QAI Laboratories
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ELECTROMAGNETIC COMPATIBILITY
TEST REPORT
TO
FCC 47 CFR Part 22
& INDUSTRY CANADA RSS-132 Issue 3, RSS – Gen Issue 4

Report Number:	E10599-1602_STARSOLUTIONS-1XRTT
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Laboratory Accreditations (per ISO/IEC 17025:2005):

American Association for Laboratory Accreditation Certificate Number: 3657.02

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Client's name:	Star Solutions International, Inc.
Address:	Suite 120 4600 Jacombs Road, Richmond BC, V6V 3B1, Canada
Phone:	(604)276-0055

Test Standard:	FCC 47 CFR Part 22 & INDUSTRY CANADA RSS-132 Issue 3, RSS – Gen Issue 4

Description of Equipment Under Test (EUT)

Product Marketing Name (PMN): iCell QUADPAC 1X IP – RAN 800MHz CPU (wo CPU) AC GPS

Model Number:	QX8003.0 QX8004.0
FCC ID:	S52-1-10-01-00-1
IC Number:	8076A-11001001
Trade Mark:	STARSOLUTIONS
Manufacturer:	Star Solutions International Inc.

Front view

Side view

Back-side view

Equipment Under Test (EUT)

Summary of Test Results

The following tests demonstrate testimony for the FCC & IC Marks for this EUT as required by FCC 47 CFR Part 22 & INDUSTRY CANADA RSS-132 Issue 3, RSS – Gen Issue 4

Test Item	Test Description	Pass / Fail
Part 1	AC Mains Conducted Emissions	Pass
Part 2	Unintentional Radiated Emissions	Pass
Part 3	Peak Conducted Output Power & EIRP	Pass
Part 4	Peak-to-Average ratio	Pass
Part 5	26dB Occupied Bandwidth	Pass
Part 6	99% Occupied Bandwidth	Pass
Part 7	Unwanted Emissions - Band Edge	Pass
Part 8	Conducted Spurious Emissions	Pass
Part 9	Radiated Spurious Emissions	Pass
Part 10	Frequency Stability	Pass
Part 11	RF Exposue MPE	Pass

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC 47 CFR Part 22 & INDUSTRY CANADA RSS-132 Issue 3, RSS – Gen Issue 4. The manufacturer is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products as required. Please note that this list of tests may only comprise a partial list of the tests that are required before a FCC or IC label can be produced by the manufacturer.

This is to certify that the following report is true and correct to the best of our knowledge.

X 

Written by Jack Qin
RF/EMC Test Engineer/Technical Writer

X 

Reviewed by Aman Jathaul,
EMC Project Manager

Revision History

Date	Report Number	Rev #	Details	Authors Initials
November 16, 2016	E10599-1502_STARSOLUTIONS-1XRTT	0.0	Draft Report	JQ
December 16, 2016	E10599-1502_STARSOLUTIONS-1XRTT	1.0	Final Report	JQ
January 26, 2017	E10599-1502_STARSOLUTIONS-1XRTT	2.0	Updated as per TCB comments	JQ

All previous versions of this Report have been superseded by the latest dated Revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.

Table of Contents

Section I GENERAL TEST INFORMATION

QAI Facilities

Founded in 1994 by a group of experienced certification and testing experts, QAI is an independent third-party testing, inspection and certification organization which serves the building industry, government and individuals with cost effective solutions through our in-house capabilities / services, and an established world-wide network of qualified affiliates. To help get your product to market, trust the provider that many leading global manufacturers do: QAI.

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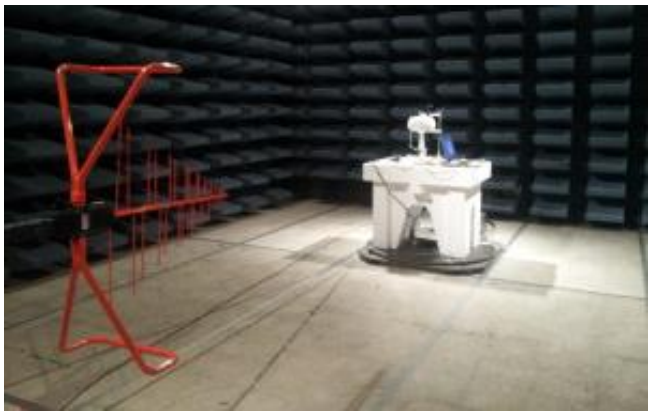
QAI EMC Accreditation

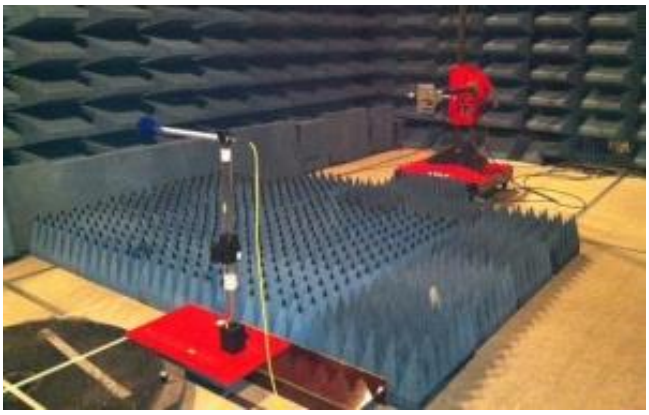
QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC Canada	CA9543	21146-1	3657.02
Everett, Washington USA	307482	11876A-1	3657.02

Headquarters & EMC Laboratory in Burnaby, BC

EMC Laboratory in Everett, Washington


3 m Semi-Anechoic Chamber (SAC) in Burnaby, BC


3 m Semi-Anechoic Chamber (SAC) in Burnaby, BC


10 m Open Area Test Site (OATS) in British Columbia, Canada


5 m Semi-Anechoic Chamber (SAC) in Everett, Washington


5 m Semi-Anechoic Chamber (SAC) in Everett, Washington

Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	Indoors
Temperature	22-28ºC
Relative Humidity	39.7 - 54.4%

Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1,5 x 10-5 MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

Worst Test Case

Worst-case orientation was determined during the preliminary testing. The final radiated emissions were performed in the worst-case orientation.

Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohdes & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Quasi-Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Quasi Peak reading shown in the table above is already corrected by the software using correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

Corr.(dB) = Antenna factor + Cable loss

Or

Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)

The final Quasi peak reading shown in the data is calculated by the software using following equation:

Corrected Quasi Peak(dBµV/m) = Raw Quasi Peak Reading + Antenna factor + Cable loss

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	44.3	1000.000	9.000	0.6	21.7	66.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	27.2	1000.000	9.000	0.6	28.8	56.0

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

Corr.(dB) = Antenna factor + Cable loss

The final Quasi peak or Average reading shown in the data is calculated by the software using following equation:

Corr. Quasi Peak/Average Reading (dBµV) = Raw Quasi Peak/Average Reading + Antenna factor + Cable loss

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

Margin(dB) = Limit – Quasi-Peak or Average reading

Test Equipment List

Manufacturer	Model	Description	Serial No.	Calibration Due Date
Sunol Sciences	SM46C	Turntable	051204-2	N/A
Sunol Sciences	TWR95	Mast	TREML0001	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	31-Oct-2018
ETS Lindgren	2165	Turntable	00043677	N/A
ETS Lindgren	2125	Mast	00077487	N/A
Rohde & Schwarz	ESU40	EMI Receiver	100011	20-Nov-2017
ETS Lindgren	S201	5 meter Semi-Anechoic Chamber	1030	N/A
ETS Lindgren	3117	Dual Ridge Horn Antenna 1G-18GHz	00075944	29-Aug-18
AH Systems	PAM118	Amplifier 100KHz-18GHz	189	Conditional Use
Electro-Mechanics	6502	Loop Antenna 10k-30MHz	2178	21-Aug-2017

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Pre-scan Test Software

Testing Method

The tests documented in this report were performed in accordance with ANSI C63.4, ANSI C63.21, FCC CFR 47 Part 2, FCC CFR 47 Part 22, and RSS-Gen, Issue 3 and RSS-132

EUT Characteristics

Frequency band: 869-890MHz
Lowest channel:869MHz
Middle channel:880MHz
Highest channel: 890MHz

Number of Antennas: No Antenna Provided for measurement Antenna Port Terminated with 50Ω

Modulation Type: QPSK
Data Rates: 1

Section II: TEST RESULTS

Part 1 - AC Mains Conducted Emissions

DATE: October 19,2016

TEST STANDARD: CISPR 16-1-2:2003, 47 CFR Part 15 Subpart B Section 15.107 and 15.207
ICES-003 Issue 6

TEST VOLTAGE: 120Vac, 60Hz

MINIMUM STANDARD: Class A Limit:

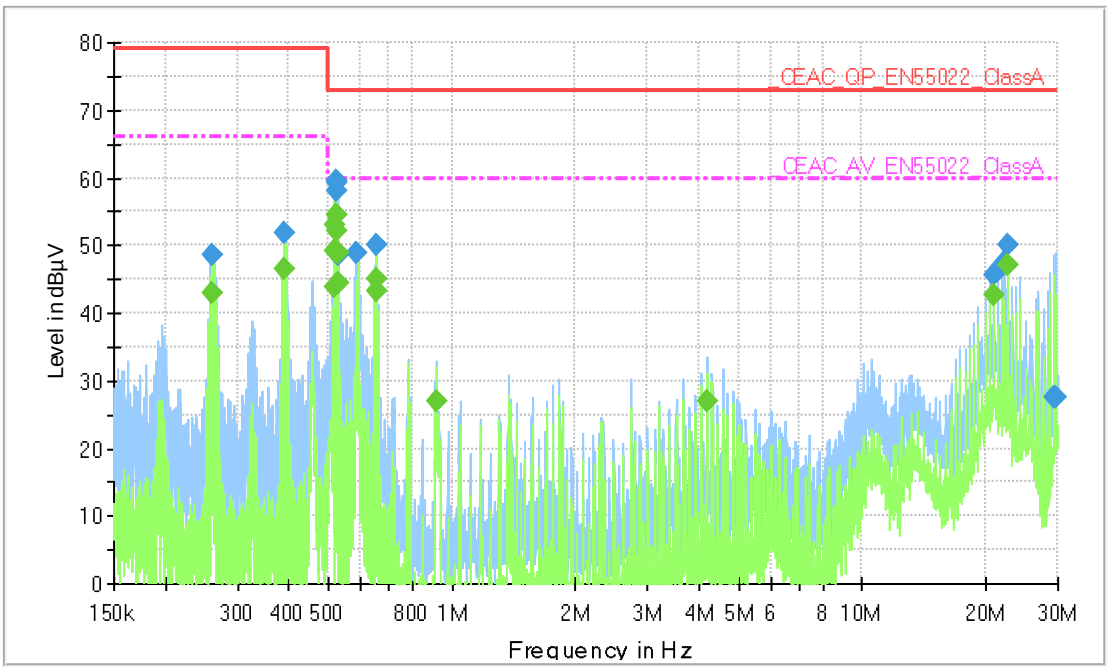
Frequency (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15 - 0.50	79	66
0.50 – 30	73	60
Note 1 The lower limit shall apply at the transition frequencies.		

