Radio Testing of the

Avitas Systems LLC
LUMEN Terrain
126M4502 Methane Sensor Node

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

America

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Avitas Systems LLC
17021 Aldine Westfield Road
Houston, Texas 77073
USA

COMMERCIAL-IN-CONFIDENCE

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

Authorized Signatory	Ferdinand S. Custodio	June 16, 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

TÜV SÜD America, Inc.
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REPORT ON	Radio Testing of the Avitas Systems LLC LUMEN Terrain 126M4502 Methane Sensor Node
TEST REPORT NUMBER	72168255G
TEST REPORT DATE	June 2021
PREPARED FOR	Avitas Systems LLC 17021 Aldine Westfield Road Houston, Texas 77073 USA
CONTACT PERSON	Ashraf El-Messidi Engineering Manager ashraf.el-messidi@bakerhughes.com (865) 399-2274
PREPARED BY	Omar Castillo **Name** Authorized Signatory Title: EMC Test Engineer
APPROVED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
DATED	June 16, 2021

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

Revision History

72168255G Avitas Systems LLC LUMEN Terrain Methane Sensor Node					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
06/16/2021	Initial Release				Ferdinand S. Custodio

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SECTION 1

1 REPORT SUMMARY

Radio Testing of the
Avitas Systems LLC
Methane Sensor Node

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Avitas Systems LLC LUMEN Terrain Methane Sensor Node 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 Sensor Node
Trade Name	LUMEN Terrain
Model Number(s)	126M4502
FCC ID Number	2AZ9Q-LTSN
IC Number	N/A
FCC Classification	Frequency Hopping Spread Spectrum systems (DSS)
Serial Number(s)	E861
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2019). • RSS-247 Issue 2 February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, April 2018). • ANSI 63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices. • AS/NZS 4268:2017 Radio equipment and systems – Short Range Devices – Limits and methods of measurement.
Start of Test	May 20, 2021
Finish of Test	May 27, 2021
Name of Engineer(s)	Omar Castillo
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 2017 and RSS-Gen Issue 5 Ammendment 1 March 2019 is 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)	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)	RSS-247 5.5	Spurious RF Conducted Emissions	Compliant	
2.10	§15.247(d)	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 to the fundamental frequency.*
*N/A** EUT does not have receiver mode.*

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) is an Avitas Systems LLC LUMEN Terrain 126M4502 Methane Sensor Node. The EUT is part of the Argus methane leak detection and location system comprising of the EUT that sense the methane leak and a base station that collects the data and 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 Sensor Node
Model Name	LUMEN Terrain
Model Number(s)	126M4502
Rated Voltage	7.0 – 36 VDC
Mode Verified	Sub 1GHz 900MHz radio
Frequency Range	902.2 MHz to 927.8 MHz
Capability	GNSS and Sub 1GHz radio
Primary Unit (EUT)	☒ Production
	☐ Pre-Production
	☐ Engineering
Manufacturer Declared Temperature Range	-30°C to 65°C
Size	239H x 146.5W x 82D mm
Weight	5.4kg
Antenna Type	Omnidirectional
Antenna Model	W5017
Antenna Manufacturer	PULSELARSEN ANTENNAS
Antenna Frequency range	868MHz to 928MHz
Antenna Gain	2 dBi

1.3.3 Maximum Conducted Output Power

Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Data Rate (kbps)	Limit (dBm)
2-GFSK	Low 1	902.2	12.64	50	30
	Low 2	915.2	12.62	50	30
	Middle 1	915	12.63	50	30
	Middle 2	921.6	12.65	50	30
	High	927.8	12.71	50	30

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 antenna connector of the 900MHz radio. Smart RF™ Studio 7 Software was used to change between channels on the 900MHz radio via a support laptop
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 base station 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. Antenna connector of the 900MHz radio was terminated with a 20dB attenuator and a 50Ω termination. Smart RFTM Studio 7™ Software was used to change between channels on the 900MHz radio via a support laptop

1.4.2 EUT Exercise Software

None. No special software was used to exercise the EUT during verification. The EUT however was programmed initially using Smart RF™ Studio 7 to change between channels on the 900MHz radio via a support laptop.

1.4.3 Support Equipment and I/O cables

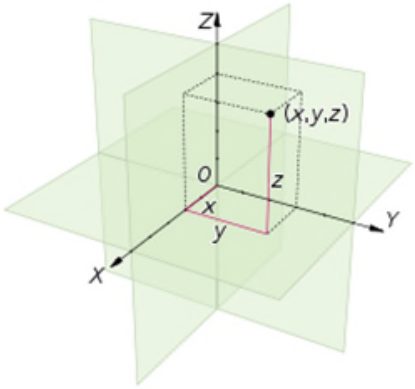
Manufacturer	Equipment/Cable	Description
Panasonic	Support Laptop	P/N: CF-54
Panasonic	Laptop Charger	P/N: CF-AA5713A M3
Texas Instrument	JTAG Debug Probe	P/N: TMDSEMU110-U
Avitas	Base Station	P/N: 126M6399

1.4.4 Worst Case Configuration

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

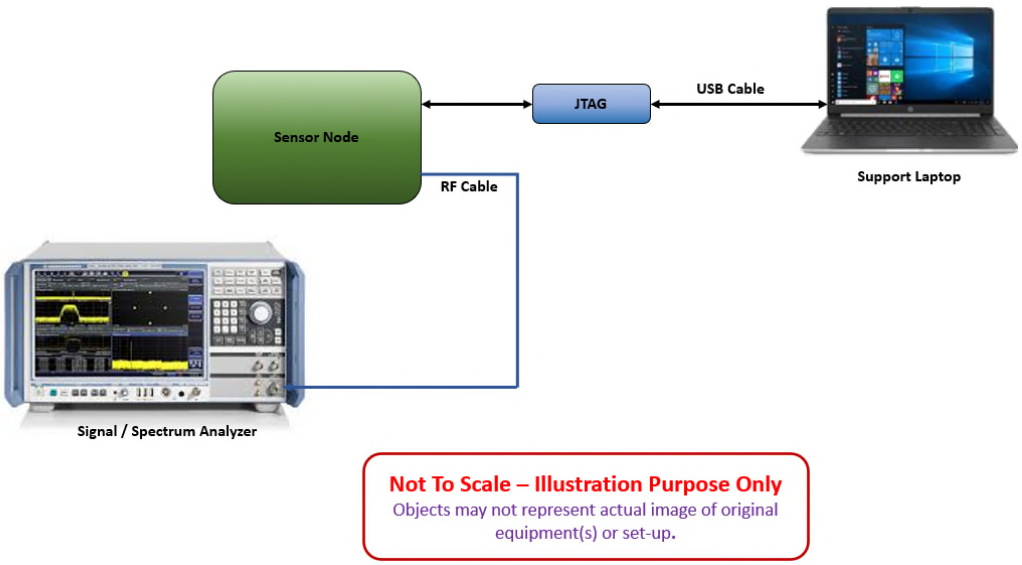
Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Data Rate (kbps)	Limit (dBm)
2-GFSK	Low 1	902.2	12.64	50	30
	Low 2	915.2	12.62	50	30
	Middle 1	915	12.63	50	30
	Middle 2	921.6	12.65	50	30
	High	927.8	12.71	50	30

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



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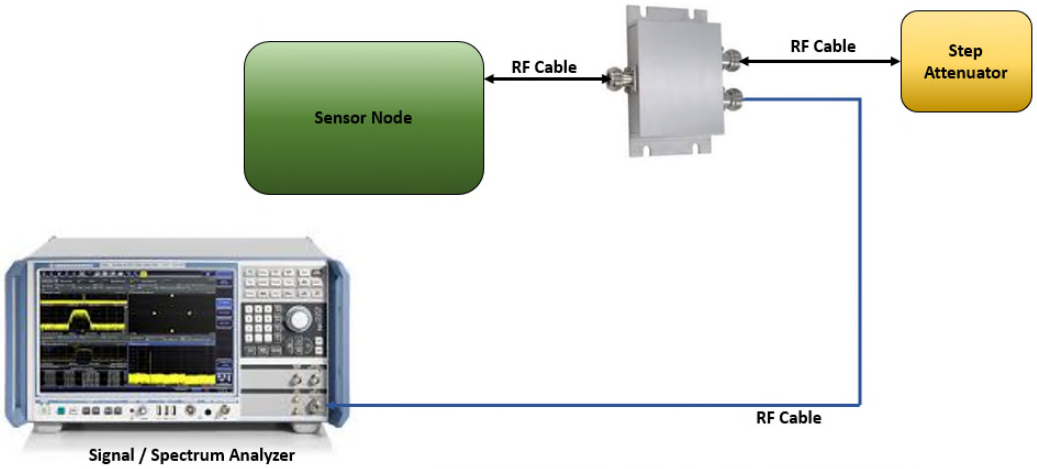
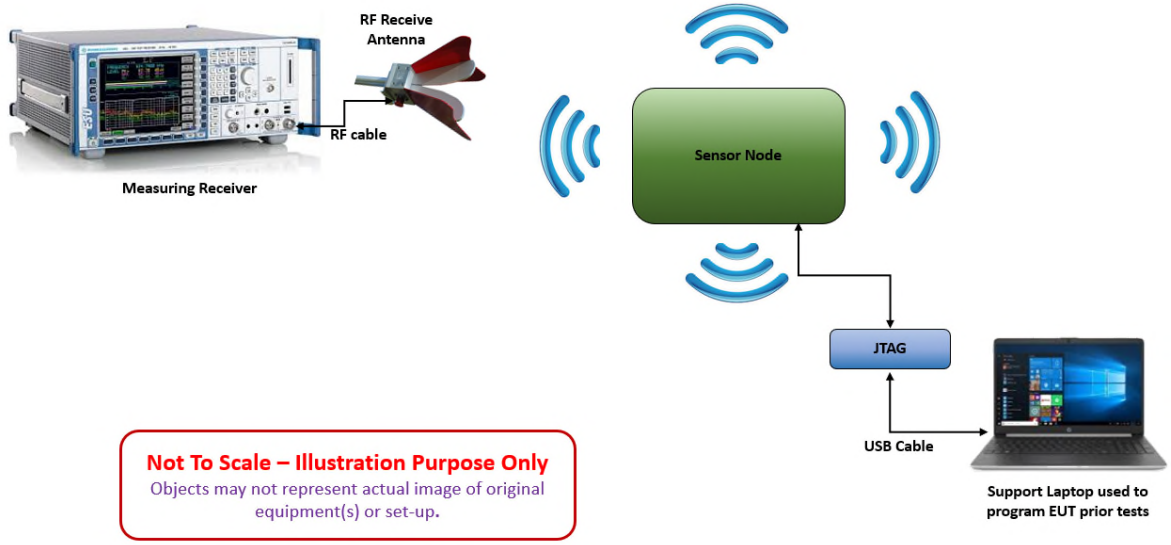
Test Configuration B



Not To Scale – Illustration Purpose Only
Objects may not represent actual image of original equipment(s) or set-up.

Test Configuration C



Not To Scale – Illustration Purpose Only
Objects may not represent actual image of original equipment(s) or set-up.

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 E861		
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.

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SECTION 2

2 TEST DETAILS

Radio Testing of the
Avitas Systems LLC
Methane Sensor Node

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

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: E861 / Test Configuration B

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

May 24, 2021/OC

2.2.5 Test Equipment Used

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

2.2.6 Environmental Conditions / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

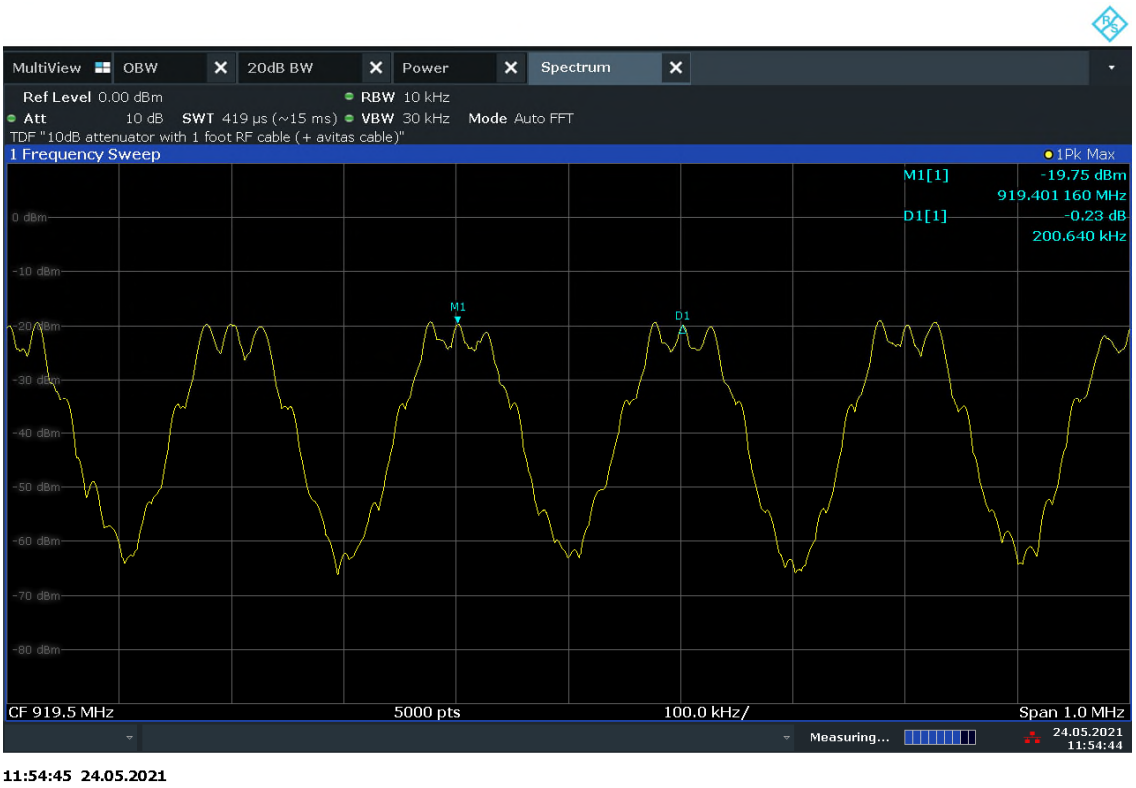
Ambient Temperature	24.3°C
Relative Humidity	45.8%
ATM Pressure	100.3 kPa

2.2.7 Additional Observations

- Hopping function enabled. Node and Base Station were connected to a power combiner connected to the signal analyzer.
- Step attenuator was connected between the Base station and the power combiner to reduce the signal level from the Base Station measured on the signal analyzer end.
- 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 3x RBW
- Sweep is auto
- Detector is peak.
- Trace is max hold.

- Marker-delta function is used between the peaks of the adjacent channels.

2.2.8 Test Results



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Observed carrier frequency separation between Channels = 200.64 kHz (**Complies**. By a minimum of the 20 dB bandwidth of the hopping channel.
200.64kHz is greater than 102.2kHz kHz which is worst case 20 dB BW [Channel Middle 2 / 2-GFSK Modulation. Section 2.5.8 from this test report])

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: E861 / Test Configuration B

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

May 24, 2021/OC

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.3°C
Relative Humidity	48.5%
ATM Pressure	10.3 kPa

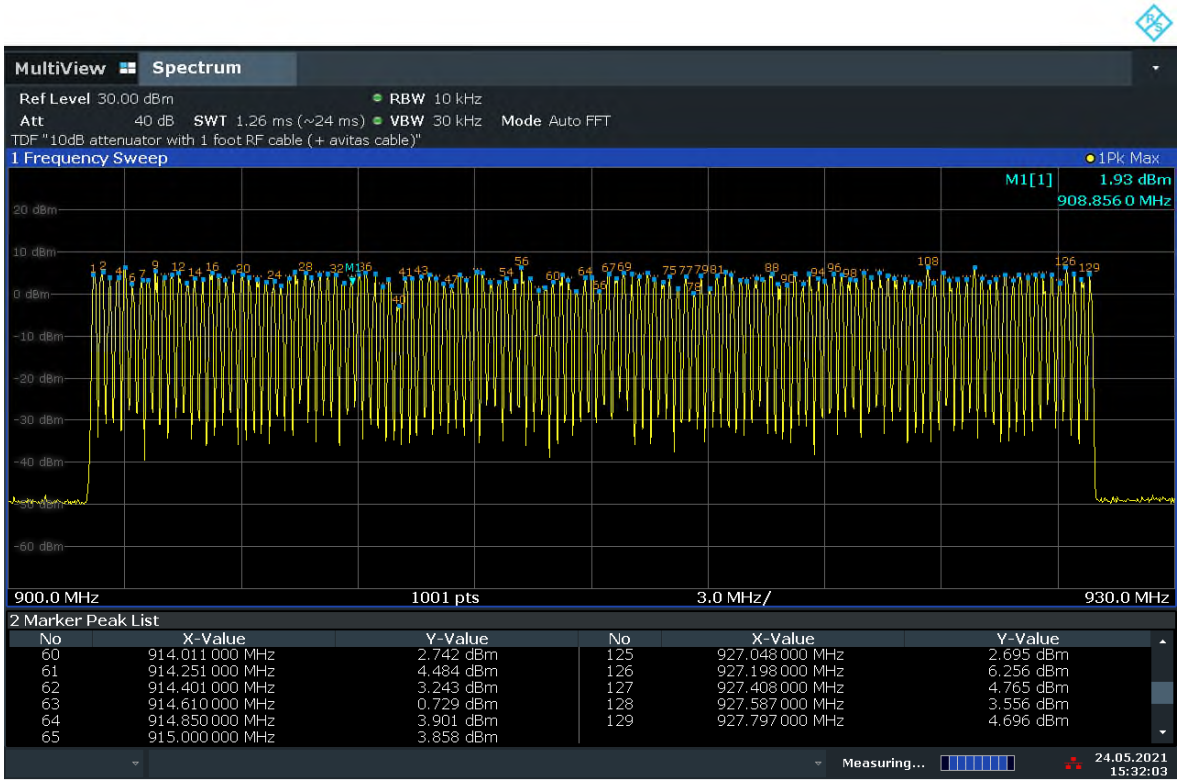
2.3.7 Additional Observations

- Hopping function enabled. Node and Base Station were connected to a power combiner connected to the signal analyzer.
- Step attenuator was connected between the Base station and the power combiner to reduce the signal level from the Base Station measured on the signal analyzer end.
- Marker peak list function was used on signal analyzer to count the number of channels.
- Span is wide enough to capture the channels of interests.
- RBW is 10kHz (Due EUT channel spacing is 200kHz, the Resolution bandwidth was <1% of the span).
- VBW is 3x RBW
- Sweep is auto
- Detector is peak, trace is max hold.
- An offset of 10.6dB was added to compensate for the external attenuator and cable used.

