FCC and IC Test Report

Vesper Marine Ltd
AIS/VHF/Monitoring Transceiver, Model: Cortex M1
VHF Handset, Model: Cortex H1

In accordance with FCC 47 CFR Part 80, FCC 47 CFR Part 2, Industry Canada RSS-182 and ISED RSS-GEN

Add value.
Inspire trust.

Prepared for: Vesper Marine Ltd
45 Sale Street
Freemans Bay
Auckland
New Zealand

FCC ID: Cortex VHF SYSTEM M1: YJDVESPM1
Cortex VHF SYSTEM H1: YJDVESPH1

IC: Cortex VHF SYSTEM M1: 9118A-M1
Cortex VHF SYSTEM H1: 9118A-H1

COMMERCIAL-IN-CONFIDENCE

Document 75943855-19 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	RF Team Leader	Authorised Signatory	28 May 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 80, FCC 47 CFR Part 2, Industry Canada RSS-182 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	Neil Rousell	28 May 2020	
Testing	Graeme Lawler	28 May 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 80: 2019, FCC 47 CFR Part 2: 2019, ISED RSS-182: Issue 5 (2012-01) and ISED RSS-GEN : Issue 5 (04-2018) + A1 (03-2019) for the tests detailed in section 1.3.

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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	28 May 2020

Table 1

1.2 Introduction

Applicant	Vesper Marine Ltd
Manufacturer	Vesper Marine Ltd
Model Number(s)	1) Cortex M1 2) Cortex H1
Serial Number(s)	M1.0000006D M1.0000006B M1.0000006F H1.0000000A
Hardware Version(s)	1) B 2) C
Software Version(s)	1) 0.2 2) 0.9
Number of Samples Tested	3 Cortex M1, 1 Cortex H1.
Test Specification/Issue/Date	FCC 47 CFR Part 80: 2019 FCC 47 CFR Part 2: 2019 Industry Canada RSS-182: Issue 5 (2012-01) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number Date	13976 20-September-2018
Date of Receipt of EUT	07-August-2019, 09-September-2019, 12-December-2019 and 03-February-2020
Start of Test	13-December-2019
Finish of Test	06-May-2020
Name of Engineer(s)	Neil Rousell, and Graeme Lawler
Related Document(s)	ANSI C63.26: 2015

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 80, FCC 47 CFR Part 2, Industry Canada RSS-182 and ISED RSS-GEN is shown below.

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 80	Part 2	RSS-182	RSS-GEN			
Configuration and Mode: DC Powered - VHF Tx							
2.1	80.215	2.1046	7.5	6.12	Transmitter Power	Pass	ANSI C63.26: 2015
2.2	80.205	2.1049	7.3	6.7	Bandwidths	Pass	ANSI C63.26: 2015
2.3	80.213	2.1047	7.3	-	Modulation Requirements	Pass	ANSI C63.26: 2015
2.4	80.211	2.1051	7.9	6.13	Spurious Emissions at Antenna Terminals	Pass	ANSI C63.26: 2015
2.5	80.211	2.1053	7.9	6.13	Radiated Spurious Emissions	Pass	ANSI C63.26: 2015

Table 2

1.4 Application Form

EQUIPMENT DESCRIPTION	
Model Name/Number	Cortex M1
Part Number	CM1
Hardware Version	C
Software Version	0.21
FCC ID (if applicable)	YJDVESPM1
Industry Canada ID (if applicable)	9118A-M1
Technical Description (Please provide a brief description of the intended use of the equipment)	VHF and Class B AIS transponder with integrated Wifi and cellular connectivity.

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
3G (WCDMA)	FDD V (824-849)	23	2.5	5	QPSK	5M00GD	826.6	836.4	846.4
WiFI	2400-2480	20	2.5	20	DSSS, OFDM	20M0GD	2412	2437	2462
VHF	156-163	44	2.5	0.025	FM	*16K0GD*	156	-	162
DSC	156.525	44	-	0.025	FSK	*16K0GD*	-	*156.525*	-
AIS	156-162	37	-	0.025	GMSK	*16K0GD*	156	-	162

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	2.4 GHz
Lowest frequency generated or used in the device or on which the device operates or tunes	0.5 Hz
Class A Digital Device (Use in commercial, industrial or business environment) ☐ Class B Digital Device (Use in residential environment only) ☒	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
External DC	Nominal Voltage	Maximum Current	
	12	6A	
Battery	Nominal Voltage	Battery Operating End Point Voltage	
Can EUT transmit whilst being charged?		Yes ☐ No ☐	

EXTREME CONDITIONS					
Maximum temperature	+55.0	°C	Minimum temperature	-25.0	°C

Ancillaries
Please list all ancillaries which will be used with the device.
GPS Antenna

ANTENNA CHARACTERISTICS				
☒	Antenna connector		State impedance	Ohm
☐	Temporary antenna connector		State impedance	Ohm
☐	Integral antenna	Type		
☐	External antenna	Type		

I hereby declare that the information supplied is correct and complete.
Name: Carl Omundsen

Position held: Director Date: 01 April 2019

EQUIPMENT DESCRIPTION	
Model Name/Number	Cortex H1 / H1P
Part Number	H1
Hardware Version	C
Software Version	0.9
FCC ID (if applicable)	YJDVESPH1
Industry Canada ID (if applicable)	9118A-H1
Technical Description (Please provide a brief description of the intended use of the equipment)	Handset for use within Cortex a VHF/DSC/AIS system

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
WiFi	2400-2480	20	2.5	20	DSSS / OFDM	20M0GD	2412	2437	2462

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	
Lowest frequency generated or used in the device or on which the device operates or tunes	
Class A Digital Device (Use in commercial, industrial or business environment) ☐	
Class B Digital Device (Use in residential environment only) ☐	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
External DC	Nominal Voltage	Maximum Current	
	12V	0.5A	
Battery	Nominal Voltage	Battery Operating End Point Voltage	
	3.6V	3.2V	
Can EUT transmit whilst being charged?	Yes ☒ No ☐		

EXTREME CONDITIONS					
Maximum temperature	55	°C	Minimum temperature	-15	°C

Ancillaries
Please list all ancillaries which will be used with the device.

ANTENNA CHARACTERISTICS					
☐	Antenna connector		State impedance		Ohm
☐	Temporary antenna connector		State impedance		Ohm
☒	Integral antenna	Type	Stripline		
☐	External antenna	Type			

I hereby declare that the information supplied is correct and complete.

Name: Carl Omundsen
Position held: CTO Date: 03/02/2020

1.5 Product Information

1.5.1 Technical Description

VHF and Class B AIS transponder with integrated Wifi and cellular connectivity.

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: Cortex M1, Serial Number: M1.0000006B			
0	As supplied by the customer	Not Applicable	Not Applicable
1	Handset Firmware updated for cold temp	Manufacturer	11-October-2019
2	R1306 100 k -> 1 M (Cold Temp Issue – Audio Codec)	Manufacturer	25-November-2019
3	Replaced component capacitor C800 value 36 pF	Manufacturer	11-February-2020
4	Shielding can was missing on the device and has now been added	Manufacturer	21-April-2020
Model: Cortex M1, Serial Number: M1.0000006D			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Cortex H1, Serial Number: H1.0000000A			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Cortex M1, Serial Number: M1.0000006F			
0	As supplied by the customer	Not Applicable	Not Applicable

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: DC Powered - VHF Tx		
Transmitter Power	Neil Rousell	UKAS
Bandwidths	Neil Rousell	UKAS
Modulation Requirements	Neil Rousell	UKAS
Spurious Emissions at Antenna Terminals	Neil Rousell	UKAS
Radiated Spurious 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 Transmitter Power

2.1.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.215
FCC 47 CFR Part 2, Clause 2.1046
ISED RSS-182, Clause 7.5
ISED RSS-GEN, Clause 6.12

2.1.2 Equipment Under Test and Modification State

Cortex M1, S/N:M1.0000006B - Modification State 0

2.1.3 Date of Test

13-December-2019

2.1.4 Test Method

The test was applied in accordance with ANSI C63.26, clause 5.2.3.3.

The EUT was configured to transmit on maximum power on the bottom and top channels with an unmodulated carrier. The EUT was connected to a spectrum analyser via a cable and attenuator. The path loss was measured using a network analyser and entered as a reference level offset in the spectrum analyser. The RBW of the spectrum analyser was set to 100 kHz and the video bandwidth to 300 kHz with the trace set to max hold using a peak detector and the result was recorded.

2.1.5 Environmental Conditions

Ambient Temperature	24.2 °C
Relative Humidity	27.6 %

2.1.6 Test Results

DC Powered - VHF Tx

Power Setting	156.025 MHz		162.025 MHz	
	Result (dBm)	Result (W)	Result (dBm)	Result (W)
High – 25 W	43.09	20.40	43.30	21.40
Low – 1 W	29.29	0.85	29.96	0.99

Table 5 - Transmitter Power Results

FCC 47 CFR Part 80, Limit Clause 80.215 (e)

Ship station frequencies above 27500 kHz. The maximum power must not exceed the values listed below:

- Ships Stations: 156 to 162 MHz - 25 W
- Marine Utility Stations and Handheld Portable Transmitters: 156 to 162 MHz - 10 W

ISED RSS-182, Limit Clause 7.5

The output power shall be within ±1.0 dB of the manufacturer's rated power and not exceed the limits listed in the table below:

Stations	Typical Power
Coast Station	50 W
Ship Stations Minimum Maximum	 6 W 25 W
Hand-held portable transmitters	5 W
Survival two-way radiotelephones	Should have a minimum e.i.r.p of 0.25 W

Table 6

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	10-Feb-2021
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	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

2.2 Bandwidths

2.2.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.205
FCC 47 CFR Part 2, Clause 2.1049,
Industry Canada RSS-182, Clause 7.3
ISED RSS-GEN, Clause 6.7

2.2.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.0000006F - Modification State 0

2.2.3 Date of Test

17-March-2020

2.2.4 Test Method

The test was applied in accordance with ANSI C63.26 clause 5.4.4.

The EUT was transmitting at maximum power, with normal modulation as described in FCC CFR 47 Part 2, clause 2.1049. The EUT was connected to a spectrum analyser via a cable and attenuator, the RBW of the spectrum analyser was set to at least 1 % of the emission bandwidth and a video bandwidth of 3 times RBW, the occupied bandwidth measurement function of the analyser was used and the 99 % bandwidth recorded.

The plots on the following pages show the resultant display from the Spectrum Analyser.

