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Radio Test report – 382276-1TRFWL

Applicant:

Redline Communications

Product:

LTE Base Station

Model:

Ellipse 4G HP Band 5

FCC ID:

QC8-B5

ISED Registration Number:

4310A-B5

Requirements/Summary:

Standard	Environmental phenomenon	Compliance
FCC 47 CFR Part 22	Public mobile services	Yes
RSS-132 Issue 3, January 2013	Cellular Telephone Systems Operating in the Bands 824–849 MHz and 869–894 MHz	Yes

Date of issue: October 15, 2019

Andrey Adelberg, Senior Wireless/EMC Specialist
Test engineer(s)

Andrey Adelberg
Signature

Kevin Rose, Wireless/EMC Specialist
Reviewed by

Signature

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	Test site registration number: FCC: CA2040; ISED: 2040A-4 (3 m semi anechoic chamber)

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 contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Redline Communications
Address	302 Town Center Blvd., Markham, ON, Canada, L3R 0E8

1.2 Test specifications

FCC 47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
FCC 47 CFR Part 22	Public mobile services
RSS-132 Issue 3, January 2013	Cellular Telephone Systems Operating in the Bands 824–849 MHz and 869–894 MHz
RSS-Gen, Issue 5, April 2018	General Requirements for Compliance of Radio Apparatus

1.3 Test method

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
KDB 662911 D01	Multiple Transmitter Output v02r01
KDB 662911 D02	MIMO with Cross-Polarized Antennas v01

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.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 22 test results

Part	Test description	Verdict
§22.913	Effective radiated power limits	Reported
§22.917(a)	Emission limitations for cellular equipment	Pass
§22.917(b)	Emission bandwidth	Pass
§22.355	Frequency tolerance	Pass

Notes: None

2.2 RSS-132 test results

Part	Test description	Verdict
5.4	Transmitter output power and Equivalent Isotropic Radiated Power (e.i.r.p.)	Pass
5.5	Spurious emissions at RF antenna connector	Pass
5.5	Radiated spurious emissions	Pass
5.3	Transmitter frequency stability	Pass
RSS-Gen, 6.7	Occupied bandwidth	Pass
5.6	Receiver Spurious Emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 16, 2019

3.2 EUT information

Product name	LTE Base Station
Model	Ellipse 4G HP Band 5
Part number	RDL6000 L1
Serial number	355RM19360001
Antenna ports	2 TX/RX Ports
Frequency bands	TX (DL): 869–894 MHz RX (UL): 824–849MHz
Modulation	LTE: QPSK, 16 QAM, 64 QAM
Channel bandwidth	LTE: 3 MHz, 5 MHz and 10 MHz
Power requirements	48 V_{DC}, 1.7 A via 100–240 V_{AC}, 50/60 Hz power supply
Regulatory requirements	Radio: FCC Parts 2, 22; ISED: RSS-132, RSS-Gen
	EMC: FCC Part 15 Subpart B; ICES-003
	Safety: Pending: IEC/EN 60950-1, CAN/CSA-C22.2 No. 60950-1-07, UL 60950-1-2007, 2nd Ed.) IEC/EN 60950-22, CSA 94.2/UL50E
Emission Designator:	3M00W7D, 5M00W7D, 10M0W7D
Supported Configuration	Single Antenna, TX Diversity, MIMO
Operating temperature	−40 °C to +65 °C
Total Power per port	6.5 W (38 dBm)

3.3 Product description and theory of operation

Ellipse 4G HP is an all outdoor LTE eNodeB (E-UTRAN Node B) single band small cell base station operating in LTE Band 5 (869–894 MHz).

3.4 EUT exercise details

EUT was controlled using laptop, connected to Ethernet port via IP address: 192.168.25.149.
EUT was configured using Tera Term sessions with pre-loaded macros for quick system responses.

3.5 EUT setup diagram

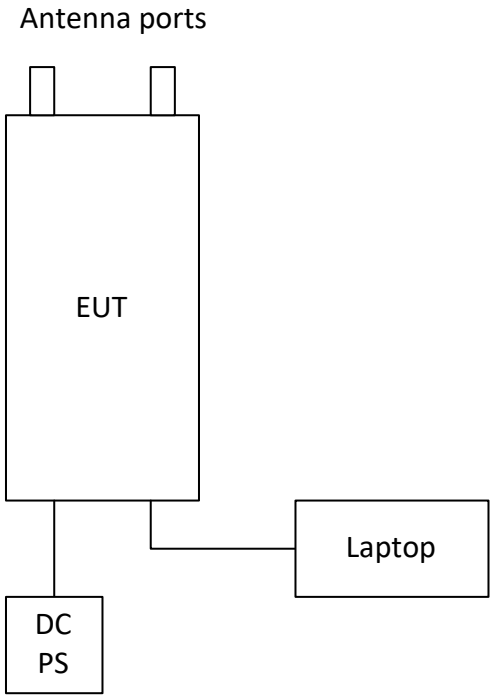


Figure 3.5-1: *Setup diagram*

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

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

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

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.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	January 24, 2020
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 8, 2020
Horn (1–18 GHz)	ETS Lindgren	3117	FA002840	1 year	January 16, 2020
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002873	1 year	November 4, 2019
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 3, 2020
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	October 26, 2019
Temperature chamber	Espec	EPX-4H	FA002735	1 year	September 11, 2020

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 22.913(a) and RSS-132 5.4 Maximum ERP

8.1.1 Definitions and limits

FCC:
Licensees in the Cellular Radiotelephone Service are subject to the effective radiated power (ERP) limits and other requirements in this Section. See also §22.169.

(a) Maximum ERP. The ERP of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(1) Except as described in paragraphs (a)(2), (3), and (4) of this section, the ERP of base stations and repeaters must not exceed—

(i) 500 watts per emission; or

(ii) 400 watts/MHz (PSD) per sector.

(2) Except as described in paragraphs (a)(3) and (4) of this section, for systems operating in areas more than 72 kilometers (45 miles) from international borders that:

(i) Are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census; or

(ii) Extend coverage into Unserved Area on a secondary basis (see §22.949), the ERP of base transmitters and repeaters must not exceed—

(A) 1000 watts per emission; or

(B) 800 watts/MHz (PSD) per sector.

(3) Provided that they also comply with paragraphs (b) and (c) of this section, licensees are permitted to operate their base transmitters and repeaters with an ERP greater than 400 watts/MHz (PSD) per sector, up to a maximum ERP of 1000 watts/MHz (PSD) per sector unless they meet the conditions in paragraph (a)(4) of this section.

(4) Provided that they also comply with paragraphs (b) and (c) of this section, licensees of systems operating in areas more than 72 kilometers (45 miles) from international borders that:

(i) Are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census; or

(ii) Extend coverage into Unserved Area on a secondary basis (see §22.949), are permitted to operate base transmitters and repeaters with an ERP greater than 800 watts/MHz (PSD) per sector, up to a maximum of 2000 watts/MHz (PSD) per sector.
ISED:
The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts. Refer to SRSP-503 for base station e.i.r.p. limits.
In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.
SRSP-503 for base station e.i.r.p. limits
5.1.1 Base stations for digital systems are limited to 1640 watts maximum equivalent isotropically radiated power (EIRP) with an antenna height above average terrain (HAAT) up to 150 m, except in urban areas where they are limited to a maximum allowable EIRP of 820 watts.

8.1.2 Test summary

Test date	September 20, 2019

8.1.3 Observations, settings and special notes

Based on the maximum RF power listed in this report, considerations pertaining to the maximum allowed ERP and antenna type should be considered for each installation. Maximum recommended antenna gain without power reduction is 18.9 dBd.
Measurement was performed using RMS power measurement technique of the Spectrum analyser.
Note: Maximum antenna gain calculation: ERP limit – Max output power = 60.0 dBm – 41.1 dBm = 18.9 dBd.
For MIMO mode, linear summation of power from individual antenna ports was performed using the following calculation:
Total power = $10 \times \text{Log}_{10}$ **(**$(10^{P1/10}) + (10^{P2/10})$**)**, where P1 and P2 are powers (in dBm) from antenna ports 1 and 2.
Based on manufacturer declaration the uncorrelated MIMO approach is used with this product, therefore no antenna gain summation is needed.

8.1.4 Test data

Table 8.1-1: *Output power measurement results for SISO (3 MHz channel BW)*

Modulation	Frequency, MHz	PSD, Port 1, dBm/MHz	RF Power, Port 1, dBm	RF Power, Port 1, W	PSD, Port 2, dBm/MHz	RF Power, Port 2, dBm	RF Power, Port 2, W
QPSK	870.5	34.89	37.84	6.08	34.20	37.27	5.33
QPSK	881.5	34.73	37.98	6.28	34.37	37.50	5.62
QPSK	892.5	34.76	37.77	5.98	34.22	37.38	5.47
16QAM	870.5	34.32	38.18	6.58	33.83	37.54	5.68
16QAM	881.5	34.49	38.08	6.43	34.18	37.60	5.75
16QAM	892.5	34.66	37.95	6.24	34.11	37.57	5.71
64QAM	870.5	34.41	37.95	6.24	33.99	37.48	5.60
64QAM	881.5	34.48	38.06	6.40	34.17	37.71	5.90
64QAM	892.5	34.32	37.80	6.03	33.87	37.40	5.50

Table 8.1-2: *Output power measurement results for MIMO 2×2 (3 MHz channel BW)*

Modulation	Frequency, MHz	Power, Port 1, dBm	Power, Port 2, dBm	Total MIMO power, dBm	Total MIMO power, W
QPSK	870.5	37.84	37.27	40.57	11.41
QPSK	881.5	37.98	37.50	40.76	11.90
QPSK	892.5	37.77	37.38	40.59	11.45
16QAM	870.5	38.18	37.54	40.88	12.25
16QAM	881.5	38.08	37.60	40.86	12.18
16QAM	892.5	37.95	37.57	40.77	11.95
64QAM	870.5	37.95	37.48	40.73	11.83
64QAM	881.5	38.06	37.71	40.90	12.30
64QAM	892.5	37.80	37.40	40.61	11.52

Table 8.1-3: *Output power measurement results for SISO (5 MHz channel BW)*

Modulation	Frequency, MHz	PSD, Port 1, dBm/MHz	RF Power, Port 1, dBm	RF Power, Port 1, W	PSD, Port 2, dBm/MHz	RF Power, Port 2, dBm	RF Power, Port 2, W
QPSK	871.5	32.46	38.11	6.47	31.82	37.40	5.50
QPSK	881.5	32.43	38.03	6.35	31.93	37.55	5.69
QPSK	891.5	32.28	37.90	6.17	31.87	37.54	5.68
16QAM	871.5	32.73	37.97	6.27	31.95	37.34	5.42
16QAM	881.5	32.99	38.21	6.62	32.61	37.66	5.83
16QAM	891.5	32.56	37.87	6.12	32.29	37.60	5.75
64QAM	871.5	32.67	38.21	6.62	32.11	37.72	5.92
64QAM	881.5	32.69	38.24	6.67	32.15	37.75	5.96
64QAM	891.5	32.46	37.99	6.30	31.94	37.55	5.69