TEST SETUP: The EUT was connected to the conducted emissions LISN apparatus. The test was performed in transmitting mode and in standby mode.

METHOD OF MEASUREMENT: Measurements were made using a test receiver with 9 kHz bandwidth, CISPR Quasi-Peak and Average detector.

PERFORMANCE: Complies with standard.

MEASUREMENT DATA:



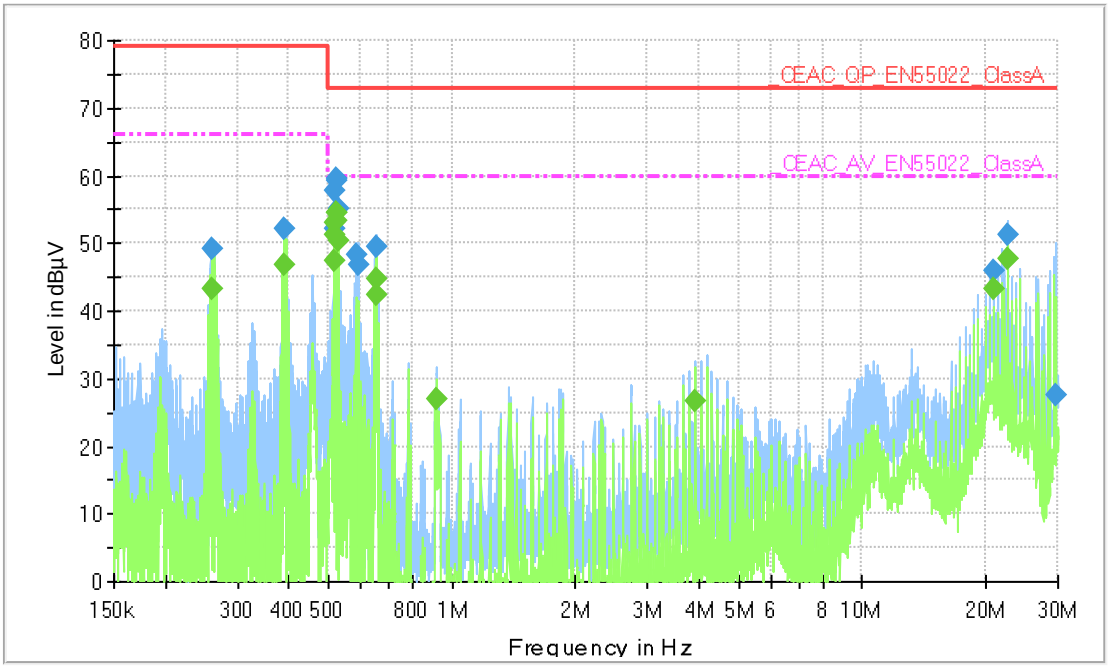
Plot: Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L1

QuasiPeak Data, Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.261480	48.6	1000.000	9.000	GND	10.4	30.4	79.0
0.391958	51.8	1000.000	9.000	GND	10.4	27.2	79.0
0.521658	59.6	1000.000	9.000	GND	10.4	13.4	73.0
0.522702	59.4	1000.000	9.000	GND	10.4	13.6	73.0
0.524272	58.0	1000.000	9.000	GND	10.4	15.0	73.0
0.527952	48.7	1000.000	9.000	GND	10.4	24.3	73.0
0.587545	48.8	1000.000	9.000	GND	10.4	24.2	73.0
0.653211	50.0	1000.000	9.000	GND	10.4	23.0	73.0
21.003893	45.7	1000.000	9.000	GND	10.7	27.3	73.0
22.257495	47.4	1000.000	9.000	GND	10.7	25.6	73.0
22.729606	50.2	1000.000	9.000	GND	10.7	22.8	73.0
29.247596	27.5	1000.000	9.000	GND	10.8	45.5	73.0
29.719084	27.4	1000.000	9.000	GND	10.8	45.6	73.0

Average Data, Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L1

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.261480	42.9	1000.000	9.000	GND	10.4	23.1	66.0
0.392350	46.5	1000.000	9.000	GND	10.4	19.5	66.0
0.515954	43.9	1000.000	9.000	GND	10.4	16.1	60.0
0.517503	49.1	1000.000	9.000	GND	10.4	10.9	60.0
0.519577	53.1	1000.000	9.000	GND	10.4	6.9	60.0
0.521137	54.5	1000.000	9.000	GND	10.4	5.5	60.0
0.522702	54.5	1000.000	9.000	GND	10.4	5.5	60.0
0.524796	52.2	1000.000	9.000	GND	10.4	7.8	60.0
0.526372	48.8	1000.000	9.000	GND	10.4	11.2	60.0
0.527952	44.5	1000.000	9.000	GND	10.4	15.5	60.0
0.653211	45.2	1000.000	9.000	GND	10.4	14.8	60.0
0.655172	43.3	1000.000	9.000	GND	10.4	16.7	60.0
0.916654	27.0	1000.000	9.000	GND	10.4	33.0	60.0
4.177776	26.9	1000.000	9.000	GND	10.5	33.1	60.0
21.003893	42.6	1000.000	9.000	GND	10.7	17.4	60.0
22.729606	47.0	1000.000	9.000	GND	10.7	13.0	60.0



Plot: Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L2

QuasiPeak Data: Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L2

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.260697	49.3	1000.000	9.000	GND	10.4	29.7	79.0
0.391567	52.0	1000.000	9.000	GND	10.4	27.0	79.0
0.516986	52.3	1000.000	9.000	GND	10.4	20.7	73.0
0.519577	57.7	1000.000	9.000	GND	10.4	15.3	73.0
0.521137	59.3	1000.000	9.000	GND	10.4	13.7	73.0
0.522180	59.5	1000.000	9.000	GND	10.4	13.5	73.0
0.525846	55.0	1000.000	9.000	GND	10.4	18.0	73.0
0.585786	48.3	1000.000	9.000	GND	10.4	24.7	73.0
0.589899	46.8	1000.000	9.000	GND	10.4	26.2	73.0
0.653211	49.4	1000.000	9.000	GND	10.4	23.6	73.0
21.003893	46.0	1000.000	9.000	GND	10.7	27.0	73.0
22.729606	51.3	1000.000	9.000	GND	10.7	21.7	73.0
29.719084	27.4	1000.000	9.000	GND	10.8	45.6	73.0

Average Data, Conducted Emission 150kHz-30MHz, 120V/60Hz, AC Mains, L2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.260697	43.2	1000.000	9.000	GND	10.4	22.8	66.0
0.391567	46.9	1000.000	9.000	GND	10.4	19.1	66.0
0.516986	47.5	1000.000	9.000	GND	10.4	12.5	60.0
0.518539	51.2	1000.000	9.000	GND	10.4	8.8	60.0
0.519577	52.9	1000.000	9.000	GND	10.4	7.1	60.0
0.521137	54.6	1000.000	9.000	GND	10.4	5.4	60.0
0.522702	54.6	1000.000	9.000	GND	10.4	5.4	60.0
0.524272	53.3	1000.000	9.000	GND	10.4	6.7	60.0
0.525846	50.4	1000.000	9.000	GND	10.4	9.6	60.0
0.653211	44.9	1000.000	9.000	GND	10.4	15.1	60.0
0.655172	42.5	1000.000	9.000	GND	10.4	17.5	60.0
0.914824	27.1	1000.000	9.000	GND	10.4	32.9	60.0
3.914985	26.5	1000.000	9.000	GND	10.5	33.5	60.0
21.003893	43.1	1000.000	9.000	GND	10.7	16.9	60.0
22.729606	47.8	1000.000	9.000	GND	10.7	12.2	60.0

Part 2 - Unintentional Radiated Emissions

DATE: October 19, 2016

TEST STANDARD: 47 CFR Part 15 Subpart B Section 15.109, ICES-003 Issue 6

TEST VOLTAGE: 120Vac 60Hz

MINIMUM STANDARD: Class A Limit:

Frequency (MHz)	Field Strength	
	μV/m at 10m	dBμV/m at 10m
30 – 88	90	39.0
88 – 216	150	43.5
216 - 960	210	46.4
960 – 1000	300	49.5

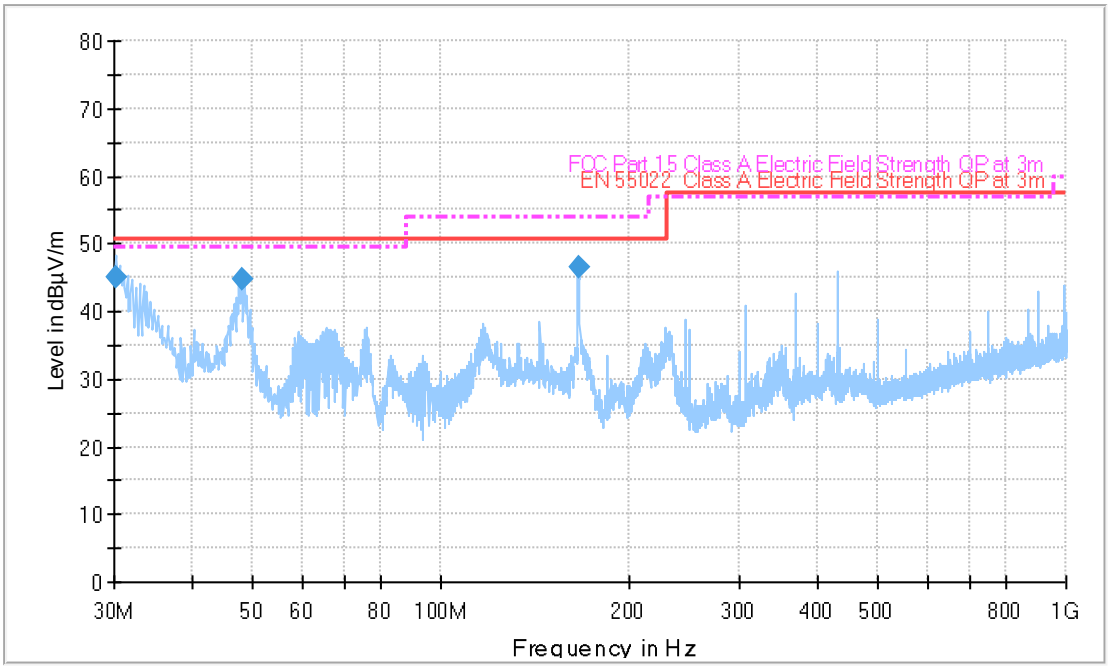
TEST SETUP: The equipment was set up in a 3-meter Semi Anechoic Chamber for preliminary measurements and finals were completed in 3m/10m Open Air Test Site at 10meters. Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength.

In cases where the presence of high ambient noise makes it impossible to measure an emission at the required distance, the measurement is performed at a closer distance and the limit is adjusted per the following table.

