

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

## In accordance with FCC Title 47 Chapter I Subchapter D Part 87

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



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Date: March 2020

Document Number: 72153658A Issue 02 | Version Number: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Alex Chang	March 18, 2020	

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 87



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

**TEST REPORT NUMBER** 72153658A

**TEST REPORT DATE** March 2020

**PREPARED FOR** Fortem Technologies, Inc.  
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**DATED** March 18, 2020



**Revision History**

72153658A 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 Capability (16.5GHz to 16.7GHz) and Emission Designator from 152MQXN to 170MQXN	Section 1.3.2	Ferdinand Custodio



# CONTENTS

<b>1</b>	<b>REPORT SUMMARY .....</b>	<b>5</b>
1.1	Introduction .....	6
1.2	Brief Summary Of Results .....	7
1.3	Product Information .....	8
1.4	EUT Test Configuration .....	9
1.5	Deviations From The Standard .....	10
1.6	Modification Record .....	10
1.7	Test Methodology .....	10
1.8	Test Facility Location .....	10
1.9	Test Facility Registration .....	10
<b>2</b>	<b>TEST DETAILS .....</b>	<b>12</b>
2.1	RF Power Output .....	13
2.2	Spurious Emissions At Antenna Terminals .....	18
2.3	Field Strength Of Radiated Spurious Emissions .....	21
2.4	Occupied Bandwidth .....	39
2.5	Frequency Stability .....	42
<b>3</b>	<b>TEST EQUIPMENT USED .....</b>	<b>46</b>
<b>4</b>	<b>DIAGRAM OF TEST SETUP .....</b>	<b>51</b>
4.1	Test Setup Diagram .....	52
<b>5</b>	<b>ACCREDITATION, DISCLAIMERS AND COPYRIGHT.....</b>	<b>55</b>
5.1	Accreditation, Disclaimers And Copyright .....	56



## 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 87.

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 87 Aviation 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"><li>• ANSI C63.26-2015. American National Standard for Compliance Testing of Transmitters Used in Licensed radio Services.</li><li>• Supporting documents for EUT certification are separate exhibits.</li></ul>



## 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 87 are shown below:

Part 2	Part 87	Test Description	Result	Comments/ Base Standard
§2.1046	§87.131	RF Power Output	Verified*	
§2.1051	§87.139(a)	Unwanted Emissions	Compliant	
§2.1053	§87.139(a)(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	§87.133(a)	Frequency Stability (Temperature Variation)	Compliant	
§2.1055	§87.133(a)	Frequency Stability (Voltage Variation)	Compliant	

Verified\*  
 N/A

*The maximum power will be determined by appropriate standards during the certification process  
 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	15.4GHz to 15.7GHz (radio navigation)
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

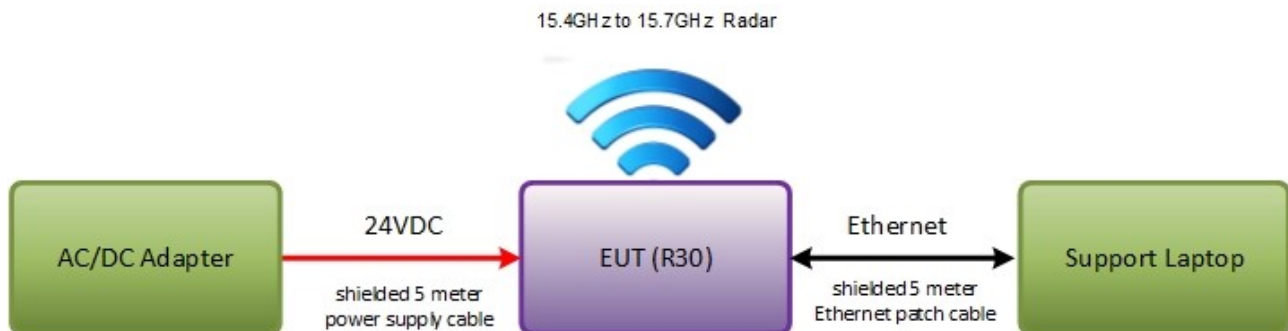
Web browser GUI (integrated with the EUT) and Python 3.7.

### 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 87, Clause 87.131

**2.1.2 Standard Applicable**

Class of Station	Frequency Band/Frequency	Authorized Emission(s) <sup>9</sup>	Maximum Power <sup>1</sup>
Radionavigation	Various <sup>7</sup>	Various <sup>7</sup>	Various <sup>7</sup>

<sup>1</sup>The power is measured at the transmitter output terminals and the type of power is determined according to the emission designator as follows:

(i) Mean power (pY) for amplitude modulated emissions and transmitting both sidebands using unmodulated full carrier.

(ii) Peak envelope power (pX) for all emission designators other than those referred to in paragraph (i) of this note.

<sup>7</sup>Frequency, emission, and maximum power will be determined by appropriate standards during the certification process.

<sup>9</sup>Excludes automatic link establishment.

**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 will be determined by appropriate standards during the certification process. The limit used during verifications will be ignored (greyed out on the test plots presented).

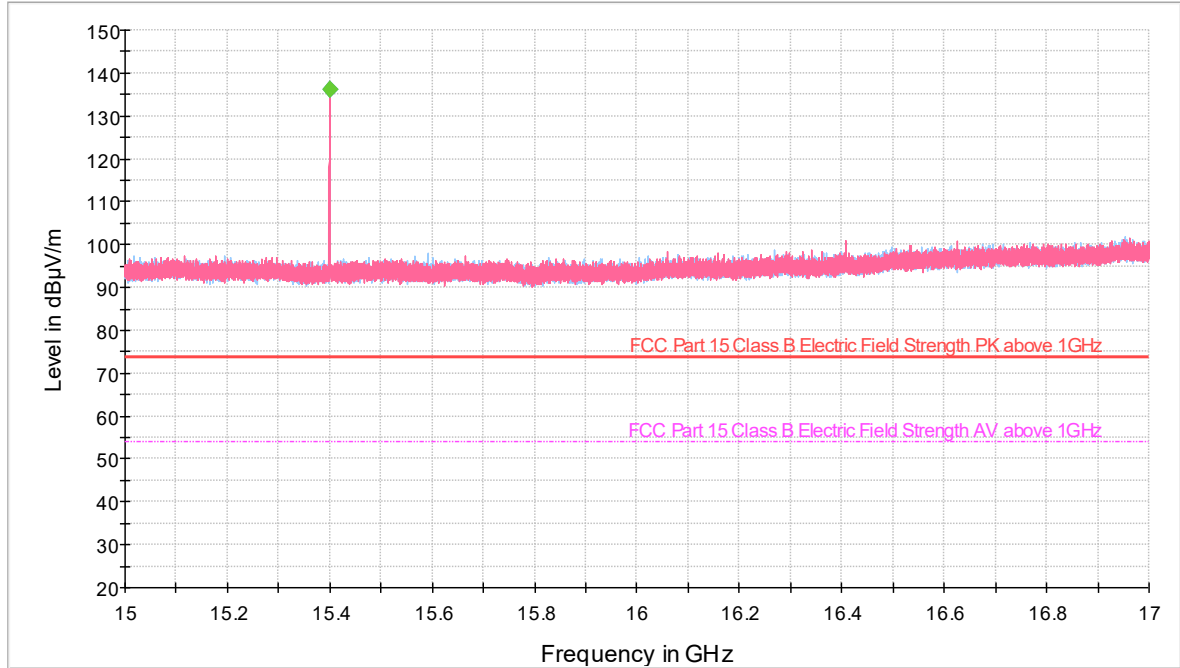
**2.1.8 Summary of Test Results**

Frequency (MHz)	Peak (dBμV/m @ 3 meters)	Average (dBμV/m @ 3 meters)	Peak EIRP (dBm)	Average EIRP (dBm)
15400.00	136.09	135.97	40.83	40.71
15550.00	141.22	141.10	45.96	45.84
15700.00	140.78	140.63	45.52	45.37



### 2.1.9 Low Channel Test Results

Full Spectrum



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

#### 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)
15400.066667	136.09	73.90	-62.19	1000.0	1000.000	125.0	V	202.0	69

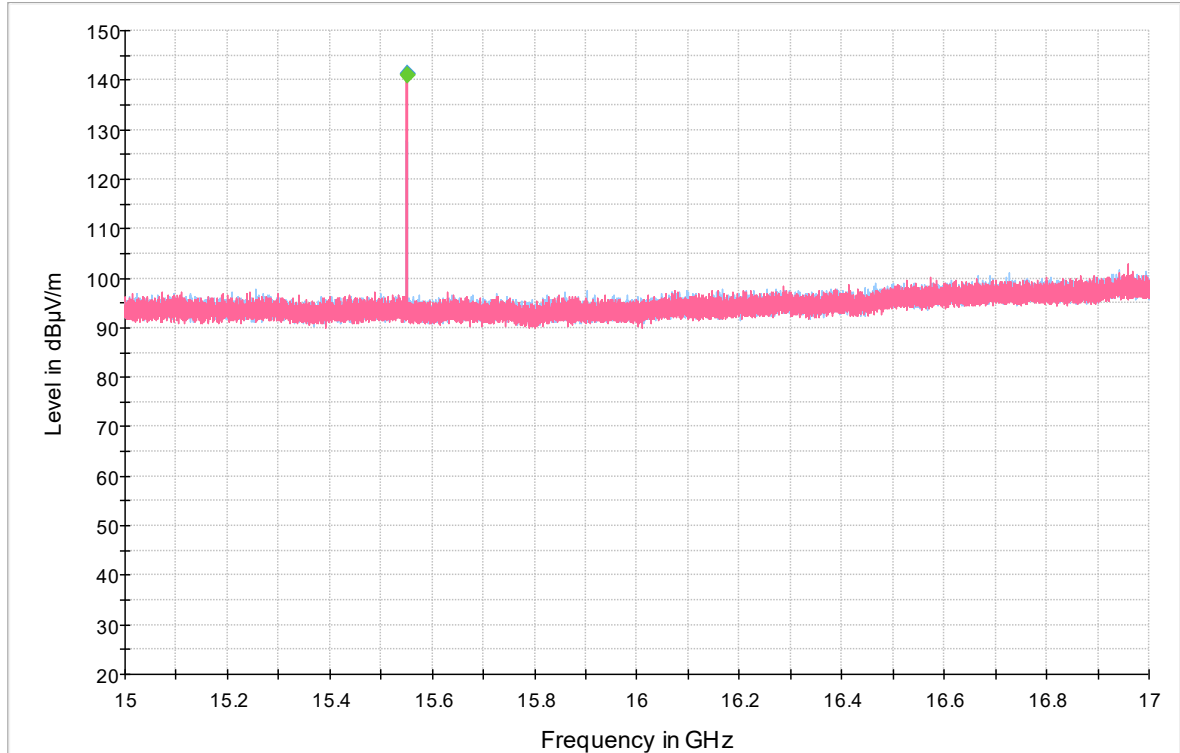
#### Average (Field Strength @ 3 meters)

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
15400.066667	135.97	53.90	-82.07	1000.0	1000.000	125.0	V	202.0	69



**2.1.10 Mid Channel Test Results**

Full Spectrum



◆ Preview Result 1H-PK+ [Preview Result 1H.Result:2] Final\_Result PK+ [Final\_Result.Result:4]  
◆ Preview Result 1V-PK+ [Preview Result 1V.Result:2] 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)
15550.133333	141.22	73.90	-67.32	1000.0	1000.000	181.0	V	203.0	69

**Average (Field Strength @ 3 meters)**

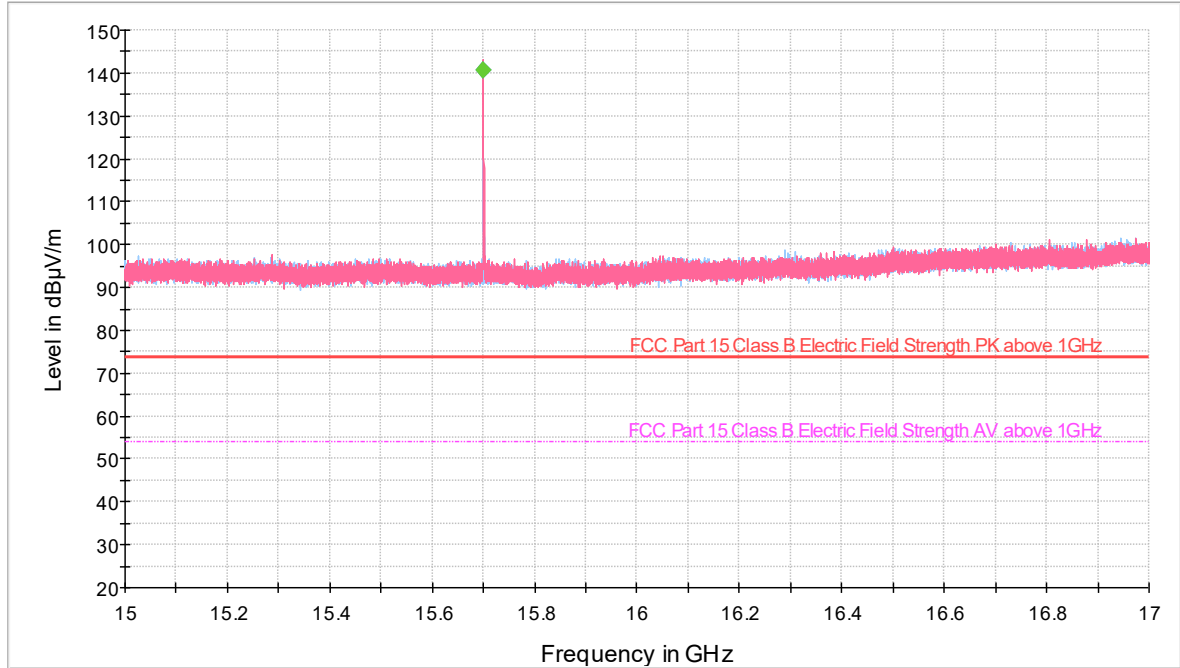
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
15550.133333	141.10	53.90	-87.20	1000.0	1000.000	181.0	V	203.0	69





