ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : **OT-18N-RWD-029**

AGR No. : **A18NA-207**

Applicant : **Umain Inc.**

Address : **9th fl. Nano Fab Centre(KAIST), Daehak-ro 291, Yuseong-gu, Daejeon, Korea**

Manufacturer : **Umain Inc.**

Address : **9th fl. Nano Fab Centre(KAIST), Daehak-ro 291, Yuseong-gu, Daejeon, Korea**

Type of Equipment : **UWB Radar Sensor**

FCC ID. : **2AN8QUMI-HST-S1M-CT**

Model Name : **HST-S1M-CT**

Multiple Model Name: N/A

Serial number : **N/A**

Total page of Report : **29 pages (including this page)**

Date of Incoming : **October 11, 2017**

Date of issue : **November 19, 2018**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART F Section 15.519***

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: Jae-Ho Lee / Chief Engineer
ONETECH Corp.

Approved by: Keun-Young, Choi / Vice President
ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W17NR-D043	November 14, 2017	Initial Issue	All
OT-18N-RWD-029	November 19, 2018	Shutoff Timing Requirements	Page 12, 13

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1. VERIFICATION OF COMPLIANCE

APPLICANT	: Umain Inc.
ADDRESS	: 9th fl. Nano Fab Centre(KAIST), Daehak-ro 291, Yuseong-gu, Daejeon, Korea
CONTACT PERSON	: Youngwhan Kim
TELEPHONE NO	: +82-42-825-9973
FCC ID	: 2AN8QUMI-HST-S1M-CT
MODEL NAME	: HST-S1M-CT
SERIAL NUMBER	: N/A
DATE	: November 19, 2018

EQUIPMENT CLASS	***UWB – ULTRA WIDEBAND TRANSMITTER***
KIND OF EQUIPMENT	UWB Radar Sensor
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART F Section 15.519
MODIFICATIONS ON THE EQUIPMENT TO ACHIEVE COMPLIANCE	None
FINAL TEST WAS CONDUCTED ON	3 m Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report shows the maximum emission levels emanating from equipment are within the compliance requirements.

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2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.207	AC Conducted Emissions	N/A (See Note)
15.519(a)(1)	Shutoff Timing Requirements	Met the Limit / PASS
15.519(b)	UWB Bandwidth	Met the Limit / PASS
15.519(c)/15.209	Radiated Emissions	Met the Limit / PASS
15.519(d)	Radiated Emissions in GPS Bands	Met the Limit / PASS
15.519(e)	Peak Emissions within a 50MHz Bandwidth	Met the Limit / PASS
15.203	Antenna requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by DC Voltage.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART F Section 15.519

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

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2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666 / T-1842

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The Umain Inc., Model HST-S1M-CT (referred to as the EUT in this report) is a UWB Radar Sensor. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	UWB Radar Sensor
OPERATING FREQUENCY	4 000 MHz
RF OUTPUT POWER	52.08 dBμV/m
MODULATION TYPE	MB-OFDM
ANTENNA TYPE	Monopole Antenna
ANTENNA GAIN	6.11 dBi
LIST OF EACH OSC. OR CRYSTAL. FREQ.(FREQ.>=1 MHz)	32.768 kHz, 16 MHz
RATED SUPPLY VOLTAGE	DC 5.0 V

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

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5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
-	-	-	-

5.2 Peripheral equipment

Model	Manufacturer	Description	Connected to
-	-	-	-

5.3 Mode of operation during the test

The EUT was used for making continuous transmitting and receiving mode during the test.

5.4 Configuration of Test System

Line Conducted Test: It is not need to test this requirement, because the EUT shall be operated by DC Voltage.

Radiated Emission Test: The EUT was tested in a Transmitting mode. Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The transmitter antenna of the EUT is a Monopole Antenna, so no consideration of replacement by the user.

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6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Tests, the following operating mode was investigated

Operation Mode	The Worse operating condition (Please check one only)
It is not need to test this requirement, because the power of the EUT is supplied by battery.	

6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

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7. Shutoff Timing Requirements

7.1 Operating environment

Temperature : 26 ℃

Relative humidity : 47 % R.H.

7.2 Test set-up

1. A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

7.2 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
☐ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Aug. 23, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Aug. 24, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA91700179	Jul. 28, 2017 (2Y)

All test equipment used is calibrated on a regular basis.

