

Radio Testing of the

Fortem Technologies, Inc.
Radar Model: R30i and R30s

In accordance with FCC Title 47 Chapter I
Subchapter D Part 90

Fortem Technologies, Inc.
1064 S N County Blvd 6th Floor
Pleasant Grove, UT 84062
USA



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Date: March 2020

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Authorized Signatory	Alex Chang	March 18, 2020	<i>Alex Chang</i>

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be in compliance with FCC Title 47 Chapter I Subchapter D Part 90



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TÜV SÜD America, Inc.
10040 Mesa Rim Road
San Diego, CA 92121-2912

TÜV SÜD America, Inc.
Rancho Bernardo Facility
16936 Via Del Campo
San Diego, CA 92127

Phone: 858 678 1400
www.tuv-sud-america.com




REPORT ON Radio Testing of the
Fortem Technologies, Inc.
Model R30i and R30s Radar

TEST REPORT NUMBER 72153658B

TEST REPORT DATE March 2020

PREPARED FOR Fortem Technologies, Inc.
1064 S N County Blvd 6th Floor
Pleasant Grove, UT 84062
USA

CONTACT PERSON Jeffery Davis
Electrical Engineer and Regulatory & Compliance Officer
jeffery.davis@fortemtech.com
(801) 822-8043

PREPARED BY 
Ferdinand S. Custodio
Name
Authorized Signatory
Title: Senior EMC Test Engineer / Wireless Team Lead

APPROVED BY 
Alex Chang
Name
Authorized Signatory
Title: Senior EMC/RF Wireless Test Engineer

DATED March 18, 2020



Revision History

72153658B Fortem Technologies, Inc. Model R30i and R30s Radar					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
03/18/2020	—	Initial Release			Alex Chang
04/06/2020	Initial Release	Issue 2	Update Mode verified/Capability (16.5GHz to 16.7GHz) and Emission Designator from 152MQXN to 170MQXN	Section 1.3.2	Ferdinand Custodio



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SECTION 1

1 REPORT SUMMARY

Radio Testing of the
Fortem Technologies, Inc.
TrueView R30 Radar



1.1 Introduction

The information contained in this report is intended to show verification of the Fortem Technologies, Inc. TrueView R30 Radar to the requirements of FCC Title 47 Chapter I Subchapter D Part 90.

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	Fortem Technologies, Inc.
EUT	Radar
Trade Name	TrueView R30 Radar
Model Name	R30i and R30s
FCC ID	2APIM-FTR30SKYD
IC Number	N/A
Serial Number(s)	R30s-A00010
Number of Samples Tested	1
Test Specification/Issue/Date	FCC Title 47 Chapter I Subchapter D Part 90 Private Land Mobile Radio Services (October 1, 2018).
Start of Test	November 05, 2019
Finish of Test	November 21, 2019
Name of Engineer(s)	Alex Chang Ferdinand Custodio
Related Document(s)	<ul style="list-style-type: none">• ANSI C63.26-2015. American National Standard for Compliance Testing of Transmitters Used in Licensed radio Services.• 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 Title 47 Chapter I Subchapter D Part 90 are shown below:

Part 2	Part 90	Test Description	Result	Comments/ Base Standard
§2.1046	§90.205(r) and (s)	RF Power Output	Compliant	
§2.1051	§90.210(n)	Unwanted Emissions (Emission Mask)	Compliant	
§2.1053	§90.210(n)(3)	Field Strength of Radiated Spurious Emissions	Compliant	
§2.1049		Occupied Bandwidth	Compliant	
§2.1047		Audio Low Pass Filter (Voice Input)	N/A	
§2.10479		Audio Frequency Response	N/A	
§2.1047		Modulation Limiting	N/A	
§2.1055	§90.213	Frequency Stability (Temperature Variation)	Compliant	
§2.1055	§90.213	Frequency Stability (Voltage Variation)	Compliant	

N/A

The EUT does not employ an audio input



1.3 Product Information

1.3.1 Technical Description

The Equipment Under Test (EUT) is a Fortem Technologies, Inc. TrueView R30 Radar. The EUT is a small, compact, powerful radar detection system providing tracking capabilities that monitor a marked or defined airspace and reports all airborne activity within that space.

1.3.2 EUT General Description

EUT Description	Radar
Model Name	TrueView R30 Radar
Model Number	R30i and R30s
Serial Number	R30s-A00010
Software Version	3.0
Input Voltage	24VDC (AC/DC Adapter, Traco Power TIB 480-124)
Operating Voltage Range	18VDC to 36VDC
Output RF Power	55 dBm EIRP (rated)
Mode Verified	16.2GHz to 16.7GHz (radio location)
Capability	15.4GHz to 15.7GHz (radio navigation) and 16.2GHz to 16.7GHz (radio location)
Operating Temperature	-40°C to 60°C
Primary Unit (EUT)	<input checked="" type="checkbox"/> Production <input type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
Emission Designator	170MQXN
Antenna Type	Internal Array
Antenna Model	N/A
Antenna gain	16 dBi
Modulation	FMCW



1.4 EUT Test configuration

1.4.1 Test Configuration Description

Test Configuration	Description
Default	EUT is configured by the support laptop through the ethernet port. The EUT was configured to transmit in either full radar swept mode or in single CW mode, depending on the test. The EUT was also configured to transmit in the frequencies at the extreme low, mid-range, and high ends of the allotted band through Python scripts and with the GUI using a web browser.

1.4.2 EUT Exercise Software

Web browser GUI (integrated with the EUT) and Python 3.7.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Dell	Support Laptop	Model: XPS 15 9570
Traco Power	EUT AC/DC Adapter	Part No. TIB 480-124 24VDC 480W
-	Ethernet Patch Cable	FPN: 220-0057. Shielded, 5m, RJ-45 to 26-pin ODU AMC
-	DC power supply end cable*	FPN: 220-0061. Shielded, 305mm, 5-pin ODU AMC to 3-pin DH-20 Series
-	DC power supply long cable*	FPN: 220-0084. Shielded, 12AWG, 2C, 5m. 3-pin DH-20 Series to 3-wire pigtail

* Note: Above "long" and "end" power cables connect to each other in series.

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: R30s-A00010		
None	—	—

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 C63.26-2015. American National Standard for Compliance Testing of Transmitters Used in Licensed radio Services.

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 C63.26-2015. 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)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678 1400
 Fax: 858 546 0364.

1.9 Test Facility Registration

1.9.1 FCC – Designation No.: US1146

TÜV SÜD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Designation is US1146.



1.9.2 Innovation, Science and Economic Development Canada (IC) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.

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

TÜV 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 NCC (National Communications Commission - US0102)

TÜV SÜD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0280 and A-0281

TÜV SÜD 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.

1.9.6 RRA – Identification No. US0102

TÜV SÜD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

1.9.7 OFCA – U.S. Identification No. US0102

TÜV SÜD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.



SECTION 2

2 TEST DETAILS

Radio Testing of the
Fortem Technologies, Inc.
R30i and R30s Radar



2.1 RF Power Output

2.1.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.205 (r) and (s)

2.1.2 Standard Applicable

(r) All other frequency bands. Requested transmitter power will be considered and authorized on a case by case basis.

(s) The output power shall not exceed by more than 20 percent either the output power shown in the Radio Equipment List [available in accordance with §90.203(a)(1)] for transmitters included in this list or when not so listed, the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

2.1.3 Equipment Under Test and Modification State

Serial No: R30s-A00010 / Default Test Configuration

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

November 07, 2018 / AC

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 performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	25.0 °C
Relative Humidity	49.4 %
ATM Pressure	99.0 kPa

2.1.7 Additional Observations

- This is a radiated test utilizing a spectrum analyzer.
- Test guidance is per Section 5.2.7 of ANSI C63.26-2015. The formula (d) was used to convert the measured field strength level to an equivalent power level for reporting:

$$EIRP (dBm) = E (dB\mu V/m) + 20\log(D) - 104.8$$

where D is the measurement distance (in the far field region) in meter

- The EUT was switched to CW mode for this test.
- The actual limit for this test is not to exceed by more than 20% of the manufacturer's rated output power. The limit used during verifications will be ignored (greyed out on the test plots presented).



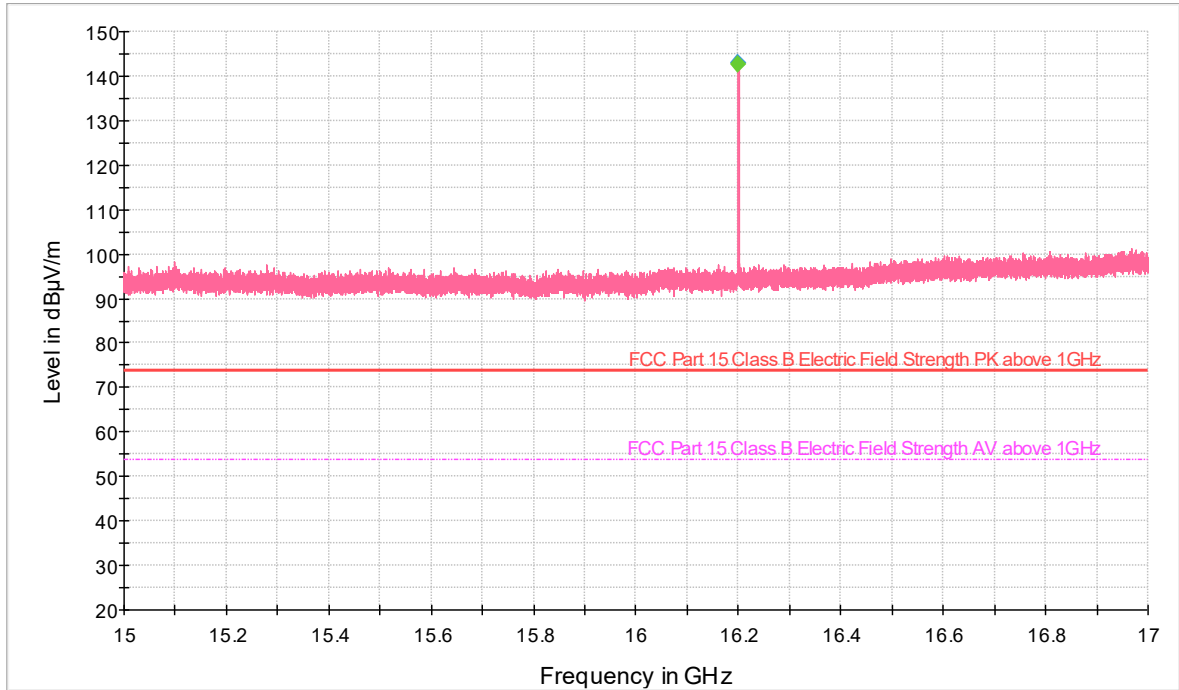
2.1.8 Summary of Test Results

Frequency (MHz)	Peak (dBµV/m @ 3 meters)	Average (dBµV/m @ 3 meters)	Peak EIRP (dBm)	Average EIRP (dBm)
16200.00	142.83	142.75	47.57	47.49
16450.00	144.91	144.83	49.65	49.57
16695.00	144.90	144.80	49.64	49.54
Manufacturer's rated output power = 55 dBm EIRP (EUT complies = <20% of rated power)				



2.1.9 Low Channel Test Results

Full Spectrum



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [..\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [..\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak (Field Strength @ 3 meters)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16200.133333	142.83	73.90	-68.93	1000.0	1000.000	137.0	V	202.0	69

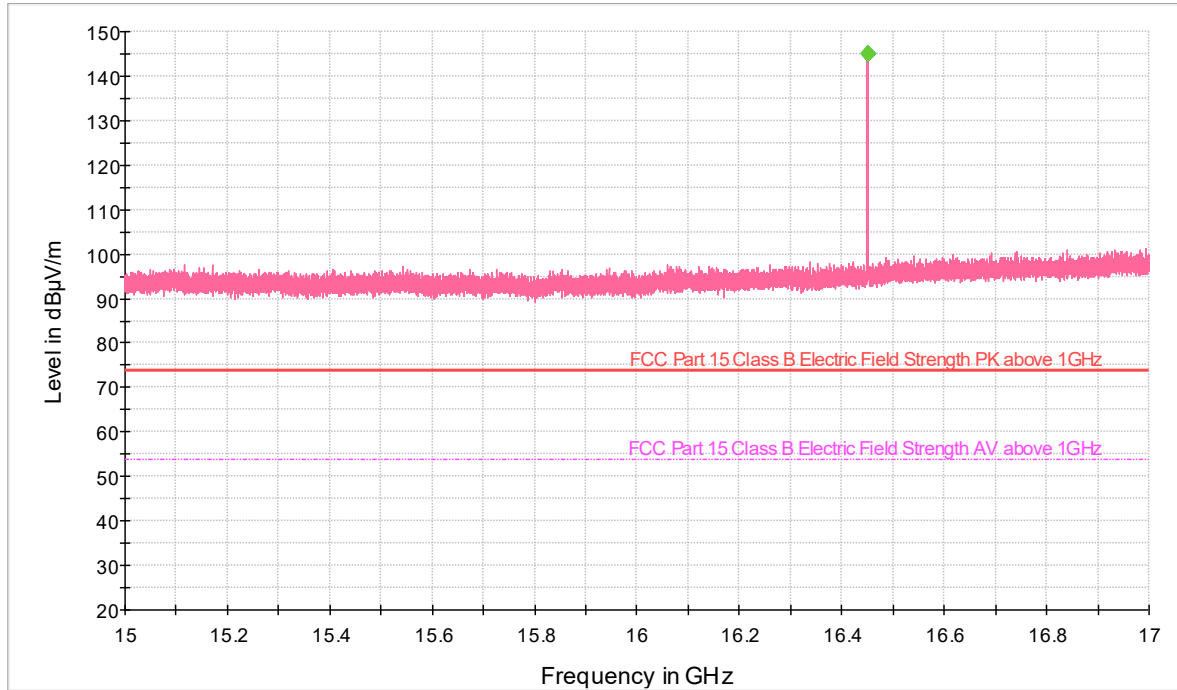
Average (Field Strength @ 3 meters)

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16200.133333	142.75	53.90	-88.85	1000.0	1000.000	137.0	V	202.0	69



2.1.10 Mid Channel Test Results

Full Spectrum



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak (Field Strength @ 3 meters)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16450.133333	144.91	73.90	-71.01	1000.0	1000.000	135.0	V	202.0	70

