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RADIO TEST REPORT – 464419-2TRFWL

Type of assessment:

Final product testing

Applicant:

Intracom S.A. Telecom Solutions

Product:

PtMP/PtP Gigabit Terminal Radio 27-29 GHz

Brand:

WiBAS G5 Connect+

Model:

WG5-CONN-PLUS-HP-27-29

FCC ID:

2AHZC-G5CONPL2729

Specification:

FCC 47 CFR Part 30

Date of issue: May 13, 2022

Andrey Adelberg, Senior EMC/RF Specialist
Tested by


Signature

Kevin Rose, Senior EMC/RF Specialist
Reviewed by


Signature

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Test site registration	**Organization**	**Recognition numbers and location**		
	FCC/ISED	FCC: CA2040; IC: 2040A-4 (Ottawa/Almonte); FCC: CA2041; IC: 2040G-5 (Montreal); CA0101 (Cambridge)		
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

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Section 1. Report summary

1.1 Test specifications

FCC 47 CFR Part 30	Upper Microwave Flexible Use Service

1.2 Test methods

ANSI C63.26 v2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
FCC 47 CFR Part 2, Subpart J	Equipment authorization procedures
KDB 971168 D01	Power Meas License Digital Systems v03r01
KDB 842590 D01	Upper Microwave Flexible Use Service v01r02

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies In full with the requirements tested. The test results relate only to the items tested. Determining compliance is based on the results of the compliance measurement, not taking into account measurement uncertainty, in accordance with section 1.3 of ANSI C63.26 v2015.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
TRF	May 13, 2022	Original report issued

Section 2. Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

EUT can operate with modulations up to 256QAM. However, everything was tested with 4QAM operation, which was verified as a worst case in respect to the performance, power, and emissions.

2.3 Model variant declaration

There were no model variants declared by the applicant.

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3. Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (1060 mbar)

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

3.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 4. Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 4.1-1: *Measurement uncertainty calculations*

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5. Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant/Manufacture

Applicant name	Intracom S.A. Telecom Solutions
Applicant address	19.7 km Markopoulou Ave., Peania, Athens GR-19002 Greece
Manufacturer	Same as applicant

5.3 EUT information

Product	PtMP/PtP Gigabit Terminal Radio 27-29 GHz
Model	WG5-CONN-PLUS-HP-27-29
Serial number	322105241626
Part number	Z00-409/78.L3
Power supply requirements	DC: 48 V from external 100–240 V(AC) PoE adapter
Product description and theory of operation	Connect+. Intracom Telecom WiBAS™ G5 Connect+ is a the new generation of Point-to-MultiPoint / Point-to-Point Terminal. WiBAS™ G5 Connect+ offers the highest capacity, convenience, performance and power-saving features in the market from a compact terminal station radio. It also offers advanced networking features, extended coverage and leading PtMP/PtP radio technology in the 24.25–29.50 GHz area-licensed bands, while enabling state-of-the art IP connectivity in zero-footprint installations and at service locations requiring cost effective and rapidly-implemented FWA networks. Zero-touch provisioning capabilities makes the deployment of the network effortless, while the improved modem technology enables higher channel bandwidth utilization and denser PtMP networks. The new WiBAS™ G5 Connect+ has the unique advantage of operating in both TDD and FDD area-licensed microwave spectrum offering great flexibility and a simple hardware choice for the operators. The flexible air frame structure and variable TDD DL/UL split of the system allows WiBAS™ G5 Connect+ to co-exist with 3GPP based 5G deployments without interference.

5.4 Radio technical information

Frequency bands	1) 27500–27925 MHz [lower block] 2) 27925–28350 MHz [upper block]
Frequency Min (MHz)	1) 27525.5 (50 MHz channel); 27551 (100 MHz channel) 2) 27950.5 (50 MHz channel); 27976 (100 MHz channel)
Frequency Max (MHz)	1) 27899.5 (50 MHz channel); 27874 (100 MHz channel) 2) 28324.5 (50 MHz channel); 28299 (100 MHz channel)
RF power Max, Conducted	22.13 dBm (50 MHz channel, lower block); 23.24 dBm (50 MHz channel, upper block) 21.90 dBm (100 MHz channel, lower block); 22.96 dBm (100 MHz channel, upper block)
Measured BW (kHz), 99% OBW	48110 (50 MHz channel, lower block); 47929 (50 MHz channel, upper block) 94566 (100 MHz channel, lower block); 94627 (100 MHz channel, upper block)
Type of modulation	From 4QAM up to 256QAM
Emission classification	50M0D7W, 100MD7W
Transmitter spurious, dBµV/m @ 3 m	66.56 @ 55.3 GHz
Antenna information	Faini telecommunication system, Low Profile WiBAS Antenna, MN: LPW 03-245RC WB (ANT-DP-2628-1F-C) ,37.5 dBi Faini telecommunication system, Low Profile WiBAS Antenna, MN: LPW 05-245RC WB (ANT-DP-2628-1D6F-C), 40.5 dBi

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	System Version: 8.1.0_2610_B.5.1.0.build_07 Order Code: WG5-CONN-PLUS-HP-27-29 Product Code: Z00-409/78.L3 / Y00-40V/82.L2 EUT was controlled using external laptop with TeraTerm telnet session over 10.10.10.110 IP address. EUT was set to transmit continuously at low, mid and high frequencies (where applicable) with 98% duty cycle and with 18 dBm power setting at channels of 50 MHz and 100 MHz bandwidth. EUT was equipped with waveguide-to-SMA adapter for antenna port measurements.

5.5.2 EUT setup configuration

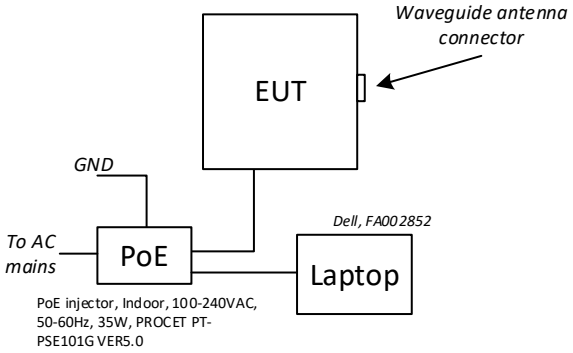


Figure 5.5-1: *Setup block diagram*

Section 6. Summary of test results

Test location (s)	Ottawa

6.1 Testing period

Test start date	August 23, 2021	Test end date	September 28, 2021

6.2 Sample information

Receipt date	August 13, 2021	Nemko sample ID number(s)	1

6.3 FCC test results

Table 6.3-1: *FCC requirements results*

Part	Test description	Verdict
§30.202, §30.405	Power limits	Pass
§30.203, §30.404	Emissions limits	Pass
§30.402, §2.1055	Frequency stability	Pass
§30.403, §2.1049	Occupied bandwidth	Pass
§2.1047(d)	Modulation characteristics	Pass

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Signal and Spectrum Analyzer	Rhode&Schwarz	FSW50	FA003267	1 year	December 7, 2021
Temperature chamber	Espec	EPX-4H	FA002735	1 year	October 8, 2021
Standard gain horn (33-50 GHz)	Mi-Wave	261B-25/383	FA003274	NCR	NCR
Standard gain horn (50-75 GHz)	Mi-Wave	261V-25/385	FA003270	NCR	NCR
Standard gain horn (75-110 GHz)	Mi-Wave	261W-25/387	FA003271	NCR	NCR
Hamonic mixer (50-75 GHz)	Rohde & Schwarz	FS-Z75	FA003263	2 years	September 24, 2022
Hamonic mixer (75-110 GHz)	Rohde & Schwarz	FS-Z110	FA003262	2 years	March 2, 2022
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	March 26, 2022
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
61505 AC source	Chroma	61509	FA003036	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 6, 2021
Horn (1–18 GHz)	ETS Lindgren	3117	FA002840	1 year	February 2, 2022
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002873	1 year	October 13, 2021
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	February 2, 2022
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	May 11, 2022
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 Number of frequencies

8.1.1 References, definitions and limits

ANSI C63.26, Clause 5.1.2:

Measurements of transmitters shall be performed and, if required, reported for each frequency band in which the EUT can be operated with the device transmitting at the number of frequencies in each band specified in table below.

Table 8.1-1: *Frequency Range of Operation*

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.1.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 23, 2021

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

Table 8.1-2: *Test channels selection*

Channel bandwidth, MHz	Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
50	27500	27925	425	27525.5	27675.5	27899.5
50	27925	28350	425	27950.5	28100.5	28324.5
100	27500	27925	425	27551.0	27651.0	27874.0
100	27925	28350	425	27976.0	28076.0	28299.0

8.2 Power limits

8.2.1 References, definitions and limits

FCC §30.202:

(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 +75 dBm/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.

FCC §30.405:

On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired. Application of this principle includes, but is not to be limited to, requiring a licensee who replaces one or more of its antennas with larger antennas to reduce its antenna input power by an amount appropriate to compensate for the increased primary lobe gain of the replacement antenna(s). In no event shall the average equivalent isotropically radiated power (EIRP), as referenced to an isotropic radiator, exceed +55 dBW (85 dBm). For Point-to-multipoint user stations authorized in these bands, the EIRP shall not exceed 55 dBW or 42 dBW/MHz (72 dBm/MHz).

8.2.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 23, 2021

8.2.3 Observations, settings and special notes

The testing was performed using subclauses 5.2.4.4.1 of ANSI C63.26-2015. For channel bandwidth less than 100 MHz the limit must be reduced proportionally and linearly based on the bandwidth relative to 100 megahertz. For 50 MHz channel the drop is 3 dB [$10 \times Log_{10}(100\ MHz/50\ MHz)$]. For 56 MHz channel the drop is 2.52 dB.

Units in dBW were calculated from dBm using the formula: $P_{dBW} = P_{dBm} - 30$ dB

Power spectral density was done using the following settings:

Resolution bandwidth:	5 MHz or 10 MHz (for output power); 1 MHz (for PSD)
Video bandwidth:	≥RBW
Detector mode:	RMS
Trace mode:	Power average over 100 traces
Power aggregation	Across the occupied bandwidth of the signal

8.2.4 Test data

Table 8.2-1: *EIRP measurements results for 50 MHz channel with LPW 03-245RC WB antenna*

Frequency, GHz	Conducted power, dBm	Max antenna gain, dBi	EIRP, dBm	EIRP, dBW	EIRP limit, dBW	EIRP margin, dB
27525.5	20.71	37.50	58.21	28.21	55.00	26.79
27675.5	20.50	37.50	58.00	28.00	55.00	27.00
27899.5	22.13	37.50	59.63	29.63	55.00	25.37
27950.5	21.96	37.50	59.46	29.46	55.00	25.54
28100.5	22.39	37.50	59.89	29.89	55.00	25.11
28324.5	23.24	37.50	60.74	30.74	55.00	24.26

Test data, continued

Table 8.2-2: *EIRP measurements results for 50 MHz channel with LPW 05-245RC WB antenna*

Frequency, GHz	Conducted power, dBm	Max antenna gain, dBi	EIRP, dBm	EIRP, dBW	EIRP limit, dBW	EIRP margin, dB
27525.5	20.71	40.50	61.21	31.21	55.00	23.79
27675.5	20.50	40.50	61.00	31.00	55.00	24.00
27899.5	22.13	40.50	62.63	32.63	55.00	22.37
27950.5	21.96	40.50	62.46	32.46	55.00	22.54
28100.5	22.39	40.50	62.89	32.89	55.00	22.11
28324.5	23.24	40.50	63.74	33.74	55.00	21.26

Table 8.2-3: *EIRP measurements results for 100 MHz channel with LPW 03-245RC WB antenna*

Frequency, GHz	Conducted power, dBm	Max antenna gain, dBi	EIRP, dBm	EIRP, dBW	EIRP limit, dBW	EIRP margin, dB
27551.0	20.32	37.50	57.82	27.82	55.00	27.18
27651.0	20.29	37.50	57.79	27.79	55.00	27.21
27874.0	21.90	37.50	59.40	29.40	55.00	25.60
27976.0	21.96	37.50	59.46	29.46	55.00	25.54
28076.0	22.96	37.50	60.46	30.46	55.00	24.54
28299.0	22.48	37.50	59.98	29.98	55.00	25.02

