Report On

Radio Testing of the
Trango Systems, Inc.
StrataPro 24 SP-24 Point-to-Point Wireless Microwave System Module

FCC Part 15 Subpart C §15.249
IC RSS-210 Issue 8 December 2010

Report No. SD72113790-0216A May 2016

TÜV SÜD America Inc., 10040 Mesa Rim Road, San Diego, CA 92121
Tel: (858) 678-1400. Website: www.TUVamerica.com

REPORT ON	Radio Testing of the Trango Systems, Inc. Point-to-Point Wireless Microwave System Module
TEST REPORT NUMBER	SD72113790-0216A
PREPARED FOR	Trango Systems, Inc. 14118 Stowe Drive, Suite B Poway, CA 92064 USA
CONTACT PERSON	Chris Gustaf Vice President, Engineering (858) 391-0010 x248 chris@trangosys.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory
DATED	May 10, 2016

Revision History

SD72113790-0216A Trango Systems, Inc. StrataPro 24 Point-to-Point Wireless Microwave System Module					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
05/10/16	Initial Release				Chip R. Fleury

CONTENTS

SECTION 1

REPORT SUMMARY

Radio Testing of the
Trango Systems, Inc.
Point-to-Point Wireless Microwave System Module

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Trango Systems, Inc. Point-to-Point Wireless Microwave System Module to the requirements of FCC Part 15 Subpart C §15.249 and IC RSS-210 Issue 8 December 2010.

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	Trango Systems, Inc.
Model Number(s)	SP-24
FCC ID Number	NCY-SP24
IC Number	2945A-SP24
Serial Number(s)	N/A
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.249 (October 1, 2015). • IC RSS-210 Issue 8 December 2010. Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment. • IC RSS-Gen Issue 4, November 2014 - General Requirements for Compliance of Radio Apparatus. • ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Start of Test	February 09, 2016
Finish of Test	February 18, 2016
Name of Engineer(s)	Ferdinand S. Custodio
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

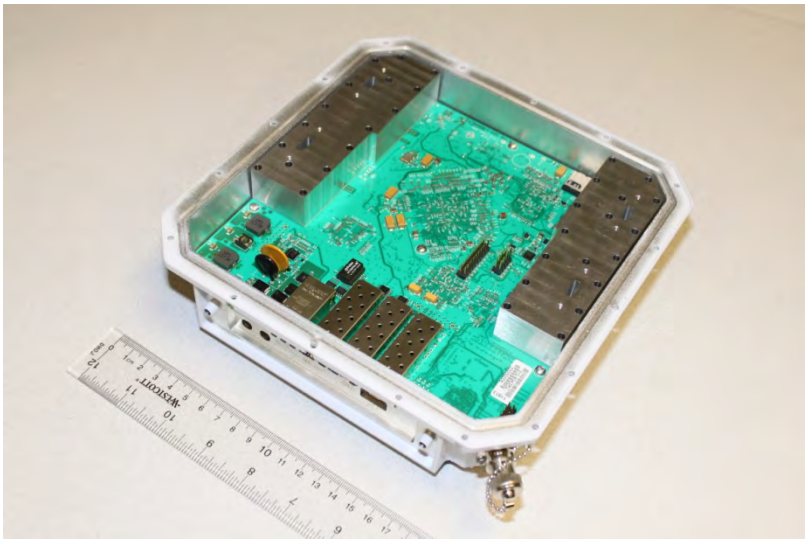
A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.249 with cross-reference to the corresponding IC RSS standard is shown below.

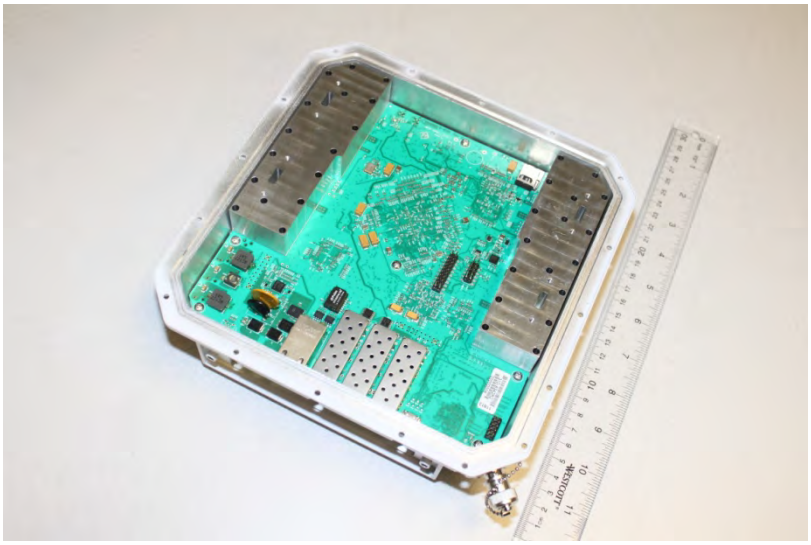
Section	Spec Clause	RSS	Test Description	Result	Comments/Base Standard
2.1	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	Compliant	
2.2	§15.215(c)		20 dB Bandwidth	Compliant	
2.3		RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.4	§15.249(b)(1)	RSS-210 A12(a)	Field Strength of Fundamental Emissions for Fixed, Point to Point Operation	Compliant	
2.5	§15.249(b)(2)	RSS-210 A12(b)	Frequency Stability	Compliant	
2.6	§15.249(d)	RSS-210 A12(d)	Spurious Radiated Emissions	Compliant	
2.7	§15.249(e)	RSS-210 A12(d)	Field Strength of Harmonics for Fixed, Point to Point Operation	Compliant	

1.3 PRODUCT INFORMATION

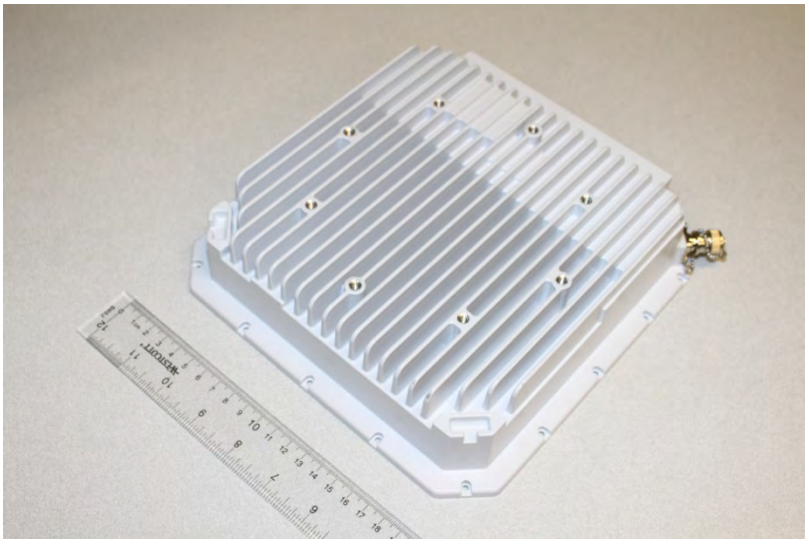
1.3.1 Technical Description

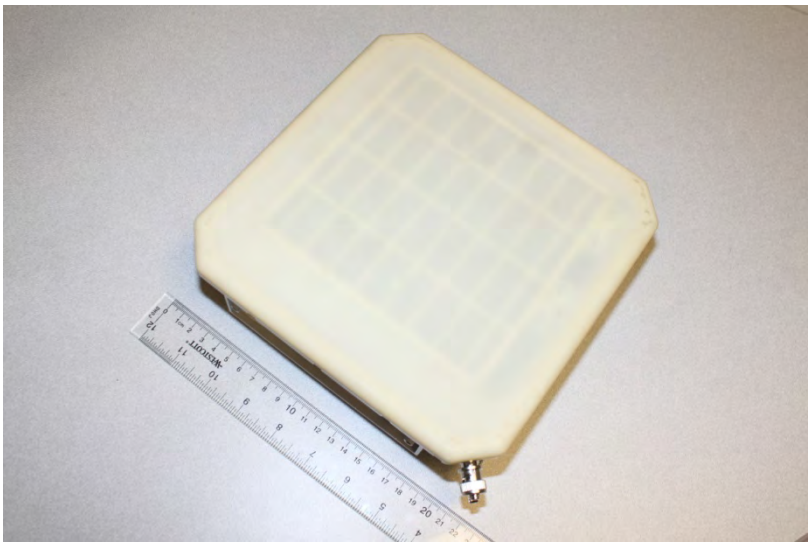
The Equipment Under Test (EUT) was a Trango Systems, Inc. Point-to-Point Wireless Microwave System Module as shown in the photograph below. The EUT is designed to interface with a custom designed 30 dBi Array Antenna designed by Trango Systems Inc. It operates using the unlicensed 24.05 to 24.25 GHz spectrum.





Equipment Under Test





Equipment Under Test with Custom Antenna

1.3.2 EUT General Description

EUT Description	Point-to-Point Wireless Microwave System Module
Model Name	StrataPro 24
Model Number(s)	SP-24
Rated Voltage	48VDC
Output Power	121.5 dBµV/m @ 3 meters (Peak/Low Channel)
Frequency Range	24050MHz to 24250 MHz in the 24000 MHz to 24250 MHz Band

Channels Verified

Channel Width	Low Frequency (MHz)	Mid Frequency (MHz)	High Frequency (MHz)
10 MHz	24055	24150	24245
30 MHz	24065	24150	24235
60 MHz	24085	24150	24215
75 MHz	24093	24150	24208
100 MHz	24100	24150	24200
120 MHz	24110	24150	24110

Antenna Type (used during evaluation)	Custom (Complies with Part 15.203 requirements)

1.3.3 Antenna Details (used during verifications)

Model	N/A
Manufacturer	Trango Systems, Inc.
Antenna Type	Array Antenna
Antenna Gain	30 dBi
Operating Frequency	24.00 to 24.25GHz
Beamwidth	<3.5 degrees symmetric in elevation and azimuth
Return Loss:	10 dB (VSWR < 1.8)

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1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configurations	Description
Default	The EUT is on Engineering mode. This mode allows configuration of RF parameters such as Frequency, Modulation and TX transmit power. Default TX transmit power setting used was "6".

1.4.2 EUT Exercise Software

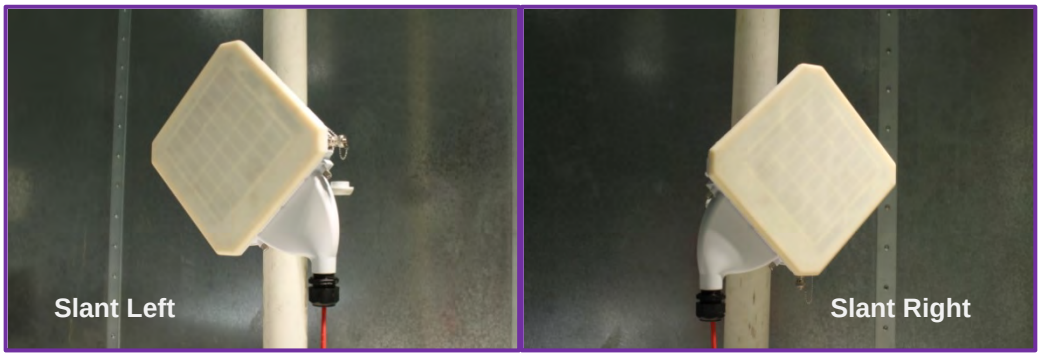
SSH connection to the EUT using its static IP address allows access to Engineering Mode. Once in this mode, RF parameters were configured as per individual test requirement.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Microsemi	60W PoE Injector	PD-9501G/SP S/N N15036517007026A03
Trango Systems	48VDC Power Supply	Model P-SUPPLY-WM-48-L 1.6A
Digitus	CAT 5e Patch Cable	3 meters, shielded, gigabit ethernet, 26AWGx4p
Lenovo	Support Laptop (T410S)	P/N 0A31972 S/N R9-92MH0 10/11

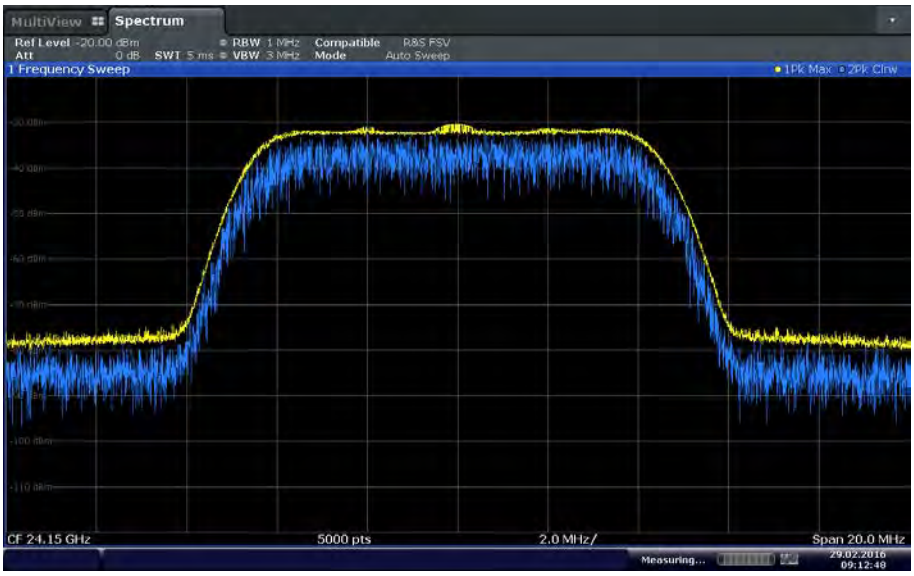
1.4.4 Worst Case Configurations

For radiated measurements, both default EUT orientations (Slant Left/Slant Right) were verified but only the worst case presented (Slant Right). The EUT was pre-scanned with a reference Tx profile on both orientations with the measurement receive antenna on both horizontal and vertical polarizations.



Using data results from OBW measurements, the worst case bandwidth was determined. Since the field strength limits is Peak, the bandwidth with the highest Peak among the available bandwidths was used for radiated measurements. This bandwidth is 10 MHz.

Each available modulation were compared (see attached modulation plots on the following pages). Using the same criteria for determining worst case bandwidth, the worst case modulation was determined. This modulation is QPSK.



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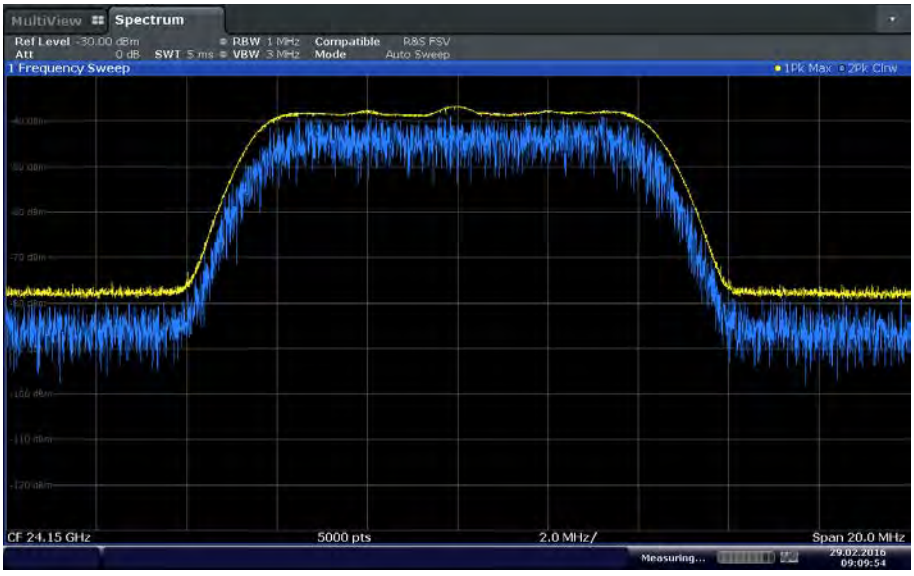
QPSK Modulation



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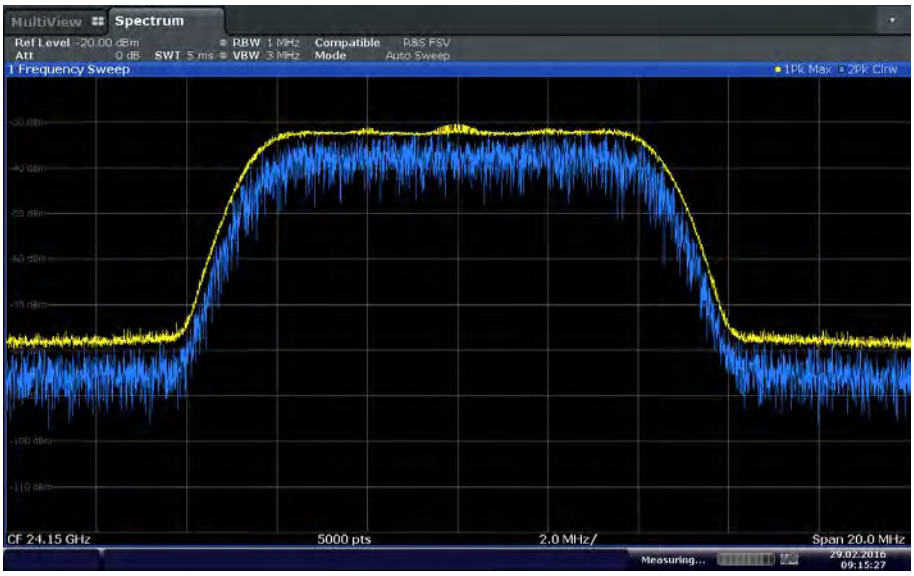
QAM16 Modulation



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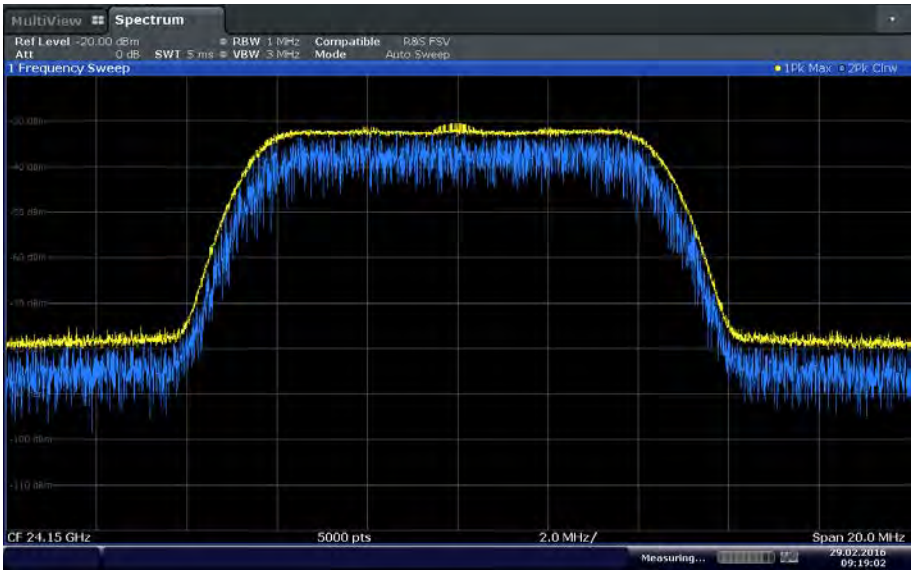
QAM32 Modulation



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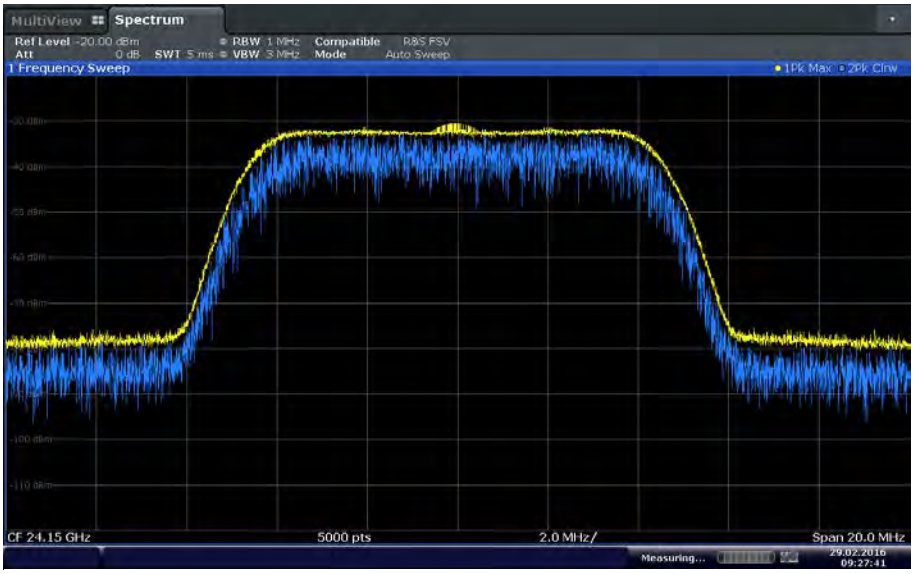
QAM64 Modulation



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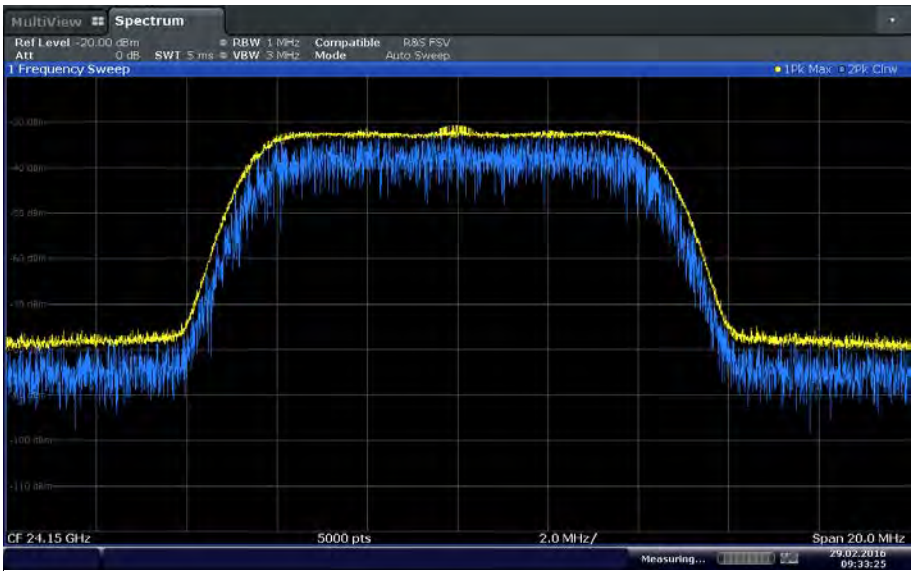
QAM128 Modulation



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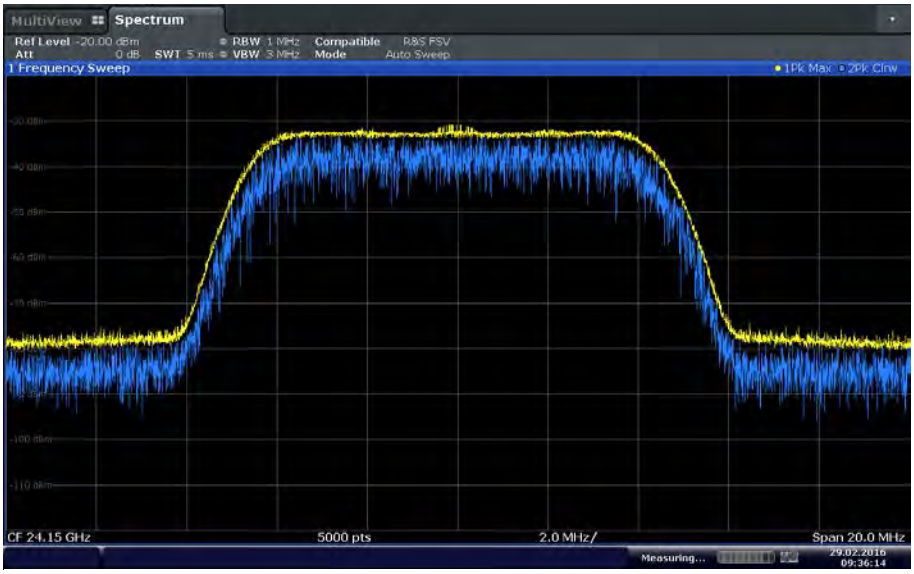
QAM256 Modulation



