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DATE: 01 December 2015

I.T.L. (PRODUCT TESTING) LTD.

FCC Radio Test Report

for

Aeroscout Industrial Ltd.

Equipment under test:

UWB Location Receiver

LR2000-R

Tested by: _____
M. Zohar

Approved by: _____
D. Shidlowsky

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Measurement/Technical Report for
Aeroscout Industrial Ltd.

UWB Location Receiver

LR2000-R

FCC ID: 2AEFEIND-LR-2000R

This report concerns:	Original Grant:	X
	Class I Change:	
	Class II Change:	

Equipment type: Ultra Wideband Transmitter (UWB)

Limits used: 47CFR15 Section 15.209, 15.207, 15.517, 15.521

Measurement procedure used is ANSI C63.4: 2009.

Application for Certification
prepared by:
R. Pinchuck
ITL (Product Testing) Ltd.
1 Bat Sheva St.
Lod 7116002
Israel
e-mail Rpinchuck@itl.co.il

Applicant for this device:
(different from "prepared by")
Eli Basri
AeroScout Industrial
2 Ilan Ramon Street
Ness Ziona, 7403635, Israel
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e-mail: eli.basri@sbdinc.com

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1. General Information

1.1 Administrative Information

Manufacturer:	Aeroscout Industrial Ltd.
Manufacturer's Address:	2 Ilan Ramon Street Ness Ziona, 7403635, Israel Tel: +972-8-936-9393 Fax: +972-8-936-5977
Manufacturer's Representative:	Eli Basri
Equipment Under Test (E.U.T):	UWB Location Receiver
Equipment Model No.:	LR2000-R
Equipment Part No.:	Not Designated
Date of Receipt of E.U.T:	22.04.2015
Start of Test:	22.04.2015
End of Test:	18.08.2015
Test Laboratory Location:	I.T.L (Product Testing) Ltd. 1 Batsheva St., Lod ISRAEL 7120101
Test Specifications:	FCC Part 15 Subpart F

1.2 List of Accreditations

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), FCC Designation Number US1004.
3. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) (Japan), Registration Numbers: C-3006, R-2729, T-1877, G-245.
5. Industry Canada (Canada), IC File No.: 46405-4025; Site No. IC 4025B-1; 4025B2.

I.T.L. Product Testing Ltd. Is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.

1.3 Product Description

The UWB Location Receiver (uLR) is a component of the AeroScout suite of enterprise-level visibility solutions. This product provides accurate, robust and sophisticated real time detection and location of tags using Wi-Fi and Ultra Wide Band (UWB) communication.

The uLR is used to complement the AeroScout Wi-Fi based solution by accurately triangulating Tags in areas where sub-meter accuracy is required.

The uLR support both PoE and external power connection as a power up.

The uLR enclosure is designed for durability against significant impacts and is water and dust resistant also with good chemical resistance.

Model name	LR2000-R
Working voltage	AC/DC or POE
Mode of operation	Transceiver UWB
Frequency Range	CH2:3993.6GHz, CH5:6489.6GHz
Antenna Gain	IND-ANT-7180 (Directional): Peak gain: ch2: +5.8dBi, ch5: +2.3dBi IND-ANT-7360 (Omni directional): Peak gain: ch2: +3.5dBi, ch5: +2dBi
Modulation BW	>500MHz
Temperature (°C)/ Humidity (%RH)	25°C/75%

1.4 Test Methodology

Radiated testing were performed according to the procedures in ANSI 63-4: 2009. Radiated testing was performed at an antenna to EUT distance of 1 meters.

1.5 Test Facility

Conducted and Radiated emissions tests were performed at I.T.L.'s testing facility in Lod, Israel. I.T.L.'s EMC Laboratory is accredited by A2LA, certificate No. 1152.01 and its FCC Designation Number is US1004.

1.6 Measurement Uncertainty

Radiated Emission

Radiated Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) for open site 30-1000MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 4.98 dB

Conducted Emission Power Lines (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)

0.15 – 30 MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 3.44 dB

2. System Test Configuration

2.1 Justification

Exploratory testing was performed in 3 orthogonal polarities to determine the worst case.

The fundamental results are shown in the below table:

Frequency (MHz)	Channel	X axis (dBuV/m)	Y axis (dBuV/m)	Z axis (dBuV/m)
3993.6	2	50.9	39.5	42.8
6489.6	5	50.8	41.8	42.1

Figure 1. Screening Results

In all axes the spurious levels were under the noise level.
According to the above results the worst case was the X axis.

2.2 EUT Exercise Software

No exercise software was used.

2.3 Special Accessories

No special accessories were needed in order to achieve compliance.

2.4 Equipment Modifications

No equipment modifications were needed to achieve compliance.

2.5 Configuration of Tested System

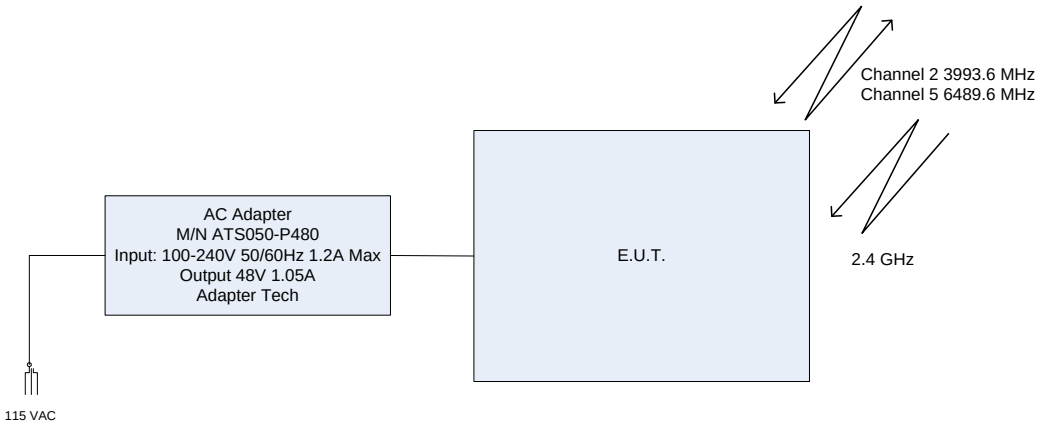

Figure 2. Conducted and Radiated Emissions Test Setup With AC Adapter

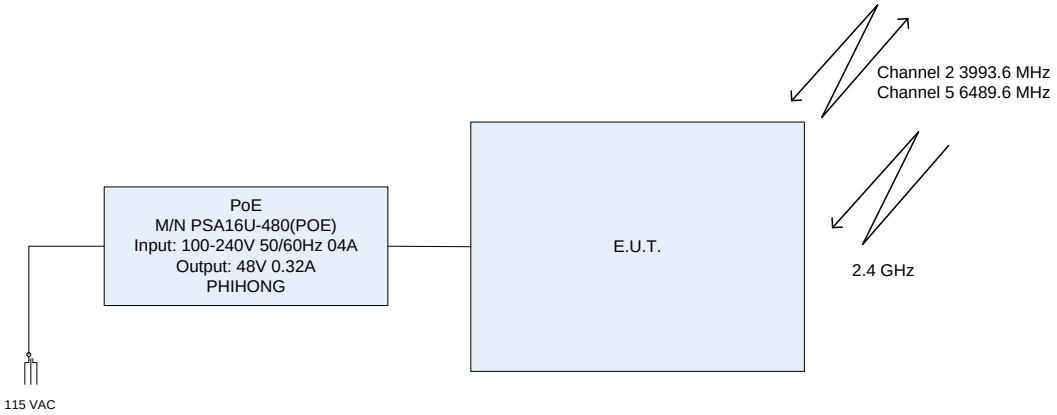

Figure 3. Power Lines Conducted Emission Setup With PoE

3. Test Set-Up Photos

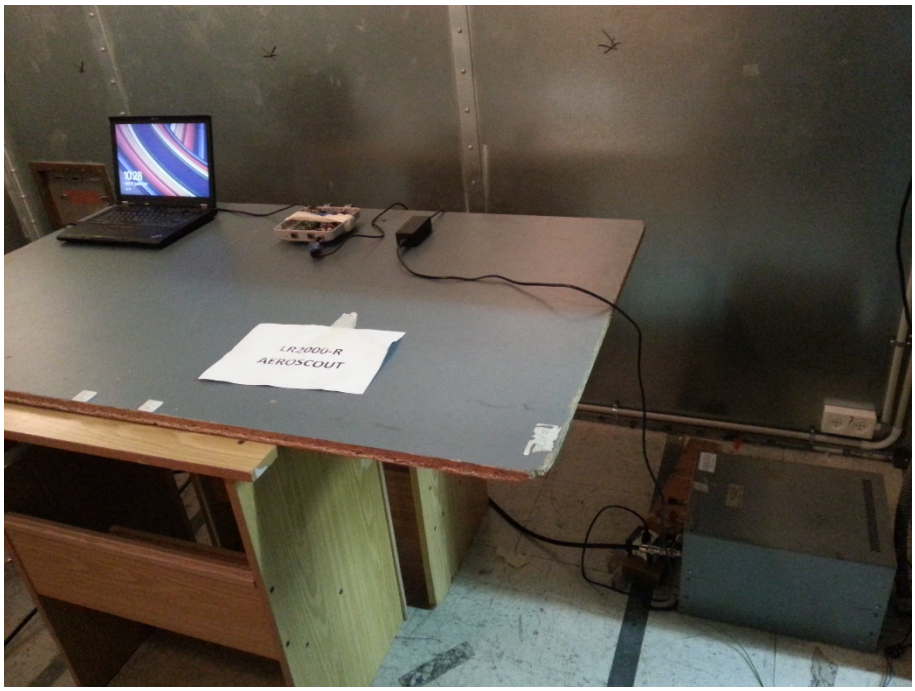

Figure 4. Conducted Emission Test Setup

Figure 5. Radiated Emission Test Setup

Figure 6. Radiated Emission Test Setup

Figure 7. Radiated Emission Test Setup – 1 GHz – 18 GHz

Figure 8. Radiated Emission Test Setup – 18 GHz -26.5 GHz

Figure 9. Radiated Emission Test Setup - 26.5 GHz-40 GHz

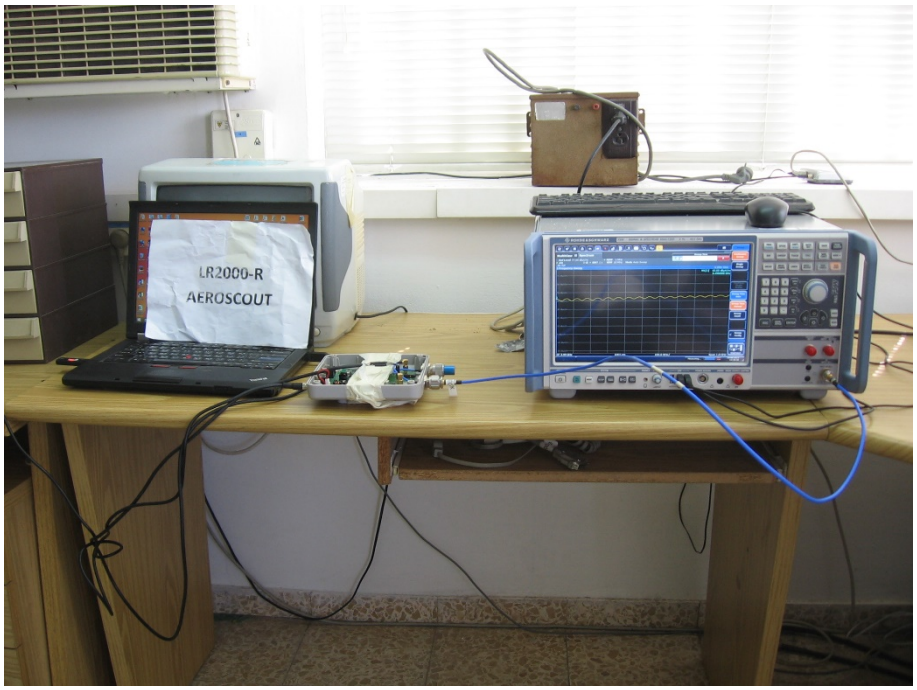

Figure 10. Conducted Emission From Antenna Port Test Setup

4. Conducted Emission From AC Mains

4.1 Test Specification

FCC Part 15, Subpart C, Section 15.207

4.2 Test Procedure

The E.U.T operation mode and test setup are as described in Section 2. In order to minimize background noise interference, the conducted emission testing was performed inside a shielded room (see Section 3), with the E.U.T placed on an 0.8 meter high wooden table, 0.4 meter from the room's vertical wall. In the case of a floor-standing E.U.T., it was placed on the horizontal ground plane.

The E.U.T was powered from 115 V AC / 60 Hz via 50 Ohm / 50 µHn Line Impedance Stabilization Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T

The center of the E.U.T.'s AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission. The configuration tested is shown in the photograph, *Figure 4. Conducted Emission Test Setup.*

The emission voltages at the LISN's outputs were measured using a computerized receiver, complying with CISPR 16 requirements. The specification limits are loaded to the receiver via a 3.5" floppy disk and are displayed on the receiver's spectrum display.

A frequency scan between 0.15 and 30 MHz was performed at 9 kHz I.F. band width, using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak and average detector.

The E.U.T was tested in 2 power operation modes:

AC adapter, M/N ATS050-P480, manufactured by ADAPTER TECH

PoE power supply, M/N PSA16U-480(POE), manufactured by PHIHONG.

4.3 Test Results for AC Adapter

JUDGEMENT: Passed by 9.23 dB

The margin between the emission levels and the specification limit is, in the worst case, 9.24dB for the phase line at 0.482 MHz and 9.23dB at 0.482 MHz for the neutral line.

The EUT met the FCC Part 15, Subpart C specification requirements.

The details of the highest emissions are given in *Figure 11* to *Figure 14*.