Table 8.1-4: *Output power measurement results for MIMO 2×2 (5 MHz channel BW)*

Modulation	Frequency, MHz	Power, Port 1, dBm	Power, Port 2, dBm	Total MIMO power, dBm	Total MIMO power, W
QPSK	871.5	38.11	37.40	40.78	11.97
QPSK	881.5	38.03	37.55	40.81	12.04
QPSK	891.5	37.90	37.54	40.73	11.84
16QAM	871.5	37.97	37.34	40.68	11.69
16QAM	881.5	38.21	37.66	40.95	12.46
16QAM	891.5	37.87	37.60	40.75	11.88
64QAM	871.5	38.21	37.72	40.98	12.54
64QAM	881.5	38.24	37.75	41.01	12.62
64QAM	891.5	37.99	37.55	40.79	11.98

Table 8.1-5: *Output power measurement results for SISO (10 MHz channel BW)*

Modulation	Frequency, MHz	PSD, Port 1, dBm/MHz	RF Power, Port 1, dBm	RF Power, Port 1, W	PSD, Port 2, dBm/MHz	RF Power, Port 2, dBm	RF Power, Port 2, W
QPSK	874.0	29.53	38.13	6.50	28.97	37.57	5.71
QPSK	881.5	29.68	38.17	6.56	29.33	37.84	6.08
QPSK	889.0	29.29	37.95	6.24	28.92	37.53	5.66
16QAM	874.0	29.72	38.05	6.38	29.18	37.51	5.64
16QAM	881.5	29.89	38.15	6.53	29.68	37.79	6.01
16QAM	889.0	29.56	37.90	6.17	29.24	37.55	5.69
64QAM	874.0	29.38	38.10	6.46	28.72	37.56	5.70
64QAM	881.5	29.63	38.37	6.87	28.99	37.79	6.01
64QAM	889.0	29.31	38.02	6.34	28.76	37.56	5.70

Table 8.1-6: *Output power measurement results for MIMO 2×2 (10 MHz channel BW)*

Modulation	Frequency, MHz	Power, Port 1, dBm	Power, Port 2, dBm	Total MIMO power, dBm	Total MIMO power, W
QPSK	874.0	38.13	37.57	40.87	12.22
QPSK	881.5	38.17	37.84	41.02	12.64
QPSK	889.0	37.95	37.53	40.76	11.90
16QAM	874.0	38.05	37.51	40.80	12.02
16QAM	881.5	38.15	37.79	40.98	12.54
16QAM	889.0	37.90	37.55	40.74	11.85
64QAM	874.0	38.10	37.56	40.85	12.16
64QAM	881.5	38.37	37.79	41.10	12.88
64QAM	889.0	38.02	37.56	40.81	12.04

Table 8.1-7: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results (3 MHz channel BW)*

Modulation, channel	0.1% CCDF at Ant 1, dB	0.1% CCDF at Ant 2, dB	Highest 0.1% CCDF level, dB	PAPR reduction limit, dB	Margin, dB
QPSK, low	7.24	7.53	7.53	13.00	5.47
QPSK, mid	7.28	7.28	7.28	13.00	5.72
QPSK, high	7.21	7.34	7.34	13.00	5.66
16QAM, low	6.44	6.51	6.51	13.00	6.49
16QAM, mid	6.57	7.47	7.47	13.00	5.53
16QAM, high	7.24	7.47	7.47	13.00	5.53
64QAM, low	7.08	7.40	7.40	13.00	5.60
64QAM, mid	7.08	7.28	7.28	13.00	5.72
64QAM, high	7.11	7.34	7.34	13.00	5.66

Table 8.1-8: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results (5 MHz channel BW)*

Modulation, channel	0.1% CCDF at Ant 1, dB	0.1% CCDF at Ant 2, dB	Highest 0.1% CCDF level, dB	PAPR reduction limit, dB	Margin, dB
QPSK, low	7.12	7.34	7.34	13.00	5.66
QPSK, mid	7.02	7.31	7.31	13.00	5.69
QPSK, high	7.24	7.34	7.34	13.00	5.66
16QAM, low	7.15	7.44	7.44	13.00	5.56
16QAM, mid	7.02	7.28	7.28	13.00	5.72
16QAM, high	7.31	7.44	7.44	13.00	5.56
64QAM, low	6.98	7.34	7.34	13.00	5.66
64QAM, mid	7.08	7.28	7.28	13.00	5.72
64QAM, high	7.18	7.28	7.28	13.00	5.72

Table 8.1-9: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results (10 MHz channel BW)*

Modulation, channel	0.1% CCDF at Ant 1, dB	0.1% CCDF at Ant 2, dB	Highest 0.1% CCDF level, dB	PAPR reduction limit, dB	Margin, dB
QPSK, low	7.40	7.56	7.56	13.00	5.44
QPSK, mid	7.50	7.53	7.53	13.00	5.47
QPSK, high	7.50	7.63	7.63	13.00	5.37
16QAM, low	7.47	7.53	7.53	13.00	5.47
16QAM, mid	7.44	7.47	7.47	13.00	5.53
16QAM, high	7.50	7.63	7.63	13.00	5.37
64QAM, low	7.34	7.56	7.56	13.00	5.44
64QAM, mid	7.37	7.47	7.47	13.00	5.53
64QAM, high	7.47	7.56	7.56	13.00	5.44