### 2.1.11 High Channel Test Results

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- 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)
15700.133333	140.78	73.90	-66.88	1000.0	1000.000	165.0	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)
15700.133333	140.63	53.90	-86.73	1000.0	1000.000	165.0	V	202.0	69



## 2.2 Spurious Emissions at Antenna Terminals

### 2.2.1 Specification Reference

FCC 47 CFR Part 87, Clause 87.139(a)

### 2.2.2 Standard Applicable

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

- (1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;
- (2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.
- (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least  $43 + 10 \log_{10} pY$  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. Mira Mesa facility

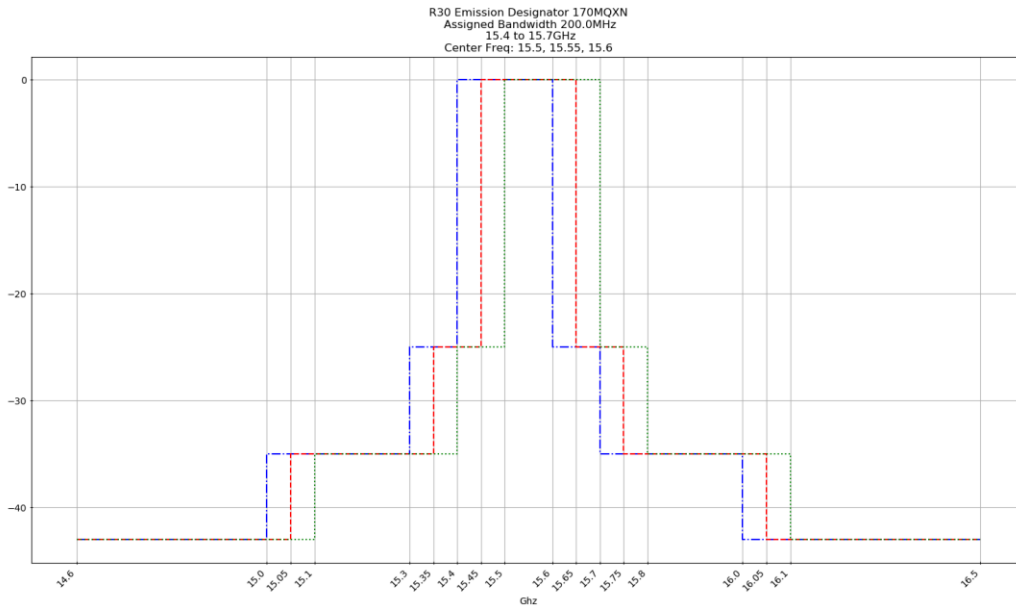
Ambient Temperature	25.0 °C
Relative Humidity	49.4 %
ATM Pressure	99.0 kPa

### 2.2.7 Additional Observations

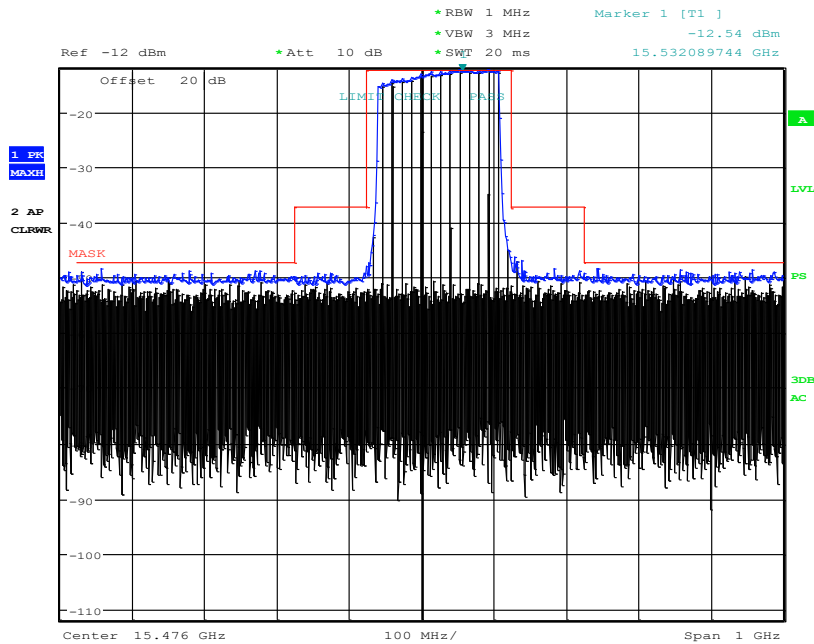
- This is a relative radiated measurement.
- EUT is on full radar swept mode for this test.
- The emission mask was applied per Section 5.7.3 of ANSI C63.26-2015.
- §87.139(a)(3) is covered under Section 2.3 of this test report.



### 2.2.8 Channel Emission Masks

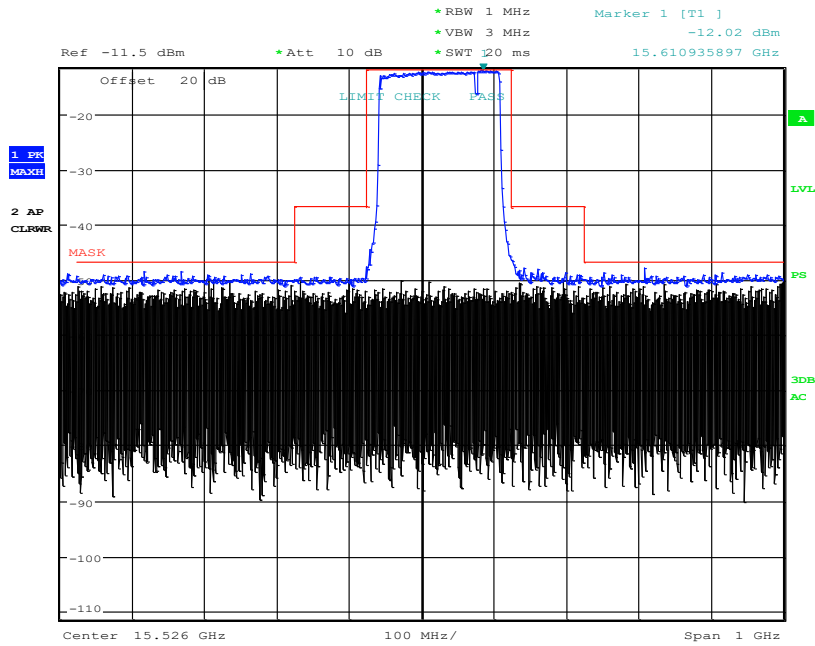


### 2.2.9 Test Result Plots



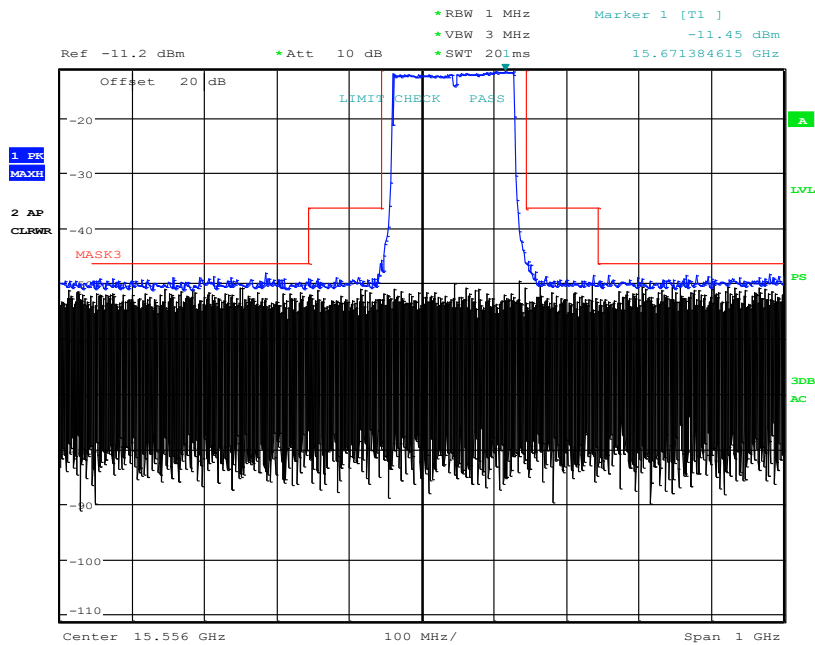
Date: 7.NOV.2019 16:15:04

Low Channel



Date: 7.NOV.2019 16:21:49

### Mid Channel



Date: 7.NOV.2019 16:25:42

### 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)  
FCC 47 CFR Part 87, Clause 87.139(a)(3)

### 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 87, Clause 87.139(a)

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

- (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least  $43 + 10 \log_{10} pY$  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)**

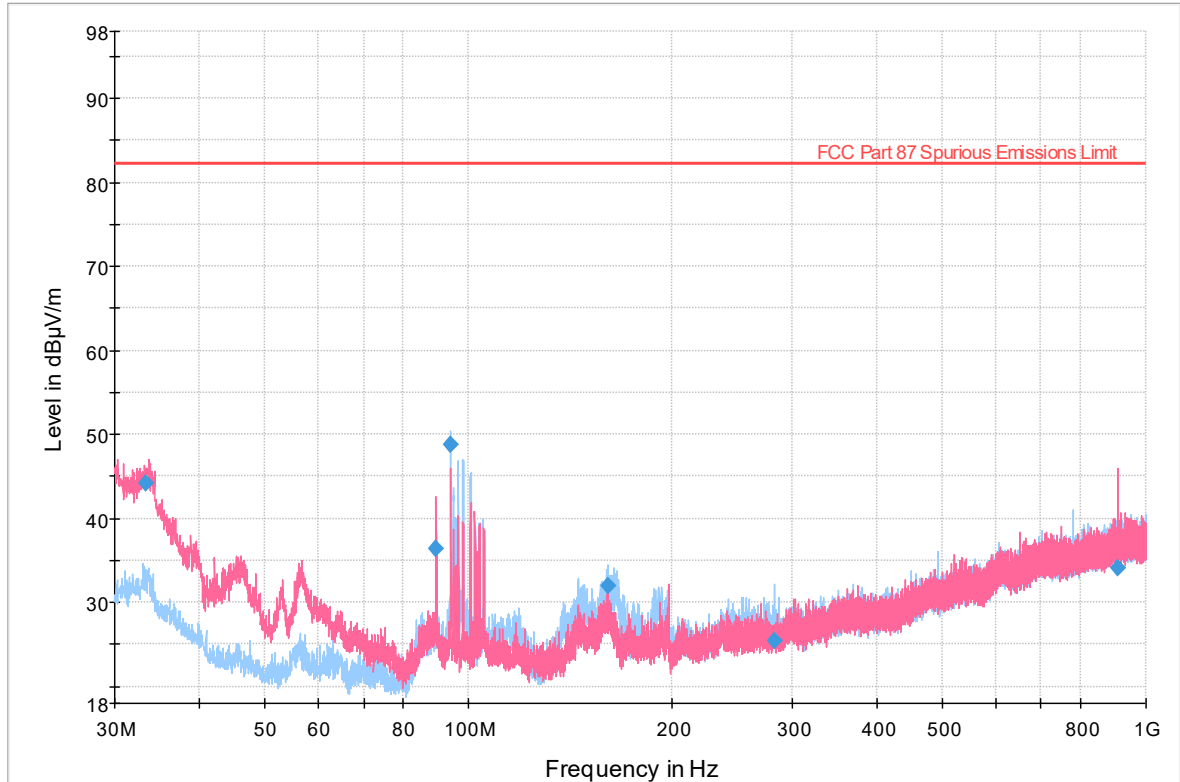
Measuring equipment raw measurement (dbµV) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	Asset# 1172 (cable)	0.3
	Asset# 1016 (preamplifier)	-30.7
	Asset# 1175(cable)	0.3
	Asset# 1002 (antenna)	17.2
<b>Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz</b>		<b>11.8</b>

**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 87 Spurious Emissions Limit [.\EMI Radiated]    
 ◆ Final\_Result QPK [Final\_Result.Result:4]

