

RADIO TEST REPORT

Report ID:

REP018521

Project number:

PRJ0044386

Type of assessment:

Class II Permissive Change

Applicant:

**ORBCOMM License Corp.
(ORBCOMM Inc.)**

Product:

**ST9100 MSES/Cellular Dual Mode
Terminal**

Model:

ST9101

Model variant(s):

ST9100-D01, ST9100-C01

FCC identifier:

FCC ID: XGS-ST9100

ISED certification number:

IC: 11881A-ST9100

Specification:

- ◆ FCC 47 CFR Part 25
- ◆ RSS-170, Issue 4, September 29, 2022

Date of issue: February 13, 2024

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Tested by

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Reviewed by



Signature



Signature

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ANAB File Number: AT-3195 (Ottawa); AT-3193 (Pointe-Claire); AT-3194 (Cambridge)

Lab and test locations

Company name	Nemko Canada Inc.			
Facilities	<i>Ottawa site:</i>	<i>Montréal site:</i>	<i>Cambridge site:</i>	
	303 River Road	292 Labrosse Avenue	1-130 Saltsman Drive	
	Ottawa, Ontario	Pointe-Claire, Québec	Cambridge, Ontario	
	Canada	Canada	Canada	
	K1V 1H2	H9R 5L8	N3E 0B2	
	Tel: +1 613 737 9680	Tel: +1 514 694 2684	Tel: +1 519 650 4811	
	Fax: +1 613 737 9691	Fax: +1 514 694 3528		
Test site identifier	Organization	Ottawa	Montreal	Cambridge
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Test specifications

FCC 47 CFR Part 25	Satellite communications
RSS-170, Issue 4, September 29, 2022	Mobile Earth Stations and Ancillary Terrestrial Component Equipment Operating in the Mobile-Satellite Service Bands

1.2 Test methods

273109 D01 Equip Auth Guide Part 25 TXReceiver v02r02 (2011)	Equipment Authorization Guidance for Part 25 Transceivers
RSS-Gen, Issue 5, April 2018	General Requirements for Compliance of Radio Apparatus
ANSI C63.26 v2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.4 below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.4 Exclusions

None

1.5 Test report revision history

Table 1.5-1: Test report revision history

Revision #	Date of issue	Details of changes made to test report
REP018521	February 13, 2024	Original report issued

Section 2. Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

Table 2.2-1: List of channel waveform and corresponding waveforms

Channel Waveform code	Channel Data rate (bps)	Channel bandwidth (CBW) (Hz)
J, N, R	1600	3250
K, S	3200	4000
T, X	6400	6000
Y	12800	10000
Z	25600	18000

Note: Among channel waveforms with the same bandwidth, one waveform was selected for testing.

2.3 Model variant declaration

As declared by the applicant, the EUT model ST9101 has been chosen to be representative for all other models in the model family. The model family, and the description of the variations, are as follows:

ST9100, a variant model has identical satellite circuits and function but has different OEM cellular modem.

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3. Test conditions

3.1 Atmospheric conditions

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

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

3.2 Power supply range

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

Section 4. Information provided by the applicant

4.1 Disclaimer

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

4.2 Applicant / Manufacturer

Name	ORBCOMM License Corp. (ORBCOMM Inc.)
Address	395 W PASSAIC STREET, SUITE 325, ROCHELLE PARK, NJ 07662 USA

4.3 EUT information

Product name	ST9100 MSES/Cellular Dual Mode Terminal
Model / HVIN	ST9101, ST9100-D01, ST9100-C01
Serial number	823150039101406001A
Power supply requirements	DC: 9–32 V
Product description and theory of operation	The device consists of a Mobile Satellite Earth Station (MSES) module, an OEM LTE/3G/2G Cellular module, a Bluetooth module and a GNSS module. The device is used for tracking and monitoring industrial assets and equipment.

4.4 Radio technical information

Frequency band	1626.5–1660.5				
Type of modulation	OQPSK, 12800 symbol/second				
Antenna information	Max 4.5 dBi for standard antenna and 2.5 dBi for low elevation antenna, external active antenna made by ORBCOMM				
Stated EIRP	37 dBm				
Frequency Min (MHz)	1626.501625	1626.502	1626.503	1626.505	1626.509
Frequency Max (MHz)	1660.498375	1660.498	1660.497	1660.495	1660.492
RF power Max (dBm), Cond.	30.77	30.90	30.60	30.73	30.34
Measured BW (kHz), 99% OBW	1.029	1.796	3.599	7.239	14.331
Emission classification	1K03G1D	1K80G1D	3K60G1D	7K24G1D	14K3G1D

4.5 EUT setup details

4.5.1 Radio exercise details

Operating conditions	Utilizing Tera Term and following the instructions provided by the client, the EUT has been successfully configured on Low/mid/high channels
Transmitter state	Continues mode (2 s On, 3 s Off)
Receiver state	Continues mode

4.5.2 EUT setup configuration

Table 4.5-1: EUT interface ports

Description	Qty.
24 pin connectors	1
SMA port	2
2 wire connector	2

Table 4.5-2: subassembly Equipment

Description	Brand name	Model, Part number, Serial number, Revision level
Power amplifier	ORBCOMM	MN: ST101599, SN: 823150009101406001A
Dual mode mobile tracker	ORBCOMM	MN: ST9101, SN: 01729056SKY58DD
Antenna	ORBCOMM	MN: N/A, SN: N/A

Table 4.5-3: Inter-connection cables

Cable description	From	To	Length (m)
2 wire connector	Power amplifier	Dual mode mobile tracker	1
Cable harness	Dual mode mobile tracker	Laptop and DC power supply	1

Table 4.5-4: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	HP	MN: 15t-da000, SN: CND9124PJ7
DC power supply	Topward	MN: 6302D, SN: 992106

EUT setup details, continued

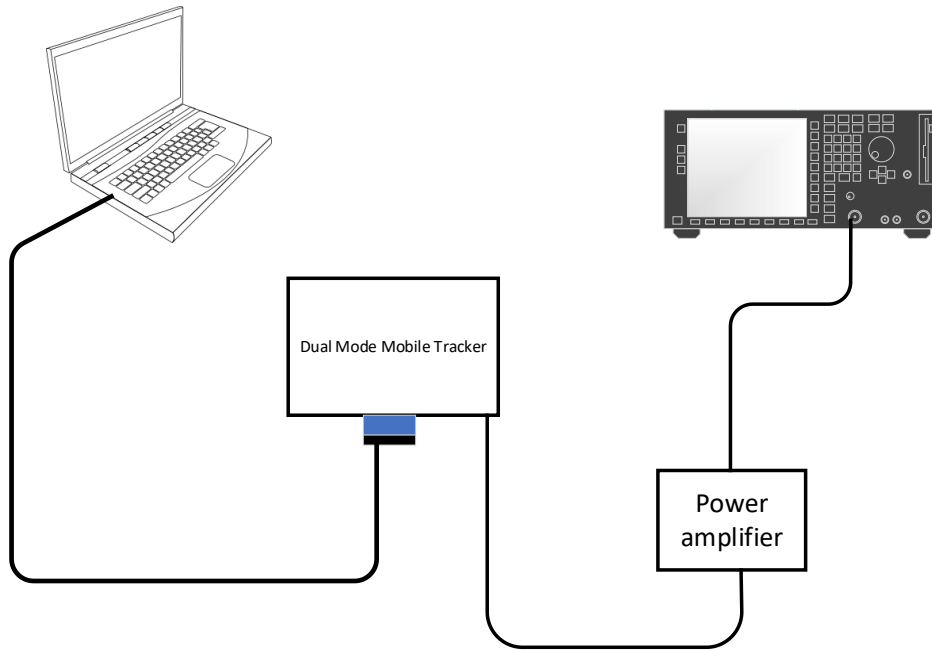


Figure 4.5-1: Block diagram for conducted test

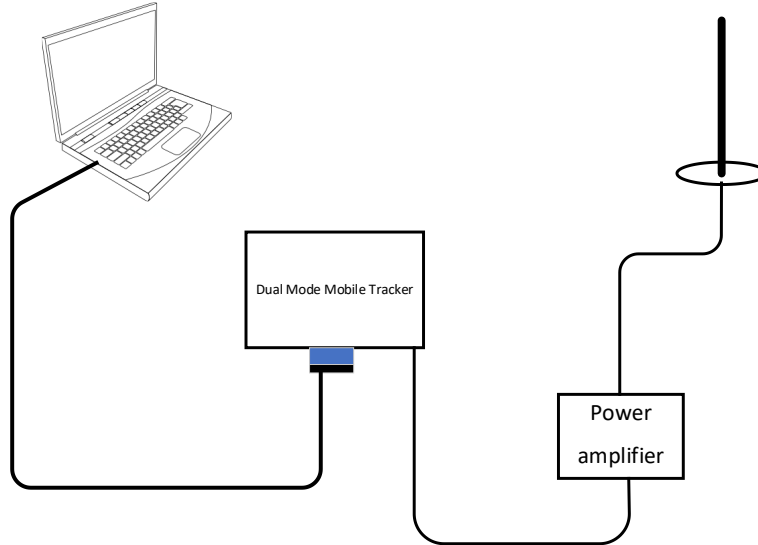


Figure 4.5-2: Block diagram for radiated test

Section 5. Summary of test results

5.1 Testing period

Test start date	October 23, 2023	Test end date	October 30, 2023
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5.2 Sample information

Receipt date	October 23, 2023	Nemko sample ID number(s)	PRJ0185210001
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5.3 FCC test results

Table 5.3-1: FCC Part 25 results

Part	Test description	Verdict
2.1046	Occupied bandwidth	Pass
25.204	Power limits for earth station	Pass
25.202(f)	Spurious emissions at the antenna terminal	Pass
25.202(f)	Field strength of spurious emissions	Pass
25.202(d)	Frequency tolerance, earth stations	Pass
25.216	Limits for emissions from mobile earth stations for protection of aeronautical radionavigation satellite service	Pass

Notes: ¹ Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed.

5.4 ISED test results

Table 5.4-2: RSS-Gen, Issue 5 test results

Part	Test description	Verdict
6.7	Occupied bandwidth	Pass
7.3	Receiver radiated emission limits	Not applicable ¹
7.4	Receiver conducted emission limits	Not applicable ¹
8.8	AC power-line conducted emission limits	Not applicable ²

Notes: ¹EUT does not have standalone receiver.
²EUT is DC powered.

Table 5.4-3: RSS-170, Issue 4 test results

Part	Test description	Verdict
5.2	Frequency bands	Pass
5.3	Frequency stability	Pass
5.5	Transmitter output power for mobile earth stations (MESs)	Pass
5.7	Unwanted emission limits for ATC mobile equipment	Pass
5.7.2	Transmitter unwanted emissions for ATC Mobile Equipment within 1626.5–1660.5 MHz band	Pass
5.8	Transmitter unwanted emissions for MESs in all frequency bands	Pass
5.9	Additional unwanted emission limits for MESs to protect radionavigation-satellite service	Pass
5.10	Carrier-off state emissions	Pass

Notes: None

Section 6. Test equipment

6.1 Test equipment list

Table 6.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002831	—	VOU
50 Ω coax cable	Huber + Suhner	None	FA002607	—	VOU
50 Ω coax cable	Sucoflex	None	FA002563	—	VOU
2.4 GHz band Notch Filter	Microwave Circuits	N0324413	FA002693	—	VOU
High Pass Filter (> 1100 MHz)	Microwave Circuits	H1G212G1	FA002689	—	VOU
Environmental Chamber	Espec	EPX-4H	FA002736	1 year	August 16, 2024
3 m EMI test chamber (Emissions)	TDK	SAC-3	FA002532e	1 year	March 8, 2024
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
3 Phase AC Power Supply	apc AC Power	AFC-33045T	FA002677	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 28, 2023
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	March 24, 2024
LNA (1–18 GHz)	Miteq	N/A	FA003391	1 year	January 9, 2025
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	March 10, 2024

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

Table 6.1-2: Automation software details

Test description	Manufacturer of Software	Details
Radiated emissions as of January 29, 2021	Rohde & Schwarz	EMC32, Software for EMC Measurements, Version 10.60.20

Table 6.1-3: Measurement uncertainty calculations based on equipment list

Measurement	Measurement uncertainty, ±dB
Radiated spurious emissions (30 MHz to 1 GHz)	4.27
Radiated spurious emissions (1 GHz to 6 GHz)	4.74
Radiated spurious emissions (6 GHz to 18 GHz)	5.04
RF Output power measurement using Spectrum Analyzer	0.71
Conducted spurious emissions	0.90
Other antenna port measurements	0.81
Signal path calibration (Insertion loss)	0.07

Notes: UKAS Lab 34, TIA-603 and ETSI TR 100 028-1&2 have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Section 7. Testing data

7.1 FCC 2.1049 and RSS-Gen 6.7 Occupied Bandwidth

7.1.1 References, definitions and limits

FCC §2.1049

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

RSS-Gen 6.7:

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the maximum power level of the transmitted emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

7.1.2 Test summary

Verdict	Pass		
Test date	October 23, 2023	Temperature	22.1 °C
Tested by	Hossein Zamani Zardehsavari	Air pressure	1010 mbar
Test location	Montreal	Relative humidity	36 %

7.1.3 Observations, settings and special notes

Measurements performed with reference to ANSI 63.26 section 5.4.4

Spectrum analyser settings:

Resolution bandwidth:	≥ 1 % of OBW
Video bandwidth:	≥ 3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

7.1.4 Test data

Table 7.1-1: 99 % occupied bandwidth results for waveform J

Frequency, MHz	99 % occupied bandwidth, kHz
1626.501625	1.026
1643.500000	1.029
1660.498375	1.024

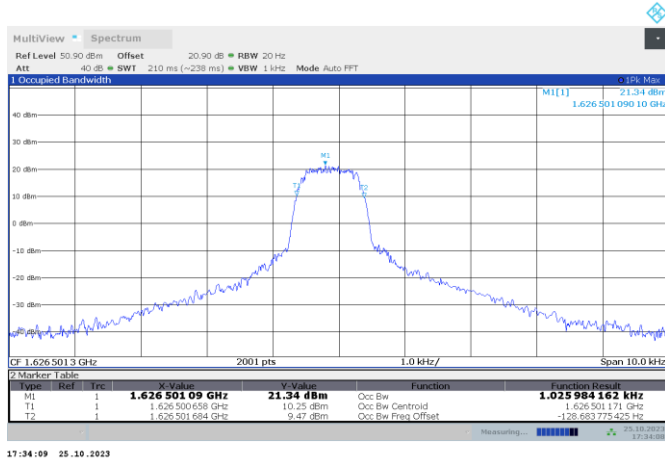


Figure 7.1-1: 99 % bandwidth on low channel for waveform J

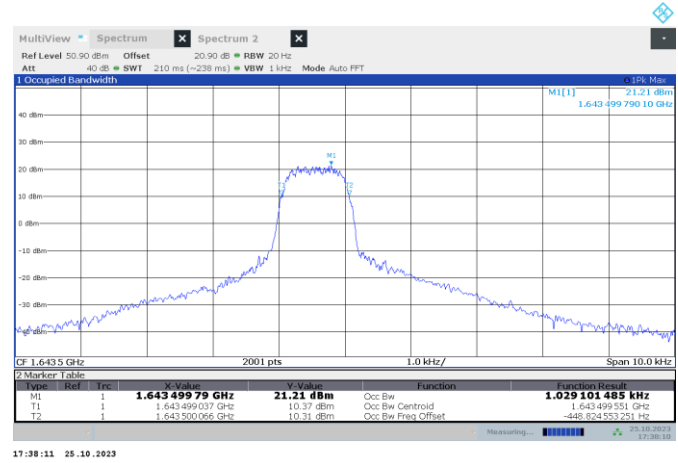


Figure 7.1-2: 99 % bandwidth on mid channel for waveform J

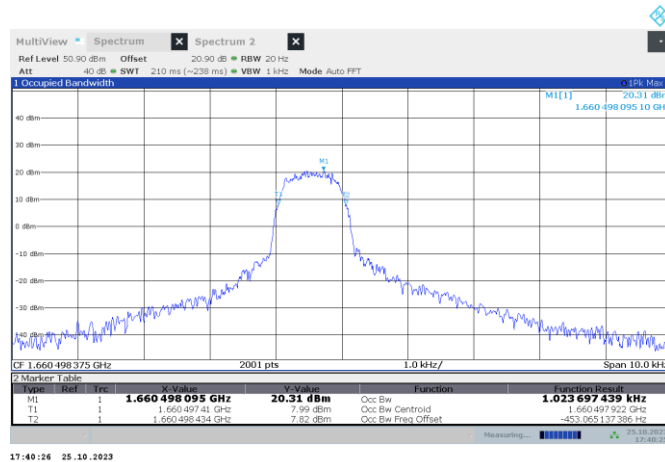


Figure 7.1-3: 99 % bandwidth on high channel for waveform J

Test data, continued

Table 7.1-2: 26 dB bandwidth results for waveform J

Frequency, MHz	26 dB bandwidth, kHz
1626.501625	1.25
1643.500000	1.25
1660.498375	1.24

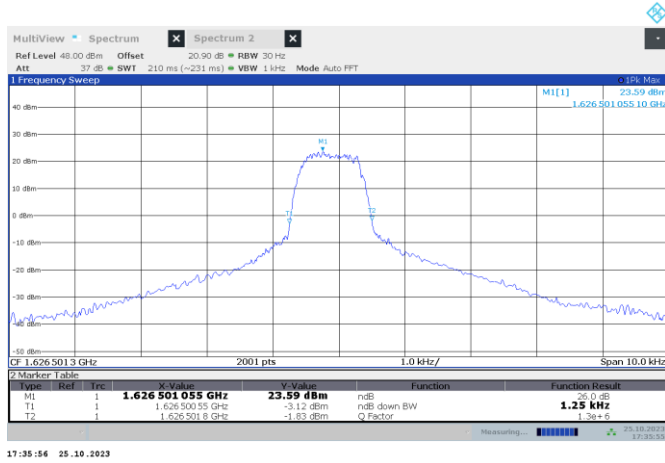


Figure 7.1-4: 26 dB bandwidth on low channel for waveform J

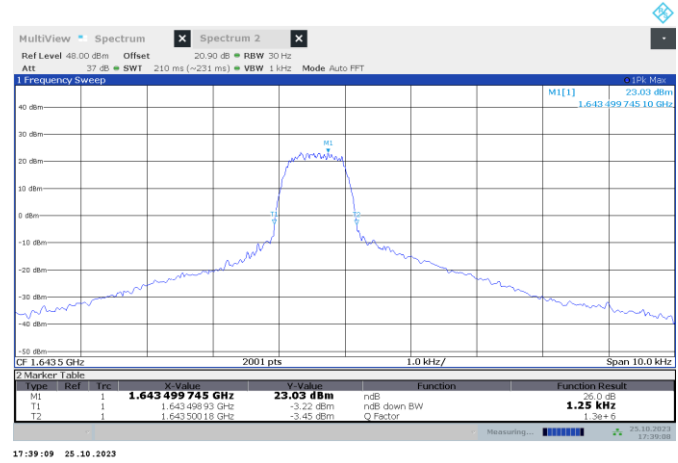


Figure 7.1-5: 26 dB bandwidth on mid channel for waveform J

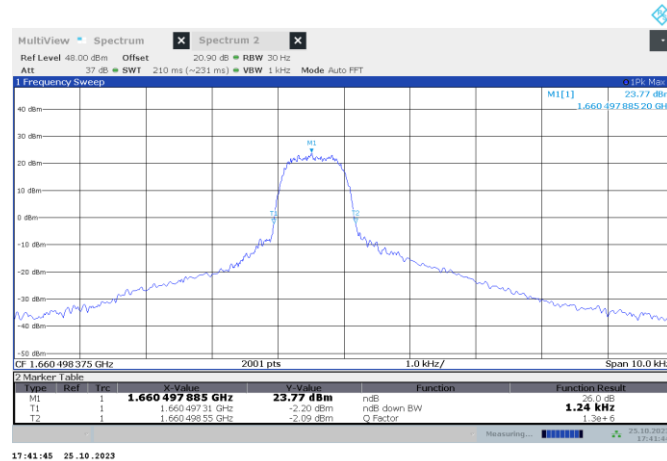


Figure 7.1-6: 26 dB bandwidth on high channel for waveform J

Test data, continued

Table 7.1-3: 99 % occupied bandwidth results for waveform K

Frequency, MHz	99 % occupied bandwidth, kHz
1626.502000	1.78
1643.500000	1.79
1660.498000	1.76

