# 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
Wireless House
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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**

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

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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<br>FCC 47 CFR Part 2: 2018<br>Industry Canada RSS-182: Issue 5 (2012-01)<br>ISEDC RSS-GEN: Issue 5 and A1 (2019-03) |
| Order Number<br>Date | 7923<br>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<br>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) ☒<br>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:<br>Standard Antenna Jack ☐ If yes, describe how user is prohibited from changing antenna (if not professional installed):<br>Equipment is only ever professionally installed ☐<br>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**

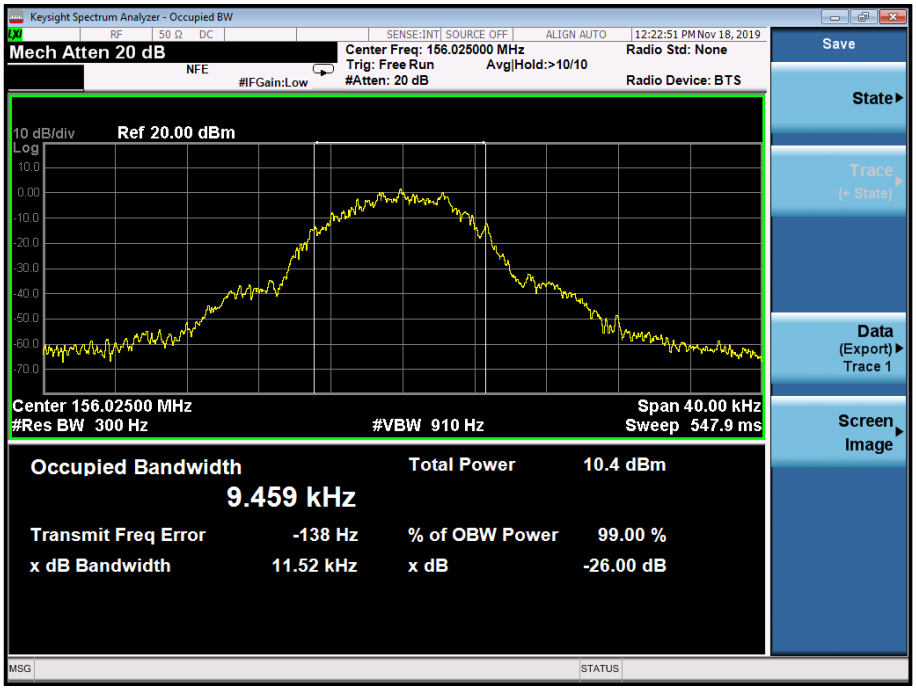


**Figure 1 - 156.025 MHz Occupied Bandwidth**

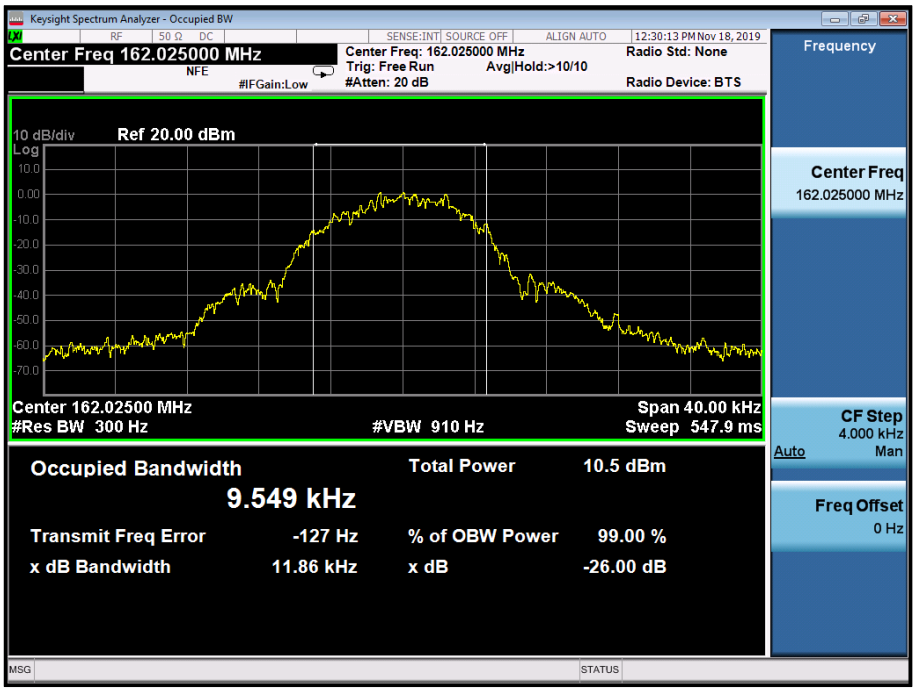


**Figure 2 - 162.025 MHz Occupied Bandwidth**

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**

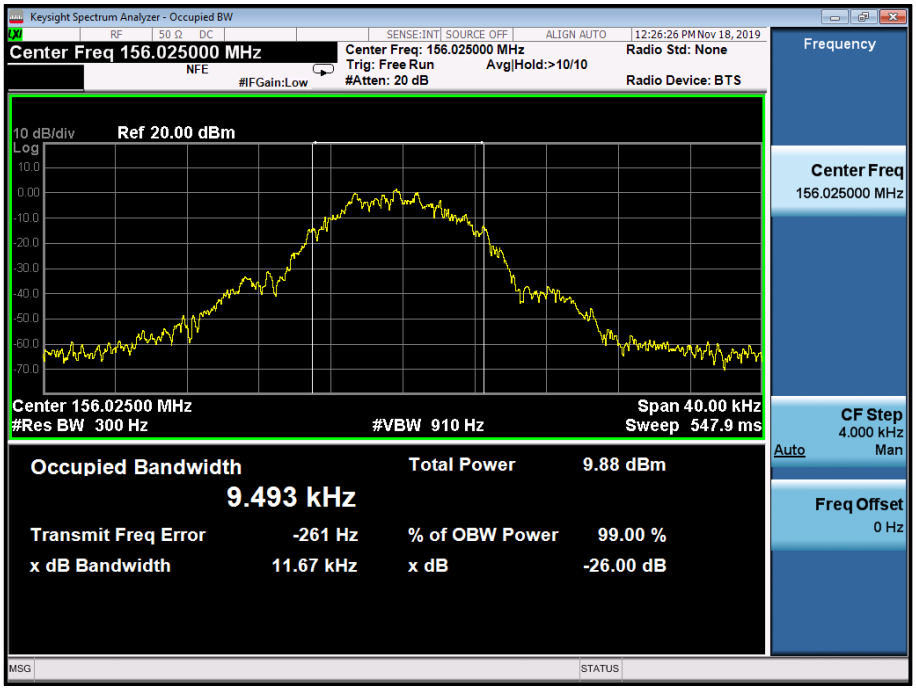


**Figure 3 - 156.025 MHz Occupied Bandwidth**

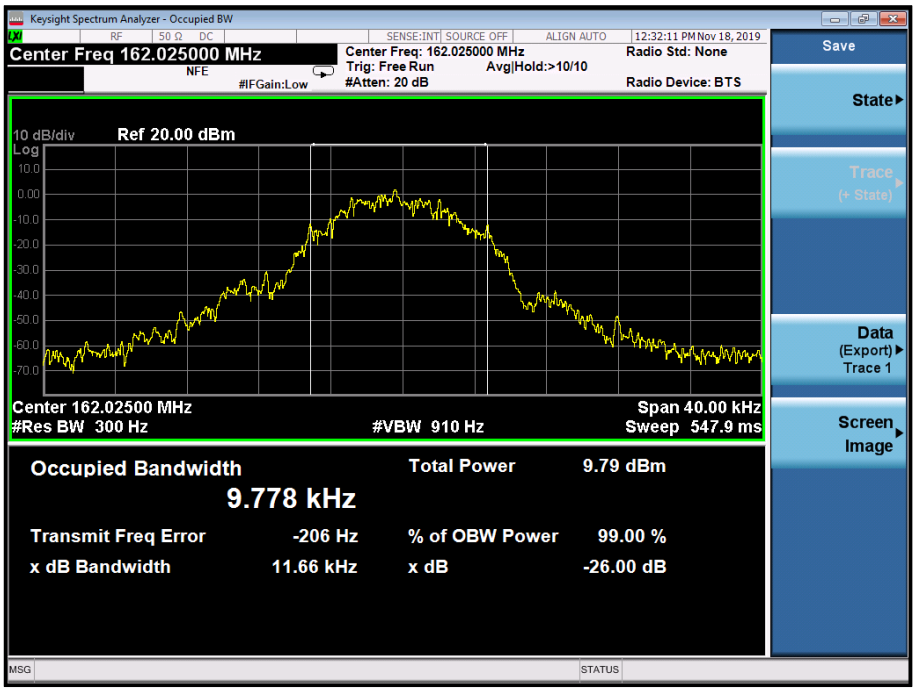


**Figure 4 - 162.025 MHz Occupied Bandwidth**

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)

