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Report On

Radio Testing of the
Advanced Sterilization Products
Model 02532481 RFID Reader Module

FCC Part 15 Subpart C §15.225
IC RSS-210 Issue 9 August 2016

Report No. SD72120612-0916A

January 2017



REPORT ON EMC Evaluation of the
Advanced Sterilization Products
Controller Model No. 02532481

TEST REPORT NUMBER SD72120612-0916A

REPORT DATE January 2017

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DATED January 12, 2017



Revision History

SD72120612-0916A Advanced Sterilization Products Controller Model 02532481 RFID Reader Module					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
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SECTION 1

REPORT SUMMARY

Radio Testing of the
Advanced Sterilization Products
Controller Model 02532481



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Advanced Sterilization Products RFID Reader Module to the requirements of FCC Part 15 Subpart C §15.225 and IC RSS-210 Issue 9 August 2016.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Advanced Sterilization Products
Model Name	Controller
Model Number(s)	02532481
FCC ID Number	AXJ02532481
IC Number	10207A-02532481
Serial Number(s)	SM-M2-MH-2.2 2230160167
Number of Samples Tested	1
Test Specification/Issue/Date	<ul style="list-style-type: none">• FCC Part 15 Subpart C §15.225 (October 1, 2016).• RSS-210 - Licence-exempt Radio Apparatus: Category I Equipment (Issue 9, August 2016).• RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 4, November 2014).
Start of Test	December 05, 2016
Finish of Test	January 06, 2017
Name of Engineer(s)	Ferdinand S. Custodio
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.



1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.225 with cross-reference to the corresponding IC RSS standard is shown below.

Section	FCC Part 15	§15.225 Spec Clause	RSS	Test Description	Result	Comments/Base Standard
	§15.31(e)			Voltage Requirement	Compliant	§15.225(e)
	§15.203 and 204		RSS-Gen 8.3	Antenna Requirements	Compliant	See Test Note ¹
2.1		§15.225(e)	RSS-210 B.6	Frequency Tolerance	Compliant	
2.2	§15.215(c)			20dB Bandwidth	Compliant	
2.3			RSS-Gen 6.6	Occupied Bandwidth	Compliant	
2.4		§15.225(a)(b)(c)	RSS-210 B.6(a)(b)(c)	Emission Mask	Compliant	
2.5	§15.209	§15.225(d)	RSS-210 B.6(d)	Spurious Radiated Emissions	Compliant	
			RSS-Gen 4.10	Receiver Spurious Emissions	N/A	See Test Note ²
2.6		§15.207(a)	RSS-Gen 7.2.4	Conducted Emissions	Compliant	

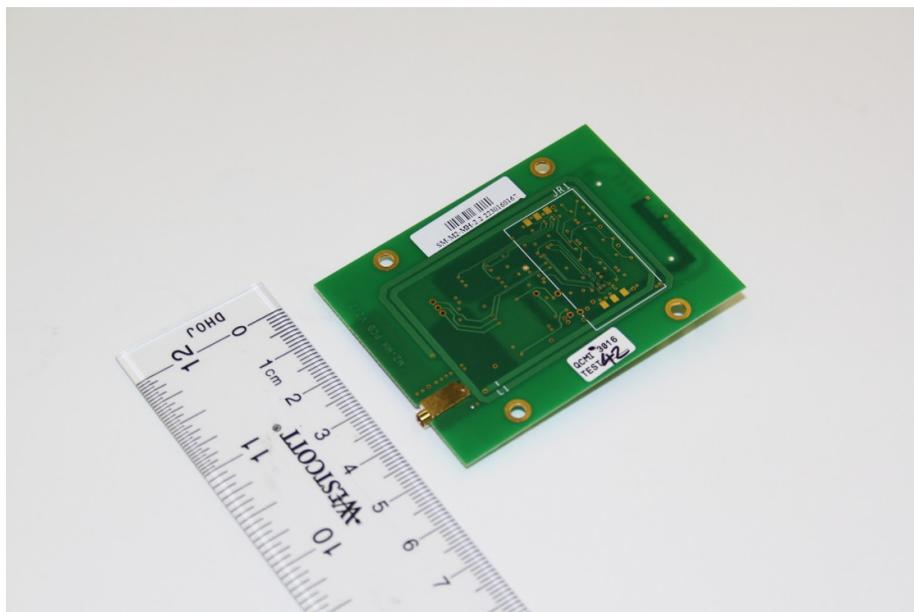
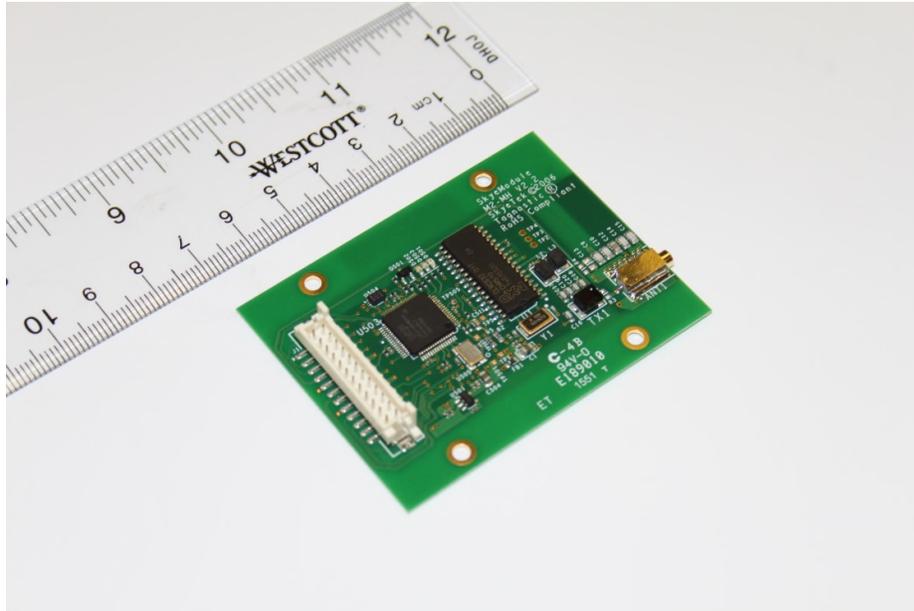
Test Note¹: The host of the EUT is professionally installed and the internal antenna used is permanently attached. These are considered sufficient evidences to comply with the provisions of this requirement.

Test Note²: The EUT does not fall into the category of a Receiver as per RSS-Gen Section 5.0.

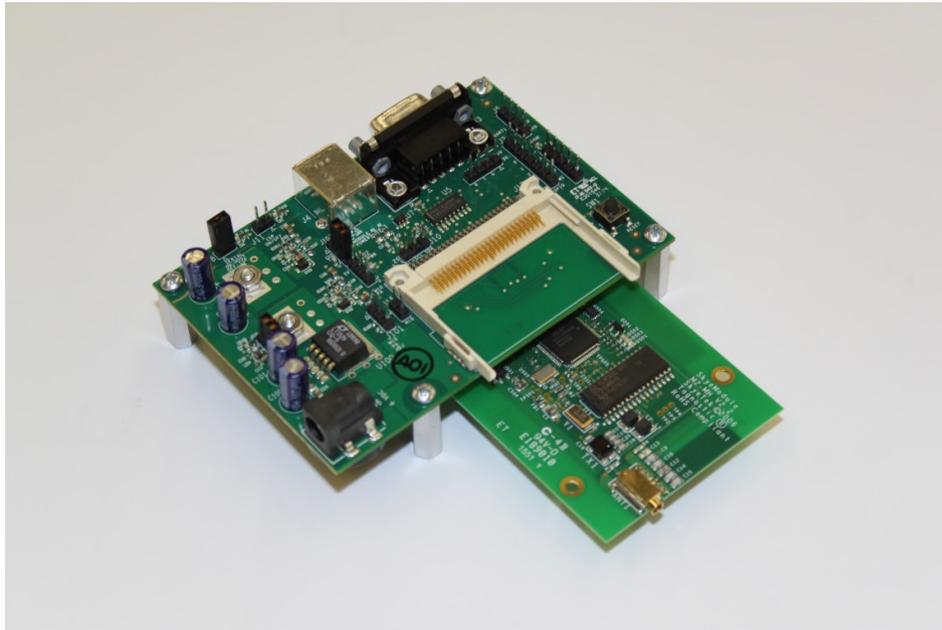
1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an Advanced Sterilization Products Controller Model No. 02532481 as shown in the photograph below. The EUT is a RFID Reader Module housed inside the manufacturer 100NX sterilizer. The EUT is used in reading STERRAD® 100NX® cassette which contains the hydrogen peroxide used for sterilization.



