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Report On

Radio Testing of the
Endress+Hauser GmbH+Co. KG
NMR81 Level Probing Radar
Model Numbers: NMR81 DN50, NMR81 DN80 and NMR81
DN100

CFR 47 Part 15, Subpart C
FCC 14-2: ET Docket No. 10-23

Report No. SD72120981-1016

October 2016

REPORT ON Radio Testing of the
Endress+Hauser GmbH+Co. KG
NMR81 Level Probing Radar

TEST REPORT NUMBER SD72120981-1016

PREPARED FOR Endress+Hauser GmbH+Co. KG
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DATED October 24, 2016



Revision History

SD72120981-1016 Endress+Hauser GmbH+Co. KG NMR81 Level Probing Radar					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
10/24/2016	Initial Release				Juan Manuel Gonzalez

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SECTION 1

REPORT SUMMARY

Radio Testing of the
Endress+Hauser GmbH+Co. KG
NMR81 Level Probing Radar

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Endress+Hauser GmbH+Co. KG NMR81 Level Probing Radar to the requirements of the CFR 47 Part 15, Subpart C.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Endress+Hauser GmbH+Co. KG
Model Number(s)	NMR81 DN50, NMR81 DN80, NMR81 DN100, Note.- Model tested in this report was NMR81 DN100 (Worst case configuration with biggest 100mm/4" antenna)
FCC ID Number	LCGNMR8XE
Serial Number(s)	N/A
Number of Samples Tested	1
Test Specification/Issue/Date	CFR 47 Part 15, Subpart C (October 1, 2016)
Start of Test	October 12, 2016
Finish of Test	October 18, 2016
Test Facility location	All tests performed on this test report were performed at: TÜV SÜD America Inc. (Mira Mesa Location) 10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,- 117.177681). Phone: 858 678 1400, FAX: 858-546 0364
Name of Engineer(s)	Nikolay Shtin
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with CFR 47 Part 15, Subpart C is shown below.

Section	FCC	Test Description	Result	Comments/Base Standard
2.1	§15.215(c)	Occupied Bandwidth	As Reported	
2.2	§15.205, §15.209	Radiated Emissions	Compliant	
2.3	§15.207(a)	AC Conducted Emissions	Compliant	

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Endress+Hauser GmbH+Co. KG NMR81 Level Probing Radar as shown in the photograph below. EUT is a directional level radar, operating based on the Frequency-Modulated Continuous Wave (FMCW) principle. The radar emits a precise signal with continuously varying frequency in the 79-83 GHz frequency range. The wave is reflected off the product surface and received again by the radar. The distance between the reference point and the product surface is determined based on the frequency shift of the transmitted and received waves.



Equipment Under Test

1.3.2 EUT General Description

EUT Description	Level Probing Radar
Model Name	NMR81
Model Number(s)	NMR81 DN100
Rated Voltage	10.0-36.0 VDC, 24.0 VDC (Nominal)
Mode Verified	FMCW Radar
Device Capabilities	FMCW Radar
Frequency Range	79-83 GHz in 75-85 GHz band
Primary Unit (EUT)	☒ Production ☐ Pre-Production ☐ Engineering
Output Power	47.98 dBμV/m @ 3 meters
Number of Operating Frequencies	1
Channel Verified	80.459 GHz
Antenna Type (used during evaluation)	Integrated antenna
Modulation Used	Linear Frequency Modulation

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	EUT in test mode continuously transmitting FMCW wave.

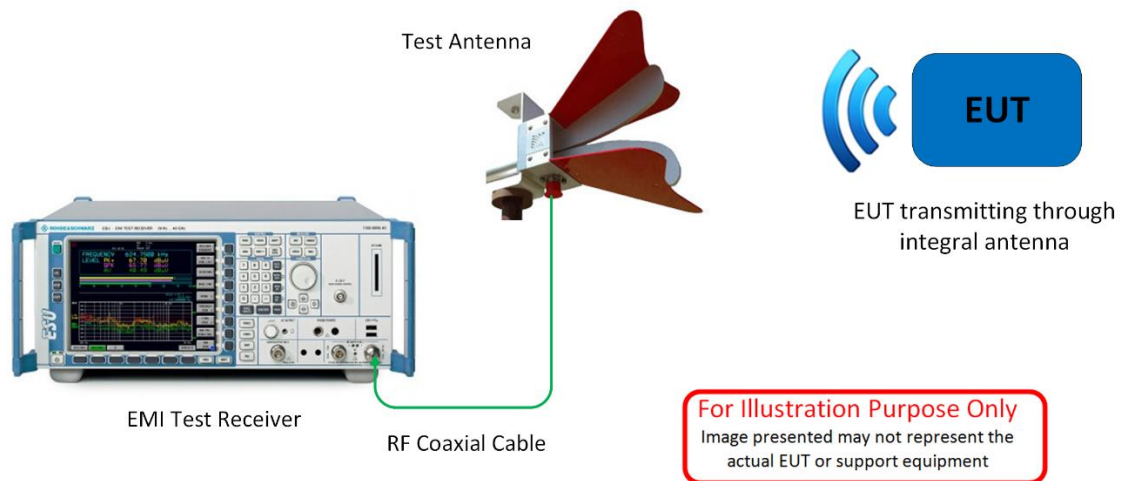
1.4.2 EUT Exercise Software

None.

1.4.3 Support Equipment and I/O cables

None.

1.4.4 Simplified Test Configuration Diagram



1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: N/A		
N/A	-	-

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 FAX: 858-546 0364

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 FAX: 858-546 0364

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.498 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

1.9.2 Innovation, Science and Economic Development Canada Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A.



1.9.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TUV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.9.4 VCCI – Registration No. A-0230

TUV SUD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

SECTION 2

TEST DETAILS

Radio Testing of the
Endress+Hauser GmbH+Co. KG
NMR81 Level Probing Radar

2.1 OCCUPIED BANDWIDTH

2.1.1 Specification Reference

FCC 47 CFR Part 15.215(c)

2.1.2 Standard Applicable

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

2.1.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

2.1.4 Date of Test/Initial of test personnel who performed the test

October 18, 2016/NS

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

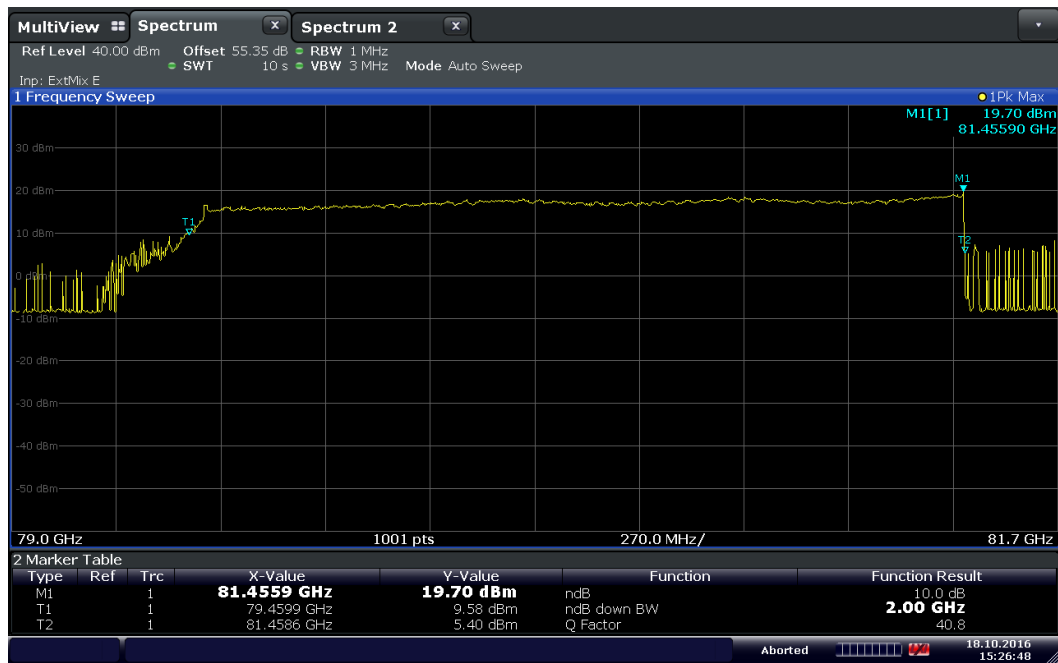
Ambient Temperature	22.7°C
Relative Humidity	48.3%
ATM Pressure	99.9kPa

2.1.7 Additional Observations

- This is a radiated test.
- Occupied bandwidth verified using the “n” dB down marker function of the spectrum analyzer.
- Span is wide enough to capture the channel transmission.
- RBW is 1 MHz
- VBW is 3 MHz.
- Sweep is auto.
- Detector is peak.
- Trace is Max Hold.

2.1.8 Test Results

Frequency	Occupied Bandwidth
80.459 GHz	2.00 GHz



15:26:49 18.10.2016

Occupied Bandwidth

2.2 RADIATED EMISSIONS

2.2.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.205 and 15.209

2.2.2 Standard Applicable

§ 15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/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

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

§ 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz
² Above 38.6

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

2.2.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

2.2.4 Date of Test/Initial of test personnel who performed the test

October 12 and October 13, 2016/NS

2.2.5 Test Equipment Used

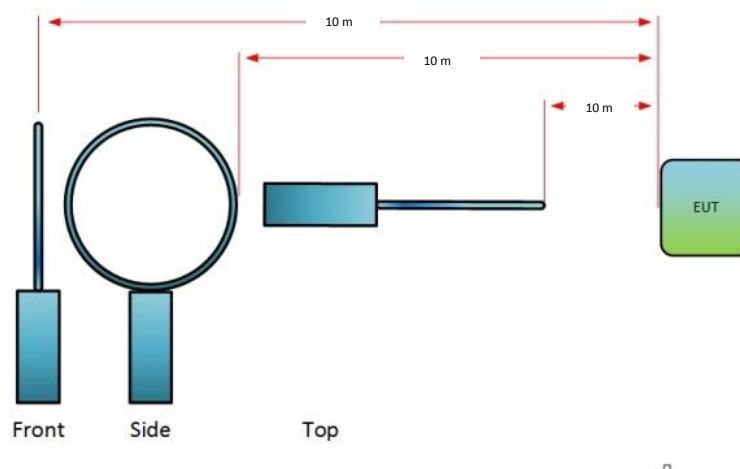
The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Ambient Temperature	22.8-23.8°C
Relative Humidity	43.6-48.2%
ATM Pressure	99.9-100.2kPa

2.2.7 Additional Observations

- This is a radiated test. The spectrum was searched from 9 kHz to 200 GHz.
- Below 30MHz, prescans were performed to determine best test antenna orientation with the highest recorded emissions. Verification was performed using “Front” configuration (see the figure below) corresponding to the best antenna orientation as found during the prescans.