20 Log (D1/D2)
Where D1 = New Distance D2 = Required Distance The result is added or subtracted to the required emission level to ensure compliance at the new distance.

PERFORMANCE: Complies with standard.

MEASUREMENT PLOT & DATA:



Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.141704	45.1	1000.000	120.000	100.0	V	1.0	26.9	5.4	50.5
47.989100	44.7	1000.000	120.000	100.0	V	170.0	16.6	5.8	50.5
166.341500	46.5	1000.000	120.000	100.0	V	162.0	19.1	4.0	50.5

Part 3 - Peak Conducted Output Power

DATE: November 3,2016

TEST STANDARD: 47 CFR Part 22 §22.913, RSS-133

TEST VOLTAGE: 120V/60Hz

MINIMUM STANDARD: §22.913 Effective radiated power limits.

The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(a)Maximum ERP. In general, the effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. However, for those systems operating in areas more than 72 km (45 miles) from international borders that:

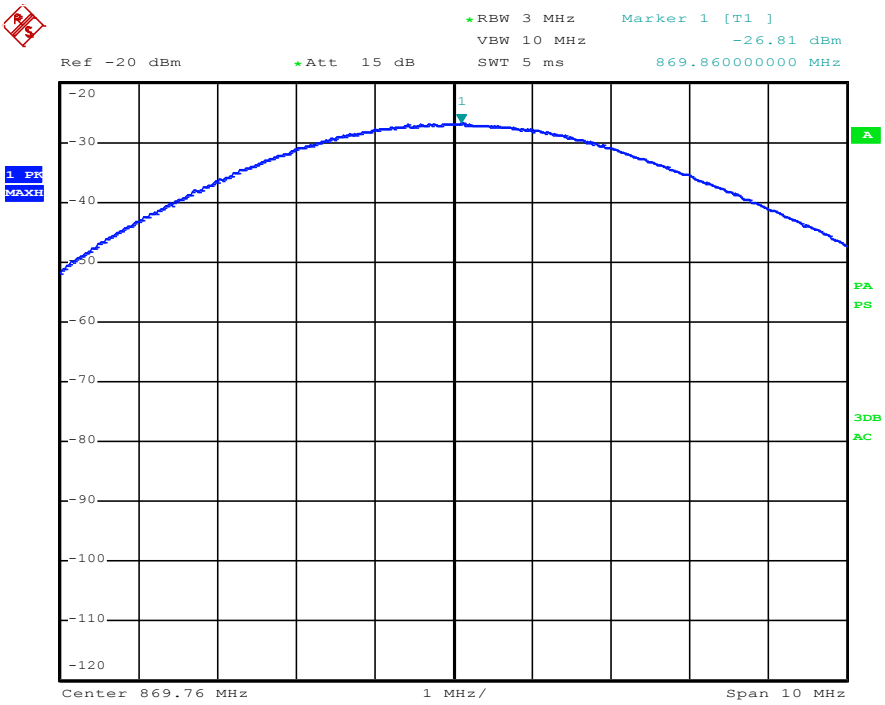
RSS-132 5.4 Transmitter Output Power and Equivalent Isotopically Radiated Power

The transmitter output power shall be measured in terms of average power. The equivalent isotopically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts.

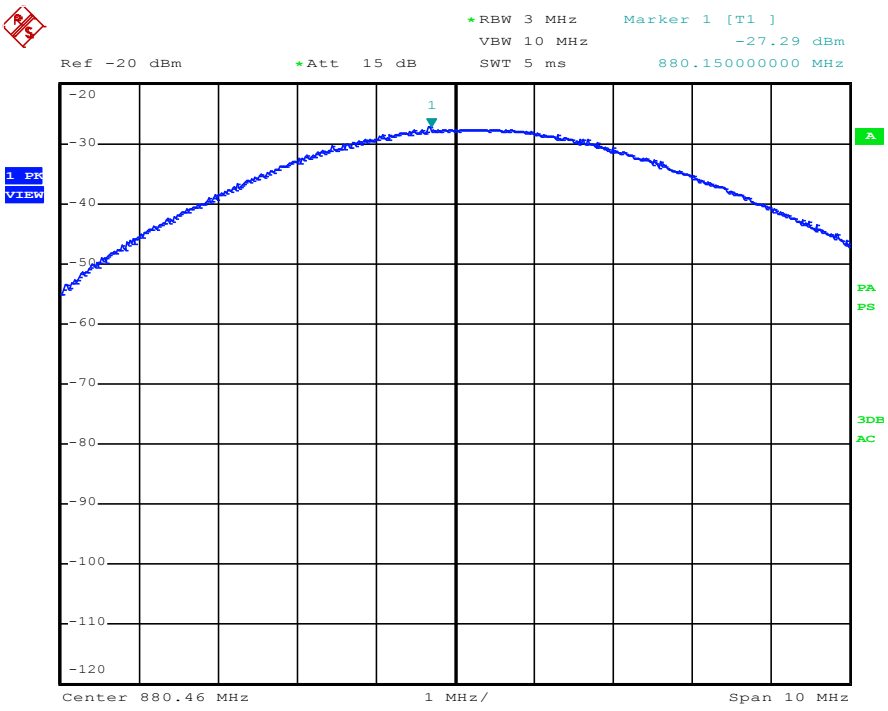
TEST SETUP: The antenna port of EUT was directly connected to EMI Receiver.

MEASUREMENT METHOD: As called by the standards above.

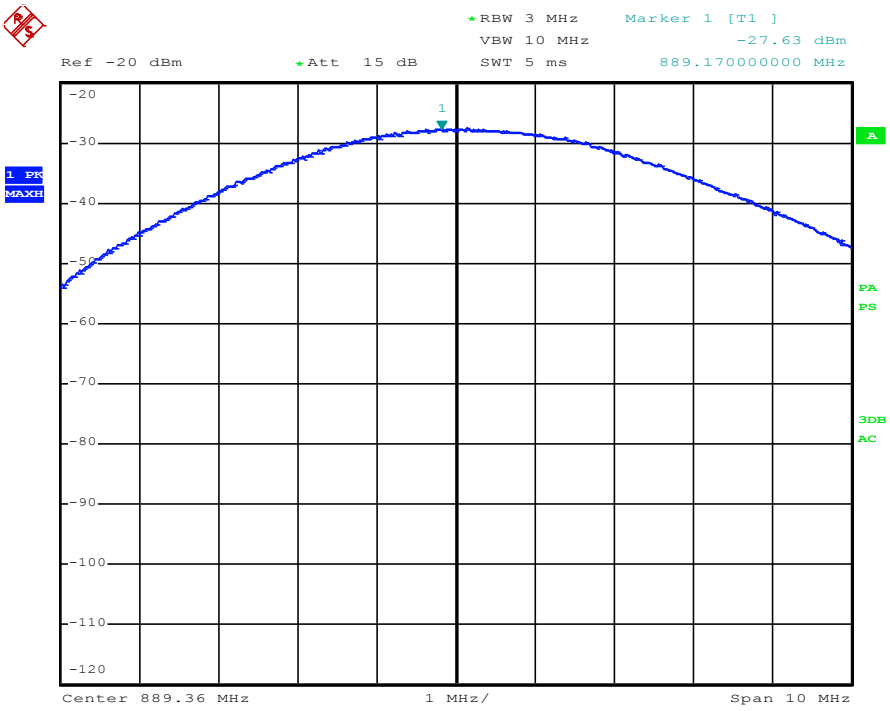
EMISSIONS DATA & PLOT:



Plot, Peak RF Conducted Power, Low Channel



Plot, Peak RF Conducted Power, Mid Channel



Plot, Peak RF Conducted Power, High Channel

Data, Peak Output Power

Frequency (MHz)	Raw (dBm)	Attenuation (dB)	Corrected Output Power (dBm)
869.76	-26.8	50.5	23.7
880.656	-27.2	50.5	23.3
889.538	-27.63	50.5	22.87

PERFORMANCE: Complies with the standards.

Part 4 - Peak-to-Average ratio

DATE: November 3,2016

TEST STANDARD: 47 CFR Part 22 §22.913, RSS-133

TEST VOLTAGE: 120V/60Hz

MINIMUM STANDARD: 13dB

TEST SETUP: The antenna port of EUT was directly connected to a spectrum analyzer.

MEASUREMENT METHOD: As called by the standards above.

Average output power measurements measurement was performed as per procedure defined in clause 5.2.1 of Measurement guidance for certification of Licensed Digital transmitters. (i.e. 971168 D01 Power Meas License Digital Systems v02r02).

Peak output power measurements measurement was performed as per procedure defined in clause 5.1.1 of Measurement guidance for certification of Licensed Digital transmitters. (i.e. 971168 D01 Power Meas License Digital Systems v02r02).

DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

MEASURED DATA:

Data, Average Output Power

Frequency (MHz)	Raw (dBm)	Attenuation (dB)	Corrected Output Power (dBm)
869.76	-21.8	40.4	18.6
880.656	-22.48	40.4	17.92
889.538	-22.86	40.4	17.54

Data, The Ratio of Peak Output Power to Average Output Power

Frequency (MHz)	Peak Output Power (dBm)	Average Output Power (dBm)	Peak to Average ratio (dB)	Limit (dB)
869.76	23.7	18.6	5.1	13
880.656	23.3	17.92	5.38	13
889.538	22.87	17.54	5.33	13

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Part 5 - 26dB Occupied Bandwidth

DATE: November 1,2016

TEST STANDARD: 47 CFR Part 22 §22.359, RSS-133

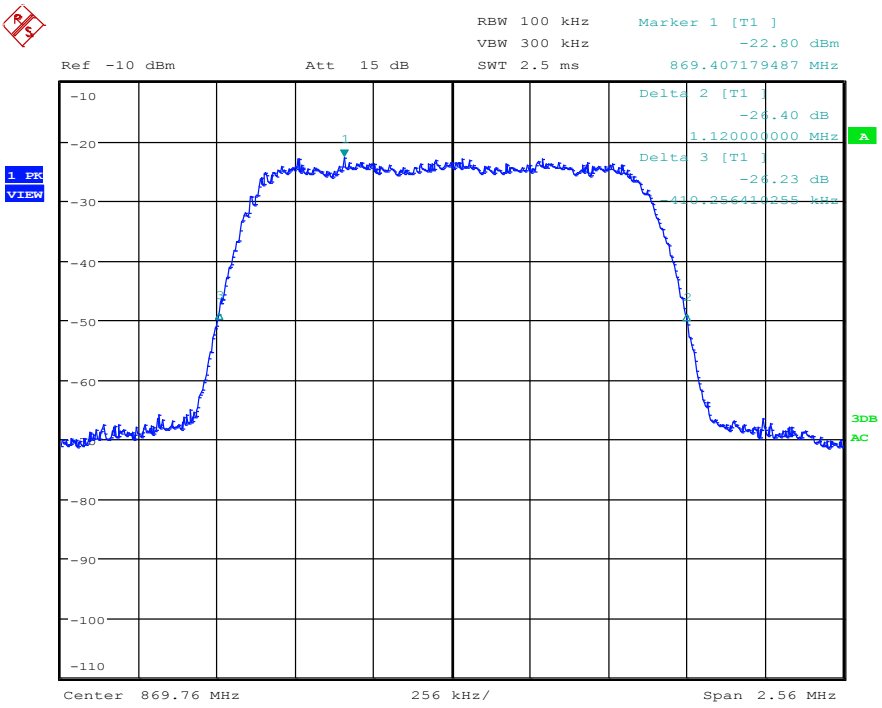
REQUIREMENTS: The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

TEST SETUP: The antenna port of EUT was directly connected to EMI Receiver.

