intertek
Total Quality. Assured.

Neurometrix

TEST REPORT

SCOPE OF WORK
EMC TESTING – Quell Nano

REPORT NUMBER
103524448BOX-001

ISSUE DATE
06/18/2018

PAGES
66

DOCUMENT CONTROL NUMBER
Non-Specific Radio Report Shell Rev. December 2017

EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 103524448BOX-001
Project Number: G103524448

Report Issue Date: 06/18/2018

Model(s) Tested: Quell Nano
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: None

Standards: CFR47 FCC Part 15.247 Subpart C: 06/2018,
CFR47 FCC Part 15 Subpart B: 06/2018,
RSS-247 Issue 2 February 2017,
ICES-003 Issue 6 Published: January 2016 Updated: April 2017,
RSS-Gen Issue 5 April 2018,
RSS-102 Issue 5 March 2015

Tested by:
Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Neurometrix
62 Fourth Avenue
Waltham, MA 02451
USA

Report prepared by Vathana Ven

Vathana Ven / EMC Staff Engineer

Report reviewed by Kouma Sinn

Kouma Sinn / EMC Staff Engineer

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Maximum Peak Output Power and Human RF exposure CFR47 FCC Part 15 Subpart C:06/2018, Section 15.247 (b)(3) RSS-247 Issue 2 February 2017, RSS-102 Issue 5 March 2015	Pass
7	6 dB Bandwidth and Occupied Bandwidth CFR47 FCC Part 15 Subpart C: 06/2018, Section 15.247 (a)(2) RSS-247 Issue 2 February 2017	Pass
8	Maximum Power Spectral Density CFR47 FCC Part 15 Subpart C: 02/2018, Section 15.247 (e) RSS-247 Issue 2 February 2017	Pass
9	Band Edge Compliance CFR47 FCC Part 15 Subpart C: 06/2018, Section 15.247 (d) RSS-247 Issue 2: 02/2017)	Pass
10	Transmitter spurious emissions CFR47 FCC Part 15 Subpart C: 02/2018, Section 15.247 (d) RSS-247 Issue 2 February 2017	Pass
11	Digital Device and Receiver Radiated Spurious Emissions (CFR47 FCC Part 15 Subpart B 15.109: 06/2018, ICES-003 Issue 6 Published: January 2016 Updated: April 2017	Pass
--	AC Mains Conducted Emissions FCC 47CFR Part 15.107: 06/2018 ICES-003 Issue 6 Published: January 2016 Updated: April 2017	N/A*
12	Revision History	--

Notes: Not applicable as the EUT powers from internal battery with no connection to AC mains.

3 Client Information

This EUT was tested at the request of:

Client: Neurometrix
62 Fourth Avenue
Waltham, MA 02451
USA

Contact: Mr. Rainer Maas
Telephone: (781) 890-9989 Ex. 2781
Fax: None
Email: rainer_maas@neurometrix.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Neurometrix
62 Fourth Avenue
Waltham, MA 02451
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Neuro Simulator For Pain Management	Neurometrix	Quell Nano	NANOX4 38 (Used for emission and ESD in Receive Mode testing
Neuro Simulator For Pain Management	Neurometrix	Quell Nano	NANOX4 35 (Used for ESD testing in RF Link Mode)
Neuro Simulator For Pain Management	Neurometrix	Quell Nano	NANOX4 54 (Used for antenna port conducted testing)
Neuro Simulator For Pain Management	Neurometrix	Quell Nano	NANOX3 54 (Receiver Blocking)

Notes: Multiple samples were used for testing at Low, Mid, High, transmitting channels and receiving channel.

Receive Date:	06/07/2018
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
The equipment under test is a Neuro Simulator For Pain Management.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
Lithium Ion Single Cell (3.3-4.2 VDC)	N/A	N/A	N/A

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmit Mode: Low, Mid, and High channels
2	Receive Only_2402MHz

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Pre-programmed using Hyper Terminal

Radio/Receiver Characteristics	
Frequency Band(s)	2402-2480 MHz
Modulation Type(s)	FSK
Maximum Output Power	Low Channel (2402 MHz): -9.57 dBm Mid Channel (2440 MHz): -9.41 dBm High Channel (2480 MHz): -9.36 dBm
Test Channels	Low Channel (2402 MHz) Mid Channel (2440 MHz) High Channel (2480 MHz)
Occupied Bandwidth	Low Channel (2402 MHz): 1.886 MHz Mid Channel (2440 MHz): 1.908 MHz High Channel (2480 MHz): 1.874 MHz
Frequency Hopper: Number of Hopping Channels	N/A
Frequency Hopper: Channel Dwell Time	N/A
Frequency Hopper: Max interval between two instances of use of the same channel	N/A
MIMO Information (# of Transmit and Receive antenna ports)	1
Equipment Type	Standalone
ETSI LBT/Adaptivity	Non-Adaptive
ETSI Adaptivity Type	N/A
ETSI Temperature Category (I, II, III)	N/A
ETSI Receiver Category (1, 2, 3)	3
Antenna Type and Gain	Integrated, -0.1 dBi

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

None

5 System Setup and Method

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
--	None	--	--	--	--

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Demo Board	Nordic	PCA10040	Not Labelled
USB Charger (0.9m cable)	Not labeled	Not labeled	Not labeled
Laptop	Lenovo	ThinkPad	R8-FPB36 09/08

5.1 Method:

Configuration as required by Configuration as required by FCC Part 15 Subpart C 15.247: 02/2018, FCC Part 15 Subpart B: 02/2018, RSS 247 Issue 2: 02/2017, ICES 003 Issue 6: 01/2016 updated 06/2016, ANSI C 63.10: 2013 and ANSI C 63.4: 2014.

5.2 EUT Block Diagram:

6 Maximum Peak Output Power and Human RF exposure

6.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, RSS-102, and ANSI C63.10.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	11/17/2017	11/17/2018
MEG002'	Cable,SMA-SMA,9KHz-40GHz, (Cable Kit 6)	Megaphase	TM40-K1K1-197	59006401001	09/05/2017	09/05/2018

Software Utilized:

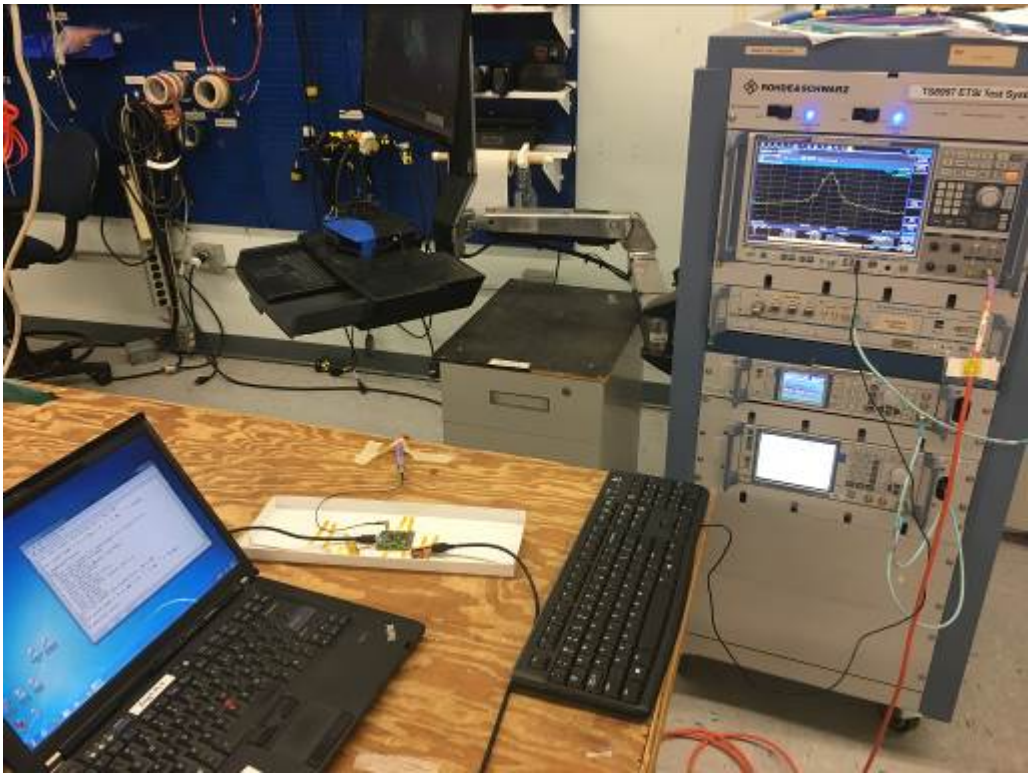
Name	Manufacturer	Version
None	--	--

6.3 Results:

The sample tested was found to Comply.

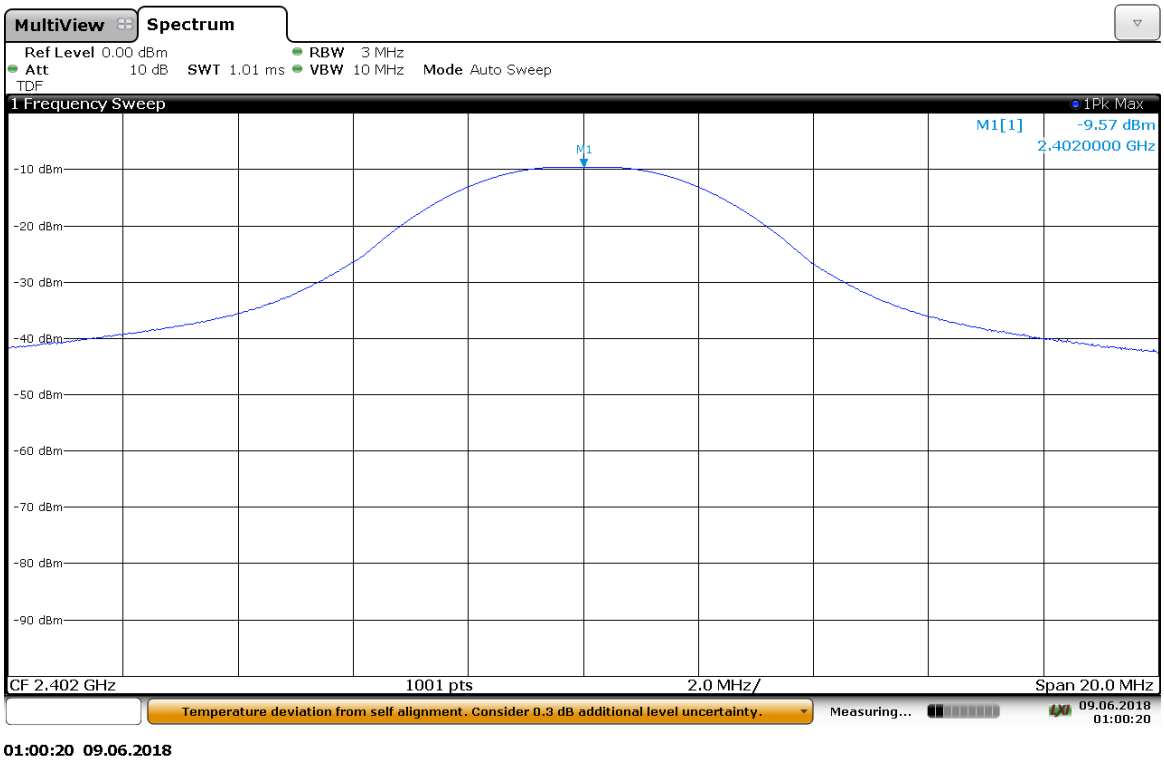
§15.247 (b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt or 30 dBm.

6.4 Setup Photograph:



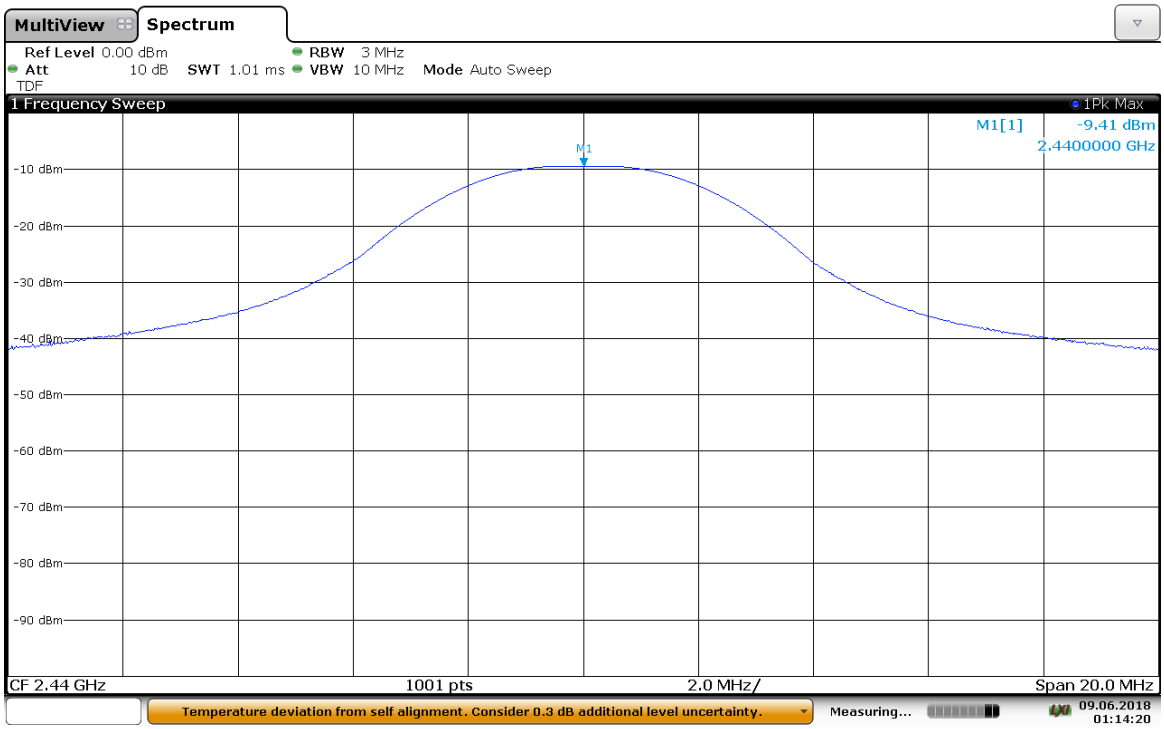
6.5 Plots/Data:

Low Channel Antenna Port Conducted Power, -9.57 dBm



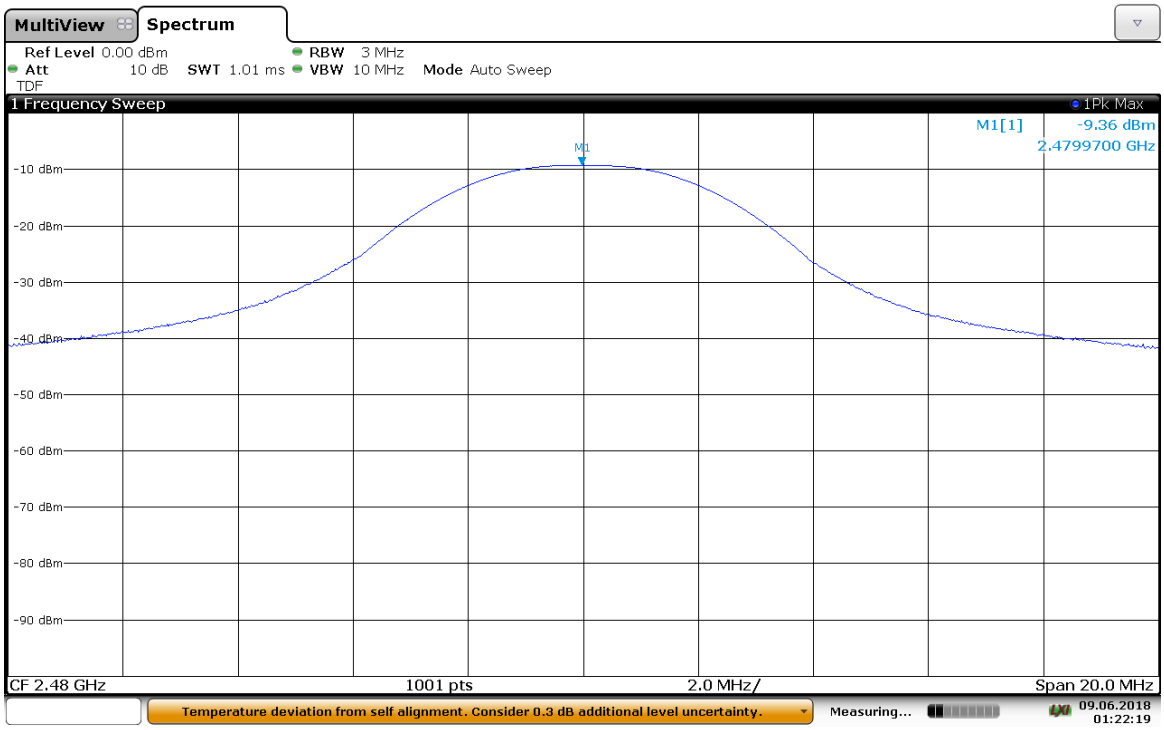
01:00:20 09.06.2018

Mid Channel Antenna Port Conducted Power, -9.41 dBm



01:14:20 09.06.2018

High Channel Antenna Port Conducted Power, -9.36 dBm



01:22:20 09.06.2018

SAR Exemption Calculation

Maximum Conducted Output Power of Transmitter = -9.36dBm = 0.12 mW

FCC SAR Exemption per KDB 447498

a) For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:

[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,[30] where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz

= (0.12/5)*(sqrt(2.480))

= 0.04 < 3.0 (below the limit SAR Exempt per FCC)

RSS 102 SAR Exemption

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

The conducted output power of the transmitter 0.12 mW @ 2480 MHz is less than 2 mW limit specified at 3500 MHz, device meets SAR exclusion.

Test Personnel:	Vathana Ven VSV	Test Date:	06/09/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247, RSS-102	Limit Applied:	See report section 6.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	24 ºC
		Relative Humidity:	48 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

7 6 dB Bandwidth and Occupied Bandwidth

7.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, RSS-102, and ANSI C63.10.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	11/17/2017	11/17/2018
MEG002'	Cable,SMA-SMA,9KHz-40GHz, (Cable Kit 6)	Megaphase	TM40-K1K1-197	59006401001	09/05/2017	09/05/2018

Software Utilized:

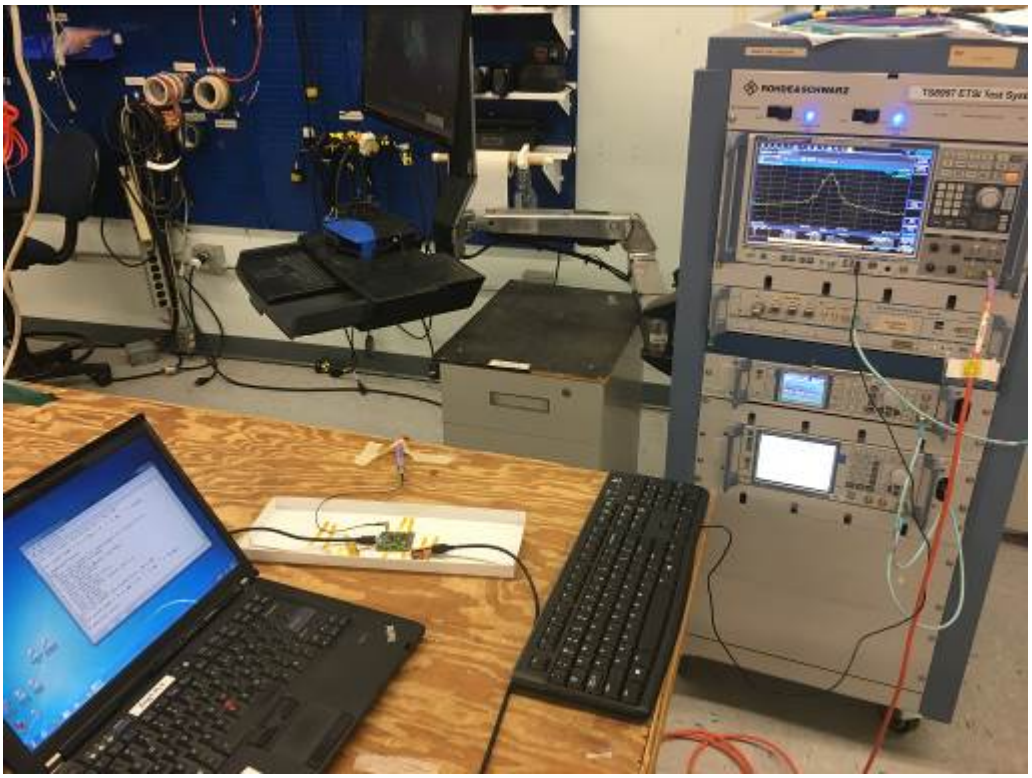
Name	Manufacturer	Version
None	--	--

7.3 Results:

The sample tested was found to Comply.