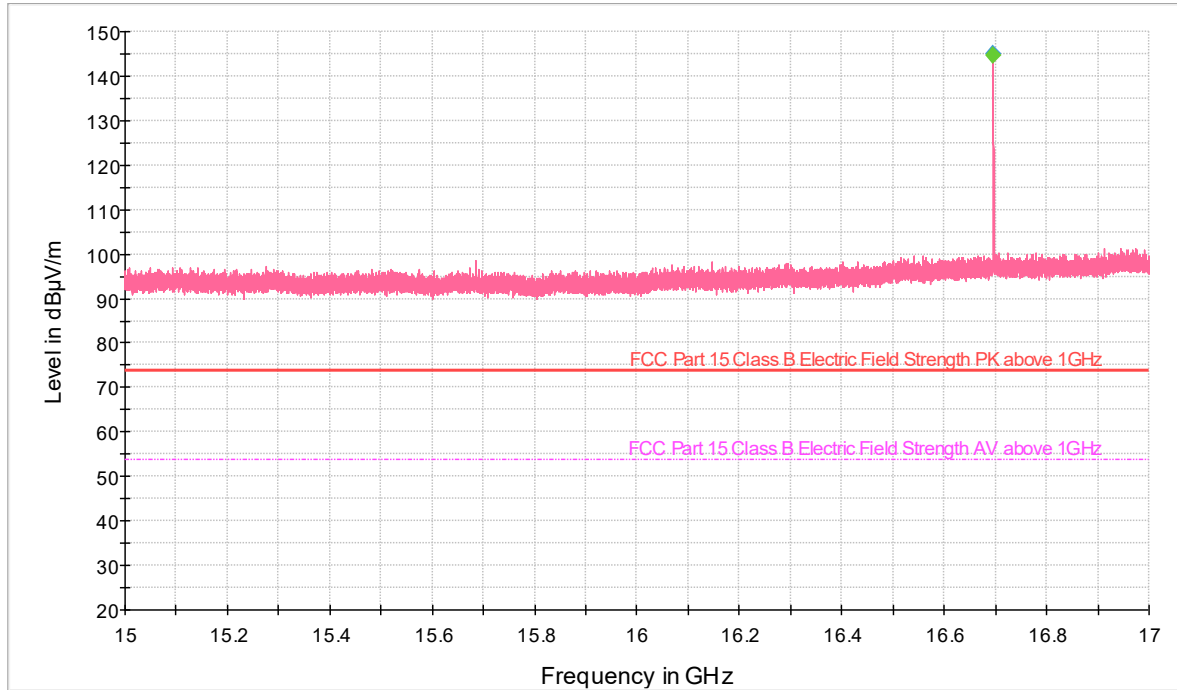
Average (Field Strength @ 3 meters)

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16450.133333	144.83	53.90	-90.93	1000.0	1000.000	135.0	V	202.0	70



2.1.11 High Channel Test Results

Full Spectrum



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak (Field Strength @ 3 meters)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16695.733333	144.90	73.90	-71.00	1000.0	1000.000	136.0	V	201.0	72

Average (Field Strength @ 3 meters)

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16695.733333	144.80	53.90	-90.90	1000.0	1000.000	136.0	V	201.0	72



2.2 Unwanted Emissions (Emission Mask)

2.2.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.210 (n)

2.2.2 Standard Applicable

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

(b) Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

2.2.3 Equipment Under Test and Modification State

Serial No: R30s-A00010 / Test Configuration A

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

November 07, 2018 / AC

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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

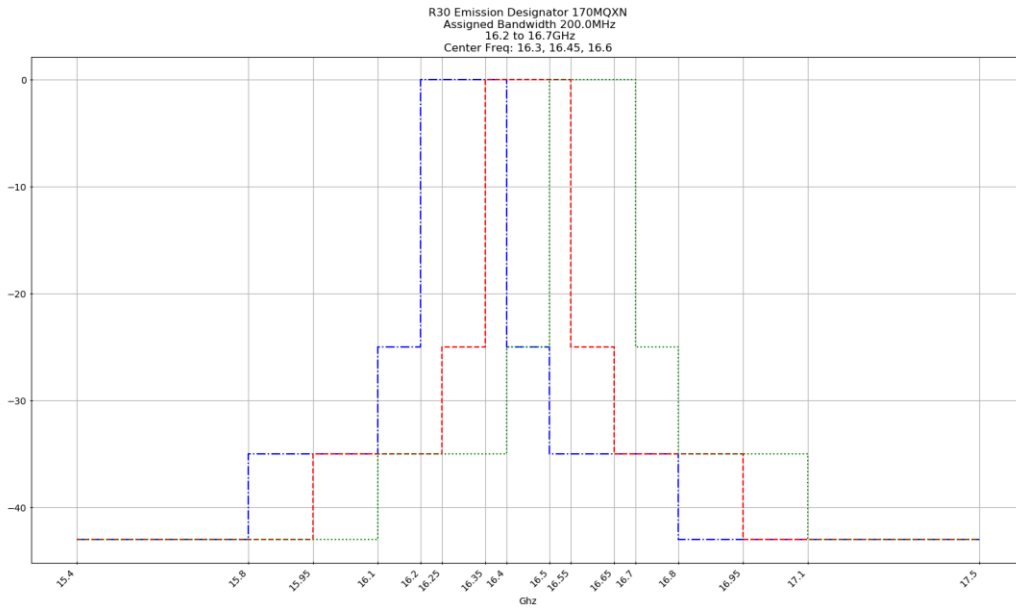
Ambient Temperature	25.0 °C
Relative Humidity	49.4 %
ATM Pressure	99.0 kPa

2.2.7 Additional Observations

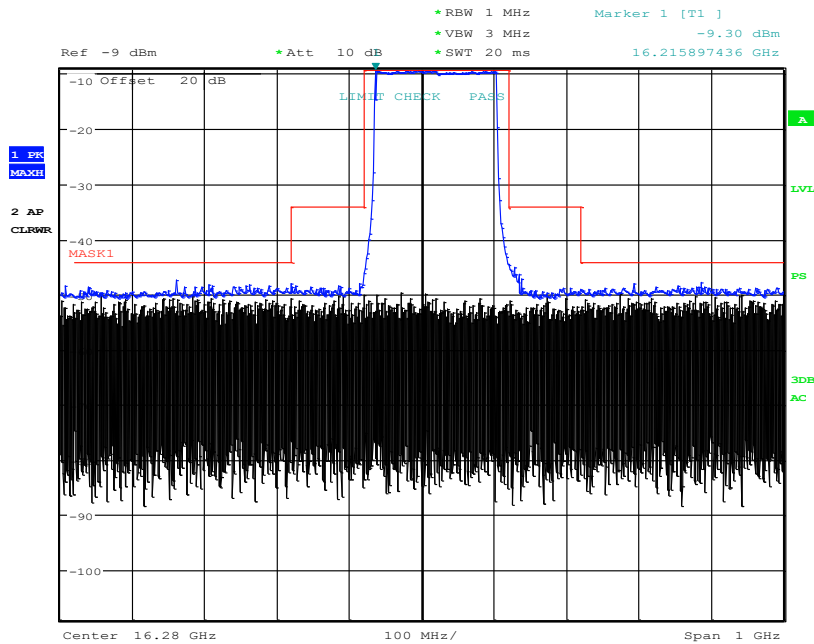
- This is a relative radiated measurement.
- EUT is on full radar swept mode for this test.
- The emission mask was applied per Section 5.7.3 of ANSI C63.26-2015.
- §90.210(n)(3) is covered under Section 2.3 of this test report.



2.2.8 Channel Emission Masks

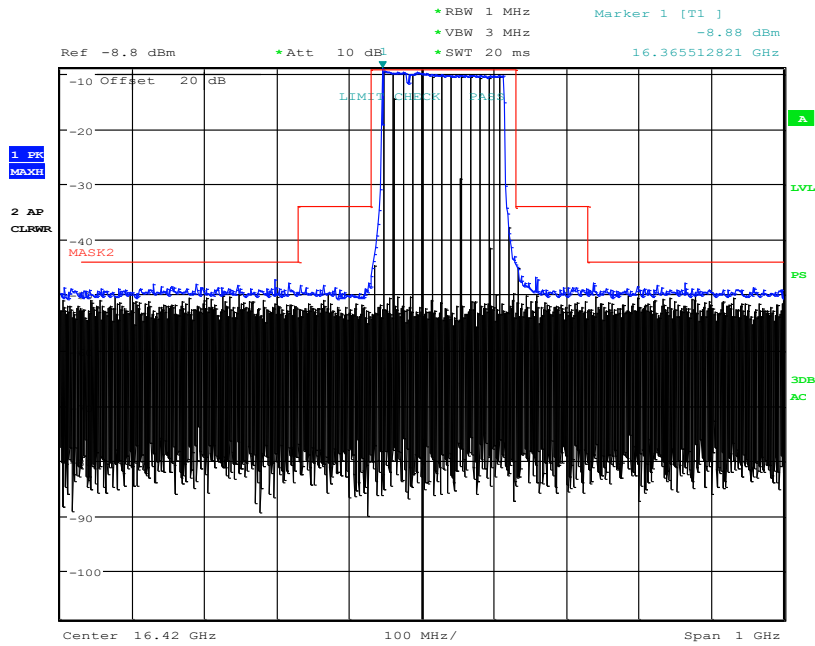


2.2.9 Test Result Plots



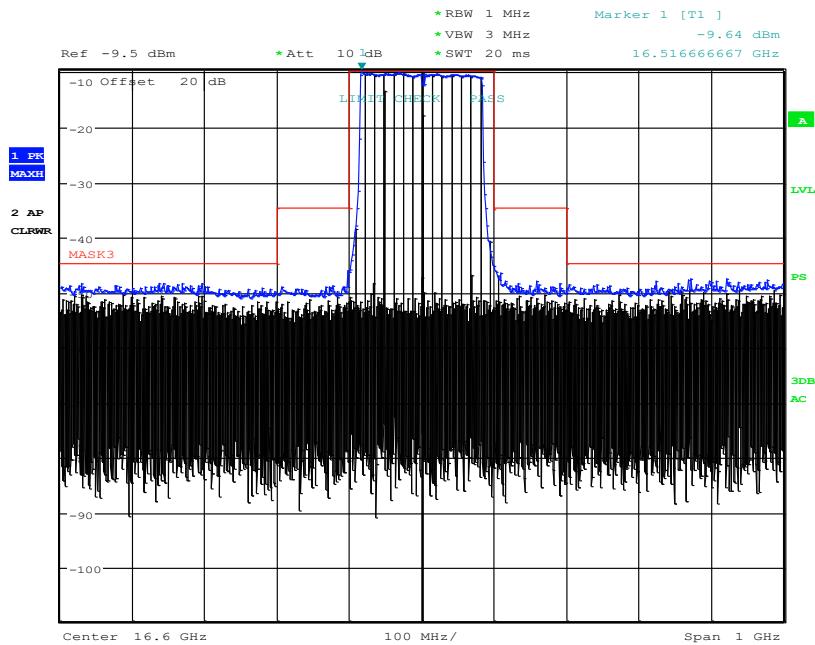
Date: 7.NOV.2019 16:37:05

Low Channel



Date: 7.NOV.2019 16:40:19

Mid Channel



Date: 7.NOV.2019 16:43:42

High Channel



2.3 Field Strength of Radiated Spurious Emissions

2.3.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1053(a) and (b)

2.3.2 Standard Applicable

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

FCC 47 CFR Part 90, Clause 90.210 (n)(3)

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

2.3.3 Equipment Under Test and Modification State

Serial No: R30s-A00010 / Default Test Configuration

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

November 05 and 07, 2019 / AC

November 08, 2019 / 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 performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature 25.0 – 25.8 °C
 Relative Humidity 48.3 - 49.4 %
 ATM Pressure 99.0 – 99.9 kPa

2.3.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to 100GHz.
- Only the worst-case transmit mode presented.
- In-band measurements are covered under Section 2.2 of this test report.
- Measurements below 40GHz were 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 2.3.8 for sample computation.
- Measurement above 40GHz are done using harmonic mixers. Corresponding TDF (Transducer Factor) are programmed for each range.
- Tests distance and frequency ranges performed are summarized below:

Frequency Range	Test Distance
30 MHz to 1GHz	3 meters
1 GHz to 18 GHz	3 meters
18 GHz to 26.5 GHz	3 meters
26 GHz to 40 GHz	3 meters
40 GHz to 60 GHz	3 meters
60 GHz to 75 GHz	1 meter
75 GHz to 100 GHz	1 meter

2.3.8 Sample Computation (Radiated Emission)

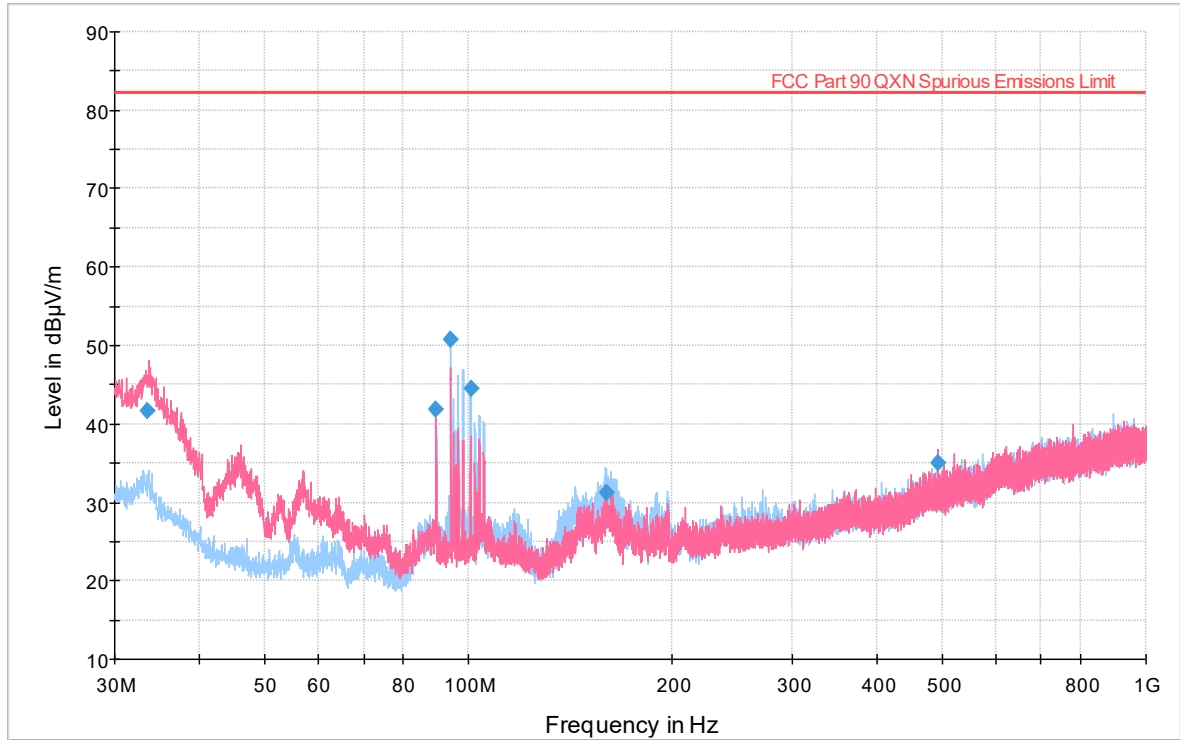
Measuring equipment raw measurement (dbµV) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	Asset# 1172 (cable)	0.3
	Asset# 1016 (preamplifier)	-30.7
	Asset# 1175(cable)	0.3
	Asset# 1002 (antenna)	17.2
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz		11.8

2.3.9 Test Results

Compliant. See attached plots.



