ENGINEERING TEST REPORT

2400 MHz OEM Wireless Module
Model: n2420B
FCC ID: NS911P31

Applicant:

Microhard Systems Inc.
150 Country Hills Landing N.W.
Calgary, Alberta
Canada T3K 5P3

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247 Frequency Hopping Spread Spectrum (FHSS)

UltraTech's File No.: 16MCRS092_FCC15C247

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: July 21, 2017	
Report Prepared by: Dan Huynh Issued Date: July 21, 2017	Tested by: Hung Trinh Test Dates: July 7 - 12, 2016

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	Equipment Certification for Part 15C Spread Spectrum Transmitter, Class II Permissive Change to Add Additional 2.5 dBi Dipole Antennas.
Test Procedures:	▪ ANSI C63.4 ▪ ANSI C63.10 ▪ FCC Public Notice DA 00-705
Environmental Classification:	[x] Commercial, industrial or business environment [x] Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2016	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CISPR 22 & EN 55022	2008-09, Edition 6.0 2006	Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-1-2 +A1 +A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding to Spread Spectrum Devices

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Microhard Systems Inc.
Address:	150 Country Hills Landing N.W. Calgary, Alberta Canada T3K 5P3
Contact Person:	Mr. Hany Shenouda Phone #: 403 248-0028 Fax #: 403 248 2762 Email Address: shenouda@microhardcorp.com

MANUFACTURER	
Name:	Microhard Systems Inc.
Address:	150 Country Hills Landing N.W. Calgary, Alberta Canada T3K 5P3
Contact Person:	Mr. Hany Shenouda Phone #: 403 248-0028 Fax #: 403 248-2762 Email Address: shenouda@microhardcorp.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Microhard Systems Inc.
Product Name:	2400 MHz OEM Wireless Module
Model Name or Number:	n2420B
Serial Number:	Test Sample
Type of Equipment:	Spread Spectrum Transmitter
Input Power Supply Type:	External Regulated DC Sources
Primary User Functions of EUT:	Spread Spectrum OEM Transceiver

2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	▪ Mobile ▪ Base Station (fixed use)
Intended Operating Environment:	▪ Commercial, industrial or business environment ▪ Residential environment
Power Supply Requirement:	3.3V or (7 to 30VDC HV option)
RF Output Power Rating:	0.1 to 1 W
Operating Frequency Range:	2401.6 – 2477.6 MHz
RF Output Impedance:	50 Ω
Duty Cycle:	Continuous
Modulation Type:	FHSS
Antenna Connector Type:	MMCX connected to antennas via RPSMA & RPTNC pigtails.

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Manufacturer	Type	Model/Part Number	Gain
Shenzhen Norminson Technology CO., LTD.	Dipole	NW001	2.5 dBi
Laird Technologies	Dipole	WCP2400-MMCX4	2.5 dBi

2.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF IN/OUT Port	1	MMCX to connect external antenna using Pigtails	Shielded coaxial cable with unique coupling connectors
2	DC Supply & I/O Port	1	Pin Header	No cable, direct connection

2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Test Jig
Brand name:	Microhard Systems Inc.
Model Name or Number:	N/A
Connected to EUT's Port:	I/O Port

Ancillary Equipment # 2	
Description:	AC/DC Adaptor
Brand name:	BI
Model Name or Number:	BI30-120200-AdU
Connected to EUT's Port:	Test jig of the EUT

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	20°C to 24°C
Humidity:	30% to 65%
Pressure:	98 to 110 kPa
Power Input Source:	3.3 VDC

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in normal Frequency Hopping mode for occupancy duration, and frequency separation.
Special Test Software & Hardware:	Test software provided by the Applicant is installed to allow the EUT to operate in hopping mode or at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2401.6 – 2477.6 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	2401.6, 2439.6 and 2477.6 MHz
RF Power Output: (measured maximum output power at antenna terminals)	1 W (conducted)
Normal Test Modulation:	See test data
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2017-04-02.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes
15.207(a)	AC Power Line Conducted Emissions	N/A
15.247(a)	Provisions for Frequency Hopping Systems	N/A
15.247(b)(2)	Peak Conducted Output Power	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(i), 1.1307, 1.1310, 2.1091	RF Exposure	N/A

