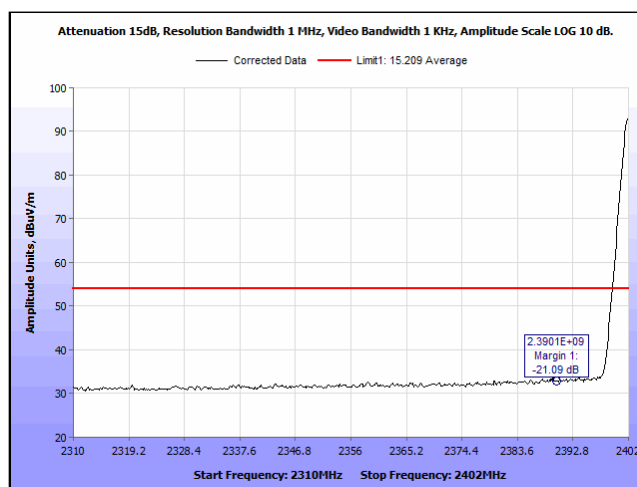
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamplifier Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
16.3253	49.08	1	40.73	-41.2	48.61	74	-25.39

Plot 17. Radiated Spurious Emissions, BLE, 7 – 18 GHz, Peak, Vertical

Radiated Band Edge Measurements

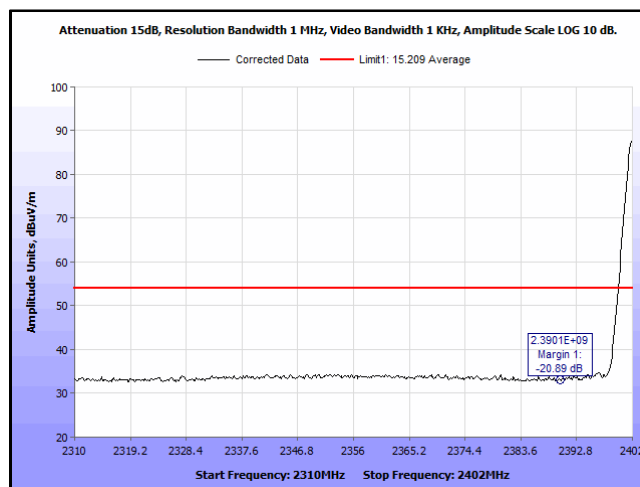
Test Procedures:

The transmitter was turned on. 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 and compared to a 3 m limit line.



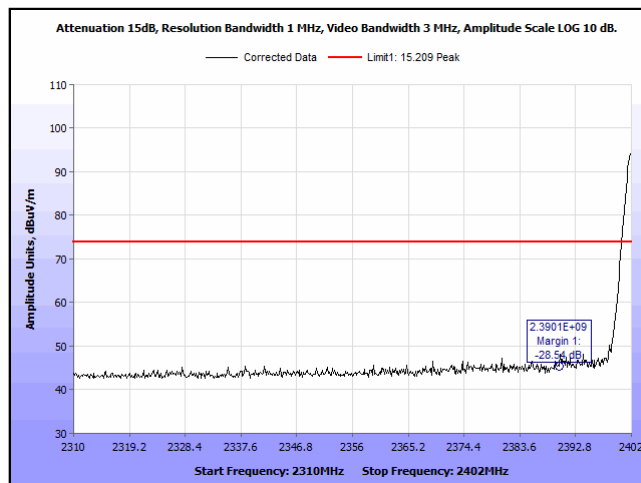
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.3901	36.02	1	31.85	-34.95	32.91	54	-21.09

Plot 18. Radiated Restricted Band Edge, BLE, 2402, Average, Horizontal



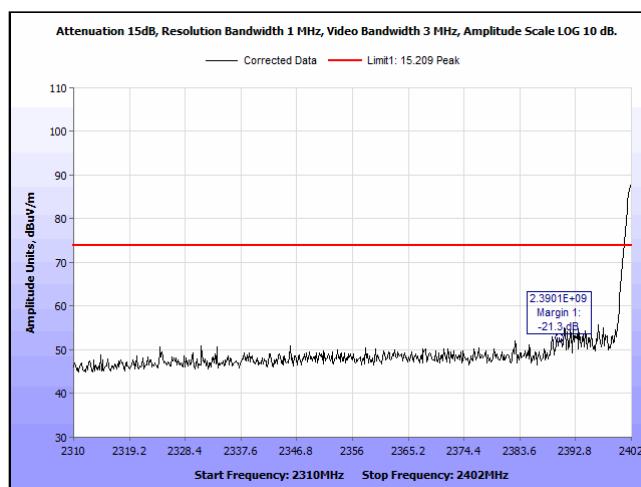
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.3901	36.21	1	31.85	-34.95	33.11	54	-20.89

Plot 19. Radiated Restricted Band Edge, BLE, 2402, Average, Vertical



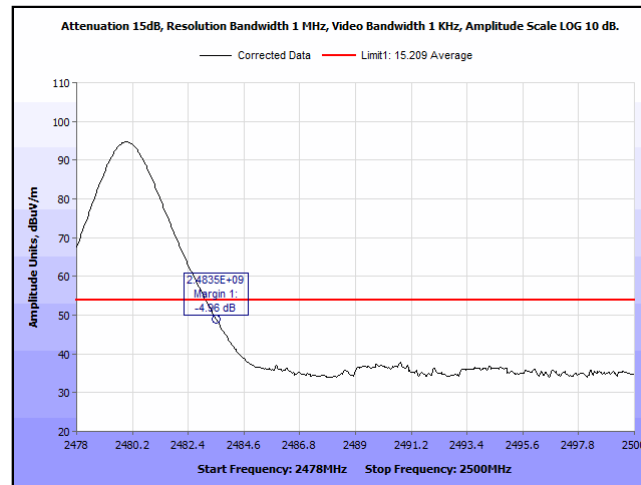
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.3901	48.57	1	31.85	-34.95	45.46	74	-28.54

