



FCC / ISED Test Report

For:

Uhnder

Model Name:

UR-HM1140-1, UR-HM1140-2, UR-HM1140-3

Product Description:

4D Digital Imaging Radar Sensor

FCC ID: 2AXF3-URHM1140

IC ID: 26449-URHM114

Applied Rules and Standards:

47 CFR Part 95 Subpart M

RSS-251 Issue 2 & RSS-Gen Issue 5

REPORT #: EMC_UHNDE_003_20001_FCC_95M_Rev1

DATE: 2020-10-28



A2LA Accredited

IC recognized #
3462B-1

CETECOM Inc.

411 Dixon Landing Road ♦ Milpitas, CA 95035 ♦ U.S.A.

Phone: + 1 (408) 586 6200 ♦ Fax: + 1 (408) 586 6299 ♦ E-mail: info@cetecom.com ♦ <http://www.cetecom.com>

CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

TABLE OF CONTENTS

1	ASSESSMENT.....	3
2	ADMINISTRATIVE DATA	4
2.1	IDENTIFICATION OF THE TESTING LABORATORY ISSUING THE EMC TEST REPORT	4
2.2	IDENTIFICATION OF THE CLIENT	4
2.3	IDENTIFICATION OF THE MANUFACTURER.....	4
3	EQUIPMENT UNDER TEST (EUT).....	5
3.1	EUT SPECIFICATIONS	5
3.2	EUT SAMPLE DETAILS	6
3.3	ACCESSORY EQUIPMENT (AE) DETAILS.....	6
3.4	TEST SAMPLE CONFIGURATION	6
3.5	EUT MODE OF OPERATION.....	6
3.6	JUSTIFICATION FOR WORST CASE MODE OF OPERATION.....	6
4	SUBJECT OF INVESTIGATION	6
5	MEASUREMENT RESULTS SUMMARY	7
6	MEASUREMENT UNCERTAINTY.....	7
6.1	ENVIRONMENTAL CONDITIONS:	7
6.2	DATES OF TESTING:	7
7	MEASUREMENT PROCEDURES.....	8
8	TEST RESULT DATA	11
8.1	OCCUPIED BANDWIDTH.....	11
8.2	FREQUENCY STABILITY	13
8.3	RADIATED POWER AND DUTY CYCLE	15
8.4	UNWANTED EMISSIONS.....	18
9	TEST SETUP PHOTOS.....	40
10	TEST EQUIPMENT AND ANCILLARIES USED FOR TESTING	40
11	HISTORY	41

1 **Assessment**

The following device was evaluated against the applicable criteria specified in FCC rules Parts 95 subpart M of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-251.

No deviations were ascertained.

Company	Description	Model #
Uhnder	4D Digital Imaging Radar Sensor	UR-HM1140-1, UR-HM1140-2, UR-HM1140-3

Responsible for Testing Laboratory:

2020-10-28	Compliance	Cindy Li (EMC Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2020-10-28	Compliance	Kris Lazarov (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.

CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	Uhnder
Street Address:	3409 Executive Center Drive Suite 205
City/Zip Code	Austin TX
Country	US

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Client
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	UR-HM1140-1, UR-HM1140-2, UR-HM1140-3 – See Note 1
HW Version :	Version 1.1
SW Version :	N/A
FCC-ID :	2AXF3-URHM1140
IC-ID:	26449-URHM114
FWIN:	N/A
HVIN:	UR-HM1140-1, UR-HM1140-2, UR-HM1140-3
PMN:	UR-HM1140
Product Description:	4D Digital Imaging Radar Sensor
Frequency Range:	Nominal band: 76 GHz – 81 GHz
Modulation Characteristics:	PMCW
Modes of Operation:	Single Mode – Continuous transmit
Antenna Information:	2*96=192 Virtual Receivers
Operating Voltage Range:	Vmin: 10V/ Vnom: 12V / Vmax: 16V
Operating Temperature Range:	From: -10 C to +85 C, > 0.8 m/s air flow
Other Co-transmitting Radios:	None
Sample Revision	<input type="checkbox"/> Prototype Unit; <input type="checkbox"/> Production Unit; <input checked="" type="checkbox"/> Pre-Production

Note 1: The modules UR-HM1140-1, UR-HM1140-2, UR-HM1140-3 are identical electrically, and mechanically, and operate with the same firmware. The only difference between devices is the length of the attached cable.

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	Engineering Sample MOD-1004	Version 1.1	N/A	

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Mini PC	Intel NUC	Intel	G6BE01600FKM

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT # 1 + AE # 1	

3.5 EUT Mode of operation

Operation Mode #	Operation Mode	Comments
1	Single Mode	Continuous transmission

3.6 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets to highest possible duty cycle. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

4 Subject of Investigation

This test report is to support a request for new equipment authorization under the FCC ID: 2AXF3-URHM1140 and IC ID: 26449-URHM1140. The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 95 subpart M of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-251 of ISED Canada.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§2.1049; §95.3379 (b) RSS-251 (7)	Occupied Bandwidth	Nominal		■	□	□	Complies
§2.1055; §95.3379 (b) RSS-251 (11); RSS-Gen (8.11)	Frequency Stability	Extreme Temperature and Voltage		■	□	□	Complies
§95.3367 RSS-251 (8)(9)	Radiated Power	Nominal		■	□	□	Complies
§95.3379 RSS-251 (10); RSS-Gen (6.13)	Unwanted Emissions	Nominal		■	□	□	Complies

Note: NA= Not Applicable; NP= Not Performed.

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: <http://physics.nist.gov/cuu/Uncertainty/typeb.html>. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is used for emissions closer than 3 dB to the limit.

6.1 Environmental Conditions:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

08/21/2020 - 08/24/2020

7 Measurement Procedures

The radiated measurement is performed according to ANSI C63.10 (2013)

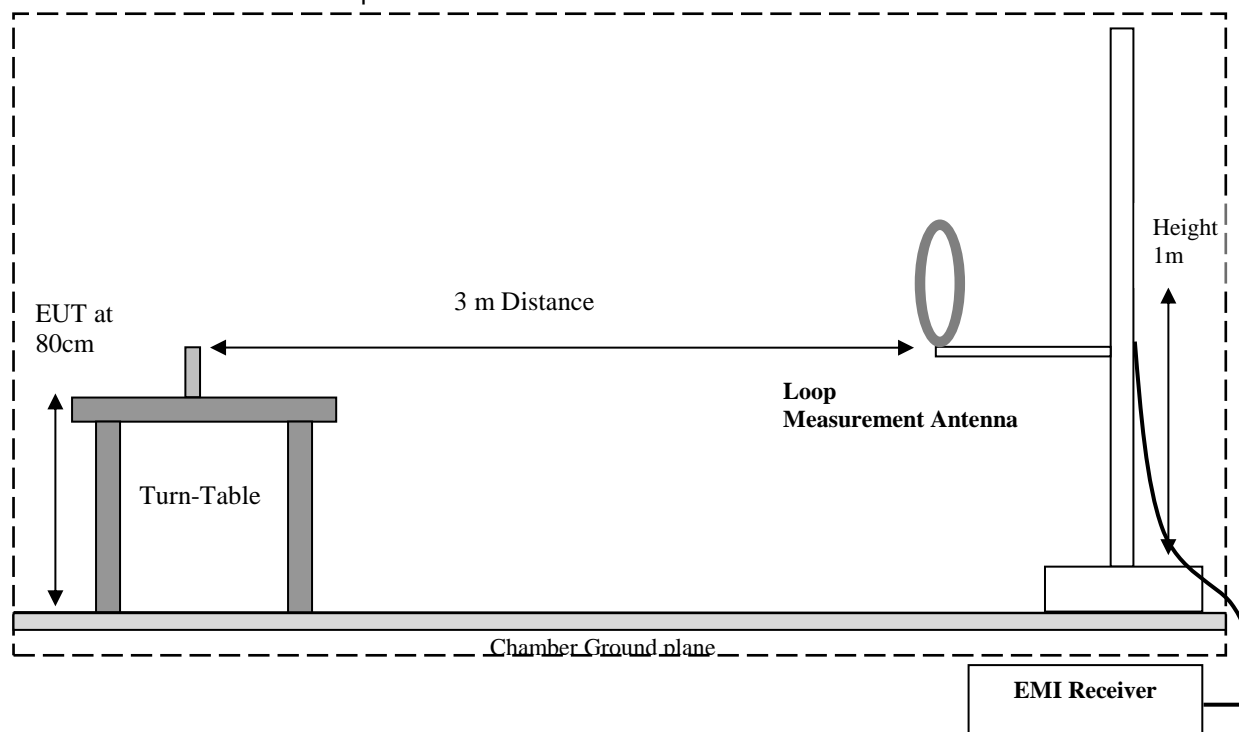
- Measurements below 40 GHz are split to 5 frequency ranges using appropriate antennas and EUT configuration. Magnetic loop is used from 9 kHz to 30 MHz; Biconilog antenna is used from 30 MHz to 1 GHz; and three different horn antennas are used to cover frequencies up to 40 GHz.
- Exploratory measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.
- Using the orientation and equipment arrangement of the EUT, based on the measurement results found during the exploratory measurement, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit are selected for the final measurement.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- Radiated field strength levels are calculated from the measurement instrument readings, using the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA} + \text{Cable Loss} + \text{Antenna Factor}$$

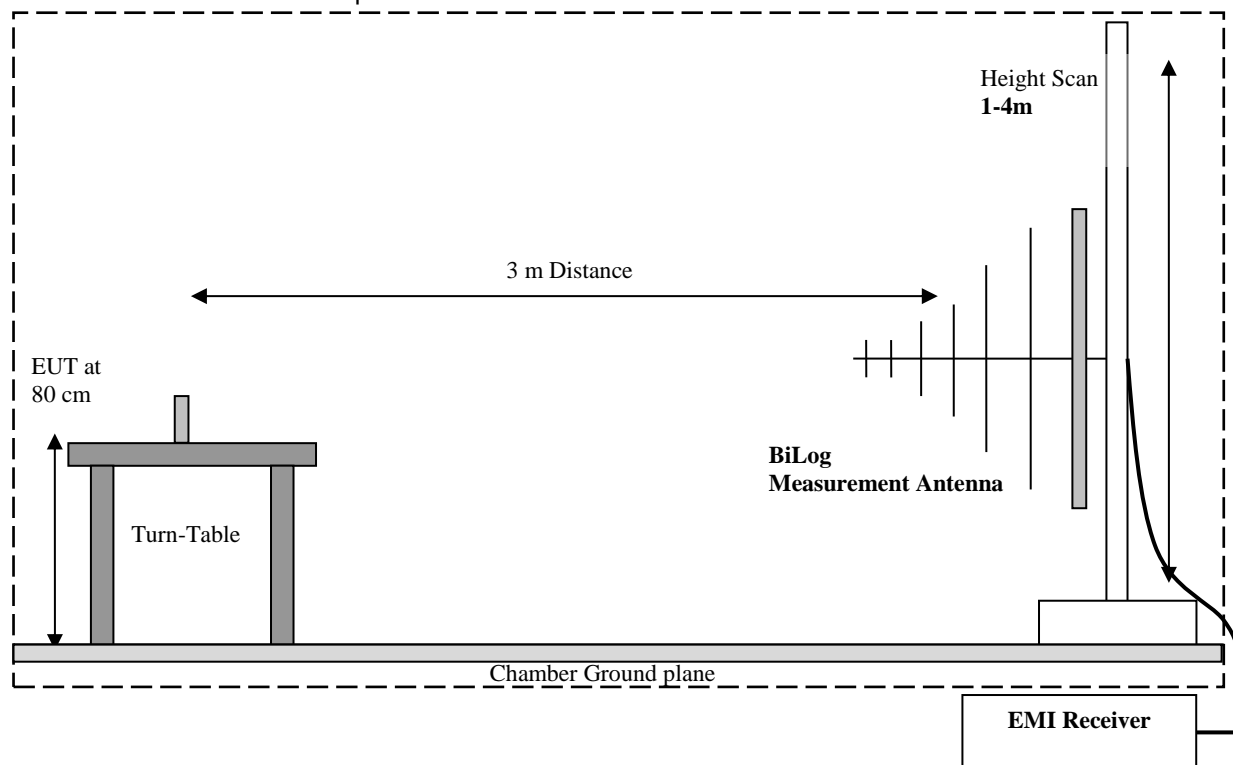
Where:

- Measured Value on SA in dB μ V
- Cable Loss between the receiving antenna and SA in dB
- Antenna Factor in dB/m

