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Report On

Application for Grant of Equipment Authorization of the
Telkonet Inc.
SS6010

FCC Part 15 Subpart C § 15.247
RSS 247 Issue 2, February 2017
RSS-Gen Issue 4, November 2014

Report No. TP72119974.101 **March 2017**

REPORT ON	Radio Testing of the Telkonet Inc. SS6010 – Energy Management Thermostat
TEST REPORT NUMBER	TP72119974.101
PREPARED FOR	Telkonet Inc. 20300 Seneca Meadows Parkway Germantown, MD 20876
CONTACT PERSON	Andrew Pozsgay apozsgay@telkonet.com
PREPARED BY	 Steven Hoke Title: Senior EMC Engineer
APPROVED BY	 Pete Walsh, NCE Authorized Signatory Title: Service Line Manager
DATED	23. March 2017

Revision History

TP72119974.101 Telkonet Inc. SS6010					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
23. March 2017	Initial Release				Pete Walsh
25. April 2017	TP72119974.100	TP72119974.101	Changed model number from EcoInsight to SS6010	1,2,3,5,6,8 & 12	Steve Hoke

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TÜV SÜD AMERICA INC 5610 W. Sligh Ave., Suite 100, Tampa, FL 33634 Phone: 813 284 2715 FAX: 813 413 3813

SECTION 1

REPORT SUMMARY

Radio Testing of the
Telkonet Inc.
SS6010

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Telkonet SS6010 to the requirements of FCC Part 15 Subpart C § 15.247, RSS-Gen, Issue 4, November 2014 and RSS 247 Issue 2, February 2017.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Telkonet Inc.
Model Number(s)	SS6010, SS6510
FCC ID Number	XV6SS6010
IC Number	22341-SS6010
Serial Number(s)	None
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 15 Subpart C § 15.247 • RSS 247 Issue 2, February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • RSS-Gen, Issue 4, November 2014 General Requirements for Compliance of Radio Apparatus. • 558074 D01 DTS Meas Guidance v03r03, (June 09, 2015) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.
Start of Test	29. November 2016
Finish of Test	06. December 2016
Name of Engineer(s)	Steven Hoke / David Foerstner
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C § 15.247 with cross-reference to the corresponding IC RSS standard is shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
2.1	§15.247(b)(3)	RSS-247 5.4(4)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	Compliant	
2.3		RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-247 5.2(1)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	Compliant	
2.7		RSS-Gen 7.1	Receiver Spurious Emissions	Compliant	
2.8	§15.247(e)	RSS-247 5.2(2)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A Not performed.

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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an SS6010, a wireless energy management device with display. The EcoSource model is identical without a display.

1.3.2 EUT General Description

EUT Description	An energy management thermostat with a built-in occupancy sensor and ZigBee® capability
Model Name	SS6010, SS6510
Model Number(s)	None
Rated Voltage	3.3 VDC
Mode Verified	Zigbee
Capability	Zigbee
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Antenna Manufacturer	Linx
Antenna Part Number	ANT-2.4-CW-RH-RPS
Antenna Type	Reduced-height helical whip
Antenna Gain	–0.9dBi
Host Brand	NA
Host Model Name	NA
Host Model Number	NA

1.3.3 Maximum Conducted Output Power (Peak)

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Zigbee	2402 - 2480	14.62	28.97

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna conducted port test configuration. Direct connection of the antenna port to a spectrum analyzer.
B	Radiated emissions test configuration. EUT transmitting through the integral antenna (mounted on the development board).
C	Radiated emissions test configuration. Antenna port terminated.

1.4.2 EUT Exercise Software

The manufacturer provided the following instructions: The serial port configuration is 9600 N81. To enable the command line interface, use a TAB-ENTER key sequence. This sequence must be executed each time the unit boots. At this point you should get the prompt "$".

To configure the RF channel, use the command "zb -c <channel>". Channel is the 802.15.4 channel number. Valid channel numbers are from 11 to 26.

To enable/disable radio transmissions (one packet per 100ms), use the command "mfg -f <0,1>" where 1 is enable and 0 is disable.

The radio transmit power is fixed at the maximum level.

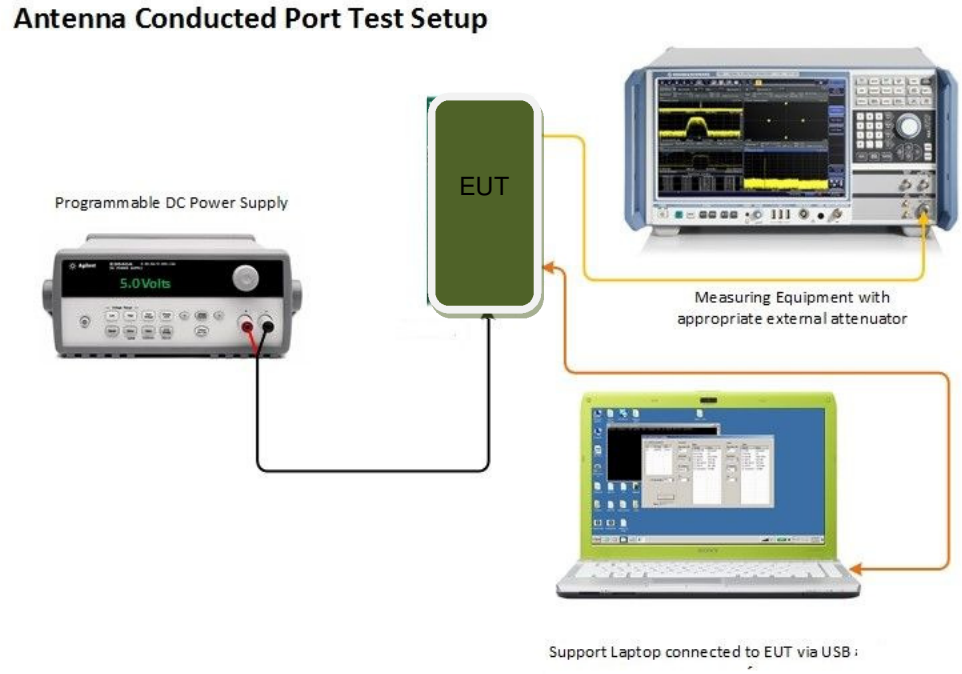
1.4.3 Support Equipment and I/O cables

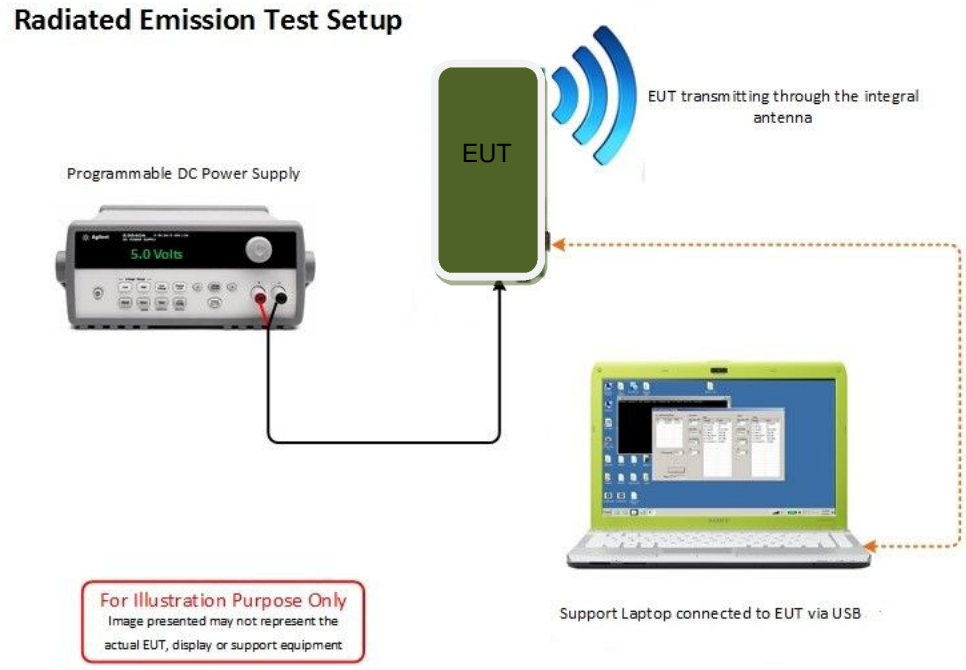
Manufacturer	Equipment/Cable	Description
Telkonet	Host	energy management thermostat
Lenovo	Support Laptop for programming EUT	B570
-	RF Cable Assembly (EUT antenna port to Spectrum Analyzer)	0.2 meter, SMA Female (Bulkhead) to U.FL

1.4.4 Worst Case Configuration

EUT verified on all three (3) orthogonal axes. Only worst case axis presented (X).

1.4.5 Simplified Test Configuration Diagram





Configuration not presented is when the EUT is installed inside a representative host. Radiated emissions were performed on the host while the EUT is in Rx and TX mode (worst case).