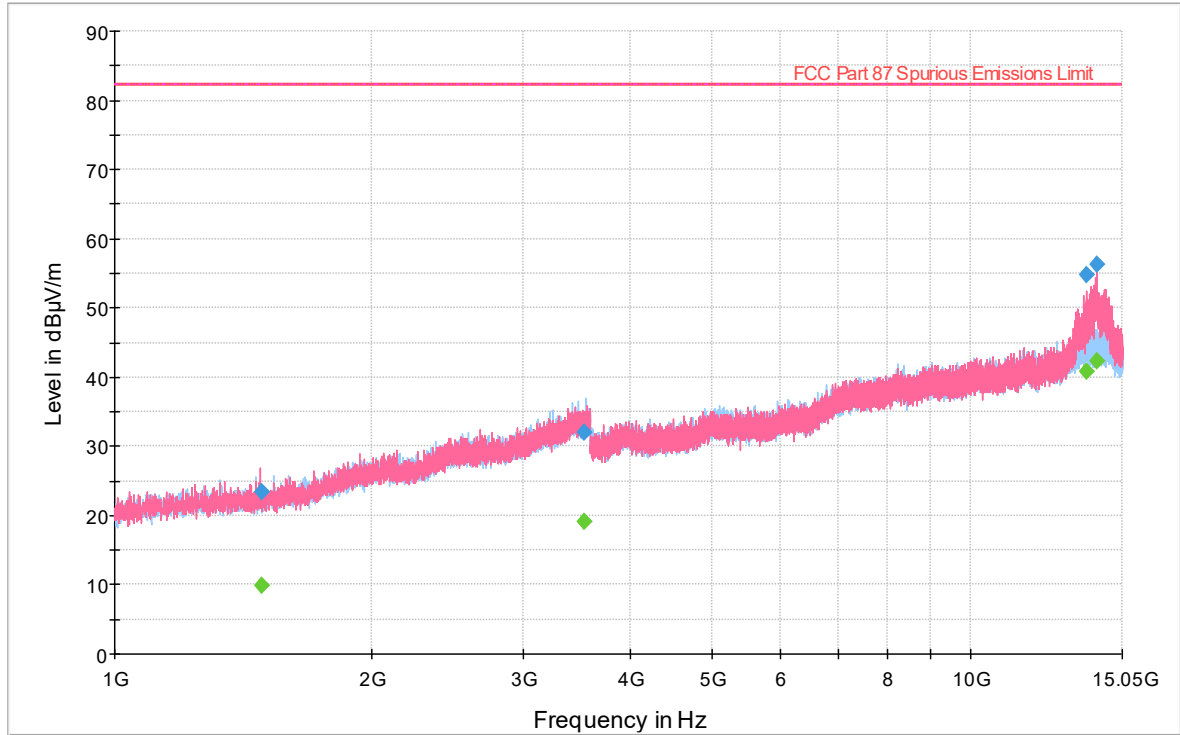
**Quasi-Peak Data**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.357570	44.18	82.23	38.05	1000.0	120.000	107.0	V	76.0	21
89.478038	36.38	82.23	45.85	1000.0	120.000	125.0	V	-6.0	15
94.174244	48.73	82.23	33.50	1000.0	120.000	190.0	H	94.0	16
160.447167	31.97	82.23	50.26	1000.0	120.000	205.0	H	70.0	17
282.349667	25.52	82.23	56.71	1000.0	120.000	108.0	H	14.0	20
910.026333	34.04	82.23	48.19	1000.0	120.000	325.0	V	191.0	31



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 87 Spurious Emissions Limit [.\EMI Radiated]    
 — FCC Part 87 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)
1487.70500	23.39	82.23	58.84	1000.0	1000.000	164.0	V	110.0	28
3537.93333	32.03	82.23	50.20	1000.0	1000.000	130.0	H	173.0	36
13686.7150	54.84	82.23	27.39	1000.0	1000.000	144.0	V	7.0	49
14056.1816	56.20	82.23	26.03	1000.0	1000.000	142.0	V	26.0	50

Average Data

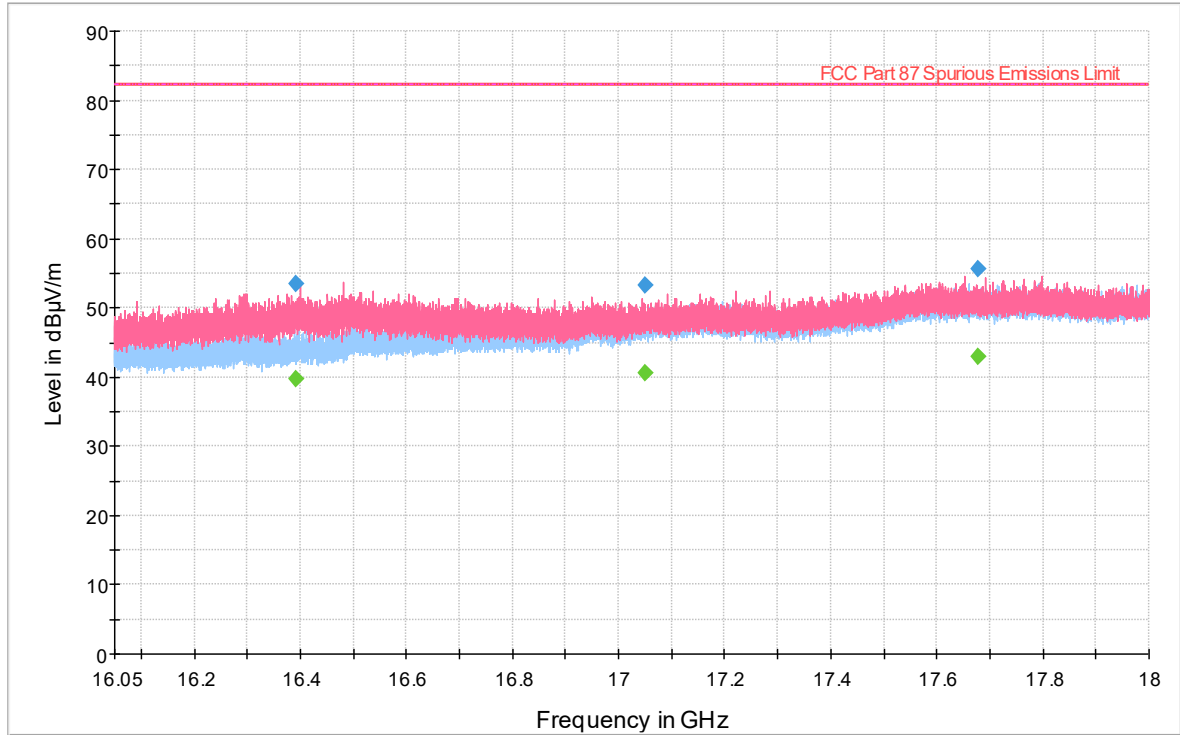
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1487.70500	9.91	82.23	72.32	1000.0	1000.000	164.0	V	110.0	28
3537.93333	19.05	82.23	63.18	1000.0	1000.000	130.0	H	173.0	36
13686.7150	40.78	82.23	41.45	1000.0	1000.000	144.0	V	7.0	49
14056.1816	42.30	82.23	39.93	1000.0	1000.000	142.0	V	26.0	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:2]  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radiated]     — FCC Part 87 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)
16390.9150	53.55	82.23	28.68	1000.0	1000.000	175.0	V	9.0	49
17050.9600	53.22	82.23	29.01	1000.0	1000.000	149.0	V	-10.0	52
17678.2300	55.64	82.23	26.59	1000.0	1000.000	132.0	V	336.0	55

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)
1487.70500	9.91	82.23	72.32	1000.0	1000.000	164.0	V	110.0	28
3537.93333	19.05	82.23	63.18	1000.0	1000.000	130.0	H	173.0	36
14056.1816	42.30	82.23	39.93	1000.0	1000.000	142.0	V	26.0	50



**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)
3604.00000	36.07	82.23	46.16	1000.0	1000.000	170.0	V	7.0	36
13913.2666	55.89	82.23	26.34	1000.0	1000.000	185.0	V	1.0	50
14040.2000	56.91	82.23	25.32	1000.0	1000.000	140.0	V	28.0	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)
3604.00000	22.58	82.23	59.65	1000.0	1000.000	170.0	V	7.0	36
13913.2666	42.01	82.23	40.22	1000.0	1000.000	185.0	V	1.0	50
14040.2000	42.50	82.23	39.73	1000.0	1000.000	140.0	V	28.0	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)
16433.8000	68.57	82.23	13.66	1000.0	1000.000	133.0	V	7.0	49
16455.8666	66.88	82.23	15.35	1000.0	1000.000	175.0	V	318.0	49
17441.8666	58.02	82.23	24.21	1000.0	1000.000	136.0	V	28.0	54

**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)
16433.8000	41.03	82.23	41.20	1000.0	1000.000	133.0	V	7.0	49
16455.8666	39.85	82.23	42.38	1000.0	1000.000	175.0	V	318.0	49
17441.8666	41.51	82.23	40.72	1000.0	1000.000	136.0	V	28.0	54

**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)
1899.55000	26.54	82.23	55.69	1000.0	1000.000	175.0	V	314.0	31
4929.45000	38.72	82.23	43.51	1000.0	1000.000	147.0	V	43.0	39
14020.7000	56.21	82.23	26.02	1000.0	1000.000	169.0	V	9.0	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)
1899.55000	13.47	82.23	68.76	1000.0	1000.000	175.0	V	314.0	31
4929.45000	25.23	82.23	57.00	1000.0	1000.000	147.0	V	43.0	39
14020.7000	42.05	82.23	40.18	1000.0	1000.000	169.0	V	9.0	50

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

**Peak Data**

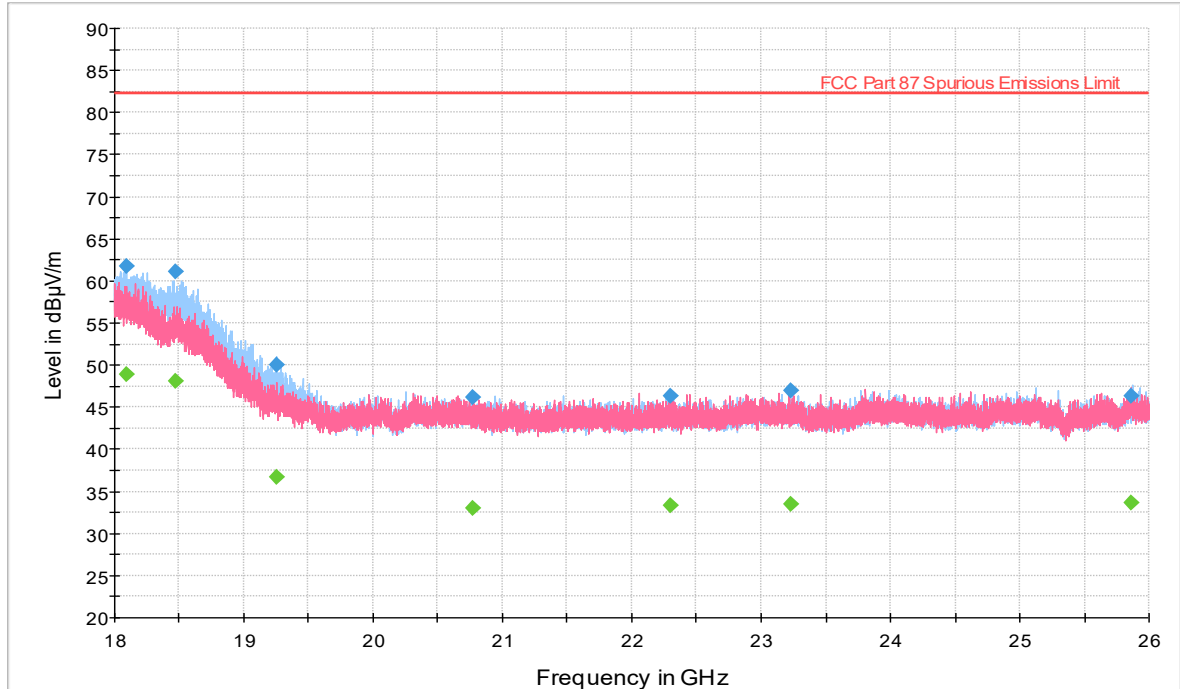
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16324.7633	52.80	82.23	29.43	1000.0	1000.000	175.0	V	15.0	49
17561.6266	56.14	82.23	26.09	1000.0	1000.000	154.0	V	14.0	54
17840.5466	56.34	82.23	25.89	1000.0	1000.000	175.0	V	-10.0	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)
16324.7633	39.11	82.23	43.12	1000.0	1000.000	175.0	V	15.0	49
17561.6266	42.91	82.23	39.32	1000.0	1000.000	154.0	V	14.0	54
17840.5466	43.14	82.23	39.09	1000.0	1000.000	175.0	V	-10.0	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:4]  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radiated\  
◆ Final\_Result AVG [Final\_Result.Result:5]    
 ◆ Final\_Result PK+ [Final\_Result.Result:4]

Peak Data

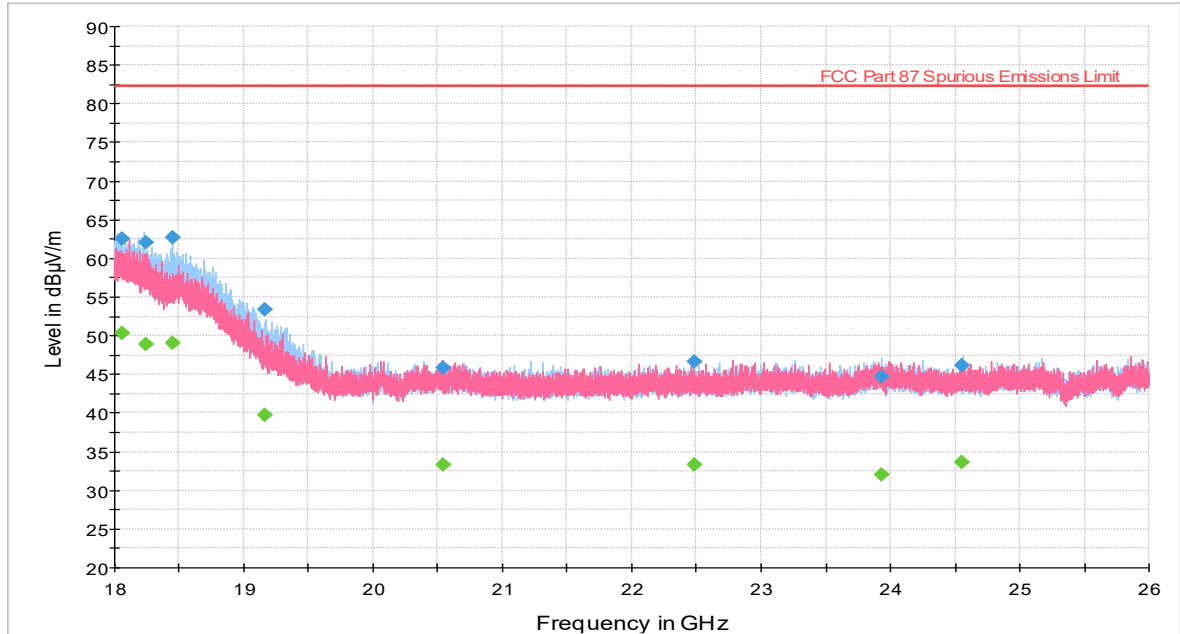
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18090.7135	61.71	82.23	20.52	1000.0	1000.000	182.0	H	136.0	0
18471.2815	61.02	82.23	21.21	1000.0	1000.000	166.0	H	155.0	0
19253.6245	50.00	82.23	32.23	1000.0	1000.000	176.0	H	153.0	0
20769.2740	46.09	82.23	36.14	1000.0	1000.000	173.0	V	327.0	0
22297.0705	46.28	82.23	35.95	1000.0	1000.000	147.0	H	116.0	1
23231.4535	46.99	82.23	35.24	1000.0	1000.000	148.0	H	305.0	2
25866.5875	46.41	82.23	35.82	1000.0	1000.000	172.0	H	131.0	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)
18090.7135	48.97	82.23	33.26	1000.0	1000.000	182.0	H	136.0	0
18471.2815	48.09	82.23	34.14	1000.0	1000.000	166.0	H	155.0	0
19253.6245	36.73	82.23	45.50	1000.0	1000.000	176.0	H	153.0	0
20769.2740	32.97	82.23	49.26	1000.0	1000.000	173.0	V	327.0	0
22297.0705	33.38	82.23	48.85	1000.0	1000.000	147.0	H	116.0	1
23231.4535	33.52	82.23	48.71	1000.0	1000.000	148.0	H	305.0	2
25866.5875	33.57	82.23	48.66	1000.0	1000.000	172.0	H	131.0	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:4]  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radiated]  
◆ Final Result AVG [Final.Result:5]

