eurofins | E&E

HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

May 10, 2021

Lat-Lon, LLC
2300 S. Jason St.
Denver, CO 80223

Dear Benjamin Jull,

Enclosed is the EMC Wireless test report for compliance testing of the Lat-Lon, LLC, X15500 as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 22 Subpart H for Cellular Devices and FCC Part 24 Subpart E for Broadband PCS Devices.

Thank you for using the services of Eurofins Electrical and Electronic Testing NA, Inc. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
EUROFINS ELECTRICAL AND ELECTRONIC TESTING NA, INC.

Arsalan Hasan
Wireless Laboratory

Reference: (\Lat-Lon, LLC\WIRS111810-FCC-22-24 Rev. 2)

A2LA ACCREDITED
TESTINGCERT #0591.02

Electromagnetic Compatibility Criteria
Test Report

for the

Lat-Lon, LLC
X15500

Tested under
FCC Certification Rules
Title 47 of the CFR,
Part 22 Subpart H for Cellular Devices
&
Part 24 Subpart E for Broadband PCS Devices

Report: WIRS111810-FCC-22-24 Rev. 2

May 10, 2021

Prepared For:

Lat-Lon, LLC
2300 S. Jason St.
Denver, CO 80223

Prepared By:
Eurofins Electrical and Electronic Testing NA, Inc.
3162 Belick St.
Santa Clara, CA 95054

Electromagnetic Compatibility Criteria
Test Report

for the

Lat-Lon, LLC
X15500

Tested Under
FCC Certification Rules
Title 47 of the CFR,
Part 22 Subpart H for Cellular Devices
&
Part 24 Subpart E for Broadband PCS Devices

Felix Huang
Engineer, Wireless Laboratory

Arsalan Hasan
Manager, Wireless Laboratory

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 22 Subpart H and Part 24 Subpart E of the FCC Rules under normal use and maintenance.

Eleazar Zuniga, PhD.
Director, Wireless Technologies

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	April 13, 2021	Initial Issue.
1	April 16, 2021	Revised to updated company name to Lat-Lon, LLC. Also amended the addressed and model name.
2	May 10, 2021	TCB Updates

Table of Contents

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

1.1 Purpose of Test

An EMC evaluation was performed to determine compliance of the Lat-Lon, LLC X15500, with the requirements of Part 22 Subpart H and Part 24 Subpart E. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the X15500. Lat-Lon, LLC should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the X15500, has been **permanently** discontinued.

1.2 Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 22 Subpart H and Part 24 Subpart E, in accordance with Lat-Lon, LLC, purchase order number PO020667.

FCC Reference	Description	Compliance
§2.1049; §22.917; §24.232(d)	Occupied Bandwidth	Data valid from module original certification FCC-ID: RI7LE910NAV2
§2.1049, §22.355, §24.238	Frequency stability	Data valid from module original certification FCC-ID: RI7LE910NAV2
§22.913(d), §24.323(d)	Peak to Average Ratio	Data valid from module original certification FCC-ID: RI7LE910NAV2
§2.1051; §22.917, §24.238	Conducted Spurious Emissions at Antenna Terminals and Band Edge	Data valid from module original certification FCC-ID: RI7LE910NAV2
§2.1046; §22.913(a); §24.232	RF Power Output	Compliant
§2.1046; §22.913(a)(2); §24.232	Effective Radiated Power	Compliant
§2.1053; §22.917(a), §24.238	Radiated Spurious Emissions	Compliant

Executive Summary of EMC ComplianceTesting

Rationale: Per KDB KDB 996369 D04 “Modular Transmitter Integration Guide – Guidance for Host Product Manufacturers” only worst-case radiated measurements are reported in this filing.

II. Equipment Configuration

2.1 Overview

Eurofins Electrical and Electronic Testing NA, Inc. was contracted by Lat-Lon, LLC to perform testing on the X15500 under purchase order number PO020667.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Lat-Lon, LLC, X15500.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	X15500			
Model(s) Covered:	X15500			
Filing Status:	Original			
EUT Specifications:	Primary Power: 3.3VDC (Battery + Solar)			
	FCC ID: W54-X15500			
	Module Original Report Number(s): 1506FR22-01 1506FR21-01			
	Type of Modulations:	QPSK, 16QAM		
	Equipment Code:	PCB		
	Technology	TX Frequency Range	(Measured) Power Output	(Rated) Power Output
	WCDMA Band V	826.4 – 846.6 MHz	22.43 dBm ERP	23.58 dBm ERP
	WCDMA Band II	1852.4 – 1907.6 MHz	24.73 dBm EIRP	25.80 dBm EIRP
	LTE Band 2	1850.7 – 1909.3 MHz	22.92 dBm EIRP	23.42 dBm EIRP
	LTE Band 5	824.7 – 848.3 MHz	21.61 dBm ERP	22.90 dBm ERP
Analysis:	The results obtained relate only to the item(s) tested.			
Environmental Test Conditions:	Temperature: 15-35º C			
	Relative Humidity: 30-60%			
	Barometric Pressure: 860-1060 mbar			
Evaluated by:	Arsalan Hasan			
Date(s):	May 10, 2021			

EUT Summary Table

2.2 References

CFR 47, Part 22, Subpart H	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 22: Rules and Regulations for Cellular Devices.
CFR 47, Part 24, Subpart E	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 24: Rules and Regulations for Personal Communications Services
KDB 996369 D04	Modular Transmitter Integration Guide – Guidance For Host Product Manufacturers
ANSI C63.4:20014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26: 2015	Compliance Testing of Transmitters Used in Licensed Radio Services
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
EIA/TIA-603-D-2010	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards
KDB 971168 v02r02	Measurement Guidance For Certification Of Licensed Digital Transmitters

References

2.3 Test Site

All testing was performed at Eurofins Electrical and Electronic Testing NA, Inc., 3162 Belick St. Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

MET Laboratories is a ISO/IEC 17025 accredited site by A2LA, California #0591.02.