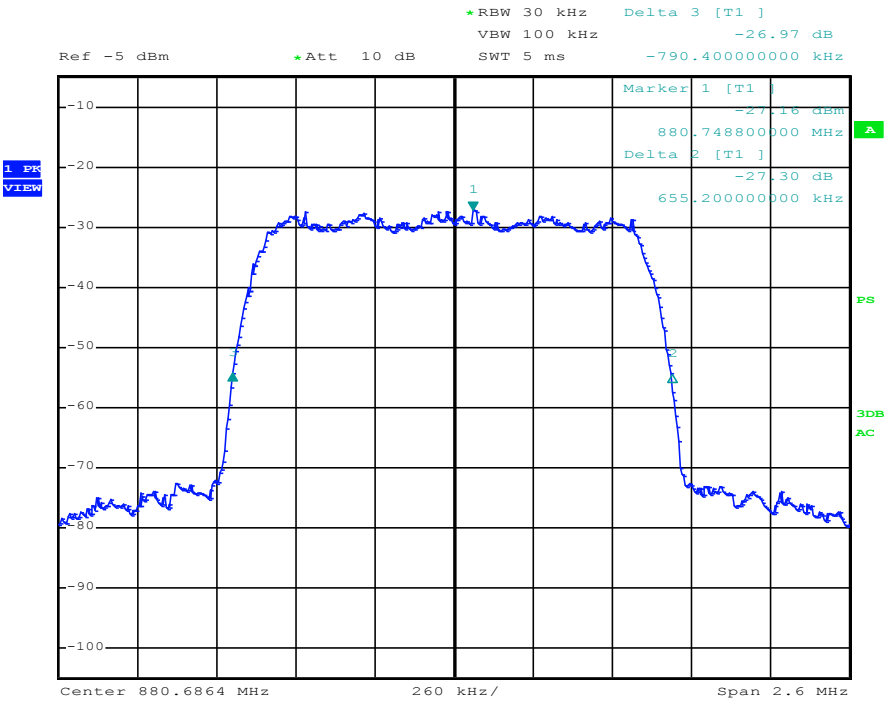
MEASUREMENT METHOD: As called by the standards above.

MEASURED DATA & PLOT:

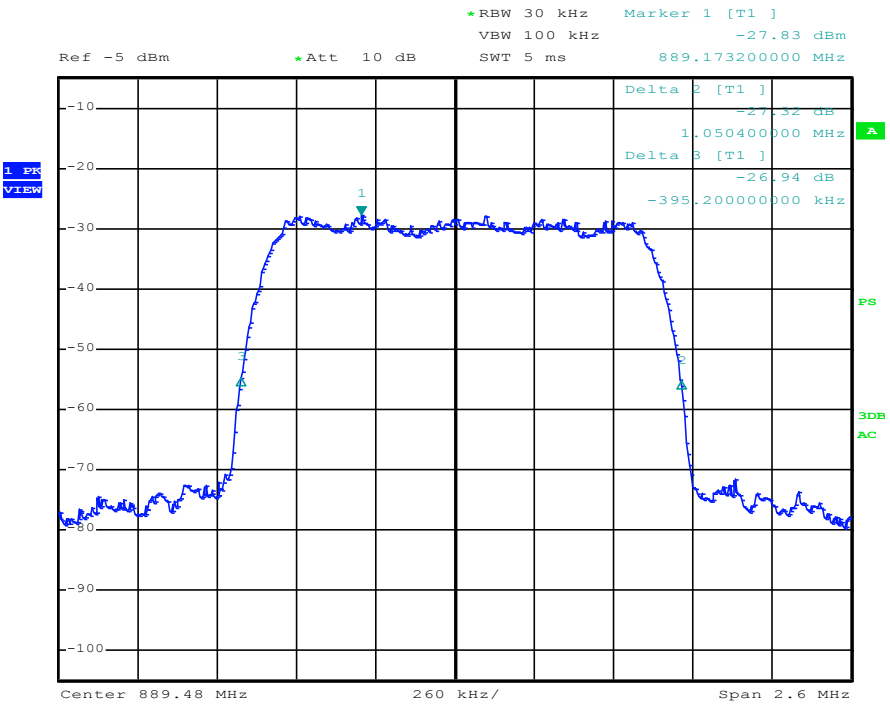
Channel	Frequency (MHz)	26dB Occupied Bandwidth
Low	869.76	1.53MHz
Mid	880.656	1.54MHz
High	889.538	1.28MHz



26dB Occupied Bandwidth low channel



26dB Occupied Bandwidth middle channe



26dB Occupied Bandwidth high channel

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Part 6 - 99% Occupied Bandwidth

DATE: November 1,2016

TEST STANDARD: RSS-Gen Issue 6

TEST VOLTAGE: 120V/60Hz

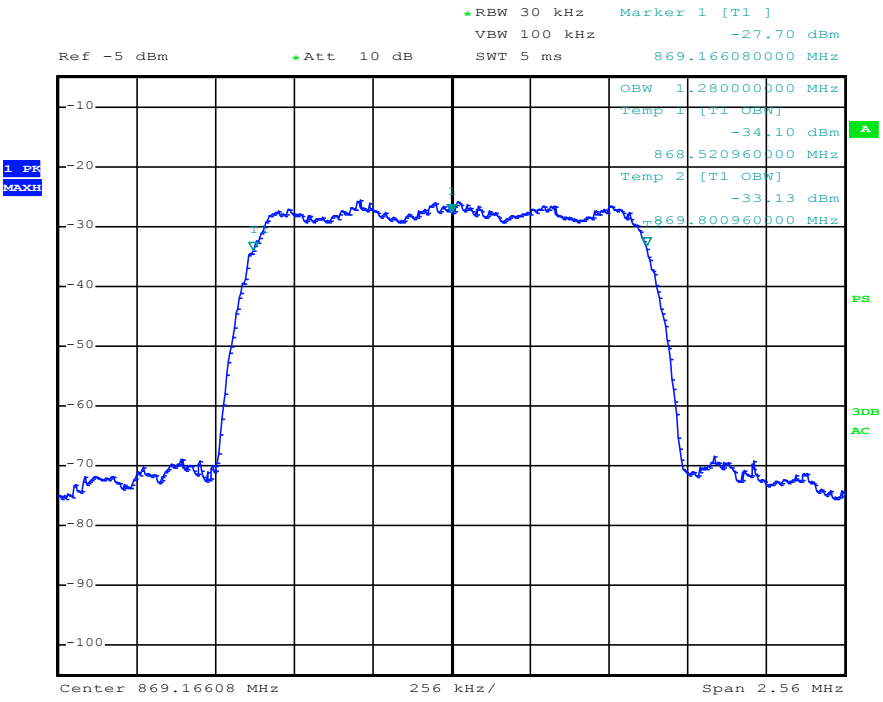
REQUIREMENT: The 99% Occupied Bandwidth should be reported

TEST SETUP: The antenna port of EUT was directly connected to EMI Receiver.

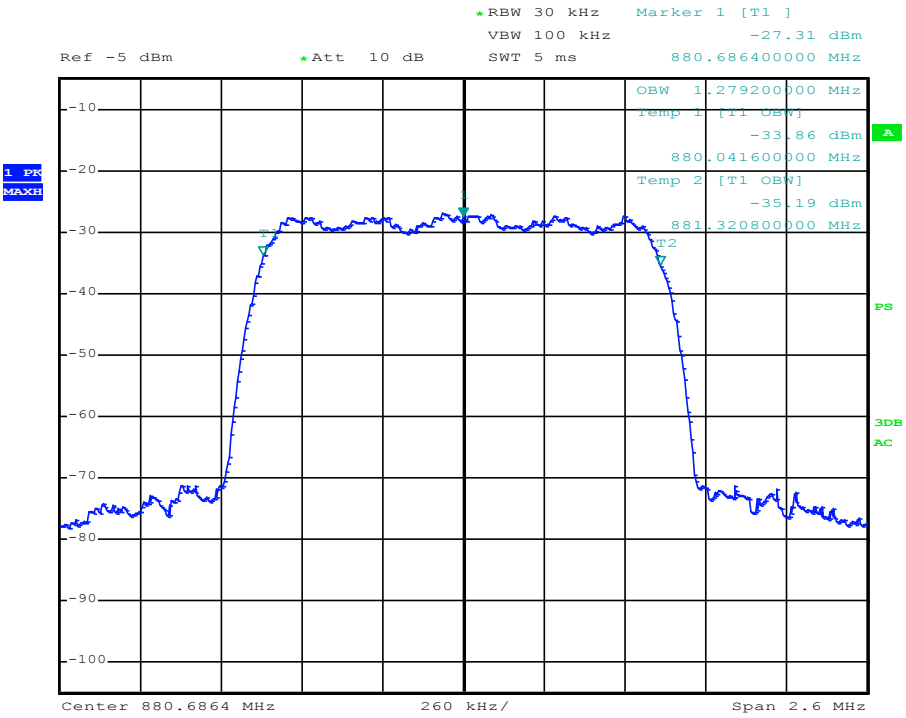
MEASUREMENT METHOD: As called by the standards above.

MEASURED DATA & PLOT:

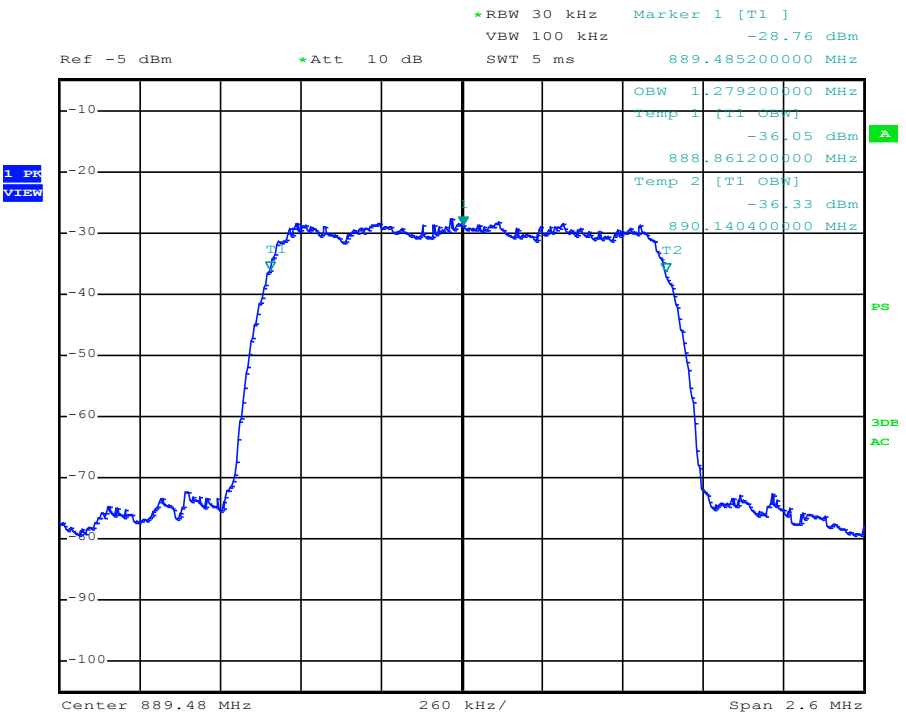
Channel	Frequency (MHz)	26dB Occupied Bandwidth
Low	869.76	1.28MHz
Mid	880.656	1.28MHz
High	889.538	1.28MHz



99% Occupied Bandwidth low channel



99% Occupied Bandwidth middle channe



99% Occupied Bandwidth high channel

OBSERVATIONS:	The EUT performed as expected.
PERFORMANCE:	Complies.