- Measurement was done at 3 meters. Limits below 30MHz were corrected using extrapolation factor of 40 dB/decade. See sample computation below:

$$\begin{aligned}
 \text{Limit @ 9kHz} &= 2400/F(\text{kHz}) \mu\text{V/m} \\
 &= 20 \log (2400/9) \text{ dB}\mu\text{V/m} \\
 &= 48.52 \text{ dB}\mu\text{V/m @ 300 meters} \\
 &= 48.52 \text{ dB}\mu\text{V/m} + (40 \log 300/3) @ 3 \text{ meters} \\
 &= 128.52 \text{ dB}\mu\text{V/m @ 3 meters}
 \end{aligned}$$

- Test distance of 3 m was used for the spurious emissions measurement below 40 GHz. The emissions in the range from 40 GHz to 110 GHz were evaluated at 1.0 m distance. For the measurements in the range from 110 GHz to 200 GHz, the test distance was reduced to 0.1 m to assure that the noise floor is below the applicable limit.
- Corrections factors of 9.64 dB and 29.54 dB were used to extrapolate the field strengths measured at 1.0 metres and 0.1 meters to the 3 meters distance as specified in § 15.31.
- Measurement was done using EMC32 V9.26.0 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Sections 2.2.8 and 2.2.9 for sample computations.

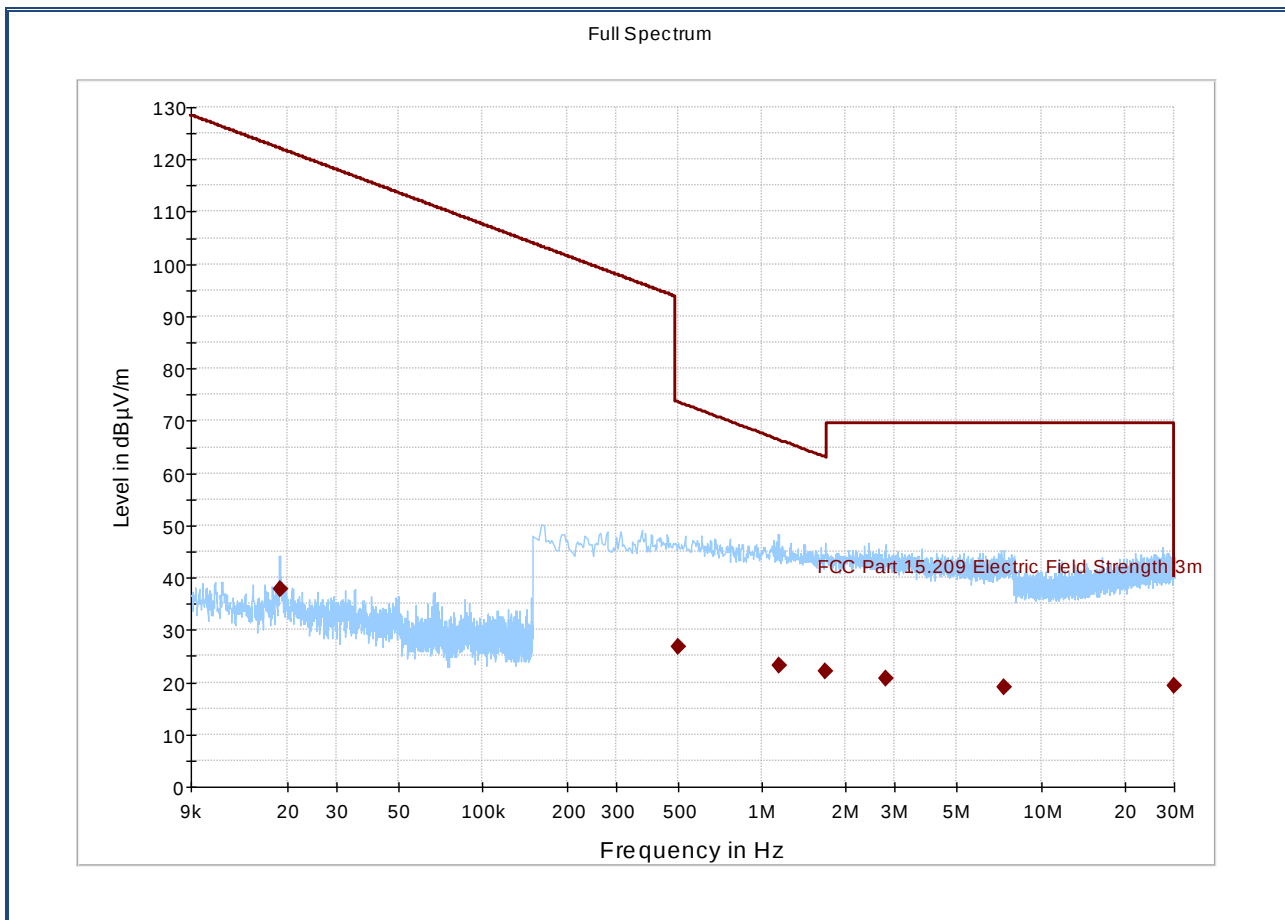
2.2.8 Sample Computation (Radiated Emission 9kHz to 30MHz)

Measuring equipment raw measurement (dbμV) @ 9 kHz			25.0
Correction Factor (dB)	Asset# 1057 (cable)	0.1	24.8
	Asset# 8850 (cable)	0.3	
	Asset# 6628 (antenna)	24.4	
Reported QuasiPeak Final Measurement (dbμV/m) @ 9kHz			49.8

2.2.9 Sample Computation (Radiated Emission 30MHz to 1GHz)

Measuring equipment raw measurement (dbμV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 8850 (cable)	0.3	
	Asset# 1033 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbμV/m) @ 30MHz			11.8

2.2.10 Test Results (9kHz to 30MHz)

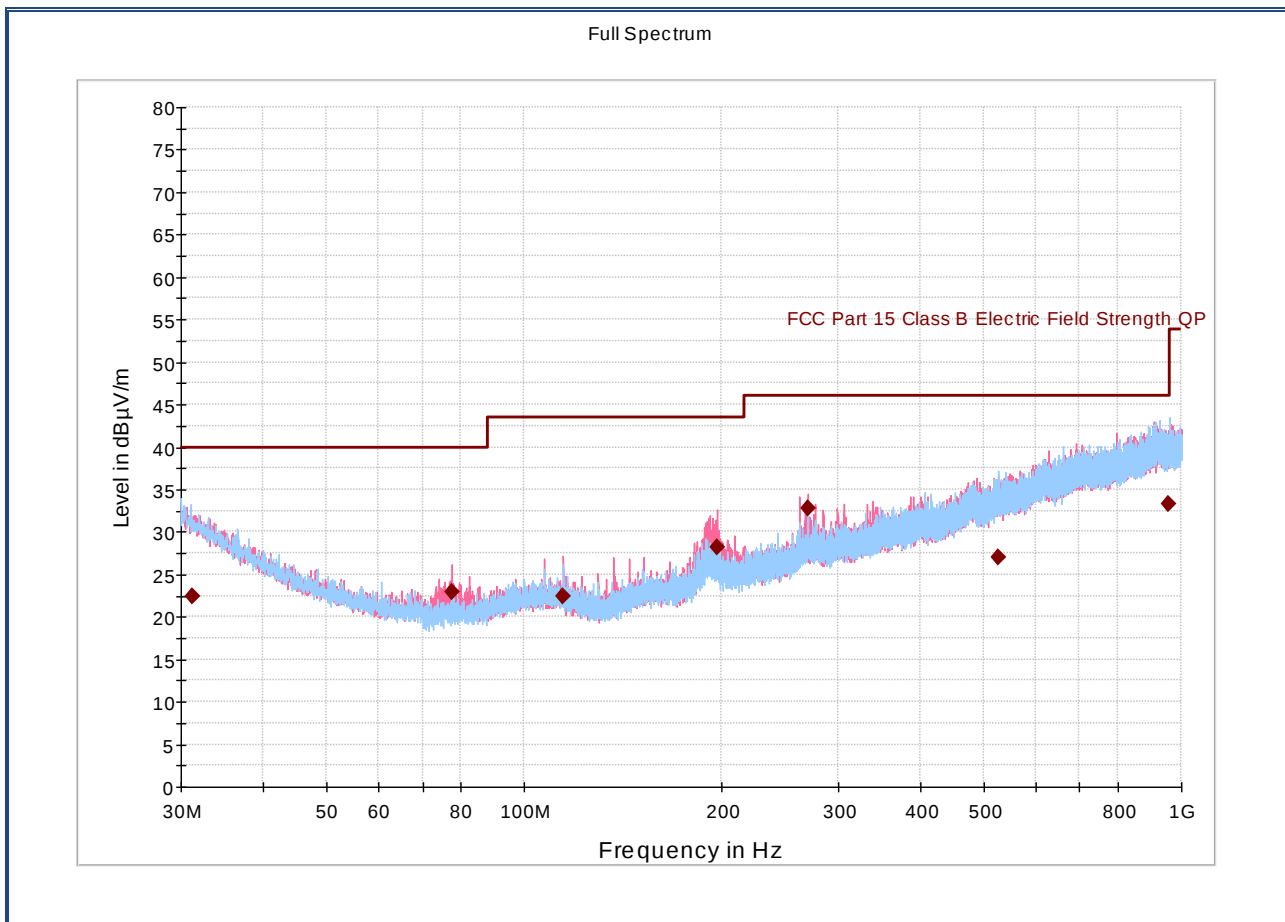


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.018721	37.94	122.15	84.21	1000.0	0.200	100	H	180.0	22.5
0.501745	26.87	73.59	46.72	1000.0	9.000	100	H	142.0	20.0
1.151490	23.24	66.37	43.13	1000.0	9.000	100	H	91.0	20.2
1.686790	22.18	63.05	40.87	1000.0	9.000	100	H	95.0	20.2
2.774330	20.58	69.50	48.92	1000.0	9.000	100	H	252.0	20.2
7.391170	19.00	69.50	50.50	1000.0	9.000	100	H	180.0	20.4
29.995500	19.33	69.50	50.17	1000.0	9.000	100	H	180.0	24.1

