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RADIO TEST REPORT

Report ID:
REP015465

Project number:
PRJ0040765

Type of assessment:
Final product testing

Applicant:
ORBCOMM License Corp. (ORBCOMM Inc.)

Product:
ST2102 MSES Terminal

Model:
ST2102

Model variant(s):
ST2102-P2X, ST2102-V2X, ST2102-PXX

FCC identifier:
FCC ID: XGS-ST2102

ISED certification number:
IC: 11881A-ST2102

Specification:

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

Date of issue: October 25, 2023

Hossein Zamani Zardehsavari, EMC/RF Specialiste
Tested by

Signature

Alvin Liu, EMC/RF Specialist
Reviewed by

Signature

Lab and test locations

Company name	Nemko Canada Inc.			
Facilities	*Ottawa site:* 303 River Road Ottawa, Ontario Canada K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691	*Montréal site:* 292 Labrosse Avenue Pointe-Claire, Québec Canada H9R 5L8 Tel: +1 514 694 2684 Fax: +1 514 694 3528	*Cambridge site:* 1-130 Saltsman Drive Cambridge, Ontario Canada N3E 0B2 Tel: +1 519 650 4811	*Almonte site:* 1500 Peter Robinson Road West Carleton, Ontario Canada K0A 1L0 Tel: +1 613 256-9117
Test site identifier	**Organization**	**Ottawa/Almonte**	**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.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Test specifications

FCC 47 CFR Part 25	Mobile Satellite Earth Station Terminal
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 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.4 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.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
REP015465	October 25, 2023	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 ST2102 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:

- ST2102-P2X is with internal sup-cap as internal back-up power source.
- ST2102-PXX is without sup-cap.
- ST2102-V2X is with internal sup-cap and customed main connector, and customer brand label.

Other than the difference described in the above, all are identical between three variants

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3. Test conditions

3.1 Atmospheric conditions

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

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

3.2 Power supply range

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

Section 4. 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 description	Communication module
Model / HVIN	ST2102
Serial number	01724830SKYFE53
Part number	ST2102-P2XREVA
Power supply requirements	DC: 9-32 V
Product description and theory of operation	The device consists of a mobile satellite earth station module and a GNSS module. The device is used for tracking and monitoring industrial equipment and assets.

4.4 Radio technical information

Frequency band	1626.5–1660.5
Frequency Min	1626.501 MHz
Frequency Max	1660.499 MHz
RF power Max (W), Conducted	1.74 W (32.40 dBm)
Field strength, dBµV/m @ 3 m	N/A
Measured BW (kHz), 99% OBW	15.11
Type of modulation	OQPSK, 800 to 12800 symbol/second
Emission classification (F1D, G1D, D1D)	G1D
Antenna information	5.6 dBi internal antenna
Stated EIRP	37 dBm

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.
8 pin connector	1

Table 4.5-2: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	HP	MN: 15t-da000, SN: CND9124PJ7

Table 4.5-3: *Inter-connection cables*

Cable description	From	To	Length (m)
8 pin connector	EUT	Serial/USB adaptor	1
USB cable	Serial/USB adaptor	Laptop	1

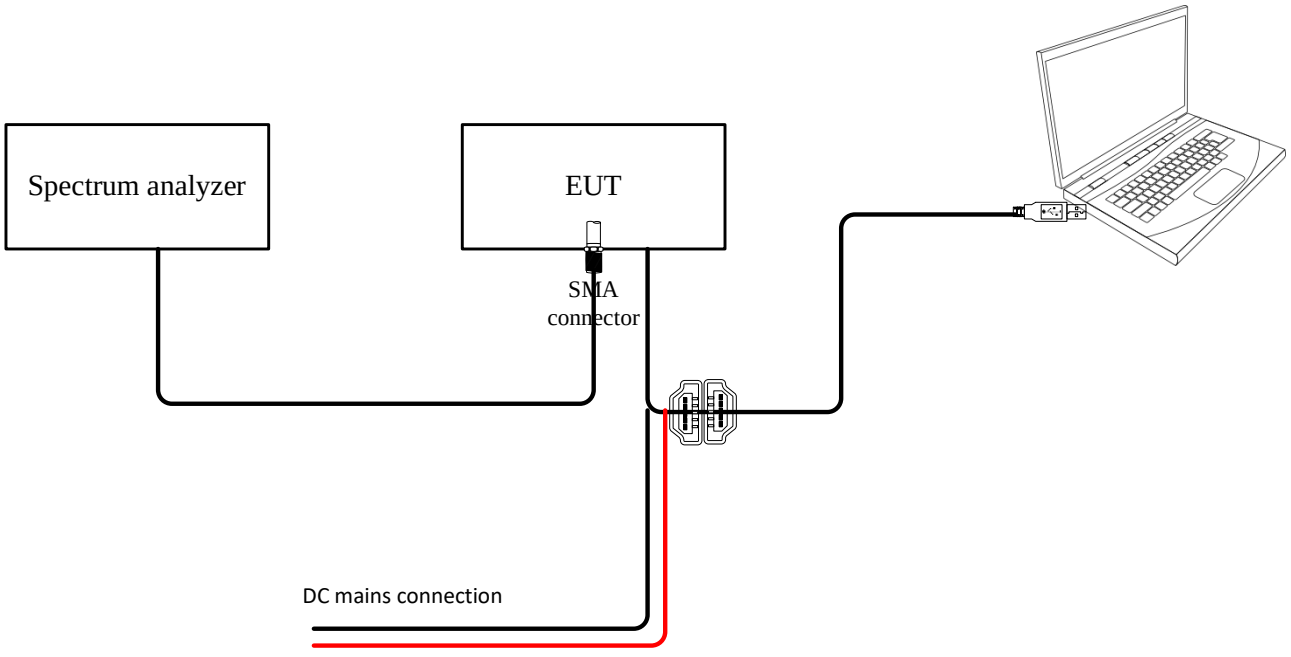


Figure 4.5-1: *Block diagram*

Section 5. Summary of test results

5.1 Testing period

Test start date	August 24, 2023	Test end date	October 20, 2023

5.2 Sample information

Receipt date	August 21, 2023	Nemko sample ID number(s)	PRJ0040750001

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
[2] The Antennas are located within the enclosure of EUT and not user accessible.

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: [1]EUT does not have standalone receiver.
[2]EUT 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
5.4	Transmitter output power for ATC equipment	Pass
5.5	Transmitter output power for mobile earth stations (MESs)	Pass
5.7	Unwanted emission limits for ATC mobile equipment	
5.7.1	Transmitter unwanted emissions for ATC Mobile Equipment within 1610–1626.5 MHz band	Not applicable
5.7.2	Transmitter unwanted emissions for ATC Mobile Equipment within 1626.5–1660.5 MHz band	Pass
5.7.3	Transmitter unwanted emissions for ATC Mobile Equipment within 2483.5-2495 MHz band	Not applicable
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
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	U_{cispr} dB	U_{lab} dB
Radiated disturbance (30 MHz to 1 GHz)	6.3	5.8
Radiated disturbance (1 GHz to 6 GHz)	5.2	4.7
Radiated disturbance (6 GHz to 18 GHz)	5.5	4.7

Notes: Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty. The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Compliance assessment:

If U_{lab} is less than or equal to U_{cispr} then:

- compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit

If U_{lab} is greater than U_{cispr} then:

- compliance is deemed to occur if no measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit
- non-compliance is deemed to occur if any measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit

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 20, 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	1.085
1643.500000	1.087
1660.498375	1.061

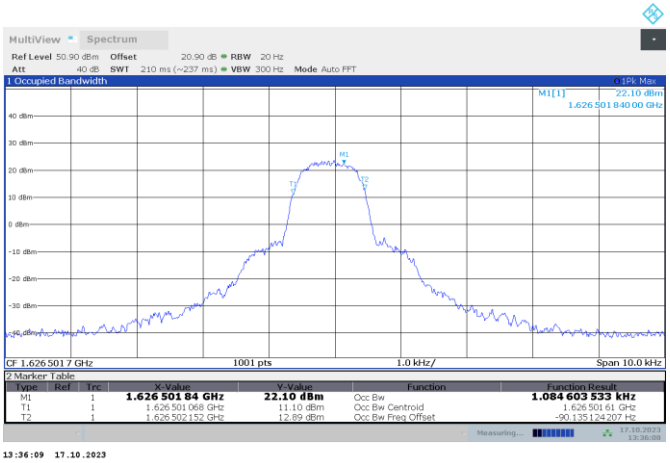


Figure 7.1-1: *99 % bandwidth on low channel for waveform **J***

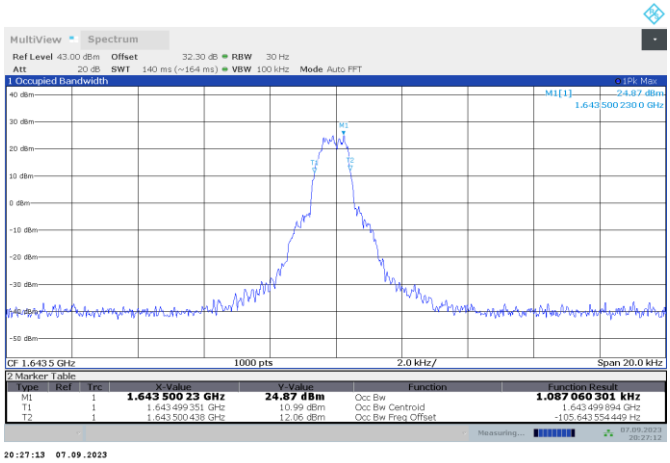


Figure 7.1-2: *99 % bandwidth on mid channel for waveform **J***

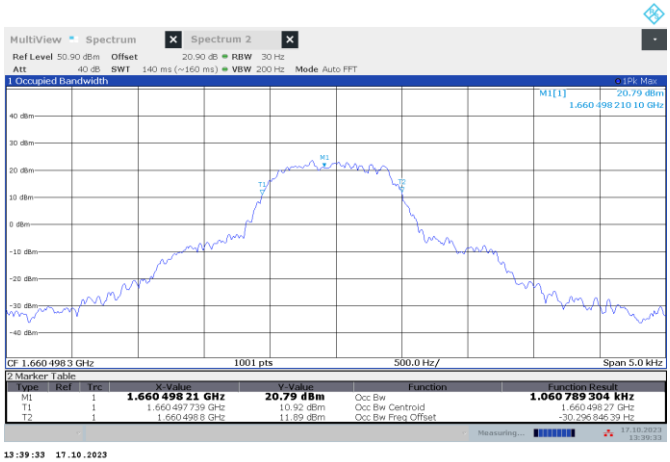


Figure 7.1-3: *99 % bandwidth on high channel for waveform **J***

Test data, continued

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

Frequency, MHz	26 dB bandwidth, kHz
1626.501625	1.33
1643.500000	1.40
1660.498375	1.34

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

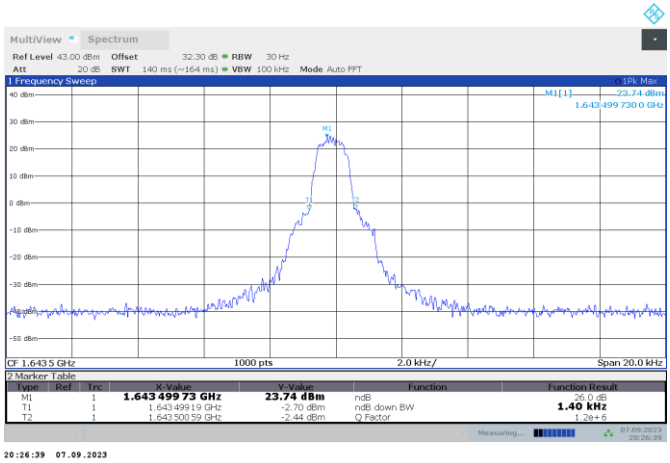


Figure 7.1-5: *26 dB bandwidth on mid channel for waveform **J***

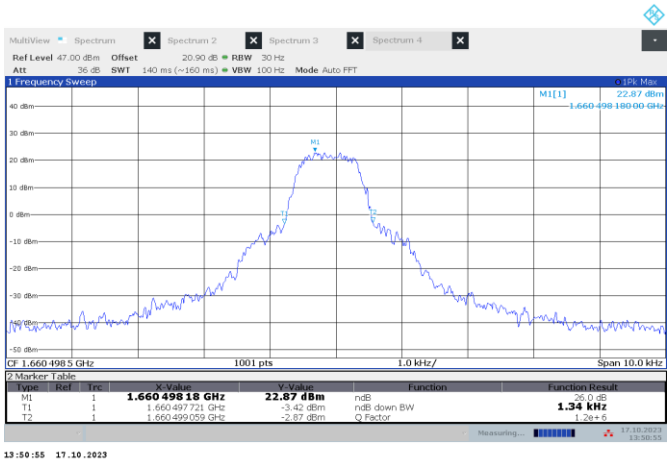


Figure 7.1-6: *26 dB bandwidth on high channel for waveform **J***

Test data, continued

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

Frequency, MHz	99 % occupied bandwidth, kHz
1626.502000	1.858
1643.500000	1.938
1660.498000	1.887

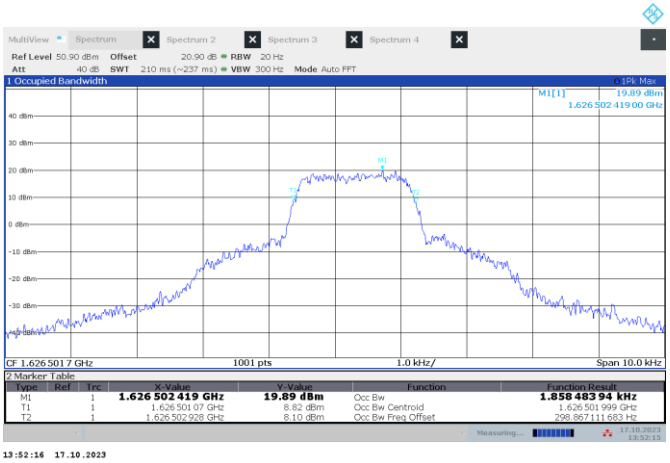


Figure 7.1-7: *99 % bandwidth on low channel for waveform* ***K***

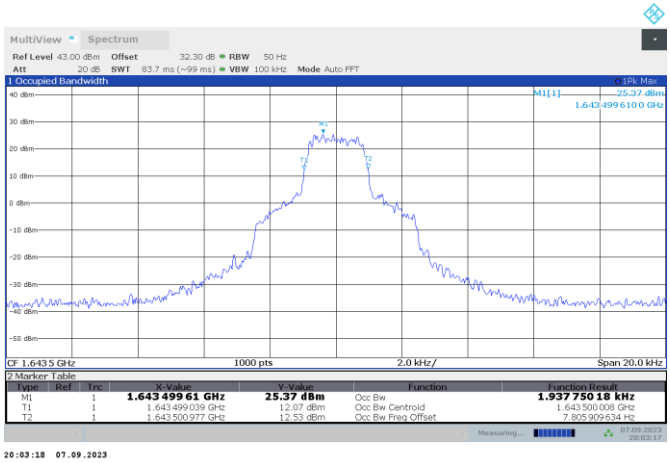


Figure 7.1-8: *99 % bandwidth on mid channel for waveform* ***K***

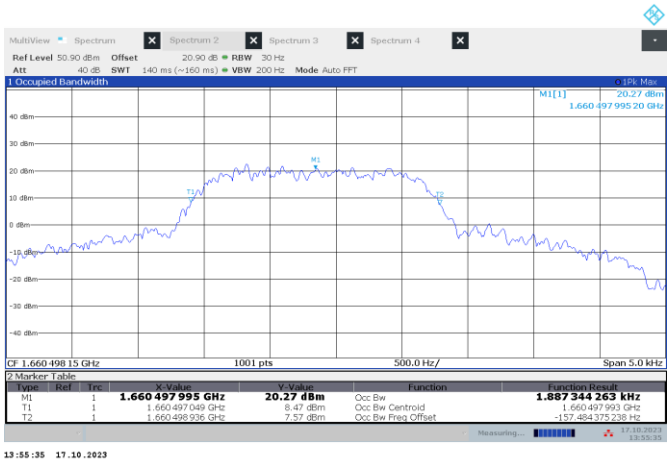


Figure 7.1-9: *99 % bandwidth on high channel for waveform* ***K***

Test data, continued

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

Frequency, MHz	26 dB bandwidth, kHz
1626.502000	2.18
1643.500000	2.94
1660.498000	2.40