2.4 Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%
Radiated Emissions, (30 MHz – 1 GHz)	±3.24	2	95%
Radiated Emissions, (1 - 25 GHz)	±3.92	2	95%
Conducted Emission	±3.53	2	95%
CEV Telecom Port	±2.44	2	95%

Uncertainty Calculations Summary

2.5 Description of Test Sample

Solar/Battery powered asset tracking device. Determines location and monitors sensor and then sends this information, by way of cellular modem, to servers that that the customer can access to see the asset tracking information.

2.6 Equipment Configuration

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Revision
1	N/A	DUST and CELL	X15500	94000	PB1	B
2	N/A	BLE and CELL	X15500	94000	PB2	B
3	N/A	BLE, DUST, and CELL	X15500	94000	PB3	B
4	N/A	Engineering Unit 1	X15500	94000	PB4	B
5	N/A	Engineering Unit 2	X15500	94000	PB5	B

Equipment Configuration

2.7 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
1	Laptop with Test Software and Power adapterInstalled	N/A	N/A	N/A
2	Power Cables	N/A	N/A	N/A
3	Extra MX5000s	Lat-lon	MX5000	N/A
4	Two DUST Sensors	Lat-lon	X200	N/A

Support Equipment

2.8 Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	DUST USB	USB for DUST module Interface	2	1.6	1.6	No	N/A
2	BLE USB	USB for BLE module Interface	2	1.6	1.6	No	N/A
3	CELL USB	USB for CELL module Interface	2	1.6	1.6	No	N/A
4	DUST POWER SWITCH	Power SWITCH for DUST Radio Module	2	3.6	3.6	No	N/A
5	BLE POWER SWITCH	Power SWITCH for BLE Radio Module	2	3.6	3.6	No	N/A

Ports and Cabling Information

2.9 Mode of Operation During Testing

There are 3 modes of operation: Cellular data being sent and received from the EUT. There are 2 wireless sensor protocols used as sensor inputs to the device which are DUST and Bluetooth. Once these radios are powered on. They will start operating in normal operation.

For our typical application, there are no power or communication cables available nearby. So the EUT has all wireless communication and Solar panels for energy harvesting.

The cellular radio will be paired with a call box (CMW500) to exercise the desired radio channels.

2.10 Method of Monitoring EUT Operation

The radio transmissions from each radio will be measurable. The device is in operation if the batteries are draining from normal operation. When a power supply is attached to the charging cable coming out of the box (lab use only), the power supply will show a current draw.

Signals will be displayed on a spectrum analyzer.

2.11 Modifications

2.11.1 Modifications to EUT

No modifications were made to the EUT.

2.11.2 Modifications to Test Standard

No modifications were made to the test standard.

2.12 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Geotab, Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

Conducted RF Power and Radiated Output Power

Test Requirements:

§ 22.913(a)(2): Extend coverage on a secondary basis into cellular unserved areas, as those areas are defined in §22.949, the ERP of base transmitters and cellular repeaters of such systems must not exceed 1000 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

§ 24.232 (c): Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

Test Procedures:

The EUT was tested according to the average power integration procedures of ANSI C63.26 (2015) 5.5.3.

Radiated measurements shall be performed using the test arrangement shown in Figure . After a direct field strength measurement of the maximum emission amplitude level (maximized as described previously), a signal generator and transmit antenna are substituted in place of the EUT, as shown in Figure 7. The output power of the signal generator is adjusted to replicate the maximized signal amplitude measured in the direct field strength measurement. The signal generator power setting is then used to determine the ERP or EIRP of the EUT spurious emission(s). These measurements shall be performed in accordance with the common requirements specified in 5.5.2 and the specific requirements provided in this subclause.

A step-by-step procedure is as follows.

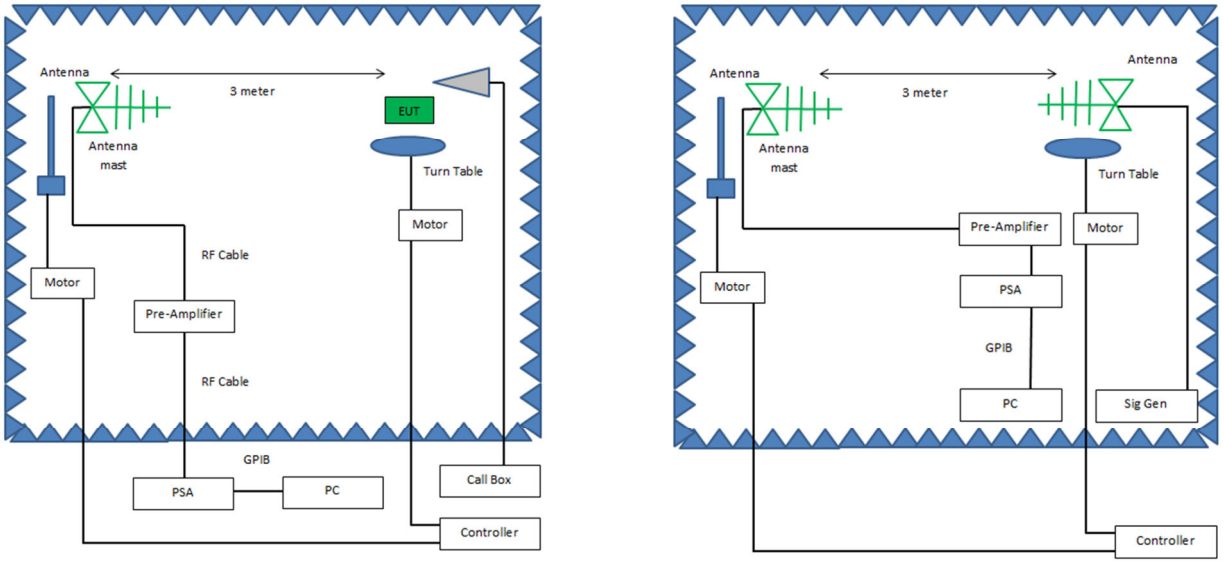
a) Place the EUT in the center of the turntable. The EUT shall be configured to transmit into the standard non-radiating load (for measuring radiated spurious emissions), connected with cables of minimal length unless specified otherwise. If the EUT uses an adjustable antenna, the antenna shall be positioned to the length that produces the worst case emission at the fundamental operating frequency.