2.2.5 Environmental Conditions

Ambient Temperature	23.9 °C
Relative Humidity	35.3 %

2.2.6 Test Results

DC Powered - VHF Tx

156.025 MHz	162.025 MHz
13.79	15.43

Table 8 – 99% Occupied Bandwidth Results

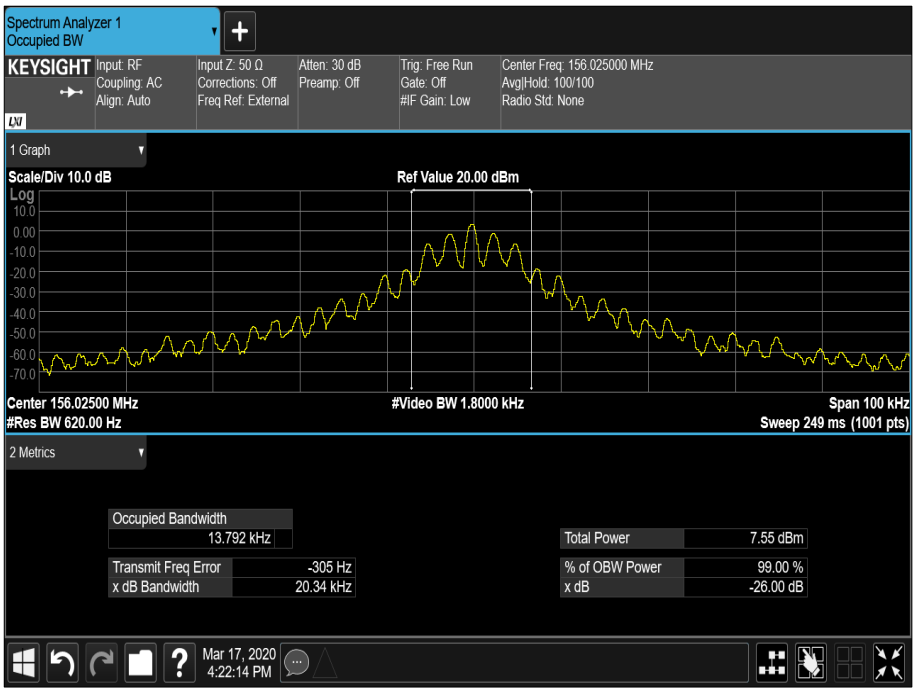

Figure 1 - 156.025 MHz Occupied Bandwidth

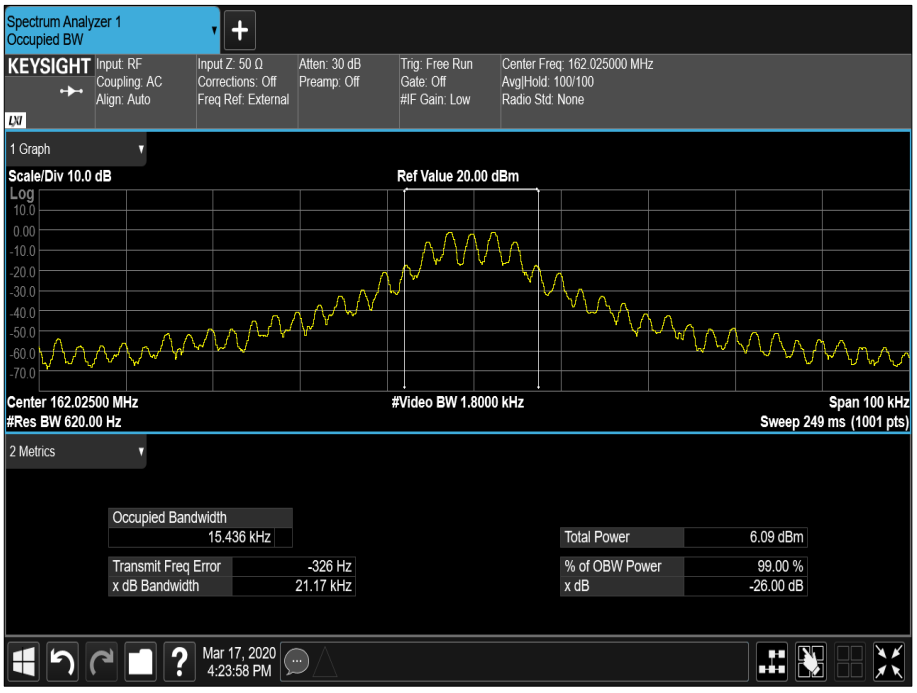

Figure 2 - 162.025 MHz Occupied Bandwidth

FCC 47 CFR Part 80, Limit Clause 80.205

< 20 kHz for G3E class of emission

ISED RSS-GEN, Limit Clause

< 20 kHz for data and < 16 kHz for data.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (30 dB, 50 W)	Bird	8321	494	12	24-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Audio Analyser	Hewlett Packard	8903B	2212	12	01-Nov-2020
Multimeter	Fluke	79 Series II	3057	12	19-Aug-2020
Attenuator (10dB, 50W)	Aeroflex / Weinschel	47-10-34	3166	12	12-Sep-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4509	12	06-Dec-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	5004	12	02-Oct-2020
MXA Signal Analyser	Keysight Technologies	N9020B	5529	24	04-Mar-2022

Table 9

O/P Mon – Output Monitored using calibrated equipment

2.3 Modulation Requirements

2.3.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.213,
FCC 47 CFR Part 2, Clause 2.1047,
ISED RSS-182, Clause 7.3

2.3.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.0000006B - Modification State 2
Cortex H1, S/N: H1.0000000A - Modification State 0

2.3.3 Date of Test

06-May-2020

2.3.4 Test Method

This test was carried out in accordance with the requirements of FCC CFR 47 Part 80, clause 80.213, FCC CFR 47 Part 2, clause 2.1047 (a) and ISED RSS 182 clause 7.3, using the test methods described in ANSI C63.26, clause 5.3.

The EUT was connected to a modulation analyser via a cable and attenuator. The EUT was configured to transmit at maximum power. The results are shown on the graph below.

2.3.5 Environmental Conditions

Ambient Temperature	22.3 °C
Relative Humidity	36.7 %

2.3.6 Test Results

DC Powered - VHF Tx

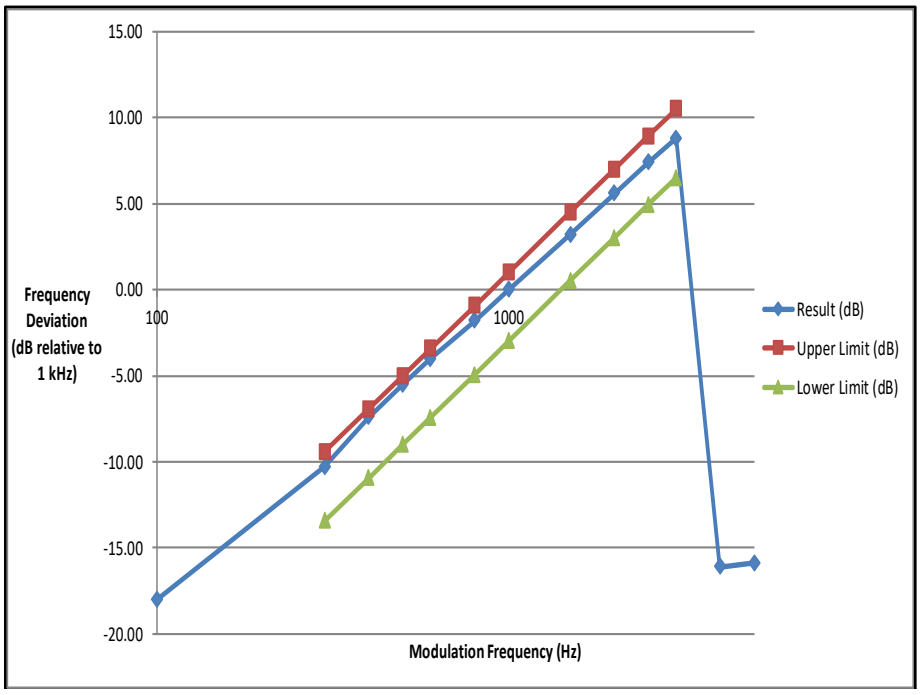

Figure 3 Modulation Requirement - Frequency Response (156.025 MHz)

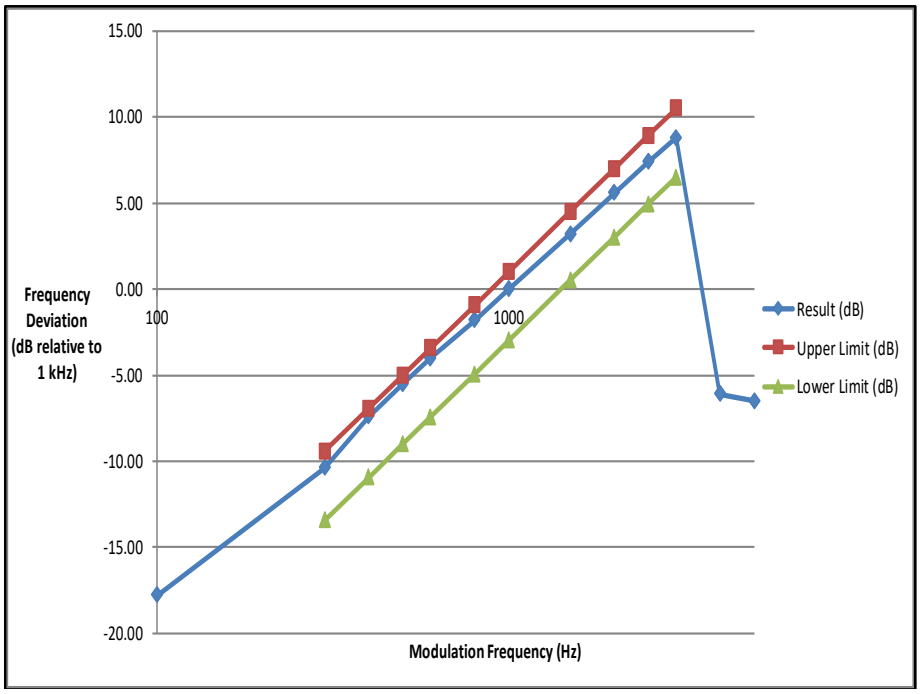

Figure 4 Modulation Requirement - Frequency Response (162.025 MHz)

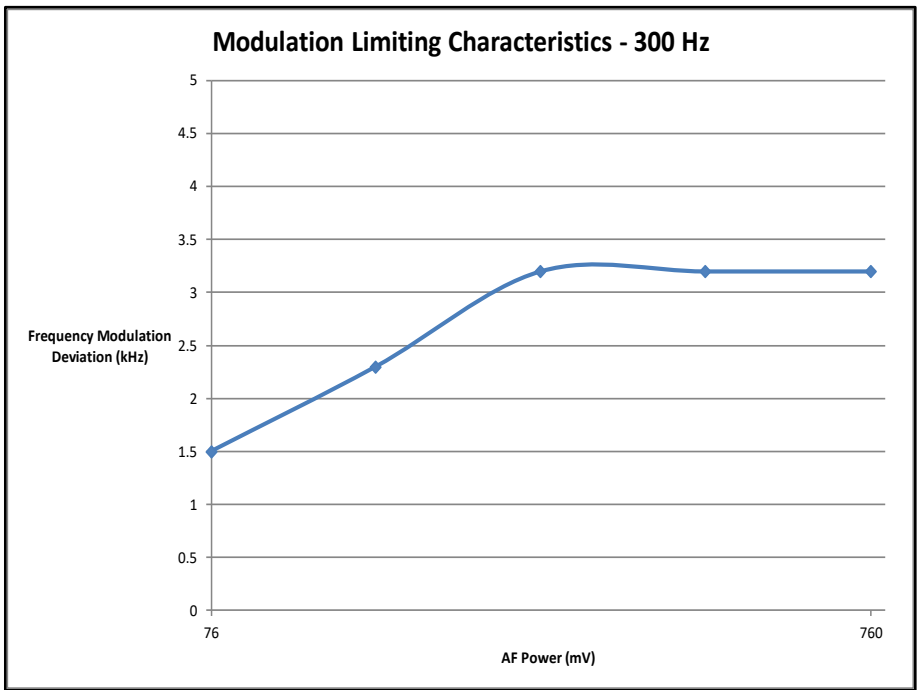

Figure 5 Modulation Limiting Capability - 300 Hz AF (156.025 MHz)

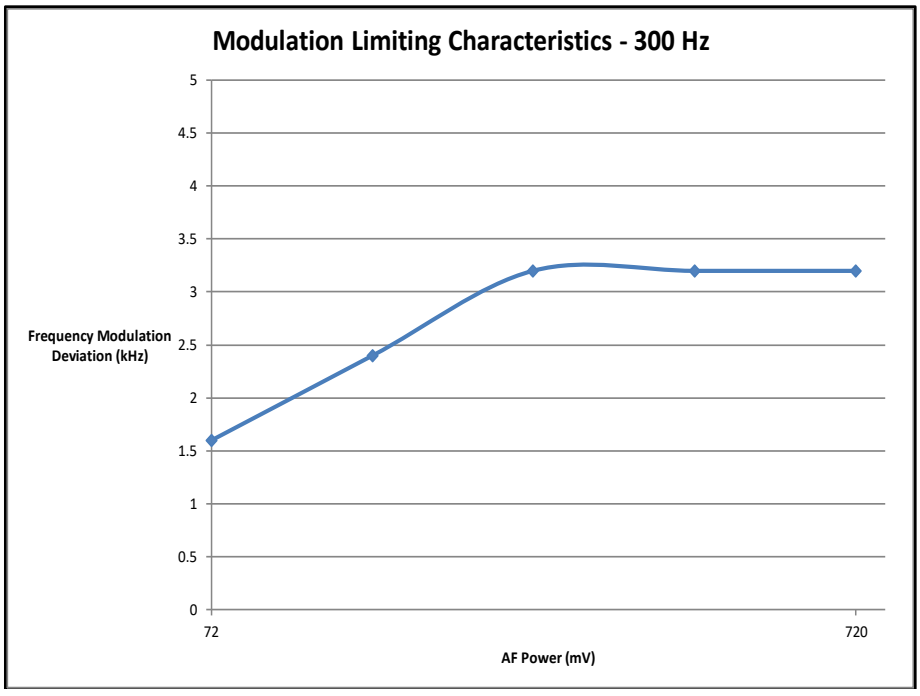

Figure 6 Modulation Limiting Capability - 300 Hz AF (162.025 MHz)

