Radio Testing of the

IPS Group Inc.
Smart Parking Meter with BLE and NFC Model: MK5

In accordance with FCC Part 15 Subpart C §15.225, IC RSS-210 Issue 9 August 2016 (Amendment November 2017) and KDB 996369 D04 Module Integration Guide V01

America

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IPS Group Inc.
7737 Kenamar Court
San Diego, CA 92121

COMMERCIAL-IN-CONFIDENCE

Date: September 2019
Document Number: 72153049C Issue 01 | Version Number: 01

Authorized Signatory	Alex Chang	October 10, 2019	alex chang

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart C §15.225 and IC RSS-210 Issue 9 August 2016 (Amendment November 2017).

A2LA Cert. No. 2955.13

ACCREDITATION
Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

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REPORT ON	Radio Testing of the IPS Group Inc. Model MK5 Smart Parking Meter with BLE and NFC
TEST REPORT NUMBER	72153049C
TEST REPORT DATE	September 2019
PREPARED FOR	IPS Group Inc. 7737 Kenamar Court San Diego, CA 92121
CONTACT PERSON	Gary Thomas Sr. RF Design Engineer gary.thomas@ipsgroupinc.com (858) 768-2401
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
APPROVED BY	Alex Chang **Name** Authorized Signatory Title: Senior EMC/Wireless Test Engineer
DATED	October 10, 2019

Revision History

72153049C IPS Group Inc. Model MK5 Smart Parking Meter with BLE and NFC					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
10/10/2018	Initial Release				Alex Chang

CONTENTS

SECTION 1

1 REPORT SUMMARY

Radio Testing of the
IPS Group Inc.
MK5 Smart Parking Meter with BLE and NFC

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the IPS Group Inc. MK5 Smart Parking Meter with BLE and NFC to the requirements of FCC Part 15 Subpart C §15.225 and IC RSS-210 Issue 9 August 2016 (Amendment November 2017).

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	IPS Group Inc.
EUT	Smart Parking Meter with BLE and NFC
Trade Name	Single Space Parking Meter
Model Name	MK5
FCC ID	SGWIPSSSPM080AB
IC Number	11583A-IPSSSPM080AB
FCC Classification	Low power Communications Device Transmitter (DXX)
Serial Number(s)	0467603
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.225 (October 1, 2018). • KDB 996369 D04 Module Integration Guide V01. Modular Transmitter Integration Guide— Guidance for Host Product Manufacturers • IC RSS-210 Issue 9 August 2016 (Amendment November 2017) – Licence-Exempt Radio Apparatus: Category I Equipment • IC RSS-Gen Issue 5 Ammendment 1 March 2019 - General Requirements for Compliance of Radio Apparatus.
Start of Test	September 24, 2019
Finish of Test	September 29, 2019
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	• ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices. • 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 and IC RSS-210 Issue 9 August 2016 (Amendment November 2017) with cross-reference to the corresponding IC RSS standard are 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 6.8	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 6.7	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 5.3	Receiver Spurious Emissions	N/A	See Test Note[2]
2.6		§15.207(a)	RSS-Gen 7.2	Conducted Emissions	N/A	Battery powered

Test Note1: The EUT uses a permanently attached antenna to the intentional radiator and is considered sufficient evidence 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 5.0.

1.3 Product Information

1.3.1 Technical Description

The Equipment Under Test (EUT) was an IPS Group Inc. Smart Parking Meter with BLE and NFC Model no. MK5The EUT is part of the Smart Metering Collection System. It uses RFID for cashbox identification, BLE for user pay by phone interface during collection process. NFC for tap and go payment by credit cards and Cellular for web-based Data Management System (DMS). The RFID function of the EUT was verified under this test report.

1.3.2 EUT General Description

EUT Description	Smart Parking Meter with BLE and NFC
Model Name	Single Space Parking Meter
Model Number(s)	MK5
Rated Voltage	• Lithium Battery (3.6V) IPS Group Inc. TL-5420/5P/IPS • Tadiran Batteries TLI-1550A 4V 330mAh (on-board battery)
RFID Module Output Power	100 mW or 200 mW (programmable)
EUT RFID Field Strength	61.7 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	Integral
RFID Antenna Connector	IPX U.FL RF Coaxial Connector
Modulation Used	ISO 15693 Compliant
Antenna Part Number	795-773-PCBA Rev-01

1.3.3 Other Approved Module Installed

Technology	Chip Set	FCC ID	Output Power	Antenna Gain/Type
Cellular	Telit LE910	RI7CE910SVV2	0.292 watt	0.5 dBi, IPS LTE Batwing 795-771-PCB Rev 01
BLE	Bluegiga Oy BLE113	QOQBGM13P	0.0011 watt	0.5 dBi, Mini 2.45 GHz Antenna, Johanson Technology P/N 2450AT18A100

**Information contained in this table were declared by the manufacturer.*

1.4 EUT Test configuration

1.4.1 Test Configuration Description

Test Configuration	*Description*
Default	Transmit Mode. RFID polling, a test card was provided by the manufacturer temporarily attached to the side of the EUT where the RFID antenna was located to initiate RFID polling. BLE set to single channel transmit mode and the cellular radio set to active under COMMS Test Mode. Once in COMMS Test Mode, a CMW500 was used to establish a call using LTE Bands 2, 4 and 13.

1.4.2 EUT Exercise Software

The EUT was running Diagnostic Software Version 62.70.7 when verified. RFID was activated by cycling through the menu until the RFID code was shown (e.g RFID:007000014D47F84).

1.4.3 Support Equipment and I/O cables

Manufacturer	*Equipment/Cable*	*Description*
N/A	N/A	-

1.4.4 Simplified Test Configuration Diagrams

Not required. EUT verified on standalone configuration. EUT is battery operated, nonetheless AC/DC adapter was provided by the manufacturer in order for the EUT to sustain extended testing time without totally draining the battery.

1.5 Deviations from the Standard

No deviations from the applicable test standards or test plan were made during testing.

1.6 Modification Record

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: 0467603		
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 – Designation 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 Designation is US1146.

1.9.2 Innovation, Science and Economic Development Canada (IC) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.

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-0280 and A-0281

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.

1.9.6 RRA – Identification No. US0102

TUV SUD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

1.9.7 OFCA – U.S. Identification No. US0102

TUV SUD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.

SECTION 2

2 TEST DETAILS

Radio Testing of the
IPS Group Inc.
MK5 Smart Parking Meter with BLE and NFC

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 ±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: 0467603 / Default Test Configuration

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

September 26, 2019/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 (Rancho Bernardo Satellite Facility)

Ambient Temperature	26.3°C
Relative Humidity	48.5%
ATM Pressure	98.8kPa

2.1.7 Additional Observations

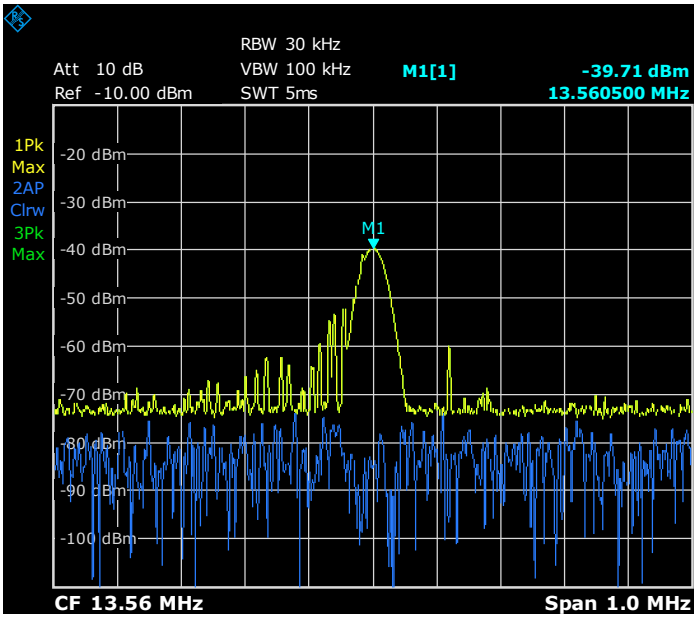
- This is a radiated test with the loop antenna next to the environmental chamber.
- Measurement was done using marker function of the spectrum analyser.
- The RBW was set to 30 kHz Hz for better resolution.
- The temperature was varied from −20°C to +50°C in 10 degree increments with voltage variation of 85% and 115% on the DC input port @ 20°C.
- The EUT was powered off, then powered on once the temperature stabilized and the frequency was then measured.
- The EUT is battery powered and being recharged via solar cells. Voltage variation was performed on the optional DC input (12VDC).