**Peak Data**

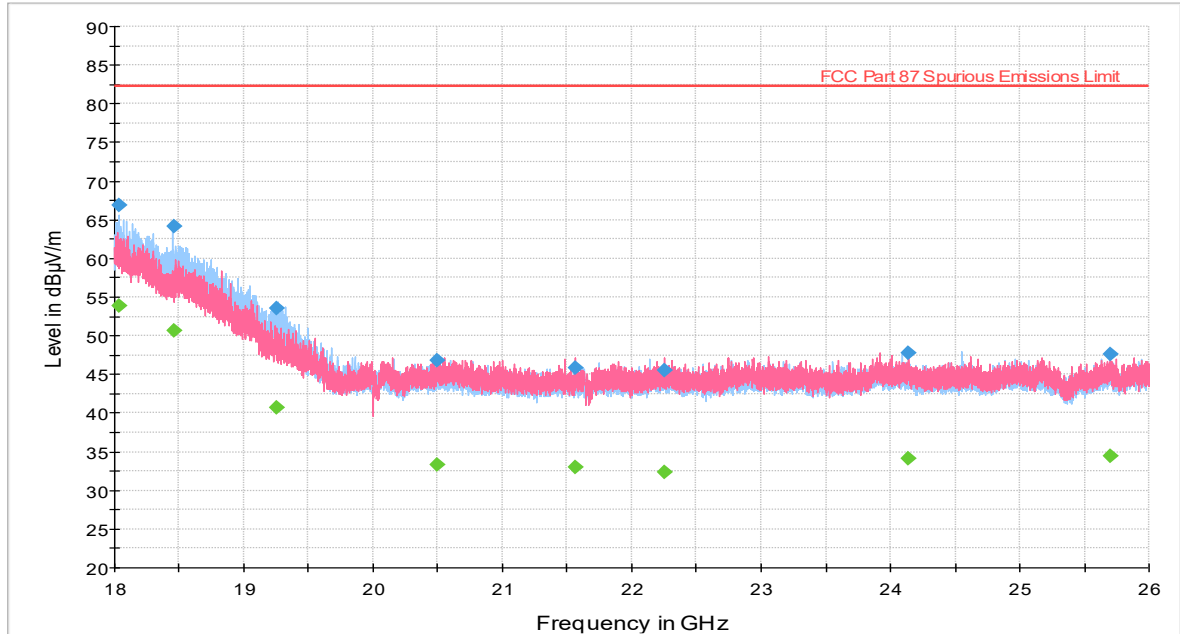
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18052.8175	62.57	82.23	19.66	1000.0	1000.000	160.0	H	214.0	0
18242.9590	62.05	82.23	20.18	1000.0	1000.000	140.0	H	146.0	0
18451.7400	62.63	82.23	19.60	1000.0	1000.000	148.0	H	138.0	0
19163.1885	53.34	82.23	28.89	1000.0	1000.000	173.0	H	216.0	0
20534.9570	45.87	82.23	36.36	1000.0	1000.000	163.0	V	29.0	0
22485.7245	46.64	82.23	35.59	1000.0	1000.000	166.0	H	278.0	1
23930.9210	44.79	82.23	37.44	1000.0	1000.000	163.0	H	9.0	2
24555.2630	46.22	82.23	36.01	1000.0	1000.000	166.0	H	54.0	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)
18052.8175	50.27	82.23	31.96	1000.0	1000.000	160.0	H	214.0	0
18242.9590	48.89	82.23	33.34	1000.0	1000.000	140.0	H	146.0	0
18451.7400	49.11	82.23	33.12	1000.0	1000.000	148.0	H	138.0	0
19163.1885	39.82	82.23	42.41	1000.0	1000.000	173.0	H	216.0	0
20534.9570	33.38	82.23	48.85	1000.0	1000.000	163.0	V	29.0	0
22485.7245	33.38	82.23	48.85	1000.0	1000.000	166.0	H	278.0	1
23930.9210	32.04	82.23	50.19	1000.0	1000.000	163.0	H	9.0	2
24555.2630	33.57	82.23	48.66	1000.0	1000.000	166.0	H	54.0	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:4]  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radiated\]     ◆ Final Result PK+ [Final.Result:4]  
◆ Final Result AVG [Final.Result:5]

Peak Data

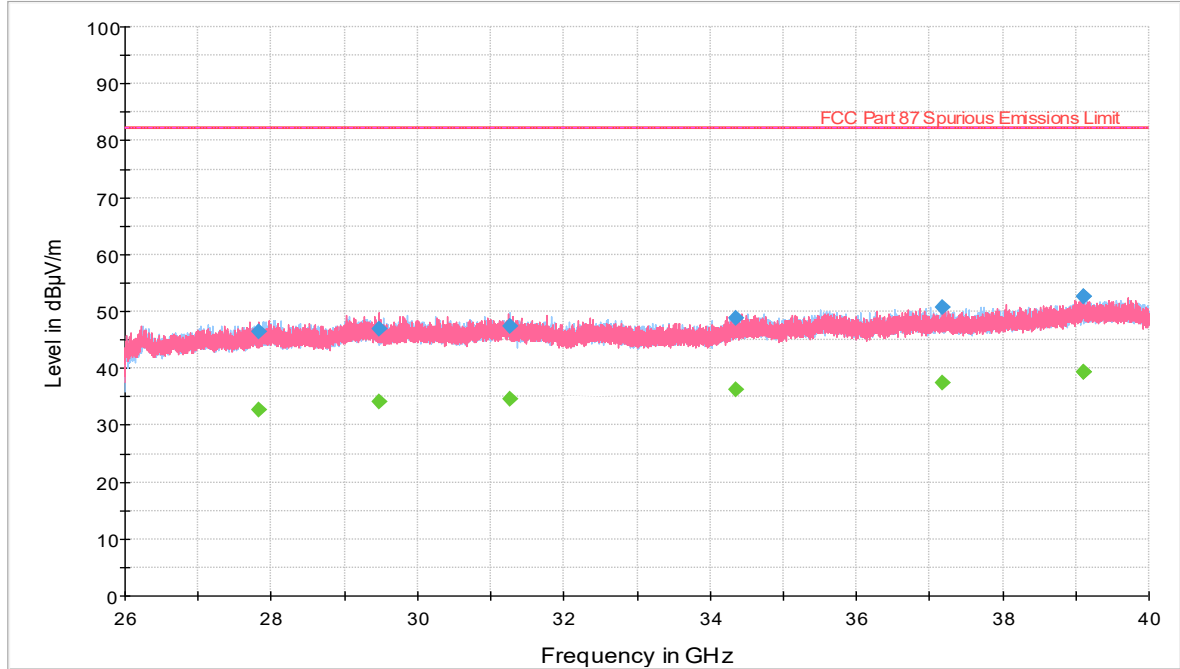
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18036.5055	66.82	82.23	15.41	1000.0	1000.000	137.0	H	149.0	0
18459.0195	64.22	82.23	18.01	1000.0	1000.000	137.0	H	140.0	0
19254.5695	53.48	82.23	28.75	1000.0	1000.000	173.0	H	209.0	0
20493.1900	46.84	82.23	35.39	1000.0	1000.000	137.0	V	210.0	0
21563.8410	45.92	82.23	36.31	1000.0	1000.000	172.0	V	191.0	0
22258.5810	45.45	82.23	36.78	1000.0	1000.000	163.0	V	304.0	1
24134.8455	47.73	82.23	34.50	1000.0	1000.000	162.0	V	285.0	2
25696.2530	47.63	82.23	34.60	1000.0	1000.000	140.0	V	303.0	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)
18036.5055	53.81	82.23	28.42	1000.0	1000.000	137.0	H	149.0	0
18459.0195	50.69	82.23	31.54	1000.0	1000.000	137.0	H	140.0	0
19254.5695	40.70	82.23	41.53	1000.0	1000.000	173.0	H	209.0	0
20493.1900	33.30	82.23	48.93	1000.0	1000.000	137.0	V	210.0	0
21563.8410	33.01	82.23	49.22	1000.0	1000.000	172.0	V	191.0	0
22258.5810	32.28	82.23	49.95	1000.0	1000.000	163.0	V	304.0	1
24134.8455	34.12	82.23	48.11	1000.0	1000.000	162.0	V	285.0	2
25696.2530	34.42	82.23	47.81	1000.0	1000.000	140.0	V	303.0	2



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



◆ Preview Result 1H-PK+ [Preview Result 1H.Result:2]  
◆ Average-AVG [Final\_Result\_AVG.Result:1]  
◆ Final\_Result PK+ [Final\_Result.Result:4]  
◆ Limit [.\EMI Radiated\]

— Preview Result 1V-PK+ [Preview Result 1V.Result:  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radi:  
◆ Final\_Result AVG [Final\_Result.Result:5]  
— Average-AVG(1) [Final\_Result AVG.Result:1]

**Peak Data**

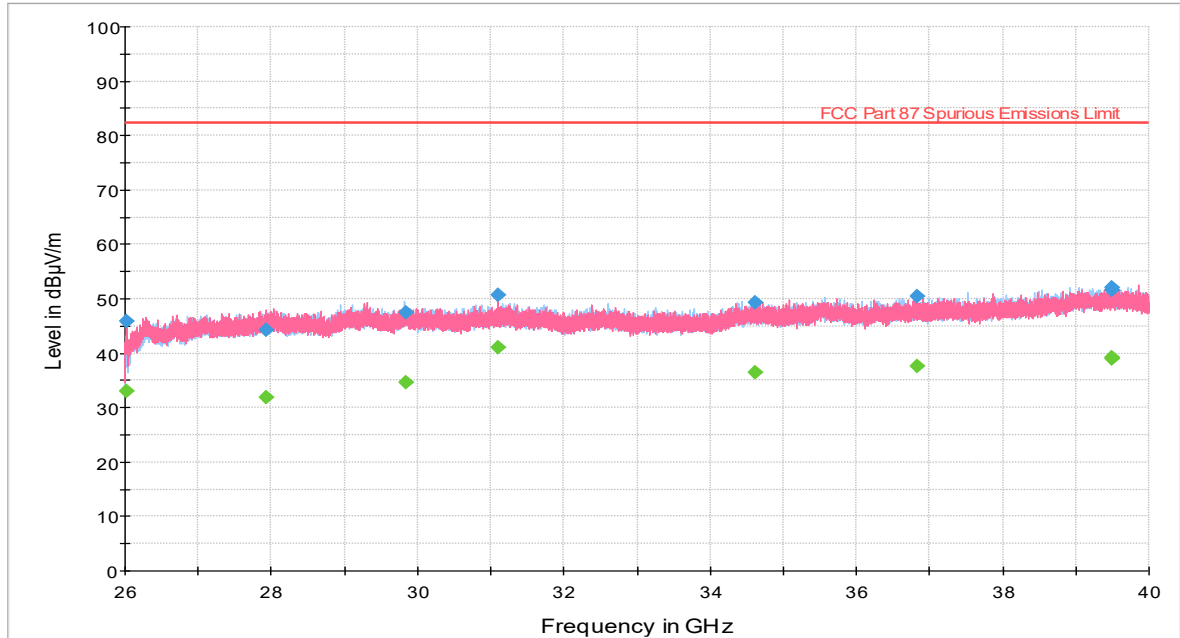
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27832.0446	46.52	82.23	35.71	1000.0	1000.000	126.0	V	7.0	3
29480.1703	46.97	82.23	35.26	1000.0	1000.000	175.0	V	315.0	4
31256.4850	47.28	82.23	34.95	1000.0	1000.000	162.0	H	107.0	6
34349.2057	48.91	82.23	33.32	1000.0	1000.000	128.0	H	82.0	7
37178.5607	50.61	82.23	31.62	1000.0	1000.000	175.0	V	10.0	7
39101.3057	52.60	82.23	29.63	1000.0	1000.000	164.0	H	30.0	9
39102.4830	52.72	82.23	29.51	1000.0	1000.000	164.0	H	35.0	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)
27832.0446	32.70	82.23	49.53	1000.0	1000.000	126.0	V	7.0	3
29480.1703	34.08	82.23	48.15	1000.0	1000.000	175.0	V	315.0	4
31256.4850	34.66	82.23	47.57	1000.0	1000.000	162.0	H	107.0	6
34349.2057	36.22	82.23	46.01	1000.0	1000.000	128.0	H	82.0	7
37178.5607	37.42	82.23	44.81	1000.0	1000.000	175.0	V	10.0	7
39101.3057	39.30	82.23	42.93	1000.0	1000.000	164.0	H	30.0	9
39102.4830	39.41	82.23	42.82	1000.0	1000.000	164.0	H	35.0	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:4]  
— FCC Part 87 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)
26014.3384	45.79	82.23	36.44	1000.0	1000.000	175.0	V	223.0	3
27935.1861	44.31	82.23	37.92	1000.0	1000.000	140.0	V	125.0	3
29838.7400	47.45	82.23	34.78	1000.0	1000.000	133.0	H	118.0	5
31100.1730	50.77	82.23	31.46	1000.0	1000.000	180.0	V	163.0	6
34606.1134	49.30	82.23	32.93	1000.0	1000.000	180.0	H	163.0	7
36821.8188	50.53	82.23	31.70	1000.0	1000.000	147.0	H	318.0	7
39495.9738	51.60	82.23	30.63	1000.0	1000.000	143.0	H	127.0	10
39501.6457	51.98	82.23	30.25	1000.0	1000.000	165.0	H	141.0	10