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. PEAK CONDUCTED OUTPUT POWER [§ 15.247(b)(2)]

5.1.1. Limits

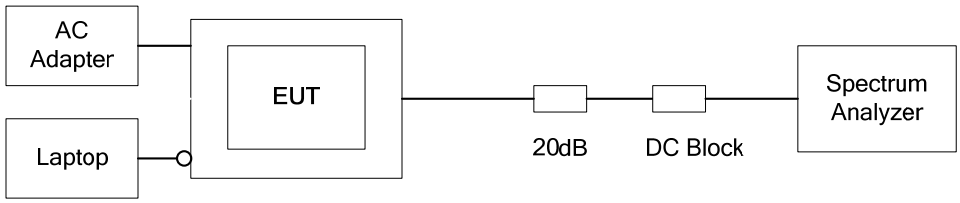
§15.247(b)(1): For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

§15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2. Method of Measurements

FCC Public Notice DA 00-705 and ANSI C63.10.

5.1.3. Test Arrangement

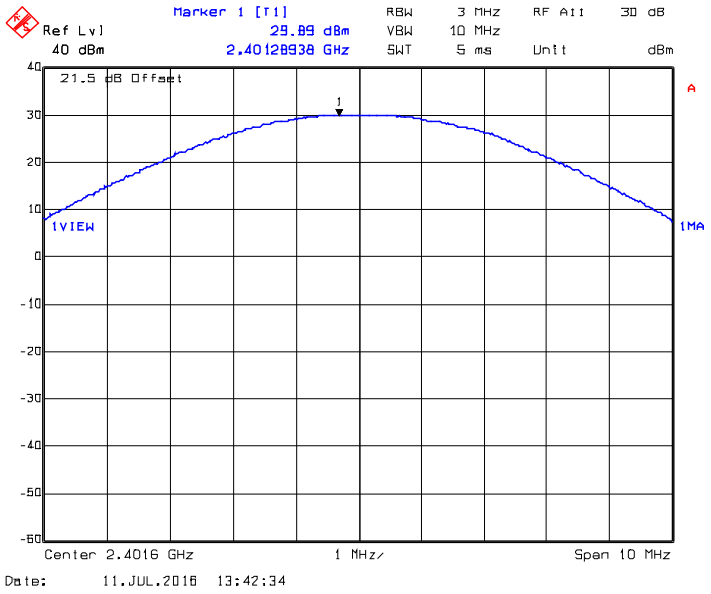


5.1.4. Test Data

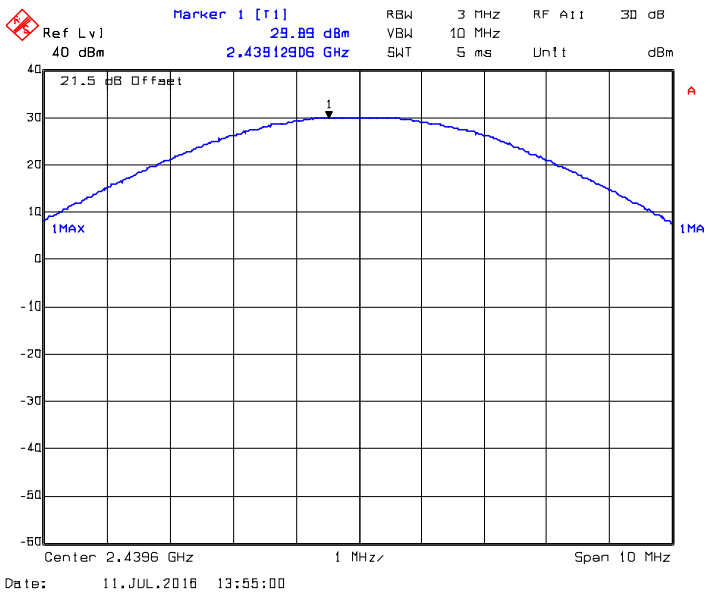
Test Configuration: EUT with 2.5 dBi Dipole Antenna
Power Setting: High (Raw power 50)
Data Rate: High