4.4 Test Results for POE Power Supply

JUDGEMENT: Passed by 0.90 dB

The margin between the emission levels and the specification limit is, in the worst case, 0.90 dB for the phase line at 0.962 MHz and 2.18 dB at 0.962 MHz for the neutral line.

The EUT met the FCC Part 15, Subpart C specification requirements.

The details of the highest emissions are given in *Figure 15* to *Figure 18.*

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Phase
Detectors:	Peak, Quasi-peak, Average
Power Operation:	AC Adapter

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	154 kHz	39.17	-26.60
1	Quasi Peak	190 kHz	34.20	-29.82
1	Quasi Peak	482 kHz	37.83	-18.47
2	Average	482 kHz	37.05	-9.24
1	Quasi Peak	722 kHz	37.41	-18.58
2	Average	722 kHz	36.73	-9.26
2	Average	962 kHz	32.85	-13.14
1	Quasi Peak	17.81 MHz	34.35	-25.65
2	Average	19.25 MHz	30.97	-19.03
1	Quasi Peak	19.254 MHz	34.53	-25.46
2	Average	19.49 MHz	31.15	-18.84
2	Average	21.178 MHz	29.74	-20.25
1	Quasi Peak	21.414 MHz	35.80	-24.19
1	Quasi Peak	23.578 MHz	32.09	-27.90
2	Average	24.786 MHz	34.12	-15.87
1	Quasi Peak	25.278 MHz	37.22	-22.77
2	Average	25.994 MHz	27.20	-22.79
2	Average	26.23 MHz	30.98	-19.01
2	Average	26.47 MHz	31.08	-18.91
1	Quasi Peak	26.718 MHz	34.32	-25.67

Date: 17.MAY.2015 09:12:53

Figure 11. Detectors: Peak, Quasi-peak, Average

Note: Delta Limit refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Phase
Detectors:	Peak, Quasi-peak, Average
Power Operation:	AC Adapter

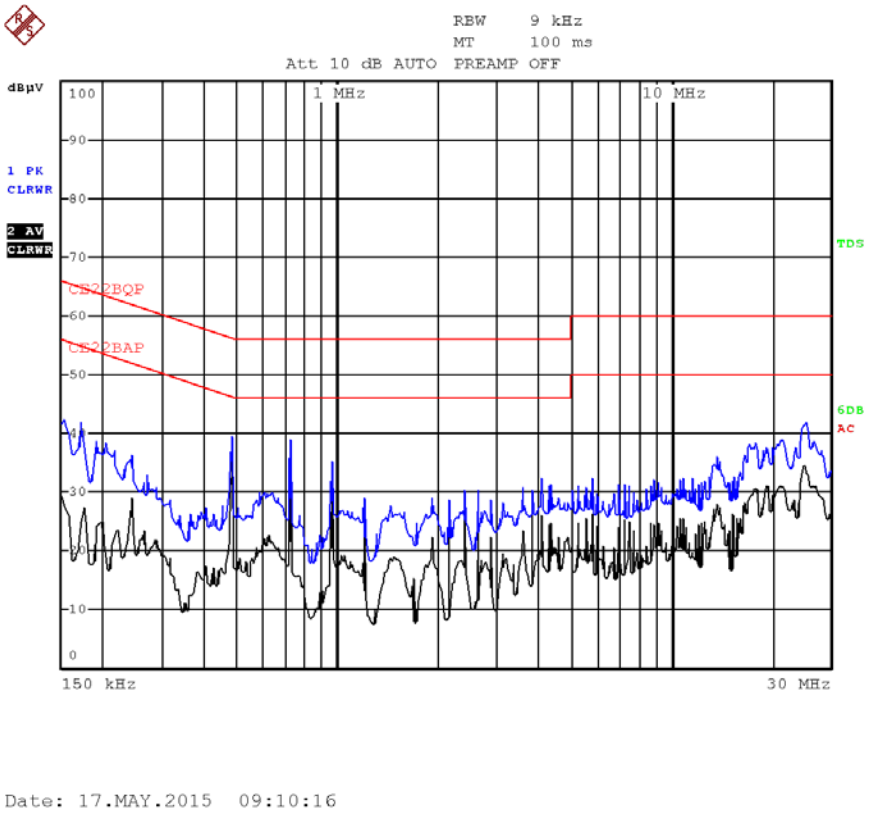

Figure 12. Detectors: Peak, Quasi-peak, Average

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation:	AC Adapter

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	150 kHz	40.37	-25.63
1	Quasi Peak	482 kHz	37.91	-18.38
2	Average	482 kHz	37.07	-9.23
1	Quasi Peak	722 kHz	37.78	-18.21
2	Average	722 kHz	36.71	-9.28
1	Quasi Peak	962 kHz	34.41	-21.58
2	Average	962 kHz	32.90	-13.09
1	Quasi Peak	17.33 MHz	33.20	-26.79
2	Average	18.046 MHz	30.25	-19.74
2	Average	19.25 MHz	31.41	-18.58
1	Quasi Peak	19.254 MHz	34.88	-25.11
1	Quasi Peak	19.482 MHz	31.49	-28.50
2	Average	19.486 MHz	28.58	-21.41
2	Average	19.73 MHz	29.84	-20.15
1	Quasi Peak	21.654 MHz	37.18	-22.81
2	Average	21.654 MHz	32.29	-17.70
1	Quasi Peak	25.022 MHz	38.07	-21.92
2	Average	25.022 MHz	33.62	-16.37
2	Average	26.47 MHz	32.71	-17.28
1	Quasi Peak	26.474 MHz	37.56	-22.43

Date: 17.MAY.2015 09:27:42

Figure 13. Detectors: Peak, Quasi-peak, Average

Note: Delta Limit refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation:	AC Adapter

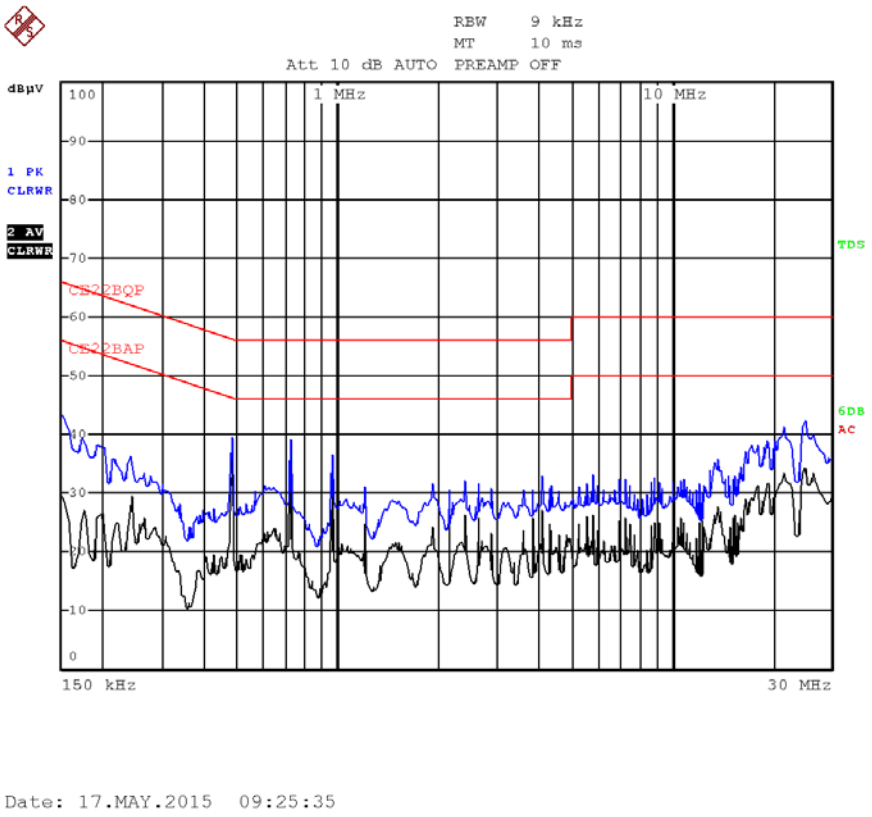

Figure 14 Detectors: Peak, Quasi-peak, Average

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Phase
Detectors:	Peak, Quasi-peak, Average
Power Operation:	PoE Power Supply

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	150 kHz	35.08	-30.91
2	Average	194 kHz	27.70	-26.16
1	Quasi Peak	290 kHz	31.18	-29.33
2	Average	386 kHz	22.97	-25.17
2	Average	434 kHz	22.44	-24.72
1	Quasi Peak	722 kHz	23.96	-32.03
1	Quasi Peak	962 kHz	45.13	-10.87
2	Average	962 kHz	45.09	-0.90
1	Quasi Peak	1.926 MHz	33.06	-22.94
2	Average	1.926 MHz	32.36	-13.64
2	Average	2.166 MHz	32.64	-13.35
1	Quasi Peak	2.406 MHz	33.20	-22.79
2	Average	3.61 MHz	30.93	-15.06
1	Quasi Peak	3.85 MHz	32.40	-23.59
1	Quasi Peak	9.386 MHz	32.88	-27.11
2	Average	10.11 MHz	32.44	-17.55
1	Quasi Peak	15.618 MHz	39.40	-20.59
2	Average	16.23 MHz	38.59	-11.40
1	Quasi Peak	17.694 MHz	32.77	-27.22
2	Average	17.694 MHz	30.53	-19.46

Date: 18.MAY.2015 09:37:59

Figure 15. Detectors: Peak, Quasi-peak, Average

Note: Delta Limit refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Phase
Detectors:	Peak, Quasi-peak, Average
Power Operation:	PoE Power Supply

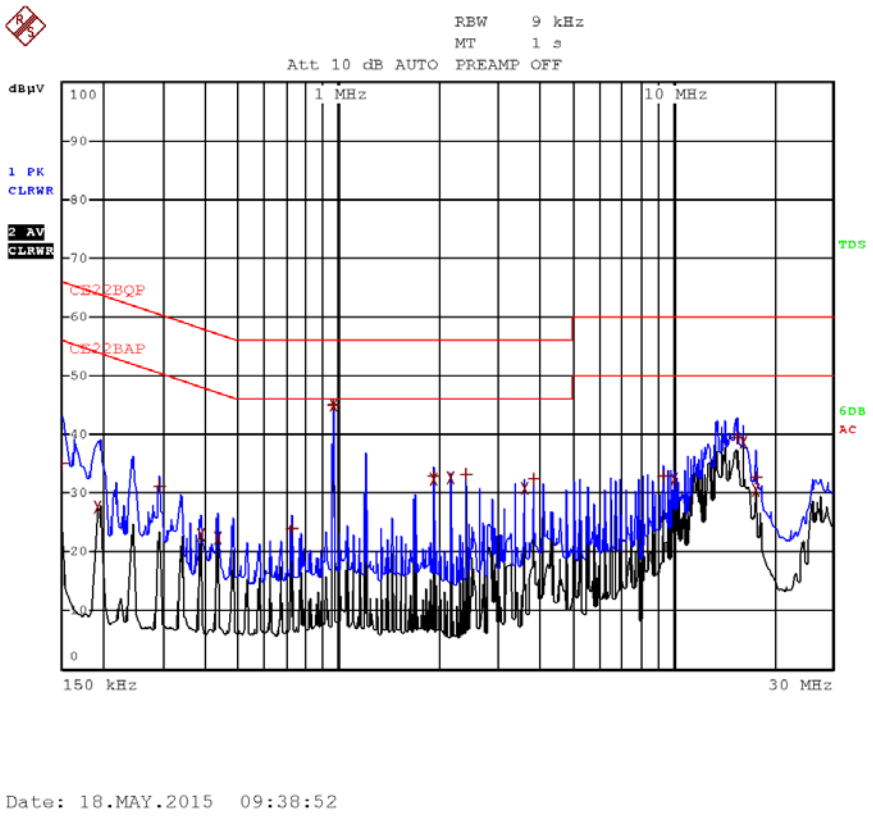

Figure 16. Detectors: Peak, Quasi-peak, Average

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation:	PoE Power Supply

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	962 kHz	44.02	-11.98
2	Average	962 kHz	43.81	-2.18
1	Quasi Peak	13.358 MHz	40.48	-19.52
2	Average	13.358 MHz	38.79	-11.20
2	Average	13.418 MHz	38.87	-11.12
1	Quasi Peak	13.482 MHz	41.25	-18.74
2	Average	13.482 MHz	37.65	-12.34
2	Average	14.03 MHz	37.22	-12.77
1	Quasi Peak	14.214 MHz	40.55	-19.44
2	Average	14.214 MHz	38.06	-11.93
1	Quasi Peak	14.274 MHz	39.31	-20.68
2	Average	14.274 MHz	37.53	-12.46
1	Quasi Peak	14.926 MHz	38.22	-21.77
1	Quasi Peak	15.17 MHz	35.75	-24.24
1	Quasi Peak	15.406 MHz	39.66	-20.33
2	Average	15.618 MHz	37.33	-12.66
1	Quasi Peak	16.166 MHz	42.05	-17.94
2	Average	16.166 MHz	38.67	-11.32
1	Quasi Peak	16.226 MHz	40.81	-19.18
2	Average	16.23 MHz	38.47	-11.52

Date: 18.MAY.2015 09:24:55

Figure 17. Detectors: Peak, Quasi-peak, Average

Note: Delta Limit refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	UWB Location Receiver
Type	LR2000-R
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation:	PoE Power Supply