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

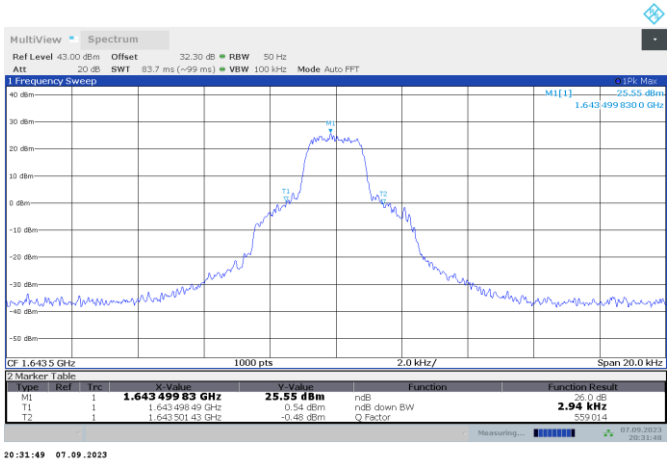


Figure 7.1-11: *26 dB bandwidth on mid channel for waveform* ***K***

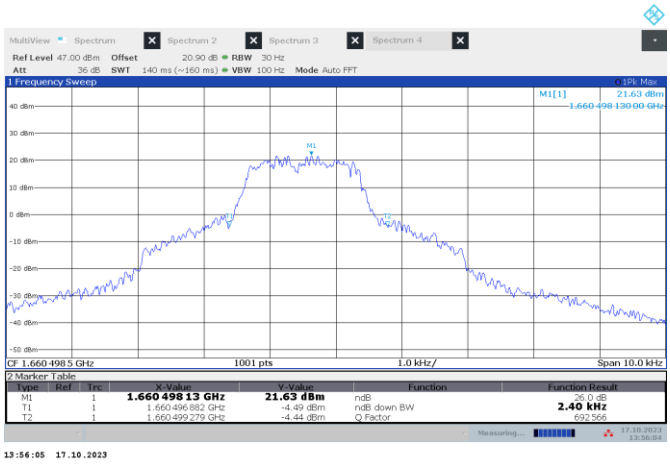


Figure 7.1-12: *26 dB bandwidth on high channel for waveform* ***K***

Test data, continued

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

Frequency, MHz	99 % occupied bandwidth, kHz
1626.503000	3.663
1643.500000	3.850
1660.497000	3.728

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

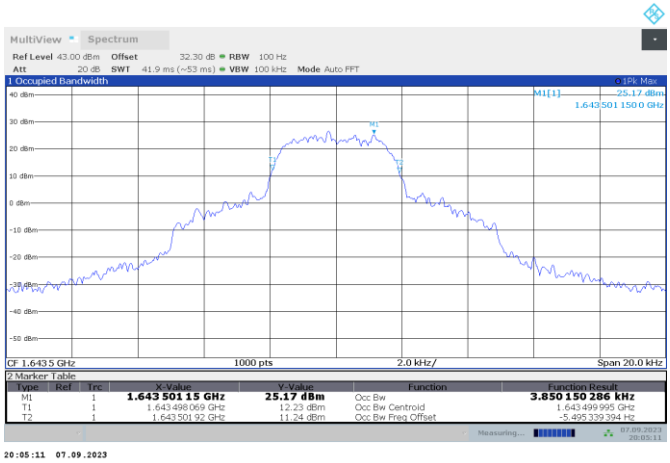


Figure 7.1-14: *99 % bandwidth on mid channel for waveform* ***T***

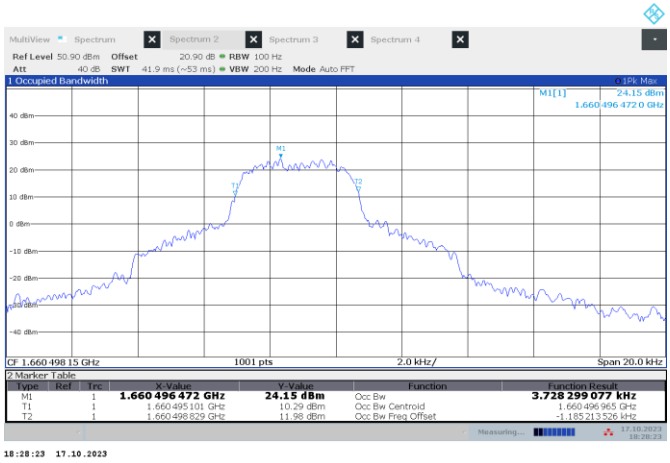


Figure 7.1-15: *99 % bandwidth on high channel for waveform* ***T***

Test data, continued

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

Frequency, MHz	26 dB bandwidth, kHz
1626.503000	5.46
1643.500000	5.86
1660.497000	5.46

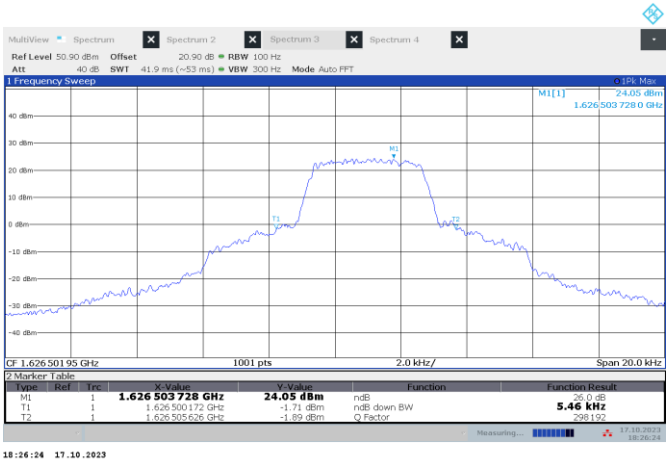


Figure 7.1-16: *26 dB bandwidth on low channel for waveform* ***T***

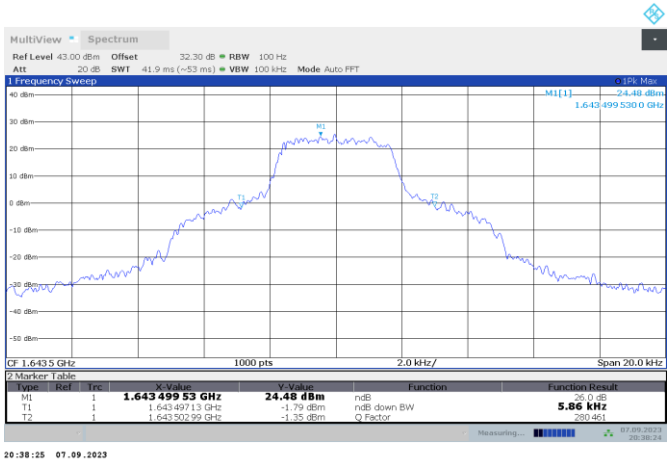


Figure 7.1-17: *26 dB bandwidth on mid channel for waveform* ***T***

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	7.467
1643.500000	7.760
1660.495000	7.630

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

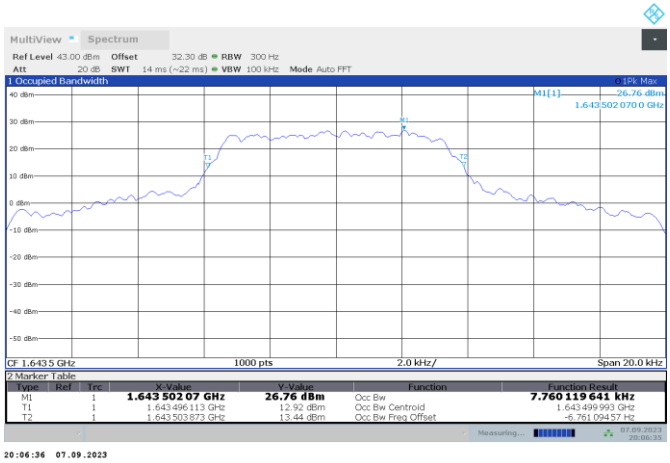


Figure 7.1-20: *99 % bandwidth on mid channel for waveform* ***Y***

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	9.01
1643.500000	9.63
1660.495000	8.90

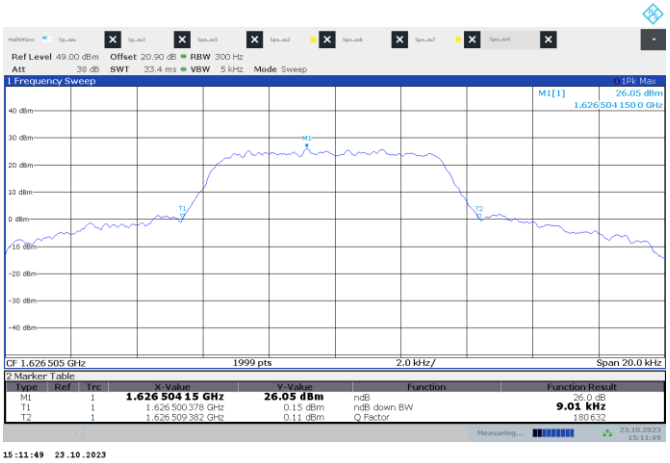


Figure 7.1-22: *26 dB bandwidth on low channel for waveform* ***Y***

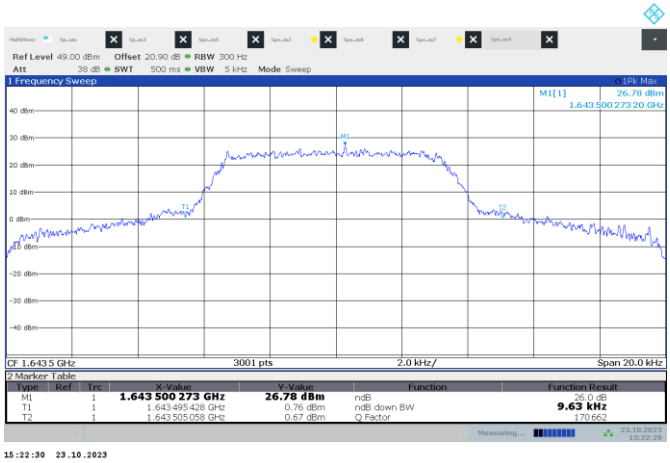


Figure 7.1-23: *26 dB bandwidth on mid channel for waveform* ***Y***

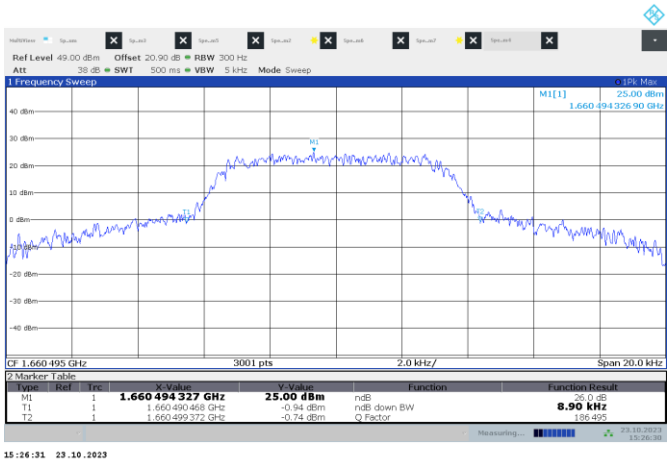


Figure 7.1-24: *26 dB bandwidth on high channel for waveform* ***Y***

Test data, continued

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

Frequency, MHz	99 % occupied bandwidth, kHz
1626.509000	14.780
1643.500000	14.833
1660.492000	15.108

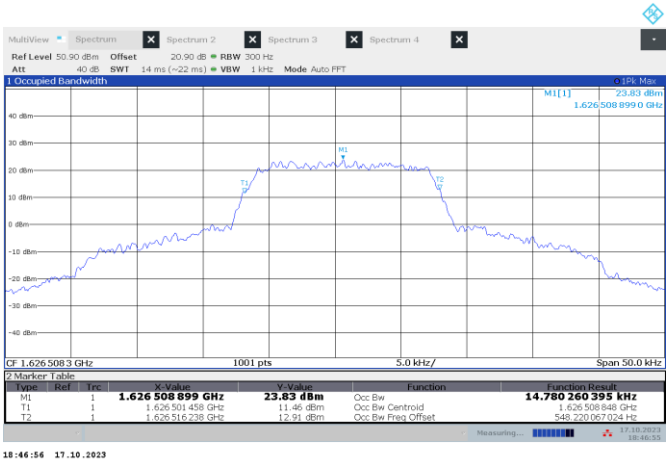


Figure 7.1-25: *99 % bandwidth on low channel for waveform **Z***

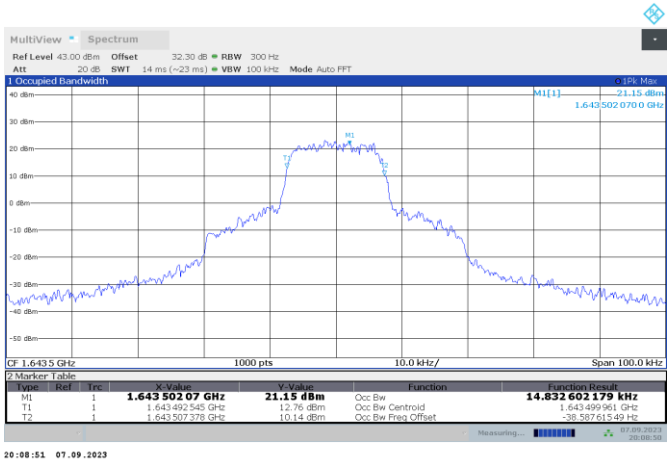


Figure 7.1-26: *99 % bandwidth on mid channel for waveform **Z***

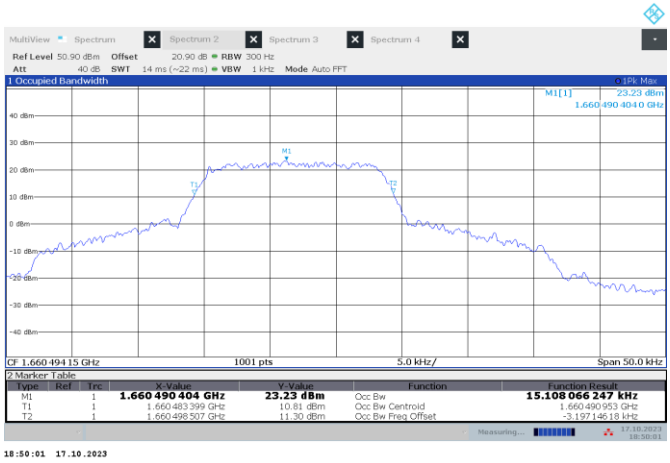


Figure 7.1-27: *99 % bandwidth on high channel for waveform **Z***

Test data, continued

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

Frequency, MHz	26 dB bandwidth, kHz
1626.509000	19.79
1643.500000	20.11
1660.492000	19.88

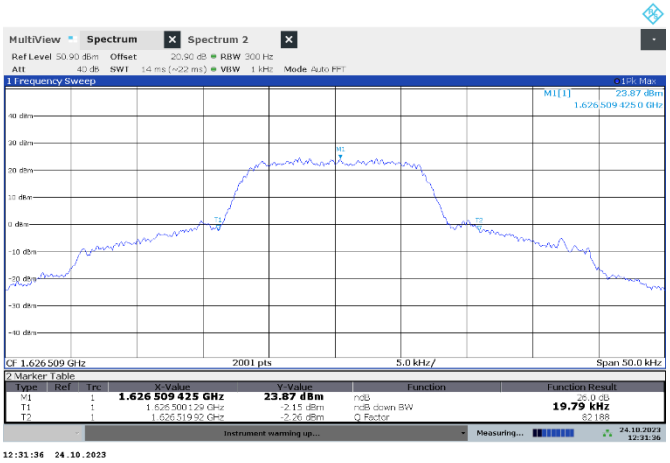


Figure 7.1-28: *26 dB bandwidth on low channel for waveform **Z***

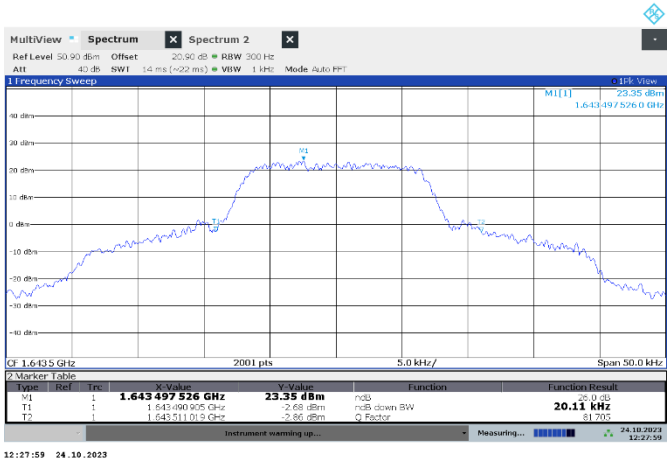


Figure 7.1-29: *26 dB bandwidth on mid channel for waveform **Z***

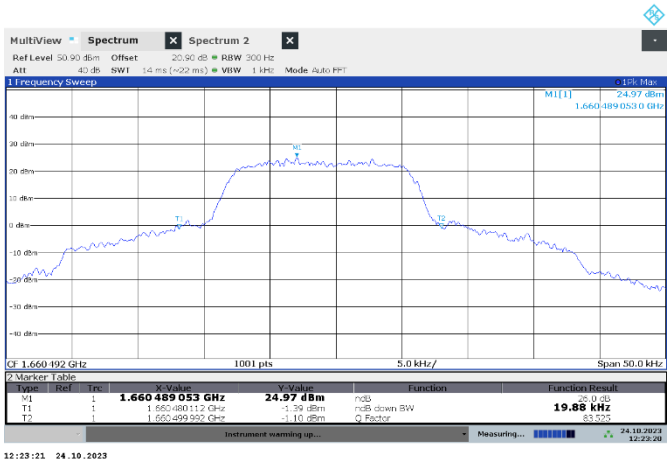


Figure 7.1-30: *26 dB bandwidth on high channel for waveform **Z***

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 Θ ≤ 0°
+40 + 3Θ dBW in any 4 kHz band for 0° < Θ ≤ 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.