Part 7 - Unwanted Emissions - Band Edge

DATE: November 1,2016

TEST STANDARD: 47 CFR Part 22 Subpart B Section 22.359 and RSS-132 Issue 8 RSS247

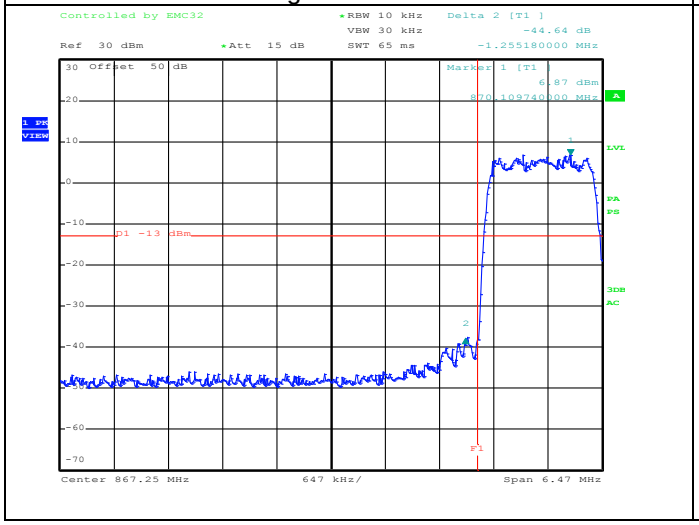
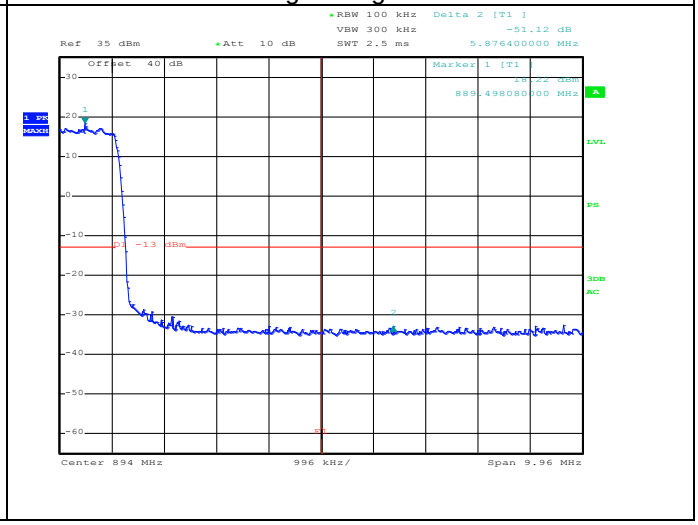
TEST VOLTAGE: 120V/60Hz

MINIMUM STANDARD: 47 CFR Part 22 Subpart B Section 22.359 (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 + 10log (P) dB.

RSS-132 5.5 Transmitter Unwanted Emissions
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).
ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

MEASURED DATA & PLOT:

Bandedge - Low Channel	Bandedge - High Channel
	

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Part 8 - Conducted Spurious Emissions

DATE: October 21,2016

TEST STANDARD: 47 CFR Part 22 Subpart B Section 22.359 and RSS-132 Issue 8 RSS247

TEST VOLTAGE: 120V/60Hz

MINIMUM STANDARD: 47 CFR Part 22 Subpart B Section 22.359 (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 + 10log (P) dB.

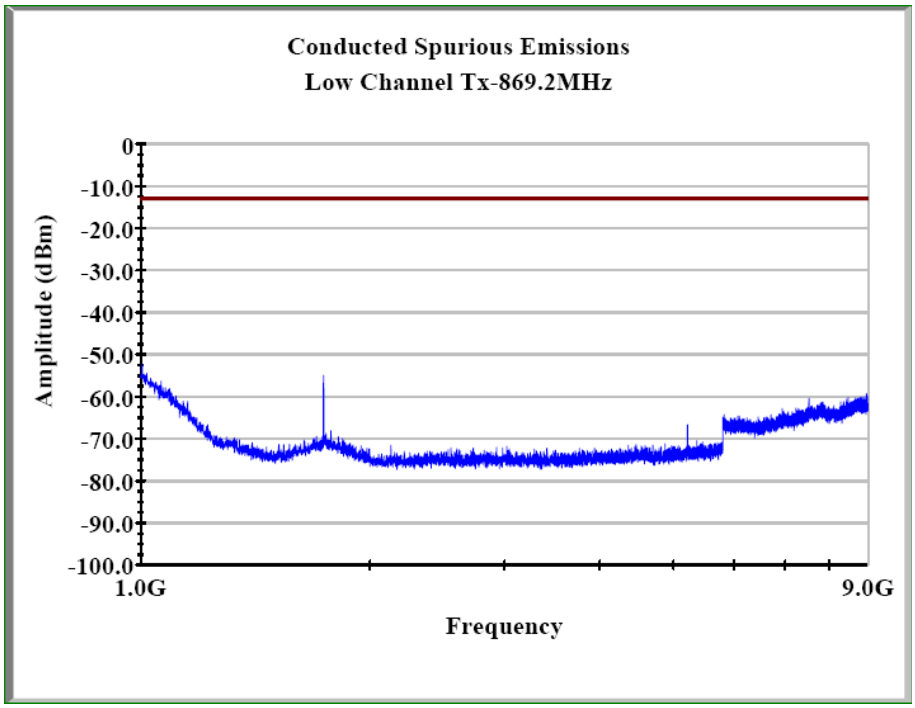
RSS-132 5.5 Transmitter Unwanted Emissions
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

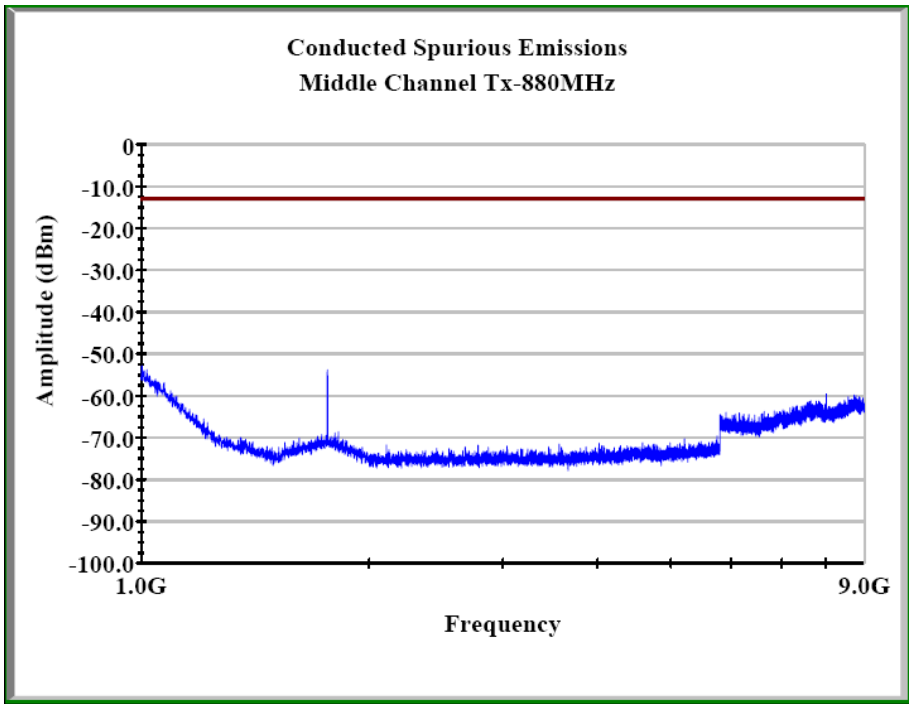
iii. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).

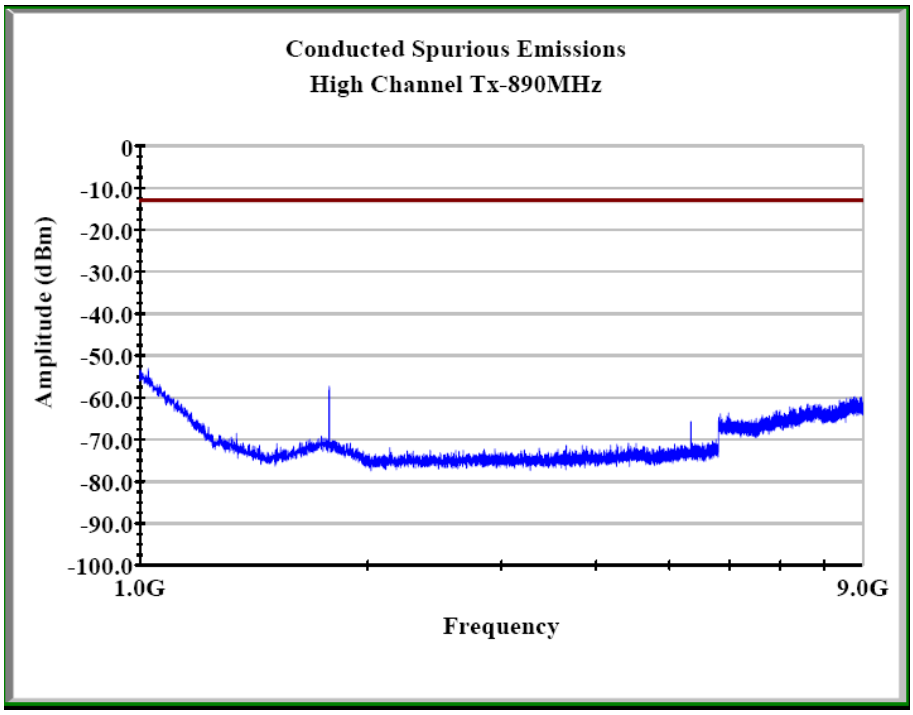
iv. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

DATA & PLOT:

Channel	Frequency	Un-corrected Peak	Correction Factor	Corrected Peak	Margin	Limit
	(GHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBm)
Low	1.74	-58.2	5.8	-52.4	39.4	-13
	5.283	-63	3.5	-59.5	46.5	-13
Mid	1.76	-55.2	5.8	-49.4	36.4	-13
	5.283	-67	3.5	-63.5	50.5	-13
High	1.78	-57.3	5.8	-51.5	38.5	-13
	5.377	-64.7	3.5	-61.2	48.2	-13


Conducted Spurious Emissions
Low Channel Tx-869.2MHz
Amplitude (dBm)
0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
1.0G
9.0G
Frequency


Conducted Spurious Emissions
Middle Channel Tx-880MHz
Amplitude (dBm)
0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
1.0G
9.0G
Frequency



OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Part 9 - Radiated Spurious Emissions

DATE: October 25, 2016

TEST STANDARD: 47 CFR Part 22 Subpart B Section 22.359 and RSS-132 Issue 8 RSS247

TEST VOLTAGE: 120V/60Hz

MINIMUM STANDARD: 47 CFR Part 22 Subpart B Section 22.359 (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 + 10log (P) dB.

