FCC and ISED Test Report

Sepura Limited
Tetra Mobile Radio, Model: SCG22

In accordance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN

Add value.
Inspire trust.

Prepared for: Sepura Limited
9000 Cambridge Research Park
Beach Drive
Waterbeach
Cambridge
CB25 9TL
United Kingdom

FCC ID: XX6SCG2229 IC: 8739A-SCG2229

COMMERCIAL-IN-CONFIDENCE

Document 75948283-02 Issue 02

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Steve Marshall	Senior Engineer	Authorised Signatory	22 June 2020

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

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Mehadi Choudhury	22 June 2020	
Testing	Graeme Lawler	22 June 2020	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2019, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) for the tests detailed in section 1.3.

TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Contents

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	First Issue	06 May 2020
2	To include new results after re-testing was required as the correct matching components were fitted to Bluetooth/Wi-Fi RF circuit.	22 June 2020

Table 1

1.2 Introduction

Applicant	Sepura Limited
Manufacturer	Sepura Limited
Model Number(s)	SCG22
Serial Number(s)	1PR002007GPH5XV 1PR002007GPH5XU
Hardware Version(s)	Pre-production PLX-89015561_Rev49b
Software Version(s)	1785 004 10138
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2019 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number Date	PLC-PO015398-1 12-February-2020
Date of Receipt of EUT	10-March-2020
Start of Test	30-March-2020
Finish of Test	09-June-2020
Name of Engineer(s)	Mehadi Choudhury and Graeme Lawler
Related Document(s)	ANSI C63.10 (2013)

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: Vehicle RSM - Bluetooth						
2.1	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10 (2013)
2.2	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Number of Hopping Channels	Pass	ANSI C63.10 (2013)
2.3	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10 (2013)
2.4	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Channel Separation	Pass	ANSI C63.10 (2013)
2.5	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - 20 dB Bandwidth	Pass	ANSI C63.10 (2013)
2.6	15.205	-	8.10	Restricted Band Edges	Pass	ANSI C63.10 (2013)
2.7	15.247 (d) and 15.205	5.5	6.13	Spurious Radiated Emissions	Pass	ANSI C63.10 (2013)

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	TETRA mobile radio for use within cars, trucks, mobile and fixed control rooms, motorcycles, boats and trains, with Wi-Fi, Bluetooth, GPS and Ethernet functions
Manufacturer:	Sepura
Model:	SCG22
Part Number:	SCG2229
Hardware Version:	Pre-production PLX-89015561_Rev49b
Software Version:	1785 004 10138
FCC ID (if applicable)	XX6SCG2229
IC ID (if applicable)	8739A-SCG2229

Intentional Radiators

Technology	TETRA	Bluetooth LE	Bluetooth Classic / EDR	Wi-Fi 802.11b, g	Wi-Fi 802.11n	Wi-Fi 802.11n
Frequency Band (MHz)	380 - 470 MHz	2402 - 2480 MHz	2402 - 2480 MHz	2412 - 2462 MHz	2412 - 2462 MHz	2422 - 2452 MHz
Conducted Declared Output Power (dBm)	40	7.4	7.382	16.5	16.5	16.5
Antenna Gain (dBi)	2	Element 3: 2 dBi	Element 3: 2 dBi	Element 3: 2 dBi	Element 3: 2 dBi	Element 3: 2 dBi
Supported Bandwidth(s) (MHz)	0.025 / 0.02	1	1	20	20	40
Modulation Scheme(s)	π/4 DQPSK	GFSK	GFSK π/4 DQPSK 8DPSK	802.11b: CCK, DBPSK, DQPSK 802.11g: BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM
ITU Emission Designator	22K0DXW 20K0DXW	1181F1D	1M01F1D 1M01G1D	19M7G1D	19M7D1D	36M8D1D
Bottom Frequency (MHz)	380 MHz	2402 MHz	2402 MHz	2412 MHz	2412 MHz	2422 MHz
Middle Frequency (MHz)	425 MHz	2441 MHz	2441 MHz	2437 MHz	2437 MHz	2437 MHz
Top Frequency (MHz)	470 MHz	2480 MHz	2480 MHz	2462 MHz	2462 MHz	2452 MHz

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2480 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	32.768 kHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

AC Power Source

AC supply frequency:		Hz
Voltage		V
Max current:		A
Single Phase ☐ Three Phase ☐		

DC Power Source

Nominal voltage:	12	V
Extreme upper voltage:	15.6	V
Extreme lower voltage:	10.8	V
Max current:	5	A

Battery Power Source None

Voltage:		V
End-point voltage:		V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*		
Other ☐ Please detail:		

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☐

Temperature

Minimum temperature:	-20	°C
Maximum temperature:	+60	°C

Antenna Characteristics

Antenna connector ☒			State impedance	50	Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☐	Type:		Gain		dBi
External antenna ☒	Type:		Gain		dBi
For external antenna only: Standard Antenna Jack ☒ If yes, describe how user is prohibited from changing antenna (if not professional installed): Equipment is only ever professionally installed ☒ Non-standard Antenna Jack ☐					

Ancillaries (if applicable)

Manufacturer:	Sepura	Part Number:	GPSB4
Model:	GPSB4 Vehicle Roof Antenna	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	AFB-TET
Model:	AFB-VAR 380-430 MHz antenna	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	AFB-UT
Model:	AFB-VAR 406-472 MHz antenna	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-02012 rev001
Model:	Extended SCG Loudspeaker / IO USB Host lead	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-02014 rev001
Model:	Extended SCG Expansion Board Loudspeaker / 8 GPIO lead	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	Netgear GS105 ProSAFE Gigabit Switch
Model:	Netgear GS105 ProSAFE Gigabit Switch	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-02010
Model:	SCG Power/ignition Lead	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00069
Model:	Mobile Remote Cable 5.0M	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00670
Model:	HBC Interface and Hands-free Box	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00079
Model:	Remote Microphone And Switch Set	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00292
Model:	Remote Microphone (Handsfree Kit) 3m	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-01801
Model:	Handset Based Console (HBC3)	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00082
Model:	Detachable Loudspeaker extension Cable	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00062
Model:	Fist microphone	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-01808
Model:	SCC3 (colour console)	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-01961
Model:	CC VAC RSM (Long Cable)	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-00719
Model:	Loudspeaker	Country of Origin:	Unknown
Manufacturer:	Sepura	Part Number:	300-01837
Model:	Loudspeaker	Country of Origin:	Unknown

I hereby declare that the information supplied is correct and complete.
Name: Chris Beecham
Position held: Conformance Engineer
Date: 10 March 2020

1.5 Product Information

1.5.1 Technical Description

TETRA mobile radio for use within cars, trucks, mobile and fixed control rooms, motorcycles, boats and trains, with Wi-Fi, Bluetooth, GPS and Ethernet functions.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

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
Model: SCG22, Serial Number: 1PR002007GPH5XV			
0	As supplied by the customer	Not Applicable	Not Applicable
1	The correct matching components were fitted to the Bluetooth/Wi-Fi RF circuit. New hardware version: PLX-89015561_Rev49b	Manufacturer	June-2020
Model: SCG22, Serial Number: 1PR002007GPH5XU			
0	As supplied by the customer	Not Applicable	Not Applicable
1	The correct matching components were fitted to the Bluetooth/Wi-Fi RF circuit. New hardware version: PLX-89015561_Rev49b	Manufacturer	June-2020

Table 3

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Vehicle RSM - Bluetooth		
Maximum Conducted Output Power	Mehadi Choudhury	UKAS
Frequency Hopping Systems - Number of Hopping Channels	Mehadi Choudhury	UKAS
Authorised Band Edges	Graeme Lawler	UKAS
Frequency Hopping Systems - Channel Separation	Mehadi Choudhury	UKAS
Frequency Hopping Systems - 20 dB Bandwidth	Mehadi Choudhury	UKAS
Restricted Band Edges	Graeme Lawler	UKAS
Spurious Radiated Emissions	Graeme Lawler	UKAS

Table 4

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
ISED RSS-247, Clause 5.4
ISED RSS-GEN, Clause 6.12

2.1.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XU - Modification State 1

2.1.3 Date of Test

09-June-2020

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 11.9.1.1.

2.1.5 Environmental Conditions

Ambient Temperature	21.5 °C
Relative Humidity	46.4 %

2.1.6 Test Results

Vehicle RSM - Bluetooth

Frequency (MHz)	Modulation Scheme	Maximum Output Power	
		dBm	mW
2402	GFSK	6.95	4.95
2402	π/4 DQPSK	7.27	5.34
2402	8-DPSK	7.94	6.22
2440	GFSK	7.03	5.04
2440	π/4 DQPSK	7.40	5.50
2440	8-DPSK	8.00	6.31
2480	GFSK	7.17	5.21
2480	π/4 DQPSK	7.53	5.66
2480	8-DPSK	8.12	6.49

Table 5

Figure 1 - 2402 MHz, GFSK

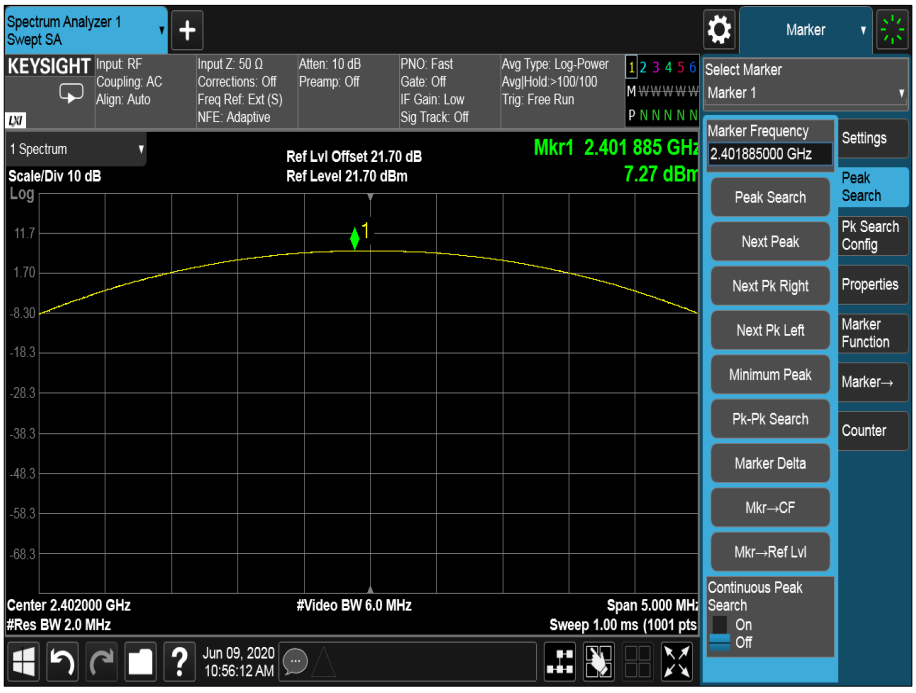

Figure 2 - 2402 MHz, π/4 DQPSK

Figure 3 - 2402 MHz, 8-DPSK

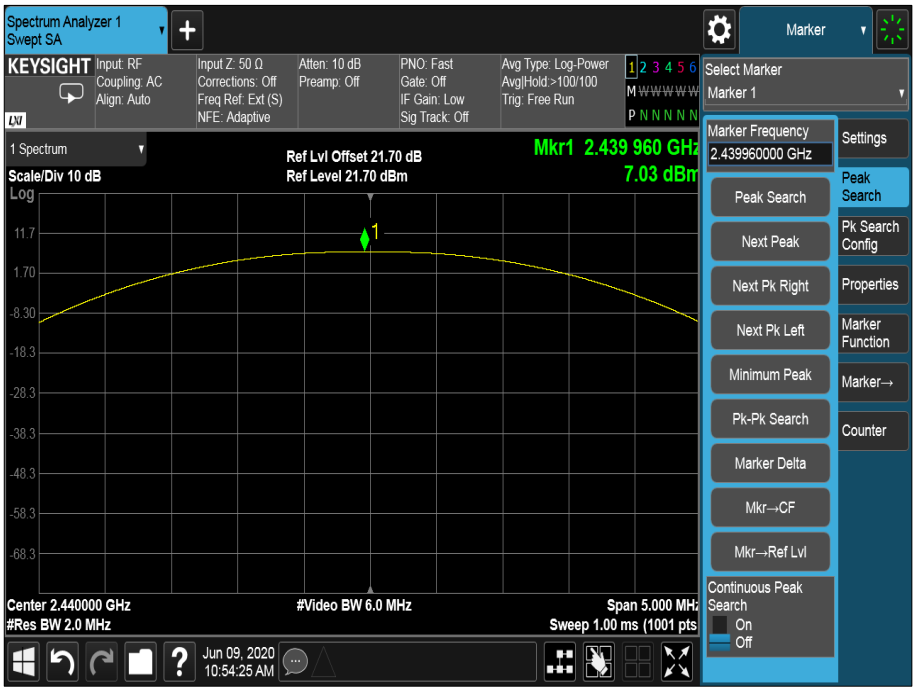

Figure 4 - 2440 MHz, GFSK

Figure 5 - 2440 MHz, π/4 DQPSK

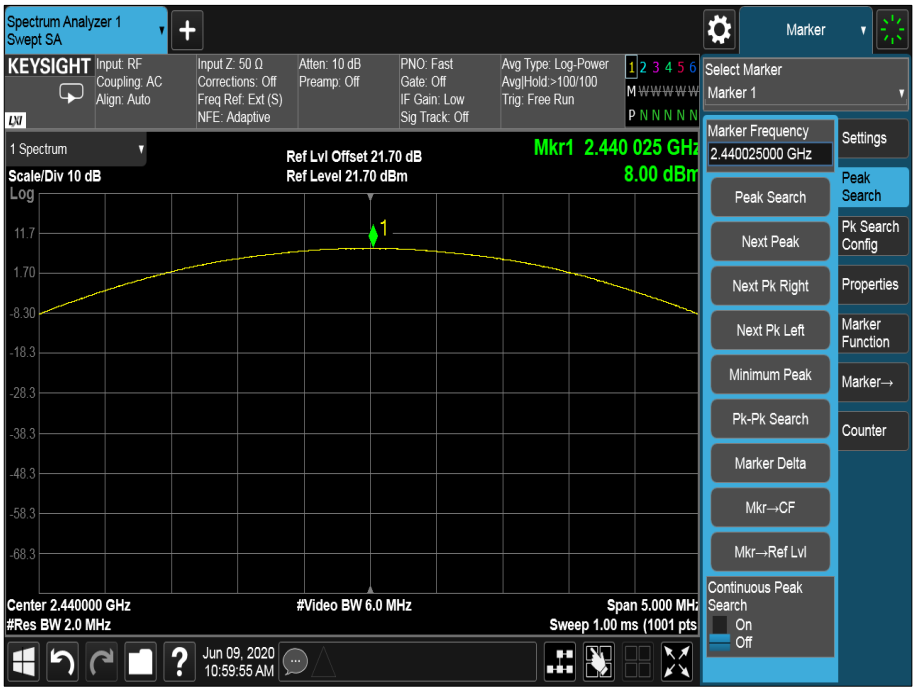

Figure 6 - 2440 MHz, 8-DPSK

Figure 7 - 2480 MHz, GFSK

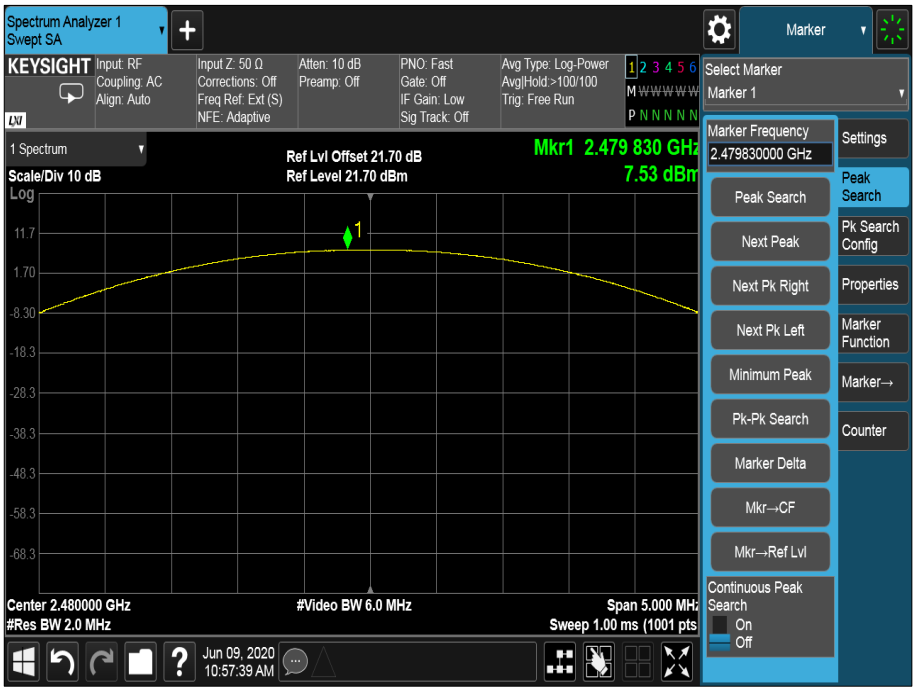

Figure 8 - 2480 MHz, π/4 DQPSK

Figure 9 - 2480 MHz, 8-DPSK

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

ISED RSS-247, Limit Clause 5.4 (b)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channel; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channel. The e.i.r.p. shall not exceed 4 W except as provided in section 5.4(e) of the specification.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	11-Dec-2020
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	28-Nov-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	08-Nov-2020
Attenuator (20dB, 100W)	Weinschel	48-20-43	4870	12	18-Jul-2020
EXA	Keysight Technologies	N9010B	4968	24	23-Dec-2021
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020

Table 6

2.2 Frequency Hopping Systems - Number of Hopping Channels

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.2.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XU - Modification State 0

2.2.3 Date of Test

01-April-2020

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.3.

