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Radio Test report – AIR 1641 B2/25a B66a

Project number:

391738-1TRFWL-R1

Applicant:

Ericsson Canada

Product:	Model:	Part number:
AIR 1641	AIR 1641 B2/25a B66a	KRD 901 800/1

FCC ID:	ISED Reg. Number	HVIN:
TA8AKRD901800-1	287AB-AS9018001	AS9018001

Requirements/Summary:

Standard	Environmental phenomenon	Compliance
FCC 47 CFR Part 27	Miscellaneous wireless communications services	Yes
FCC 47 CFR Part 24, Subpart E	Broadband Personal Communications Services (PCS)	Yes
RSS-133 Issue 6 A1, Jan 18, 2018	2 GHz Personal Communications Services	Yes
RSS-139 Issue 3, July 16, 2015	Advanced Wireless Services (AWS) Equipment Operating in the Bands 1710–1780 MHz and 2110–2180 MHz	Yes
RSS-170 Issue 3, July 9, 2015	Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands	Yes

Date of issue: February 25, 2020

Andrey Adelberg, Senior EMC/Wireless Specialist
Tested by — Signature

Predrag Golic, EMC Specialist
Tested by — Signature

David Duchesne, Senior EMC/Wireless Specialist
Reviewed by — Signature

Two test locations

Company name	Nemko Canada Inc.	
Address	303 River Road	349 Terry Fox
City	Ottawa	Ottawa
Province	Ontario	Ontario
Postal code	K1V 1H2	K2K 2V6
Country	Canada	Canada
Telephone	+1 613 737 9680	+1 613 963 8000
Facsimile	+1 613 737 9691	
Toll free	+1 800 563 6336	
Website	www.nemko.com	
Site number	FCC test site registration number: CA2040, IC: 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 reAnt 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	Ericsson Canada Inc.
Address	349 Terry Fox Drive, Ottawa, ON, Canada, K2K 2V6

1.2 Test specifications

FCC 47 CFR Part 2	Frequency Allocations and Radio Treaty Maters; General Rules and Regulations
FCC 47 CFR Part 24, Subpart E	Broadband Personal Communications Services (PCS)
FCC 47 CFR Part 27	Miscellaneous wireless communications services (2110–2200 MHz)
RSS-133 Issue 6 A1, Jan 18, 2018	2 GHz Personal Communications Services
RSS-139 Issue 3, July 16, 2015	Advanced Wireless Services (AWS) equipment operating in the bands 1710–1780 MHz and 2110–2180 MHz
SRSP-510, Issue 5, Feb. 2009	Technical Requirements for Personal Communications Services (PCS) in the Bands 1850–1915 MHz and 1930–1995 MHz
RSS-170 Issue 3, July 9, 2015	Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands
RSS-Gen, Issue 5, April 2018	General Requirements for Compliance of Radio Apparatus

Equipment operating in the ancillary terrestrial component (ATC) of the frequency bands 2000–2020 MHz and 2180–2200 MHz is certified under RSS-170.

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.
This report (**391738-1TRFWL-R1**) applies to the AIR 1641 B2/25a and B66 with model number KRD 901 800/1. See "Summary of test results" for full details.
EUT Configuration(s):
LTE: 10, 15, 20 MHz (1-2 Carriers)
LTE + NB IoT (GB, IB): 10, 15, 20 MHz

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Details of changes made to test report
TRFWL-R1	Original report issued

Section 2. Summary of test results

2.1 FCC Part 27 test results

Part	Test description	Verdict
§27.50(b)	Maximum output power at RF antenna connector	Pass
§27.53	Spurious emissions at RF antenna connector	Pass
§27.53	Radiated spurious emissions (conducted and radiated)	Pass
§27.54	Frequency stability	Pass
§2.1049	Occupied bandwidth	Pass

2.2 FCC Part 24 test results

Part	Test description	Verdict
§24.229	Frequencies	Pass[1]
§24.232(a)(2)	Power and antenna height limits for base stations with BW greater than 1 MHz	Pass
§24.235	Frequency stability	Pass
§24.238(a)	Emission limitations for Broadband PCS equipment – out of band emissions (conducted and radiated)	Pass
§2.1049	Occupied bandwidth	Pass

Notes: [1]EUT transmits within 1930–1995 MHz frequency range

2.3 RSS-133 test results

Part	Test description	Verdict
6.1	Frequency Plan	Pass[1]
6.2	Types of Modulation	Pass[2]
6.3	Frequency stability	Pass
6.4	Transmitter Output Power and Equivalent Isotropically Radiated Power	Pass
6.5	Transmitter Unwanted Emissions (conducted and radiated)	Pass
6.6	Receiver Spurious Emissions	Pass
RSS-Gen, 6.7	Occupied bandwidth	Pass

Notes: [1]EUT transmits within 1930–1995 MHz frequency range. [2]EUT employs digital modulation (QPSK to 256-QAM)

2.4 RSS-139 test results

Part	Test description	Verdict
4.1	Transmitter output power and Equivalent Isotropic Radiated Power (e.i.r.p.)	Pass
4.2	Spurious emissions at RF antenna connector	Pass
4.2	Radiated spurious emissions (conducted and radiated)	Pass
6.4	Transmitter frequency stability	Pass
RSS-Gen, 6.7	Occupied bandwidth	Pass

2.5 RSS-170 test results

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

Note: **ATC Base Station Equipment operating in bands 2000–2020 MHz and 2180–2200 MHz**

The unwanted emissions of ATC base station equipment transmitting in the bands 2000–2020 MHz and 2180–2200 MHz shall comply with the following:

(1) The power of any unwanted emissions at frequencies outside the equipment's operating frequency block shall be attenuated below the transmitter power P (dBW), by 43 + 10 log p (watts), dB.

(2) For equipment operating in the band 2180–2200 MHz, in addition to (1), the power of any emissions on all frequencies between 2200 MHz and 2290 MHz shall not exceed an e.i.r.p. of −100.6 dBW/4 kHz (−70.6 dBm/4 kHz).*

* **This requirement is for implementation and is enforced at the time of licensing. Therefore, results are not included in this report.**

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 20, 2020
Nemko sample ID number	None

3.2 EUT information

Product name	AIR 1641
Model	AIR 1641 B2/25a B66a
Part number	KRD 901 800/1
Revision	R1D
Serial number	E23B014781
Antenna ports	16 TX/RX Ports
RF BW / IBW	B25 IBW DL: 65 MHz B25 IBW UL: 65 MHz B66 IBW DL: 90 MHz B66 IBW UL: 70 MHz
FDD	B2/25: 80 MHz B66: 400 MHz
Frequency	B25 TX (DL): 1930–1995 MHz B25 RX (UL): 1850–1915 MHz B66 TX (DL): 2110–2200 MHz B66 RX (UL): 1710–1780 MHz
Nominal O/P per Antenna port	20 W (43 dBm): 10 W (40 dBm) per Band
Nominal O/P per Band	Single Carrier: 1 × 10 W (40 dBm) 2 Carrier: 2 × 5 W (40 dBm total)
Accuracy (nominal)	±0.1 ppm
Nominal voltage	−48 V_{DC} @ 40 A
RAT	LTE: SC, MC, IoT (GB, IB)
Modulation	LTE: QPSK, 16 QAM, 64 QAM, 256 QAM
Channel bandwidth	LTE: 10, 15, 20 MHz
Channel bandwidth LTE + NB IoT	LTE + NB IoT: GB, IB (200 kHz) LTE BW: 10, 15, 20 MHz (IB, GB)
Maximum combined OBW per port	B2/25: 65 MHz B66: 90 MHz
CPRI	10 Gbps
Channel raster	LTE: 100 kHz
Regulatory requirements	Radio: FCC Part 2, 24, 27, RSS-Gen, RSS-133, RSS-139, RSS-170
	EMC: FCC Part 15, ICES-003
	Safety: IEC/EN 62368-1, UL/CSA 62368-1 IEC/EN 60950-22, UL 50E
Emission Designator	LTE: 10M0W7D, 15M0W7D, 20M0W7D
Supported Configurations	Single Antenna, TX Diversity, MIMO, Carrier Aggregation
Operating temperature	−40 °C to +55 °C
Total Power based on IBW	160 W/band; Total (Radio) 320 W (16 × 20 W)
Supported carrier / port	LTE: (1-2) LTE + IoT: GB (1-2), IB (1-2)

3.3 Product description and theory of operation

EUT description of the methods used to exercise the EUT and all relevant ports:

Description/theory of operation	The AIR 1641 B2/25a B66a (KRD 901 800/1) is a multi-standard remote Dual Band radio forming part of the Ericsson RBS (Radio Base Station) equipment. The AIR (Antenna Integrated Radio) 1641 provides radio access for mobile and fixed devices and is designed for the outdoor environment. The AIR 1641 operates over 2 bands (Band 2/25 and Band 66) via 16 TX/RX ports connected directly into an integrated antenna. Radio unit installation is designed for pole, wall or mast mount options. A fiber optic interface (4) provides the RRU/RBS control and digital interface between the Radio and the RBS. The AIR 1641 product is convection cooled and shall be mounted vertically. Output RF Power is rated at 16 × 10 W (per Band). Altitude during operation: Below 4000 m The AIR 1641 is a synthesized Transceiver designed for use in the 3GPP (Third Generation Partnership Project) for LTE (Long Term Evolution) - E-UTRA Base Station. AIR 1641 B2/25a B66a is a 16TX/16RX remote radio unit (RRU). This RRU operates in Band 2/25 as defined by 3GPP. TX (DL): 1930–1995 MHz, RX (UL): 1850–1915 MHz and Band 66 TX (DL): 2110–2200 MHz, RX (UL): 1710–1780 MHz For LTE, the AIR 1641 B2/25a B66a supports modulations QPSK, 16QAM, 64QAM and 256QAM. Channel Bandwidth is configurable for 10, 15 or 20 MHz. The Radio transmits in single carrier mode and multi carrier mode within the Band Specific IBW (Instantaneous Band Width). NB IoT is supported for IB and GB. The AIR 1641 supports single and multi-beam FD MIMO (Multiple Input Multiple Output) and Carrier Aggregation for LTE. ***Test Configuration:*** KRC 161 800/1: The radio functionality and performance is evaluated without the antenna attached. This configuration replaces the antenna with the Ericsson RDNB (Radio Distribution Network Board) providing access to the RF Ports for compliance measurements. The RDNB is an ODM supplied assembly (KRE 105 341/1R) designed to plug into and support the radio equipment assessment, test and compliance verification.

