FCC / ISED Test Report

For:

FreeFall 5G, Inc.

Model Name:

FF5GAAS001BC

Product Description:

FreeStar5G Advanced Antenna System

FCC ID: 2AY36- FF5GAAS001BC

Applied Rules and Standards:
47 CFR Part 30

REPORT #: EMC_FREEF-002-21001_FCC_30_Rev2

DATE: 2021-09-09

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 30 of Title 47 of the Code of Federal Regulations.

No deviations were ascertained.

Company	Description	Model #
FreeFall 5G, Inc.	FreeStar5G Advanced Antenna System	FF5GAAS001BC

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2021-09-09	Compliance	Kevin Wang (EMC Lab Manager)	kevin.wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2021.09.09 18:20:56 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
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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
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EMC Lab Manager:	Kevin Wang
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	FreeFall 5G, Inc.
Street Address:	3525 E. Fort Lowell Road
City/Zip Code	Tucson, Arizona / 85716
Country	United States

2.3 Identification of the Manufacturer

Manufacturer's Name:	ED2 Corporation
Manufacturers Address:	7636 N. Oracle Road
City/Zip Code	Tucson, Arizona / 85704
Country	United States

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	FF5GAAS001BC
HW Version :	Version 1.0
SW Version :	Version 1.0
FCC-ID :	2AY36- FF5GAAS001BC
Product Description:	FreeStar5G Advanced Antenna System. The antenna system is comprised of a Switch Matrix CCA and 16 Stack assemblies. For FCC (Federal Communications Commission) test, only a single stack was tested.
Frequency Range:	5G n261 band: 27.5 - 28.35 GHz
Antenna Information as declared:	Maximum Gain: 18 dBi
Max EIRP Density:	Average measurement: 41.14 dBm/100MHz
Power Supply/ Rated Operating Voltage Range:	Vnom: 120 VAC
Operating Temperature Range	-40ºC to 55 ºC
Sample Revision	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	DAS #011	Version 1.0	Version 1.0	Only one Stack Assembly was mounted on Advanced Antenna System Base.

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Vector Signal Generator	SMW200A	R&S	1412.0000K02-103919-Sc

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using a signal generator. And a software, ED2 DAS Control, was used to control the antenna system.
2	EUT#1	Only the Advanced Antenna System Base was used. This setup is only used for Frequency Stability test.

3.5 Justification for Worst Case Mode of Operation

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

The following Signal Generator settings were used:

For single input source at Radio1(Vertical) or Radio8(Horizontal):

Power Level (dBm)	Modulation	Baseband Frequency (GHz)	Output Frequency (GHz)	BW	RB
-5.5	QPSK	3.125	27.525	50MHz	1RB
					Full RB
		3.3	27.7	400MHz	1RB
					Full RB
	16QAM	3.125	27.525	50MHz	1RB
					Full RB
		3.3	27.7	400MHz	1RB
					Full RB
	64QAM	3.125	27.525	50MHz	1RB
					Full RB
		3.3	27.7	400MHz	1RB
					Full RB
	256QAM	3.125	27.525	50MHz	1RB
					Full RB
		3.3	27.7	400MHz	1RB
					Full RB
	QPSK	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	16QAM	3.525	27.925	50MHz	1RB

					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	64QAM	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	256QAM	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	QPSK	3.925	28.325	50MHz	1RB
					Full RB
		3.75	28.15	400MHz	1RB
					Full RB
	16QAM	3.925	28.325	50MHz	1RB
					Full RB
		3.75	28.15	400MHz	1RB
					Full RB
	64QAM	3.925	28.325	50MHz	1RB
					Full RB
		3.75	28.15	400MHz	1RB
					Full RB
	256QAM	3.925	28.325	50MHz	1RB
					Full RB
		3.75	28.15	400MHz	1RB
					Full RB

For two input sources both at Radio1(Vertical) and Radio8(Horizontal), a splitter was used:

Power Level (dBm)	Modulation	Baseband Frequency (GHz)	Output Frequency (GHz)	BW	RB
-2.1dBm	QPSK	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	100MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	16QAM	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	100MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB

					Full RB
	64QAM	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	100MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB
	256QAM	3.525	27.925	50MHz	1RB
					Full RB
		3.525	27.925	100MHz	1RB
					Full RB
		3.525	27.925	400MHz	1RB
					Full RB

Note: the splitter has 3.4dB loss and the signal generator power level is -2.1dBm. Then power level to each port is -2.1-3.4=-5.5dBm, still the same input power level.

4 Subject of Investigation

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 30 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under
FCC ID: 2AY36- FF5GAAS001BC

5 Measurement Results Summary

5.1 Test Specification Results Summary Table

Test Specification	Test Case	Temperature and Voltage Conditions	Set-up	Pass	NA	NP	Result
§2.1055	Frequency Stability	Extreme Condition	#2	■	☐	☐	Complies
§30.202	E.I.R.P Density	Nominal	#1	■	☐	☐	Complies
§2.1049	99% Bandwidth	Nominal	#1	■	☐	☐	Complies
§2.1051 §30.203	Out-of-Band Emission at Band Edges	Nominal	#1	■	☐	☐	Complies
§2.1051 §30.203	Out-of-Band Emission Spurious Emissions	Nominal	#1	■	☐	☐	Complies

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

5.2 Emissions Summary

Based on the test results achieved and the understood operation of devices in the n261 microwave band per 3GPP TS 38.104 version 15.14.0 Release 15 the following emissions were selected to appropriately represent the device.

FCC Part	Freq. Range MHz	PD / 100 MHz	Tolerance	Designator
30	27500.0 - 28350.0	11.83	0.86 PM	97M8G7D
30	27500.0 - 28350.0	11.86	0.86 PM	95M5W7D
30	27500.0 - 28350.0	3.22	0.86 PM	391MG7D
30	27500.0 - 28350.0	3.26	0.86 PM	382MW7D

The single RB results achieved with this BSS were not included above. A 1RB emission is not an expected scenario, with a standard 3GGP 5G deployment. The 100 MHz BW emissions were derived from the measure 400 MHz emissions.

5.3 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)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)

RF conducted measurement	±0.5 dB

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 always used when the EUT comes closer than 3 dB to the limit.

5.4 Environmental Conditions During Testing:

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

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

5.5 Dates of Testing:

04/30/2021 – 05/12/2021

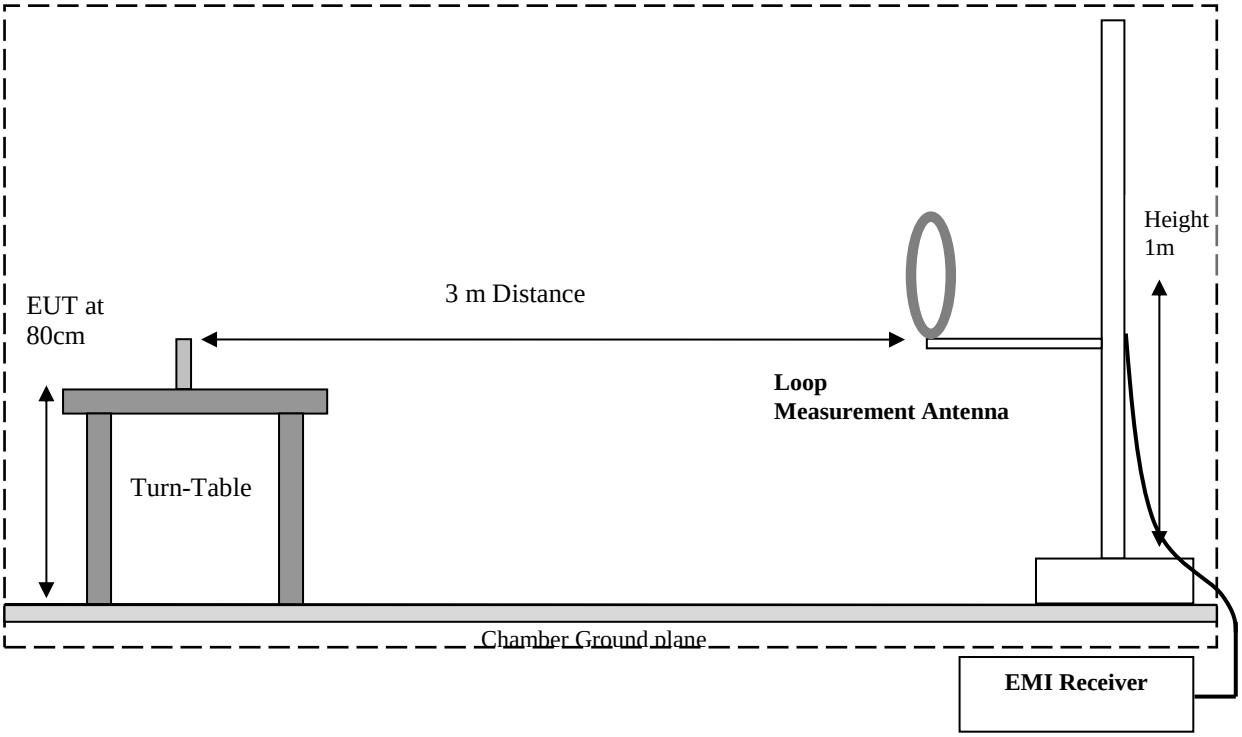
6 Measurement Procedures

6.1 Radiated Measurement

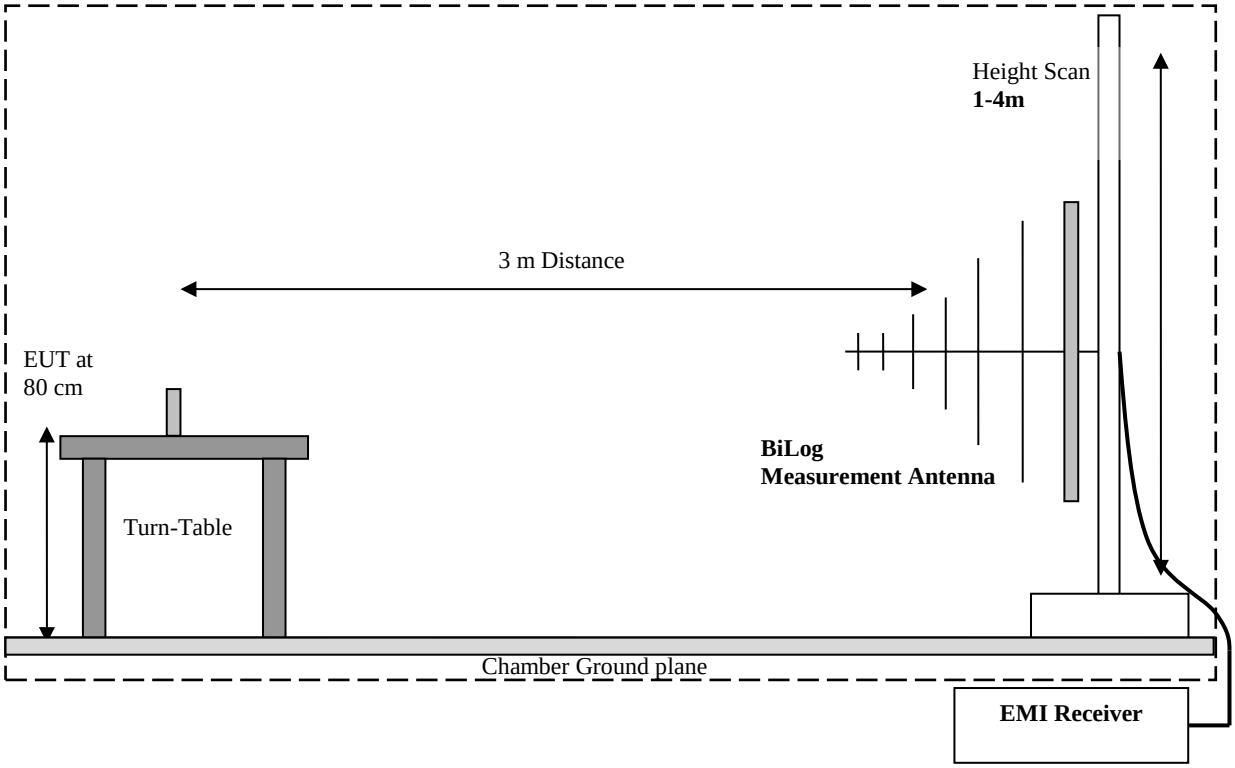
The radiated measurement is performed according to ANSI C63.26 (2015)

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

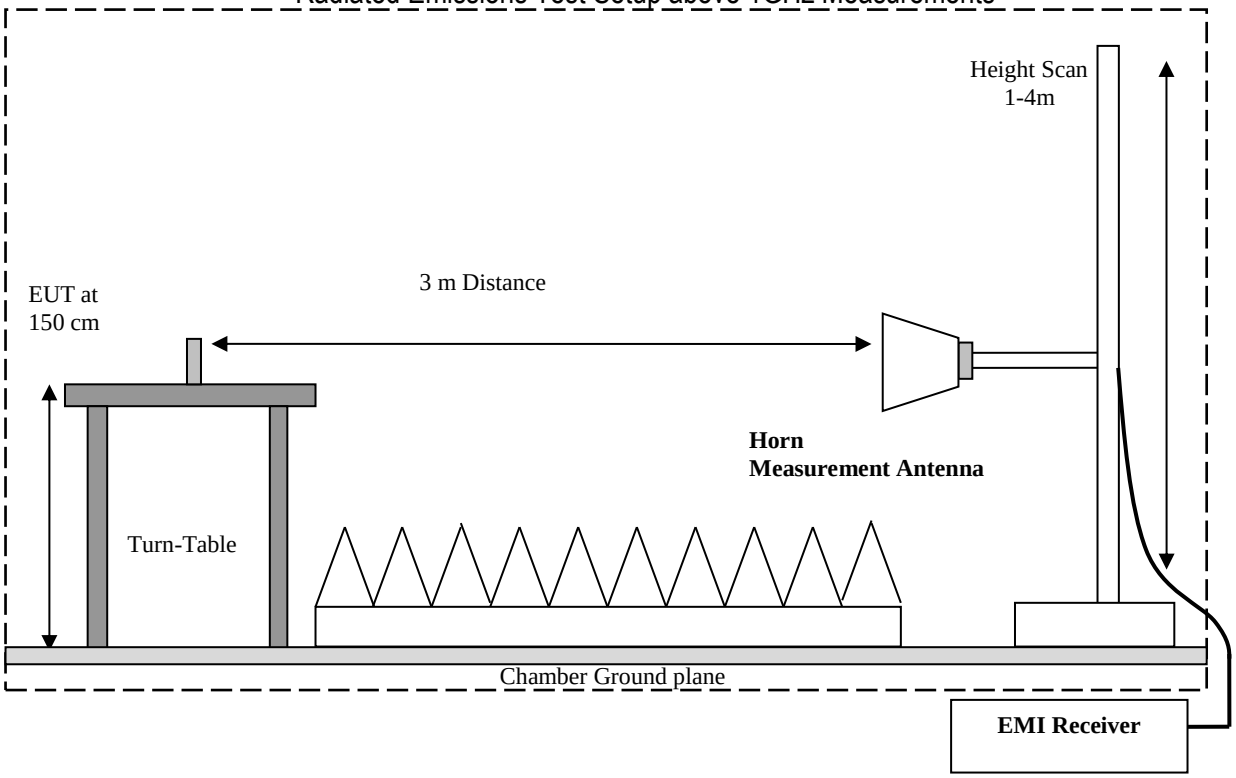
Radiated Emissions Test Setup below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



6.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

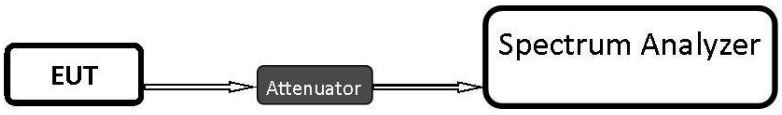
FS (dBµV/m) = Measured Value on SA (dBµV) + Cable Loss (dB) + Antenna Factor (dB/m)

Example:

Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

6.2 RF Conducted Measurement Procedure

Testing procedures are based on ANSI C63.26 – "American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Devices", by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

7 Test Result Data

7.1 Frequency Stability

7.1.1 Measurement according to FCC §2.1055, and ANSI C63.26 (2015)

Refer to FCC §2.1055:

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

7.1.2 Limits:

N/A

7.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain
23.8°C	2	110 VAC	18dBi

7.1.4 Measurement result:

Temperature Variation @110 VAC:

Temperature (°C)	Frequency (MHz)	Measured Frequency (MHz)	Deviation (MHz)	Deviation (ppm)	Limit
-40	100	100.0000497	0.0000497	0.50	-
-30	100	100.0000545	0.0000545	0.54	-
-20	100	100.0000849	0.0000849	0.85	-
-10	100	100.0000865	0.0000865	0.87	-
0	100	100.0000817	0.0000817	0.82	-
10	100	100.0000785	0.0000785	0.79	-
20	100	100.0000849	0.0000849	0.85	-
30	100	100.0000929	0.0000929	0.93	-
40	100	100.0000978	0.0000978	0.98	-
50	100	100.0000978	0.0000978	0.98	-
55	100	100.0000946	0.0000946	0.95	-

Supply Voltage Variation @25°C:

Voltage (V)	Frequency (MHz)	Measured Frequency (MHz)	Deviation (MHz)	Deviation (ppm)	Limit
93.5	100	100.0000865	0.0000865	0.87	-
110	100	100.0000849	0.0000849	0.85	-
126.5	100	100.0000881	0.0000881	0.88	-

Based on a frequency stability value of 0.007 PPM for R&S Base station Simulator derived from P.10 of VECTOR SIGNAL GENERATOR Specifications Version 15.00, May 2021 a frequency stability value of this overall system is calculated as 0.86 PPM

7.2 E.I.R.P Density

7.2.1 Measurement according to ANSI C63.26-2015 Section 5.2.4.4.1

- Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
- RBW = 1-5% of the expected OBW
- VBW >= 3 * RBW
- Span = 2 * to 3 * the OBW
- Detector = RMS
- Trigger is set to "free run"
- Trace mode = trace averaging (RMS) over 100 sweeps
- Allow trace to fully stabilize.