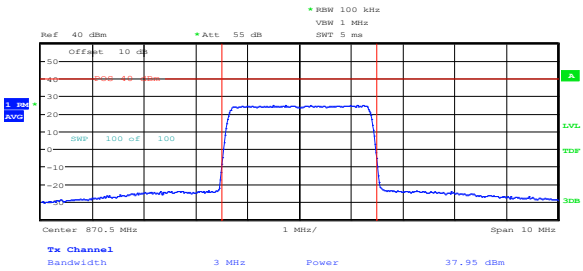


Figure 8.1-1: *Output power measurement of 3 MHz channel, sample plot*

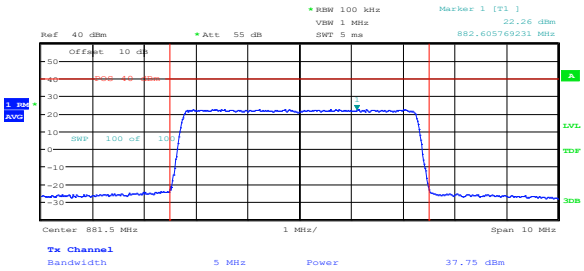


Figure 8.1-2: *Output power measurement of 5 MHz channel, sample plot*

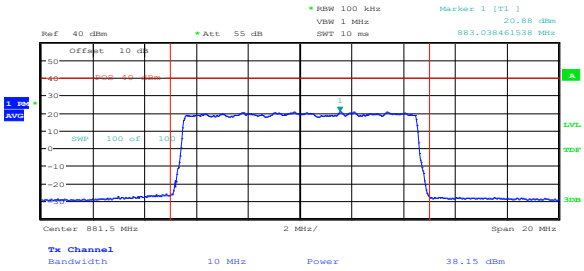


Figure 8.1-3: *Output power measurement of 10 MHz channel, sample plot*

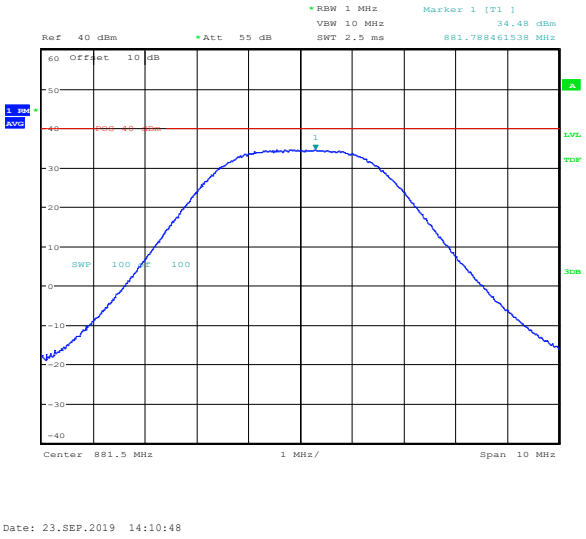


Figure 8.1-4: *PSD measurement of 3 MHz channel, sample plot*

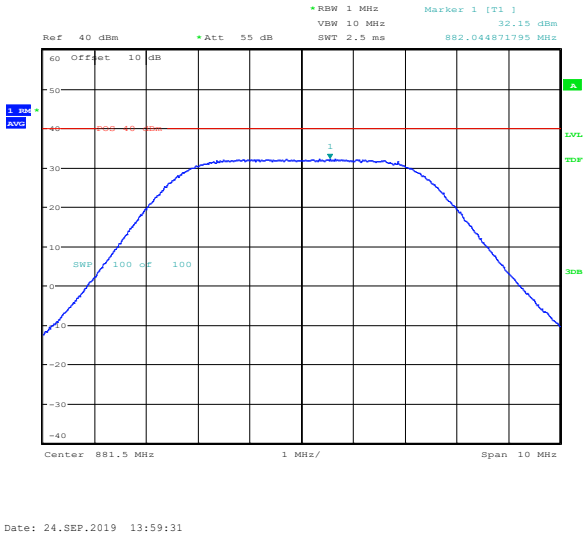


Figure 8.1-5: *PSD measurement of 5 MHz channel, sample plot*

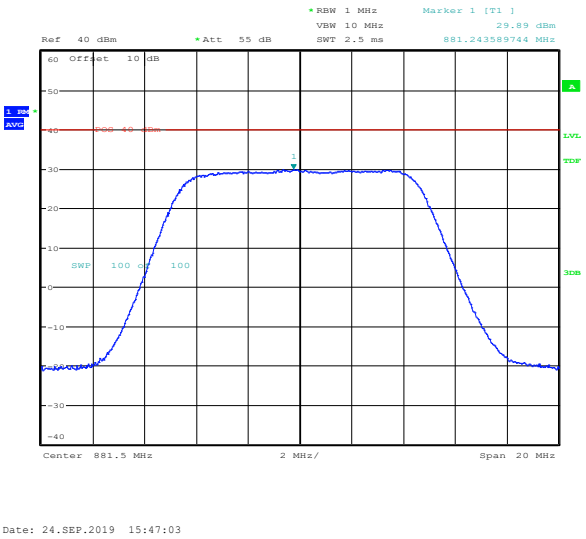


Figure 8.1-6: *PSD measurement of 10 MHz channel, sample plot*

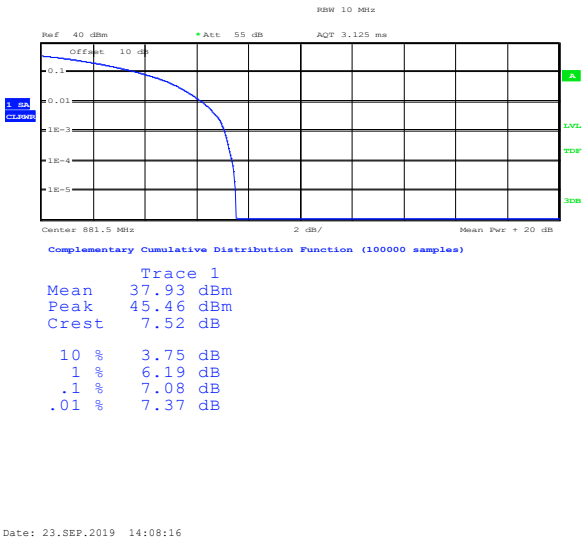


Figure 8.1-7: *CCDF measurement of 3 MHz channel, sample plot*

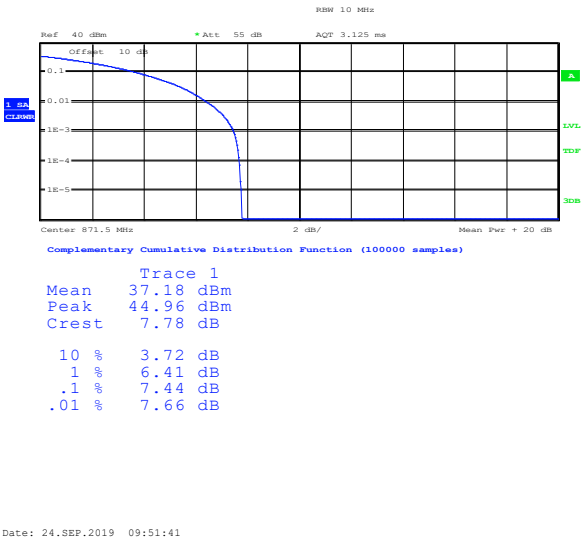


Figure 8.1-8: *CCDF measurement of 5 MHz channel, sample plot*

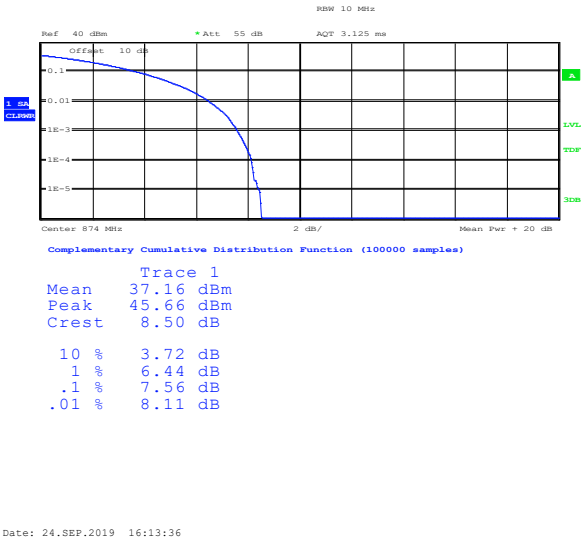


Figure 8.1-9: *CCDF measurement of 10 MHz channel, sample plot*

8.2 FCC 22.917(a) and RSS-132 5.5 Spurious emissions at RF antenna connector

8.2.1 Definitions and limits

FCC:
(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

(c) Alternative out of band emission limit. Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.
ISED:
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

1. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $\log_{10}$p (watts).
2. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $\log_{10}$ p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

8.2.2 Test summary

Test date	September 23, 2019

8.2.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a RMS detector. The testing was performed on both antenna ports and 3 modulations, only sample plots provided, since there was no observable difference between the above settings.
For compensation of MIMO 2×2 application limit lines need to be adjusted by −3 dB[1] to −16 dBm
[1]10 × Log_{10}(2) = 3 dB