1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number		
N/A		

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Tampa)

5610 W. Sligh Ave., Tampa, FL 33634 Phone: 813 284 2715 FAX: 813-413 3813

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No

The TUV SUD America Inc. (Tampa), test facility has been registered with the Federal Communication Commission as an ISO/IEC 17025 accredited test laboratory and assigned the designation number US1063.

1.9.2 Innovation, Science and Economic Development Canada Registration

The TUV SUD America Inc. (Tampa), test facility has been registered with Innovation, Science and Economic Development Canada and assigned the site number 2087A-2.

SECTION 2

TEST DETAILS

Radio Testing of the
Telkonet Inc.
SS6010

2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

2.1.2 Standard Applicable

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.1.4 Date of Test/Initial of test personnel who performed the test

30. November, 2016 / SH

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.1.7 Additional Observations

- This is a conducted test (Maximum Peak Conducted Output Power) using direct connection to a spectrum analyzer.
- The cable loss of (0.64) dB was added to the measured value.
- Test methodology is per Clause 9.2.2.6 of KDB 558074 D01 (DTS Meas Guidance v03r05, April 08, 2016). All conditions under this Clause were satisfied.

2.1.8 Test Results

Channel	Modulation	Measured Peak Power (dBm)	Cable loss (dB)	Actual Peak Power (dBm)	Actual Peak Power (mW)
2405 MHz	Zigbee	13.98	0.64	14.62	28.97
2440 MHz		13.80	0.64	14.44	27.8
2480 MHz		13.46	0.64	14.10	25.7

2.1.9 Test Plots

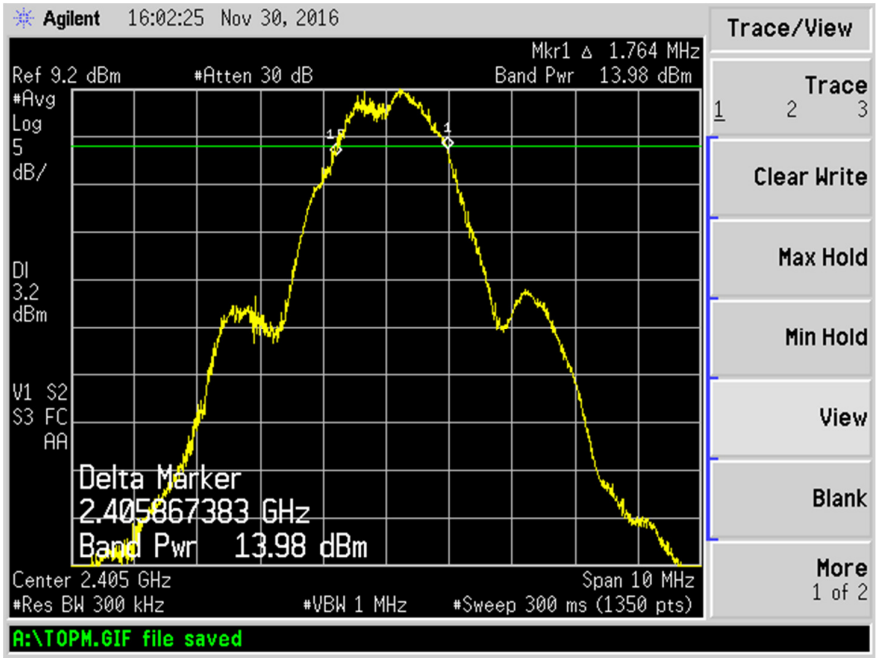


Figure 2.1.9-1 - Low Channel Peak Power

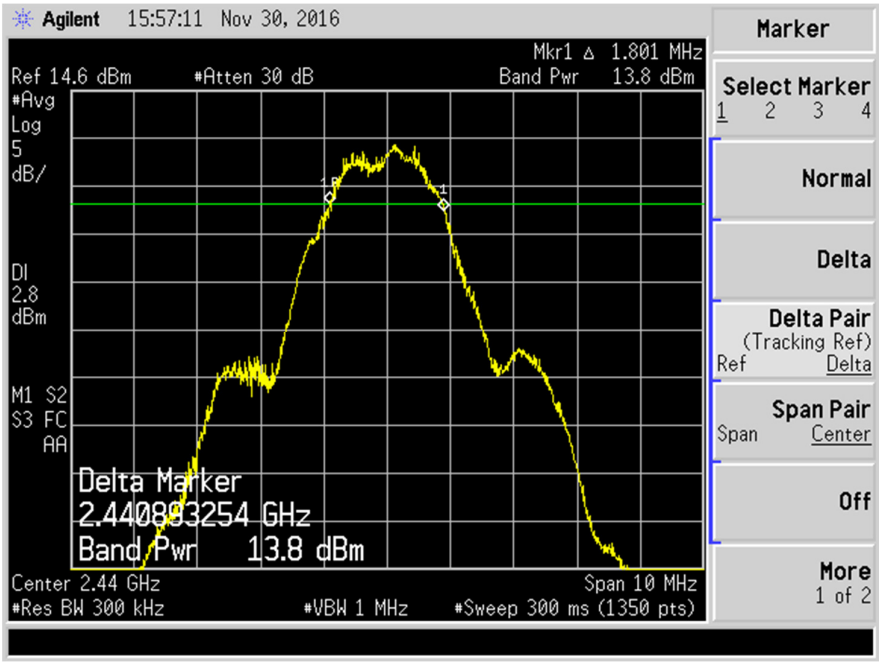


Figure 2.1.9-2 - Mid Channel Peak Power

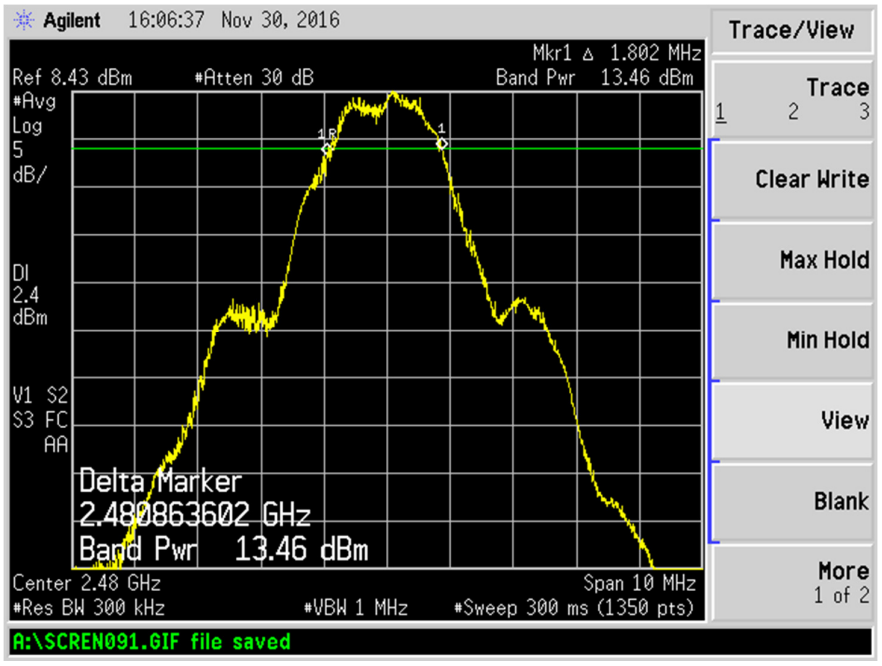


Figure 2.1.9-3 - High Channel Peak Power

2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.2.2 Standard Applicable

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 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration C

2.2.4 Date of Test/Initial of test personnel who performed the test

09. December 2016/DF

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Ambient Temperature	25.3°C
Relative Humidity	20.2%
ATM Pressure	99.3 kPa

2.2.7 Additional Observations

- The EUT is a RF board and is not AC powered.
- To show general compliance to the present requirement, the EUT was installed inside the normal host representing real world installation.
- The EUT was set to transmit mode. Only the worst channel presented.

- Measurement was done using EMC32 V8.54 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.2.8 for sample computation.

2.2.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dBµV) @ 150kHz			30.0
Correction Factor (dB)	TEMC00002 - LISN	0.03	0.11
	Cable 1	0.08	
Reported QuasiPeak Final Measurement (dBµV) @ 150kHz			**30.11**

2.2.9 Test Results

Compliant. See attached plots and tables.