Test Notes:

2.2.11 Test Results (30MHz to 1GHz)

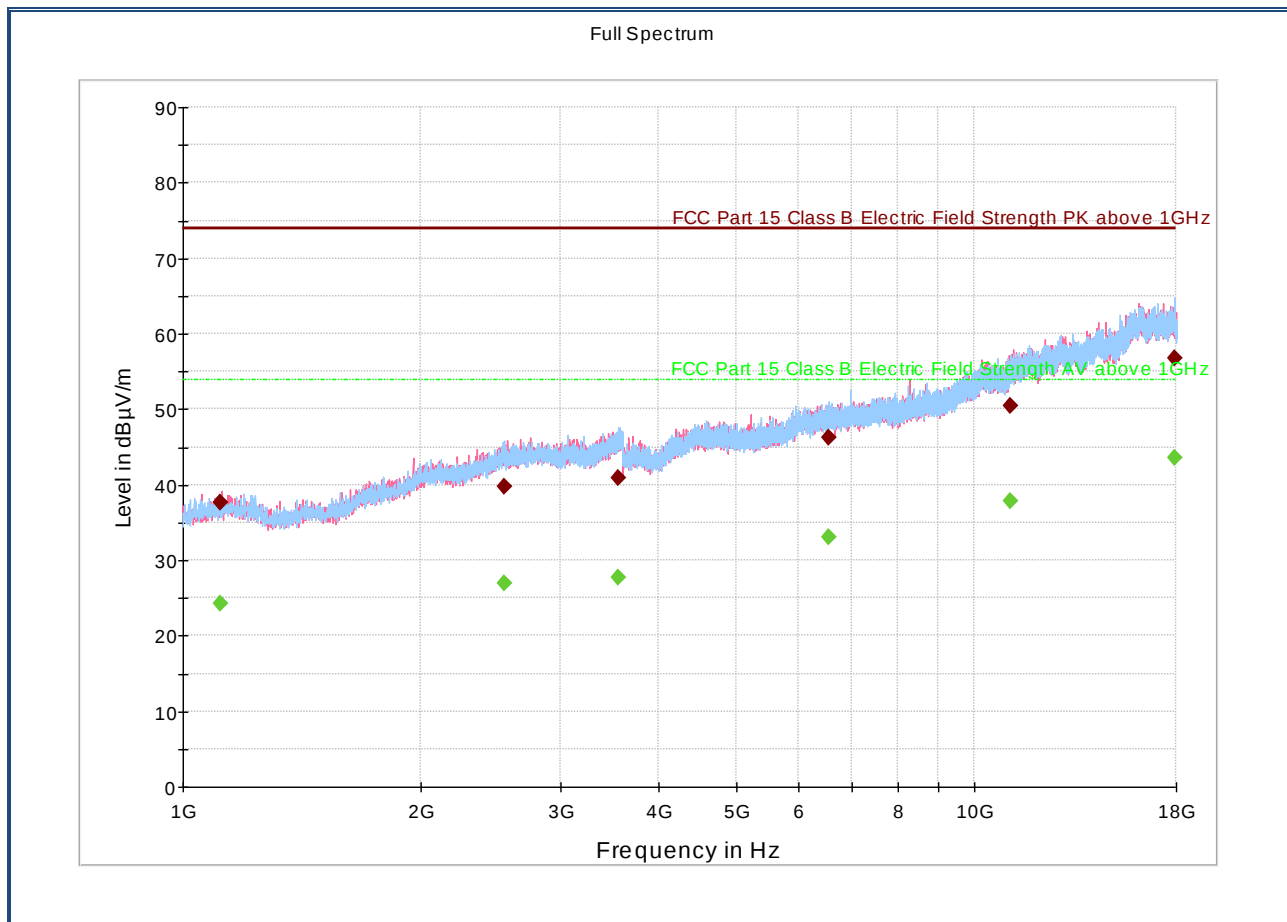


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.280000	22.39	40.00	17.61	1000.0	120.000	250.2	H	171.0	24.2
77.691667	22.99	40.00	17.01	1000.0	120.000	149.5	V	321.0	13.7
114.673333	22.43	43.50	21.07	1000.0	120.000	171.3	V	-8.0	15.4
196.136333	28.22	43.50	15.28	1000.0	120.000	103.7	V	290.0	18.2
270.115000	32.83	46.00	13.17	1000.0	120.000	108.1	V	212.0	21.0
527.481667	26.96	46.00	19.04	1000.0	120.000	110.3	H	337.0	27.6
957.770667	33.23	46.00	12.77	1000.0	120.000	174.3	H	300.0	33.1

Test Notes:

2.2.12 Test Results (1GHz to 18GHz)



Peak Data

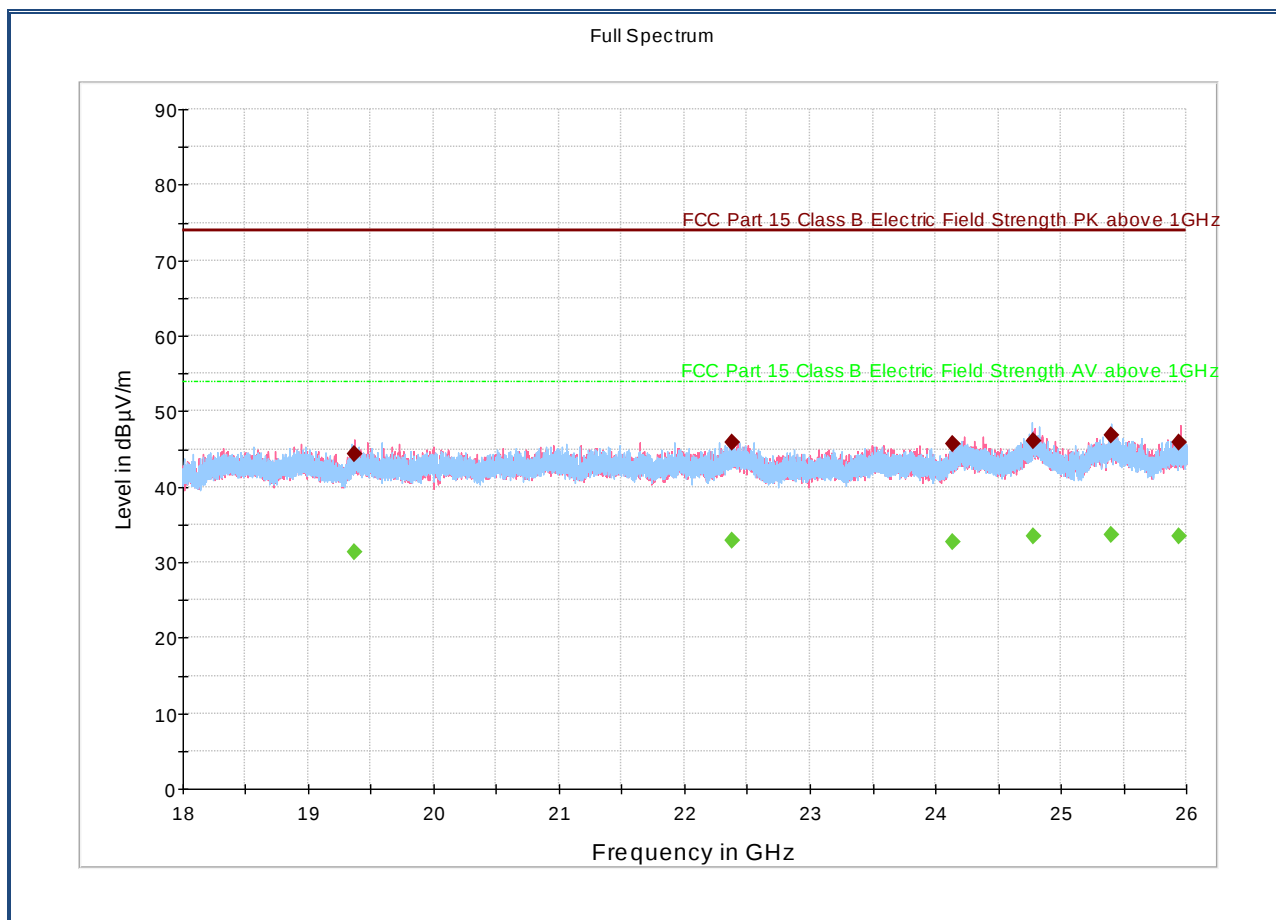
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1116.77272	37.70	73.90	36.20	1000.0	1000.000	370.0	V	35.0	-1.6
2553.33636	39.71	73.90	34.19	1000.0	1000.000	150.1	H	317.0	4.4
3542.51818	40.92	73.90	32.98	1000.0	1000.000	150.2	H	236.0	6.0
6543.77272	46.20	73.90	27.70	1000.0	1000.000	150.1	H	323.0	13.2
11089.9909	50.50	73.90	23.40	1000.0	1000.000	153.6	H	59.0	19.2
17908.1181	56.81	73.90	17.09	1000.0	1000.000	264.1	H	337.0	25.2

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1116.77272	24.18	53.90	29.72	1000.0	1000.000	370.0	V	35.0	-1.6
2553.33636	26.98	53.90	26.92	1000.0	1000.000	150.1	H	317.0	4.4
3542.51818	27.70	53.90	26.20	1000.0	1000.000	150.2	H	236.0	6.0
6543.77272	33.11	53.90	20.79	1000.0	1000.000	150.1	H	323.0	13.2
11089.9909	37.80	53.90	16.10	1000.0	1000.000	153.6	H	59.0	19.2
17908.1181	43.59	53.90	10.31	1000.0	1000.000	264.1	H	337.0	25.2