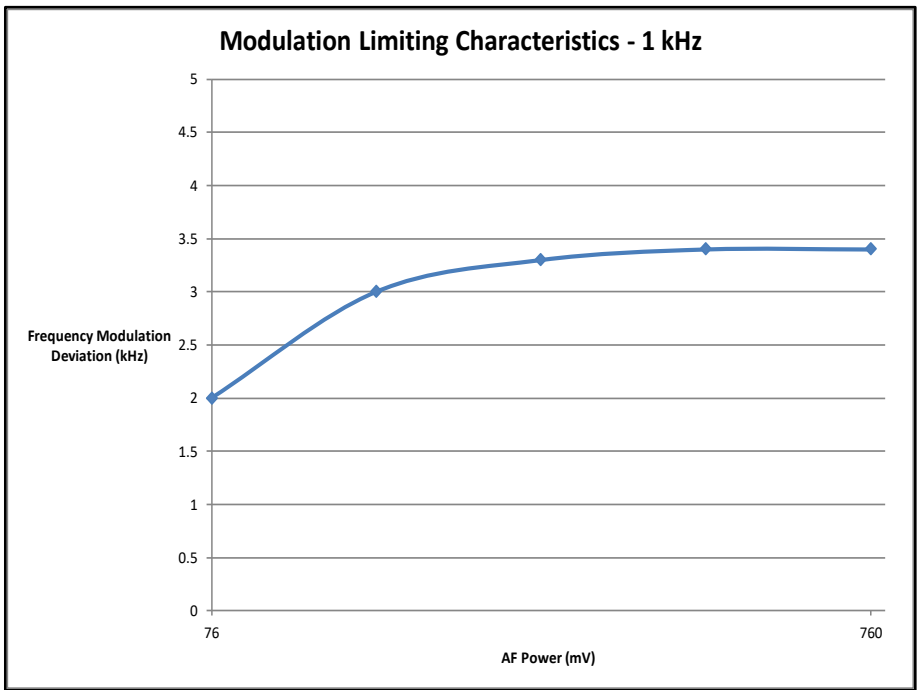

Figure 7 Modulation Limiting Capability - 1 kHz AF (156.025 MHz)

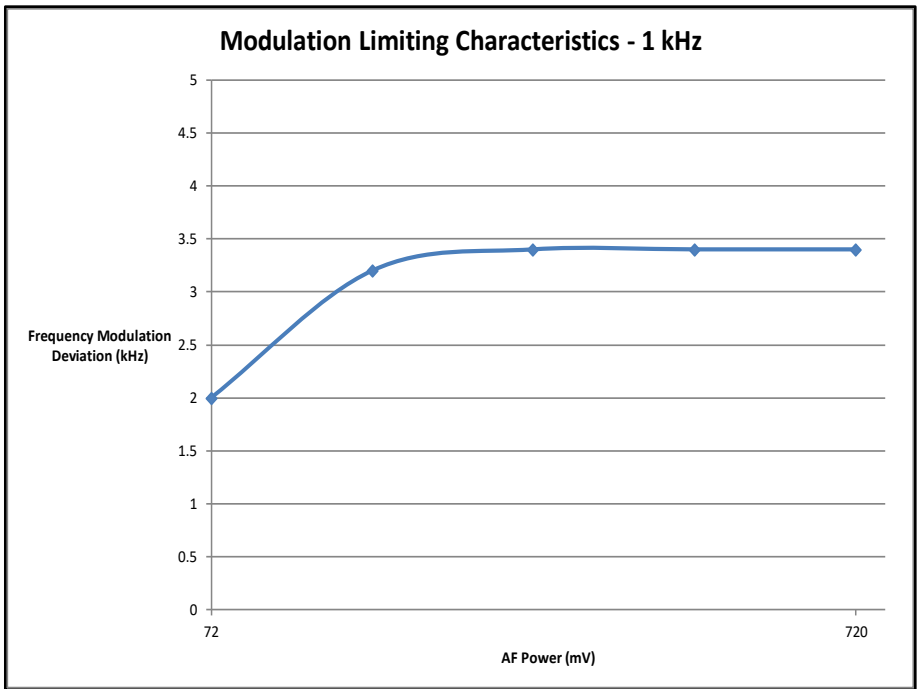

Figure 8 Modulation Limiting Capability - 1 kHz AF (162.025 MHz)

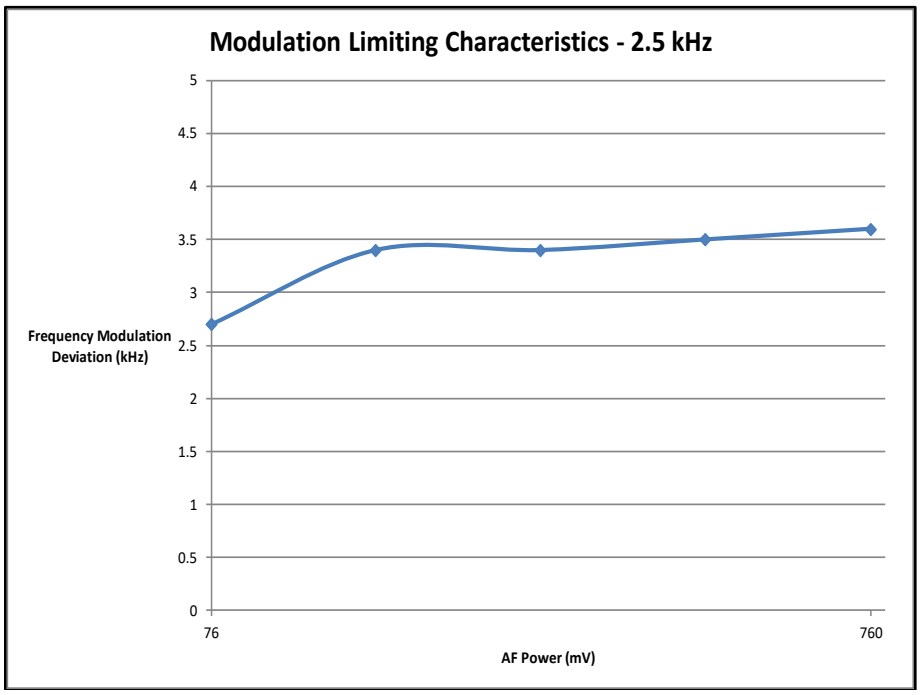

Figure 9 Modulation Limiting Capability - 2.5 kHz AF (156.025 MHz)

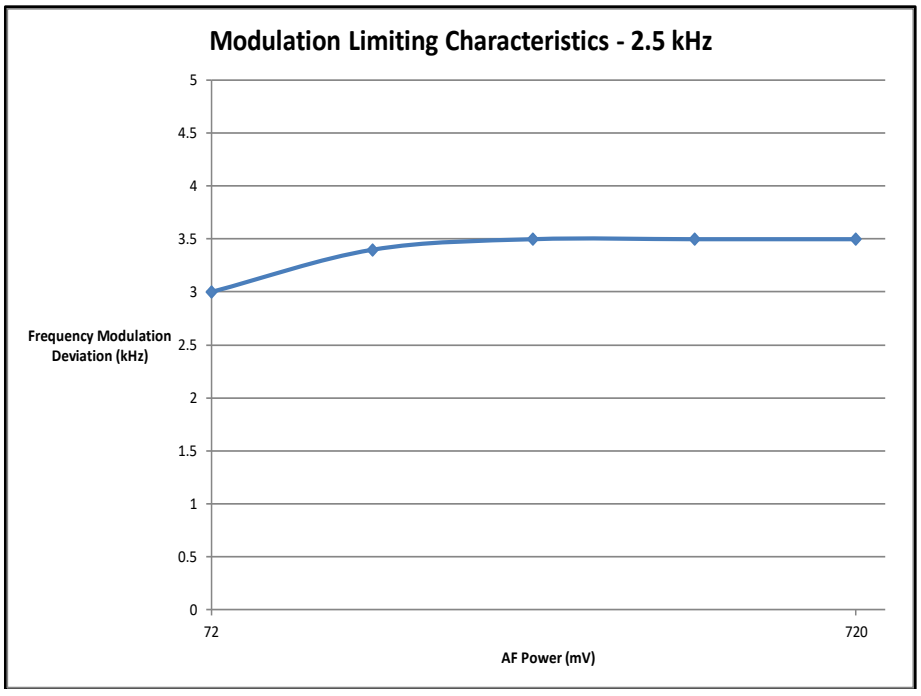

Figure 10 Modulation Limiting Capability - 2.5 kHz AF (162.025 MHz)

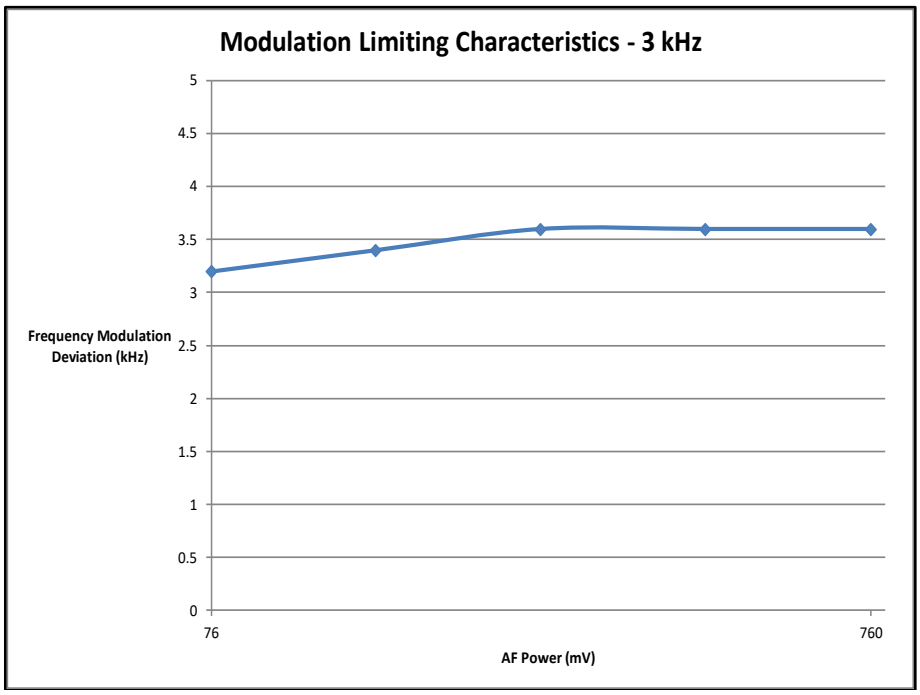

Figure 11 Modulation Limiting Capability - 3 kHz AF (156.025 MHz)

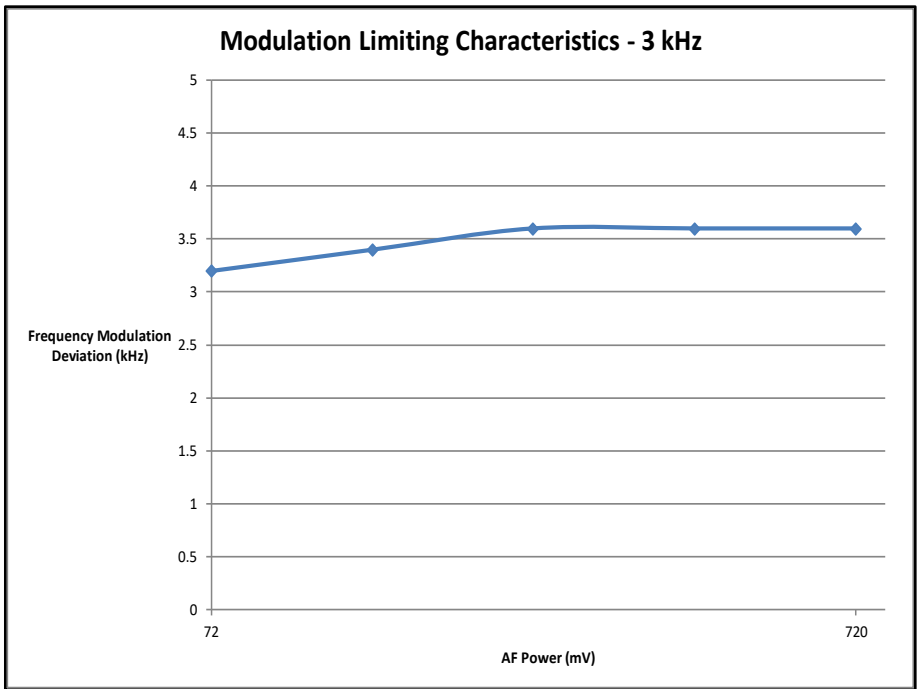

Figure 12 Modulation Limiting Capability - 3 kHz AF (162.025 MHz)

FCC 47 CFR Part 80, Limit Clause 80.213

Radiotelephone transmitters using A3E, F3E and G3E emission must have a modulation limiter to prevent any modulation over 100 percent.

FCC 47 CFR Part 2, Limit Clause 2.1047

Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

ISED RSS-182, Limit Clause 7.3

VHF radiocommunication shall employ G3E or F3E modulation for voice communication and G2B for DSC signals.

Maritime VHF transceivers shall have the following characteristics:

(a) 25 kHz channel spacing;
(b) frequency modulation with a pre-emphasis of 6 dB/octave (phase modulation (PM)) shall be used;
(c) the frequency deviation corresponding to 100% modulation shall approach "5 kHz as nearly as practicable and in no event shall the frequency deviation exceed "5 kHz;
(d) the audio-frequency band shall be 3000 Hz;
(e) the authorized channel bandwidth for voice shall be 16 kHz; and
(f) the authorized channel bandwidth for data shall be 20 kHz.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Modulation Analyser	Hewlett Packard	8901B	773	12	28-Jun-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	05-May-2020
Power Supply Unit	Farnell	TSV-70	2043	12	O/P Mon
Audio Analyser	Hewlett Packard	8903B	2212	12	01-Nov-2020
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Multimeter	Fluke	177	3813	12	09-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	05-May-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
4 Channel PSU	Rohde & Schwarz	HMP4040	4736	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5480	12	18-Mar-2021

Table 10

O/P Mon – Output Monitored using calibrated equipment

2.4 Spurious Emissions at Antenna Terminals

2.4.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.211,
FCC 47 CFR Part 2, Clause 2.1051,
ISED RSS-182, Clause 7.9
ISED RSS-GEN, Clause 6.13.