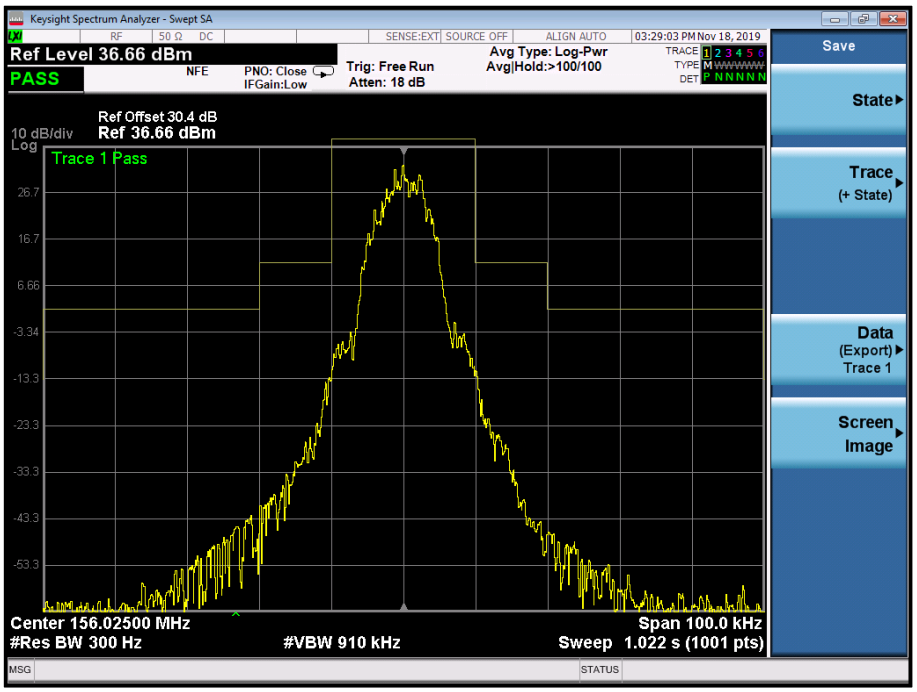


**Figure 5 - 156.025 MHz - Transmitter Spectrum Mask**

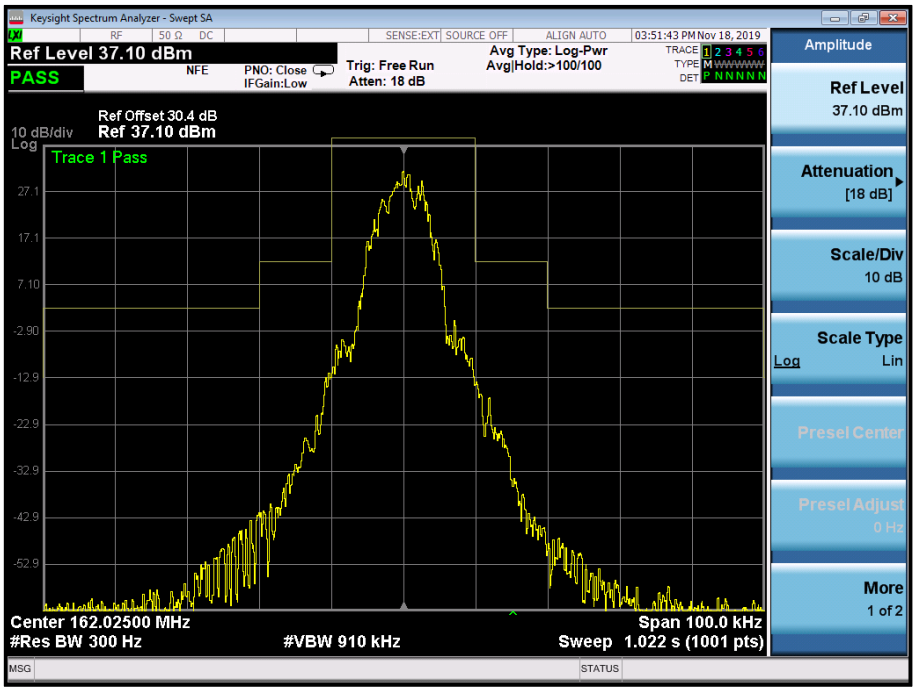


**Figure 6 - 162.025 MHz - Transmitter Spectrum Mask**

