FCC and ISEDC Test Report

SRT Marine Technology Limited
AIS, Model: B954

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

Add value.
Inspire trust.

Prepared for: SRT Marine Technology Limited
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FCC ID: YYG-4300016 IC: 9384A-4300016

COMMERCIAL-IN-CONFIDENCE

Document 75947453-02 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	RF Team Leader	Authorised Signatory	09 December 2019

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 ISEDC RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Daniel Bishop	09 December 2019	
Testing	Graeme Lawler	09 December 2019	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISEDC 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: 2018, FCC 47 CFR Part 2: 2018, Industry Canada RSS-182: Issue 5 (2012-01) and ISEDC RSS-GEN: Issue 5 and A1 (2019-03) for the tests detailed in section 1.3.

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ACCREDITATION

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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	First Issue	09 December 2019

Table 1

1.2 Introduction

Applicant	SRT Marine Technology Limited
Manufacturer	SRT Marine Technology Limited
Model Number(s)	B954
Serial Number(s)	001
Hardware Version(s)	9
Software Version(s)	150200.01.11.00
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 80: 2018 FCC 47 CFR Part 2: 2018 Industry Canada RSS-182: Issue 5 (2012-01) ISEDC RSS-GEN: Issue 5 and A1 (2019-03)
Order Number Date	7923 06-November-2019
Date of Receipt of EUT	18-November-2019
Start of Test	18-November-2019
Finish of Test	01-December-2019
Name of Engineer(s)	Daniel Bishop and Graeme Lawler
Related Document(s)	ANSI C63.26: 2015 KDB 971168 D01 V03r01

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 ISEDC 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 - 12 V DC - AIS Transmitter (Tx1)							
2.1	80.205	2.1049	-	6.7	Bandwidths	Pass	
2.2	80.209	2.1055	7.4	6.11	Transmitter Frequency Tolerances	Pass	
2.3	80.211	2.1051	7.9	6.13	Spurious Emissions at Antenna Terminals	Pass	
2.4	80.213	2.1047	7.7	-	Modulation Requirements	Pass	
2.5	80.215	2.1046	7.5	6.12	Transmitter Power	Pass	
2.7	80.211	2.1051	7.9	6.13	Radiated Spurious Emissions	Pass	
Configuration and Mode: DC Powered - 12 V DC - AIS Transmitter (Tx2)							
2.1	80.205	2.1049	-	6.7	Bandwidths	Pass	
2.2	80.209	2.1055	7.4	6.11	Transmitter Frequency Tolerances	Pass	
2.3	80.211	2.1051	7.9	6.13	Spurious Emissions at Antenna Terminals	Pass	
2.4	80.213	2.1047	7.7	-	Modulation Requirements	Pass	
2.5	80.215	2.1046	7.5	6.12	Transmitter Power	Pass	
2.7	80.211	2.1051	7.9	6.13	Radiated Spurious Emissions	Pass	
Configuration and Mode: DC Powered - 12 V DC - AIS Receiver Operating							
2.6	80.217(b)	-	-	-	Suppression of Interference Aboard Ships	Pass	

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	Class B SOTDMA AIS Transceiver with Splitter, WI-FI and Bluetooth
Manufacturer:	SRT Marine Systems plc
Model:	B954
Part Number:	430-0016
Hardware Version:	9
Software Version:	150200.01.11.00
FCC ID (if applicable)	YYG-4300016
IC ID (if applicable)	9384A-4300016

Intentional Radiators

Technology	AIS	WIFI / Bluetooth	WIFI			
Frequency Band (MHz)	156 - 162	2400 - 2500	5180 - 5825			
Conducted Declared Output Power (dBm)	37	15	15			
Antenna Gain (dBi)	3	0.5	0.5			
Supported Bandwidth(s) (MHz)	0.015	20	20			
Modulation Scheme(s)	GMSK	CCK/DSSS	OFDM			
ITU Emission Designator	25K0G1B	12M2GXW	17M9GXW			
Bottom Frequency (MHz)	156.025	2400	5180			
Middle Frequency (MHz)	159.025	2450	5502.5			
Top Frequency (MHz)	162.025	2500	5825			

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	191.28MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	19.2MHz
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 – 24	V
Extreme upper voltage:	31.2	V
Extreme lower voltage:	9.6	V
Max current:	6	A

Battery Power Source

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:	-15	°C
Maximum temperature:	+55	°C

Antenna Characteristics

Antenna connector ☒			State impedance	50	Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☐	Type:		Gain		dBi
External antenna ☒	Type:	Marine VHF Vertical	Gain	3dBi	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:		Part Number:	
Model:		Country of Origin:	

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

Name: Abdul Mohammed
Position held: Compliance Engineer
Date: 05/12/2019

1.5 Product Information

1.5.1 Technical Description

The EUT is a Class B SOTDMA AIS transmitter with splitter, WiFi and Bluetooth.

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: B954: Serial Number: 001			
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 - 12 V DC - AIS Transmitter (Tx1)		
Bandwidths	Daniel Bishop	UKAS
Transmitter Frequency Tolerances	Daniel Bishop	UKAS
Spurious Emissions at Antenna Terminals	Daniel Bishop	UKAS
Modulation Requirements	Daniel Bishop	UKAS
Transmitter Power	Daniel Bishop	UKAS
Radiated Spurious Emissions	Graeme Lawler	UKAS
Configuration and Mode: DC Powered - 12 V DC - AIS Transmitter (Tx2)		
Bandwidths	Daniel Bishop	UKAS
Transmitter Frequency Tolerances	Daniel Bishop	UKAS
Spurious Emissions at Antenna Terminals	Daniel Bishop	UKAS
Modulation Requirements	Daniel Bishop	UKAS
Transmitter Power	Daniel Bishop	UKAS
Radiated Spurious Emissions	Graeme Lawler	UKAS
Configuration and Mode: DC Powered - 12 V DC - AIS Receiver Operating		
Suppression of Interference Aboard Ships	Daniel Bishop	UKAS

Table 4

Office Address:

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

2 Test Details

2.1 Bandwidths

2.1.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.205
FCC 47 CFR Part 2, Clause 2.1049
ISEDC RSS-GEN, Clause 6.7.

2.1.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.1.3 Date of Test

18-November-2019 to 19-November-2019

2.1.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.205, Part 2.1049, ISEDC RSS-GEN Clause 6.6 and KDB 971168.

The EUT was transmitting at maximum power, modulated by the standard AIS test signal using PRBS packet payloads. 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.

2.1.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	26.9 %

2.1.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

99% Occupied Bandwidth (kHz)	
156.025 MHz	162.025 MHz
9.459	9.549

Table 5 - Occupied Bandwidth Results

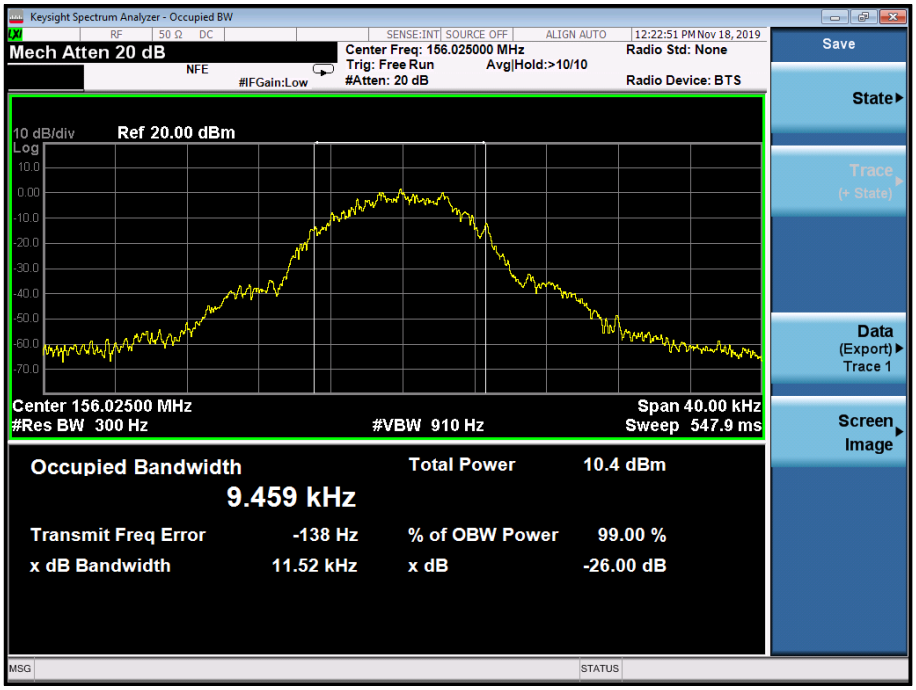

Figure 1 - 156.025 MHz Occupied Bandwidth

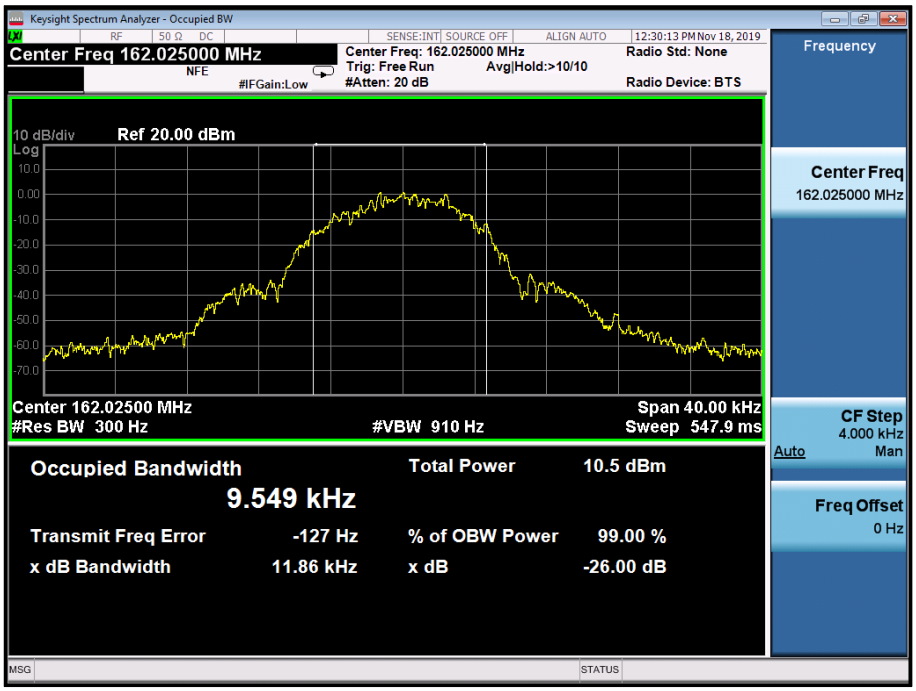

Figure 2 - 162.025 MHz Occupied Bandwidth

DC Powered - 12 V DC - AIS Transmitter (Tx2)

99% Occupied Bandwidth (kHz)	
156.025 MHz	162.025 MHz
9.493	9.778

Table 6 - Occupied Bandwidth Results

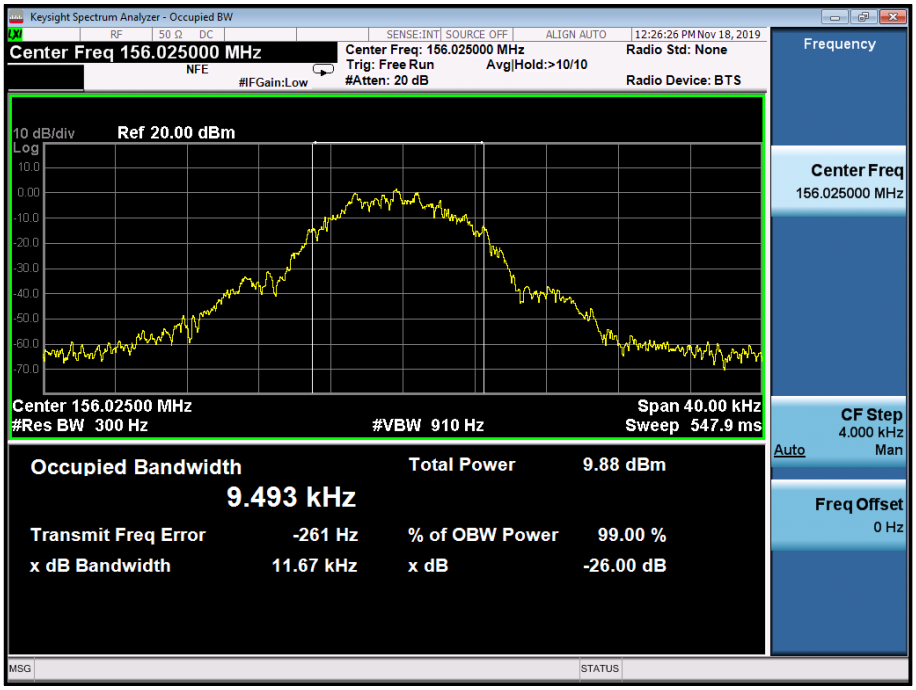

Figure 3 - 156.025 MHz Occupied Bandwidth

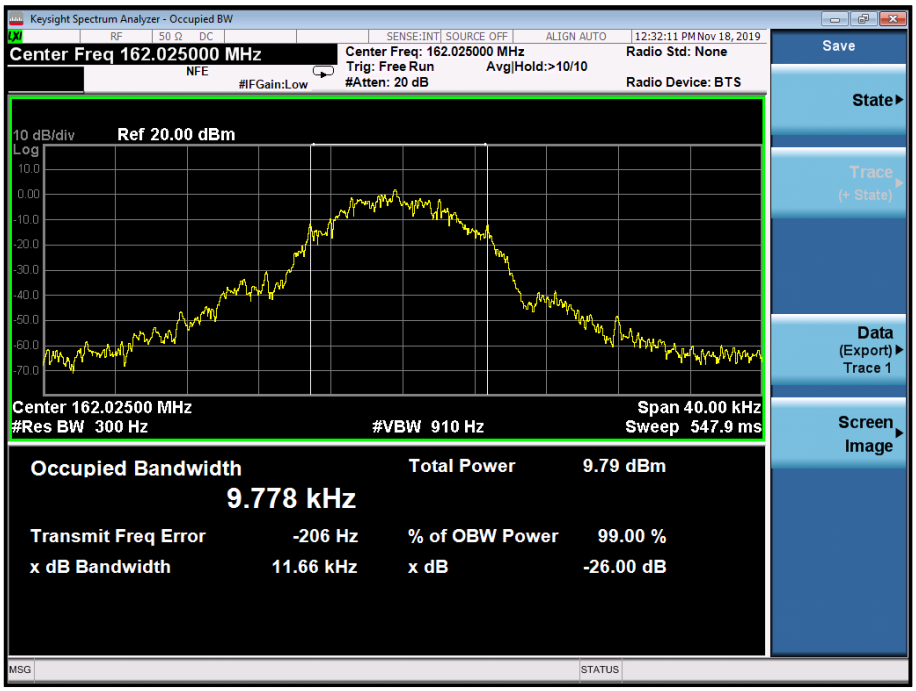

Figure 4 - 162.025 MHz Occupied Bandwidth

FCC 47 CFR Part 80, Limit Clause 80.205

< 0.020 kHz

ISEDC RSS-GEN, Limit Clause

None Specified.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
4 Channel PSU	Rohde & Schwarz	HMP4040	4736	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 7

O/P Mon – Output Monitored using calibrated equipment

2.2 Transmitter Frequency Tolerances

2.2.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.209
FCC 47 CFR Part 2, Clause 2.1055
Industry Canada RSS-182, Clause 7.4
ISEDC RSS-GEN, Clause 6.11

2.2.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.2.3 Date of Test

19-November-2019

2.2.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.209 (a) and FCC CFR 47 Part 2.1055 (a) (2), (d) (1).

The EUT was set to transmit on maximum power with an unmodulated carrier on bottom and top channels. The EUT was connected to a spectrum analyser and a single marker was used to determine the frequency. The difference between the frequency of the fundamental and the frequency of the assigned channel in accordance with the manufacture's documentation was recorded. In accordance with 2.1055, the temperature was varied from -20°C to +50° in 10° steps at both minimum and maximum voltage extremes.

2.2.5 Environmental Conditions

Ambient Temperature	22.5 °C
Relative Humidity	27.4 %

2.2.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

Voltage	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
10.2 V DC	0.7717	1.4696
27.6 V DC	0.8992	1.5992

Table 8 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
+50.0 °C	0.793	0.004
+40.0 °C	1.528	1.316
+30.0 °C	1.286	1.397
+20.0 °C	0.779	1.416
+10.0 °C	0.349	0.403
0 °C	0.104	0.152
-10.0 °C	0.734	0.309
-20.0 °C	1.543	1.318

Table 9 - Frequency Stability Under Temperature Variations

DC Powered - 12 V DC - AIS Transmitter (Tx2)

Voltage	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
10.2 V DC	0.084	0.633
27.6 V DC	0.545	1.026

Table 10 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
+50.0 °C	1.493	1.740
+40.0 °C	0.937	1.088
+30.0 °C	0.348	0.505
+20.0 °C	0.051	0.225
+10.0 °C	1.106	0.484
0 °C	1.610	0.150
-10.0 °C	2.251	1.997
-20.0 °C	2.964	2.715

Table 11 - Frequency Stability Under Temperature Variations

FCC 47 CFR Part 80, Limit Clause 80.209 and ISEDC RSS-182, Limit Clause 7.4

± 10 ppm.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Digital Temperature Indicator	Fluke	51	2267	12	02-Oct-2020
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
Climatic Chamber	TAS	Micro 225	2892	-	O/P Mon
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 12

O/P Mon – Output Monitored using calibrated equipment

2.3 Spurious Emissions at Antenna Terminals

2.3.1 Specification Reference

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

2.3.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.3.3 Date of Test

18-November-2019

2.3.4 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 in to the spectrum analyser as a reference level offset. The reference level for the mask was established with an RBW approximately 2 or 3 times the emission bandwidth. The RBW was then reduced to at least 1% of the emission bandwidth, with a VBW of 3 times RBW. The mask as per FCC CFR 47 Part 80.211 (f) was applied.

