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Wireless test report – 393609-1TRFWL

Applicant:

ORBCOMM License Corp.

Product:

ST9100 Terrestrial/Satellite Communication Terminal

Model:

ST9100-D01

Model variants:

ST9100-C01

- FCC 47 CFR Part 25

  Satellite communications

- RSS-170, Issue 3, July 9, 2015

  Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

Date of issue: May 14, 2020

Kevin Rose, Wireless/EMC Specialist	
Mark Libbrecht, Wireless/EMC Specialist	
Reviewed by	Signature

Test location

Company name	Nemko Canada Inc.
Facility Name	Cambridge
Address	130 Saltsman Drive, Unit #1
City	Cambridge
Province	Ontario
Postal code	N3E 0B2
Country	Canada
Telephone	+1 519 680 4811
Toll free	+1 800 563 6336
Website	www.nemko.com
ISED Site designation number	CA0101

Limits of responsibility

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

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	ORBCOMM License Corp.
Address	750 Palladium Drive, Suite 368
City	Ottawa
Province/State	ON
Postal/Zip code	K2V 1CV
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 25	Satellite communications
RSS-170, Issue 3, July 9, 2015	Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

1.3 Test methods

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio services
273109 D01 Equip Auth Guide Part 25 TXReceiver v02r02 (2011)	Equipment Authorization Guidance for Part 25 Transceivers

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. 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 Exclusions

None

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	May 14, 2020	Original report issued

Section 2. Summary of test results

2.1 FCC Part 25 test results

Part	Test description	Verdict
25.204	Power limit	Pass
2.1046	Occupied bandwidth	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: None

2.2 IC 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	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Not applicable[2]

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

[2] EUT is a battery-operated device intended to be installed in a vehicle.

2.3 IC RSS-170, Issue 3 test results

Part	Test description	Verdict
5.1	Frequency bands	Pass
5.2	Frequency stability	Pass
5.3.1	Transmitter e.i.r.p. for ATC equipment	Not applicable
5.3.2	Transmitter e.i.r.p. for mobile earth stations (MESs)	Pass
5.4.1.1	Transmitter unwanted emissions for ATC Base Station Equipment within 1525–1559 MHz band	Not applicable
5.4.1.2	Transmitter unwanted emissions for ATC Base Station Equipment within 2000–2020 MHz and 2180–2200 MHz bands	Not applicable
5.4.1.3	Transmitter unwanted emissions for ATC Base Station Equipment within 2483.5–2500 MHz band	Not applicable
5.4.2.1	Transmitter unwanted emissions for ATC Mobile Equipment within 1610–1626.5 MHz band	Not applicable
5.4.2.2	Transmitter unwanted emissions for ATC Mobile Equipment within 1626.5–1660.5 MHz band	Pass
5.4.2.3	Transmitter unwanted emissions for ATC Mobile Equipment within 2000–2020 MHz band	Not applicable
5.4.3.1	Transmitter unwanted emissions for MESs in all frequency bands	Pass
5.4.3.2	Additional unwanted emission limits for MESs to protect radionavigation-satellite service	Pass
5.5	Carrier-off state emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	March 10, 2020
Nemko sample ID number	7

3.2 EUT information

Product name	ST9100 Terrestrial/Satellite Communication Terminal
Model	ST9100-D01
Serial number	01174831SKYCC28
Part Number	ST9100-D01-BETA
Software revision	4.0.3
Model Variant	ST9100-C01

3.3 Technical information

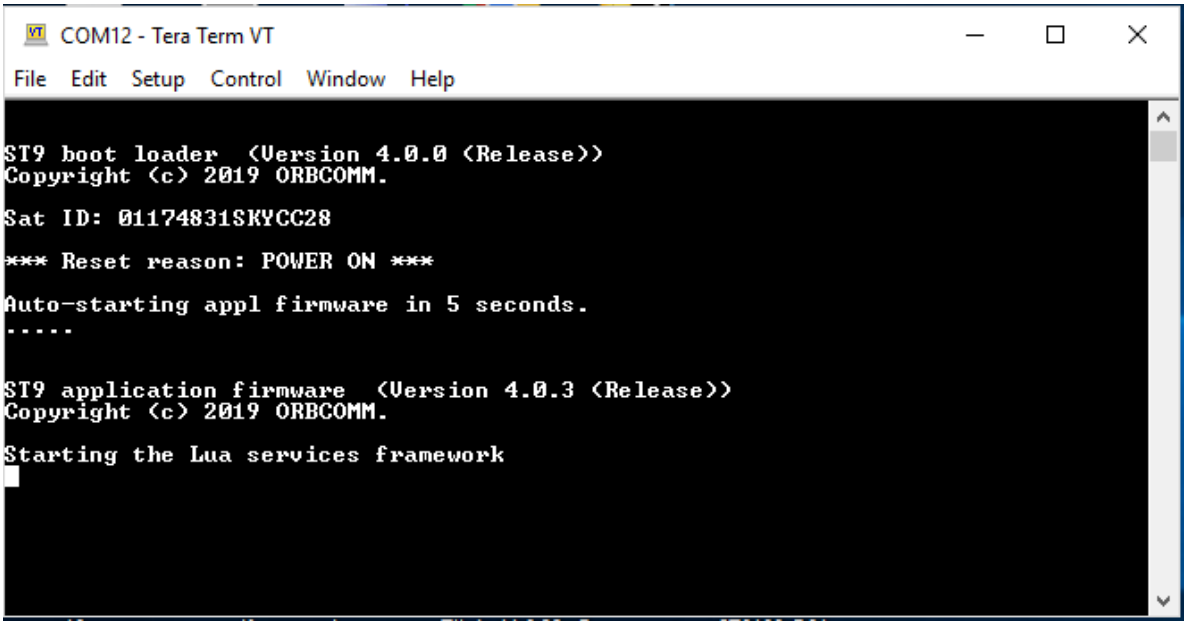
Applicant IC company number	3745A
IC UPN number	ST9100
All used IC test site(s) Reg. number	24676
RSS number and Issue number	RSS-170, Issue 3, July 9, 2015
Frequency band	1626.5–1660.5 MHz
Frequency Min (MHz)	1626.501
Frequency Max (MHz)	1660.499
RF power Max (W)	1.11 (30.46 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz) (99 %)	1.49
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	OQPSK
Emission classification (F1D, G1D, D1D)	G1D
Power requirements	24 V_{DC}
Antenna information	4.5 dBi peak, Model : ST901065, S/N: S0618N01WSJ EUT is designed so that the end user may replace a broken antenna. (The EUT has a non-standard antenna jack or electrical connector.)
Stated EIRP, dBm	37 (peak)

3.4 Product description and theory of operation

The EUT is a low data rate land mobile satellite earth station (LMES) that operates in microwave L-band (1.5/1.6 GHz) and it is designed to be used within Inmarsat global satellite network for asset tracking and management systems.

3.5 EUT exercise details

- EUT was controlled by TeraTerm, Version 4.102 session from Laptop to run the module to transmit a modulated signal for 2 sec ON and 2 sec OFF.
- Serial to USB cable, Baud rate is 9600
- Periodically an external CW calibration signal is required at 1543 MHz (-130 dBm) to lock EUT oscillator (open-loop system)



3.6 EUT setup diagram

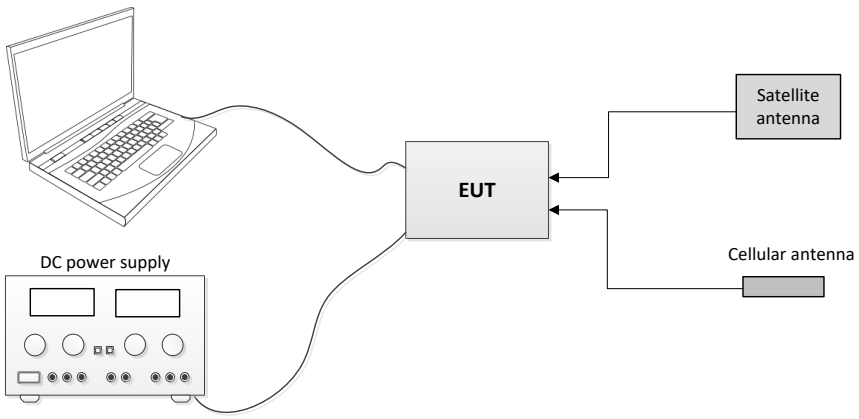


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Antenna	ORBCOMM	ST901065	S0618N01WSJ
Cellular Antenna	None	ST101066-001	None
Cable Harness	None	CA301009-001-E	None