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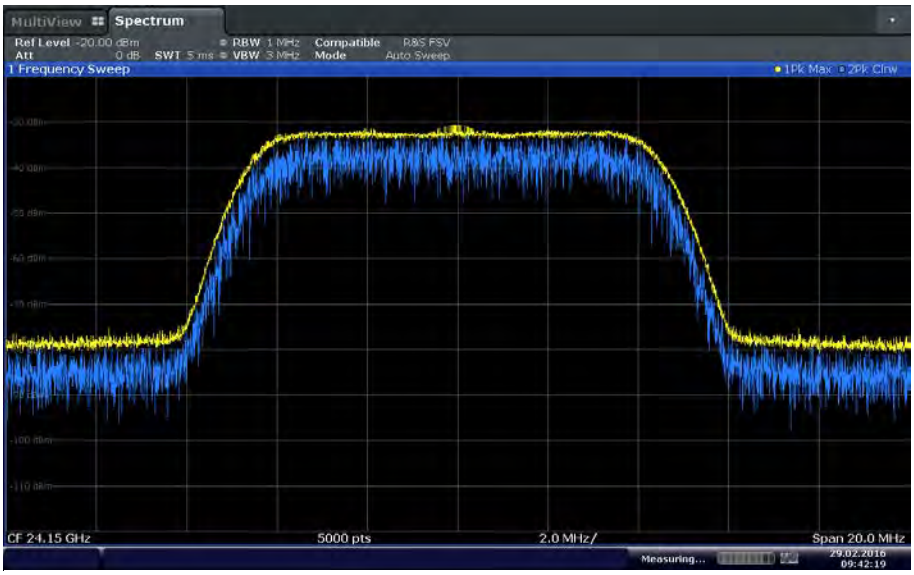
QAM512 Modulation



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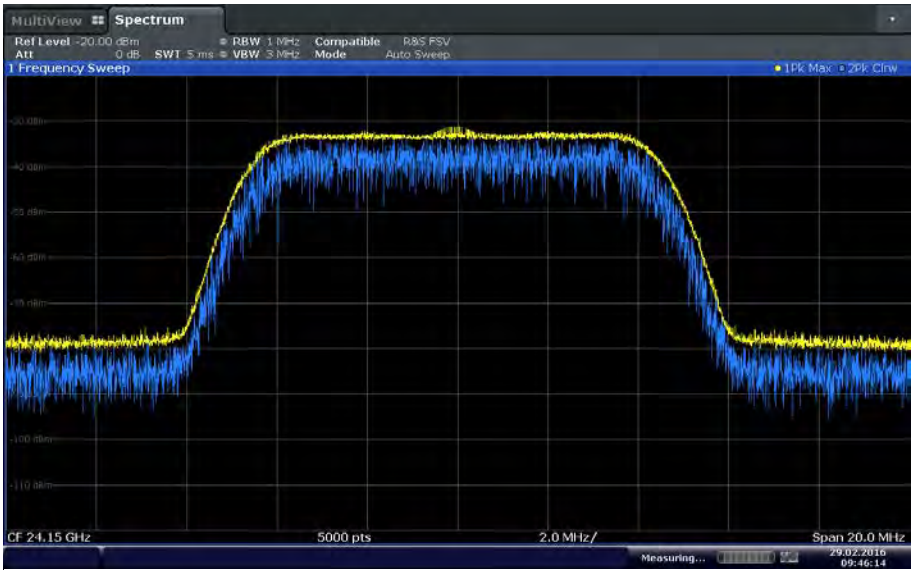
QAM1024 Modulation



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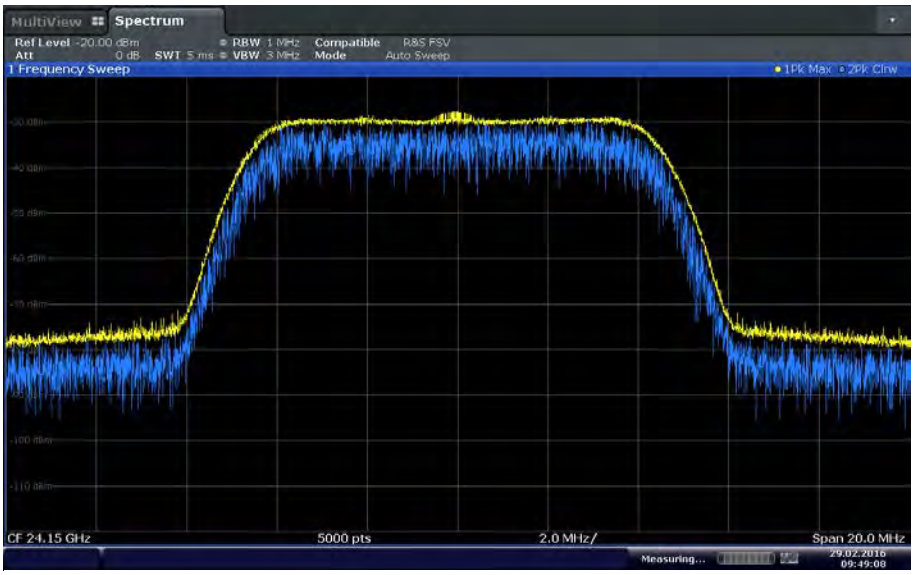
QAM2048 Modulation



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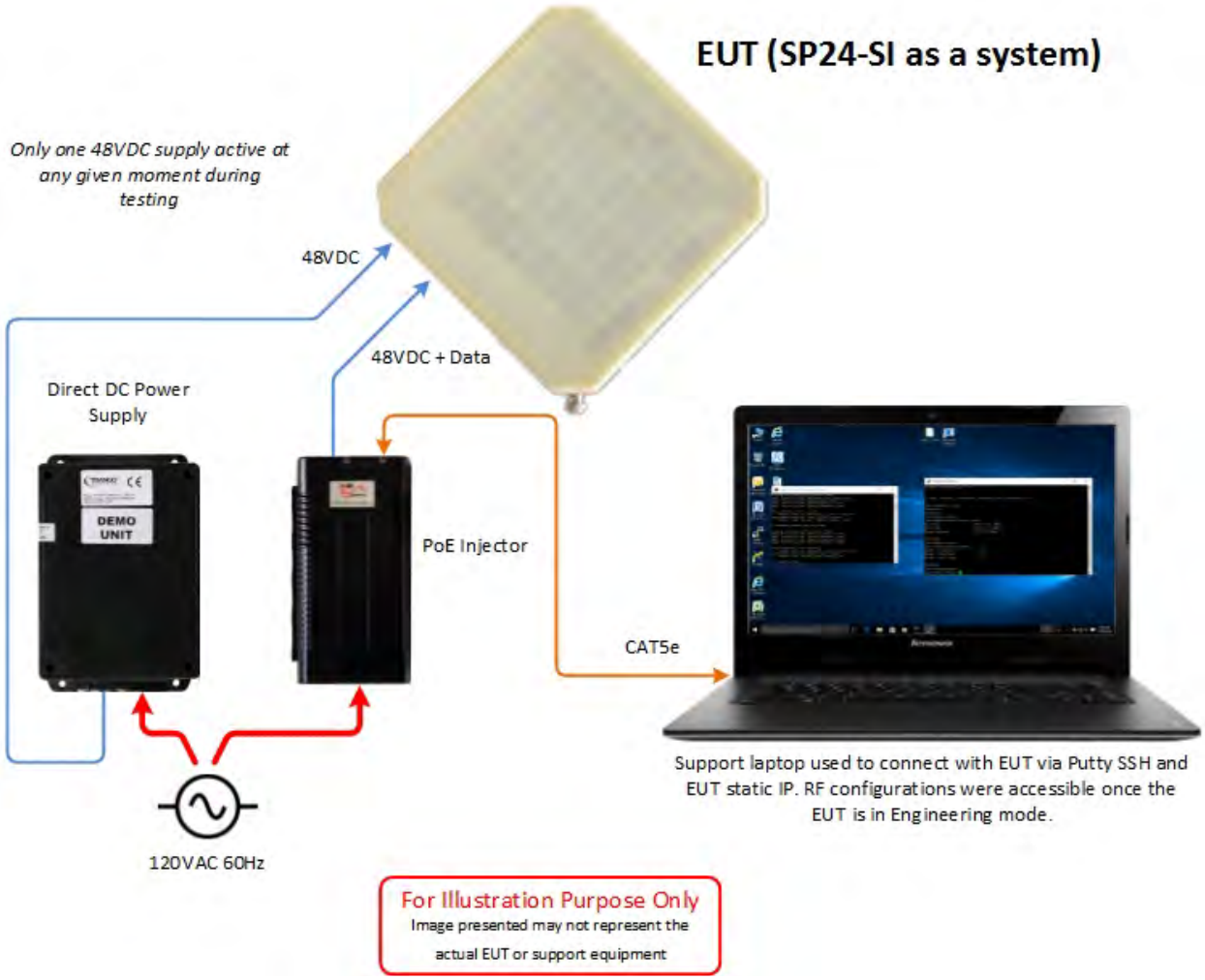
QAM4096 Modulation

1.4.5 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 ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

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)

Building #8 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.

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SECTION 2

TEST DETAILS

Radio Testing of the
Trango Systems, Inc.
Point-to-Point Wireless Microwave System Module

2.1 CONDUCTED EMISSIONS

2.1.1 Specification Reference

Part 15 Subpart C §15.207(a) and RSS-Gen 8.8

2.1.2 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 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	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.*

2.1.3 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

February 29, 2016/FSC

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	27.2 °C
Relative Humidity	20.3 %
ATM Pressure	99.4 kPa

2.1.7 Additional Observations

- Both PoE and direct DC power input verified.
- Verification performed using representative PoE injector and DC power supply (supplied by the manufacturer for testing purposes).
- EUT in Tx mode and max power during verification.

- Measurement was done using EMC32 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 2.1.8 for sample computation.

2.1.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 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# 7567 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.1.9 Test Results

Compliant. See attached plots and tables.

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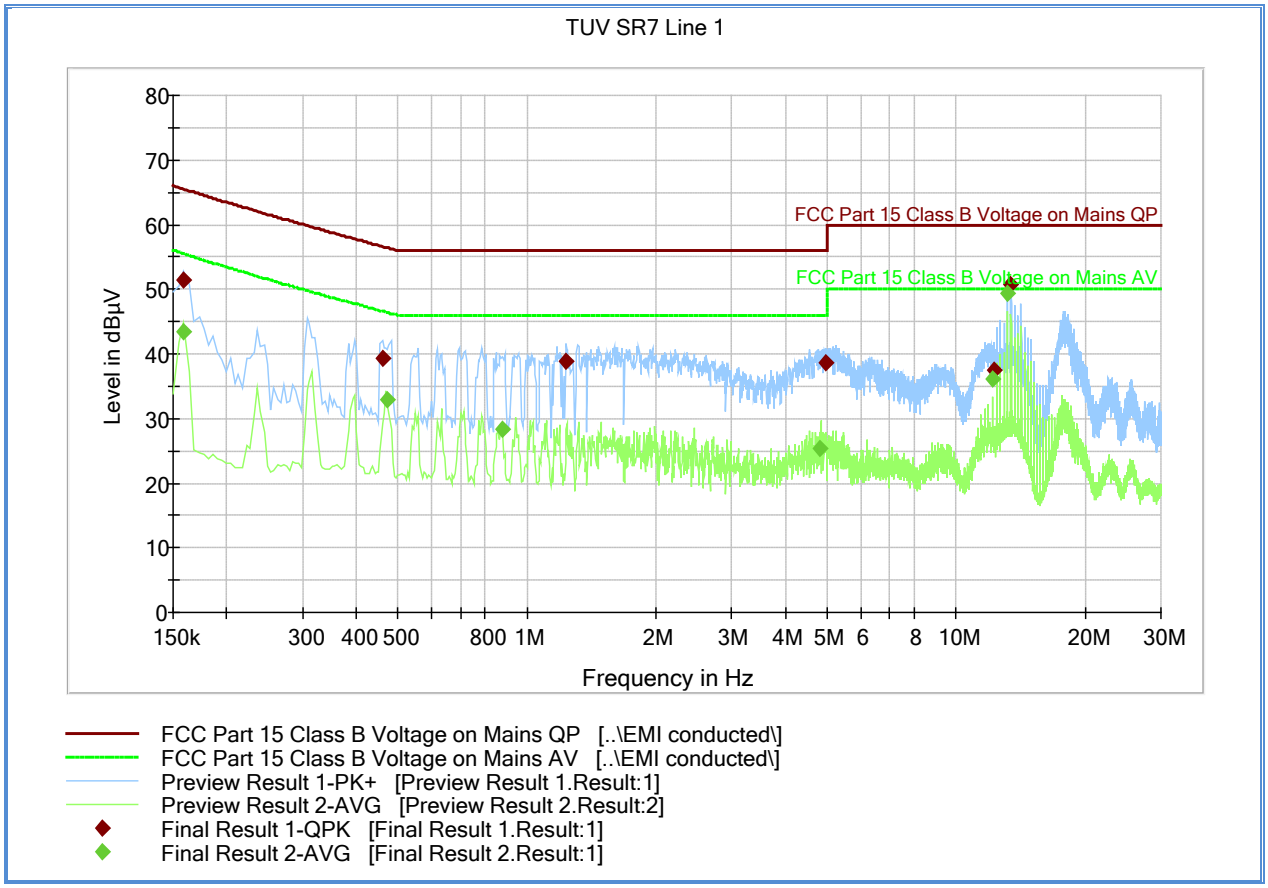
2.1.10 FCC Conducted Emissions Line 1 – Hot (PoE Injector)



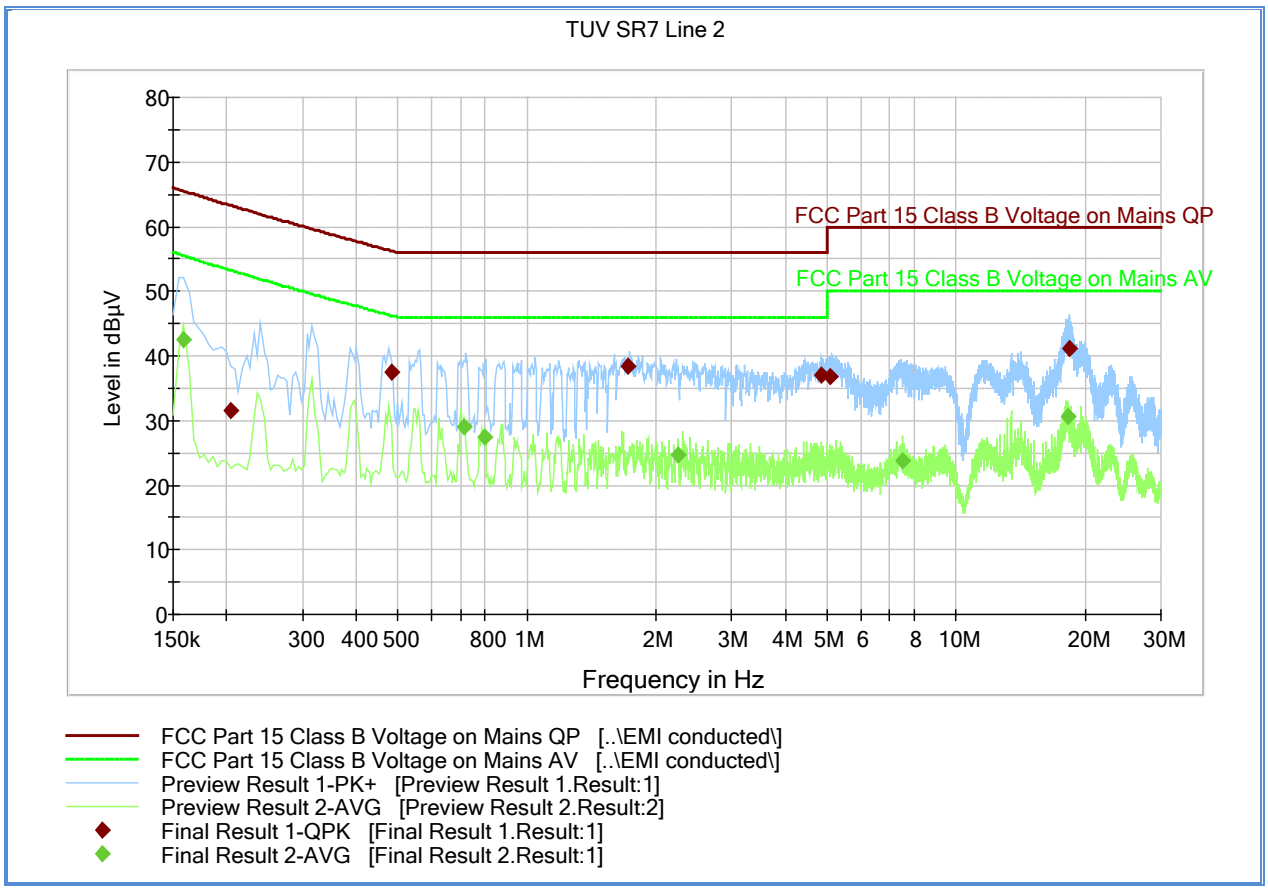
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.159000	51.4	1000.0	9.000	Off	L1	20.0	14.1	65.5
0.460500	39.3	1000.0	9.000	Off	L1	20.2	17.3	56.6
1.234500	39.0	1000.0	9.000	Off	L1	20.1	17.0	56.0
4.974000	38.7	1000.0	9.000	Off	L1	20.5	17.3	56.0
12.232500	37.6	1000.0	9.000	Off	L1	20.6	22.4	60.0
13.425000	50.7	1000.0	9.000	Off	L1	20.6	9.3	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.159000	43.3	1000.0	9.000	Off	L1	20.0	12.1	55.5
0.474000	32.9	1000.0	9.000	Off	L1	20.1	13.5	46.4
0.874500	28.2	1000.0	9.000	Off	L1	20.1	17.8	46.0
4.821000	25.3	1000.0	9.000	Off	L1	20.5	20.7	46.0
12.160500	36.0	1000.0	9.000	Off	L1	20.6	14.0	50.0
13.173000	49.4	1000.0	9.000	Off	L1	20.6	0.6	50.0

2.1.11 FCC Conducted Emissions Line 2 – Neutral (PoE Injector)



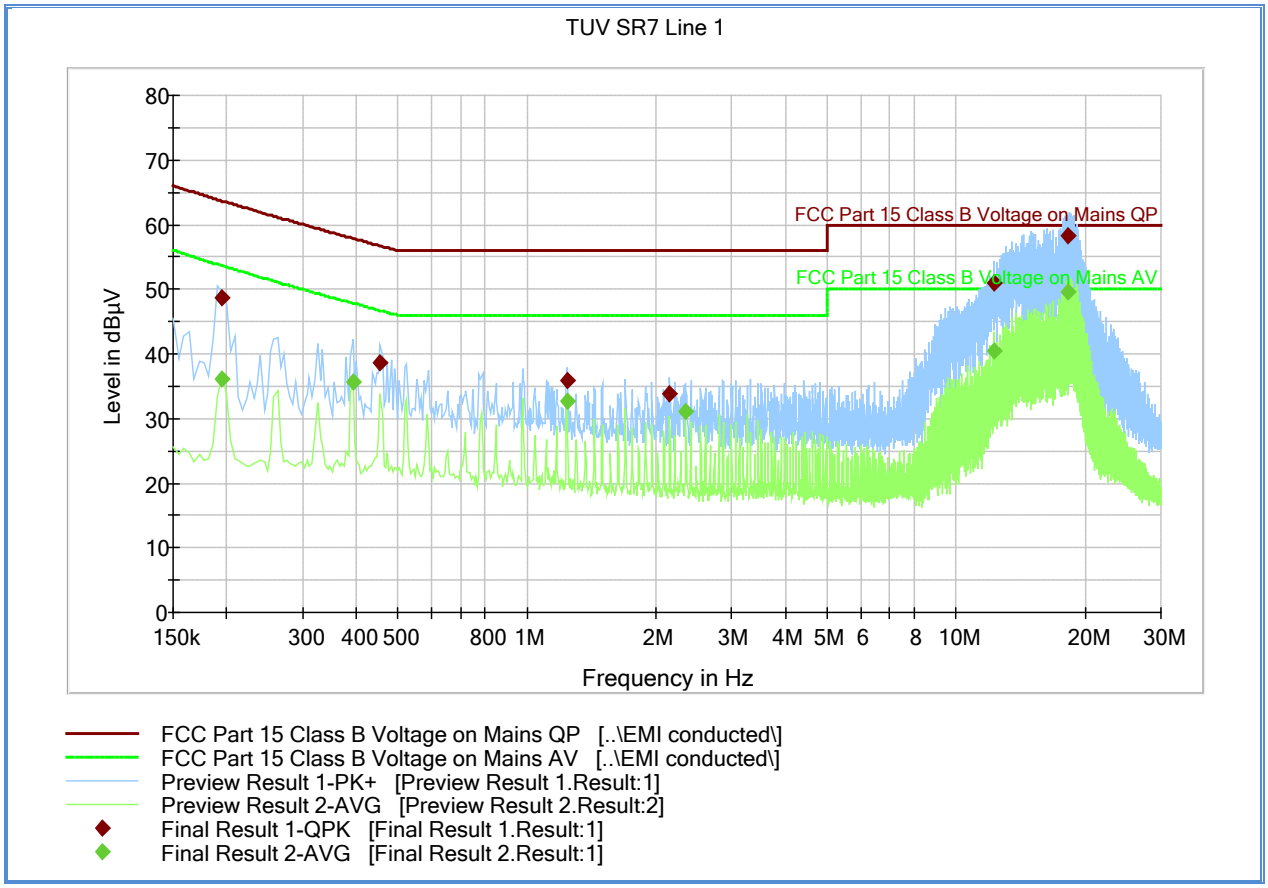
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.204000	31.5	1000.0	9.000	Off	N	20.1	31.8	63.3
0.483000	37.5	1000.0	9.000	Off	N	20.1	18.8	56.3
1.725000	38.4	1000.0	9.000	Off	N	20.2	17.6	56.0
4.861500	37.1	1000.0	9.000	Off	N	20.5	18.9	56.0
5.073000	36.9	1000.0	9.000	Off	N	20.5	23.1	60.0
18.388500	41.2	1000.0	9.000	Off	N	20.8	18.8	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.159000	42.5	1000.0	9.000	Off	N	20.0	13.0	55.5
0.712500	29.0	1000.0	9.000	Off	N	20.2	17.0	46.0
0.798000	27.4	1000.0	9.000	Off	N	20.3	18.6	46.0
2.247000	24.6	1000.0	9.000	Off	N	20.4	21.4	46.0
7.498500	23.9	1000.0	9.000	Off	N	20.5	26.1	50.0
18.222000	30.6	1000.0	9.000	Off	N	20.8	19.4	50.0