2.2.10 FCC Part 15 Composite Line and Neutral Plot

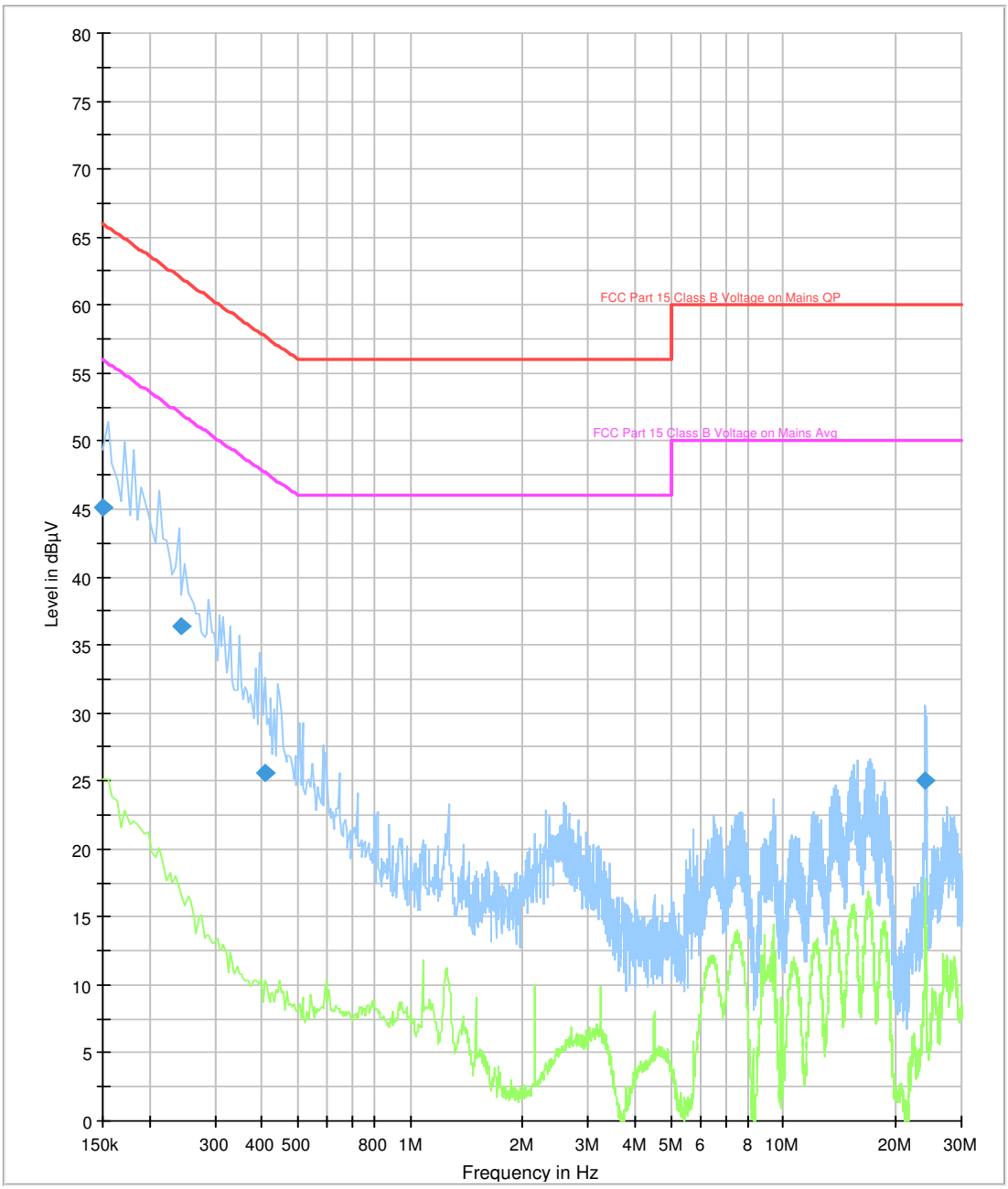


Figure 2.1.10-1 – Conducted Emissions Plot

Table 2.1.10-1 - Quasi Peak Detector Results on the AC Power Port

Frequency (MHz)	Quasi-peak (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	45.1	L1	0.1	20.9	66.0
0.244500	36.3	L1	0.1	25.6	61.9
0.406500	25.6	L1	0.2	32.1	57.7
23.977500	25.0	N	2.2	35.0	60.0

2.3 99% Emission Bandwidth

2.3.1 Specification Reference

RSS-Gen Clause 6.6

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- • The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- • The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.3.4 Date of Test/Initial of test personnel who performed the test

05. December 2016 / SH

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampafacility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.3.7 Additional Observations

- This is a conducted test. EUT on normal test mode.
- Span is wide enough to capture the channel transmission.
- RBW is 1% to 5% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.

2.3.8 Test Results (For reporting purposes only)

Mode	Channel	Measured 99% Bandwidth (kHz)
Zigbee	2405 MHz	3000
	2440 MHz	2975
	2480 MHz	2938

2.3.9 Test Plots

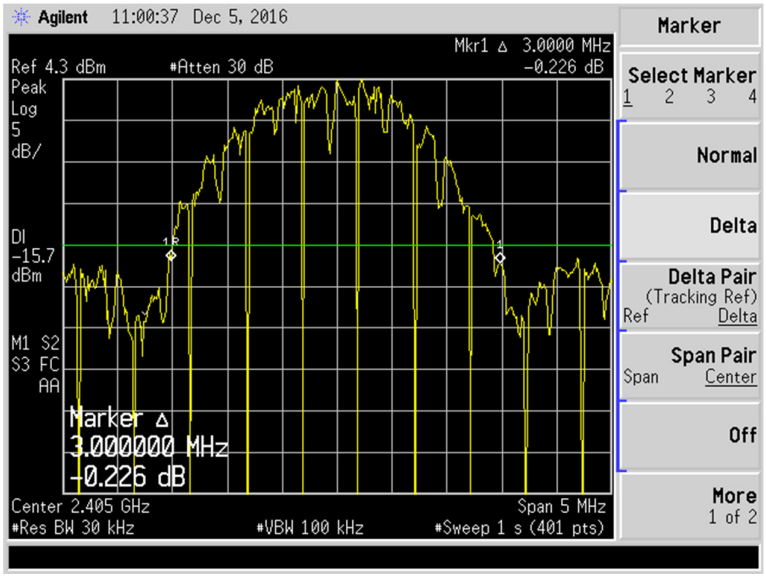


Figure 2.3.9-1 - Low Channel Bandwidth

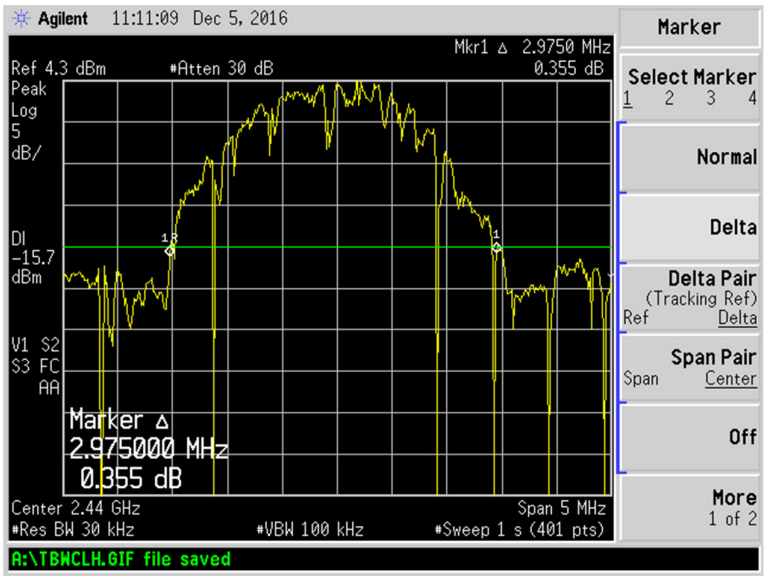


Figure 2.3.9-2 - Mid Channel Bandwidth

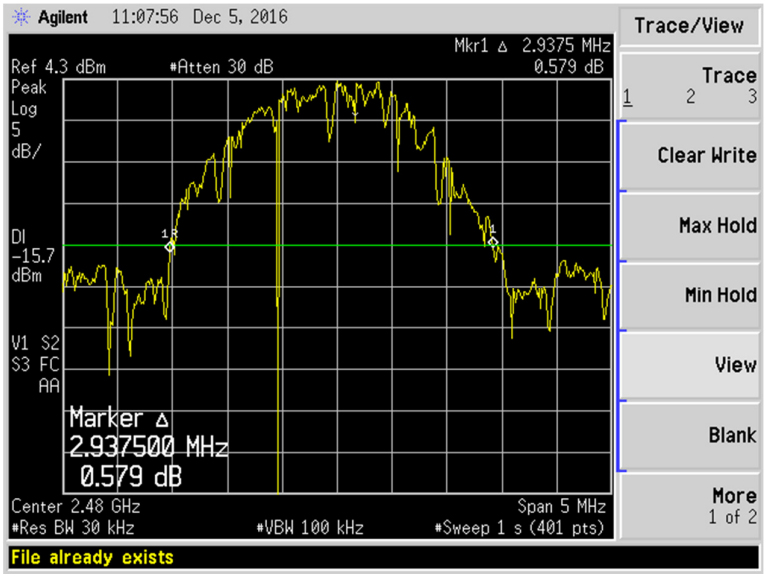


Figure 2.3.9-3 - High Channel Bandwidth

2.4 MINIMUM 6 dB RF BANDWIDTH

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

2.4.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.4.3 Equipment Under Test and Modification State

Serial No: none/ Test Configuration A

2.4.4 Date of Test/Initial of test personnel who performed the test

30. November, 2016 / SH

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.4.7 Additional Observations

- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 100 kHz.
- VBW is ≥3X RBW.
- Sweep is auto.
- Detector is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.