7.2.2 Limits:

FCC §30.202 Power Limit

(a) For fixed and base stations operating in connection with mobile systems, the average power of the sum of all antenna elements is limited to an equivalent isotopically radiated power (EIRP) density of +75dBm/100 MHz. For channel bandwidths less than 100 megahertz the EIRP must be reduced proportionally and linearly based on the bandwidth relative to 100 megahertz.
(b) For mobile stations, the average power of the sum of all antenna elements is limited to a maximum EIRP of +43 dBm.
(c) For transportable stations, as defined in §30.2, the average power of the sum of all antenna elements is limited to a maximum EIRP of +55 dBm.
(d) For fixed point-to-point and point-to-multipoint limits see §30.405.

7.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain
23.8°C	1	110 VAC	18dBi

7.2.4 Measurement result:

Tested with only one port (H/V) input:

Bands	Modulation	Baseband Frequency (GHz)	Output Frequency (GHz)	BW	RB	Measured Power Density (dBm/100MHz)		Corrected Power Density (dBm/100MHz)		Total Power Density (dBm/100MHz)	Limit (dBm/100MHz)
						H-Pol	V-Pol	H-Pol	V-Pol		
Low	QPSK	3.125	27.525	50MHz	1RB	-25.2	-27.23	34.3	32.27	36.41	75
					Full RB	-24.66	-27.03	34.84	32.47	36.83	75
		3.3	27.7	400MHz	1RB	-25.38	-24.95	34.12	34.55	37.35	75
					Full RB	-30.58	-30.52	28.92	28.98	31.96	75
	16QAM	3.125	27.525	50MHz	1RB	-25.22	-27.26	34.28	32.24	36.39	75
					Full RB	-24.63	-27.01	34.87	32.49	36.85	75
		3.3	27.7	400MHz	1RB	-25.33	-24.88	34.17	34.62	37.41	75
					Full RB	-30.56	-30.44	28.94	29.06	32.01	75
	64QAM	3.125	27.525	50MHz	1RB	-25.15	-27.3	34.35	32.2	36.42	75
					Full RB	-24.61	-26.12	34.89	33.38	37.21	75
		3.3	27.7	400MHz	1RB	-25.23	-24.85	34.27	34.65	37.47	75
					Full RB	-30.55	-30.42	28.95	29.08	32.03	75
	256QAM	3.125	27.525	50MHz	1RB	-25.11	-27.27	34.39	32.23	36.45	75
					Full RB	-24.6	-26.08	34.9	33.42	37.23	75
		3.3	27.7	400MHz	1RB	-25.31	-25.11	34.19	34.39	37.30	75
					Full RB	-30.52	-30.39	28.98	29.11	32.06	75
Mid	QPSK	3.525	27.925	50MHz	1RB	-26.7	-19.4	32.8	40.1	40.84	75
					Full RB	-26.5	-19.14	33	40.36	41.09	75
		3.525	27.925	400MHz	1RB	-26.8	-19.38	32.7	40.12	40.84	75
					Full RB	-32.36	-25.18	27.14	34.32	35.08	75
	16QAM	3.525	27.925	50MHz	1RB	-26.66	-19.39	32.84	40.11	40.86	75
					Full RB	-26.5	-19.14	33	40.36	41.09	75
		3.525	27.925	400MHz	1RB	-26.89	-19.31	32.61	40.19	40.89	75
					Full RB	-32.35	-25.16	27.15	34.34	35.10	75
	64QAM	3.525	27.925	50MHz	1RB	-26.6	-19.42	32.9	40.08	40.84	75
					Full RB	-26.49	-19.1	33.01	40.4	41.13	75
		3.525	27.925	400MHz	1RB	-26.79	-19.18	32.71	40.32	41.01	75
					Full RB	-32.31	-25.13	27.19	34.37	35.13	75
	256QAM	3.525	27.925	50MHz	1RB	-26.67	-19.46	32.83	40.04	40.80	75
					Full RB	-26.49	-19.08	33.01	40.42	**41.14**	75
		3.525	27.925	400MHz	1RB	-26.7	-19.22	32.8	40.28	40.99	75
					Full RB	-32.29	-25.13	27.21	34.37	35.13	75
High	QPSK	3.925	28.325	50MHz	1RB	-24.36	-21.53	35.14	37.97	39.79	75
					Full RB	-24.78	-21.59	34.72	37.91	39.61	75
		3.75	28.15	400MHz	1RB	-26.43	-22.69	33.07	36.81	38.34	75

					Full RB	-32.58	-28.45	26.92	31.05	32.47	75
	16QAM	3.925	28.325	50MHz	1RB	-24.36	-21.55	35.14	37.95	39.78	75
					Full RB	-24.73	-21.58	34.77	37.92	39.63	75
		3.75	28.15	400MHz	1RB	-26.54	-22.79	32.96	36.71	38.24	75
					Full RB	-32.58	-28.65	26.92	30.85	32.33	75
	64QAM	3.925	28.325	50MHz	1RB	-24.38	-21.59	35.12	37.91	39.75	75
					Full RB	-24.78	-21.6	34.72	37.9	39.61	75
		3.75	28.15	400MHz	1RB	-26.53	-22.66	32.97	36.84	38.33	75
					Full RB	-32.58	-28.58	26.92	30.92	32.38	75
	256QAM	3.925	28.325	50MHz	1RB	-24.4	-21.57	35.1	37.93	39.75	75
					Full RB	-24.74	-21.59	34.76	37.91	39.62	75
		3.75	28.15	400MHz	1RB	-26.77	-22.75	32.73	36.75	38.20	75
					Full RB	-32.56	-28.57	26.94	30.93	32.39	75

Note:
Correction Factor = FSPL + Cable loss – Ant Gain = 59.5dB
Tested at Signal Generator Power Level -5.5dBm

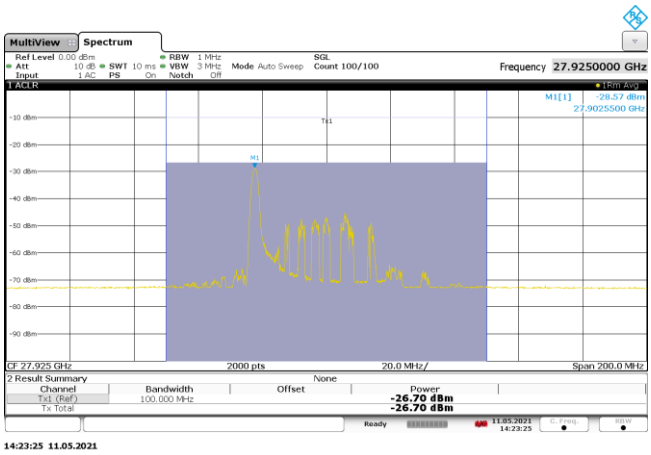
Tested with both antennas and two ports (H and V) input:

Bands	Modulation	Baseband Frequency (GHz)	Output Frequency (GHz)	BW	RB	Measured Power Density (dBm/100MHz)		Corrected Power Density (dBm/100MHz)		Total Power Density (dBm/100MHz)	Limit (dBm/100MHz)
						H-Pol	V-Pol	H-Pol	V-Pol		
Mid	QPSK	3.525	27.925	50MHz	1RB	-26.62	-19.96	32.88	39.54	40.39	75
					Full RB	-26.35	-19.63	33.15	39.87	40.71	75
		3.525	27.925	100MHz	1RB	-26.51	-20.68	32.99	38.82	39.83	75
					Full RB	-26.35	-19.6	33.15	39.9	40.73	75
		3.525	27.925	400MHz	1RB	-26.74	-19.76	32.76	39.74	40.53	75
					Full RB	-32.06	-25.46	27.44	34.04	34.90	75
	16QAM	3.525	27.925	50MHz	1RB	-26.6	-20.03	32.9	39.47	40.33	75
					Full RB	-26.32	-19.61	33.18	39.89	40.73	75
		3.525	27.925	100MHz	1RB	-26.55	-20.64	32.95	38.86	39.85	75
					Full RB	-26.35	-19.59	33.15	39.91	40.74	75
		3.525	27.925	400MHz	1RB	-25.85	-19.22	33.65	40.28	**41.13**	75
					Full RB	-32.1	-25.47	27.4	34.03	34.88	75
	64QAM	3.525	27.925	50MHz	1RB	-26.56	-20.05	32.94	39.45	40.33	75
					Full RB	-26.39	-19.64	33.11	39.86	40.69	75
		3.525	27.925	100MHz	1RB	-26.64	-20.57	32.86	38.93	39.89	75
					Full RB	-26.36	-19.61	33.14	39.89	40.72	75
		3.525	27.925	400MHz	1RB	-26.29	-19.58	33.21	39.92	40.76	75
					Full RB	-32.08	-25.48	27.42	34.02	34.88	75
	256QAM	3.525	27.925	50MHz	1RB	-26.68	-19.9	32.82	39.6	40.43	75
					Full RB	-26.3	-19.6	33.2	39.9	40.74	75
		3.525	27.925	100MHz	1RB	-26.72	-20.54	32.78	38.96	39.90	75
					Full RB	-26.34	-19.67	33.16	39.83	40.68	75
		3.525	27.925	400MHz	1RB	-26.52	-19.54	32.98	39.96	40.75	75
					Full RB	-32.08	-25.48	27.42	34.02	34.88	75

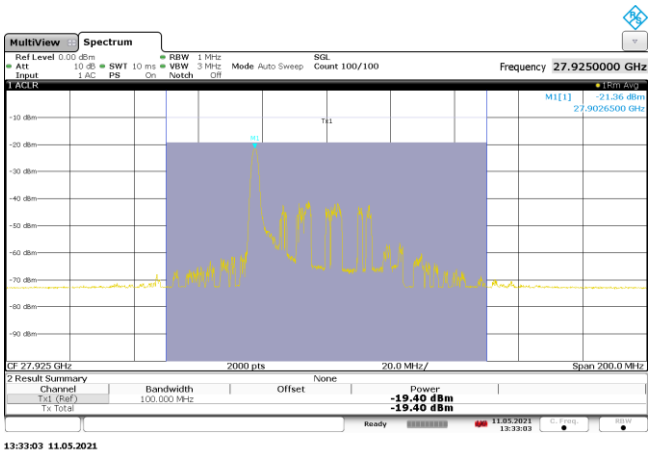
Comparing the above to the earlier results, it is noted that the actual contribution of the 2nd polarization to the overall measurement is negligible. As in the driving both the horizontal and vertical antenna inputs simultaneously to both antennas does not increase the measured power density.
Accounting for KDB 662911 it is noted that the antenna beams do not overlap as the antennas by design and as declared has 22.5° HPBW for Azimuth & Elevation.

7.2.5 Measurement Plots worst case only(Single input Mid CH):

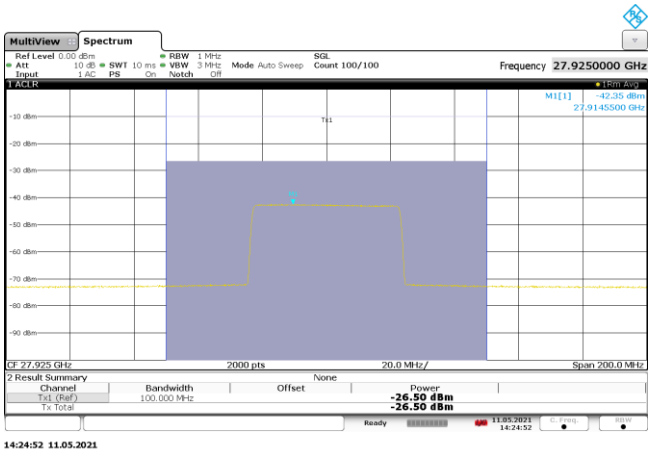
E.I.R.P Density - Mid CH			
H-Pol	QPSK	50MHz	1RB



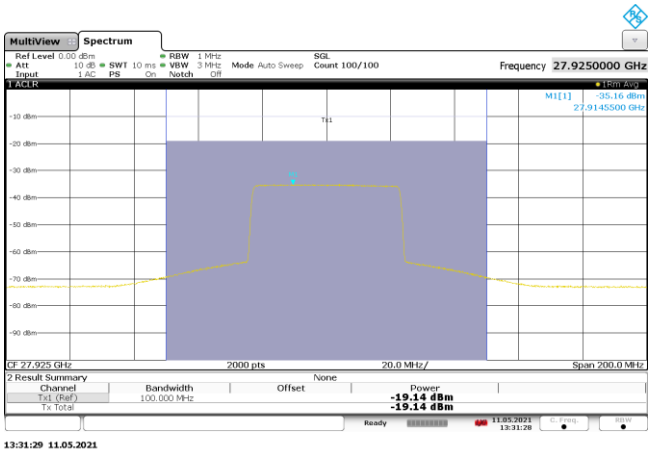
E.I.R.P Density - Mid CH			
V-Pol	QPSK	50MHz	1RB



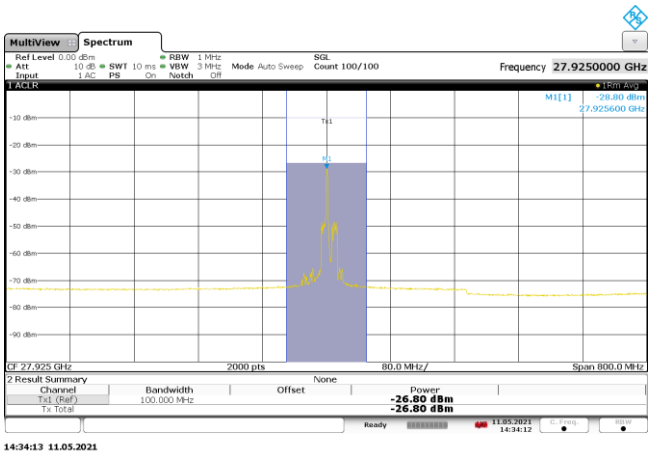
E.I.R.P Density - Mid CH			
H-Pol	QPSK	50MHz	Full RB



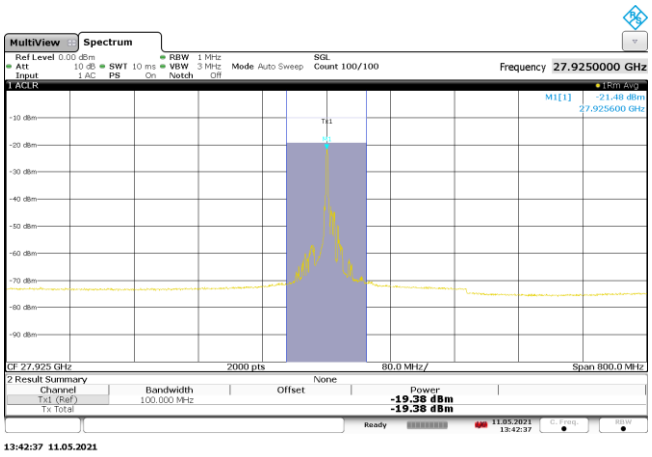
E.I.R.P Density - Mid CH			
V-Pol	QPSK	50MHz	Full RB



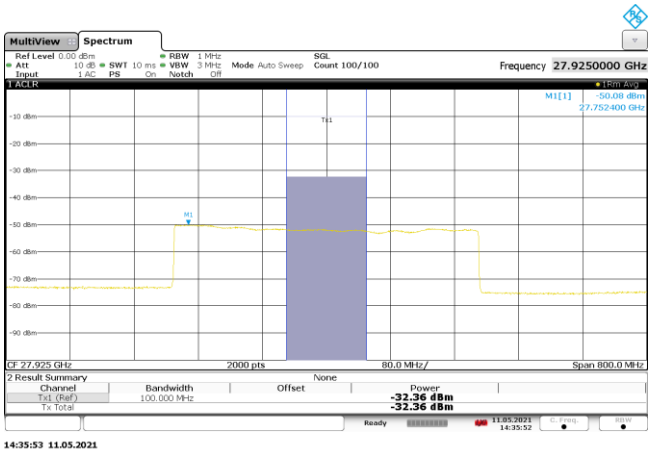
E.I.R.P Density - Mid CH			
H-Pol	QPSK	400MHz	1RB



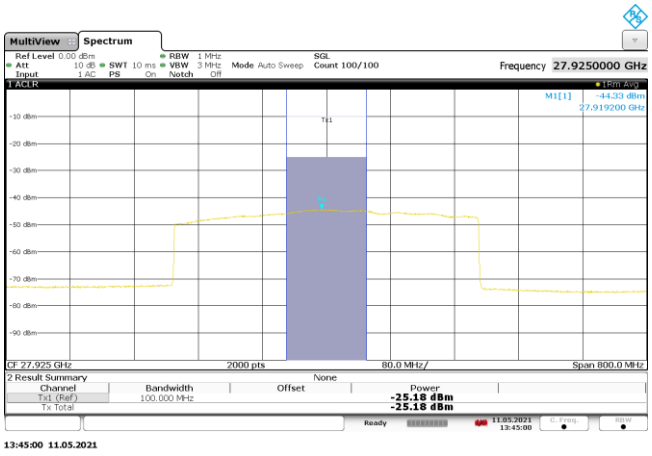
E.I.R.P Density - Mid CH			
V-Pol	QPSK	400MHz	1RB