2.2.5 Environmental Conditions

Ambient Temperature	25.9 °C
Relative Humidity	18.0 %

2.2.6 Test Results

Vehicle RSM - Bluetooth

Number of Hopping Channels: 79

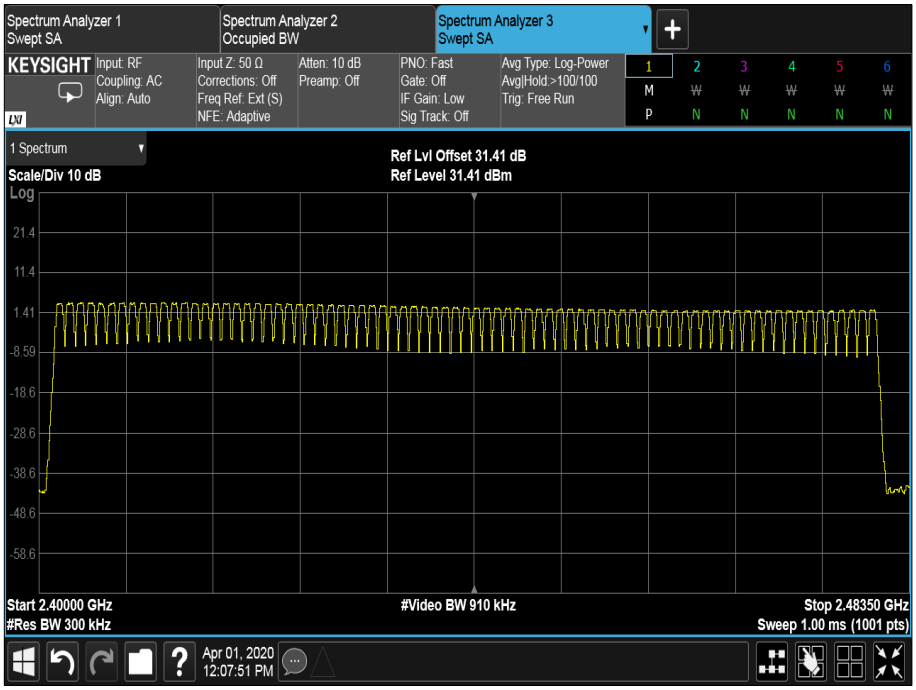

Figure 10 - Measurement Frequency Range: 2400 MHz to 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(iii)

≥ 15 channels

ISED RSS-247, Limit Clause 5.1 (d)

FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
30dB Attenuator	Narda	766-30	4783	12	24-Mar-2021
EXA	Keysight Technologies	N9010B	4969	24	03-Feb-2022
Cable (40 GHz)	Rosenberger	LU1-001-1000	5022	12	12-Nov-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 7

O/P Mon – Output Monitored using calibrated equipment

2.3 Authorised Band Edges

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d)
ISED RSS-247, Clause 5.5

2.3.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XV - Modification State 1

2.3.3 Date of Test

09-June-2020

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

2.3.5 Environmental Conditions

Ambient Temperature	22.6 °C
Relative Humidity	44.1 %

2.3.6 Test Results

Vehicle RSM - Bluetooth

Mode	Modulation	Packet Type	Frequency (MHz)	Band Edge Frequency (MHz)	Level (dBc)
Static	GFSK	DH5	2402	2400.0	-59.19
Static	π/4 DQPSK	2DH5	2402	2400.0	-53.14
Static	8-DPSK	3DH5	2402	2400.0	-53.85
Hopping	GFSK	DH5	2402	2400.0	-63.94
Hopping	π/4 DQPSK	2DH5	2402	2400.0	-62.08
Hopping	8-DPSK	3DH5	2402	2400.0	-62.92
Hopping	GFSK	DH5	2480	2483.5	-56.47
Hopping	π/4 DQPSK	2DH5	2480	2483.5	-55.35
Hopping	8-DPSK	3DH5	2480	2483.5	-58.09