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

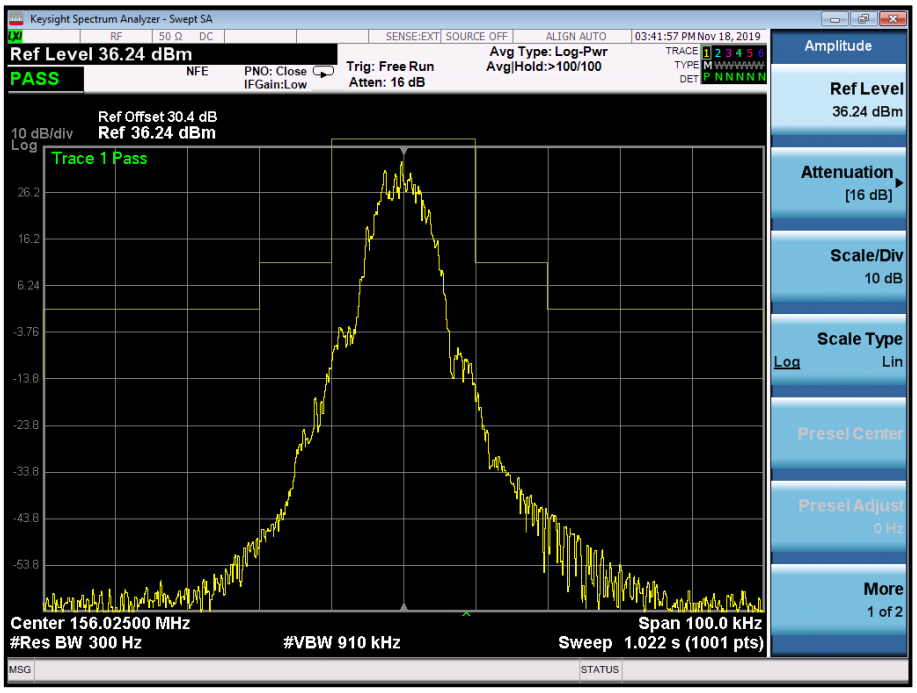


**Figure 7 - 156.025 MHz - Transmitter Spectrum Mask**

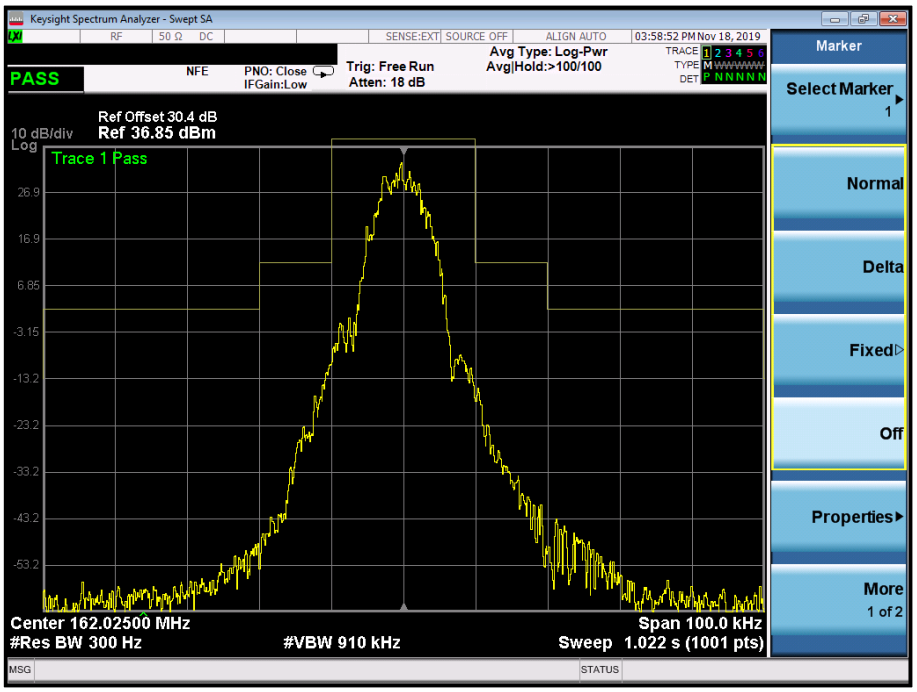