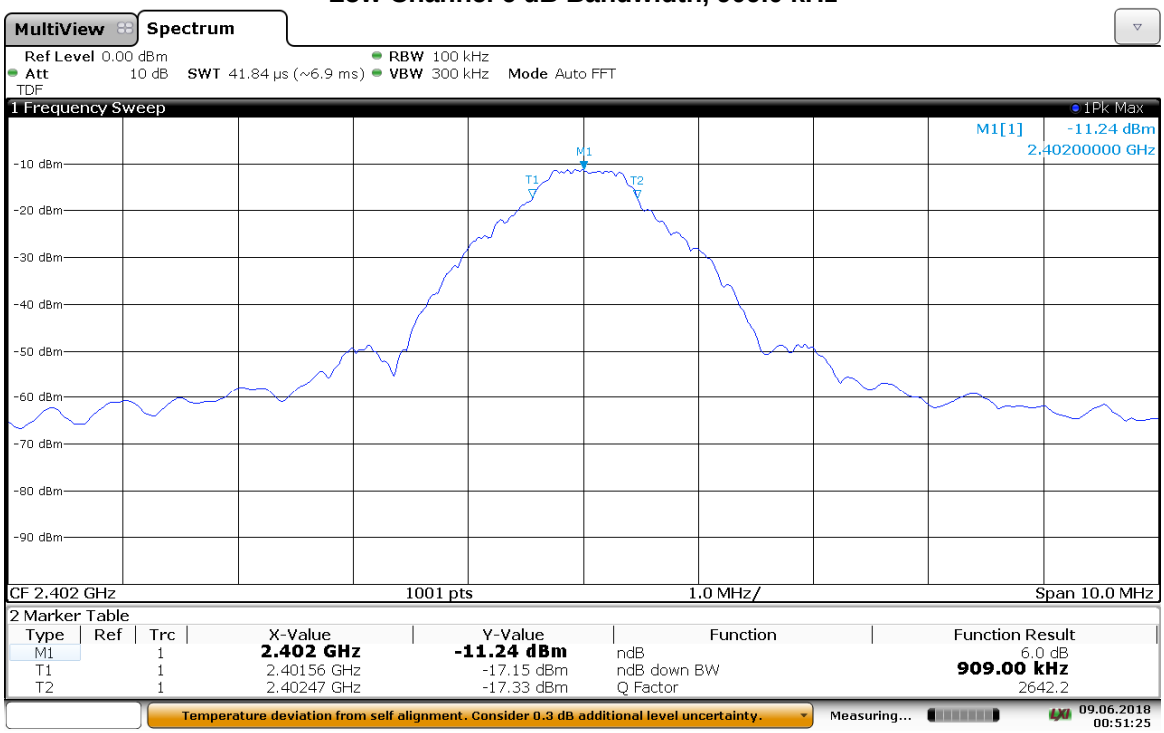
§15.247 (a) (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

7.4 Setup Photograph:



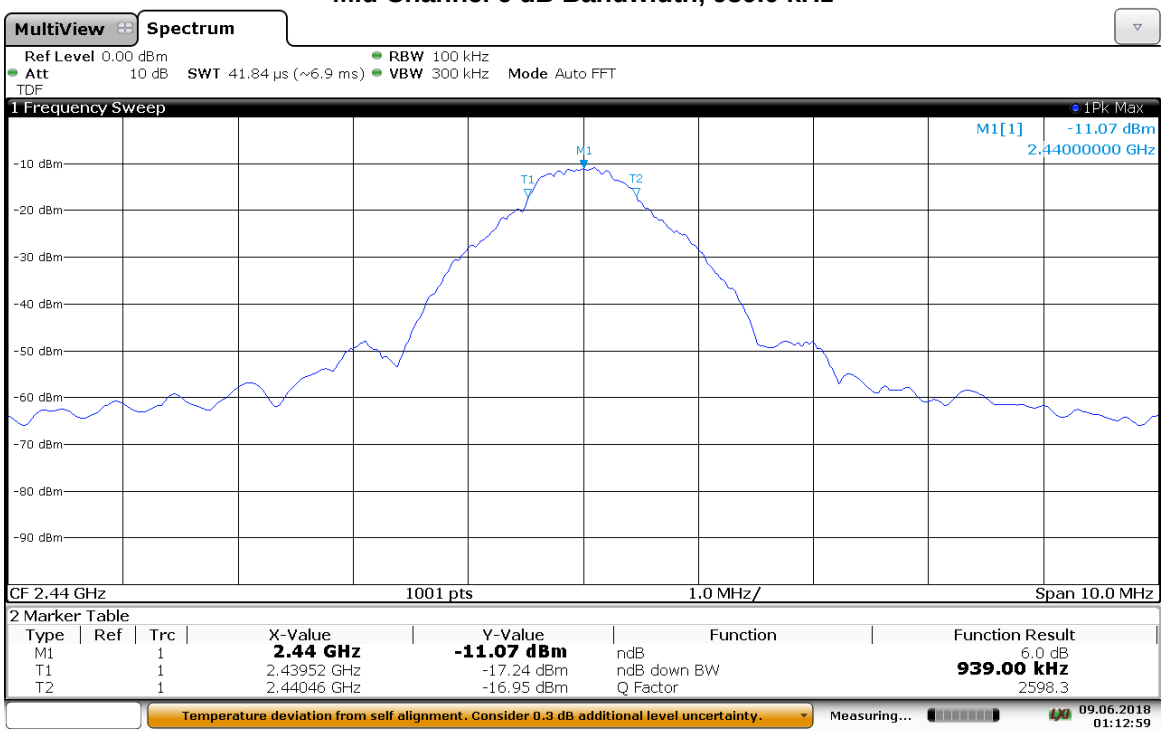
7.5 Plots/Data:

Low Channel 6 dB Bandwidth, 909.0 kHz



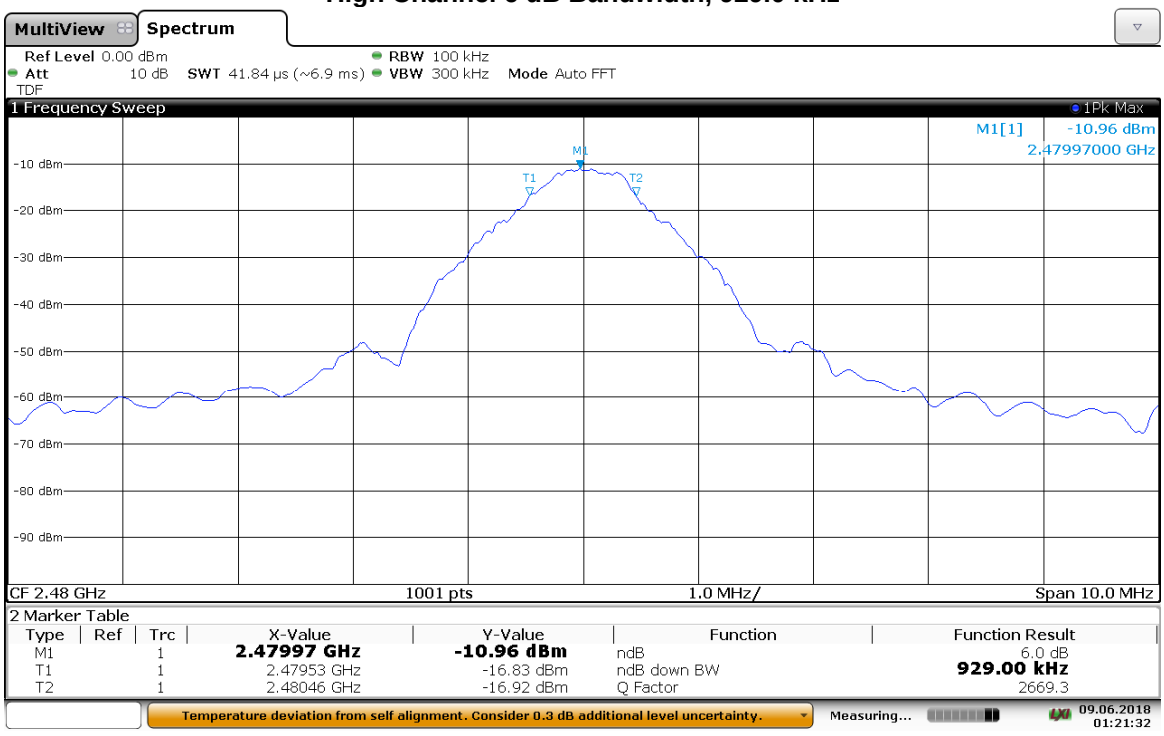
00:51:25 09.06.2018

Mid Channel 6 dB Bandwidth, 939.0 kHz



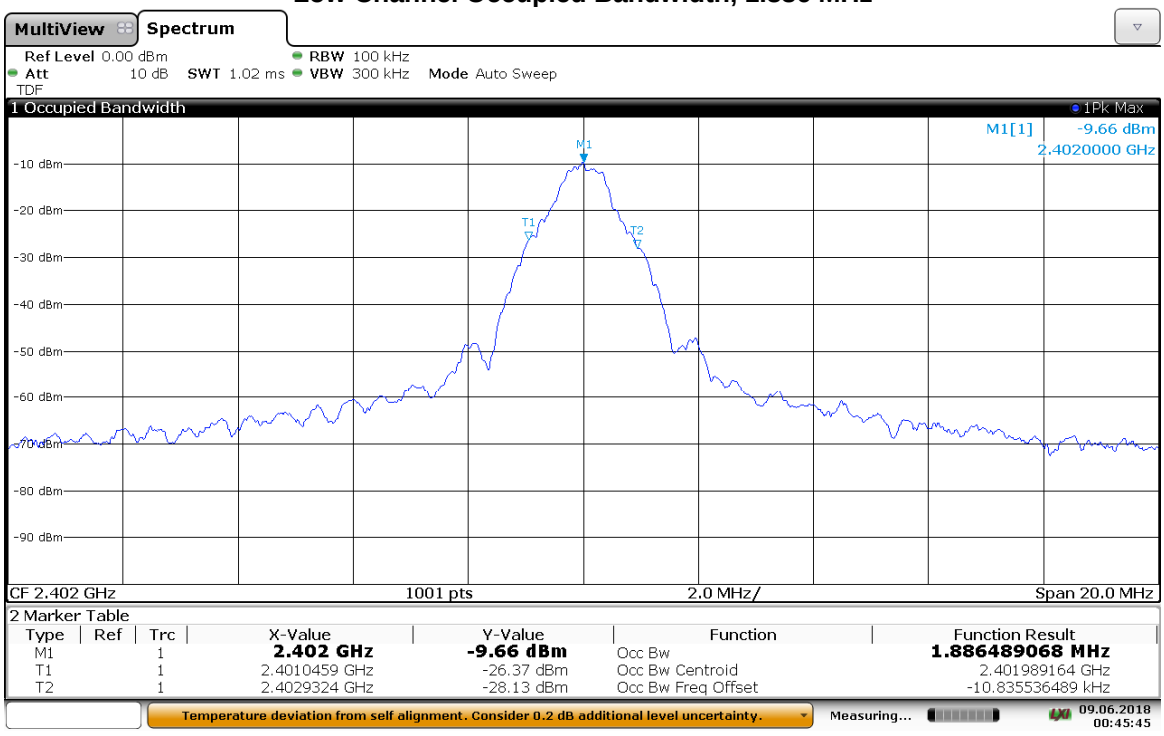
01:13:00 09.06.2018

High Channel 6 dB Bandwidth, 929.0 kHz



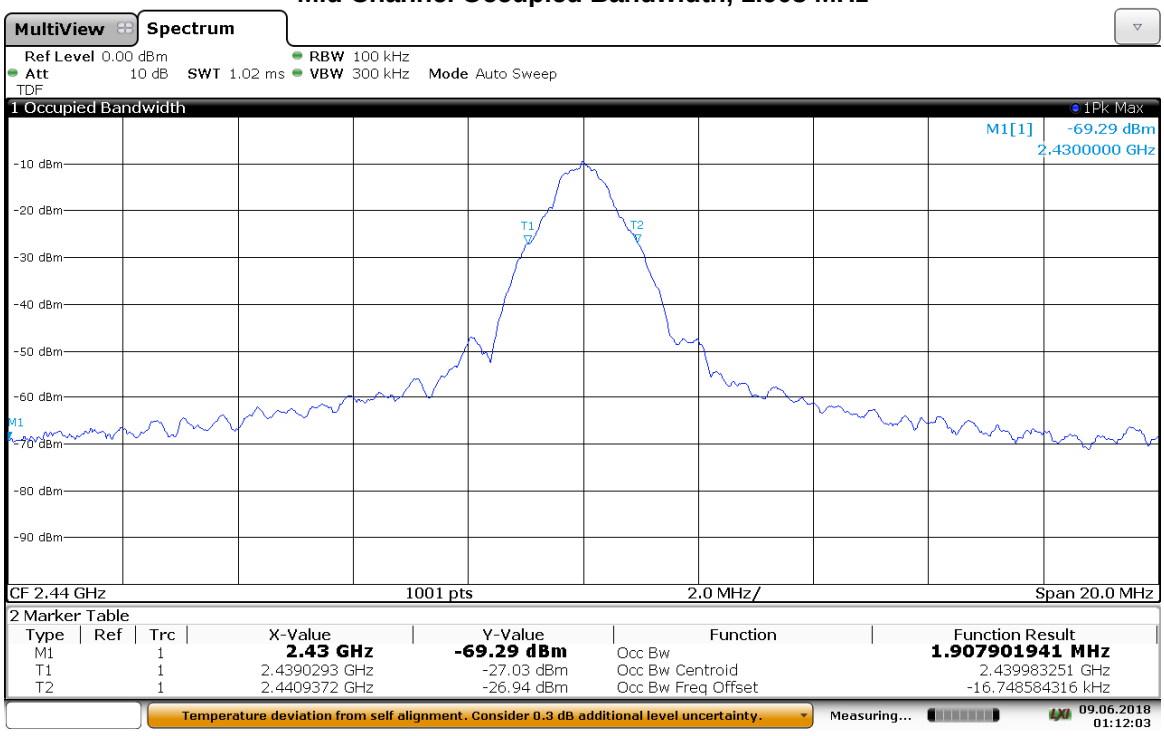
01:21:33 09.06.2018

Low Channel Occupied Bandwidth, 1.886 MHz



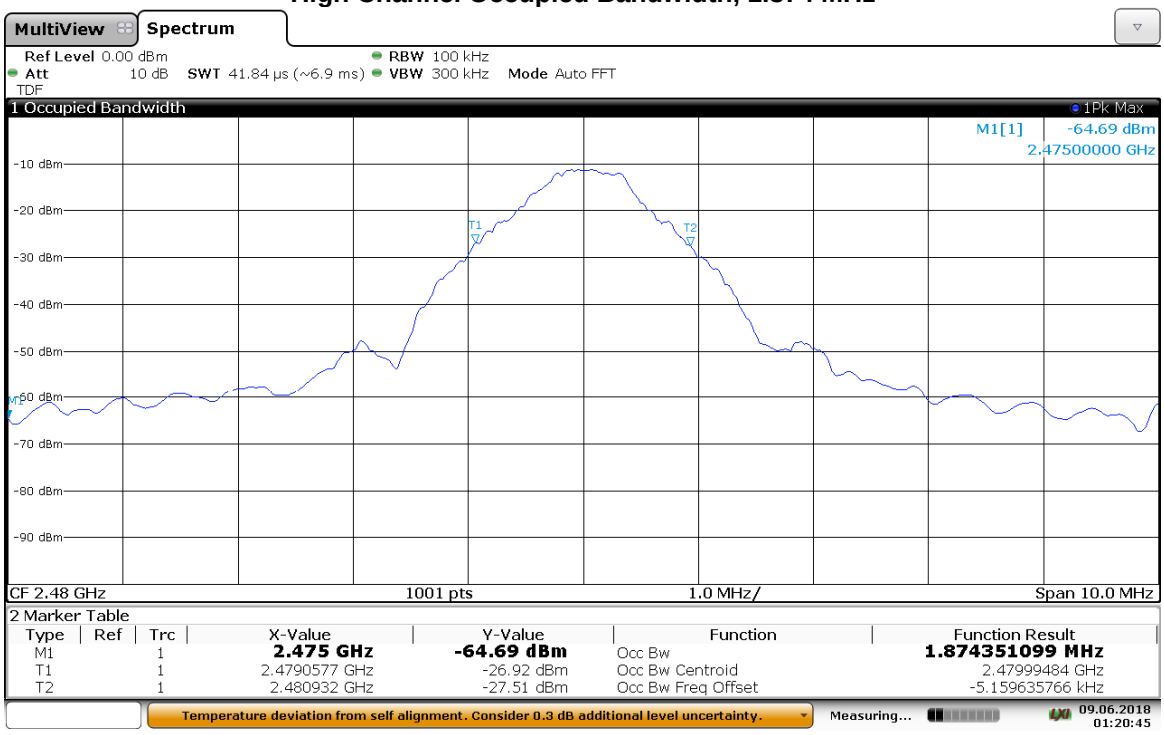
00:45:46 09.06.2018

Mid Channel Occupied Bandwidth, 1.908 MHz



01:12:03 09.06.2018

High Channel Occupied Bandwidth, 1.874 MHz



01:20:46 09.06.2018

Test Personnel:	Vathana Ven VSV	Test Date:	06/09/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 7.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	24 ºC
		Relative Humidity:	48 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

8 Maximum Power Spectral Density

8.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, RSS-102, and ANSI C63.10.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	11/17/2017	11/17/2018
MEG002'	Cable,SMA-SMA,9KHz-40GHz, (Cable Kit 6)	Megaphase	TM40-K1K1-197	59006401001	09/05/2017	09/05/2018

Software Utilized:

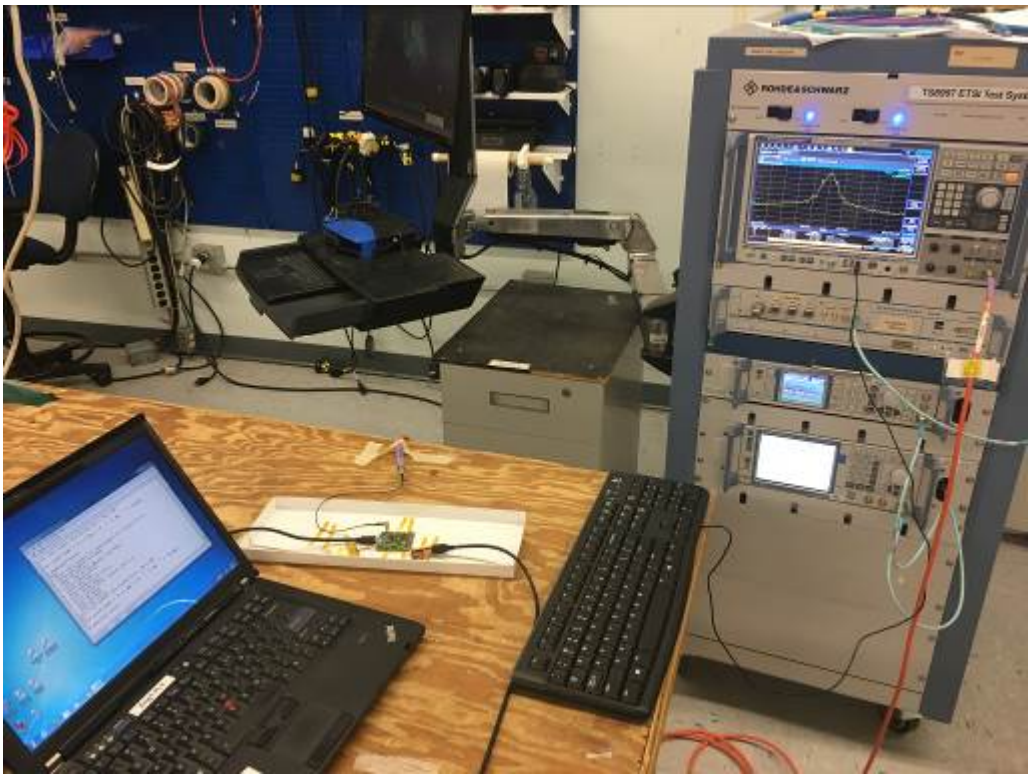
Name	Manufacturer	Version
None		

8.3 Results:

The sample tested was found to Comply with 100 kHz RBW.

