TEST REPORT

Testing laboratory:
SK Tech Co., Ltd.
88, Geulgaeul-ro, 81beon-gil,
Wabu-eup, Namyangju-si,
Gyeonggi-do, Korea
TEL: +82-31-576-2204
FAX: +82-31-576-2205

Test Report Number: SKT-RFC-220003
Date of issue: October 5, 2022

Applicant:	**Intellian Technologies, Inc.** 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri) Pyeongtaek-si, Gyeonggi-do, 17709 Korea
Manufacturer:	**Intellian Technologies, Inc.** 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri) Pyeongtaek-si, Gyeonggi-do, 17709 Korea
Product:	Marine Fleet Broadband
Model:	F4-A500-S, F4-A500-R
FCC ID:	XXZ-INTFB500
IC:	26236-INTFB500
Project number:	SKTEU22-1169
EUT received:	August 22, 2022

Applied standards:	ANSI C63.26-2015 ANSI C63.4a-2017
Rule parts:	FCC 47 CFR Part 2, Part 25 RSS-170, Issue 3, July 2015 RSS-Gen Issue 5, April 2018
Equipment Class:	**TNB: Licensed Non-Broadcast Station Transmitter**
Type of Radio Equipment:	**Mobile Earth Station**
Remarks to the standards:	None

The above equipment has been tested by SK Tech Co., Ltd., and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product or system, which was tested.

Changwon Yang / **Testing Engineer**

Jongsoo Yoon / **Technical Manager**

This report shall not be reproduced except in full, without the written approval of SK Tech Co., Ltd. The client should not use it to claim product endorsement by any government agencies.

Revision History of Test Report

Rev.	Revisions	Effect page	Approved by	Date
-	Initial issue	All	Jongsoo Yoon	Oct. 05, 2022

TABLE OF CONTENTS

1 Summary of test results 4

2 Description of equipment under test (EUT) 5

3 Test and measurement conditions 7

3.1. Operating modes 7
3.2. Description of support units (accessory equipment) 8
3.3. Interconnection and I/O cables 8
3.4. Test configuration (arrangement of EUT) 9
3.5. Test date 9

4 Facilities and accreditations 10

4.1. Facilities 10
4.2. Accreditations 10
4.3. List of test and measurement instruments 10

5 Test and measurements 12

5.1. RF Power Output / Power limits 12
5.2. Occupied Bandwidth 22
5.3. Spurious Emissions at Antenna Terminals (conducted emissions) 28
5.4. Field Strength of Spurious Radiation (radiated emissions) 49
5.5. Protection of Aeronautical Radionavigation-Satellite Service (conducted emissions) 63
5.6. Transmitter Frequency Stability 68

1 Summary of test results

Requirement	FCC, CFR 47 Section	ISED, RSS section	Result
RF power output / Power limits	§2.1046, 25.204(a)	RSS-170, 5.3.2	Meets the requirements
Occupied bandwidth	§2.1049	RSS-Gen 6.7	Meets the requirements
Spurious emissions at antenna terminals (conducted emissions)	§2.1051, 25.202(f)	RSS-170, 5.4.3.1	Meets the requirements
Field strength of spurious radiation (radiated emissions)	§2.1053, 25.202(f)	RSS-170, 5.4.3.1	Meets the requirements
Limits on emissions from mobile earth stations for protection of aeronautical radio navigation satellite service / Carrier-off state emissions (conducted emissions)	§2.1051, 25.216(h),(i)	RSS-170, 5.4.3.2, 5.4.4	Meets the requirements
Transmitter frequency stability / Frequency tolerances	§2.1055, 25.202(d)	RSS-170, 5.2, RSS-Gen 6.11	Meets the requirements

Note: -

2 Description of equipment under test (EUT)

Product:	Marine Fleet Broadband
Model:	F4-A500-S, F4-A500-R
Serial number:	None (prototype)
Hardware version:	prototype
Software version:	prototype

Product Marketing Name (PMN):	FB500
Hardware Version Identification Number (HVIN):	F4-A500-S, F4-A500-R
Firmware Version Identification Number (FVIN):	-
Host Marketing Name (HMN):	-

Model differences:

Model name	Difference	Tested (checked)
F4-A500-S	fully tested model that was provided by the applicant. Stand-alone, support all functions	☒
F4-A500-R	Listed without the tests by the applicant's request. Rack mount, support all functions	☐

Technical data:

Transmit frequency	1 626.5 MHz to 1 660.5 MHz 2412 MHz to 2462 MHz (NOTE 1)
Nominal EIRP	22 dBW (52 dBm)
Nominal antenna gain	19.39 dBi
Type of modulation	16-QAM, Pi/4 QPSK
Authorized/Necessary bandwidth	200 kHz
Transmitter output power (conducted) (NOTE 2)	33.45 dBm (average power; calculated value with 2 combined ports)
Transmitter output power (radiated)	52.8 dBm (190.5 W) (calculated value with 2 combined ports and antenna gain)
Maximum occupied bandwidth	167.8 kHz
Antenna type (NOTE 3)	Patch array antenna
Power source	DC 24 V from power supply
Operation temperature range	-25 °C to +55 °C

Note:
1. *The EUT incorporates an already certified WiFi module (FCC ID: VVX-LM811-04XX, IC: 10531A-LM811), and this test report did not contain the test results for the WiFi module*
2. *The EUT has two output ports which is located at FEM board and connected to the patch antenna. The EUT has one transmit chain and the transmit signal path is internally split by the Divider in FEM board, and therefore the output power will be the same at each port.*
3. *All radiating 19 patches are connected together and activated at the same time. The direction antenna gain was directly measured when radiating from all 19 patches. The additional array gain (e.g. beamforming gain) was not required to be added during the conducted measurements.*

I/O port	Type	Q'ty	Remark
EUT, Above Deck Unit (ADU) / Antenna Unit			
Antenna	LMR200, N to TNC Type (TX, RX, 48V DC Power(Input))	1	
EUT, Below Deck Unit (BDU)			
Antenna	TNC Type (TX, RX, 48V DC Power(Output), 30 m)	1	
POTS (Plain Old Telephone Service) Phone	RJ-14	1	
WAN (Wide Area Grounding Power Network)	RJ-45	4	
Power	4-pin cable, 10.8~30 V DC (Recommended Voltage: 24 V DC)	1	
Wi-Fi	Reverse SMA Antenna connector	1	
GPIO	16-pin AWG 24 unscreened wire type	1	
USIM Card	SIM Card	1	

Modification of EUT during the compliance testing: none

3 Test and measurement conditions

3.1. Operating modes

Operating modes of the sample:

No.	Description
-	Normal operating mode: the product can support the following transmitting modes.

Bearer Identifier	Burst duration [ms]	Symbol rate [ksym/s]	Authorized/Necessary bandwidth [kHz]	Modulation	System designator
R5T1XD-1B	5	33.6	200	16-QAM	200KD1W
R5T2XD-1B		2 × 33.6			
R5T4.5XD-1B		4.5 × 33.6			
R20T1XD-1B	20	33.6			
R20T2XD-1B		2 × 33.6			
R20T4.5XD-2B		4.5 × 33.6			
R5T2QD-1B	5	2 × 33.6	200	Pi/4 QPSK	200KG1W
R5T4.5QD-1B		4.5 × 33.6			
R20T0.5QD-1B	20	0.5 × 33.6			
R20T1QD-1B		33.6			
R20T2QD-1B		2 × 33.6			
R20T4.5QD-1B		4.5 × 33.6			

Operating modes used for the Test:

No.	Operating mode
1	Normal operating mode: (a) The EUT was operated in the special Test mode, continuously transmitting the modulated RF signals without an off-time interval. The tests were performed regardless of the burst duration. (b) The lowest and highest frequency were placed on frequencies slightly due to the bandwidth. (1) f_{LOW}: 1626.6 MHz (2) f_{MID}: 1643.5 MHz (3) f_{HIGH}: 1660.4 MHz (c) The tests were performed for each Symbol rate and/or Modulation.
2	TX off, carrier off state
3	CW carrier activated for the measurement of frequency stability

3.2. Description of support units (accessory equipment)

The following support units or accessories were used to form a representative test configuration during the tests.

#	Equipment	Manufacturer	Model No.	Serial No.
1	Notebook	HP	HSN-I14C-5H	-
2	Notebook	HP	CHR0M1A15H	00081000DP
3	AC Adapter for #1	HP	PPP009D	-
4	AC Adapter for #2	HP	PPP012C-S	-
5	DC power supply	Keysight	E3634A	MY57396006

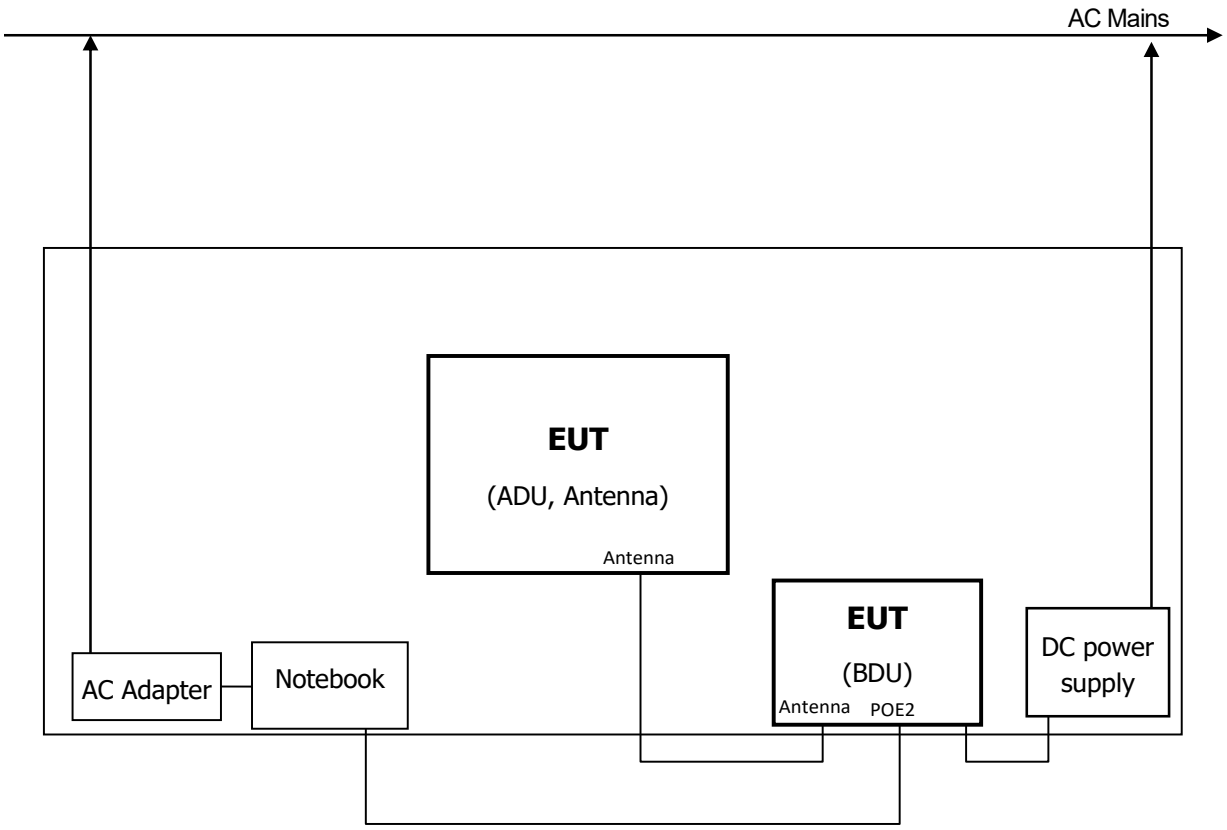
3.3. Interconnection and I/O cables

The following support units or accessories were used to form a representative test configuration during the tests.

#	Start		End		Cable	
	Name	I/O port	Name	I/O port	length (m)	shielded (Y/N)
1	EUT (ADU, Antenna)	(Antenna removed)	Dummy load	-	1.2	Y
2	EUT (ADU, Antenna)	Antenna	EUT (BDU)	Antenna	20.0	Y
3	EUT (BDU)	POWER	DC power supply	DC output	1.0	N
4	EUT (BDU)	POE2	Notebook	LAN	1.0	Y
5	DC power supply	AC Input	AC Mains	AC Mains	1.5	N
6	Notebook	DC Input	AC adapter	DC output	1.7	N
7	AC Adapter	AC Input	AC Mains	AC Mains	1.6	N

Note: *All the operating conditions including the cable connection were selected by the applicant.*

3.4. Test configuration (arrangement of EUT)



3.5. Test date

Date Tested	September 6, 2022 - September 19, 2022

4 Facilities and accreditations

4.1. Facilities

All of the measurements described in this report were performed at SK Tech Co., Ltd.

Site I: 88, Geulgaeul-ro, 81beon-gil, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea
Site II: 124-8, Geulgaeul-ro, Wabu-eup, Namyangju-si, Gyeonggi-do, Korea

The sites are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-4. The sites comply with the Normalized Site Attenuation requirements given in ANSI C63.4, and site VSWR requirements specified in CISPR 16-1-4. The FAR used for the radiated spurious emissions fulfills the NSA requirements specified in ETSI TS 102 321 V1.1.1 (2004-05) and ETSI TR 102 273-2 V1.2.1 (2001-12). The measuring apparatus and ancillary equipment conform to CISPR 16-1 series.

4.2. Accreditations

The laboratory has been also notified to FCC and ISED by RRA as a Conformity Assessment Body, and designated to perform compliance testing on equipment subject to Certification under Parts 15, 18, 22, 24, 25, 27, 74, 90, 95, 97 and 101 of the FCC Rules, and RSS-GEN, RSS-170, RSS-210, RSS-247, RSS-248, and RSS-102 (RF Exp.)[MEAS].

Designation No.	KR0007
Company Number (IC)	5429A

4.3. List of test and measurement instruments

4.3.1 Instruments for the conducted measurements

No	Description	Model	Manufacturer	Serial No.	Cal. due	Use
1	Spectrum Analyzer	FSW67	Rohde&Schwarz	101371	2023.05.17	☒
2	Power Meter	E4417A	Agilent	MY450042B	2023.05.11	☐
3	Power Sensor	8485A	HP	3318A1396	2023.05.11	☐
4	Vector Signal Generator	SMBV100B	Rohde&Schwarz	101179	2023.05.10	☐
5	Signal Generator	SMB100A	Rohde&Schwarz	180704	2023.02.07	☐
6	Dual-Directional Coupler	778D	HP	15977	2023.05.10	☐
7	High pass filter (3 GHz)	WHKX 3.0/18G-12SS	Wainwright	8	2023.05.11	☒
8	Band reject Filter	WRCD20-1625.8-1627.8-1659.2-1661.2-40SS	Wainwright	1	2023.07.22	☒
9	Attenuator (10 dB)	50HFAR-010-2.9mm	JFW	-	2023.07.21	☐
10	Attenuator (6 dB, 5 W)	18N5W-06	API Technologies	1	2023.05.11	☐
11	Attenuator (6 dB, 5 W)	18N5W-06	API Technologies	2	2023.05.11	☐
12	Attenuator (30 dB, 100 W)	MV4G-30dB100W-ATT04	WAVERCOMM	-	2023.08.24	☒
13	Attenuator (30 dB, 100 W)	MV4G-30dB100W-ATT04	WAVERCOMM	-	2023.08.24	☒
14	RF cable assembly (1.2 m × 2)	n/a	n/a	1 & 2	2023.08.24	☒
15	RF cable assembly (2 m)	MWX221	JUNKOSHA	2201S176	2023.08.24	☒
16	Temperature Chamber	DJ-THC1000	DAE JIN ENG	22-002	2023.02.17	☒
17	Multimeter	17B+	FLUKE	32700017WS	2023.02.07	☒
18	Digital Thermo-Hygrometer	608-H1	Testo	41383411	2023.05.20	☒

4.3.2 Instruments for the radiated measurements

No	Description	Model	Manufacturer	Serial No.	Cal. due	Use
1	EMI Test Receiver	ESR 26	Rohde&Schwarz	101441	2023.06.29	☒
2	Spectrum Analyzer	FSW67	Rohde&Schwarz	101371	2023.05.17	☒
3	Vector Signal Generator	SMBV100B	Rohde&Schwarz	101179	2023.05.10	☐
4	Signal Generator	SMB100A	Rohde&Schwarz	180704	2023.02.07	☐
5	Loop Antenna (9 kHz - 30 MHz)	HFH2-Z2E	Rohde&Schwarz	100883	2023.12.16	☒
6	BiLog broadband Antenna (30 MHz - 1 GHz)	VULB9168	Schwarzbeck	9168-230	2024.03.11	☒
7	Horn Antenna (1 GHz - 18 GHz)	3117	ETS Lindgren	00205960	2024.06.07	☒
8	Horn Antenna (1 GHz - 18 GHz)	BBHA 9120D	Schwarzbeck	9120D-816	2024.04.26	☐
9	Horn Antenna (6.5 GHz - 18 GHz)	LB-65180-20-C-SF	A-INFO	2110054000021	2024.01.22	☐
10	Horn Antenna (18 GHz - 26.5 GHz)	20240-20	Flann microwave	273364	2023.12.08	☐
11	Horn Antenna (18 GHz - 26.5 GHz)	20240-20	Flann microwave	273363	2023.12.08	☐
12	Horn Antenna (26.5 GHz - 40 GHz)	22240-20	Flann microwave	274186	2023.12.10	☐
13	Horn Antenna (26.5 GHz - 40 GHz)	22240-20	Flann microwave	274185	2022.12.10	☐
14	Pre-amplifier (30 MHz - 1 GHz)	MLA-10K01-B01-27	TSJ	2005350	2023.05.11	☒
15	Pre-amplifier (1 GHz - 18 GHz)	MLA-0118-J01-40	TSJ	14879	2023.05.09	☒
16	Pre-amplifier (18 GHz - 40 GHz)	MLA-1840-A01-50	TSJ	2610050	2023.05.17	☐
17	High pass filter (3 GHz)	WHKX 3.0/18G-12SS	Wainwright	8	2023.05.11	☒
18	Multimeter	17B+	FLUKE	32700017WS	2023.02.07	☒
19	Digital Thermo-Hygrometer	608-H1	Testo	41383411	2023.05.20	☒

Radiated emission measurement software (30 MHz to 1 GHz): TEPTO-DV/RE_Version: 3.1.0044
Radiated spurious emission measurement software (above 1 GHz): TEPTO-DV/RSE_Version: 2.01.0036

5 Test and measurements

5.1. RF Power Output / Power limits

5.1.1 Regulation

FCC, CFR 47 Section

According to 2.1046, Measurements required: RF power output:

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in According to 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in According to 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

According to 25.204, Power limits for earth stations

(a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

+40 dBW in any 4 kHz band for $\theta \leq 0°$

+40 + 3θ dBW in any 4 kHz band for $0° < \theta \leq 5°$

where θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

(c) For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

ISED, RSS section

RSS-170, 5.3.2. Mobile Earth Stations (MESs)

The application for MES certification shall state the MES e.i.r.p. that is necessary for satisfactory communication. The maximum permissible e.i.r.p. will be the stated e.i.r.p. plus a 2 dB margin. If a detachable antenna is used, the certification application shall state the recommended antenna type and manufacturer, the antenna gain and the maximum transmitter output power at the antenna terminal.

5.1.2 Test Procedure

The RF output power were measured with the following setting according to Subclause 5.2.4.2, 5.2.4.3 and/or 5.2.4.4 of ANSI C63.26-2015.

Procedure for measuring average power with an average power meter:
An average power meter can always be used to perform the measurement when the EUT can be configured to transmit continuously. If the EUT cannot be configured to transmit continuously (i.e., burst duty cycle < 98%), the measurement should be measured during the active transmission bursts if the gating parameters can be adjusted, otherwise the duty cycle correction should be considered.

Procedure for measuring average power of a narrowband signal with spectrum analyzer:

(a) Set span to 2 × to 3 × the OBW.
(b) Set RBW ≥ OBW.
(c) Set VBW ≥ 3 × RBW.
(d) Set number of measurement points in sweep ≥ 2 × span / RBW.
(e) Sweep time:
  (1) Set ≥ auto-couple, and enable trace averaging, or
  (2) Set ≥ [10 × (number of points in sweep) × (transmission symbol period)] and enable a single sweep (automation-compatible) measurement. The sweep time should never be faster than the auto-coupled sweep time.
(f) Detector = power averaging (rms).
(g) If the EUT can be configured to transmit continuously, then set the trigger to free run.
(h) Trace average at least 100 traces in power averaging (i.e., rms) mode if sweep is set to auto-couple. (To accurately determine the average power over multiple transmit symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.)
(i) Use the peak marker function to determine the maximum amplitude level.

Procedure for RF power output in any 4 kHz band:
The average power spectral density was measured according to Subclause 5.2.4.5 of ANSI C63.26-2015. The same test procedure for the measurements of Spurious Emissions at Antenna Terminals (Out-of-band emissions measurements) was used.

NOTE: As shown in the Figure 1, during the measurements, the insertion loss (external attenuators, RF cable assembly) was included in the spectrum analyzer as the TDF.

5.1.3 Result: PASS

Table 1: Measured values of RF Power Output

Bearer type	Conducted power output (antenna port 1) [dBm]			Conducted power output (antenna port 2) [dBm]			EIRP (sum) (NOTE) [dBm]		
	f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}
R5T1XD-1B R20T1XD-1B	30.11	29.89	30.38	30.21	29.78	30.50	52.6	52.2	**52.8**
R5T2XD-1B R20T2XD-1B	30.07	29.69	30.38	30.10	29.73	30.40	52.5	52.1	52.8
R5T4.5XD-1B R20T4.5XD-2B	29.87	29.87	30.09	29.88	29.47	30.29	52.3	52.1	52.6
R20T0.5QD-1B	29.96	29.60	30.22	30.01	29.54	30.35	52.4	52.0	**52.7**
R20T1QD-1B	29.94	29.61	30.21	30.02	29.56	30.34	52.4	52.0	52.7
R5T2QD-1B R20T2QD-1B	29.94	29.59	30.20	29.97	29.55	30.33	52.4	52.0	52.7
R5T4.5QD-1B R20T4.5QD-1B	29.81	29.43	30.10	29.86	29.37	30.20	52.2	51.8	52.6

NOTE: Transmitter radiated output power including the antenna gain (19.39 dBi). The EIRP (sum) was calculated as below:

EIRP (sum) [dBm] = 10 × log(Antenna Power (two ports) [mW]) + Antenna gain

where, Antenna Power (two ports) [mW] = $10^{(\text{Conducted power output at port 1 [dBm]} / 10)} + 10^{(\text{Conducted power output at port 2 [dBm]} / 10)}$

Table 2: Measured values of RF Power Output (measured with Spectrum Analyzer in any 4 kHz band)

Bearer type	EIRP (antenna port 1) (NOTE 1) [dBm]			EIRP (antenna port 2) (NOTE 1) [dBm]			EIRP (sum) (NOTE2) [dBm]		
	f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}	f_{LOW}	f_{MID}	f_{HIGH}
R5T1XD-1B R20T1XD-1B	40.51	40.61	40.92	40.76	40.37	41.31	43.65	43.50	44.13
R5T2XD-1B R20T2XD-1B	37.69	37.58	38.04	37.81	37.45	38.19	40.76	40.53	41.13
R5T4.5XD-1B R20T4.5XD-2B	34.30	33.86	34.56	34.47	33.94	34.79	37.40	36.91	37.69
R20T0.5QD-1B	43.35	43.13	43.99	43.48	43.00	43.87	46.43	46.08	**46.94**
R20T1QD-1B	40.63	40.35	40.90	40.71	40.35	40.98	43.68	43.36	43.95
R5T2QD-1B R20T2QD-1B	37.81	36.88	38.13	37.17	37.41	38.24	40.51	40.16	41.20
R5T4.5QD-1B R20T4.5QD-1B	34.31	33.09	34.63	34.41	34.12	34.76	37.37	36.65	37.71

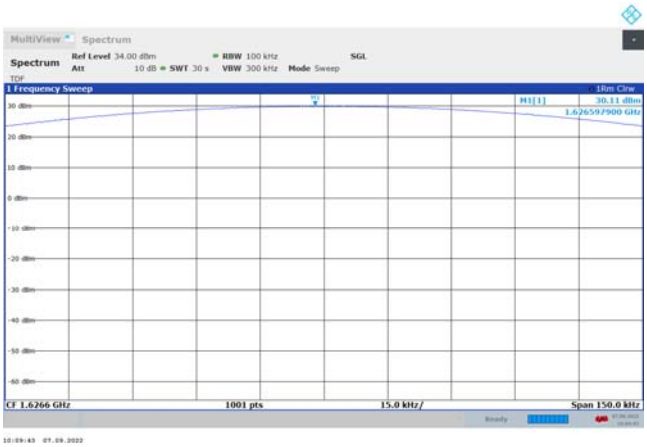
NOTE1: The EIRP values for each antenna port were calculated by subtracting the 3 dB Offset value from the plots (in the Figure 3) for the out-of-band emissions measurements, which contained the RF power output in 4 kHz band. During the OOBE measurements at each antenna port, the Offset (3 dB) was additionally applied due to the number of antenna ports.

NOTE 2: The maximum output power (two ports) were summed.

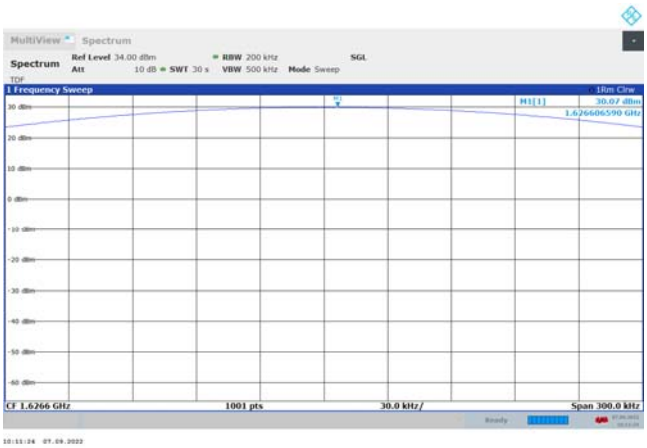
Figure 1. Plot of RF Power Output

RF Power output for each bearer type

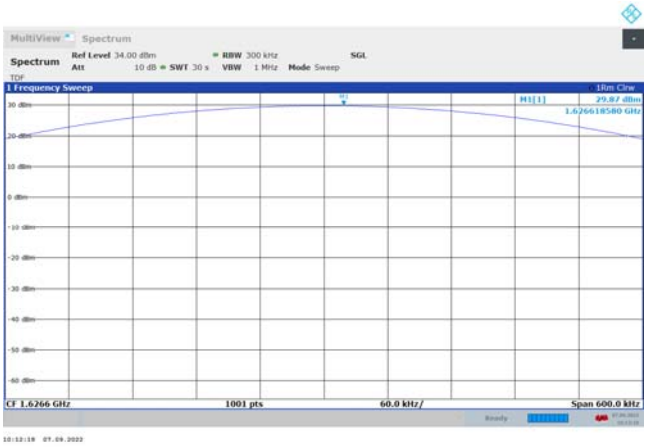
measured at Antenna port 1



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

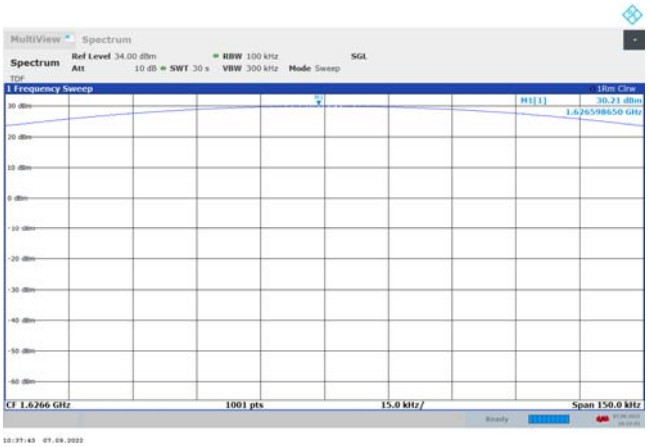


f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

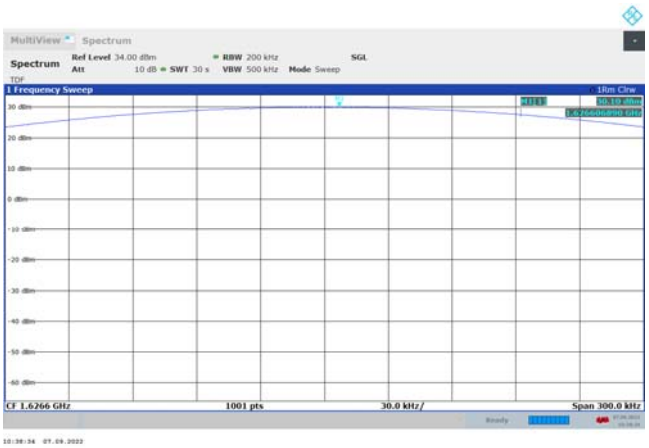


f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

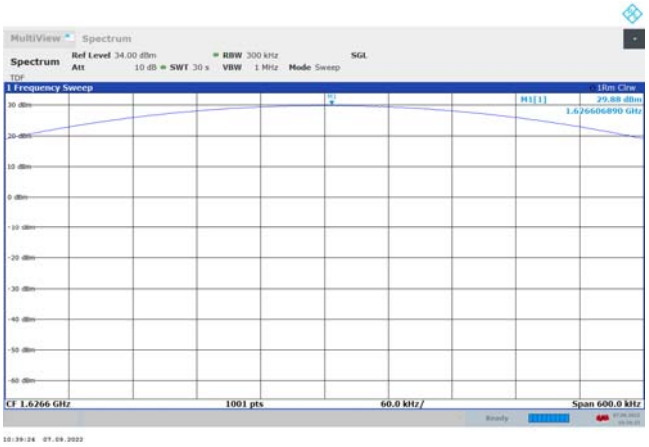
measured at Antenna port 2



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



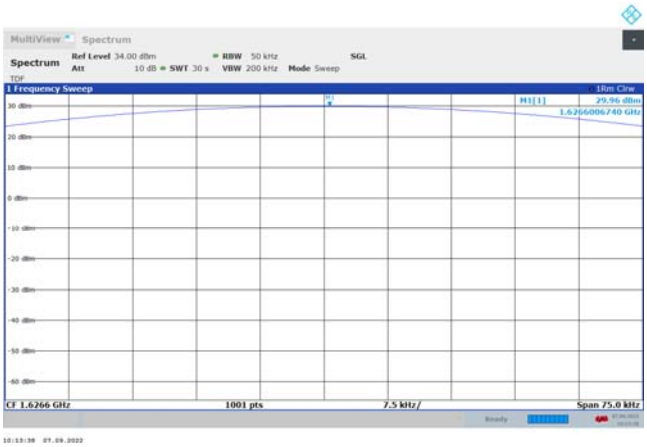
f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



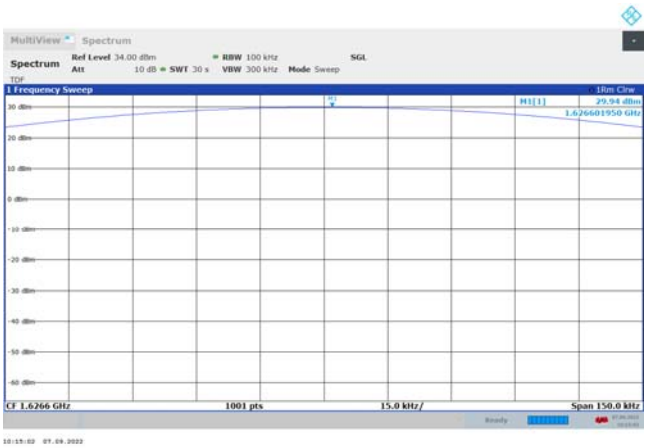
f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

RF Power output for each bearer type

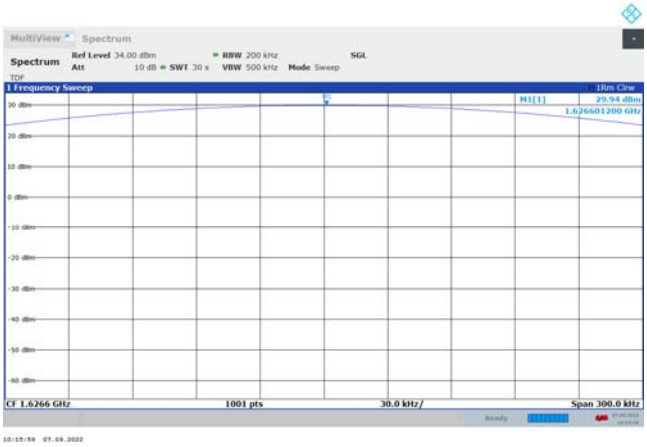
measured at Antenna port 1



f_{LOW} (4. Bearer type: R20T0.5QD-1B)

