Radio Testing of the

Avitas Systems LLC
LUMEN Terrain 126M6399 Methane Leak Detection and Location Base Station

In accordance with
FCC Part 15 Subpart C §15.247
RSS-247 Issue 2 February 2017
AS/NZS 4268:2017

America

Add value.
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Avitas Systems LLC
17021 Aldine Westfield Road
Houston, TX 77073

COMMERCIAL-IN-CONFIDENCE

Date: June 2021
Document Number: 72168255F Issue 01 | Version Number: 01

Authorized Signatory	Ferdinand S. Custodio	June 14, 2021	

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 §15.247, RSS-247 Issue 2 February 2017 and AS/NZS 4268:2017.

A2LA Cert. No. 2955.13

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REPORT ON	Radio Testing of the Avitas Systems LLC LUMEN Terrain 126M6399 Methane Leak Detection and Location Base Station
TEST REPORT NUMBER	72168255F
TEST REPORT DATE	June 2021
PREPARED FOR	Avitas Systems LLC 17021 Aldine Westfield Road Houston, TX 77073
CONTACT PERSON	Ashraf El-Messidi EngineerING Manager ashraf.el-messidi@bakerhughes.com (865) 399 2274
PREPARED BY	Xiaoying Zhang **Name** Authorized Signatory Title: Senior RF Wireless Test Engineer
APPROVED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer/Wireless Team Lead
DATED	June 14, 2021

Revision History

72168255F Avitas Systems LLC LUMEN Terrain Methane Leak Detection and Location Base Station					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
06/14/2021	—	Initial Release			Ferdinand S. Custodio

CONTENTS

SECTION 1

REPORT SUMMARY

Radio Testing of the
Avitas Systems LLC
LUMEN Terrain Methane Leak Detection and Location Base Station

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Avitas Systems LLC LUMEN Terrain Methane Leak Detection and Location Base Station to the requirements of FCC Part 15 Subpart C §15.247 and RSS-247 Issue 2 February 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	Avitas Systems LLC
EUT	Methane Leak Detection and Location Base Station
Model Name	LUMEN Terrain
Model Number(s)	126M6399
FCC ID	2AZ9Q-LTBS
IC Number	N/A
FCC Classification	Frequency Hopping Spread Spectrum systems (DSS)
Serial Number(s)	TUV 01
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2019). • RSS-247–Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (Issue 2, February 2017). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, Amendment 2 February 2020). • AS/NZS 4268:2017 Radio equipment and systems – Short Range Devices – Limits and methods of measurement.
Start of Test	May 24, 2021
Finish of Test	May 27, 2021
Name of Engineer(s)	Xiaoying Zhang
Related Document(s)	ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to RSS-247 Issue 2 February 2017and RSS-Gen Issue 5 Amendment 1 March 2019 are shown below:

Section	§15.247 Spec Clause	RSS-247 RSS-GEN	Test Description	Result	Comments /Base Standard
2.1	§15.207 (a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.2	§15.247(a)(1)	RSS-247 5.1 (b)	Carrier Frequency Separation	Compliant	
2.3	§15.247(a)(1)(i)	RSS-247 5.1 (c)	Number of Hopping Frequencies	Compliant	
2.4	§15.247(a)(1)(i)	RSS-247 5.1 (c)	Time of Occupancy (Dwell Time)	Compliant	
2.5	§15.215(c) §15.247(a)(1)(i)	RSS-247 5.1 (a)	20 dB Bandwidth	Compliant	
2.6	-	RSS-Gen 6.7	99% Emission Bandwidth	Compliant	
2.7	§15.247(b)(2)	RSS-247 5.4 (a)	Peak Output Power	Compliant	
2.8	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.9	§15.247(d) §15.205(a)	RSS-247 5.5	Spurious RF Conducted Emissions	Compliant	
2.10	§15.247(d) §15.205(a)	RSS-247 5.5	Spurious Radiated Emissions	Compliant	
-	§15.247(d)	RSS-Gen 8.10	Radiated Immediate Restricted Bands	NA**	
-	-	RSS-Gen 7.0	Receiver Spurious Emissions	N/A***	

N/A* EUT is battery / solar powered not designed to be connected to the public utility (AC) power line.
N/A** There are no immediate restricted bands near the 902-928 MHz band.
N/A*** Not required as per RSS-Gen 5.3 The EUT does not fall into any category defined as Receiver under RSS-Gen.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Avitas Systems LLC LUMEN Terrain 126M6399 Methane Leak Detection and Location Base Station. The EUT is the base station of a methane leak detection and location system that collects the data from methane nodes that sense the methane leak. The base station transmits the collected data to a cloud server for processing and customer review through a user interface on a PC. Only the ISM 900 MHz function was verified in this report.

1.3.2 EUT General Description

EUT Description	Methane Leak Detection and Location Base Station
Model Name	LUMEN Terrain
Model Number(s)	126M6399
Rated Voltage	7.0 – 36 VDC
Mode Verified	ISM 900 MHz
Frequency Range	902.2 MHz to 927.8 MHz
Capability	ISM 900 MHz, GSM Band 1, 2, 5 and LTE Band 1, 2, 4, 5, 7, 25, 26, 41
Primary Unit (EUT)	☒ Production
	☐ Pre-Production
	☐ Engineering
Manufacturer Declared Temperature Range	-30°C to 65°C
Antenna Type	Omnidirectional
Antenna Model	W5017
Antenna Manufacturer	PULSELARSEN ANTENNAS
Antenna Frequency range	868MHz to 928MHz
Antenna Gain	2 dBi

1.3.3 Maximum Output Power

Mode	Frequency Range (MHz)	Conducted Peak Power (dBm)
ISM 900 MHz	902.2 to 927.8	13.70

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna conducted port test configuration. All measurements were performed on the ISM 900 MHz antenna connector. ISM 900 MHz functions were controlled by SmartRF software run on a support laptop which connects to the EUT via JTAG Box and Cable. EUT configured to transmit at Low, Mid and High channels at max allowed operating power (14 dBm setting).
B	Antenna conducted port test configuration. All measurements were performed on the ISM 900 MHz antenna connector. The ISM 900 MHz RF antenna port was connected to a power splitter. One of the ports was connected to the Spectrum Analyzer and the other port was connected to the sensor with a step attenuator in between. EUT was powered on and paired with a sensor node. Then both the EUT and the sensor worked on hopping mode.
C	Radiated emissions test configuration. ISM 900 MHz Antenna port was terminated with a 50Ω load. ISM 900 MHz functions were controlled by SmartRF software run on a support laptop which connects to the EUT via JTAG Box and Cable. EUT configured to transmit at Low, Mid and High channels at max allowed operating power (14 dBm setting).

1.4.2 EUT Exercise Software

The ISM 900MHz frequencies and power are controlled/configured through Texas Instrument SmarRF software. In the final product, the users and clients will have no access to this SmartRF software and will never alter/change/configure the ISM 900MHz settings.

1.4.3 Support Equipment and I/O cables

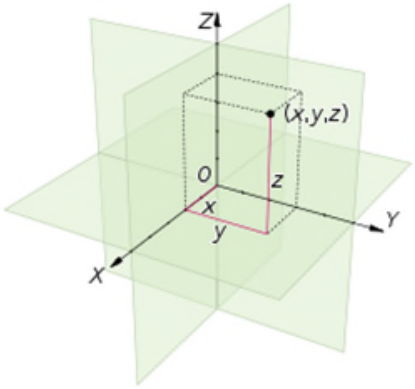
Manufacturer	Equipment/Cable	Description
Panasonic	Support Laptop	PN: CF-54
Panasonic	Laptop Charger	PN: CF-AA5713A M3
Texas Instrument	JTAG Debug Probe	P/N: TMDSEMU110-U
Avitas Systems LLC	Methane Sensor Node	Model Name: LUMEN Terrain Model Number: 126M4502 S/N: FBEB

1.4.4 Worst Case Configuration

Worst-case configuration used in this test report as per maximum conducted output power measurements:

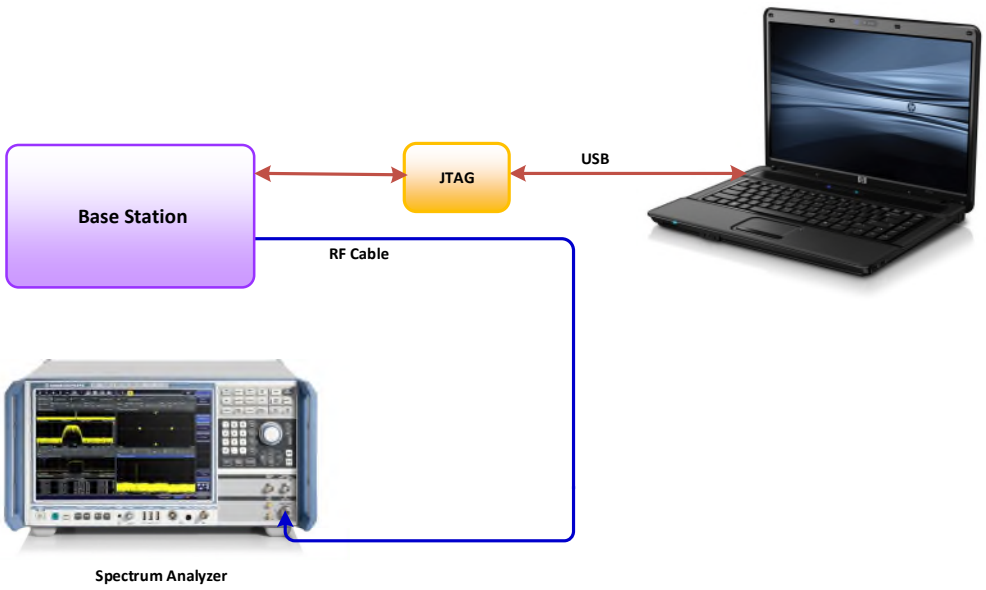
Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Data Rate (kbps)	Limit (dBm)
2-GFSK	Low	902.2	13.70	50	30
	Middle 1	915.0	13.50	50	30
	Low 1	915.2	13.47	50	30
	Middle 2	921.6	13.39	50	30
	High	927.8	13.26	50	30

EUT is a fixed device. Final installation position is vertical orientation. Radiated emissions tests were performed at vertical orientation.

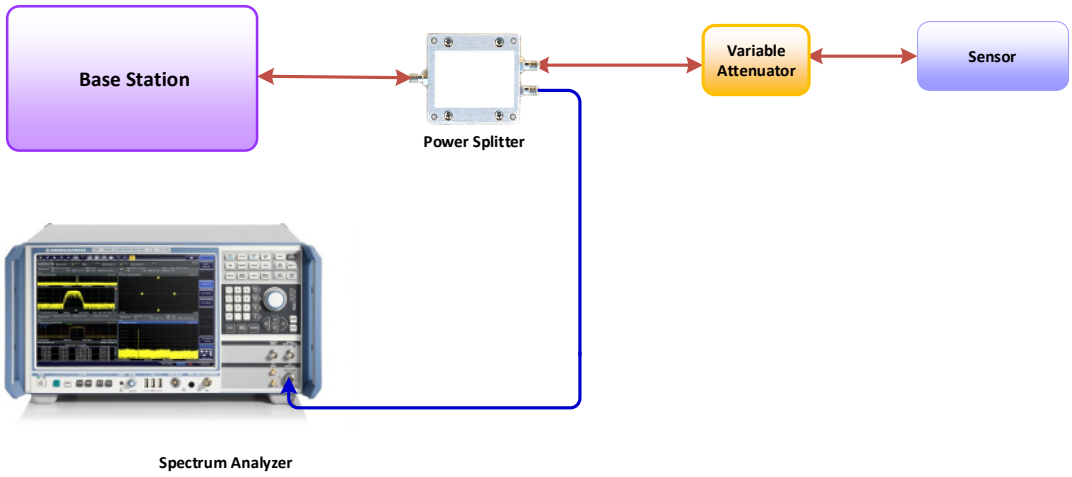


1.4.5 Simplified Test Configuration Diagram

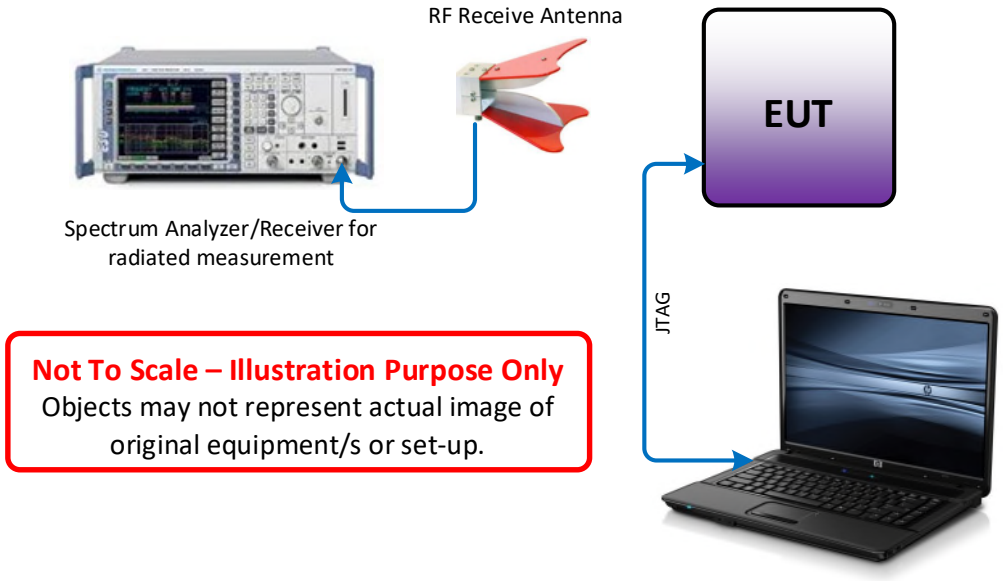
Test Configuration A:



Test Configuration B:



Test Configuration C:



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: TUV 01		
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

TEST DETAILS

Radio Testing of the
Avitas Systems LLC
LUMEN Terrain Methane Leak Detection and Location Base Station

2.1 CONDUCTED EMISSIONS

2.1.1 Specification Reference

Part 15 Subpart C §15.207(a)
RSS-Gen 8.8

2.1.2 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.*

2.1.3 Equipment Under Test and Modification State

Not performed. EUT is not designed to be connected to the public utility (AC) power line. The EUT is battery / solar powered.