Table 3.7-2: EUT support equipment

Description	Brand name	Model/Part number	Serial number
Laptop	Dell	Latitude E6420	DPN:VVF52 A01
DC power supply	GWInstek	GPR-3060D	None

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

The following modifications were performed by Nemko Canada:
EUT requires an external CW signal of -130 dBm @ 1543 MHz to calibrate the open loop local oscillator

4.2 Technical judgment

ST9100 product family have two models: ST9100-C01 and ST9100-D01. The two models use the identical enclosure. The difference between variant details are listed below:

Product model number	ST9100-C01	ST9100-D01	Note
Product description	Cellular + OGi satellite dual mode	Cellular + OGi satellite dual mode	–
HW configuration	Cellular radio global, Satellite radio, Bluetooth, GPS/GNSS receiver	Cellular radio N.A., Satellite radio, Bluetooth, GPS/GNSS receiver	Cellular modem is different. All other are identical in two variants
Cellular radio	LTE, UMTS/GSM, Global band	LTE, UMTS/GSM, N.A. bands mainly	–
Satellite radio	RX: 1525 - 1559MHz, TX: 1626.5 – 1660.5MHz	RX: 1525 - 1559MHz, TX: 1626.5 – 1660.5MHz	–

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 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.

5.2 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 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

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

Table 6.1-1: Measurement uncertainty

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

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	June 4, 2020
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	October 10, 2020
50 Ω coax cable	Huber + Suhner	None	FA003044	1 year	October 7, 2020
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	September 30, 2020
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003010	1 year	September 17, 2020
Horn antenna (1–18 GHz)	ETS Lindgren	3117	FA002911	1 year	September 11, 2020
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	September 26, 2020
Receiver/spectrum analyzer	Rohde & Schwarz	FSW43	FA002971	1 year	June 21, 2020
Vector Signal Generator	Rohde & Schwarz	SMW200A	FA002970	1 year	July 16, 2020
Temperature Chamber	Espec	EPX-4H	FA0003033	—	VOU

Note: NCR - no calibration required; VOU – verification on use

Section 8. Testing data

8.1 FCC 2.1049 and RSS-Gen 6.7 Occupied bandwidth

8.1.1 Definitions and limits

FCC:
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.

IC:
The emission bandwidth (× dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the 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.

8.1.2 Test summary

Test date	March 23, 2020
Test engineer	Kevin Rose
Verdict	Pass

8.1.3 Observations, settings and special notes

Measurement performed with reference to ANSI 63.26 section 5.4.4

Spectrum analyser settings for 99% occupied bandwidth:

Resolution bandwidth:	1 - 5 % OBW
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-1: 99 % bandwidth results

Frequency, MHz	99 % occupied bandwidth, kHz
1626.501	1.49
1642.000	1.48
1660.499	1.47

8.1.5 Test data, continued

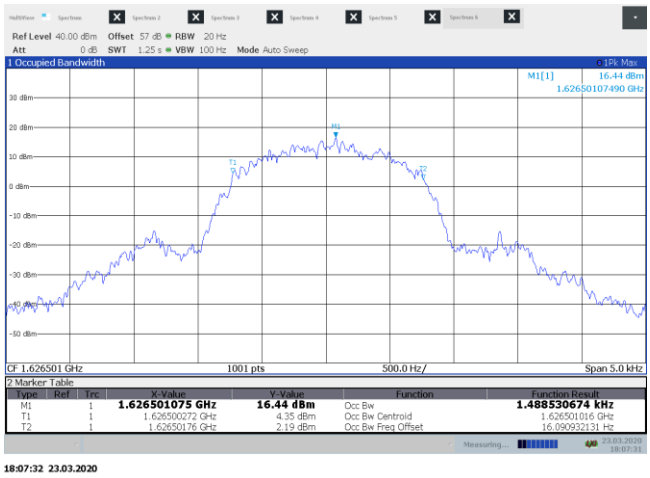


Figure 8.1-1: 99 % bandwidth on low channel

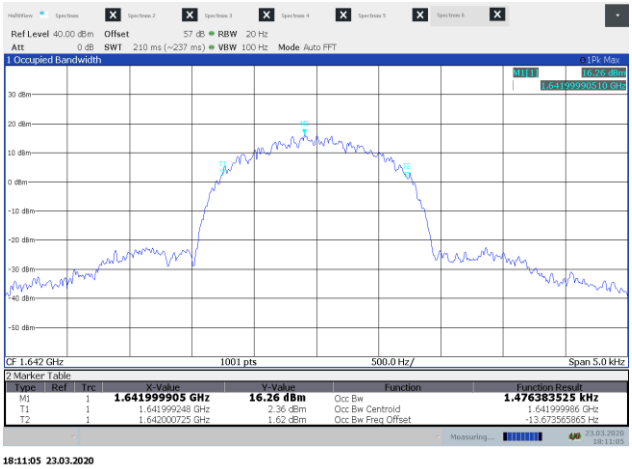


Figure 8.1-2: 99 % bandwidth on mid channel

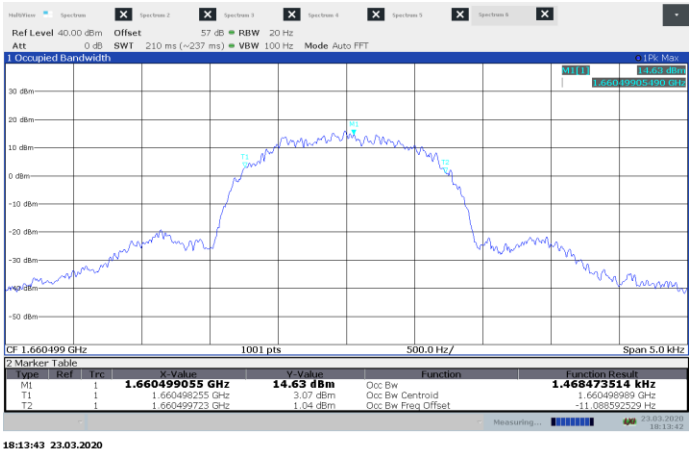


Figure 8.1-3: 99 % bandwidth on high channel

8.2 FCC 25.204 and RSS-170 5.3.2 Transmitter e.i.r.p. for mobile earth stations

8.2.1 Definitions and limits

FCC:

(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.

IC:

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.

8.2.2 Test summary

Test date	April 17, 2020
Test engineer	Kevin Rose
Verdict	Pass

8.2.3 Observations, settings and special notes

Measurements performed with reference to ANSI 63.26 section 5.2.3.3 for peak power of narrowband signal using a spectrum analyzer.
Resolution bandwidth of 5 kHz selected in lieu of a 4kHz to satisfy FCC requirement.

Spectrum analyser settings:

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

8.2.4 Test data

Table 8.2-1: Conducted peak output power measurement results - ISED

Frequency, MHz	Output power, dBm	Gain, dBi	EIRP, dBm	Stated EIRP, dBm	Maximum permissible EIRP, dBm	Margin, dB
1626.501	30.9	4.5	35.4	37.0	39.0	3.6
1642.000	30.8	4.5	35.3	37.0	39.0	3.7
1660.499	30.4	4.5	34.9	37.0	39.0	4.1

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

Table 8.2-2: Conducted peak output power measurement results - FCC

Frequency, MHz	Output power, dBm/5 kHz	Gain, dBi	EIRP, dBm/5 kHz	EIRP limit, dBm/4kHz	Margin, dB
1626.501	30.9	4.5	35.4	70	34.6
1642.000	30.8	4.5	35.3	70	34.7
1660.499	30.4	4.5	34.9	70	35.1