Frequency (MHz)	Peak Output Power at Antenna Terminal (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Peak Conducted Output Power Limit (dBm)	EIRP Limit (dBm)
2401.6	29.89	2.5	32.39	30	36
2439.6	29.89	2.5	32.39	30	36
2477.6	29.89	2.5	32.39	30	36

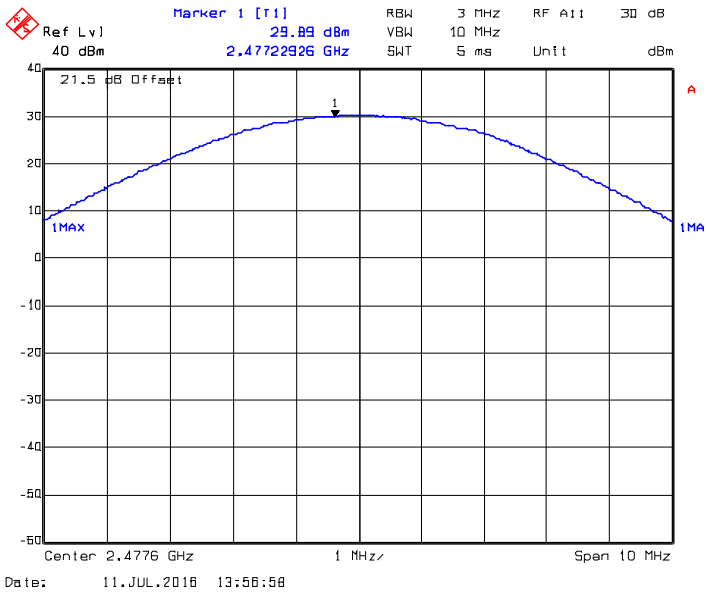
Plot 5.1.4.1. Peak Conducted Output Power
2401.6 MHz, High Data Rate, Power Scheme Raw, Raw Power 50



Plot 5.1.4.2. Peak Conducted Output Power
2439.6 MHz, High Data Rate, Power Scheme Raw, Raw Power 50



Plot 5.1.4.3. Peak Conducted Output Power
2477.6 MHz, High Data Rate, Power Scheme Raw, Raw Power 50



5.2. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.2.1. Limit

§ 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)).

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	([2])
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