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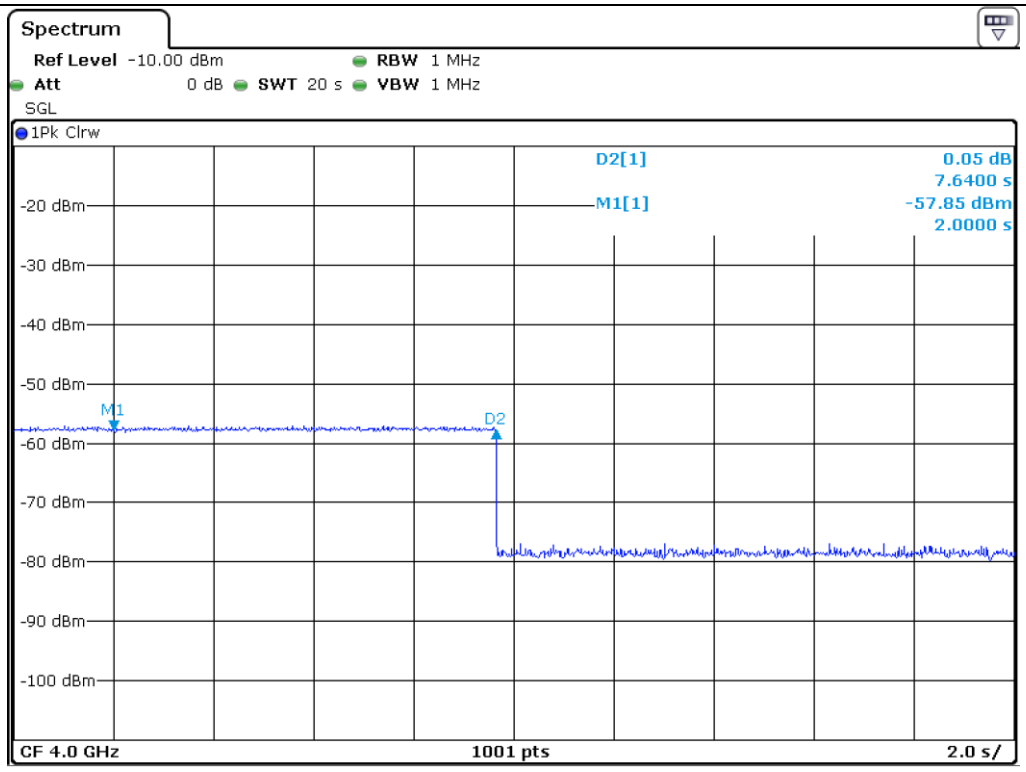
7.3 Test data

-. Test Date : November 19, 2018

-. Test Result : Pass

Frequency (MHz)	Shutdown Time (s)	Limit (s)	Margin (s)	Test Result
4000.00	7.64	10.00	2.36	PASS

Tested by: Ha-Ram, Lee / Assistant Manager



Shutdown Time

8. UWB Bandwidth Measurement

8.1 Operating environment

Temperature : 25 ℃

Relative humidity : 45 % R.H.

8.2 Test set-up

1. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. The horn receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
3. For maximum emission amplitude, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading and was used to determine the frequency at which the highest radiated emission occurs, fM. Next, the points that are 10dB or more below the highest radiated emission were observed in a search from fM in both the lower and higher frequency direction in the measured frequency EIRP graph, they are denoted as fL and fH, respectively. The UWB bandwidth is the difference between fL and fH.
4. The individual UWB bandwidths were measured for each BAND_ID (nb) of the UWB spectrum. Both horizontal and vertical polarizations were taken into account to determine the full UWB BW on the maximized (in azimuth and elevation) signals.

8.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
☐ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Aug. 23, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Aug. 24, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA91700179	Jul. 28, 2017 (2Y)

All test equipment used is calibrated on a regular basis.

