FCC / ISED Test Report

For:

Uhnder Inc.

Model Name:

UR-AS2120

Product Description:

4D Digital Imaging Radar Sensor

FCC ID: 2AXF3-URAS2120
ISED: 26449-URAS2120

Applied Rules and Standards:
47 CFR Part 95 Subpart M
RSS-251 Issue 2 & RSS-Gen Issue 5

REPORT #: EMC_UHNDE_010_22001_FCC_95M_Rev1

DATE: 12-16-2022

A2LA Accredited

IC recognized #
3462B-1

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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 Inc.	4D Digital Imaging Radar Sensor	UR-AS2120

Responsible for Testing Laboratory:

Date	Section	Name	Signature
12-16-2022	Compliance	Arndt Stoecker (Director of Regulatory Services)	Arndt Stoecker Digitally signed by: Arndt Stoecker DN: CN = Arndt Stoecker email = arndt.stoecker@cetecom.com C = US O = CETECOM Inc Date: 2022.12.16 16:20:40 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
12-16-2022	Compliance	Kris Lazarov (Senior EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2022.12.16 11:13:35 -08'00'

The test results of this test report relate exclusively to the test item specified in Section3.
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
Director of Regulatory Services:	Arndt Stoecker
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	Uhnder Inc.
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-AS2120
HW Version :	P2
SW Version :	SRS 0.81.3
FCC-ID :	2AXF3-URAS2120
ISED:	26449-URAS2120
FWIN:	N/A
HVIN:	UR-AS2120
PMN:	UR-AS2120
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 +75 C, > 0.8 m/s air flow
Other Co-transmitting Radios:	None
Sample Revision	☐Prototype Unit; ☐Production Unit; ■Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	Engineering Sample MOD-2289	P2	SRS 0.81.3	

3.3 Support Equipment (SE) details

SE #	Type	Model	Manufacturer	Serial Number
1	Mini PC	Intel NUC	Intel	G6BE01600FKM
2	Ethernet Converter	Easy CON	Gopel Electronic	20201116

3.4 Test Sample Configuration

EUT Set-up #	Combination of SE used for test set up	Comments
1	EUT#1 + SE#1 + SE#2	

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

The device uses very directional fixed antenna array placed on the long side of the enclosure. For all testing the device was positioned vertically, thus insuring that the field of view of the measurement antenna is aligned with the boresight of the device transmit antenna array along the turn-table plane of rotation.

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.

This device does not use fast frequency sweeping narrow pulses, and the measurement bandwidth of 1 MHz is much smaller than the transmission bandwidth. In addition, trace max-hold was used with the device continuously transmitting over the same frequency for the peak measurements, so pulse desensitization is not considered an issue.

4 Subject of Investigation

This test report is to support a request for new equipment authorization under the FCC ID: 2AXF3-URAS2120 and ISED: 26449-URAS2120 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)	Emissions 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=2.

Measurement System		EMC 1	EMC 2
Conducted emissions (mains port)		1.12 dB	0.46 dB
Radiated emissions	(< 30 MHz)	3.66 dB	3.88 dB
	(30 MHz – 1GHz)	3.17 dB	3.34 dB
	(1 GHz – 3 GHz)	5.01 dB	4.45 dB
	(>3 GHz)	4.0 dB	4.79 dB

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:

11/07/2022 - 11/10/2022

7 Measurement Procedures

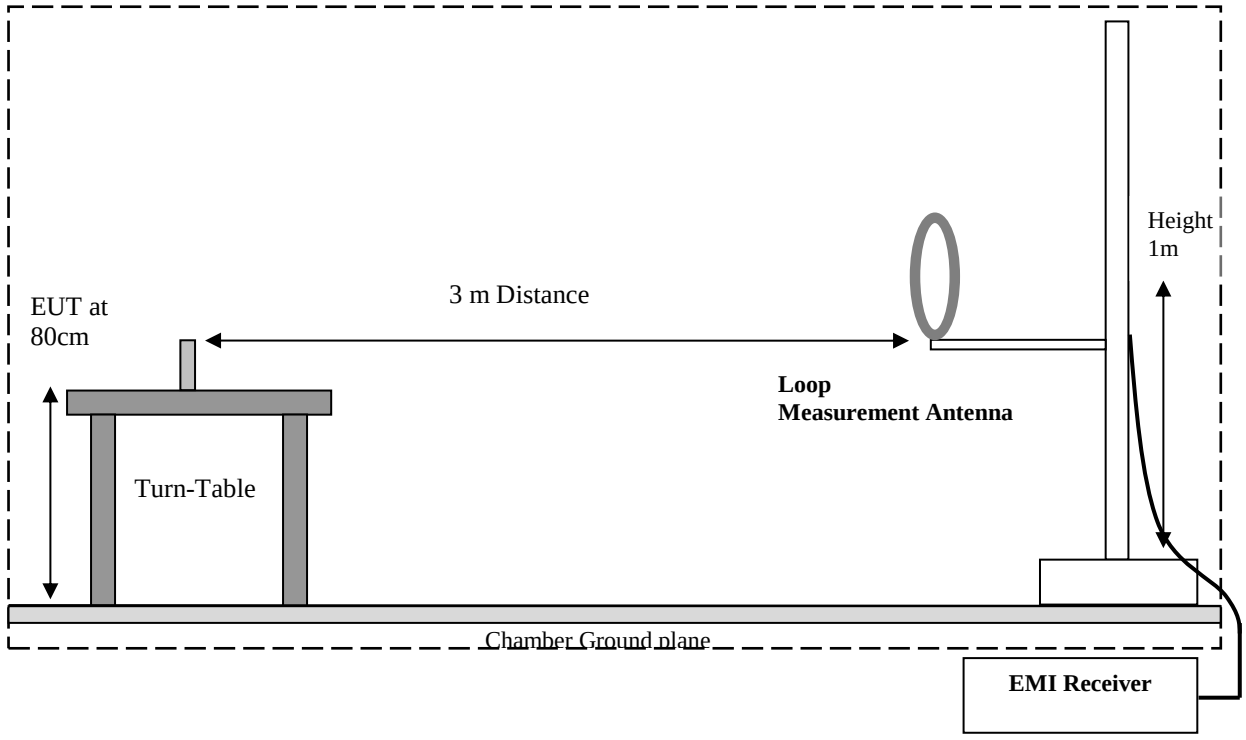
The radiated measurement is performed according to KDB 653005 D01 76-81 GHz Radars v01r02 using ANSI C63.26 (2015), and ANSI C63.10 (2013)

- 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:

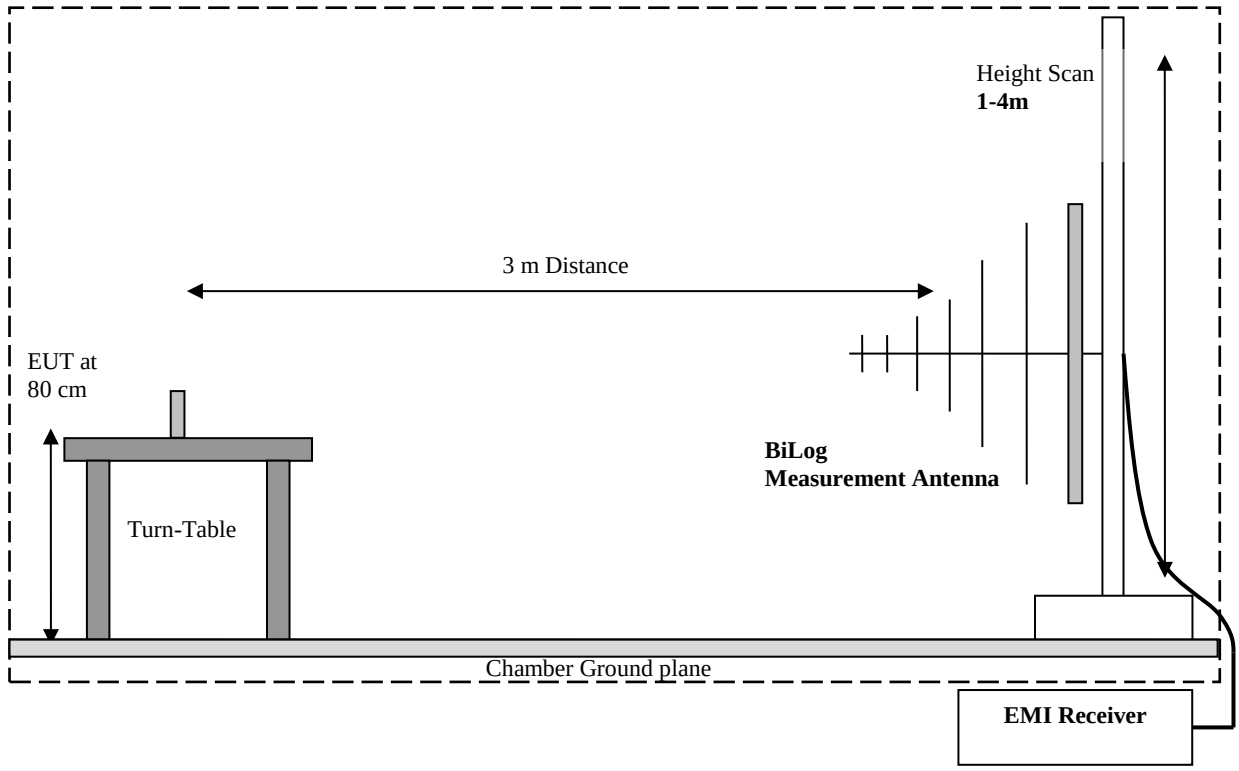
  FS (dBµV/m) = Measured Value on SA + Cable Loss + Antenna Factor

  Where:
  - Measured Value on SA in dBµV
  - Cable Loss between the receiving antenna and SA in dB
  - Antenna Factor in dB/m

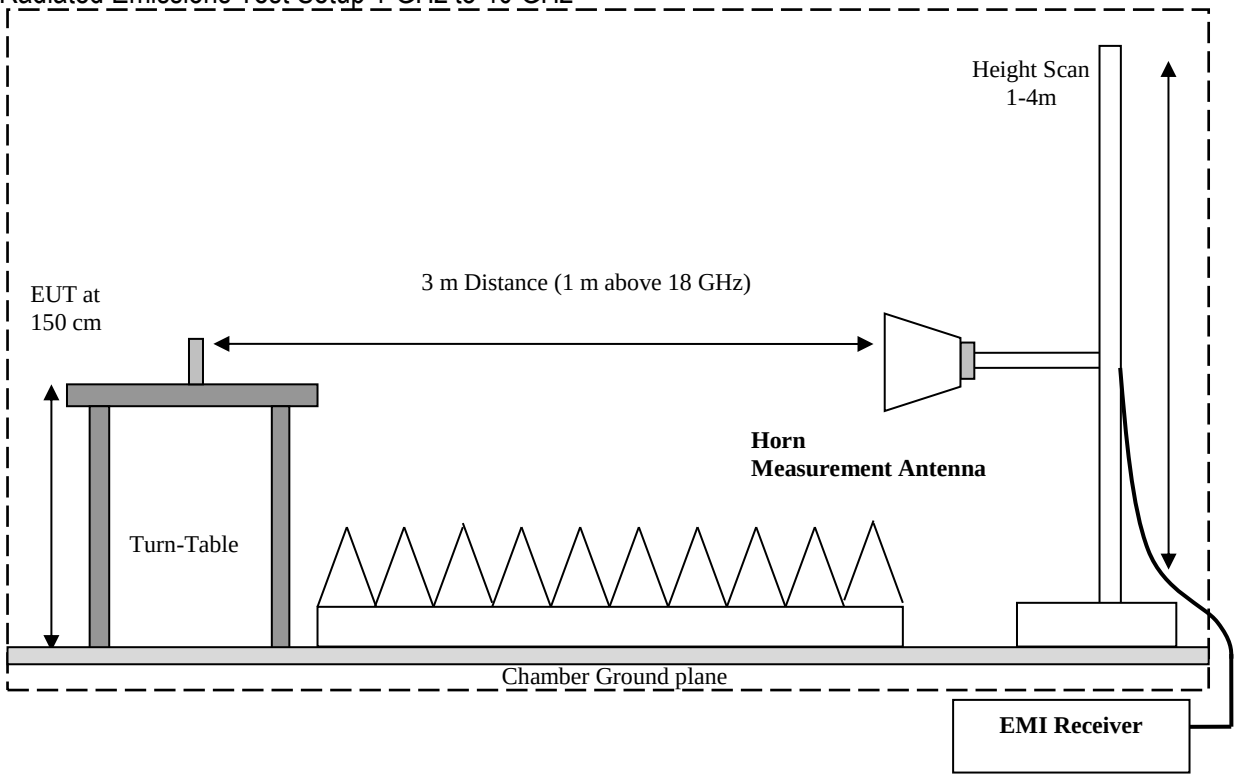
Radiated Emissions Test Setup 9 kHz to 30 MHz



