



FCC LISTED, REGISTRATION  
NUMBER: 2764.01

ISED LISTED REGISTRATION  
NUMBER: 23595-1

Test report No:  
3992ERM.004A1

## Test report

USA FCC 15.519/FCC 15.521  
CANADA RSS-220

RF Measurement of Ultra-Wideband (UWB) devices operating within  
the band 3100 MHz and 10600 MHz.

(*) Identification of item tested	Ultra Wideband (UWB) Impulse Radar Sensor
(*) Trademark	Novelda
(*) Model and /or type reference	X4F103
Other identification of the product	FCC ID: 2AD9Q-X4F103 IC: 22782-X4F103
(*) Features	---
(*) Manufacturer	Novelda AS Garverivegen 2 Kviteseid 3850 Norway
Test method requested, standard	FCC CFR Title 47 Part 15 Subpart F: 2015 CANADA RSS-220 Issue 1 (July 2018). RSS-GEN Issue 5 (March 2019) ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Domingo Galvez EMC&RF Lab Manager
Date of issue	08-11-2023
Report template No	FDT08_23 (*) "Data provided by the client"

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## Competences and guarantees

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DEKRA Certification Inc. is a testing laboratory accredited by A2LA (The American Association for Laboratory Accreditation), to perform the tests indicated in the Certificate 2764.01

DEKRA Certification Inc. is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Certification Inc. has a calibration and maintenance program for its measurement equipment.

DEKRA Certification Inc. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Certification at the time of performance of the test.

DEKRA Certification Inc. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

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## General conditions

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Certification Inc. and the Accreditation Bodies.

## Uncertainty

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Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Certification internal document PODT000.

Frequency (MHz)	U( $k=2$ )	Units
30-180	<b>4.27</b>	dB
180-1000	<b>3.14</b>	dB
1000-18000	<b>3.30</b>	dB
18000-40000	<b>3.49</b>	dB

## Data provided by the client

The X4F103 is an Ultra-Wideband (UWB) short-range impulse radar sensor module, designed for unlicensed operation in world-wide markets. The X4F103 contains all required circuitry, such as antennas, clocks and decoupling capacitors and can be connected directly to existing systems through a standard I2C or SPI interface.

The X4F103 sensor is extremely sensitive and can detect human presence based on respiration motion alone. The sensor accurately detects presence within the detection zone and has configurable range limits and sensitivity settings.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

## Usage of samples

Samples undergoing test have been selected by: The client.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
3992.03	X4F103 sensor with MCU board	X4F103	--	12/07/2022

Sample S/01 is composed of the following Auxiliaries elements:

Control Nº	Description	Model	Serial Nº	Date of reception
Dekra	AC Adapter	Ktec / KSA01A5210100D5	--	--
Dekra	USB type A(male) to USB-C (male) cable	--	--	--

Sample S/01 was used in following testing: All Conducted and Radiated tests mentioned in Appendix A

## Test sample description

Ports.....	Port name and description	Cable				
		Specified length [m]	Attached during test	Shielded		
		<input type="checkbox"/>	<input type="checkbox"/>			
		<input type="checkbox"/>	<input type="checkbox"/>			
		<input type="checkbox"/>	<input type="checkbox"/>			
		<input type="checkbox"/>	<input type="checkbox"/>			
		<input type="checkbox"/>	<input type="checkbox"/>			
Supplementary information to the ports.....:	No Data provided					
Rated power supply .....	Voltage and Frequency	Reference poles				
		L1	L2	L3	N	
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		<input checked="" type="checkbox"/>	DC: 1.8 V – 3.3 V, Nominal 2.5 V			
		<input type="checkbox"/>	DC:			
Rated Power .....	No Data provided					
Clock frequencies .....	No Data provided					
Other parameters.....:	No Data provided					
Software version .....	0.3.1					
Hardware version.....:	1.4					
Dimensions in cm (L x W x D) ....:	No Data provided					
Mounting position.....	<input type="checkbox"/>	<i>Table top equipment</i>				
	<input type="checkbox"/>	<i>Wall/Ceiling mounted equipment</i>				
	<input type="checkbox"/>	<i>Floor standing equipment</i>				
	<input type="checkbox"/>	<i>Hand-held equipment</i>				
	<input type="checkbox"/>	Other:				

Modules/parts .....	Module/parts of test item	Type	Manufacturer
	No Data provided		
Accessories (not part of the test item) .....	Description	Type	Manufacturer
	No Data provided		
Documents as provided by the applicant .....	Description	File name	Issue date
	Declaration Equipment Data	FDT30_18 Declaration Equipment Data (1).pdf	1/17/2023
<b>Copy of marking plate:</b>			
No Marking Plate found on EUT			

## Identification of the client

Novelda AS  
Garverivegen 2  
Kviteseid 3850  
Norway

## Testing period and place

Test Location	DEKRA Certification Inc.
Date (start)	02-15-2023
Date (finish)	02-23-2023

## Document history

Report number	Date	Description
3992ERM.004	03-28-2023	First release
3992ERM.004A1	08-11-2023	Second release. Summary section was updated, Limits were updated to include RSS 220 in Appendix A, Test A.1: Radiated Emission Limit Section and spectrum analyser settings were added in test results section. This modification test report cancels and replaces the test report 3992ERM.004.

## Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semi-anechoic chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 60 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

## Remarks and comments

The tests have been performed by the technical personnel: Sravani Gollamudi, Qi Zhang, and Koji Nishimoto.

## Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

## Summary

FCC PART 15.519 /15.521					
Section	FCC Spec Clause	RSS Spec Clause	Test Description	Verdict	Remark
	§ Section 15.207	RSS-GEN Clause 8.8	Conducted Emission	N/A	Refer 1
A.1	§ Section 15.209 § Section 15.519(c)	RSS GEN Clause 8.9 RSS -220 Clause 5.3.1(c)(d)	Radiated Emission	P	N/A
A.2	§ Section 15.519(d)	RSS -220 Clause 5.3.1(e)	Radiated Emission in GPS band	P	N/A
A.3	§ Section 15.519(a)	RSS -220 Clause 5.3.1(b)	Transmitter On/Off Requirement	P	N/A
A.4	§Section 15.503(a) § Section 15.519(b)	RSS -220 Clause 5.1(a)	10 dB Bandwidth	P	N/A
A.5	§ Section 15.521(g) § Section 15.519(e)	RSS -220 Clause 5.3.1(g)	Peak level of Emission	P	N/A

Supplementary information and remarks:

- 1) According with the requirements of FCC Rules and Regulations, title 47, Chapter I, Subchapter A, Part 15, Subpart B & C, §15.107 & §15.207 Conducted limits, (d) & (c), Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation, and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits. According to ISED requirements,

## List of equipment used during the test

### Conducted Measurements

CONTROL NUMBER	DESCRIPTION	MANUFACTURER	MODEL	LAST CALIBRATION	NEXT CALIBRATION
1039	Spectrum analyzer	Rohde & Schwarz	FSV40	2022/11	2024/11

### Radiated Measurements

CONTROL NUMBER	DESCRIPTION	MANUFACTURER	MODEL	LAST CALIBRATION	NEXT CALIBRATION
1012	EMI Test Receiver	Rohde & Schwarz	ESR26	2022/04	2024/04
1014	Spectrum analyzer	Rohde & Schwarz	FSV40	2021/05	2023/05
1055	Double-Ridged Waveguide Horn Antennas	ETS Lindgren	3116C	2023/02	2026/02
1057	Double Ridged Waveguide Horn Antenna	ETS Lindgren	3115	2020/05	2023/05
1065	Biconical Log antenna	ETS Lindgren	3142E	2020/08	2023/08
1108	Ethernet SNMP Thermometer- CR Room	HW Group	HWg-STE Plain	2022/10	2024/10
1111	Ethernet SNMP Thermometer- SAC	HW Group	HWg-STE Plain	2022/10	2024/10
1179	Semi anechoic Absorber Lined Chamber"	Frankonia	SAC 3 plus L	N/A	N/A
1314	EMC measurement Software	Rohde & Schwarz	EMC32	N/A	N/A
1461	Low Noise Preamplifier	BONN ELECKTRONIK	BLMA0118-2A	2022/06	2024/06

## **Appendix A: Test results**

## Appendix A Content

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## PRODUCT INFORMATION

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The following information is provided by the client

Information	Description
Modulation	Pulsed TX with pseudo random biphasic
Lowest Operating Frequency	6.2 GHz
Highest Operating Frequency	8.3 GHz
RF output Power	-43.9 dBm/MHz (Power Spectral Density)
Operating Voltage range	1.8 V – 3.3 V
- Nominal Voltage	2.5 V
Channel bandwidth	900 MHz
Antenna gain	-0.27 dBi
Type of Antenna	Integrated PCB antenna

## DESCRIPTION OF TEST CONDITIONS

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TEST CONDITIONS	DESCRIPTION
TC/01	<p><u>Power supply (V):</u> <math>V_{nominal} = 2.5 \text{ V}</math></p> <p><u>Modulation:</u> Pulsed TX with pseudo random bi-phase</p> <p><u>Test Frequency band / range:</u> 6.2 – 8.3 GHz</p>

## TEST A.1: RADIATED EMISSION

<b>LIMITS:</b>	Product standard:	Part 15 Subpart C §15.209(a) and Subpart F § 15.519 (c) and RSS-GEN Clause 8.9 and RSS 220 Clause 5.3(c)(d)
	Test standard:	ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6, 10.2 and 10.3

### LIMITS

Part 15 Subpart C §15.209(a) and Subpart F § 15.519 (c)

Frequency (MHz)	Distance(m)	Level (dB $\mu$ V/m)
0.009-0.490	300	20 log (2400/F(kHz))
0.490-1.705	30	20 log (24000/F(kHz))
1.705-30.0	30	29.5
30-88	3	40
88-216	3	43.5
216-960	3	46

Note 1: The lower limit shall apply at the transition frequency.

Note 2: Distance refers to the distance in meters between the measuring instrument antenna and the close point of any part of the device or system.

Note 3: E field strength (dB $\mu$ V/m) = 20 log E field strength ( $\mu$ V/m)

Note 4: E field strength (dB $\mu$ V/m) = EIRP (dBm) + 95.2

The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Fundamental frequency (MHz)	EIRP in dBm
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

LIMITS

RSS-GEN Clause 8.9 and RSS 220 Clause 5.3(c)(d)

Frequency (MHz)	Field Strength (Microvolts/m)	Distance(m)	E.i.r.p. (dBmW)
0.009-0.490	2,400/F (F in kHz)	300	10 log (17.28 / F <sup>2</sup> ) (F in kHz)
0.490-1.705	24,000/F (F in kHz)	30	10 log (17.28 / F <sup>2</sup> ) (F in kHz)
1.705-30.0	30	30	-45.7
30-88	100	3	-45.7
88-216	150	3	-51.7
216-960	200	3	-49.2

Radiated emissions at or below 960 MHz from a device shall not exceed the limits in section 3.4 (table above).