Table 8

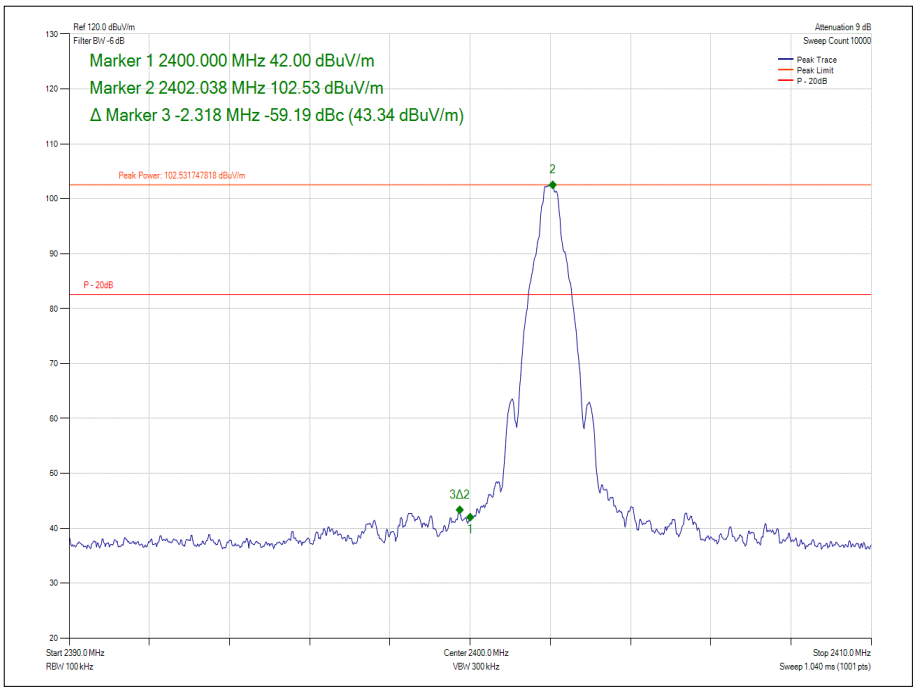

Figure 11 - Static - GFSK/DH5, 2402 MHz - Measured Frequency 2400.0 MHz

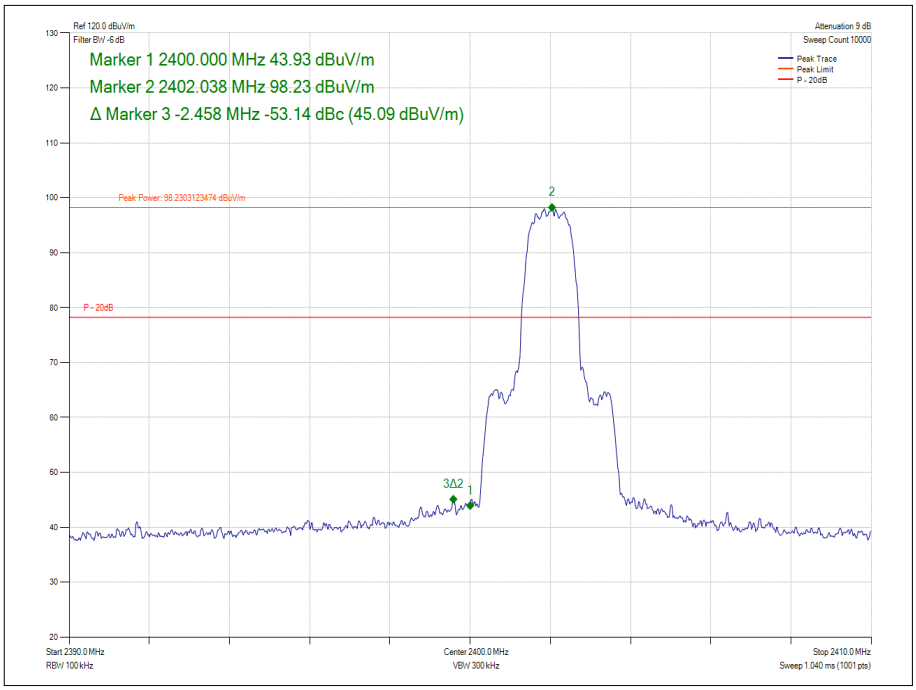

Figure 12 - Static - π/4 DQPSK/2DH5, 2402 MHz - Measured Frequency 2400.0 MHz

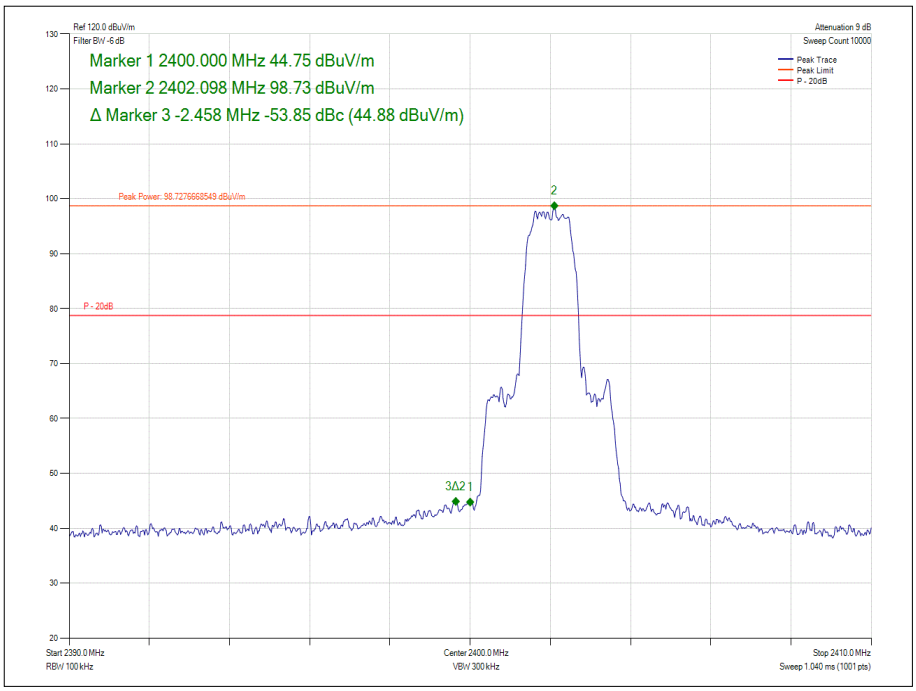

Figure 13 - Static - 8-DPSK/3DH5, 2402 MHz - Measured Frequency 2400.0 MHz

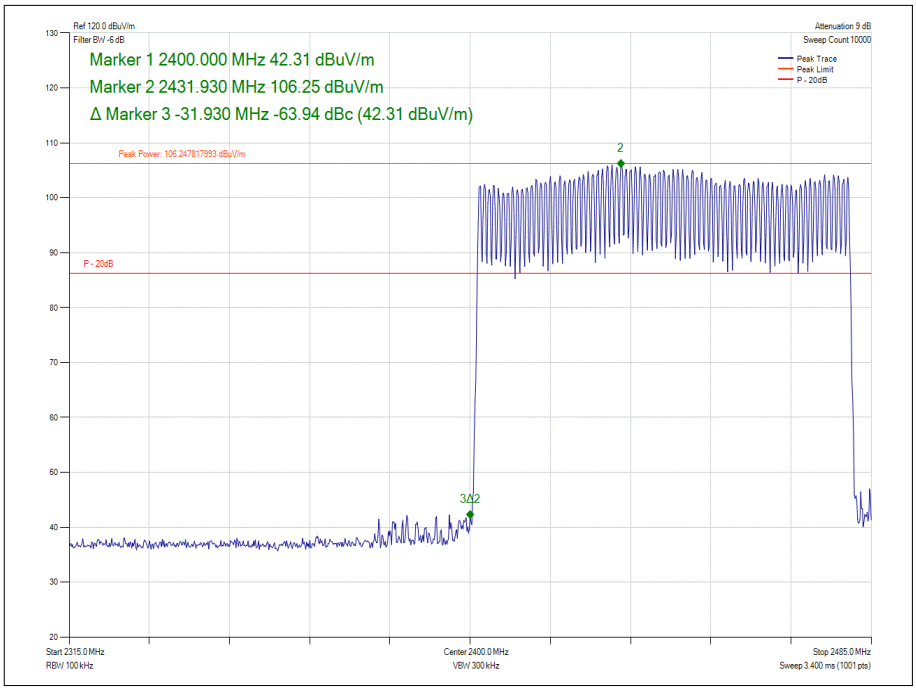

Figure 14 - Hopping - GFSK/DH5, 2402 MHz - Measured Frequency 2400.0 MHz

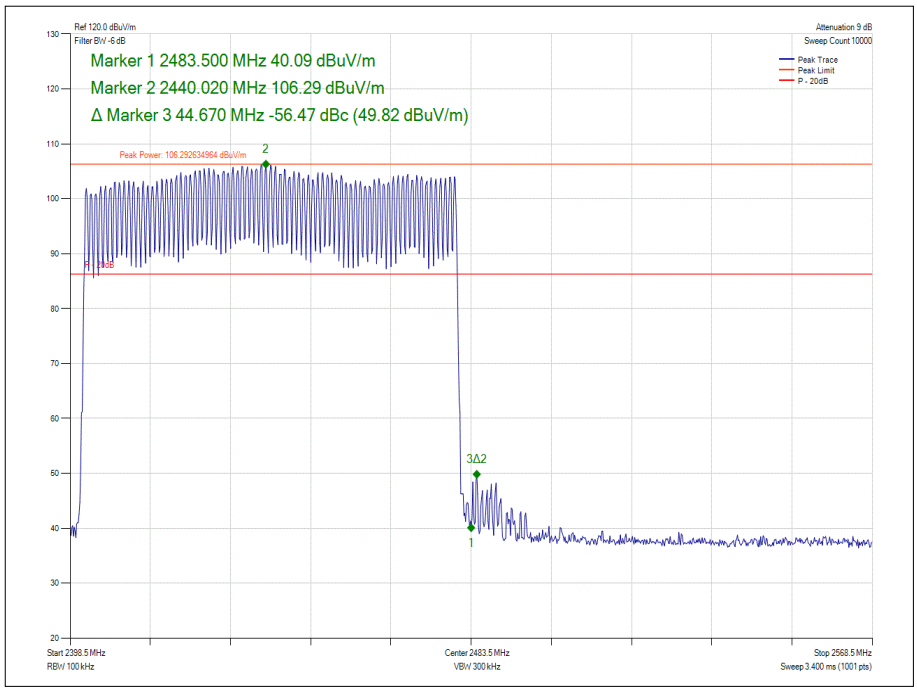

Figure 15 - Hopping - GFSK/DH5, 2480 MHz - Measured Frequency 2483.5 MHz

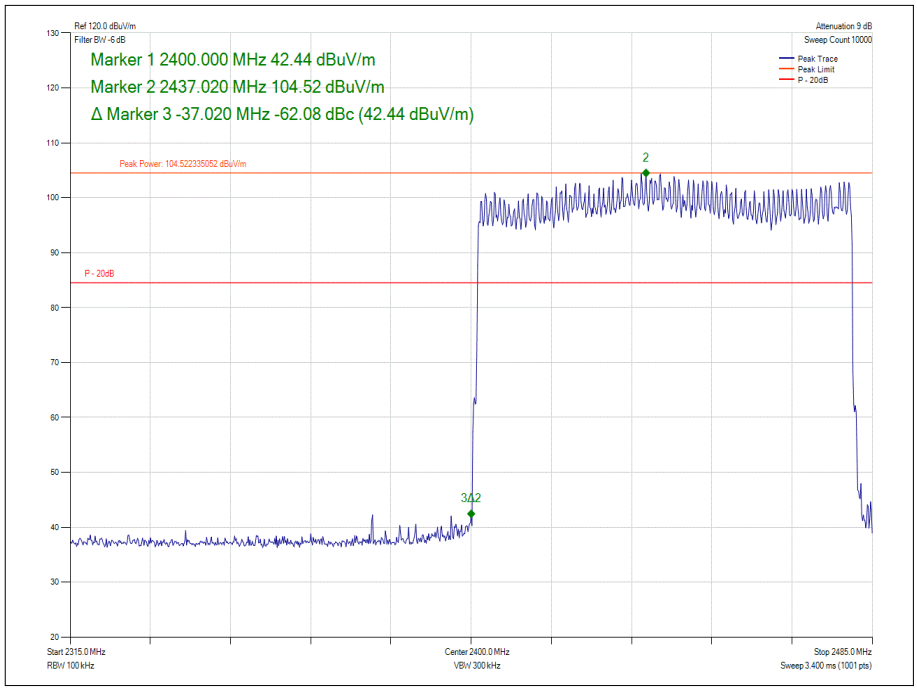

Figure 16 - Hopping - π/4 DQPSK/2DH5, 2402 MHz - Measured Frequency 2400.0 MHz

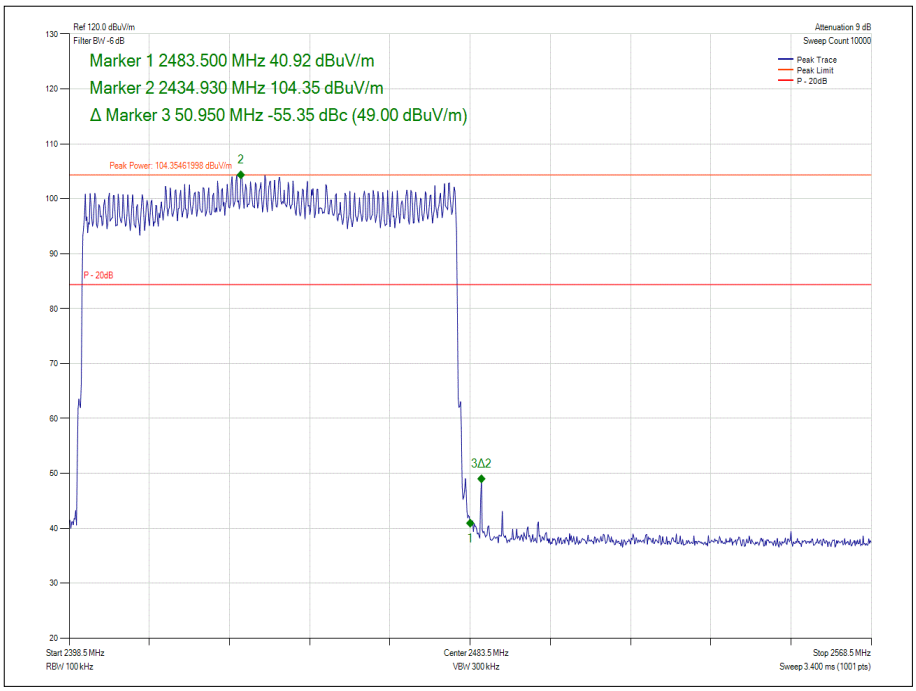

Figure 17 - Hopping - π/4 DQPSK/2DH5, 2480 MHz - Measured Frequency 2483.5 MHz

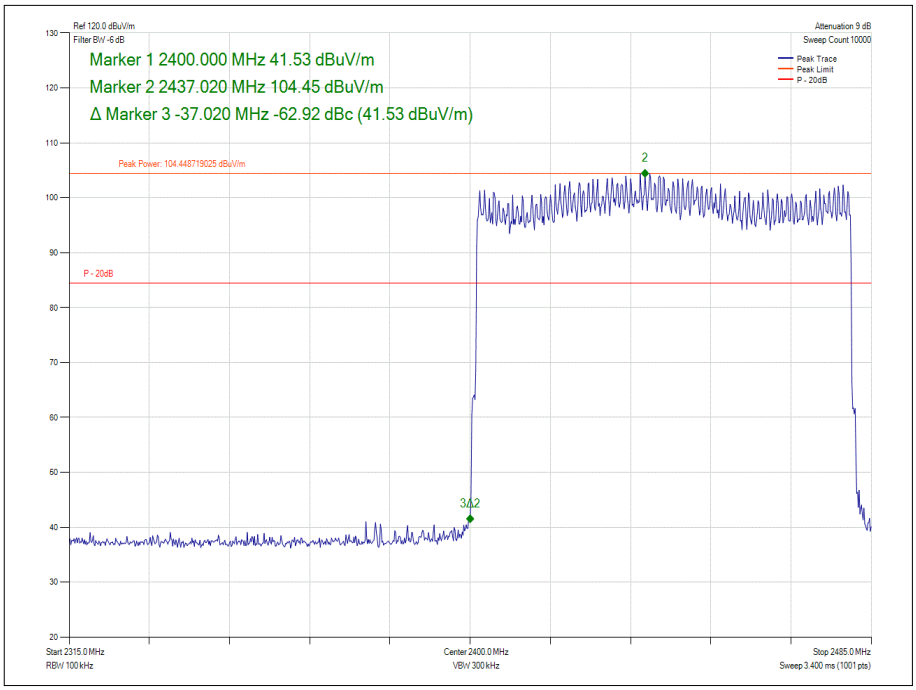

Figure 18 - Hopping - 8-DPSK/3DH5, 2402 MHz - Measured Frequency 2400.0 MHz

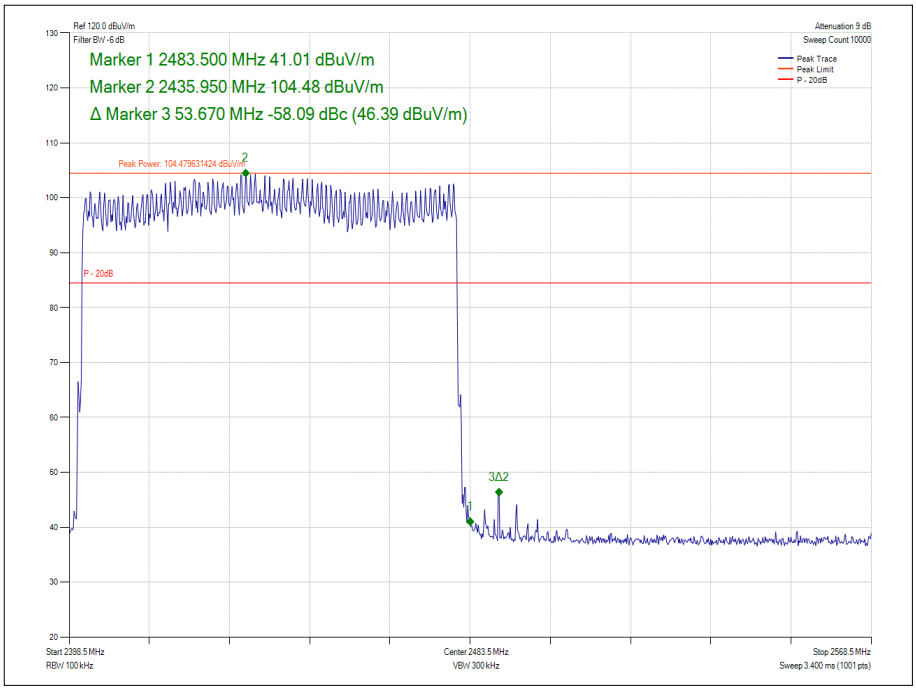

Figure 19 - Hopping - 8-DPSK/3DH5, 2480 MHz - Measured Frequency 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.3.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
DC Power Supply	Hewlett Packard	6269B	1909	-	TU
Multimeter	Iso-tech	IDM 101	2118	12	07-Feb-2021
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	10-Mar-2021
EmX Emissions Software	TUV SUD	EmX	5125	-	Software
Thermo-Hygro-Barometer	PCE Instruments	OCE-THB-40	5470	12	16-Mar-2021
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	01-Apr-2021
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2021
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	06-Feb-2021

Table 9

TU - Traceability Unscheduled

2.4 Frequency Hopping Systems - Channel Separation

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.4.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XU - Modification State 0

2.4.3 Date of Test

01-April-2020

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.2.

2.4.5 Environmental Conditions

Ambient Temperature	25.9 °C
Relative Humidity	18.0 %

2.4.6 Test Results

Vehicle RSM - Bluetooth

Modulation	Channel Separation (MHz)
GFSK	1.002
π/4 DQPSK	1.002
8-DPSK	1.002

Table 10

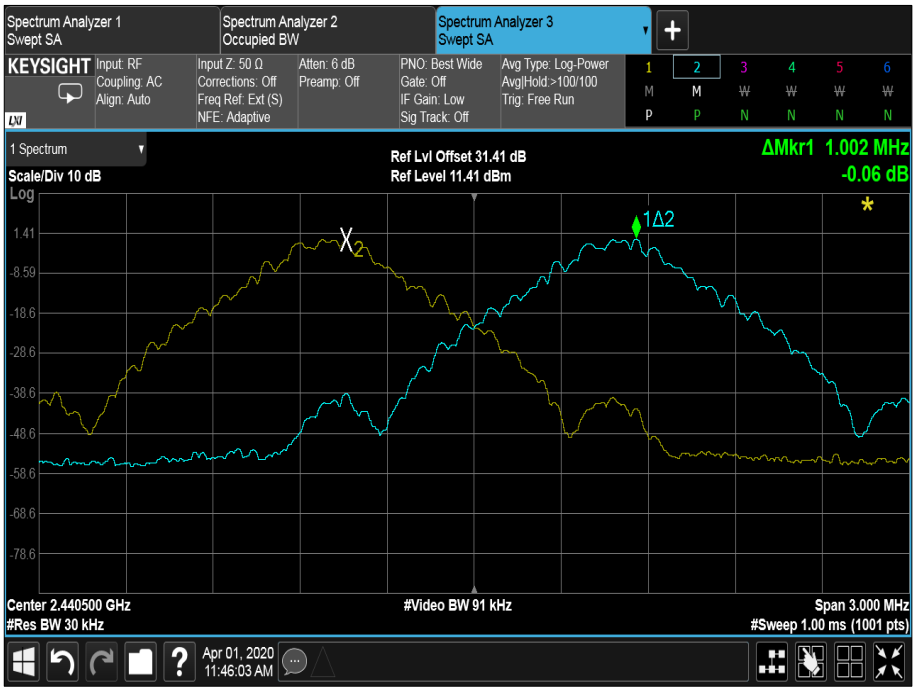

Figure 20 - GFSK

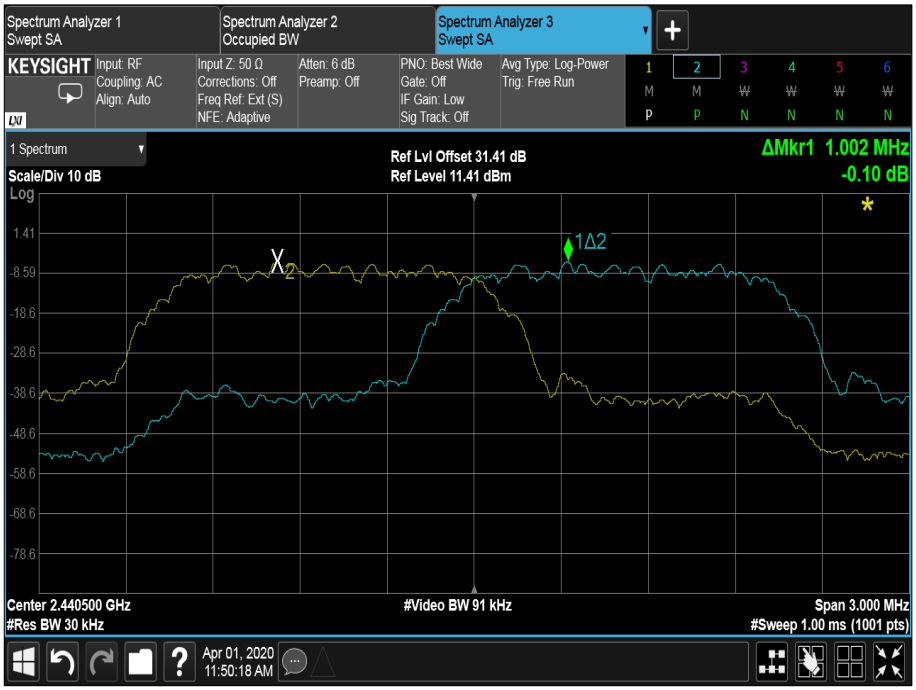

Figure 21 - π/4 DQPSK

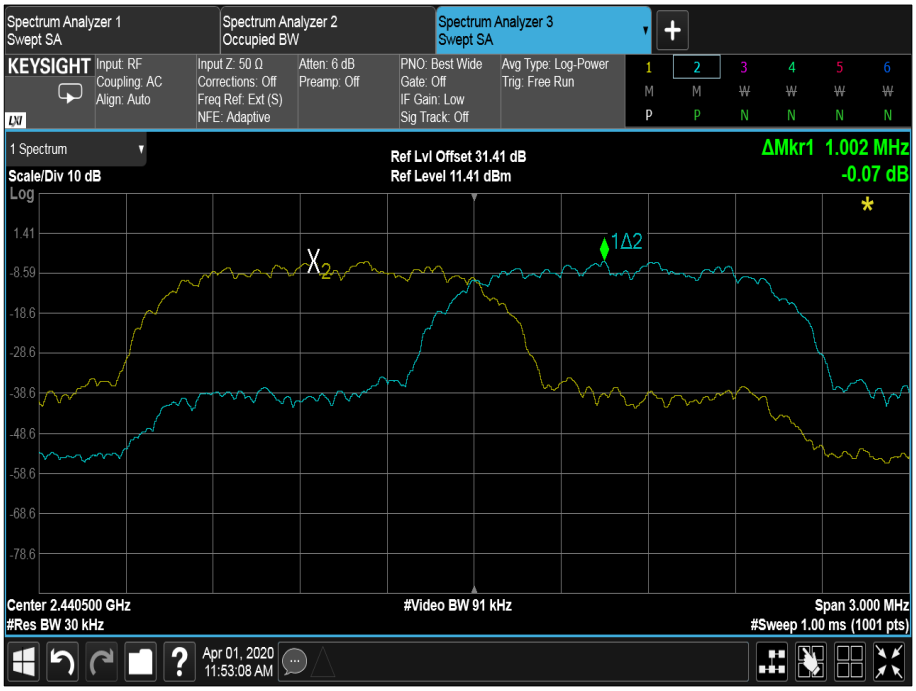

Figure 22 - 8-DPSK

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(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 band 2400-2483.5 MHz 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 0.125 W.

ISED RSS-247, Limit Clause 5.1 (b)

FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
30dB Attenuator	Narda	766-30	4783	12	24-Mar-2021
EXA	Keysight Technologies	N9010B	4969	24	03-Feb-2022
Cable (40 GHz)	Rosenberger	LU1-001-1000	5022	12	12-Nov-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 11

O/P Mon – Output Monitored using calibrated equipment

2.5 Frequency Hopping Systems - 20 dB Bandwidth

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.5.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XU - Modification State 0

2.5.3 Date of Test

01-April-2020

2.5.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.9.2.