2.1.8 Test Results

RFID @ 13.56MHz					
Voltage (%)	***Power (VDC)***	***Temp (°C)***	***Frequency (Hz)***	***Frequency Deviation***	***Deviation (%)***
100	12	-20	13.560500	0.001	0.00737
100		-10	13.560500	0.001	0.00737
100		0	13.560500	0.001	0.00737
100		+10	13.560500	0.001	0.00737
100		+20	13.561500	0.000	0.00000
100		+30	13.560500	0.001	0.00737
100		+40	13.560500	0.001	0.00737
100		+50	13.560500	0.001	0.00737
Voltage Variation (85% and 115%)	10.2	+20	13.561500	0.000	0.00000
	13.8	+20	13.560500	0.001	0.00737

Maximum Deviation = 0.00737%
= 0.00737% < 0.01% Limit (**Complies**)

2.1.9 Sample Test Plots



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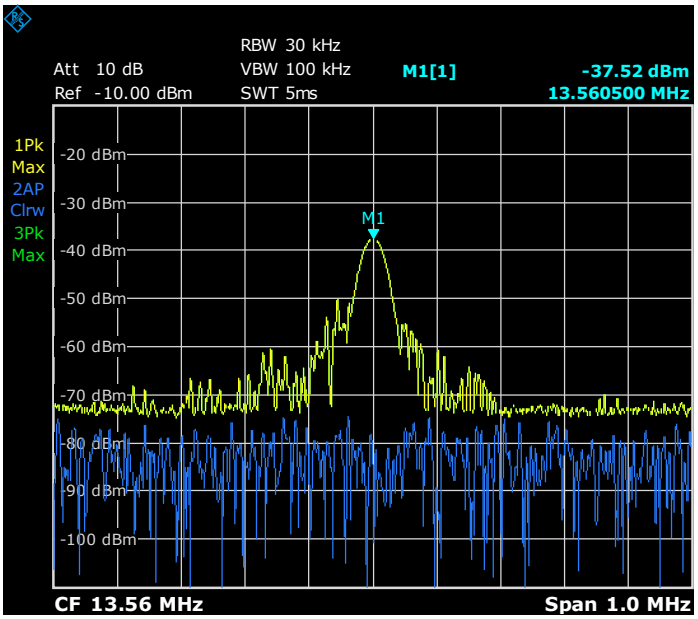
Nominal Voltage @ 40°C



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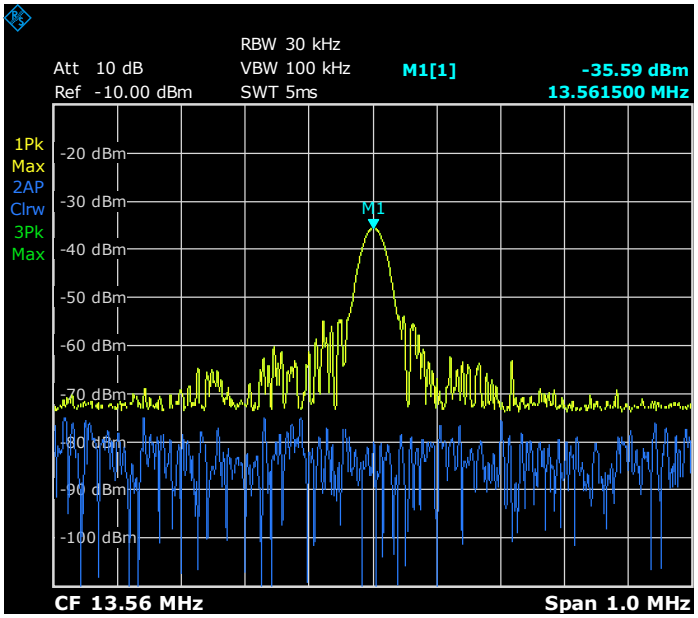
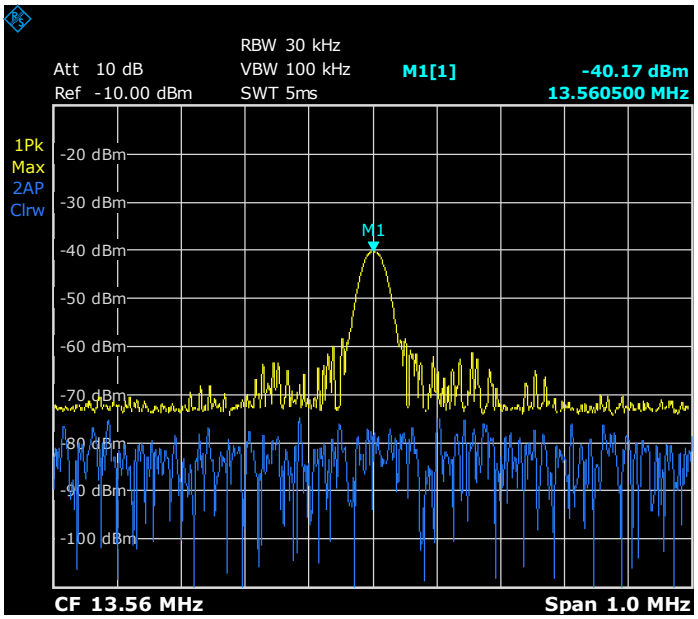
Nominal Voltage @ 30°C



Date: 26.SEP.2019 14:35:20

Nominal Voltage @ 20°C



Date: 26.SEP.2019 16:59:19

Nominal Voltage @ -10°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: 0467603 / Default Test Configuration

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

September 28, 2019/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 (Rancho Bernardo Satellite Facility)

Ambient Temperature	26.8°C
Relative Humidity	47.8%
ATM Pressure	99.56kPa

2.2.7 Additional Observations

- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- RBW is set from 1% to 5% of the anticipated 20 dB bandwidth.
- 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	12.84 kHz

Date: 28.SEP.2019 09:14:58

Measured 20dB Bandwidth: 12.84 kHz
Frequency Band: 13.110 to 14.010 MHz

13.56 MHz – (20dB BW/2) = 13.55358 MHz (within the frequency band - **Compliant**)
13.56 MHz + (20dB BW/2) = 13.56642 MHz (within the frequency band - **Compliant**)

2.3 99% EMISSION bandwidth

2.3.1 Specification Reference

RSS-Gen Clause 6.7

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 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 (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level 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 (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: 0467603 / Default Test Configuration

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

September 28, 2019/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 (Rancho Bernardo Satellite Facility)

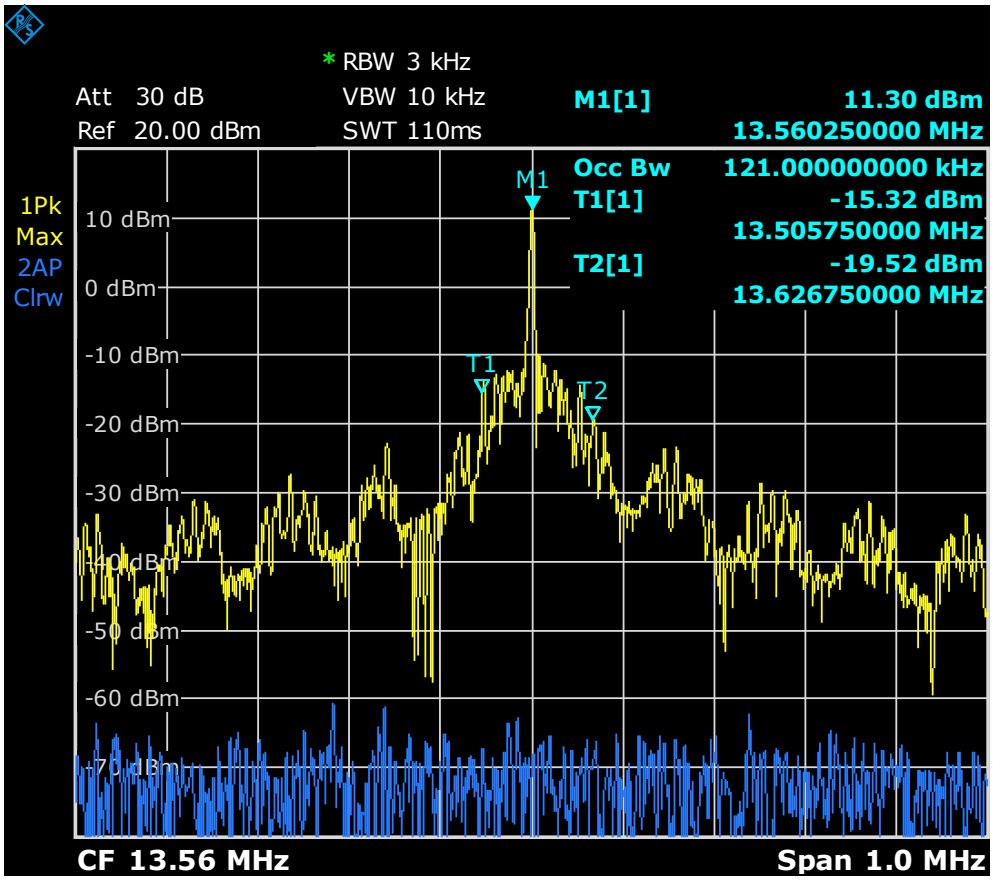
Ambient Temperature	26.8°C
Relative Humidity	47.8%
ATM Pressure	99.56kPa