8.2.4 Test data

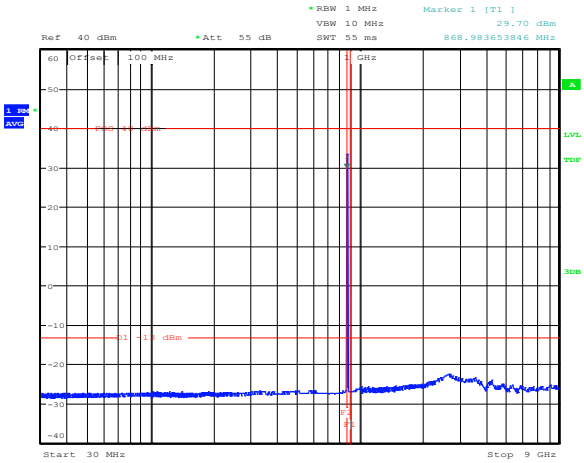


Figure 8.2-1: *Conducted spurious emissions, sample plot*

Channel bandwidth: 3 MHz
Channel: Low

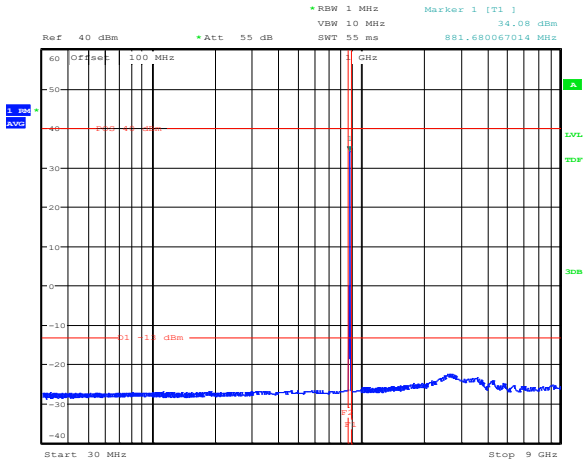


Figure 8.2-2: *Conducted spurious emissions, sample plot*

Channel bandwidth: 3 MHz
Channel: Mid

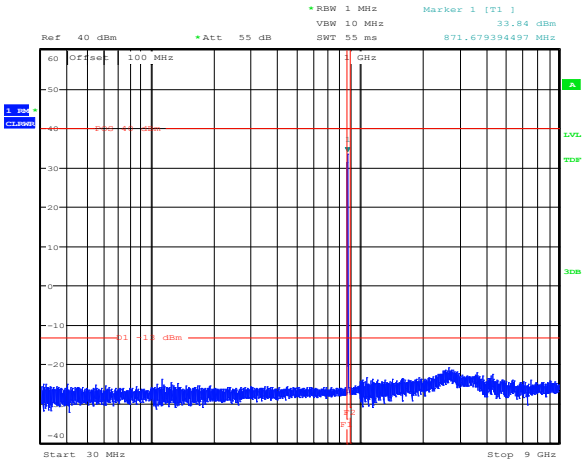


Figure 8.2-3: *Conducted spurious emissions, sample plot*

Channel bandwidth: 3 MHz
Channel: High

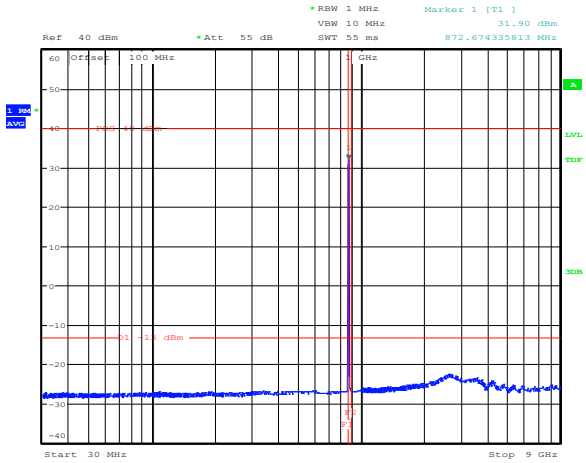


Figure 8.2-4: *Conducted spurious emissions, sample plot*

Channel bandwidth: 5 MHz
Channel: Low

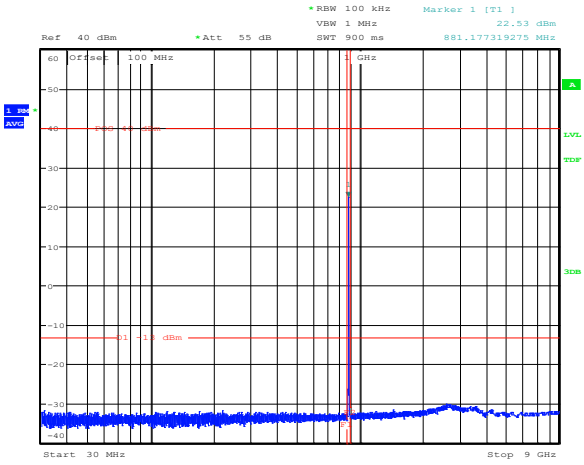


Figure 8.2-5: *Conducted spurious emissions, sample plot*

Channel bandwidth: 5 MHz
Channel: Mid

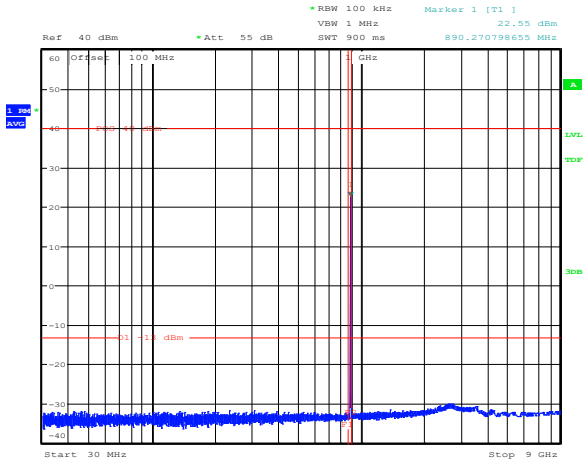


Figure 8.2-6: *Conducted spurious emissions, sample plot*

Channel bandwidth: 5 MHz
Channel: High

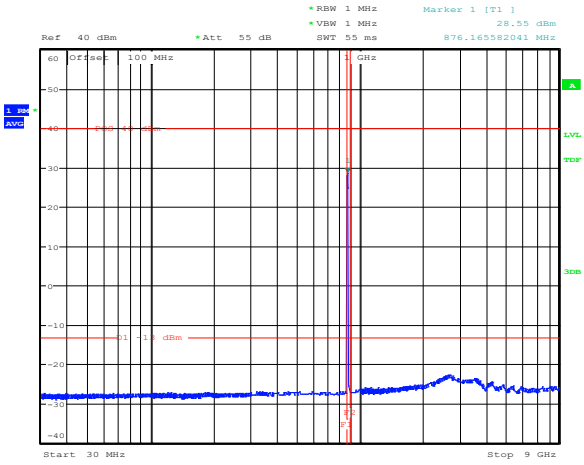


Figure 8.2-7: *Conducted spurious emissions, sample plot*

Channel bandwidth: 10 MHz
Channel: Low

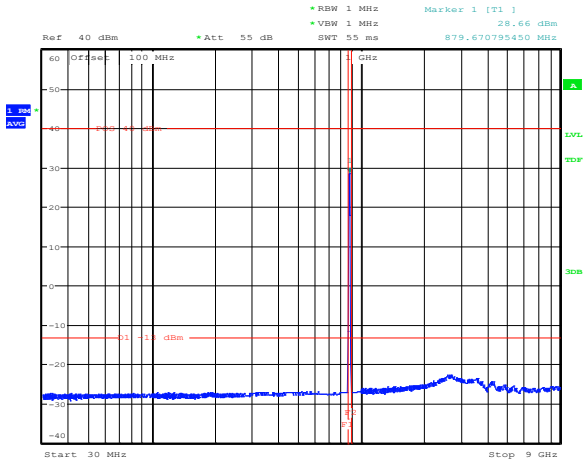


Figure 8.2-8: *Conducted spurious emissions, sample plot*

Channel bandwidth: 10 MHz
Channel: Mid

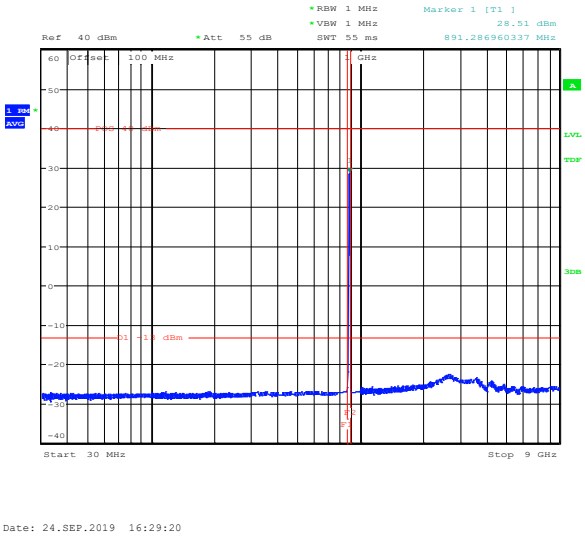


Figure 8.2-9: *Conducted spurious emissions, sample plot*

Channel bandwidth: 10 MHz
Channel: High

Table 8.2-1: *Conducted band edge measurement results for 3 MHz channel BW*

Modulation, channel, Ant port	Frequency, MHz	Power measurement, dBm	RBW, kHz	Limit, dBm	Margin, dB
QPSK, Low, Ant 1	869	-28.61	30	-16.00	12.61
QPSK, Low, Ant 1	868	-24.04	100	-16.00	8.04
16QAM, Low, Ant 1	869	-28.04	30	-16.00	12.04
16QAM, Low, Ant 1	868	-23.21	100	-16.00	7.21
64QAM, Low, Ant 1	869	-29.32	30	-16.00	13.32
64QAM, Low, Ant 1	868	-24.51	100	-16.00	8.51
QPSK, High, Ant 1	894	-26.17	30	-16.00	10.17
QPSK, High, Ant 1	895	-23.29	100	-16.00	7.29
16QAM, High, Ant 1	894	-28.65	30	-16.00	12.65
16QAM, High, Ant 1	895	-23.57	100	-16.00	7.57
64QAM, High, Ant 1	894	-26.87	30	-16.00	10.87
64QAM, High, Ant 1	895	-25.95	100	-16.00	9.95
QPSK, Low, Ant 2	869	-31.50	30	-16.00	15.50
QPSK, Low, Ant 2	868	-29.14	100	-16.00	13.14
16QAM, Low, Ant 2	869	-28.68	30	-16.00	12.68
16QAM, Low, Ant 2	868	-25.61	100	-16.00	9.61
64QAM, Low, Ant 2	869	-30.91	30	-16.00	14.91
64QAM, Low, Ant 2	868	-27.36	100	-16.00	11.36
QPSK, High, Ant 2	894	-29.44	30	-16.00	13.44
QPSK, High, Ant 2	895	-26.77	100	-16.00	10.77
16QAM, High, Ant 2	894	-28.38	30	-16.00	12.38
16QAM, High, Ant 2	895	-24.12	100	-16.00	8.12
64QAM, High, Ant 2	894	-27.34	30	-16.00	11.34
64QAM, High, Ant 2	895	-28.72	100	-16.00	12.72

Table 8.2-2: *Conducted band edge measurement results for 5 MHz channel BW*

Modulation, channel, Ant port	Frequency, MHz	Power measurement, dBm	RBW, kHz	Limit, dBm	Margin, dB
QPSK, Low, Ant 1	869	-28.49	50	-16.00	12.49
QPSK, Low, Ant 1	868	-25.59	100	-16.00	9.59
16QAM, Low, Ant 1	869	-28.24	50	-16.00	12.24
16QAM, Low, Ant 1	868	-26.67	100	-16.00	10.67
64QAM, Low, Ant 1	869	-26.26	50	-16.00	10.26
64QAM, Low, Ant 1	868	-22.26	100	-16.00	6.26
QPSK, High, Ant 1	894	-27.94	50	-16.00	11.94
QPSK, High, Ant 1	895	-27.91	100	-16.00	11.91
16QAM, High, Ant 1	894	-18.92	50	-16.00	2.92
16QAM, High, Ant 1	895	-26.90	100	-16.00	10.90
64QAM, High, Ant 1	894	-28.63	50	-16.00	12.63
64QAM, High, Ant 1	895	-26.12	100	-16.00	10.12
QPSK, Low, Ant 2	869	-30.31	50	-16.00	14.31
QPSK, Low, Ant 2	868	-29.39	100	-16.00	13.39
16QAM, Low, Ant 2	869	-28.23	50	-16.00	12.23
16QAM, Low, Ant 2	868	-28.79	100	-16.00	12.79
64QAM, Low, Ant 2	869	-28.89	50	-16.00	12.89
64QAM, Low, Ant 2	868	-27.35	100	-16.00	11.35
QPSK, High, Ant 2	894	-29.43	50	-16.00	13.43
QPSK, High, Ant 2	895	-28.80	100	-16.00	12.80
16QAM, High, Ant 2	894	-19.78	50	-16.00	3.78
16QAM, High, Ant 2	895	-28.91	100	-16.00	12.91
64QAM, High, Ant 2	894	-29.99	50	-16.00	13.99
64QAM, High, Ant 2	895	-28.51	100	-16.00	12.51

Table 8.2-3: *Conducted band edge measurement results for 10 MHz channel BW*

Modulation, channel, Ant port	Frequency, MHz	Power measurement, dBm	RBW, kHz	Limit, dBm	Margin, dB
QPSK, Low, Ant 1	869	-25.18	100	-16.00	9.18
QPSK, Low, Ant 1	868	-26.14	100	-16.00	10.14
16QAM, Low, Ant 1	869	-27.36	100	-16.00	11.36
16QAM, Low, Ant 1	868	-29.12	100	-16.00	13.12
64QAM, Low, Ant 1	869	-26.27	100	-16.00	10.27
64QAM, Low, Ant 1	868	-27.36	100	-16.00	11.36
QPSK, High, Ant 1	894	-27.91	100	-16.00	11.91
QPSK, High, Ant 1	895	-28.89	100	-16.00	12.89
16QAM, High, Ant 1	894	-29.30	100	-16.00	13.3
16QAM, High, Ant 1	895	-28.84	100	-16.00	12.84
64QAM, High, Ant 1	894	-28.84	100	-16.00	12.84
64QAM, High, Ant 1	895	-29.47	100	-16.00	13.47
QPSK, Low, Ant 2	869	-27.92	100	-16.00	11.92
QPSK, Low, Ant 2	868	-28.84	100	-16.00	12.84
16QAM, Low, Ant 2	869	-28.34	100	-16.00	12.34
16QAM, Low, Ant 2	868	-28.88	100	-16.00	12.88
64QAM, Low, Ant 2	869	-28.57	100	-16.00	12.57
64QAM, Low, Ant 2	868	-29.45	100	-16.00	13.45
QPSK, High, Ant 2	894	-30.04	100	-16.00	14.04
QPSK, High, Ant 2	895	-30.73	100	-16.00	14.73
16QAM, High, Ant 2	894	-30.22	100	-16.00	14.22
16QAM, High, Ant 2	895	-29.83	100	-16.00	13.83
64QAM, High, Ant 2	894	-29.33	100	-16.00	13.33
64QAM, High, Ant 2	895	-29.91	100	-16.00	13.91

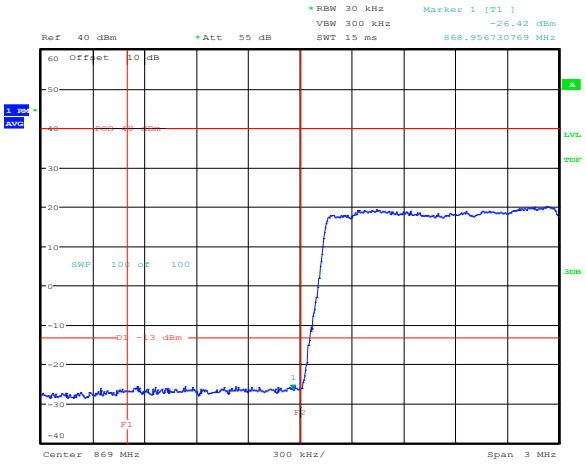


Figure 8.2-10: *Conducted spurious emissions at the lower band edge, sample plot*