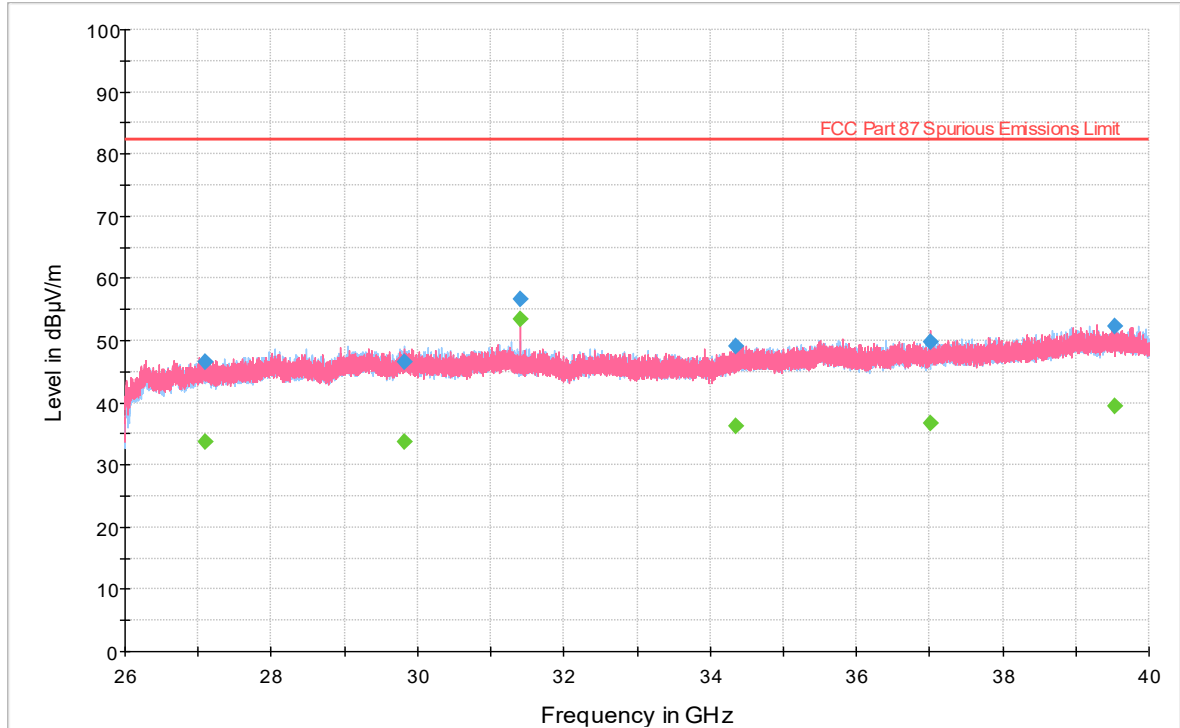
**Average Data**

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26014.3384	33.02	82.23	49.21	1000.0	1000.000	175.0	V	223.0	3
27935.1861	31.89	82.23	50.34	1000.0	1000.000	140.0	V	125.0	3
29838.7400	34.54	82.23	47.69	1000.0	1000.000	133.0	H	118.0	5
31100.1730	41.10	82.23	41.13	1000.0	1000.000	180.0	V	163.0	6
34606.1134	36.57	82.23	45.66	1000.0	1000.000	180.0	H	163.0	7
36821.8188	37.58	82.23	44.65	1000.0	1000.000	147.0	H	318.0	7
39495.9738	38.99	82.23	43.24	1000.0	1000.000	143.0	H	127.0	10
39501.6457	39.12	82.23	43.11	1000.0	1000.000	165.0	H	141.0	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:4]  
— FCC Part 87 Spurious Emissions Limit [.\EMI Radiated]     ◆ Final\_Result PK+ [Final\_Result.Result:4]  
◆ Final\_Result AVG [Final\_Result.Result:5]

**Peak Data**

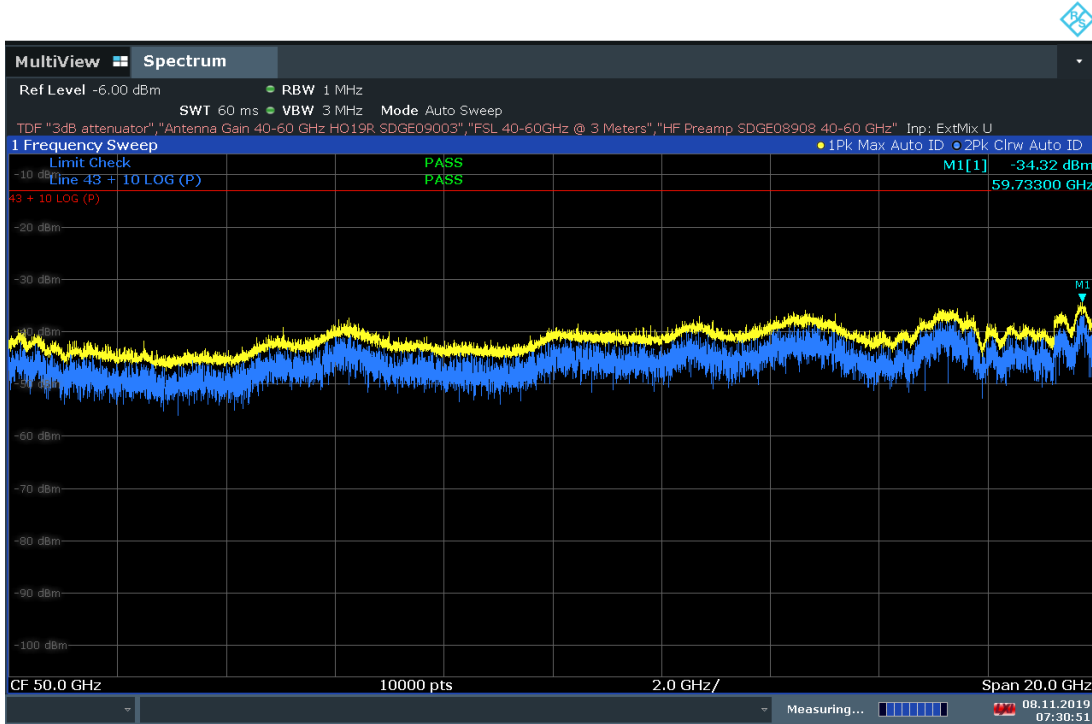
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27092.8815	46.49	82.23	35.74	1000.0	1000.000	180.0	H	190.0	3
29823.6584	46.64	82.23	35.59	1000.0	1000.000	151.0	H	115.0	5
31400.1026	56.74	82.23	25.49	1000.0	1000.000	125.0	V	149.0	5
34348.8561	49.03	82.23	33.20	1000.0	1000.000	175.0	H	228.0	7
37017.5623	49.68	82.23	32.55	1000.0	1000.000	156.0	V	196.0	7
39523.0615	52.33	82.23	29.90	1000.0	1000.000	175.0	H	263.0	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)
27092.8815	33.72	82.23	48.51	1000.0	1000.000	180.0	H	190.0	3
29823.6584	33.70	82.23	48.53	1000.0	1000.000	151.0	H	115.0	5
31400.1026	53.37	82.23	28.86	1000.0	1000.000	125.0	V	149.0	5
34348.8561	36.19	82.23	46.04	1000.0	1000.000	175.0	H	228.0	7
37017.5623	36.63	82.23	45.60	1000.0	1000.000	156.0	V	196.0	7
39523.0615	39.50	82.23	42.73	1000.0	1000.000	175.0	H	263.0	10