2.4.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Zigbee	2405 MHz	1.610	0.500	Complies
	2440 MHz	1.613	0.500	Complies
	2480 MHz	1.625	0.500	Complies

2.4.9 Test Results Plots

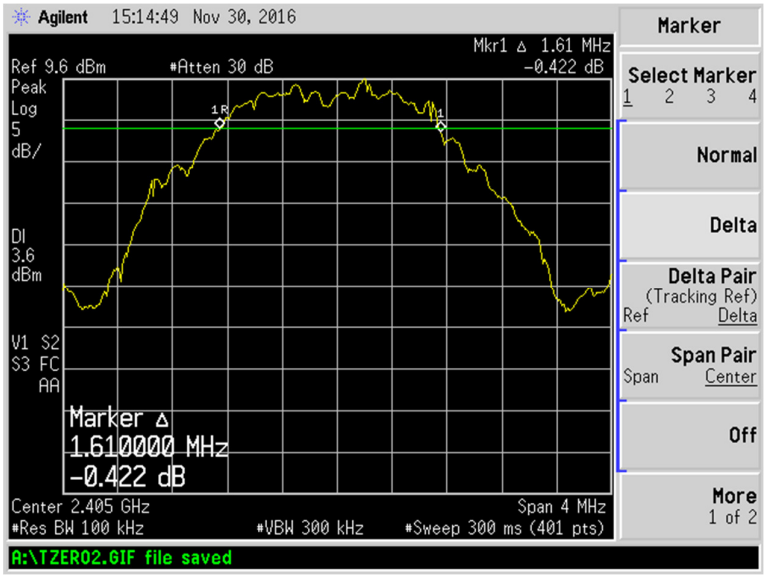


Figure 2.4.9-1 - LoRa Low Channel Bandwidth

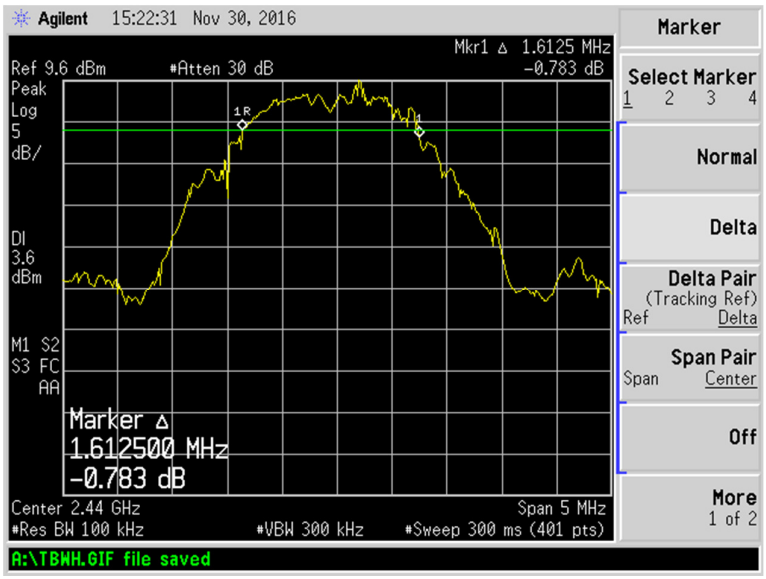


Figure 2.4.9-2 - LoRa Mid Channel Bandwidth

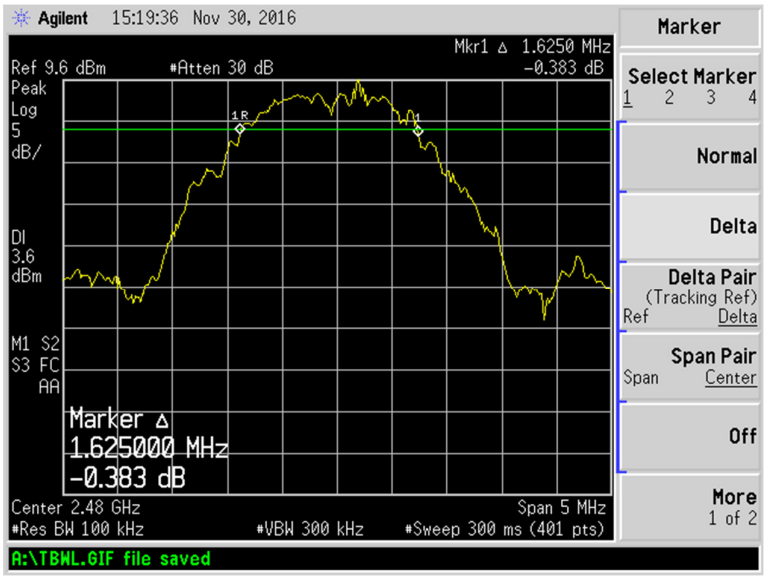


Figure 2.4.9-3 - LoRa High Channel Bandwidth

2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.5.2 Standard Applicable

(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. 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) (see §15.205(c)).

2.5.3 Equipment Under Test and Modification State

Serial No: none/ Test Configuration A

2.5.4 Date of Test/Initial of test personnel who performed the test

06. December 2016 / SH

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions

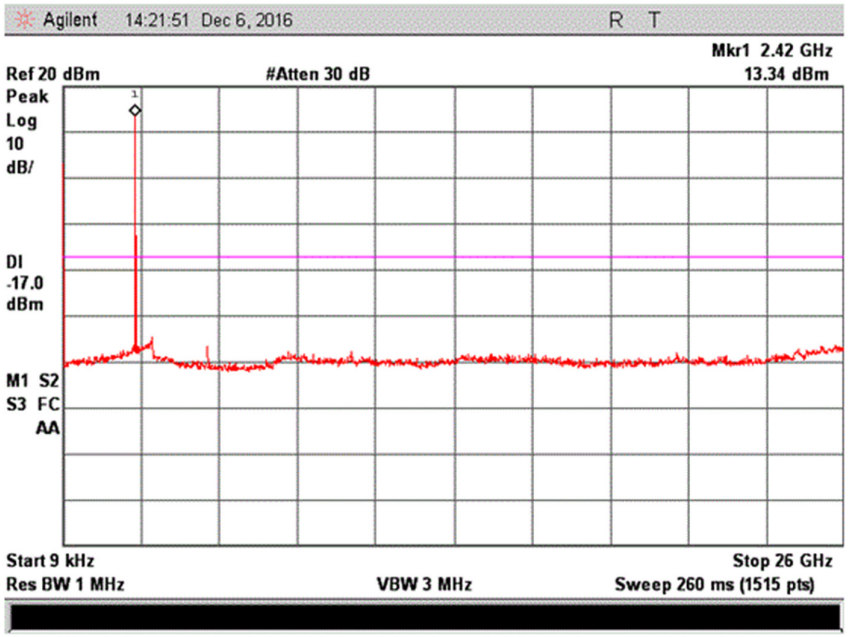
Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.5.7 Additional Observations

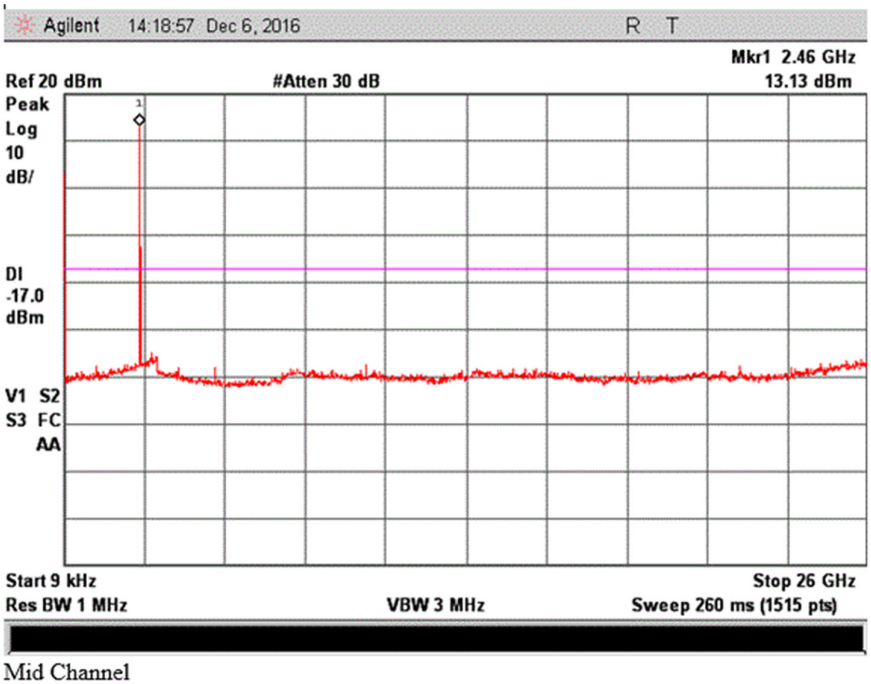
- This is a conducted test.
- RBW is 1 MHz. VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold. Sweep points set to maximum.
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 30dB below this level.
- Spectrum was searched from 9 kHz up to 26 GHz.