2.3.7 Additional Observations

- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- RBW is set from 1% to 5% of the anticipated 99% EBW.
- 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	121.00 kHz



Date: 27.SEP.2019 17:07:03

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: 0467603 / Default Test Configuration

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

September 29, 2016 /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	25.2 °C
Relative Humidity	47.8 %
ATM Pressure	99.5 kPa

2.4.7 Additional Observations

- This is a radiated test. The spectrum was searched from 9kHz to 30MHz. Only 13.110 MHz to 14.010 MHz presented. There are no significant emissions observed other than the fundamental frequency (13.56 MHz) measured at 3 meters.
- Limits were converted from 30 meters to 3 meters using 40 dB/decade extrapolation rules.
- Measurement was done using EMC32 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	21.5
	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**

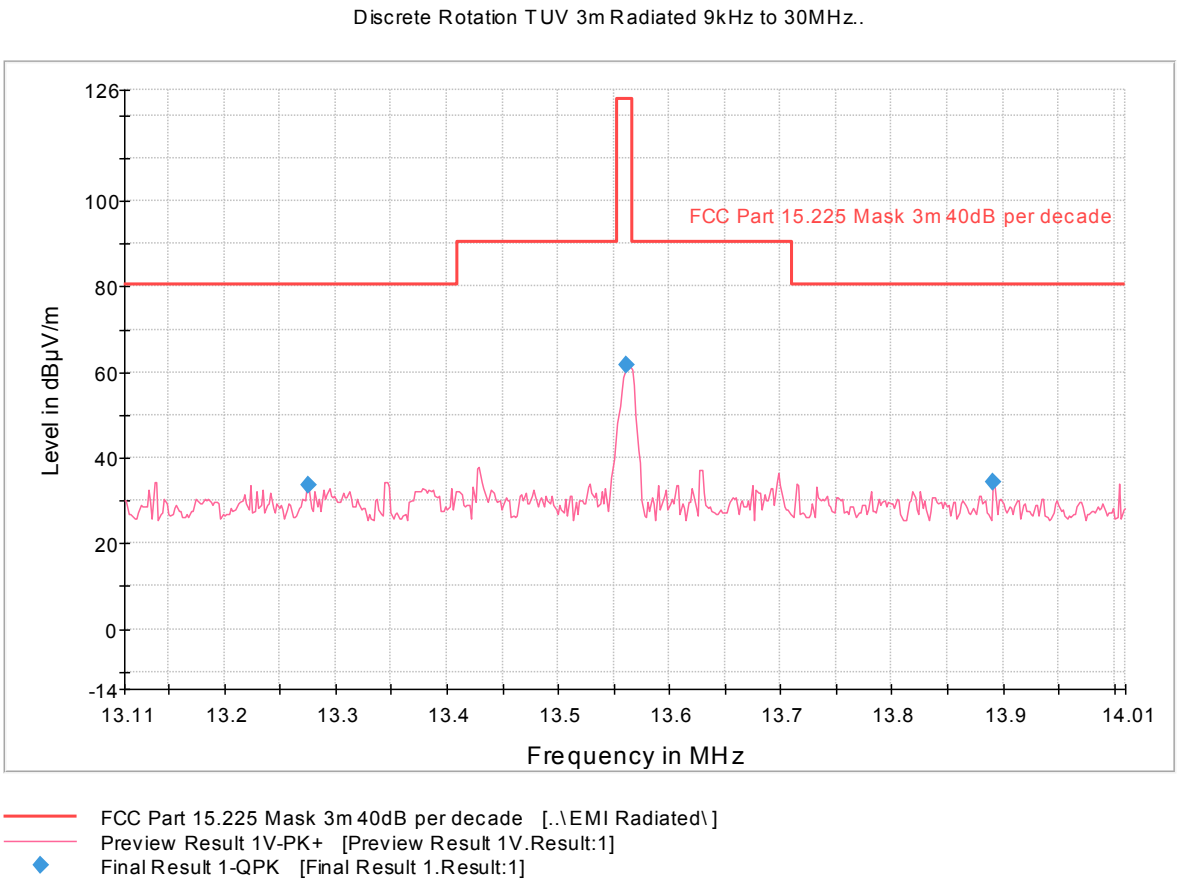
2.4.9 Sample Computation (Limits)

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

2.4.10 Test Results

See attached plots.

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)
13.275217	33.8	1500.0	9.000	100.0	V	7.0	21.7	46.7	80.5
13.561509	61.7	1500.0	9.000	100.0	V	0.0	21.8	62.3	124.0
13.890676	34.2	1500.0	9.000	100.0	V	345.0	21.9	38.3	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: 0467603 / Default Test Configuration

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

August 27, 2019/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 (Rancho Bernardo Satellite Facility)

Ambient Temperature	26.3°C
Relative Humidity	48.5%
ATM Pressure	98.8kPa

2.5.7 Additional Observations

- This is a radiated test. The spectrum was searched from 9kHz to 26GHz (to satisfy intentional emitter composite emissions requirement KDB996369 DO4 Module Integration Guide V01, e.g. inclusion of BLE and Cellular RF module). EUT does not support simultaneous transmission, intermodulation verification is not required.
- Only noise floor observed after 18GHz. Data presented is up to 18GHz only.
- Only worst-case channel per technology presented (Mid Channel for BLE and Mid Channel Band 2 for LTE).
- Initial prescan indicates similar spurious response between LTE Bands 2, 4 and 13. BW and Modulations also does not impact the test results. LTE verification was performed using 10MHz BW and QPSK modulation.
- There are 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 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.

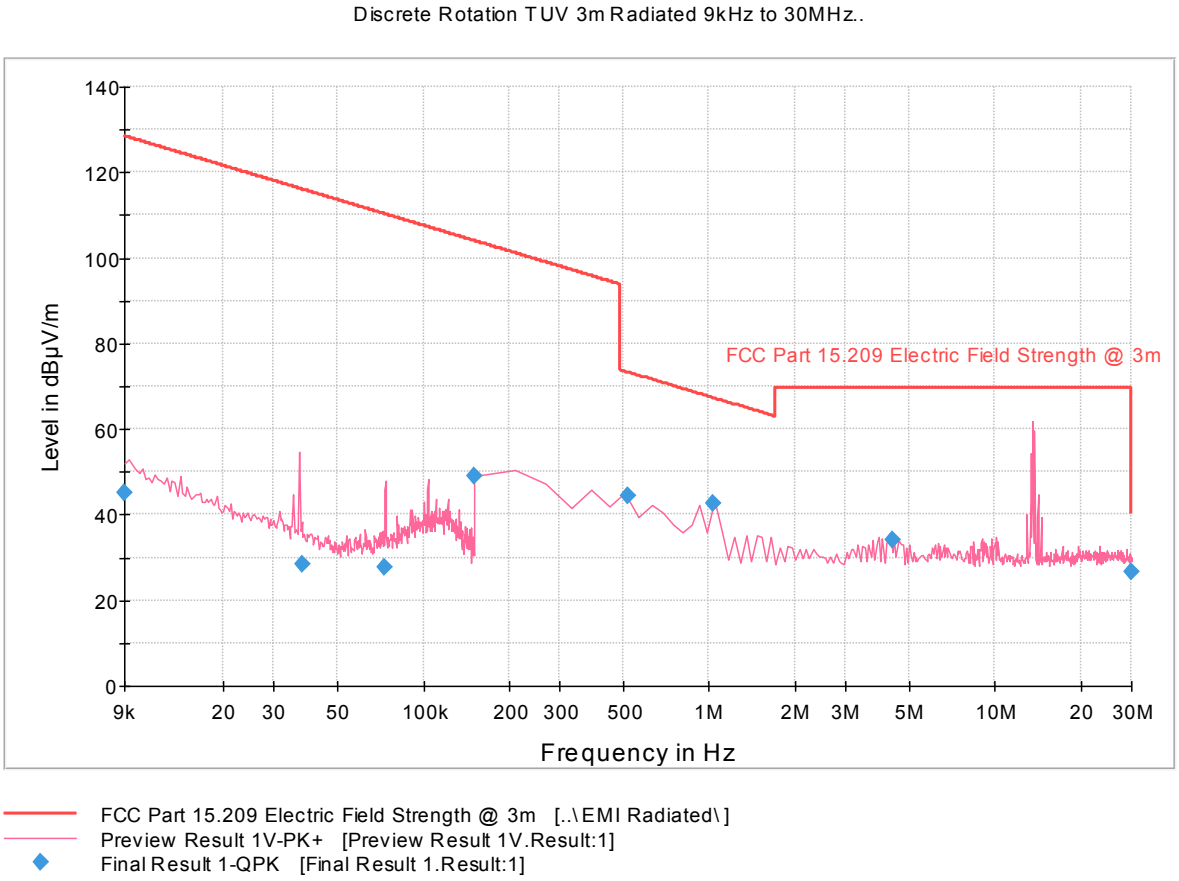
2.5.8 Sample Computation (Radiated Emission)