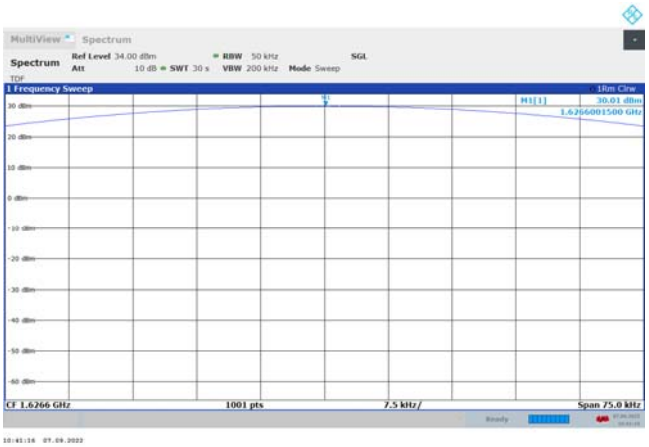


f_{LOW} (5. Bearer type: R20T1QD-1B)

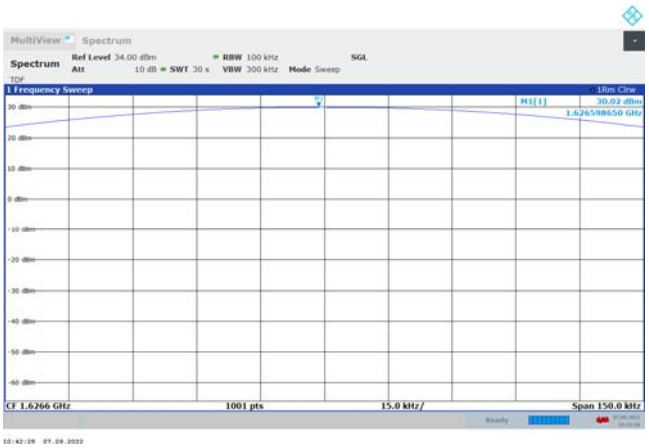


f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

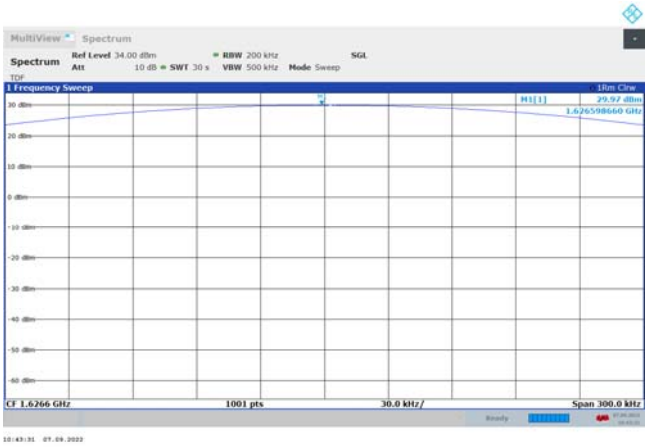
measured at Antenna port 2



f_{LOW} (4. Bearer type: R20T0.5QD-1B)



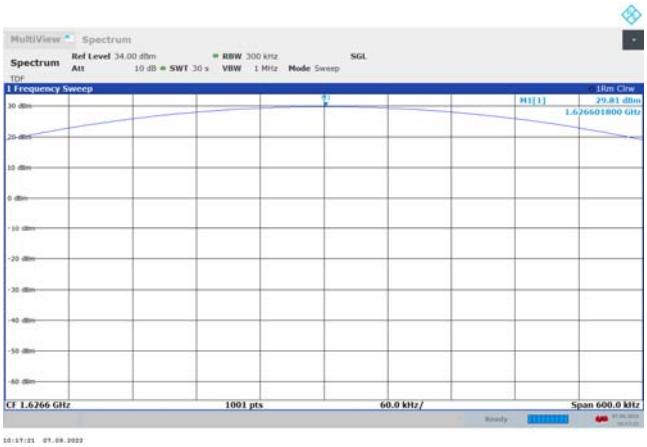
f_{LOW} (5. Bearer type: R20T1QD-1B)



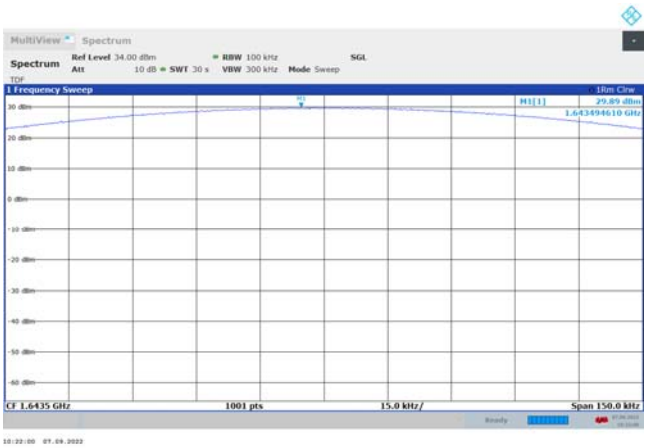
f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

RF Power output for each bearer type

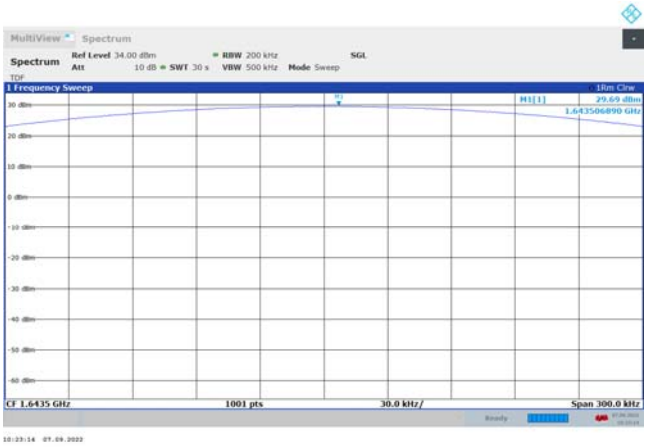
measured at Antenna port 1



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

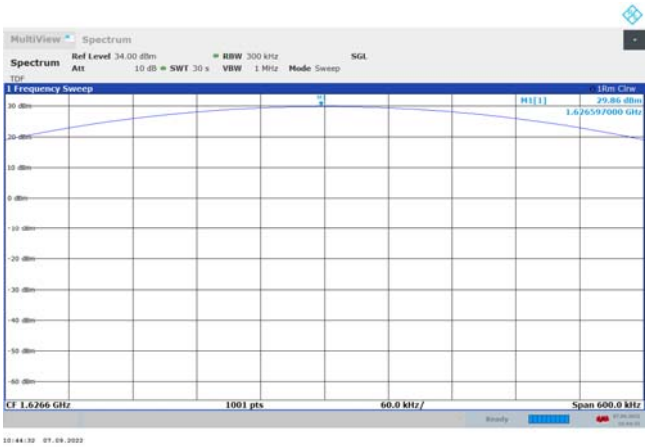


f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

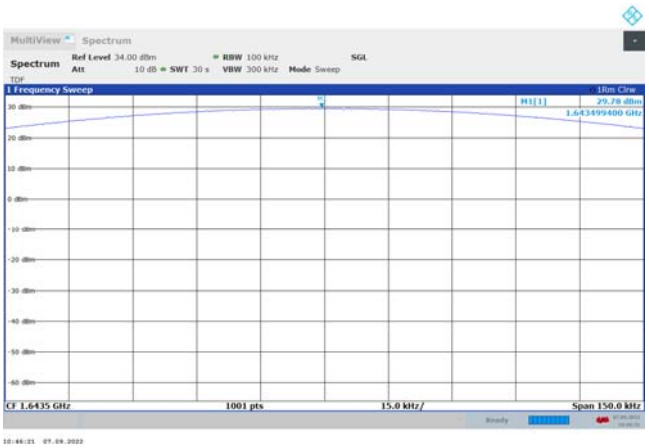


f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

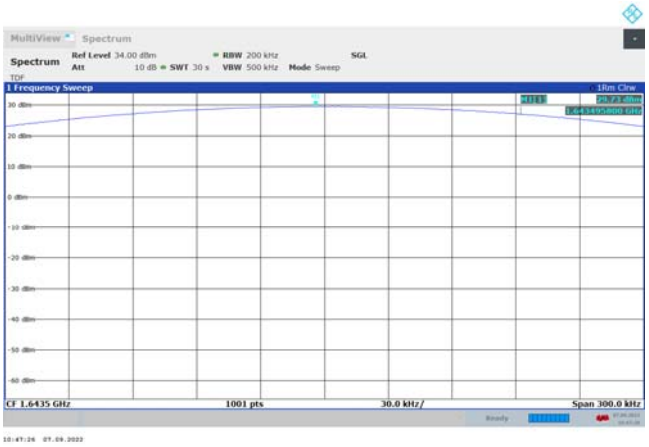
measured at Antenna port 2



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



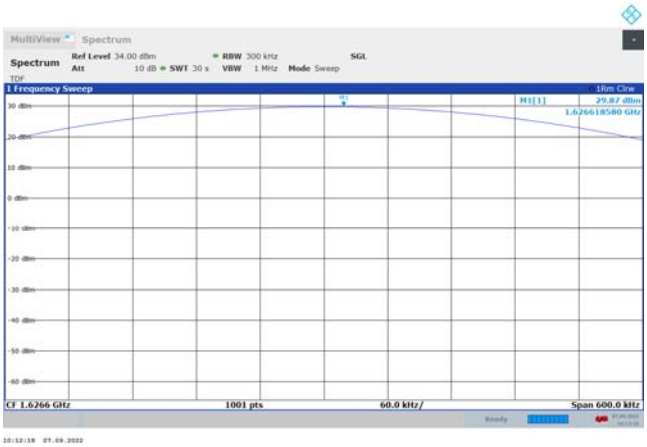
f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



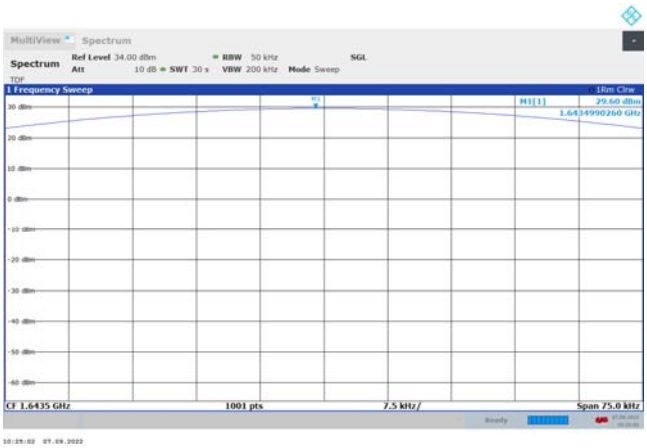
f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

RF Power output for each bearer type

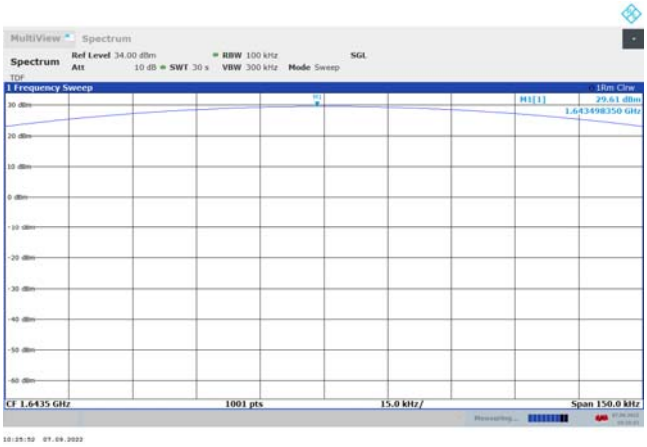
measured at Antenna port 1



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

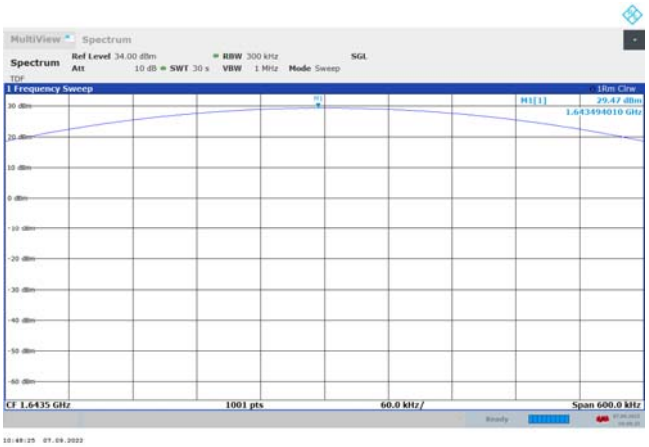


f_{MID} (4. Bearer type: R20T0.5QD-1B)

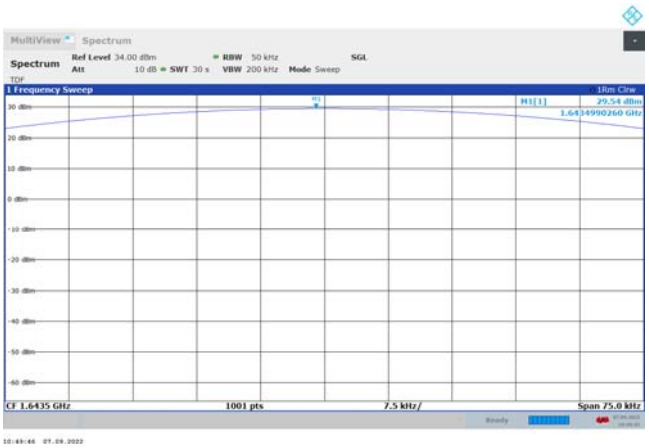


f_{MID}(5. Bearer type: R20T1QD-1B)

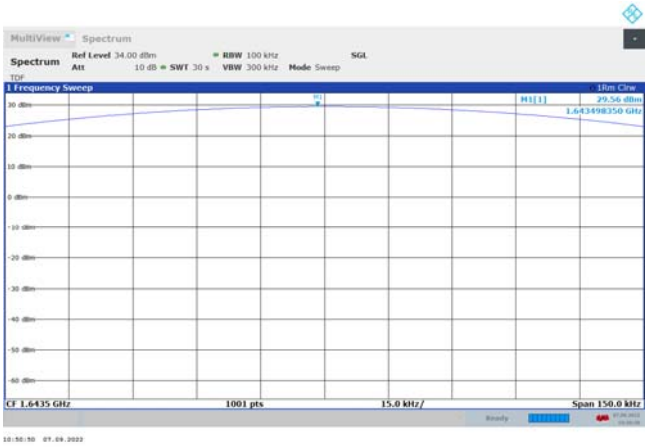
measured at Antenna port 2



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



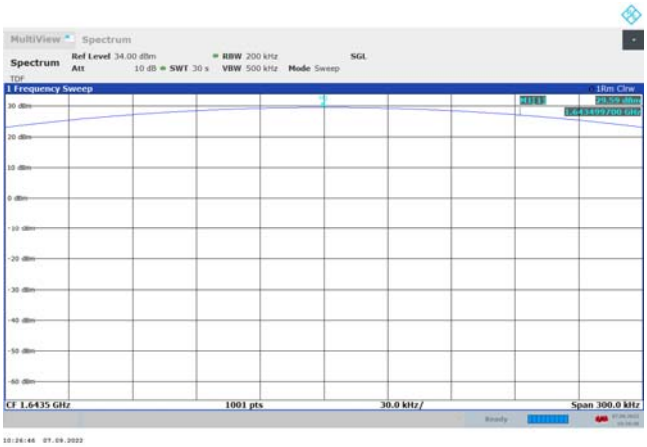
f_{MID} (4. Bearer type: R20T0.5QD-1B)



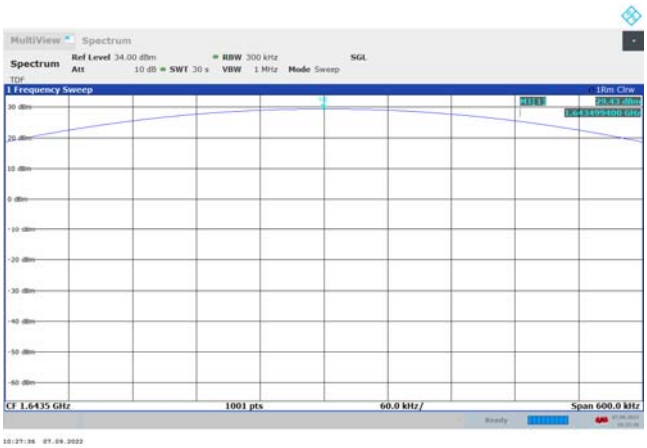
f_{MID}(5. Bearer type: R20T1QD-1B)

RF Power output for each bearer type

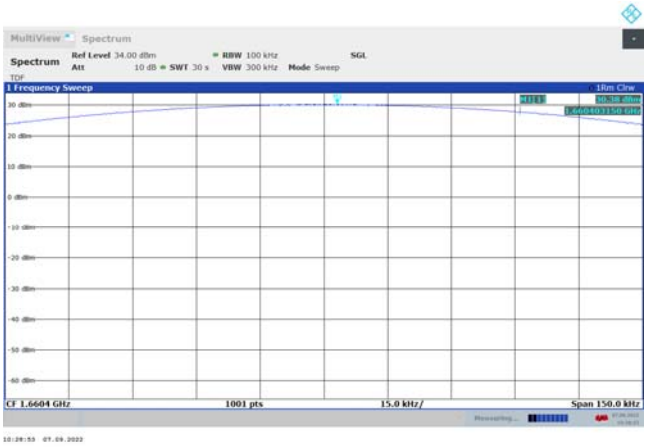
measured at Antenna port 1



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

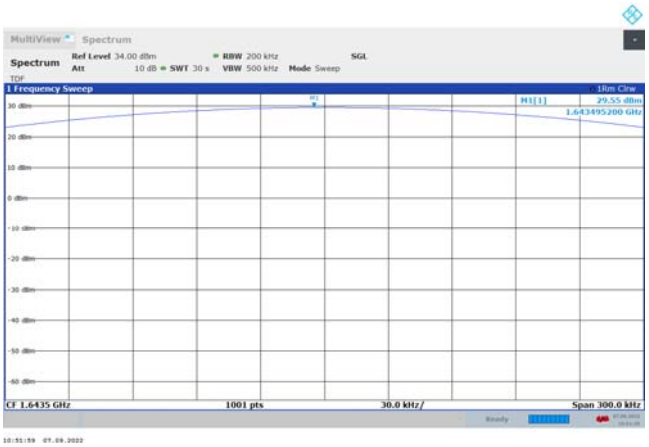


f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

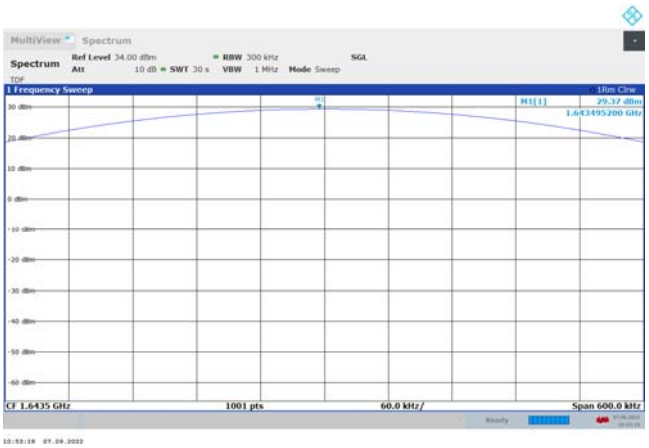


f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

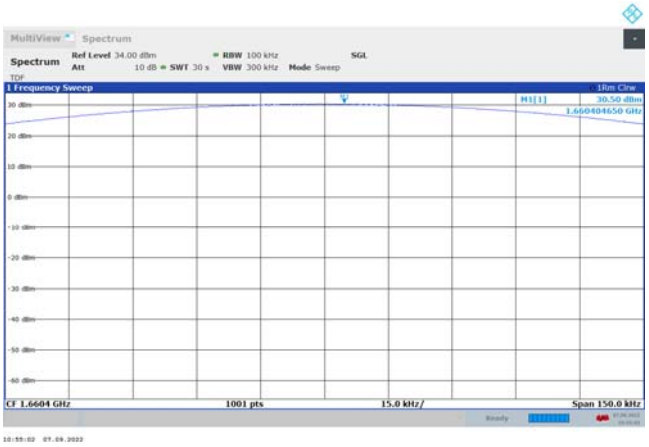
measured at Antenna port 2



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



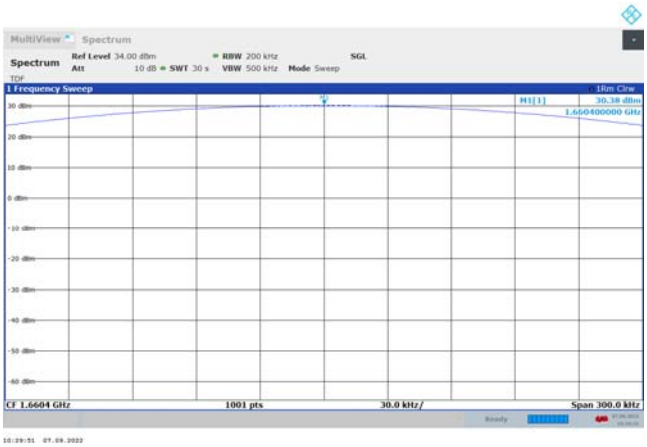
f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



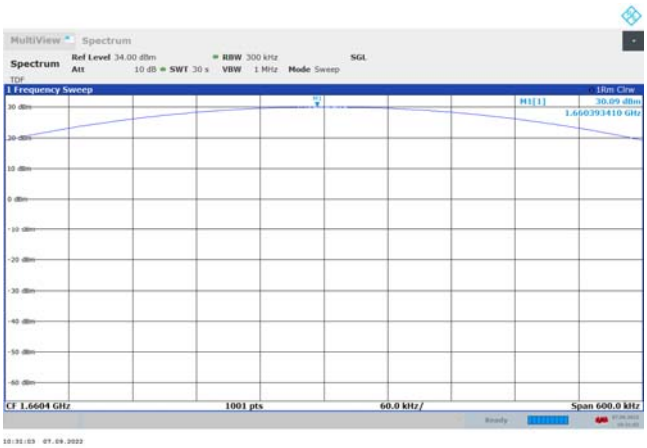
f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

RF Power output for each bearer type

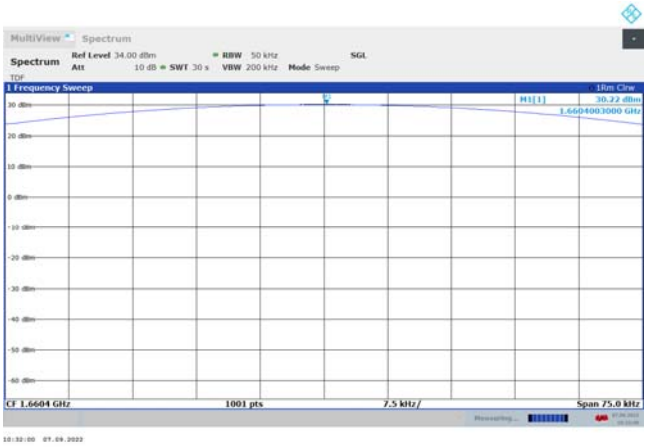
measured at Antenna port 1



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

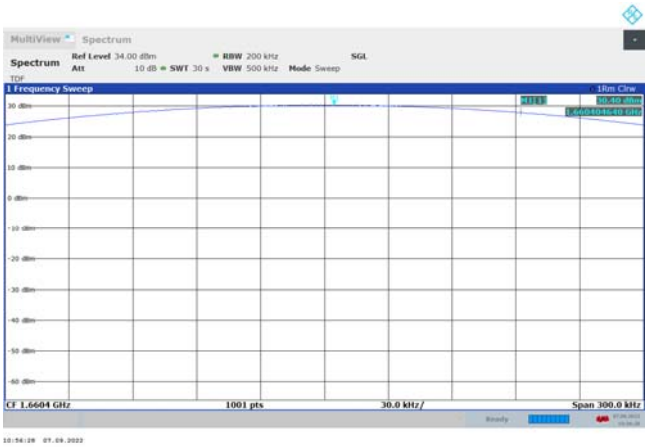


f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

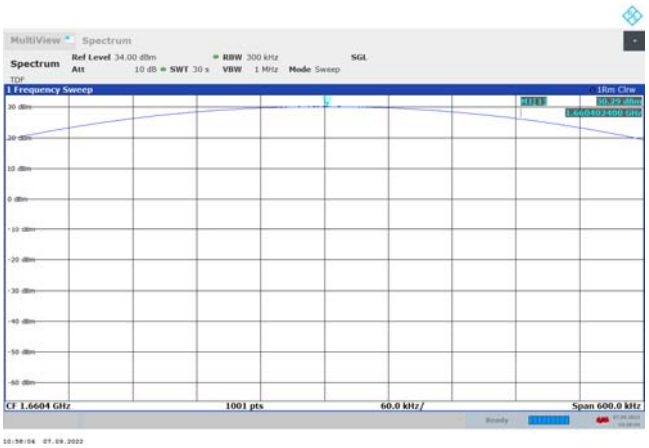


f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

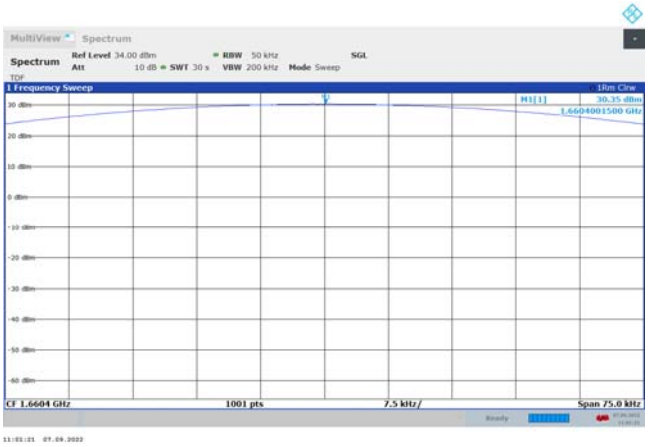
measured at Antenna port 2



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



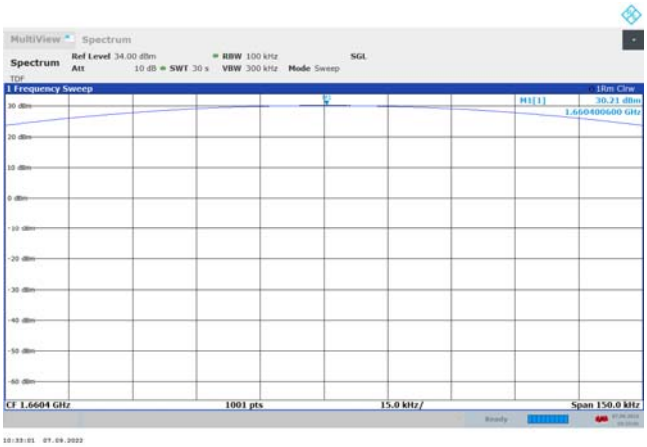
f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



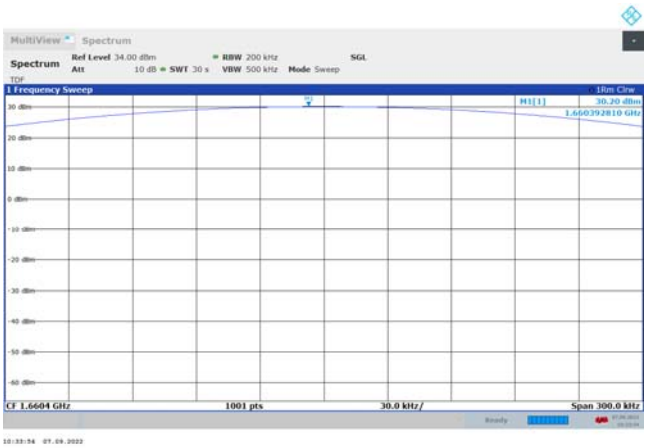
f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

RF Power output for each bearer type

measured at Antenna port 1



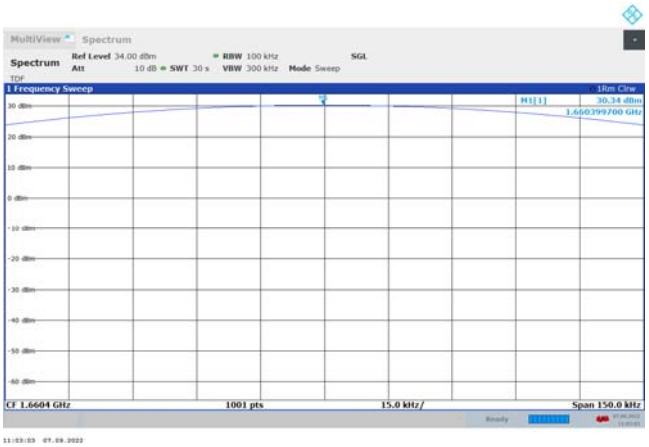
f_{MID}(5. Bearer type: R20T1QD-1B)



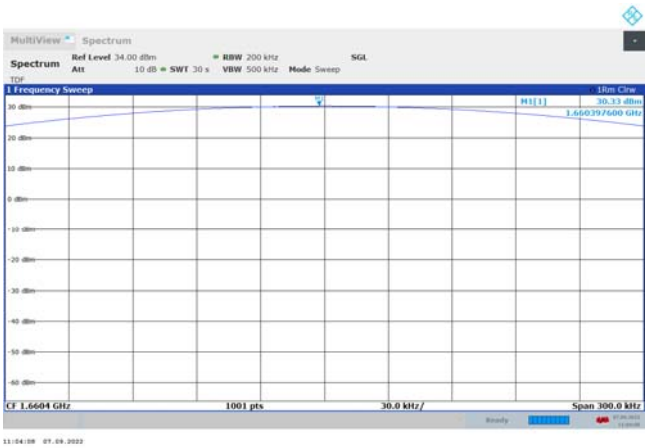
f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

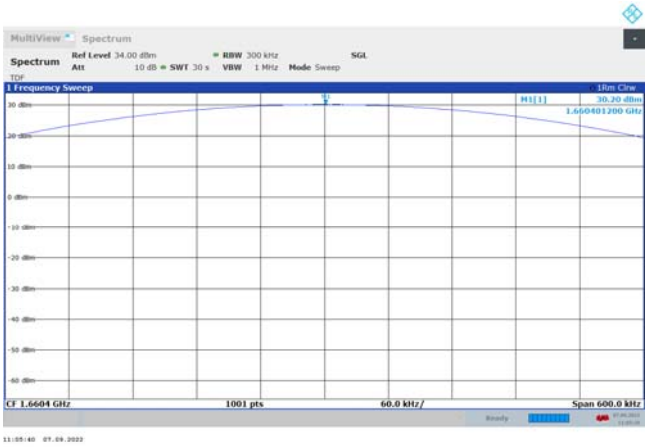
measured at Antenna port 2



f_{MID}(5. Bearer type: R20T1QD-1B)



f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

5.2. Occupied Bandwidth

5.2.1 Regulation

FCC, CFR 47 Section

According to 2.1049, Measurements required: Occupied bandwidth: 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 shall be measured under the specified conditions of 2.1049 (a) through (i) as applicable.

ISED, RSS section

RSS-Gen, 6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

5.2.2 Test Procedure

The Occupied bandwidth (99 %) were measured with the following setting according to subclause 5.4.4 of ANSI C63.26.

(a) Set the spectrum analyzer to be entered in OBW measurement.

(b) The spectrum analyzer center frequency was set to the nominal EUT channel center frequency.

(c) The span range for the spectrum analyzer should be wide enough to see sufficient roll off of the signal to make the measurement.

(d) The RBW should be in the range of 1% to 5% of the anticipated OBW, and the VBW should be set ≥ 3 × RBW.

(e) Set spectrum analyzer detection mode to peak, and the trace mode to max hold.

5.2.3 Result: PASS

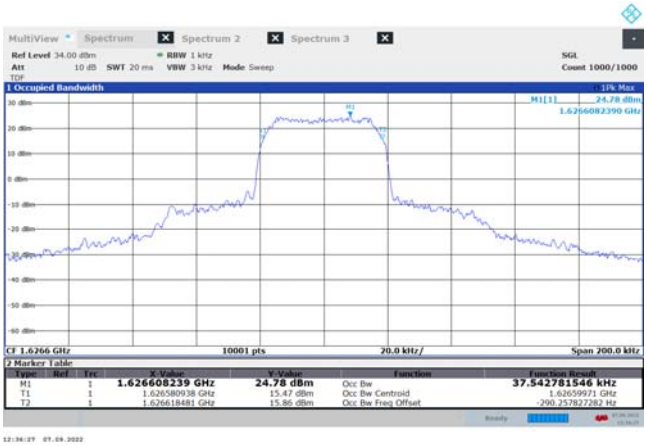
Table 3: Measured values of Occupied Bandwidth

Bearer type	Occupied bandwidth [kHz]			Symbol rate [ksym/s]	Modulation
	f_{LOW}	f_{MID}	f_{HIGH}		
R5T1XD-1B R20T1XD-1B	37.5	37.4	37.3	33.6	16-QAM
R5T2XD-1B R20T2XD-1B	74.4	74.0	74.2	2 × 33.6	
R5T4.5XD-1B R20T4.5XD-2B	167.7	166.0	**167.8**	4.5 × 33.6	
R20T0.5QD-1B	18.9	18.8	18.9	0.5 × 33.6	Pi/4 QPSK
R20T1QD-1B	37.4	37.3	37.3	33.6	
R5T2QD-1B R20T2QD-1B	74.5	74.2	74.6	2 × 33.6	
R5T4.5QD-1B R20T4.5QD-1B	**167.1**	166.1	166.9	4.5 × 33.6	

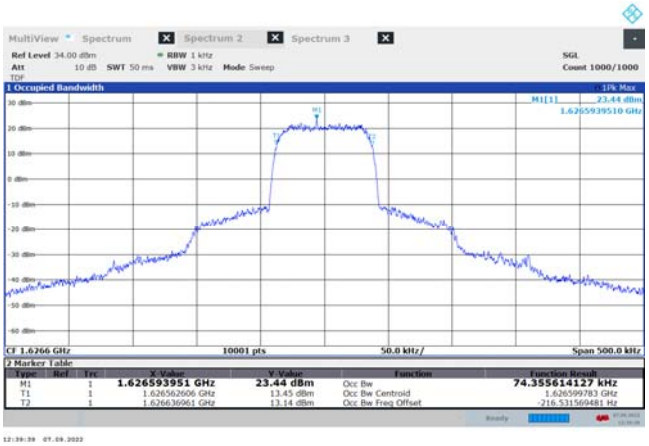
NOTE: The occupied bandwidth was measured at the antenna port 1.

