

RADIO Testing of the
 Progress Rail Locomotive, Inc.
 Locomotive Doppler Radar Speed Sensor
 Model: 40256201

In accordance with:
 FCC Part 15.245 and RSS-210 Issue 10

Prepared for:
 Progress Rail Locomotive, Inc.
 9301 West 55th Street, LaGrange,
 IL 60525, USA.



COMMERCIAL-IN-CONFIDENCE

Issue Date: May 2023
 Document Number: 72181779 | Issue: 01

RESPONSIBLE FOR	NAME	TITLE	DATE	SIGNATURE
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Authorized Signatory	Omar Castillo	Senior EMC/Wireless Test Engineer	05/25/2023	

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

EXECUTIVE SUMMARY
 A sample of this product was tested and found to be in compliance with FCC Part 15.245 and RSS-210 Issue 10



A2LA Cert. No. 2955.13

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	Initial Release	05/25/2023

1.2 Introduction

Manufacturer	Progress Rail Locomotive, Inc. 9301 West 55th Street, LaGrange, IL 60525, USA.
Applicant Contact Information	Brian Koldoff Electrical Test Engineer – Embedded Systems & Tools Automation bkoldoff@progressrail.com (708) 387-6275
FCC ID	2BAOV40256201
ISED Certification Number:	30354-40256201
Model Number(s)	40256201
Serial Number(s)	17H11807
Mode Verified	24.160 GHz ± 0.015 GHz
Capability	24.160 GHz ± 0.015 GHz
Number of Samples Tested	1
Test Specification/Issue/Date	<ul style="list-style-type: none"> FCC Part 15.245 (October 2022) ISED RSS-210 Issue 10 (December 2019 with Amendment (April 2020))
Date of Receipt of EUT	August 17, 2022
Start of Test	August 17, 2022
Finish of Test	August 19, 2022
Name of Engineer(s)	Ferdinand S. Custodio
Related Document(s)	ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.245 with cross-reference to the corresponding ISED RSS standard are shown below.

Section	Part 15	RSS	Test Description	Result	Tester	Accreditation
2.1	§15.207	RSS-Gen 8.8	AC Powerline conducted Emissions	N/A		
2.2	§15.245(b)1 and 2	RSS-210 Annex F.2(a) to (c)	Field Strength of Emissions	Pass	FSC	A2LA
2.3	§15.209(b)3	RSS-210 Annex F.2 (d)	Spurious Emissions	Pass	FSC	A2LA
2.4		RSS-Gen 6.11 and RSS-210 Annex F.2 (e)	Carrier Frequency Stability	Pass	FSC	A2LA

N/A EUT is for locomotive use only. It does not have provisions to connect with Public AC Mains



1.4 Product Information

1.4.1 Technical Description

The Equipment Under Test (EUT) was a Progress Rail Locomotive, Inc., Locomotive Doppler Radar Model No: 40256201 Speed Sensor. The EUT is an integral part of the locomotive control systems.

1.4.2 EUT Specification

Power Supply Requirements	14 to 16VDC, 0.5A
Radar Output Frequency	24.160 GHz ± 0.015 GHz
Radar EIRP	214.35mW
Radar Output Signal	Digital Square Wave with a frequency of 22.19 Hz/mph (13.79 Hz/kph) and a duty cycle of 50% ± 0.1%. Output Amplitude (High.): Approx. 0.5VDC less than operating voltage Output Amplitude (Low): 0VDC minimum, 1VDC maximum
EUT Weight	Less than 15lbs (6.8Kg)
Radar Speed Measurement Range	Max Speed: 120mph (193 kph) Min Speed: 1mph (1.61 kph)
Radar Operating Temperature Range	-45°C to 55°C

1.4.3 Test Configuration

Configuration Number	Description
Default	Unit is powered by 15VDC. The EUT will default to TX mode with 100% duty cycle.

1.4.4 Simplified Test Configuration Diagram

Not required, the EUT is tested on a standalone configuration.

1.4.5 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Progress Rail Locomotive, Inc.	EUT Interface Cable	P/N 40107583. Cable length is 12.2 meters
Protek	DC Power Supply	Model 35010M S/N D102007S



1.5 Deviations from the Standard

There were no deviations made during testing from the applicable test standard or test plan.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test program. The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the manufacturer	-	-

1.7 Test Methods

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 Location

TÜV SÜD America conducted the following tests at our San Diego CA, Test Laboratory's.

Office Address:

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.

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

TÜV SÜD 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 (ISED) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TÜV SÜD 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 TÜV SÜD 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)

TÜV Product Service Inc. (San Diego) is a recognized RADIO 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)

TÜV SÜD 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 LP0002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0280 and A-0281

TÜV SÜD 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

TÜV SÜD 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

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



2 Test Details

2.1 Conducted Limits (AC Conducted Emissions Verification)

2.1.1 Specification Reference

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

2.1.2 Standard Applicable

Except as shown in paragraphs (b) and (c) of this section, for 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). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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
0.5–30	60	50

*Decreases with the logarithm of the frequency.

2.1.3 Equipment Under Test and Modification State

Not performed. EUT is for locomotive use only. It does not have provisions to connect with Public AC Mains.



2.2 Field Strength of Emissions

2.2.1 Specification Reference

FCC 47 Chapter I Subchapter A Part 15 Subpart C §15.245 (b)
 RSS-210, Annex F.2(a) to (c)

2.2.2 Standard Applicable

(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (mv/m)	Field strength of harmonics (mv/m)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

(i) For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

(ii) For all other field disturbance sensors, 7.5 mV/m.

(iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075-24175 MHz band, fully comply with the limits given in §15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as forklifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

2.2.3 Equipment Under Test and Modification State

Serial No: 17H11807 / Default Test Configuration



2.2.4 Date of Test

August 17 and 18, 2022

2.2.5 Environmental Conditions

Ambient Temperature 28.5 - 29.4 °C
 Relative Humidity 45.4 – 47.7 %
 Atmospheric Pressure 99.8 - 100.1 kPa

2.2.6 Additional Observations

- The spectrum was searched from 9kHz to 100GHz
- Verifications performed at 3 meters up to 60GHz and 1 meter up to 100GHz.
- Limit used above 60GHz is for 3 meters (worst-case).
- 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 2.2.7 for sample computation.