2.3.8 Test Results

Observed Number of Hopping Frequencies is = **129**
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: E861 / Test Configuration B

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

May 24, 2021/OC

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	48.5%
ATM Pressure	100.3 kPa

2.4.7 Additional Observations

- Hopping function enabled.
- Span = zero span, centered on a hopping channel.
- RBW is 100kHz.
- VBW is 3x RBW
- Detector is peak.
- 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	28.9058 ms	<400 ms

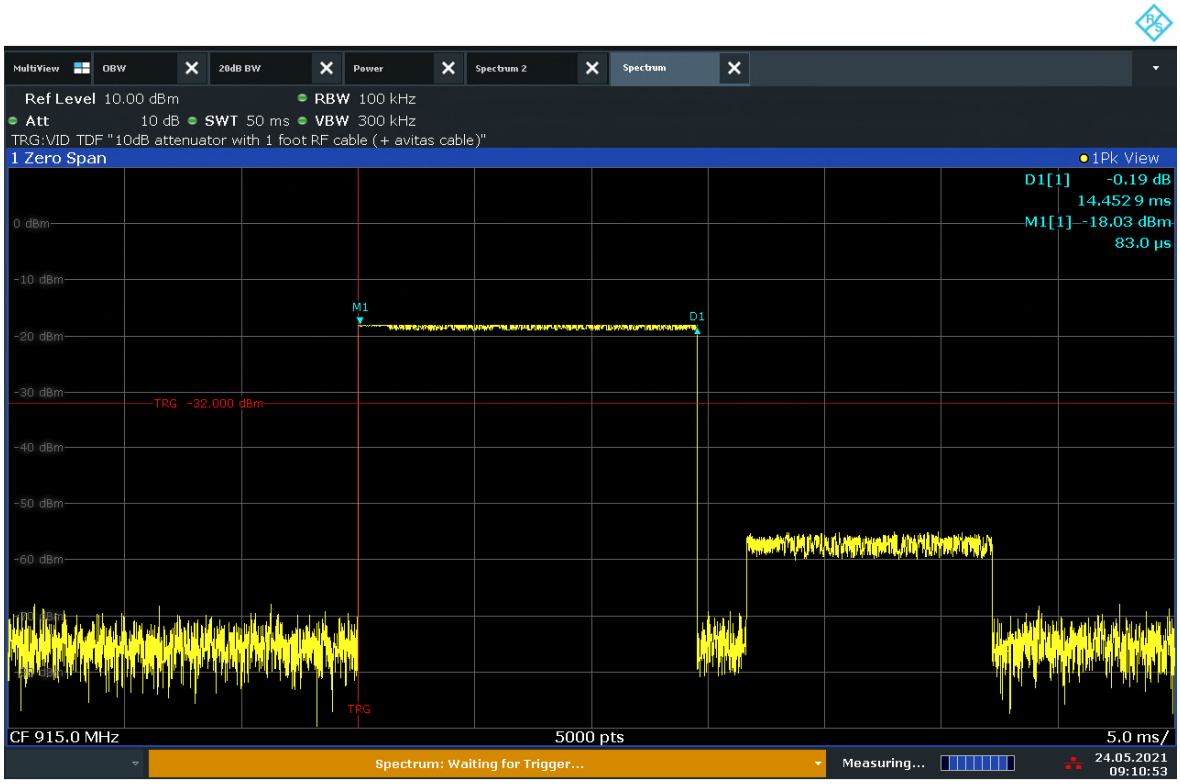
2.4.9 Sample Computation

Width of single pulse = 0.0144529 second
Observed occurrence = 2 pulses / 20 seconds

Time of occupancy = Pulse width x #pulses in 20 seconds
= 0.0144529 second x 2
= 0.0289058 second

Compliance = **Complies.** 0.0289058 second < 0.4 second

2.4.10 Test Results Plots



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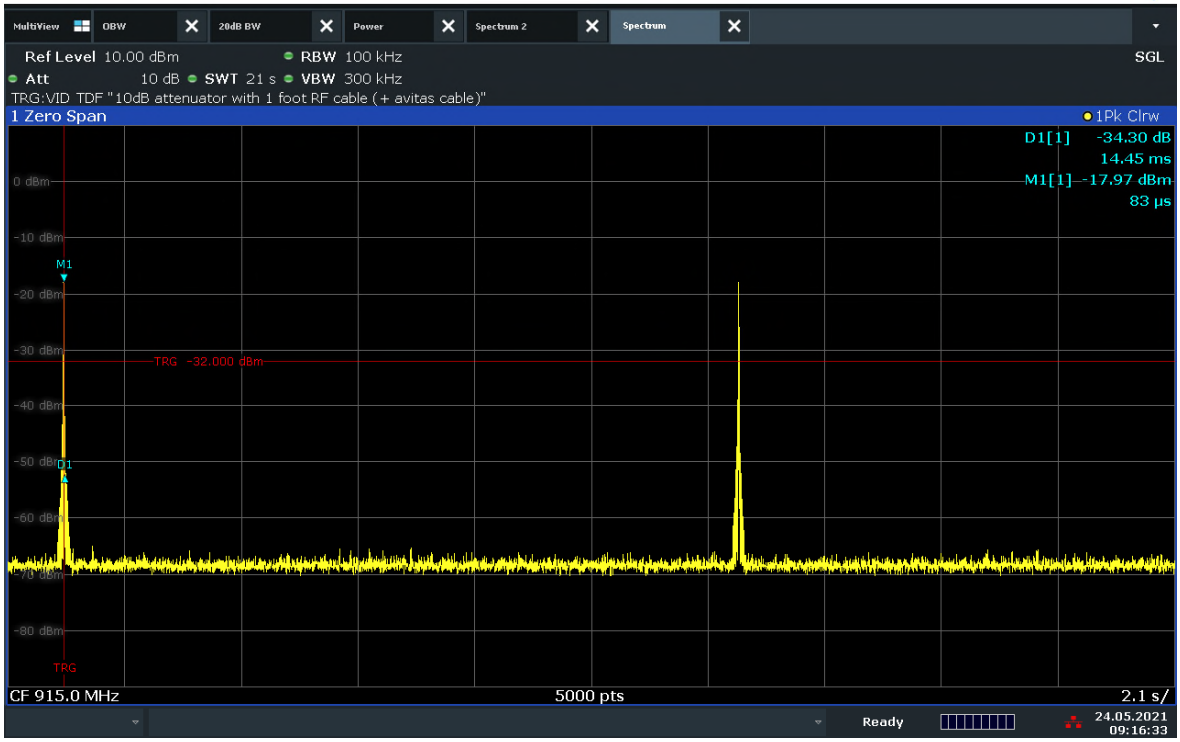
Single pulse (14.4529ms)



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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: E861 / Test Configuration A

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

May 20 and May 27, 2021/OC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.5°C	24.2°C
Relative Humidity	42.5%	42.4%
ATM Pressure	98.7 kPa	100.6 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 3 times the expected 20dB bandwidth.
- RBW is ≥ 1% of the expected 20dB 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.

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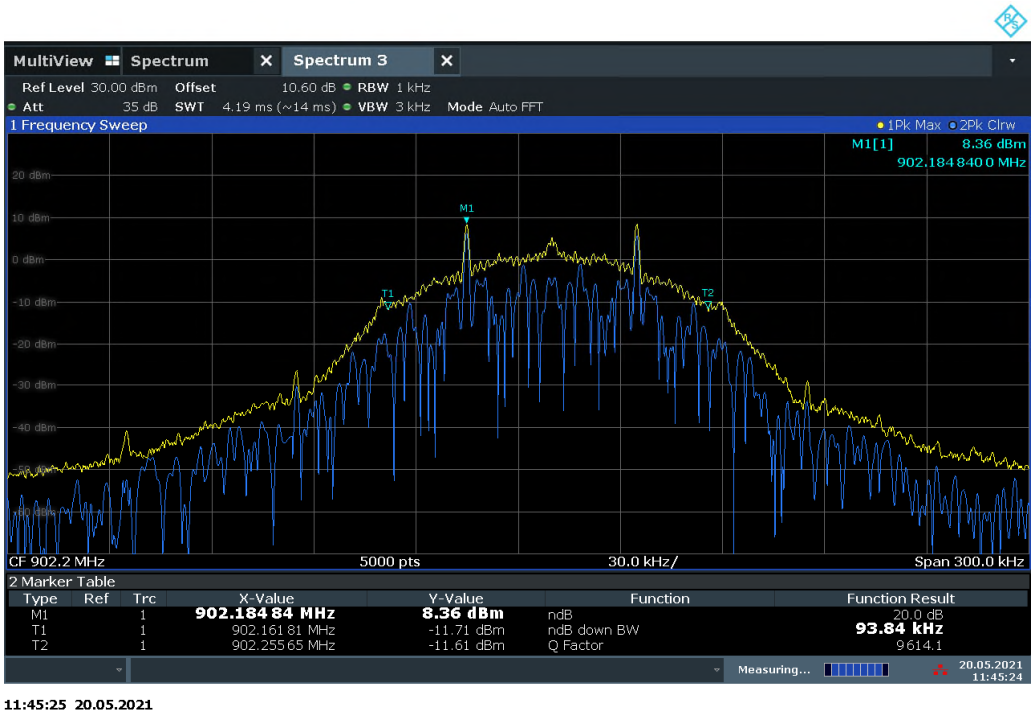
2.5.8 Test Results

Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (kHz)	Data Rate (kbps)
2-GFSK	Low1	902.2	93.84	50
	Low2	915.2	95.20	50
	Middle 1	915.0	91.5	50
	Middle 2	921.6	100.02	50
	High	927.8	90.42	50

902.2 MHz – (20dB BW/2) = 902.15308 MHz (within the frequency band - **Compliant**)

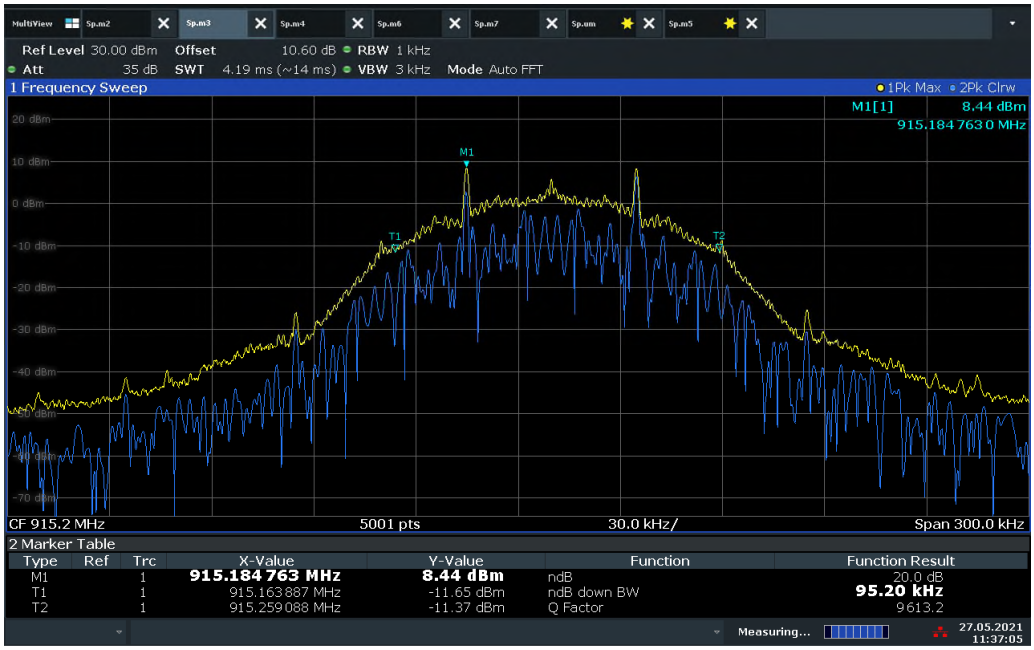
927.8 MHz + (20dB BW/2) = 927.75479 MHz (within the frequency band - **Compliant**)