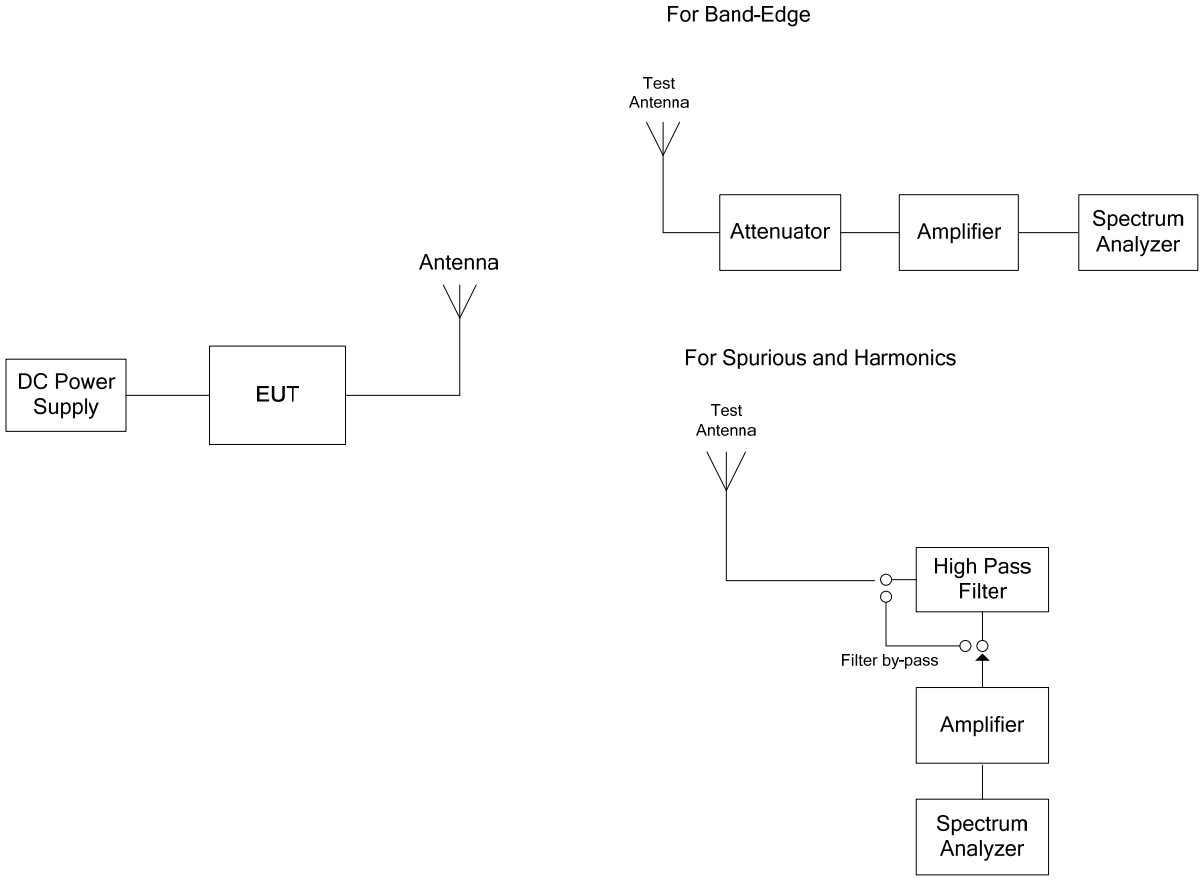
Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / 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

5.2.2. Method of Measurements

FCC Public Notice DA 00-705, ANSI C63.10 and ANSI 63.4 procedures.

5.2.3. Test Arrangement



5.2.4. Test Data

Remark(s):

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- Test conducted high power setting and high data rate for worst-case test configuration.

5.2.4.1. EUT with 2.5 dBi Dipole Antenna

5.2.4.1.1. Spurious Radiated Emissions

Fundamental Frequency:	2401.6 MHz
Measured Conducted Power:	29.89 dBm
Frequency Test Range:	30 MHz - 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2401.6	130.66	--	V	--	--	--	--
2401.6	126.38	--	H	--	--	--	--
4803.2	54.34	49.39	V	54.0	110.7	-4.6	Pass*
4803.2	54.36	49.75	H	54.0	110.7	-4.3	Pass*
12008.0	54.67	41.97	V	54.0	110.7	-12.0	Pass*
12008.0	55.04	42.46	H	54.0	110.7	-11.5	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:	2439.6 MHz
Measured Conducted Power:	29.89 dBm
Frequency Test Range:	30 MHz - 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2439.6	130.21	--	V	--	--	--	--
2439.6	127.55	--	H	--	--	--	--
4879.2	53.28	47.65	V	54.0	110.2	-6.4	Pass*
4879.2	52.27	43.93	H	54.0	110.2	-10.1	Pass*
7318.8	54.86	45.08	V	54.0	110.2	-8.9	Pass*
7318.8	54.90	45.59	H	54.0	110.2	-8.4	Pass*
12198.0	55.01	41.90	V	54.0	110.2	-12.1	Pass*
12198.0	55.87	42.11	H	54.0	110.2	-11.9	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:	2477.6 MHz
Measured Conducted Power:	29.89 dBm
Frequency Test Range:	30 MHz – 25 GHz