2.2.7 Sample Computation (Radiated Emissions – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	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

2.2.8 Test Results

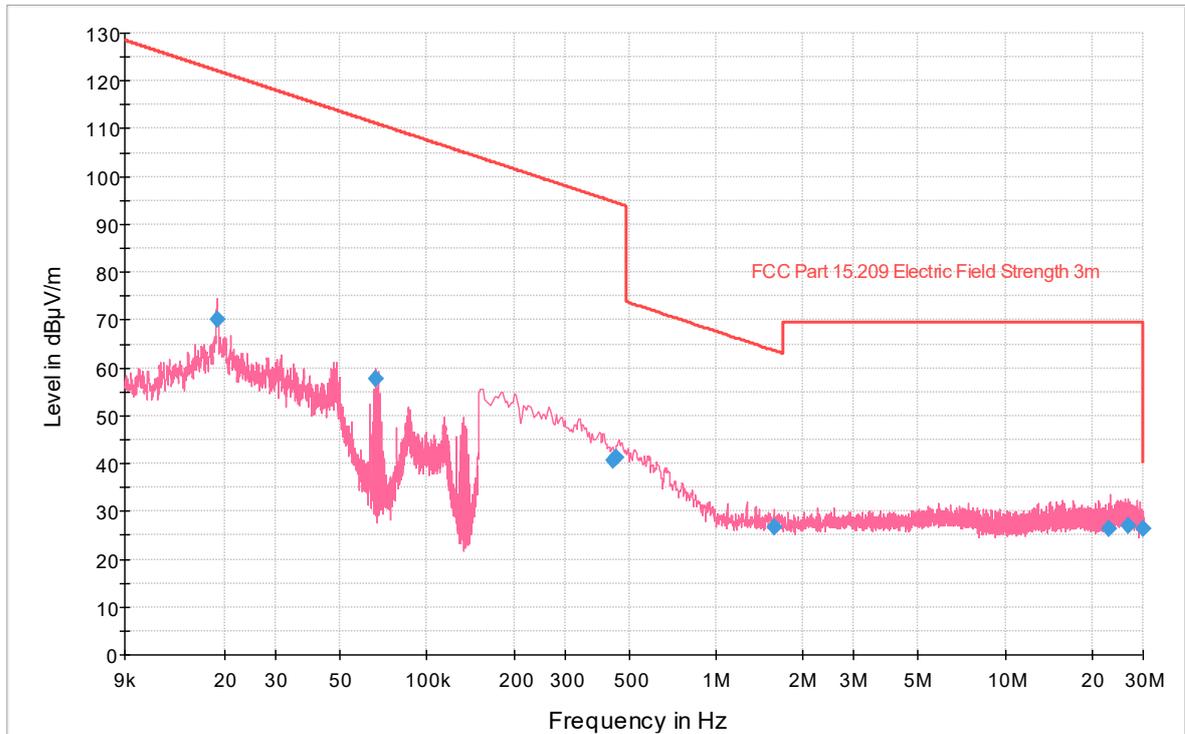
Performance assessment of the EUT made during this test: **Pass**

Detailed results are shown below.



2.2.8.1 Below 30MHz Radiated Emissions

Full Spectrum



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15.209 Electric Field Strength 3m [..EMI Radiated\]
- ◆ Final_Result QPK [Final_Result.Result:4]

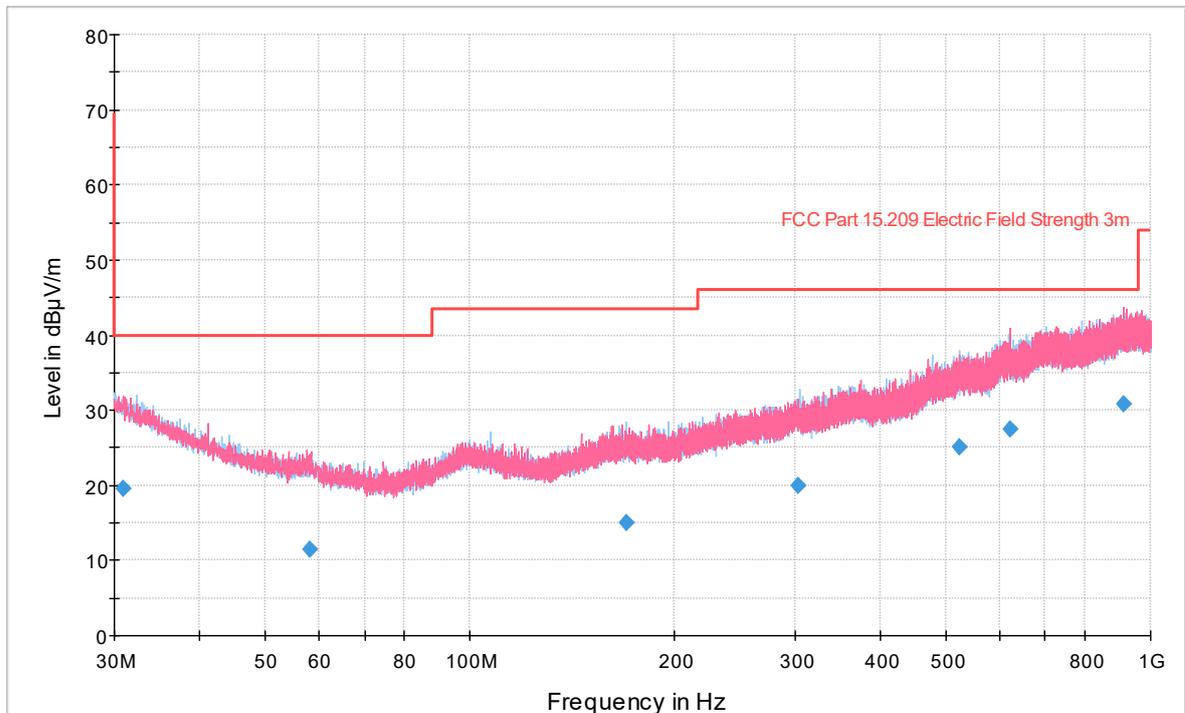
Quasi-Peak Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.018857	70.23	122.09	51.86	1000.0	0.200	400.0	H	16.0	22
0.066575	57.58	111.13	53.56	1000.0	0.200	400.0	H	16.0	20
0.439655	40.55	94.74	54.19	1000.0	9.000	400.0	H	65.0	19
0.449625	41.38	94.55	53.16	1000.0	9.000	400.0	H	6.0	19
1.581906	26.72	63.61	36.89	1000.0	9.000	400.0	H	216.0	20
22.908458	26.34	69.50	43.16	1000.0	9.000	400.0	H	51.0	24
26.685462	26.92	69.50	42.58	1000.0	9.000	400.0	H	38.0	25
29.933125	26.46	69.50	43.04	1000.0	9.000	400.0	H	209.0	25



2.2.8.2 30MHz to 1GHz Radiated Emissions

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15.209 Electric Field Strength 3m [..\EMI Radiated\]
- ◆ Final_Result QPK [Final_Result.Result4]