Equipment Under Test



Equipment Under Test (installed on a Development board)



EUT Antenna



Control Enclosure housing the EUT installed next to the antenna



1.3.2 EUT General Description

EUT Description	RFID Reader Module
Model Name	Controller
Model Number(s)	02532481
Rated Voltage	6V through the Development Board (EUT rated is from 3.5V to 5.5V with 5.0VDC nominal)
EUT Rated Output Power	23.0±2 dBm
EUT Measured Field Strength	78.3 dBµV/m @ 3 meters
Frequency Range	13.56 MHz in the 13.110 to 14.0101 MHz band
Number of Operating Frequencies	1
Antenna Type	PCBA
Manufacturer	ASP
Manufacturer Part Number	04-53067-0-001
Antenna Q Factor	20
Antenna Impedance	50Ω @ 13.56 MHz
RFID Antenna Connector	MMCX jack
Modulation Used	ISO 15693 Compliant
Antenna Dimension	288mm x 92mm



1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

<i>Test Configuration</i>	<i>Description</i>
A	Conducted Transmit Mode. The EUT was installed on a Development Board and the RF function controlled by software provided by the module manufacturer. Direct measurement with the EUT antenna port.
B	Radiated Transmit Mode. The antenna of the host (100NX System) was used for this test. The EUT was verified installed in the host (Limited Modular Approval). Since the host is a Class A device, functionality of the host not related to the RFID operation wasn't exercised.

1.4.2 EUT Exercise Software

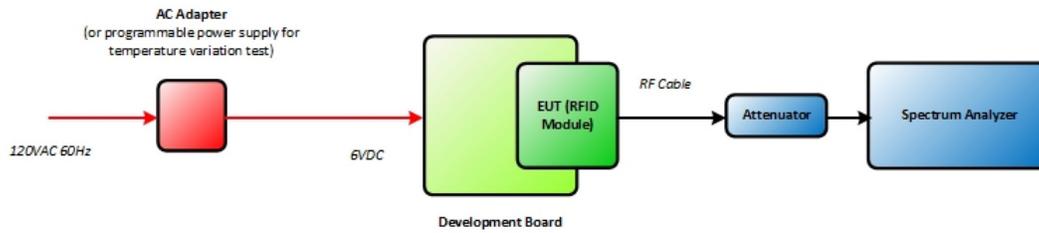
The EUT was exercised using SkyWare 4 Version 4.2.0.1394. The EUT was identified by the application as SkyeModule M2 COM3. The carrier was activated using the following instructions: Capabilities → Protocol → Flags → RF → Send. No other settings were modified in the software.

1.4.3 Support Equipment and I/O cables

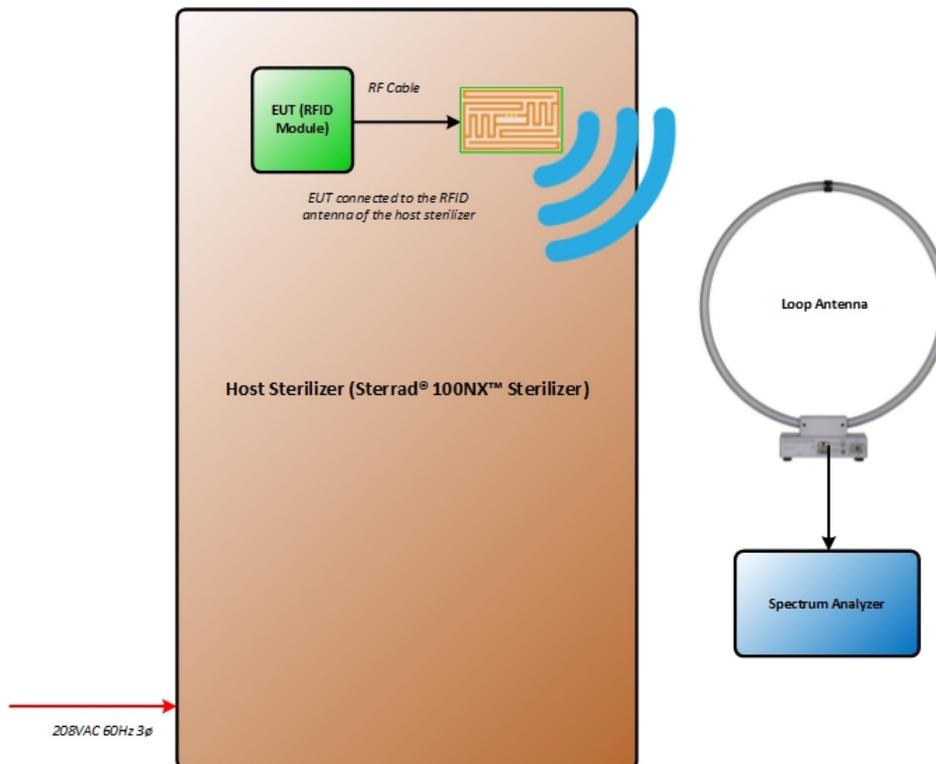
<i>Manufacturer</i>	<i>Equipment/Cable</i>	<i>Description</i>
Skyetek	Support Development Board	Host Interface Board V5.2 S/N 1606270002
CUI Inc	Support AC Adapter for Development Board	M/N EMSA060300 6VDC @ 3.0A
-	RF Cable Assembly (EUT antenna port)	0.30 meter SMA right angle to MMCX
Lenovo	Support Laptop	Thinkpad W541 S/N R9-OJM7MU 16/01
Lenovo	Support Laptop AC Adapter	M/N ADL170NDC2A S/N 11S36200317ZZ3005BS2T8
StarTech.com	Support RS232 Serial Express Card	M/N EC1S232U2 1 port USB Based with 16950 UART
-	Serial Cable (RS232 Serial Express Card to Development Board)	3.0 meters, RS232 DB9 connector, Male to Female
Pasternack	Support 20dB attenuator	M/N PE7017-20 25 watts DC-18GHz
Narda	Support 50Ω Termination	M/N 370BNM 50-Ohm Coaxial Termination DC-18GHz
ASP	Host Sterilizer	Sterrad® 100NX™ Sterilizer S/N 1044130223

1.4.4 Simplified Test Configuration Diagrams

Antenna Conducted Port Test Setup



Radiated Measurements Test Setup





1.5 DEVIATIONS FROM THE STANDARD

Manufacturer declared temperature operating range was from 18°C to 45°C. All temperature related verifications in this test report were performed using this temperature range.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number SM-M2-MH-2.2 2230160167		
N/A		

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 Fax: 858 546 0364.

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678-1400 Fax: 858 546 0364.

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.



1.9.2 Innovation, Science and Economic Development Canada (IC) Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A.

1.9.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TUV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.9.4 NCC (National Communications Commission - US0102)

TUV SUD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0230

TUV SUD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.



SECTION 2

TEST DETAILS

Radio Testing of the
Advanced Sterilization Products
Controller Model 02532481



2.1 FREQUENCY STABILITY

2.1.1 Specification Reference

Part 15 Subpart C §15.225(e) and RSS-210 B.6

2.1.2 Standard Applicable

(e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

2.1.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167 / Test Configuration A

2.1.4 Date of Test/Initial of test personnel who performed the test

December 05, 2016 /FSC

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.1 °C
Relative Humidity	44.3 %
ATM Pressure	99.8 kPa

2.1.7 Additional Observations

- This is a conducted test. The module antenna output is directly connected to the spectrum analyzer input via a suitable external attenuator.
- Measurement was done using the spectrum analyzer's frequency counter function to measure the frequency variation of the EUT's RFID system.
- The RBW was set to 10 kHz Hz for better resolution.
- The temperature was varied from 18°C to +45°C as requested by the manufacturer in 10 degree increments with voltage variation of 85% and 115% on the Development Board AC Adapter output @ 20°C.
- The EUT was powered off, then powered on once the temperature stabilized and the frequency was then measured.



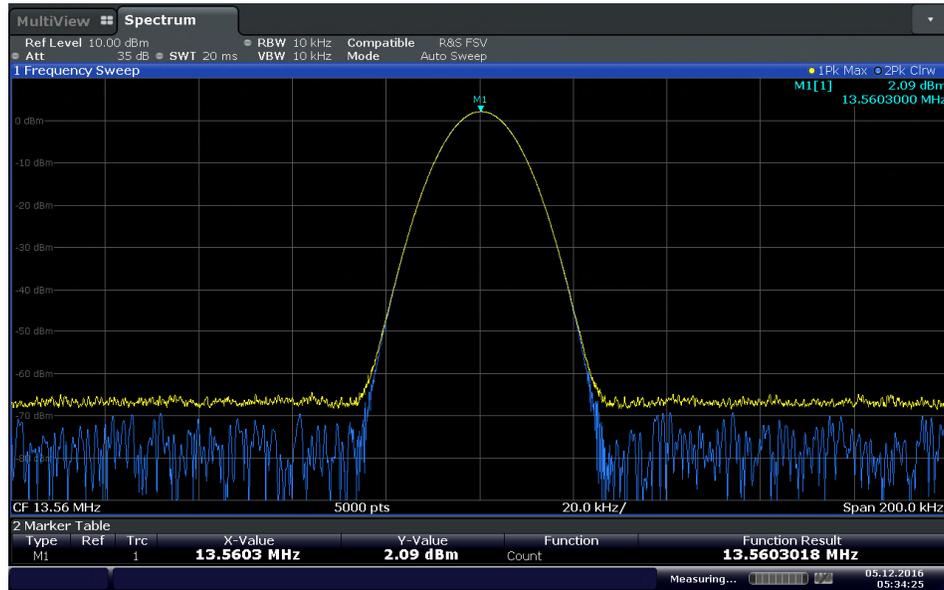
2.1.8 Test Results

RFID @ 13.56MHz					
Voltage (%)	Power (VDC)	Temp (°C)	Frequency (Hz)	Frequency Deviation	Deviation (%)
100	6.0	+18	13.5604104	0.0008190	0.00303
100		+20	13.5604006	0.0006757	0.00295
100		+25	13.5603790	0.0006757	0.00279
100		+35	13.5603360	0.0009672	0.00248
100		+45	13.5603018	0.0005579	0.00223
Voltage Variation (85% and 115%)	5.1	+20	13.5604012	0.0003290	0.00296
	6.9	+20	13.5604009	0.0006916	0.00296