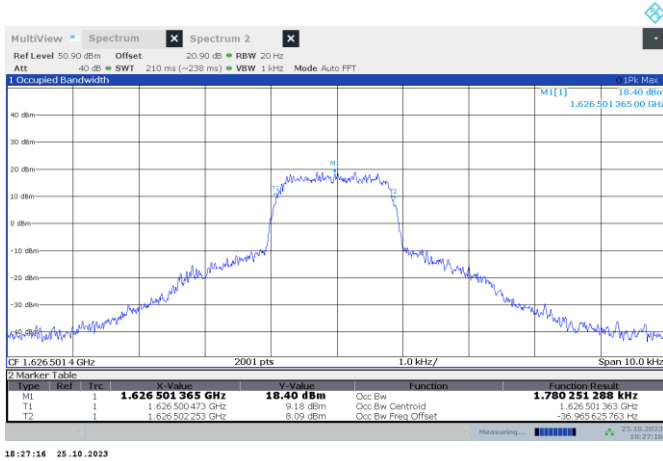


Figure 7.1-7: 99 % bandwidth on low channel for waveform K

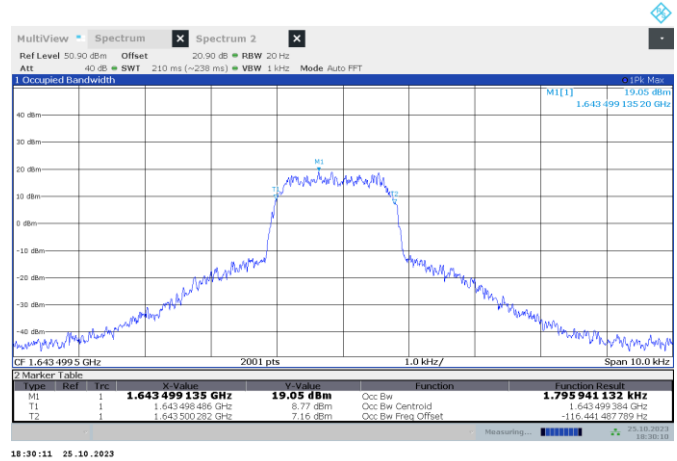


Figure 7.1-8: 99 % bandwidth on mid channel for waveform K

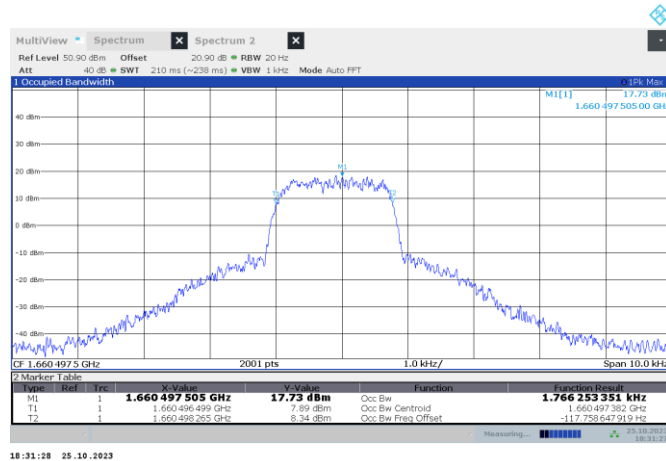


Figure 7.1-9: 99 % bandwidth on high channel for waveform K

Test data, continued

Table 7.1-4: 26 dB bandwidth results for waveform K

Frequency, MHz	26 dB bandwidth, kHz
1626.502000	2.05
1643.500000	2.04
1660.498000	2.05

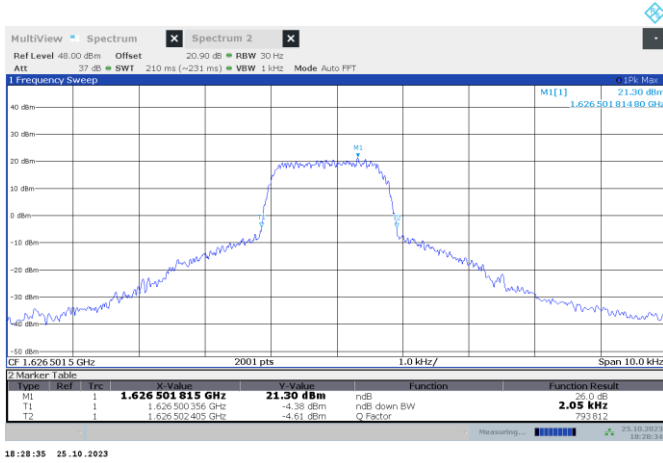


Figure 7.1-10: 26 dB bandwidth on low channel for waveform K

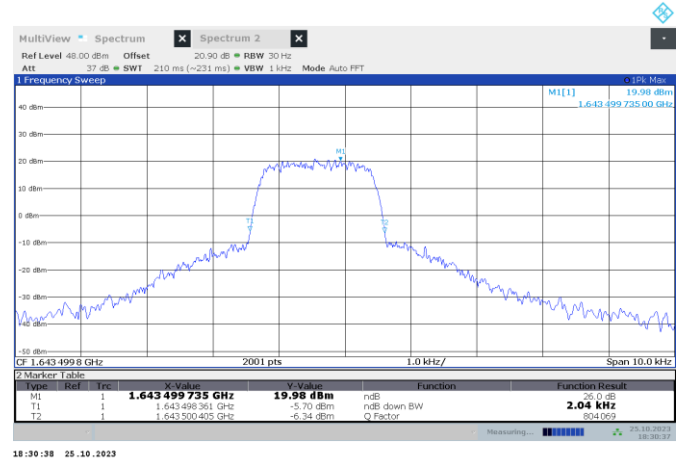


Figure 7.1-11: 26 dB bandwidth on mid channel for waveform K

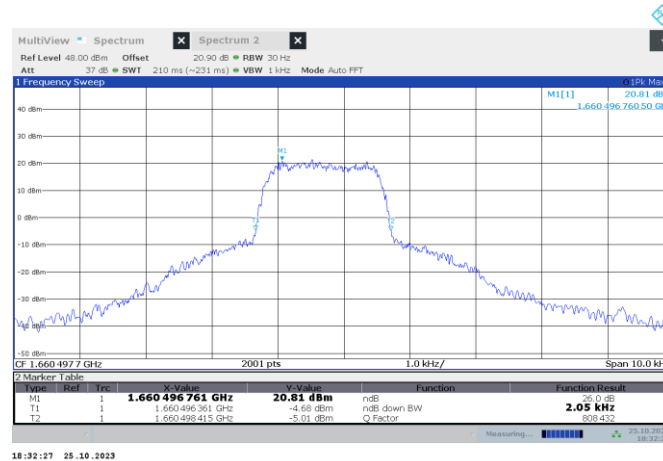


Figure 7.1-12: 26 dB bandwidth on high channel for waveform K

Test data, continued

Table 7.1-5: 99 % occupied bandwidth results for waveform T

Frequency, MHz	99 % occupied bandwidth, kHz
1626.503000	3.59
1643.500000	3.55
1660.497000	3.58

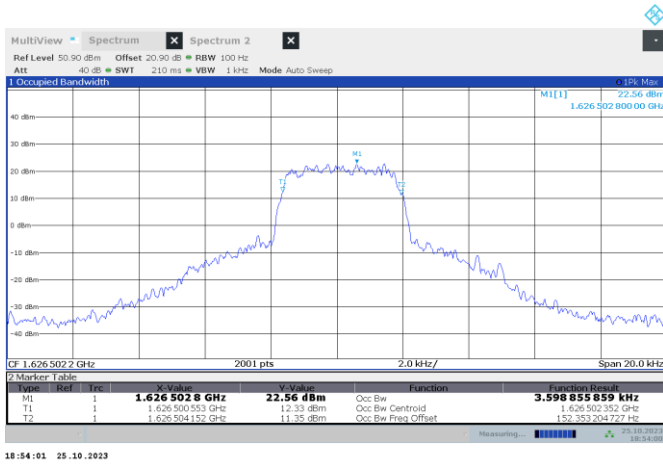


Figure 7.1-13: 99 % bandwidth on low channel for waveform T

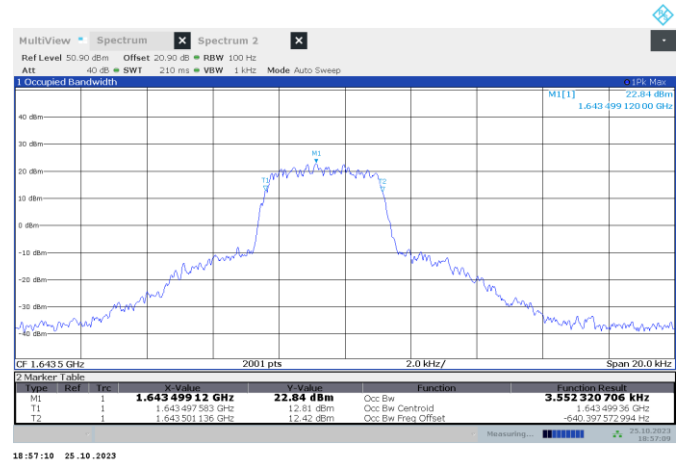


Figure 7.1-14: 99 % bandwidth on mid channel for waveform T

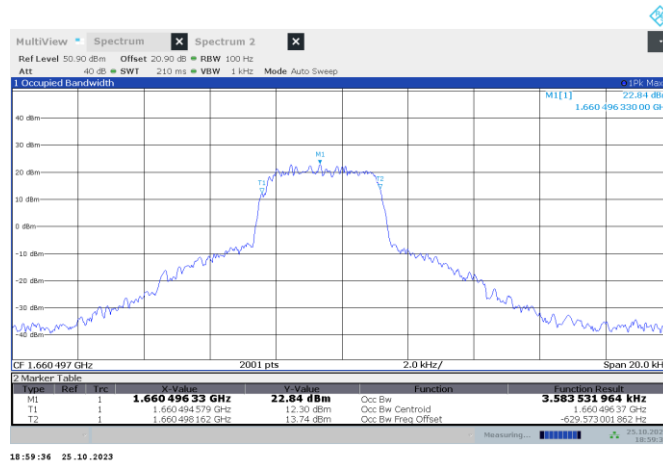


Figure 7.1-15: 99 % bandwidth on high channel for waveform T

Test data, continued

Table 7.1-6: 26 dB bandwidth results for waveform T

Frequency, MHz	26 dB bandwidth, kHz
1626.503000	4.14
1643.500000	4.12
1660.497000	4.12

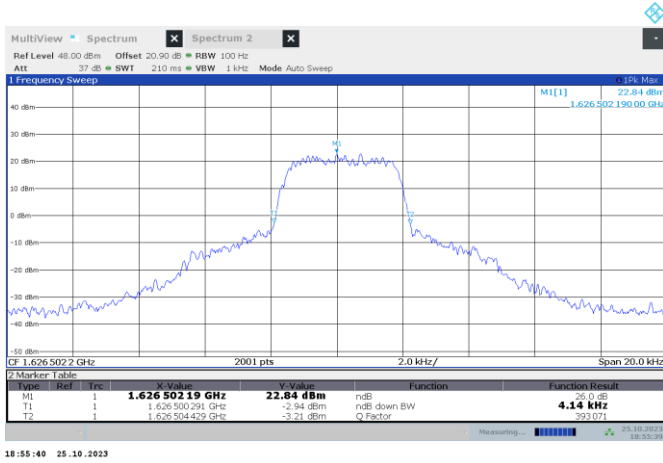


Figure 7.1-16: 26 dB bandwidth on low channel for waveform T

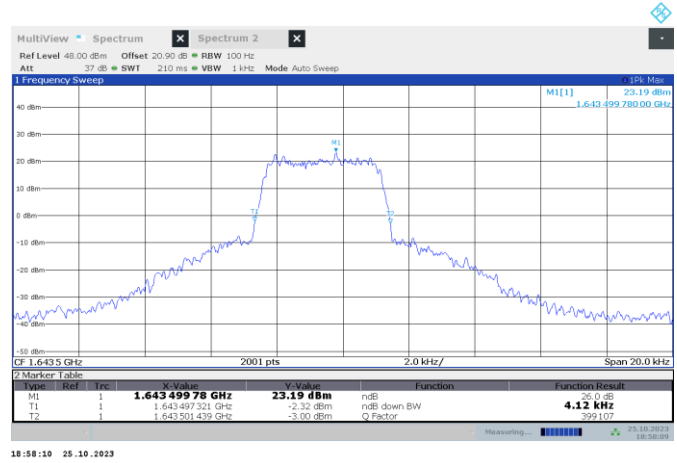


Figure 7.1-17: 26 dB bandwidth on mid channel for waveform T



Figure 7.1-18: 26 dB bandwidth on high channel for waveform T

Test data, continued

Table 7.1-7: 99 % occupied bandwidth results for waveform Y

Frequency, MHz	99 % occupied bandwidth, kHz
1626.505000	7.23
1643.500000	7.18
1660.495000	7.22

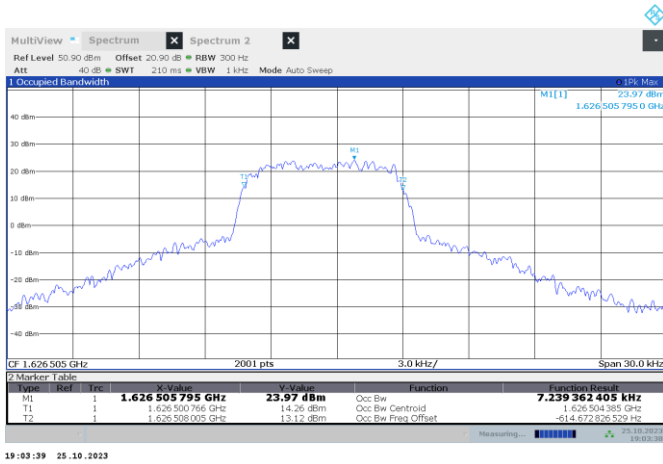


Figure 7.1-19: 99 % bandwidth on low channel for waveform Y

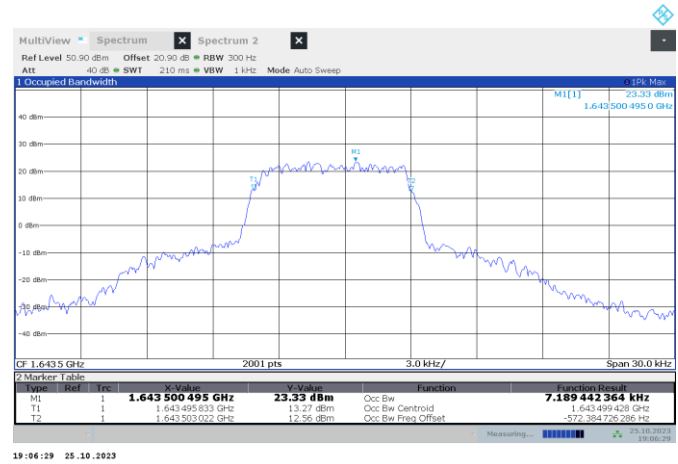


Figure 7.1-20: 99 % bandwidth on mid channel for waveform Y



Figure 7.1-21: 99 % bandwidth on high channel for waveform Y

Test data, continued

Table 7.1-8: 26 dB bandwidth results for waveform Y

Frequency, MHz	26 dB bandwidth, kHz
1626.505000	8.37
1643.500000	8.23
1660.495000	8.31

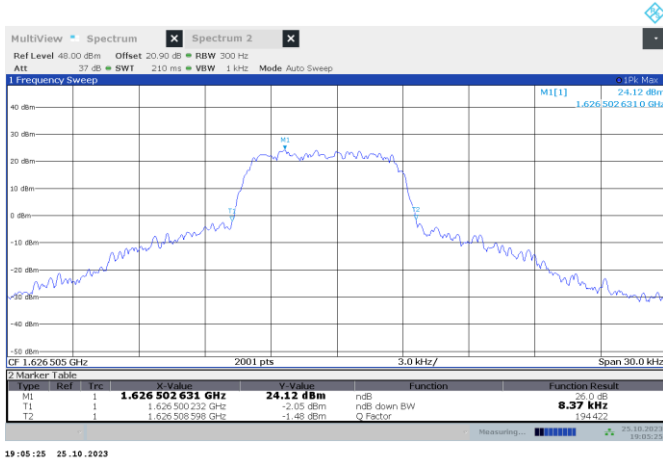


Figure 7.1-22: 26 dB bandwidth on low channel for waveform Y

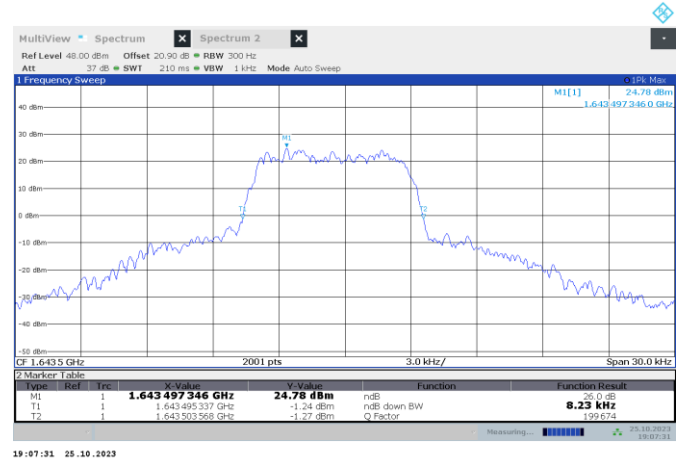


Figure 7.1-23: 26 dB bandwidth on mid channel for waveform Y



Figure 7.1-24: 26 dB bandwidth on high channel for waveform Y

Test data, continued

Table 7.1-9: 99 % occupied bandwidth results for waveform Z

Frequency, MHz	99 % occupied bandwidth, kHz
1626.509000	14.17
1643.500000	14.33
1660.492000	14.28

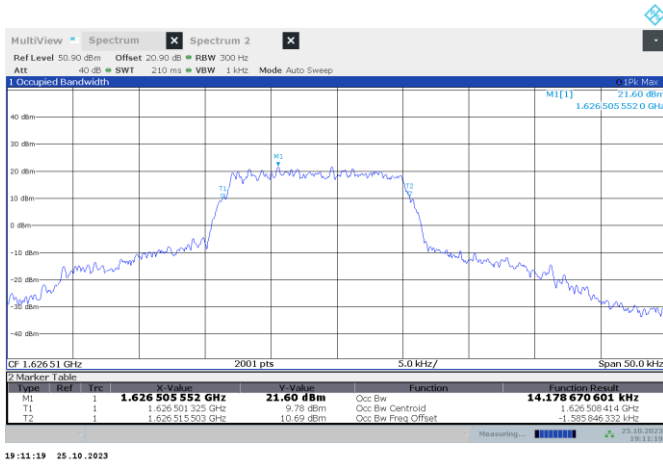


Figure 7.1-25: 99 % bandwidth on low channel for waveform Z

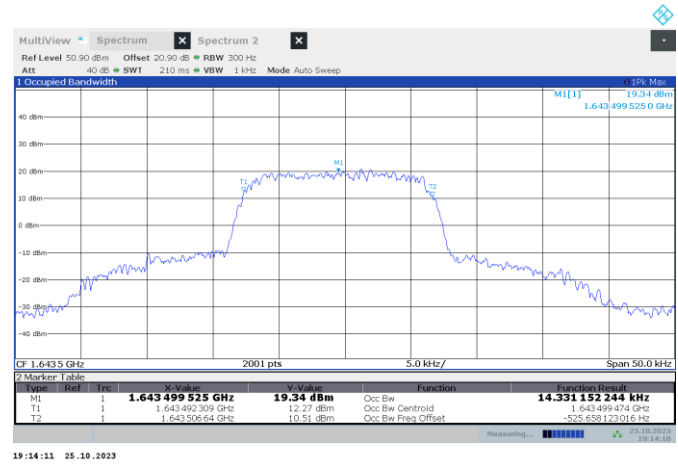


Figure 7.1-26: 99 % bandwidth on mid channel for waveform Z



Figure 7.1-27: 99 % bandwidth on high channel for waveform Z

Test data, continued

Table 7.1-10: 26 dB bandwidth results for waveform Z

Frequency, MHz	26 dB bandwidth, kHz
1626.509000	16.47
1643.500000	16.29
1660.492000	16.37

