COMPLIANCE WORLDWIDE INC.
TEST REPORT 280-17

In Accordance with the Requirements of

Federal Communications Commission 47 CFR Part 15, Subpart F
Technical Requirements for Ground Penetrating Radar Systems

Issued to

Easy Radar USA, LLC.
237 Implement Road
Aiken, SC 29803
(803) 761-3699

For the

Ground Penetrating Radar
Model: ER500A

FCC ID: 2AJAHER500A

Report Issued on July 17, 2017

Tested by

Larry K. Stillings

Reviewed By

Brian F. Breault

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1. Scope

This test report certifies that the Easy Radar USA, Model ER500A, as tested, meets the FCC Part 15, Subpart F requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required.

2. Product Details

2.1. Manufacturer: Easy Radar USA, LLC
2.2. Model Number: ER500A
2.3. Serial Number: Pre production unit
2.4. Description: Ground Penetrating Radar
2.5. Power Source: 12V Battery Powered
2.6. Hardware Revision: N/A
2.7. Software Revision: N/A
2.8. Modulation Type: 500 nS Impulse every 14 µS ~ 71 kHz PRF
2.9. Operating Frequency: 500 MHz Nominal
2.10. EMC Modifications: None

3. Product Configuration

3.1 Operational Characteristics & Software

1. Connect the USB cable from the laptop to the ER500A Antenna and turn on the laptop.
2. Turn on the ER500A antenna and allow the unit to boot up.

Software Setup:

1. After boot up of the laptop start the unit scanning by selecting the arrow key in the control software.

3.2. EUT Hardware

Manufacturer	Model	Serial Number	Description/Function
Easy Radar	ER500A	Pre production	GPR 500 MHz Antenna

3.3. EUT Cables/Transducers

Manufacturer	Model/Part #	Length (m)	Shield Y/N	Description/Function
Any	USB	4	Y	Remote communications to Laptop

3.4. Support Equipment

Panasonic Toughbook Laptop

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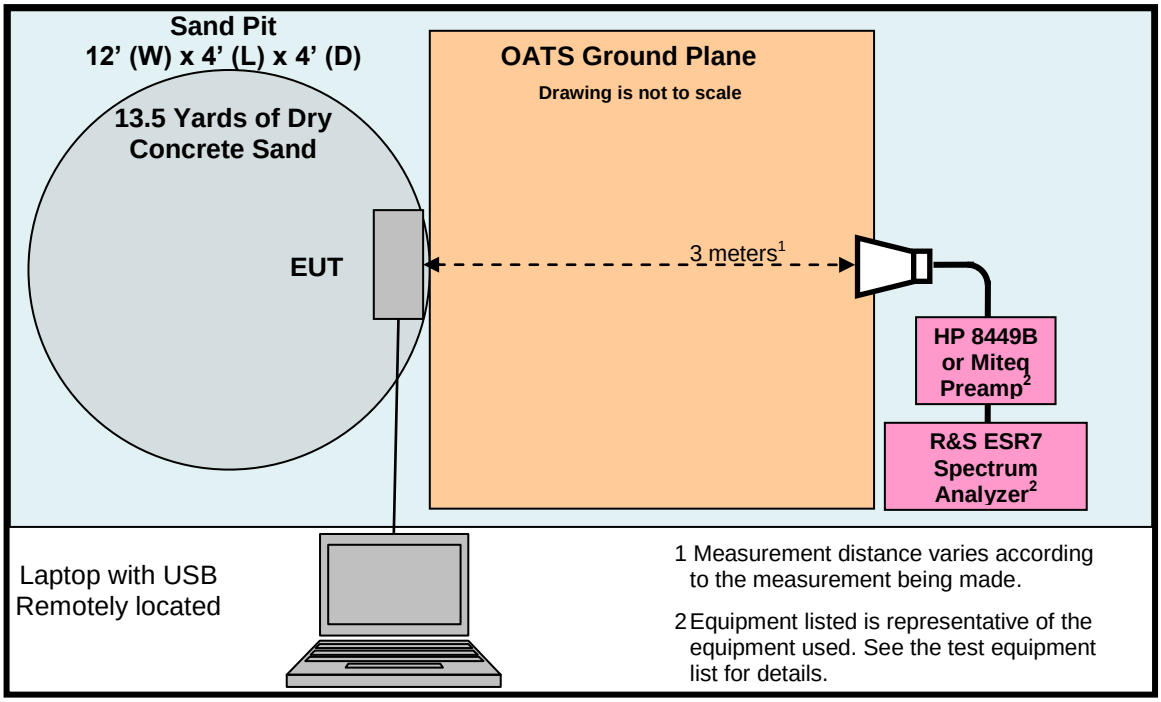
3. Product Configuration (continued)

3.5. Test Setup Diagram



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4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Cal Interval
EMI Test Receiver, 9kHz - 7GHz	Rohde & Schwarz	ESR7	101156	7/23/2017	2 Year
Spectrum Analyzer	Rohde & Schwarz	FSV40	100899	7/23/2017	2 Year
Microwave Preamp	Hewlett Packard	8449B	3008A01323	7/23/2017	2 Year
Preamp 100 MHz – 7 GHz	Miteq	AFS3-01000200-10-15P-4	988773	6/2/2018	1 Year
Bilog Antenna 30 to 2000 MHz	Com-Power	AC-220	25509	5/12/2018	2 Year
Horn Antenna 960 MHz to 18 GHz	Electro-Metrics	EM-6961	6337	5/2/2018	2 Year
Barometer – Temperature & Humidity	Control Company	4195	ID236	10/8/2017	2 Year

[1] ESR7 Firmware revision: V2.28,SP1 Date installed: 9/2/2016 Previous V2.26, installed 8/15/2014.
[2] FSV40 Firmware revision: V2.30 SP4, Date installed: 5/4/2016 Previous V2.30 SP1, installed 10/22/2014.

4.2. Measurement & Equipment Setup

Test Date:	6/22/2017, 6/27/2017
Test Engineer:	Larry Stillings
Normal Site Temperature (15 - 35°C):	21.6
Relative Humidity (20 - 75%RH):	35
Frequency Range:	30 MHz to 20 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	120 kHz - 30 MHz to 960 MHz 1 MHz - Above 960 MHz
EMI Receiver Avg Bandwidth:	300 kHz - 30 MHz to 960 MHz 3 MHz - Above 960 MHz
Detector Function:	Peak, Quasi-Peak, EMI Average and RMS Average

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4. Measurements Parameters (continued)

4.3. Measurement Procedures

Test measurements were made in accordance FCC Part 15.509, 15.521, IC RSS-220 Issue I, RSS-Gen, Issue 4, ANSI C63.10:2013 Clause 10 and KDB Publication 393764 D01 UWB FAG v01, dated July 31, 2015.