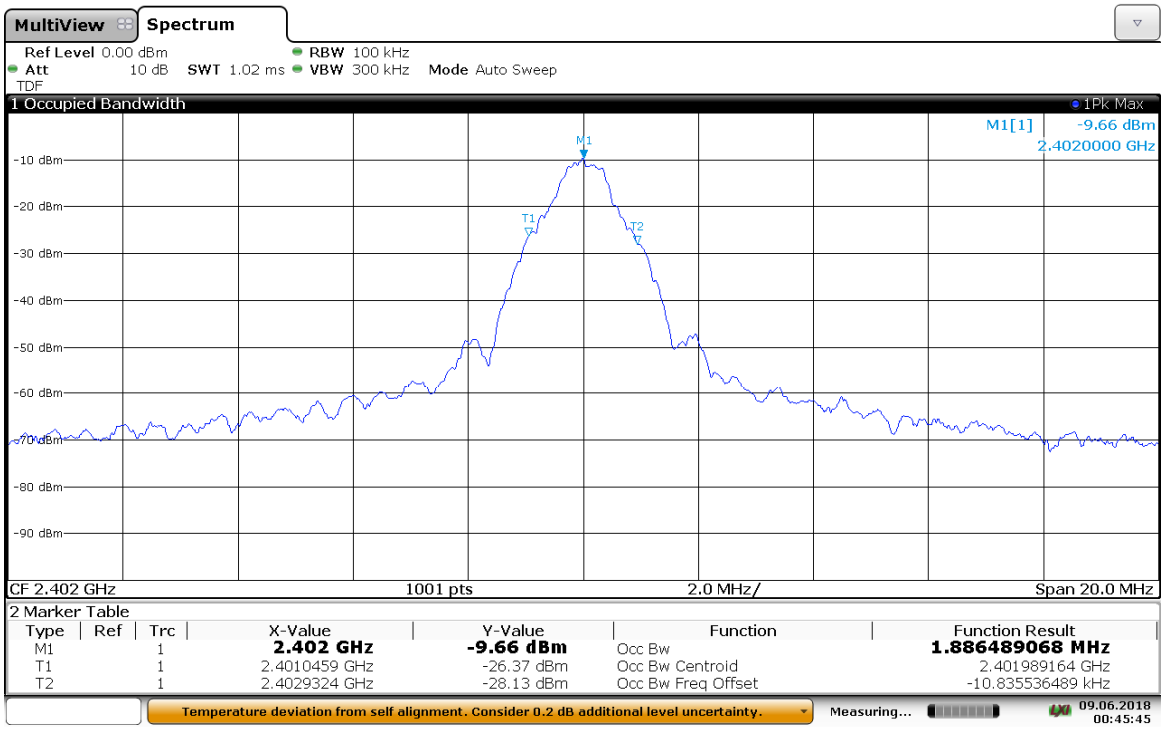
§15.247 (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.4 Setup Photograph:



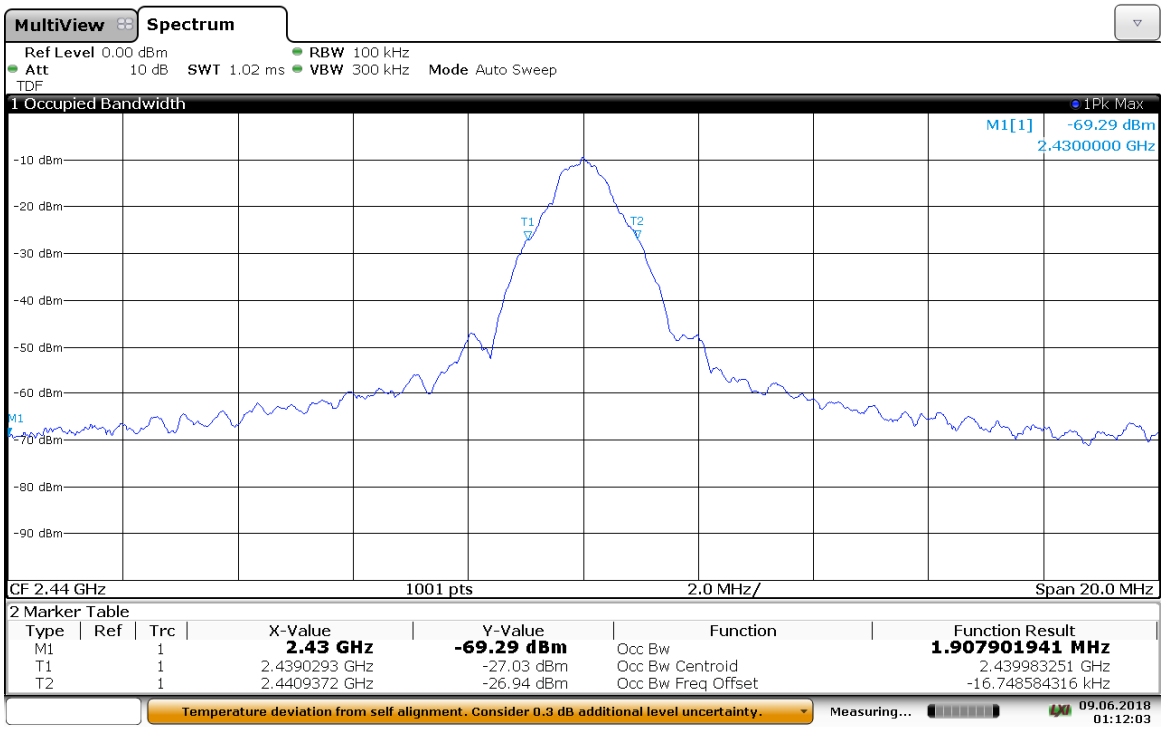
8.5 Plots/Data:

Low Channel Power Spectral Density, -9.66 dBm



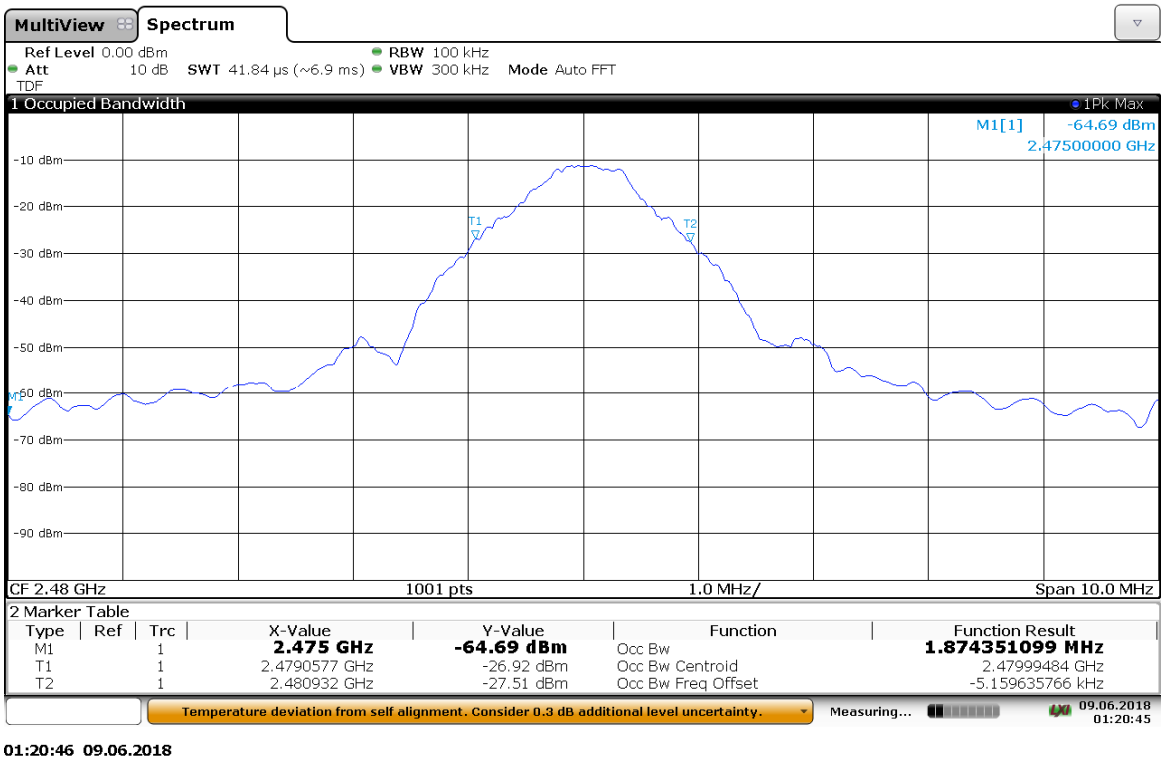
00:45:46 09.06.2018

Mid Channel Power Spectral Density, -9.41 dBm



01:12:03 09.06.2018

High Channel Power Spectral Density, -9.36 dBm



Test Personnel:	Vathana Ven	Test Date:	06/09/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 8.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	24 ºC
		Relative Humidity:	48 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

9 Band Edge Compliance

9.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247 RSS 247, ANSI C 63.10, and ANSI C 63.4.

TEST SITE: EMC Lab & 10m ALSE

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/22/2018	03/22/2019
ETS005'	1-18GHz horn antenna	ETS-Lindgren	3117	00218279	05/14/2018	05/14/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2017	07/25/2018

Software Utilized:

Name	Manufacturer	Version
None	--	--

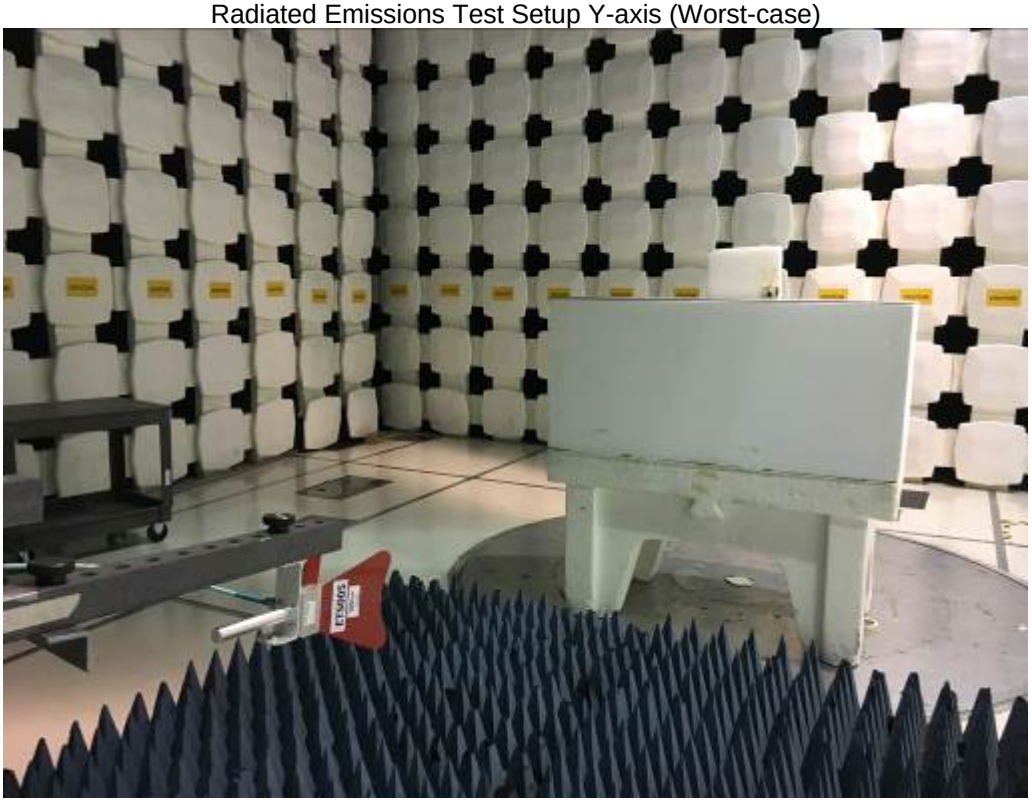
9.3 Results:

The sample tested was found to Comply.

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. 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))

9.4 Setup Photographs:

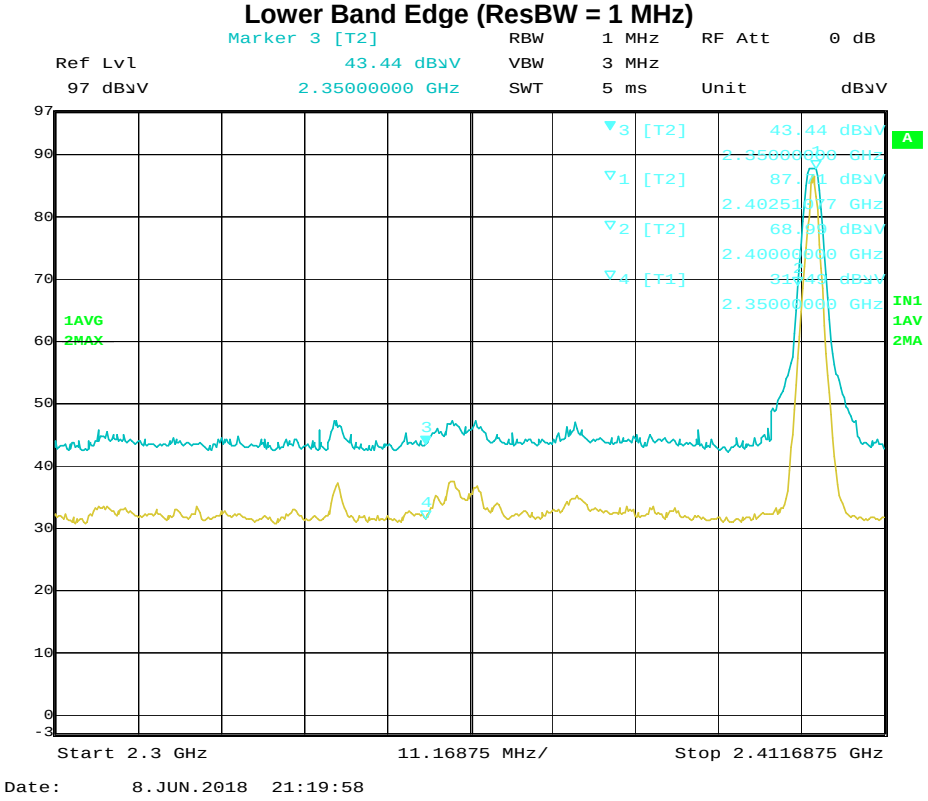
Radiated Emissions Test Setup Y-axis (Worst-case)



Radiated Emissions Test Setup Y-axis (Worst-case)

9.5 Plots/Data:

Lower Band Edge (ResBW = 1 MHz)



Radiated Emissions

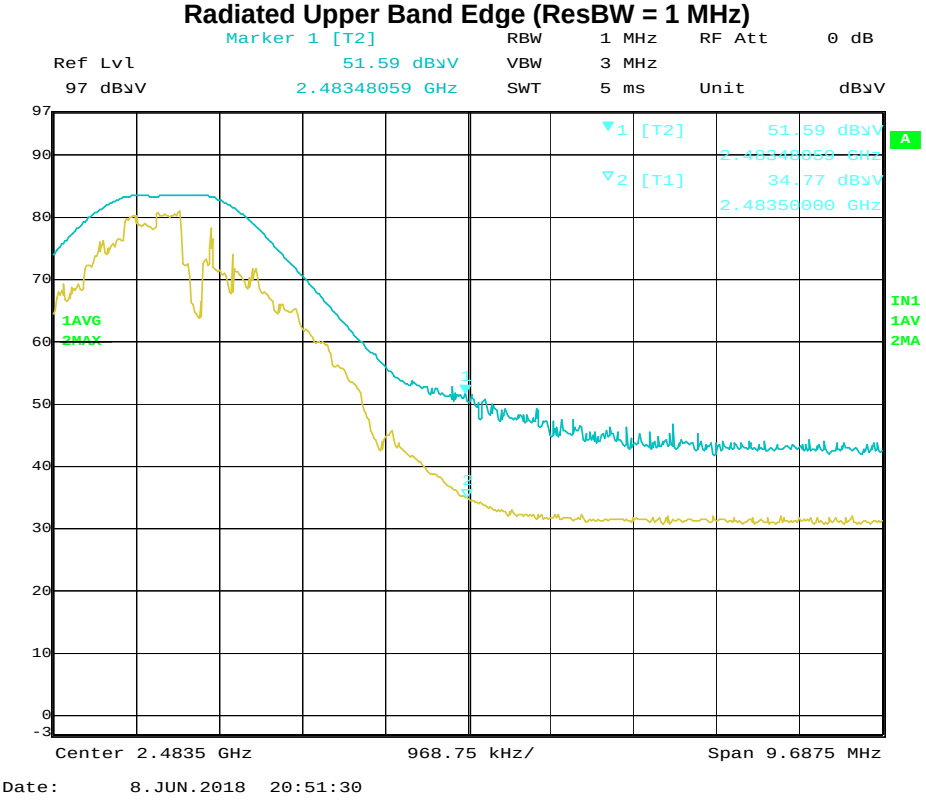
Company: Neurometrix
Model #: Quell Nano
Serial #: NANOX4 38
Engineers: Vathana Ven
Project #: G103524448
Standard: 15.247/RSS-247
Receiver: R&S ESI (145-128) 10-01-2014
PreAmp: 145020__08-25-2018.txt
Location: 10M
Date(s): 06/08/18
Limit Distance (m): 3
Test Distance (m): 3
Antenna & Cables: HF
Bands: N, LF, HF, SHF
Antenna: ETS005_Vertical_5-14-2019.txt ETS005_Horizontal_5-14-2019.txt
Cable(s): 145-416__7-25-18.txt NONE.
Barometer: DAV002
Filter: NONE
Temp/Humidity/Pressure: 24 deg C 48% 1007 mB
PreAmp Used? (Y or N): Y
Voltage/Frequency: Battery power
Frequency Range: Specific frequencies

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
Lower Band Edge, X-Axis													
PK	H	2350.000	43.44	32.19	6.51	38.03	0.00	44.11	74.00	-29.89	1/3 MHz	RB	RB
AVG	H	2350.000	32.50	32.19	6.51	38.03	0.00	33.17	54.00	-20.83	1/3 MHz	RB	RB
Lower Band Edge, Y-Axis													
PK	H	2350.000	43.51	32.19	6.51	38.03	0.00	44.18	74.00	-29.82	1/3 MHz	RB	RB
AVG	H	2350.000	32.80	32.19	6.51	38.03	0.00	33.47	54.00	-20.53	1/3 MHz	RB	RB
Lower Band Edge, Z-Axis													
PK	V	2350.000	42.34	32.49	6.51	38.03	0.00	43.31	74.00	-30.69	1/3 MHz	RB	RB
AVG	V	2350.000	33.50	32.49	6.51	38.03	0.00	34.47	54.00	-19.53	1/3 MHz	RB	RB

Radiated Upper Band Edge (ResBW = 1 MHz)



Radiated Emissions

Company: Neurometrix
Model #: Quell Nano
Serial #: NANOX4 38
Engineers: Vathana Ven
Project #: G103524448
Standard: 15.247/RSS-247
Receiver: R&S ESI (145-128) 10-01-2014
PreAmp: 145020__08-25-2018.txt
Date(s): 06/08/18
Location: 10M
Limit Distance (m): 3
Test Distance (m): 3
PreAmp Used? (Y or N): Y
Voltage/Frequency: Battery power
Antenna & Cables: HF Bands: N, LF, HF, SHF
Antenna: ETS005_Vertical_5-14-2019.txt ETS005_Horizontal_5-14-2019.txt
Cable(s): 145-416__7-25-18.txt NONE.
Barometer: DAV002 Filter: NONE
Temp/Humidity/Pressure: 24 deg C 48% 1007 mB
Frequency Range: Specific frequencies

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
Upper Band Edge, X-Axis													
PK	H	2483.500	49.53	32.27	6.44	37.98	0.00	50.26	74.00	-23.74	1/3 MHz	RB	
AVG	H	2483.500	35.10	32.27	6.44	37.98	0.00	35.83	54.00	-18.17	1/3 MHz	RB	
Upper Band Edge, Y-Axis													
PK	V	2483.500	49.53	32.77	6.44	37.98	0.00	50.76	74.00	-23.24	1/3 MHz	RB	
AVG	V	2483.500	34.70	32.77	6.44	37.98	0.00	35.93	54.00	-18.07	1/3 MHz	RB	
Upper Band Edge, Z-Axis													
PK	V	2483.500	48.50	32.77	6.44	37.98	0.00	49.73	74.00	-24.27	1/3 MHz	RB	
AVG	V	2483.500	34.30	32.77	6.44	37.98	0.00	35.53	54.00	-18.47	1/3 MHz	RB	

Test Personnel:	Vathana Ven VSV	Test Date:	06/08/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 9.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	24 ºC
		Relative Humidity:	48 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

10 Transmitter spurious emissions

10.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247, FCC Part 15 Subpart B, RSS 247 ICES 003, ANSI C 63.10, and ANSI C 63.4.

TEST SITE: EMC Lab & 10m ALSE

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

10.2 Test Equipment Used:

Test equipment used for radiated measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/22/2018	03/22/2019
ETS005'	1-18GHz horn antenna	ETS-Lindgren	3117	00218279	05/14/2018	05/14/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2017	07/25/2018
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/16/2018	05/16/2019
PRE11'	50dB gain pre-amp	Keith H	PRE11	PRE11	12/02/2017	12/02/2018
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/25/2017	07/25/2018
145020'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00948	08/25/2017	08/25/2018

Name	Manufacturer	Version
BAT-EMC Emissions	Nexio	3.16.0.69

Test equipment used for conducted measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	11/17/2017	11/17/2018
MEG002'	Cable,SMA-SMA,9KHz-40GHz, (Cable Kit 6)	Megaphase	TM40-K1K1-197	59006401001	09/05/2017	09/05/2018

Software Utilized:

Name	Manufacturer	Version
None		

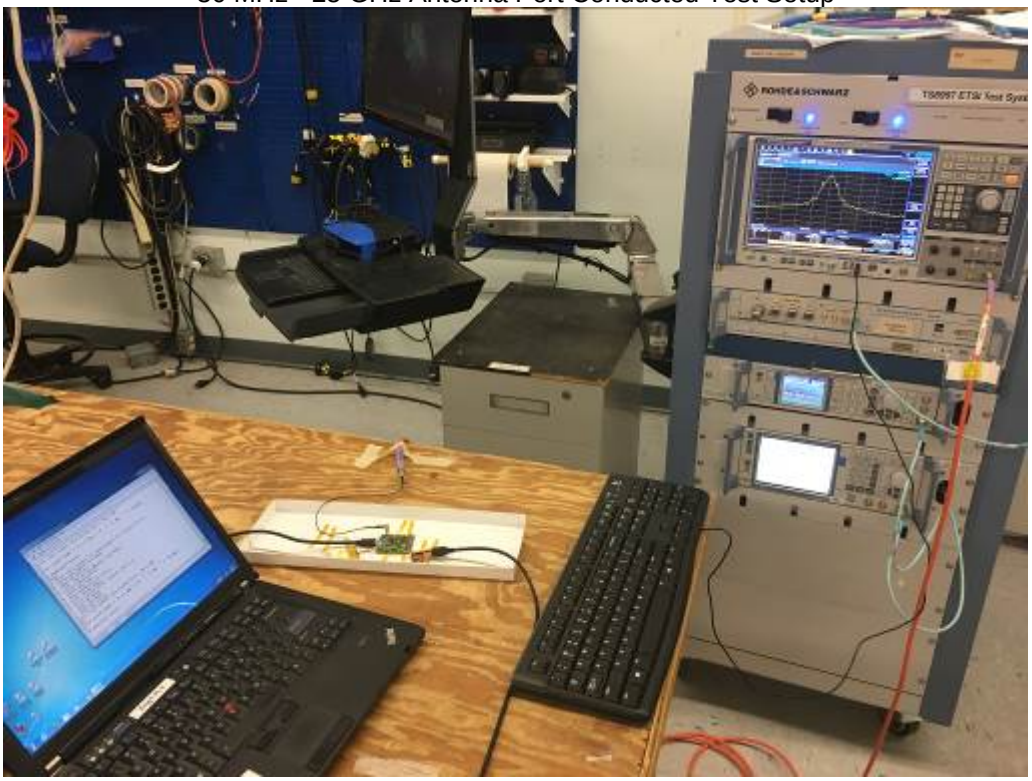
10.3 Results:

The sample tested was found to Comply.