2.4.2 Equipment Under Test and Modification State

Cortex M1, S/N:M1.0000006B - Modification State 2
Cortex H1, S/N: H1.0000000A - Modification State 0

2.4.3 Date of Test

04-May-2020 to 05-May-2020

2.4.4 Test Method

For emissions where the frequency is removed less than 250 % of the authorized bandwidth measurements were performed conducted as follows:

The EUT was connected to a spectrum analyser via a cable and attenuator. The path loss between the EUT and analyser was calibrated using a network analyser and entered into the spectrum analyser as a reference level offset. The reference level for the mask was established with a RBW 300 Hz. The mask as per FCC CFR 47 Part 80, clause 80.211 (f) was applied.

For emissions where the frequency is removed more than 250 % of the authorized bandwidth measurements were performed as follows:

A network analyser was used to measure the path loss and the worst case was entered as a reference level offset into the spectrum analyser. The EUT was connected to a spectrum analyser via attenuators and cable. The spectrum analyser was configured with an RBW of 30 kHz with the trace set to max hold using a peak detector. Between 9 kHz and 150 kHz the limit was adjusted for a measurement bandwidth of 1 kHz. Between 300 MHz and 2 GHz a 300 MHz high pass filter was used.

The EUT was modulated with a test signal as described in FCC 47 CFR Part 2.1047.