Maximum Deviation = 0.00303%
 = 0.00303% < 0.01% Limit **(Complies)**

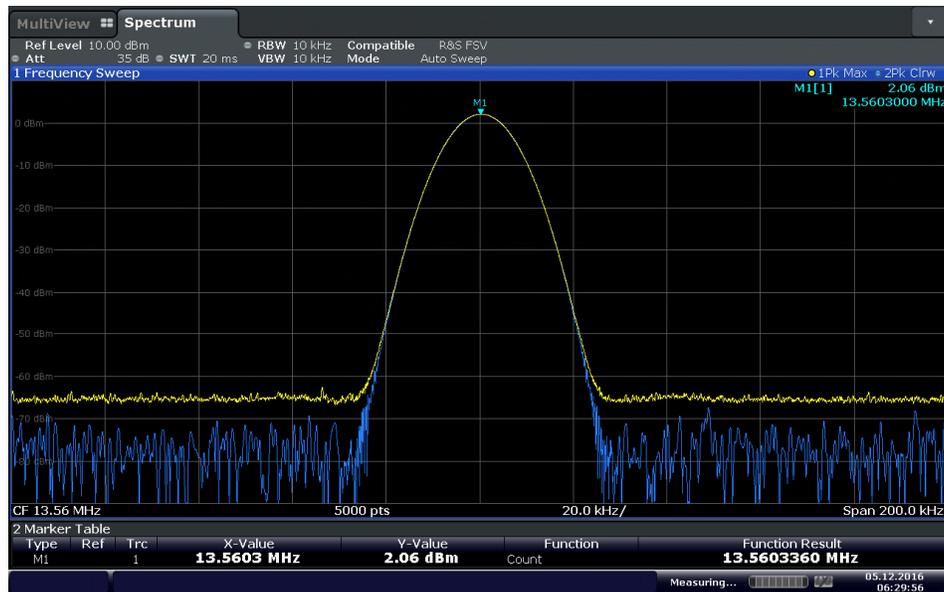


2.1.9 Test Plots



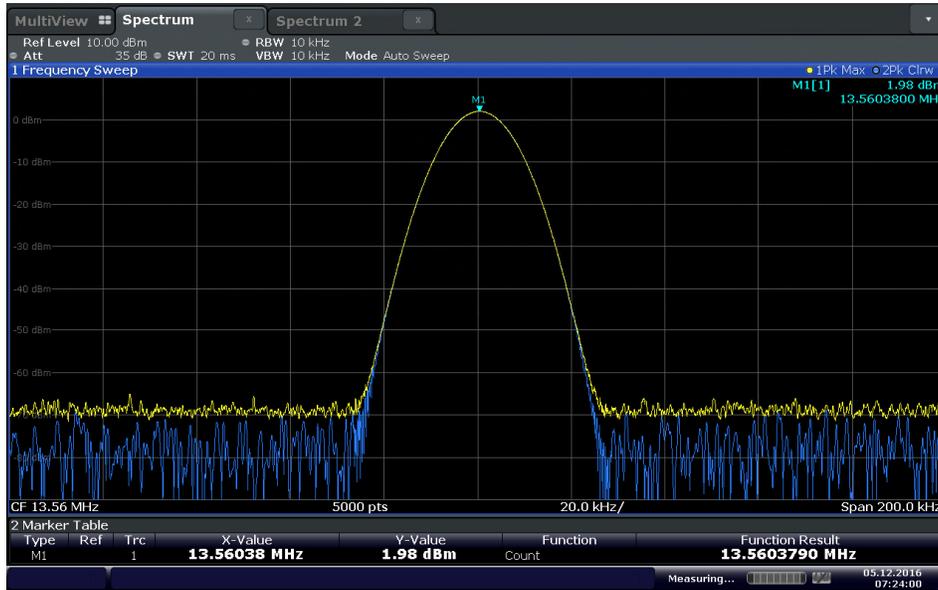
Date: 5.DEC.2016 05:34:24

Nominal Voltage @ 45°C

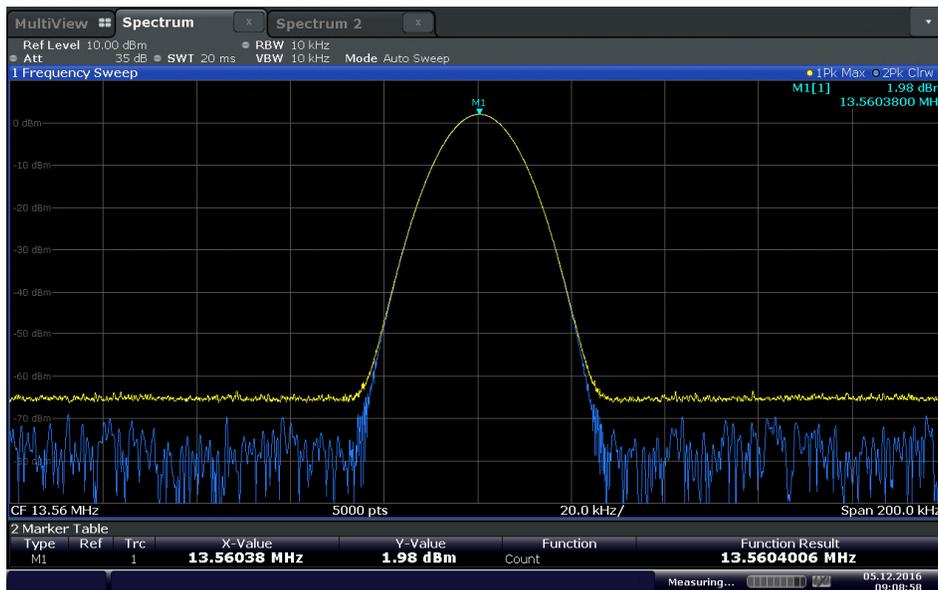


Date: 5.DEC.2016 06:29:56

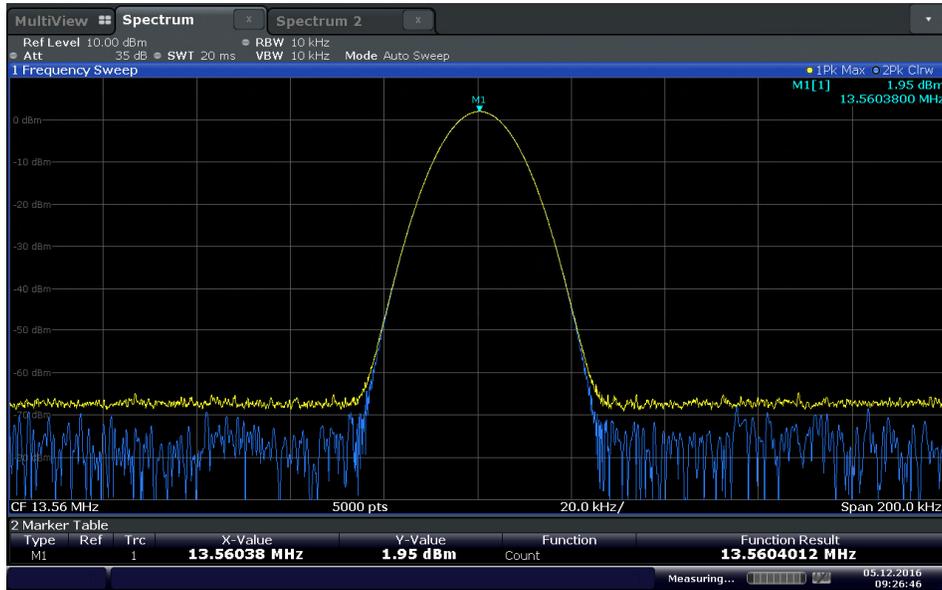
Nominal Voltage @ 35°C



Nominal Voltage @ 25°C

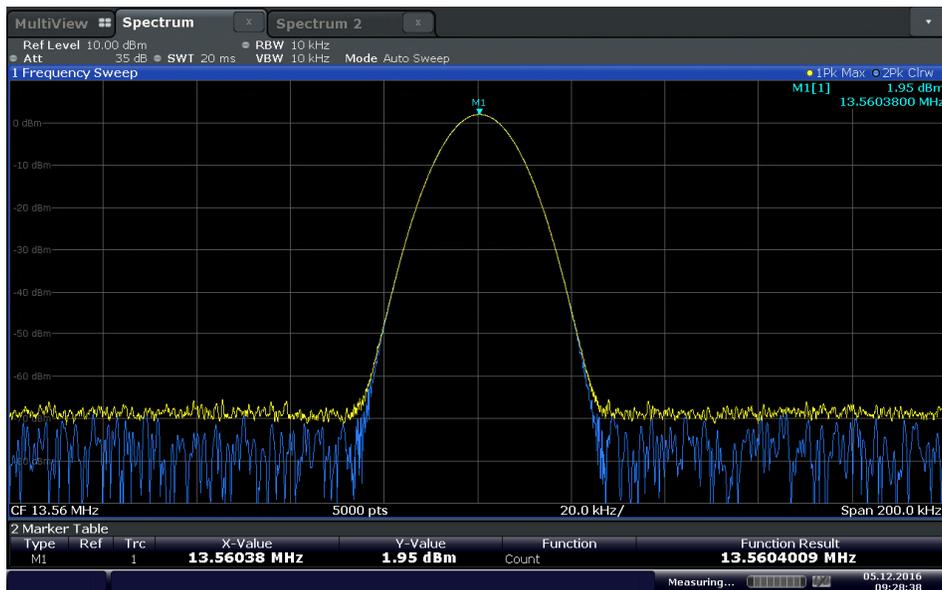


Nominal Voltage @ 20°C



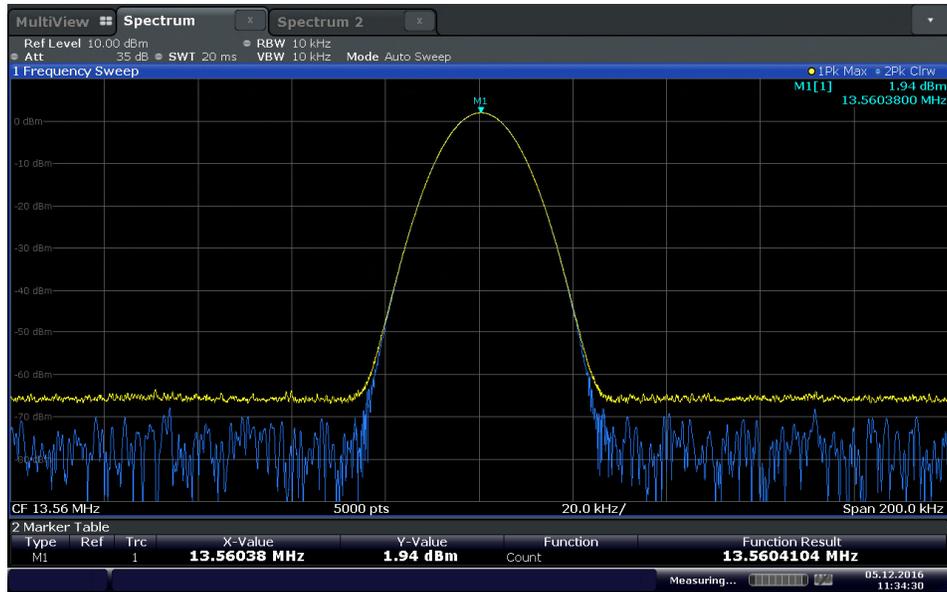
Date: 5 DEC.2016 09:26:45

5.1VDC @ 20°C



Date: 5 DEC.2016 09:28:38

6.9VDC @ 20°C



Date: 5 DEC.2016 11:34:30

Nominal Voltage @ 18°C



2.2 20 dB BANDWIDTH

2.2.1 Specification Reference

Part 15 Subpart C §15.215(c)

2.2.2 Standard Applicable

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

2.2.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167 / Test Configuration A

2.2.4 Date of Test/Initial of test personnel who performed the test

December 07, 2016/FSC

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

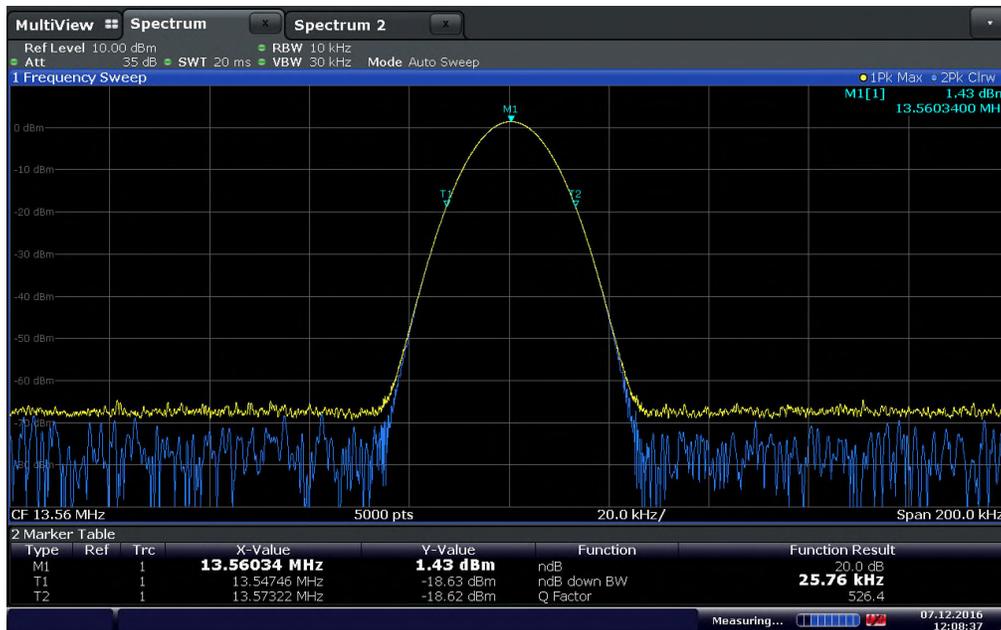
Ambient Temperature	23.1 °C
Relative Humidity	44.4 %
ATM Pressure	99.9 kPa

2.2.7 Additional Observations

- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- Since RBW wasn't specified, RBW was set to 10 kHz (standard bandwidth) for the band 150 kHz to 30 MHz This is worst case compared to 1% to 5% of the OBW.VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The "n" dB down marker function of the spectrum analyser was used for this test.

2.2.8 Test Results

Frequency	20dB bandwidth
13.56 MHz	25.76 kHz



Date: 7.DEC.2016 12:08:37

Measured 20dB Bandwidth: 25.76 kHz
 Frequency Band: 13.110 to 14.010 MHz

13.56 MHz – (20dB BW/2) = 13.54712 MHz (within the frequency band - **Compliant**)
 13.56 MHz + (20dB BW/2) = 13.57288 MHz (within the frequency band - **Compliant**)