Figure 2. Plot of Occupied Bandwidth

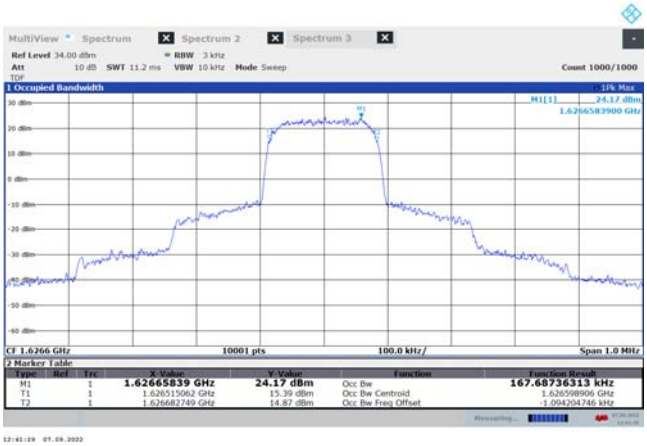
Occupied bandwidth for each bearer type



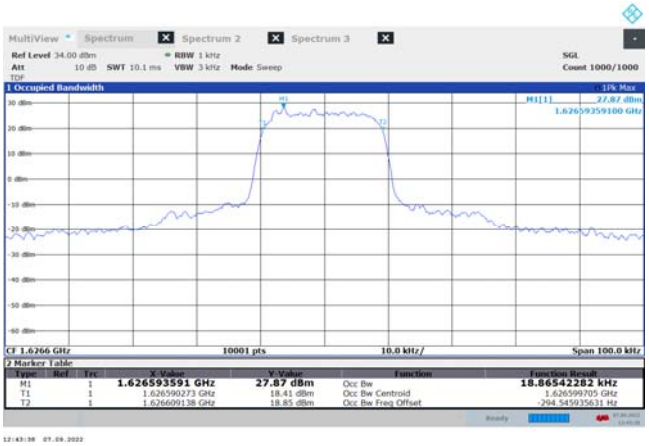
f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



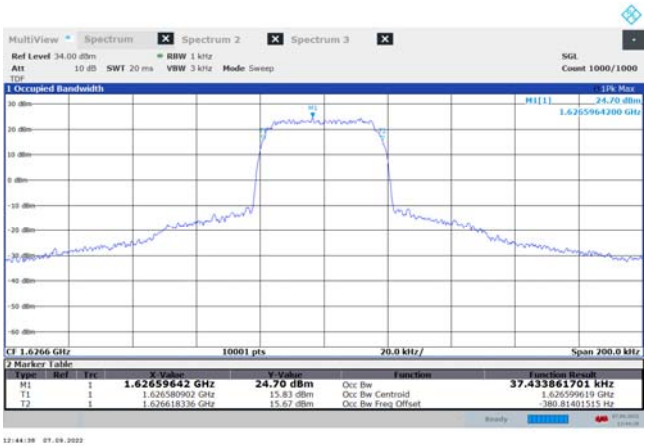
f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



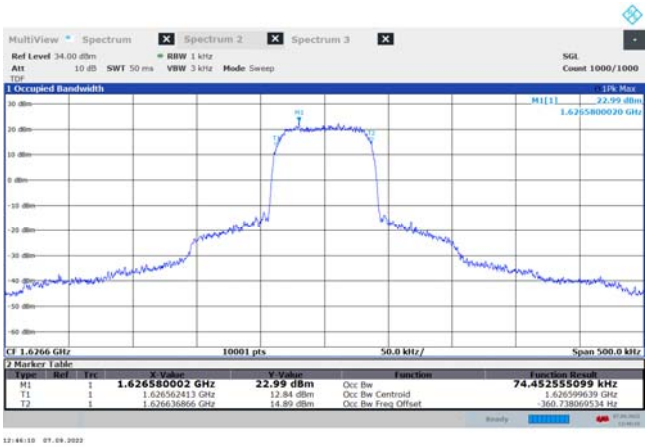
f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



f_{LOW} (4. Bearer type: R20T0.5QD-1B)

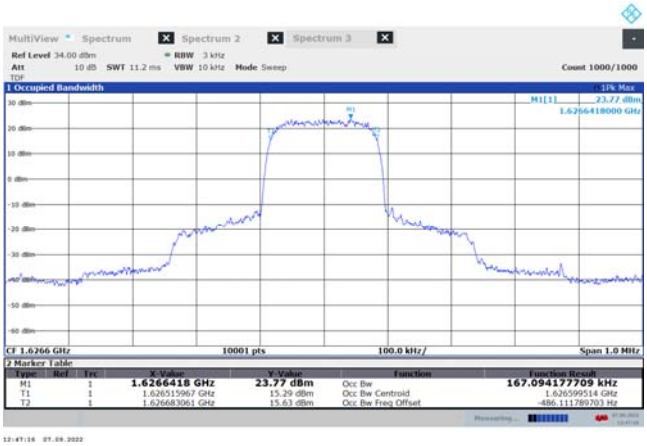


f_{LOW} (5. Bearer type: R20T1QD-1B)



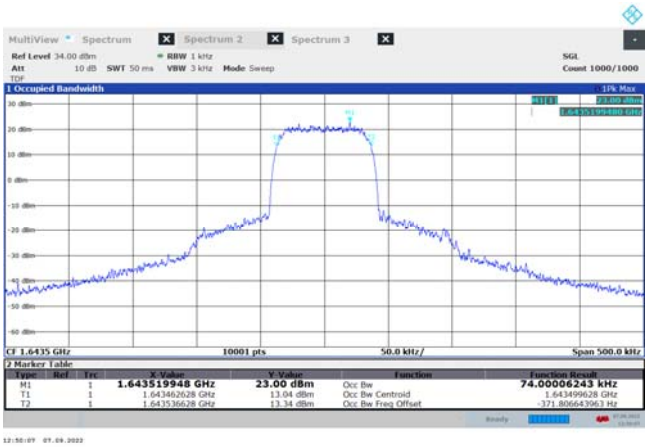
f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

Occupied bandwidth for each bearer type

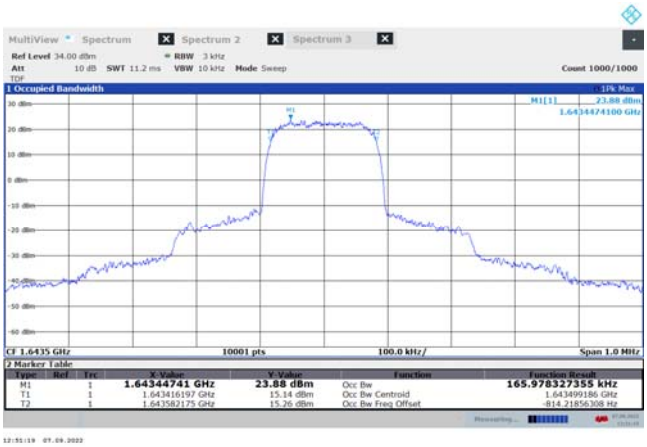


f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

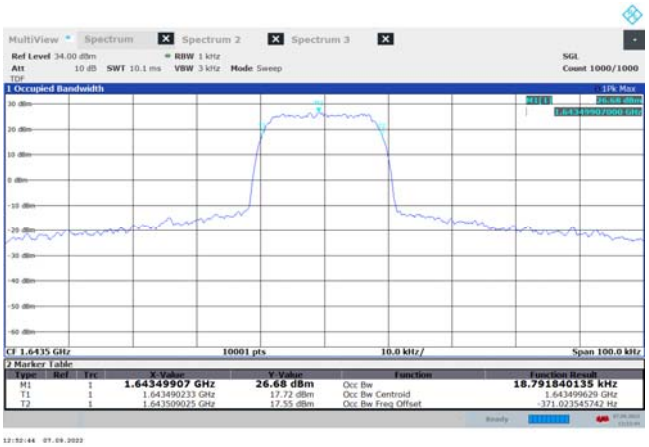
f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

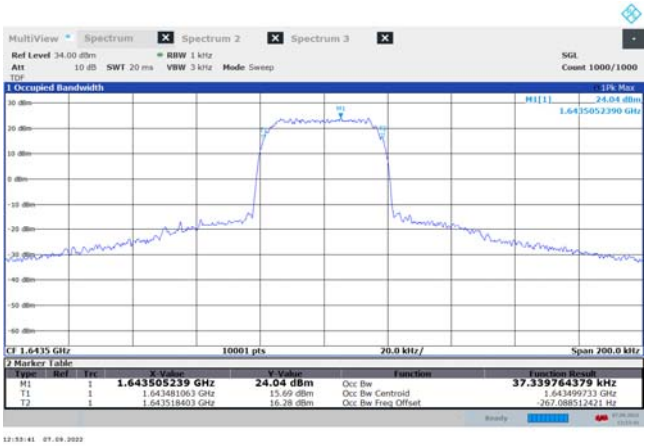


f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

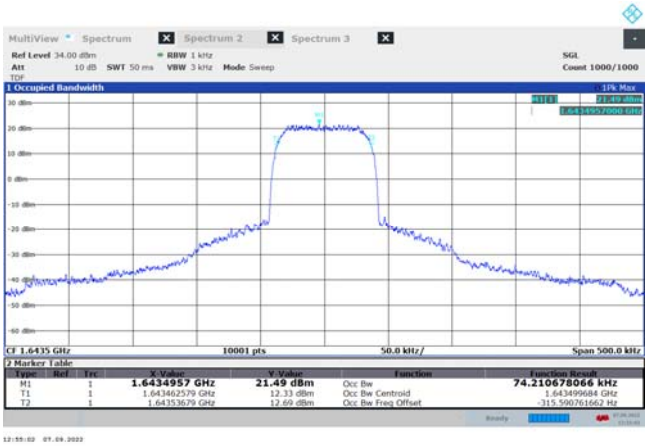


f_{MID} (4. Bearer type: R20T0.5QD-1B)

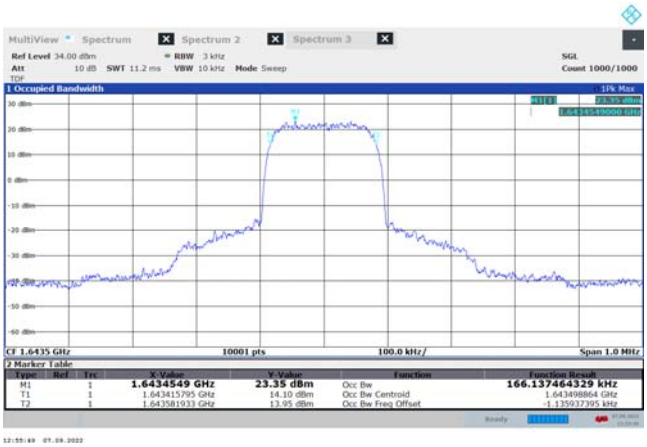
Occupied bandwidth for each bearer type



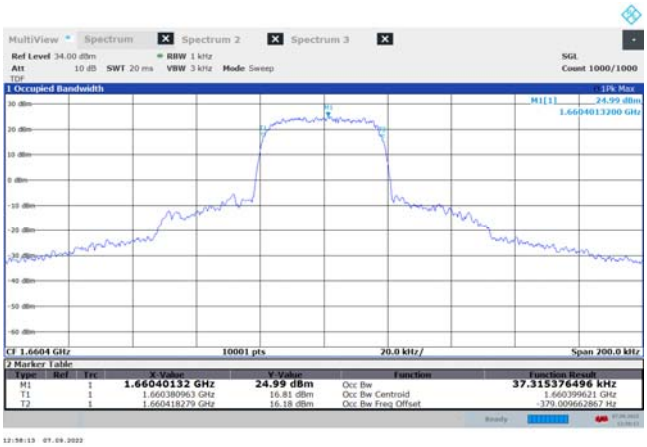
f_{MID} (5. Bearer type: R20T1QD-1B)



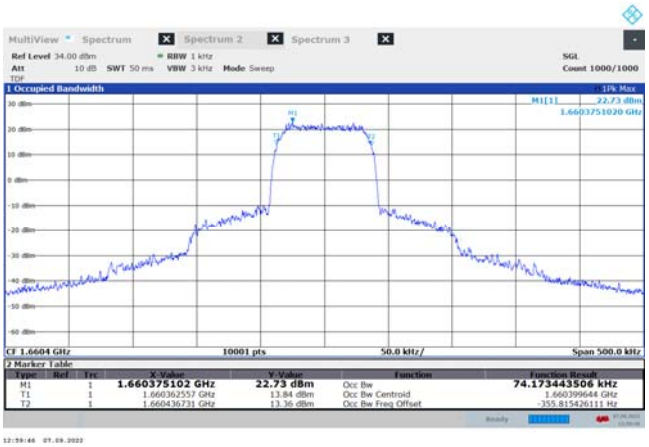
f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

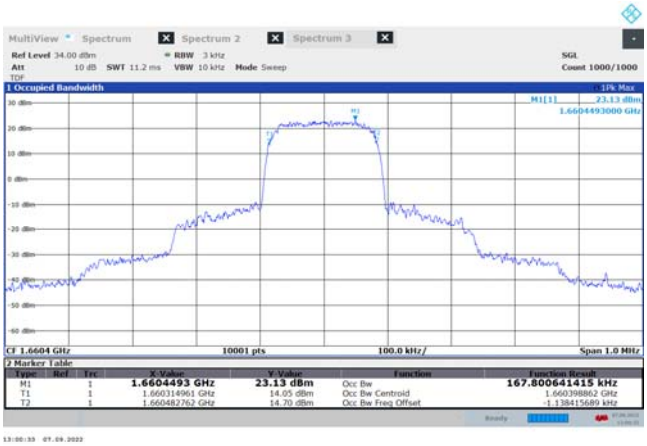


f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

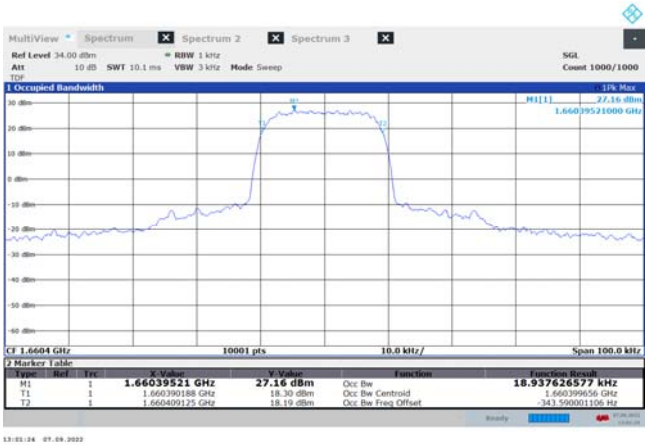


f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

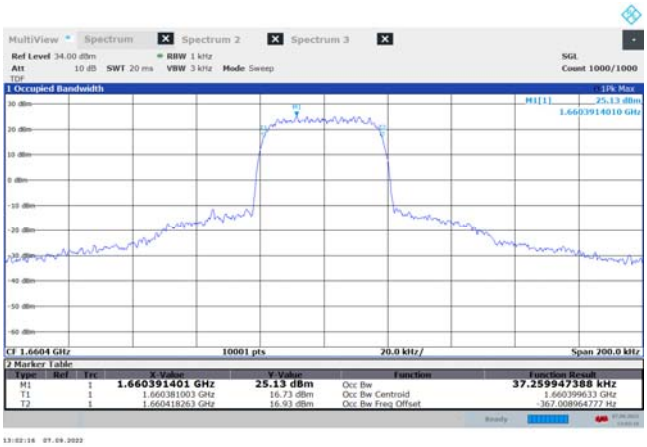
Occupied bandwidth for each bearer type



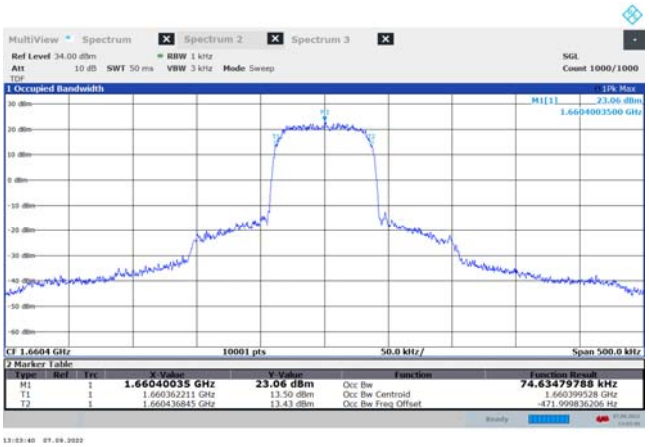
f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



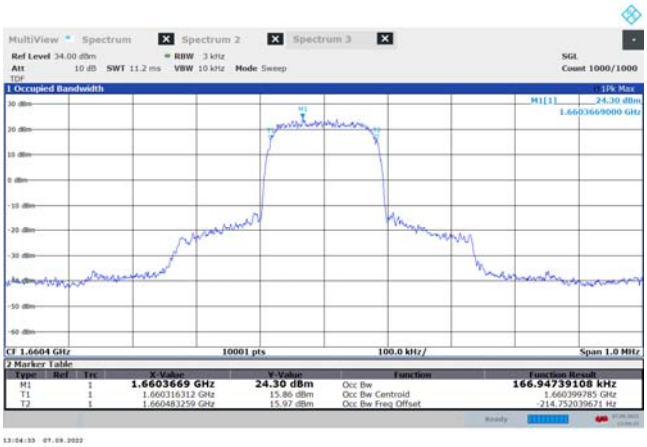
f_{HIGH} (4. Bearer type: R20T0.5QD-1B)



f_{HIGH} (5. Bearer type: R20T1QD-1B)



f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

5.3. Spurious Emissions at Antenna Terminals (conducted emissions)

5.3.1 Regulation

FCC, CFR 47 Section

According to 2.1051, Measurements required: Spurious emissions at antenna terminals: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

According to 25.202(f), Emission limitations. Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;
(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

ISED, RSS section

RSS-170, 5.4.3.1. Mobile Earth Stations in All Frequency Bands

The average power of unwanted emissions shall be attenuated below the average output power, P (dBW), of the transmitter, as specified below:

(1) 25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 50%, up to and including 100% of the occupied bandwidth or necessary bandwidth, whichever is greater;
(2) 35 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 100%, up to and including 250% of the occupied bandwidth or necessary bandwidth, whichever is greater; and
(3) 43 + 10 log p (watts) in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 250% of the occupied bandwidth or necessary bandwidth, whichever is greater.

5.3.2 Test Procedure

The Spurious Emissions at Antenna Terminals were measured with the following setting according to subclause 5.7.3 and 5.7.4 of ANSI C63.26.
Connect the EUT antenna output port to the spectrum analyzer via an appropriate RF cable. Insert external attenuation as necessary and adjust the spectrum analyzer settings to account for the corresponding insertion loss. The unwanted emission limit was expressed in terms of "average" power. The use of "Max Hold" will not result in a true average power measurement. Instead, the proper trace mode for performing an average measurement was the "trace average" mode. Alternatively, a single sweep measurement could be used with the sweep speed set such that a relatively long dwell was realized in each trace bucket (typically at least 1 ms per trace point).

Out-of-band emissions measurements:

(a) Set the spectrum analyzer center frequency to the block, band, or channel edge frequency.

(b) Set the span wide enough to capture the fundamental emission closest to the authorized block or band edge, and to include all modulation products that spill into the immediately adjacent frequency band. In some cases, it may be possible to set the center frequency and span so as to encompass the fundamental emission and the unwanted out-of-band (band-edge) emissions on either side of the authorized block, band, or channel. This could be accomplished with a single (slow) sweep, if adequate overload protection and sufficient dynamic range could be maintained.

(c) Set the number of points in sweep ≥ 2 × span / RBW.

(d) Sweep time should be auto for peak detection. For rms detection the sweep time should be set as follows:

(1) If the device could be configured to transmit continuously, set the (sweep time) > (number of points in sweep) × (symbol period) (e.g., by a factor of 10 × symbol period × number of points). Increasing the sweep time (i.e., slowing the sweep speed) will allow for averaging over multiple symbols.

(2) If the device could not transmit continuously, a gated sweep should be used when possible, set the sweep time > (number of points in sweep) × (symbol period) but the sweep time should always be maintained at a value that was less than or equal to the minimum transmission time.

(3) If the device could not be configured to transmit continuously and a free running sweep must be used, set the sweep time so that the averaging was performed over multiple on/off cycles by setting the sweep time > (number of points in sweep) × (transmitter period) (i.e., the transmit on-time + the off-time). The spectrum analyzer readings should subsequently be corrected by [10 log (1/duty cycle)]. This assumes that the transmission period and duty cycle was relatively constant (duty cycle variation ≤ ±2%).

(4) If the device could not be configured to transmit continuously and a free-running sweep must be used, and if the transmissions exhibit a non-constant duty cycle (duty cycle variations > ±2%), set the sweep time so that the averaging was performed over the on-period by setting the sweep time > (symbol period) × (number of points), while also maintaining the sweep time < (transmitter on-time). The trace mode should be set to max hold, since not every display point will be averaged only over just the on-time. Thus, multiple sweeps (e.g., 100) in maximum hold are necessary to ensure that the maximum power was measured.

Conducted spurious emissions measurements:

(a) Set the spectrum analyzer start frequency to the lowest frequency generated by the EUT, without going below 9 kHz, and the stop frequency to the lower frequency covered by the out-of-band emissions measurements.

(b) When using an average power (rms) detector, ensure that the number of points in the sweep ≥ 2 × (span / RBW). This may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the spectrum analyzer capabilities. This requirement does not apply to peak-detected power measurements. When average power was specified by the applicable regulation, a peak-detector could be utilized for preliminary measurements to accommodate wider frequency spans. Any emissions found in the preliminary measurement to exceed the applicable limit(s) should be further examined using a power averaging (rms) detector with the minimum number of measurement points as defined above.

(c) The sweep time should be set to auto-couple for performing peak-detector measurements. For measurements that use a power averaging (rms) detector, the sweep time should be set as described for out-of-band emissions measurements.

(d) Identify and measure the highest spurious emission levels in each frequency range. It was not necessary to re-measure the out-of-band emissions as a part of this test. Record the frequencies and amplitudes corresponding to the measured emissions and capture the data plots.

(e) Repeat step (b) through step (d) for the upper spurious emission frequency range if not already captured by a wide span measurement.

(f) Compare the results with the corresponding limit in the applicable regulation.

Calculation of bandwidth correction factor 5.7.2 of ANSI C63.26:

If the measurement bandwidth used to perform the measurement is less than the reference bandwidth, the following scaling is applied: 10 × log [(reference bandwidth) / (resolution or measurement bandwidth)]

For example, the reference bandwidth is specified as 4 kHz and the RBW 3 kHz is used during the measurement, the bandwidth correction factor = 10 × log (4 kHz / 3 kHz) = 1.25 [dB]

NOTE 1: As shown in the Figure 3, during the Out-of-band emission measurements, the insertion loss (external attenuator, RF cable assembly) was included in the spectrum analyzer as the TDF, and the antenna gain (19.39 dBi), bandwidth correction factor (1.25 dB) and multiple transmit antenna output ports (3 dB for 2-port outputs) were applied as the Offset.

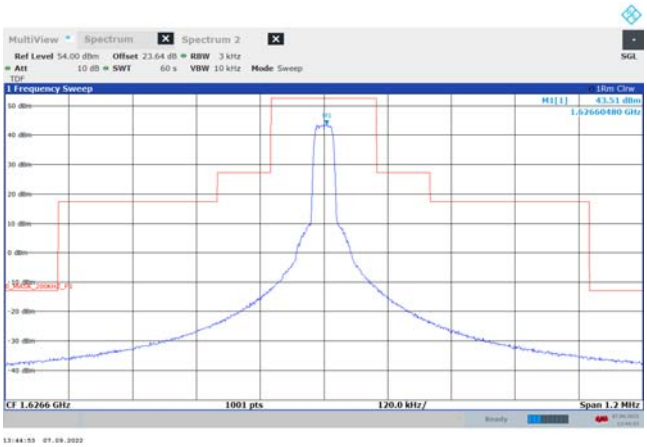
NOTE 2: As shown in the Figure 4, during the spurious emission measurements, the peak detector was used with RBW 3 kHz (or 10 kHz) for the preliminary measurements. Any emissions found in the preliminary measurements to exceed the limits were further examined using the RMS detector with the narrow Span. The insertion loss (external attenuator / 3 GHz high pass filter, RF cable assembly) was included in the spectrum analyzer as the TDF, and the antenna gain (19.39 dBi), bandwidth correction factor (1.25 dB, when RBW 3 kHz was used) and multiple transmit antenna output ports (3 dB for 2-port outputs) were applied as the Offset.

5.3.3 Result: PASS

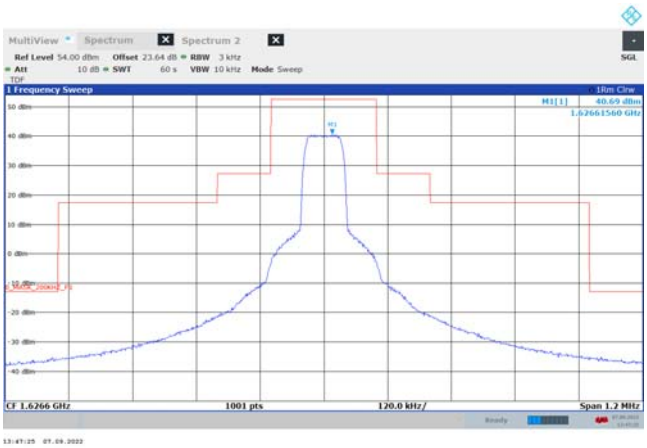
Figure 3. Plot of Out-of-band Emissions (conducted emissions measurements)

Out-of-band emissions (OOBE) for each bearer type

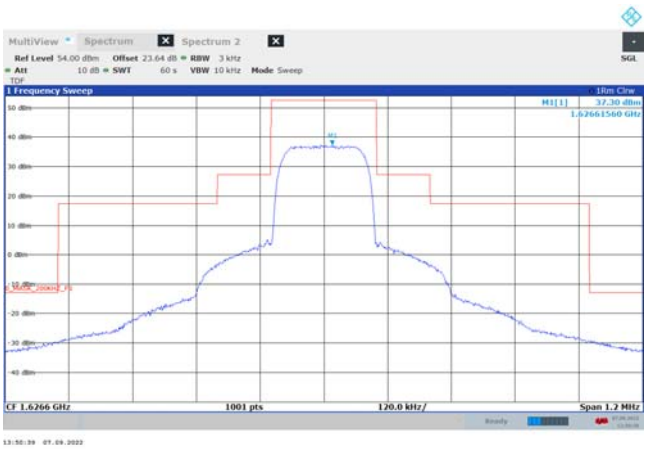
measured at Antenna port 1



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

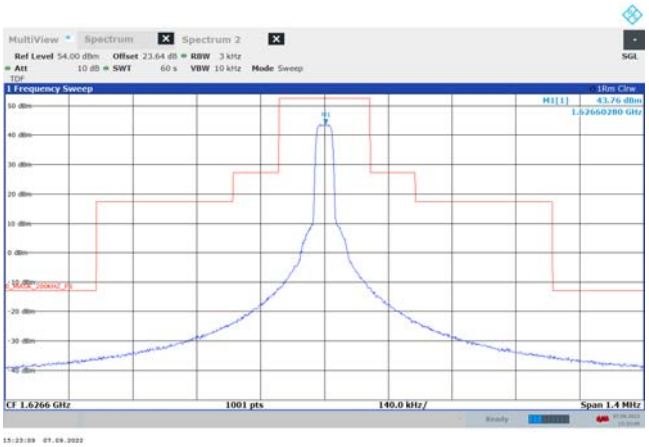


f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

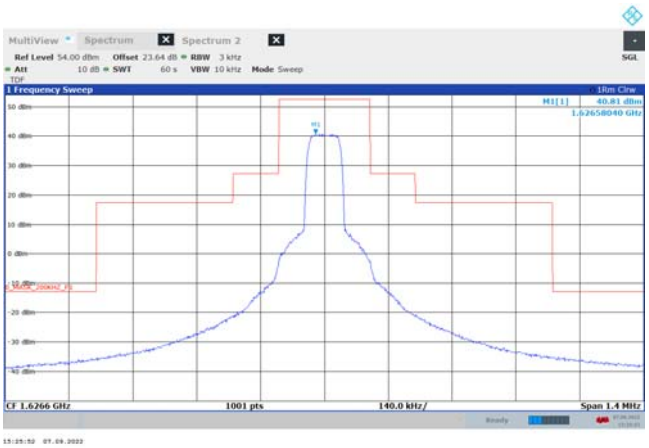


f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

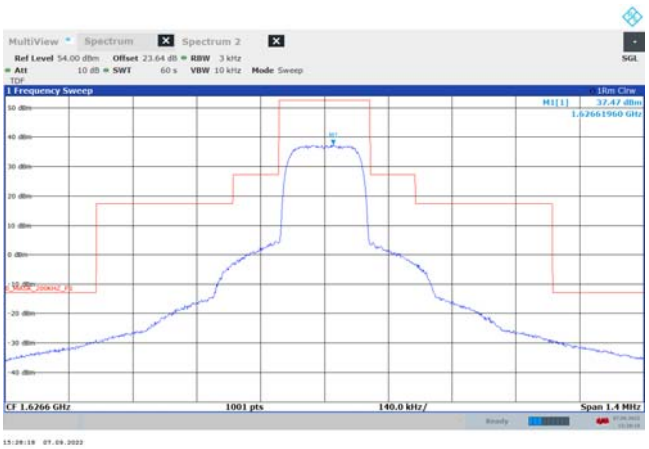
measured at Antenna port 2



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



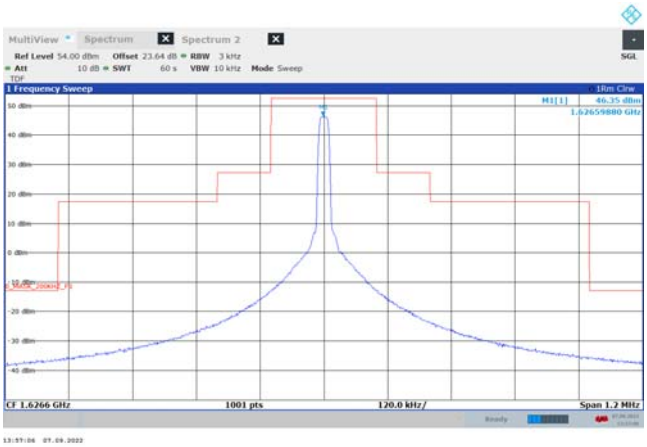
f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



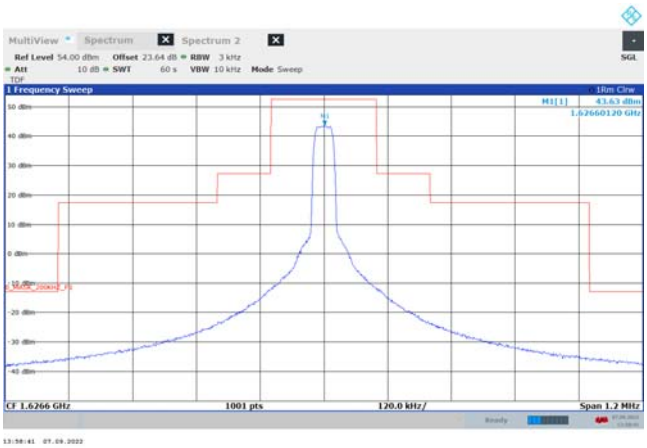
f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

Out-of-band emissions (OOBE) for each bearer type

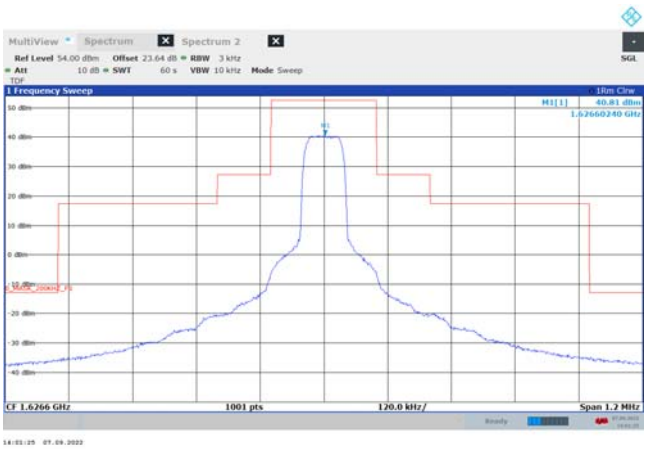
measured at Antenna port 1



f_{LOW} (4. Bearer type: R20T0.5QD-1B)