Table 8.2-4: *EIRP measurements results for 100 MHz channel with LPW 05-245RC WB antenna*

Frequency, GHz	Conducted power, dBm	Max antenna gain, dBi	EIRP, dBm	EIRP, dBW	EIRP limit, dBW	EIRP margin, dB
27551.0	20.32	40.50	60.82	30.82	55.00	24.18
27651.0	20.29	40.50	60.79	30.79	55.00	24.21
27874.0	21.90	40.50	62.40	32.40	55.00	22.60
27976.0	21.96	40.50	62.46	32.46	55.00	22.54
28076.0	22.96	40.50	63.46	33.46	55.00	21.54
28299.0	22.48	40.50	62.98	32.98	55.00	22.02

Table 8.2-5: *EIRP density measurements results for 50 MHz channel with LPW 03-245RC WB antenna*

Frequency, GHz	Conducted power density, dBm/MHz	Max antenna gain, dBi	EIRP density, dBm/MHz	EIRP density, dBW/MHz	EIRP density limit, dBW/MHz	EIRP margin, dB
27525.5	4.96	37.50	42.46	12.46	42.00	29.54
27675.5	5.09	37.50	42.59	12.59	42.00	29.41
27899.5	6.63	37.50	44.13	14.13	42.00	27.87
27950.5	6.83	37.50	44.33	14.33	42.00	27.67
28100.5	6.79	37.50	44.29	14.29	42.00	27.71
28324.5	7.76	37.50	45.26	15.26	42.00	26.74

Table 8.2-6: *EIRP density measurements results for 50 MHz channel with LPW 05-245RC WB antenna*

Frequency, GHz	Conducted power density, dBm/MHz	Max antenna gain, dBi	EIRP density, dBm/MHz	EIRP density, dBW/MHz	EIRP density limit, dBW/MHz	EIRP margin, dB
27525.5	4.96	40.50	45.46	15.46	42.00	26.54
27675.5	5.09	40.50	45.59	15.59	42.00	26.41
27899.5	6.63	40.50	47.13	17.13	42.00	24.87
27950.5	6.83	40.50	47.33	17.33	42.00	24.67
28100.5	6.79	40.50	47.29	17.29	42.00	24.71
28324.5	7.76	40.50	48.26	18.26	42.00	23.74

Test data, continued

Table 8.2-7: *EIRP density measurements results for 100 MHz channel with LPW 03-245RC WB antenna*

Frequency, GHz	Conducted power density, dBm/MHz	Max antenna gain, dBi	EIRP density, dBm/MHz	EIRP density, dBW/MHz	EIRP density limit, dBW/MHz	EIRP margin, dB
27551.0	2.10	37.50	39.60	9.60	42.00	32.40
27651.0	2.02	37.50	39.52	9.52	42.00	32.48
27874.0	3.33	37.50	40.83	10.83	42.00	31.17
27976.0	3.75	37.50	41.25	11.25	42.00	30.75
28076.0	4.16	37.50	41.66	11.66	42.00	30.34
28299.0	4.29	37.50	41.79	11.79	42.00	30.21

Table 8.2-8: *EIRP density measurements results for 100 MHz channel with LPW 05-245RC WB antenna*

Frequency, GHz	Conducted power density, dBm/MHz	Max antenna gain, dBi	EIRP density, dBm/MHz	EIRP density, dBW/MHz	EIRP density limit, dBW/MHz	EIRP margin, dB
27551.0	2.10	40.50	42.60	12.60	42.00	29.40
27651.0	2.02	40.50	42.52	12.52	42.00	29.48
27874.0	3.33	40.50	43.83	13.83	42.00	28.17
27976.0	3.75	40.50	44.25	14.25	42.00	27.75
28076.0	4.16	40.50	44.66	14.66	42.00	27.34
28299.0	4.29	40.50	44.79	14.79	42.00	27.21

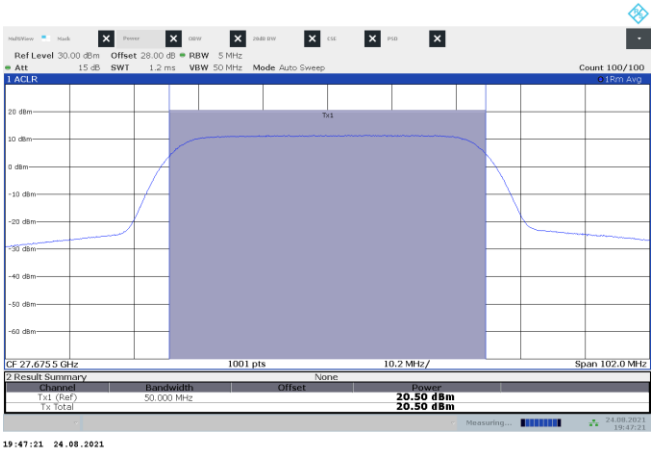


Figure 8.2-1: *Power on 50 MHz channel, sample plot*

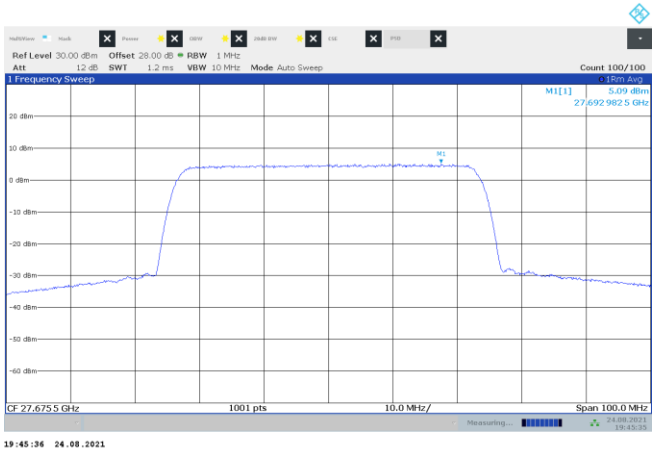


Figure 8.2-2: *PSD on 50 MHz channel, sample plot*

Test data, continued

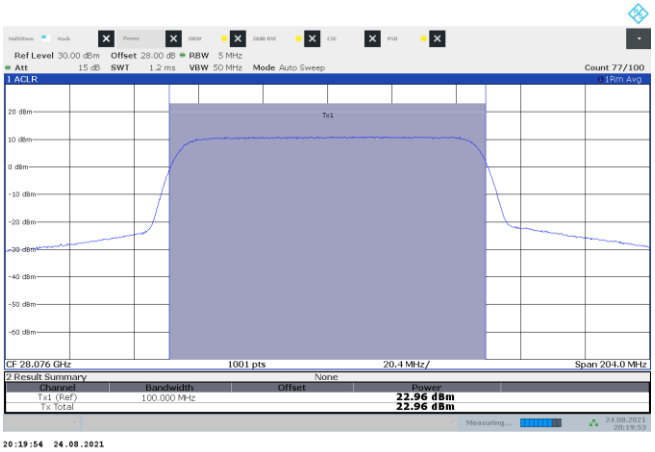


Figure 8.2-3: *Power on 100 MHz channel, sample plot*

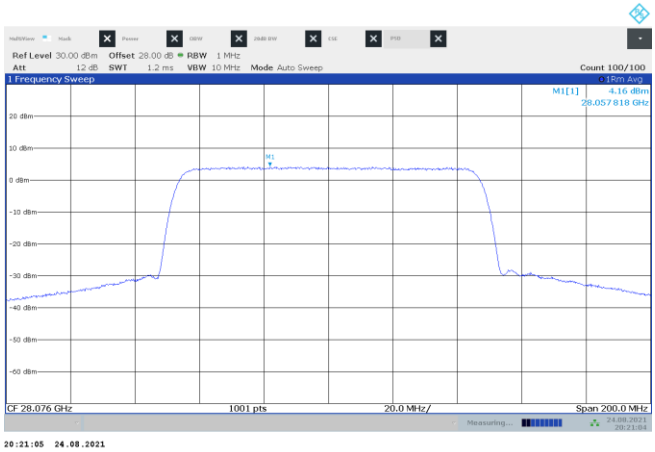


Figure 8.2-4: *PSD on 100 MHz channel, sample plot*

8.3 Occupied bandwidth

8.3.1 References, definitions and limits

FCC §30.403:

(a) Stations under this subpart will be authorized any type of emission, method of modulation, and transmission characteristic, consistent with efficient use of the spectrum and good engineering practice.

(b) The maximum bandwidth authorized per frequency to stations under this subpart is 850 MHz within 27.5–28.35 GHz band.

FCC §2.1049:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

ANSI C63.26-2015:

5.4.4 The OBW is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

8.3.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 23, 2021

8.3.3 Observations, settings and special notes

The testing was performed using subclauses 5.4.4 of ANSI C63.26-2015. Spectrum analyser settings:

Resolution bandwidth	2 MHz
Video bandwidth	≥ RBW
Frequency span	Wider than emission bandwidth
Detector mode	RMS/Peak, max-hold

8.3.4 Test data

Table 8.3-1: *Occupied bandwidth measurement results and limitations*

Channel bandwidth, MHz	Fundamental frequency, GHz	99% BW, MHz	Lower 99% BW frequency cross, GHz	Lower limit, GHz	Margin, MHz	Upper 99% BW frequency cross, GHz	Upper limit, GHz	Margin, MHz
50	27525.5	48.110	27.502	27.500	2	27.549	27.925	376
50	27675.5	47.941	27.652	27.500	152	27.699	27.925	226
50	27899.5	47.977	27.876	27.500	376	27.924	27.925	1
50	27950.5	47.912	27.927	27.925	2	27.975	28.350	375
50	28100.5	47.929	28.077	27.925	152	28.125	28.350	225
50	28324.5	47.883	28.301	27.925	376	28.348	28.350	2
100	27551.0	94.208	27.504	27.500	4	27.598	27.925	327
100	27651.0	94.297	27.604	27.500	104	27.698	27.925	227
100	27874.0	94.566	27.827	27.500	327	27.921	27.925	4
100	27976.0	94.480	27.929	27.925	4	28.023	28.350	327
100	28076.0	94.621	28.029	27.925	104	28.124	28.350	226
100	28299.0	94.627	28.252	27.925	327	28.346	28.350	4

Test data, continued

Table 8.3-2: *20 dB bandwidth measurement results*

Channel bandwidth, MHz	Fundamental frequency, GHz	20 dB bandwidth, MHz	Maximum authorized BW, MHz	Margin, MHz
50	27525.5	51.95	850.00	798.05
50	27675.5	52.15	850.00	797.85
50	27899.5	51.75	850.00	798.25
50	27950.5	51.95	850.00	798.05
50	28100.5	52.15	850.00	797.85
50	28324.5	51.75	850.00	798.25
100	27551.0	101.10	850.00	748.90
100	27651.0	101.30	850.00	748.70
100	27874.0	101.30	850.00	748.70
100	27976.0	101.70	850.00	748.30
100	28076.0	101.50	850.00	748.50
100	28299.0	101.70	850.00	748.30