Channel bandwidth: 3 MHz
Channel: Low

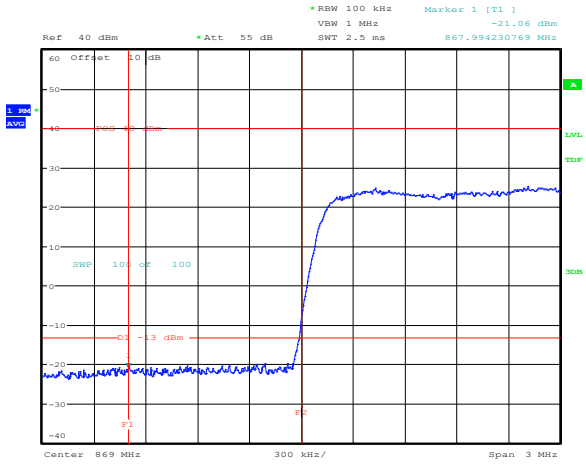


Figure 8.2-11: *Conducted spurious emissions at the lower band edge – 1 MHz, sample plot*

Channel bandwidth: 3 MHz
Channel: Low

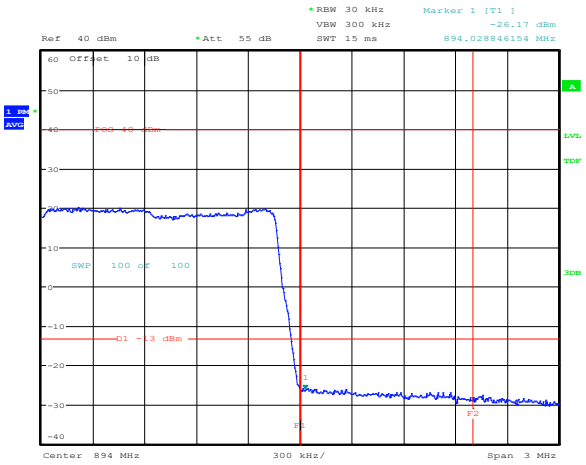


Figure 8.2-12: *Conducted spurious emissions at the upper band edge, sample plot*

Channel bandwidth: 3 MHz
Channel: High

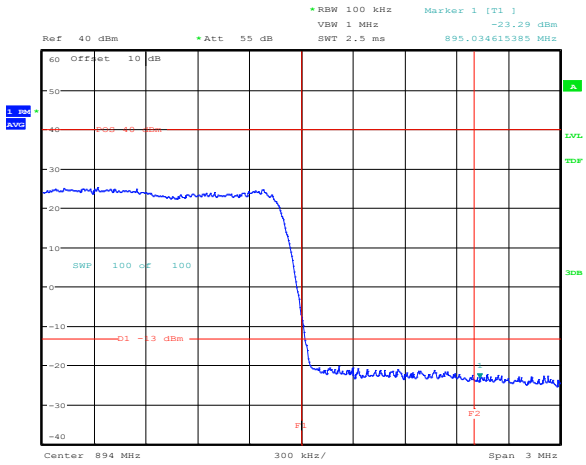


Figure 8.2-13: *Conducted spurious emissions at the upper band edge + 1 MHz, sample plot*

Channel bandwidth: 3 MHz
Channel: High

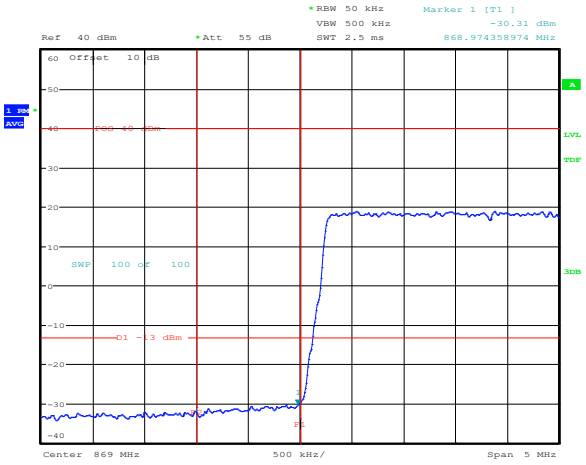


Figure 8.2-14: *Conducted spurious emissions at the lower band edge, sample plot*

Channel bandwidth: 5 MHz
Channel: Low

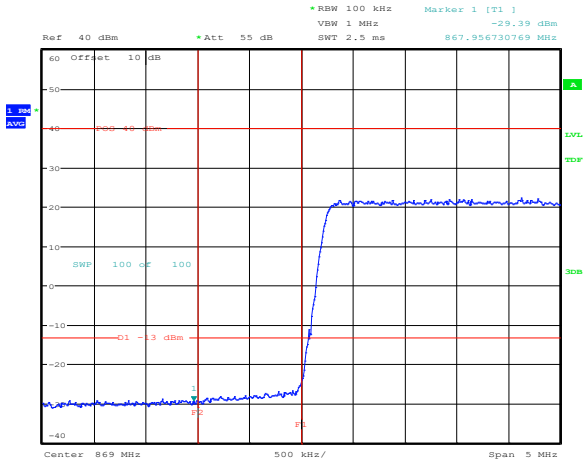


Figure 8.2-15: *Conducted spurious emissions at the lower band edge – 1 MHz, sample plot*

Channel bandwidth: 5 MHz
Channel: Low

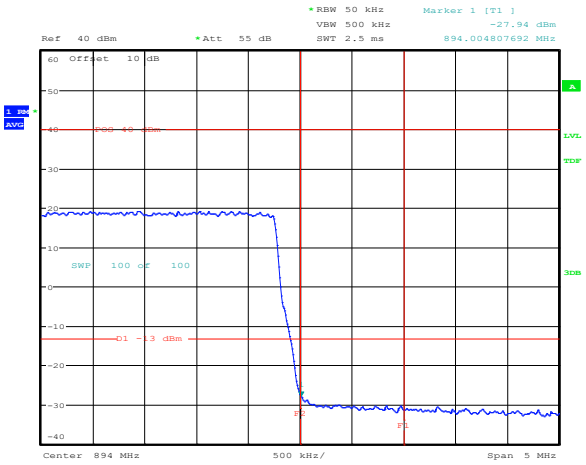


Figure 8.2-16: *Conducted spurious emissions at the upper band edge, sample plot*

Channel bandwidth: 5 MHz
Channel: High

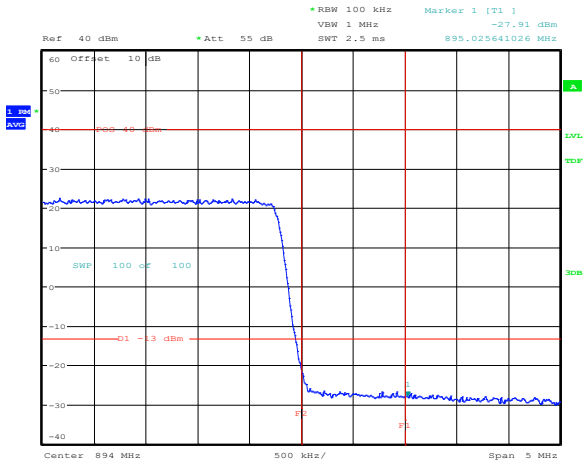


Figure 8.2-17: *Conducted spurious emissions at the upper band edge + 1 MHz, sample plot*

Channel bandwidth: 5 MHz
Channel: High

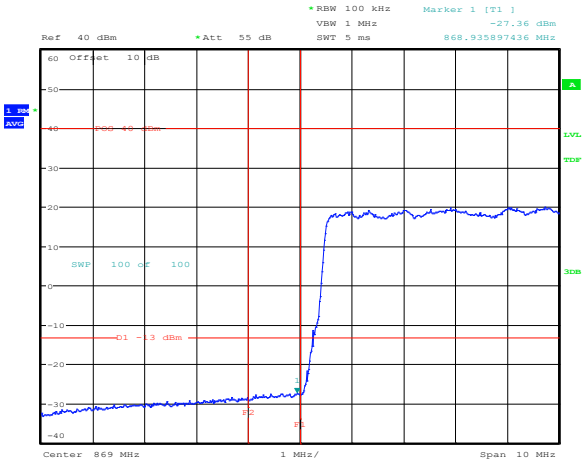


Figure 8.2-18: *Conducted spurious emissions at the lower band edge, sample plot*

Channel bandwidth: 10 MHz
Channel: Low

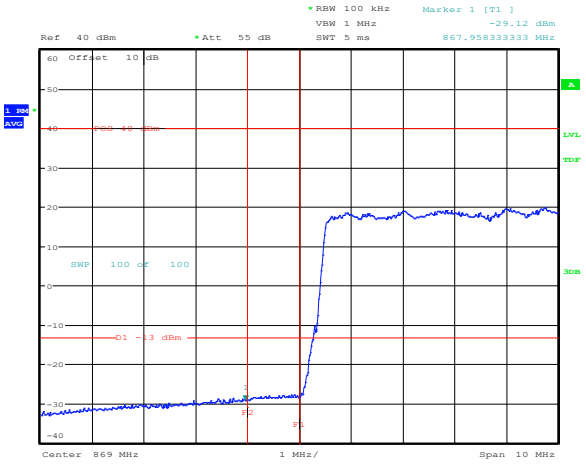


Figure 8.2-19: *Conducted spurious emissions at the lower band edge – 1 MHz, sample plot*

Channel bandwidth: 10 MHz
Channel: Low

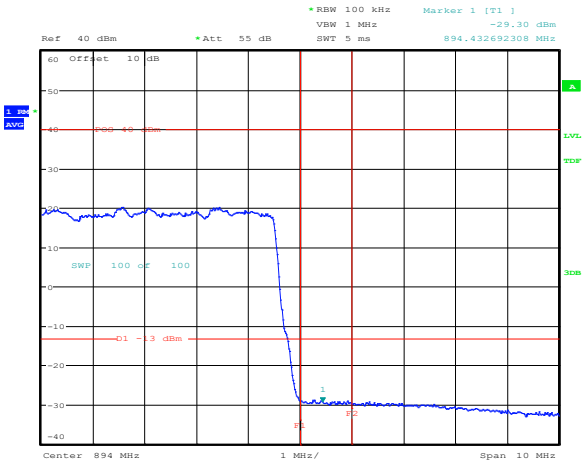


Figure 8.2-20: *Conducted spurious emissions at the upper band edge, sample plot*

Channel bandwidth: 10 MHz
Channel: High

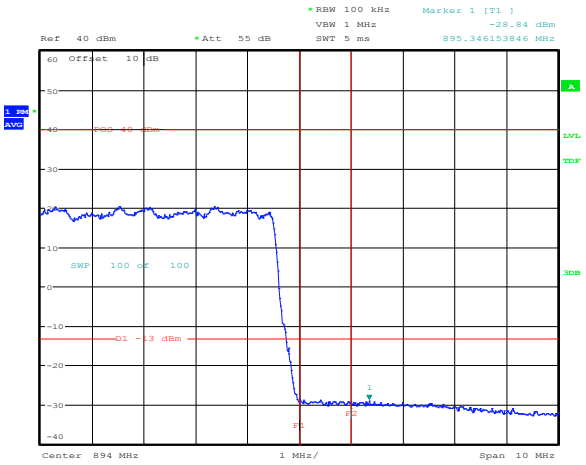


Figure 8.2-21: *Conducted spurious emissions at the upper band edge + 1 MHz, sample plot*

Channel bandwidth: 10 MHz
Channel: High

8.3 Radiated spurious emissions

8.3.1 Definitions and limits

FCC P22 and RSS-132
Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

(c) Alternative out of band emission limit. Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

8.3.2 Test summary

Test date	September 24, 2019

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic (9 GHz).
All measurements were performed using a peak detector.
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.
Testing was performed with both RF ports terminated with 50 Ohm load. Transmissions on low, mid and high channels of 3 MHz channel BW and 10 MHz channel BW were tested with one 16QAM modulation.