2.5.8 Test Results Plots



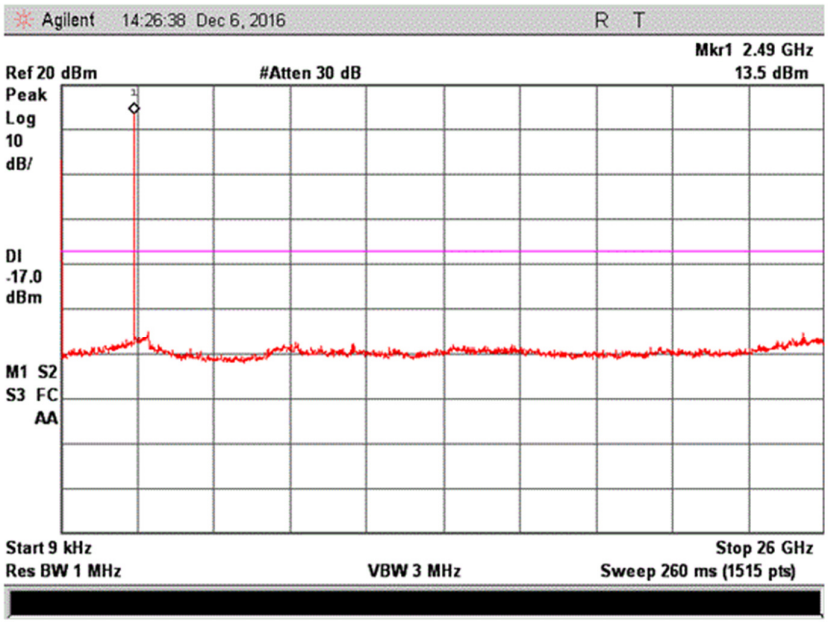
Low Channel

Figure 2.5.8-1 - Low Channel Out-of-Band Conducted Emissions



Mid Channel

Figure 2.5.8-2 - Mid Channel Out-of-Band Conducted Emissions



High Channel

Figure 2.5.8-3 - High Channel Out-of-Band Conducted Emissions

2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 Standard Applicable

See previous test.

2.6.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.6.4 Date of Test/Initial of test personnel who performed the test

01.December 2016 / SH

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.6.7 Additional Observations

- This is a conducted test.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Trace was centred on the band-edge frequency.
- Span was set to encompass the band-edge frequency and the peak of the emission.
- Using Marker function, peak of the emission was determined and the delta to the band-edge frequency measured.
- Band-edges were verified ≤ 30 dBc.

2.6.8 Test Results

Complies. See attached plots.

Figure 2.6.8-1 - Low Channel (2405 MHz)

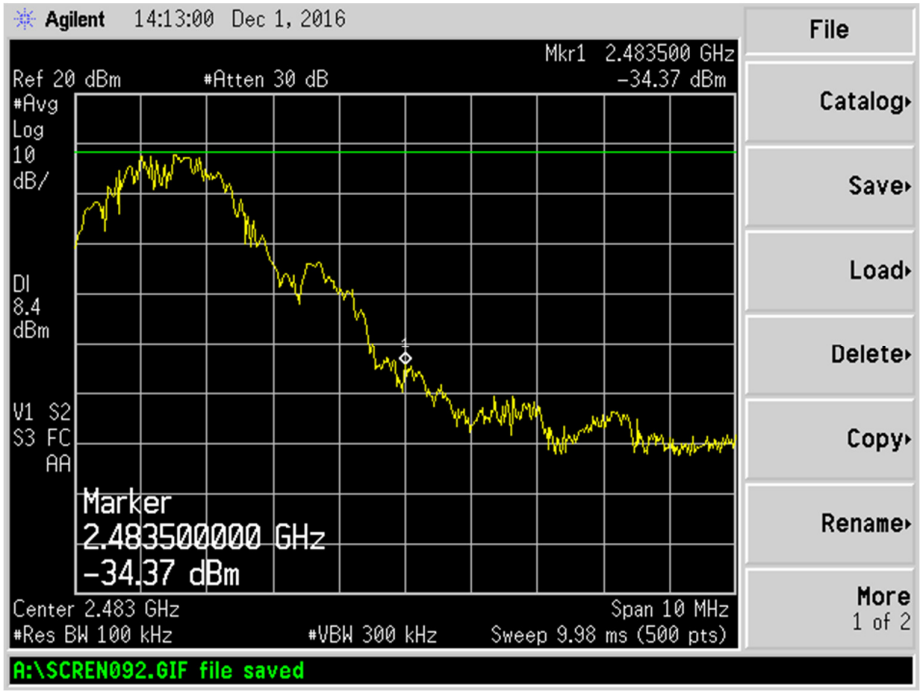


Figure 2.6.8-2 - High Channel (2480 MHz)

2.7 SPURIOUS RADIATED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 Standard Applicable

(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. 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) (see §15.205(c)).

2.7.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration B and C

2.7.4 Date of Test/Initial of test personnel who performed the test

23. November 2016 /CF

2.7.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only noise floor measurements observed above 18GHz.
- Verification of the EUT while inside a representative host were also performed.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.6.8 for sample computation.

2.7.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.7.9 Test Results

See attached plots.

2.7.10 Test Results below 1GHz (Worst Case Configuration)

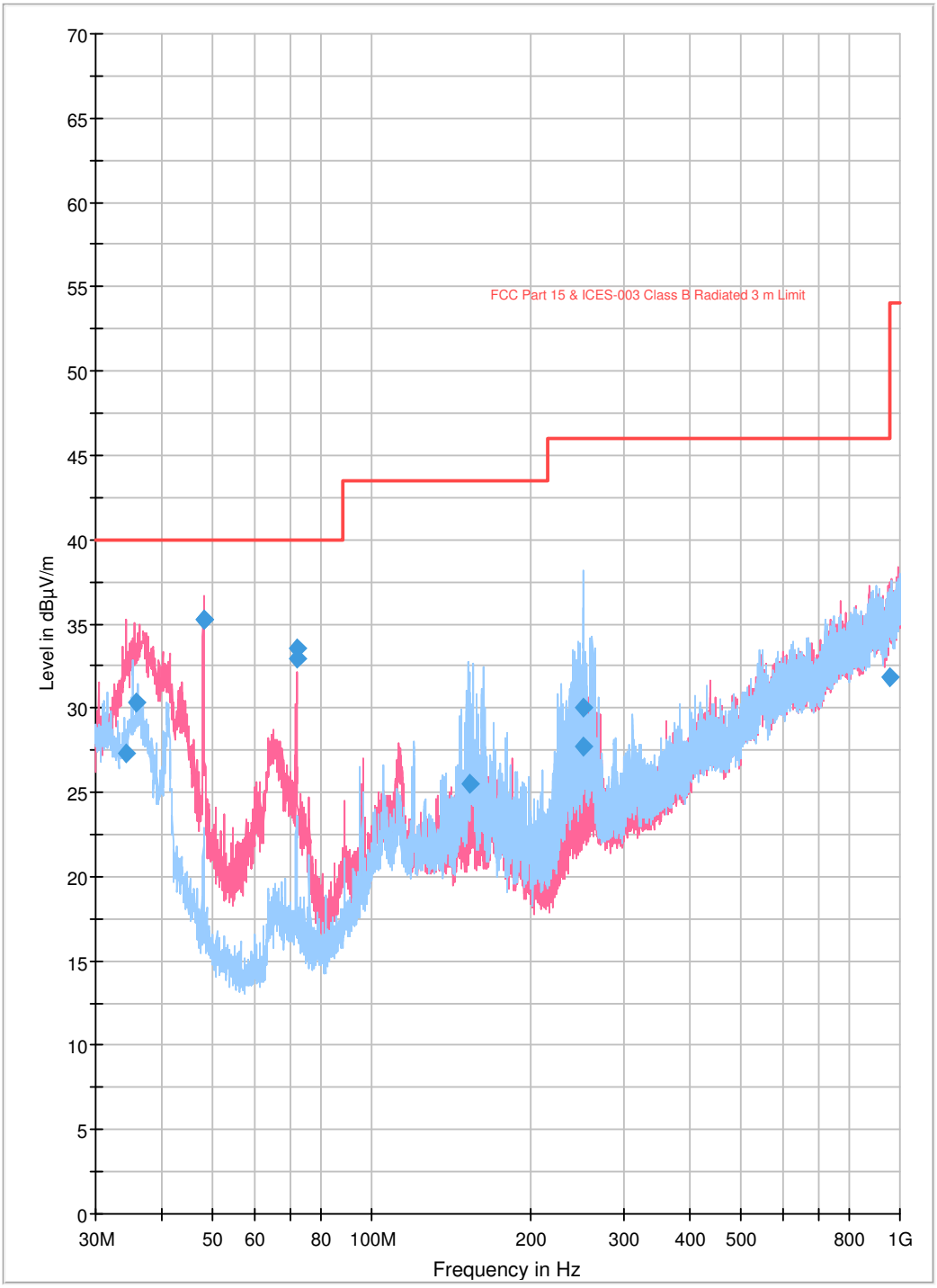


Figure 2.7.10-1 – Radiated Emissions Plot

Table 2.7.10-1 - Quasi Peak Data

Frequency (MHz)	Quasi-peak (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
34.240000	27.3	150.0	V	147.0	22.4	12.7	40.0
35.800000	30.3	100.0	V	180.0	21.5	9.7	40.0
48.000000	35.2	100.0	V	271.0	15.2	4.8	40.0
48.040000	35.3	100.0	V	281.0	15.2	4.8	40.0
72.000000	33.5	135.0	V	1.0	12.9	6.5	40.0
72.080000	32.9	151.0	V	0.0	12.9	7.1	40.0
152.800000	25.5	199.0	H	279.0	17.3	18.0	43.5
252.040000	27.7	149.0	H	85.0	20.1	18.3	46.0
252.360000	30.0	145.0	H	337.0	20.1	16.0	46.0
959.320000	31.9	348.0	H	282.0	31.5	14.1	46.0