2.5.9 Test Results Plots



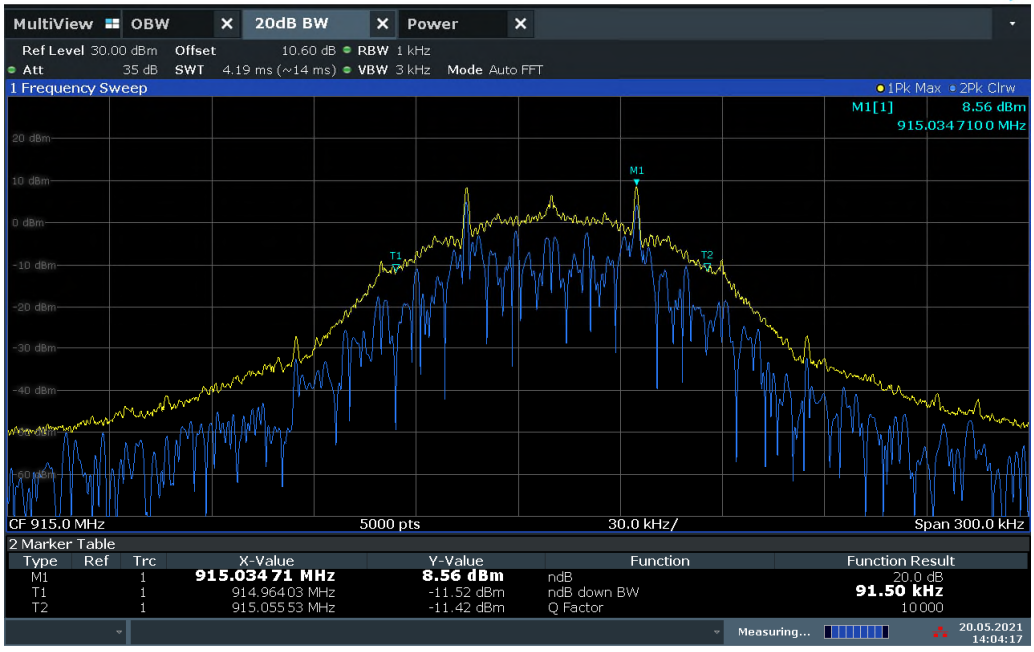
11:45:25 20.05.2021

Low 1 Channel



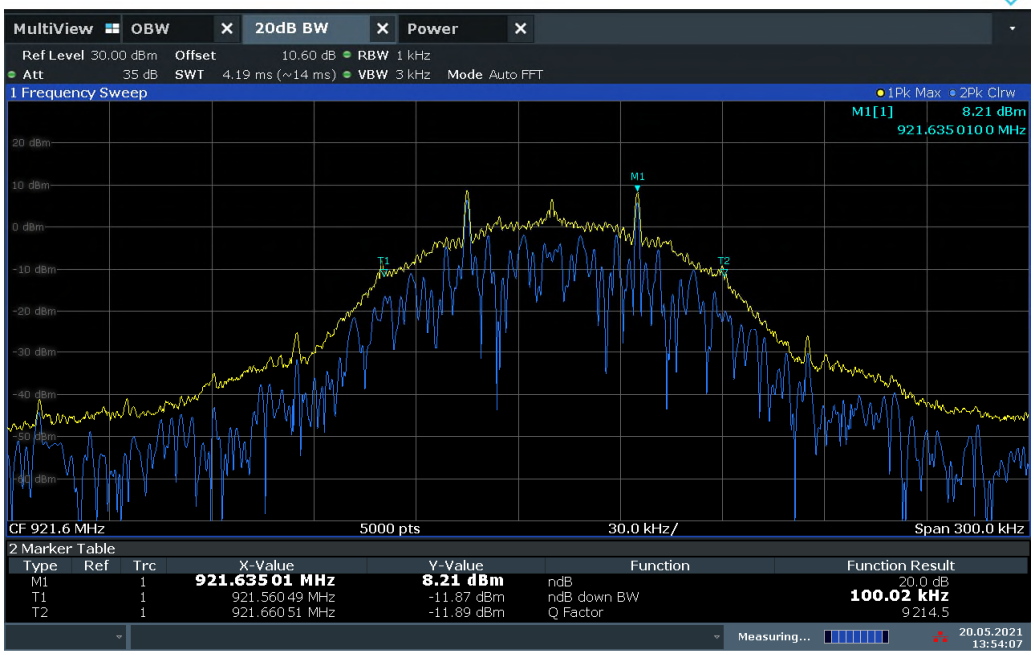
11:37:05 27.05.2021

Low 2 Channel



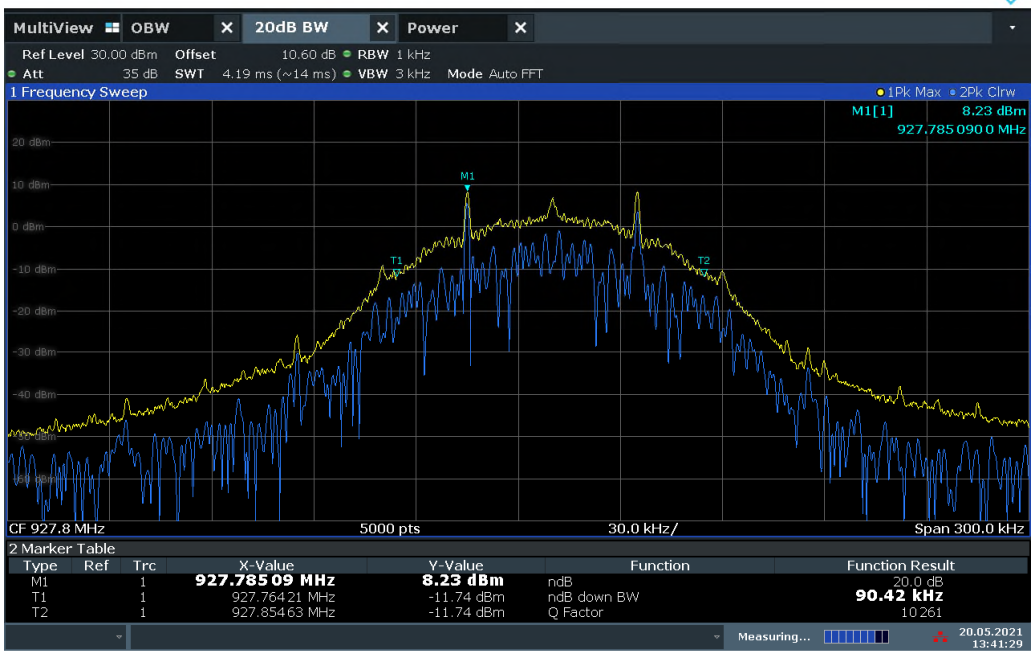
14:04:18 20.05.2021

Mid 1 Channel



13:54:07 20.05.2021

Mid 2 Channel



13:41:29 20.05.2021

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: E861 / Test Configuration A

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

May 20 and 27 2021/OC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.5°C	24.2°C
Relative Humidity	42.5%	42.4%
ATM Pressure	98.1 kPa	100.6 kPa

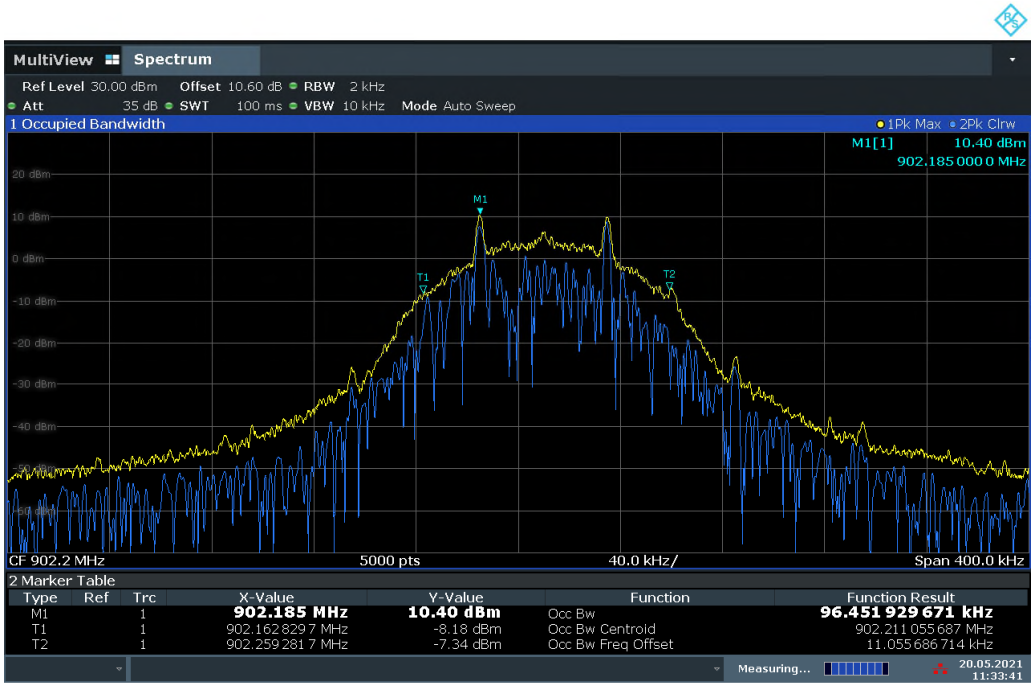
2.6.7 Additional Observations

- 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 analyzer was set to 99% (default).
- The OBW power measurement function of the spectrum analyzer was used for this test.

2.6.8 Test Results (For reporting purposes only)

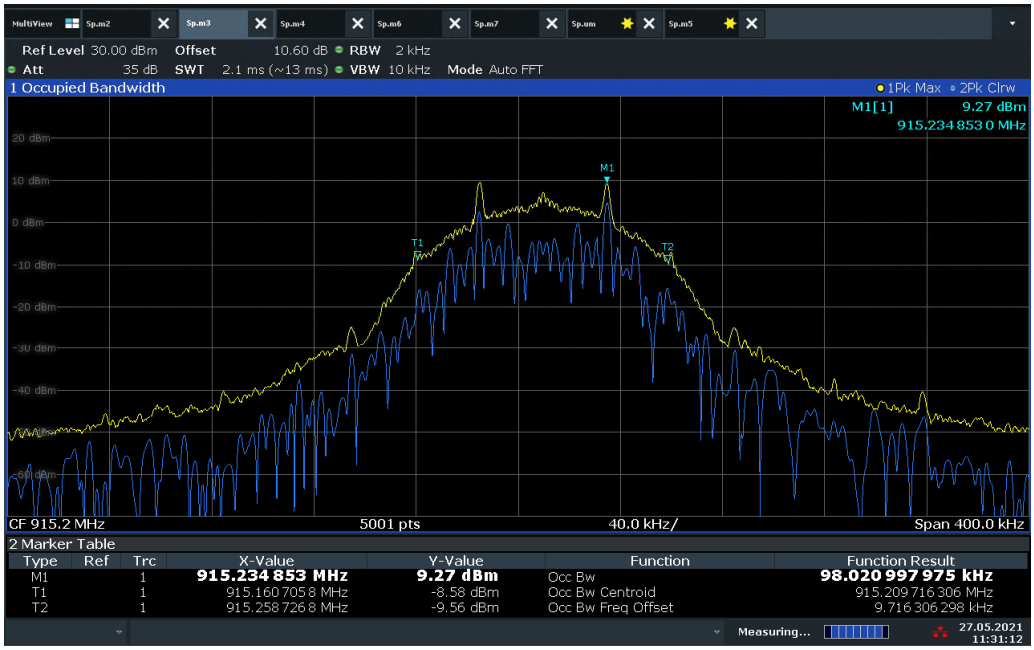
Modulation	Channel	Frequency (MHz)	Measured Occupied Bandwidth (kHz)	Data Rate (kbps)
2-GFSK	Low 1	902.2	96.451929671	50
	Low 2	915.2	98.02	50
	Middle 1	915.0	96.6894763	50
	Middle 2	921.6	97.611527896	50
	High	927.8	95.276960995	50

2.6.9 Test Results Plots



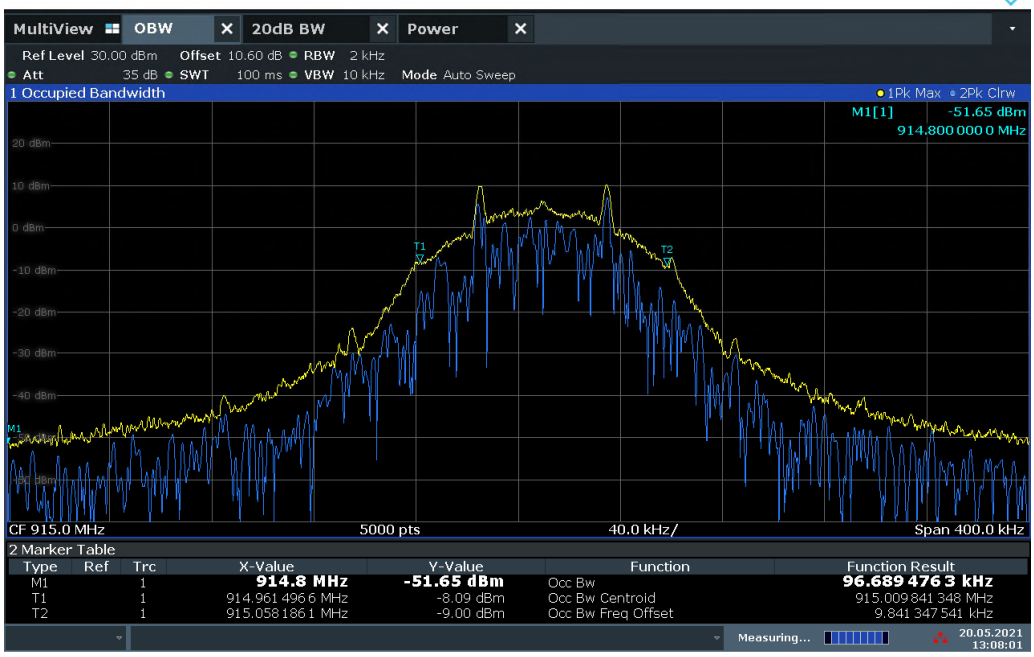
11:33:41 20.05.2021

Low 1 Channel



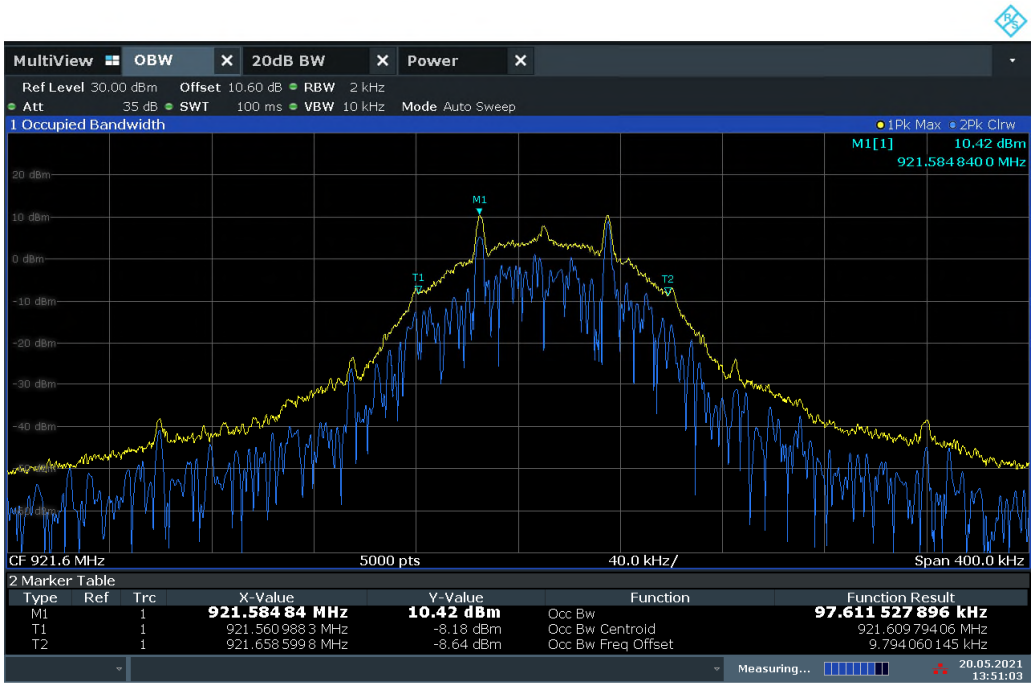
11:31:12 27.05.2021

Low 2 Channel



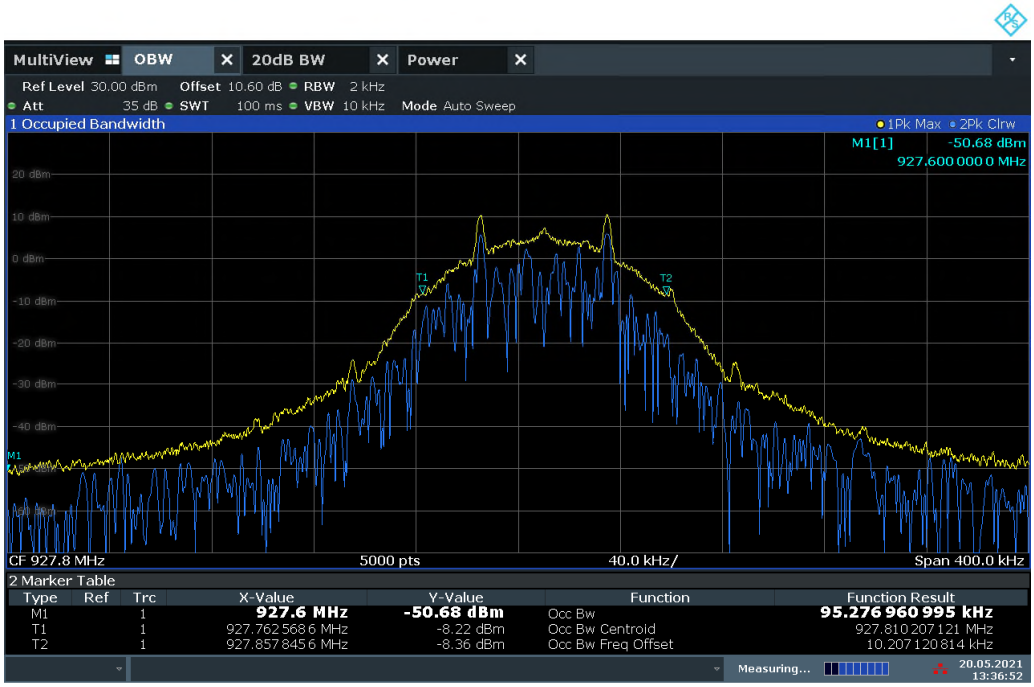
13:08:01 20.05.2021

Mid 1 Channel



13:51:04 20.05.2021

Mid 2 Channel



13:36:52 20.05.2021

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: E861 / Test Configuration A

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

May 27, 2021/OC

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 / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.2°C
Relative Humidity	42.4%
ATM Pressure	100.6 kPa

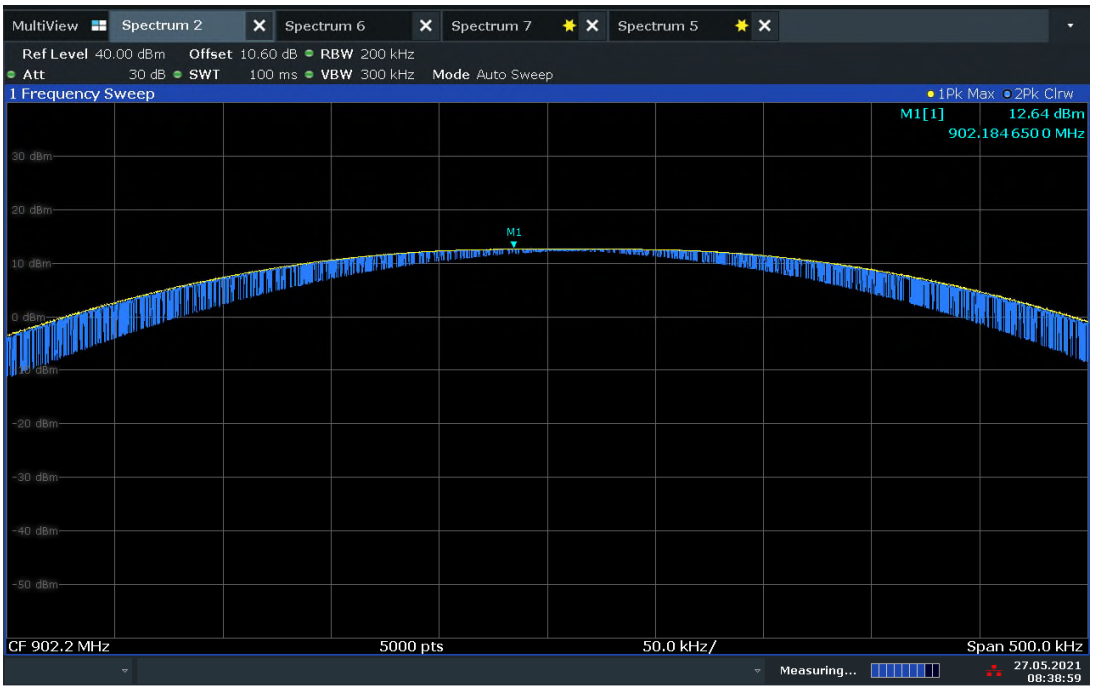
2.7.7 Additional Observations

- 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 is > RBW.
- Sweep is auto.
- Detector is peak.
- Trace is max hold.