b) Each emission under consideration shall be evaluated:

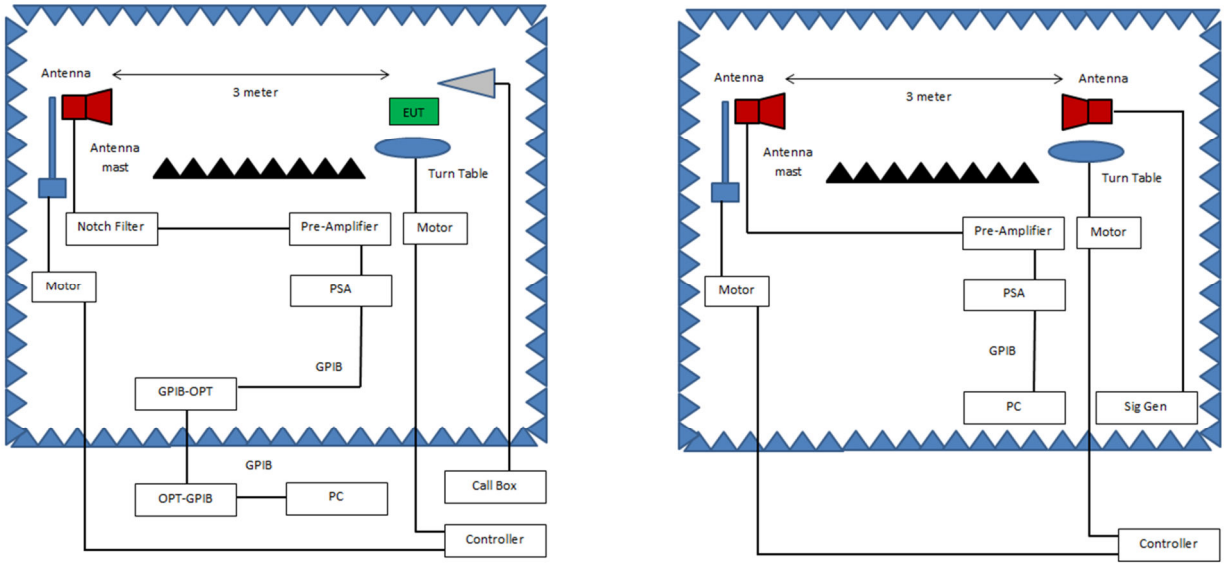
1) Raise and lower the measurement antenna in accordance 5.5.2, as necessary to enable detection of the maximum emission amplitude relative to measurement antenna height.
2) Rotate the EUT through 360° to determine the maximum emission level relative to the axial position.
3) Return the turntable to the azimuth where the highest emission amplitude level was observed.
4) Vary the measurement antenna height again through 1 m to 4 m again to find the height associated with the maximum emission amplitude.
5) Record the measured emission amplitude level and frequency using the appropriate RBW.

c) Repeat step b) for each emission frequency with the measurement antenna oriented in both the horizontal and vertical polarizations to determine the orientation that gives the maximum emissions amplitude.

d) Set-up the substitution measurement with the reference point of the substitution a antenna located as near as possible to where the center of the EUT radiating element was located during the initial EUT measurement.



ERP / EIRP, Block Diagram, Test Setup Below 1GHz



ERP / EIRP, Block Diagram, Test Setup Above 1GHz

e) Maintain the previous measurement instrument settings and test set-up, with the exception that the EUT is removed and replaced by the substitution antenna.

f) Connect a signal generator to the substitution antenna; locate the signal generator so as to minimize any potential influences on the measurement results. Set the signal generator to the frequency where emissions are detected, and set an output power level such that the radiated signal can be detected by the measurement instrument, with sufficient dynamic range relative to the noise floor.

g) For each emission that was detected and measured in the initial test [i.e., in step b) and step c)]:

1) Vary the measurement antenna height between 1 m to 4 m to maximize the received (measured) signal amplitude.
2) Adjust the signal generator output power level until the amplitude detected by the measurement instrument equals the amplitude level of the emission previously measured directly in step b) and step c).
3) Record the output power level of the signal generator when equivalence is achieved in step 2).

h) Repeat step e) through step g) with the measurement antenna oriented in the opposite polarization.

i) Calculate the emission power in dBm referenced to a half-wave dipole using the following equation:

Pe = Ps(dBm) - cable loss (dB) + antenna gain (dBd)

where

Pe = equivalent emission power in dBm

Ps = source (signal generator) power in dBm

NOTE—dBd refers to the measured antenna gain in decibels relative to a half-wave dipole.

j) Correct the antenna gain of the substitution antenna if necessary to reference the emission power to a half-wave dipole. When using measurement antennas with the gain specified in dBi, the equivalent dipole-referenced gain can be determined from: gain (dBd) = gain (dBi) - 2.15 dB. If necessary, the antenna gain can be calculated from calibrated antenna factor information

Test Results: The EUT was found compliant with the requirements of this section.