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.

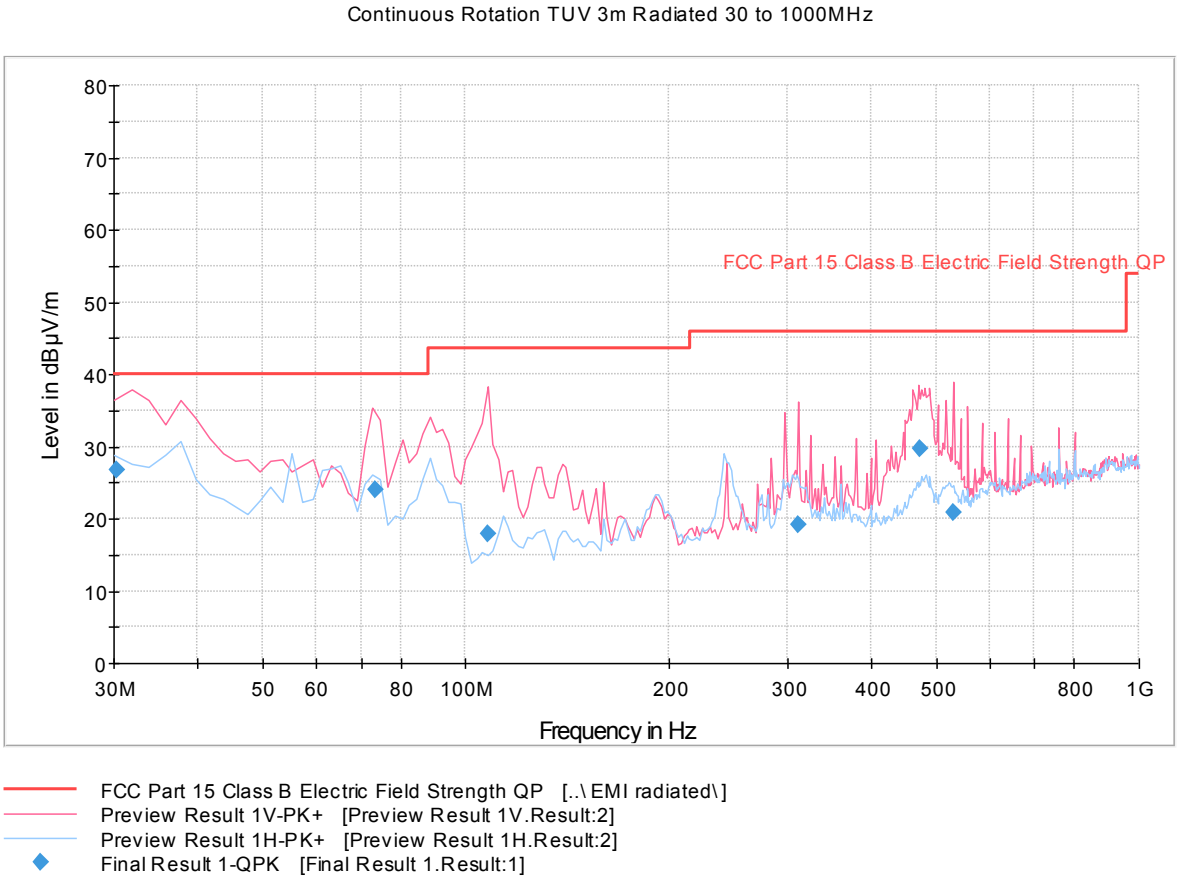
2.5.10 Test Results Below 30MHz (RFID Active)



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)
0.009000	45.2	1000.0	0.200	100.0	V	103.0	25.0	83.3	128.5
0.037691	28.5	1000.0	0.200	100.0	V	282.0	21.2	87.5	116.1
0.072707	27.6	1000.0	0.200	100.0	V	37.0	20.0	82.8	110.4
0.150000	49.1	1000.0	0.200	100.0	V	147.0	19.7	55.0	104.1
0.517918	44.3	1500.0	9.000	100.0	V	-9.0	19.8	29.1	73.3
1.036295	42.8	1500.0	9.000	100.0	V	101.0	20.1	24.5	67.3
4.358555	33.9	1500.0	9.000	100.0	V	-9.0	20.4	35.6	69.5
29.917000	26.6	1500.0	9.000	100.0	V	-15.0	25.1	42.9	69.5

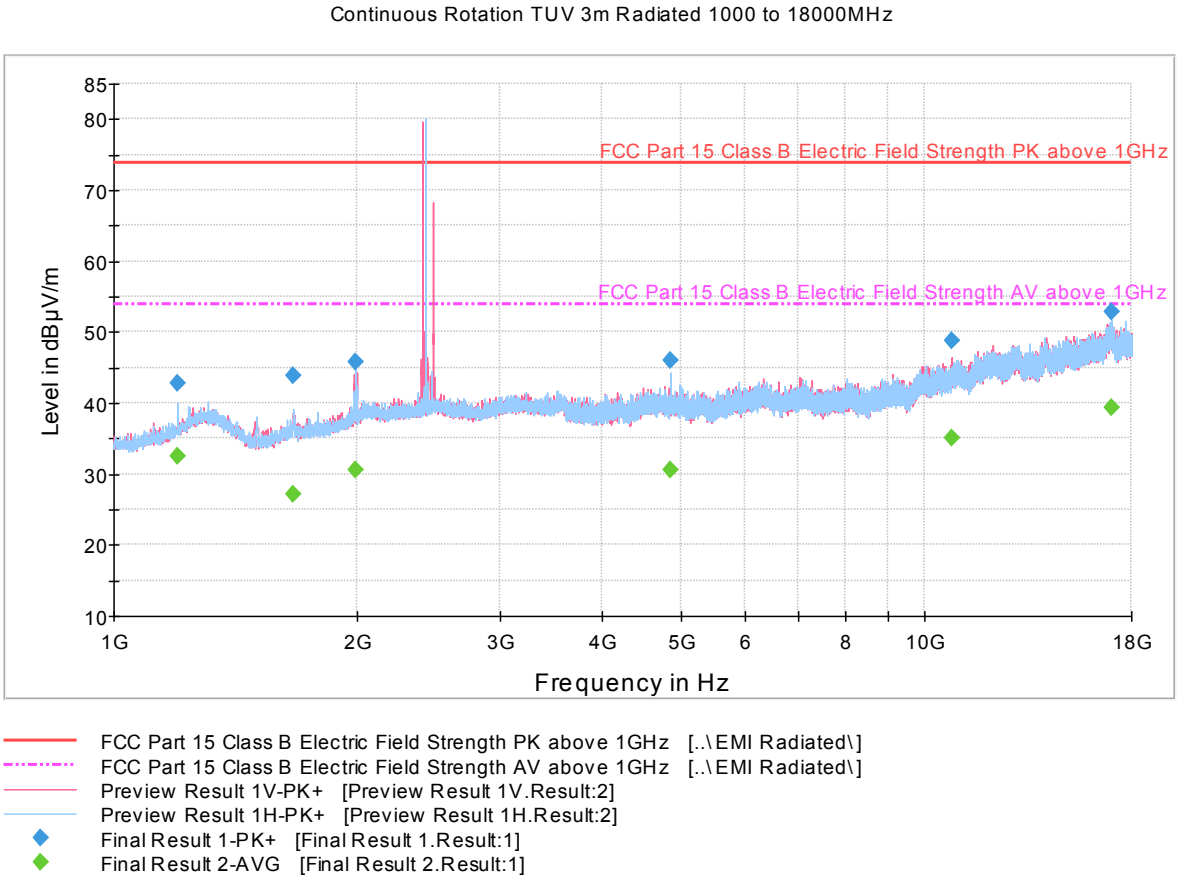
2.5.11 Test Results 30MHz to 1GHz (RFID Active)