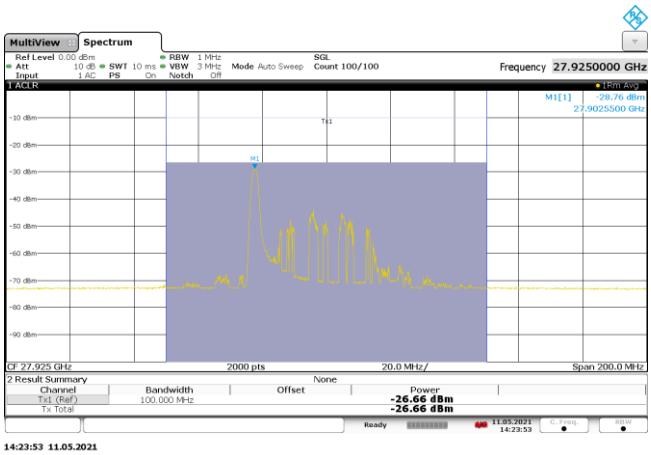
E.I.R.P Density - Mid CH			
H-Pol	QPSK	400MHz	Full RB



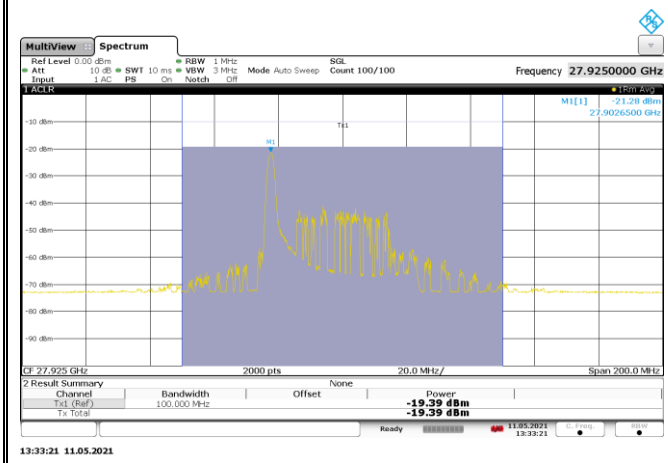
E.I.R.P Density - Mid CH			
V-Pol	QPSK	400MHz	Full RB



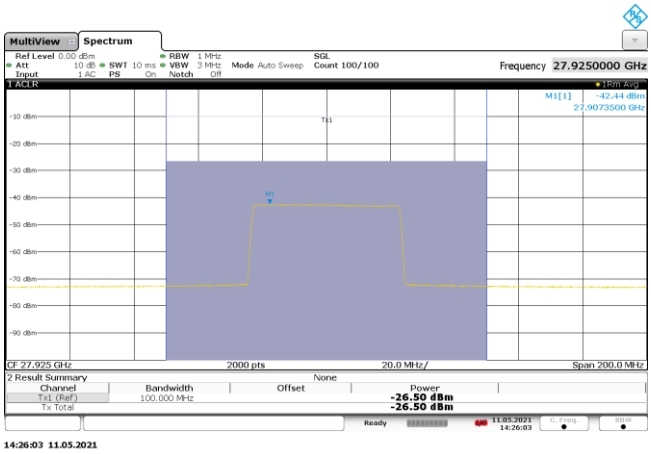
E.I.R.P Density - Mid CH			
H-Pol	16QAM	50MHz	1RB



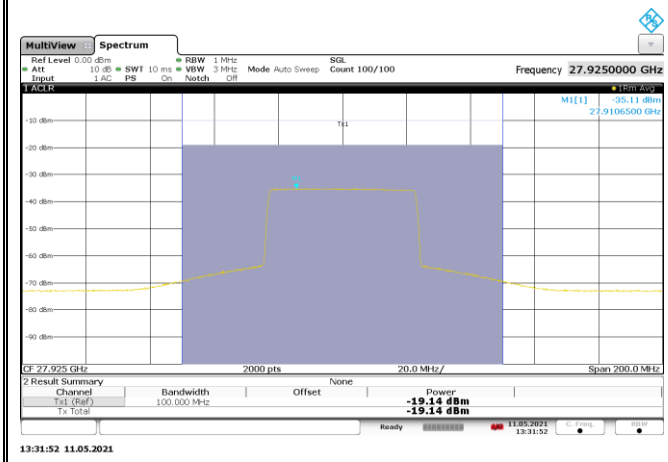
E.I.R.P Density - Mid CH			
V-Pol	16QAM	50MHz	1RB



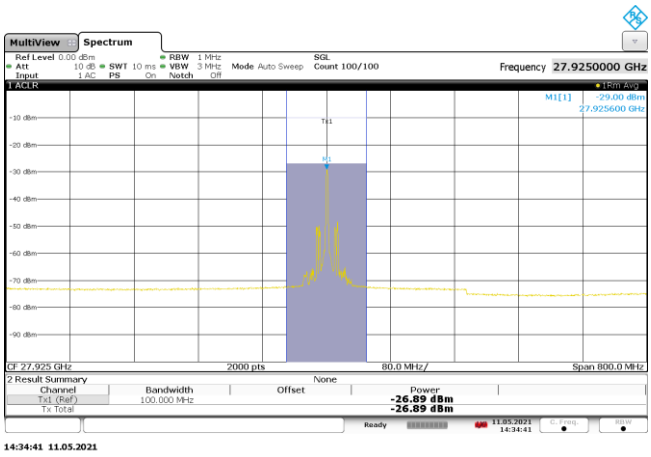
E.I.R.P Density - Mid CH			
H-Pol	16QAM	50MHz	Full RB



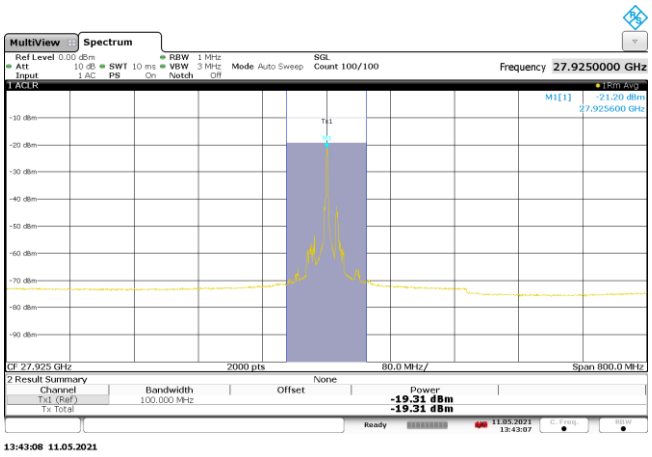
E.I.R.P Density - Mid CH			
V-Pol	16QAM	50MHz	Full RB



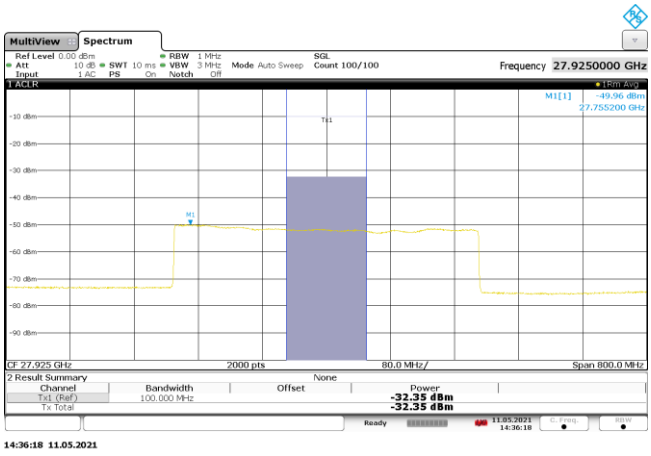
E.I.R.P Density - Mid CH			
H-Pol	16QAM	400MHz	1RB



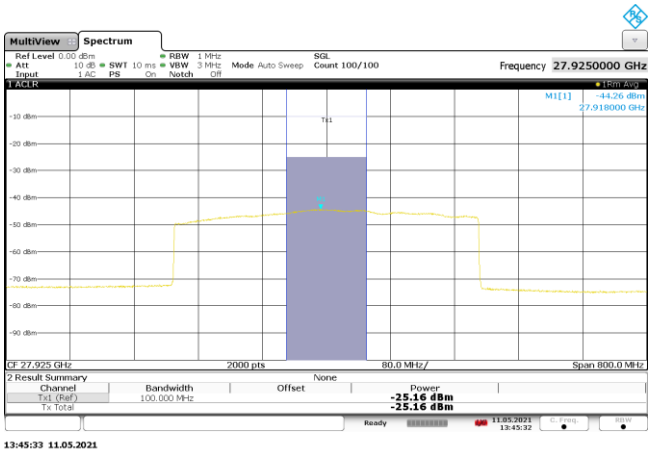
E.I.R.P Density - Mid CH			
V-Pol	16QAM	400MHz	1RB



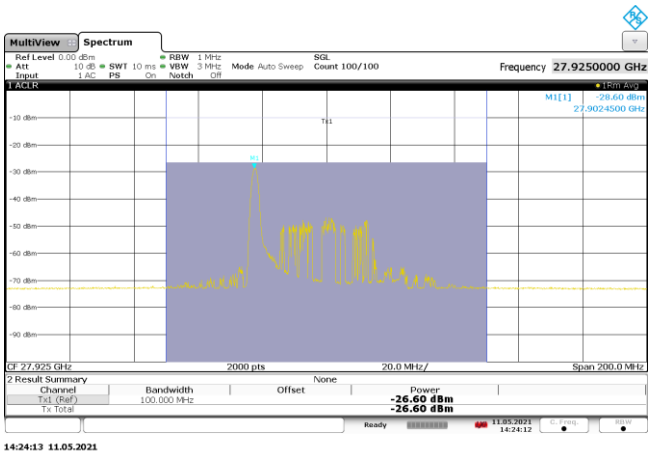
E.I.R.P Density - Mid CH			
H-Pol	16QAM	400MHz	Full RB



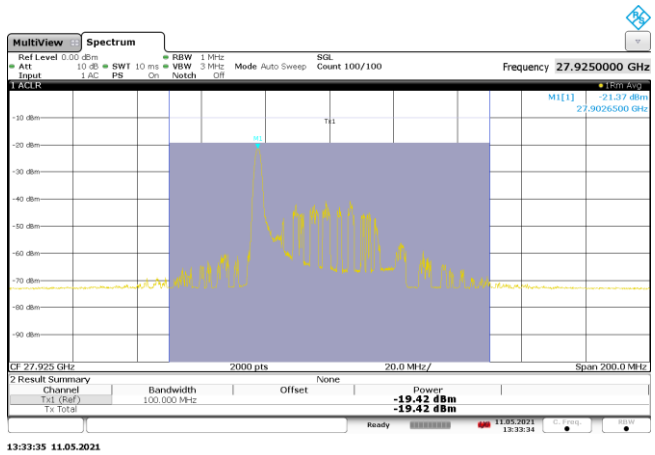
E.I.R.P Density - Mid CH			
V-Pol	16QAM	400MHz	Full RB



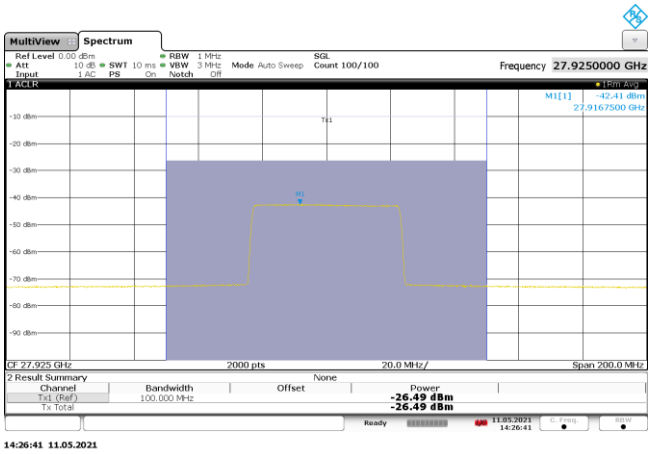
E.I.R.P Density - Mid CH			
H-Pol	64QAM	50MHz	1RB



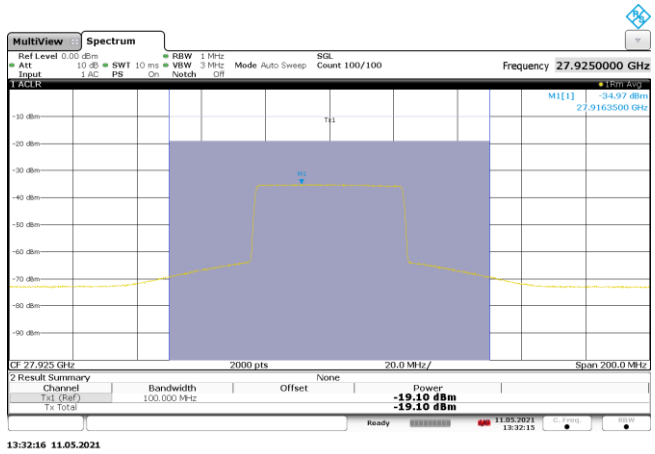
E.I.R.P Density - Mid CH			
V-Pol	64QAM	50MHz	1RB



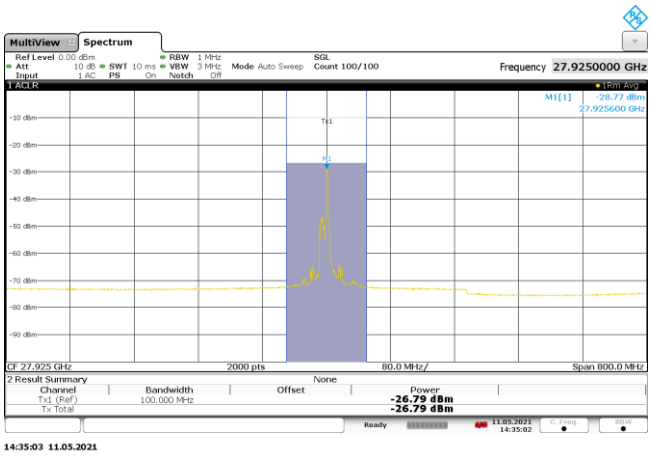
E.I.R.P Density - Mid CH			
H-Pol	64QAM	50MHz	Full RB



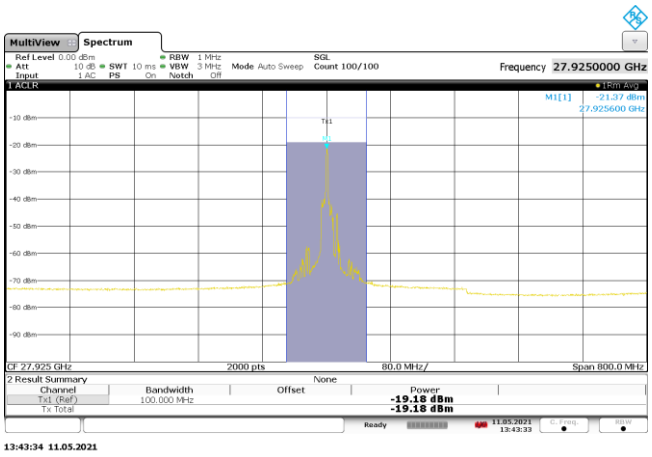
E.I.R.P Density - Mid CH			
V-Pol	64QAM	50MHz	Full RB



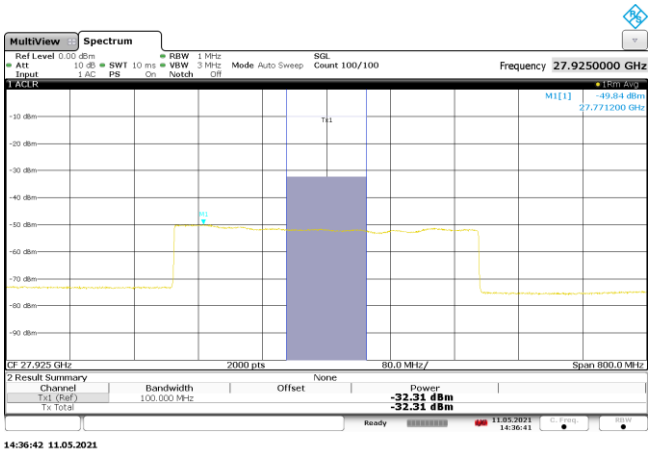
E.I.R.P Density - Mid CH			
H-Pol	64QAM	400MHz	1RB



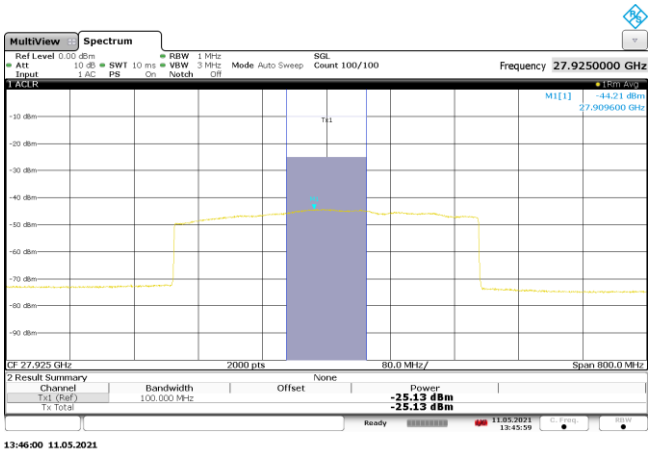
E.I.R.P Density - Mid CH			
V-Pol	64QAM	400MHz	1RB