2.3.10 Worst Case Channel Below 1GHz Radiated Emission Test



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 90 QXN Spurious Emissions Limit [..\EMI Radiated\]
- ◆ Final_Result QPK [Final_Result.Result:4]

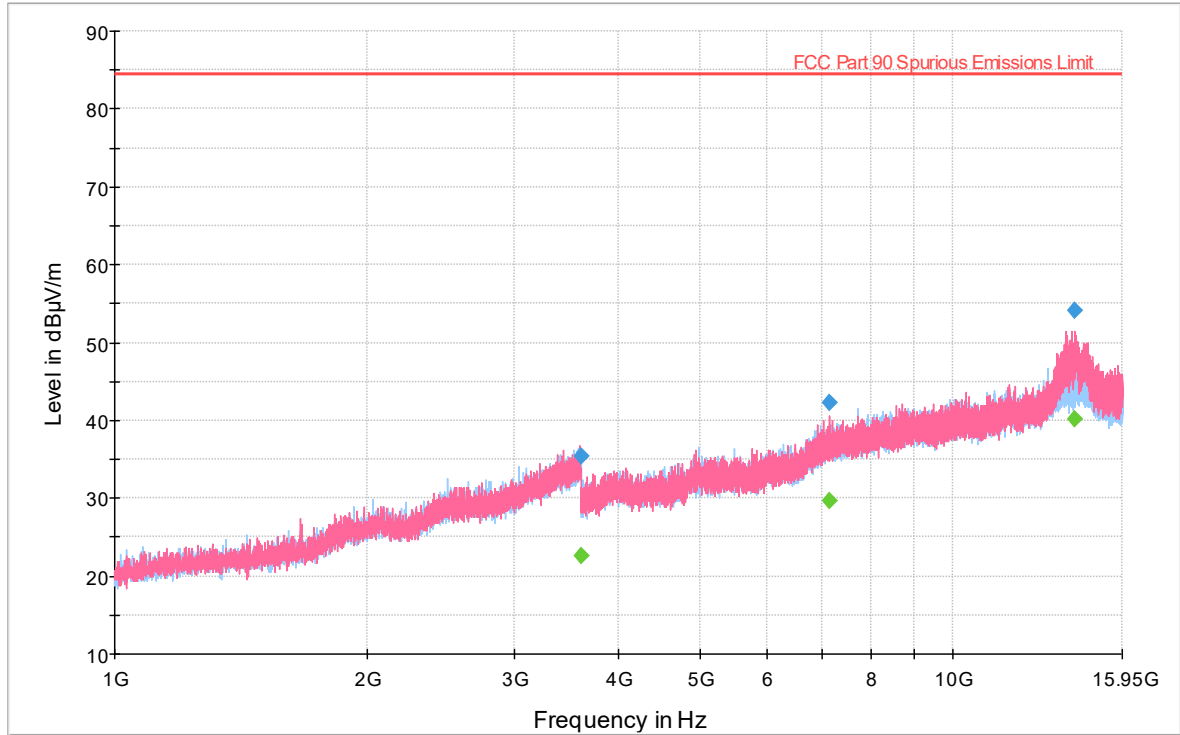
Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.605398	41.66	82.23	40.57	1000.0	120.000	110.0	V	101.0	21
89.485866	41.81	82.23	40.42	1000.0	120.000	196.0	H	85.0	15
94.166415	50.78	82.23	31.45	1000.0	120.000	200.0	H	81.0	16
100.657167	44.44	82.23	37.79	1000.0	120.000	215.0	H	93.0	16
160.129833	31.23	82.23	51.00	1000.0	120.000	194.0	H	48.0	17
491.991000	35.01	82.23	47.22	1000.0	120.000	100.0	V	355.0	25



2.3.11 1GHz up to lower edge of the emission mask used (Mid Channel)

Full Spectrum



— Preview Result 1H-PK+ [Preview Result 1H.Result:2] — Preview Result 1V-PK+ [Preview Result 1V.Result:4]
— FCC Part 90 Spurious Emissions Limit [.\EMI Radiated\] ◆ Final_Result PK+ [Final_Result.Result:4]
◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3601.93333	35.35	84.40	49.05	1000.0	1000.000	132.0	V	172.0	36
7119.11000	42.23	84.40	42.17	1000.0	1000.000	147.0	V	36.0	43
14010.8050	54.04	84.40	30.36	1000.0	1000.000	132.0	V	350.0	50

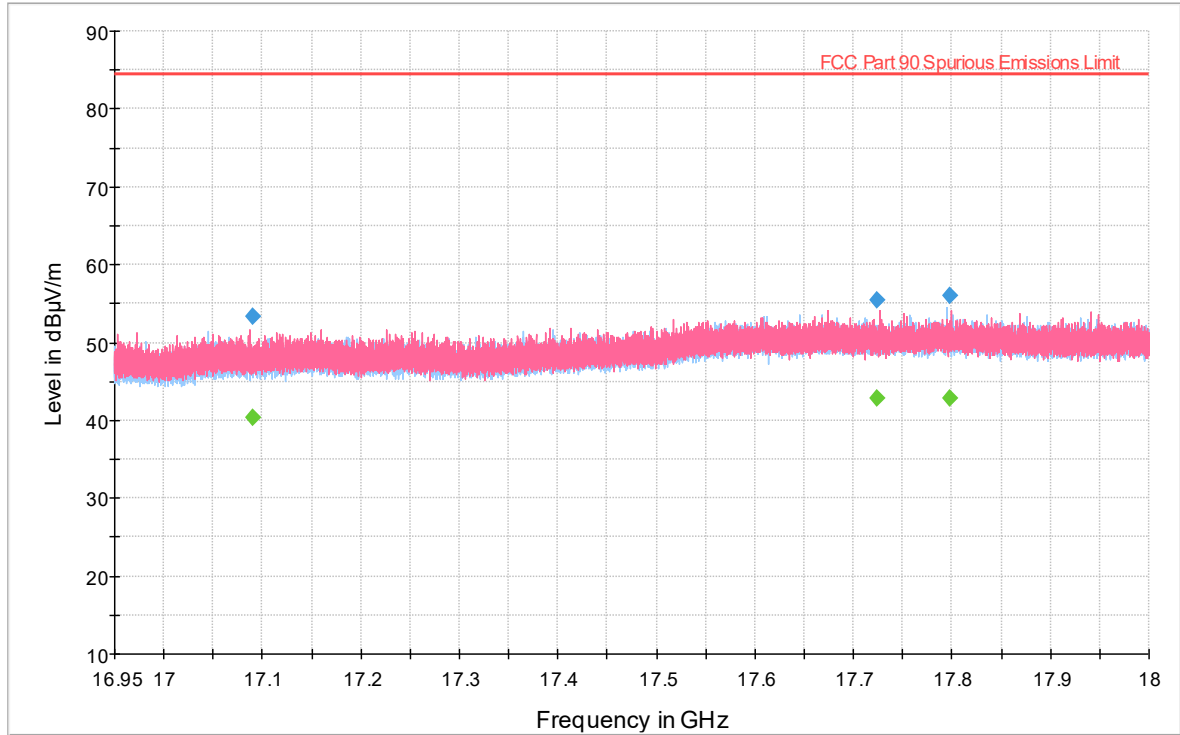
Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3601.93333	22.58	84.40	61.82	1000.0	1000.000	132.0	V	172.0	36
7119.11000	29.70	84.40	54.70	1000.0	1000.000	147.0	V	36.0	43
14010.8050	40.26	84.40	44.14	1000.0	1000.000	132.0	V	350.0	50



2.3.12 Upper edge of the emission mask used up to 18GHz (Mid Channel)

Full Spectrum



— Preview Result 1H-PK+ [Preview Result 1H.Result:2] — Preview Result 1V-PK+ [Preview Result 1V.Result:4]
— FCC Part 90 Spurious Emissions Limit [.\EMI Radiated\] ◆ Final_Result PK+ [Final_Result.Result:4]
◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17089.5750	53.41	84.40	30.99	1000.0	1000.000	161.0	V	336.0	52
17723.5450	55.52	84.40	28.88	1000.0	1000.000	160.0	V	4.0	55
17798.0250	56.01	84.40	28.39	1000.0	1000.000	130.0	H	272.0	56

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17089.5750	40.29	84.40	44.11	1000.0	1000.000	161.0	V	336.0	52
17723.5450	42.77	84.40	41.63	1000.0	1000.000	160.0	V	4.0	55
17798.0250	42.76	84.40	41.64	1000.0	1000.000	130.0	H	272.0	56



Test Note: Test plots for Section 2.3.13 up to Section 2.3.16 are identical to Section 2.3.11 and Section 2.3.12 test plots. Only the worst test plot presented.

2.3.13 1GHz up to lower edge of the emission mask used (Low Channel)

Peak Data

Frequency (MHz)	Max Peak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3587.50666	32.23	84.40	52.17	1000.0	1000.000	129.0	V	224.0	36
8173.04000	44.20	84.40	40.20	1000.0	1000.000	175.0	H	156.0	45
14030.6933	54.73	84.40	29.67	1000.0	1000.000	175.0	V	359.0	50

Average Data

Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3587.50666	18.84	84.40	65.56	1000.0	1000.000	129.0	V	224.0	36
8173.04000	31.37	84.40	53.03	1000.0	1000.000	175.0	H	156.0	45
14030.6933	40.92	84.40	43.48	1000.0	1000.000	175.0	V	359.0	50

2.3.14 Upper edge of the emission mask used up to 18GHz (LowChannel)

Peak Data

Frequency (MHz)	Max Peak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17030.1600	52.83	84.40	31.57	1000.0	1000.000	175.0	V	0.0	52
17559.6000	55.20	84.40	29.20	1000.0	1000.000	136.0	V	6.0	54
17877.5600	55.60	84.40	28.80	1000.0	1000.000	175.0	V	352.0	56

Average Data

Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17030.1600	40.03	84.40	44.37	1000.0	1000.000	175.0	V	0.0	52
17559.6000	42.32	84.40	42.08	1000.0	1000.000	136.0	V	6.0	54
17877.5600	42.78	84.40	41.62	1000.0	1000.000	175.0	V	352.0	56

2.3.15 1GHz up to lower edge of the emission mask used (High Channel)

Peak Data

Frequency (MHz)	Max Peak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3542.33000	31.82	84.40	52.58	1000.0	1000.000	152.0	V	68.0	36
14050.3166	54.06	84.40	30.34	1000.0	1000.000	167.0	V	22.0	50
15663.6400	60.27	84.40	24.13	1000.0	1000.000	132.0	V	340.0	47



America

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3542.33000	19.08	84.40	65.32	1000.0	1000.000	152.0	V	68.0	36
14050.3166	40.60	84.40	43.80	1000.0	1000.000	167.0	V	22.0	50
15663.6400	36.87	84.40	47.53	1000.0	1000.000	132.0	V	340.0	47

2.3.16 Upper edge of the emission mask used up to 18GHz (High Channel)

Peak Data

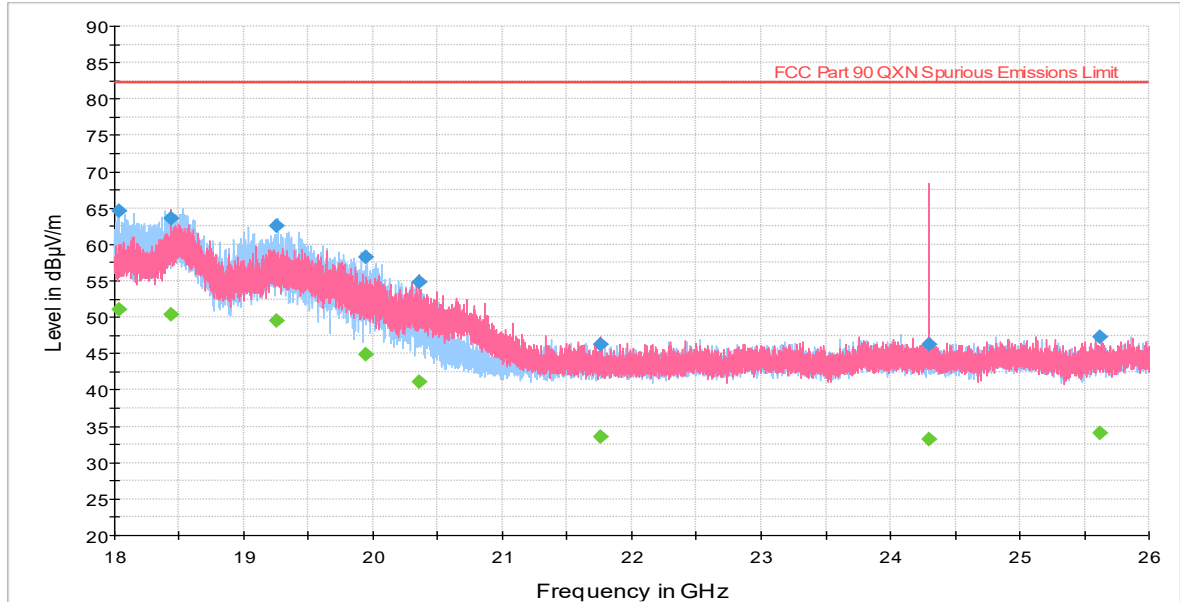
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17144.6800	53.77	84.40	30.63	1000.0	1000.000	175.0	V	18.0	53
17651.7700	67.79	84.40	16.61	1000.0	1000.000	161.0	V	46.0	55
17684.3100	69.06	84.40	15.34	1000.0	1000.000	134.0	V	-14.0	55
17991.2600	55.35	84.40	29.05	1000.0	1000.000	175.0	V	91.0	56

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17144.6800	40.73	84.40	43.67	1000.0	1000.000	175.0	V	18.0	53
17651.7700	43.41	84.40	40.99	1000.0	1000.000	161.0	V	46.0	55
17684.3100	43.64	84.40	40.76	1000.0	1000.000	134.0	V	-14.0	55
17991.2600	42.59	84.40	41.81	1000.0	1000.000	175.0	V	91.0	56



2.3.17 18GHz to 26GHz Radiated Emission Test (Low Channel)



— Preview Result 1H-PK+ [Preview Result 1H.Result:2]
 — Preview Result 1V-PK+ [Preview Result 1V.Result:2]
 — FCC Part 90 QXN Spurious Emissions Limit [..EMI Radiated\
 ◆ Final_Result PK+ [Final_Result.Result:4]
 ◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

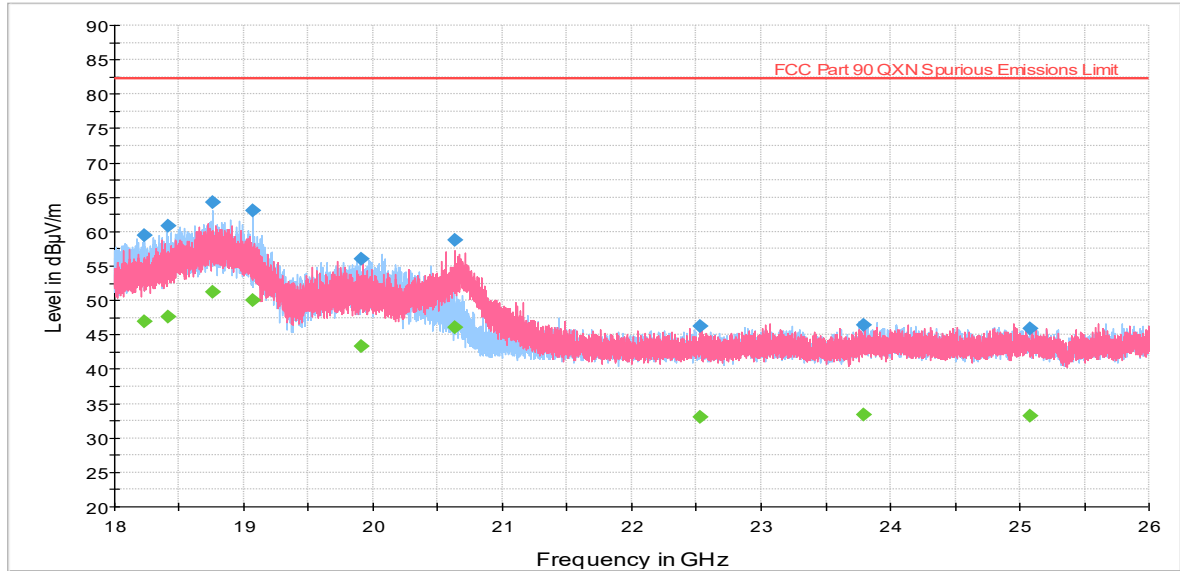
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18037.0800	64.56	82.23	17.67	1000.0	1000.000	172.0	H	150.0	0
18431.4805	63.58	82.23	18.65	1000.0	1000.000	172.0	V	142.0	0
19255.3025	62.47	82.23	19.76	1000.0	1000.000	172.0	H	154.0	0
19945.5705	58.31	82.23	23.92	1000.0	1000.000	172.0	H	156.0	0
20356.9790	54.75	82.23	27.48	1000.0	1000.000	173.0	V	209.0	0
21759.6925	46.32	82.23	35.91	1000.0	1000.000	172.0	V	86.0	0
24296.1420	46.28	82.23	35.95	1000.0	1000.000	160.0	V	209.0	2
25618.0625	47.33	82.23	34.90	1000.0	1000.000	147.0	V	44.0	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/m)
18037.0800	51.12	82.23	31.11	1000.0	1000.000	172.0	H	150.0	0
18431.4805	50.35	82.23	31.88	1000.0	1000.000	172.0	V	142.0	0
19255.3025	49.46	82.23	32.77	1000.0	1000.000	172.0	H	154.0	0
19945.5705	44.83	82.23	37.40	1000.0	1000.000	172.0	H	156.0	0
20356.9790	41.02	82.23	41.21	1000.0	1000.000	173.0	V	209.0	0
21759.6925	33.54	82.23	48.69	1000.0	1000.000	172.0	V	86.0	0
24296.1420	33.25	82.23	48.98	1000.0	1000.000	160.0	V	209.0	2
25618.0625	34.14	82.23	48.09	1000.0	1000.000	147.0	V	44.0	2