2.5.5 Environmental Conditions

Ambient Temperature	25.9 °C
Relative Humidity	18.0 %

2.5.6 Test Results

Vehicle RSM - Bluetooth

Frequency (MHz)	20 dB Bandwidth (kHz)		
	GFSK	π/4 DQPSK	8-DPSK
2402	951.9	1371	1359
2440	956.3	1370	1356
2480	954.3	1368	1356

Table 12

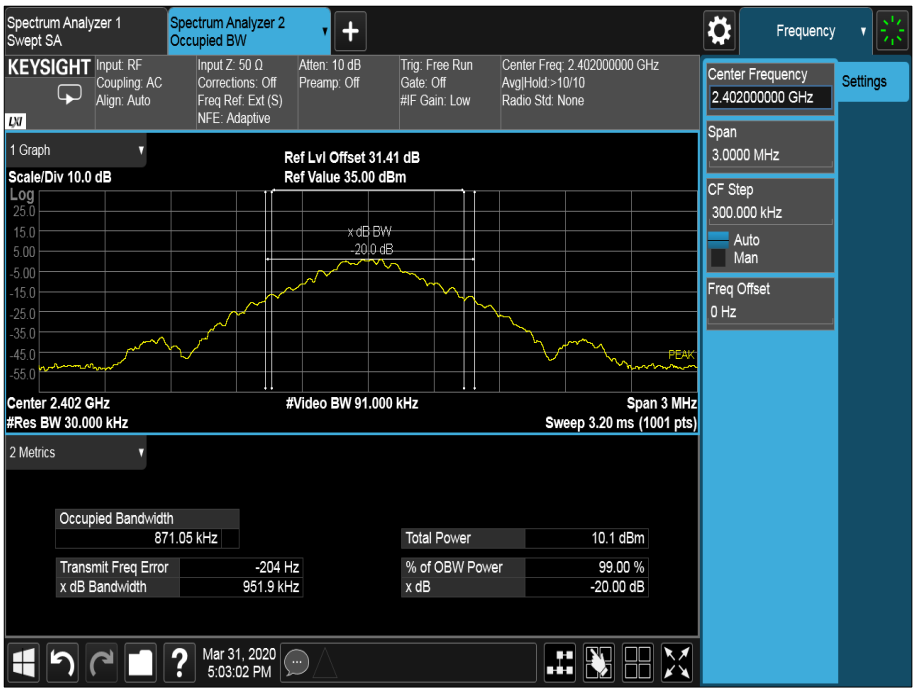

Figure 23 - 2402 MHz - GFSK

Figure 24 - 2402 MHz - π/4 DQPSK

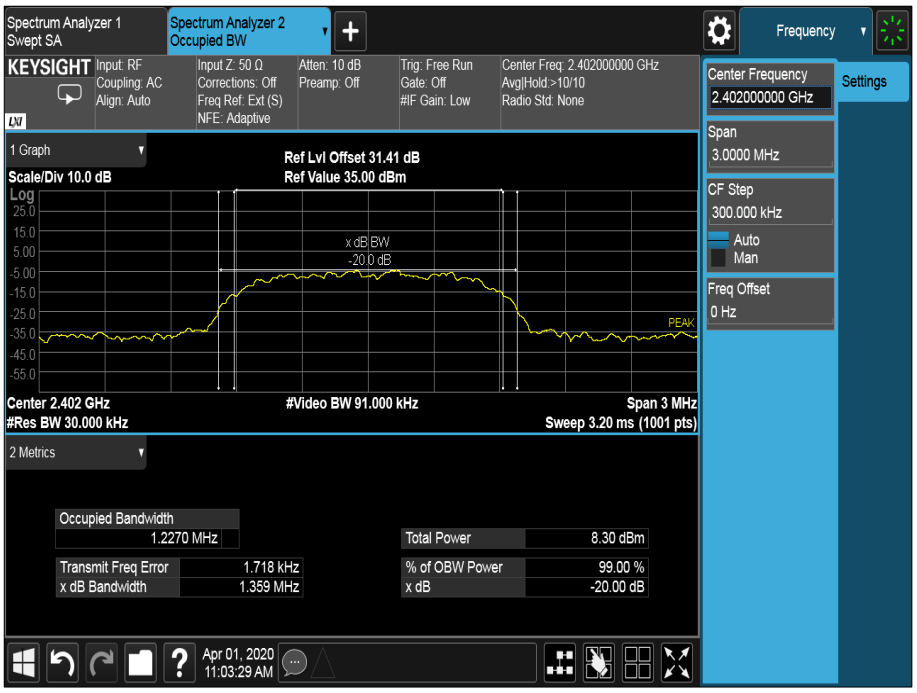

Figure 25 - 2402 MHz - 8-DPSK

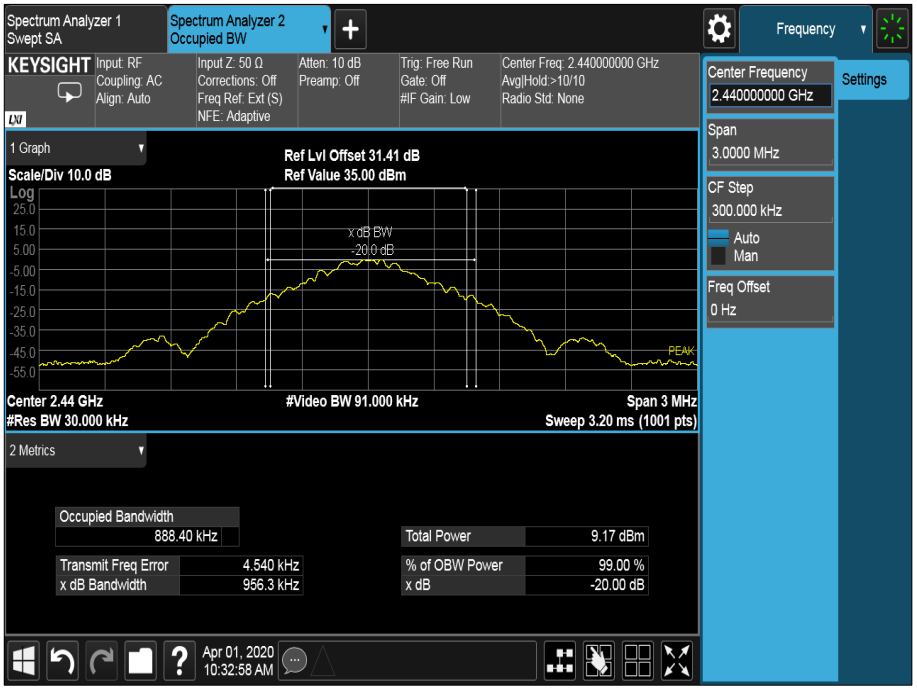

Figure 26 - 2440 MHz - GFSK

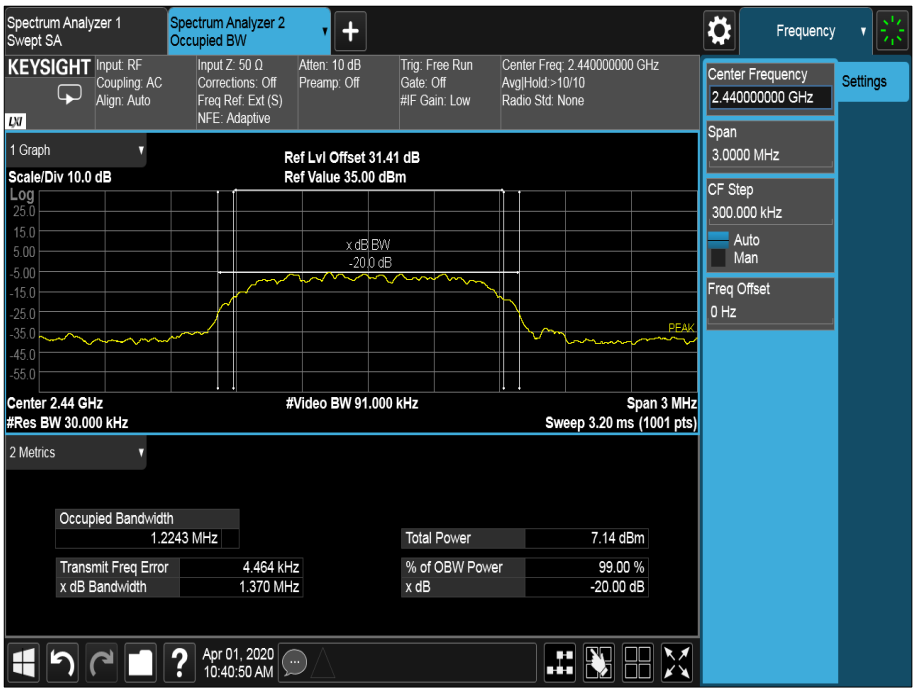

Figure 27 - 2440 MHz - π/4 DQPSK

Figure 28 - 2440 MHz - 8-DPSK

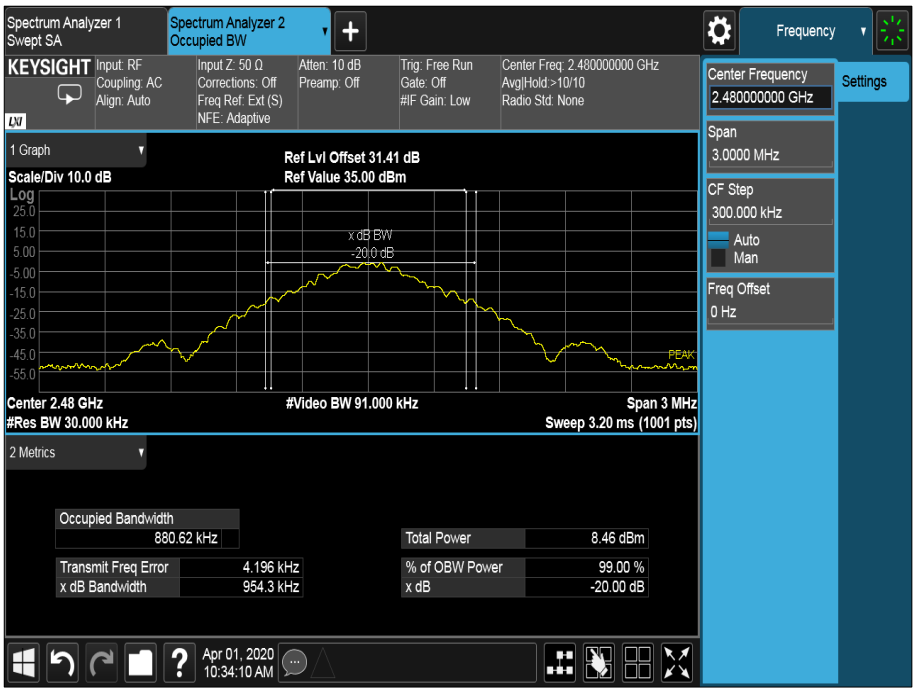

Figure 29 - 2480 MHz - GFSK

Figure 30 - 2480 MHz - π/4 DQPSK

Figure 31 - 2480 MHz - 8-DPSK

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
30dB Attenuator	Narda	766-30	4783	12	24-Mar-2021
EXA	Keysight Technologies	N9010B	4969	24	03-Feb-2022
Cable (40 GHz)	Rosenberger	LU1-001-1000	5022	12	12-Nov-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 13

O/P Mon – Output Monitored using calibrated equipment

2.6 Restricted Band Edges

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
ISED RSS-GEN, Clause 8.10

2.6.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XV - Modification State 1

2.6.3 Date of Test

09-June-2020

2.6.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5. These are shown for information purposes and were used to determine the worst case measurement point. Final average measurements were then taken in accordance with ANSI C63.10, clause 4.1.4.2.2 to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.6.5 Environmental Conditions

Ambient Temperature	22.6 °C
Relative Humidity	44.1 %

2.6.6 Test Results

Vehicle RSM - Bluetooth

Modulation	Packet Type	Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
GFSK	DH5	2402	2390.0	47.95	35.78
8-DPSK	2DH5	2402	2483.5	48.71	36.98
π/4 DQPSK	3DH5	2402	2390.0	52.07	37.59
GFSK	DH5	2480	2483.5	52.36	42.61
8-DPSK	2DH5	2480	2390.0	54.17	43.00
π/4 DQPSK	3DH5	2480	2483.5	57.41	43.19