Ant Description

Port	Description
ANT 1–16	RF Output ports from 1 to 16
Alarm	Alarm
Data 1	Optical Interface Data 1
Data 2	Optical Interface Data 2
Data 3	Optical Interface Data 3
Data 4	Optical Interface Data 4
DC Input	−48 V_{DC}
MMI	Display - Radio Status
GND	Ground

Physical

Dimensions	1555 mm × 635 mm × 320 mm (H × W × D)
Weight	101 kg
Operating Temperature	−40 to +55 °C
Mounting	Pole, Wall, Mast Mount
Cooling	Convection (forced air)

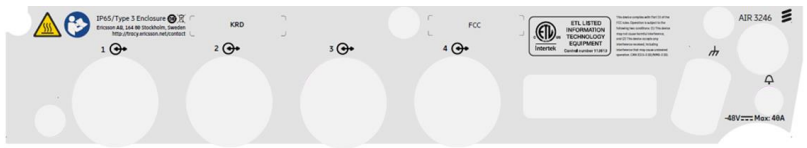
Software details: CXP9017316%12-R81JC

Radio Hardware Configuration

Product: KRD 901 800/1	R1D	KRC 161 800/1	R1D	Description
KRY 901 800/1	R1C	KRY 901 800/1	R1C	Radio Unit
ROA 128 6840/625	R1C	ROA 128 6840/625	R1C	Radio PCP (4)
ROA 128 6850/625	R1B	ROA 128 6850/625	R1B	FIB PCP
ROA 128 6860/625	R1B	ROA 128 6860/625	R1B	PCB PCP
KRF 901 800	R1A	KRF 901 800	R1A	Filter Unit (4)
NTB 101 0679/1	R1B	NTB 101 0679/1	R1B	Parts
KRY 901 850/1	R1B	KRY 901 850/1	R1B	I/O Assembly
ROA 128 6850/99	R1B	ROA 128 6850/99	R1B	PCB SFP Daughter Card
KRE 105 322	R1B	KRE 105 341/1R	R1B	Antenna / RDNB
NTB 101 0678/1	R1B	NTB 101 0678/1	R1B	Parts

Product Identification Label

FCC ID: TA8AKRD901800-1
IC: 287AB-AS9018001
AS9018001



3.4 EUT test details

EUT setup/configuration rationale:

Down link

RAT	Modulation	Performance Requirement	Test Model / Configuration
LTE	QPSK	N/A	E-TM1.1
LTE	16QAM	N/A	E-TM3.2
LTE	64QAM	N/A	E-TM3.1
LTE	256QAM	N/A	E-TM3.1a

Up link

RAT	Modulation	Performance Requirement	Input Signal	Test Model / Configuration
LTE	QPSK	N/A		E-UTRA-UL

Single carrier B25

Bandwidth, MHz	LTE Transmit / DL, MHz					
	B	EARFCN	M	EARFCN	T	EARFCN
5	1932.5	*66461*	1962.5	*66761*	1992.5	*67061*
10	1935.0	*66486*	1962.5	*66761*	1990.0	*67036*
15	1937.5	*66511*	1962.5	*66761*	1987.5	*67011*
20	1940.0	*66536*	1962.5	*66761*	1985.0	*66986*

Bandwidth, MHz	LTE Receive / UL, MHz					
	B	EARFCN	M	EARFCN	T	EARFCN
5	1852.5	*131997*	1882.5	*132297*	1912.5	*132597*
10	1855.0	*132022*	1882.5	*132297*	1910.0	*132572*
15	1857.5	*132047*	1882.5	*132297*	1907.5	*132547*
20	1860.0	*132072*	1882.5	*132297*	1905.0	*132522*

Single carrier B66

Bandwidth, MHz	LTE Transmit / DL, MHz					
	B	EARFCN	M	EARFCN	T	EARFCN
5	2112.5	*66461*	2155.0	*66886*	2197.5	*67311*
10	2115.0	*66486*	2155.0	*66886*	2195.0	*67286*
15	2117.5	*66511*	2155.0	*66886*	2192.5	*67261*
20	2120.0	*66536*	2155.0	*66886*	2190.0	*67236*

Bandwidth, MHz	LTE Receive / UL, MHz					
	B	EARFCN	M	EARFCN	T	EARFCN
5	1712.5	*131997*	1745.0	*132322*	1777.5	*132647*
10	1715.0	*132022*	1745.0	*132322*	1775.0	*132622*
15	1717.5	*132047*	1745.0	*132322*	1772.5	*132597*
20	1720.0	*132072*	1745.0	*132322*	1770.0	*132572*

B25 LTE Multi-Carrier for Band Edge Emissions:

Bandwidth, MHz	Transmit / DL, MHz								
	B1	EARFCN	B2	EARFCN		T2	EARFCN	T1	EARFCN
5	1932.5	*66461*	1937.5	*66511*		1987.5	*67011*	1992.5	*67061*
10	1935.0	*66486*	1945.0	*66586*		1980.0	*66936*	1990.0	*67036*
15	1937.5	*66511*	1952.5	*66661*		1972.5	*66861*	1987.5	*67011*
20	1940.0	*66536*	1960.0	*66736*		1965.0	*66786*	1985.0	*66986*

Bandwidth, MHz	Receive / UL, MHz								
	B1	EARFCN	B2	EARFCN		T2	EARFCN	T1	EARFCN
5	1852.5	*131997*	1857.5	*132047*		1907.5	*132547*	1912.5	*132597*
10	1855.0	*132022*	1865.0	*132122*		1900.0	*132472*	1910.0	*132572*
15	1857.5	*132047*	1872.5	*132197*		1892.5	*132397*	1907.5	*132547*
20	1860.0	*132072*	1880.0	*132272*		1885.0	*132322*	1905.0	*132522*

B66 LTE Multi-Carrier for Band Edge Emissions:

Bandwidth, MHz	Transmit / DL, MHz								
	B1	EARFCN	B2	EARFCN		T2	EARFCN	T1	EARFCN
5	2112.5	***66461***	2117.5	***66511***		2192.5	***67261***	2197.5	***67311***
10	2115.0	***66486***	2125.0	***66586***		2185.0	***67186***	2195.0	***67286***
15	2117.5	***66511***	2132.5	***66661***		2177.5	***67111***	2192.5	***67261***
20	2120.0	***66536***	2140.0	***66736***		2170.0	***67036***	2190.0	***67236***

Bandwidth, MHz	Receive / UL, MHz								
	B1	EARFCN	B2	EARFCN		T2	EARFCN	T1	EARFCN
5	1712.5	*131997*	1717.5	*132047*		1772.5	*132597*	1777.5	*132647*
10	1715.0	*132022*	1725.0	*132122*		1765.0	*132522*	1775.0	*132622*
15	1717.5	*132047*	1732.5	*132197*		1757.5	*132447*	1772.5	*132597*
20	1720.0	*132072*	1740.0	*132272*		1750.0	*132372*	1770.0	*132572*

B25 LTE Multiple-Carriers for spurious emissions (IBW=65MHz):

Bandwidth (MHz)	Transmit / DL (MHz)			
	C1	*EARFCN*	C2	*EARFCN*
5	1932.5	*66461*	1992.5	*67061*
10	1935.0	*66486*	1990.0	*67036*
15	1937.5	*66511*	1987.5	*67011*
20	1940.0	*66536*	1985.0	*66986*

Bandwidth (MHz)	Receive / UL (MHz)			
	C1	*EARFCN*	C2	*EARFCN*
5	1852.5	*131997*	1912.5	*132597*
10	1855.0	*132022*	1910.0	*132572*
15	1857.5	*132047*	1907.5	*132547*
20	1860.0	*132072*	1905.0	*132522*

B66 LTE Multiple-Carriers for spurious emissions (IBW=70)

Bandwidth (MHz)	Transmit / DL (MHz)			
	C1	***EARFCN***	**C2**	***EARFCN***
5	2112.5	*66461*	2177.5	*67111*
10	2115.0	*66486*	2175.0	*67086*
15	2117.5	*66511*	2172.5	*67061*
20	2120.0	*66536*	2170.0	*67036*

Bandwidth (MHz)	Receive / UL (MHz)			
	C1	***EARFCN***	**C2**	***EARFCN***
5	1712.5	*131997*	1777.5	*132647*
10	1715.0	*132022*	1775.0	*132622*
15	1717.5	*132047*	1772.5	*132597*
20	1720.0	*132072*	1770.0	*132572*

EUT Monitoring Method / Equipment:

Support equipment	**Node EMC Test System** - Anritsu MS 2691 VSA/Sig Gen - HP Laptop - Timing and Synchronization box (GPS) - Ethernet Switch - Isolation Transformer **RBS 6601, BFM 901 009/1:** - DUS 4101 KDU 137 624/ 11, R4G, S/N: T48X68357 - DUS SW: CXP102051/27-R18A179 - Input Voltage: −48 V_{DC}