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)
30.240000	26.6	1000.0	120.000	100.0	V	120.0	-8.0	13.4	40.0
73.325531	24.0	1000.0	120.000	200.0	V	230.0	-17.2	16.0	40.0
107.835511	17.9	1000.0	120.000	109.0	V	135.0	-13.4	25.6	43.5
312.143727	19.1	1000.0	120.000	133.0	V	247.0	-7.0	26.9	46.0
473.622525	29.7	1000.0	120.000	109.0	V	24.0	-2.1	16.3	46.0
528.819158	20.8	1000.0	120.000	100.0	V	15.0	-1.0	25.2	46.0

2.5.12 Test Results above 1GHz (RFID Active)



Peak Data

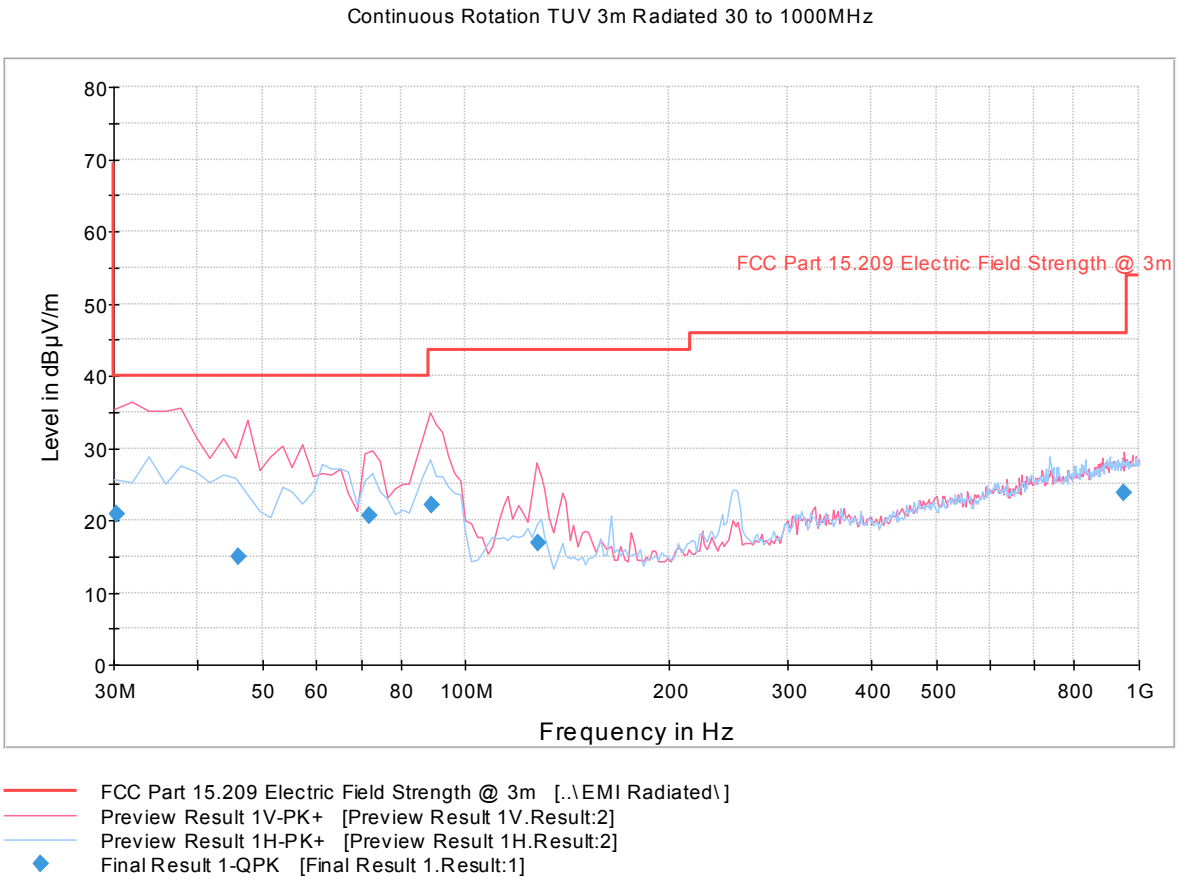
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1200.233333	42.7	1000.	1000.000	111.7	H	86.0	-6.4	31.2	73.9
1666.833333	43.9	1000.	1000.000	103.7	V	101.0	-5.1	30.0	73.9
1989.933333	45.8	1000.	1000.000	389.1	V	318.0	-2.3	28.1	73.9
4853.000000	46.0	1000.	1000.000	102.8	H	300.0	3.7	27.9	73.9
10830.93333	48.8	1000.	1000.000	406.7	V	89.0	11.8	25.1	73.9
17027.96666	52.9	1000.	1000.000	152.6	H	334.0	17.8	21.0	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1200.233333	32.5	1000.	1000.000	111.7	H	86.0	-6.4	21.4	53.9
1666.833333	27.1	1000.	1000.000	103.7	V	101.0	-5.1	26.8	53.9
1989.933333	30.6	1000.	1000.000	389.1	V	318.0	-2.3	23.3	53.9
4853.000000	30.6	1000.	1000.000	102.8	H	300.0	3.7	23.3	53.9
10830.93333	35.1	1000.	1000.000	406.7	V	89.0	11.8	18.8	53.9
17027.96666	39.3	1000.	1000.000	152.6	H	334.0	17.8	14.6	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures. BLE operation will be ignored for this test.

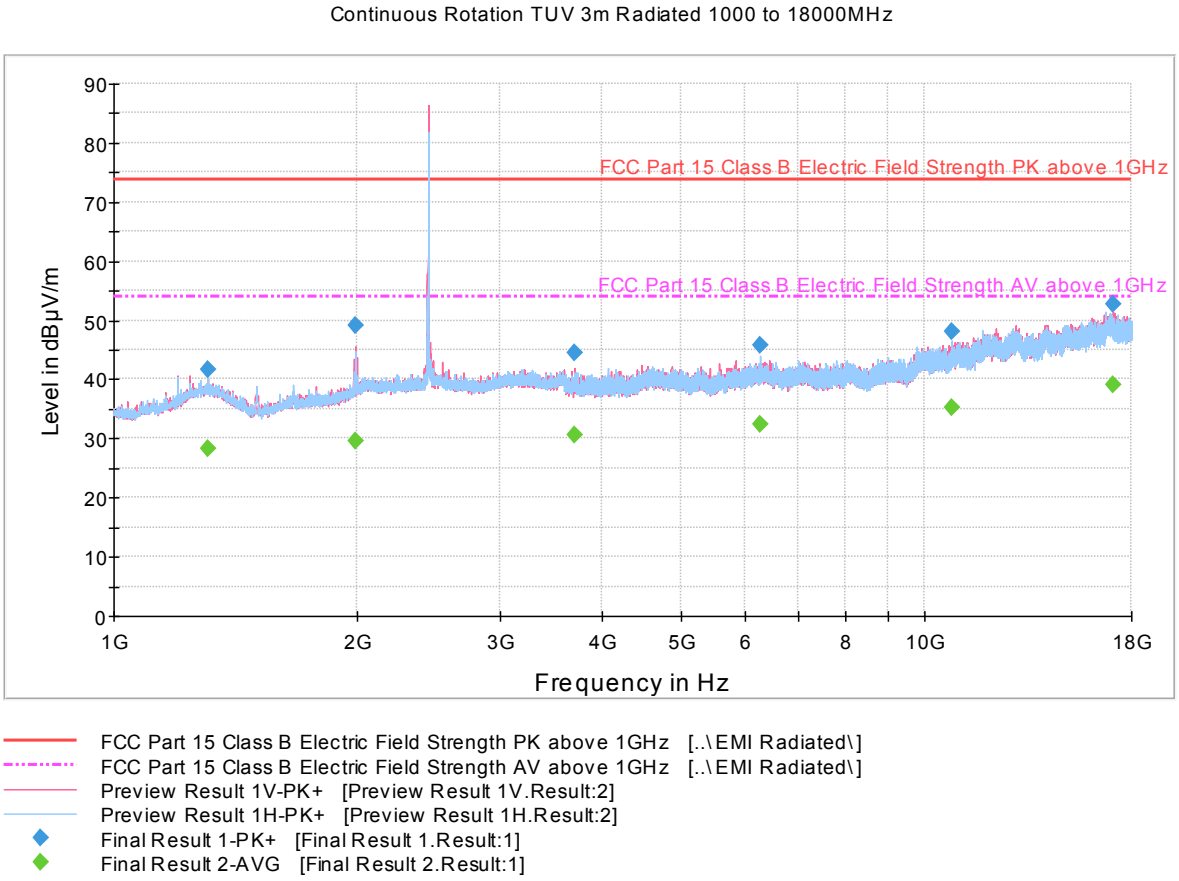
2.5.13 Test Results 30MHz to 1GHz (BLE Active)