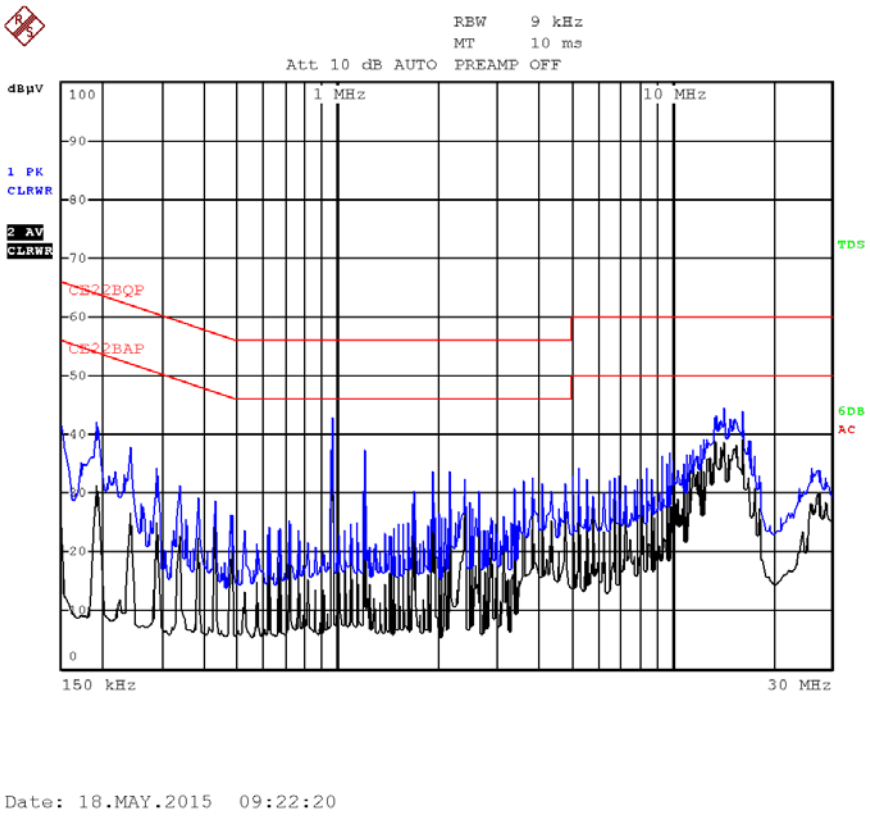

Figure 18 Detectors: Peak, Quasi-peak, Average

4.5 Test Instrumentation Used, Conducted Measurement

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
LISN	Fischer	FCC-LISN-2A	127	March 16, 2015	1 Year
Transient Limiter	HP	11947A	3107A03041	May 31, 2015	1 Year
EMI Receiver	Rohde & Schwarz	ESCI7	100724	January 4, 2015	1 Year

Figure 19 Test Equipment Used

5. UWB Bandwidth

5.1 Test Specification

FCC, Part 15, Subpart F, Section 15.517(b)

5.2 Test Procedure

The E.U.T. operation mode and test set-up are as described in Section 2.

The E.U.T. was connected directly to the EMI receiver through RF cable. RBW was set to 1MHz using RMS detector.

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 evaluation was done for each operational frequency.

The UWB bandwidth of a UWB system operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

5.3 Test Results

Operational Channel	Bandwidth (MHz)	Frequency Range (MHz)
2	651.4	3697.9 - 4349.3
5	663.4	6151.8 – 6815.2

Figure 20. UWB Bandwidth Test Results

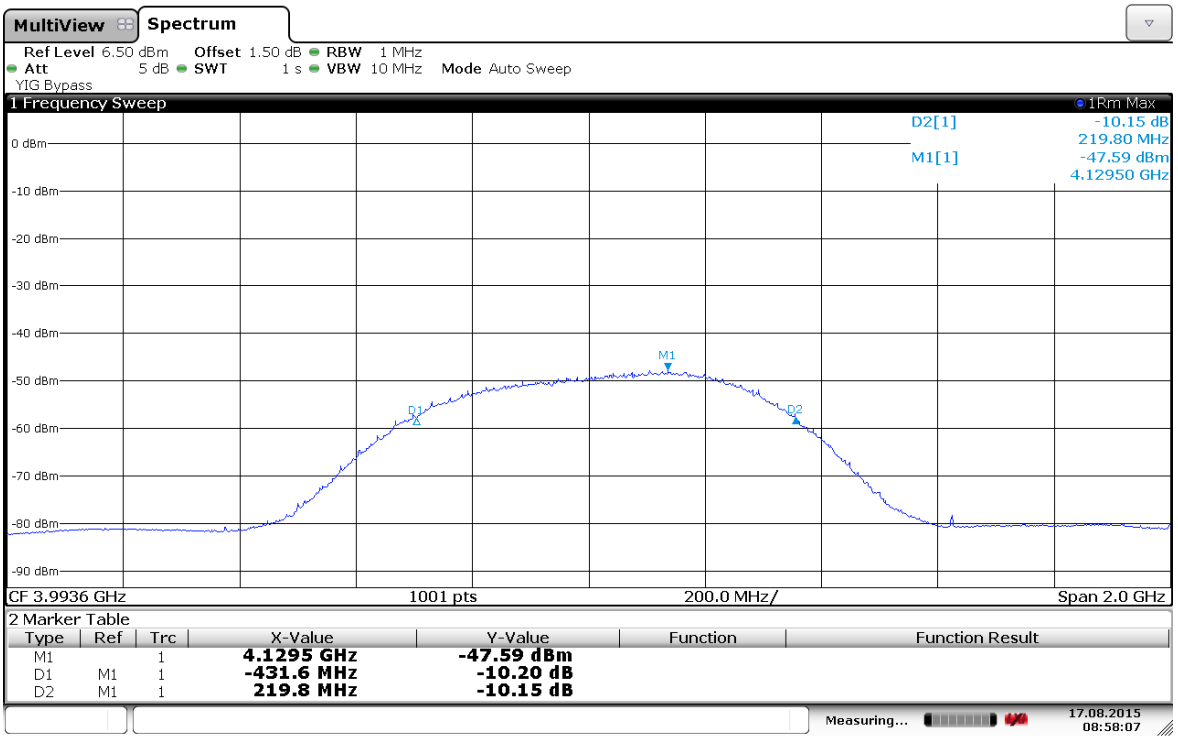

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Figure 21 UWB Bandwidth for Low Operation Freq = 651.4MHz

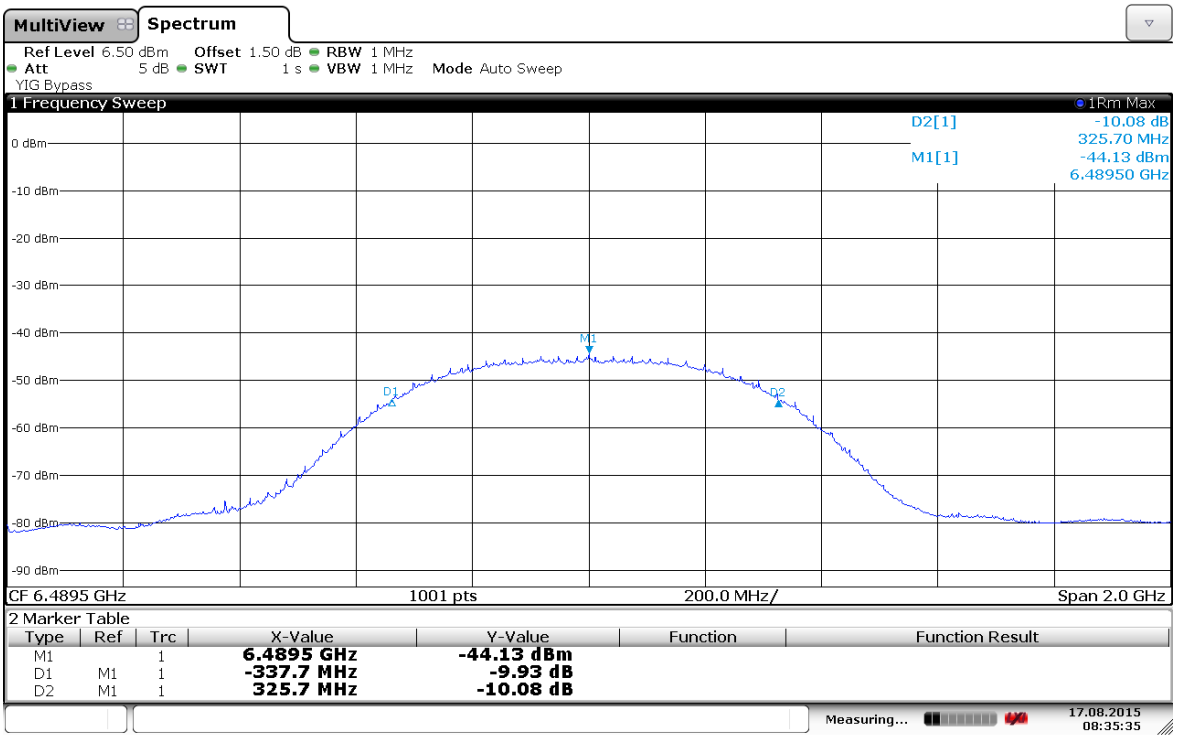

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Figure 22 UWB Bandwidth for High Operation Freq = 663.4MHz

5.4 Test Instrumentation Used, UWB Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
Signal Analyzer	R&S	FSW	1608688E	August 7, 2015	1 year

Figure 23 Test Equipment Used

6. Conducted Emissions + GPS BAND

6.1 Test Specification

FCC, Part 15, Subpart F, Sections 15.517 (c)(d), 15.209

6.2 Test Procedure

The E.U.T. operation mode and test set-up are as described in Section 2.

The E.U.T. was connected directly to the EMI receiver through RF cable (max loss=3dB). RBW was set to 1kHz/200kHz/1MHz depending on the frequency band scanned using an RMS detector at “max hold” trace and with 1msec or less averaging time.

The frequency range 9 kHz-40000 MHz was scanned.

The evaluation was performed for each of the 2 operation channels.

Final EIRP calculation was calculated for each highest emission frequency fundamental with the maximum, worst case antenna gain.

Table of Limits

Frequency band (MHz)	Eirp (dBm)	RBW
0.009-960.0	As specified in section 15.209	9KHz/120KHz
960.0-1610.0	-75.3	1MHz
1610.0-1990.0	-53.3	1MHz
1990.0-3100.0	-51.3	1MHz
3100.0-10600.0	-41.3	1MHz
10600.0-40000.0	-51.3	1MHz
1164.0-1240.0(GPS)	-85.3	1KHz
1559.0-1610.0(GPS)	-85.3	1KHz

6.3 Test Results

The EUT met the FCC Part 15, Subpart F, Sections 15.517 (c)(d), 15.209 requirements.

JUDGEMENT: Passed

The details of the highest emissions are given in Figure 24 to Figure 43 .

Channel	Fundamental Reading (dbm)	Antenna Gain (dBi)	EIRP (dbm)	Limit (dbm)	Margin (dB)
2	-47.6	5.8	-41.8	-41.3	-0.5
5	-44.8	2.3	-42.5	-41.3	-1.2

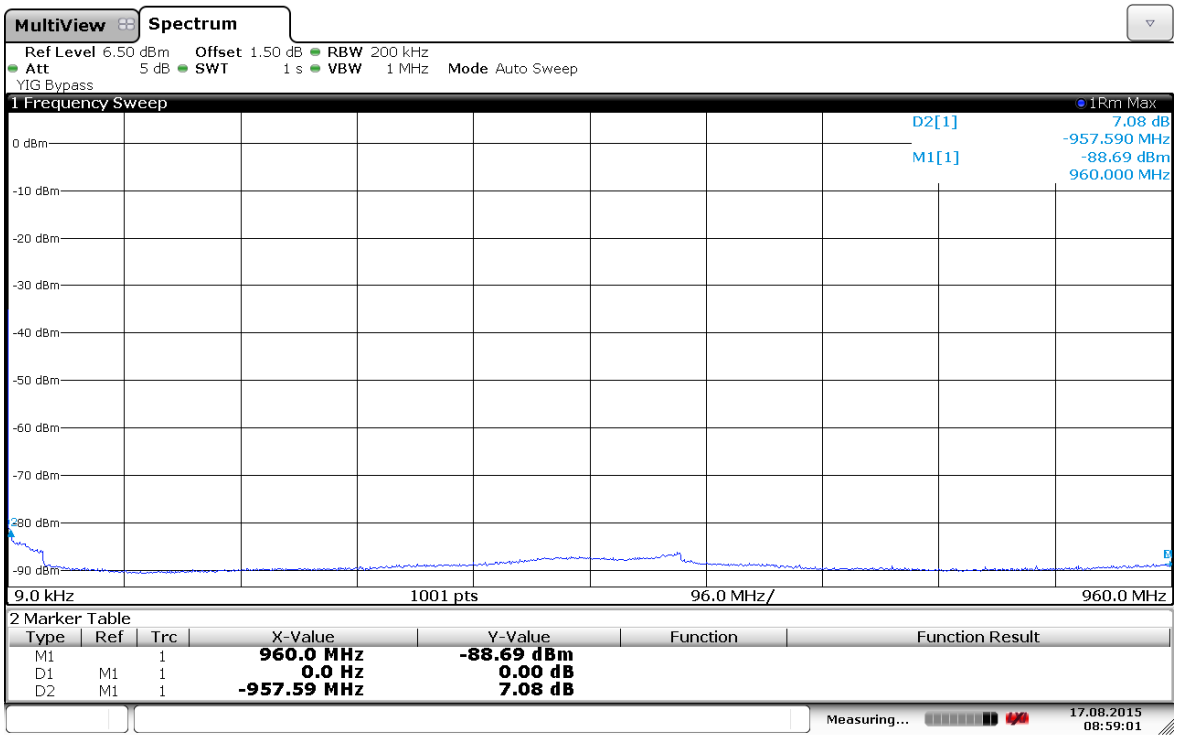

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Figure 24 Channel 2 – Frequency Range: 0.009MHz-960.0MHz