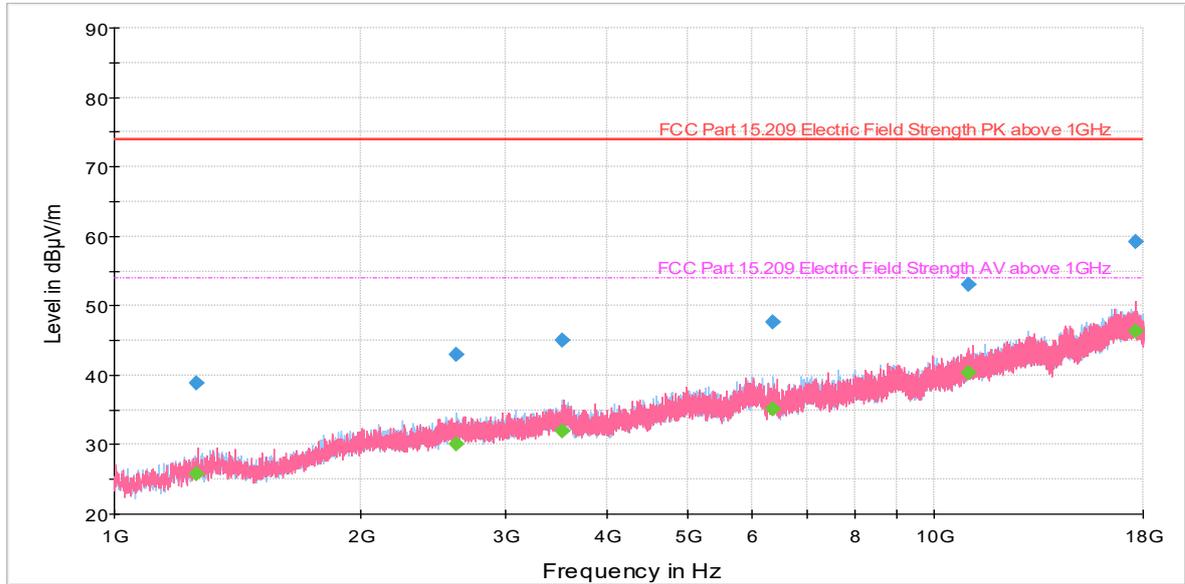
Quasi-Peak Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.855667	19.49	40.00	20.51	1000.0	120.000	370.0	H	275.0	22
58.197333	11.48	40.00	28.52	1000.0	120.000	372.0	V	9.0	14
169.623000	15.08	43.50	28.42	1000.0	120.000	282.0	H	289.0	17
303.757667	20.04	46.00	25.96	1000.0	120.000	358.0	H	310.0	22
523.374333	25.14	46.00	20.86	1000.0	120.000	400.0	H	0.0	26
623.089667	27.42	46.00	18.58	1000.0	120.000	194.0	V	265.0	27
912.610333	30.85	46.00	15.15	1000.0	120.000	400.0	V	186.0	31



2.2.8.3 1GHz to 18GHz Radiated Emissions

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15.209 Electric Field Strength PK above 1GHz [.\NEMI Radiated\]
- FCC Part 15.209 Electric Field Strength AV above 1GHz [.\NEMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak Result

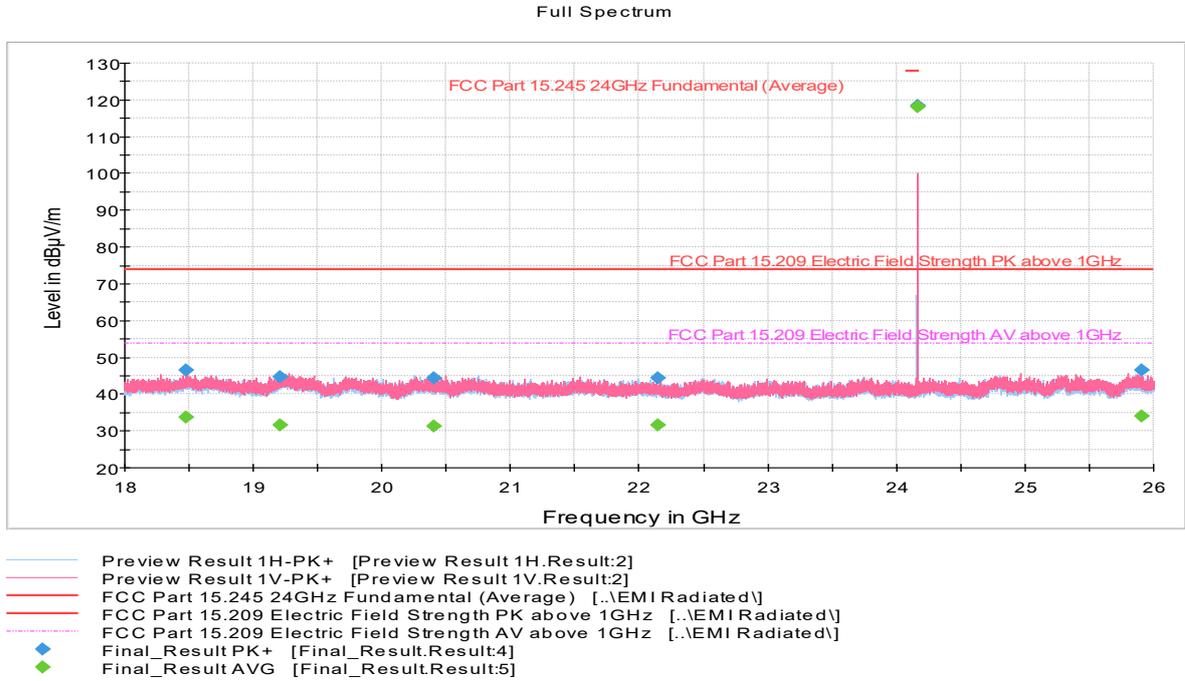
Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1261.933333	38.79	73.90	35.11	1000.0	1000.000	244.0	V	24.0	-4
2616.400000	43.02	73.90	30.88	1000.0	1000.000	127.0	H	46.0	1
3521.766667	45.02	73.90	28.88	1000.0	1000.000	332.0	H	13.0	3
6363.400000	47.72	73.90	26.18	1000.0	1000.000	255.0	H	1.0	6
11017.166666	53.12	73.90	20.78	1000.0	1000.000	306.0	V	206.0	14
17648.433333	59.29	73.90	14.61	1000.0	1000.000	210.0	V	106.0	19

Average Result

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1261.933333	25.87	53.90	28.03	1000.0	1000.000	244.0	V	24.0	-4
2616.400000	30.10	53.90	23.80	1000.0	1000.000	127.0	H	46.0	1
3521.766667	31.91	53.90	21.99	1000.0	1000.000	332.0	H	13.0	3
6363.400000	35.16	53.90	18.74	1000.0	1000.000	255.0	H	1.0	6
11017.166666	40.34	53.90	13.56	1000.0	1000.000	306.0	V	206.0	14
17648.433333	46.33	53.90	7.57	1000.0	1000.000	210.0	V	106.0	19



2.2.8.4 18GHz to 26GHz Radiated Emissions



Peak Result

Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18475.498500	46.54	73.90	27.36	1000.0	1000.000	213.0	V	200.0	3
19210.031000	44.57	73.90	29.33	1000.0	1000.000	163.0	V	97.0	3
20407.325500	44.24	73.90	29.66	1000.0	1000.000	213.0	H	58.0	3
22145.581000	44.45	73.90	29.45	1000.0	1000.000	212.0	H	190.0	5
24163.565000	118.54	147.95	29.41	1000.0	1000.000	140.0	H	27.0	6
25904.808500	46.61	73.90	27.29	1000.0	1000.000	213.0	V	359.0	8