2.1.12 FCC Conducted Emissions Line 1 – Positive (48VDC Direct Inject)



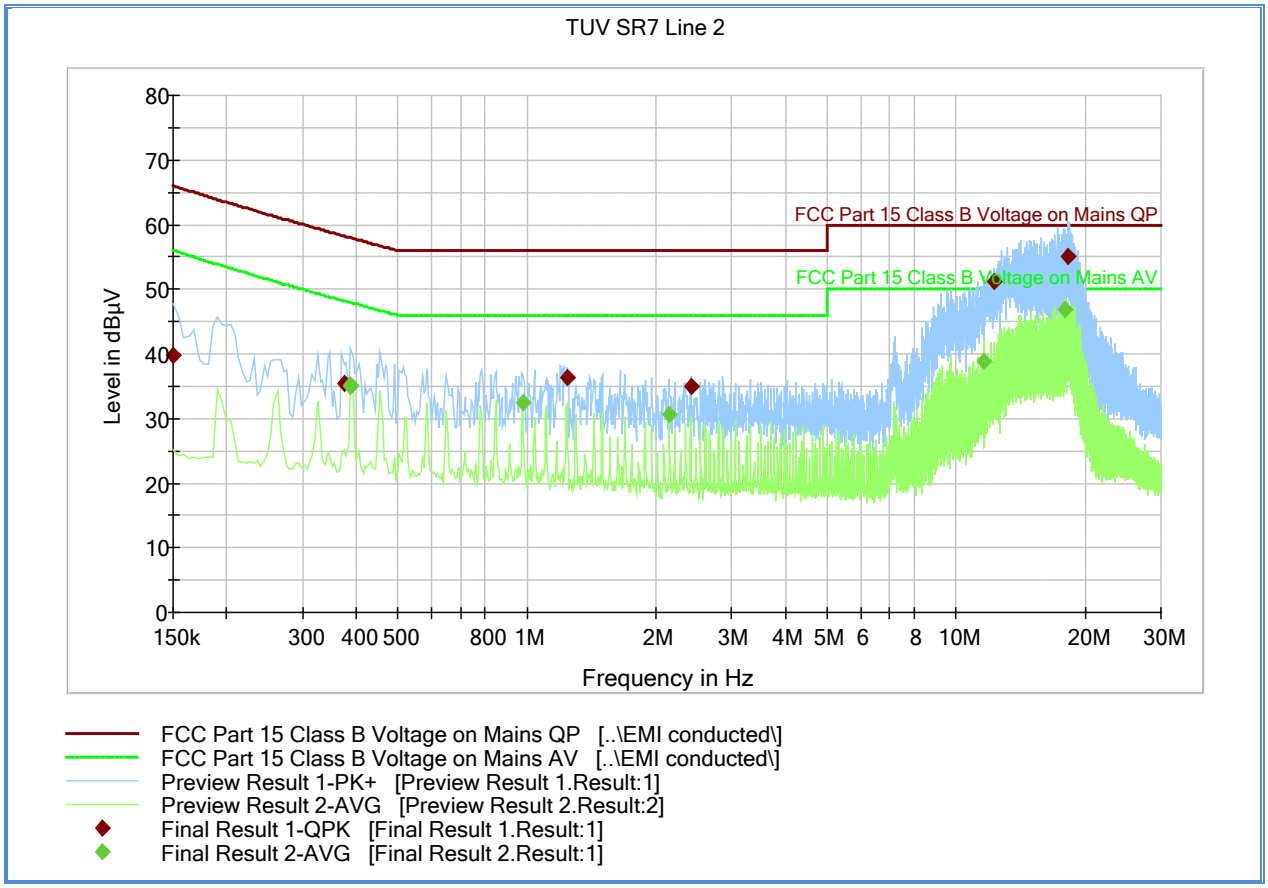
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.195000	48.6	1000.0	9.000	Off	L1	20.1	15.1	63.7
0.456000	38.7	1000.0	9.000	Off	L1	20.2	18.0	56.7
1.239000	35.8	1000.0	9.000	Off	L1	20.1	20.2	56.0
2.148000	33.7	1000.0	9.000	Off	L1	20.3	22.3	56.0
12.255000	50.9	1000.0	9.000	Off	L1	20.6	9.1	60.0
18.249000	58.4	1000.0	9.000	Off	L1	20.8	1.6	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.195000	36.0	1000.0	9.000	Off	L1	20.1	17.6	53.7
0.393000	35.6	1000.0	9.000	Off	L1	20.3	12.3	47.8
1.239000	32.8	1000.0	9.000	Off	L1	20.1	13.2	46.0
2.346000	31.1	1000.0	9.000	Off	L1	20.5	14.9	46.0
12.255000	40.5	1000.0	9.000	Off	L1	20.6	9.5	50.0
18.249000	49.6	1000.0	9.000	Off	L1	20.8	0.4	50.0

2.1.13 FCC Conducted Emissions Line 2 – Negative (48VDC Direct Inject)



Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.150000	39.8	1000.0	9.000	Off	N	20.1	26.2	66.0
0.375000	35.5	1000.0	9.000	Off	N	20.2	22.7	58.2
1.239000	36.2	1000.0	9.000	Off	N	20.1	19.8	56.0
2.409000	34.9	1000.0	9.000	Off	N	20.5	21.1	56.0
12.304500	51.2	1000.0	9.000	Off	N	20.7	8.8	60.0
18.163500	55.1	1000.0	9.000	Off	N	20.8	4.9	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.388500	35.0	1000.0	9.000	Off	N	20.3	12.9	47.9
0.388500	35.3	1000.0	9.000	Off	N	20.3	12.7	47.9
0.978000	32.5	1000.0	9.000	Off	N	20.1	13.5	46.0
2.148000	30.7	1000.0	9.000	Off	N	20.3	15.3	46.0
11.589000	39.0	1000.0	9.000	Off	N	20.6	11.0	50.0
17.902500	46.9	1000.0	9.000	Off	N	20.8	3.1	50.0

2.2 20 dB BANDWIDTH

2.2.1 Specification Reference

Part 15 Subpart C §15.215(c)

2.2.2 Standard Applicable

(c) 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. 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.

2.2.3 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

February 11, 2016/FSC

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.8 °C
Relative Humidity	19.4 %
ATM Pressure	99.5 kPa

2.2.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is between 1% to 5% of the OBW.
- VBW is approx. 3X of the RBW.
- Sweep is auto.
- Detector is positive peak.
- “n dB down” marker function of the Spectrum Analyzer was used for this test.

- All available BW verified using the worst case modulation (See Section 1.4.4 of this test report).
- Worst case BW edges (T_1 and T_2 on the test plots) will determine if the EUT operates within band (24.0 GHz to 24.25 GHz).

2.2.8 Test Results

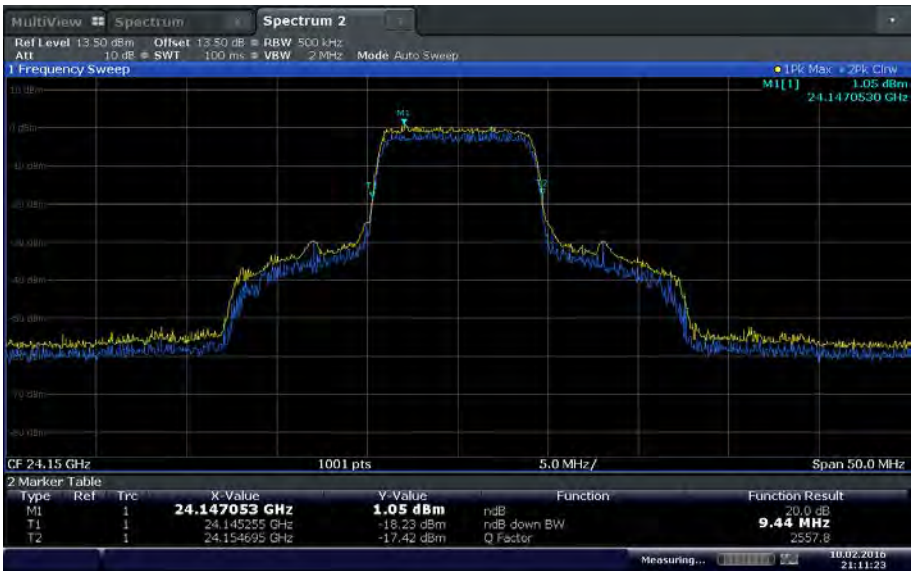
Channel BW	Low Channel (MHz)	Mid Channel (MHz)	High Channel (MHz)
10 MHz	9.490	9.440	9.490
30 MHz	27.07	27.22	27.22
60 MHz	57.54	57.74	57.64
75 MHz	70.53	70.23	70.03
100 MHz	94.71	95.30	94.95
120 MHz	113.71	113.99	113.71

Worst case lower 20dB BW edge (T_1 of 10 MHz BW Low Channel) = 24.050255 GHz (within band, **EUT complies**)
Worst case upper 20dB BW edge (T_2 of 10 MHz BW High Channel) = 24.249745 GHz (within band, **EUT complies**)

2.2.9 Test Plots

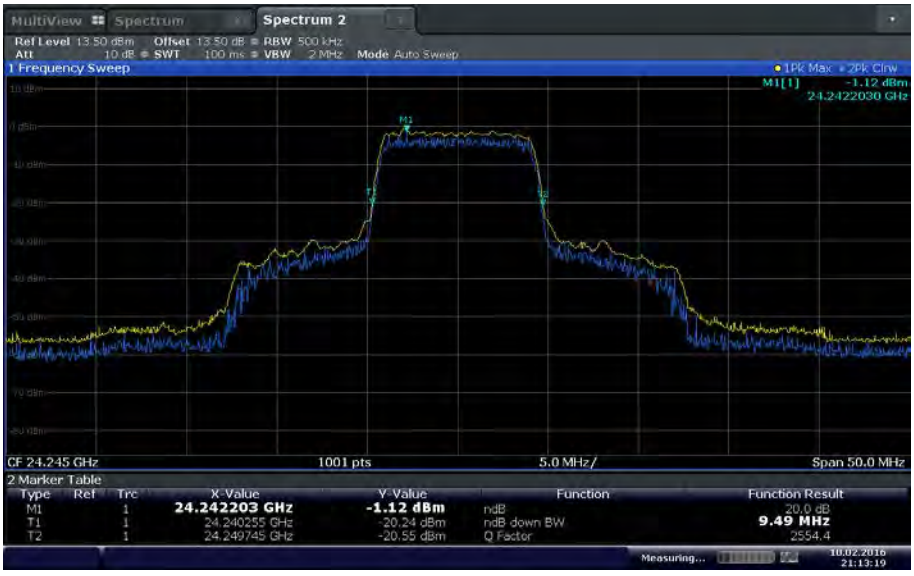
Date: 10.FEB.2016 21:07:41

10 MHz BW (Low Channel)



Date: 10.FEB.2016 21:11:23

10 MHz BW (Mid Channel)



Date: 10.FEB.2016 21:13:19

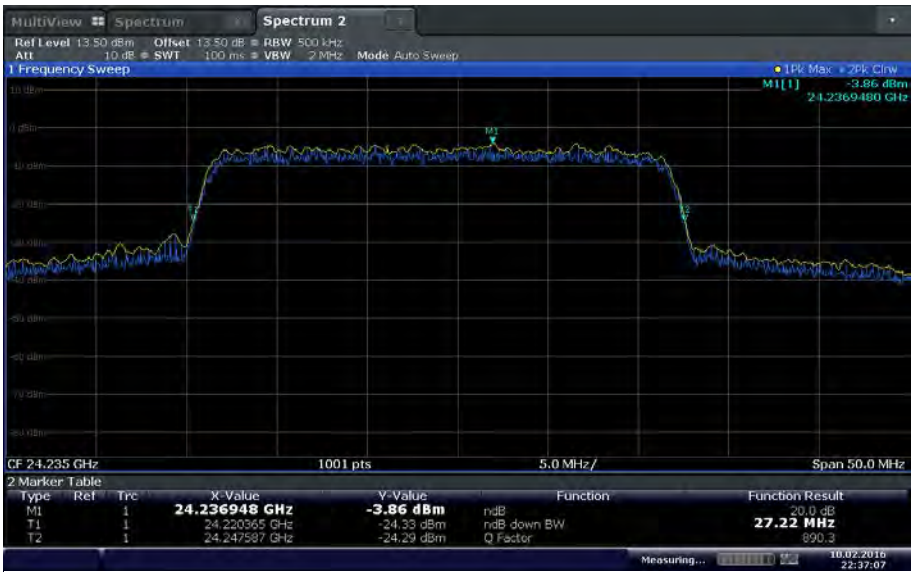
10 MHz BW (High Channel)

Date: 10.FEB.2016 22:34:43

30 MHz BW (Low Channel)

Date: 10.FEB.2016 21:26:17

30 MHz BW (Mid Channel)



Date: 10.FEB.2016 22:37:07

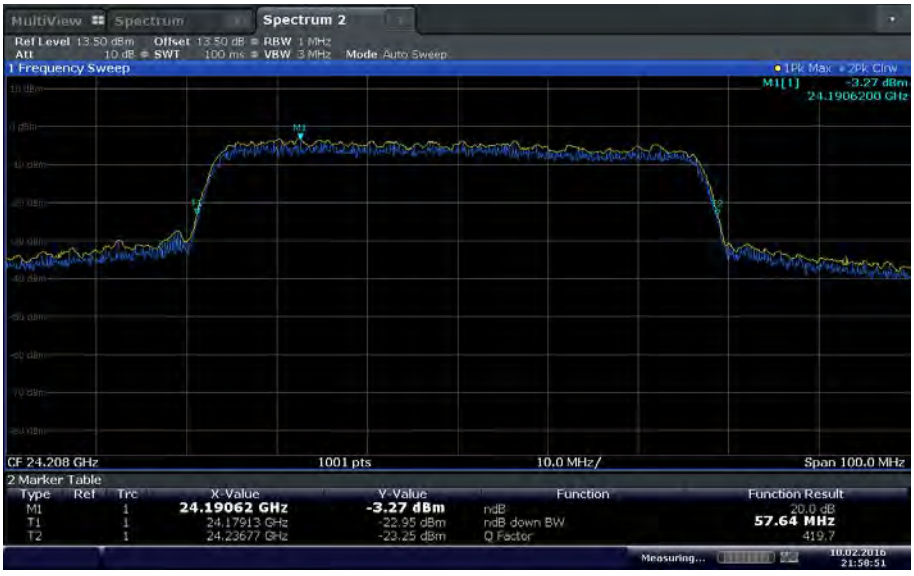
30 MHz BW (High Channel)

Date: 10.FEB.2016 21:49:37

60 MHz BW (Low Channel)

Date: 10.FEB.2016 21:56:47

60 MHz BW (Mid Channel)



Date: 10.FEB.2016 21:58:51

60 MHz BW (High Channel)

Date: 10.FEB.2016 22:07:57

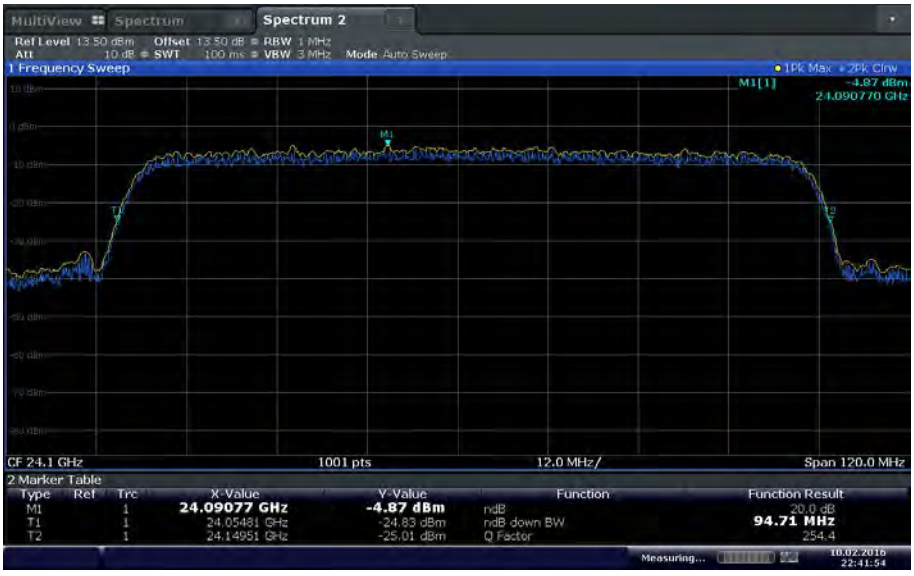
75 MHz BW (Low Channel)

Date: 10.FEB.2016 22:22:36

75 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:19:16

75 MHz BW (High Channel)

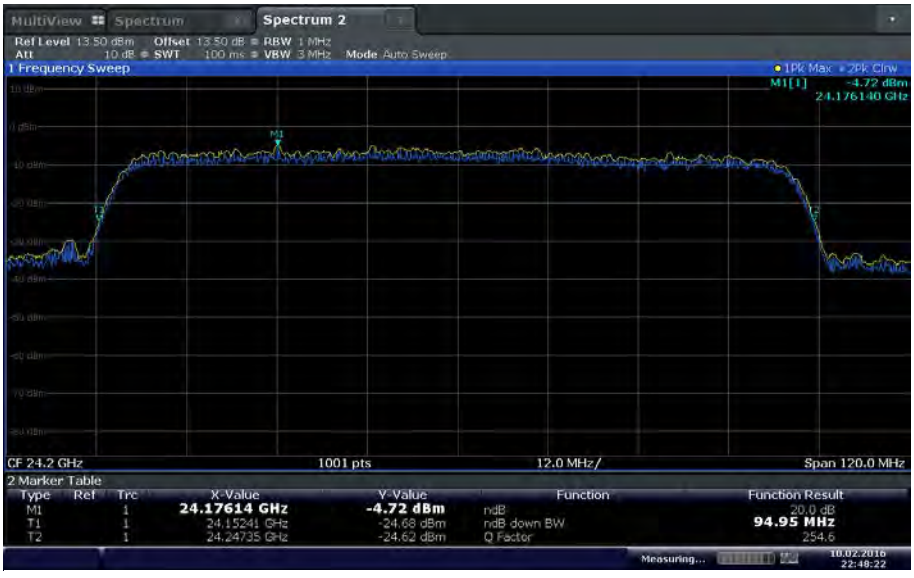


Date: 10.FEB.2016 22:41:54

100 MHz BW (Low Channel)

Date: 10.FEB.2016 22:44:30

100 MHz BW (Mid Channel)



Date: 10.FEB.2016 22:48:22

100 MHz BW (High Channel)

Date: 10.FEB.2016 22:52:46

120 MHz BW (Low Channel)

Date: 10.FEB.2016 22:54:31

120 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:56:15

120 MHz BW (High Channel)

2.3 99% EMISSION BANDWIDTH

2.3.1 Specification Reference

RSS-Gen Clause 6.6

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

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

February 11, 2016/FSC

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	25.8 °C
Relative Humidity	19.4 %
ATM Pressure	99.5 kPa

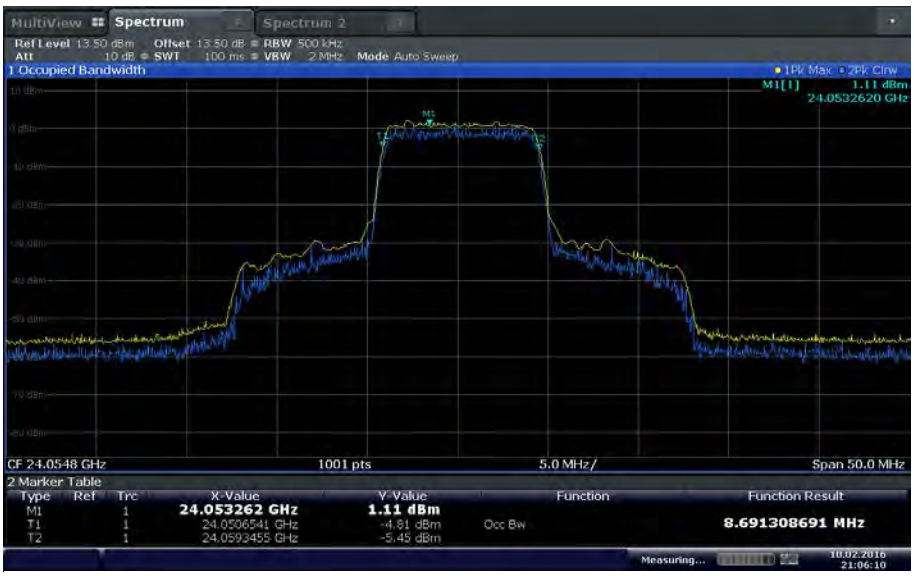
2.3.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is between 1% to 5% of the OBW.
- VBW is approx. 3X of the RBW.
- Sweep is auto.
- Detector is positive peak.
- All available BW verified using the worst case modulation (See Section 1.4.4 of this test report).
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

2.3.8 Test Results

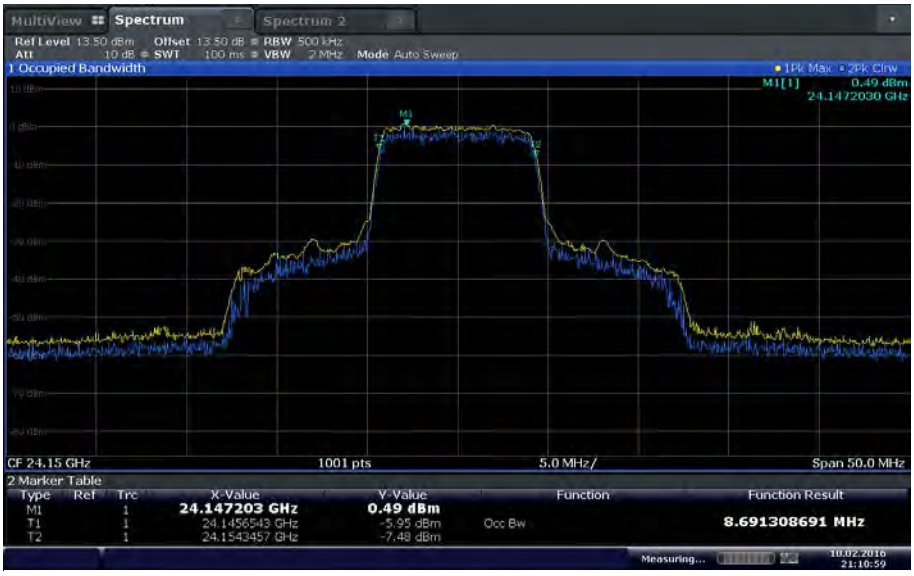
Channel BW	Low Channel (MHz)	Mid Channel (MHz)	High Channel (MHz)
10 MHz	8.690	8.690	8.690
30 MHz	25.32	25.37	25.42
60 MHz	53.65	53.95	54.05
75 MHz	65.63	65.53	65.43
100 MHz	88.47	89.31	88.71
120 MHz	106.29	106.99	106.43

2.3.9 Test Plots



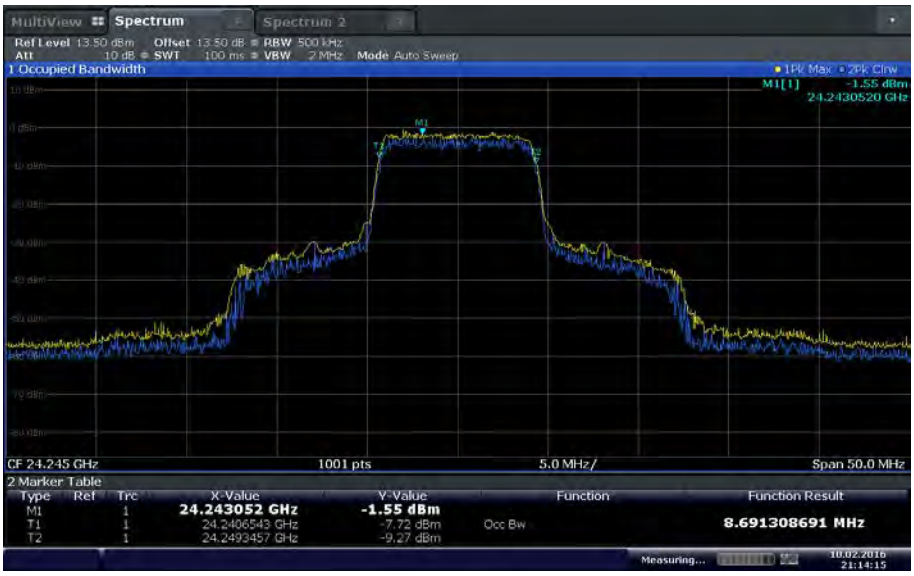
Date: 10.FEB.2016 21:06:11

10 MHz BW (Low Channel)



Date: 10.FEB.2016 21:10:59

10 MHz BW (Mid Channel)



Date: 10.FEB.2016 21:14:15

10 MHz BW (High Channel)

Date: 10.FEB.2016 22:35:14

30 MHz BW (Low Channel)

Date: 10.FEB.2016 21:27:34

30 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:37:32

30 MHz BW (High Channel)

Date: 10.FEB.2016 22:28:46

60 MHz BW (Low Channel)

Date: 10.FEB.2016 22:29:57

60 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:30:56

60 MHz BW (High Channel)

Date: 10.FEB.2016 22:08:32

75 MHz BW (Low Channel)

Date: 10.FEB.2016 22:22:05

75 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:19:54

75 MHz BW (High Channel)

Date: 10.FEB.2016 22:42:28

100 MHz BW (Low Channel)

Date: 10.FEB.2016 22:45:19

100 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:47:04

100 MHz BW (High Channel)

Date: 10.FEB.2016 22:52:18

120 MHz BW (Low Channel)

Date: 10.FEB.2016 22:54:06

120 MHz BW (Mid Channel)

Date: 10.FEB.2016 22:55:48

120 MHz BW (High Channel)

2.4 FIELD STRENGTH OF FUNDAMENTAL EMISSIONS FOR FIXED, POINT TO POINT OPERATION

2.4.1 Specification Reference

47 CFR §15.249(b)(1) and RSS-210 A12(a)

2.4.2 Standard Applicable

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

2.4.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

February 15, 2016/FSC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.8 °C
Relative Humidity	39.3 %
ATM Pressure	99.4 kPa

2.4.7 Additional Observations

- Only the worst case modulation and bandwidth verified (Section 1.4.4 of this test report).
- The spectrum was searched from 18GHz up to 40GHz. Band edge measurements were included on the final measurements.
- For Fundamental measurements, the maximization was repeated manually in addition to auto maximization via software.