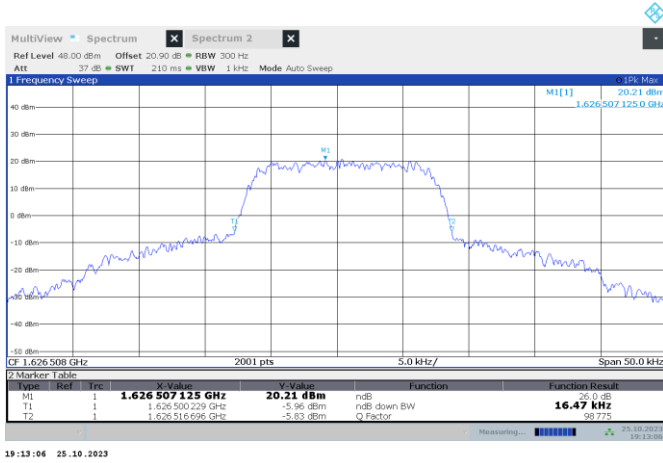


Figure 7.1-28: 26 dB bandwidth on low channel for waveform Z

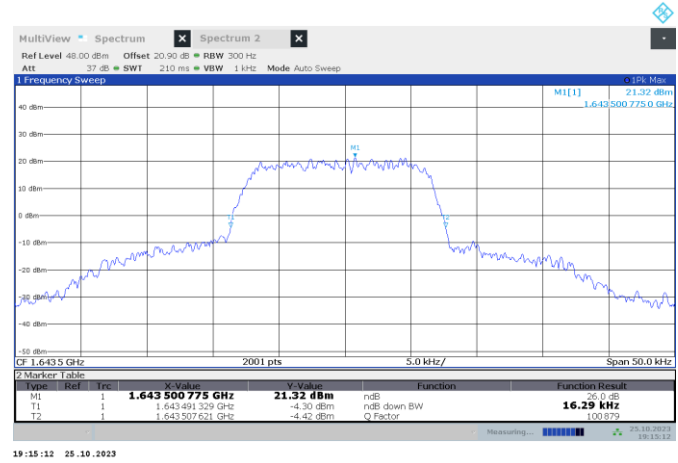


Figure 7.1-29: 26 dB bandwidth on mid channel for waveform Z

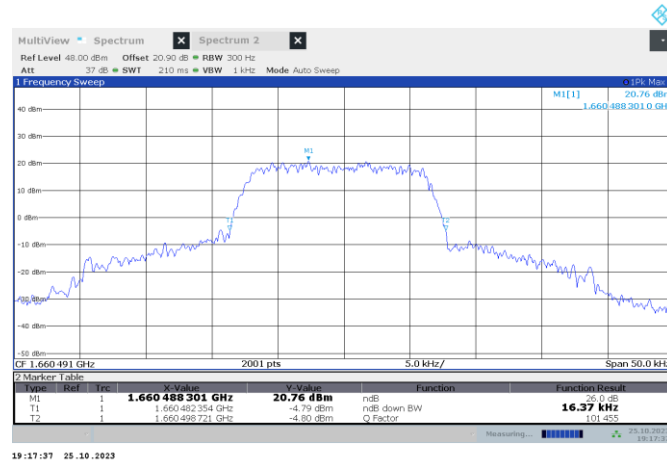


Figure 7.1-30: 26 dB bandwidth on high channel for waveform Z

7.2 FCC 25.204 and RSS-170 5.5 Transmitter e.i.r.p. for mobile earth stations

7.2.1 References, definitions and limits

FCC §25.204:

- (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) below:
+40 dBW (70 dBm) in any 4 kHz band for $\Theta \leq 0^\circ$
+40 + 3 Θ dBW in any 4 kHz band for $0^\circ < \Theta \leq 5^\circ$
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.
- (b) In bands shared coequally with terrestrial radiocommunication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station operating in frequency bands above 15 GHz shall not exceed the following limits except as provided for in paragraph (c) below:
+64 dBW (94 dBm) in any 1 MHz band for $\Theta \leq 0^\circ$
+64 + 3 Θ dBW in any 1 MHz band for $0^\circ < \Theta \leq 5^\circ$
where Θ is as defined in paragraph (a) above.
- (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.
- (d) Notwithstanding the e.i.r.p. and e.i.r.p. density limits specified in the station authorization, each earth station transmission shall be conducted at the lowest power level that will provide the required signal quality as indicated in the application and further amended by coordination agreements.

RSS-170, clause 5.5:

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.

7.2.2 Test summary

Verdict	Pass		
Test date	October 25, 2023	Temperature	23 °C
Tested by	Hossein Zamani	Air pressure	1021 mbar
Test location	Montreal	Relative humidity	35.1 %

7.2.3 Observations, settings and special notes

Measurement performed with reference to ANSI C63.26 section 5.2.3 for peak power of narrowband signal using spectrum analyzer.
Resolution bandwidth of 5 kHz selected in lieu of 4 kHz to satisfy FCC requirements.

Spectrum analyser settings:

Resolution bandwidth:	5 kHz
Video bandwidth:	20 kHz
Detector mode:	Peak
Trace mode:	Max Hold

7.2.4 Test data

Table 7.2-1: Conducted peak output power measurement results – ISCED for waveform J

Frequency, MHz	Output power, dBm/5 kHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.501625	31.74	30.77	4.5	35.27	37	39	3.73
1643.500000	31.68	30.71	4.5	35.21	37	39	3.79
1660.498375	31.74	30.77	4.5	35.27	37	39	3.73

Note: Maximum permissible EIRP, dBm = Stated EIRP + 2 dB

Table 7.2-2: Conducted peak output power measurement results – FCC for waveform J

Frequency, MHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm/4 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.501625	30.77	4.5	35.27	70	34.73
1643.500000	30.71	4.5	35.21	70	34.79
1660.498375	30.77	4.5	35.27	70	34.73

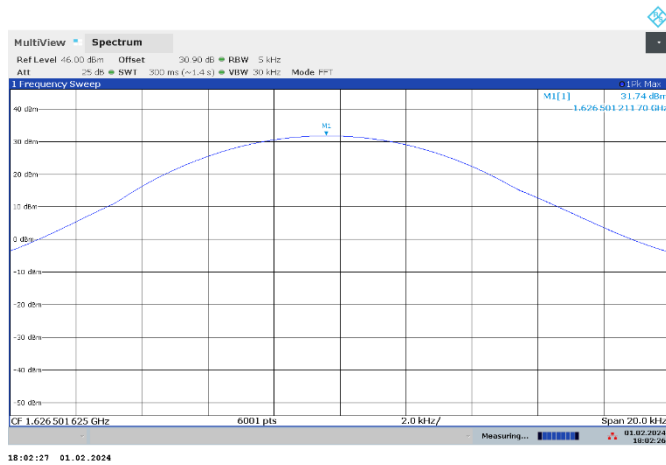


Figure 7.2-1: Conducted peak output power on low channel for waveform J

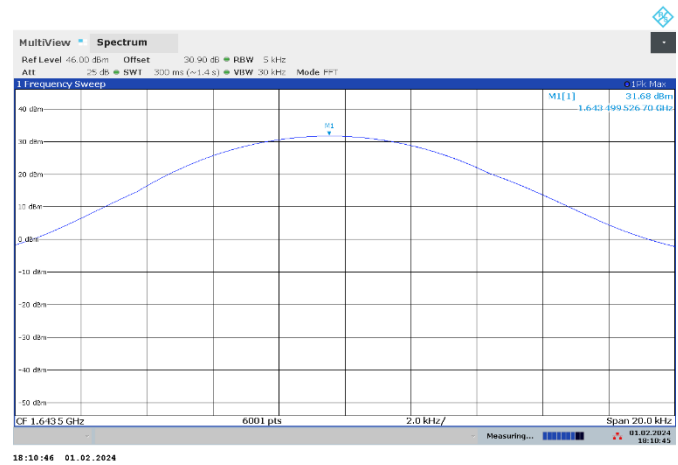


Figure 7.2-2: Conducted peak output power on mid channel for waveform J

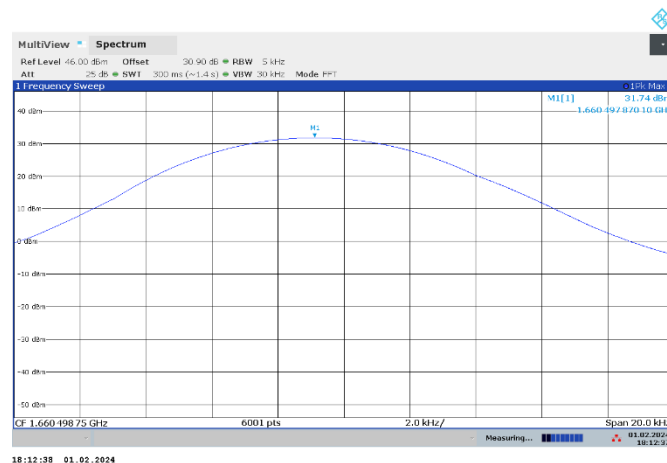


Figure 7.2-3: Conducted peak output power on high channel for waveform J

Test data, continued

Table 7.2-3: Conducted peak output power measurement results – ISSED for waveform K

Frequency, MHz	Output power, dBm/5 kHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.502000	31.81	30.84	4.5	35.34	37	39	3.66
1643.500000	31.76	30.79	4.5	35.29	37	39	3.71
1660.498000	31.87	30.90	4.5	35.40	37	39	3.60

Note: Maximum permissible EIRP, dBm = Stated EIRP + 2 dB

Table 7.2-4: Conducted peak output power measurement results – FCC for waveform K

Frequency, MHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm/4 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.502000	30.84	4.5	35.34	70	34.66
1643.500000	30.79	4.5	35.29	70	34.71
1660.498000	30.90	4.5	35.40	70	34.60

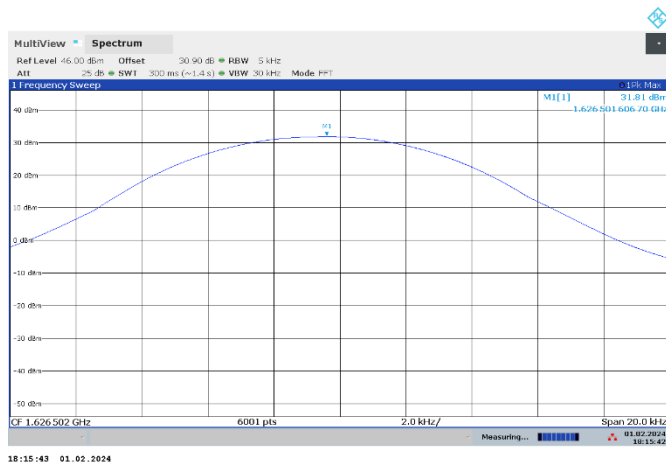


Figure 7.2-4: Conducted peak output power on low channel for waveform K

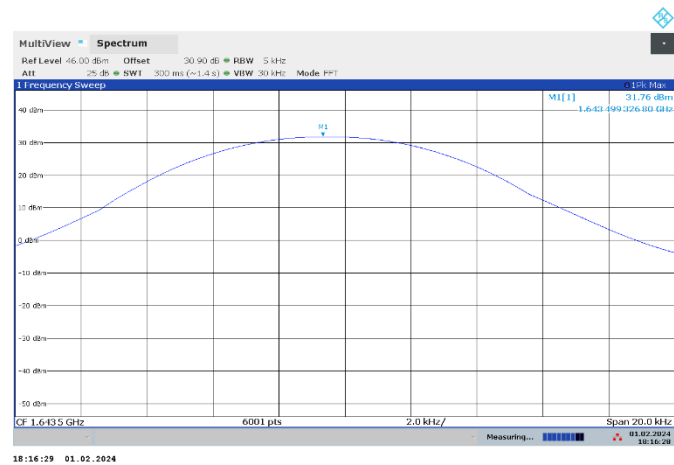


Figure 7.2-5: Conducted peak output power on mid channel for waveform K

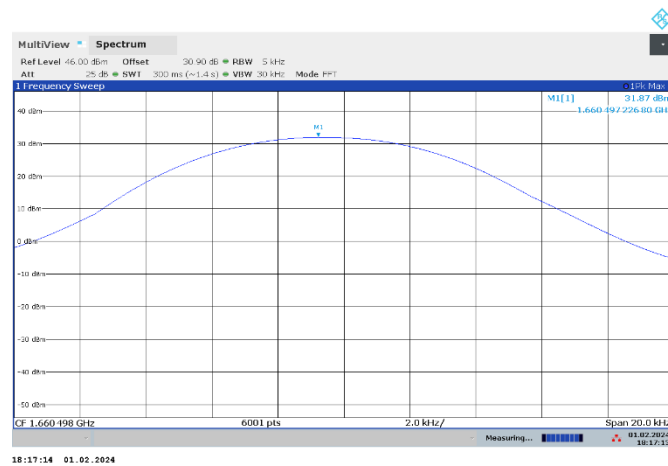


Figure 7.2-6: Conducted peak output power on high channel for waveform K



Section 7
Test name
Specification

Testing data
FCC 25.204 and RSS-170 5.5 Transmitter e.i.r.p. for mobile earth stations
FCC Part 25 and RSS-170, Issue 4

Test data, continued

Table 7.2-5: Conducted peak output power measurement results – ISSED for waveform T

Frequency, MHz	Output power, dBm/ 5 kHz	Output power, dBm/ 4 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.503000	31.46	30.49	4.5	34.99	37	39	4.01
1643.500000	31.57	30.60	4.5	35.10	37	39	3.90
1660.497000	31.56	30.59	4.5	35.09	37	39	3.91

Note: Maximum permissible EIRP, dBm = Stated EIRP + 2 dB

Table 7.2-6: Conducted peak output power measurement results – FCC for waveform T

Frequency, MHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm/4 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.503000	30.49	4.5	34.99	70	35.01
1643.500000	30.60	4.5	35.10	70	34.90
1660.497000	30.59	4.5	35.09	70	34.91

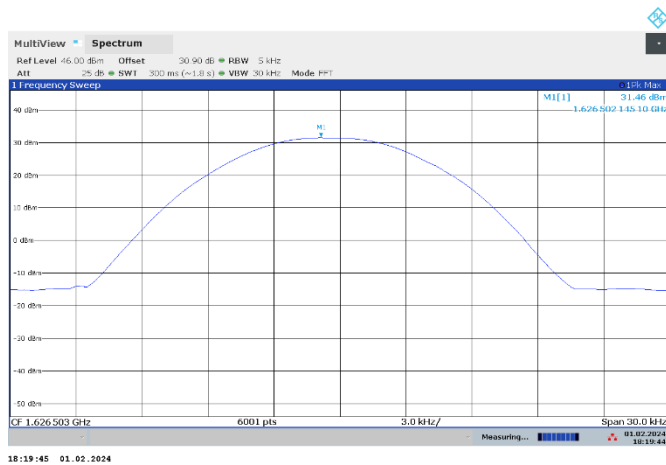


Figure 7.2-7: Conducted peak output power on low channel for waveform T

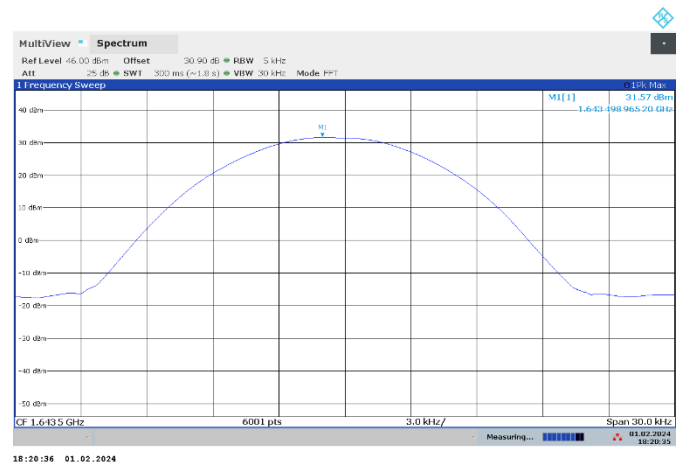


Figure 7.2-8: Conducted peak output power on mid channel for waveform T

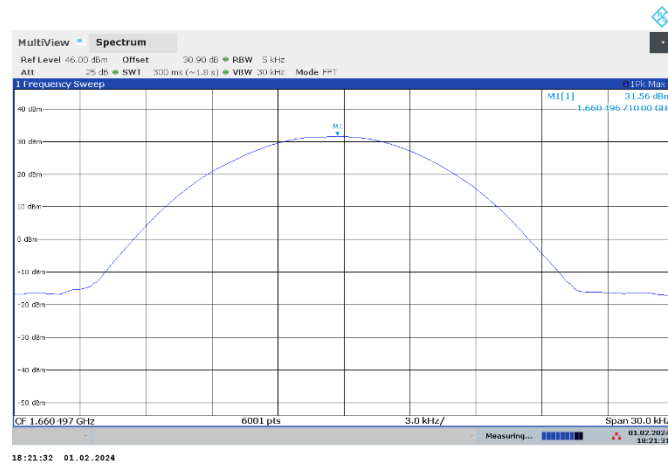


Figure 7.2-9: Conducted peak output power on high channel for waveform T



Section 7
Test name
Specification

Testing data
FCC 25.204 and RSS-170 5.5 Transmitter e.i.r.p. for mobile earth stations
FCC Part 25 and RSS-170, Issue 4

Test data, continued

Table 7.2-7: Conducted peak output power measurement results – ISFD for waveform Y

Frequency, MHz	Output power, dBm/5 kHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.505000	31.61	30.64	4.5	35.14	37	39	3.86
1643.500000	31.70	30.73	4.5	35.23	37	39	3.77
1660.495000	31.56	30.59	4.5	35.09	37	39	3.91

Note: Maximum permissible EIRP, dBm = Stated EIRP + 2 dB

Table 7.2-8: Conducted peak output power measurement results – FCC for waveform Y

Frequency, MHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm/4 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.505000	30.64	4.5	35.14	70	34.86
1643.500000	30.73	4.5	35.23	70	34.77
1660.495000	30.59	4.5	35.09	70	34.91

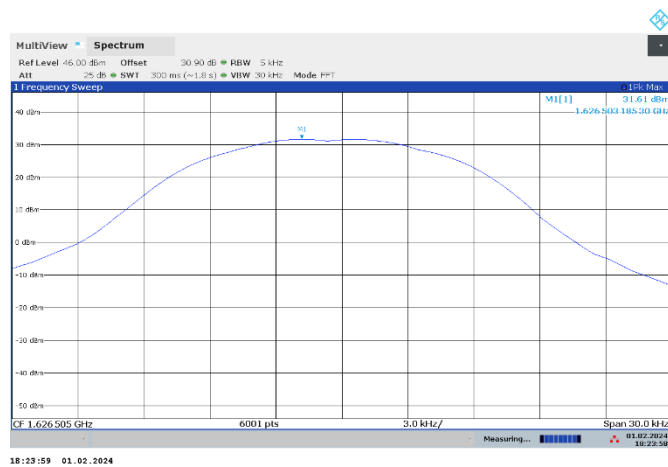


Figure 7.2-10: Conducted peak output power on low channel for waveform Y

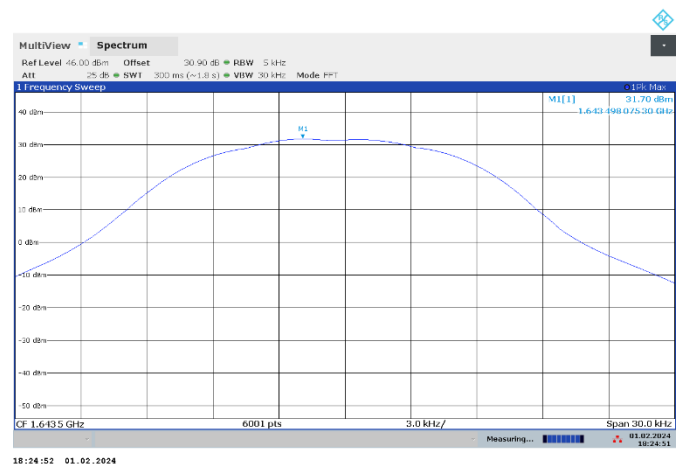


Figure 7.2-11: Conducted peak output power on mid channel for waveform Y

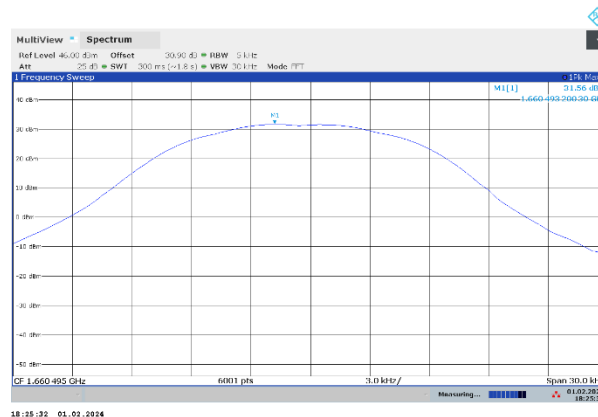


Figure 7.2-12: Conducted peak output power on high channel for waveform Y

Test data, continued

Table 7.2-9: Conducted peak output power measurement results – ISED for waveform Z

Frequency, MHz	Output power, dBm/ 5 kHz	Output power, dBm/ 4 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.509000	31.27	30.30	4.5	34.80	37	39	4.20
1643.500000	31.31	30.34	4.5	34.84	37	39	4.16
1660.492000	31.27	30.30	4.5	34.80	37	39	4.20

Note: Maximum permissible EIRP, dBm = Stated EIRP + 2 dB

Table 7.2-10: Conducted peak output power measurement results – FCC for waveform Z