Test Notes:

2.2.13 Test Results (18GHz to 26GHz)



Peak Data

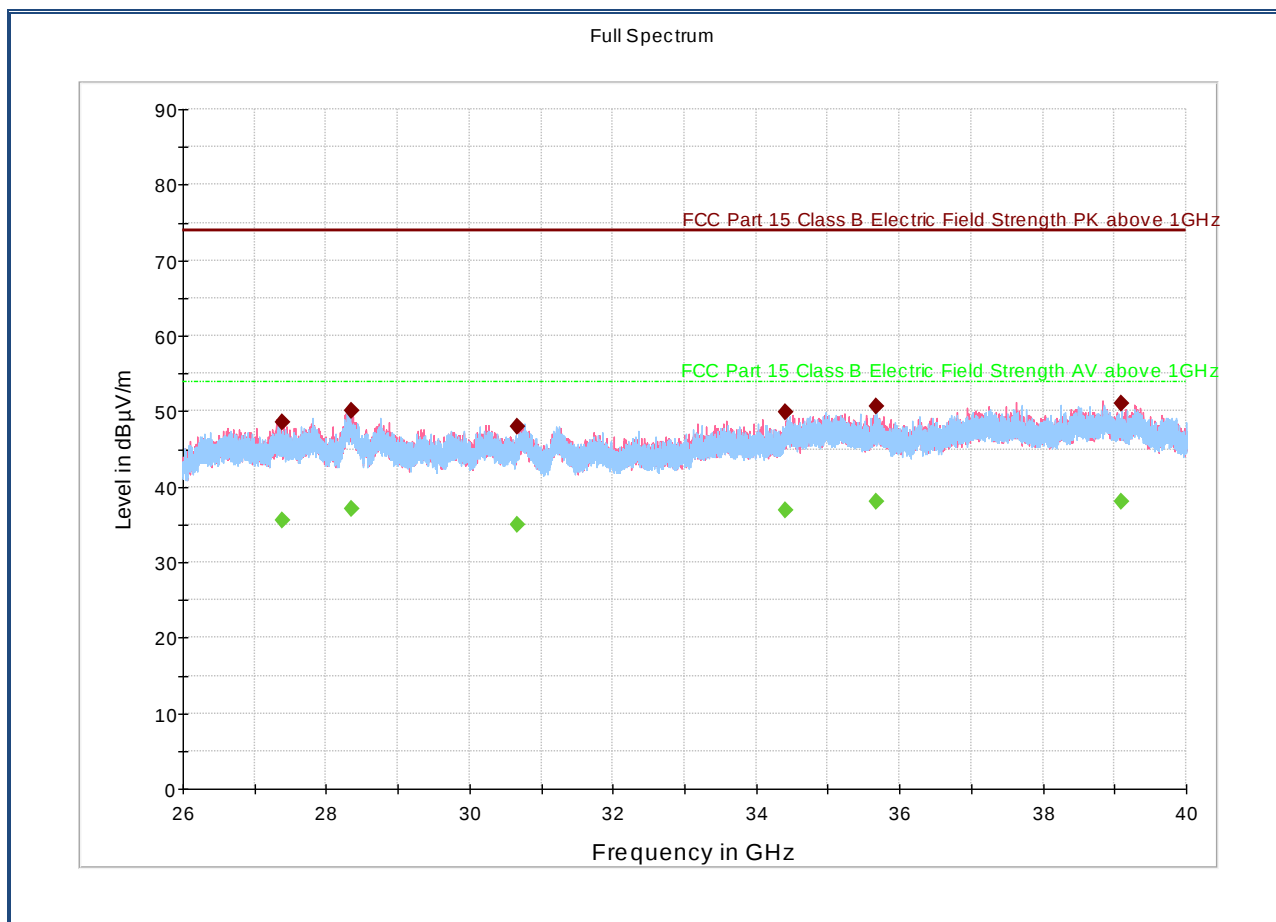
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
19369.8000	44.33	73.90	29.57	1000.0	1000.000	114.8	V	186.0	1.7
22377.4000	45.80	73.90	28.10	1000.0	1000.000	159.7	H	23.0	3.9
24141.4000	45.76	73.90	28.14	1000.0	1000.000	175.2	V	329.0	4.3
24777.8000	46.06	73.90	27.84	1000.0	1000.000	114.8	H	342.0	4.8
25400.6000	46.89	73.90	27.01	1000.0	1000.000	161.6	H	54.0	4.7
25948.2000	45.94	73.90	27.96	1000.0	1000.000	102.4	V	274.0	5.0

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
19369.8000	31.40	53.90	22.50	1000.0	1000.000	114.8	V	186.0	1.7
22377.4000	32.82	53.90	21.08	1000.0	1000.000	159.7	H	23.0	3.9
24141.4000	32.65	53.90	21.25	1000.0	1000.000	175.2	V	329.0	4.3
24777.8000	33.44	53.90	20.46	1000.0	1000.000	114.8	H	342.0	4.8
25400.6000	33.63	53.90	20.28	1000.0	1000.000	161.6	H	54.0	4.7
25948.2000	33.36	53.90	20.54	1000.0	1000.000	102.4	V	274.0	5.0

Test Notes:

2.2.14 Test Results (26GHz to 40GHz)



Peak Data

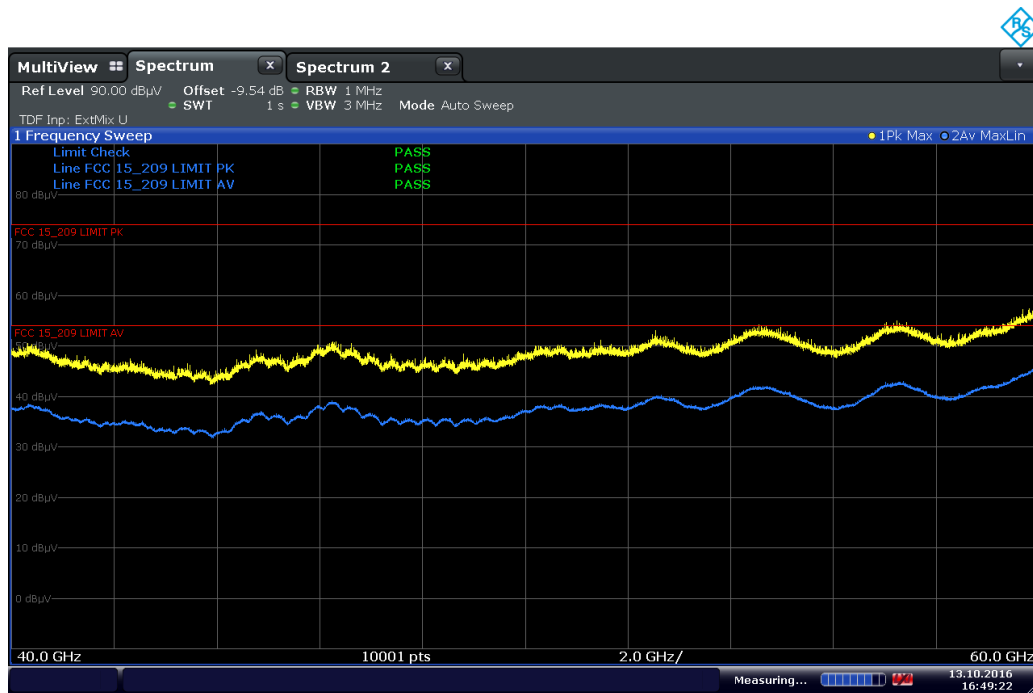
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27392.1076	48.63	73.90	25.27	1000.0	1000.000	101.6	V	290.0	6.2
28346.2153	49.97	73.90	23.93	1000.0	1000.000	126.4	V	2.0	7.0
30671.2923	48.02	73.90	25.88	1000.0	1000.000	114.0	V	57.0	7.9
34415.0615	49.82	73.90	24.09	1000.0	1000.000	124.5	V	-1.0	9.7
35683.8461	50.72	73.90	23.18	1000.0	1000.000	128.4	H	196.0	9.8
39096.4769	51.05	73.90	22.85	1000.0	1000.000	175.1	V	339.0	12.2

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27392.1076	35.59	53.90	18.31	1000.0	1000.000	101.6	V	290.0	6.2
28346.2153	37.08	53.90	16.82	1000.0	1000.000	126.4	V	2.0	7.0
30671.2923	34.89	53.90	19.01	1000.0	1000.000	114.0	V	57.0	7.9
34415.0615	36.97	53.90	16.93	1000.0	1000.000	124.5	V	-1.0	9.7
35683.8461	37.93	53.90	15.97	1000.0	1000.000	128.4	H	196.0	9.8
39096.4769	38.05	53.90	15.85	1000.0	1000.000	175.1	V	339.0	12.2