Test Engineer(s): Felix Huang; Arsalan Hasan

Test Date(s): 03/10/2021; 05/05/2021

Test Results

WCDMA (Band V)	Conducted Power (dBm)		
	Low Channel	Mid Channel	High Channel
	824.4 (MHz)	836.6 (MHz)	846.6 (MHz)
Rel 99	23.53	23.56	23.42

Measured Conducted Powers

Note: Channels with highest conducted powers were selected for further radiated testing.

Mode	Freq. (MHz)	SG (dBm)	CL (dB)	AG (dBi)	Ant. Pol.	ERP Level (dBm)	Limit (dBm)	Margin
Rel 99	836.6	21.95	0.87	3.5	Vertical	22.43	38.45	16.02

Measured ERP, Test Results, WCDMA Band V

WCDMA (Band II)	Conducted Power (dBm)		
	Low Channel	Mid Channel	High Channel
	1852.4 (MHz)	1880.0 (MHz)	1907.6 (MHz)
Rel 99	23.64	23.61	23.55

Measured Conducted Powers

Note: Channels with highest conducted powers were selected for further radiated testing.

Mode	Freq. (MHz)	SG (dBm)	CL (dB)	AG (dBi)	Ant. Pol.	EIRP Level (dBm)	Limit (dBm)	Margin
Rel 99	1852.4	-4.34	1.34	30.41	Vertical	24.73	33.01	8.28

Measured EIRP, Test Results, WCDMA Band II

Note:

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1850.7 (MHz)	1880.0 (MHz)	1909.3 (MHz)
1.4M	QPSK	23.22	23.35	23.04
	16-QAM	22.60	22.64	22.23

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1851.5 (MHz)	1880.0 (MHz)	1908.5 (MHz)
3M	QPSK	23.21	23.35	23.19
	16-QAM	22.43	22.52	22.34

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1852.5(MHz)	1880.0 (MHz)	1907.5 (MHz)
5M	QPSK	23.20	23.35	23.22
	16-QAM	22.42	22.64	22.45

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1855.0 (MHz)	1880.0 (MHz)	1905.0 (MHz)
10M	QPSK	23.29	23.27	23.23
	16-QAM	22.31	22.53	22.40

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1857.5(MHz)	1880.0 (MHz)	1902.5 (MHz)
15M	QPSK	23.31	23.42	23.35
	16-QAM	22.23	22.57	22.18

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 2)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	1860.0(MHz)	1880.0 (MHz)	1900.0 (MHz)
20M	QPSK	23.29	23.39	23.24
	16-QAM	22.35	22.36	22.74

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

Mode	Freq. (MHz)	SG (dBm)	CL (dB)	AG (dBi)	Ant. Pol.	EIRP Level (dBm)	Limit (dBm)	Margin
LTE Band 2 1.4M QPSK	1880.0	-6.34	1.34	30.41	Vertical	22.73	33.01	10.28
LTE Band 2 1.4M 16QAM	1880.0	-6.78	1.34	30.41	Vertical	22.29	33.01	10.72
LTE Band 2 3M QPSK	1880.0	-6.64	1.34	30.41	Vertical	22.43	33.01	10.58
LTE Band 2 3M 16QAM	1880.0	-6.51	1.34	30.41	Vertical	22.56	33.01	10.45
LTE Band 2 5M QPSK	1880.0	-7.10	1.34	30.41	Vertical	21.97	33.01	11.04
LTE Band 2 5M 16QAM	1880.0	-6.63	1.34	30.41	Vertical	22.44	33.01	10.57
LTE Band 2 10M QPSK	1855.0	-6.43	1.33	30.40	Vertical	22.64	33.01	10.37
LTE Band 2 10M 16QAM	1880.0	-6.89	1.34	30.41	Vertical	22.18	33.01	10.83
LTE Band 2 15M QPSK	1880.0	-7.03	1.34	30.41	Vertical	22.04	33.01	10.97
LTE Band 2 15M 16QAM	1880.0	-6.75	1.34	30.41	Vertical	22.32	33.01	10.69
LTE Band 2 20M QPSK	1880.0	-6.92	1.34	30.41	Vertical	22.15	33.01	10.86
LTE Band 2 20M 16QAM	1900.0	-6.36	1.37	30.65	Vertical	22.92	33.01	10.09

Measured EIRP, Test Results, LTE Band 2

Note:

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE (Band 5)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	824.7 (MHz)	836.5 (MHz)	848.3 (MHz)
1.4M	QPSK	22.72	22.73	22.79
	16-QAM	21.75	21.83	21.92

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 5)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	825.5 (MHz)	836.5 (MHz)	847.5 (MHz)
3M	QPSK	22.70	22.69	22.87
	16-QAM	21.95	21.93	21.71

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 5)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	826.5 (MHz)	836.5 (MHz)	846.5 (MHz)
5M	QPSK	22.72	22.59	22.76
	16-QAM	21.91	21.89	21.94

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

LTE (Band 5)		Conducted Power (dBm)		
		Low Channel	Mid Channel	High Channel
Bandwidth	Modulation	829.0 (MHz)	836.5 (MHz)	844.0 (MHz)
10M	QPSK	22.75	22.74	22.78
	16-QAM	21.60	21.91	21.94

Measured Conducted Output power

Note: Channels with highest conducted powers were selected for further radiated testing.