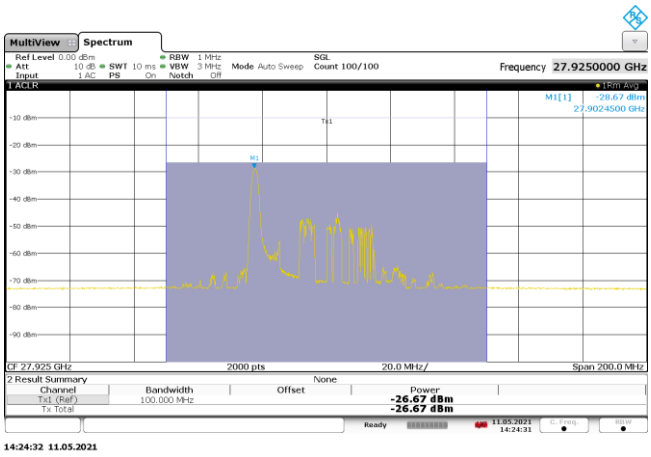
E.I.R.P Density - Mid CH			
H-Pol	64QAM	400MHz	Full RB



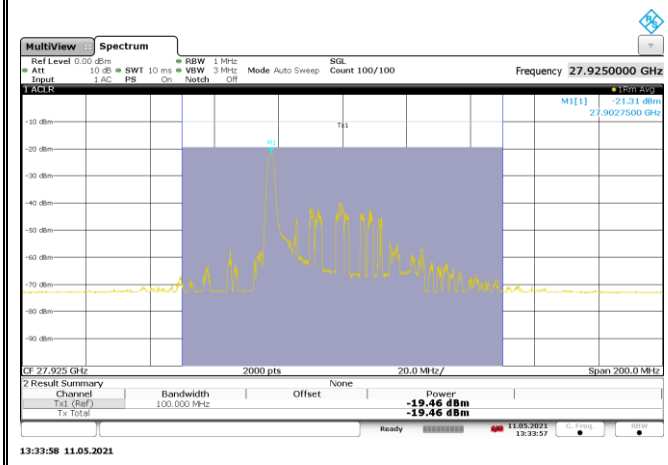
E.I.R.P Density - Mid CH			
V-Pol	64QAM	400MHz	Full RB



E.I.R.P Density - Mid CH			
H-Pol	256QAM	50MHz	1RB

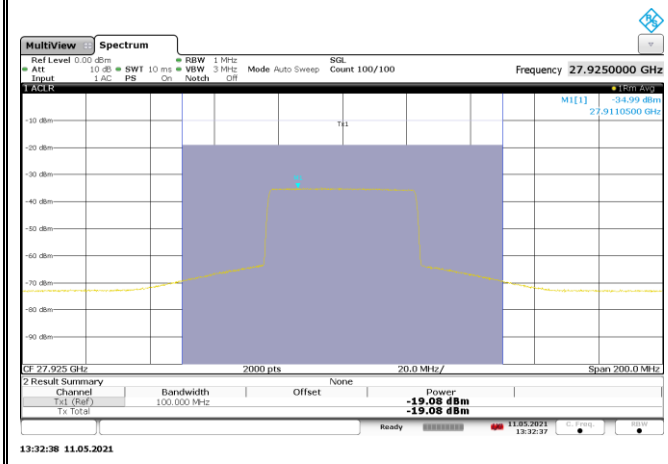


E.I.R.P Density - Mid CH			
V-Pol	256QAM	50MHz	1RB

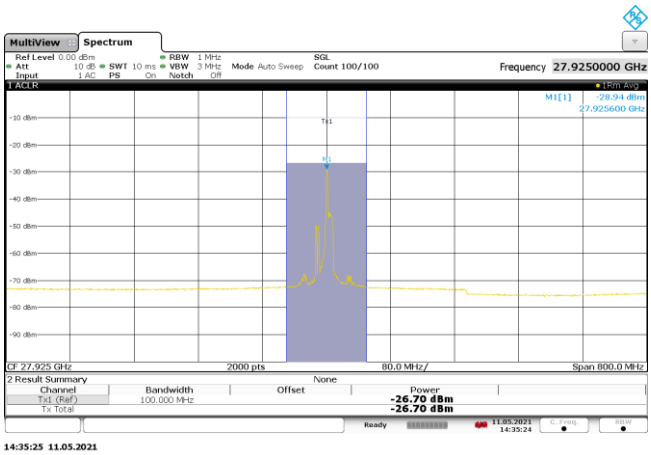


E.I.R.P Density - Mid CH			
H-Pol	256QAM	50MHz	Full RB

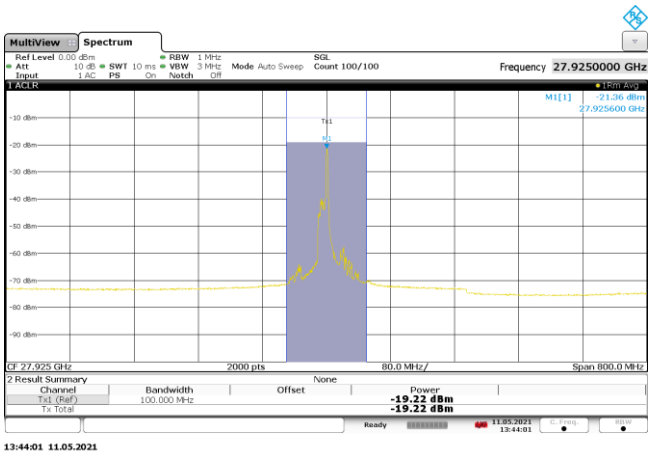
E.I.R.P Density - Mid CH			
V-Pol	256QAM	50MHz	Full RB



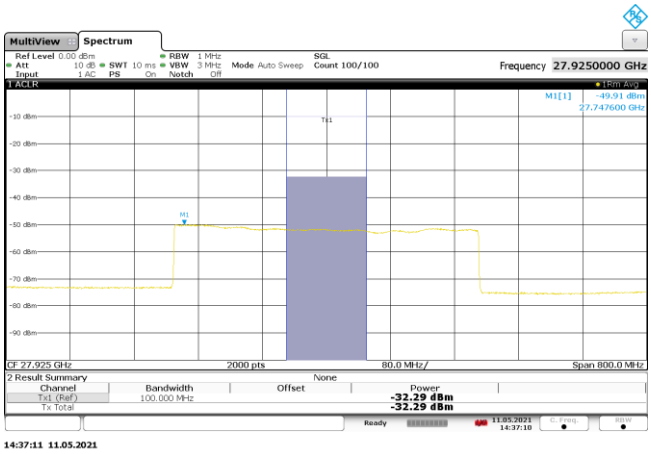
E.I.R.P Density - Mid CH			
H-Pol	256QAM	400MHz	1RB



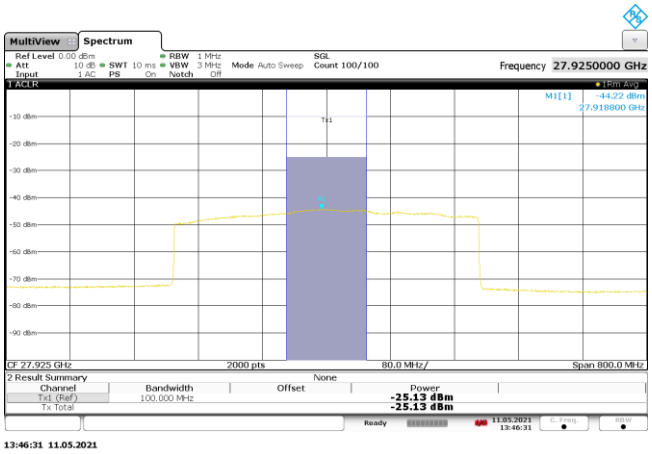
E.I.R.P Density - Mid CH			
V-Pol	256QAM	400MHz	1RB



E.I.R.P Density - Mid CH			
H-Pol	256QAM	400MHz	Full RB



E.I.R.P Density - Mid CH			
V-Pol	256QAM	400MHz	Full RB



7.3 99% Occupied Bandwidth

7.3.1 Measurement according to ANSI C63.26-2015 Section 5.4.4

Spectrum Analyzer settings:

99% Occupied Bandwidth:

- Set frequency = nominal EUT channel center frequency
- Set Span = 1.5 x to 5.0 x OBW
- Set RBW = 1% to 5% of OBW
- 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.

7.3.2 Limits:

N/A

7.3.3 Test conditions and setup:

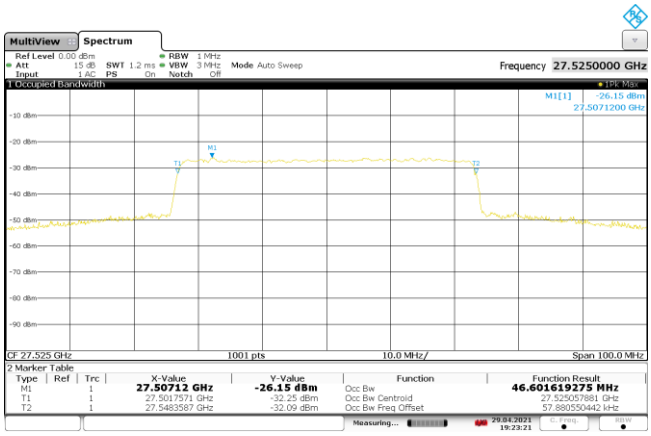
Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain
23.8°C	1	110 VAC	18dBi

7.3.4 Measurement result:

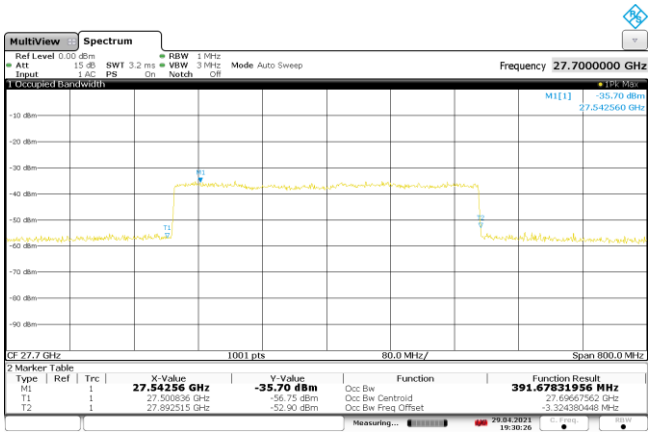
Plot #	Bands	Modulation	Baseband Frequency (GHz)	Output Frequency (GHz)	BW	RB	OBW (MHz)
1	Low	QPSK	3.125	27.525	50MHz	Full RB	46.58
2			3.3	27.7	400MHz	Full RB	391
3		16QAM	3.125	27.525	50MHz	Full RB	46.38
4			3.3	27.7	400MHz	Full RB	382
5		64QAM	3.125	27.525	50MHz	Full RB	46.3
6			3.3	27.7	400MHz	Full RB	381.1
7		256QAM	3.125	27.525	50MHz	Full RB	46.4
8			3.3	27.7	400MHz	Full RB	381
9	Mid	QPSK	3.525	27.925	50MHz	Full RB	46.28
10			3.525	27.925	400MHz	Full RB	381
11		16QAM	3.525	27.925	50MHz	Full RB	46.18
12			3.525	27.925	400MHz	Full RB	380.1
13		64QAM	3.525	27.925	50MHz	Full RB	46.23
14			3.525	27.925	400MHz	Full RB	379.6
15		256QAM	3.525	27.925	50MHz	Full RB	46.2
16			3.525	27.925	400MHz	Full RB	379.7
17	High	QPSK	3.925	28.325	50MHz	Full RB	46.01
18			3.75	28.15	400MHz	Full RB	382
19		16QAM	3.925	28.325	50MHz	Full RB	46.06
20			3.75	28.15	400MHz	Full RB	380.1
21		64QAM	3.925	28.325	50MHz	Full RB	46.06
22			3.75	28.15	400MHz	Full RB	380.24
23		256QAM	3.925	28.325	50MHz	Full RB	46.04
24			3.75	28.15	400MHz	Full RB	380.3

7.3.5 Measurement Plots:

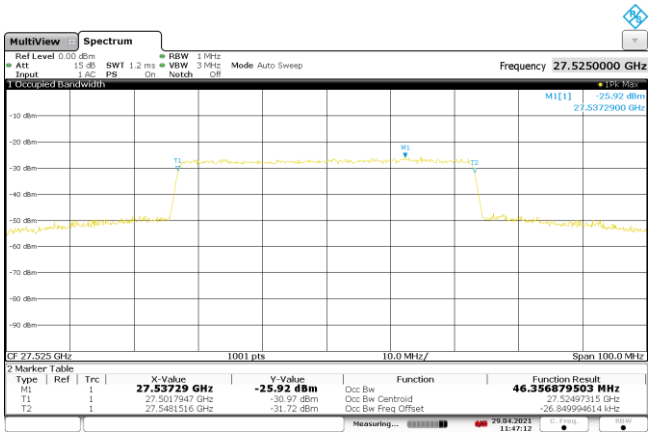
Plot# 1 OBW			
Low CH	QPSK	50MHz	Full RB



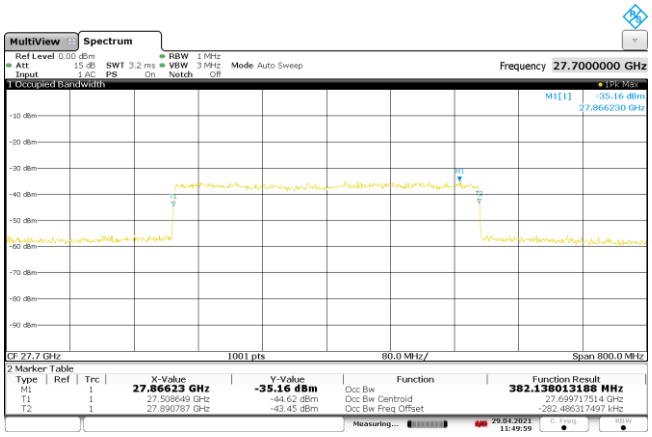
Plot# 2 OBW			
Low CH	QPSK	400MHz	Full RB



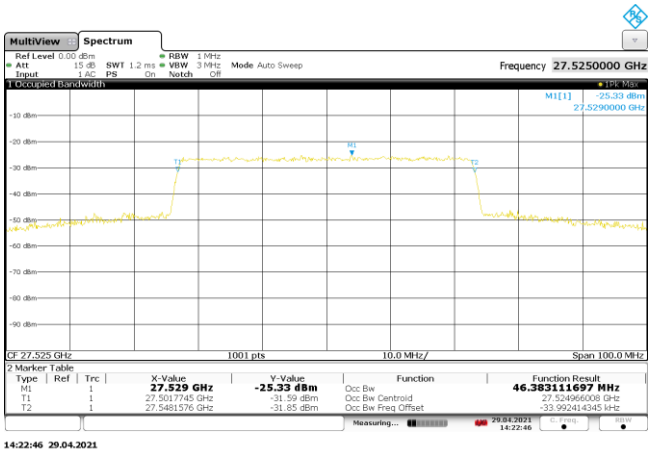
Plot# 3 OBW			
Low CH	16QAM	50MHz	Full RB



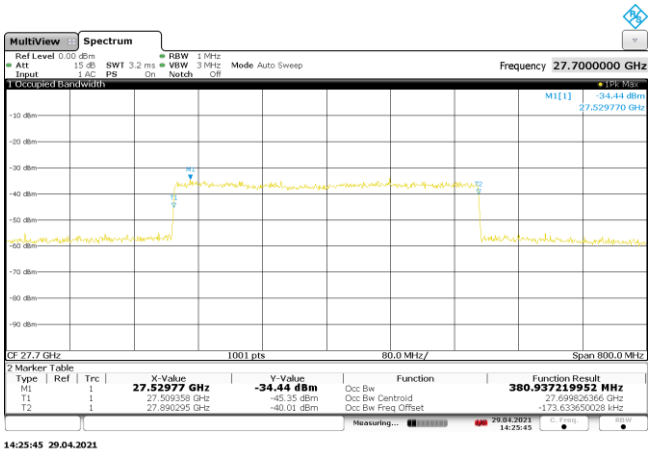
Plot# 4 OBW			
Low CH	16QAM	400MHz	Full RB



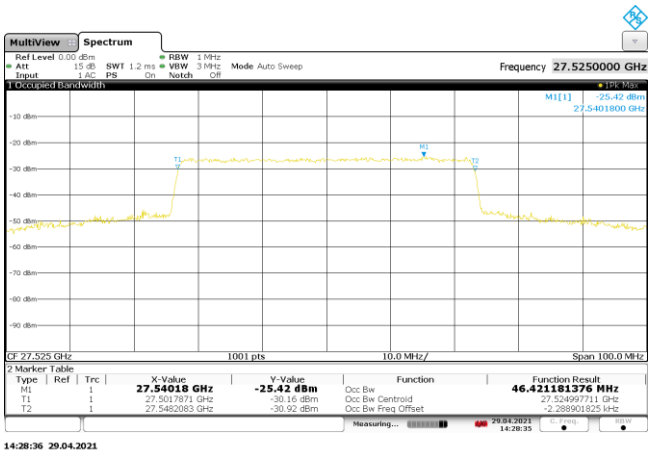
Plot# 5 OBW			
Low CH	64QAM	50MHz	Full RB