Average Result

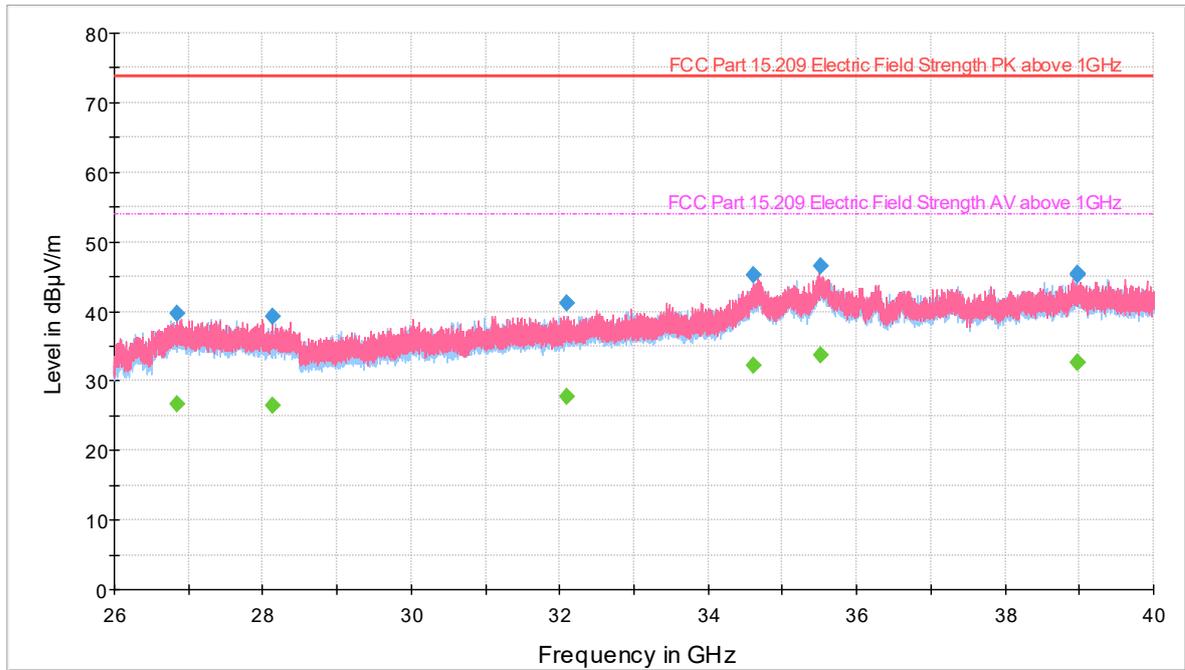
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18475.498500	33.58	53.90	20.32	1000.0	1000.000	213.0	V	200.0	3
19210.031000	31.50	53.90	22.40	1000.0	1000.000	163.0	V	97.0	3
20407.325500	31.40	53.90	22.50	1000.0	1000.000	213.0	H	58.0	3
22145.581000	31.72	53.90	22.18	1000.0	1000.000	212.0	H	190.0	5
24163.565000	118.20	127.95	9.75	1000.0	1000.000	140.0	H	27.0	6
25904.808500	33.90	53.90	20.00	1000.0	1000.000	213.0	V	359.0	8

Test Note: 24163.56MHz is subject to §15.245 fundamental limit and not §15.209 emission limits. §15.245 fundamental Peak limits is not showed as the Peak level complies with the Average limits.



2.2.8.5 26GHz to 40GHz Radiated Emissions

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15.209 Electric Field Strength PK above 1GHz [..\EMI Radiated\]
- FCC Part 15.209 Electric Field Strength AV above 1GHz [..\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

Peak Result

Frequency (MHz)	Max Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26836.577307	39.71	73.90	34.19	1000.0	1000.000	175.0	H	232.0	3
28128.134231	39.22	73.90	34.68	1000.0	1000.000	210.0	V	9.0	2
32094.026154	41.10	73.90	32.80	1000.0	1000.000	191.0	H	70.0	6
34604.026538	45.30	73.90	28.60	1000.0	1000.000	225.0	V	234.0	7
35505.944615	46.41	73.90	27.49	1000.0	1000.000	225.0	V	96.0	7
38967.170769	45.45	73.90	28.45	1000.0	1000.000	138.0	H	317.0	8
38967.772693	45.27	73.90	28.63	1000.0	1000.000	139.0	H	317.0	8



Average Result

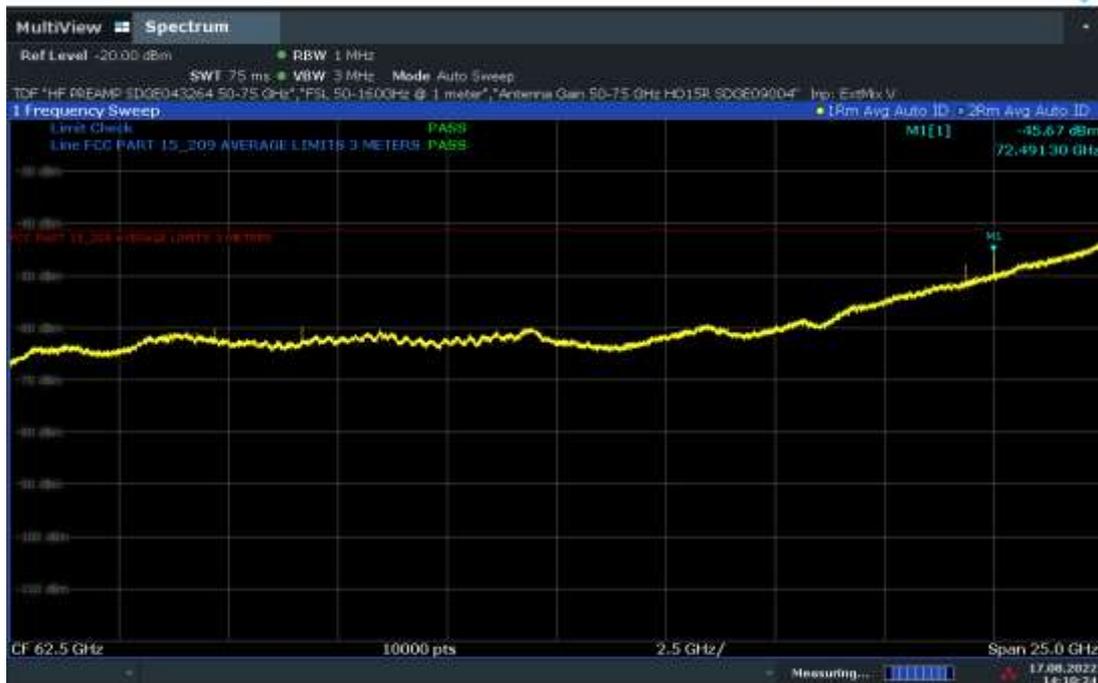
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26836.577307	26.63	53.90	27.27	1000.0	1000.000	175.0	H	232.0	3
28128.134231	26.36	53.90	27.54	1000.0	1000.000	210.0	V	9.0	2
32094.026154	27.64	53.90	26.26	1000.0	1000.000	191.0	H	70.0	6
34604.026538	32.22	53.90	21.68	1000.0	1000.000	225.0	V	234.0	7
35505.944615	33.62	53.90	20.28	1000.0	1000.000	225.0	V	96.0	7
38967.170769	32.54	53.90	21.36	1000.0	1000.000	138.0	H	317.0	8
38967.772693	32.58	53.90	21.32	1000.0	1000.000	139.0	H	317.0	8