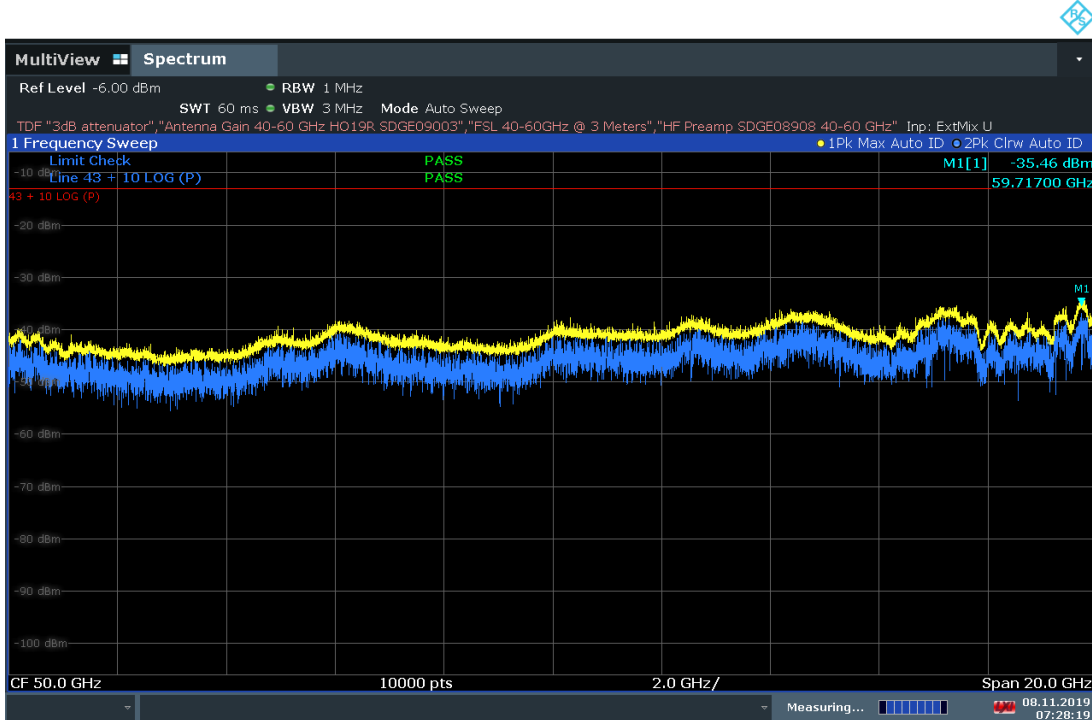


### 2.3.23 40GHz to 100GHz Maximized Plots



07:30:51 08.11.2019

### 40GHz to 60GHz Plot (Low Channel)

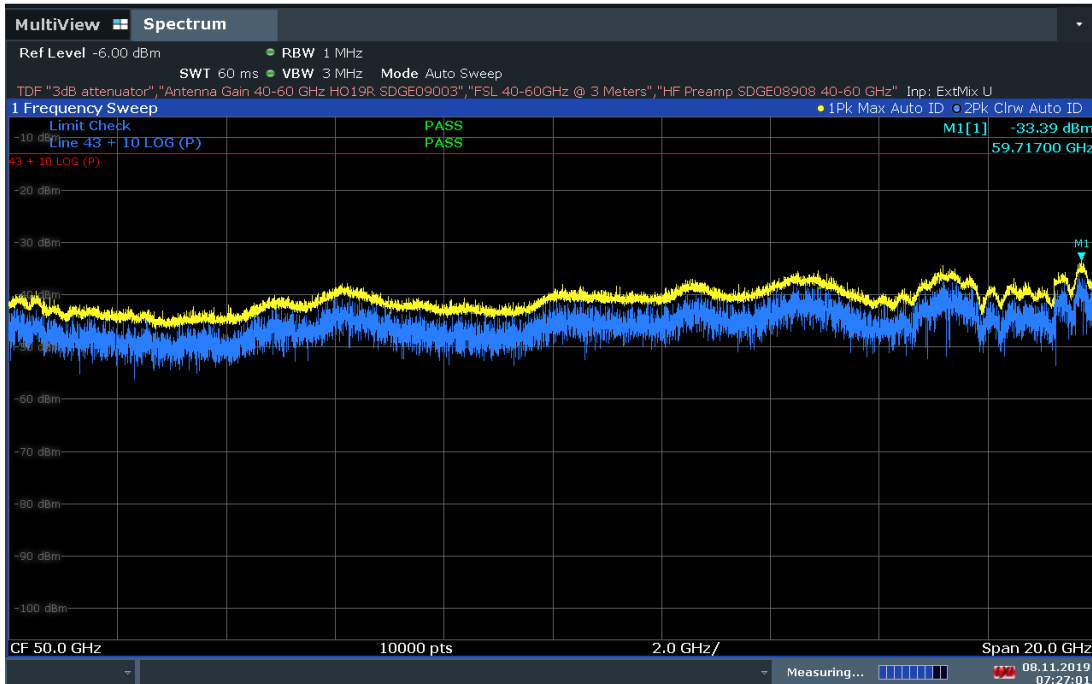


07:28:20 08.11.2019

### 40GHz to 60GHz Plot (Middle Channel)

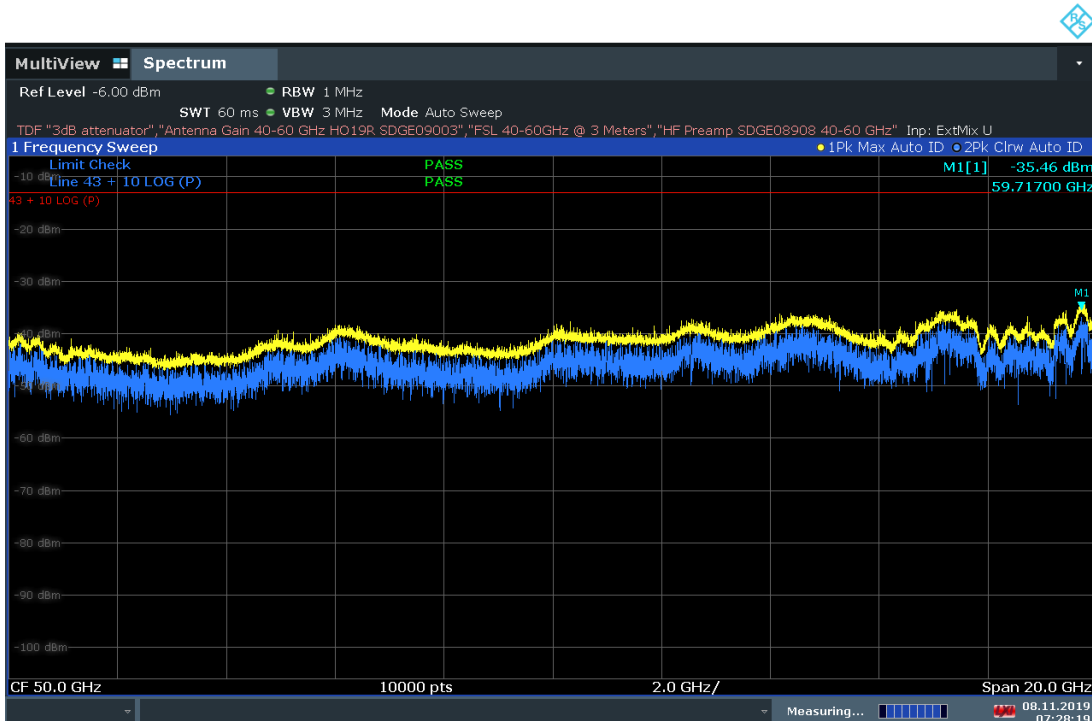


America



07:27:02 08.11.2019

### 40GHz to 60GHz Plot (High Channel)



07:28:20 08.11.2019

### 60GHz to 75GHz Plot (Low Channel)

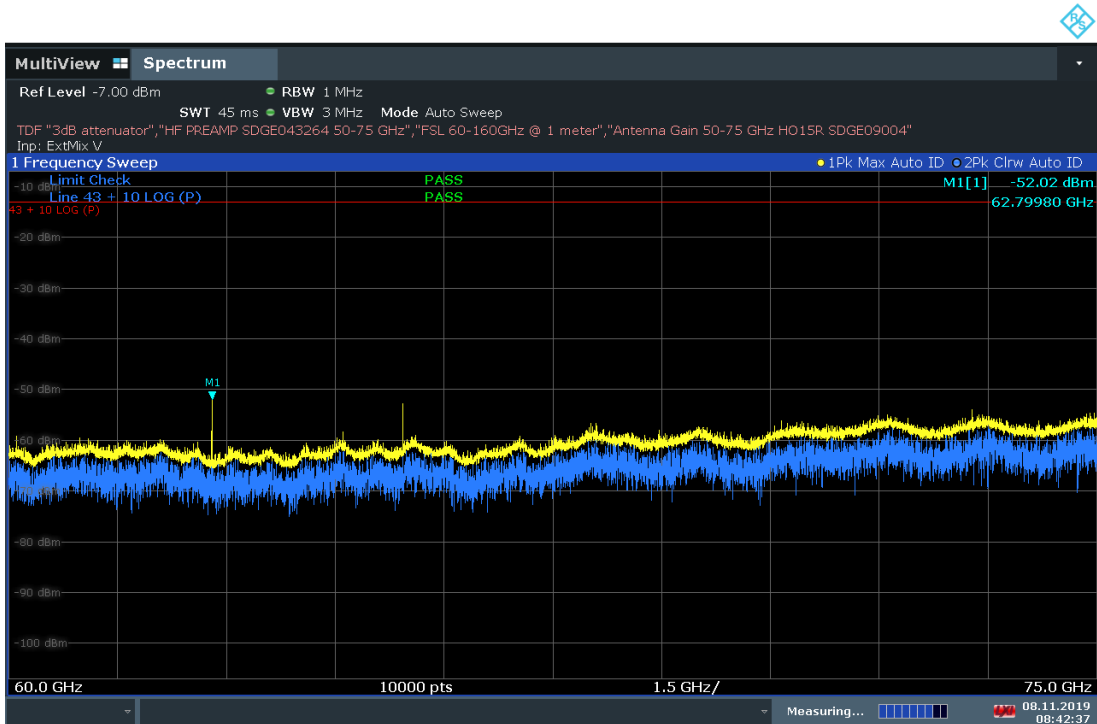


America



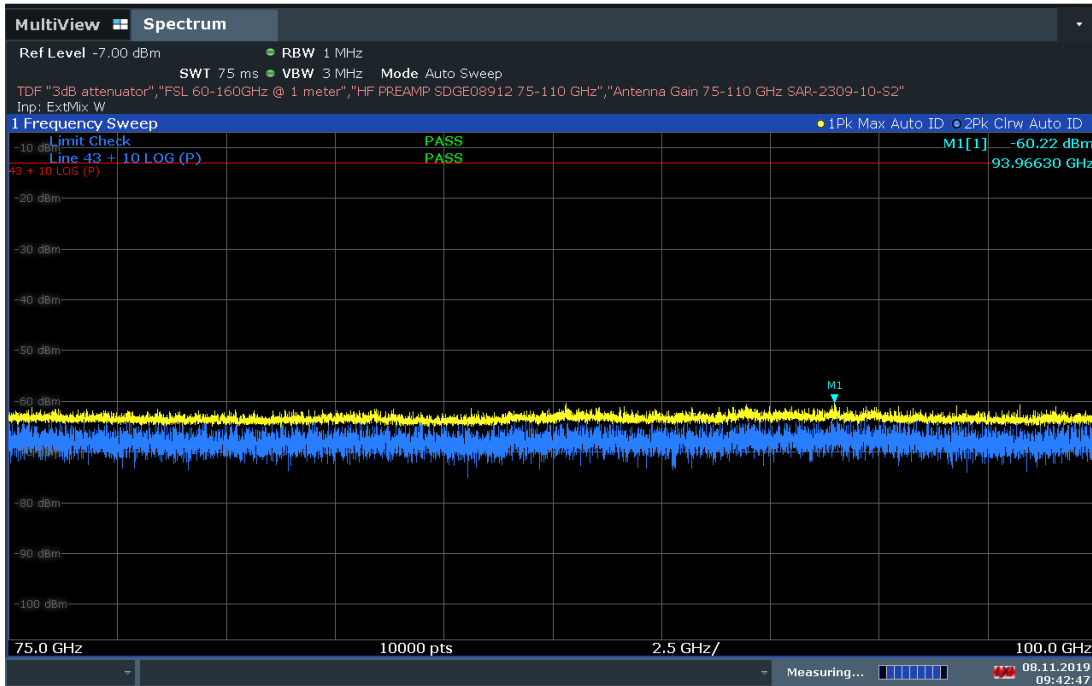
08:41:00 08.11.2019

60GHz to 75GHz Plot (Middle Channel)



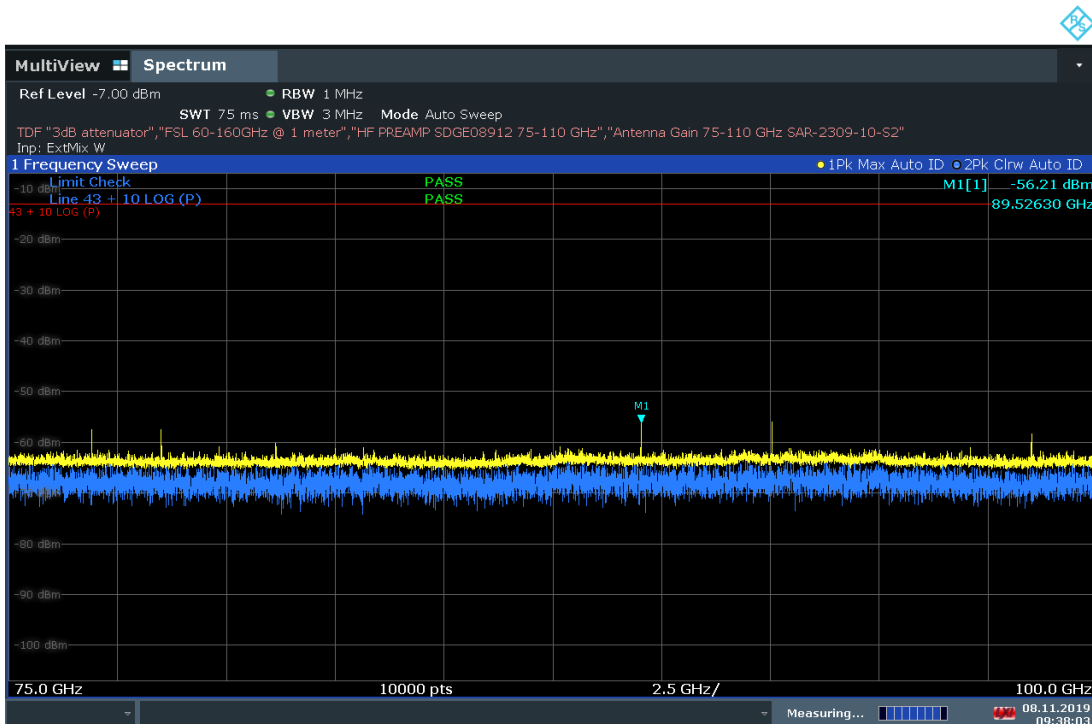
08:42:38 08.11.2019

60GHz to 75GHz Plot (High Channel)



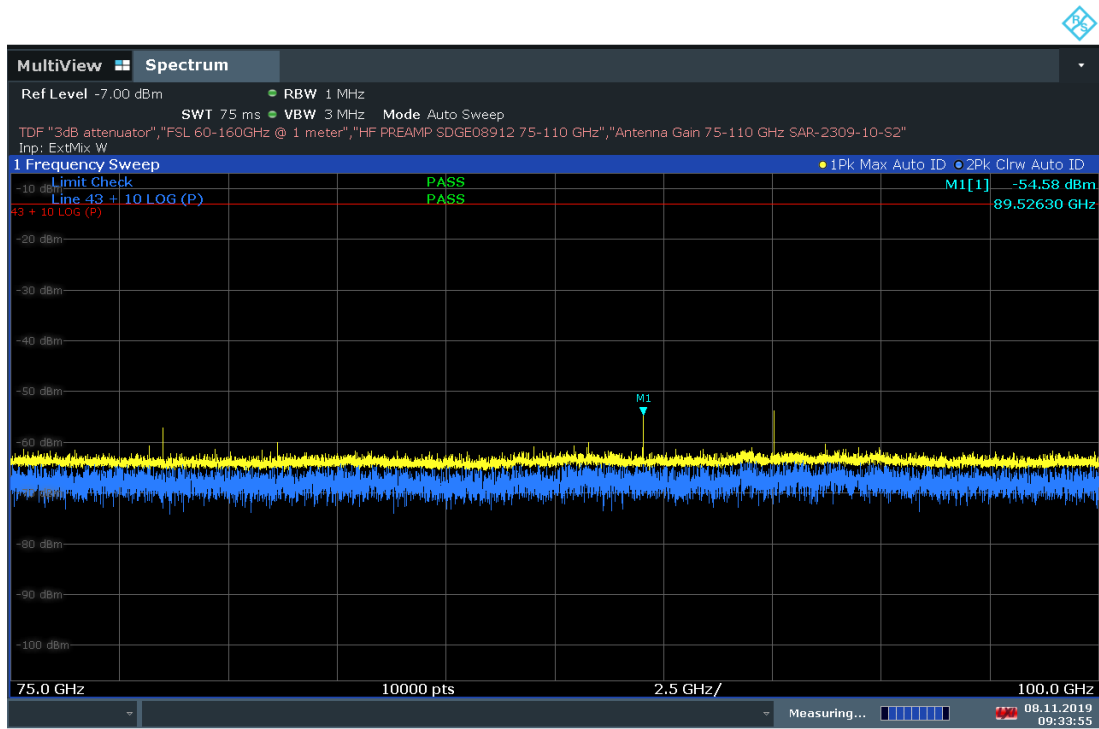
09:42:47 08.11.2019

75GHz to 100GHz Plot (Low Channel)



09:38:04 08.11.2019

75GHz to 100GHz Plot (Middle Channel)