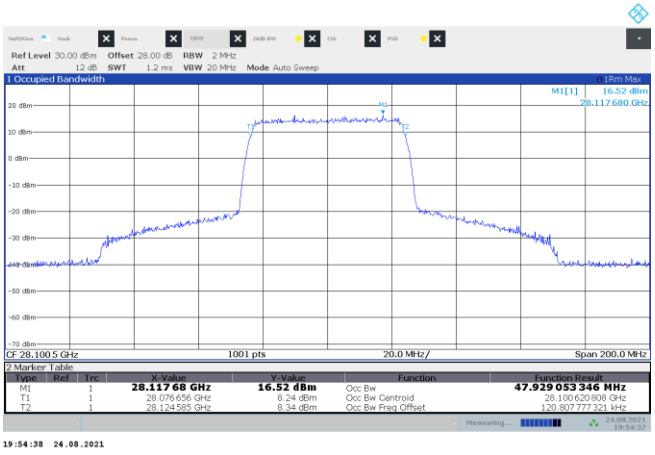


Figure 8.3-1: *99 % occupied bandwidth for 50 MHz channel, sample plot*

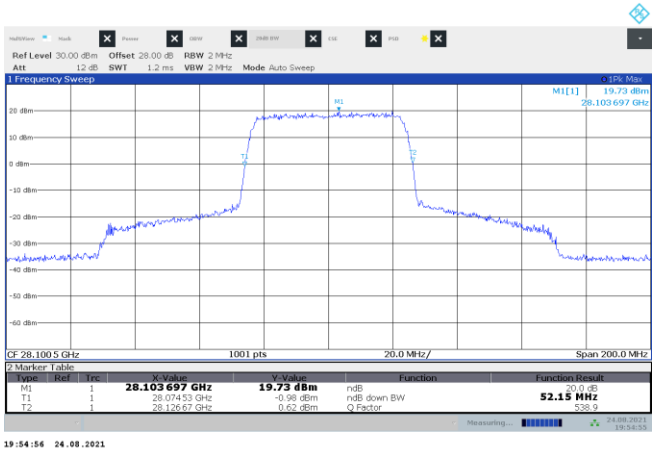


Figure 8.3-2: *20 dB bandwidth for 50 MHz channel, sample plot*

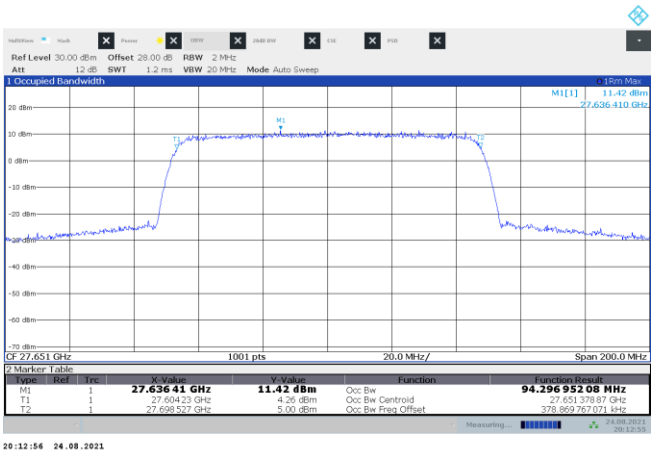


Figure 8.3-3: *99 % occupied bandwidth for 100 MHz channel, sample plot*

Figure 8.3-4: *20 dB bandwidth for 100 MHz channel, sample plot*

8.4 Emission limits

8.4.1 References, definitions and limits

FCC §30.203:

(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.

(b)(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.

(b)(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

FCC §30.404:

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(a)(2) When using transmissions employing digital modulation techniques in situations not covered in this section:

(a)(2)(i) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$A = 11 + 0.4(P-50) + 10 \log_{10}(B)$ (Attenuation greater than 56 decibels or to an absolute power of less than −13 dBm/MHz is not required.)

(a)(2)(ii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \text{ Log}_{10}$ (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation. The authorized bandwidth includes the nominal radio frequency bandwidth of an individual transmitter/modulator in block-assigned bands.

(a)(2)(iii) The emission mask in paragraph (a)(2)(i) of this section applies only to the band edge of each block of spectrum, but not to subchannels established by licensees. The value of P in the equation is the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The emission mask can be satisfied by locating a carrier of the subchannel sufficiently far from the channel edges so that the emission levels of the mask are satisfied. The emission mask shall use a value B (bandwidth) of 40 MHz, for all cases even in the case where a narrower subchannel is used (for instance the actual bandwidth is 10 MHz) and the mean output power used in the calculation is the sum of the output power of a fully populated channel. For block assigned channels, the out-of-band emission limits apply only outside the assigned band of operation and not within the band.

8.4.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 23, 2021

8.4.3 Observations, settings and special notes

The testing was performed using subclause 5.7 (conducted test at antenna port), 5.5.3 of ANSI C63.26 (substitution method) or 5.5.4 of ANSI C63.26 (field strength method). Radiated spurious emissions (cabinet radiation) measurements were performed while the antenna port was loaded with 50-Ohm termination. Radiated pre-scan field strength limit equivalent was derived from power limit: −13 dBm + 95.23 dB = 82.23 dBµV/m. Only 50 MHz channel was selected for the cabinet radiation test as it has a higher power density of the signal than the 56 and 100 MHz channels, also these measurements below 18 GHz were performed at the distance of 3 m, within the frequency range of 18–50 GHz at the distance of 30 cm, and above 50 GHz at the distance of 3 cm. All distances below 3 m were addressed with distance correction factor, calculated as follows: $20 \times \text{Log}_{10}$ (new distance [m] / 3 [m]).