(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 Θ ≤ 0°
+64 + 3 Θ dBW in any 1 MHz band for 0° < Θ ≤ 5°
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	September 13, 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 – ISED for waveform **J***

Frequency, MHz	Output power, dBm/5 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.501625	32.05	5.6	37.65	37	39	1.35
1643.500000	32.01	5.6	37.61	37	39	1.39
1660.498375	32.07	5.6	37.67	37	39	1.33

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/5 kHz	Gain, dBi	EIRP, dBm/5kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.501625	32.05	5.6	37.65	70	32.35
1643.500000	32.01	5.6	37.61	70	32.39
1660.498375	32.07	5.6	37.67	70	32.33

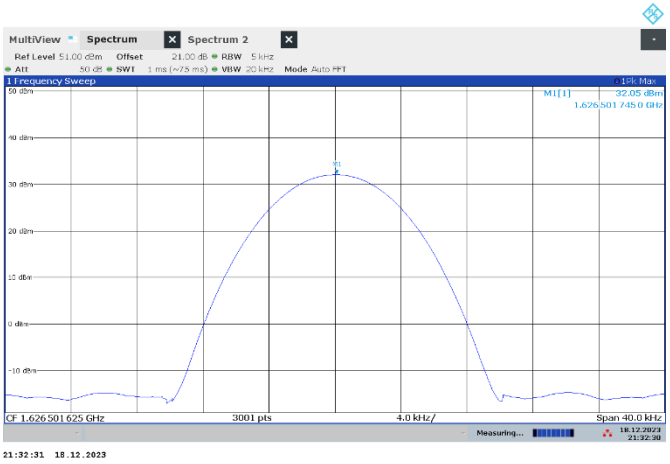


Figure 7.2-1: *Conducted peak output power on low channel for waveform **J***

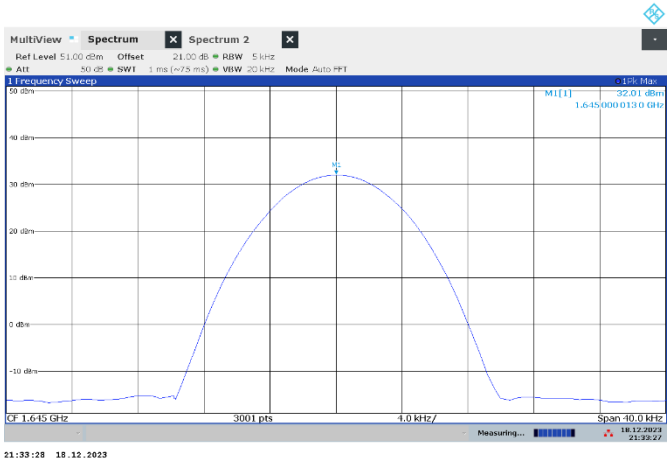


Figure 7.2-2: *Conducted peak output power on mid channel for waveform **J***

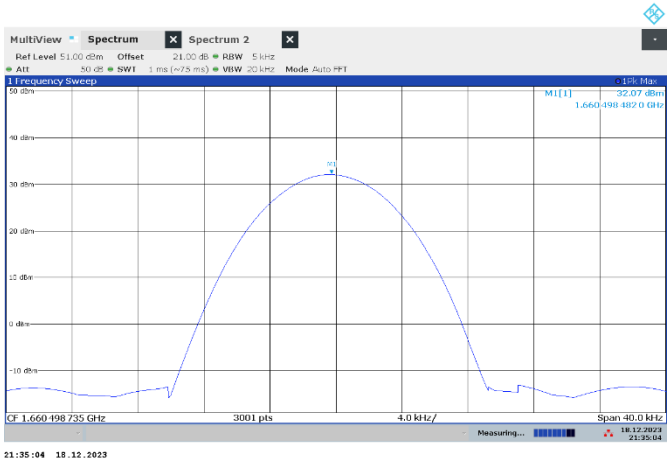


Figure 7.2-3: *Conducted peak output power on high channel for waveform **J***

Test data, continued

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

Frequency, MHz	Output power, dBm/5 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.502000	32.40	5.6	38	37	39	1
1643.500000	32.29	5.6	37.89	37	39	1.11
1660.498000	32.40	5.6	38	37	39	1

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/5 kHz	Gain, dBi	EIRP, dBm/5 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.502000	32.40	5.6	38	70	32
1643.500000	32.29	5.6	37.89	70	32.11
1660.498000	32.40	5.6	38	70	32

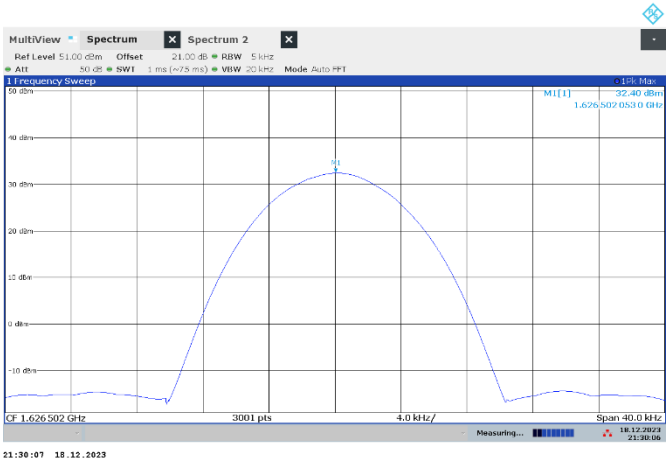


Figure 7.2-4: *Conducted peak output power on low channel for waveform* ***K***

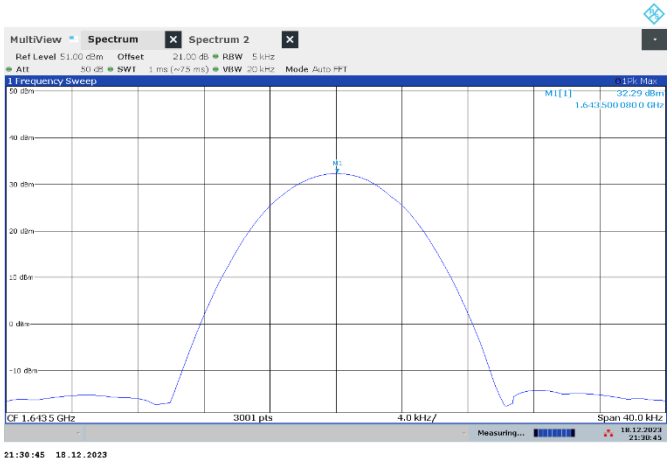


Figure 7.2-5: *Conducted peak output power on mid channel for waveform* ***K***

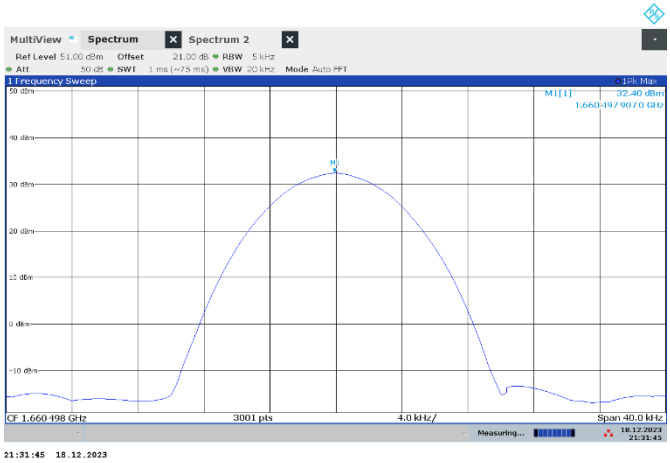


Figure 7.2-6: *Conducted peak output power on high channel for waveform* ***K***

Test data, continued

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

Frequency, MHz	Output power, dBm/ 5 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.503000	32.40	5.6	38	37	39	1
1643.500000	32.20	5.6	37.8	37	39	1.2
1660.497000	32.05	5.6	37.65	37	39	1.35

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/5 kHz	Gain, dBi	EIRP, dBm/5 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.503000	32.40	5.6	38	70	32
1643.500000	32.20	5.6	37.8	70	32.2
1660.497000	32.05	5.6	37.65	70	32.35

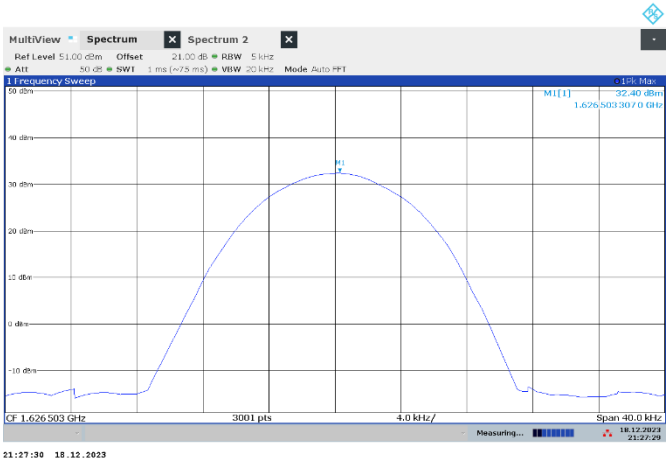


Figure 7.2-7: *Conducted peak output power on low channel for waveform* ***T***

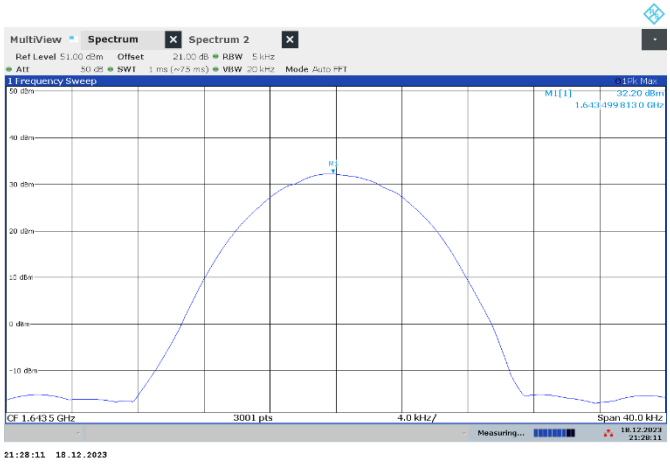


Figure 7.2-8: *Conducted peak output power on mid channel for waveform* ***T***

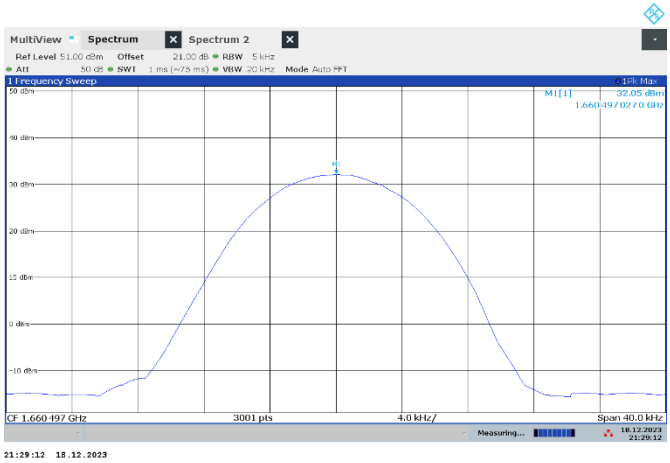


Figure 7.2-9: *Conducted peak output power on high channel for waveform* ***T***

Test data, continued

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

Frequency, MHz	Output power, dBm/5 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.505000	31.90	5.6	37.5	37	39	1.5
1643.500000	31.77	5.6	37.37	37	39	1.63
1660.495000	31.91	5.6	37.51	37	39	1.49

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/5 kHz	Gain, dBi	EIRP, dBm/5 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.505000	31.90	5.6	37.5	70	32.5
1643.500000	31.77	5.6	37.37	70	32.63
1660.495000	31.91	5.6	37.51	70	32.49

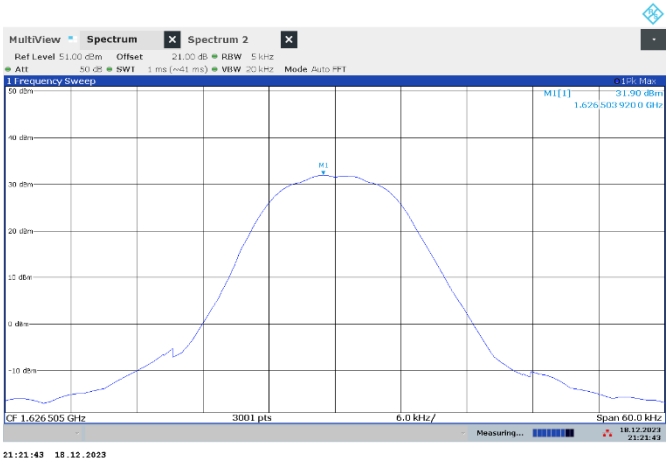


Figure 7.2-10: *Conducted peak output power on low channel for waveform **Y***

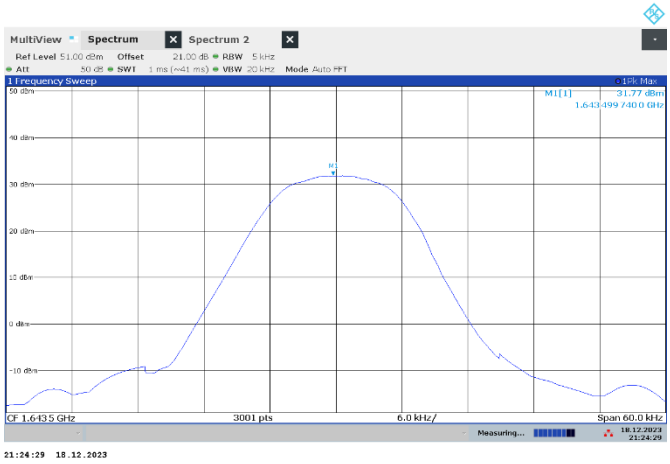


Figure 7.2-11: *Conducted peak output power on mid channel for waveform **Y***

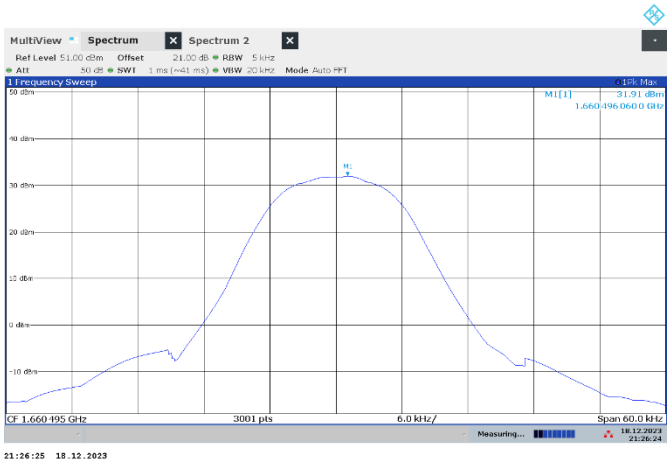


Figure 7.2-12: *Conducted peak output power on high channel for waveform **Y***

Test data, continued

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

Frequency, MHz	Output power, dBm/ 5 kHz	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.509000	31.65	5.6	37.25	37	39	1.75
1643.500000	31.80	5.6	37.4	37	39	1.6
1660.492000	31.63	5.6	37.23	37	39	1.77

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/5 kHz	Gain, dBi	EIRP, dBm/5 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.509000	31.65	5.6	37.25	70	32.75
1643.500000	31.80	5.6	37.4	70	32.6
1660.492000	31.63	5.6	37.23	70	32.77