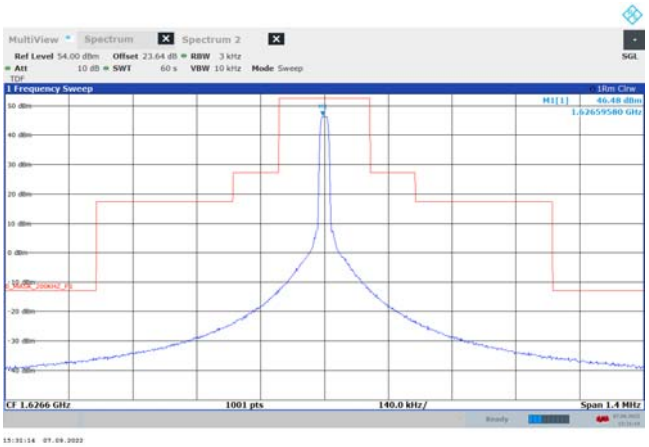


f_{LOW} (5. Bearer type: R20T1QD-1B)

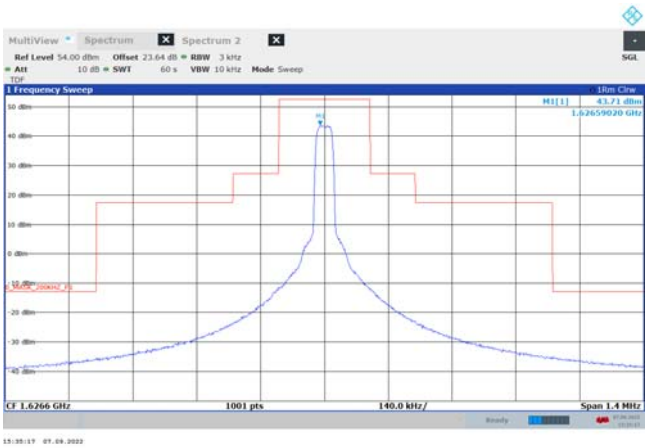


f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

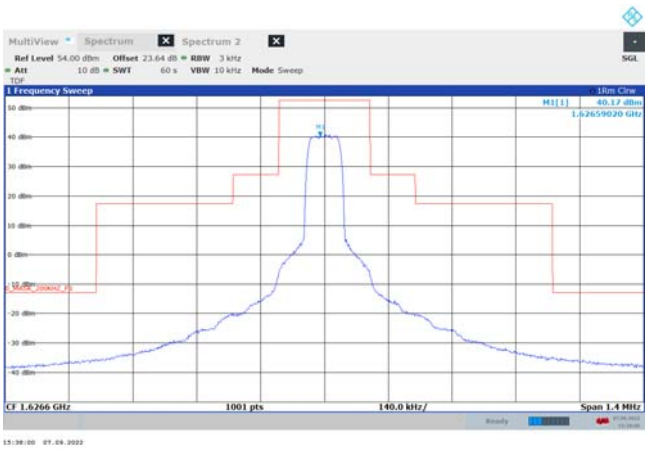
measured at Antenna port 2



f_{LOW} (4. Bearer type: R20T0.5QD-1B)



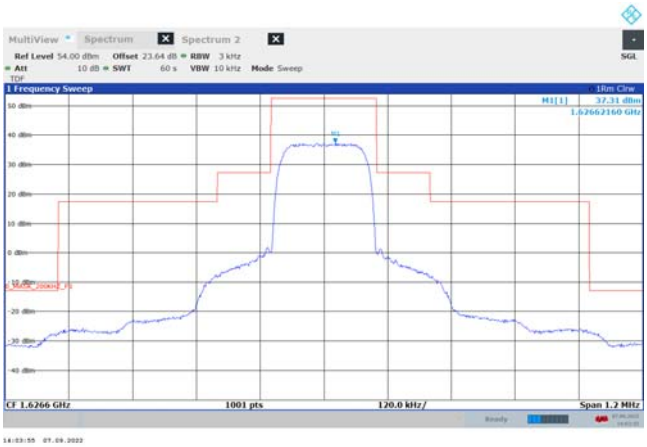
f_{LOW} (5. Bearer type: R20T1QD-1B)



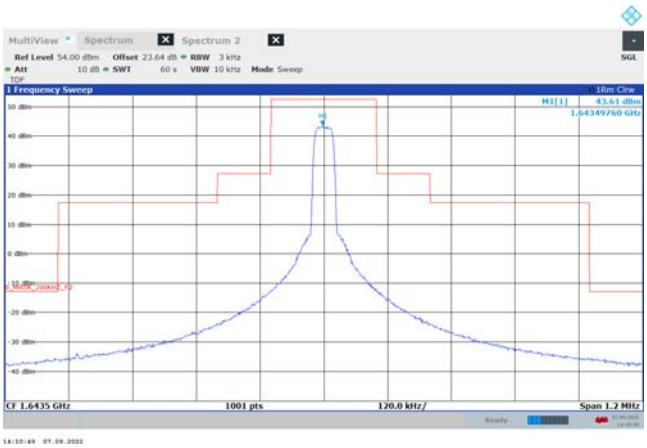
f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

Out-of-band emissions (OOBE) for each bearer type

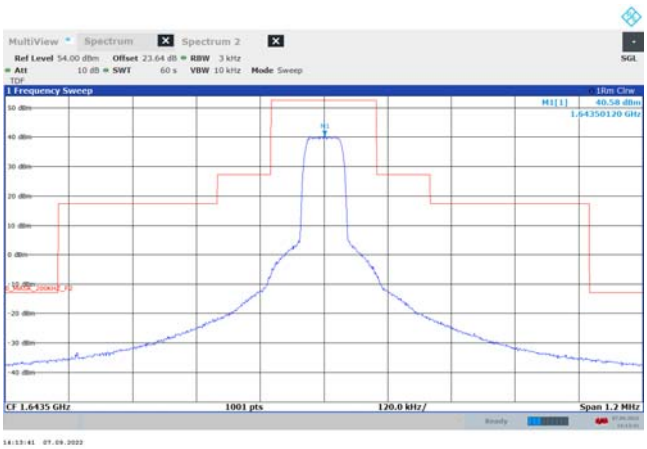
measured at Antenna port 1



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

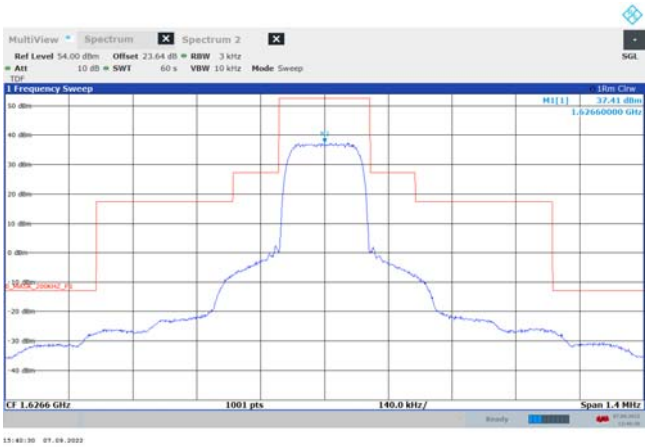


f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

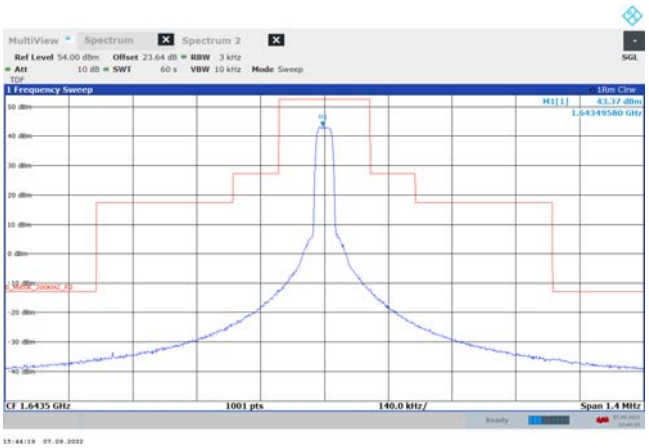


f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

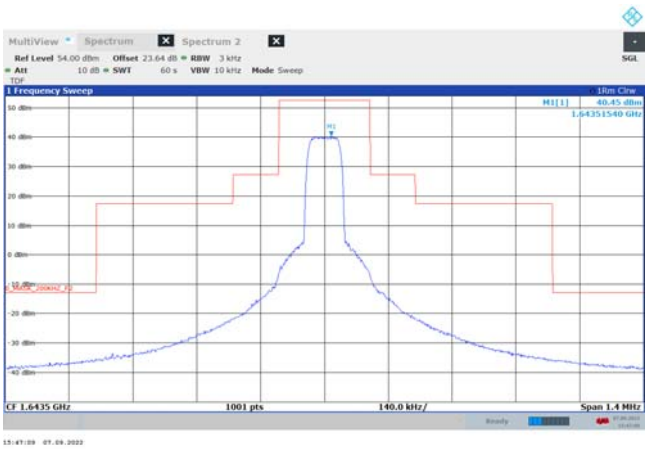
measured at Antenna port 2



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



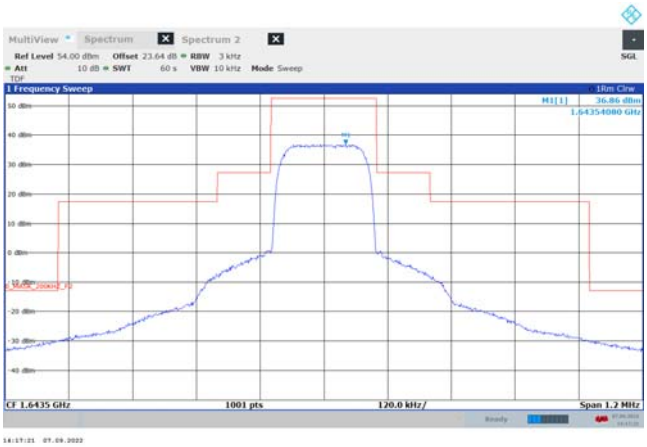
f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



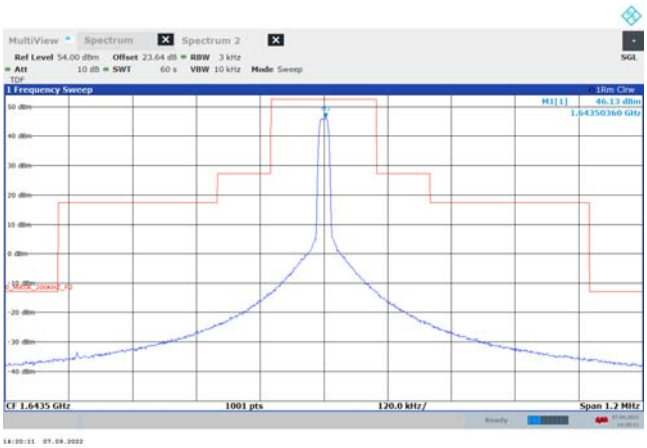
f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

Out-of-band emissions (OOBE) for each bearer type

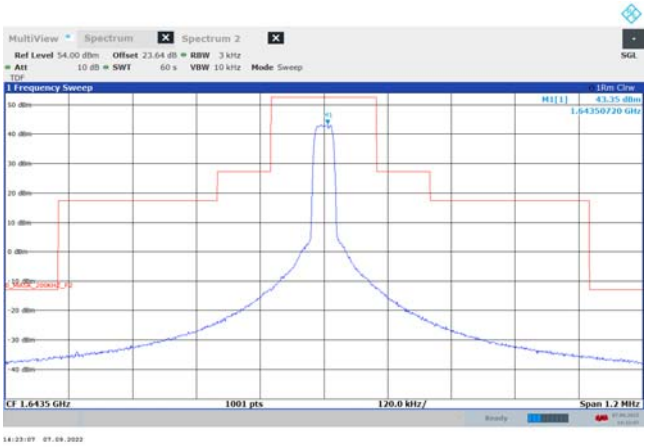
measured at Antenna port 1



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

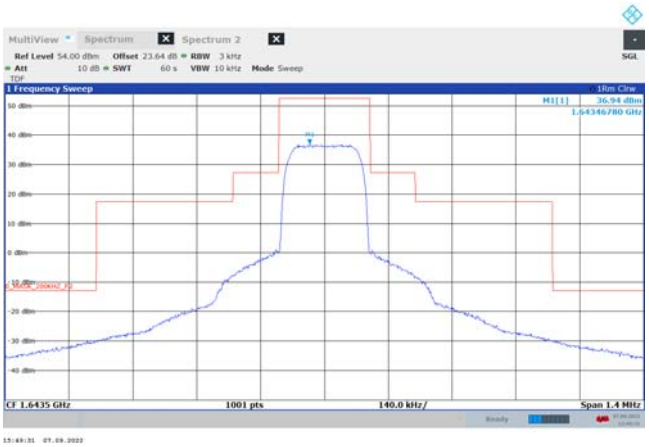


f_{MID} (4. Bearer type: R20T0.5QD-1B)

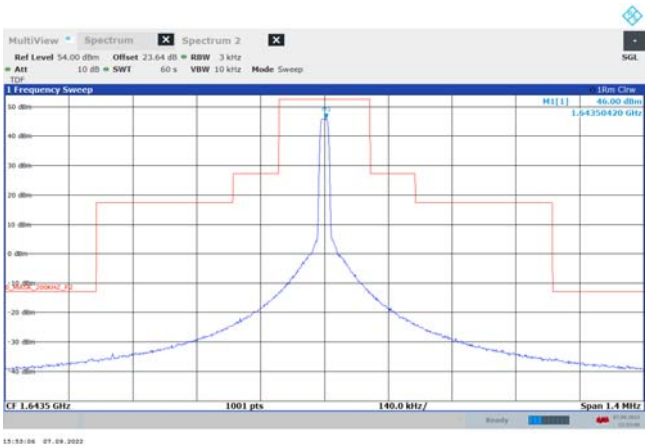


f_{MID}(5. Bearer type: R20T1QD-1B)

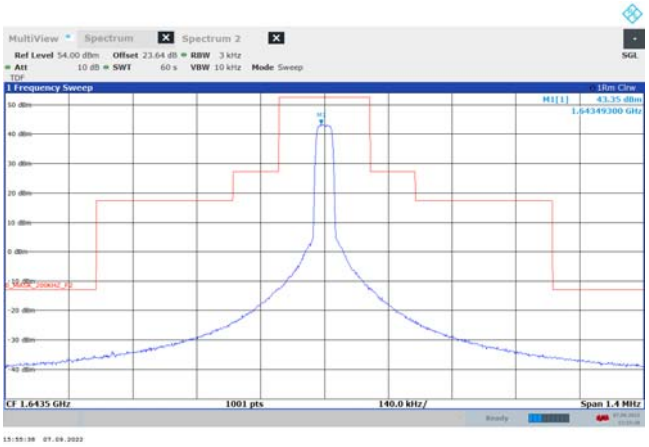
measured at Antenna port 2



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



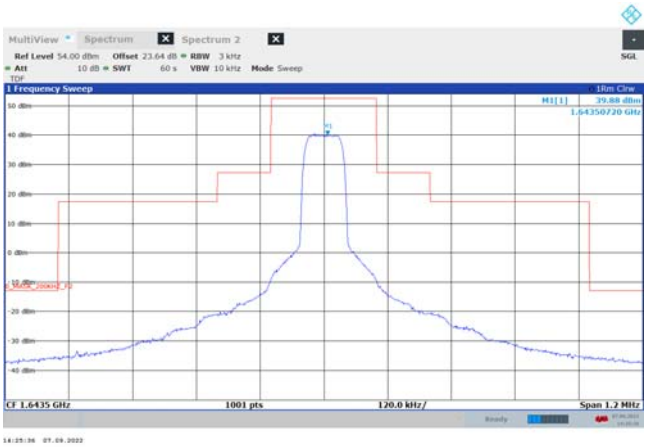
f_{MID} (4. Bearer type: R20T0.5QD-1B)



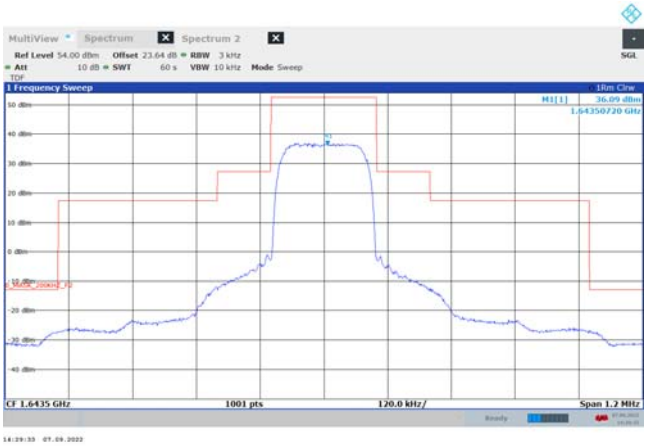
f_{MID}(5. Bearer type: R20T1QD-1B)

Out-of-band emissions (OOBE) for each bearer type

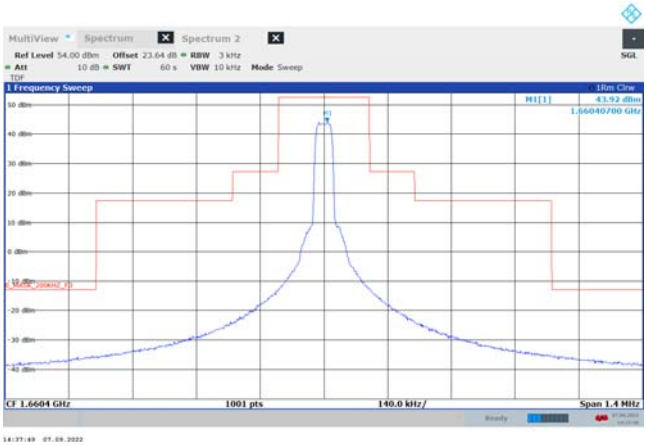
measured at Antenna port 1



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

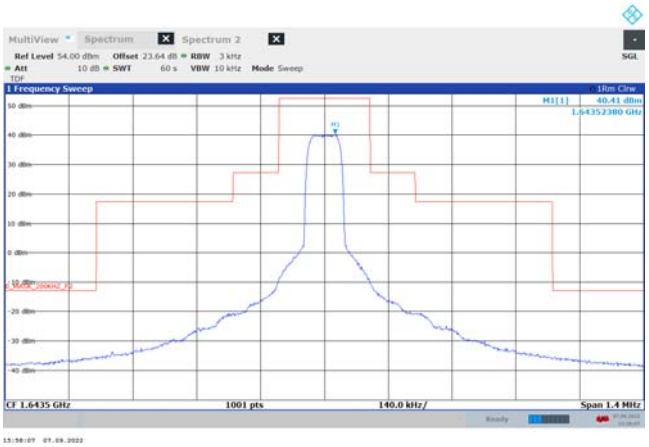


f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

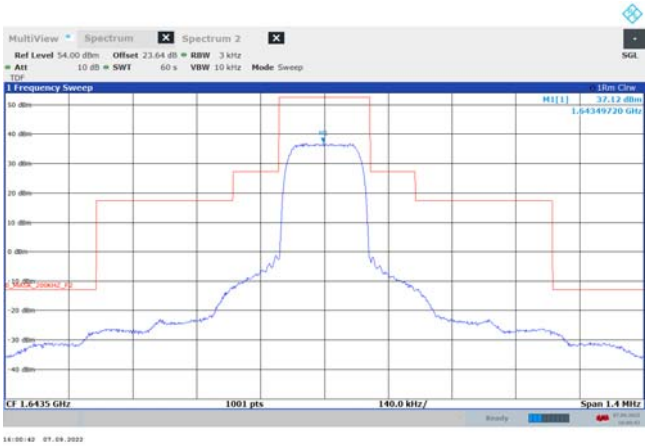


f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

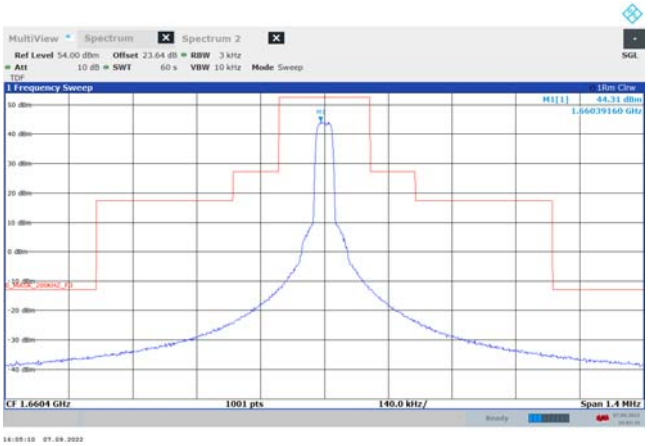
measured at Antenna port 2



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



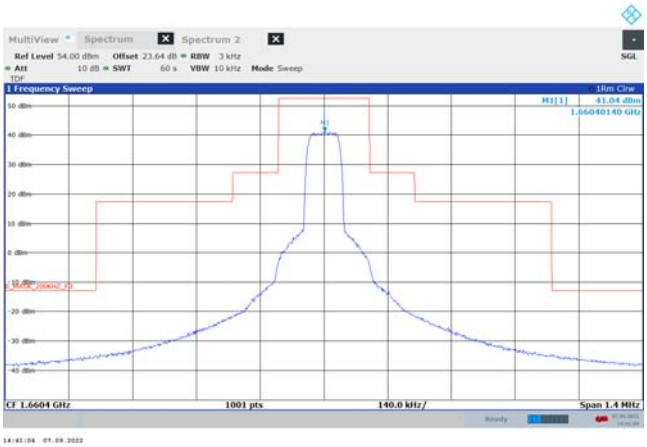
f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



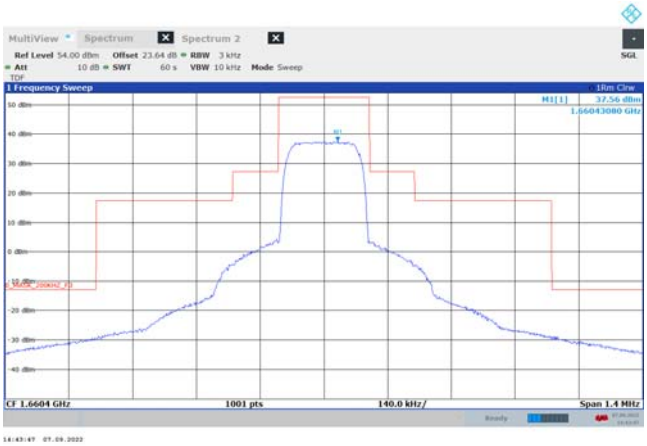
f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

Out-of-band emissions (OOBE) for each bearer type

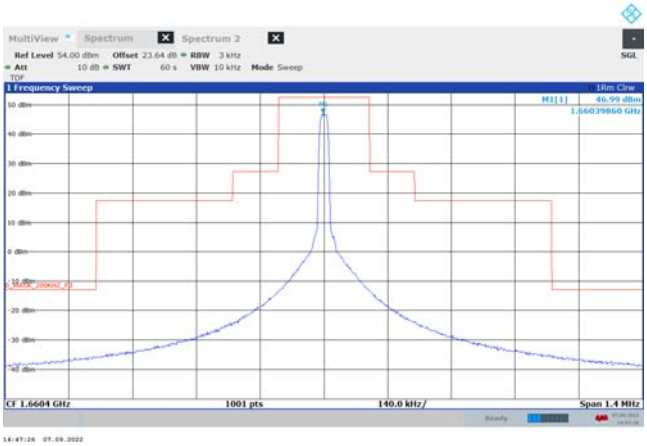
measured at Antenna port 1



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

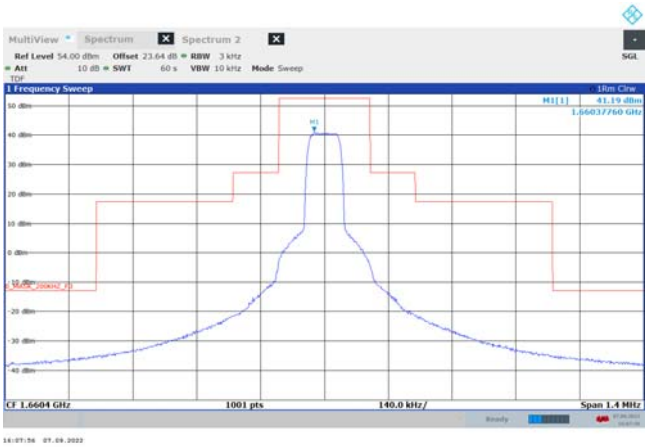


f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

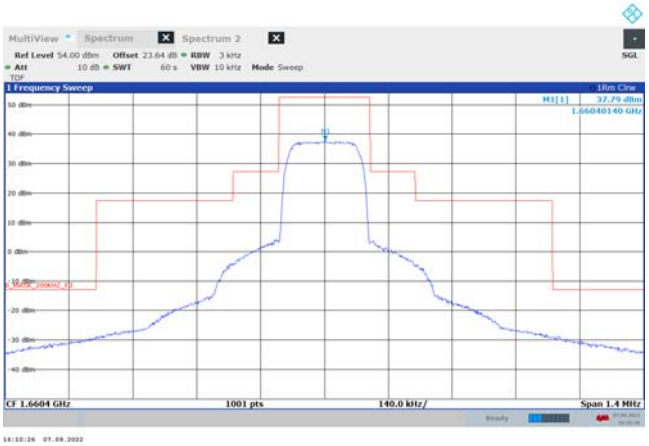


f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

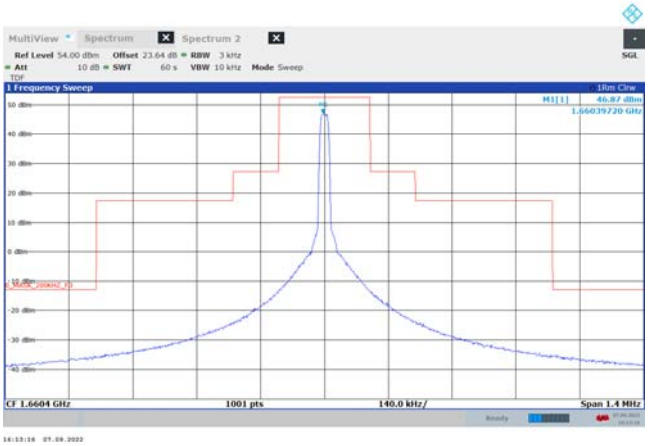
measured at Antenna port 2



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



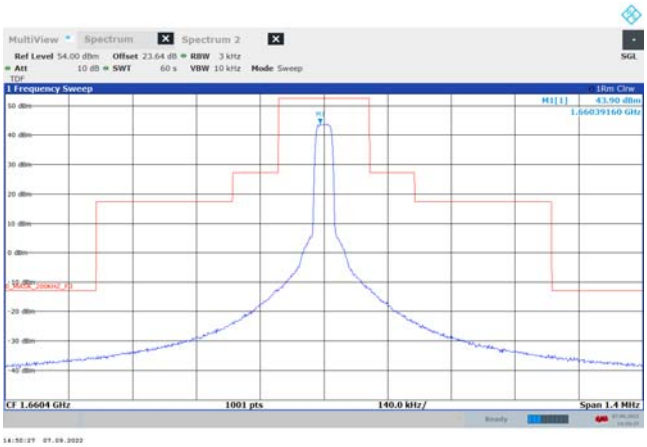
f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



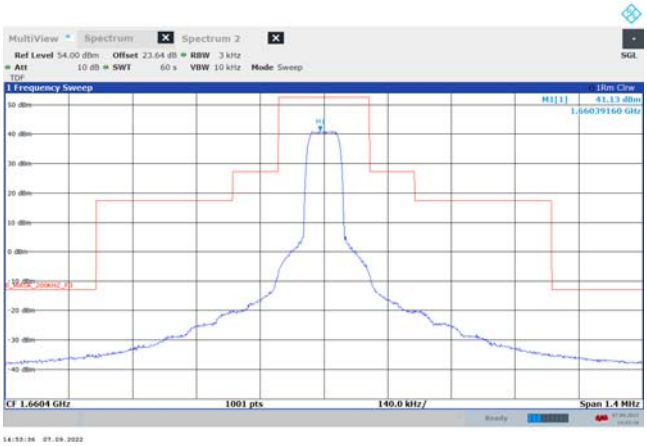
f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

Out-of-band emissions (OOBE) for each bearer type

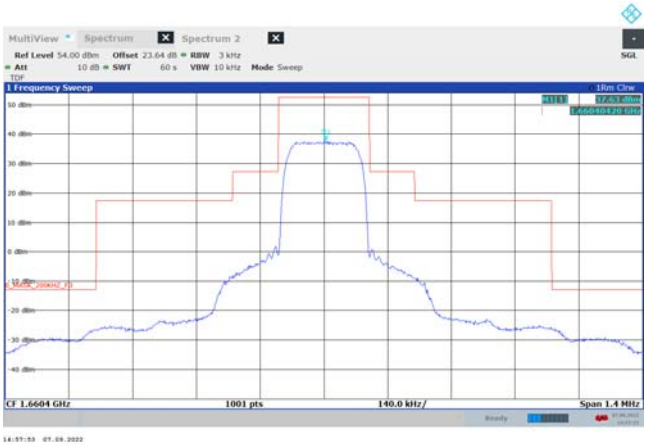
measured at Antenna port 1



f_{MID}(5. Bearer type: R20T1QD-1B)

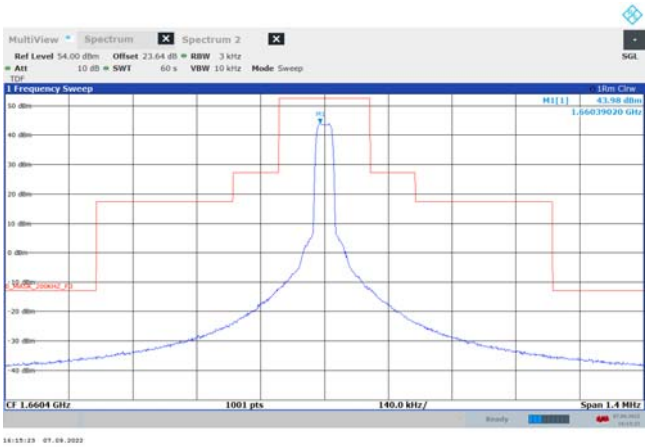


f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

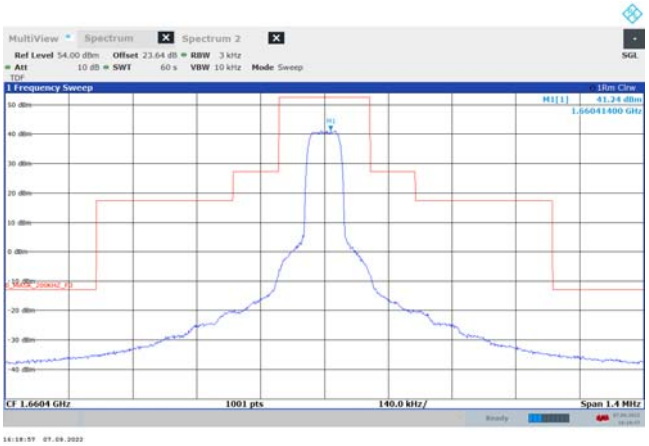


f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

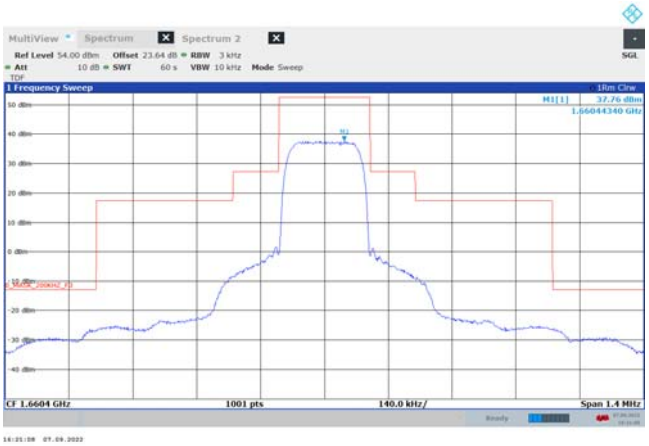
measured at Antenna port 2



f_{MID}(5. Bearer type: R20T1QD-1B)



f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

Table 4: Spurious Emissions at Antenna Terminals (conducted emissions)

Transmitting frequency Bearer type	Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Transmitting at f_{LOW}				
R5T1XD-1B / R20T1XD-1B	1636.657	-26.42	-13.00	13.42
R5T2XD-1B/R20T2XD-1B	1636.657	-28.19	-13.00	15.19
R5T4.5XD-1B / R20T4.5XD-2B	1636.757	-30.54	-13.00	17.54
R20T0.5QD-1B	**1636.657**	**-25.09**	**-13.00**	**12.09**
R20T1QD-1B	1636.707	-26.48	-13.00	13.48
R5T2QD-1B / R20T2QD-1B	1636.707	-28.57	-13.00	15.57
R5T4.5QD-1B / R20T4.5QD-1B	1636.707	-29.93	-13.00	16.93
Transmitting at f_{MID}				
R5T1XD-1B / R20T1XD-1B	1632.511	-26.42	-13.00	13.42
R5T2XD-1B/R20T2XD-1B	1632.461	-27.77	-13.00	14.77
R5T4.5XD-1B / R20T4.5XD-2B	1632.511	-31.16	-13.00	18.16
R20T0.5QD-1B	1632.511	-25.29	-13.00	12.29
R20T1QD-1B	1632.461	-27.00	-13.00	14.00
R5T2QD-1B / R20T2QD-1B	1632.511	-28.19	-13.00	15.19
R5T4.5QD-1B / R20T4.5QD-1B	1632.561	-30.36	-13.00	17.36
Transmitting at f_{HIGH}				
R5T1XD-1B / R20T1XD-1B	1653.190	-27.34	-13.00	14.34
R5T2XD-1B/R20T2XD-1B	1663.980	-28.55	-13.00	15.55
R5T4.5XD-1B / R20T4.5XD-2B	1663.980	-28.08	-13.00	15.08
R20T0.5QD-1B	1653.190	-25.90	-13.00	12.90
R20T1QD-1B	1653.190	-26.36	-13.00	13.36
R5T2QD-1B / R20T2QD-1B	1663.980	-27.86	-13.00	14.86
R5T4.5QD-1B / R20T4.5QD-1B	1663.980	-27.87	-13.00	14.87

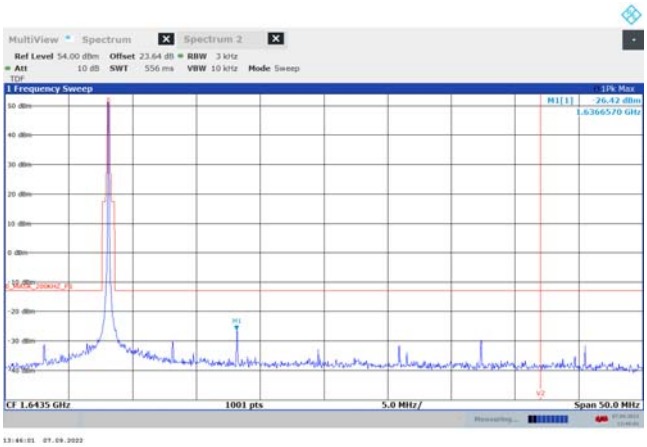
Note: *1) Margin = EIRP - Actual*

Remark: the measured EIRP in the above table were obtained from the Band-edge measurements in Figure 4, taking the highest value of the measured values at two antenna ports.