2.3 99% EMISSION BANDWIDTH

2.3.1 Specification Reference

RSS-Gen Clause 6.6

2.3.2 Standard Applicable

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167 / Test Configuration A

2.3.4 Date of Test/Initial of test personnel who performed the test

December 07, 2016/FSC

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	23.1 °C
Relative Humidity	44.4 %
ATM Pressure	99.9 kPa

2.3.7 Additional Observations

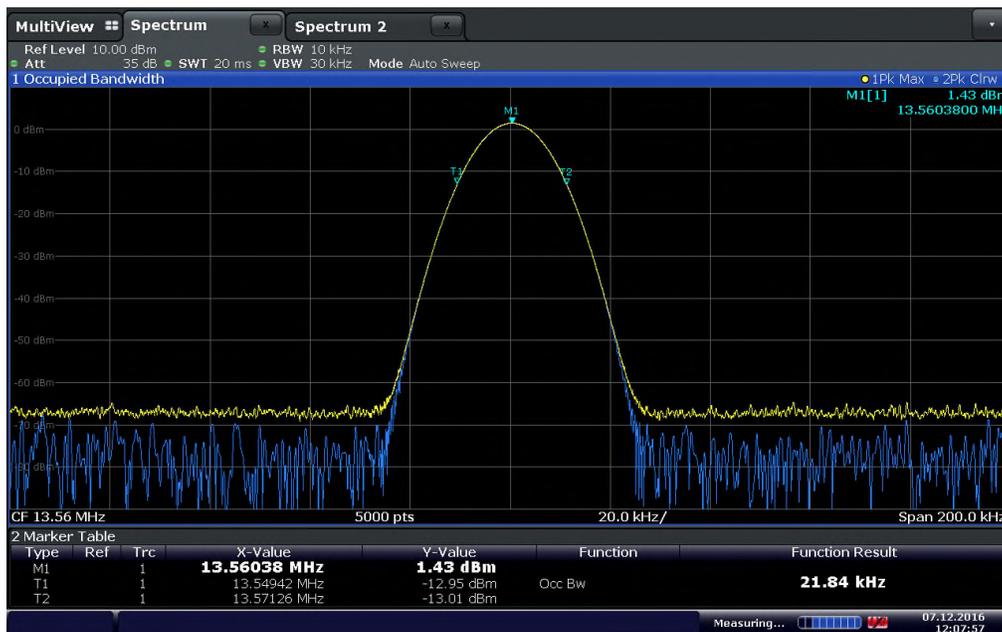
- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- Since RBW wasn't specified, RBW was set to 10 kHz (standard bandwidth) for the band 150 kHz to 30 MHz This is worst case compared to 1% to 5% of the expected OBW.VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.



- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

2.3.8 Test Results (Reporting Purposes Only)

Frequency	99% Emission bandwidth
13.56 MHz	21.84 kHz



Date: 7.DEC.2016 12:07:57



2.4 EMISSION MASK

2.4.1 Specification Reference

Part 15 Subpart C §15.225(a)(b)(c) and RSS-210 B.6(a)(b)(c)

2.4.2 Standard Applicable

- (a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
- (b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- (c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

2.4.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167 / Test Configuration B

2.4.4 Date of Test/Initial of test personnel who performed the test

January 06, 2017 /FSC

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 23.5 °C
 Relative Humidity 48.6 %
 ATM Pressure 99.8 kPa

2.4.7 Additional Observations

- This is a radiated test. The spectrum was searched from 13.110 MHz to 14.010 MHz.
- Limits were converted from 30 meters to 3 meters using 40 dB/decade extrapolation rules.
- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.4.8 for sample computation.