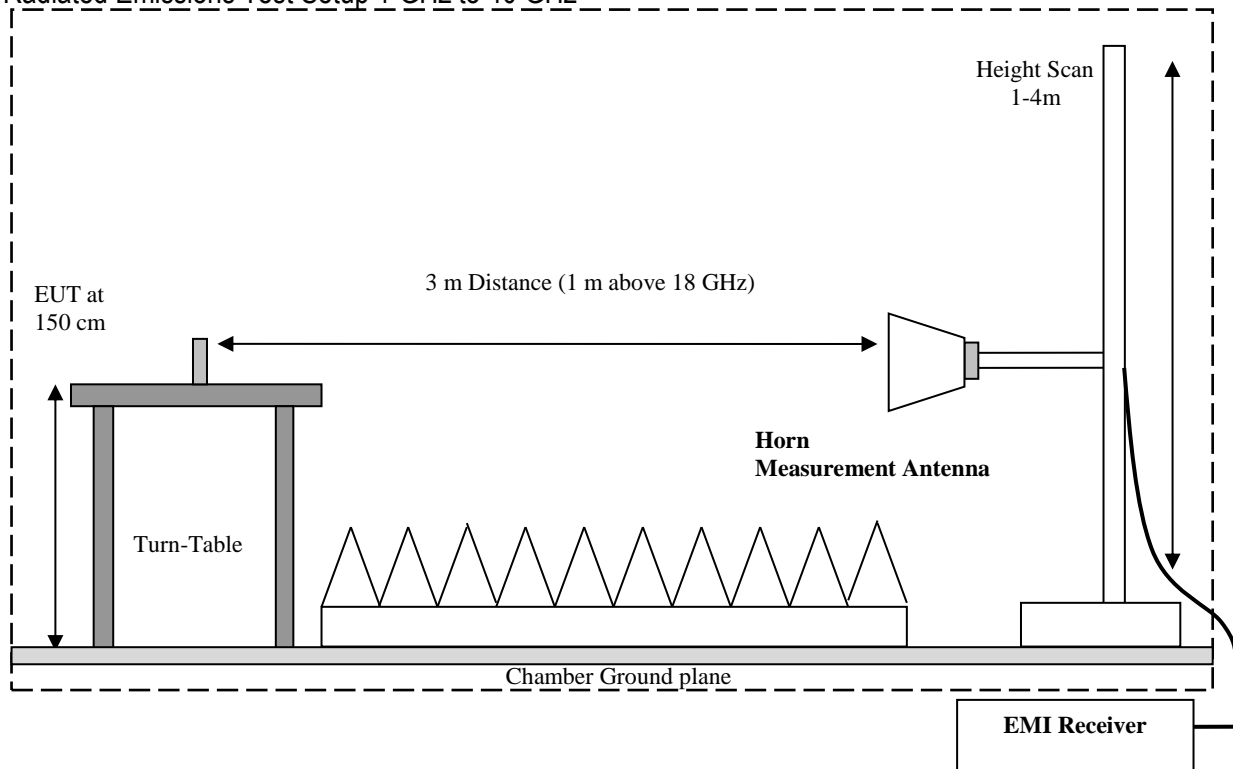
Radiated Emissions Test Setup 9 kHz to 30 MHz



Radiated Emissions Test Setup 30 MHz to 1 GHz



Radiated Emissions Test Setup 1 GHz to 40 GHz



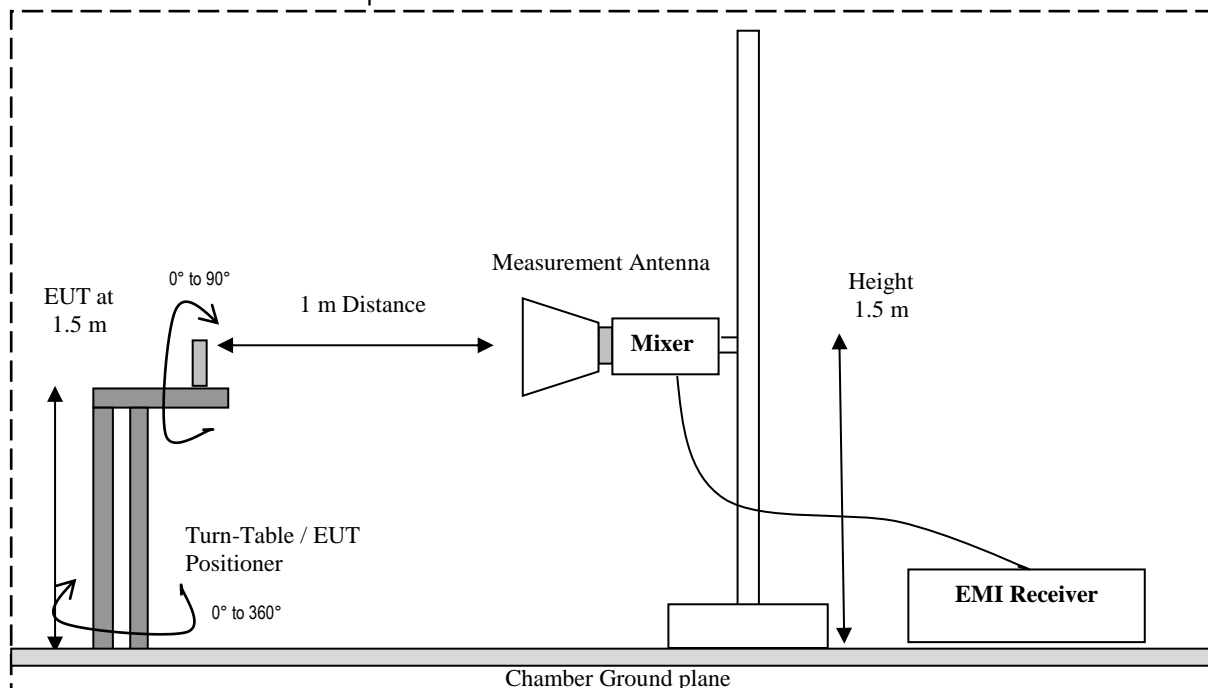
- Measurements above 40 GHz are split to 5 frequency ranges using E&S external mixers and appropriate antennas as follow:
 - 40-60 GHz FS-Z60 + 261U-25
 - 60-90 GHz FS-Z90 + 261E-23
 - 90-140 GHz FS-Z140 + 261F-25
 - 140-220 GHz FS-Z220 + 261G-25
 - 220-231 GHz FS-Z325 + 32240-20
- Exploratory measurements are performed with the EUT rotated horizontally from 0° to 360°, and vertically from 0° to 90°, and the antenna rotated to repeat the measurements for horizontal and vertical antenna polarizations.
- Using the orientation and equipment arrangement of the EUT, found during the exploratory measurement, at the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit are selected for the final measurement.
- The field strength is calculate from the radiated measurement using equation (19) from ANSI C63.10 (2013):

$$E = 126.8 - 20\log(\lambda) + P - G$$

Where:

- E is the field strength of the emission at the measurement distance, in dBμV/m
- P is the power measured at the output of the test antenna, in dBm
- λ is the wavelength of the emission under investigation [300/fMHz], in m
- G is the gain of the test antenna, in dBi

Radiated Emissions Test Setup above 40 GHz



8 Test Result Data

8.1 Occupied Bandwidth

8.1.1 Measurement according to ANSI C63.10 (2013) Section 9.3

99% Occupied Bandwidth:

- Set frequency = nominal EUT channel center frequency
- Set Span = 1.5 x to 5.0 x OBW
- Set RBW = 100kHz
- Set the video bandwidth (VBW) $\approx 3 \times$ RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth
- If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

8.1.2 Limits:

FCC § 95.3379 (b) and RSS-251 7.2

- The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be contained in the 76-81GHz frequency band.

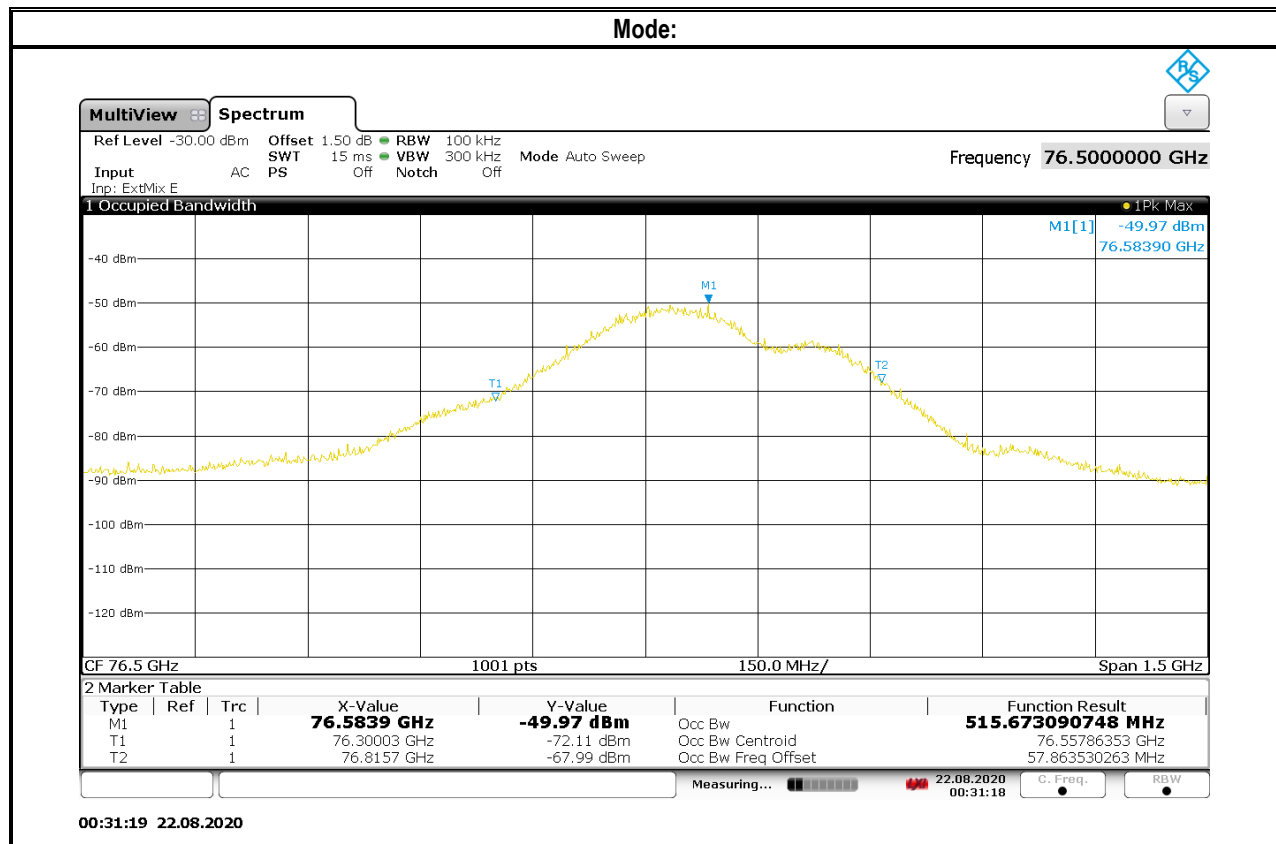
8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	1	12 VDC

8.1.4 Measurement result:

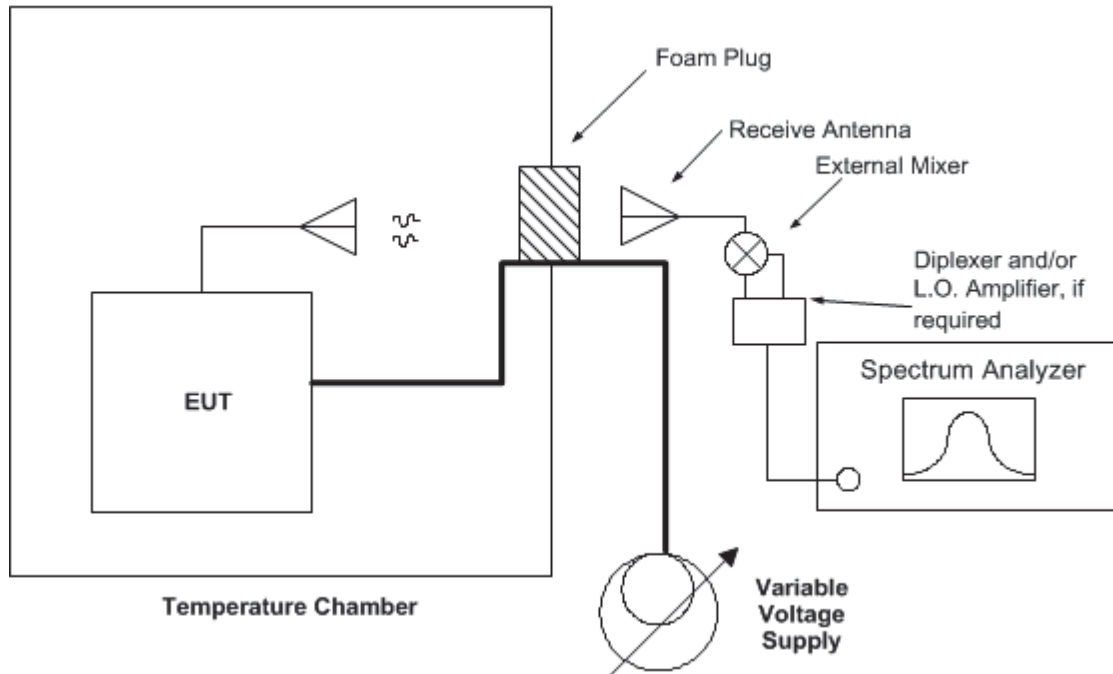
Frequency (GHz)	99% Occupied Bandwidth (MHz)	Limit	Result
76.5	516	76-81GHz	Pass

8.1.5 Measurement Plot:



8.2 Frequency Stability

8.2.1 Measurement according to ANSI C63.10 (2013) Section 9.14



- Arrange EUT and test equipment as shown in the figure above.
- With the EUT at ambient temperature (approximately 25 °C) and voltage source set to the EUT nominal operating voltage (100%), record the spectrum mask of the EUT emission on the spectrum analyzer.
- Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask.
- Set the power supply to 100% nominal setting, and raise EUT operating temperature to 50 °C. Record the frequency excursion of the EUT emission mask.
- Repeat step d) at each 10 °C increment down to -20 °C.

8.2.2 Limits:

FCC § 95.3379 (b)

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

RSS-251 7.2

The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be maintained within the 76-81 GHz frequency band while subjected to all conditions of operation specified in RSS-Gen.