Note: EIRP limit, dBm/4kHz calculated as follows: 40 dBW = 70 dBm

8.2.5 Test data

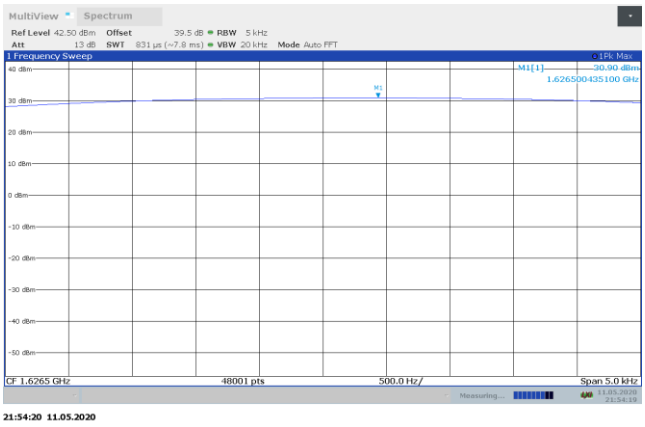


Figure 8.2-1: Conducted peak output power, low channel

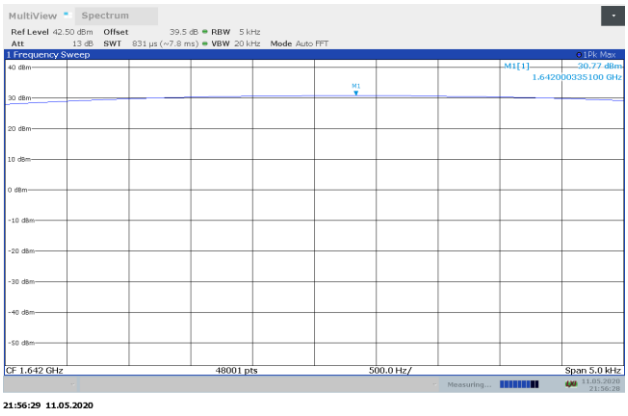


Figure 8.2-2: Conducted peak output power, mid channel

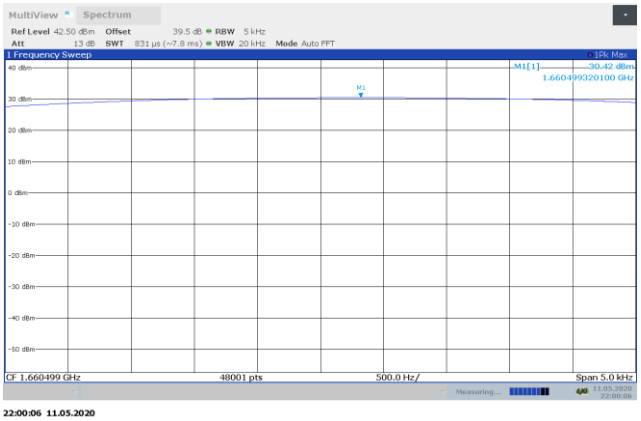


Figure 8.2-3: Conducted peak output power, high channel

8.3 FCC 25.202(f) and RSS-170 5.4 Field strength of spurious emissions

8.3.1 Definitions and limits

FCC:
(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.

ISED:
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 root-mean-square detector with a resolution bandwidth of 1 MHz for broadband emissions and a resolution bandwidth of 1 kHz for discrete emissions, unless stated otherwise.
5.4.3 Mobile Earth Stations
5.4.3.1 Mobile Earth Stations in All Frequency Bands
The average power of unwanted emissions shall be attenuated below the average output power, P(dBW), of the transmitter, as specified below:
(1) 25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 50%, up to and including 100% of the occupied bandwidth;
(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;
(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.
5.4.4 Carrier-off State Emissions
Mobile equipment with transmitting frequencies between 1 GHz and 3 GHz shall have the e.i.r.p. density of carrier‑off state emissions in the band 1559–1610 MHz not exceed −80 dBW/MHz.

8.3.2 Test summary

Test date	May 12, 2020
Test engineer	Kevin Rose
Verdict	Pass

8.3.3 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
Authorized bandwidth (2 kHz) > Occupied bandwidth (1.4 kHz). Therefore, the authorized bandwidth was used to calculate spurious emission mask.

50 - 100% Authorized bandwidth = ± 1 kHz, - 25 dBc/ 4 kHz
100 - 250 % Authorized bandwidth = ± 2 kHz, - 35 dBc/ 4 kHz
> 250% Authorized bandwidth = ± 5 kHz, -13 dBm/ 4 kHz

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)

Signal type is CW like with 100% duty cycle. Average mean power of fundamental using integration method is greater vs. peak power measured in section 8.2. This measurement variance is dependent on the measurement type selected for narrowband signals in ANSI 63.26 (2015).

Spectrum analyser settings for conducted spurious emissions measurements 30 MHz – 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	20 Hz
Video bandwidth	3 kHz
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

8.3.4 Test data

Emissions in 50 - 100% Authorized bandwidth

Frequency, (MHz)	Mean output power, (dBm/2 kHz)	Scaled mean average power, (dBm/4 kHz)	Mean adjacent power 50 - 100% BW, (dBm/kHz)	Scaled mean adjacent power 50 -100% BW, (dBm/4 kHz)	Limit, 50-100% dBc /4 kHz	Margin, (dB)
1626.500	29.2	32.2	-8.4	-2.4	7.2	9.6
1660.499.	28.8	31.8	-7.65	-1.7	6.8	8.5

Note: Scaled power = measured power + 10log(Reference BW/Measurement BW), Limit = scaled mean average power, dBm/4 kHz - 25 dBc

Emissions in 100 - 250 % Authorized bandwidth

Frequency, (MHz)	Mean output power, (dBm/2 kHz)	Scaled mean average power (dBm/4 kHz)	Mean adjacent power 100 - 250% BW, (dBm/kHz)	Scaled mean adjacent power 100 - 250% BW, (dBm/4 kHz)	Limit 100-250% dBc /4 kHz	Margin, (dB)
1626.500	29.2	32.2	-22.5	-21.3	-2.8	18.5
1660.499.	28.8	31.8	-21.8	-20.6	-3.2	17.4

Note: Scaled power = measured power + 10log(Reference BW/Measurement BW), Limit = scaled mean average power, dBm/4 kHz - 35 dBc

8.3.5 Test data, continued

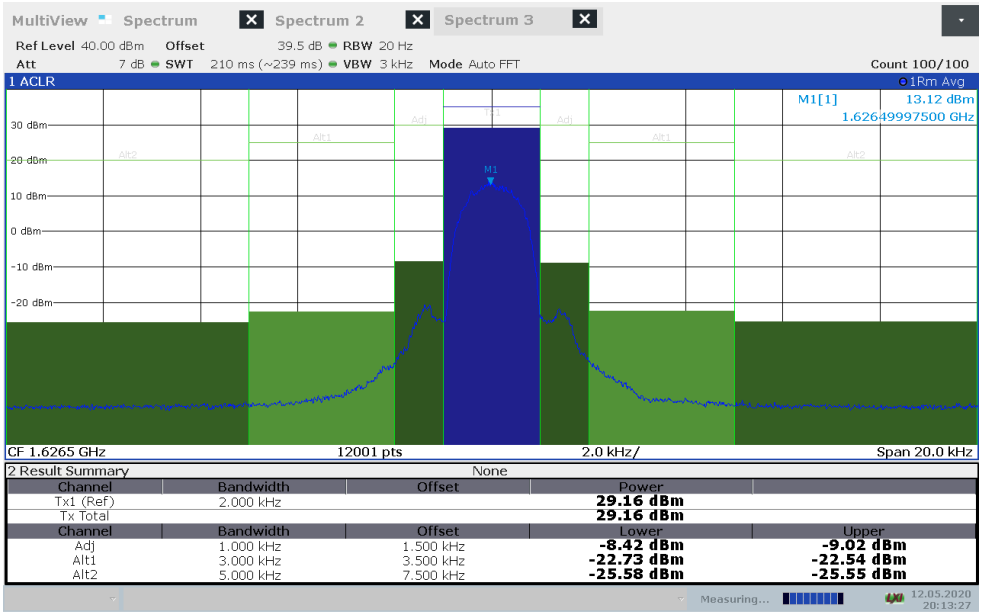


Figure 8.3-1: Conducted band edge spurious emissions outside assigned bandwidth, low channel