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

Conducted: A network analyser was used to measure the path loss and the worst case was entered as a reference level offset in to the spectrum analyser. The EUT was connected to a spectrum analyser via an attenuator, filter and cable. Between 9 kHz and 300 MHz a notch filter was used tuned to the frequency of the fundamental. Between 300 MHz and 2 GHz a 300 MHz high pass filter was used.

The spectrum analyser was configured with an RBW as follows:

- 9 kHz to 150 kHz: 1 kHz
- 150 kHz to 30 MHz: 10 kHz
- 30 MHz to 1 GHz: 100 kHz
- 1 GHz to 2 GHz: 1 MHz

Where the RBW above is less than 30 kHz, it was ensured that there was at least 10*LOG(30/RBW) of margin between the trace and limit line as RSS-182 requires a measurement bandwidth of 30 kHz. The trace set to max hold using a peak detector.

Radiated measurements are recorded in section 2.7 of the present document.

2.3.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	26.9 %

2.3.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

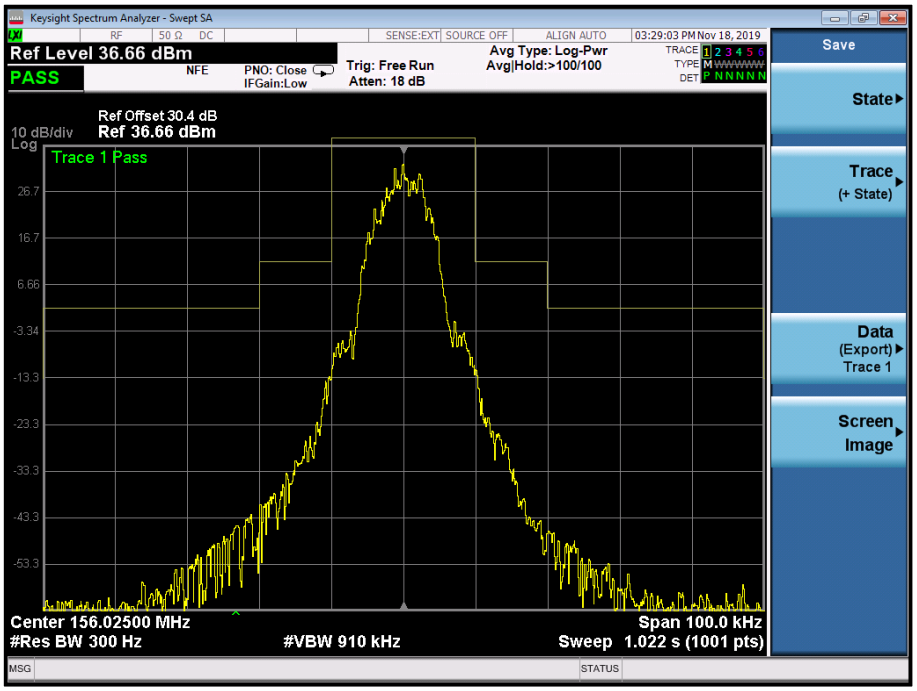

Figure 5 - 156.025 MHz - Transmitter Spectrum Mask

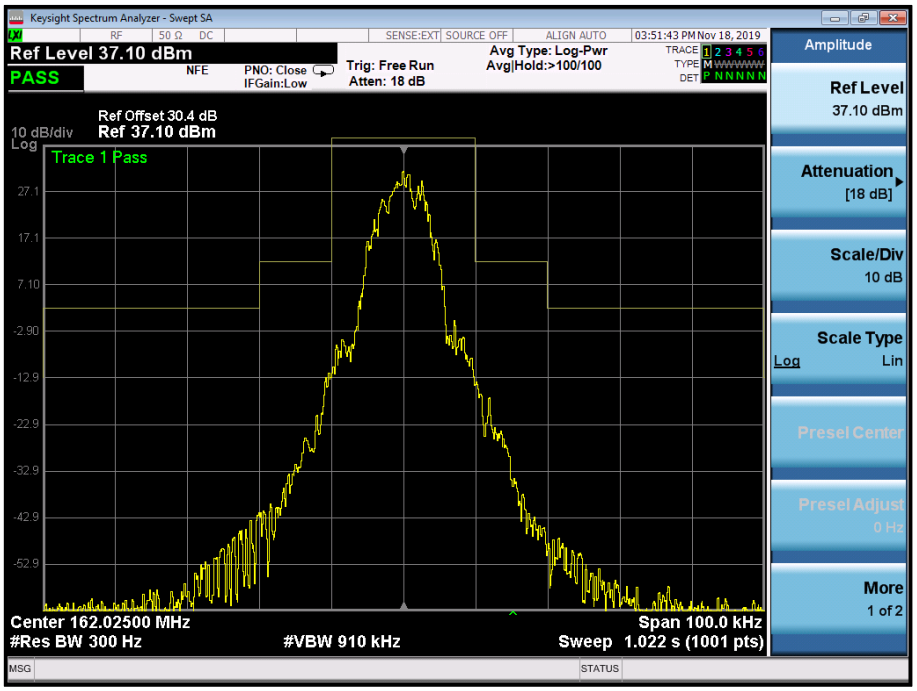

Figure 6 - 162.025 MHz - Transmitter Spectrum Mask

DC Powered - 12 V DC - AIS Transmitter (Tx2)

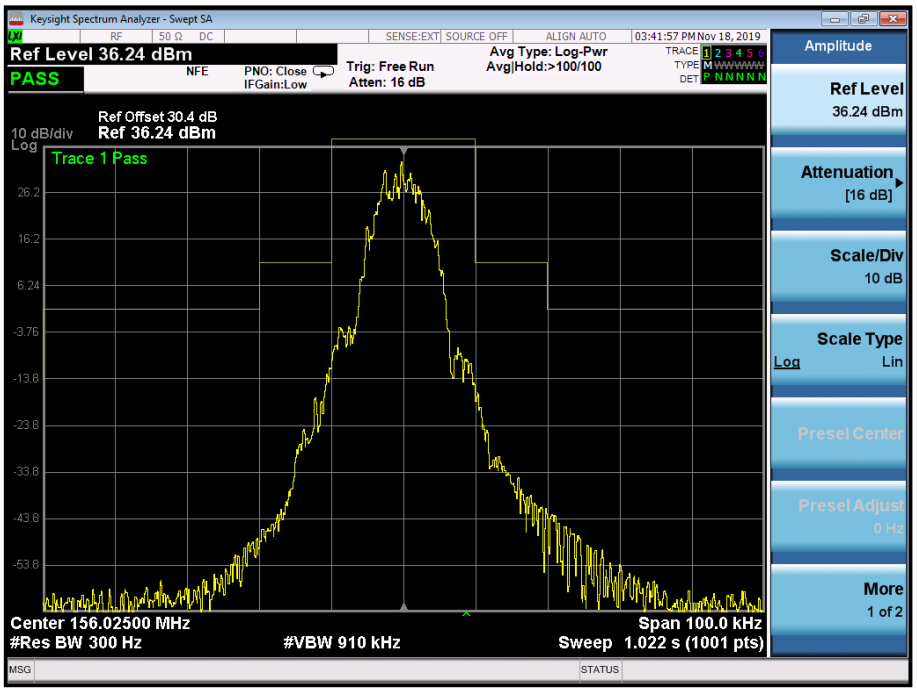

Figure 7 - 156.025 MHz - Transmitter Spectrum Mask

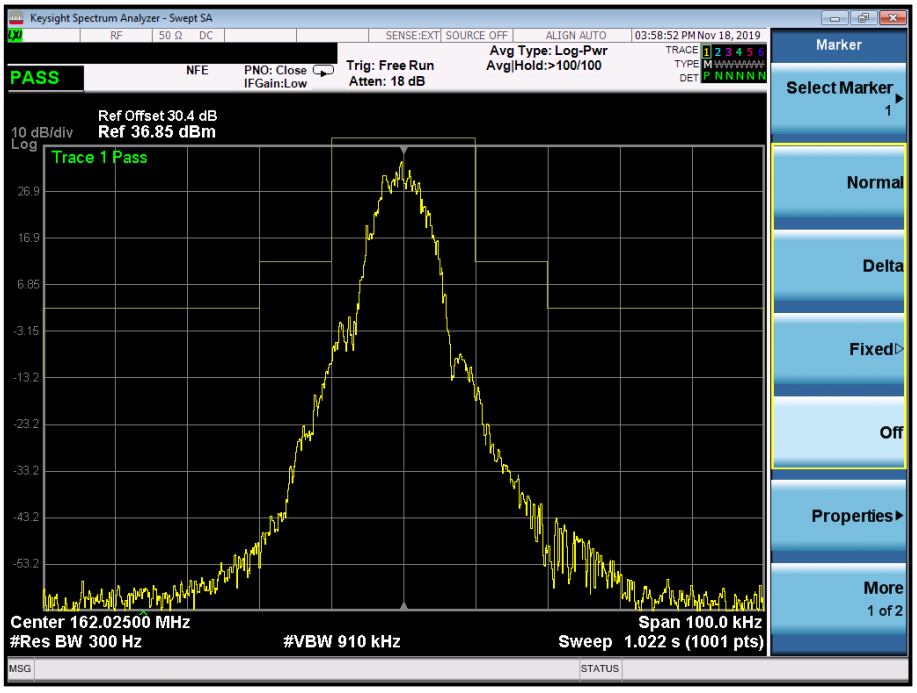

Figure 8 - 162.025 MHz - Transmitter Spectrum Mask

DC Powered - 12 V DC - AIS Transmitter (Tx1 and Tx2 – Operating in-turn)

