FCC / ISED C2PC Test Report

For:

Uhnder Inc.

Model Name:

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

Product Description:

4D Digital Imaging Radar Sensor

FCC ID: 2AXF3-URHM1140
ISED ID: 26449-URHM1140

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

REPORT #: EMC_UHNDE_008_21001_C2PC

DATE: 2021-09-20

A2LA Accredited

IC recognized # 3462B-1

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1 Assessment

This test report is to support a request for C2PC 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.

The testing carried out by CETECOM Inc. is sufficient to verify that there is no increase of emissions due to the product changes submitted by the manufacturer. All HW changes encompassed in this C2PC filing were to reduce costs by adding cable vendors and to improve the design to reduce emissions below 18 GHz. No changes were made that would cause an increase in emissions above 18 GHz.

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

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2021-09-20	Compliance	Kevin Wang (EMC Lab Manager)	kevin.wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2021.09.20 09:28:56 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2021-09-20	Compliance	Yuchan Lu (EMC Engineer)	Yuchan Lu Digitally signed by: Yuchan Lu DN: CN = Yuchan Lu email = Yuchan.Lu@cetecom.com C = US O = CETECOM Inc. OU = EMC Date: 2021.09.20 11:18:20 -07'00'

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
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EMC Lab Manager:	Kevin Wang
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-HM1140-1, UR-HM1140-2, UR-HM1140-3(See Notes 1 & 2)
HW Version :	See Note 2 and Section 3.2
SW Version :	See Note 2 and Section 3.2
FCC-ID :	2AXF3-URHM1140
ISED-ID:	26449-URHM1140
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	☐Prototype Unit; ☐Production Unit; ■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.
Note 2: 2 Samples with respective HW and SW were submitted for radiated spurious emission evaluation from 9kHz to 90GHz, For sample details see Section 3.2 of this report.

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Comments
1	MOD-1585	Quill v1.8	srs v0.7.8-U1 mcu v1.6-Au	PCBA: Lockhart v1p80 with Sabine B3(Radar Chip) & Black Cable (1400mm) & EMI gasket / copper tape
2	MOD-1588	Quill v1.8	srs v0.7.8-U1 mcu v1.6-Au	PCBA: Lockhart v1p80 with Sabine B0(Radar Chip) & Black Cable (1400mm) & EMI gasket / copper tape

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	
2	EUT # 2 + AE # 1	

3.5 EUT Mode of operation

Operation Mode #	Operation Mode	Comments
1	VP112	Higher range resolution(accuracy) Scan Frame Config
2	VP114U	Standard Scan Frame Config

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 EUT orientation. Frequency Stability was tested with the mode of operation with highest power.

4 Subject of Investigation

This test report is to support a request for C2PC check on a certified equipment under the FCC ID: 2AXF3-URHM1140 and ISED 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	-	☐	☐	■	Note1
§2.1055; §95.3379 (b) RSS-251 (11); RSS-Gen (8.11)	Frequency Stability	Extreme Temperature and Voltage	-	☐	☐	■	Note1
§95.3367 RSS-251 (8)(9)	Radiated Power	Nominal	-	☐	☐	■	Note1
§95.3379 RSS-251 (10); RSS-Gen (6.13)	Unwanted Emissions	Nominal	VP112 VP114U	■	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.
Note1: Leveraged from Cetecom Inc. test report, EMC_UHNDE_003_20001_FCC_95M_Rev1, dated on 2020-10-28.

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:

08/20/2021 - 08/24/2021

7 Measurement Procedures

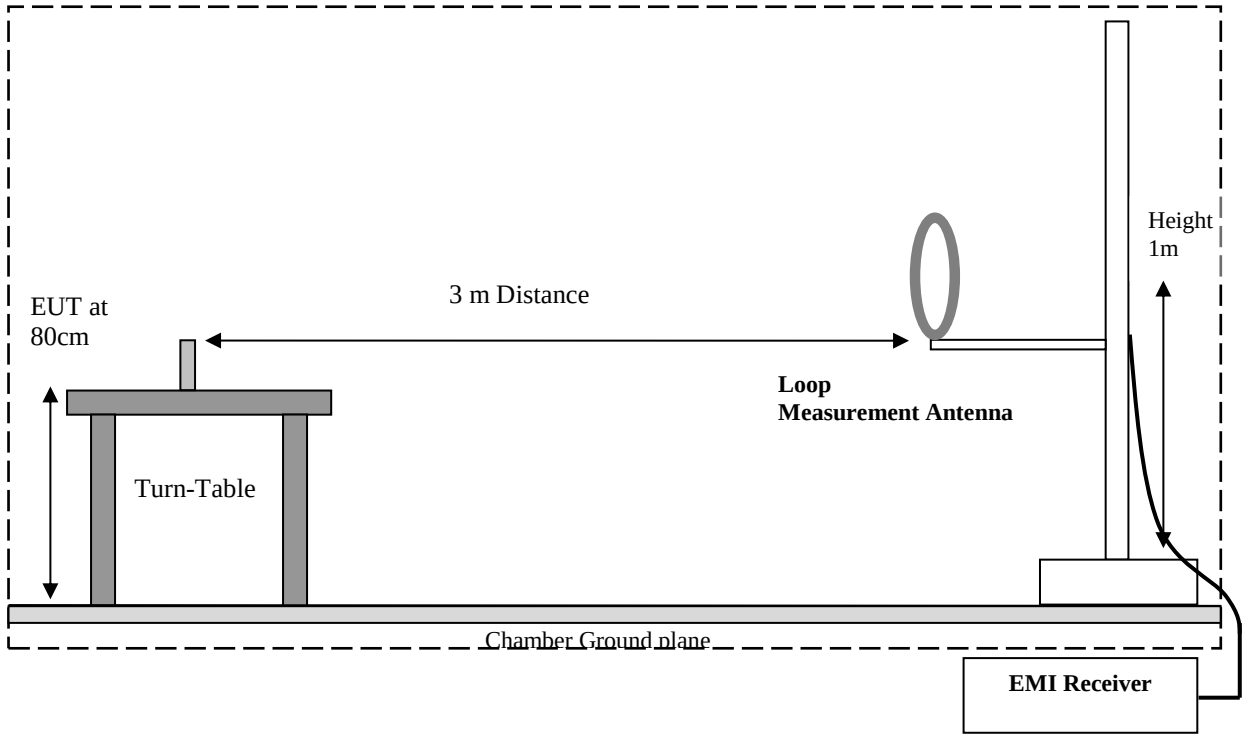
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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:

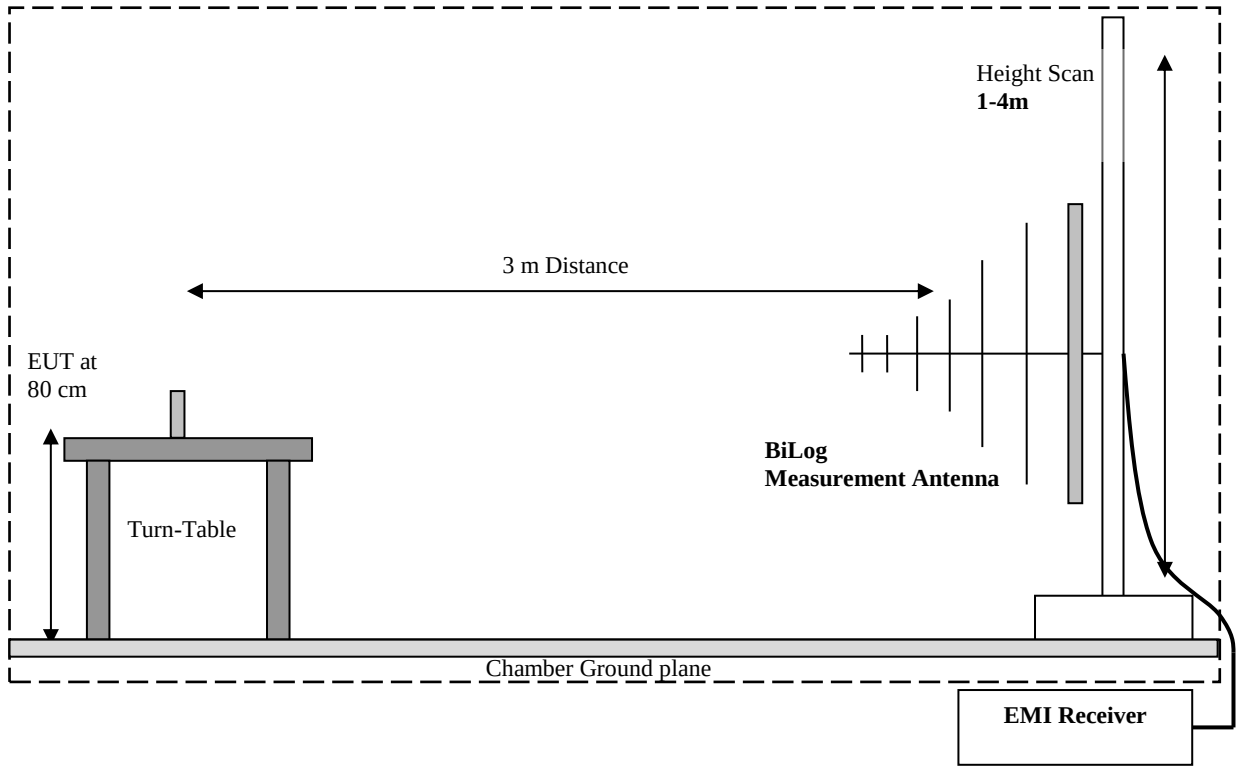
  FS (dBµV/m) = Measured Value on SA + Cable Loss + Antenna Factor

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

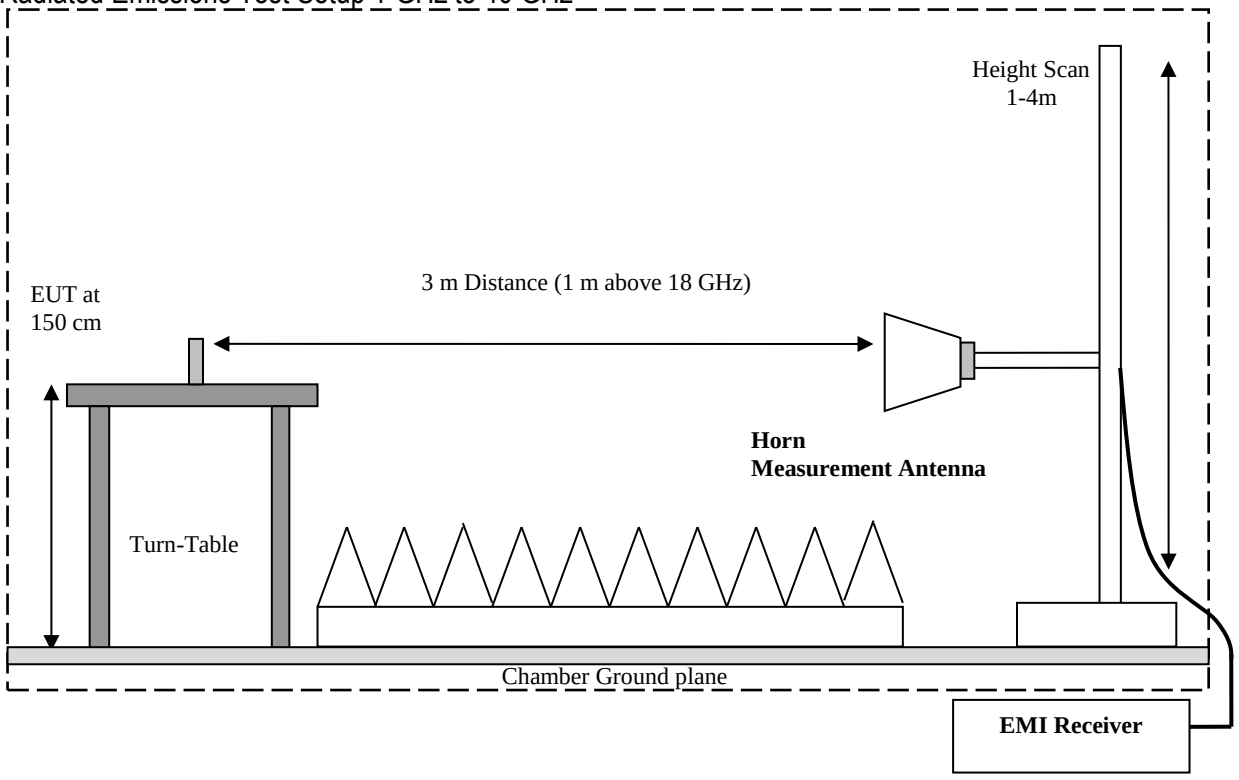
Radiated Emissions Test Setup 9 kHz to 30 MHz



Radiated Emissions Test Setup 30 MHz to 1 GHz



Radiated Emissions Test Setup 1 GHz to 40 GHz



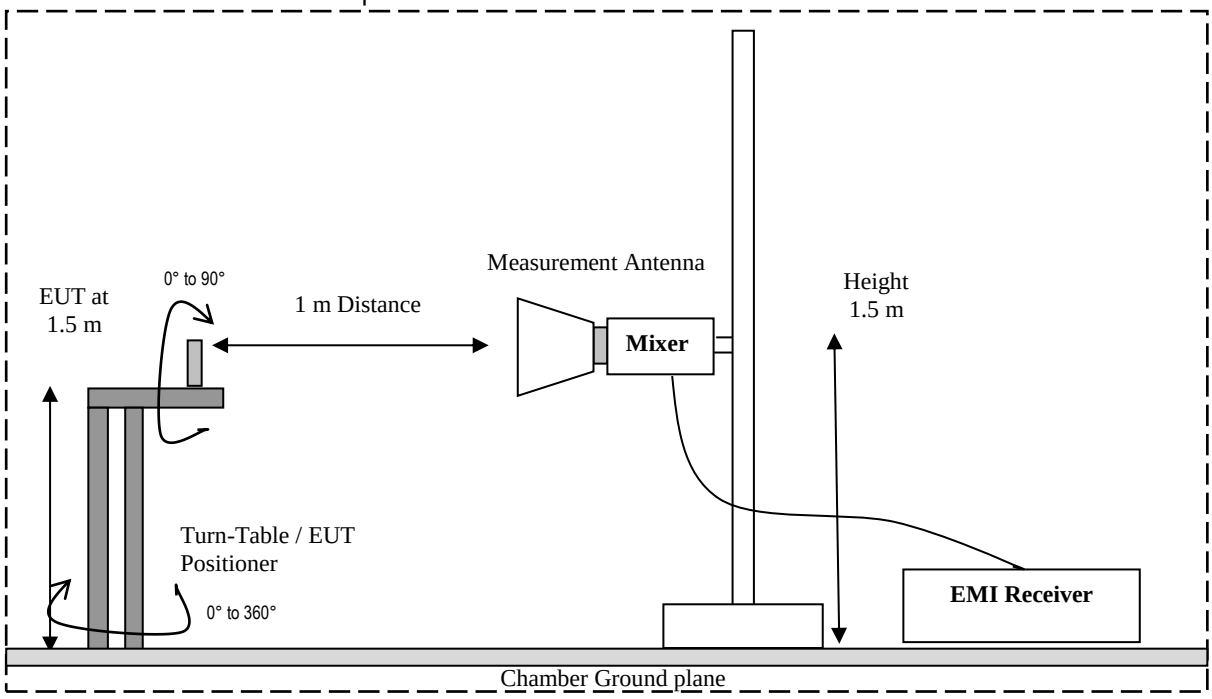
- Measurements above 40 GHz are split to 5 frequency ranges using E&S external mixers and appropriate antennas as follow:
  - 40-60 GHz FS-Z60 + 261U-25
  - 60-90 GHz FS-Z90 + 261E-23
  - 90-140 GHz FS-Z140 + 261F-25
  - 140-220 GHz FS-Z220 + 261G-25
  - 220-231 GHz FS-Z325 + 32240-20
- Exploratory measurements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

8.1.1 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.

8.1.2 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

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1, 2	1 , 2	12 VDC

8.1.4 Measurement result:

Plot #	EUT #	Operating Mode	Scan Frequency	Limit	Result
1 – 13	MOD-1585	VP112	9 kHz – 90 GHz	See section 8.4.2	Pass
14 – 26	MOD-1585	VP114	9 kHz – 90 GHz	See section 8.4.2	Pass
27 – 39	MOD-1588	VP112	9 kHz – 90 GHz	See section 8.4.2	Pass
40 – 52	MOD-1588	VP114	9 kHz – 90 GHz	See section 8.4.2	Pass

8.1.5 Testing notes:

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

Measurement Antenna	Frequency Range (GHz)	Largest Antenna Dimension (m)	Far-field Boundary (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

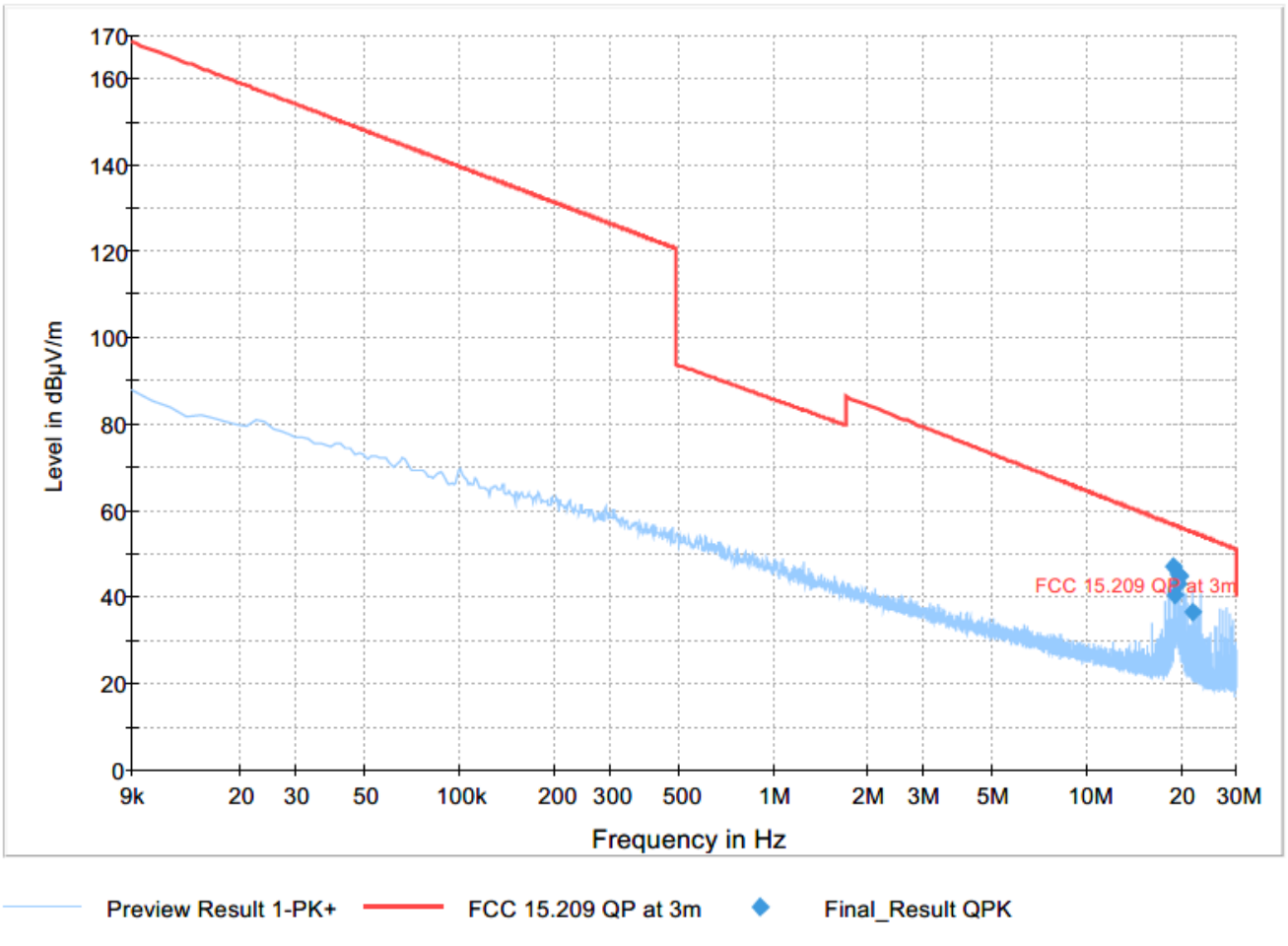
- The measurements from 18 – 220 GHz were conducted at 1 m, and from 220 – 231 at 0.7 m distance.
- The measurement plots above 40 GHz include a reference line corresponding to the limit level at the measurement distance specified by the requirements, and accounting for the measurement system configuration, 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.

8.1.6 Measurement Plots:

Plot # 1 Unwanted Emissions: 9 kHz - 30 MHz

Final_Result

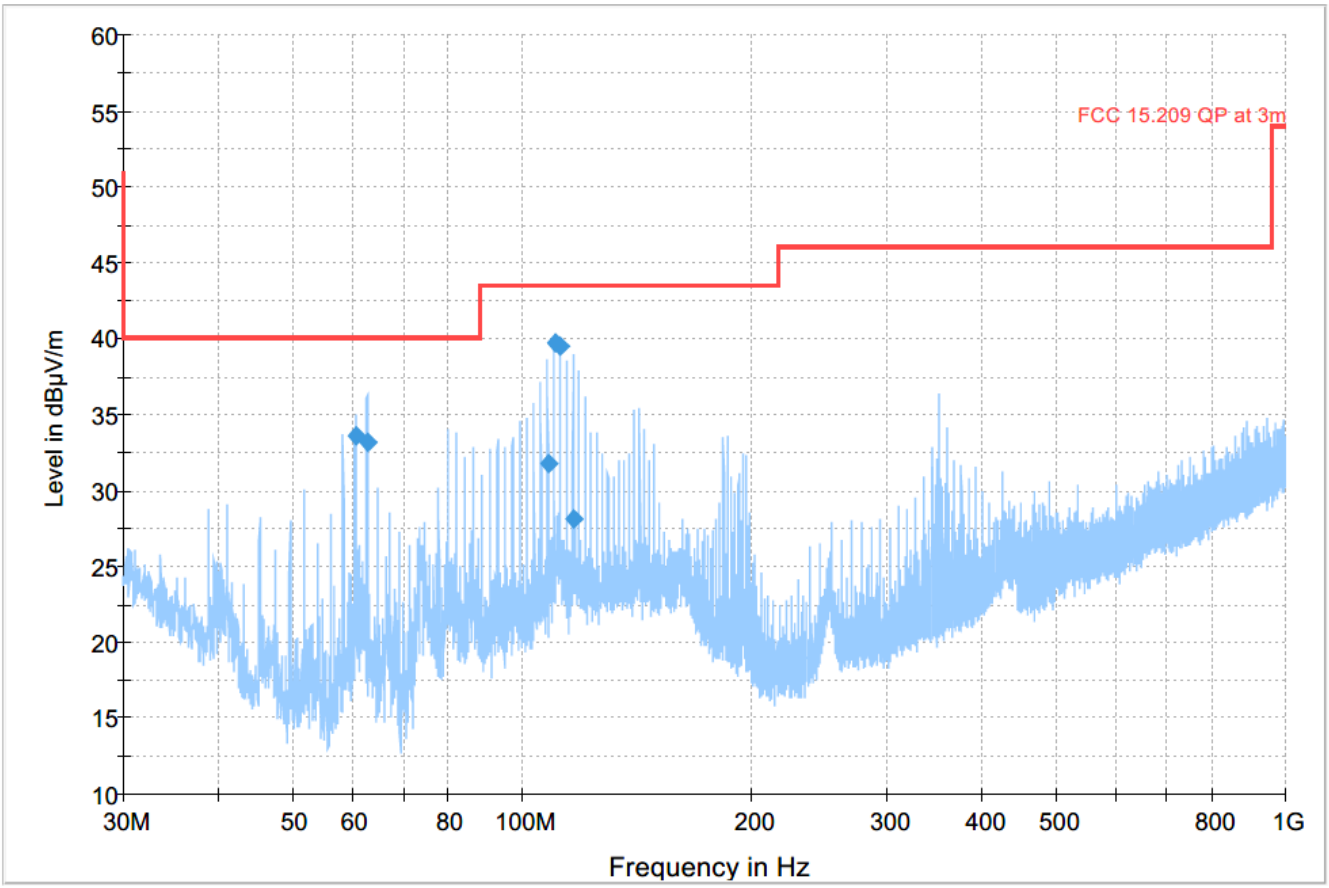
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
18.916	47.06	56.72	9.66	500.0	9.000	107.0	H	51.0	16.9	
19.160	40.44	56.56	16.12	500.0	9.000	100.0	H	-65.0	16.9	
19.465	43.18	56.37	13.18	500.0	9.000	100.0	H	-26.0	16.9	
19.588	45.22	56.29	11.07	500.0	9.000	100.0	H	134.0	16.9	
19.710	45.03	56.21	11.18	500.0	9.000	100.0	H	145.0	16.9	
21.665	36.55	55.05	18.50	500.0	9.000	100.0	H	67.0	16.8	



Plot # 2 Unwanted Emissions 30 MHz – 1GHz

Final_Result

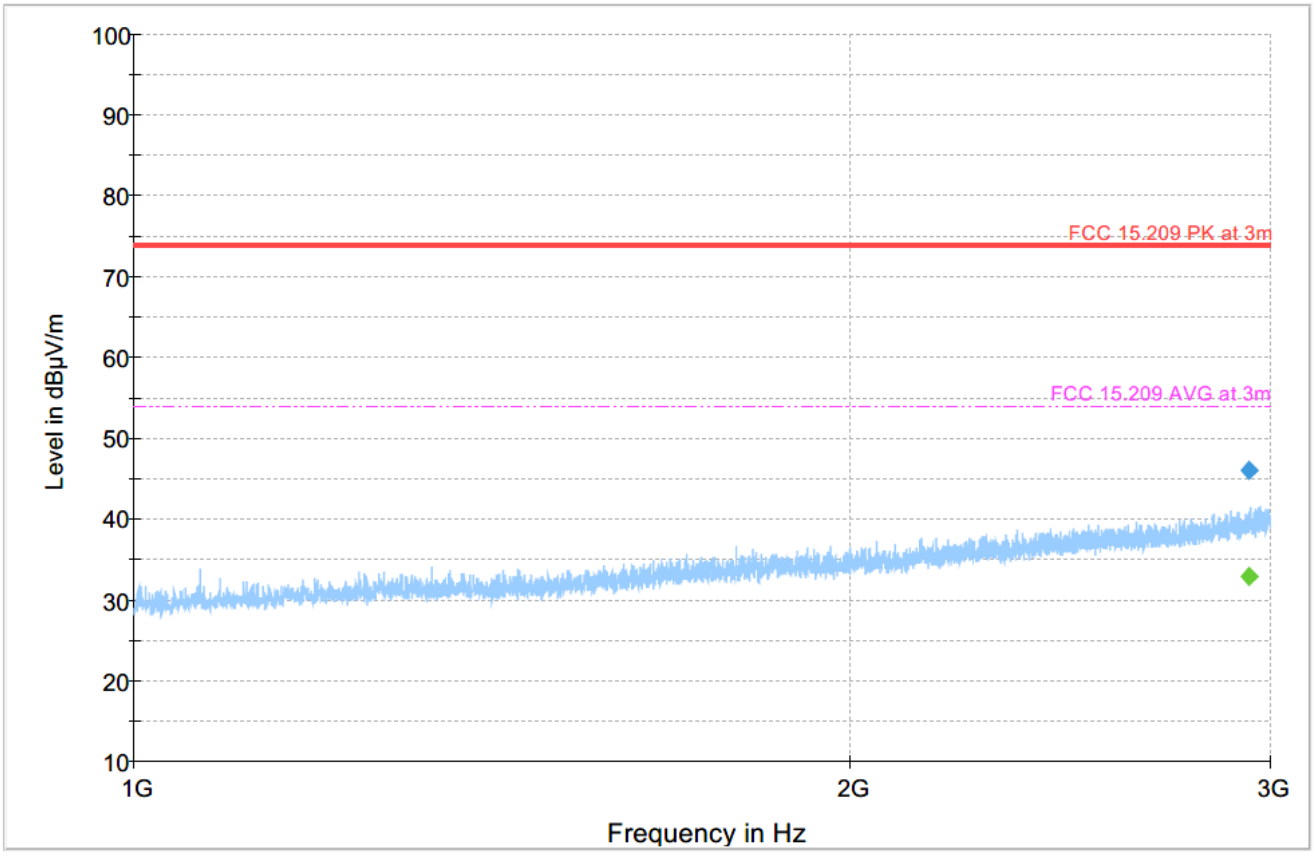
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
60.494	33.64	40.00	6.36	500.0	120.000	195.0	V	90.0	7.1	
62.652	33.19	40.00	6.81	500.0	120.000	244.0	V	-3.0	7.1	
108.071	31.82	43.50	11.68	500.0	120.000	116.0	V	199.0	15.5	
110.222	39.68	43.50	3.82	500.0	120.000	100.0	V	240.0	16.0	
112.332	39.45	43.50	4.05	500.0	120.000	117.0	V	245.0	16.4	
116.737	28.12	43.50	15.38	500.0	120.000	100.0	V	182.0	16.9	