2.3.18 18GHz to 26GHz Radiated Emission Test (Mid Channel)



— Preview Result 1H-PK+ [Preview Result 1H.Result:2]
— Preview Result 1V-PK+ [Preview Result 1V.Result:2]
— FCC Part 90 QXN Spurious Emissions Limit [..\EMI Radiated\
◆ Final_Result PK+ [Final_Result.Result:4]
◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

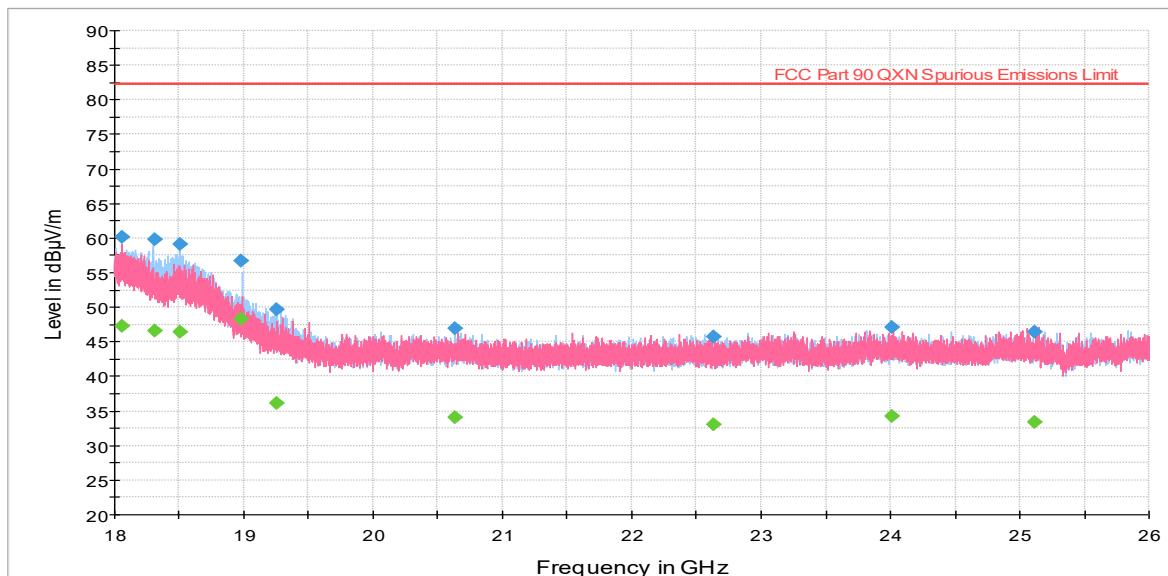
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18227.6830	59.38	82.23	22.85	1000.0	1000.000	172.0	H	155.0	0
18412.8495	60.86	82.23	21.37	1000.0	1000.000	172.0	H	146.0	0
18756.8265	64.28	82.23	17.95	1000.0	1000.000	150.0	H	149.0	0
19063.3070	62.99	82.23	19.24	1000.0	1000.000	173.0	H	151.0	0
19908.9915	55.99	82.23	26.24	1000.0	1000.000	160.0	V	222.0	0
20637.6345	58.73	82.23	23.50	1000.0	1000.000	149.0	V	148.0	0
22533.6965	46.30	82.23	35.93	1000.0	1000.000	173.0	V	345.0	1
23798.6285	46.44	82.23	35.79	1000.0	1000.000	172.0	H	282.0	2
25076.2850	45.97	82.23	36.26	1000.0	1000.000	147.0	H	-2.0	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/m)
18227.6830	46.87	82.23	35.36	1000.0	1000.000	172.0	H	155.0	0
18412.8495	47.61	82.23	34.62	1000.0	1000.000	172.0	H	146.0	0
18756.8265	51.17	82.23	31.06	1000.0	1000.000	150.0	H	149.0	0
19063.3070	50.04	82.23	32.19	1000.0	1000.000	173.0	H	151.0	0
19908.9915	43.30	82.23	38.93	1000.0	1000.000	160.0	V	222.0	0
20637.6345	46.14	82.23	36.09	1000.0	1000.000	149.0	V	148.0	0
22533.6965	33.03	82.23	49.20	1000.0	1000.000	173.0	V	345.0	1
23798.6285	33.44	82.23	48.79	1000.0	1000.000	172.0	H	282.0	2
25076.2850	33.18	82.23	49.05	1000.0	1000.000	147.0	H	-2.0	2



2.3.19 18GHz to 26GHz Radiated Emission Test (High Channel)



— Preview Result 1H-PK+ [Preview Result 1H.Result:2]
 — Preview Result 1V-PK+ [Preview Result 1V.Result:2]
 — FCC Part 90 QXN Spurious Emissions Limit [..EMI Radiated]
 ◆ Final_Result PK+ [Final_Result.Result:4]
 ◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

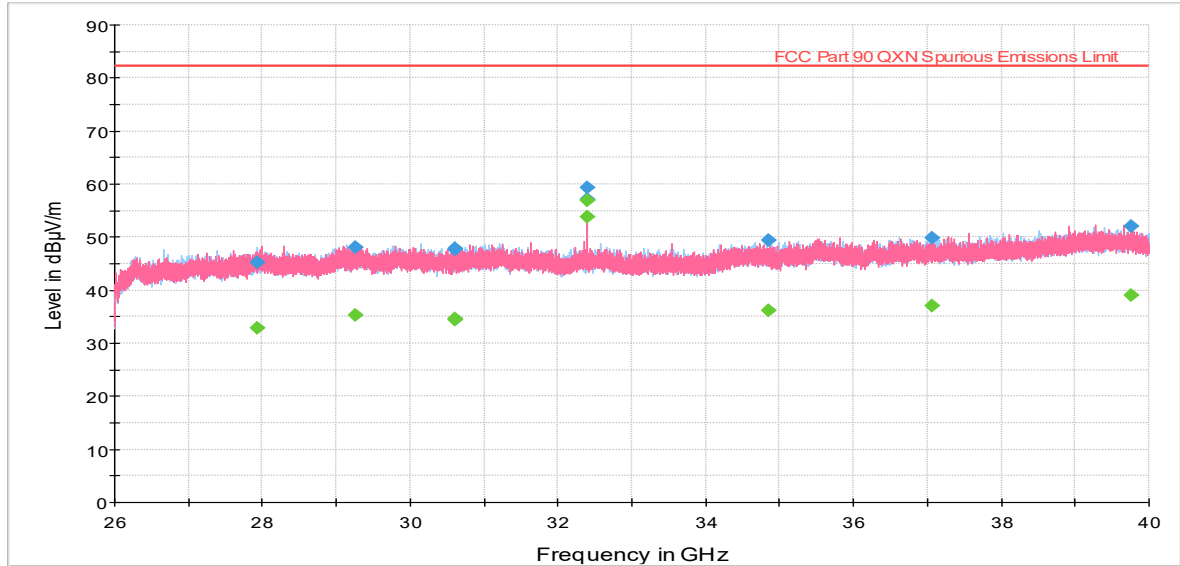
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18057.9765	60.08	82.23	22.15	1000.0	1000.000	173.0	V	230.0	0
18308.2560	59.85	82.23	22.38	1000.0	1000.000	150.0	H	189.0	0
18505.4290	59.08	82.23	23.15	1000.0	1000.000	153.0	H	208.0	0
18977.6290	56.72	82.23	25.51	1000.0	1000.000	172.0	H	180.0	0
19248.1760	49.67	82.23	32.56	1000.0	1000.000	172.0	H	195.0	0
20632.1865	46.93	82.23	35.30	1000.0	1000.000	173.0	H	76.0	0
22628.7770	45.77	82.23	36.46	1000.0	1000.000	166.0	H	2.0	1
24014.4600	47.13	82.23	35.10	1000.0	1000.000	160.0	V	200.0	2
25117.6515	46.35	82.23	35.88	1000.0	1000.000	151.0	H	-10.0	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/m)
18057.9765	47.27	82.23	34.96	1000.0	1000.000	173.0	V	230.0	0
18308.2560	46.55	82.23	35.68	1000.0	1000.000	150.0	H	189.0	0
18505.4290	46.42	82.23	35.81	1000.0	1000.000	153.0	H	208.0	0
18977.6290	48.32	82.23	33.91	1000.0	1000.000	172.0	H	180.0	0
19248.1760	36.05	82.23	46.18	1000.0	1000.000	172.0	H	195.0	0
20632.1865	34.04	82.23	48.19	1000.0	1000.000	173.0	H	76.0	0
22628.7770	33.01	82.23	49.22	1000.0	1000.000	166.0	H	2.0	1
24014.4600	34.20	82.23	48.03	1000.0	1000.000	160.0	V	200.0	2
25117.6515	33.31	82.23	48.92	1000.0	1000.000	151.0	H	-10.0	2



2.3.20 26GHz to 40GHz Radiated Emission Test (Low Channel)



— Preview Result 1H-PK+ [Preview Result 1H.Result:2]
— Preview Result 1V-PK+ [Preview Result 1V.Result:2]
— FCC Part 90 QXN Spurious Emissions Limit [..\EMI Radiate\d\
◆ Final_Result PK+ [Final_Result.Result:4]
◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

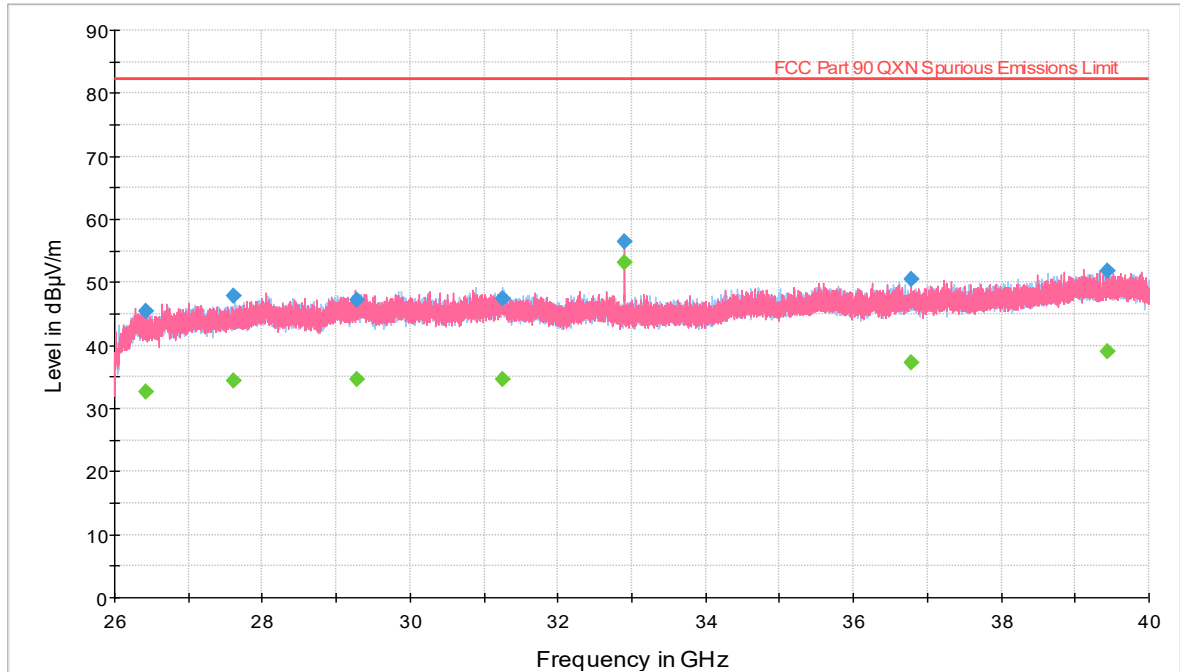
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27923.1834	45.30	82.23	36.93	1000.0	1000.000	185.0	H	211.0	3
29255.8311	48.10	82.23	34.13	1000.0	1000.000	169.0	V	63.0	4
30596.6384	47.56	82.23	34.67	1000.0	1000.000	180.0	H	6.0	5
30596.8092	47.93	82.23	34.30	1000.0	1000.000	180.0	H	358.0	5
32399.9230	57.06	82.23	25.17	1000.0	1000.000	135.0	V	134.0	6
32399.9311	59.40	82.23	22.83	1000.0	1000.000	138.0	V	133.0	6
34844.8473	49.41	82.23	32.82	1000.0	1000.000	156.0	H	220.0	7
37073.1573	49.90	82.23	32.33	1000.0	1000.000	185.0	V	148.0	7
39761.3761	52.09	82.23	30.14	1000.0	1000.000	185.0	V	96.0	9

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27923.1834	32.78	82.23	49.45	1000.0	1000.000	185.0	H	211.0	3
29255.8311	35.33	82.23	46.90	1000.0	1000.000	169.0	V	63.0	4
30596.6384	34.38	82.23	47.85	1000.0	1000.000	180.0	H	6.0	5
30596.8092	34.60	82.23	47.63	1000.0	1000.000	180.0	H	358.0	5
32399.9230	53.73	82.23	28.50	1000.0	1000.000	135.0	V	134.0	6
32399.9311	56.95	82.23	25.28	1000.0	1000.000	138.0	V	133.0	6
34844.8473	36.22	82.23	46.01	1000.0	1000.000	156.0	H	220.0	7
37073.1573	37.05	82.23	45.18	1000.0	1000.000	185.0	V	148.0	7
39761.3761	38.96	82.23	43.27	1000.0	1000.000	185.0	V	96.0	9



2.3.21 26GHz to 40GHz Radiated Emission Test (Mid Channel)



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 90 QXN Spurious Emissions Limit [..\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