Plot 20. Radiated Restricted Band Edge, BLE, 2402, Peak, Horizontal



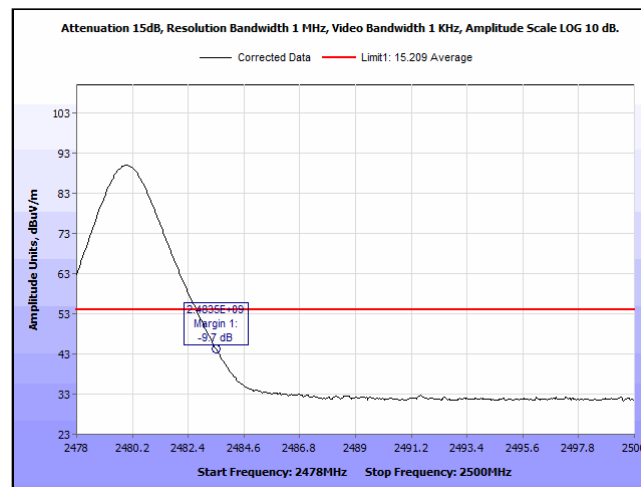
Frequency (Hz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	Limit 1, 15.209 Peak dBuV/m	Margin 1 (dB)
2.3901	55.8	1	31.85	-34.95	52.7	74	-21.3

Plot 21. Radiated Restricted Band Edge, BLE, 2402, Peak, Vertical



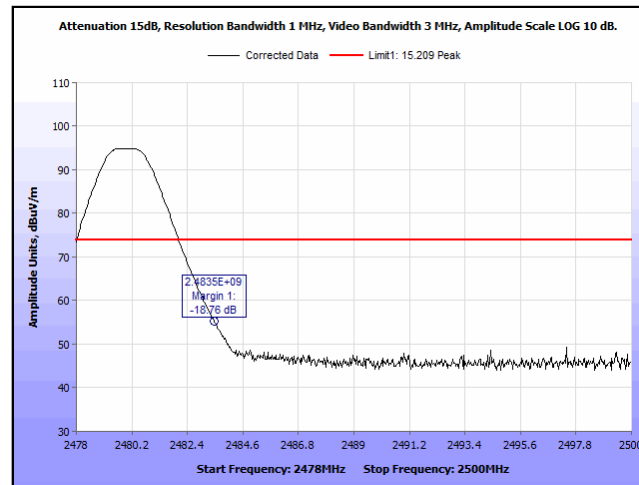
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.4835	51.93	1	32.32	-35.21	49.04	54	-4.96

Plot 22. Radiated Restricted Band Edge, BLE, 2480, Average, Horizontal



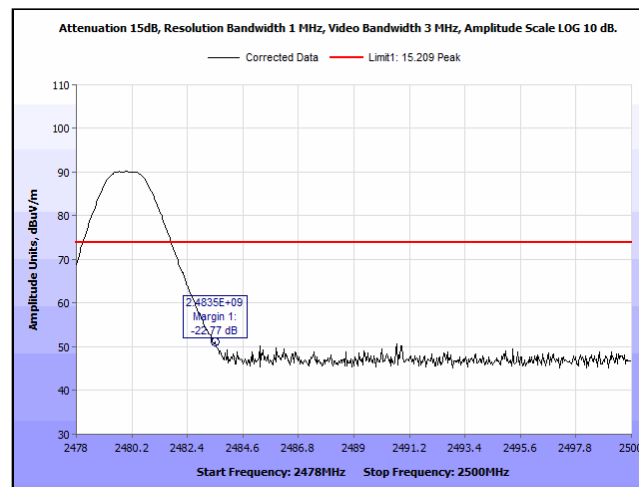
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.4835	47.19	1	32.32	-35.21	44.3	54	-9.7

Plot 23. Radiated Restricted Band Edge, BLE, 2480, Average, Vertical



Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.4835	58.13	1	32.32	-35.21	55.24	74	-18.76

Plot 24. Radiated Restricted Band Edge, BLE, 2480, Peak, Horizontal



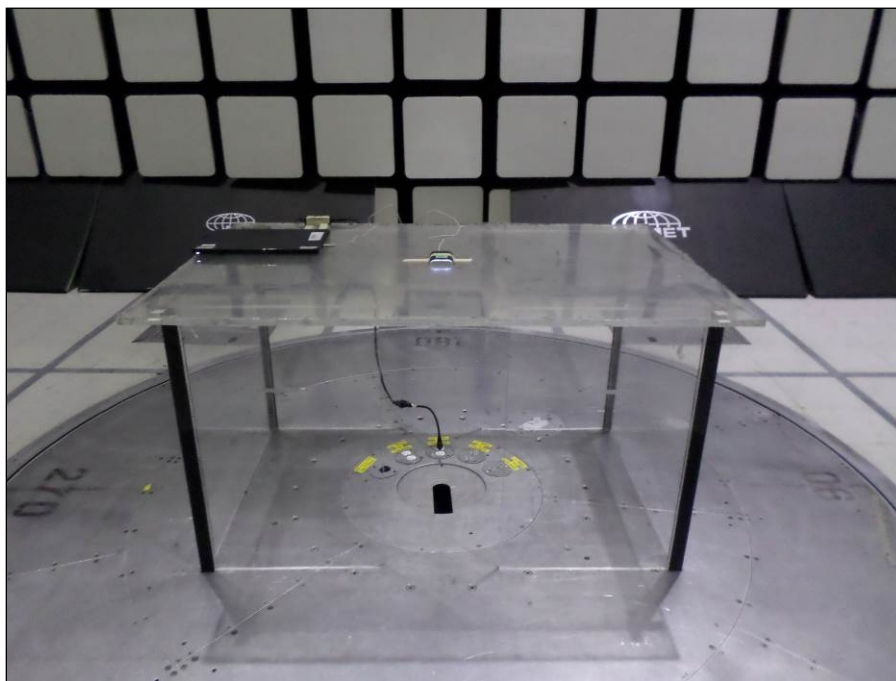
Frequency (GHz)	Meter Reading (dBuV)	RBW (MHz)	Measurement Sensor Factor Amplitude (dBuV)	Preamp Factor (dB)	Corrected Measurement dBuV/m	15.209 Average dBuV/m	Margin (dB)
2.4835	54.12	1	32.32	-35.21	51.23	74	-22.77