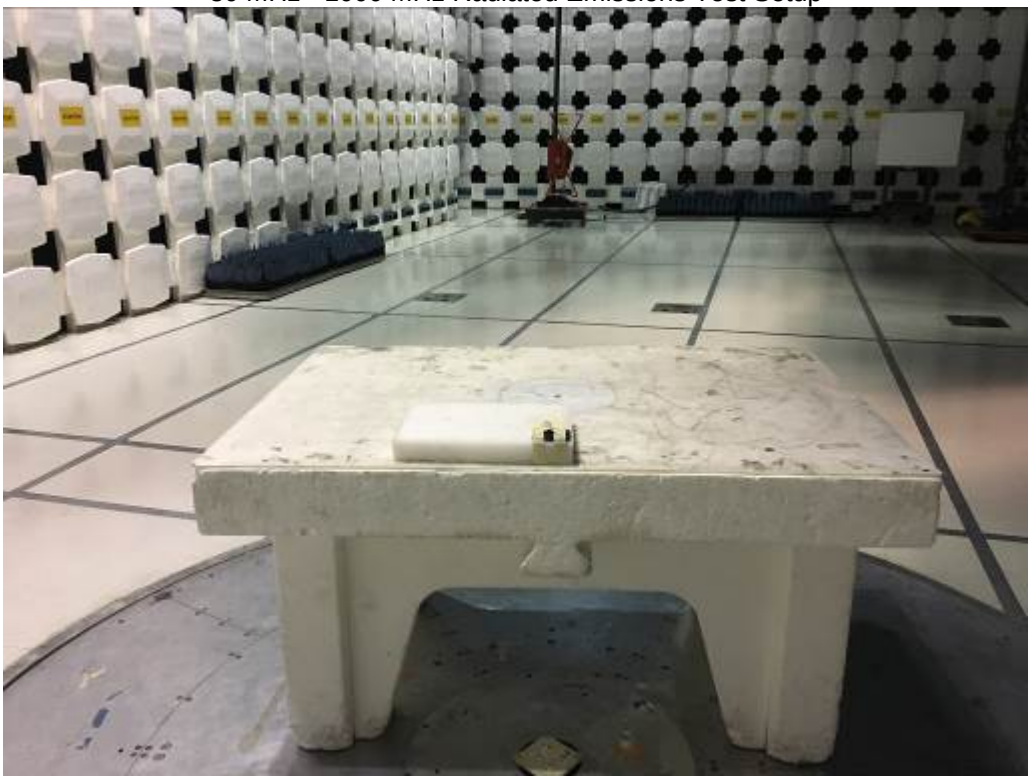
15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that 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. 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))

10.4 Setup Photographs:

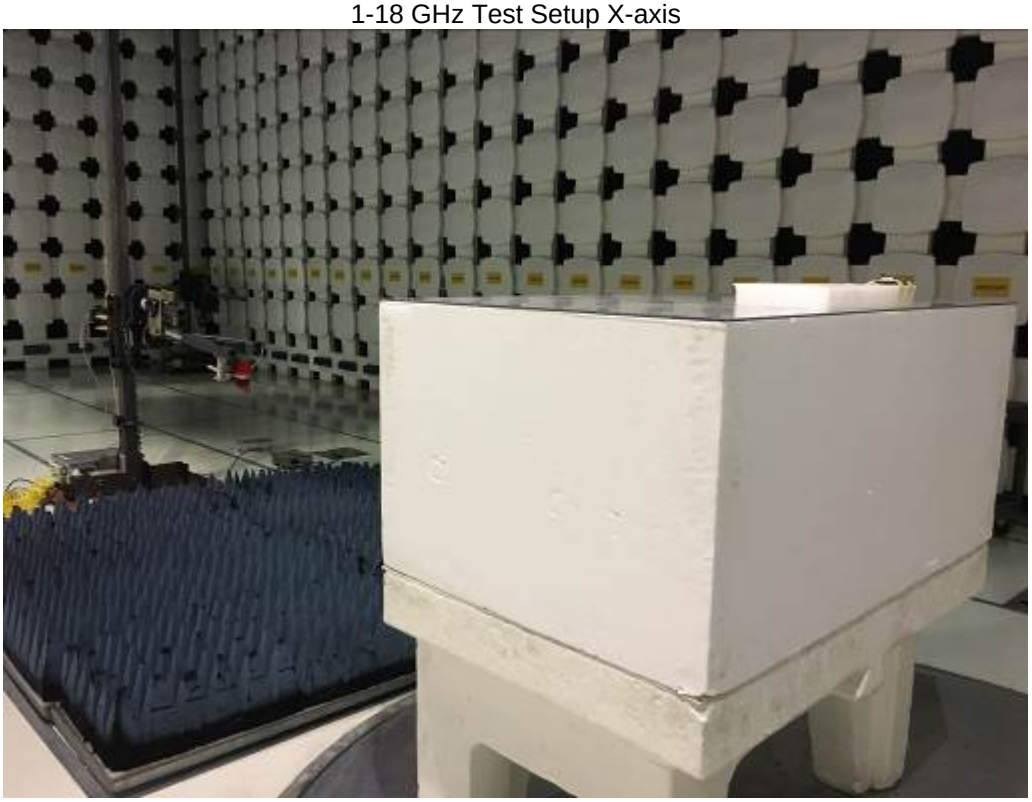
30 MHz - 25 GHz Antenna Port Conducted Test Setup