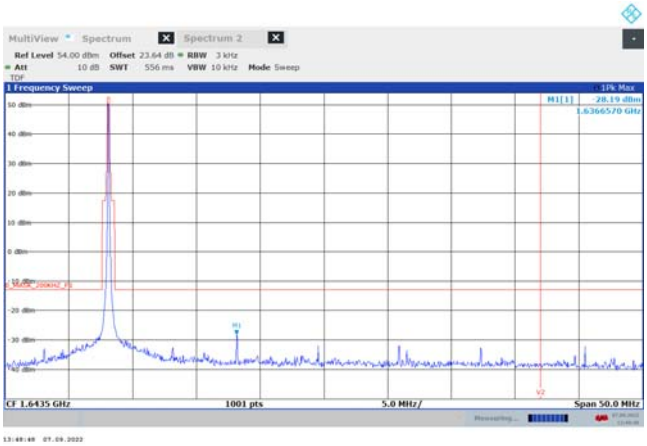
Figure 4. Plot of Spurious Emissions at Antenna Terminals (conducted emissions measurements)

Band-edge measurements for each bearer type

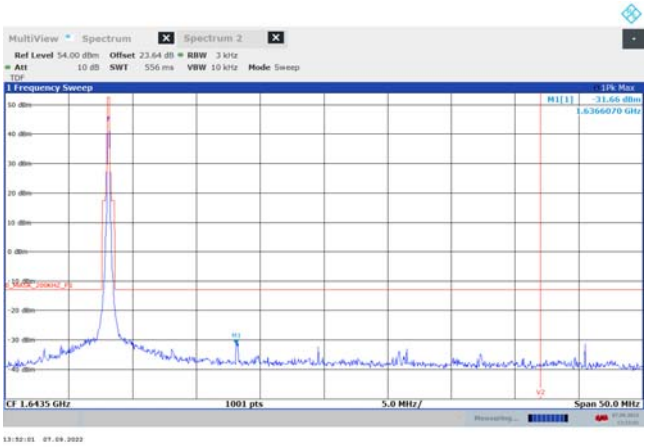
measured at Antenna port 1



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

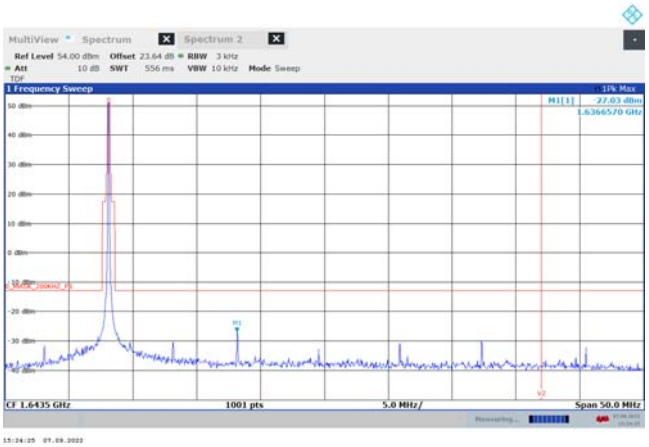


f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

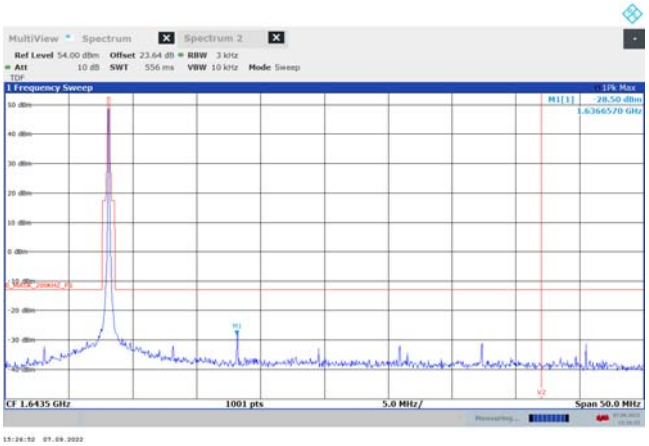


f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

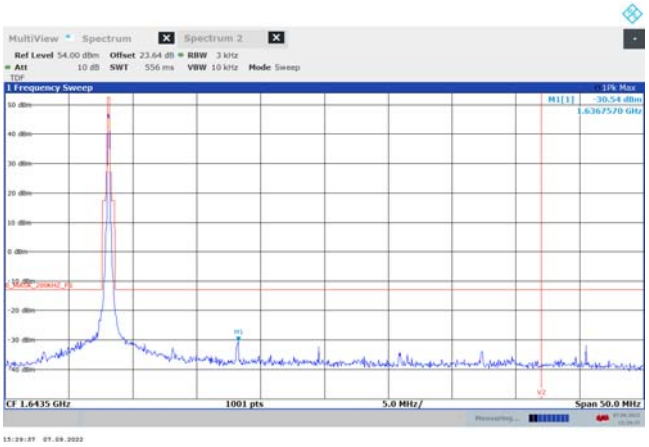
measured at Antenna port 2



f_{LOW} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



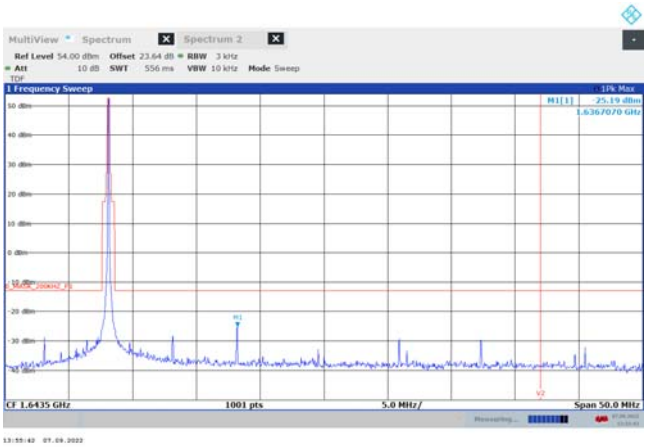
f_{LOW} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



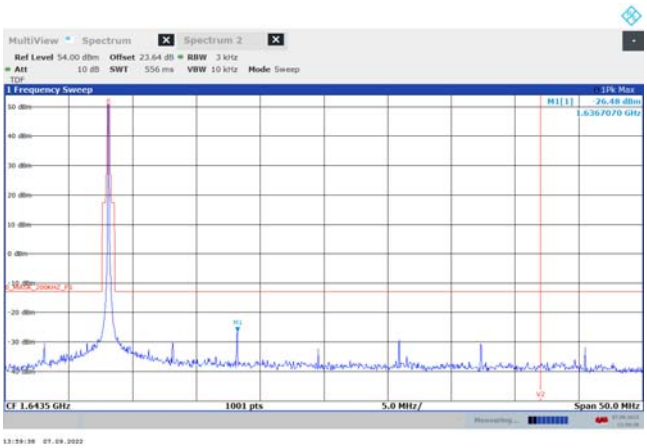
f_{LOW} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

Band-edge measurements for each bearer type

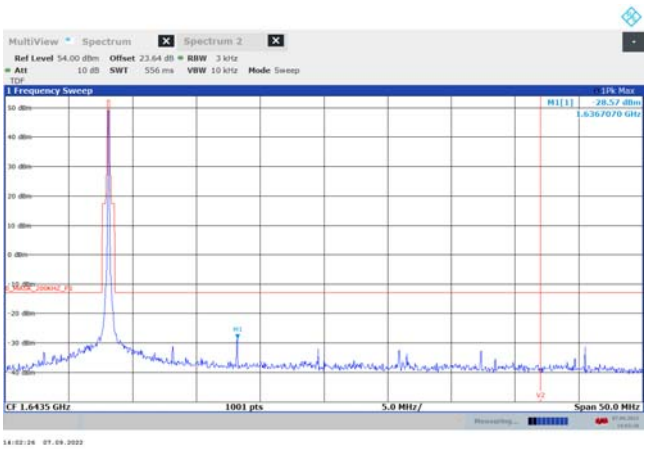
measured at Antenna port 1



f_{LOW} (4. Bearer type: R20T0.5QD-1B)

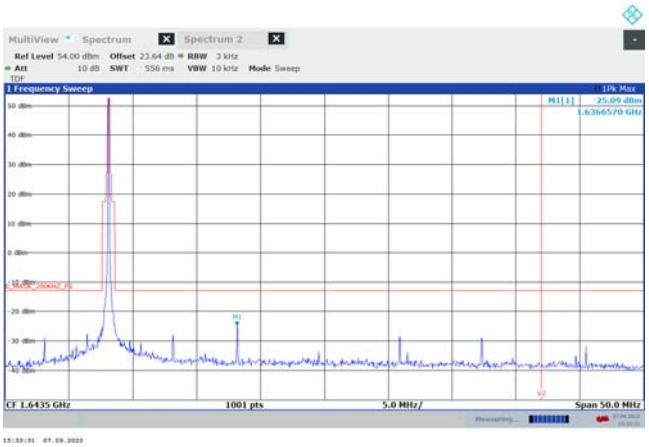


f_{LOW} (5. Bearer type: R20T1QD-1B)

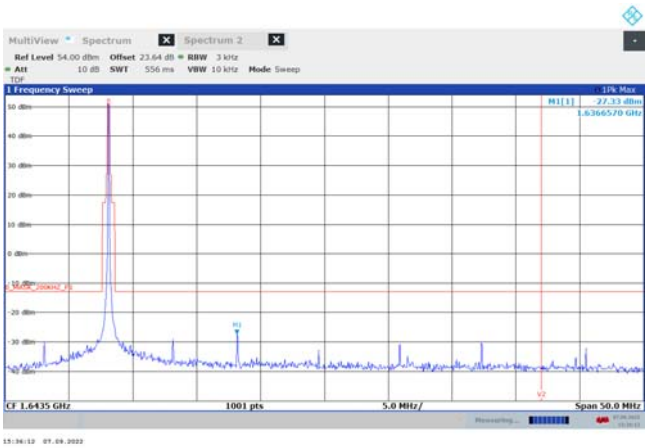


f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

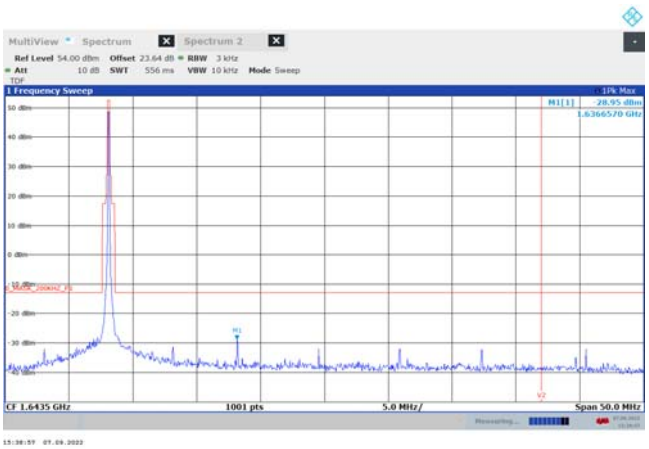
measured at Antenna port 2



f_{LOW} (4. Bearer type: R20T0.5QD-1B)



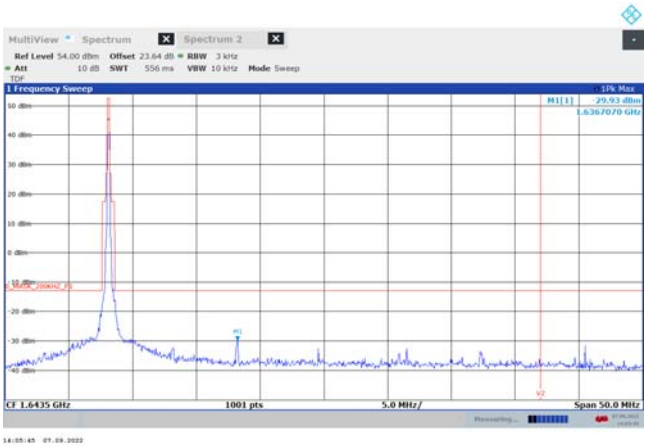
f_{LOW} (5. Bearer type: R20T1QD-1B)



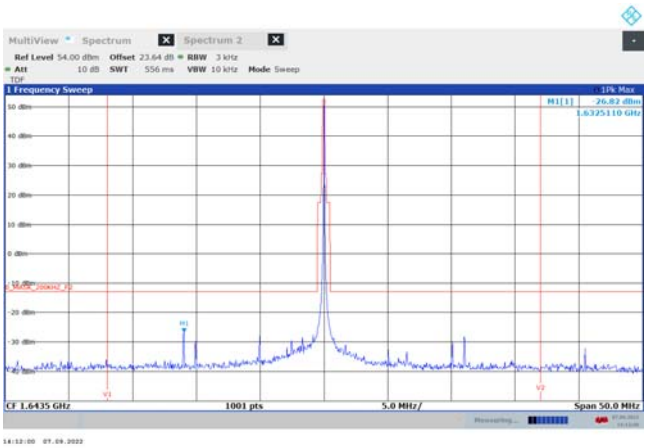
f_{LOW} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

Band-edge measurements for each bearer type

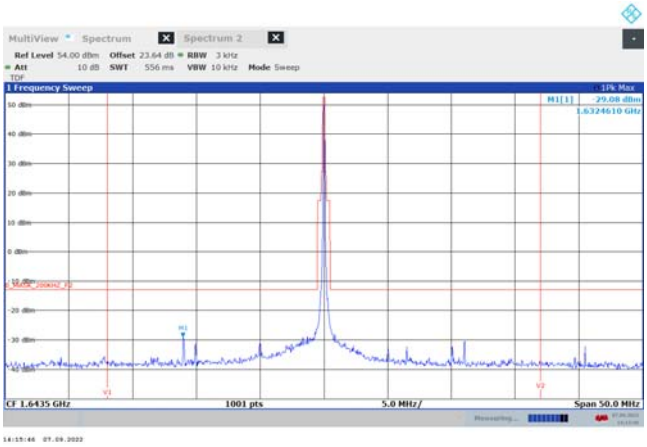
measured at Antenna port 1



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

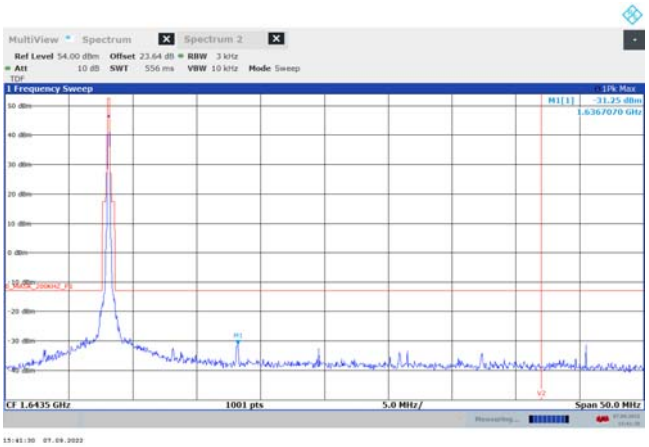


f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

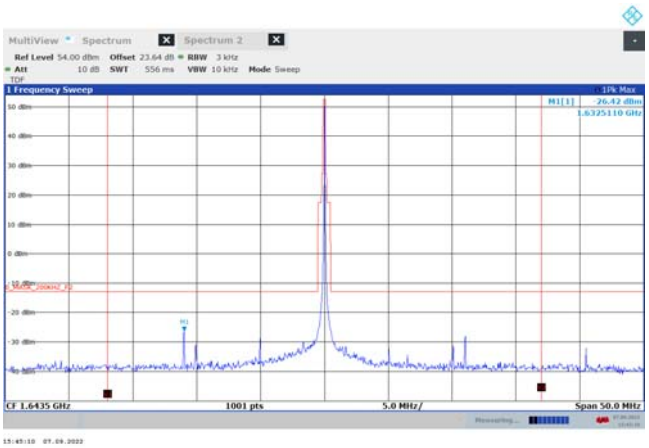


f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

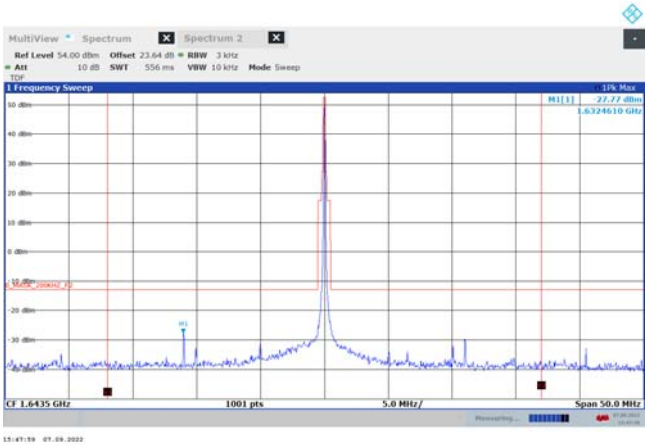
measured at Antenna port 2



f_{LOW} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



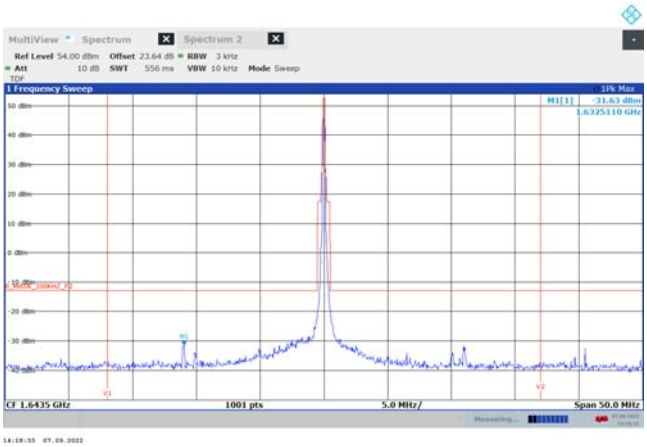
f_{MID} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)



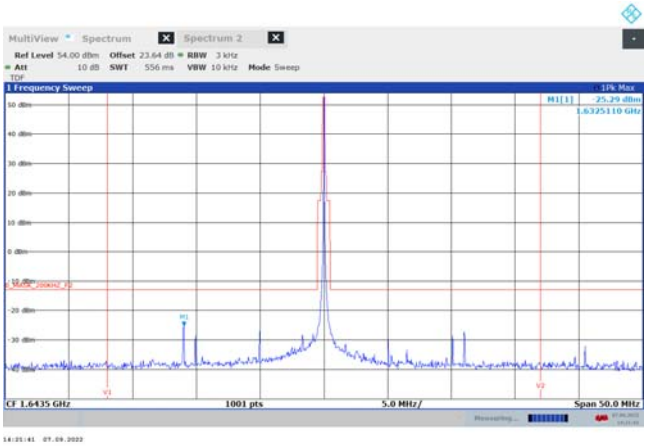
f_{MID} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

Band-edge measurements for each bearer type

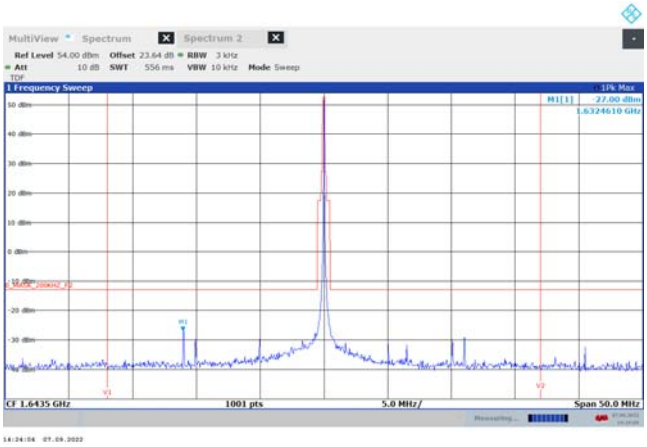
measured at Antenna port 1



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

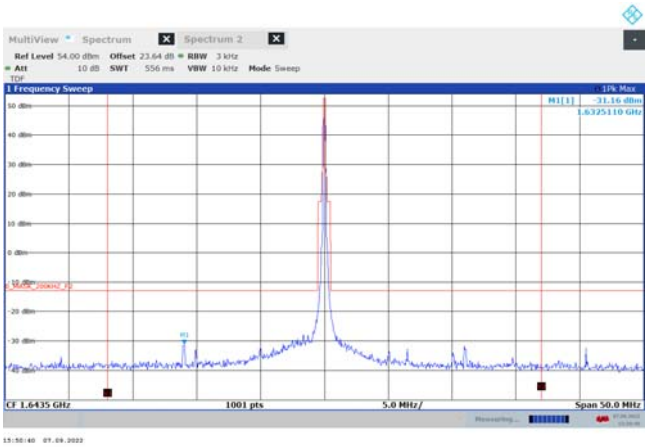


f_{MID} (4. Bearer type: R20T0.5QD-1B)

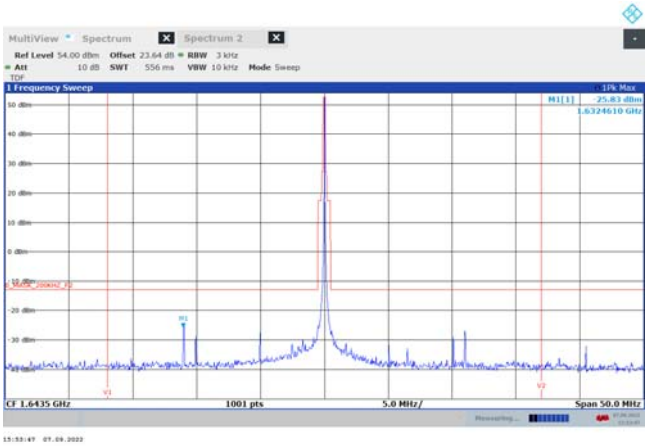


f_{MID}(5. Bearer type: R20T1QD-1B)

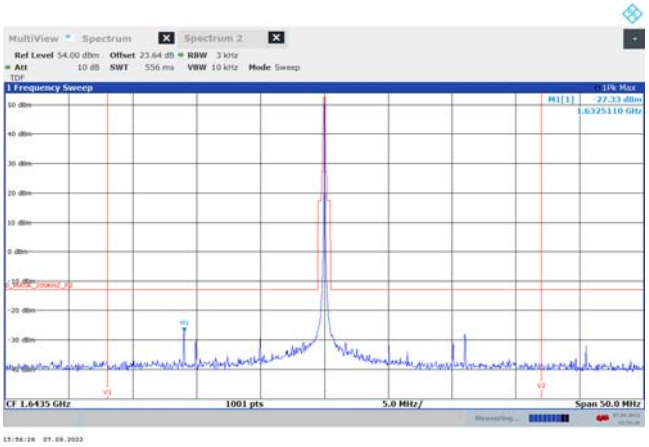
measured at Antenna port 2



f_{MID} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



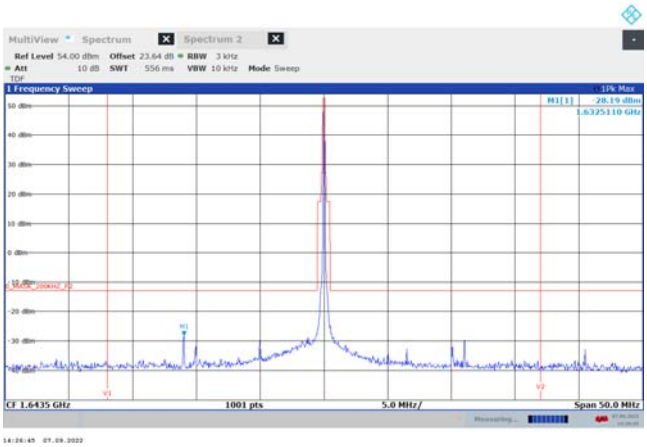
f_{MID} (4. Bearer type: R20T0.5QD-1B)



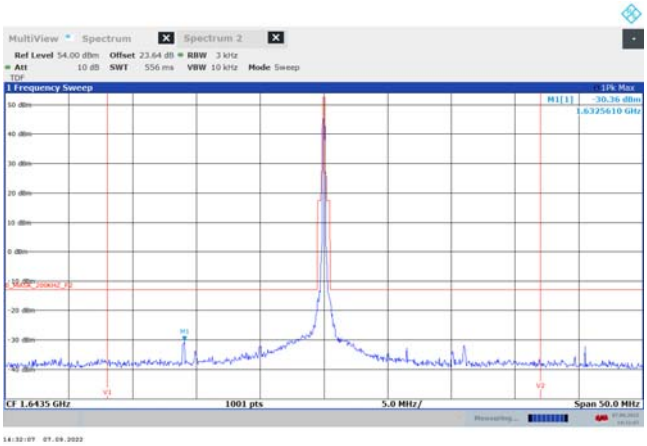
f_{MID}(5. Bearer type: R20T1QD-1B)

Band-edge measurements for each bearer type

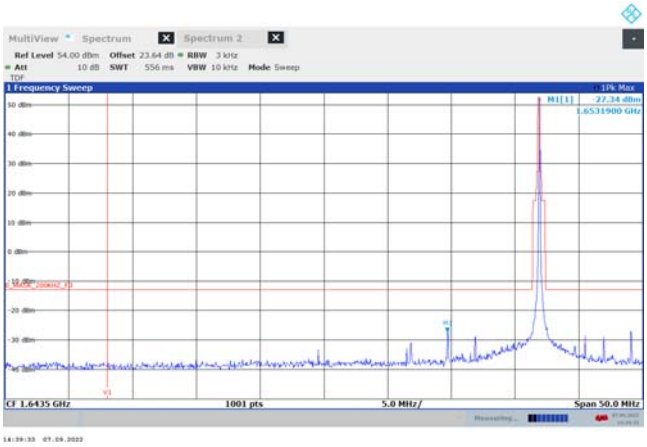
measured at Antenna port 1



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

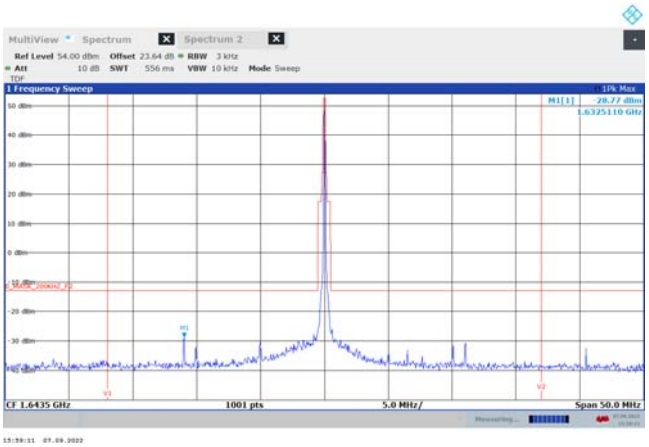


f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

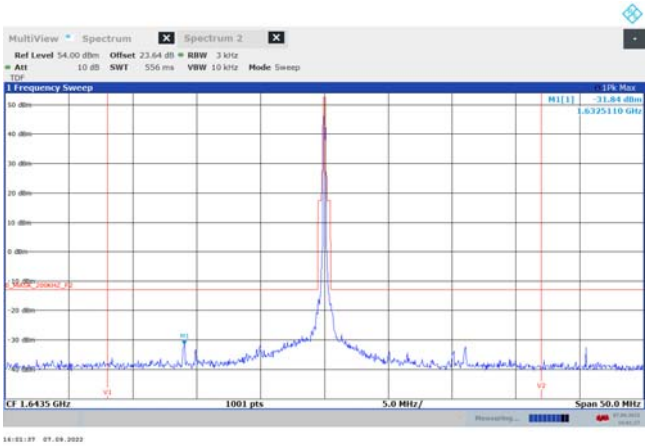


f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

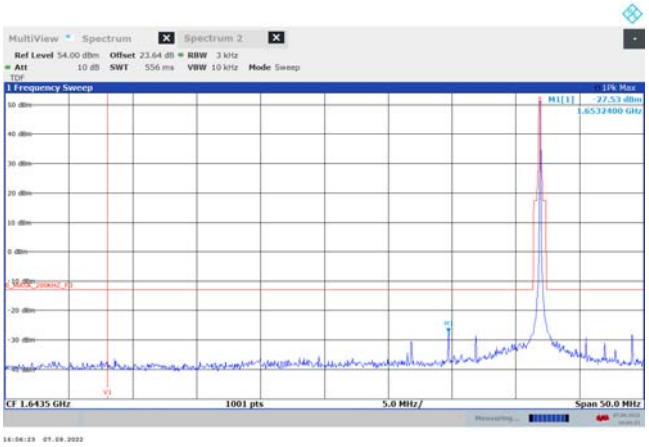
measured at Antenna port 2



f_{MID} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)



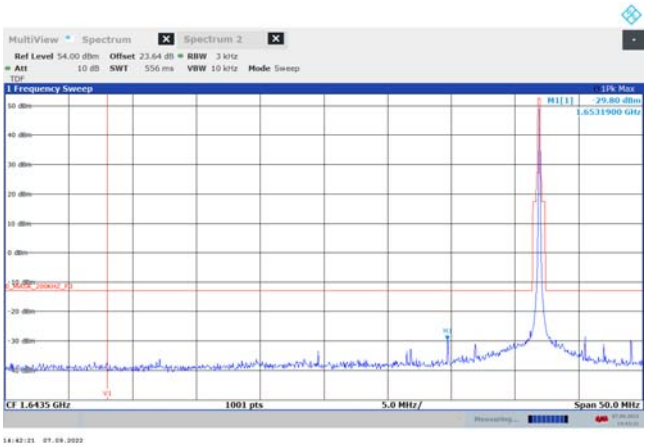
f_{MID} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)



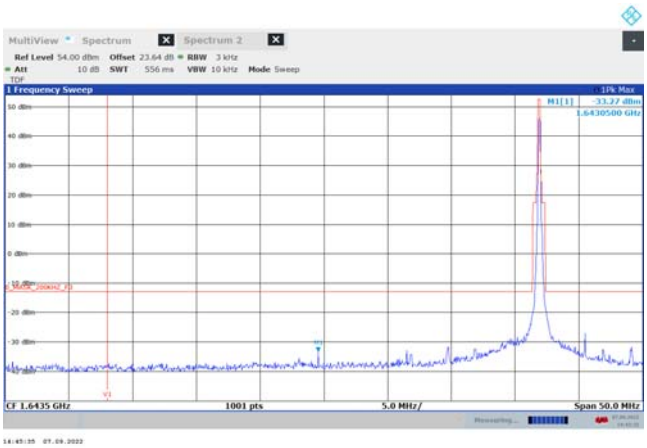
f_{HIGH} (1. Bearer type: R5T1XD-1B / R20T1XD-1B)