Plot # 3 Unwanted Emissions: 1-3 GHz

Final_Result

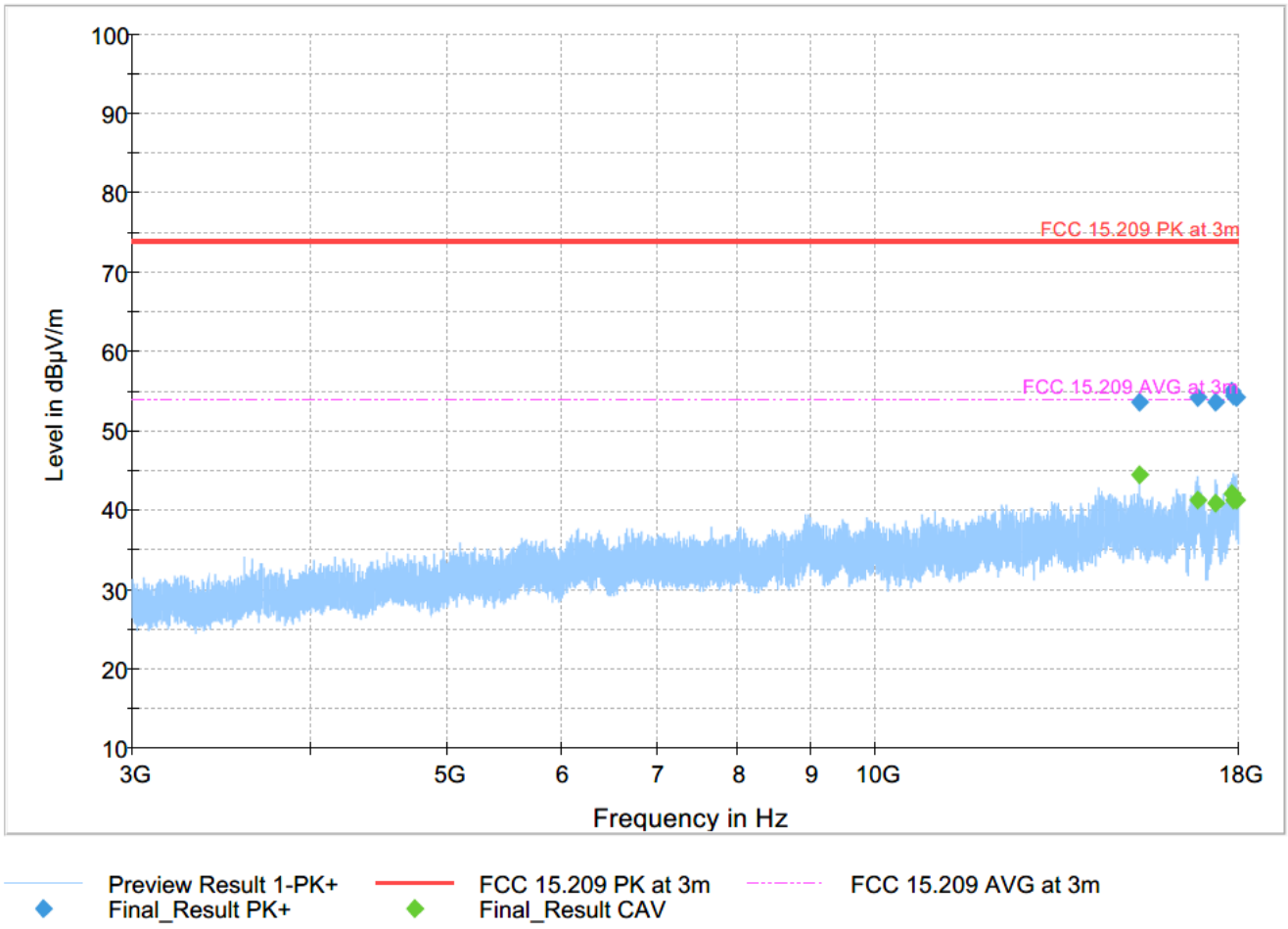
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2939.450	---	32.96	53.98	21.02	500.0	1000.000	152.0	V	3.0	35.1	
2939.450	45.98	---	73.98	28.00	500.0	1000.000	152.0	V	3.0	35.1	



Plot # 4 Unwanted Emissions: 3 - 18 GHz

Final_Result

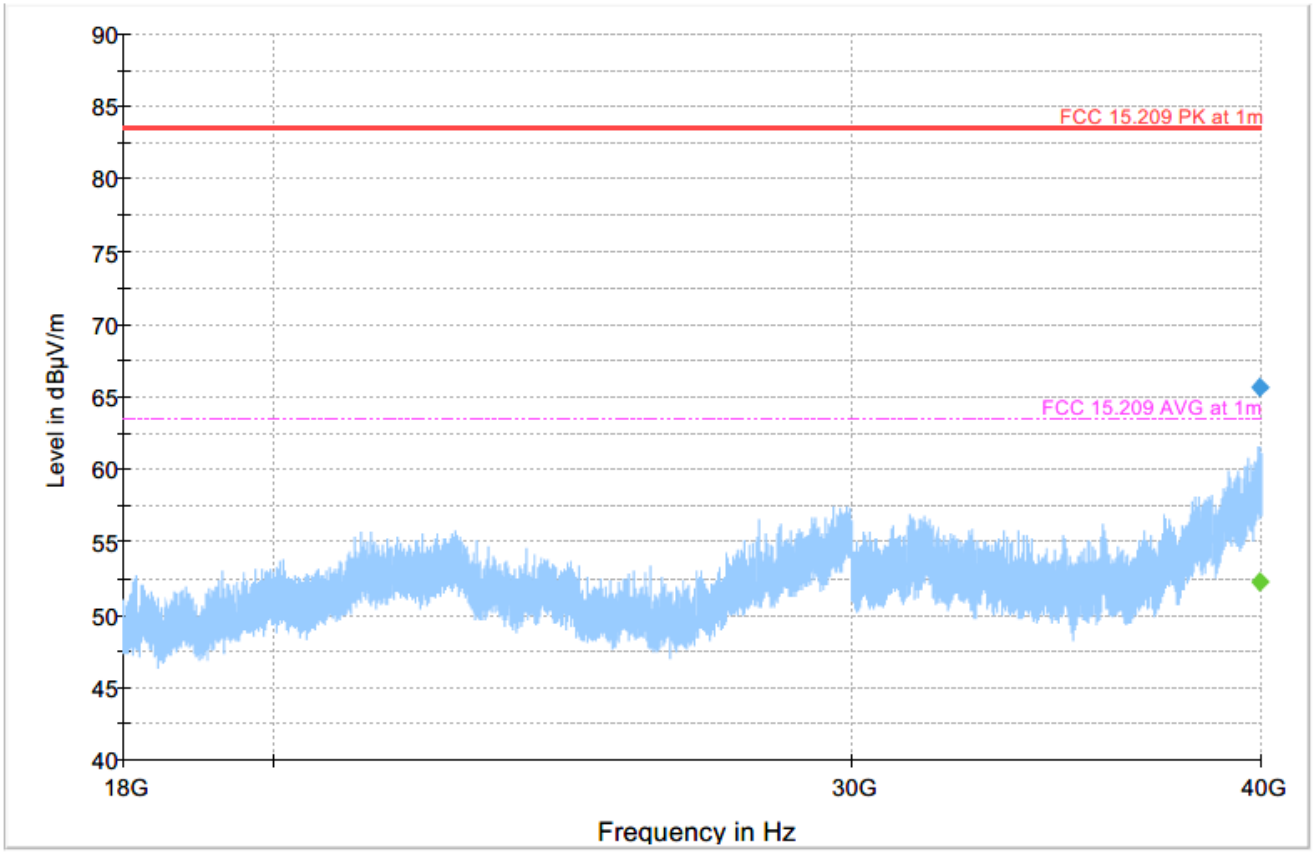
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
15316.850	53.54	---	73.98	20.44	500.0	1000.000	254.0	V	89.0	10.3	
15316.850	---	44.39	53.98	9.59	500.0	1000.000	254.0	V	89.0	10.3	
16850.250	---	41.27	53.98	12.71	500.0	1000.000	210.0	H	131.0	14.4	
16850.250	54.22	---	73.98	19.76	500.0	1000.000	210.0	H	131.0	14.4	
17361.100	53.68	---	73.98	20.29	500.0	1000.000	292.0	H	206.0	15.9	
17361.100	---	40.78	53.98	13.20	500.0	1000.000	292.0	H	206.0	15.9	
17802.200	54.91	---	73.98	19.07	500.0	1000.000	182.0	V	150.0	17.8	
17802.200	---	42.11	53.98	11.87	500.0	1000.000	182.0	V	150.0	17.8	
17878.050	---	41.28	53.98	12.69	500.0	1000.000	100.0	V	39.0	18.2	
17878.050	54.41	---	73.98	19.57	500.0	1000.000	100.0	V	39.0	18.2	
17937.700	54.29	---	73.98	19.69	500.0	1000.000	236.0	V	104.0	17.7	
17937.700	---	41.33	53.98	12.65	500.0	1000.000	236.0	V	104.0	17.7	



Plot # 5 Unwanted Emissions: 18-40 GHz

Final_Result

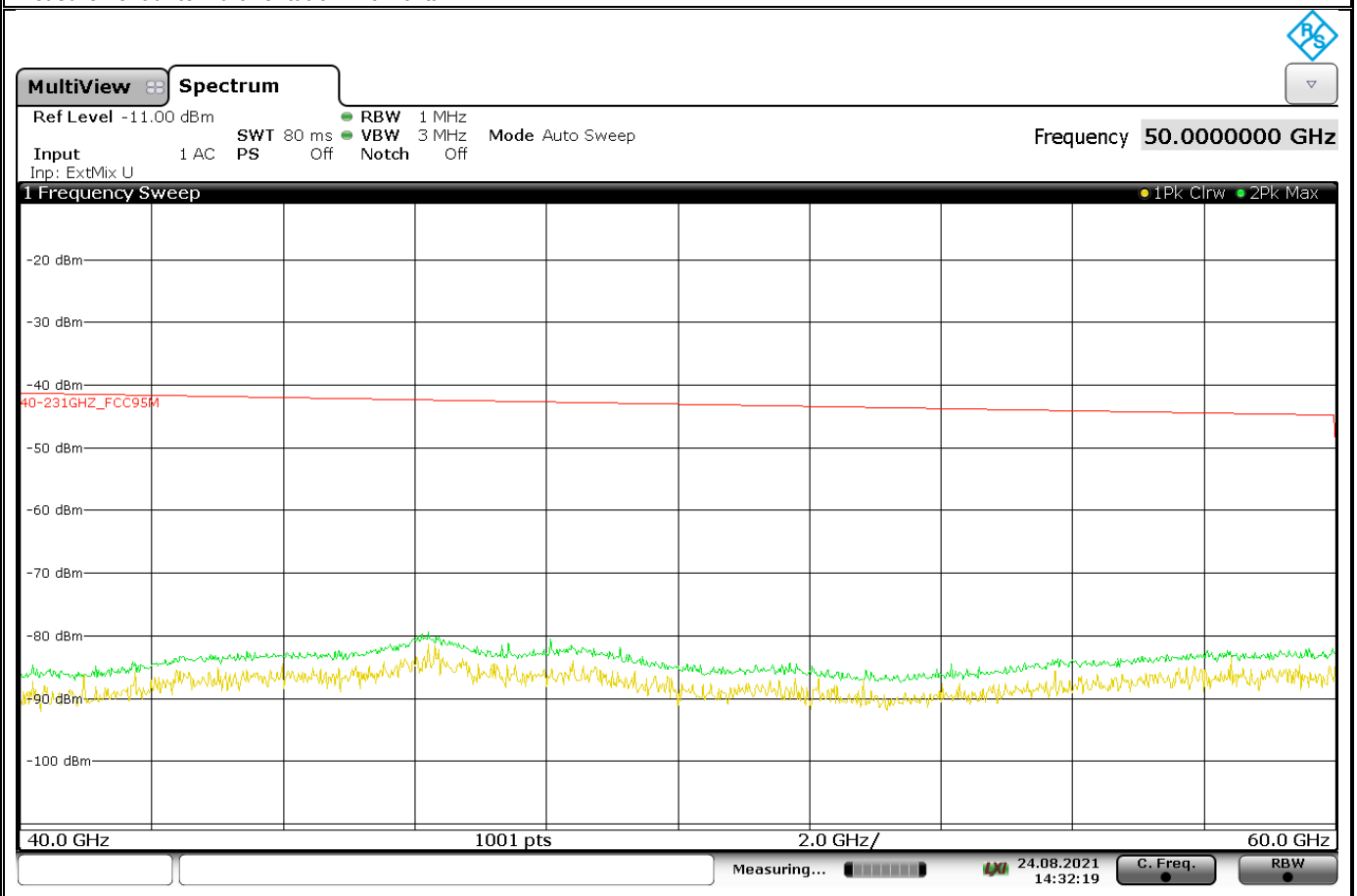
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
39972.500	---	52.24	63.50	11.26	500.0	1000.000	150.0	V	169.0	24.9	
39972.500	65.62	---	83.50	17.88	500.0	1000.000	150.0	V	169.0	24.9	



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



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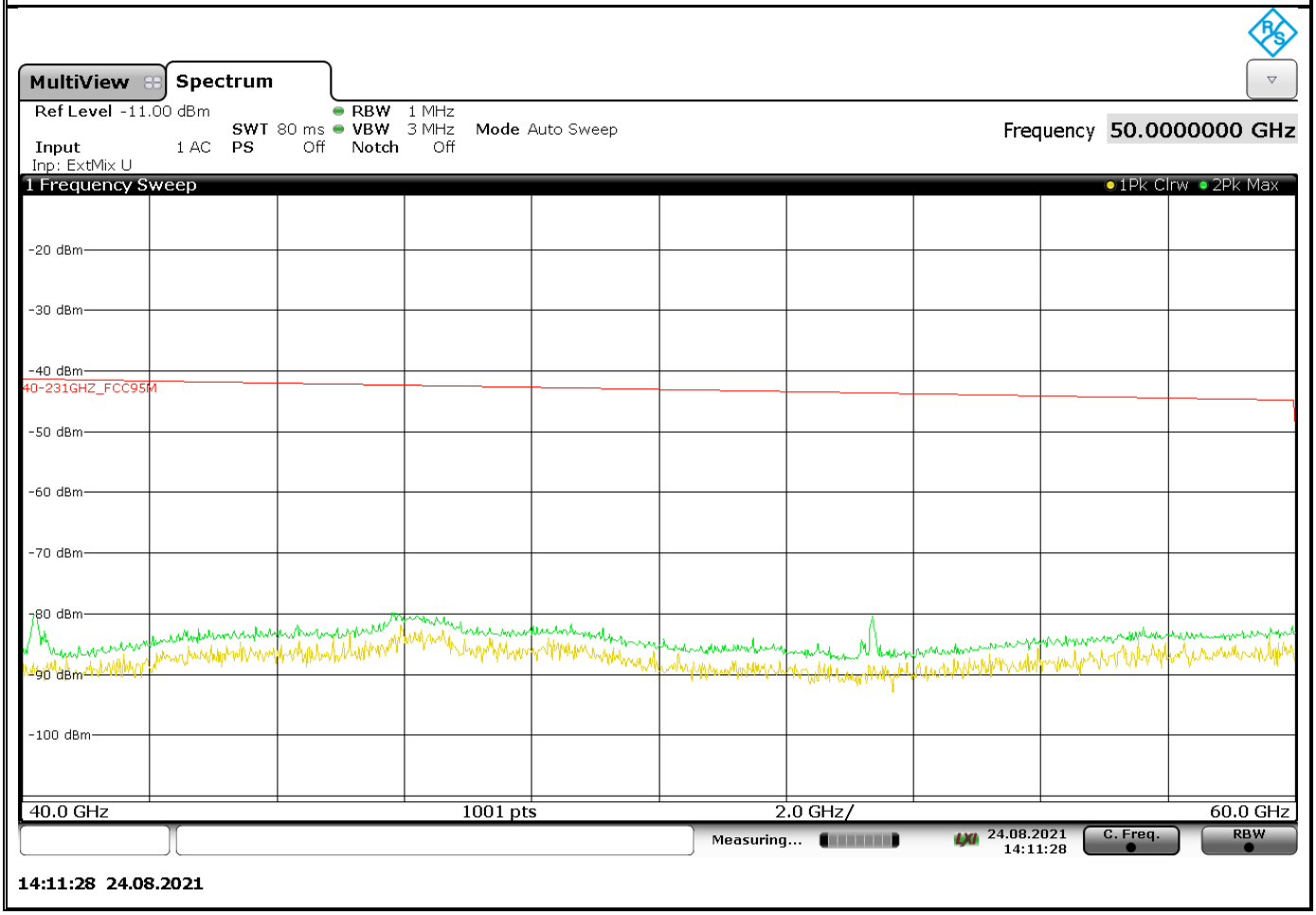
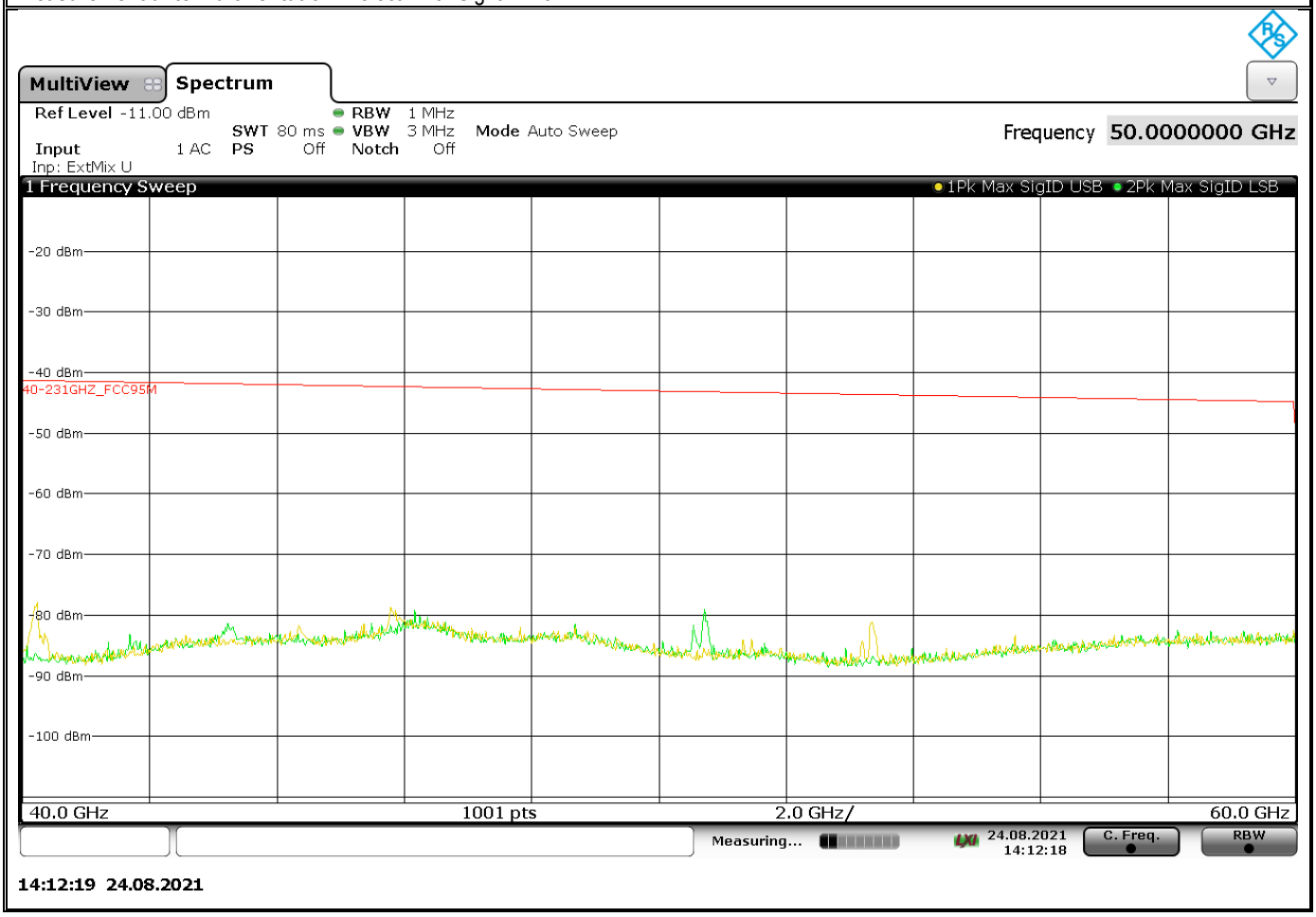
Plot # 7 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Vertical



Plot # 8 Unwanted Emissions: 40 - 60 GHz

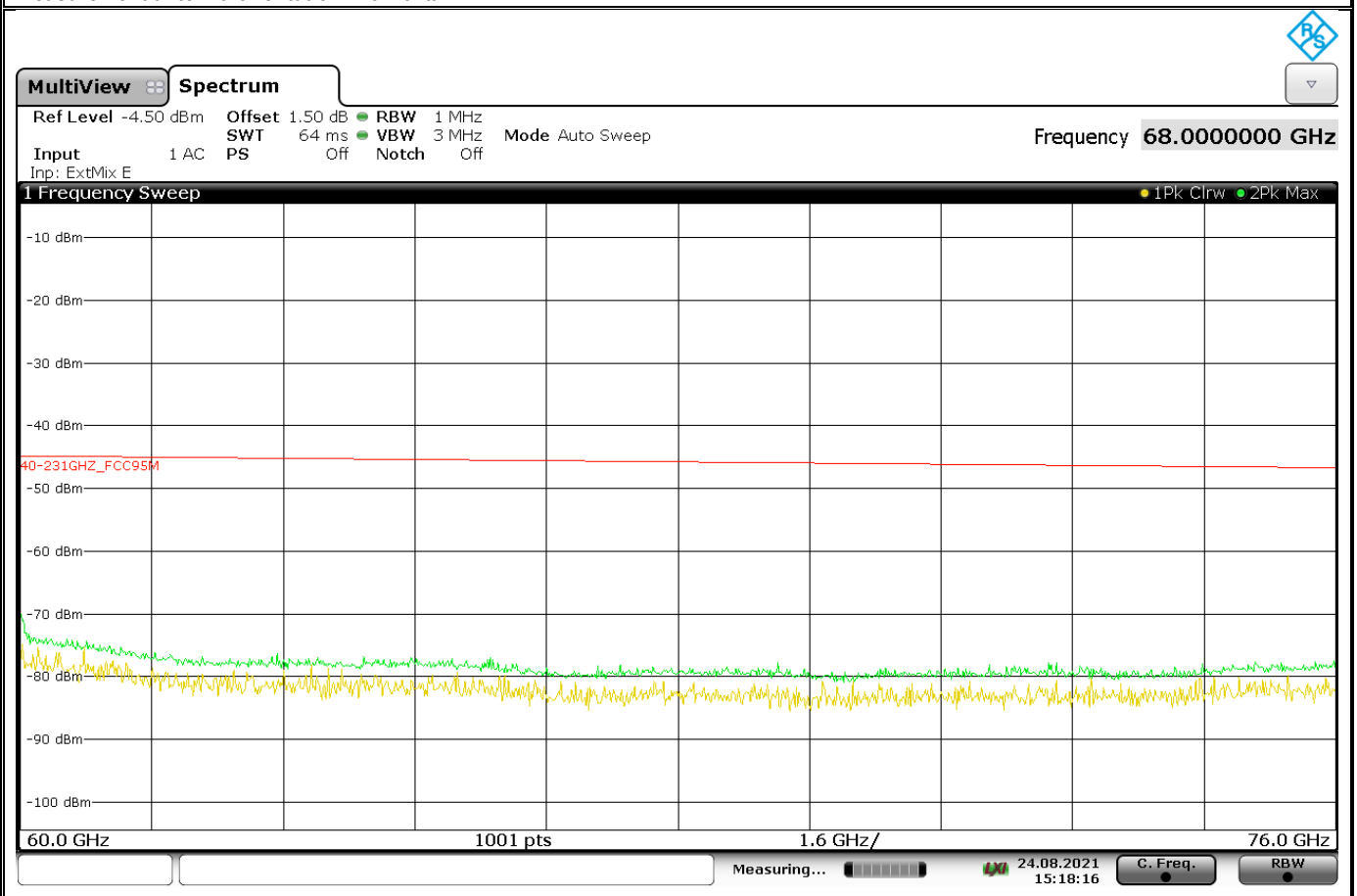
Measurement antenna orientation: Vertical with Signal ID on



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.