Table 14

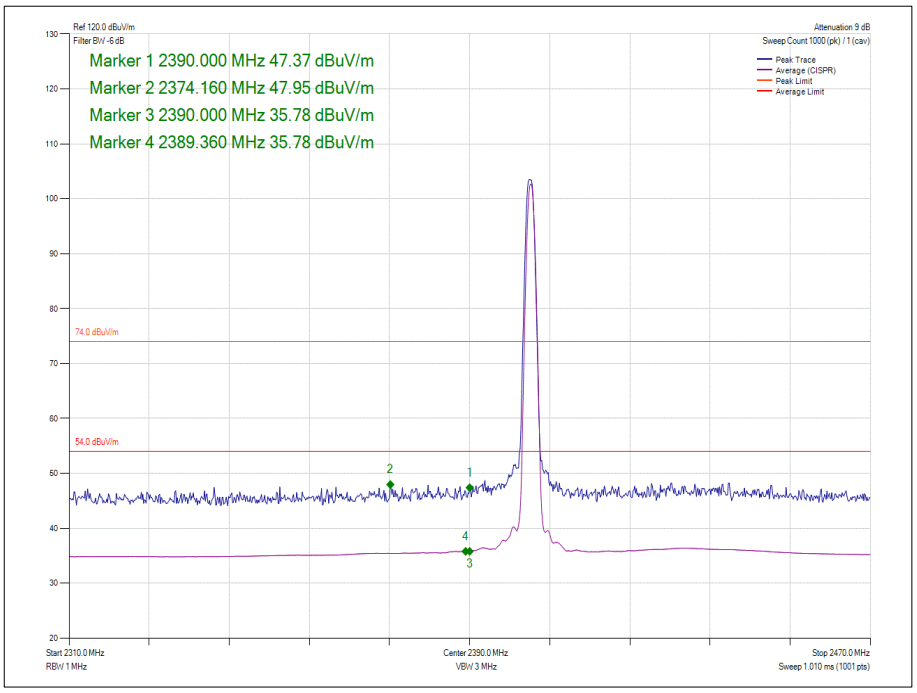

Figure 32 -GFSK/DH5 - 2402 MHz - Measured Frequency 2390.0 MHz

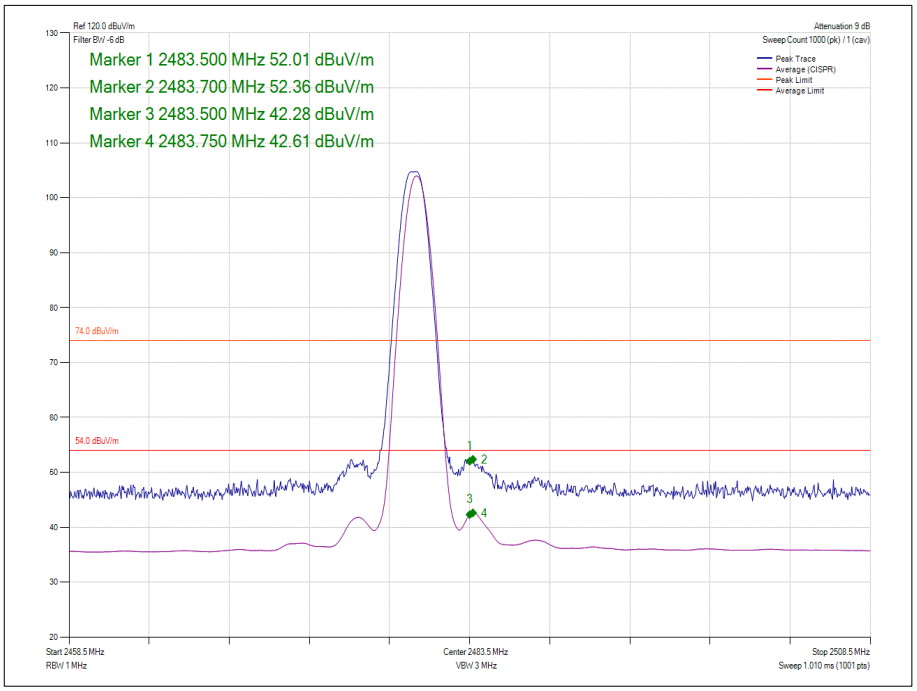

Figure 33 – GFSK/DH5 - 2480 MHz - Measured Frequency 2390.0 MHz

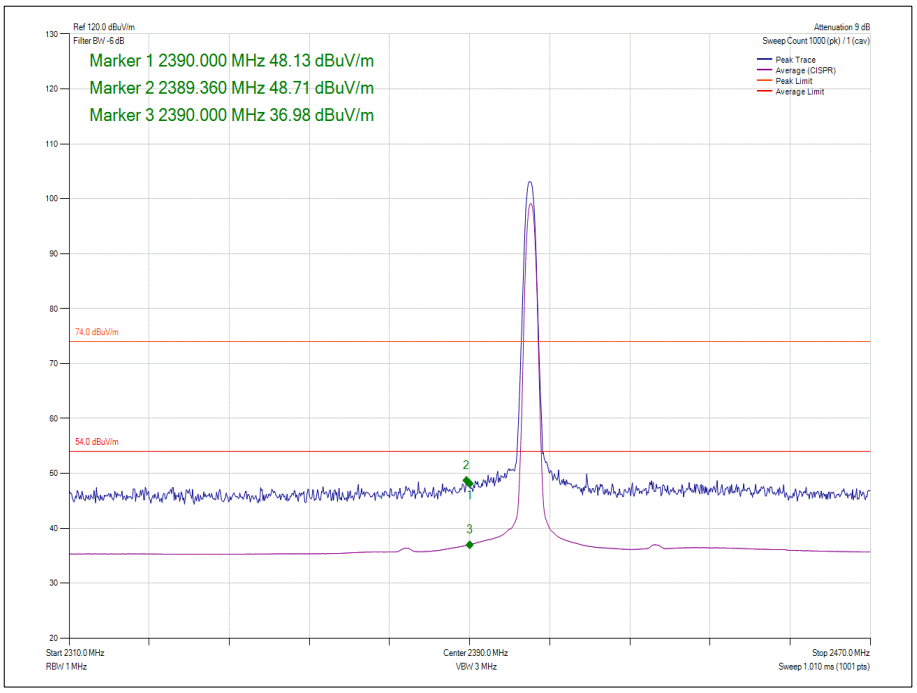

Figure 34 - π/4 DQPSK/2DH5 - 2402 MHz - Measured Frequency 2390.0 MHz

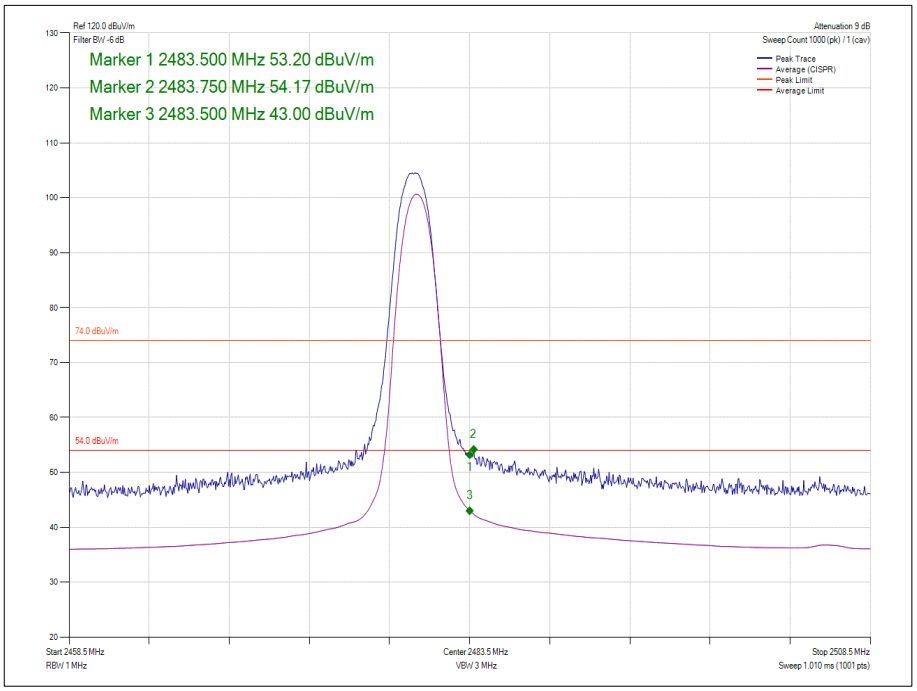

Figure 35 - π/4 DQPSK/2DH5 - 2480 MHz - Measured Frequency 2483.5 MHz

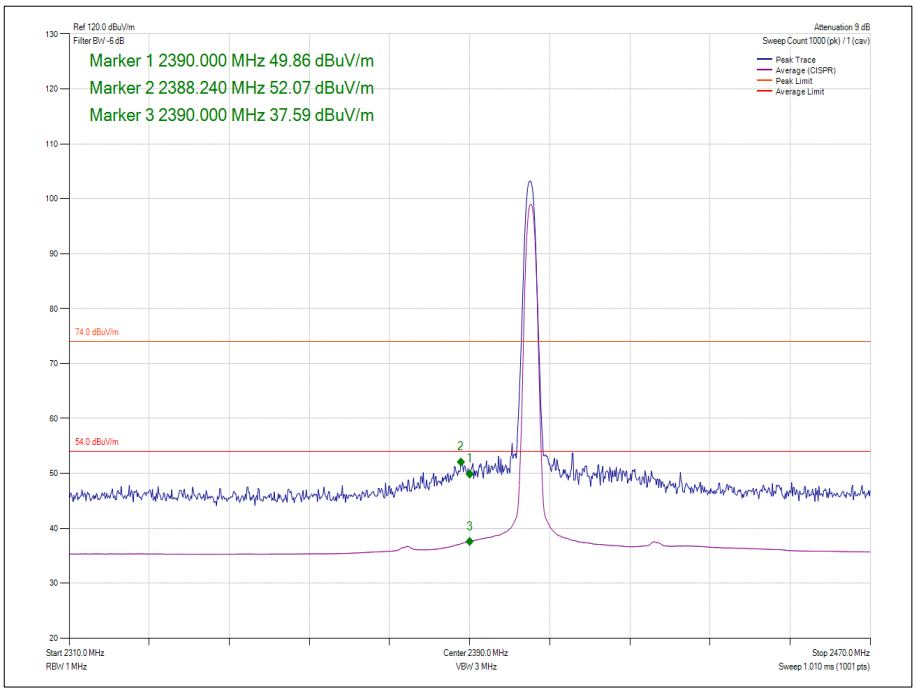

Figure 36 - 8-DPSK/3DH5 - 2402 MHz - Measured Frequency 2483.5 MHz

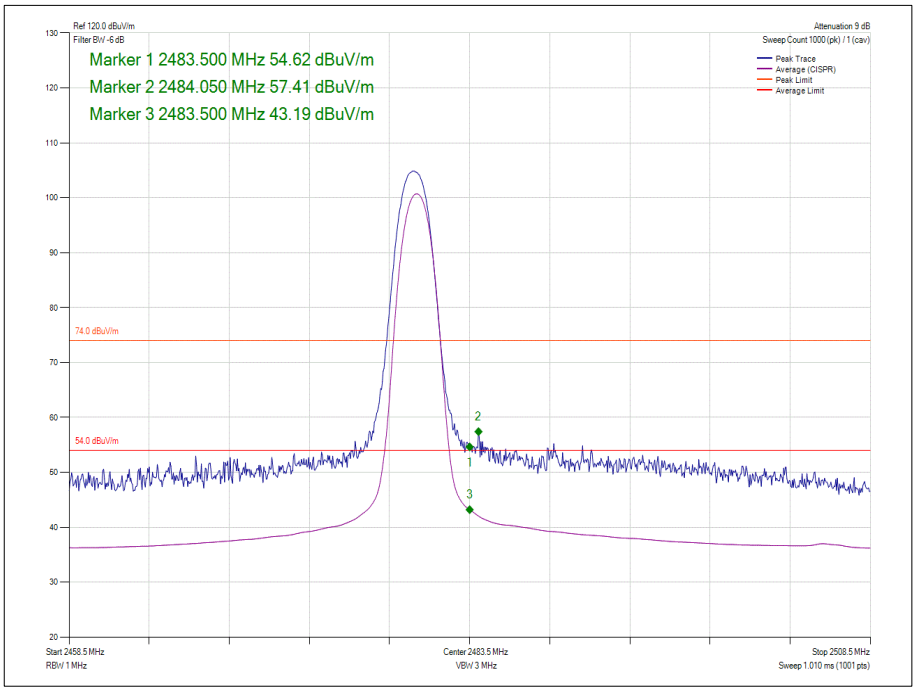

Figure 37 - 8-DPSK/3DH5 - 2480 MHz - Measured Frequency 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 15

ISED RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960*	500

Table 16

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

2.6.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
DC Power Supply	Hewlett Packard	6269B	1909	-	TU
Multimeter	Iso-tech	IDM 101	2118	12	07-Feb-2021
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	10-Mar-2021
EmX Emissions Software	TUV SUD	EmX	5125	-	Software
Thermo-Hygro-Barometer	PCE Instruments	OCE-THB-40	5470	12	16-Mar-2021
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	01-Apr-2021
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2021
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	06-Feb-2021

Table 17

TU - Traceability Unscheduled

2.7 Spurious Radiated Emissions

2.7.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.205
ISED RSS-247, Clause 5.5
ISED RSS-GEN, Clause 6.13

2.7.2 Equipment Under Test and Modification State

SCG22, S/N: 1PR002007GPH5XV - Modification State 1

2.7.3 Date of Test

07-June-2020 to 09-June-2020

2.7.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.3, 6.5 and 6.6.

The EUT was placed on the non-conducting platform in a manner typical of a normal installation. For an EUT which could reasonable be used in multiple planes, pre-scans were performed with the EUT orientated in X, Y and Z planes with reference to the ground plane.

Port on the EUT were terminated with loads as described in ANSI C63.4 clause 6.2.4. For EUT's with multiple connectors of the same type, additional interconnecting cables were connected, and pre-scans performed to determine whether the level of the emissions were increased by >2 dB. For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.2.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

Above 18 GHz, the measurement distance was reduced to 1 m. Due to the narrow beamwidth of the test antenna and large EUT. Prescans were performed with the test antenna in three positions relative to the EUT. These additional setups are shown in the photos section.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

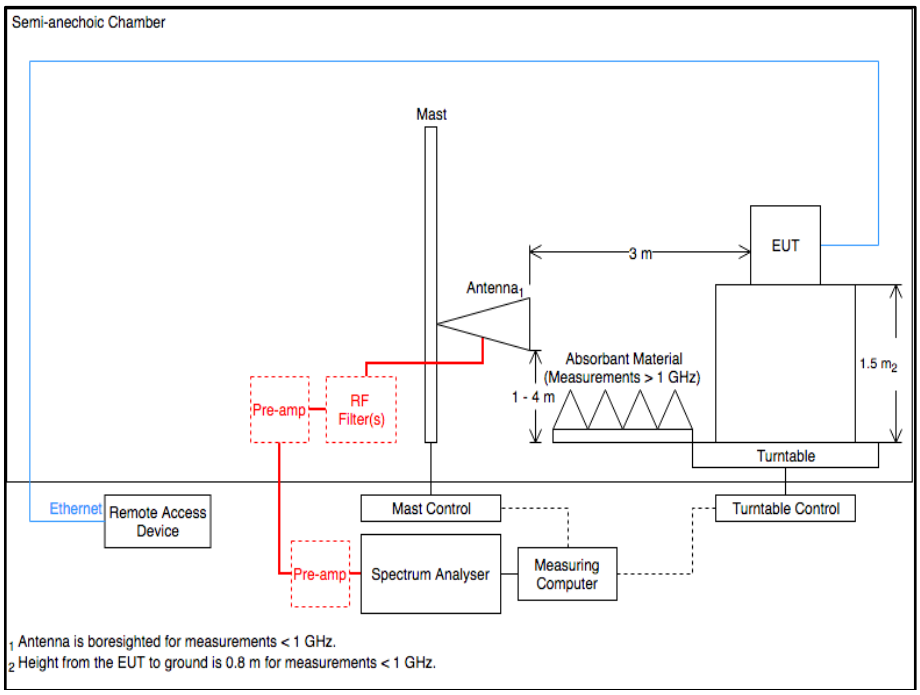

Figure 38 - Radiated Emissions Test Setup Diagram

2.7.5 Environmental Conditions

Ambient Temperature	20.3 - 20.7 °C
Relative Humidity	45.9 - 46.6 %

2.7.6 Test Results

Vehicle RSM - Bluetooth

Testing was performed on the modulation and packet type which resulted in the highest conducted output power. The Modulation/Packet type was GFSK/DH5.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 18 - 2402 MHz, 30 MHz to 1 GHz

*No emissions were detected within 10 dB of the limit.

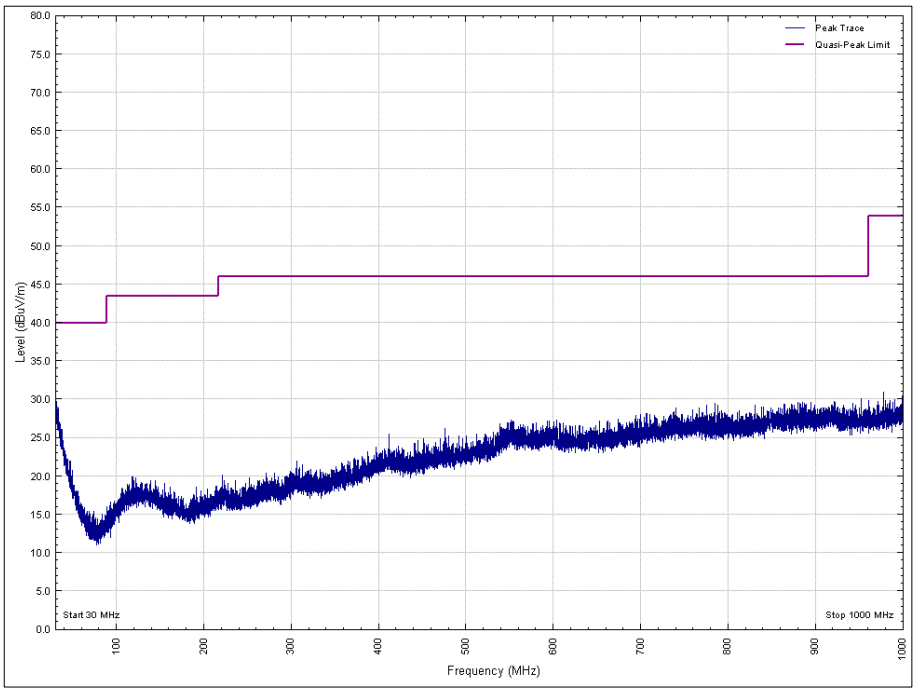

Figure 39 - 2402 MHz, 30 MHz to 1 GHz, Vertical, X Orientation

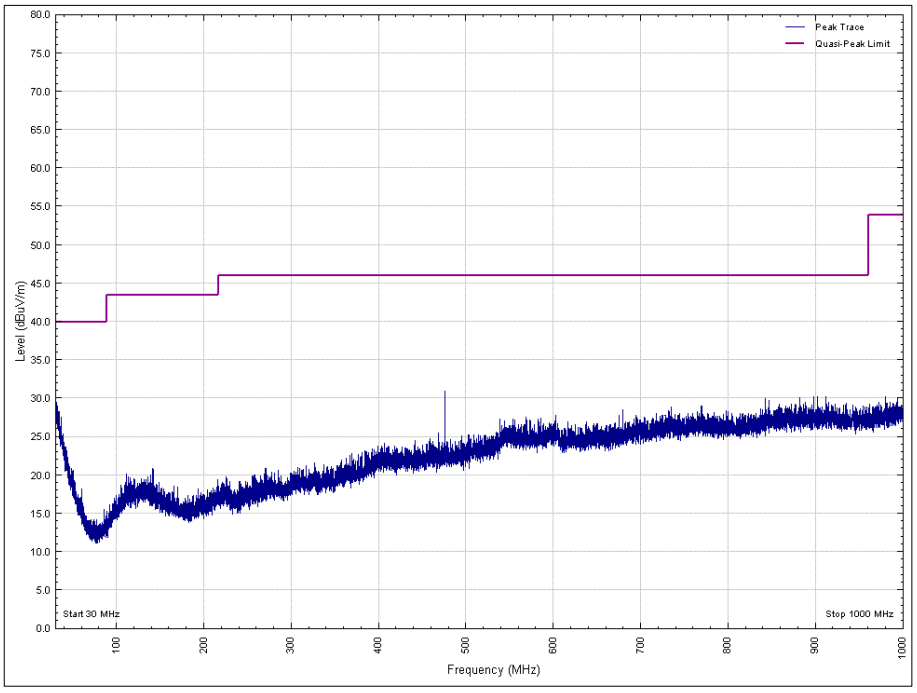

Figure 40 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 19 - 2402 MHz, 1 GHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