Mode	Freq. (MHz)	SG (dBm)	CL (dB)	AG (dBi)	Ant. Pol.	ERP Level (dBm)	Limit (dBm)	Margin
LTE Band 5 1.4M QPSK	848.3	20.67	0.90	3.8	Vertical	21.42	38.45	17.03
LTE Band 5 1.4M 16QAM	848.3	20.86	0.90	3.8	Vertical	21.61	38.45	16.84
LTE Band 5 3M QPSK	847.5	20.53	0.89	3.8	Vertical	21.28	38.45	17.17
LTE Band 5 3M 16QAM	825.5	20.67	0.85	3.5	Vertical	21.17	38.45	17.28
LTE Band 5 5M QPSK	846.5	20.12	0.89	3.8	Vertical	20.88	38.45	17.57
LTE Band 5 5M 16QAM	846.5	20.75	0.89	3.8	Vertical	21.51	38.45	16.94
LTE Band 5 10M QPSK	844.0	20.89	0.89	3.7	Vertical	21.55	38.45	16.90
LTE Band 5 10M 16QAM	844.0	20.63	0.89	3.7	Vertical	21.29	38.45	17.16

Measured ERP, Test Results, LTE Band 5

Note:

EIRP = SG – CL + AG
ERP = EIRP – 2.15

Electromagnetic Compatibility Criteria for Intentional Radiators

Radiated Spurious Emissions

Test Requirement(s): **§ 2.1053 Measurements required: Field strength of spurious radiation.**

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

§ 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.

(2) All equipment operating on frequencies higher than 25 MHz.

(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.

(4) Other types of equipment as required, when deemed necessary by the Commission.

§ 22.917 Emission limitations Cellular equipment: The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

§ 22.917 (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). Limit is -13 dBm.

§ 24.238 (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. Limit is -13 dBm.

Test Procedures: The EUT was tested according to the average power integration procedures of ANSI C63.26 (2015) 5.5.3.

Radiated measurements shall be performed using the test arrangement shown in Figure. After a direct field strength measurement of the maximum emission amplitude level (maximized as described previously), a signal generator and transmit antenna are substituted in place of the EUT, as shown in Figure 7. The output power of the signal generator is adjusted to replicate the maximized signal amplitude measured in the direct field strength measurement. The signal generator power setting is then used to determine the ERP or EIRP of the EUT spurious emission(s). These measurements shall be performed in accordance with the common requirements specified in 5.5.2 and the specific requirements provided in this subclause.

A step-by-step procedure is as follows.

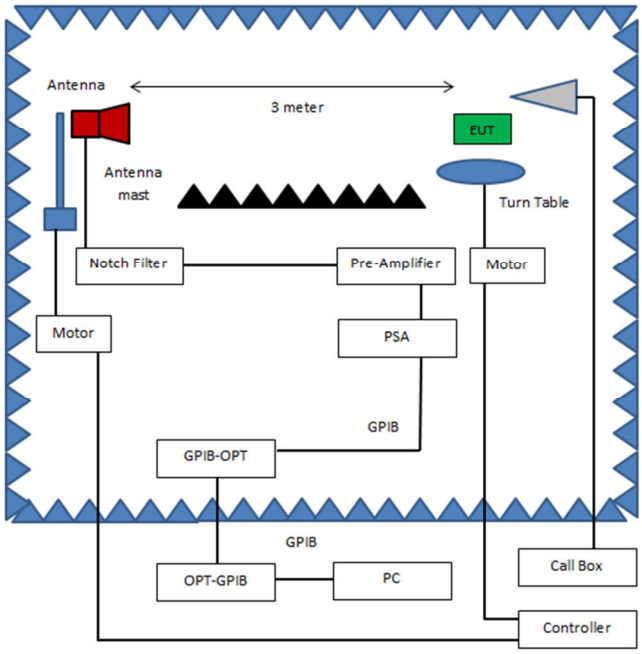
k) Place the EUT in the center of the turntable. The EUT shall be configured to transmit into the standard non-radiating load (for measuring radiated spurious emissions), connected with cables of minimal length unless specified otherwise. If the EUT uses an adjustable antenna, the antenna shall be positioned to the length that produces the worst case emission at the fundamental operating frequency.

l) Each emission under consideration shall be evaluated:

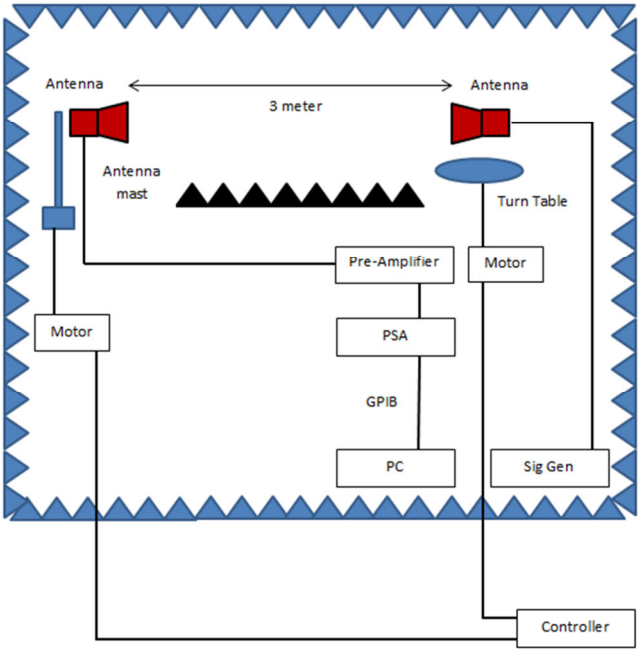
6) Raise and lower the measurement antenna in accordance 5.5.2, as necessary to enable detection of the maximum emission amplitude relative to measurement antenna height.
7) Rotate the EUT through 360° to determine the maximum emission level relative to the axial position.
8) Return the turntable to the azimuth where the highest emission amplitude level was observed.
9) Vary the measurement antenna height again through 1 m to 4 m again to find the height associated with the maximum emission amplitude.
10) Record the measured emission amplitude level and frequency using the appropriate RBW.

m) Repeat step b) for each emission frequency with the measurement antenna oriented in both the horizontal and vertical polarizations to determine the orientation that gives the maximum emissions amplitude.

n) Set-up the substitution measurement with the reference point of the substitution a antenna located as near as possible to where the center of the EUT radiating element was located during the initial EUT measurement.