2.2 CARRIER FREQUENCY SEPARATION

2.2.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)
RSS-247 Section 5.1 b)

2.2.2 Standard Applicable

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

2.2.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration B

2.2.4 Date of Test/Initial of Test Personnel who Performed the Test

May 24, 2021/XYZ

2.2.5 Test Equipment Used

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

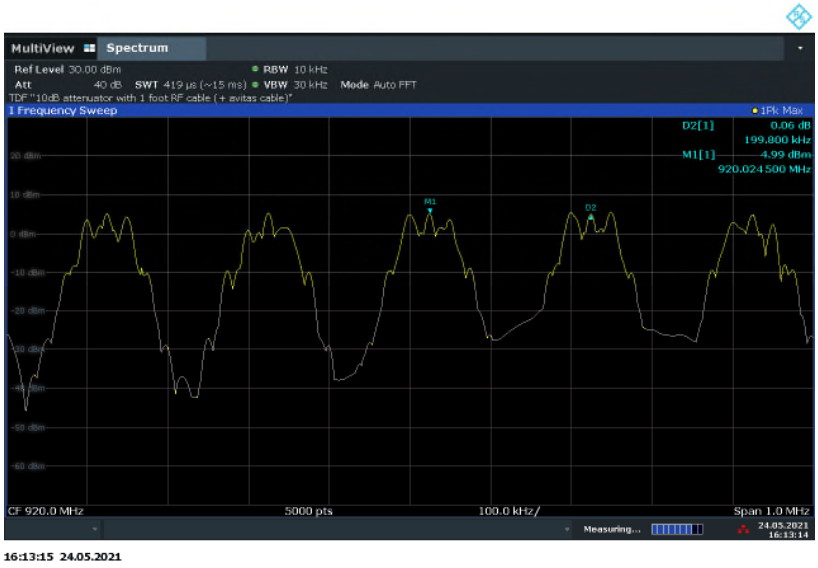
2.2.6 Environmental Conditions

Ambient Temperature	24.3°C
Relative Humidity	45.8%
ATM Pressure	100.3 kPa

2.2.7 Additional Observations

- Hopping function enabled. A power combiner was used to connect the Base Station to the paired Node and Spectrum Analyzer.
- A Step attenuator was used between the Base Station and Node to reduce the signal level from the Node to Spectrum Analyzer.
- Span is wide enough to capture the peaks of two adjacent channels.
- RBW is 1% of OBW to identify the centre of each individual channel.
- VBW is 3 x RBW
- Sweep is auto
- Detector is peak.
- Trace is max hold.

2.2.8 Test Results



Observed carrier frequency separation between Channels = 199.8 kHz (**Complies**. By a minimum of the 20 dB bandwidth of the hopping channel. 199.8 kHz is greater than 102.15 kHz which is worst case 20 dB BW)

2.3 NUMBER OF HOPPING FREQUENCIES

2.3.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(i)
RSS-247 Section 5.1 b)

2.3.2 Standard Applicable

(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

2.3.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration B

2.3.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 24, 2021/XYZ

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

Ambient Temperature	24.3°C
Relative Humidity	45.8%
ATM Pressure	100.3 kPa

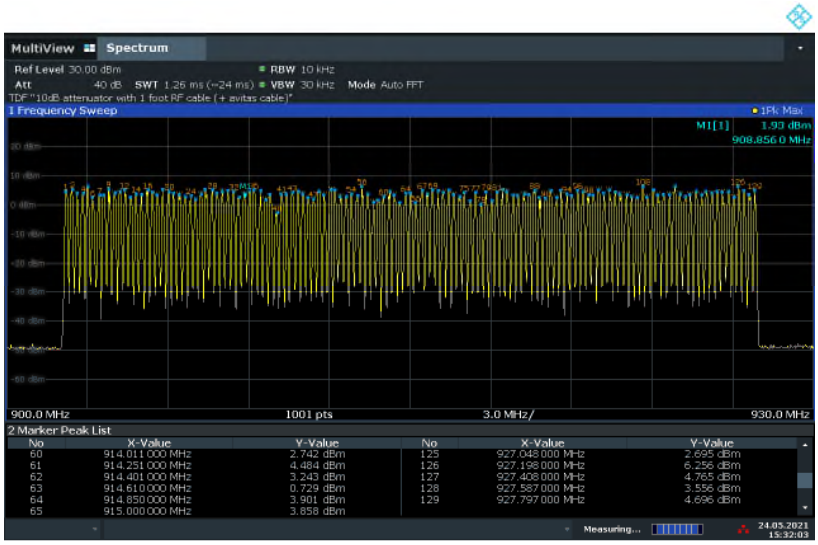
2.3.7 Additional Observations

- Hopping function enabled. A power combiner was used to connect the Base Station to the paired Node and Spectrum Analyzer.
- A Step attenuator was used between the Base Station and Node to reduce the signal level from the Node to Spectrum Analyzer.
- Marker peak list function was used on signal analyzer to count the number of channels.
- Span is wide enough than the frequency band of operation to capture the channels of interests.
- RBW is 10kHz (Due to the OBW of the EUT 100kHz, the Resolution bandwidth was adjusted to identify the channels).
- VBW is 3 x RBW
- Sweep is auto
- Detector is peak, trace is max hold.

2.3.8 Test Results

Observed Number of Hopping Frequencies is = **129** **(> 50, Complies)**

2.3.9 Test Plot



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2.4 TIME OF OCCUPANCY (DWELL TIME)

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(i)
RSS-247 Section 5.1 c)

2.4.2 Standard Applicable

(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel
is 500 kHz.

2.4.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration B

2.4.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 24, 2021/ XYZ

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

Ambient Temperature	24.3°C
Relative Humidity	45.8%
ATM Pressure	100.3 kPa

2.4.7 Additional Observations

- Hopping function enabled.
- Span = zero span.
- RBW is 100kHz.
- VBW is 3 x RBW
- Detector is peak.
- Trace is maxhold.
- A single pulse is first measured. This measurement is then used to compute the average time of occupancy in the required period.
- For the 20 seconds sweep time, a 1 second offset trigger was set to display the first pulse completely and the 20 seconds plot.

2.4.8 Test Results

Modulation	Measured time of occupancy	Requirement
2-GFSK	9.94424 ms	<400 ms

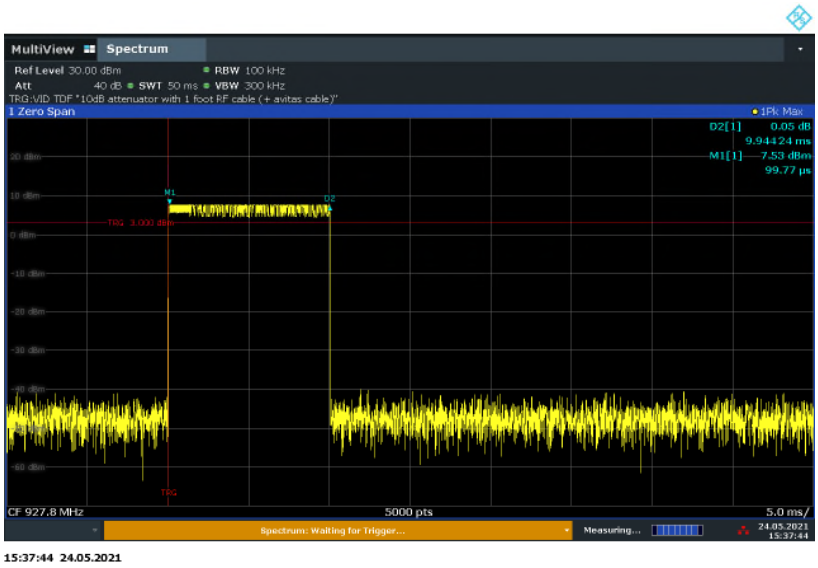
2.4.9 Sample Computation

Width of single pulse = 0.00994424 second
Observed occurrence = 1 pulses / 20 seconds

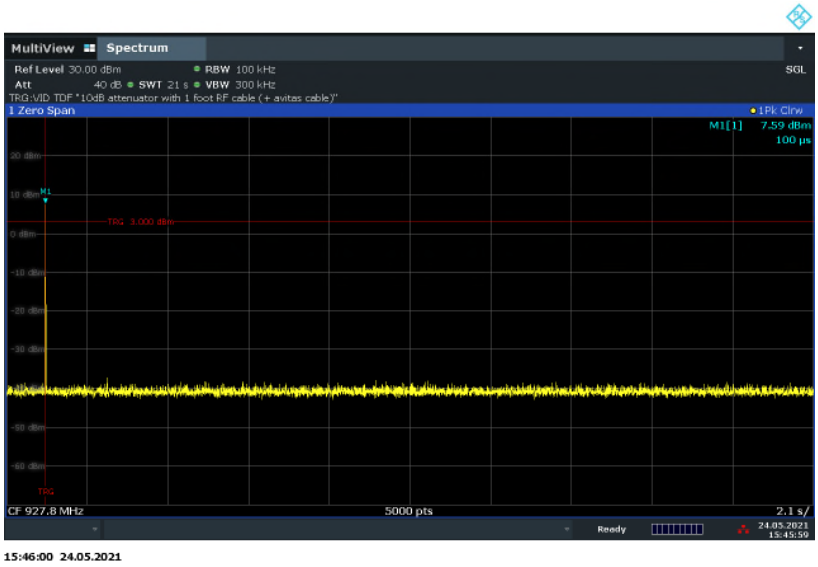
Time of occupancy = Pulse width x #pulses in 20 seconds
= 0.00994424 second x 1
= 0.00994424 second

Compliance = **Complies.** 0.00994424 second < 0.4 second

2.4.10 Test Results Plots



Single pulse (9.94424ms)



Observed Occurrence in 20 seconds

2.5 20 DB BANDWIDTH

2.5.1 Specification Reference

Part 15 Subpart C §15.215(c)
Part 15 Subpart C §15.247(a)(1)
RSS-247 Section 5.1a)

2.5.2 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.

2.5.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A

2.5.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 25, 2021 / XYZ

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

Ambient Temperature	26.6 °C
Relative Humidity	47.6 %
ATM Pressure	100.2 kPa

2.5.7 Additional Observations

- This is a conducted test.
- An offset of 10.6dB was added to compensate for the external attenuator and cable used.
- Span is approximately 2 to 5 times the expected Occupied bandwidth.
- RBW is in the range of 1% to 5% of the expected Occupied bandwidth while VBW is ≥ RBW.
- Sweep is auto.
- Detector is peak.
- Max hold function activated.
- “n dB down” marker function (20dB) of the spectrum analyzer was used for this test.

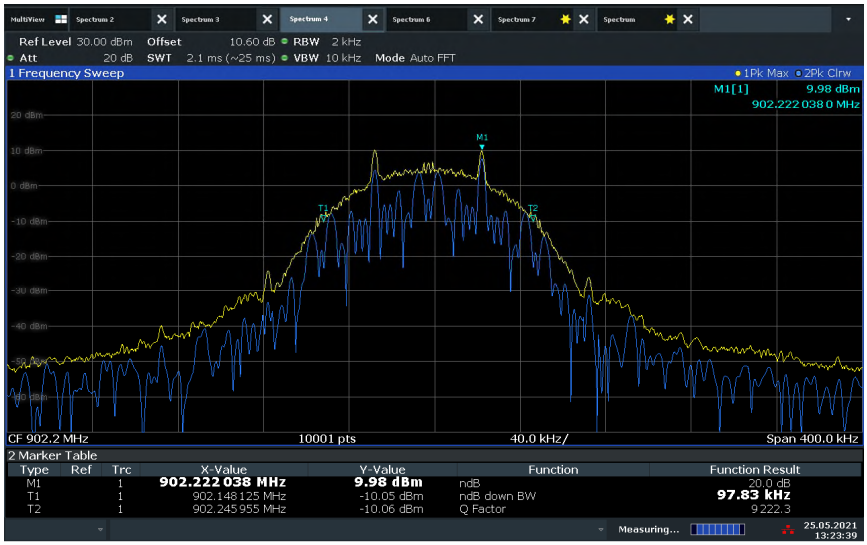
2.5.8 Test Results

Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (kHz)	Data Rate (kbps)
2-GFSK	Low	902.2	97.83	50
	Middle 1	915.0	101.63	50
	Low 1	915.2	101.71	50
	Middle 2	921.6	99.99	50
	High	927.8	102.15	50

902.2 MHz – (20dB BW/2) = 902.1511 MHz (within the frequency band - **Compliant**)

927.8 MHz + (20dB BW/2) = 927.8511 MHz (within the frequency band - **Compliant**)

2.5.9 Test Results Plots



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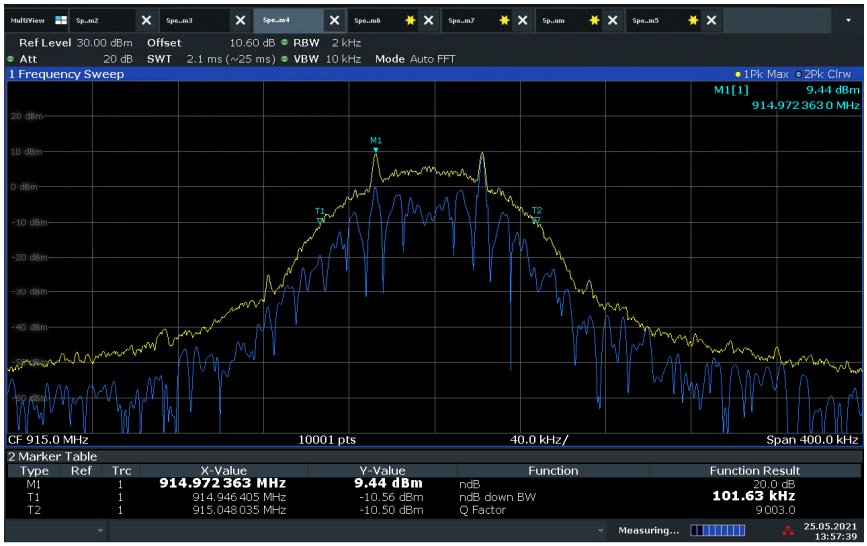
Low Channel



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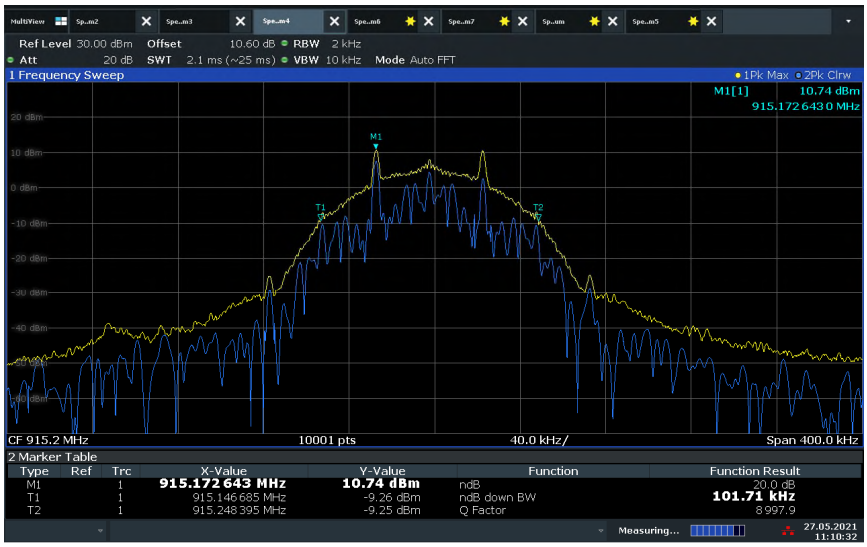
Middle 1 Channel