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥ 3 × RBW
Detector mode	RMS

8.4.4 Test data

Frequency band: 27500–27925 MHz
Channel BW: 50 MHz
Channel: Low

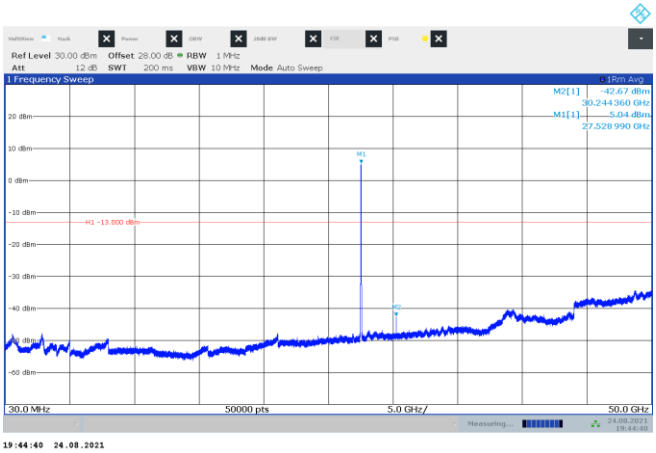


Figure 8.4-1: *Conducted spurious emissions*

Frequency band: 27500–27925 MHz
Channel BW: 50 MHz
Channel: Mid

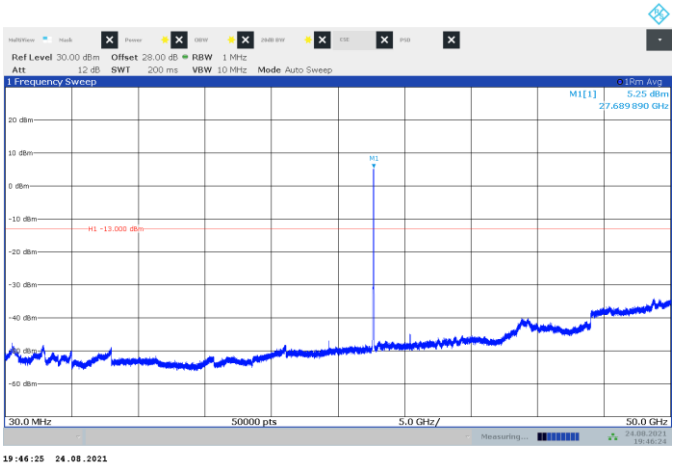


Figure 8.4-2: *Conducted spurious emissions*

Frequency band: 27500–27925 MHz
Channel BW: 50 MHz
Channel: Top

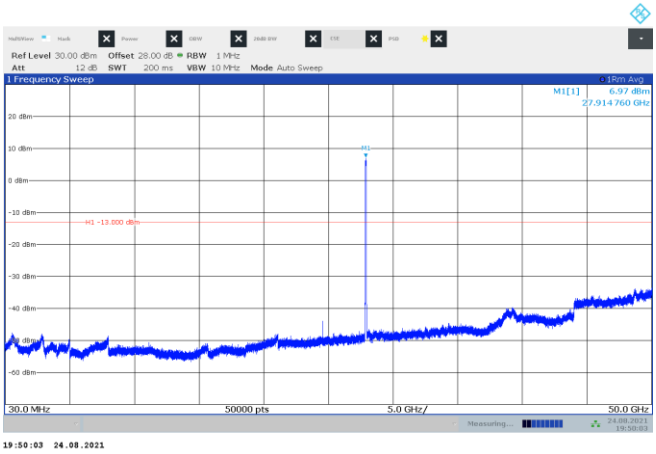


Figure 8.4-3: *Conducted spurious emissions*

Frequency band: 27925–28350 MHz
Channel BW: 50 MHz
Channel: Low

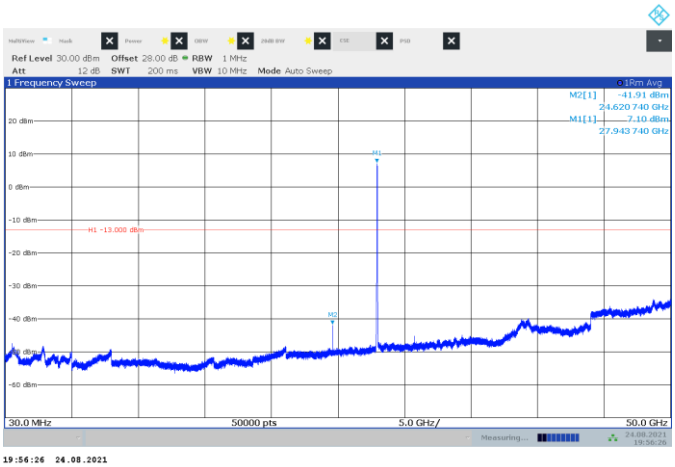


Figure 8.4-4: *Conducted spurious emissions*

Test data, continued

Frequency band: 27925–28350 MHz
Channel BW: 50 MHz
Channel: Mid

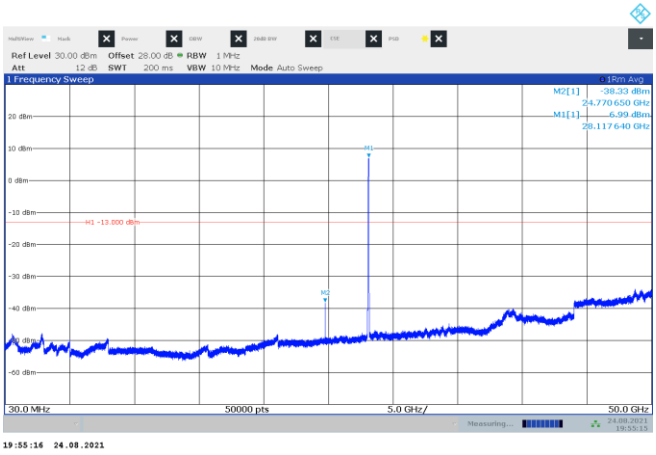


Figure 8.4-5: *Conducted spurious emissions*

Frequency band: 27925–28350 MHz
Channel BW: 50 MHz
Channel: Top

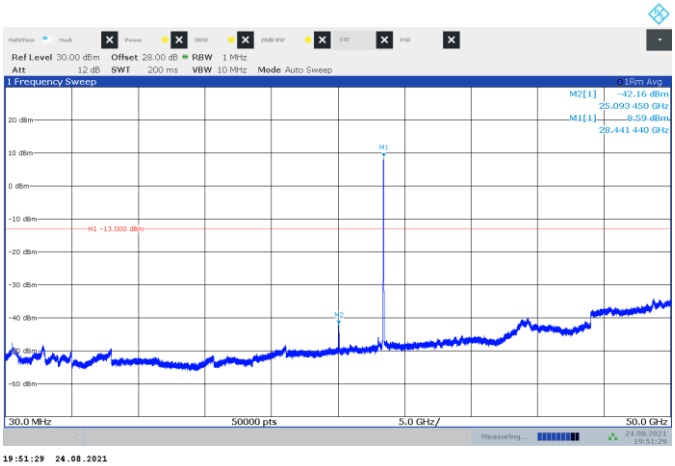


Figure 8.4-6: *Conducted spurious emissions*

Frequency band: 27500–27925 MHz
Channel BW: 100 MHz
Channel: Low

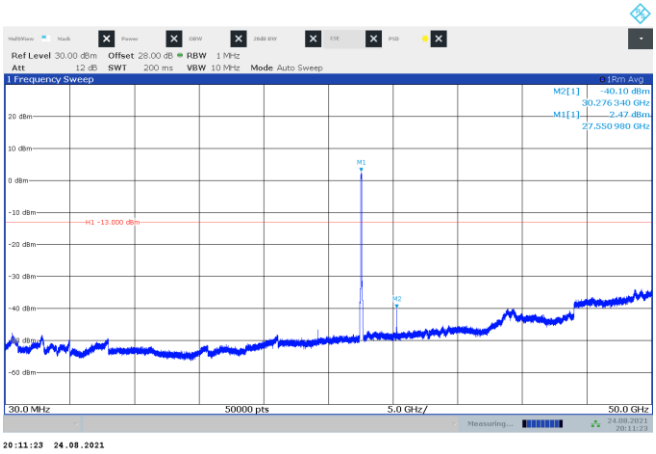


Figure 8.4-7: *Conducted spurious emissions*

Frequency band: 27500–27925 MHz
Channel BW: 100 MHz
Channel: Mid

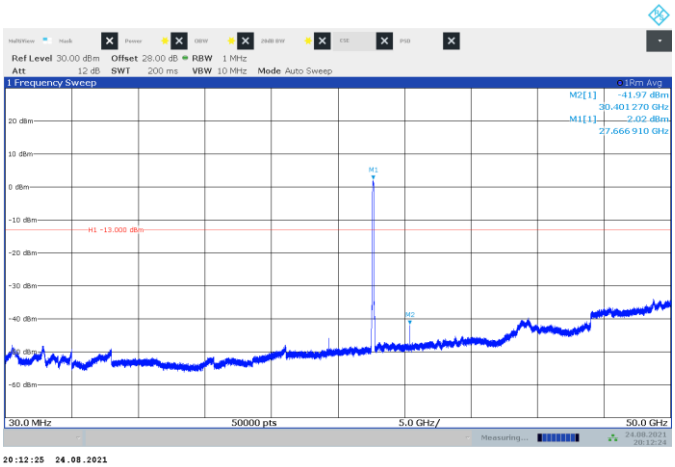


Figure 8.4-8: *Conducted spurious emissions*

Test data, continued

Frequency band: 27500–27925 MHz
Channel BW: 100 MHz
Channel: Top

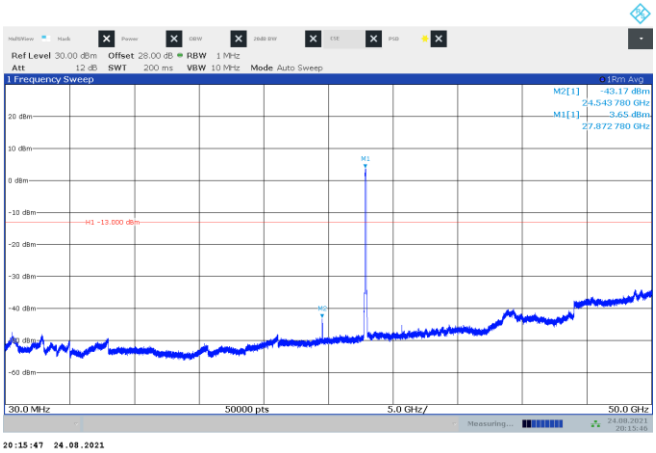


Figure 8.4-9: *Conducted spurious emissions*

Frequency band: 27925–28350 MHz
Channel BW: 100 MHz
Channel: Low

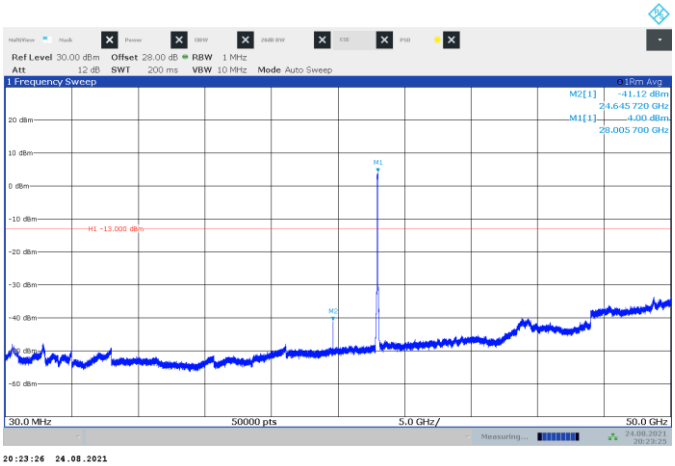


Figure 8.4-10: *Conducted spurious emissions*

Frequency band: 27925–28350 MHz
Channel BW: 100 MHz
Channel: Mid

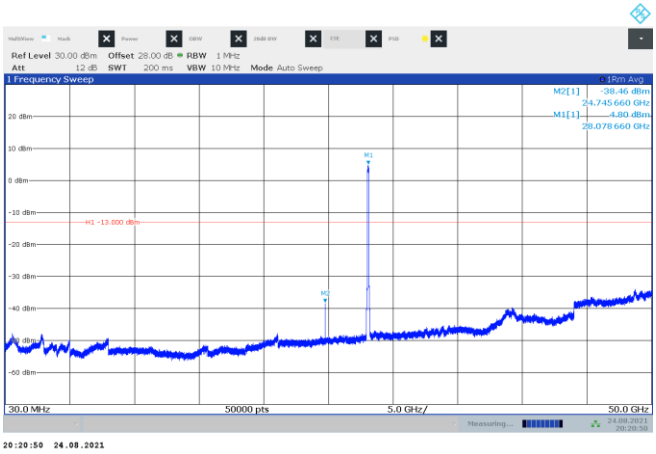


Figure 8.4-11: *Conducted spurious emissions*

Frequency band: 27925–28350 MHz
Channel BW: 100 MHz
Channel: Top

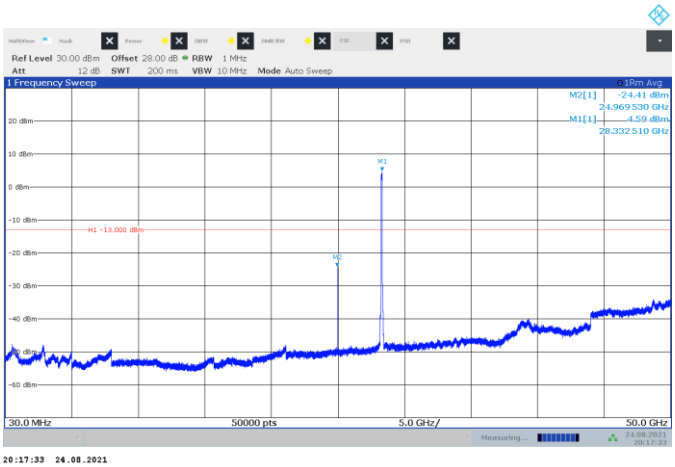


Figure 8.4-12: *Conducted spurious emissions*

Test data, continued

Frequency band: 27500–27925 MHz
Channel BW: 50 MHz
Channel: Low

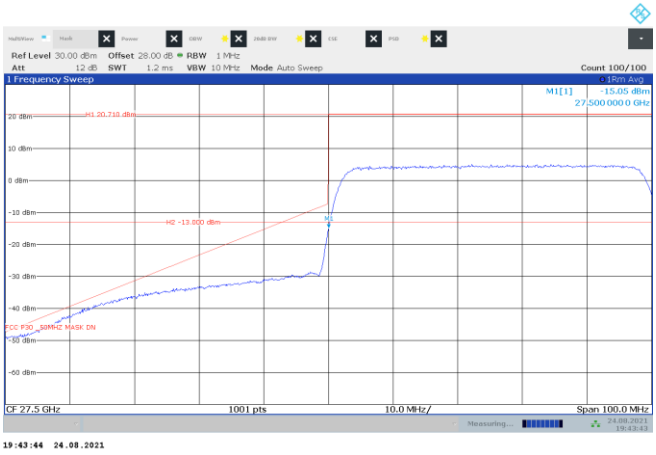


Figure 8.4-13: *Conducted emissions mask, band edge*

Frequency band: 27500–27925 MHz
Channel BW: 50 MHz
Channel: Top

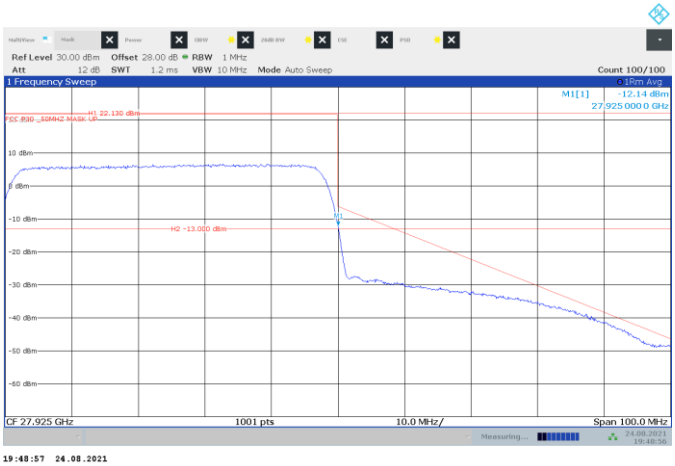


Figure 8.4-14: *Conducted emissions mask, band edge*

Frequency band: 27925–28350 MHz
Channel BW: 50 MHz
Channel: Low

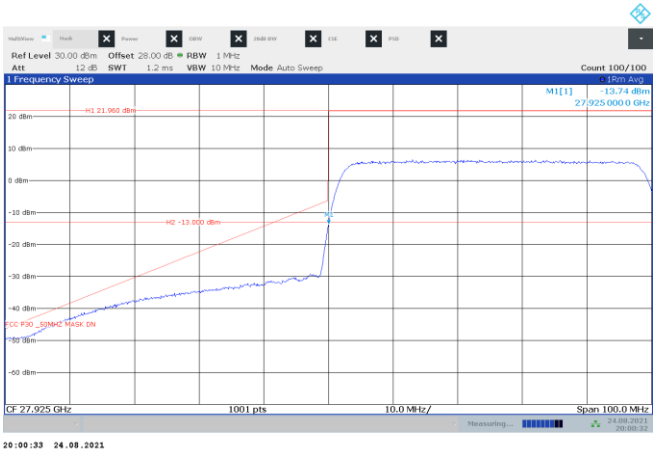


Figure 8.4-15: *Conducted emissions mask, band edge*