The test methods used to generate the data is this test report is in accordance with ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

In accordance with ANSI C63.10:2013, Section 10.2.2, the device under test was placed on a bed of dry sand and rotated through 16 azimuth angles (per Clause 5.4) to determine which produced the highest emission relative to the limit. The azimuth that produced the highest emission relative to the limit was used for all radiated emission measurements.

4.4. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency (out of band)	$\pm$ 1x10^{-8}
Radiated Emission of Transmitter to 10 GHz	$\pm$ 4.55 dB
Radiated Emission of Receiver	$\pm$ 4.55 dB
Temperature	$\pm$ 0.91^{o} C
Humidity	$\pm$ 5%

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5. Measurements Summary

Test Requirement	FCC Rule Requirement	Test Report Section	Result	Comment
Antenna Requirement	15.203	6.1	Compliant	The antenna is housed within a sealed enclosure with the intentional radiator.
Operational Requirements	15.509 (b)	6.2	Compliant	
UWB Bandwidth	15.503 (a)	6.3	Compliant	
Spurious Radiated Emissions	15.509 (d) 15.209	6.4	Compliant	
Radiated Emissions in GPS Bands	15.509 (e) 15.209	6.5	Compliant	
Peak Emissions in a 50 MHz Bandwidth	15.509 (f)	6.6	Compliant	
Conducted Emissions	15.207	6.7	Compliant	EUT is battery powered
Radio Frequency Exposure	FCC OET Bulletin 65	6.8	Compliant	

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6. Measurement Data

6.1. Antenna Requirement (15.203)

Requirement: 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply

Result: The antenna utilized by the device under test is an internal, non user replaceable unit.

6.2. Operational Requirements of the Device under Test (15.509 (b))

Requirement: Operation under the provisions of this section is limited to GPRs and wall imaging systems operated for the purposes with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction.

Result: The manufacturer states that the device under test complies with the requirements outlined in section FCC Part 15.509 (b).

6.3. UWB Bandwidth (15.503 (a))

Requirement: The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M. The center frequency f_C, equals $(f_H + f_L)/2$. The fractional bandwidth equals $2 * (f_H – f_L) / (f_H + f_L)$.

6.3.1. Measurement Data (Values in GHz)

f_M	The highest emission peak	0.305601
f_L	10 dB below the highest peak	0.240244
f_H	10 dB above the highest peak	0.413821
f_C	Calculated: $(f_H + f_L)/2$	0.327033
Bandwidth	Calculated: $(f_H - f_L)$	0.173577
Fractional BW	Calculated: $2*(f_H - f_L)/(f_H + f_L)$	0.530764

Note: The Fraction Bandwidth is greater than 0.2 and therefore the minimum UWB Bandwidth of 500 MHz requirement does not need to be met.

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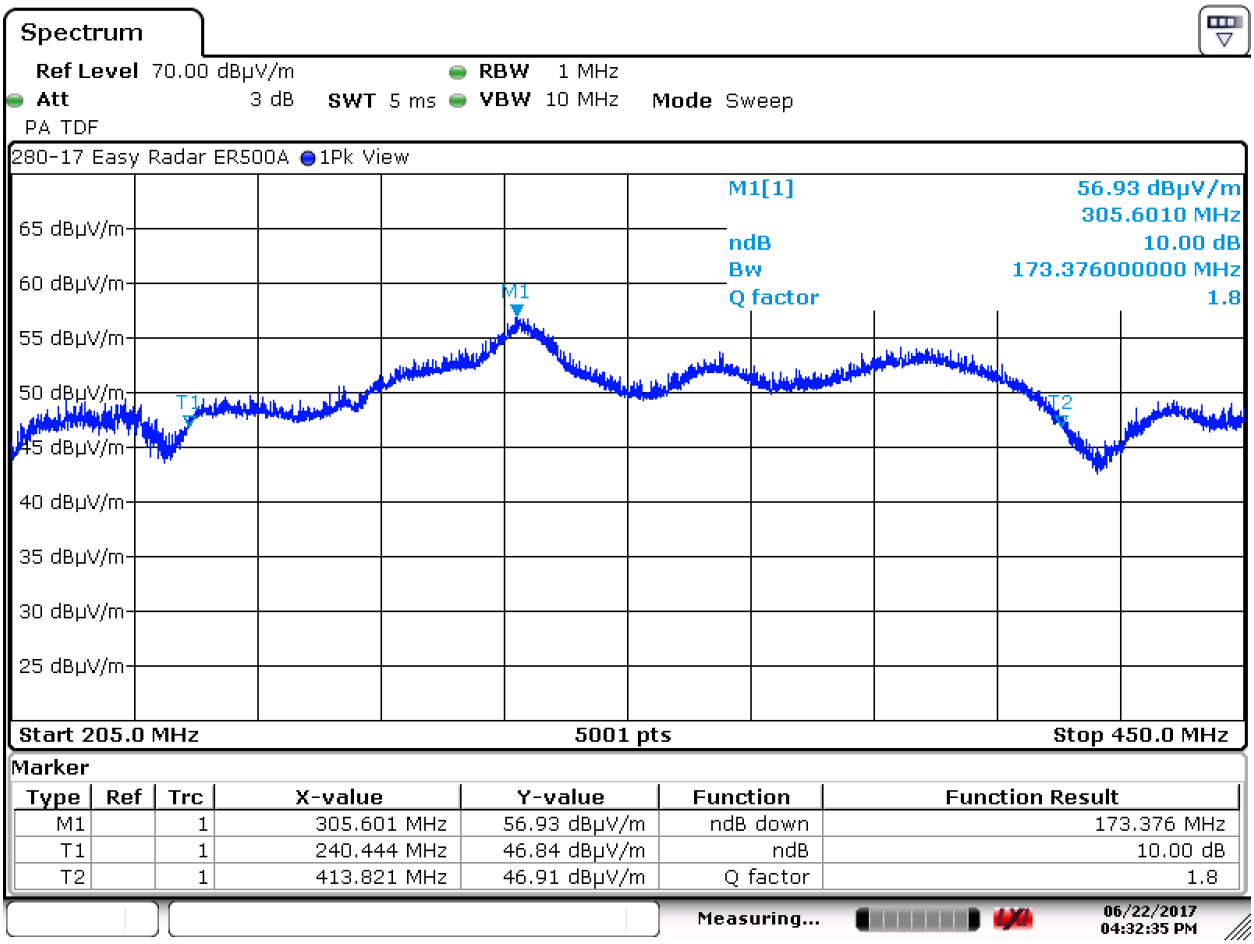
6. Measurement Data (continued)