Plot 25. Radiated Restricted Band Edge, BLE, 2480, Peak, Vertical

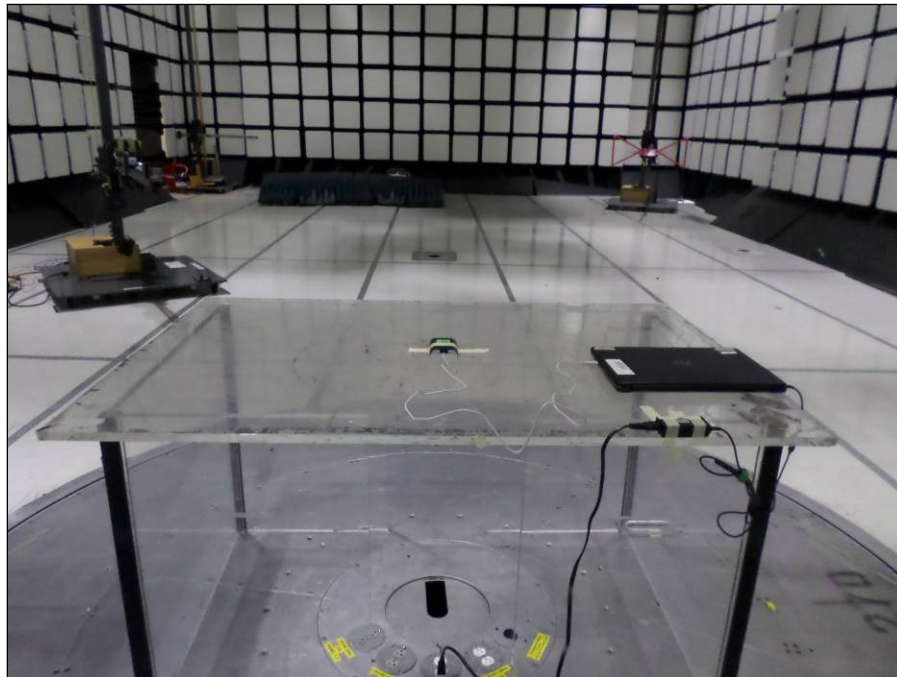
Radiated Spurious Emissions Test Setup



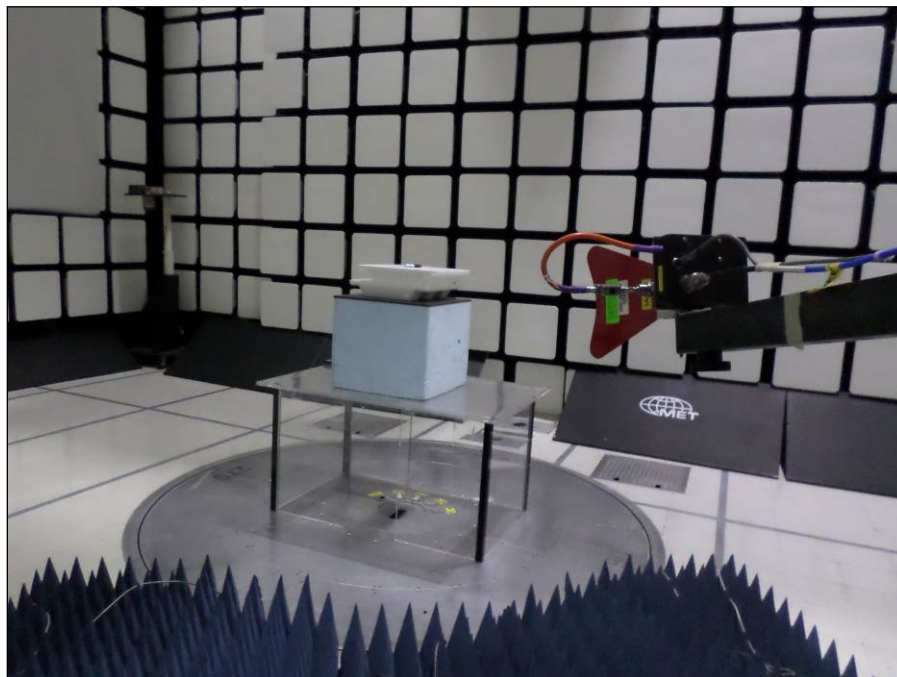
Photograph 4. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz, Antenna View



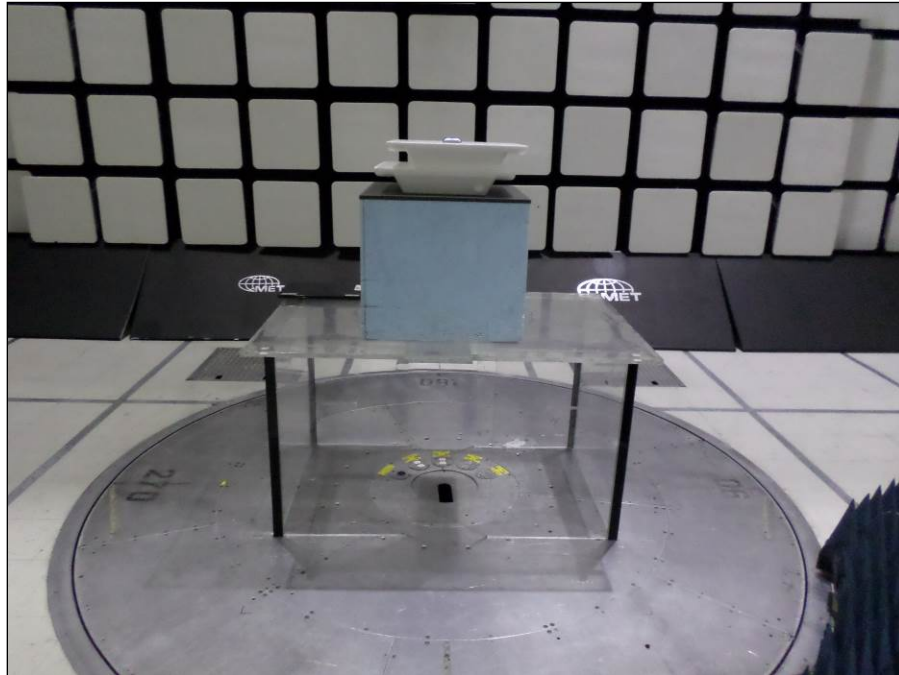
Photograph 5. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz, Front