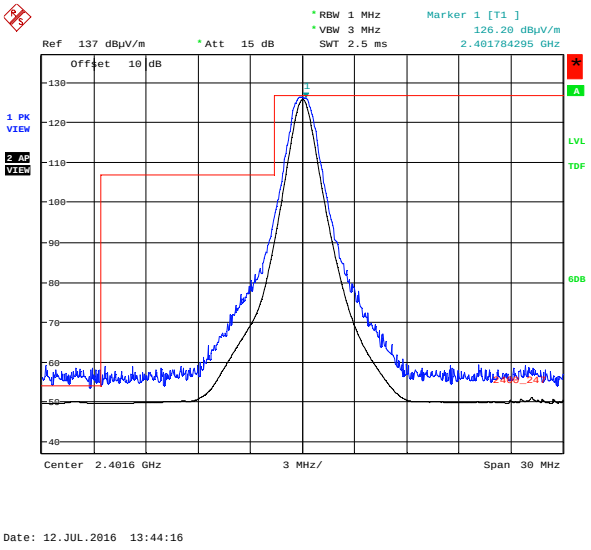
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
2477.6	129.72	--	V	--	--	--	--
2477.6	127.86	--	H	--	--	--	--
4955.2	52.98	46.28	V	54.0	109.7	-7.7	Pass*
7432.8	55.02	46.13	V	54.0	109.7	-7.9	Pass*
12388.0	55.36	42.47	V	54.0	109.7	-11.5	Pass*
4955.2	51.22	42.81	H	54.0	109.7	-11.2	Pass*
7432.8	56.26	48.68	H	54.0	109.7	-5.3	Pass*
12388.0	55.84	42.77	H	54.0	109.7	-11.2	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

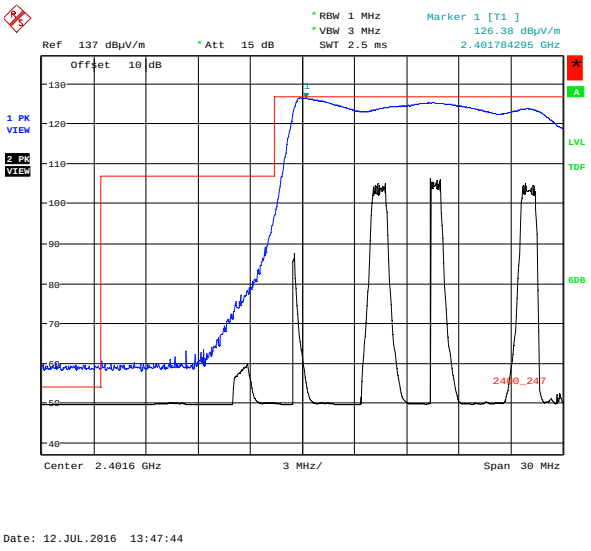
5.2.4.1.2. Band –Edge RF Radiated Emissions

Plot 5.2.4.1.2.1. Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
Single Frequency Mode, Low End of Frequency Band



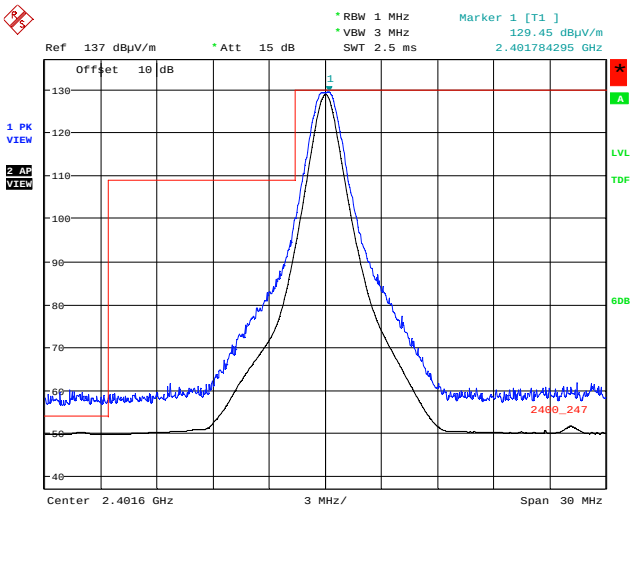
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.2. Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
Pseudorandom Channel Hopping Mode, Low End of Frequency Band