2.4.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 13.56MHz		15.0
Correction Factor (dB)	Asset# 1026 (cable)	0.6
	Asset# 1057 3m (cable)	0.7
	Asset# 6628 (antenna)	19.9
	Asset# 1187(cable)	0.3
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz		36.5



2.4.9 Sample Computation (Limits)

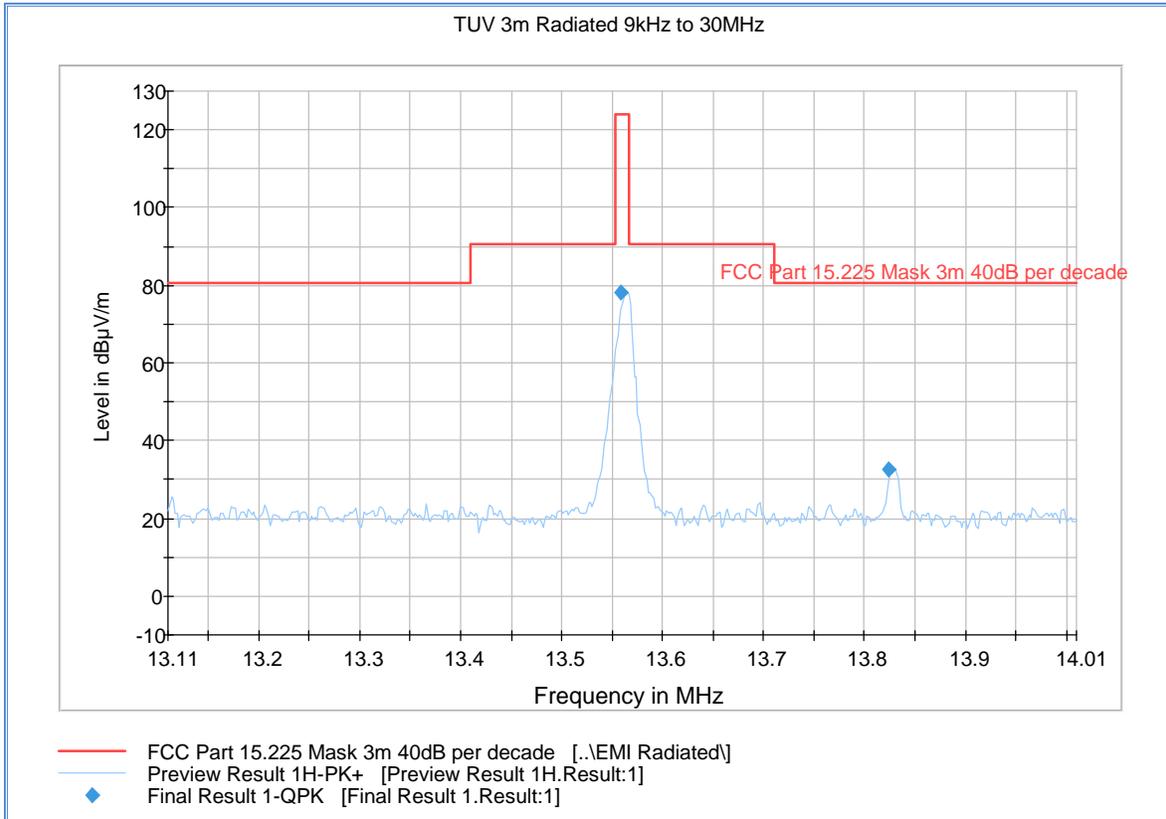
Limit @ 13.553–13.567 MHz:	= 15,848 $\mu\text{V}/\text{m}$ @30 meters
	= $20 \log(15,848 \mu\text{V}/\text{m})$
	= 84 dB $\mu\text{V}/\text{m}$ @30 meters
Using 20dB/decade extrapolation rule:	= $40 \log(30\text{m}/3\text{m})$
Measuring distance correction factor:	= 40 dB
Calculated limit @ 3 meters:	= 84 dB $\mu\text{V}/\text{m}$ + 40 dB
	= 124 dB $\mu\text{V}/\text{m}$

2.4.10 Test Results

Complies. See attached plot.



2.4.11 Test Results



Quasi Peak Data (§15.225 Limits)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
13.558509	78.3	1500.0	9.000	100.0	H	57.0	15.4	45.7	124.0
13.823639	32.5	1500.0	9.000	120.0	H	341.0	15.4	48.0	80.5



2.5 SPURIOUS RADIATED EMISSIONS

2.5.1 Specification Reference

Part 15 Subpart C §15.225(d) and RSS-210 B.6(d)

2.5.2 Standard Applicable

(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

2.5.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167 / Test Configuration B

2.5.4 Date of Test/Initial of test personnel who performed the test

January 05 and 06, 2017 /FSC

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 23.5 °C
 Relative Humidity 48.6 %
 ATM Pressure 99.8 kPa

2.5.7 Additional Observations

- This is a radiated test. The spectrum was searched from 9kHz to 1GHz
- There were no emissions found that do not comply with the restricted bands defined in FCC Part 15 Subpart C, 15.205.
- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.5.8 for sample computation.

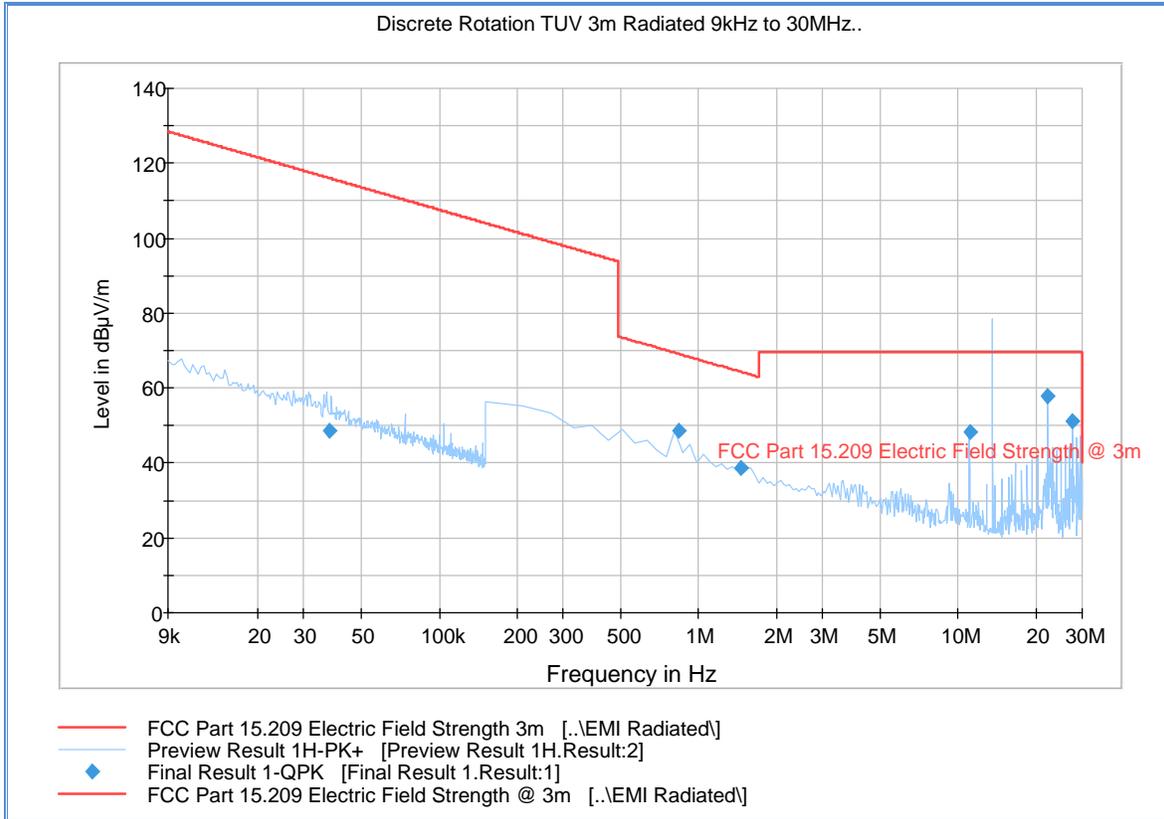
2.5.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			11.8

2.5.9 Test Results

See attached plots.