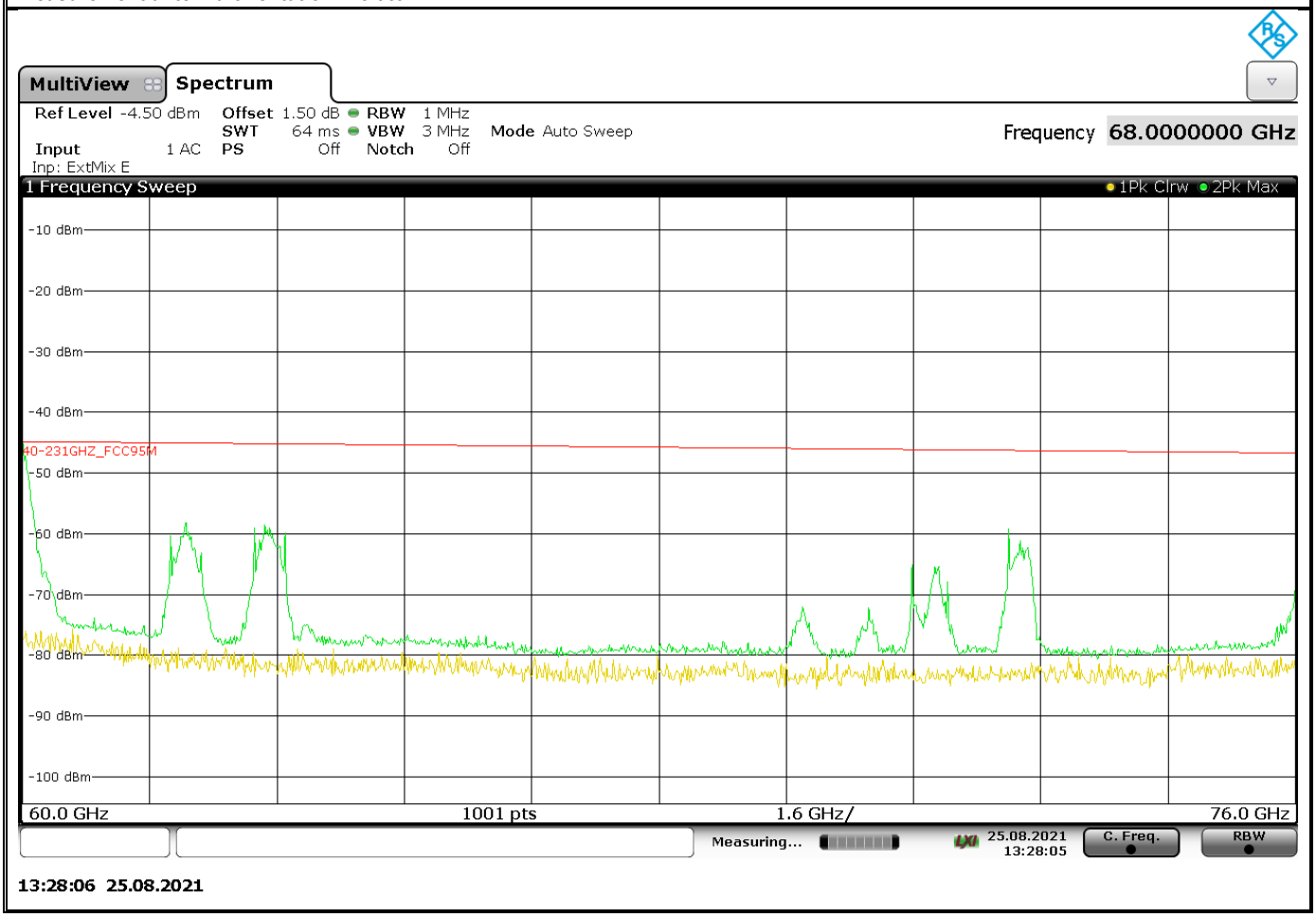
Plot # 9 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Horizontal



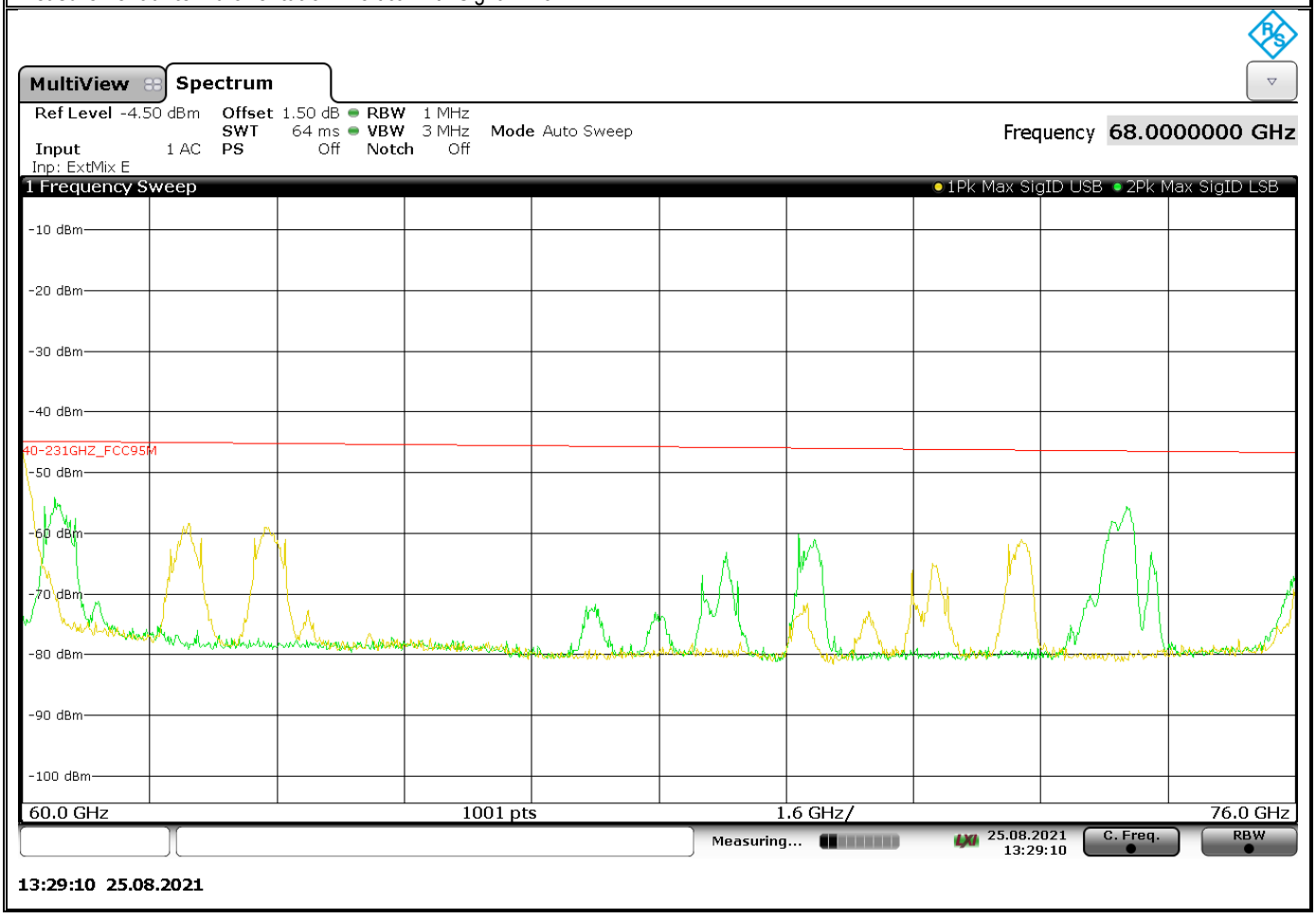
Plot # 10 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical



Plot # 11 Unwanted Emissions: 60 - 76 GHz

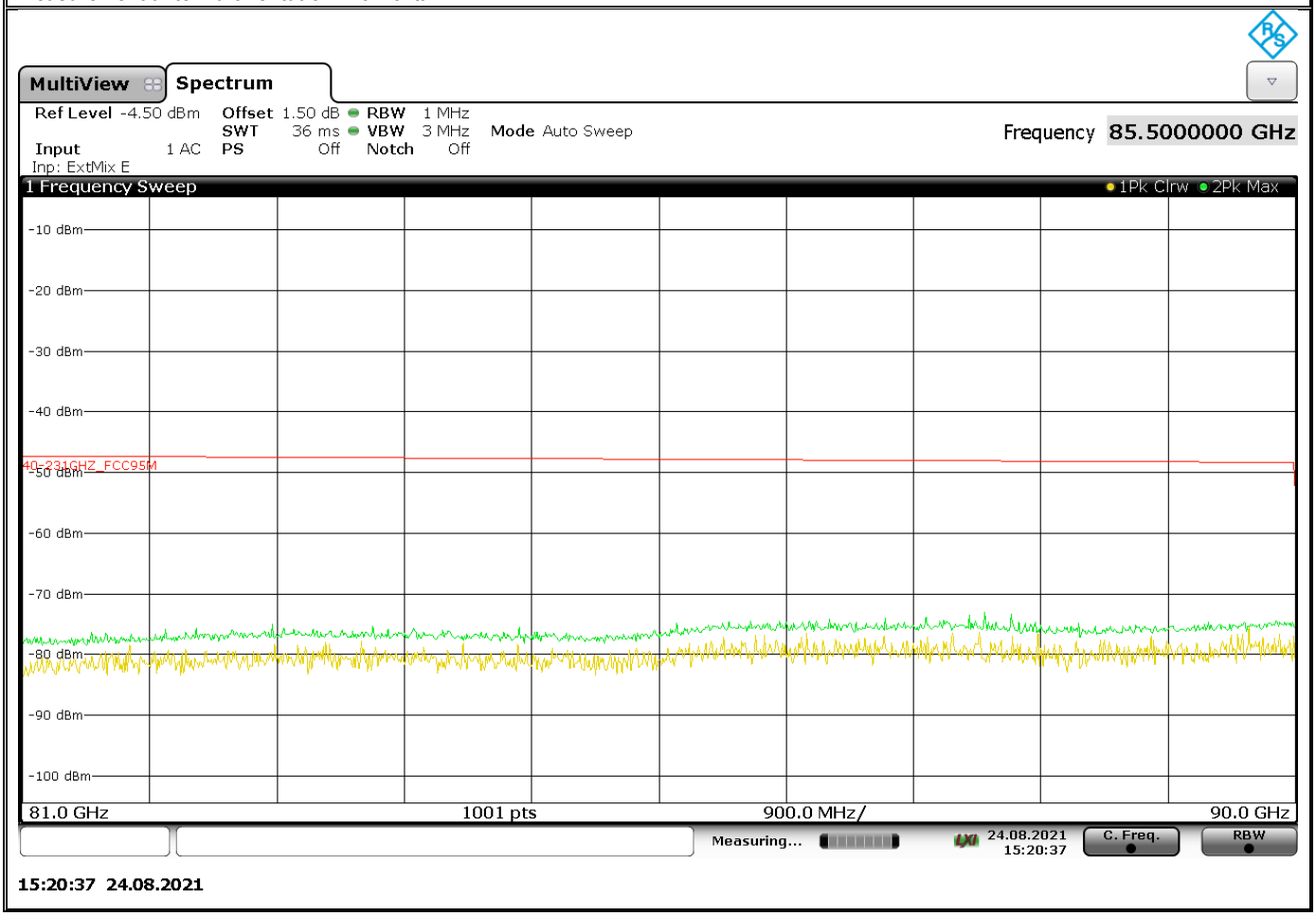
Measurement antenna orientation: Vertical with Signal ID on



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.

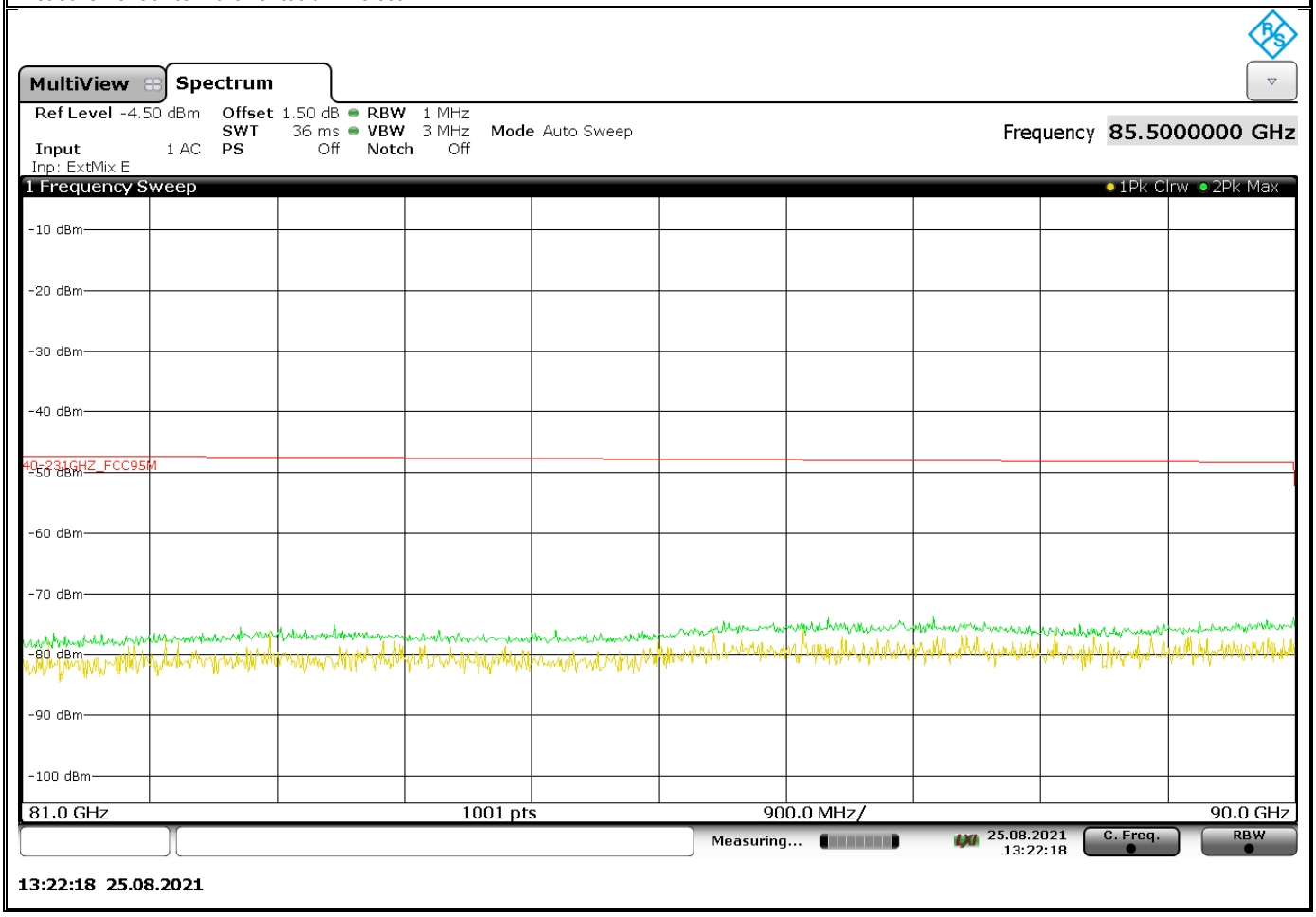
Plot # 12 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Horizontal



Plot # 13 Unwanted Emissions: 81 - 90 GHz

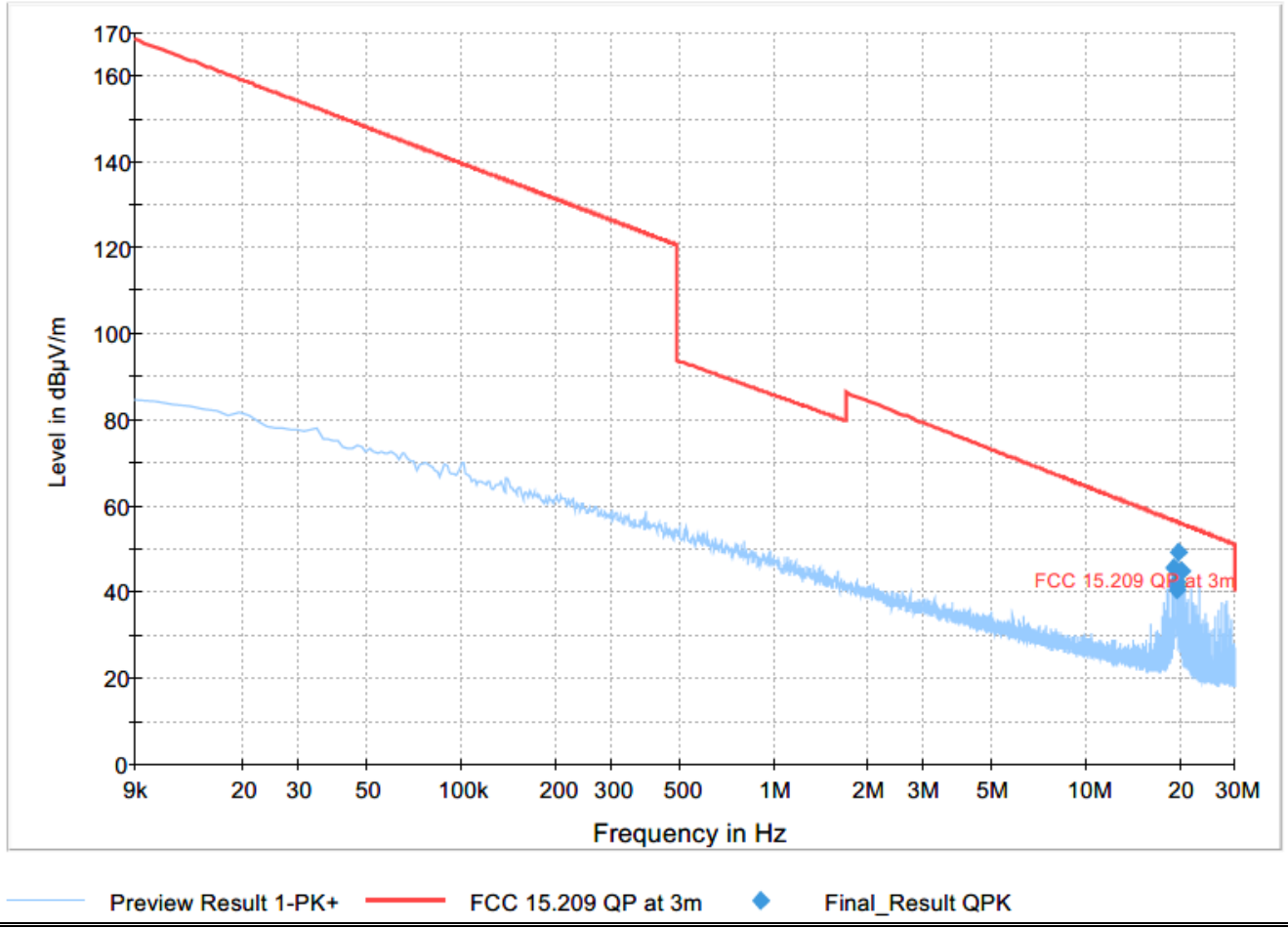
Measurement antenna orientation: Vertical



Plot # 14 Unwanted Emissions: 9 kHz - 30 MHz

Final_Result

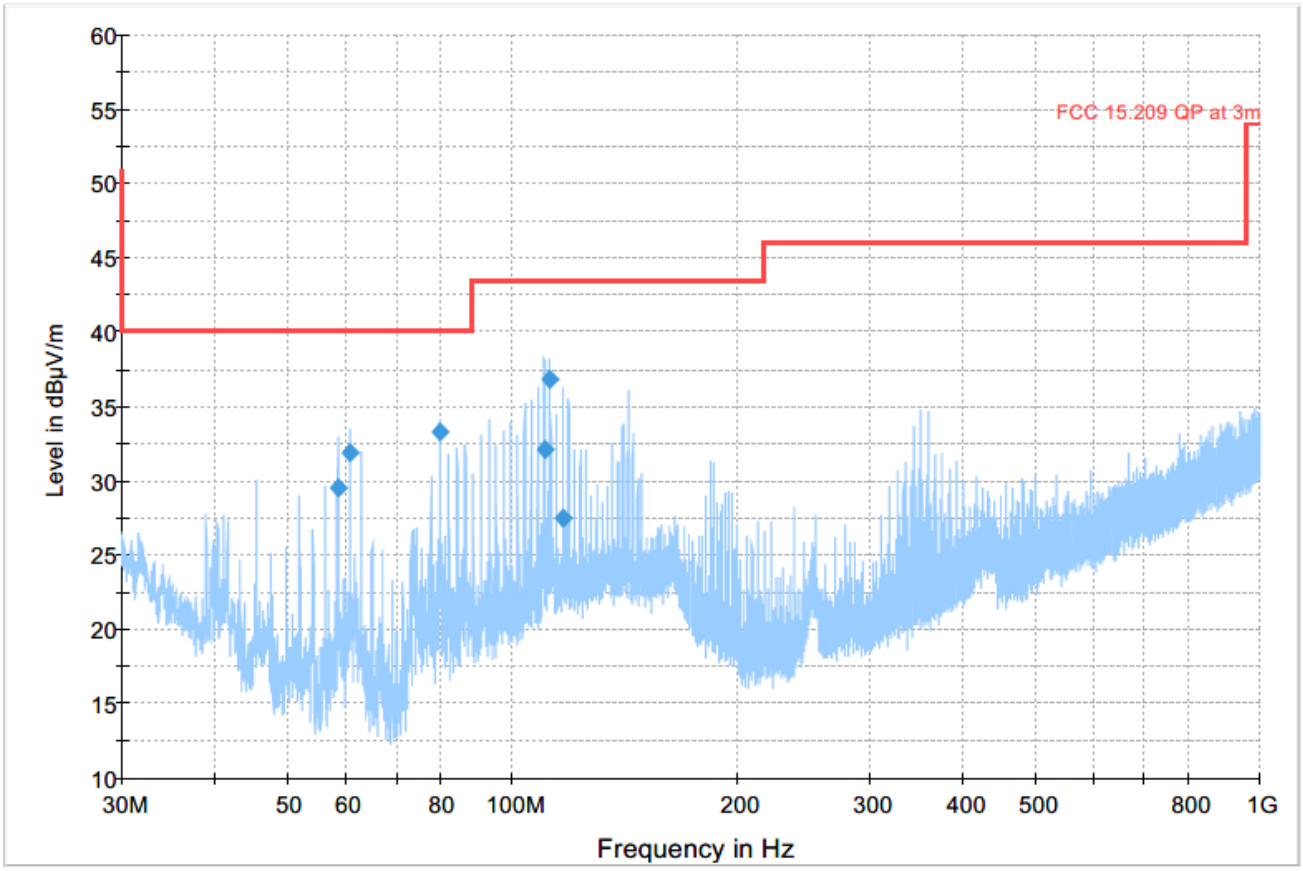
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
19.159	45.70	56.56	10.86	500.0	9.000	107.0	H	36.0	16.9	
19.449	41.35	56.38	15.03	500.0	9.000	100.0	H	258.0	16.9	
19.465	40.67	56.37	15.69	500.0	9.000	100.0	H	95.0	16.9	
19.587	42.28	56.29	14.01	500.0	9.000	100.0	H	305.0	16.9	
19.711	49.37	56.21	6.84	500.0	9.000	100.0	H	154.0	16.9	
20.259	44.89	55.87	10.98	500.0	9.000	100.0	H	-23.0	16.9	



Plot # 15 Unwanted Emissions 30 MHz – 1GHz

Final_Result

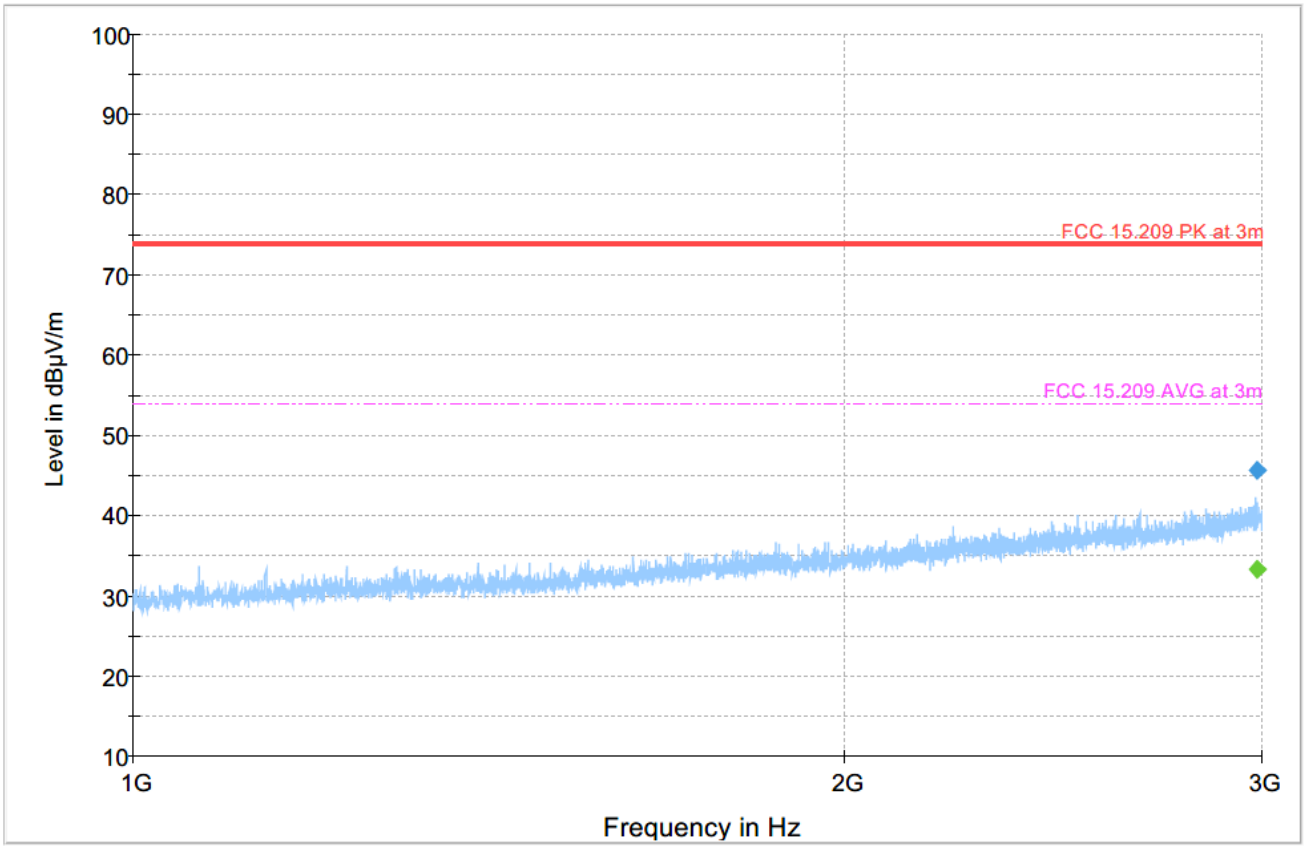
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
58.408	29.53	40.00	10.47	500.0	120.000	100.0	V	41.0	7.2	
60.527	31.87	40.00	8.13	500.0	120.000	167.0	V	62.0	7.1	
80.015	33.30	40.00	6.70	500.0	120.000	142.0	V	199.0	9.6	
110.255	32.10	43.50	11.40	500.0	120.000	100.0	V	35.0	16.0	
112.357	36.81	43.50	6.69	500.0	120.000	116.0	V	295.0	16.4	
116.738	27.53	43.50	15.97	500.0	120.000	100.0	V	39.0	16.9	



Plot # 16 Unwanted Emissions: 1-3 GHz

Final_Result

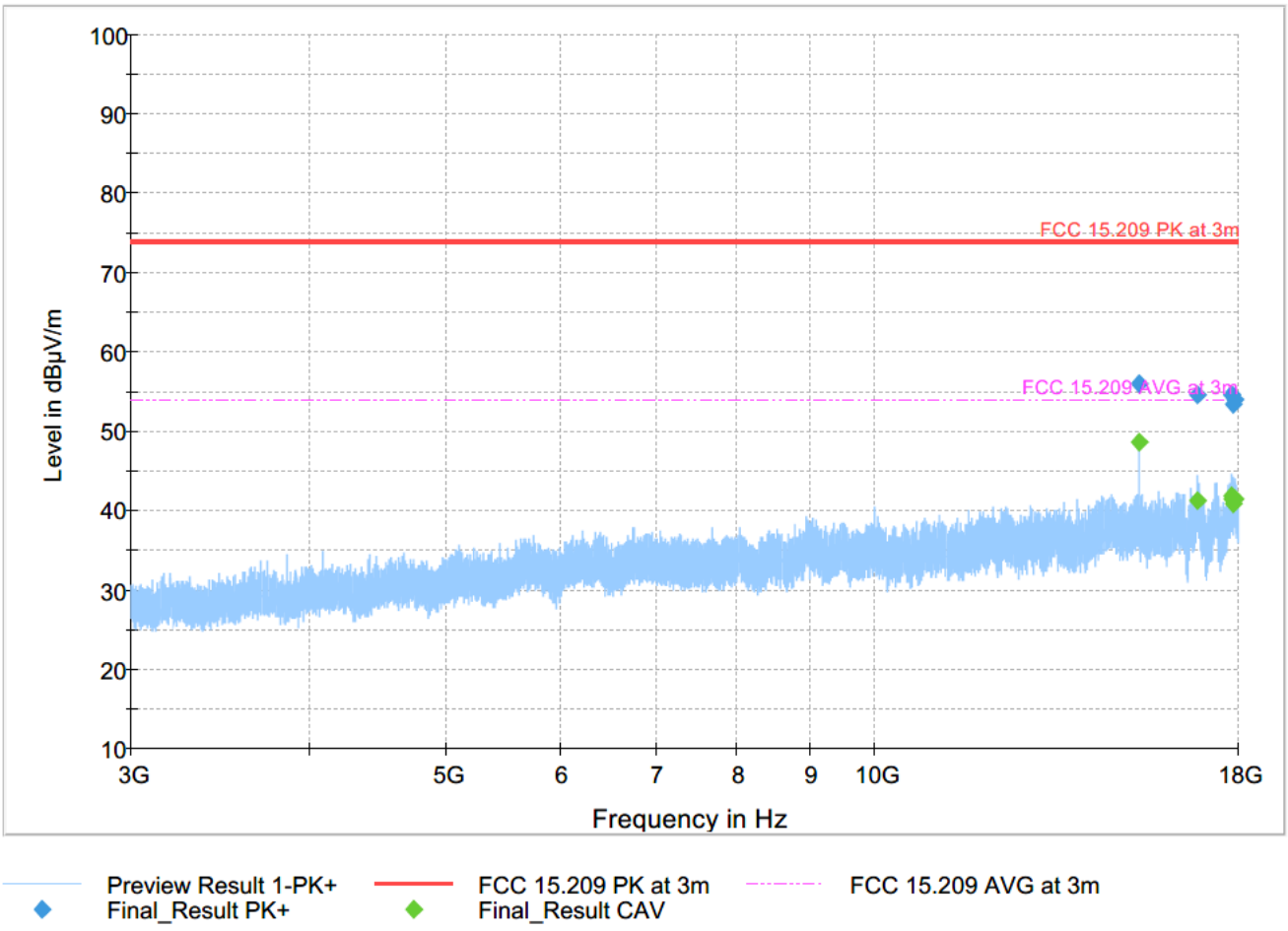
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2983.950	---	33.37	53.98	20.61	500.0	1000.000	177.0	V	153.0	35.2	
2983.950	45.63	---	73.98	28.35	500.0	1000.000	177.0	V	153.0	35.2	