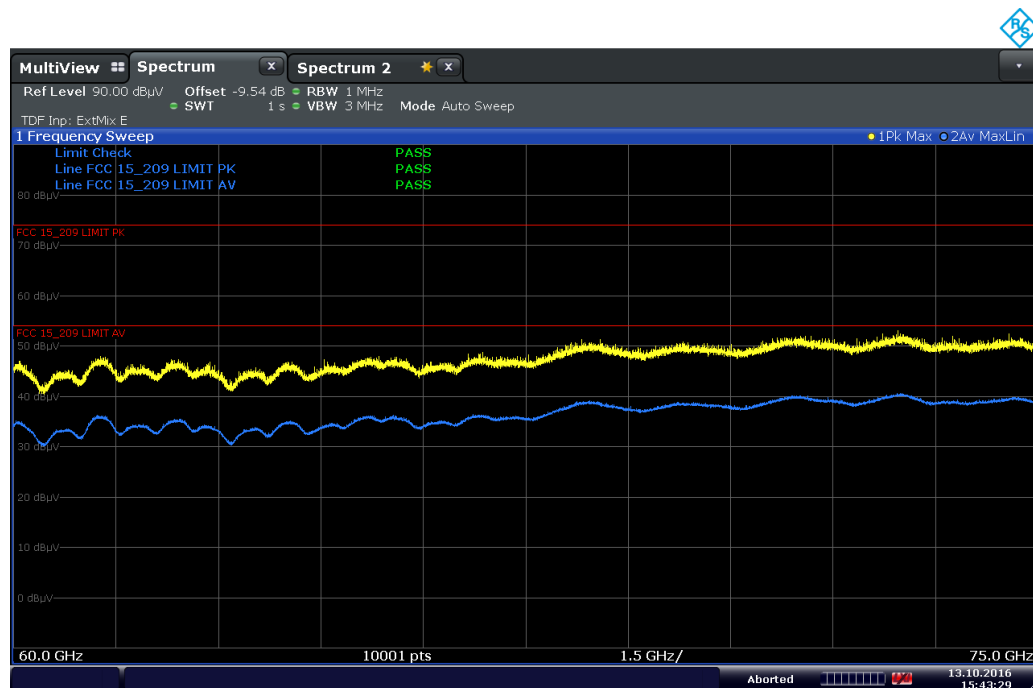
Test Notes:

2.2.15 Test Results 40GHz to 200GHz



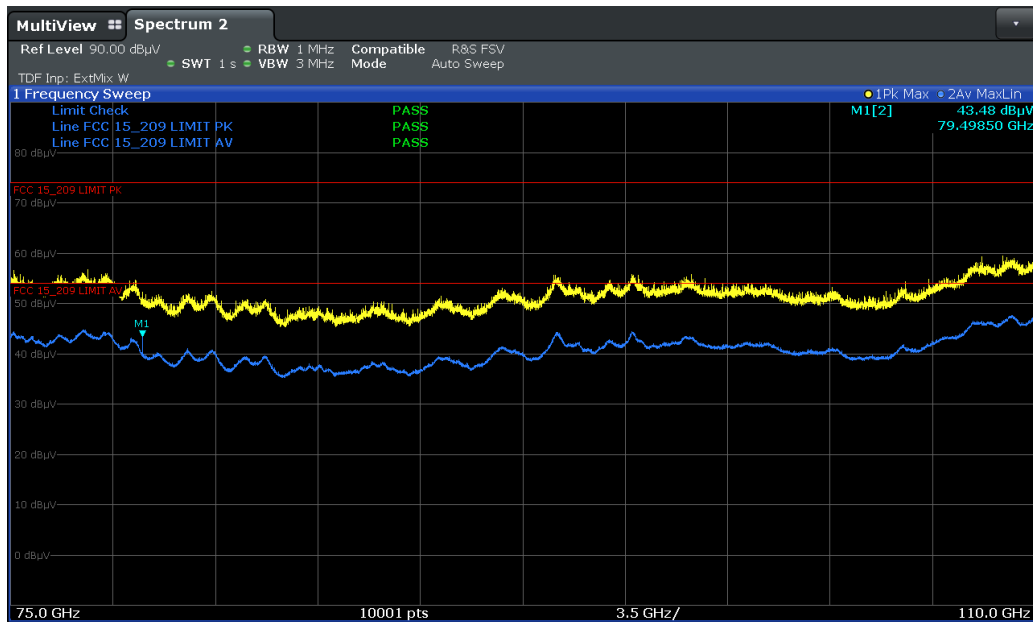
16:49:22 13.10.2016

40 GHz to 60 GHz

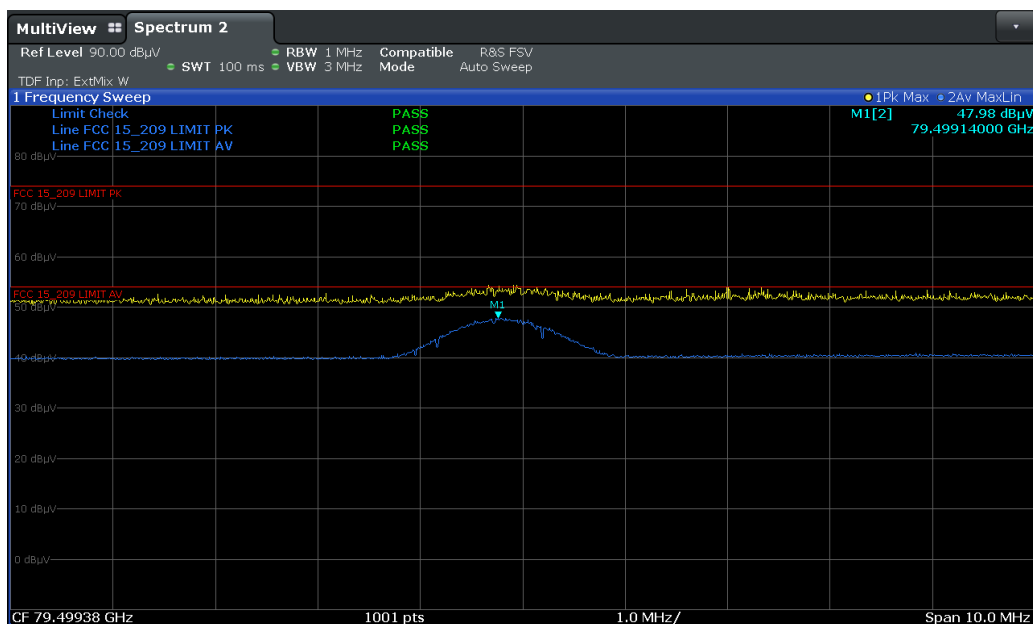


15:43:29 13.10.2016

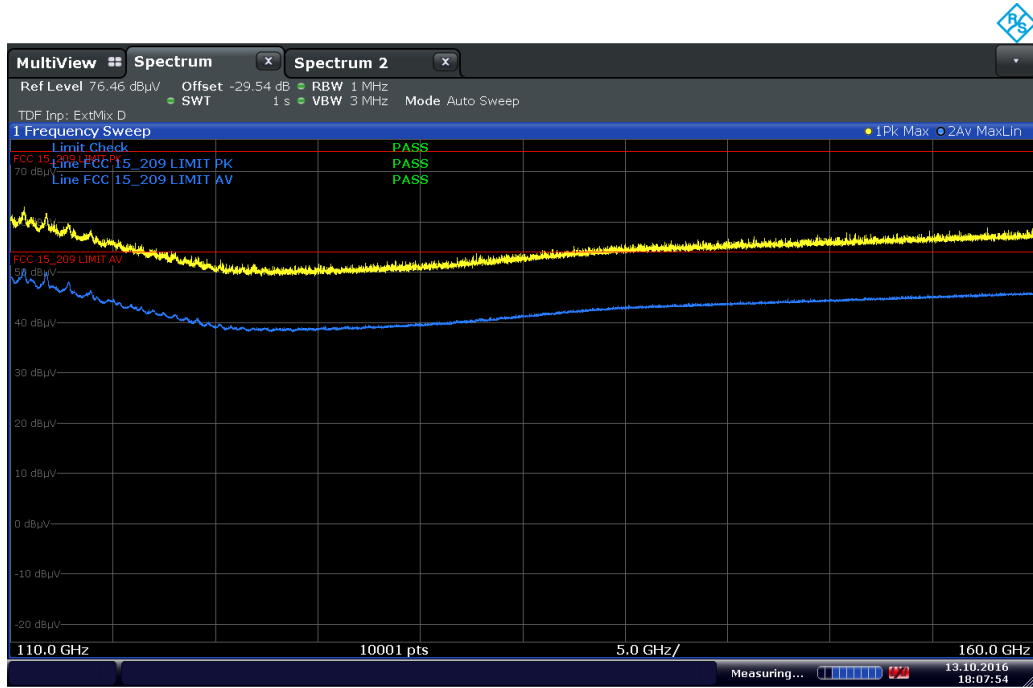
60 GHz to 75 GHz



75 GHz to 110 GHz

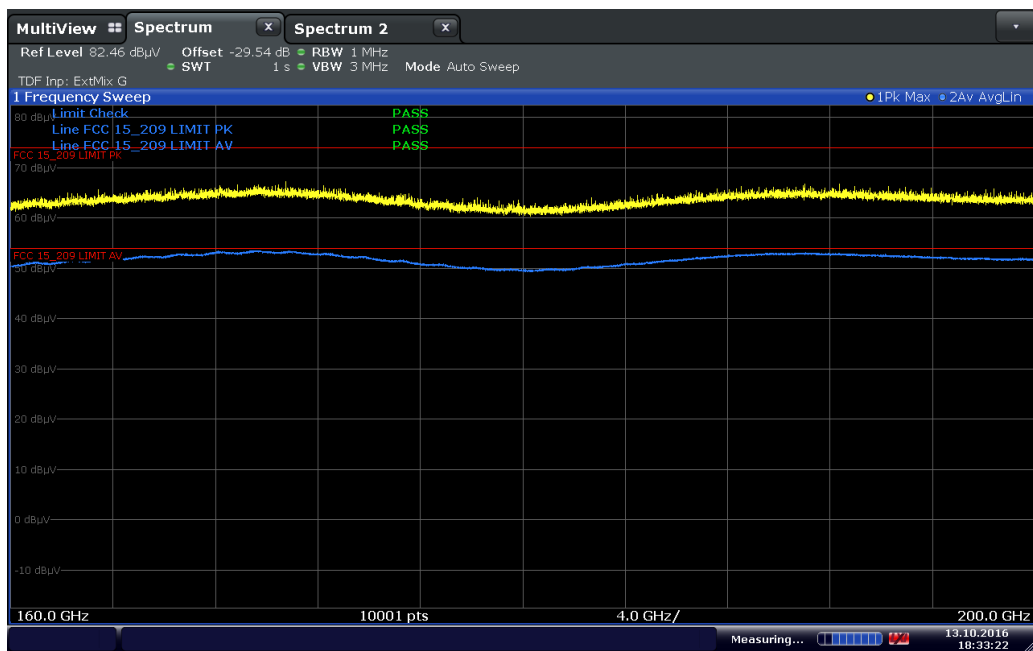


Zoom at 79.5 GHz for spurious verification



18:07:55 13.10.2016

110 GHz to 160 GHz



18:33:23 13.10.2016

160 GHz to 200 GHz

2.3 CONDUCTED EMISSIONS

2.3.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.3.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

2.3.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

2.3.4 Date of Test/Initial of test personnel who performed the test

October 18, 2016 /NS

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.7°C
Relative Humidity	48.3%
ATM Pressure	99.9 kPa

2.3.7 Additional Observations

- The EUT was powered from a laboratory DC power supply.

- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.3.8 for sample computation.

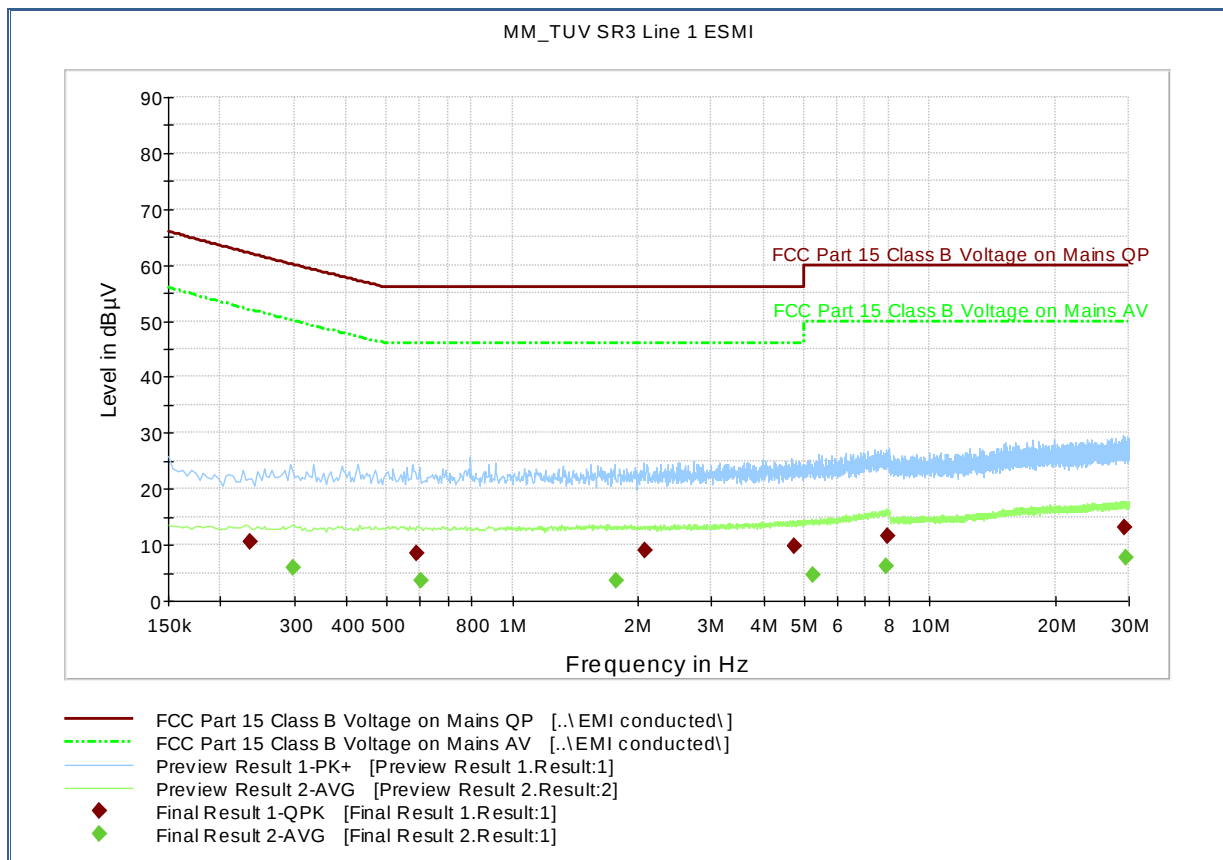
2.3.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (db μ V) @ 150kHz			5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9	20.7
	Asset# 1177 (cable)	0.15	
	Asset# 1176 (cable)	0.35	
	Asset# 7568 (LISN)	0.30	
Reported QuasiPeak Final Measurement (db μ V) @ 150kHz			26.2

2.3.9 Test Results

Compliant. See attached plots and tables.

2.3.10 Line 1 (Hot)



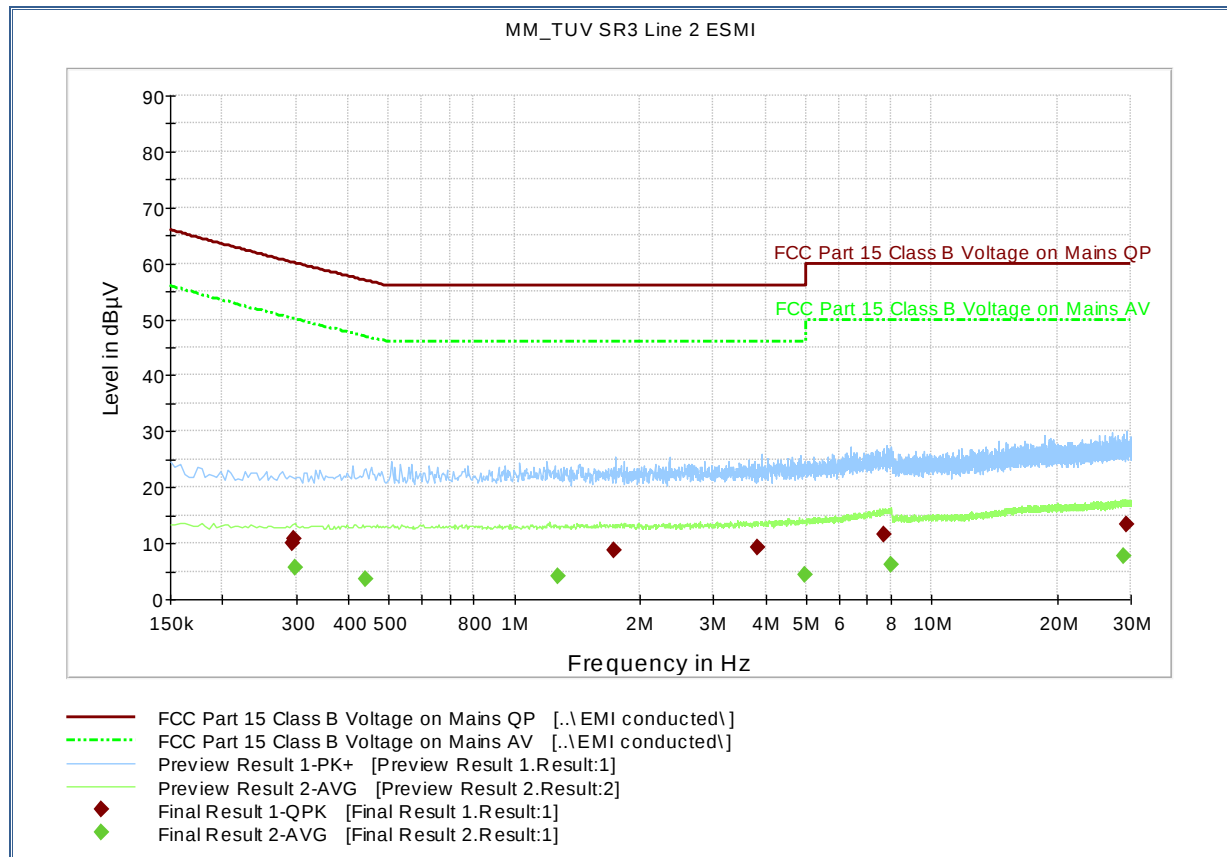
Final Result 1

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV)	Comment
0.235500	10.6	1000.0	9.000	Off	L1	20.2	51.4	62.1	
0.591500	8.6	1000.0	9.000	Off	L1	20.1	47.4	56.0	
2.083500	9.1	1000.0	9.000	Off	L1	20.1	46.9	56.0	
4.734500	9.8	1000.0	9.000	Off	L1	20.1	46.2	56.0	
7.910000	11.7	1000.0	9.000	Off	L1	20.1	48.3	60.0	
29.224500	13.2	1000.0	9.000	Off	L1	20.4	46.8	60.0	

Final Result 2

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - AVG (dB)	Limit - AVG (dBμV)	Comment
0.299000	5.9	1000.0	9.000	Off	L1	20.2	44.1	50.0	
0.602500	3.5	1000.0	9.000	Off	L1	20.1	42.5	46.0	
1.776500	3.6	1000.0	9.000	Off	L1	20.1	42.4	46.0	
5.260000	4.7	1000.0	9.000	Off	L1	20.1	45.3	50.0	
7.851000	6.3	1000.0	9.000	Off	L1	20.1	43.7	50.0	
29.589000	7.8	1000.0	9.000	Off	L1	20.4	42.2	50.0	

2.3.11 Line 2 (Neutral)



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.294500	10.1	1000.0	9.000	Off	N	20.2	50.1	60.2	
0.297000	10.8	1000.0	9.000	Off	N	20.2	49.3	60.1	
1.728000	8.8	1000.0	9.000	Off	N	20.1	47.2	56.0	
3.817500	9.3	1000.0	9.000	Off	N	20.1	46.7	56.0	
7.693500	11.6	1000.0	9.000	Off	N	20.1	48.4	60.0	
29.191000	13.3	1000.0	9.000	Off	N	20.4	46.7	60.0	

Final Result 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.299500	5.6	1000.0	9.000	Off	N	20.2	44.4	50.0	
0.439000	3.6	1000.0	9.000	Off	N	20.1	43.4	47.0	
1.272000	4.1	1000.0	9.000	Off	N	20.1	41.9	46.0	
4.967500	4.5	1000.0	9.000	Off	N	20.1	41.5	46.0	
7.990500	6.3	1000.0	9.000	Off	N	20.1	43.7	50.0	
28.797000	7.8	1000.0	9.000	Off	N	20.4	42.2	50.0	