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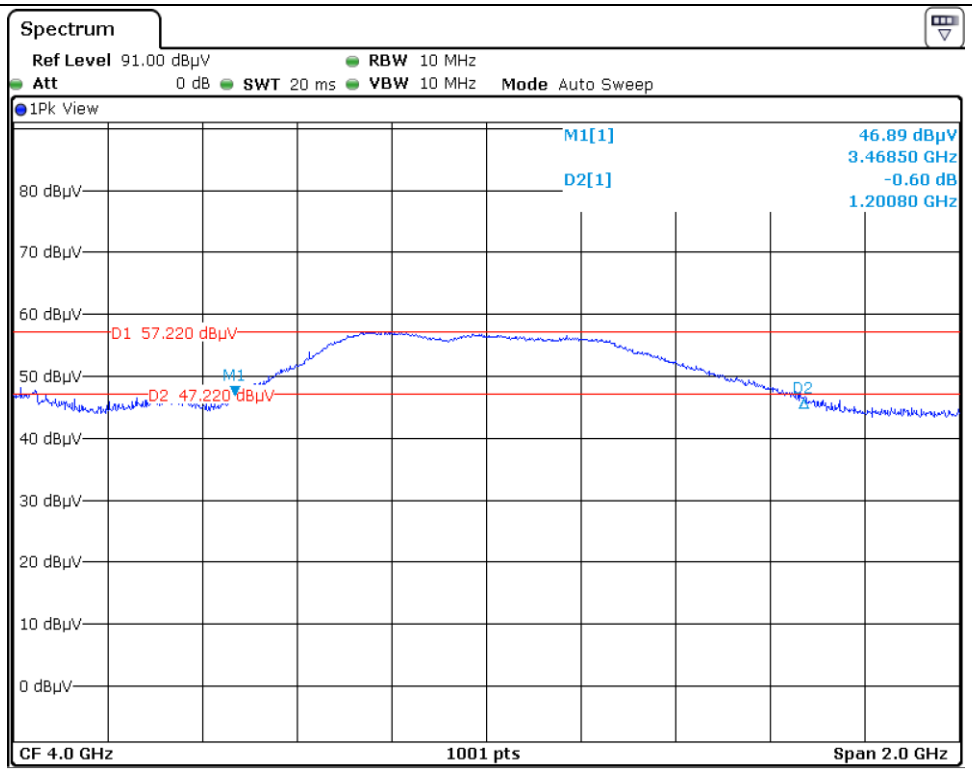
8.4 Test data

-. Test Date : November 03, 2017

-. Test Result : Pass

Frequency (MHz)	FL (GHz)	FH (GHz)	Limit	Test Result
4000.00	3.468 50	4.669 30	Between 3 100 MHz and 10 600 MHz	PASS

Tested by: Ha-Ram, Lee / Assistant Manager



3 100 MHz ~ 10 600 MHz

9. Radiated Emissions Measurement

9.1 Operating environment

Temperature : 25 ℃

Relative humidity : 45 % R.H.

9.2 Test set-up

1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable for measured the frequency range below 960 MHz and antenna tower was placed below 1 meters far away from the turntable for measured the frequency range above 960 MHz.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. The measurements made over the frequency range from 9 kHz to 960 MHz were maximized using an EMI receiver with peak detector capabilities. Measurements of the radiated field from 9 kHz to 960 MHz were made with the measurement antenna located a distance of 3 meters from the EUT. If the emissions level of the EUT in peak mode was 3 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
6. Measurements above 960 MHz were maximized using a spectrum analyzer with RMS detector capabilities. A spectrum analyzer was used for the final measurements utilizing an RMS detector at the frequencies with the largest amplitudes. The prescribed RBW of 1 MHz and VBW of 3 MHz, and a1 msec averaging time were used for these measurements. Measurements of the radiated field at frequencies above 960 MHz were made with the measurement antenna located a distance of below 1 meter from the EUT.
7. The spectrum between 9 kHz and 960 MHz contained no intentional radiation and lies below the limits. The spectrum from 960MHz to18GHz contained intentional UWB signals between 3100 MHz and 10600 MHz and lie below the limits. No other emissions above 10600 MHz were detected. The maximum frequency tested was 40 GHz.
8. Per 47 CFR, Part 15, Subpart F, §15.521© (§15.209) all digital emissions from the transmitter not intended to be radiated from the antenna port meet the 15.209 subpart C limits.
9. Additional measurements in the 960 MHz to 40 GHz range were performed to determine the nature of all unintentional emissions in this span. Conducted antenna port measurement and terminated antenna port measurement were done in the 960 MHz to 8 GHz range show that all noise peaks have the same frequency and polarization and are determined to be emission from the digital circuit and are not radiated from the antenna.