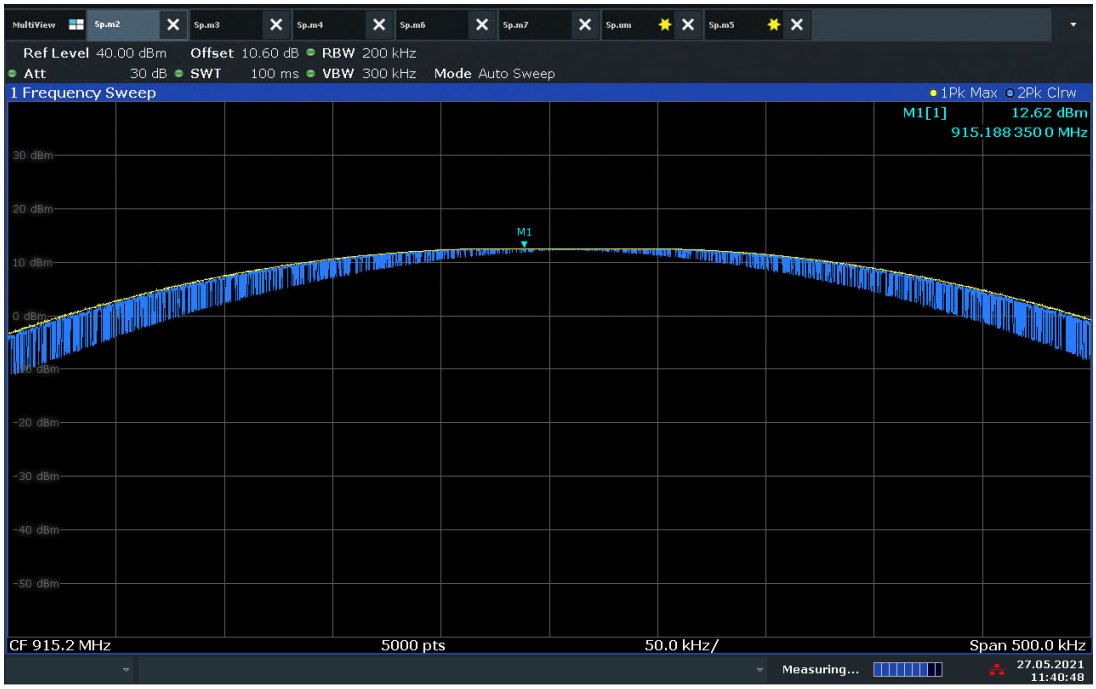
2.7.8 Test Results (Conducted)

Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Data Rate (kbps)	Limit (dBm)
2-GFSK	Low 1	902.2	12.64	50	30
	Low 2	915.2	12.62	50	30
	Middle 1	915	12.63	50	30
	Middle 2	921.6	12.65	50	30
	High	927.8	12.71	50	30

2.7.9 Test Results Plots

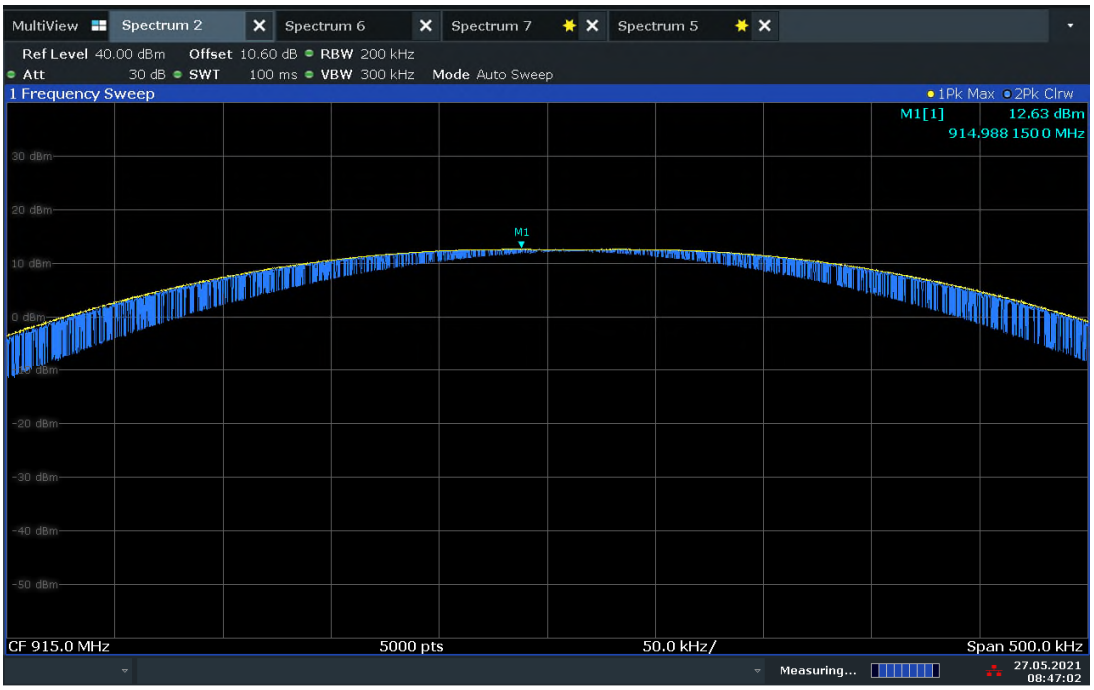


Low 1 Channel



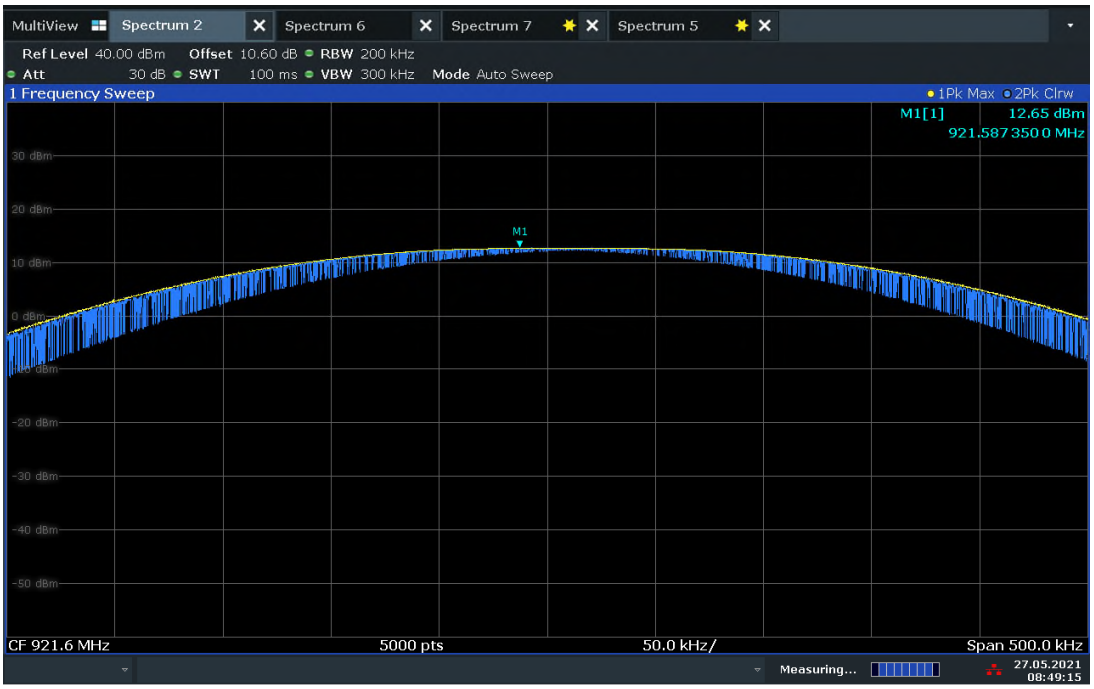
11:40:48 27.05.2021

Low 2 Channel



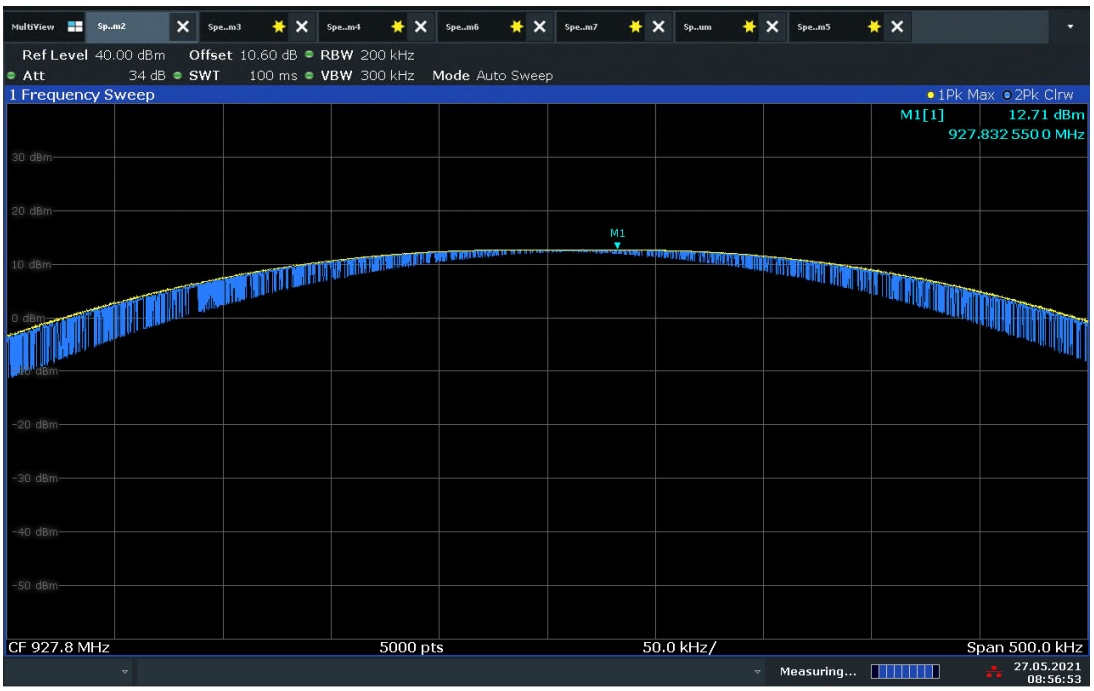
08:47:02 27.05.2021

Mid 1 Channel



08:49:15 27.05.2021

Mid 2 Channel



08:56:53 27.05.2021

High Channel

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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: E861 / Test Configuration A and B

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

May 27,2021/OC

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 / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

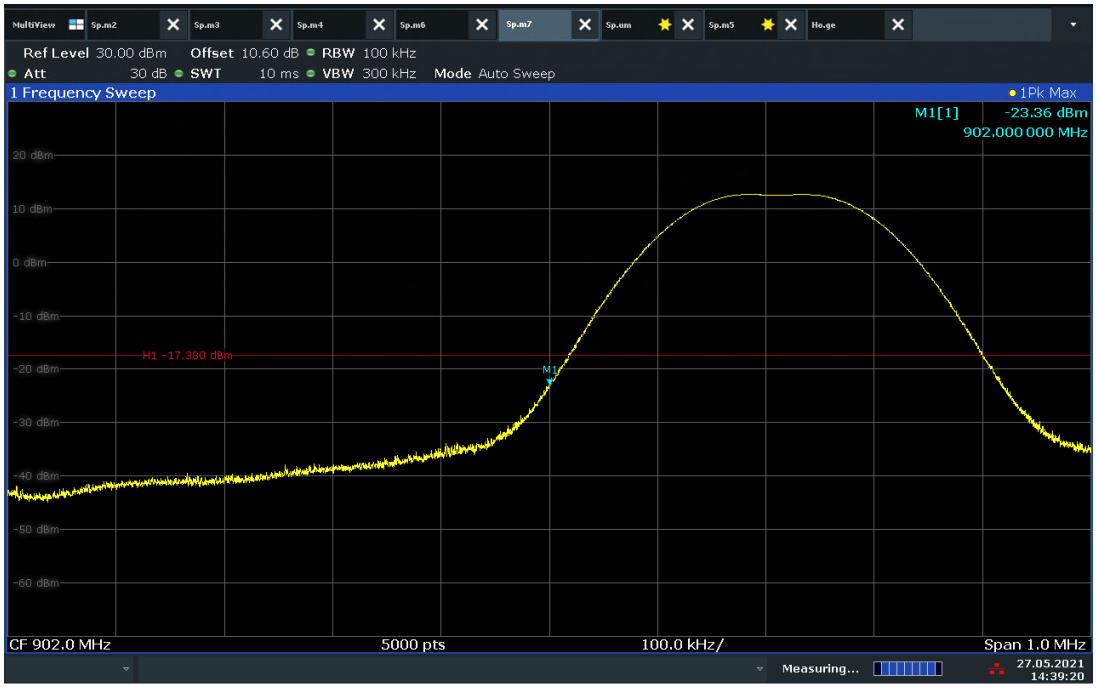
Ambient Temperature	24.2°C
Relative Humidity	42.4%
ATM Pressure	100.6 kPa

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 100kHz.
- VBW is 300kHz.
- Sweep is auto, detector is peak, trace is max hold.
- Trace allowed to stabilize.
- Limit is 20dBc (30dBc was measured as worst case on most of the channels).

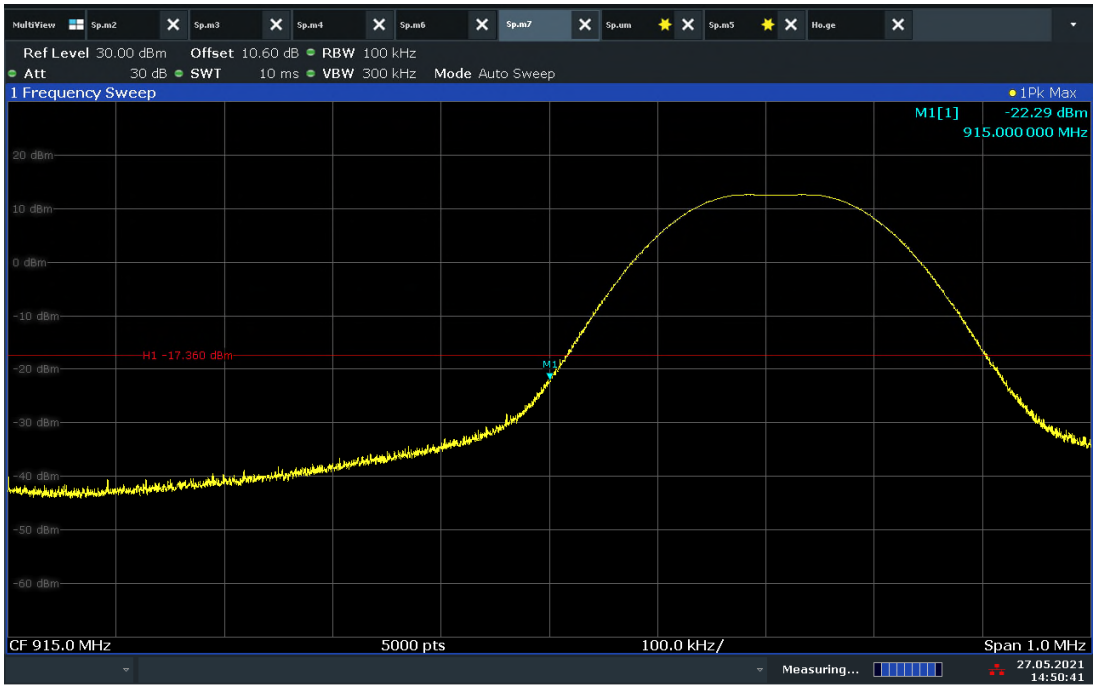
- Both Hopping and Non-Hopping mode verified.
- Band edges verified were all >20dBc, EUT complies.