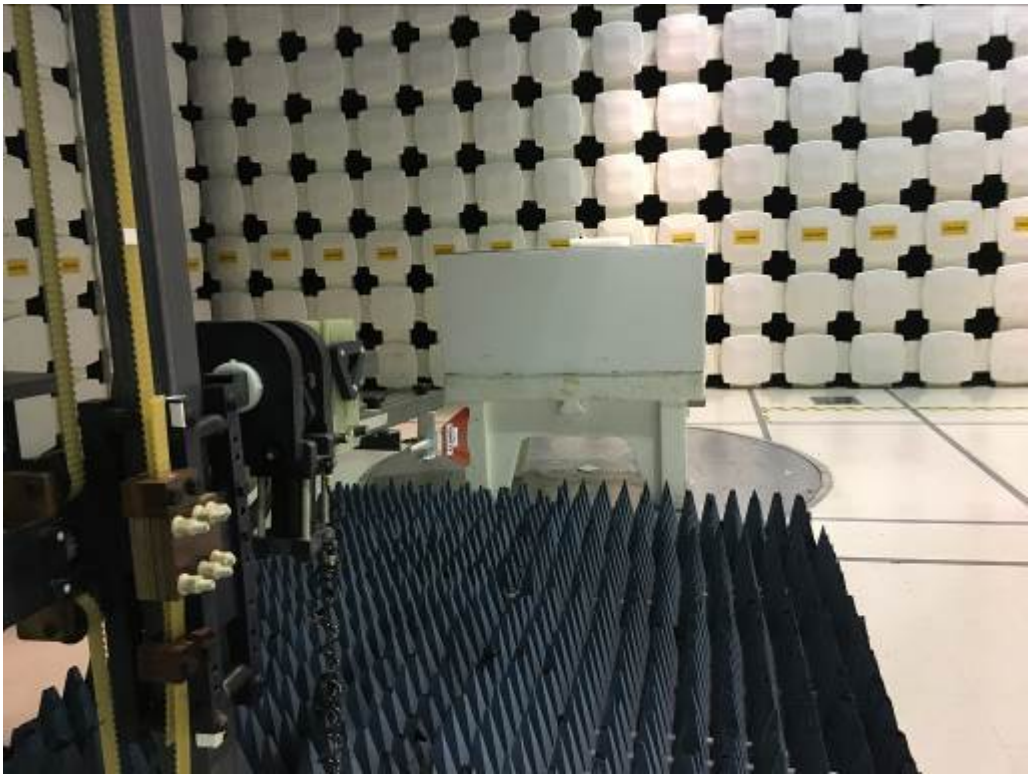


30 MHz - 1000 MHz Radiated Emissions Test Setup

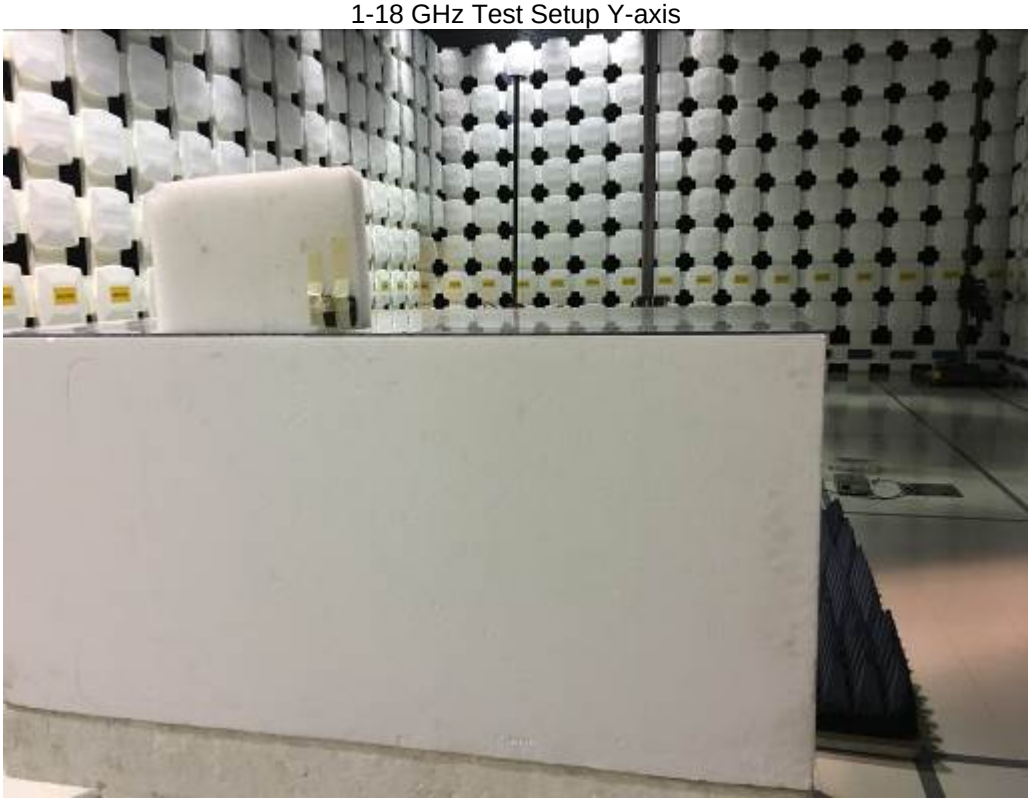


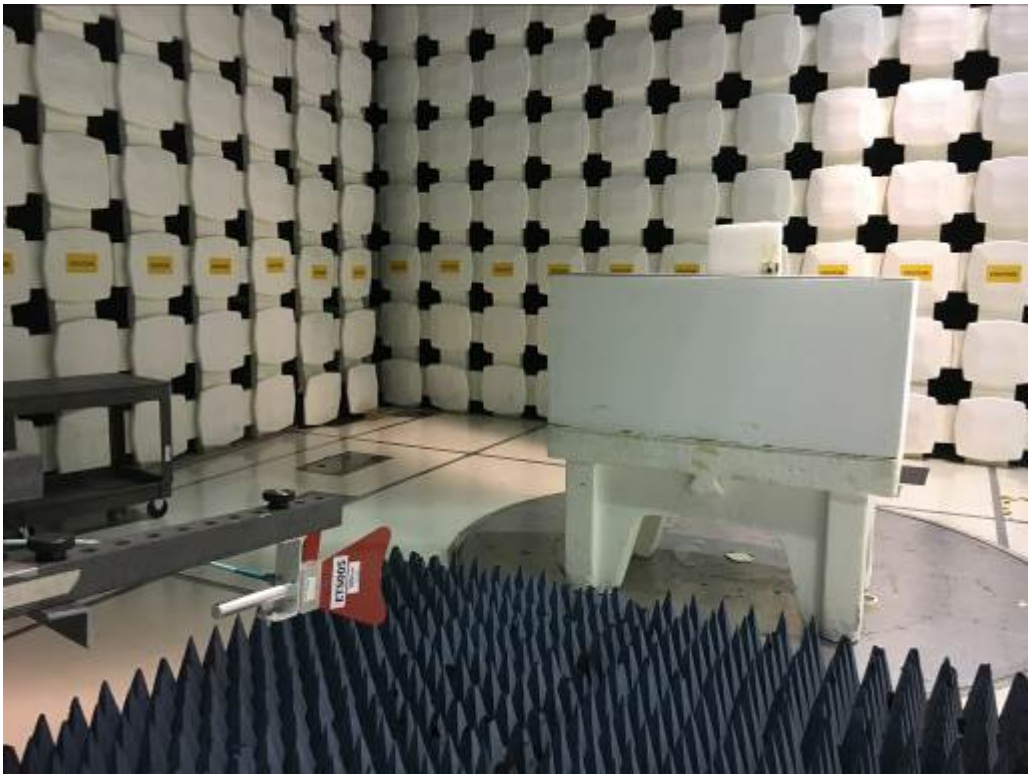
1-18 GHz Test Setup X-axis



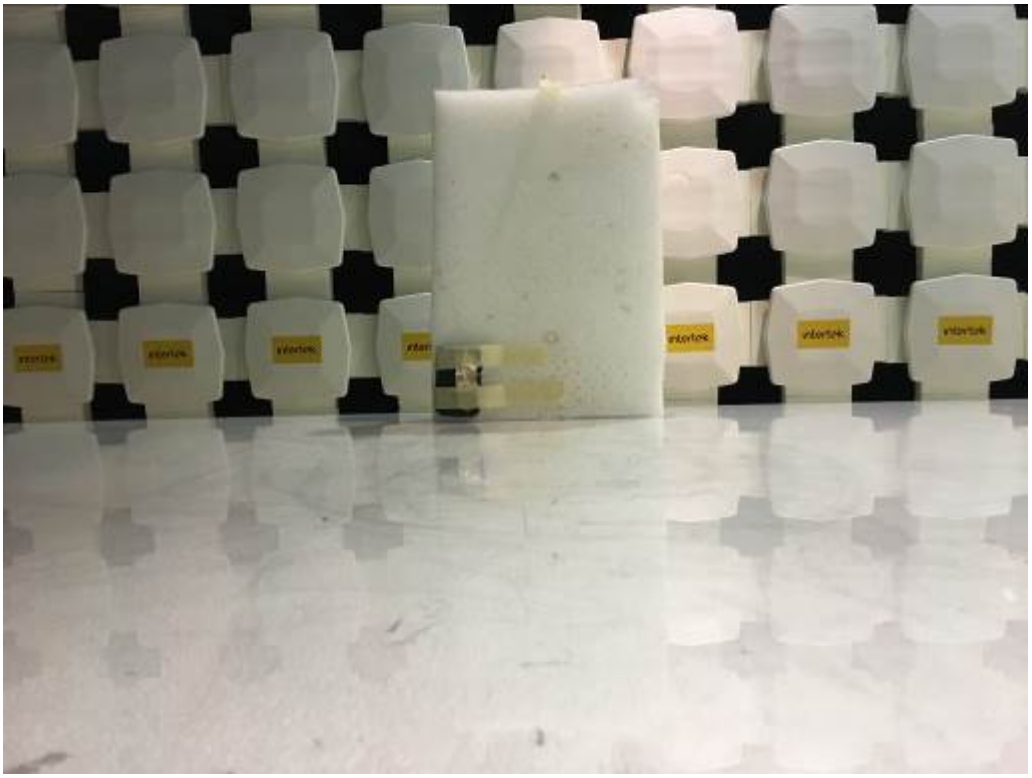


1-18 GHz Test Setup Y-axis

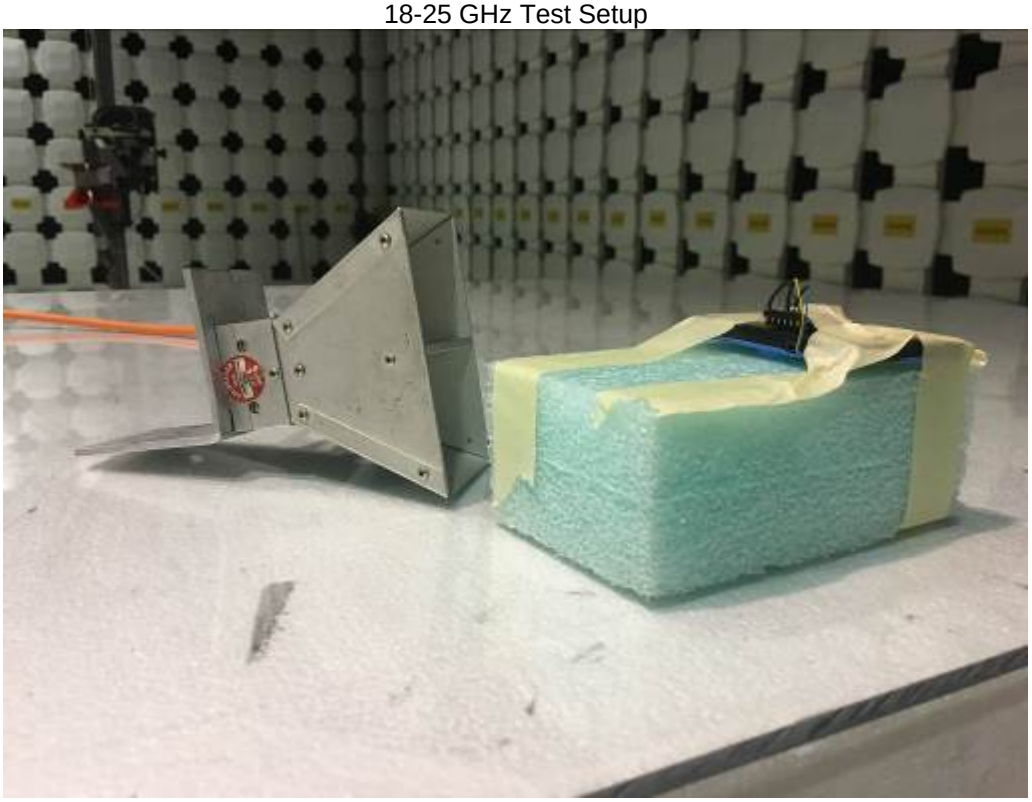




1-18 GHz Test Setup Z-axis

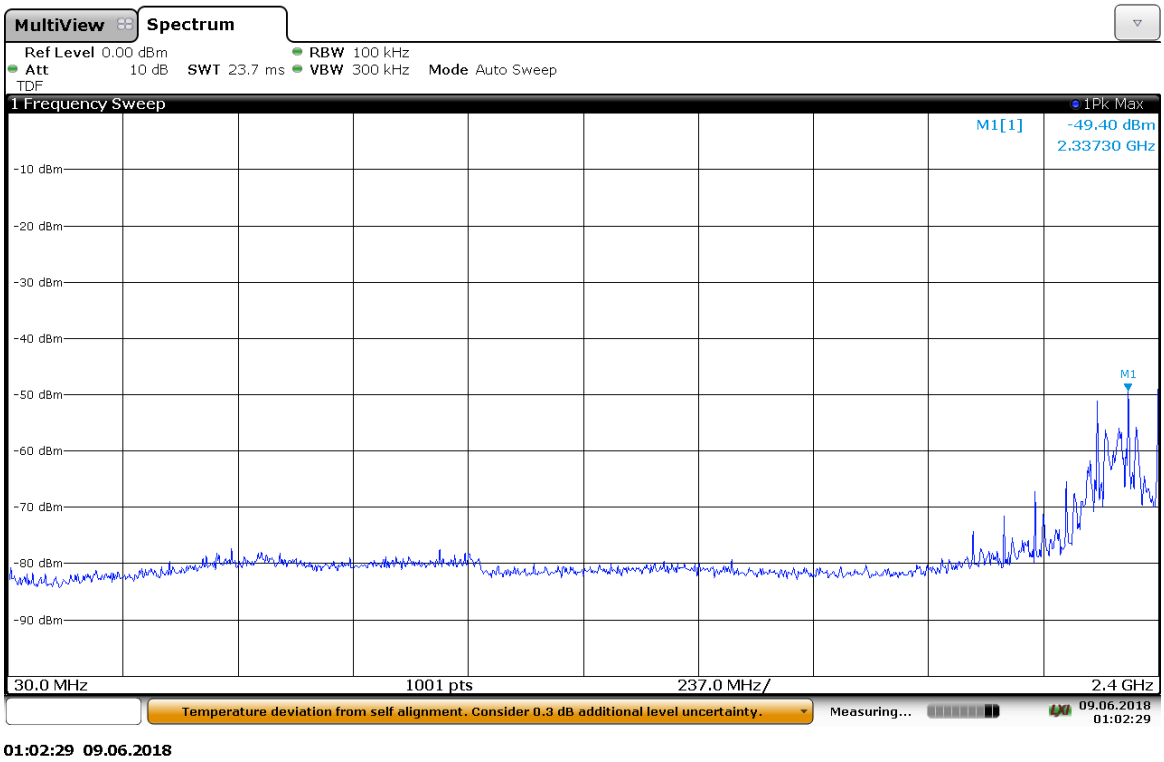


18-25 GHz Test Setup



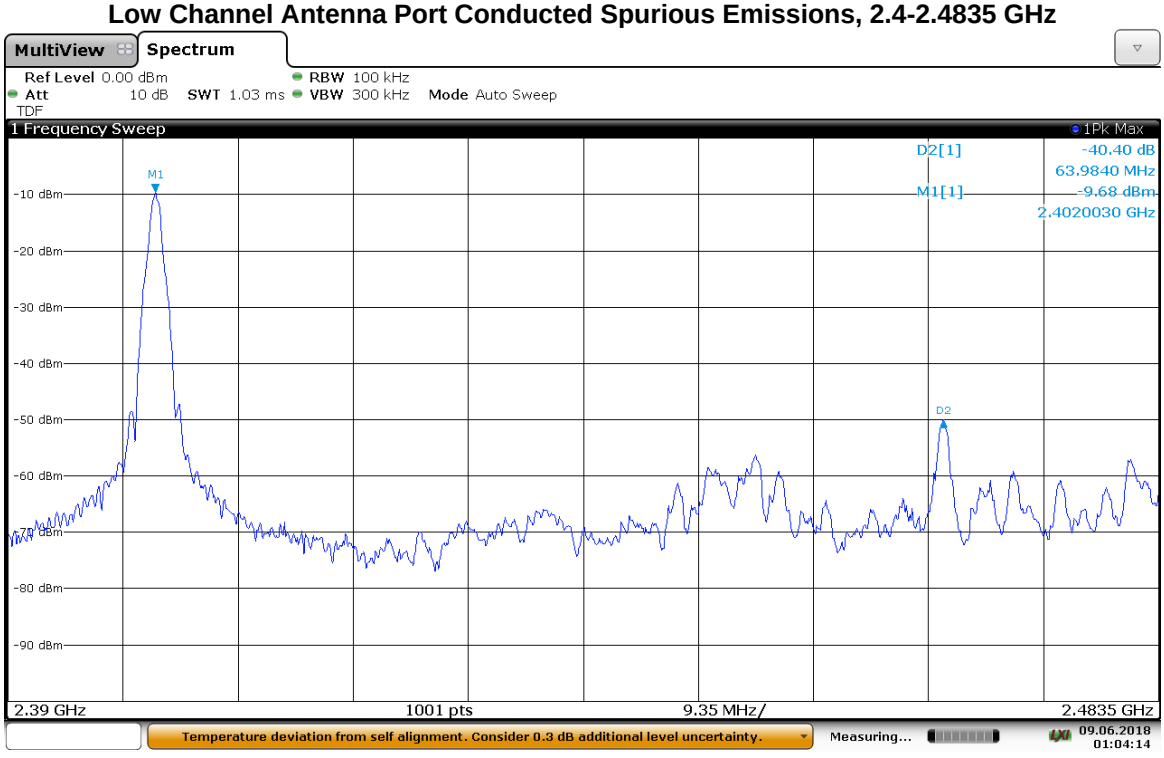
10.5 Plots/Data:

Low Channel Antenna Port Conducted Spurious Emissions, 30 MHz-2.4 GHz



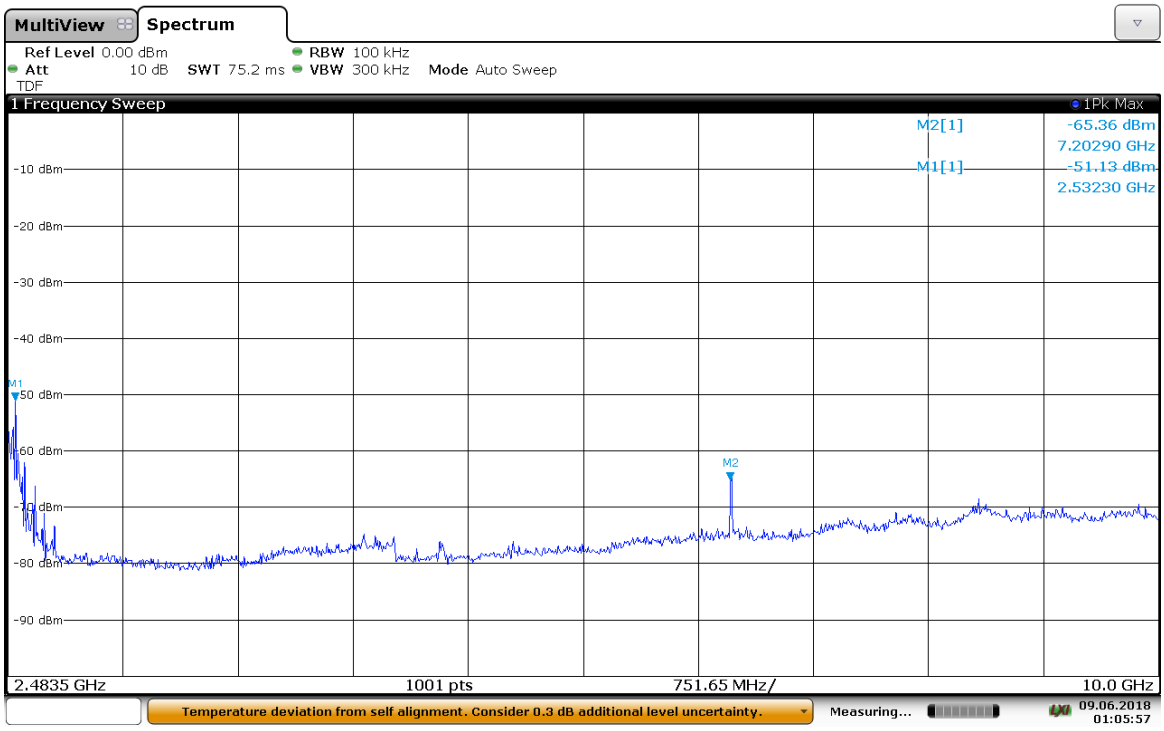
01:02:29 09.06.2018

Low Channel Antenna Port Conducted Spurious Emissions, 2.4-2.4835 GHz



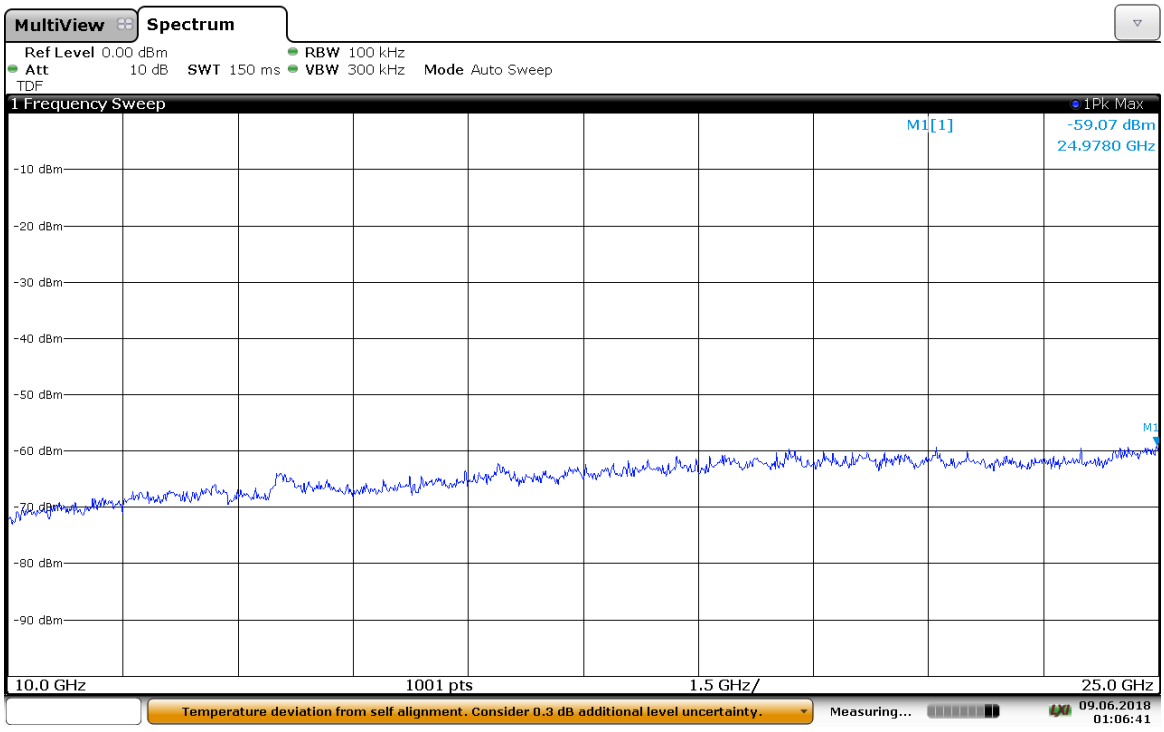
01:04:15 09.06.2018

Low Channel Antenna Port Conducted Spurious Emissions, 2.4835-10 GHz



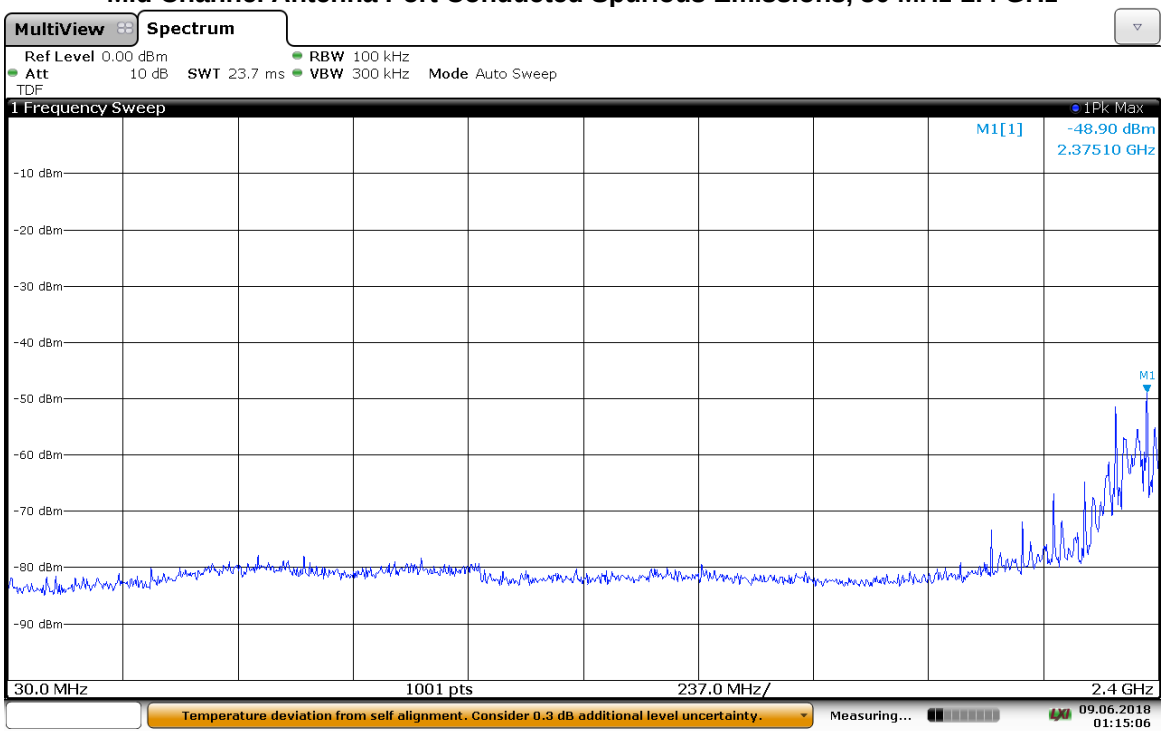
01:05:58 09.06.2018

Low Channel Antenna Port Conducted Spurious Emissions, 10-25 GHz



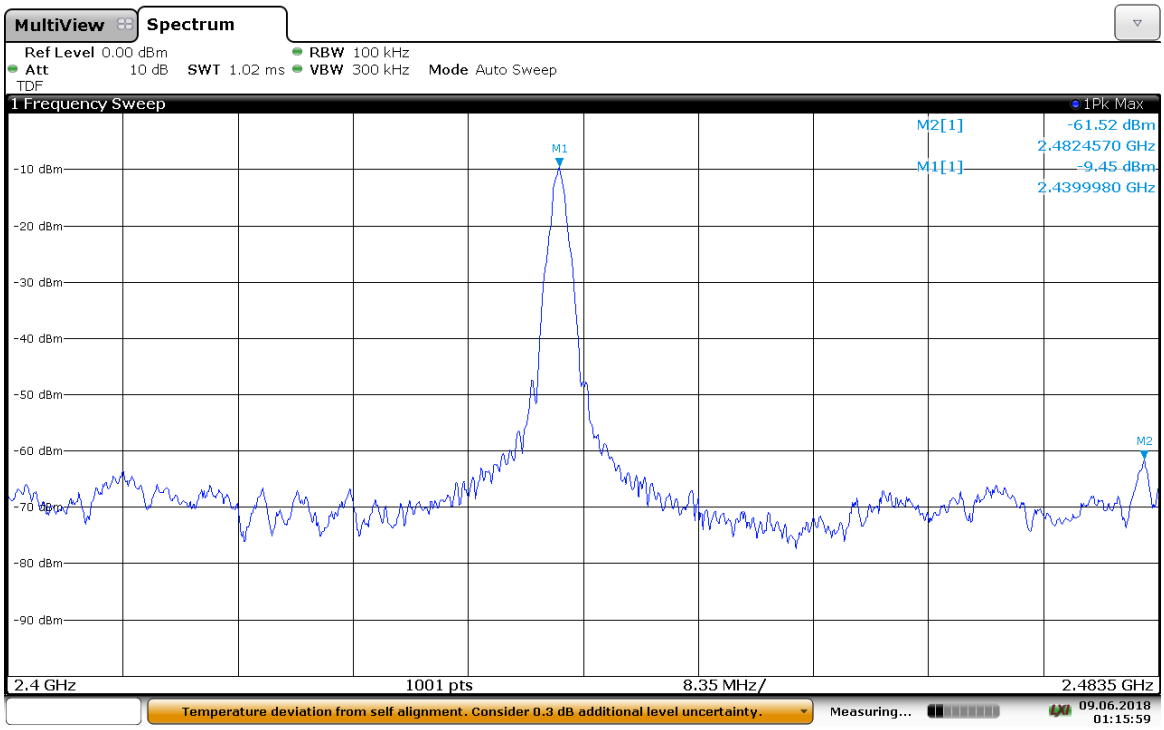
01:06:42 09.06.2018

Mid Channel Antenna Port Conducted Spurious Emissions, 30 MHz-2.4 GHz



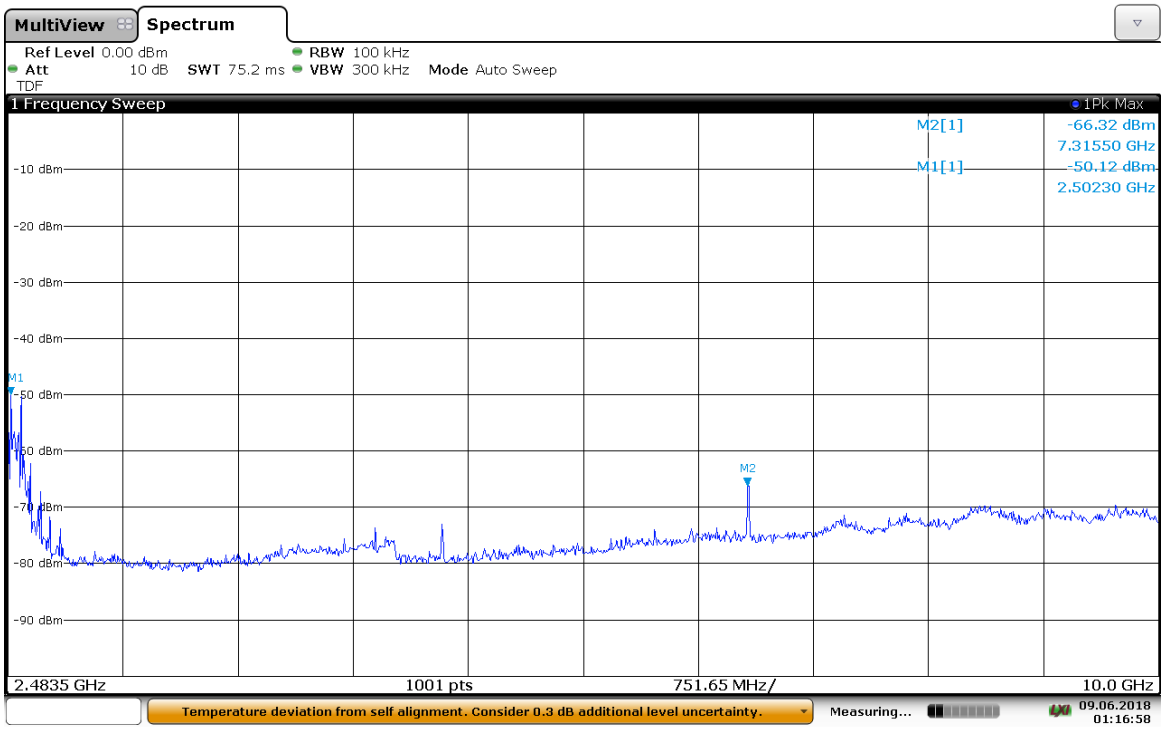
01:15:07 09.06.2018

Mid Channel Antenna Port Conducted Spurious Emissions, 2.4-2.4835 GHz



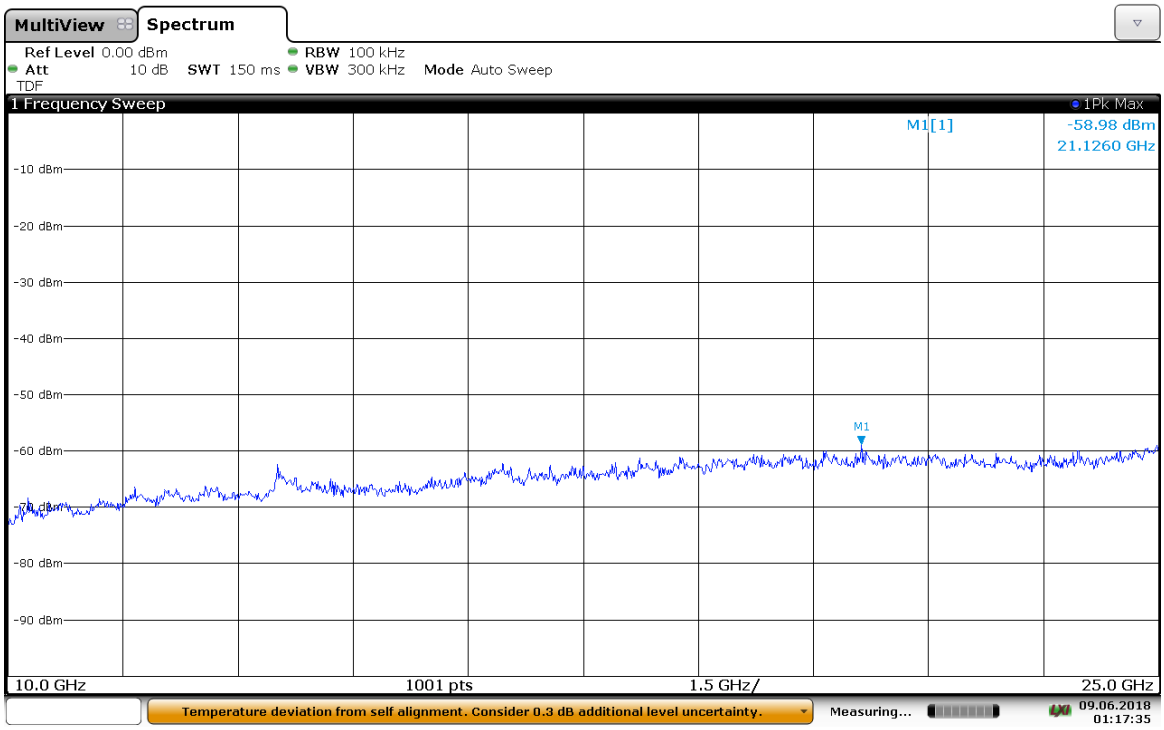
01:15:59 09.06.2018

Mid Channel Antenna Port Conducted Spurious Emissions, 2.4835-10 GHz



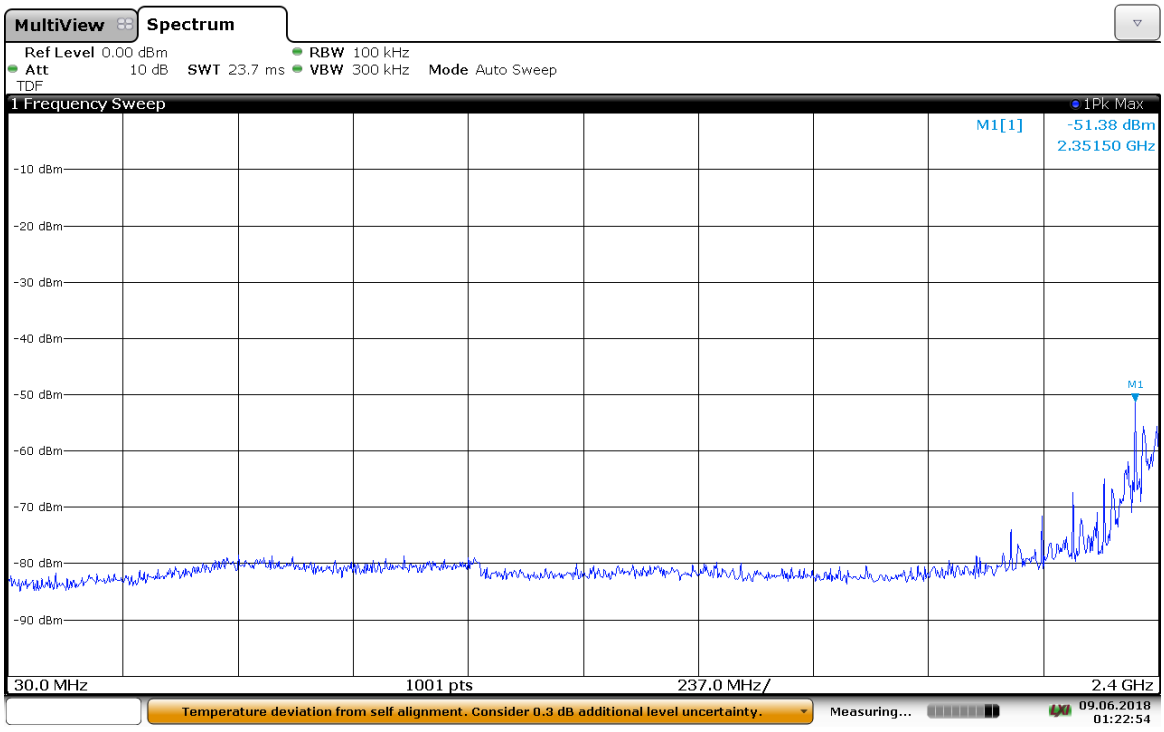
01:16:58 09.06.2018

Mid Channel Antenna Port Conducted Spurious Emissions, 10-25 GHz



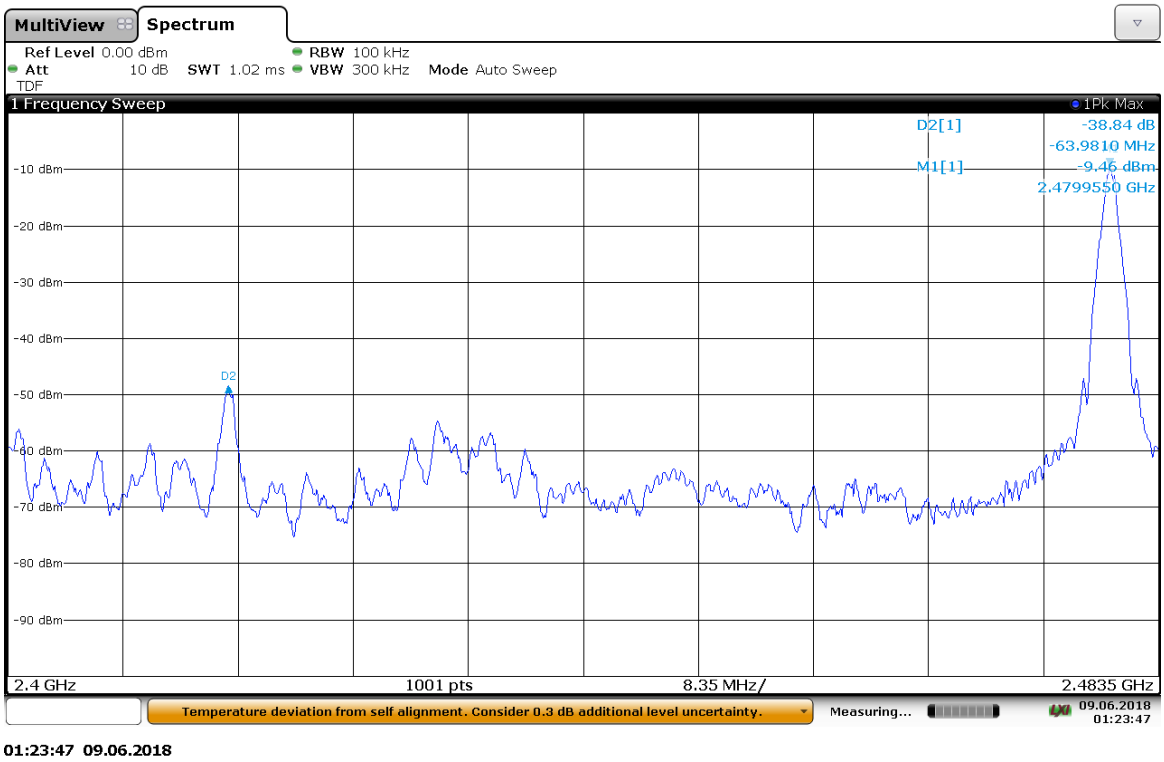
01:17:36 09.06.2018

High Channel Antenna Port Conducted Spurious Emissions, 30 MHz-2.4 GHz



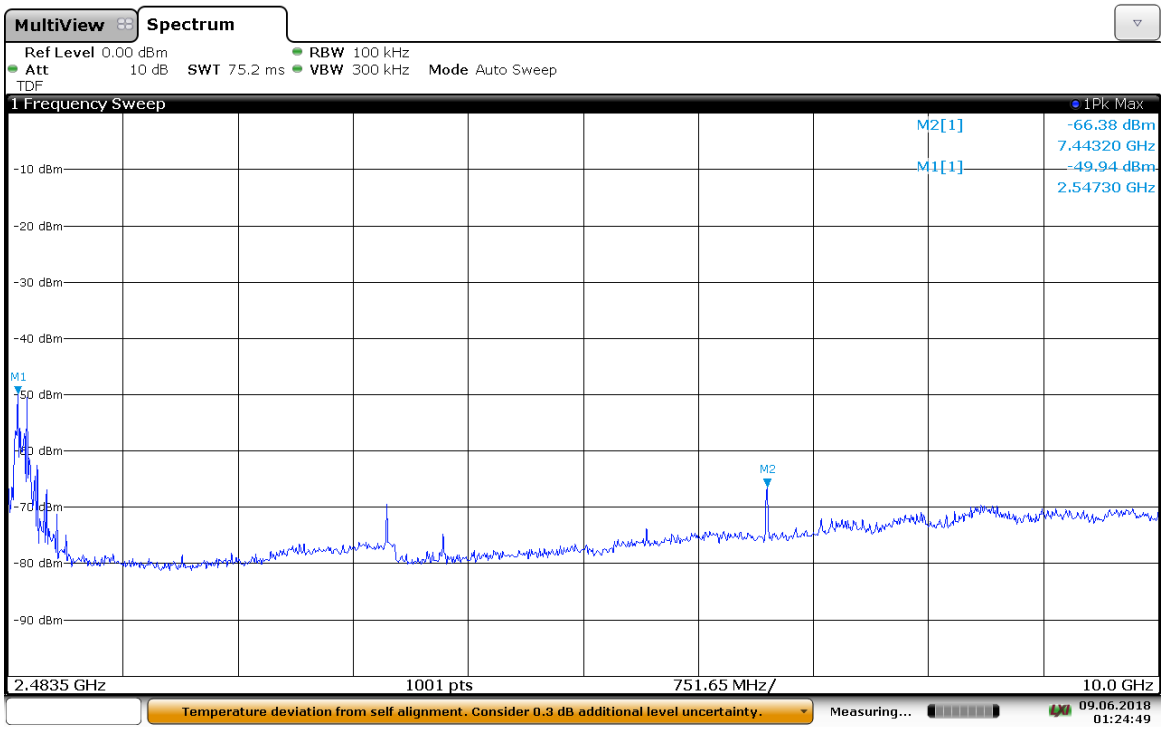
01:22:54 09.06.2018

High Channel Antenna Port Conducted Spurious Emissions, 2.4-2.4835 GHz



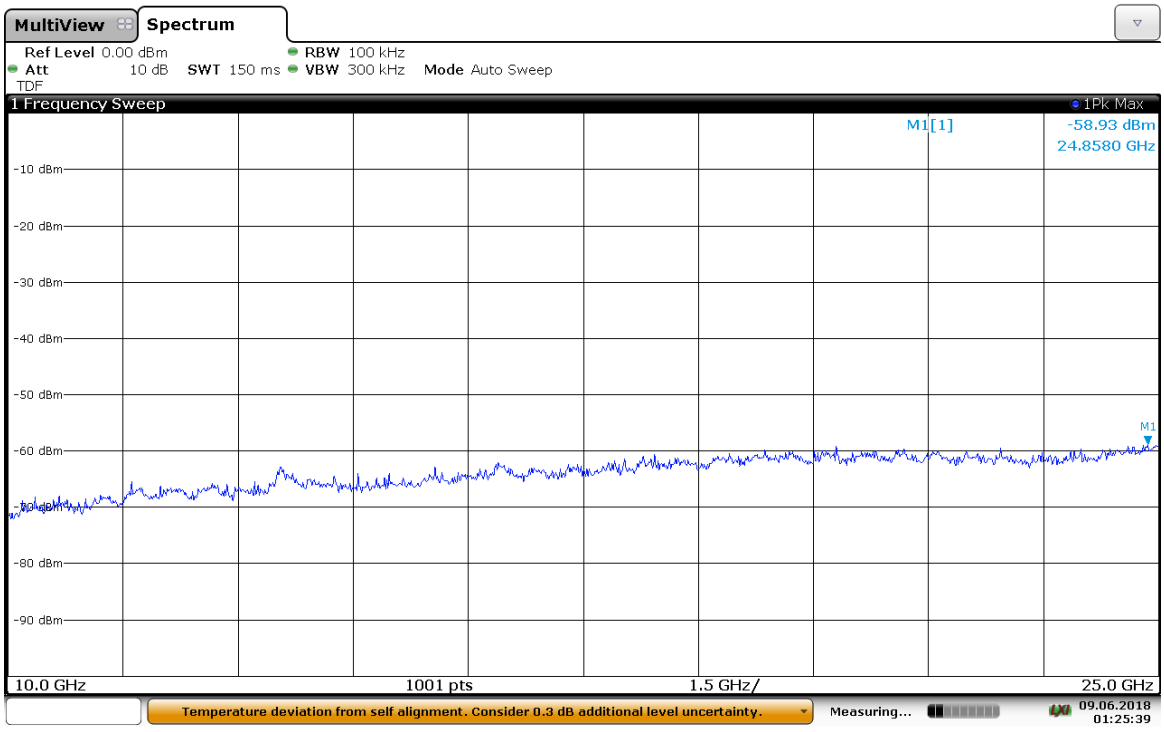
01:23:47 09.06.2018

High Channel Antenna Port Conducted Spurious Emissions, 2.4835-10 GHz



01:24:50 09.06.2018

High Channel Antenna Port Conducted Spurious Emissions, 10-25 GHz



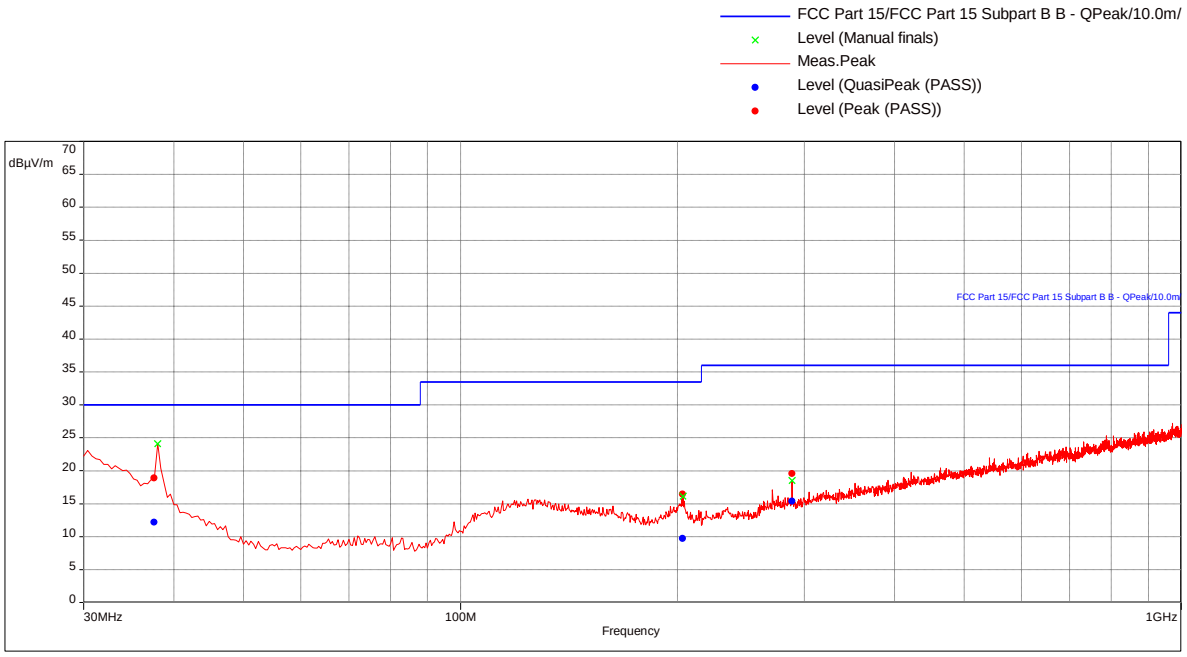
01:25:39 09.06.2018

High Channel Radiated Spurious Emissions (X-axis), 30-1000 MHz

Test Information:

Date and Time	6/7/2018 5:13:09 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 30-1000MHz_Hi Channel_Tx mode_X-axis

Graph:



Results:

QuasiPeak (PASS) (3)

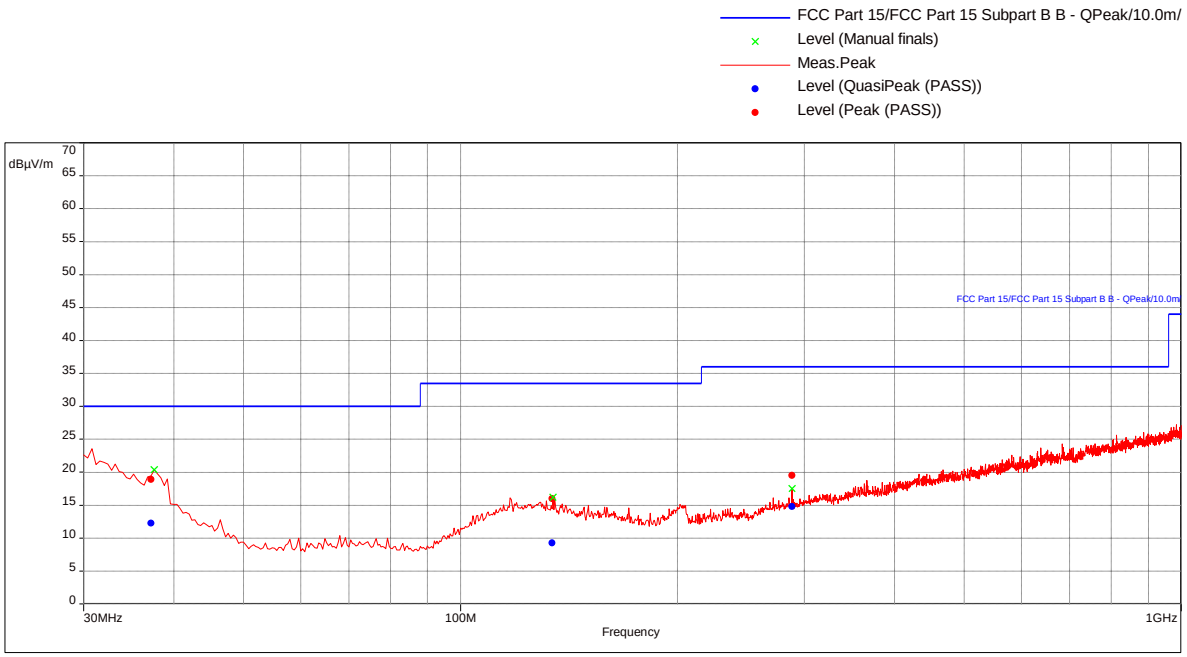
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
37.65263158	12.17	30.00	-17.83	240.00	3.13	Vertical	120000.00	-27.56
203.2526316	9.70	33.50	-23.80	85.00	2.27	Vertical	120000.00	-29.57
288.5578947	15.35	36.00	-20.65	247.00	1.00	Vertical	120000.00	-28.32

High Channel Radiated Spurious Emissions (X-axis), 30-1000 MHz

Test Information:

Date and Time	6/7/2018 5:51:50 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 30-1000MHz_Hi Channel_Tx mode_Y-axis

Graph:



Results:

QuasiPeak (PASS) (3)

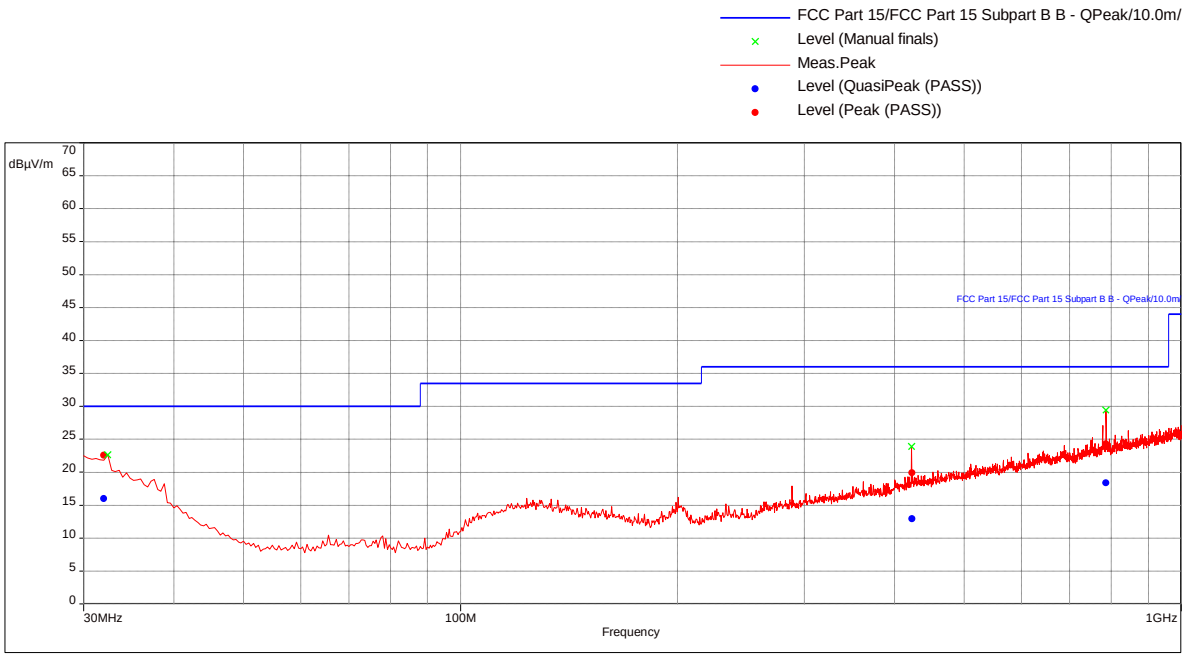
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
37.25263158	12.26	30.00	-17.74	55.00	3.80	Vertical	120000.00	-27.29
134.0842105	9.28	33.50	-24.22	254.00	2.39	Horizontal	120000.00	-29.07
288.5263158	14.75	36.00	-21.25	143.00	1.00	Vertical	120000.00	-28.32

High Channel Radiated Spurious Emissions (Z -axis), 30-1000 MHz

Test Information:

Date and Time	6/7/2018 6:29:47 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 30-1000MHz_Hi Channel_Tx mode_Z-axis

Graph:



Results:

QuasiPeak (PASS) (3)