8.3.4 Test data

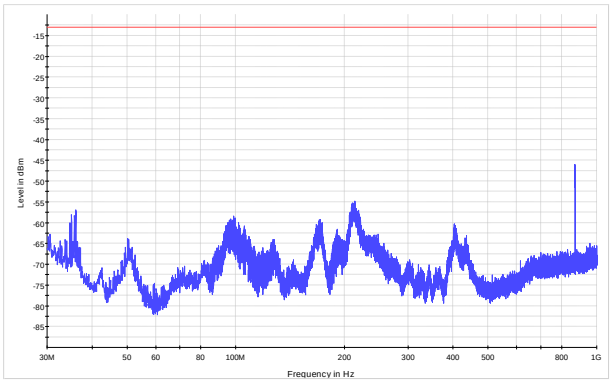


Figure 8.3-1: *Radiated spurious emissions below 1 GHz for 3 MHz channel, low channel*

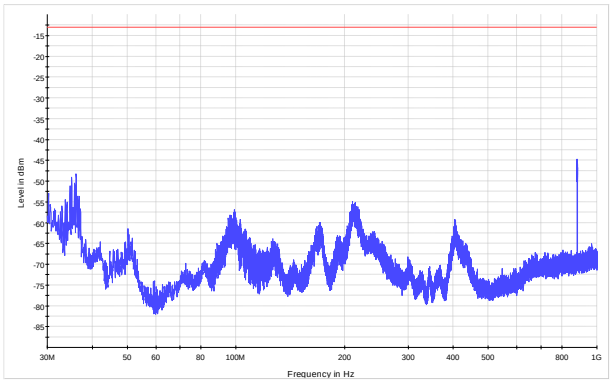


Figure 8.3-2: *Radiated spurious emissions below 1 GHz for 3 MHz channel, mid channel*

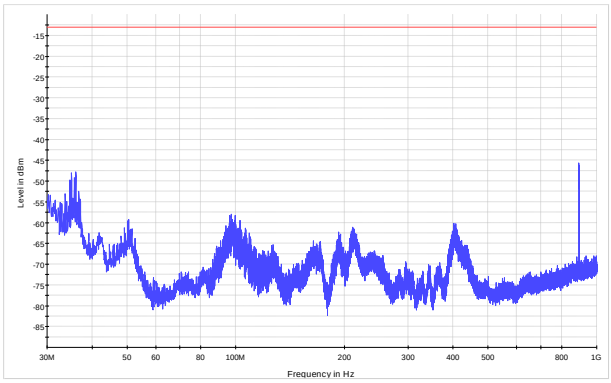


Figure 8.3-3: *Radiated spurious emissions below 1 GHz for 3 MHz channel, high channel*

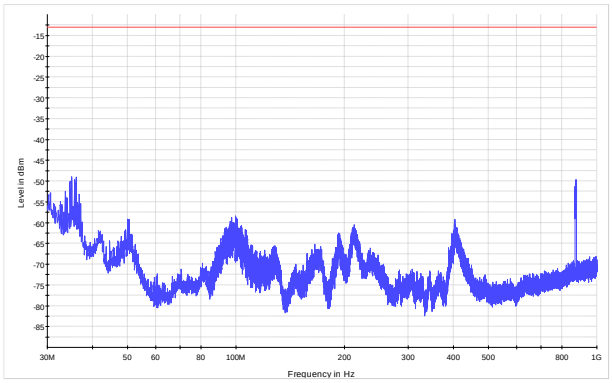


Figure 8.3-4: *Radiated spurious emissions below 1 GHz for 10 MHz channel, low channel*

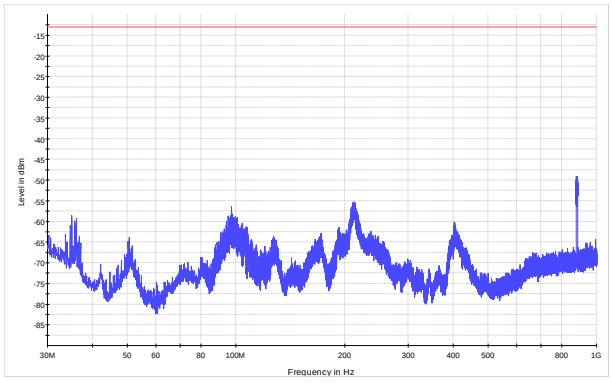


Figure 8.3-5: *Radiated spurious emissions below 1 GHz for 10 MHz channel, mid channel*

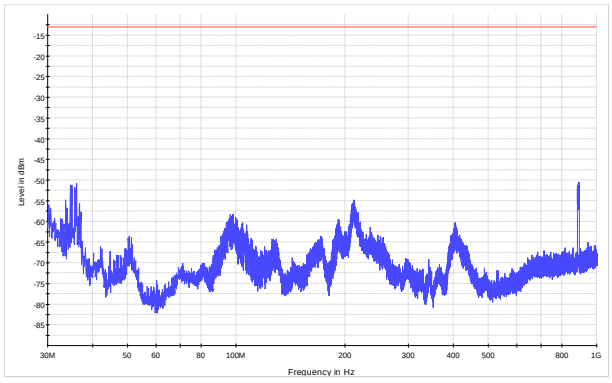


Figure 8.3-6: *Radiated spurious emissions below 1 GHz for 10 MHz channel, high channel*

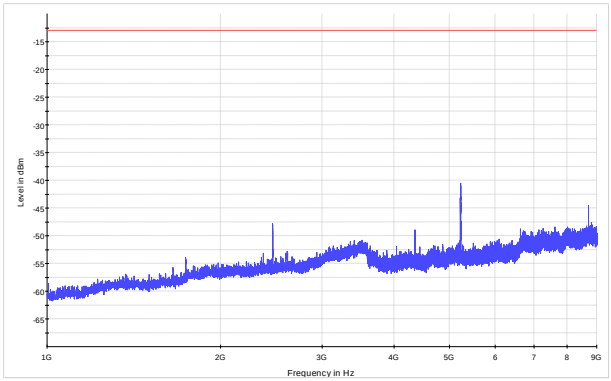


Figure 8.3-7: *Radiated spurious emissions above 1 GHz for 3 MHz channel, low channel*

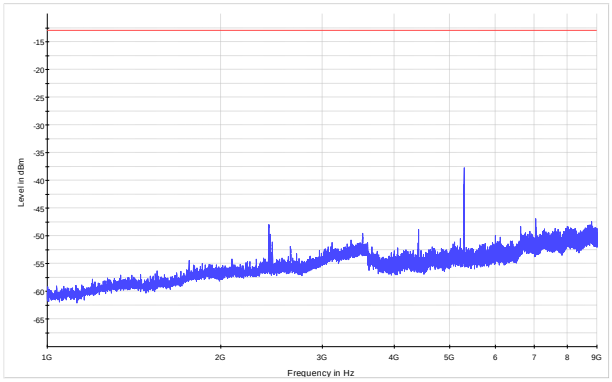


Figure 8.3-8: *Radiated spurious emissions above 1 GHz for 3 MHz channel, mid channel*

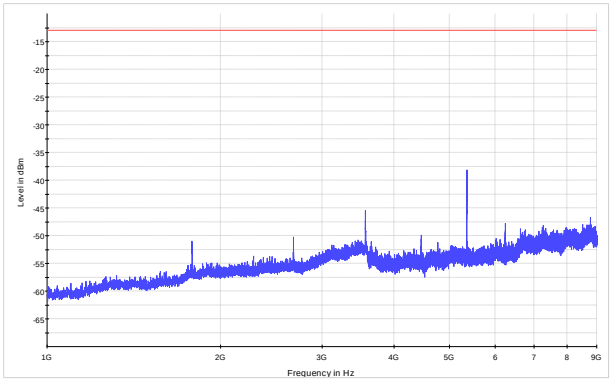


Figure 8.3-9: *Radiated spurious emissions above 1 GHz for 3 MHz channel, high channel*

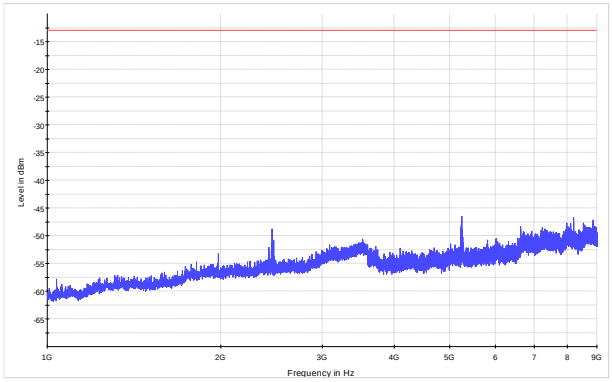


Figure 8.3-10: *Radiated spurious emissions above 1 GHz for 10 MHz channel, low channel*

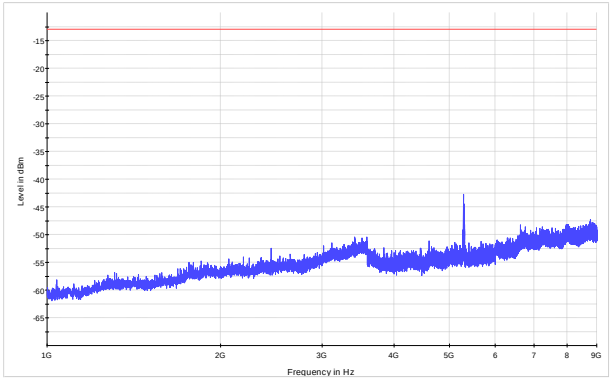


Figure 8.3-11: *Radiated spurious emissions above 1 GHz for 10 MHz channel, mid channel*

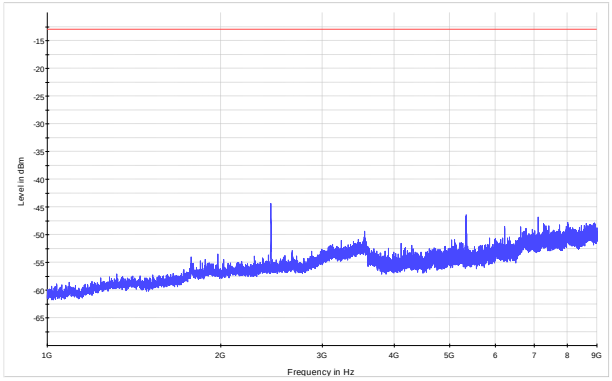


Figure 8.3-12: *Radiated spurious emissions above 1 GHz for 10 MHz channel, high channel*

8.4 FCC 22.355 and RSS-132 5.3 Frequency tolerance

8.4.1 Definitions and limits

FCC:
The carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerance of ±1.5 ppm for Base/fixed stations operating within 821–896 MHz.
ISED:
The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations and ±1.5 ppm for base stations.