2.8.8 Test Results



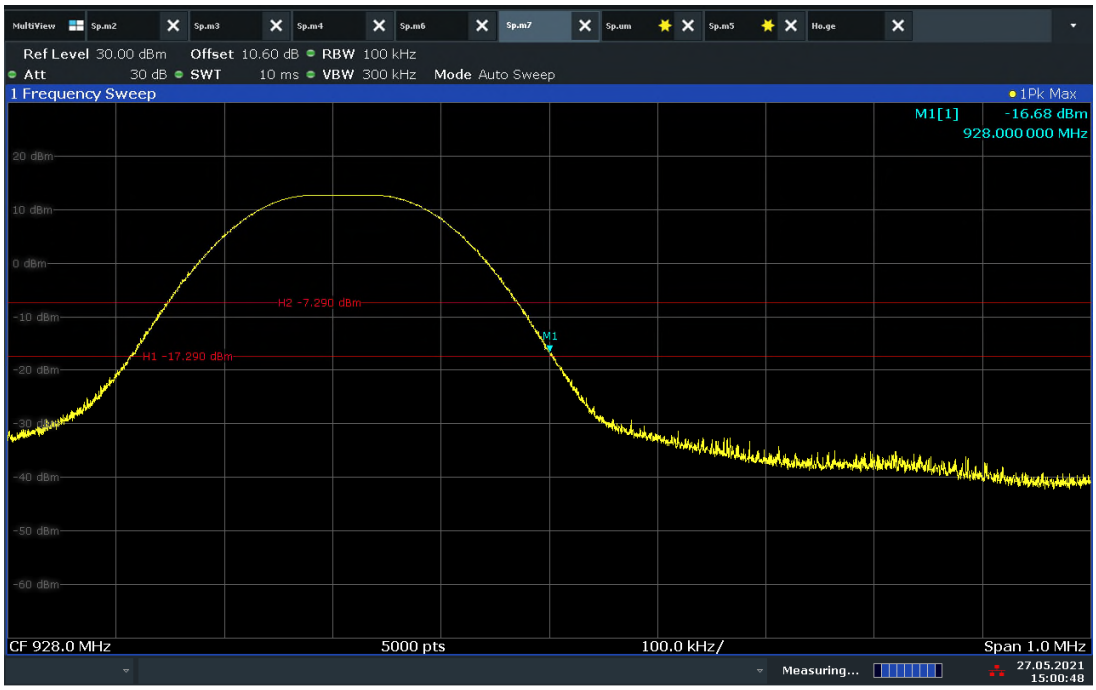
14:39:20 27.05.2021

Low 1 Channel @ 902 MHz



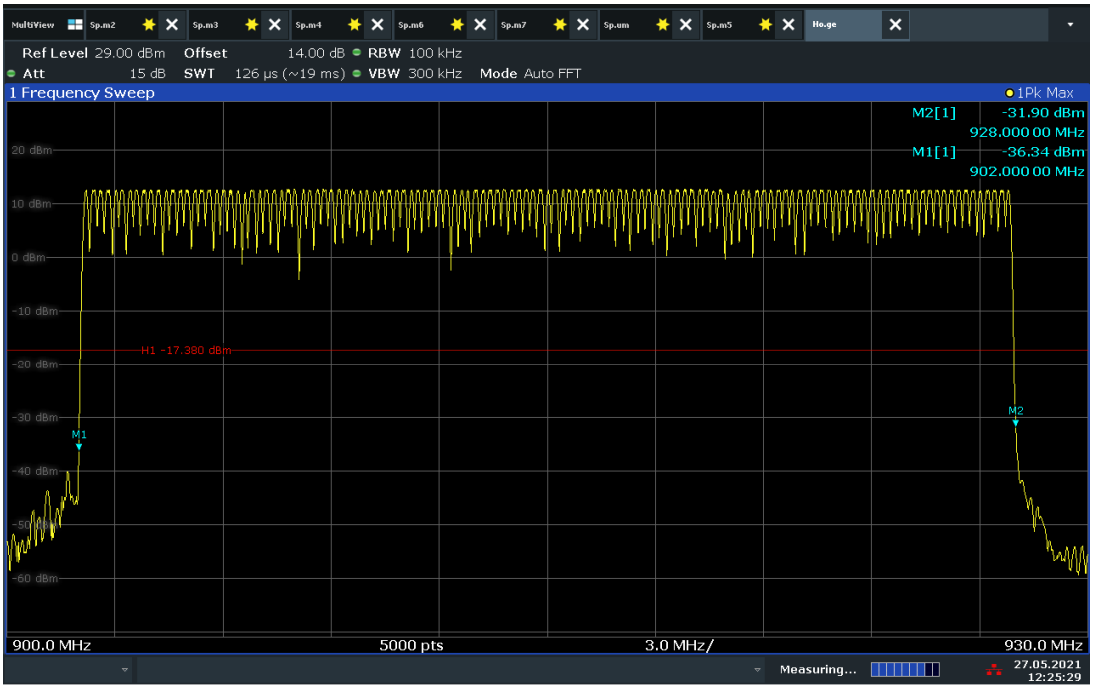
14:50:41 27.05.2021

Low 2 Channel @ 915 MHz



15:00:49 27.05.2021

high Channel @ 928 MHz



Band Edge Hopping Mode @ 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: E861 / Test Configuration A

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

May 27,2021/OC

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 / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.2°C
Relative Humidity	42.4%
ATM Pressure	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 10GHz (to cover 10th harmonic of the High Channel).
- RBW is 100 kHz for below 1GHz and 1MHz above 1GHz.
- BW is 300kHz for below 1GHz and 3MHz for above 1GHz.
- Sweep is auto, detector is peak.
- Trace is max hold.
- Trace allowed to stabilize. Maximum spurious emission compared to limit.

- Spurious emissions limit is 20dBc (worst case of 30dBc was measured).

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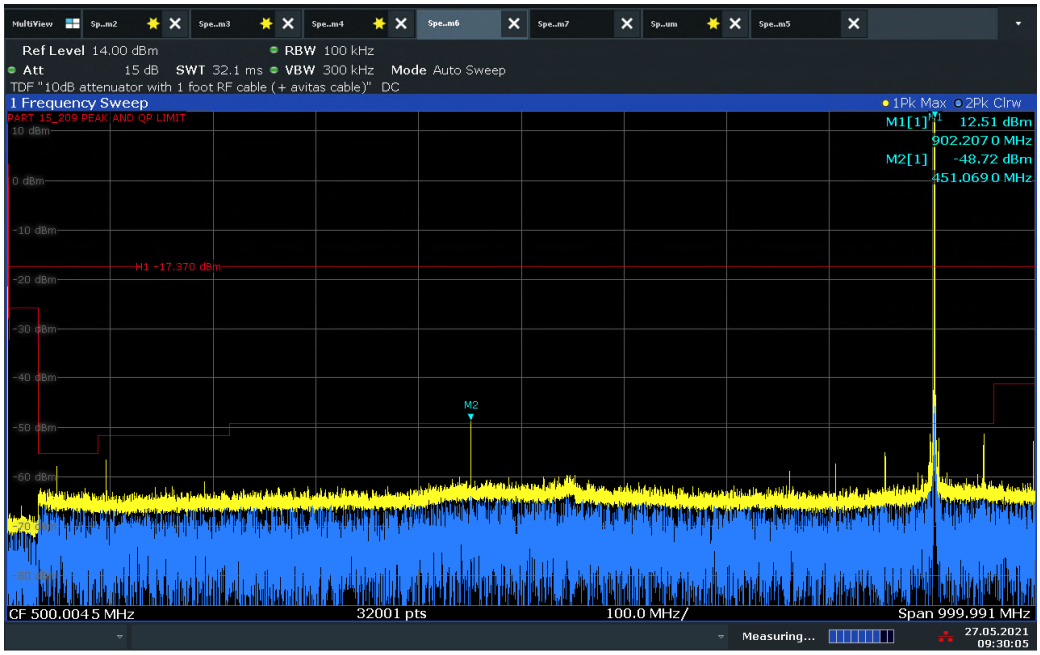
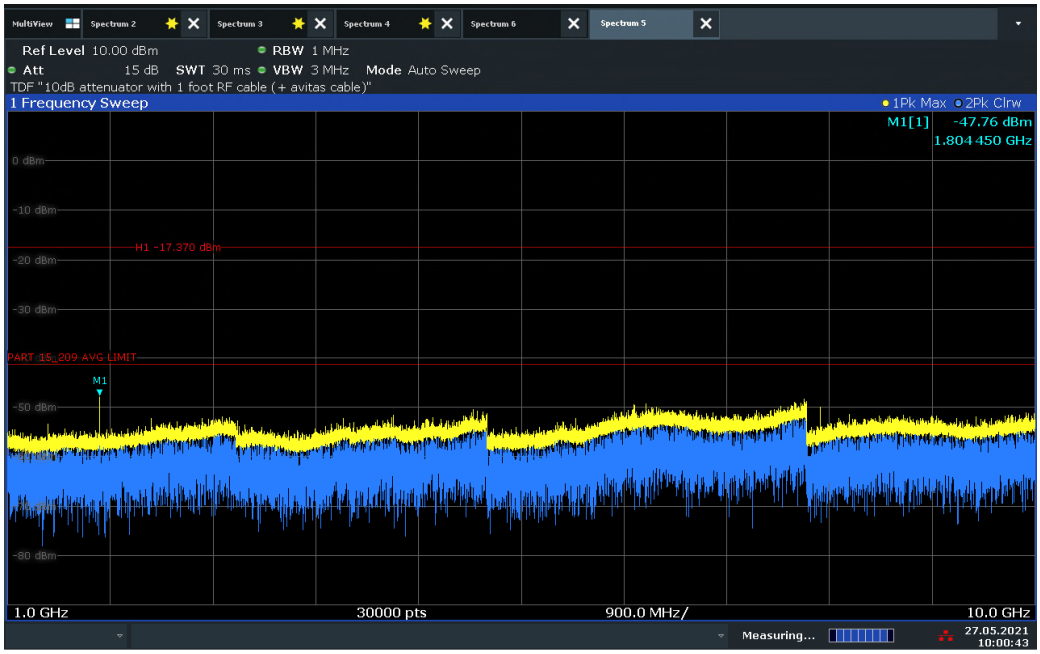
- None of the spurious emissions fall in the restricted bands.

2.9.8 Test Results Plots



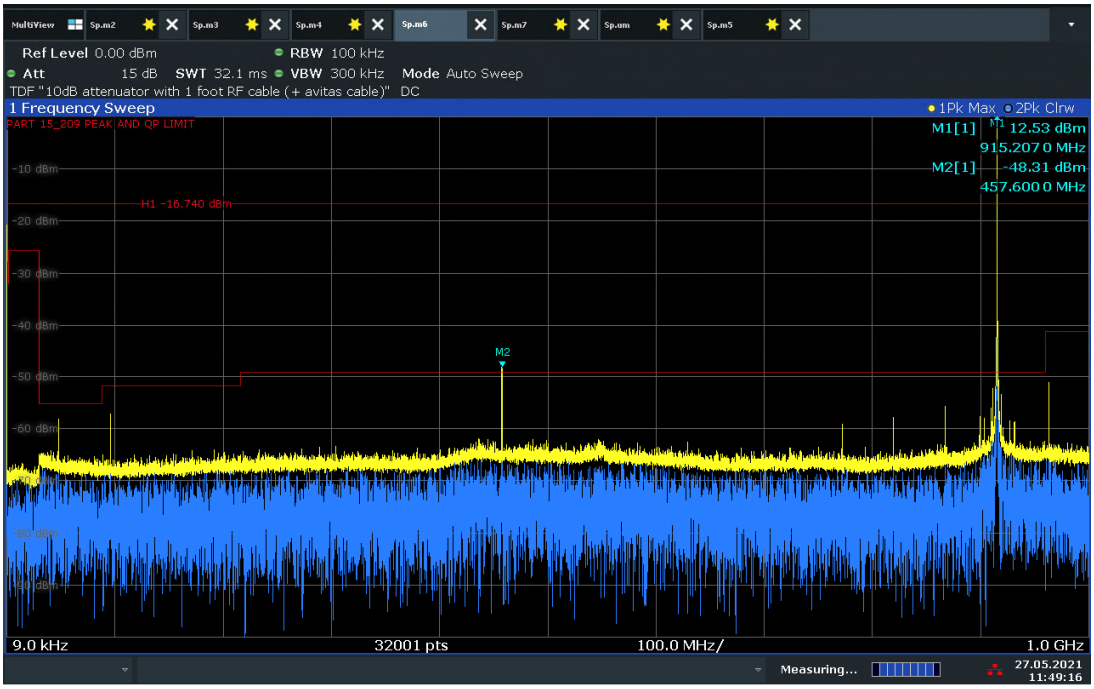
09:30:06 27.05.2021

Low 1 Channel (9kHz to 1GHz)



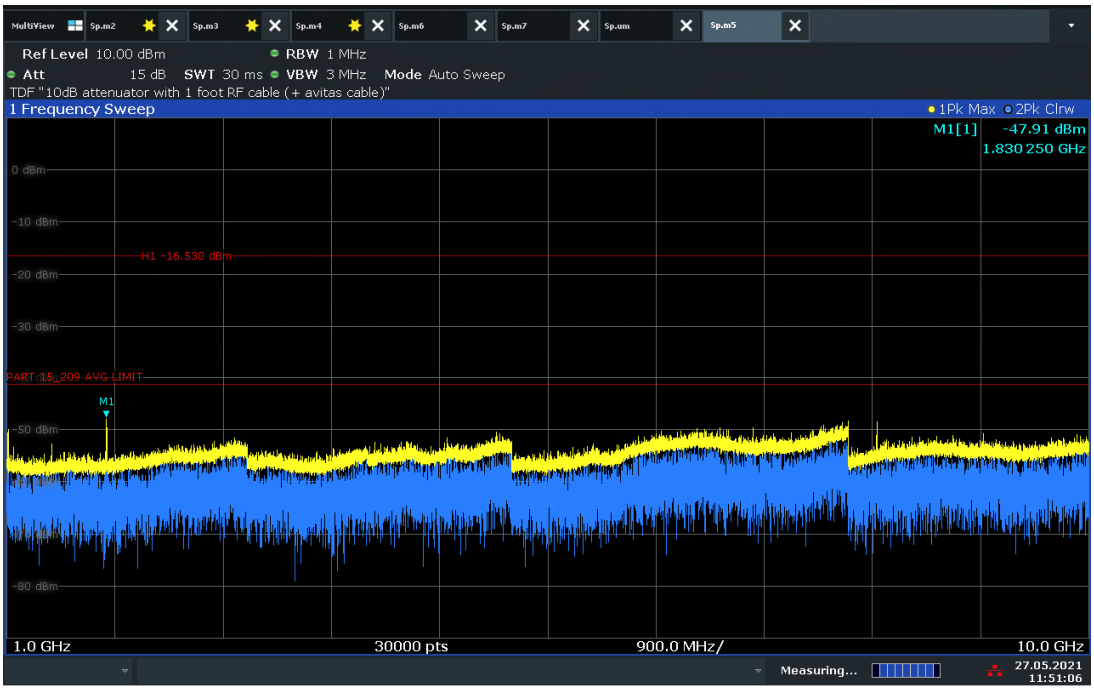
10:00:43 27.05.2021

Low 1 Channel (1GHz to 10GHz)



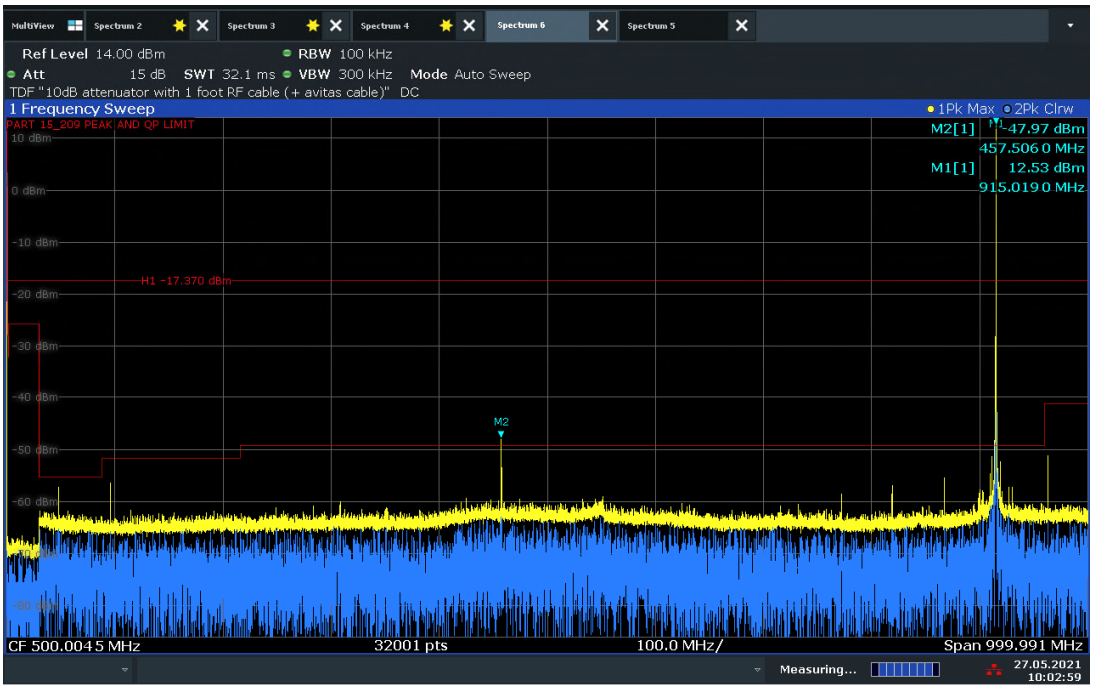
11:49:17 27.05.2021

Low 2 Channel (9kHz to 1GHz)