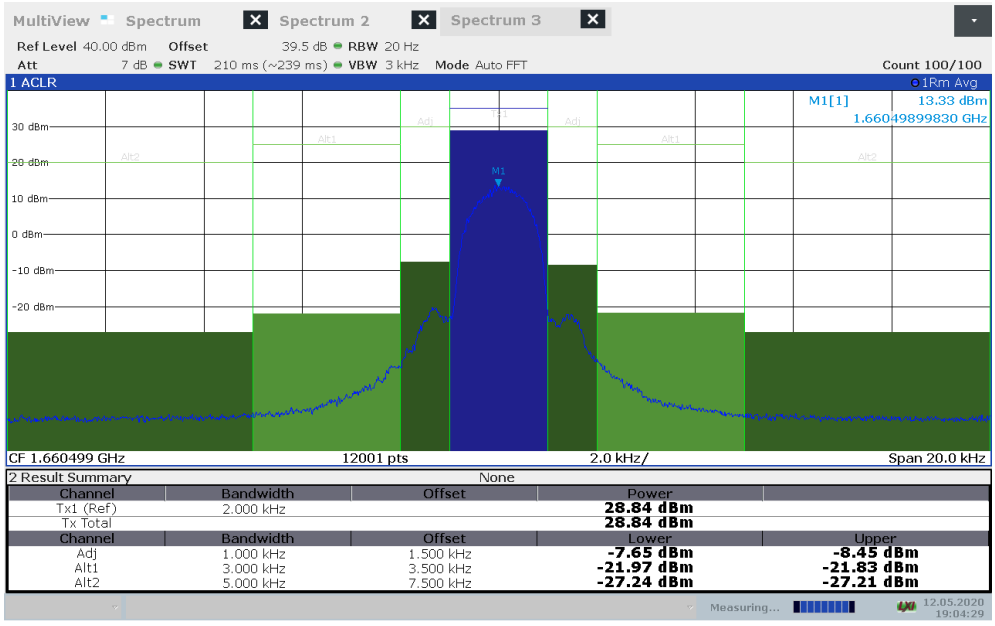


Figure 8.3-2: Conducted band edge spurious emissions outside assigned bandwidth, high channel