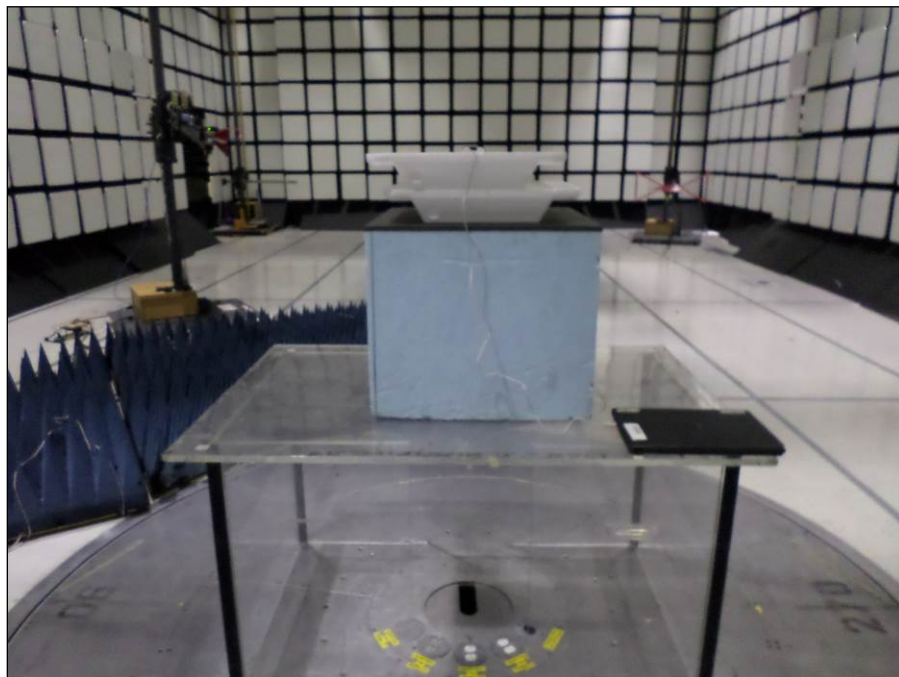
Photograph 6. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz, Rear



Photograph 7. Radiated Spurious Emissions, Test Setup, 1 – 18 GHz, Antenna View



Photograph 8. Radiated Spurious Emissions, Test Setup, 1 – 18 GHz, Front View



Photograph 9. Radiated Spurious Emissions, Test Setup, 1 – 18 GHz, Rear View

Electromagnetic Compatibility Criteria for Intentional Radiators

§3.10.1.5 Spurious RF Conducted Emissions

Test Requirement:	§3.10.1.5: 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below: (1) The attenuation shall be at least 20dB when the conducted power is measured according to Appendix II of this section, based on either an RF conducted or a radiated measurement. (2) The attenuation shall be at least 30dB when the conducted power is measured according to the paragraph (1) (C) of this section 3.10.1.2.
Test Procedure:	For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated with 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. 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 §3.10.1.5 . Measured emissions were within applicable limits.
Test Engineer(s):	Giuliano Messina
Test Date(s):	June 7, 2018

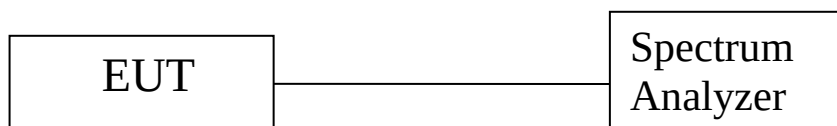
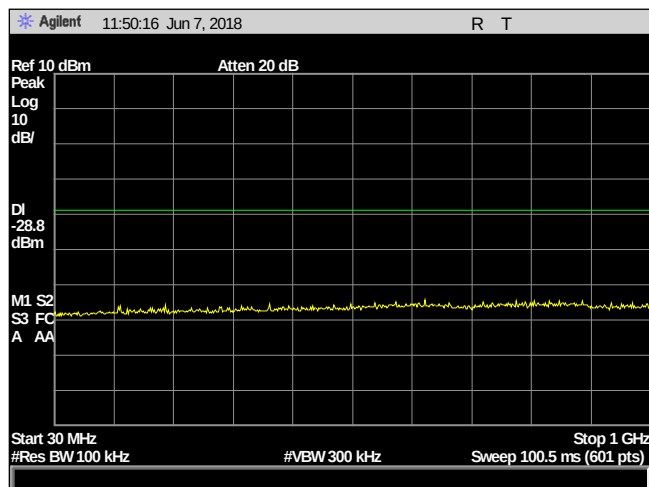
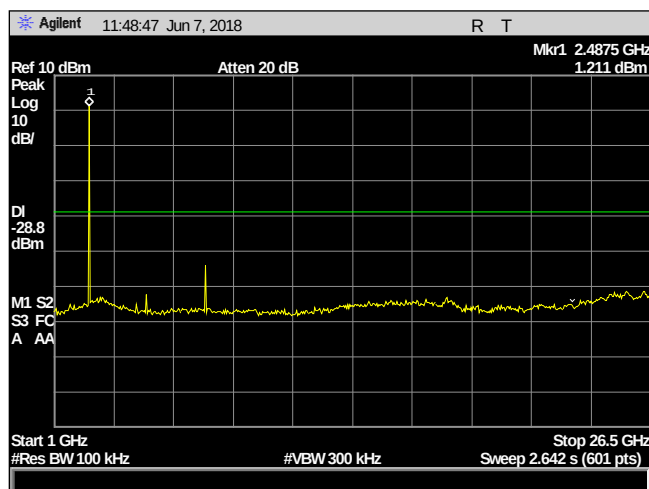


Figure 3. Block Diagram, Conducted Spurious Emissions Test Setup

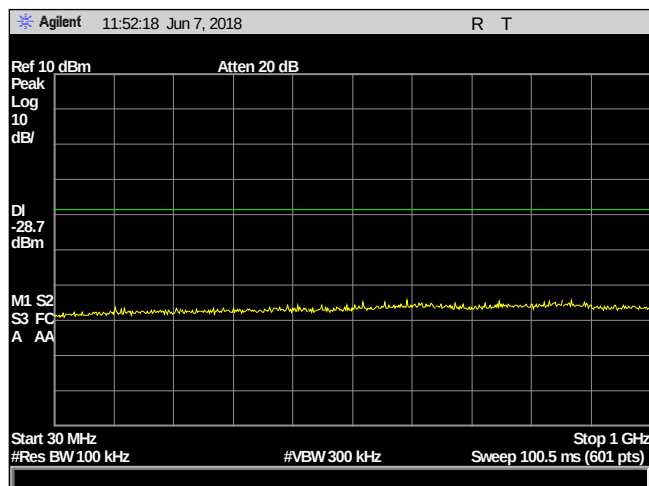
Conducted Spurious Emissions Test Results