Frequency, MHz	Output power, dBm/4 kHz	Gain, dBi	EIRP, dBm/4 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.509000	30.30	4.5	34.80	70	35.20
1643.500000	30.34	4.5	34.84	70	35.16
1660.492000	30.30	4.5	34.80	70	35.20

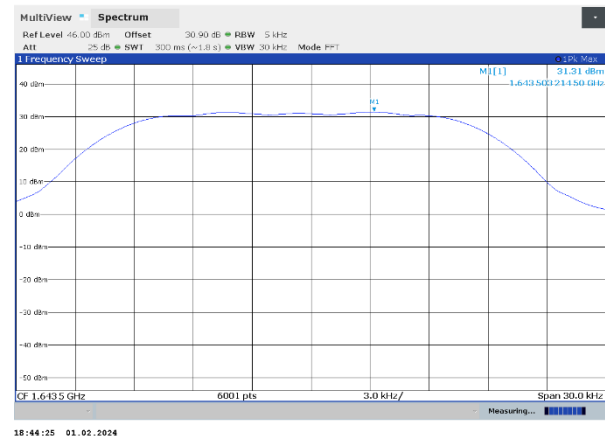
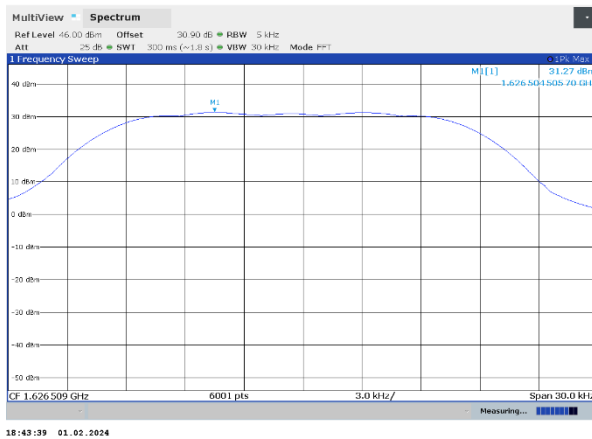


Figure 7.2-13: Conducted peak output power on low channel for waveform Z

Figure 7.2-14: Conducted peak output power on mid channel for waveform Z

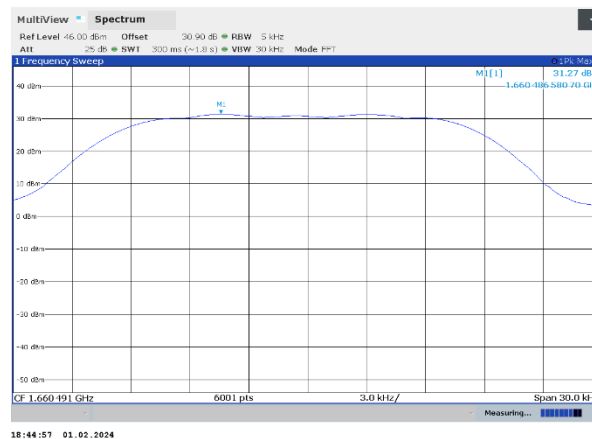


Figure 7.2-15: Conducted peak output power on high channel for waveform Z

7.3 FCC 25.202(f) and RSS-170 5.8 Field strength of spurious emissions

7.3.1 References, definitions and limits

FCC §15.202:

- (f) Emission limitations. The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
- (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 (–13 dBm fixed);
 - (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.

RSS-170

- 5.1 The transmitter unwanted emissions shall be measured with the carrier frequency set at both the highest and lowest channels in which the equipment is designed to operate.
The e.i.r.p. density of unwanted and carrier-off emissions in this section shall be averaged over any 2 ms active transmission using a power average detector with a resolution bandwidth of 1 MHz for broadband emissions and a resolution bandwidth of 1 kHz for discrete emissions, unless stated otherwise
- 5.8 **Unwanted emissions limits for 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.
 - (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.
- 5.10 **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.

7.3.2 Test summary

Verdict	Pass		
Test date	October 30, 2023	Temperature	23 °C
Tested by	Hossein Zamani	Air pressure	1011 mbar
Test location	Montreal	Relative humidity	32.1 %

7.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.

Radiated measurements were performed at a distance of 3 m per ANSI 63.26, section 5.5.2 on a test site validated to the requirements of ANSI 63.10

Conducted spurious measurements were performed with reference to ANSI 63.26 section 5.7.4

Conducted out of band emissions measurements performed with using the power integration method per ANSI 63.26 section 5.7.2 (a); the measured value is scaled using $10 \log (\text{Reference bandwidth})/(\text{Measurement bandwidth})$

Spectrum analyser settings for conducted spurious emissions measurements 30 MHz – 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements 1 GHz – 18 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for conducted bandedge spurious emission measurements outside assigned channel

Span	20 kHz
Resolution bandwidth	$\geq 1\%$ of OBW
Video bandwidth	$\geq 3 \times \text{RBW}$
Detector mode	RMS
Trace mode	Averaging

Spectrum analyser settings for radiated spurious emissions measurements below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for radiated spurious emissions measurements above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

7.3.4 Test data

Table 7.3-1: Emissions in 50 – 100% Authorized bandwidth – Waveform J

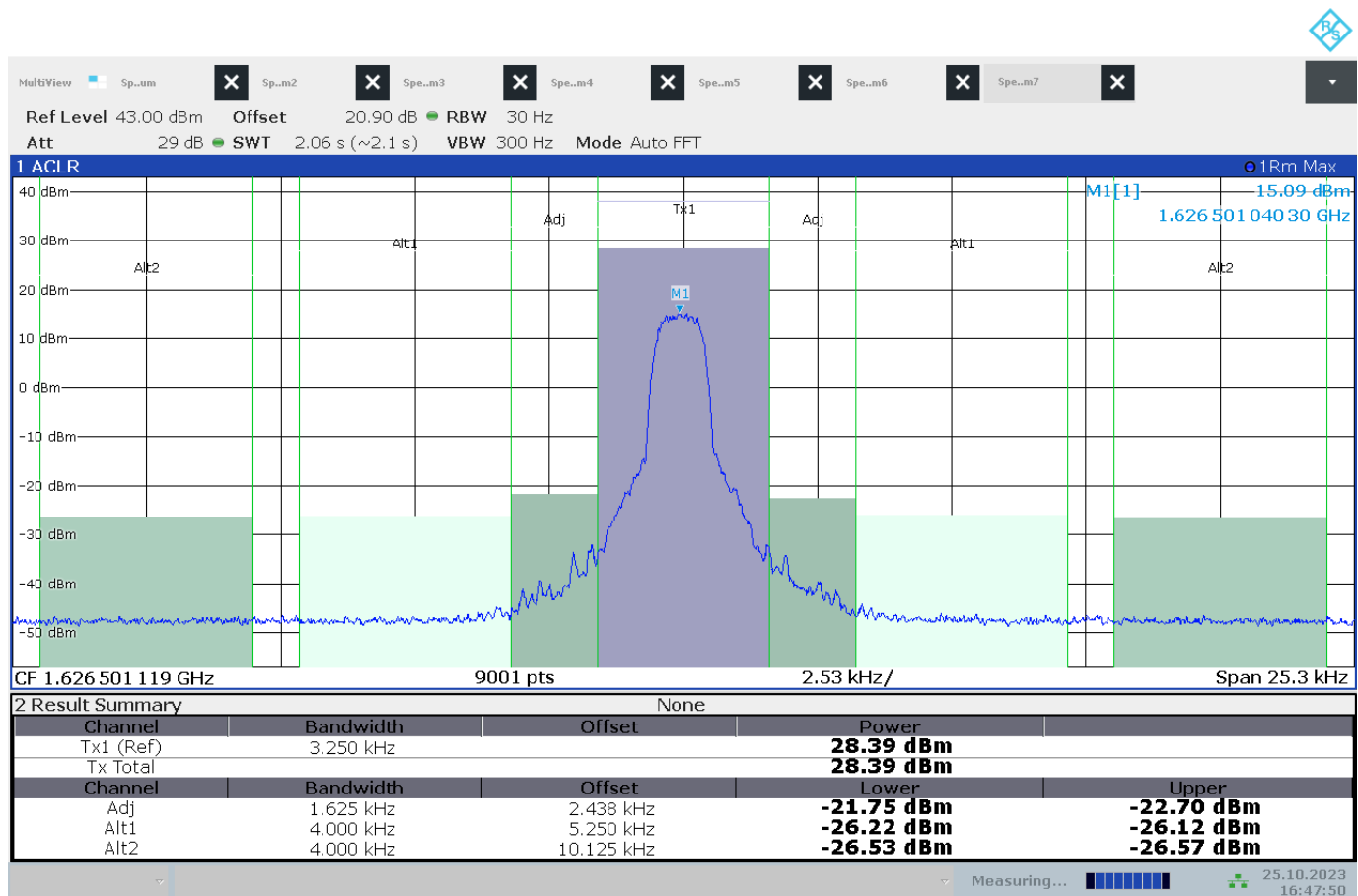
Frequency, (MHz)	Measured mean output power, (dBm/3.25 kHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/1.625 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1626.501625	28.9	27.99	-21.75	-17.83	2.99	25.37

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-2: Emissions in 100 – 250 % Authorized bandwidth – Waveform J

Frequency, (MHz)	Measured mean output power, (dBm/3.25 kHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1626.501625	28.9	27.99	-26.12	-8.38	-7.01

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



16:47:50 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform J, low channel

Test data continued

Table 7.3-3: Emissions in 50 – 100% Authorized bandwidth – Waveform J

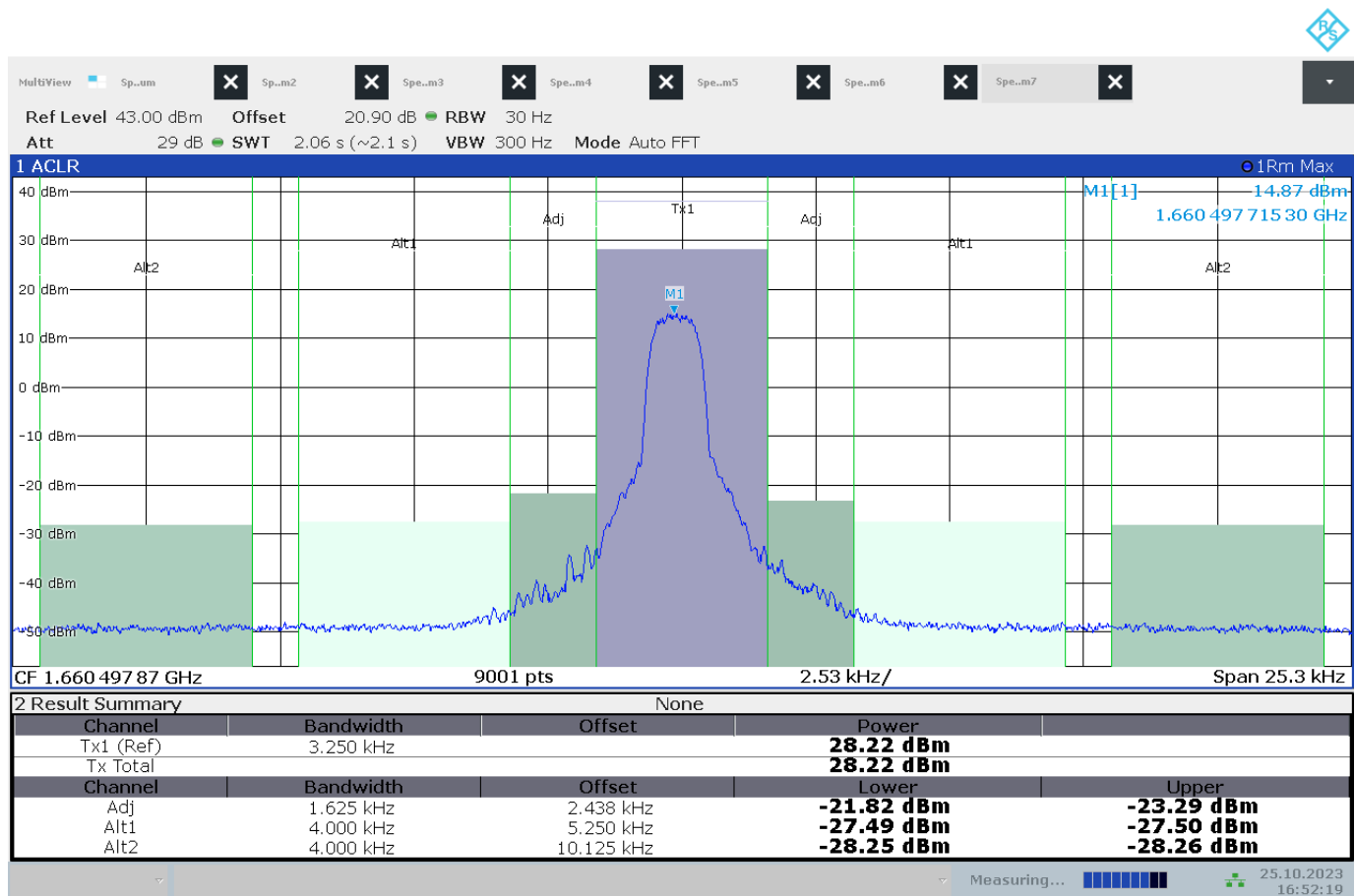
Frequency, (MHz)	Measured mean output power, (dBm/3.25 kHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/1.625 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1660.498375	28.22	27.31	-21.82	-17.90	2.31	20.21

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-4: Emissions in 100 – 250 % Authorized bandwidth – Waveform J

Frequency, (MHz)	Measured mean output power, (dBm/3.25 kHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1660.498375	28.22	27.31	-27.49	-7.69	19.80

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



16:52:19 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform J, high channel

Test data continued

Table 7.3-5: Emissions in 50 – 100% Authorized bandwidth – Waveform K

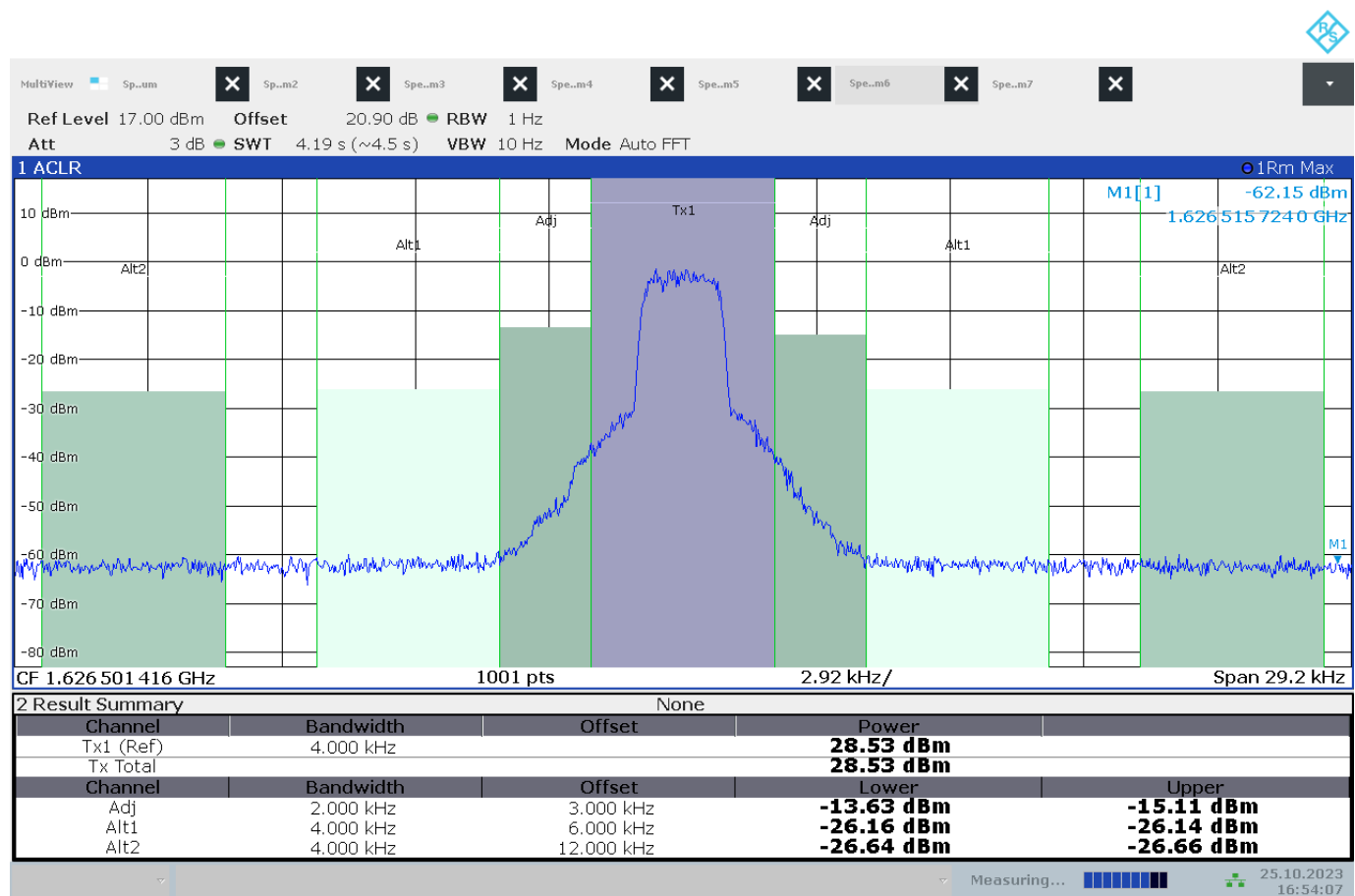
Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/2 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1626.502000	28.53	-13.63	-10.61	3.53	14.14

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-6: Emissions in 100 – 250 % Authorized bandwidth – Waveform K

Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1626.502000	28.53	-26.14	-6.47	19.67

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



16:54:07 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform K, low channel

Test data continued

Table 7.3-7: Emissions in 50 – 100% Authorized bandwidth – Waveform K

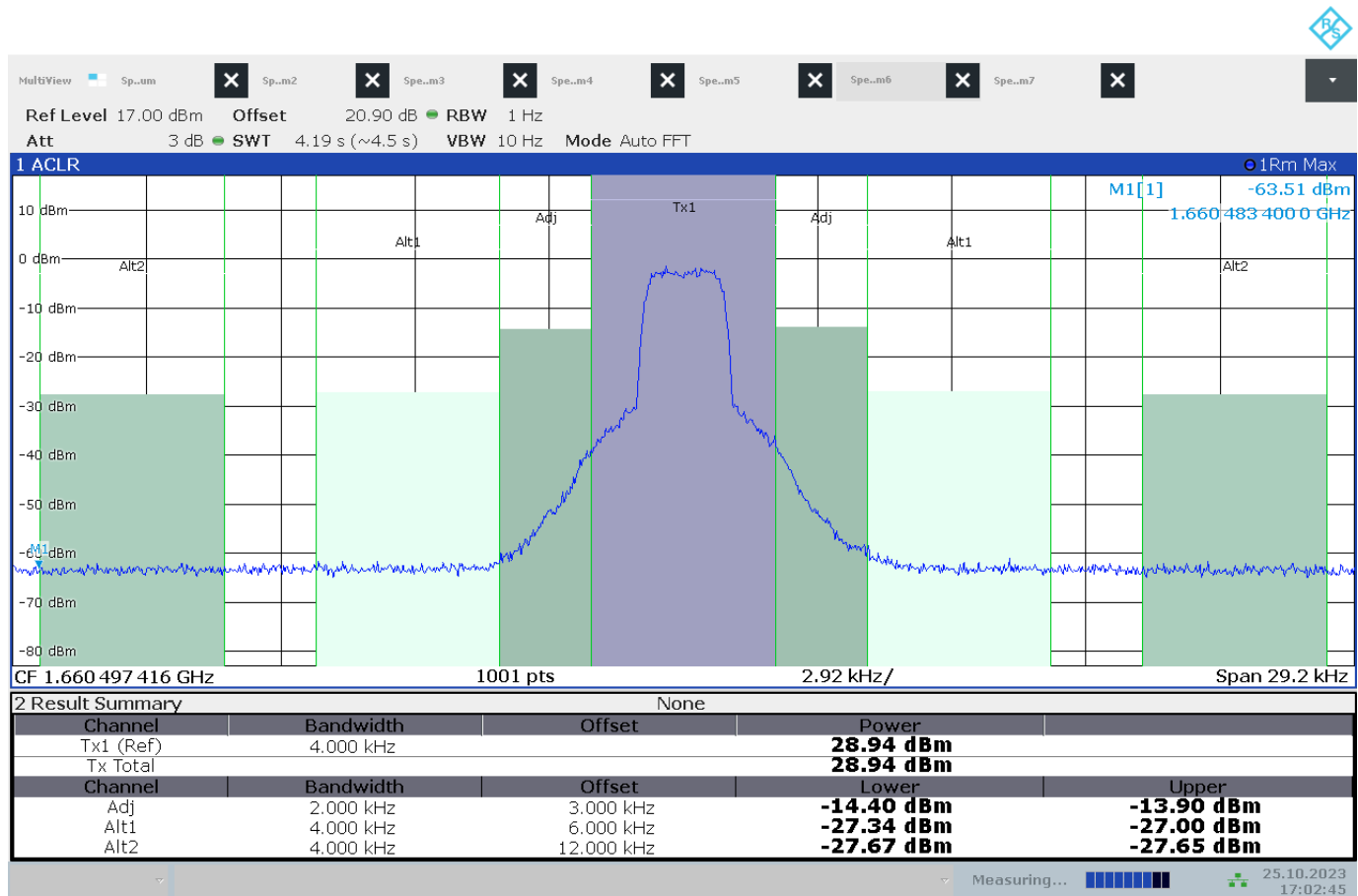
Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/2 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1660.498000	28.94	-13.90	-10.88	3.94	14.82