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

Hand-held (Outdoor) Communication, Measurement, Location Sensing, and Tracking Devices	
Fundamental frequency (MHz)	EIRP in a Resolution Bandwidth of 1 MHz (dBm)
960-1610	-75.3
1610-4750	-70.0
4750-10600	-41.3
Above 10600	-61.3

## TEST SETUP:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at 3 m for the frequency range 30-960 MHz (Bilog antenna), 960 MHz -18 GHz (Double ridge horn antennas) and at 1 m for the frequency range 18 GHz- 40 GHz (Double ridge horn antennas).

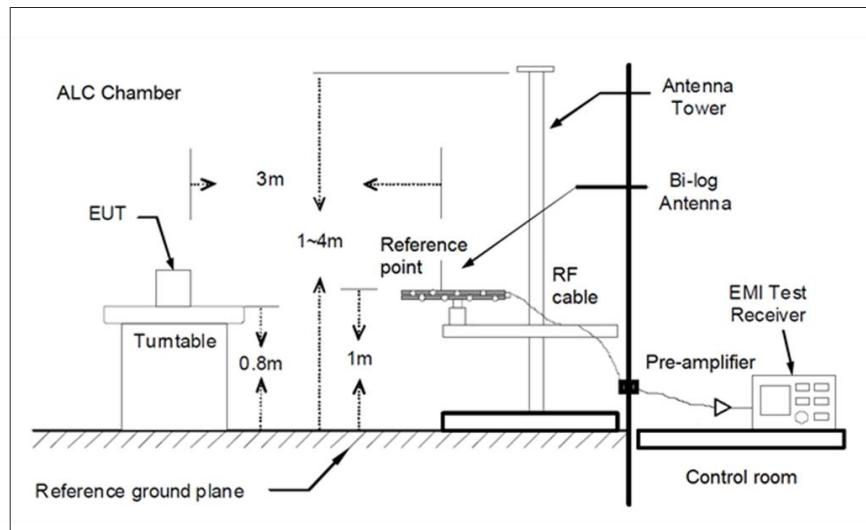
For radiated emissions in the range 960 MHz - 40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

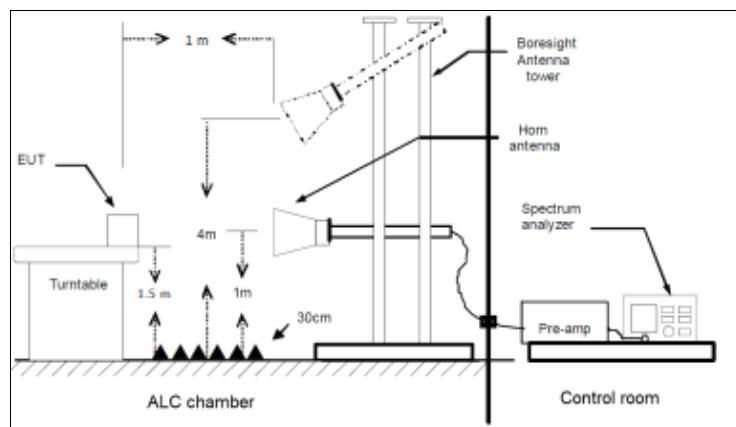
Measurements were made in both horizontal and vertical planes of polarization.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain

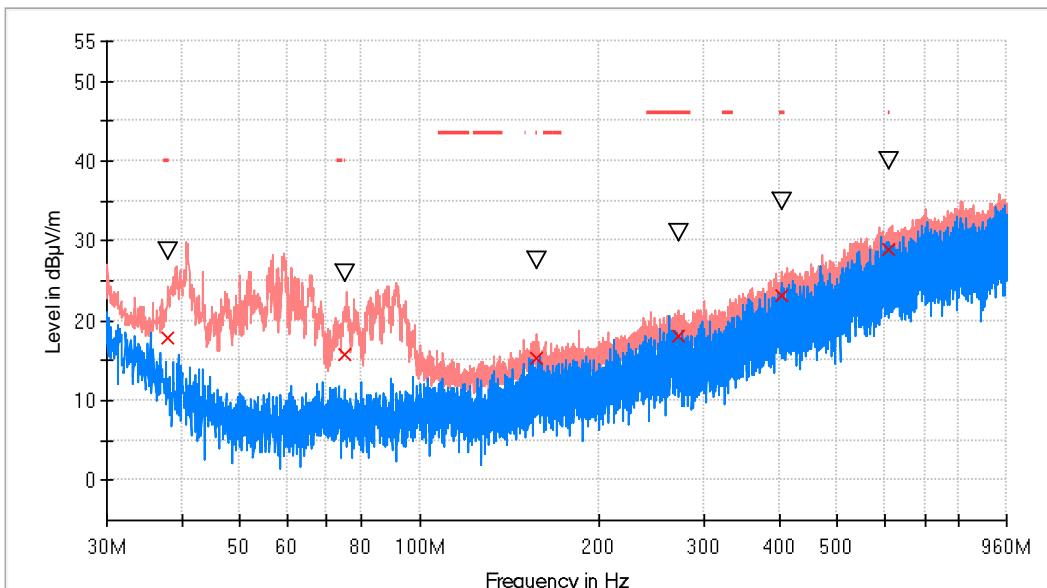
### Radiated measurements Setup 30 MHz to 18 GHz



### Radiated measurements setup f > 18 GHz



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC/01
TEST RESULTS	PASS
FREQUENCY RANGE	30 - 960 MHz