8.2.3 Test conditions and setup:

Ambient Temperature °C	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22° C	1	1	12 VDC

8.2.4 Measurement result:

Temperature °C	Voltage (VDC)	f _L (GHz)	f _H (GHz)	f _{Center} (GHz)	f _{Center - 258MHz} (GHz)	f _{Center + 258MHz} (GHz)	Limit (GHz)	Result
50	12	76.4426	76.6104	76.527	76.2685	76.7845	76 – 81	Pass
40	12	76.4466	76.6095	76.528	76.27005	76.78605	76 – 81	Pass
30	12	76.4486	76.6094	76.529	76.271	76.787	76 – 81	Pass
20	12	76.4486	76.6054	76.527	76.269	76.785	76 – 81	Pass
20	11.2	76.4456	76.6084	76.527	76.269	76.785	76 – 81	Pass
20	13.8	76.4496	76.6034	76.527	76.2685	76.7845	76 – 81	Pass
10	12	76.4326	76.6074	76.520	76.262	76.778	76 – 81	Pass
0	12	76.4336	76.6144	76.524	76.266	76.782	76 – 81	Pass
-10	12	76.4556	76.6134	76.535	76.2765	76.7925	76 – 81	Pass
-20	12	76.4628	76.6194	76.541	76.2831	76.7991	76 – 81	Pass

Note: The f_L and f_H are the frequencies at 6 dB below the peak of the recorded spectral mask. This results are used to calculate the center frequency. The center frequency is compared to the limit, accounting for 516 MHz Occupied Bandwidth.

8.3 Radiated Power and Duty Cycle

8.3.1 Measurement according to ANSI C63.10 (2013) Section 9.10

Spectrum Analyzer settings:

- Center Frequency = Fundamental
- RBW = 1 MHz
- VBW = 3 MHz
- Span $\geq 2 \times$ Occupied Bandwidth
- Sweep = Auto couple
- Detector function = Peak, repeat with RMS
- Trace = Max hold
- Compute power by integrating the spectrum across the occupied bandwidth of the signal using the spectrum analyzer's band power measurement function.

8.3.2 Limits:

FCC § 95.3367 and RSS-251 8.2; 9.2

- The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz RBW.
- The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	1	1	12 VDC	25 dBi

8.3.4 Measurement result:

Plot #	Frequency (GHz)	Instrument Reading (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	76.5	-26.14 RMS Detector	19.09	50	Pass
2	76.5	-17.71 Peak Detector	27.52	55	Pass

Note: The EIRP is calculate from the radiated measurement using equation (22) from ANSI C63.10 (2013):

$$\text{EIRP} = E_{\text{Meas}} + 20\log(d_{\text{Meas}}) - 104.7$$

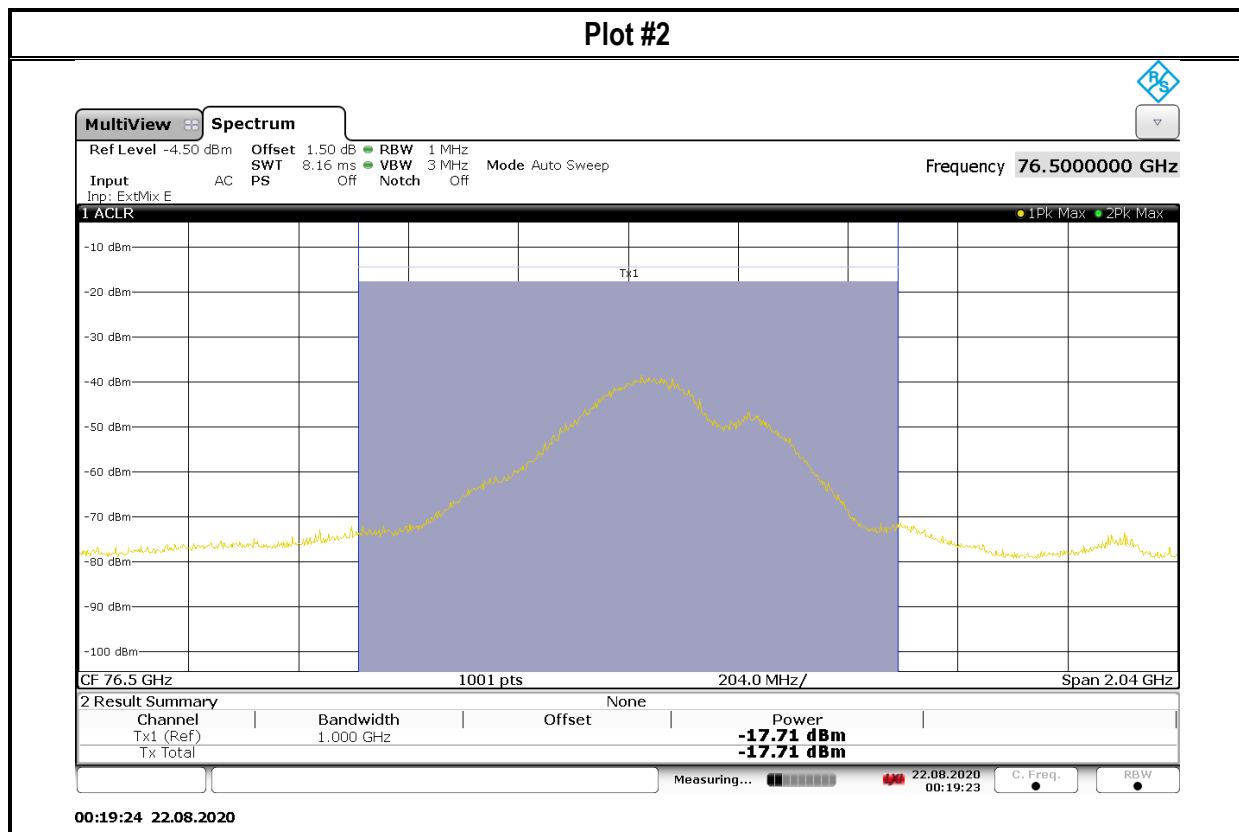
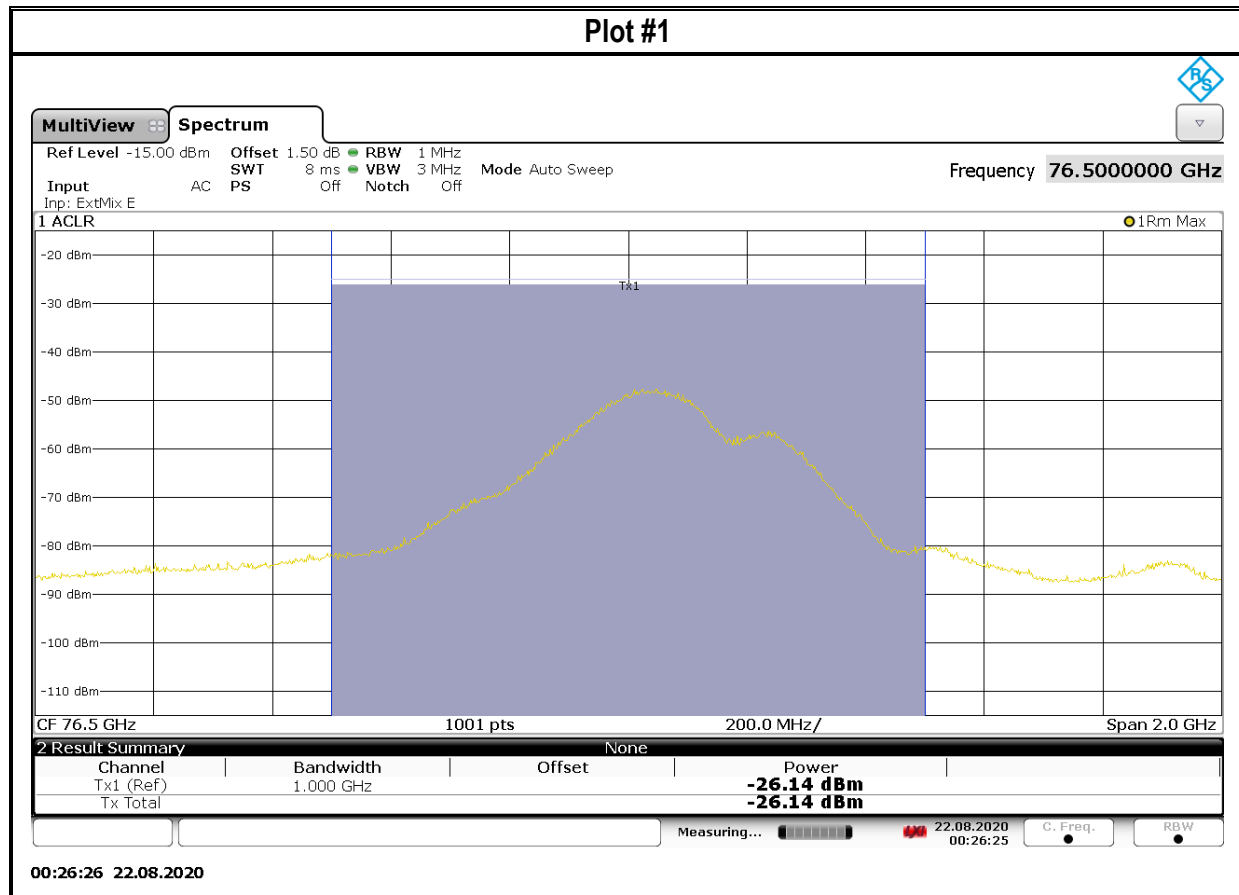
Where:

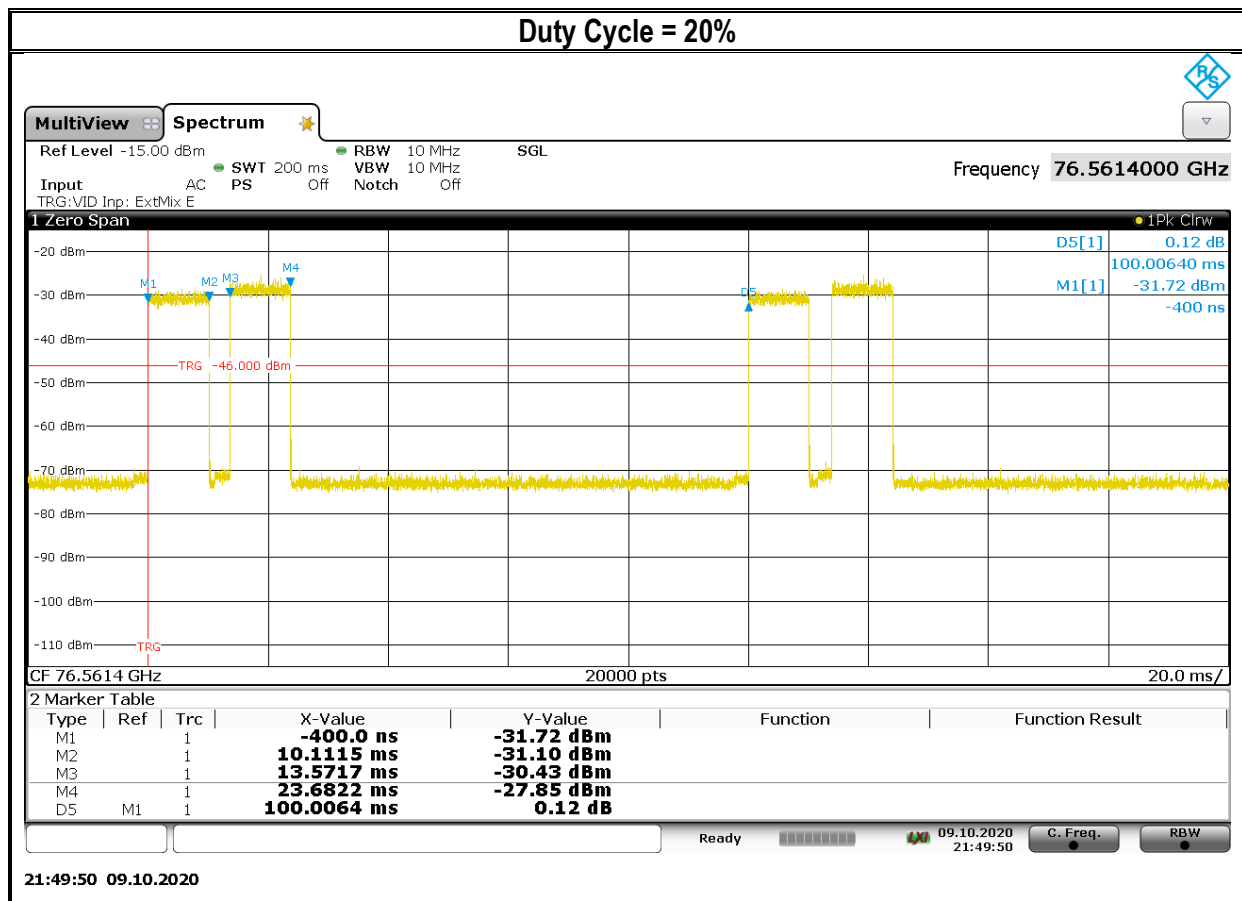
EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dB μ V/m

d_{Meas} is the measurement distance, in m

8.3.5 Measurement Plots:





8.4 Unwanted Emissions

8.4.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Quasi-Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Quasi-Peak
- RBW= 120 KHz

- Frequency 1 - 231 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

8.4.2 Limits:

FCC § 95.3379 (a) & RSS-Gen 8.9

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Frequency of emission (MHz)	Field strength (μV/m)	Measurement Distance (m)	Field strength @ 3m (dBμV/m)
0.009–0.490	2400/F(kHz) / -----	300	-
0.490–1.705	24000/F(kHz) / -----	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBμV/m
88–216	150	3	43.5 dBμV/m
216–960	200	3	46 dBμV/m
Above 960	500	3	54 dBμV/m

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

RSS-251 8.2; 9.2

The radar device's unwanted emissions outside the 76-81 GHz frequency band shall comply with the limits in table below.