6.3. UWB Bandwidth (15.503 (a)) (continued)

6.3.2. Measurement Plot of 10 dB BW on GPR Site = 173.376 MHz



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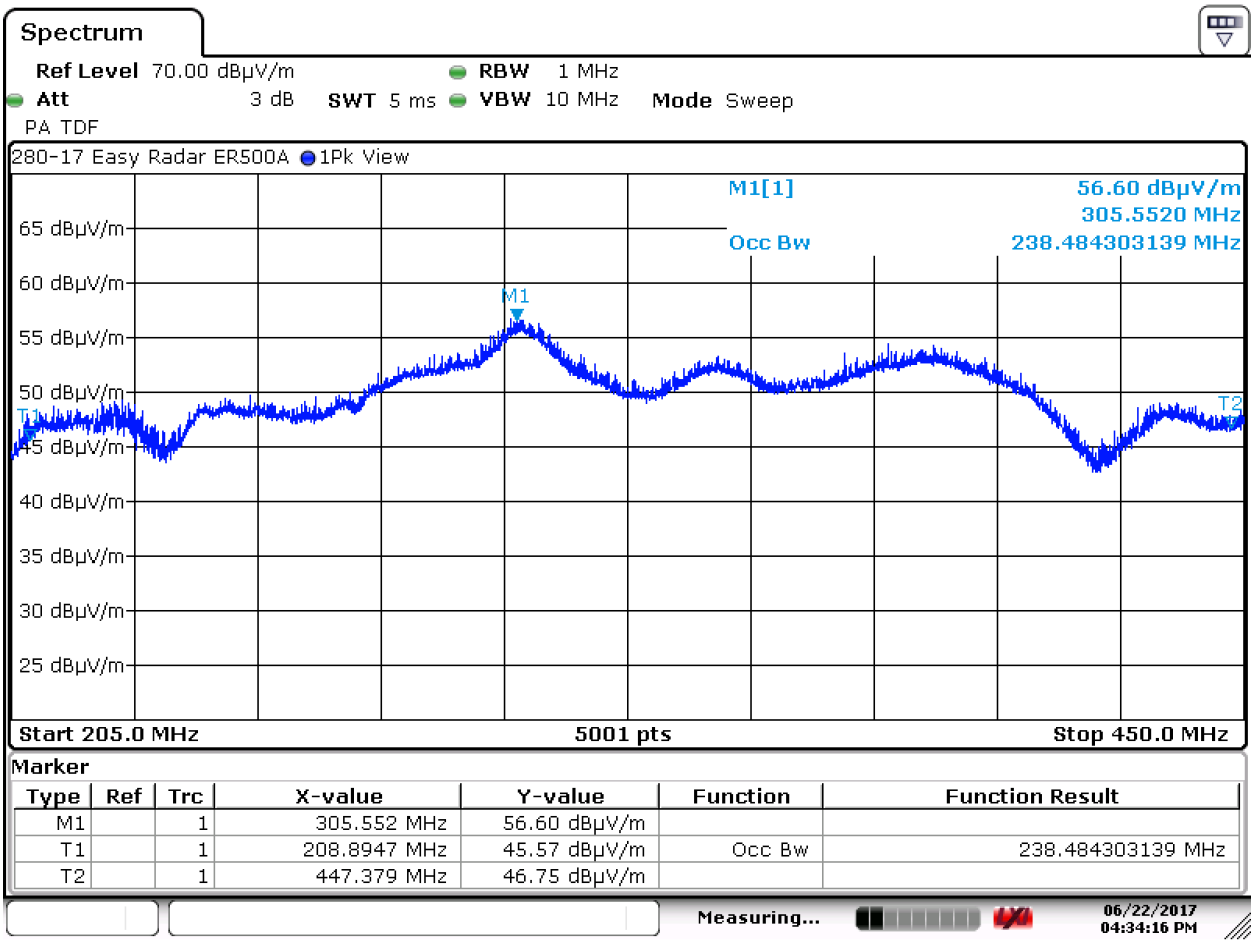
6. Measurement Data (continued)

6.3. UWB Bandwidth (15.503 (a)) (continued)

6.3.3. Measurement Plot of 99% BW on GPR Site = 238.484 MHz



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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209)

Requirement: 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 Section 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. Limits are converted from EIRP (dBm) to field strength at 3 meters using a conversion factor of 95.2.

Frequency (MHz)	EIRP (dBm)	Field Strength (dBµV/m)
960 - 1610	-65.3	29.9
1610 - 1990	-53.3	41.9
1990 - 3100	-51.3	43.9
3100 - 10600	-41.3	53.9
Above 10600	-51.3	43.9

Radiated Emissions Field Strength Limits at 3 Meters (Section 15.209)

Frequency (MHz)	Field Strength (dBµV/m)
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0

Test Notes: Refer to Section 4.1 for the test equipment used and Section 4.2 for the test equipment setups.

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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.1. 30 MHz to 960 MHz, Horizontal measured at 3 Meters

Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi-Peak	Quasi-Peak				
163.95	24.39	22.46	43.5	-21.04	H	310	90
177.08	27.76	24.95	43.5	-18.55	H	310	90
193.71	29.86	27.26	43.5	-16.24	H	310	90
195.42	29.83	26.81	43.5	-16.69	H	310	90
208.55	29.94	28.56	43.5	-14.94	H	230	90
239.14	29.58	28.34	46.0	-17.66	H	170	90
270.72	33.14	31.14	46.0	-14.86	H	170	90
303.76	34.82	33.57	46.0	-12.43	H	170	90
356.43	35.65	34.47	46.0	-11.53	H	185	90
418.55	35.80	34.33	46.0	-11.67	H	205	90
489.34	35.74	34.19	46.0	-11.81	H	220	90
533.04	34.91	31.66	46.0	-14.34	H	220	90
556.77	34.65	32.97	46.0	-13.03	H	220	90
612.21	32.38	30.20	46.0	-15.80	H	160	90
655.42	32.02	28.11	46.0	-17.89	H	160	90
684.89	33.19	29.12	46.0	-16.88	H	160	90
718.31	32.97	28.49	46.0	-17.51	H	160	90