3.5 EUT setup diagram

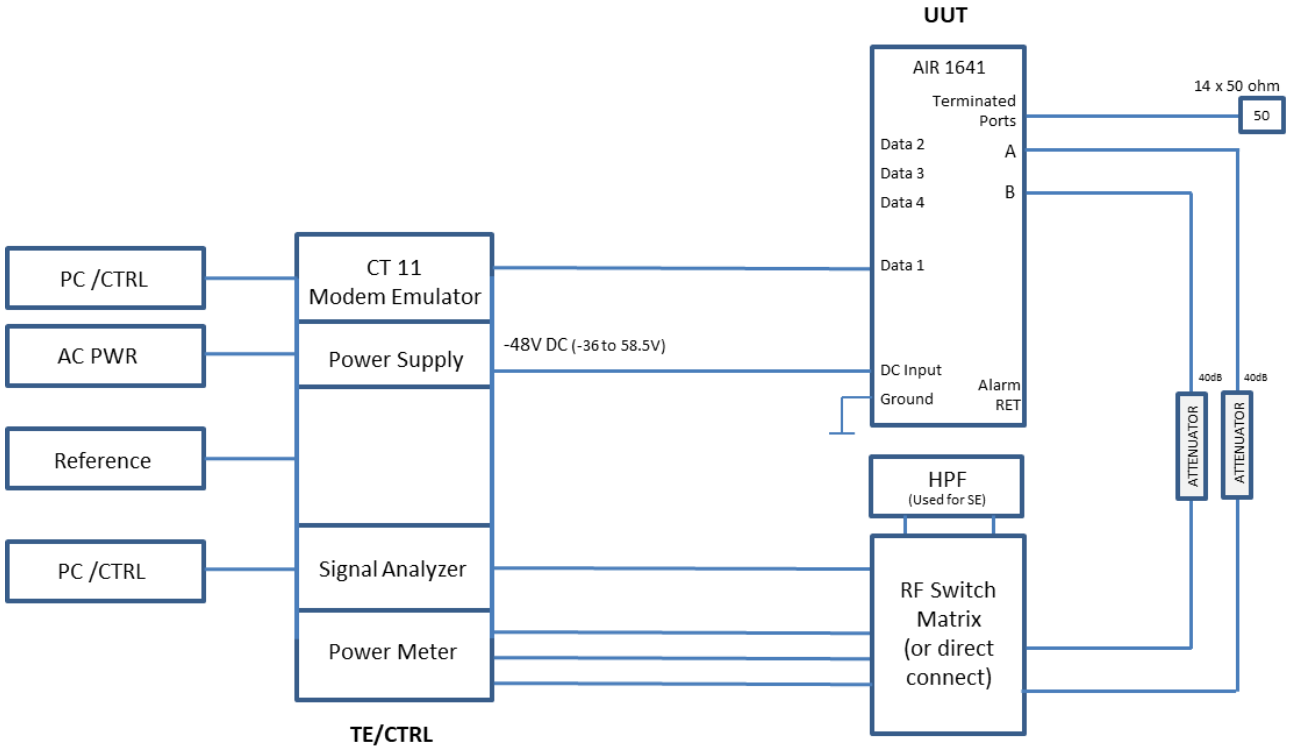


Figure 3.5-1: *Setup diagram – Radio Compliance*

3.6 Setup photographs

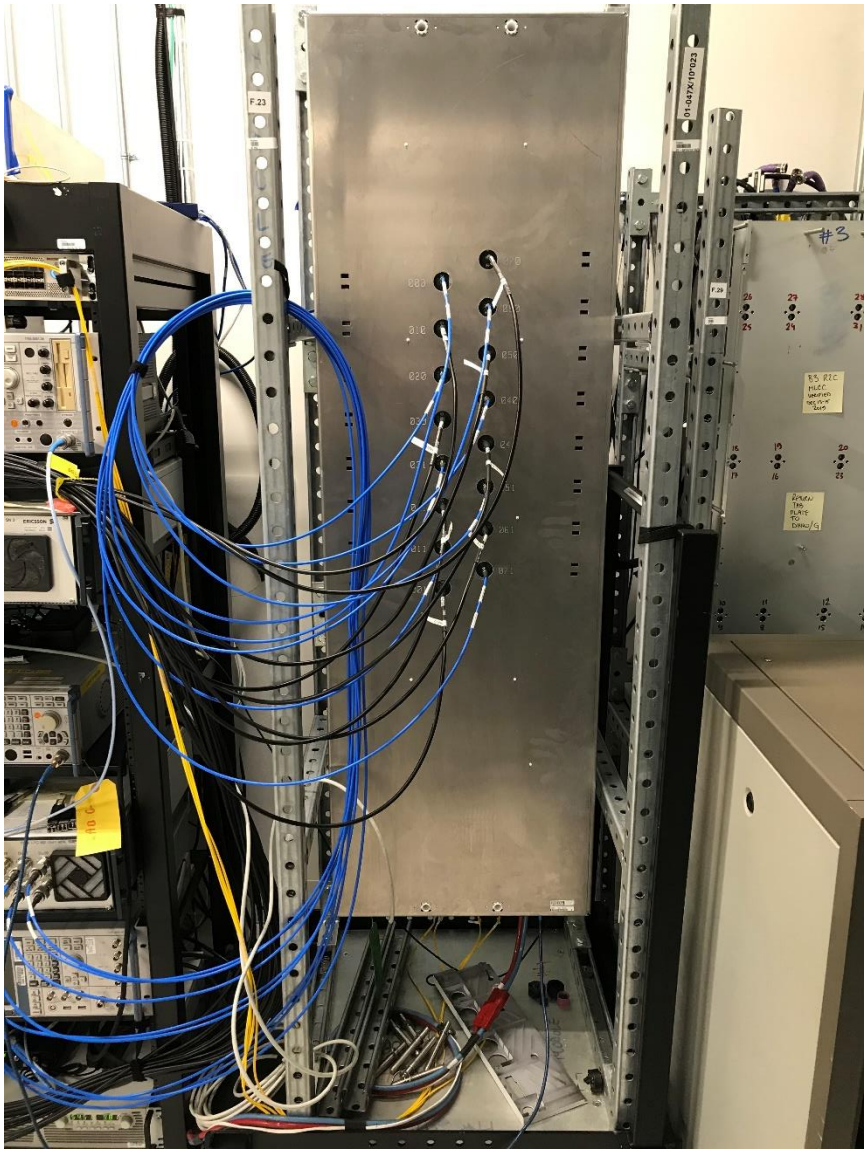


Figure 3.6-1: *Set up photo for Radio Compliance Testing*

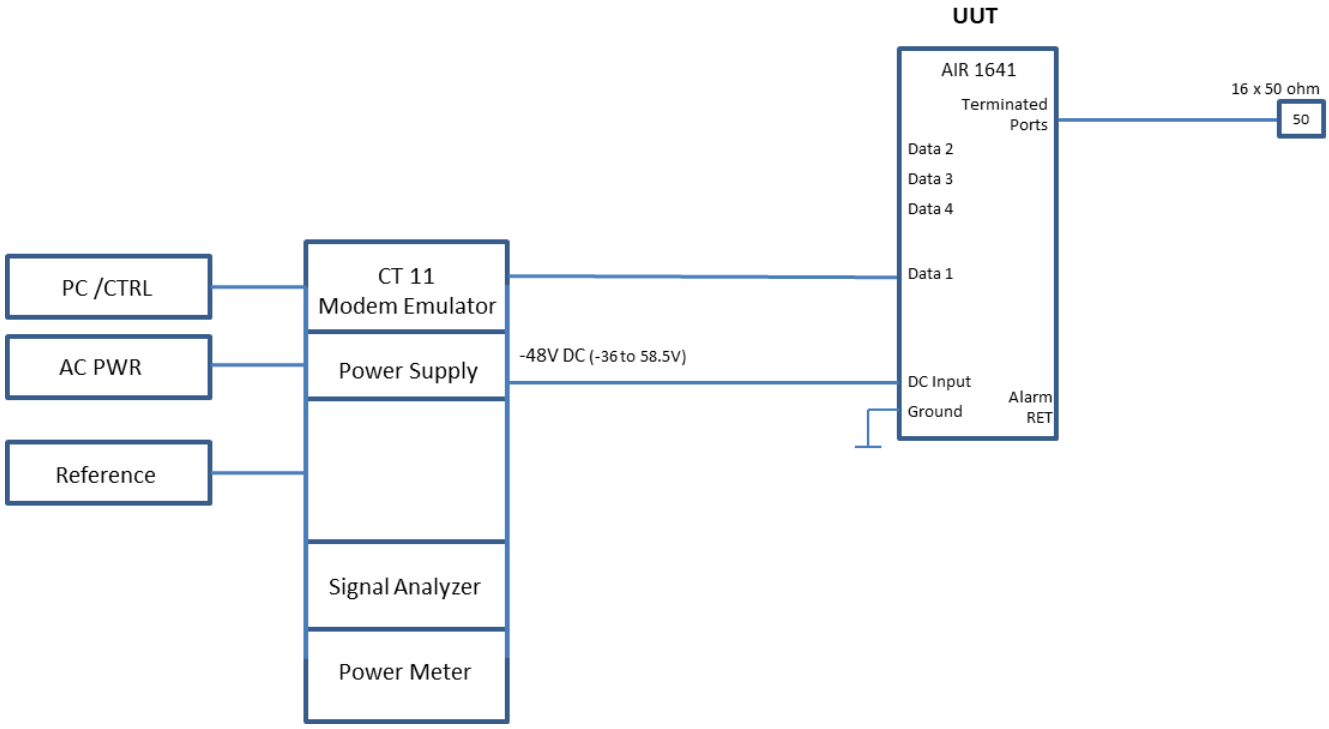


Figure 3.6-2: *EUT Set-up diagram for Radiated Compliance Testing*

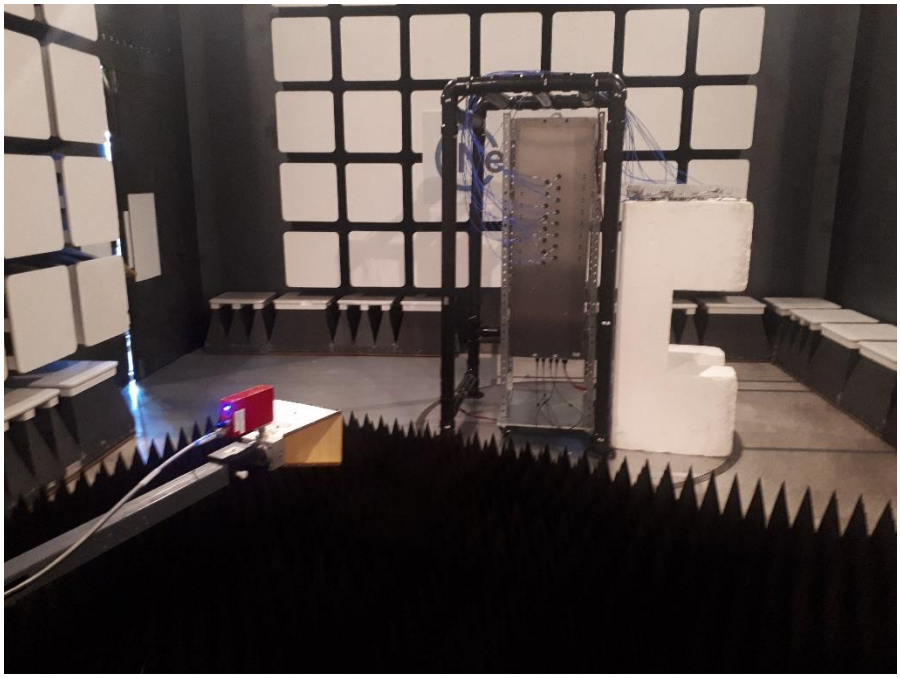


Figure 3.6-3: *EUT Set-up photo for Radiated Compliance Testing*

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

The testing was performed in accordance with the test plan, which suggested to measure output power on all 16 antenna ports, to find the port with the highest output power and perform the rest of the testing on that one representing antenna port.

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, 2021
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
DC Power source	Ametek	SGA80X125C-0AAA	FA002737	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	May 8, 2020
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002877	1 year	November 4, 2020
Biconical antenna (30–300 MHz)	Sunol	BC2	FA002078	1 year	October 31, 2020
Log periodic antenna (200–5000 MHz)	Sunol	LP5	FA002077	1 year	October 31, 2020
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	October 31, 2020
Horn antenna (18–26.5 GHz)	Electro-metrics	SH-50/60-1	FA000479	—	VOU
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
50 Ω coax cable	C.C.A.	None	FA002556	1 year	April 18, 2020
50 Ω coax cable	Huber + Suhner	None	FA003099	1 year	May 10, 2020
Spectrum Analyser	Keysight	PXA N9030A	MY55410202	1 year	September 24, 2020
PSU (DC)	Xantrex	XKW60-50	1001425551	—	NCR
USB Power Sensor	Keysight	U2044XA	MY58090002	2 year	April 16, 2020
USB Power Sensor	Keysight	U2044XA	MY58040008	2 year	April 16, 2020
USB Power Sensor	Keysight	U2044XA	MY57510012	2 year	April 15, 2020
USB Power Sensor	Keysight	U2044XA	MY57520003	2 year	April 15, 2020
RF Swtich	Ericsson	RARFSW4X1	1	—	NCR
Switch Driver	Hewlett Packard	11713A	3748A06076	—	NCR
PSU (DC)	Leader	730-3D	9801135	—	NCR
Testing Equipment*	Ericsson	CT11	T01G495060	—	NCR

Note: NCR - no calibration required, VOU - verify on use.

* Testing equipment (CT11) is the test equipment that drives the radios traffic.

Section 8. Testing data

8.1 FCC 27.50(d) and RSS-139, 4.1, RSS-170, 5.3 Maximum output power at RF antenna connector (B66)

8.1.1 Definitions and limits

§ 27.50(d) Operation within the bands: 2110–2155 MHz and 2155–2180 MHz.

(1) The power of each fixed or base station transmitting in the 1995–2000 MHz, 2110–2155 MHz, 2155–2180 MHz or 2180–2200 MHz band and located in any county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, is limited to:

(i) An equivalent isotropically radiated power (EIRP) of 3280 watts when transmitting with an emission bandwidth of 1 MHz or less;

(ii) An EIRP of 3280 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

(2) The power of each fixed or base station transmitting in the 1995–2000 MHz, the 2110–2155 MHz 2155–2180 MHz band, or 2180–2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:

(i) An equivalent isotropically radiated power (EIRP) of 1640 watts when transmitting with an emission bandwidth of 1 MHz or less;

(ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

(3) A licensee operating a base or fixed station in the 2110–2155 MHz band utilizing a power greater than 1640 watts EIRP and greater than 1640 watts/MHz EIRP must coordinate such operations in advance with all Government and non-Government satellite entities in the 2025–2110 MHz band. A licensee operating a base or fixed station in the 2110–2180 MHz band utilizing power greater than 1640 watts EIRP and greater than 1640 watts/MHz EIRP must be coordinated in advance with the following licensees authorized to operate within 120 kilometers (75 miles) of the base or fixed station operating in this band: All Broadband Radio Service (BRS) licensees authorized under this part in the 2155–2160 MHz band and all advanced wireless services (AWS) licensees authorized to operate on adjacent frequency blocks in the 2110–2180 MHz band.