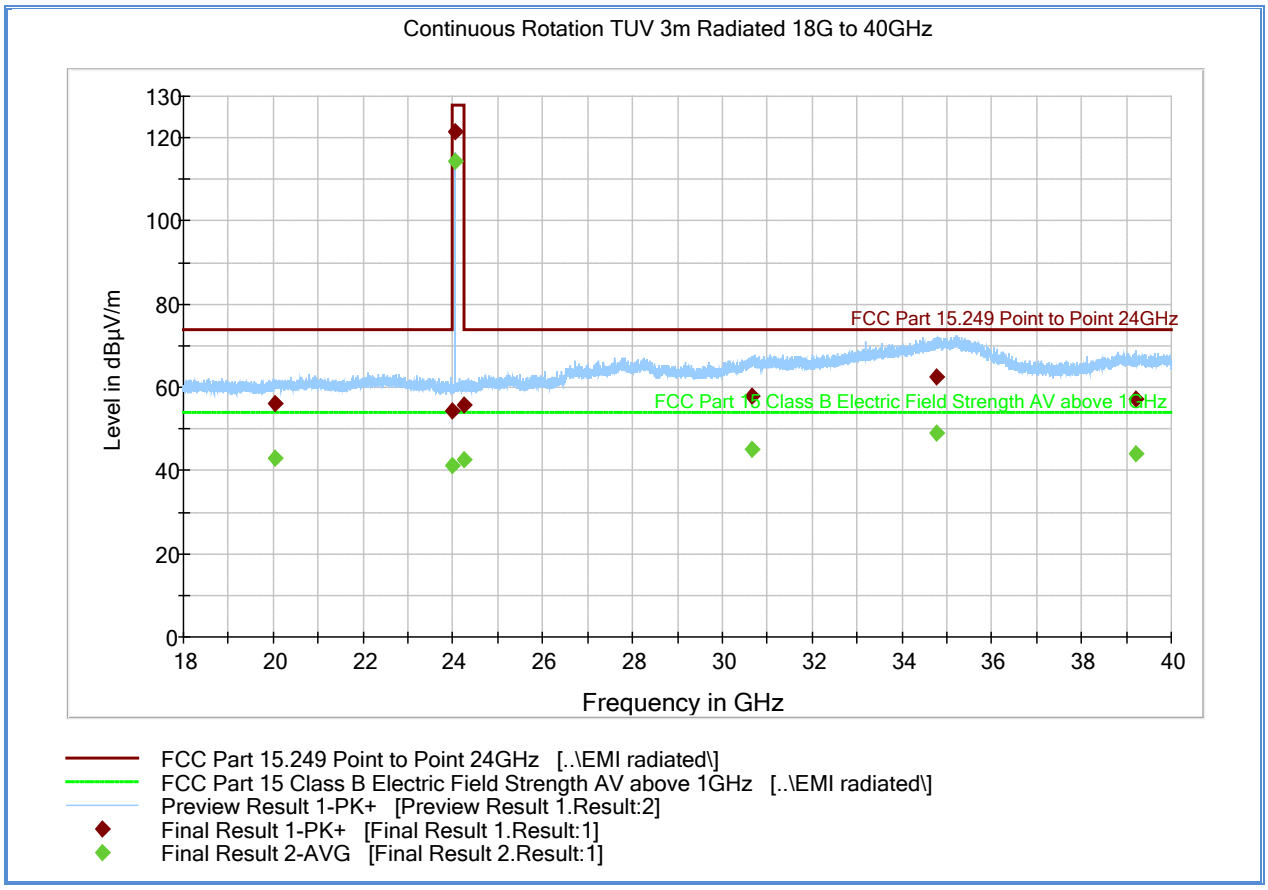
2.4.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) **@ 24055MHz**			107
Correction Factor (dB)	Asset# 8851 (cable)	8.8	**14.5**
	SLKaa-30-6 (preamplifier)	-39.5	
	Asset# 1054 (antenna)	45.2	
Reported Peak Final Measurement (dbµV/m) @ 24055 MHz			**121.5**

2.4.9 Test Results

See attached plots.

2.4.10 Test Results for Low Channel (Fundamental, Band-Edges and General Spurious Emissions from 18GHz to 40GHz)



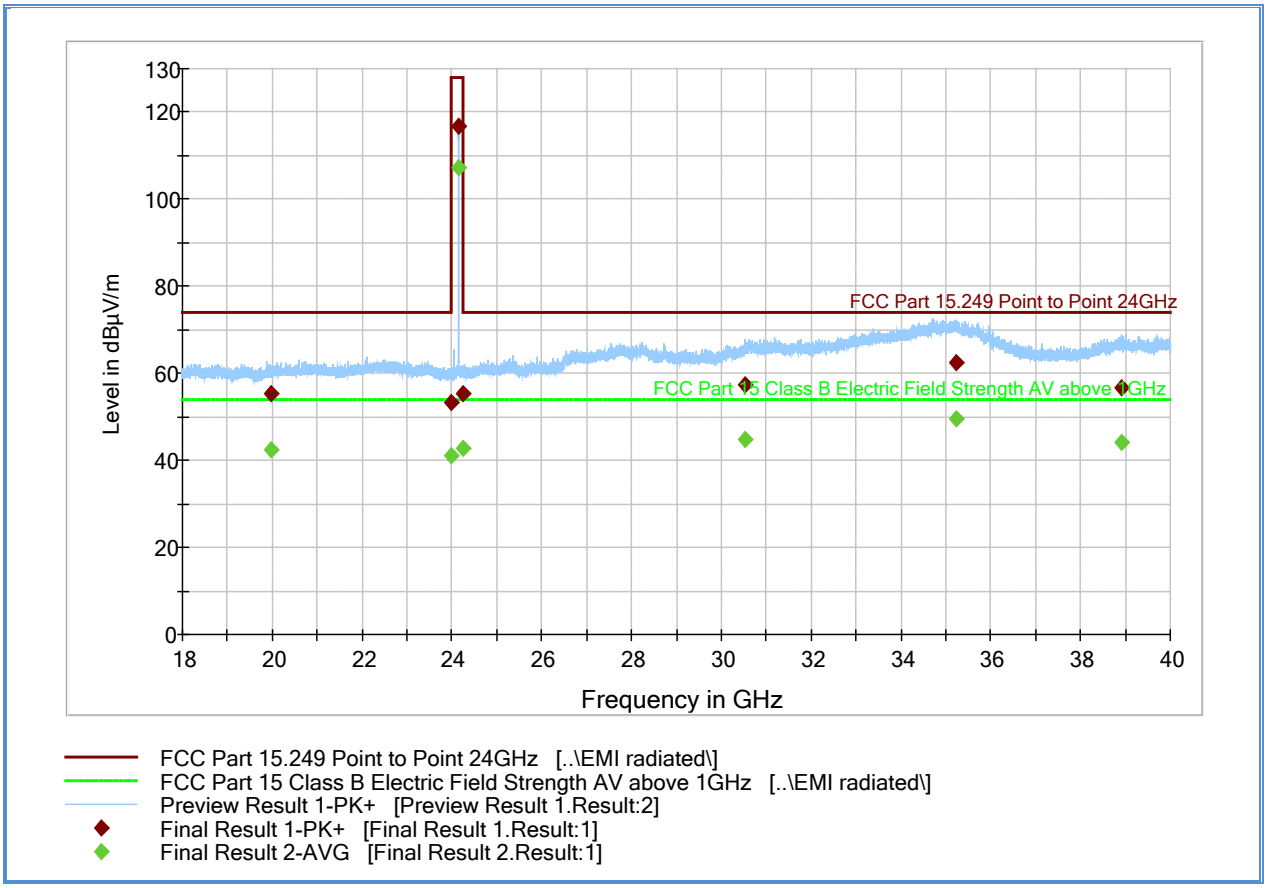
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
20033.3333	56.0	1000.0	1000.000	140.0	V	14.0	14.0	17.9	73.9
23999.2000	54.3	1000.0	1000.000	140.0	V	1.0	14.5	19.6	73.9
24051.5333	121.5	1000.0	1000.000	150.0	H	1.0	14.5	6.5	128.0
24250.4666	55.9	1000.0	1000.000	150.0	V	169.0	14.7	18.0	73.9
30650.8000	57.9	1000.0	1000.000	154.0	V	253.0	18.6	16.0	73.9
34766.0000	62.4	1000.0	1000.000	120.0	H	8.0	22.6	11.5	73.9
39208.2666	57.0	1000.0	1000.000	120.0	V	-15.0	18.3	16.9	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
20033.3333	43.1	1000.0	1000.000	140.0	V	14.0	14.0	10.8	53.9
23999.2000	41.4	1000.0	1000.000	140.0	V	1.0	14.5	12.5	53.9
24051.5333	114.2	1000.0	1000.000	150.0	H	1.0	14.5	Fundamental	
24250.4666	42.8	1000.0	1000.000	150.0	V	169.0	14.7	11.1	53.9
30650.8000	45.2	1000.0	1000.000	154.0	V	253.0	18.6	8.7	53.9
34766.0000	48.8	1000.0	1000.000	120.0	H	8.0	22.6	5.1	53.9
39208.2666	44.0	1000.0	1000.000	120.0	V	-15.0	18.3	9.9	53.9

2.4.11 Test Results for Mid Channel (Fundamental, Band-Edges and General Spurious Emissions from 18GHz to 40GHz)



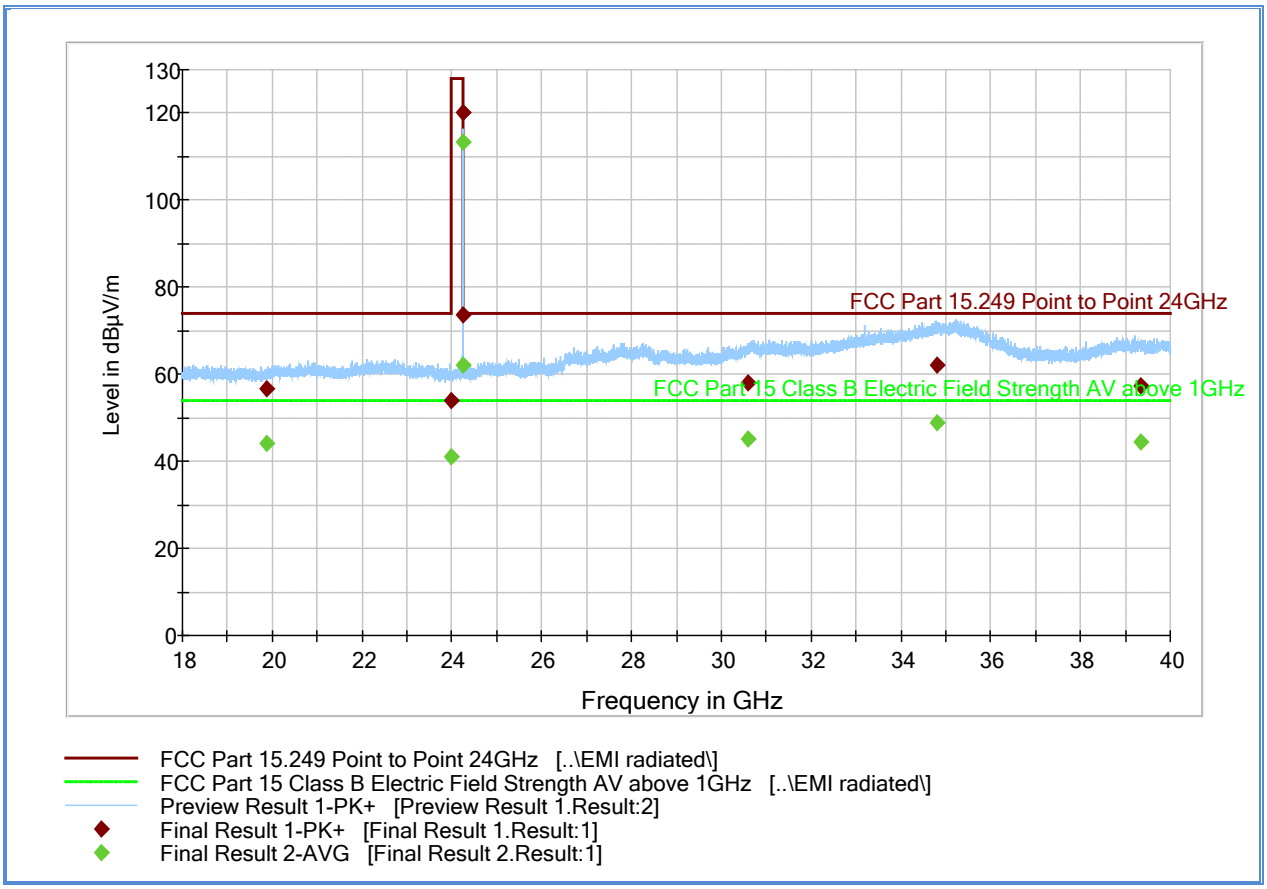
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
19983.8000	55.3	1000.0	1000.000	160.0	H	331.0	14.1	18.6	73.9
23998.9333	53.4	1000.0	1000.000	170.0	V	0.0	14.5	20.5	73.9
24146.6000	116.9	1000.0	1000.000	160.0	V	0.0	14.6	11.0	128.0
24250.3333	55.2	1000.0	1000.000	160.0	H	117.0	14.7	18.7	73.9
30528.7333	57.5	1000.0	1000.000	140.0	V	72.0	18.3	16.4	73.9
35218.8000	62.3	1000.0	1000.000	170.0	H	92.0	22.6	11.6	73.9
38925.4666	56.8	1000.0	1000.000	160.0	H	-2.0	18.5	17.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
19983.8000	42.4	1000.0	1000.000	160.0	H	331.0	14.1	11.5	53.9
23998.9333	40.9	1000.0	1000.000	170.0	V	0.0	14.5	13.0	53.9
24146.6000	107.2	1000.0	1000.000	160.0	V	0.0	14.6	Fundamental	
24250.3333	42.9	1000.0	1000.000	160.0	H	117.0	14.7	11.0	53.9
30528.7333	44.6	1000.0	1000.000	140.0	V	72.0	18.3	9.3	53.9
35218.8000	49.5	1000.0	1000.000	170.0	H	92.0	22.6	4.4	53.9
38925.4666	44.0	1000.0	1000.000	160.0	H	-2.0	18.5	9.9	53.9

2.4.12 Test Results for High Channel (Fundamental, Band-Edges and General Spurious Emissions from 18GHz to 40GHz)



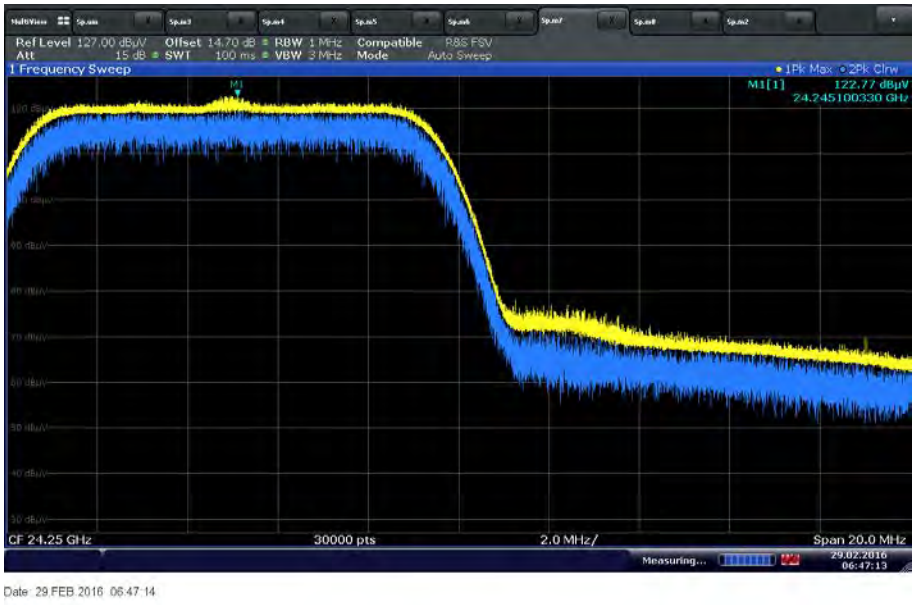
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
19888.3333	56.8	1000.0	1000.000	122.5	H	69.0	14.1	17.1	73.9
24000.0333	54.1	1000.0	1000.000	130.5	V	18.0	14.5	73.8	128.0
24248.8000	120.1	1000.0	1000.000	130.5	V	6.0	14.7	7.9	128.0
24250.0000	73.7	1000.0	1000.000	130.5	H	7.0	14.7	15.0	128.0
30609.7333	57.9	1000.0	1000.000	170.4	H	172.0	18.5	16.0	73.9
34813.3333	62.0	1000.0	1000.000	132.5	V	20.0	22.6	11.9	73.9
39340.4000	57.2	1000.0	1000.000	135.5	V	159.0	18.3	16.7	73.9

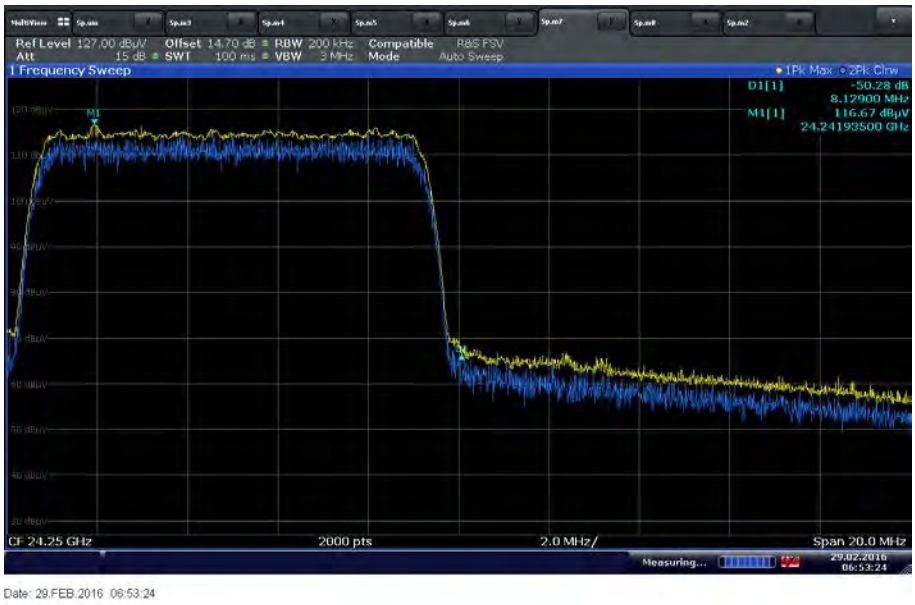
Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
19888.3333	44.1	1000.0	1000.000	122.5	H	69.0	14.1	9.8	53.9
24000.0333	41.1	1000.0	1000.000	130.5	V	18.0	14.5	12.8	53.9
24248.8000	113.4	1000.0	1000.000	130.5	V	6.0	14.7	Fundamental	
24250.0000	62.2	1000.0	1000.000	130.5	H	7.0	14.7	Complies with 50dBc	
30609.7333	45.1	1000.0	1000.000	170.4	H	172.0	18.5	8.8	53.9
34813.3333	48.9	1000.0	1000.000	132.5	V	20.0	22.6	5.0	53.9
39340.4000	44.4	1000.0	1000.000	135.5	V	159.0	18.3	9.5	53.9

2.4.13 Band Edge Verification at High Channel (Worst Case Configuration) using Delta Marker Method



High Channel Band-Edge using 1MHz RBW/3MHz VBW



High Channel Band-Edge using Delta-Marker Method as per Clause 6.10.6 of ANSI C63.10-2013 showing >50dBc edge measurement

2.5 FREQUENCY STABILITY

2.5.1 Specification Reference

47 CFR §15.249(b)(2) and RSS-210 A12(b)

2.5.2 Standard Applicable

(2) The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of −20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

2.5.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

February 10 and 11, 2016/FSC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.4 -27.2 °C
Relative Humidity	19.4 - 20.0 %
ATM Pressure	99.5 - 99.7 kPa

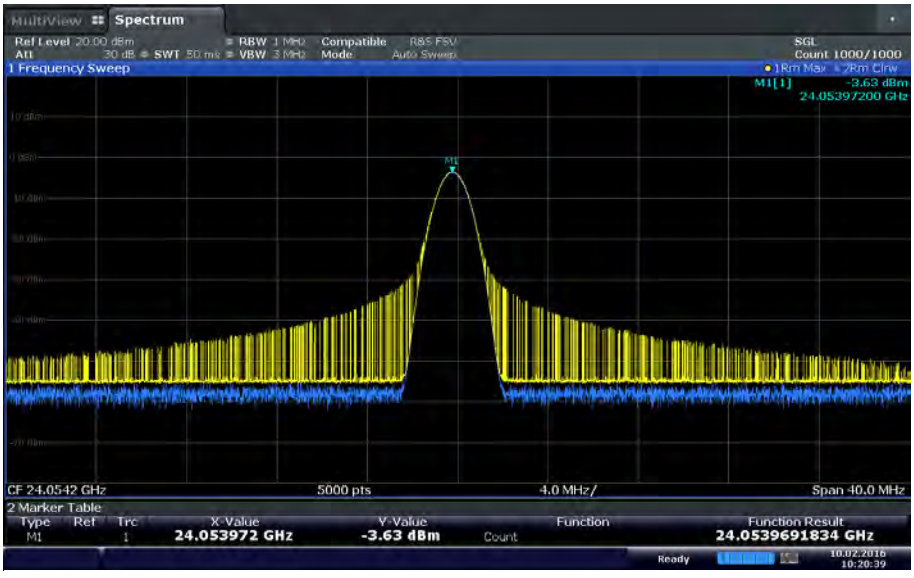
2.5.7 Additional Observations

- This is a radiated test performed with the EUT inside the environmental chamber.
- The Temperature was reduced to -20°C and allowed to sit for 1 hour to allow the equipment and chamber temperature to stabilize. The measurements were then performed. The temperature was then increased by 10°C steps and allowed to settle before taking the next set of measurements.
- Voltage variation was also performed using 85% and 115% of the nominal voltage at 20°C.
- Verification performed on a representative channel only (min. TX frequency for channel width of 10 MHz).
- EUT was configured in CW mode for this test (opmode off).