2.5.10 Test Results Below 30MHz



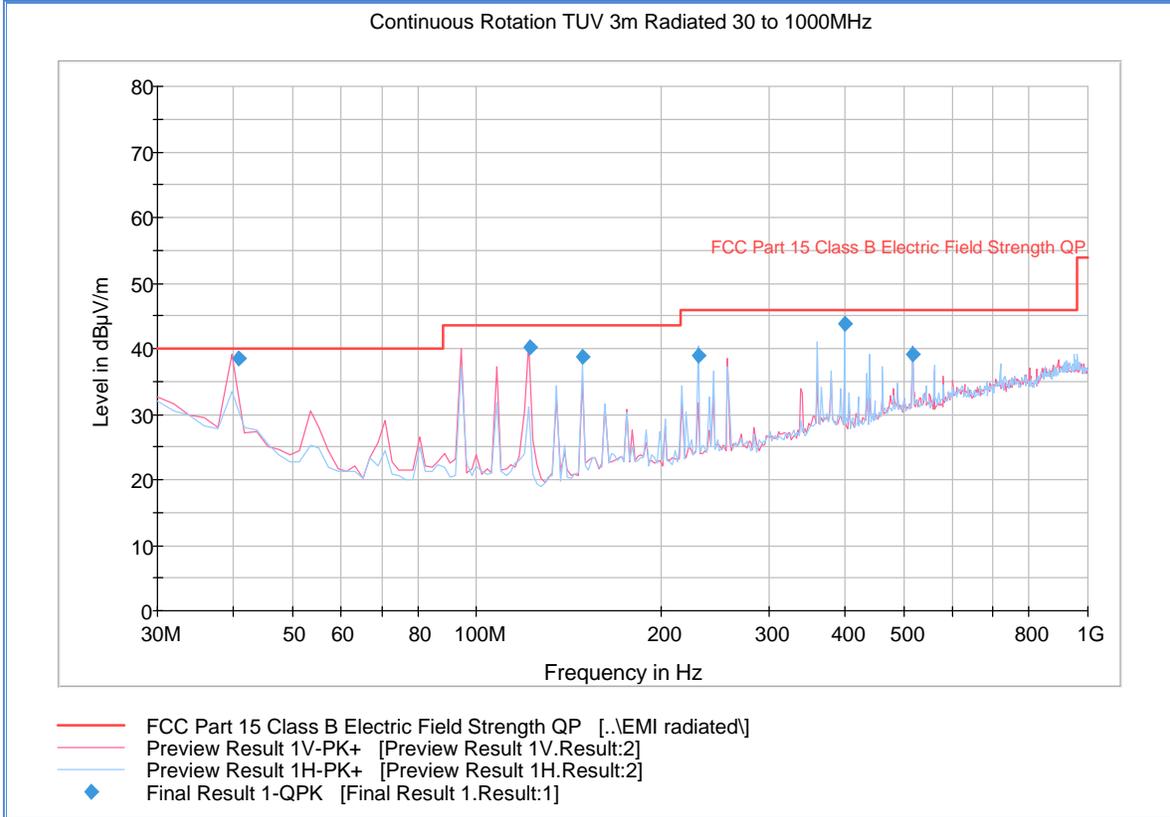
Quasi Peak Data (§15.209 Limits)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
0.037691	48.6	1000.0	0.200	100.0	H	100.0	15.2	67.5	116.1
0.833016	48.7	1500.0	9.000	100.0	H	97.0	14.5	20.5	69.2
1.459032	38.8	1500.0	9.000	100.0	H	97.0	14.8	25.5	64.3
11.058174	48.3	1500.0	9.000	100.0	H	-31.0	15.4	21.3	69.5
22.120627	57.9	1500.0	9.000	100.0	H	104.0	15.1	11.7	69.5
27.652034	51.3	1500.0	9.000	100.0	H	74.0	14.2	18.2	69.5

Test Notes: Fundamental frequency ignored (13.56 MHz)



2.5.11 Test Results 30MHz to 1GHz



Quasi Peak Data (§15.209 Limits)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
40.679439	38.5	1000.0	120.000	100.0	V	306.0	-11.1	1.5	40.0
122.042725	40.2	1000.0	120.000	100.0	V	-8.0	-14.2	3.3	43.5
149.177154	38.8	1000.0	120.000	121.0	H	78.0	-12.0	4.7	43.5
230.540441	38.9	1000.0	120.000	100.0	H	313.0	-8.1	7.1	46.0
399.978677	43.8	1000.0	120.000	100.0	H	15.0	-2.2	2.2	46.0
515.291944	39.2	1000.0	120.000	100.0	V	0.0	1.4	6.8	46.0



2.6 CONDUCTED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.6.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

2.6.3 Equipment Under Test and Modification State

Serial No: SM-M2-MH-2.2 2230160167/Test Configuration A

2.6.4 Date of Test/Initial of test personnel who performed the test

December 07, 2016/FSC

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 23.1 °C
Relative Humidity 44.4 %
ATM Pressure 99.9 kPa

2.6.7 Additional Observations

- The EUT is a module and was verified installed on a development board to show compliance to the general limits of §15.207(a).
- The antenna port of the module was terminated to a 50 Ω load for this test.



- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.6.8 for sample computation.

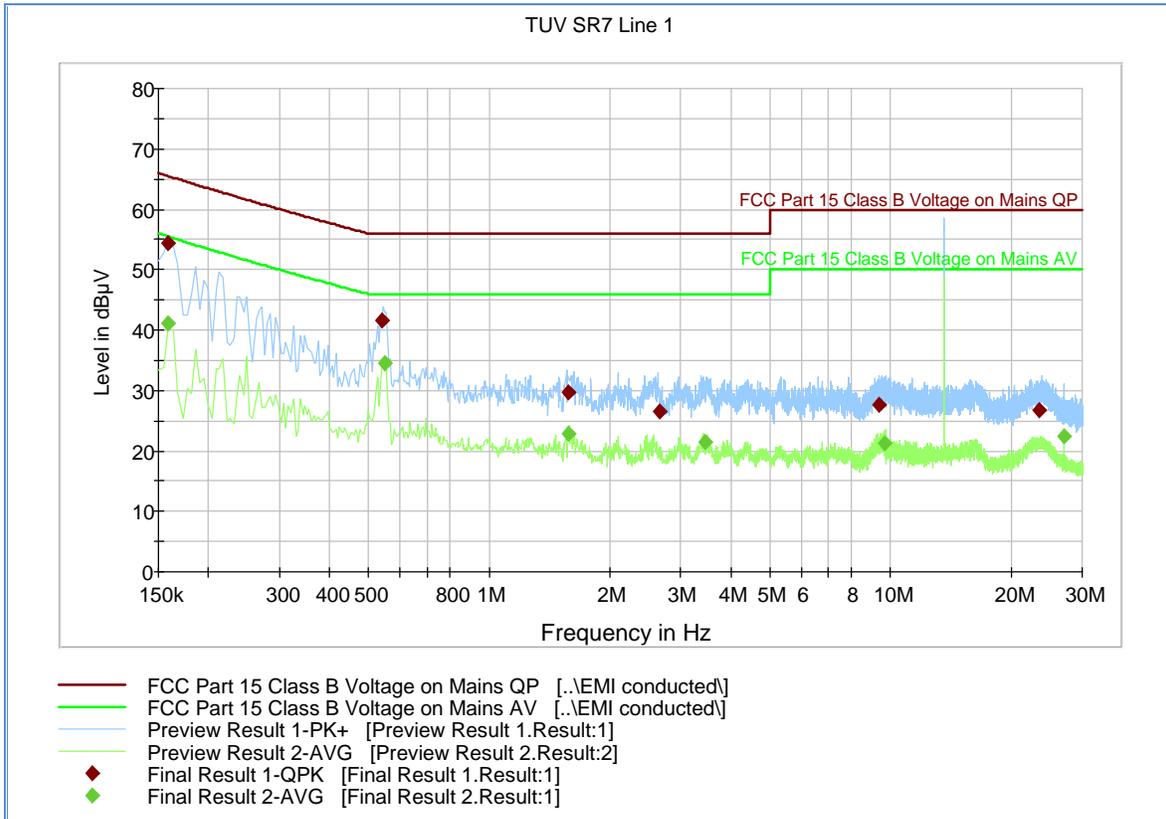
2.6.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (db μ V) @ 150kHz		5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9
	Asset# 1177 (cable)	0.15
	Asset# 1176 (cable)	0.35
	Asset# 7568 (LISN)	0.30
Reported QuasiPeak Final Measurement (dbμV) @ 150kHz		26.2

2.6.9 Test Results

Compliant. See attached plots and tables.