Frequency band: 27925–28350 MHz
Channel BW: 50 MHz
Channel: Top

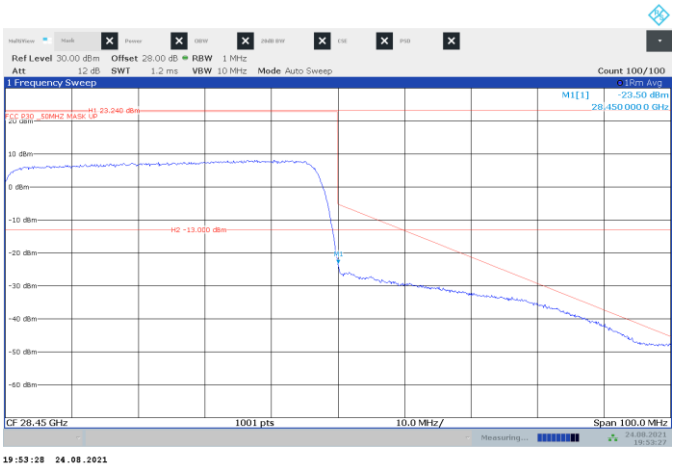


Figure 8.4-16: *Conducted emissions mask, band edge*

Test data, continued

Frequency band: 27500–27925 MHz
Channel BW: 100 MHz
Channel: Low

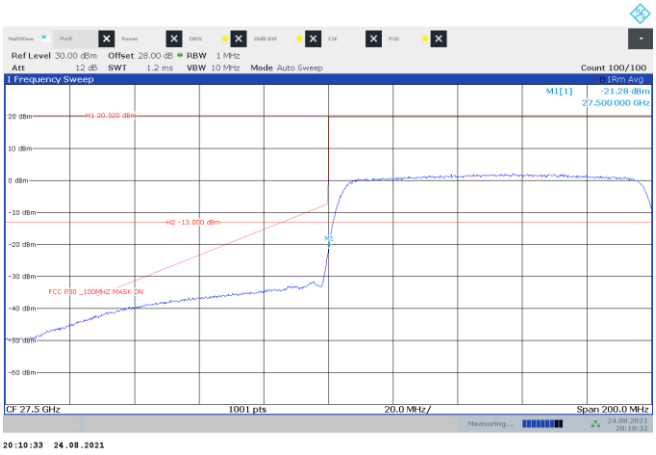


Figure 8.4-17: *Conducted emissions mask, band edge*

Frequency band: 27500–27925 MHz
Channel BW: 100 MHz
Channel: Top

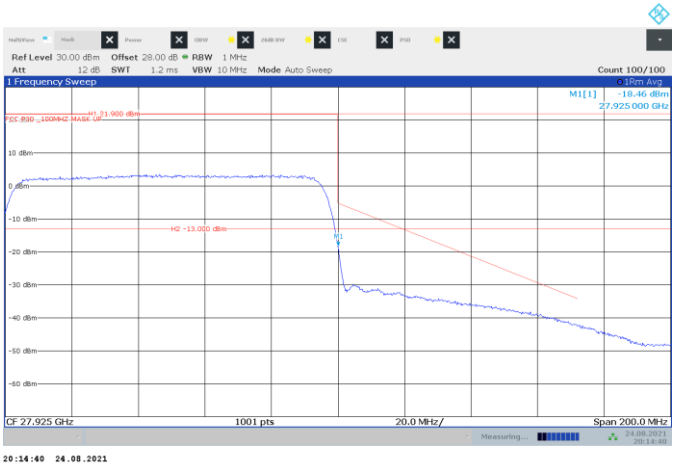


Figure 8.4-18: *Conducted emissions mask, band edge*

Frequency band: 27925–28350 MHz
Channel BW: 100 MHz
Channel: Low

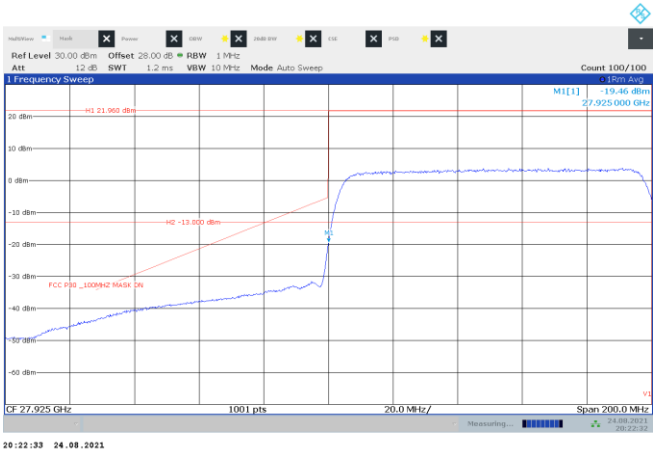


Figure 8.4-19: *Conducted emissions mask, band edge*

Frequency band: 27925–28350 MHz
Channel BW: 100 MHz
Channel: Top

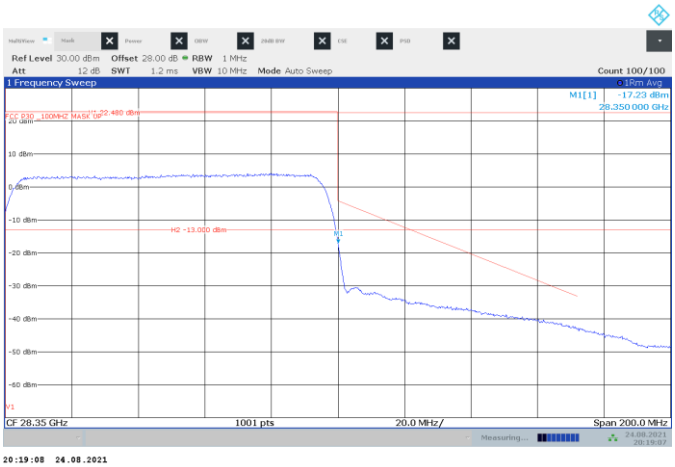


Figure 8.4-20: *Conducted emissions mask, band edge*

Test data, continued

Channel: Low/mid/top
Subband: Lower/upper
Channel BW: 50 MHz
Frequency range: Below 1 GHz

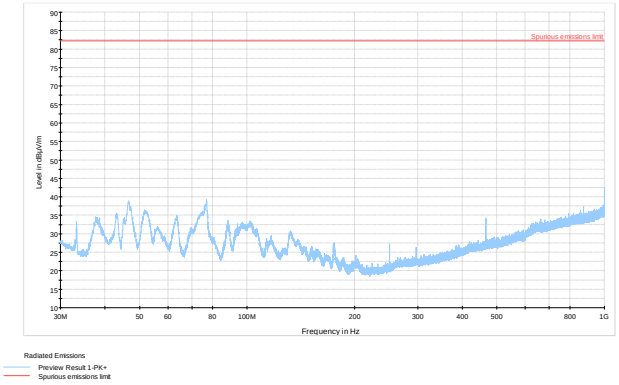


Figure 8.4-21: *Radiated spurious emissions*

Channel: Low/mid/top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 1–18 GHz

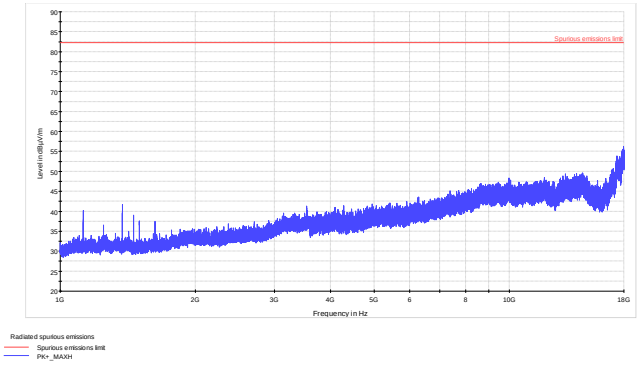


Figure 8.4-22: *Radiated spurious emissions*

Channel: Low/mid/top
Subband: Upper
Channel BW: 50 MHz
Frequency range: Below 1 GHz

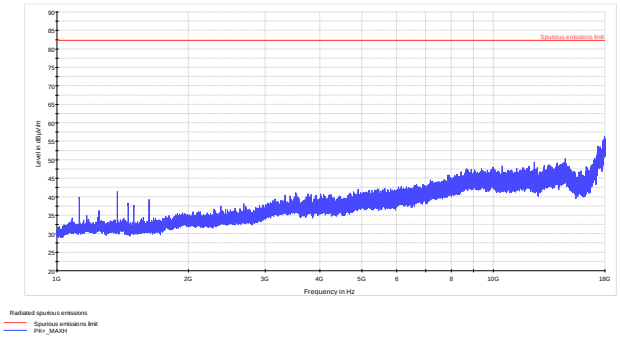


Figure 8.4-23: *Radiated spurious emissions*

Channel: Low
Subband: Lower
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

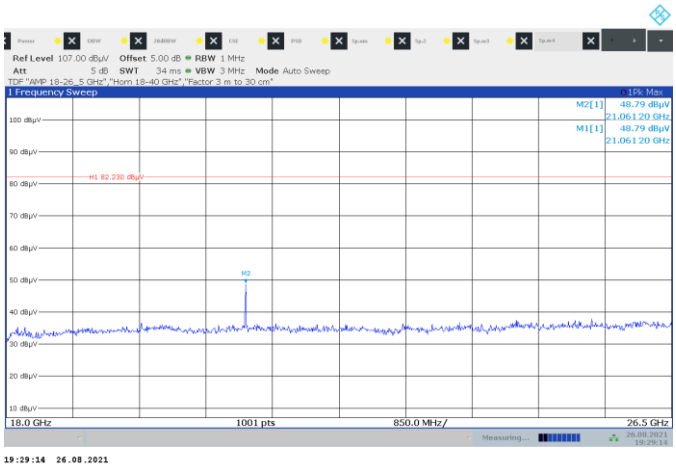


Figure 8.4-24: *Radiated spurious emissions*

Note: 21 GHz emission spike within 18–26.5 GHz band is a background noise, and it doesn't belong to the EUT.

Test data, continued

Channel: Mid
Subband: Lower
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

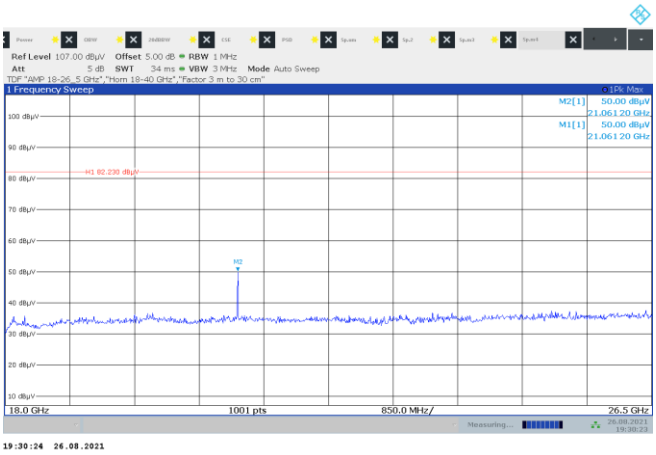


Figure 8.4-25: *Radiated spurious emissions*

Channel: Top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

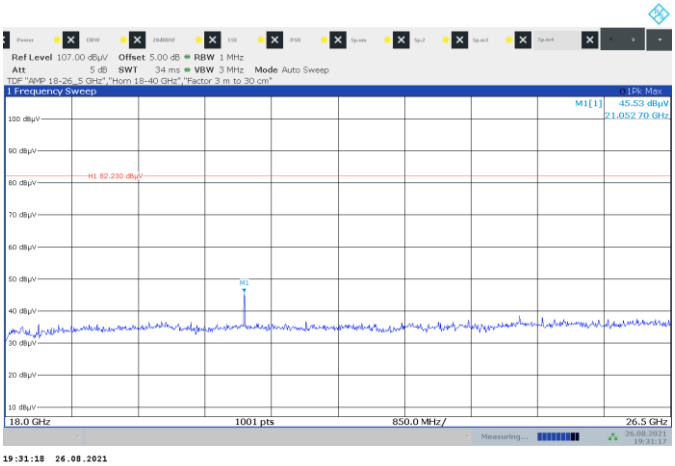


Figure 8.4-26: *Radiated spurious emissions*

Channel: Low
Subband: Upper
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

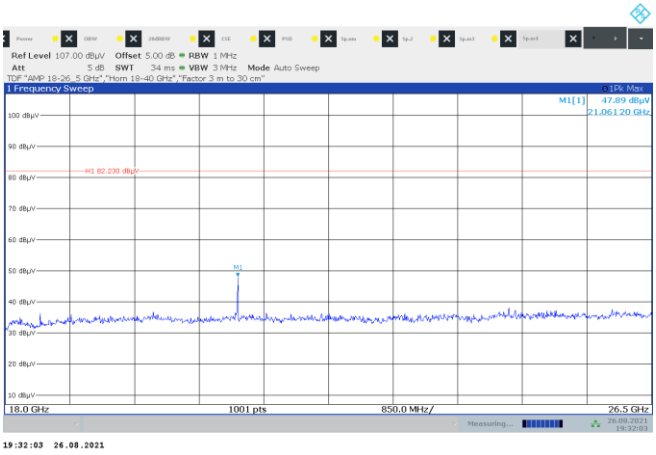


Figure 8.4-27: *Radiated spurious emissions*

Channel: Mid
Subband: Upper
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

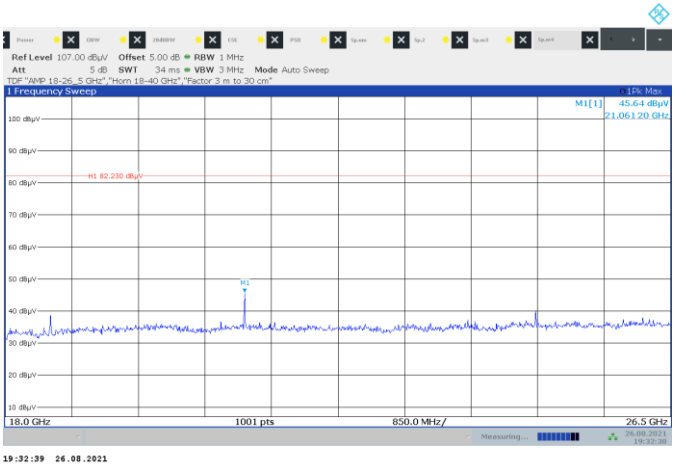


Figure 8.4-28: *Radiated spurious emissions*

Note: 21 GHz emission spike within 18–26.5 GHz band is a background noise, and it doesn't belong to the EUT.