Radiated Emissions Test Setup 30 MHz to 1 GHz



Radiated Emissions Test Setup 1 GHz to 40 GHz



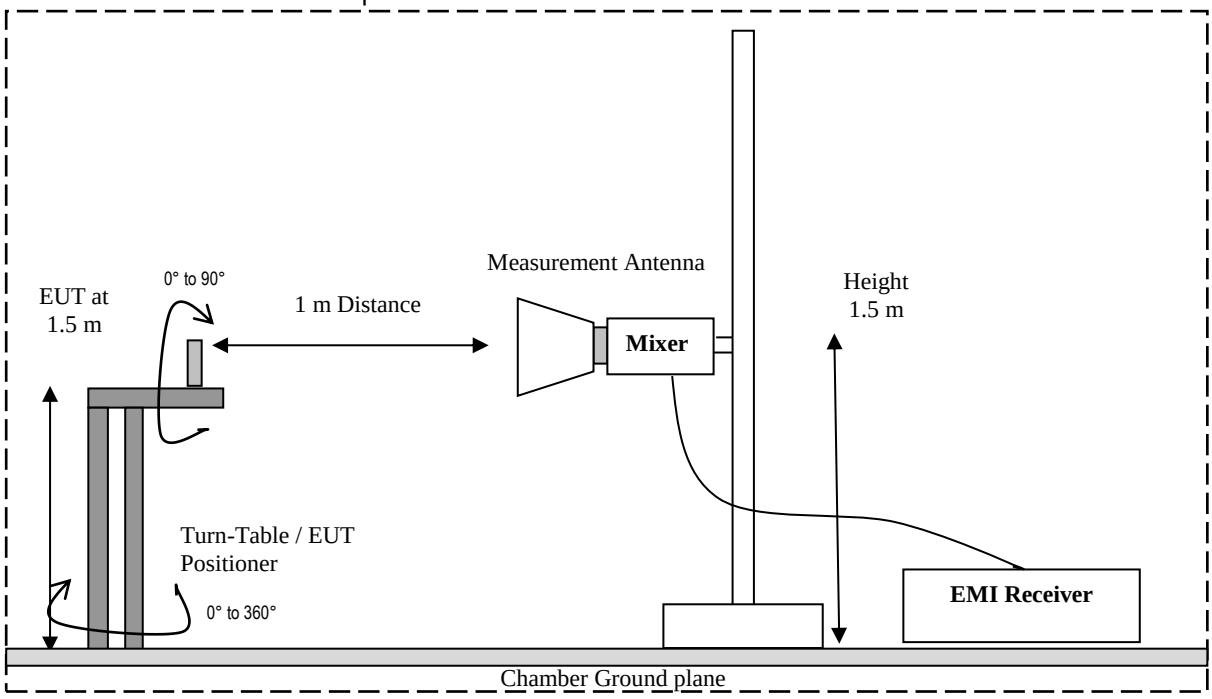
- Measurements above 40 GHz are split to 5 frequency ranges using E&S external mixers and appropriate antennas as follow:
  - 40-60 GHz FS-Z60 + 261U-25
  - 60-90 GHz FS-Z90 + 261E-23
  - 90-140 GHz FS-Z140 + 261F-25
  - 140-220 GHz FS-Z220 + 261G-25
  - 220-231 GHz FS-Z325 + 32240-20
- Exploratory measurements 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 Emissions Bandwidth

8.1.1 Measurement according to KDB 653005 D01 76-81 GHz Radars v01r02, and ANSI C63.10 (2013)

99% Emissions 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) ≈ 3 x 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
20° C	1	1	12 VDC

8.1.4 Measurement result:

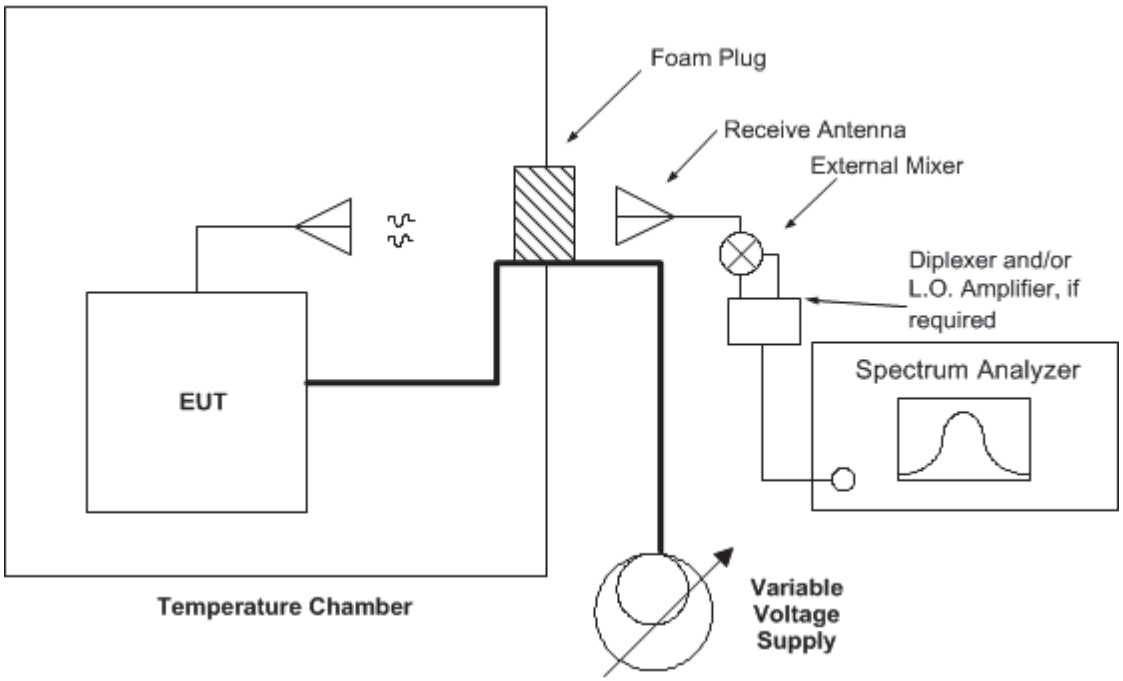
Frequency (GHz)	99% Emissions Bandwidth (MHz)	Limit	Result
76.5	450	76-81GHz	Pass

8.1.5 Measurement Plot:

Mode:

8.2 Frequency Stability

8.2.1 Measurement according to KDB 653005 D01 76-81 GHz Radars v01r02, and ANSI C63.10 (2013)



a) Arrange EUT and test equipment as shown in the figure above.
b) 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.
c) Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask.
d) 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.
e) 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 ©	EUT Set-Up #	EUT operating mode	Power Input (VDC)
20° C	1	1	12 VDC

The device was powered by lab bench variable DC power supply for this test. The supply voltage was set and verified with a calibrated voltmeter Model 407, made by AEMC Instruments.

8.2.4 Measurement result:

Temperature ©	Voltage (VDC)	f_L (GHz)	f_H (GHz)	f_{Center} (GHz)	$f_{Center - 225MHz}$ (GHz)	$f_{Center + 225MHz}$ (GHz)	Limit (GHz)	Result
50	12	76.496	76.7238	76.6099	76.3849	76.8349	76 – 81	Pass
40	12	76.494	76.7298	76.6119	76.3869	76.8369	76 – 81	Pass
30	12	76.492	76.7318	76.6119	76.3869	76.8369	76 – 81	Pass
25	11.2	76.498	76.7218	76.6099	76.3849	76.8349	76 – 81	Pass
25	12	76.474	76.7438	76.6089	76.3839	76.8339	76 – 81	Pass
25	13.8	76.492	76.7338	76.6129	76.3879	76.8379	76 – 81	Pass
20	12	76.488	76.7198	76.6039	76.3789	76.8289	76 – 81	Pass
10	12	76.482	76.7338	76.6079	76.3829	76.8329	76 – 81	Pass
0	12	76.482	76.7458	76.6139	76.3889	76.8389	76 – 81	Pass
-10	12	76.492	76.7358	76.6139	76.3889	76.8389	76 – 81	Pass
-20	12	76.482	76.7378	76.6099	76.3849	76.8349	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 450 MHz Occupied Bandwidth.

8.3 Radiated Power and Duty Cycle

8.3.1 Measurement according to KDB 653005 D01 76-81 GHz Radars v01r02, and ANSI C63.10 (2013)

Spectrum Analyzer settings:

- Center Frequency = Fundamental
- RBW = 1 MHz
- VBW = 3 MHz
- Span ≥ 2 x 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
20° C	1	1	12 VDC	15.6 dBi

8.3.4 Measurement result:

Plot #	Frequency (GHz)	Instrument Reading (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	76.5	-14.70 RMS Detector	29.44	50	Pass
2	76.5	-7.67 Peak Detector	36.47	55	Pass