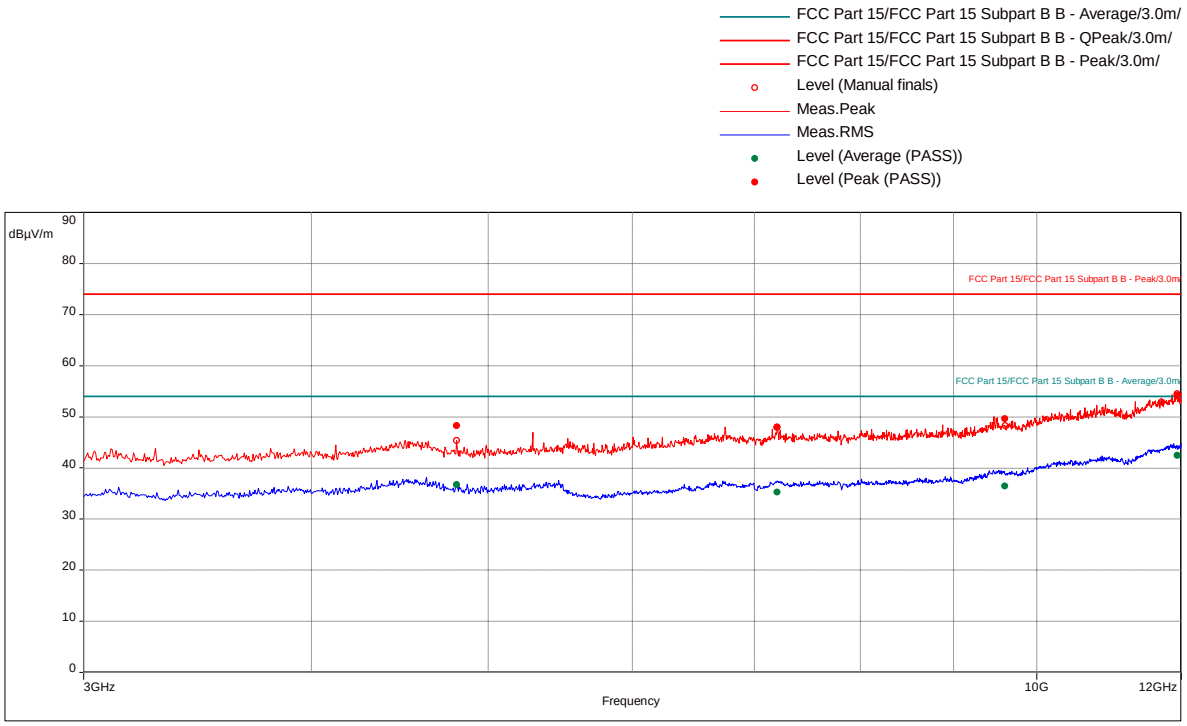
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
32.05263158	15.99	30.00	-14.01	77.00	3.07	Vertical	120000.00	-23.33
422.6842105	12.92	36.00	-23.08	129.00	3.52	Horizontal	120000.00	-24.18
786.4315789	18.36	36.00	-17.64	321.00	3.15	Vertical	120000.00	-17.49

Low Channel Radiated Spurious Emissions (X-axis), 1-25 GHz

Test Information:

Date and Time	6/7/2018 9:48:46 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 3 to 12 GHz_Low Channel_Tx mode_X-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	48.25	74.00	-25.75	107.00	2.06	Vertical	1000000.00	5.68
7203.947368	47.98	74.00	-26.02	157.00	2.12	Vertical	1000000.00	9.09
9605.789474	49.61	74.00	-24.39	277.00	2.30	Vertical	1000000.00	10.47
11938.94737	54.24	74.00	-19.76	46.00	1.45	Horizontal	1000000.00	16.96

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	36.72	54.00	-17.28	107.00	2.06	Vertical	1000000.00	5.68
7203.947368	35.26	54.00	-18.74	157.00	2.12	Vertical	1000000.00	9.09
9605.789474	36.41	54.00	-17.59	277.00	2.30	Vertical	1000000.00	10.47
11938.94737	42.46	54.00	-11.54	46.00	1.45	Horizontal	1000000.00	16.96

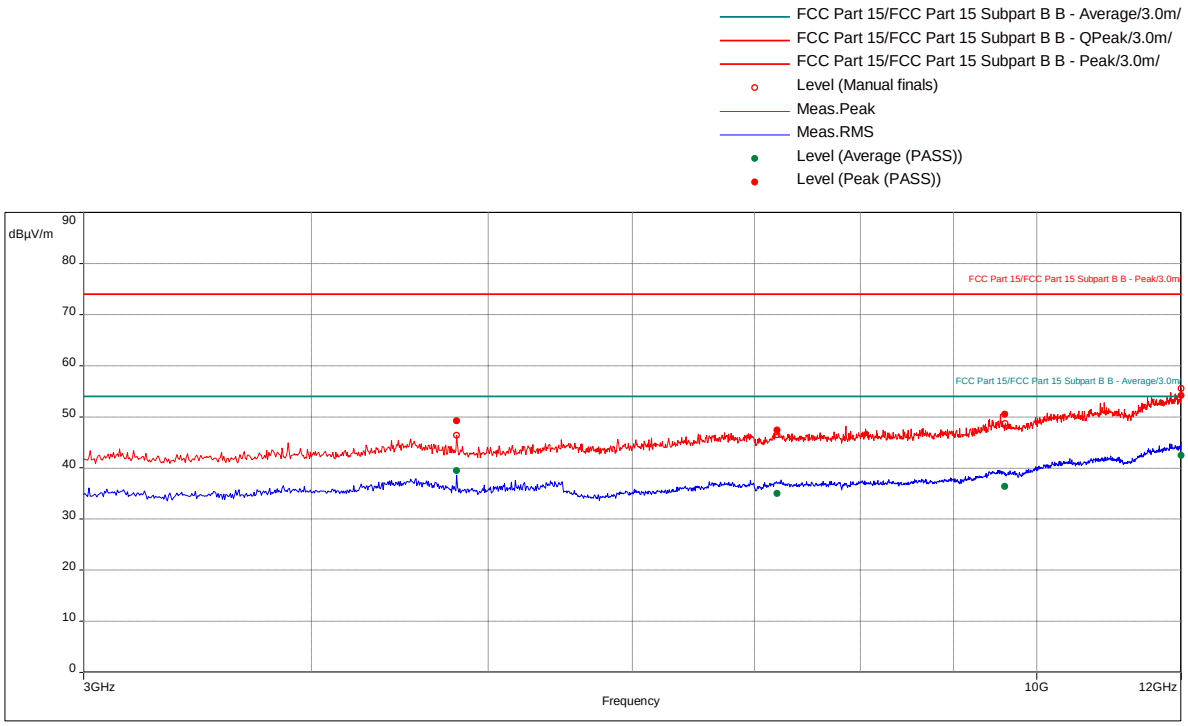
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Low Channel Radiated Spurious Emissions (Y-axis), 1-25 GHz

Test Information:

Date and Time	6/7/2018 10:07:52 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 3 to 12 GHz_Low Channel_Tx mode_Y-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	49.21	74.00	-24.79	320.00	1.22	Vertical	1000000.00	5.68
7203.157895	47.44	74.00	-26.56	4.00	1.80	Horizontal	1000000.00	9.09
9605.789474	50.47	74.00	-23.53	150.00	2.93	Vertical	1000000.00	10.47
11998.15789	54.12	74.00	-19.88	18.00	1.26	Horizontal	1000000.00	17.10

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	39.48	54.00	-14.52	320.00	1.22	Vertical	1000000.00	5.68
7203.157895	34.97	54.00	-19.03	4.00	1.80	Horizontal	1000000.00	9.09
9605.789474	36.34	54.00	-17.66	150.00	2.93	Vertical	1000000.00	10.47
11998.15789	42.44	54.00	-11.56	18.00	1.26	Horizontal	1000000.00	17.10

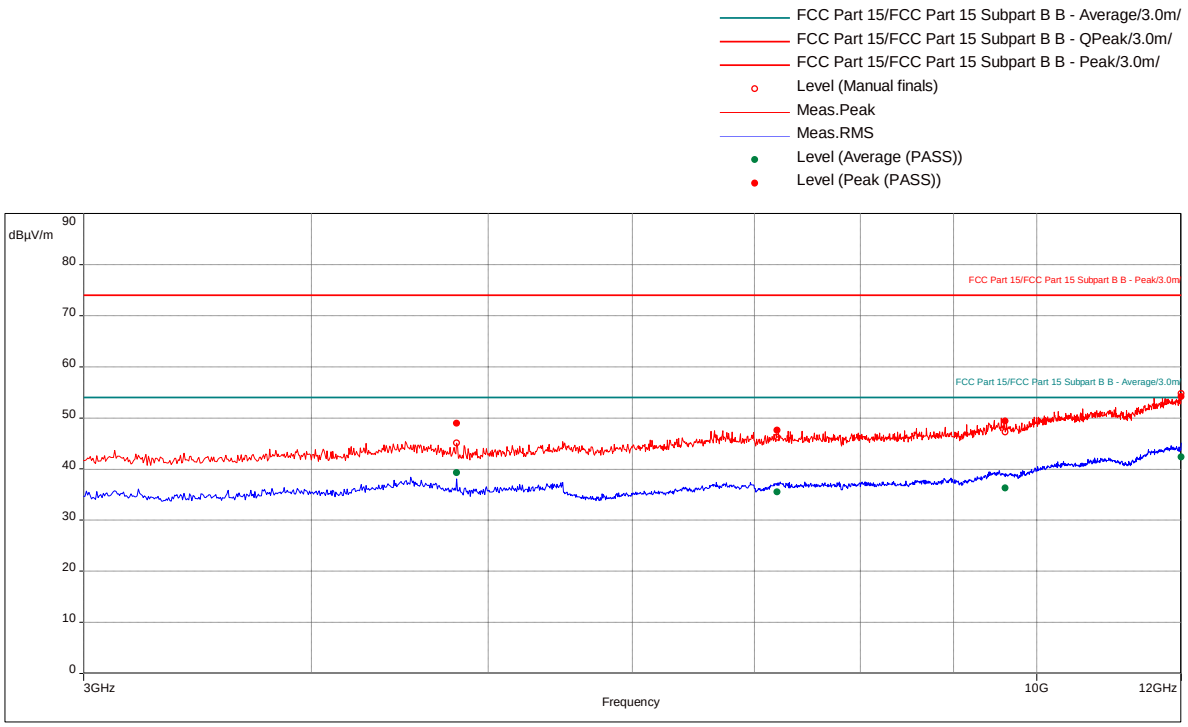
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Low Channel Radiated Spurious Emissions (Z-axis), 1-25 GHz

Test Information:

Date and Time	6/7/2018 10:30:38 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 3 to 12 GHz_Low Channel_Tx mode_Z-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	48.95	74.00	-25.05	320.00	3.10	Vertical	1000000.00	5.68
7203.947368	47.58	74.00	-26.42	223.00	2.15	Horizontal	1000000.00	9.09
9610	49.37	74.00	-24.63	203.00	3.20	Vertical	1000000.00	10.48
11998.94737	54.12	74.00	-19.88	306.00	2.22	Vertical	1000000.00	17.10

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4803.947368	39.27	54.00	-14.73	320.00	3.10	Vertical	1000000.00	5.68
7203.947368	35.54	54.00	-18.46	223.00	2.15	Horizontal	1000000.00	9.09
9610	36.28	54.00	-17.72	203.00	3.20	Vertical	1000000.00	10.48
11998.94737	42.36	54.00	-11.64	306.00	2.22	Vertical	1000000.00	17.10

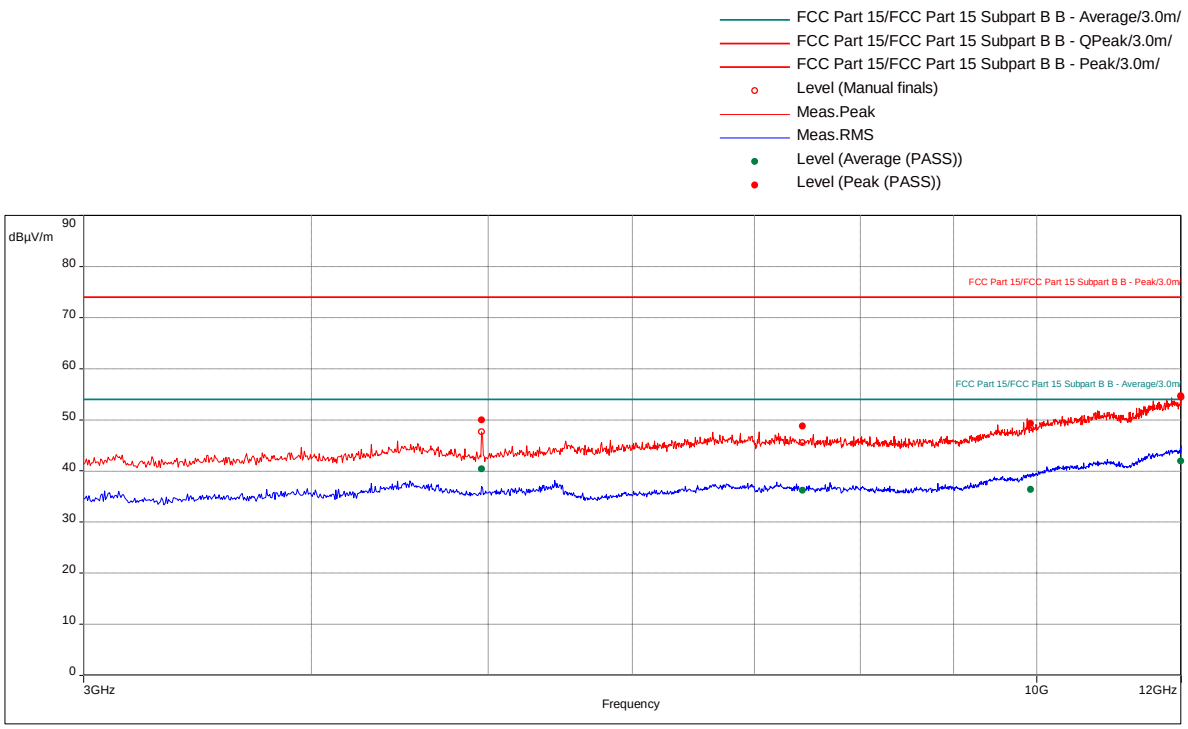
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Mid Channel Radiated Spurious Emissions (X-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 7:26:56 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Hi Channel_Tx mode_X-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	49.95	74.00	-24.05	205.00	2.77	Vertical	1000000.00	5.76
7441.052632	48.81	74.00	-25.19	144.00	3.66	Vertical	1000000.00	9.09
9921.315789	49.29	74.00	-24.71	166.00	3.05	Horizontal	1000000.00	11.07
11995.39474	54.65	74.00	-19.35	174.00	2.91	Horizontal	1000000.00	17.09

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	40.38	54.00	-13.62	205.00	2.77	Vertical	1000000.00	5.76
7441.052632	36.20	54.00	-17.80	144.00	3.66	Vertical	1000000.00	9.09
9921.315789	36.33	54.00	-17.67	166.00	3.05	Horizontal	1000000.00	11.07
11995.39474	41.95	54.00	-12.05	174.00	2.91	Horizontal	1000000.00	17.09

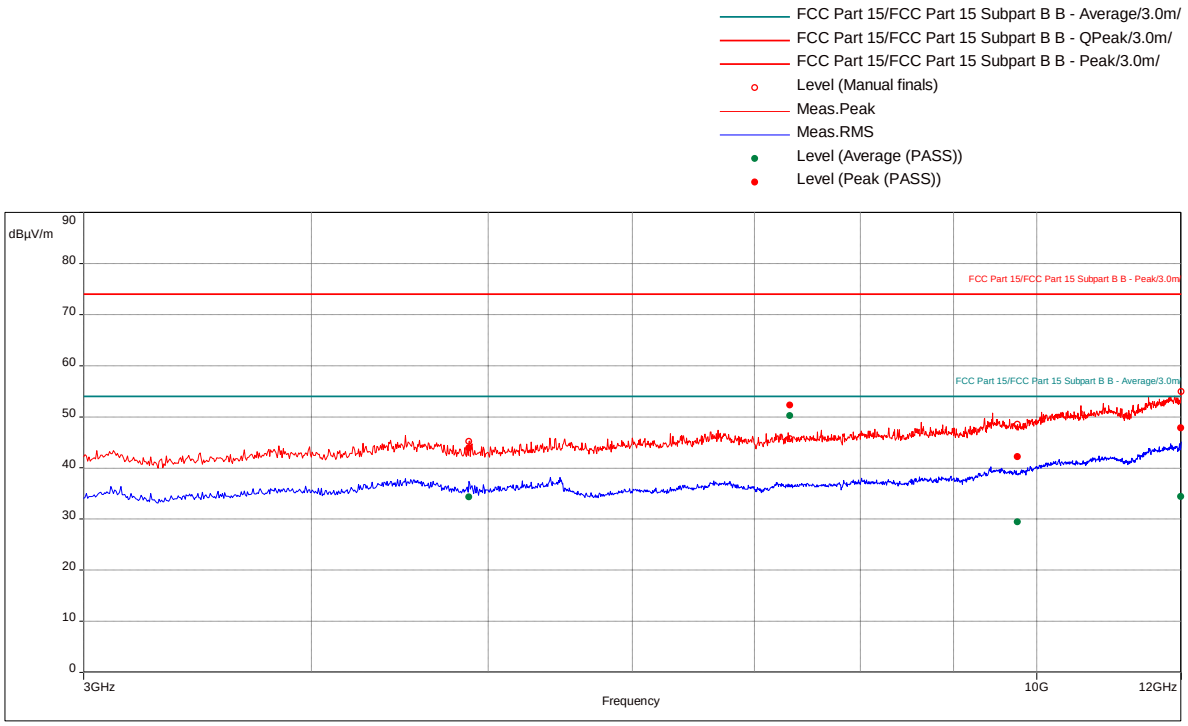
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Mid Channel Radiated Spurious Emissions (Y-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 5:58:47 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Mid Channel_Tx mode_Y-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4880	43.92	74.00	-30.08	277.00	2.50	Vertical	1000000.00	5.70
7318.421053	52.28	74.00	-21.72	158.00	3.95	Vertical	1000000.00	9.01
9760.526316	42.21	74.00	-31.79	143.00	3.82	Vertical	1000000.00	10.69
11995.13158	47.80	74.00	-26.20	321.00	2.50	Vertical	1000000.00	17.09

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4880	34.32	54.00	-19.68	277.00	2.50	Vertical	1000000.00	5.70
7318.421053	50.20	54.00	-3.80	158.00	3.95	Vertical	1000000.00	9.01
9760.526316	29.45	54.00	-24.55	143.00	3.82	Vertical	1000000.00	10.69
11995.13158	34.39	54.00	-19.61	321.00	2.50	Vertical	1000000.00	17.09

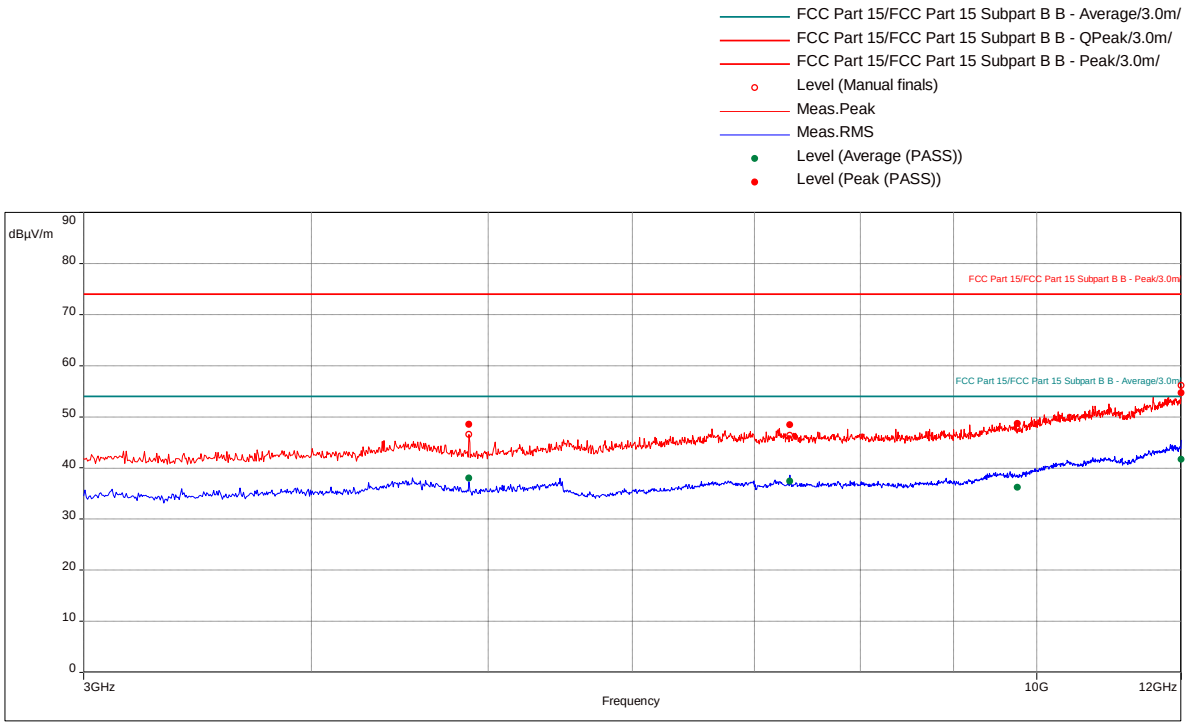
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Mid Channel Radiated Spurious Emissions (Z-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 6:58:14 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Mid Channel_Tx mode_Z-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4879.473684	48.55	74.00	-25.45	283.00	3.89	Vertical	1000000.00	5.70
7321.052632	48.44	74.00	-25.56	56.00	1.42	Vertical	1000000.00	9.01
9760.526316	48.64	74.00	-25.36	269.00	4.00	Vertical	1000000.00	10.69
11998.55263	54.65	74.00	-19.35	203.00	3.14	Horizontal	1000000.00	17.10

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4879.473684	37.95	54.00	-16.05	283.00	3.89	Vertical	1000000.00	5.70
7321.052632	37.42	54.00	-16.58	56.00	1.42	Vertical	1000000.00	9.01
9760.526316	36.19	54.00	-17.81	269.00	4.00	Vertical	1000000.00	10.69
11998.55263	41.70	54.00	-12.30	203.00	3.14	Horizontal	1000000.00	17.10