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)
30.240000	20.9	1000.0	120.000	100.0	V	200.0	-8.0	19.0	40.0
45.974990	14.9	1000.0	120.000	105.0	V	71.0	-13.8	25.1	40.0
71.805531	20.6	1000.0	120.000	300.0	V	236.0	-17.2	19.3	40.0
88.836633	22.1	1000.0	120.000	300.0	V	10.0	-15.3	21.4	43.5
127.994389	16.8	1000.0	120.000	100.0	V	222.0	-14.5	26.7	43.5
949.482806	23.8	1000.0	120.000	250.0	V	11.0	5.6	22.2	46.0

2.5.14 Test Results above 1GHz (BLE Active)



Peak Data

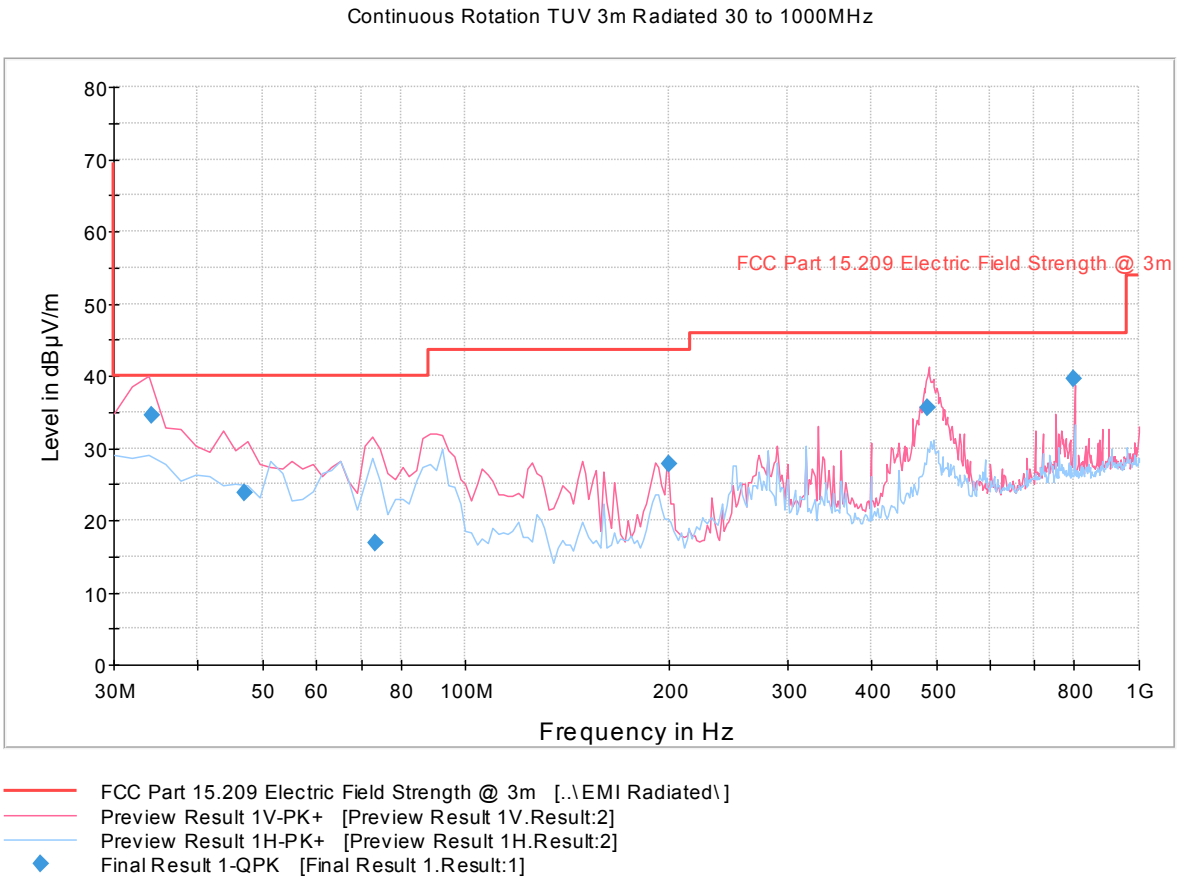
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1305.233333	41.7	1000.	1000.000	401.1	H	352.0	-5.1	32.2	73.9
1986.400000	49.2	1000.	1000.000	327.2	V	13.0	-2.3	24.7	73.9
3707.000000	44.5	1000.	1000.000	367.1	V	141.0	2.0	29.4	73.9
6284.566667	45.9	1000.	1000.000	131.7	H	148.0	6.3	28.0	73.9
10795.76666	48.1	1000.	1000.000	102.7	H	97.0	11.7	25.8	73.9
17078.60000	52.8	1000.	1000.000	246.3	V	36.0	17.6	21.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1305.233333	28.4	1000.	1000.000	401.1	H	352.0	-5.1	25.5	53.9
1986.400000	29.6	1000.	1000.000	327.2	V	13.0	-2.3	24.3	53.9
3707.000000	30.5	1000.	1000.000	367.1	V	141.0	2.0	23.4	53.9
6284.566667	32.4	1000.	1000.000	131.7	H	148.0	6.3	21.5	53.9
10795.76666	35.1	1000.	1000.000	102.7	H	97.0	11.7	18.8	53.9
17078.60000	39.1	1000.	1000.000	246.3	V	36.0	17.6	14.8	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures.

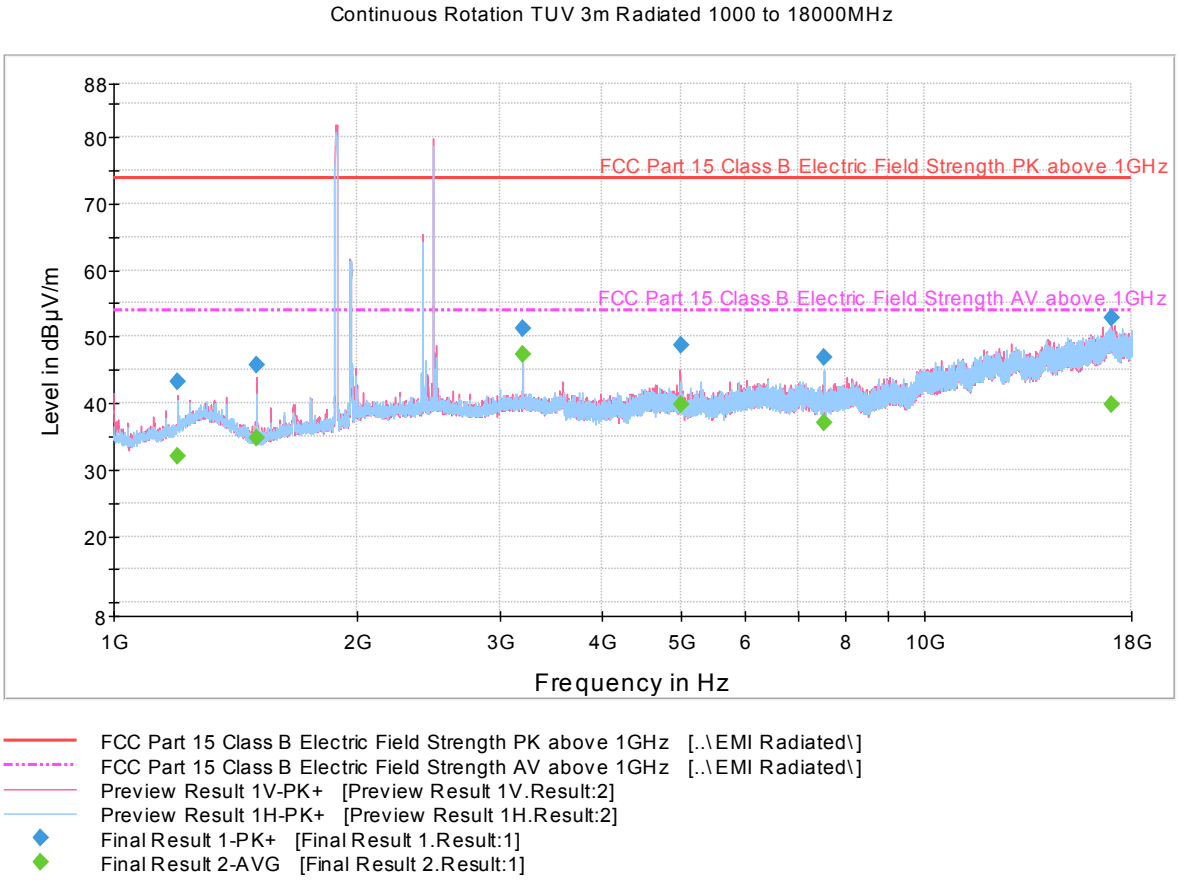
2.5.15 Test Results 30MHz to 1GHz (Cellular Active)