(5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

(6) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

RSS-139, Section 4.1

The transmitter power shall be measured in terms of a root-mean-square (RMS) average value.

RSS-139, Section 6.5

Consult SRSP-513 for e.i.r.p. limits on fixed and base stations operating in the band 2110–2180 MHz.

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the highest PAPR during periods of continuous transmission.

RSS-170, Section 5.3.1

Consult SRSP-519 for e.i.r.p. limits on ATC base stations operating in the bands 2000–2020 MHz and 2180–2200 MHz.

SRSP-513, Section 5.1

5.1.1 Fixed and base stations

5.1.1.1 For fixed and base stations operating within the frequency range 2110–2180 MHz with a channel bandwidth equal to or less than 1 MHz, the maximum permissible equivalent isotropically radiated power (e.i.r.p.) is 1640 watts with an antenna height above average terrain (HAAT) up to 300 metres.

5.1.1.2 For fixed and base stations operating within the frequency range 2110–2180 MHz with a channel bandwidth greater than 1 MHz, the maximum permissible e.i.r.p. is 1640 watts/MHz e.i.r.p. (i.e. no more than 1640 watts e.i.r.p. in any 1 MHz band segment) with an antenna height above average terrain (HAAT) up to 300 metres.

5.1.1.3 Fixed and base stations located in geographic areas at a distance greater than 26 km from large or medium population centres, and transmitting within the frequency range 2110–2180 MHz, may increase their e.i.r.p. up to a maximum of 3280 watts/MHz (i.e. no more than 3280 watts e.i.r.p. in any 1 MHz band segment), with an antenna HAAT up to 300 metres.

Within 26 km of any large or medium population centre, fixed and base stations may operate at increased e.i.r.p. if more than 50% of the population within a particular sector's coverage is located outside these large and medium population centres.

Fixed and base stations with increased e.i.r.p. must not be used to provide coverage to large and medium population centres. However, some incidental coverage of these large and medium population centres by stations with increased e.i.r.p. is permitted.

This provision also applies for fixed and base stations with a channel bandwidth equal to or less than 1 MHz (i.e. the e.i.r.p. may be increased up to a maximum of 3280 watts).

5.1.1.4 Fixed and base station antenna heights above average terrain may exceed 300 metres with a reduction in e.i.r.p. The maximum permissible e.i.r.p. for installations with antenna HAAT in excess of 300 metres is given in the following table:

Table 8.1-1: *Reduction to Maximum Allowable E.I.R.P. for HAAT > 300 m*

HAAT (m)	Maximum EIRP, W/MHz
HAAT ≤ 300	1640 (or 3280[1])
300 < HAAT ≤ 500	1070
500 < HAAT ≤ 1000	490
1000 < HAAT ≤ 1500	270
1500 < HAAT ≤ 2000	160

Note: [1]for fixed and base stations with a channel bandwidth equal to or less than 1 MHz

SRSP-519, Section 5.1

The equivalent isotropically radiated power (e.i.r.p.) of base stations shall not exceed 1640 W when transmitting with an emission bandwidth of 1 MHz or less, and 1640 W/MHz when transmitting with an emission bandwidth greater than 1 MHz.

Base stations located outside of large or medium population may increase their e.i.r.p. to a maximum of 3280 W when transmitting with an emission bandwidth of 1 MHz or less, and to 3280 W/MHz when transmitting with an emission bandwidth greater than 1 MHz.

A licensee operating a base station utilizing an e.i.r.p greater than 1640 W/MHz must coordinate in advance with all AWS–4 licensees authorized to operate on adjacent frequency blocks within the same band.