**Figure 8 - 162.025 MHz - Transmitter Spectrum Mask**

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

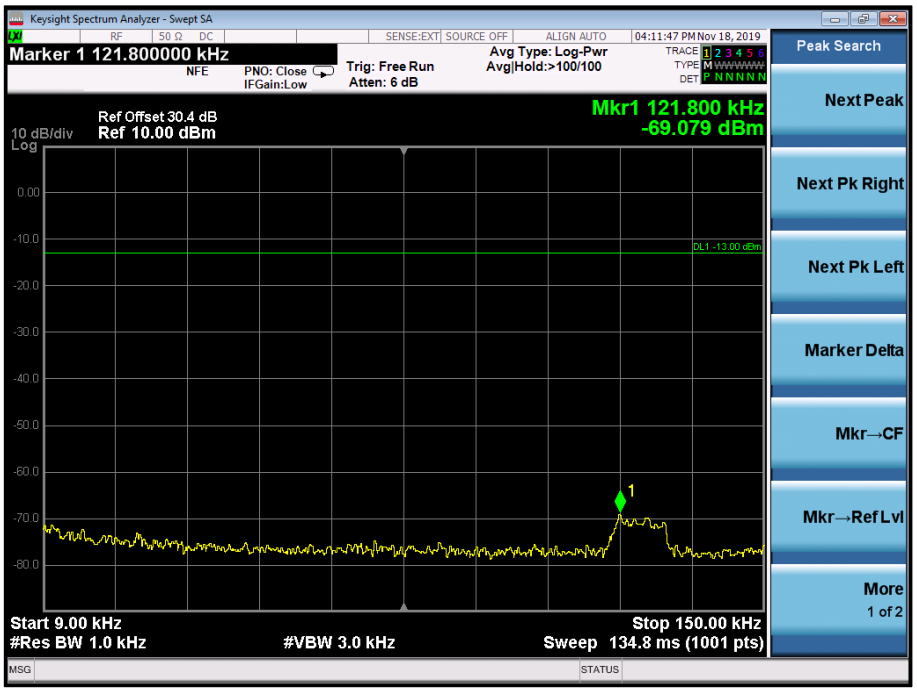


**Figure 9 - 156.025 MHz - 9 kHz to 150 kHz**

**Figure 10 - 162.025 MHz - 9 kHz to 150 