2.4.5 Environmental Conditions

Ambient Temperature	22.5 - 24.3 °C
Relative Humidity	39.4 - 43.2 %

2.4.6 Test Results

DC Powered - VHF Tx

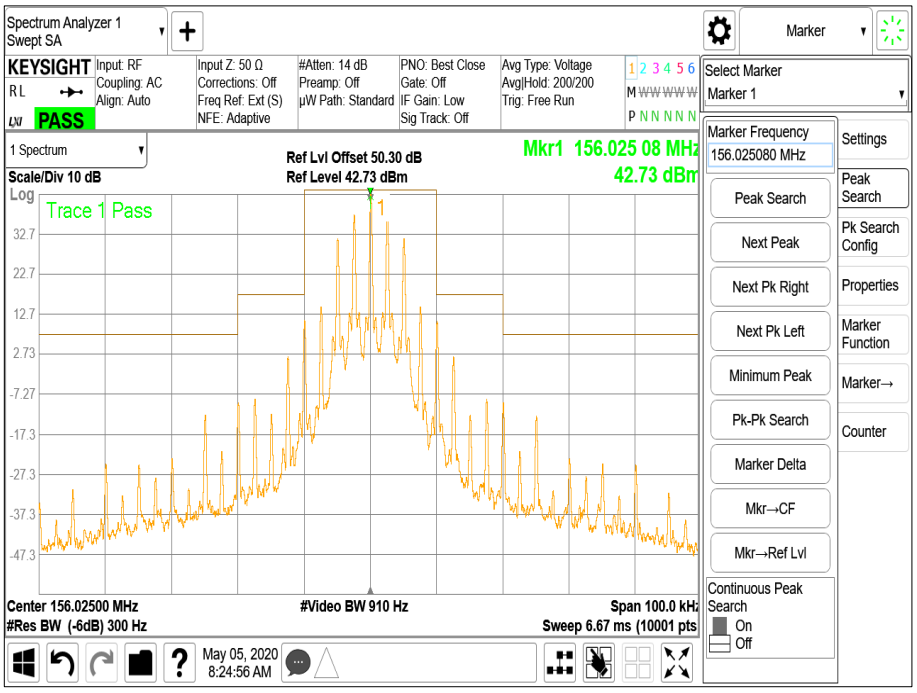

Figure 13 - 156.025 MHz - Transmitter Spectrum Mask

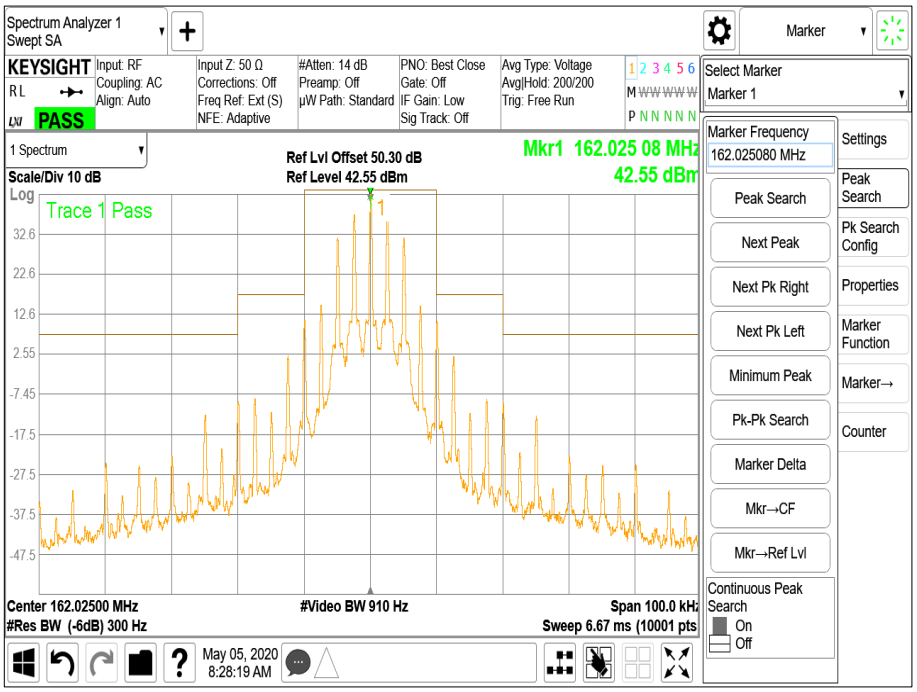

Figure 14 - 162.025 MHz - Transmitter Spectrum Mask

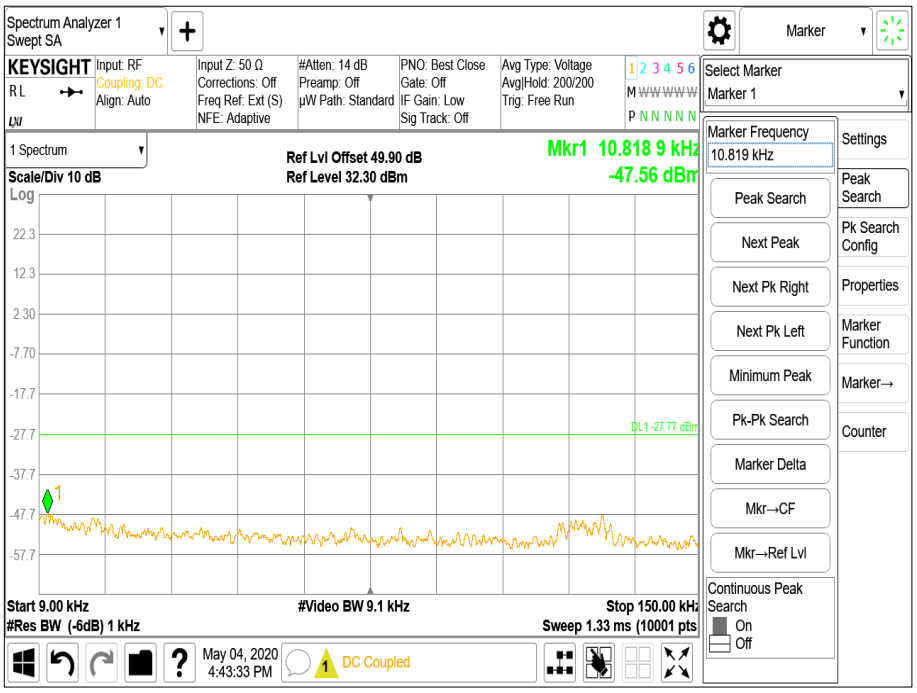

Figure 15 - 156.025 MHz - 9 kHz to 150 kHz

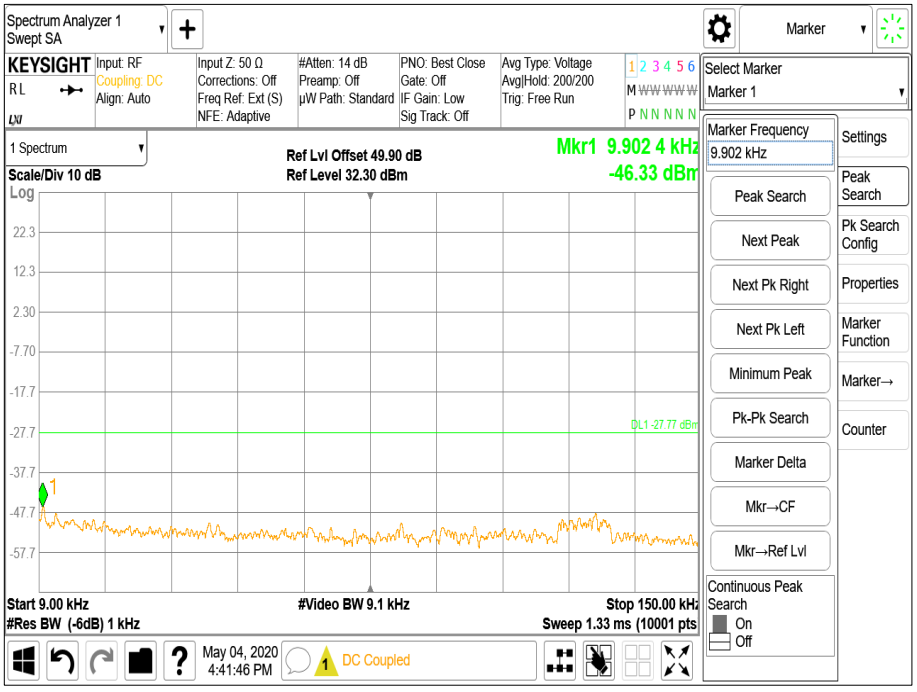

Figure 16 - 162.025 MHz - 9 kHz to 150 kHz

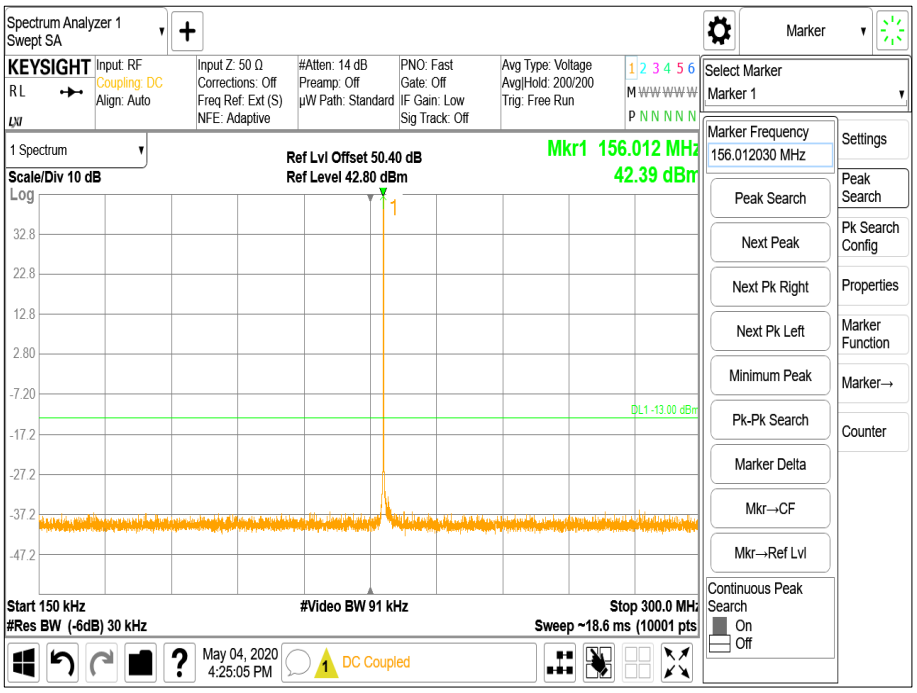

Figure 17 - 156.025 MHz - 150 kHz to 300 MHz

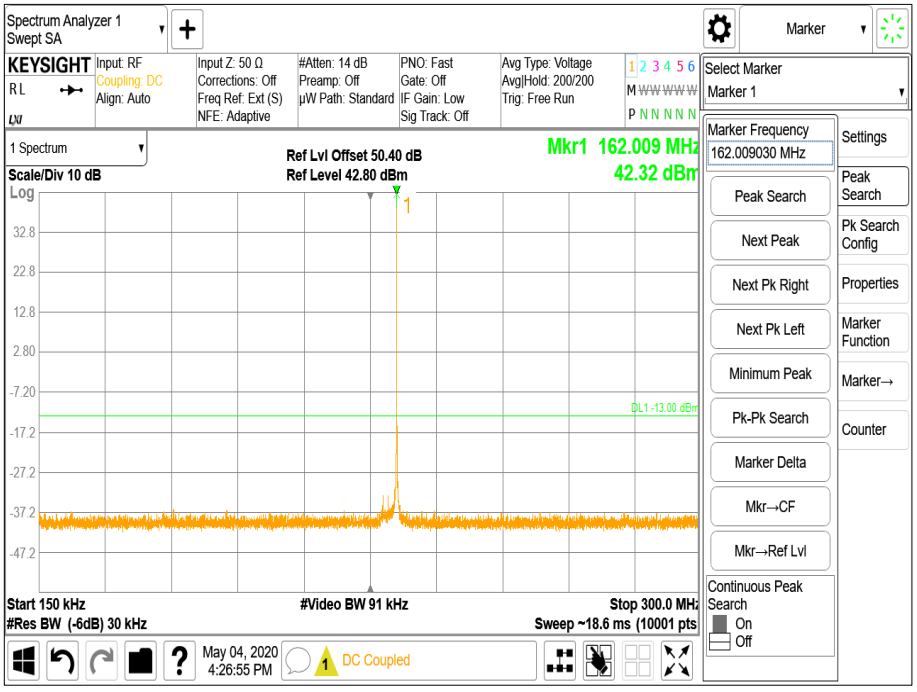

Figure 18 - 162.025 MHz - 150 kHz to 300 MHz

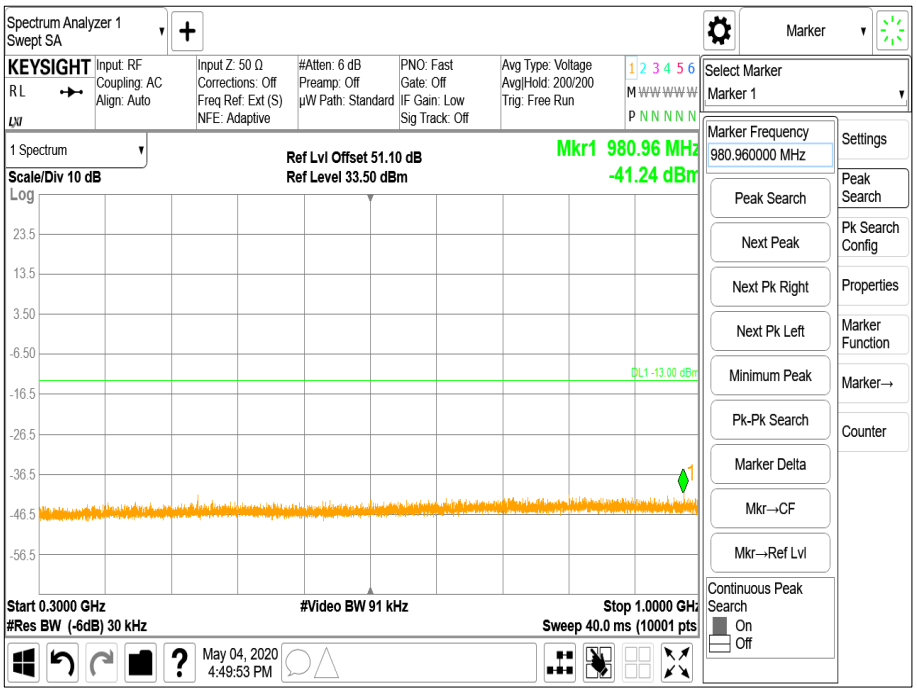

Figure 19 - 156.025 MHz - 300 MHz to 1 GHz

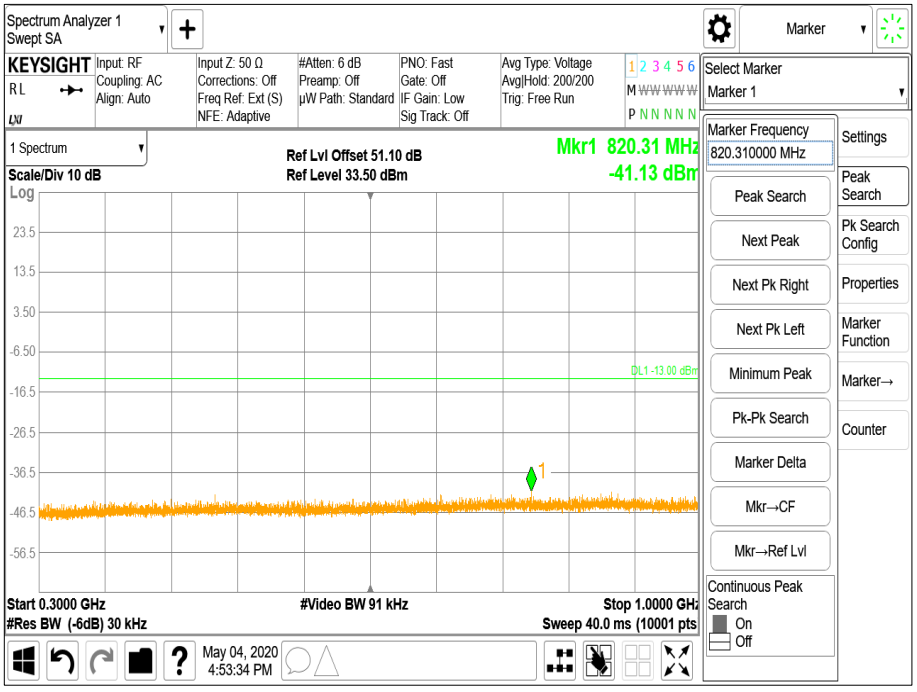

Figure 20 - 162.025 MHz - 300 MHz to 1 GHz

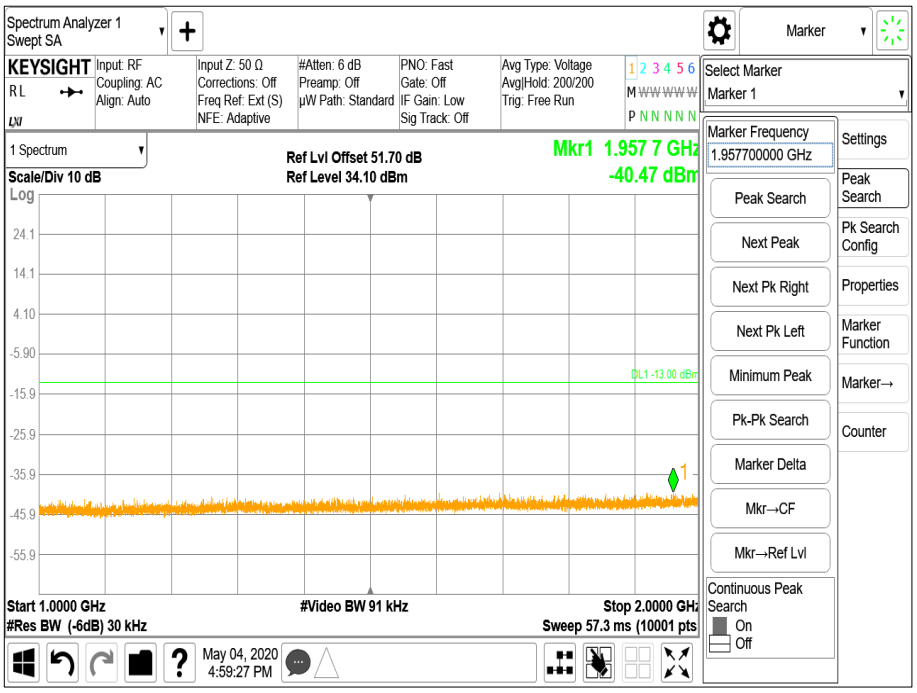

Figure 21 - 156.025 MHz - 1 GHz to 2 GHz

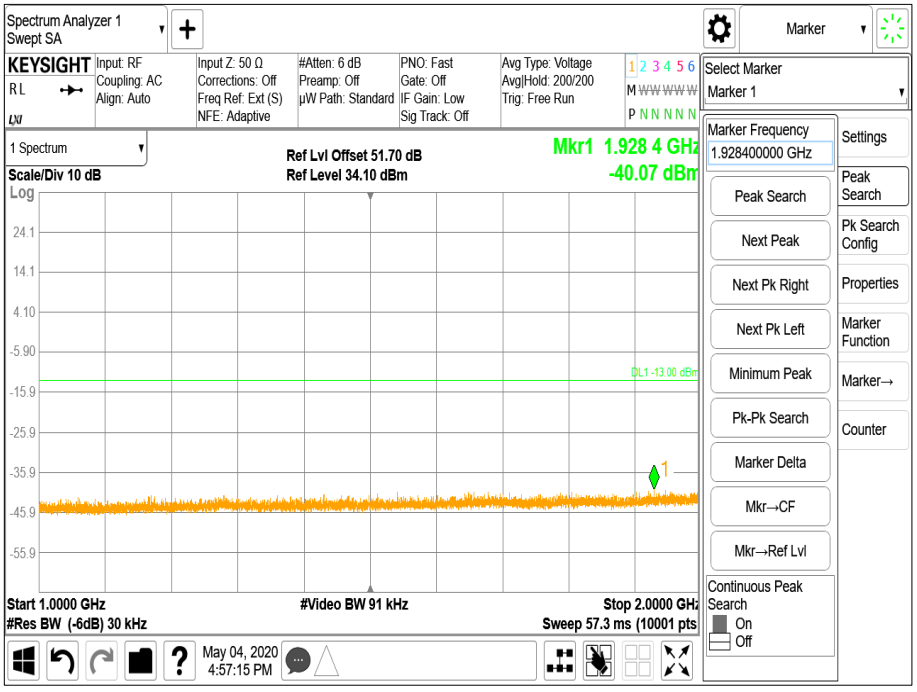

Figure 22 - 162.025 MHz - 1 GHz to 2 GHz

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Modulation Analyser	Hewlett Packard	8901B	773	12	28-Jun-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	05-May-2020
Power Supply Unit	Farnell	TSV-70	2043	12	O/P Mon
Audio Analyser	Hewlett Packard	8903B	2212	12	01-Nov-2020
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	11-Dec-2020
Multimeter	Fluke	177	3813	12	09-Oct-2020
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	28-Nov-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	05-May-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
4 Channel PSU	Rohde & Schwarz	HMP4040	4736	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Signal Analyzer	Keysight Technologies	PXA N9030B	5432	12	05-Dec-2020
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5480	12	18-Mar-2021
300 MHz High Pass Filter	Mini-Circuits	NHP-300	5532	12	25-Mar-2021

Table 11

O/P Mon – Output Monitored using calibrated equipment

2.5 Radiated Spurious Emissions

2.5.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.211
FCC 47 CFR Part 2, Clause 2.1053
Industry Canada RSS-182, Clause 7.9
ISED RSS-GEN, Clause 6.13.

2.5.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.0000006D - Modification State 0

2.5.3 Date of Test

10-February-2020

2.5.4 Test Method

A preliminary profile of the Spurious Radiated Emissions was obtained up to the 10th harmonic by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber.

Measurements of emissions from the EUT were obtained with the Measurement Antenna in both horizontal and vertical polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Testing was performed in accordance with ANSI C63.26, clause 5.5.

Prescans and final measurements were performed using the direct field strength method.

The Regulatory limit of -13 dBm/MHz has been converted to a field strength limit in accordance with ANSI C63.26, clause 5.2.7 equation c)

This is the limit line shown on the plots.