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Radiated Test Setup						
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	05/16/16	05/16/17
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	02/01/16	02/01/17
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/06/15	11/06/17
6628	Loop Antenna	HFH 2 –Z2	880 458/25	Rhode & Schwarz	10/28/15	10/28/16
8878	High-frequency cable	R90-088-240	N/A	Teledyne/Storm Microwave	03/16/16	03/16/17
8879	High-frequency cable	084-0505-100	N/A	Teledyne/Storm Microwave	03/16/16	03/16/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	07/05/16	07/05/17
9001	Horn antenna (18-26 GHz)	HO42S	101	Custom Microwaves	07/23/16	07/23/17
9002	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	07/10/16	07/10/17
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves	04/18/2016	04/18/2017
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	04/18/2016	04/18/2017
9005	Horn antenna (75-110 GHz)	HO10R	105	Custom Microwaves	04/27/2016	04/27/2017
9081	Horn antenna (110-170 GHz)	HO6R	N/A	Custom Microwaves	Verified	
9082	Horn antenna (140-220 GHz)	HO5R	N/A	Custom Microwaves	Verified	
8891	Pre-amplifier (1-18 GHz)	PE15A3262	1012	Pasternack	Verified with 1003 and 7611	
8893	Pre-amplifier (18-40 GHz)	SLKka-30-6	15G27	Spacek Labs	Verified with 1003 and 7611	
8908	Pre-amplifier (40-60 GHz)	SBL-4036033080-1919-E1	12020-01	Sage Millimeter, Inc.	Verified	
8892	Pre-amplifier (50-75 GHz)	SBL-5037533050-1515-E1	12020-01	Sage Millimeter, Inc.	Verified	
8912	Pre-amplifier (75-110 GHz)	FLNA-10-0005	FTL10839	Farran Technology Ltd.	Verified	
7637	Harmonic mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	01/26/16	01/26/18
7636	Harmonic mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	10/26/15	10/26/17
7633	Harmonic mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	Verified	
7634	Harmonics mixer (110-170 GHz)	HM-170	0062	Radiometer Physics	Verified	
7635	Harmonics mixer (170-220 GHz)	HM-220	020022	Radiometer Physics	Verified	
8872	Direct Reading Attenuator	STA-60-19-D1	11875-01	Sage Millimeter, Inc.	Verified	
8860	Direct Reading Attenuator	STA-60-15-D1	11466-01	Sage Millimeter, Inc.	Verified	
8861	Direct Reading Attenuator	STA-60-10-D1	11466-01	Sage Millimeter, Inc.	Verified	
8873	Active Multiplier (40-60 GHz)	AMC-19-RFH00	124	Millitech, Inc.	Verified	
8914	Active Multiplier (50-75 GHz)	AMC-15-RFH00	283	Millitech, Inc.	Verified	
8915	Active Multiplier (75-110 GHz)	AMC-10-RFH00	606	Millitech, Inc.	Verified	
Conducted Test Setup						
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
6836	LISN	FCC-LISN-50-25-2	5024	FCC	04/29/16	04/29/17
Miscellaneous						
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/29/16	08/29/17
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	Sper Scientific	04/09/16	04/09/17



6672	DC Power Supply	E3611A	KR73012637	HP	Verified by 6792
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A
	Test Software	EMC32	V9.26.0	Rhode & Schwarz	N/A

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

3.2.1 Conducted Emissions (AC) Measurements

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.36	0.21	0.04
2	Cables	Rectangular	0.50	0.29	0.08
3	LISN	Rectangular	0.66	0.38	0.15
4	Attenuator	Rectangular	0.30	0.17	0.03
5	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					0.80
Coverage Factor (k):					2
Expanded Uncertainty:					1.59

3.2.2 Radiated Emission Measurements (Below 1 GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	3.55	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					1.78
Coverage Factor (k):					2
Expanded Uncertainty:					3.57

3.2.3 Radiated Emission Measurements (1 GHz to 40 GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	3.55	2.05	4.20
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					2.22
Coverage Factor (k):					2
Expanded Uncertainty:					4.44

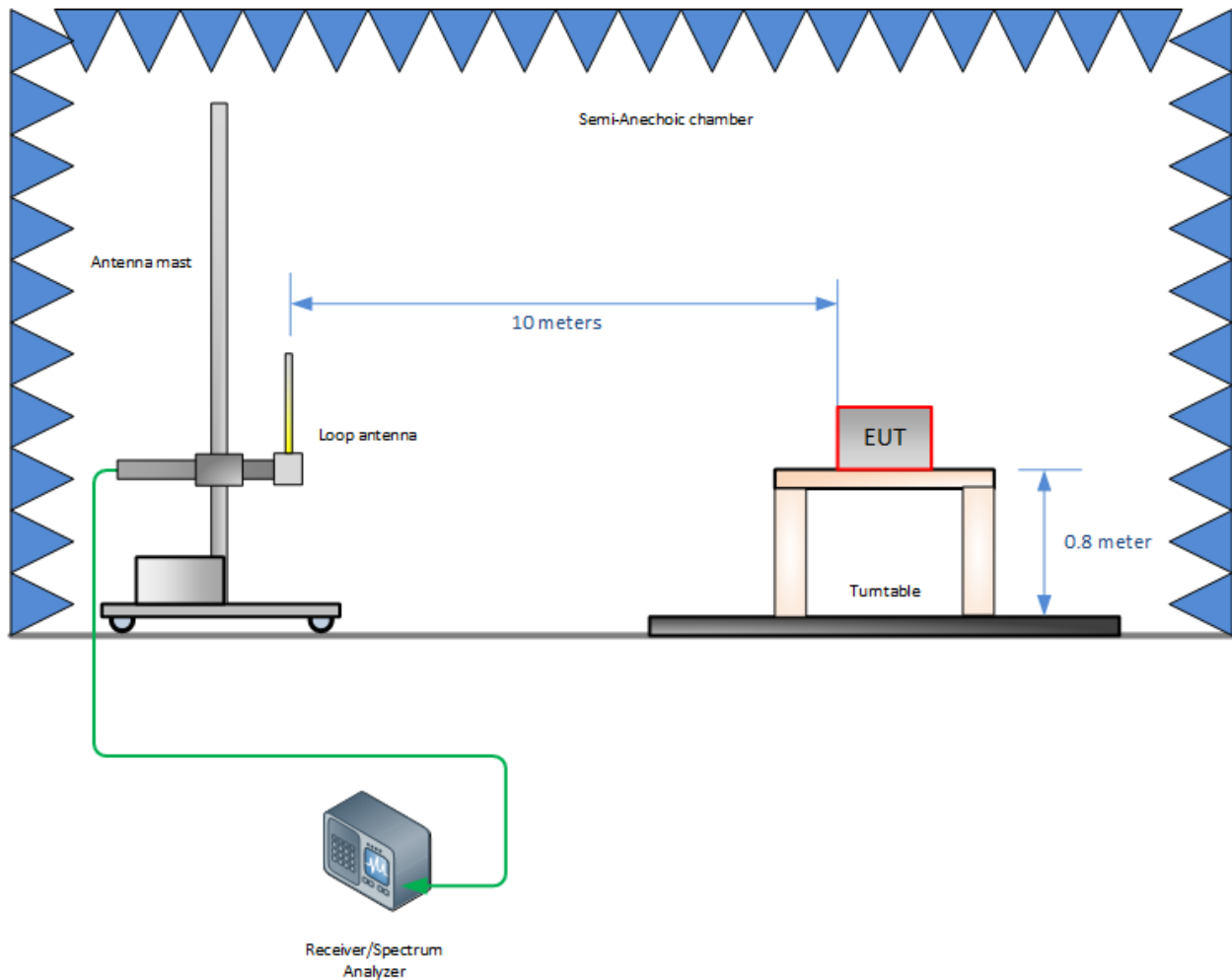
3.2.4 Radiated Emission Measurements (Above 40 GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Spectrum Analyzer/External Mixer	Rectangular	3.34	1.93	3.72
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.50	0.87	0.75
Combined Uncertainty (u_c):					2.67
Coverage Factor (k):					2
Expanded Uncertainty:					5.35