Plot # 17 Unwanted Emissions: 3 - 18 GHz

Final_Result

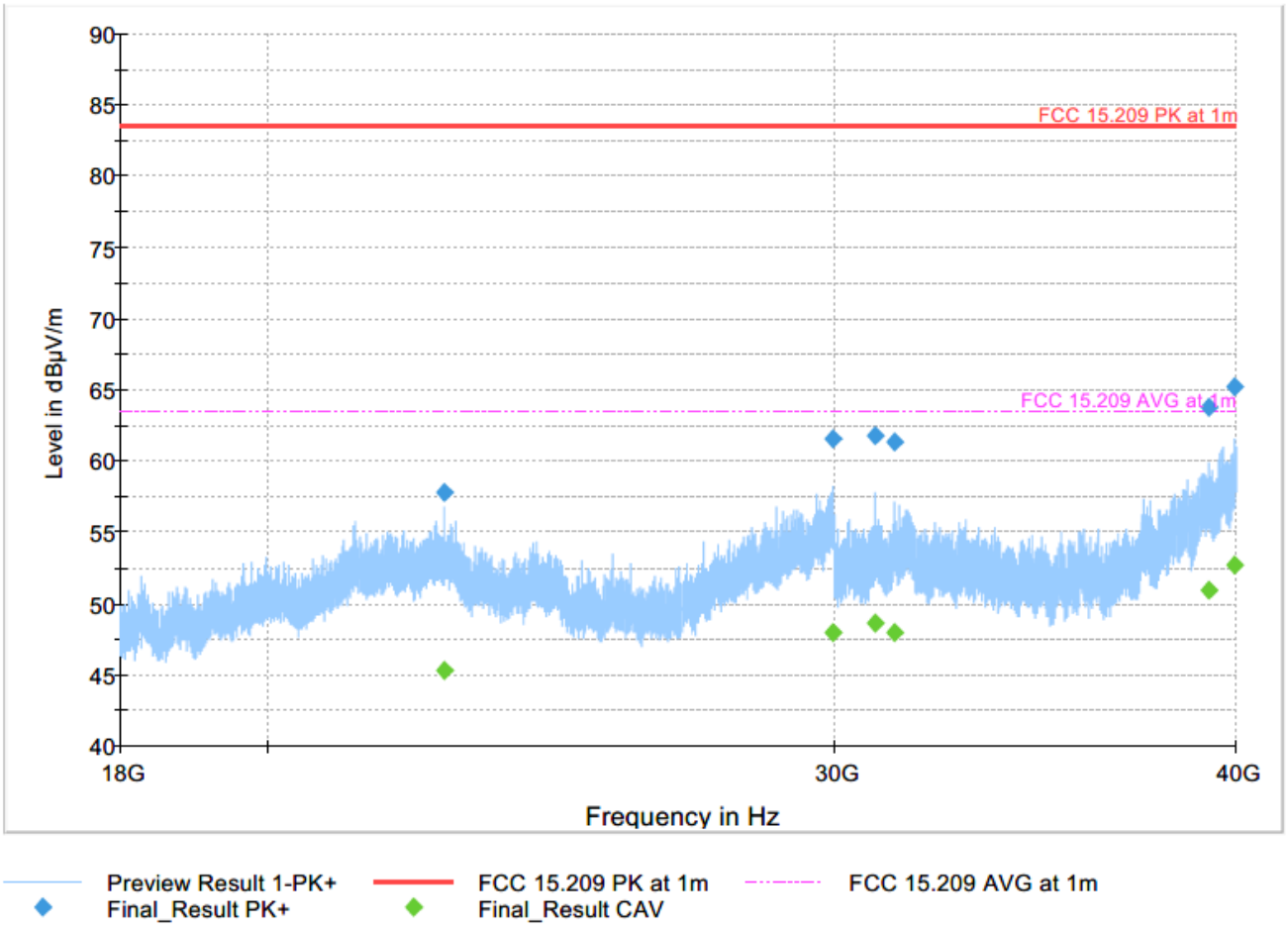
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
15316.650	55.96	---	73.98	18.02	500.0	1000.000	118.0	V	89.0	10.3	
15316.650	---	48.68	53.98	5.30	500.0	1000.000	118.0	V	89.0	10.3	
16852.550	54.58	---	73.98	19.40	500.0	1000.000	173.0	V	215.0	14.4	
16852.550	---	41.34	53.98	12.64	500.0	1000.000	173.0	V	215.0	14.4	
17801.750	54.69	---	73.98	19.29	500.0	1000.000	163.0	V	101.0	17.8	
17801.750	---	41.93	53.98	12.05	500.0	1000.000	163.0	V	101.0	17.8	
17823.500	---	41.45	53.98	12.53	500.0	1000.000	127.0	H	180.0	17.9	
17823.500	54.58	---	73.98	19.40	500.0	1000.000	127.0	H	180.0	17.9	
17868.100	---	40.81	53.98	13.17	500.0	1000.000	145.0	V	36.0	18.1	
17868.100	53.50	---	73.98	20.48	500.0	1000.000	145.0	V	36.0	18.1	
17923.900	53.92	---	73.98	20.06	500.0	1000.000	212.0	V	103.0	17.9	
17923.900	---	41.48	53.98	12.50	500.0	1000.000	212.0	V	103.0	17.9	



Plot # 18 Unwanted Emissions: 18-40 GHz

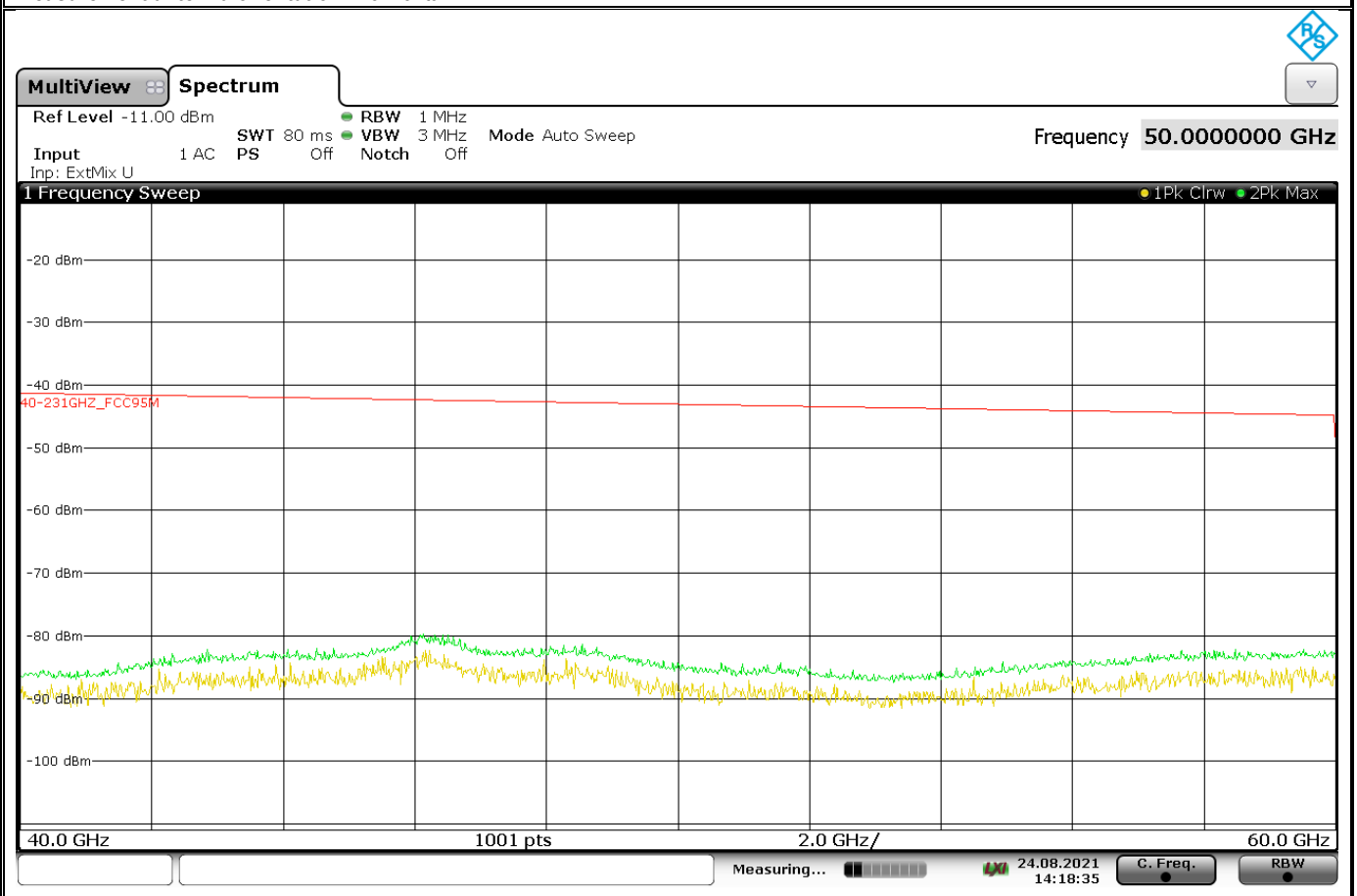
Final_Result

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)	Comment
22695.750	57.84	---	83.50	25.66	500.0	1000.000	150.0	H	276.0	19.9	
22695.750	---	45.26	63.50	18.24	500.0	1000.000	150.0	H	276.0	19.9	
29970.000	---	47.93	63.50	15.57	500.0	1000.000	150.0	H	122.0	23.0	
29970.000	61.54	---	83.50	21.96	500.0	1000.000	150.0	H	122.0	23.0	
30886.563	---	48.60	63.50	14.90	500.0	1000.000	150.0	H	201.0	23.4	
30886.563	61.84	---	83.50	21.66	500.0	1000.000	150.0	H	201.0	23.4	
31317.188	---	47.96	63.50	15.55	500.0	1000.000	150.0	V	245.0	22.8	
31317.188	61.30	---	83.50	22.20	500.0	1000.000	150.0	V	245.0	22.8	
39209.375	---	50.97	63.50	12.53	500.0	1000.000	150.0	H	250.0	24.2	
39209.375	63.74	---	83.50	19.76	500.0	1000.000	150.0	H	250.0	24.2	
39936.250	65.21	---	83.50	18.29	500.0	1000.000	150.0	V	102.0	24.7	
39936.250	---	52.76	63.50	10.74	500.0	1000.000	150.0	V	102.0	24.7	



Plot # 19 Unwanted Emissions: 40 - 60 GHz

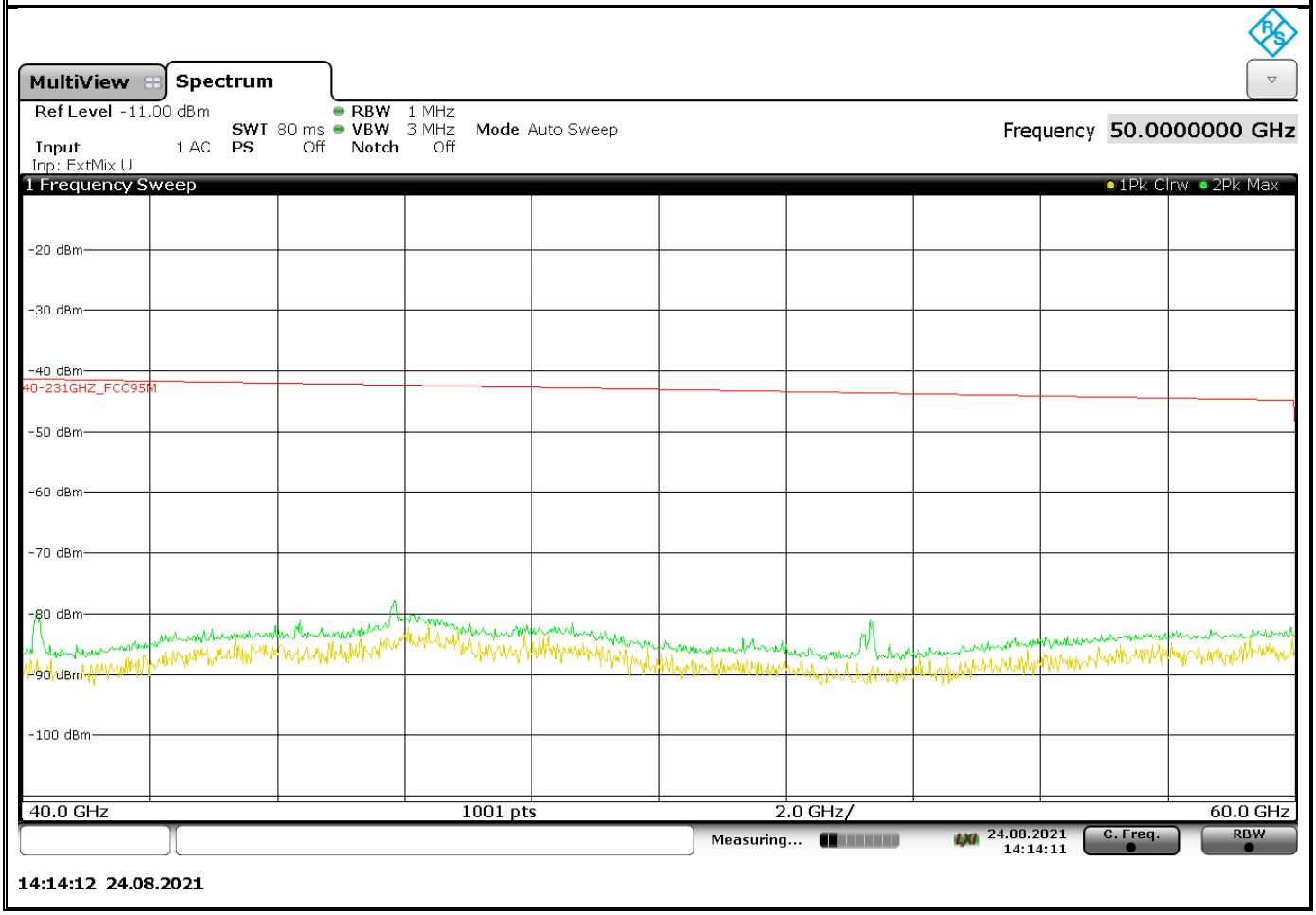
Measurement antenna orientation: Horizontal



14:18:36 24.08.2021

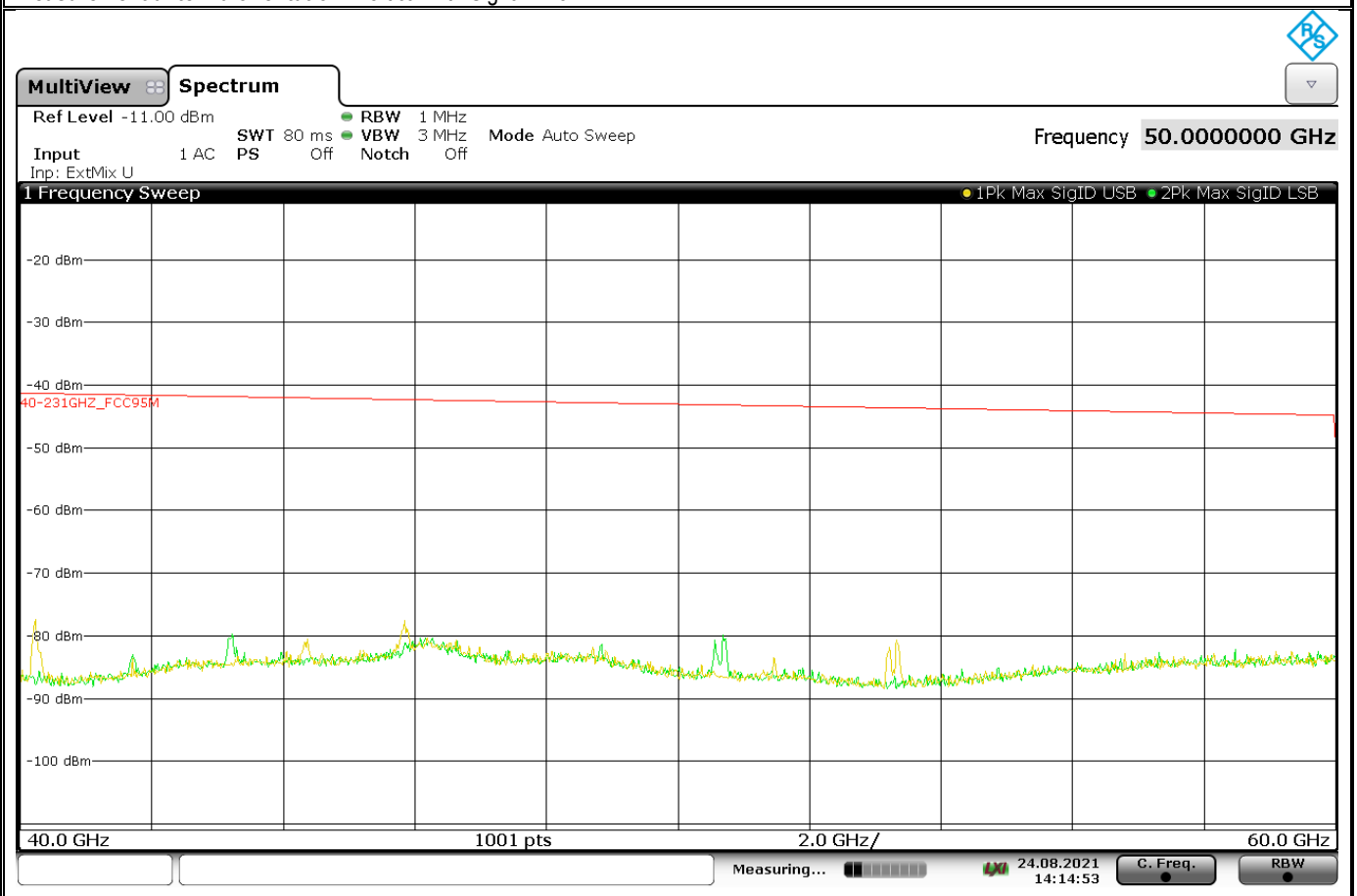
Plot # 20 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Vertical



Plot # 21 Unwanted Emissions: 40 - 60 GHz

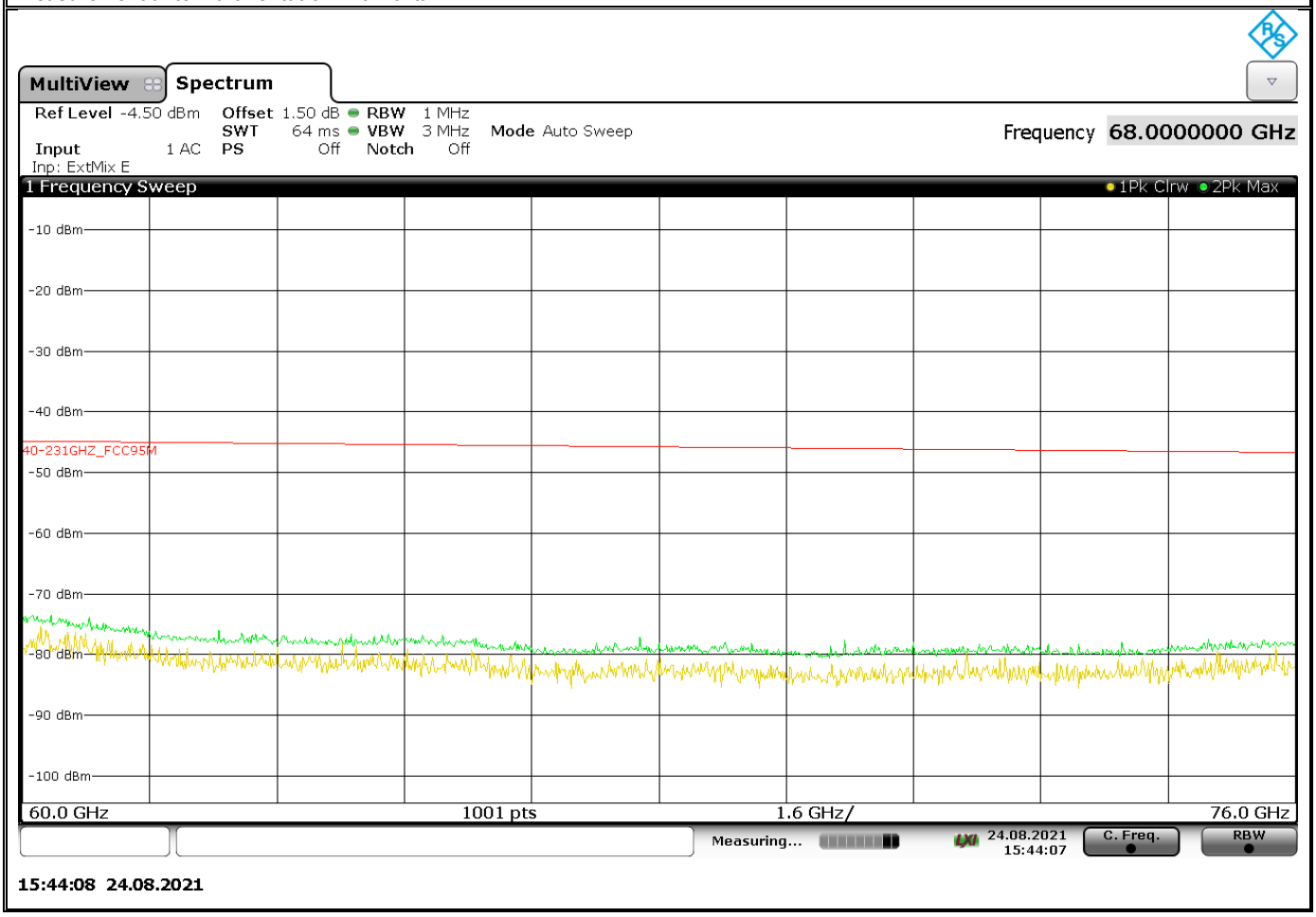
Measurement antenna orientation: Vertical with Signal ID on



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.

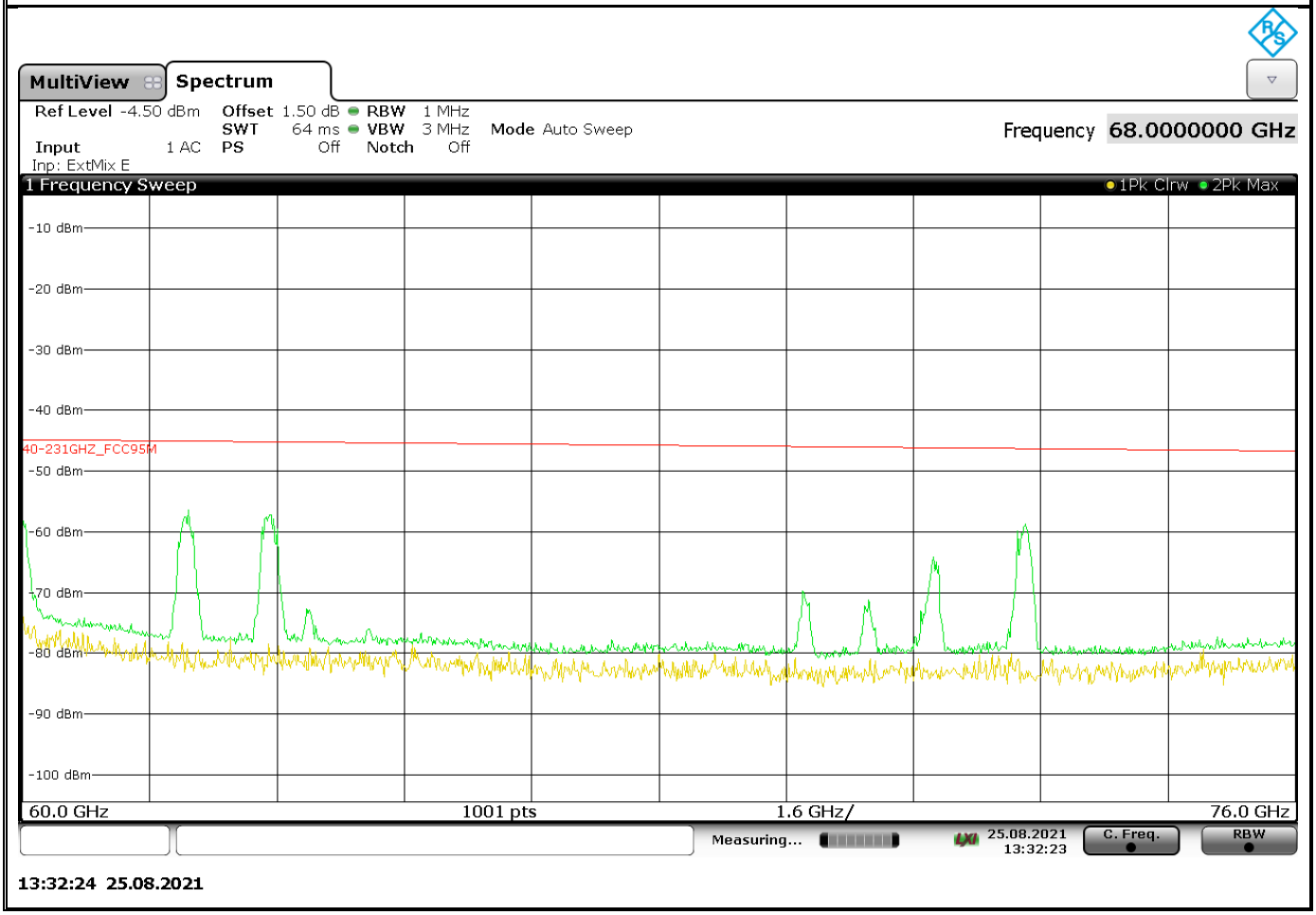
Plot # 22 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Horizontal



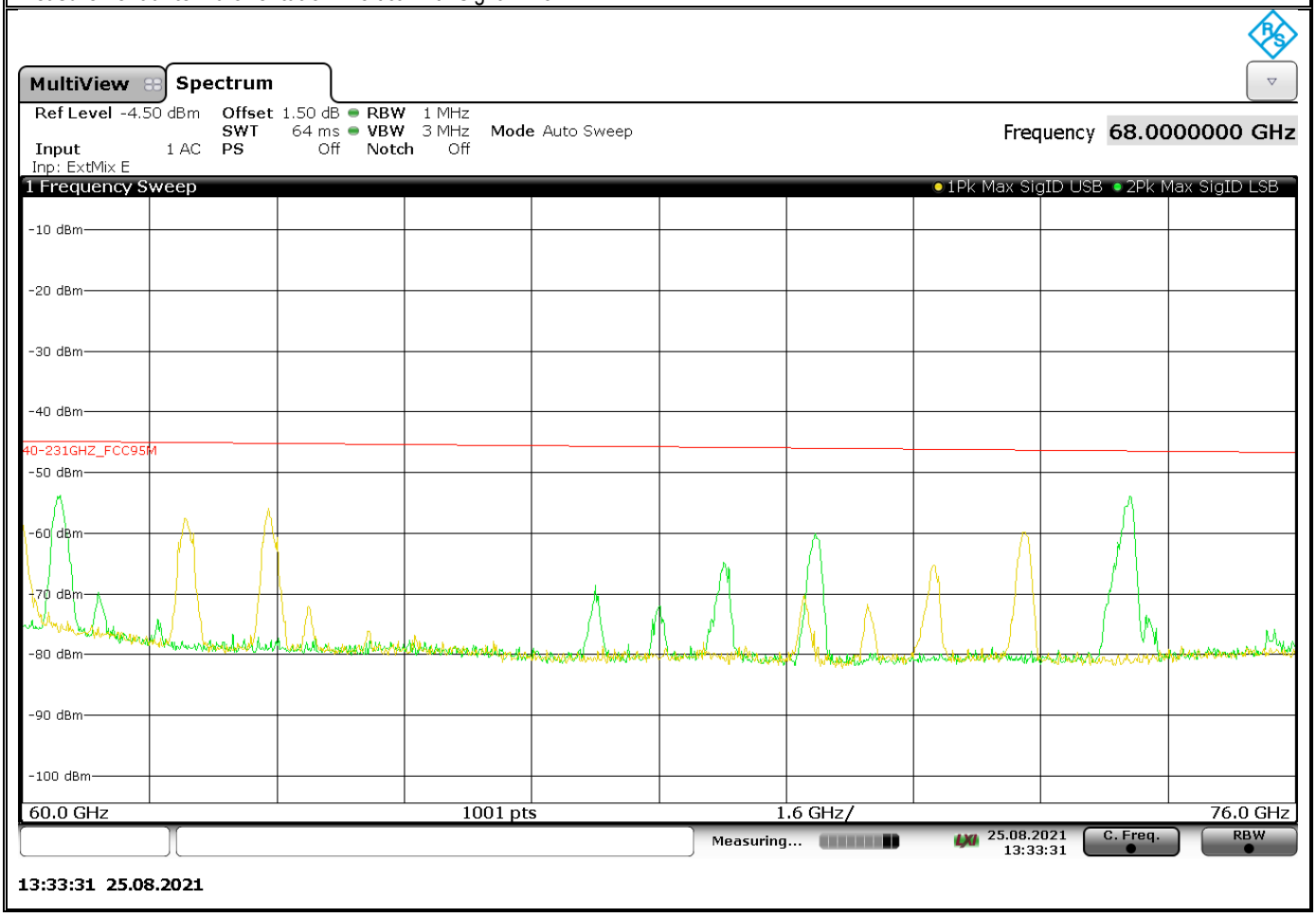
Plot # 23 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical



Plot # 24 Unwanted Emissions: 60 - 76 GHz

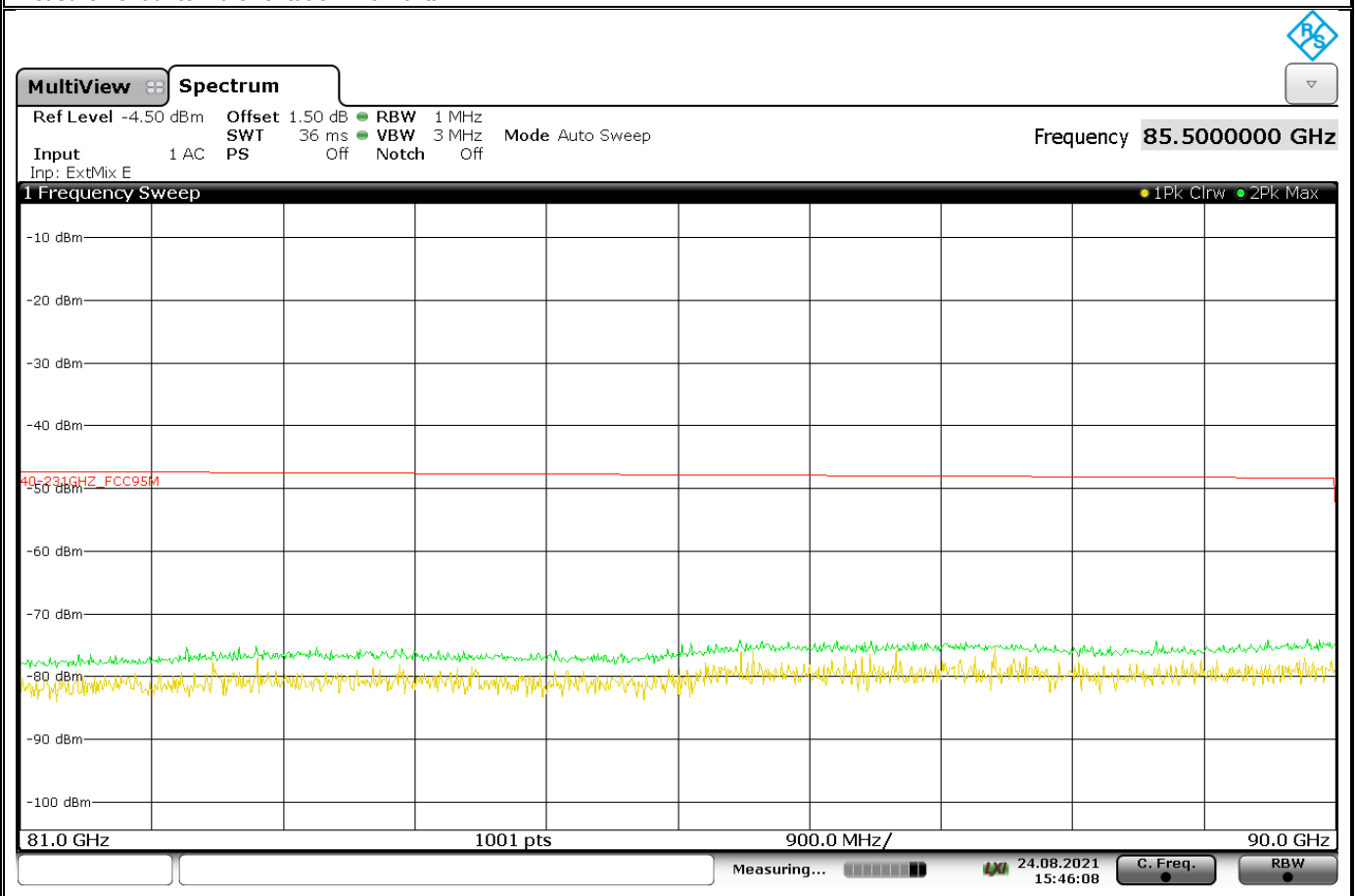
Measurement antenna orientation: Vertical with Signal ID on



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.