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-8: Emissions in 100 – 250 % Authorized bandwidth – Waveform K

Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1660.498000	28.94	-27.00	-6.06	20.94

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



17:02:45 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform K, high channel

Test data continued

Table 7.3-9: Emissions in 50 – 100% Authorized bandwidth – Waveform T

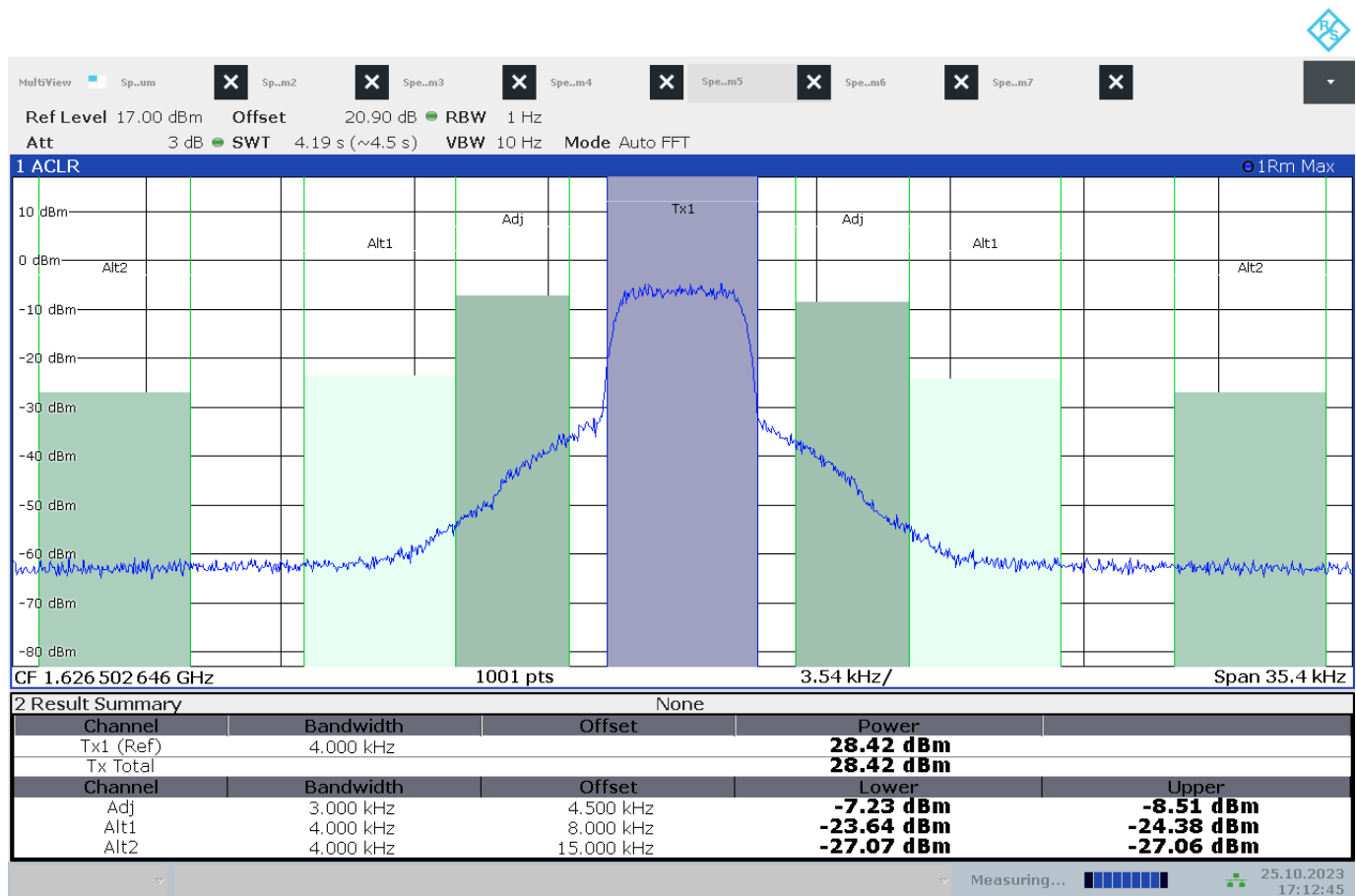
Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/3 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1626.503000	28.42	-7.23	-5.98	3.42	9.40

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-10: Emissions in 100 – 250 % Authorized bandwidth – Waveform T

Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1626.503000	28.42	-23.64	-6.58	17.06

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



17:12:45 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform T, low channel

Test data continued

Table 7.3-11: Emissions in 50 – 100% Authorized bandwidth – Waveform T

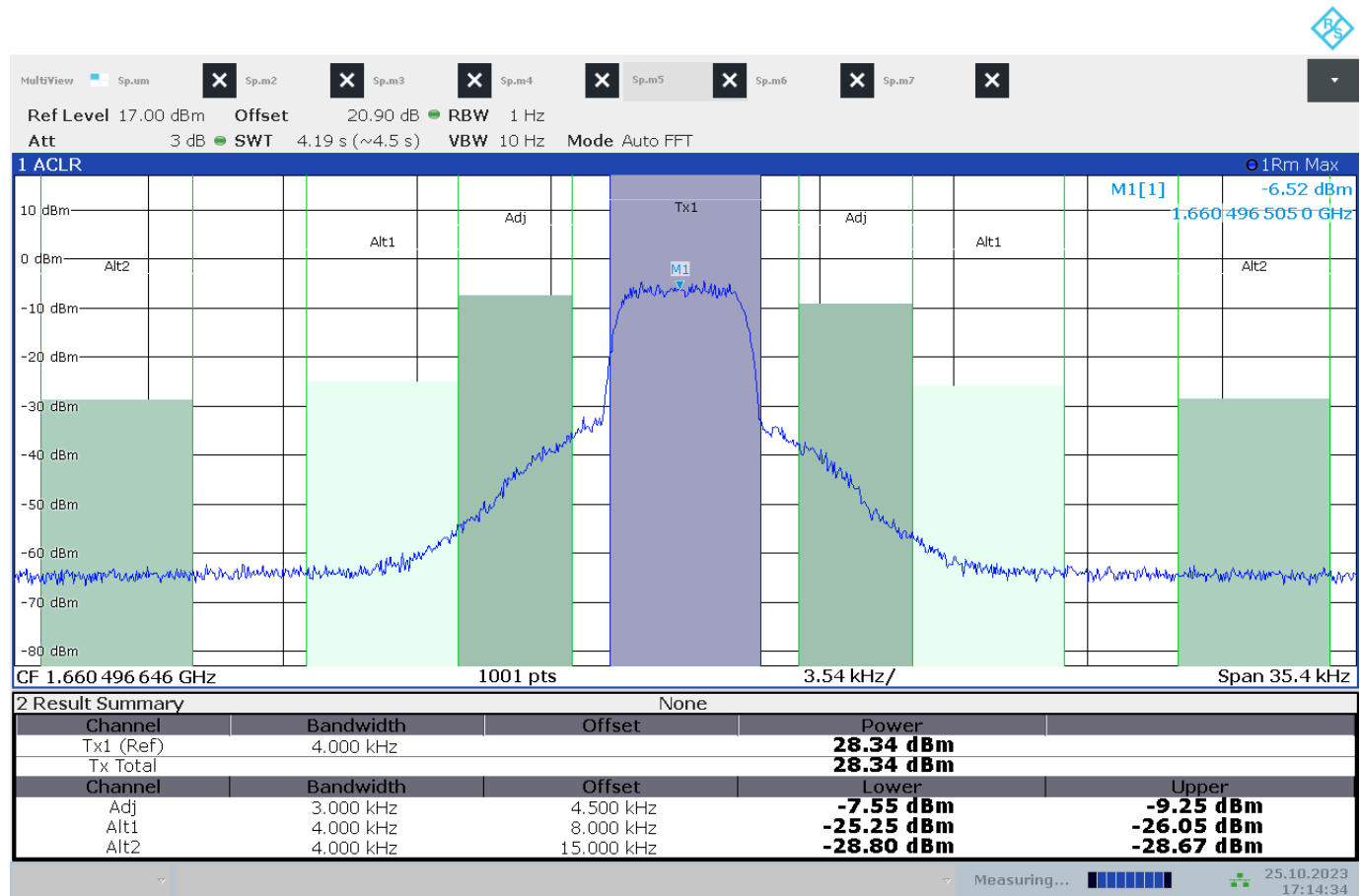
Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Measured mean adjacent power 50–100% BW, (dBm/3 kHz)	Scaled mean adjacent power 50–100% BW, (dBm/4 kHz)	Limit, 50–100% (dBm/4 kHz)	Margin, (dB)
1660.497000	28.34	-7.55	-6.30	3.34	9.64

Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 25 dB

Table 7.3-12: Emissions in 100 – 250 % Authorized bandwidth – Waveform T

Frequency, (MHz)	Measured mean output power, (dBm/4 kHz)	Scaled mean adjacent power 100–250% BW, (dBm/4 kHz)	Limit, 100–250% (dBm/4 kHz)	Margin, (dB)
1660.497000	28.34	-25.25	-6.66	18.59

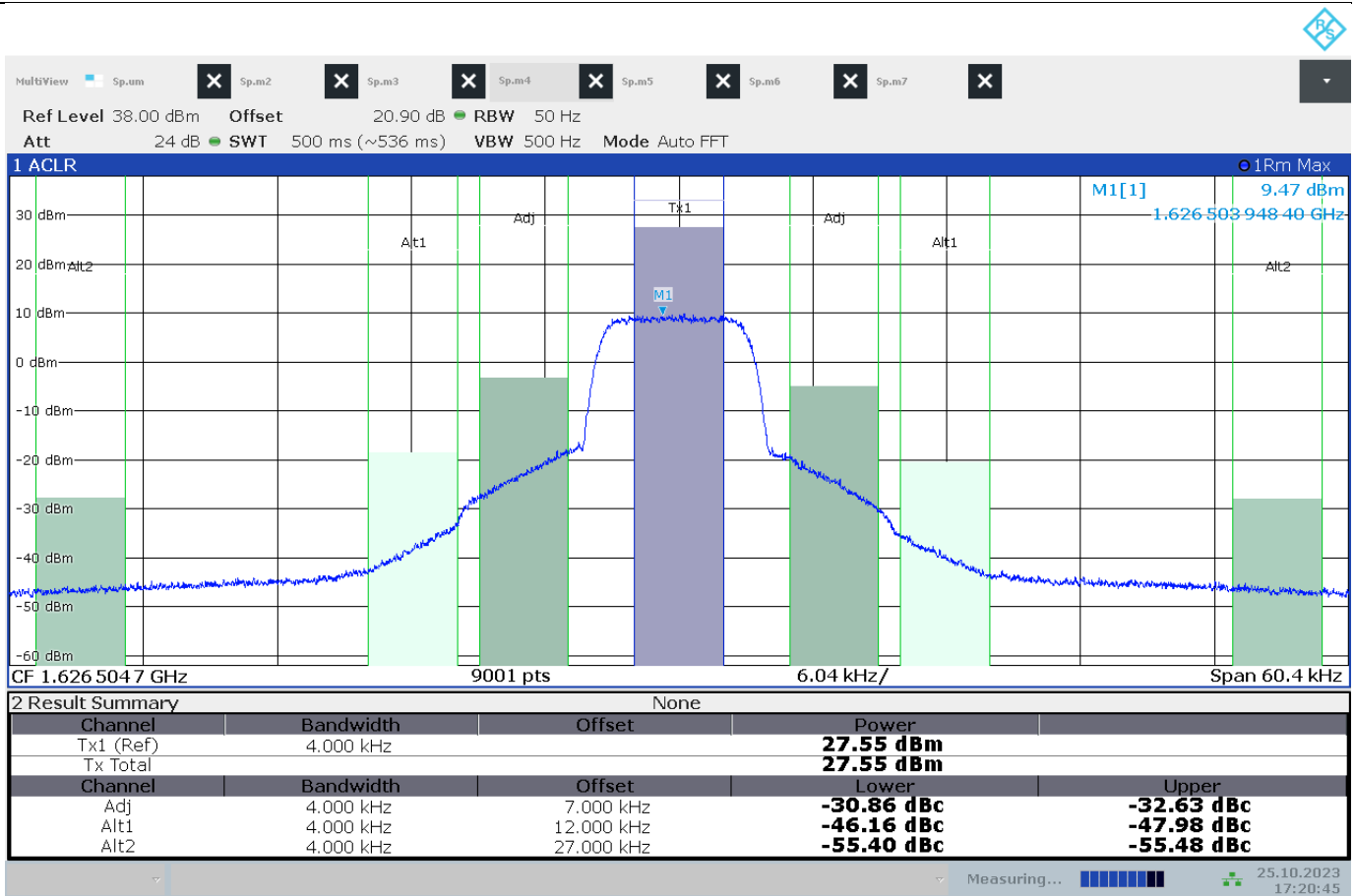
Note: Scaled power = measured power + 10×log (4 kHz/Measurement BW), Limit = scaled mean average power [dBm/4 kHz] – 35 dB



17:14:35 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform T, high channel