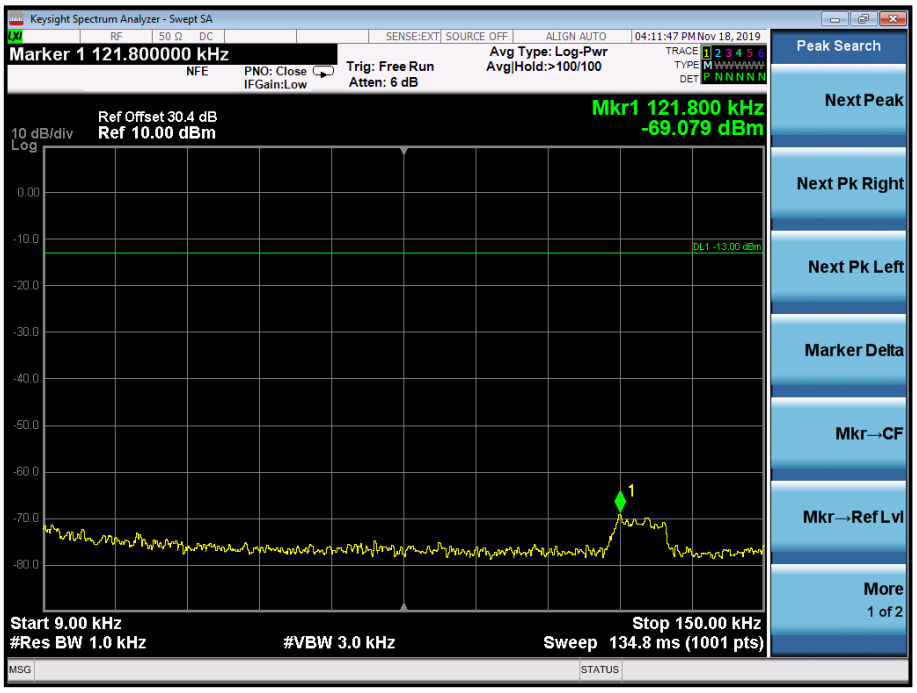

Figure 9 - 156.025 MHz - 9 kHz to 150 kHz

Figure 10 - 162.025 MHz - 9 kHz to 150 kHz

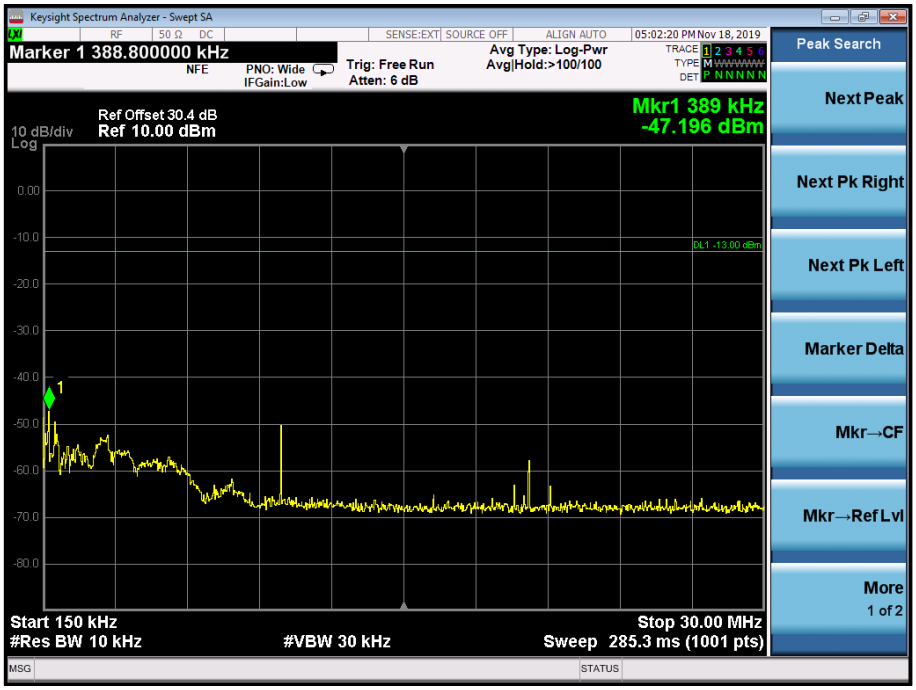

Figure 11 - 156.025 MHz - 150 kHz to 30 MHz

Figure 12 - 162.025 MHz - 150 kHz to 30 MHz

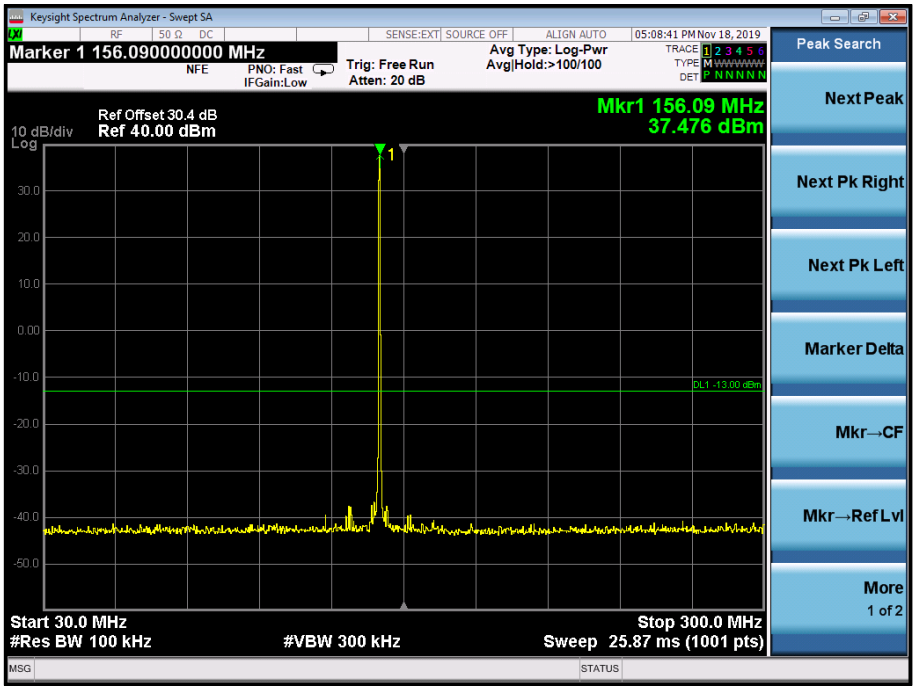

Figure 13 - 156.025 MHz - 30 MHz to 300 MHz

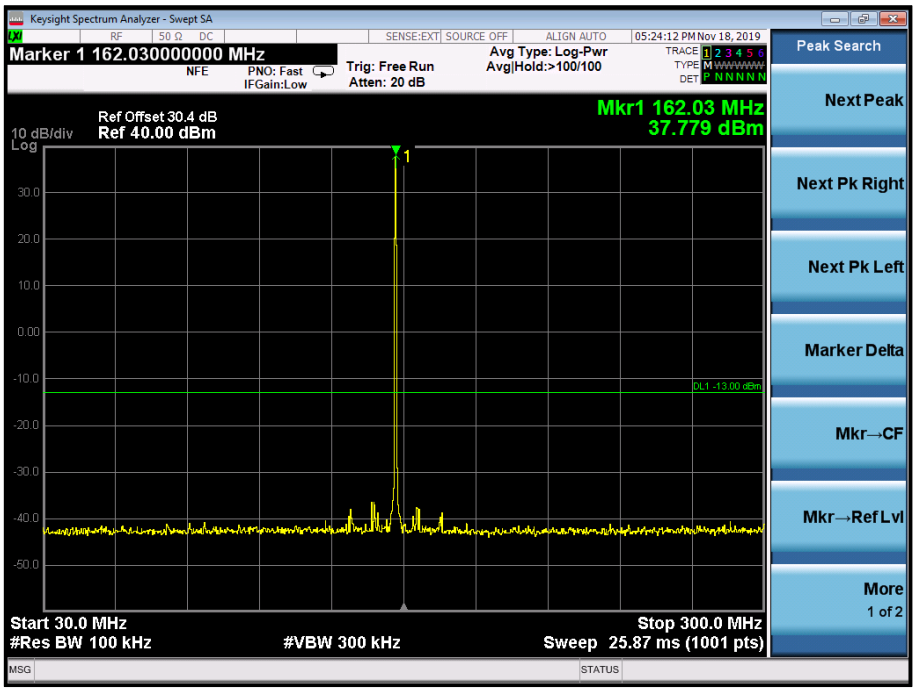

Figure 14 - 162.025 MHz - 30 MHz to 300 MHz

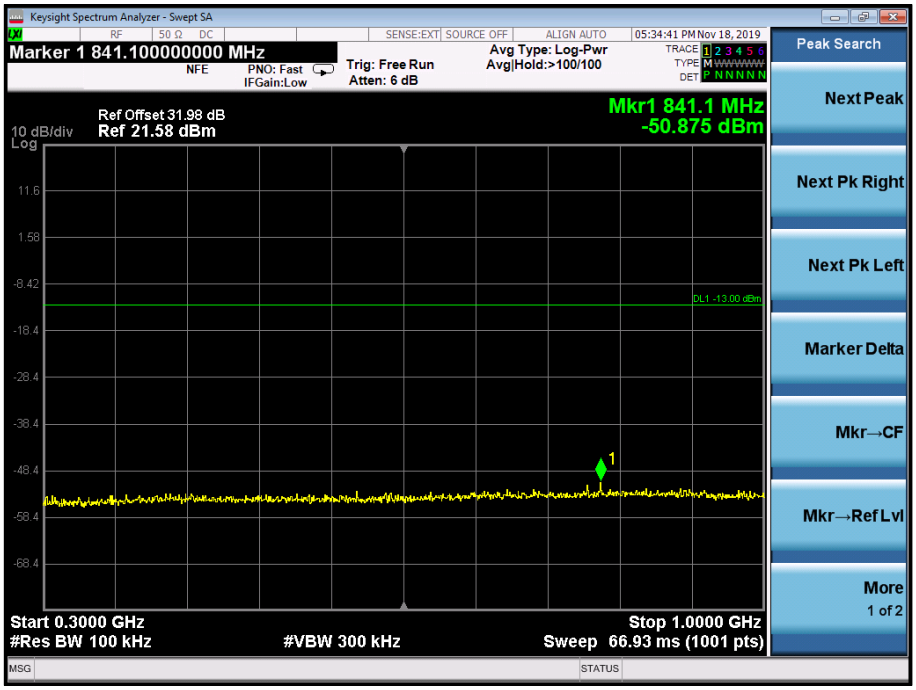

Figure 15 - 156.025 MHz - 300 MHz to 1 GHz

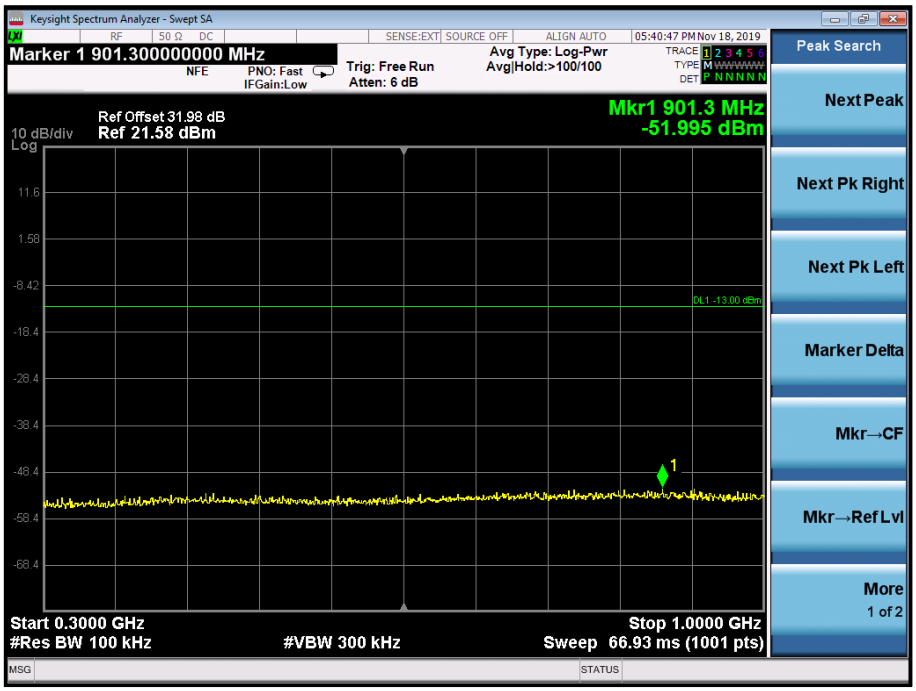

Figure 16 - 162.025 MHz - 300 MHz to 1 GHz

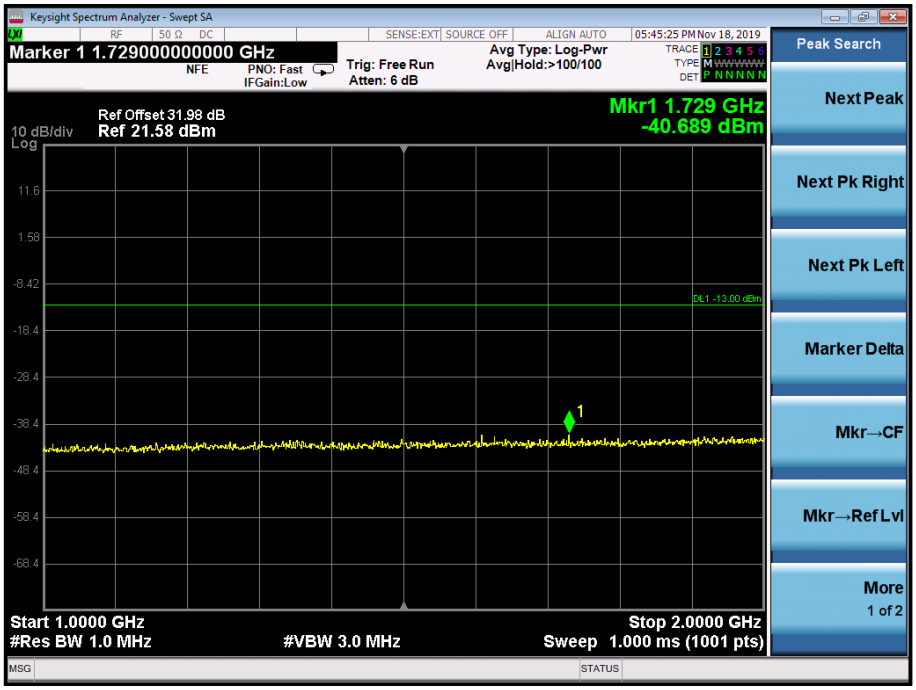

Figure 17 - 156.025 MHz - 1 GHz to 2 GHz

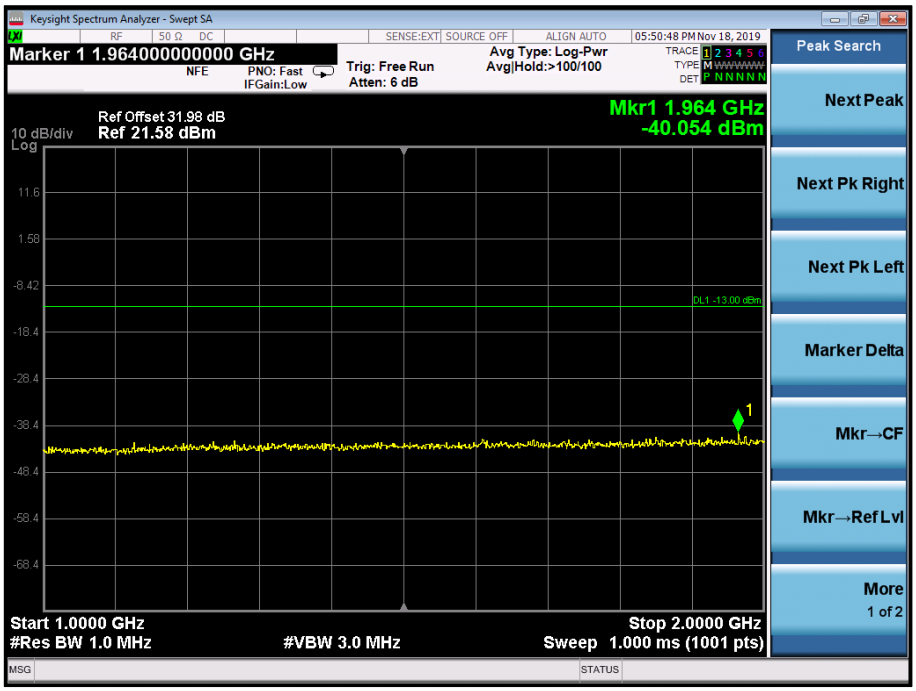

Figure 18 - 162.025 MHz - 1 GHz to 2 GHz

FCC 47 CFR Part 80, Limit Clause 80.211

Within 250% of the Authorised Bandwidth:

On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB

More than 250% of the Authorised Bandwidth:

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

Industry Canada RSS-182, Limit Clause 7.9.1

On any frequency removed from the carrier frequency by more than 50%, but not more than 100% of the authorized bandwidth: at least 25 dB, measured with a bandwidth of 300 Hz.

On any frequency removed from the carrier frequency by more than 100%, but not more than 250% of the authorized bandwidth: at least 35 dB, measured with a bandwidth of 300 Hz.

On any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth: at least 43 + 10 log10 p(watts) dB, measured with a bandwidth of 30 kHz.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
High Pass Filter	Mini-Circuits	NHP-300	1640	-	O/P Mon
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 13

O/P Mon – Output Monitored using Calibrated Equipment

2.4 Modulation Requirements

2.4.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.213
FCC 47 CFR Part 2, Clause 2.1047
Industry Canada RSS-182 Clause 7.7.

2.4.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.4.3 Date of Test

18-November-2019

2.4.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.213 (d).

The EUT was transmitting at maximum power, modulated by the standard AIS test signals using either PRS, 01010101 or 00001111 packet payloads. The EUT was connected to a spectrum analyser via a cable and attenuator, using the FM demodulation function of the spectrum analyser, the peak frequency deviation was observed and shown in the plots on the following pages.