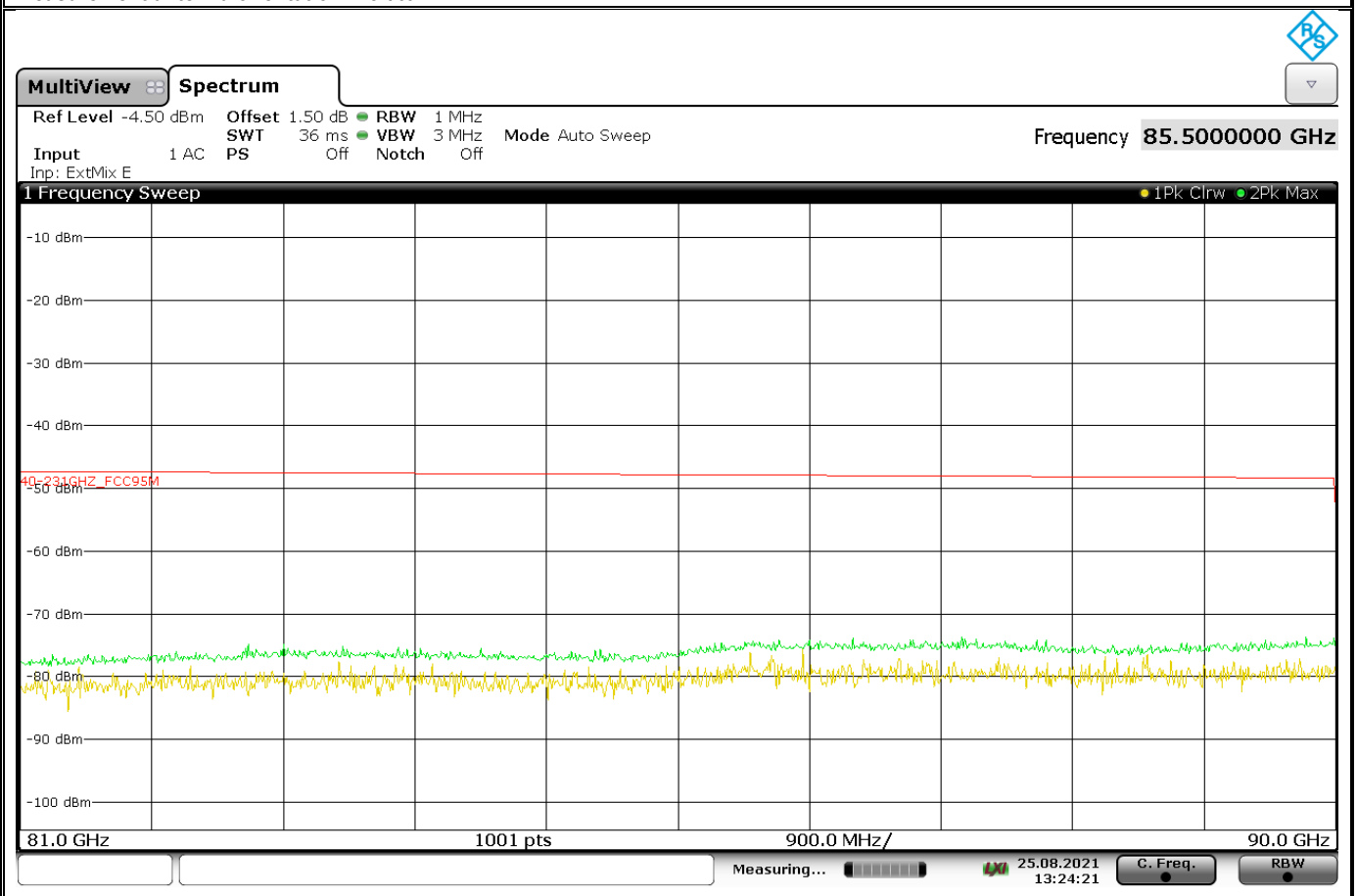
Plot # 25 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Horizontal



Plot # 26 Unwanted Emissions: 81 - 90 GHz

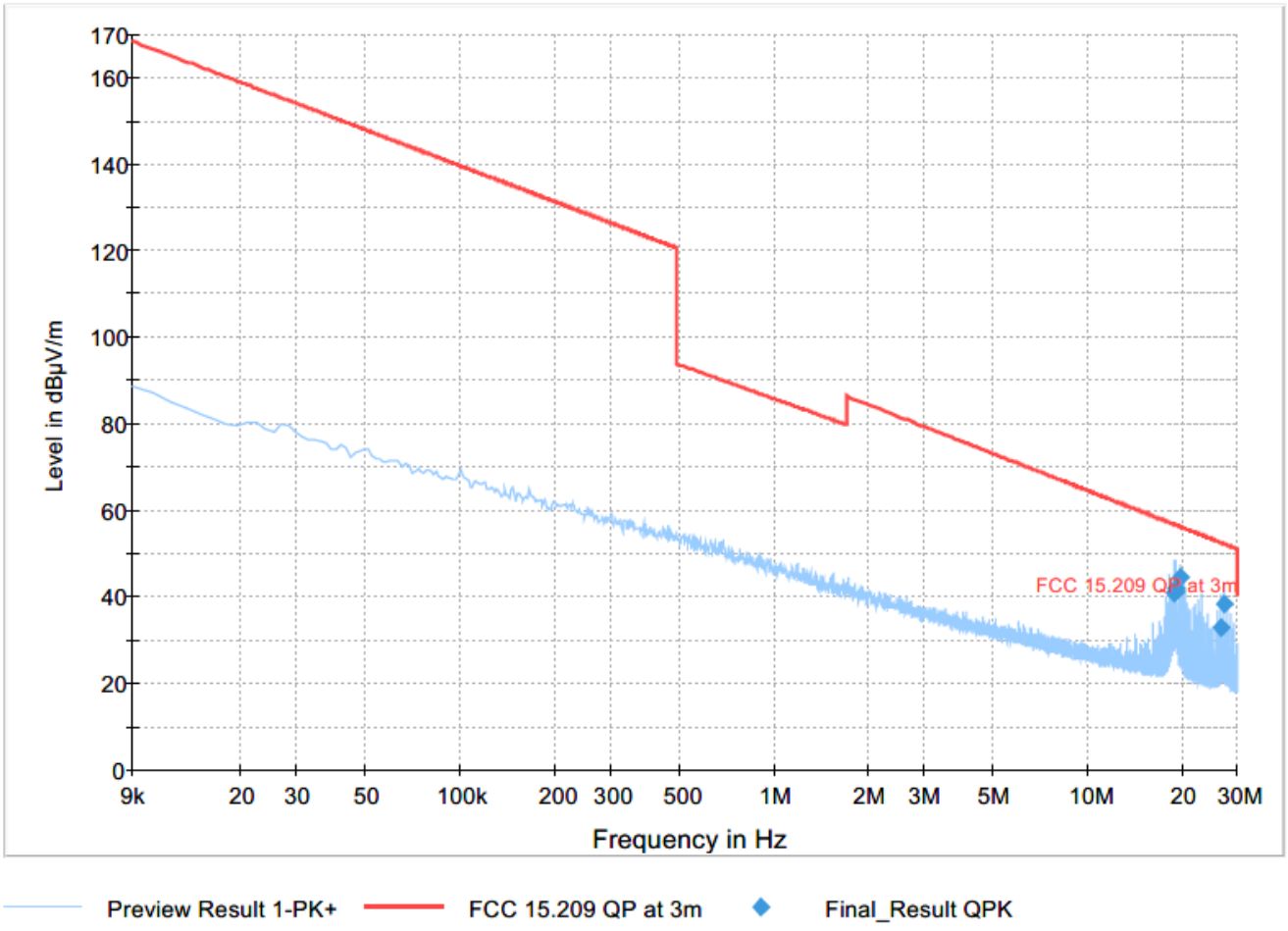
Measurement antenna orientation: Vertical



Plot # 27 Unwanted Emissions: 9 kHz - 30 MHz

Final_Result

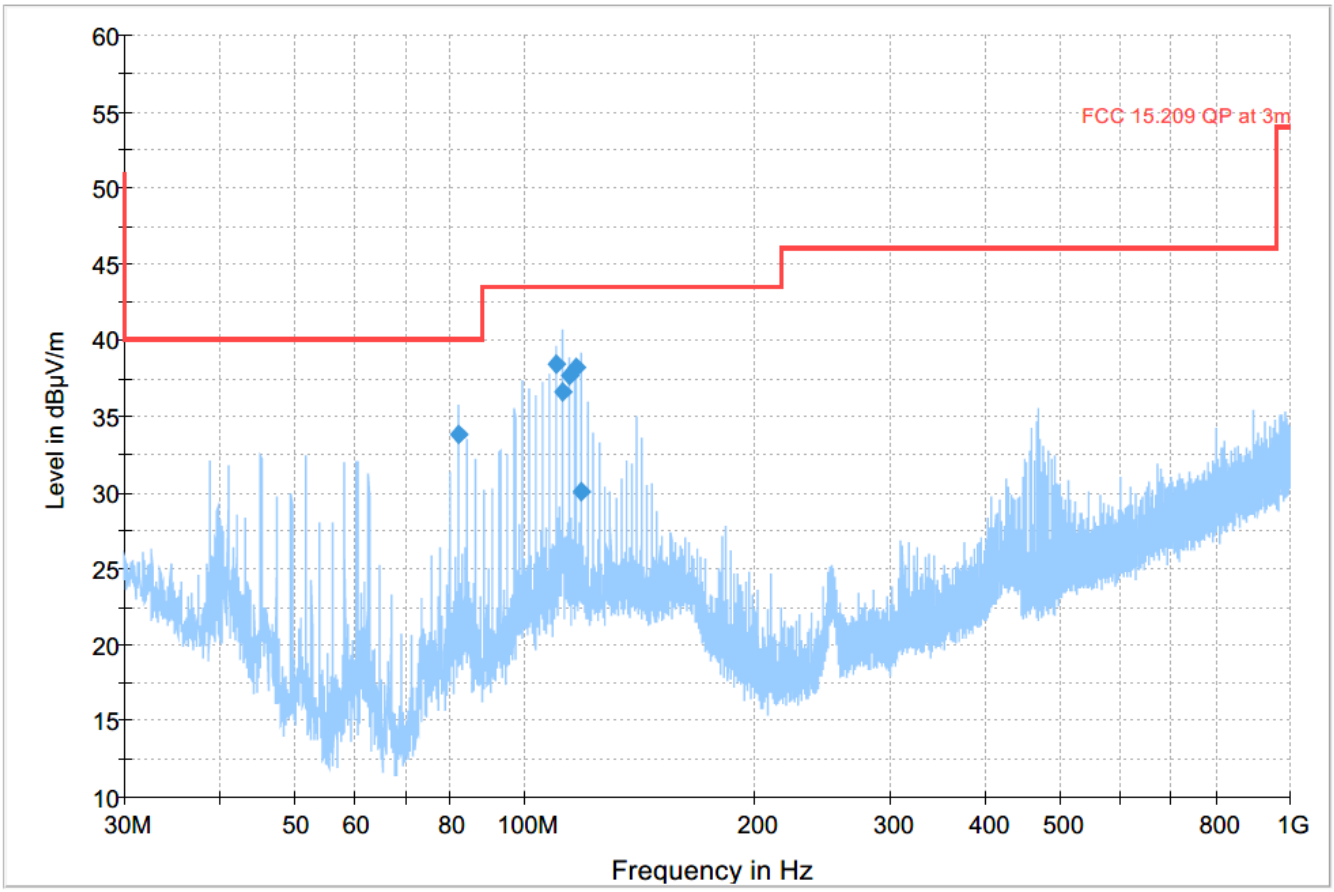
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
18.916	40.83	56.72	15.88	500.0	9.000	100.0	H	84.0	16.9	
19.100	41.98	56.60	14.62	500.0	9.000	100.0	H	-13.0	16.9	
19.160	41.22	56.56	15.34	500.0	9.000	107.0	H	-48.0	16.9	
19.710	44.45	56.21	11.76	500.0	9.000	100.0	H	92.0	16.9	
26.488	32.91	52.57	19.66	500.0	9.000	107.0	H	-65.0	16.4	
27.159	38.48	52.27	13.78	500.0	9.000	100.0	H	-13.0	16.4	



Plot # 28 Unwanted Emissions 30 MHz – 1GHz

Final_Result

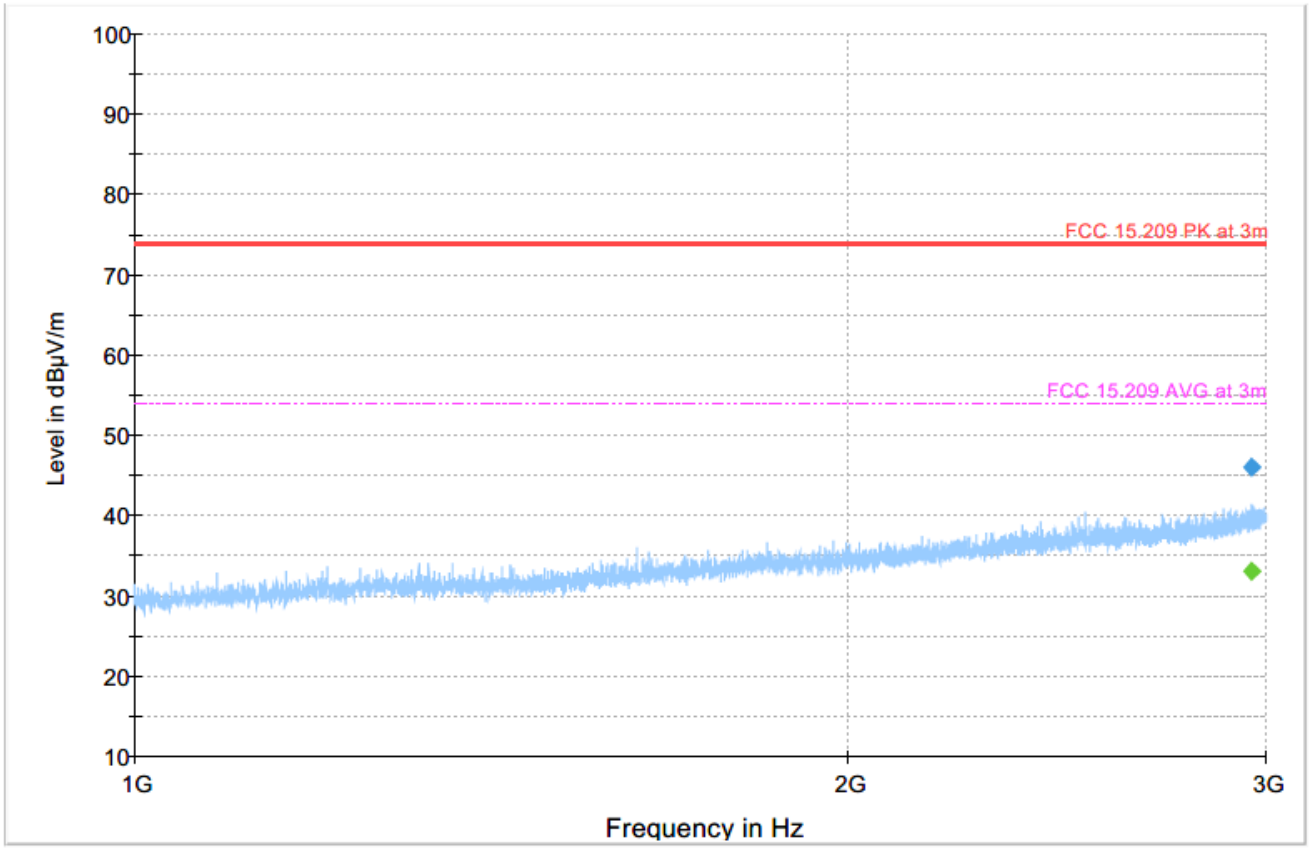
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
82.052	33.83	40.00	6.17	500.0	120.000	107.0	V	186.0	10.1	
110.109	38.41	43.50	5.09	500.0	120.000	133.0	V	218.0	16.0	
112.268	36.65	43.50	6.85	500.0	120.000	107.0	V	219.0	16.4	
114.466	37.67	43.50	5.83	500.0	120.000	107.0	V	222.0	16.5	
116.576	38.20	43.50	5.30	500.0	120.000	100.0	V	200.0	16.9	
118.702	30.02	43.50	13.48	500.0	120.000	100.0	V	64.0	17.2	



Plot # 29 Unwanted Emissions: 1-3 GHz

Final_Result

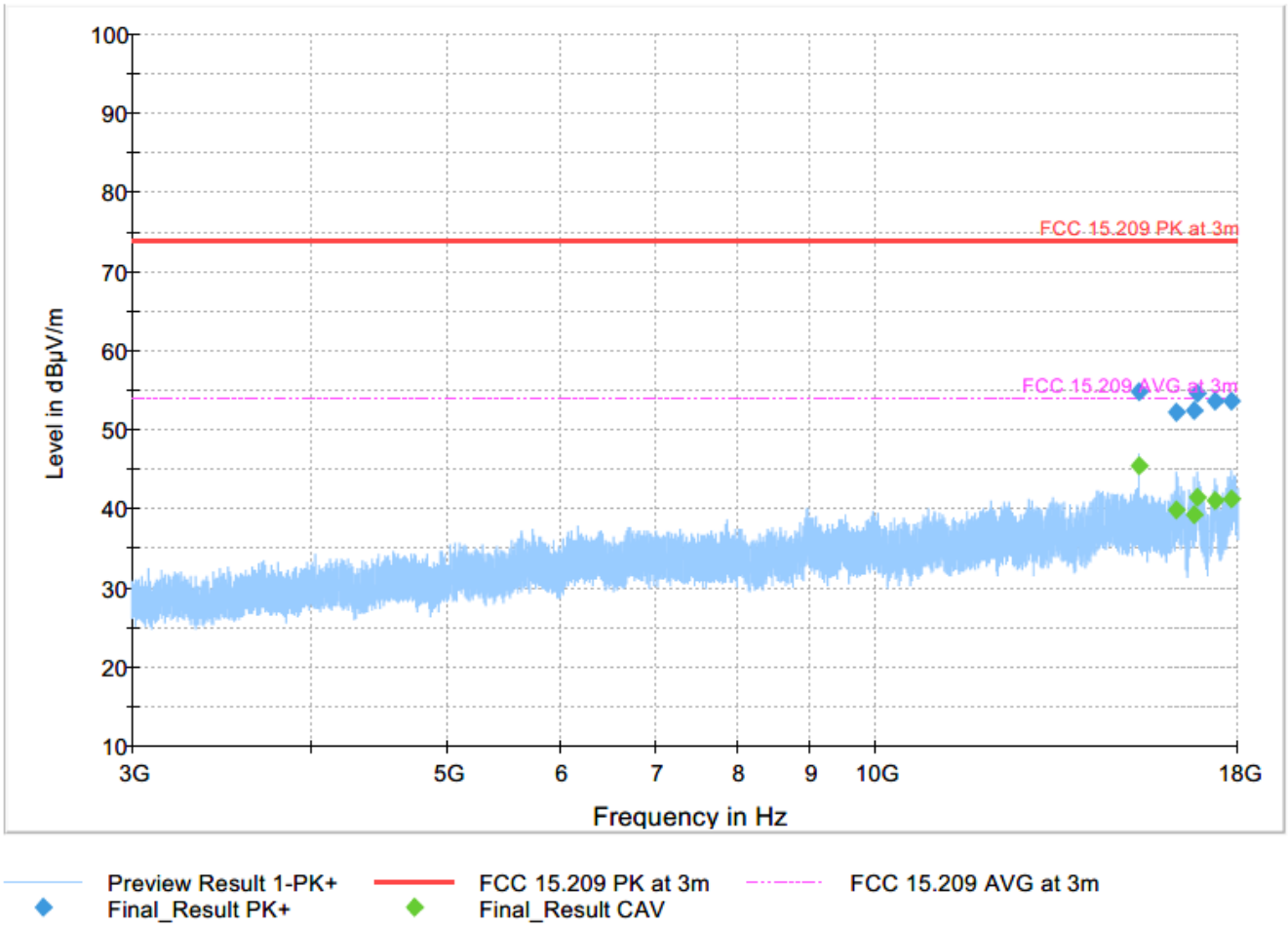
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2956.600	---	33.17	53.98	20.81	500.0	1000.000	134.0	V	-21.0	35.1	
2956.600	46.00	---	73.98	27.98	500.0	1000.000	134.0	V	-21.0	35.1	



Plot # 30 Unwanted Emissions: 3 - 18 GHz

Final_Result

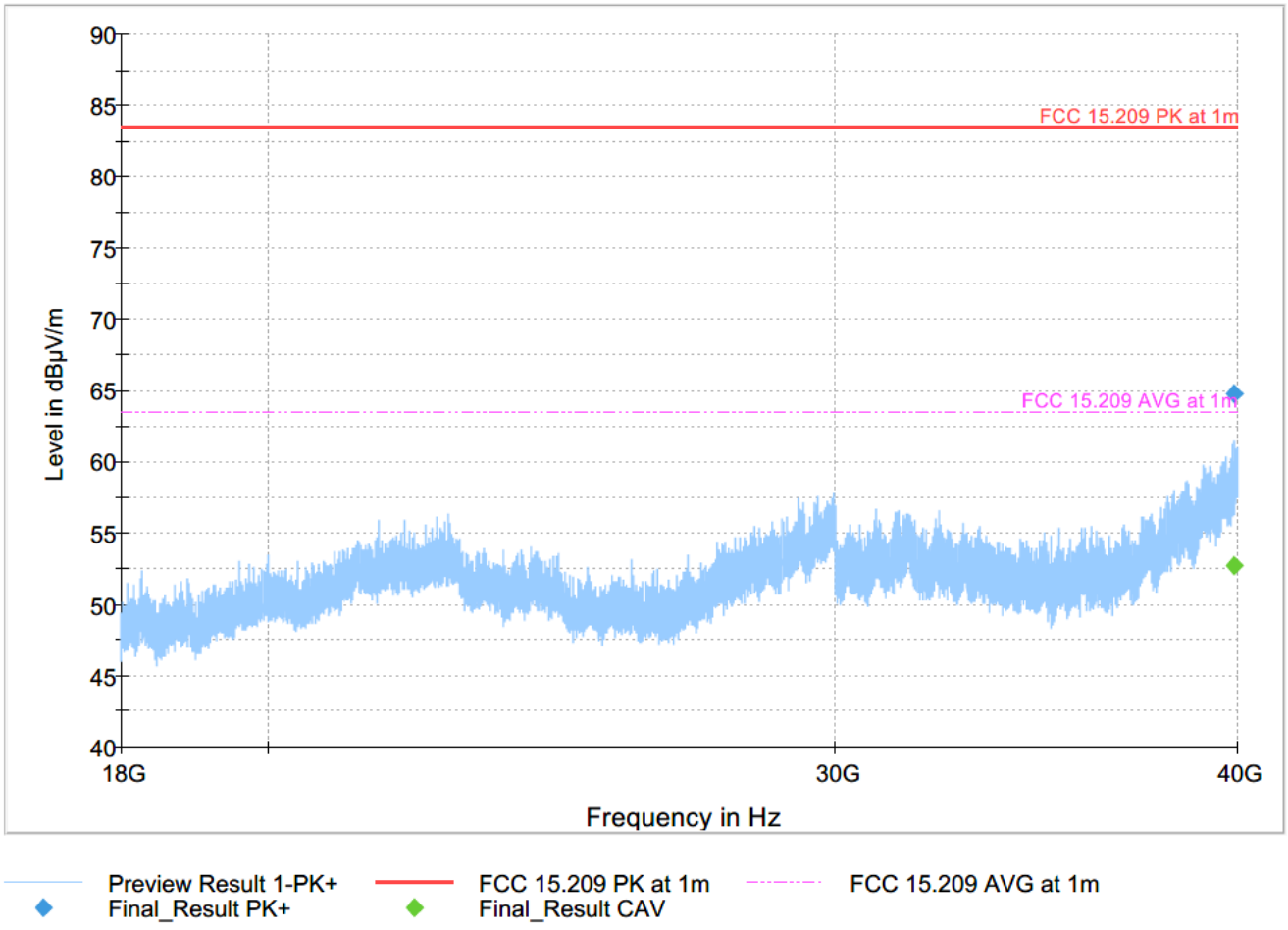
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
15316.850	---	45.49	53.98	8.49	500.0	1000.000	165.0	H	-2.0	10.3	
15316.850	54.77	---	73.98	19.21	500.0	1000.000	165.0	H	-2.0	10.3	
16309.400	52.23	---	73.98	21.75	500.0	1000.000	244.0	V	40.0	13.8	
16309.400	---	39.79	53.98	14.19	500.0	1000.000	244.0	V	40.0	13.8	
16776.000	52.38	---	73.98	21.60	500.0	1000.000	261.0	V	258.0	14.0	
16776.000	---	39.32	53.98	14.65	500.0	1000.000	261.0	V	258.0	14.0	
16853.500	---	41.53	53.98	12.45	500.0	1000.000	172.0	V	60.0	14.4	
16853.500	54.56	---	73.98	19.42	500.0	1000.000	172.0	V	60.0	14.4	
17364.800	---	41.01	53.98	12.97	500.0	1000.000	276.0	H	-9.0	15.9	
17364.800	53.66	---	73.98	20.32	500.0	1000.000	276.0	H	-9.0	15.9	
17819.100	---	41.28	53.98	12.70	500.0	1000.000	163.0	V	75.0	17.8	
17819.100	53.66	---	73.98	20.32	500.0	1000.000	163.0	V	75.0	17.8	