Base station antenna heights above average terrain may exceed 300 m with a corresponding reduction in e.i.r.p. in accordance with Table above

8.1.2 Test summary

Test date	January 20, 2020
Test engineer	Andrey Adelberg

8.1.3 Observations, settings and special notes

Output power was measured with RMS power meter per ANSI C63.26 Paragraph 5.2.4.2 method. PSD was measured using method described in paragraph 5.2.4.4.
Antenna sub-array gain is 14.5 dBi with uncorrelated signals.
Test receiver settings for PSD measurements:

Detector mode	RMS
Resolution bandwidth	1 MHz
Video bandwidth	>RBW
Measurement mode	Power over emission bandwidth
Trace mode	Averaging
Measurement time	Auto

8.1.4 Test data

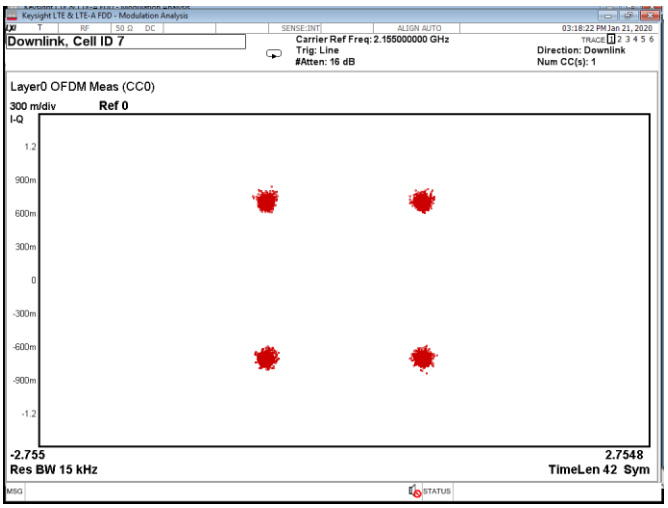


Figure 8.1-1: *Modulation characteristics, QPSK*

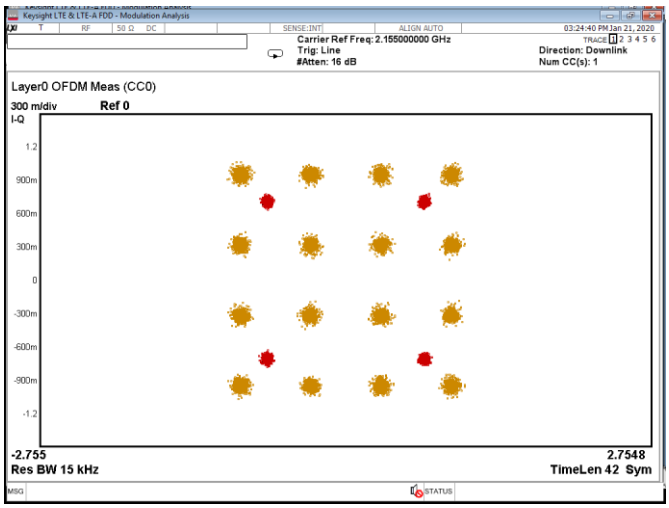


Figure 8.1-2: *Modulation characteristics, 16QAM*

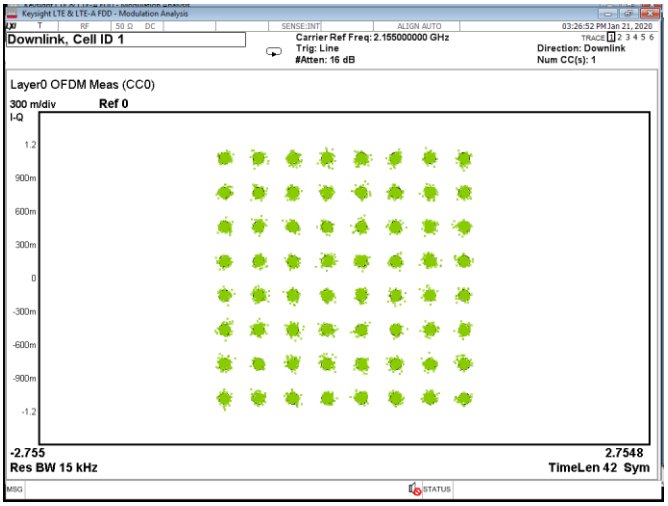


Figure 8.1-3: *Modulation characteristics, 64QAM*

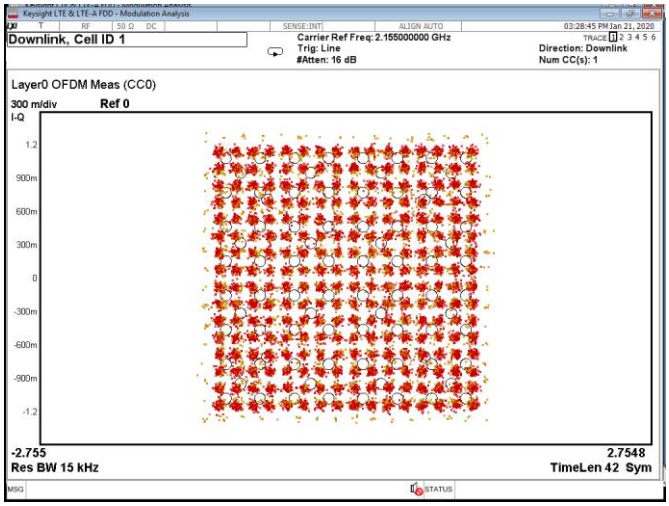


Figure 8.1-4: *Modulation characteristics, 256QAM*

Table 8.1-2: *Output power measurement results*

Port	RF output power, dBm	RF output power, W	Dual band combined power, dBm	Dual band combined power, W
000	39.22	8.356	42.63	18.323
010	39.35	8.610	42.77	18.923
020	39.44	8.790	42.73	18.750
030	39.41	8.730	42.83	19.187
031	39.28	8.472	42.66	18.450
021	**39.49**	**8.892**	**42.84**	**19.231**
011	39.23	8.375	42.62	18.281
001	39.27	8.453	42.67	18.493
070	39.19	8.299	42.64	18.365
060	39.48	8.872	42.83	19.187
050	39.29	8.492	42.67	18.493
040	39.44	8.790	42.84	19.231
041	39.28	8.472	42.71	18.664
051	39.43	8.770	42.77	18.923
061	39.23	8.375	42.70	18.621
071	39.26	8.433	42.68	18.535

Note: The measurement results in the table above were obtained during single band and multi band operation. 10 MHz channel BW (worst case) was used. Frequency of carriers were 2155.0 MHz and 1962.5 MHz for dual band config.

Note: it was determined that the highest level of output power is at antenna port **021**. This port was considered as a representative one and all the rest of the measurements were performed on it.

Table 8.1-3: *Output power density measurement results of a single-carrier operation for Port* ***021***

Remarks	Frequency, MHz	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
QPSK, 10 MHz, Low channel	2115.0	29.69	14.50	44.19	62.15	17.96
16QAM, 10 MHz, Low channel	2115.0	30.35	14.50	44.85	62.15	17.30
64QAM, 10 MHz, Low channel	2115.0	29.60	14.50	44.10	62.15	18.05
256QAM, 10 MHz, Low channel	2115.0	29.76	14.50	44.26	62.15	17.89
16QAM, 10 MHz, Mid channel	2155.0	30.72	14.50	45.22	62.15	16.93
16QAM, 10 MHz, High channel	2195.0	29.79	14.50	44.29	62.15	17.86
QPSK, 15 MHz, Low channel	2117.5	28.11	14.50	42.61	62.15	19.54
16QAM, 15 MHz, Low channel	2117.5	28.81	14.50	43.31	62.15	18.84
64QAM, 15 MHz, Low channel	2117.5	28.24	14.50	42.74	62.15	19.41
256QAM, 15 MHz, Low channel	2117.5	27.95	14.50	42.45	62.15	19.70
16QAM, 15 MHz, Mid channel	2155.0	29.53	14.50	44.03	62.15	18.12
16QAM, 15 MHz, High channel	2192.5	28.94	14.50	43.44	62.15	18.71
QPSK, 20 MHz, Low channel	2120.0	27.09	14.50	41.59	62.15	20.56
16QAM, 20 MHz, Low channel	2120.0	27.26	14.50	41.76	62.15	20.39
64QAM, 20 MHz, Low channel	2120.0	27.01	14.50	41.51	62.15	20.64
256QAM, 20 MHz, Low channel	2120.0	27.02	14.50	41.52	62.15	20.63
16QAM, 20 MHz, Mid channel	2155.0	27.71	14.50	42.21	62.15	19.94
16QAM, 20 MHz, High channel	2190.0	27.39	14.50	41.89	62.15	20.26

Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 30.72 dBm/MHz. Maximum PSD sum = 30.72 dBm/MHz + 10 × Log_{10}(8) = 39.75 dBm/MHz

Table 8.1-4: *Total EIRP calculation for a single-carrier operation*

Maximum PSD sum, dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[1], dB	EIRP per polarization[2], dBm/MHz	EIRP per polarization, W/MHz
39.75	14.50	9.00	63.25	2113.489

Notes: [1] Antenna Array Column Gain = 10 × Log_{10}(8)
[2]EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain
Total EIRP calculation for a single Macro Narrow traffic beam: 39.75 + 25 dBi *(directional beam)* = 64.75 dBm or 2985 W

Table 8.1-5: *Output power density measurement results of a two-carrier operation for Port* ***021***

Frequency, MHz	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
2115 + 2125	27.45	14.50	41.95	62.15	20.20
2150 + 2160	27.72	14.50	42.22	62.15	19.93
2185 + 2195	27.22	14.50	41.72	62.15	20.43
2117.5 + 2132.5	26.05	14.50	40.55	62.15	21.60
2147.5 + 2162.5	26.28	14.50	40.78	62.15	21.37
2177.5 + 2192.5	26.17	14.50	40.67	62.15	21.48
2120 + 2140	24.52	14.50	39.02	62.15	23.13
2145 + 2165	24.65	14.50	39.15	62.15	23.00
2170 + 2190	24.66	14.50	39.16	62.15	22.99

Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 27.72 dBm/MHz. Maximum PSD sum = 27.72 dBm/MHz + 10 × Log_{10}(8) = 36.75 dBm/MHz

Table 8.1-6: *Total EIRP calculation for a two-carrier operation*

Maximum PSD sum, dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[1], dB	EIRP per polarization[2], dBm/MHz	EIRP per polarization, W/MHz
36.75	14.50	9.00	60.25	1059.473

Notes: [1] Antenna Array Column Gain = 10 × Log_{10}(8); [2]EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

Table 8.1-7: *Output power density measurement results of LTE and IoT operation for Port* ***021***