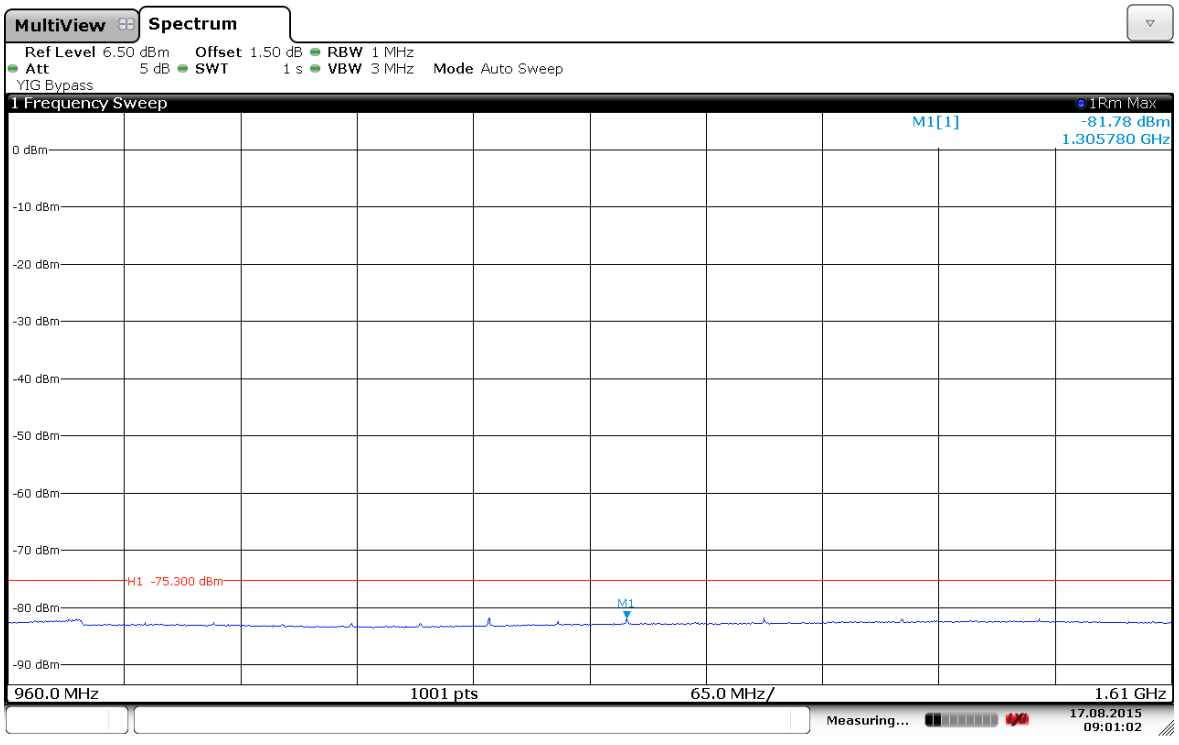

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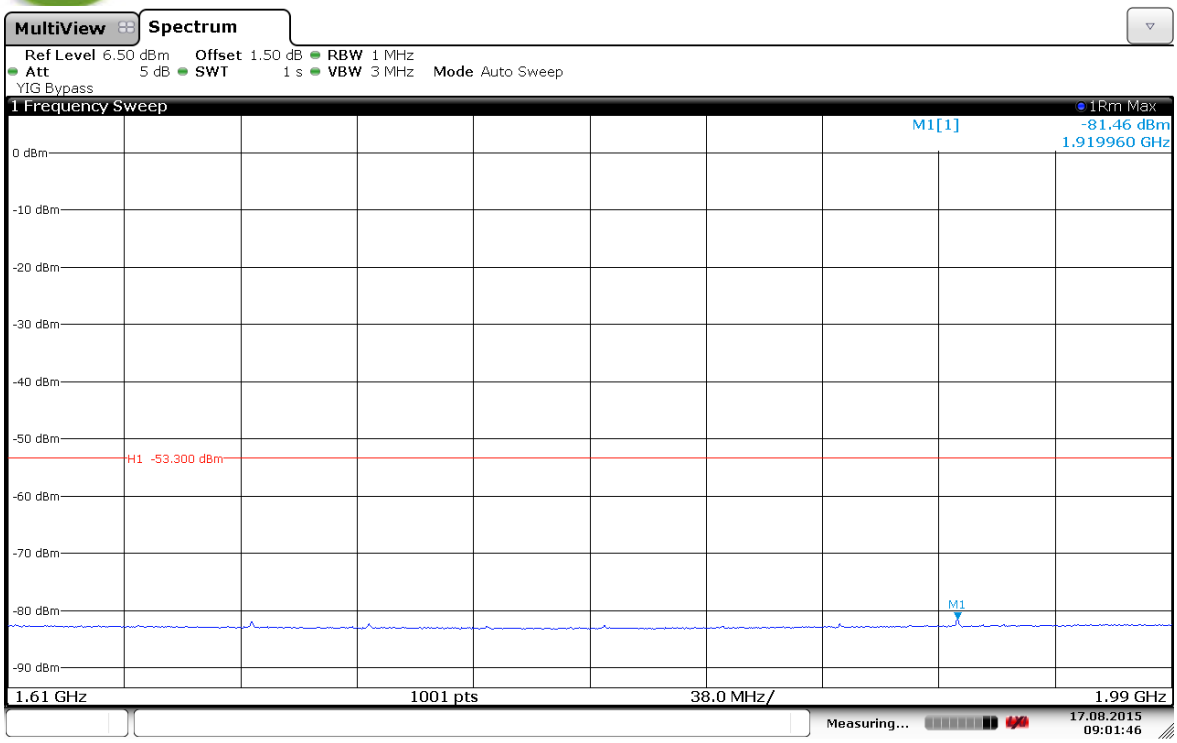
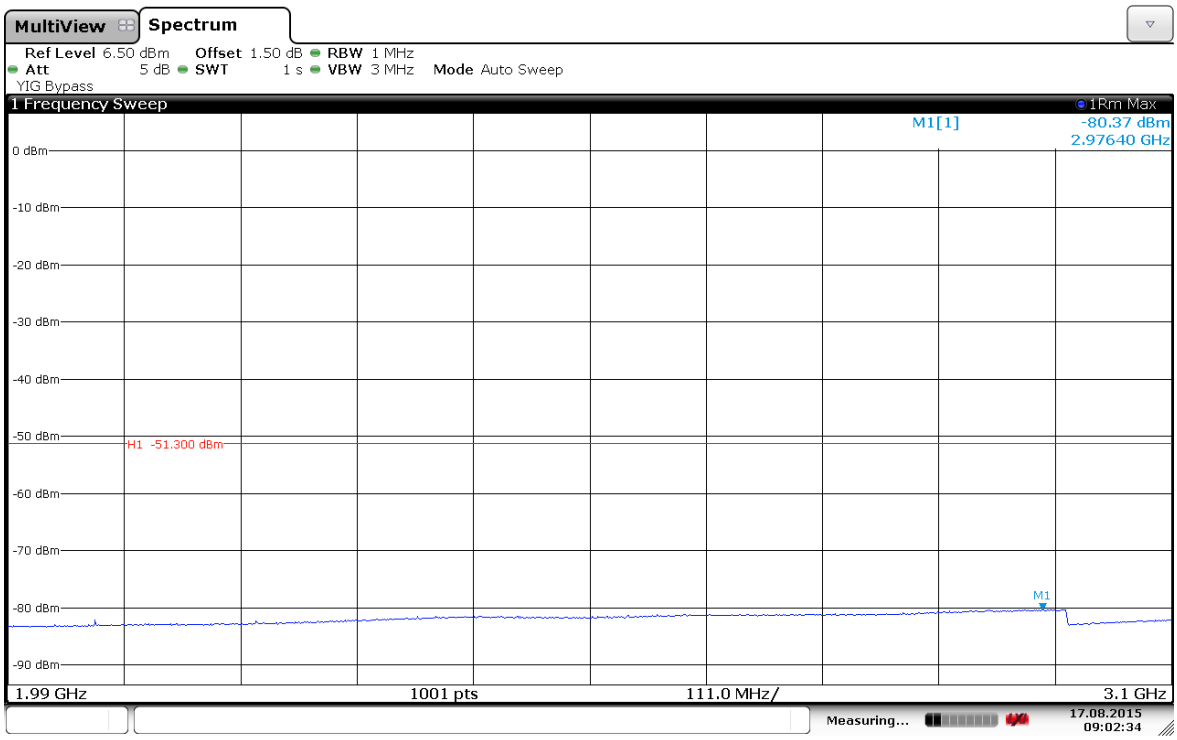
Figure 25 Channel 2 – Frequency Range: 960.0MHz-1610.0MHz