Plot # 31 Unwanted Emissions: 18-40 GHz

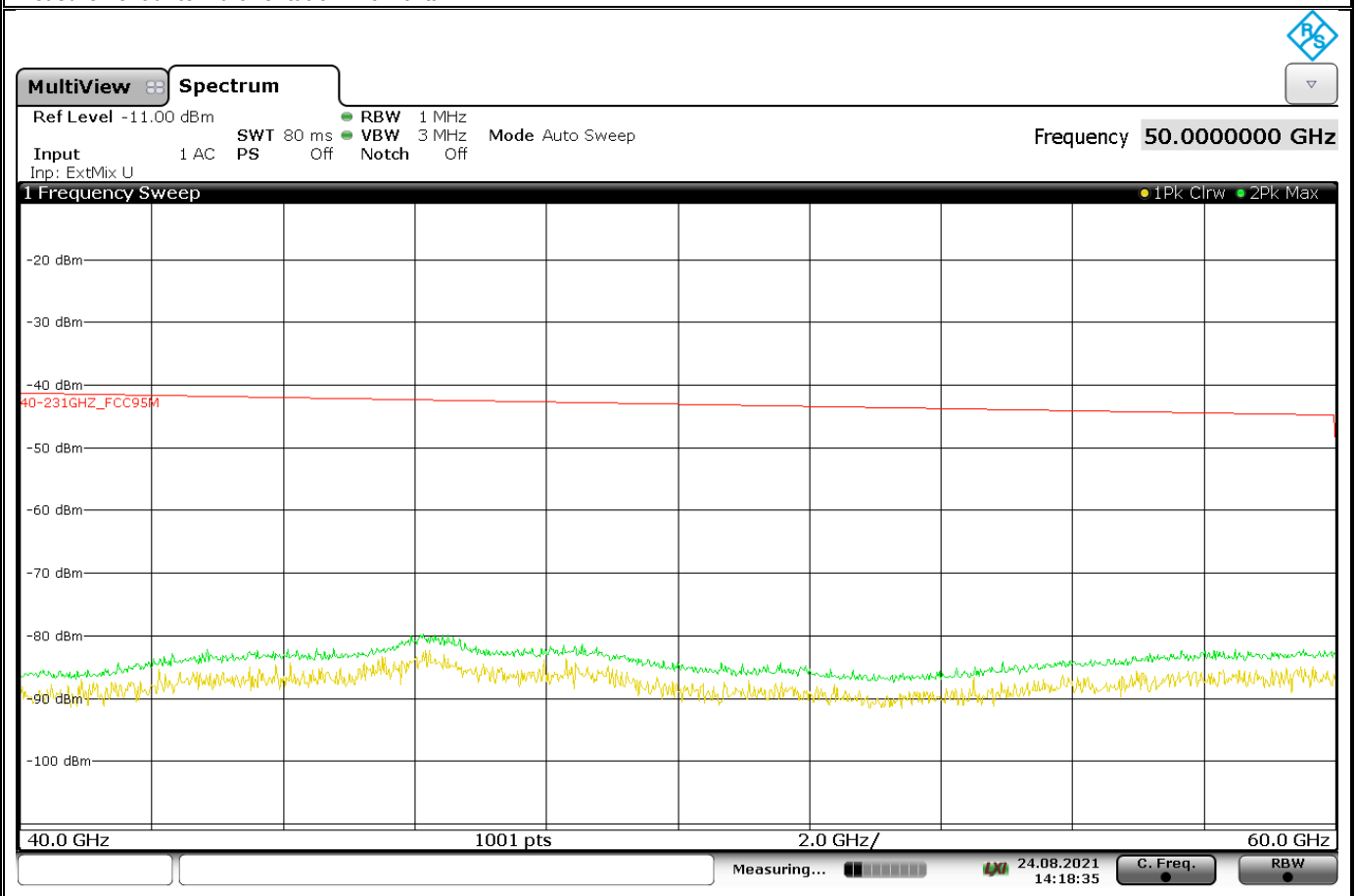
Final_Result

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)	Comment
39907.188	---	52.68	63.50	10.82	500.0	1000.000	150.0	H	89.0	24.6	
39907.188	64.80	---	83.50	18.70	500.0	1000.000	150.0	H	89.0	24.6	



Plot # 32 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Horizontal



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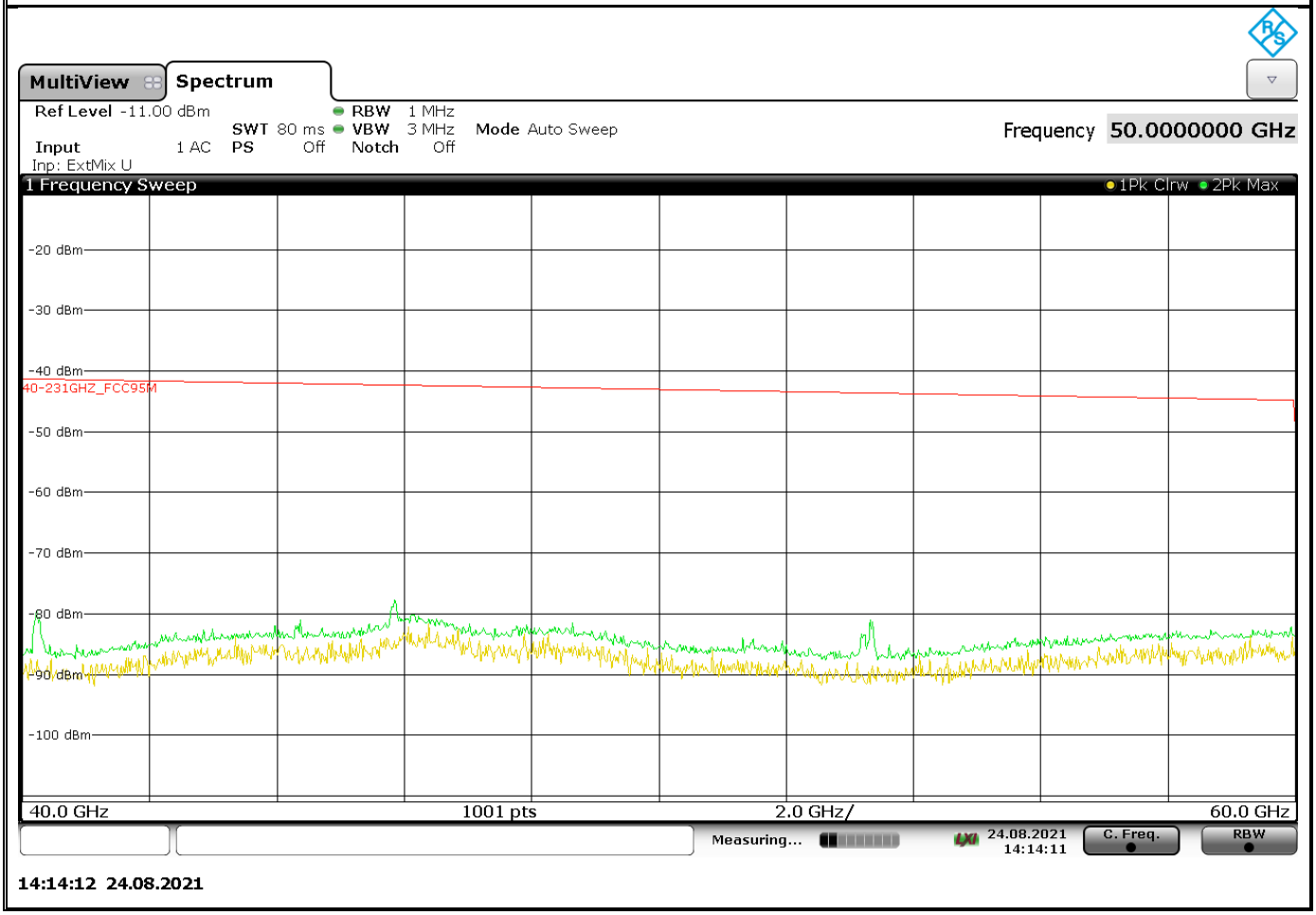
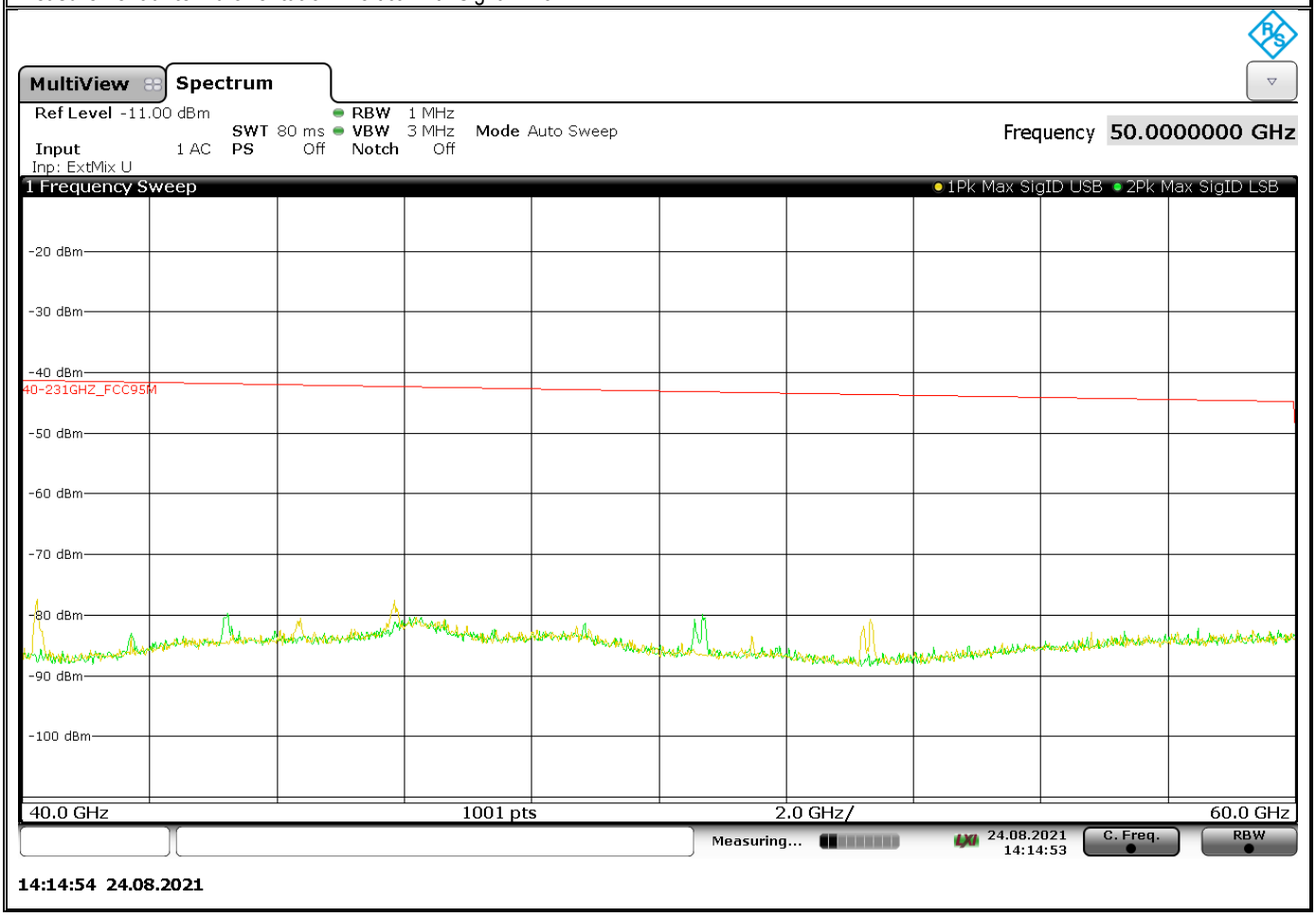
Plot # 33 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Vertical



Plot # 34 Unwanted Emissions: 40 - 60 GHz

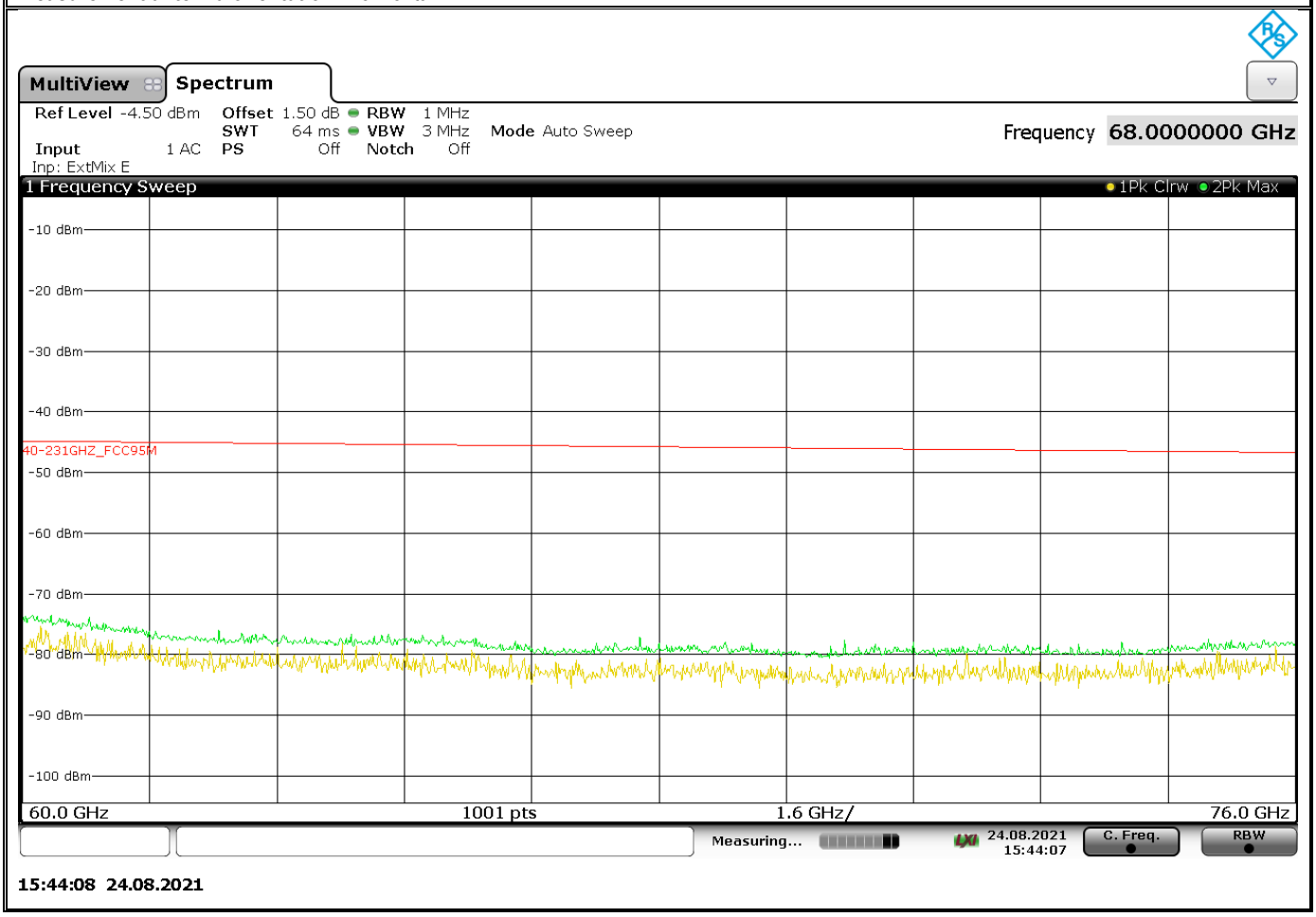
Measurement antenna orientation: Vertical with Signal ID on



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 # 35 Unwanted Emissions: 60 - 76 GHz

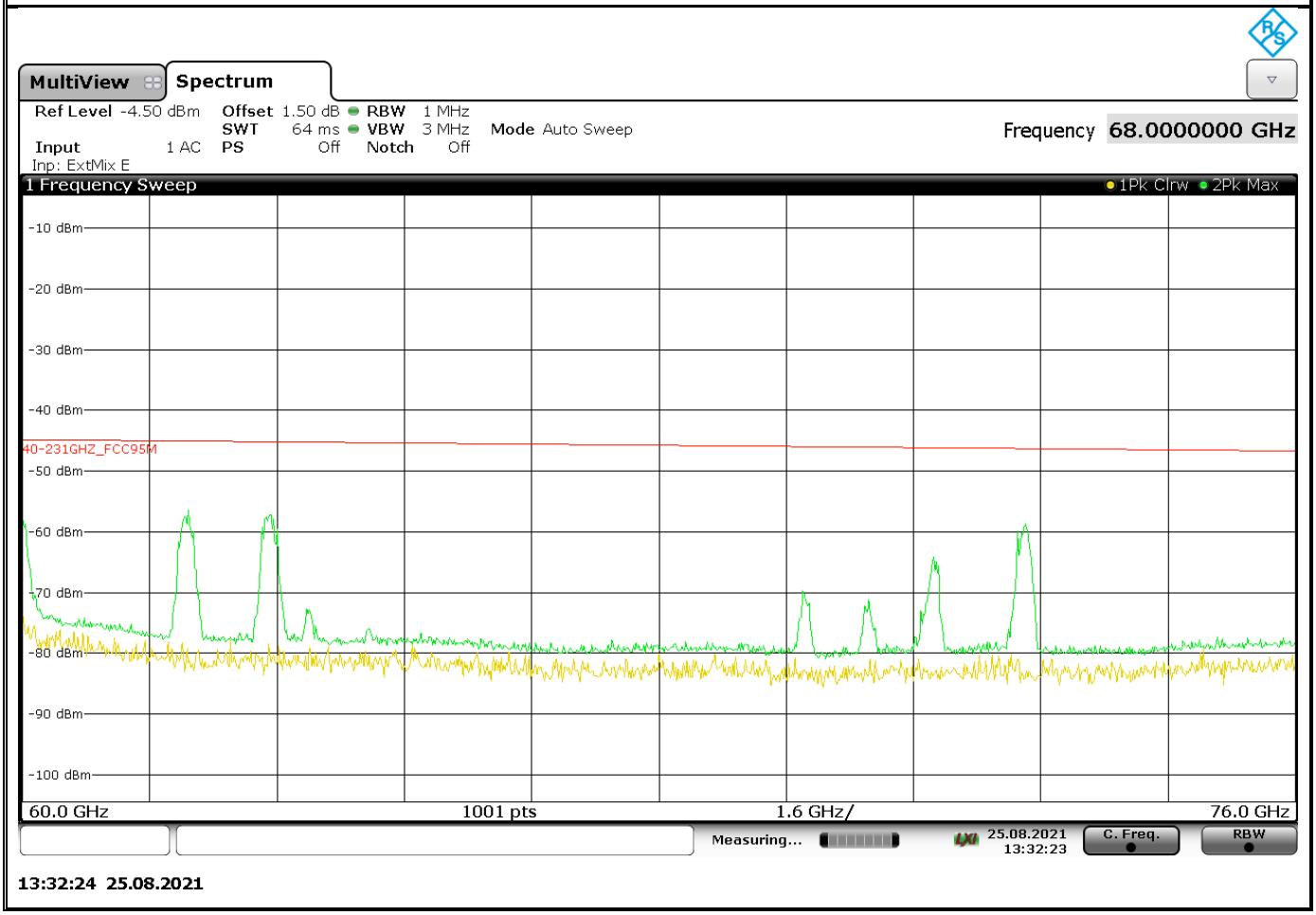
Measurement antenna orientation: Horizontal



15:44:08 24.08.2021

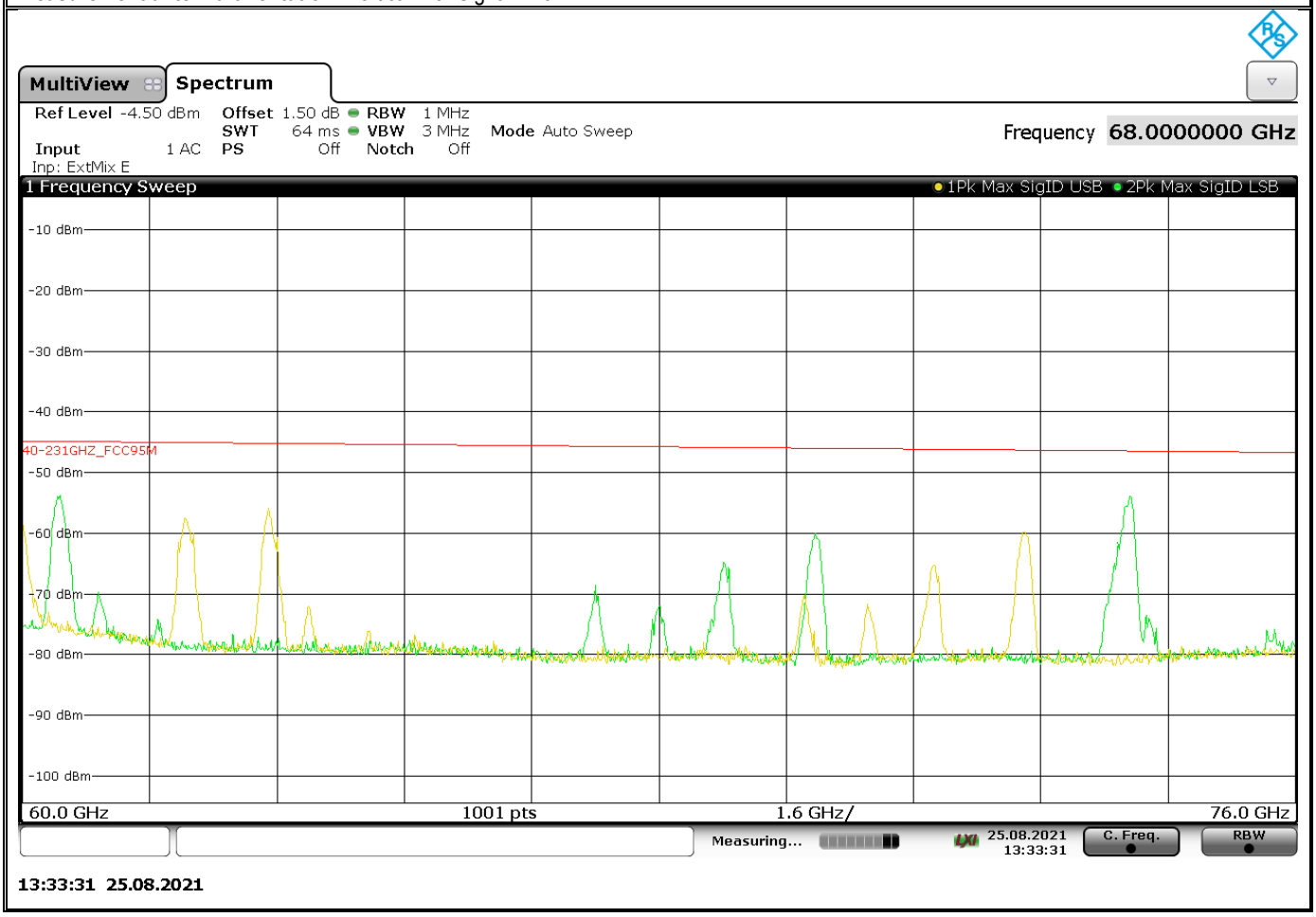
Plot # 36 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical



Plot # 37 Unwanted Emissions: 60 - 76 GHz

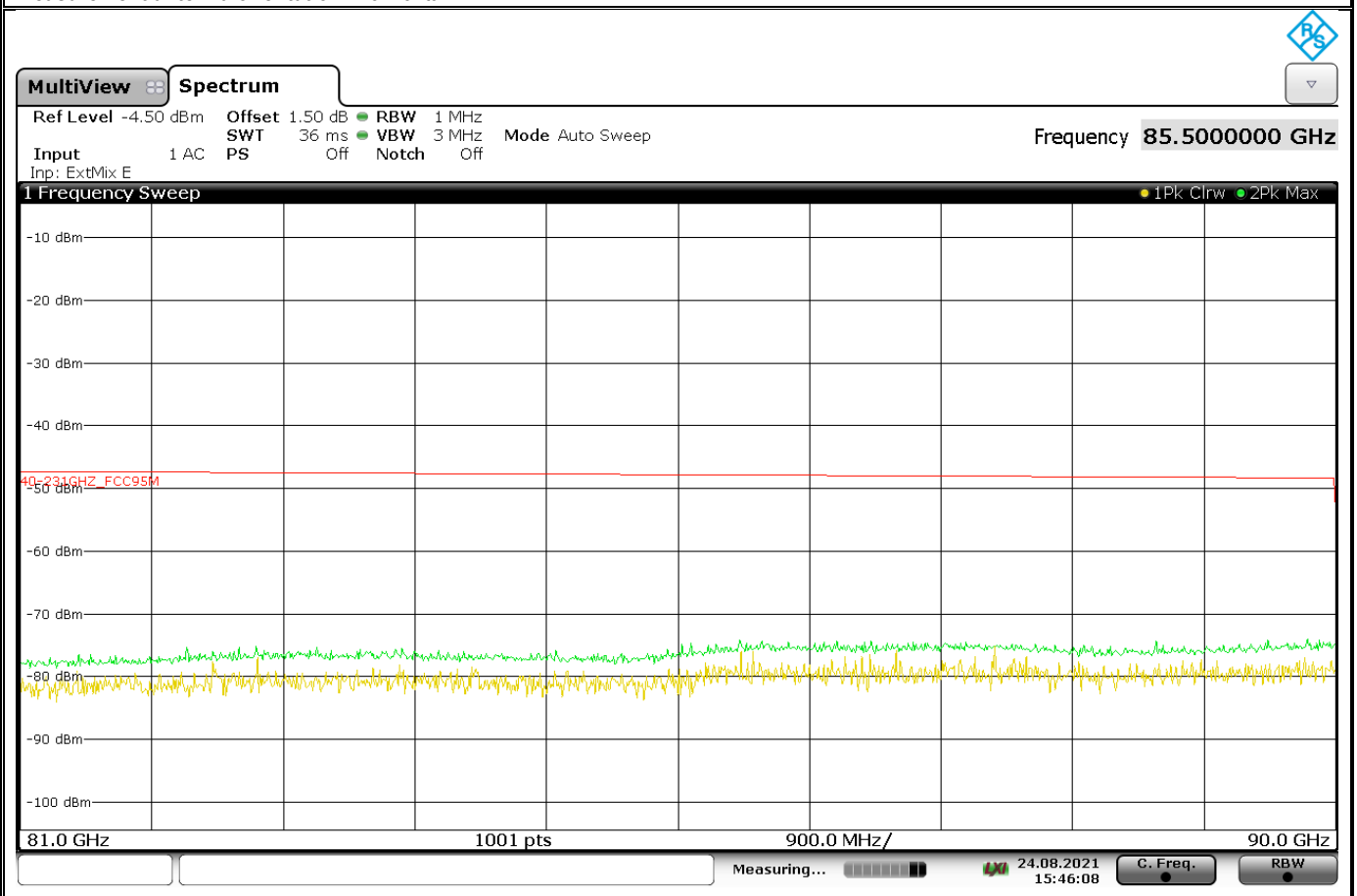
Measurement antenna orientation: Vertical with Signal ID on



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.