In lieu of meeting the above stability values, the test report may show that the frequency stability is sufficient to ensure that the occupied bandwidth stays within each of the sub-bands (see Section 5.1) when tested to the temperature and supply voltage variations specified in RSS-Gen.

8.4.2 Test summary

Test date	September 26, 2019

8.4.3 Observations, settings and special notes

1.5 ppm of 881.5 MHz is 1322 Hz.

8.4.4 Test data

Table 8.4-1: *Frequency tolerance results*

Temperature, °C	Voltage, V_{AC}	Frequency, MHz	Frequency drift, Hz	Limit, ±Hz
+50	110.0	870.499934295	3.205	1322
+40	110.0	870.499935363	2.137	1322
+30	110.0	870.499936432	1.068	1322
+20	126.5	870.499937500	0.000	1322
+20	110.0	870.499937500	Reference	1322
+20	93.5	870.499937500	0.000	1322
+10	110.0	870.499935898	1.602	1322
0	110.0	870.499934295	3.205	1322
−10	110.0	870.499932693	4.807	1322
−20	110.0	870.499931090	6.410	1322

8.5 FCC Part 22.917(b) and RSS-Gen 6.7 Occupied bandwidth

8.5.1 Definitions and limits

FCC:
The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
ISED:
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.5.2 Test summary

Test date	September 24, 2019

8.5.3 Observations, settings and special notes

None

8.5.4 Test data

Table 8.5-1: *Occupied bandwidth measurement results for 3 MHz channel*

Modulation	Frequency, MHz	26 dB BW, Port 1, MHz	99% OBW, Port 1, MHz	26 dB BW, Port 2, MHz	99% OBW, Port 2, MHz
QPSK	870.5	2.981	2.740	2.997	2.740
QPSK	881.5	2.997	2.740	2.981	2.740
QPSK	892.5	2.981	2.740	2.997	2.740
16QAM	870.5	2.997	2.740	2.997	2.740
16QAM	881.5	2.981	2.740	2.997	2.740
16QAM	892.5	2.997	2.740	2.981	2.740
64QAM	870.5	2.981	2.740	2.997	2.724
64QAM	881.5	2.997	2.724	2.997	2.756
64QAM	892.5	2.965	2.740	2.965	2.740

Table 8.5-2: *Occupied bandwidth measurement results for 5 MHz channel*

Modulation	Frequency, MHz	26 dB BW, Port 1, MHz	99% OBW, Port 1, MHz	26 dB BW, Port 2, MHz	99% OBW, Port 2, MHz
QPSK	871.5	4.792	4.487	4.760	4.487
QPSK	881.5	4.776	4.487	4.792	4.487
QPSK	891.5	4.792	4.487	4.792	4.487
16QAM	871.5	4.824	4.487	4.808	4.487
16QAM	881.5	4.728	4.471	4.776	4.487
16QAM	891.5	4.776	4.471	4.792	4.487
64QAM	871.5	4.792	4.487	4.760	4.503
64QAM	881.5	4.760	4.487	4.808	4.487
64QAM	891.5	4.792	4.503	4.760	4.487

Table 8.5-3: *Occupied bandwidth measurement results for 10 MHz channel*

Modulation	Frequency, MHz	26 dB BW, Port 1, MHz	99% OBW, Port 1, MHz	26 dB BW, Port 2, MHz	99% OBW, Port 2, MHz
QPSK	874.0	9.583	8.974	9.551	8.942
QPSK	881.5	9.551	8.974	9.551	8.974
QPSK	889.0	9.615	8.974	9.551	8.974
16QAM	874.0	9.520	8.974	9.520	8.974
16QAM	881.5	9.487	8.974	9.487	8.974
16QAM	889.0	9.487	8.942	9.520	8.974
64QAM	874.0	9.551	9.006	9.583	8.974
64QAM	881.5	9.520	8.974	9.583	8.974
64QAM	889.0	9.520	8.974	9.551	8.974

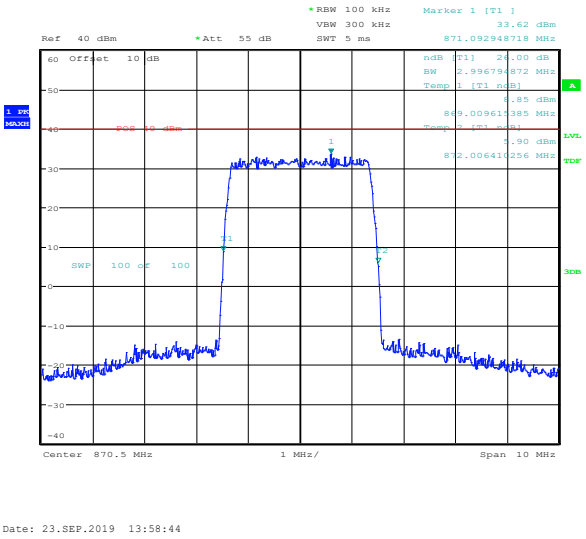


Figure 8.5-1: *Occupied 26 dB bandwidth measurement of 3 MHz channel, sample plot*

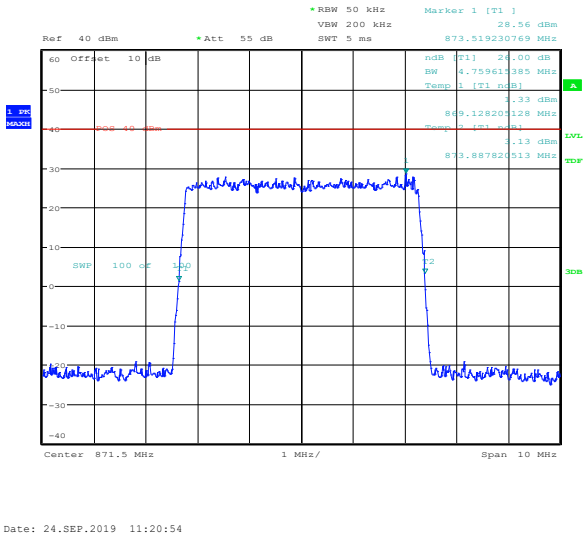


Figure 8.5-2: *Occupied 26 dB bandwidth measurement of 5 MHz channel, sample plot*

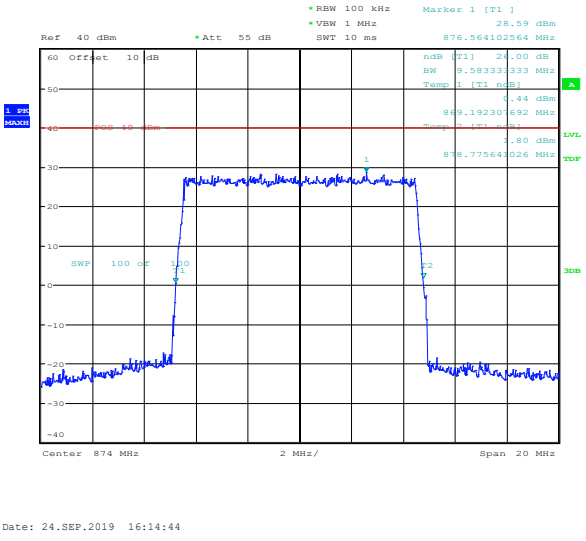


Figure 8.5-3: *Occupied 26 dB bandwidth measurement of 10 MHz channel, sample plot*

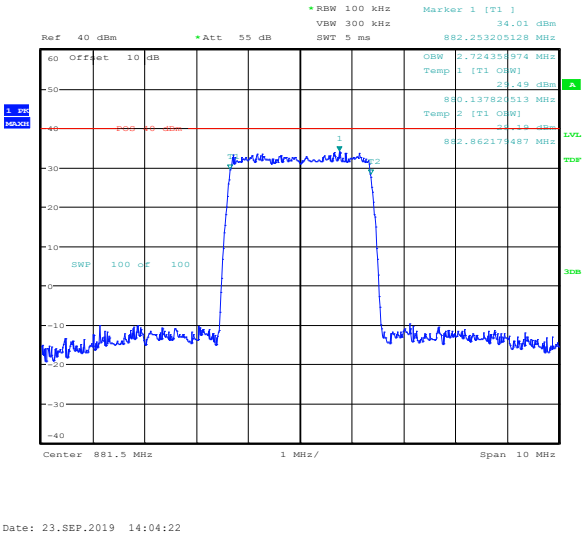


Figure 8.5-4: *Occupied 99% bandwidth measurement of 3 MHz channel, sample plot*

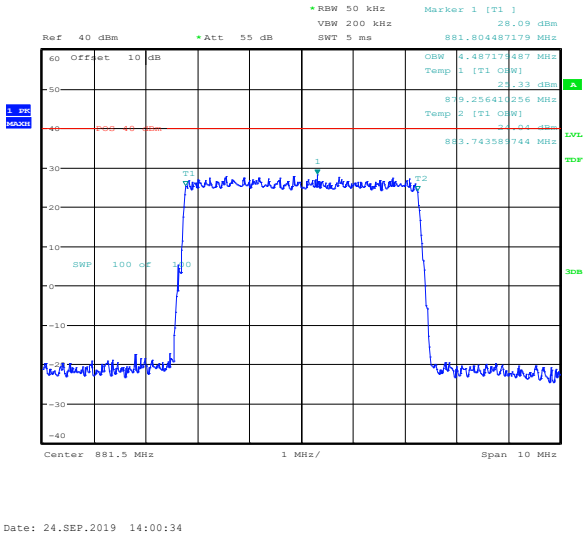


Figure 8.5-5: *Occupied 99% bandwidth measurement of 5 MHz channel, sample plot*

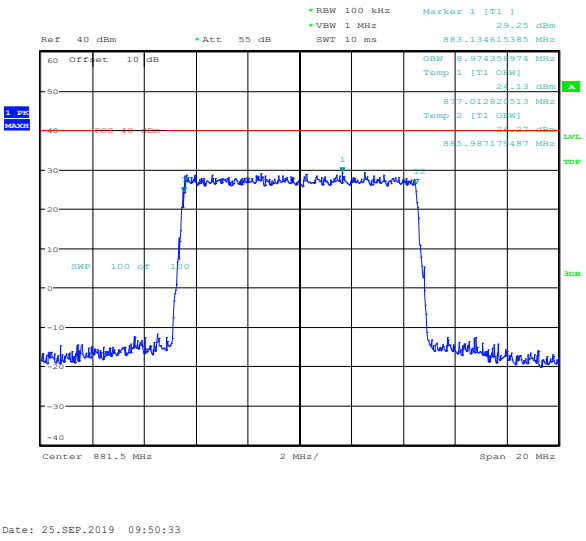


Figure 8.5-6: *Occupied 99% bandwidth measurement of 10 MHz channel, sample plot*

8.6 RSS-132 5.6 Receiver Spurious Emissions

8.6.1 Definitions and limits

Receiver spurious emissions shall comply with the limits specified in RSS-Gen.
RSS-Gen, 7.4:
The antenna-conducted test shall be performed with the antenna disconnected and with the receiver antenna port connected to a measuring instrument having equal input impedance to that specified for the antenna. The RF cable connecting the receiver under test to the measuring instrument shall also have the same impedance to that specified for the receiver's antenna.