Date: 17.AUG.2015 09:01:46

Figure 26 Channel 2 – Frequency Range: 1610.0MHz-1990.0MHz



Date: 17.AUG.2015 09:02:33

Figure 27 Channel 2 – Frequency Range: 1990.0MHz-3100.0MHz

Date: 17.AUG.2015 09:08:03

Figure 28 Channel 2 – GPS Frequency Range: 1164.0MHz-1240.0MHz

Date: 17.AUG.2015 09:08:54

Figure 29 Channel 2 – GPS Frequency Range: 1559.0MHz-1610.0MHz

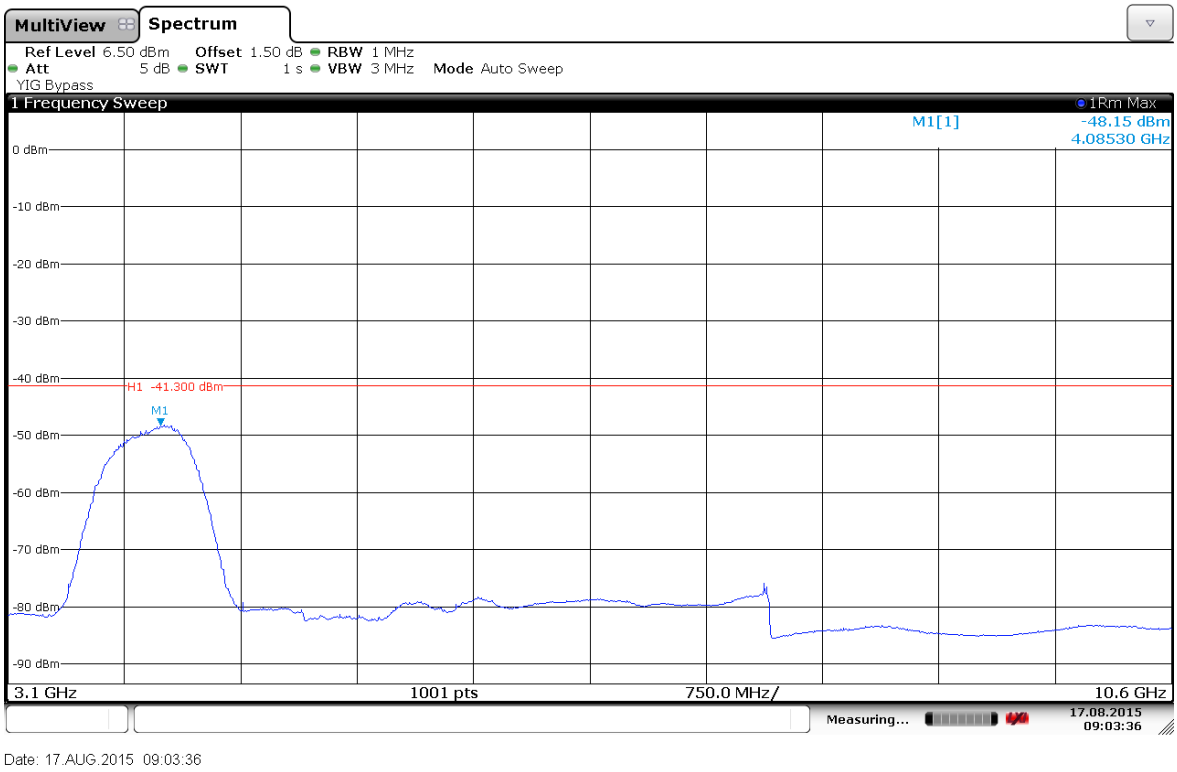


Figure 30 Channel 2 – Frequency Range: 3100.0MHz-10600.0MHz

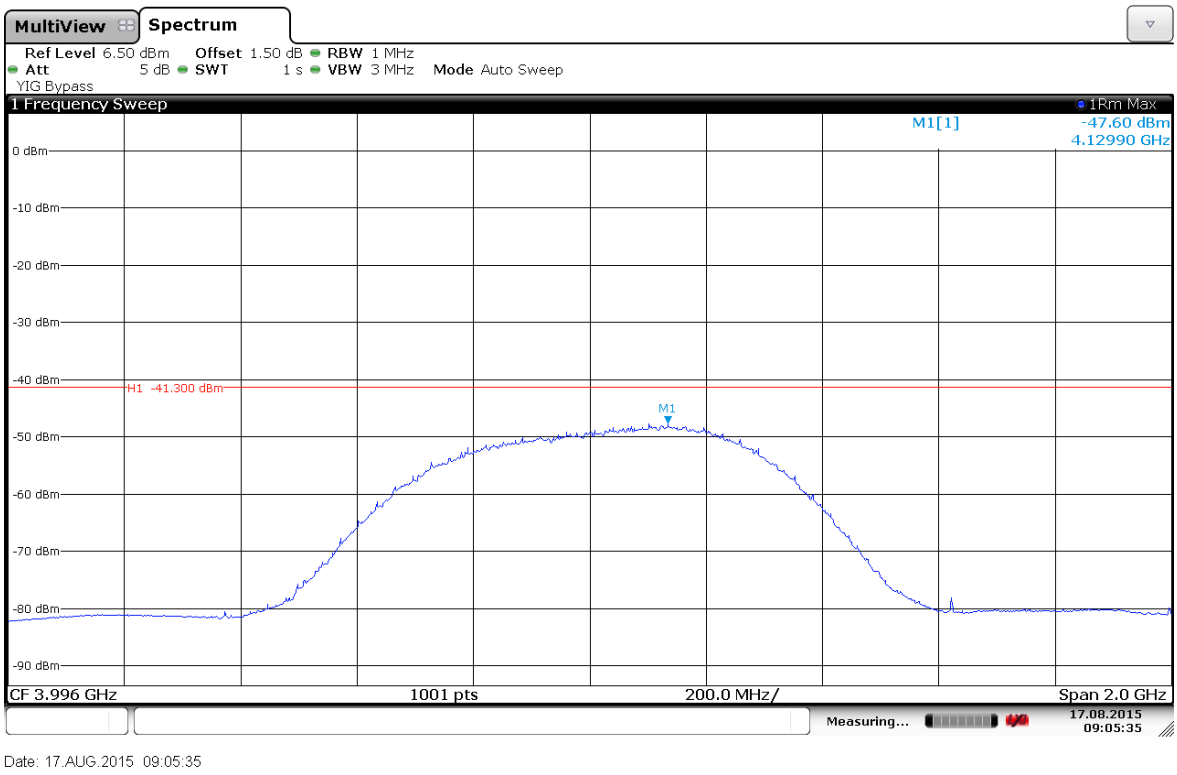


Figure 31 EIRP CH2=-47.6dBm+5.8dBi (antenna gain)=-41.8dBm

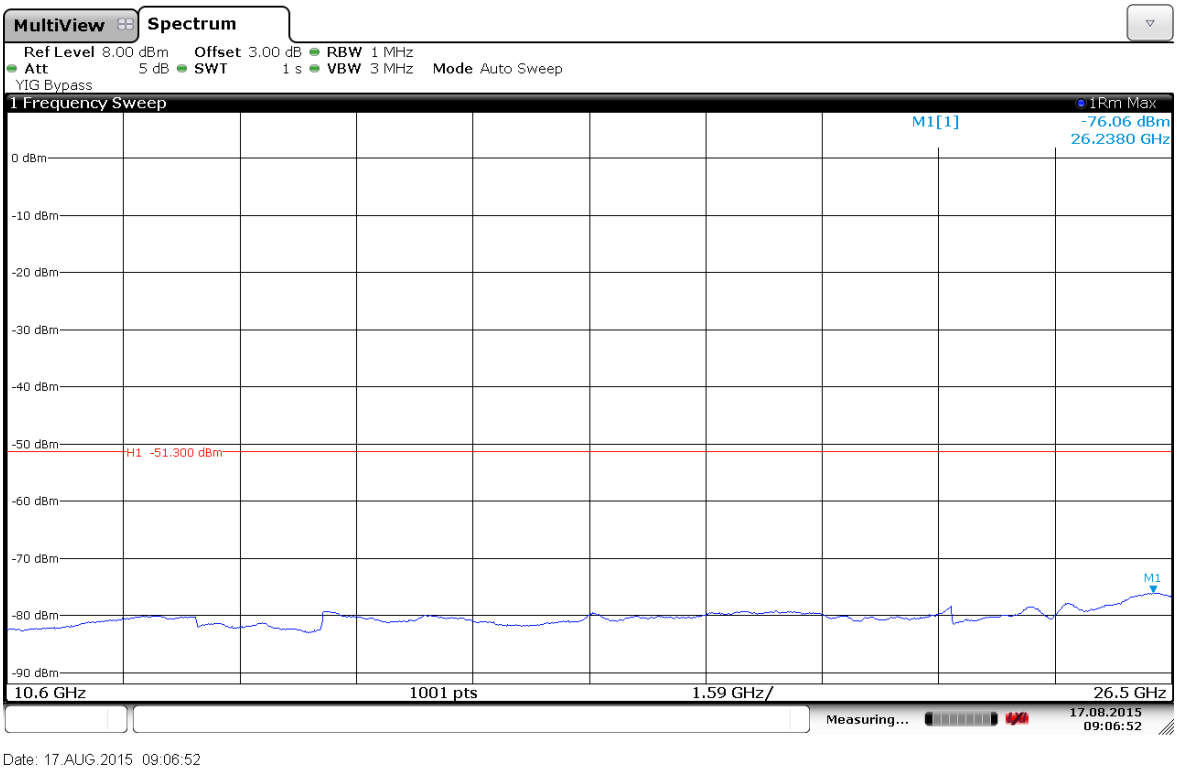


Figure 32 Channel 2 – Frequency Range:10600.0MHz-265000.0MHz

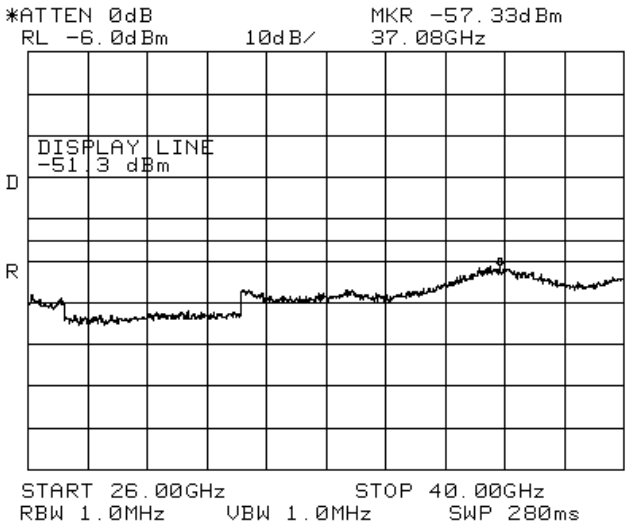
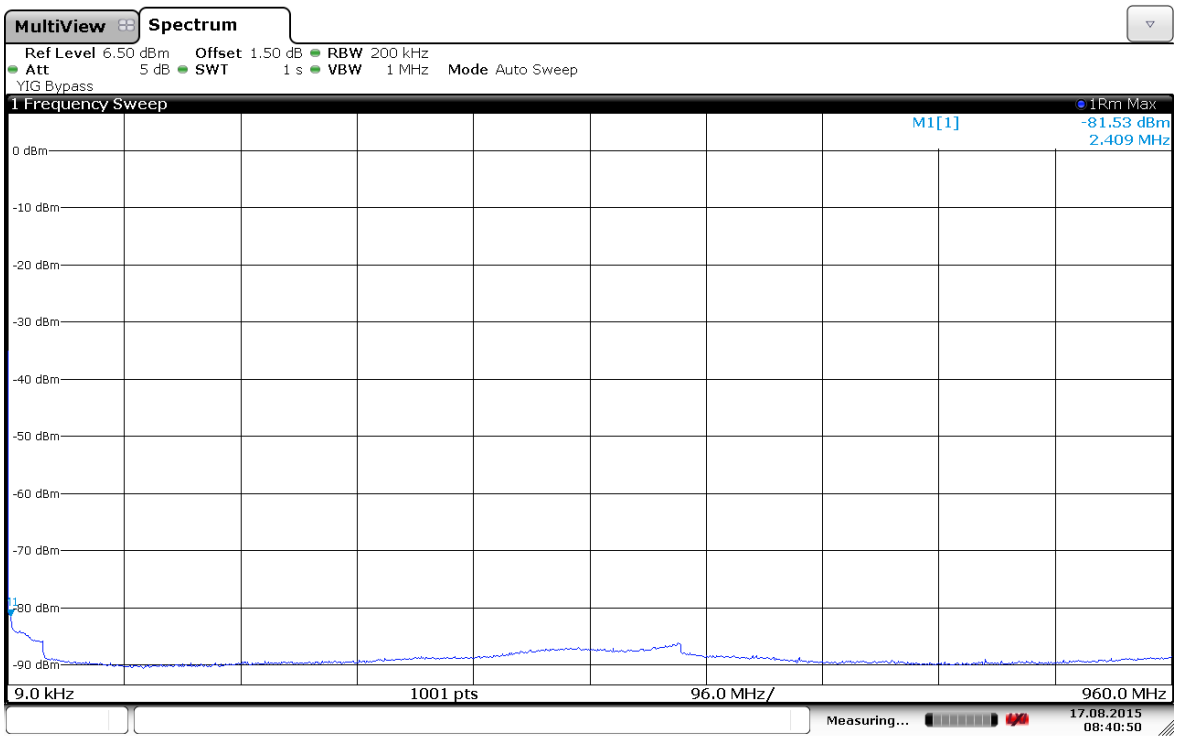
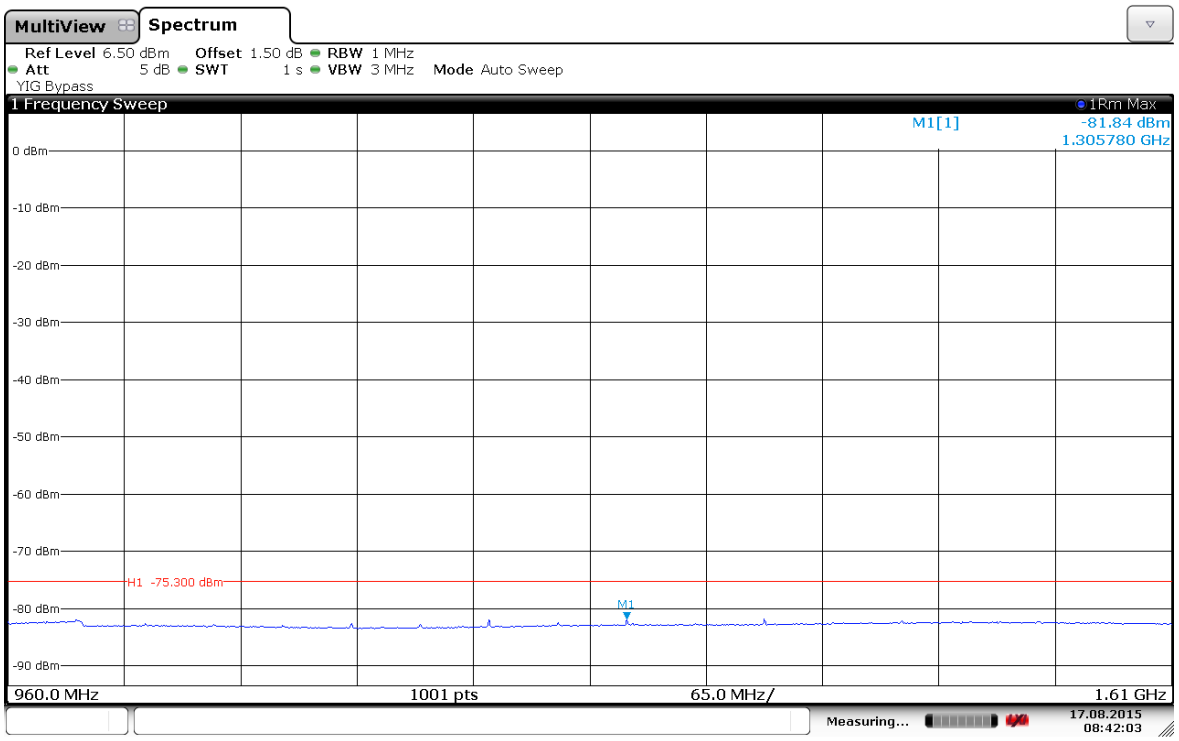