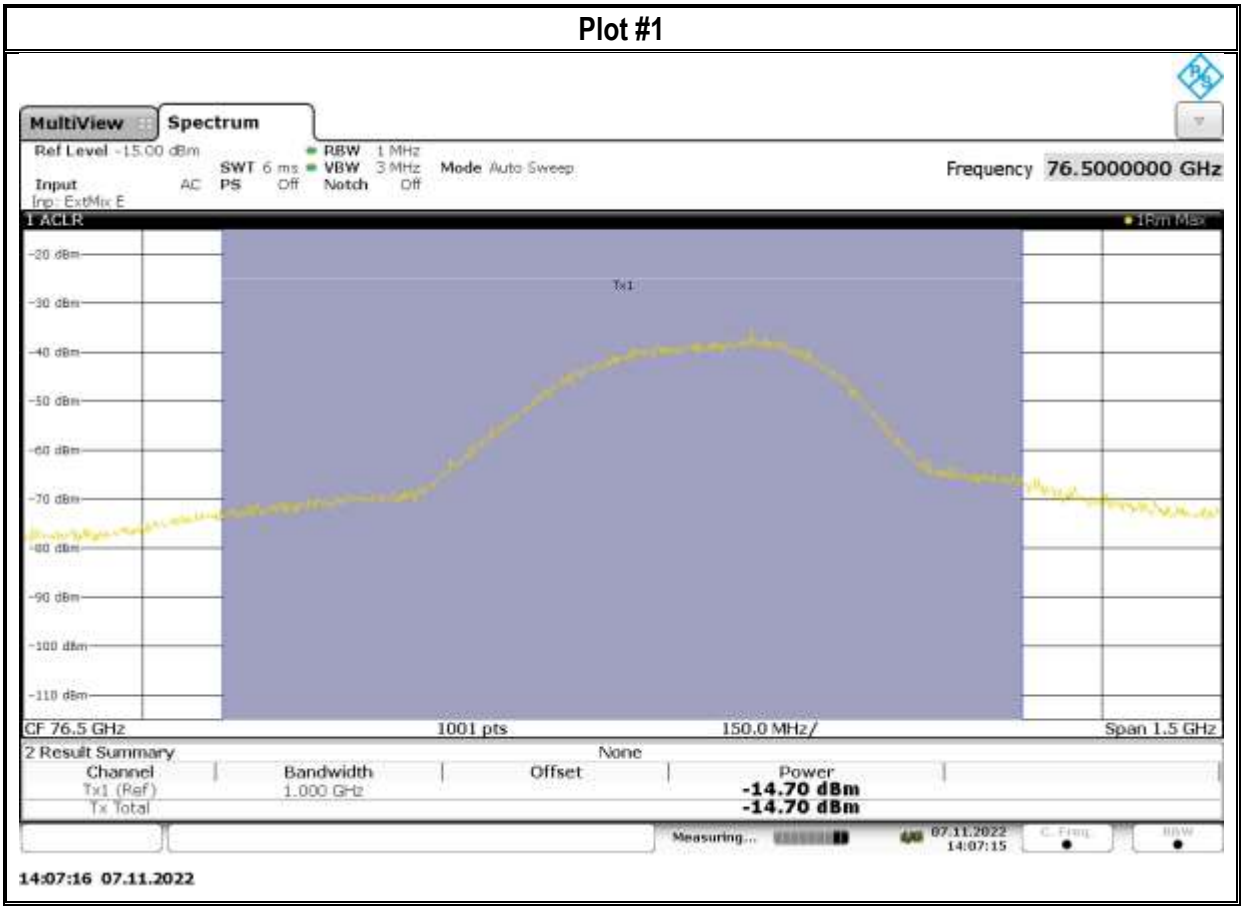
Note: The EIRP is calculate from the radiated measurement using equation (22) from ANSI C63.10 (2013):

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

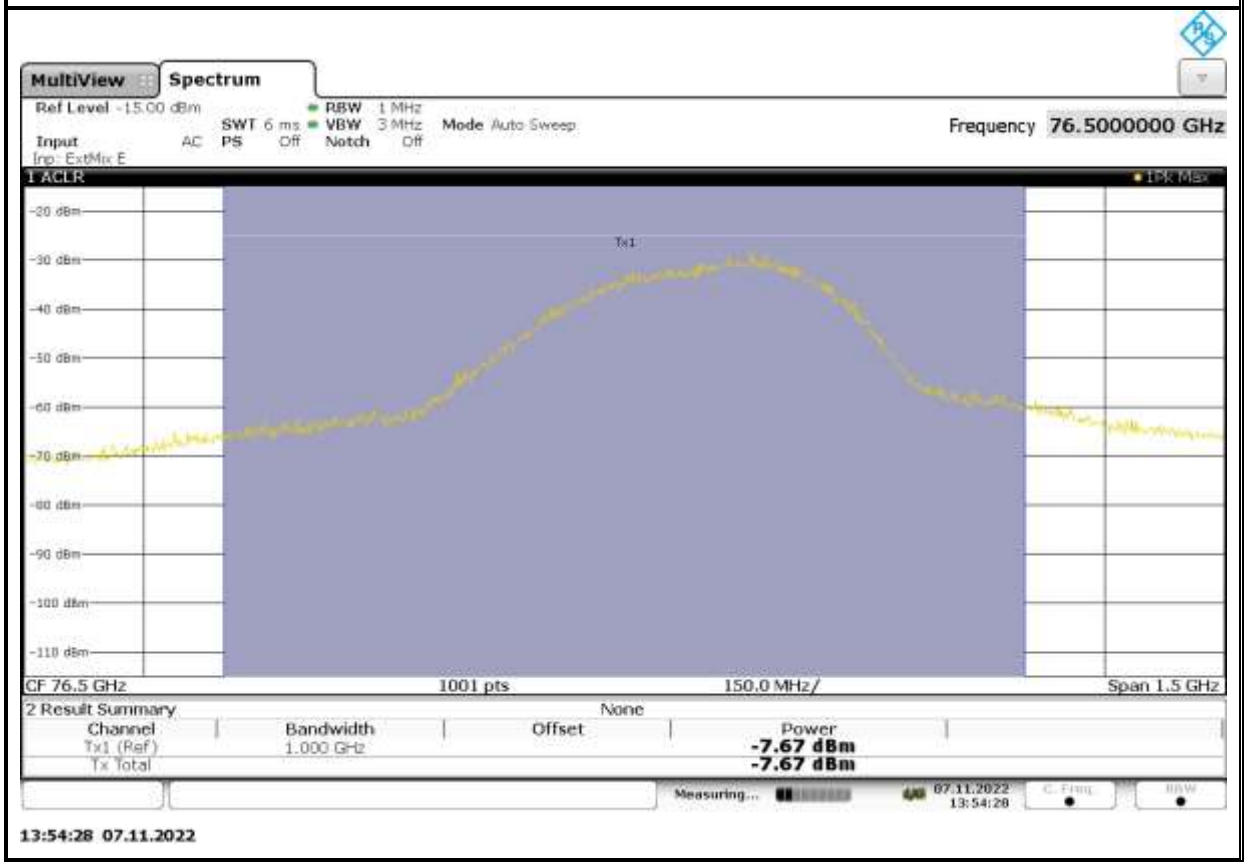
Where:
EIRP is the equivalent isotropically radiated power, in dBm
E_{Meas} is the field strength of the emission at the measurement distance, in dBµV/m
d_{Meas} is the measurement distance, in m

8.3.5 Measurement Plots:

Plot #1



Plot #2


MultiView
Spectrum
Ref Level -15.00 dBm
RBW 1 MHz
SWT 6 ms VBW 3 MHz
Mode Auto Sweep
Frequency 76.5000000 GHz
Input AC
PS Off
Notch Off
Inp: ExtMix E
1 ACLR
PK Max
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
-110 dBm
Tx1
CF 76.5 GHz
1001 pts
150.0 MHz/
Span 1.5 GHz
2 Result Summary
None
Channel
Bandwidth
Offset
Power
Tx1 (Ref)
1.000 GHz
-7.67 dBm
Tx Total
-7.67 dBm
Measuring...
07.11.2022
13:54:28
13:54:28 07.11.2022

Duty Cycle 7%


MultiView
Spectrum
Ref Level -7.00 dBm
SWT 170 ms
RBW (CHAN) 10 MHz
VBW 10 MHz
Notch Off
Input AC
PS Off
TRG:VID Inp: ExtMix E
Frequency 76.5011000 GHz
1 Zero Span
1Pk View
D7[1] 3.12 dB
100.130 ms
M1[1] -34.53 dBm
2.540 ms
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
TRG -67.000 dBm
CF 76.5011 GHz
1001 pts
17.0 ms/
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 2.54 ms -34.53 dBm
M2 1 5.09 ms -31.41 dBm
D3 M1 1 5.95 ms 3.22 dB
D4 M1 1 8.33 ms 2.94 dB
D5 M1 1 11.39 ms 14.15 dB
D6 M1 1 13.6 ms 12.98 dB
D7 M1 1 100.13 ms 3.12 dB
Measuring...
09.11.2022
15:20:09
C Freq
RBW
15:20:10 09.11.2022

8.4 Unwanted Emissions

8.4.1 Measurement according to ANSI C63.26 (2015), and 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
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	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 - 18	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

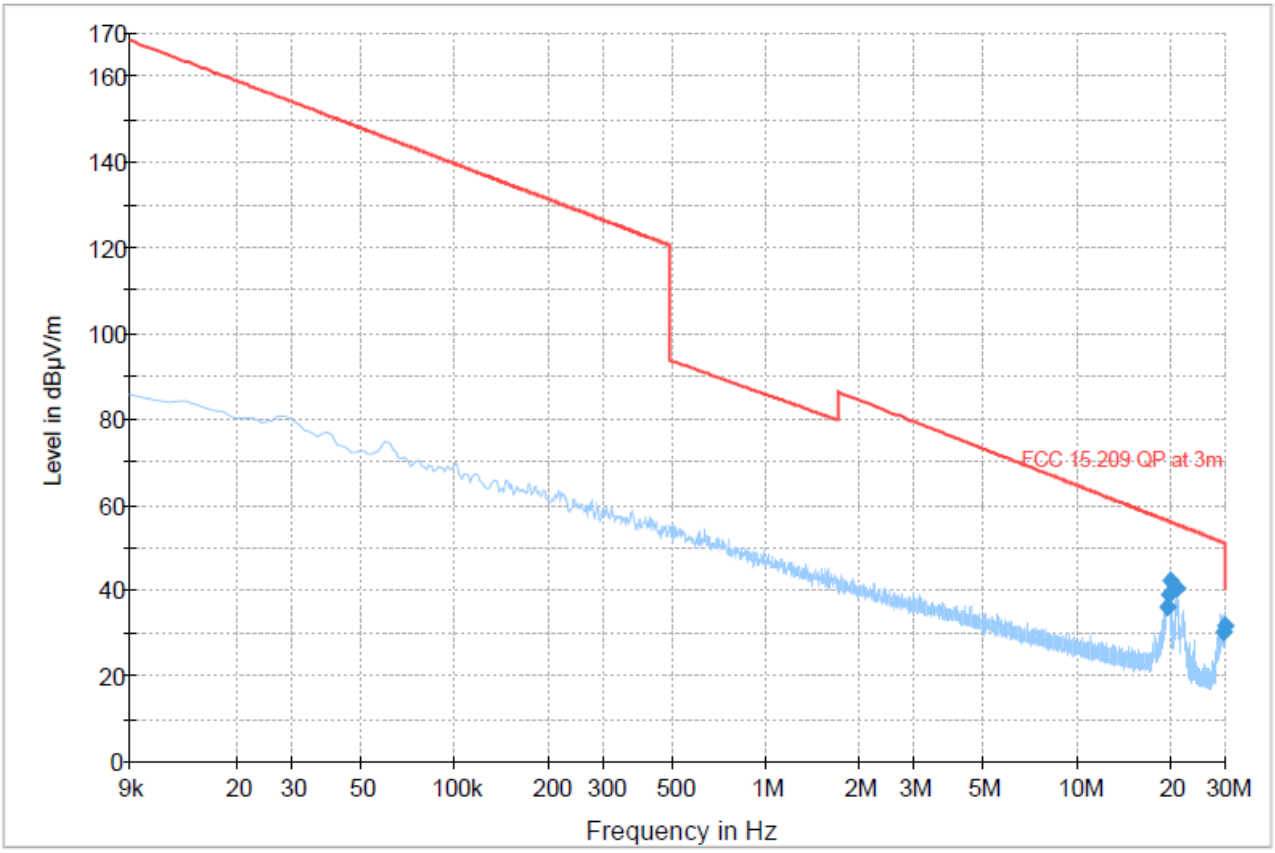
Measurement Antenna	F range GHz	Largest Antenna Dimention (m)	Far-field Boundry (m)
261U-25	40 - 60	0.0500	0.67 – 1.00
261E-25	60 - 90	0.0350	0.49 - 0.74
261W-25	75 - 110	0.0280	0.39 - 0.57
261F-25	90 - 140	0.0190	0.22 - 0.34
261G-25	140 - 220	0.0120	0.13 - 0.21
32240-20	220 - 231	0.0045	0.03 - 0.05