2.4.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	26.9 %

2.4.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

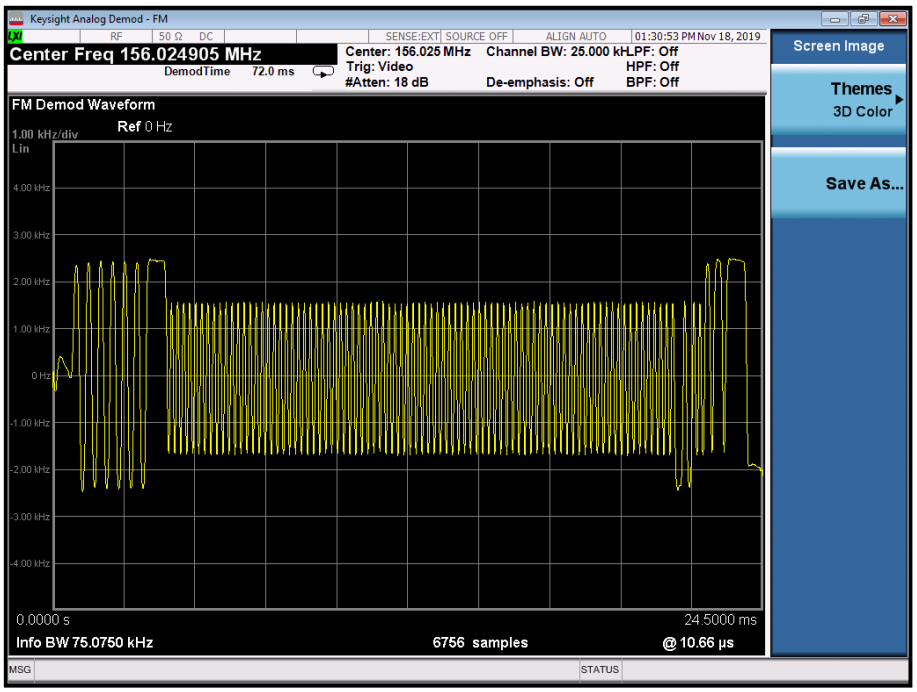

Figure 19 - 156.025 MHz - 01010101

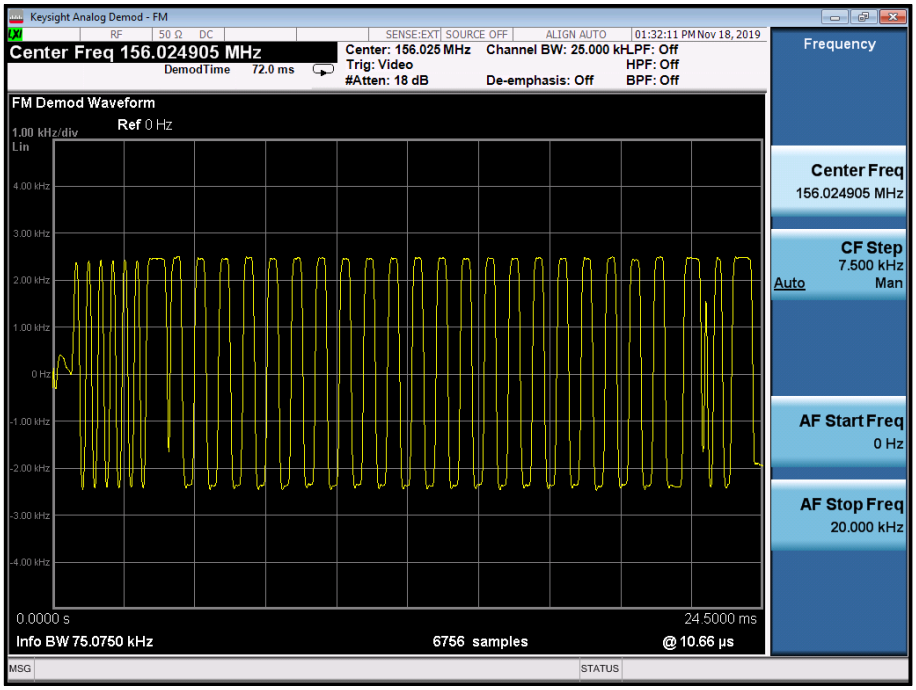

Figure 20- 156.025 MHz - 00001111

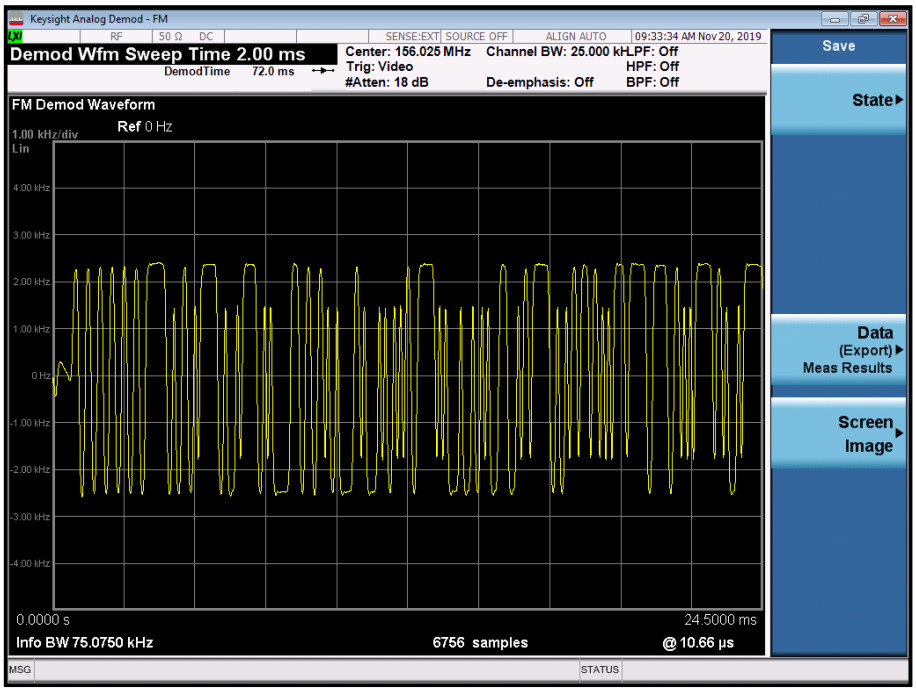

Figure 21- 156.025 MHz - PRBS

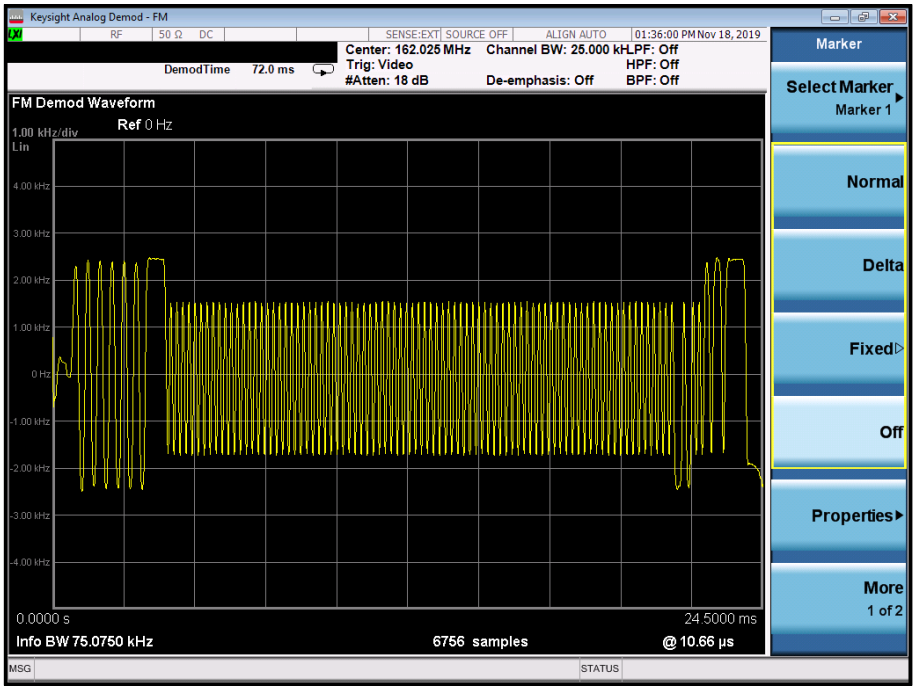

Figure 22 - 162.025 MHz - 01010101

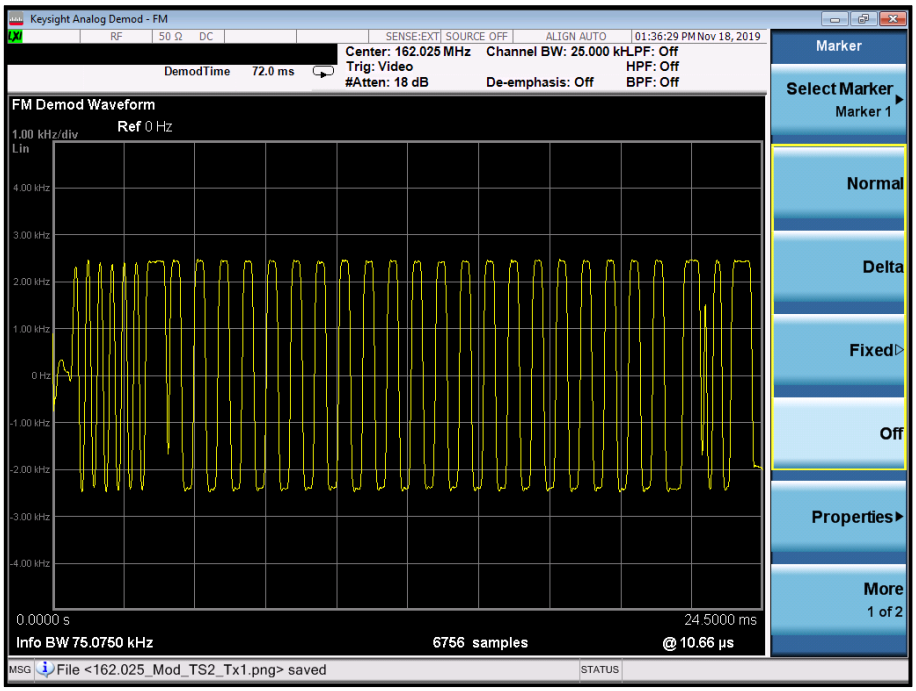

Figure 23- 162.025 MHz - 00001111

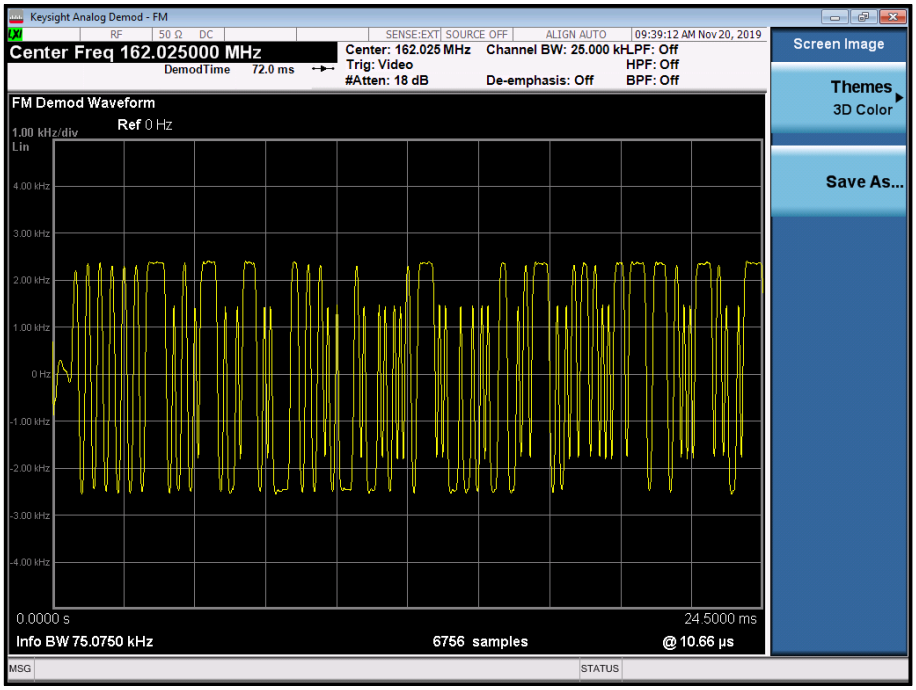

Figure 24- 162.025 MHz - PRBS

DC Powered - 12 V DC - AIS Transmitter (Tx2)

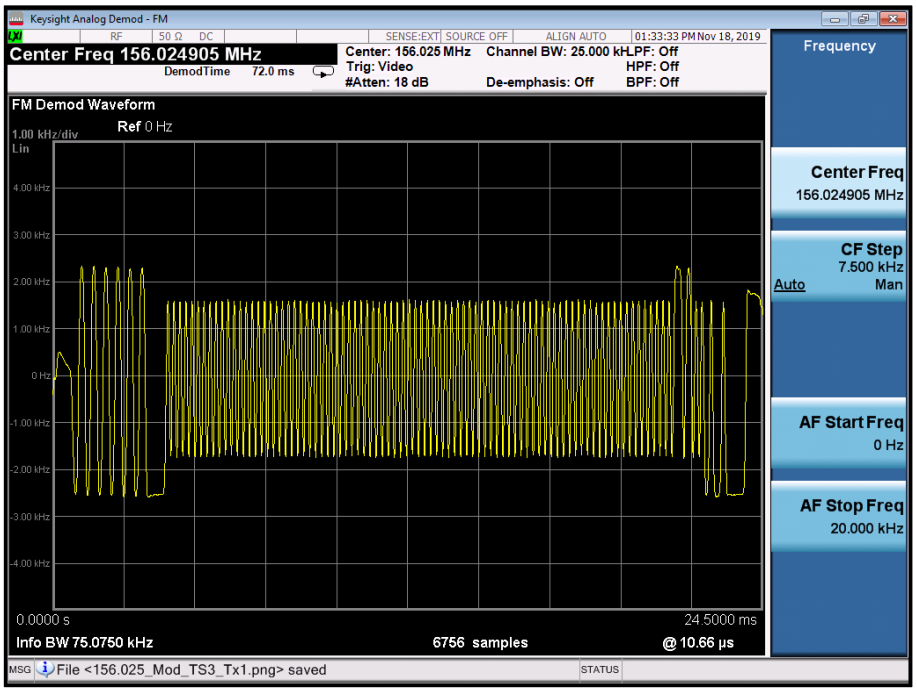

Figure 25 - 156.025 MHz - 01010101

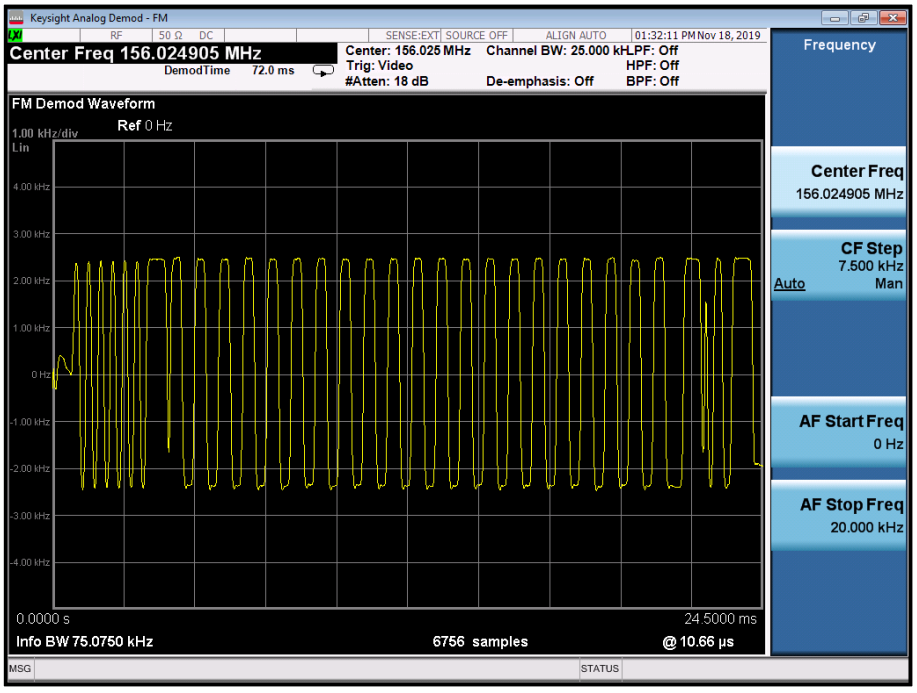

Figure 26- 156.025 MHz - 00001111

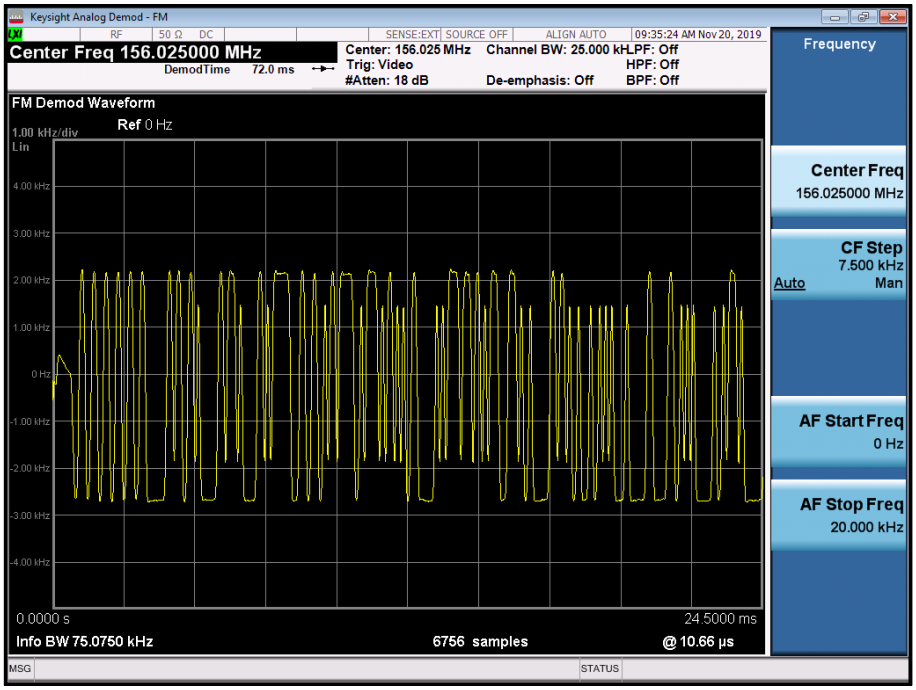

Figure 27- 156.025 MHz - PRBS

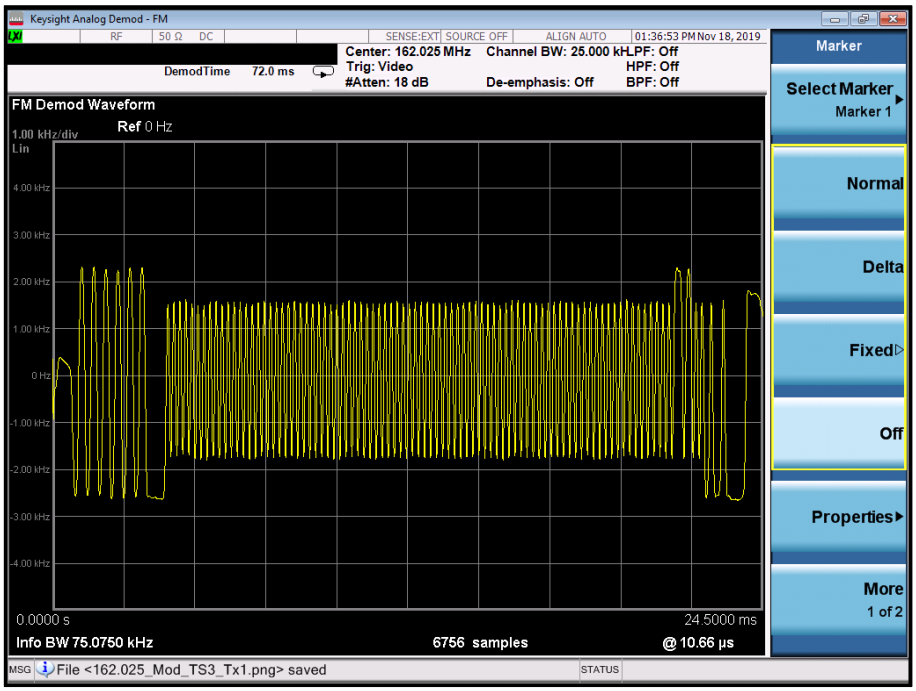

Figure 28 - 162.025 MHz - 01010101

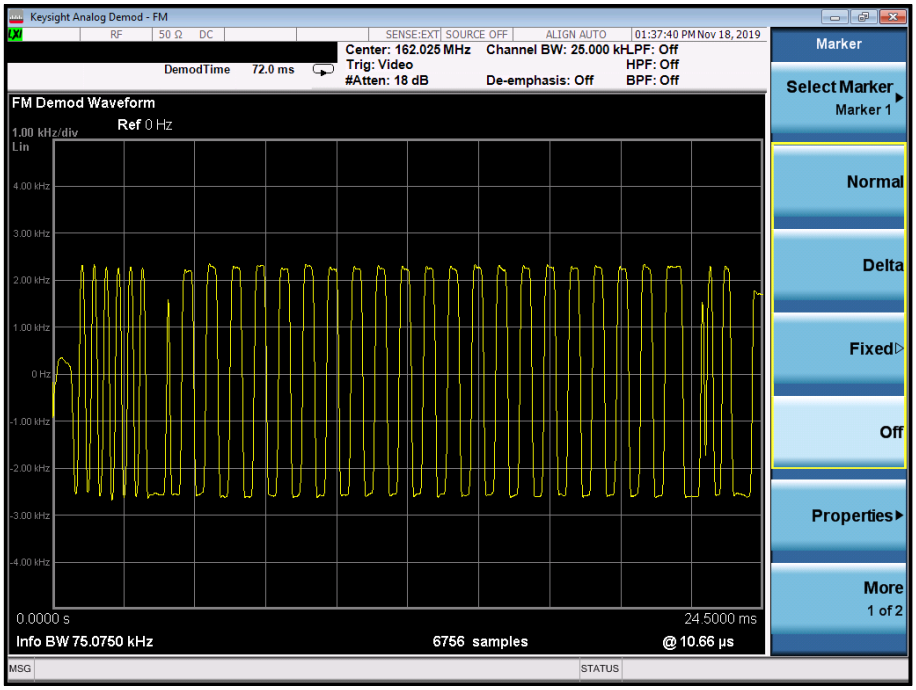

Figure 29- 162.025 MHz - 00001111

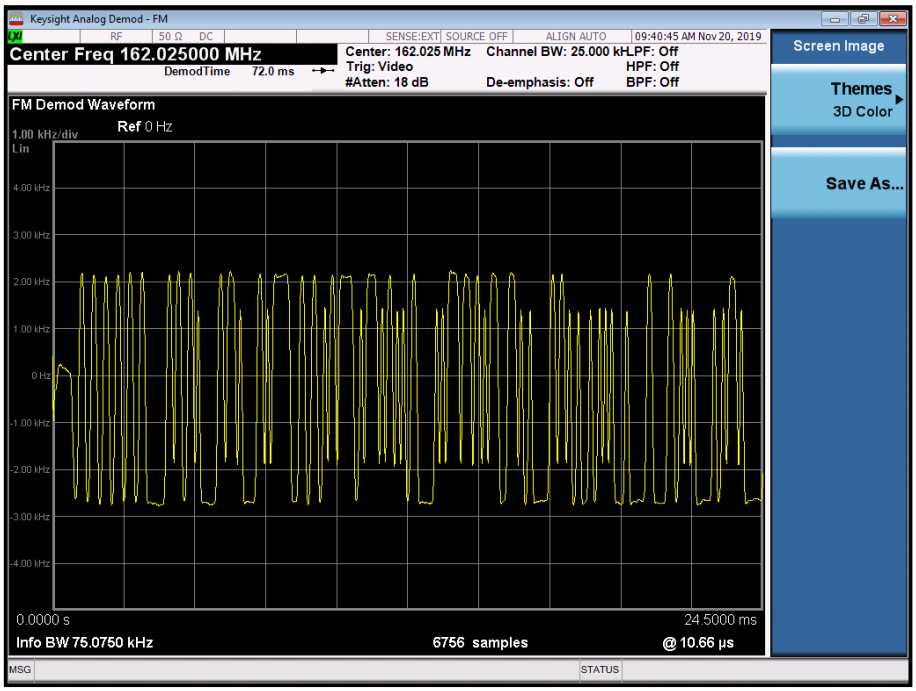

Figure 30- 162.025 MHz - PRBS

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.