Test data, continued

Channel: Top
Subband: Upper
Channel BW: 50 MHz
Frequency range: 18–26.5 GHz

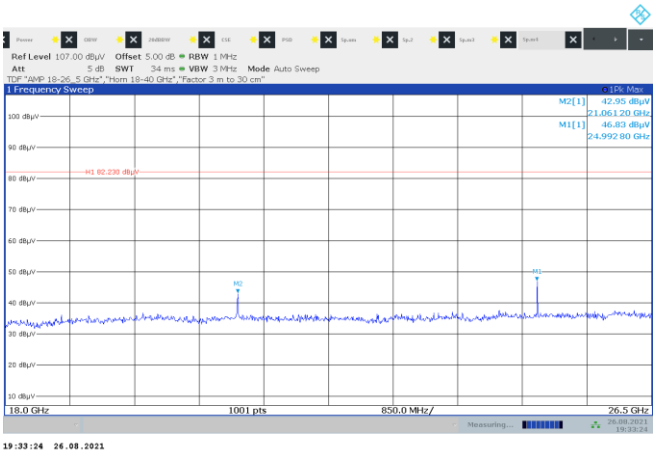


Figure 8.4-29: *Radiated spurious emissions*

Channel: Low
Subband: Lower
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

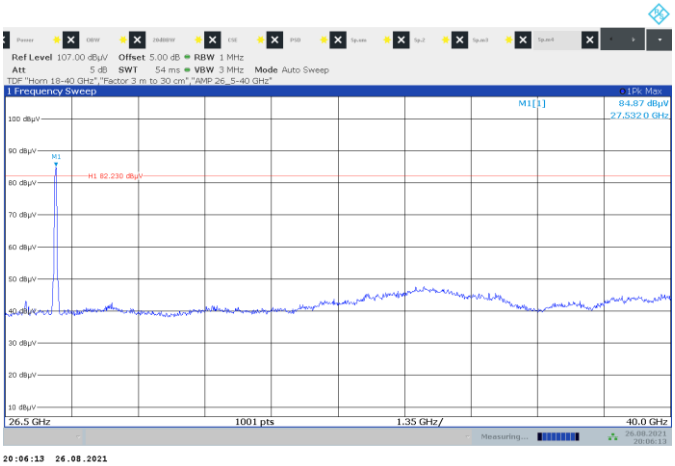


Figure 8.4-30: *Radiated spurious emissions*

Note: 21 GHz emission spike within 18–26.5 GHz band is a background noise, and it doesn't belong to the EUT.

Channel: Mid
Subband: Lower
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

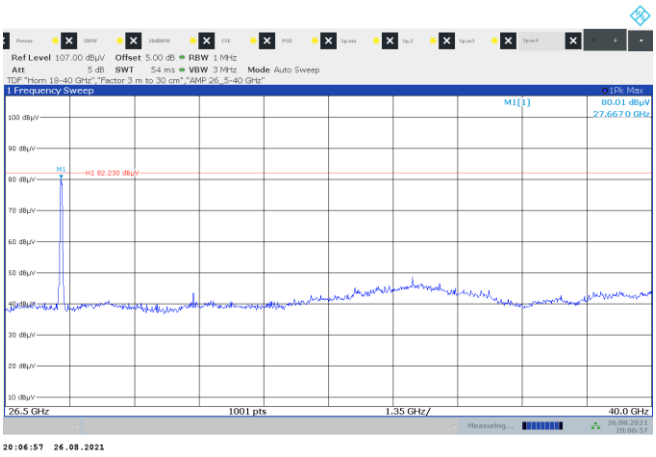


Figure 8.4-31: *Radiated spurious emissions*

Channel: Top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

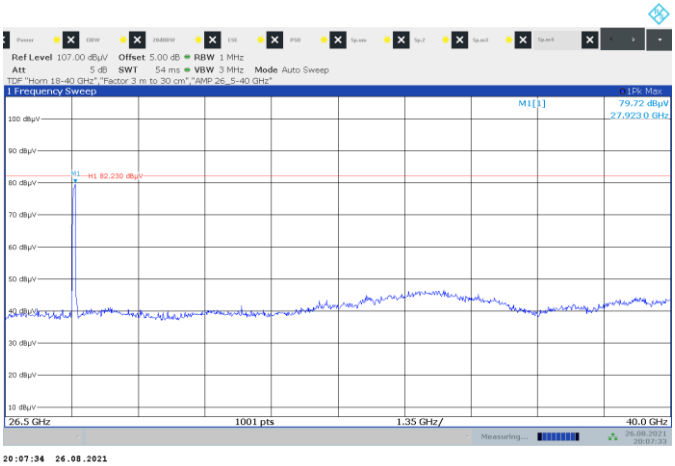


Figure 8.4-32: *Radiated spurious emissions*

Test data, continued

Channel: Low
Subband: Upper
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

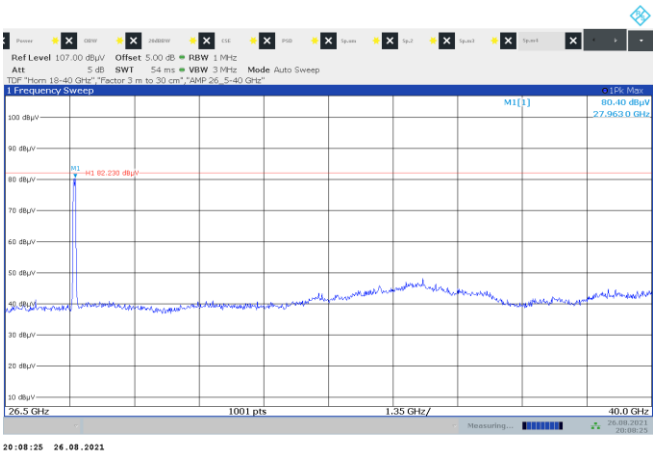


Figure 8.4-33: *Radiated spurious emissions*

Channel: Mid
Subband: Upper
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