2.6.10 120VAC 60Hz (Line 1)



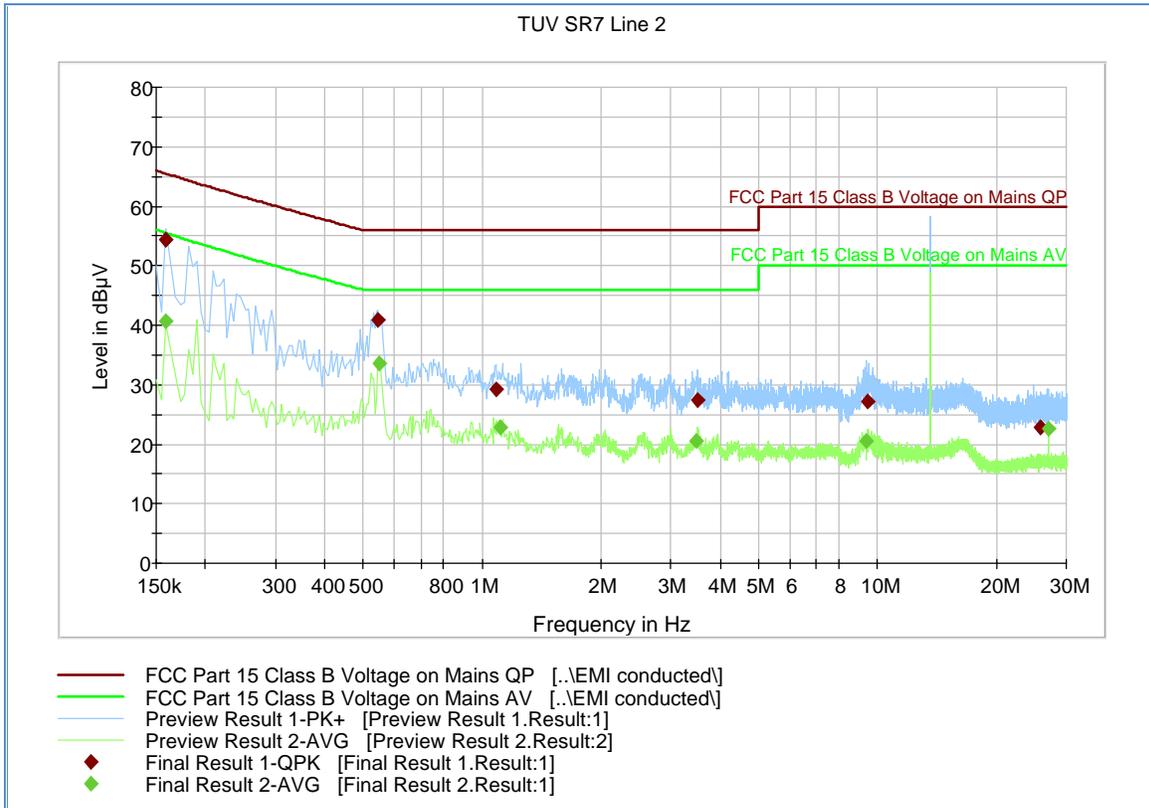
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.159000	54.3	1000.0	9.000	Off	L1	20.2	11.2	65.5
0.541500	41.6	1000.0	9.000	Off	L1	20.0	14.4	56.0
1.576500	29.8	1000.0	9.000	Off	L1	20.0	26.2	56.0
2.656500	26.4	1000.0	9.000	Off	L1	20.1	29.6	56.0
9.361500	27.6	1000.0	9.000	Off	L1	20.1	32.4	60.0
23.437500	26.7	1000.0	9.000	Off	L1	20.5	33.3	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.159000	41.2	1000.0	9.000	Off	L1	20.2	14.3	55.5
0.550500	34.5	1000.0	9.000	Off	L1	20.0	11.5	46.0
1.576500	22.9	1000.0	9.000	Off	L1	20.0	23.1	46.0
3.453000	21.4	1000.0	9.000	Off	L1	20.1	24.6	46.0
9.694500	21.2	1000.0	9.000	Off	L1	20.2	28.8	50.0
27.123000	22.4	1000.0	9.000	Off	L1	20.5	27.6	50.0

2.6.11 120VAC 60Hz (Line 2)



Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.159000	54.4	1000.0	9.000	Off	N	20.2	11.1	65.5
0.546000	41.0	1000.0	9.000	Off	N	20.0	15.0	56.0
1.086000	29.4	1000.0	9.000	Off	N	20.0	26.6	56.0
3.516000	27.5	1000.0	9.000	Off	N	20.1	28.5	56.0
9.447000	27.2	1000.0	9.000	Off	N	20.1	32.8	60.0
25.737000	22.8	1000.0	9.000	Off	N	20.4	37.2	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.159000	40.8	1000.0	9.000	Off	N	20.2	14.7	55.5
0.550500	33.6	1000.0	9.000	Off	N	20.0	12.4	46.0
1.113000	22.8	1000.0	9.000	Off	N	20.0	23.2	46.0
3.489000	20.6	1000.0	9.000	Off	N	20.1	25.4	46.0
9.375000	20.6	1000.0	9.000	Off	N	20.1	29.4	50.0
27.118500	22.7	1000.0	9.000	Off	N	20.4	27.3	50.0



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Emissions						
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
7568	LISN	FCC-LISN-50-25-2-10	120305	Fischer Custom Comm.	11/05/16	11/05/17
6837	LISN	FCC-LISN-50-25-2	5025	Fischer Custom Comm.	03/29/16	03/29/17
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	02/29/16	02/28/17
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	02/29/16	02/28/17
Antenna Conducted Port						
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	10/26/16	10/26/17
8607	20dB Attenuator	CAT-20	N/A	MCL HAT-20	10/10/16	10/10/17
7579	Temperature Chamber	115	151617	TestQuity	08/25/16	08/25/17
Radiated Emission						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/06/15	11/06/17
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/07/16	10/07/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
7640	Loop Antenna	AL-130R	121086	Com-Power	11/21/16	11/21/17
Miscellaneous						
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/29/16	08/29/17
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	Sper Scientific	08/22/16	08/22/17
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

3.2.1 Radiated Measurements (Below 30MHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
4	Loop Antenna	Rectangular	0.75	0.44	0.19
5	Site	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					1.76
Coverage Factor (k):					2
Expanded Uncertainty:					3.53

3.2.2 Radiated Measurements (Below 1GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					1.78
Coverage Factor (k):					2
Expanded Uncertainty:					3.57

3.2.1 AC Conducted Emissions

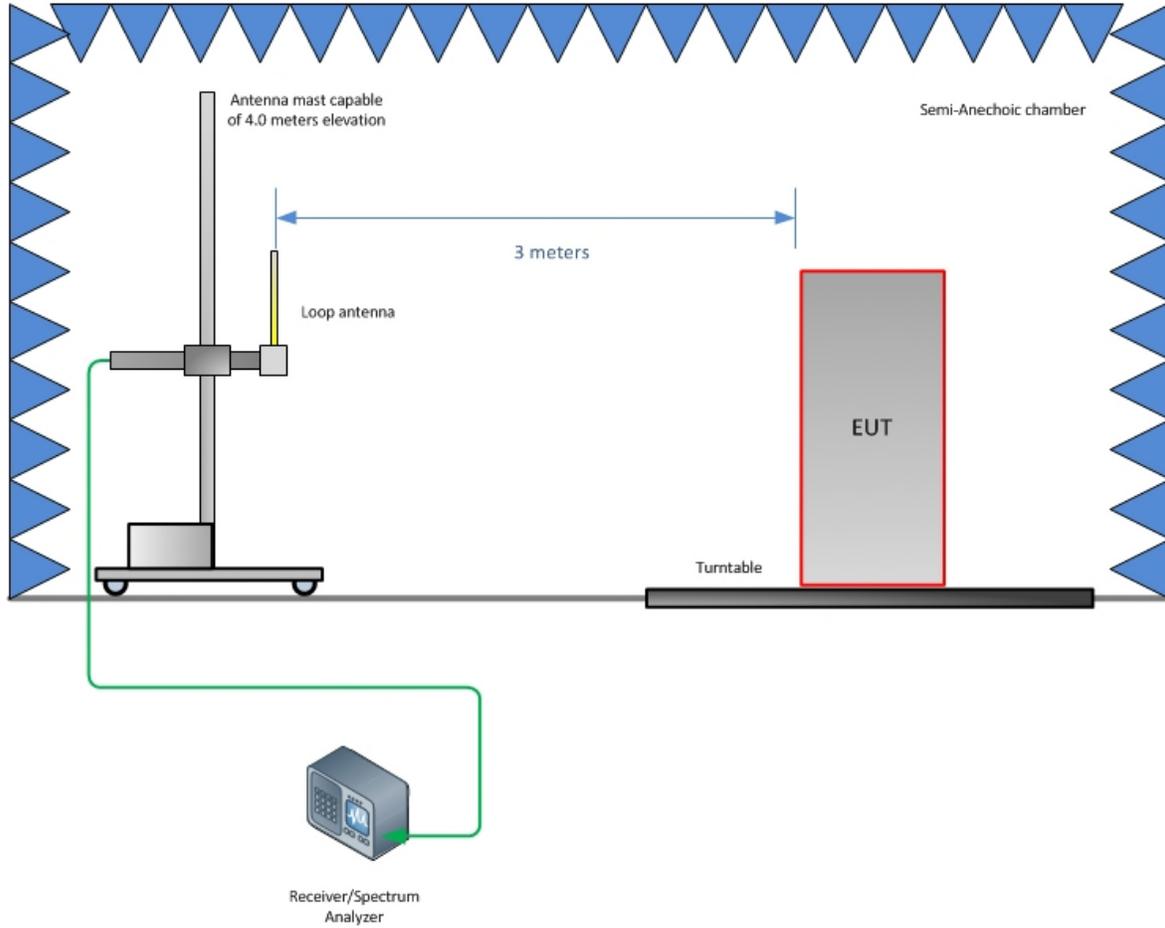
Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.36	0.21	0.04
2	Cables	Rectangular	0.50	0.29	0.08
3	LISN	Rectangular	0.66	0.38	0.15
4	Attenuator	Rectangular	0.30	0.17	0.03
5	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					0.80
Coverage Factor (k):					2
Expanded Uncertainty:					1.59