Example calculation
E (dBuV/m) = EIRP (dBm) - 20log(d) + 104.8 where (d) is the measurement distance.
E (dBuV/m) = -13 - 20log(3) + 104.8
E (dBuV/m) = 82.26

2.5.5 Environmental Conditions

Ambient Temperature	19.7 °C
Relative Humidity	33.1 %

2.5.6 Test Results

DC Powered - VHF Tx

Frequency (MHz)	Level (dBµV/m at 3m)
312.089	72.57

Table 12 - 156.025 MHz - Emissions Results

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

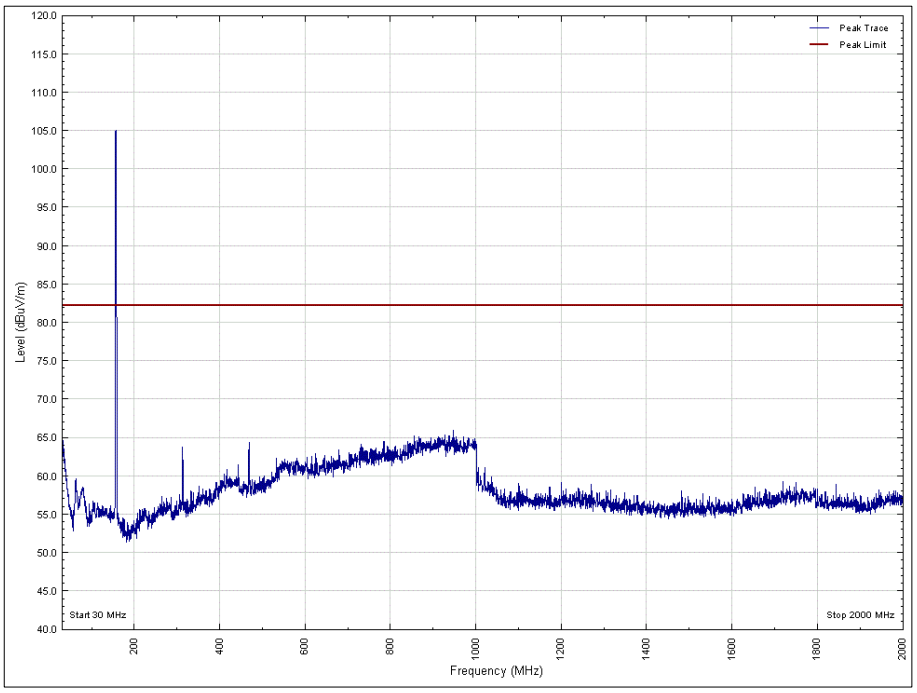

Figure 23 - 156.025 MHz - 30 MHz to 2 GHz, X – Orientation, Vertical

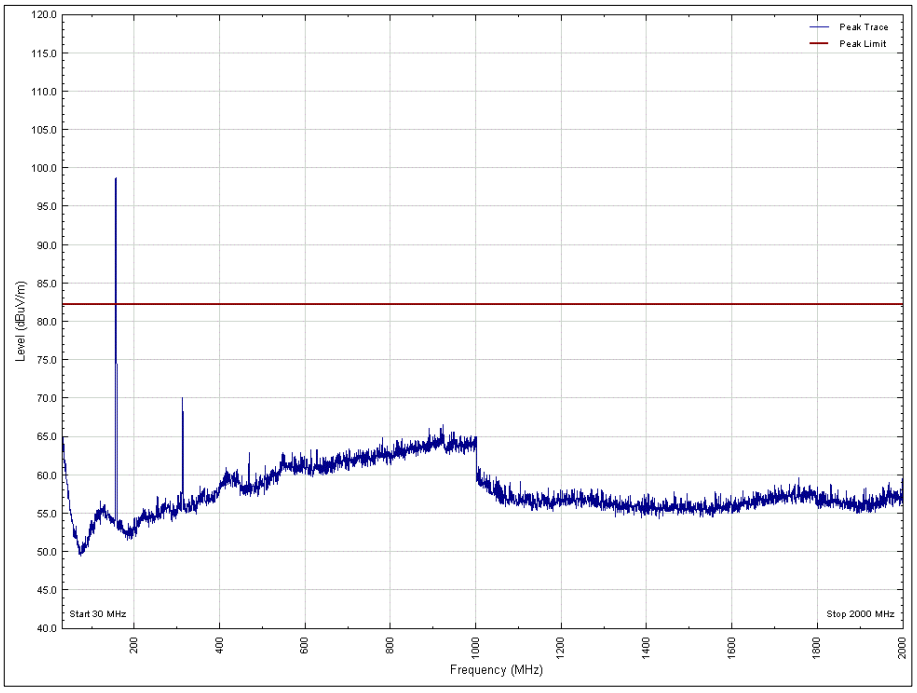

Figure 24 - 156.025 MHz - 30 MHz to 2 GHz, X – Orientation, Horizontal

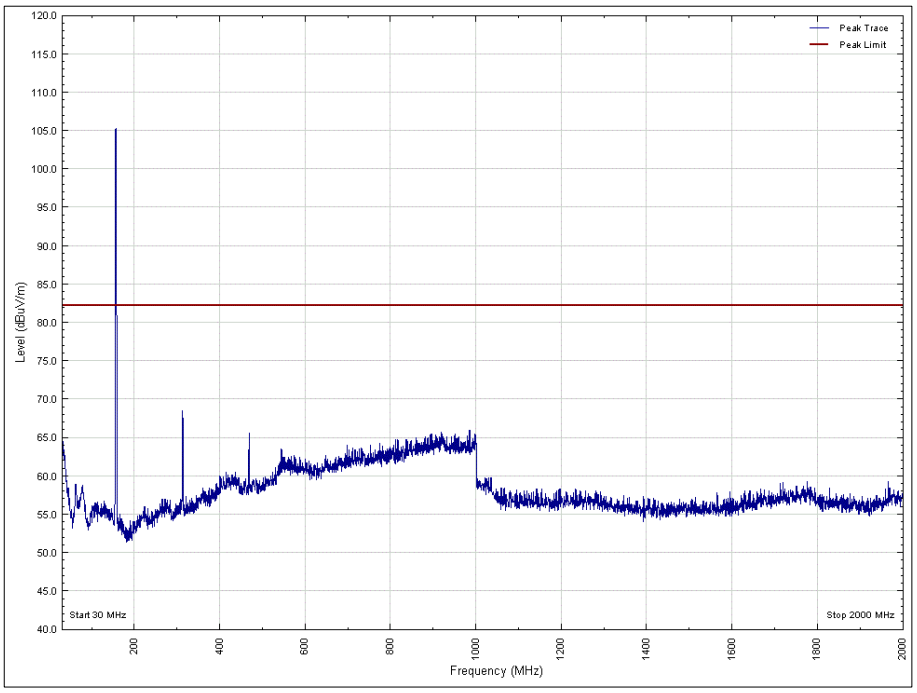

Figure 25 - 156.025 MHz - 30 MHz to 2 GHz, Y – Orientation, Vertical

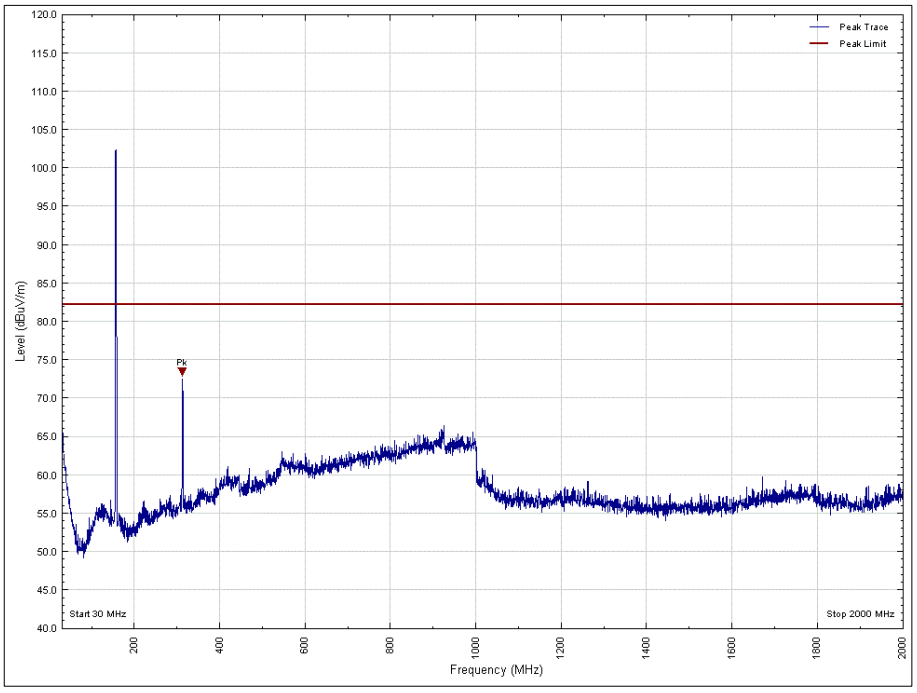

Figure 26 - 156.025 MHz - 30 MHz to 2 GHz, Y – Orientation, Horizontal

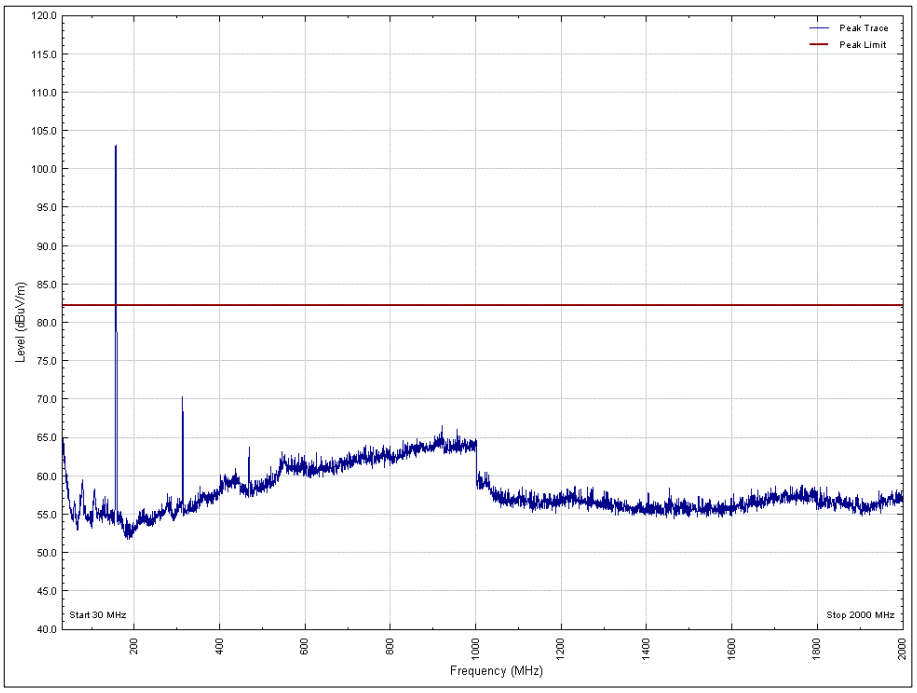

Figure 27 - 156.025 MHz - 30 MHz to 2 GHz, Z – Orientation, Vertical

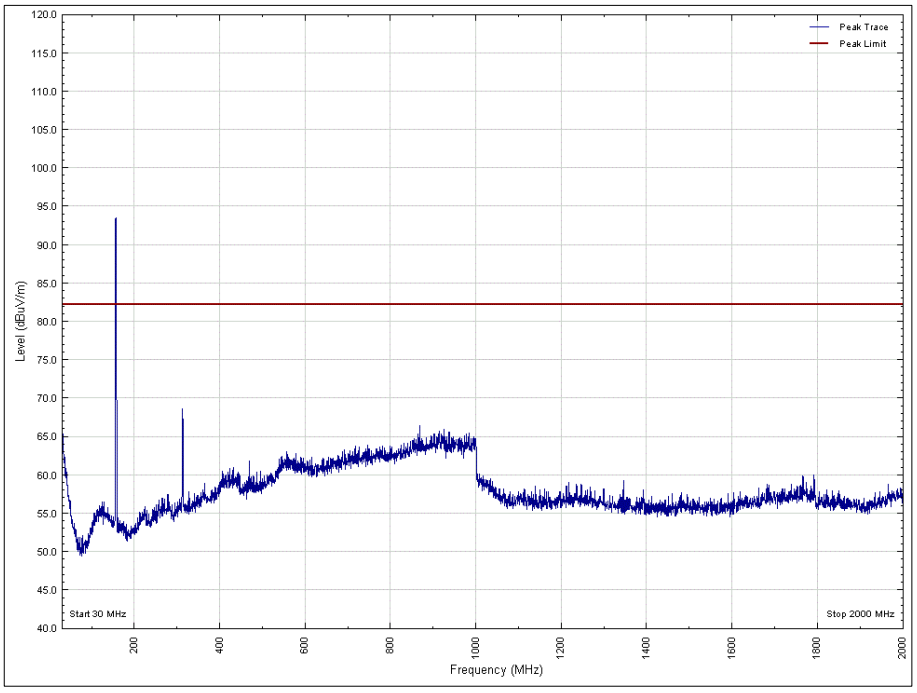

Figure 28 - 156.025 MHz - 30 MHz to 2 GHz, Z – Orientation, Horizontal

Frequency (MHz)	Level (dBµV/m at 3m)
*	

Table 13 - 162.025 MHz - Emissions Results

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