2.5.8 Test Results Summary

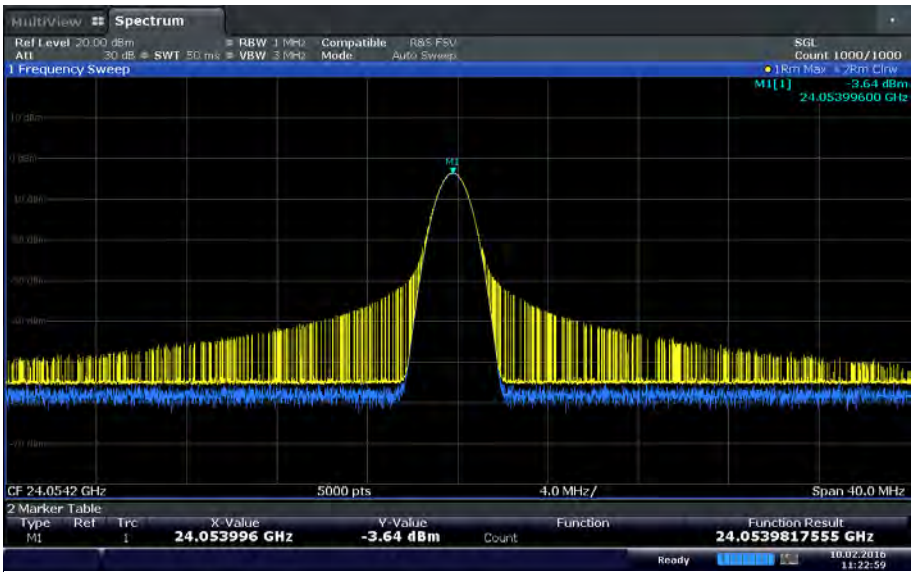
Low Channel for 10MHz Bandwidth (24.055 GHz) CW Mode					
Voltage (%)	***Power (VDC)***	***Temp (°C)***	***Center Frequency (GHz)***	***Frequency Deviation (GHz)***	***Deviation (%)***
100	48.0	-20	24.0539691834	0.0000428	0.0002
100		-10	24.0539817555	0.0000303	0.0001
100		0	24.0539969059	0.0000151	0.0001
100		+10	24.0540046165	0.0000074	0.0000
100		+20	24.0540120065	Reference	0
100		+30	24.0540128702	-0.0000009	0.0000
100		+40	24.0540049452	0.0000071	0.0000
100		+50	24.0540037898	0.0000082	0.0000
115	55.2	+20	24.0539891467	0.0000229	0.0001
85	40.8	+20	24.0540092413	0.0000028	0.0000
Max frequency deviation was 0.0002%, limit is 0.001%, therefore EUT complies.					

2.5.9 Test Plots



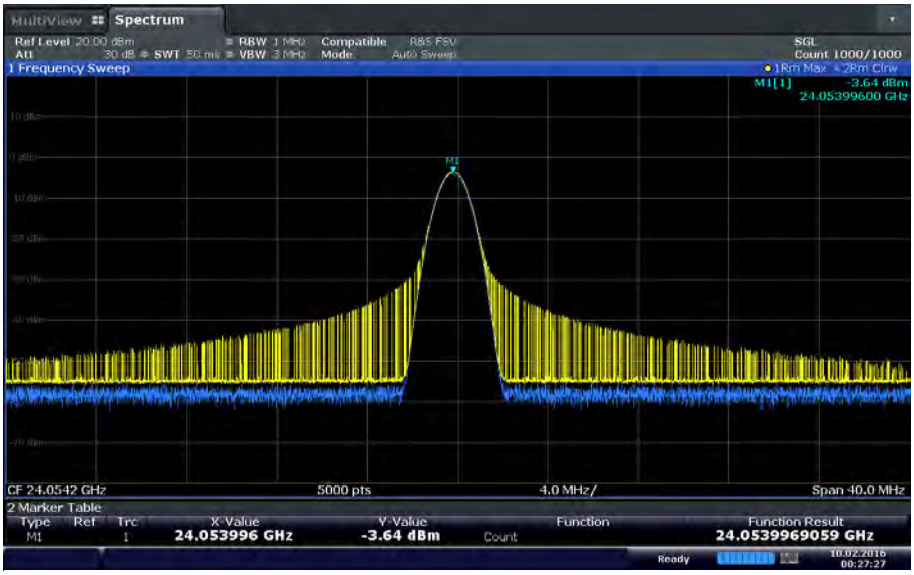
Date: 10.FEB.2016 10:20:39

-20°C @ 48VDC



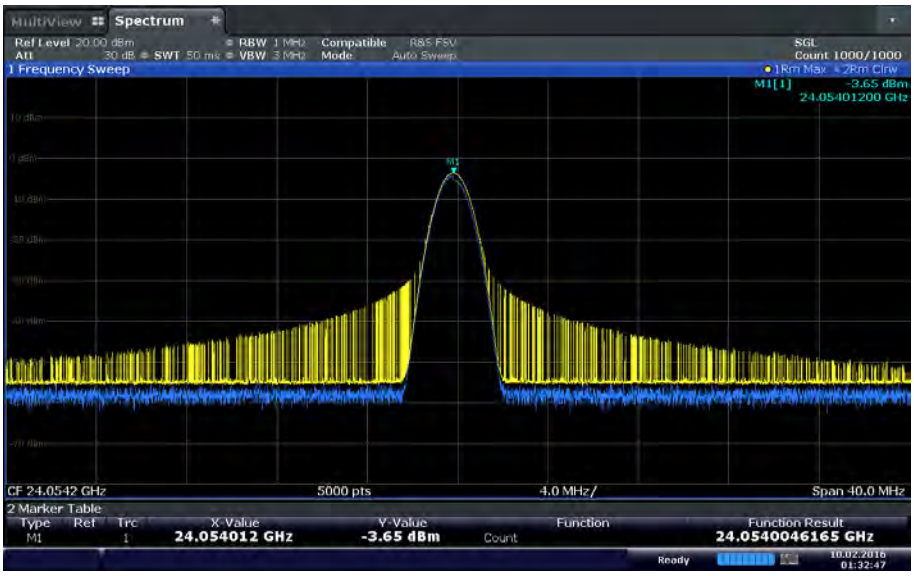
Date: 10.FEB.2016 11:22:58

-10°C @ 48VDC



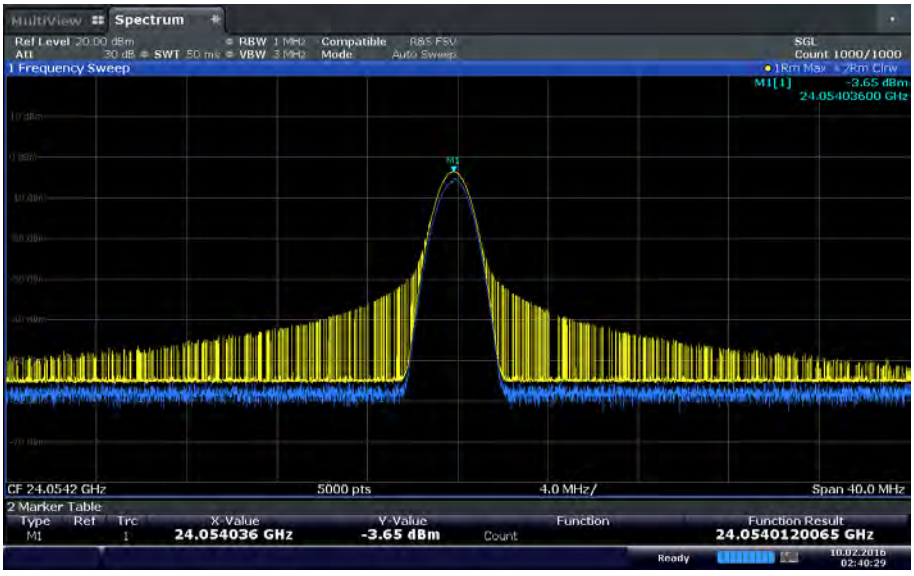
Date: 10.FEB.2016 00:27:27

0°C @ 48VDC



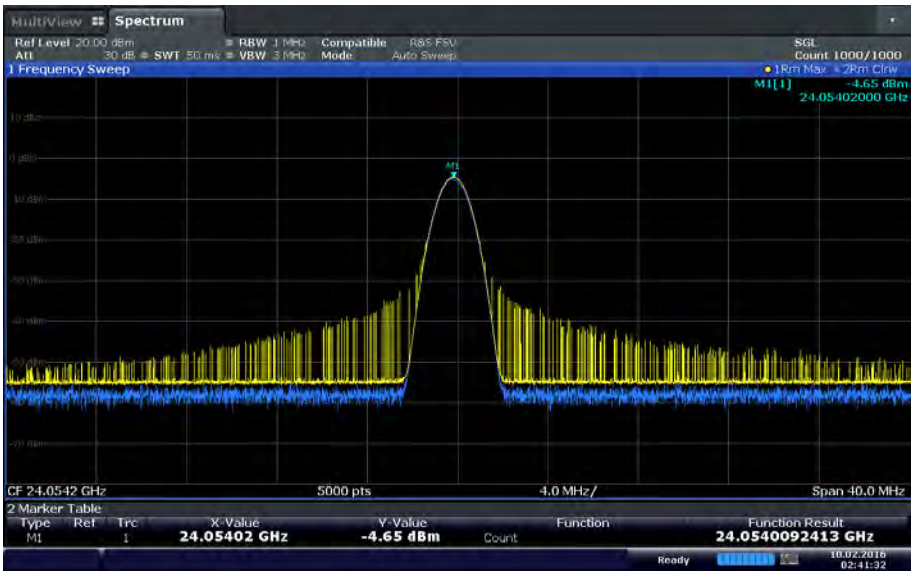
Date: 10.FEB.2016 01:32:47

10°C @ 48VDC



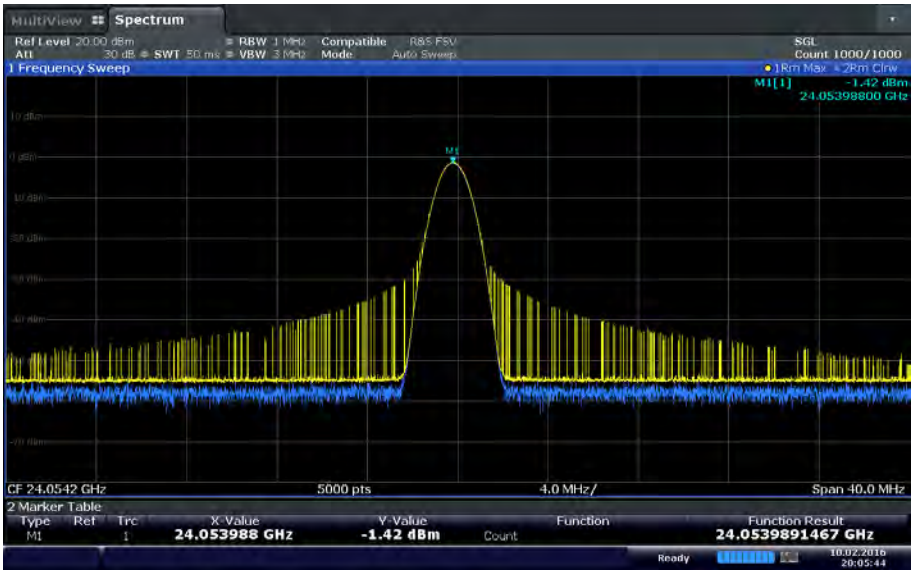
Date: 10.FEB.2016 02:40:29

20°C @ 48VDC



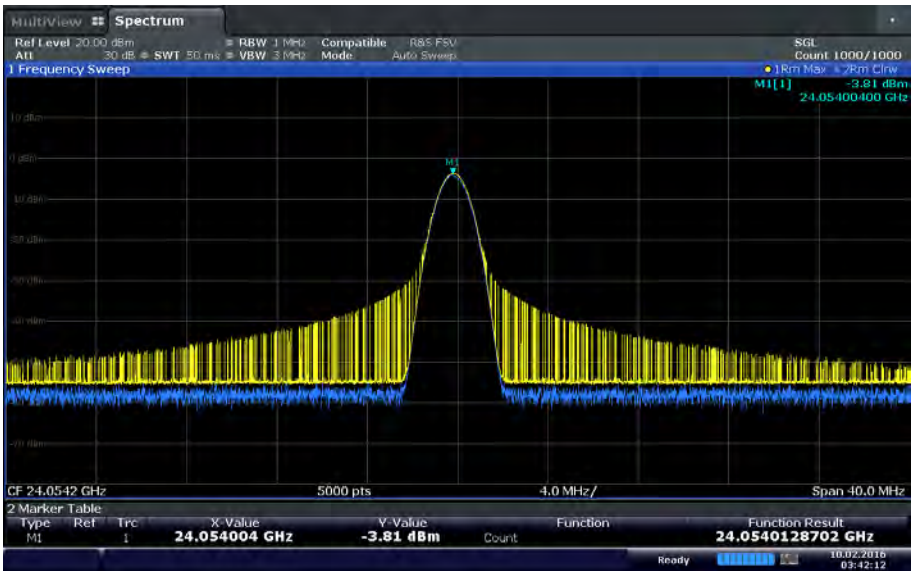
Date: 10.FEB.2016 02:41:33

20°C @ 40VDC



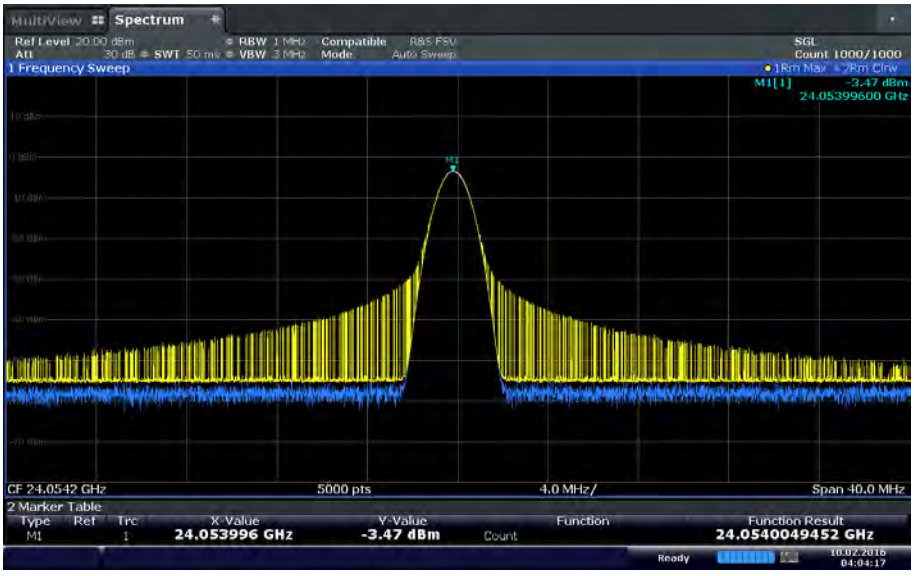
Date: 10.FEB.2016 20:05:45

20°C @ 55VDC



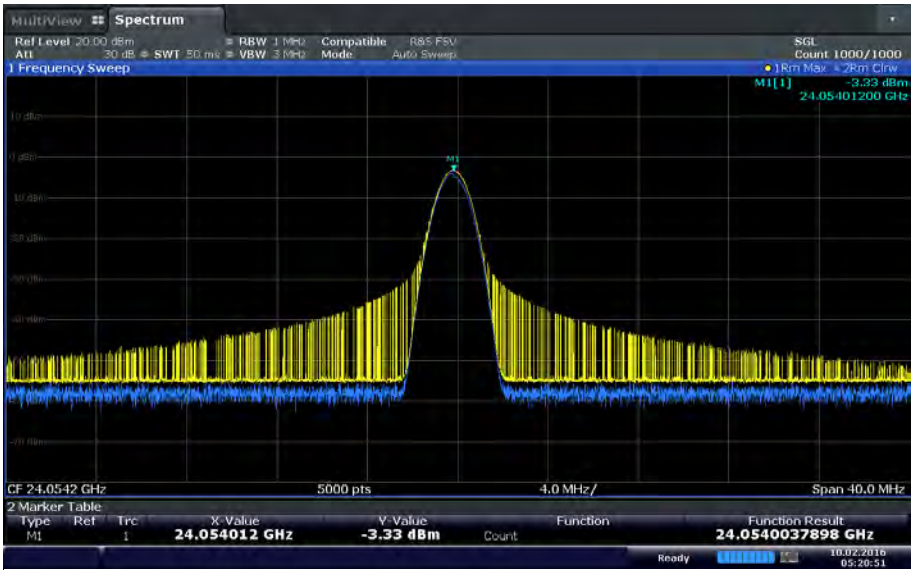
Date: 10.FEB.2016 03:42:12

30°C @ 48VDC



Date: 10.FEB.2016 04:04:17

40°C @ 48VDC



Date: 10.FEB.2016 05:20:51

50°C @ 48VDC

2.6 SPURIOUS RADIATED EMISSIONS

2.6.1 Specification Reference

47 CFR §15.249(d) and RSS-210 A12(d)

2.6.2 Standard Applicable

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation

2.6.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

February 15, 2016/FSC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.8 °C
Relative Humidity	39.3 %
ATM Pressure	99.4 kPa

2.6.7 Additional Observations

- The spectrum was searched from 30 MHz up to 100GHz. Scans from 90GHz up to 100GHz were done manually. No spurious emissions observed on this range.
- Only worst case channel, bandwidth and modulation presented below 18GHz. There were no significant differences between Low, Mid and High channels below 18GHz.
- Results from 18GHz to 40GHz are identical to Section 2.4 of this test report.
- The spurious emissions were assessed to the general radiated emission limits in §15.209 (worst case) or 50 dB below the level of the fundamental (lesser attenuation).
- If using 50 dB below the level of the fundamental, the limits was based from the minimum fundamental measurement (116.9dBµV/m @ 3 meters). This will result with worst case 50dBc limit.
- For measurements performed @ 1 meter, the limits were further adjusted by 9.54dB distance correction factor.

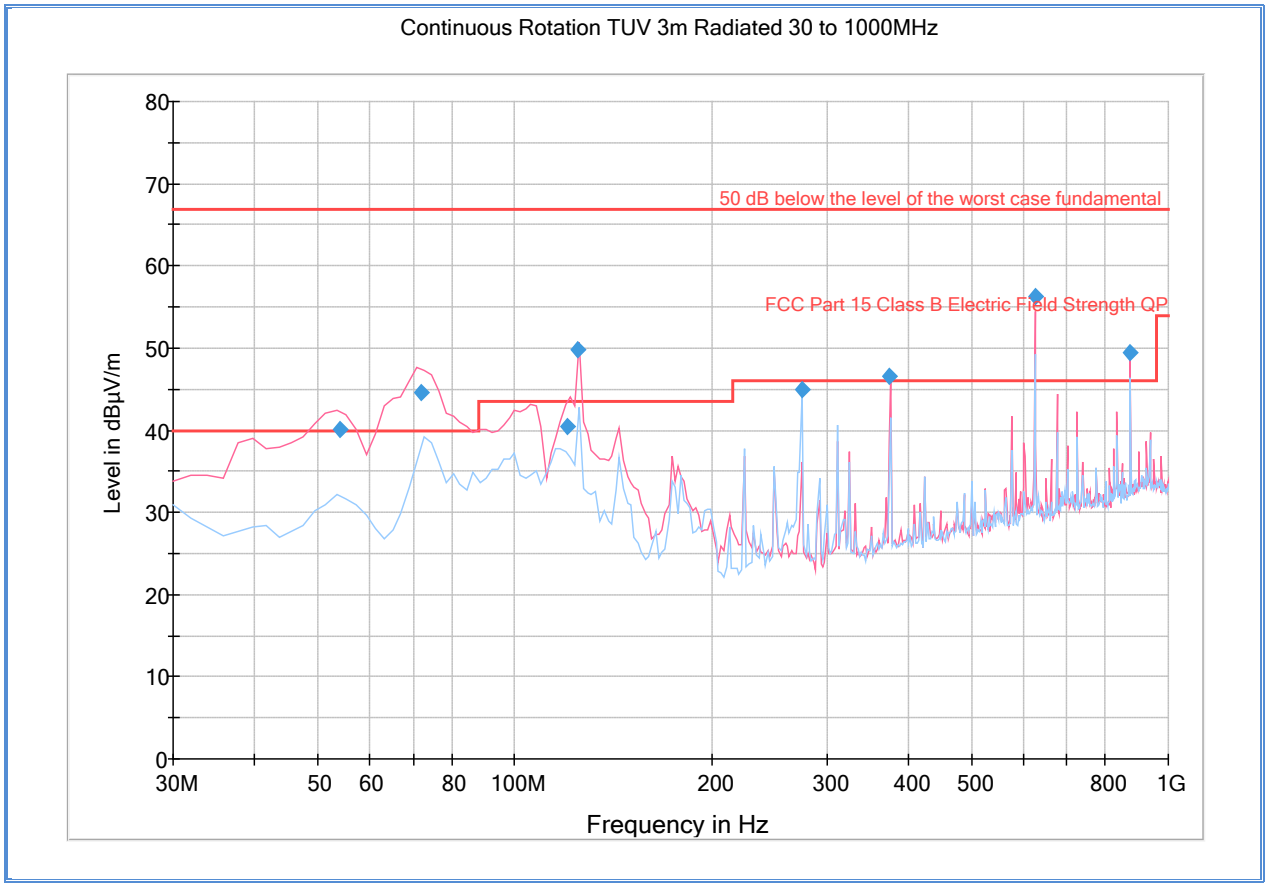
2.6.1 Sample Computation (Radiated Emission)

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# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.6.2 Test Results

See attached plots.