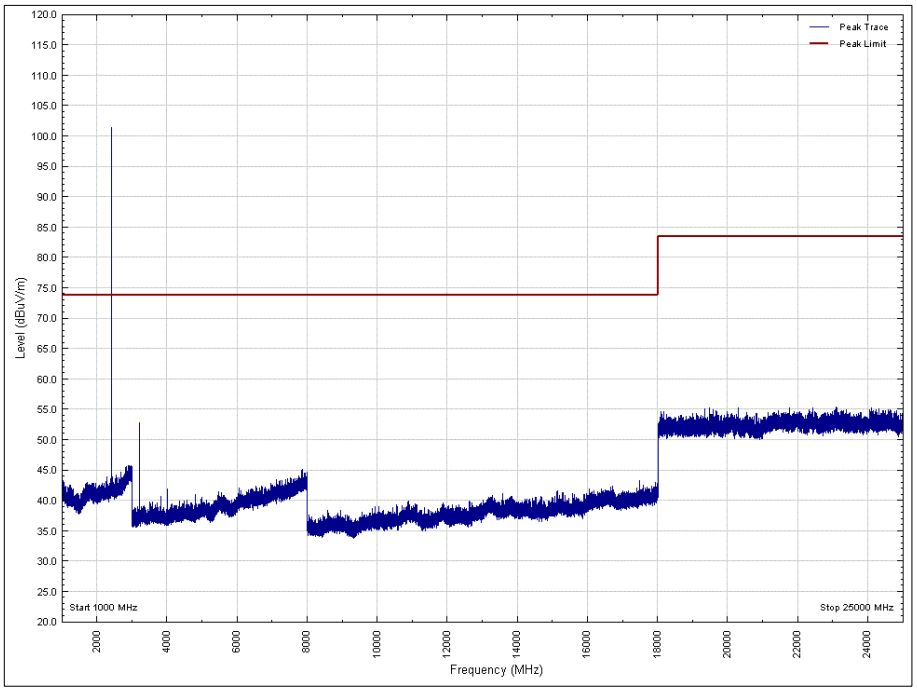

Figure 41 - 2402 MHz, 1 GHz to 25 GHz, Vertical, X Orientation - Peak

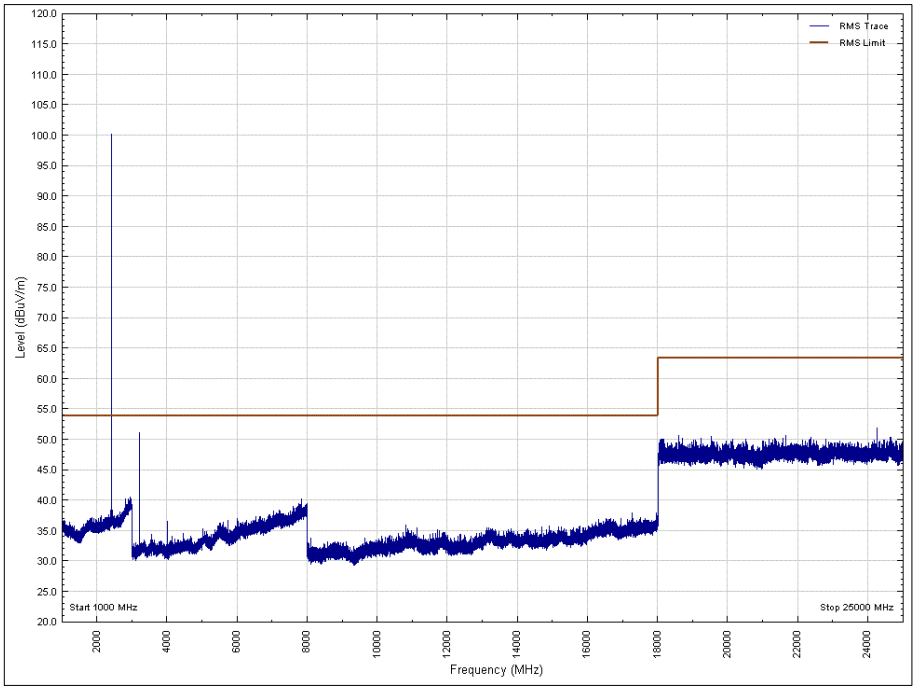

Figure 42 - 2402 MHz, 1 GHz to 25 GHz, Vertical, X Orientation - Average

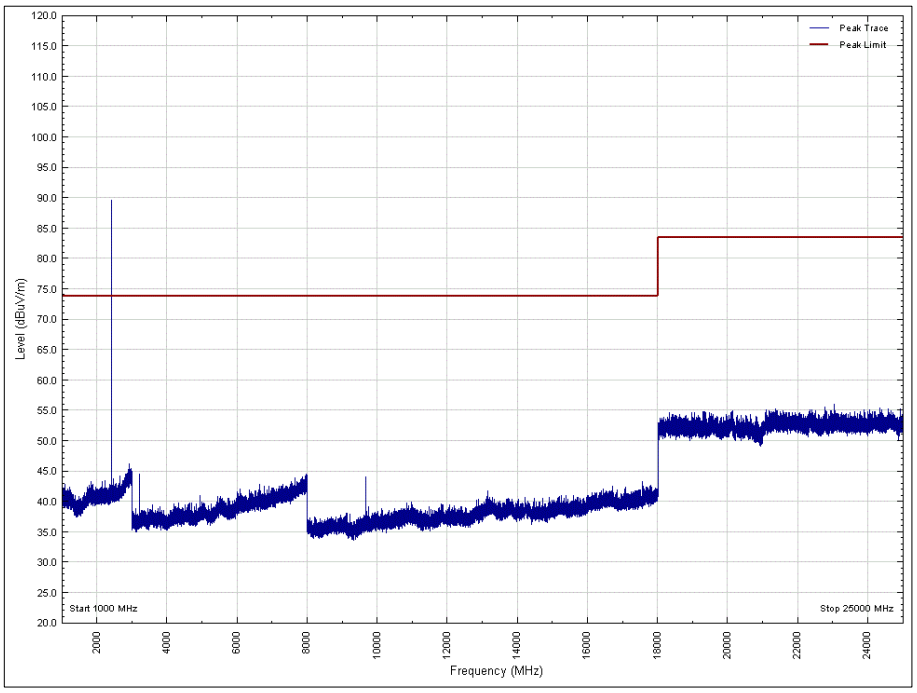

Figure 43 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

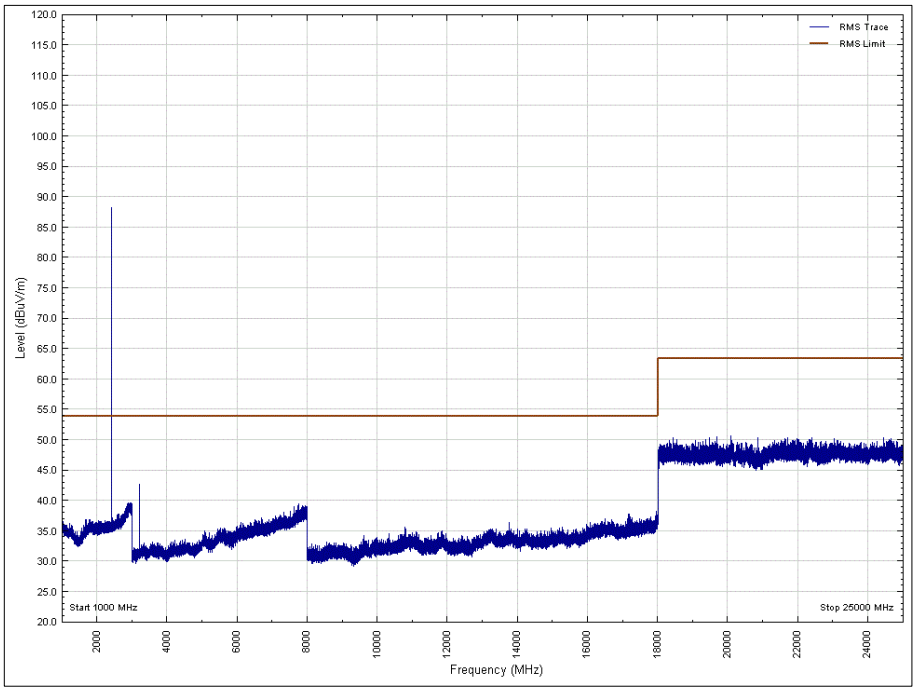

Figure 44 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, X Orientation - Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 20 - 2440 MHz, 30 MHz to 1 GHz - Emission Results

*No emissions were detected within 10 dB of the limit.

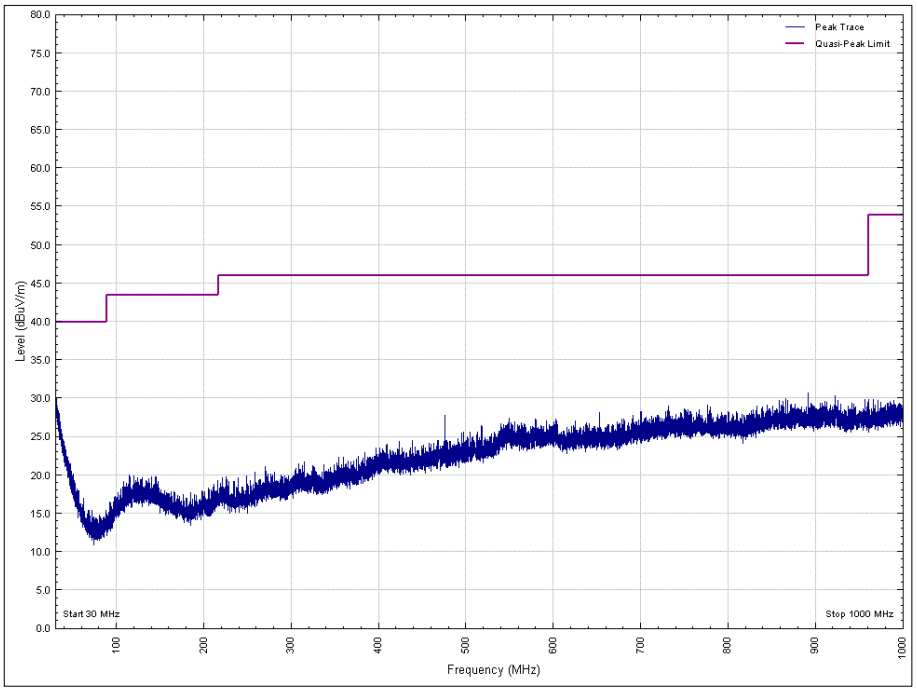

Figure 45 - 2440 MHz, 30 MHz to 1 GHz, Vertical, X Orientation

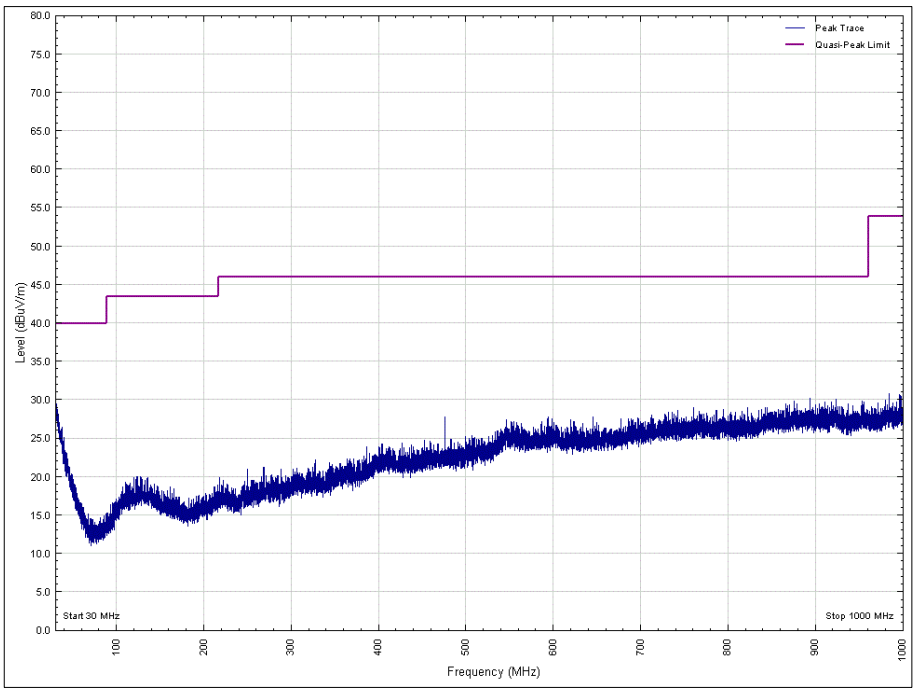

Figure 46 - 2440 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 21 - 2440 MHz - 1 GHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