RSS-132 5.5 Transmitter Unwanted Emissions
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).

ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

Limits if emissions fall in restricted bands:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

TEST SETUP: The equipment was set up in a 3-meter Semi Anechoic Chamber for preliminary measurements and finals were completed in 3m/10m Open Air Test Site at 10meters. Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength.

In cases where the presence of high ambient noise makes it impossible to measure an emission at the required distance, the measurement is performed at a closer distance and the limit is adjusted per the following table.

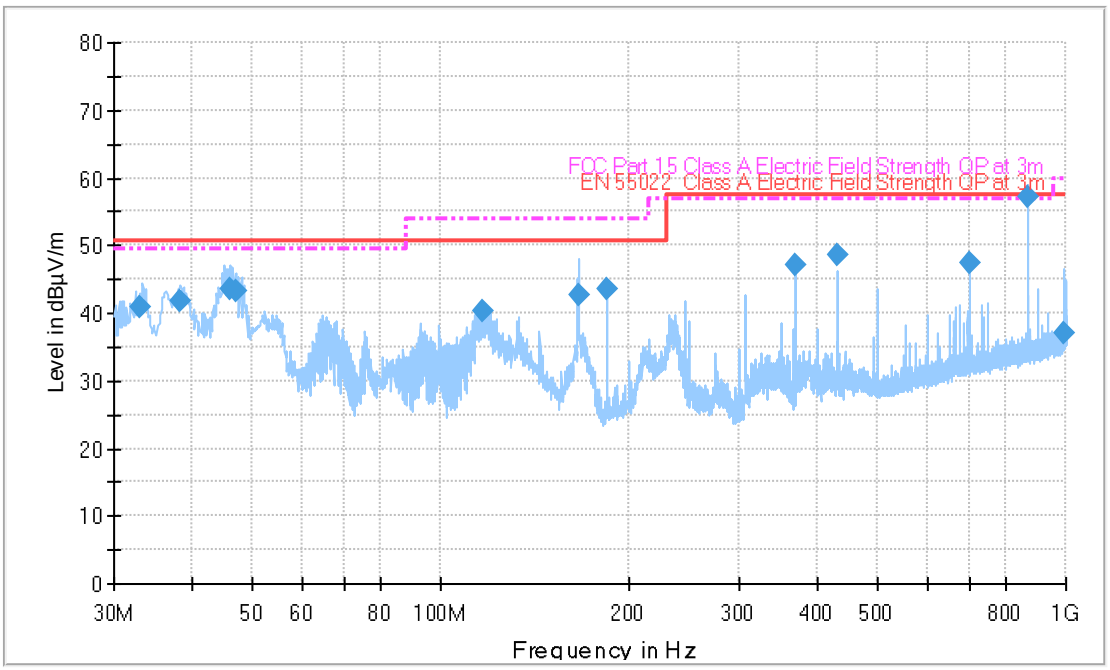
20 Log (D1/D2)
Where D1 = New Distance D2 = Required Distance The result is added or subtracted to the required emission level to ensure compliance at the new distance.

PERFORMANCE: Complies with standard.

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies with the standard.

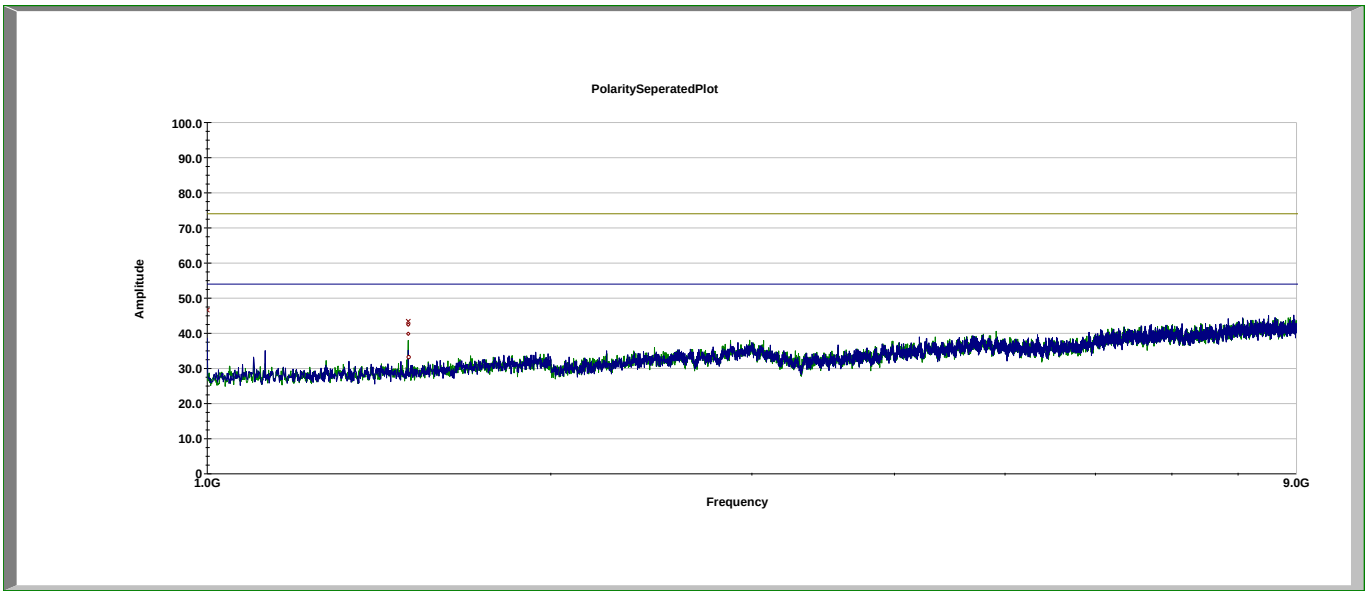
DATA & PLOT:



Plot, Radiated Emissions, 30MHz – 1GHz, Low Channel

Data, Radiated Emissions, 30MHz – 1GHz, Low Channel

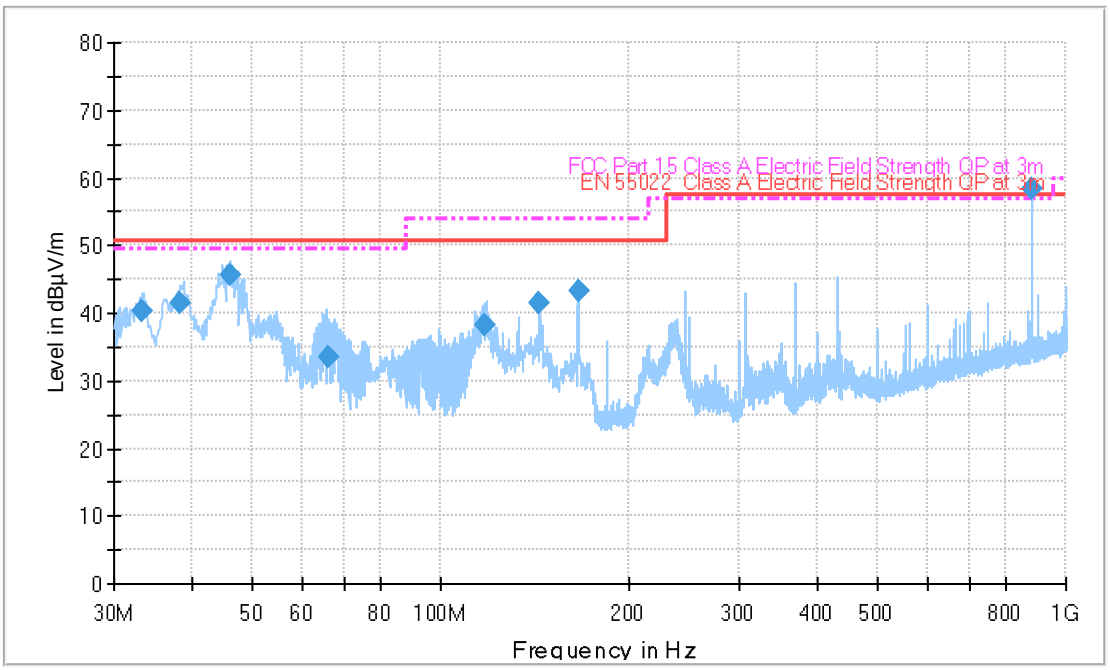
Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
32.913750	40.9	1000.000	120.000	100.0	V	320.0	25.0	9.6	50.5
38.346750	41.7	1000.000	120.000	100.0	V	0.0	21.7	8.8	50.5
46.090750	43.5	1000.000	120.000	125.0	V	153.0	17.5	7.0	50.5
46.998200	43.2	1000.000	120.000	100.0	V	197.0	17.0	7.3	50.5
116.408900	40.4	1000.000	120.000	264.0	H	44.0	20.4	10.1	50.5
165.873700	42.6	1000.000	120.000	160.0	H	0.0	19.1	7.9	50.5
184.316150	43.6	1000.000	120.000	174.0	H	0.0	18.3	6.9	50.5
368.645250	47.1	1000.000	120.000	100.0	H	6.0	22.4	10.4	57.5
430.096200	48.5	1000.000	120.000	100.0	H	319.0	24.3	9.0	57.5
699.986700	47.5	1000.000	120.000	132.0	H	0.0	28.7	10.0	57.5
869.057550	57.1	1000.000	120.000	100.0	H	186.0	30.7	0.4	57.5
996.066200	37.1	1000.000	120.000	156.0	H	248.0	32.4	20.4	57.5