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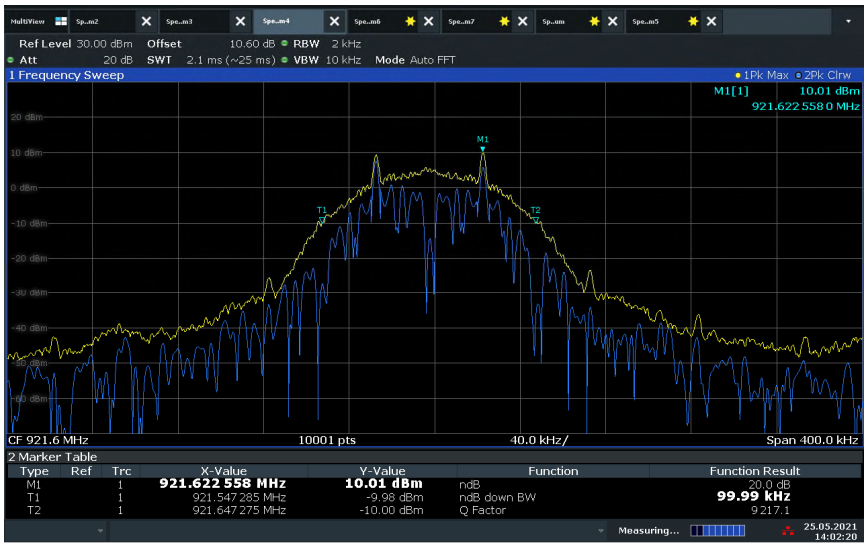
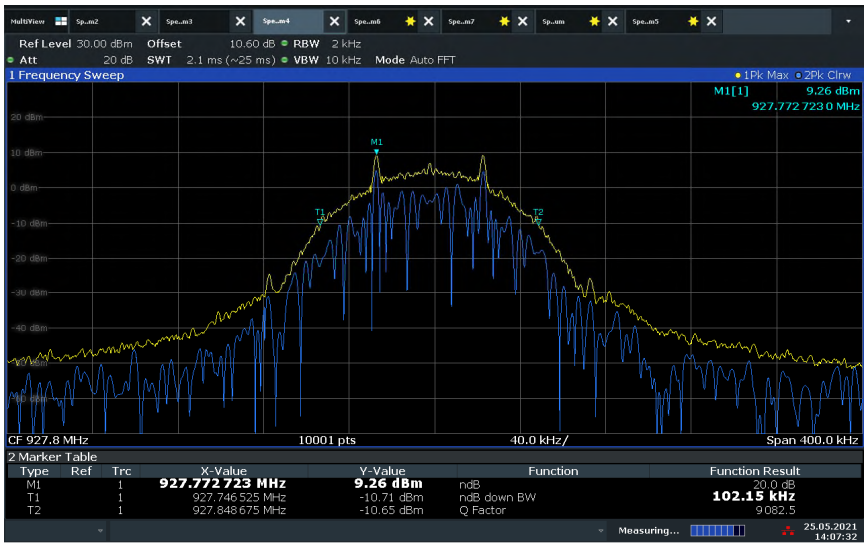
Low 1 Channel



14:02:20 25.05.2021

Middle 2 Channel



14:07:33 25.05.2021

High Channel

2.6 99% EMISSION bandwidth

2.6.1 Specification Reference

RSS-Gen Clause 6.7

2.6.2 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.

2.6.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A

2.6.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 25 and 27, 2021 / XYZ

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

Ambient Temperature	24.5 - 26.6°C
Relative Humidity	42.3 - 47.6%
ATM Pressure	100.2 - 100.6kPa

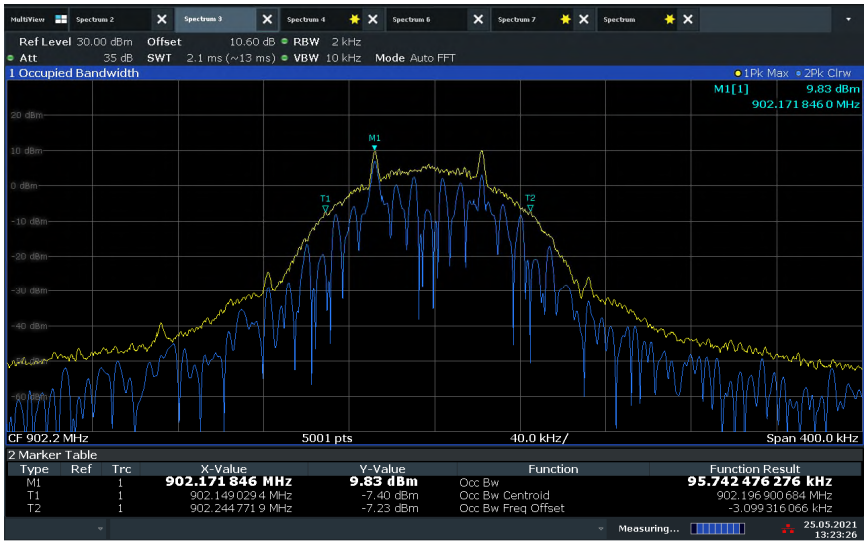
2.6.7 Additional Observations

- This is a conducted test.
- An offset of 10.6dB was added to compensate for the external attenuator and cable used.
- Span was set between two times to five times OBW
- RBW is 1% to 5% of the OBW.
- VBW is > RBW.
- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyser was set to 99% (default).
- The OBW measurement function of the spectrum analyser was used for this test.

2.6.8 Test Results (For reporting purposes only)

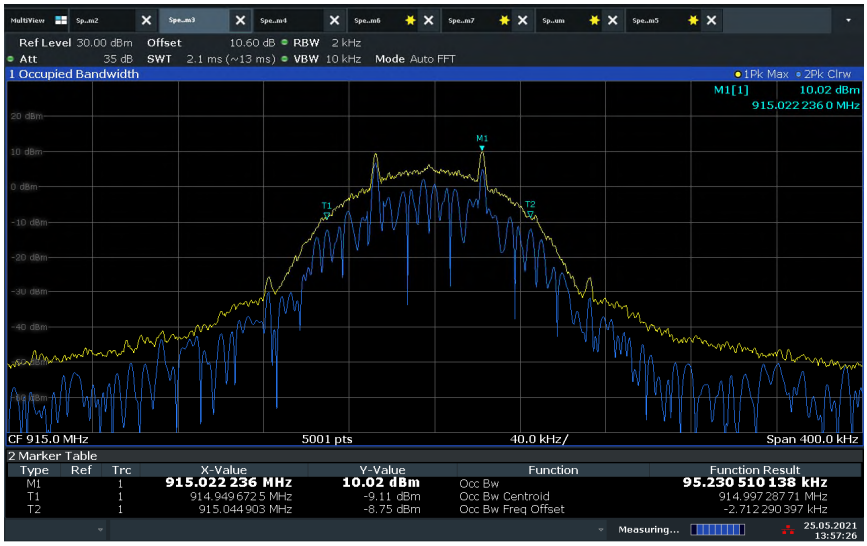
Modulation	Channel	Frequency (MHz)	Measured Occupied Bandwidth (kHz)	Data Rate (kbps)
2-GFSK	Low	902.2	95.74	50
	Middle 1	915.0	95.23	50
	Low 1	915.2	96.46	50
	Middle 2	921.6	97.92	50
	High	927.8	96.92	50

2.6.9 Test Results Plots



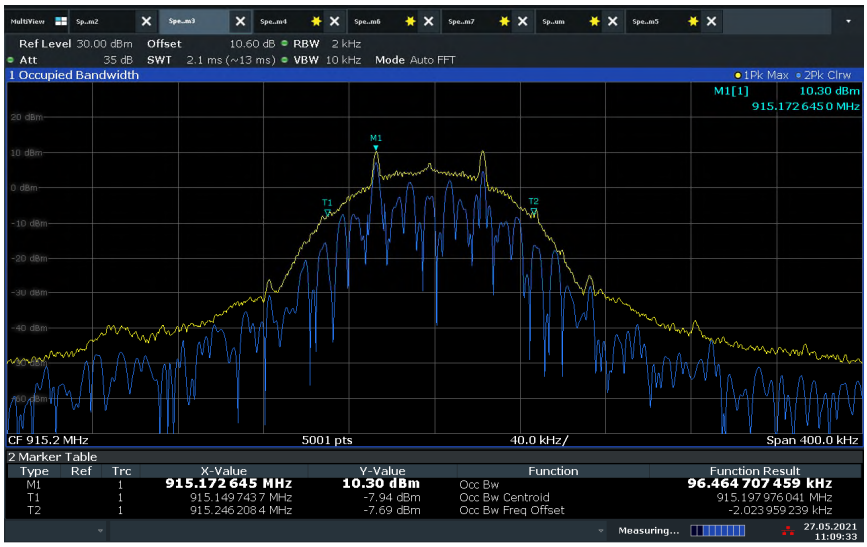
13:23:26 25.05.2021

Low Channel



13:57:27 25.05.2021

Middle 1 Channel

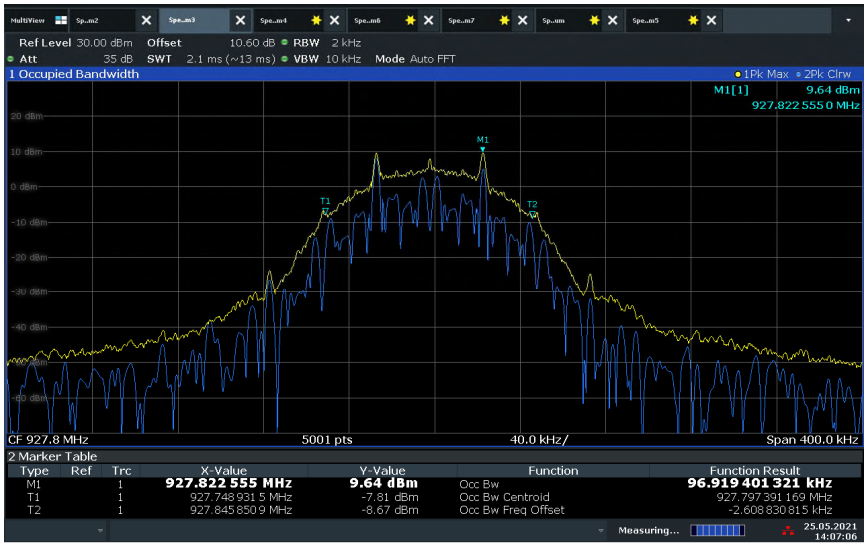


11:09:34 27.05.2021

Low 1 Channel

14:01:57 25.05.2021

Middle 2 Channel



14:07:07 25.05.2021

High Channel

2.7 PEAK OUTPUT POWER

2.7.1 Specification Reference

Part 15 Subpart C §15.247(b)(2)
RSS-247 Section 5.4 (a)

2.7.2 Standard Applicable

(2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

2.7.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A

2.7.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 25 and 27, 2021 / XYZ

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions

Ambient Temperature	24.5 - 26.6°C
Relative Humidity	42.3 - 47.6%
ATM Pressure	100.2 - 100.6kPa

2.7.7 Additional Observations

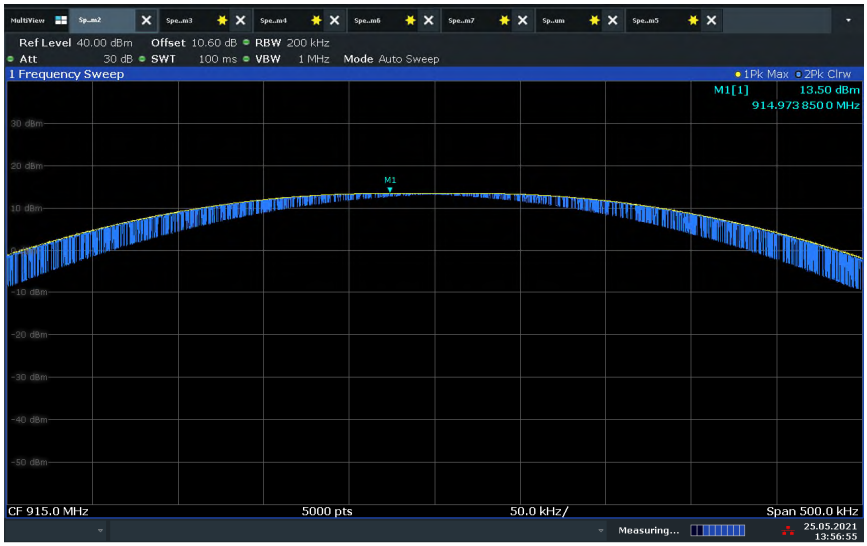
- This is a conducted test.
- An offset of 10.6dB was added to compensate for the external attenuator and cable used.
- Span was set to five times 20dB BW
- RBW is > 20dB BW.
- VBW > RBW.
- Sweep is auto.
- Detector is peak.
- Trace is max hold.

2.7.8 Test Results (Conducted)

Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Data Rate (kbps)	Limit (dBm)
2-GFSK	Low	902.2	13.70	50	30
	Middle 1	915.0	13.50	50	30
	Low 1	915.2	13.47	50	30
	Middle 2	921.6	13.39	50	30
	High	927.8	13.26	50	30

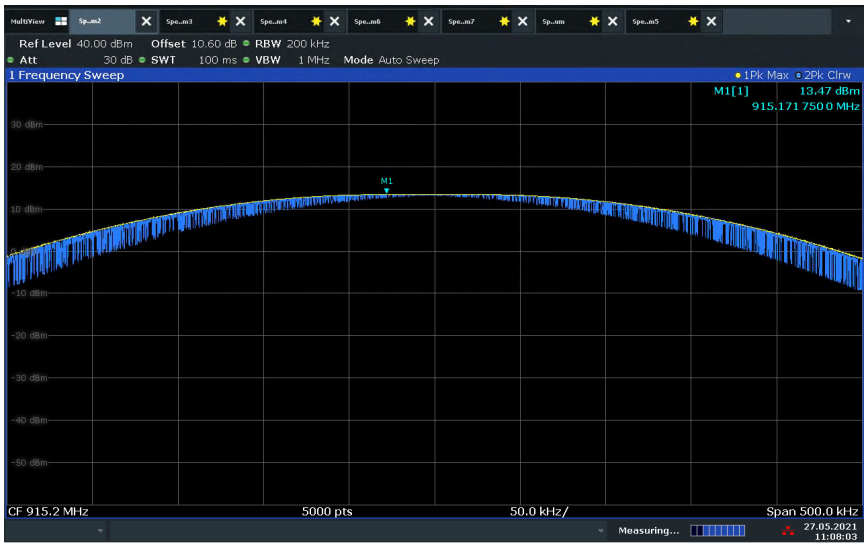
2.7.9 Test Results Plots

Low Channel



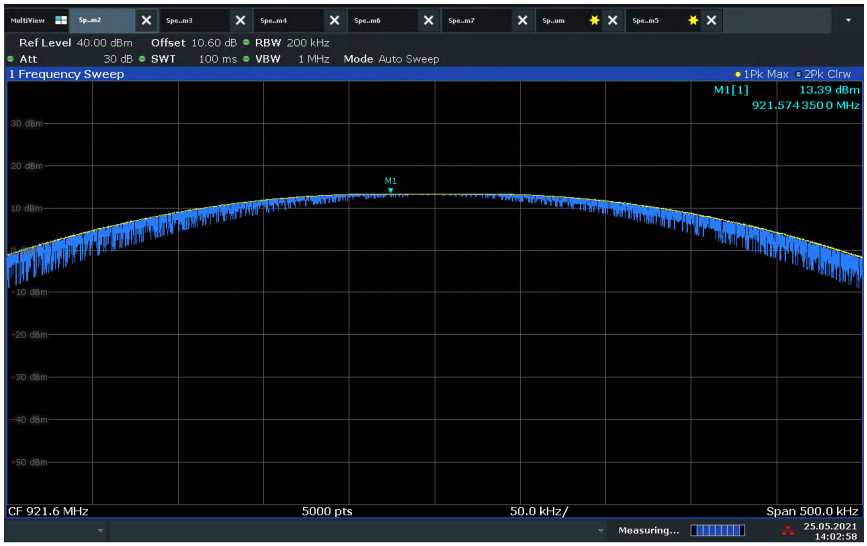
13:56:55 25.05.2021

Middle 1 Channel



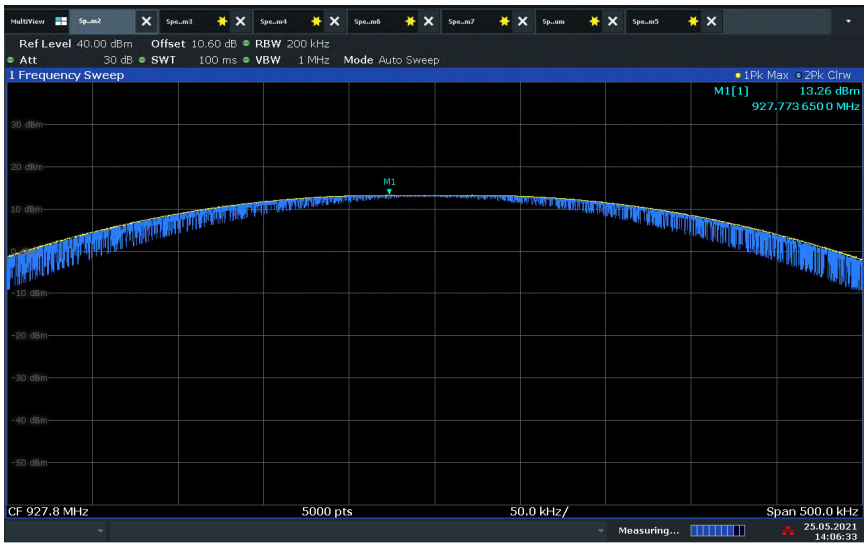
11:08:03 27.05.2021

Low 1 Channel



14:02:58 25.05.2021

Middle 2 Channel



14:06:34 25.05.2021

High Channel

2.8 Band-edge Compliance of RF Conducted Emissions

2.8.1 Specification Reference

Part 15 Subpart C §15.247(d)
RSS-247, Section 5.5

2.8.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.8.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A and B