Band-edge measurements for each bearer type

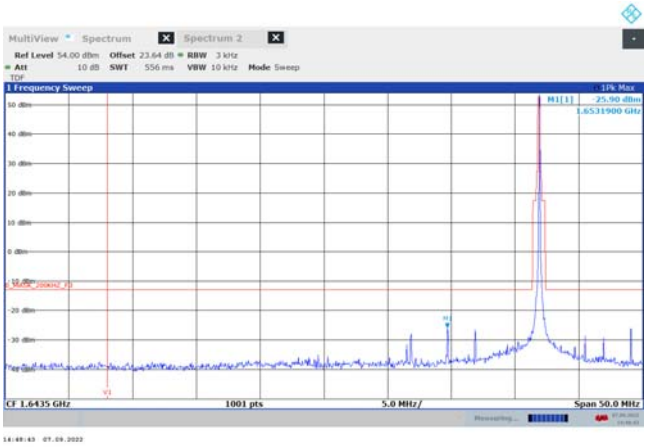
measured at Antenna port 1



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)

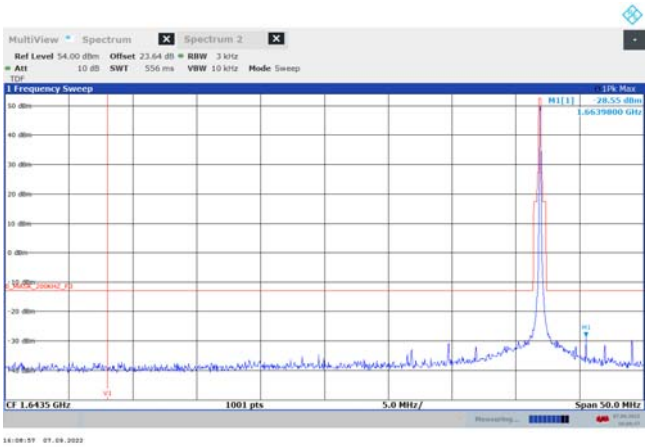


f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)

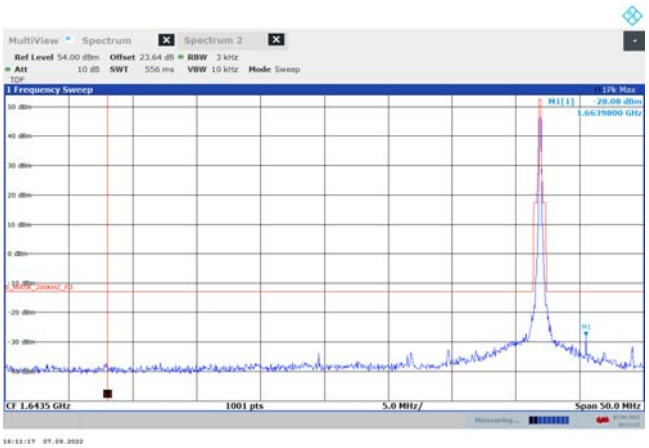


f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

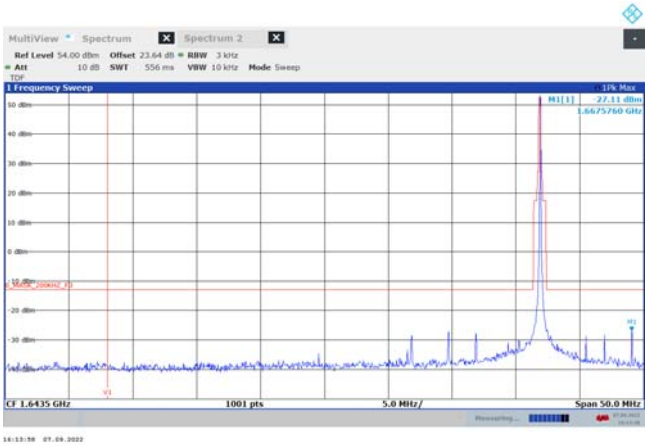
measured at Antenna port 2



f_{HIGH} (2. Bearer type: R5T2XD-1B/R20T2XD-1B)



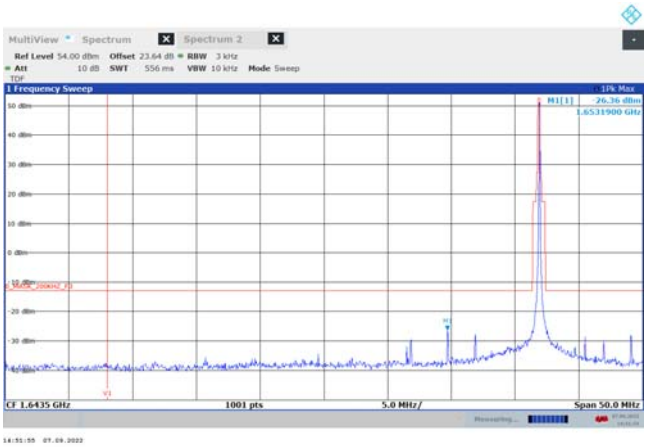
f_{HIGH} (3. Bearer type: R5T4.5XD-1B / R20T4.5XD-2B)



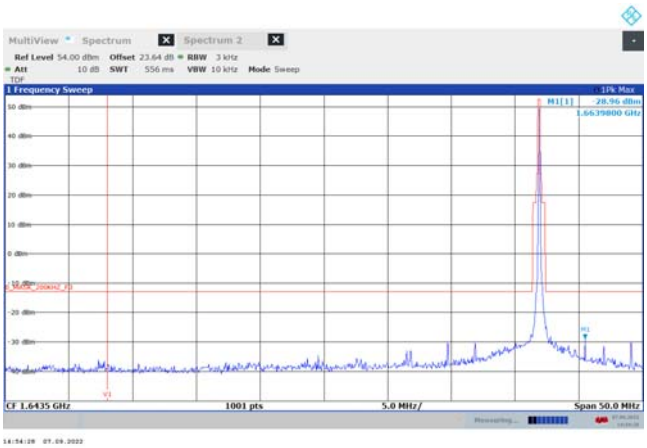
f_{HIGH} (4. Bearer type: R20T0.5QD-1B)

Band-edge measurements for each bearer type

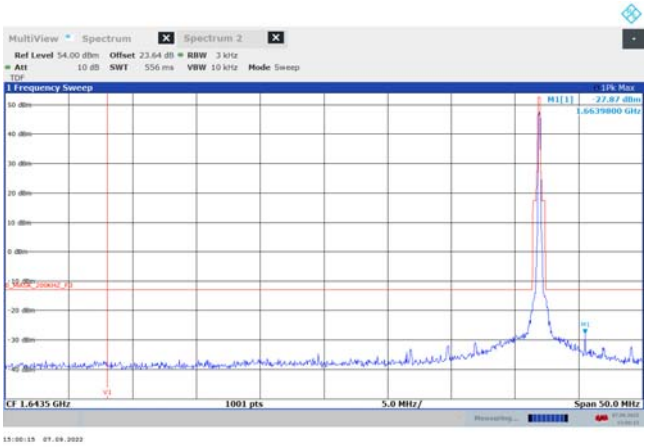
measured at Antenna port 1



f_{MID}(5. Bearer type: R20T1QD-1B)

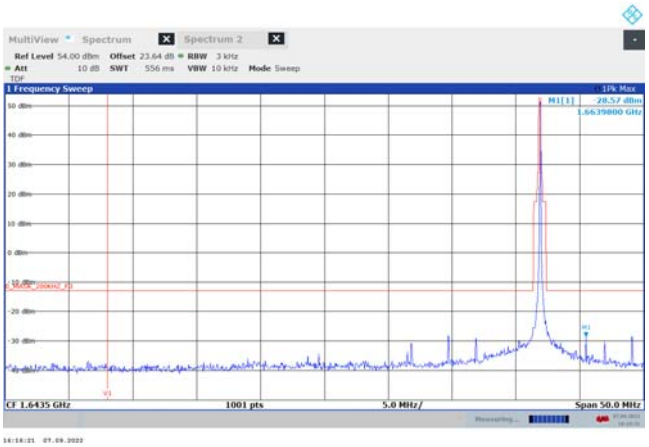


f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

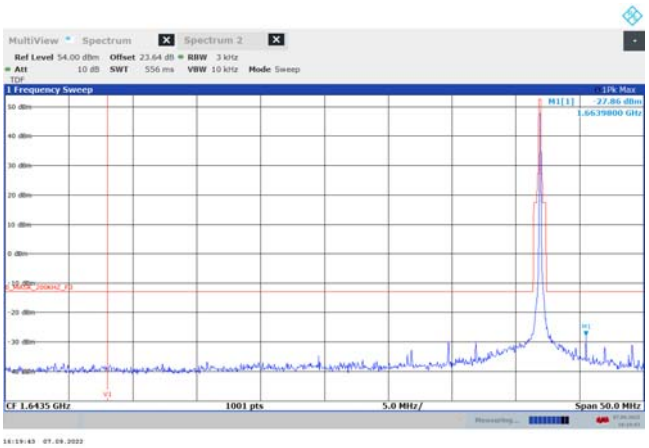


f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

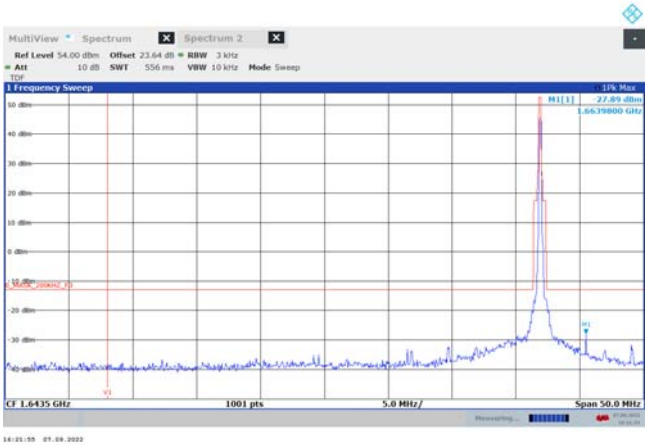
measured at Antenna port 2



f_{MID}(5. Bearer type: R20T1QD-1B)



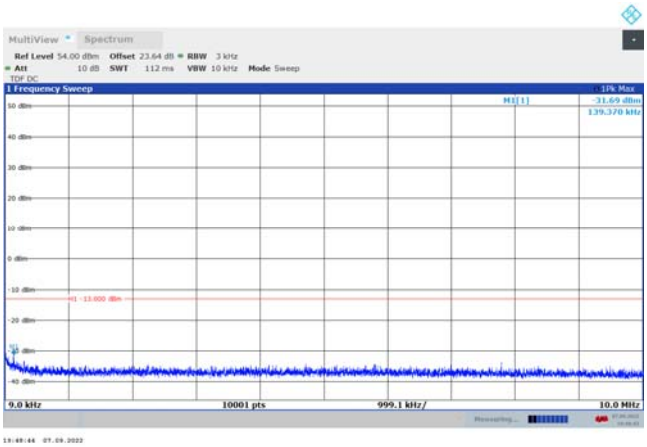
f_{HIGH} (6. Bearer type: R5T2QD-1B / R20T2QD-1B)

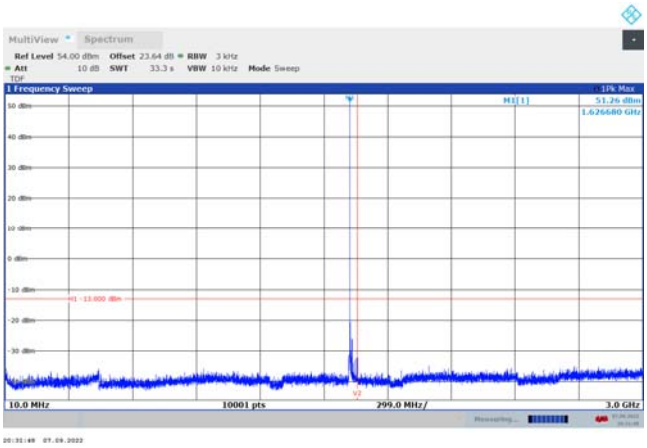


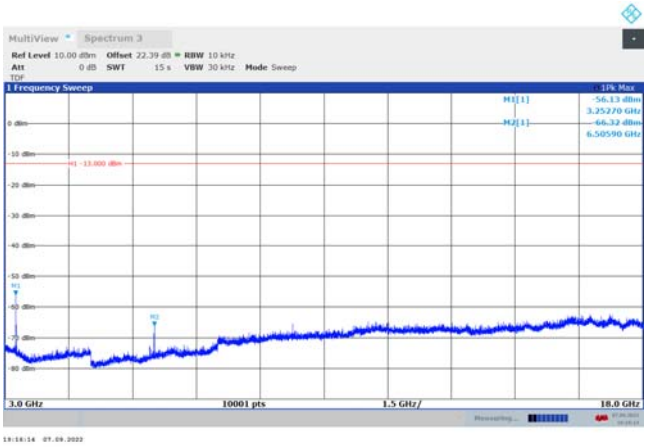
f_{HIGH} (7. Bearer type: R5T4.5QD-1B / R20T4.5QD-1B)

Conducted spurious emission measurements; all bearer types were activated with the max hold function.

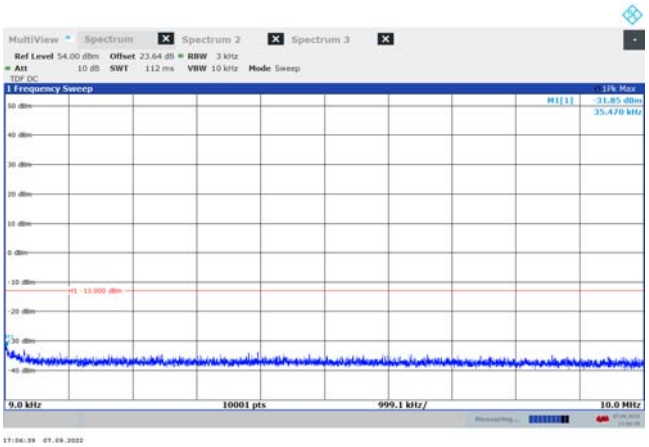
measured at Antenna port 1: transmitting at f_{LOW}

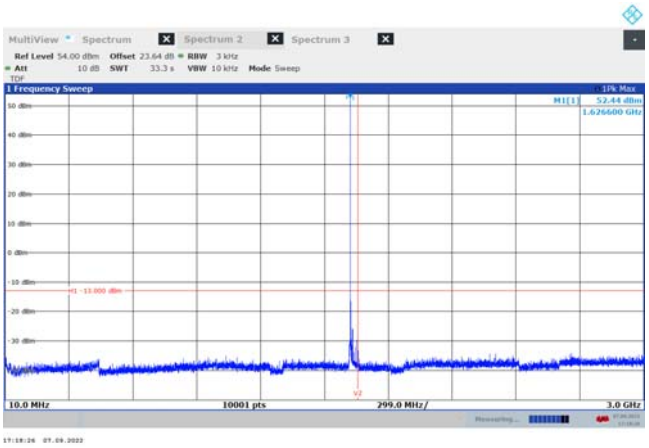


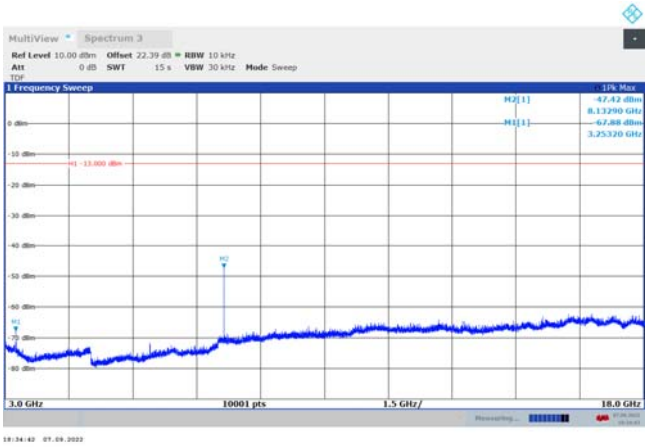




measured at Antenna port 2: transmitting at f_{LOW}

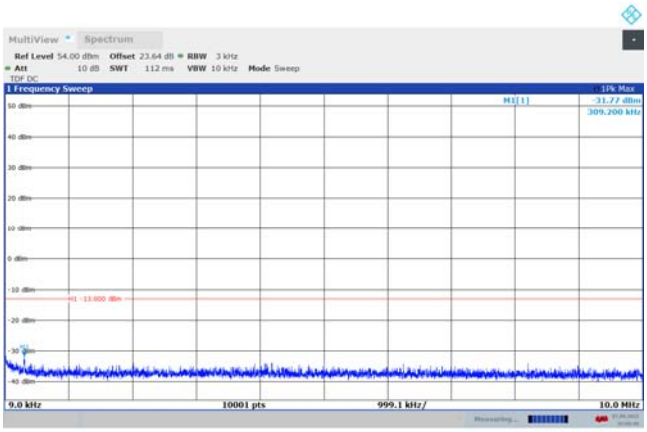


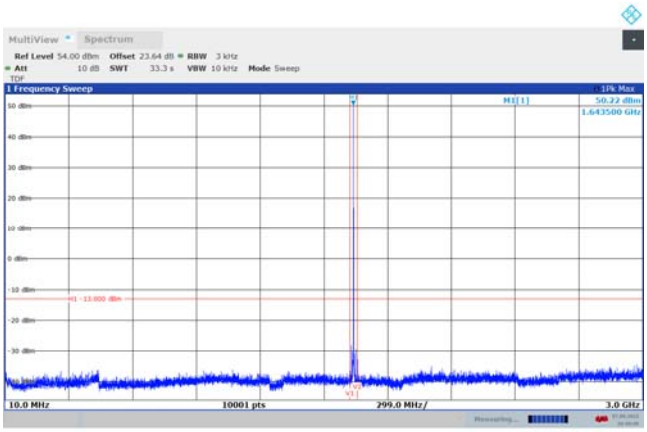


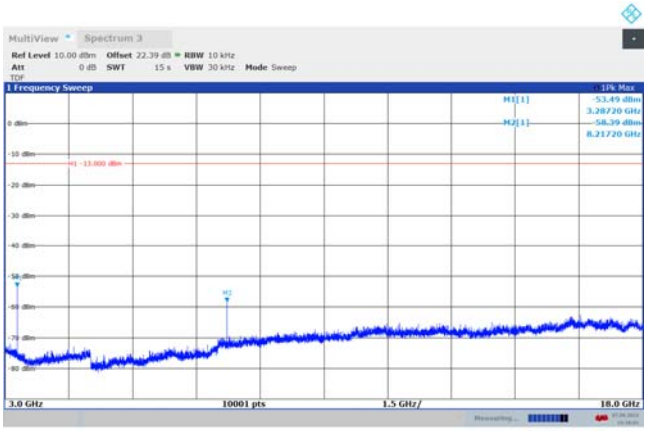


Conducted spurious emission measurements; all bearer types were activated with the max hold function.

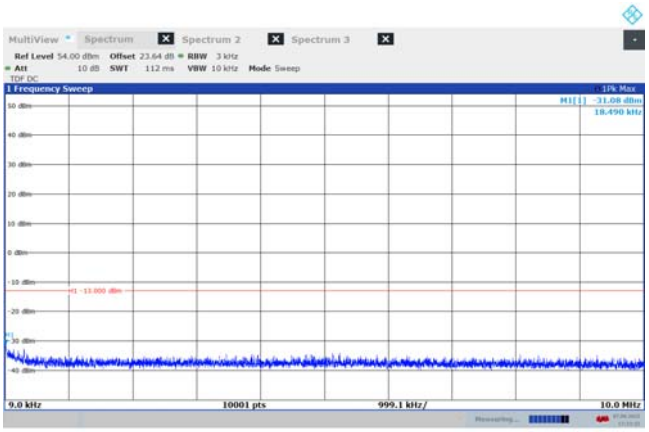
measured at Antenna port 1: transmitting at f_{MID}

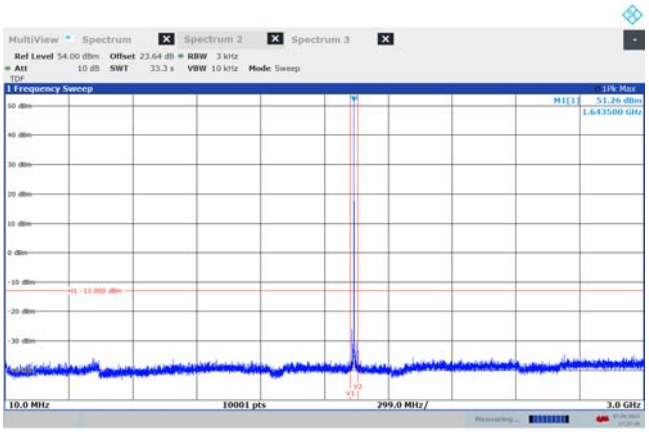


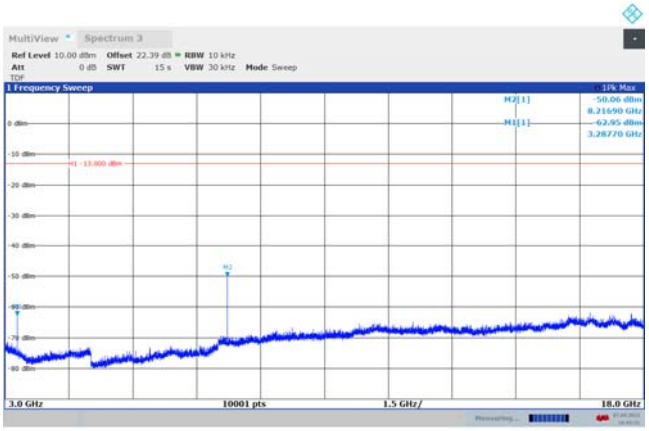




measured at Antenna port 2: transmitting at f_{MID}

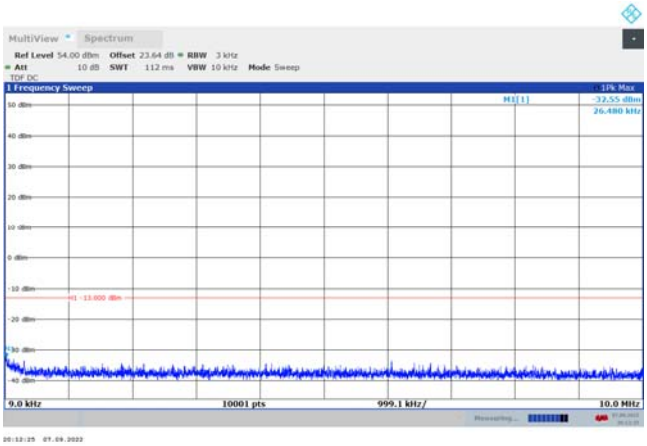


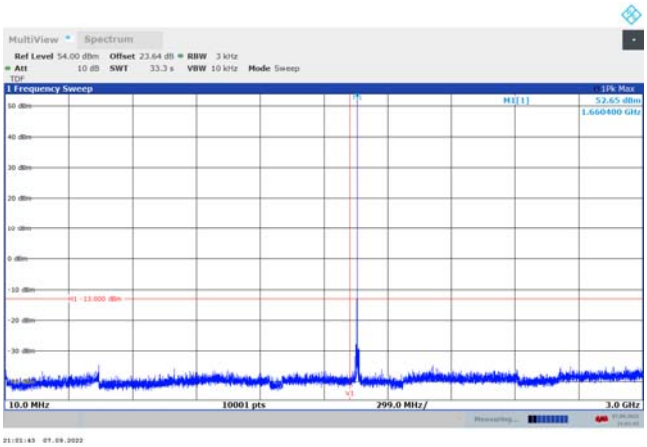


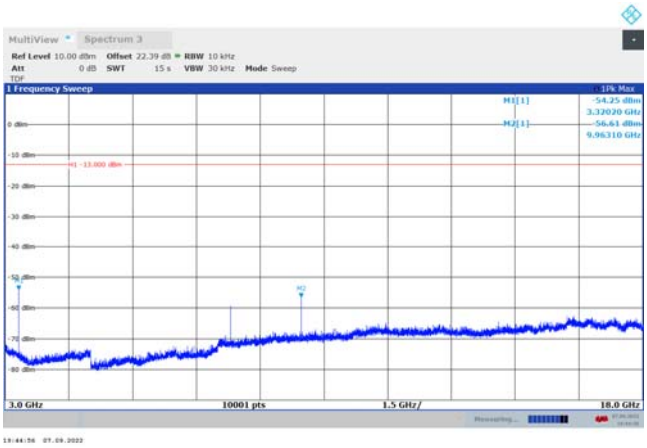


Conducted spurious emission measurements; all bearer types were activated with the max hold function.

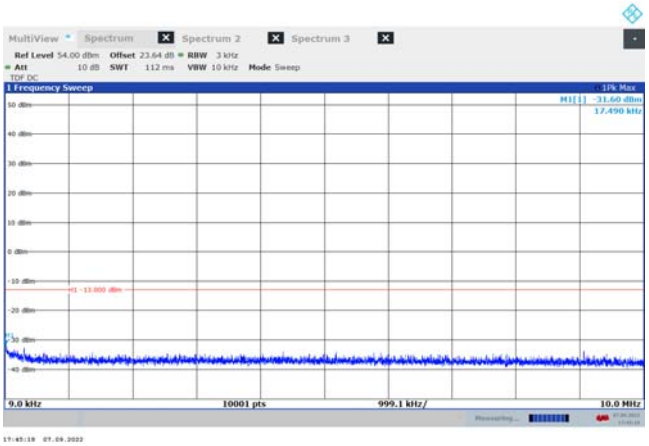
measured at Antenna port 1: transmitting at f_{HIGH}

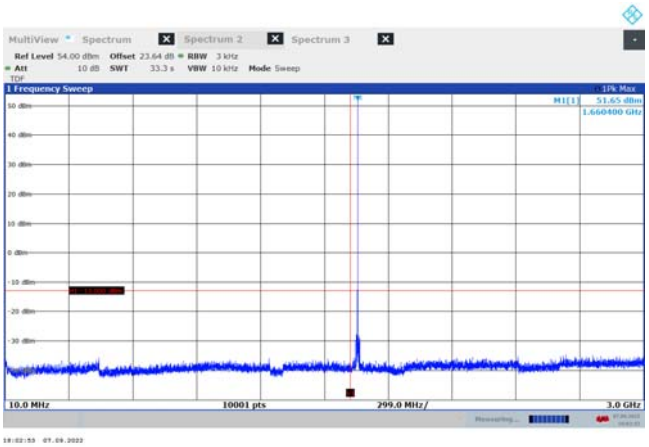


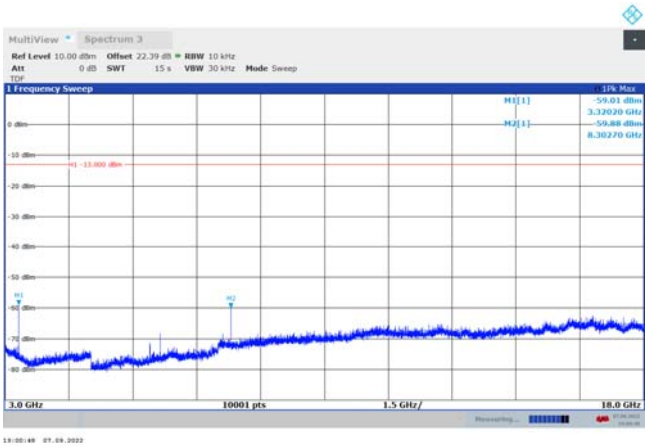




measured at Antenna port 2: transmitting at f_{HIGH}







5.4. Field Strength of Spurious Radiation (radiated emissions)

5.4.1 Regulation

FCC, CFR 47 Section

According to 2.1053(a), Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

According to 2.1053(b), The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

According to 25.202(f), Emission limitations. Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;
(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

ISED, RSS section

RSS-170, 5.4.3.1. Mobile Earth Stations in All Frequency Bands

The average power of unwanted emissions shall be attenuated below the average output power, P (dBW), of the transmitter, as specified below:

(1) 25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more

than 50%, up to and including 100% of the occupied bandwidth or necessary bandwidth, whichever is greater;

(2) 35 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 100%, up to and including 250% of the occupied bandwidth or necessary bandwidth, whichever is greater; and

(3) 43 + 10 log p (watts) in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 250% of the occupied bandwidth or necessary bandwidth, whichever is greater.

5.4.2 Test Procedure

The field strength of radiated spurious measurements was made in accordance with the procedures of subclause 5.5 of ANSI C63.26

The radiated emission measurements were performed inside the chamber.

(a) The EUT was placed on the support at the height of 80 cm (below 1 GHz) or 1.5 m (above 1 GHz).

(b) The EUT's RF ports were terminated by the 50 ohm load.

(c) The EUT was tested using both modulations and at the low, mid, and high channels.

(d) The EUT was rotated about 360° and the receiving antenna scanned from 1 to 4m in order to capture the maximum emission.

(e) The measurements were made with the receive antenna in both horizontal and vertical polarizations.

(f) If the EUT was designed to be installed in one of two distinct orientations, the tests should be performed in both orientations. If the EUT could be operated in one of multiple orientations (e.g., handheld, portable, or modular devices), the tests should be performed in a minimum of three orientations.

(g) The harmonic emissions up to the 10th or 40 GHz, whichever was the lesser, were investigated.

(h) The plots were corrected for the cable loss, antenna factor, and distance correction.

For the measurement frequency below 1 GHz, the field strength was measured and then mathematically corrected to an E.I.R.P., according to 5.2.7 of ANSI C63.26.

(a) E (dBμV/m) = Measured amplitude level (dBμV) + Cable Loss (dB) + Antenna Factor (dB/m).

(b) E (dBμV/m) = Measured amplitude level (dBm) + 107 + Cable Loss (dB) + Antenna Factor (dB/m).

(c) E (dBμV/m) = EIRP (dBm) - 20log(D) + 104.8; where D is the measurement distance in m.

(d) EIRP (dBm) = E (dBμV/m) + 20log(D) - 104.8; where D is the measurement distance in m.

For the measurement frequency above 1 GHz, the EIRP was directly determined by using the basic free-space propagation path loss according to the C.5.2 of ANSI C63.26. The radiated measurements using substitution techniques were performed if the emissions exceeded (or approached to) the specified limits.

NOTE 1: During the preliminary measurements, the EUT was operated with the narrowest bandwidth (Bearer type R20T0.5QD-1B) with highest power density in 4 kHz during the preliminary measurements as the worst-case. The peak detector was used with the appropriate measurement bandwidth (RBW) as 1 kHz (from 9 kHz to 150 kHz), 10 kHz (from 150 kHz to 30 MHz), 100 kHz (from 30 MHz to 1 GHz), and 1 MHz (from 1 GHz to 18 GHz).

NOTE 2: For the final measurements, any emissions found in the preliminary measurements were further examined by using the RMS detector with RBW 3 kHz and corrected to the reference bandwidth of 4 kHz.

5.4.3 Result: PASS

Table 5: Field Strength of Spurious Radiation (radiated emissions from 9 kHz to 30 MHz)

Test set-up:	Refer to the test configuration and photographs of the test setup. Test site: SAC Antenna distance: ☐ 10 m ☒ 3 m Rx antenna height: 1 m frequency range: 9 kHz to 30 MHz reference bandwidth: 4 kHz (with RMS dectector)
Operating mode:	#1

(The chart below shows the highest readings taken from the final data. The other emission levels were very low against the limit.)