Plot, Radiated Emissions, 1GHz – 9GHz, Low Channel

Data, Radiated Emissions, 1GHz – 9GHz, Low Channel

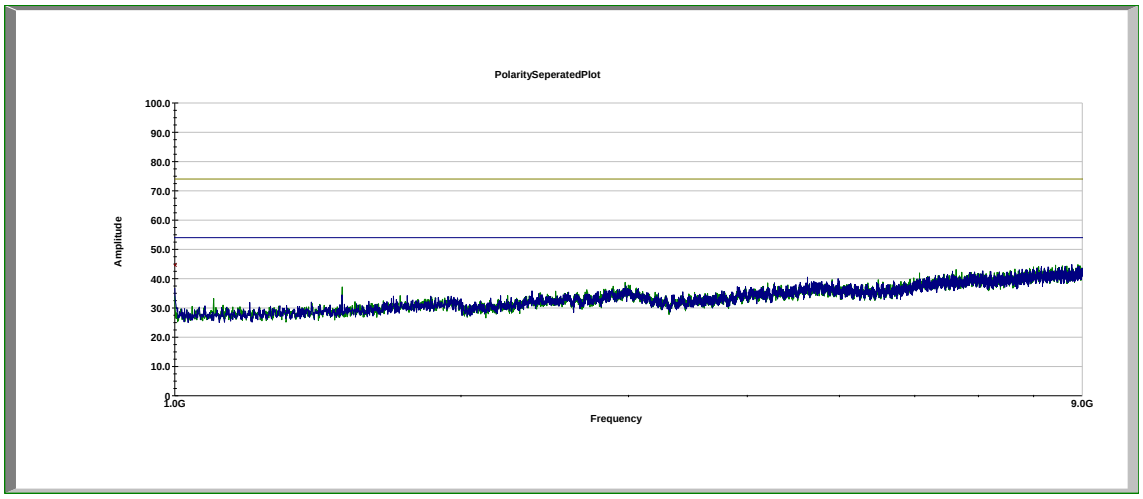
Frequency	Average	Peak	Antenna Height	Polarity	Turntable Position	H Corr.	V Corr	Margin	Limit
MHz	dBuV/m	dBuV/m	cm		deg	dB	dB	dB	dBuV/m
1499.961	33.35	39.863	105	Out_POL	55	-5.437	-5.437	20.63	53.98
1499.999	NAN	42.463	NAN	V	NAN	-5.437	-5.437	NAN	53.98



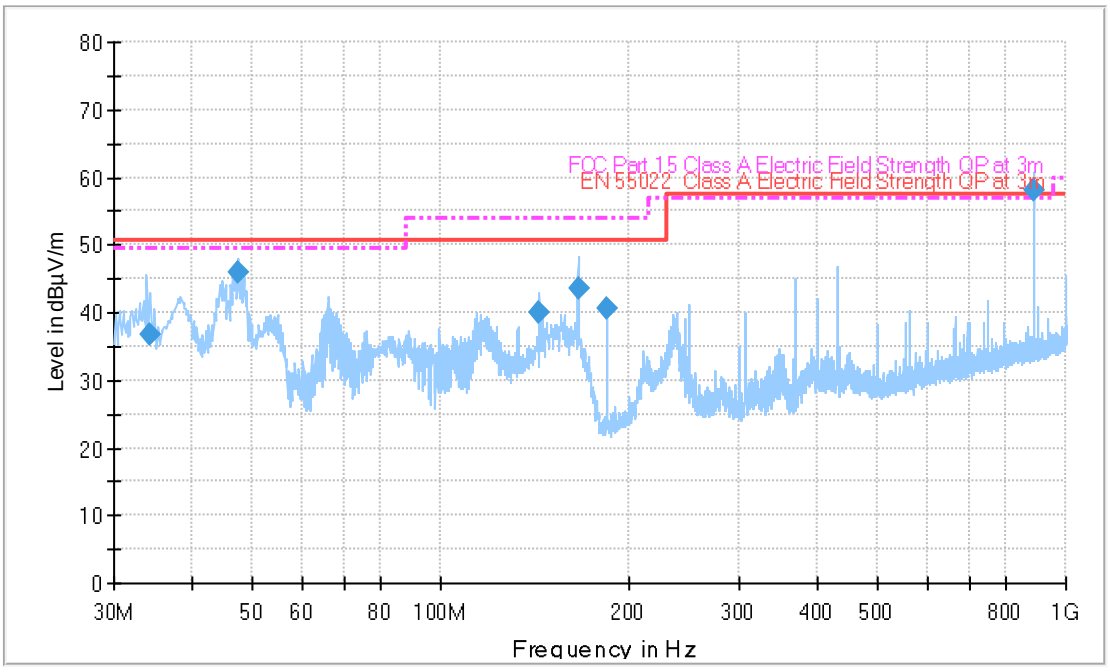
Plot, Radiated Emissions, 30MHz – 1GHz, Mid Channel

Data, Radiated Emissions, 30MHz – 1GHz, Mid Channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
33.366500	40.3	1000.000	120.000	100.0	V	307.0	24.7	10.2	50.5
38.351700	41.4	1000.000	120.000	100.0	V	37.0	21.7	9.1	50.5
46.077900	45.7	1000.000	120.000	100.0	V	187.0	17.5	4.8	50.5
66.171900	33.4	1000.000	120.000	146.0	V	0.0	14.6	17.1	50.5
117.322550	38.2	1000.000	120.000	350.0	H	60.0	20.5	12.3	50.5
143.977100	41.4	1000.000	120.000	216.0	H	44.0	20.1	9.1	50.5
166.353750	43.1	1000.000	120.000	207.0	H	219.0	19.1	7.4	50.5
880.631200	58.5	1000.000	120.000	100.0	V	80.0	30.9	-1.0	57.5



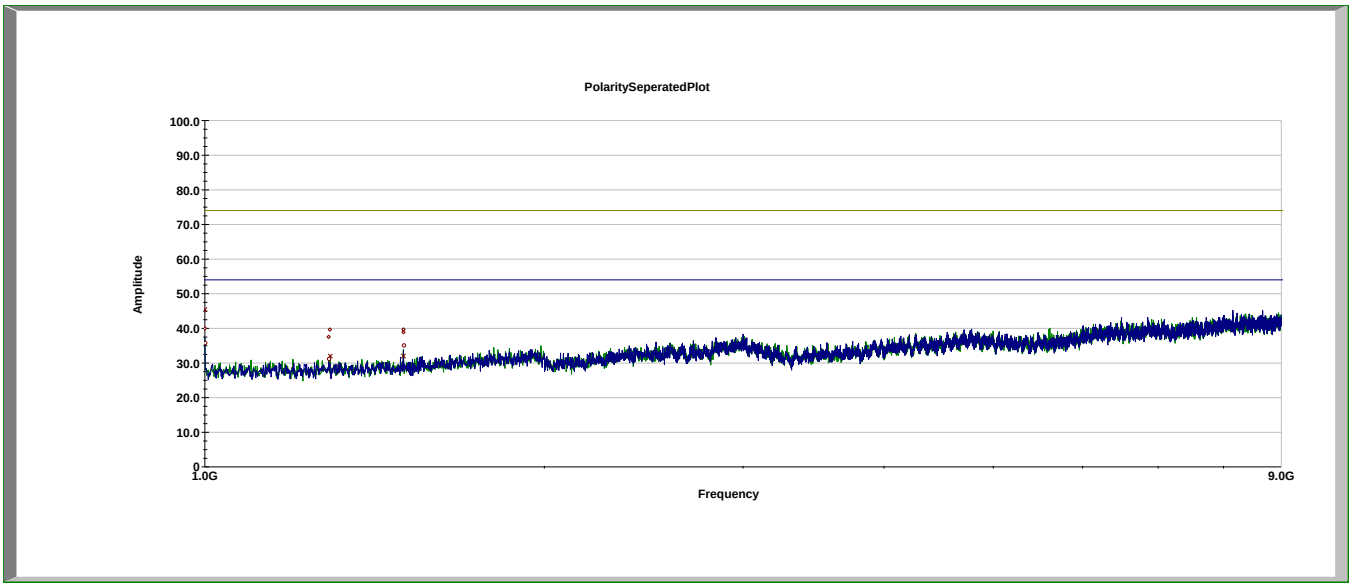
Plot, Radiated Emissions, 1GHz – 9GHz, Mid Channel



Plot, Radiated Emissions, 30MHz – 1GHz, High Channel

Data, Radiated Emissions, 30MHz – 1GHz, High Channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
34.326400	36.9	1000.000	120.000	100.0	V	237.0	24.1	13.6	50.5
47.487000	45.8	1000.000	120.000	123.0	V	204.0	16.8	4.7	50.5
143.948000	39.9	1000.000	120.000	267.0	H	28.0	20.1	10.6	50.5
166.149850	43.6	1000.000	120.000	243.0	H	62.0	19.1	6.9	50.5
184.329650	40.7	1000.000	120.000	181.0	H	6.0	18.3	9.8	50.5
889.170050	58.2	1000.000	120.000	135.0	V	64.0	31.0	-0.7	57.5



Plot, Radiated Emissions, 1GHz – 9GHz, High Channel

Data, Radiated Emissions, 1GHz – 9GHz, High Channel

Frequency	Average	Peak	Antenna Height	Polarity	Turntable Position	H Corr.	V Corr	Margin	Limit
MHz	dBuV/m	dBuV/m	cm	Out_POL	deg	dB	dB	dB	dBuV/m
1000.039	35.893	39.983	100		297	-7.917	-7.917	18.087	53.98
1287.633	31.29	37.518	289	V	5	-6.382	-6.382	22.69	53.98
1290.841	NAN	39.632	NAN		NAN	-6.368	-6.368	NAN	53.98
1500.045	35.191	38.863	146	V	9	-5.437	-5.437	18.789	53.98
1500.113	NAN	39.664	NAN		NAN	-5.436	-5.436	NAN	53.98

Part 10 - Frequency Stability

DATE: October 25, 2016

TEST STANDARD: FCC Part 22and IC RSS-133

TEST CONDITIONS: Temperature Controlled Chamber -30 to +50ºCelsius

MINIMUM STANDARD: 1.5ppm

TEST SETUP: The EUT was tested in our Temperature Chamber and was positioned on the center of the turntable and powered up. The Transmitter Output was connected to a Spectrum Analyzer using appropriate attenuators.

MEASUREMENT METHOD: The transmitter was not able to be set for CW Signals so the readings were taken with modulated signals using the ndB down method using 30kHz RBW.. Only the middle channel was measured. The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements.

DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.

DATA:

Temperature (Celsius)	Test Frequency (MHz)	Measured Frequency (MHZ)	Frequency Drift (Hz)	(ppm)	Limit (ppm)
-30	869.76	869.76069	690	0.793322296	1.5
-20	869.76	869.7606	600	0.689845475	1.5
-10	869.76	869.76058	580	0.666850625	1.5
0	869.76	869.76039	390	0.448399559	1.5
10	869.76	869.7603	300	0.344922737	1.5
20	869.76	869.76045	450	0.517384106	1.5
30	869.76	869.76049	490	0.563373804	1.5
40	869.76	869.76051	510	0.586368653	1.5
50	869.76	869.76058	580	0.666850625	1.5

Temperature (Celcius)	Test Frequency (MHz)	Measured Frequency (MHZ)	Frequency Drift (Hz)	(ppm)	Limit (ppm)
-30	889.953	889.9539	900.0	1.01128936	1.5
-20	889.953	889.95375	750.0	0.842741134	1.5
-10	889.953	889.95357	570.0	0.640483262	1.5
0	889.953	889.95354	540.0	0.606773616	1.5
10	889.953	889.95357	570.0	0.640483262	1.5
20	889.953	889.95352	520.0	0.584300519	1.5
30	889.953	889.95362	620.0	0.696666004	1.5
40	889.953	889.95366	660.0	0.741612198	1.5
50	889.953	889.95382	820.0	0.921396973	1.5

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Part 11 - RF Exposue MPE

Date: January 26, 2017

MPE Requirement: Limits for general population that are specified under FCC Part 1 - Section 1.1310 - Table 1

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

Evaluation:

No antenna is supplied with this unit. The installer must not exceed the antenna gain limitations related to total power requirements in order to be excluded from routine environmental evaluation.