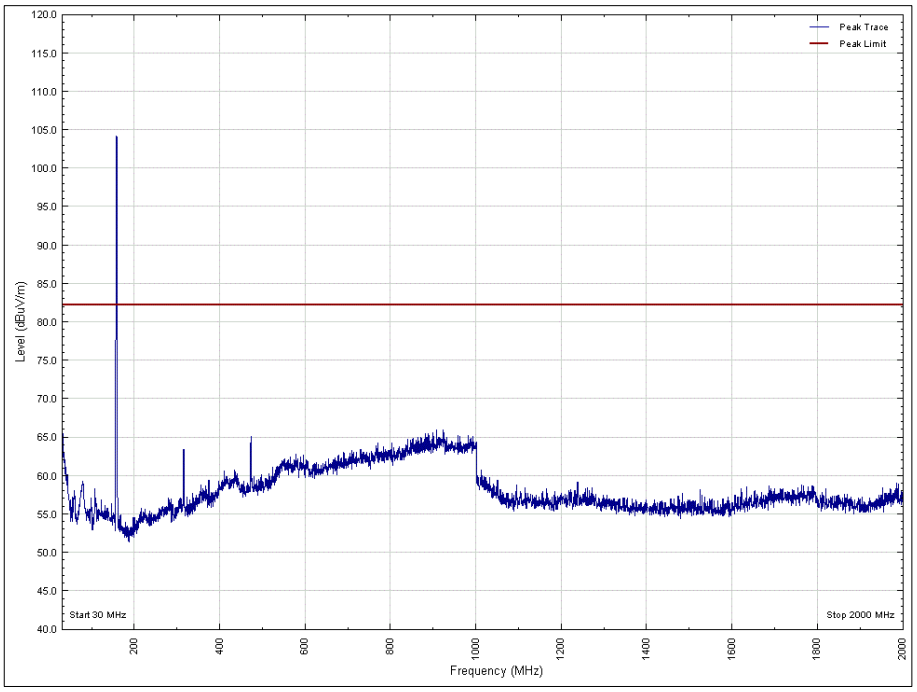

Figure 29 - 162.025 MHz - 30 MHz to 2 GHz, X – Orientation, Vertical

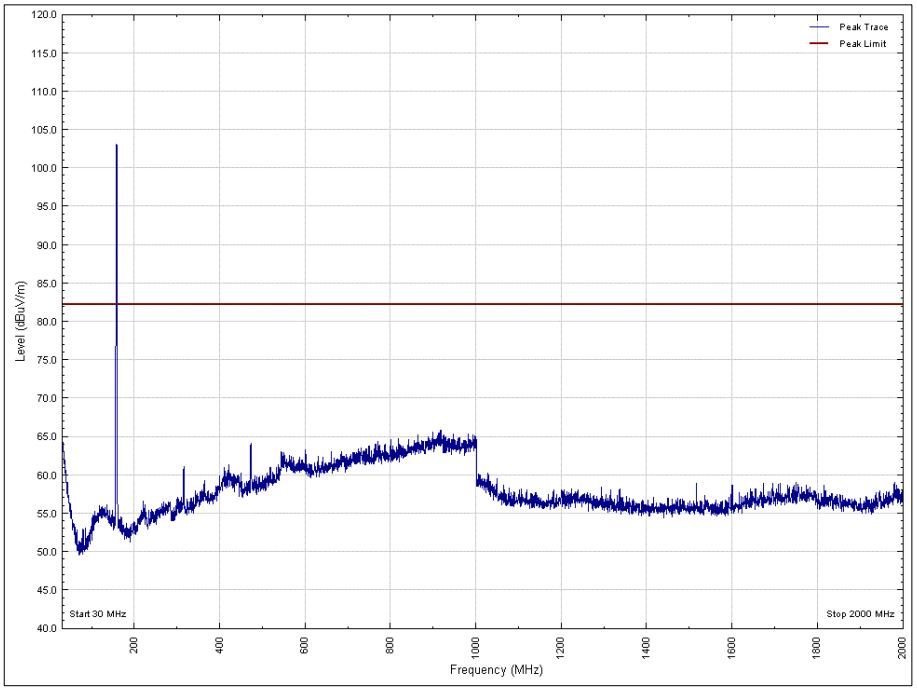

Figure 30 - 162.025 MHz - 30 MHz to 2 GHz, X – Orientation, Horizontal

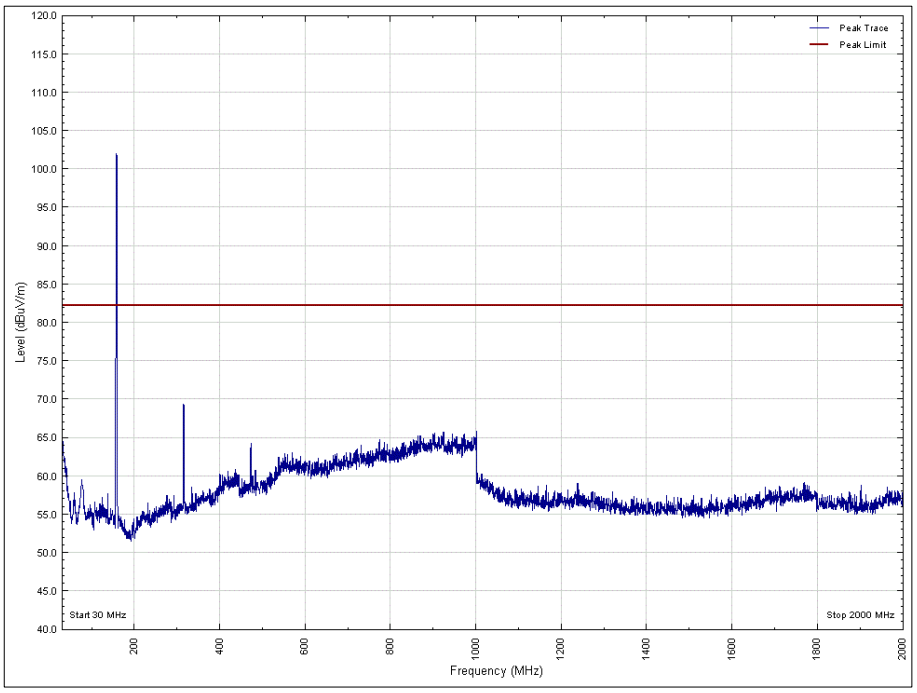

Figure 31 - 162.025 MHz - 30 MHz to 2 GHz, Y – Orientation, Vertical

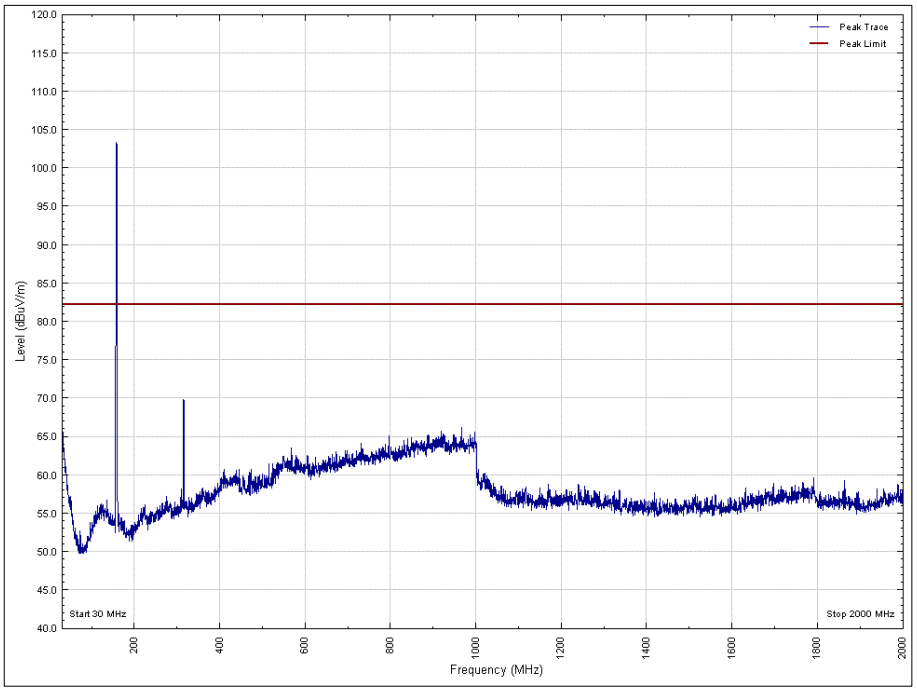

Figure 32 - 162.025 MHz - 30 MHz to 2 GHz, Y – Orientation, Horizontal

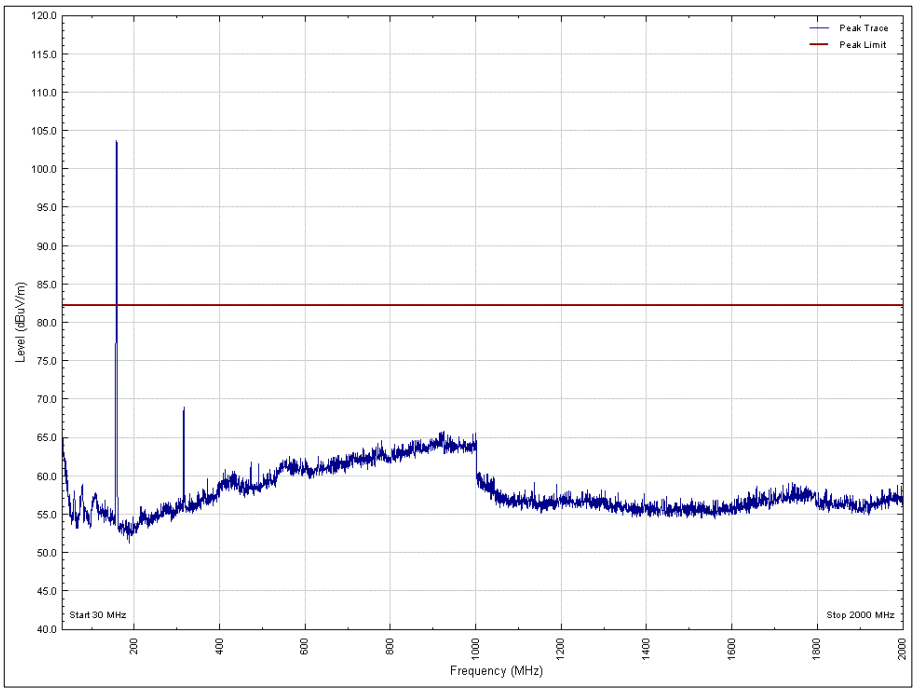

Figure 33 - 162.025 MHz - 30 MHz to 2 GHz, Z – Orientation, Vertical

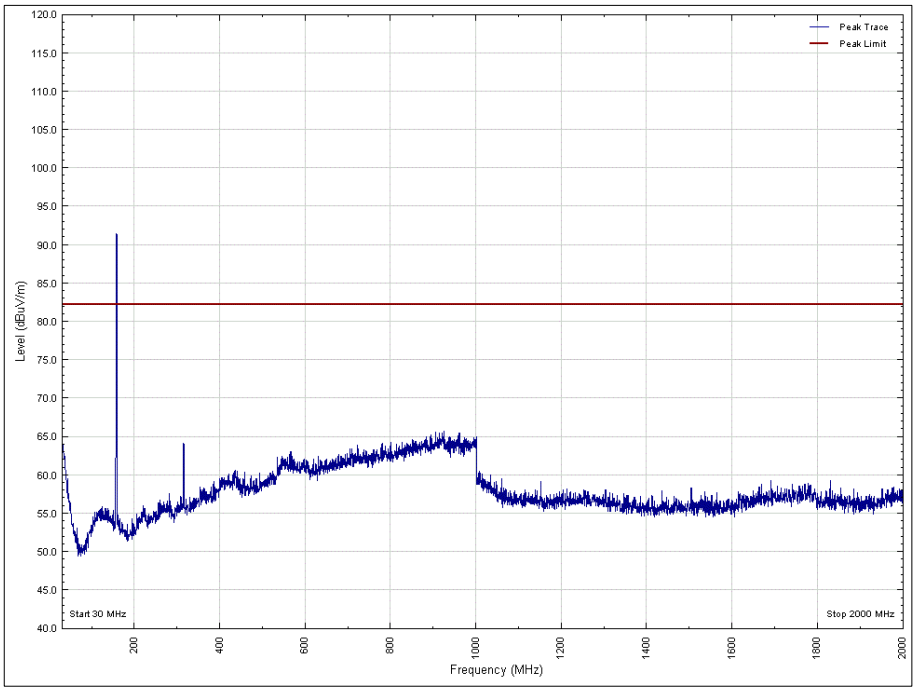

Figure 34 - 162.025 MHz - 30 MHz to 2 GHz, Z – Orientation, Horizontal

2.5.7 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
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	30-Sep-2021
Comb Generator	Schaffner	RSG1000	3034	-	TU
'2.92mm' - '2.92mm' RF Cable (2m)	Rhophase	KPS-1503-2000-KPS	3695	12	11-Jun-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
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	11-Mar-2020
4dB Attenuator	Pasternack	PE7047-4	4935	24	30-Sep-2021
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
8 Meter Cable	Teledyne	PR90-088-8MTR	5212	12	30-Aug-2020
EMI Test Receiver	Rohde & Schwarz	ESW44	5382	12	08-Oct-2020