Remarks	Frequency, MHz	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz	EIRP limit, dBm/MHz	Margin, dB
10 MHz low channel with 2 × GB IoT	2115.0	29.63	14.50	44.13	62.15	18.02
10 MHz mid channel with 2 × GB IoT	2155.0	30.10	14.50	44.60	62.15	17.55
10 MHz high channel with 2 × GB IoT	2195.0	29.75	14.50	44.25	62.15	17.90
15 MHz low channel with 2 × GB IoT	2117.5	28.10	14.50	42.60	62.15	19.55
15 MHz mid channel with 2 × GB IoT	2155.0	28.56	14.50	43.06	62.15	19.09
15 MHz high channel with 2 × GB IoT	2192.5	28.15	14.50	42.65	62.15	19.50
20 MHz low channel with 2 × GB IoT	2120.0	27.12	14.50	41.62	62.15	20.53
20 MHz mid channel with 2 × GB IoT	2155.0	27.44	14.50	41.94	62.15	20.21
20 MHz high channel with 2 × GB IoT	2190.0	27.42	14.50	41.92	62.15	20.23

Linear sum of 8 ports of each polarization was based on the worst-case scenario, then all ports transmit at the maximum found power density of 30.10 dBm/MHz. Maximum PSD sum = 30.10 dBm/MHz + 10 × Log_{10}(8) = 39.13 dBm/MHz

Table 8.1-8: *Total EIRP calculation for LTE + IoT operation*

Maximum PSD sum, dBm/MHz	Antenna Gain, dBi	Antenna Array Column Gain[1], dB	EIRP per polarization[2], dBm/MHz	EIRP per polarization, W/MHz
39.13	14.50	9.00	62.63	1832.694

Notes: [1] Antenna Array Column Gain = 10 Log(8)
[2]EIRP = PSD Sum + Antenna Gain + Antenna Array Column Gain

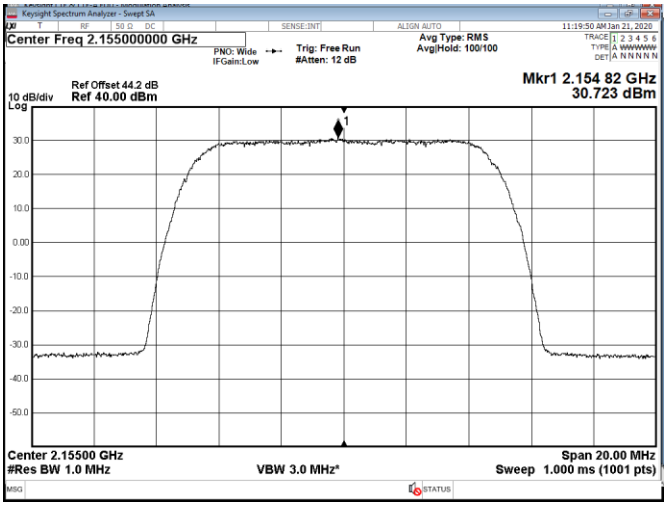


Figure 8.1-5: *PSD of 10 MHz channel bandwidth, single carrier operation, sample plot*

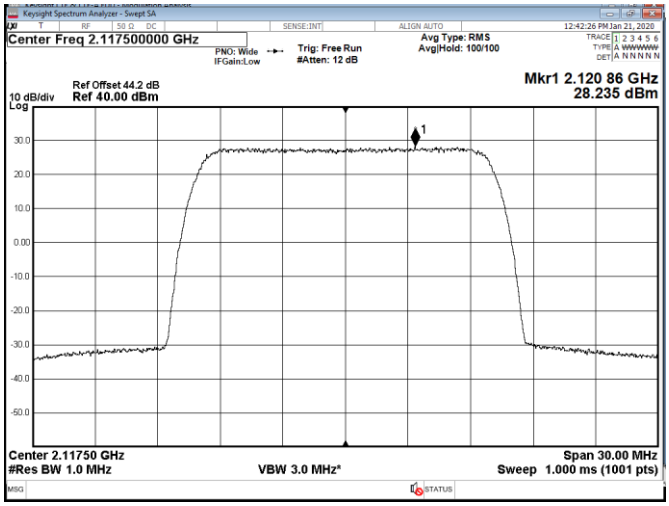


Figure 8.1-6: *PSD of 15 MHz channel bandwidth, single carrier operation, sample plot*

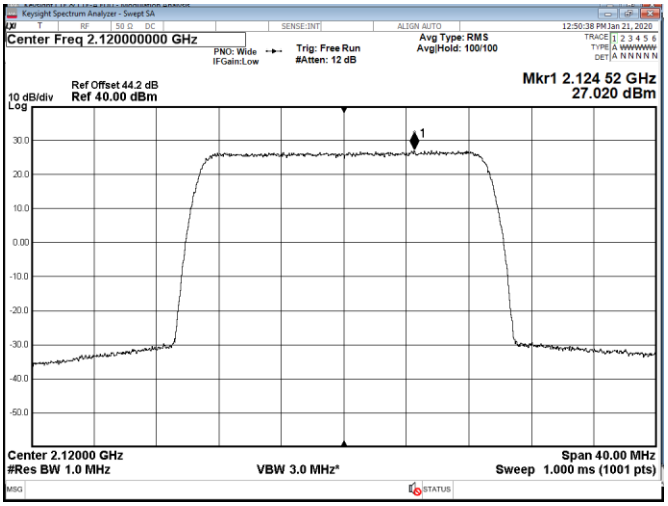


Figure 8.1-7: *PSD of 20 MHz channel bandwidth, single carrier operation, sample plot*

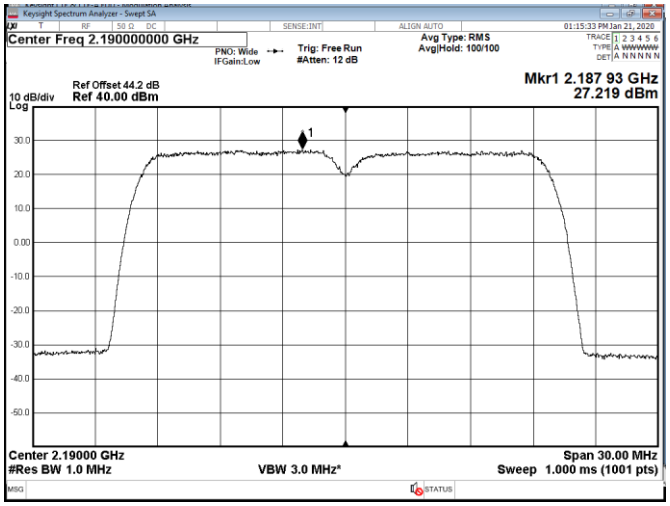


Figure 8.1-8: *PSD of 10 MHz channel bandwidth, two-carrier operation, sample plot*

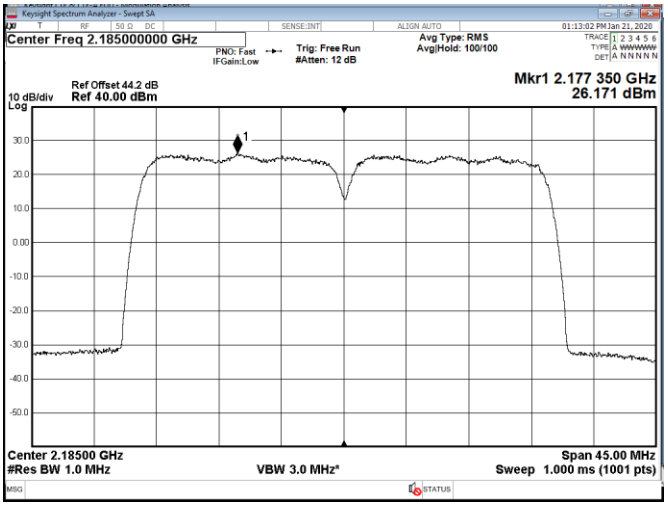


Figure 8.1-9: *PSD of 15 MHz channel bandwidth, two-carrier operation, sample plot*

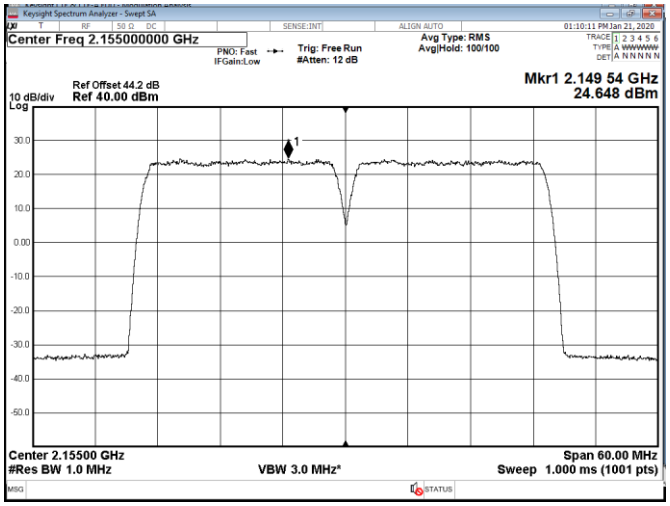


Figure 8.1-10: *PSD of 20 MHz channel bandwidth, two-carrier operation, sample plot*

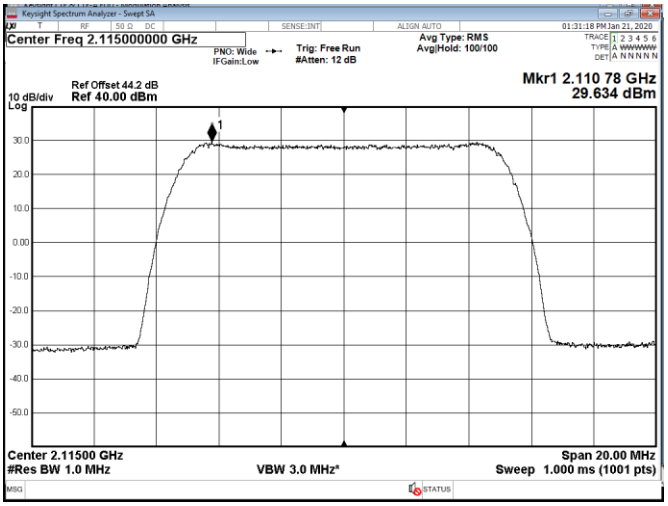


Figure 8.1-11: *PSD of 10 MHz channel bandwidth, LTE and IoT operation, sample plot*