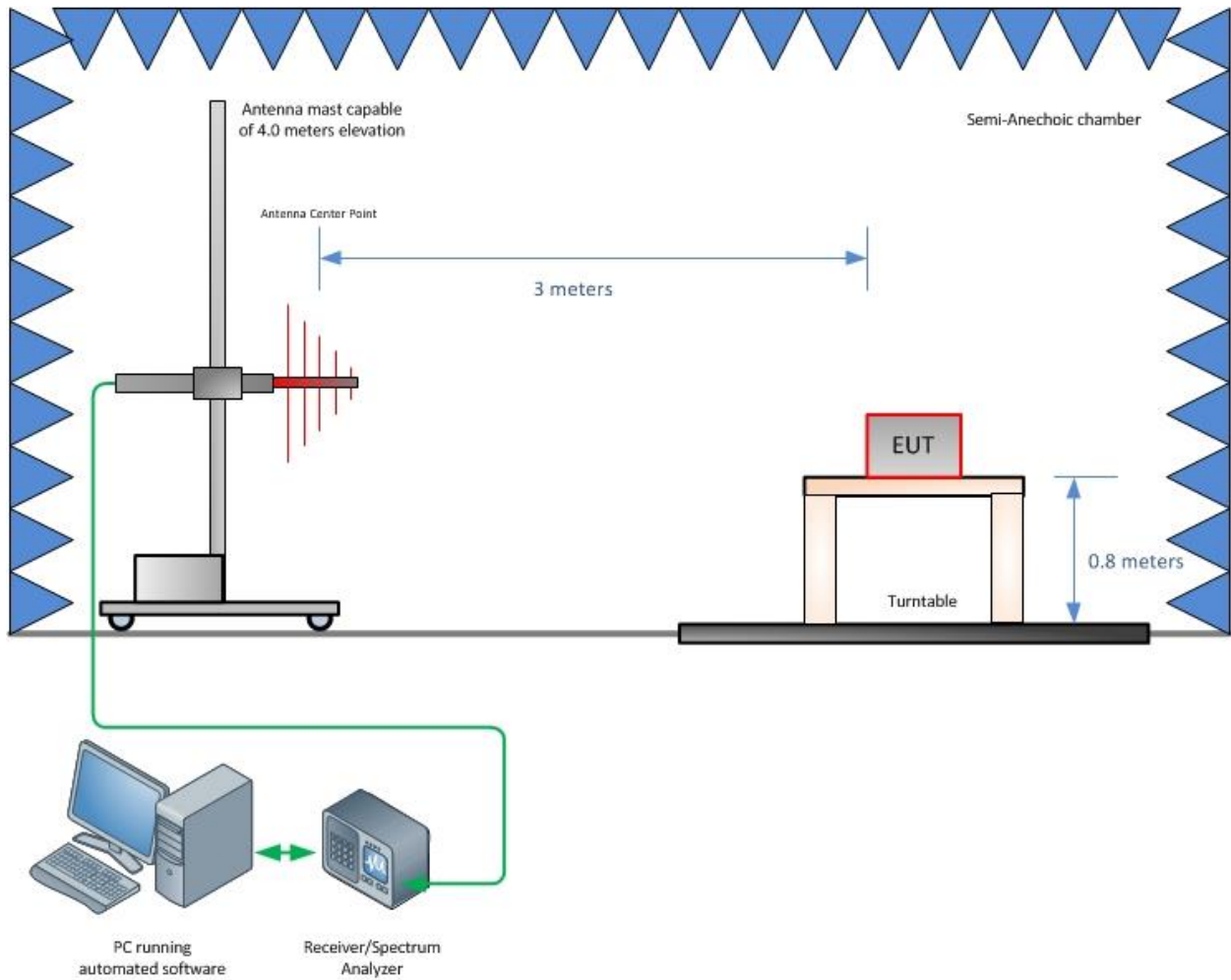
SECTION 4

DIAGRAM OF TEST SETUP

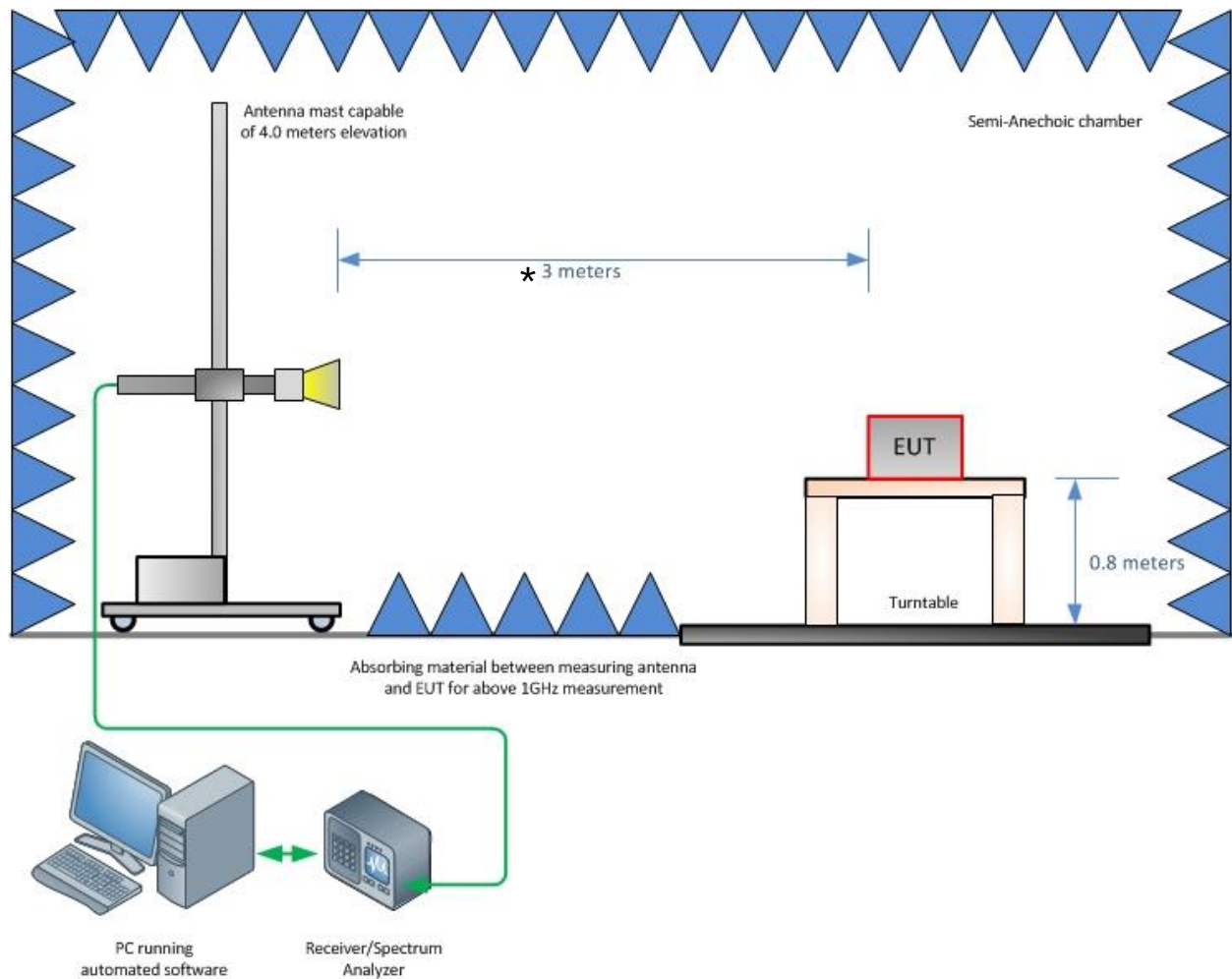
4.1 TEST SETUP DIAGRAM (RADIATED EMISSIONS)



Radiated Emission Test Setup (Below 30 MHz)



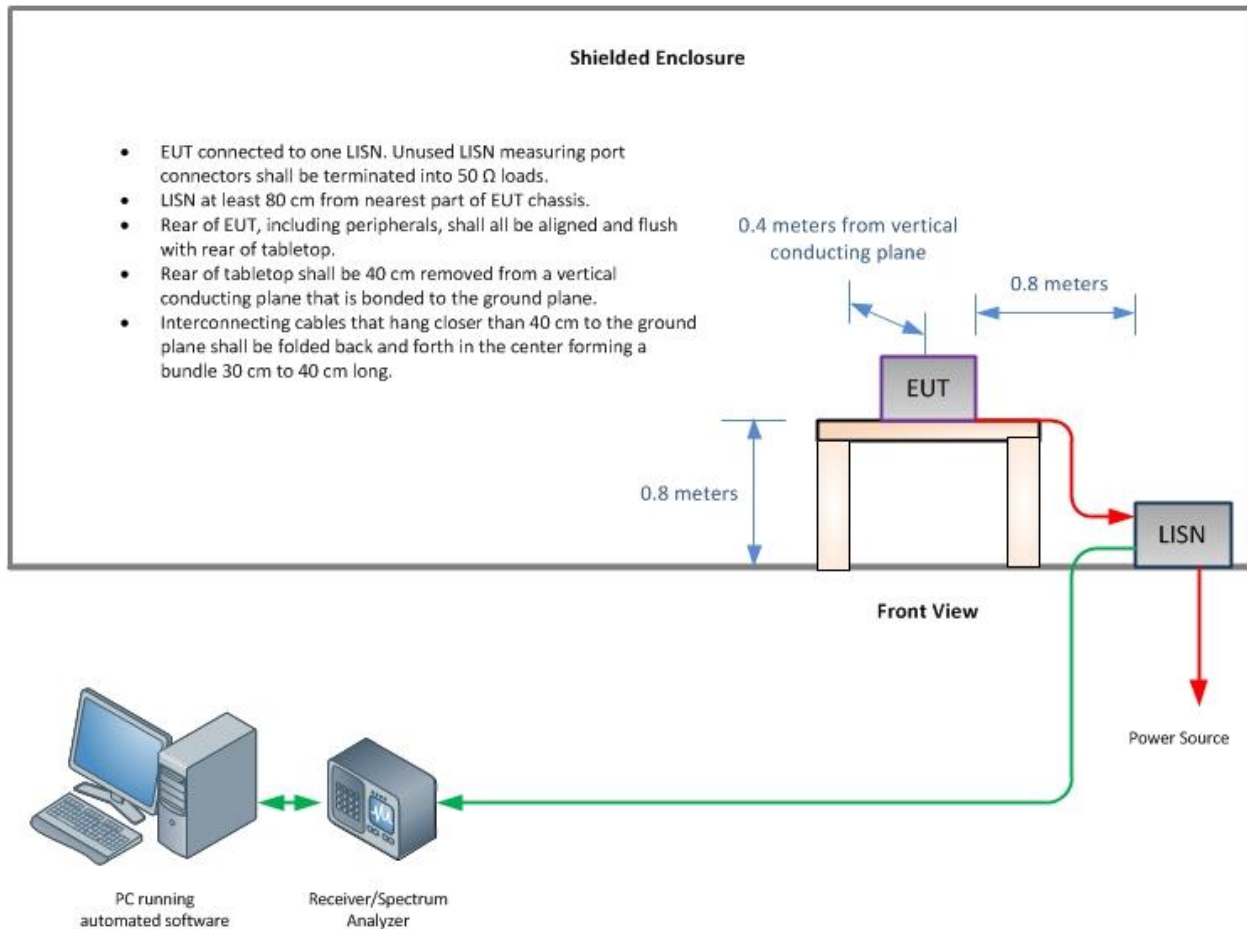
Radiated Emission Test Setup (30MHz to 1GHz)



*A test distance of 3 m was used for measurements below 40 GHz. The emissions in the range from 40 GHz to 110 GHz were evaluated at 1.0 m distance. For the measurements from 110 GHz to 200 GHz, the test distance was reduced to 0.1 m to assure that the noise floor is below the applicable limit.

Radiated Emission Test Setup (Above 1 GHz)

4.2 TEST SETUP DIAGRAM (CONDUCTED EMISSIONS)



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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