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9.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
☐ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Aug. 23, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	FSV40	Rohde & Schwarz	SPECTRUM ANALYZER	101069	Mar. 15, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Aug. 02, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jul. 28, 2017 (2Y)
■ -	SCU40A	Rohde & Schwarz	Pre-Amplifier	100436	Mar. 15, 2018 (1Y)
■ -	83051A	Agilent	Microwave System Preamplifer	3950M00201	Mar. 15, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

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9.4 Test data

9.4.1 Test Data for 30 MHz ~ 960 MHz

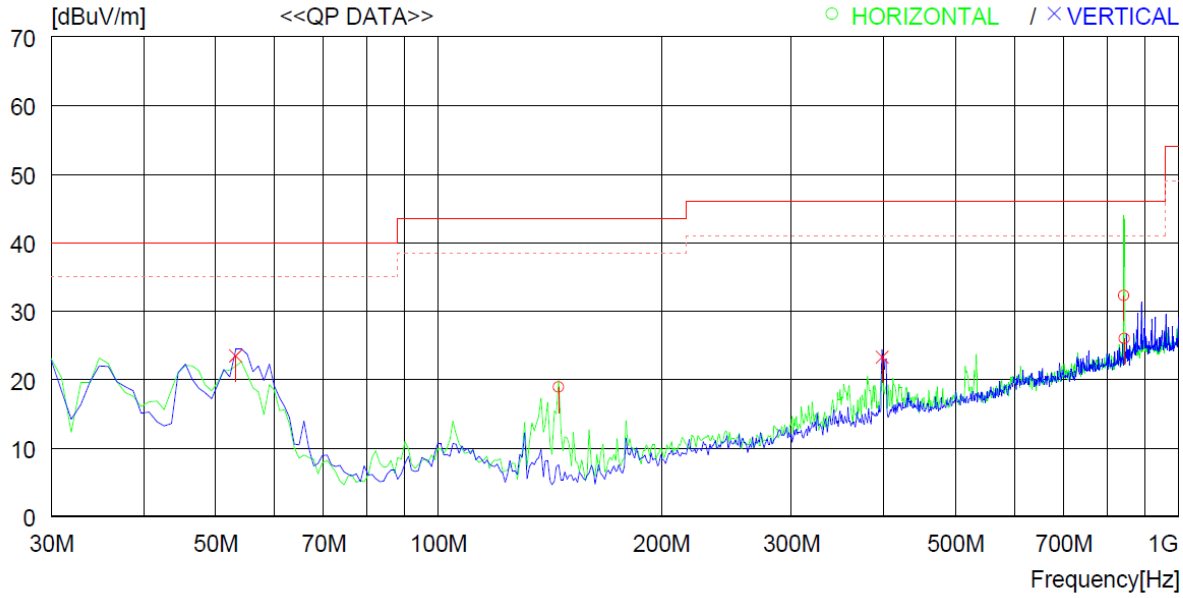
Humidity Level : 45 % R.H. Temperature: 25 ℃

Limits apply to : FCC CFR 47, PART 15, SUBPART F, SECTION 15.519

Result : PASSED

EUT : UWB Radar Sensor Date: November 10, 2017

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	145.430	41.1	7.8	2.9	32.9	18.9	43.5	24.6	100	346
2	843.821	37.6	21.0	6.7	33.0	32.3	46.0	13.7	100	278
3	845.761	31.2	21.1	6.7	33.0	26.0	46.0	20.0	100	278
----- Vertical -----										
4	53.280	41.0	13.8	1.8	33.1	23.5	40.0	16.5	300	0
5	397.630	35.9	16.0	4.6	33.2	23.3	46.0	22.7	100	244

Tested by: Ha-Ram, Lee / Assistant Manager

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9.4.2 Test Data for 960 MHz ~ 40 GHz