Radiated Spurious Emissions, Block Diagram, Test Setup



Radiated Spurious Emissions, Block Diagram, Test Setup

o) Maintain the previous measurement instrument settings and test set-up, with the exception that the EUT is removed and replaced by the substitution antenna.

p) Connect a signal generator to the substitution antenna; locate the signal generator so as to minimize any potential influences on the measurement results. Set the signal generator to the frequency where emissions are detected, and set an output power level such that the radiated signal can be detected by the measurement instrument, with sufficient dynamic range relative to the noise floor.

q) For each emission that was detected and measured in the initial test [i.e., in step b) and step c)]:

4) Vary the measurement antenna height between 1 m to 4 m to maximize the received (measured) signal amplitude.
5) Adjust the signal generator output power level until the amplitude detected by the measurement instrument equals the amplitude level of the emission previously measured directly in step b) and step c).
6) Record the output power level of the signal generator when equivalence is achieved in step 2).

r) Repeat step e) through step g) with the measurement antenna oriented in the opposite polarization.

s) Calculate the emission power in dBm referenced to a half-wave dipole using the following equation:

Pe = Ps(dBm) - cable loss (dB) + antenna gain (dBd)

where
Pe = equivalent emission power in dBm
Ps = source (signal generator) power in dBm

NOTE—dBd refers to the measured antenna gain in decibels relative to a half-wave dipole.

t) Correct the antenna gain of the substitution antenna if necessary to reference the emission power to a half-wave dipole. When using measurement antennas with the gain specified in dBi, the equivalent dipole-referenced gain can be determined from: gain (dBd) = gain (dBi) - 2.15 dB. If necessary, the antenna gain can be calculated from calibrated antenna factor information

Test Results: The EUT was found compliant with the requirements of this section.

Measurements were made in each configuration. Data is presented for the worse case configuration.

Test Engineer(s): Felix Huang

Test Date(s): 03/14/2021

Radiated Spurious Emissions Test Results,

WCDMA Band V								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1673.2	-90	1.25	28.63	Vertical	-64.77	-13	51.77
3	2509.8	-89	1.53	32.10	Vertical	-60.58	-13	47.58
4	3346.4	-88	1.76	32.70	Vertical	-59.21	-13	46.21
5	4183.0	-87	1.99	33.21	Vertical	-57.93	-13	44.93
6	5019.6	-86	2.33	33.95	Vertical	-56.53	-13	43.53
7	5856.2	-85	2.73	34.79	Vertical	-55.09	-13	42.09
8	6692.8	-84	2.87	35.43	Vertical	-53.59	-13	40.59
9	7529.4	-83	3.21	35.62	Vertical	-52.74	-13	39.74
10	8366.0	-82	3.47	35.79	Vertical	-51.83	-13	38.83

Measured Radiated Spurious Emissions, Test Results, WCMDA, Band V

WCDMA Band II								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, Test Results, WCMDA, Band II

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (1.4M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-90	1.87	33.26	Vertical	-58.61	-13	45.61
3	5640	-89	2.75	34.54	Vertical	-57.21	-13	44.21
4	7520	-88	3.21	35.66	Vertical	-55.55	-13	42.55
5	9400	-87	3.89	36.47	Vertical	-54.42	-13	41.42
6	11280	-86	4.10	37.74	Vertical	-52.36	-13	39.36
7	13160	-85	4.93	38.91	Vertical	-51.02	-13	38.02
8	15040	-84	4.54	39.96	Vertical	-48.58	-13	35.58
9	16920	-83	4.99	41.67	Vertical	-46.32	-13	33.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (1.4M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (3M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-92	1.87	33.26	Vertical	-60.61	-13	47.61
3	5640	-91	2.75	34.54	Vertical	-59.21	-13	46.21
4	7520	-90	3.21	35.66	Vertical	-57.55	-13	44.55
5	9400	-89	3.89	36.47	Vertical	-56.42	-13	43.42
6	11280	-88	4.10	37.74	Vertical	-54.36	-13	41.36
7	13160	-87	4.93	38.91	Vertical	-53.02	-13	40.02
8	15040	-86	4.54	39.96	Vertical	-50.58	-13	37.58
9	16920	-85	4.99	41.67	Vertical	-48.32	-13	35.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (3M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (5M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-90	1.87	33.26	Vertical	-58.61	-13	45.61
3	5640	-89	2.75	34.54	Vertical	-57.21	-13	44.21
4	7520	-88	3.21	35.66	Vertical	-55.55	-13	42.55
5	9400	-87	3.89	36.47	Vertical	-54.42	-13	41.42
6	11280	-86	4.10	37.74	Vertical	-52.36	-13	39.36
7	13160	-85	4.93	38.91	Vertical	-51.02	-13	38.02
8	15040	-84	4.54	39.96	Vertical	-48.58	-13	35.58
9	16920	-83	4.99	41.67	Vertical	-46.32	-13	33.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (5M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (10M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3710	-91	1.89	33.04	Vertical	-59.85	-13	46.85
3	5565	-90	2.54	34.43	Vertical	-58.11	-13	45.11
4	7420	-89	3.12	35.65	Vertical	-56.47	-13	43.47
5	9275	-88	3.66	36.27	Vertical	-55.39	-13	42.39
6	11130	-87	3.99	37.72	Vertical	-53.27	-13	40.27
7	12985	-86	4.62	39.05	Vertical	-51.57	-13	38.57
8	14840	-85	4.55	39.73	Vertical	-49.82	-13	36.82
9	16695	-84	4.97	41.70	Vertical	-47.27	-13	34.27
10	18550	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (10M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (15M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-88	1.87	33.26	Vertical	-56.61	-13	43.61
3	5640	-87	2.75	34.54	Vertical	-55.21	-13	42.21
4	7520	-86	3.21	35.66	Vertical	-53.55	-13	40.55
5	9400	-85	3.89	36.47	Vertical	-52.42	-13	39.42
6	11280	-84	4.10	37.74	Vertical	-50.36	-13	37.36
7	13160	-83	4.93	38.91	Vertical	-49.02	-13	36.02
8	15040	-82	4.54	39.96	Vertical	-46.58	-13	33.58
9	16920	-81	4.99	41.67	Vertical	-44.32	-13	31.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (15M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-90	1.87	33.26	Vertical	-58.61	-13	45.61
3	5640	-89	2.75	34.54	Vertical	-57.21	-13	44.21
4	7520	-88	3.21	35.66	Vertical	-55.55	-13	42.55
5	9400	-87	3.89	36.47	Vertical	-54.42	-13	41.42
6	11280	-86	4.10	37.74	Vertical	-52.36	-13	39.36
7	13160	-85	4.93	38.91	Vertical	-51.02	-13	38.02
8	15040	-84	4.54	39.96	Vertical	-48.58	-13	35.58
9	16920	-83	4.99	41.67	Vertical	-46.32	-13	33.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 2 (20M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3760	-91	1.87	33.26	Vertical	-59.61	-13	46.61
3	5640	-90	2.75	34.54	Vertical	-58.21	-13	45.21
4	7520	-89	3.21	35.66	Vertical	-56.55	-13	43.55
5	9400	-88	3.89	36.47	Vertical	-55.42	-13	42.42
6	11280	-87	4.10	37.74	Vertical	-53.36	-13	40.36
7	13160	-86	4.93	38.91	Vertical	-52.02	-13	39.02
8	15040	-85	4.54	39.96	Vertical	-49.58	-13	36.58
9	16920	-84	4.99	41.67	Vertical	-47.32	-13	34.32
10	18800	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