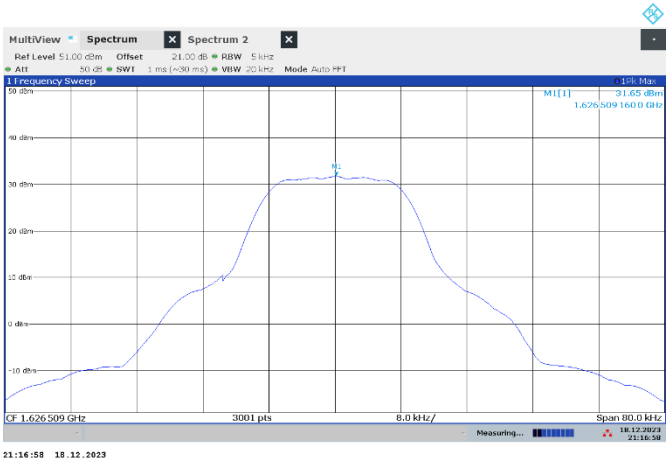


Figure 7.2-13: *Conducted peak output power on low channel for waveform* ***Z***

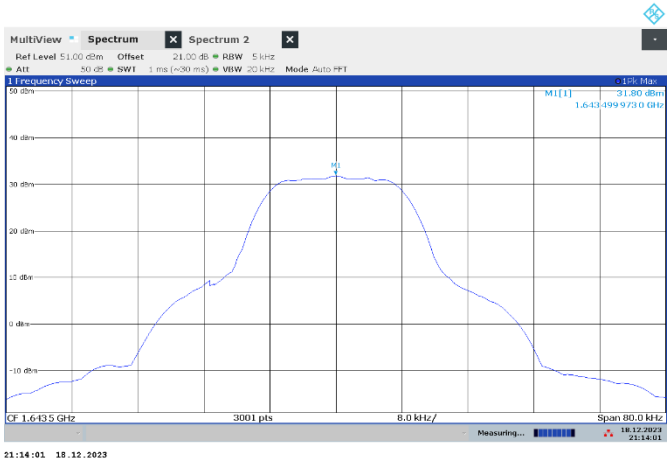


Figure 7.2-14: *Conducted peak output power on mid channel for waveform* ***Z***

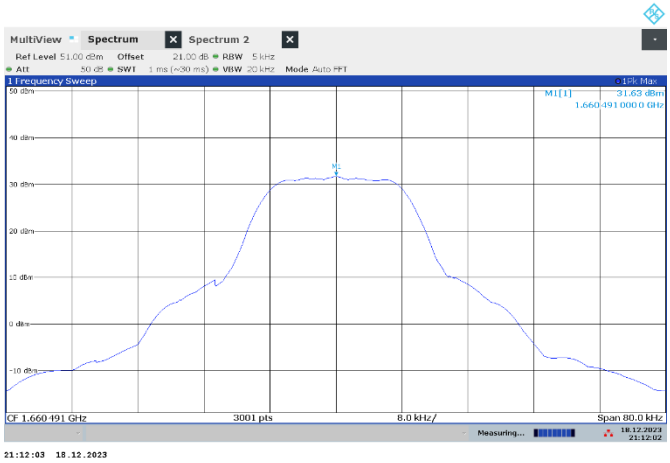


Figure 7.2-15: *Conducted peak output power on high channel for waveform* ***Z***

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 6, 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 (Reference bandwidth)/(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	≥ 1 % of OBW
Video bandwidth	≥3 × RBW
Detector mode	RMS
Trace mode	Averaging
Integration bandwidth	Fundamental dBm/2 kHz, 50-100% BW dBm/kHz, 100-250% BW dBm/3 kHz, ≥ 250% BW dBm/5 kHz

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	26.62	27.52	-23.78	-19.86	2.52	22.38

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	26.62	27.52	-29.45	-8.38	21.07

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

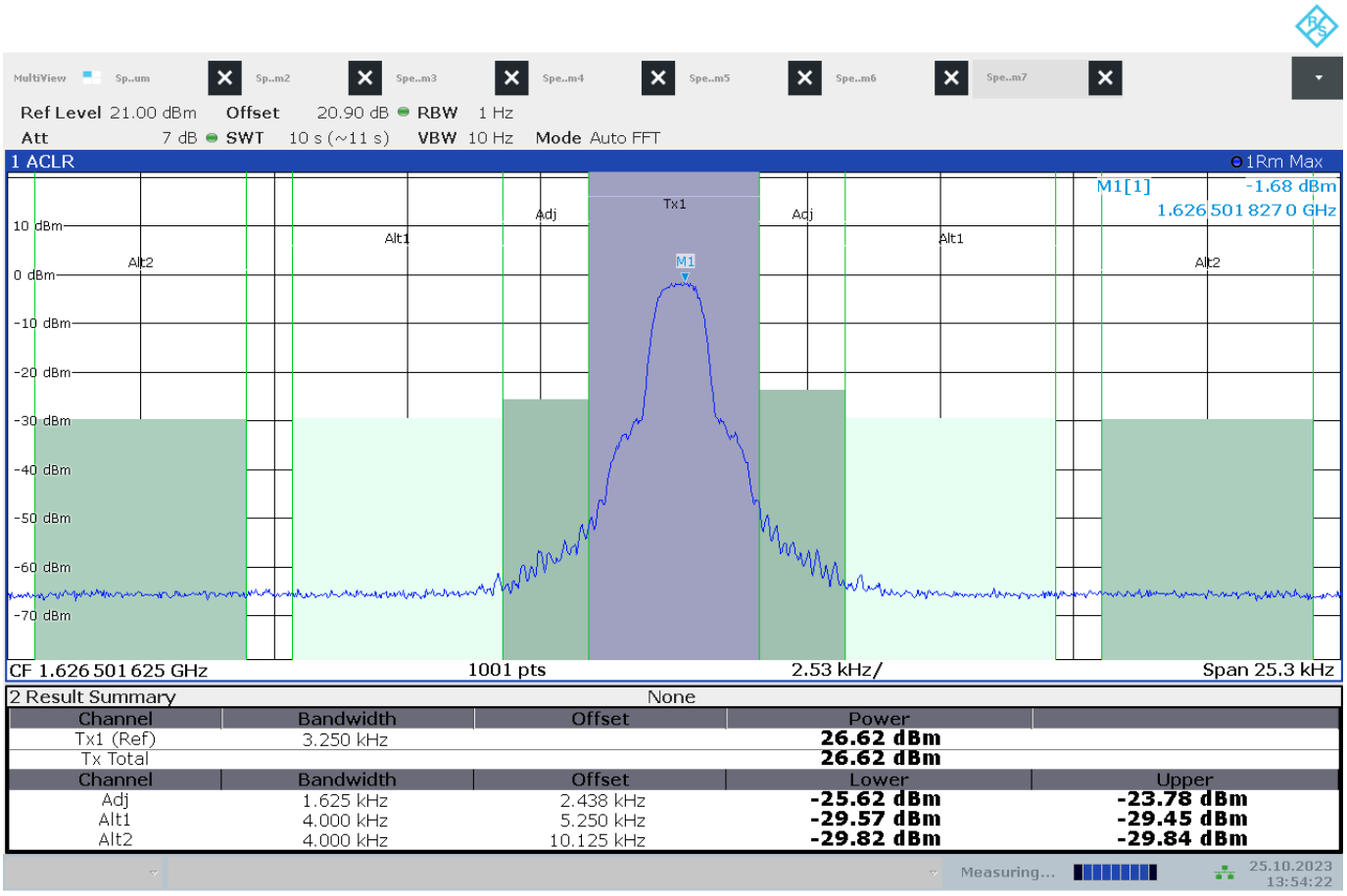


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform J, low channel

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	23.91	24.81	-24.63	-20.71	-0.19	20.52

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	23.91	24.81	-32.31	-10.19	22.12

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

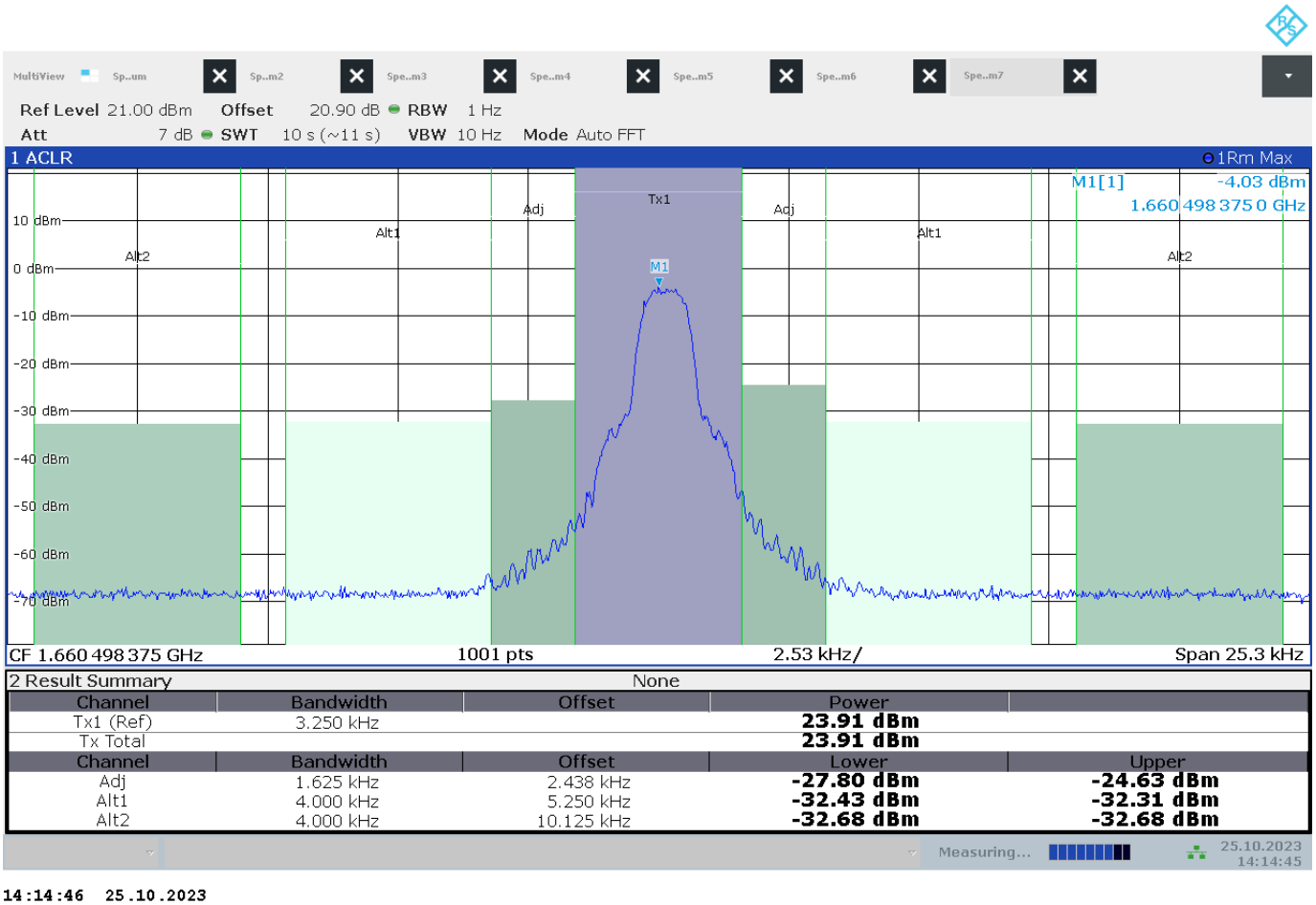


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform J, high channel

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	29.02	-6.73	-3.71	4.02	7.73

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	29.02	-24.56	-5.98	18.58

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

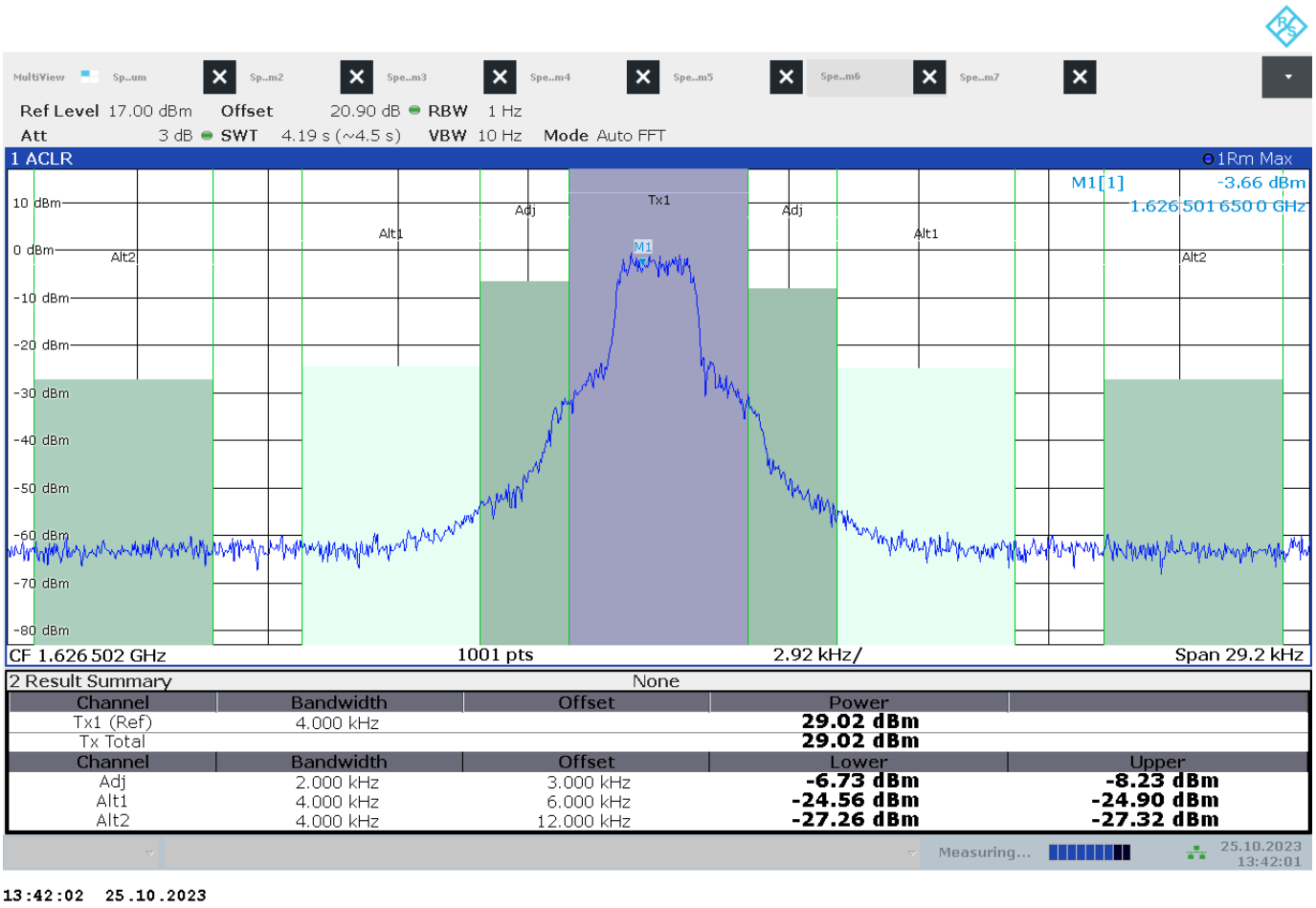


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform K, low channel

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	29.07	-6.85	-3.83	4.07	7.90