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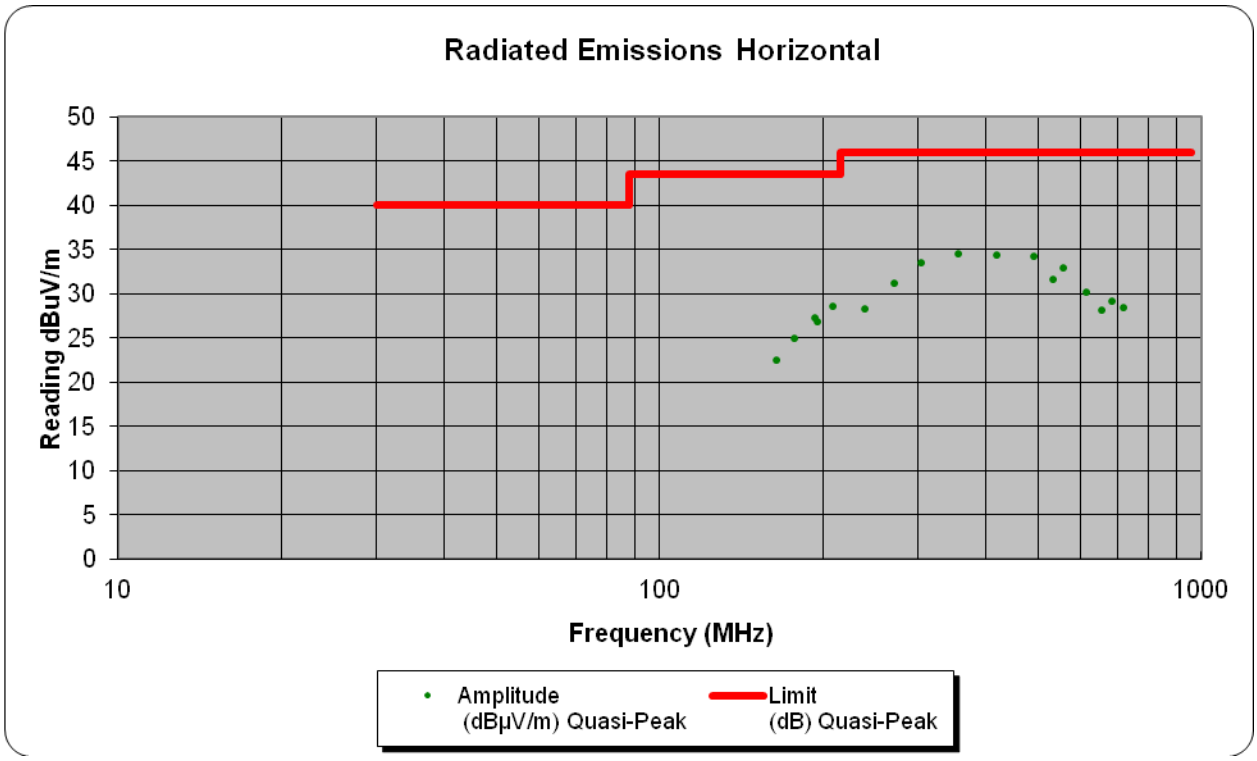
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.2. 30 MHz to 960 MHz, Horizontal Plot



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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.3. 30 MHz to 960 MHz, Vertical measured at 3 Meters

Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi-Peak	Quasi-Peak				
160.67	23.05	20.64	43.5	-22.86	V	100	135
164.02	23.30	20.42	43.5	-23.08	V	100	135
175.66	22.54	20.71	43.5	-22.79	V	100	135
185.13	25.51	23.31	43.5	-20.19	V	100	135
193.47	28.10	25.22	43.5	-18.28	V	100	135
196.70	27.15	25.03	43.5	-18.47	V	100	135
209.55	26.07	25.87	43.5	-17.63	V	100	135
216.95	27.75	25.43	46.0	-20.57	V	100	135
243.43	30.35	29.38	46.0	-16.62	V	100	135
304.11	35.67	33.86	46.0	-12.14	V	100	135
360.29	28.79	25.42	46.0	-20.58	V	100	135
396.17	30.08	26.74	46.0	-19.26	V	100	135
444.15	31.38	27.21	46.0	-18.79	V	100	135
457.05	30.05	29.34	46.0	-16.66	V	100	135
475.14	32.69	30.63	46.0	-15.37	V	100	135
532.24	33.72	28.57	46.0	-17.43	V	100	135
609.96	34.59	28.88	46.0	-17.12	V	100	135
686.34	34.96	29.38	46.0	-16.62	V	100	135
718.97	34.94	28.48	46.0	-17.52	V	100	135

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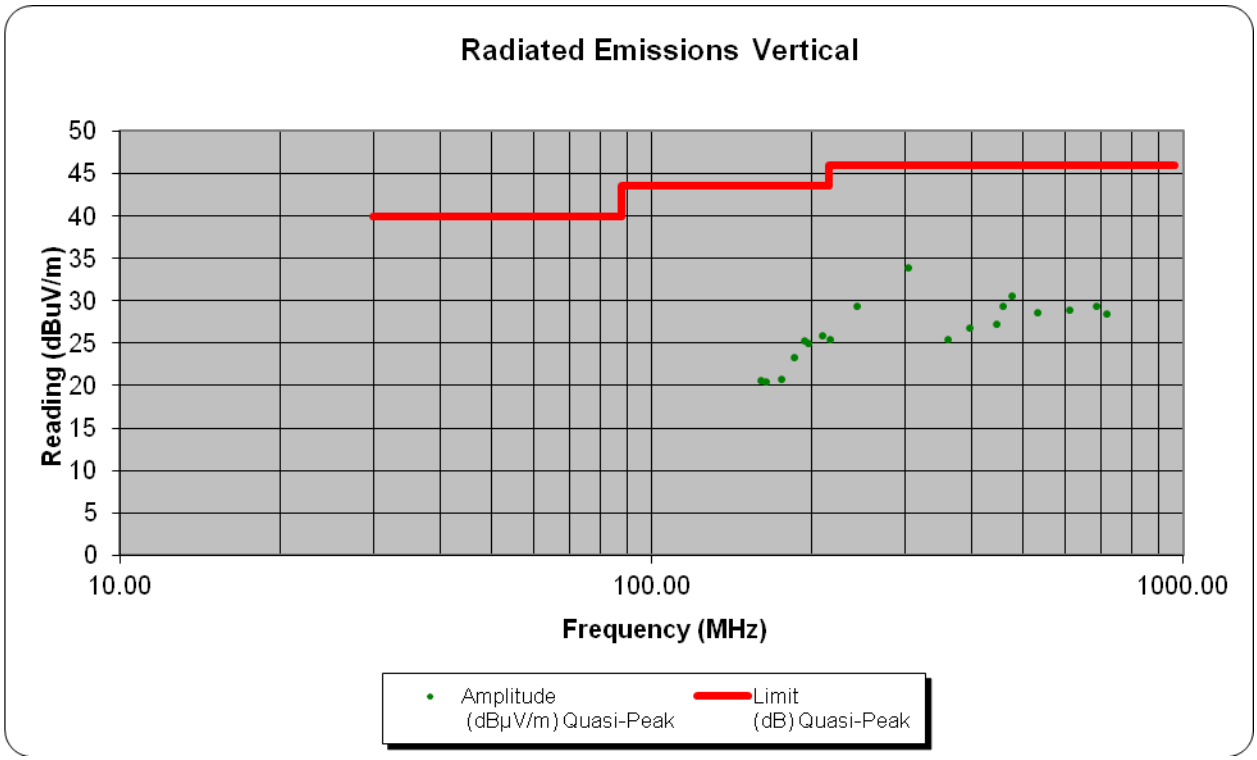
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.4. 30 MHz to 960 MHz, Vertical Plot