2.7.11 Test Results Above 1GHz (Worst Case Configuration)

Table 2.7.11-1 - Low Channel

Frequency (MHz)	Field Strength (dBµV/m)	Detector	Polarization	Restricted Band	Margin (dB)	Limit (dBµV/m)
2405	79.2	AVG	Horz	NO	NA	NA
2405	107.9	PEAK	Horz	NO	NA	NA
4810	39.5	AVG	Vert	YES	14.5	54
4810	65.1	PEAK	Vert	YES	8.9	74
7215	45.6	AVG	Horz	NO	13.6	59.2
7215	69.1	PEAK	Horz	NO	10.1	79.2
9620	42.6	AVG	Vert	NO	16.6	59.2
9620	56	PEAK	Vert	NO	23.2	79.2
12025	48	AVG	Vert	YES	6	54
12025	63.2	PEAK	Vert	YES	10.8	74

Table 2.7.11-2 - Mid Channel

Frequency (MHz)	Field Strength (dBµV/m)	Detector	Polarization	Restricted Band	Margin (dB)	Limit (dBµV/m)
2440	79.6	AVG	Horz	NO	NA	NA
2440	108.4	PEAK	Horz	NO	NA	NA
4880	40.2	AVG	Vert	YES	13.8	54
4880	65.3	PEAK	Vert	YES	8.7	74
7320	46.4	AVG	Horz	YES	7.6	54
7320	69.7	PEAK	Horz	YES	4.3	74
9760	42.6	AVG	Vert	NO	17	59.6
9760	56	PEAK	Vert	NO	23.6	79.6
12200	48	AVG	vert	YES	6	54
12200	63.2	PEAK	vert	YES	10.8	74

Table 2.7.11-3 - High Channel

Frequency (MHz)	Field Strength (dBµV/m)	Detector	Polarization	Restricted Band	Margin (dB)	Limit (dBµV/m)
2480	79.2	AVG	Horz	NO	NA	NA
2480	107.9	PEAK	Horz	NO	NA	NA
4960	41	AVG	Vert	YES	13	54
4960	67.1	PEAK	Vert	YES	6.9	74
7440	48.2	AVG	Horz	YES	5.8	54
7440	71.5	PEAK	Horz	YES	2.5	74
9920	42.6	AVG	Horz	NO	16.6	59.2
9920	56	PEAK	Horz	NO	23.2	79.2
12400	48	AVG	Vert	YES	6	54
12400	63.2	PEAK	Vert	YES	10.8	74

Test Notes: No significant emissions observed above 12GHz. Measurements above 12GHz were noise floor figures.

2.8 POWER SPECTRAL DENSITY

2.8.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.8.2 Standard Applicable

(e) For digitally modulated systems, the 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.8.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.8.4 Date of Test/Initial of test personnel who performed the test

29. November 2016 / SH

2.8.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.8.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampafacility

Ambient Temperature	24 - 26 °C
Relative Humidity	30 - 32 %

2.8.7 Additional Observations

- This is a conducted test.
- Test procedure is per Section 10.8 of KDB 558074 v03r05, (April 08, 2016).
- Detector is Peak.
- Trace Mode is Max hold.
- Sweep time is Auto Couple.
- EUT complies with 3 kHz RBW.
- T= 4.0 mSec (VBW ≥ 1/T) (1/T=250 Hz) (VBW set to >250 Hz)
- Number of points in sweep ≥ 2 Span / RBW (4,000,000/30,000) =133
- Display mode is set to linear

2.8.8 Test Results Summary (PKPSD Method)

Table 2.8.8-1 – PSD Results

Mode	Channel	Marker Reading using 3 kHz RBW (dBm)	Linear mode Correction - add (1) dB	PSD Limit (dBm)	Compliance
	2405 MHz	4.66	5.66	8	Complies
	2440 MHz	3.84	4.84	8	Complies
	2480 MHz	4.55	5.55	8	Complies