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	29.07	-23.75	-5.93	17.82

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

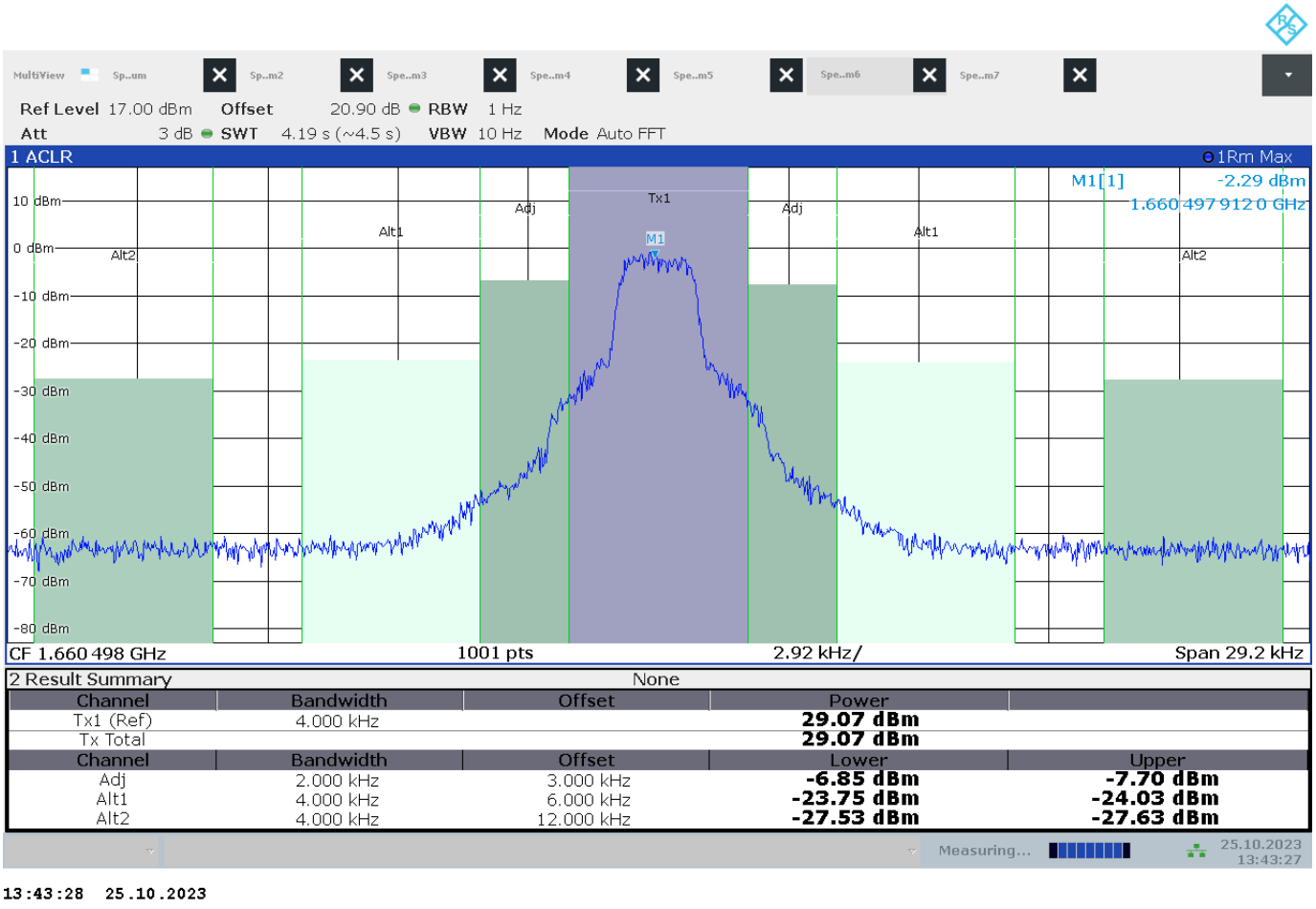


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform K, high channel

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	29.02	-1.81	-0.56	4.02	4.58