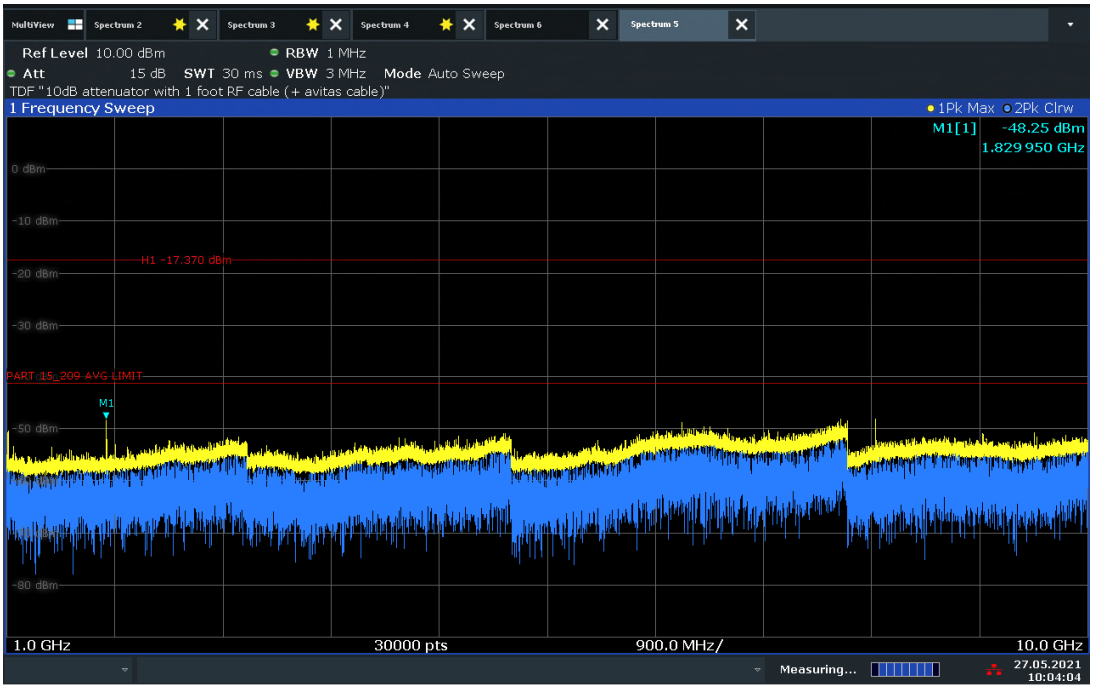
11:51:07 27.05.2021

Low 2 Channel (1GHz to 10GHz)



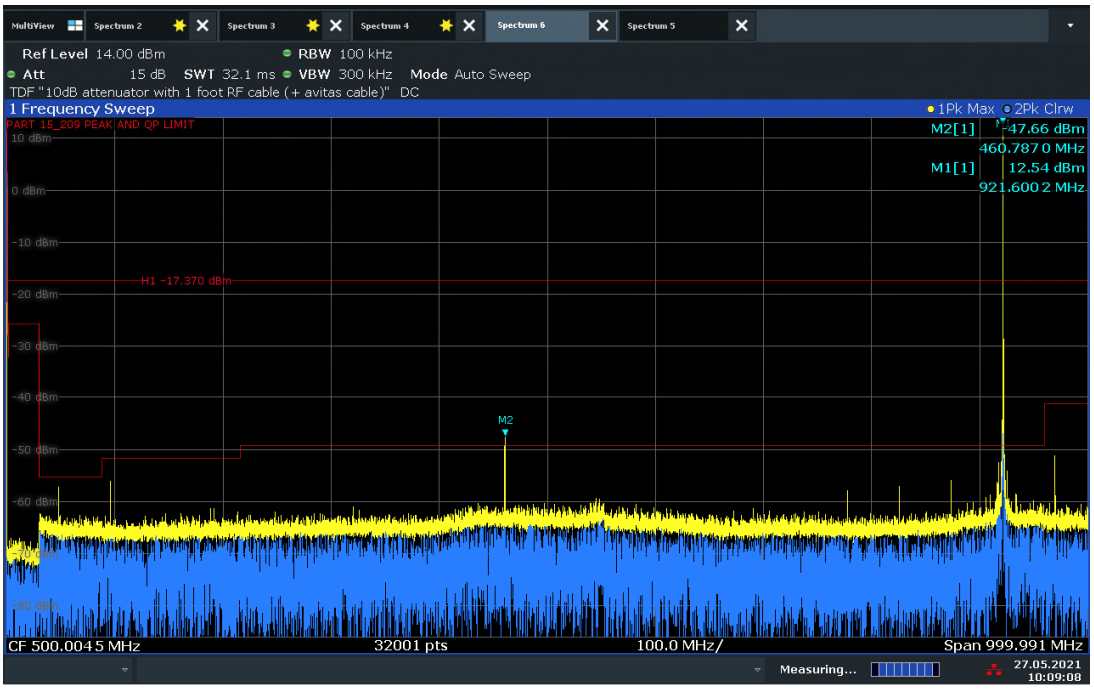
10:02:59 27.05.2021

Mid 1 Channel (9kHz to 1GHz)



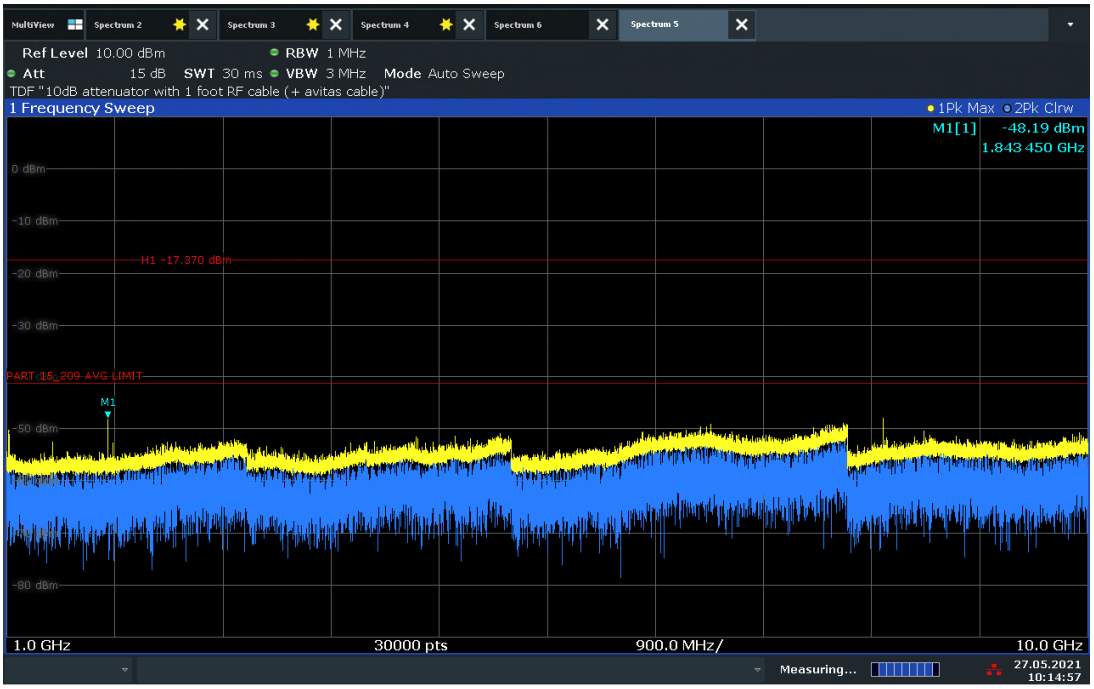
10:04:04 27.05.2021

Mid 1 Channel (1GHz to 10GHz)



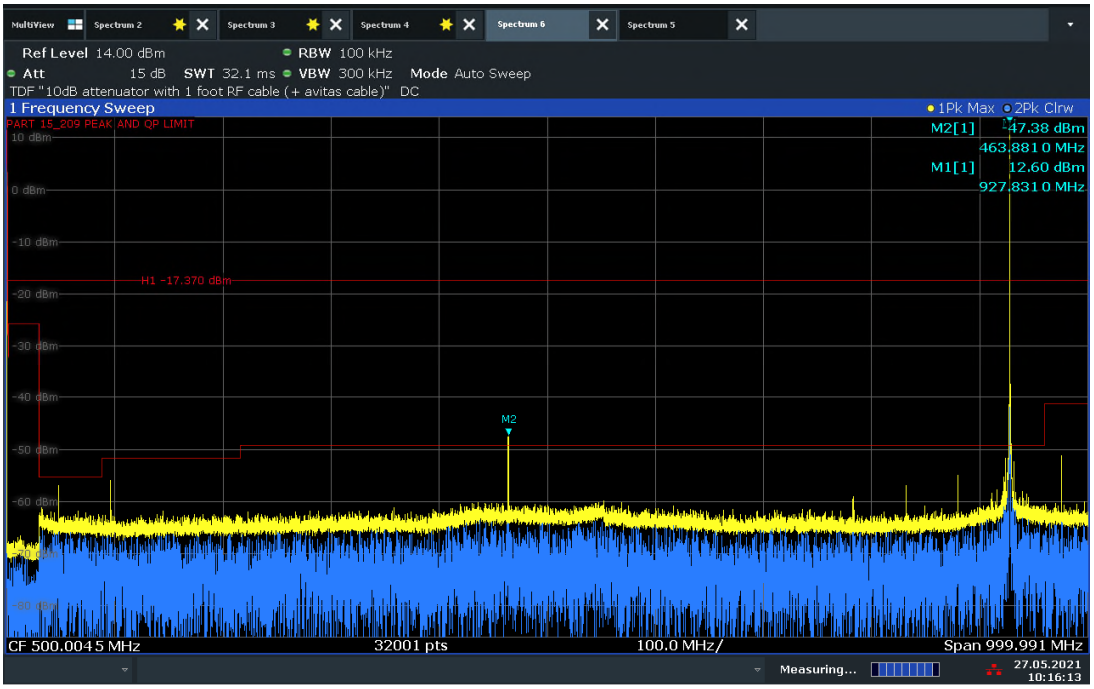
10:09:08 27.05.2021

Mid 2 Channel (9kHz to 1GHz)



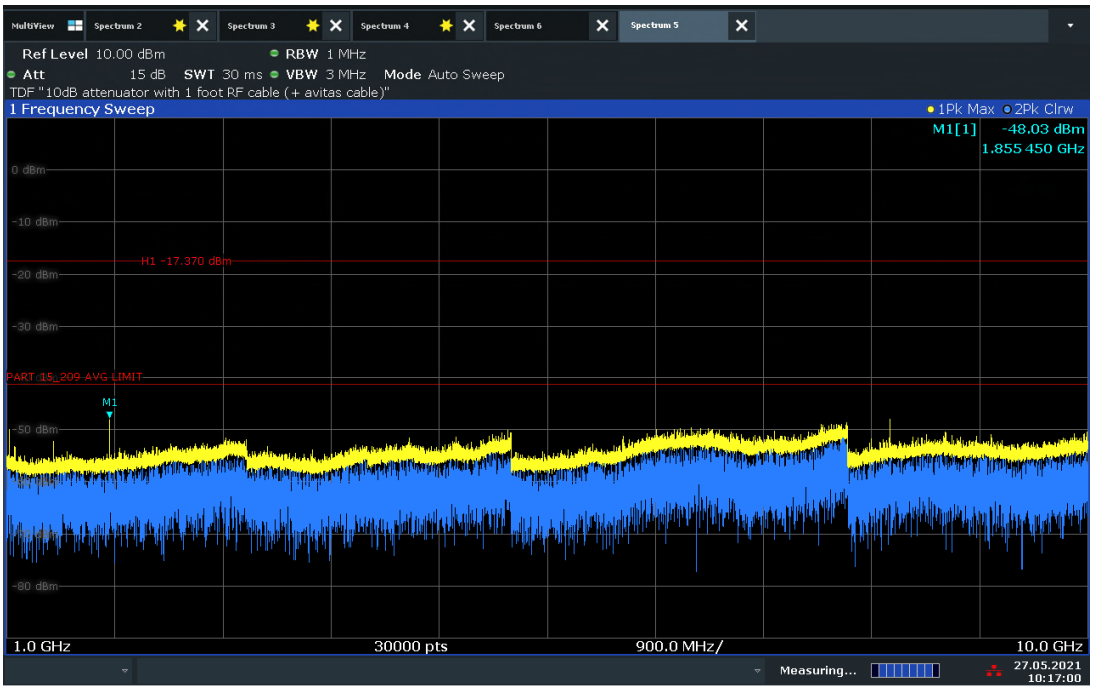
10:14:57 27.05.2021

Mid 2 Channel (1GHz to 10GHz)



10:16:13 27.05.2021

High Channel (9kHz to 1GHz)



10:17:00 27.05.2021

High Channel (1GHz to 10GHz)

2.10 SPURIOUS RADIATED 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

(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)).

2.10.3 Equipment Under Test and Modification State

Serial No: E861 / Test Configuration C

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

May 25, 2021/OC

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 / Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

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

2.10.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to 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).
- Antenna port was terminated with a 20 dB attenuator and 50 Ω
- For 9kHz to 1GHz frequency range, only worst case is presented (high channel 927.8 MHz).
- Measurement was done using EMC32 v10.50.40 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 to 2.10.10 for sample computation.

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2.10.8 Sample Computation (Radiated Emission 9 kHz to 30 MHz)

Measuring equipment raw measurement (dbµV) @ 9 kHz			25.0
Correction Factor (dB)	Asset# 1057 (cable)	0.1	25.9
	Asset# 8850 (cable)	0.0	
	Asset# 6628 (antenna)	25.8	
	Asset# 1026 (cable)	0.0	
Reported QuasiPeak Final Measurement (dbµV/m) @ 9kHz			**50.9**

2.10.9 Sample Computation (Radiated Emission 30 MHz to 1 GHz)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1026 (cable)	0.8	-7.0
	Asset# 1057 (cable)	0.2	
	Asset# 1016 (preamplifier)	-30.8	
	Asset# 8850 (cable)	0.2	
	Asset# 1033 (antenna)	17.2	
	Asset# 8771 (6-dB attenuator)	5.4	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**17.4**

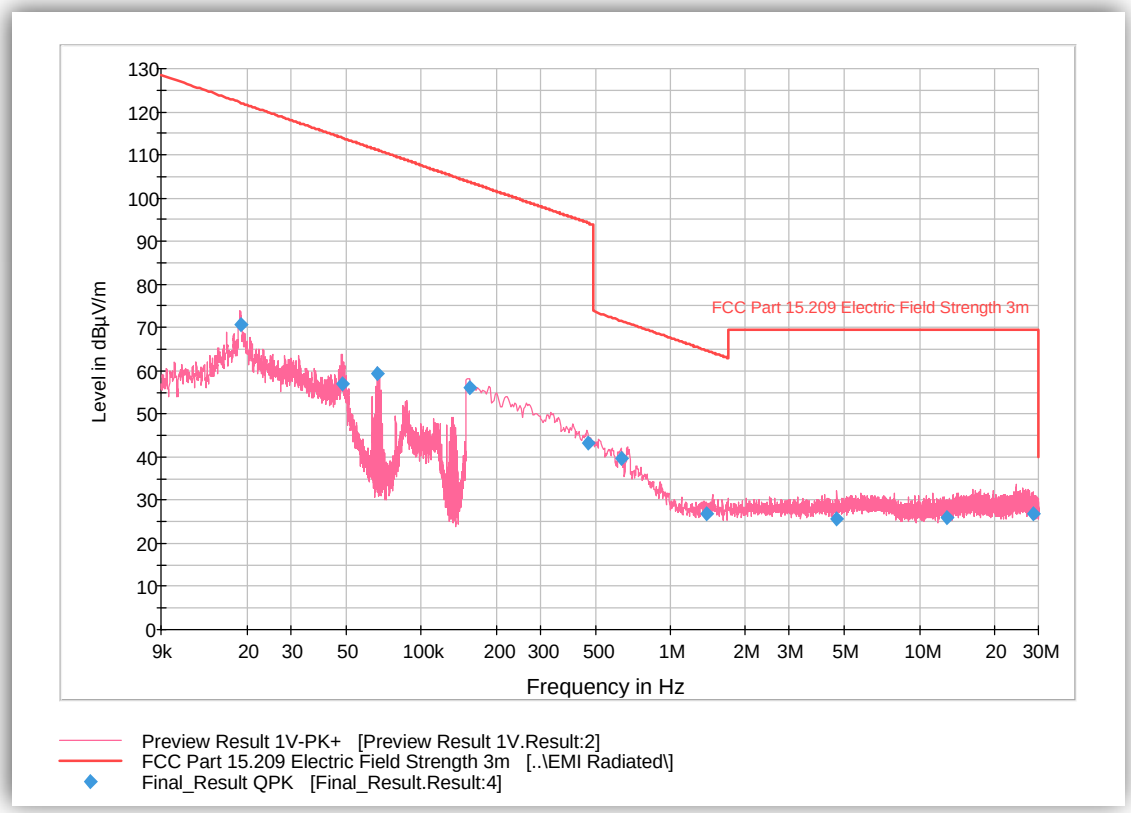
2.10.10 Sample Computation (Radiated Emission above 1GHz)

Measuring equipment raw measurement (dbµV) @ 2629 MHz			37.59
Correction Factor (dB)	Asset# 1016 (preamplifier)	-31.9	3
	Asset# 1175(cable)	2.5	
	Asset# 7631 (antenna)	32.4	
Reported Peak Final Measurement (dbµV/m) @ 30MHz			**40.59**

2.10.11 Test Results

See attached plots.