kHz**

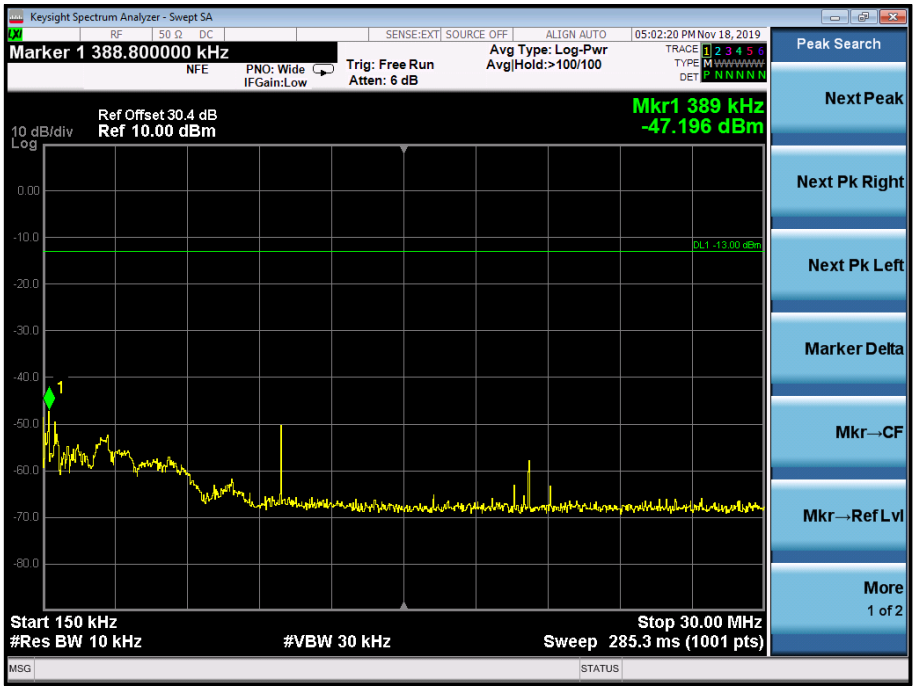


**Figure 11 - 156.025 MHz - 150 kHz to 30 MHz**

**Figure 12 - 162.025 MHz - 150 kHz to 30 MHz**

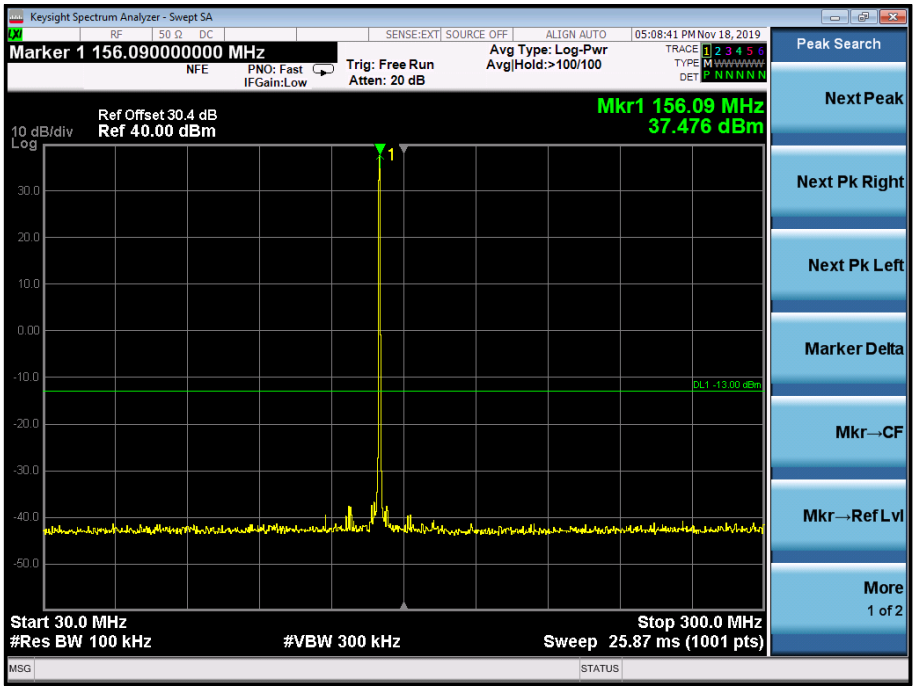