Emission frequency range	Limit	Applicable detector
Below 40 GHz	RSS-Gen general field strength limits for license-exempt radio apparatus	RSS-Gen requirements
40-162 GHz *	-30 dBm/MHz (e.i.r.p.)	RMS detector
Note: * For radar devices that operate solely in the 76-77 GHz band (i.e. the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in table 1 shall apply.		

FCC §15.205 & RSS-Gen 8.10

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

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

*PEAK LIMIT= 74 dBμV/m

*AVG. LIMIT= 54 dBμV/m

8.4.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	1	12 VDC

8.4.4 Measurement result:

Plot #	Scan Frequency	Limit	Result
1 - 5	9 kHz – 40 GHz	See section 8.4.2	Pass
6 - 21	40 GHz – 231 GHz	See section 8.4.2	Pass

8.4.5 Testing notes:

- Measurement antenna far-field boundary was evaluated according to ANSI C63.10-2013

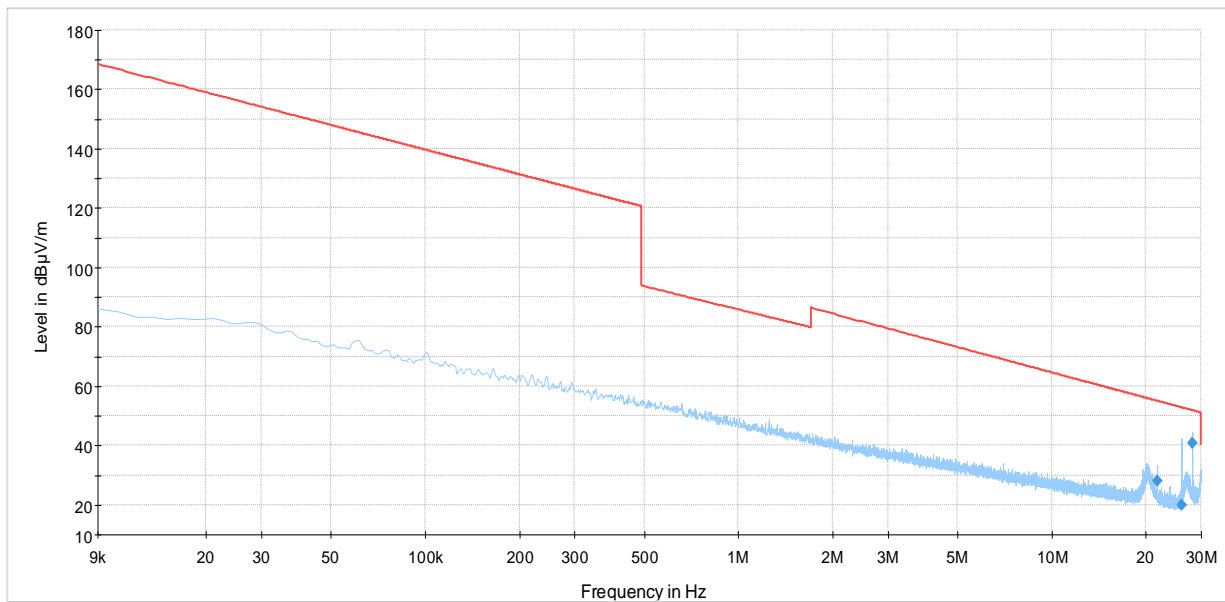
Measurement Antenna	F range GHz	Largest Antenna Dimension (m)	Far-field Boundry (m)
261U-25	40 - 60	0.0500	0.67 – 1.00
261E-25	60 - 90	0.0350	0.49 - 0.74
261W-25	75 - 110	0.0280	0.39 - 0.57
261F-25	90 - 140	0.0190	0.22 - 0.34
261G-25	140 - 220	0.0120	0.13 - 0.21
32240-20	220 - 231	0.0045	0.03 - 0.05

- The measurements from 40 – 220 GHz were conducted at 1 m, and from 220 – 231 at 0.7 m distance.
- The measurement plots above 40 GHz include a reference line corresponding to the limit level at the measurement distance specified by the requirements, and accounting for the measurement system configuration, the external mixers conversion loss, IF cable path loss, and antenna gain. The reference line is derived from reverse calculation from the 3 m limit using the equations (19), (22), (24), and (25) from ANSI C63.10 (2013)
- For all measurements above 40 GHz the measurement system noise floor was more than 6 dB below the limit levels at the measurement distance.
- All significant emissions above the noise floor above 40 GHz were evaluated with the ESW 44 Signal ID function to eliminate the mixing products resulting from the use of external mixers in the measurement.
- For all measurements above 40 GHz the plots are providing a max peak pre-scan for each measurement antenna and the EUT orientation. If no emissions above the measurement system noise floor were detected during the pre-scan, no final (RMS detector) measurements were conducted.

8.4.6 Measurement Plots:

Plot # 1 Unwanted Emissions: 9 kHz - 30 MHz

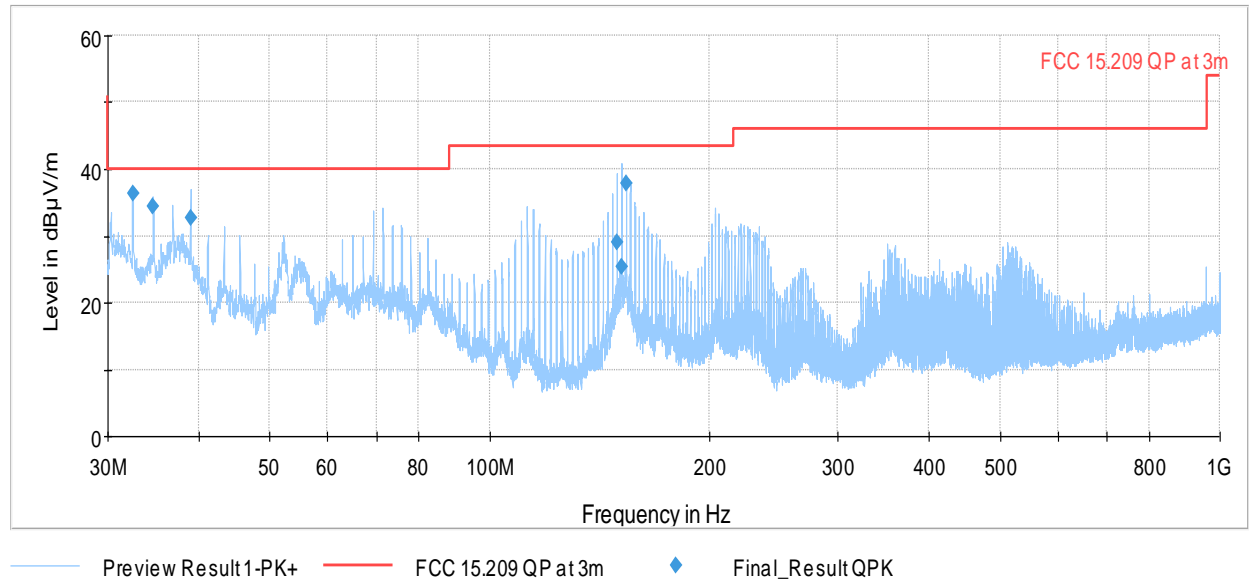
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
21.671	28.23	55.04	26.81	500.0	9.000	100.0	H	68.0	16.7
26.002	19.78	52.80	33.02	500.0	9.000	107.0	V	-45.0	16.4
28.166	40.98	51.82	10.84	500.0	9.000	100.0	H	121.0	16.3



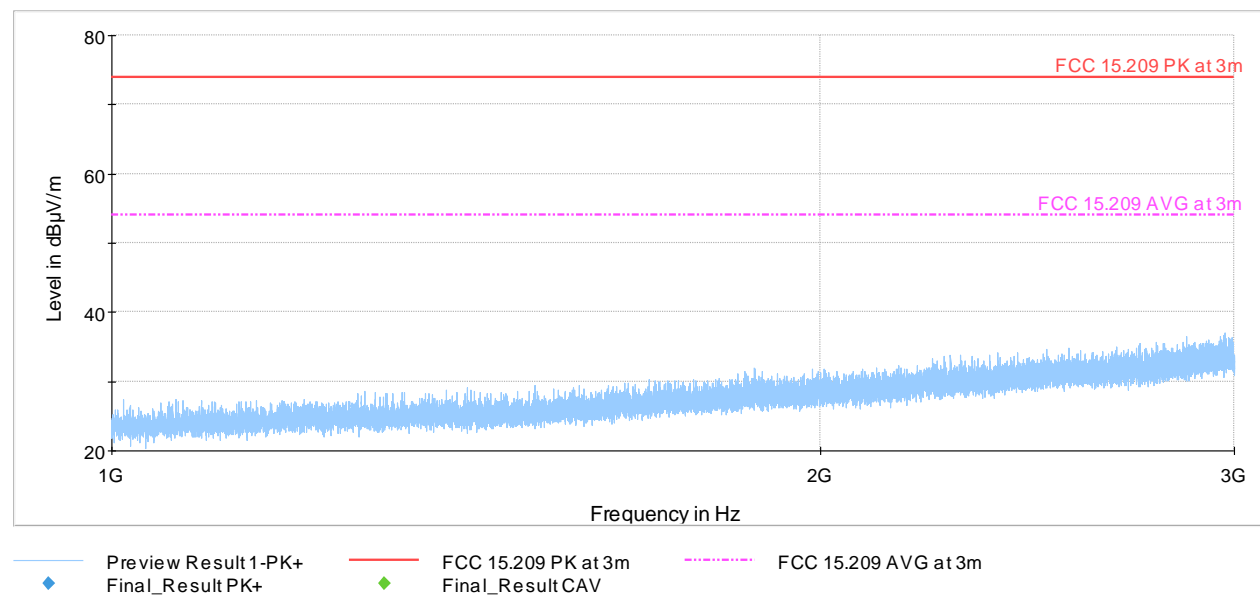
Preview Result 1-PK+ FCC 15.209 QP at 3m Final_Result QPK

Plot # 2 Unwanted Emissions 30 MHz – 1GHz

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
32.474	36.45	40.00	3.55	500.0	120.000	107.0	V	189.0	-13.9
34.632	34.47	40.00	5.53	500.0	120.000	177.0	V	290.0	-15.2
38.948	32.70	40.00	7.30	500.0	120.000	100.0	V	101.0	-16.8
149.480	29.05	43.50	14.45	500.0	120.000	172.0	V	243.0	-22.3
151.614	25.36	43.50	18.15	500.0	120.000	134.0	V	280.0	-22.6
153.821	37.88	43.50	5.62	500.0	120.000	142.0	V	132.0	-22.7