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	29.02	-20.94	-5.98	14.96

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

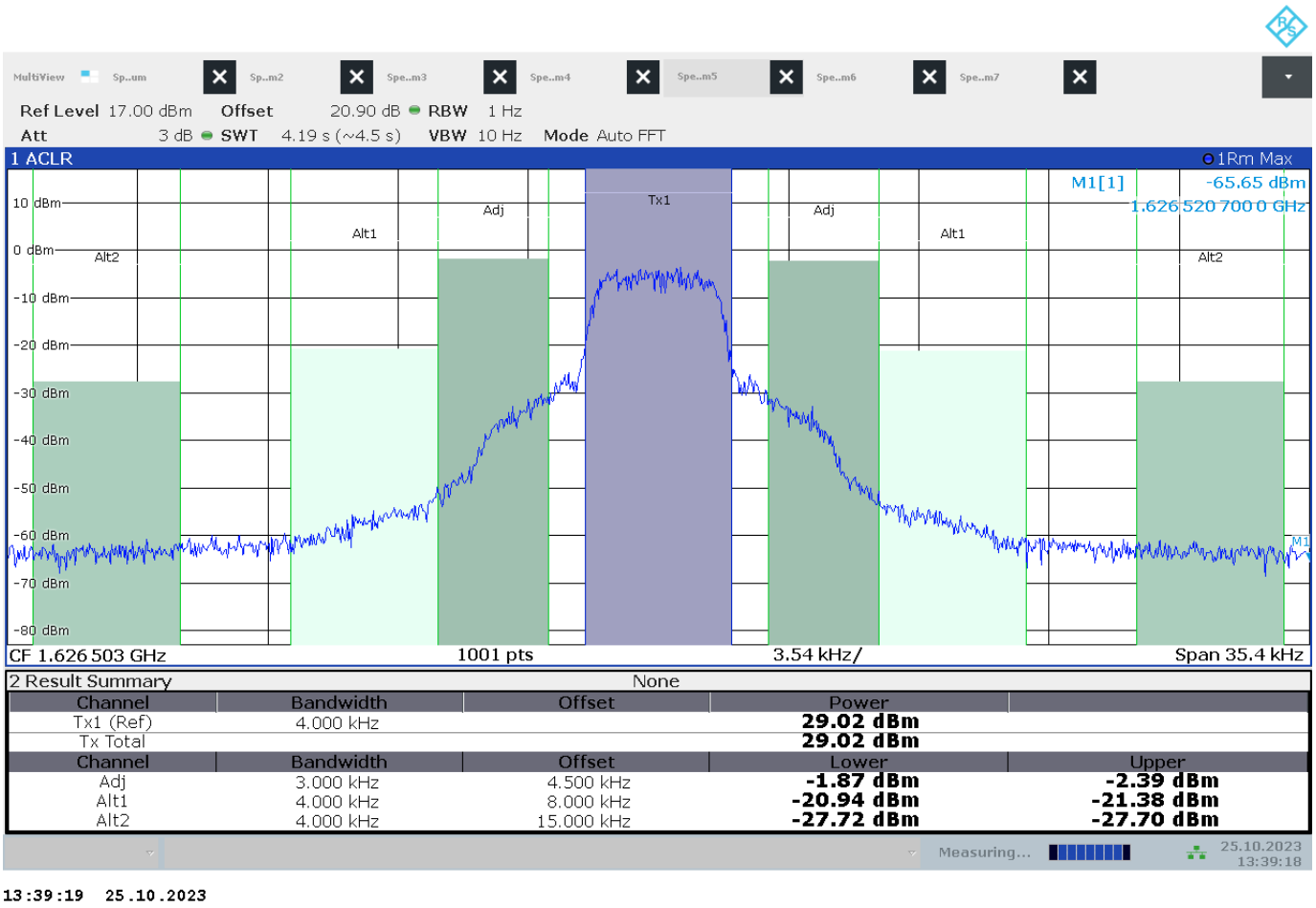


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform T, low channel

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	29.58	-0.93	0.31	4.58	4.89

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	29.58	-18.80	-5.42	13.38

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

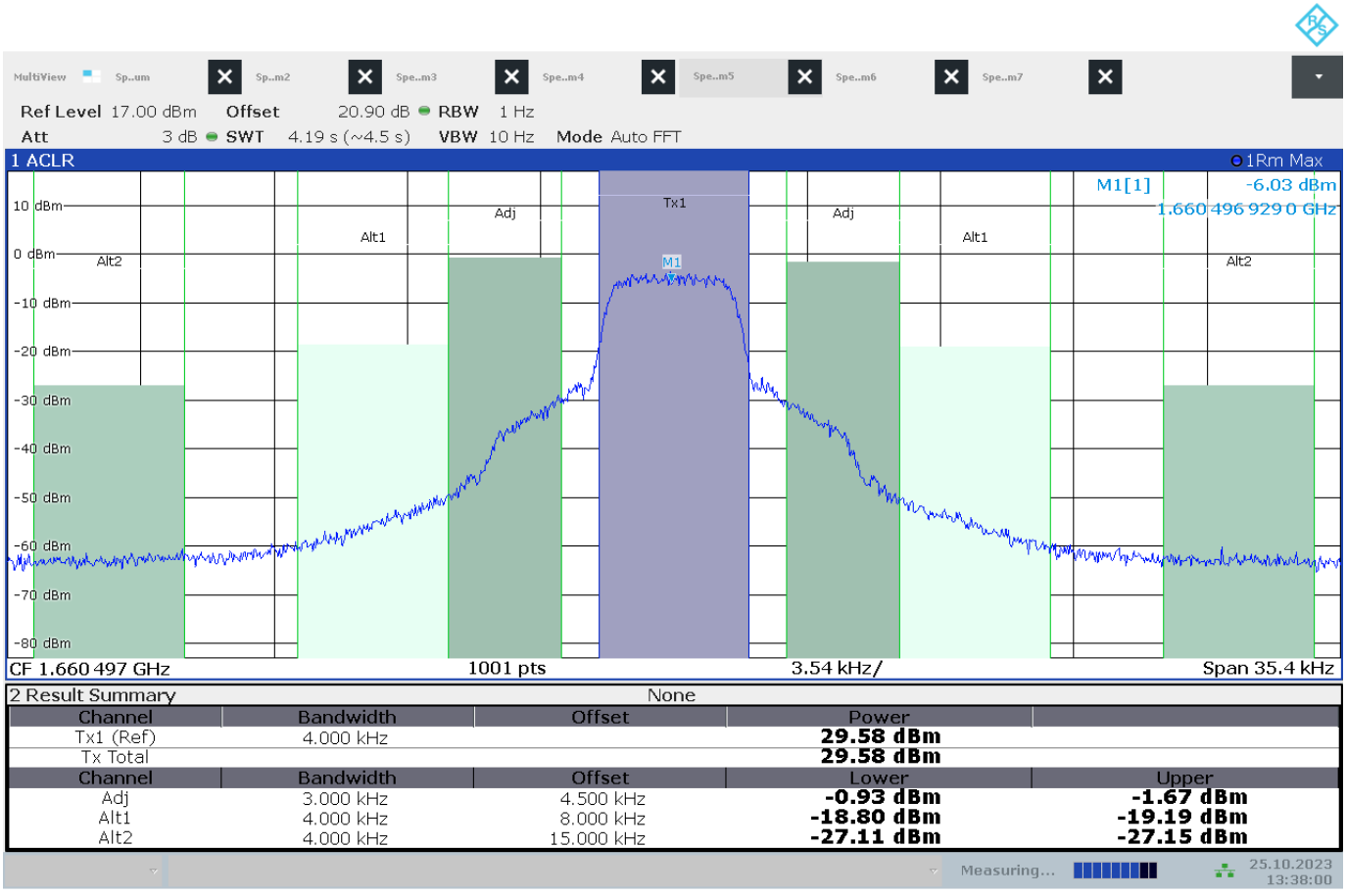


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform T, high channel

Test data continued

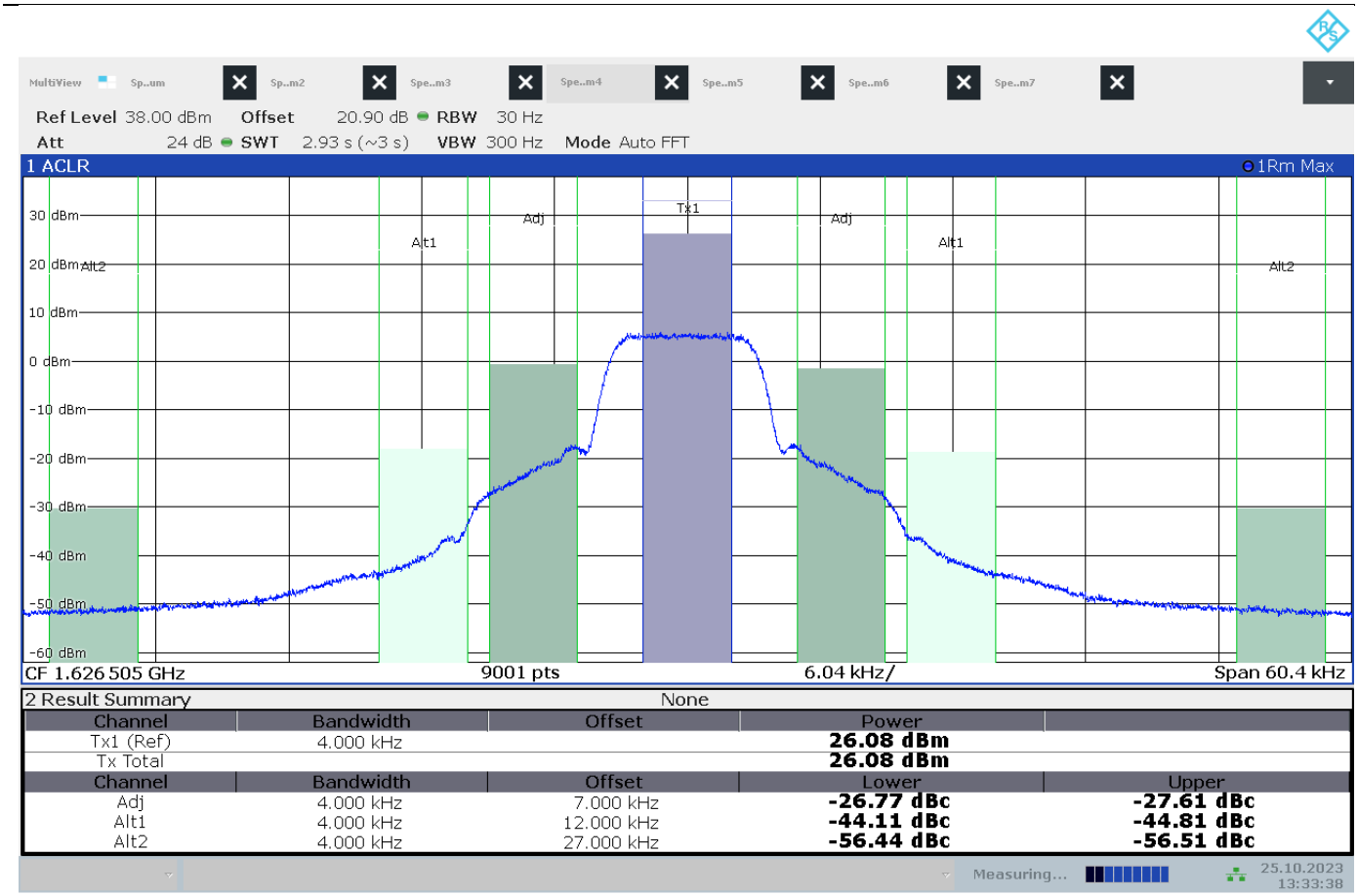


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Y, low channel

Test data continued

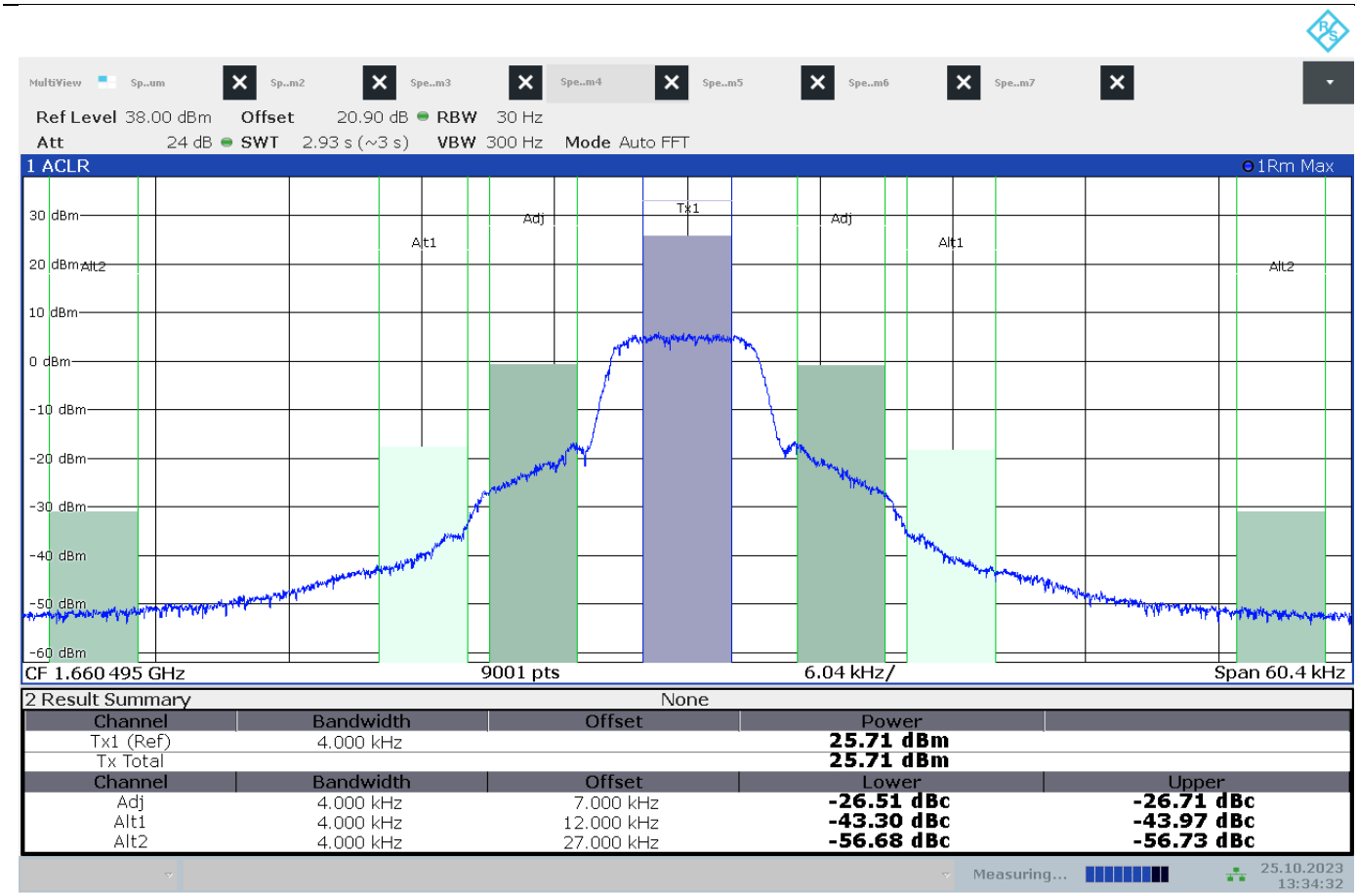


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Y, high channel

Test data continued

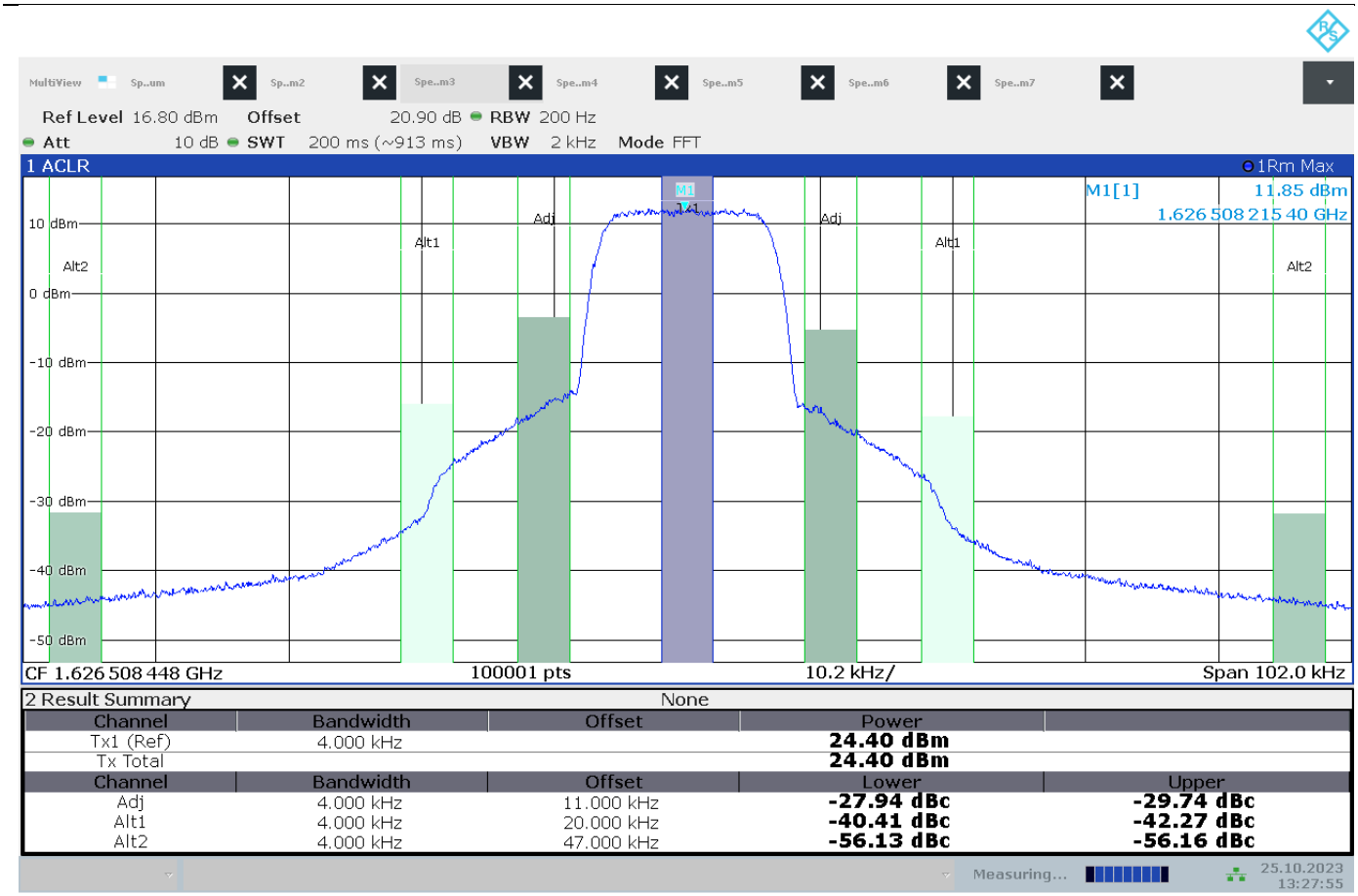


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Z, low channel

Test data continued

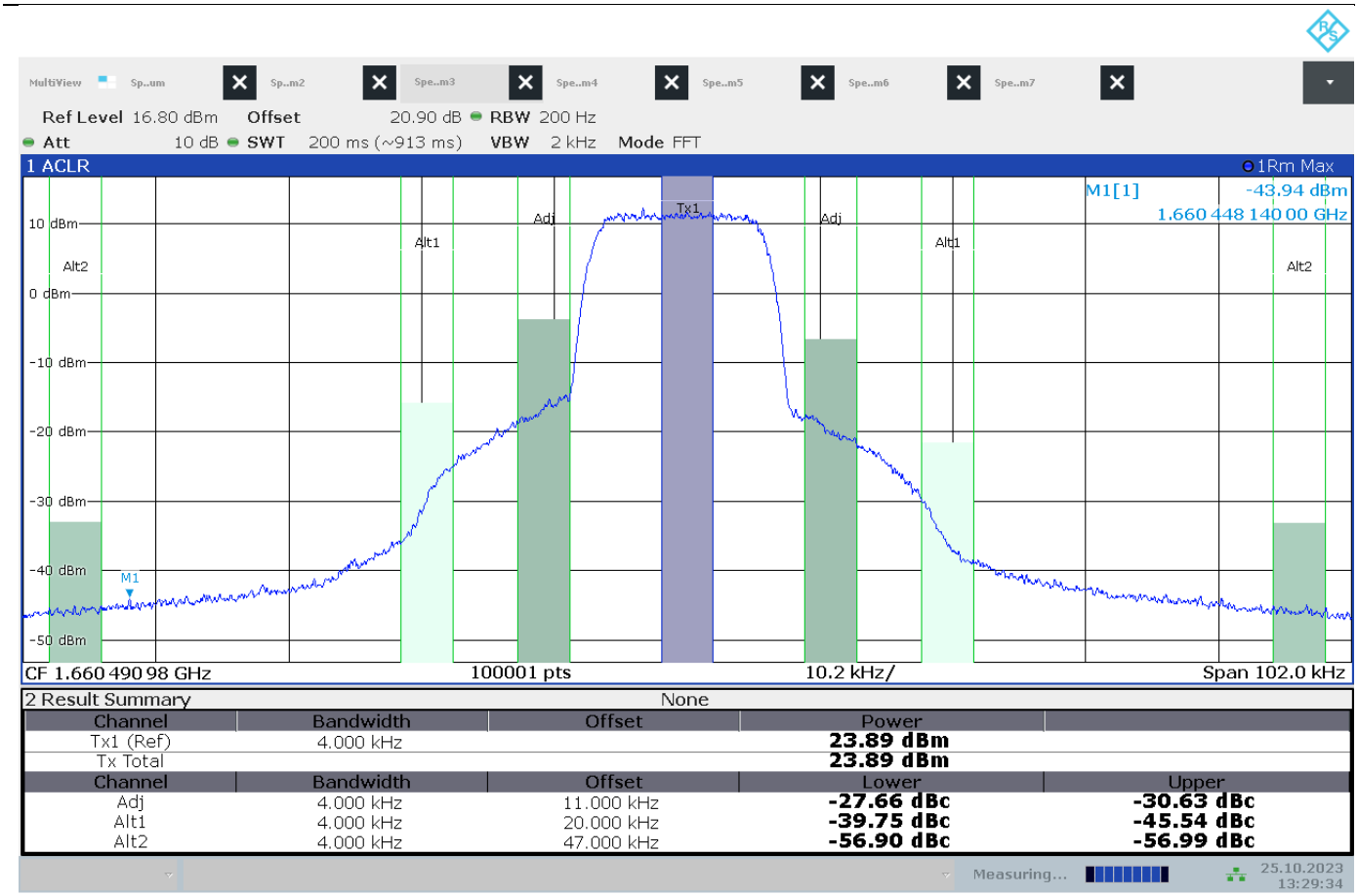


Figure 7.3-2: Conducted band edge spurious emissions outside assigned bandwidth – Waveform Z, high channel

Test data, continued

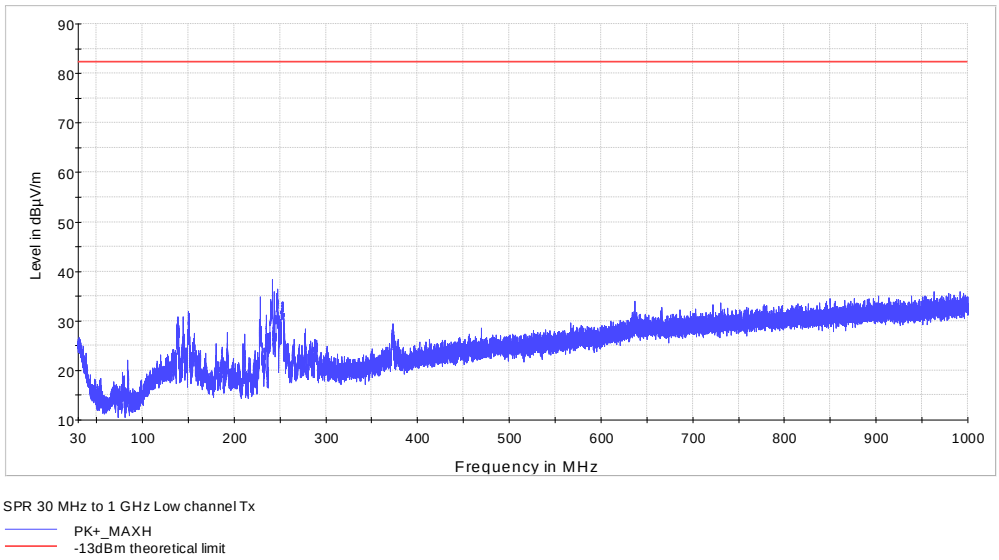


Figure 7.3-1: *Radiated spurious emissions below 1 GHz for sub-band 1, low channel for waveform **J***

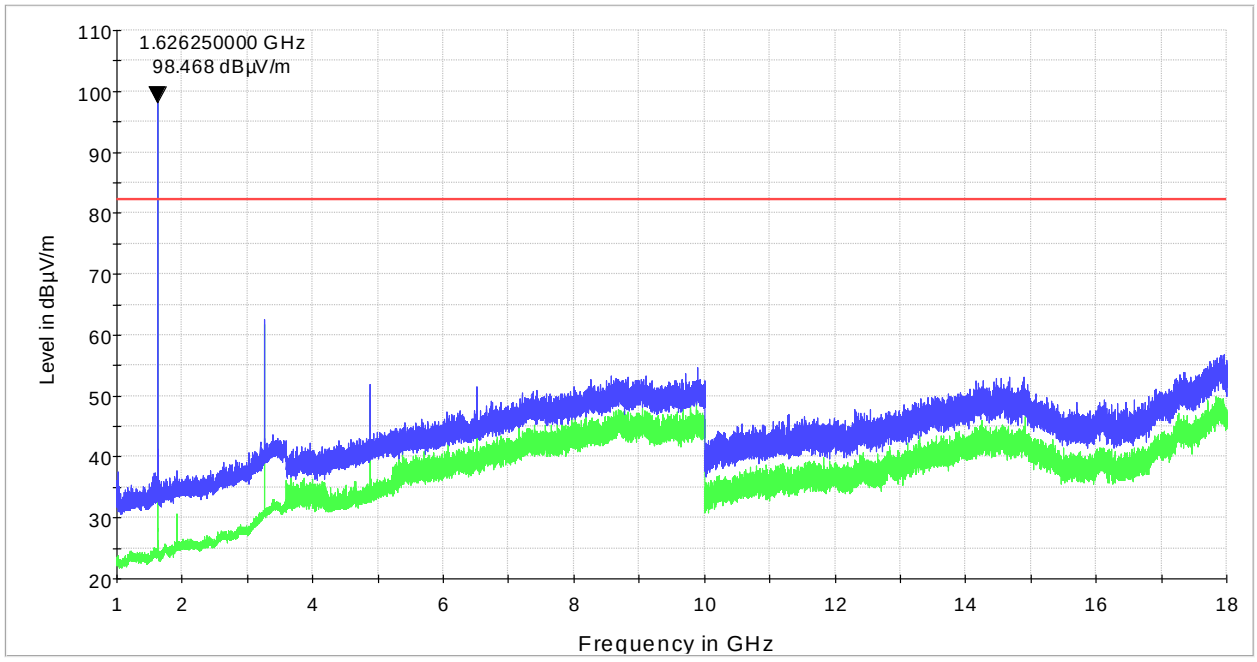


Figure 7.3-2: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, low channel waveform **J***

Test data, continued

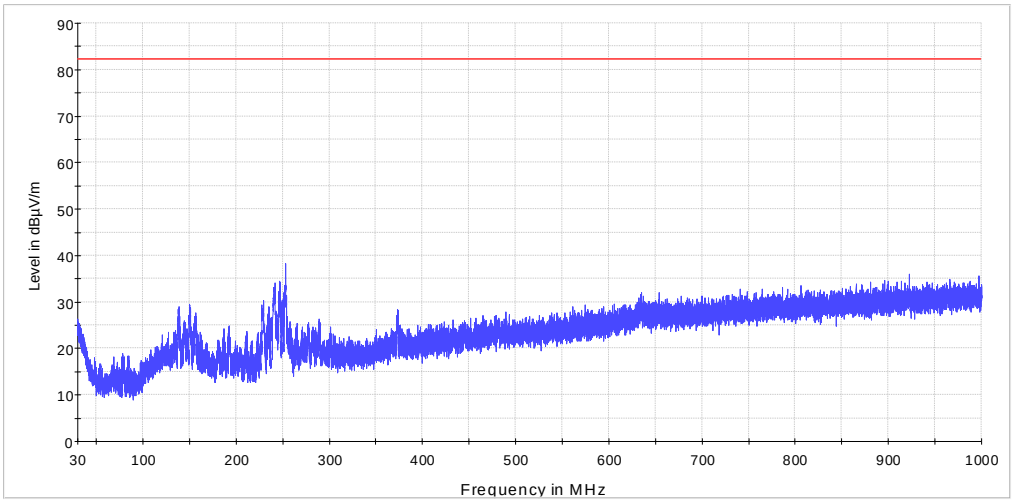


Figure 7.3-3: *Radiated spurious emissions below 1 GHz for sub-band 1, mid channel waveform **J***

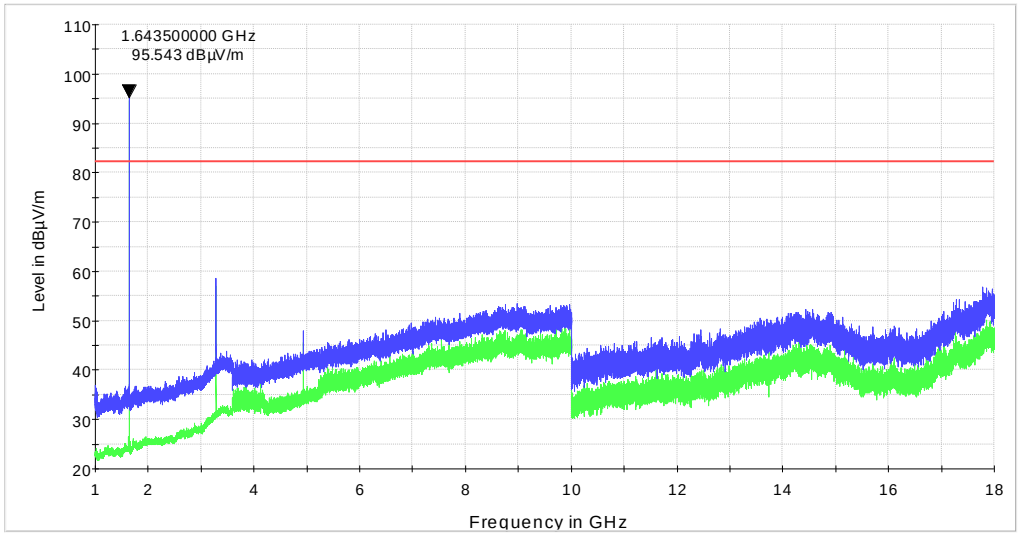


Figure 7.3-4: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, mid channel waveform **J***