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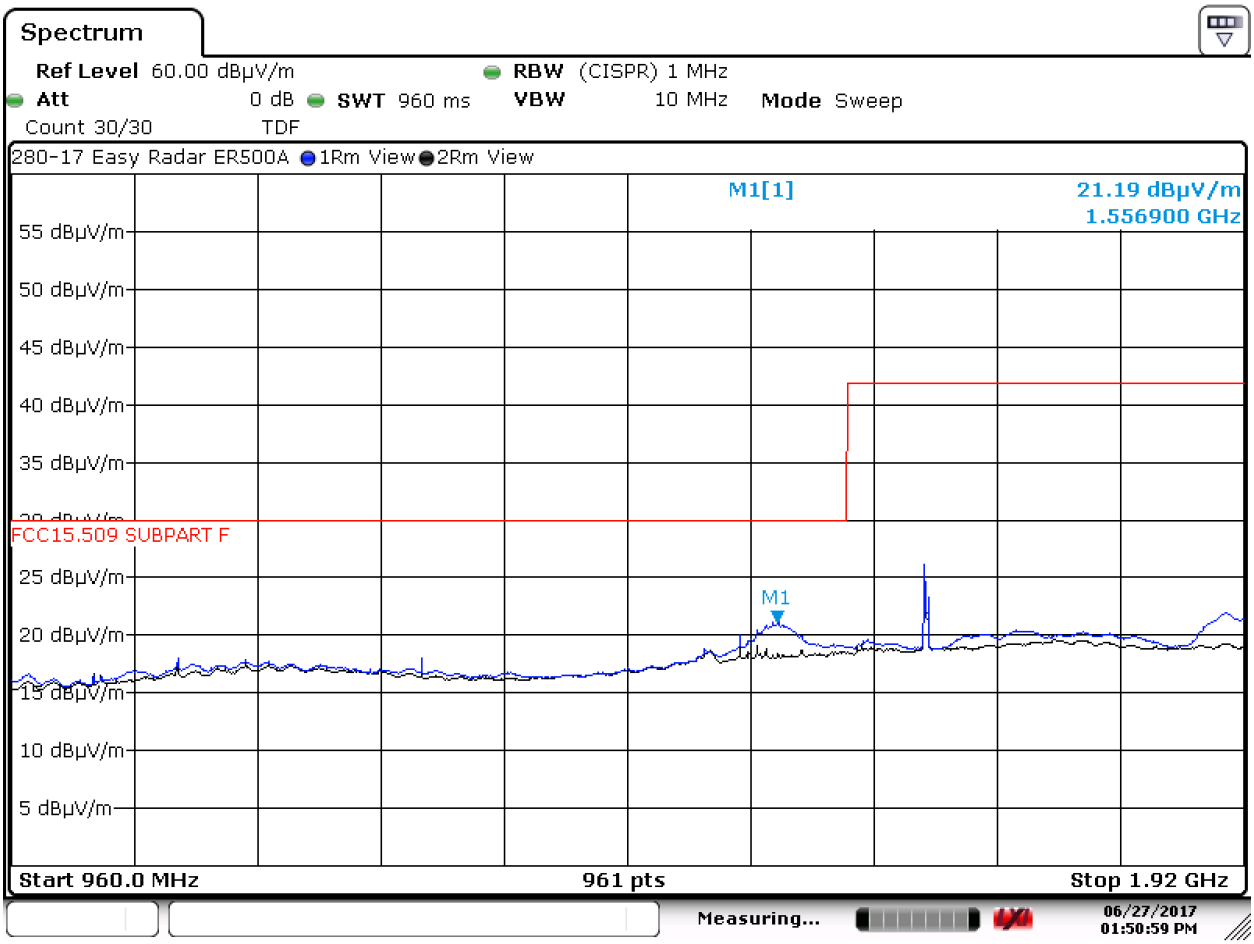
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d))

6.4.5. 960 MHz to 5 GHz at 3 meters

6.4.5.1 Plot of 960 MHz to 1.92 GHz RMS Power Horizontal



Date: 27.JUN.2017 13:50:59

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector.

There were no other measurable emissions between 1.92 to 5 GHz.

Blue trace with with UWB turned on, Black trace is with UWB turned off.