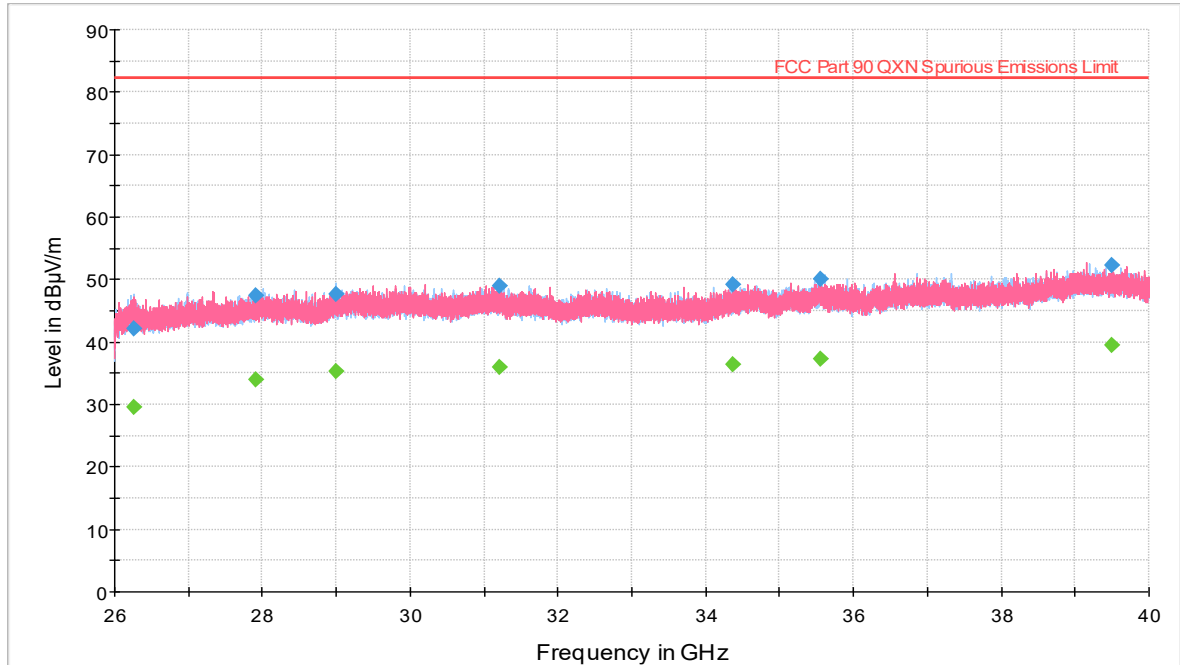
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26423.9565	45.46	82.23	36.77	1000.0	1000.000	135.0	V	248.0	3
27611.6711	47.96	82.23	34.27	1000.0	1000.000	137.0	H	285.0	3
29270.1219	47.31	82.23	34.92	1000.0	1000.000	146.0	V	238.0	5
31258.2407	47.32	82.23	34.91	1000.0	1000.000	185.0	H	253.0	6
32900.0861	56.38	82.23	25.85	1000.0	1000.000	174.0	V	148.0	6
36778.1349	50.41	82.23	31.82	1000.0	1000.000	135.0	V	154.0	7
39433.3757	51.88	82.23	30.35	1000.0	1000.000	181.0	H	297.0	10

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26423.9565	32.75	82.23	49.48	1000.0	1000.000	135.0	V	248.0	3
27611.6711	34.41	82.23	47.82	1000.0	1000.000	137.0	H	285.0	3
29270.1219	34.56	82.23	47.67	1000.0	1000.000	146.0	V	238.0	5
31258.2407	34.73	82.23	47.50	1000.0	1000.000	185.0	H	253.0	6
32900.0861	53.15	82.23	29.08	1000.0	1000.000	174.0	V	148.0	6
36778.1349	37.21	82.23	45.02	1000.0	1000.000	135.0	V	154.0	7
39433.3757	39.09	82.23	43.14	1000.0	1000.000	181.0	H	297.0	10



2.3.22 26GHz to 40GHz Radiated Emission Test (High Channel)



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 90 QXN Spurious Emissions Limit [..\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak Data

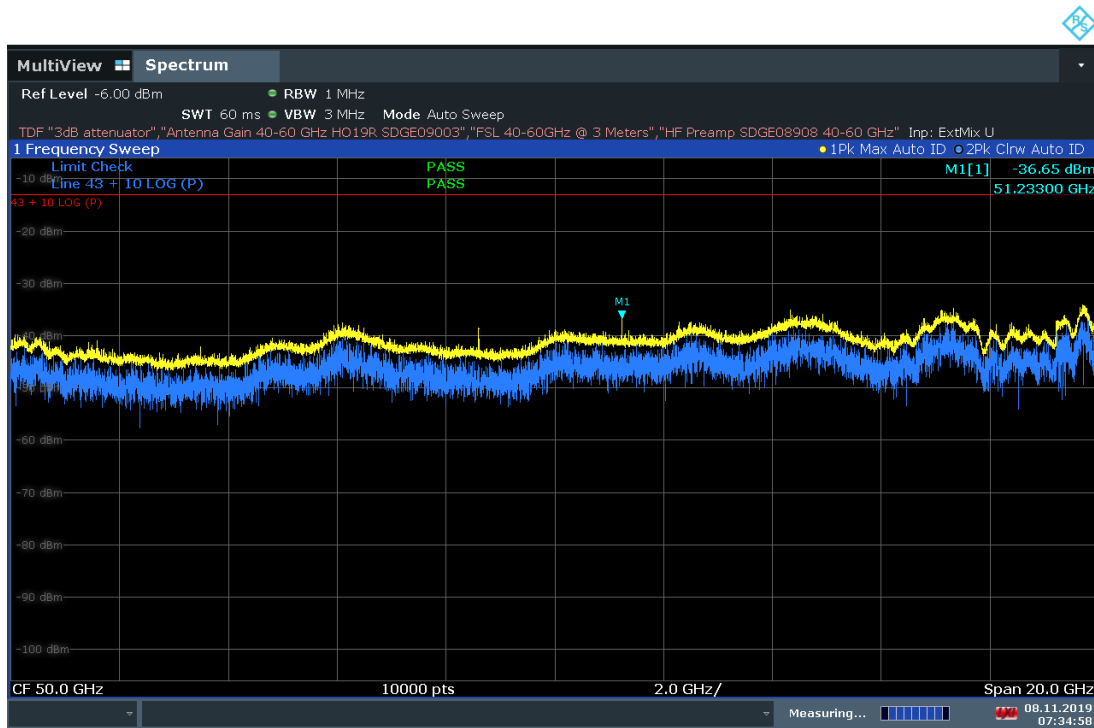
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26259.8538	42.19	82.23	40.04	1000.0	1000.000	138.0	H	110.0	3
27915.5796	47.47	82.23	34.76	1000.0	1000.000	185.0	V	283.0	3
28995.5315	47.71	82.23	34.52	1000.0	1000.000	149.0	H	281.0	4
31201.7196	48.92	82.23	33.31	1000.0	1000.000	138.0	V	299.0	6
34375.4015	49.21	82.23	33.02	1000.0	1000.000	169.0	V	267.0	7
35555.8661	50.03	82.23	32.20	1000.0	1000.000	181.0	V	350.0	7
39497.7303	52.32	82.23	29.91	1000.0	1000.000	185.0	V	326.0	10

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26259.8538	29.53	82.23	52.70	1000.0	1000.000	138.0	H	110.0	3
27915.5796	33.87	82.23	48.36	1000.0	1000.000	185.0	V	283.0	3
28995.5315	35.32	82.23	46.91	1000.0	1000.000	149.0	H	281.0	4
31201.7196	35.93	82.23	46.30	1000.0	1000.000	138.0	V	299.0	6
34375.4015	36.30	82.23	45.93	1000.0	1000.000	169.0	V	267.0	7
35555.8661	37.25	82.23	44.98	1000.0	1000.000	181.0	V	350.0	7
39497.7303	39.43	82.23	42.80	1000.0	1000.000	185.0	V	326.0	10

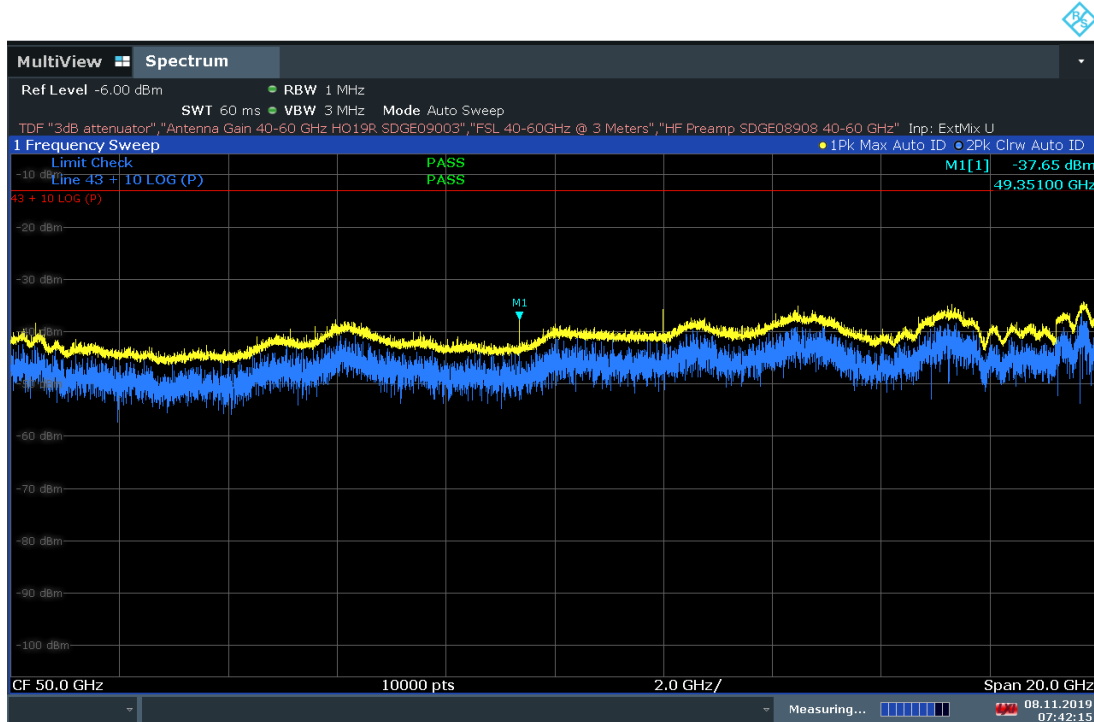


2.3.23 40GHz to 100GHz Maximized Plots



07:34:59 08.11.2019

40GHz to 60GHz Plot (Low Channel)

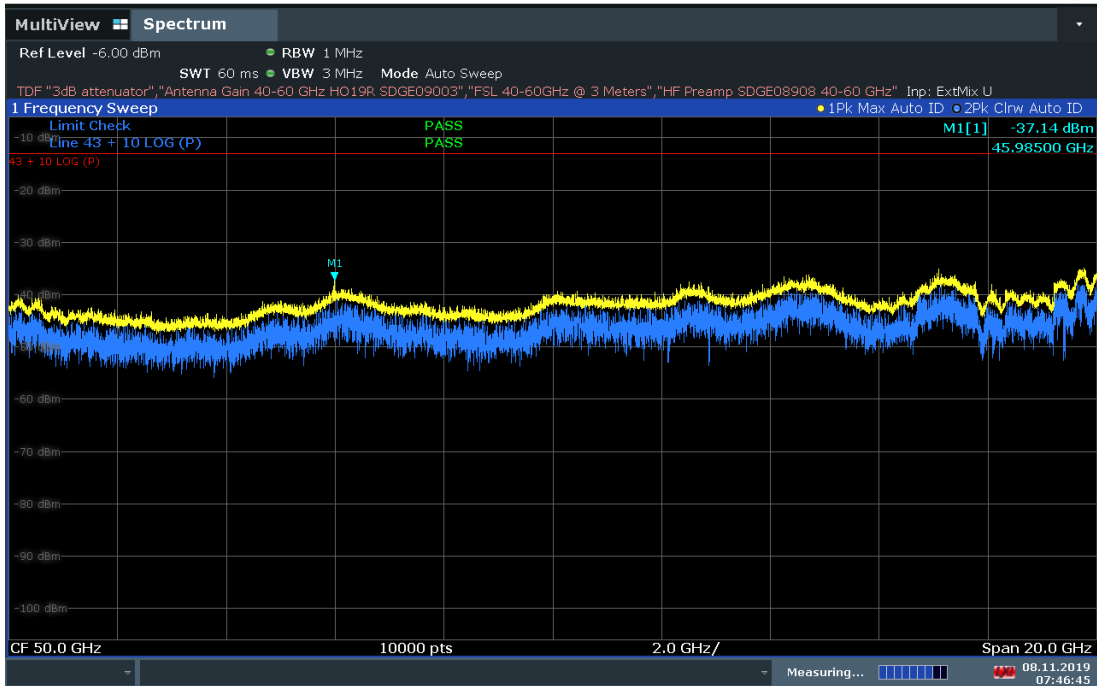


07:42:15 08.11.2019

40GHz to 60GHz Plot (Middle Channel)

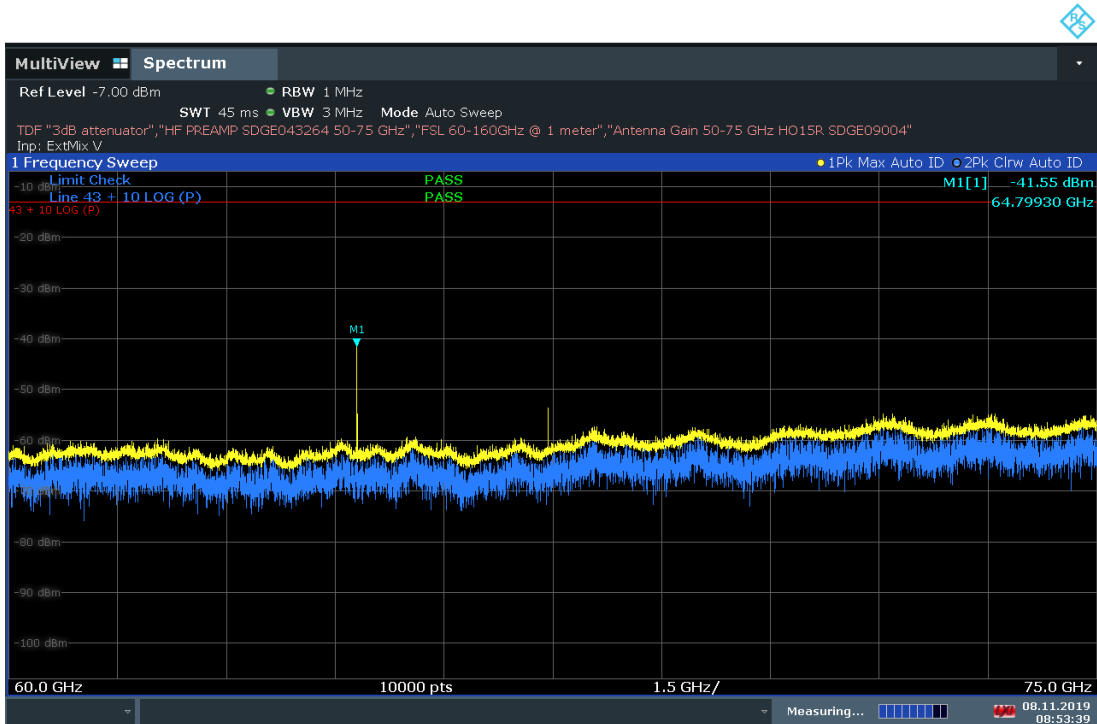


America



07:46:45 08.11.2019

40GHz to 60GHz Plot (High Channel)