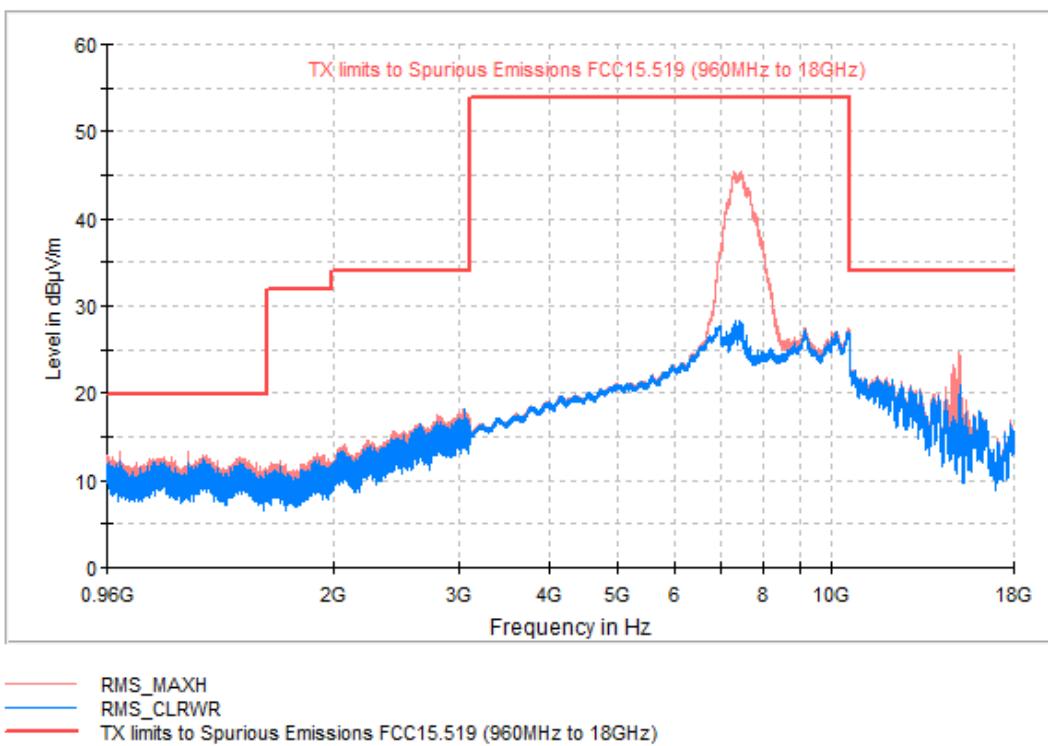


— PK+\_MAXH  
 — PK+\_CLRWR  
 — TX limits to Spurious Emission FCC15.519 (30MHz to 960MHz)  
 ▽ MaxPeak-PK+ (Single)  
 ✕ QuasiPeak-QPK (Single)

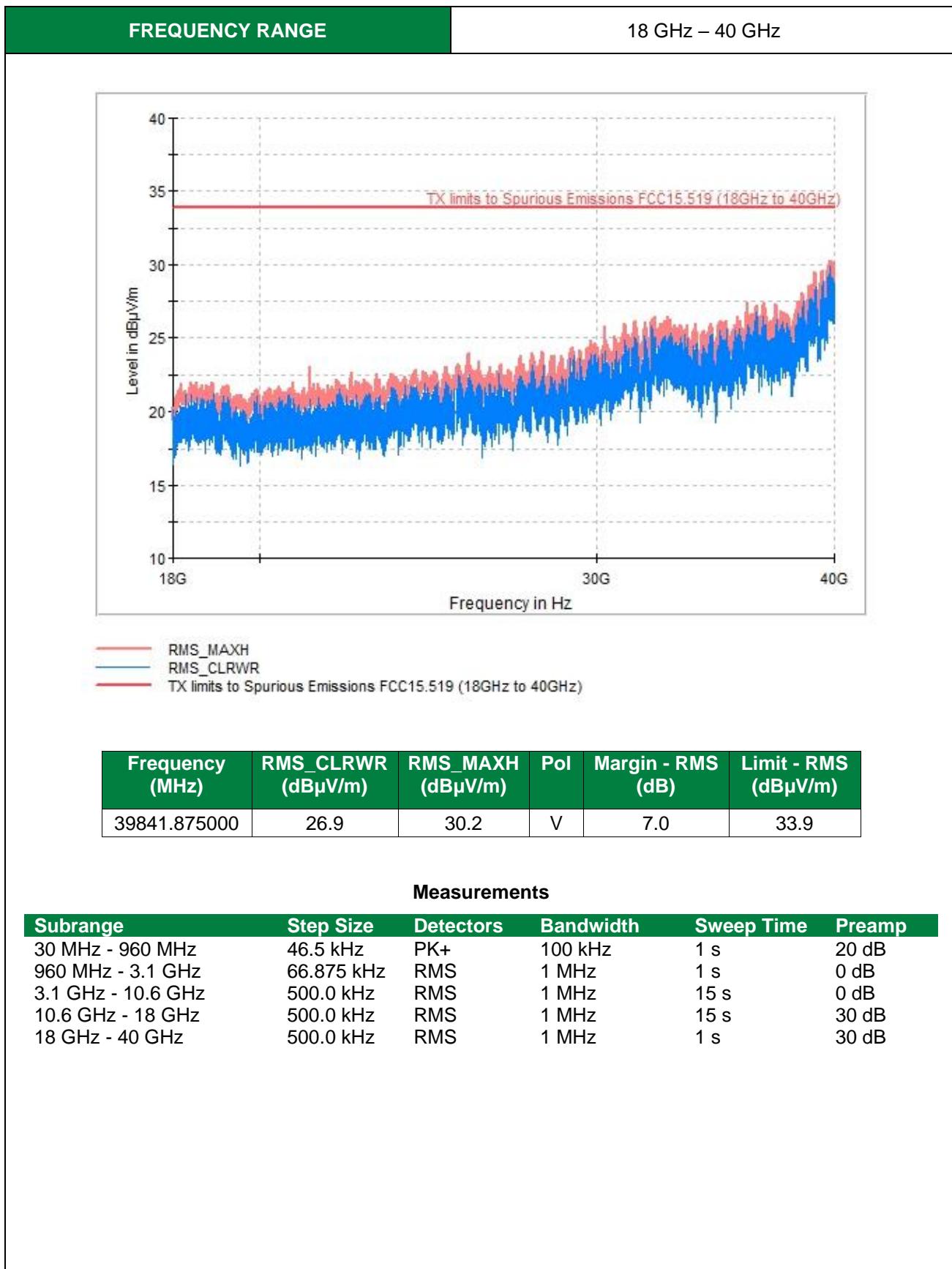
Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	QuasiPeak (dB $\mu$ V/m)	Pol	Margin - QPK (dB)	Limit - QPK (dB $\mu$ V/m)
38.044500	28.7	17.9	V	22.1	40.0
74.826000	25.9	15.8	V	24.2	40.0
156.759000	27.5	15.2	V	28.3	43.5
271.428000	30.9	18.2	H	27.9	46.0
404.976000	35.0	23.2	H	22.8	46.0
609.529500	39.9	28.9	V	17.1	46.0