2.8.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 27, 2021 / XYZ

2.8.5 Test Equipment Used

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

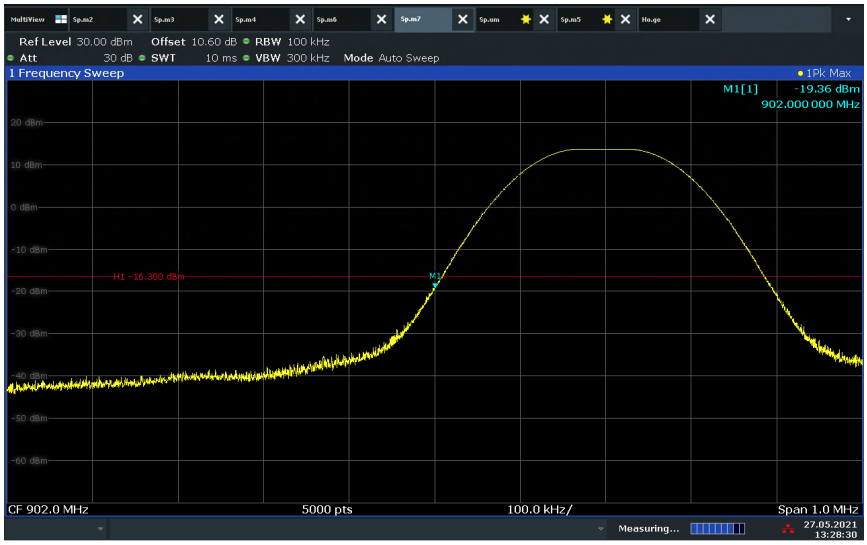
2.8.6 Environmental Conditions

Ambient Temperature	24.5°C
Relative Humidity	42.3%
ATM Pressure	100.6kPa

2.8.7 Additional Observations

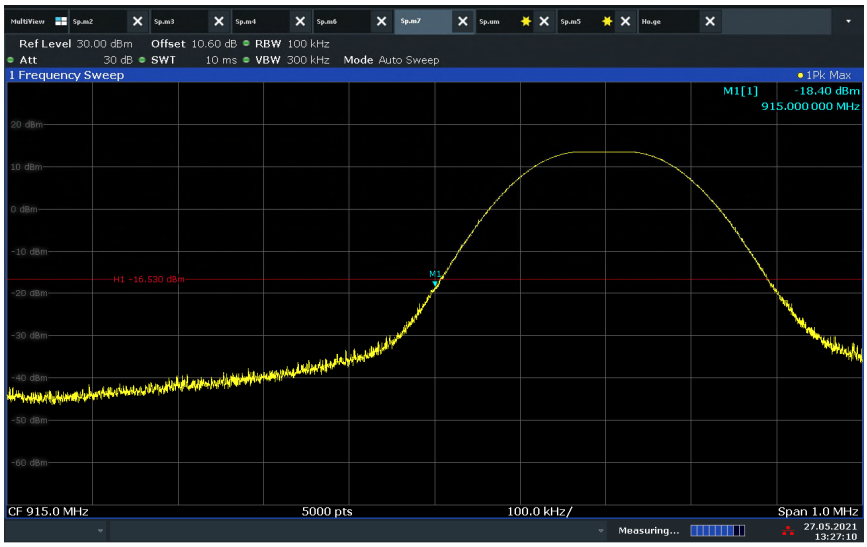
- This is a conducted test.
- An offset of 10.6dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the peak level of the emission operating on the channel closest to the band edge.
- RBW is 100 kHz.
- VBW is 300 kHz.
- Sweep is auto, detector is peak, trace is max hold.
- Trace allowed to stabilize. Marker-delta function used to verify compliance.
- Limit is 20dBc (30dBc was measured as worst case).
- Both Hopping and Non-Hopping mode verified.
- Band edges verified were all >20dBc, EUT complies.

2.8.8 Test Results



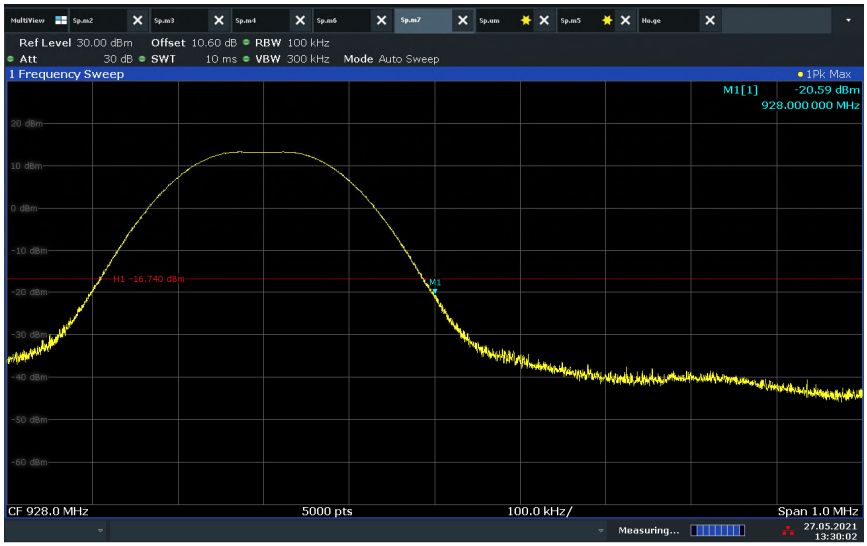
13:28:31 27.05.2021

Low Channel Band Edge @ 902 MHz



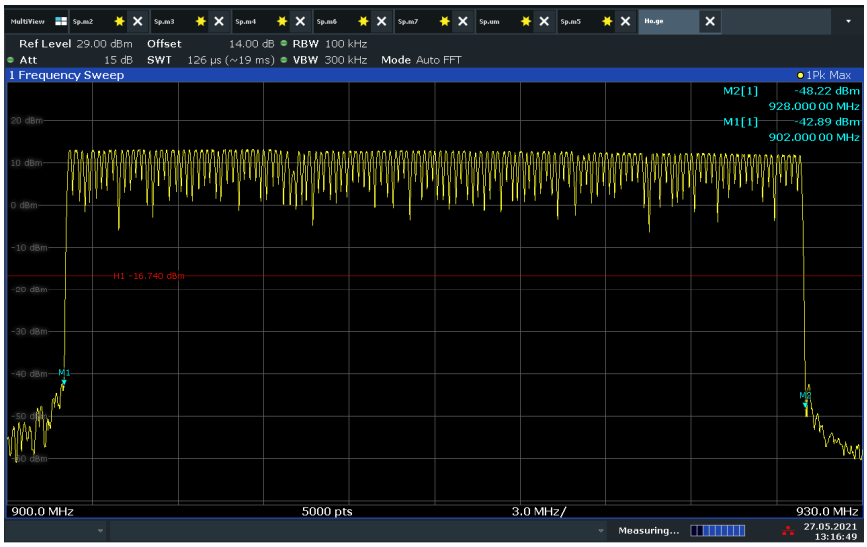
13:27:11 27.05.2021

Low 1 Channel Band Edge @ 915 MHz



13:30:03 27.05.2021

High Channel Band Edge @ 928 MHz



13:16:49 27.05.2021

Hopping Mode Band Edge @ 902 MHz and 928 MHz

2.9 SPURIOUS RF CONDUCTED EMISSIONS

2.9.1 Specification Reference

Part 15 Subpart C §15.247(d)
Part 15 Subpart C §15.205(a)
RSS-247, Section 5.5

2.9.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.9.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A

2.9.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 26 and 27, 2021 / XYZ

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions

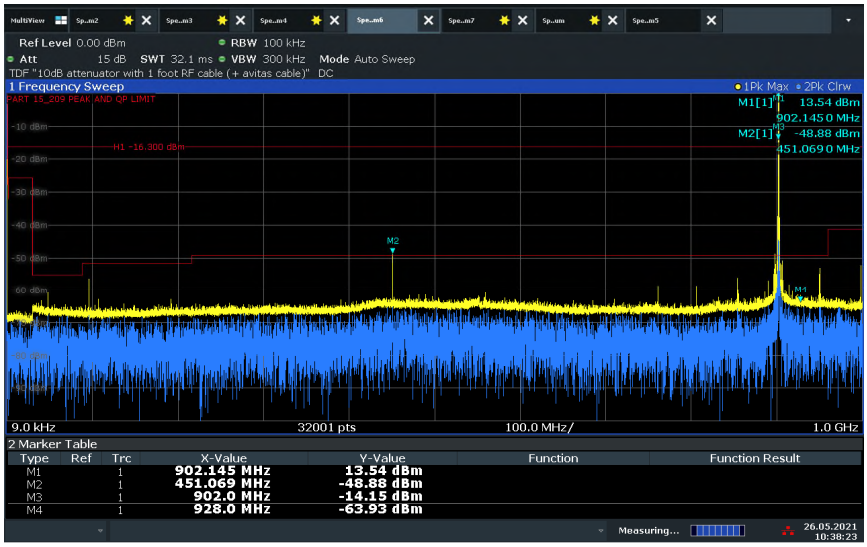
Ambient Temperature	24.5 - 25.5°C
Relative Humidity	42.3 - 44.3%
ATM Pressure	100.4 - 100.6 kPa

2.9.7 Additional Observations

- This is a conducted test. A transducer factor (TDF) was used to compensate for the external attenuator and cable used.
- Span is from 9kHz up to 10 GHz (to cover 10th harmonic of the High Channel).
- Sweep point setting of the spectrum analyzer is set to maximum (32001).
- RBW is 100 kHz
- BW is 300kHz
- Sweep is auto, detector is peak.
- Trace is max hold.
- Trace allowed to stabilize. Maximum spurious emission compared to limit.

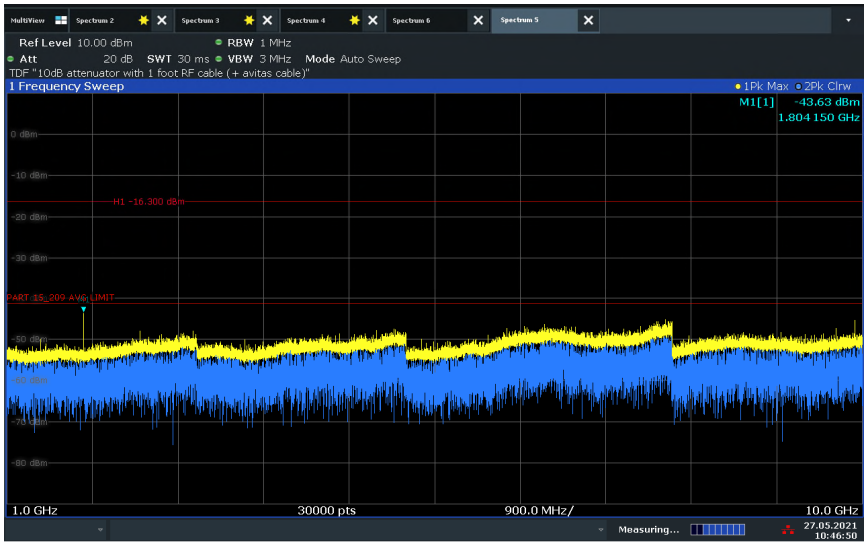
- Limit is 20dBc (worst case 30dBc was measured).
- Emissions which fall in the restricted bands, as defined in § 15.205(a), limits specified in § 15.209(a) is verified (see § 15.205(c)).

2.9.8 Test Results Plot



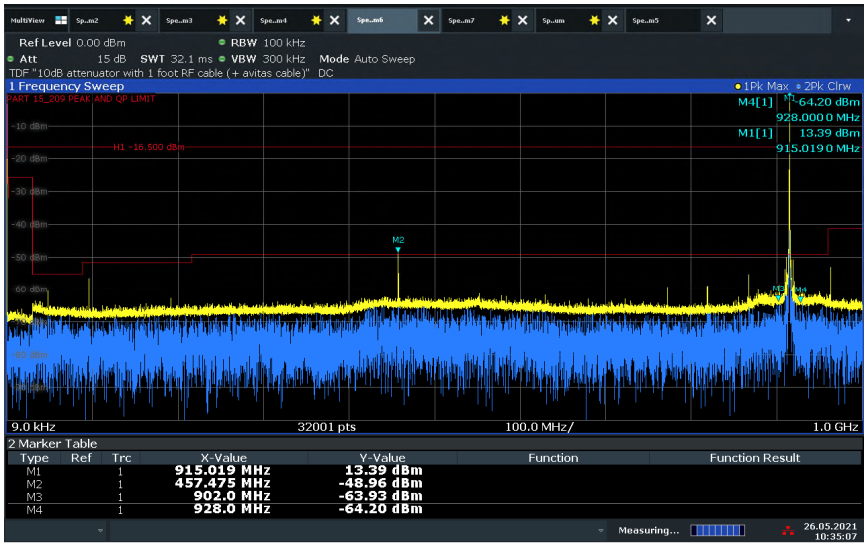
10:38:23 26.05.2021

Note: 451.069 MHz does not fall in restricted band. 20dBc Limit applies.