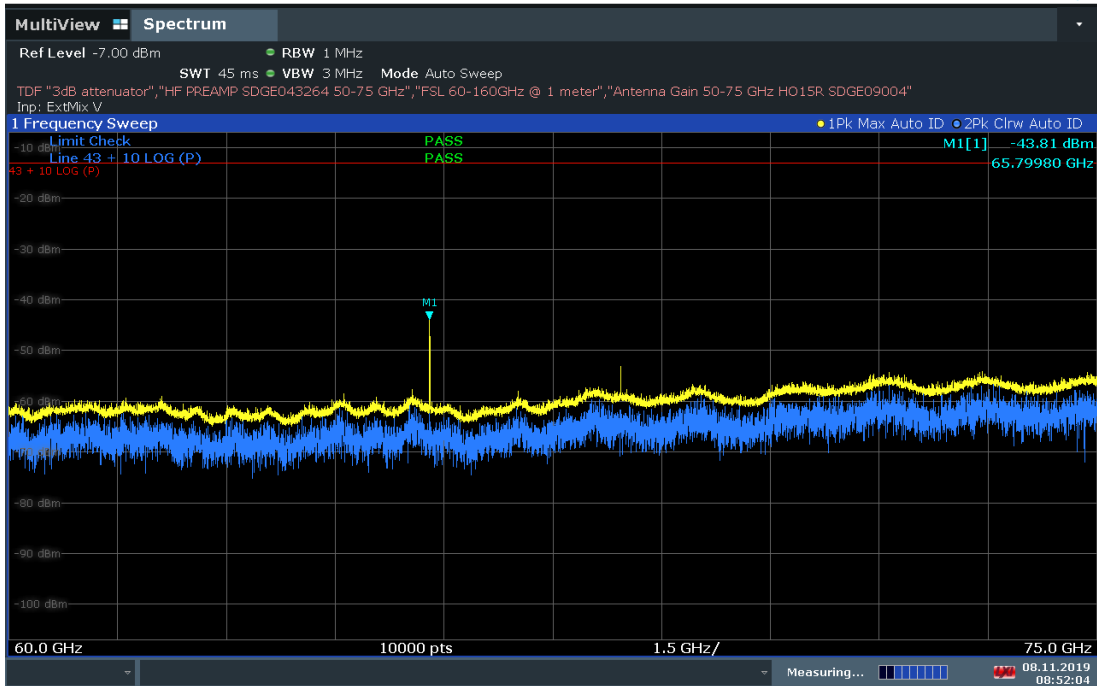


08:53:40 08.11.2019

60GHz to 75GHz Plot (Low Channel)

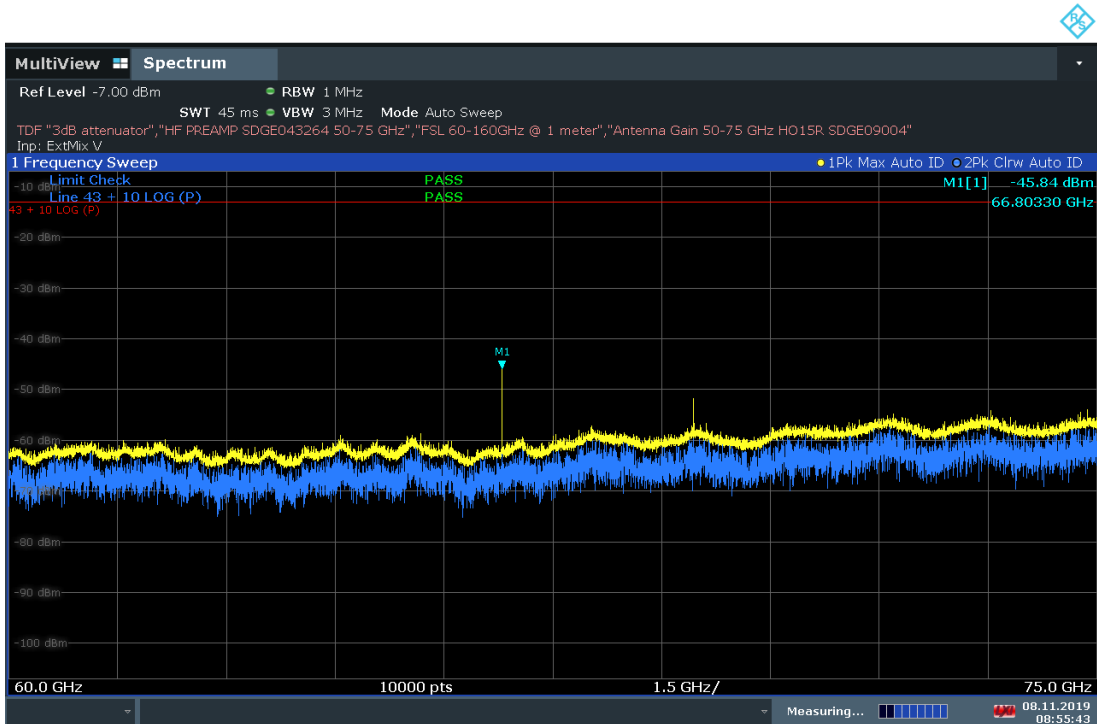


America



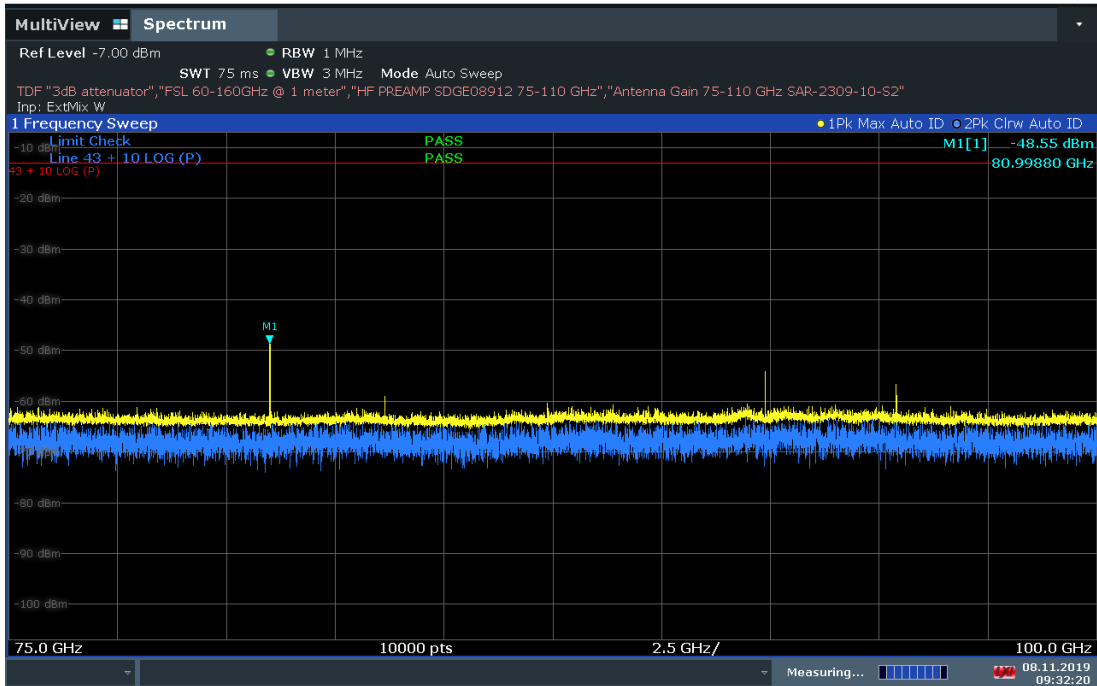
08:52:04 08.11.2019

60GHz to 75GHz Plot (Middle Channel)



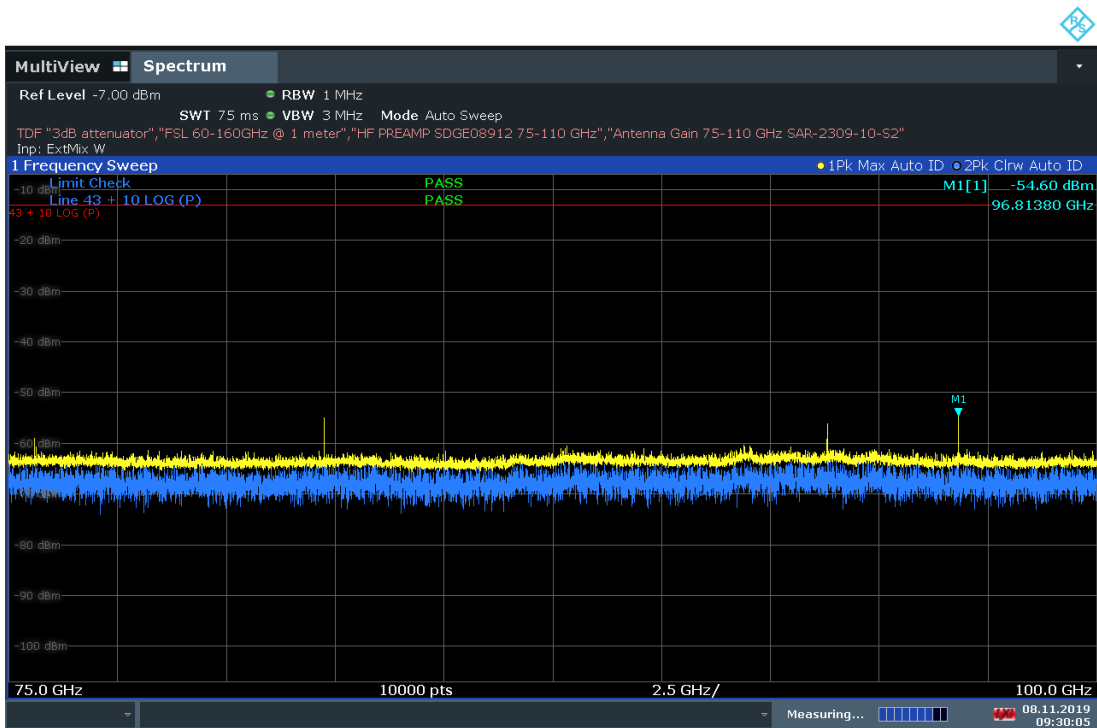
08:55:44 08.11.2019

60GHz to 75GHz Plot (High Channel)



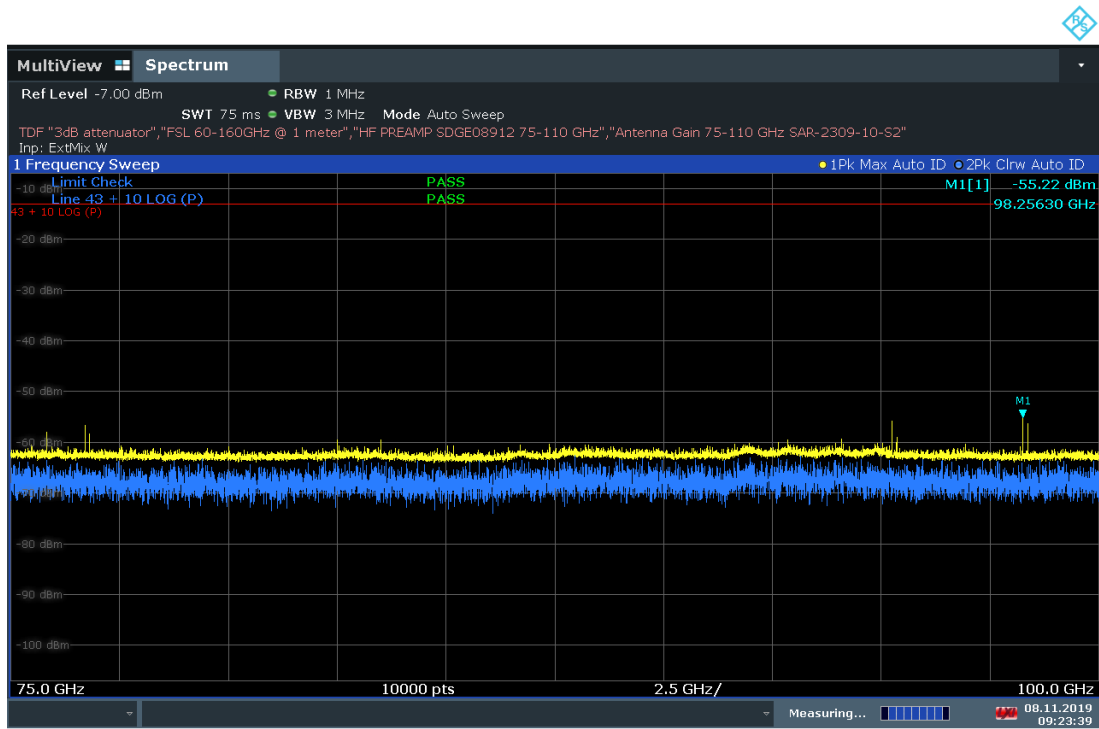
09:32:20 08.11.2019

75GHz to 100GHz Plot (Low Channel)



09:30:06 08.11.2019

75GHz to 100GHz Plot (Middle Channel)



09:23:39 08.11.2019

75GHz to 100GHz Plot (High Channel)



2.4 Occupied Bandwidth

2.4.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1049

2.4.2 Standard Applicable

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

2.4.3 Equipment Under Test and Modification State

Serial No: R30s-A00010 / Default Test Configuration

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

November 21, 2019 / 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 performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	25.4 °C
Relative Humidity	44.7 %
ATM Pressure	99.6 kPa

2.4.7 Additional Observations

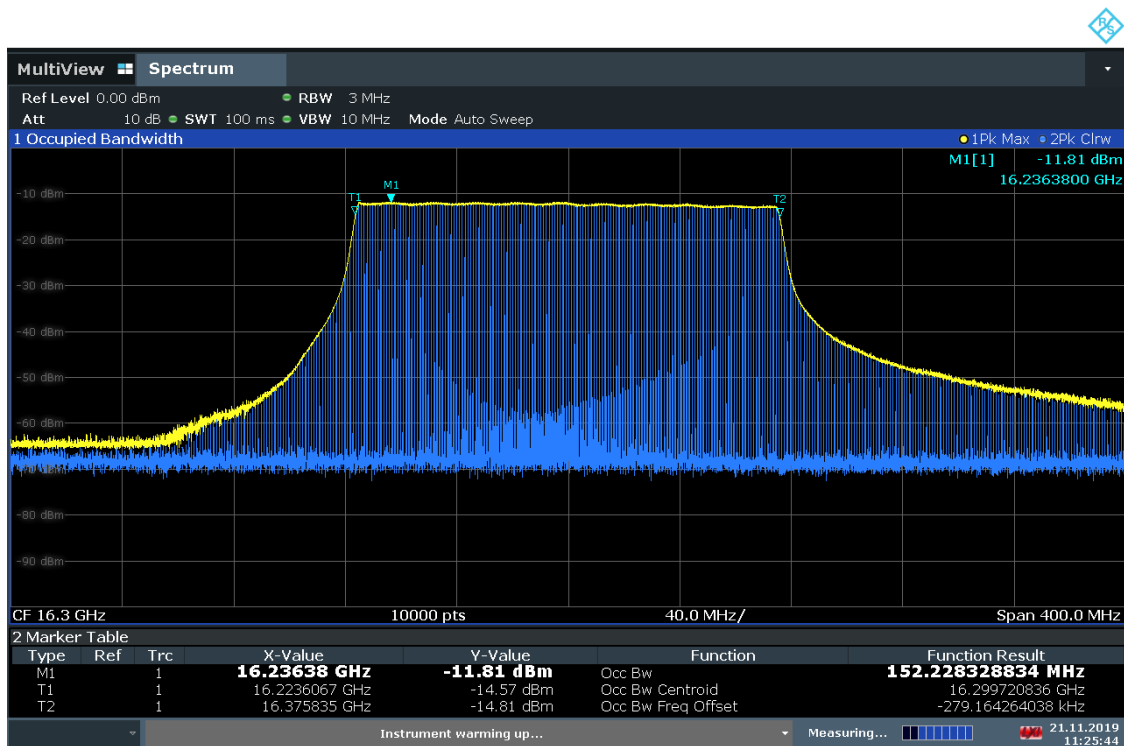
- This is a radiated test.
- This is a radiated test utilizing a spectrum analyser.
- The attenuation for the external attenuator, adapter and cable is measured and entered as a Transducer factor (TDF).
- Occupied bandwidth measurement function of the spectrum analyser was utilized for this test.
- Span is wide enough to capture the channel transmission.
- RBW is 1% to 5% of the occupied bandwidth.
- VBW is >3 X RBW.
- Sweep is auto.
- Detector is peak.
- Trace is max hold.