FREQUENCY RANGE

960 MHz – 18 GHz



Frequency (MHz)	RMS_CLRWR (dB $\mu$ V/m)	RMS_MAXH (dB $\mu$ V/m)	Pol	Margin - RMS (dB)	Limit - RMS (dB $\mu$ V/m)	Comment
999.790625	11.9	13.4	V	6.5	19.9	
3022.826250	15.1	18.2	V	15.7	33.9	
7275.625000	26.8	45.5	V	8.4	53.9	Fundamental
15073.300000	19.9	24.7	V	9.2	33.9	



## TEST A.2: RADIATED EMISSION IN GPS BAND

<b>LIMITS:</b>	Product standard:	Part 15 Subpart F § 15.519 (d) and RSS 220 Clause 5.3(e)
	Test standard:	ANSI C63.10-2013 Section 6.6, 10.3.7 and 10.3.10

### LIMITS

In addition to the radiated emission limits specified in the table in paragraph (c) of this section, 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:

Fundamental Frequency (MHz)	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

### **TEST SETUP:**

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at 1 m for the frequency range 960 MHz -18 GHz (1-18 GHz Double ridge horn antenna).

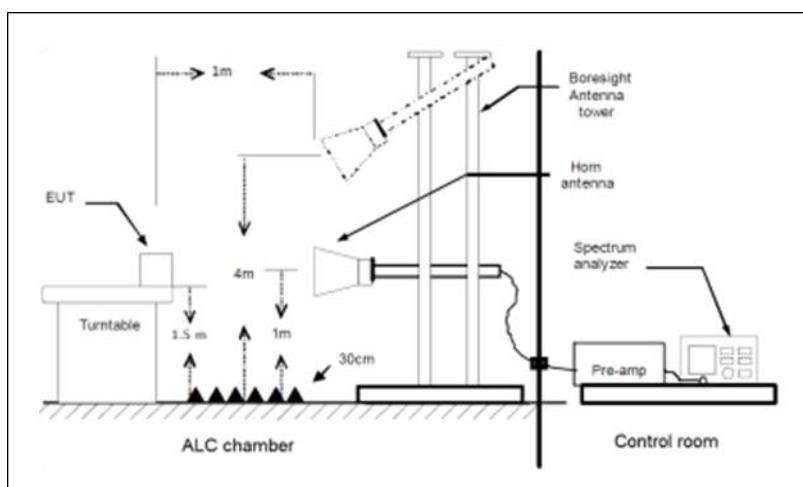
For radiated emissions in the range 960 MHz - 18 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

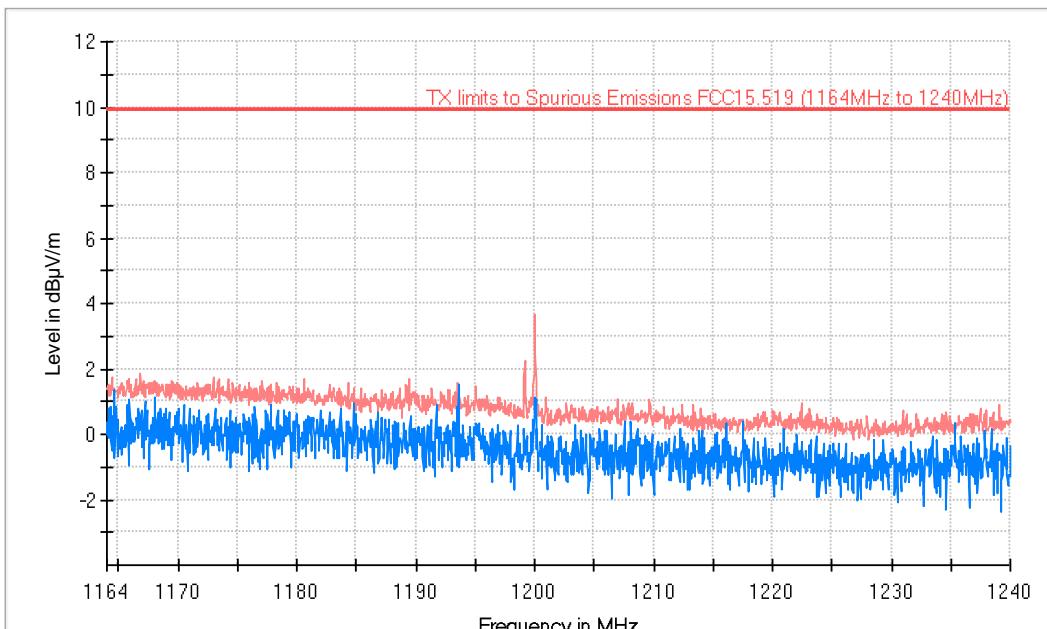
Measurements were made in both horizontal and vertical planes of polarization.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain