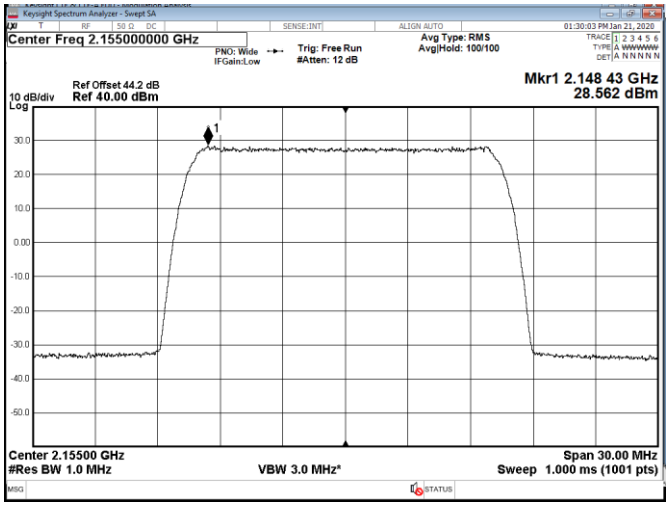


Figure 8.1-12: *PSD of 15 MHz channel bandwidth, LTE and IoT operation, sample plot*

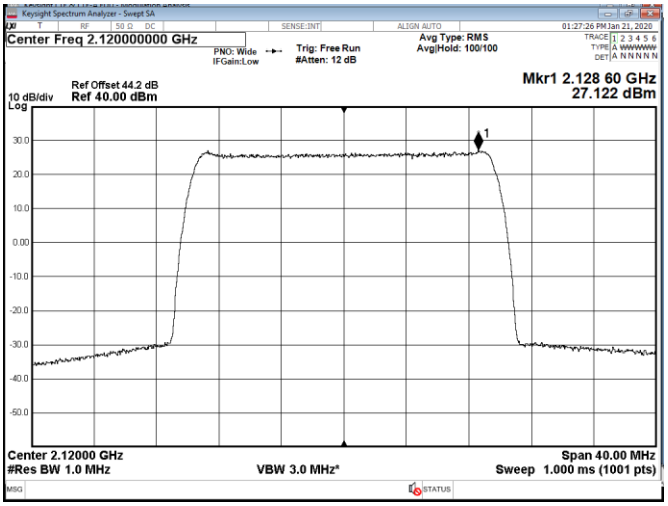


Figure 8.1-13: *PSD of 20 MHz channel bandwidth, LTE and IoT operation, sample plot*

Table 8.1-9: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for single carrier operation*

Remarks	Frequency, MHz	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 10 MHz, Low channel	2115.0	7.37	13.00	5.63
16QAM, 10 MHz, Low channel	2115.0	7.36	13.00	5.64
64QAM, 10 MHz, Low channel	2115.0	7.37	13.00	5.63
256QAM, 10 MHz, Low channel	2115.0	7.38	13.00	5.62
16QAM, 10 MHz, Mid channel	2155.0	7.36	13.00	5.64
16QAM, 10 MHz, High channel	2195.0	7.37	13.00	5.63
QPSK, 15 MHz, Low channel	2117.5	7.39	13.00	5.61
16QAM, 15 MHz, Low channel	2117.5	7.39	13.00	5.61
64QAM, 15 MHz, Low channel	2117.5	7.40	13.00	5.60
256QAM, 15 MHz, Low channel	2117.5	7.40	13.00	5.60
16QAM, 15 MHz, Mid channel	2155.0	7.37	13.00	5.63
16QAM, 15 MHz, High channel	2192.5	7.39	13.00	5.61
QPSK, 20 MHz, Low channel	2120.0	7.41	13.00	5.59
16QAM, 20 MHz, Low channel	2120.0	7.39	13.00	5.61
64QAM, 20 MHz, Low channel	2120.0	7.42	13.00	5.58
256QAM, 20 MHz, Low channel	2120.0	7.41	13.00	5.59
16QAM, 20 MHz, Mid channel	2155.0	7.38	13.00	5.62
16QAM, 20 MHz, High channel	2190.0	7.40	13.00	5.60

Table 8.1-10: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results for LTE + IoT operation*

Remarks	Frequency, MHz	RF power density, dBm/MHz	Antenna gain, dBi	EIRP, dBm/MHz
10 MHz low channel with 2 × GB IoT	2115.0	7.54	13.00	5.46
10 MHz mid channel with 2 × GB IoT	2155.0	7.55	13.00	5.45
10 MHz high channel with 2 × GB IoT	2195.0	7.54	13.00	5.46
15 MHz low channel with 2 × GB IoT	2117.5	7.50	13.00	5.50
15 MHz mid channel with 2 × GB IoT	2155.0	7.49	13.00	5.51
15 MHz high channel with 2 × GB IoT	2192.5	7.50	13.00	5.50
20 MHz low channel with 2 × GB IoT	2120.0	7.47	13.00	5.53
20 MHz mid channel with 2 × GB IoT	2155.0	7.46	13.00	5.54
20 MHz high channel with 2 × GB IoT	2190.0	7.48	13.00	5.52