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1 023.960	31.92	Average	H	23.71	0.61	31.40	24.84	29.50	4.66
1 197.990	32.16	Average	V	23.71	0.67	31.80	24.74	29.50	4.76
1 861.880	29.43	Average	V	26.93	0.82	30.50	26.68	41.50	14.82
1 862.260	29.34	Average	H	26.93	0.82	30.50	26.59	41.50	14.91
2 023.800	28.57	Average	H	26.93	0.85	30.00	26.35	43.50	17.15
2 036.000	28.55	Average	V	26.93	0.85	30.00	26.33	43.50	17.17
6 160.700	27.25	Average	V	33.26	1.64	28.10	34.05	63.50	29.45
7 039.200	24.18	Average	H	36.60	1.94	27.40	35.32	63.50	28.18
14 898.800	23.73	Average	V	40.69	2.95	30.60	36.77	43.50	6.73
15 859.800	23.71	Average	H	37.60	3.59	31.00	33.90	43.50	9.60
18 011.000	38.29	Average	H	38.71	3.32	55.87	24.45	43.50	19.05
18 011.000	38.40	Average	V	38.71	3.32	55.87	24.56	43.50	18.94

Tested by: Ha-Ram, Lee / Assistant Manager

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9.5 Limit

The radiated emissions at or below 960 MHz from a device shall not exceed the emission levels in section 15.209(a) limit below.

Frequencies (MHz)	Field Strength (micorvolts/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

The radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Freq. (MHz)	EIRP (dBm)	- Field (dBμV/m) at 3m	E- Field (dBμV/m) at 1m
960-1610	-75.3	19.9	29.5
1 610-1 990	-63.3	31.9	41.5
1 990-3 100	-61.3	33.9	43.5
3 100-10 600	-41.3	53.9	63.5
10 600 above	-61.3	33.9	43.5

Note 1: This may be converted to a peak field strength level at 3 meters using E(dBuV/m) = P(dBm EIRP) + 95.2 dB. Note 2: Above 960MHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m. Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB); Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB].

From 47 CFR Section 15.517(c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in Section 15.209 of this chapter, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in Section 15.3(k) of this chapter, e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of Part 15 of this chapter.

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The radiated emissions from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209.

Freq. (MHz)	E- Field (dBμV/m) at 3m		E- Field (dBμV/m) at 1m	
	Quasi Peak			
30 ~ 88	40.00		49.54	
88 ~ 216	43.50		53.04	
216 ~ 960	46.00		54.54	
	Peak	**Average**	**Peak**	**Average**
Above 960	74.00	54.00	83.54	63.54

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10. Radiated Emissions in GPS Bands Measurement

10.1 Operating environment

Temperature : 25 ℃

Relative humidity : 45 % R.H

10.2 Test set-up

1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Measurements frequencies were maximized using a spectrum analyzer with RMS detector capabilities. A spectrum analyzer was used for the final measurements utilizing an RMS detector at the frequencies with the largest amplitudes. The prescribed RBW of 1 kHz and VBW of 1 kHz, and a 1 msec averaging time were used for these measurements.
6. Per 47 CFR, Part 15, Subpart F, §15.521© (§15.209) all digital emissions from the transmitter not intended to be radiated from the antenna port meet the 15.209 subpart C limits.

10.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
☐ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Aug. 23, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	FSV40	Rohde & Schwarz	SPECTRUM ANALYZER	101069	Mar. 15, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Aug. 02, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jul. 28, 2017 (2Y)
■ -	83051A	Agilent	Microwave System Preamplifer	3950M00201	Mar. 15, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

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10.4 Test data

-. Test Date : November 10, 2017

-. Resolution bandwidth : 1 kHz for Average Mode

-. Video bandwidth : 1 kHz for Average Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1 199.950	2.87	Average	V	24.30	0.69	31.40	-3.54	19.44	22.98
1 559.940	0.15	Average	V	25.30	0.77	32.60	-6.38	19.44	25.82