### Radiated measurements setup f > 960 MHz



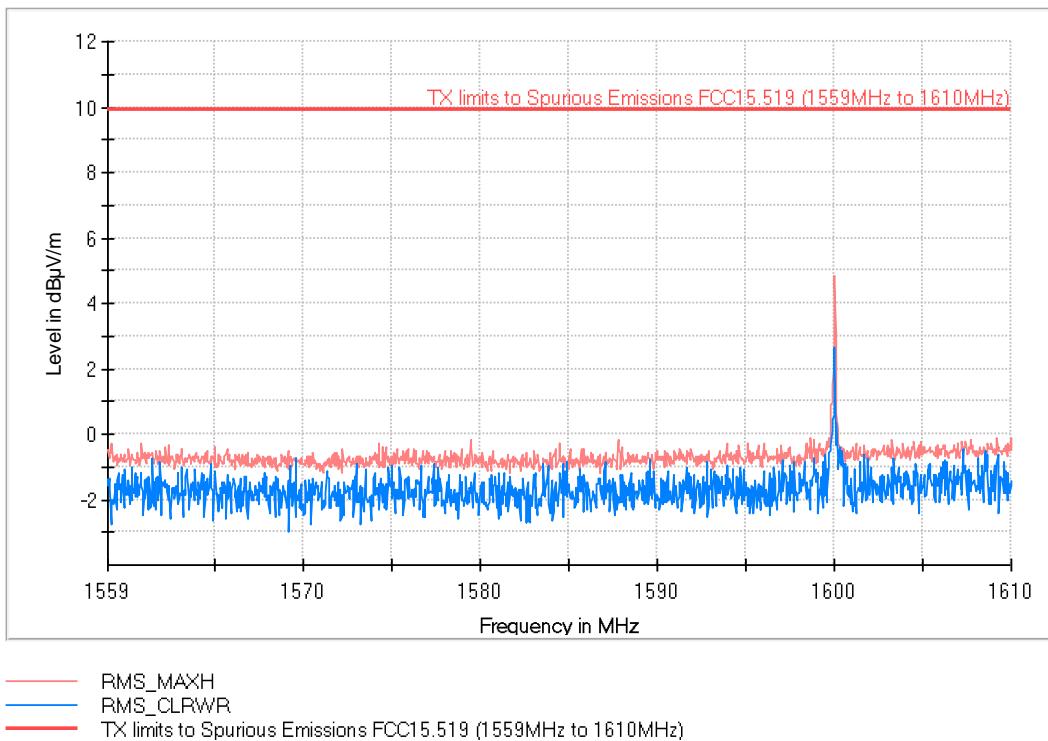
TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC/01
TEST RESULTS	PASS
FREQUENCY RANGE	1164 MHz – 1240 MHz



Frequency (MHz)	RMS_CLRWR (dB $\mu$ V/m)	RMS_MAXH (dB $\mu$ V/m)	Pol	Margin - RMS (dB)	Limit - RMS (dB $\mu$ V/m)
1166.850000	0.4	1.9	V	8.0	9.9
1200.005000	1.1	3.7	V	6.2	9.9
1239.097500	-0.8	0.9	V	9.0	9.9

FREQUENCY RANGE

1559 MHz –1610 MHz



Frequency (MHz)	RMS_CLRWR (dB $\mu$ V/m)	RMS_MAXH (dB $\mu$ V/m)	Pol	Margin - RMS (dB)	Limit - RMS (dB $\mu$ V/m)
1579.485000	-1.8	-0.2	V	10.1	9.9
1600.012500	2.6	4.9	H	5.0	9.9
1609.192500	-0.9	-0.1	H	10.0	9.9

Measurements

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
1.164 GHz - 1.24 GHz	50.0 kHz	RMS	100 kHz	1 s	30 dB
1.559 GHz - 1.61 GHz	50.0 kHz	RMS	100 kHz	1 s	30 dB

## TEST A.3: TRANSMITTER ON/OFF REQUIREMENT

<b>LIMITS:</b>	Product standard:	Part 15 Subpart F § 15.519 (a) and RSS 220 Clause 5.3(b)
	Test standard:	ANSI C63.10-2013

### LIMITS

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 acknowledgement of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