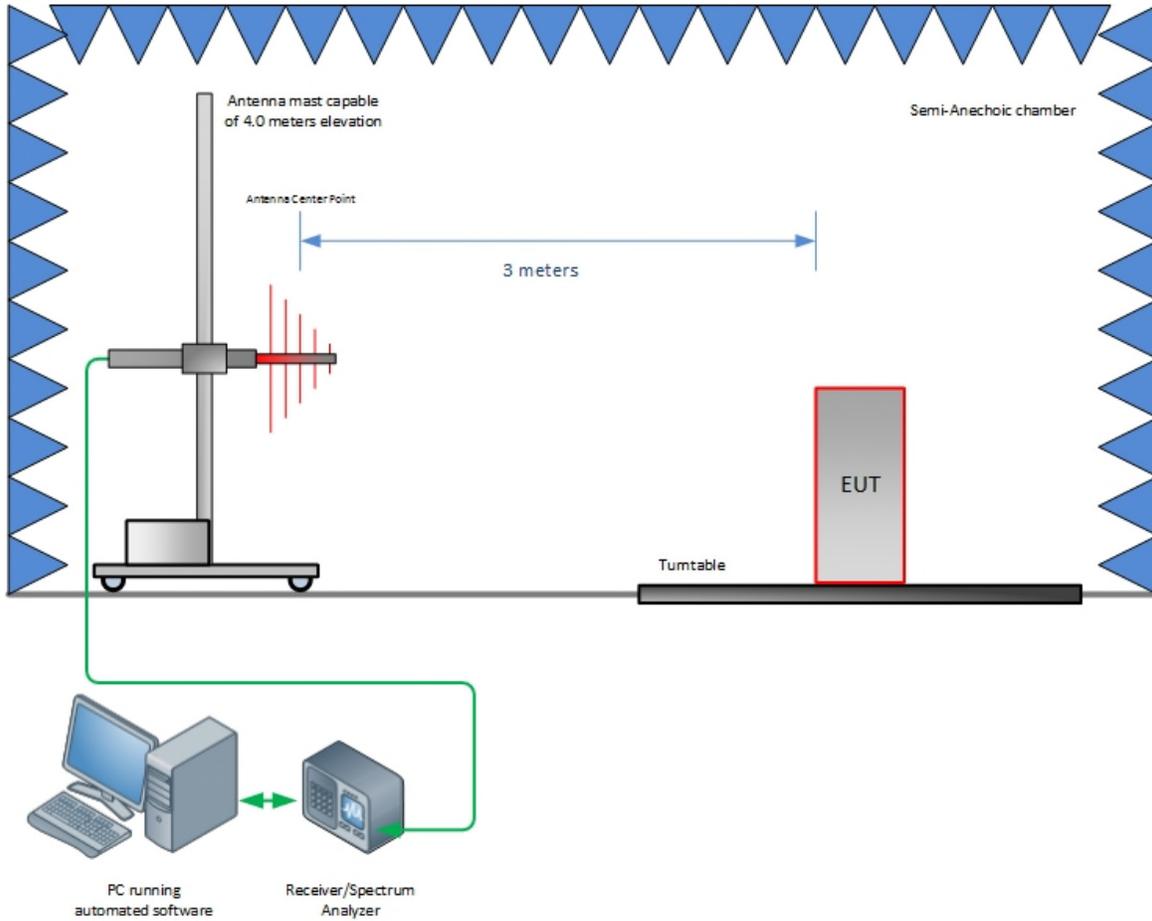
SECTION 4

DIAGRAM OF TEST SETUP

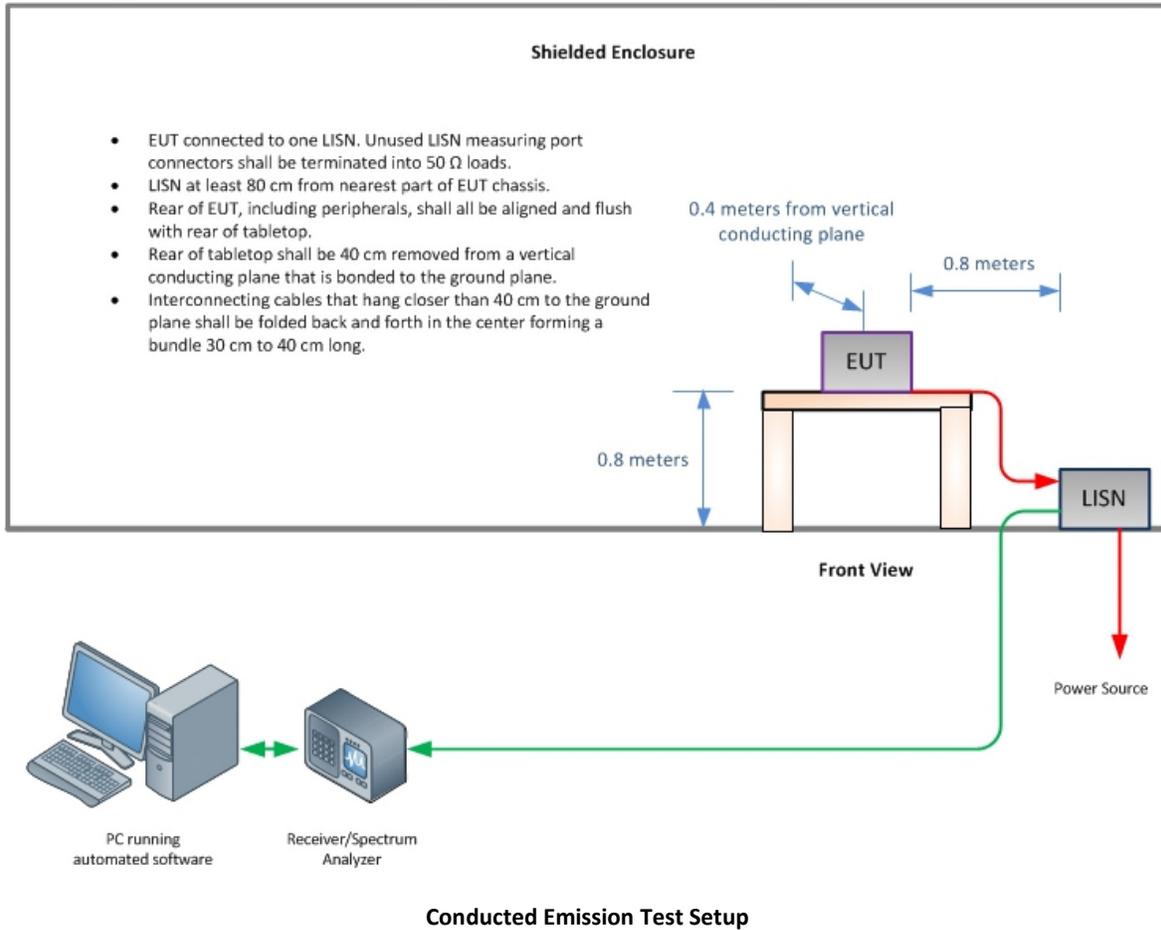
4.1 TEST SETUP DIAGRAM (EMISSION MASK AND BELOW 30MHZ)

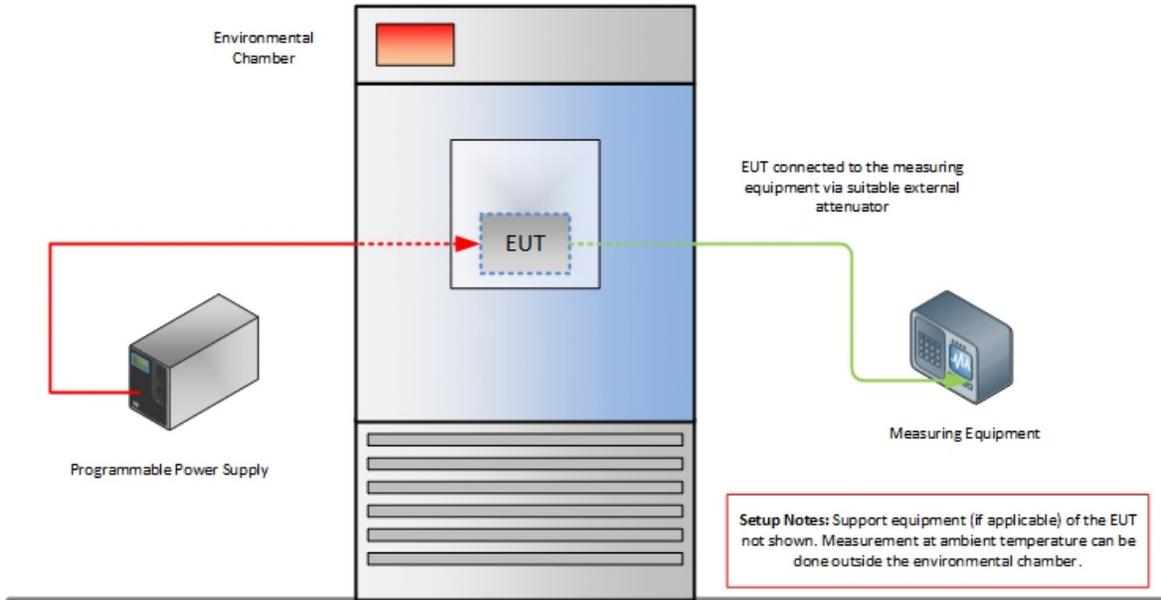


4.2 TEST SETUP DIAGRAM (30MHZ TO 1GHZ)



Radiated Emission Test Setup (Below 1GHz)





Transmission Spectrum Mask Test Configuration



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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