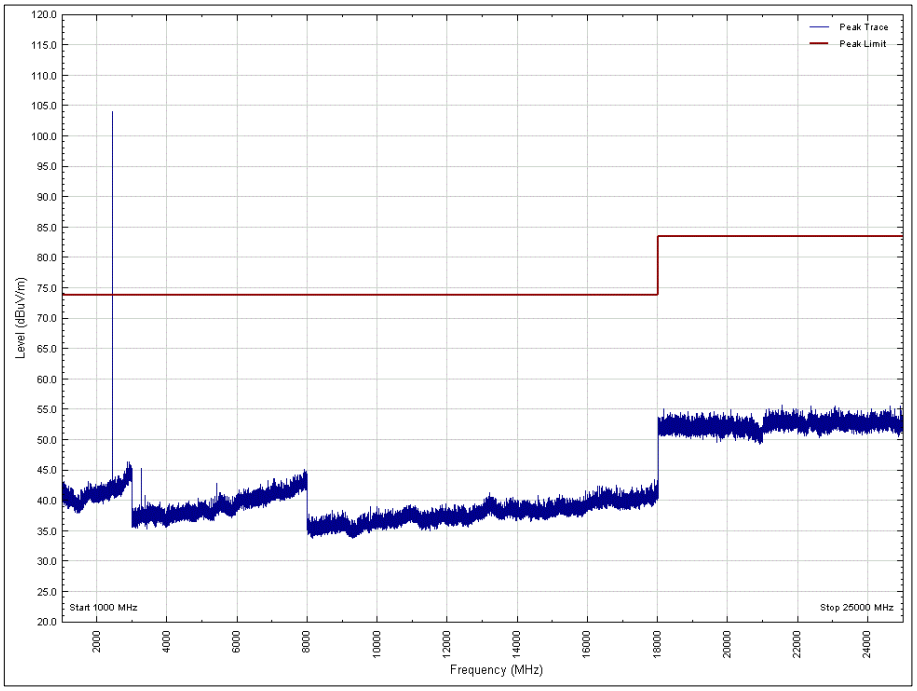

Figure 47 - 2440 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Peak

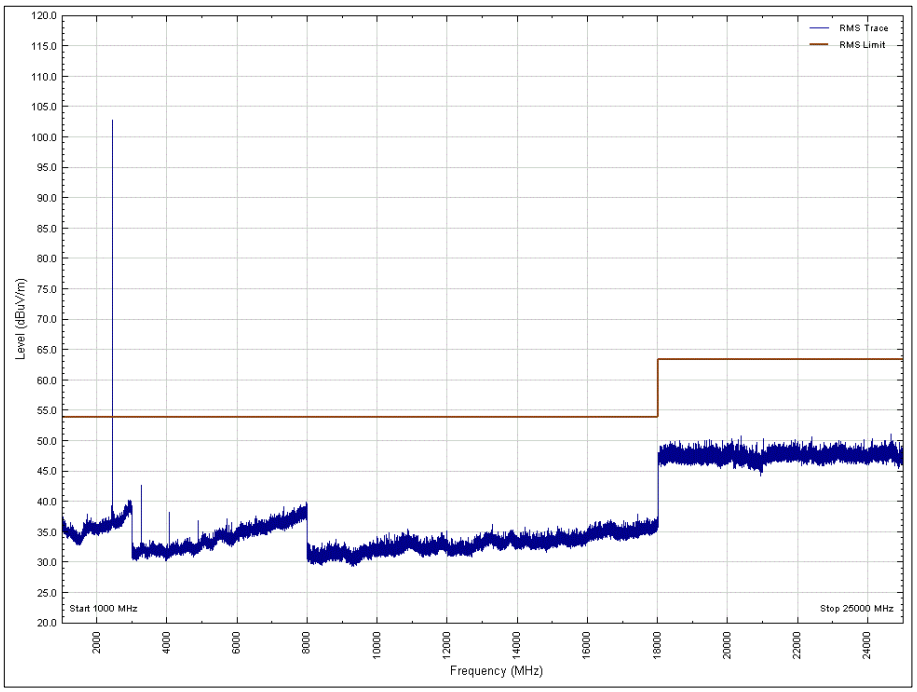

Figure 48 - 2440 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Average

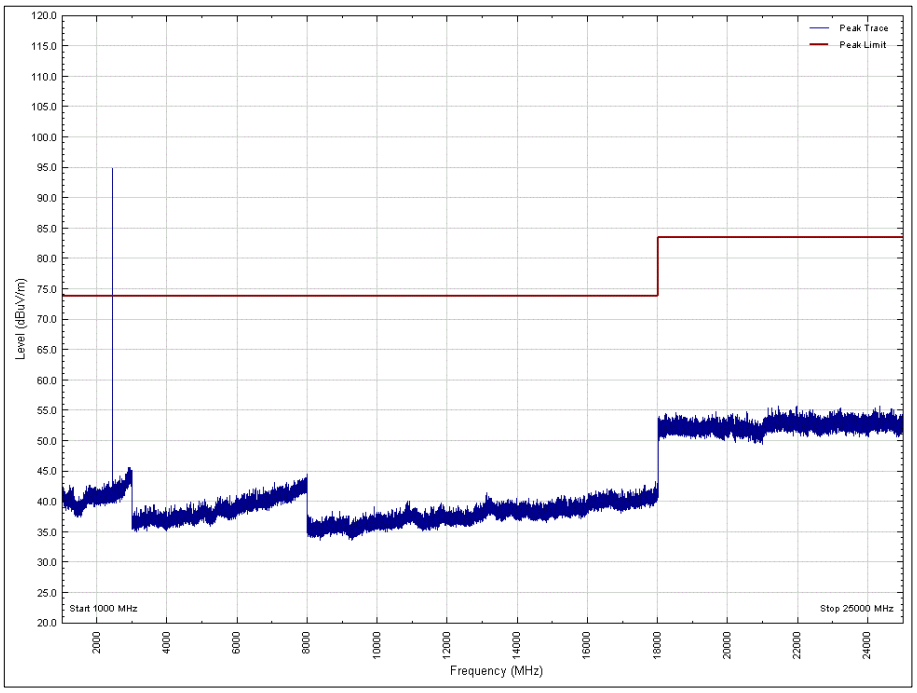

Figure 49 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

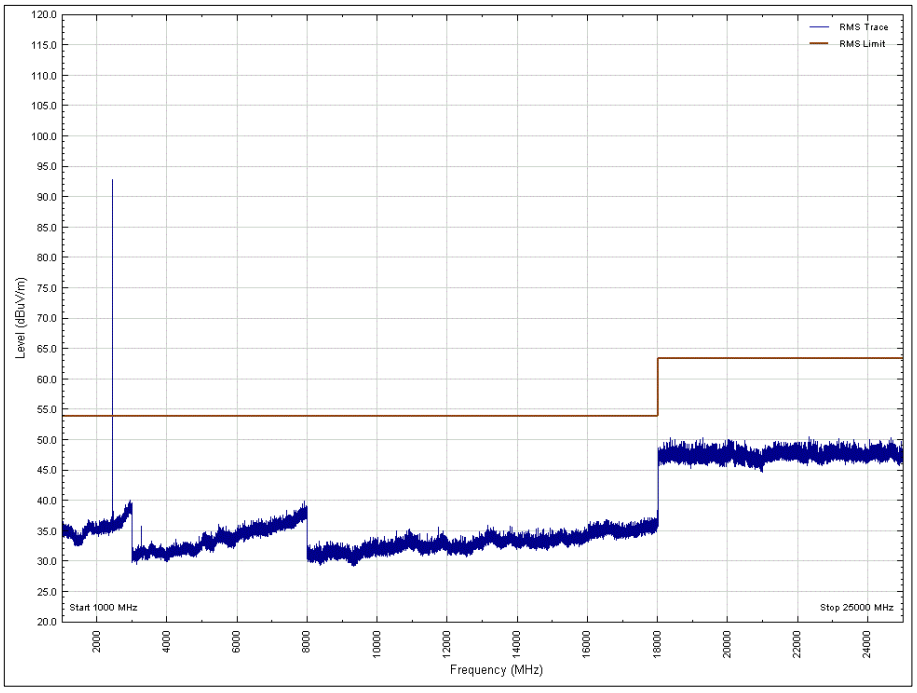

Figure 50 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 22 - 2480 MHz, 30 MHz to 1 GHz

*No emissions were detected within 10 dB of the limit.