Industry Canada RSS-182, Limit Clause 7.7

The VHF AIS equipment shall comply with the following characteristics.

Transmitter frequency:	161.975 MHz (channel 87B) 162.025 MHz (channel 88B)
Channel spacing:	25 kHz or 12.5 kHz
Modulation scheme:	GMSK/FM
Modulation index:	0.5 max. for 25 kHz channel spacing 0.25 max. for 12.5 kHz channel spacing
Transmission rate:	9600 bps

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
4 Channel PSU	Rohde & Schwarz	HMP4040	4736	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 14

O/P Mon – Output Monitored using calibrated equipment

2.5 Transmitter Power

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.5.3 Date of Test

18-November-2019

2.5.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.215 (e) and KDB 971168.

The EUT was set to transmit on maximum power in turn on either AIS channel. The EUT was modulated using the standard AIS test signal with PRBS packet payload. 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.

2.5.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	26.9 %

2.5.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

156.025 MHz		162.025 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)
36.66	4.63	37.10	5.13

Table 15 - Transmitter Power Results

DC Powered - 12 V DC - AIS Transmitter (Tx2)

156.025 MHz		162.025 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)
36.24	4.21	36.855	4.85

Table 16 - Transmitter Power Results

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

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

Industry Canada RSS-182, Limit Clause 7.5

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 17

AIS VHF Transponder Class B shall comply with IEC 62287-2.

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
4 Channel PSU	Rohde & Schwarz	HMP4040	4736	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 18

O/P Mon – Output Monitored using calibrated equipment

2.6 Suppression of Interference Aboard Ships

2.6.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.217(b)

2.6.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.6.3 Date of Test

19-November-2019

2.6.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.217 (b) and KDB 971168.

A network analyser was used to measure the path loss and the worst case was entered as a reference level offset in to the spectrum analyser for each frequency range of interest. The EUT was connected to a spectrum analyser via a cable and attenuator. The EUT was configured in a receive only state. The spectrum analyser settings were configured with an RBW of 100 kHz below 1 GHz and 1 MHz for frequencies greater than 1 GHz using a VBW of 3 times the RBW. The trace set to max hold using a peak detector and the plots recorded as shown.

2.6.5 Environmental Conditions

Ambient Temperature	22.5 °C
Relative Humidity	27.4 %

2.6.6 Test Results

DC Powered - 12 V DC AIS Receiver Operating

Frequency of Interfering Emissions	Maximum Power delivered to Artificial Antenna (dBm)	Maximum Power delivered to Artificial Antenna (µW)
(156.025 MHz) 9 kHz to 150 kHz	-47.11	0.019
(156.025 MHz) 150 kHz to 30 MHz	-46.38	0.023
(156.025 MHz) 30 MHz to 300 MHz	-82.19	0.000006
(156.025 MHz) 300 MHz to 2 GHz	-56.32	0.002
(162.025 MHz) 9 kHz to 150 kHz	-48.33	0.014
(162.025 MHz) 150 kHz to 30 MHz	-46.38	0.023
(162.025 MHz) 30 MHz to 300 MHz	-81.04	0.000008
(162.025 MHz) 300 MHz to 2 GHz	-57.85	0.002

Table 19 - Receive Mode Spurious Emissions Results

Figure 31 - (156.025 MHz) 9 kHz to 150 kHz

Figure 32 - (156.025 MHz) 150 kHz to 30 MHz

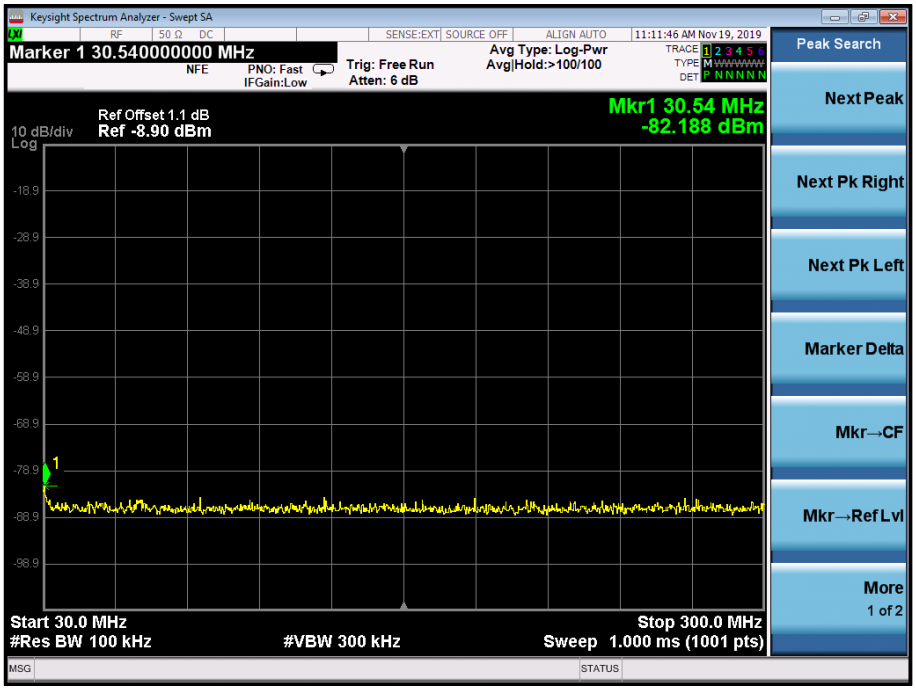

Figure 33 - (156.025 MHz) 30 MHz to 300 MHz

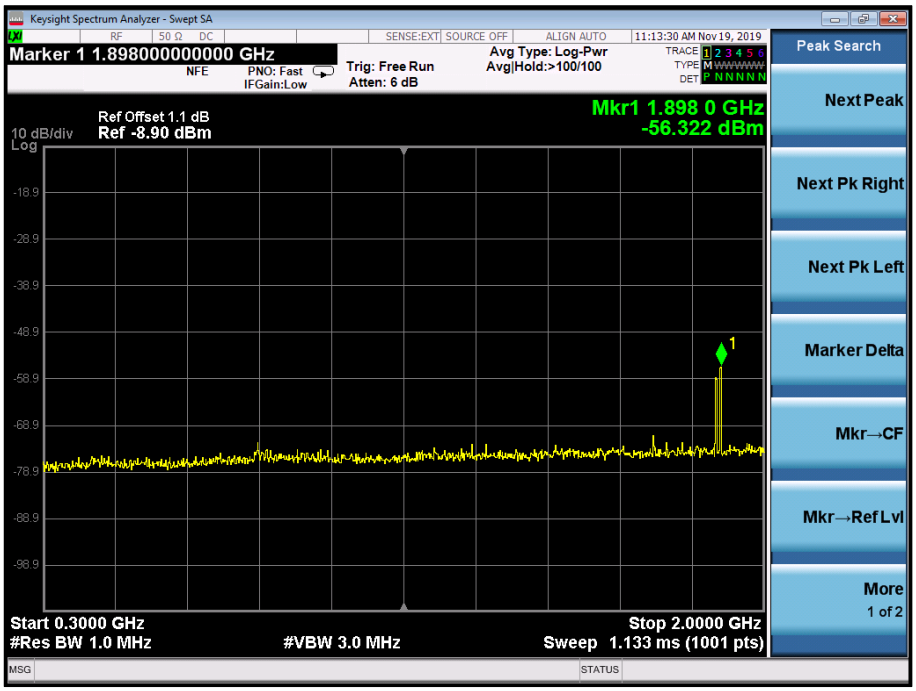

Figure 34 - (156.025 MHz) 300 MHz to 2 GHz

Figure 35 - (162.025 MHz) 9 kHz to 150 kHz

Figure 36 - (162.025 MHz) 150 kHz to 30 MHz

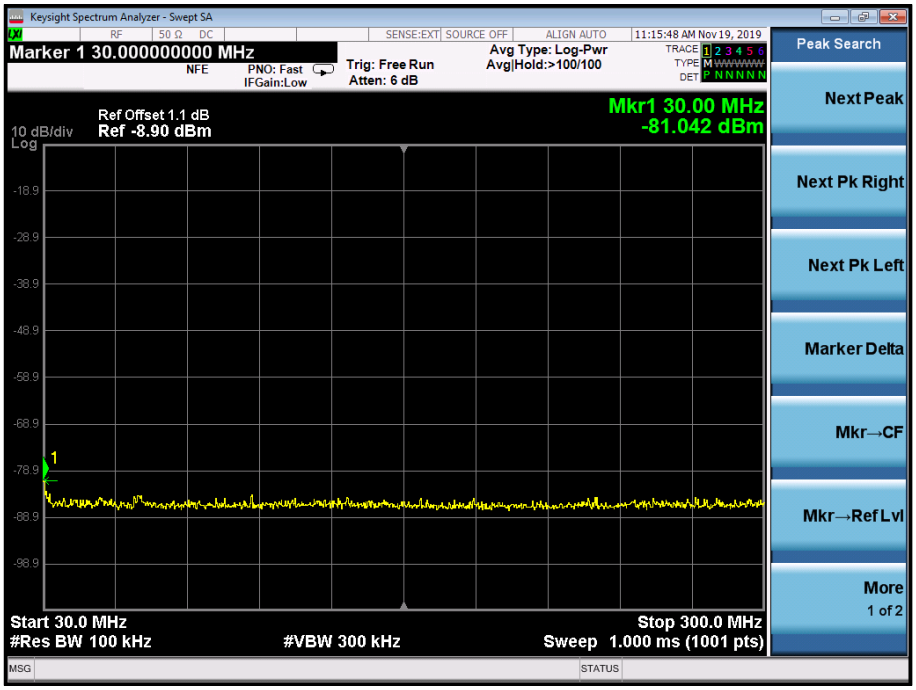

Figure 37 - (162.025 MHz) 30 MHz to 300 MHz

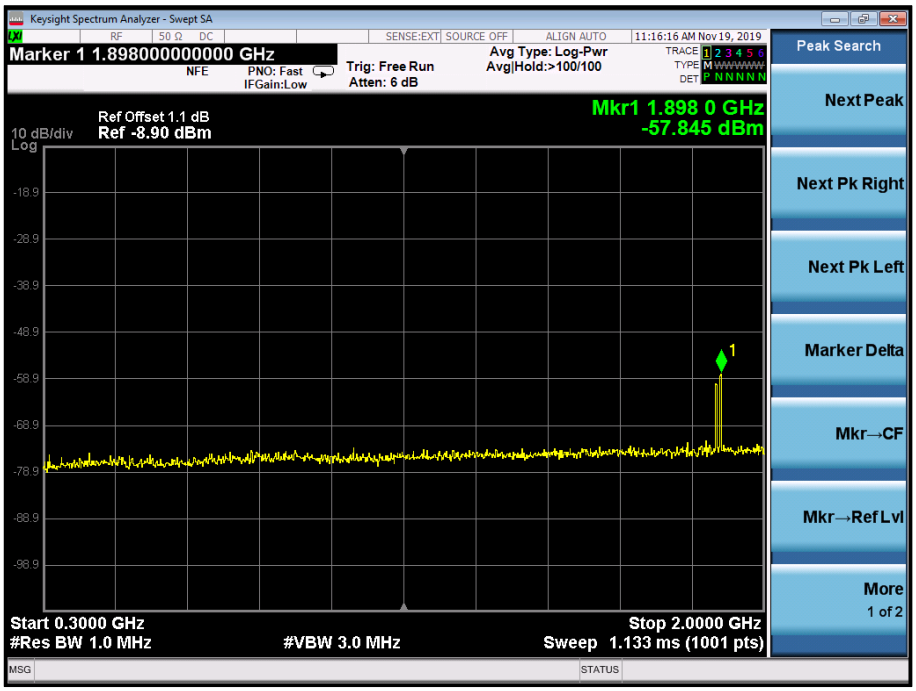

Figure 38 - (162.025 MHz) 300 MHz to 2 GHz

FCC 47 CFR Part 80, Limit Clause 80.217 (b)

The EUT shall deliver not more than the following amounts of power, to an artificial antenna having electrical characteristics equivalent to those of the average receiving antenna(s) use on shipboard:

Frequency of interfering emissions	Power to artificial antenna in µW
Below 30 MHz	400
30 to 100 MHz	4,000
100 to 300 MHz	40,000
Over 300 MHz	400,000

Table 20

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygrometer	Rotronic	I-1000	2891	12	02-Oct-2020
True RMS Multimeter	Fluke	179	4007	12	31-Oct-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4518	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 21

2.7 Radiated Spurious Emissions

2.7.1 Specification Reference

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

2.7.2 Equipment Under Test and Modification State

B954, S/N: 001 - Modification State 0

2.7.3 Date of Test

01-December-2019

2.7.4 Test Method

The EUT was set to transmit on maximum power with each channel tested separately.

Testing was performed in accordance with FCC Part 80, Clause 80.211. The Out of Band Emissions limit is -13 dBm.