09:33:55 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

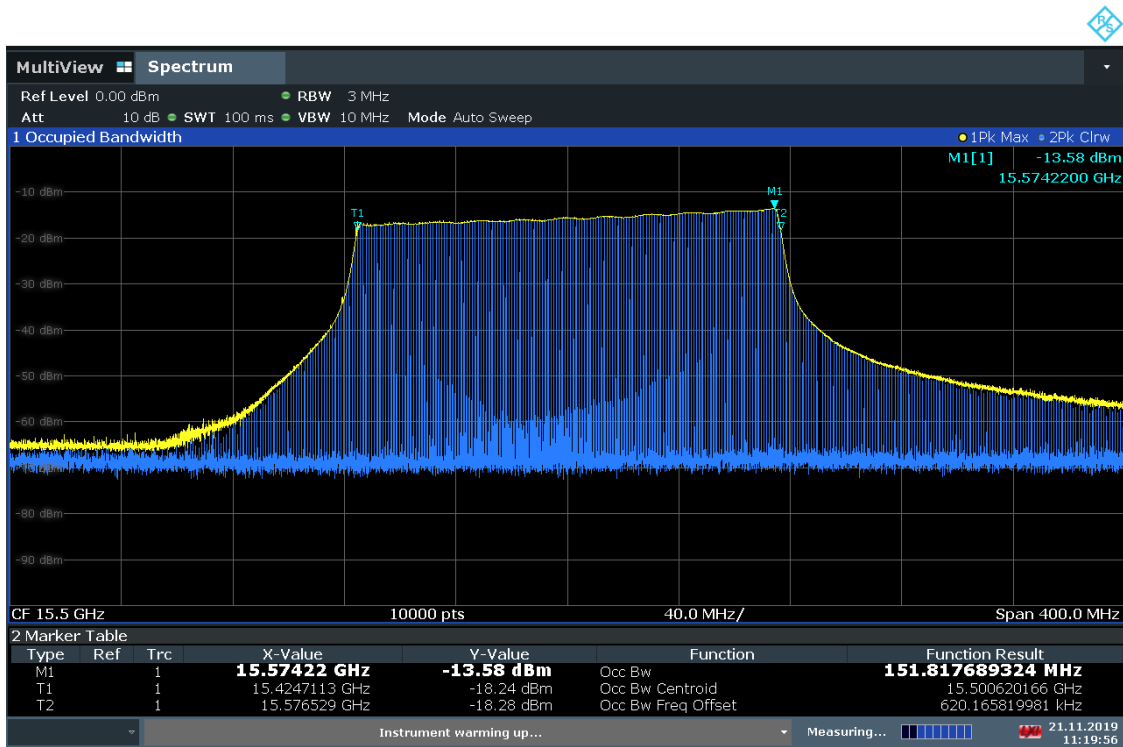
- This is a radiated test.
- This is a radiated test utilizing a spectrum analyser.
- The attenuation for the external attenuator, adapter and cable is measured and entered as a Transducer factor (TDF).
- Occupied bandwidth measurement function of the spectrum analyser was utilized for this test.
- Span 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	15.50	151.82
Mid	15.55	151.38
High	15.60	152.10

2.4.9 Test Result Plots



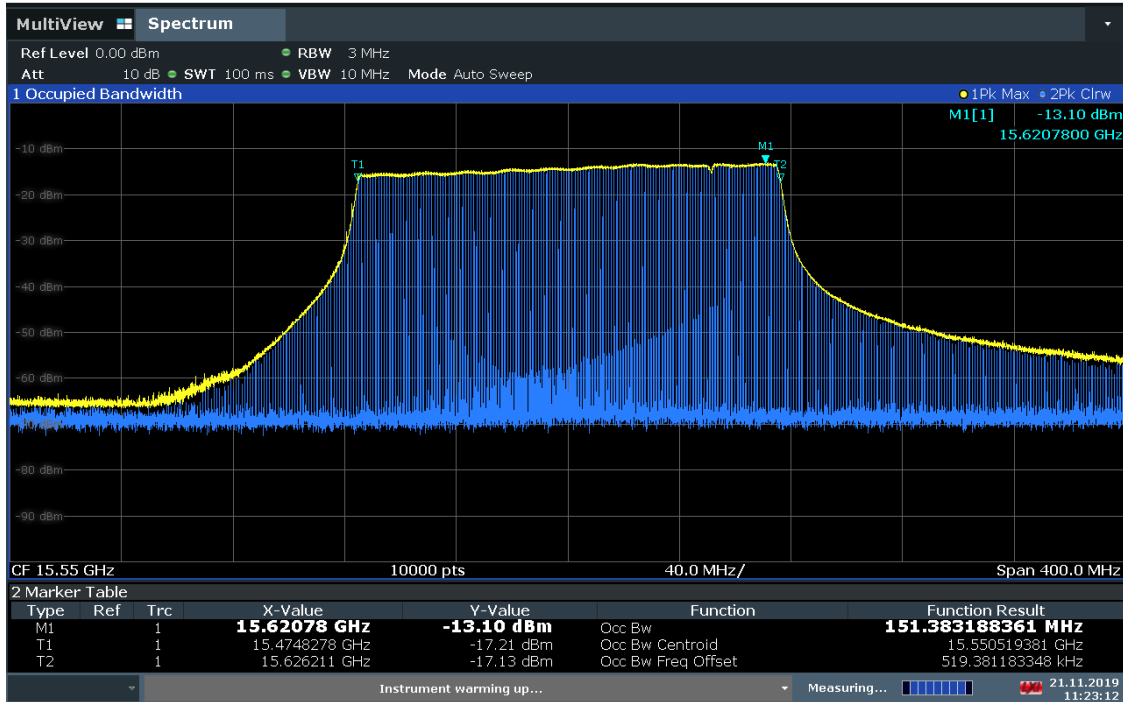
11:19:56 21.11.2019

Center Frequency @ 15.5GHz



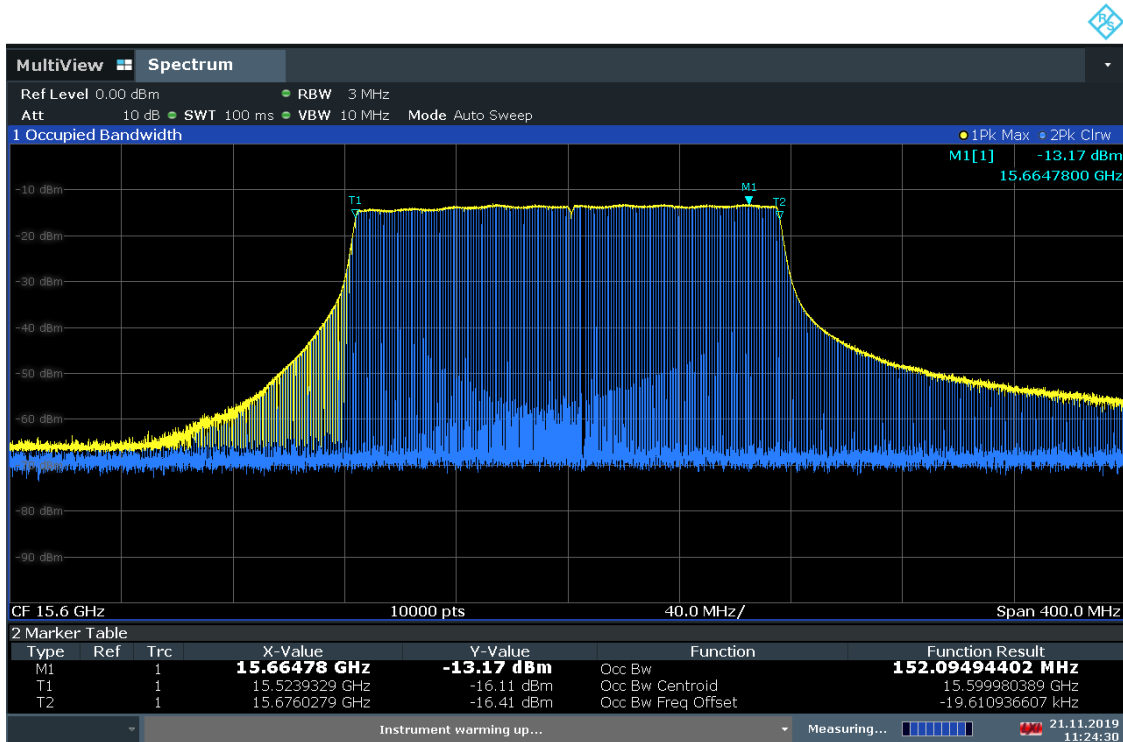


America



11:23:13 21.11.2019

Center Frequency @ 15.55GHz



11:24:31 21.11.2019

Center Frequency @ 15.60GHz



## 2.5 Frequency Stability

### 2.5.1 Specification Reference

FCC 47 CFR Part 87, Clause 87.133(a)

### 2.5.2 Standard Applicable

(a) Except as provided in paragraphs (c), (d), (f), and (g) of this section, the carrier frequency of each station must be maintained within these tolerances:

Frequency band (lower limit exclusive, upper limit inclusive), and categories of stations	Tolerance
Band 10.5 GHz to 40 GHz radionavigation stations	5000 ppm

### 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.



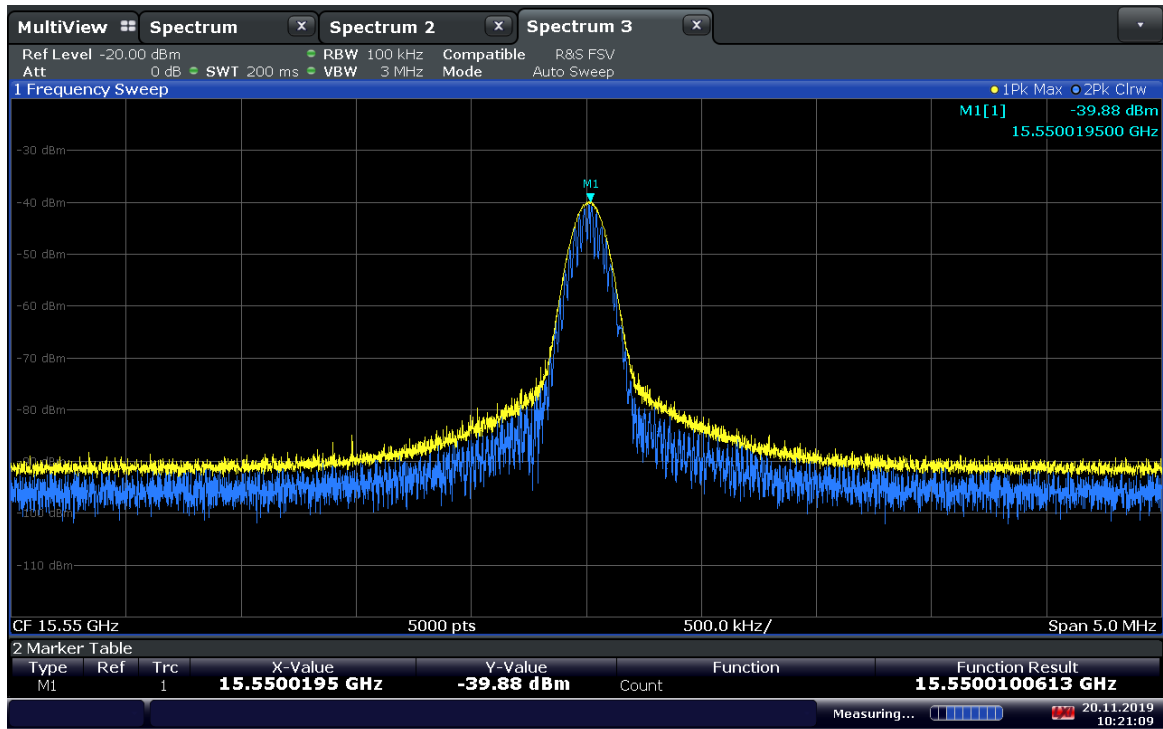
**2.5.8 Test Result Table**

Temperature (°C)	Frequency (MHz)	ppm
50°C	15,550,019.50	-0.84
40°C	15,550,015.50	-0.58
30°C	15,550,006.50	0.00
20°C	15,550,006.50	0.00
10°C	15,549,999.50	0.45
0°C	15,549,998.50	0.51
-10°C	15,550,002.50	0.26
-20°C	15,550,010.50	-0.26
-30°C	15,550,001.50	0.32
<b>85% of Nominal Voltage</b>	15,550,001.50	0.32
<b>115% of Nominal Voltage</b>	15,550,010.50	-0.26
<b>Nominal Voltage</b>	15,550,006.50	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