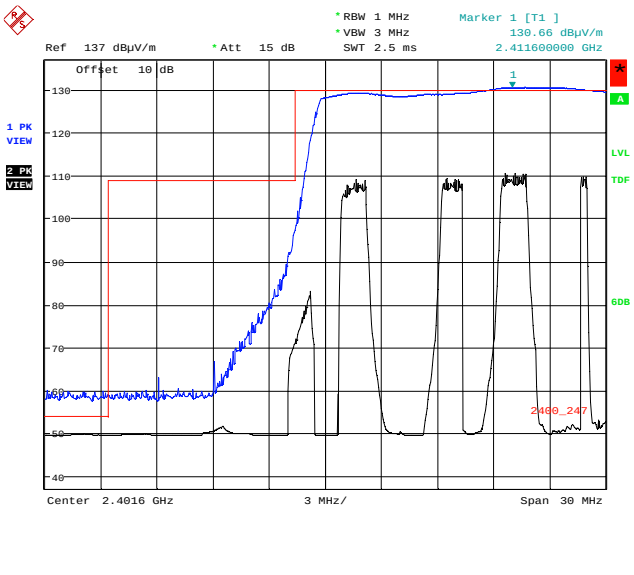
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.3. Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
Single Frequency Mode, Low End of Frequency Band



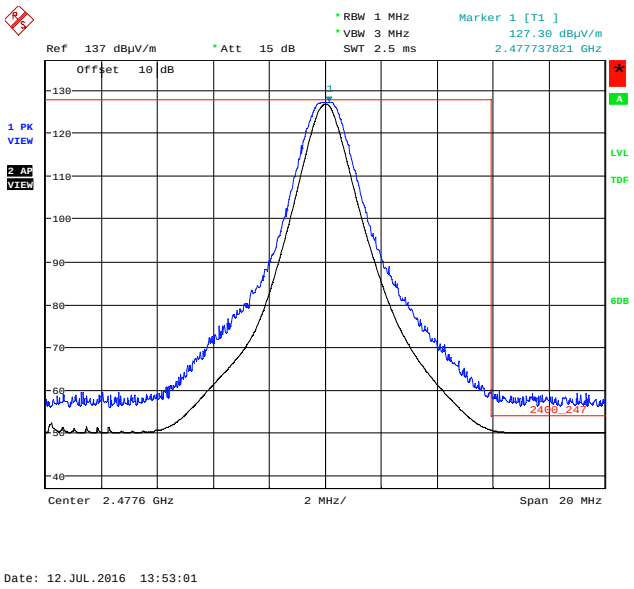
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.4. Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
Pseudorandom Channel Hopping Mode, Low End of Frequency Band



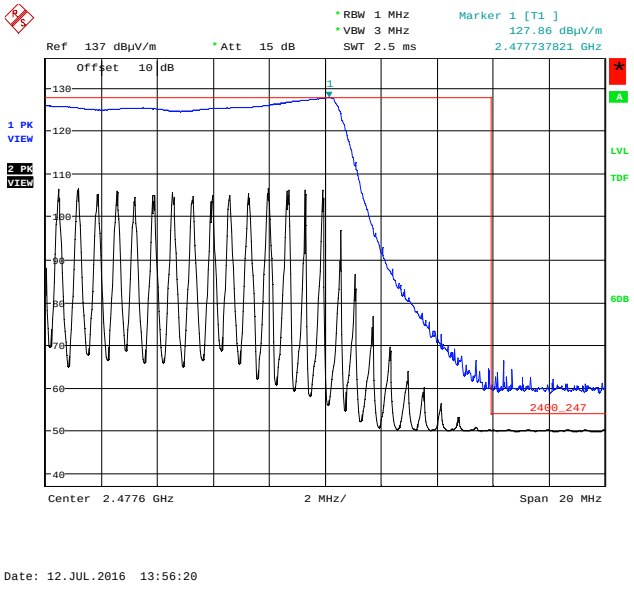
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.5. Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
Single Frequency Mode, High End of Frequency Band