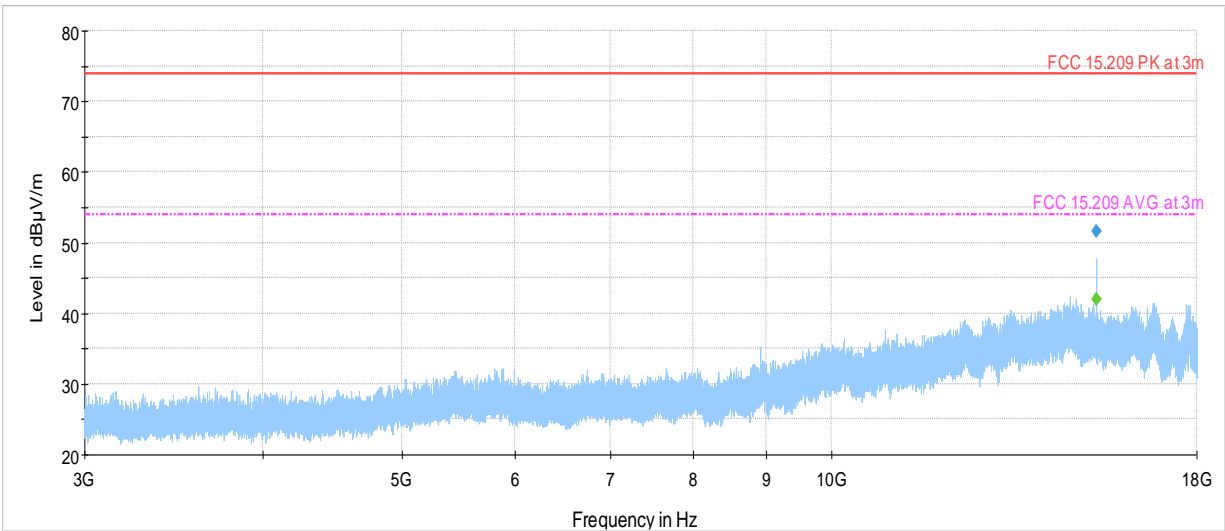


Plot # 3 Unwanted Emissions: 1-3 GHz



Plot # 4 Unwanted Emissions: 3 - 18 GHz

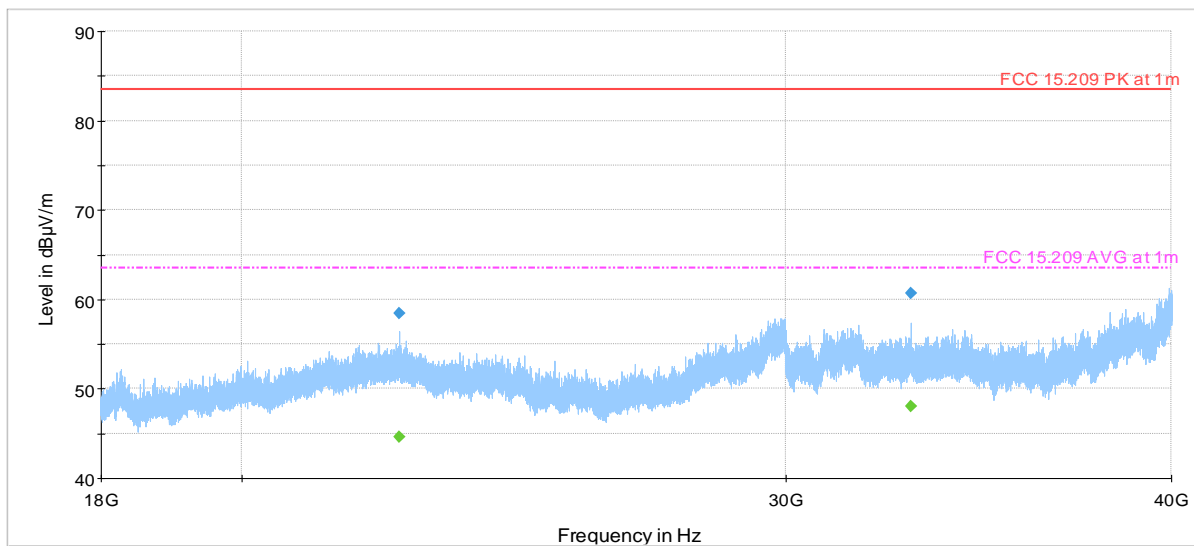
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
15316.750	---	42.04	53.98	11.94	500.0	1000.000	292.0	V	50.0	7.2
15316.750	51.64	---	73.98	22.34	500.0	1000.000	292.0	V	50.0	7.2



Preview Result 1-PK+ FCC 15.209 PK at 3m FCC 15.209 AVG at 3m Final_Result PK+ Final_Result CAV

Plot # 5 Unwanted Emissions: 18-40 GHz

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
22479.750	---	44.59	63.50	18.91	500.0	1000.000	150.0	H	291.0	18.8
22479.750	58.42	---	83.50	25.08	500.0	1000.000	150.0	H	291.0	18.8
32946.875	---	48.01	63.50	15.49	500.0	1000.000	150.0	V	149.0	22.5
32946.875	60.70	---	83.50	22.80	500.0	1000.000	150.0	V	149.0	22.5



Preview Result 1-PK+ Final_Result PK+ FCC 15.209 PK at 1m Final_Result CAV FCC 15.209 AVG at 1m

Plot # 6 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Horizontal



MultiView

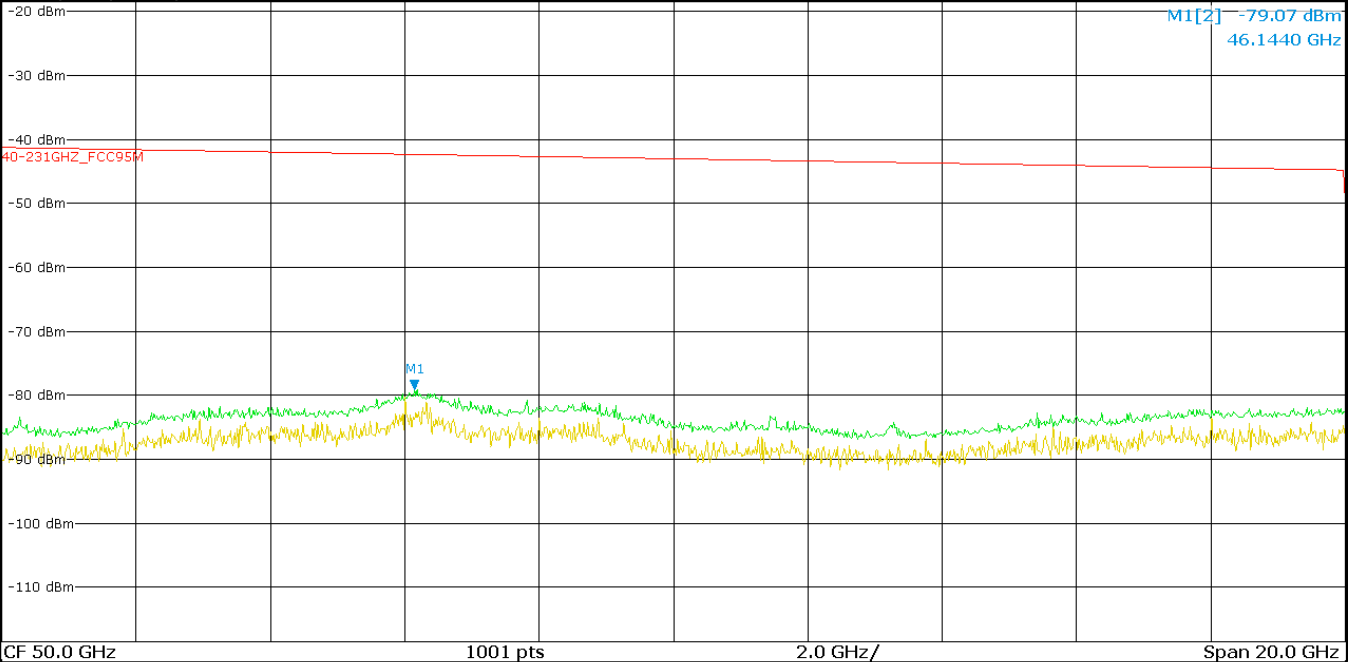
Spectrum

Ref Level -18.50 dBm Offset 1.50 dB RBW 1 MHz
SWT 80 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix U

Frequency 50.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max



Measuring...

21.08.2020
22:34:46

C. Freq.

RBW

22:34:47 21.08.2020

Plot # 7 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Vertical



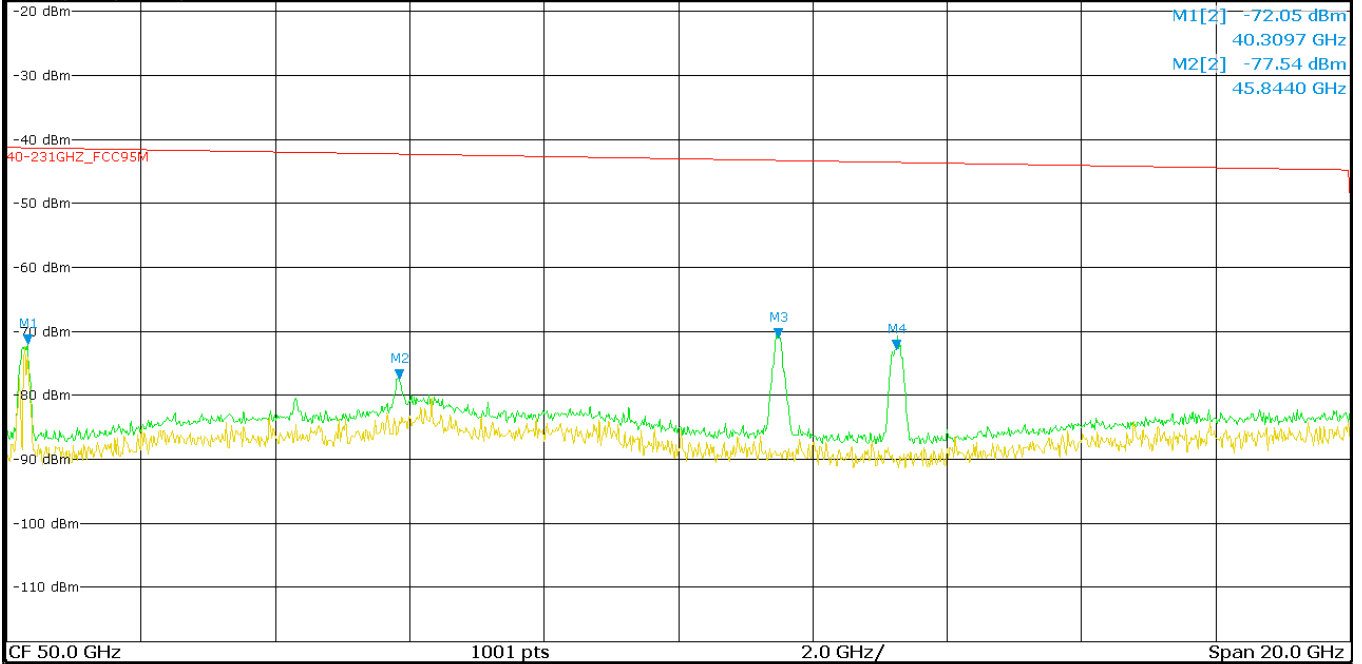
MultiView Spectrum

Ref Level -18.50 dBm Offset 1.50 dB RBW 1 MHz
SWT 80 ms VBW 3 MHz Mode Auto Sweep
Input AC PS Off Notch Off
Inp: ExtMix U

Frequency 50.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max



CF 50.0 GHz

1001 pts

2.0 GHz/

Span 20.0 GHz

Measuring...

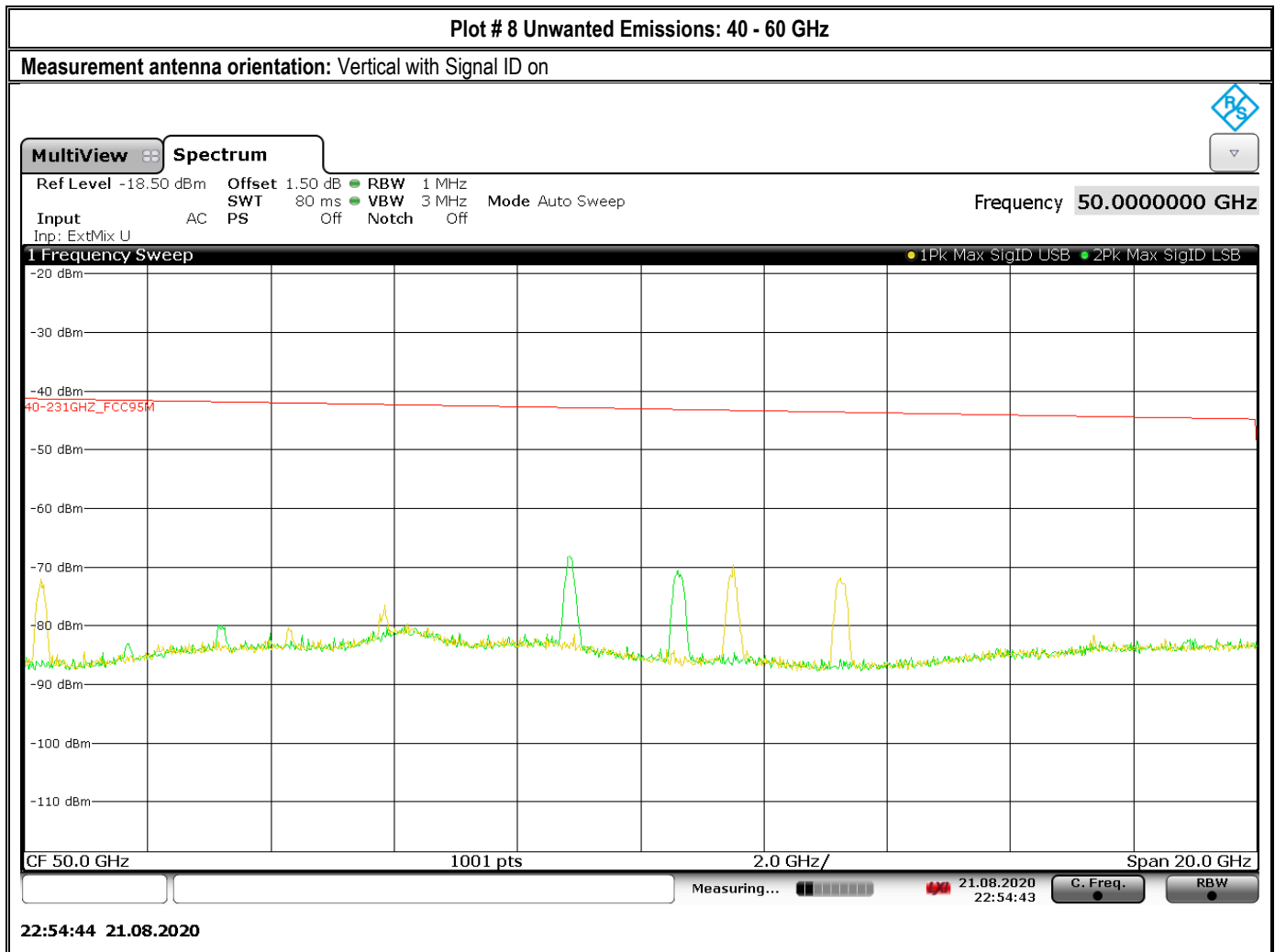
21.08.2020

22:50:36

C. Freq.

RBW

22:50:37 21.08.2020



Note: The Signal ID function of the ESW44 was used to evaluate the spectrum from 40 – 60 GHz. The conclusion is that all observed emissions are products of the external mixer.