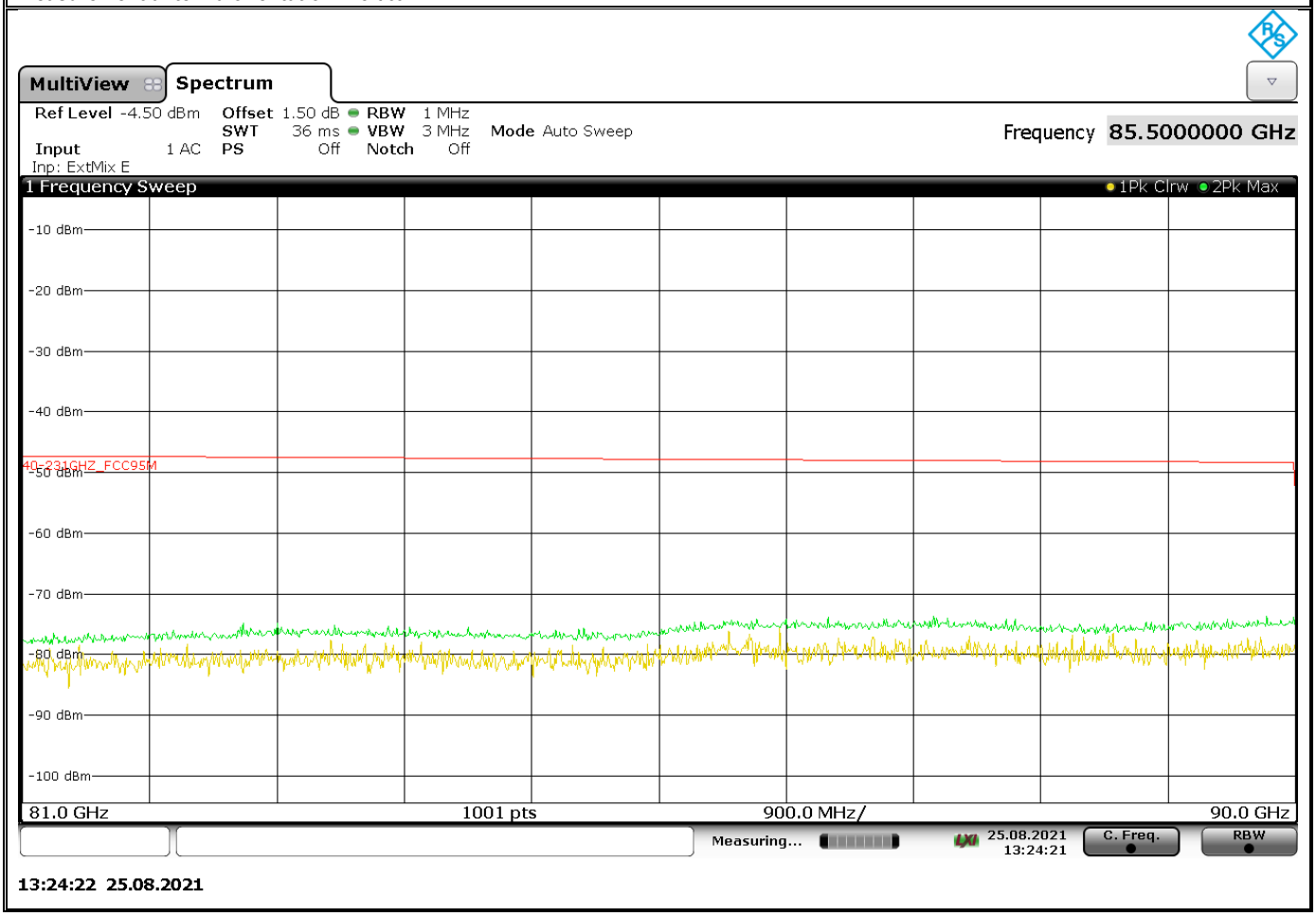
Plot # 38 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Horizontal



Plot # 39 Unwanted Emissions: 81 - 90 GHz

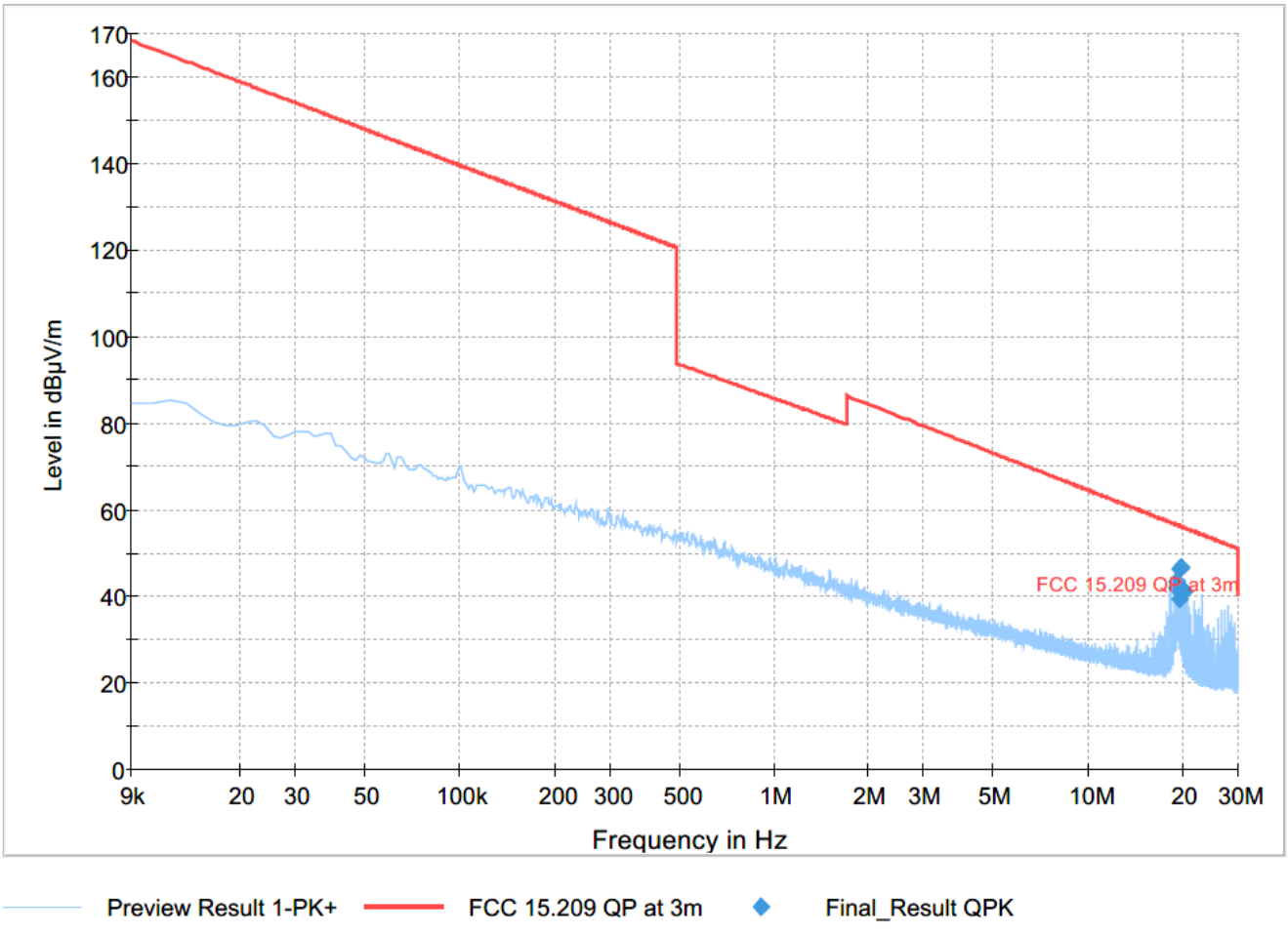
Measurement antenna orientation: Vertical



Plot # 40 Unwanted Emissions: 9 kHz - 30 MHz

Final_Result

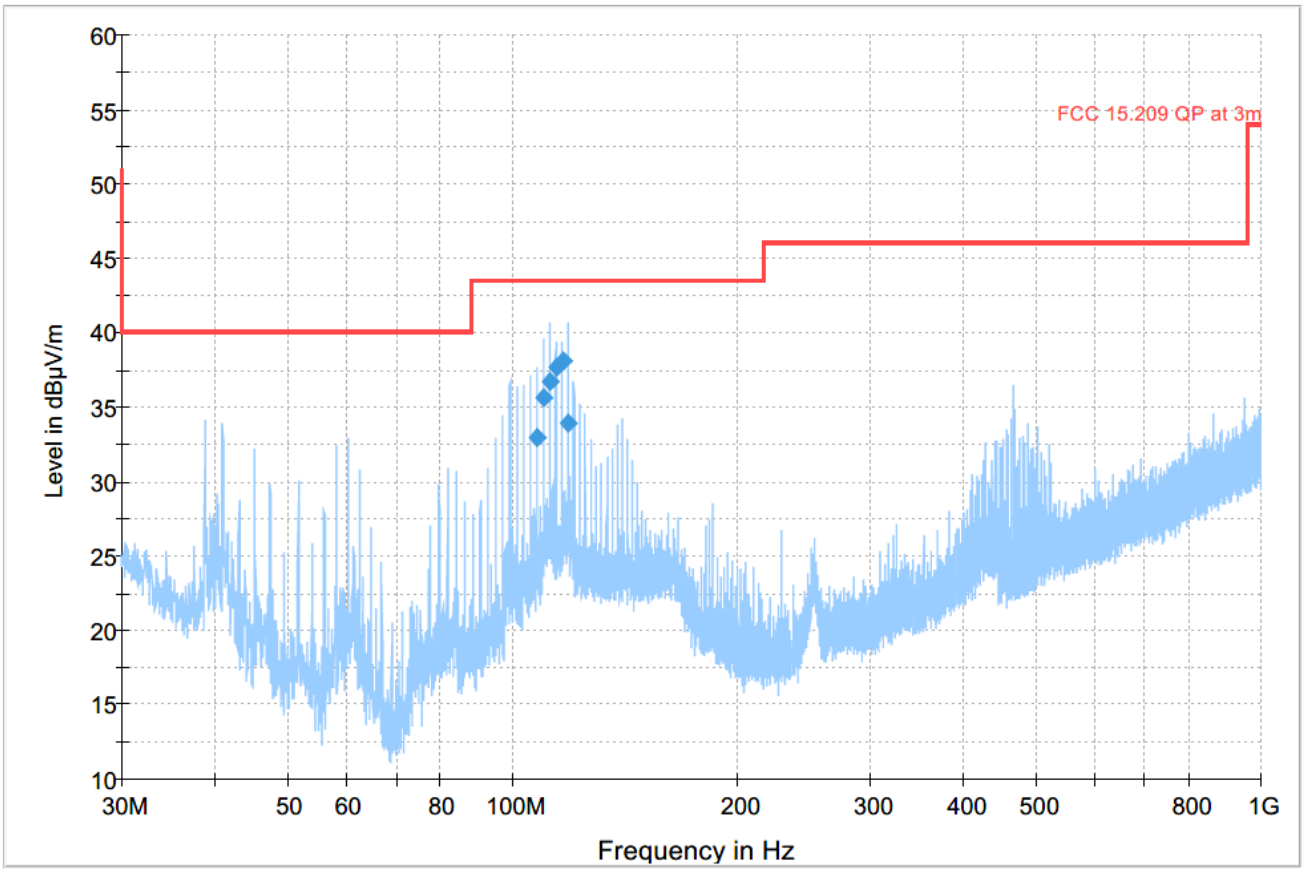
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
19.099	43.23	56.60	13.37	500.0	9.000	100.0	H	138.0	16.9	
19.160	41.99	56.56	14.57	500.0	9.000	100.0	H	102.0	16.9	
19.465	39.49	56.37	16.87	500.0	9.000	100.0	H	71.0	16.9	
19.588	46.37	56.29	9.92	500.0	9.000	100.0	H	-71.0	16.9	
19.710	46.74	56.21	9.48	500.0	9.000	100.0	H	182.0	16.9	
20.259	41.35	55.87	14.52	500.0	9.000	100.0	H	13.0	16.9	



Plot # 41 Unwanted Emissions 30 MHz – 1GHz

Final_Result

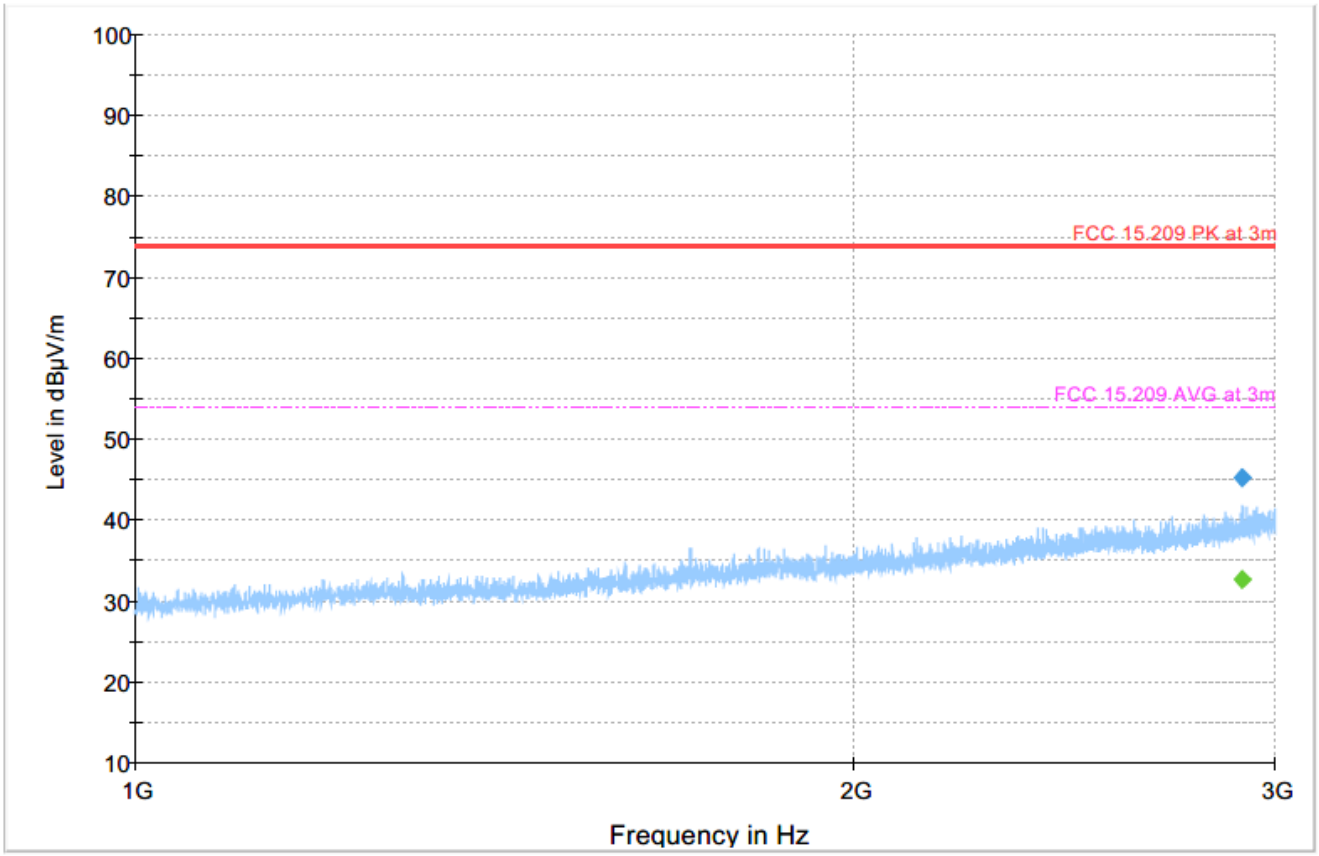
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
107.821	33.01	43.50	10.49	500.0	120.000	154.0	V	149.0	15.5	
110.004	35.62	43.50	7.88	500.0	120.000	100.0	V	289.0	15.9	
112.218	36.72	43.50	6.78	500.0	120.000	211.0	V	235.0	16.3	
114.320	37.63	43.50	5.87	500.0	120.000	100.0	V	202.0	16.5	
116.519	38.16	43.50	5.34	500.0	120.000	107.0	V	202.0	16.9	
118.573	33.95	43.50	9.55	500.0	120.000	126.0	V	79.0	17.2	



Plot # 42 Unwanted Emissions: 1-3 GHz

Final_Result

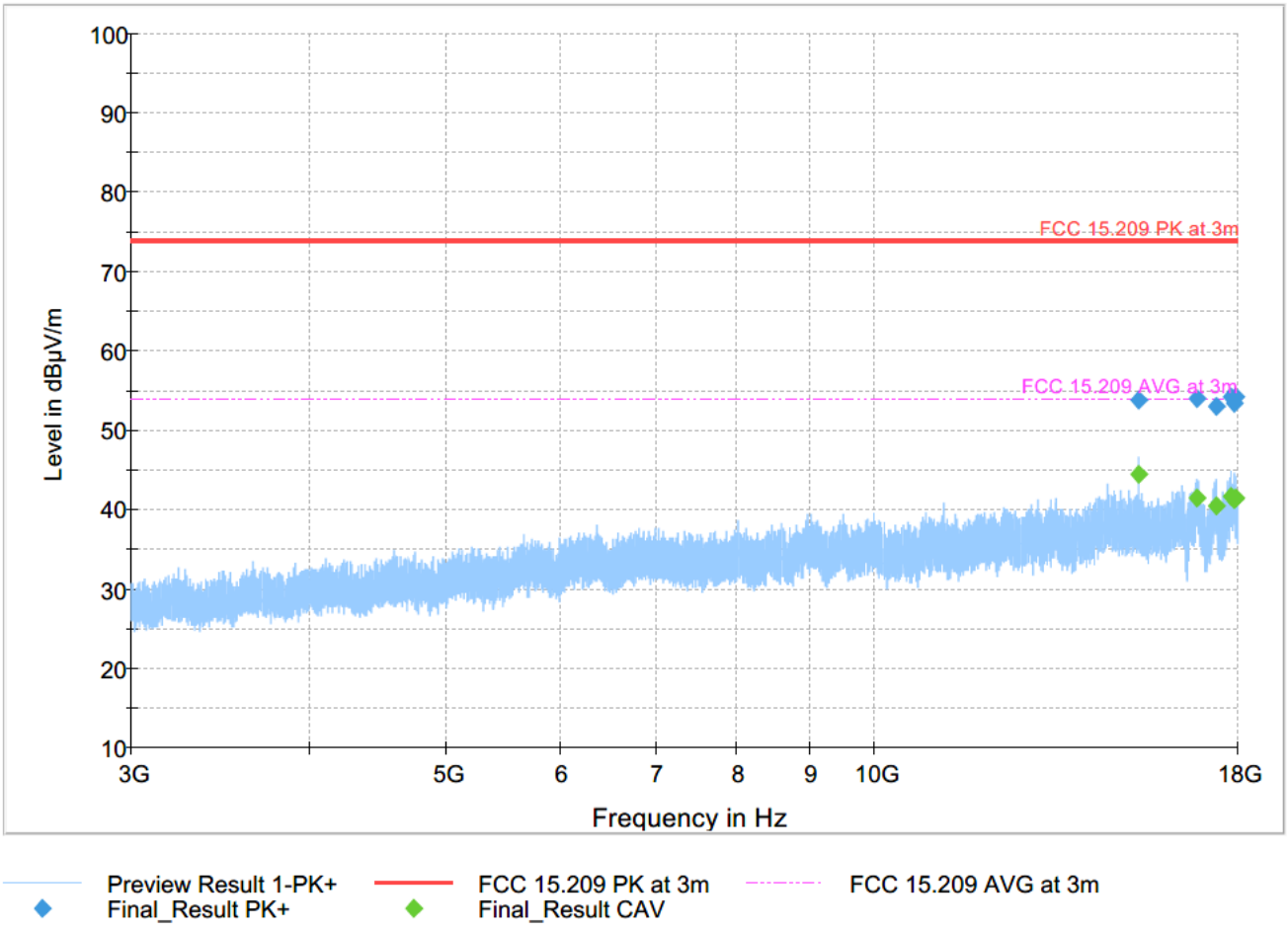
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2907.700	---	32.68	53.98	21.30	500.0	1000.000	194.0	H	90.0	34.9	
2907.700	45.29	---	73.98	28.69	500.0	1000.000	194.0	H	90.0	34.9	



Plot # 43 Unwanted Emissions: 3 - 18 GHz

Final_Result

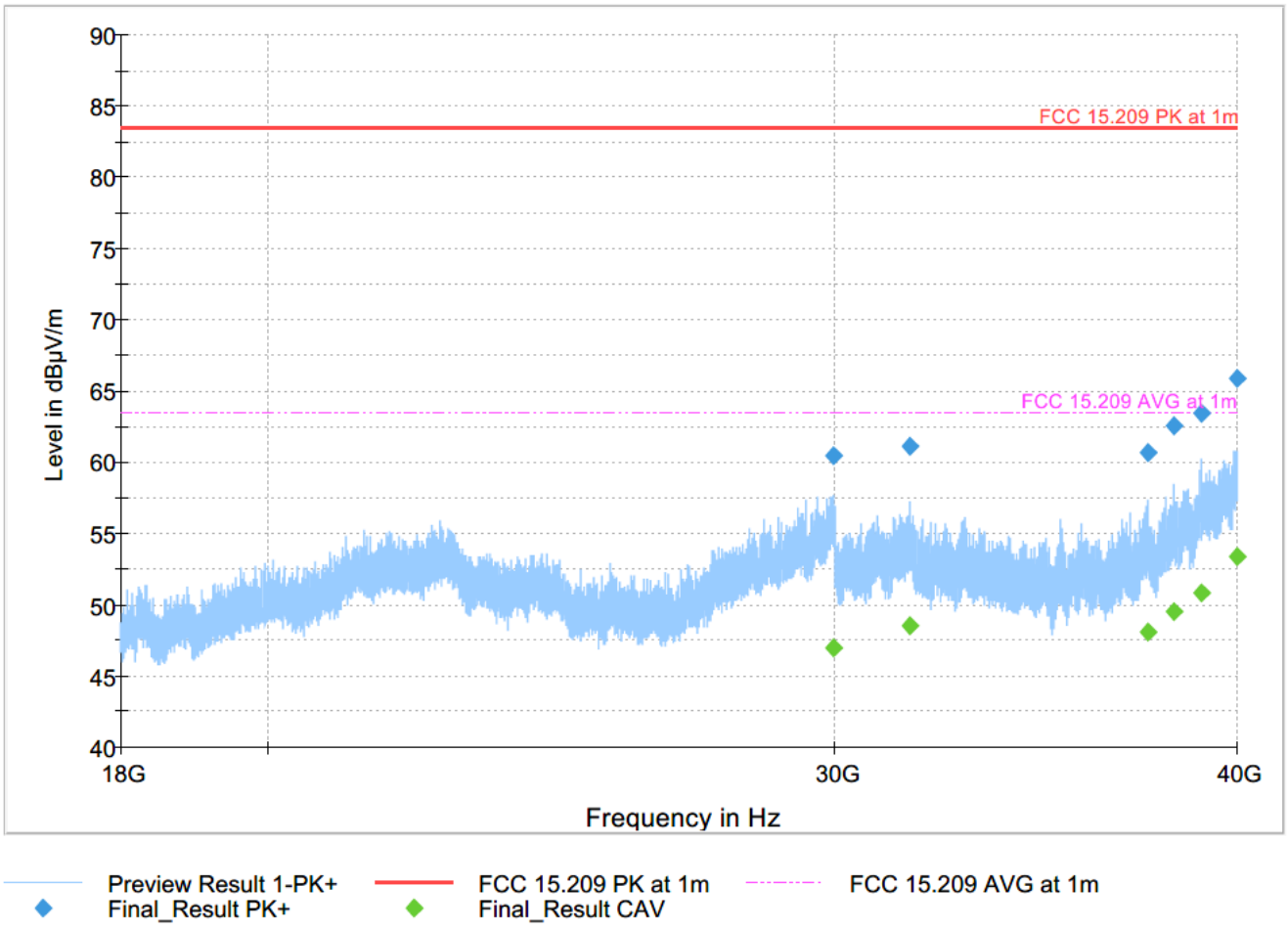
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
15317.250	---	44.51	53.98	9.47	500.0	1000.000	146.0	H	12.0	10.3	
15317.250	53.89	---	73.98	20.09	500.0	1000.000	146.0	H	12.0	10.3	
16857.750	54.04	---	73.98	19.94	500.0	1000.000	228.0	V	158.0	14.3	
16857.750	---	41.50	53.98	12.48	500.0	1000.000	228.0	V	158.0	14.3	
17388.300	---	40.51	53.98	13.47	500.0	1000.000	191.0	H	316.0	16.0	
17388.300	53.01	---	73.98	20.97	500.0	1000.000	191.0	H	316.0	16.0	
17808.500	---	41.75	53.98	12.23	500.0	1000.000	239.0	V	317.0	17.8	
17808.500	54.28	---	73.98	19.70	500.0	1000.000	239.0	V	317.0	17.8	
17882.950	53.47	---	73.98	20.51	500.0	1000.000	136.0	V	115.0	18.2	
17882.950	---	41.23	53.98	12.75	500.0	1000.000	136.0	V	115.0	18.2	
17931.500	---	41.39	53.98	12.59	500.0	1000.000	237.0	H	53.0	17.8	
17931.500	54.28	---	73.98	19.70	500.0	1000.000	237.0	H	53.0	17.8	



Plot # 44 Unwanted Emissions: 18-40 GHz

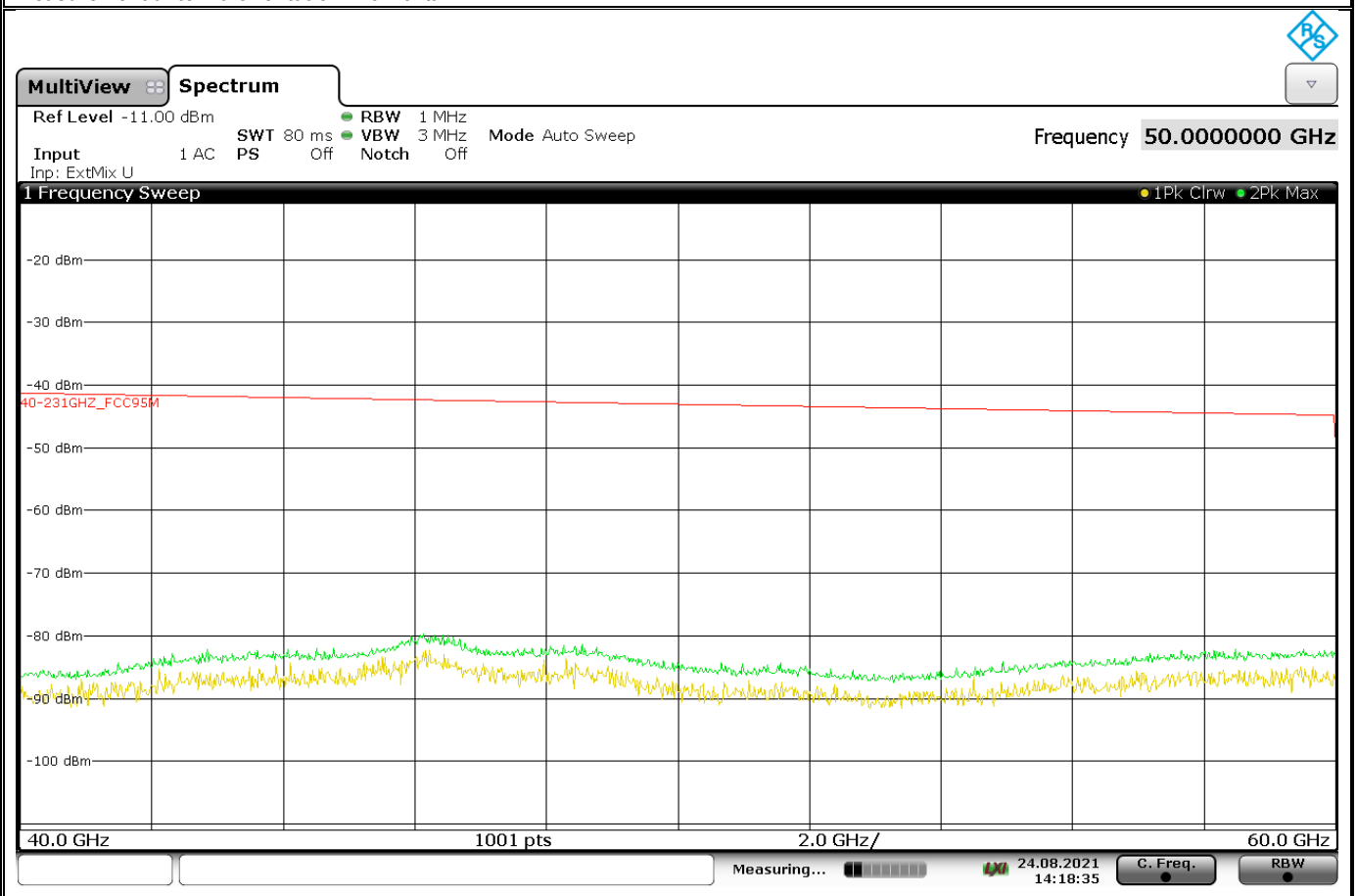
Final_Result

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)	Comment
29979.000	---	46.95	63.50	16.55	500.0	1000.000	150.0	H	211.0	23.0	
29979.000	60.41	---	83.50	23.09	500.0	1000.000	150.0	H	211.0	23.0	
31642.813	61.10	---	83.50	22.40	500.0	1000.000	150.0	H	-88.0	23.2	
31642.813	---	48.52	63.50	14.98	500.0	1000.000	150.0	H	-88.0	23.2	
37511.875	---	48.03	63.50	15.47	500.0	1000.000	150.0	H	163.0	21.3	
37511.875	60.63	---	83.50	22.87	500.0	1000.000	150.0	H	163.0	21.3	
38214.375	62.55	---	83.50	20.95	500.0	1000.000	150.0	H	159.0	22.4	
38214.375	---	49.47	63.50	14.03	500.0	1000.000	150.0	H	159.0	22.4	
39010.000	63.44	---	83.50	20.06	500.0	1000.000	150.0	V	191.0	23.6	
39010.000	---	50.79	63.50	12.71	500.0	1000.000	150.0	V	191.0	23.6	
39995.625	65.94	---	83.50	17.56	500.0	1000.000	150.0	H	-13.0	25.0	
39995.625	---	53.34	63.50	10.16	500.0	1000.000	150.0	H	-13.0	25.0	