Test data, continued

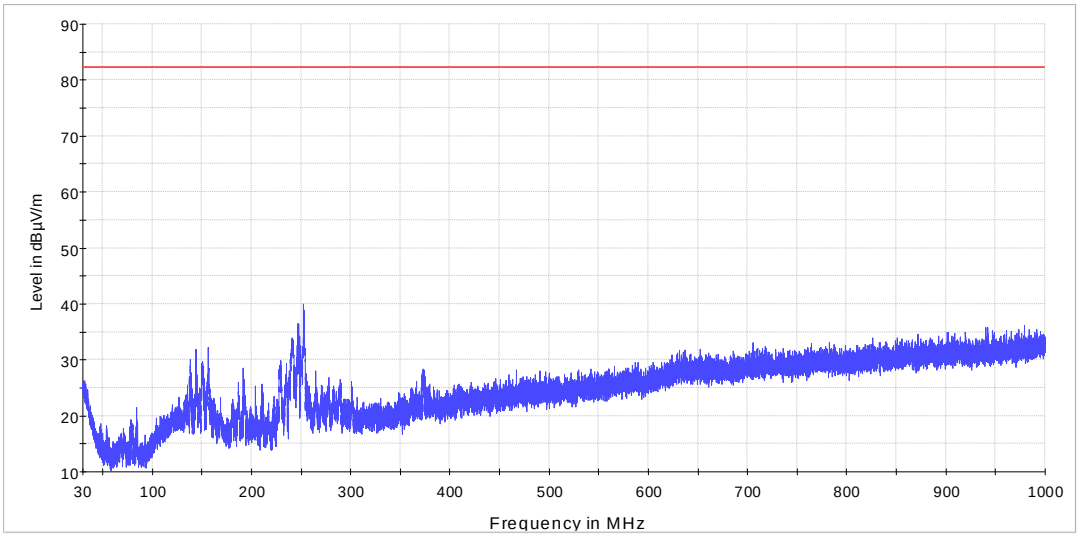


Figure 7.3-5: *Radiated spurious emissions below 1 GHz for sub-band 1, high channel waveform **J***

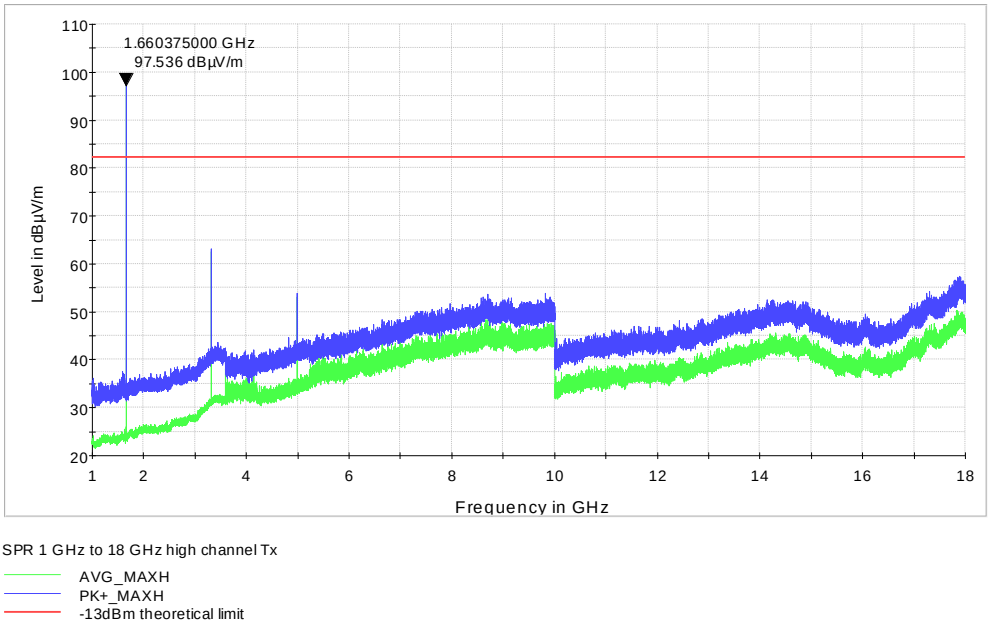


Figure 7.3-6: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, high channel waveform **J***

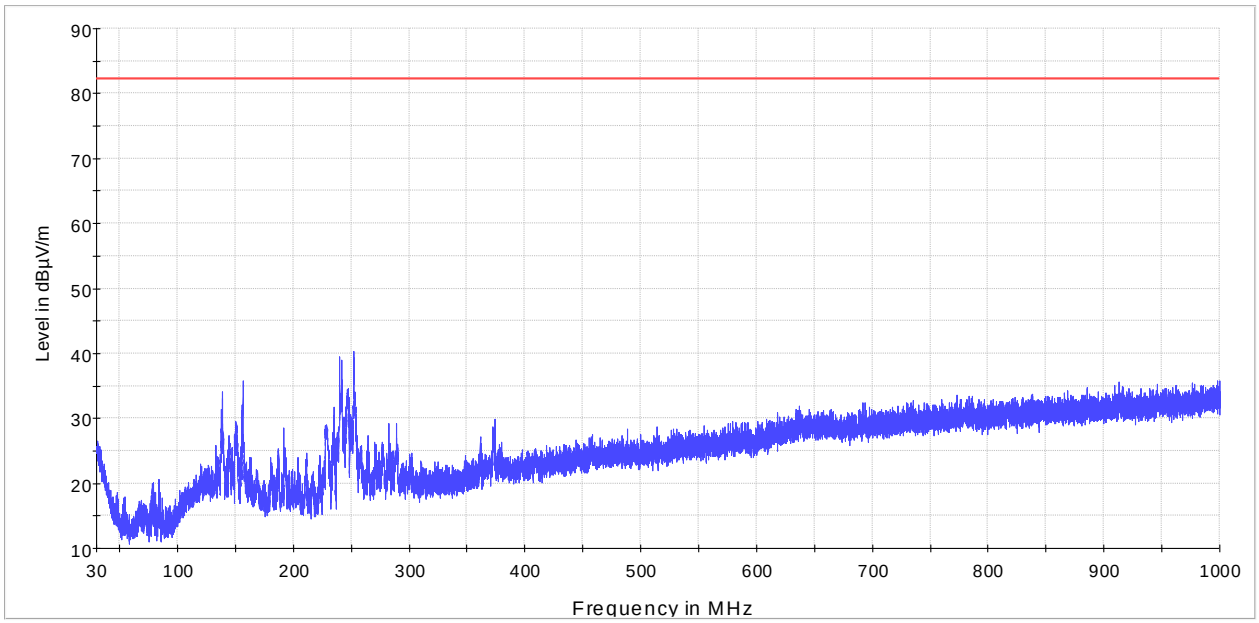


Figure 7.3-7: *Radiated spurious emissions below 1 GHz for sub-band 1, low channel waveform* ***K***

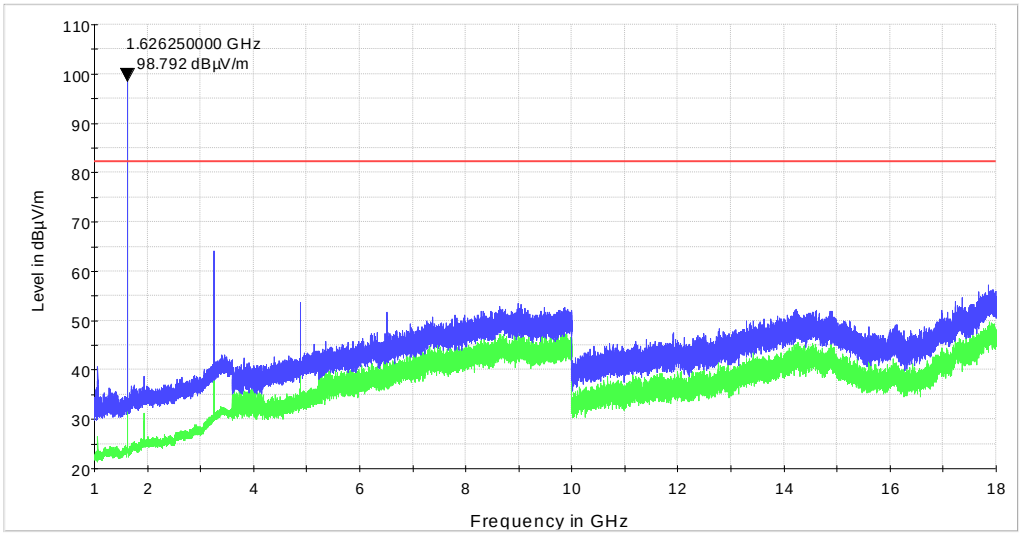


Figure 7.3-8: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, low channel waveform* ***K***

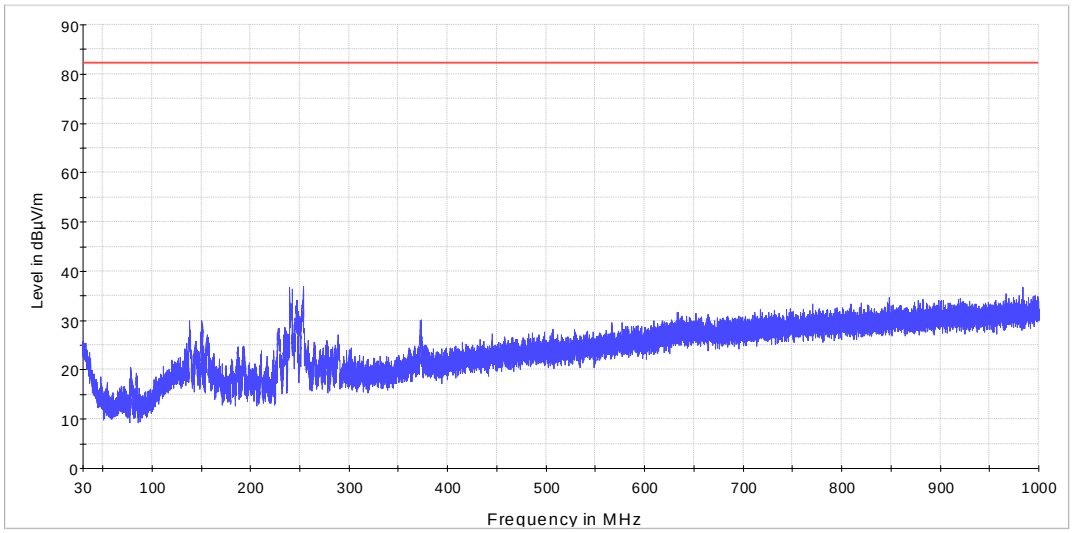


Figure 7.3-9: *Radiated spurious emissions below 1 GHz for sub-band 1, mid channel waveform* ***K***

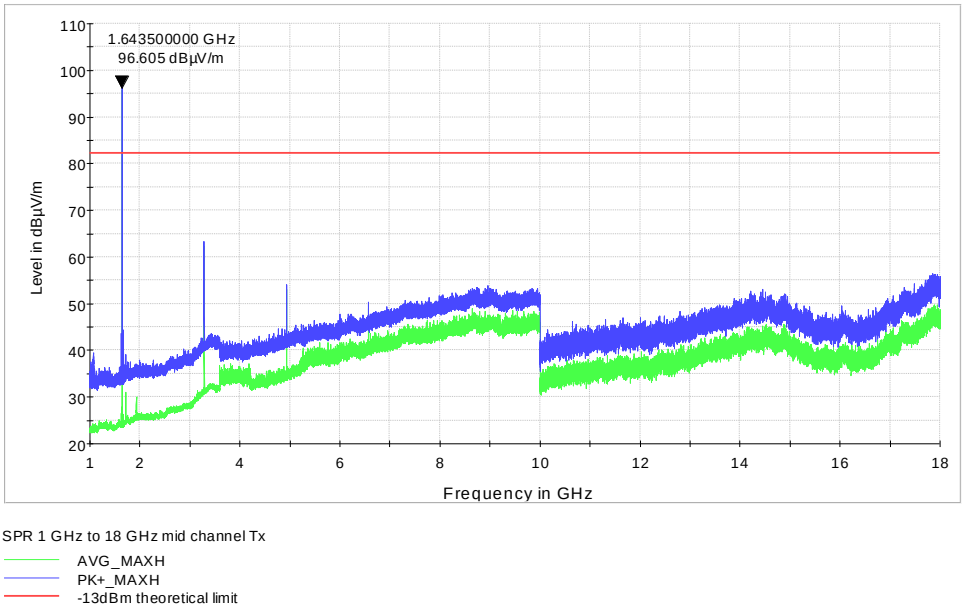


Figure 7.3-10: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, mid channel waveform* ***K***

Test data, continued

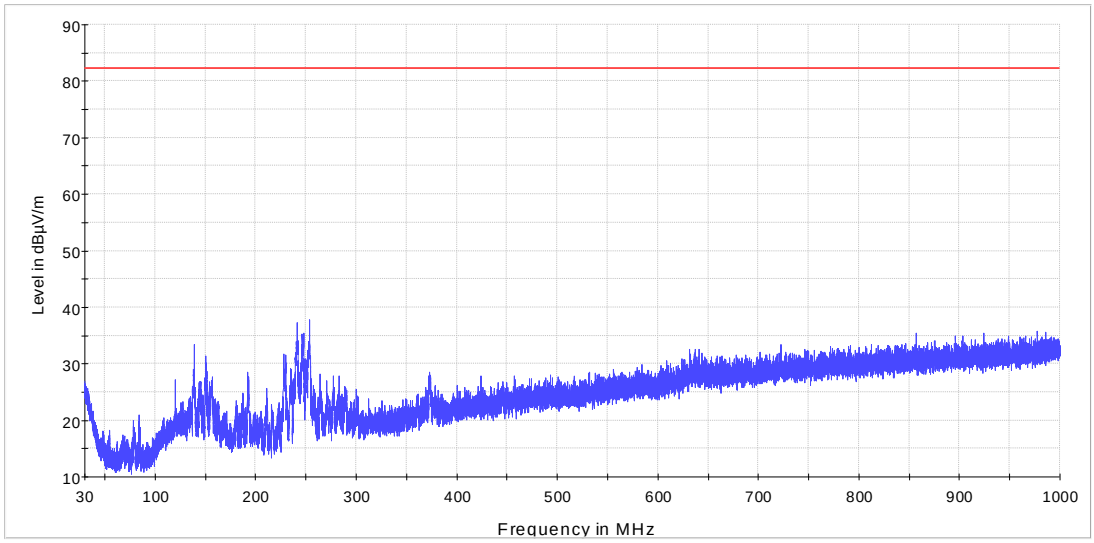


Figure 7.3-11: *Radiated spurious emissions below 1 GHz for sub-band 1, high channel waveform* ***K***

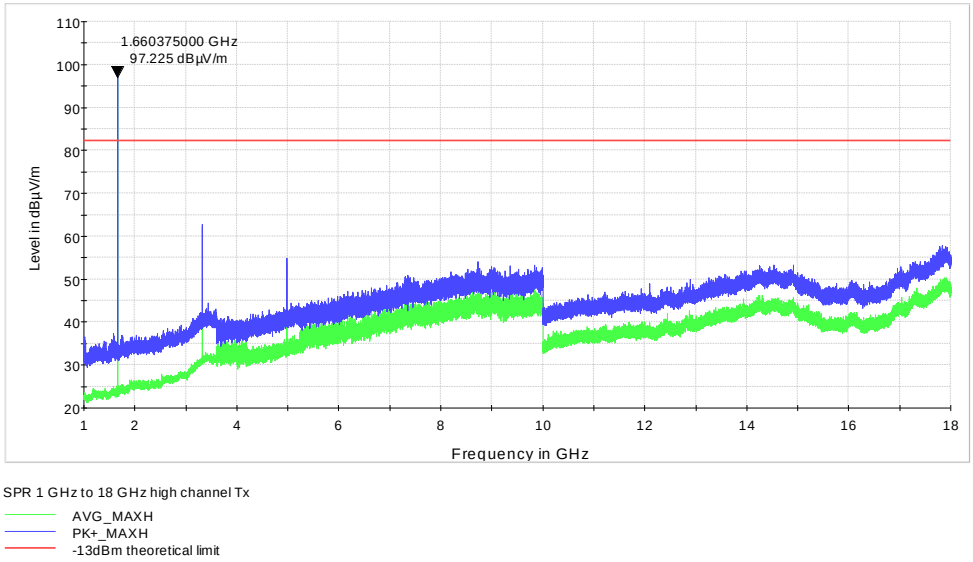


Figure 7.3-12: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, high channel waveform* ***K***