2.2.8.6 Maximized Plot from 40GHz to 60GHz



2.2.8.7 Maximized Plot from 60GHz to 75GHz





2.2.8.8 Maximized Plot from 75GHz to 110GHz



14:18:26 17.08.2022



2.2.9 Test Location and Test Equipment Used

This test was carried out in Mira Mesa CA, (SR5) using equipment listed below:

Asset ID Number	Test Equipment	Type	Serial Number	Manufacturer	Cal Due Date
6628	Loop Antenna	HFH2-Z2335.4711.52	FNr.800.458/25	Schwarbeck	06/23/24
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	10/21/23
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	09/16/22
7611	Signal & Spectrum Analyzer	FSW26	102017	Rohde & Schwarz	02/09/23
1049	EMI Test Receiver	ESU	100133	Rohde & Schwarz	10/01/22
46797	Preamplifier	PS-122	181925	Com Power	10/11/22
9001	Horn antenna (18-26.5GHz)	HO42S	101	Custom Microwave	09/23/23
9002	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	09/23/23
40815	18GHz to 40GHz Low Noise Amplifier	SLKka-30-6	19D18	Spacek Labs	10/11/22
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves	07/29/23
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	07/29/23
7628	Horn antenna (75-110 GHz)	SAR-2309-10-S2	13481-01	Sage Millimeter, Inc.	07/29/23
7637	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	07/23/23
7636	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	07/23/23
7633	Harmonics mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	07/23/23
7611	Signal/Spectrum Analyzer	FSW26	102017	Rohde & Schwarz	02/09/23
1003	Signal Generator	SMR40	100443	Rohde & Schwarz	11/17/22
43003	True RMS Multimeter	85 III	69880143	Fluke	11/19/22
7619	Barometer/ Temperature/Humidity Transmitter	iBTHX-W	15250268	Omega	05/27/23



2.3 Spurious Emissions

2.3.1 Specification Reference

FCC 47 Chapter I Subchapter A Part 15 Subpart C §15.245 (b)(3)
RSS-210, Annex F.2(d)

2.3.2 Standard Applicable

(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in [§ 15.209](#), whichever is the lesser attenuation.

2.3.3 Equipment Under Test and Modification State

Serial No: 17H11807 / Default Test Configuration

2.3.4 Date of Test

August 17 and 18, 2022

2.3.5 Environmental Conditions

Ambient Temperature	28.5 - 29.4 °C
Relative Humidity	45.4 – 47.7 %
Atmospheric Pressure	99.8 - 100.1 kPa

2.3.6 Additional Observations

Test results and conditions from Section 2.2 of this test report applies.

2.3.7 Test Results

Performance assessment of the EUT made during this test: **Pass**



2.4 Carrier Frequency Stability

2.4.1 Specification Reference

RSS-210, Annex F.2(e)
RSS-Gen 6.11

2.4.2 Standard Applicable

(e) The carrier frequency stability shall be sufficient to ensure that the 40 dB bandwidth stays within the operating frequency band when tested at the temperature and supply voltage variations specified for the frequency stability measurement in RSS-Gen.

2.4.3 Equipment Under Test and Modification State

Serial No: 17H11807 / Default Test Configuration

2.4.4 Date of Test

August 19, 2022

2.4.5 Environmental Conditions

Ambient Temperature 26.1 °C
Relative Humidity 46.7 %
Atmospheric Pressure 99.9 kPa

2.4.6 Additional Observations

- Test performed per RSS-Gen 6.11 requirements for license-exempt devices.
- Worst case RBW setting of 1MHz is used for 20°C and 50°C. For -20°C verification, the recommended RBW setting of 30kHz is used derived from 99% Bandwidth RBW requirement of 1% to 5% of the actual OBW.