LTE Band 2 (20M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**EIRP Level (dBm)**	**Limit (dBm)**	**Margin**
2	3800	-90	1.93	33.33	Vertical	-58.6	-13	45.6
3	5700	-89	2.63	34.61	Vertical	-57.02	-13	44.02
4	7600	-88	3.30	35.66	Vertical	-55.64	-13	42.64
5	9500	-87	3.81	36.56	Vertical	-54.25	-13	41.25
6	11400	-86	3.93	37.80	Vertical	-52.13	-13	39.13
7	13300	-85	4.87	39.02	Vertical	-50.85	-13	37.85
8	15200	-84	4.43	40.15	Vertical	-48.28	-13	35.28
9	17100	-83	4.92	41.53	Vertical	-46.39	-13	33.39
10	19000	x	x	x	x	x	x	x

Measured Radiated Spurious Emissions, LTE Band 2, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 5 (1.4M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1696.6	-90	1.25	28.91	Vertical	-64.49	-13	51.49
3	2544.9	-89	1.47	32.40	Vertical	-60.22	-13	47.22
4	3393.2	-88	1.81	32.44	Vertical	-59.52	-13	46.52
5	4241.5	-87	2.02	33.24	Vertical	-57.93	-13	44.93
6	5089.8	-86	2.33	34.04	Vertical	-56.44	-13	43.44
7	5938.1	-85	2.73	35.01	Vertical	-54.87	-13	41.87
8	6786.4	-84	2.91	35.40	Vertical	-53.66	-13	40.66
9	7634.7	-83	3.22	35.66	Vertical	-52.71	-13	39.71
10	8483.0	-82	3.45	35.71	Vertical	-51.89	-13	38.89

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

LTE Band 5 (1.4M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1696.6	-91	1.25	28.91	Vertical	-65.49	-13	52.49
3	2544.9	-90	1.47	32.40	Vertical	-61.22	-13	48.22
4	3393.2	-89	1.81	32.44	Vertical	-60.52	-13	47.52
5	4241.5	-88	2.02	33.24	Vertical	-58.93	-13	45.93
6	5089.8	-87	2.33	34.04	Vertical	-57.44	-13	44.44
7	5938.1	-86	2.73	35.01	Vertical	-55.87	-13	42.87
8	6786.4	-85	2.91	35.40	Vertical	-54.66	-13	41.66
9	7634.7	-84	3.22	35.66	Vertical	-53.71	-13	40.71
10	8483.0	-83	3.45	35.71	Vertical	-52.89	-13	39.89

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 5 (3M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1695.0	-90	1.25	28.91	Vertical	-64.49	-13	51.49
3	2542.5	-89	1.47	32.40	Vertical	-60.22	-13	47.22
4	3390.0	-88	1.81	32.44	Vertical	-59.52	-13	46.52
5	4237.5	-87	2.02	33.24	Vertical	-57.93	-13	44.93
6	5085.0	-86	2.33	34.04	Vertical	-56.44	-13	43.44
7	5932.5	-85	2.73	35.01	Vertical	-54.87	-13	41.87
8	6780.0	-84	2.91	35.40	Vertical	-53.66	-13	40.66
9	7627.5	-83	3.22	35.66	Vertical	-52.71	-13	39.71
10	8475.0	-82	3.45	35.71	Vertical	-51.89	-13	38.89