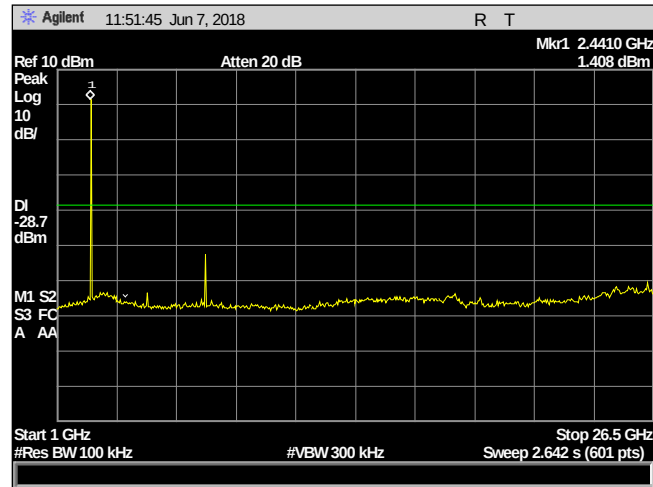
Plot 26. Conducted Spurious Emissions, 2402, 30 MHz - 1 GHz



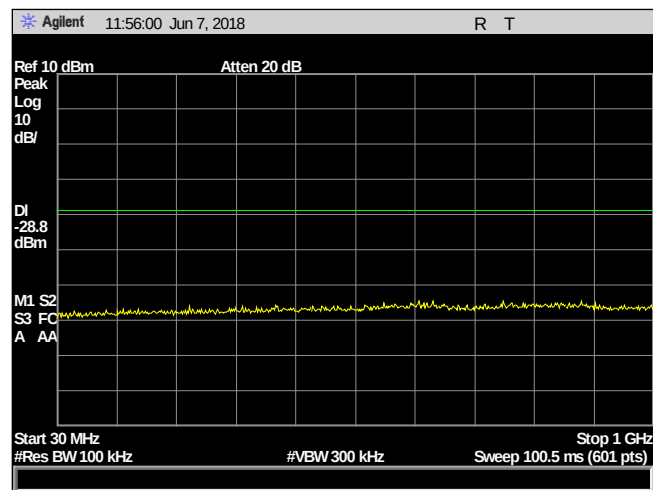
Plot 27. Conducted Spurious Emissions, 2402, 1 – 26.5 GHz



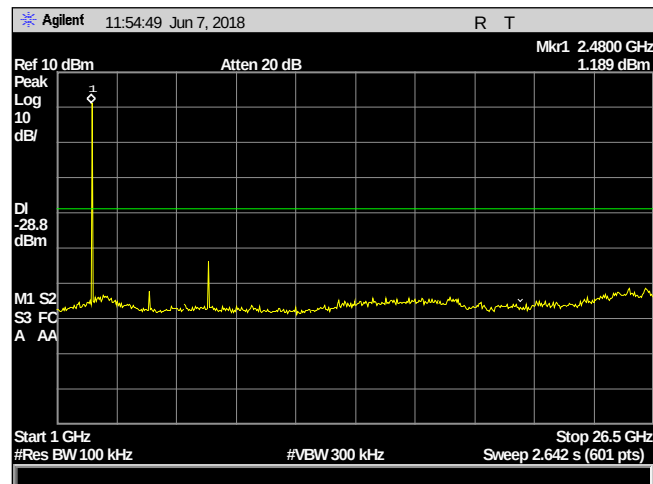
Plot 28. Conducted Spurious Emissions, 2441, 30 MHz – 1 GHz