Prescans and final measurements were performed using the direct field strength method. The limit line on the prescan plots was calculated from equation c) in clause 5.2.7 of ANSI C63.26.
Example Calculation:
E (dBuV/m) = EIRP (dBm) - 20log (d) + 104.8 where (d) is the far field measurement distance.
E (dBuV/m) = -13 - 20log (3) + 104.8
E (dBuV/m) = 82.26

2.7.5 Environmental Conditions

Ambient Temperature	18.9 °C
Relative Humidity	33.1 %

2.7.6 Test Results

DC Powered - 12 V DC - AIS Transmitter (Tx1)

Frequency (MHz)	Level (dBm)
*	

Table 22 - 156.025 MHz - Emissions Results

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

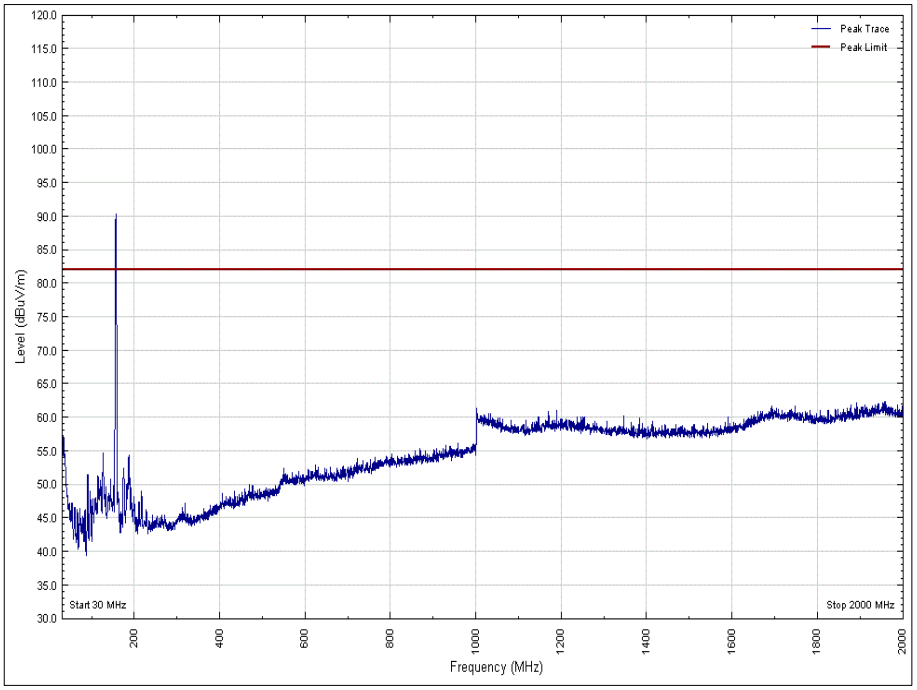

Figure 39 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

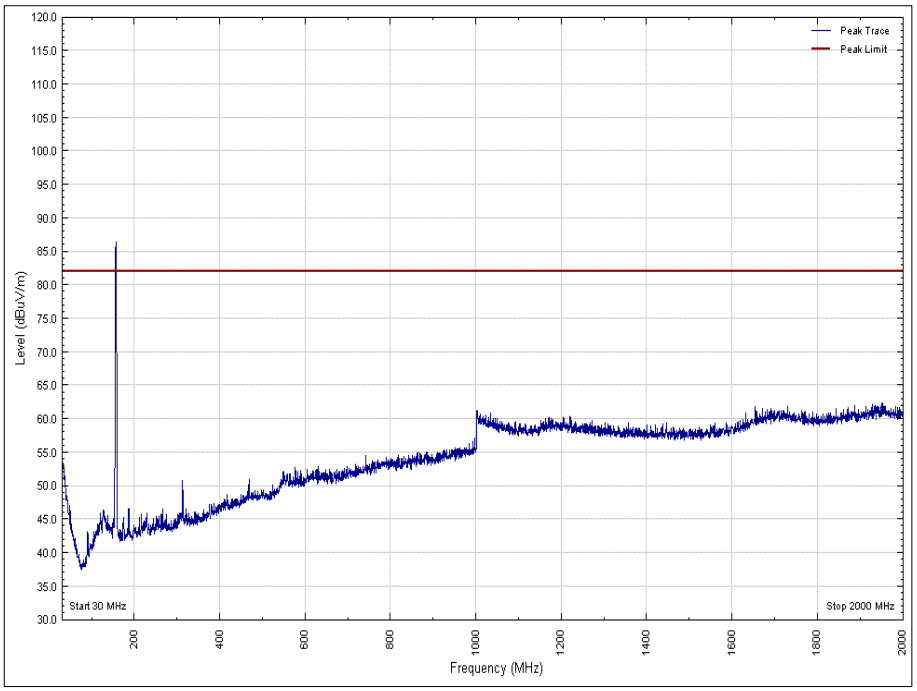

Figure 40 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

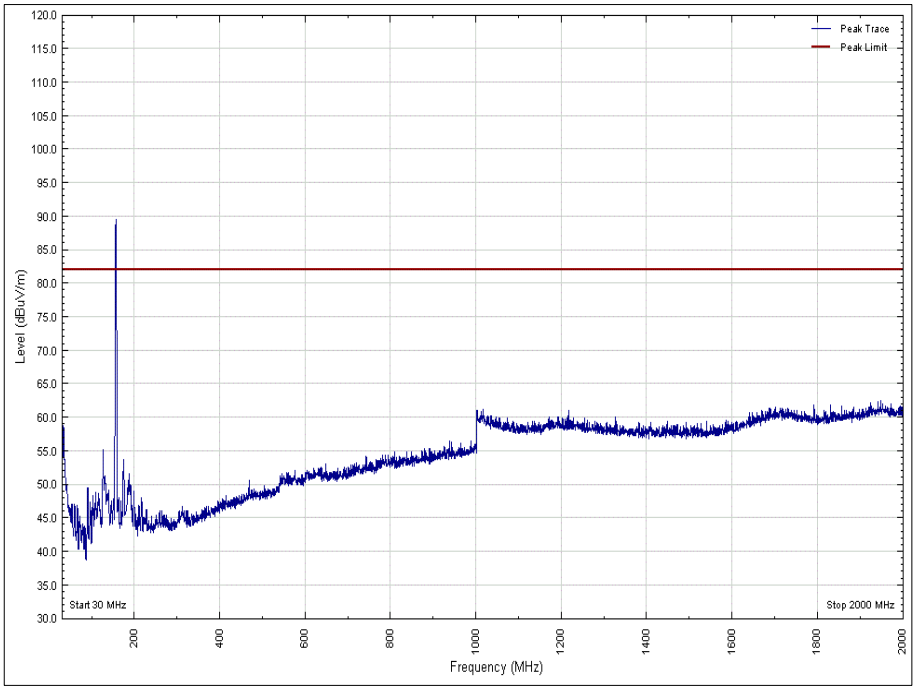

Figure 41 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

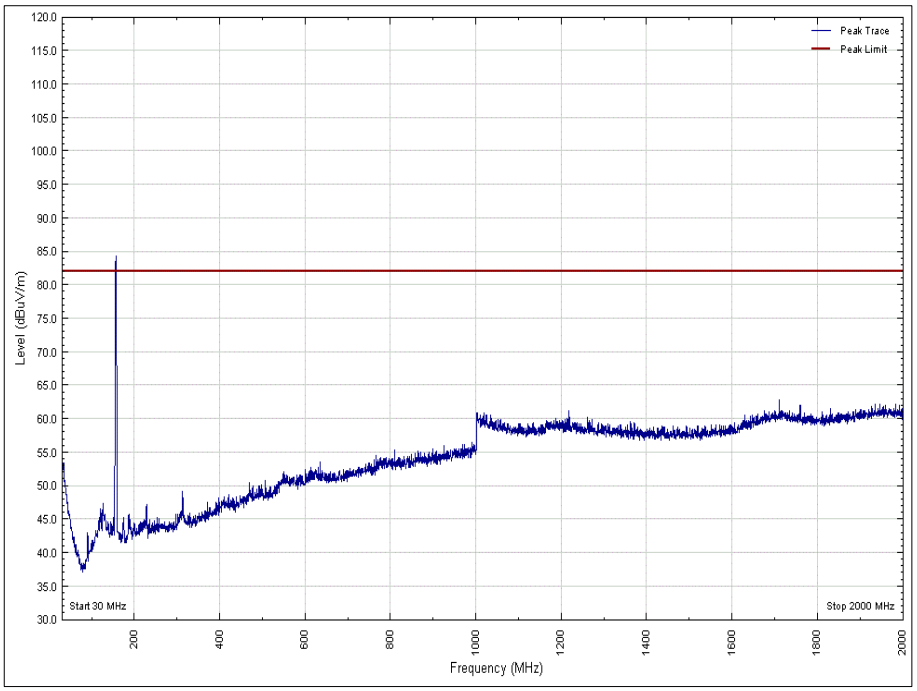

Figure 42 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

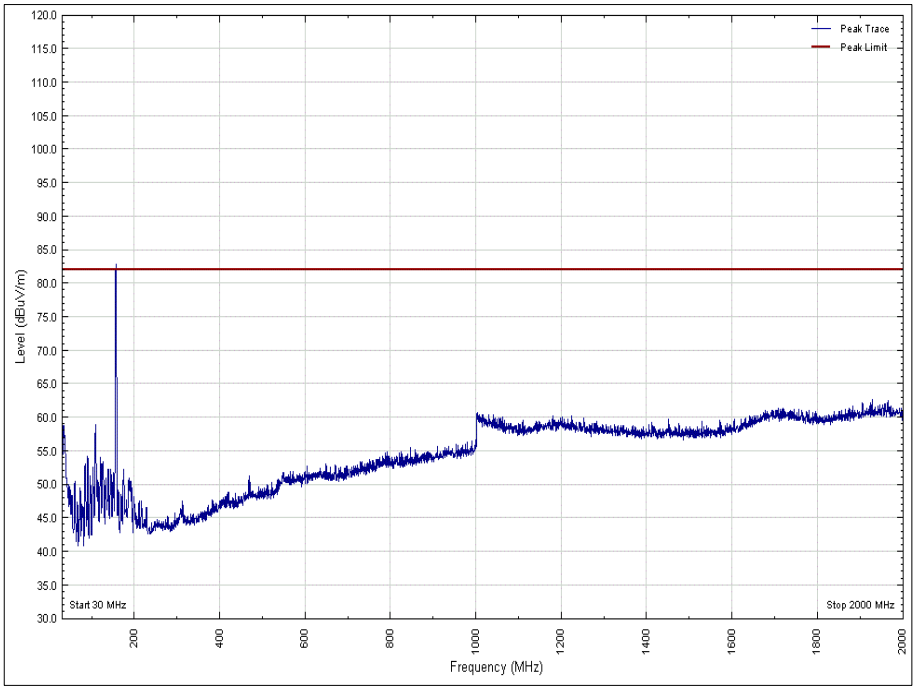

Figure 43 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

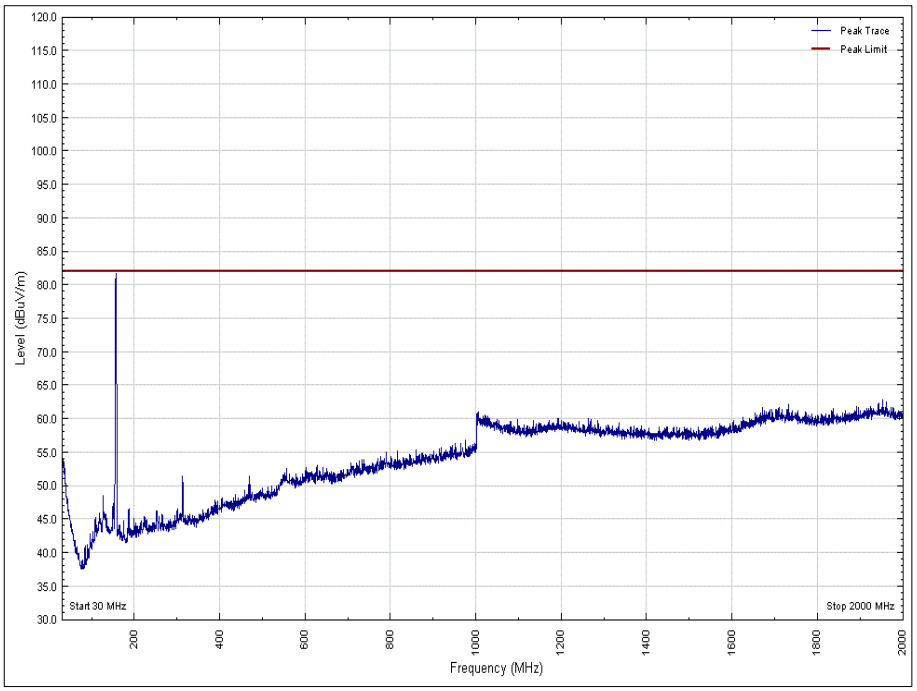

Figure 44 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 23 - 162.025 MHz - Emissions Results