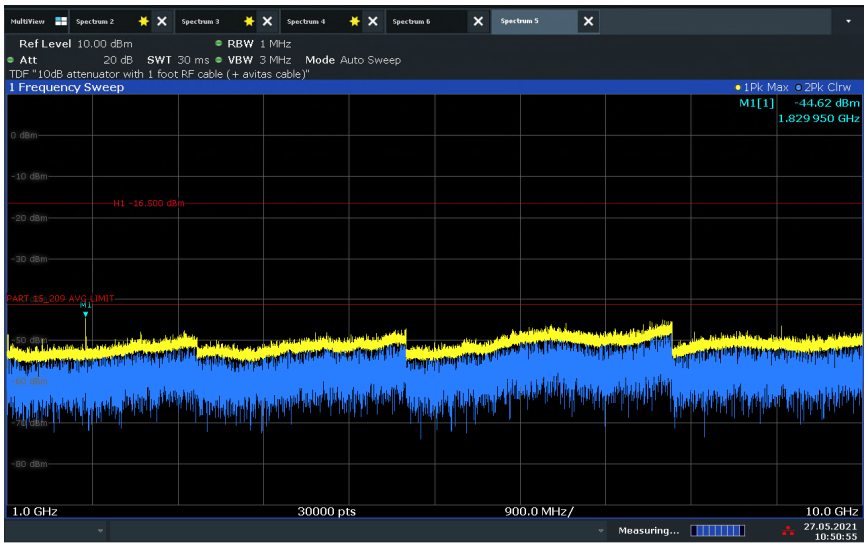
10:46:51 27.05.2021

Low Channel – 902.2 MHz



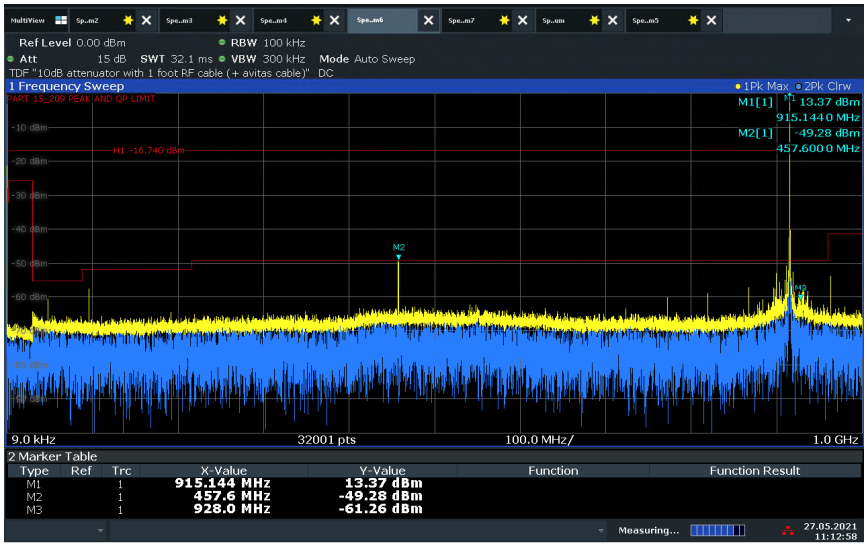
10:35:08 26.05.2021

Note: 457.475 MHz does not fall in restricted band. 20dBc Limit applies.



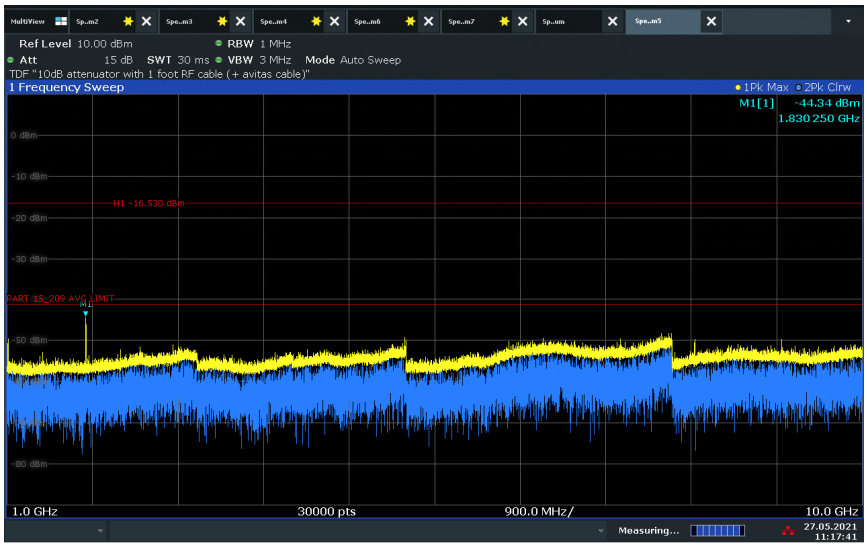
10:50:56 27.05.2021

Middle 1 Channel – 915 MHz



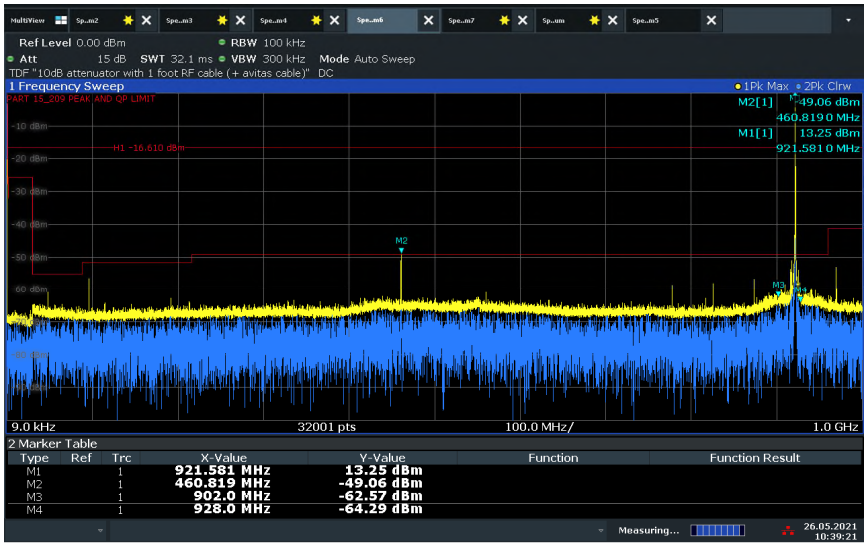
11:12:58 27.05.2021

Note: 457.6 MHz does not fall in restricted band. 20dBc Limit applies.



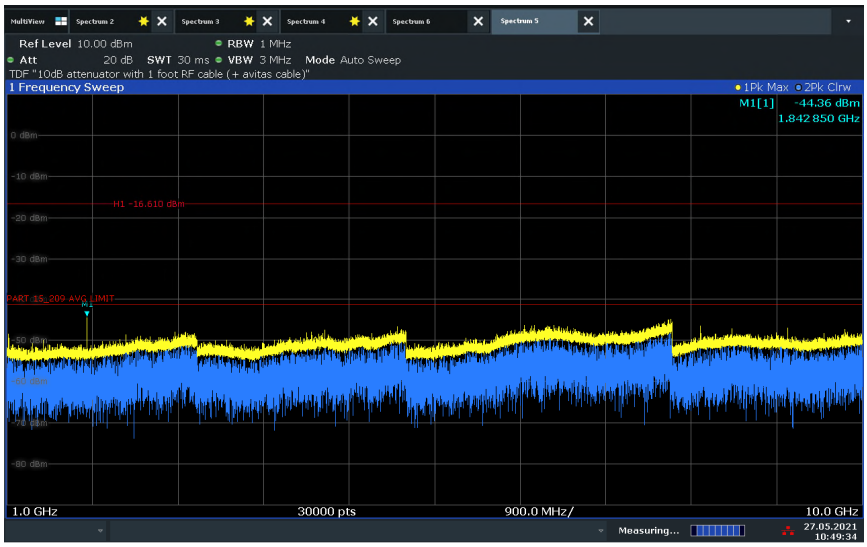
11:17:41 27.05.2021

Low 1 Channel – 915.2 MHz



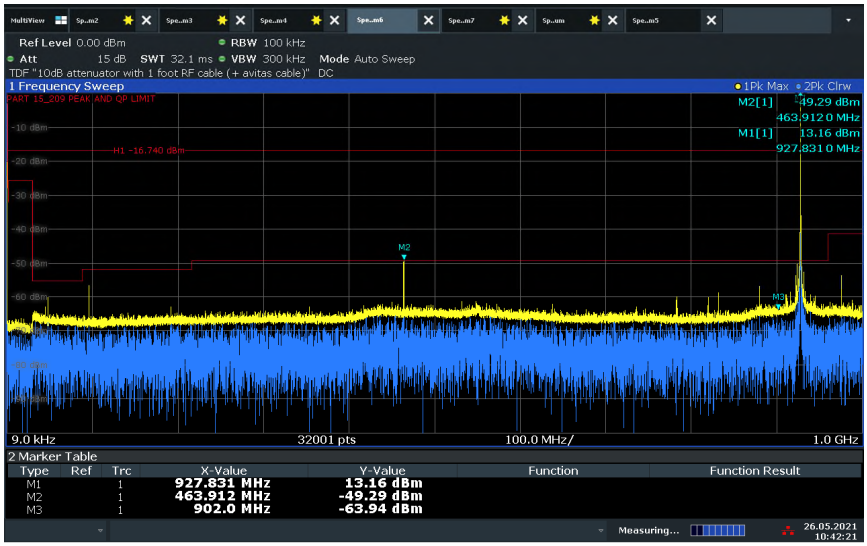
10:39:22 26.05.2021

Note: 460.819 MHz does not fall in restricted band. 20dBc Limit applies.



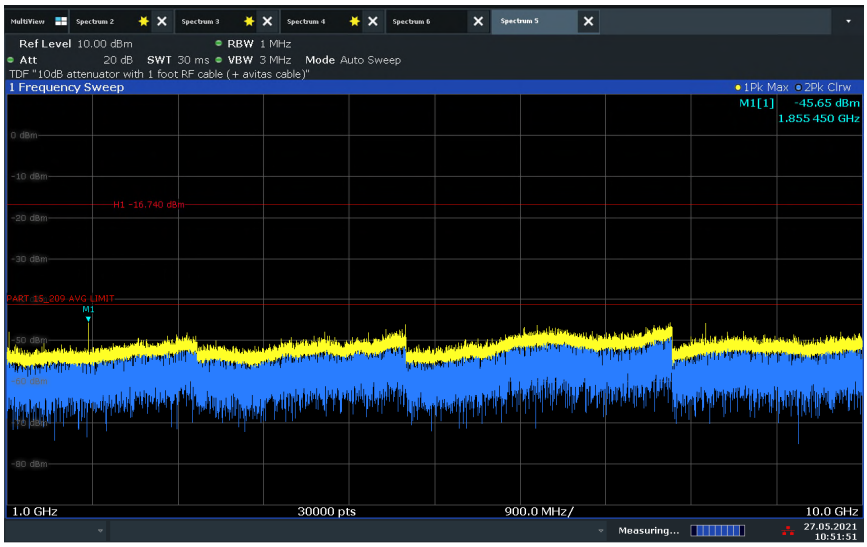
10:49:35 27.05.2021

Middle 2 Channel – 921.6 MHz



10:42:21 26.05.2021

Note: 463.912 MHz does not fall in restricted band. 20dBc Limit applies.



10:51:52 27.05.2021

High Channel – 927.8 MHz

2.10 RADIATED SPURIOUS EMISSIONS

2.10.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
Part 15 Subpart C §15.205(a)
RSS-247, Clause 5.5

2.10.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.10.3 Equipment Under Test and Modification State

Serial No: TUV 01 / Test Configuration A

2.10.4 Date of Test/ Initial of Test Personnel who Performed the Test

May 26 and 27, 2021 / XYZ

2.10.5 Test Equipment Used

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

2.10.6 Environmental Conditions

Ambient Temperature	24.5 - 25.5°C
Relative Humidity	42.3 - 44.3%
ATM Pressure	100.4 - 100.6kPa

2.10.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to at least 10th harmonic (18GHz).
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the considered worst case configuration (Low channel 902.2 MHz and Middle 2 channel 921.6 MHz) presented for radiated emissions below 1GHz when not hopping. There are no significant differences in radiated emissions between channels.
- For radiated emissions above 1GHz, test result for Low, Middle and High channels presented.
- 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 2.10.8 for sample computation.

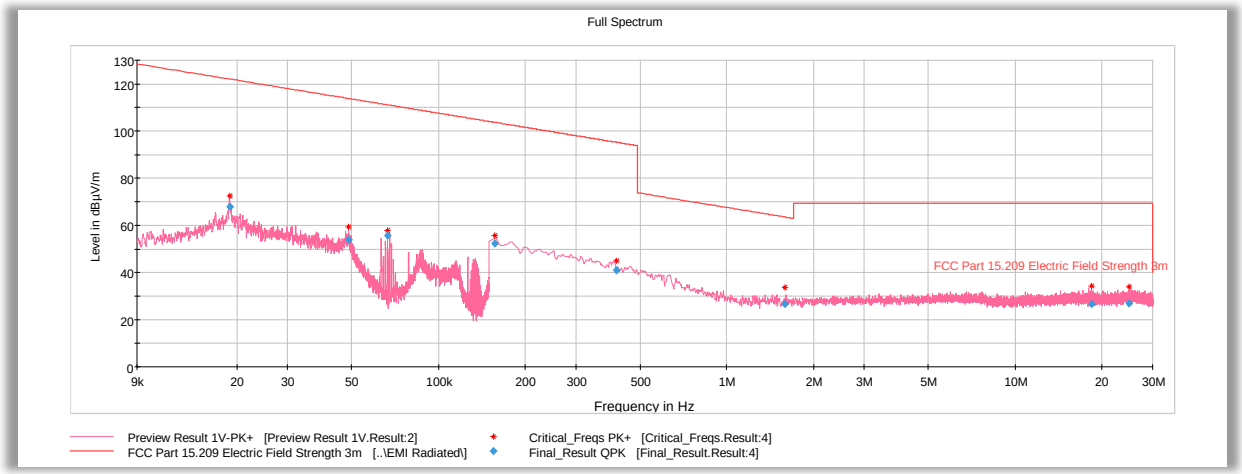
2.10.8 Sample Computation (Radiated Emission)

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**

2.10.9 Test Results

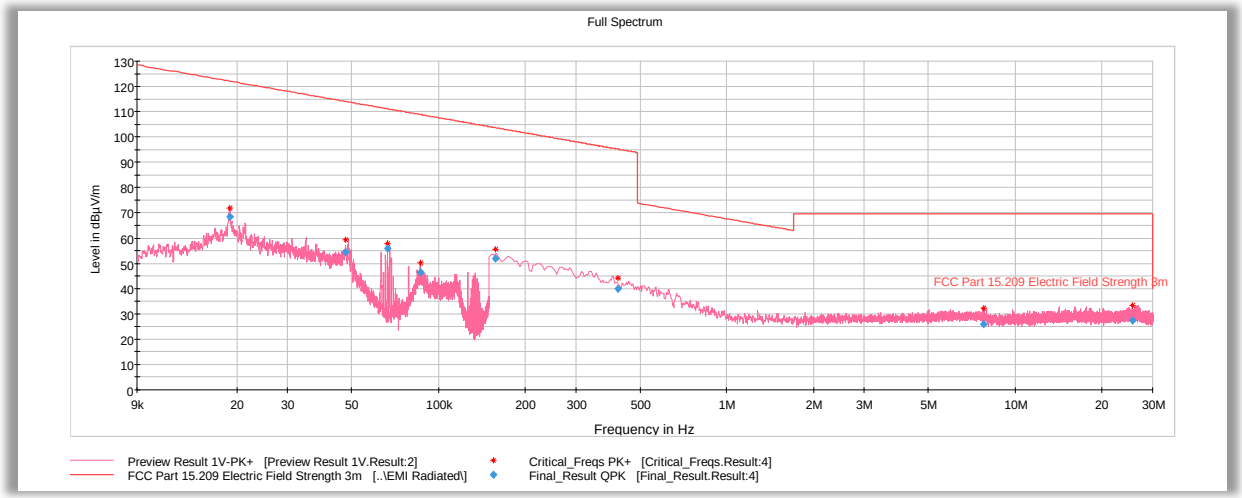
See attached plots.