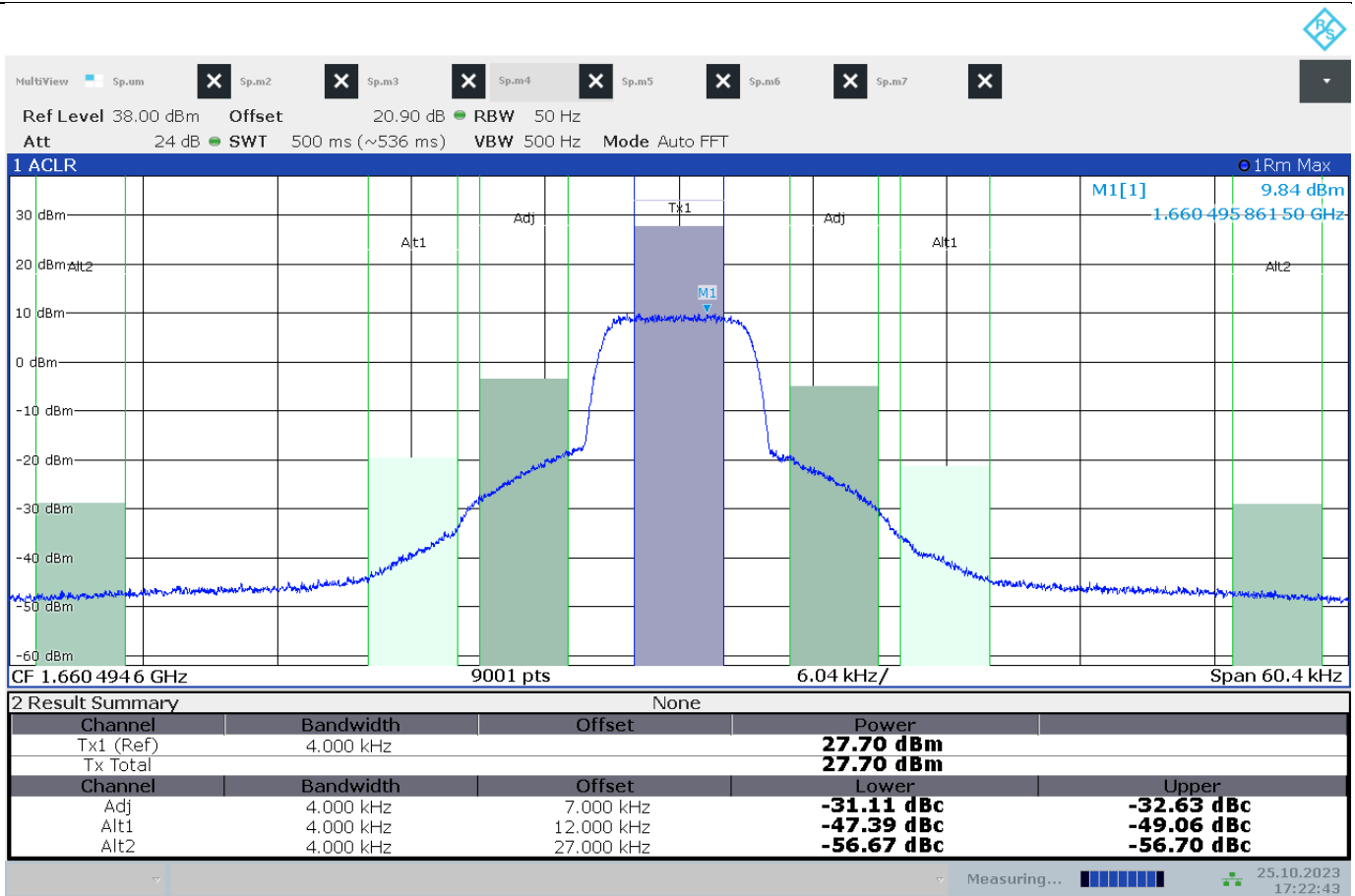
Test data continued



17:20:46 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Y, low channel

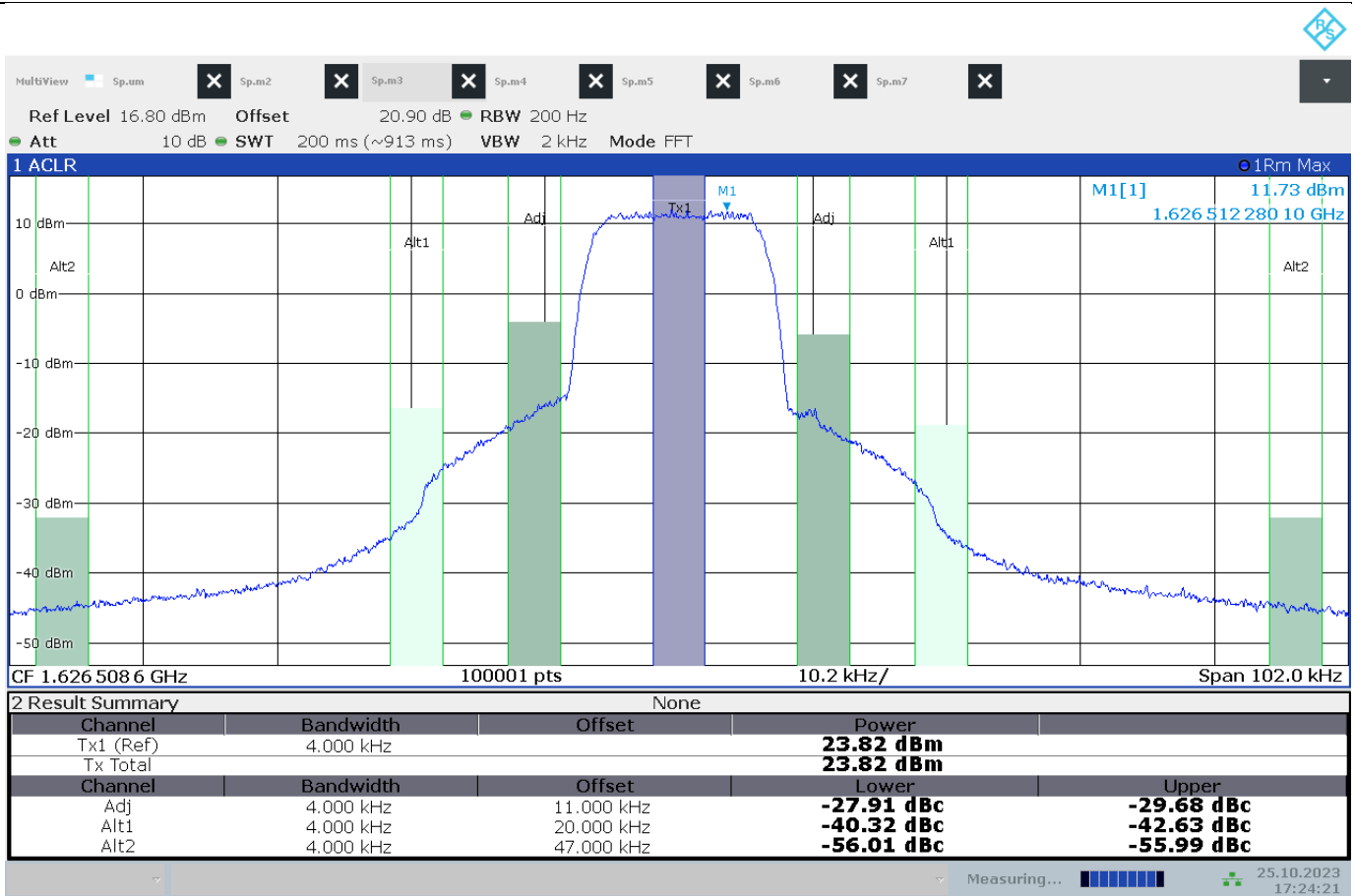
Test data continued



17:22:44 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Y, high channel

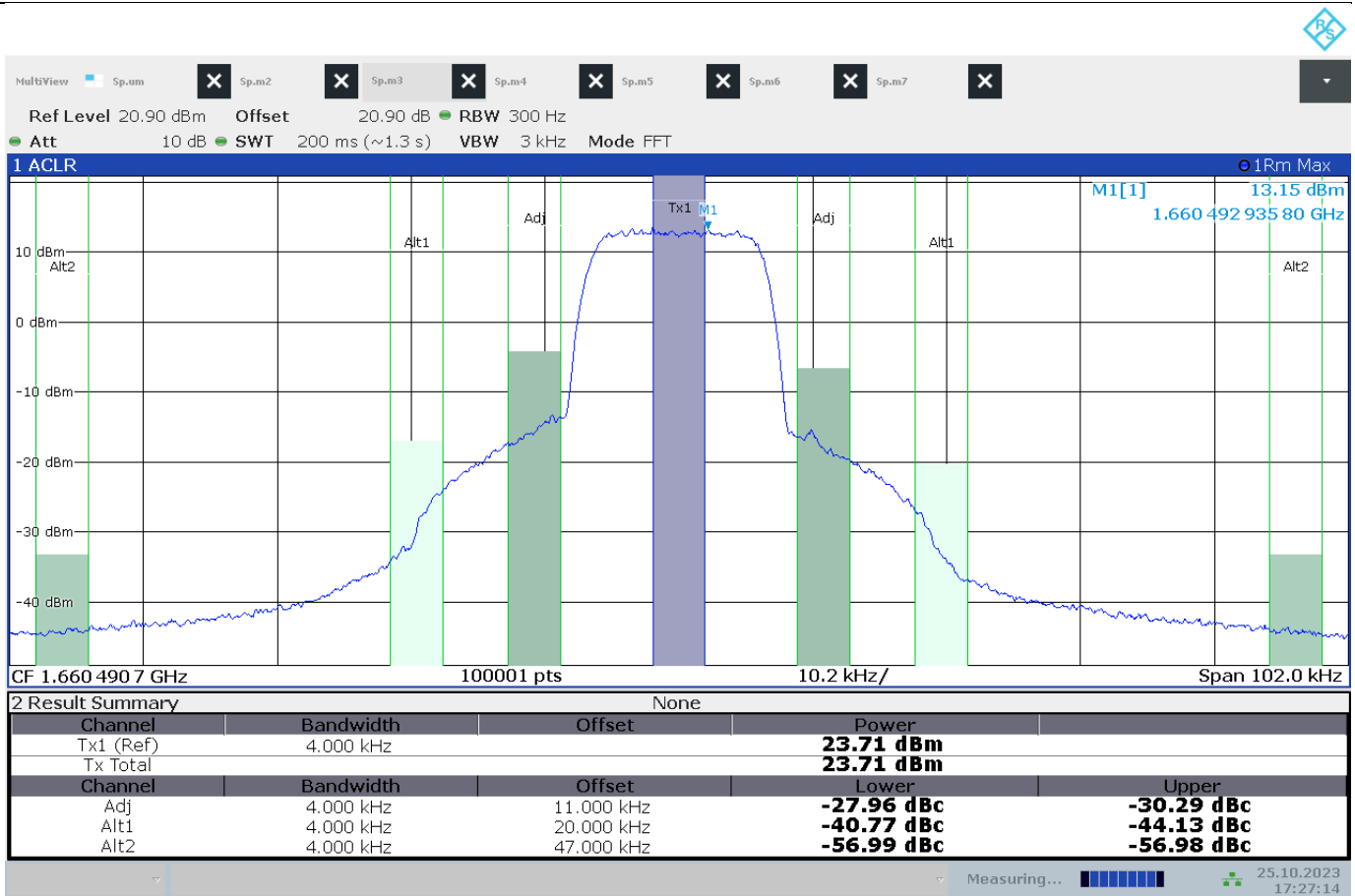
Test data continued



17:24:22 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Z, low channel

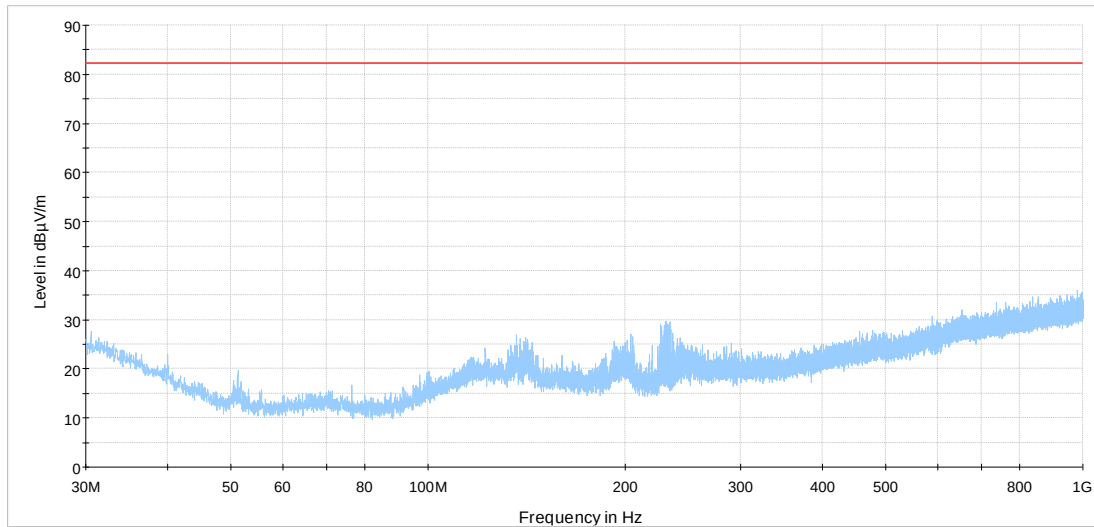
Test data continued



17:27:14 25.10.2023

Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Z, high channel

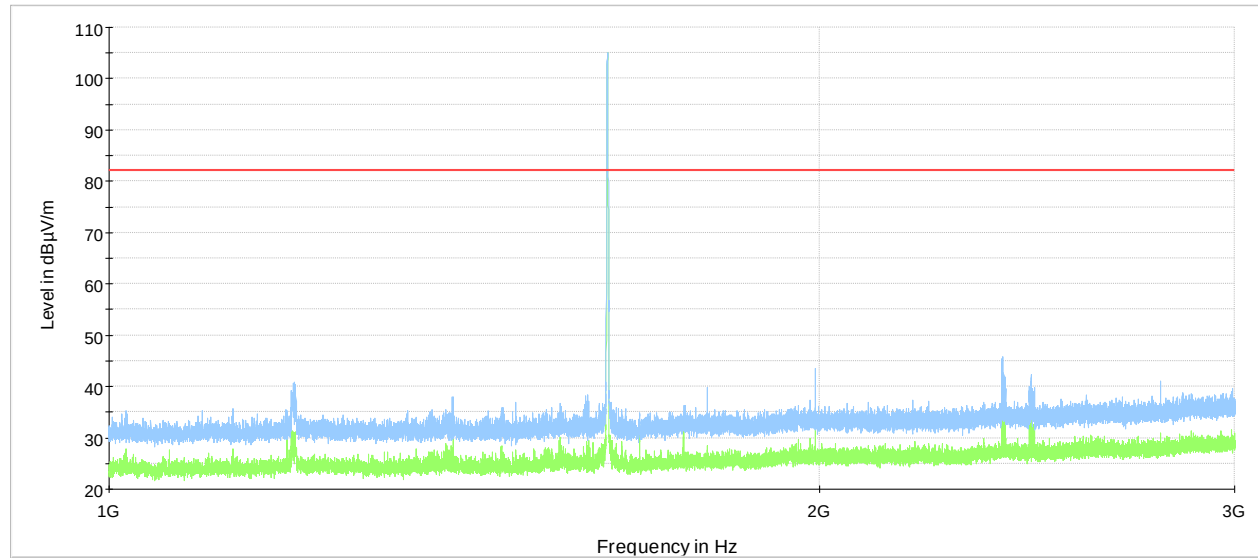
Test data, continued



SPR 30 MHz to 1 GHz low channel

Preview Result 1-PK+
-13dBm theoretical limit

Figure 7.3-1: Radiated spurious emissions below 1 GHz for low channel for waveform J



SPR 1 GHz to 3 GHz low channel

Preview Result 2-AVG
Preview Result 1-PK+
-13dBm theoretical limit

Figure 7.3-2: Radiated spurious emissions 1 – 3 GHz for low channel waveform J

Test data, continued

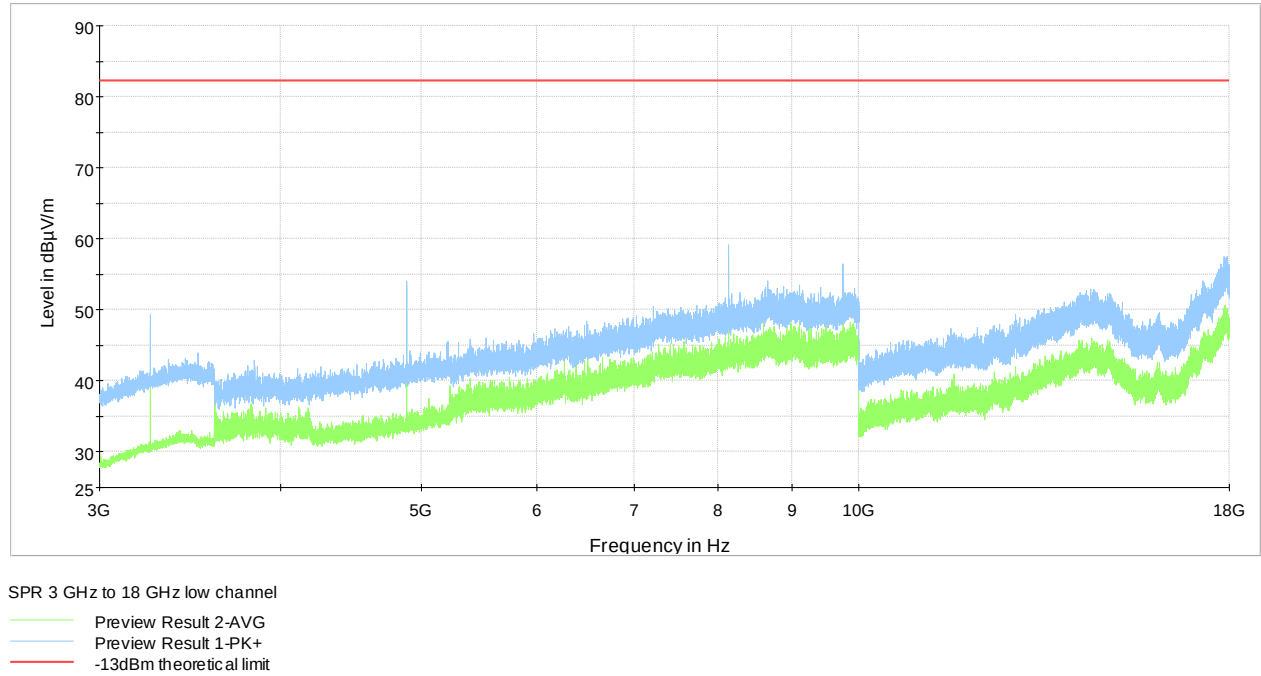


Figure 7.3-3: Radiated spurious emissions 3 – 18 GHz for low channel waveform J

Test data, continued

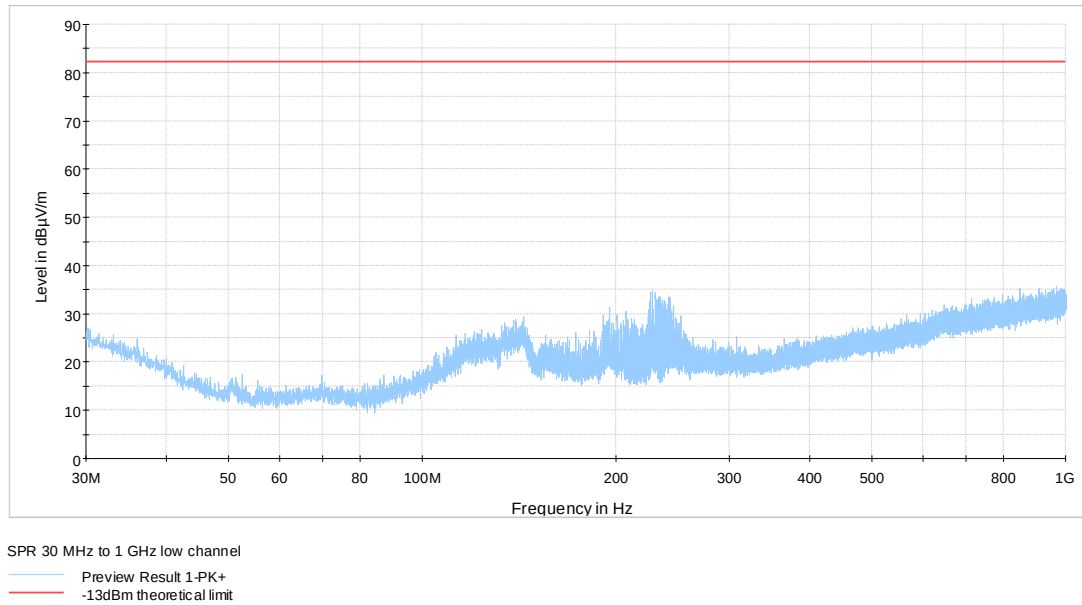


Figure 7.3-4: Radiated spurious emissions below 1 GHz for mid channel for waveform J

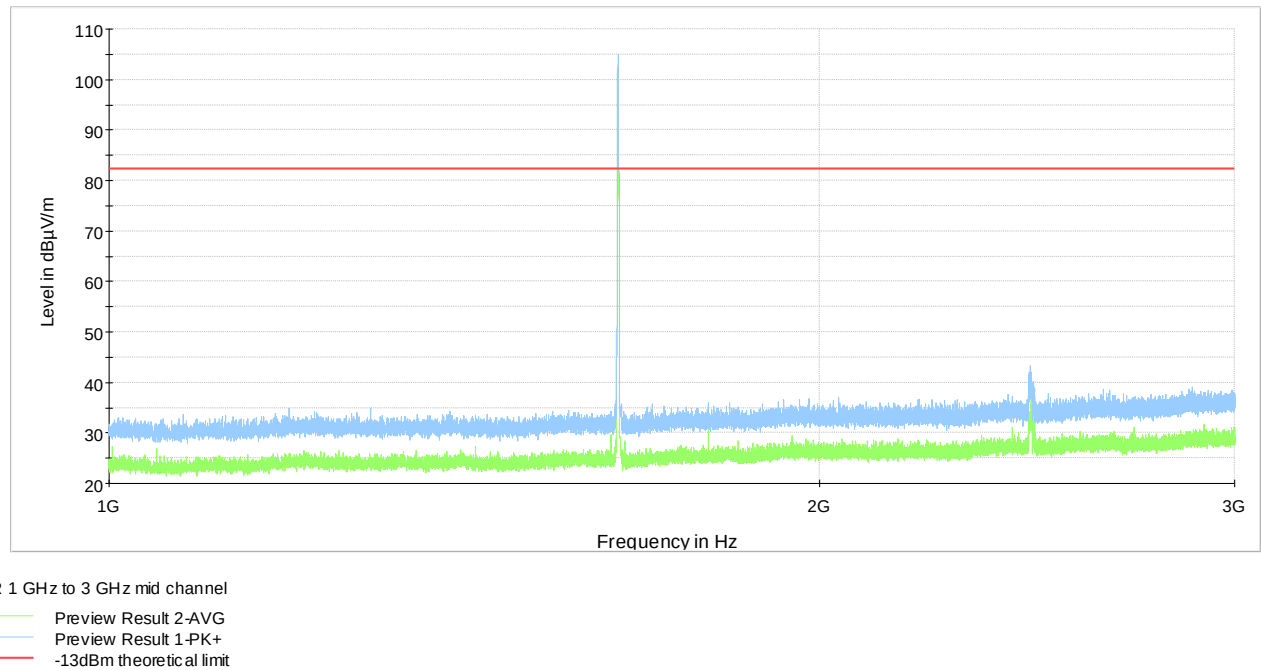
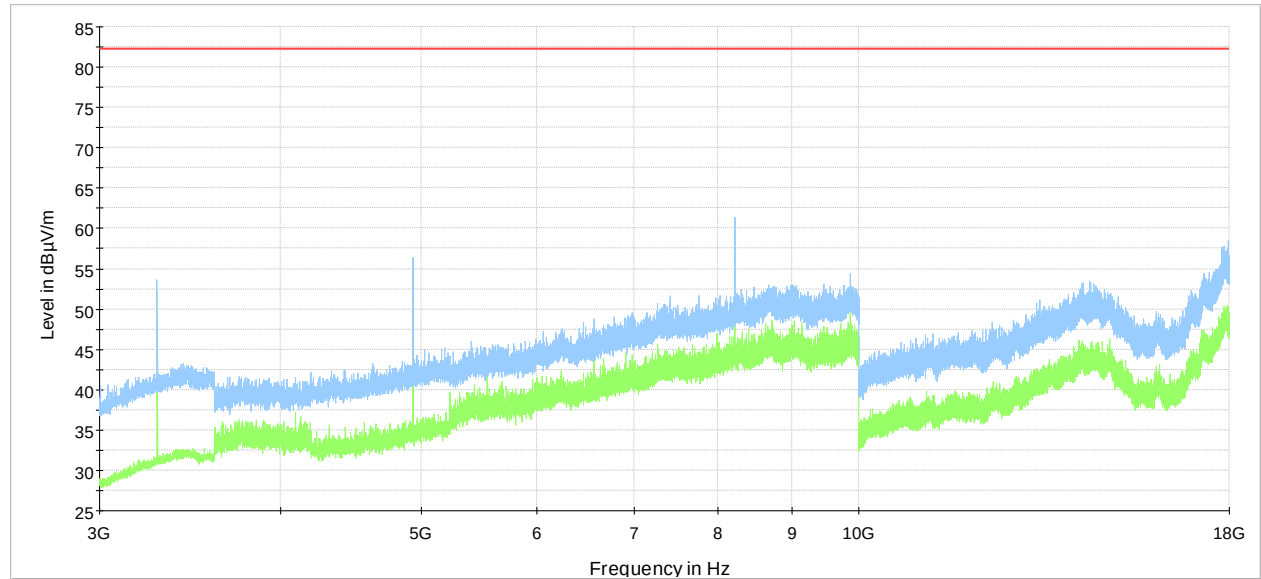


Figure 7.3-5: Radiated spurious emissions 1 – 3 GHz for mid channel waveform J

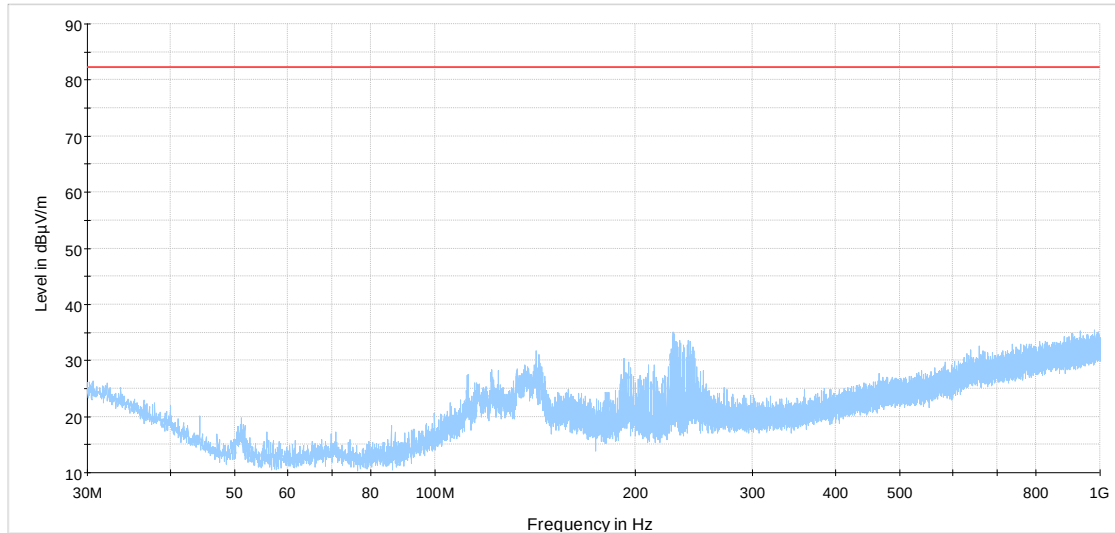
Test data, continued



SPR 3 GHz to 18 GHz mid channel
 — Preview Result 2-AVG
 — Preview Result 1-PK+
 — -13dBm theoretical limit