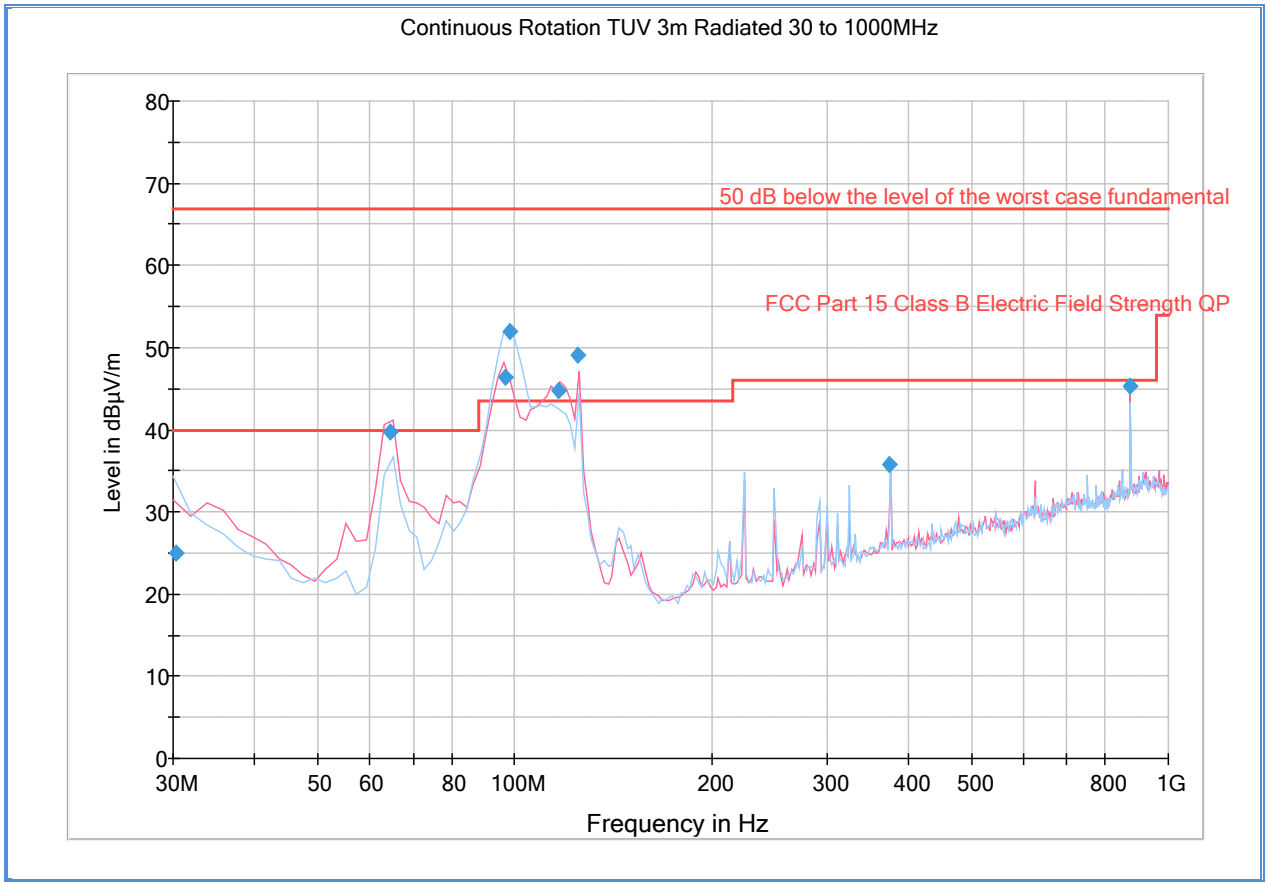
2.6.3 Test Results Below 1GHz (Worst Case RF Configuration using direct DC Power)



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
53.926653	40.1	1000.0	120.000	100.0	V	49.0	-15.0	-0.1	40.0
71.781643	44.6	1000.0	120.000	127.0	V	101.0	-16.7	-4.6	40.0
120.402725	40.4	1000.0	120.000	100.0	V	118.0	-15.1	3.1	43.5
125.010501	49.8	1000.0	120.000	100.0	V	102.0	-15.3	-6.3	43.5
275.009860	45.0	1000.0	120.000	100.0	H	86.0	-7.7	1.0	46.0
375.012024	46.6	1000.0	120.000	100.0	V	127.0	-4.5	-0.6	46.0
624.989659	56.3	1000.0	120.000	100.0	V	257.0	1.7	-10.3	46.0
874.991182	49.4	1000.0	120.000	100.0	V	10.0	5.3	-3.4	46.0

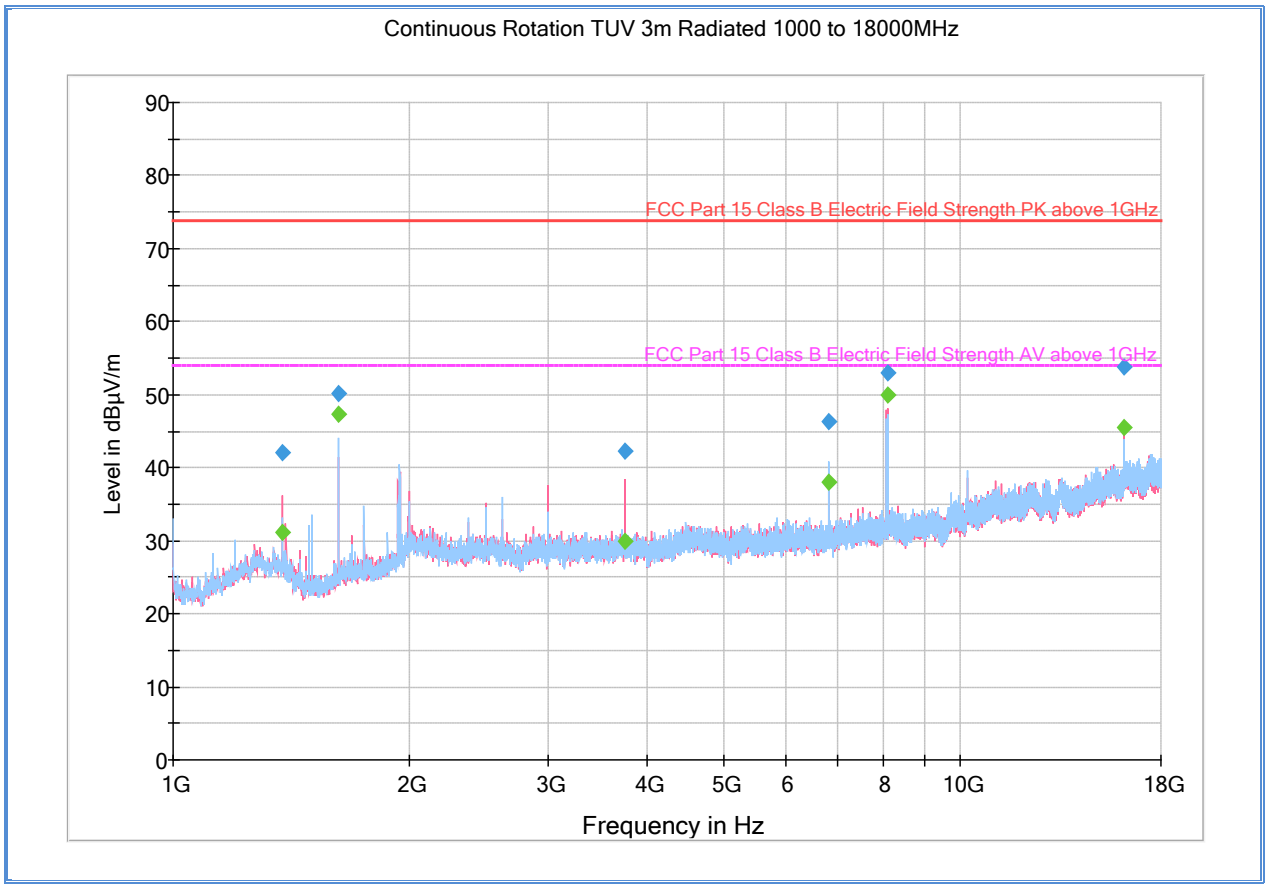
2.6.4 Test Results Below 1GHz (Worst Case RF Configuration using PoE)



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.320000	25.0	1000.0	120.000	208.0	H	15.0	-5.7	15.0	40.0
64.589980	39.7	1000.0	120.000	100.0	V	242.0	-16.4	0.3	40.0
96.532184	46.4	1000.0	120.000	100.0	V	51.0	-14.2	-2.9	43.5
98.476072	51.9	1000.0	120.000	182.0	H	323.0	-14.1	-8.4	43.5
116.627174	44.8	1000.0	120.000	105.0	V	285.0	-14.9	-1.3	43.5
125.010501	49.0	1000.0	120.000	100.0	V	122.0	-15.3	-5.5	43.5
375.012024	35.8	1000.0	120.000	100.0	H	117.0	-4.5	10.2	46.0
874.991182	45.3	1000.0	120.000	100.0	V	-8.0	5.3	0.7	46.0

2.6.5 Test Results Below from 1GHz to 18GHz (Worst Case RF Configuration)



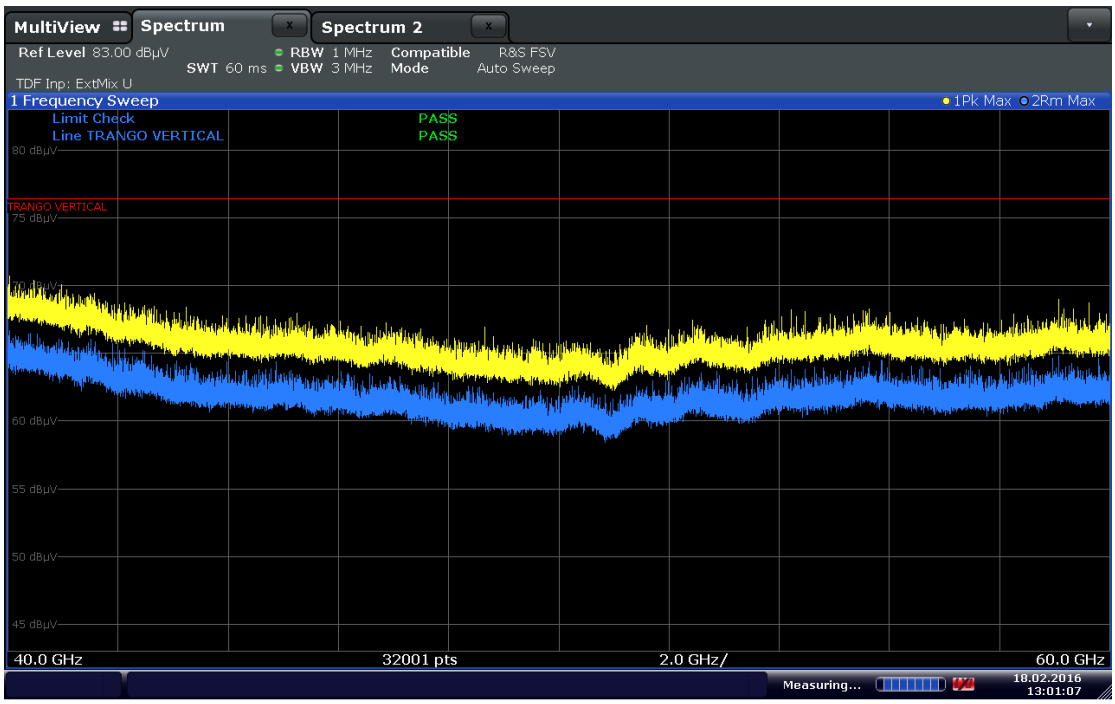
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1374.96666	42.0	1000.0	1000.000	148.7	V	20.0	-5.6	31.9	73.9
1624.86666	50.2	1000.0	1000.000	131.7	H	311.0	-5.8	23.7	73.9
3750.03333	42.2	1000.0	1000.000	158.6	V	312.0	1.3	31.7	73.9
6800.03333	46.3	1000.0	1000.000	116.7	H	346.0	5.8	27.6	73.9
8082.00000	53.1	1000.0	1000.000	116.7	V	30.0	7.0	20.8	73.9
16164.2000	53.7	1000.0	1000.000	102.7	V	16.0	16.9	20.2	73.9

Average Data

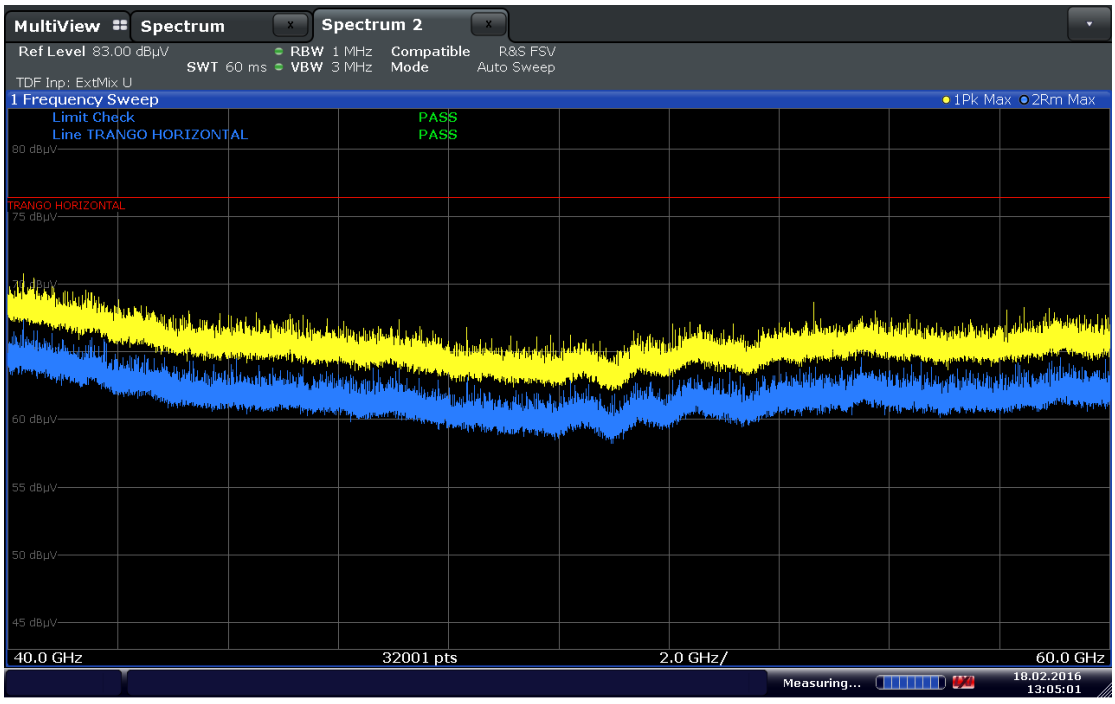
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1374.96666	31.1	1000.0	1000.000	148.7	V	20.0	-5.6	22.8	53.9
1624.86666	47.3	1000.0	1000.000	131.7	H	311.0	-5.8	6.6	53.9
3750.03333	30.0	1000.0	1000.000	158.6	V	312.0	1.3	23.9	53.9
6800.03333	38.1	1000.0	1000.000	116.7	H	346.0	5.8	15.8	53.9
8082.00000	49.9	1000.0	1000.000	116.7	V	30.0	7.0	4.0	53.9
16164.2000	45.6	1000.0	1000.000	102.7	V	16.0	16.9	8.3	53.9

2.6.6 Test Plots above 40GHz (1 meter measurement distance)



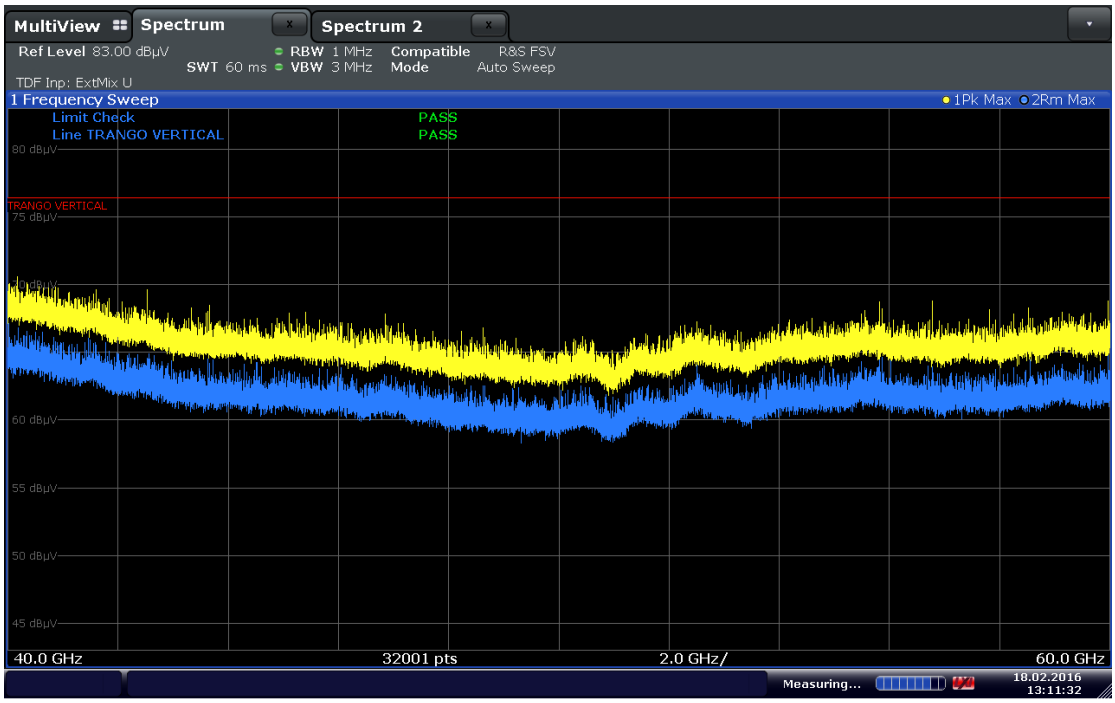
Date: 18.FEB.2016 13:01:08

Low Channel Vertical (40GHz to 60GHz)



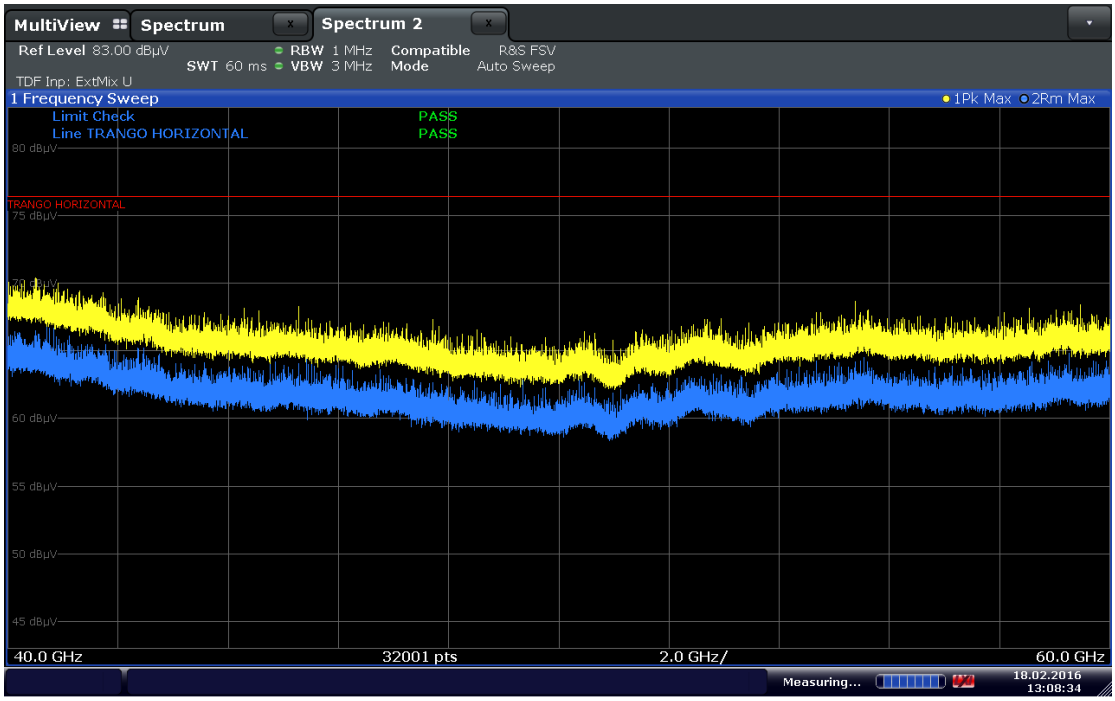
Date: 18.FEB.2016 13:05:01

Low Channel Horizontal (40GHz to 60GHz)



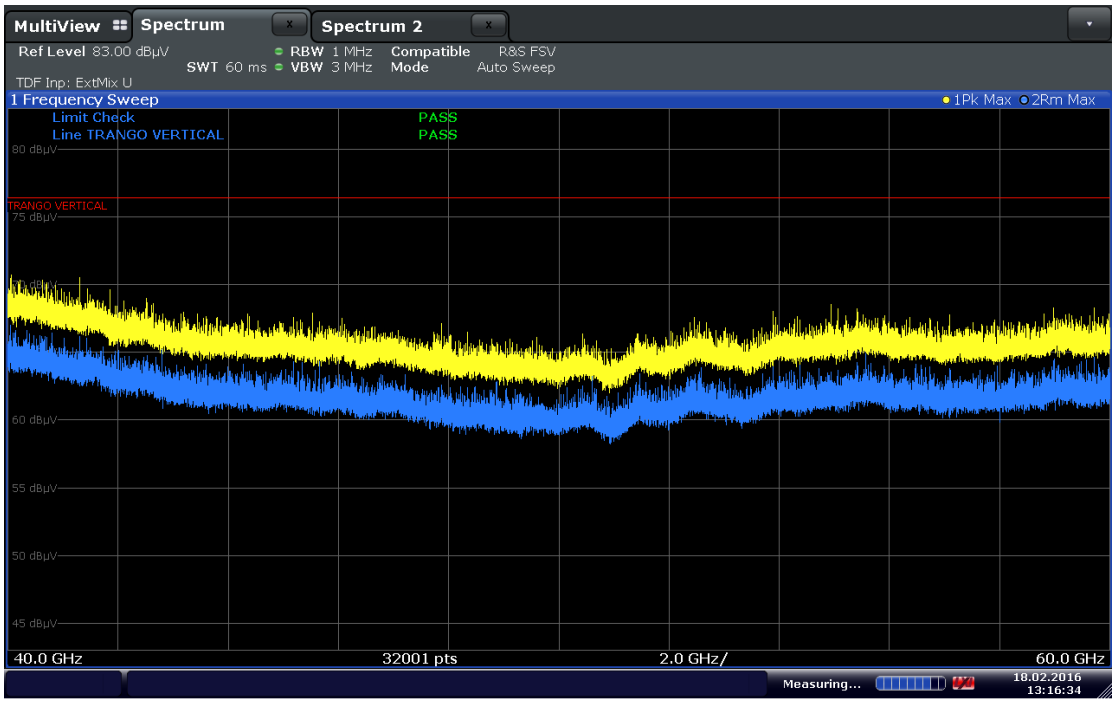
Date: 18.FEB.2016 13:11:32

Mid Channel Vertical (40GHz to 60GHz)



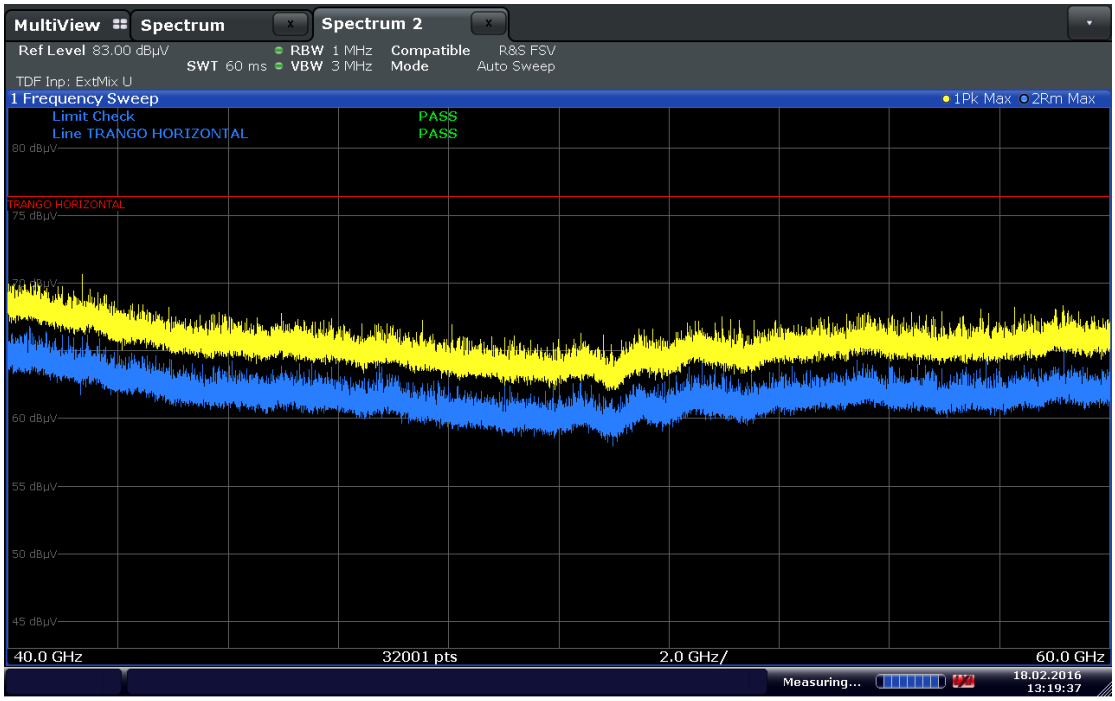
Date: 18.FEB.2016 13:08:34

Mid Channel Horizontal (40GHz to 60GHz)