2.10.10 Test Results for below 30 MHz – Low Channel (902.2 MHz)



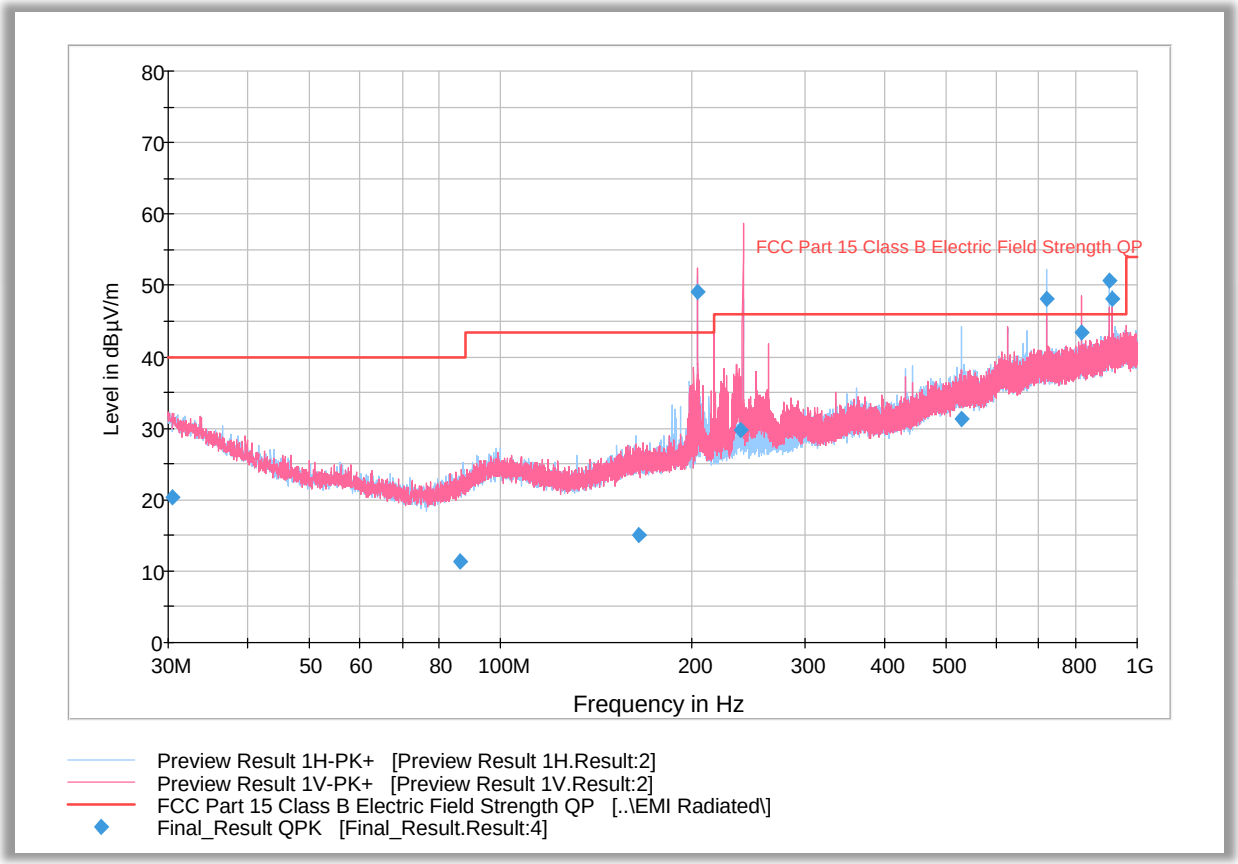
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018860	68.00	122.09	54.09	1000.0	0.200	100.0	H	350.0	22
0.048833	53.97	113.82	59.86	1000.0	0.200	100.0	H	280.0	20
0.066561	55.78	111.14	55.35	1000.0	0.200	100.0	H	16.0	20
0.156500	52.31	103.71	51.40	1000.0	9.000	100.0	H	5.0	20
0.413730	40.88	95.27	54.38	1000.0	9.000	100.0	H	238.0	19
1.593742	26.60	63.55	36.95	1000.0	9.000	100.0	H	77.0	20
18.402473	26.69	69.50	42.81	1000.0	9.000	100.0	H	128.0	23
24.844097	27.02	69.50	42.48	1000.0	9.000	100.0	H	320.0	24

2.10.11 Test Results for below 30 MHz – Middle Channel (921.6 MHz)



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018860	68.32	122.09	53.77	1000.0	0.200	100.0	H	17.0	22
0.047724	54.31	114.02	59.71	1000.0	0.200	100.0	H	230.0	20
0.066557	55.84	111.14	55.29	1000.0	0.200	100.0	H	326.0	20
0.086479	46.58	108.86	62.28	1000.0	0.200	100.0	H	302.0	20
0.157500	51.85	103.66	51.80	1000.0	9.000	100.0	H	109.0	20
0.419670	39.77	95.15	55.37	1000.0	9.000	100.0	H	53.0	19
7.774548	25.97	69.50	43.53	1000.0	9.000	100.0	H	7.0	20
25.600748	27.26	69.50	42.24	1000.0	9.000	100.0	H	296.0	25

2.10.12 Test Results for 30MHz to 1GHz – Low Channel (902.2 MHz)

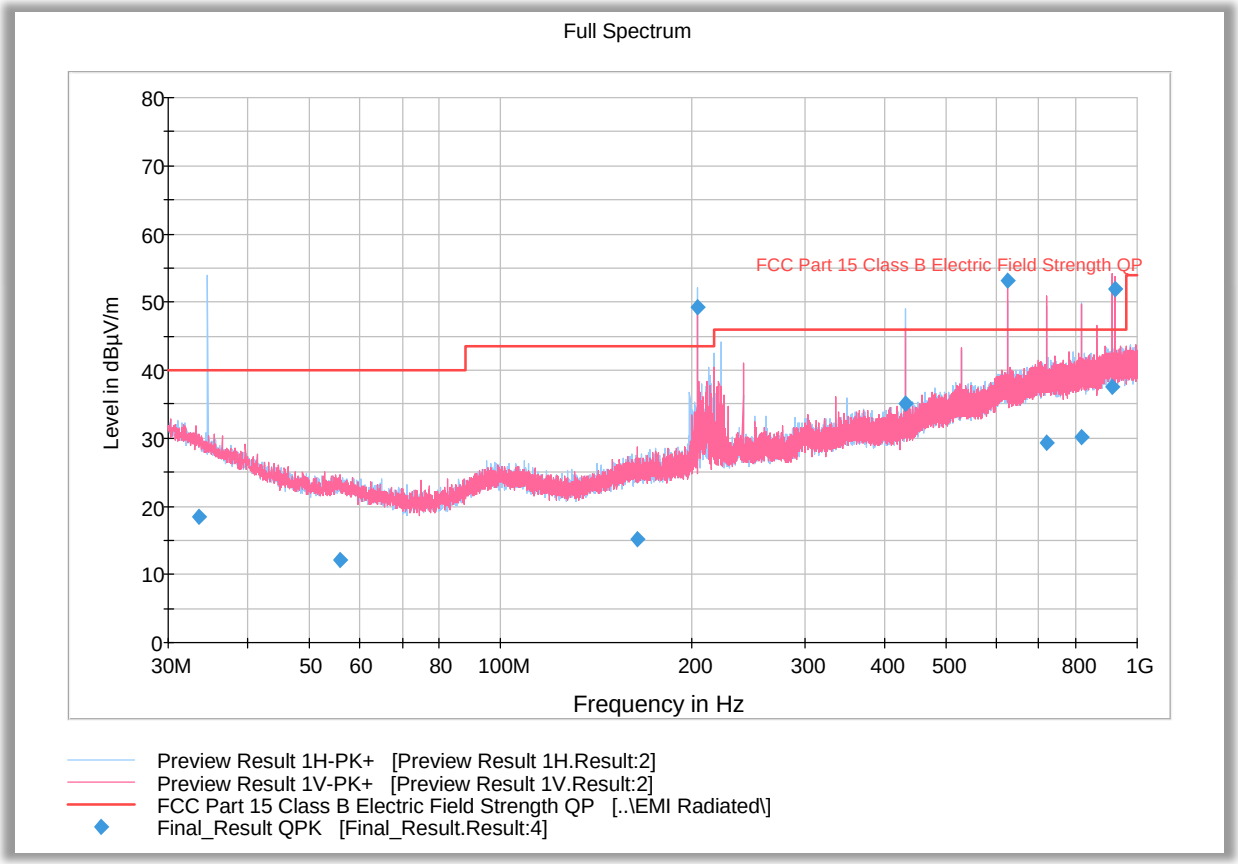


Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.440000	20.30	40.00	19.70	1000.0	120.000	125.0	V	332.0	22
86.228333	11.27	40.00	28.73	1000.0	120.000	395.0	H	185.0	14
164.581000	15.13	43.50	28.37	1000.0	120.000	215.0	H	-5.0	17
204.018000*	49.18	43.50	-5.68	1000.0	120.000	116.0	V	334.0	18
238.445000*	29.80	46.00	16.20	1000.0	120.000	125.0	V	358.0	20
527.910333	31.29	46.00	14.71	1000.0	120.000	225.0	H	283.0	26
720.098000*	48.02	46.00	-2.02	1000.0	120.000	116.0	H	81.0	29
816.008000*	43.43	46.00	2.57	1000.0	120.000	100.0	V	0.0	30
902.208667	50.70	Fundamental Carrier		1000.0	120.000	125.0	H	217.0	31
912.093333*	48.11	46.00	-2.11	1000.0	120.000	119.0	H	-6.0	31

Note *: These frequencies are not within the restricted bands. They complies with the -20 dBc limit (-6.3 dBm = 13.7 dBm – 20 dBc, converted to field streanth is 88.53 dBµV/m)

2.10.13 Test Results for 30MHz to 1GHz – Middel 2 Channel (921.6 MHz)

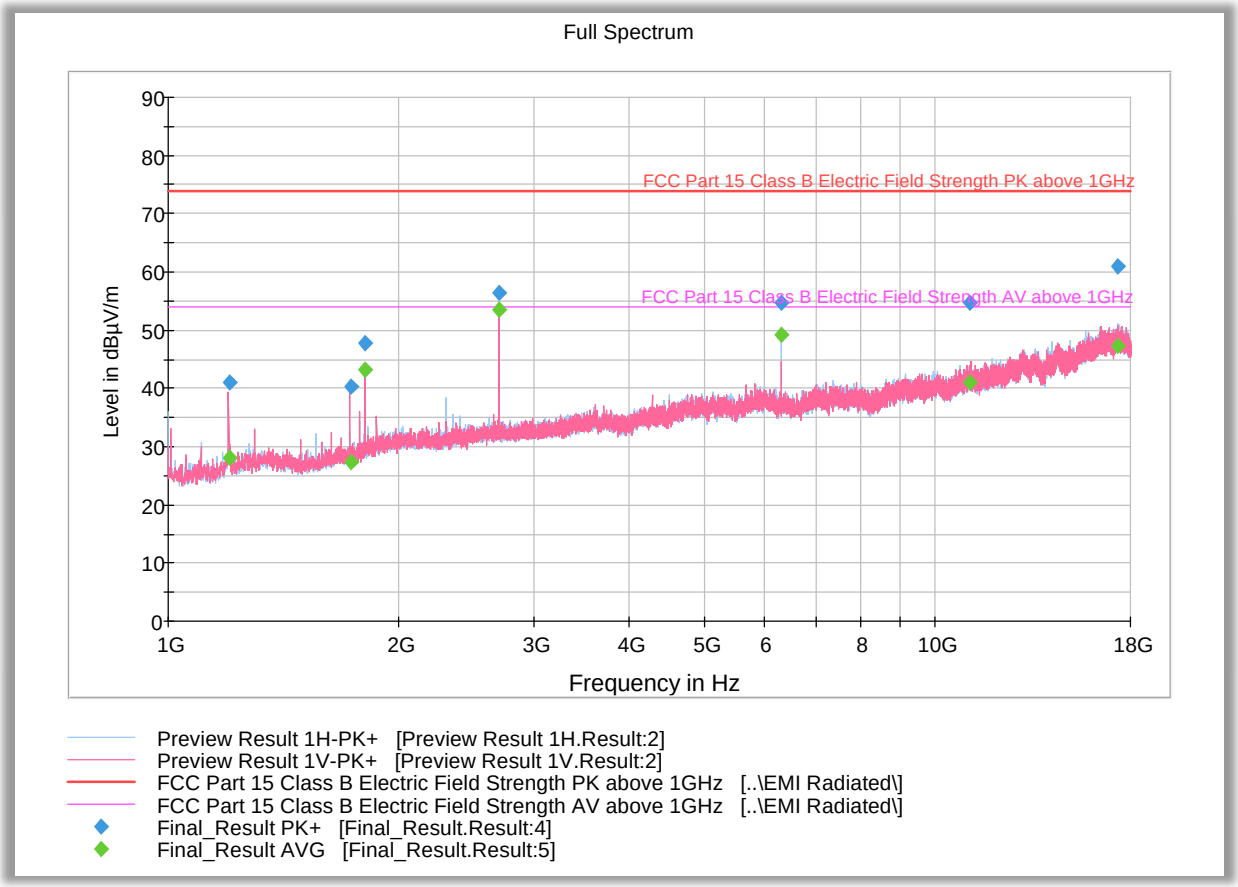


Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.463667*	18.55	40.00	21.45	1000.0	120.000	125.0	H	333.0	21
55.946667	12.00	40.00	28.00	1000.0	120.000	325.0	V	73.0	14
163.921333	15.13	43.50	28.37	1000.0	120.000	316.0	V	174.0	17
204.018000*	49.18	43.50	-5.68	1000.0	120.000	208.0	H	352.0	18
431.912667*	35.12	46.00	10.88	1000.0	120.000	216.0	H	338.0	23
624.060333*	53.23	46.00	-7.23	1000.0	120.000	298.0	V	8.0	28
719.898000*	29.37	46.00	16.63	1000.0	120.000	190.0	V	-2.0	29
816.960333*	30.09	46.00	15.91	1000.0	120.000	125.0	V	20.0	30
912.053333*	37.53	46.00	8.47	1000.0	120.000	185.0	V	-8.0	31
921.624000	51.99	46.00	-5.99	1000.0	120.000	299.0	V	185.0	31

Note *: These frequencies are not within the restricted bands. They complies with the -20 dBc limit (-6.61 dBm = 13.39 dBm – 20 dBc, converted to field streanth is 88.62 dBµV/m)