Plot 29. Conducted Spurious Emissions, 2441, 1 – 26.5 GHz

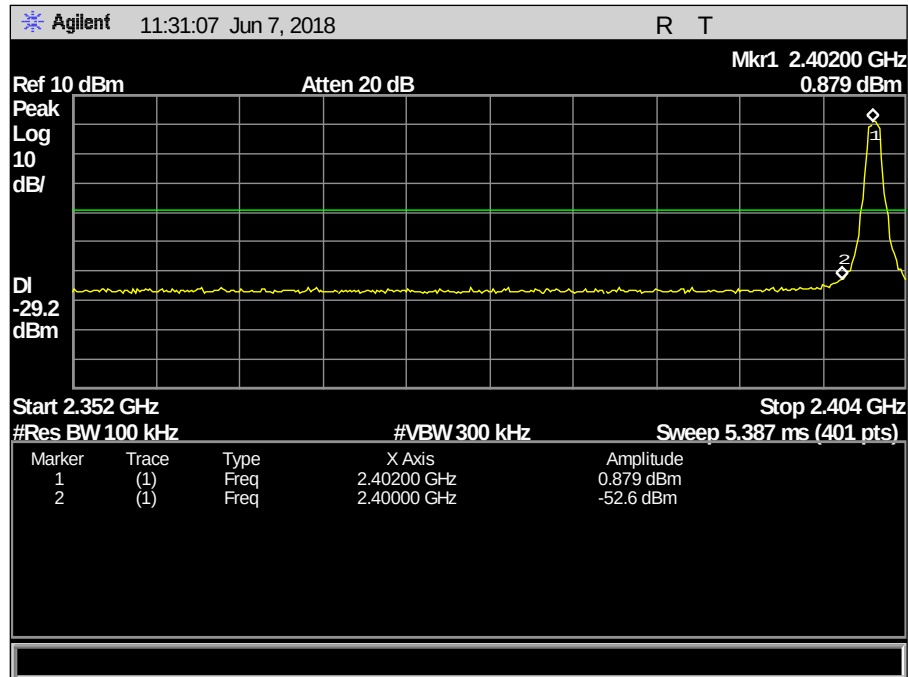


Plot 30. Conducted Spurious Emissions, 2480, 30 MHz – 1 GHz

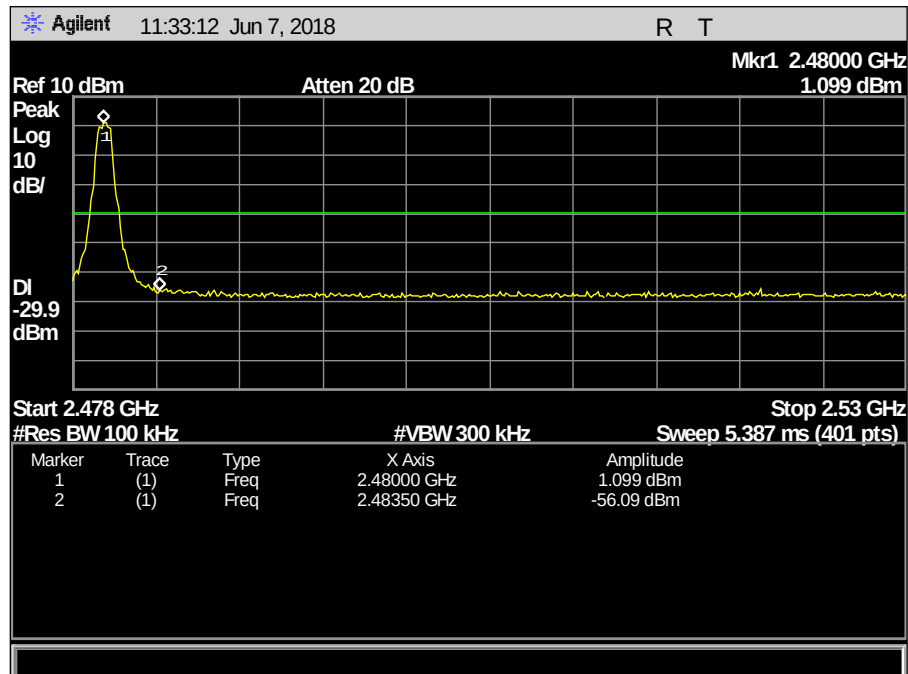


Plot 31. Conducted Spurious Emissions, 2480, 1 – 26.5 GHz

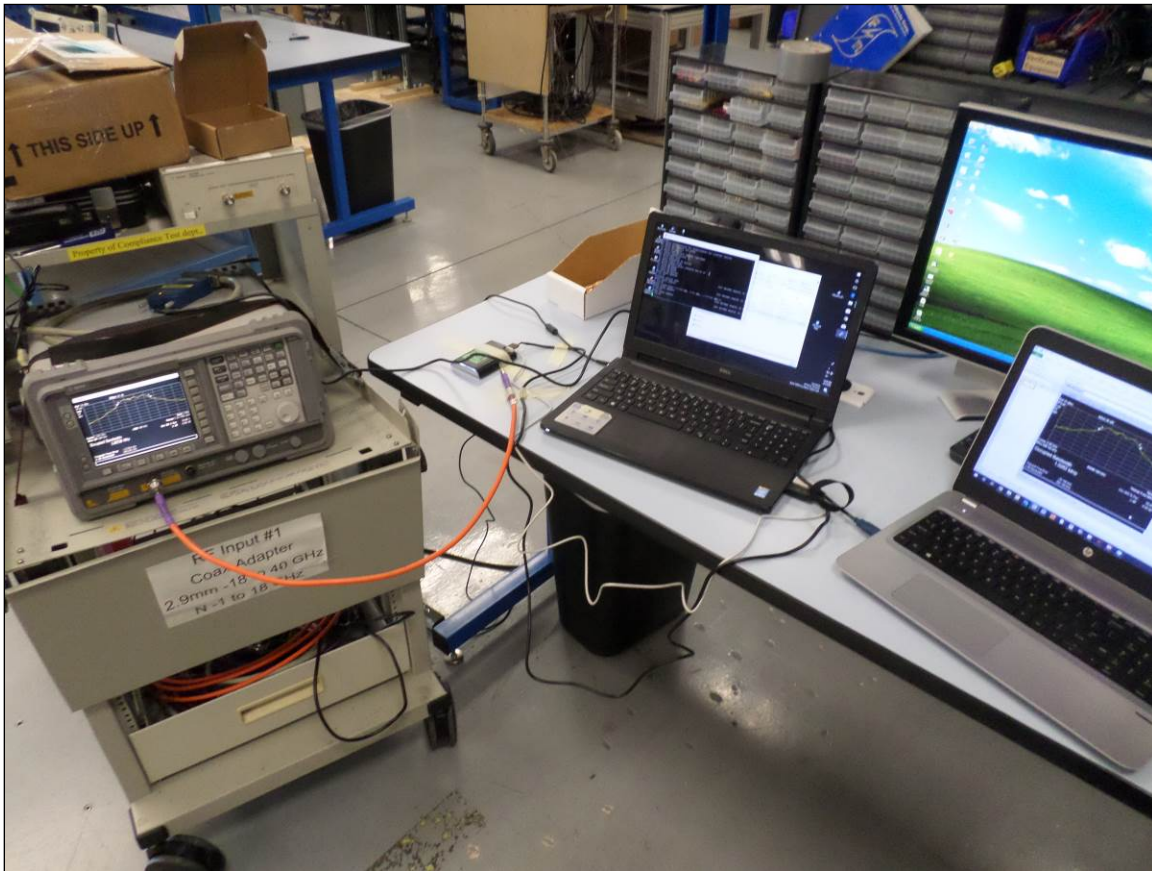
Conducted Band Edge Test Results



Plot 32. Conducted Band Edge, 2402



Plot 33. Conducted Band Edge, 2480



Photograph 10. Conducted Spurious Emissions, Conducted Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 3.10.1.6 Occupied Bandwidth

Test Requirements: §3.10.1.6: 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 minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was compliant with §3.10.1.6. No anomalies detected.

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Giuliano Messina

Test Date(s): June 7, 2018

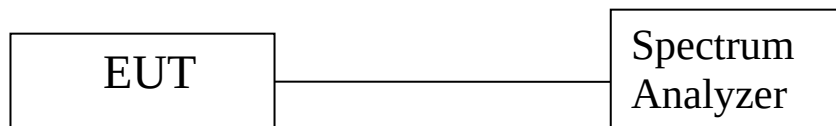
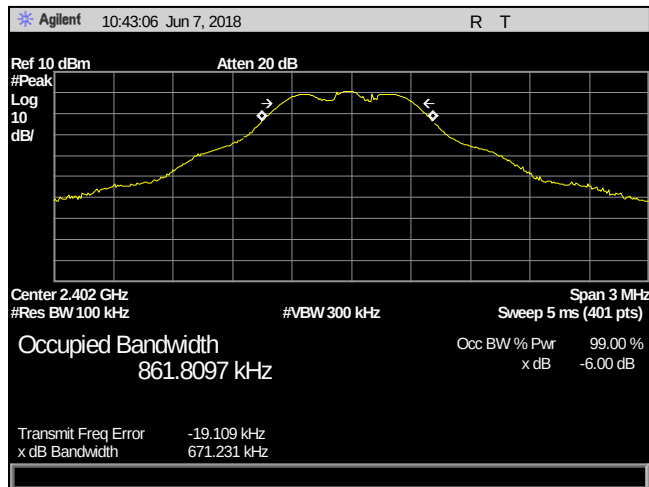