Figure 33 Channel 2 – Frequency Range: 26000.0MHz-40000.0MHz



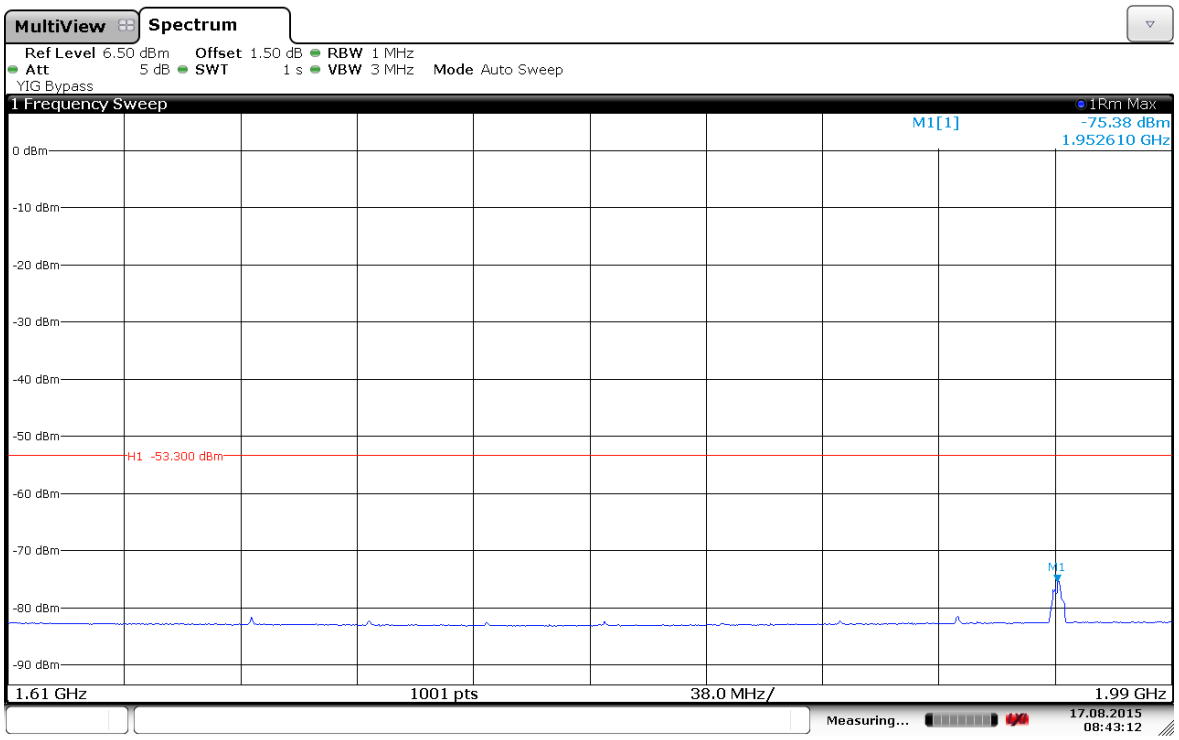
Date: 17.AUG.2015 08:40:50

Figure 34 Channel 5 Frequency Range: 0.009MHz-960.0MHz



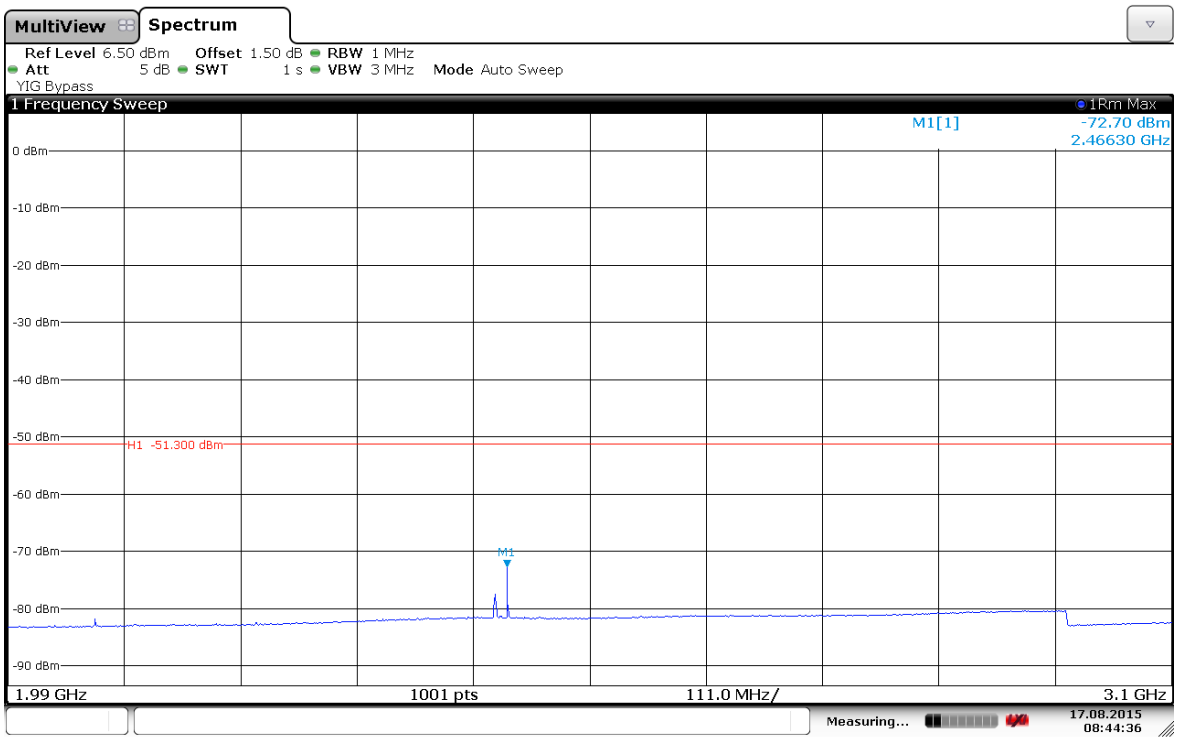
Date: 17.AUG.2015 08:42:03

Figure 35 Channel 5 Frequency Range: 960.0MHz-1610.0MHz



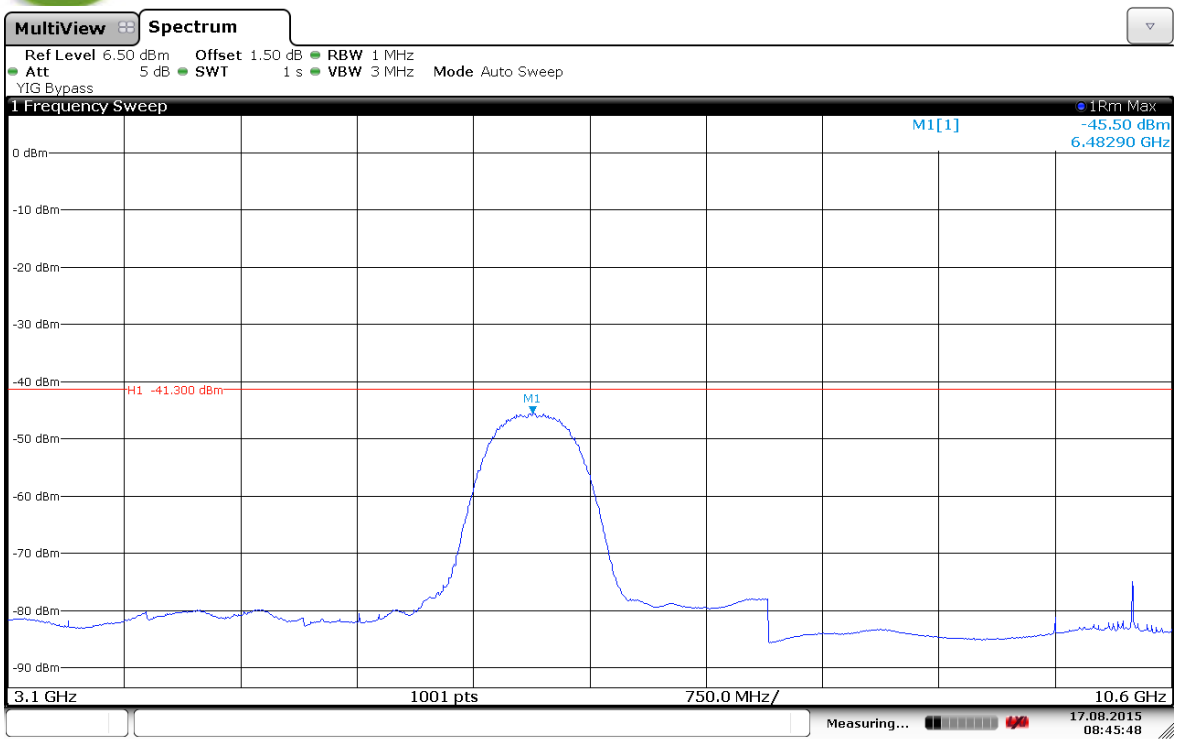
Date: 17.AUG.2015 08:43:11

Figure 36 Channel 5 Frequency Range: 1610.0MHz-1990.0MHz



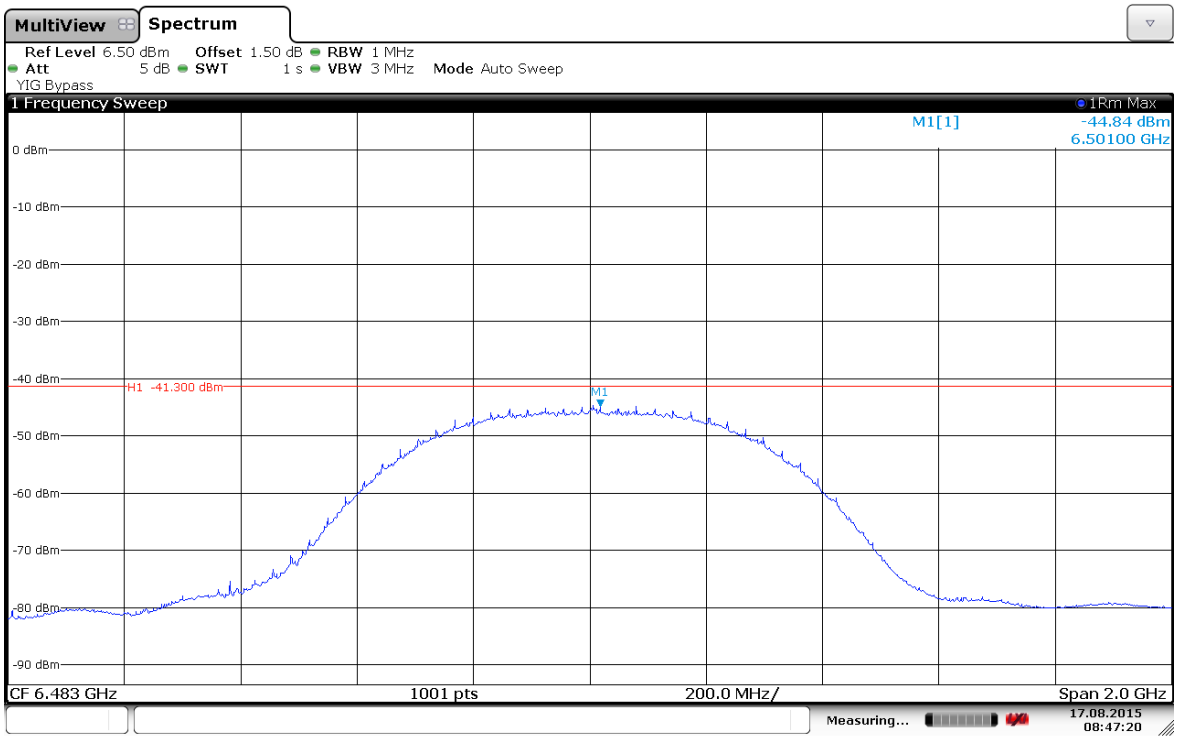
Date: 17.AUG.2015 08:44:36

Figure 37 Channel 5 Frequency Range: 1990.0MHz-3100.0MHz



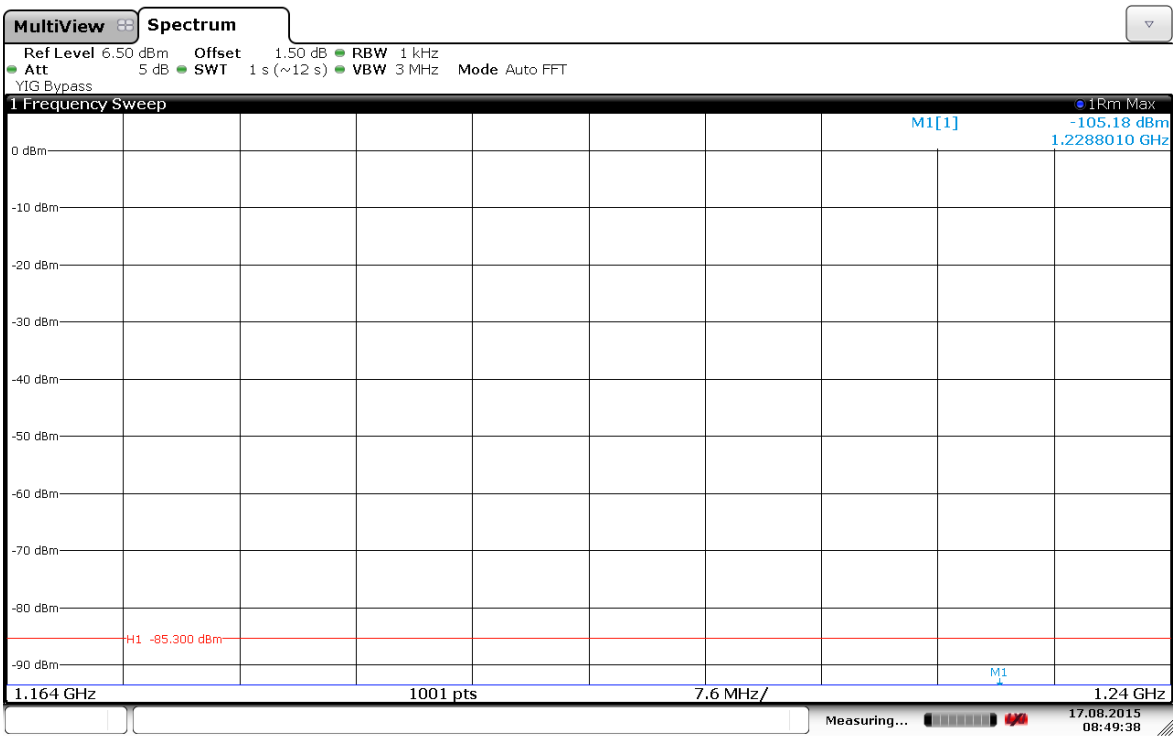
Date: 17.AUG.2015 08:45:48

Figure 38 Channel 5 Frequency Range: 3100.0MHz-10600.0MHz



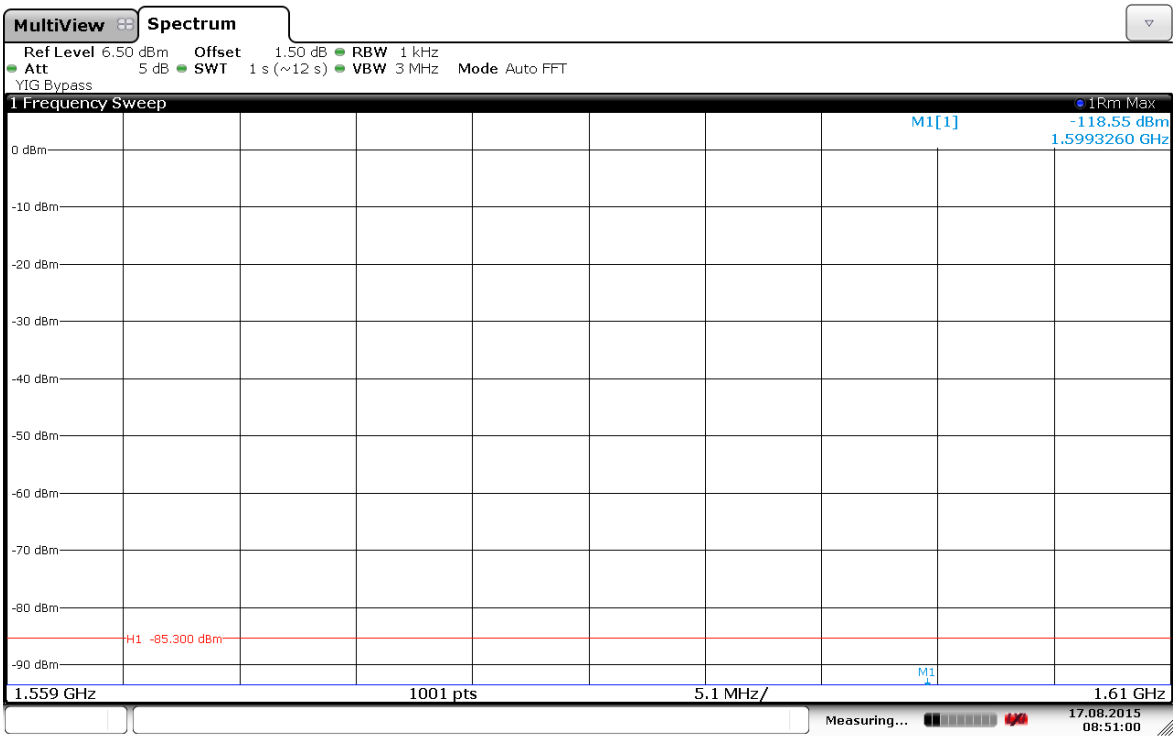
Date: 17.AUG.2015 08:47:20

Figure 39 EIRP CH5=-44.8dBm+2.3dBi(ant gain)=-42.5dBm



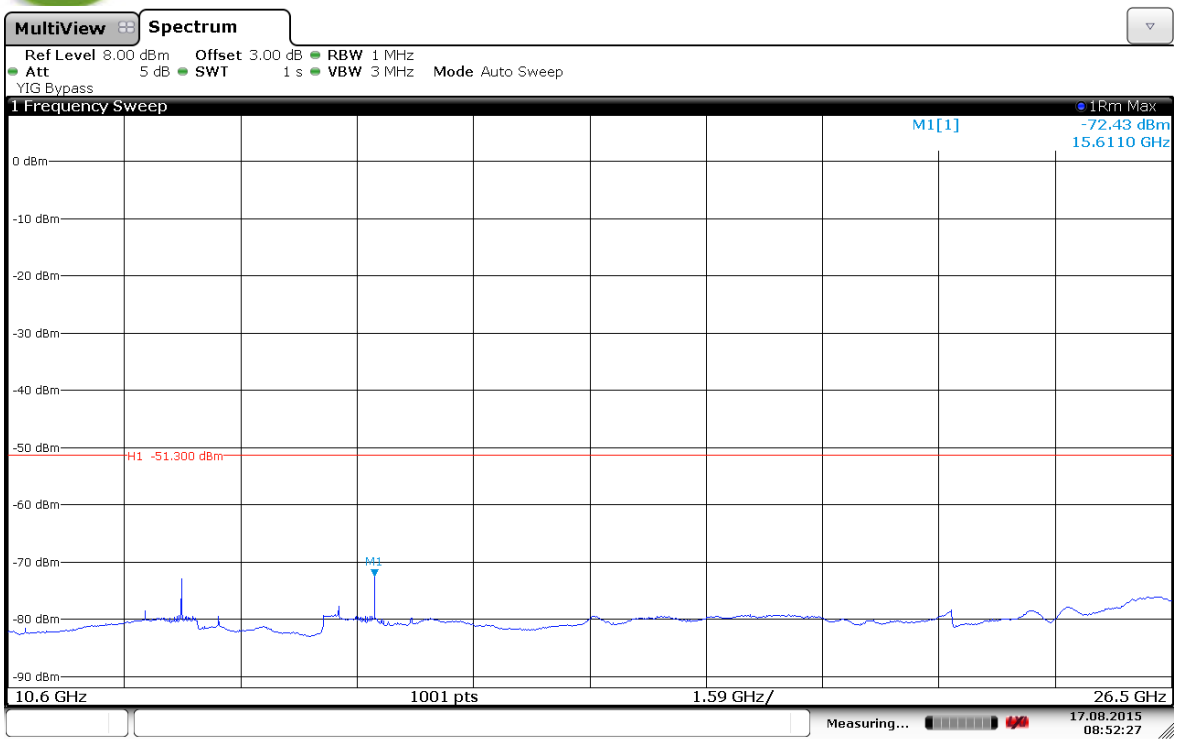
Date: 17.AUG.2015 08:49:38

Figure 40 Channel 5 GPS Frequency Range:1164.0MHz-1240.0MHz



Date: 17.AUG.2015 08:51:00

Figure 41 Channel 5 GPS Frequency Range: 1559.0MHz-1610.0MHz



Date: 17.AUG.2015 08:52:27

Figure 42 Channel 5 Frequency Range: 10600.0MHz-265000.6MHz

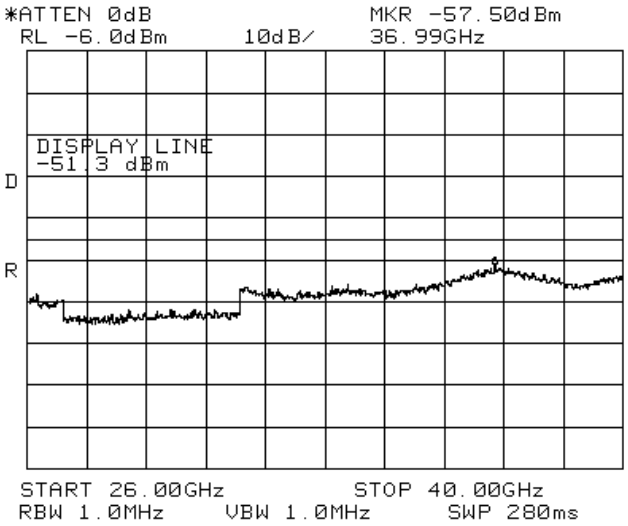


Figure 43 Channel 5 Frequency Range: 26000.0MHz-40000.0MHz

6.1 Test Instrumentation Used, Conducted Emissions and GPS Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
Signal Analyzer	R&S	FSW	1608688E	August 7, 2015	1 year
Spectrum Analyzer	HP	8564E	3442A00275	March 11, 2015	1 year

Figure 44 Test Equipment Used

7. RADIATED EMISSIONS + GPS BAND

7.1 Test Specification

FCC, Part 15, Subpart F, Sections 15.517 (c) (d), 15.209

7.2 Test Procedure

The E.U.T. operation mode and test set-up are as described in Section 2.
A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 1 meters, using peak detection mode and broadband antennas. The frequency range 9 kHz-40000 MHz was scanned.
The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The configuration tested is shown in Figure 2.
The distance between the E.U.T. and test antenna was 1 meter.
The turntable and antenna were adjusted for maximum level reading on the EMI receiver.
The frequency range 9 kHz-40000 MHz was scanned.
The E.U.T was evaluated with 50Ω terminations on the antenna port.
For emission measurements below 960MHz quasi-peak detector was used with RBW of 120 kHz.
For emission measurements above 960MHz, a RMS detector was used with RBW of 1000 kHz, trace in “max hold” and a 1 millisecond or less averaging time.
For emission measurements in the frequency ranges 1164-1240 and 1559.0-1610.0 MHz, a RMS detector is used with RBW of 1 kHz and a 1 millisecond or less averaging time.
Trace was set to “max hold”.
Testing below 1 GHz was performed at a distance of 3 meters.
Testing above 1 GHz was performed at a distance of 1 meter and “Measurement Distance” correction factor was calculated for the final results as this equation: 20 log (D/3) where D is the measurement distance in meters=1m.
Accordingly, the “measurement distance” correction factor is
20 log (1/3) = -9.54 dB.

Table of Limits

Frequency (MHz)	Eirp (dBm)	Eirp (dBµV/m)@3m	RBW
0.009-960.0	-	As specified in section 15.209	9KHz/120KHz
960.0-1610.0	-75.3	19.9	1MHz
1610.0-1990.0	-53.3	41.9	1MHz
1990.0-3100.0	-51.3	43.9	1MHz
3100.0-10600.0	-41.3	53.9	1MHz
10600.0-40000.0	-51.3	43.9	1MHz
1164.0-1240.0(GPS BAND)	-85.3	9.9	1KHz
1559.0-1610.0(GPS BAND)	-85.3	9.9	1KHz

7.3 Test Results