Figure 7.3-6: Radiated spurious emissions 3 – 18 GHz for mid channel waveform J

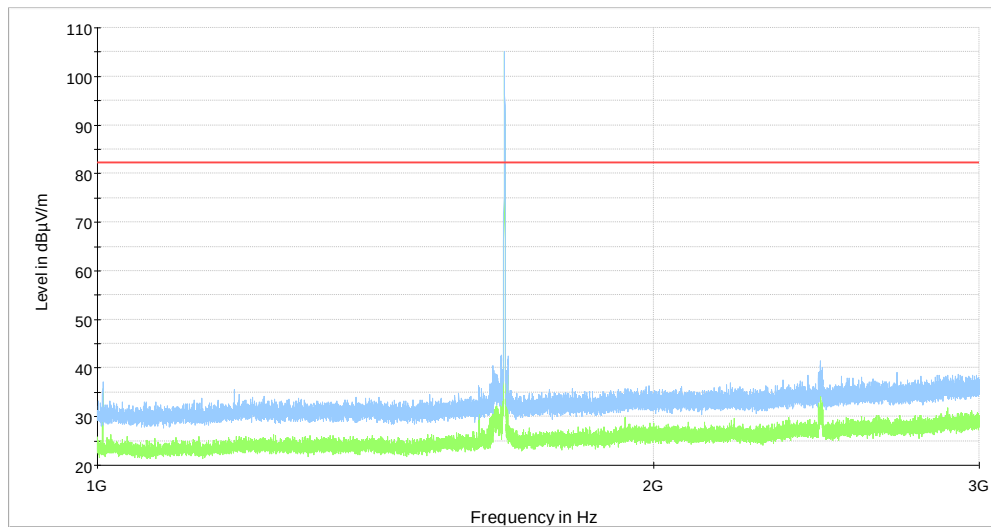
Test data, continued



SPR 30 MHz to 1 GHz high channel

— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-7: Radiated spurious emissions below 1 GHz for high channel for waveform J



SPR 1 GHz to 3 GHz high channel

— Preview Result 2-AVG
— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-8: Radiated spurious emissions 1 – 3 GHz for high channel waveform J

Test data, continued

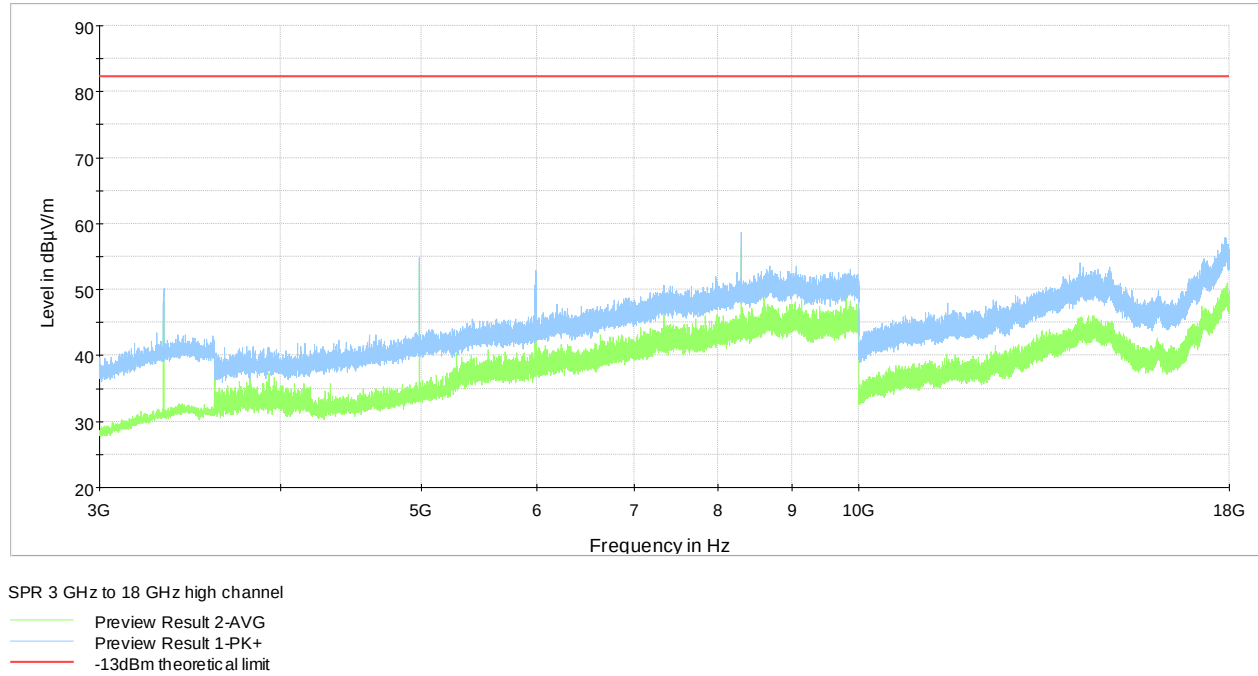
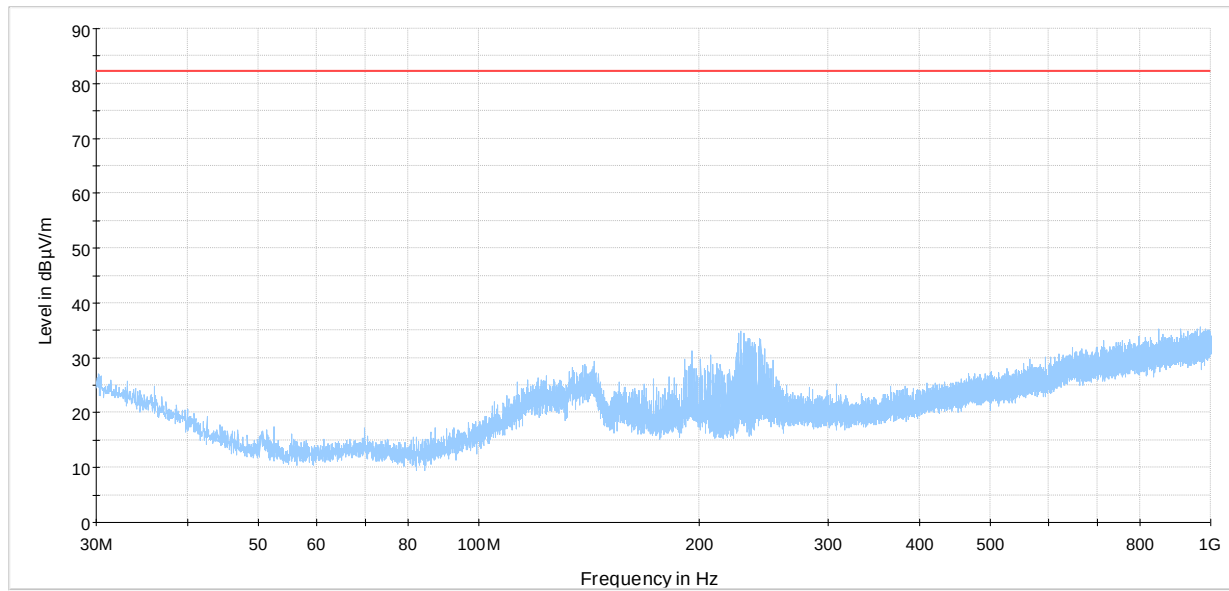


Figure 7.3-9: Radiated spurious emissions 3 – 18 GHz for high channel waveform J

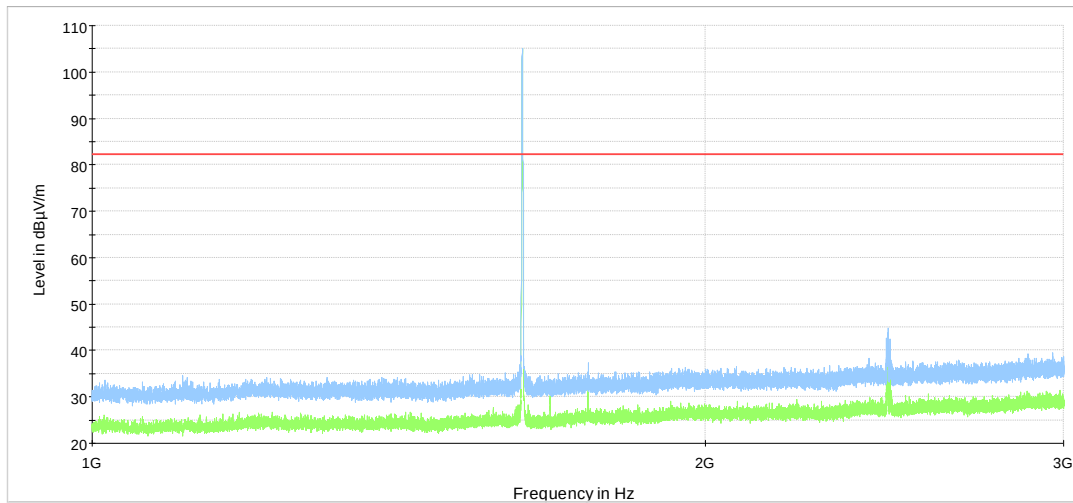
Test data, continued



SPR 30 MHz to 1 GHz low channel

— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-10: Radiated spurious emissions below 1 GHz for low channel for waveform K



SPR 1 GHz to 3 GHz low channel

— Preview Result 2-AVG
— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-11: Radiated spurious emissions 1 – 3 GHz for low channel waveform K

Test data, continued

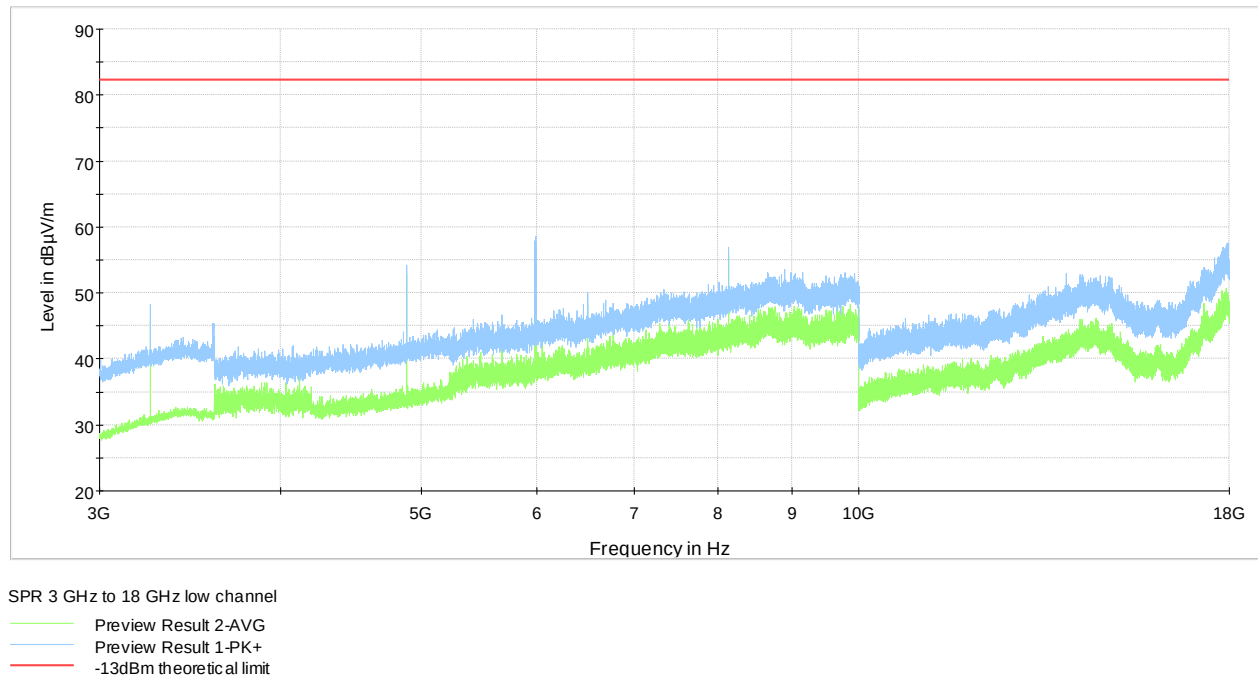
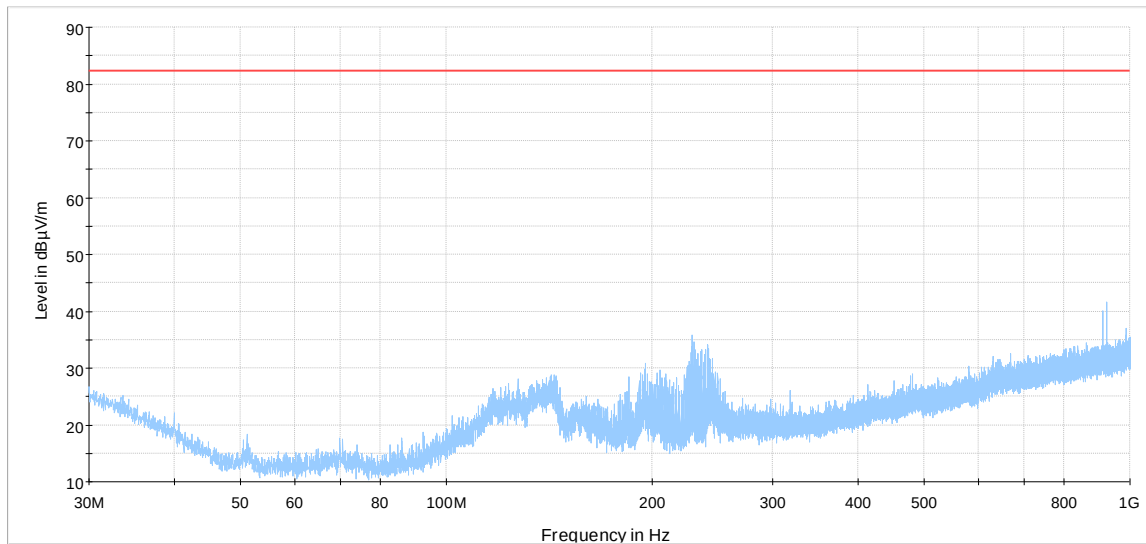


Figure 7.3-12: Radiated spurious emissions 3 – 18 GHz for low channel waveform K

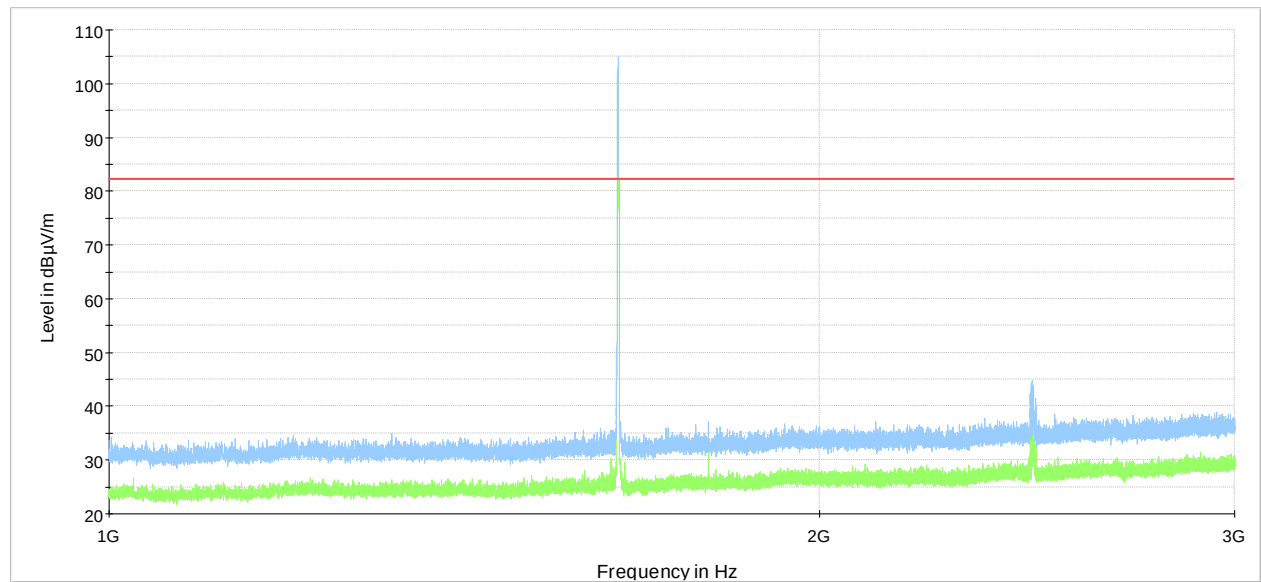
Test data, continued



SPR 30 MHz to 1 GHz mid channel

— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-13: Radiated spurious emissions below 1 GHz for mid channel for waveform K



SPR 1 GHz to 3 GHz mid channel

— Preview Result 2-AVG
— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-14: Radiated spurious emissions 1 – 3 GHz for mid channel waveform K

Test data, continued

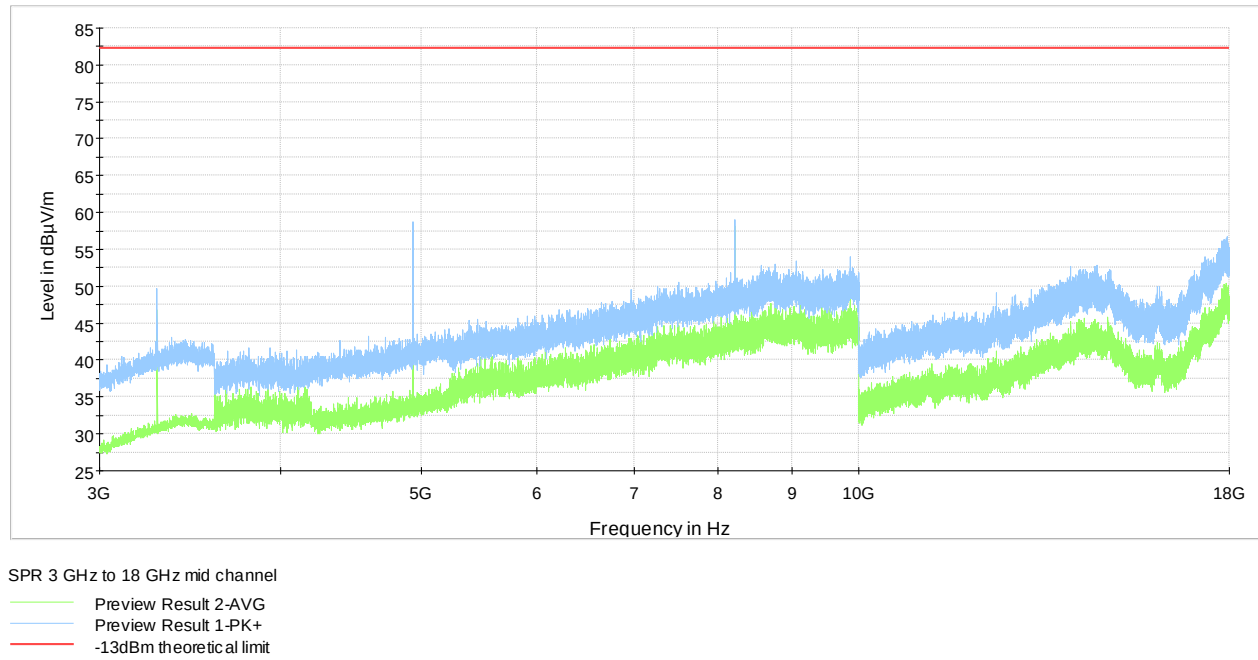
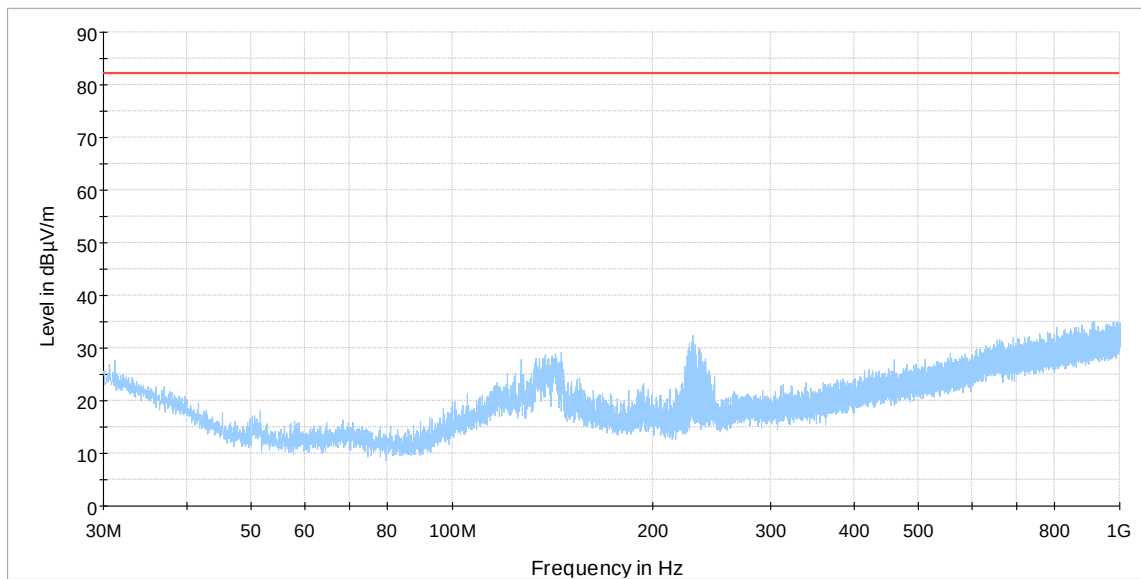