Remark. Total = Reading + Antenna Factor + Cable loss - Amp Gain

Tested by: Ha-Ram, Lee / Assistant Manager

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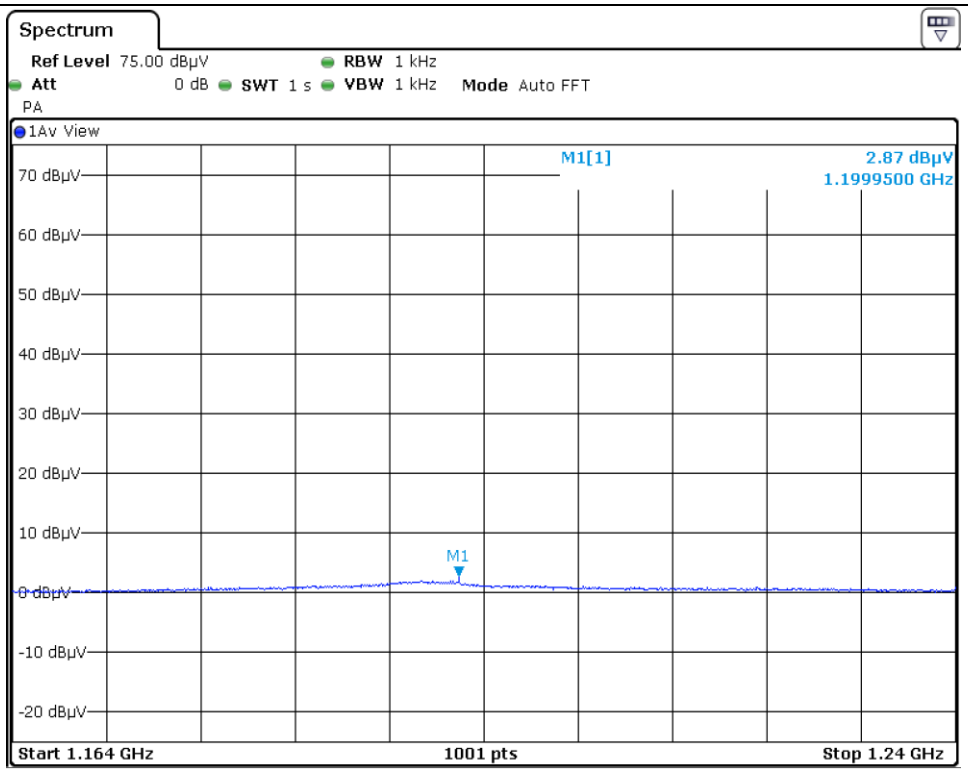
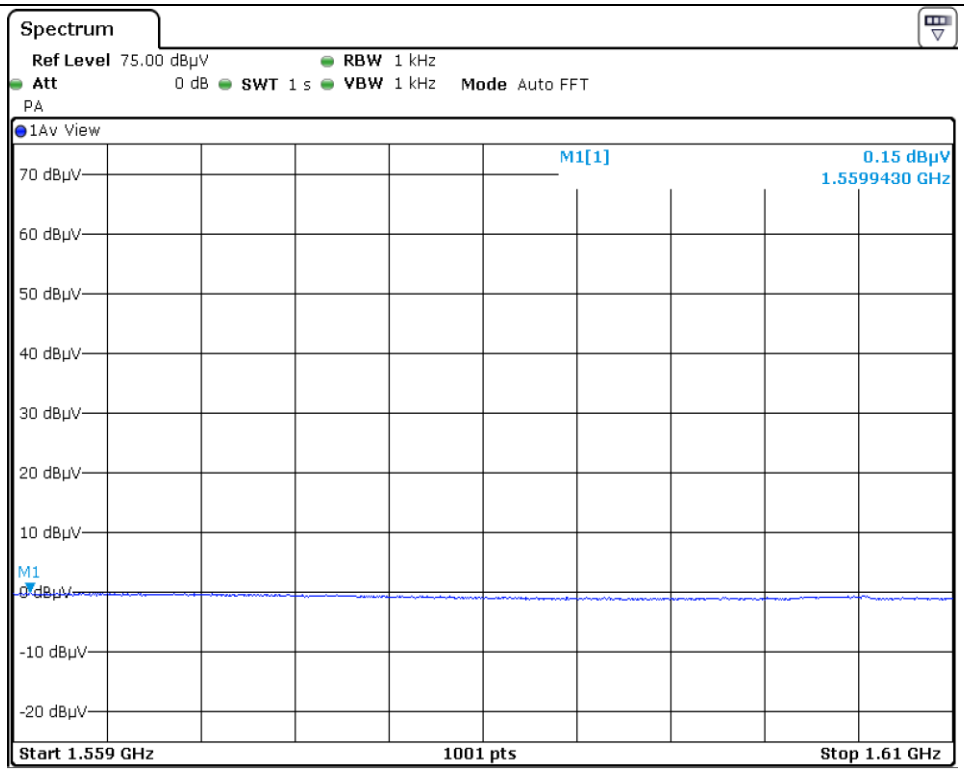


1 164 MHz ~ 1 240 MHz



1 559 MHz ~ 1 610 MHz

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10.5 Limit

In addition to the radiated emission limits specified in the table in paragraph 4.5.1 of this report, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz.