8.3.6 Test data, radiated spurious emissions 30 MHz – 1 GHz

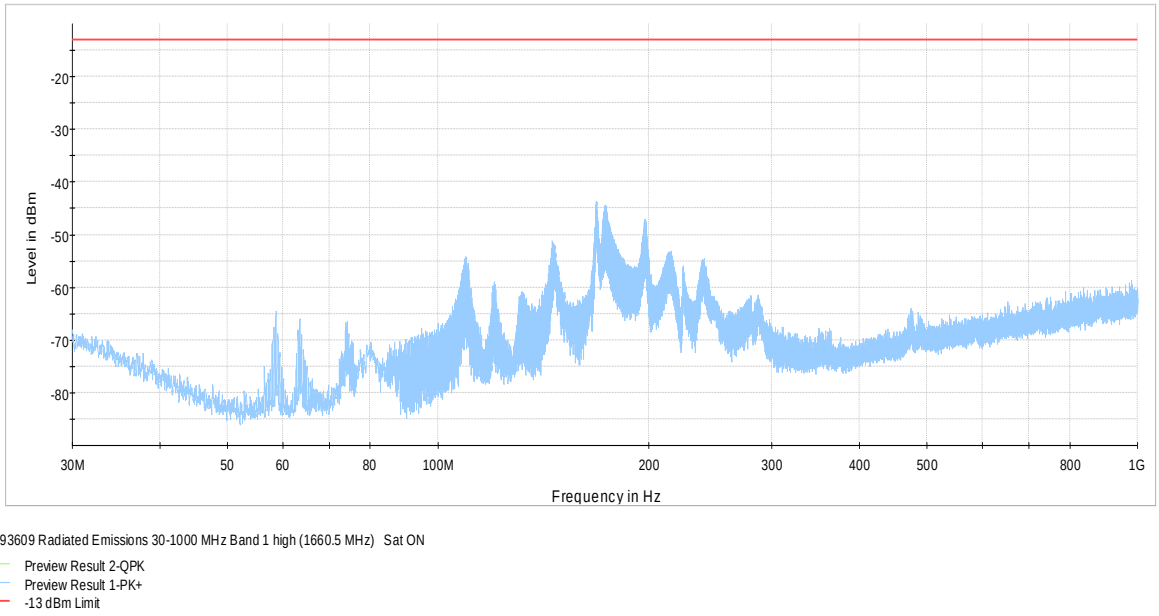


Figure 8.3-2: Spurious emissions below 1 GHz, low channel

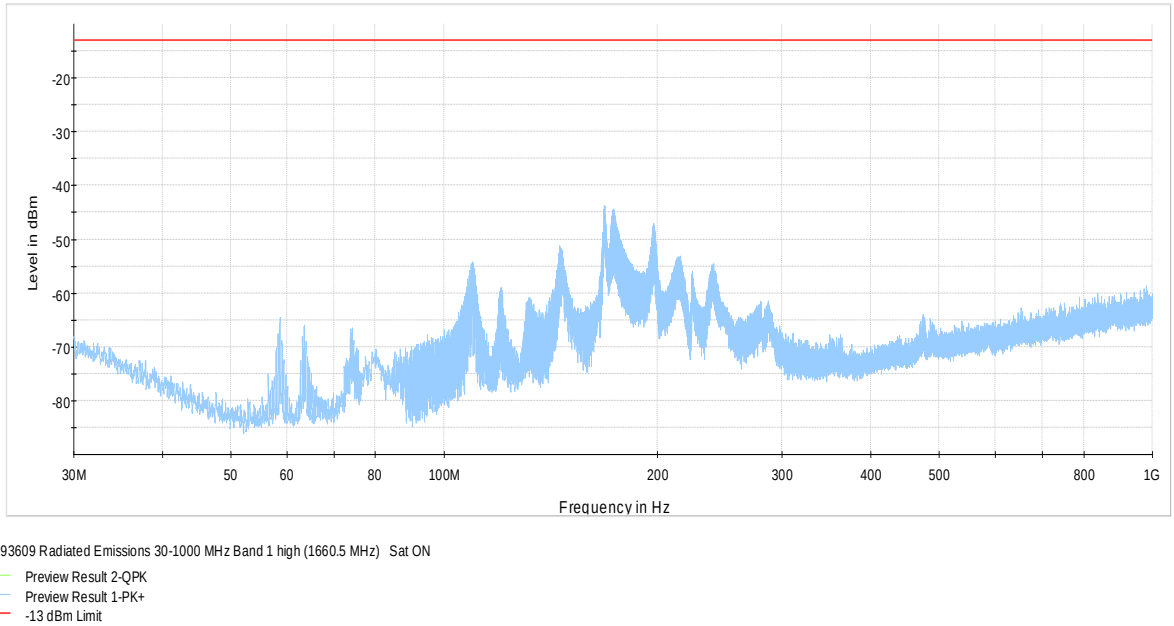


Figure 8.3-3: Spurious emissions below 1 GHz, high channel

8.3.7 Test data, radiated spurious emissions 1 – 3 GHz

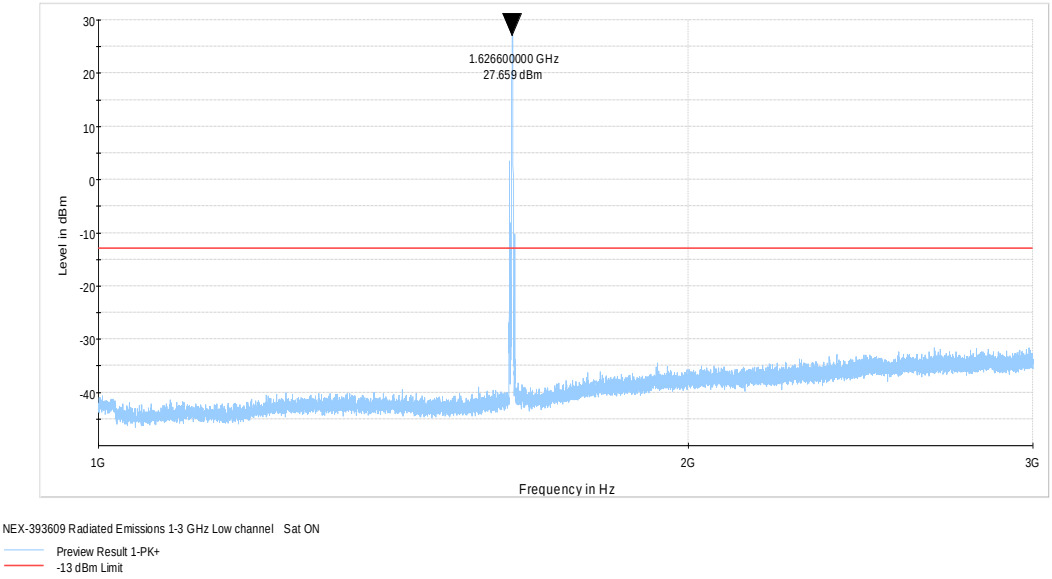


Figure 8.3-4: Radiated spurious emissions 1–3 GHz, low channel

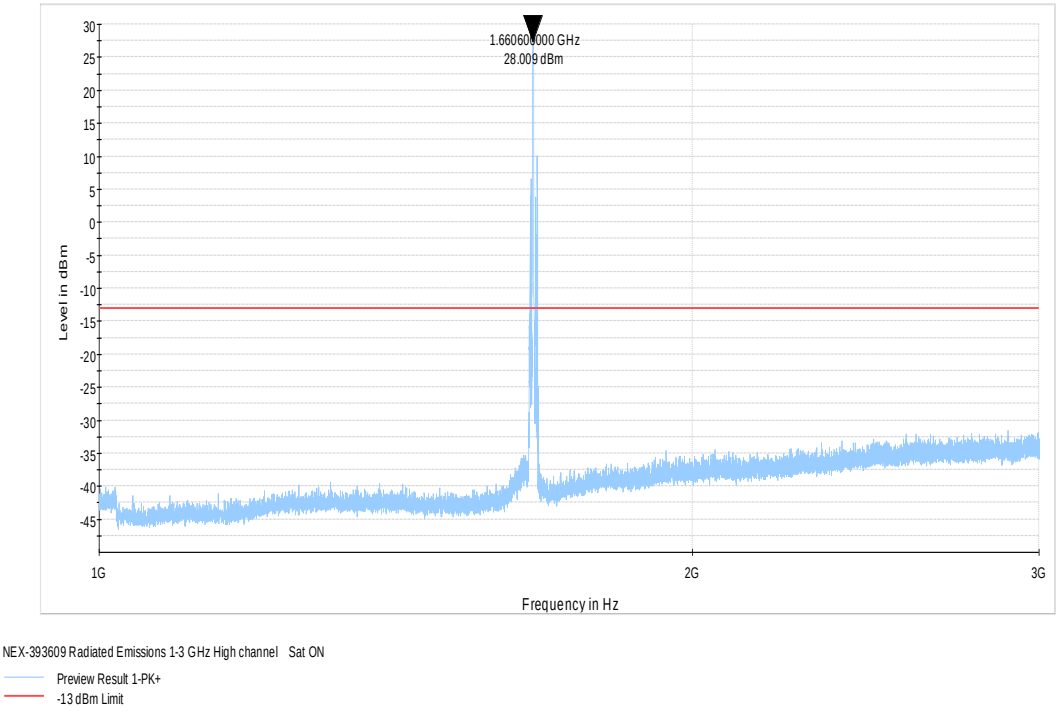


Figure 8.3-5: Radiated spurious emissions 1–3 GHz, high channel

8.3.8 Test data, radiated spurious emissions 3 – 18 GHz

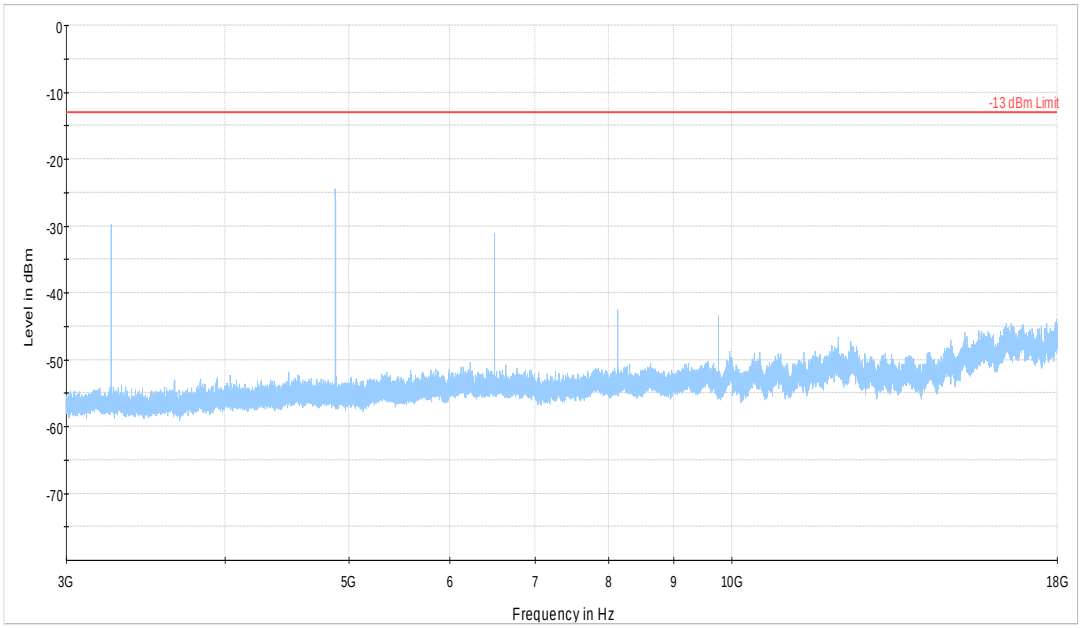


Figure 8.3-6: Radiated spurious emissions 3 – 18 GHz, low channel

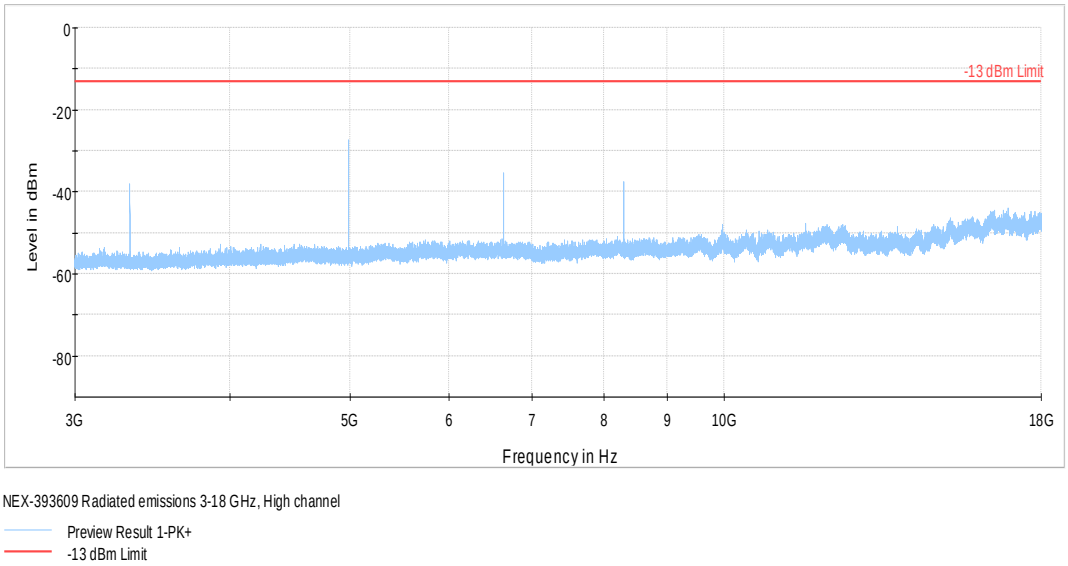
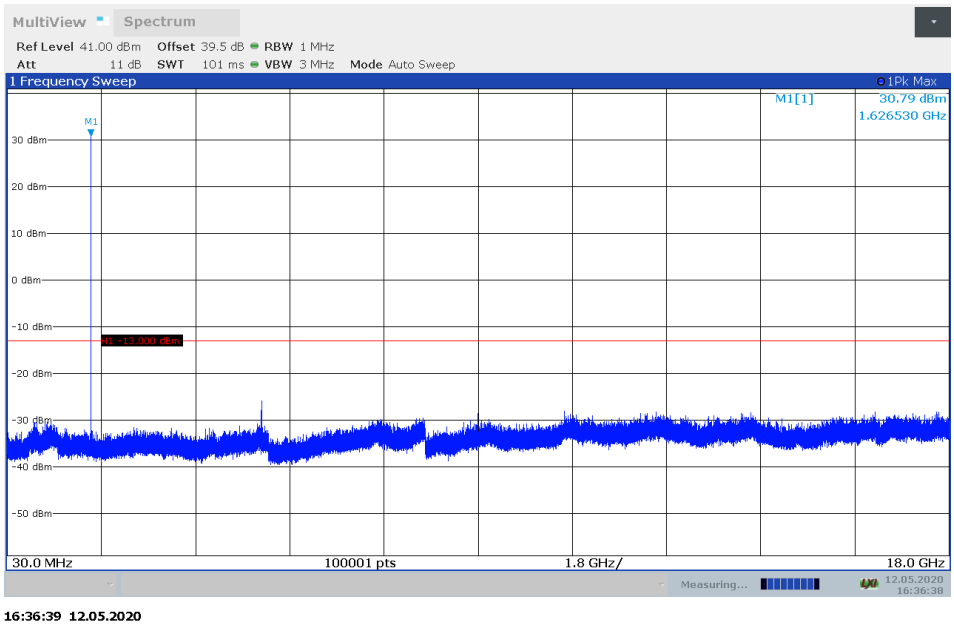