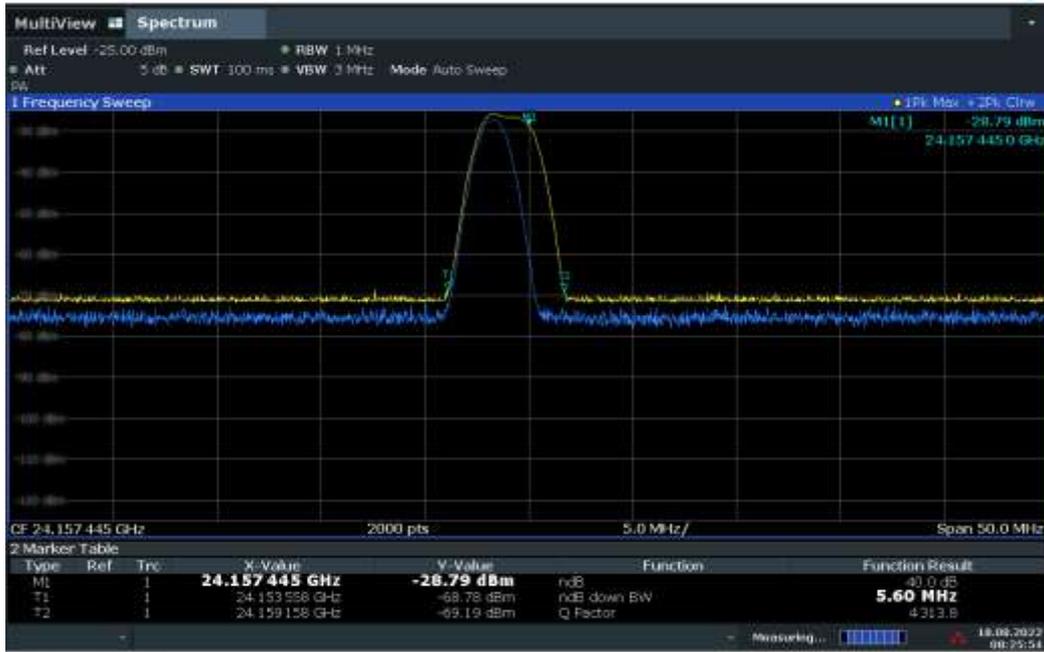
2.4.7 Test Results

Performance assessment of the EUT made during this test: **Pass**

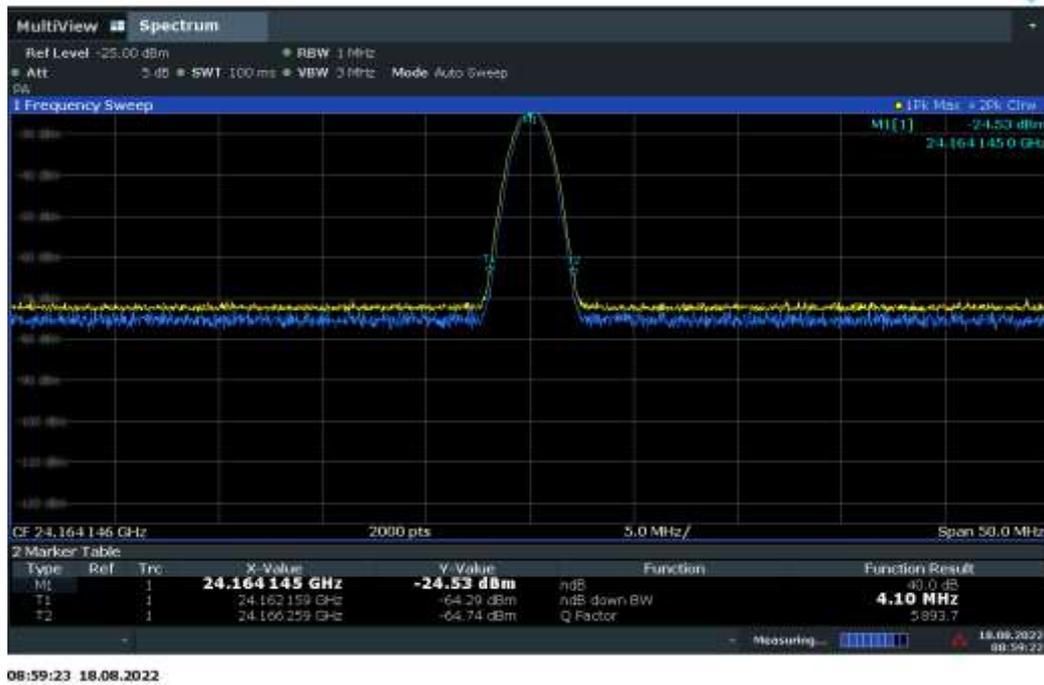
Temperature	Test Voltage	Observation
50°C	15VDC	Stayed within the operating frequency band of 24.075GHz to 24.175GHz (worst case recorded is 24.174673GHz which is 327kHz from the upper edge of the operating band)
20°C	15VDC	
20°C	12.75VDC	
20°C	17.25VDC	
-20°C	15VDC	



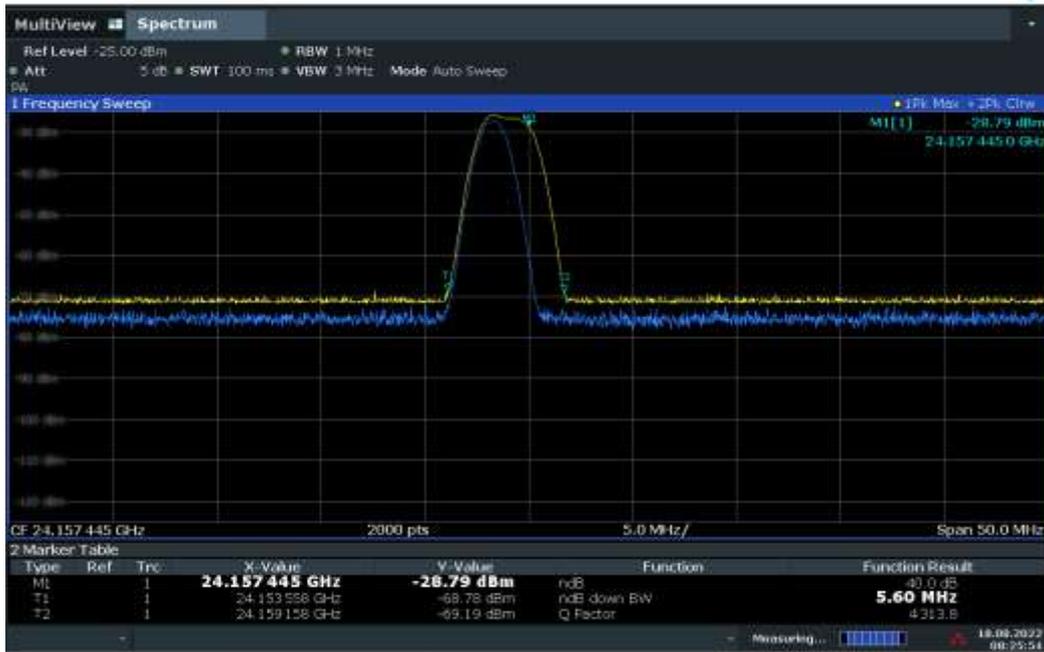
2.4.8 Test Plots



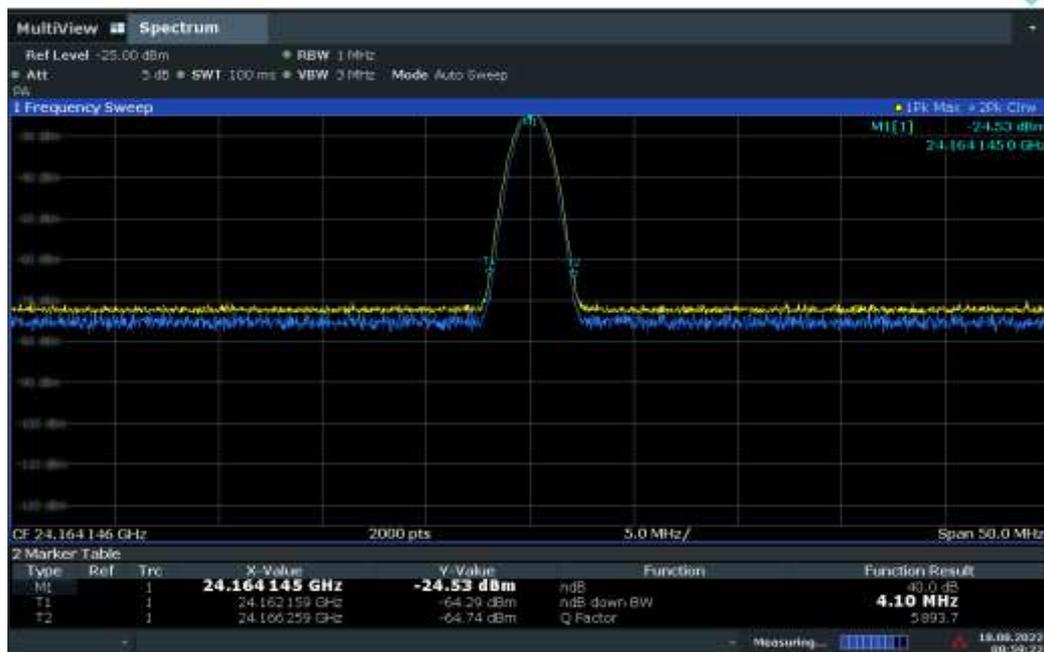
50°C at nominal voltage (15VDC)