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

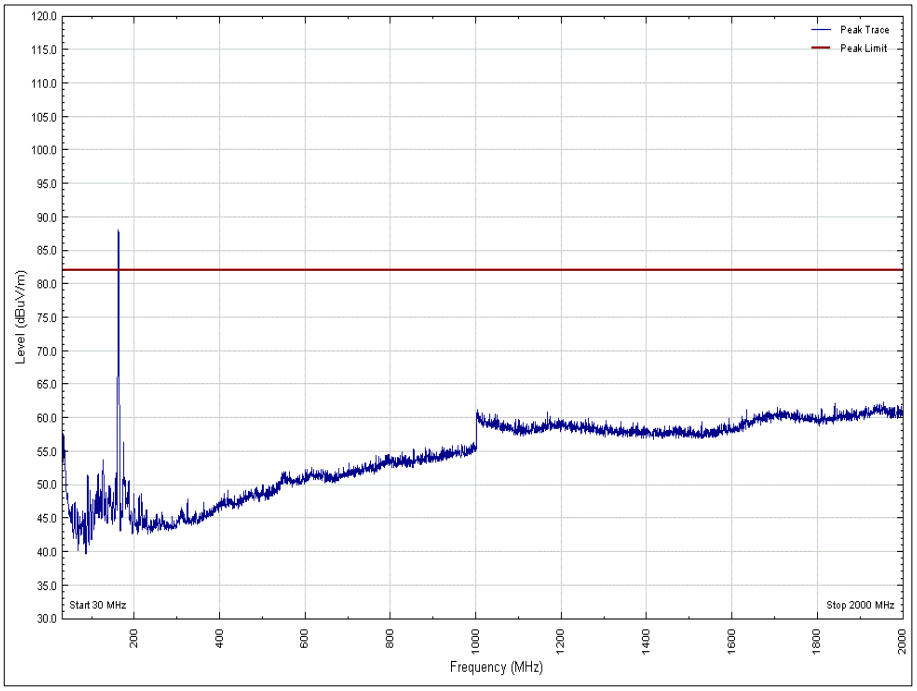

Figure 45 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

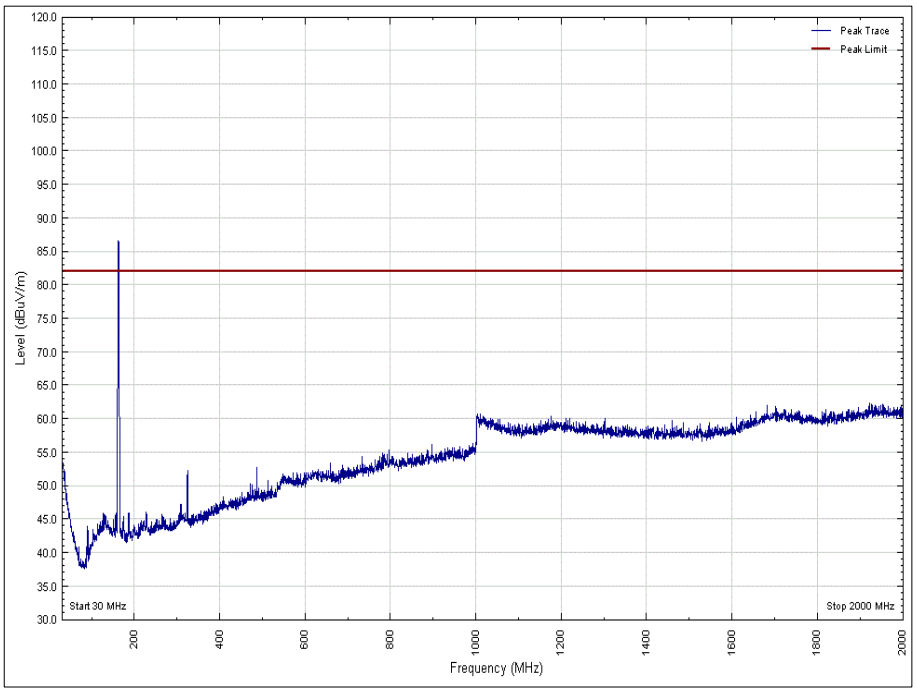

Figure 46 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

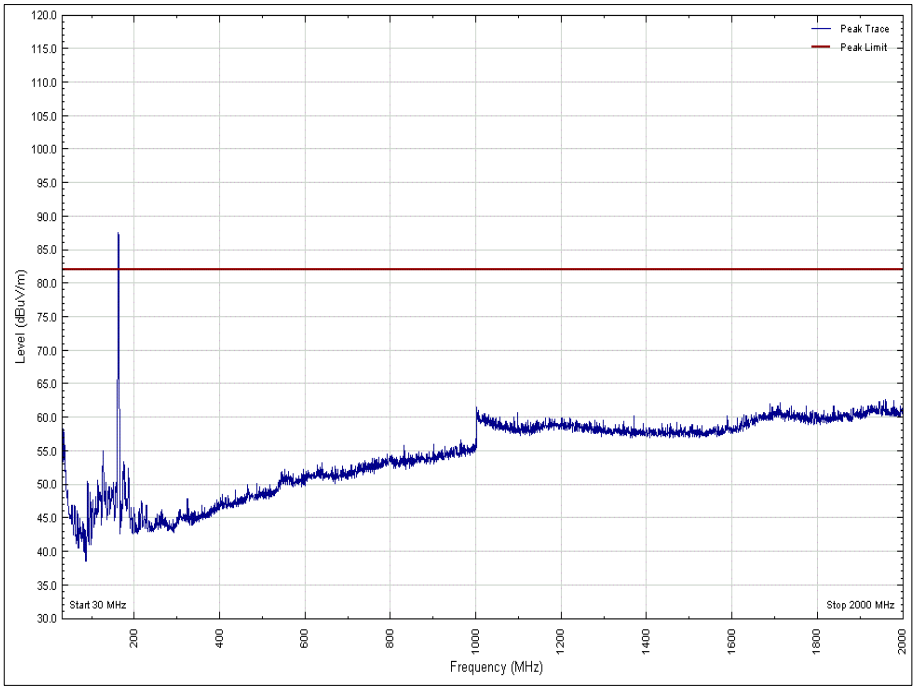

Figure 47 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

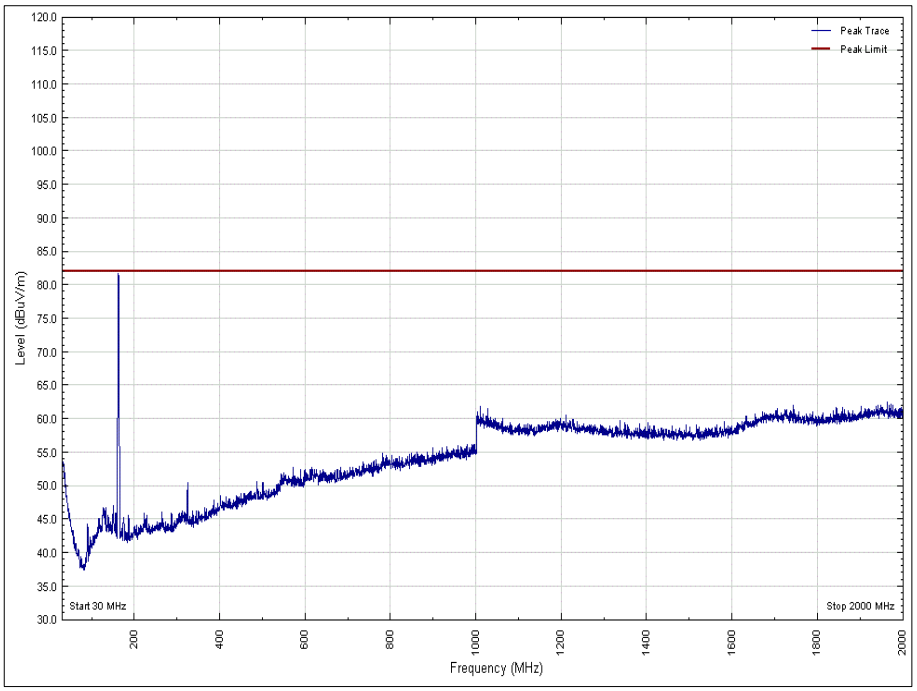

Figure 48 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

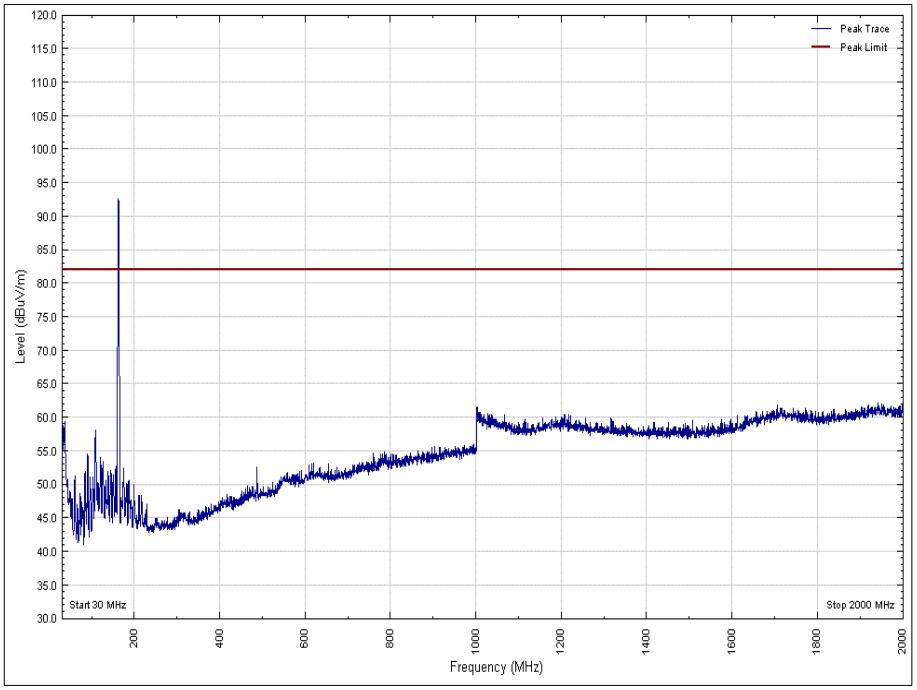

Figure 49 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

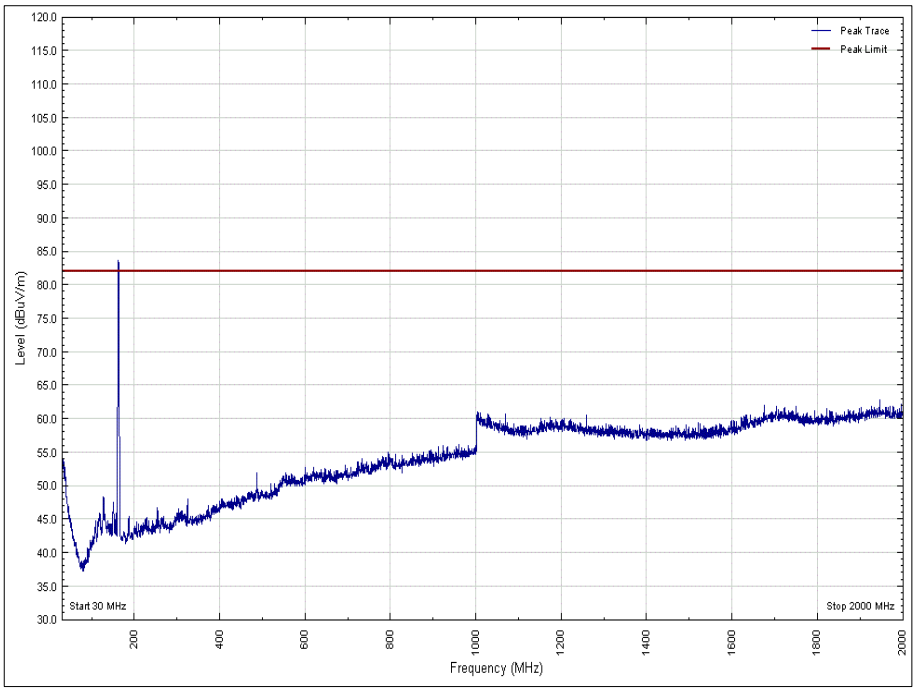

Figure 50 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal

DC Powered - 12 V DC - AIS Transmitter (Tx2)

Frequency (MHz)	Level (dBm)
*	

Table 24 - 156.025 MHz - Emissions Results

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

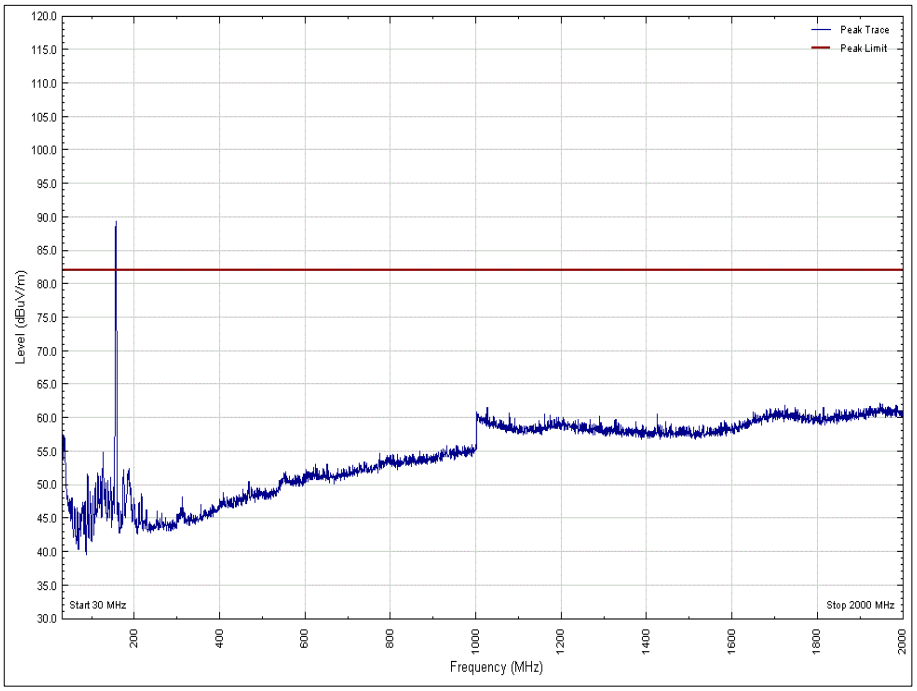

Figure 51 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

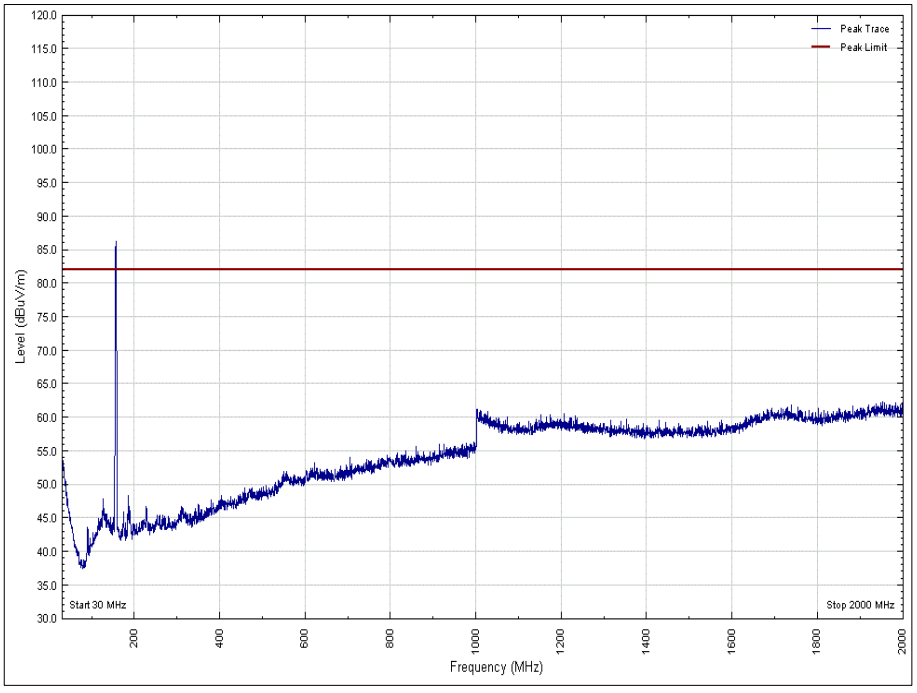

Figure 52 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

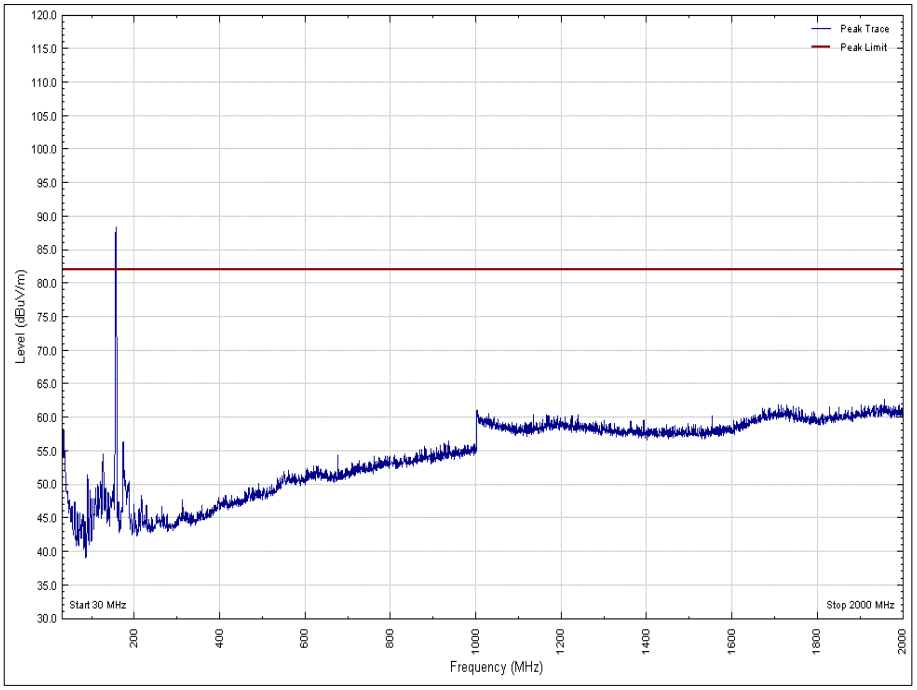

Figure 53 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

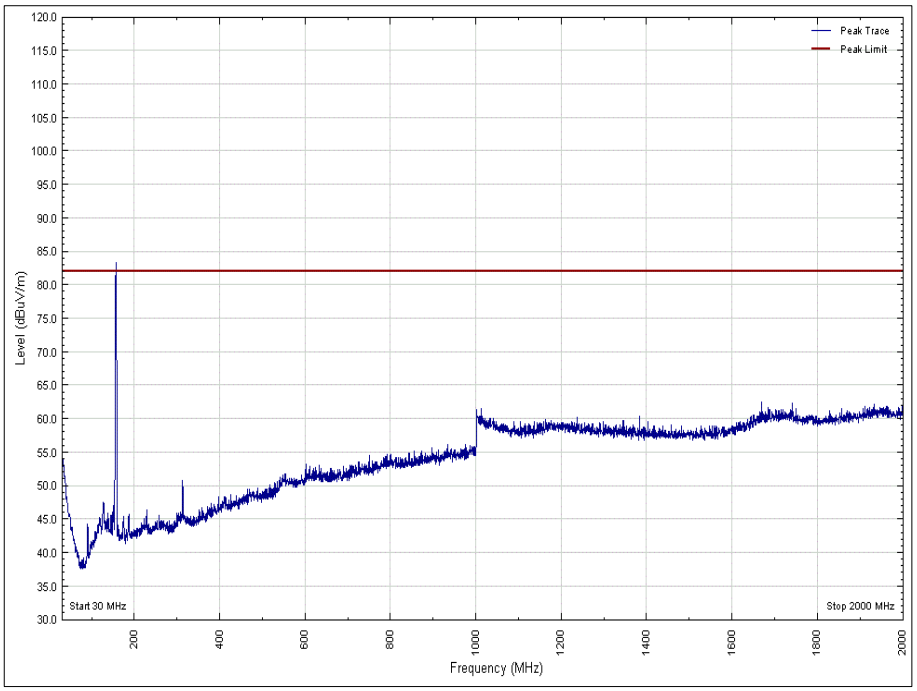

Figure 54 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

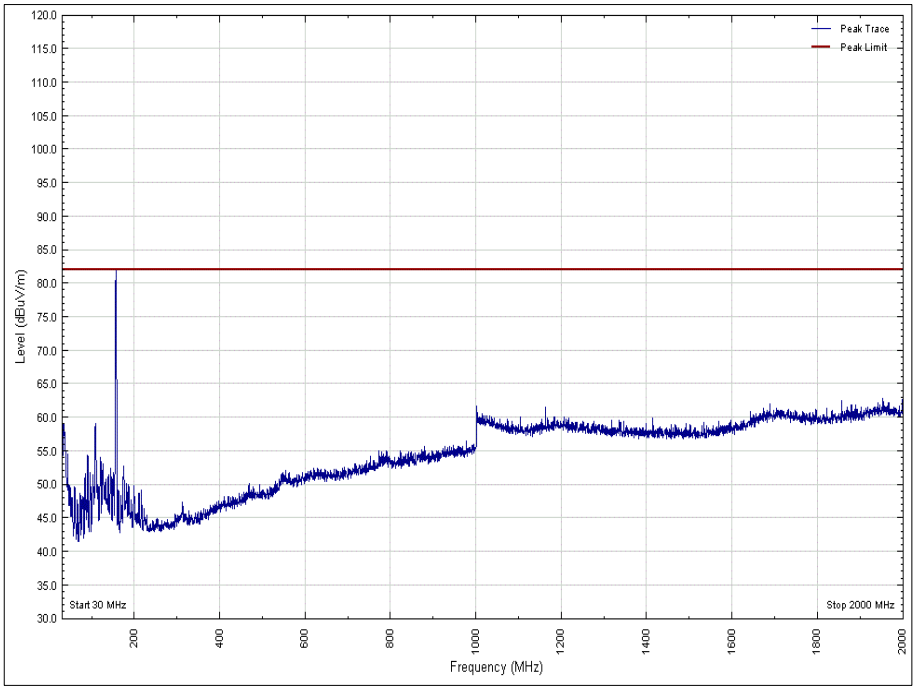

Figure 55 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

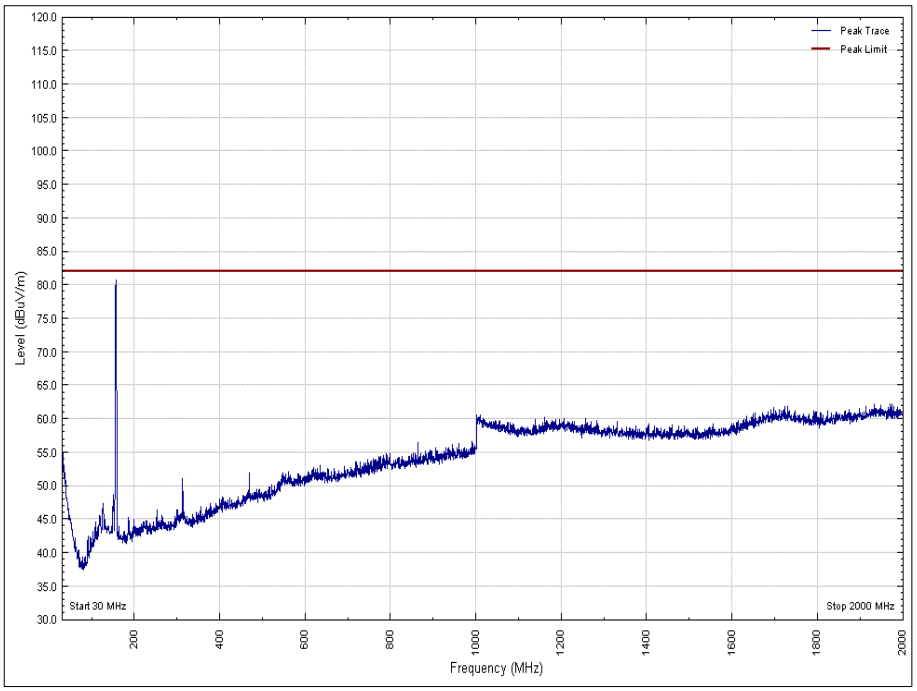

Figure 56 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 25 - 162.025 MHz - Emissions Results