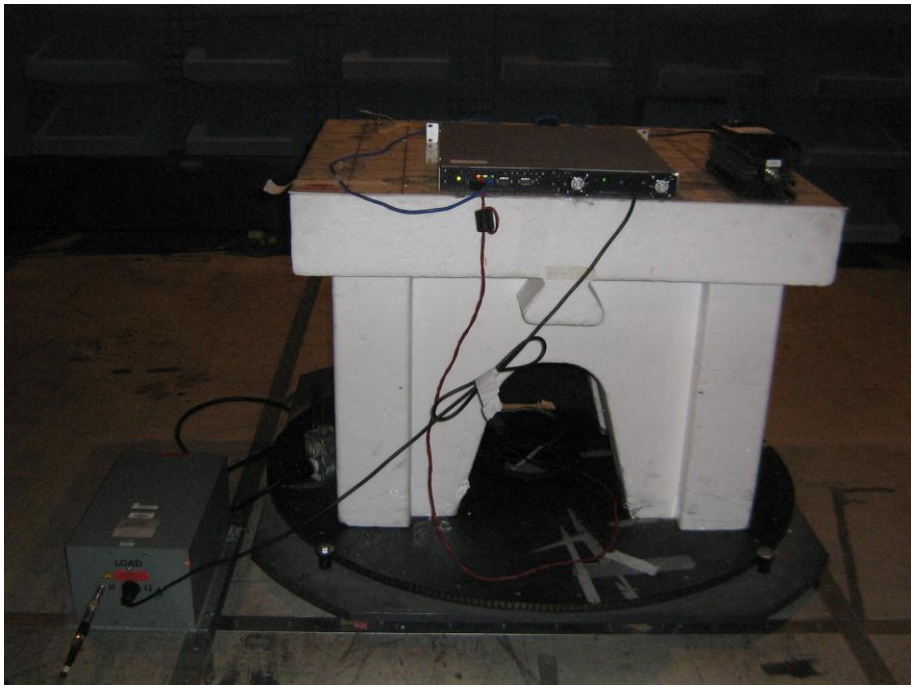
The maximum power density Power density: f/1500 = 0.58 mW/cm^2
This value can be achieved by multiple combinations of RF output, antenna gain, and distance from the antenna when energized.

The MPE is expressed as follows:
Power Density Pd (mW/cm^2) = EIRP/[4*Pi*d^2]
Where:
- d = distance from the antenna expressed in cm.
- EIRP expressed in mW = 10[TX Power (dBm) + Ant Gain(dBi)]/10
- TX Power (dBm) = 10*log [Tx Power (mW)]

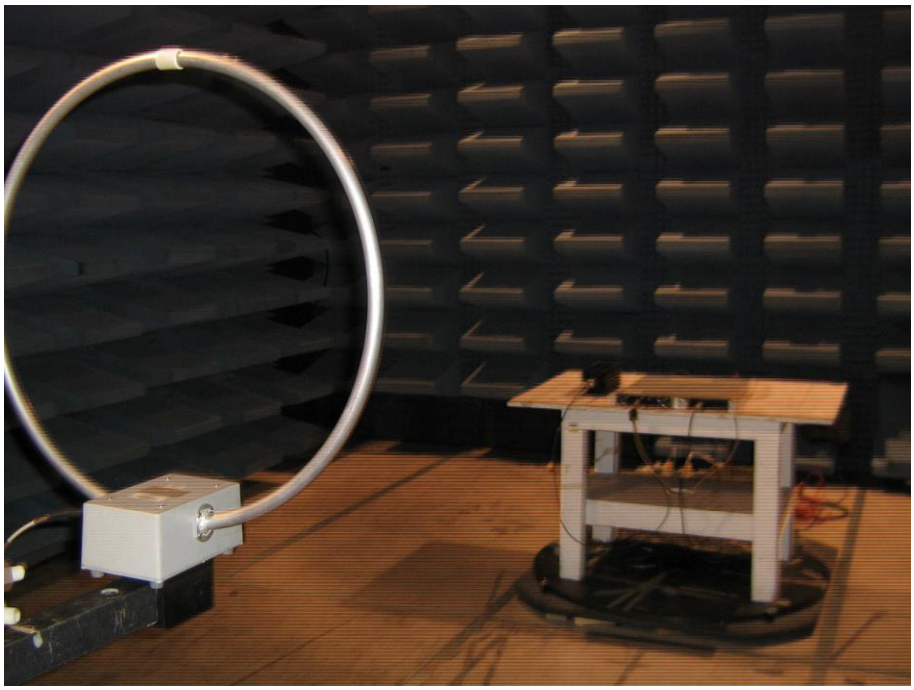
As an example, with the transmitter running at 23.7dBm output into an antenna with a gain of 10 dBi, the minimum safe distance from the antenna to ensure exposure would be:
- 18 cm to remain below 0.58 mW/cm2

When installing the antenna, the above relationship should be used to ensure the RF Maximum Permissible Exposure (MPE) Exhibit Requirements

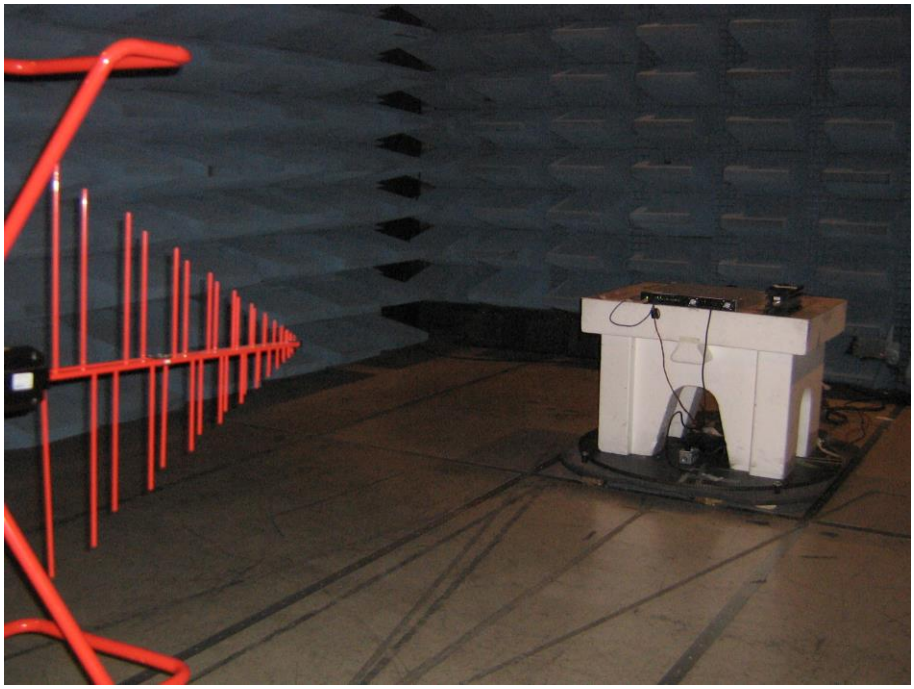
Appendix A: EUT photos during the testing



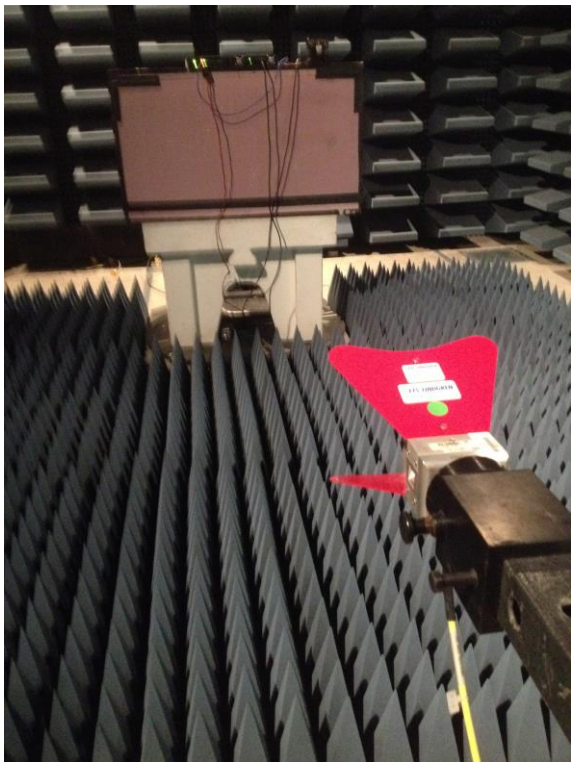
Conducted Emission Test Setup



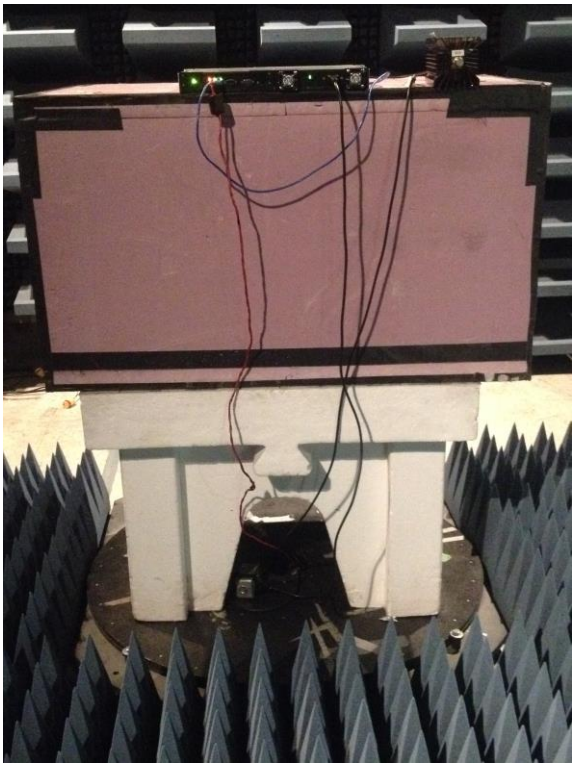
Radiated Emission Test Setup 9kHz - 30MHz



Radiated Emission Test Setup 30MHz – 1GHz



Radiated Emissions Setup above 1 GHz



Radiated Emissions Setup

End of report

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