- 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 ate 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:

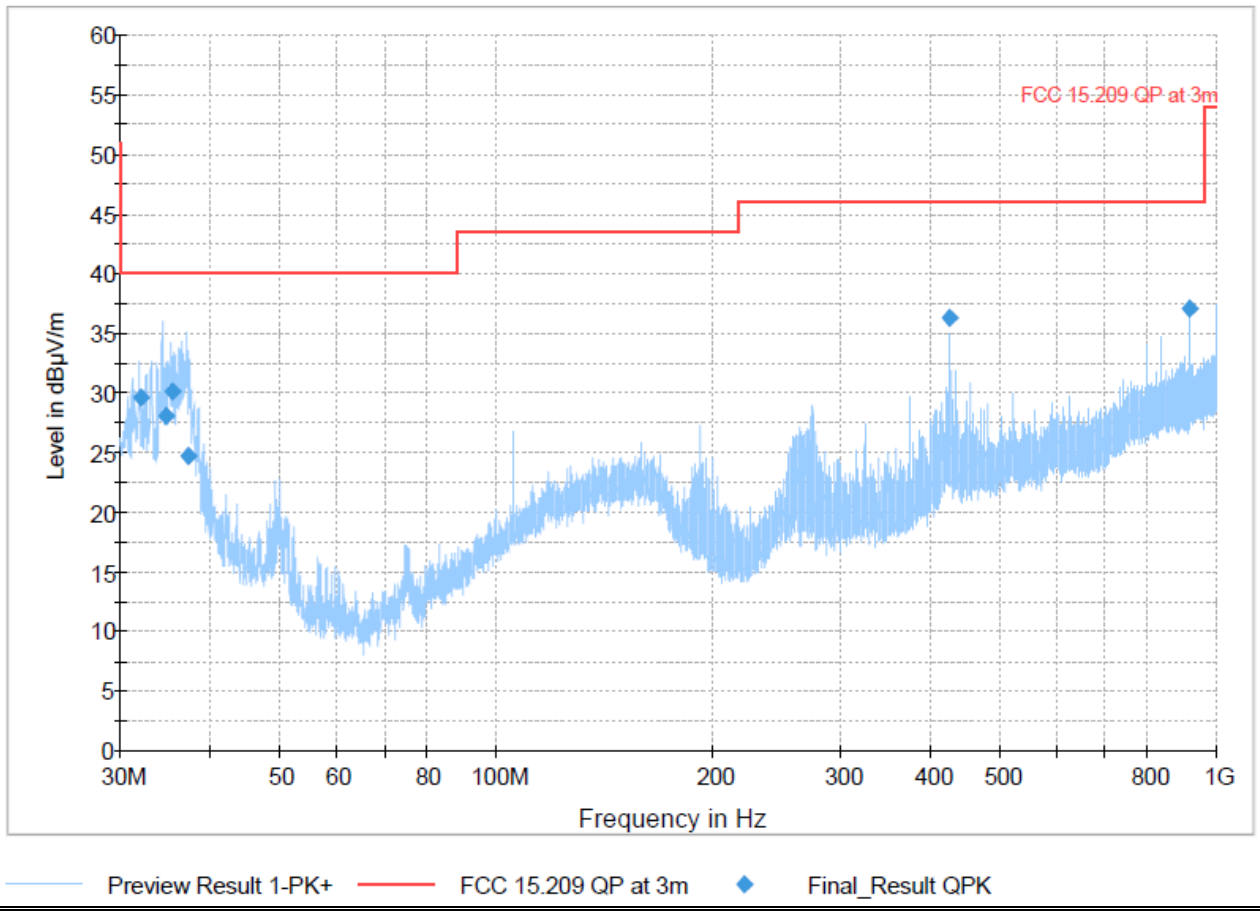
Plot # 1 Unwanted Emissions: 9 kHz - 30 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19.51	36.10	56.34	20.24	500.0	9.0	117.0	H	22.0	16.5
19.68	38.91	56.23	17.32	500.0	9.0	107.0	H	235.0	16.5
19.94	42.39	56.07	13.68	500.0	9.0	100.0	H	-60.0	16.5
20.99	40.37	55.44	15.06	500.0	9.0	100.0	H	-52.0	16.4
29.60	30.17	51.21	21.03	500.0	9.0	100.0	H	216.0	15.9
29.86	31.59	51.10	19.51	500.0	9.0	107.0	H	153.0	15.9



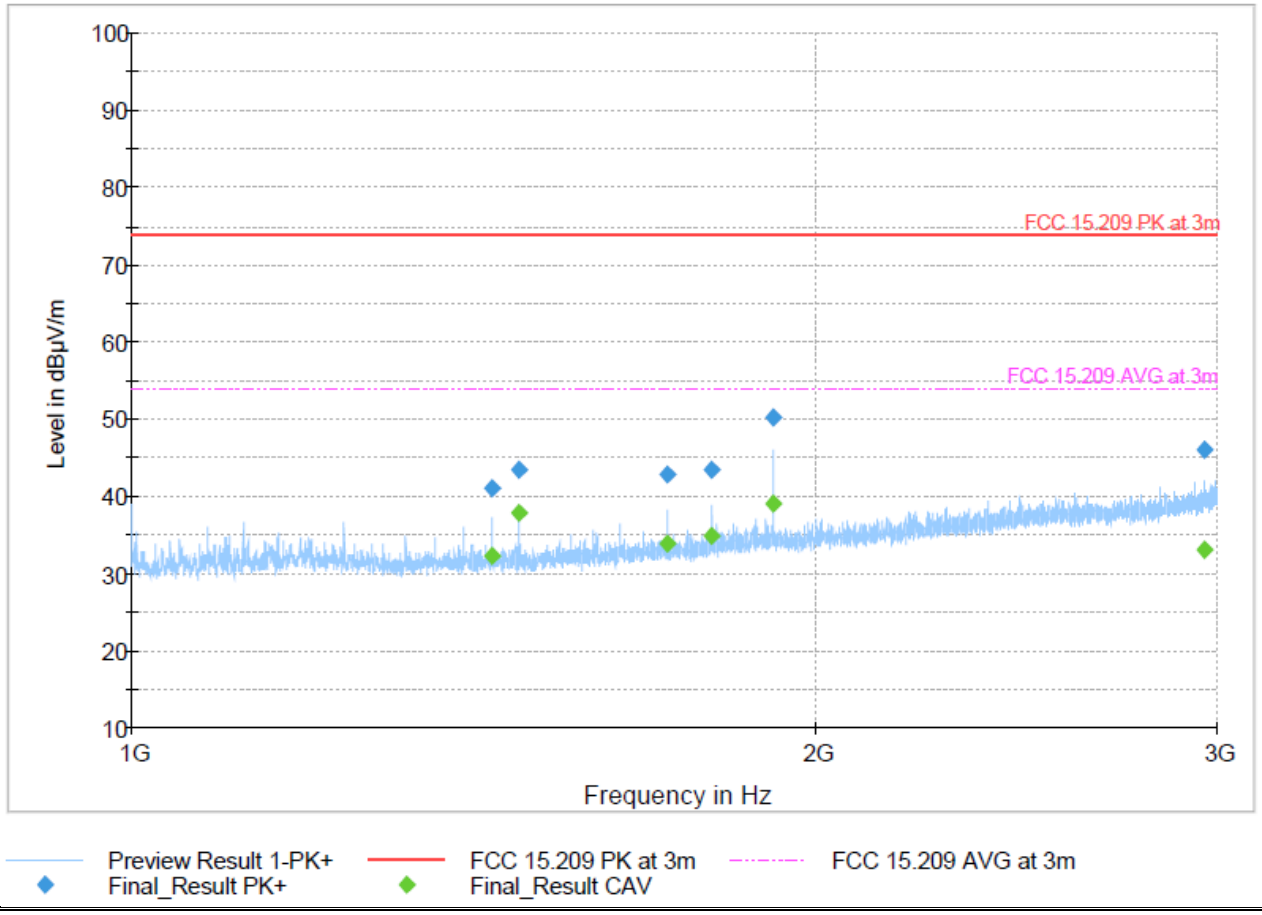
Plot # 2 Unwanted Emissions 30 MHz – 1GHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
32.03	29.57	40.00	10.43	500.0	120.0	211.0	H	106.0	23.8
34.77	28.11	40.00	11.89	500.0	120.0	237.0	H	141.0	22.4
35.50	30.19	40.00	9.81	500.0	120.0	117.0	H	85.0	21.9
37.20	24.71	40.00	15.29	500.0	120.0	125.0	H	114.0	21.0
424.99	36.27	46.02	9.75	500.0	120.0	100.0	V	167.0	23.6
919.83	37.08	46.02	8.94	500.0	120.0	250.0	V	352.0	31.8