2.10.12 Test Results Below 30MHz (Worst Case –High channel 927.8MHz)

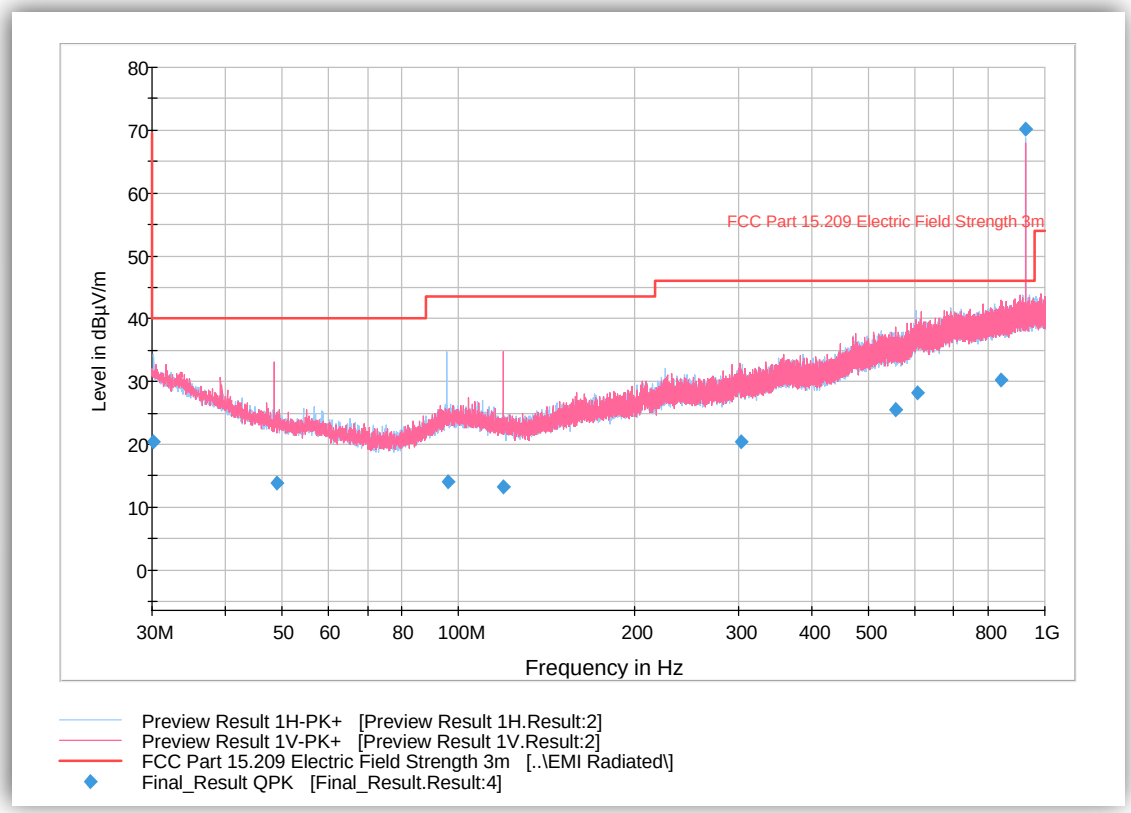


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018725	70.63	122.15	51.52	1000.0	0.200	100.0	H	300.0	22
0.047874	56.89	114.00	57.11	1000.0	0.200	100.0	H	159.0	20
0.066543	59.23	111.14	51.90	1000.0	0.200	100.0	H	159.0	20
0.156500	55.91	103.71	47.80	1000.0	9.000	100.0	H	42.0	20
0.466670	43.09	94.22	51.13	1000.0	9.000	100.0	H	128.0	20
0.635875	39.71	71.54	31.82	1000.0	9.000	100.0	H	140.0	20
1.399811	26.83	64.68	37.84	1000.0	9.000	100.0	H	196.0	20
4.653099	25.58	69.50	43.92	1000.0	9.000	100.0	H	322.0	20
12.837670	25.85	69.50	43.65	1000.0	9.000	100.0	H	76.0	21
28.607305	26.84	69.50	42.66	1000.0	9.000	100.0	H	273.0	25

Test Notes: Only worst case channel presented for spurious emissions below 30MHz.

2.10.13 Test Results Below 1GHz (Worst Case –High channel 927.8MHz)

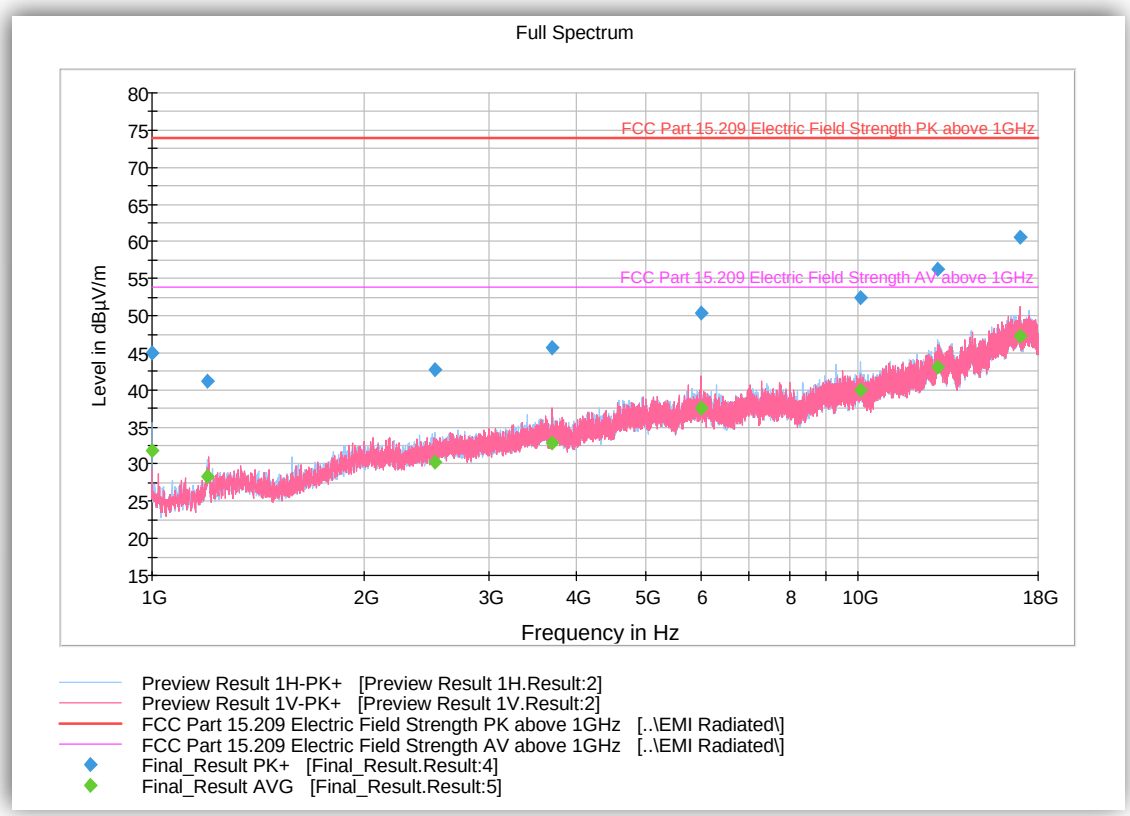


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.160000	20.46	40.00	19.54	1000.0	120.000	283.0	H	131.0	23
48.917667	13.86	40.00	26.14	1000.0	120.000	175.0	V	50.0	15
95.730333	14.00	43.50	29.50	1000.0	120.000	283.0	H	64.0	16
119.358333	13.31	43.50	30.19	1000.0	120.000	196.0	V	47.0	15
303.191333	20.50	46.00	25.50	1000.0	120.000	410.0	V	150.0	22
555.460667	25.59	46.00	20.41	1000.0	120.000	121.0	V	296.0	26
605.649333	28.13	46.00	17.87	1000.0	120.000	325.0	H	16.0	27
843.361000	30.18	46.00	15.82	1000.0	120.000	125.0	V	219.0	30
927.792000	70.10	46.00	-24.10	1000.0	120.000	183.0	H	10.0	31

Test Notes: Only worst case channel presented for spurious emissions below 1GHz.

2.10.14 Test Results Above 1GHz (Low channel 902.2MHz)



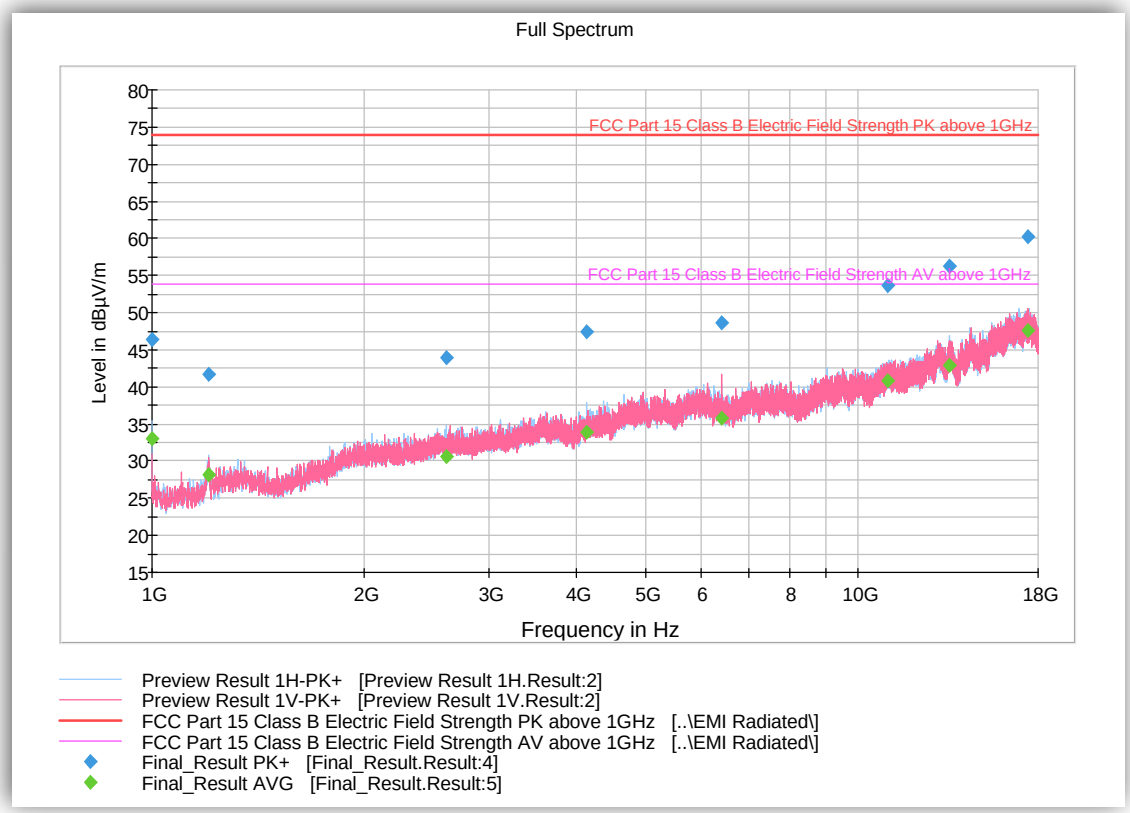
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	45.02	73.90	28.88	1000.0	1000.000	333.0	H	264.0	-6
1199.933333	41.15	73.90	32.75	1000.0	1000.000	255.0	V	91.0	-2
2518.900000	42.75	73.90	31.15	1000.0	1000.000	175.0	H	113.0	1
3685.533333	45.71	73.90	28.19	1000.0	1000.000	306.0	V	78.0	4
6007.900000	50.38	73.90	23.52	1000.0	1000.000	315.0	V	238.0	6
10107.200000	52.43	73.90	21.47	1000.0	1000.000	335.0	H	326.0	10
12979.200000	56.33	73.90	17.57	1000.0	1000.000	313.0	H	238.0	13
16973.300000	60.60	73.90	13.30	1000.0	1000.000	129.0	V	290.0	18

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	31.75	53.90	22.15	1000.0	1000.000	333.0	H	264.0	-6
1199.933333	28.27	53.90	25.63	1000.0	1000.000	255.0	V	91.0	-2
2518.900000	30.24	53.90	23.66	1000.0	1000.000	175.0	H	113.0	1
3685.533333	32.93	53.90	20.97	1000.0	1000.000	306.0	V	78.0	4
6007.900000	37.53	53.90	16.38	1000.0	1000.000	315.0	V	238.0	6
10107.200000	40.00	53.90	13.90	1000.0	1000.000	335.0	H	326.0	10
12979.200000	43.00	53.90	10.90	1000.0	1000.000	313.0	H	238.0	13
16973.300000	47.17	53.90	6.73	1000.0	1000.000	129.0	V	290.0	18

2.10.15 Test Results Above 1GHz (Middle 1 channel 915MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	46.36	73.90	27.54	1000.0	1000.000	243.0	H	34.0	-6
1200.433333	41.73	73.90	32.17	1000.0	1000.000	303.0	H	134.0	-2
2615.633333	43.95	73.90	29.95	1000.0	1000.000	255.0	H	274.0	1
4134.633333	47.39	73.90	26.51	1000.0	1000.000	336.0	H	46.0	5
6401.466667	48.55	73.90	25.35	1000.0	1000.000	327.0	V	238.0	6
11040.900000	53.71	73.90	20.19	1000.0	1000.000	365.0	H	28.0	14
13493.233333	56.22	73.90	17.68	1000.0	1000.000	326.0	H	157.0	13
17379.066667	60.20	73.90	13.70	1000.0	1000.000	162.0	V	267.0	19

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	33.10	53.90	20.80	1000.0	1000.000	243.0	H	34.0	-6
1200.433333	28.22	53.90	25.68	1000.0	1000.000	303.0	H	134.0	-2
2615.633333	30.54	53.90	23.36	1000.0	1000.000	255.0	H	274.0	1
4134.633333	33.89	53.90	20.01	1000.0	1000.000	336.0	H	46.0	5
6401.466667	35.84	53.90	18.06	1000.0	1000.000	327.0	V	238.0	6
11040.900000	40.79	53.90	13.11	1000.0	1000.000	365.0	H	28.0	14
13493.233333	42.91	53.90	10.99	1000.0	1000.000	326.0	H	157.0	13
17379.066667	47.63	53.90	6.27	1000.0	1000.000	162.0	V	267.0	19

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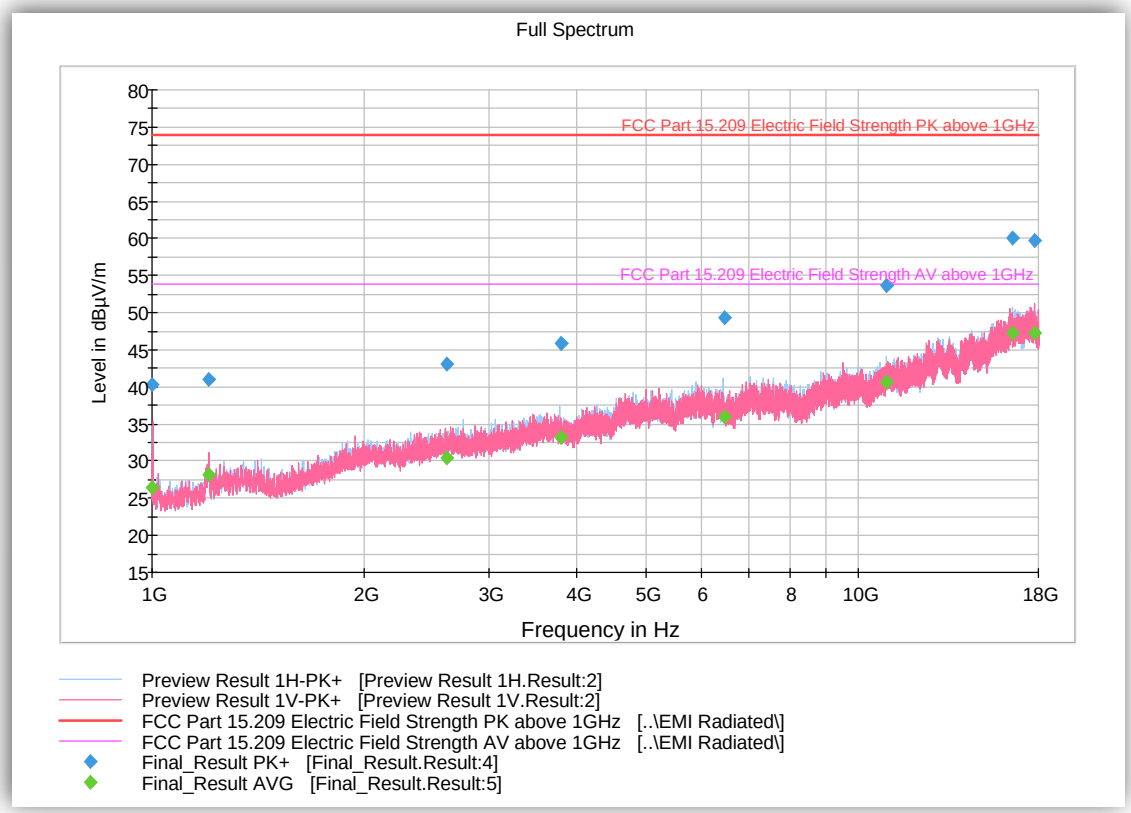
2.10.16 Test Results Above 1GHz (Middle 2 channel 921.6MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	40.36	73.90	33.54	1000.0	1000.000	129.0	V	50.0	-6
1202.100000	41.02	73.90	32.88	1000.0	1000.000	300.0	V	149.0	-2
2610.066667	43.06	73.90	30.84	1000.0	1000.000	255.0	V	11.0	1
3792.733333	45.91	73.90	27.99	1000.0	1000.000	317.0	H	43.0	4
6455.933333	49.25	73.90	24.65	1000.0	1000.000	175.0	H	247.0	6
10990.233333	53.58	73.90	20.32	1000.0	1000.000	128.0	H	119.0	14
16538.766667	60.01	73.90	13.89	1000.0	1000.000	209.0	H	218.0	17
17771.000000	59.80	73.90	14.10	1000.0	1000.000	216.0	V	124.0	20