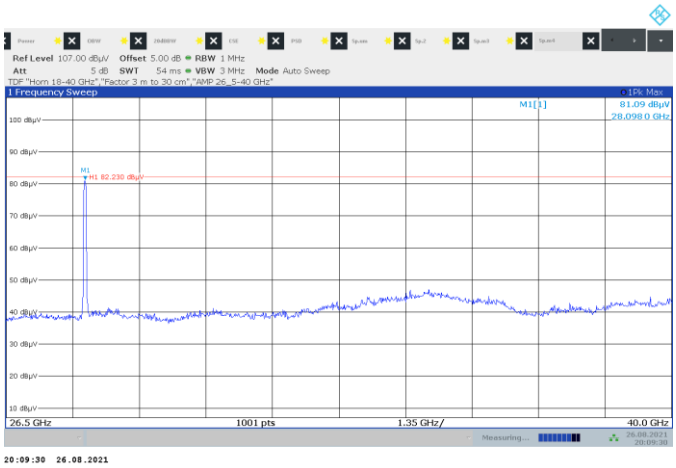


Figure 8.4-34: *Radiated spurious emissions*

Channel: Top
Subband: Upper
Channel BW: 50 MHz
Frequency range: 26.5–40 GHz

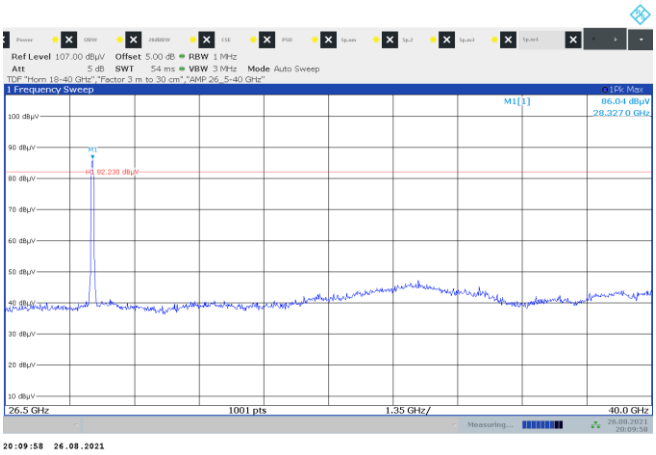


Figure 8.4-35: *Radiated spurious emissions*

Channel: Low
Subband: Lower
Channel BW: 50 MHz
Frequency range: 40–50 GHz

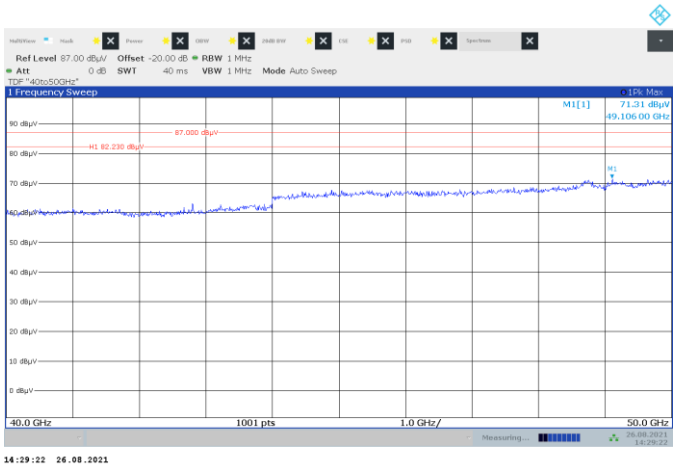


Figure 8.4-36: *Radiated spurious emissions*

Test data, continued

Channel: Mid
Subband: Lower
Channel BW: 50 MHz
Frequency range: 40–50 GHz

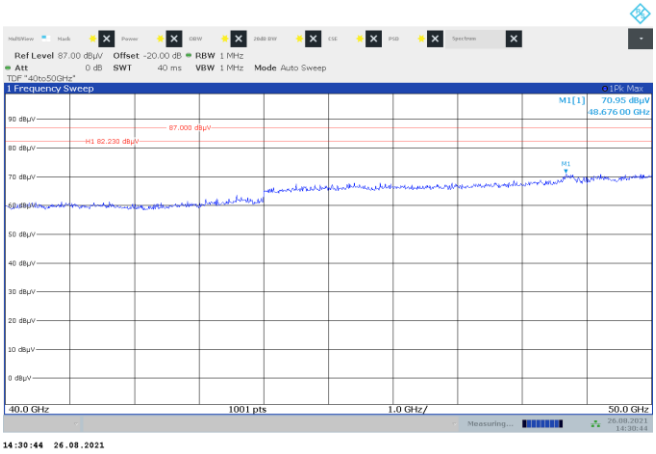


Figure 8.4-37: *Radiated spurious emissions*

Channel: Top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 40–50 GHz

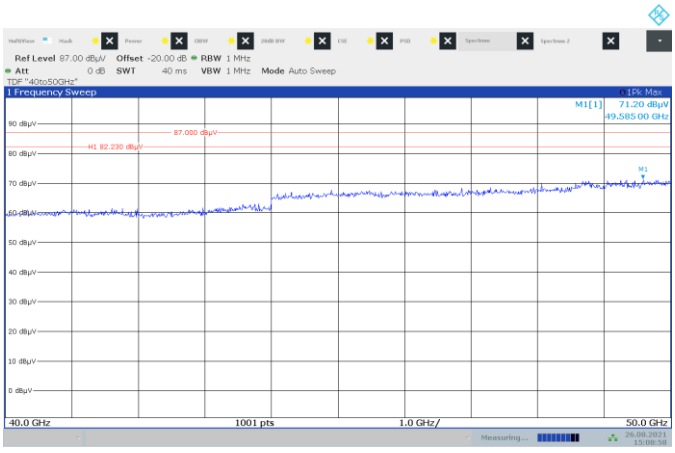


Figure 8.4-38: *Radiated spurious emissions*

Channel: Low
Subband: Upper
Channel BW: 50 MHz
Frequency range: 40–50 GHz

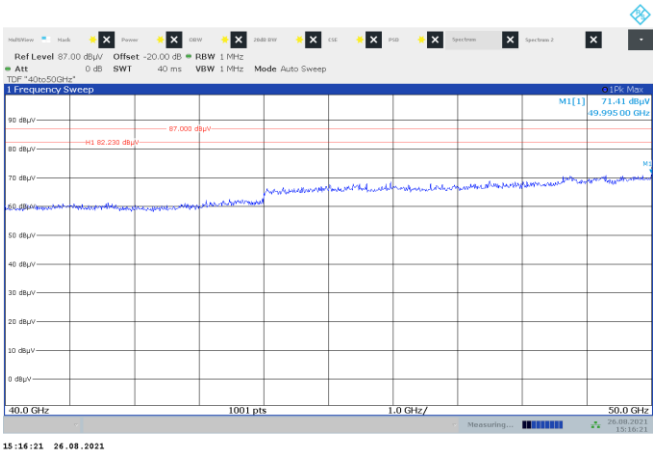


Figure 8.4-39: *Radiated spurious emissions*

Channel: Mid
Subband: Upper
Channel BW: 50 MHz
Frequency range: 40–50 GHz

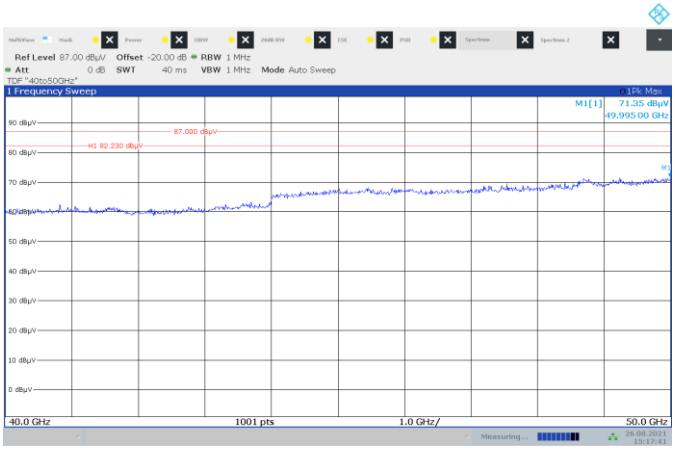


Figure 8.4-40: *Radiated spurious emissions*

Test data, continued

Channel: Top
Subband: Upper
Channel BW: 50 MHz
Frequency range: 40–50 GHz

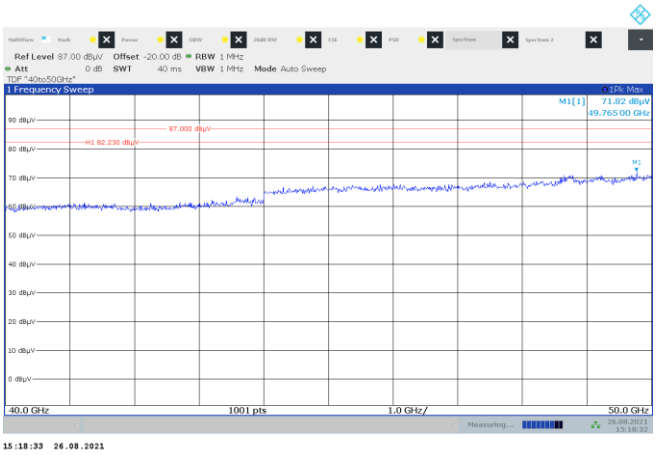


Figure 8.4-41: *Radiated spurious emissions*

Channel: Low
Subband: Lower
Channel BW: 50 MHz
Frequency range: 50–75 GHz

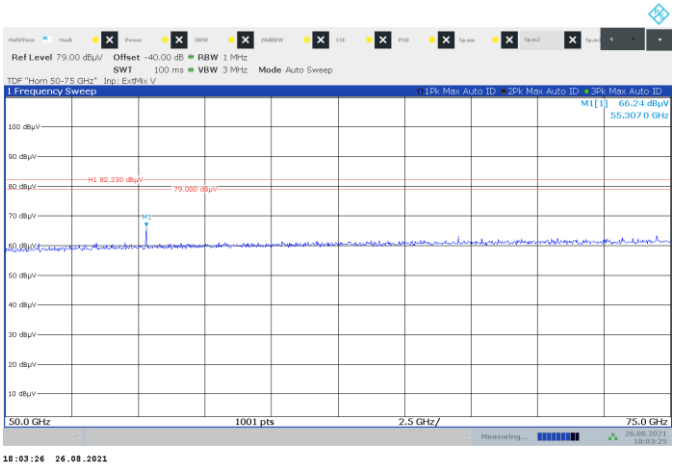


Figure 8.4-42: *Radiated spurious emissions*

Channel: Mid
Subband: Lower
Channel BW: 50 MHz
Frequency range: 50–75 GHz

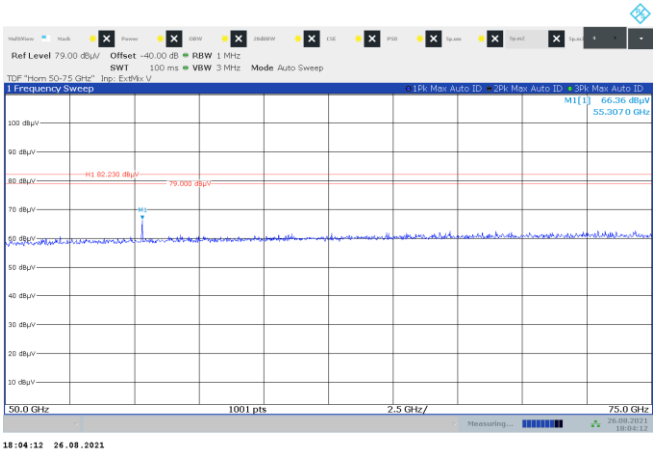


Figure 8.4-43: *Radiated spurious emissions*

Channel: Top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 50–75 GHz

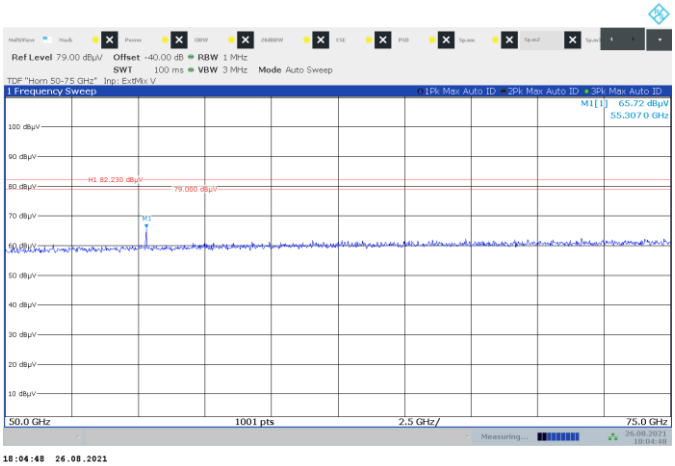


Figure 8.4-44: *Radiated spurious emissions*

Test data, continued

Channel: Low
Subband: Upper
Channel BW: 50 MHz
Frequency range: 50–75 GHz

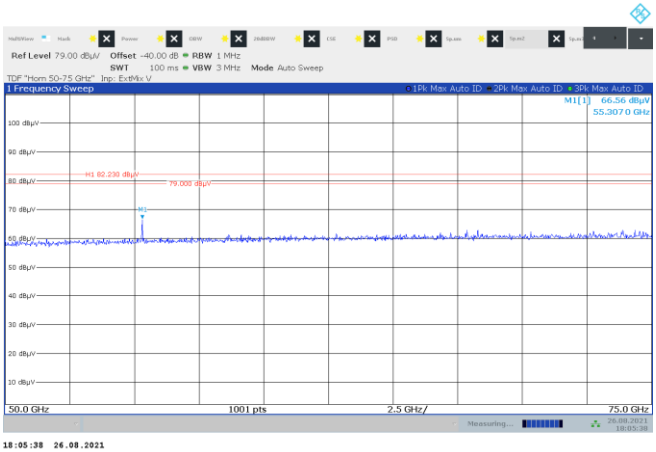


Figure 8.4-45: *Radiated spurious emissions*

Channel: Mid
Subband: Upper
Channel BW: 50 MHz
Frequency range: 50–75 GHz

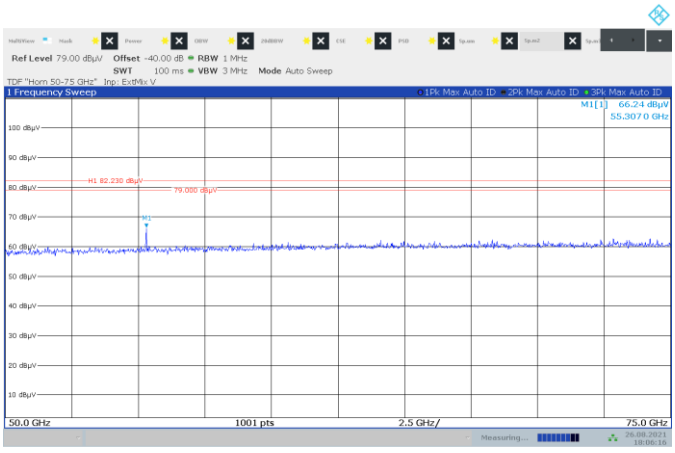


Figure 8.4-46: *Radiated spurious emissions*

Channel: Top
Subband: Upper
Channel BW: 50 MHz
Frequency range: 50–75 GHz

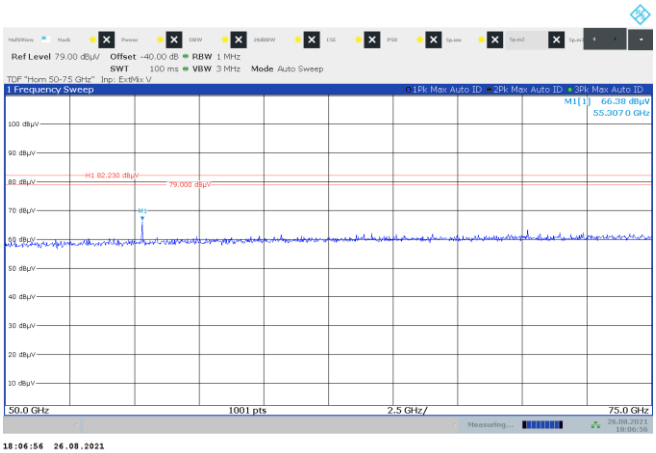


Figure 8.4-47: *Radiated spurious emissions*

Channel: Low
Subband: Lower
Channel BW: 50 MHz
Frequency range: 75–100 GHz

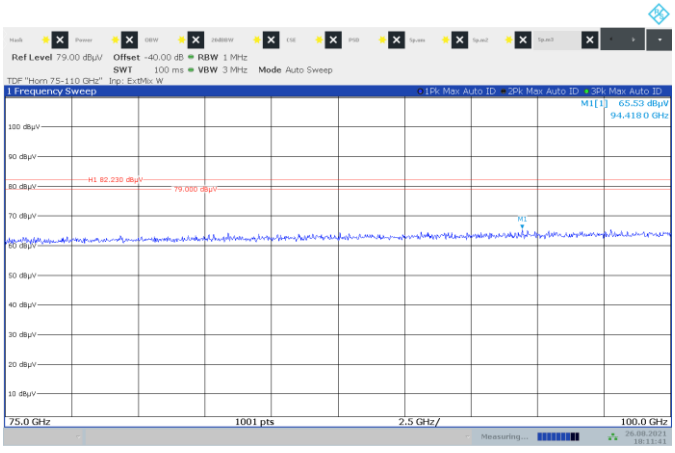


Figure 8.4-48: *Radiated spurious emissions*

Test data, continued

Channel: Mid
Subband: Lower
Channel BW: 50 MHz
Frequency range: 75–100 GHz

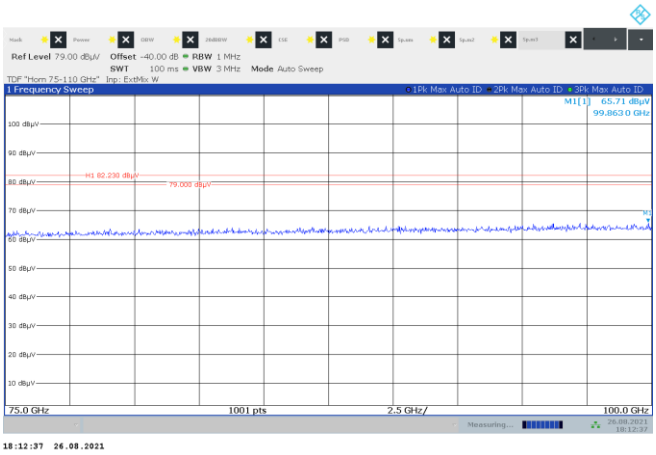


Figure 8.4-49: *Radiated spurious emissions*

Channel: Top
Subband: Lower
Channel BW: 50 MHz
Frequency range: 75–100 GHz

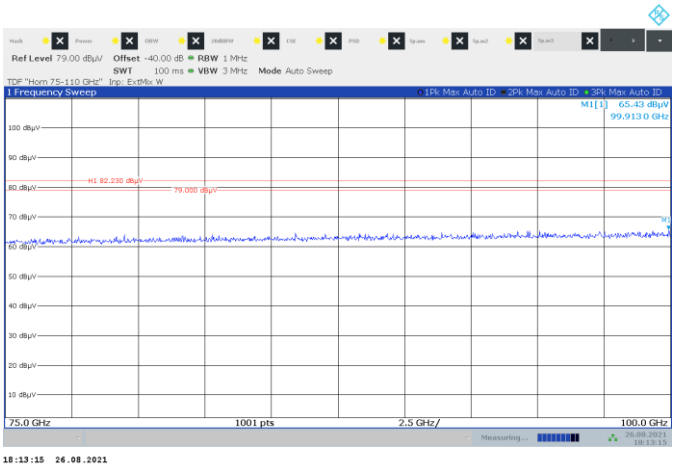


Figure 8.4-50: *Radiated spurious emissions*