Freq. (MHz)	EIRP (dBm)	E- Field (dBμV/m) at 3 m	E- Field (dBμV/m) at 1 m	E- Field (dBμV/m) at 0.5 m
1 164-1 240	-85.3	9.9	19.44	25.46
1 559-1 610	-85.3	9.9	19.44	25.46

Note 1: This may be converted to a peak field strength level at 3 meters using E(dBuV/m) = P(dBm EIRP) + 95.2 dB. Note 2: Above 960MHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m. Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB); Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB].

Note 3: Above 960MHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m. Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB); Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB]. form 3m to 0.5m. Distance extrapolation factor = 20 log (specific distance [3m] / test distance [0.5m]) (dB); Limit line = specific limits (dBuV) + distance extrapolation factor [15.56 dB].

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11. Peak Emissions within a 50 MHz Bandwidth Measurement

11.1 Operating environment

Temperature : 25 ℃

Relative humidity : 45 % R.H

11.2 Test set-up

1. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1 meters far away from the turntable.
2. The horn receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
3. For maximum peak emission amplitude, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading and was used to determine the frequency at which the highest radiated emission occurs, fM.
4. The individual UWB bandwidths were measured for each BAND_ID (nb) of the UWB spectrum. Both horizontal and vertical polarizations were taken into account to determine the full UWB BW on the maximized (in azimuth and elevation) signals.
5. A spectrum analyzer was used for the final measurement utilizing a peak detector at the frequency with the largest amplitude. The prescribed resolution bandwidth of 50 MHz was not supported by the spectrum analyzer. However, when a peak measurement is required, The resolution bandwidth for this measurement was set to 10 MHz, and the measurement was centered on the frequency at which the highest radiated emission occurred, fM. The video bandwidth was 10 MHz.

11.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
☐ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Aug. 23, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Aug. 24, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA91700179	Jul. 28, 2017 (2Y)

All test equipment used is calibrated on a regular basis.

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11.4 Test data

-. Test Date : November 03, 2017

-. Resolution bandwidth : 10 MHz for Peak Mode

-. Video bandwidth : 10 MHz for Peak Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
4 000.00	45.34	Peak	H	29.50	12.10	40.70	46.24	90.77	44.53
4 000.00	51.18	Peak	V	29.50	12.10	40.70	52.08	90.77	38.69