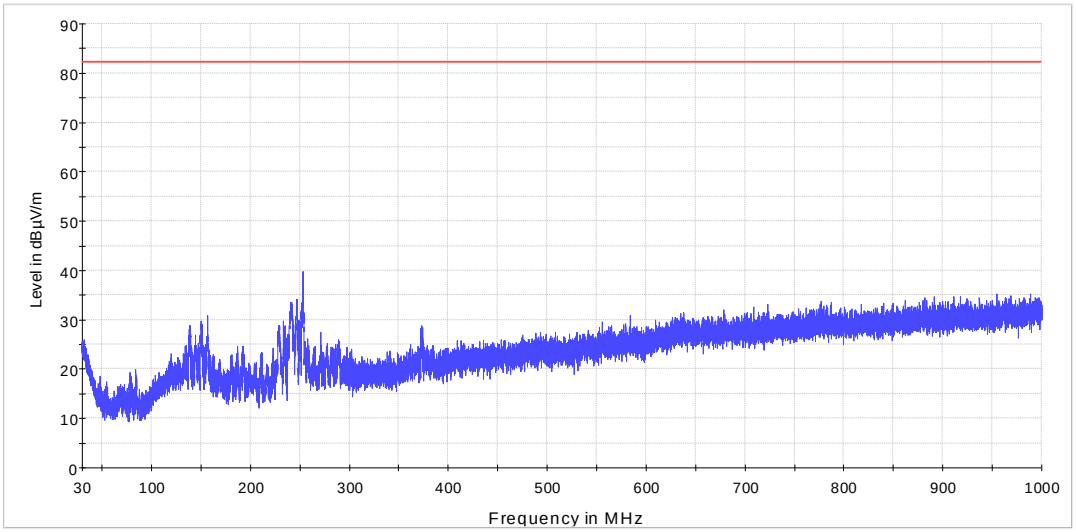


Figure 7.3-13: *Radiated spurious emissions below 1 GHz for sub-band 1, low channel waveform* ***T***

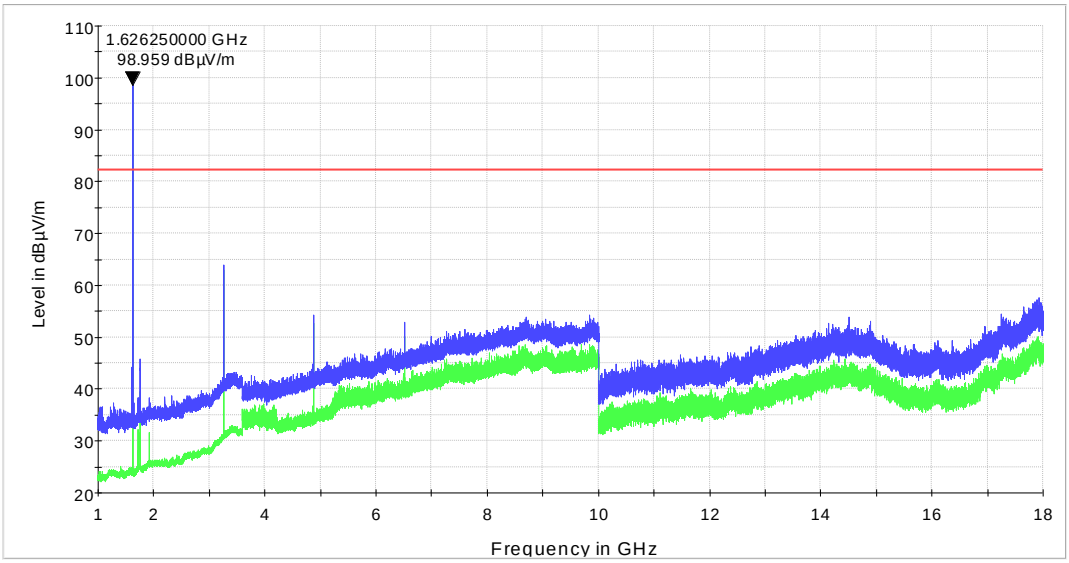
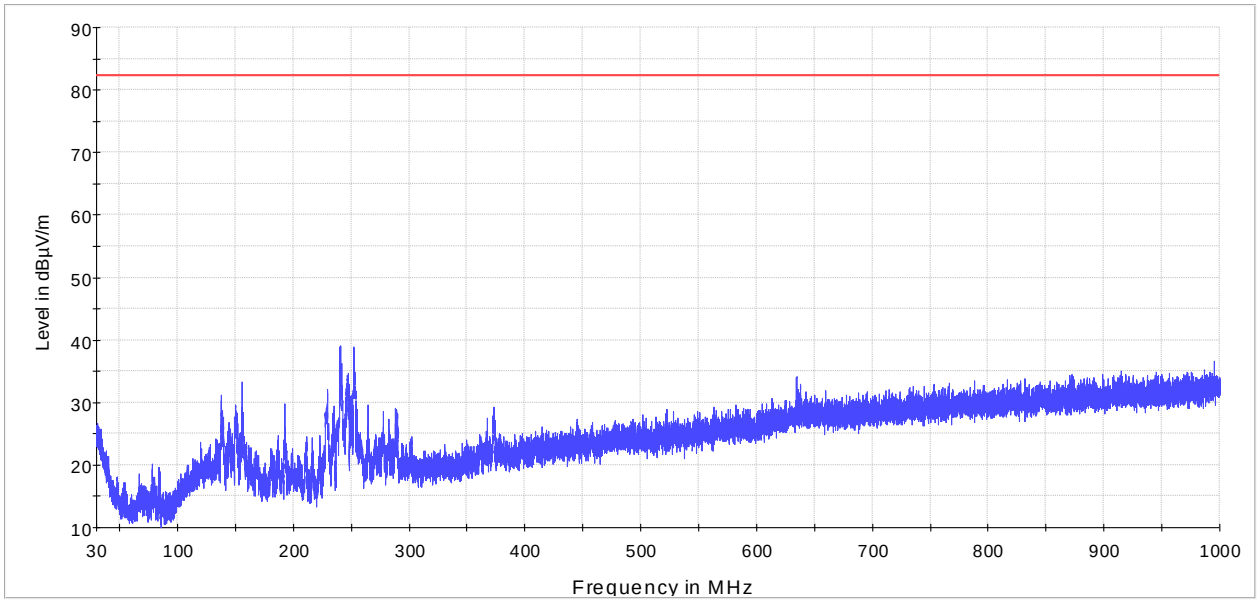


Figure 7.3-14: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, low channel waveform* ***T***

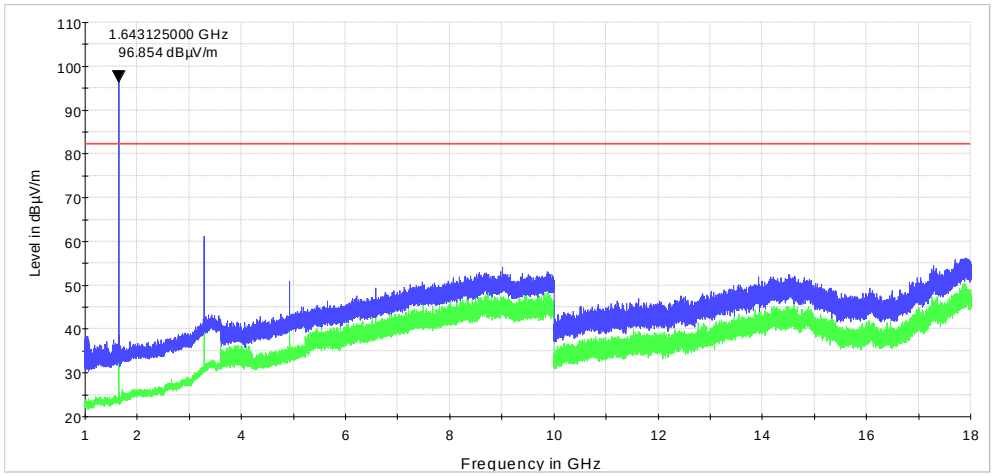


SPR 30 MHz to 1 GHz mid channel Tx

PK+_MAXH

-13dBm theoretical limit

Figure 7.3-15: *Radiated spurious emissions below 1 GHz for sub-band 1, mid channel waveform* ***T***



SPR 1 GHz to 18 GHz mid channel Tx

AVG_MAXH

PK+_MAXH

-13dBm theoretical limit

Figure 7.3-16: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, mid channel waveform* ***T***

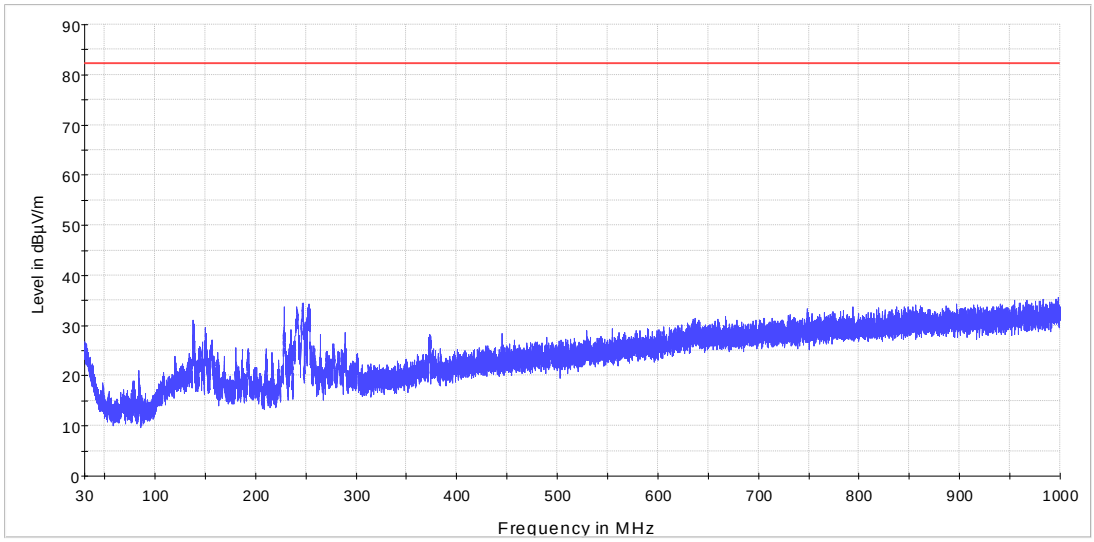


Figure 7.3-17: *Radiated spurious emissions below 1 GHz for sub-band 1, high channel waveform* ***T***

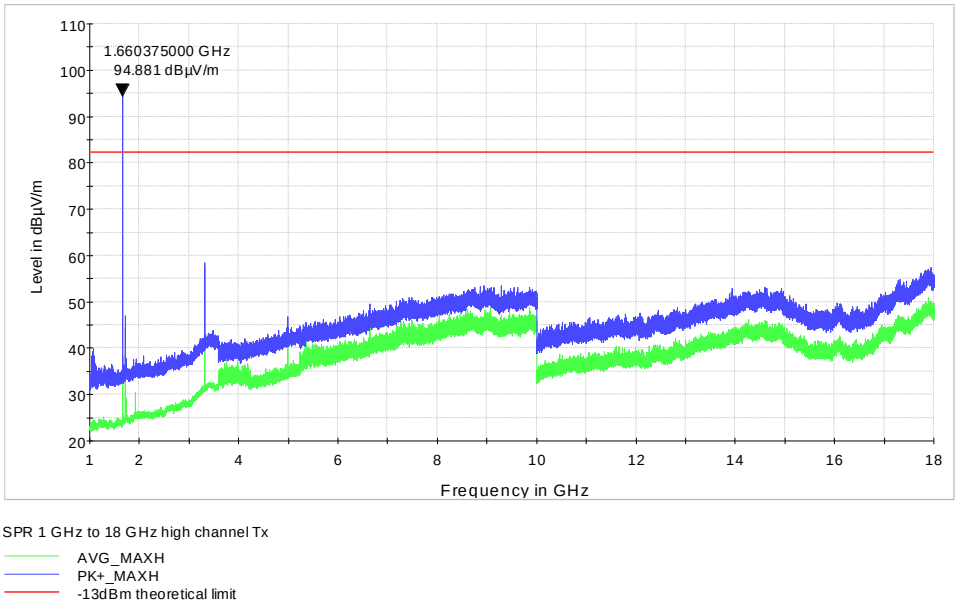


Figure 7.3-18: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, high channel waveform* ***T***

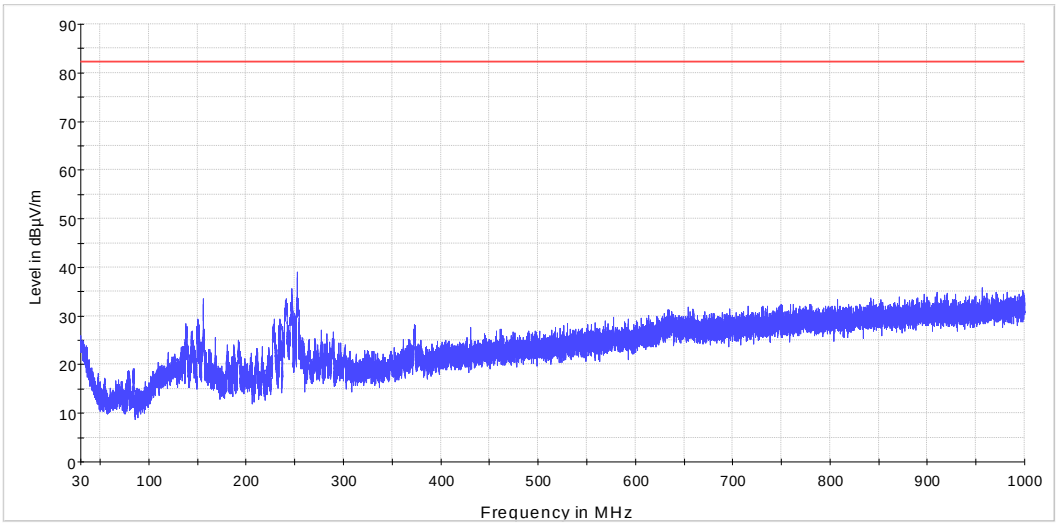


Figure 7.3-19: *Radiated spurious emissions below 1 GHz for sub-band 1, low channel waveform* ***Y***

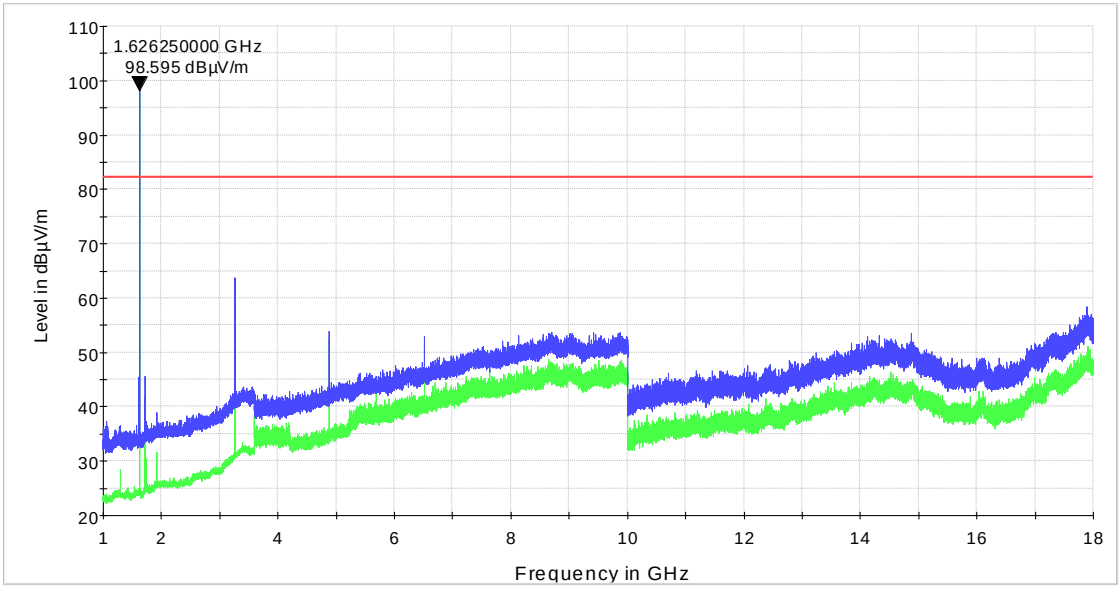


Figure 7.3-20: *Radiated spurious emissions 1 – 18 GHz for sub-band 1, low channel waveform* ***Y***