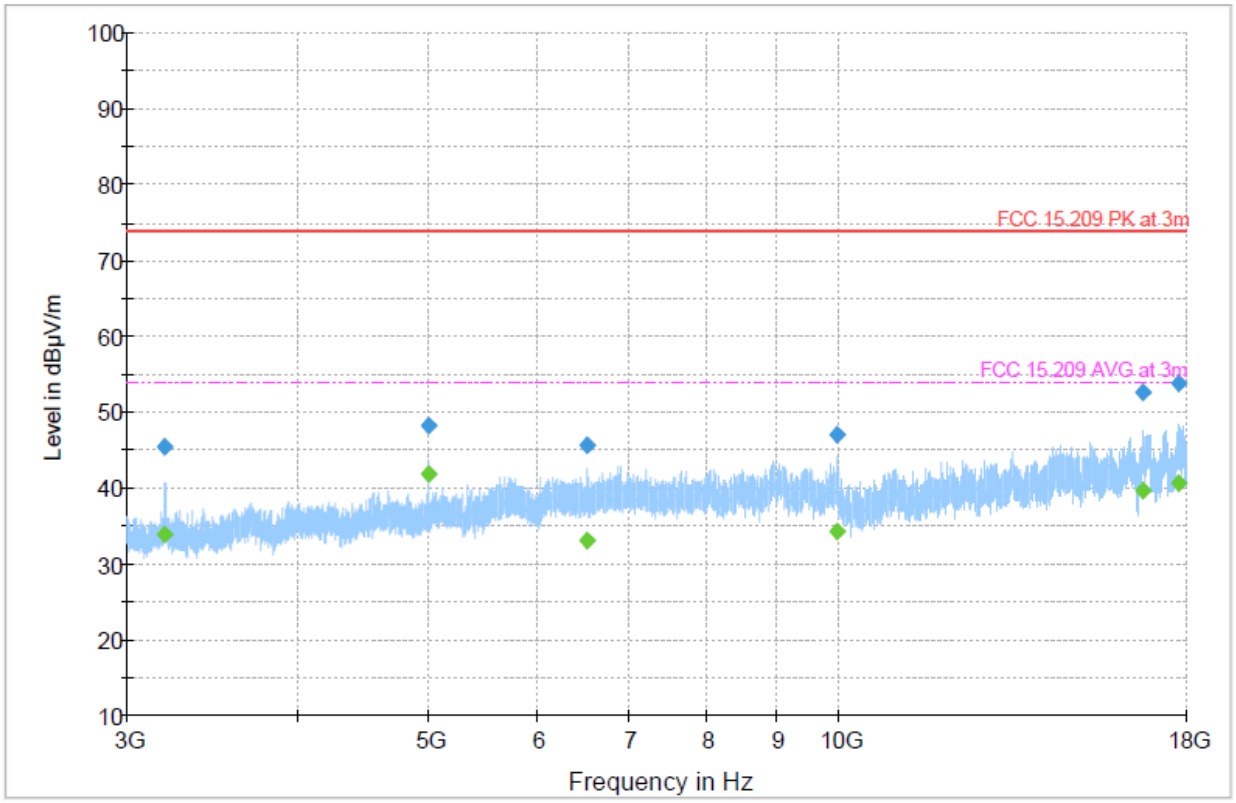
Plot # 3 Unwanted Emissions: 1-3 GHz

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)
1439.85	---	32.25	53.98	21.73	500.0	1000.0	147.0	H	237.0	28.8
1439.85	41.07	---	73.98	32.91	500.0	1000.0	147.0	H	237.0	28.8
1479.80	---	37.90	53.98	16.08	500.0	1000.0	100.0	H	120.0	28.9
1479.80	43.46	---	73.98	30.52	500.0	1000.0	100.0	H	120.0	28.9
1719.85	---	33.93	53.98	20.05	500.0	1000.0	186.0	H	246.0	30.1
1719.85	42.79	---	73.98	31.19	500.0	1000.0	186.0	H	246.0	30.1
1799.65	---	34.85	53.98	19.13	500.0	1000.0	116.0	H	282.0	30.4
1799.65	43.37	---	73.98	30.61	500.0	1000.0	116.0	H	282.0	30.4
1914.65	---	39.15	53.98	14.83	500.0	1000.0	107.0	H	312.0	31.2
1914.65	50.26	---	73.98	23.72	500.0	1000.0	107.0	H	312.0	31.2
2959.50	---	33.16	53.98	20.82	500.0	1000.0	204.0	H	-15.0	35.0
2959.50	46.10	---	73.98	27.88	500.0	1000.0	204.0	H	-15.0	35.0



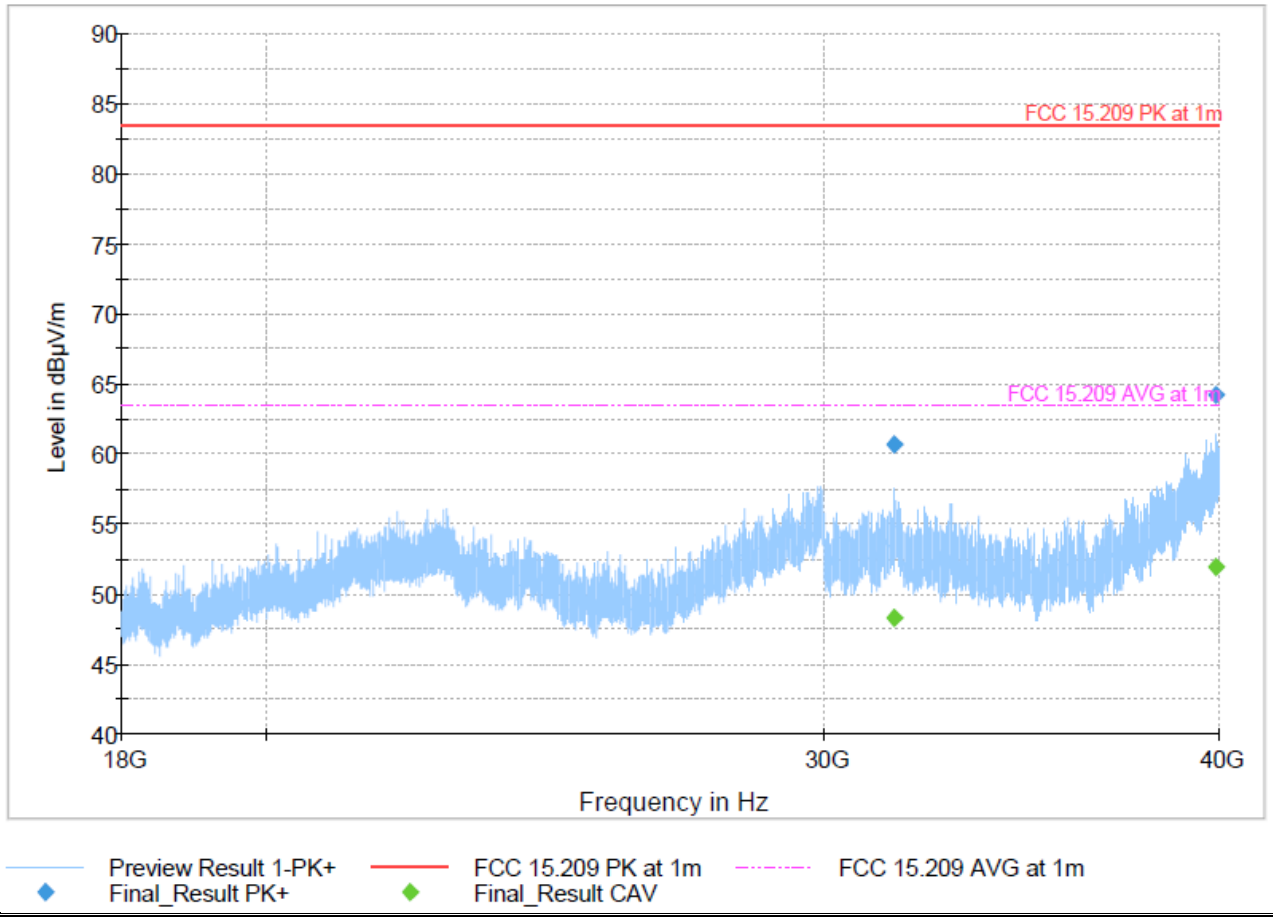
Plot # 4 Unwanted Emissions: 3 - 18 GHz

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)
3199.16	---	33.80	53.98	20.18	500.0	1000.0	155.0	H	113.0	-7.0
3199.16	45.49	---	73.98	28.49	500.0	1000.0	155.0	H	113.0	-7.0
4999.96	48.28	---	73.98	25.70	500.0	1000.0	135.0	V	321.0	-3.3
4999.96	---	41.93	53.98	12.05	500.0	1000.0	135.0	V	321.0	-3.3
6534.50	---	33.12	53.98	20.86	500.0	1000.0	162.0	V	249.0	-1.1
6534.50	45.65	---	73.98	28.33	500.0	1000.0	162.0	V	249.0	-1.1
9954.54	---	34.20	53.98	19.78	500.0	1000.0	161.0	V	334.0	3.1
9954.54	47.06	---	73.98	26.92	500.0	1000.0	161.0	V	334.0	3.1
16737.22	52.69	---	73.98	21.29	500.0	1000.0	267.0	H	318.0	13.5
16737.22	---	39.68	53.98	14.30	500.0	1000.0	267.0	H	318.0	13.5
17781.04	---	40.72	53.98	13.26	500.0	1000.0	174.0	V	353.0	17.3
17781.04	53.76	---	73.98	20.22	500.0	1000.0	174.0	V	353.0	17.3

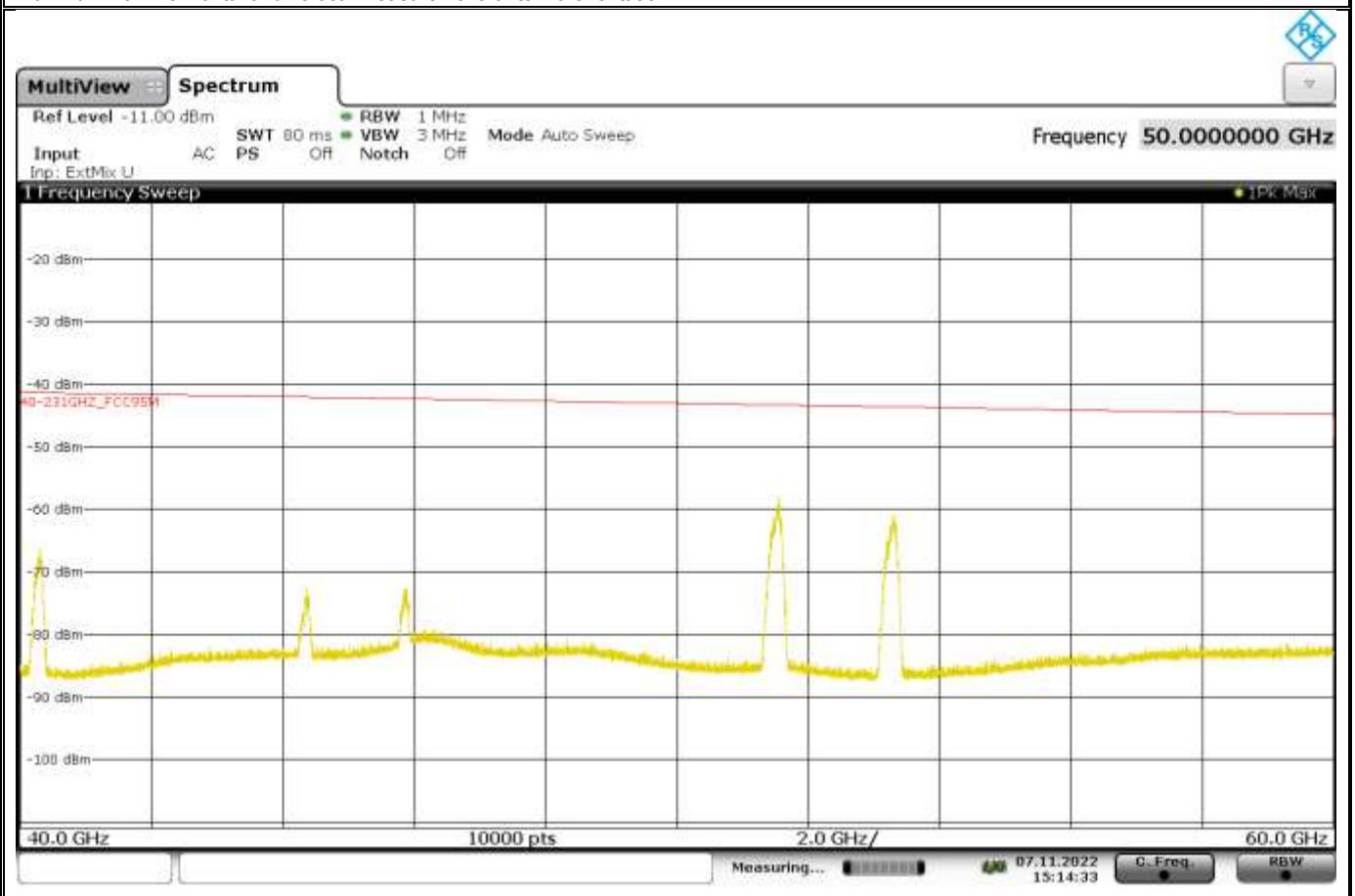


Plot # 5 Unwanted Emissions: 18-40 GHz

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)
31578.13	60.74	---	83.50	22.76	500.0	1000.0	150.0	V	217.0	23.1
31578.13	---	48.27	63.50	15.23	500.0	1000.0	150.0	V	217.0	23.1
39910.31	64.25	---	83.50	19.25	500.0	1000.0	150.0	H	162.0	24.6
39910.31	---	51.92	63.50	11.58	500.0	1000.0	150.0	H	162.0	24.6