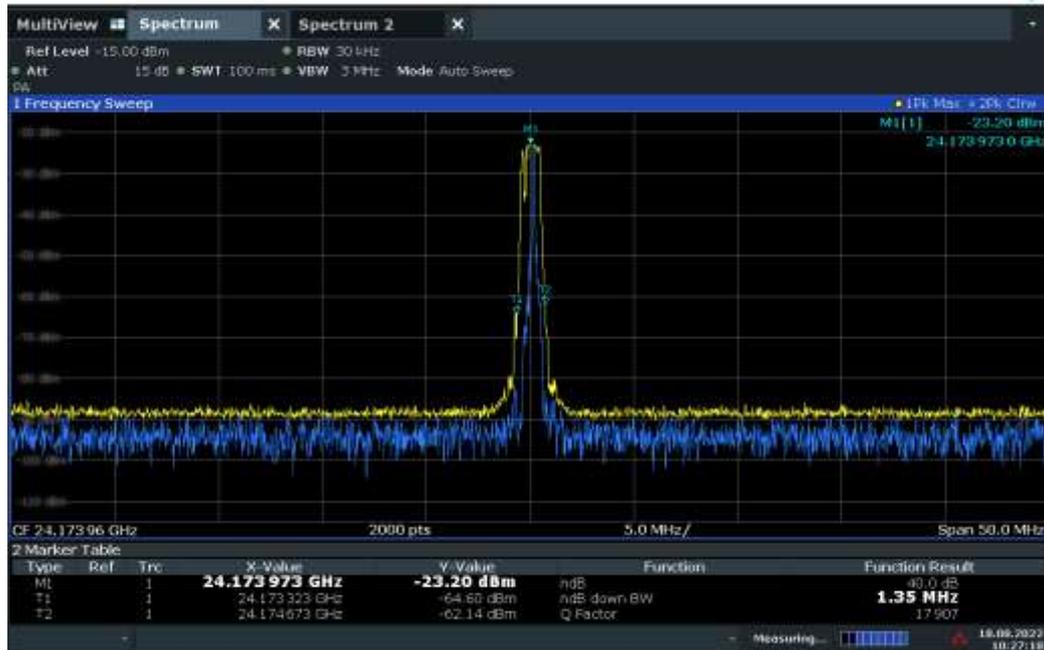
20°C at nominal voltage (15VDC)



20°C at 85% nominal voltage (12.75VDC)



20°C at 115% nominal voltage (17.25VDC)



10:27:18 18.08.2022

-20°C at nominal voltage (15VDC)



10:25:57 18.08.2022

99% OBW to determine correct RBW setting (1% to 5% of OBW)



3 Measurement Uncertainty

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

3.1 Radiated Emissions Measurements – Below 30 MHz at a distance of 3 m (alternate site)

	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-polarization	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 Radiated Emissions Measurements - 30 MHz – 1000 MHz at a distance of 3 m

	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

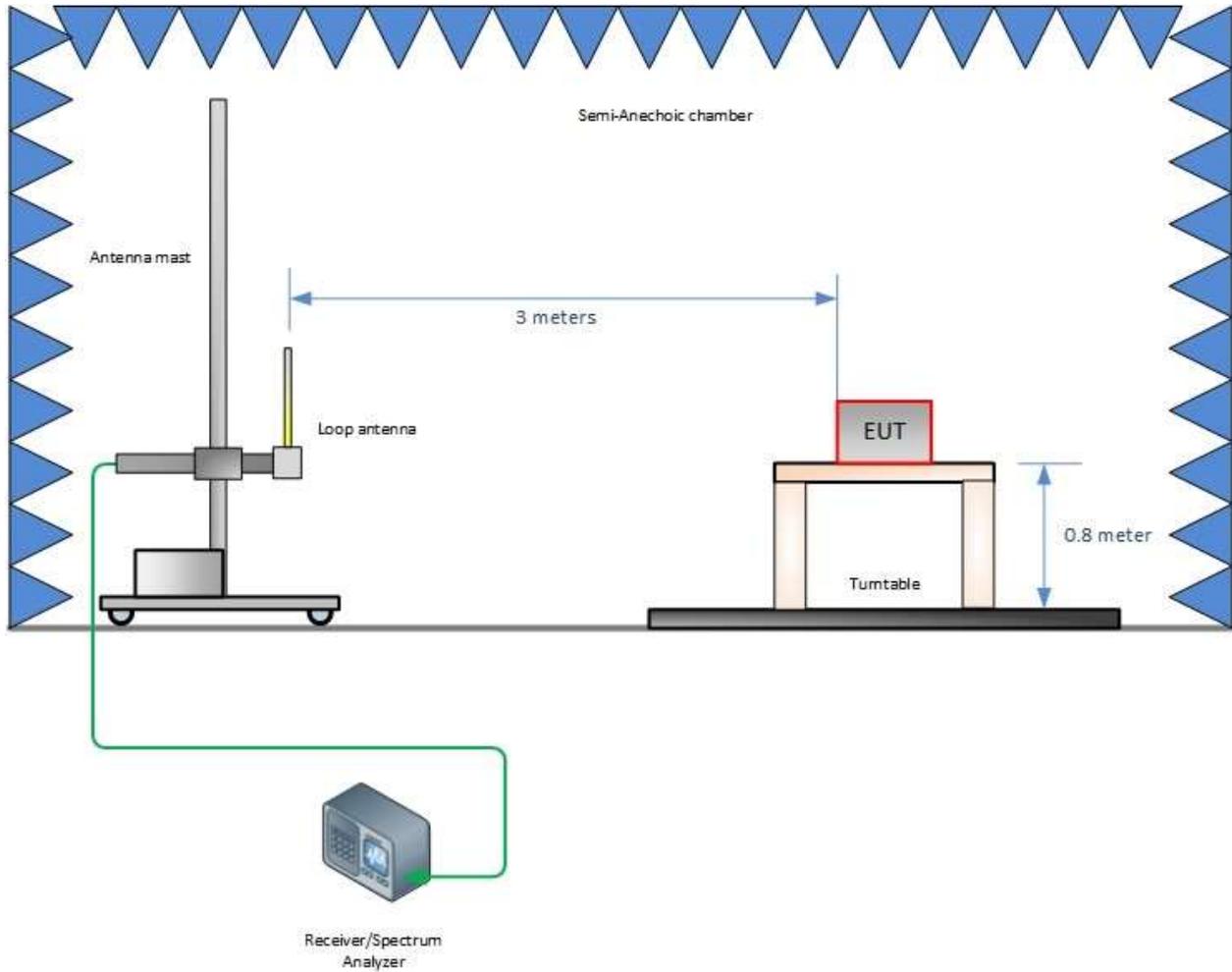


8	Mismatch: antenna-receiver	0.95 dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30 dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10 dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12 dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00 dB	Rectangular	1.732	0.58	0.33
13	Cross-polarization	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	