Plot # 9 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Horizontal



MultiView

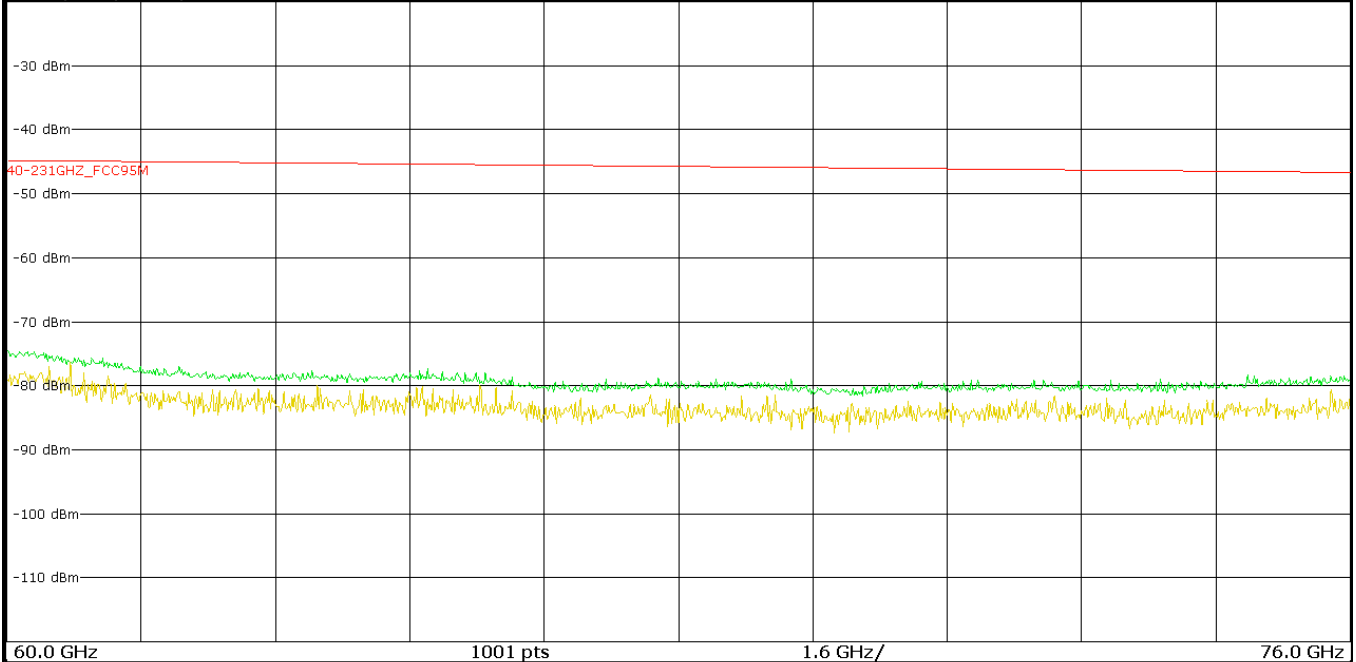
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 64 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix E

Frequency 68.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max



60.0 GHz 1001 pts 1.6 GHz/ 76.0 GHz

Measuring...

40

21.08.2020
23:21:13

C. Freq.

RBW

23:21:13 21.08.2020

Plot # 10 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical



MultiView

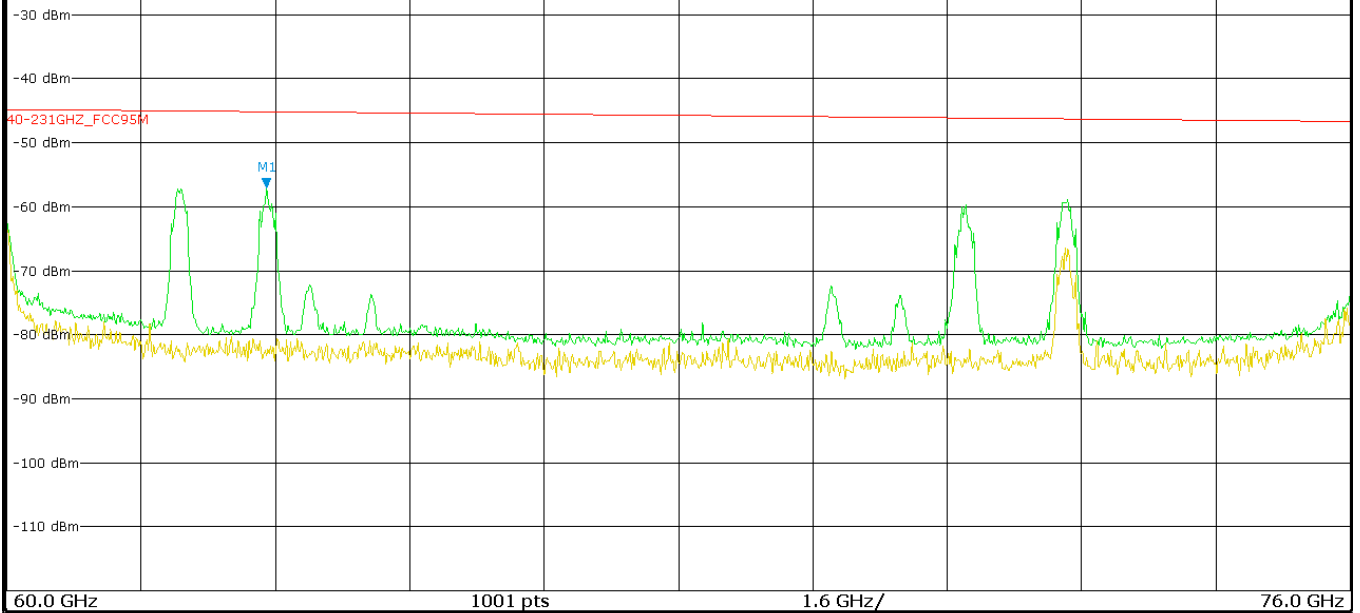
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 64 ms VBW 3 MHz Mode Auto Sweep
Input AC PS Off Notch Off
Inp: ExtMix E

Frequency 68.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max
M1[2] -57.00 dBm
63.0930 GHz



23:50:25 21.08.2020

Measuring...

21.08.2020
23:50:25

C. Freq.

RBW

Plot # 11 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical with Signal ID on



MultiView

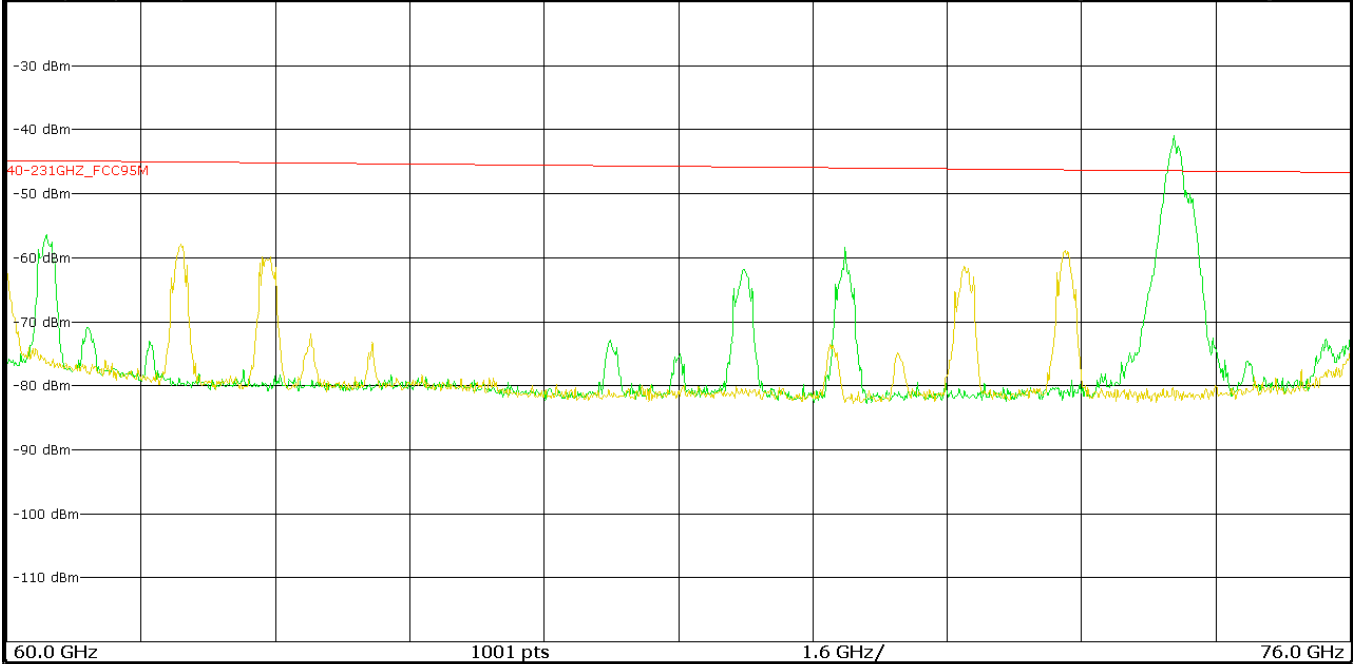
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 64 ms VBW 3 MHz Mode Auto Sweep
Input AC PS Off Notch Off
Inp: ExtMix E

Frequency 68.000000 GHz

1 Frequency Sweep

1Pk Max SigID USB 2Pk Max SigID LSB



23:49:11 21.08.2020

Measuring...

21.08.2020
23:49:10

C. Freq.

RBW

Note: The Signal ID function of the ESW44 was used to evaluate the spectrum from 60 – 76 GHz. The conclusion is that all observed emissions are products of the external mixer.

Plot # 12 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Horizontal



MultiView

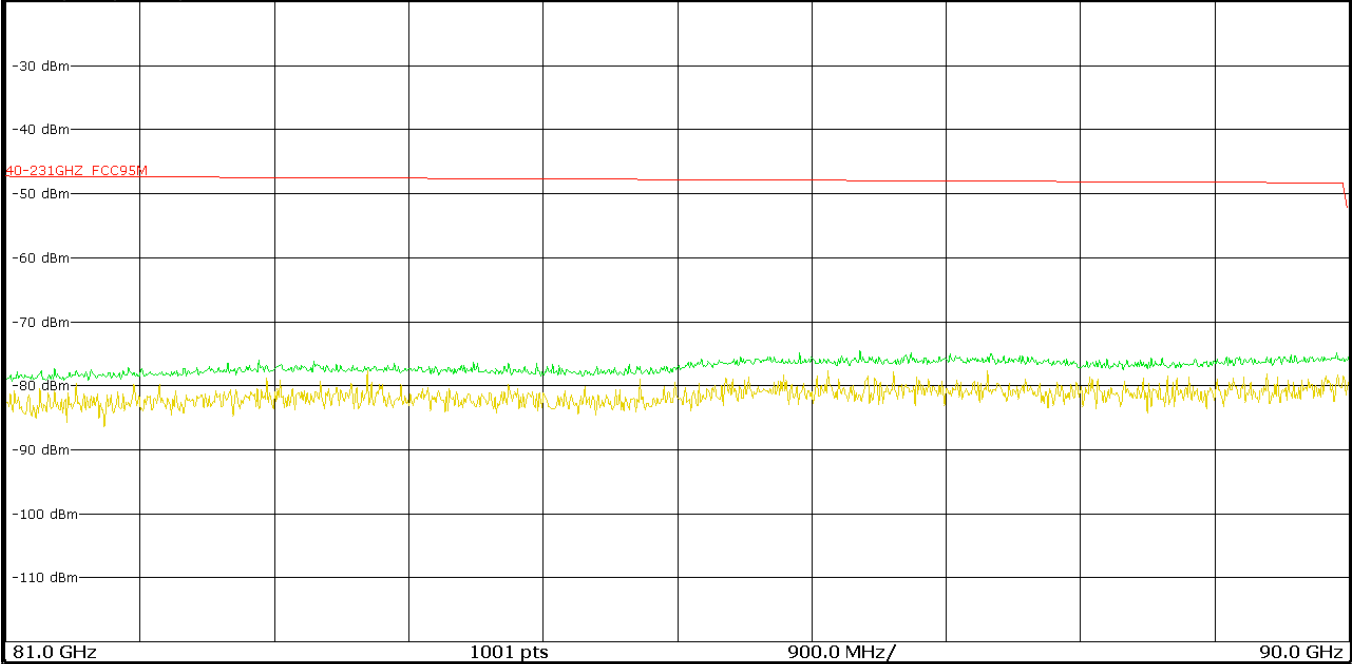
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 36 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix E

Frequency 85.5000000 GHz

1 Frequency Sweep

1Pk ClrW 2Pk Max



81.0 GHz 1001 pts 900.0 MHz/ 90.0 GHz

Measuring...