Plot # 45 Unwanted Emissions: 40 - 60 GHz

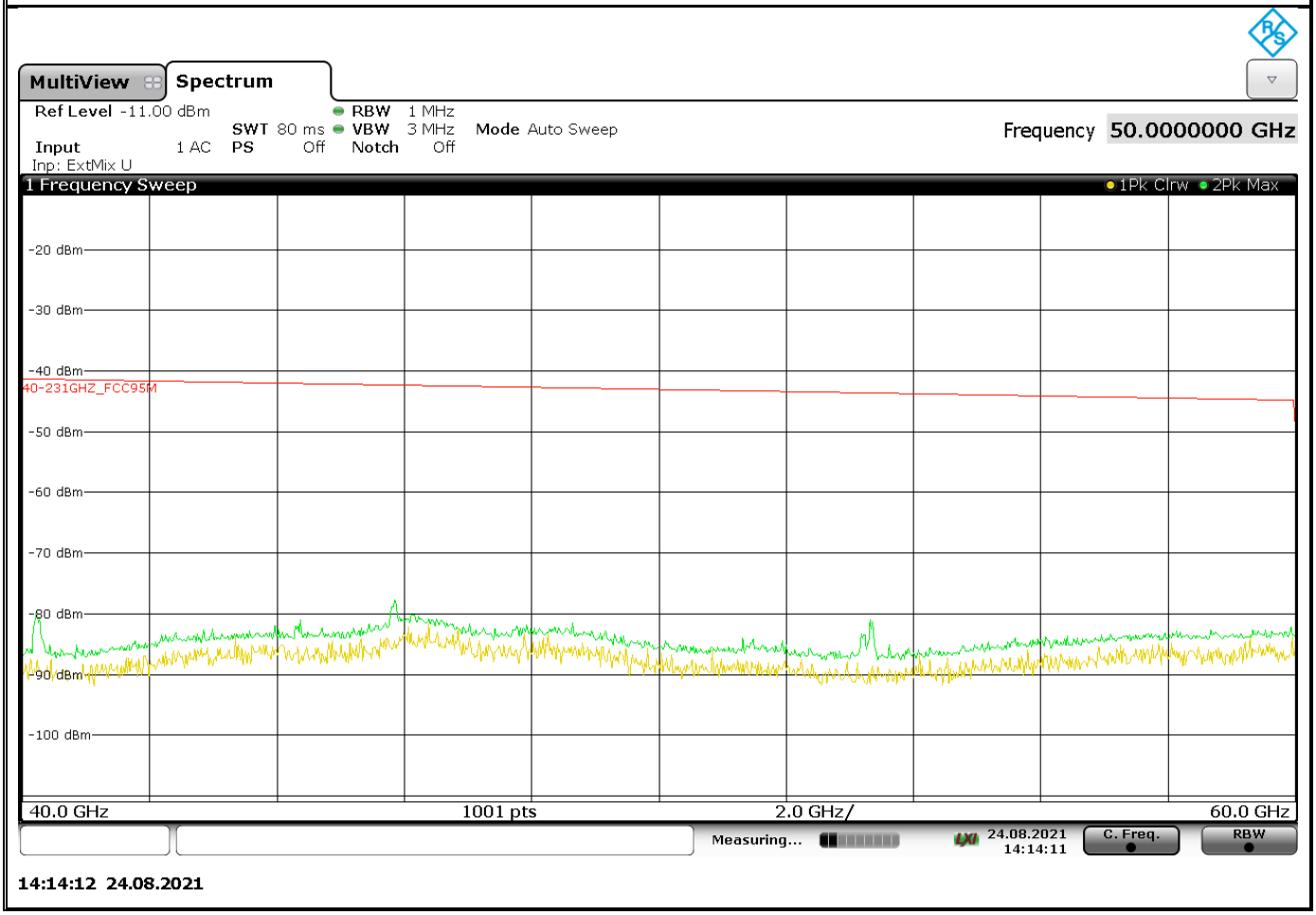
Measurement antenna orientation: Horizontal



14:18:36 24.08.2021

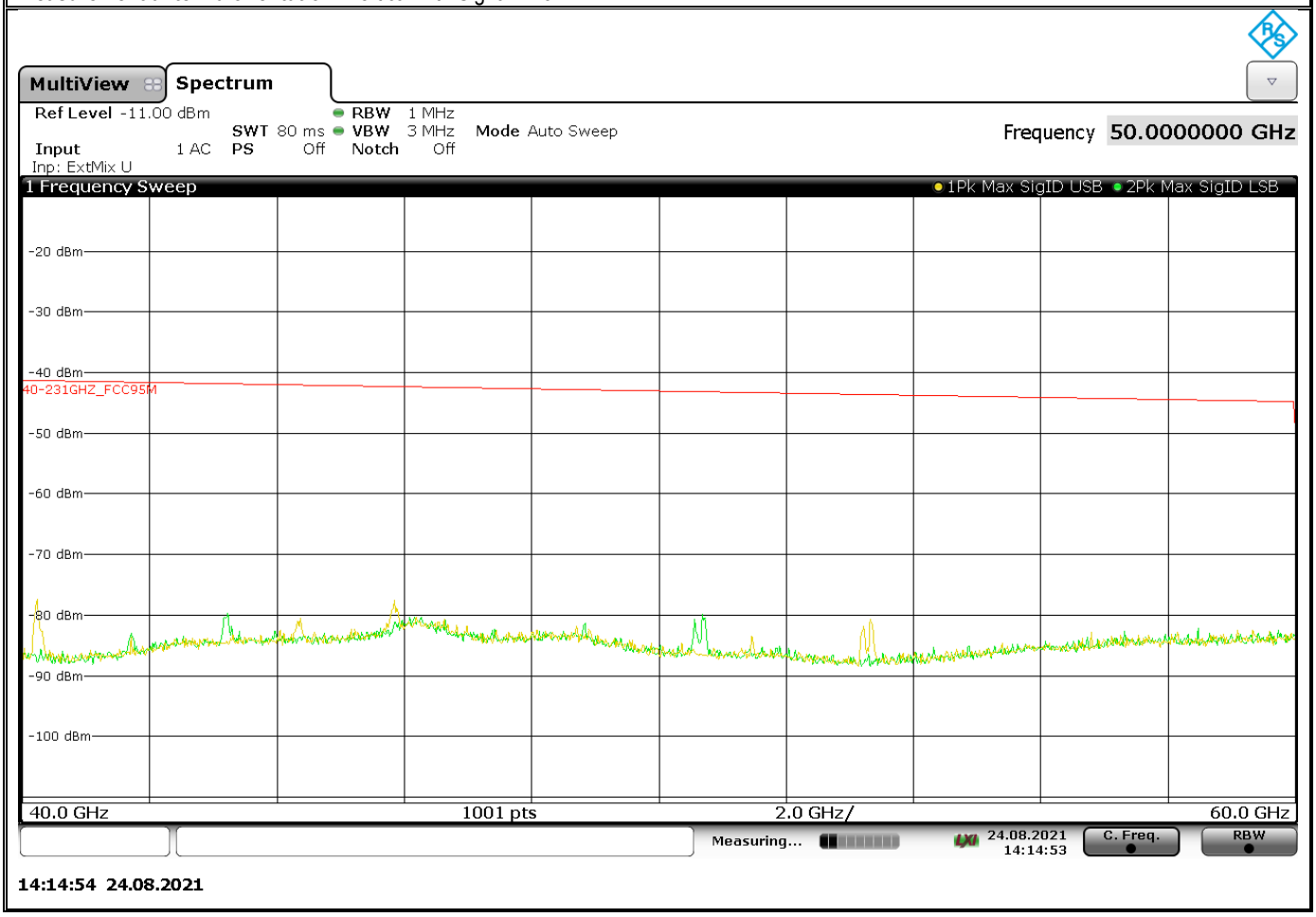
Plot # 46 Unwanted Emissions: 40 - 60 GHz

Measurement antenna orientation: Vertical



Plot # 47 Unwanted Emissions: 40 - 60 GHz

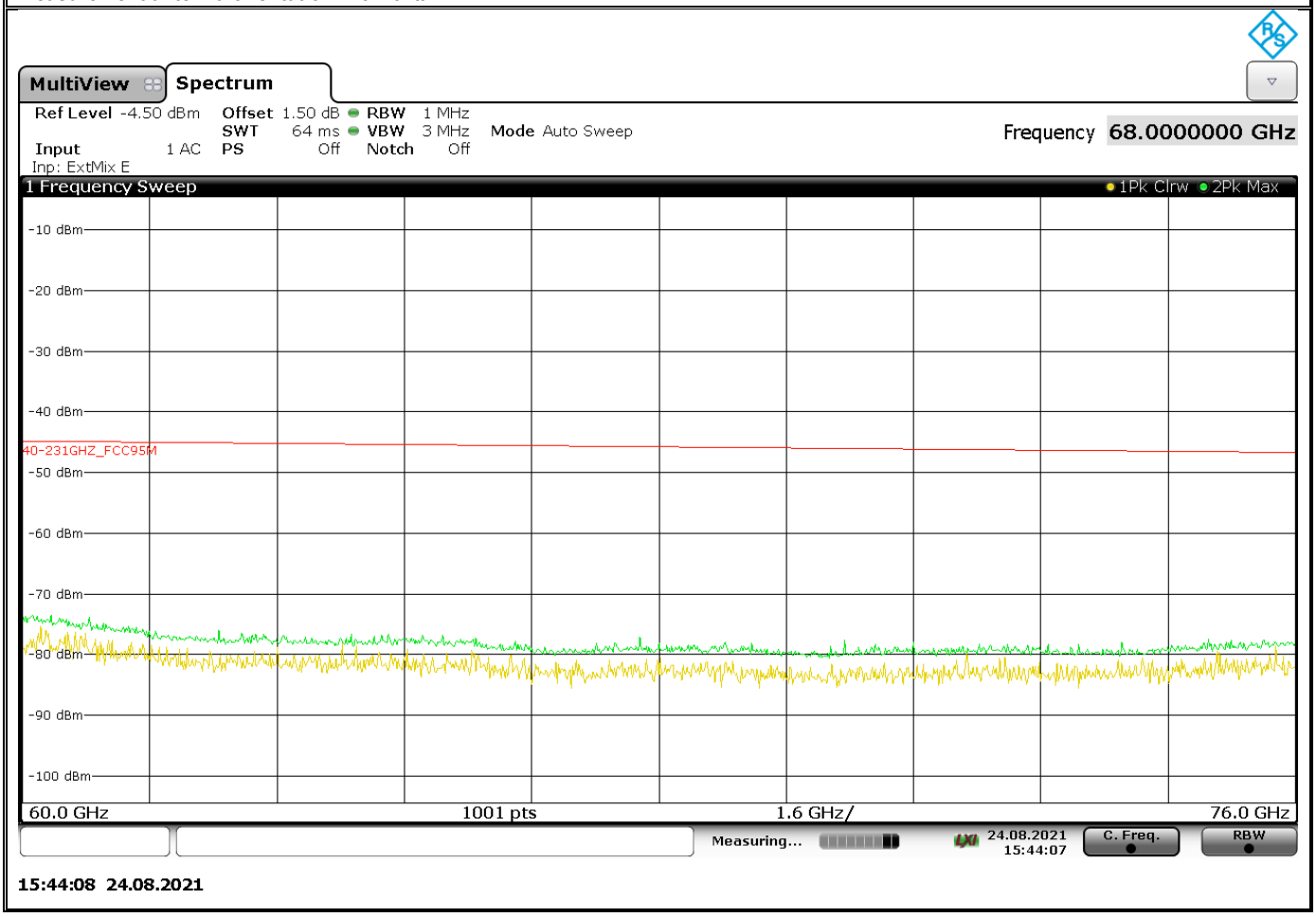
Measurement antenna orientation: Vertical with Signal ID on



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 # 48 Unwanted Emissions: 60 - 76 GHz

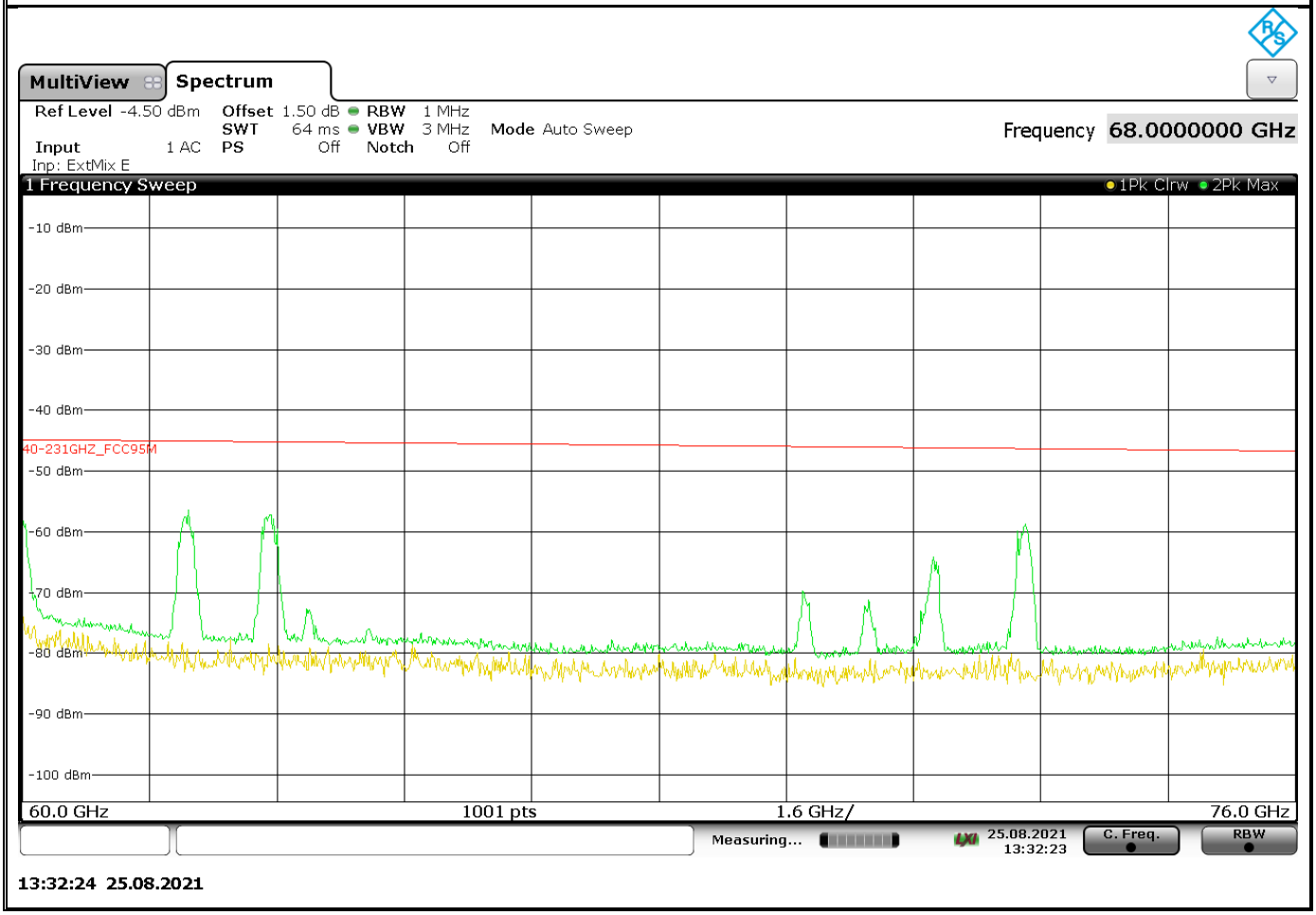
Measurement antenna orientation: Horizontal



15:44:08 24.08.2021

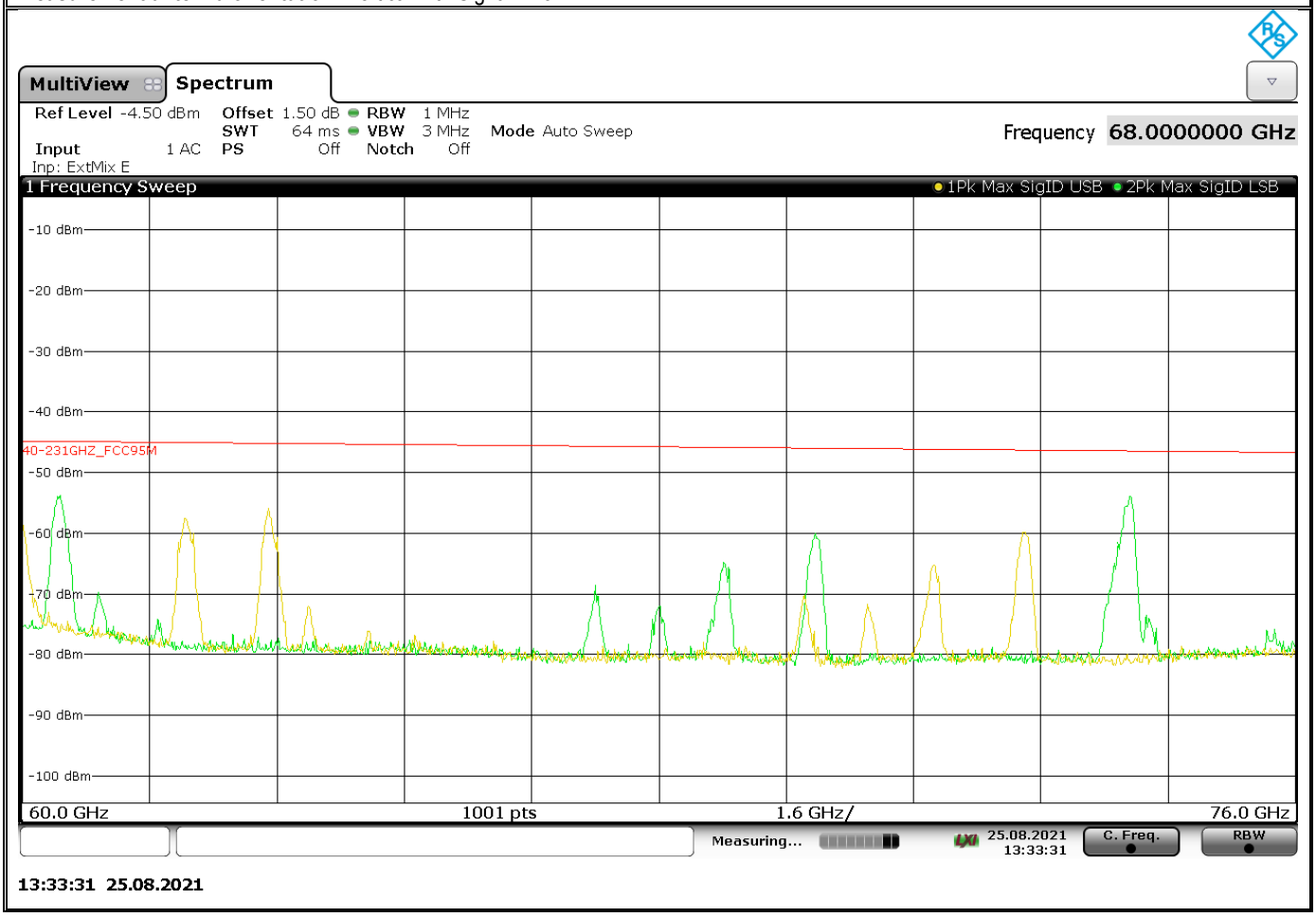
Plot # 49 Unwanted Emissions: 60 - 76 GHz

Measurement antenna orientation: Vertical



Plot # 50 Unwanted Emissions: 60 - 76 GHz

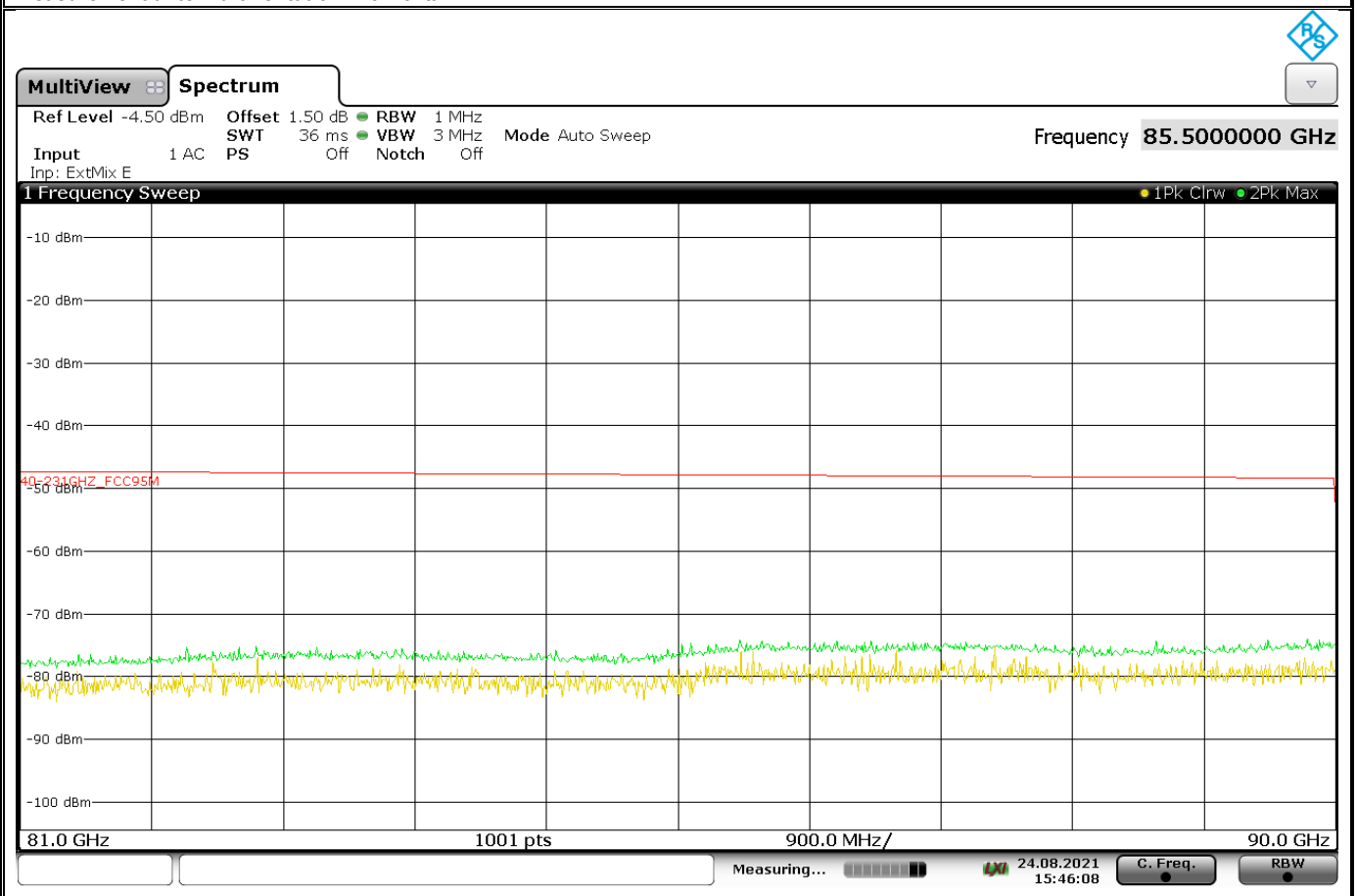
Measurement antenna orientation: Vertical with Signal ID on



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.

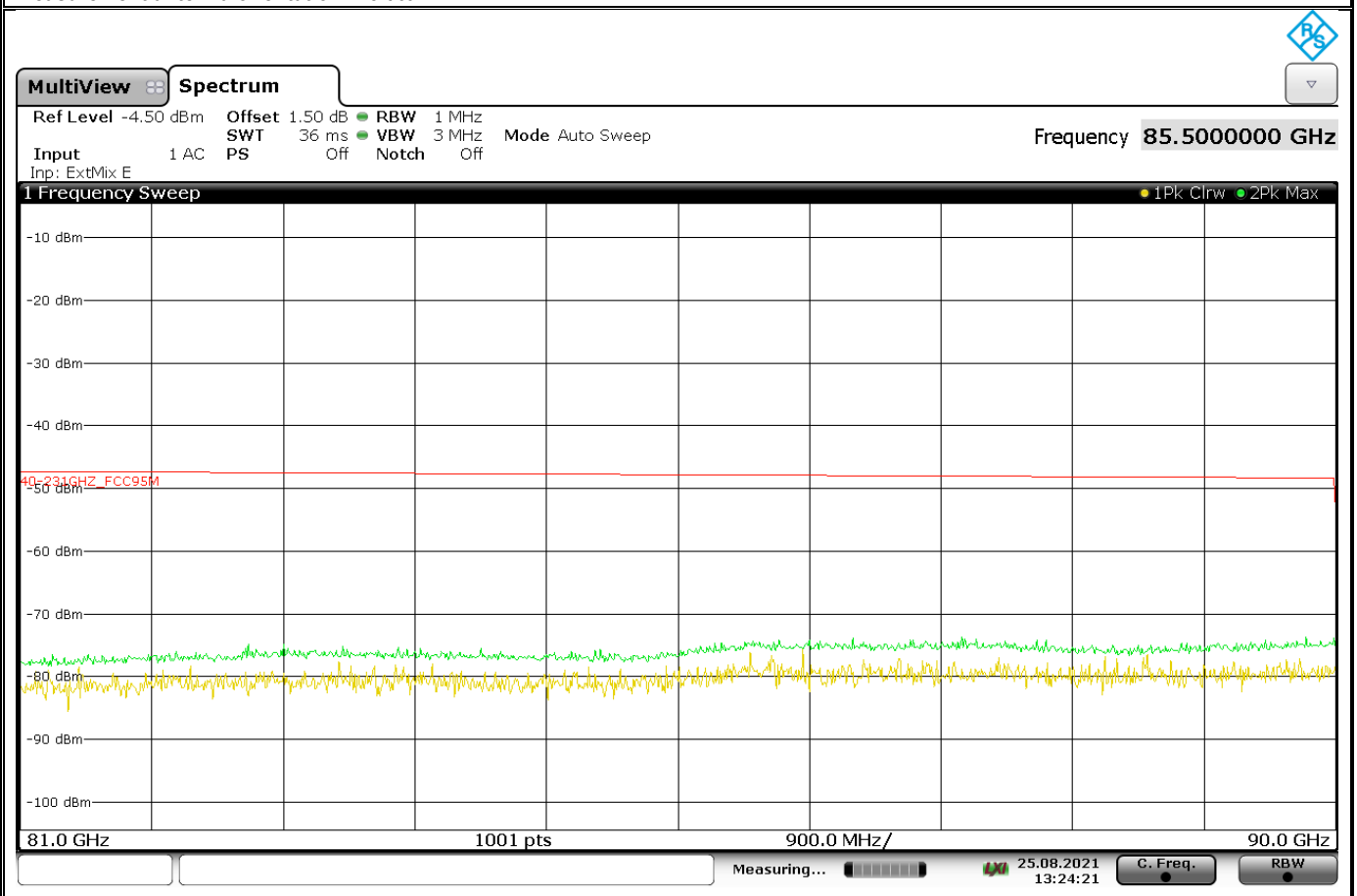
Plot # 51 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Horizontal



Plot # 52 Unwanted Emissions: 81 - 90 GHz

Measurement antenna orientation: Vertical



9 Test setup photos

Setup photos are included in supporting file name: "EMC_UHNDE_008_20001_C2PC_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	10/30/2020
Biconlog Antenna	EMCO	3142E	166067	3 years	03/12/2020
Horn Antenna	EMCO	3115	35114	3 years	08/10/2020
Horn Antenna	ETS Lindgren	3117-PA	215984	3 years	01/31/2021
Horn Antenna	ETS Lindgren	3116C-PA	169535	3 years	09/23/2020
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
Compact Digital Barometer	Control Company	D4540001	130070752	3 Years	04/13/2020

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
2021-09-17	EMC_UHNDE_008_21001_C2PC	Initial Version	Yuchan Lu

<<< The End >>>