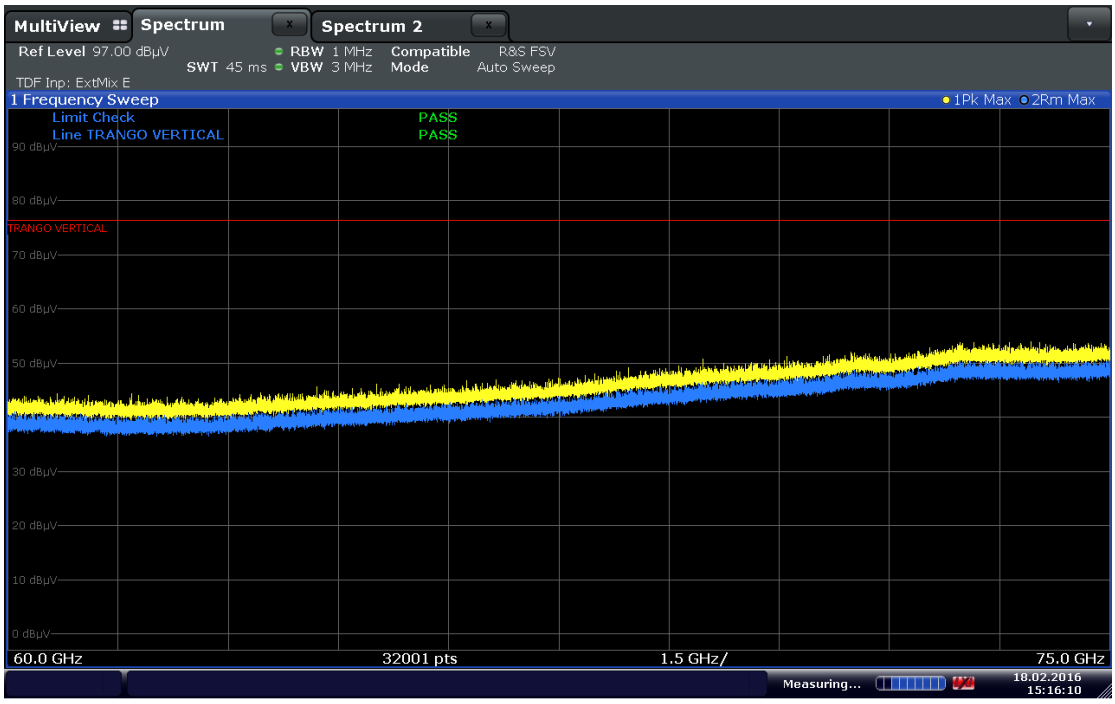
Date: 18.FEB.2016 13:16:35

High Channel Vertical (40GHz to 60GHz)



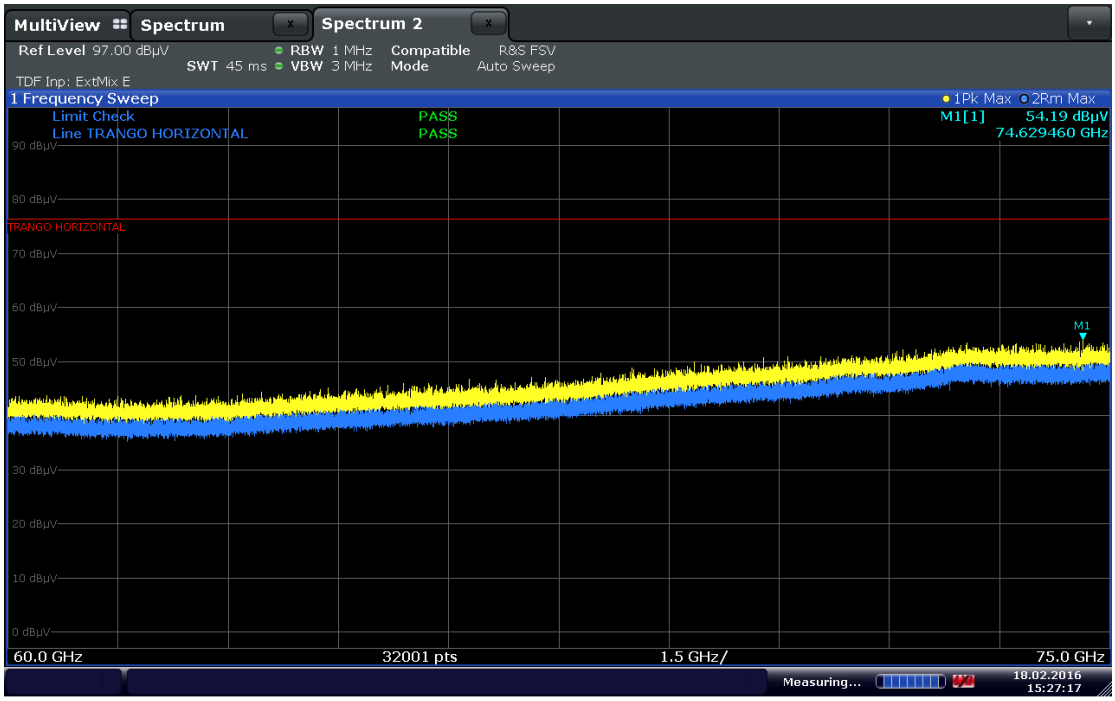
Date: 18.FEB.2016 13:19:37

High Channel Horizontal (40GHz to 60GHz)



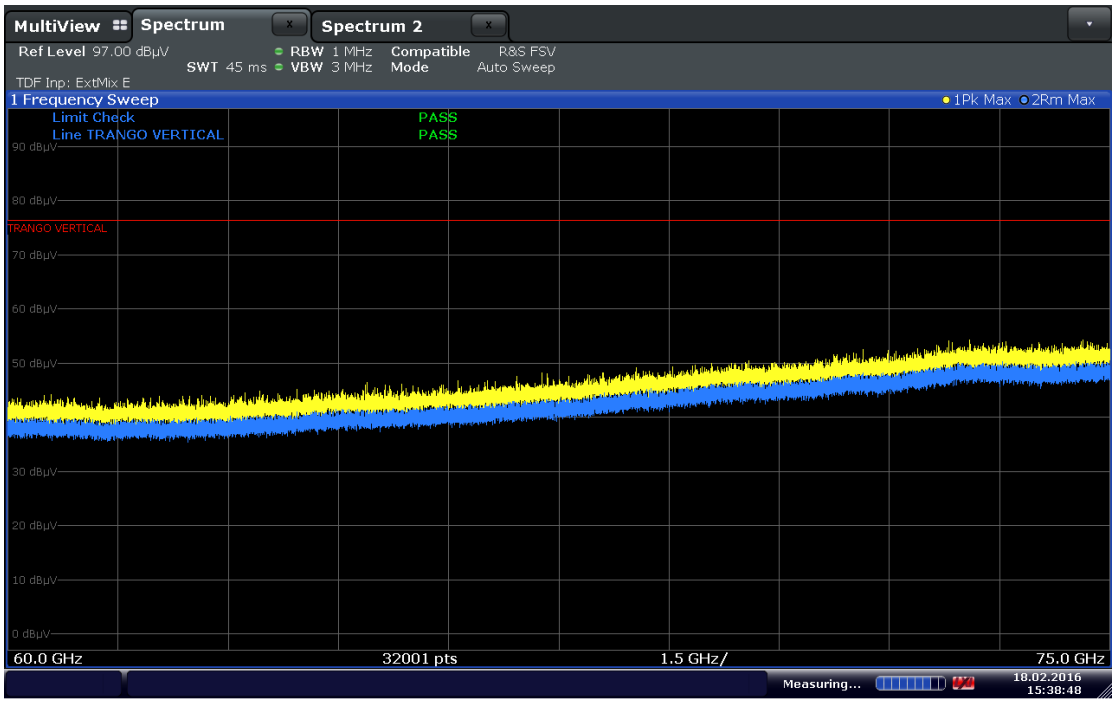
Date: 18.FEB.2016 15:16:10

Low Channel Vertical (60GHz to 75GHz)



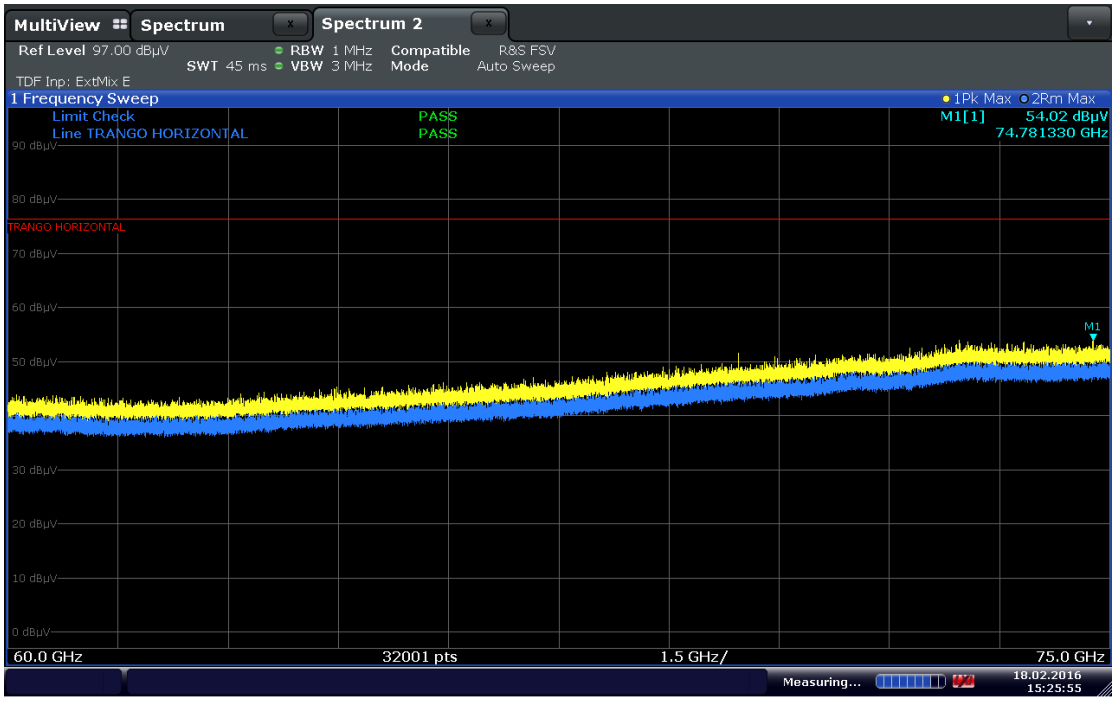
Date: 18.FEB.2016 15:27:17

Low Channel Horizontal (60GHz to 75GHz)



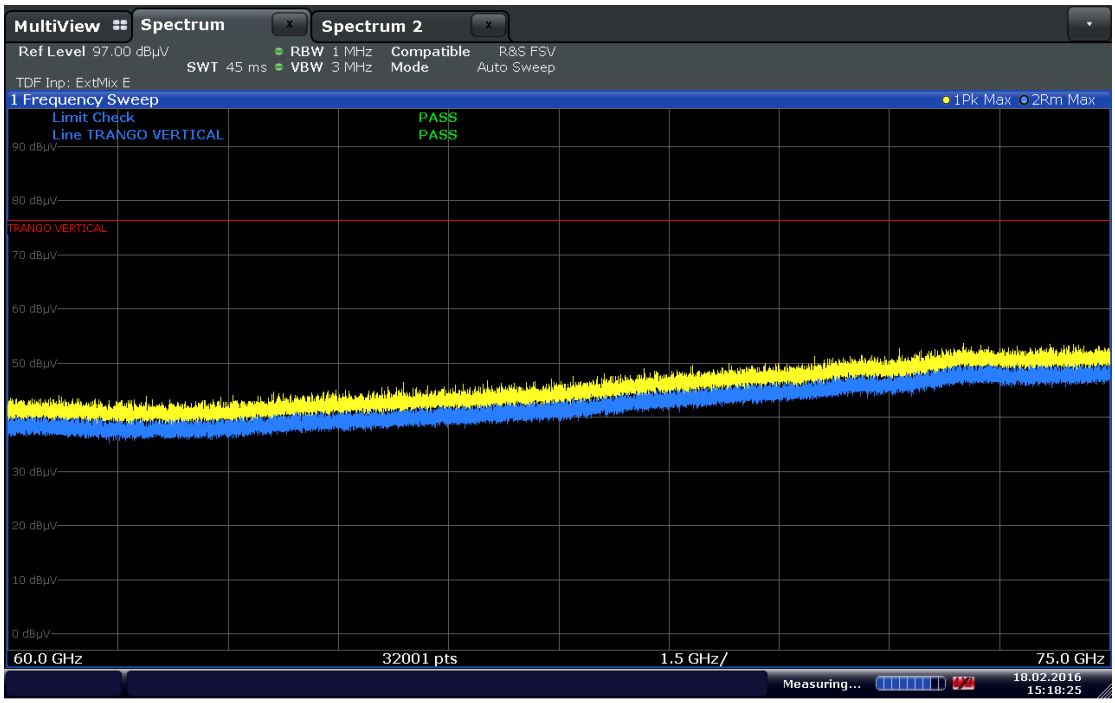
Date: 18.FEB.2016 15:38:48

Mid Channel Vertical (60GHz to 75GHz)



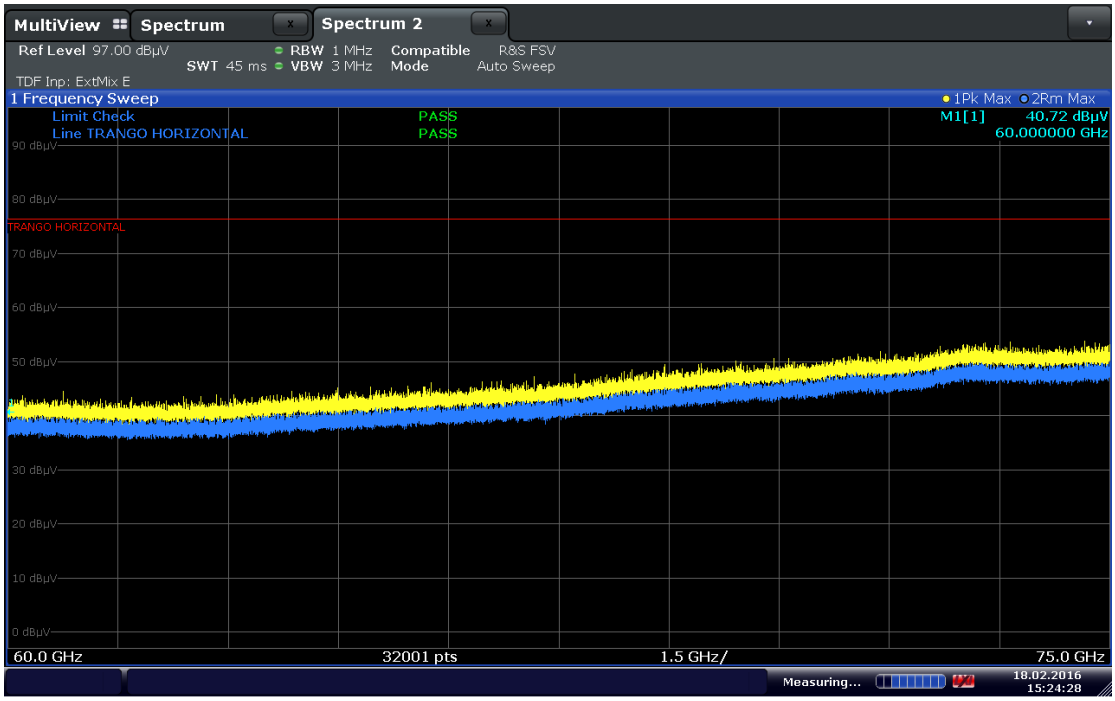
Date: 18.FEB.2016 15:25:55

Mid Channel Horizontal (60GHz to 75GHz)



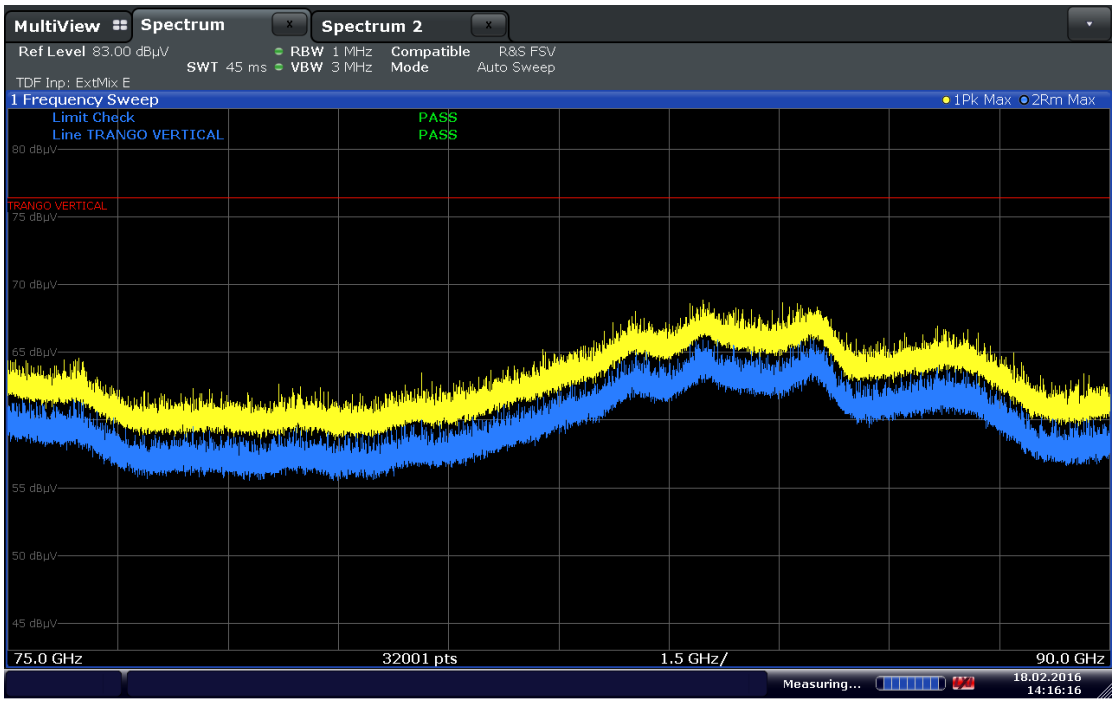
Date: 18.FEB.2016 15:18:26

High Channel Vertical (60GHz to 75GHz)



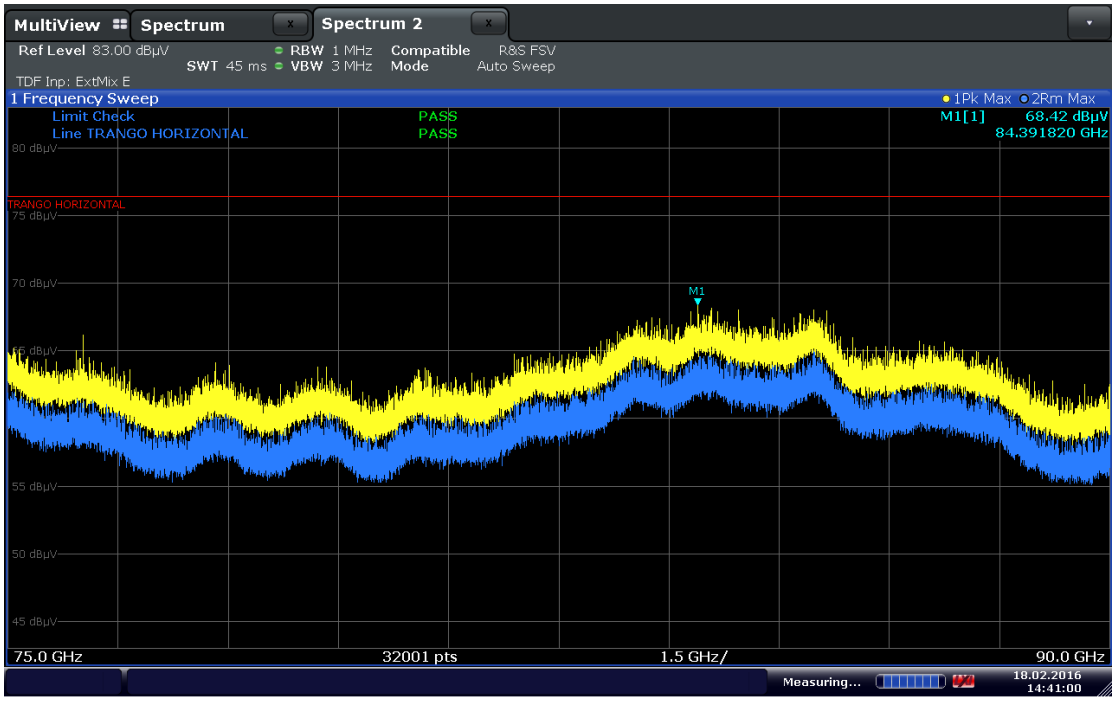
Date: 18.FEB.2016 15:24:28

High Channel Horizontal (60GHz to 75GHz)



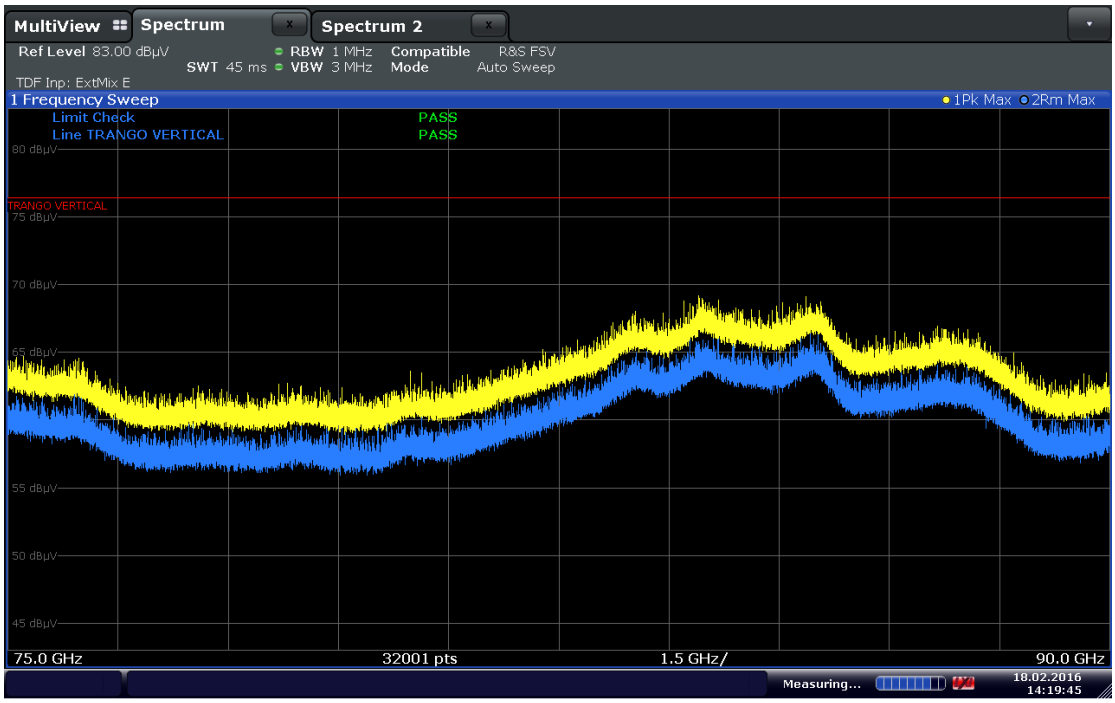
Date: 18.FEB.2016 14:16:16

Low Channel Vertical (75GHz to 90GHz)