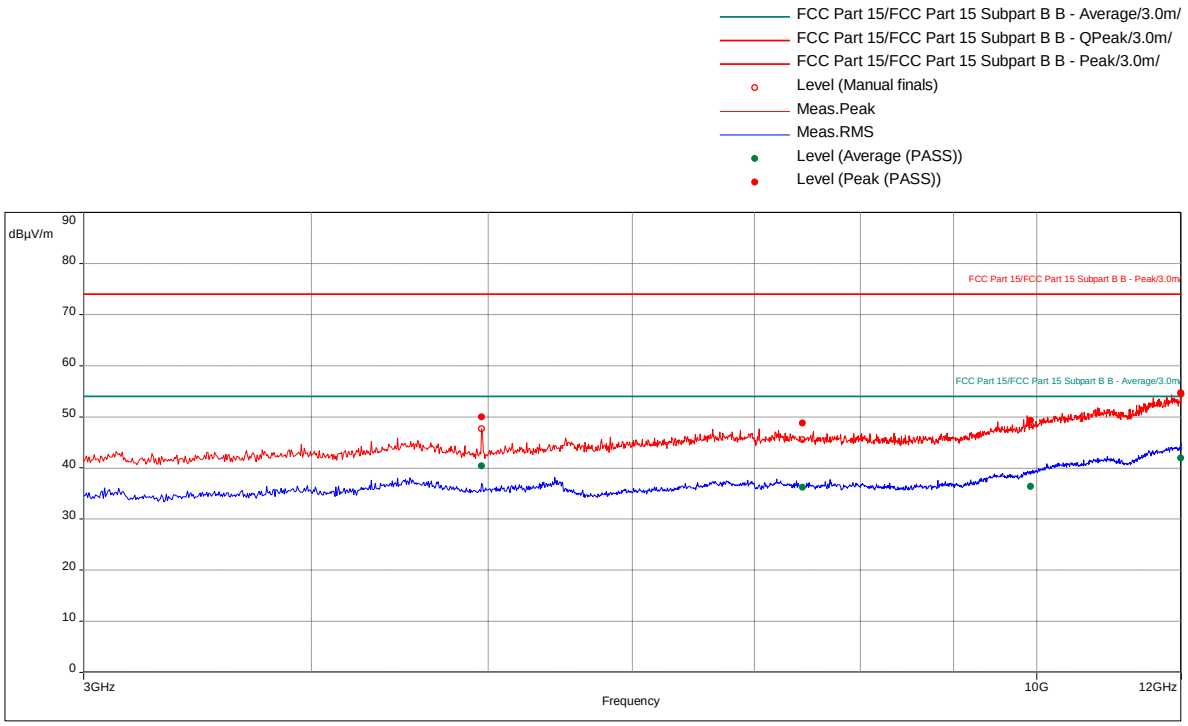
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

High Channel Radiated Spurious Emissions (X-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 7:26:56 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Hi Channel_Tx mode_X-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	49.95	74.00	-24.05	205.00	2.77	Vertical	1000000.00	5.76
7441.052632	48.81	74.00	-25.19	144.00	3.66	Vertical	1000000.00	9.09
9921.315789	49.29	74.00	-24.71	166.00	3.05	Horizontal	1000000.00	11.07
11995.39474	54.65	74.00	-19.35	174.00	2.91	Horizontal	1000000.00	17.09

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	40.38	54.00	-13.62	205.00	2.77	Vertical	1000000.00	5.76
7441.052632	36.20	54.00	-17.80	144.00	3.66	Vertical	1000000.00	9.09
9921.315789	36.33	54.00	-17.67	166.00	3.05	Horizontal	1000000.00	11.07
11995.39474	41.95	54.00	-12.05	174.00	2.91	Horizontal	1000000.00	17.09

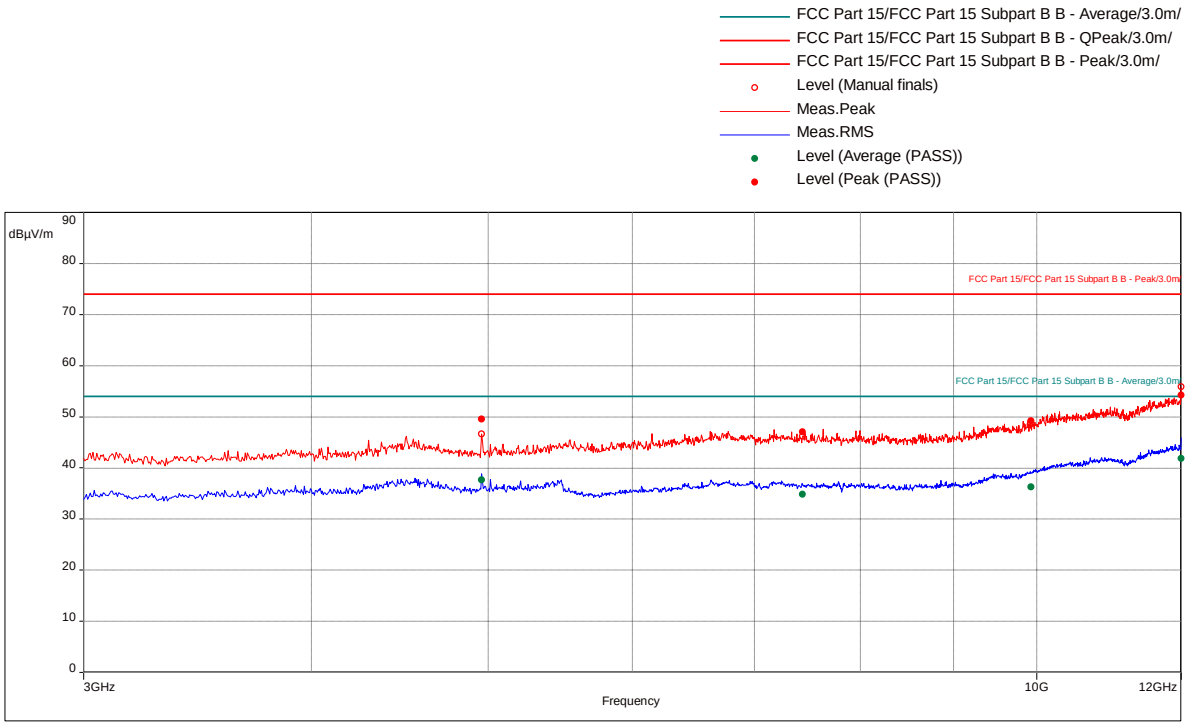
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

High Channel Radiated Spurious Emissions (Y-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 7:51:47 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Hi Channel_Tx mode_Y-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960.789474	49.54	74.00	-24.46	84.00	1.00	Vertical	1000000.00	5.76
7438.947368	47.04	74.00	-26.96	158.00	2.51	Horizontal	1000000.00	9.09
9925	49.16	74.00	-24.84	158.00	2.41	Vertical	1000000.00	11.08
11998.55263	54.24	74.00	-19.76	261.00	3.82	Horizontal	1000000.00	17.10

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960.789474	37.65	54.00	-16.35	84.00	1.00	Vertical	1000000.00	5.76
7438.947368	34.81	54.00	-19.19	158.00	2.51	Horizontal	1000000.00	9.09
9925	36.27	54.00	-17.73	158.00	2.41	Vertical	1000000.00	11.08
11998.55263	41.87	54.00	-12.13	261.00	3.82	Horizontal	1000000.00	17.10

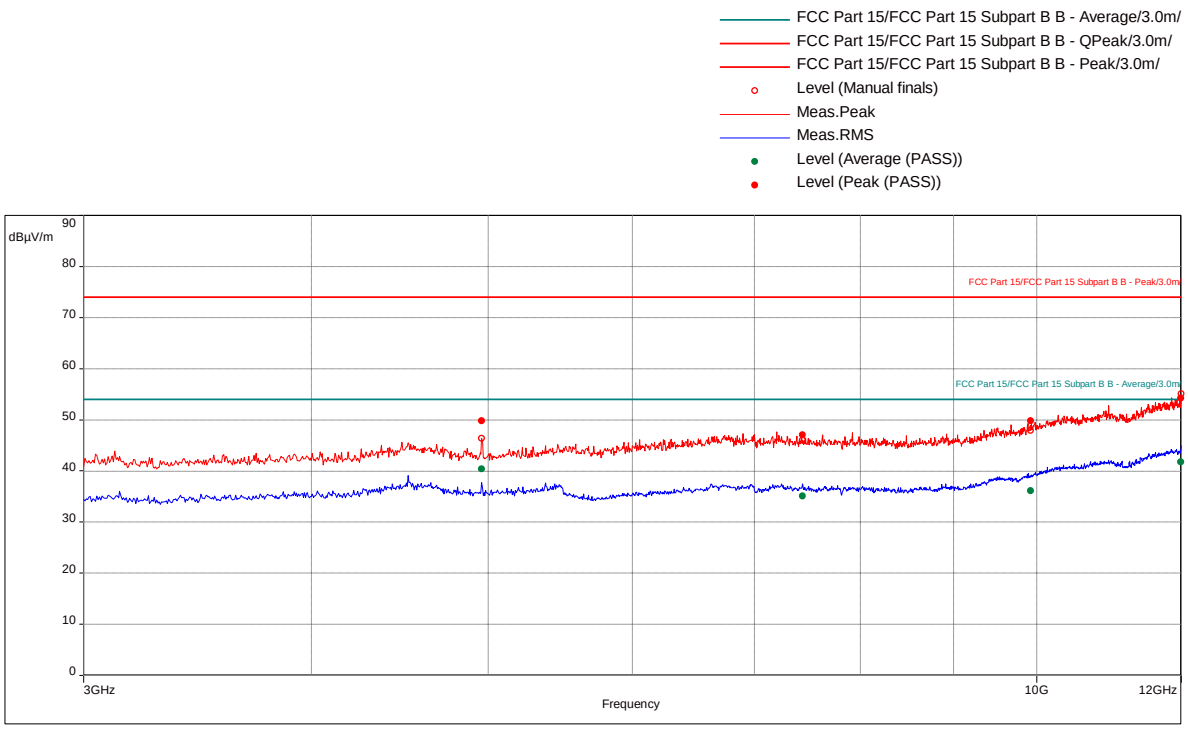
Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

High Channel Radiated Spurious Emissions (Z-axis), 1-25 GHz

Test Information:

Date and Time	6/8/2018 8:13:04 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	48%
Atmospheric Pressure	1007mB
Comments	RE 3 to 12 GHz_Hi Channel_Tx mode_Z-Axis

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	49.81	74.00	-24.19	279.00	2.45	Vertical	1000000.00	5.76
7441.842105	47.04	74.00	-26.96	232.00	3.01	Horizontal	1000000.00	9.09
9921.842105	49.83	74.00	-24.17	107.00	2.41	Vertical	1000000.00	11.07
11995	54.23	74.00	-19.77	240.00	1.53	Vertical	1000000.00	17.09

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
4960	40.38	54.00	-13.62	279.00	2.45	Vertical	1000000.00	5.76
7441.842105	35.11	54.00	-18.89	232.00	3.01	Horizontal	1000000.00	9.09
9921.842105	36.09	54.00	-17.91	107.00	2.41	Vertical	1000000.00	11.07
11995	41.78	54.00	-12.22	240.00	1.53	Vertical	1000000.00	17.09

Notes: Test was performed manually from 1-3 and 12-25 GHz with no emissions were detected.

Test Personnel:	Vathana Ven VSV	Test Date:	06/07/2018 06/08/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC Part 15.247, FCC Part 15 Subpart B, RSS-247, ICES-003	Limit Applied:	See report section 10.3
Input Voltage:	Internal Battery	Ambient Temperature:	23, 24 ºC
Pretest Verification w/ Ambient Signals or BB Source:	BB Source	Relative Humidity:	44, 48 %
		Atmospheric Pressure:	1008, 1007 mbars

Deviations, Additions, or Exclusions: None

11 Digital Device and Receiver Radiated Spurious Emissions

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B, ICES 003, and ANSI C 63.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/14/2017	06/14/2018
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/22/2018	03/22/2019
145020'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00948	08/25/2017	08/25/2018
ETS005	1-18GHz horn antenna	ETS-Lindgren	3117	00218279	05/14/2018	05/14/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2017	07/25/2018
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/16/2018	05/16/2019
PRE11'	50dB gain pre-amp	Keith H	PRE11	PRE11	12/02/2017	12/02/2018
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/25/2017	07/25/2018

Software Utilized:

Name	Manufacturer	Version
BAT-EMC Emissions	Nexio	3.16.0.69

11.3 Results:

The sample tested was found to Comply.

§15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

11.4 Setup Photographs:

30-1000 MHz Test Setup

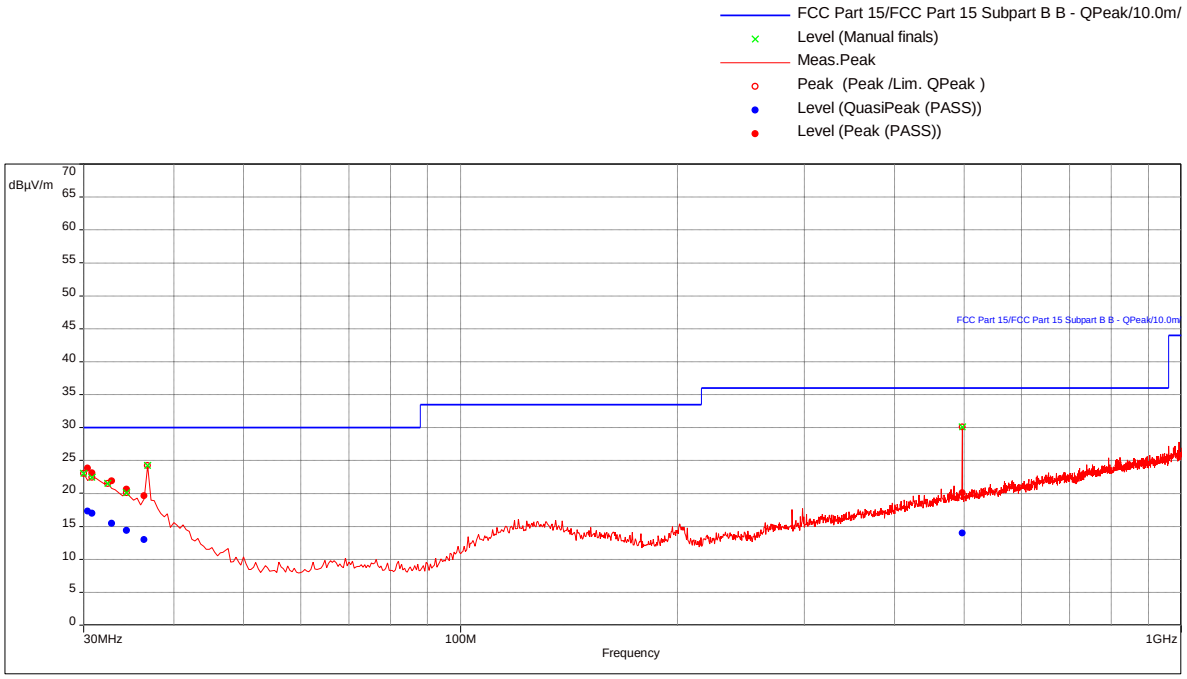
11.5 Plots/Data:

Digital Device Radiated Spurious Emissions (X-axis), 30-1000 MHz

Test Information:

Date and Time	6/7/2018 7:08:56 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 30-1000MHz_Rx mode

Graph:



Results:

QuasiPeak (PASS) (6)

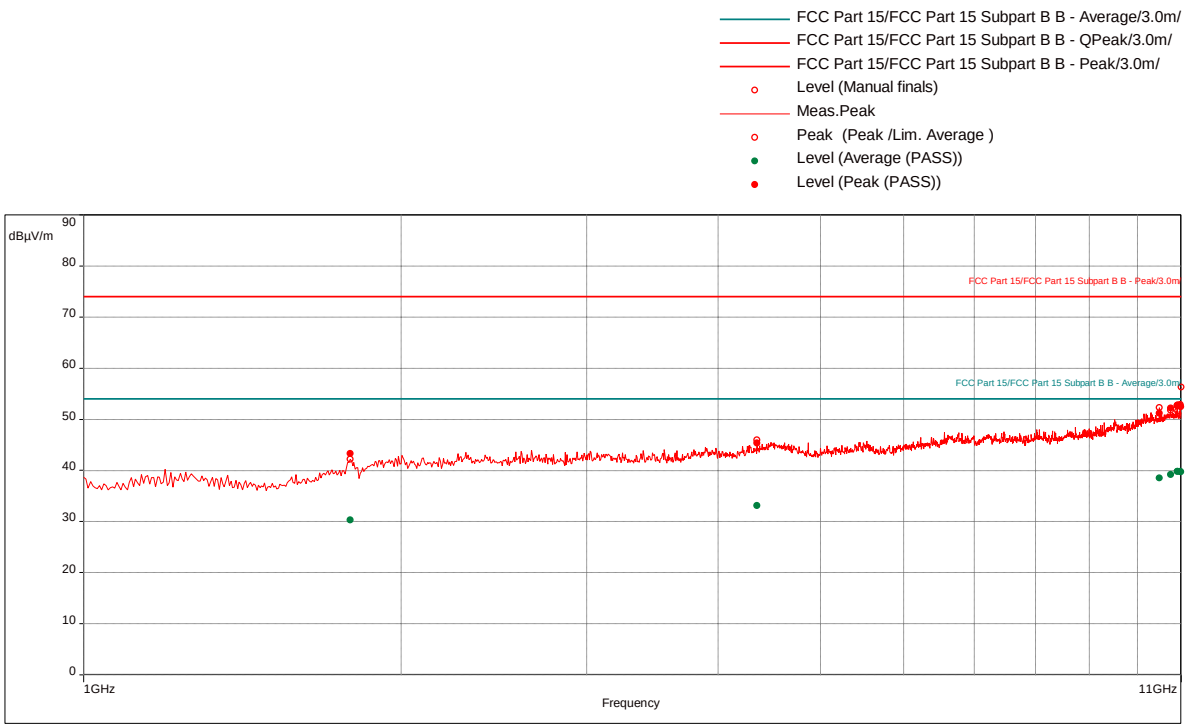
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
30.41052632	17.32	30.00	-12.68	40.00	3.58	Horizontal	120000.00	-22.09
30.95789474	16.95	30.00	-13.05	283.00	1.97	Vertical	120000.00	-22.48
32.87368421	15.46	30.00	-14.54	99.00	1.96	Vertical	120000.00	-23.89
34.36842105	14.40	30.00	-15.60	232.00	3.94	Horizontal	120000.00	-25.05
36.29473684	12.99	30.00	-17.01	224.00	2.63	Vertical	120000.00	-26.56
496.9894737	13.97	36.00	-22.03	218.00	2.04	Horizontal	120000.00	-22.80

Digital Device Radiated Spurious Emissions (X-axis), 1-13 GHz

Test Information:

Date and Time	6/7/2018 8:23:08 PM
Client and Project Number	Neurometrix_G103524448
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	44%
Atmospheric Pressure	1008mB
Comments	RE 1 to 13 GHz_Rx mode

Graph:



Notes: From 11 to 13 GHz was manually scanned. No emissions were detected.

Results:

Peak (PASS) (8)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
1790.263158	43.30	74.00	-30.70	232.00	2.42	Vertical	1000000.00	-1.57
4356.842105	45.31	74.00	-28.69	47.00	3.12	Vertical	1000000.00	5.31
10492.10526	51.15	74.00	-22.85	284.00	3.09	Horizontal	1000000.00	13.46
10747.89474	52.17	74.00	-21.83	357.00	1.65	Vertical	1000000.00	14.09
10904.47368	52.74	74.00	-21.26	18.00	3.98	Horizontal	1000000.00	14.52
10922.10526	52.79	74.00	-21.21	320.00	3.96	Horizontal	1000000.00	14.56
10975.26316	52.64	74.00	-21.36	33.00	2.31	Horizontal	1000000.00	14.69
10994.34211	52.43	74.00	-21.57	298.00	3.28	Horizontal	1000000.00	14.74

Average (PASS) (8)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Correction (dB)
1790.263158	30.33	54.00	-23.67	232.00	2.42	Vertical	1000000.00	-1.57
4356.842105	33.09	54.00	-20.91	47.00	3.12	Vertical	1000000.00	5.31
10492.10526	38.48	54.00	-15.52	284.00	3.09	Horizontal	1000000.00	13.46
10747.89474	39.20	54.00	-14.80	357.00	1.65	Vertical	1000000.00	14.09
10904.47368	39.79	54.00	-14.21	18.00	3.98	Horizontal	1000000.00	14.52
10922.10526	39.75	54.00	-14.25	320.00	3.96	Horizontal	1000000.00	14.56
10975.26316	39.79	54.00	-14.21	33.00	2.31	Horizontal	1000000.00	14.69
10994.34211	39.68	54.00	-14.32	298.00	3.28	Horizontal	1000000.00	14.74

Test Personnel:	Vathana Ven VSV	Test Date:	06/07/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC Part 15 Subpart B, ICES-003	Limit Applied:	See report section 11.3
Input Voltage:	Internal Battery	Ambient Temperature:	23 ºC
Pretest Verification w/ Ambient Signals or BB Source:	BB Source	Relative Humidity:	44 %
		Atmospheric Pressure:	1008 mbars

Deviations, Additions, or Exclusions: None

12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	06/18/2018	103524448BOX-001	VFV	KPS	Original Issue