JUDGEMENT: Passed by 0.2 dB

The EUT met the Subpart F, Sections 15.517 (c) (d), 15.209 specifications requirements.

The details of the highest emissions are given in *Figure 45* to *Figure 48.*

Frequency	Polarity	Peak Reading@3m	Quasi-Peak Reading@3m	Quasi-Peak Spec@3m	Margin
(MHz)	(V/H)	(dbuV/m)	(dbuV/m)	(dbuV/m)	(dB)
48.8	H	45.6	32.7	40.0	-7.3
	V	45.6	37.1	40.0	-2.9
71.6	H	41.0	31.0	40.0	-9.0
	V	50.8	39.8	40.0	-0.2
292.0	H	43.3	38.3	46.0	-7.7
	V	34.5	29.1	46.0	-16.9

Figure 45 Channel 2 – Frequency Range: 0.009MHz-960MHz

Frequency	Polarity	Avg Reading@1m	Distance FACTOR	Avg Reading@3m	Avg Spec@3m	Margin
(MHz)	**(V/H)**	**(dbuV/m)**	**(dB)**	**(dbuV/m)**	**(dbuV/m)**	**(dB)**
1300.0	H	24.4	-9.5	14.9	19.9	-5.0
1300.0	V	25.4	-9.5	15.9	19.9	-4.0
2440.2	H	42.3	-9.5	32.8	43.9	-11.1
2440.2	V	44.1	-9.5	34.6	43.9	-9.3
1220.5	H	4.3	-9.5	-5.2	9.9	-15.1
1220.5	V	4.4	-9.5	-5.1	9.9	-15.0
4069.1	H	46.9	-9.5	37.4	53.9	-16.5
4069.1	V	46.7	-9.5	37.2	53.9	-16.7
7990.5	H	41.3	-9.5	31.8	53.9	-22.1
7990.5	V	41.5	-9.5	32.0	53.9	-21.9
35666.4	H	39.3	-9.5	29.8	43.9	-14.1
35666.4	V	39.3	-9.5	29.8	43.9	-14.1

Figure 46 Channel 2 – Frequency Range: 960MHz-40000MHz

Frequency	Polarity	Peak Reading@3m	Q.Peak Reading@3m	Q.Peak Spec@3m	Margin
(MHz)	(V/H)	(dbuV/m)	(dbuV/m)	(dbuV/m)	(dB)
48.8	H	46.6	32.7	40.0	-7.3
	V	45.6	32.1	40.0	-7.9
71.6	H	41.5	31.6	40.0	-8.4
	V	44.6	36.5	40.0	-3.5
292.0	H	43.4	38.3	46.0	-7.7
	V	38.8	35.1	46.0	-10.9

Figure 47 Channel 5 – Frequency Range: 0.009MHz-960MHz

Frequency	Polarity	Avg Reading@1m	Distance FACTOR	Avg Reading@3m	Avg Spec@3m	Margin
(MHz)	(V/H)	(dbuV/m)	(dB)	(dbuV/m)	(dbuV/m)	(dB)
1880.0	H	47.3	-9.5	37.8	41.9	-4.1
1880.0	V	47.9	-9.5	38.4	41.9	-3.5
1228.0	H	6.8	-9.5	-2.7	9.9	-12.6
1228.0	V	6.8	-9.5	-2.7	9.9	-12.6
2405.9	H	40.6	-9.5	31.1	43.9	-12.8
2405.9	V	40.8	-9.5	31.3	43.9	-12.6
6554.3	H	56.2	-9.5	46.7	53.9	-7.2
6554.3	V	56.1	-9.5	46.6	53.9	-7.3
35761.4	H	40.1	-9.5	30.6	43.9	-13.3
35761.4	V	40.3	-9.5	30.8	43.9	-13.1

Figure 48 Channel 2 – Frequency Range: 960MHz-40000MHz

5.4 Test Equipment Used; Radiated Emissions and GPS Band

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
Signal Analyzer	R&S	FSW	1608688E	August 7, 2015	1 year
Spectrum Analyzer	HP	8564E	3442A00275	March 11, 2015	1 year
Spectrum Analyzer	HP	8592L	3826A01204	March 4, 2015	1 year
Active Loop Antenna	EMCO	6502	9506-2950	November 4, 2014	1 year
Biconilog Antenna	EMCO	3142B	1250	May 22, 2014	1 year
Horn Antenna 1GHz-18GHz	ETS	3115	6142	May 19 2015	3 years
Horn Antenna 18GHz-26GHz	ARA	SWH-28	1007	March 30, 2014	2 years
Horn Antenna 26GHz-40GHz	OSR Electronics	PE9850R-20	J202021732	February 1, 2015	1 year
Low Noise Amplifier	Narda	LNA-DBS-0411N313	013	August 22, 2014	1 year
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	August 29, 2014	1 year
Antenna Mast	ETS	2070-2	9608-1497	N/A	N/A
Turntable	ETS	2087	-	N/A	N/A
Mast & Table Controller	ETS/EMCO	2090	9608-1456	N/A	N/A

Figure 49 Test Equipment Used Radiated Emissions and GPS Band

8. Peak Level Emission

8.1 Test Specification

FCC, Part 15, Subpart F, Section 15.517(e)

8.2 Test Procedure

The E.U.T. operation mode and test set-up are as described in Section 2.

The E.U.T was connected directly to the EMI receiver through a low loss RF cable. (1.5 dB loss).

The EMI receiver detector was set to PEAK detector and trace in max hold.

RBW was set to 50MHz and VBW was set to 80MHz.

Sweep time was set to 1sec to achieve 1msec every trace point.