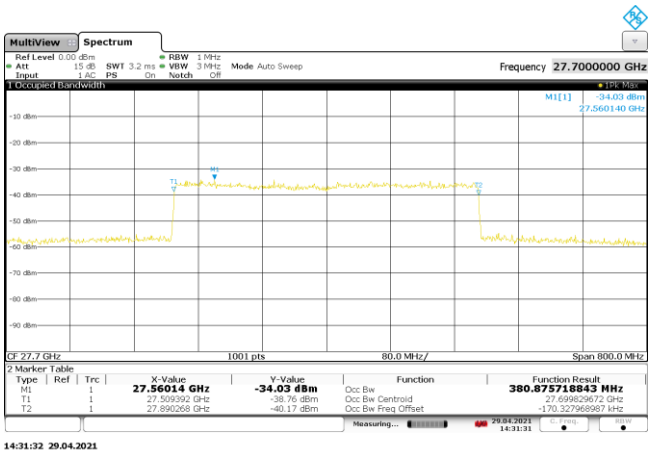
Plot# 6 OBW			
Low CH	64QAM	400MHz	Full RB



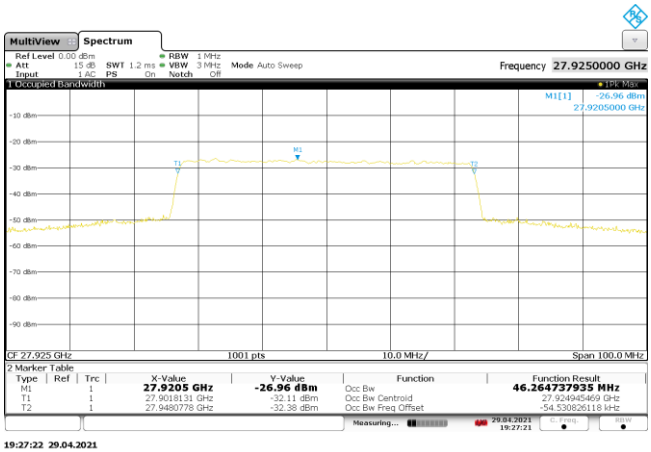
Plot# 7 OBW			
Low CH	256QAM	50MHz	Full RB



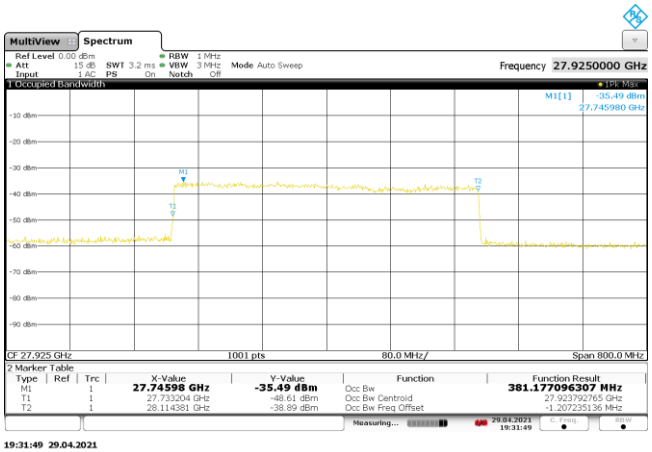
Plot# 8 OBW			
Low CH	256QAM	400MHz	Full RB



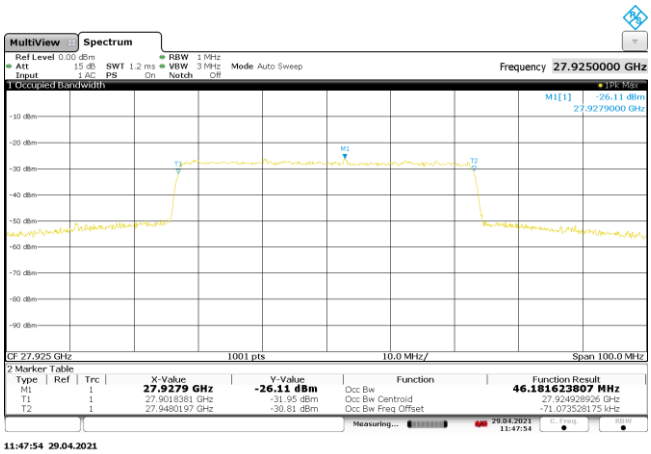
Plot# 9 OBW			
Mid CH	QPSK	50MHz	Full RB



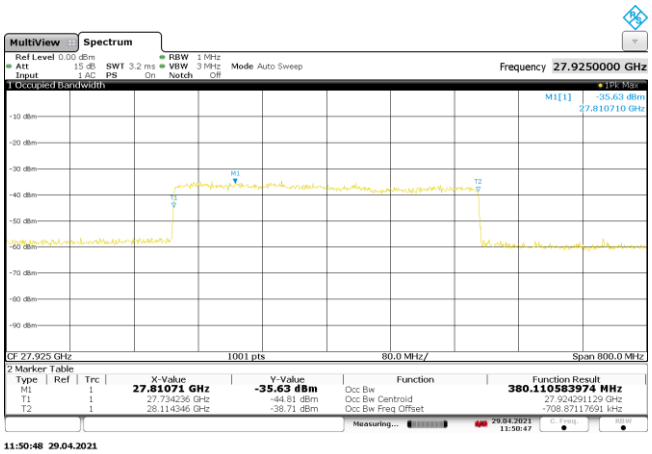
Plot# 10 OBW			
Mid CH	QPSK	400MHz	Full RB



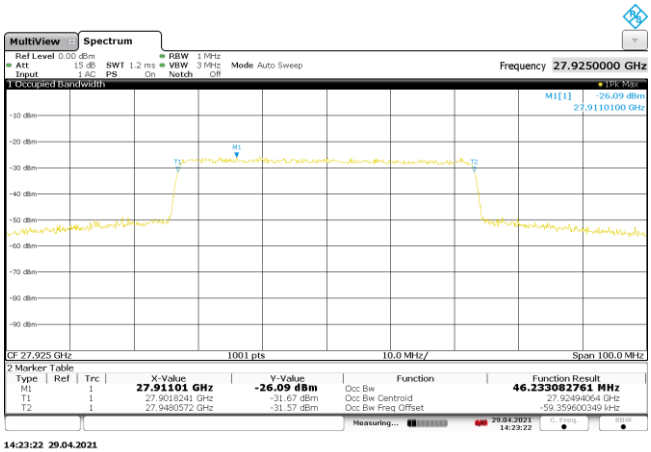
Plot# 11 OBW			
Mid CH	16QAM	50MHz	Full RB



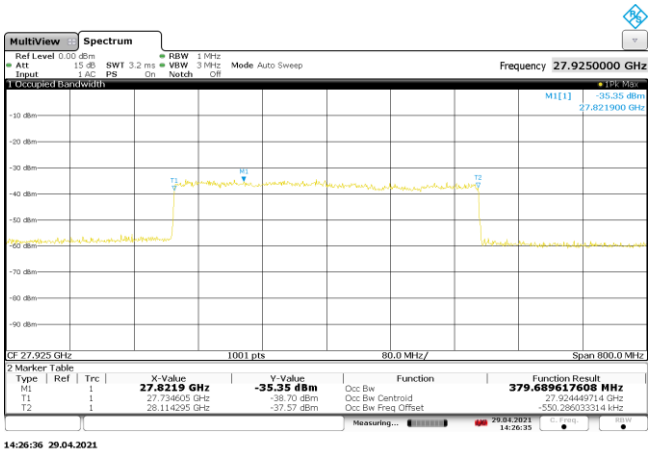
Plot# 12 OBW			
Mid CH	16QAM	400MHz	Full RB



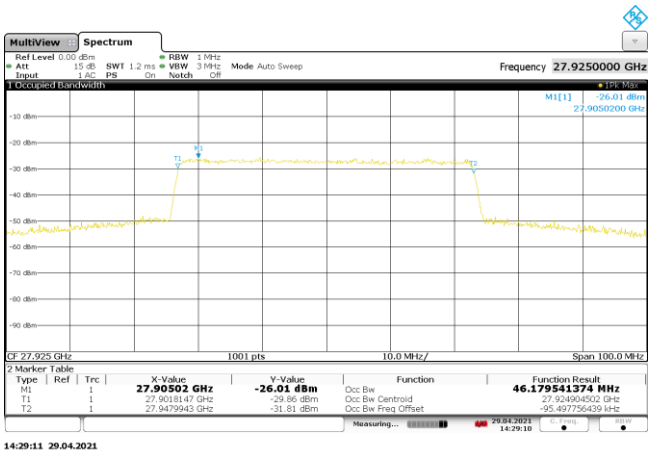
Plot# 13 OBW			
Mid CH	64QAM	50MHz	Full RB



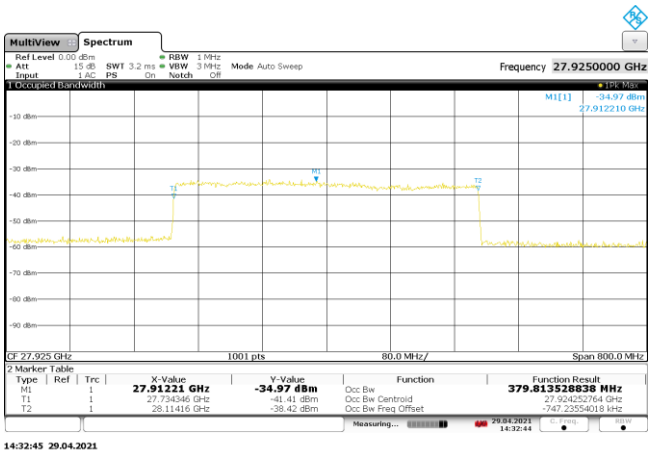
Plot# 14 OBW			
Mid CH	64QAM	400MHz	Full RB



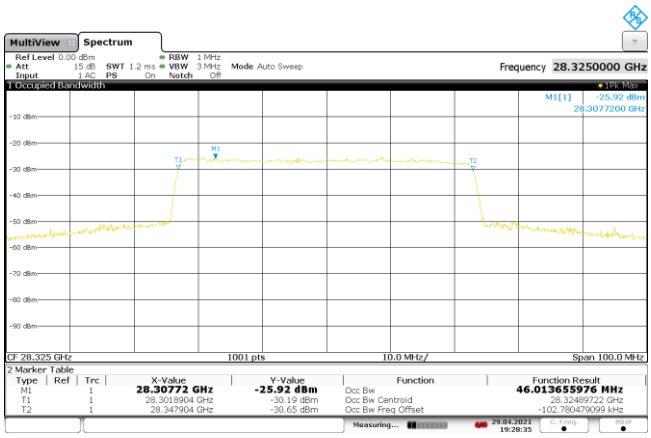
Plot# 15 OBW			
Mid CH	256QAM	50MHz	Full RB



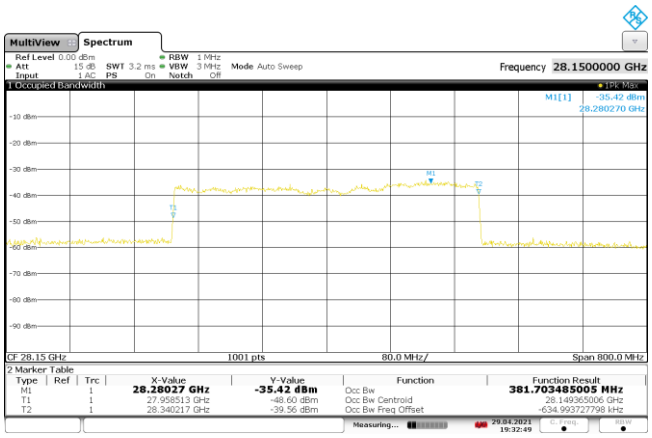
Plot# 16 OBW			
Mid CH	256QAM	400MHz	Full RB



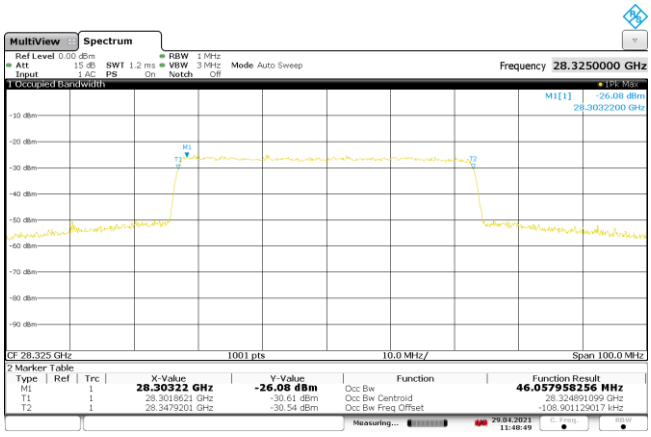
Plot# 17 OBW			
High CH	QPSK	50MHz	Full RB



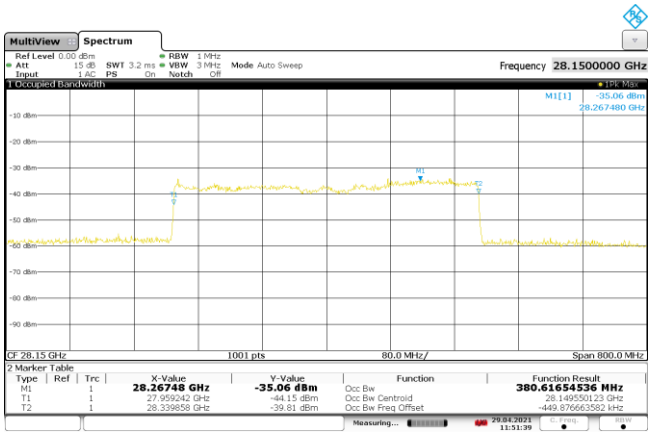
Plot# 18 OBW			
High CH	QPSK	400MHz	Full RB



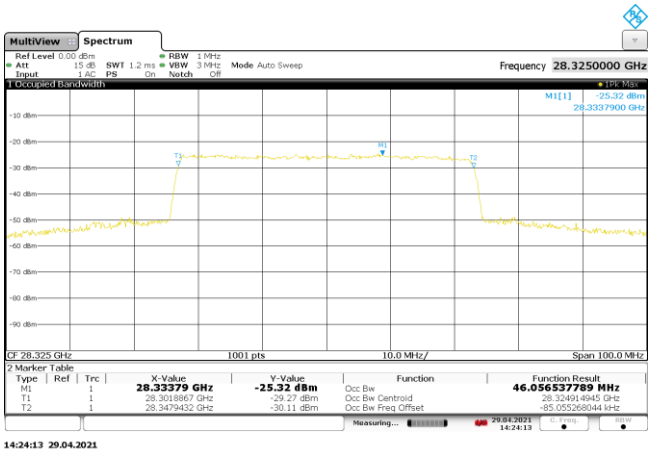
Plot# 19 OBW			
High CH	16QAM	50MHz	Full RB



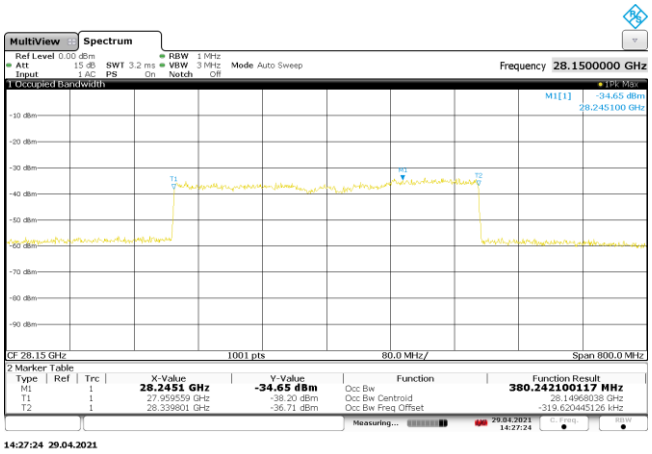
Plot# 20 OBW			
High CH	16QAM	400MHz	Full RB



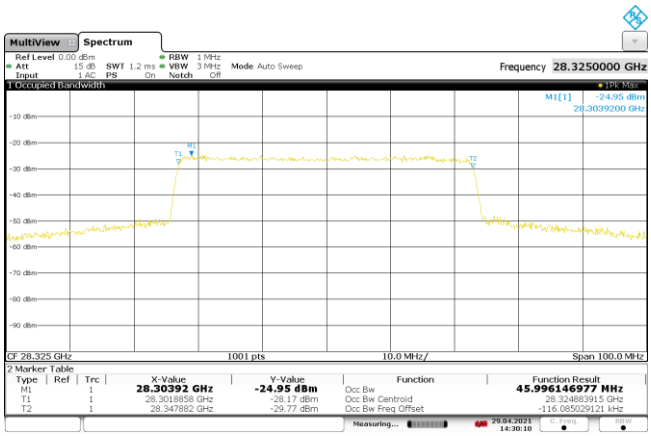
Plot# 21 OBW			
High CH	64QAM	50MHz	Full RB



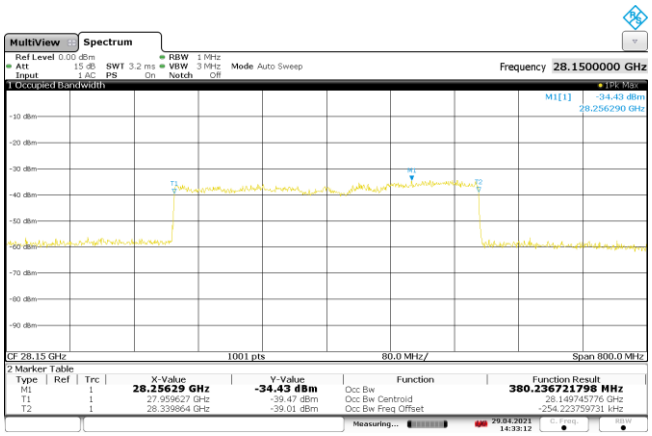
Plot# 22 OBW			
High CH	64QAM	400MHz	Full RB



Plot# 23 OBW			
High CH	256QAM	50MHz	Full RB



Plot# 24 OBW			
High CH	256QAM	400MHz	Full RB



7.4 Band Edge Compliance

7.4.1 Measurement according to ANSI C63.26-2015 Section

Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 1 MHz
- VBW ≥ 3 x RBW
- Sweep Time: Auto couple
- Detector = RMS
- Trace = trace averaging
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level
- Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge

7.4.2 Limits:

FCC§30.203 Emission Limits

(a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be −13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be −5 dBm/MHz or lower.