Table 14

TU - Traceability Unscheduled

3 Photographs

3.1 Test Setup Photographs

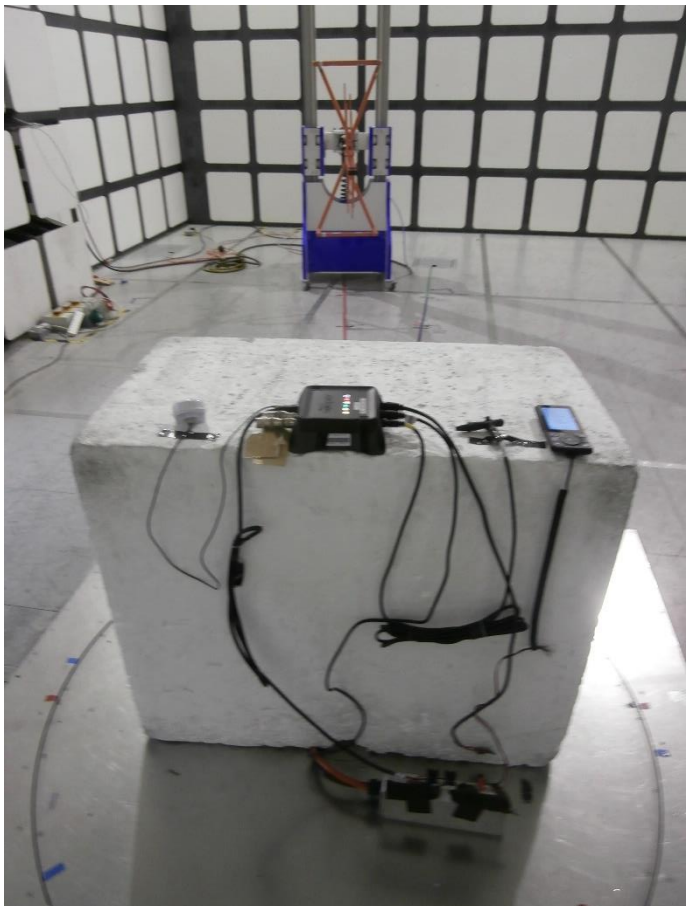

Figure 35 – Radiated Emissions, 30 MHz to 1 GHz, Orientation X

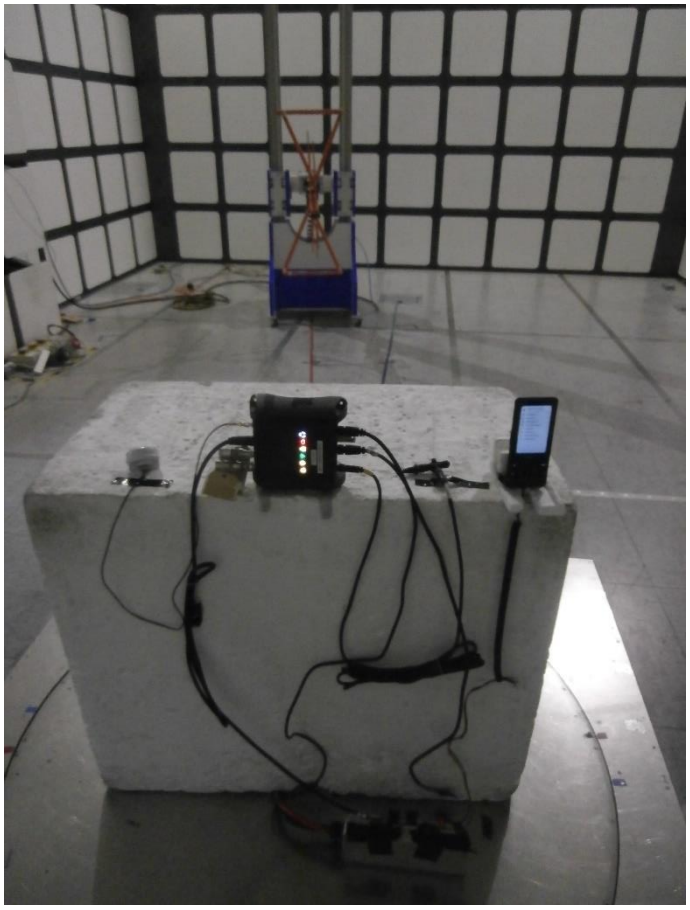

Figure 36 – Radiated Emissions, 30 MHz to 1 GHz, Orientation Y

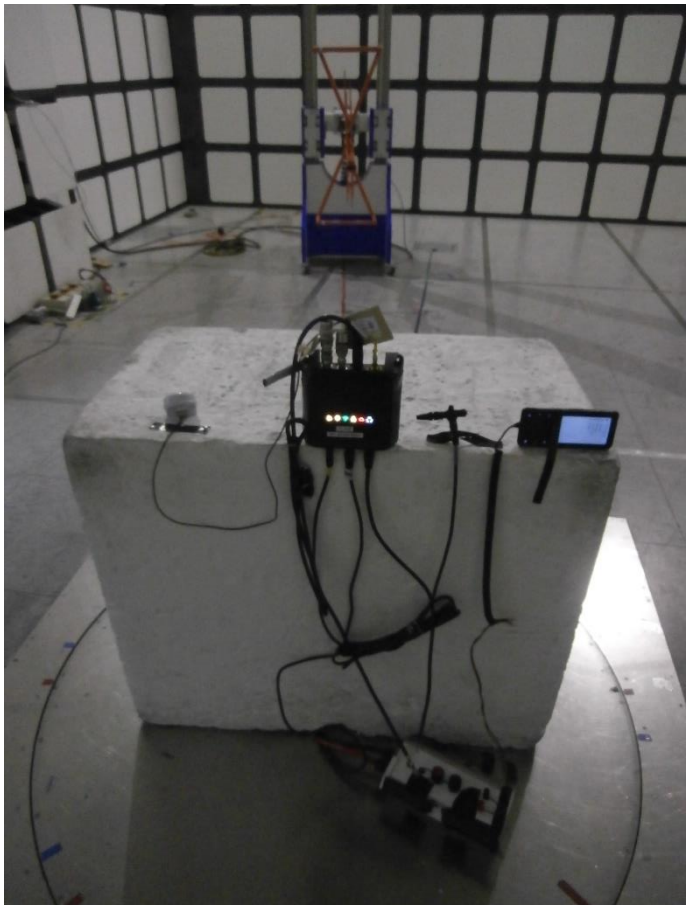

Figure 37 – Radiated Emissions, 30 MHz to 1 GHz, Orientation Z

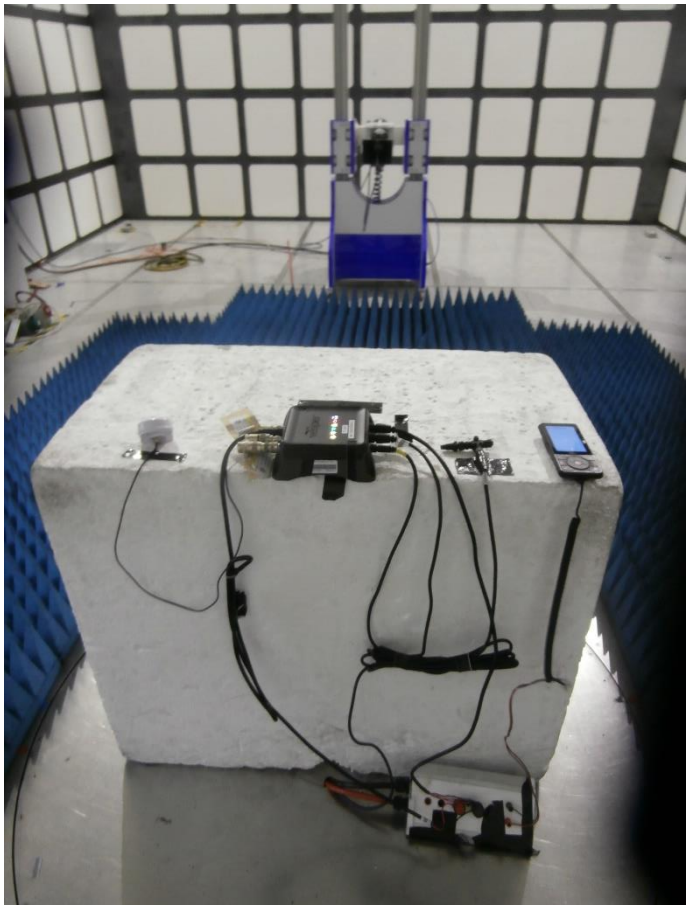

Figure 38 – Radiated Emissions, 1 GHz to 2 GHz, Orientation X

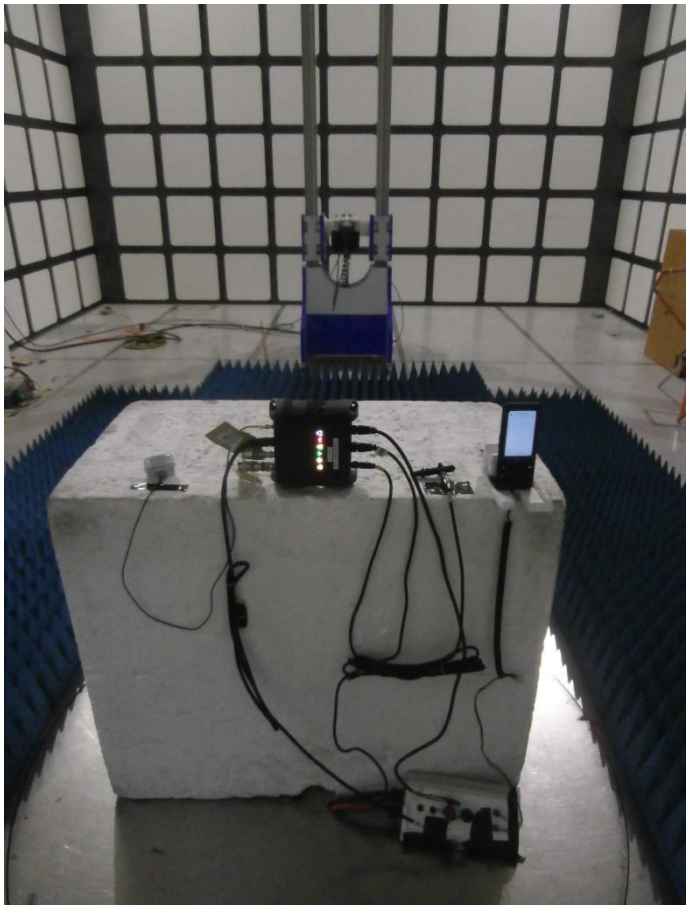

Figure 39 – Radiated Emissions, 1 GHz to 2 GHz, Orientation Y

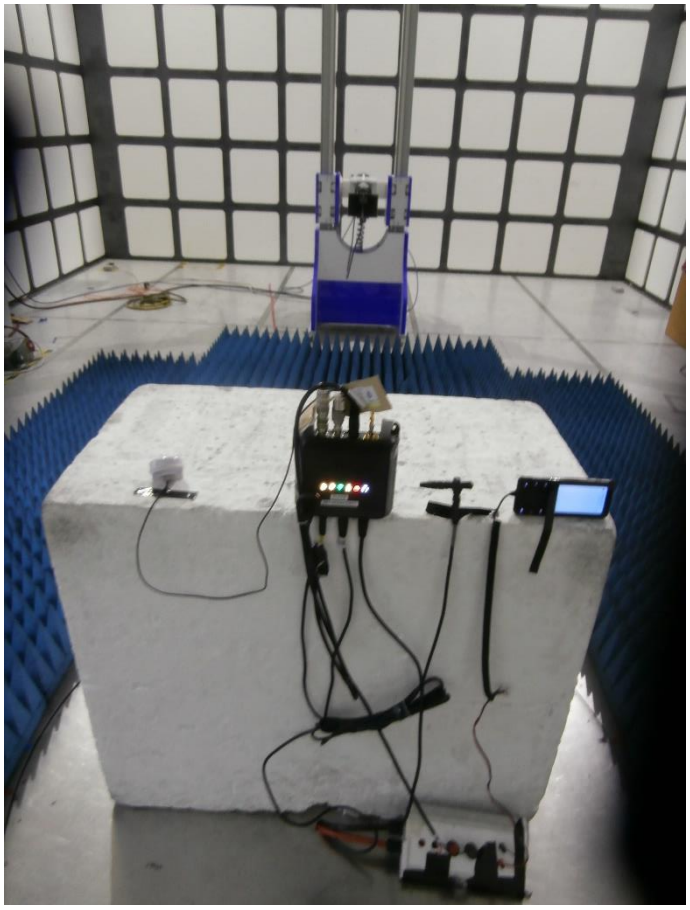

Figure 40 – Radiated Emissions, 1 GHz to 2 GHz, Orientation Z

4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Transmitter Power	± 3.2 dB
Bandwidths	± 58.05 Hz
Modulation Requirements	-
Spurious Emissions at Antenna Terminals	± 3.45 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 18 GHz: ± 6.3 dB

Table 15

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.