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)
34.127776	34.5	1000.0	120.000	100.0	V	143.0	-9.6	5.5	40.0
46.967214	23.7	1000.0	120.000	100.0	V	249.0	-14.2	16.3	40.0
73.325531	16.8	1000.0	120.000	300.0	V	232.0	-17.2	23.2	40.0
199.998236	27.9	1000.0	120.000	100.0	V	176.0	-10.9	15.6	43.5
485.613627	35.7	1000.0	120.000	100.0	V	0.0	-1.9	10.3	46.0
800.003447	39.6	1000.0	120.000	100.0	V	191.0	3.6	6.4	46.0

2.5.16 Test Results above 1GHz (Cellular Active)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1200.233333	43.1	1000.	1000.000	152.2	V	215.0	-6.4	30.8	73.9
1500.000000	45.8	1000.	1000.000	186.6	V	51.0	-6.1	28.1	73.9
3200.000000	51.3	1000.	1000.000	166.6	H	93.0	1.1	22.6	73.9
4999.733333	48.8	1000.	1000.000	305.2	V	199.0	3.8	25.1	73.9
7519.866667	46.8	1000.	1000.000	152.2	V	234.0	7.0	27.1	73.9
17016.83333	52.7	1000.	1000.000	183.5	V	164.0	17.8	21.2	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1200.233333	32.0	1000.	1000.000	152.2	V	215.0	-6.4	21.9	53.9
1500.000000	34.7	1000.	1000.000	186.6	V	51.0	-6.1	19.2	53.9
3200.000000	47.2	1000.	1000.000	166.6	H	93.0	1.1	6.7	53.9
4999.733333	39.9	1000.	1000.000	305.2	V	199.0	3.8	14.0	53.9
7519.866667	36.9	1000.	1000.000	152.2	V	234.0	7.0	17.0	53.9
17016.83333	39.7	1000.	1000.000	183.5	V	164.0	17.8	14.2	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures. Uplink frequency , Downlink frequency and BLE will be ignored for this test.

2.6 AC 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 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	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

Not performed. EUT is battery powered and designed to be charged via solar cells.

SECTION 3

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
Radiated Emission						
1033	Bilog Antenna	3142C	00044556	EMCO	11/06/18	11/06/20
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	08/20/18	08/20/20
8628	Pre-amplifier	QLI-01182835-JO	8986002	Quinstar	03/07/19	03/07/20
6628	Loop Antenna	HFH 2 –Z2	880 458/25	Rhode & Schwarz	05/02/18	05/02/20
7640	Loop Antenna	AL-130R	121086	Com-Power	03/08/19	03/28/21
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 7643 and 7654	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 7643 and 7654	
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/15/18	10/15/19
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/18	10/18/19
1016	Pre-Amplifier	PAM-0202	187	PAM	03/08/19	03/08/20
7562	Wideband Radio Communication	CMW 500	1201.0002k50 /103829	Rhode & Schwarz	11/16/18	11/16/19
Miscellaneous						
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	11312	04/16/19	04/16/20
7642	Temperature Chamber	SU-241	92010175	ESPEC	Verified by 11312	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 Measurement Uncertainty

Calculation of Measurement Uncertainty per CISPR 16-4-2:2011 with Corr. 1

3.2.1 Radiated Measurements (Below 1GHz)

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45	dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.76	dB	Triangular	2.449	1.54	2.36
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
	Combined standard uncertainty			Normal	2.95	dB	
	Expanded uncertainty			Normal, k=2	**5.90**	**dB**	

3.2.2 Radiated Emission Measurements (Above 1GHz)

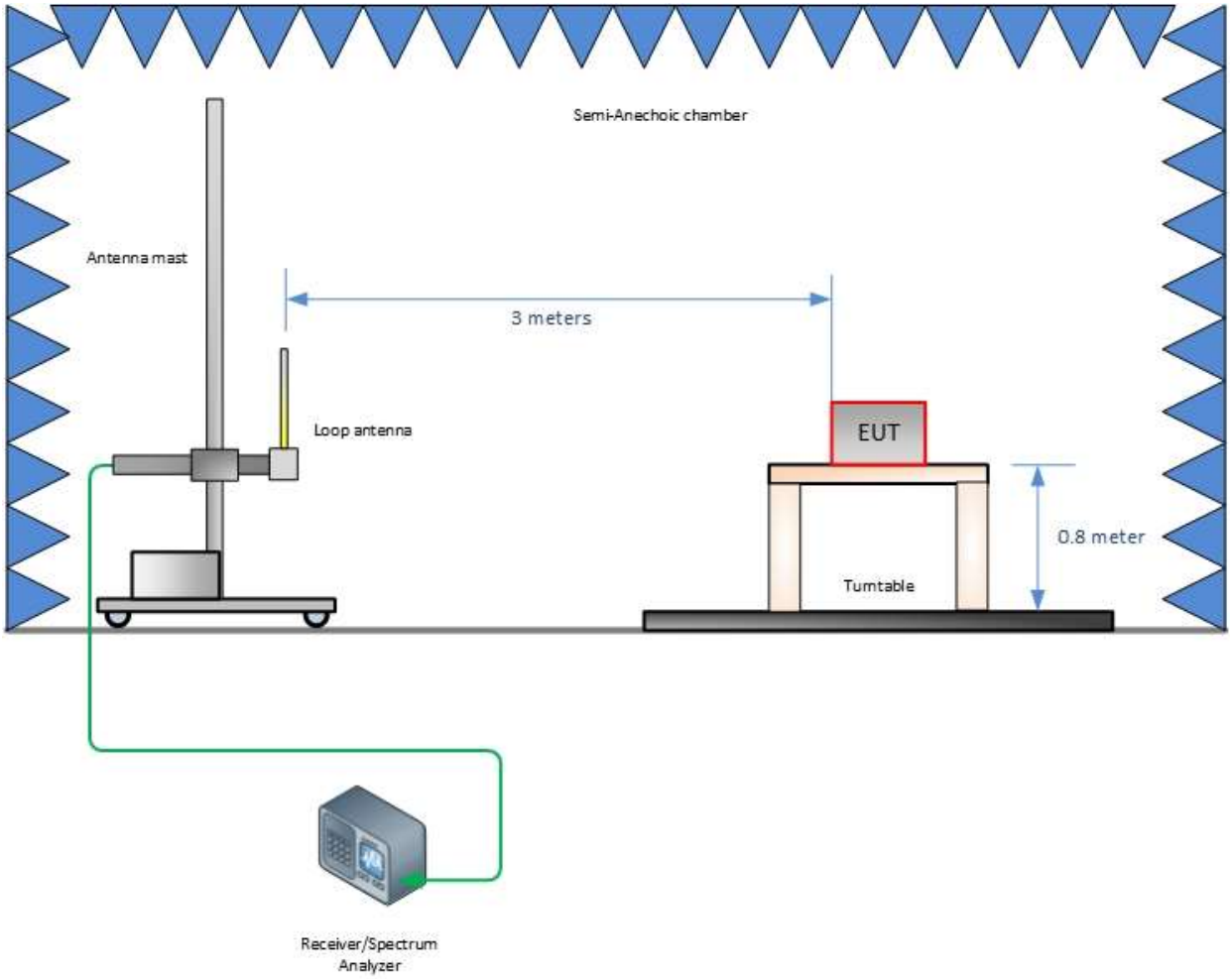
	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45	dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24