(b)(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.

(3) The measurements of emission power can be expressed in peak or average values.

(c) For fixed point-to-point and point-to-multipoint limits see §30.404.

7.4.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain
23.8°C	1	110 VAC	18dBi

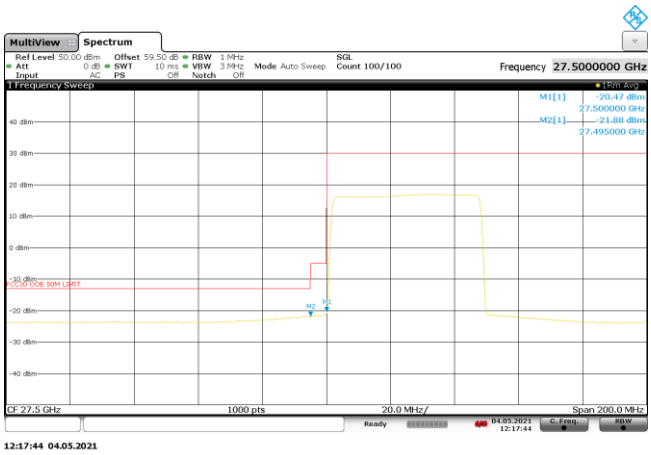
7.4.4 Measurement result:

Plot #	Bands	Modulation	Baseband frequency (GHz)	Output Frequency (GHz)	BW	RB	Freq (GHz)	EIRP (dBm)	Limit (dBm)	Result
1	Low	QPSK	3.125	27.525	50MHz	Full RB	27.5	-20.47	-5	Pass
							27.495	-21.88	-13	Pass
2			3.3	27.7	400MHz	Full RB	27.5	-23.19	-5	Pass
							27.46	-23.3	-13	Pass
3		16QAM	3.125	27.525	50MHz	Full RB	27.5	-20.63	-5	Pass
							27.495	-21.99	-13	Pass
4			3.3	27.7	400MHz	Full RB	27.5	-23.03	-5	Pass
							27.46	-23.29	-13	Pass
5		64QAM	3.125	27.525	50MHz	Full RB	27.5	-20.68	-5	Pass
							27.495	-21.56	-13	Pass
6			3.3	27.7	400MHz	Full RB	27.5	-22.88	-5	Pass
							27.46	-23.25	-13	Pass
7		256QAM	3.125	27.525	50MHz	Full RB	27.5	-20.39	-5	Pass
							27.495	-21.91	-13	Pass
8			3.3	27.7	400MHz	Full RB	27.5	-23.06	-5	Pass
							27.46	-23.44	-13	Pass
9	High	QPSK	3.925	28.325	50MHz	Full RB	28.35	-13.35	-5	Pass
							28.355	-14.61	-13	Pass
10			3.75	28.15	400MHz	Full RB	28.35	-22.04	-5	Pass
							28.39	-23.11	-13	Pass
11		16QAM	3.925	28.325	50MHz	Full RB	28.35	-13.01	-5	Pass
							28.355	-14.36	-13	Pass
12			3.75	28.15	400MHz	Full RB	28.35	-22.08	-5	Pass
							28.39	-23.15	-13	Pass
13		64QAM	3.925	28.325	50MHz	Full RB	28.35	-13.34	-5	Pass
							28.355	-14.22	-13	Pass
14			3.75	28.15	400MHz	Full RB	28.35	-22.28	-5	Pass
							28.39	-23.07	-13	Pass
15		256QAM	3.925	28.325	50MHz	Full RB	28.35	-13.2	-5	Pass
							28.355	-14.33	-13	Pass
16			3.75	28.15	400MHz	Full RB	28.35	-21.92	-5	Pass
							28.39	-22.7	-13	Pass

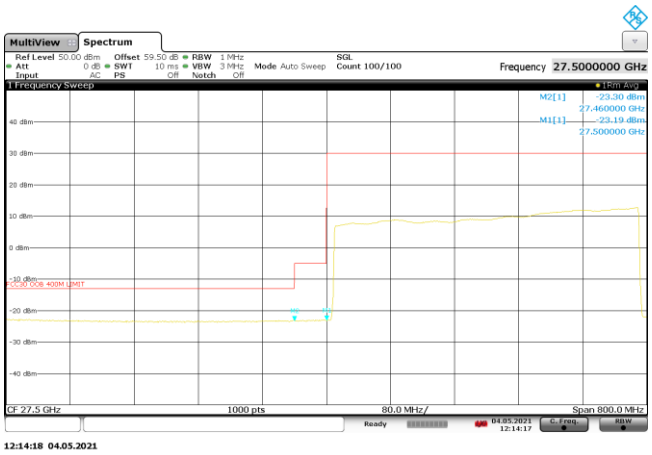
Note: Signal Generator Power Level @ -5.5dBm

7.4.5 Measurement Plots:

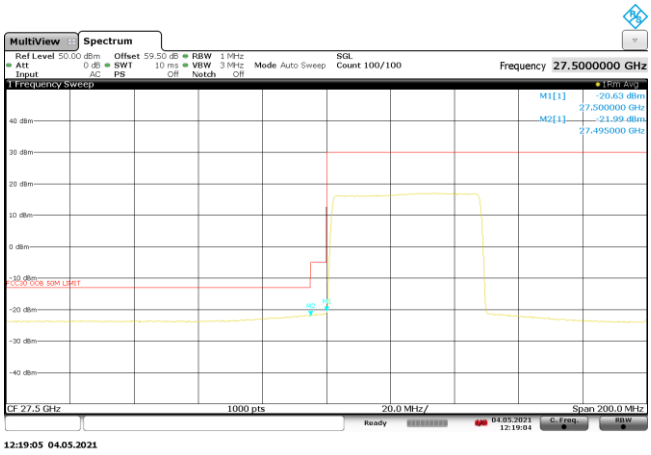
Plot# 1 Band Edge			
Low CH	QPSK	50MHz	Full RB



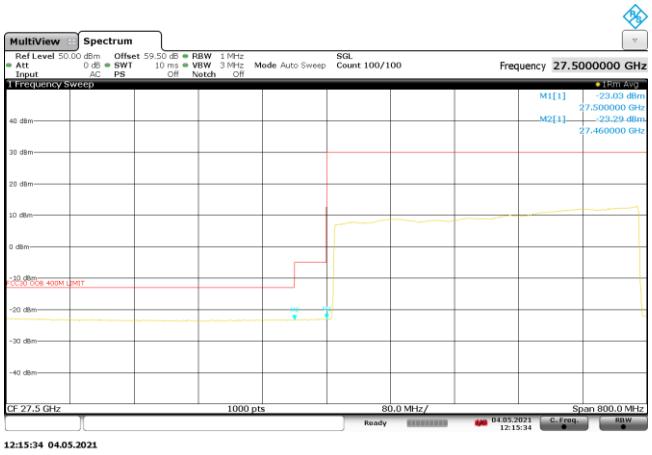
Plot# 2 Band Edge			
Low CH	QPSK	400MHz	Full RB



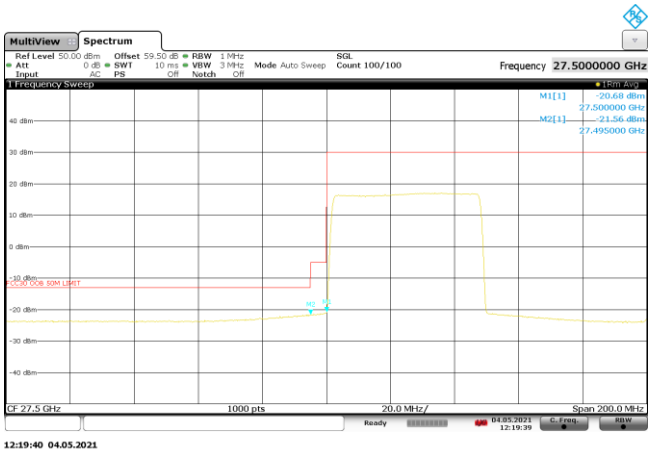
Plot# 3 Band Edge			
Low CH	16QAM	50MHz	Full RB



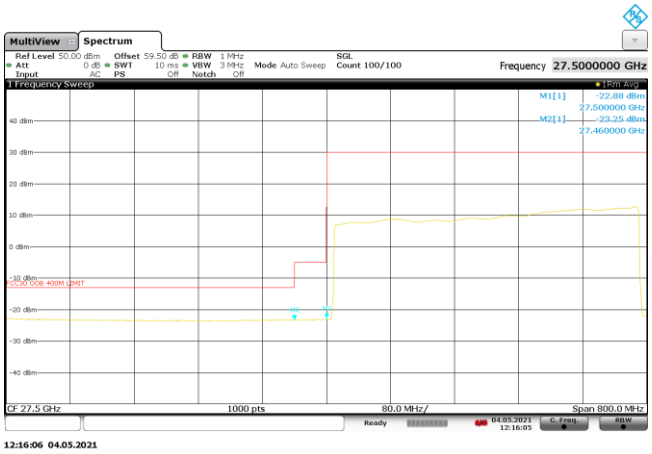
Plot# 4 Band Edge			
Low CH	16QAM	400MHz	Full RB



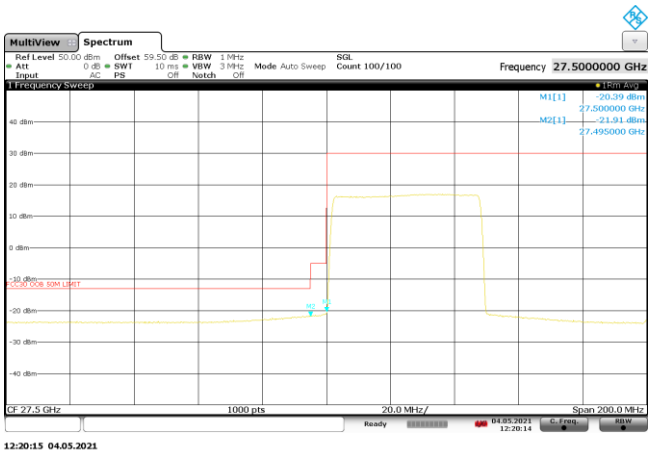
Plot# 5 Band Edge			
Low CH	64QAM	50MHz	Full RB



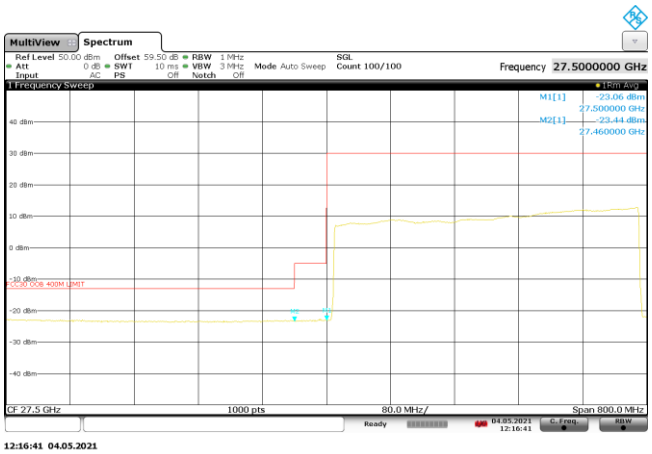
Plot# 6 Band Edge			
Low CH	64QAM	400MHz	Full RB



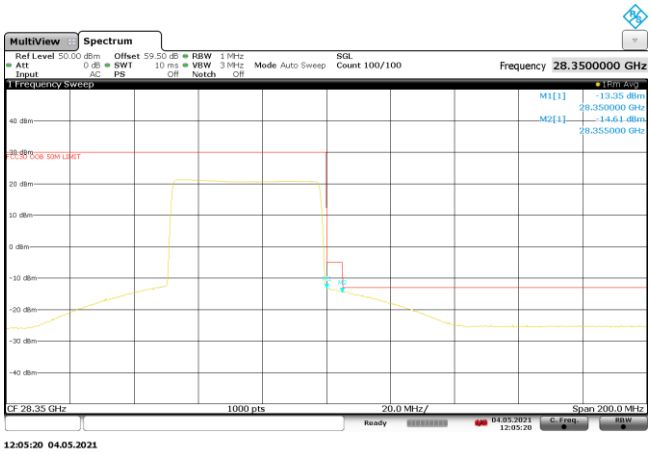
Plot# 7 Band Edge			
Low CH	256QAM	50MHz	Full RB