Frequency (MHz)	Pol. (V/H)	Reading (dBμV)	AMP (dB)	AF (dB/m)	CL (dB)	CB (dB)	FS (dBμV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Transmitting at f_{LOW}										
0.106	H	47.3	0.0	20.9	0.1	1.3	69.6	-25.7	-13.0	12.7
0.106	V	43.1	0.0	20.9	0.1	1.3	65.4	-29.9	-13.0	16.9
Transmitting at f_{MID}										
0.106	H	47.5	0.0	20.9	0.1	1.3	69.8	-25.5	-13.0	12.5
0.106	V	42.9	0.0	20.9	0.1	1.3	65.2	-30.1	-13.0	17.1
Transmitting at f_{HIGH}										
0.106	H	47.9	0.0	20.9	0.1	1.3	70.2	-25.1	-13.0	12.1
0.106	V	43.3	0.0	20.9	0.1	1.3	65.6	-29.7	-13.0	16.7

Note: *1) V/H: Vertical / Horizontal polarization*
2) AMP, AF, CL: pre-amplifier gain, antenna factor, cable loss
3) CB: bandwidth correction factor (1.3 dB, when RBW 3 kHz was used)
4) FS: field strength, FS = Reading - AMP + AF + CL + CB
5) EIRP = FS + 20log(D) - 104.8; i.e. EIRP (-13 dBm) is corresponded to FS (82.2 dBμV/m) (where D = 3 m)
6) Margin = Limit - EIRP

Table 6: Field Strength of Spurious Radiation (radiated emissions from 30 MHz to 1 GHz)

Test set-up:	Refer to the test configuration and photographs of the test setup. Test site: SAC Antenna distance: ☐ 10 m ☒ 3 m Rx antenna height: 1 m to 4 m frequency range: 30 MHz to 1 GHz reference bandwidth: 4 kHz (with RMS dectector)
Operating mode:	#1

Frequency (MHz)	Pol. (V/H)	Height (m)	Reading (dBμV)	AMP (dB)	AF (dB/m)	CL (dB)	FS (dBμV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Transmitting at f_{LOW}										
263.019	H	1.00	50.4	29.7	18.1	1.7	40.5	-54.8	-13.0	41.8
293.448	H	1.00	49.3	29.9	19.2	1.8	40.4	-54.9	-13.0	41.9
753.446	H	2.00	43.9	31.8	27.7	2.8	42.6	-52.7	-13.0	39.7
287.906	V	1.50	45.6	29.8	19.0	1.8	36.6	-58.7	-13.0	45.7
755.034	V	1.50	43.7	31.8	27.7	2.8	42.4	-52.9	-13.0	39.9
Transmitting at f_{MID}										
287.947	H	1.00	50.8	29.8	19.0	1.8	41.8	-53.5	-13.0	40.5
753.422	H	1.50	43.9	31.8	27.7	2.8	42.6	-52.7	-13.0	39.7
141.297	V	1.00	51.3	29.7	18.4	1.2	41.2	-54.1	-13.0	41.1
287.947	V	2.00	46.1	29.8	19.0	1.8	37.1	-58.2	-13.0	45.2
741.696	V	1.50	48.3	31.7	27.5	2.8	46.9	-48.4	-13.0	35.4
758.460	V	2.00	44.3	31.8	27.8	2.8	43.1	-52.2	-13.0	39.2
Transmitting at f_{HIGH}										
287.937	H	1.00	50.1	29.8	19.0	1.8	41.1	-54.2	-13.0	41.2
299.017	H	1.00	50.1	29.9	19.4	1.8	41.4	-53.9	-13.0	40.9
758.442	H	1.00	48.6	31.8	27.8	2.8	47.4	-47.9	-13.0	34.9
287.937	V	1.50	47.2	29.8	19.0	1.8	38.2	-57.1	-13.0	44.1
741.686	V	2.00	43.3	31.7	27.5	2.8	41.9	-53.4	-13.0	40.4

Note: *1) V/H: Vertical / Horizontal polarization*
2) AMP, AF, CL: pre-amplifier gain, antenna factor, cable loss
3) FS: field strength, FS = Reading - AMP + AF + CL
4) EIRP = FS + 20log(D) - 104.8; i.e. EIRP (-13 dBm) is corresponded to FS (82.2 dBμV/m) (where D = 3 m)
5) Margin = Limit - EIRP

Remark: the measured EIRP in the above table were obtained from the preliminary measurements (peak data) by using the Peak detector with RBW 100 kHz. The final measurements (RMS detector with RBW 3 kHz, and adding the bandwidth correction factor) were not performed because the emissions were very low against the limit.

Table 7: Field Strength of Spurious Radiation (radiated emissions from 1 GHz to 18 GHz)

Test set-up:	Refer to the test configuration and photographs of the test setup. Test site: FAR Antenna distance: ☒ 3 m ☐ 1 m Rx antenna height: 1 m to 4 m frequency range: 1 GHz to 18 GHz reference bandwidth: 4 kHz (with RMS dectector)
Operating mode:	#1

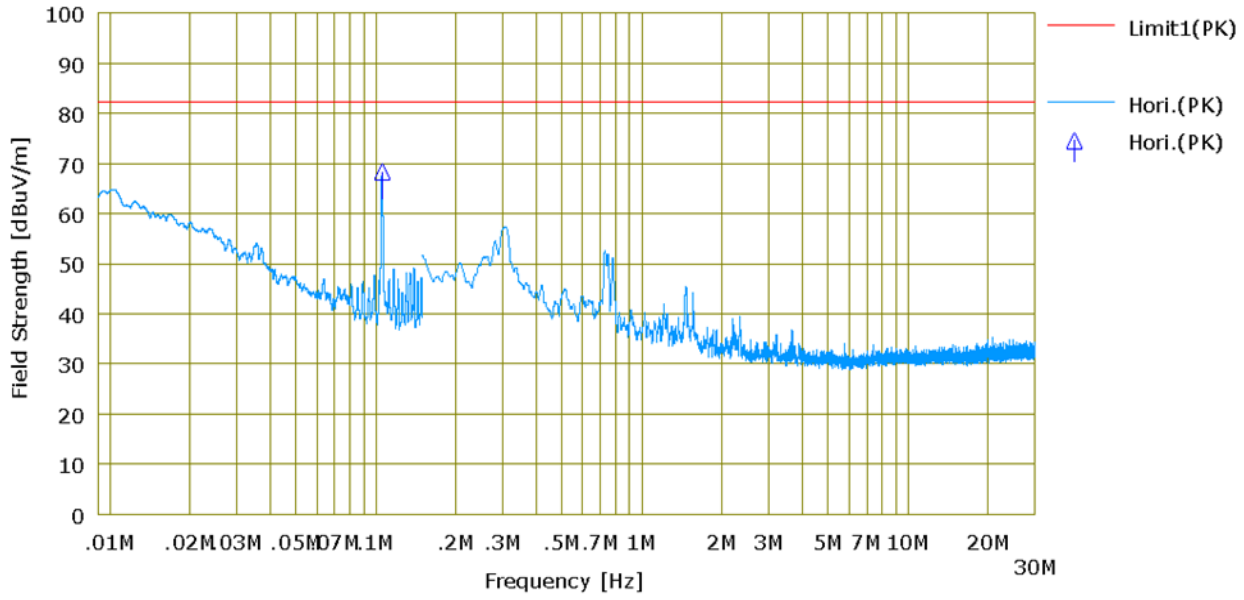
Frequency (MHz)	Pol. (V/H)	Reading (dBm)	PL (dB)	AG (dBi)	CL (dB)	AMP (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
Transmitting at f_{LOW}									
3253.000	H	-43.50	52.23	7.86	9.47	46.73	-36.39	-13.00	23.39
4879.500	H	-55.90	55.75	9.88	12.34	46.28	-43.97	-13.00	30.97
6506.000	H	-57.40	58.25	10.81	14.08	46.06	-41.94	-13.00	28.94
3253.000	V	-40.90	52.23	7.86	9.47	46.73	-33.79	-13.00	20.79
4879.500	V	-56.10	55.75	9.88	12.34	46.28	-44.17	-13.00	31.17
6506.000	V	-59.10	58.25	10.81	14.08	46.06	-43.64	-13.00	30.64
Transmitting at f_{MID}									
3287.000	H	-43.00	52.32	7.96	9.64	46.71	-35.71	-13.00	22.71
6574.000	H	-57.50	58.34	10.87	14.15	46.03	-41.91	-13.00	28.91
3287.000	V	-40.50	52.32	7.96	9.64	46.71	-33.21	-13.00	20.21
6574.000	V	-61.10	58.34	10.87	14.15	46.03	-45.51	-13.00	32.51
Transmitting at f_{HIGH}									
3320.500	H	-39.10	52.41	8.06	10.36	46.69	-31.08	-13.00	18.08
6641.500	H	-58.50	58.43	10.94	14.25	46.00	-42.76	-13.00	29.76
3320.500	V	-38.10	52.41	8.06	10.36	46.69	-30.08	-13.00	17.08
6641.500	V	-58.50	58.43	10.94	14.25	46.00	-42.76	-13.00	29.76

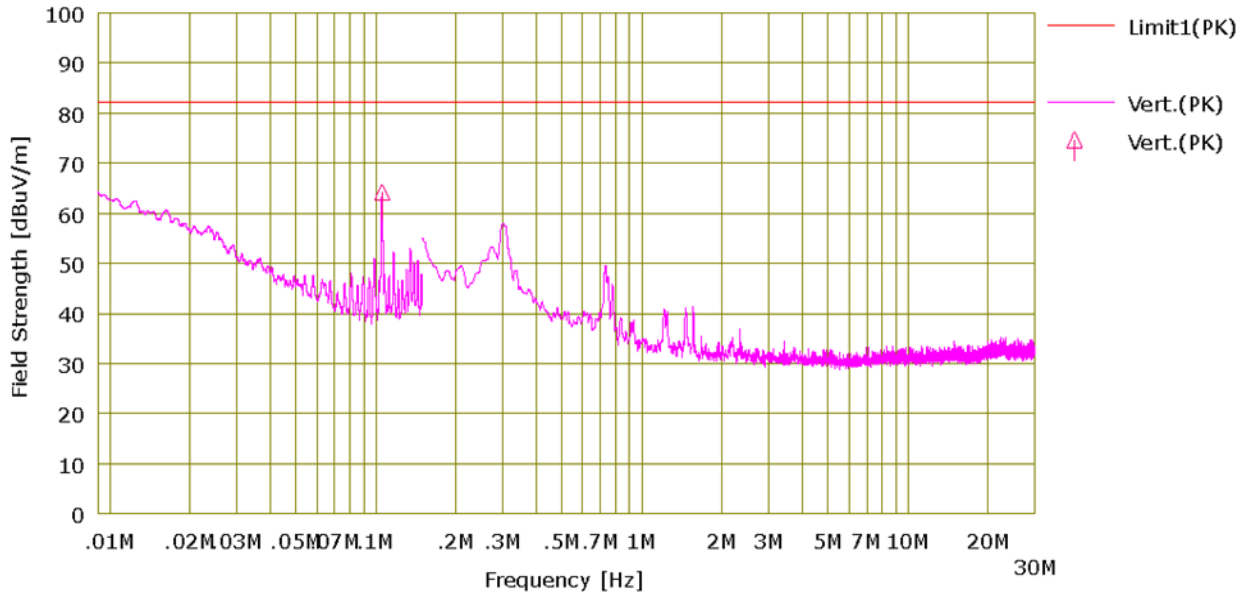
Note: *1) V/H: Vertical / Horizontal polarization*
2) PL, AG, CL, AMP: free space Path Loss, Antenna Gain, Cable Loss (including HPF) and Gain of pre-amplifier
3) EIRP = Reading + PL - AG + CL - AMP
4) Margin = Limit - EIRP

Remark: the measured EIRP in the above table were obtained from the preliminary measurements (peak data) by using the Peak detector with RBW 1 MHz. The final measurements (RMS detector with RBW 3 kHz, and adding the bandwidth correction factor) were not performed because the emissions were very low against the limit.

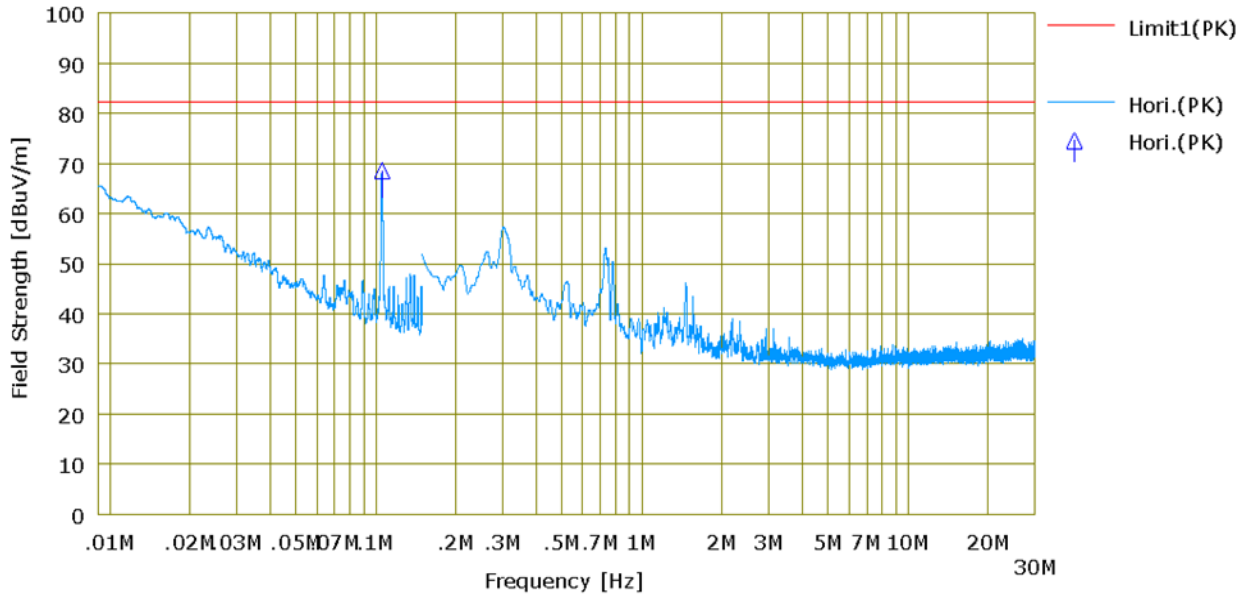
Figure 5. Plot of Field Strength of Spurious Radiation (radiated emissions from 9 kHz to 30 MHz)

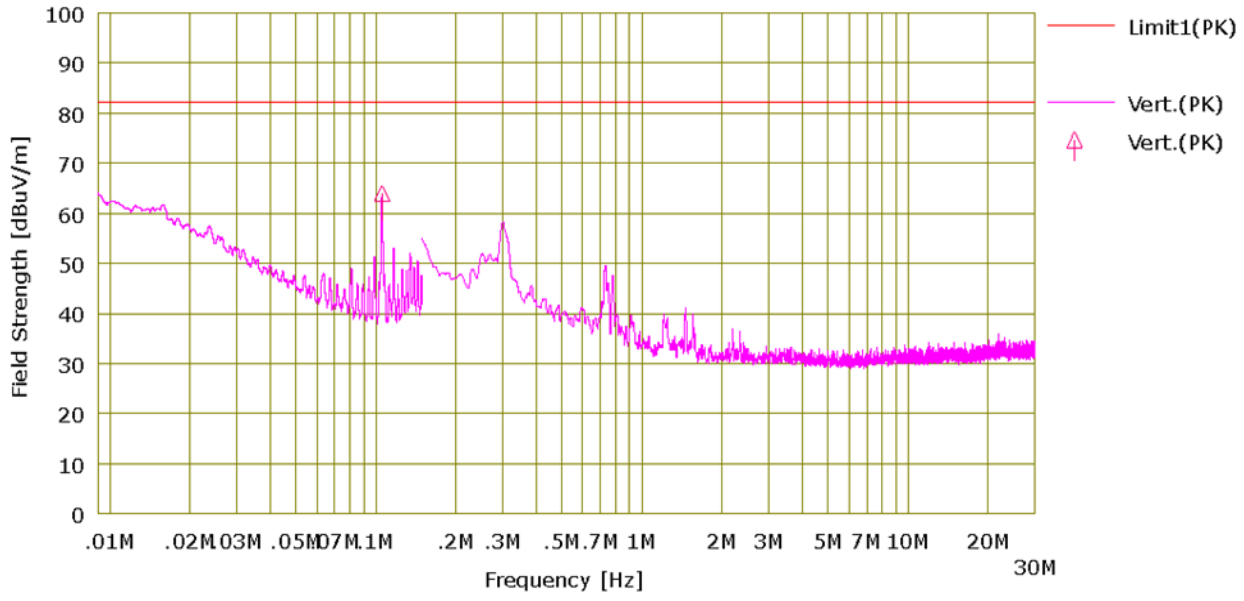
transmitting at f_{LOW}



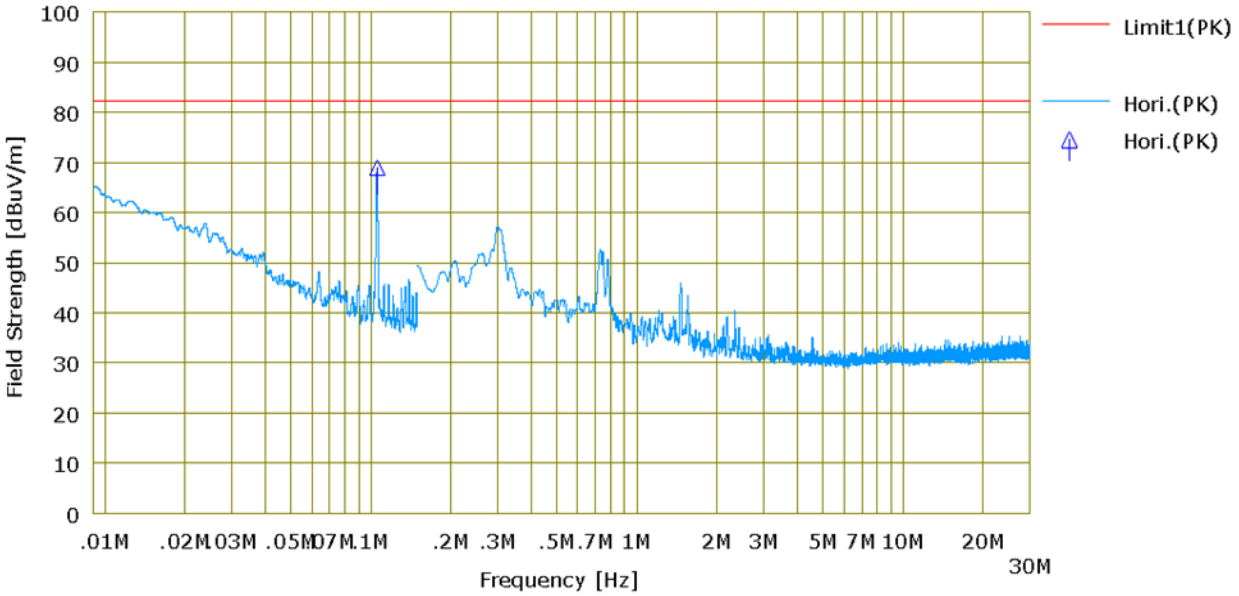


transmitting at f_{MID}





transmitting at f_{HIGH}



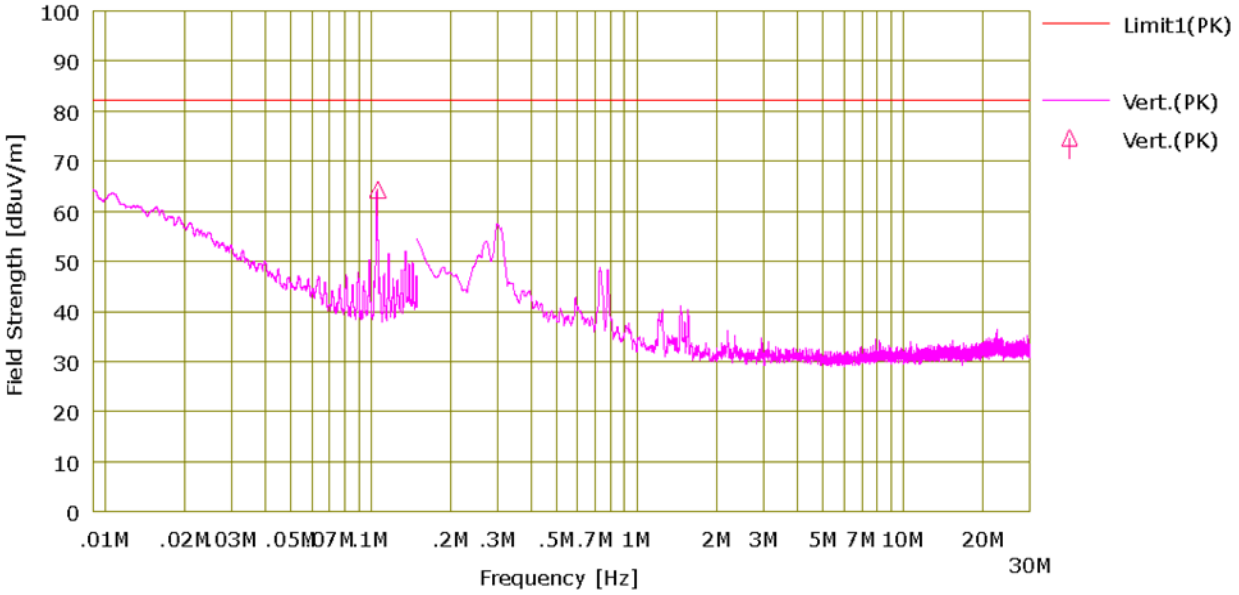
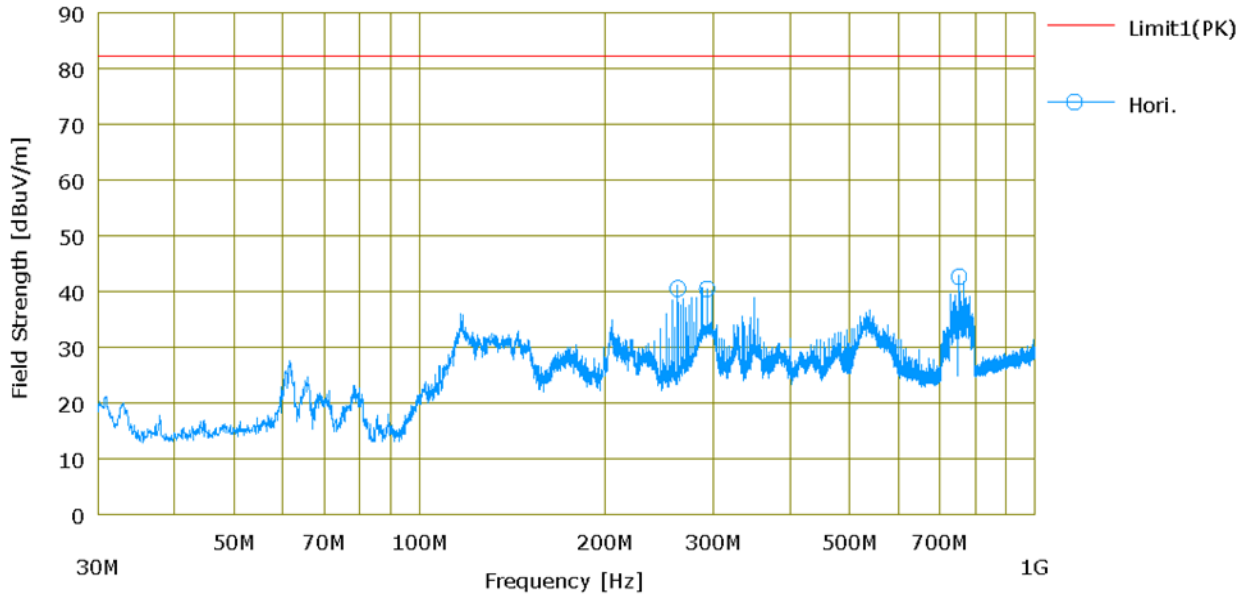
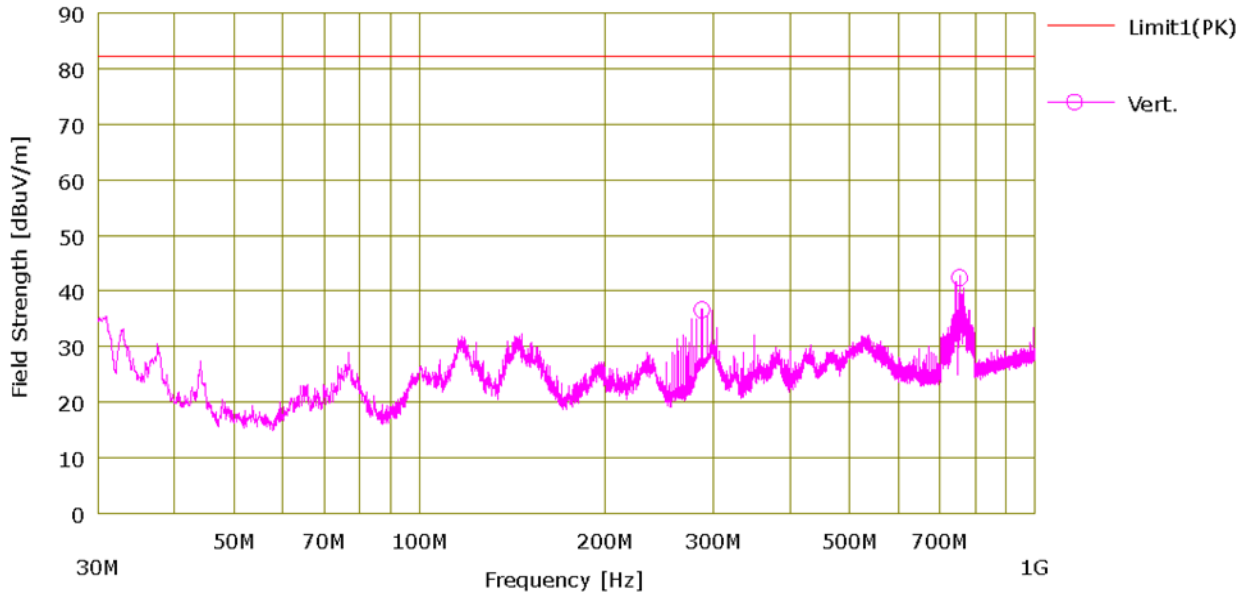


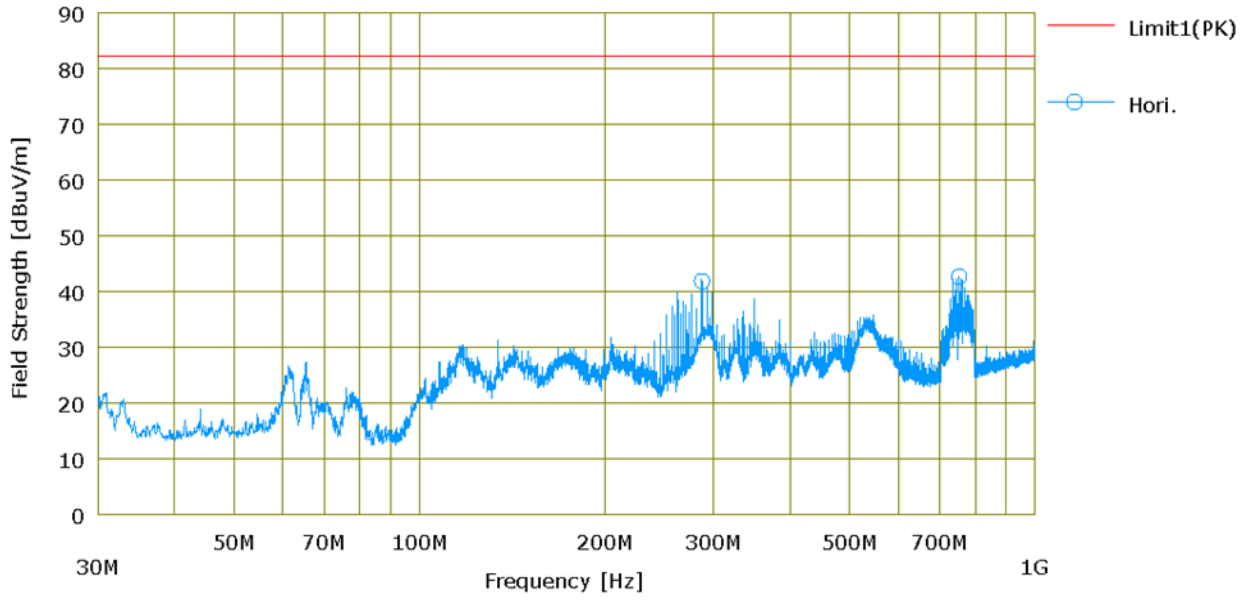
Figure 6. Plot of Field Strength of Spurious Radiation (radiated emissions from 30 MHz to 1 GHz)