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

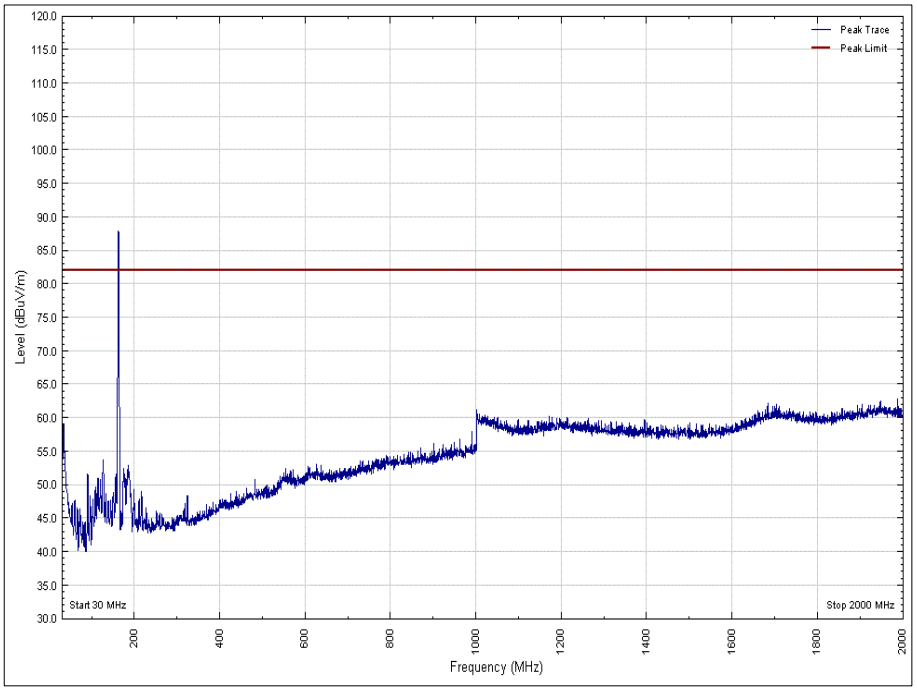

Figure 57 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

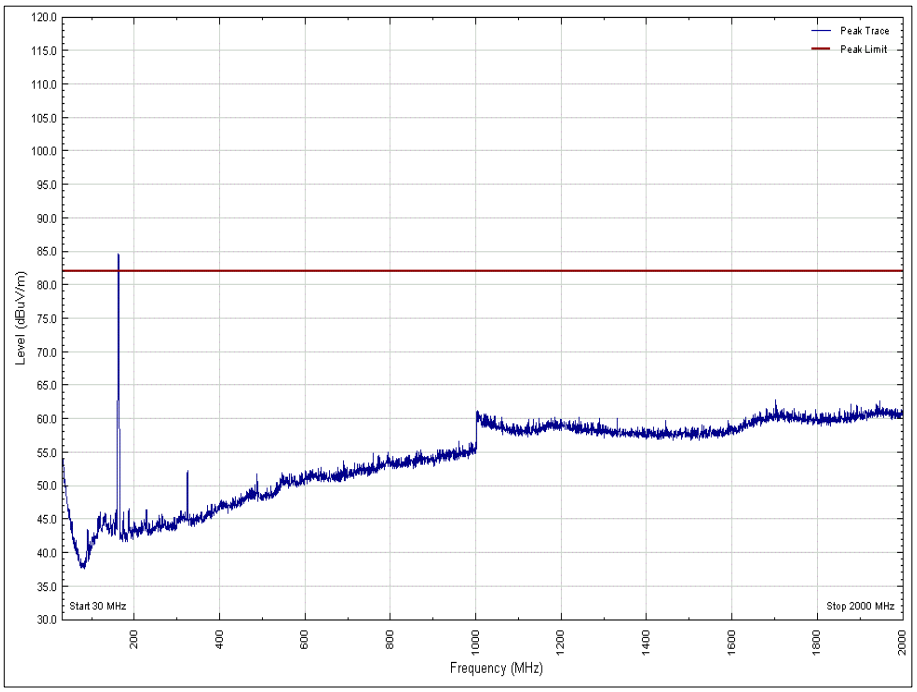

Figure 58 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

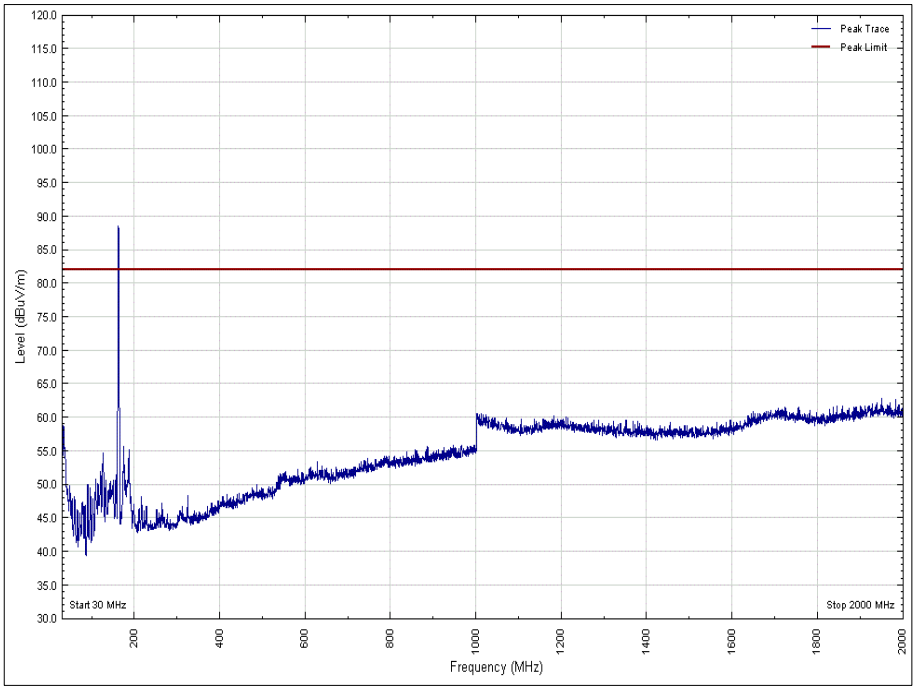

Figure 59 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

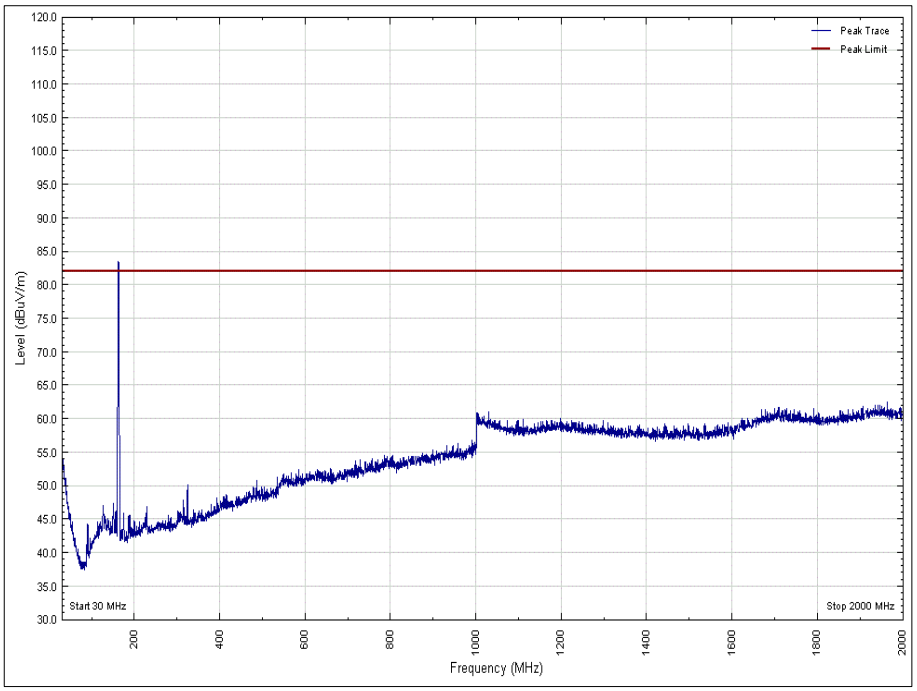

Figure 60 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

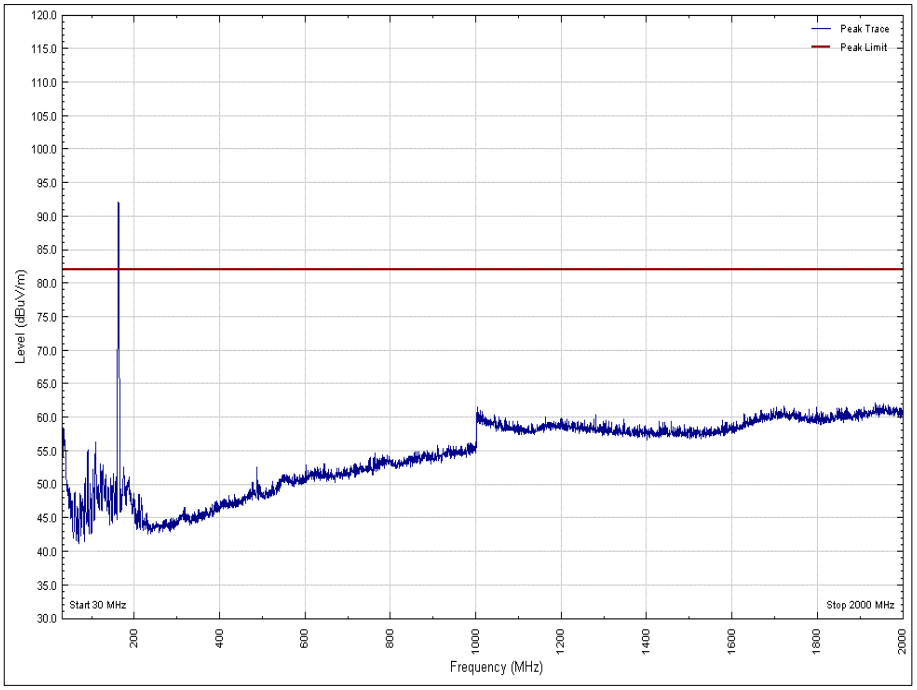

Figure 61 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

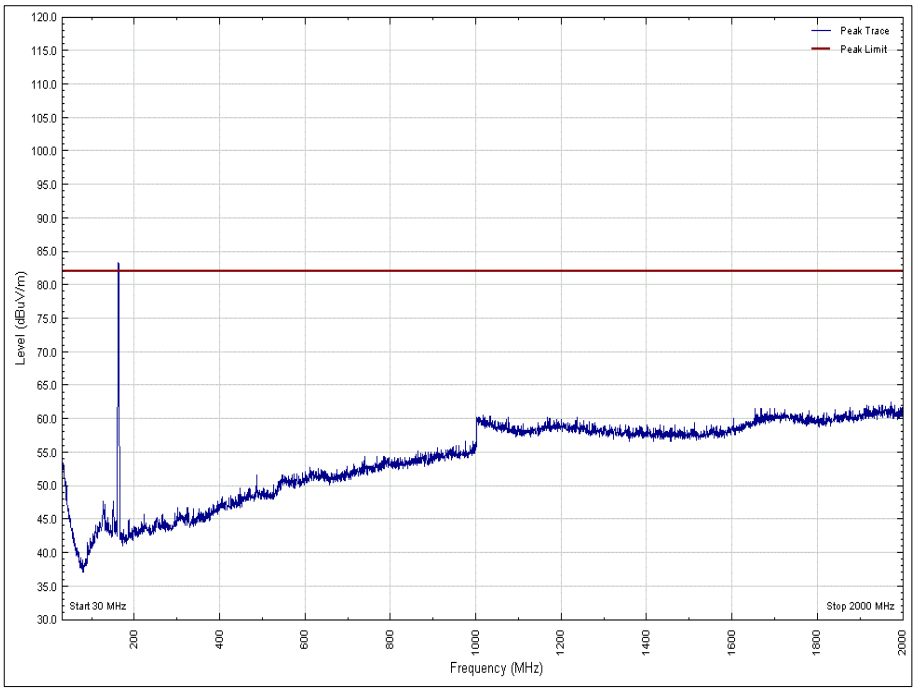

Figure 62 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal

FCC 47 CFR Part 80, Limit Clause 80.211

More than 250% of the Authorised Bandwidth:

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

Industry Canada RSS-182, Limit Clause 7.9.1

On any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth: at least 43 + 10 log10 p(watts) dB, measured with a bandwidth of 30 kHz.

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
Termination (50ohm)	Weinschel	50T-054	276	12	25-Jun-2020
Pre-Amplifier	Phase One	PS04-0086	1533	12	08-Feb-2020
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	IDM101	2421	12	31-Oct-2020
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	30-Sep-2021
Comb Generator	Schaffner	RSG1000	3034	-	TU
Signal Generator	Rohde & Schwarz	SMR40	3171	12	27-Nov-2019
Power Supply	Farnell	LT30/2	3422		TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	17-Dec-2019
Cable 1503 2M 2.92(P)m 2.92(P)m	Rhophase	KPS-1503A-2000-KPS	4293	12	08-Nov-2020
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	14-Nov-2020
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	11-Dec-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	05-Mar-2020
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
EmX Emissions Software	TUV SUD	EmX	5125	-	Software
8 Meter Cable	Teledyne	PR90-088-8MTR	5212	12	30-Aug-2020

Table 26

TU - Traceability Unscheduled

3 Photographs

3.1 Test Setup Photographs

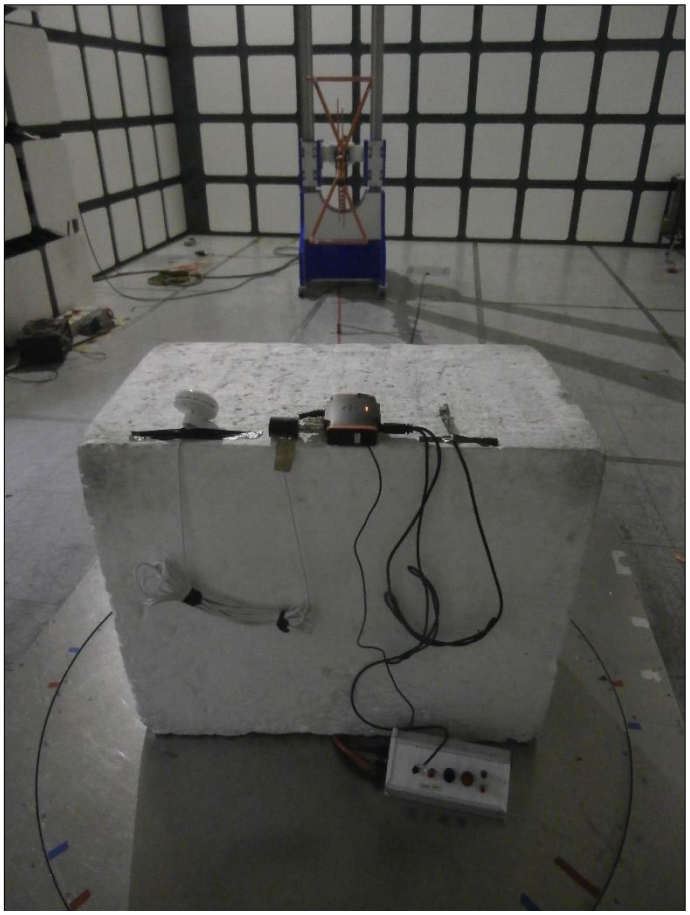

Figure 63 - Test Setup - 30 MHz to 1 GHz

Figure 64 - Test Setup - 1 GHz to 2 GHz

4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Bandwidths	± 58.05 Hz
Transmitter Frequency Tolerances	± 11 Hz
Spurious Emissions at Antenna Terminals	± 3.45 dB
Modulation Requirements	-
Transmitter Power	± 3.2 dB
Suppression of Interference Aboard Ships	± 3.45 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 18 GHz: ± 6.3 dB

Table 27

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.