2.10.14 Test Results for above 1GHz – Low Channel (902.2 MHz)



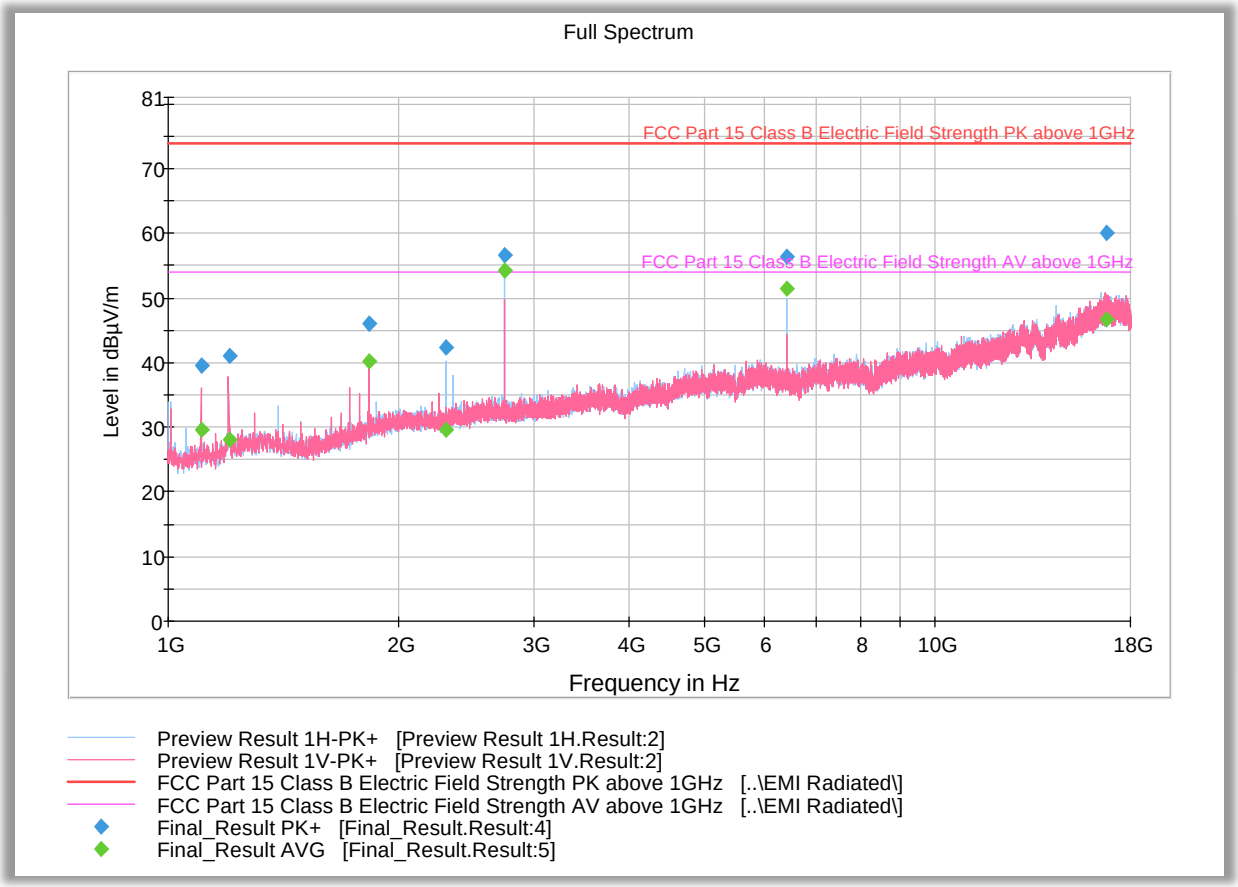
Peak Results

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1202.633333	40.98	73.90	32.92	1000.0	1000.000	317.0	V	240.0	-2
1729.400000	40.42	73.90	33.48	1000.0	1000.000	205.0	V	44.0	-2
1804.300000	47.77	73.90	26.13	1000.0	1000.000	336.0	V	215.0	-1
2706.833333	56.33	73.90	17.57	1000.0	1000.000	165.0	V	54.0	2
6315.533333	54.80	73.90	19.10	1000.0	1000.000	302.0	H	279.0	6
11113.200000	54.60	73.90	19.30	1000.0	1000.000	175.0	V	316.0	14
17333.166667	60.90	73.90	13.00	1000.0	1000.000	355.0	H	52.0	19

Average Results

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1202.633333	28.09	53.90	25.81	1000.0	1000.000	317.0	V	240.0	-2
1729.400000	27.39	53.90	26.51	1000.0	1000.000	205.0	V	44.0	-2
1804.300000	43.26	53.90	10.64	1000.0	1000.000	336.0	V	215.0	-1
2706.833333	53.63	53.90	0.27	1000.0	1000.000	165.0	V	54.0	2
6315.533333	49.20	53.90	4.70	1000.0	1000.000	302.0	H	279.0	6
11113.200000	40.98	53.90	12.92	1000.0	1000.000	175.0	V	316.0	14
17333.166667	47.35	53.90	6.55	1000.0	1000.000	355.0	H	52.0	19

2.10.15 Test Results for above 1GHz – Middle 1 Channel (915 MHz)



Peak Results

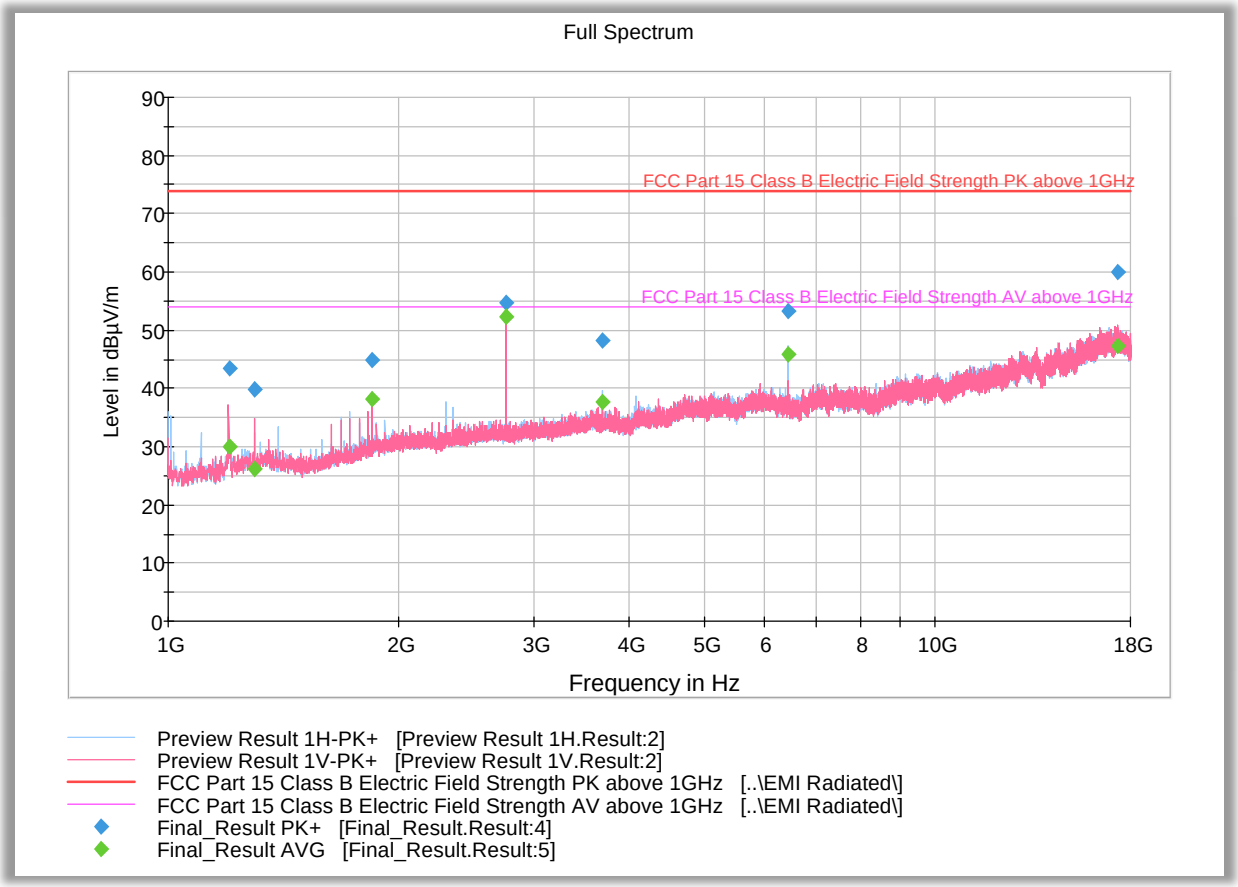
Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1104.300000	39.59	73.90	34.31	1000.0	1000.000	339.0	V	4.0	-6
1202.233333	41.13	73.90	32.77	1000.0	1000.000	240.0	V	63.0	-2
1829.800000	45.91	73.90	27.99	1000.0	1000.000	142.0	V	43.0	-1
2306.100000	42.39	73.90	31.51	1000.0	1000.000	207.0	H	229.0	0
2744.966667	56.50	73.90	17.40	1000.0	1000.000	348.0	H	125.0	1
6405.233333	56.37	73.90	17.53	1000.0	1000.000	285.0	H	254.0	6
16788.800000	60.14	73.90	13.76	1000.0	1000.000	356.0	H	115.0	18

Average Results

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1104.300000	29.56	53.90	24.34	1000.0	1000.000	339.0	V	4.0	-6
1202.233333	28.11	53.90	25.79	1000.0	1000.000	240.0	V	63.0	-2
1829.800000	40.12	53.90	13.78	1000.0	1000.000	142.0	V	43.0	-1
2306.100000	29.60	53.90	24.30	1000.0	1000.000	207.0	H	229.0	0
2744.966667	54.15	53.90	-0.25*	1000.0	1000.000	348.0	H	125.0	1
6405.233333	51.51	53.90	2.39	1000.0	1000.000	285.0	H	254.0	6
16788.800000	46.58	53.90	7.32	1000.0	1000.000	356.0	H	115.0	18

Note *: The duty cycle of the EUT is 1.25%. Since a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device, the average result complies with the limit when DCCF (-19 dB = 10lg(0.0125) is applied.

2.10.16 Test Results for above 1GHz – Middle 2 Channel (921.6 MHz)



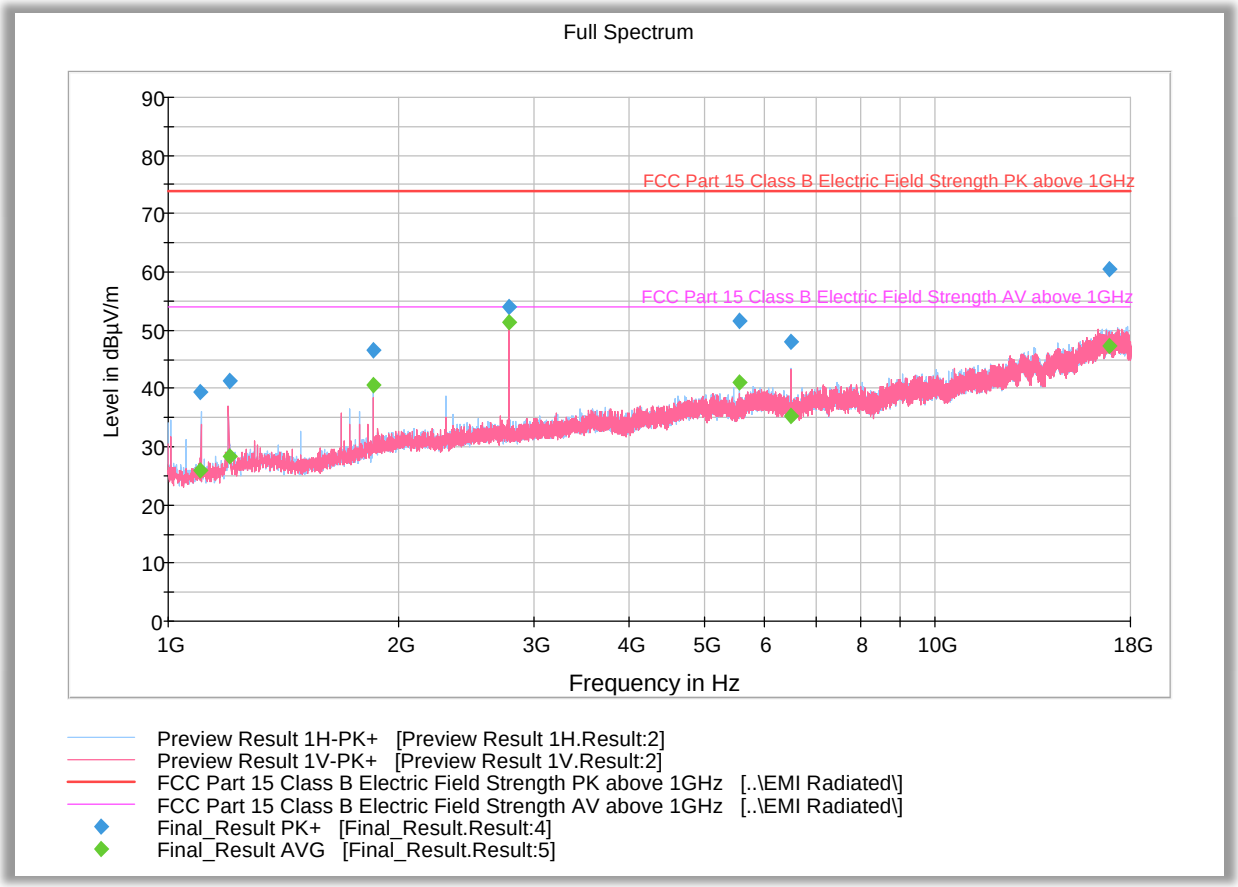
Peak Results

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.233333	43.32	73.90	30.58	1000.0	1000.000	255.0	H	290.0	-2
1296.000000	39.88	73.90	34.02	1000.0	1000.000	320.0	V	15.0	-4
1843.400000	44.79	73.90	29.11	1000.0	1000.000	226.0	H	244.0	0
2764.800000	54.73	73.90	19.17	1000.0	1000.000	148.0	V	56.0	1
3686.600000	48.13	73.90	25.77	1000.0	1000.000	243.0	H	248.0	4
6451.133333	53.23	73.90	20.67	1000.0	1000.000	159.0	H	289.0	6
17359.533333	60.05	73.90	13.85	1000.0	1000.000	140.0	V	18.0	19

Average Results

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1200.233333	30.07	53.90	23.83	1000.0	1000.000	255.0	H	290.0	-2
1296.000000	26.22	53.90	27.68	1000.0	1000.000	320.0	V	15.0	-4
1843.400000	38.13	53.90	15.77	1000.0	1000.000	226.0	H	244.0	0
2764.800000	52.24	53.90	1.66	1000.0	1000.000	148.0	V	56.0	1
3686.600000	37.61	53.90	16.29	1000.0	1000.000	243.0	H	248.0	4
6451.133333	45.76	53.90	8.14	1000.0	1000.000	159.0	H	289.0	6
17359.533333	47.36	53.90	6.54	1000.0	1000.000	140.0	V	18.0	19

2.10.17 Test Results for above 1GHz – High Channel (927.8 MHz)



Peak Results

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1099.900000	39.41	73.90	34.49	1000.0	1000.000	320.0	H	34.0	-6
1200.233333	41.35	73.90	32.55	1000.0	1000.000	365.0	H	258.0	-2
1855.466667	46.52	73.90	27.38	1000.0	1000.000	175.0	H	238.0	0
2783.500000	54.09	73.90	19.81	1000.0	1000.000	353.0	V	165.0	1
5566.966667	51.62	73.90	22.28	1000.0	1000.000	149.0	H	298.0	6
6507.966667	48.03	73.90	25.87	1000.0	1000.000	335.0	H	299.0	6
16901.800000	60.47	73.90	13.43	1000.0	1000.000	339.0	H	290.0	18