Figure 7.3-15: Radiated spurious emissions 3 – 18 GHz for mid channel waveform K

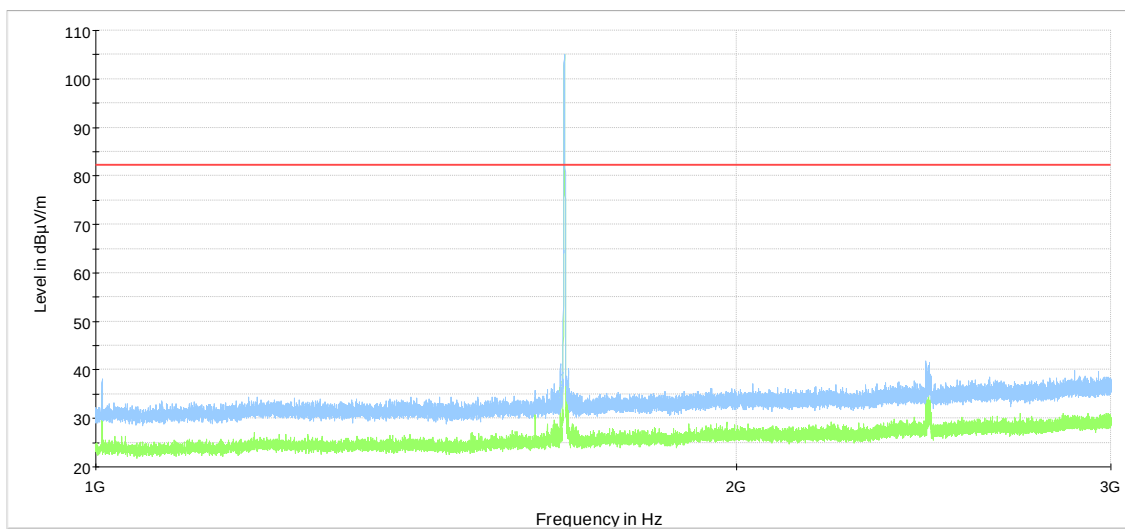
Test data, continued



SPR 30 MHz to 1 GHz high channel

— Preview Result 1-PK+
 — -13dBm theoretical limit

Figure 7.3-16: Radiated spurious emissions below 1 GHz for high channel for waveform *K*

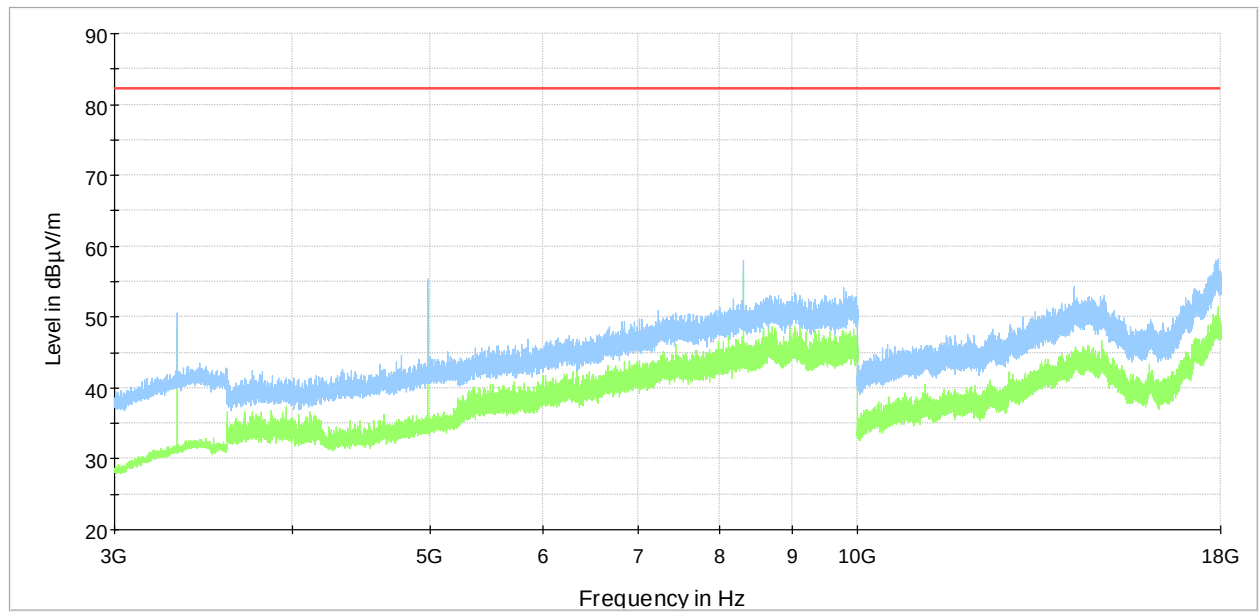


SPR 1 GHz to 3 GHz high channel

— Preview Result 2-AVG
 — Preview Result 1-PK+
 — -13dBm theoretical limit

Figure 7.3-17: Radiated spurious emissions 1 – 3 GHz for high channel waveform *K*

Test data, continued

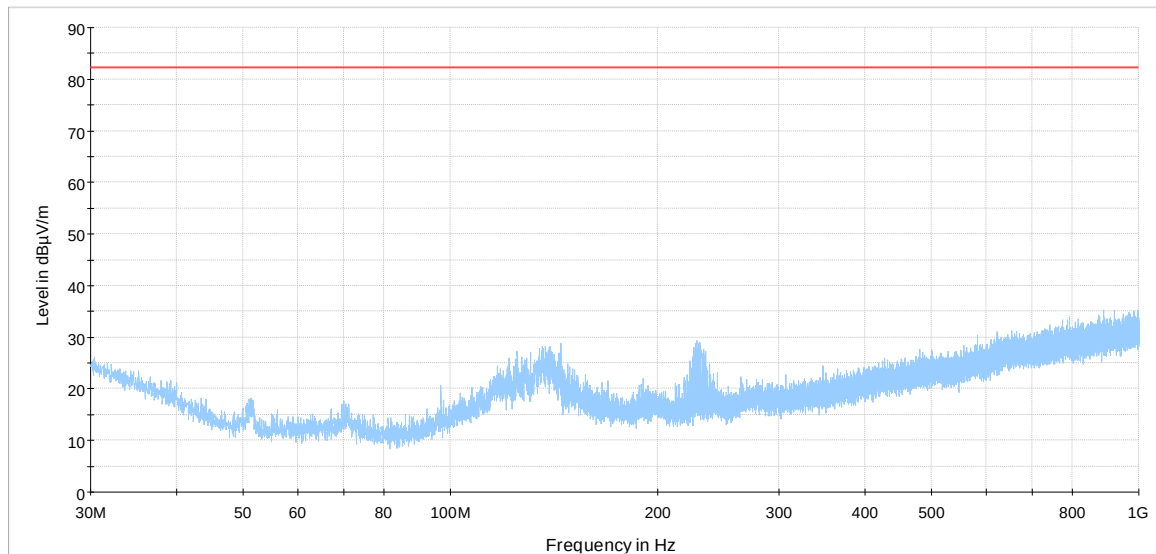


SPR 3 GHz to 18 GHz high channel

- Preview Result 2-AVG
- Preview Result 1-PK+
- -13dBm theoretical limit

Figure 7.3-18: Radiated spurious emissions 3 – 18 GHz for high channel waveform *K*

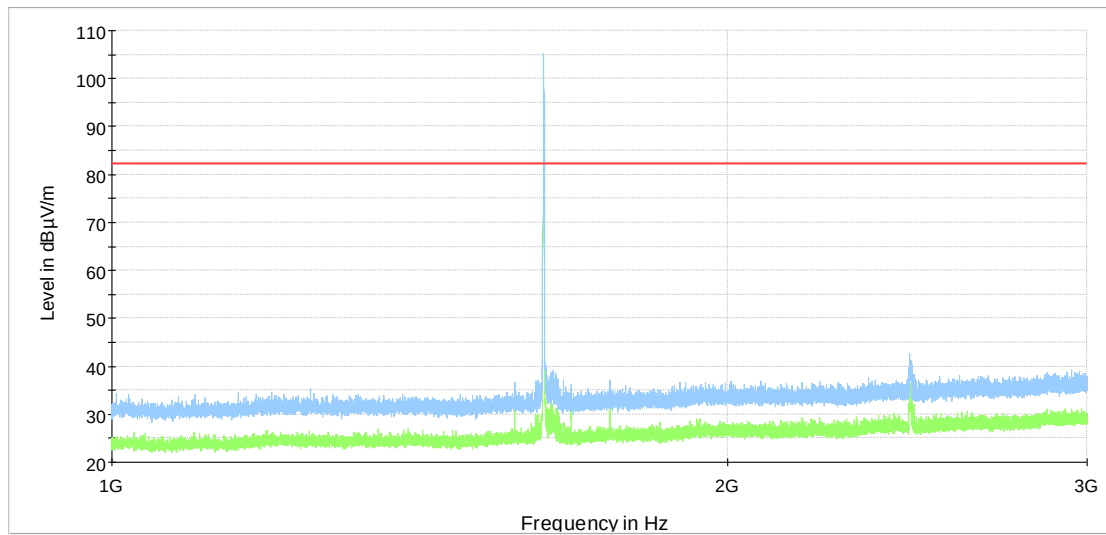
Test data, continued



SPR 30 MHz to 1 GHz low channel

— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-19: Radiated spurious emissions below 1 GHz for low channel for waveform *T*



SPR 1 GHz to 3 GHz low channel

— Preview Result 2-AVG
— Preview Result 1-PK+
— -13dBm theoretical limit

Figure 7.3-20: Radiated spurious emissions 1 – 3 GHz for low channel waveform *T*

Test data, continued

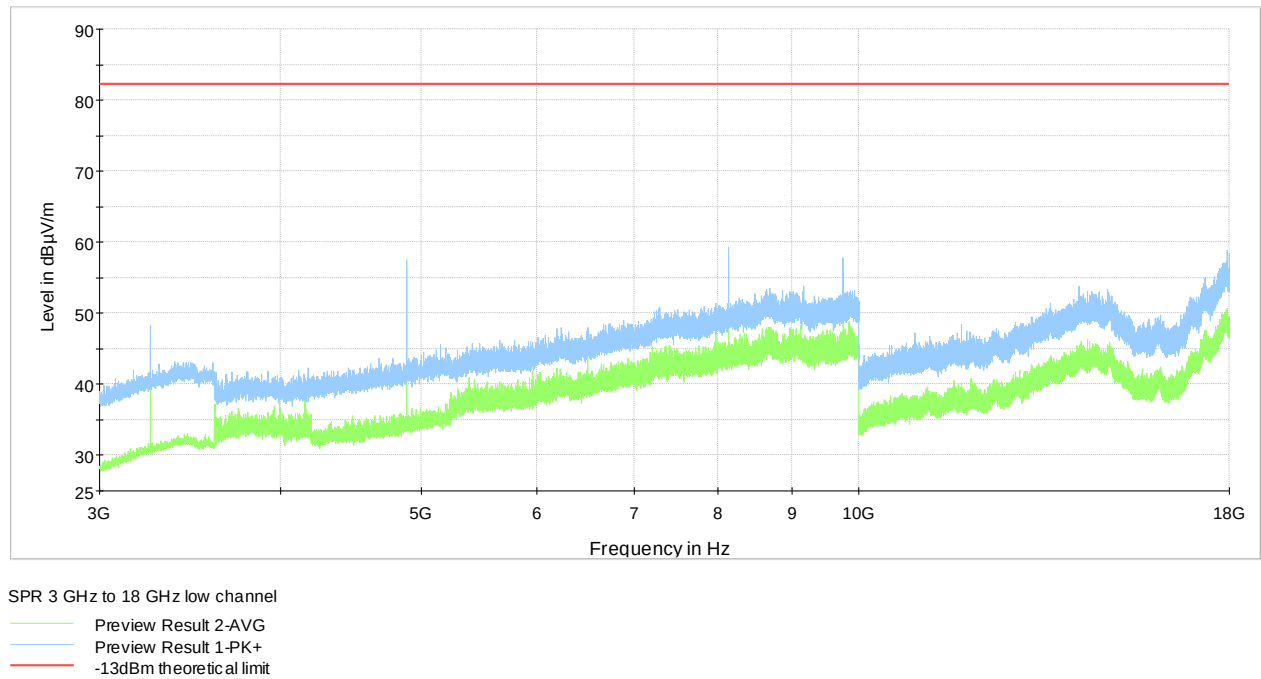
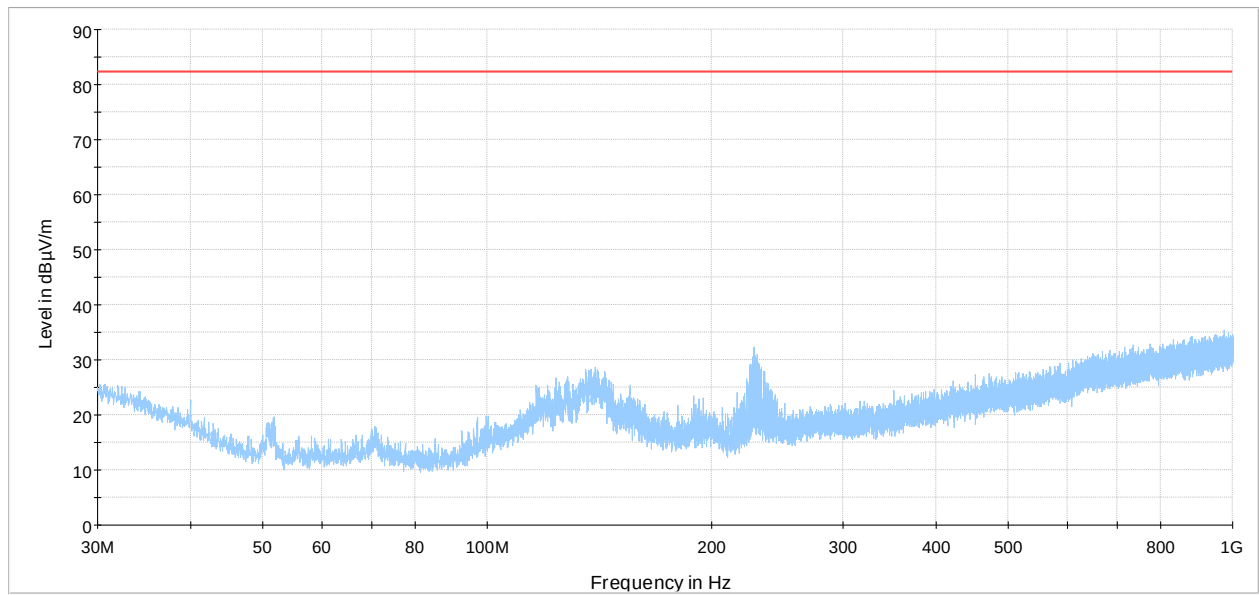


Figure 7.3-21: Radiated spurious emissions 3 – 18 GHz for low channel waveform T

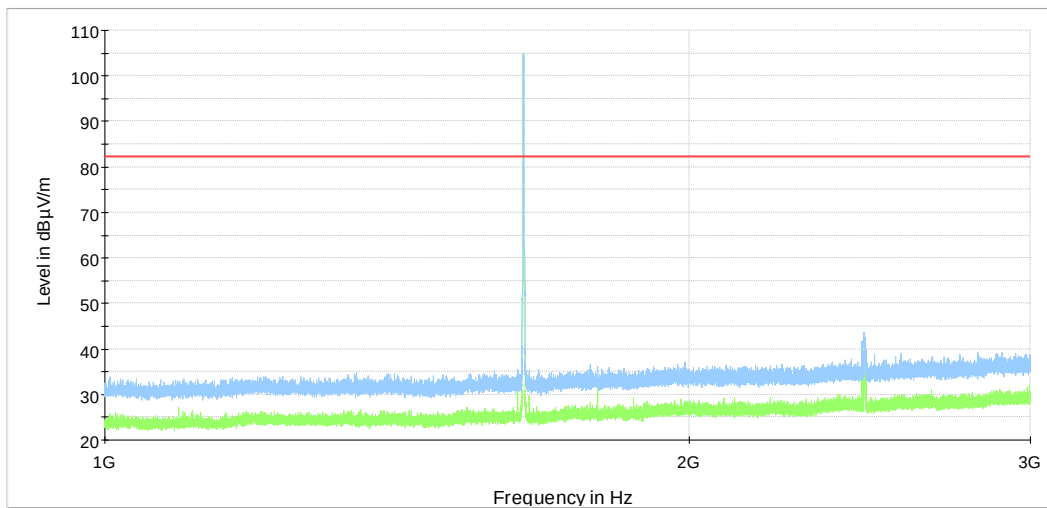
Test data, continued



SPR 30 MHz to 1 GHz mid channel

— Preview Result 1-PK+
 — -13dBm theoretical limit

Figure 7.3-22: Radiated spurious emissions below 1 GHz for mid channel for waveform *T*

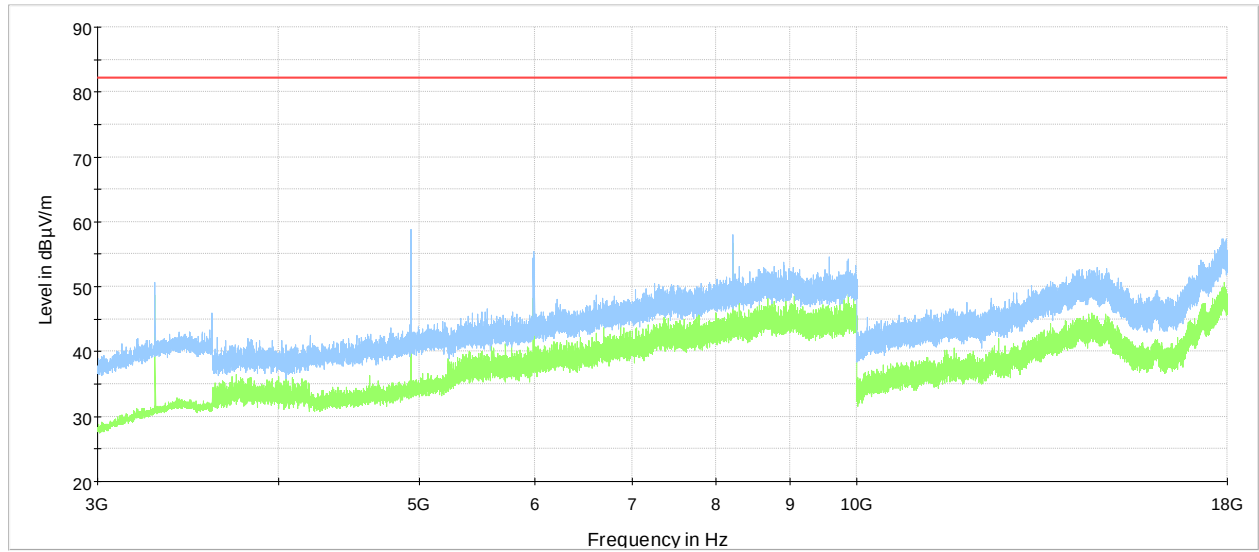


SPR 1 GHz to 3 GHz mid channel

— Preview Result 2-AVG
 — Preview Result 1-PK+
 — -13dBm theoretical limit

Figure 7.3-23: Radiated spurious emissions 1 – 3 GHz for mid channel waveform *T*

Test data, continued



SPR 3 GHz to 18 GHz mid channel
 Preview Result 2-AVG
 Preview Result 1-PK+
 -13dBm theoretical limit

Figure 7.3-24: Radiated spurious emissions 3 – 18 GHz for mid channel waveform T