The spurious emissions from the receiver at any discrete frequency, measured at the antenna port by the antenna-conducted method, shall not exceed 2 nW in the frequency range 30–1000 MHz and 5 nW above 1 GHz.

8.6.2 Test summary

Test date	September 27, 2019

8.6.3 Observations, settings and special notes

Scans were done up to 12.75 GHz.
Limit lines calculation within 30–1000 MHz: $10 \times \text{Log}_{10}$ (2 [nW]) = $10 \times \text{Log}_{10}$ (0.000002 [mW]) = −57 dBm
Above 1 GHz: $10 \times \text{Log}_{10}$ (5 [nW]) = $10 \times \text{Log}_{10}$ (0.000005 [mW]) = −53 dBm.

8.6.4 Test data

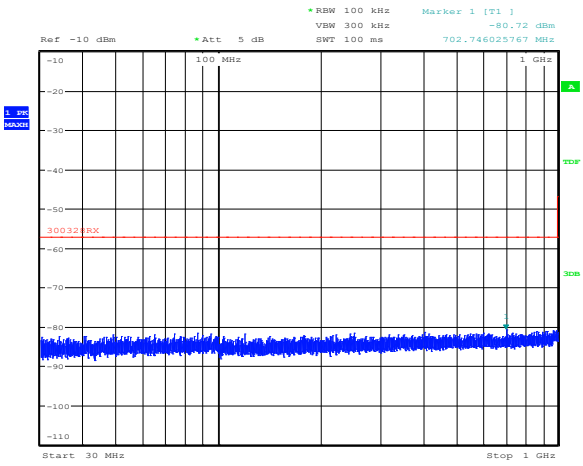


Figure 8.6-1: *Receiver spurious emissions below 1 GHz, antenna port 1*

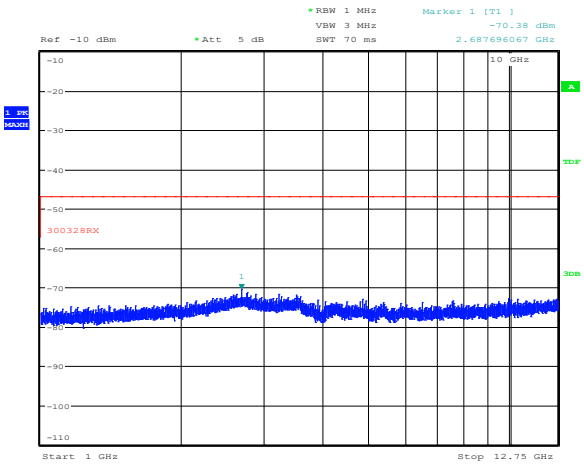


Figure 8.6-2: *Receiver spurious emissions above 1 GHz, antenna port 1*

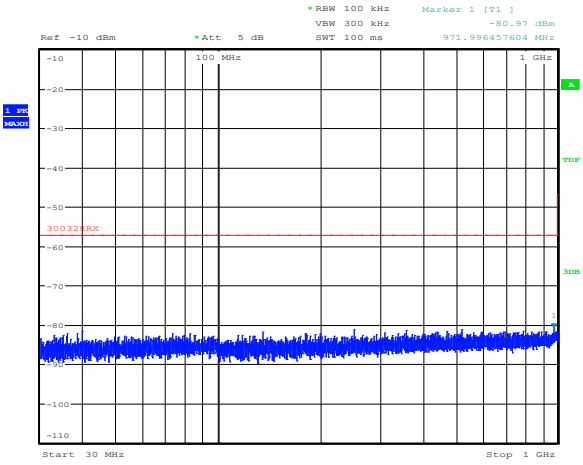


Figure 8.6-3: *Receiver spurious emissions below 1 GHz, antenna port 2*

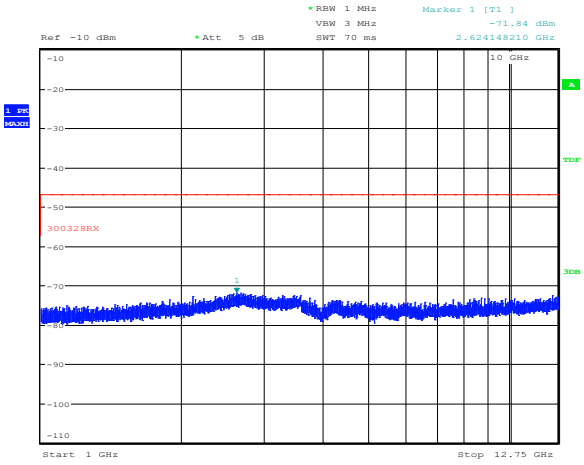
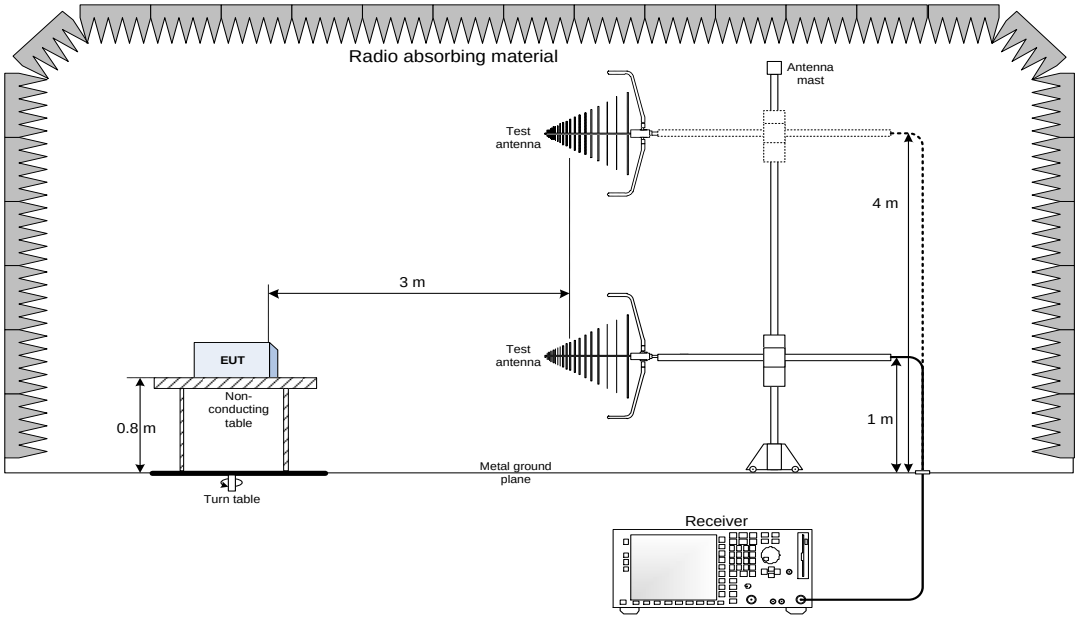


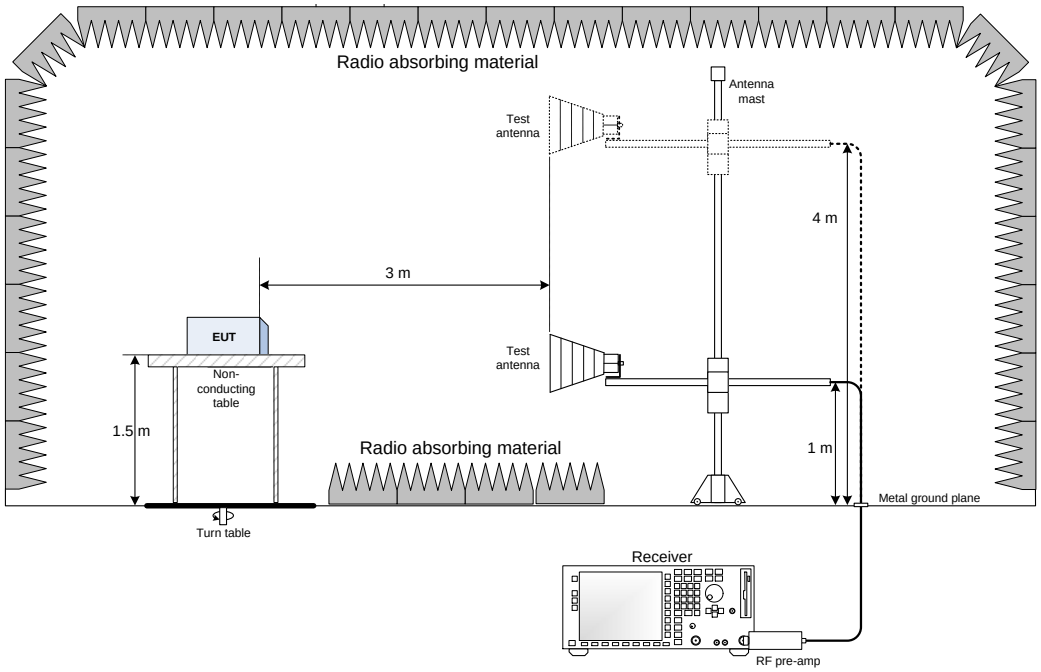
Figure 8.6-4: *Receiver spurious emissions above 1 GHz, antenna port 2*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Antenna port set-up