Average Results

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1099.900000	26.01	53.90	27.89	1000.0	1000.000	320.0	H	34.0	-6
1200.233333	28.39	53.90	25.51	1000.0	1000.000	365.0	H	258.0	-2
1855.466667	40.44	53.90	13.46	1000.0	1000.000	175.0	H	238.0	0
2783.500000	51.43	53.90	2.47	1000.0	1000.000	353.0	V	165.0	1
5566.966667	41.04	53.90	12.86	1000.0	1000.000	149.0	H	298.0	6
6507.966667	35.32	53.90	18.58	1000.0	1000.000	335.0	H	299.0	6
16901.800000	47.21	53.90	6.69	1000.0	1000.000	339.0	H	290.0	18

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 Port Setup						
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	02/02/21	02/22/22
1003	Signal Generator	SMR40	1104.0002.40	Rhode & Schwarz	06/18/20	06/18/21
8832	10dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 1003 and 7611	
-	Step Attenuator	8494B	2812A17193	Agilent	Verified by 1003 and 7611	
-	Step Attenuator	8496B	MY42143874	Agilent	Verified by 1003 and 7611	
-	Power splitter	ZN2PD-63-S+	S UU74001429	Mini-Circuits	Verified by 1003 and 7611	
Radiated Emission						
1002	Bilog Antenna	3142C	0058717	EMCO	10/09/19	10/09/21
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	09/16/20	09/16/22
46797	Preamplifier	PA-122	181925	Com Power	10/28/20	10/28/21
1049	EMI Test Receiver	ESU40	100133	Rohde & Schwarz	09/25/20	09/25/21
6628	Loop Antenna	HFH2-Z2335.4711.52	FNr.800.458/25	Schwarbeck	05/22/20	05/22/22
Miscellaneous						
43003	True RMS Multimeter	85 III	69880143	Fluke	10/23/20	10/23/21
7619	Temp & Humidity Sensor	iBTHX-W	15050268	Omega	03/09/21	03/09/22
	Test Software	EMC32	V10.50.40	Rhode & Schwarz	N/A	

3.2 Measurement Uncertainty

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

3.2.1 Conducted Antenna Port Measurement

	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	Cable attenuation	1.00	dB	Normal, k=2	2.000	0.50	0.25
3	Received sinewave accuracy	0.07	dB	Normal, k=2	2.000	0.04	0.00
4	Receiver pulse amplitude	0.00	dB	Rectangular	1.732	0.00	0.00
5	Receiver pulse repetition rate	0.00	dB	Rectangular	1.732	0.00	0.00
6	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
7	Frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
8	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00
	Combined standard uncertainty			Normal		0.52	dB
	Expanded uncertainty			**Normal, k=2**		**1.03**	**dB**

3.2.2 Radiated Measurements (Below 30 MHz)

	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	0.44	dB	Normal, k=2	2.000	0.22	0.05
4	Receiver sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
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 10 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 10 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	0.00	dB	Triangular	2.449	0.00	0.00
16	Separation distance at 10 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.00	dB	Rectangular	1.732	0.00	0.00
18	Table height at 10 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		2.45	dB
	Expanded uncertainty			**Normal, k=2**		**4.91**	**dB**

3.2.3 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	0.58	dB	Normal, k=2	2.000	0.29	0.08
4	Receiver sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
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	3.99	dB	Triangular	2.449	1.63	2.65
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.57	dB	Rectangular	1.732	0.33	0.11
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	2.97	dB	
	Expanded uncertainty			**Normal, k=2**	**5.94**	**dB**	

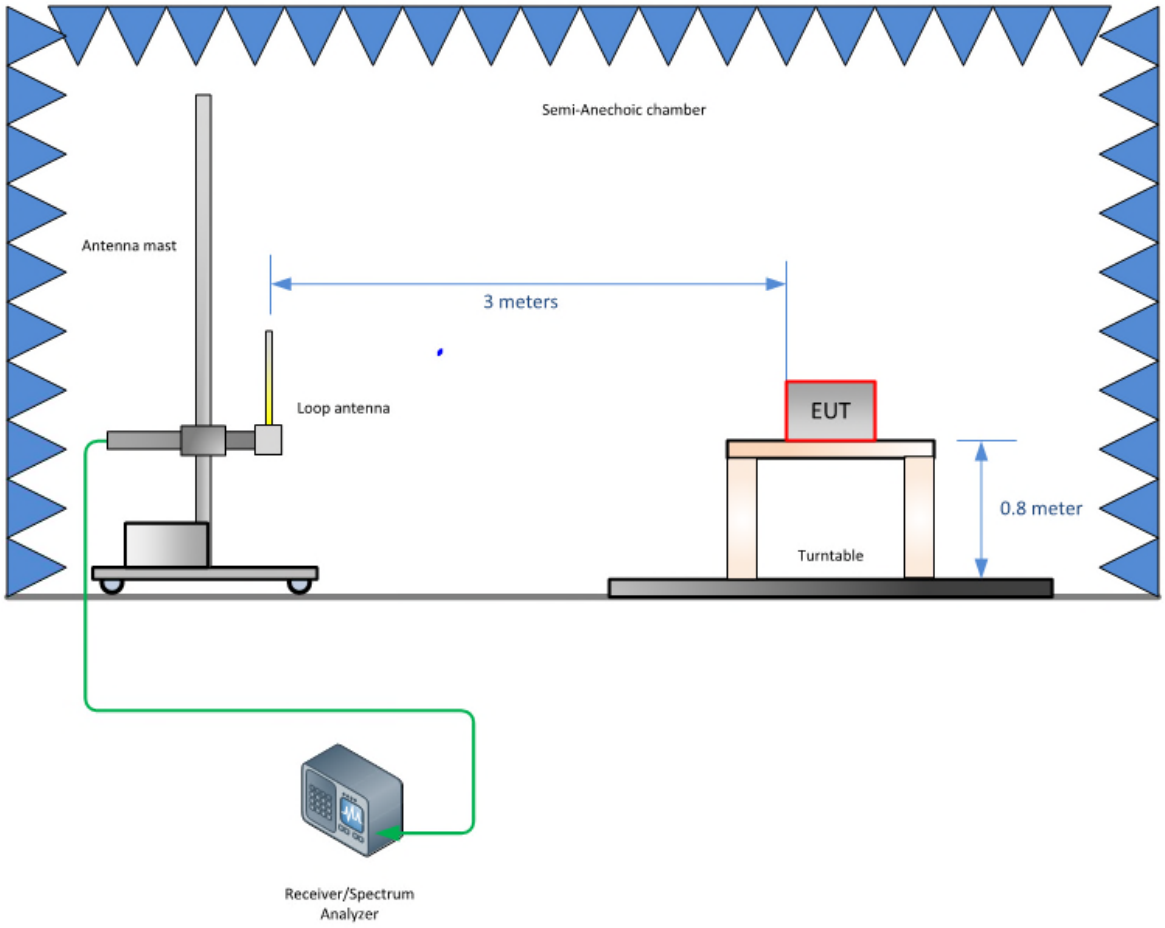
3.2.4 Radiated Emission Measurements (Above 1GHz)

	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	0.30	dB	Normal, k=2	2.000	0.15	0.02
3	Preamplifier Gain	0.20	dB	Normal, k=2	2.000	0.10	0.01
4	Antenna factor AF	0.47	dB	Normal, k=2	2.000	0.24	0.06
5	Sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
6	Instability of preamp gain	1.21	dB	Rectangular	1.732	0.70	0.49
7	Noise floor proximity	0.70	dB	Rectangular	1.732	0.40	0.16
8	Mismatch: antenna-preamplifier	1.41	dB	U-shaped	1.414	1.00	0.99
9	Mismatch: preamplifier-receiver	1.30	dB	U-shaped	1.414	0.92	0.85
10	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
11	Directivity difference at 3 m	1.50	dB	Rectangular	1.732	0.87	0.75
12	Phase center location at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Site imperfections VSWR (Method 2)	5.91	dB	Triangular	2.000	4.89	1.21
15	Effect of setup table material	1.57	dB	Rectangular	1.732	0.91	0.82
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Table height at 3 m	0.00	dB	Normal, k=2	2.000	0.00	0.00
	Combined standard uncertainty			Normal	2.39	dB	
	Expanded uncertainty			**Normal, k=2**	**4.79**	**dB**	

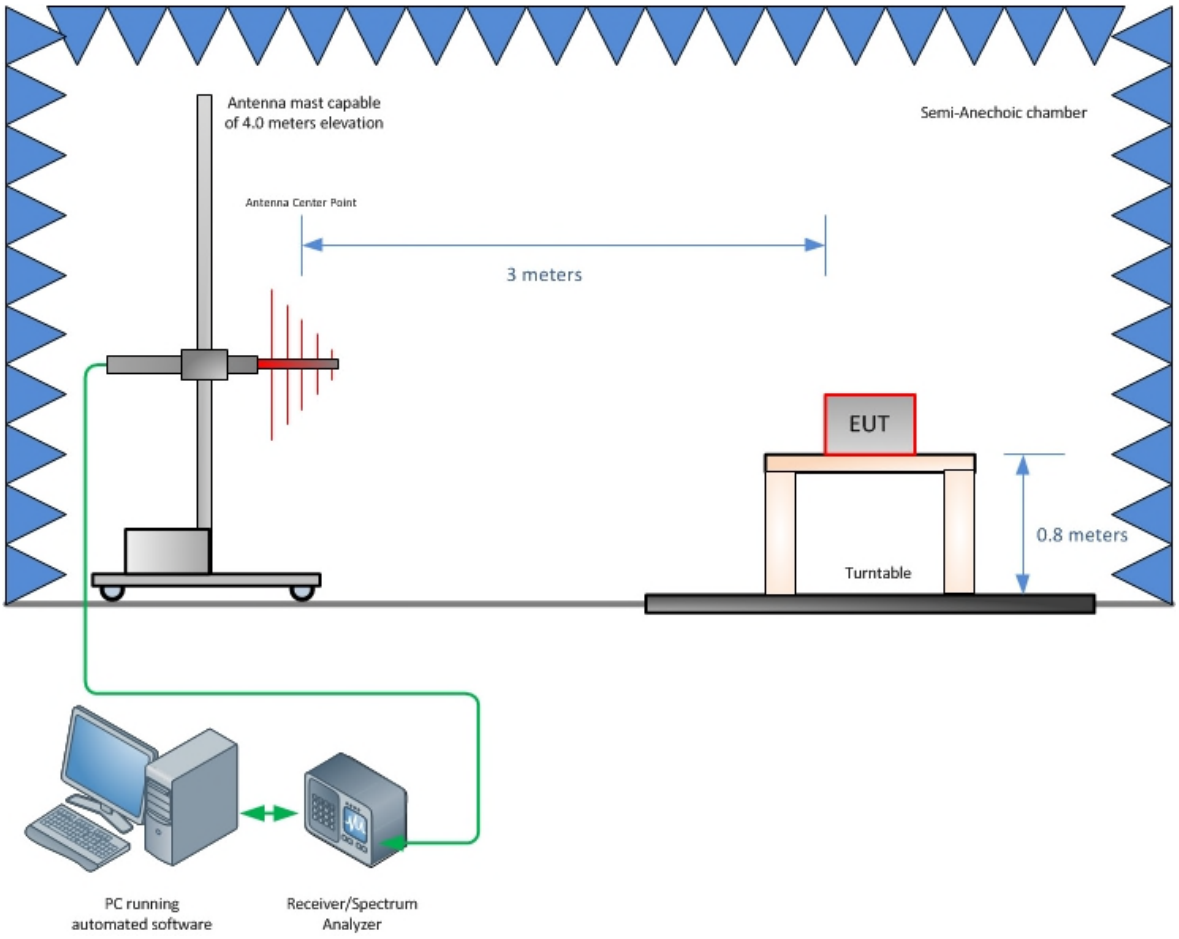
SECTION 4

Diagram of Test Setup

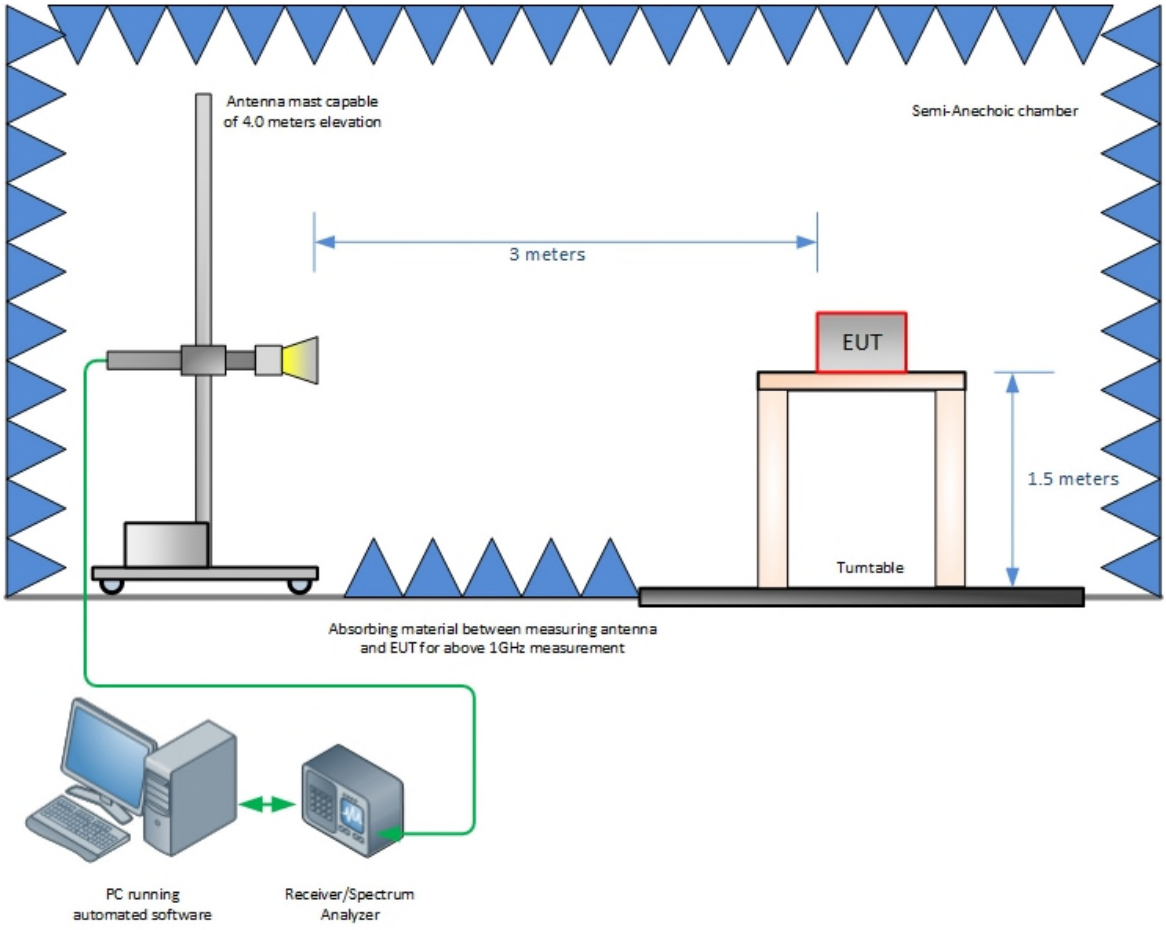
4.1 Test Setup Diagram



Radiated Emission Test Setup (Below 30MHz)



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 Accreditation, Disclaimers and Copyright

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