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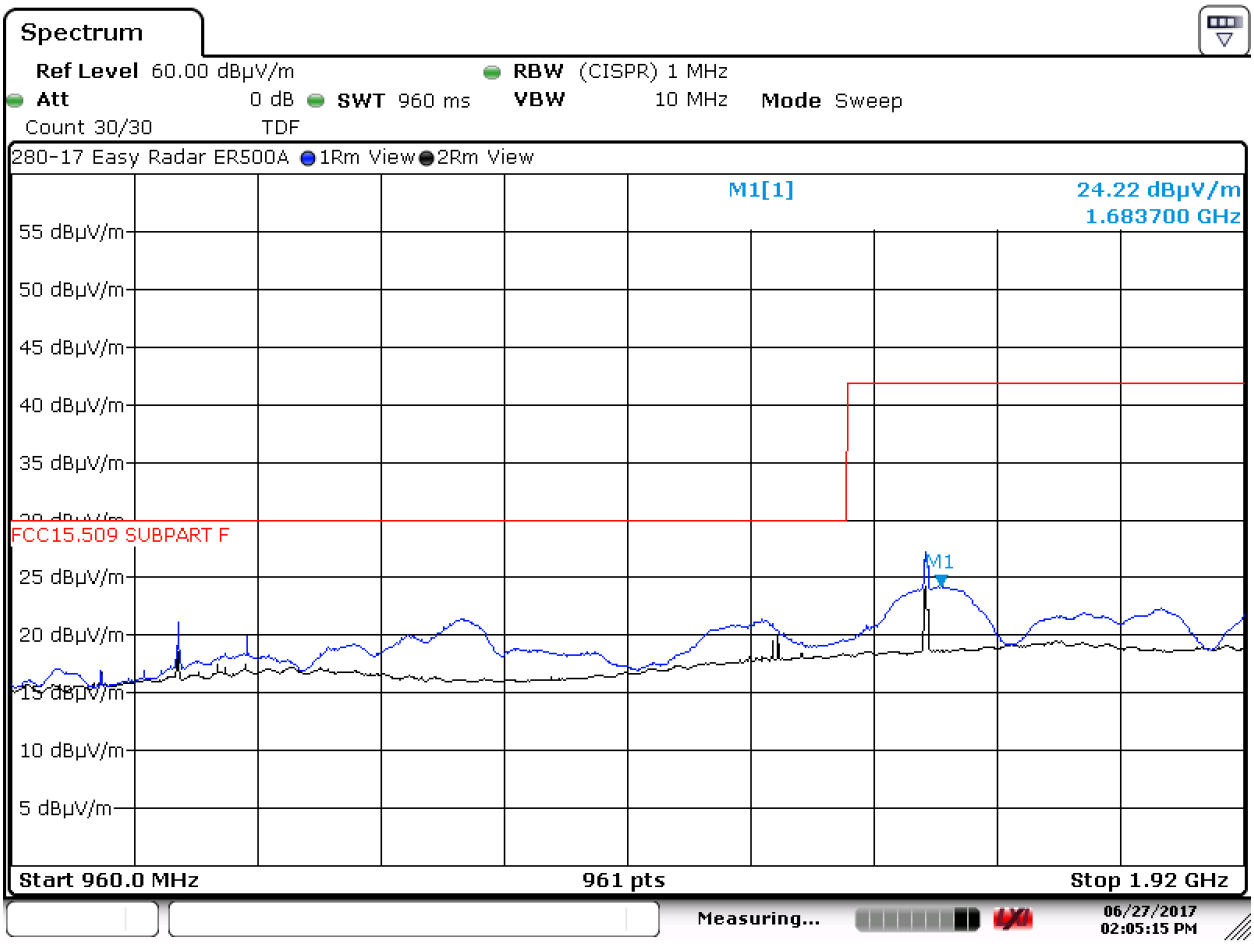
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d) continued)

6.4.5. 960 MHz to 5 GHz at 3 meters (continued)

6.4.5.2 Plot of 960 MHz to 1.92 GHz RMS Power Vertical



Date: 27.JUN.2017 14:05:15

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector.

There were no other measurable emissions between 1.92 to 5 GHz.

Blue trace with with UWB turned on, Black trace is with UWB turned off.

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6. Measurement Data (continued)

6.5. Spurious Radiated Emissions in GPS Bands (15.509 (e))

Requirement: In addition to the radiated emission limits specified in the table in paragraph (d) 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:

Frequency (MHz)	EIRP (dBm)	Field Strength (dBµV/m) at 3 Meters
1164 - 1240	-75.3	19.9
1559 - 1610	-75.3	19.9

6.5.1. Measurement & Equipment Setup

EMI Receiver IF Bandwidth: 1 kHz

EMI Receiver Avg Bandwidth: 10 kHz

Detector Function: RMS

6.5.2. Test Procedure

Test measurements were made in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

6.5.3. 1164 to 1240 MHz & 1559 to 1610 MHz

There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. Measurements were made at 3 Meters and the -75.3 dBm limit was converted to a field strength limit of 19.9 dBuV/m using a distance correction factor of 95.2.

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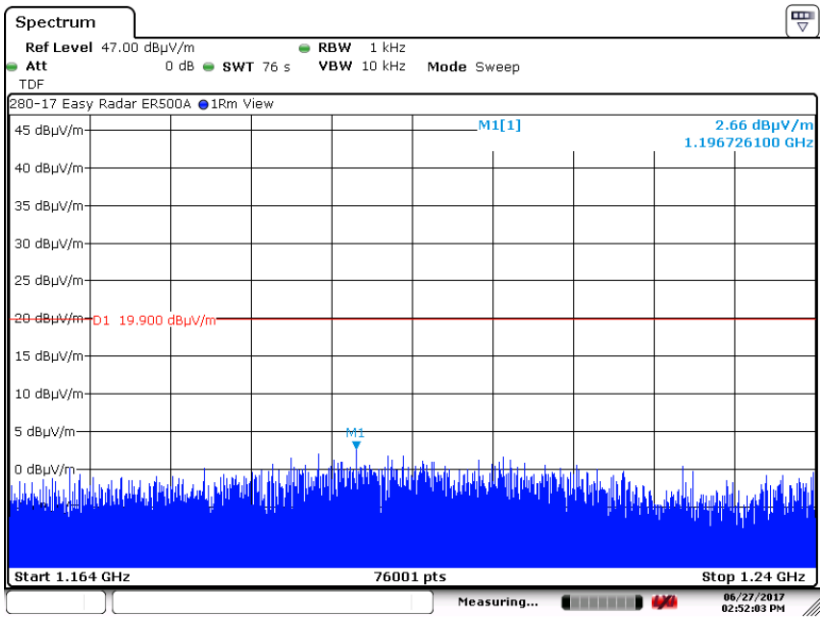
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.1 1164 to 1240 MHz - Horizontal



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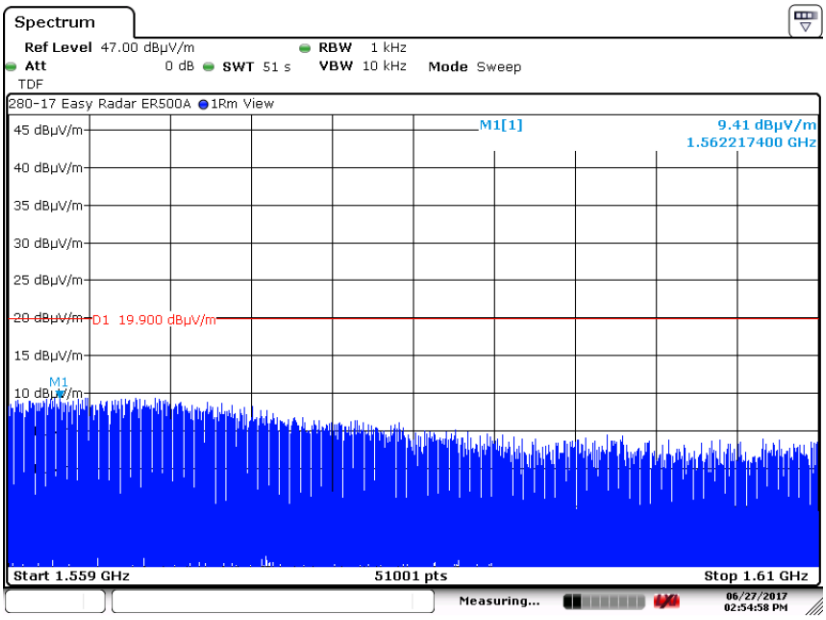
6.5.4.2 1559 to 1610 MHz - Horizontal