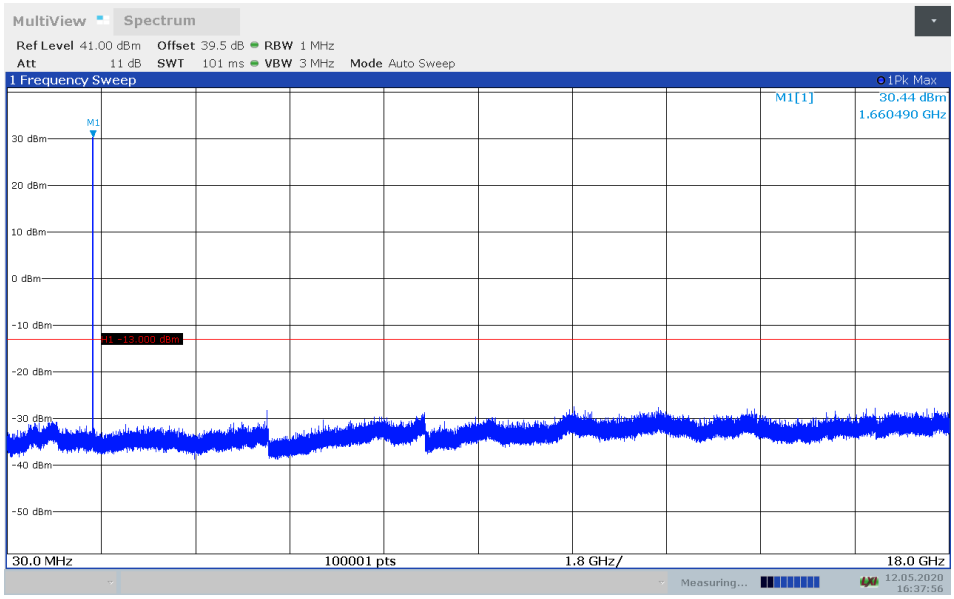
Figure 8.3-7: Radiated spurious emissions 3 – 18 GHz, high channel

8.3.9 Test data, conducted spurious emissions 30 MHz – 18 GHz



16:36:39 12.05.2020

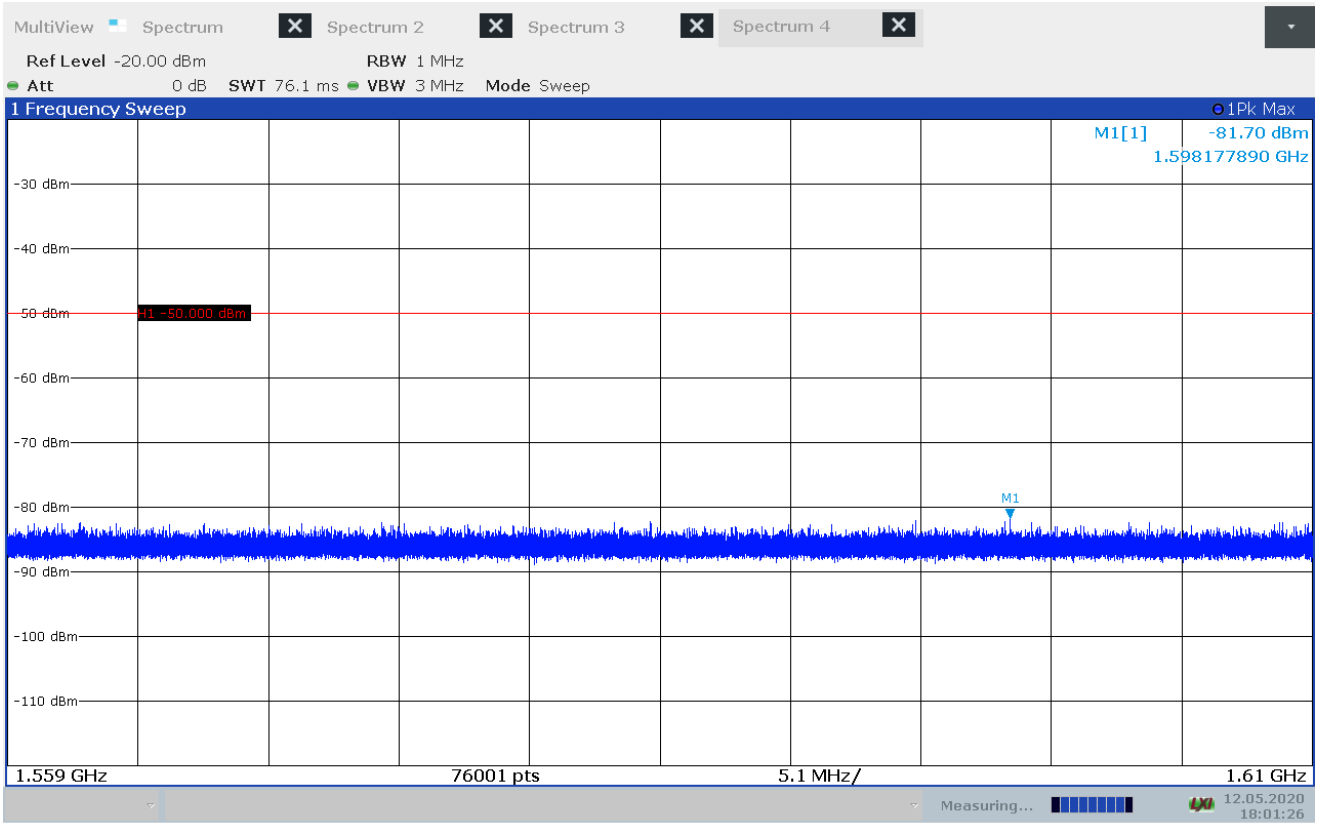
Figure 8.3-8: Conducted spurious emissions, low channel



16:37:57 12.05.2020

Figure 8.3-9: Conducted spurious emissions, high channel

8.3.10 Test data, conducted carrier-off state emissions, 1559-1610 MHz



18:01:27 12.05.2020

Figure 8.3-10: Conducted emissions 1559 – 1610 MHz, Carrier-off state

8.4 FCC 25.202(d) and RSS-170 5.2 Frequency tolerance, Earth stations

8.4.1 Definitions and limits

FCC:
The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent (±10 ppm) of the reference frequency.

§2.1055 Frequency stability
(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From −30°C to +50°C for all equipment except that specified in paragraphs (a)(2) and (3) of this section
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10 °C through the range.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

ISED:
For mobile earth station equipment, the carrier frequency shall not depart from the reference frequency by more than ±10 ppm.