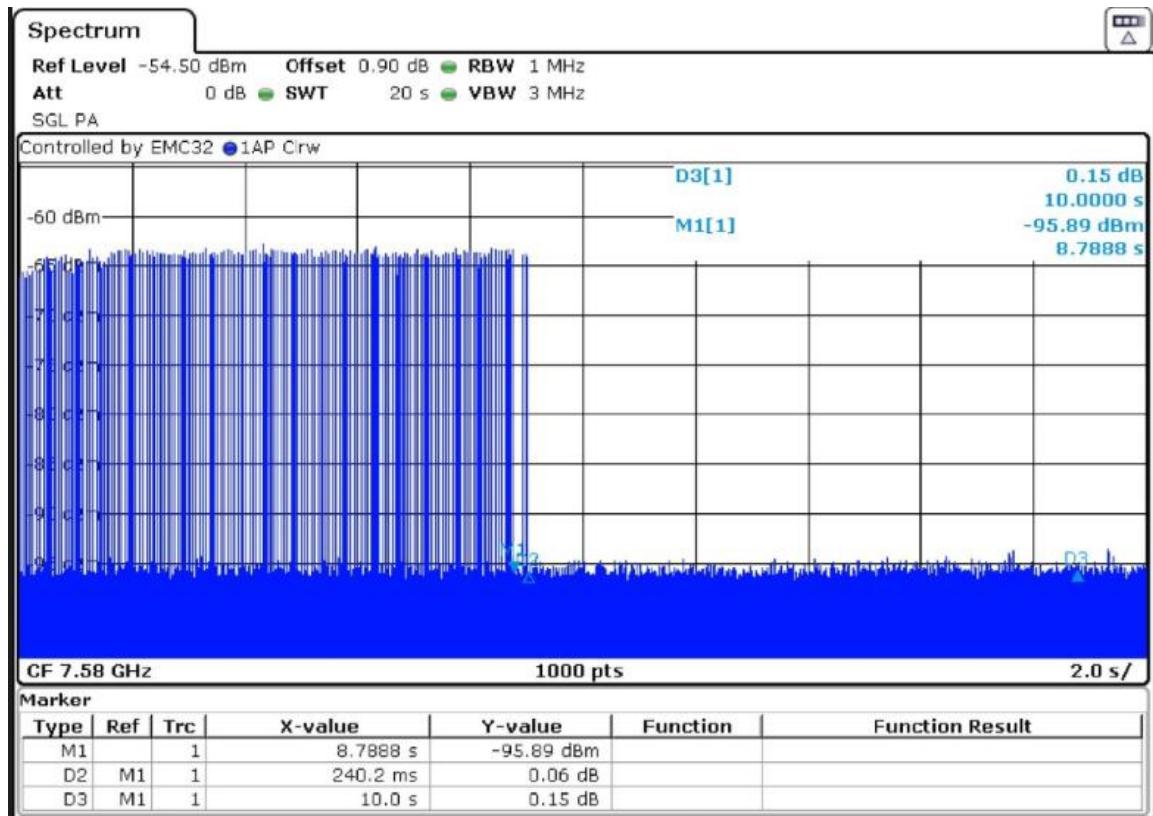
<b>TESTED SAMPLES:</b>	S/01
<b>TESTED CONDITIONS MODES:</b>	TC/01
<b>TEST RESULTS:</b>	PASS

Frequency (MHz)	Measurement result (sec):	Limit (sec)	Test Result
7580	0.24	10	P

TEST RESULTS (Cont.)

Marker M1: Associated receiver stopped transmission to send acknowledgement.

Marker D2: Transmitter device stopped transmission.



## TEST A.4: 10 dB BANDWIDTH

<b>LIMITS:</b>	Product standard:	Part 15 Subpart F § 15.503 (a), § 15.519(b) and RSS 220 Clause 5.1(a)
	Test standard:	ANSI C63.10 Section 10.1

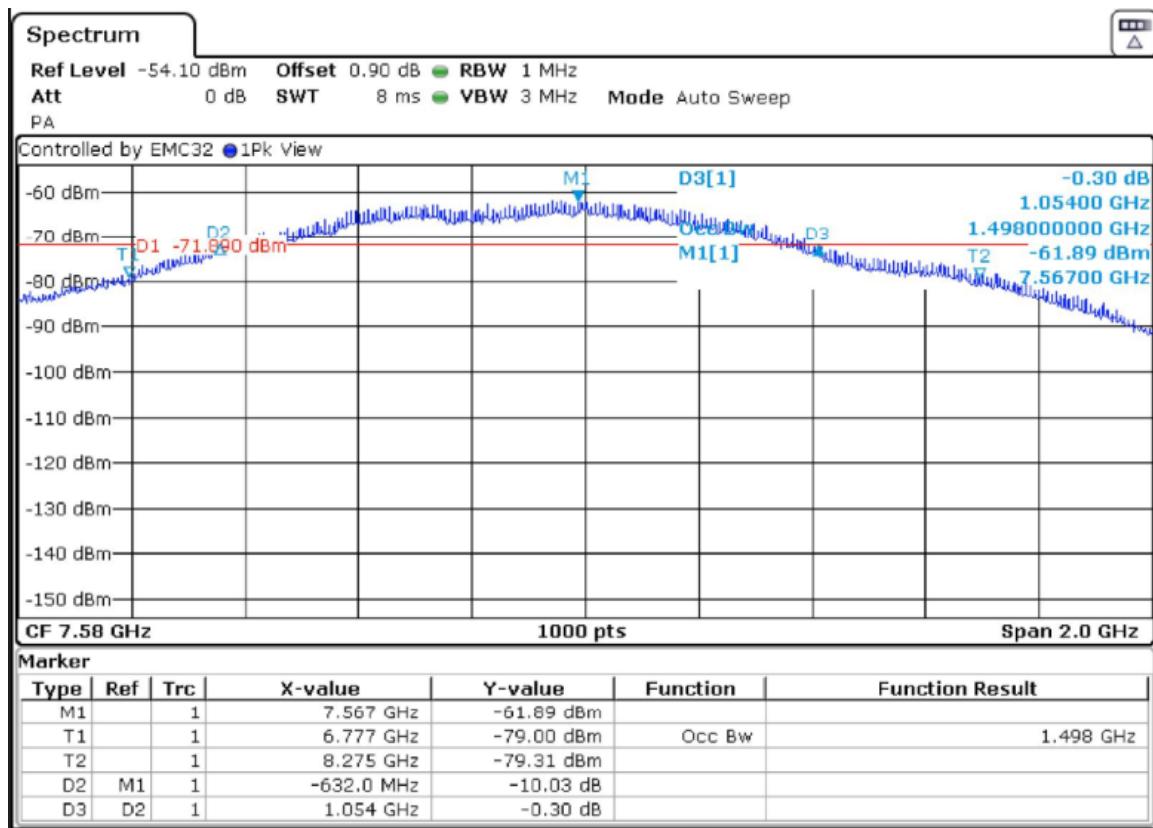
### LIMITS

Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth. The UWB bandwidth of a device operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