Figure 4. Block Diagram, Occupied Bandwidth Test Setup

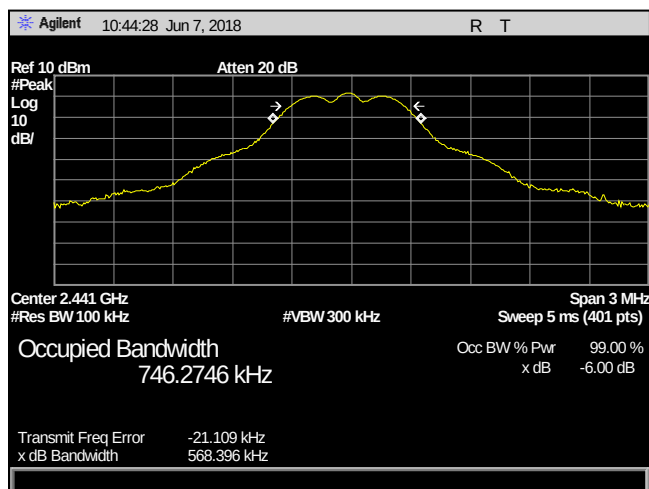
Channel	Frequency (MHz)	6dB OBW (kHz)
Low	2402	671.231
Mid	2441	568.396
High	2480	805.148

Table 17. Occupied Bandwidth Test Results

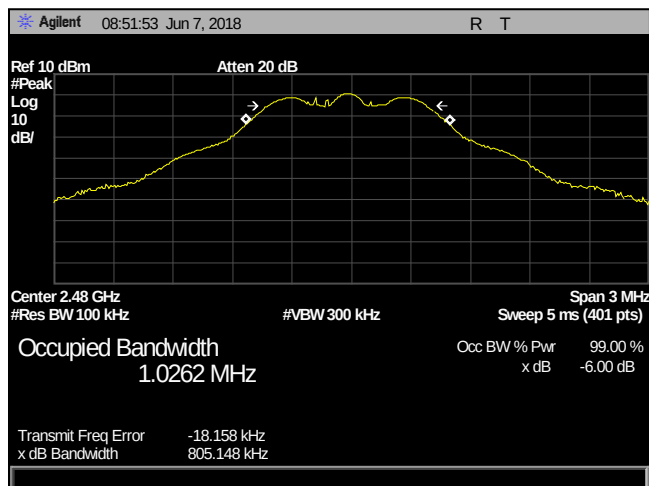
Occupied Bandwidth Test Results



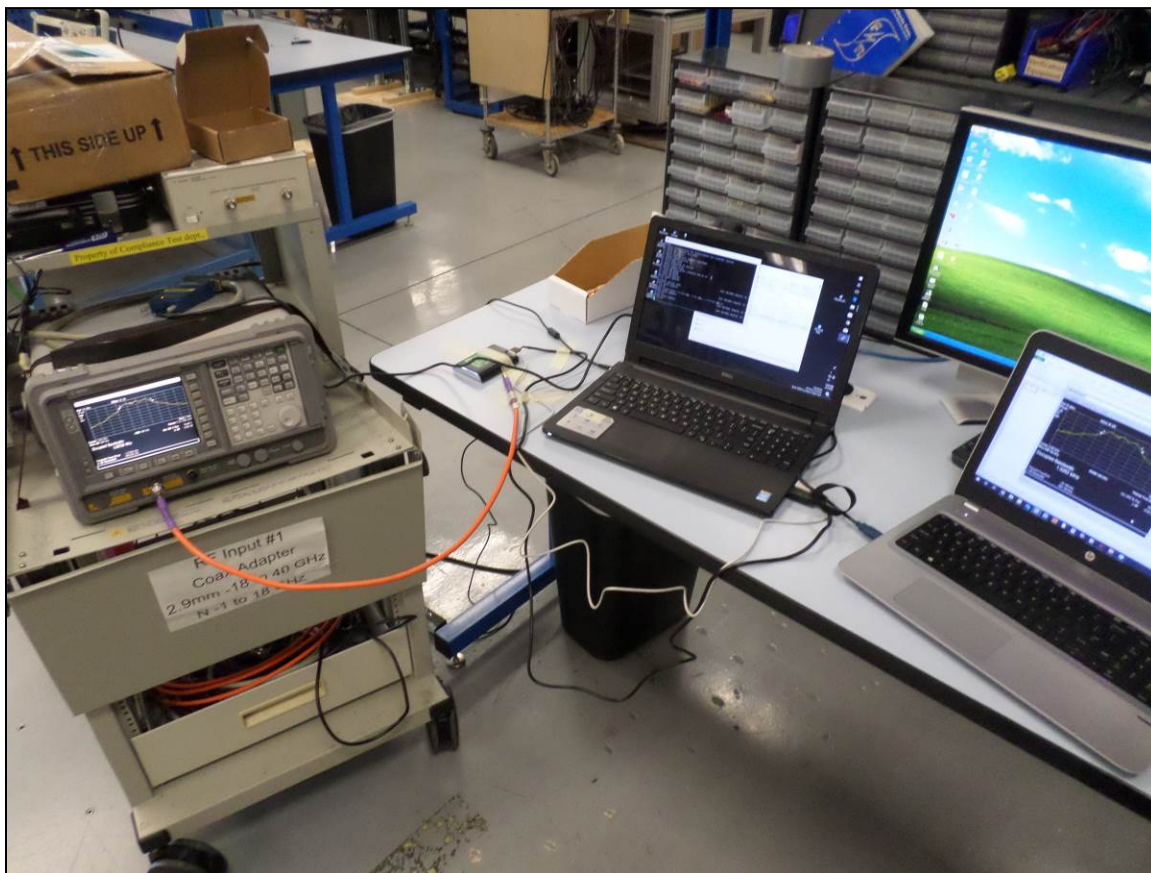
Plot 34. Occupied Bandwidth, 2402 MHz, 6 dB



Plot 35. Occupied Bandwidth, 2441 MHz, 6 dB



Plot 36. Occupied Bandwidth, 2480 MHz, 6 dB



Photograph 11. Occupied Bandwidth, Conducted Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§3.10.1.6 Peak Power Spectral Density

Test Requirements: §3.10.1.6: For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 3 kHz and a VBW set to 9 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was compliant with the peak power spectral density limits of §3.10.1.6.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Giuliano Messina