Channel: Low
Subband: Upper
Channel BW: 50 MHz
Frequency range: 75–100 GHz

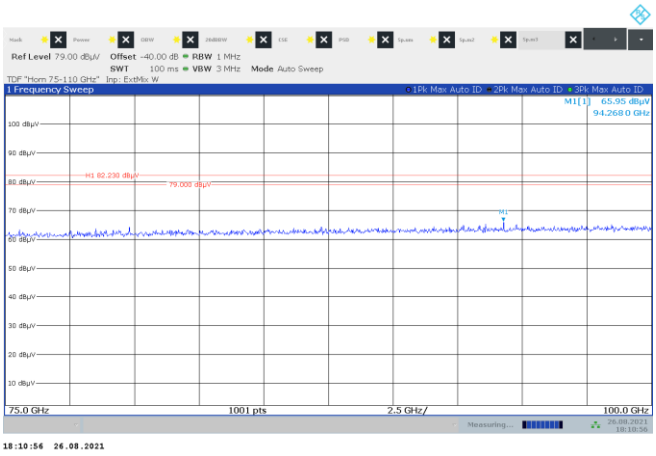


Figure 8.4-51: *Radiated spurious emissions*

Channel: Mid
Subband: Upper
Channel BW: 50 MHz
Frequency range: 75–100 GHz

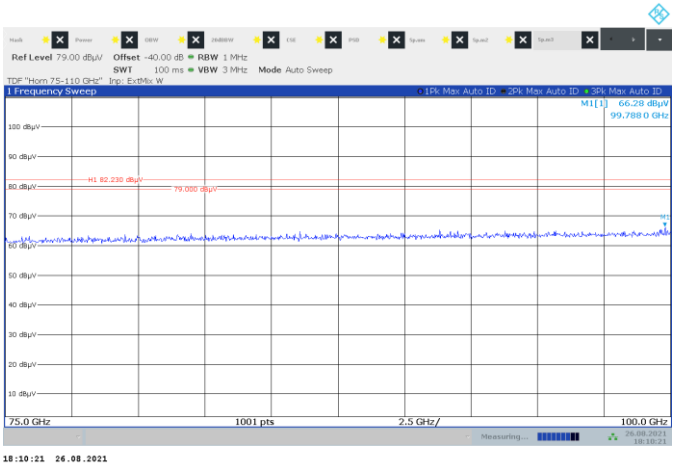


Figure 8.4-52: *Radiated spurious emissions*

Test data, continued

Channel: Top
Subband: Upper
Channel BW: 50 MHz
Frequency range: 75–100 GHz

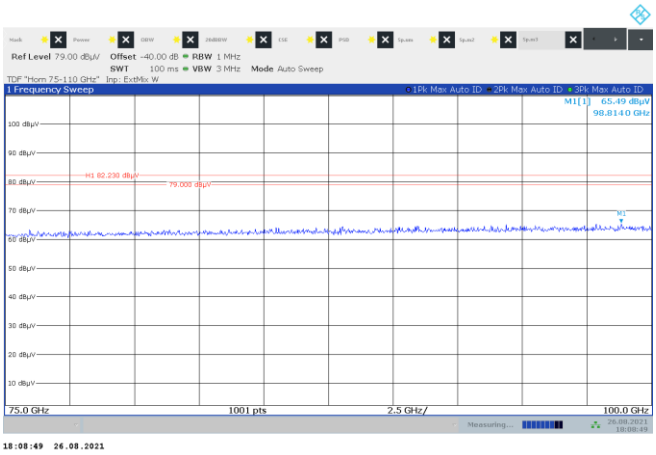


Figure 8.4-53: *Radiated spurious emissions*

8.5 Frequency stability

8.5.1 References, definitions and limits

FCC §30.402:

The carrier frequency of each transmitter authorized under this subpart must be maintained within the following percentage of the reference frequency (unless otherwise specified in the instrument of station authorization the reference frequency will be deemed to be the assigned frequency): 0.001%

FCC §2.1055:

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
(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.
(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.

8.5.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 27, 2021

8.5.3 Observations, settings and special notes

Testing was performed using subclause 5.6 of ANSI C63.26-2015
Offset (in ppm) was calculated as follows: $\frac{F_{Measured}-F_{reference}}{F_{reference}} \times 10^6$

8.5.4 Test data

Table 8.5-1: *Frequency drift*

Test conditions	Frequency, Hz	Drift, ppm	Limit, ±ppm
+55 °C, Nominal voltage	28299997894	-0.040	10
+40 °C, Nominal voltage	28299999141	0.004	10
+30 °C, Nominal voltage	28300001458	0.086	10
+20 °C, Nominal voltage +15 %	28299998967	-0.002	10
+20 °C, Nominal voltage	28299999034	Reference	
+20 °C, Nominal voltage −15 %	28299999003	-0.001	10
+10 °C, Nominal voltage	28299996709	-0.082	10
0 °C, Nominal voltage	28299993733	-0.187	10
−10 °C, Nominal voltage	28299992395	-0.235	10
−20 °C, Nominal voltage	28299994135	-0.173	10
−30 °C, Nominal voltage	28300000258	0.043	10

Test results.

Highest positive measured frequency drift was 6.639 kHz. Highest negative measured frequency drift was −2.424 kHz.
Minimum distance of 99% OBW from the band edge is 1 MHz.

8.6 Modulation characteristics

8.6.1 References, definitions and limits

FCC §2.1047:

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

8.6.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	August 27, 2021

8.6.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	2 MHz
Detector mode	Peak, max-hold

8.6.4 Test data

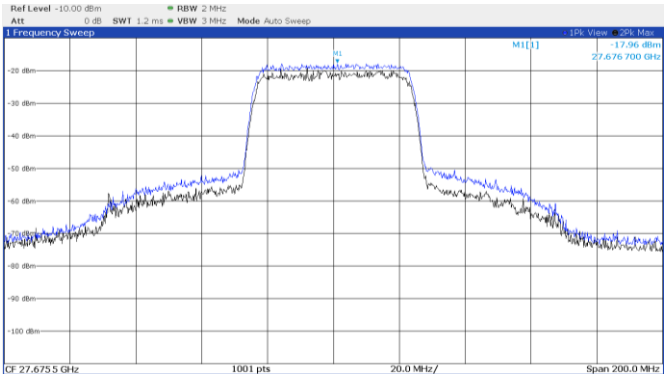
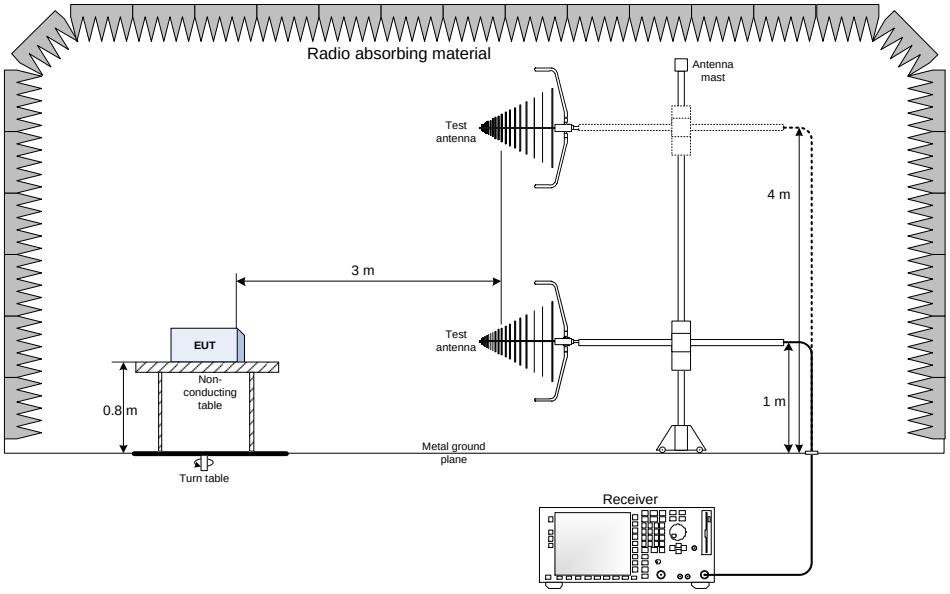


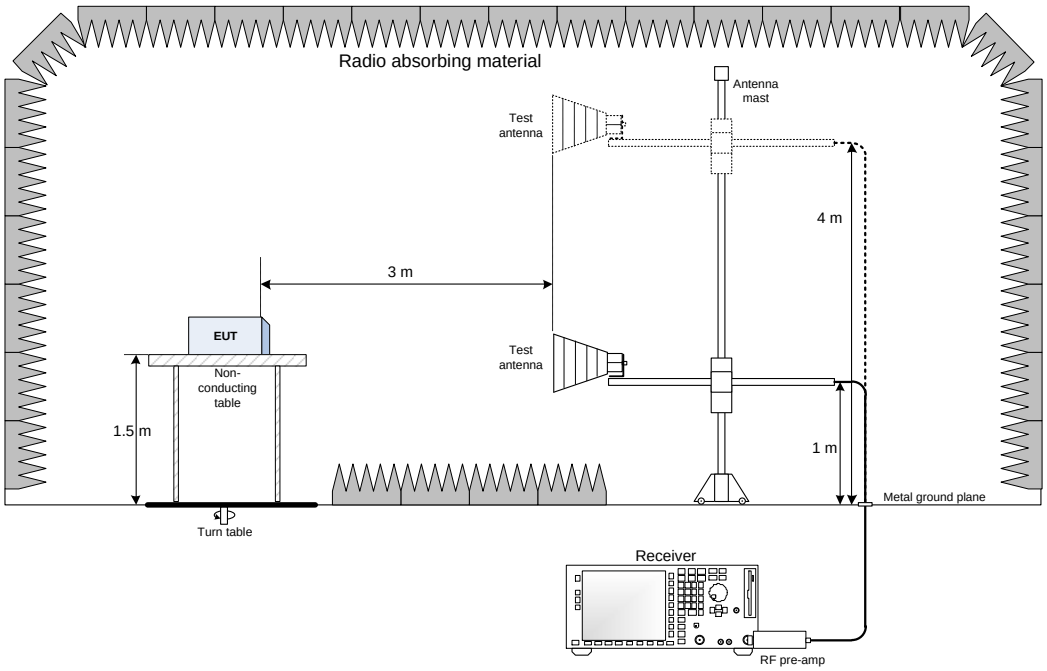
Figure 8.6-1: *Plot showing envelope of a digital modulation (Blue: 256QAM, Black: 4QAM)*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Antenna port set-up