2.8.9 Test Results Plots

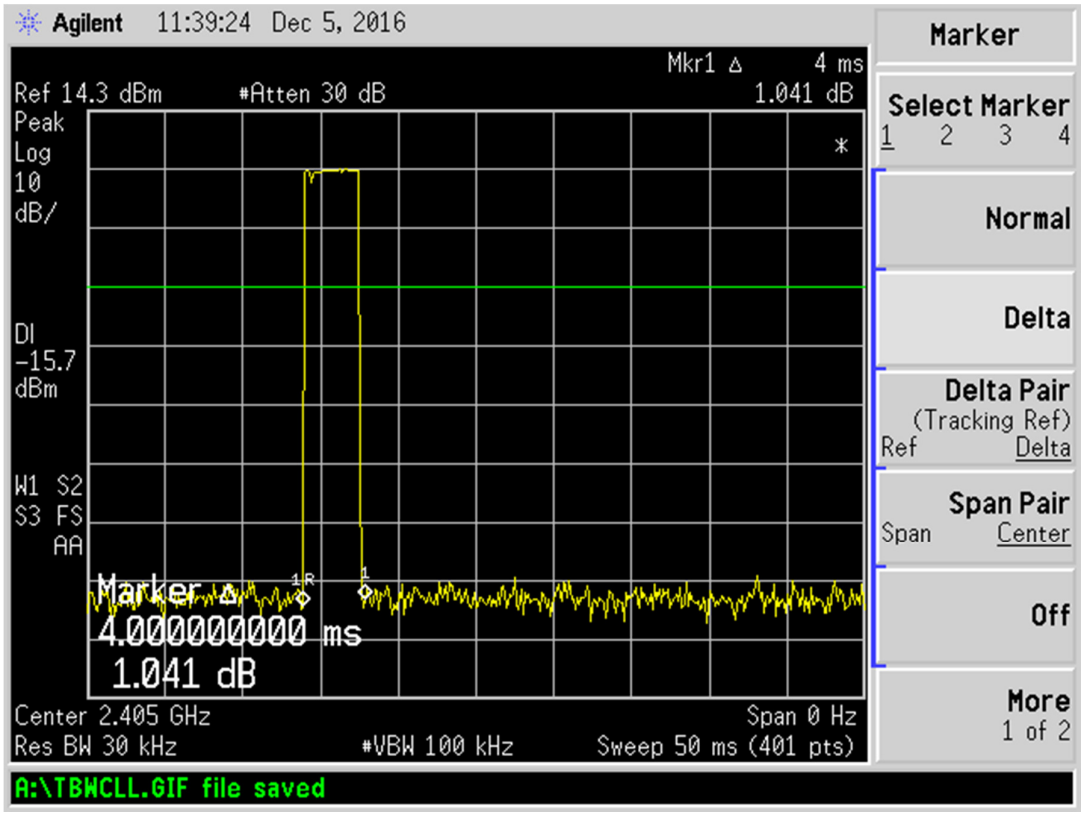


Figure 2.8.9-1 - Zero Span (T=4.0 mSec) Time Domain Results

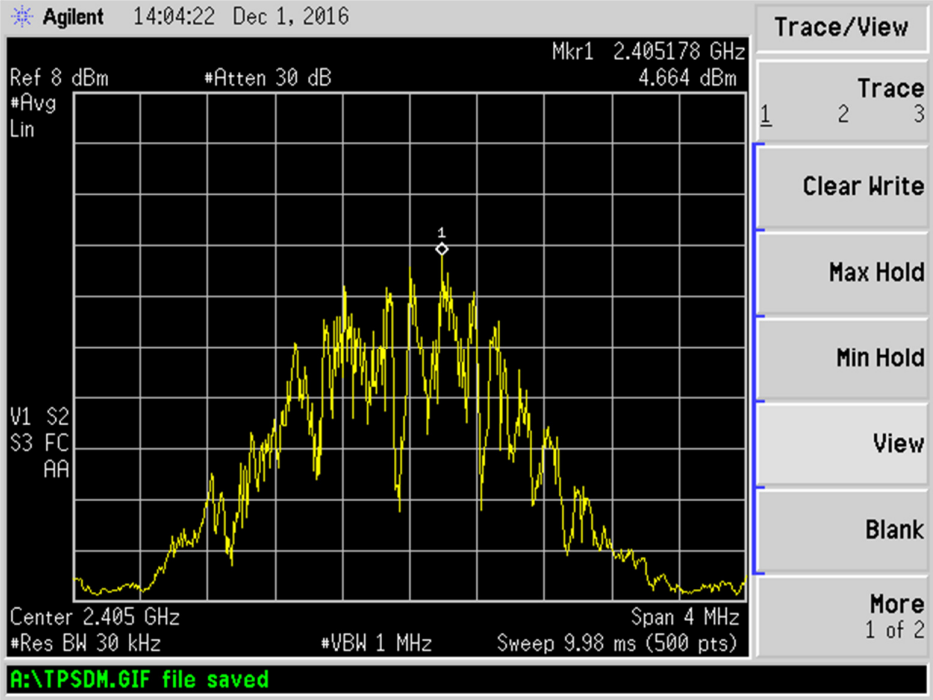


Figure 2.8.9-2 - Low Channel PSD

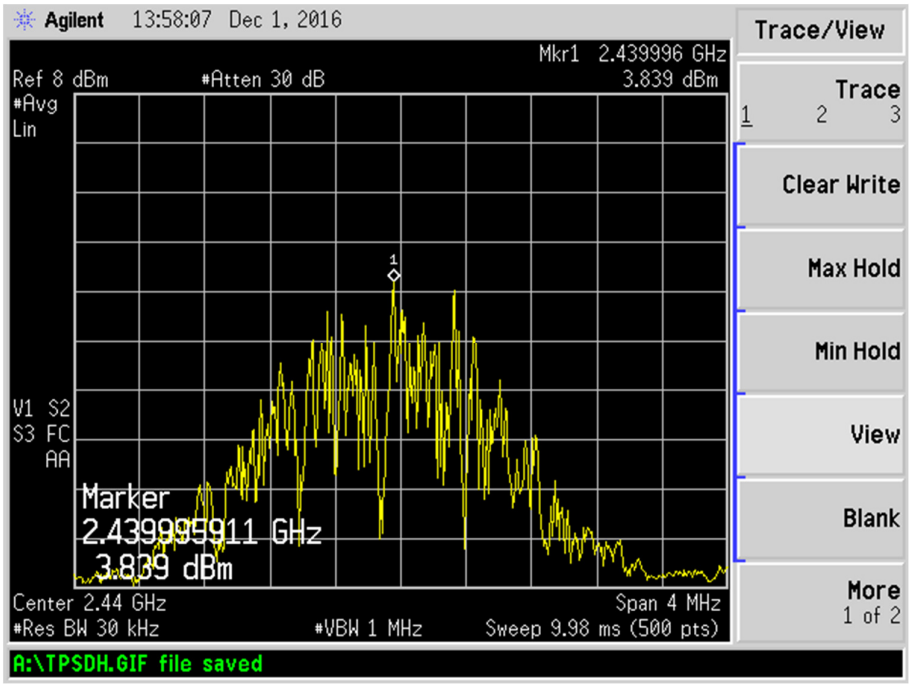


Figure 2.8.9-3 - Mid Channel PSD

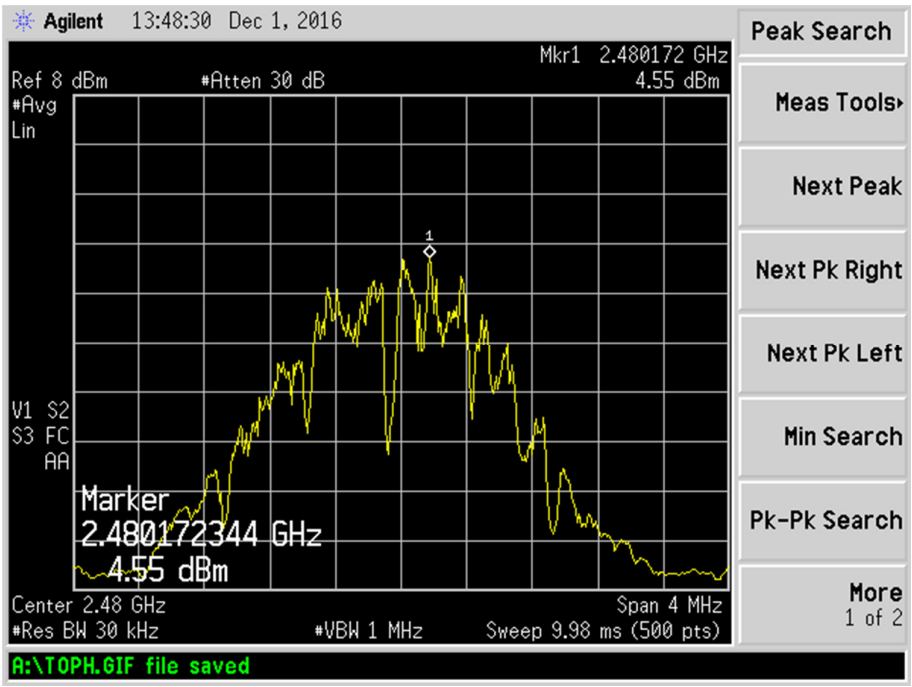


Figure 2.8.9-4 - High Channel PSD

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Port Measurement						
NA	High-frequency cable	SMA to N (12) inch	NA	NA	Validated 10/21/16 due 10/21/17	
TAME01064	DC Power Supply	HPD 60-5	NA	XANTREX	NCR	
TEMC00091	Spectrum Analyzer	E7402A	US39150137	Agilent	1/21/2016	1/21/2017
Radiated Emissions						
TEMC00005	Bilog Antenna	6112B	2579	Chase EMC		12/17/2017
TEMC00061	Double-ridged waveguide horn antenna	3117	00109296	ETS Lindgren		2/3/2018
TEMC00011	EMI Test Receiver	ESCS30	825788/002	Rhode & Schwarz		12/4/2017
TEMC00012	Spectrum Analyzer	E7404A	MY42000055	Agilent	4/10/2015	4/10/2017
TEMC00013	Pre-amplifier	PA-122	181925	Compower		10/3/2017
Conducted Emissions						
TEMC00011	EMI Test Receiver	ESCS30	825788/002	Rhode & Schwarz	2.3002.0102.36	12/4/2017
TEMC00002	LISN	ESH3-Z5	840730/005	Rhode & Schwarz	N/A	8/9/2017
Miscellaneous						
N/A	Test Software	EMC32	V8.54	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

3.2.1 Radiated Emission Measurements (Below 1GHz)

Radiated Measurement 30 - 1000 MHz at a distance of 3 m

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.58	dB	Normal, k=2	2.000	0.29	0.08
4	Receiver sinewave accuracy	0.40	dB	Normal, k=2	2.000	0.20	0.04
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.85	dB	Triangular	2.449	1.57	2.47
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00

Combined standard uncertainty	Normal	2.96	dB
Expanded uncertainty	Normal, k=2	**5.92**	**dB**

3.2.2 Radiated Emission Measurements (Above 1GHz)

Radiated Measurement Above 1 GHz at a distance of 3 m

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.30	dB	Normal, k=2	2.000	0.15	0.02
3	Preamplifier Gain	0.20	dB	Normal, k=2	2.000	0.10	0.01
4	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
5	Sinewave accuracy	0.20	dB	Normal, k=2	2.000	0.10	0.01
6	Instability of preamp gain	1.21	dB	Rectangular	1.732	0.70	0.49
7	Noise floor proximity	0.70	dB	Rectangular	1.732	0.40	0.16
8	Mismatch: antenna-preamplifier	1.41	dB	U-shaped	1.414	1.00	0.99
9	Mismatch: preamplifier-receiver	1.30	dB	U-shaped	1.414	0.92	0.85
10	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
11	Directivity difference at 3 m	1.50	dB	Rectangular	1.732	0.87	0.75
12	Phase center location at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Site imperfections VSWR (Method 2)	2.25	dB	Triangular	2.449	0.92	0.84
15	Effect of setup table material	2.90	dB	Rectangular	1.732	1.67	2.80
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Table height at 3 m	0.00	dB	Normal, k=2	2.000	0.00	0.00

Combined standard uncertainty	Normal	2.73	dB
Expanded uncertainty	Normal, k=2	**5.46**	**dB**

3.2.3 MU for Conducted Emissions Measurement

Conducted Measurement 9 kHz - 150 kHz, 50 ohm / 50 uH LISN

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	LISN-receiver attenuation	0.10	dB	Normal, k=2	2.000	0.05	0.00
3	LISN voltage division factor	0.10	dB	Normal, k=2	2.000	0.05	0.00
4	Receiver sinewave accuracy	0.40	dB	Normal, k=2	2.000	0.20	0.04
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
8	AMN VDF frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
9	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00
10	LISN impedance	3.35	dB	Triangular	2.449	1.37	1.87
11	Effect of mains disturbance	0.00	dB			0.00	0.00
12	Effect of the environment						