21.08.2020 23:29:37

C. Freq.

RBW

23:29:38 21.08.2020

Plot # 13 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Vertical



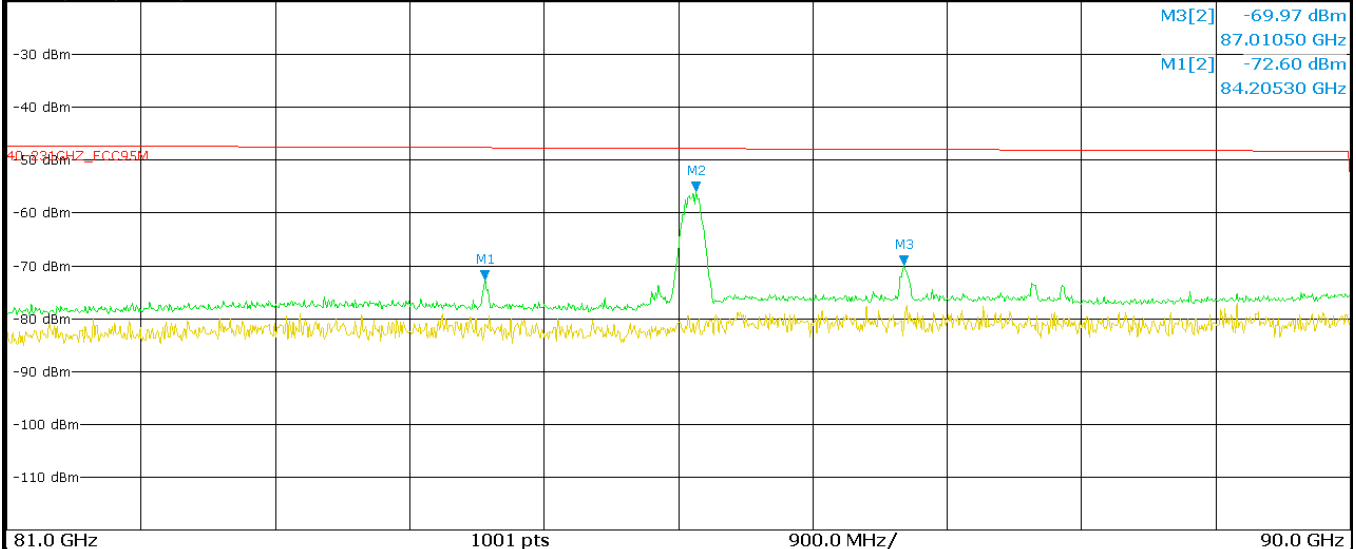
MultiView Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 36 ms VBW 3 MHz Mode Auto Sweep
Input AC PS Off Notch Off
Inp: ExtMix E

Frequency 85.500000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1	2		84.2053 GHz	-72.60 dBm		
M2	2		85.6169 GHz	-55.96 dBm		
M3	2		87.0105 GHz	-69.97 dBm		

Measuring...

21.08.2020
23:38:27

C. Freq.

RBW

23:38:27 21.08.2020

Plot # 14 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Vertical with Signal ID on



MultiView

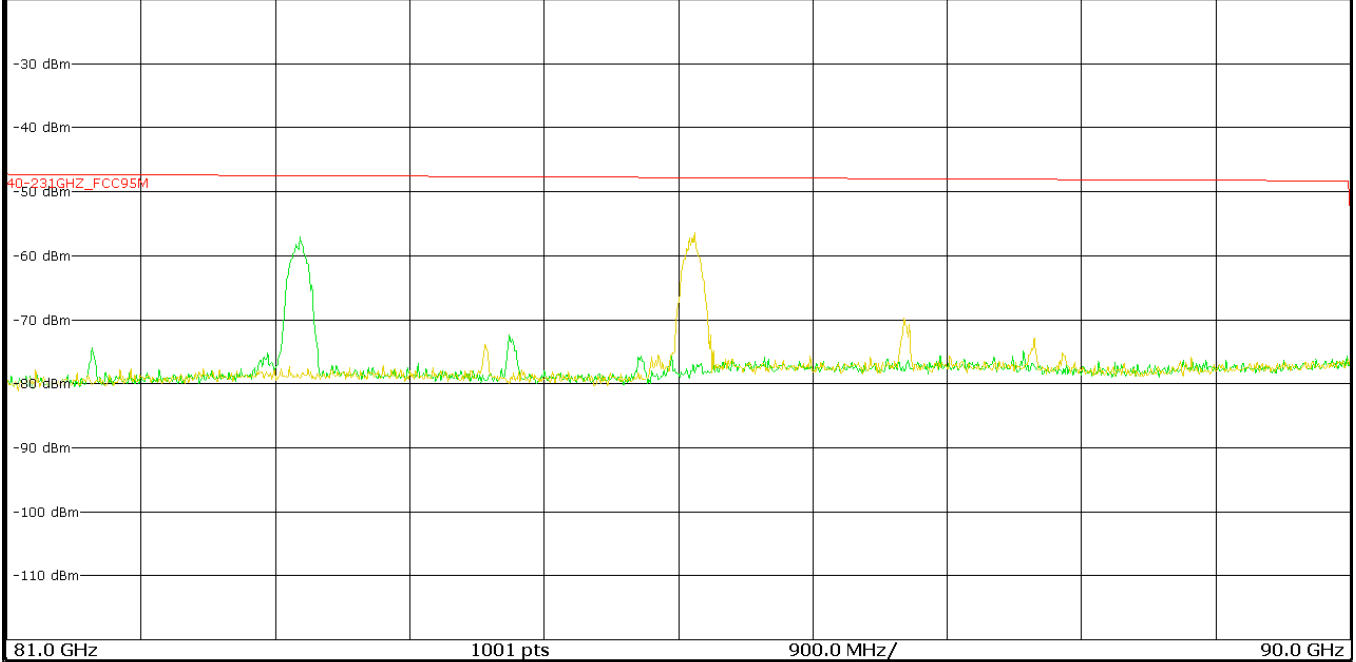
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 36 ms VBW 3 MHz Mode Auto Sweep
Input AC PS Off Notch Off
Inp: ExtMix E

Frequency 85.500000 GHz

1 Frequency Sweep

1Pk Max SigID USB 2Pk Max SigID LSB



23:39:28 21.08.2020

Note: The Signal ID function of the ESW44 was used to evaluate the spectrum from 81 – 90 GHz. The conclusion is that all observed emissions are products of the external mixer.

Plot # 15 Unwanted Emissions: 90 - 140 GHz

Measurement antenna orientation: Horizontal



MultiView

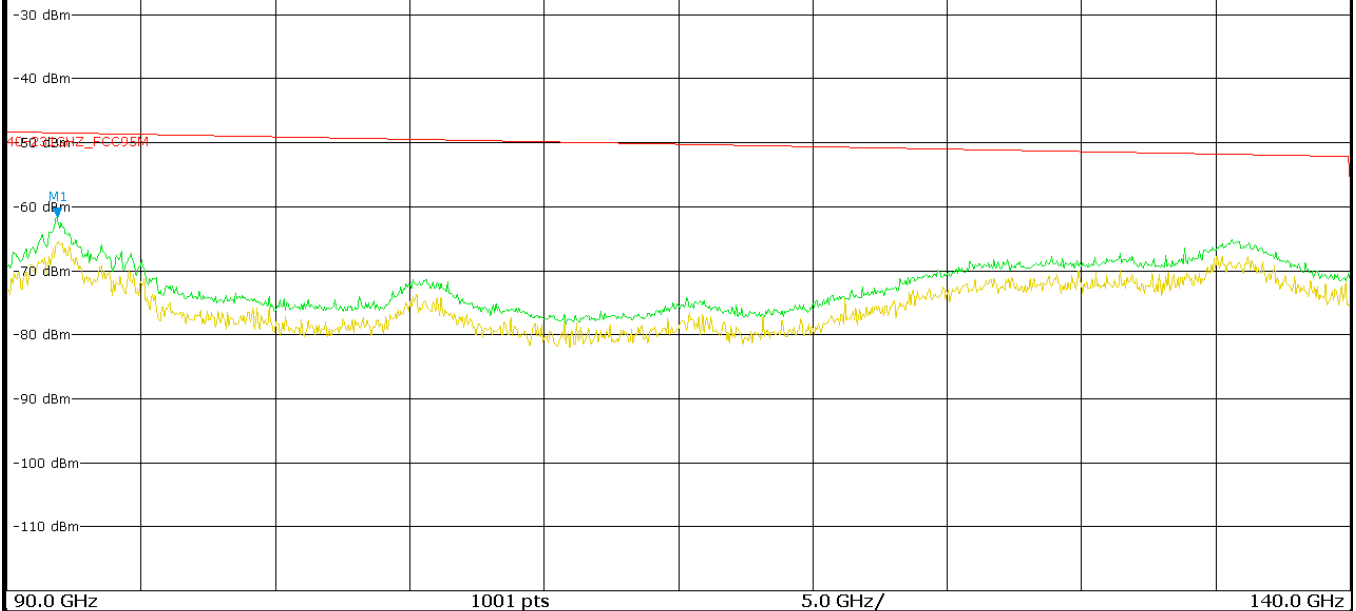
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 200 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix F

Frequency 115.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max

M1[2] -61.67 dBm
91.8730 GHz

00:55:14 22.08.2020

Measuring...

22.08.2020
00:55:14

C. Freq.

RBW

Plot # 16 Unwanted Emissions: 90 - 140 GHz

Measurement antenna orientation: Vertical



MultiView

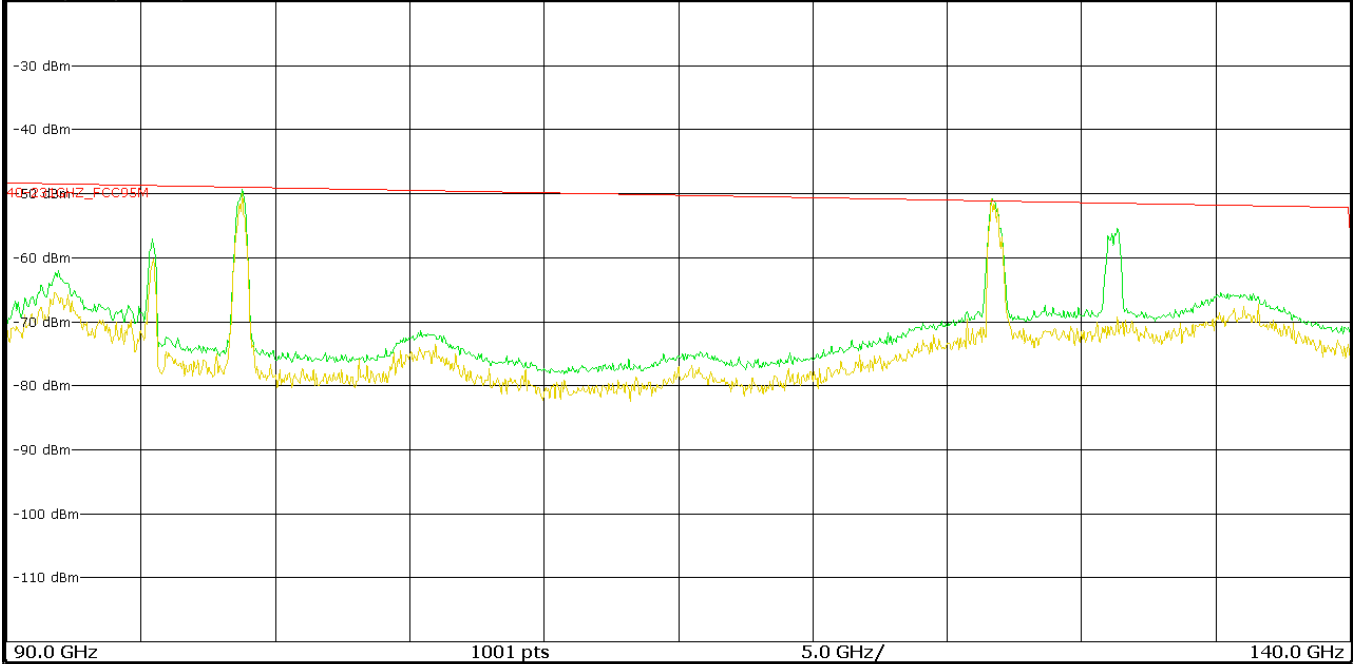
Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 200 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix F

Frequency 115.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max



01:02:28 22.08.2020

Measuring...

22.08.2020
01:02:27

C. Freq.

RBW

Plot # 17 Unwanted Emissions: 90 - 140 GHz

Measurement antenna orientation: Vertical with Signal ID on



MultiView

Spectrum

Ref Level -20.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 200 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix F

Frequency 115.000000 GHz

1 Frequency Sweep

1Pk Max SigID USB 2Pk Max SigID LSB



01:03:11 22.08.2020

Measuring...

22.08.2020
01:03:10

C. Freq.

RBW

Note: The Signal ID function of the ESW44 was used to evaluate the spectrum from 90 – 140 GHz. The conclusion is that all observed emissions are products of the external mixer.