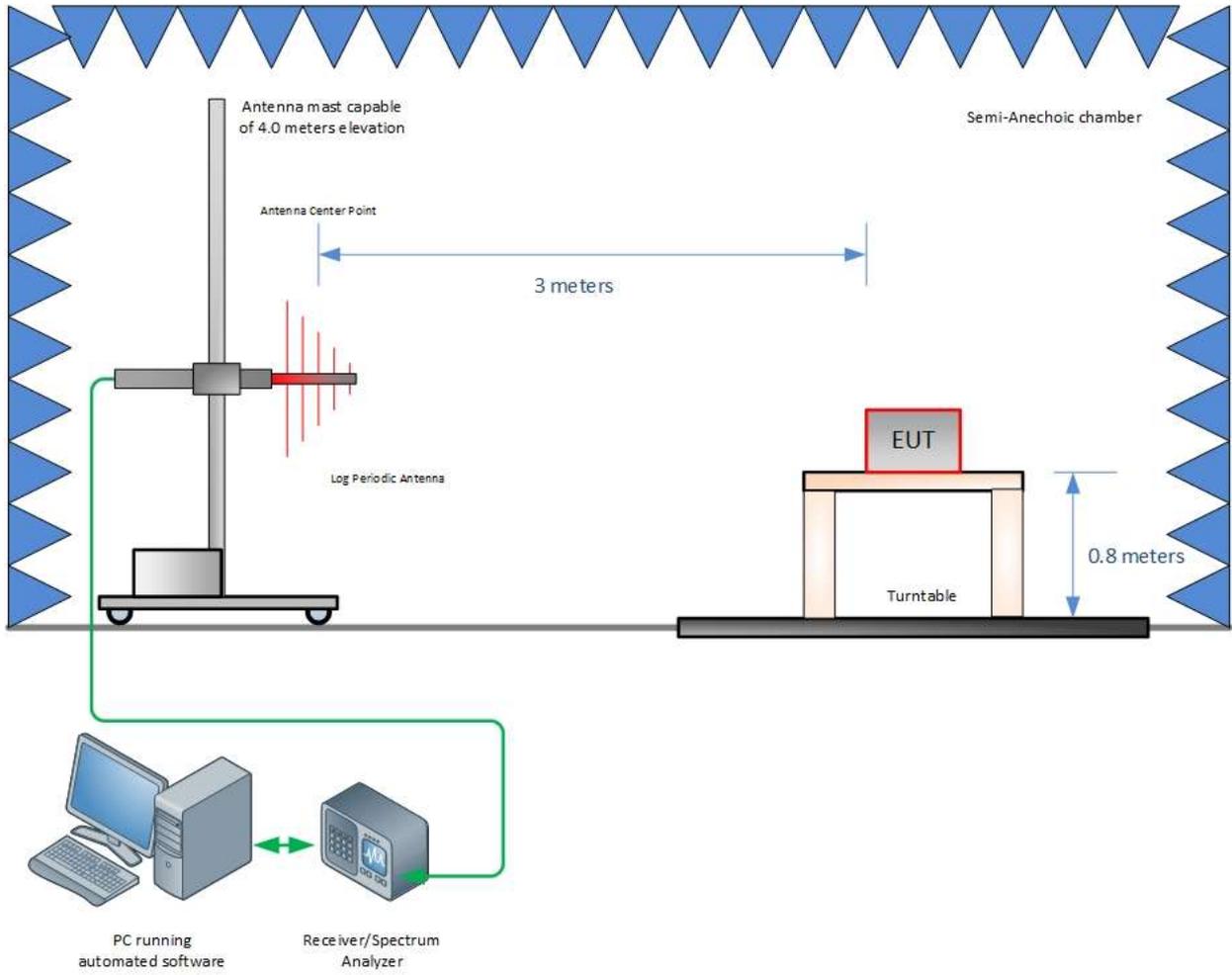
3.3 Radiated Emissions Measurements – 1GHz – 18 GHz at a distance of 3 m

	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20 dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75 dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45 dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50 dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50 dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50 dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95 dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30 dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10 dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12 dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00 dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90 dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00 dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.25 dB	Triangular	2.449	1.33	1.76
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77 dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10 dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00 dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00 dB				0.00
Combined standard uncertainty				Normal	2.85 dB	
Expanded uncertainty				Normal, k=2	5.70 dB	

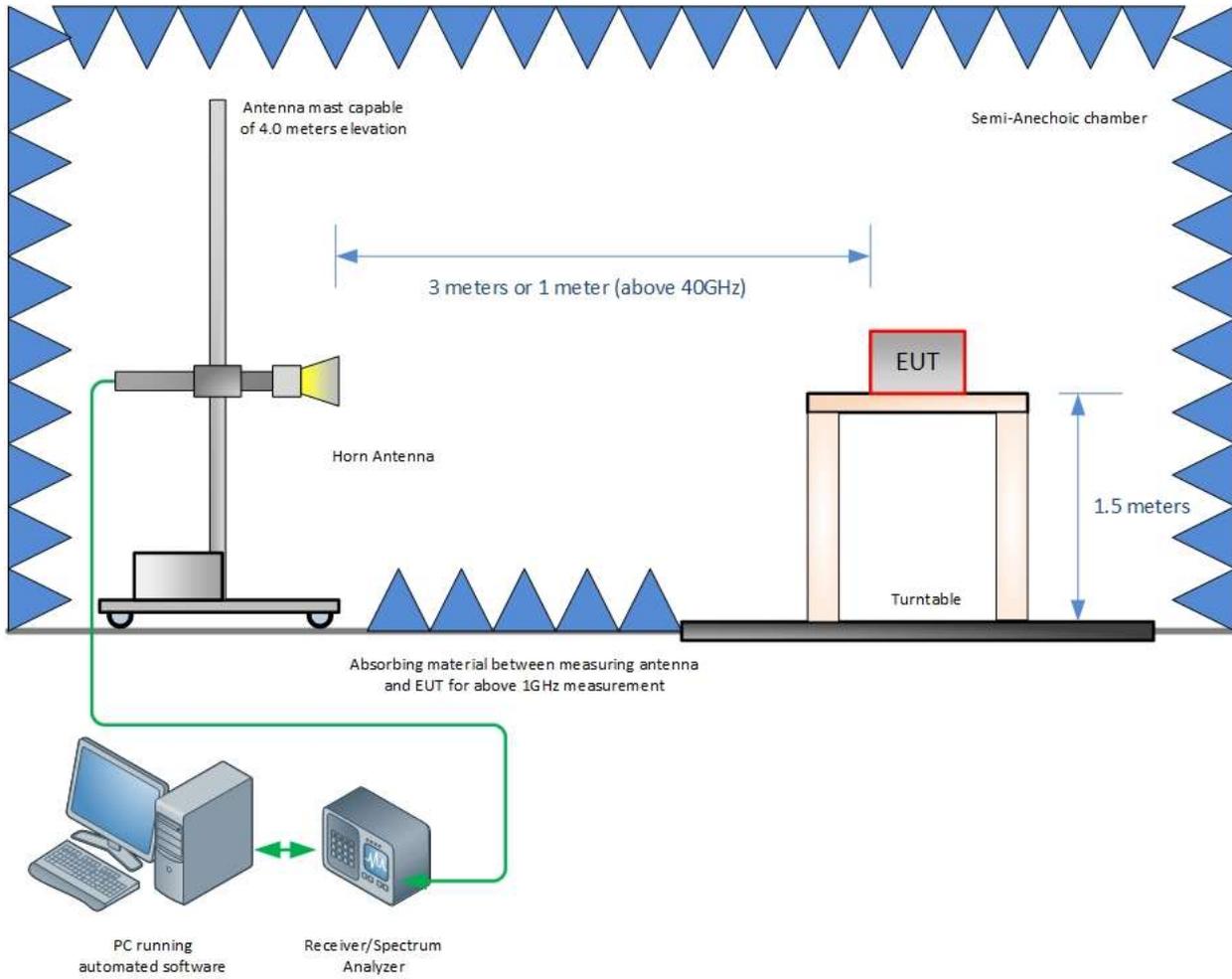
4 Test Set-up Diagrams for Emissions Test



Radiated Emission Test Setup (Below 30MHz)



Radiated Emission Test Setup (30MHz to 1GHz)



Radiated Emission Test Setup (Above 1GHz)



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