Plot# 8 Band Edge			
Low CH	256QAM	400MHz	Full RB

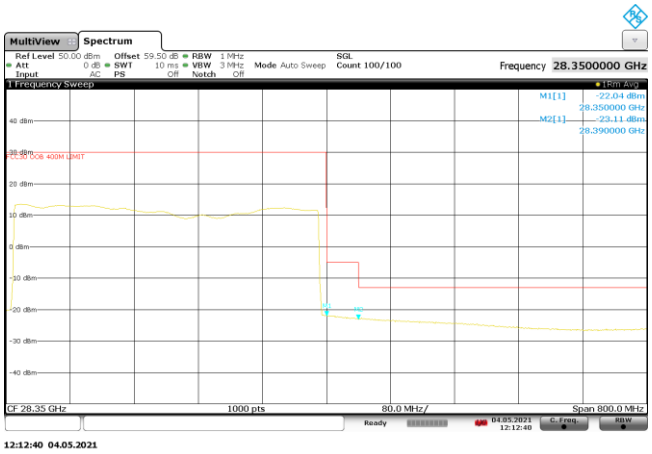


Plot# 9 Band Edge			
High CH	QPSK	50MHz	Full RB



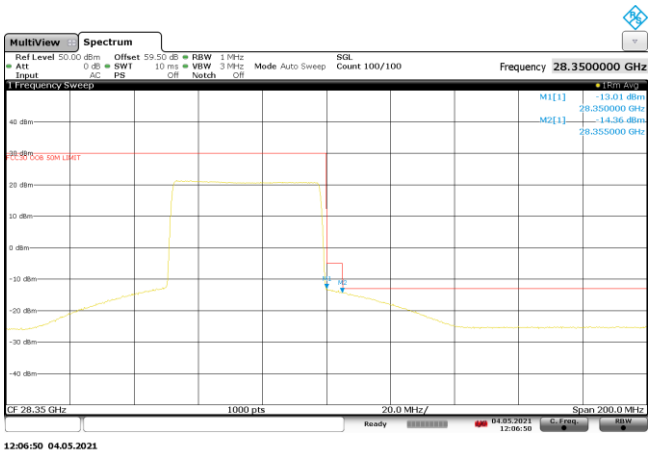
12:05:20 04.05.2021

Plot# 10 Band Edge			
High CH	QPSK	400MHz	Full RB



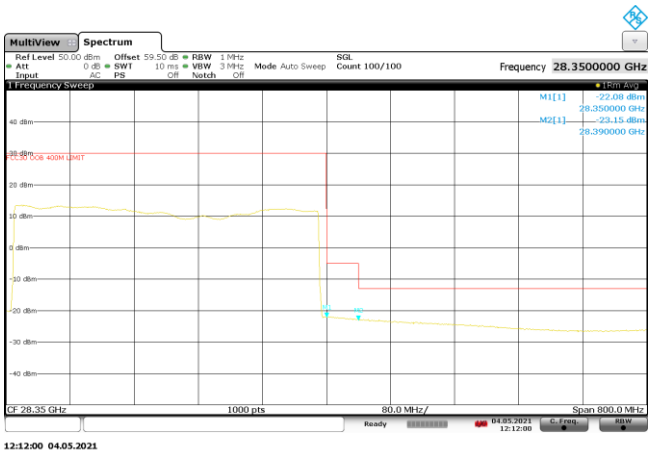
12:12:40 04.05.2021

Plot# 11 Band Edge			
High CH	16QAM	50MHz	Full RB



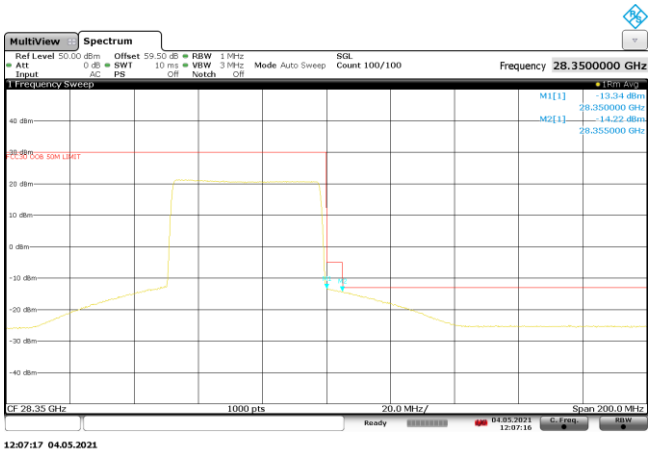
12:06:50 04.05.2021

Plot# 12 Band Edge			
High CH	16QAM	400MHz	Full RB

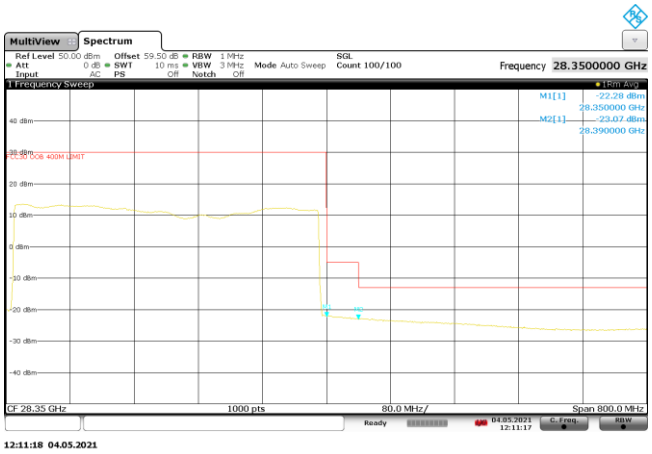


12:12:00 04.05.2021

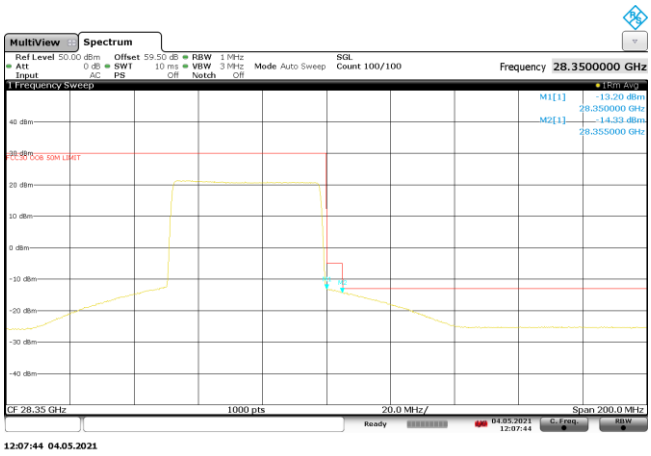
Plot# 13 Band Edge			
High CH	64QAM	50MHz	Full RB



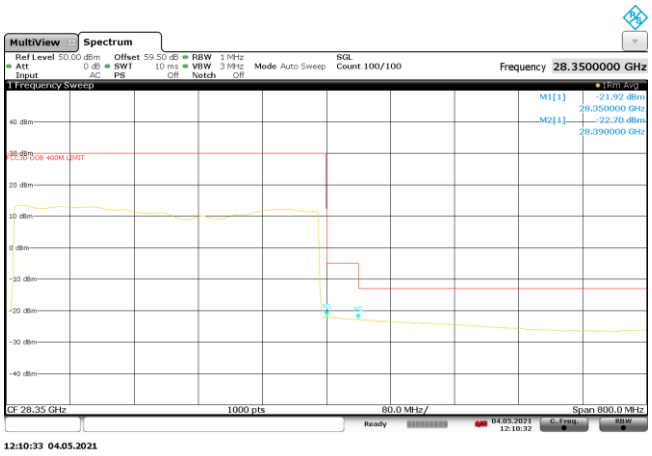
Plot# 14 Band Edge			
High CH	64QAM	400MHz	Full RB



Plot# 15 Band Edge			
High CH	256QAM	50MHz	Full RB



Plot# 16 Band Edge			
High CH	256QAM	400MHz	Full RB



7.5 Radiated Transmitter Spurious Emissions

7.5.1 Measurement according to ANSI C63.26 (2013)

Spectrum Analyzer Settings:

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

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)

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

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.

7.5.2 Limits:

(a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be −13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be −5 dBm/MHz or lower.
(b)(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.
(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.
(3) The measurements of emission power can be expressed in peak or average values.
(c) For fixed point-to-point and point-to-multipoint limits see §30.404.

7.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain
23.8°C	1	110 VAC	18dBi

7.5.4 Measurement result:

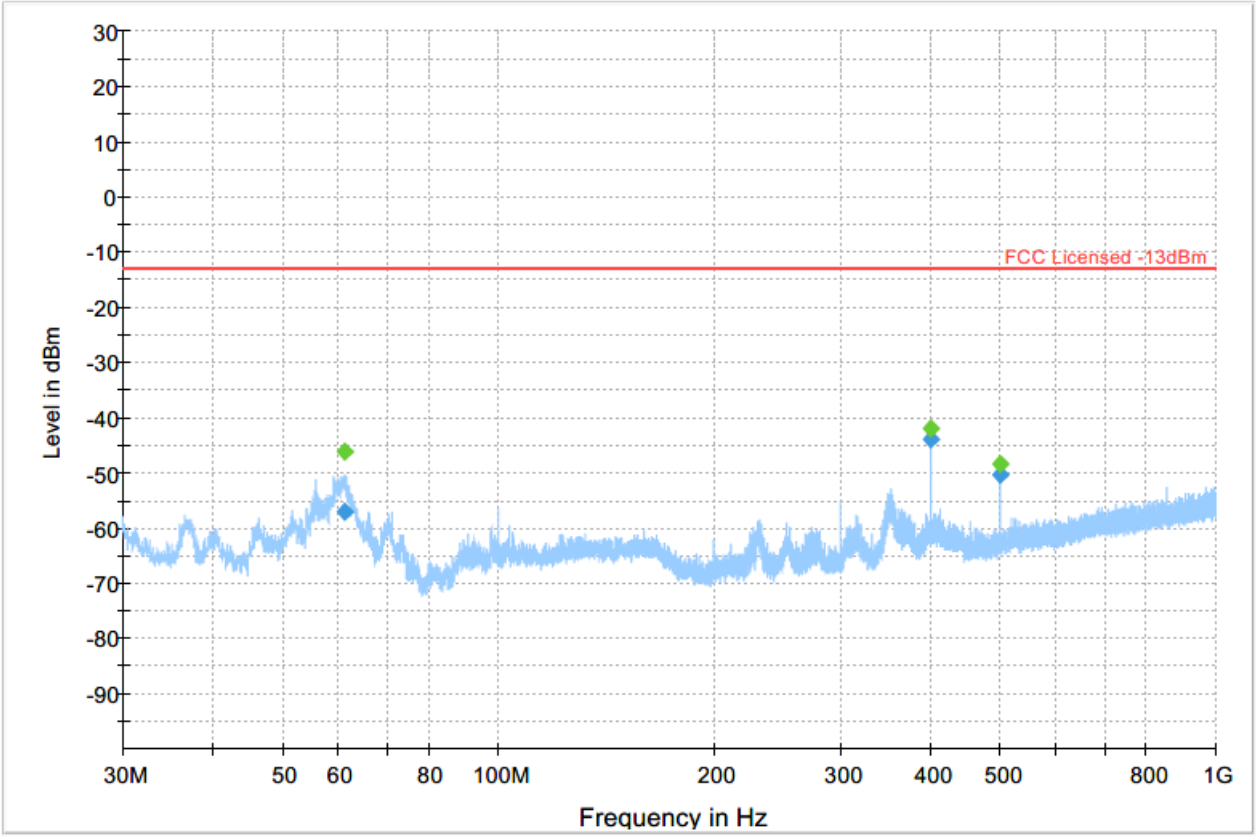
Plot #	Channel #	Bandwidth (MHz)	RB	Scan Frequency	Limit	Result
1 – 7	Low	50	1RB	30 MHz – 110 GHz	See section 8.5.2	Pass
8 – 14	Low	400	1RB	30 MHz – 110 GHz	See section 8.5.2	Pass
15 – 21	Low	400	Full RB	30 MHz – 110 GHz	See section 8.5.2	Pass
22 – 29	Mid	50	1RB	9 kHz – 110 GHz	See section 8.5.2	Pass
30 – 37	Mid	400	1RB	9 kHz – 110 GHz	See section 8.5.2	Pass
38 – 45	Mid	400	Full RB	9 kHz – 110 GHz	See section 8.5.2	Pass
46 – 52	High	50	1RB	30 MHz – 110 GHz	See section 8.5.2	Pass
53 – 59	High	400	1RB	30 MHz – 110 GHz	See section 8.5.2	Pass
60 – 66	High	400	Full RB	30 MHz – 110 GHz	See section 8.5.2	Pass

7.5.5 Measurement Plots:

Plot # 1 Radiated Emissions: 30 MHz – 1GHz		
Channel: Low	Bandwidth: 50MHz	1RB

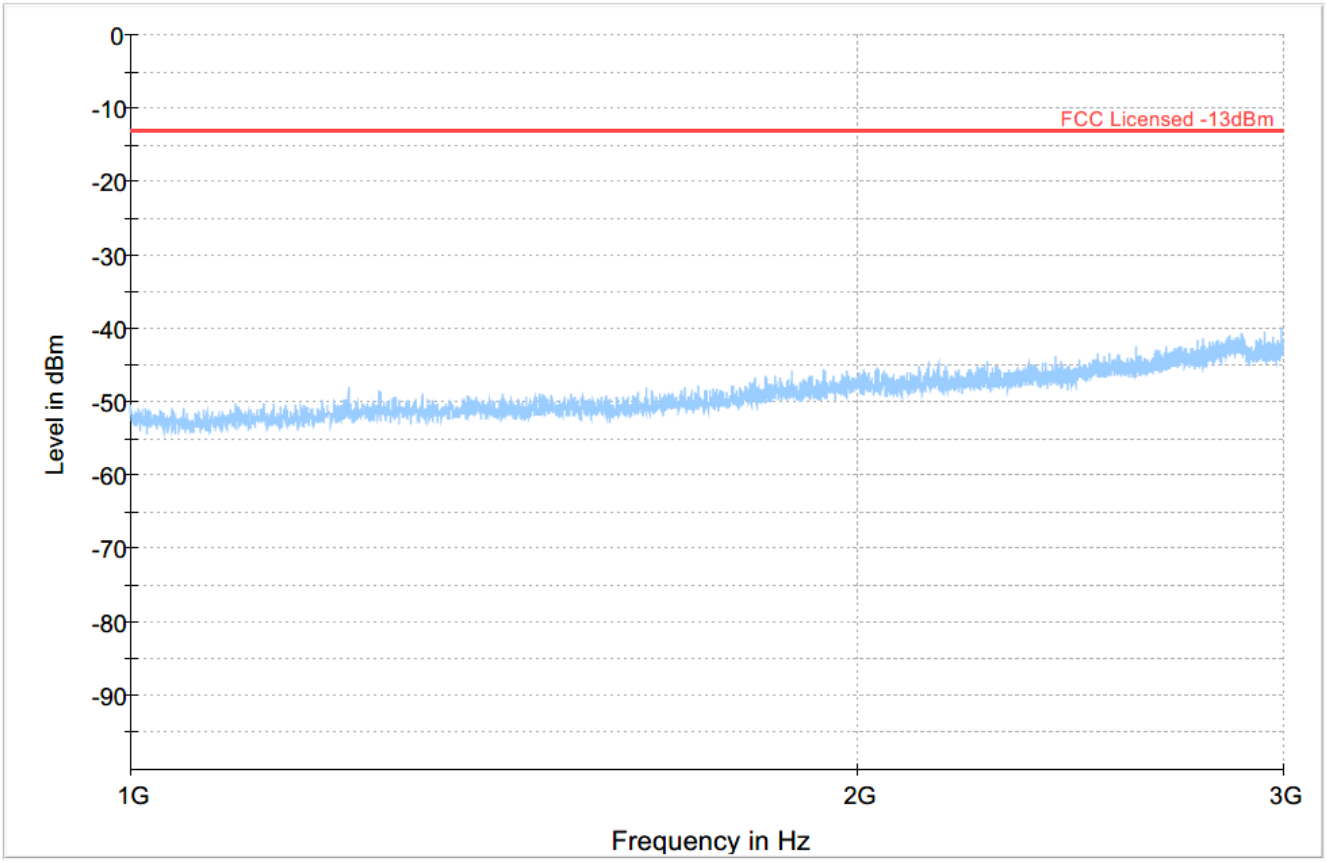
Final_Result

Frequency (MHz)	RMS (dBm)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
61.064	---	-46.26	---	---	500.0	100.000	269.0	V	321.0	-88.1
61.064	-56.96	---	-13.00	43.96	500.0	100.000	269.0	V	321.0	-88.1
399.982	---	-41.99	---	---	500.0	100.000	100.0	H	324.0	-77.2
399.982	-44.03	---	-13.00	31.03	500.0	100.000	100.0	H	324.0	-77.2
499.989	---	-48.40	---	---	500.0	100.000	126.0	H	334.0	-75.3
499.989	-50.46	---	-13.00	37.46	500.0	100.000	126.0	H	334.0	-75.3



Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS Final_Result PK+

Plot # 2 Radiated Emissions: 1-3 GHz		
Channel: Low	**Bandwidth: 50MHz**	**1RB**

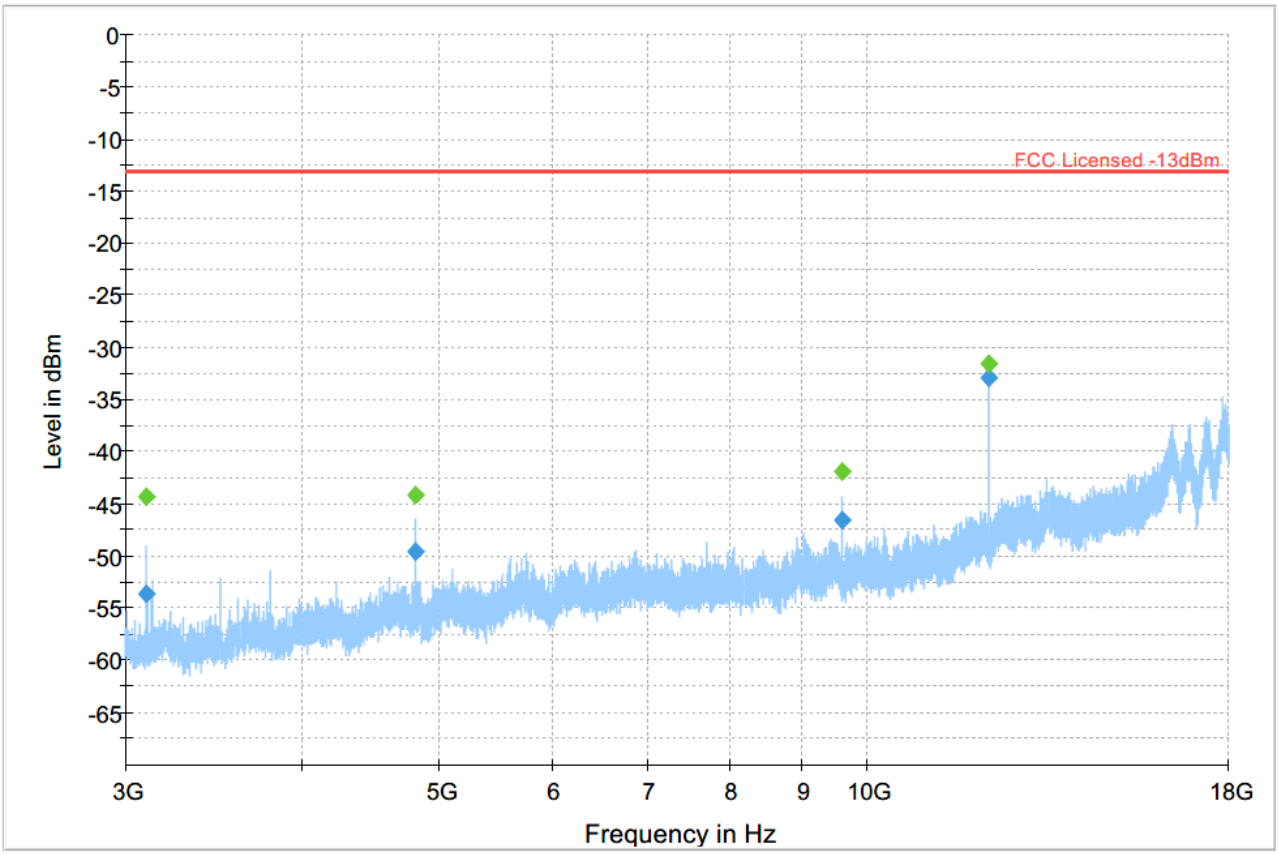


Preview Result 1-PK+ Critical_Freqs PK+ FCC Licensed -13dBm
Final_Result RMS Final_Result PK+