<b>TESTED RESULTS:</b>	S/01
<b>TESTED CONDITIONS MODES:</b>	TC/01
<b>TEST RESULTS:</b>	PASS

Frequency (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	10 dB Bandwidth (MHz)	Limit (MHz)		Result
				Lower Frequency	Upper Frequency	
7580	6935	7989	1054	3100	10600	Pass

TEST RESULTS (Cont.)



## TEST A.5: PEAK LEVEL OF THE EMISSION

<b>LIMITS:</b>	Product standard:	Part 15 Subpart F § 15.519(e), § 15.521(g), and RSS 220 Clause 5.3(g)
	Test standard:	ANSI C63.10 Section 6.6

### LIMITS

There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

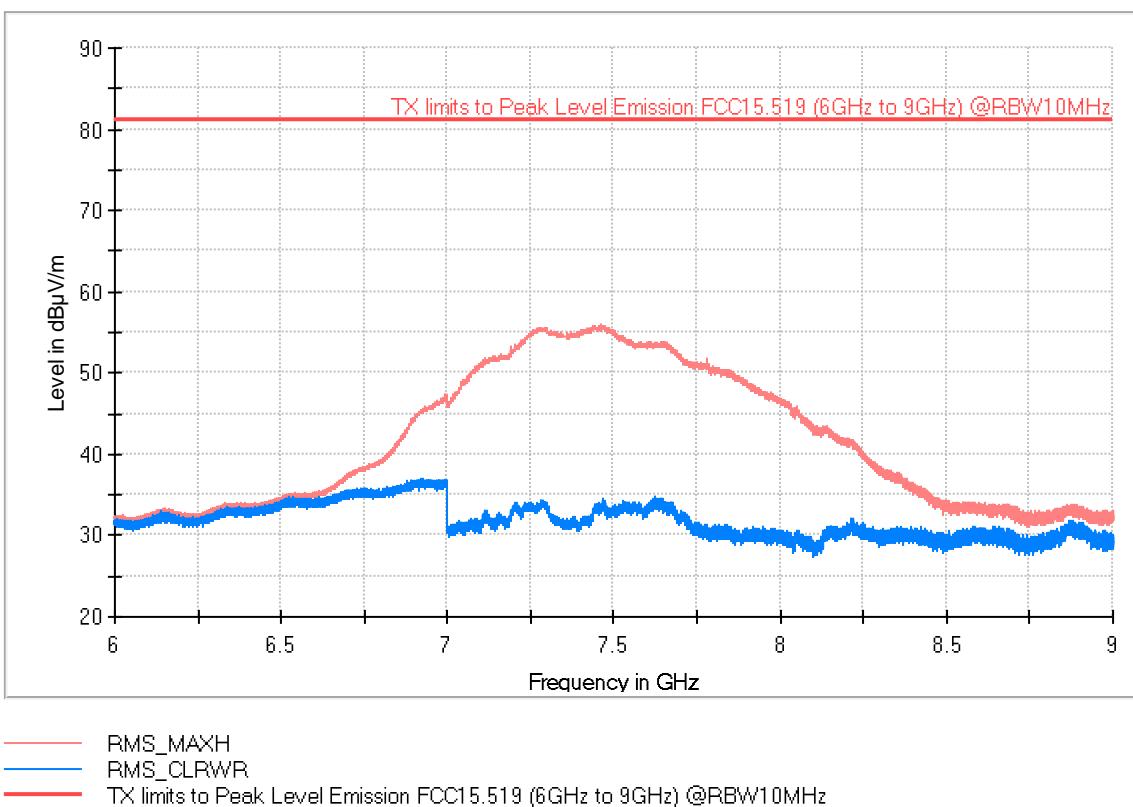
When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs,  $f_M$ . If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be  $20 \log (RBW/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using  $E$  (dB $\mu$ V/m) =  $P$  (dBm EIRP) + 95.2.

Note: The RBW = 10 MHz, so the RBW correction is  $20 \log (10/50) = -14.0$  dB.

Limit in dB $\mu$ V/m @RBW 10 MHz = 0 + 95.2 -14.0 = 81.2 dB $\mu$ V/m - This value is shown in the plot below.

TESTED RESULTS:	S/01
TESTED CONDITIONS MODES:	TC/01
TEST RESULTS:	PASS
FREQUENCY RANGE	6 GHz – 9 GHz z axis

Plot shows below represents worst case of DUT Orientation



Frequency (MHz)	RMS_CLRWR (dB $\mu$ V/m)	RMS_MAXH (dB $\mu$ V/m)	Pol	Margin - RMS (dB)	Limit - RMS (dB $\mu$ V/m)
7462.031250	33.9	55.9	V	25.3	81.2

### Measurements

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
6 GHz - 9 GHz	93.75 kHz	RMS	10 MHz	1 s	30 dB