8.4.2 Test summary

Test date	March 23, 2020
Test engineer	Kevin Rose
Verdict	Pass

8.4.3 Observations, settings and special notes

Frequency stability measurements were performed with reference to ANSI 63.26 section 5.6.3 and section 5.6.5

Spectrum analyser settings:

Resolution bandwidth:	20 Hz
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

Table 8.4-1: Frequency tolerance measurement result – Low channel

Test conditions	Frequency, Hz	Offset, ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	1.626501055	0.0240	10.0000	9.9760
+40 °C, Nominal	1.626501088	0.0443	10.0000	9.9557
+30 °C, Nominal	1.626501081	0.0400	10.0000	9.9600
+20 °C, +15 %	1.626500993	0.0141	10.0000	9.9859
+20 °C, Nominal	**1.626501016**		**Reference**	
+20 °C, -15 %	1.62650101	0.0037	10.0000	9.9963
+10 °C, Nominal	1.626500853	0.1002	10.0000	9.8998
0 °C, Nominal	1.626500851	0.1014	10.0000	9.8986
−10 °C, Nominal	1.626500855	0.0990	10.0000	9.9010
−20 °C, Nominal	1.626500838	0.1094	10.0000	9.8906
−30 °C, Nominal	1.626500774	0.1488	10.0000	9.8512

Note: Offset was calculated as per the following formula: $\frac{F_{Measured} - F_{reference}}{F_{reference}} \times 1 \cdot 10^{6}$

Table 8.4-2: Frequency tolerance measurement result – Mid channel

Test conditions	Frequency, Hz	Offset, ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	1.642000007	0.0128	10.0000	9.9872
+40 °C, Nominal	1.642000094	0.0658	10.0000	9.9342
+30 °C, Nominal	1.642000053	0.0408	10.0000	9.9592
+20 °C, +15 %	1.642000013	0.0164	10.0000	9.9836
+20 °C, Nominal	**1.641999986**		**Reference**	
+20 °C, -15 %	1.642000004	0.0110	10.0000	9.9890
+10 °C, Nominal	1.641999885	0.0615	10.0000	9.9385
0 °C, Nominal	1.641999853	0.0810	10.0000	9.9190
−10 °C, Nominal	1.641999851	0.0822	10.0000	9.9178
−20 °C, Nominal	1.64199983	0.0950	10.0000	9.9050
−30 °C, Nominal	1.641999792	0.1181	10.0000	9.8819

Note: Offset was calculated as per the following formula: $\frac{F_{Measured} - F_{reference}}{F_{reference}} \times 1 \cdot 10^{6}$

Table 8.4-3: Frequency tolerance measurement result – High channel

Test conditions	Frequency, Hz	Offset, ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	1.660499065	0.0458	10.0000	9.9542
+40 °C, Nominal	1.660499081	0.0554	10.0000	9.9446
+30 °C, Nominal	1.660498991	0.0012	10.0000	9.9988
+20 °C, +15 %	1.660499019	0.0181	10.0000	9.9819
+20 °C, Nominal	**1.660498989**		**Reference**	
+20 °C, -15 %	1.660499018	0.0175	10.0000	9.9825
+10 °C, Nominal	1.660498911	0.0470	10.0000	9.9530
0 °C, Nominal	1.660498858	0.0789	10.0000	9.9211
−10 °C, Nominal	1.660498869	0.0723	10.0000	9.9277
−20 °C, Nominal	1.660498788	0.1210	10.0000	9.8790
−30 °C, Nominal	1.660498794	0.1174	10.0000	9.8826

Note: Offset was calculated as per the following formula: $\frac{F_{Measured} - F_{reference}}{F_{reference}} \times 1 \cdot 10^{6}$

8.5 FCC 25.216 and RSS-170 5.4.3.2 Limits on emissions from MESs for protection of aeronautical radionavigation-satellite service

8.5.1 Definitions and limits

FCC:
(c) The e.i.r.p. density of emissions from mobile earth stations with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed −70 dBW/MHz (−40 dBm/MHz), averaged over any 2 millisecond active transmission interval, in the band 1559–1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed −80 dBW (−50 dBm), averaged over any 2 millisecond active transmission interval, in the 1559–1605 MHz band.

(f) Mobile earth stations with assigned uplink frequencies in the 1610–1660.5 MHz band shall suppress the power density of emissions in the 1605–1610 MHz band to an extent determined by linear interpolation from −70 dBW/MHz (−40 dBm/MHz) at 1605 MHz to −10 dBW/MHz (20 dBm/MHz) at 1610 MHz.

IC:
Mobile earth stations with transmitting frequencies between 1626.5 and 1660.5 MHz shall have the e.i.r.p. density of unwanted emissions in the band 1605–1610 MHz, averaged over any 2 ms active transmission interval, not exceed the following limits:
(1) −70 dBW/MHz (−40 dBm/MHz) at 1605 MHz, linearly interpolated to −46 dBW/MHz (−16 dBm/MHz) at 1610 MHz, for broadband emissions; and
(2) −80 dBW/kHz (−50 dBm/kHz) at 1605 MHz, linearly interpolated to −56 dBW/kHz (−26 dBm/kHz) at 1610 MHz, for discrete emissions.

8.5.2 Test summary

Test date	March 9, 2020
Test engineer	Kevin Rose
Verdict	Pass

8.5.3 Observations, settings and special notes

The test was performed radiated at the distance of 3 m. (Direct radiated field strength method based on a pre-characterized path loss per ANSI 63.4)