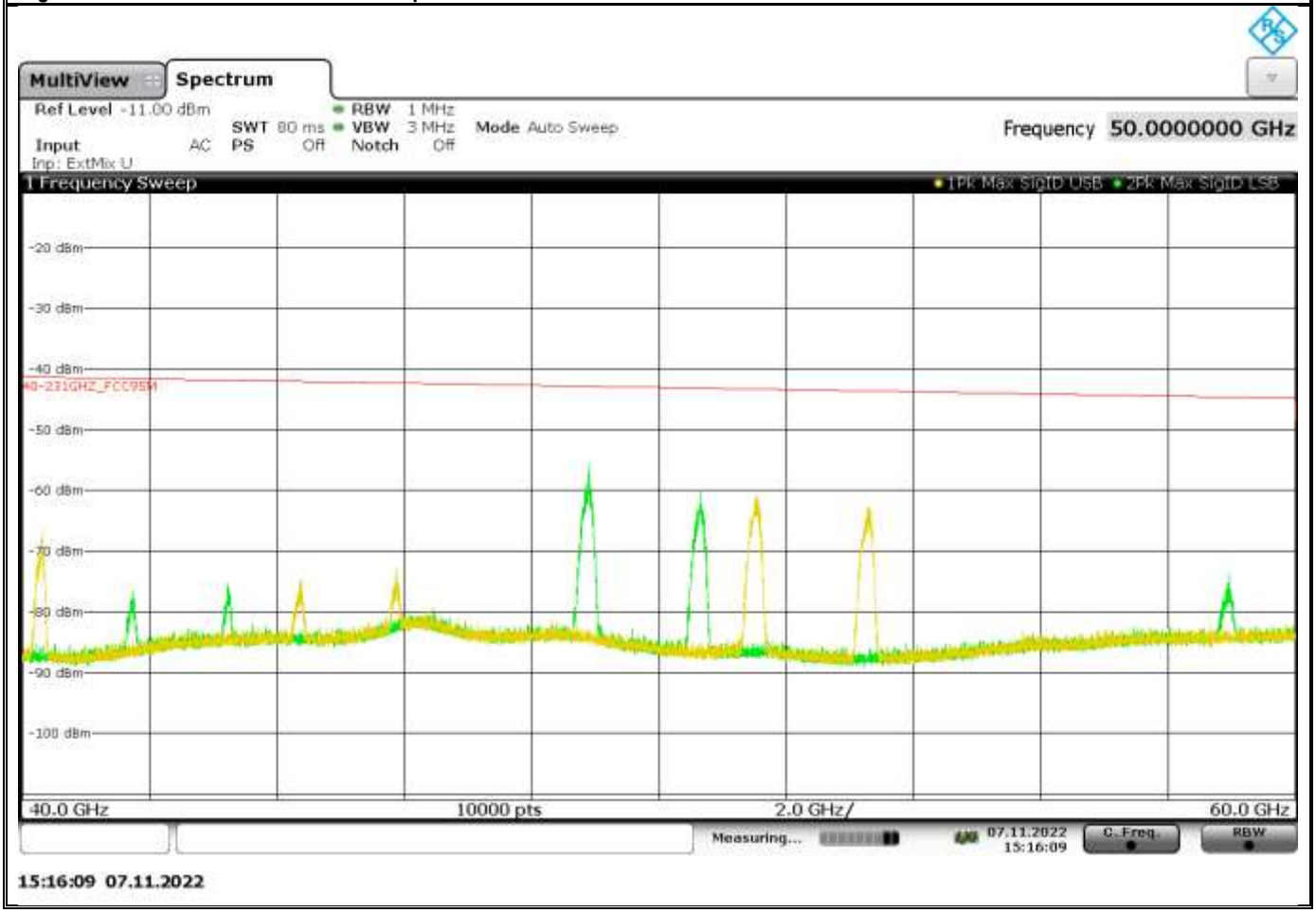


Plot # 6 Unwanted Emissions: 40 - 60 GHz
Maximum from horizontal and vertical measurement antenna orientation

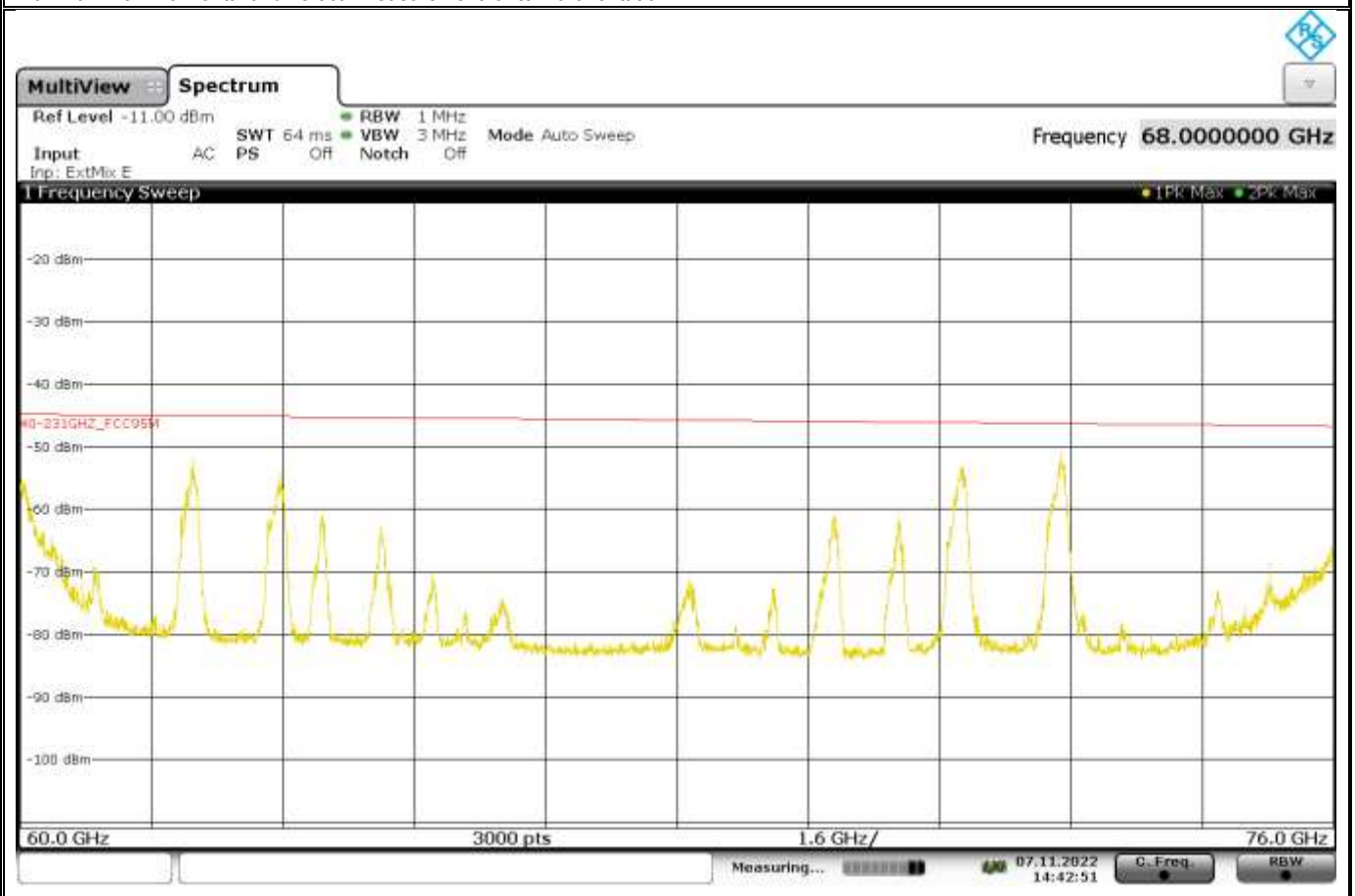


Plot # 7 Unwanted Emissions: 40 - 60 GHz

Maximum from horizontal and vertical measurement antenna orientation
Signal ID ON - all observed emissions are products of the external mixer



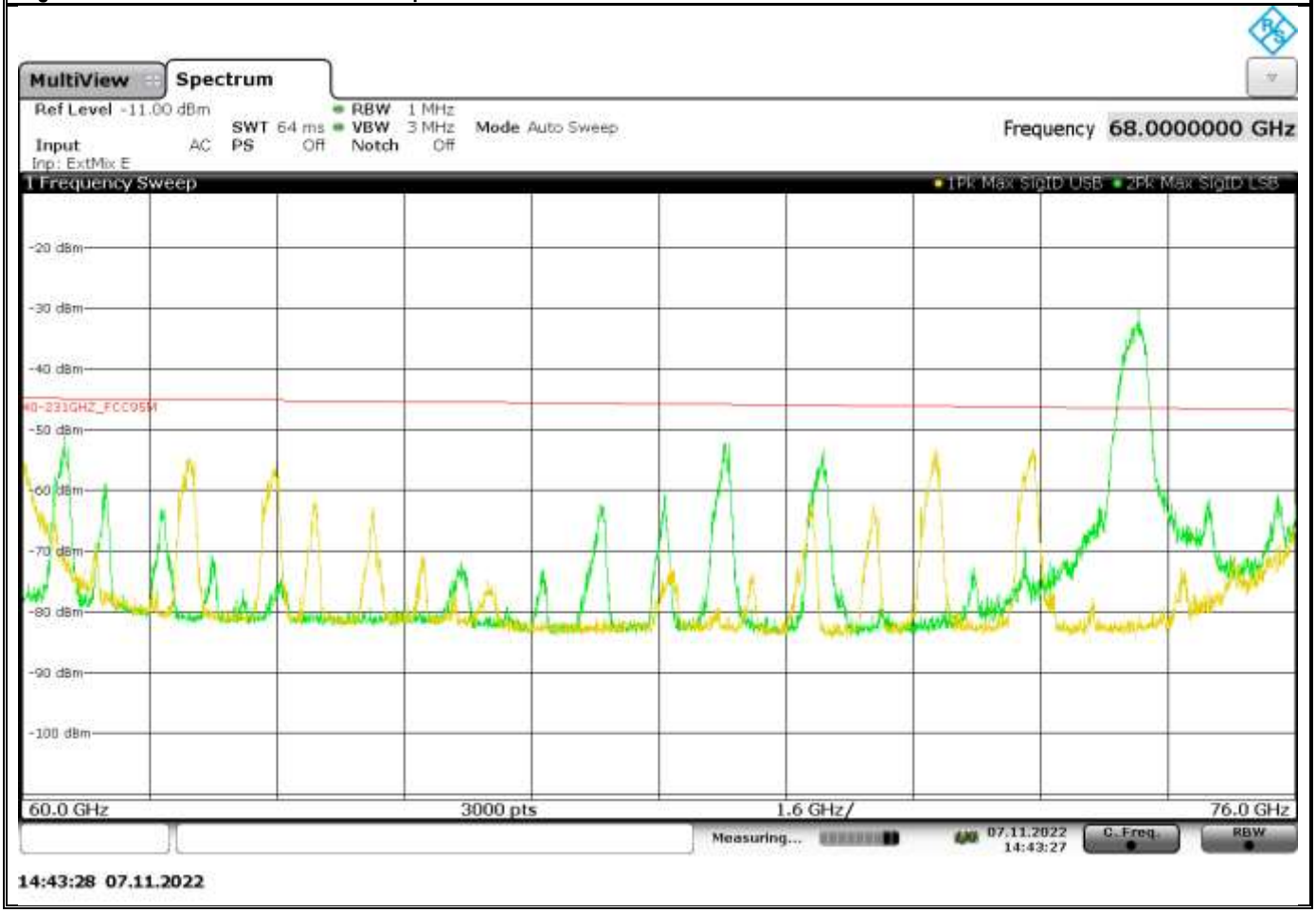
Plot # 8 Unwanted Emissions: 60 - 76 GHz
Maximum from horizontal and vertical measurement antenna orientation