8.3 Test Results

Channel	Fundamental Reading (dbm)	Antenna Gain (dBi)	EIRP (dbm)	Limit (dbm)	Margin (dB)
2	-7.96	5.8	-2.1	0.00	-2.1
5	-4.1	2.3	-1.8	0.00	-1.8

Figure 50 Peak Level Emission Test Results

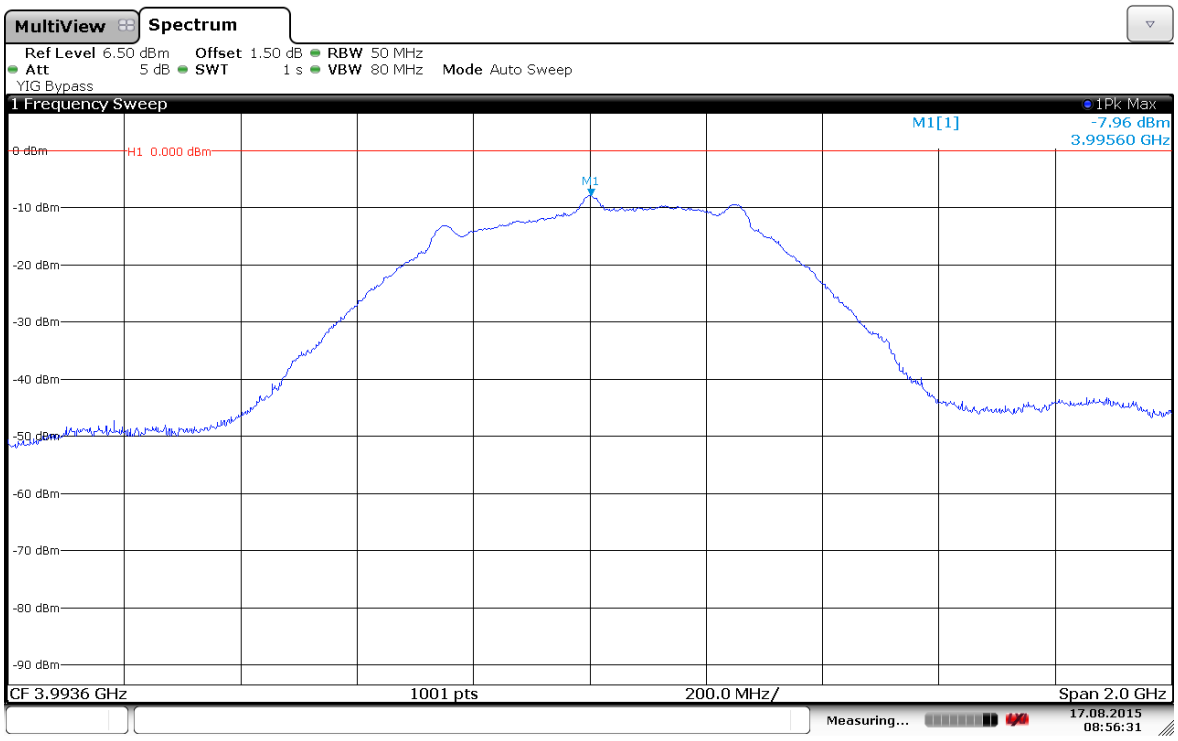


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Figure 51 EIRP peak level CH2=-7.9dBm+5.8dBi (ant gain) =-2.1dBm

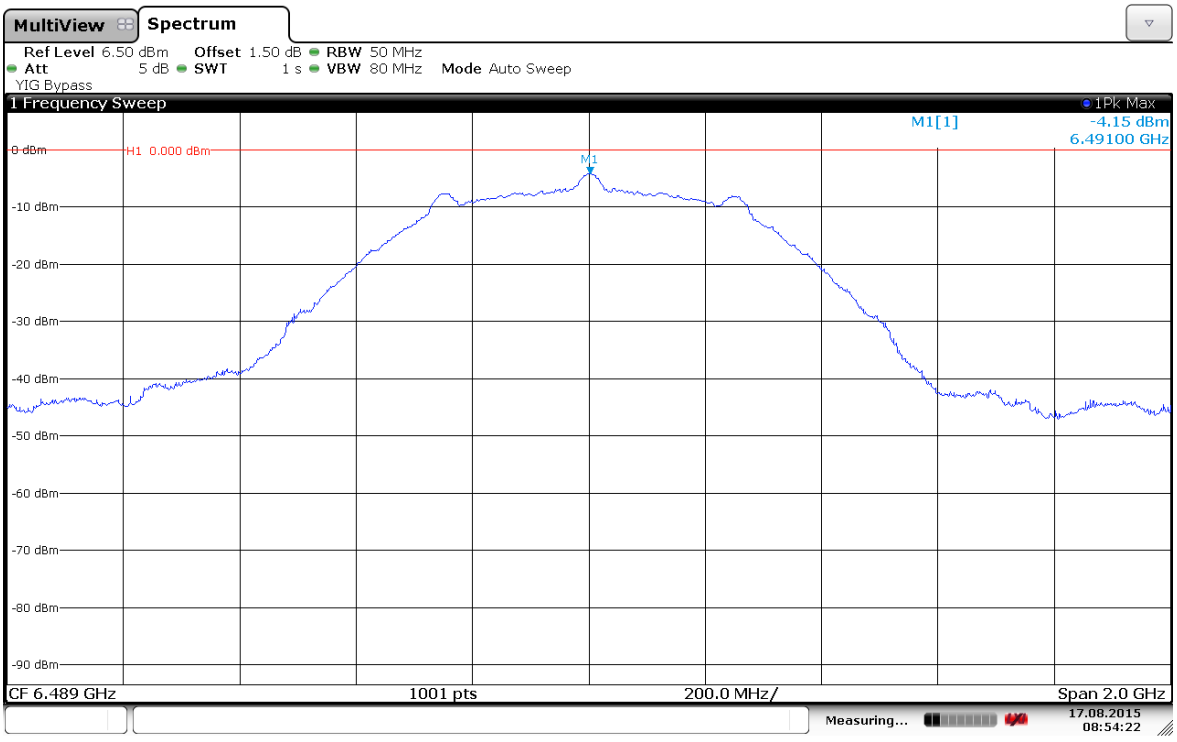

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Figure 52 EIRP peak level CH5=-4.1dBm+2.3dBi (ant gain) =-1.8dBm

8.4 Test Instrumentation Used, Peak Level Emission

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
Signal Analyzer	R&S	FSW	1608688E	August 7, 2015	1 year
Spectrum Analyzer	HP	8564E	3442A00275	March 11, 2015	1 year

Figure 53 Test Equipment Used

9. R.F Exposure/Safety

Typical use of the E.U.T. is as location receiver for UBW asset tags.

The typical placement of the E.U.T. is mounted either vertically or horizontally or handheld. The typical distance between the E.U.T. and the user is 20.0 cm.

Calculation of Maximum Permissible Exposure (MPE)

Based on FCC Section 1.1310 Requirements

(a) FCC limits at 2412 MHz is: $1\frac{mW}{cm^2}$

Using table 1 of Section 1.1310 limit for general population/uncontrolled exposures, the above level is an average over 30 minutes.

(b) The power density produced by the E.U.T. is

$$S = \frac{P_t G_t}{4\pi R^2}$$

For Channel 2:
P_t- Transmitted Power -47.6 dBm = 0.00002mW
G_T- Antenna Gain, 5.8 dBi (antenna with highest gain) = 3.8 numeric
R- Distance from Transmitter using 20.0 cm worst case
The peak power density is:

$$\frac{0.00002\times3.8}{4\pi(20)^2} = 1.512 \times 10^{-8} \text{ mW/cm}^2$$

For Channel 5:
P_t- Transmitted Power -44.8 dBm = 0.00003mW
G_T- Antenna Gain, 2.3 dBi (antenna with highest gain) = 1.7 numeric
R- Distance from Transmitter using 20.0 cm worst case
The peak power density is:

$$\frac{0.00003\times1.7}{4\pi(20)^2} = 1.015 \times 10^{-8} \text{ mW/cm}^2$$

(c) This is below the FCC limit.

10. Correction Factors

10.1 Correction factors for 35M Coaxial cable for OATS

Manufacturer: Huber Zoner
Model number: SPUMA400-FR-50

Frequency (MHz)	Ref. (dBm)	Tested (dBm)	Cable loss (dB)
10	-29.7	-29.4	0.3
20	-29.6	-29.4	0.2
50	-29.8	-29.9	-0.1
100	-29.9	-30.5	-0.6
200	-29.9	-31.1	-1.2
500	-30.0	-32.3	-2.3
1000	-30.0	-33.6	-3.6
2000	-30.2	-36.0	-5.8
5000	-11.5	-22.6	-11.1
10,000	-12.4	-29.5	-17.1
15,000	-16.0	-39.3	-23.3
18,000	-20.0	-43.6	-23.6

10.2 Correction factors for ***Horn Antenna***

Model: SWH-28
at 1 meter range.

FREQUENCY (GHz)	AFE (dB /m)	Gain (dB1)
18.0	40.3	16.1
19.0	40.3	16.3
20.0	40.3	16.1
21.0	40.3	16.3
22.0	40.4	16.8
23.0	40.5	16.4
24.0	40.5	16.6
25.0	40.5	16.7
26.0	40.6	16.4

10.3 Correction factors for ACTIVE LOOP ANTENNA

Model 6502
S/N 9506-2950

FREQUENCY	Magnetic Antenna Factor	Electric Antenna Factor
(MHz)	(dB)	(dB)
.009	-35.1	16.4
.010	-35.7	15.8
.020	-38.5	13.0
.050	-39.6	11.9
.075	-39.8	11.8
.100	-40.0	11.6
.150	-40.0	11.5
.250	-40.0	11.6
.500	-40.0	11.5
.750	-40.1	11.5
1.000	-39.9	11.7
2.000	-39.5	12.0
3.000	-39.4	12.1
4.000	-39.7	11.9
5.000	-39.7	11.8
10.000	40.2	11.3
15.000	-40.7	10.8
20.000	-40.5	11.0
25.000	-41.3	10.2
30.000	42.3	9.2

10.4 Correction factors for Biconical log ANTENNA

Model: 3142
Antenna serial number: 1250
3 meter range

FREQUENCY (MHz)	AFE (dB/m)	FREQUENCY (MHz)	AFE (dB/m)
30	18.4	1100	25
40	13.7	1200	24.9
50	9.9	1300	26
60	8.1	1400	26.1
70	7.4	1500	27.1
80	7.2	1600	27.2
90	7.5	1700	28.3
100	8.5	1800	28.1
120	7.8	1900	28.5
140	8.5	2000	28.9
160	10.8		
180	10.4		
200	10.5		
250	12.7		
300	14.3		
400	17		
500	18.6		
600	19.6		
700	21.1		
800	21.4		
900	23.5		
1000	24.3		

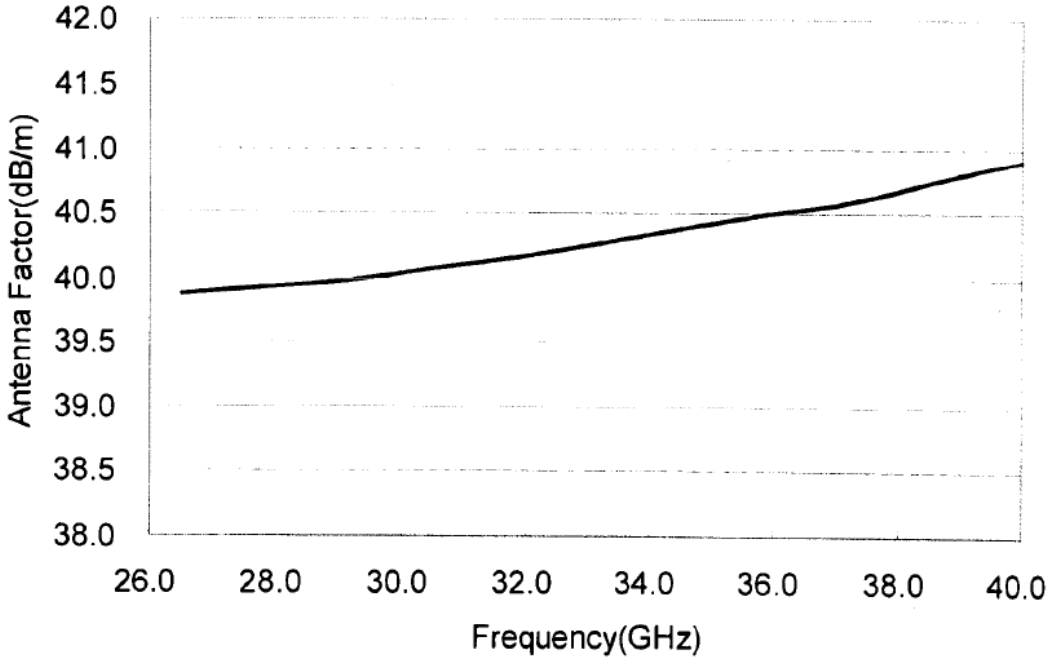
10.5 Correction factors for Horn ANTENNA

Model: 3115
Antenna serial number: 6142
10 meter range

FREQUENCY	Antenna Factor	FREQUENCY	Antenna Factor
(GHz)	(dB/m)	(GHz)	(dB/m)
1	**23.2**	**10**	**37.0**
2	**25.3**	**11**	**36.3**
3	**30.7**	**12**	**40.3**
4	**30.6**	**13**	**39.1**
5	**34.5**	**14**	**41.3**
6	**31.5**	**15**	**39.8**
7	**34.4**	**16**	**38.2**
8	**35.8**	**17**	**41.8**
9	**37.2**	**18**	**43.1**

10.6 Horn Antenna Ka Band

Model: PE9850R-20
Serial No: J202021732



Frequency(GHz)	Gain(dB)	Antenna Factor(dB/m)
26.50	18.80	39.87
27.85	19.18	39.93
29.20	19.53	39.99
30.55	19.83	40.08
31.90	20.12	40.17
33.25	20.37	40.28
34.60	20.60	40.39
35.95	20.82	40.50
37.30	21.05	40.59
38.65	21.20	40.75
40.00	21.34	40.91