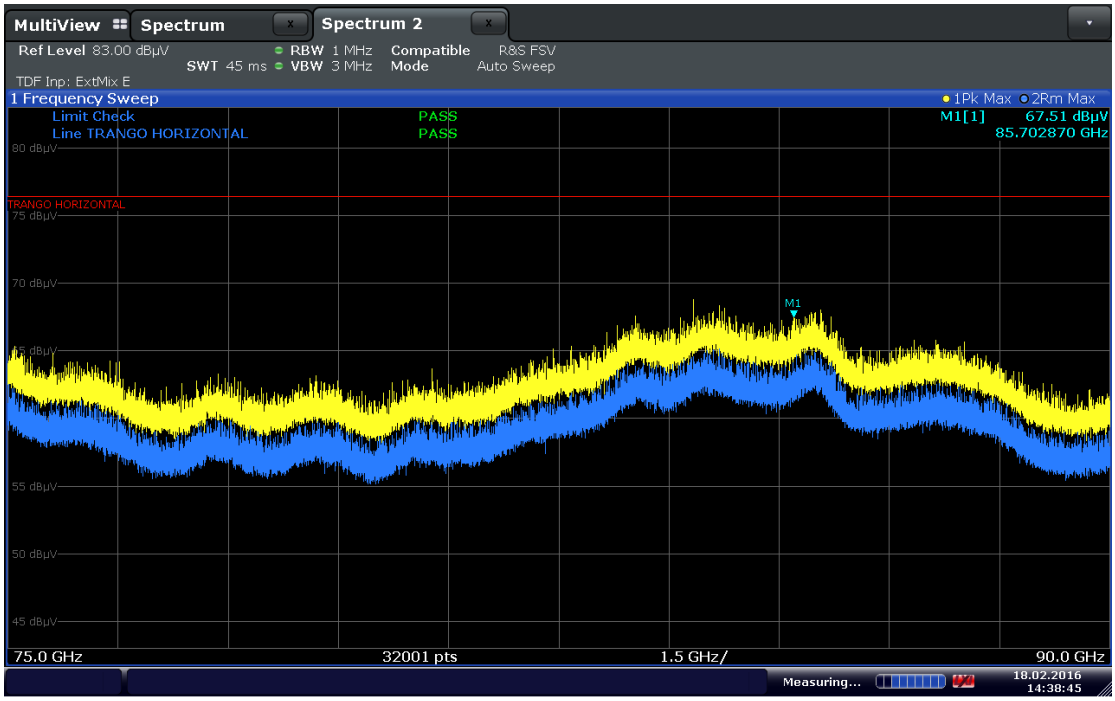
Date: 18.FEB.2016 14:41:00

Low Channel Horizontal (75GHz to 90GHz)



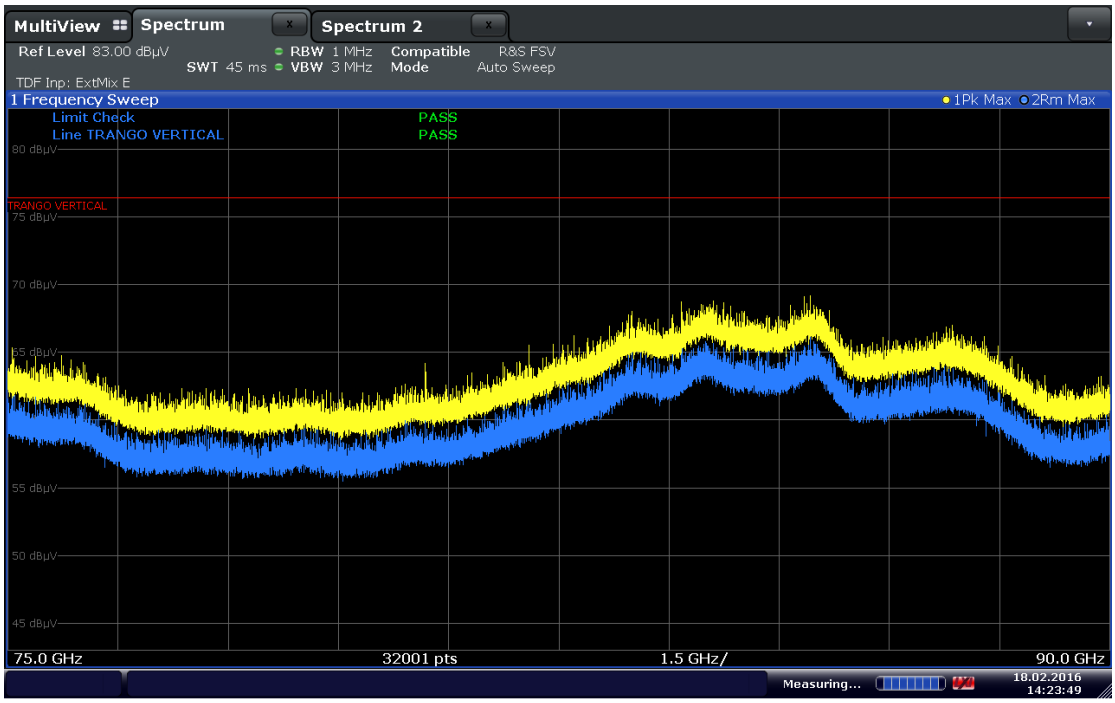
Date: 18.FEB.2016 14:19:45

Mid Channel Vertical (75GHz to 90GHz)



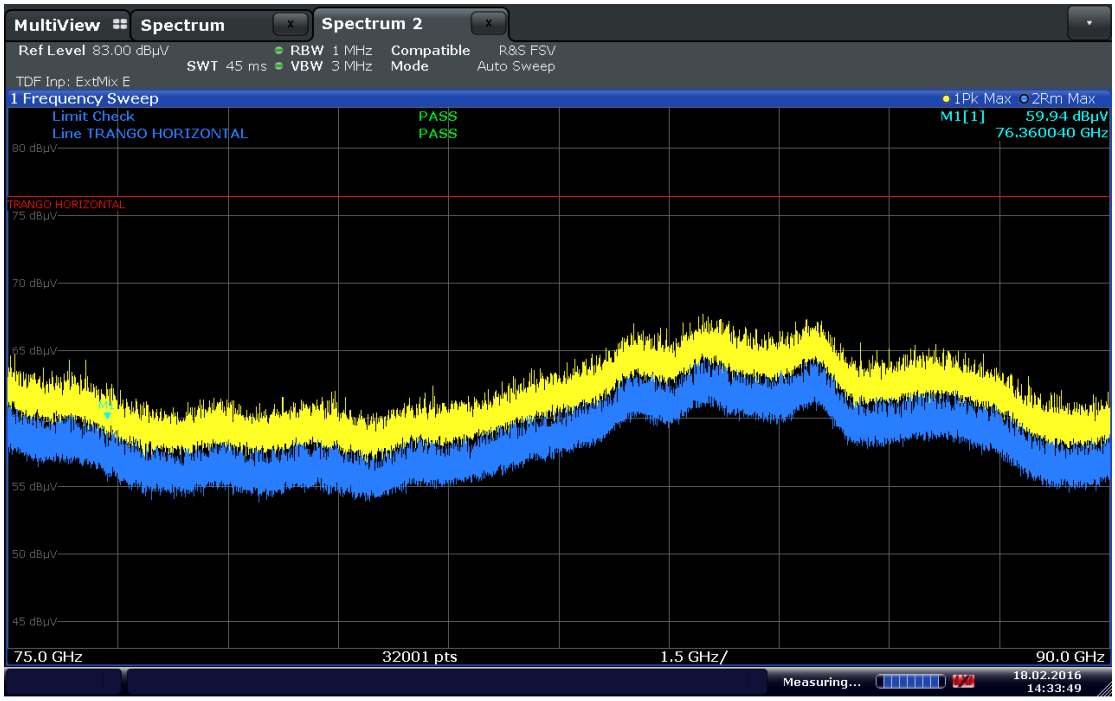
Date: 18.FEB.2016 14:38:45

Mid Channel Horizontal (75GHz to 90GHz)



Date: 18.FEB.2016 14:23:49

High Channel Vertical (75GHz to 90GHz)



Date: 18.FEB.2016 14:33:49

High Channel Horizontal (75GHz to 90GHz)

2.7 FIELD STRENGTH OF HARMONICS FOR FIXED, POINT TO POINT OPERATION

2.7.1 Specification Reference

47 CFR §15.249(e) and RSS-210 A12(d)

2.7.2 Standard Applicable

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

2.7.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

February 15, 2016/FSC

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.8 °C
Relative Humidity	39.3 %
ATM Pressure	99.4 kPa

2.7.7 Test Results

Test results identical to Section 2.4 and section 2.6 of this test report. No Harmonics observed from the scans performed between 40GHz up to 100GHz.

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						
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/08/15	05/08/16
7618	Horn antenna	3160-09	012054-004	ETS	07/16/15	07/16/17
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	02/01/16	02/01/17
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/08/15	05/08/16
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	09/29/15	09/29/16
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
1054	Horn antenna (18-40 GHz)	3116	9407-2233	EMCO	12/22/2015	12/22/2017
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
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/11/15	03/11/16
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	03/20/15	03/20/16
n/a	Pre-amplifier (18-40 GHz)	SLKKa-30-6	15G27	Spacek Labs	Verified by 1003 and 7611	
n/a	Pre-amplifier (40-60 GHz)	SBL-4036033080-1919-E1		Sage Millimeter, Inc.	Verified	
n/a	Pre-amplifier (50-75 GHz)	SBL-5037533050-1515-E1		Sage Millimeter, Inc.	Verified	
n/a	Pre-amplifier (75-110 GHz)	FLNA-10-0005	FTL10839	Farran Technology Ltd.	Verified	
n/a	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	01/26/16	01/26/18
n/a	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	10/26/15	10/26/17
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	
n/a	Active Multiplier (50-75 GHz)	AMC-15-RFH00	283	Millitech, Inc.	Verified	
n/a	Active Multiplier (75-110 GHz)	AMC-10-RFH00	606	Millitech, Inc.	Verified	
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7611	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7611	
8849	High-frequency cable	SAC-26G-6.1	363	A.H.Systems	01/14/15	01/14/16

Power Line Conducted Emissions						
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	09/03/15	09/03/16
7568	LISN	FCC-LISN-50-25-2-10	120305	Fischer Custom Comm.	10/28/15	10/28/16
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	02/20/15	02/20/16
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	02/20/15	02/20/16
Miscellaneous						
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	04/29/15	04/29/16
7579	Temperature Chamber	115	151617	TestQuity	08/14/15	08/14/16
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/14/15	08/14/16
	DC Power Supply	6015A	3044A-00106	Hewlett Packard	Verified by 6792	
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	10/19/15	10/19/16
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 AC Conducted Emissions

	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 Measurements (Below 1GHz)

	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	2.70	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 Measurements (Above 1GHz up to 18GHz)

	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	2.70	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

3.2.1 Radiated Measurements (Above 18GHz up to 100GHz)

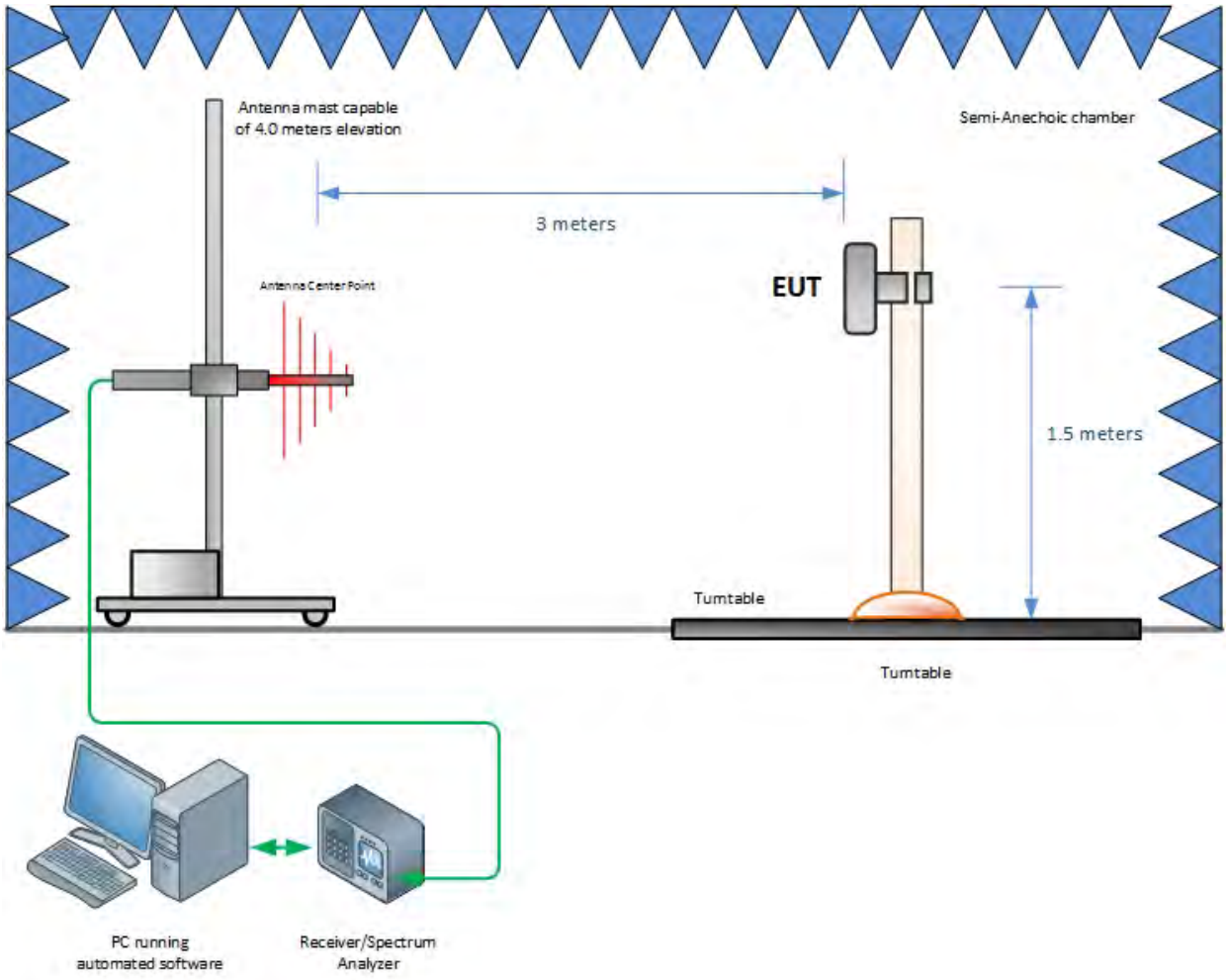
	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Cables	Rectangular	0.70	0.40	0.16
2	Preamp	Rectangular	0.50	0.29	0.08
3	Spectrum Analyzer/Mixers	Rectangular	3.34	1.93	3.72
4	Antenna	Rectangular	2.70	1.56	2.43
5	EUT Setup	Rectangular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

For radiated emissions above 18 GHz alternative interpretation procedure was employed. The measurement uncertainty calculated by the test engineer may be a maximum value for a range of values of measurement, or may be the measurement uncertainty for the specific measurement untaken.

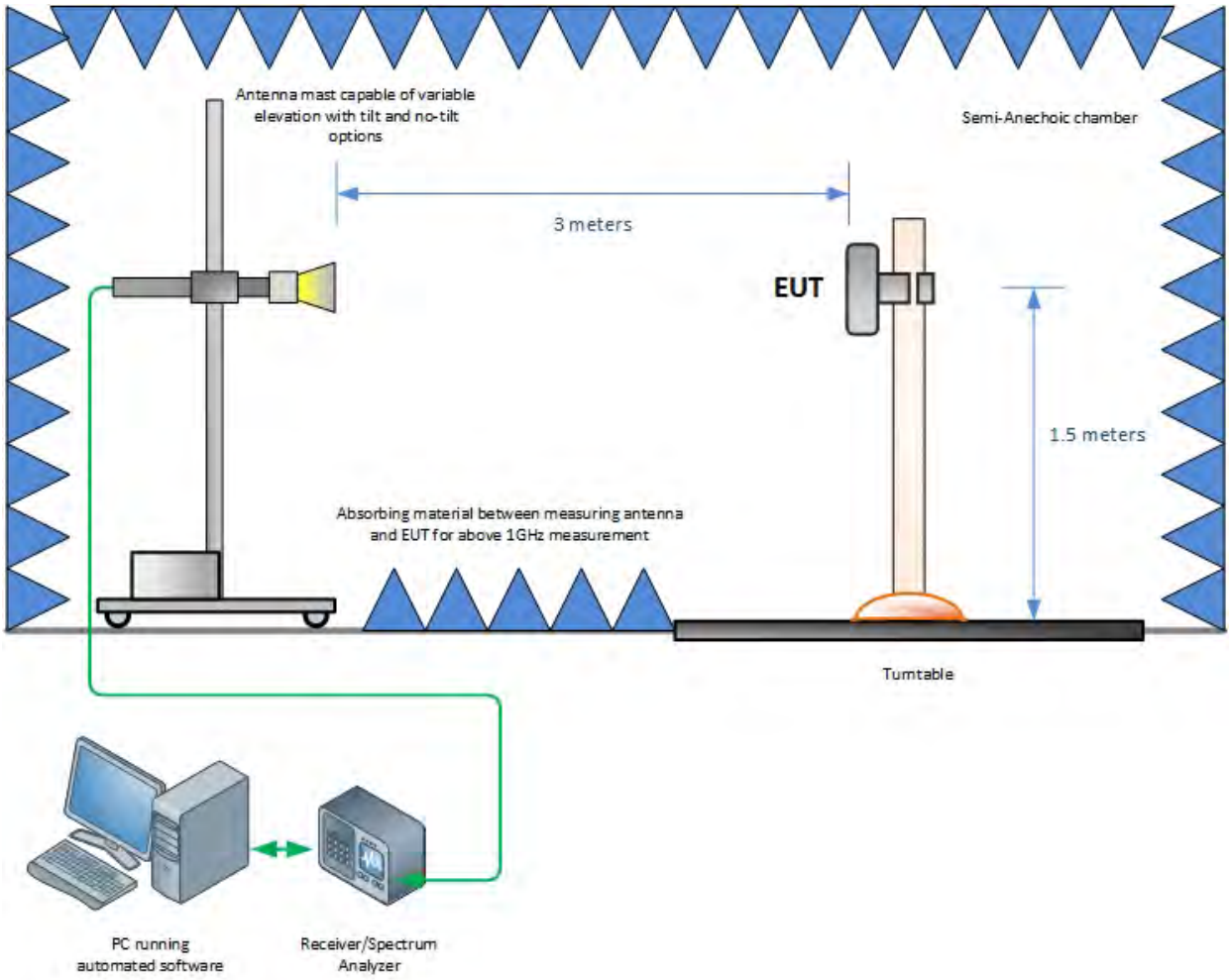
SECTION 4

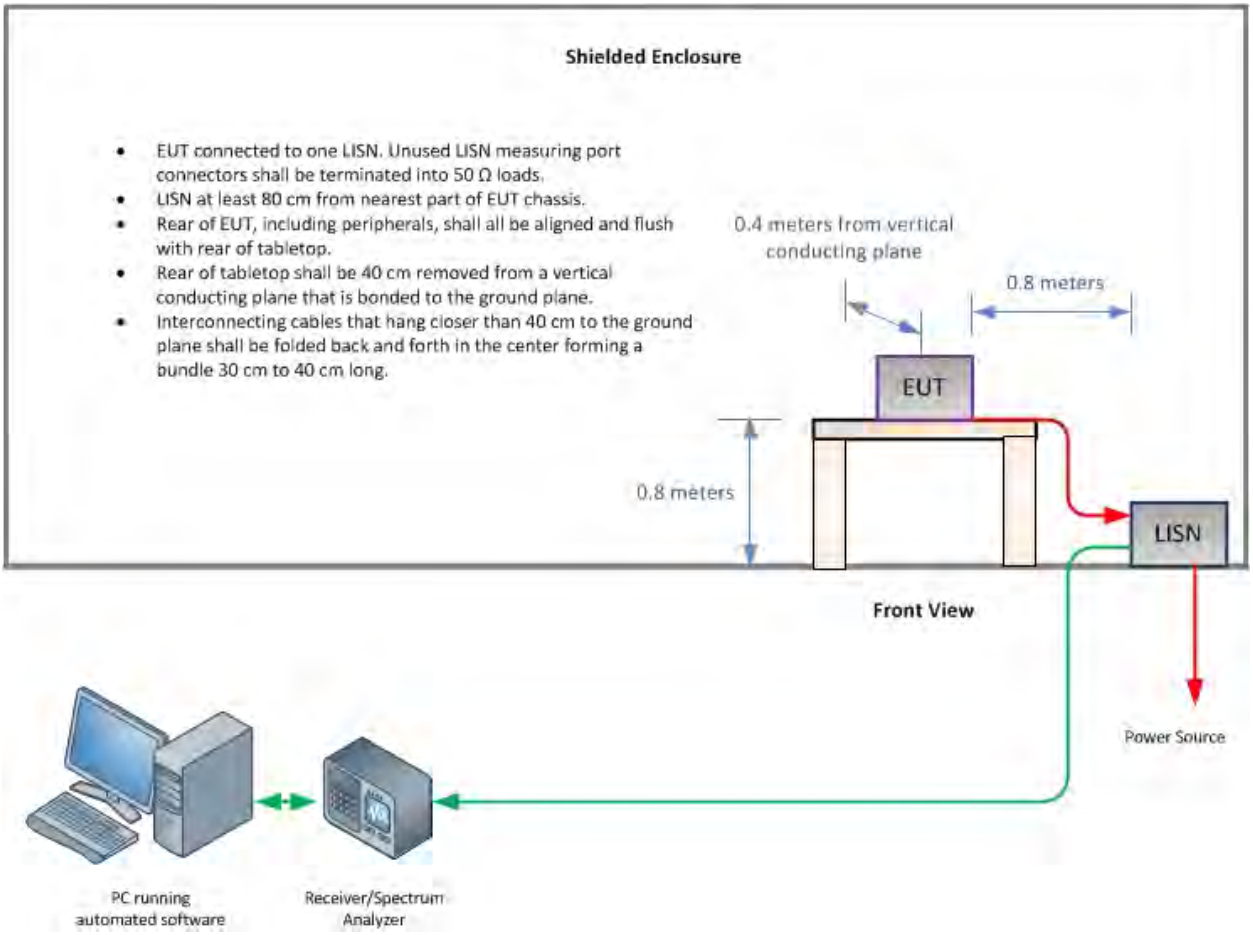
DIAGRAM OF TEST SETUP

4.1 RADIATED EMISSION TEST SETUP (BELOW 1GHZ)



4.2 RADIATED EMISSION TEST SETUP (ABOVE 1GHZ)





Conducted Emission Test Setup

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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