Plot # 18 Unwanted Emissions: 140 - 220 GHz

Measurement antenna orientation: Horizontal



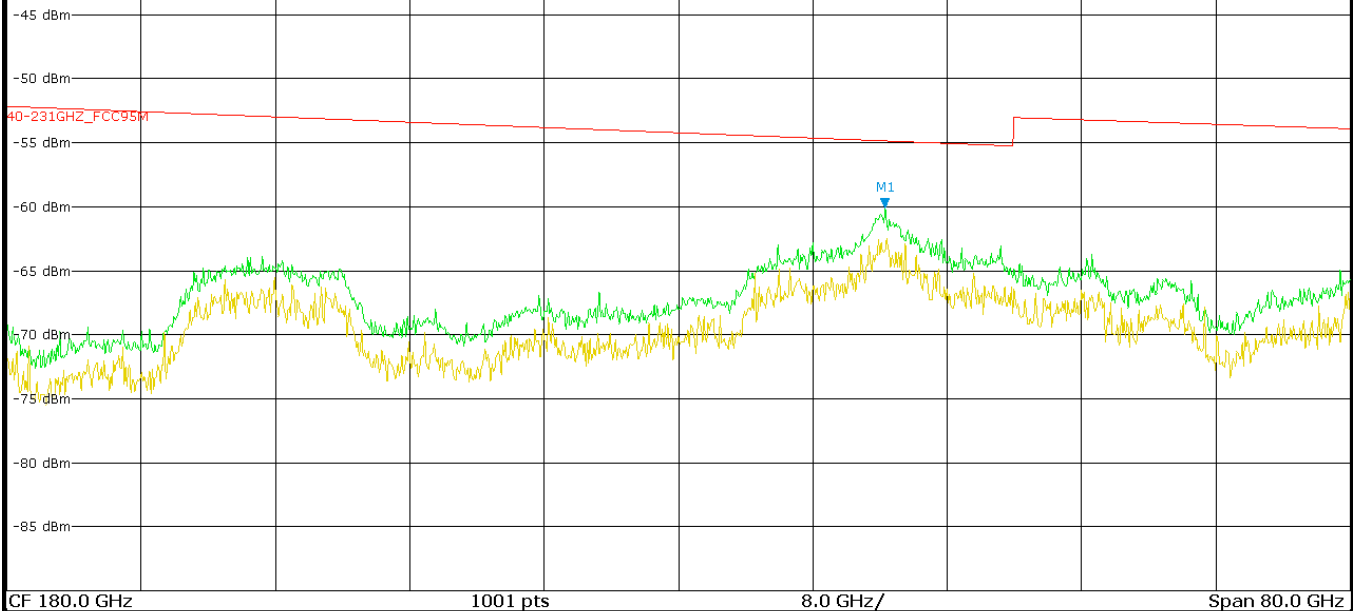
MultiView Spectrum

Ref Level -40.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 320 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix G

Frequency 180.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max
M1[2] -60.11 dBm
192.3080 GHz



CF 180.0 GHz

1001 pts

8.0 GHz/

Span 80.0 GHz

Measuring...

24.08.2020
18:20:41

C. Freq.

RBW

18:20:41 24.08.2020

Plot # 19 Unwanted Emissions: 140 - 220 GHz

Measurement antenna orientation: Vertical



MultiView

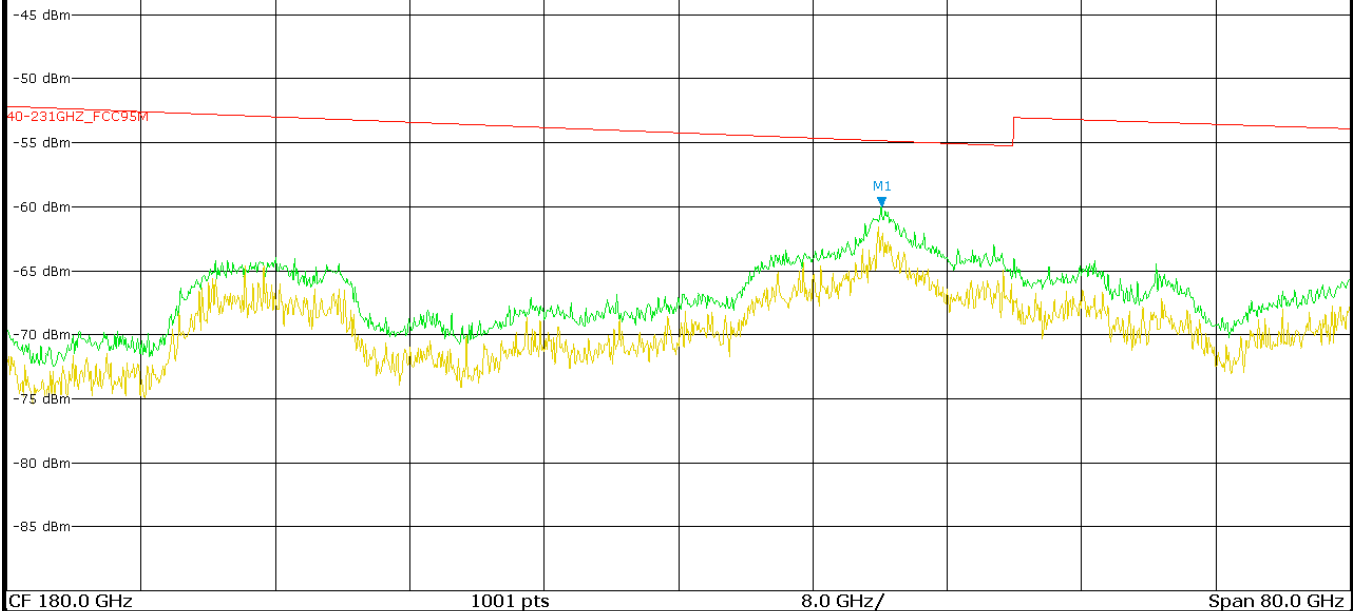
Spectrum

Ref Level -40.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 320 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix G

Frequency 180.000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max
M1[2] -60.04 dBm
192.0680 GHz



Measuring...

24.08.2020 18:25:56

C. Freq.

RBW

18:25:57 24.08.2020

Plot # 20 Unwanted Emissions: 220 - 231 GHz

Measurement antenna orientation: Horizontal



MultiView

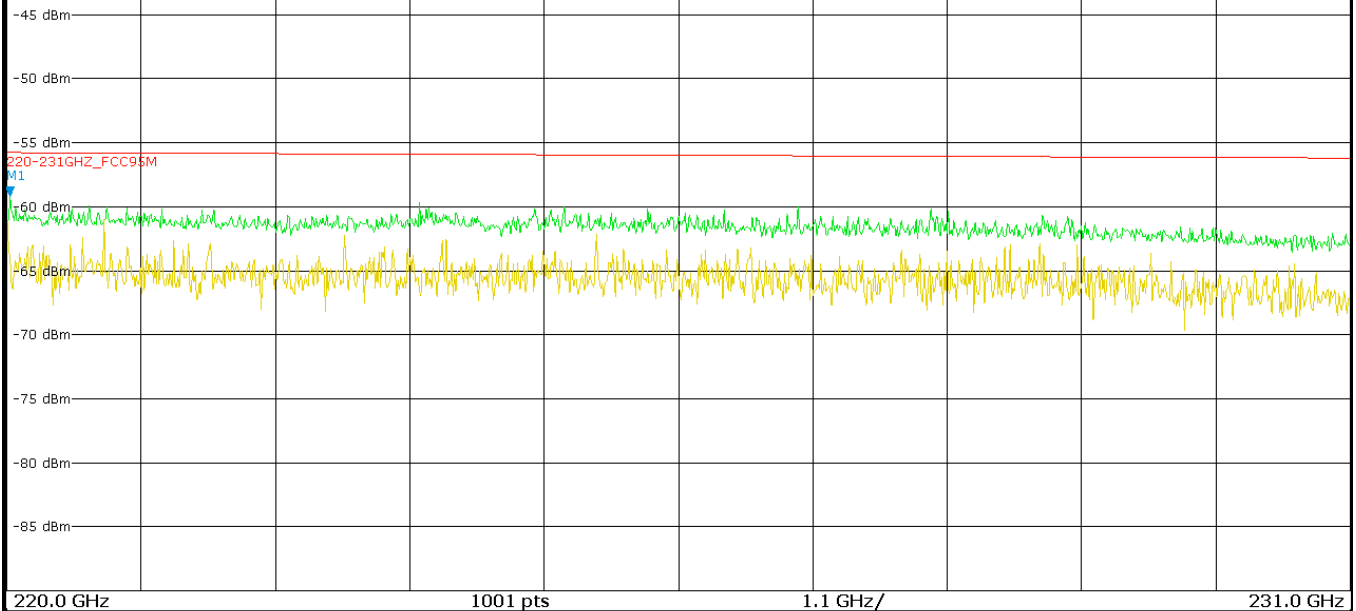
Spectrum

Ref Level -40.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 44 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix J

Frequency 225.5000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max
M1[2] -59.18 dBm
220.0270 GHz



220.0 GHz 1001 pts 1.1 GHz/ 231.0 GHz
Measuring... 24.08.2020 19:26:53 C. Freq. RBW

19:26:53 24.08.2020

Plot # 21 Unwanted Emissions: 220 - 231 GHz

Measurement antenna orientation: Vertical



MultiView

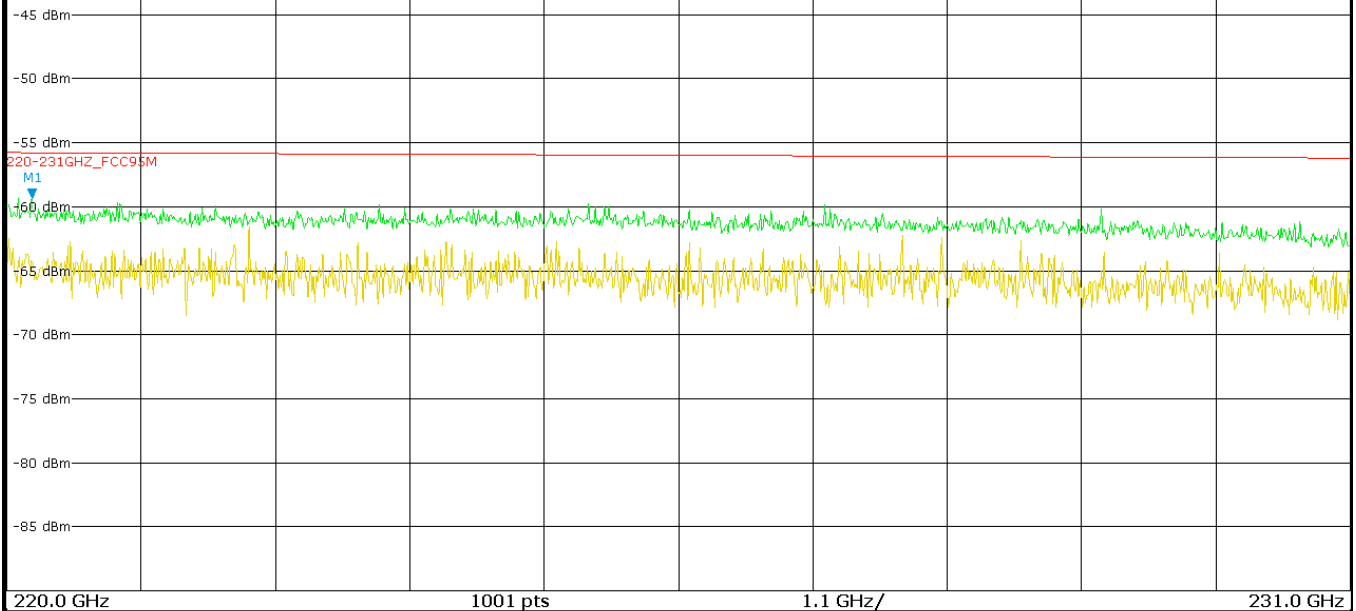
Spectrum

Ref Level -40.00 dBm Offset 1.50 dB RBW 1 MHz
SWT 44 ms VBW 3 MHz Mode Auto Sweep
Input 1 AC PS Off Notch Off
Inp: ExtMix J

Frequency 225.5000000 GHz

1 Frequency Sweep

1Pk Clrw 2Pk Max
M1[2] -59.34 dBm
220.2030 GHz



19:33:50 24.08.2020

Measuring...

24.08.2020
19:33:50

C. Freq.

RBW

9 Test setup photos

Setup photos are included in supporting file name: "EMC_UHNDE_003_20001_FCC_95M_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Name/Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
EMI Receiver/Analyzer	Rohde&Schwarz	ESW44	101715	3 years	01/07/2020
Loop antenna	ETS Lindgren	6507	161344	3 Years	10/26/2017
Biconlog Antenna	Teseq	CBL 6141B	41106	3 years	11/07/2017
Horn Antenna	EMCO	3115	35111	3 years	04/17/2019
Horn Antenna	ETS Lindgren	3117-PA	215984	3 years	01/26/2018
Horn Antenna	ETS Lindgren	3116C-PA	169535	3 years	09/24/2017
Horn Antenna 25 dBi Gain	Mi-Wave	261U-25	N/A	3 years	06/03/2020
Horn Antenna 25 dBi Gain	Mi-Wave	261E-25	N/A	3 years	06/03/2020
Horn Antenna 25 dBi Gain	Mi-Wave	261W-25	N/A	3 years	06/03/2020
Horn Antenna 25 dBi Gain	Mi-Wave	261F-25	N/A	3 years	06/03/2020
Horn Antenna 25 dBi Gain	Mi-Wave	261G-25	N/A	3 years	06/03/2020
Horn Antenna 20 dBi Gain	Flann Microwave	32240-20	N/A	3 years	06/08/2020
Harmonic Mixer	Rohde&Schwarz	FS-Z60	101025	3 years	01/22/2020
Harmonic Mixer	Rohde&Schwarz	FS-Z90	102088	3 years	02/19/2020
Harmonic Mixer	Rohde&Schwarz	FS-Z140	101145	3 years	02/24/2020
Harmonic Mixer	Rohde&Schwarz	FS-Z220	101037	3 years	03/23/2020
Harmonic Mixer	Rohde&Schwarz	FS-Z325	100943	3 years	02/27/2020
Compact Digital Barometer	Control Company	35519-055	91119547	3 years	06/08/2017

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.

Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

11 History

Date	Template Revision	Changes to report	Prepared by	Approved by
2020-09-21	EMC_UHNDE_003_20001_FCC_95M	Initial Version	Kris Lazarov	
2020-10-28	EMC_UHNDE_003_20001_FCC_95M_Rev1	Corrected RBW typo in section 8.1.1; Corrected horn antenna information in section 11; Added loop antenna information in section 11	Kris Lazarov	

<<< The End >>>