Date: 27.JUN.2017 14:54:58

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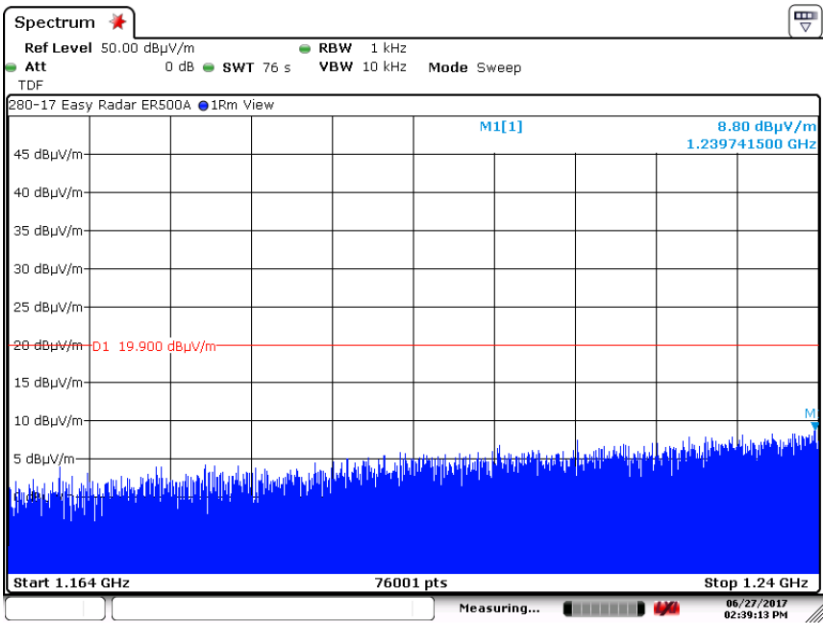
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.3 1164 to 1240 MHz - Vertical



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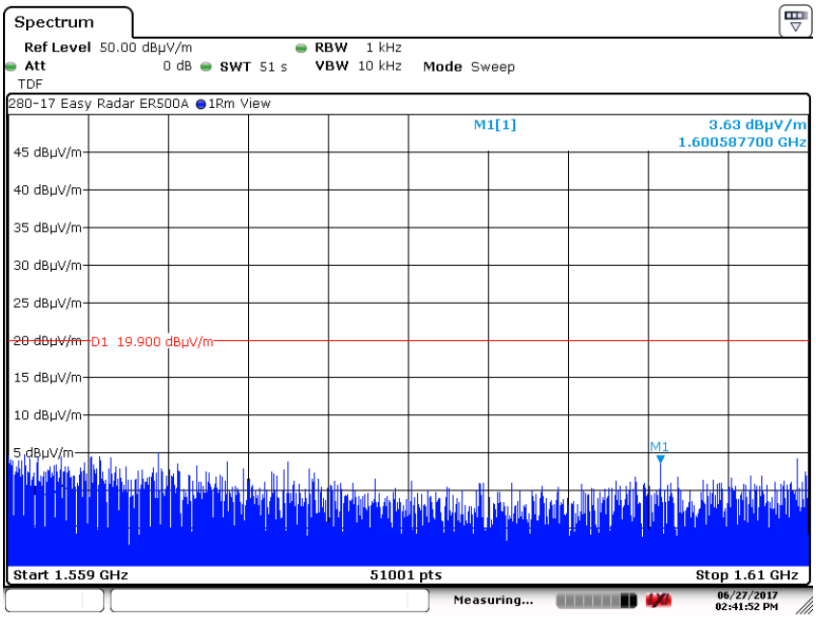
6.5.4.4 1559 to 1610 MHz - Vertical



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6. Measurement Data (continued)

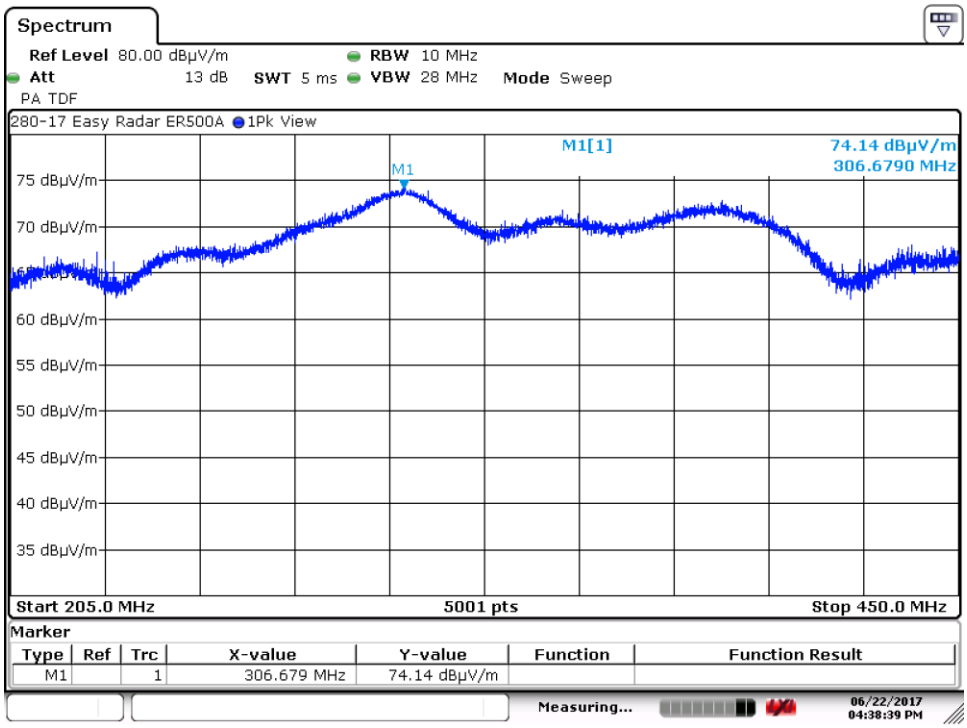
6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f))

Requirement: For UWB devices where the frequency at which the highest radiated emissions occurs, f_M, is above 960 MHz, there is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency 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 Section 15.521. The 0 dBm limit was converted to -13.98 dBm limit when using a 10 MHz RBW. The limit was then converted to a 3 meter field strength limit of 81.22 dBµV/m by using a conversion factor of 95.2.