Test Date: June 7, 2018

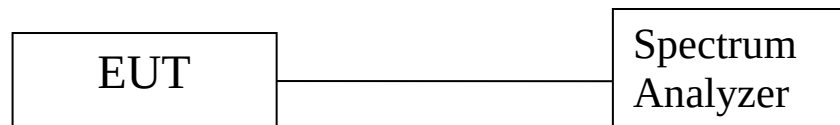
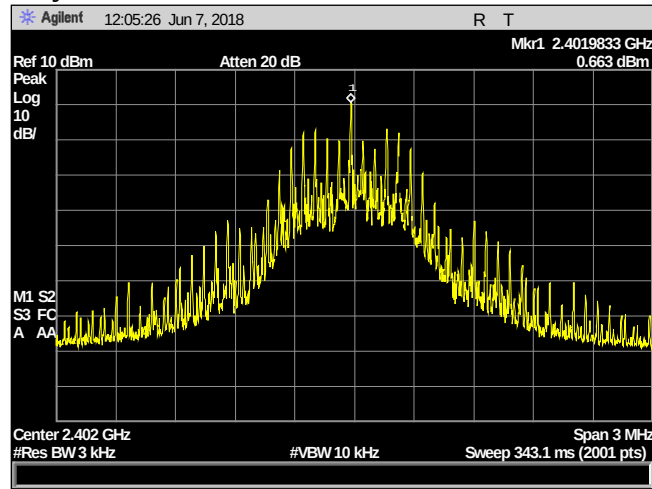


Figure 5. Block Diagram, Peak Power Spectral Density Test Setup

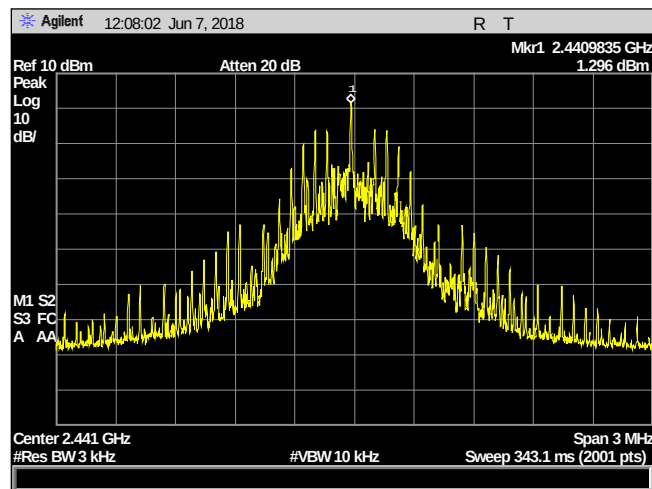
Channel	Frequency (MHz)	PSD (dBm)	PSD Limit (dBm)
Low	2402	0.633	8
Mid	2441	1.296	8
High	2480	0.847	8

Table 18. Power Spectral Density Test Results

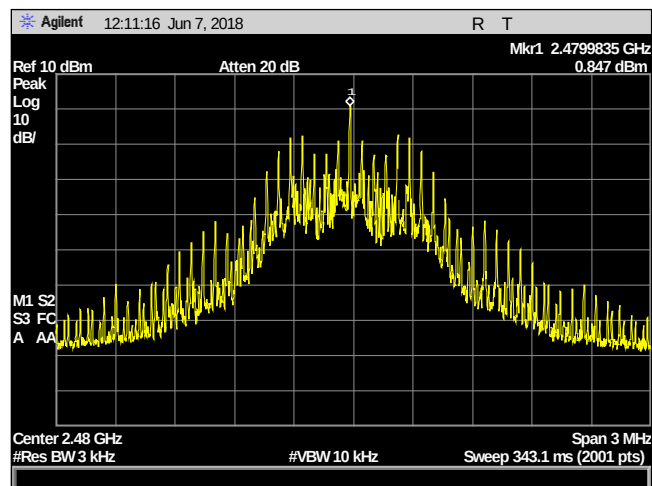
Peak Power Spectral Density Test Results



Plot 37. Peak Power Spectral Density, 2402 MHz



Plot 38. Peak Power Spectral Density, 2441 MHz



Plot 39. Peak Power Spectral Density, 2480 MHz



Photograph 12. Power Density, Conducted Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§5.20 Maximum Permissible Exposure

BLE SAR Exclusion Calculation

Per KDB 447498, Section 4.3.1 (a), applicable for frequencies from 100 MHz to 6 GHz and test separation distances ≤ 50 mm:

Using the formula from 4.3.1 (a), and using the LP0002 whole-body uncontrolled exposure SAR limit of 0.08 W/kg:

$$\text{Power allowed at numeric threshold for 50 mm and 2.4 GHz in step 4.3.1 (a)} = \left(\frac{0.08}{\sqrt{2.4}} \right) * 50 \text{ mm} = 2.582 \text{ mW}$$

FCC						
Frequency (MHz)	Corrected Meter Reading (dBuV/m)	TX Power (dbm)	TX Power (mW)	SAR Limit (mW)	Margin (mW)	Result
2441	N/A	1.07	1.279	2.582	-1.303	Pass

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 #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1A1083	EMI Test Receiver	Rohde & Schwarz	ESU40	9/12/2017	9/12/2018
1A1106	10m Chamber (FCC)	ETS	Semi-Anechoic	See Note	
1A1147	Bilog Antenna (30MHz to 1GHz)	Sunol Sciences Corp	JB3	3/9/2017	9/9/2018
1A1047	Horn Antenna	ETS	3117	2/23/2017	8/23/2018
1A1161	DRG Horn Antenna	ETS	3116C-PA	3/6/2017	9/6/2018
1A1099	Generator	COM-Power Corp	CGO-51000	See Note	
1A1088	Pre-Amp	Rohde & Schwarz	TS-PR1	See Note	
1A1044	Generator	COM-Power Corp	CG-520	See Note	
1A1073	Multi Device Controller	ETS EMCO	2090	See Note	
1A1074	System Controller	Panasonic	WV-CU101	See Note	
1A1075	System Controller	Panasonic	WV-CU101	See Note	
1A1080	Multi Device Controller	ETS EMCO	2090	See Note	
1A1180	Pre-Amp	Miteq	AMF-7D-01001800-22-10P	See Note	
1A1141	Spectrum Analyzer	Agilent Technologies	E4407B	7/13/2017	7/13/2018

Table 19. Test Equipment List

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

End of Report