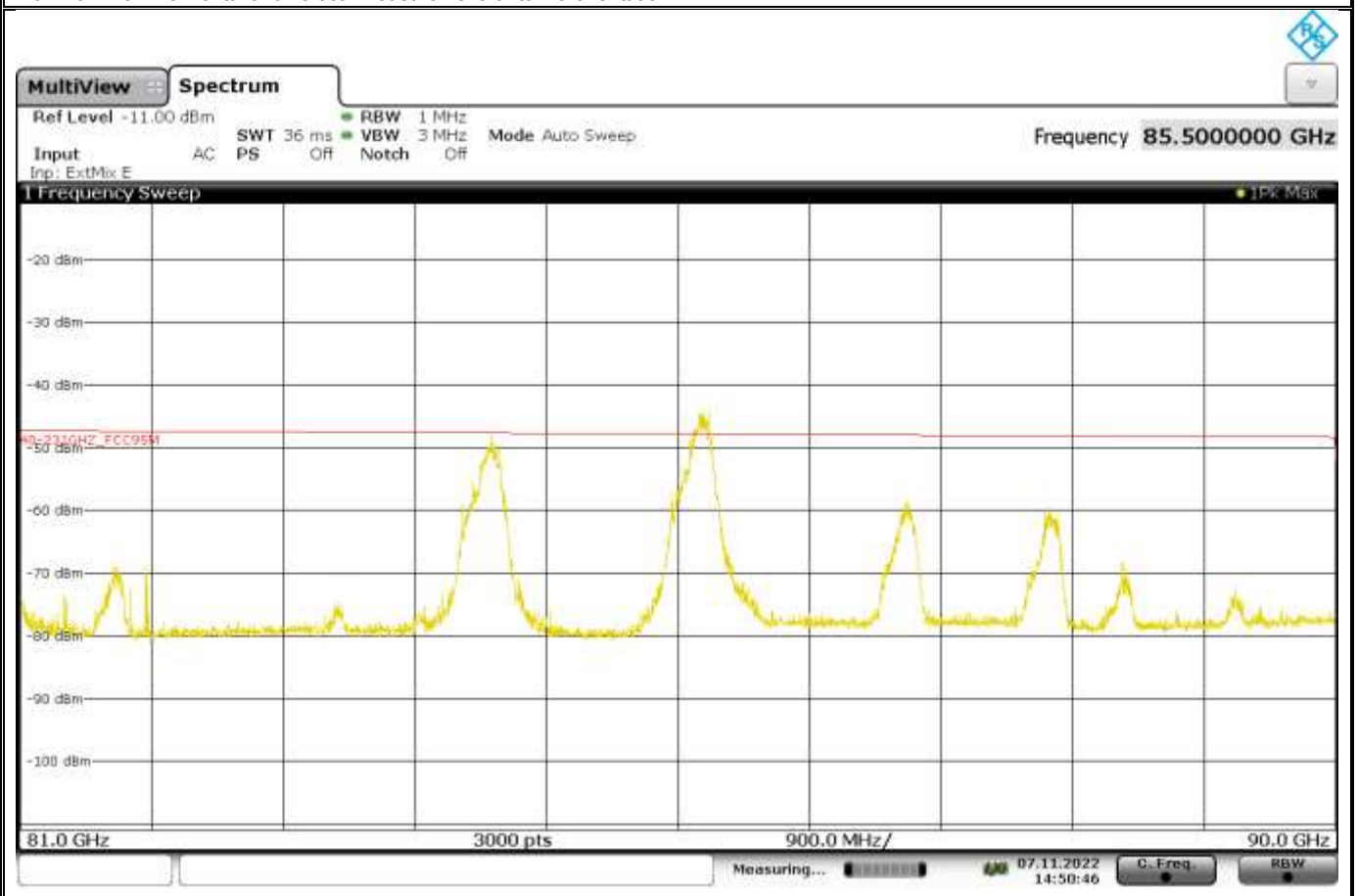
Plot # 9 Unwanted Emissions: 60 - 76 GHz

Maximum from horizontal and vertical measurement antenna orientation

Signal ID ON - all observed emissions are products of the external mixer

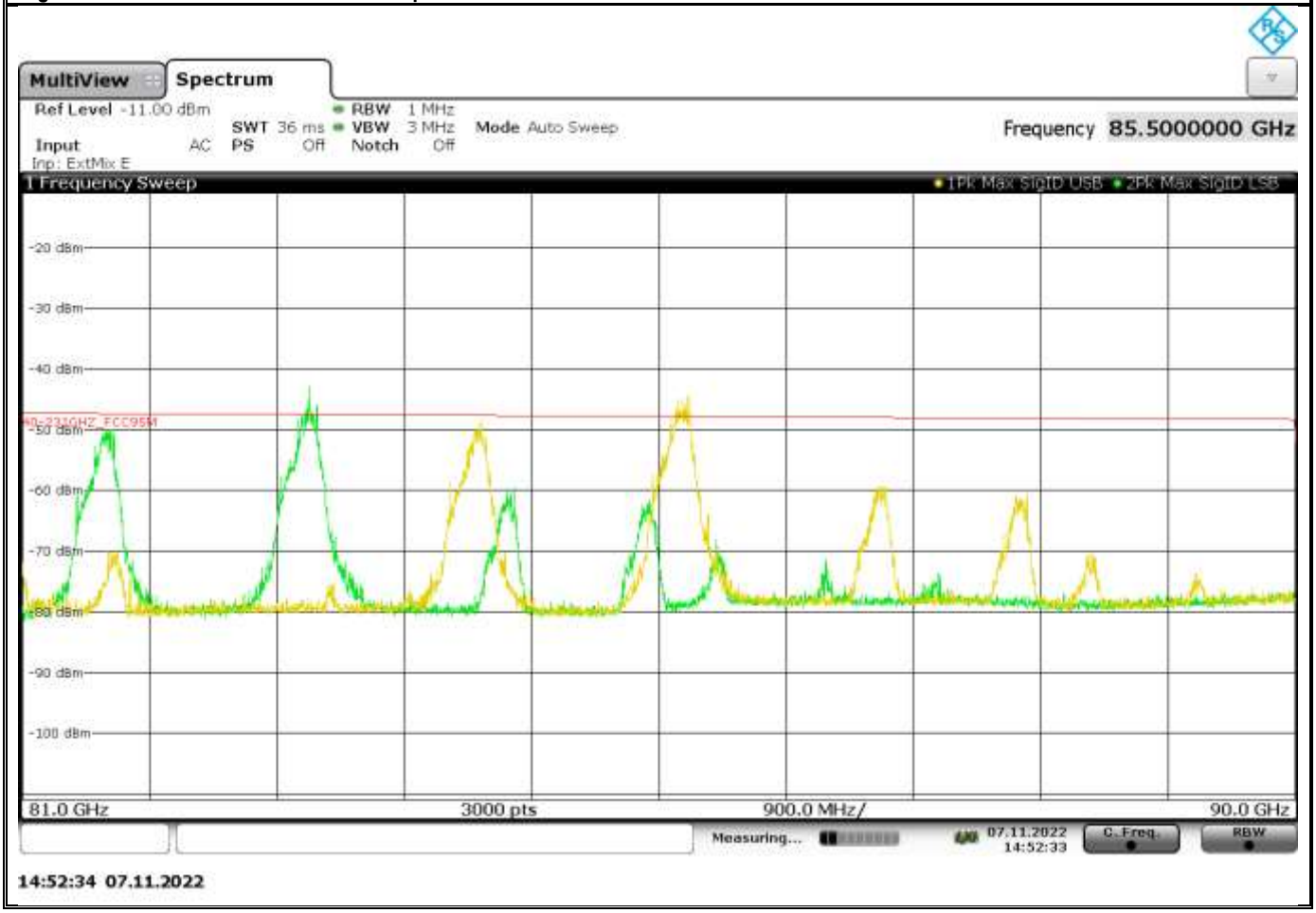


Plot # 10 Unwanted Emissions: 81 - 90 GHz
Maximum from horizontal and vertical measurement antenna orientation



Plot # 11 Unwanted Emissions: 81 - 90 GHz

Maximum from horizontal and vertical measurement antenna orientation
Signal ID ON - all observed emissions are products of the external mixer



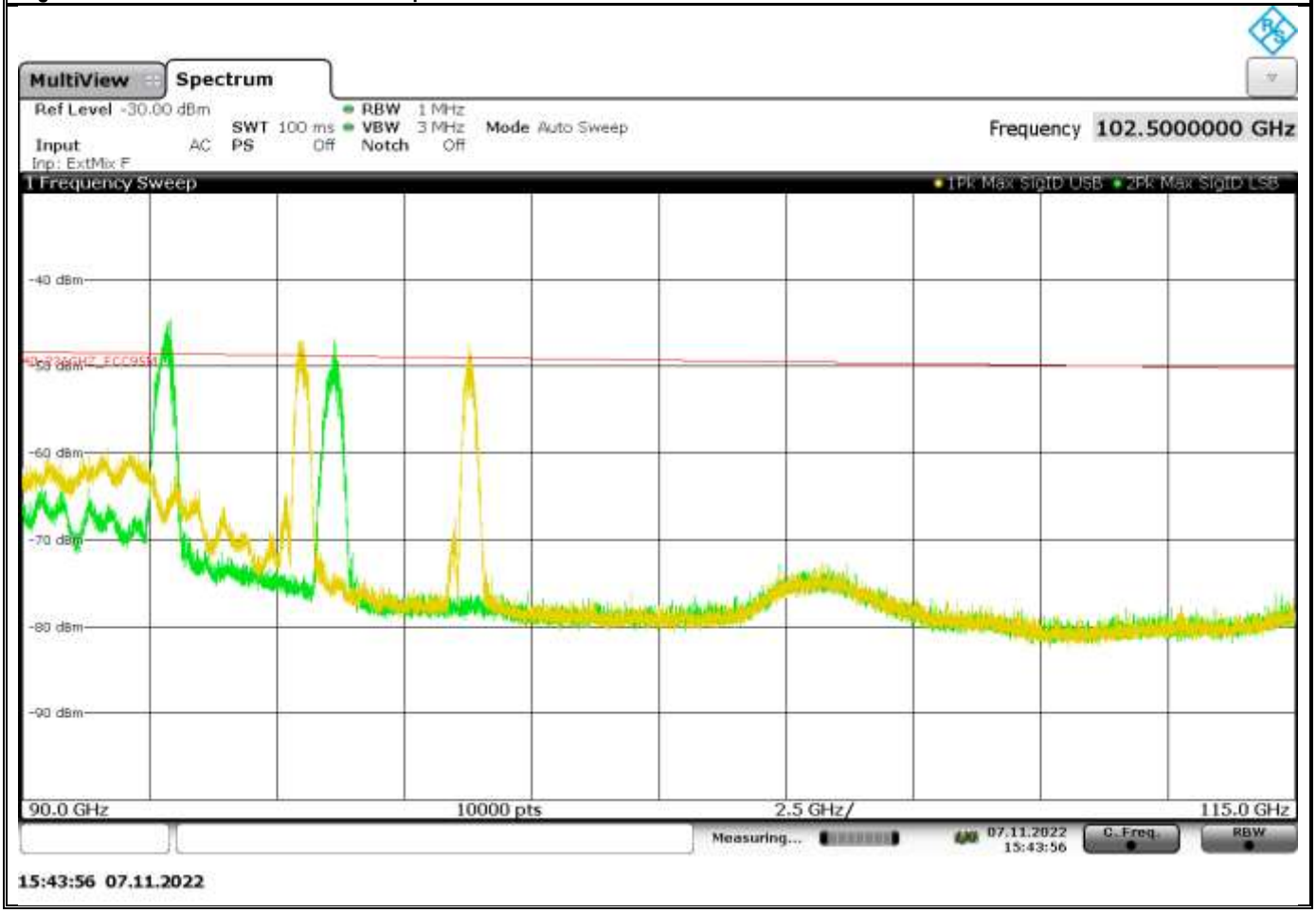
Plot # 12 Unwanted Emissions: 90 - 115 GHz