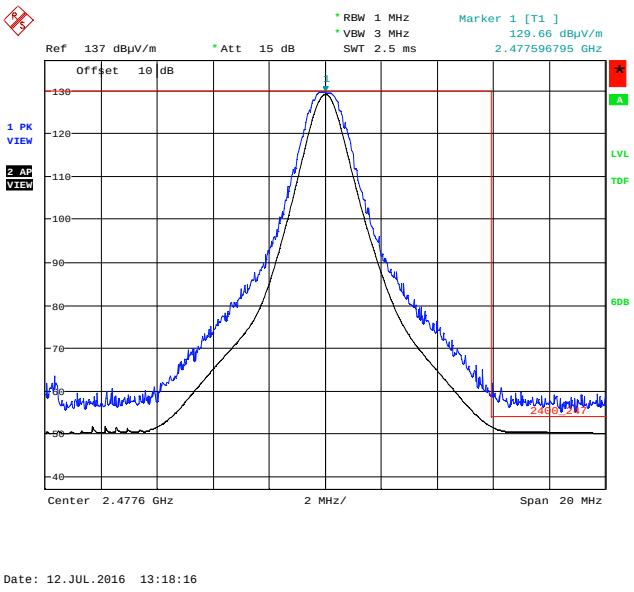
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.6. Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
Pseudorandom Channel Hopping Mode, High End of Frequency Band



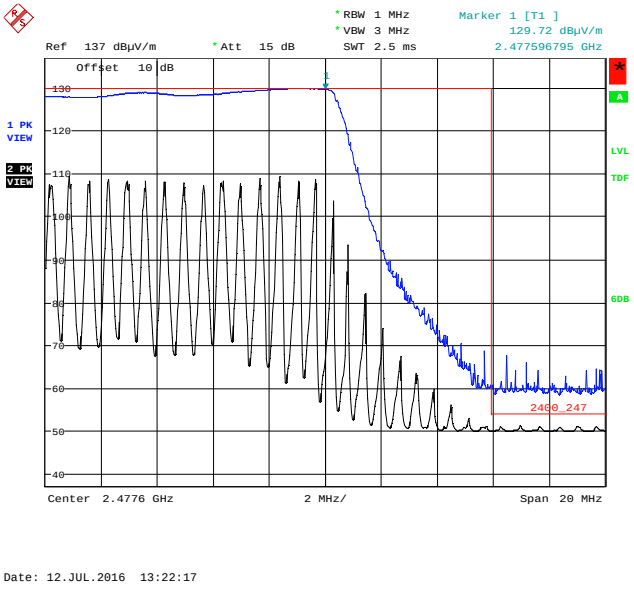
Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.7. Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
Single Frequency Mode, High of Frequency Band



Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

Plot 5.2.4.1.2.8. Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
Pseudorandom Channel Hopping Mode, High End of Frequency Band



Trace 1: RBW = 1 MHz, VBW = 3 MHz, EMI 6dB filter
Trace 2: RBW = 1 MHz, VBW = 10 Hz, EMI 6dB filter

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz - 40 GHz	21 Nov 2016
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz	Cal on use
Attenuator	Pasternack	7024-20	6	DC–26.5 GHz	Cal on use
EMI Receiver	Rohde & Schwarz	ESU40	100037	20 Hz–40 GHz	08 May 2017
RF Amplifier	Com-Power	PAM-0118A	551052	0.5 – 18 GHz	13 Jul 2016
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	05 May 2017
Biconilog	EMCO	3142	9601-1005	26-1000 MHz	12 May 2017
Horn Antenna	EMCO	3155	6570	1 – 18 GHz	11 Sep 2016
Horn Antenna	EMCO	3160-09	118385	18 – 26.5 GHz	04 Aug 2016
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2400 MHz	Cal on use
Band Reject Filter	Micro-Tronics	BRM50701	105	Cut off 2.4-2.483 GHz	Cal on use
Spectrum Analyzer	Rohde & Schwarz	FSU26	100398	20 Hz – 26.5 GHz	14 Sep 2017
Attenuator	Pasternack	PE7024-10	4	DC – 26.5 GHz	Cal on use

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.44**	**± 1.8**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 2.89**	**± 3.6**

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	**Measured (dB)**	**Limit (dB)**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.39**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.79**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	**Measured (dB)**	**Limit (dB)**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.39**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.78**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	**Measured (dB)**	**Limit (dB)**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.87**	**Under consideration**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 3.75**	**Under consideration**