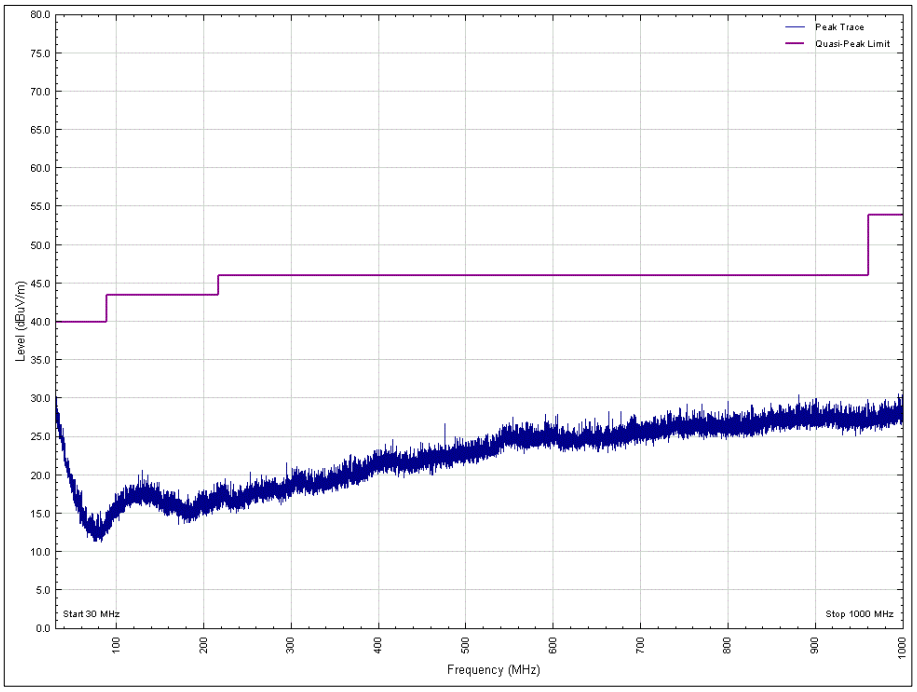

Figure 51 - 2480 MHz, 30 MHz to 1 GHz, Vertical, X Orientation

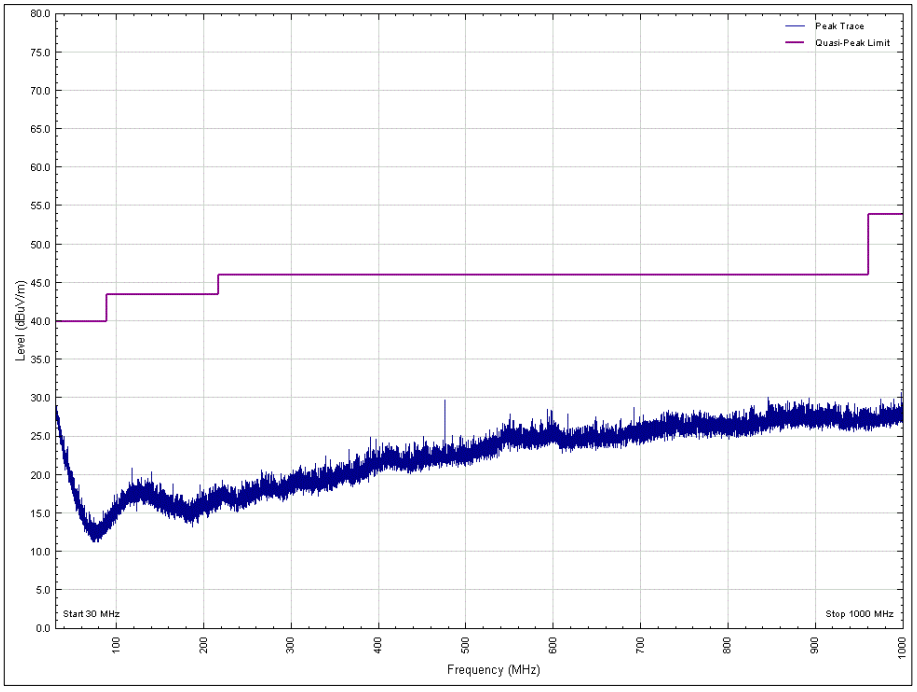

Figure 52 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
*								

Table 23 - 2480 MHz - 1 GHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

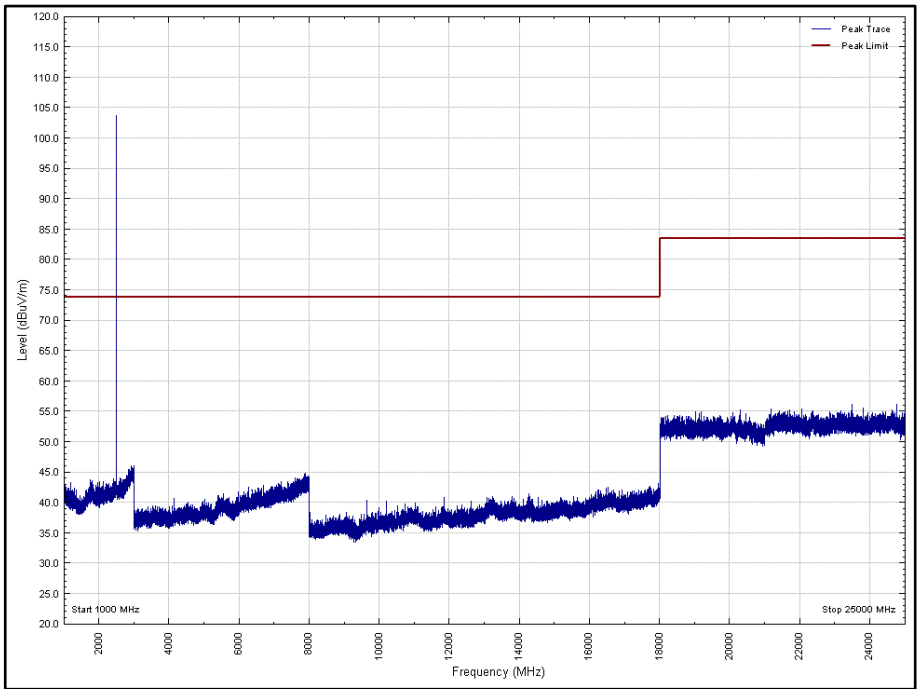

Figure 53 - 2480 MHz – 1 GHz to 25 GHz, Vertical, X Orientation - Peak

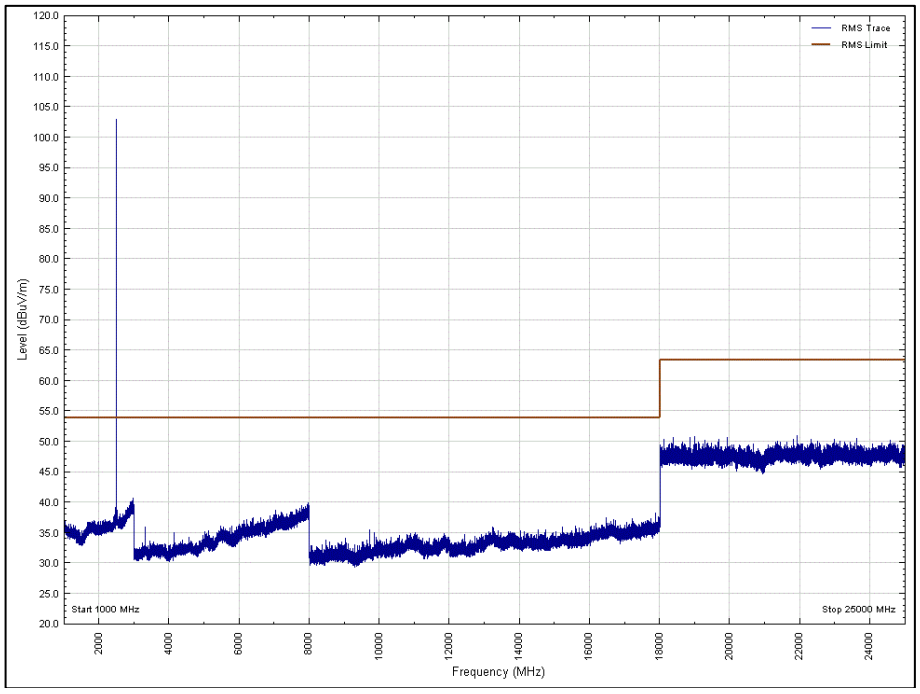

Figure 54 - 2480 MHz – 1 GHz to 25 GHz, Vertical, X Orientation - Average

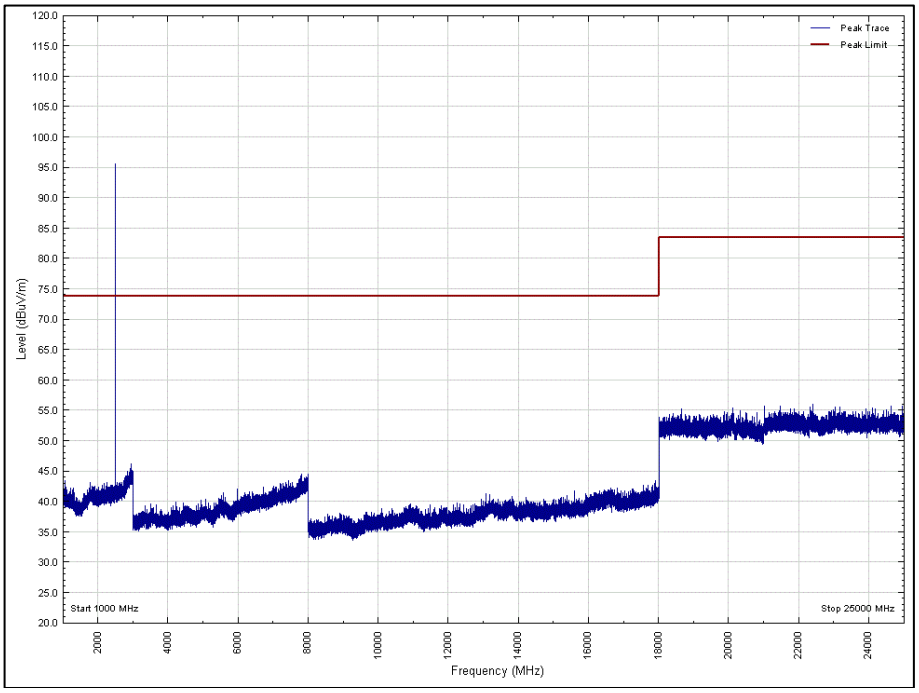

Figure 55 - 2480 MHz – 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

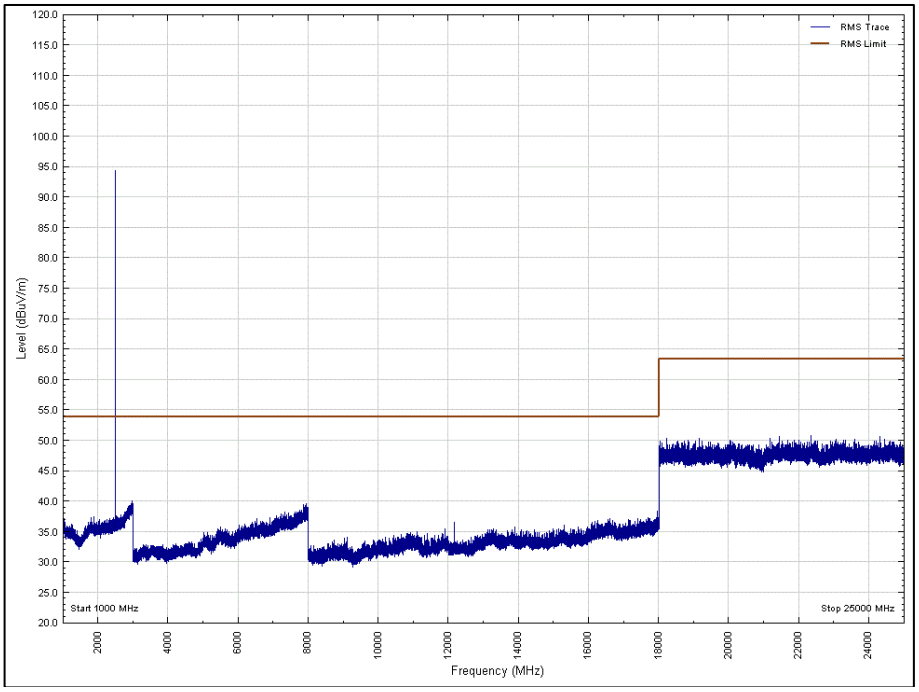

Figure 56 - 2480 MHz – 1 GHz to 25 GHz, Horizontal, X Orientation - Average

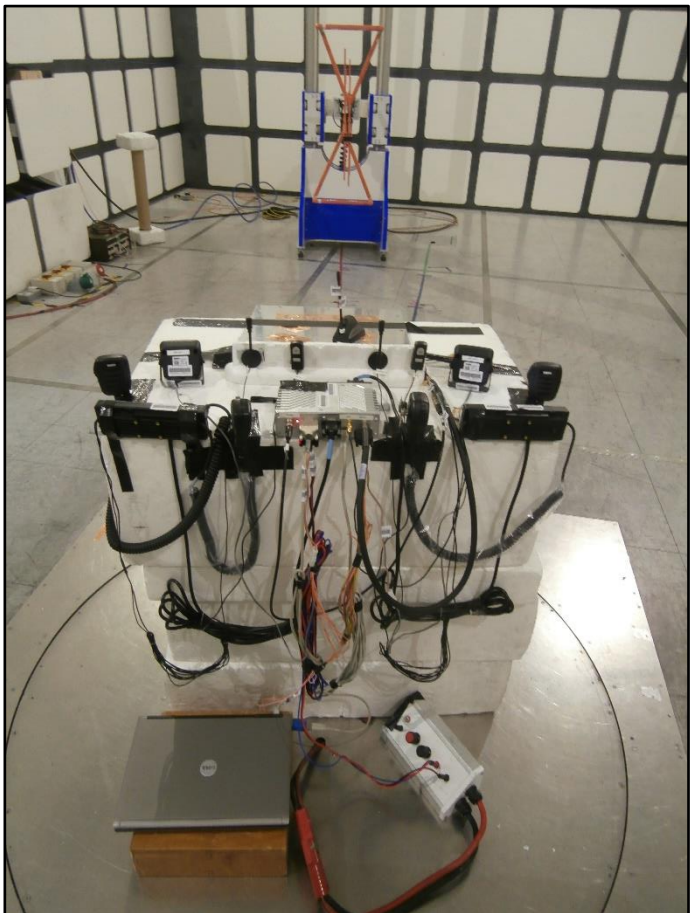

Figure 57 - Test Setup – 30 MHz to 1 GHz – X Orientation

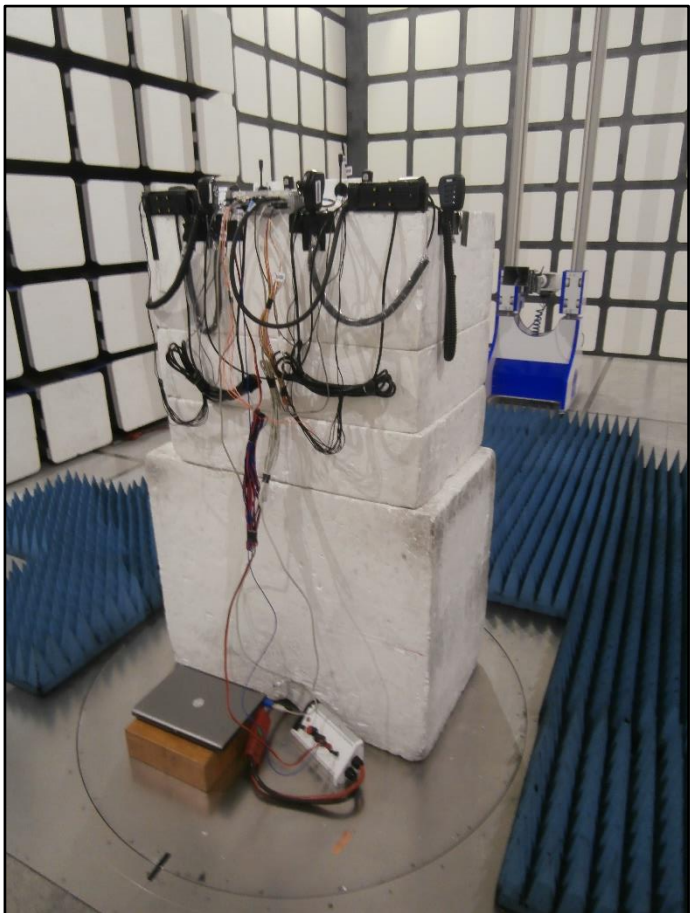

Figure 58 - Test Setup – 1 GHz to 8 GHz – X Orientation

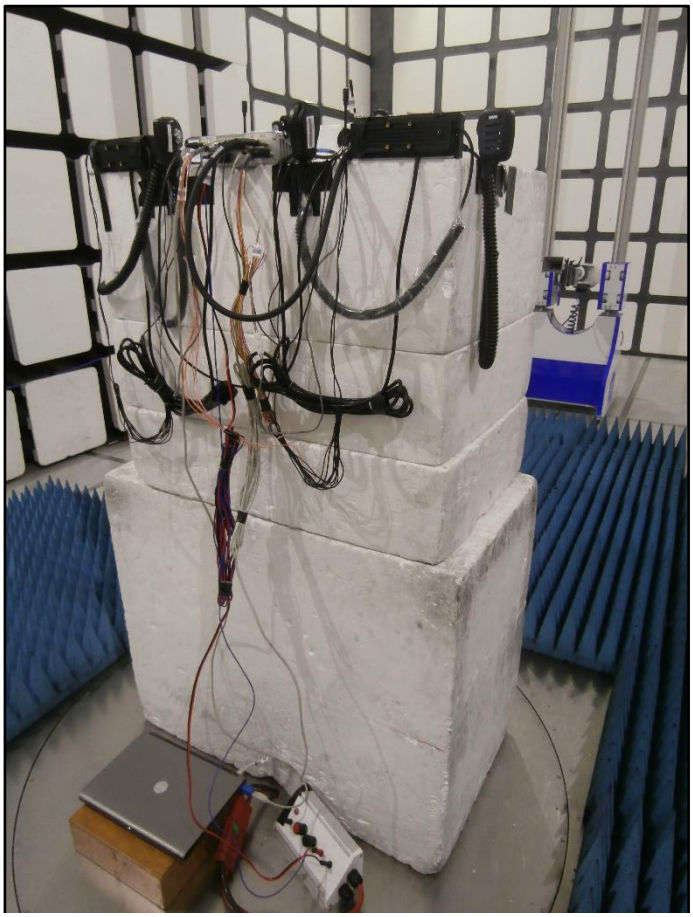

Figure 59 - Test Setup – 8 GHz to 18 GHz – X Orientation

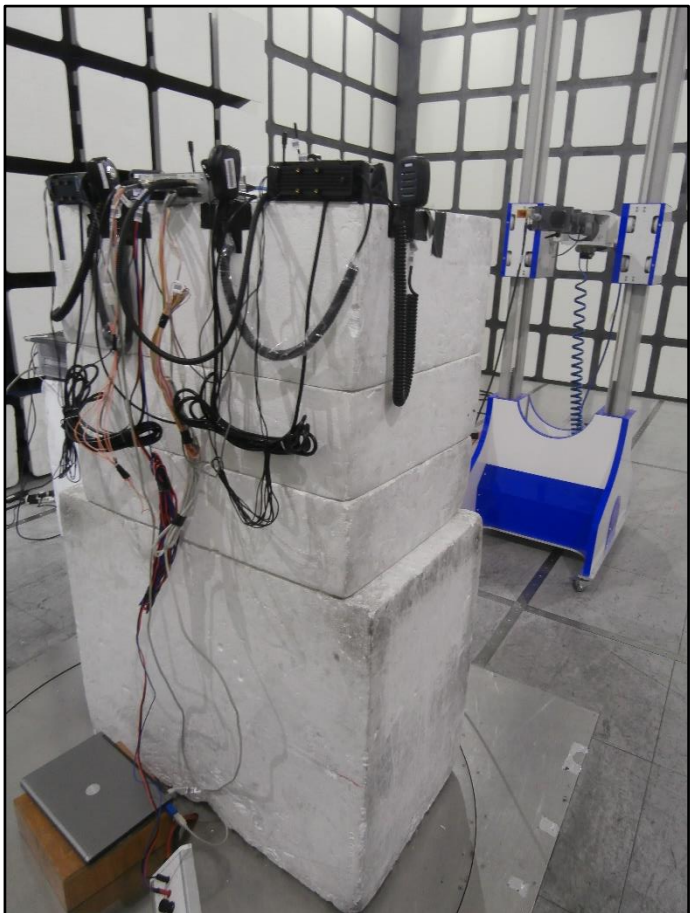

Figure 60 - Test Setup – 18 GHz to 25 GHz (Left View) – X Orientation

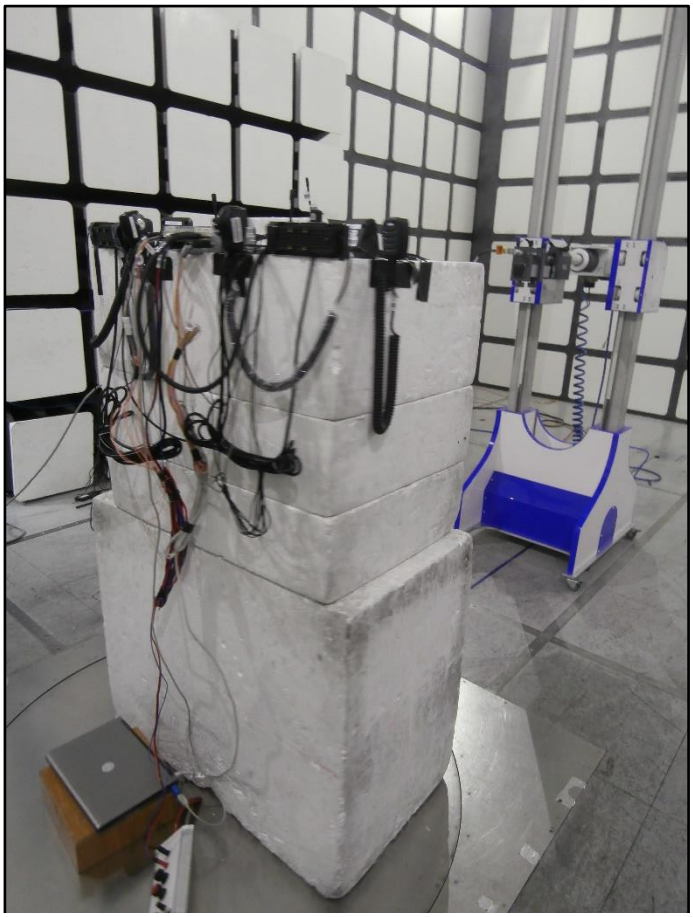

Figure 61 - Test Setup – 18 GHz to 25 GHz (Middle View) – X Orientation

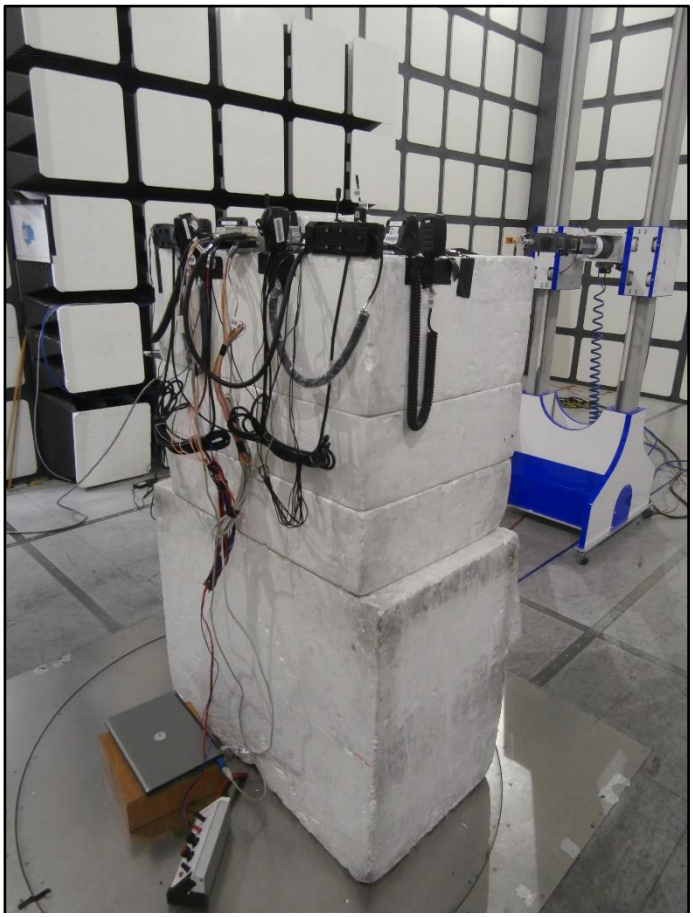

Figure 62 - Test Setup – 18 GHz to 25 GHz (Right View) – X Orientation

FCC 47 CFR Part 15, Limit Clause 15.247 (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)

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.7.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Antenna 18-40GHz (Double Ridge Guide)	Q-Par Angus Ltd	QSH 180K	1511	24	02-Oct-2021
Pre-Amplifier	Phase One	PS04-0086	1533	12	04-Aug-2020
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	18-Feb-2021
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
DC Power Supply	Hewlett Packard	6269B	1909	-	TU
Multimeter	Iso-tech	IDM 101	2118	12	07-Feb-2021
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	30-Sep-2021
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	10-Mar-2021
4dB Attenuator	Pasternack	PE7047-4	4935	24	30-Sep-2021
EmX Emissions Software	TUV SUD	EmX	5125	-	Software
3 GHz High pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	5220	12	25-Mar-2021
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	07-Apr-2021
Antenna (DRG Horn 7.5-18GHz)	Schwarzbeck	HWRD750	5348	12	04-Sep-2020
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5350	12	21-Aug-2020
Thermo-Hygro-Barometer	PCE Instruments	OCE-THB-40	5470	12	16-Mar-2021
1m K-Type Cable	Junkosha	MWX241-01000KMSKMS/A	5511	12	03-Apr-2021
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5513	12	01-Apr-2021
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	01-Apr-2021
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2021
2 m K Type Cable	Junkosha	MWX241-02000KMSKMS/A	5523	12	03-Apr-2021
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	06-Feb-2021

Table 24

TU - Traceability Unscheduled

3 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Frequency Hopping Systems - 20 dB Bandwidth	± 30.43 kHz
Frequency Hopping Systems - Channel Separation	± 30.43 kHz
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Frequency Hopping Systems - Number of Hopping Channels	-
Maximum Conducted Output Power	± 3.2 dB

Table 25

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.