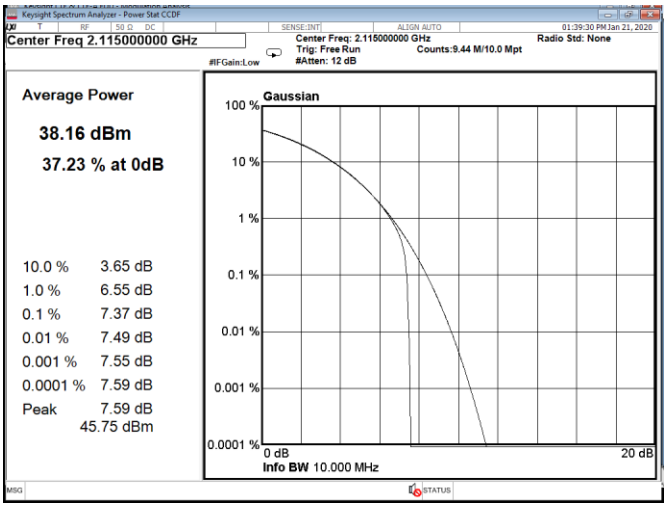


Figure 8.1-14: *CCDF sample plot, 10 MHz channel*

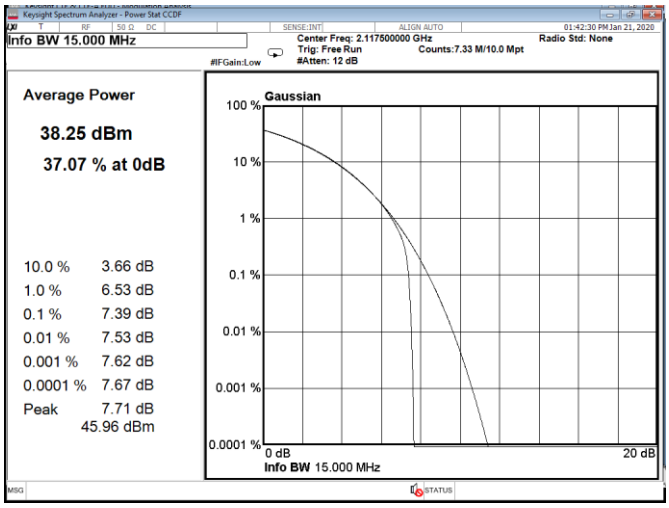


Figure 8.1-15: *CCDF sample plot, 15 MHz channel*

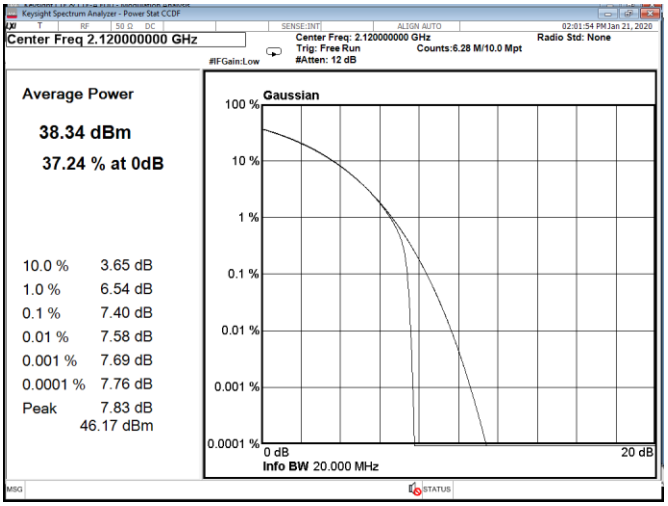


Figure 8.1-16: *CCDF sample plot, 20 MHz channel*

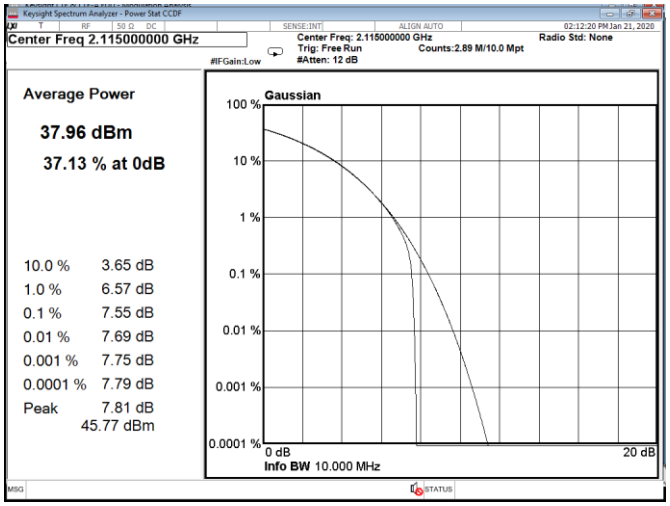


Figure 8.1-17: *CCDF sample plot, 10 MHz channel LTE + IoT*

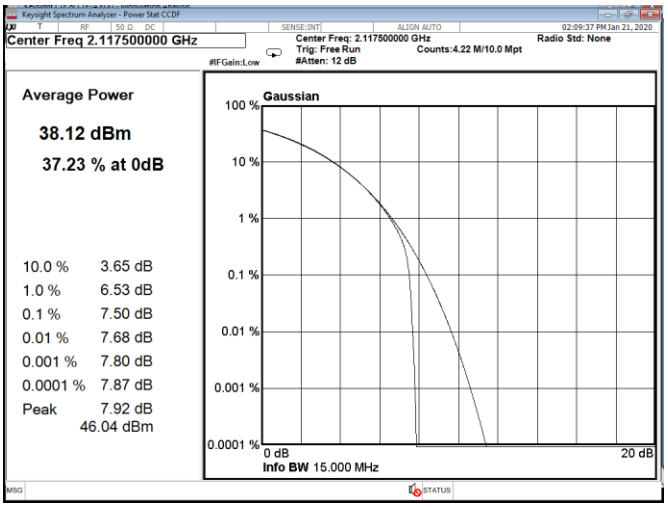


Figure 8.1-18: *CCDF sample plot, 15 MHz channel LTE + IoT*

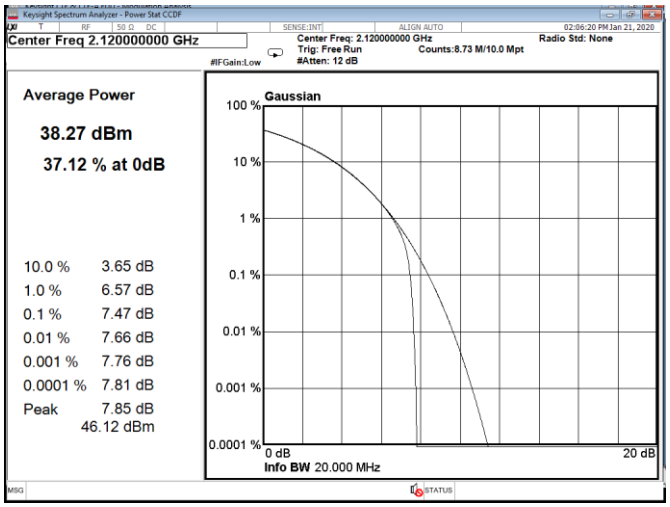


Figure 8.1-19: *CCDF sample plot, 20 MHz channel LTE + IoT*

8.2 FCC 24.232(a)(2) and RSS-133, 6.4 Transmitter output power (EIRP) and antenna height (B2/25a)

8.2.1 Definitions and limits

§24.232(a)(2)

Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(2) Base station antenna heights may exceed 300 meters HAAT with a corresponding reduction in power; see table below.

(b)(1) Base stations that 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, with an emission bandwidth of 1 MHz or less are limited to 3280 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.

(d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

RSS-133, Section 6.4

The equivalent isotropically radiated power (e.i.r.p.) for transmitters shall not exceed the limits given in SRSP-510.
In addition, the transmitter's peak-to-average power ratio (PAPR) 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-510, Section 5.1

5.1.1 Base stations

For base stations with a channel bandwidth greater than 1 MHz, the maximum e.i.r.p. is limited to 3280 watts/MHz e.i.r.p. (i.e., no more than 3280 watts e.i.r.p. in any 1 MHz band segment) with an antenna height above average terrain (HAAT) up to 300 metres. Fixed or base stations operating in urban areas are limited to a maximum allowable e.i.r.p. of 1640 watts/MHz e.i.r.p. Base station antenna heights above average terrain may exceed 300 metres with a corresponding reduction in e.i.r.p. according to the following table.

Table 8.2-1: *Reduction to Maximum Allowable E.I.R.P. for HAAT > 300 m*

HAAT (m)	Maximum EIRP, W/MHz
HAAT ≤ 300	1640
300 < HAAT ≤ 500	1070
500 < HAAT ≤ 1000	490
1000 < HAAT ≤ 1500	270
1500 < HAAT ≤ 2000	160

8.2.2 Test summary

Test date	January 21, 2020
Test engineer	Andrey Adelberg

8.2.3 Observations, settings and special notes

Output power was measured with RMS power meter per ANSI C63.26 Paragraph 5.2.4.2 method. PSD was measured using method described in paragraph 5.2.4.4.
Antenna sub-array gain is 14.5 dBi with uncorrelated signals.
Test receiver settings for PSD measurements:

Detector mode	RMS
Resolution bandwidth	1 MHz
Video bandwidth	>RBW
Measurement mode	Power over emission bandwidth
Trace mode	Averaging
Measurement time	Auto

8.2.4 Test data

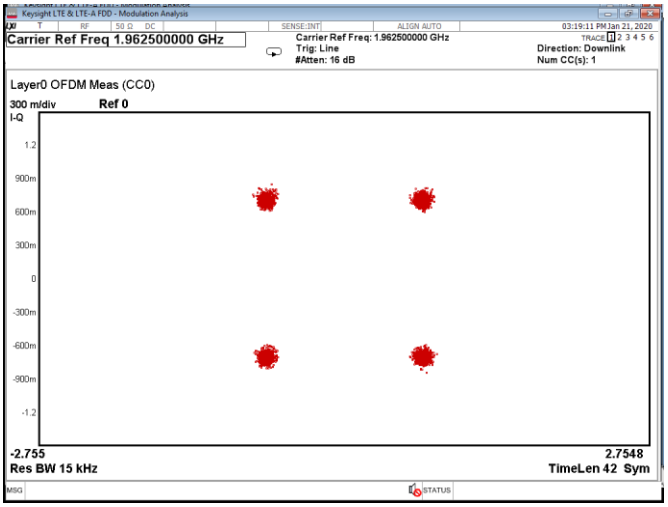


Figure 8.2-1: *Modulation characteristics, QPSK*

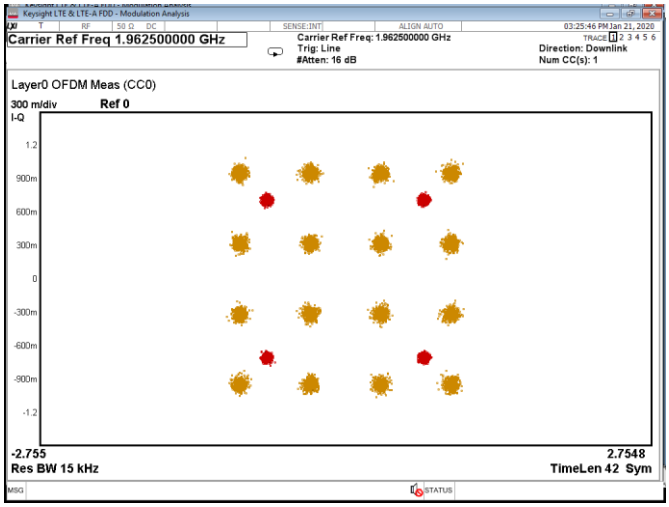
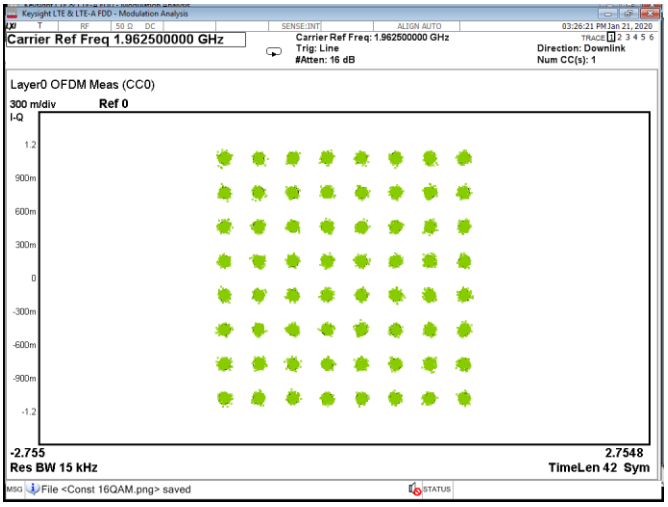


Figure 8.2-2: *Modulation characteristics, 16QAM*



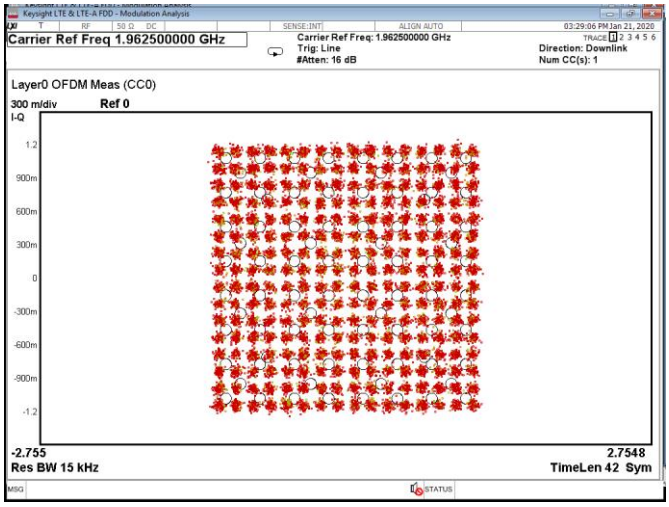


Figure 8.2-3: *Modulation characteristics, 64QAM*

Figure 8.2-4: *Modulation characteristics, 256QAM*