2.4.8 Test Results Table (for reference only)

Channel	Center Frequency (GHz)	99% OBW (MHz)
Low	16.30	152.23
Mid	16.45	152.35
High	16.60	152.42

2.4.9 Test Result Plots

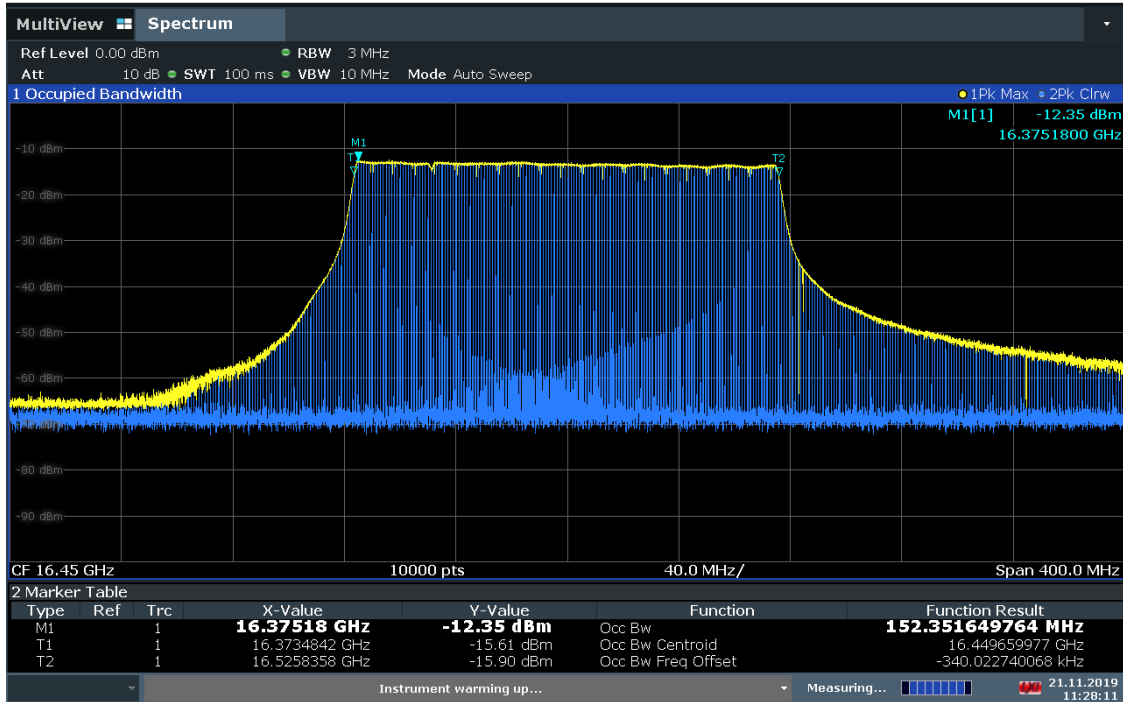


11:25:45 21.11.2019

Center Frequency @ 16.30GHz

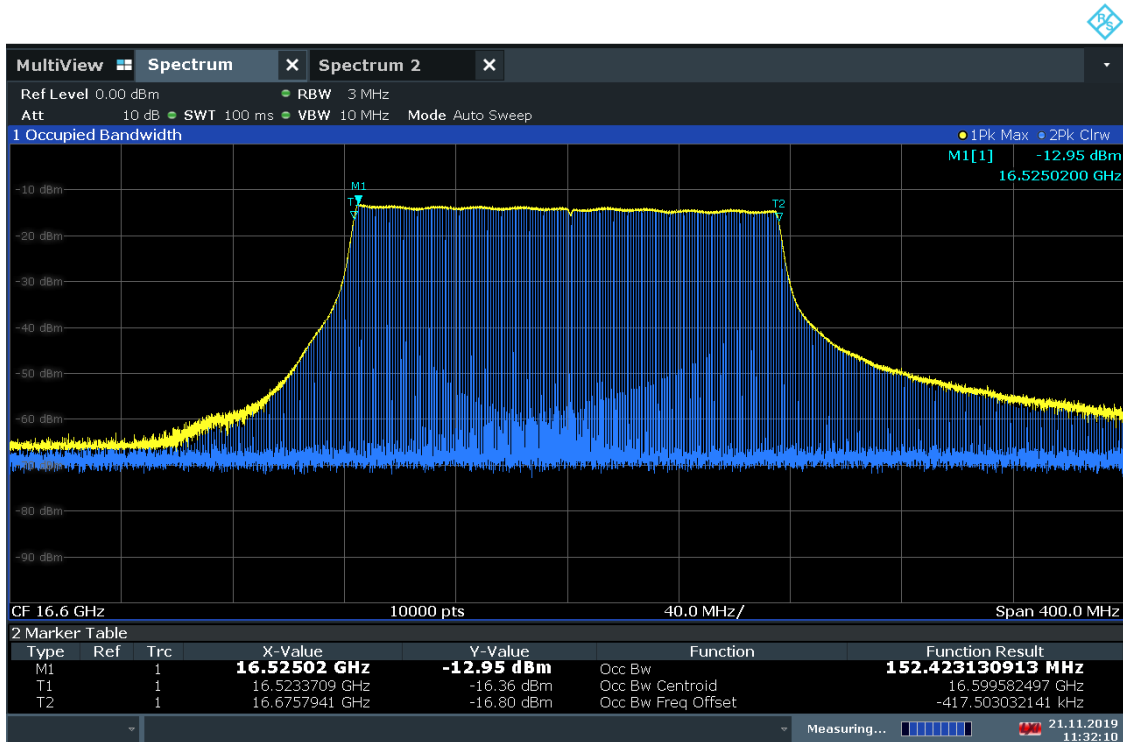


America



11:28:13 21.11.2019

Center Frequency @ 16.45GHz



11:32:10 21.11.2019

Center Frequency @ 16.60GHz



2.5 Frequency Stability

2.5.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.213

2.5.2 Standard Applicable

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table:

Frequency Range (MHz)	Fixed and base station	Mobile Stations	
		>2 watts output power	<2 watts output power
Above 2450 ¹⁰	-	-	-

¹⁰Except for DSRCS equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850-5925 MHz band is specified in subpart M of this part.

2.5.3 Equipment Under Test and Modification State

Serial No: R30s-A00010 / Default Test Configuration

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

November 20 and 21, 2019 / 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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 24.4 – 25.6 °C
 Relative Humidity 43.1 – 44.7 %
 ATM Pressure 97.9 – 98.9 kPa

2.5.7 Additional Observations

- This is a radiated test utilizing the spectrum analyser marker signal count function.
- Test Methodology is per Section 5.6 and Annex A A.2.9.7 of ANSI C63.26-2015.
- The EUT is in CW mode for this test.
- Nominal voltage was declared at 24VDC.

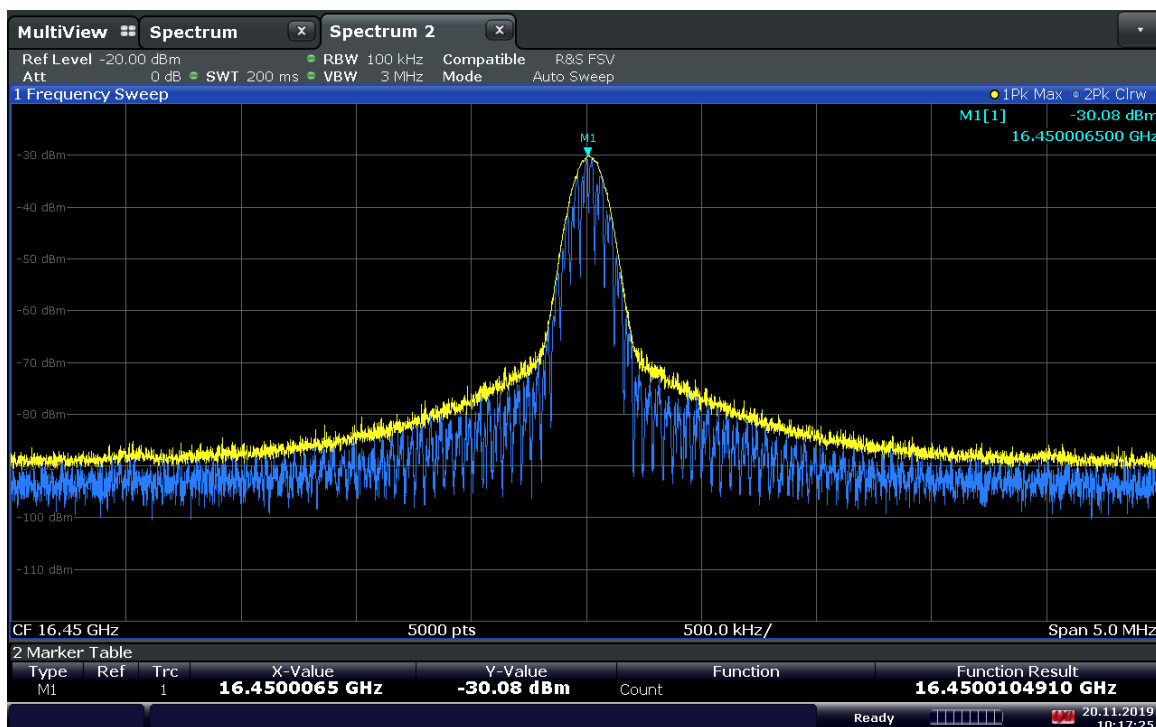


2.5.8 Test Result Table

Temperature (°C)	Frequency (MHz)	ppm
50°C	16,450,006.50	-0.24
40°C	16,450,005.50	-0.18
30°C	16,450,014.50	-0.73
20°C	16,450,002.50	0.00
10°C	16,450,017.50	-0.91
0°C	16,449,997.50	0.30
-10°C	16,449,995.50	0.43
-20°C	16,450,004.50	-0.12
-30°C	16,450,002.50	0.00
85% of Nominal Voltage	16,450,007.50	-0.30
115% of Nominal Voltage	16,449,998.50	0.24
Nominal Voltage	16,450,002.50	0.00

NOTE—Parts per million (ppm) is obtained as the difference from the reference frequency (in Hz) divided by the reference frequency (in MHz).

2.5.9 Sample Test Plots

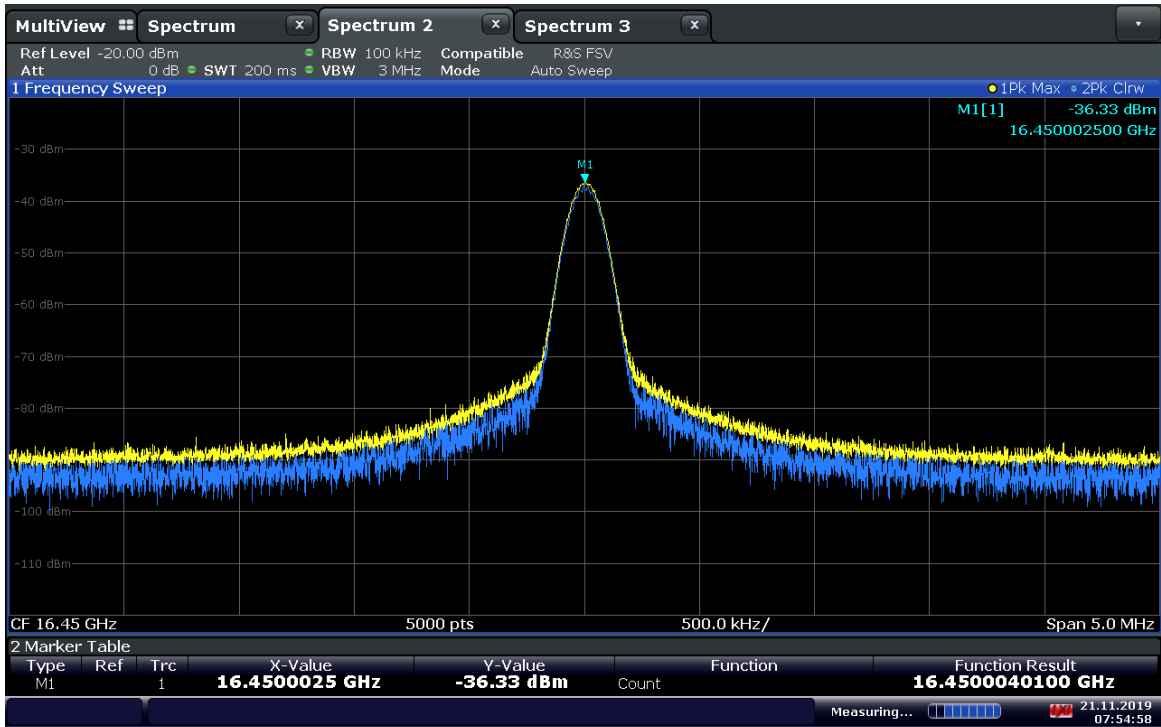


10:17:26 20.11.2019

Frequency Stability @ 50°C

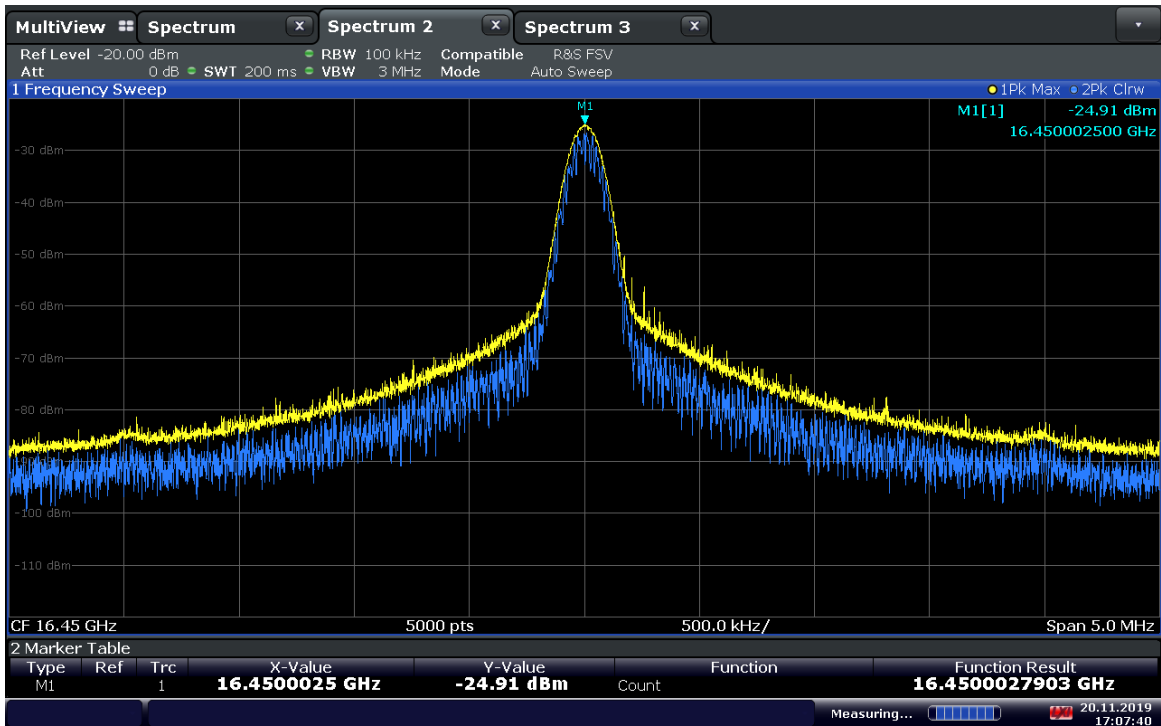


America



07:54:58 21.11.2019

Frequency Stability @ 20°C (Nominal Voltage)



17:07:40 20.11.2019

Frequency Stability @ -30°C



SECTION 3

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 Emission						
1033	Bilog Antenna	3142C	00044556	EMCO	11/06/18	11/06/20
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	08/20/18	08/20/20
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/05/19	03/05/20
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/05/19	03/05/20
8628	Pre-amplifier	QLI-01182835-JO	8986002	Quinstar	03/07/19	03/07/20
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	10/10/19	10/10/21
7628	Horn antenna (75-110 GHz)	SAR-2309-10-S2	13481-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/Active multiplier combination	
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves		
-	Harmonics mixer (50-75 GHz)	FS-Z75	101564	Rhode & Schwarz	01/24/19	01/24/20
7637	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	05/31/18	05/31/20
7636	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	04/11/18	04/11/20
7633	Harmonics mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	Verified by 7611 and corresponding antenna/mixer combination	
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7620	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7620	
40815	Pre-amplifier (18-40 GHz)	19D18	15G27	Spacek Labs	Verified by 1003 and 7620	
44137	V Band waveguide Detector	PE80T3002	V0011860417 20158046	Pasternack	Verified by 1003 and 7611	
8872	Direct Reading Attenuator (40-60)	STA-60-19-D1	11875-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/mixer combination	
8860	Direct Reading Attenuator (50-75)	STA-60-15-D1	11466-01	Sage Millimeter, Inc.		
8861	Direct Reading Attenuator (75-110)	STA-60-10-D1	11466-01	Sage Millimeter, Inc.		
8919	Direct Reading Attenuator (90-140)	STA-60-08-D1	12605-01	Sage Millimeter, Inc.		
8873	Active Multiplier (40-60 GHz)	AMC-19-RFH00	124	Millitech, Inc.		
8914	Active Multiplier (50-75 GHz)	AMC-15-RFH00	283	Millitech, Inc.		
8915	Active Multiplier (75-110 GHz)	AMC-10-RFH00	606	Millitech, Inc.		
8920	Active Multiplier (90-140 GHz)	AMC-08-RFH00	58	Millitech, Inc.		



ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
9001	Horn antenna (18-26.5GHz)	HO42S	101	Custom Microwave	09/09/19	09/09/21
9003	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	09/09/19	09/09/21
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	09/12/19	09/12/20
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	06/20/19	06/20/20
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/11/19	10/11/20
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/19	10/18/20
1016	Pre-Amplifier	PAM-0202	187	PAM	03/08/19	03/08/20
Miscellaneous						
6708	Multimeter	34401A	US36086974	Hewlett Packard	07/18/18	01/07/20
7579	Temperature Chamber	115	151617	TestQuity	09/09/19	09/09/20
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	11312	04/16/19	04/16/20
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	



3.2 Measurement Uncertainty

Calculation of Measurement Uncertainty per CISPR 16-4-2:2011 with Corr. 1

3.2.1 Radiated Measurements (Below 1GHz)

	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20 dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.58 dB	Normal, k=2	2.000	0.38	0.08
4	Receiver sinewave accuracy	0.15 dB	Normal, k=2	2.000	0.23	0.01
5	Receiver pulse amplitude	1.50 dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50 dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50 dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95 dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30 dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10 dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12 dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00 dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90 dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00 dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.99 dB	Triangular	2.449	1.54	2.65
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.57 dB	Rectangular	1.732	0.44	0.11
18	Table height at 3 m	0.10 dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00 dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00 dB				0.00
Combined standard uncertainty				Normal	2.97 dB	
Expanded uncertainty				Normal, k=2	5.94 dB	



3.2.2 Radiated Emission Measurements (Above 1GHz)

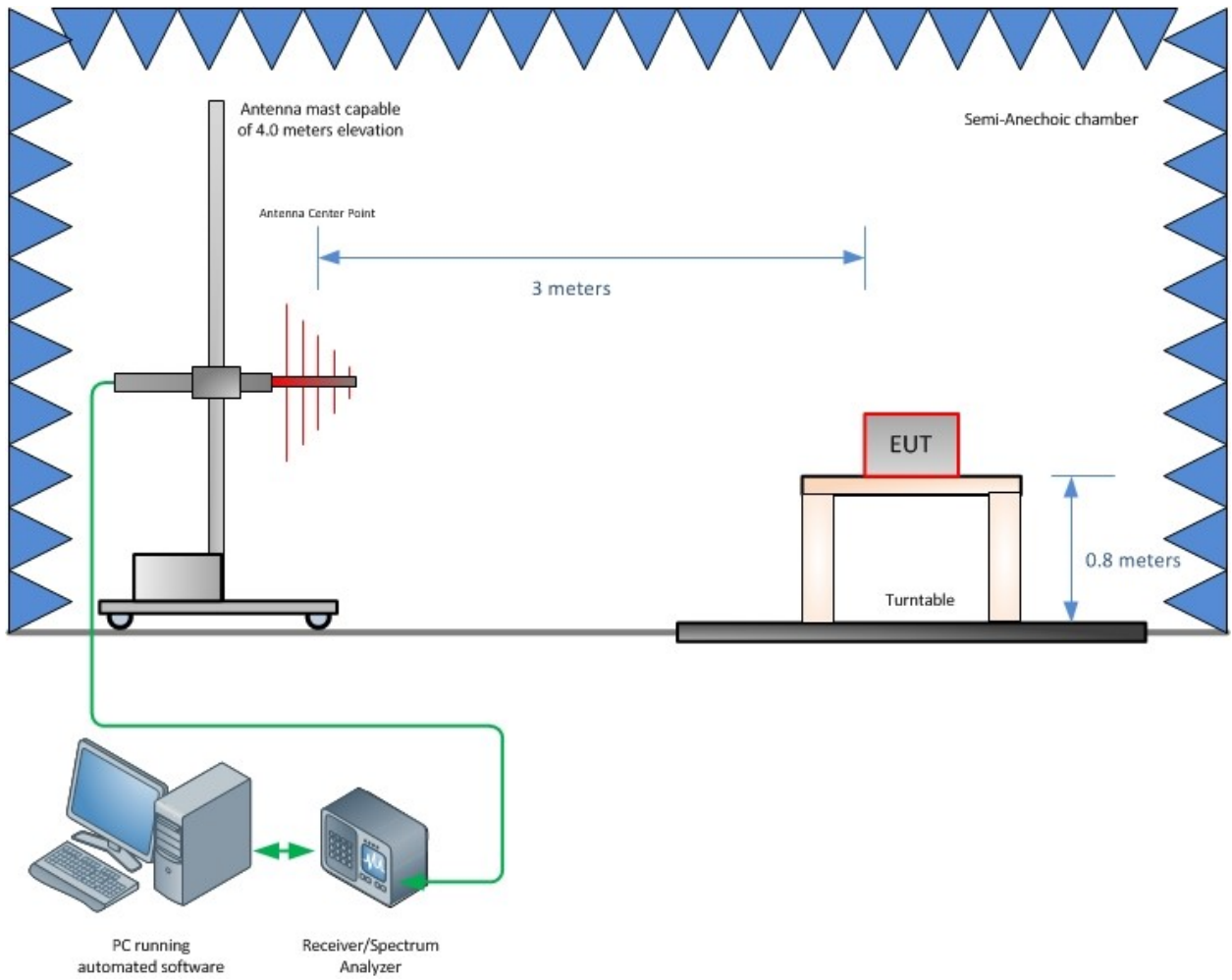
	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.30 dB	Normal, k=2	2.000	0.10	0.02
3	Antenna factor AF	0.20 dB	Normal, k=2	2.000	0.38	0.01
4	Receiver sinewave accuracy	0.47 dB	Normal, k=2	2.000	0.23	0.06
5	Receiver pulse amplitude	0.15 dB	Rectangular	1.732	0.87	0.01
6	Receiver pulse repetition rate	1.21 dB	Rectangular	1.732	0.87	0.49
7	Noise floor proximity	0.70 dB	Rectangular	1.732	0.29	0.16
8	Mismatch: antenna-receiver	1.41 dB	U-shaped	1.414	0.67	0.99
9	AF frequency interpolation	1.30 dB	Rectangular	1.732	0.17	0.85
10	AF height deviations	0.30 dB	Rectangular	1.732	0.06	0.03
11	Directivity difference at 3 m	1.50 dB	Rectangular	1.732	1.80	0.75
12	Phase center location at 3 m	0.30 dB	Rectangular	1.732	0.58	0.03
13	Cross-polarisation	0.90 dB	Rectangular	1.732	0.52	0.27
14	Balance	5.91 dB	Rectangular	1.732	0.00	1.21
15	Site imperfections	1.57 dB	Triangular	2.449	1.33	0.82
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.00 dB	Rectangular	1.732	0.44	0.00
18	Table height at 3 m	0.10 dB	Normal, k=2	2.000	0.05	0.01
19	Near-field effects	0.30 dB	Triangular	2.449	0.00	0.02
20	Effect of ambient noise on OATS	0.20 dB				0.01
Combined standard uncertainty				Normal	2.39 dB	
Expanded uncertainty				Normal, k=2	4.79 dB	



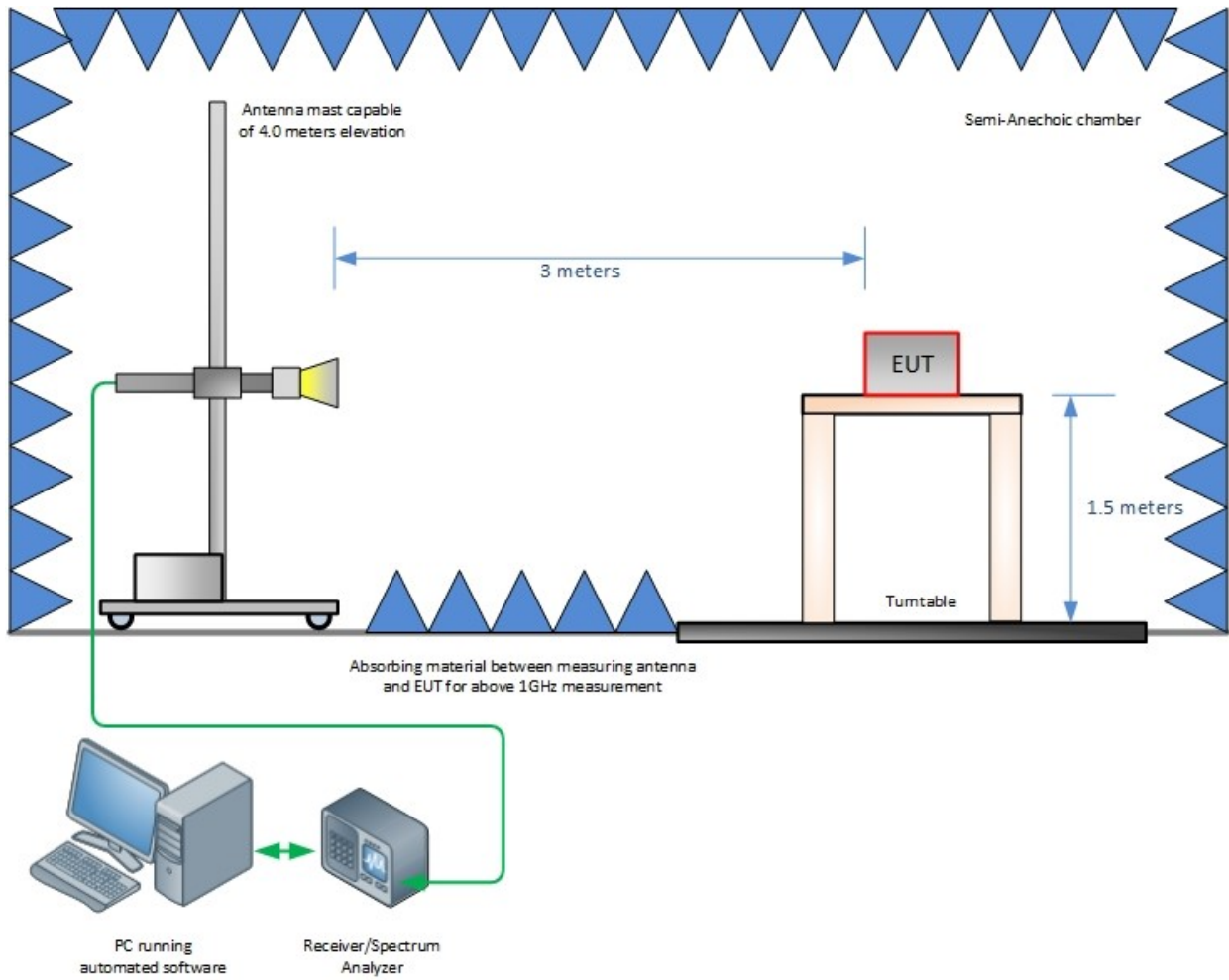
SECTION 4

4 Diagram of Test Setup

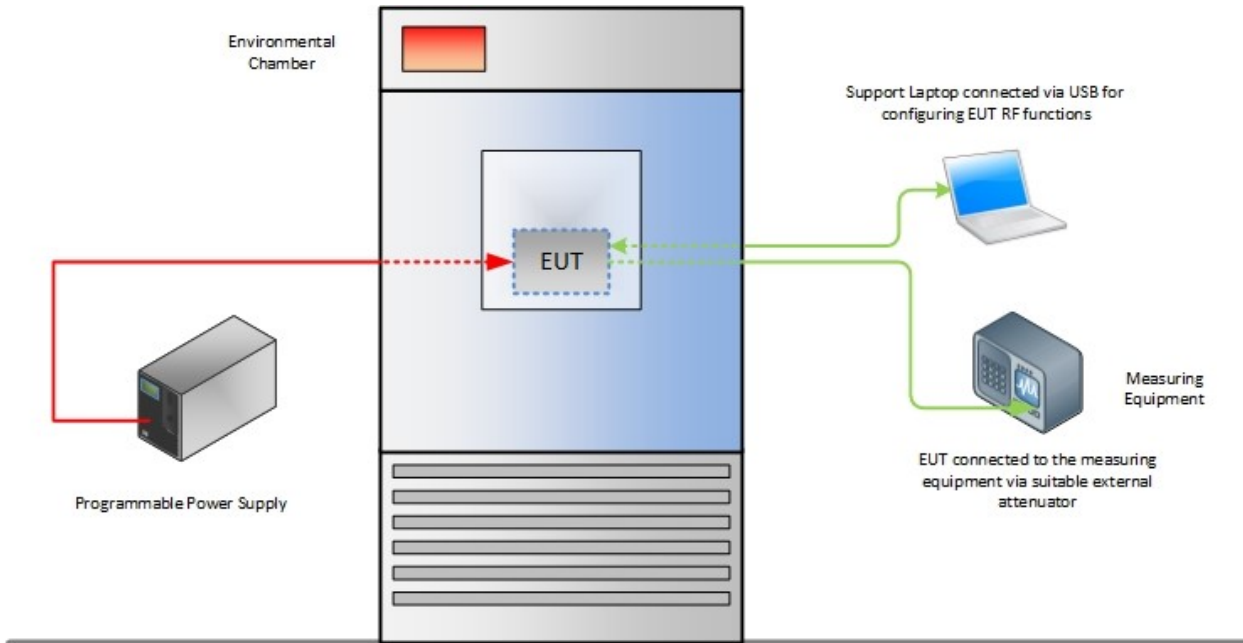
4.1 Test Setup Diagram



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



Frequency Stability Test Configuration



SECTION 5

5 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 Accreditation, Disclaimers and Copyright

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