Combined standard uncertainty	Normal	1.85	dB
Expanded uncertainty	Normal, k=2	**3.71**	**dB**

Conducted Measurement 150 kHz - 30 MHz, 50 ohm / 50 uH LISN

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	LISN-receiver attenuation	0.10	dB	Normal, k=2	2.000	0.05	0.00
3	LISN voltage division factor	0.10	dB	Normal, k=2	2.000	0.05	0.00
4	Receiver sinewave accuracy	0.40	dB	Normal, k=2	2.000	0.20	0.04
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
8	AMN VDF frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
9	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00
10	LISN impedance	2.65	dB	Triangular	2.449	1.08	1.17
11	Effect of mains disturbance	0.00	dB			0.00	0.00
12	Effect of the environment						

Combined standard uncertainty	Normal	1.65	dB
Expanded uncertainty	Normal, k=2	**3.31**	**dB**

3.2.4 Conducted Antenna Port Measurement

Antenna Port Conducted Measurements

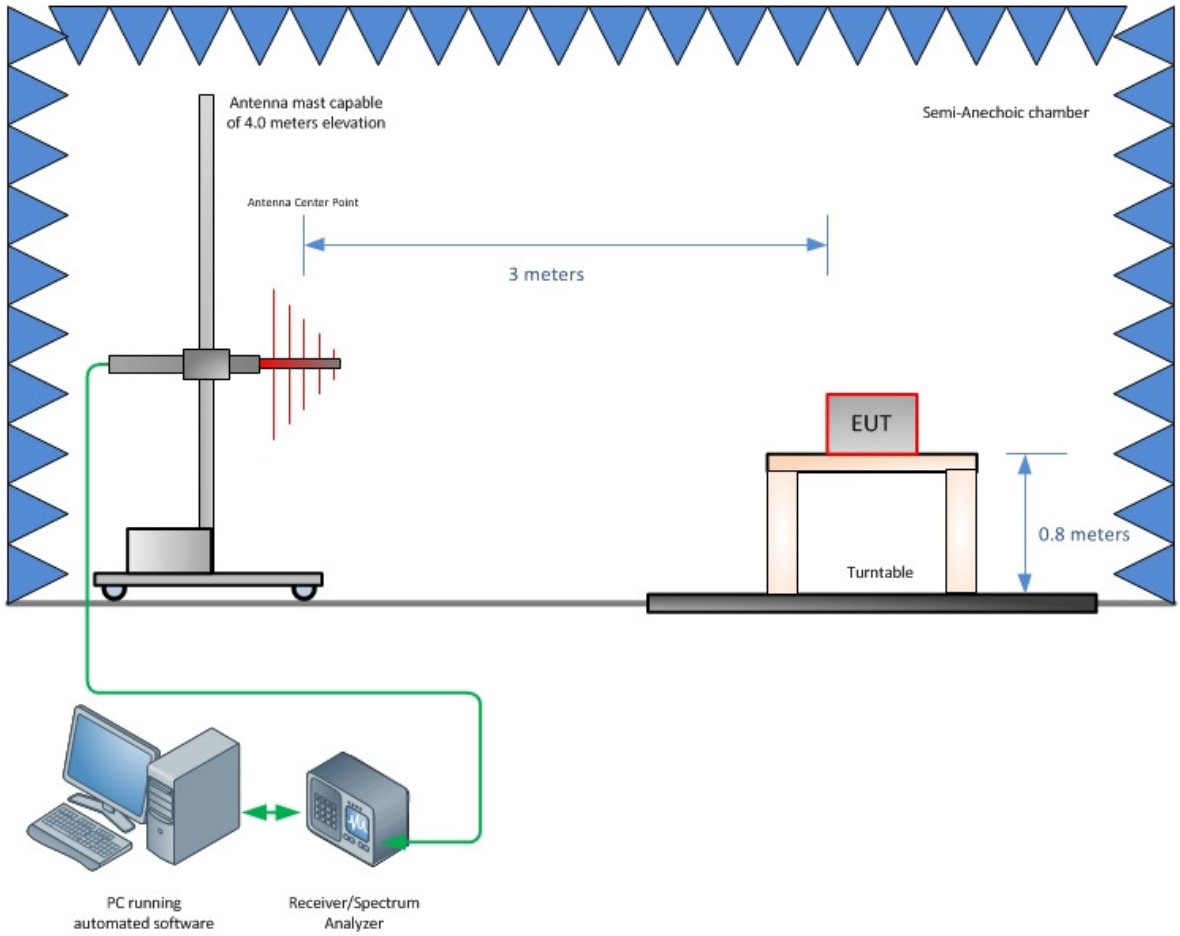
	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Cable attenuation	1.00	dB	Normal, k=2	2.000	0.50	0.25
3	Receiver sinewave accuracy	0.47	dB	Normal, k=2	2.000	0.24	0.06
4	Receiver pulse amplitude	0.00	dB	Rectangular	1.732	0.00	0.00
5	Receiver pulse repetition rate	0.00	dB	Rectangular	1.732	0.00	0.00
6	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
7	Frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
8	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00

Combined standard uncertainty	Normal	0.57	dB
Expanded uncertainty	Normal, k=2	**1.13**	**dB**

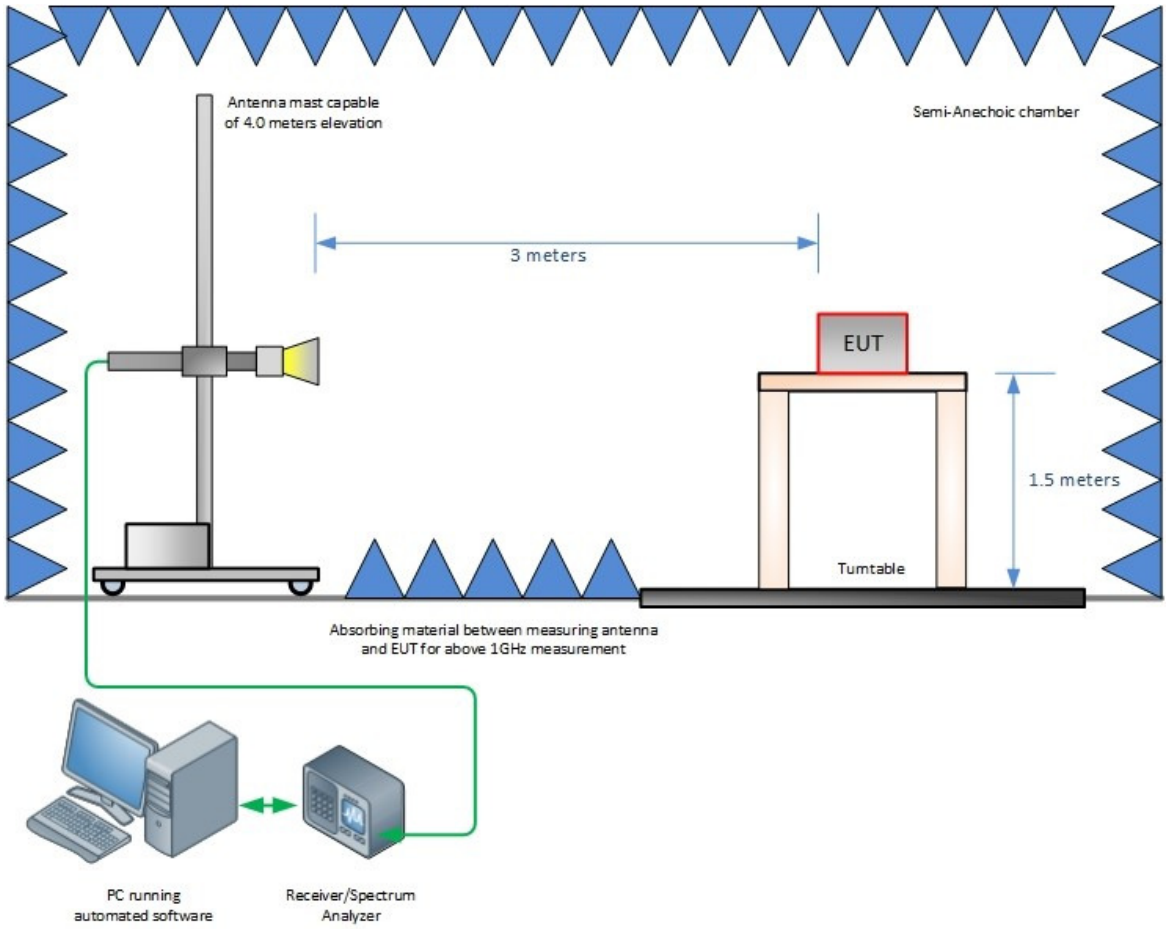
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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