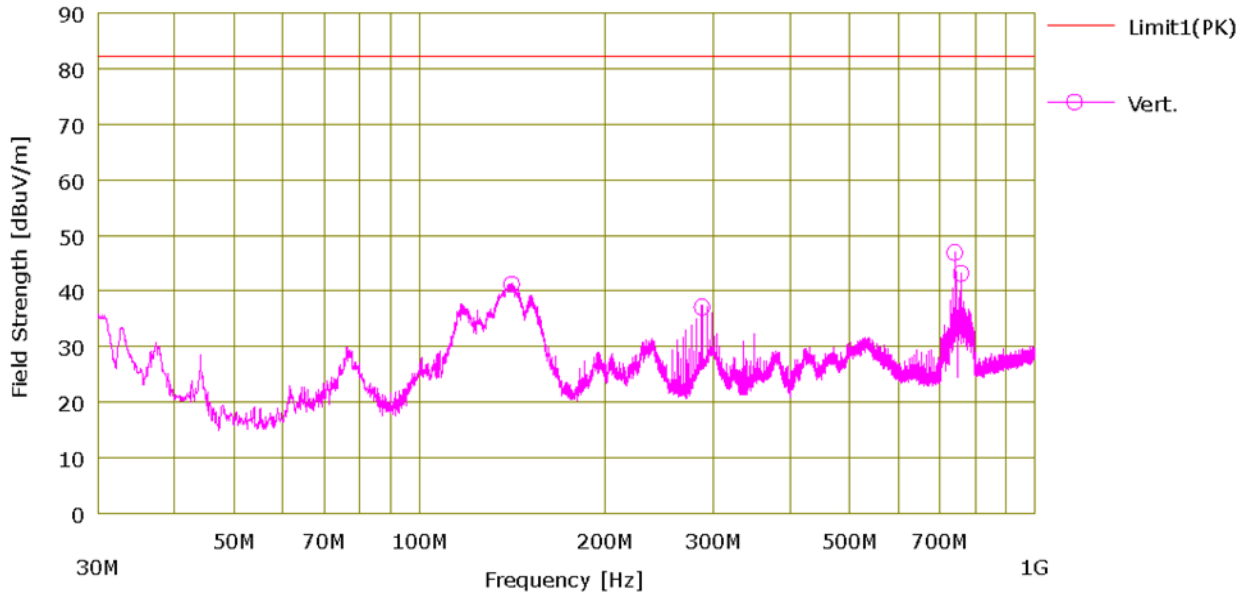
transmitting at f_{LOW}



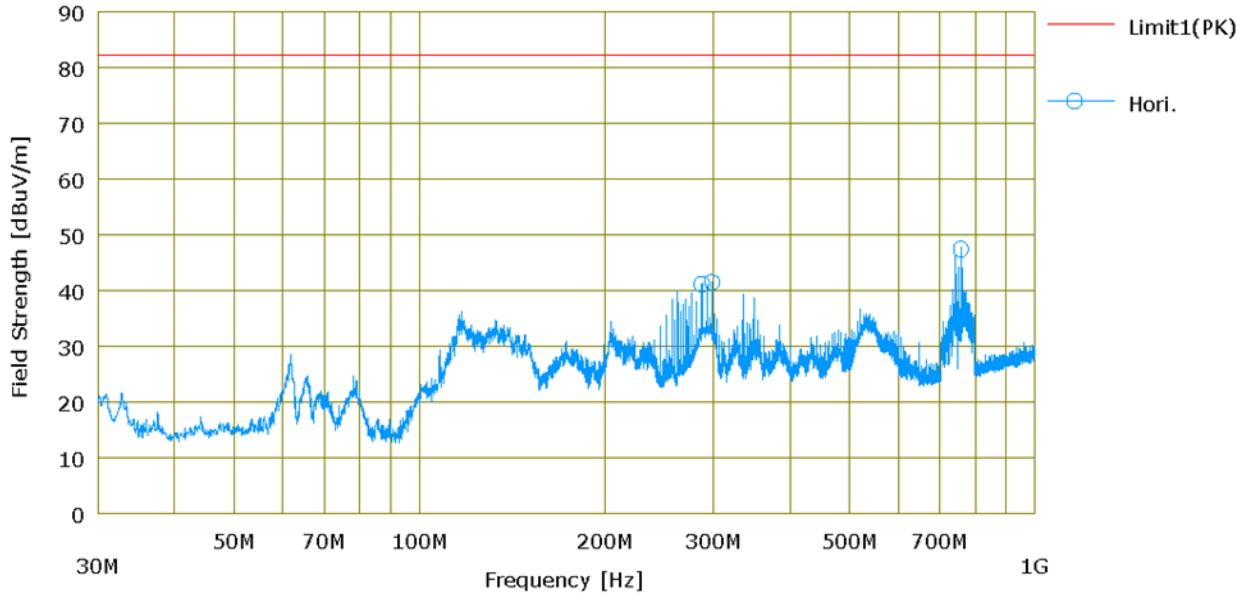


transmitting at f_{MID}





transmitting at f_{HIGH}



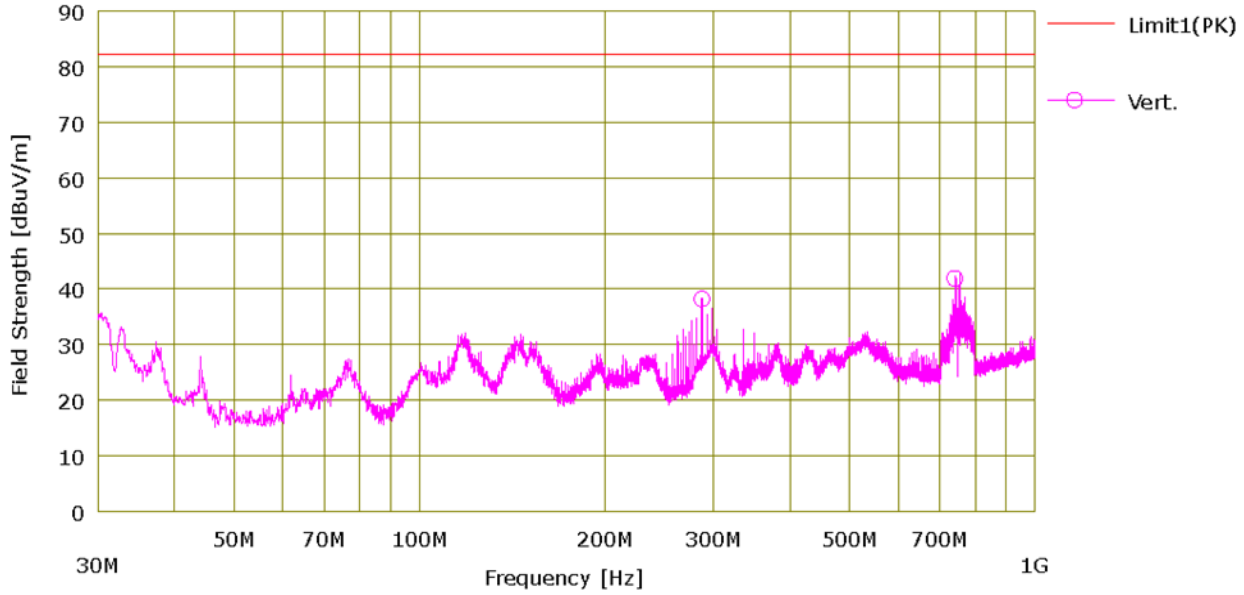
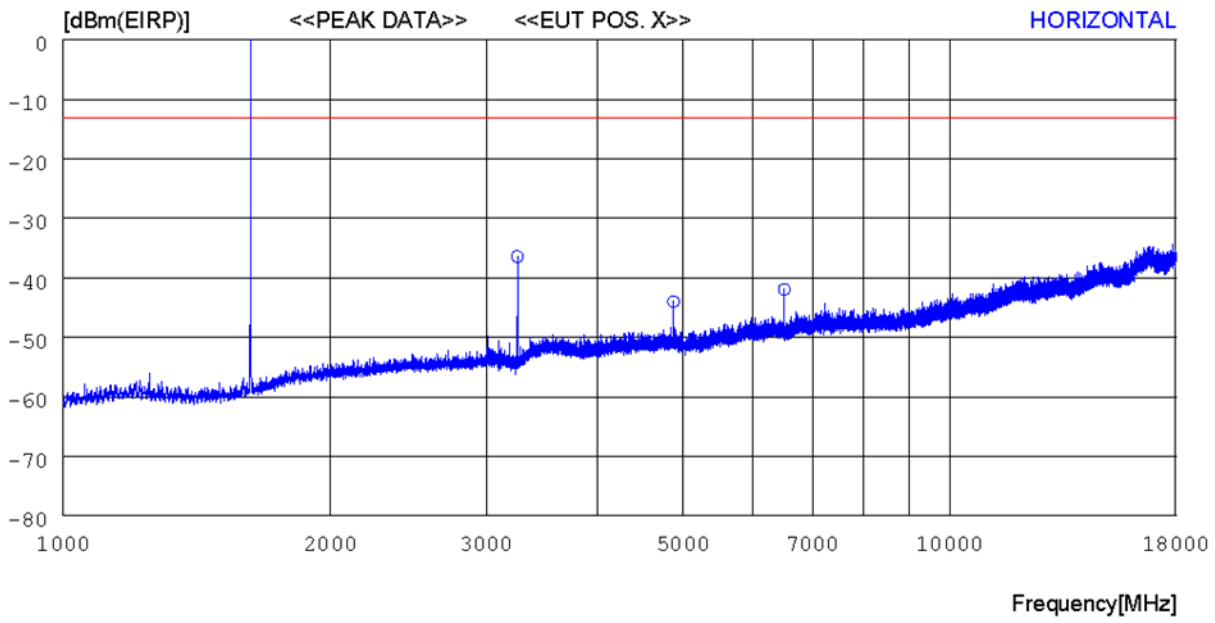
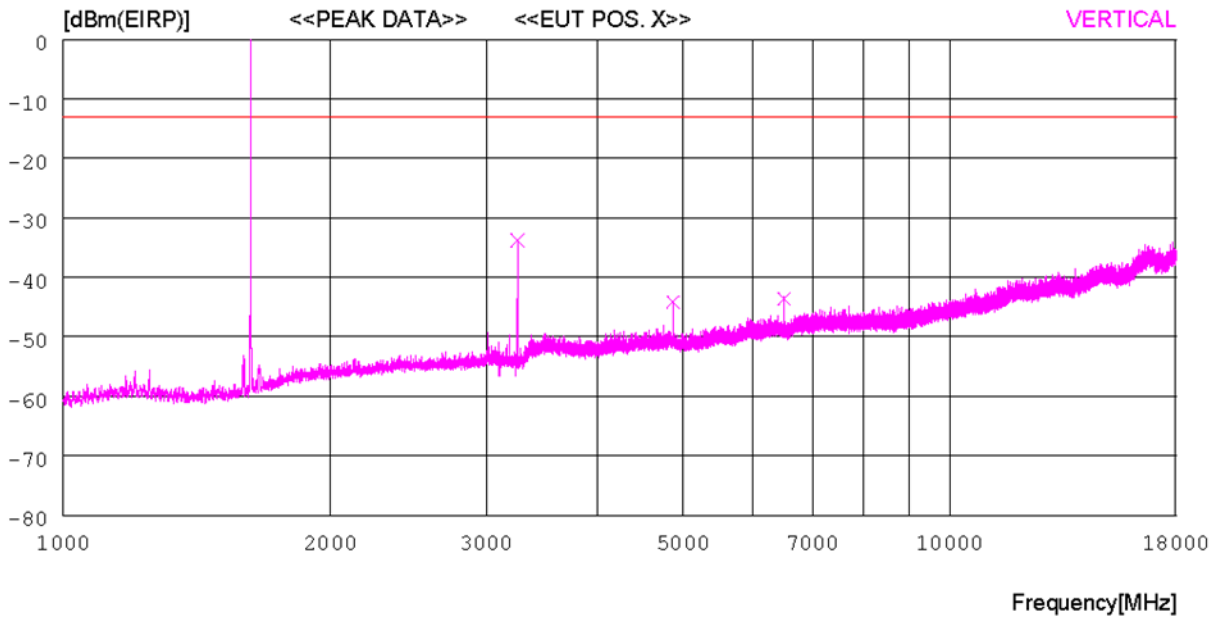


Figure 7. Plot of Field Strength of Spurious Radiation (radiated emissions from 1 GHz to 18 GHz)

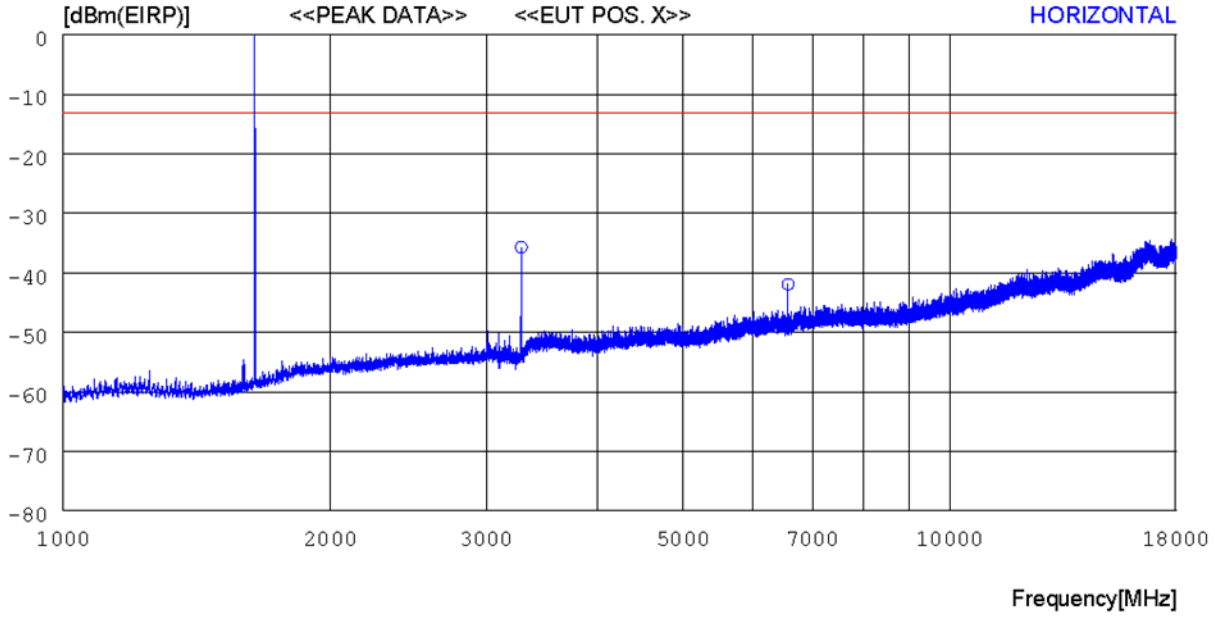
transmitting at f_{LOW}

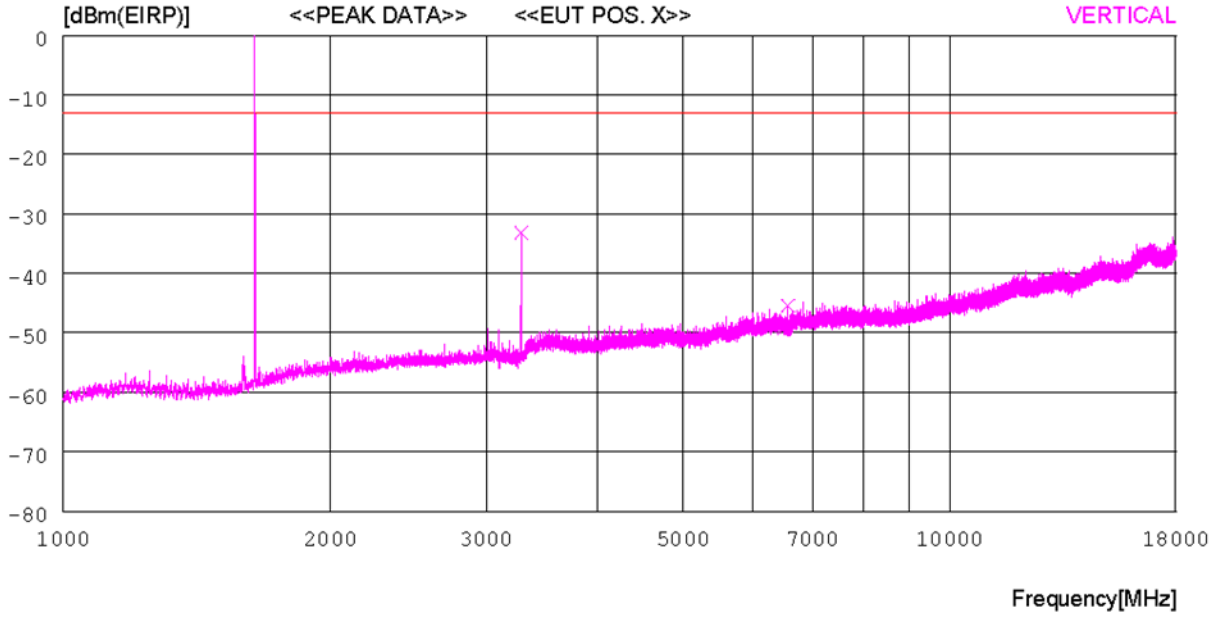




remark: the emissions in the fundamental frequency were not subject to the limits; although the antennas were terminated by the dummy loads, the fundamental transmitting signal was leaked and detected and therefore these emissions were ignored.

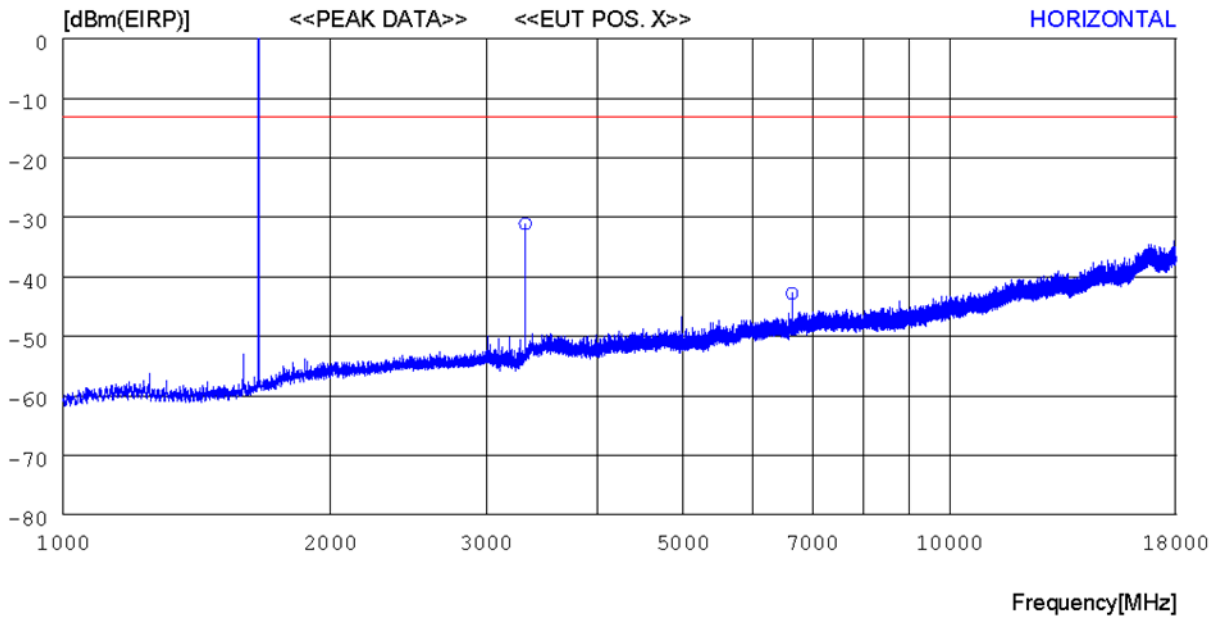
transmitting at f_{MID}

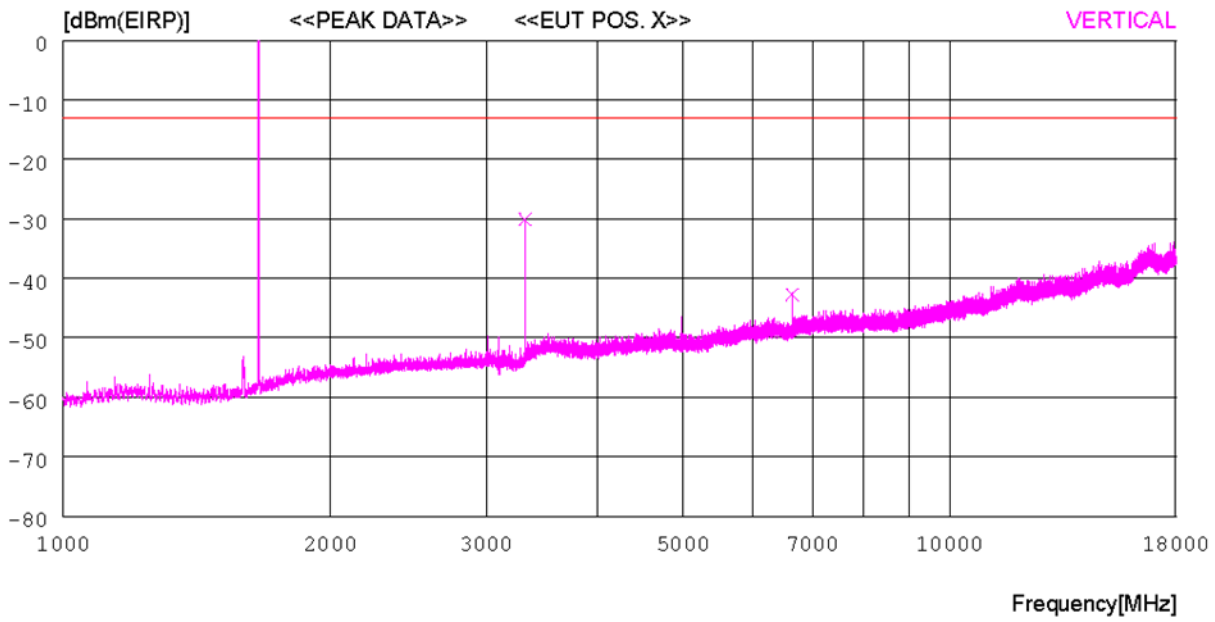




remark: the emissions in the fundamental frequency were not subject to the limits; although the antennas were terminated by the dummy loads, the fundamental transmitting signal was leaked and detected and therefore these emissions were ignored.

transmitting at f_{HIGH}





remark: the emissions in the fundamental frequency were not subject to the limits; although the antennas were terminated by the dummy loads, the fundamental transmitting signal was leaked and detected and therefore these emissions were ignored.

5.5. Protection of Aeronautical Radionavigation-Satellite Service (conducted emissions)

5.5.1 Regulation

FCC, CFR 47 Section

According to 2.1051, Measurements required: Spurious emissions at antenna terminals: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

According to 25.216, Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.

(h) Mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies in the 1626.5-1660.5 MHz band shall suppress the power density of emissions in the 1605-1610 MHz band-segment to an extent determined by linear interpolation from -70 dBW/MHz at 1605 MHz to -46 dBW/MHz at 1610 MHz, averaged over any 2 millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from -80 dBW at 1605 MHz to -56 dBW at 1610 MHz, averaged over any 2 millisecond active transmission interval.

(i) The e.i.r.p density of carrier-off state emissions from mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies between 1 and 3 GHz shall not exceed -80 dBW/MHz in the 1559-1610 MHz band averaged over any two millisecond interval.

(j) A Root-Mean-Square detector shall be used for all power density measurements.

ISED, RSS section

RSS-170, 5.4.3.2. Additional Unwanted Emission Limits for MESs to Protect Radionavigation-Satellite Service (5.4.3.2.2. Band 1626.5-1660.5 MHz)

Mobile earth stations with transmitting frequencies between 1626.5 MHz and 1660.5 MHz shall have the e.i.r.p. density of unwanted emissions in the band 1605-1610 MHz, averaged over any 2-ms active transmission interval, not exceed the following limits:

(1) -70 dBW/MHz at 1605 MHz, linearly interpolated to -46 dBW/MHz at 1610 MHz, for broadband emissions; and

(2) -80 dBW/kHz at 1605 MHz, linearly interpolated to -56 dBW/kHz at 1610 MHz, for discrete emissions.

RSS-170, 5.4.4. Carrier-off State Emissions

Mobile equipment with transmitting frequencies between 1 GHz and 3 GHz shall have the e.i.r.p. density of carrier-off state emissions in the band 1559-1610 MHz not exceed -80 dBW/MHz.

5.5.2 Test Procedure

The procedure for the measurements of Spurious Emissions at Antenna Terminals (conducted emissions) was used, except for the measurement frequency range and the reference measurement bandwidth.

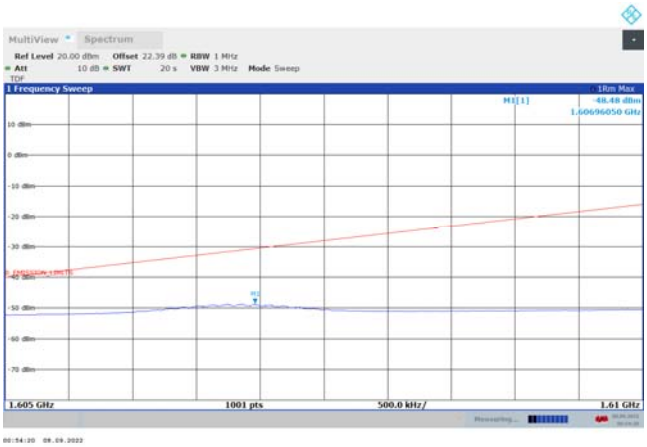
NOTE: During the measurements, the insertion loss (Band Reject Filter and RF cable assembly) was included in the spectrum analyzer as the TDF, and the antenna gain (19.39 dBi) and multiple transmit antenna output ports (3 dB for 2-port outputs) were applied as the Offset.

5.5.3 Result: PASS

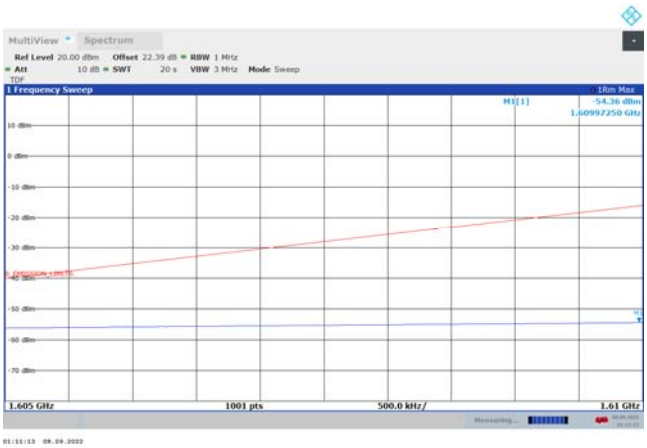
Figure 8. Plot of conducted emissions from 1605 MHz to 1610 MHz

Emission limits (PSD in 1 MHz); all bearer types were activated with the max hold function.

measured at Antenna port 1



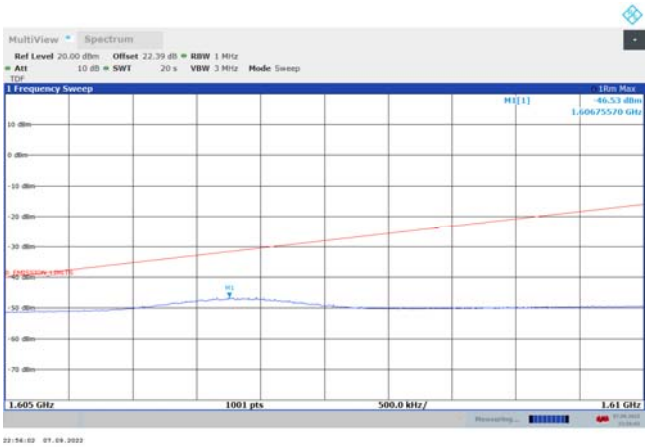
Transmitting at f_{LOW}



Transmitting at f_{MID}

Transmitting at f_{HIGH}

measured at Antenna port 2



Transmitting at f_{LOW}

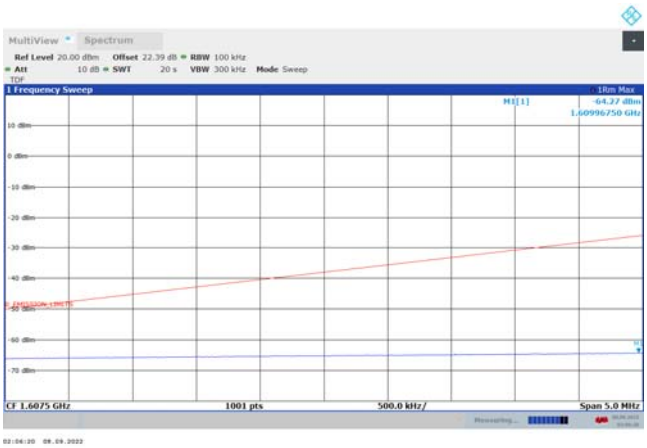
Transmitting at f_{MID}

Transmitting at f_{HIGH}

Emission limits (PSD in 100 kHz); all bearer types were activated with the max hold function.

measured at Antenna port 1

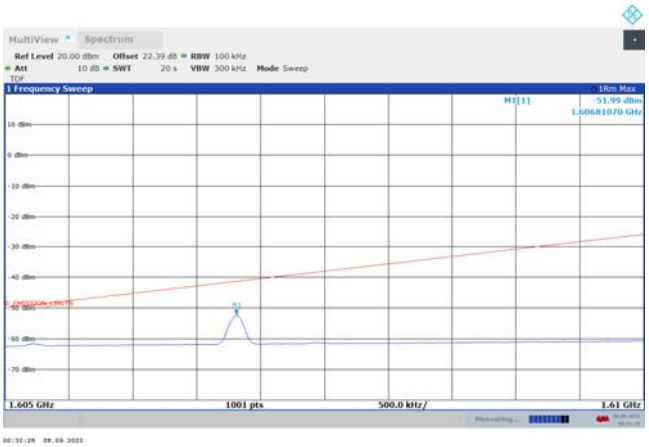
Transmitting at f_{LOW}



Transmitting at f_{MID}

Transmitting at f_{HIGH}

measured at Antenna port 2



Transmitting at f_{LOW}

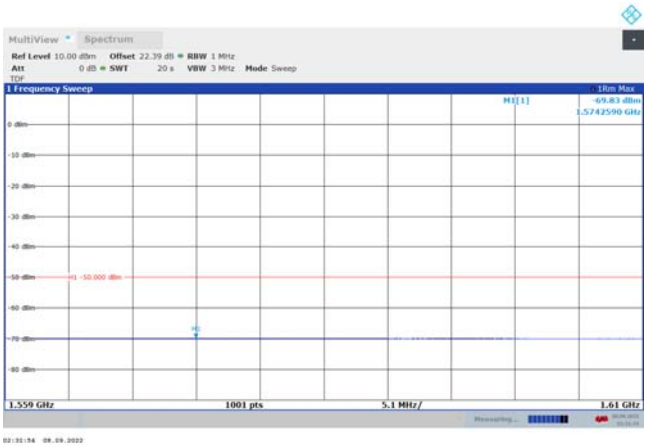
Transmitting at f_{MID}

Transmitting at f_{HIGH}

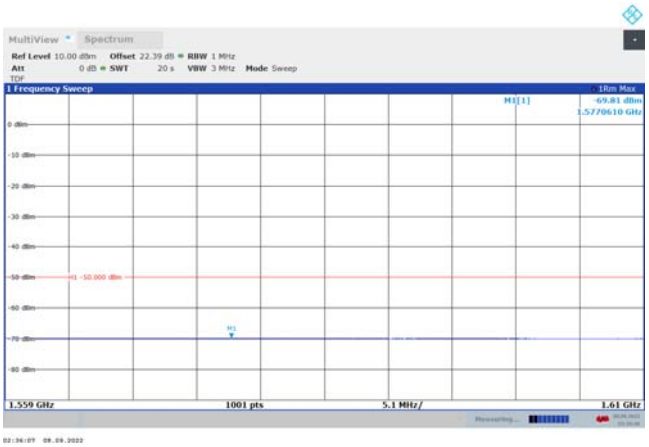
Figure 9. Plot of conducted emissions from 1559 MHz to 1610 MHz (carrier-off state emissions)

Emission limits (carrier-off)

measured at Antenna port 1



measured at Antenna port 2



5.6. Transmitter Frequency Stability

5.6.1 Regulation

FCC, CFR 47 Section
According to 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.

(2) From -20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radio beacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

(3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(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.

(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and + 30° centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

(4) When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

(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.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

According to 25.202(d), Frequency tolerance, Earth stations. The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

ISED, RSS section
RSS-170, 5.2. Frequency Stability
For mobile earth station equipment, the carrier frequency shall not depart from the reference frequency by more than ±10 ppm.

5.6.2 Test Procedure

The frequency stability was measured with the following setting according to subclause 5.6.3 of ANSI C63.26.

Frequency stability versus environmental temperature:

(a) Supply the EUT with nominal voltage.
(b) Turn on the EUT and tune it to the center frequency of the operating band.
(c) Turn the EUT off and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT was inside the chamber.
(d) RF output was connected to the frequency counter or spectrum analyzer via feed through attenuators.
(e) Set the temperature control on the chamber to the highest specified EUT operating temperature and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.
(f) While maintaining a constant temperature inside the environmental chamber, turn on the EUT and record the operating frequency at startup and two, five, and ten minutes after the EUT was energized.
(g) After all measurements have been made at the highest specified temperature turn the EUT off.
(h) Repeat the above measurement process for the EUT with the test chamber set at the appropriate temperature.
When the frequency stability limit is stated as being sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point should be established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation should be identified as f_L and f_H respectively. The worst-case frequency offset determined in the above methods should be added or subtracted from the values of f_L and f_H and the resulting frequencies must remain within the band.

Frequency Stability versus Input Voltage:

(a) These tests should be made at room temperature (20 ± 5) °C supply the EUT with nominal voltage.
(b) Couple RF output to the frequency counter or spectrum analyzer.
(c) Tune the EUT to the center frequency of the operating band and measure the frequency at startup and

two, five, and ten minutes after startup.

(d) Supply it with 85 % of the nominal voltage and repeat the above procedure.

(e) Supply it with 115 % of the nominal voltage and repeat the above procedure.

(f) Repeat the frequency measurement at the low and high channel of the operating band.

5.6.3 Result: PASS

Table 8: Frequency stability (temperature variations)

Reference Frequency: 1643.5 MHz

Temperature	Voltage	Measured Carrier Frequency with time elapsed			
		START UP	2 minutes	5 minutes	10 minutes
[°C]	[V_{DC}]	[MHZ]	[MHZ]	[MHZ]	[MHZ]
+50	24	1643.5000224	1643.4999684	1643.4999148	1643.4998486
+40	24	1643.5001967	1643.5001590	1643.5001251	1643.5000767
+30	24	1643.5003073	1643.5002848	1643.5002672	1643.5002385
+20	24	1643.4998065	1643.4998146	1643.4998145	1643.4998132
+10	24	1643.5002081	1643.5002296	1643.5002453	1643.5002768
0	24	1643.5001077	1643.5001404	1643.5001554	1643.5001664
-10	24	1643.4999403	1643.4999909	1643.5000201	1643.5000546
-20	24	1643.4996434	1643.4997750	1643.4997874	1643.4998113
-30	24	1643.4995956	1643.4995635	1643.4995615	1643.4995762

Reference Frequency: 1643.5 MHz, LIMIT: within 0.001 % (10 ppm; within ± 16 435 Hz)

Temperature	Voltage	Frequency Tolerance							
		START UP		2 minutes		5 minutes		10 minutes	
[°C]	[V_{DC}]	Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]
+50	24	22.4	0.01	-31.6	-0.02	-85.2	-0.05	-151.4	-0.09
+40	24	196.7	0.12	159	0.10	125.1	0.08	76.7	0.05
+30	24	307.3	0.19	284.8	0.17	267.2	0.16	238.5	0.15
+20	24	-193.5	-0.12	-185.4	-0.11	-185.4	-0.11	-186.8	-0.11
+10	24	208.1	0.13	229.6	0.14	245.3	0.15	276.8	0.17
0	24	107.7	0.07	140.4	0.09	155.4	0.09	166.4	0.10
-10	24	-59.7	-0.04	-9.1	-0.01	20.1	0.01	54.6	0.03
-20	24	-356.6	-0.22	-225	-0.14	-212.6	-0.13	-188.7	-0.11
-30	24	-404.4	-0.25	-436.5	-0.27	**-438.5**	**-0.27**	-423.8	-0.26

Err [Hz] = 10^6 × (Measured frequency [MHz] - Reference Frequency [MHz])

Err [ppm] = 10^6 × (Measured frequency [MHz] - Reference Frequency [MHz]) / Reference frequency [MHz]

NOTE: For testing purpose EUT's modulation was deactivated, and the CW carrier was activated.

Table 9: Frequency stability (voltage variations)

Reference Frequency [MHz]	Voltage [V_{DC}]	Measured Carrier Frequency with time elapsed			
		START UP [MHZ]	**2 minutes** [MHZ]	**5 minutes** [MHZ]	**10 minutes** [MHZ]
1626.6	85 %	1626.5998062	1626.5998206	1626.5998206	1626.5998169
	100 %	1626.5998284	1626.5998299	1626.5998275	1626.5998272
	115 %	1626.5997876	1626.5998091	1626.5998103	1626.5998121
1643.5	85 %	1643.4997809	1643.4998041	1643.4998026	1643.4998030
	100 %	1643.4998065	1643.4998146	1643.4998145	1643.4998132
	115 %	1643.4997761	1643.4997993	1643.4997993	1643.4997986
1660.4	85 %	1660.3997690	1660.3997863	1660.3997864	1660.3997870
	100 %	1660.3997954	1660.3997986	1660.3997978	1660.3997972
	115 %	1660.3997593	1660.3997833	1660.3997831	1660.3997829

Reference Frequency [MHz]	Voltage [V_{DC}]	Frequency Tolerance (LIMIT: within 0.001 %;10 ppm)							
		START UP		2 minutes		5 minutes		10 minutes	
		Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]	Err [Hz]	Err [ppm]
1626.6	85 %	-193.8	-0.12	-179.4	-0.11	-179.4	-0.11	-183.1	-0.11
	100 %	-171.6	-0.11	-170.1	-0.10	-172.5	-0.11	-172.8	-0.11
	115 %	-212.4	-0.13	-190.9	-0.12	-189.7	-0.12	-187.9	-0.12
1643.5	85 %	-219.1	-0.13	-195.9	-0.12	-197.4	-0.12	-197.0	-0.12
	100 %	-193.5	-0.12	-185.4	-0.11	-185.5	-0.11	-186.8	-0.11
	115 %	-223.9	-0.14	-200.7	-0.12	-200.7	-0.12	-201.4	-0.12
1660.4	85 %	-231.0	-0.14	-213.7	-0.13	-213.6	-0.13	-213.0	-0.13
	100 %	-204.6	-0.12	-201.4	-0.12	-202.2	-0.12	-202.8	-0.12
	115 %	**-240.7**	**-0.14**	-216.7	-0.13	-216.9	-0.13	-217.1	-0.13

Err [Hz] = 10^6 × (Measured frequency [MHz] - Reference Frequency [MHz])

Err [ppm] = 10^6 × (Measured frequency [MHz] - Reference Frequency [MHz]) / Reference frequency [MHz]

NOTE: For testing purpose EUT's modulation was deactivated, and the CW carrier was activated.