Plot # 3 Radiated Emissions: 3-18 GHz		
Channel: Low	Bandwidth: 50MHz	1RB

Final Result

Frequency (MHz)	RMS (dBm)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
3102.000	---	-44.33	---	---	500.0	1000.000	129.0	V	115.0	-103.5
3102.000	-53.68	---	-13.00	40.68	500.0	1000.000	129.0	V	115.0	-103.5
4799.750	---	-44.14	---	---	500.0	1000.000	151.0	H	303.0	-98.4
4799.750	-49.59	---	-13.00	36.59	500.0	1000.000	151.0	H	303.0	-98.4
9600.000	---	-41.85	---	---	500.0	1000.000	152.0	H	281.0	-93.7
9600.000	-46.51	---	-13.00	33.51	500.0	1000.000	152.0	H	281.0	-93.7
12200.000	---	-31.49	---	---	500.0	1000.000	171.0	H	146.0	-90.2
12200.000	-32.85	---	-13.00	19.85	500.0	1000.000	171.0	H	146.0	-90.2

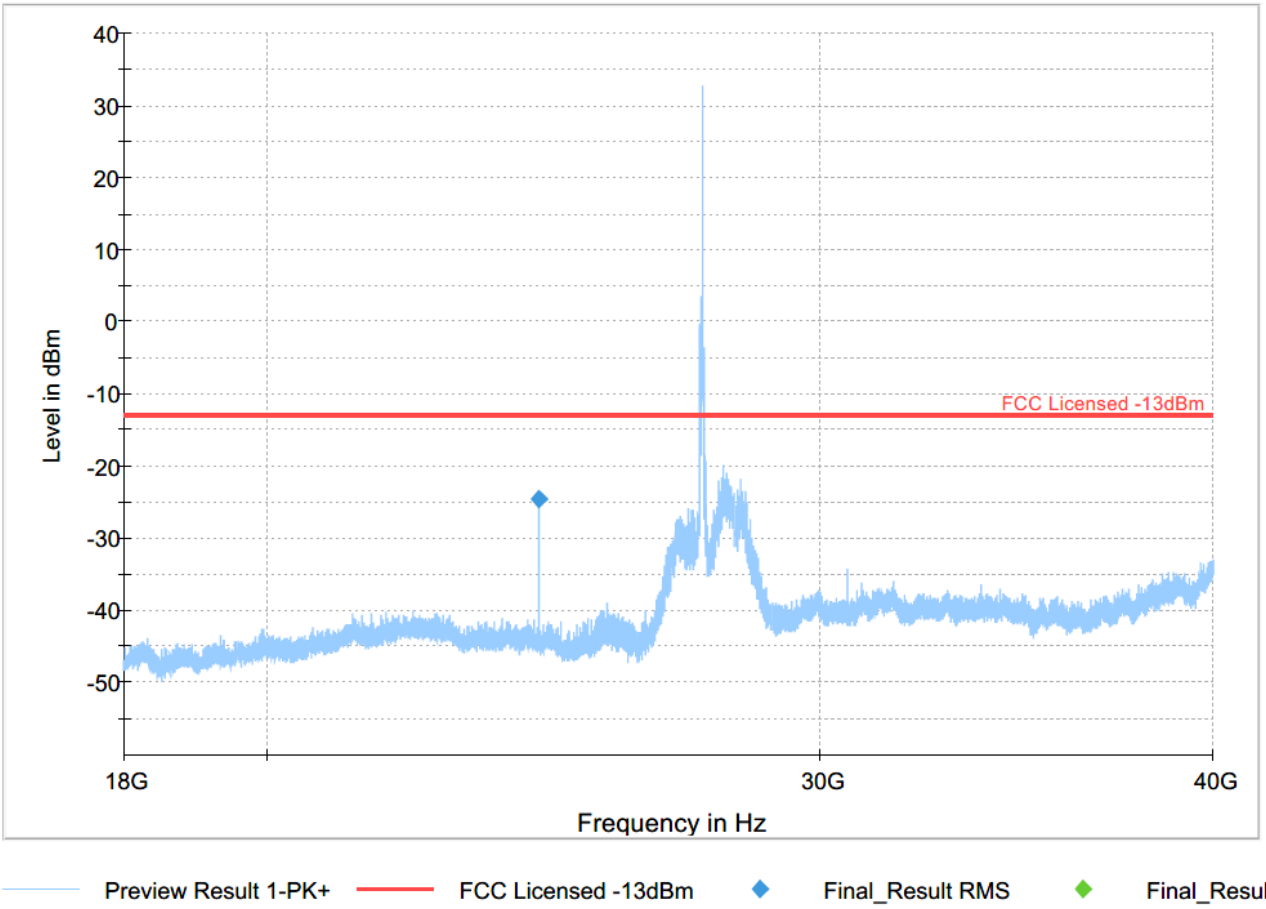


Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS Final_Result PK+

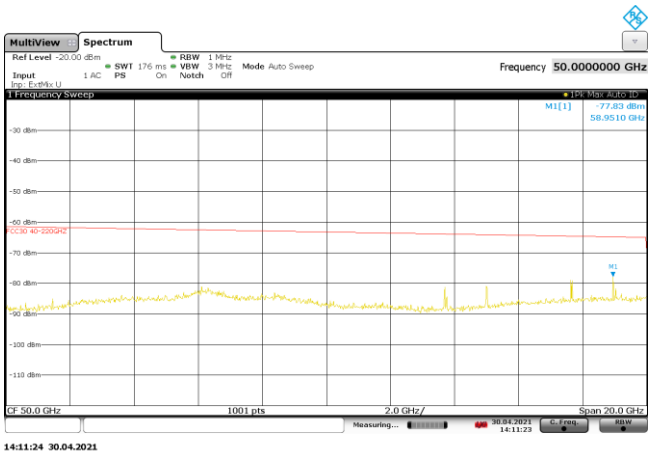
Plot # 4 Radiated Emissions: 18-40 GHz		
Channel: Low	Bandwidth: 50MHz	1RB

Final_Result

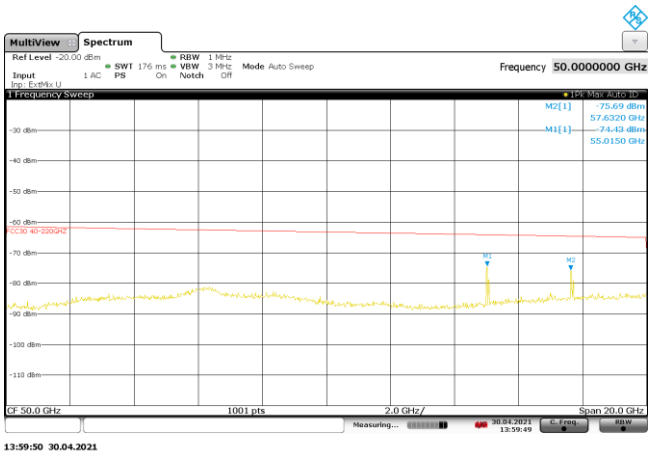
Frequency (MHz)	RMS (dBm)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
24399.938	-24.55	---	-13.00	11.55	500.0	1000.000	100.0	H	7.0	-78.0



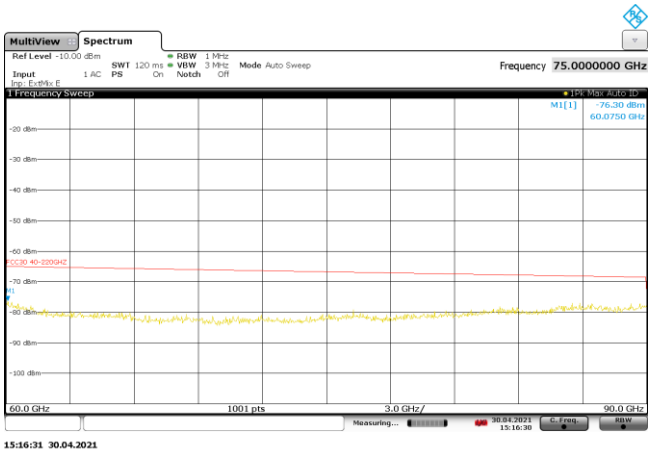
Plot# 5 Radiated Emission 40-60GHz			
Low CH	H-Pol	50MHz	1 RB



Plot# 6 Radiated Emission 40-60GHz			
Low CH	V-Pol	50MHz	1 RB

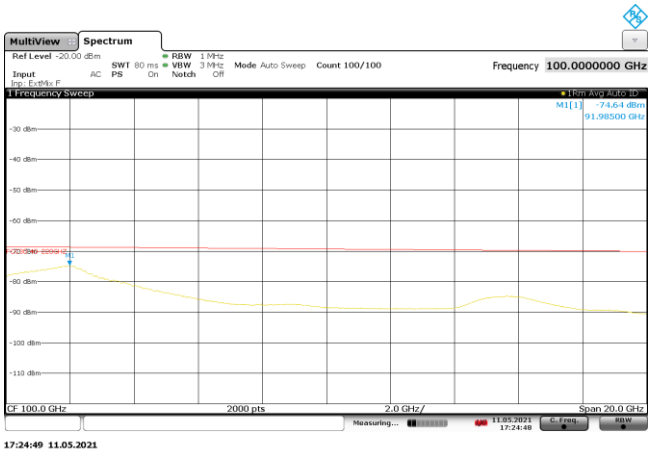


Plot# 7 Radiated Emission 60-90GHz			
Low CH	H-Pol	50MHz	1 RB



Plot# 8 Radiated Emission 60-90GHz			
Low CH	V-Pol	50MHz	1 RB

Plot# 9 Radiated Emission 90-110GHz			
Low CH	H-Pol	50MHz	1 RB



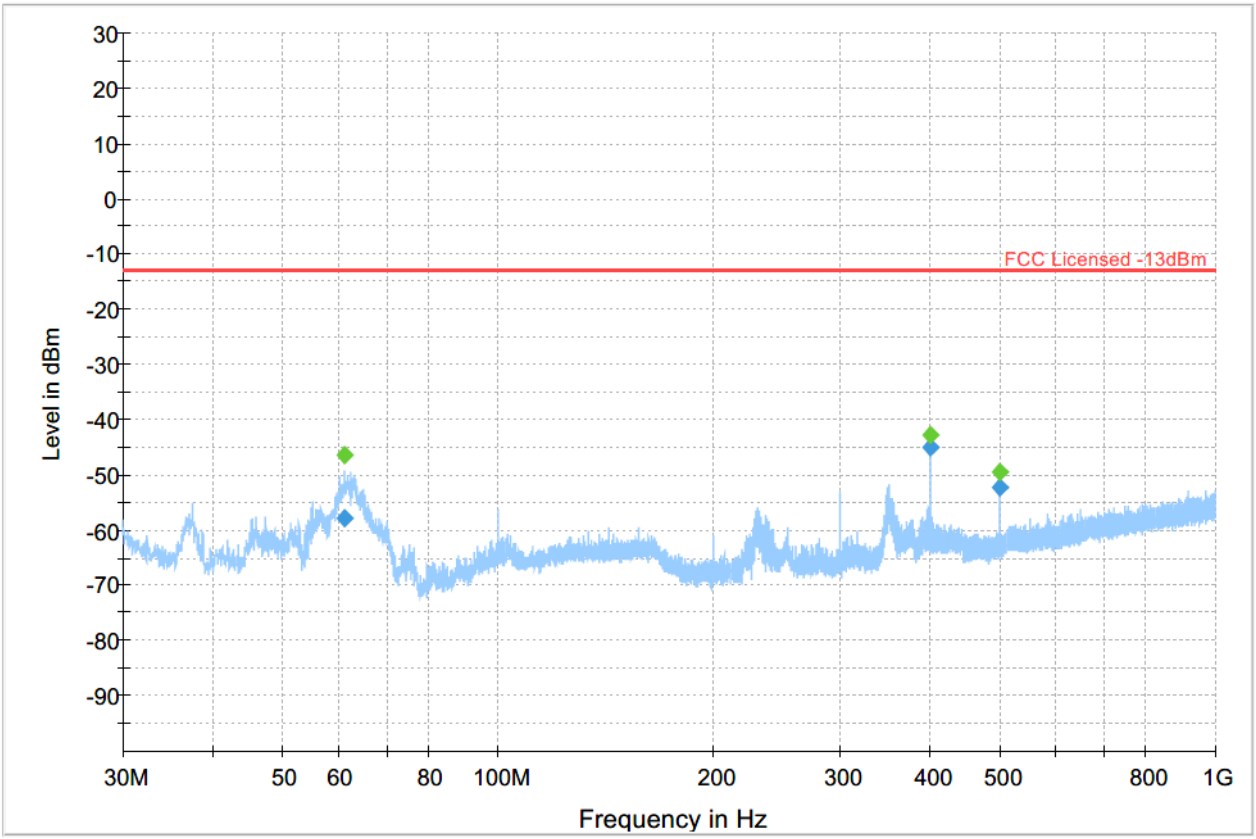
Plot# 10 Radiated Emission 90-110GHz			
Low CH	V-Pol	50MHz	1 RB

Plot # 11 Radiated Emissions: 30 MHz – 1GHz

Channel: Low	Bandwidth: 400MHz	1 RB

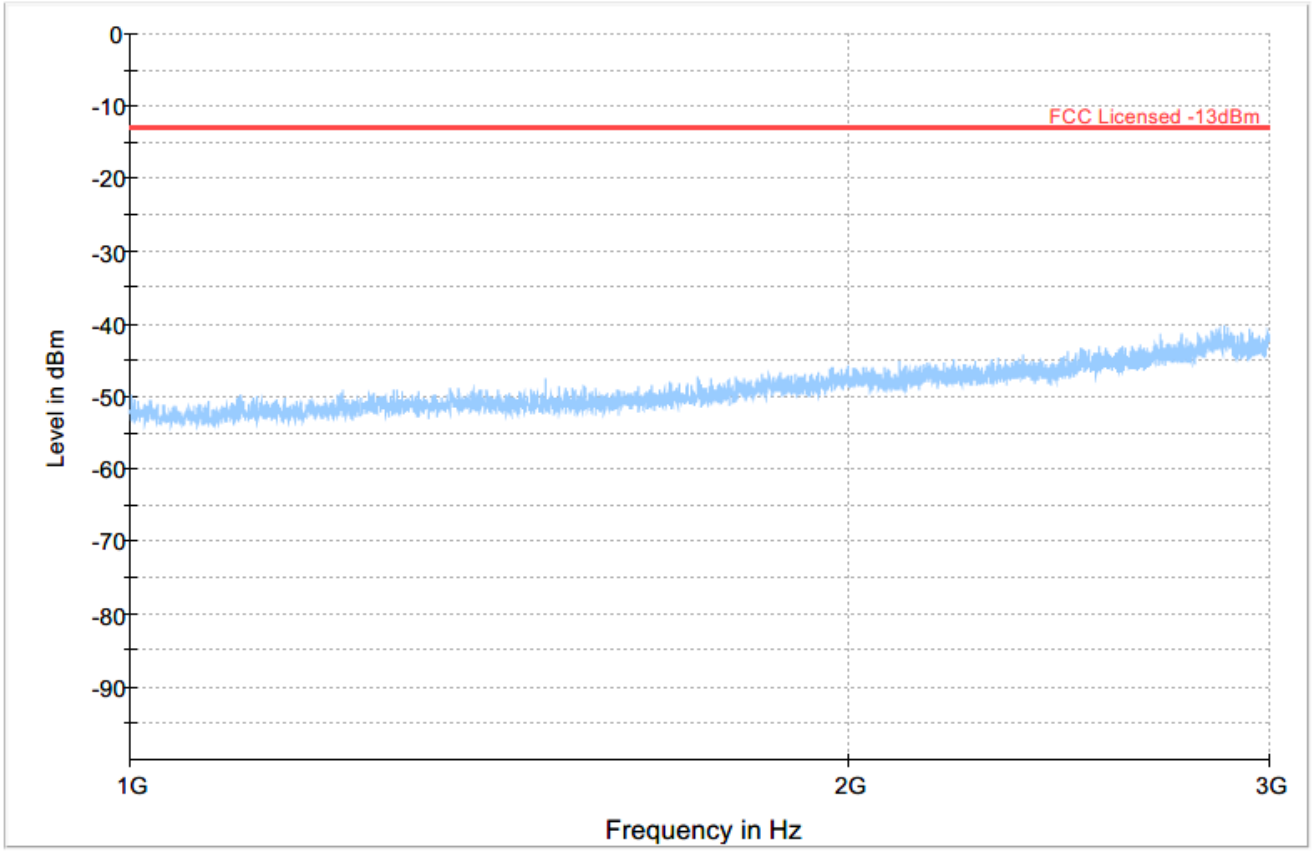
Final_Result

Frequency (MHz)	RMS (dBm)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
61.186	---	-46.32	---	---	500.0	100.000	237.0	V	31.0	-88.1
61.186	-57.82	---	-13.00	44.82	500.0	100.000	237.0	V	31.0	-88.1
399.982	---	-42.85	---	---	500.0	100.000	116.0	H	318.0	-77.2
399.982	-44.94	---	-13.00	31.94	500.0	100.000	116.0	H	318.0	-77.2
499.989	---	-49.54	---	---	500.0	100.000	100.0	V	210.0	-75.5
499.989	-52.20	---	-13.00	39.20	500.0	100.000	100.0	V	210.0	-75.5



Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS Final_Result PK+

Plot # 12 Radiated Emissions: 1-3 GHz		
Channel: Low	**Bandwidth: 400MHz**	**1 RB**



Preview Result 1-PK+ Critical_Freqs PK+ FCC Licensed -13dBm
Final_Result RMS Final_Result PK+