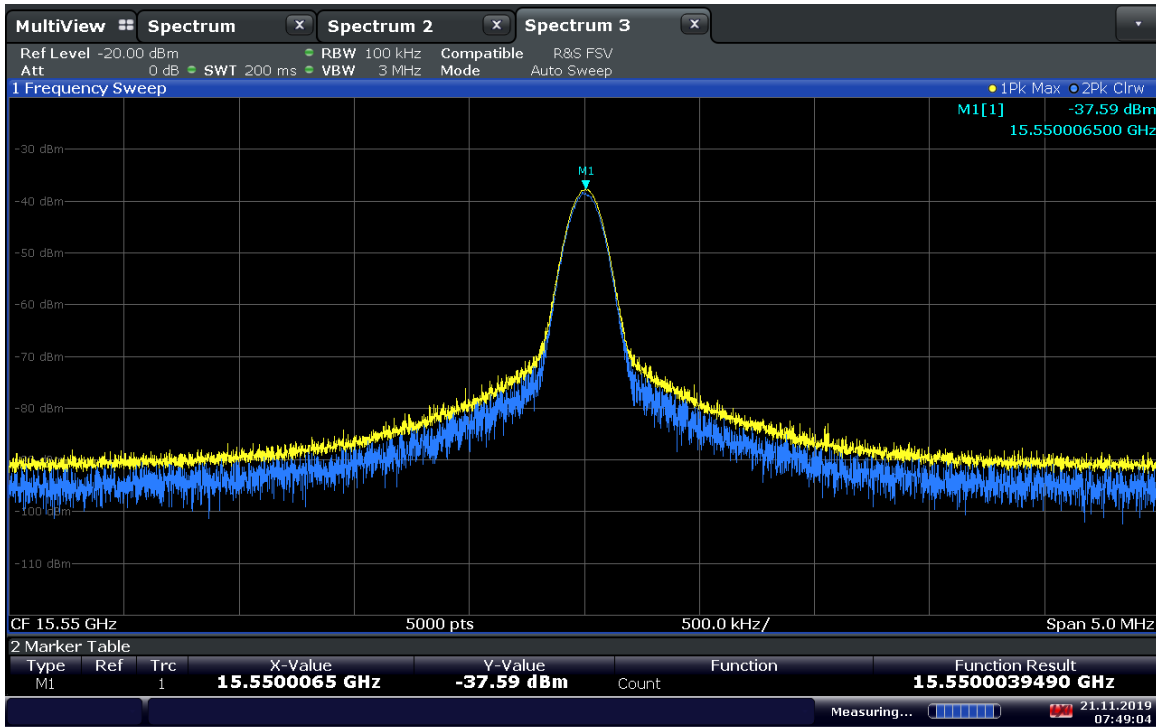


10:21:10 20.11.2019

Frequency Stability @ 50°C

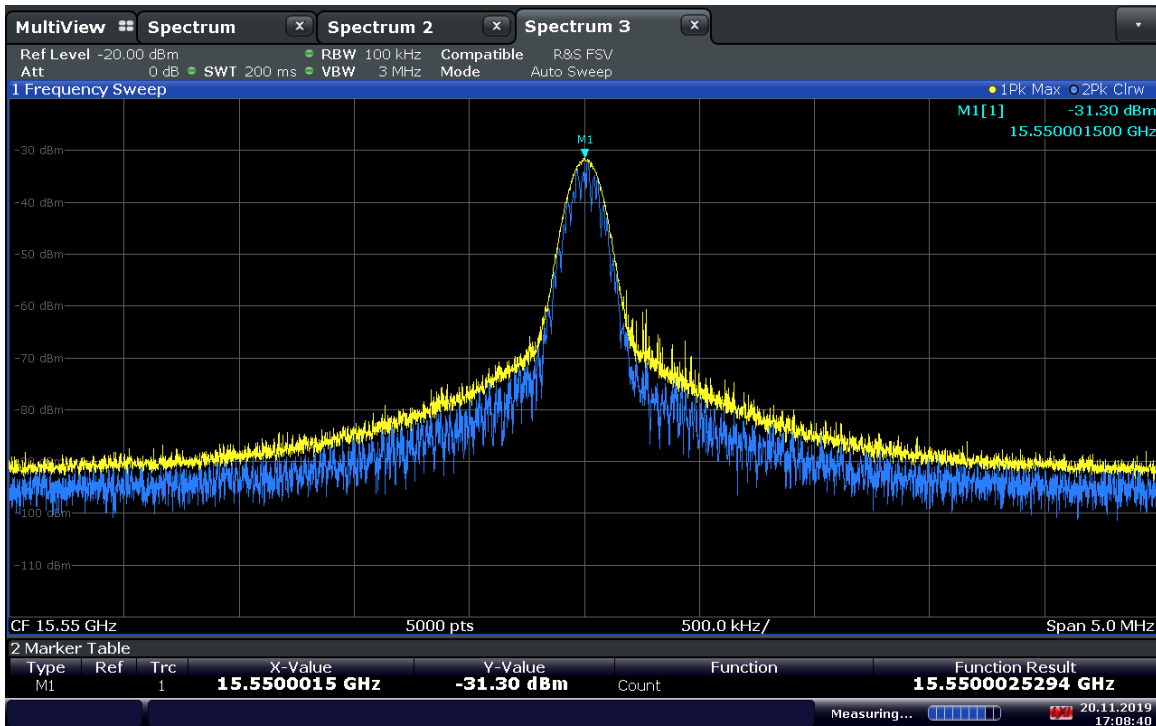


America



07:49:05 21.11.2019

**Frequency Stability @ 20°C (Nominal Voltage)**



17:08:40 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
<b>Radiated Emission</b>						
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
<b>Miscellaneous</b>						
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
<b>Combined standard uncertainty</b>				Normal	<b>2.97 dB</b>	
<b>Expanded uncertainty</b>				Normal, k=2	<b>5.94 dB</b>	



**3.2.2 Radiated Emission Measurements (Above 1GHz)**

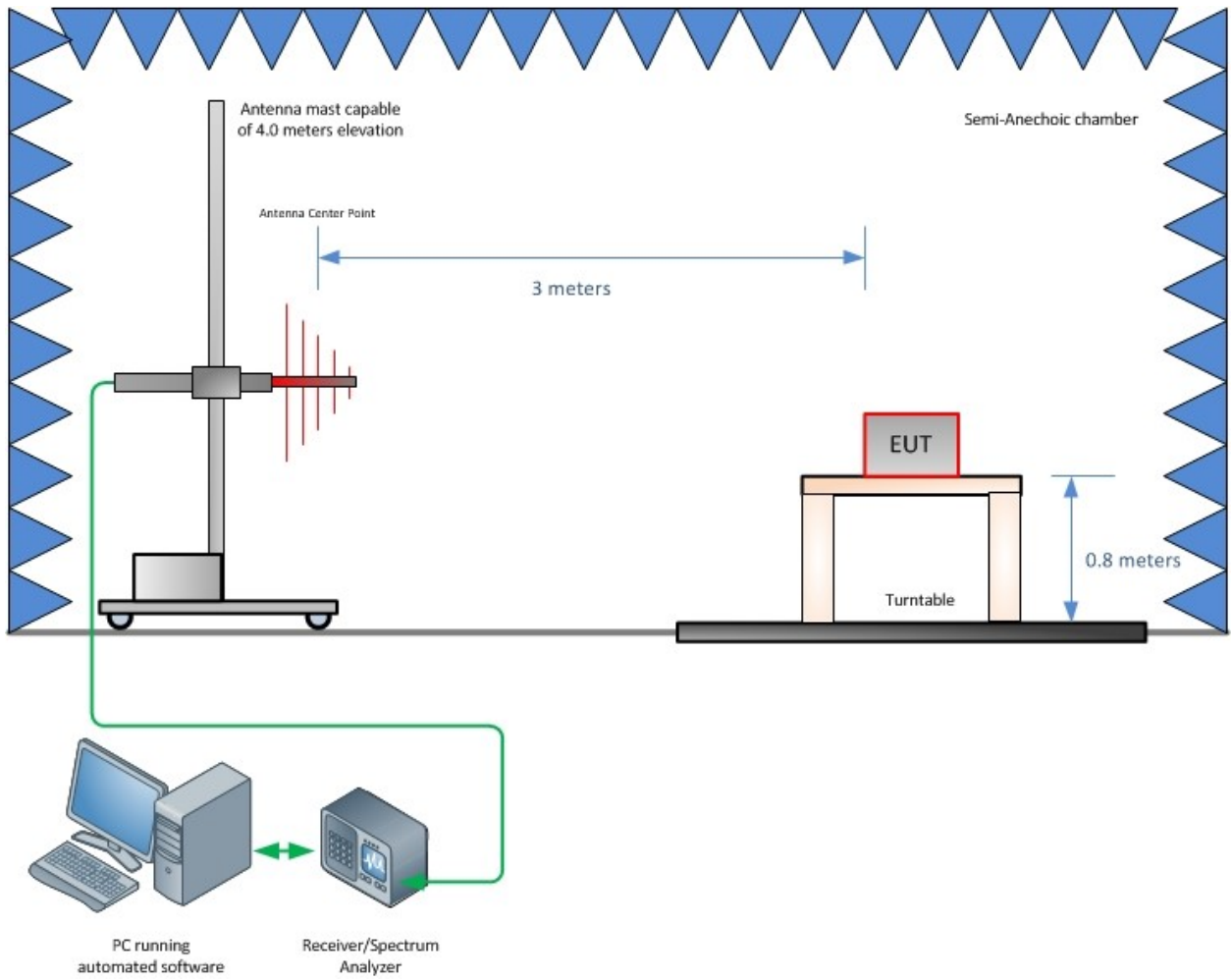
	Input Quantity (Contribution) $X_i$	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.30 dB	Normal, k=2	2.000	0.10	0.02
3	Antenna factor AF	0.20 dB	Normal, k=2	2.000	0.38	0.01
4	Receiver sinewave accuracy	0.47 dB	Normal, 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	
<b>Expanded uncertainty</b>				<b>Normal, k=2</b>	<b>4.79 dB</b>	



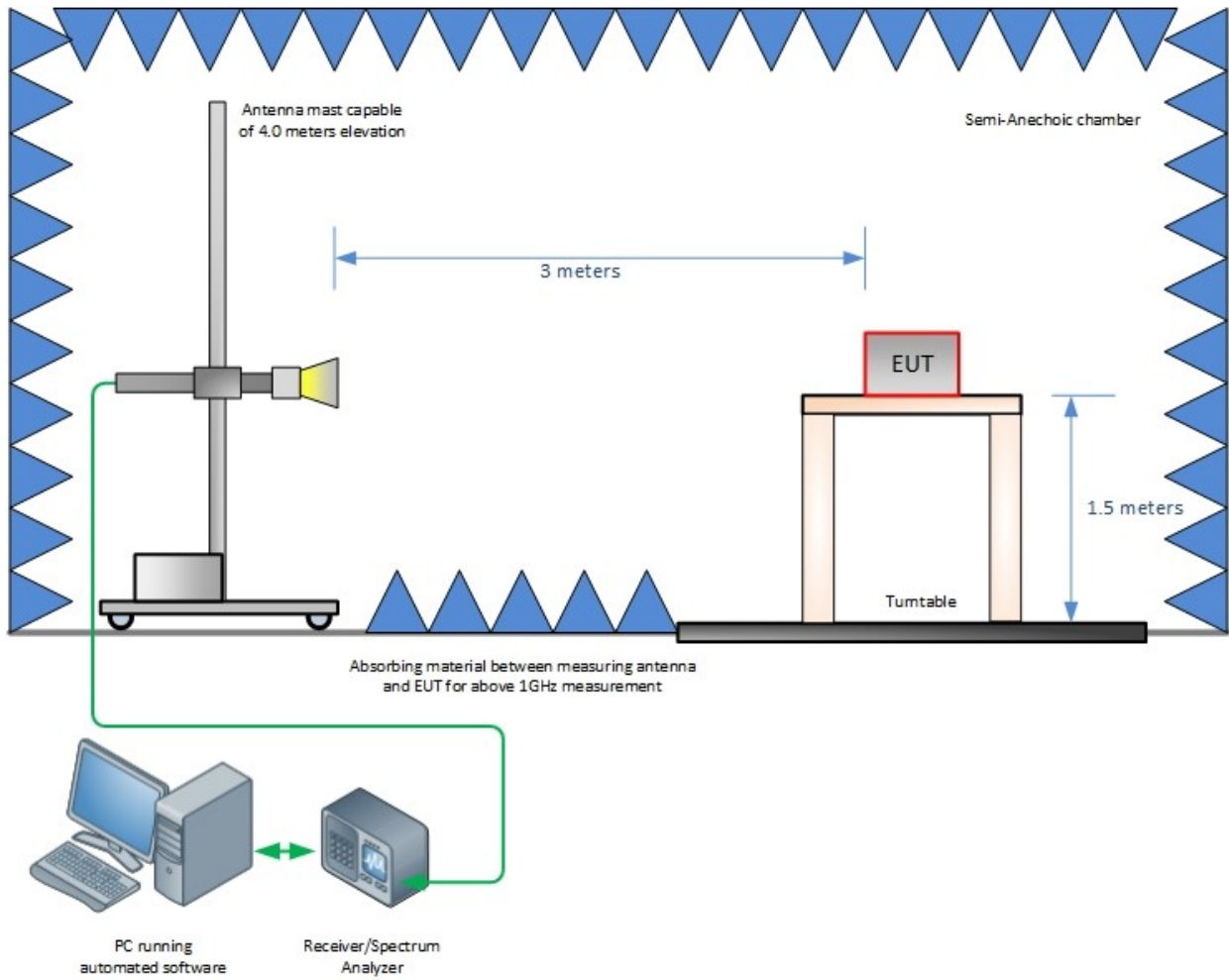
## SECTION 4

### 4 Diagram of Test Setup

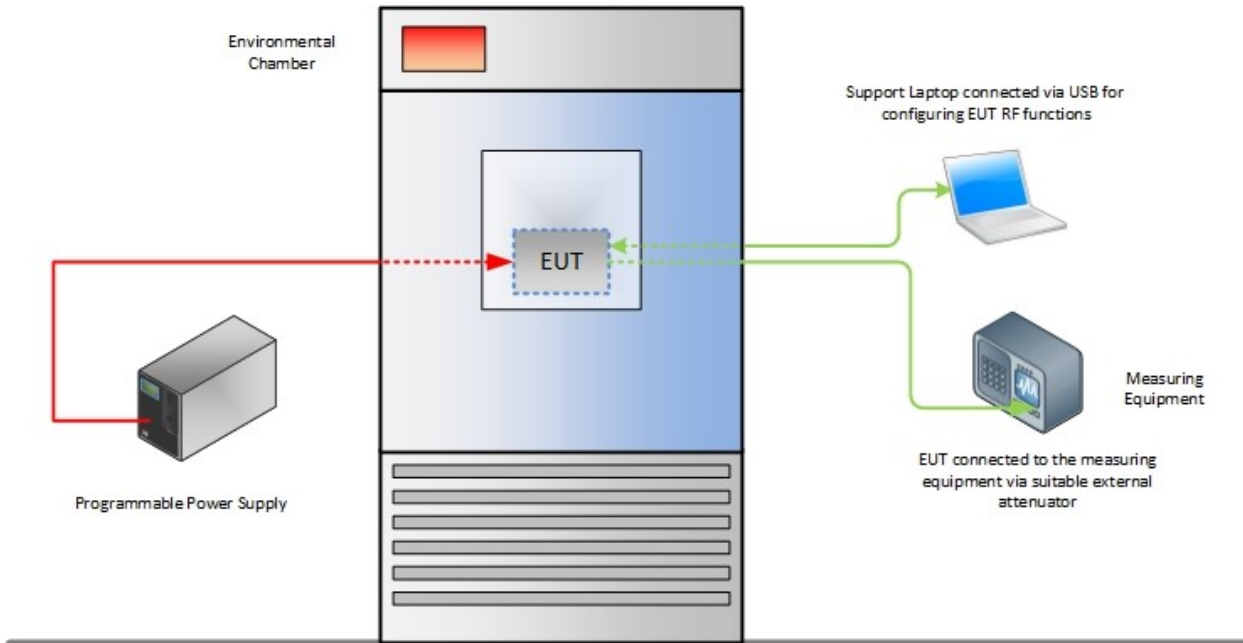
#### 4.1 Test Setup Diagram



**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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