Tested by: Ha-Ram, Lee / Assistant Manager

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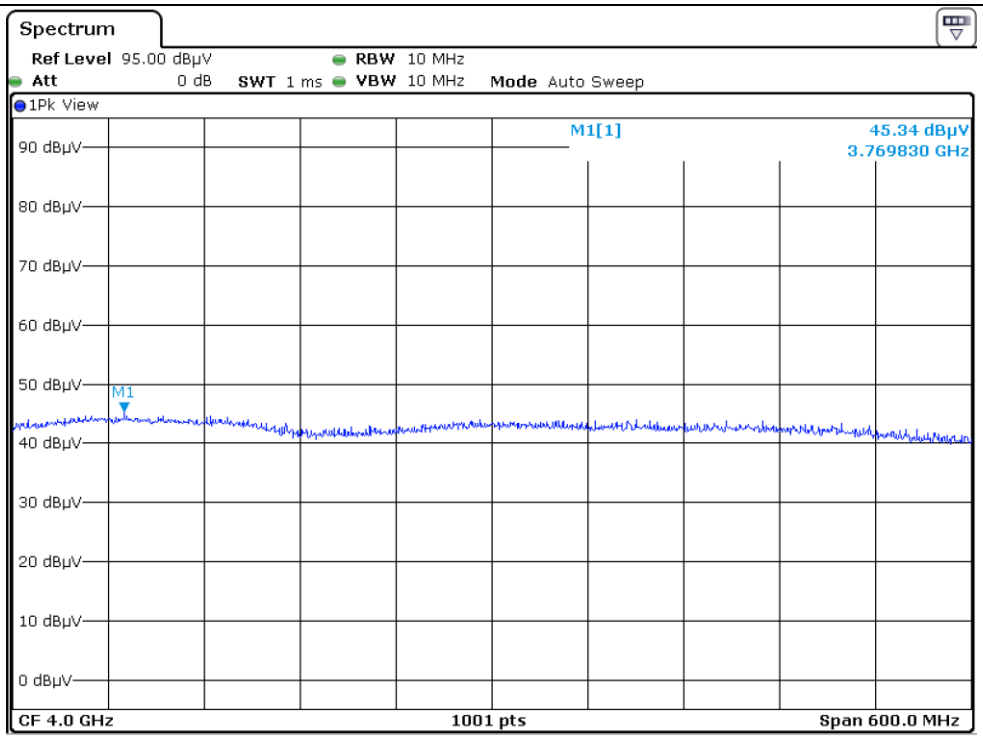
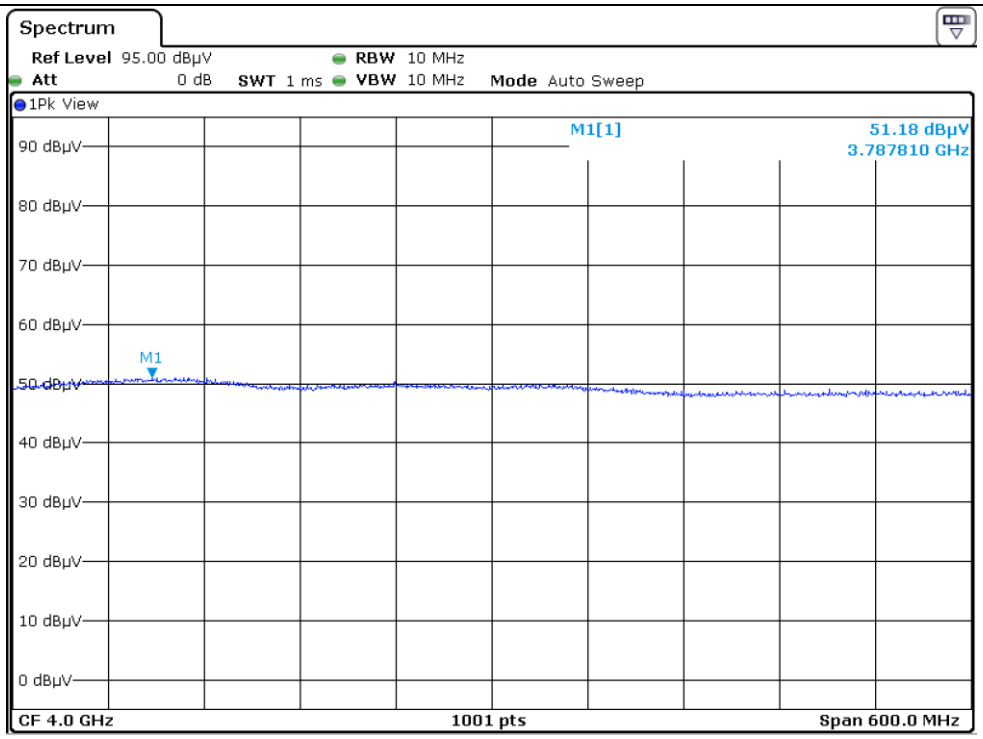


HORIZONTAL at 1m



VERTICAL at 1m

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11.5 Limit

There is a limit on the peak level of the emissions contained within a 10 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, fM. That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, EIRP limit has to be adjusted by the resolution bandwidth ratio of 20log(RBW/50) dB, where RBW is the resolution bandwidth used for the measurement expressed in MHz. In addition, This may be converted to a peak field strength level at 3 meters using E(dBuV/m) = P(dBm EIRP) + 95.2 dB. And Peak emission shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m. Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB); Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB]

Peak EIRP limit dBm (RB / VB : 50MHz)	Peak EIRP limit dBm (RB / VB: 10MHz)	E- Field (dBμV/m) at 3m (RB / VB: 10MHz)	E- Field (dBμV/m) at 1m (RB / VB: 10MHz)
0	-13.97	81.23	90.77

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