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

LTE Band 5 (3M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1651.0	-90	1.23	28.43	Vertical	-64.95	-13	51.95
3	2476.5	-89	1.52	32.05	Vertical	-60.62	-13	47.62
4	3302.0	-88	1.82	32.76	Vertical	-59.21	-13	46.21
5	4127.5	-87	1.99	33.21	Vertical	-57.93	-13	44.93
6	4953.0	-86	2.40	33.84	Vertical	-56.71	-13	43.71
7	5778.5	-85	2.64	34.75	Vertical	-55.04	-13	42.04
8	6604.0	-84	2.82	35.45	Vertical	-53.52	-13	40.52
9	7429.5	-83	3.09	35.62	Vertical	-52.62	-13	39.62
10	8255.0	-82	3.55	35.71	Vertical	-51.99	-13	38.99

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 5 (5M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1693.0	-92	1.25	28.91	Vertical	-66.49	-13	53.49
3	2539.5	-91	1.47	32.40	Vertical	-62.22	-13	49.22
4	3386.0	-90	1.81	32.44	Vertical	-61.52	-13	48.52
5	4232.5	-89	2.02	33.24	Vertical	-59.93	-13	46.93
6	5079.0	-88	2.33	34.04	Vertical	-58.44	-13	45.44
7	5925.5	-87	2.73	35.01	Vertical	-56.87	-13	43.87
8	6772.0	-86	2.91	35.40	Vertical	-55.66	-13	42.66
9	7618.5	-85	3.22	35.66	Vertical	-54.71	-13	41.71
10	8465.0	-84	3.45	35.71	Vertical	-53.89	-13	40.89

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

LTE Band 5 (5M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1693.0	-90	1.25	28.91	Vertical	-65.49	-13	52.49
3	2539.5	-89	1.47	32.40	Vertical	-61.22	-13	48.22
4	3386.0	-88	1.81	32.44	Vertical	-60.52	-13	47.52
5	4232.5	-87	2.02	33.24	Vertical	-58.93	-13	45.93
6	5079.0	-86	2.33	34.04	Vertical	-57.44	-13	44.44
7	5925.5	-85	2.73	35.01	Vertical	-55.87	-13	42.87
8	6772.0	-84	2.91	35.40	Vertical	-54.66	-13	41.66
9	7618.5	-83	3.22	35.66	Vertical	-53.71	-13	40.71
10	8465.0	-82	3.45	35.71	Vertical	-52.89	-13	39.89

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

LTE Band 5 (10M BW QPSK)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1688.0	-91	1.25	28.91	Vertical	-65.49	-13	52.49
3	2532.0	-90	1.54	32.37	Vertical	-61.32	-13	48.32
4	3376.0	-89	1.82	32.65	Vertical	-60.32	-13	47.32
5	4220.0	-88	2.03	33.27	Vertical	-58.91	-13	45.91
6	5064.0	-87	2.39	34.02	Vertical	-57.52	-13	44.52
7	5908.0	-86	2.67	35.01	Vertical	-55.81	-13	42.81
8	6752.0	-85	2.88	35.45	Vertical	-54.58	-13	41.58
9	7596.0	-84	3.22	35.66	Vertical	-53.71	-13	40.71
10	8440.0	-83	3.58	35.61	Vertical	-53.12	-13	40.12

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

LTE Band 5 (10M BW 16-QAM)								
Harmonic	**Freq. (MHz)**	**SG (dBm)**	**Cable Loss (dB)**	**Gain (dBi)**	**Ant. Pol.**	**ERP Level (dBm)**	**Limit (dBm)**	**Margin**
2	1688.0	-90	1.25	28.91	Vertical	-64.49	-13	51.49
3	2532.0	-89	1.54	32.37	Vertical	-60.32	-13	47.32
4	3376.0	-88	1.82	32.65	Vertical	-59.32	-13	46.32
5	4220.0	-87	2.03	33.27	Vertical	-57.91	-13	44.91
6	5064.0	-86	2.39	34.02	Vertical	-56.52	-13	43.52
7	5908.0	-85	2.67	35.01	Vertical	-54.81	-13	41.81
8	6752.0	-84	2.88	35.45	Vertical	-53.58	-13	40.58
9	7596.0	-83	3.22	35.66	Vertical	-52.71	-13	39.71
10	8440.0	-82	3.58	35.61	Vertical	-52.12	-13	39.12

Measured Radiated Spurious Emissions, LTE Band 5, Test Results

Note :

EIRP = SG – CL + AG
ERP = EIRP – 2.15

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S4075	RADIO COMMUNICATION TESTER	ROHDE & SCHWARZ	CMW500	09/20/2020	09/20/2022
1S2399	TURNTABLE/MAST CONTROLLER	SUNOL SCIENCES	SC99V	SEE NOTE 1	
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	03/19/2019	06/19/2021
1S2733	BILOG ANTENNA	TESEQ	CBL6112D	06/05/2019	06/05/2021
1S3826	DRG HORN ANTENNA	ETS-LINDGREN	3117	12/03/2020	12/03/2022
1S2198	DRG HORN ANTENNA	ETS-LINDGREN	3117	10/07/2019	10/07/2021
1S2003	PXA Signal Analyzer	Keysight	N9030B	09/15/2020	09/15/2021
1S2587	PRE AMPLIFIER	AML COMMUNICATIONS	AML0126L3801	SEE NOTE 1	
1S2653	AMPLIFIER	SONOMA INSTRUMENT	310 N	SEE NOTE 1	
1S2486	5 METER CHAMBER	PANASHIELD - ETS	5M	SEE NOTE 2	
1S3824	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMA100B	11/06/2019	05/06/2021

Test Equipment List

Note 1: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.
Note 2: Latest NSA and VSWR data available upon request.

End of Report