Maximum from horizontal and vertical measurement antenna orientation

Plot # 13 Unwanted Emissions: 90 - 115 GHz

Maximum from horizontal and vertical measurement antenna orientation

Signal ID ON - all observed emissions are products of the external mixer

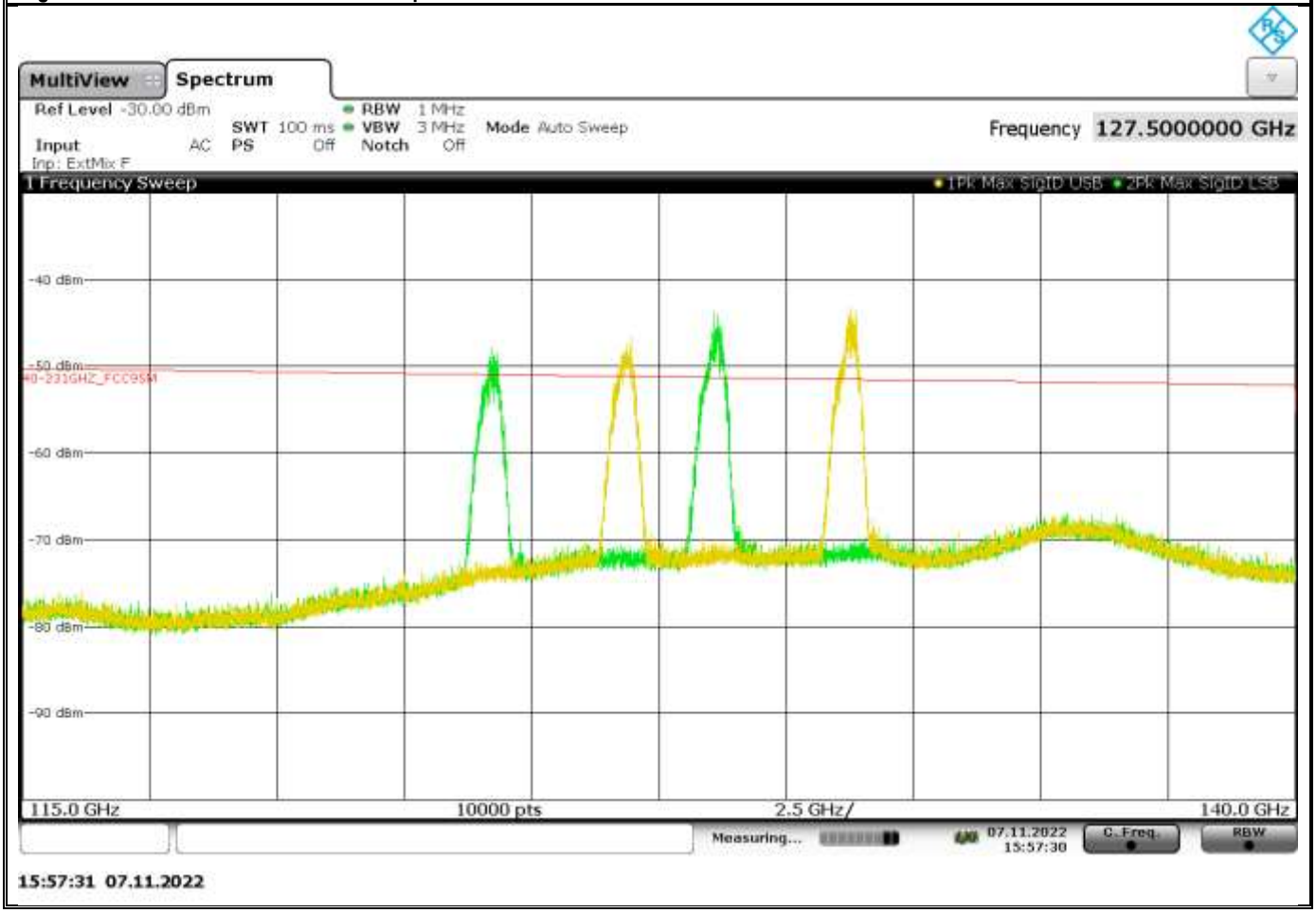


Plot # 14 Unwanted Emissions: 115 - 140 GHz
Maximum from horizontal and vertical measurement antenna orientation

Plot # 15 Unwanted Emissions: 115 - 140 GHz

Maximum from horizontal and vertical measurement antenna orientation

Signal ID ON - all observed emissions are products of the external mixer



Plot # 16 Unwanted Emissions: 140 - 180 GHz

Maximum from horizontal and vertical measurement antenna orientation

No significant peaks above the noise floor

Plot # 17 Unwanted Emissions: 180 - 220 GHz

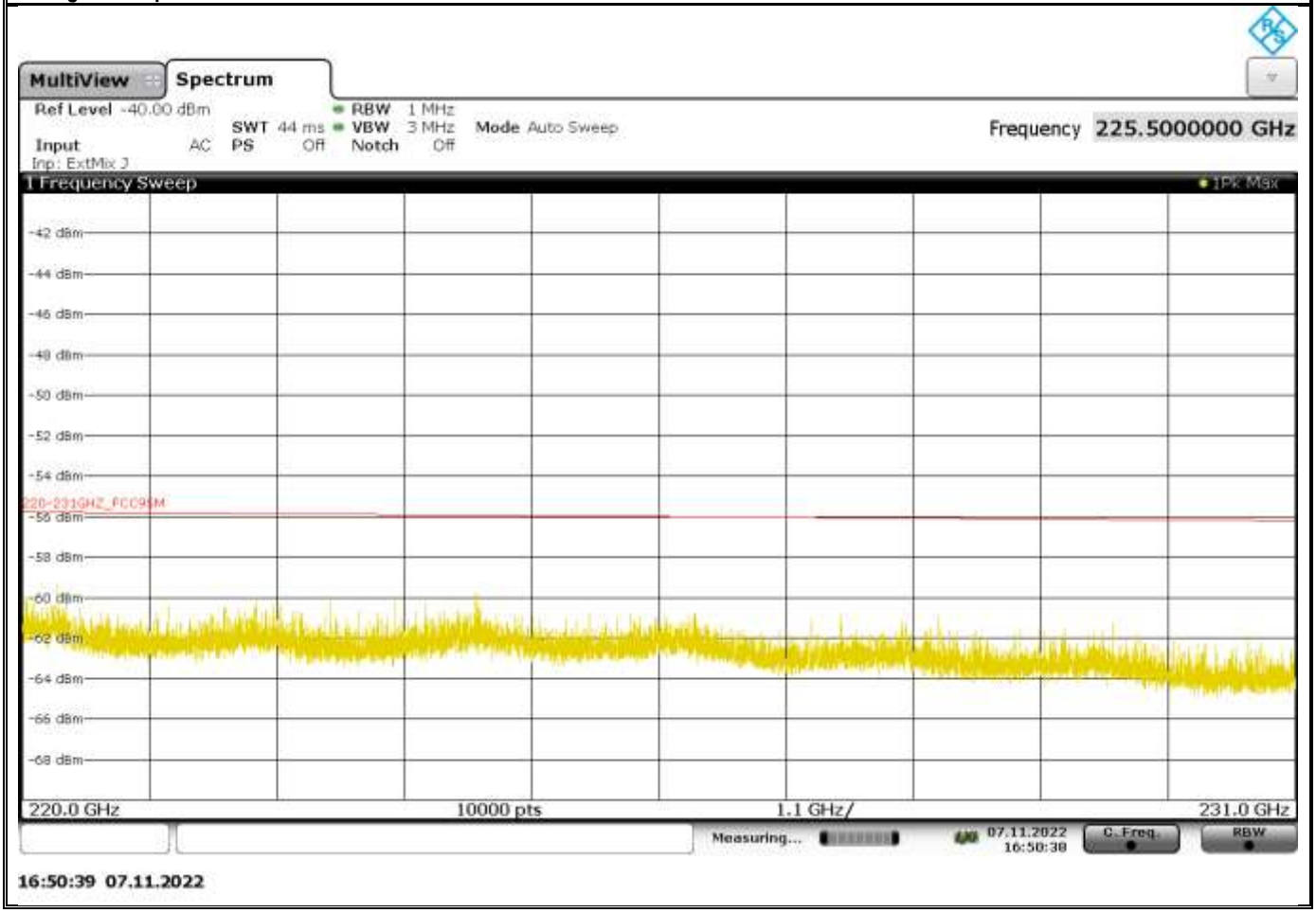
Maximum from horizontal and vertical measurement antenna orientation

No significant peaks above the noise floor

Plot # 18 Unwanted Emissions: 220 - 231 GHz

Maximum from horizontal and vertical measurement antenna orientation

No significant peaks above the noise floor



9 Test setup photos

Setup photos are included in supporting file name: "EMC_UHNDE_010_22001_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	9/13/2021
Loop antenna	ETS Lindgren	6507	161344	3 Years	10/30/2020
Biconlog Antenna	AH systems	BiLA2G	569	3 years	12/01/2020
Horn Antenna	EMCO	3115	35111	3 years	9/30/2021
Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	9/01/2020
Horn Antenna	ETS Lindgren	3116C-PA	169535	3 years	9/30/2020
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
Power Clamp-on Meter	AEMC Instruments	407	122000SKDV	3 Years	01/23/2020
Digital Thermometer	Control Company	36934-164	191872028	3 Years	10/20/2021
Digital Barometer	VWR	10510-922	200236891	3 Years	4/13/2020

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
11-28-2022	EMC_UHNDE_010_22001_FCC_95M	Initial Version	Kris Lazarov
12-16-2022	EMC_UHNDE_010_22001_FCC_95M_Rev1	Updated the table in section 3.1; Added justifications about the transmit antenna boresight, and pulse desensitization to section 3.6; Added reference to KDB 653005, and ANSI C63.26 in sections 7; 8.1.1: 8.2.1: 8.3.1: 8.4.1; Added DC source information in section 8.2.3; Updated the table in section 10	Kris Lazarov

<<< The End >>>