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	26.51	53.90	27.39	1000.0	1000.000	129.0	V	50.0	-6
1202.100000	28.17	53.90	25.73	1000.0	1000.000	300.0	V	149.0	-2
2610.066667	30.46	53.90	23.44	1000.0	1000.000	255.0	V	11.0	1
3792.733333	33.20	53.90	20.70	1000.0	1000.000	317.0	H	43.0	4
6455.933333	35.89	53.90	18.01	1000.0	1000.000	175.0	H	247.0	6
10990.233333	40.57	53.90	13.33	1000.0	1000.000	128.0	H	119.0	14
16538.766667	47.21	53.90	6.69	1000.0	1000.000	209.0	H	218.0	17
17771.000000	47.28	53.90	6.62	1000.0	1000.000	216.0	V	124.0	20

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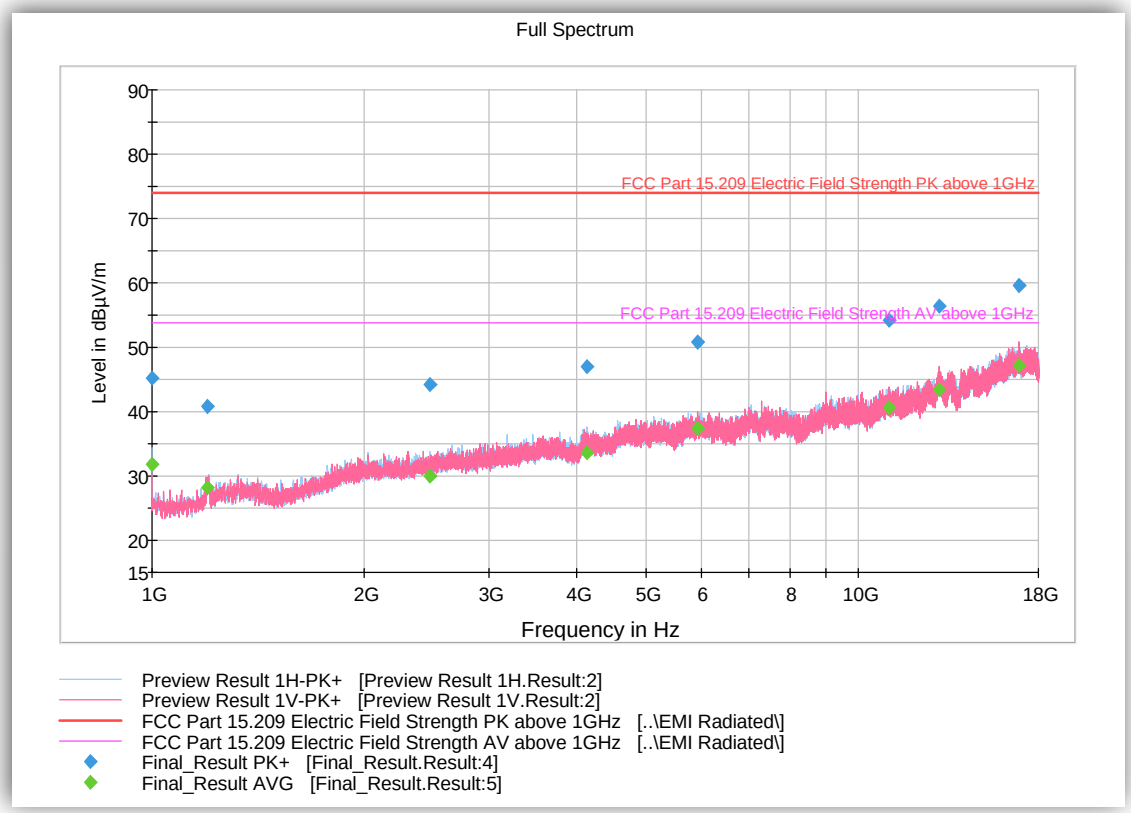
2.10.17 Test Results Above 1GHz (High channel 927.8MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	45.13	73.90	28.77	1000.0	1000.000	331.0	H	263.0	-6
1199.600000	40.80	73.90	33.10	1000.0	1000.000	354.0	H	328.0	-2
2474.633333	44.12	73.90	29.78	1000.0	1000.000	365.0	H	18.0	1
4125.933333	47.01	73.90	26.89	1000.0	1000.000	125.0	H	347.0	5
5922.666667	50.71	73.90	23.19	1000.0	1000.000	255.0	V	303.0	6
11058.766667	54.28	73.90	19.62	1000.0	1000.000	365.0	V	253.0	14
13038.166667	56.32	73.90	17.58	1000.0	1000.000	329.0	V	256.0	13
16908.033333	59.54	73.90	14.36	1000.0	1000.000	335.0	V	49.0	18

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.000000	31.71	53.90	22.19	1000.0	1000.000	331.0	H	263.0	-6
1199.600000	28.12	53.90	25.78	1000.0	1000.000	354.0	H	328.0	-2
2474.633333	30.05	53.90	23.85	1000.0	1000.000	365.0	H	18.0	1
4125.933333	33.69	53.90	20.21	1000.0	1000.000	125.0	H	347.0	5
5922.666667	37.48	53.90	16.42	1000.0	1000.000	255.0	V	303.0	6
11058.766667	40.70	53.90	13.20	1000.0	1000.000	365.0	V	253.0	14
13038.166667	43.49	53.90	10.41	1000.0	1000.000	329.0	V	256.0	13
16908.033333	47.14	53.90	6.76	1000.0	1000.000	335.0	V	49.0	18

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
Antenna Conducted Port Setup						
7611	Signal/Spectrum Analyzer	FSW26	102017	Rohde & Schwarz	02/02/21	02/02/22
1003	Signal Generator	SMR-40	100443	Rohde & Schwarz	06/18/20	06/18/21
7608	Vector Signal Generator	SMBV100A	259021	Rohde & Schwarz	10/10/19	10/10/21
8832	10dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 1003, 7608 and 7611	
-	Step Attenuator	8494B	2812A17193	Agilent	Verified by 1003, 7608 and 7611	
-	Step Attenuator	8496B	MY42143874	Agilent	Verified by 1003, 7608 and 7611	
-	Power splitter	ZN2PD-63-S+	S UU74001429	Mini-Circuits	Verified by 1003, 7608 and 7611	
Radiated Emissions						
6628	Loop Antenna	HFH 2 –Z2	880 458/25	Rohde & Schwarz	5/22/20	05/22/22
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	10/09/19	10/09/21
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	09/16/20	09/16/22
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	09/25/20	09/25/21
46797	Preamplifier	PS-122	181925	Com Power	10/28/20	10/28/21
Miscellaneous						
43003	True RMS Multimeter	85 III	69880143	Fluke	10/23/20	10/23/21
7619	Barometer/Temperature/Humidity Transmitter	iBTHX-W	15250268	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 Emission Measurements (Below 30MHz)

	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**	

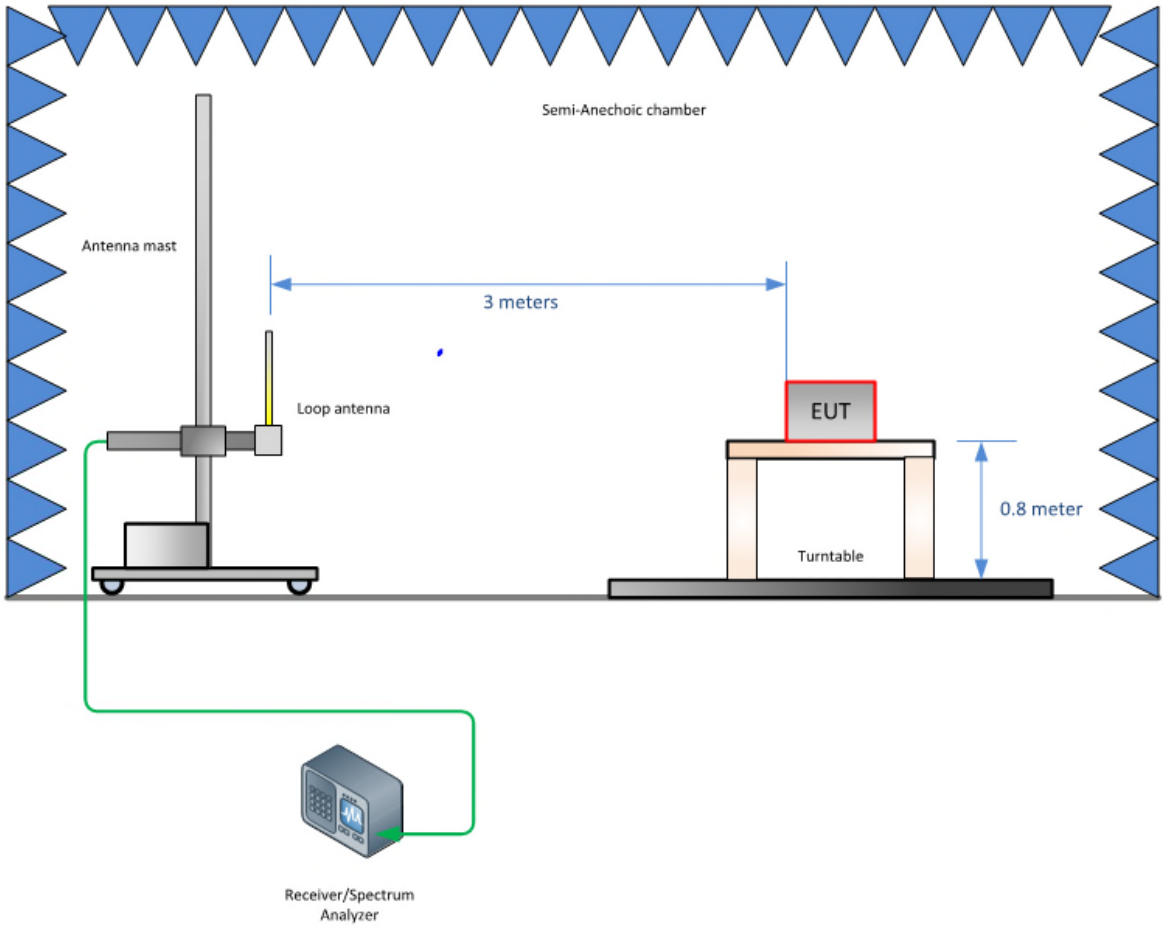
3.2.4 Radiated Emission Measurements (Above 1GHz)

	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**	

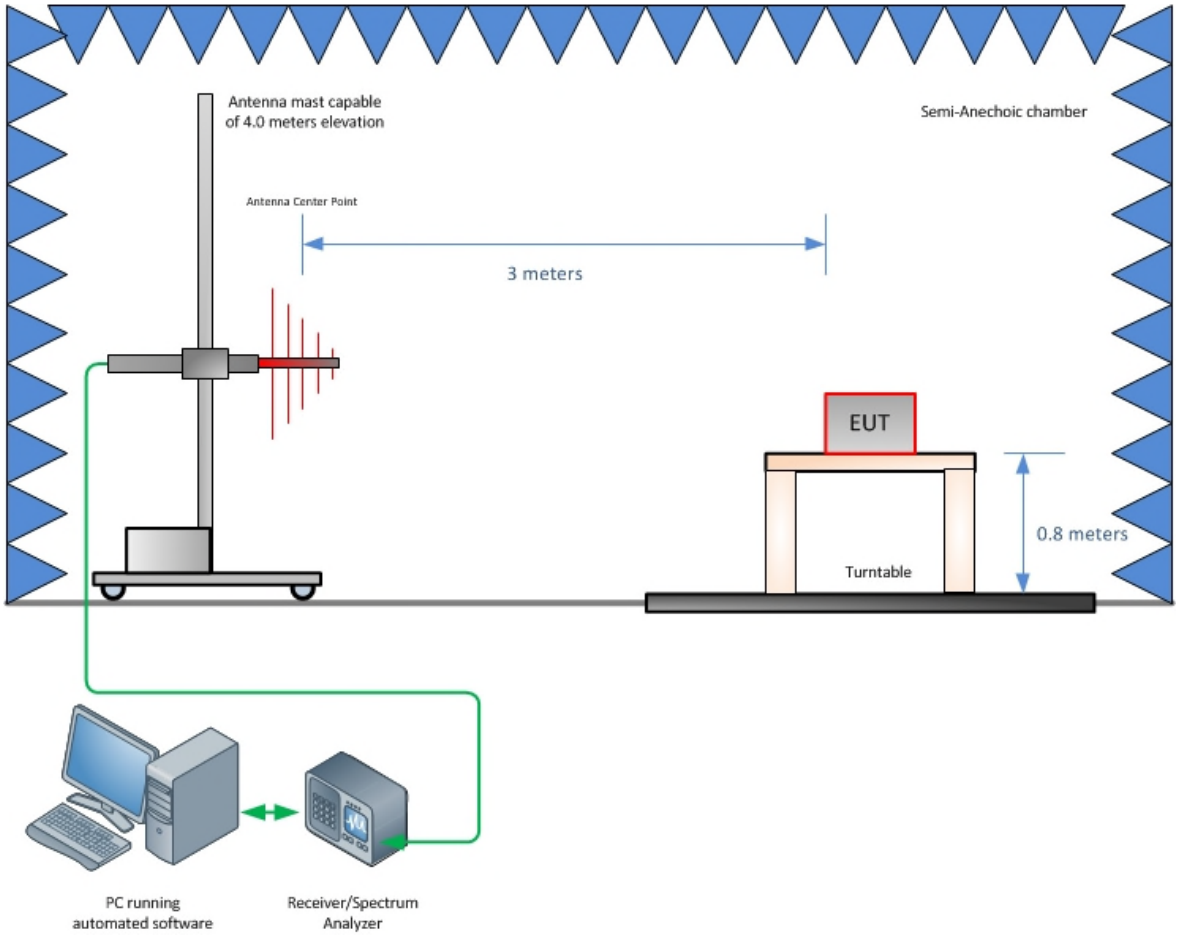
SECTION 4

4 DIAGRAM OF TEST SETUP

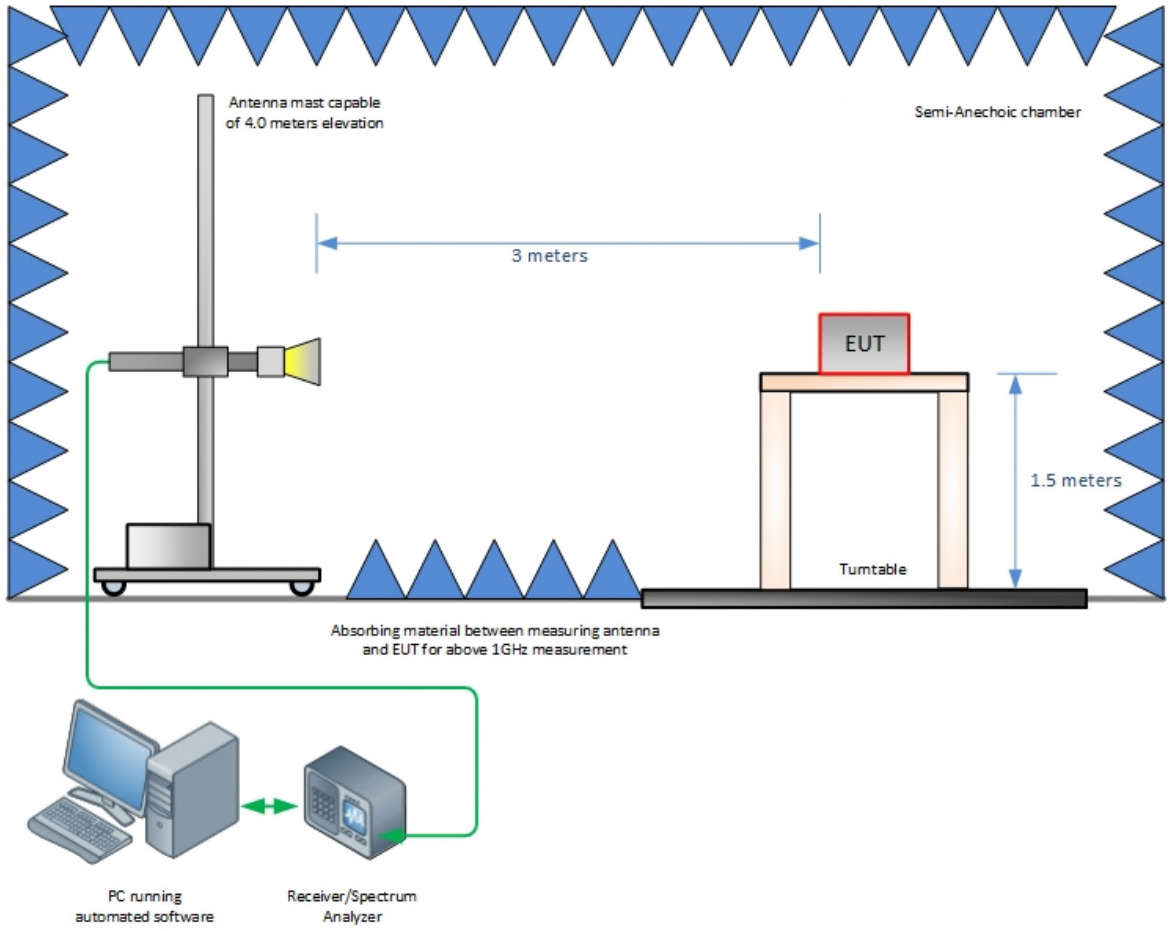
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 30MHz)



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

5 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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