12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.25	dB	Triangular	2.449	1.33	1.76
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
	Combined standard uncertainty			Normal	2.85	dB	
	Expanded uncertainty			Normal, k=2	**5.70**	**dB**	

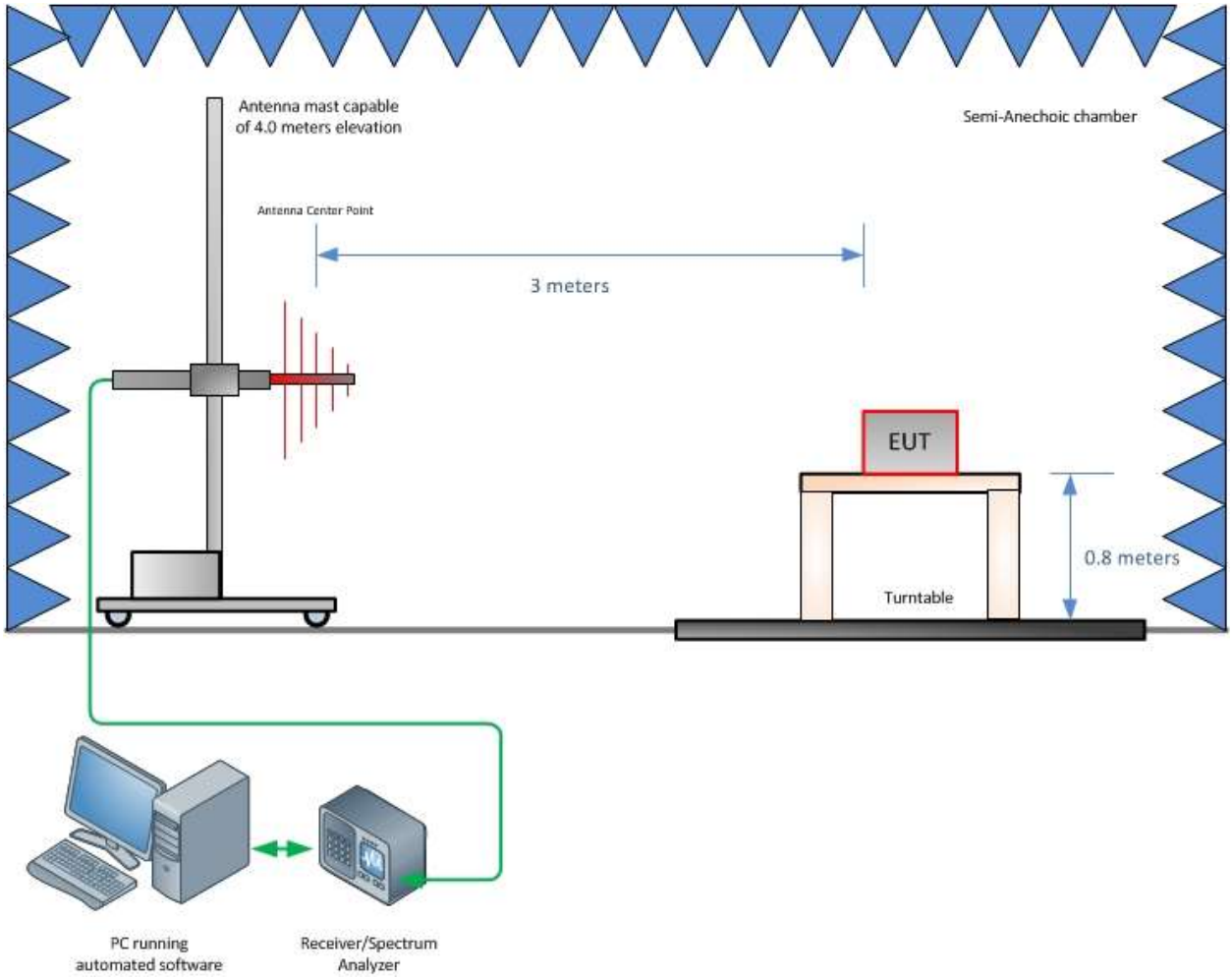
SECTION 4

4 Diagram of Test Setup

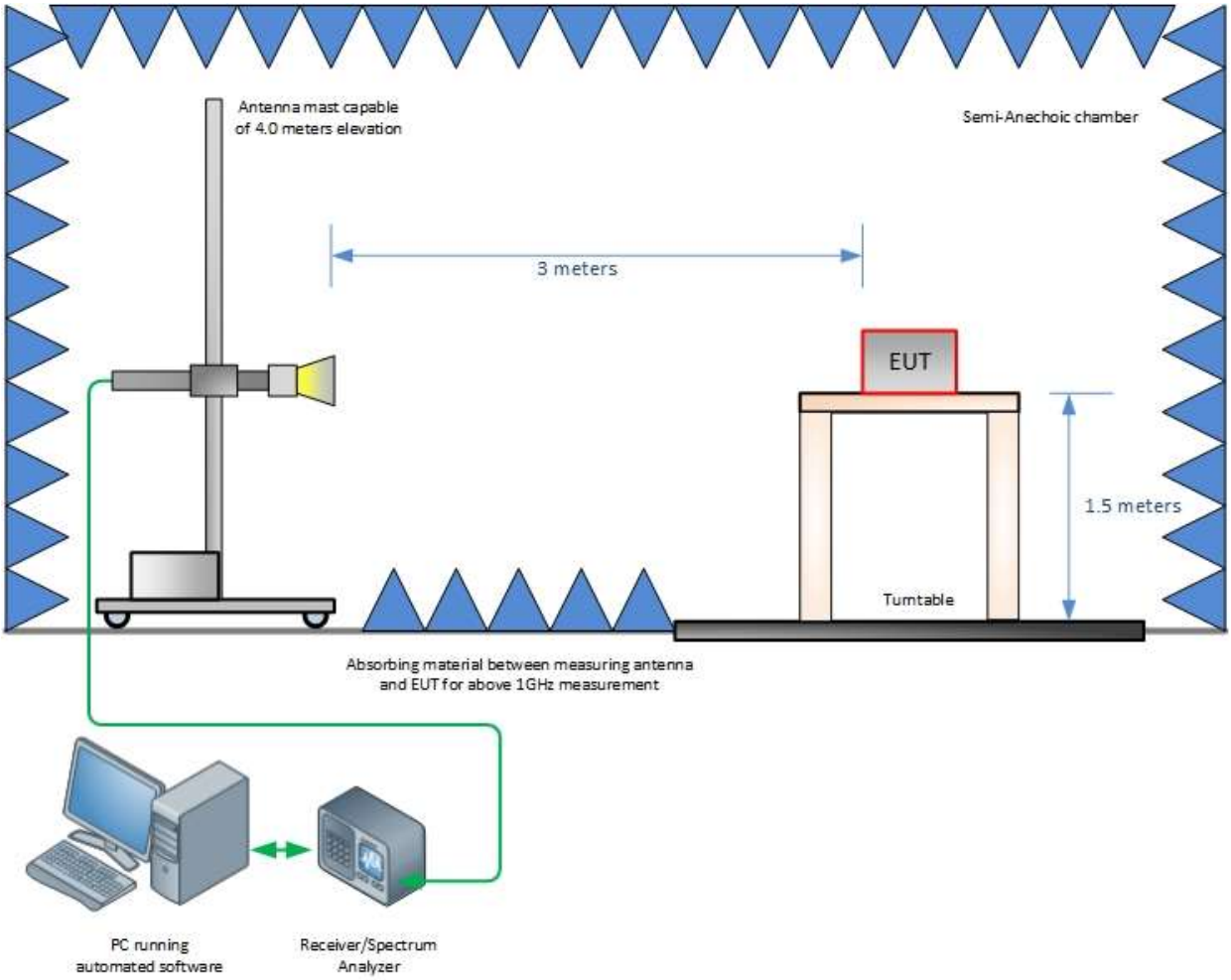
4.1 Test Setup Diagrams



Radiated Emission Test Setup (Below 30MHz)



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

5 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 Accreditation, Disclaimers and Copyright

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