Freq. (MHz)	Peak Amplitude (dBµV/m)	Corr. Factor (dB)	Peak Amplitude (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Pol (H/V)	El. (cm)	Az. (deg)
306.679	74.14	Included	74.14	N/A	N/A	V	100	0
1274.20	58.50	Included	58.50	81.22	22.72	V	100	0

Note using: 10 MHz RBW / 40 MHz VBW

6.6.1 Plot of Peak Power below 960 MHz



Date: 22.JUN.2017 16:38:39

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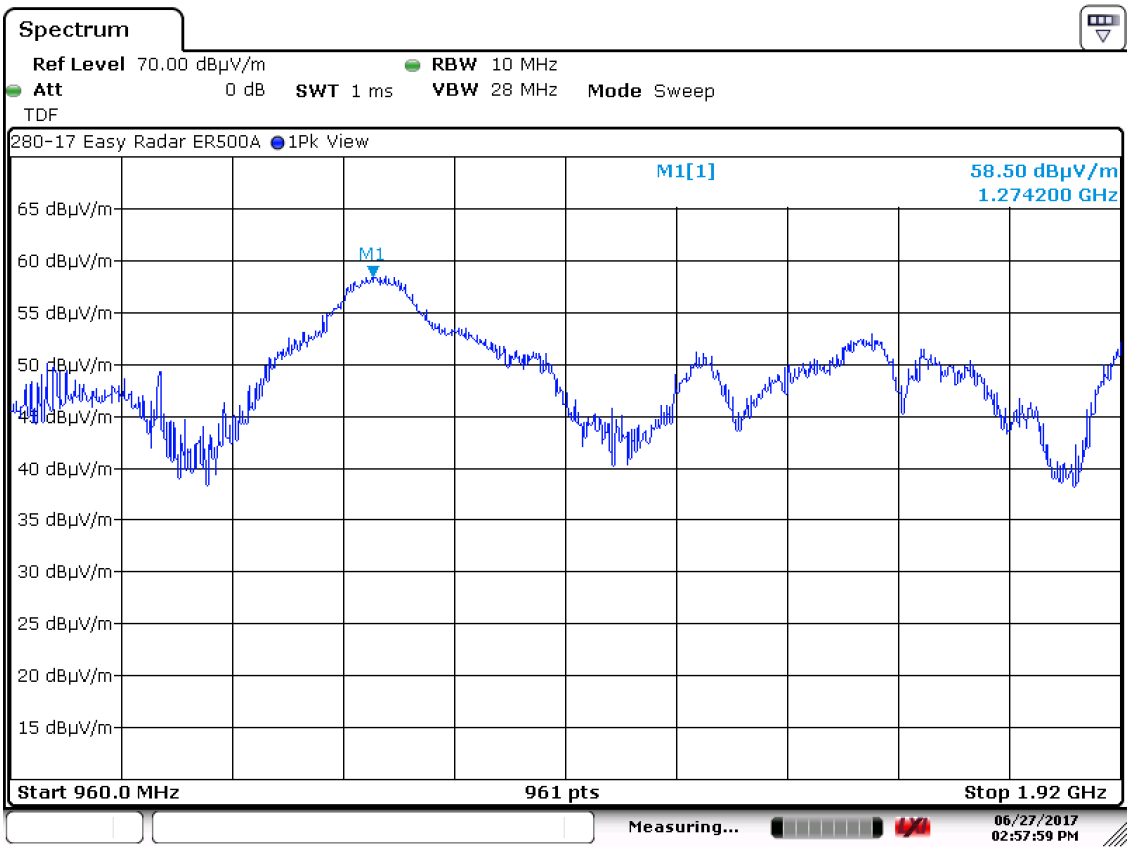
6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f) continued)

6.6.2 Plot of Peak Power above 960 MHz



Date: 27.JUN.2017 14:57:59

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6. Measurement Data (continued)

6.7. Conducted Emissions, Regulatory Limit: FCC Part 15.209

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50
* Decreases with the logarithm of the frequency.		

6.7.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due
LISN	EMCO	3825/2	9109-1860	7/21/2016
EMI Receiver	Hewlett Packard	8546A	3330A00115	6/2/2016

6.7.2. Measurement & Equipment Setup

Test Date:	N/A
Test Engineer:	N/A
Site Temperature (°C):	N/A
Relative Humidity (%RH):	N/A
Frequency Range:	0.15 MHz to 30 MHz
EMI Receiver IF Bandwidth:	9 kHz
EMI Receiver Avg Bandwidth:	30 kHz
Detector Functions:	Peak, Quasi-Peak. & Average

6.7.3. Test Procedure

Test measurements were made in accordance with ANSI C63.10-2013, Standard Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronics Equipment in the Range of 9 kHz to 40 GHz.

EUT is battery powered and the batteries are recharged using a separate charger not contained in the device.

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6. Measurement Data (continued)

6.8. Public Exposure to Radio Frequency Energy Levels (1.1307 (b)(1))

6.8.1. SAR Test Exclusion for UWB transmitter

Requirement: Portable devices are subject to radio frequency radiation exposure requirements as explained in FCC KDB 447498 D01 General RF Exposure Guidance v06, dated October 23, 2015.

For a 1-g SAR, the test exclusion result must be ≤ 3.0 and ≤ 7.5 for 10-g extremity SAR.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \frac{P_{MAX}}{d_{MIN}} \times \sqrt{f_{(GHz)}} \qquad (1)$$

P_{MAX}	mW	Maximum power of channel, including tune-up tolerance
d_{MIN}	mm	Minimum test separation distance, mm (≤ 50 mm)
$f_{(GHz)}$	GHz	$f_{(GHz)}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz)

Power and distance are rounded to the nearest mW and mm before calculation

The result is rounded to one decimal place for comparison

The values 3.0 and 7.5 are referred to as numeric thresholds below

Per KDB 447498 Appendix A SAR Exclusion Threshold at 50 mm is 274 mW at 300 MHz. Extremity SAR is 2.5 times this value or 685 mW at 300 MHz.

The EUT transmits -1.21 dBm EIRP or 0.757 mW at 307 MHz and therefore meets the SAR Test Exclusion.

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7. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025:2005 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1)** and VCCI (Member number 3168) under registration number A-0208.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane required by EN 55022. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

Both sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

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8. Test Images

8.1. Spurious Emissions – 30 MHz – 960 MHz Front

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8. Test Images

8.2. Spurious Emissions – 30 MHz – 960 MHz Rear

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8. Test Images

8.3. Spurious Emissions – 960 MHz - 18 GHz Front

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8. Test Images

8.4. Spurious Emissions – 960 MHz - 18 GHz Rear

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