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	RMS
Trace mode	Max-hold

8.5.4 Test data, FCC

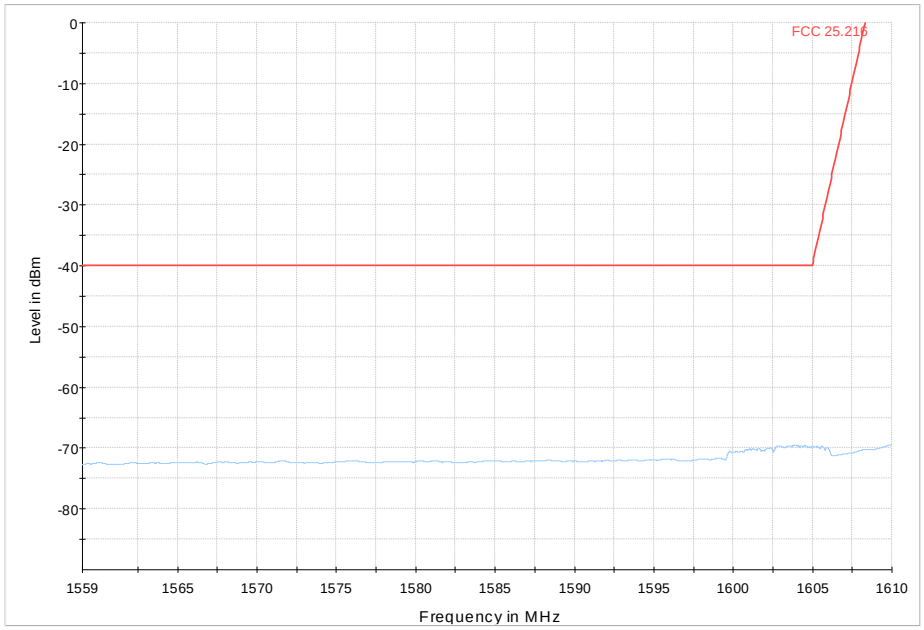


Figure 8.5-1: Radiated spurious emissions 1559–1610 MHz, low channel, FCC limit

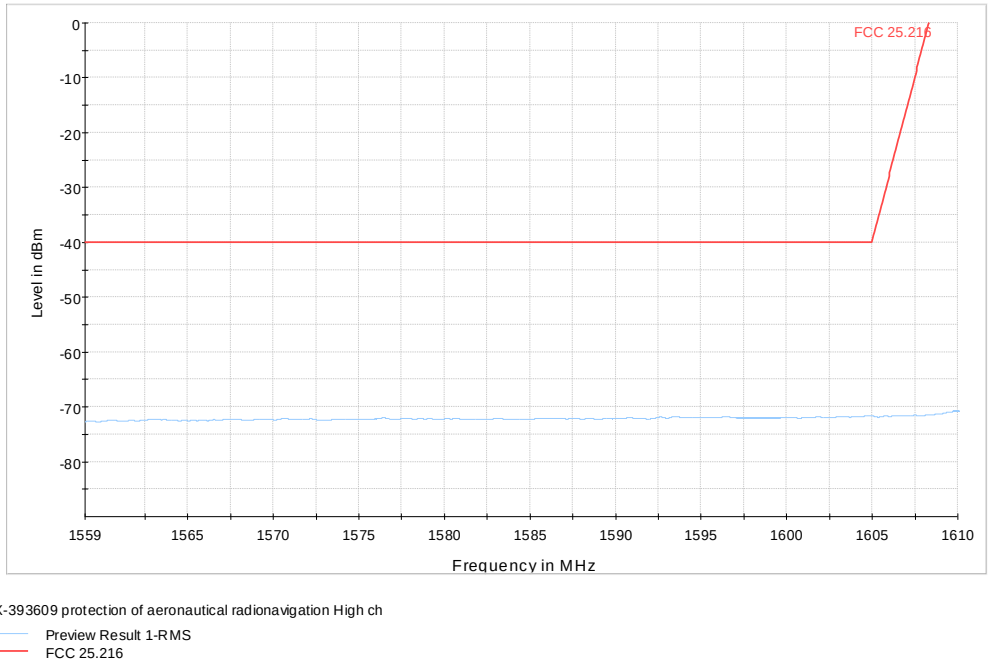


Figure 8.5-2: Radiated spurious emissions 1559–1610 MHz, high channel, FCC limit

8.5.5 Test data, ISED

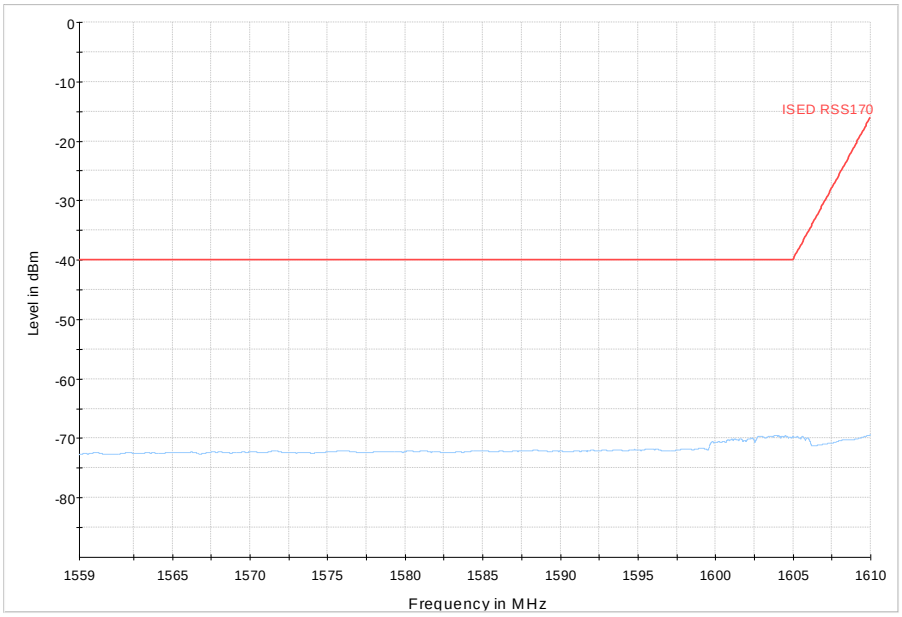


Figure 8.5-3: Radiated spurious emissions 1559–1610 MHz, low channel, ISED limit

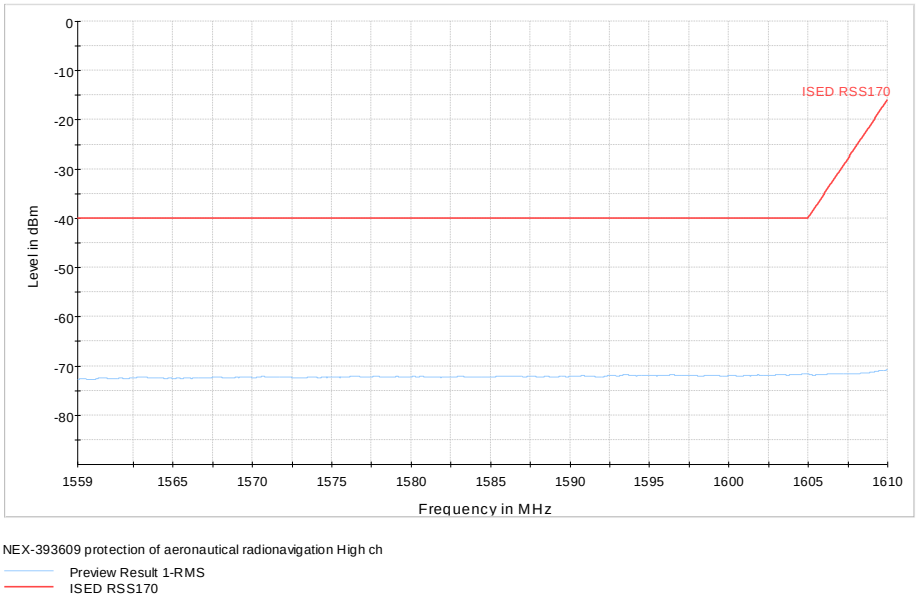
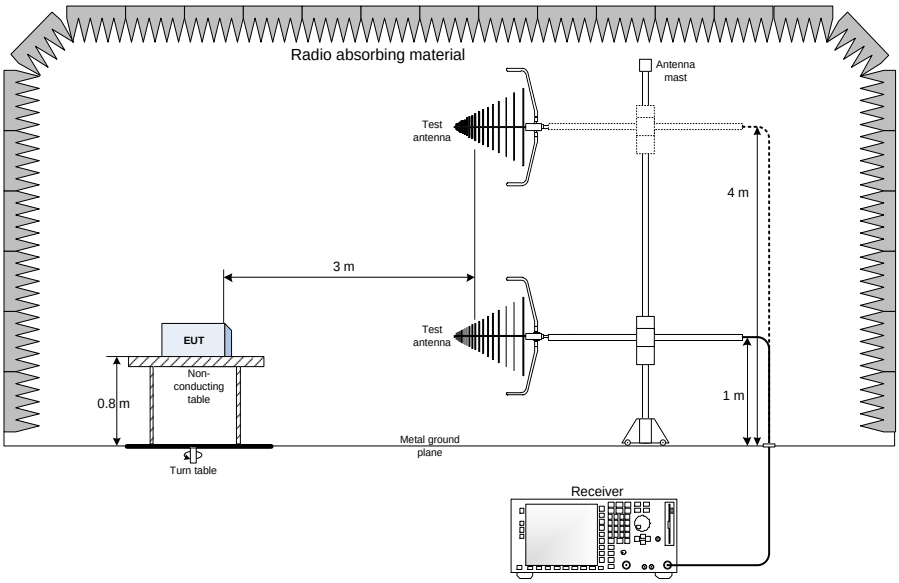


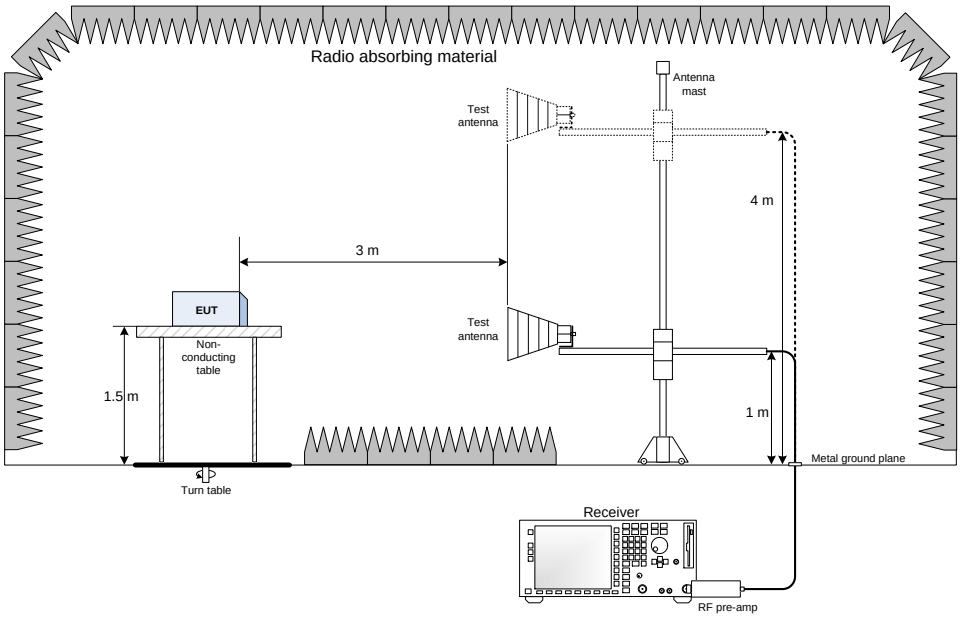
Figure 8.5-4: Radiated spurious emissions 1559–1610 MHz, high channel, ISED limit

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted measurement set-up