**Figure 13 - 156.025 MHz - 30 MHz to 300 MHz**

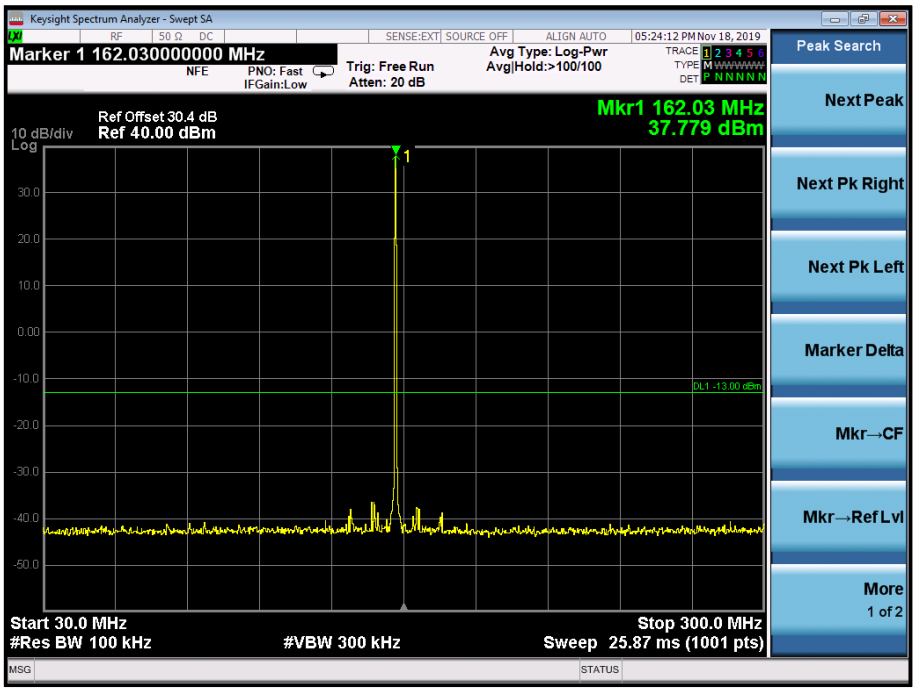


**Figure 14 - 162.025 MHz - 30 MHz to 300 MHz**

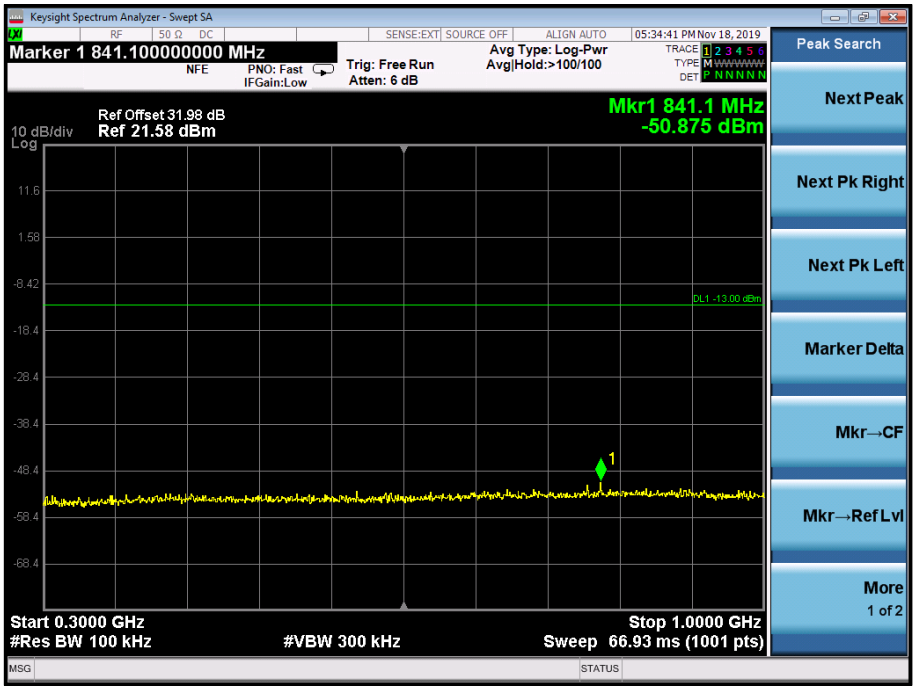


**Figure 15 - 156.025 MHz - 300 MHz to 1 GHz**

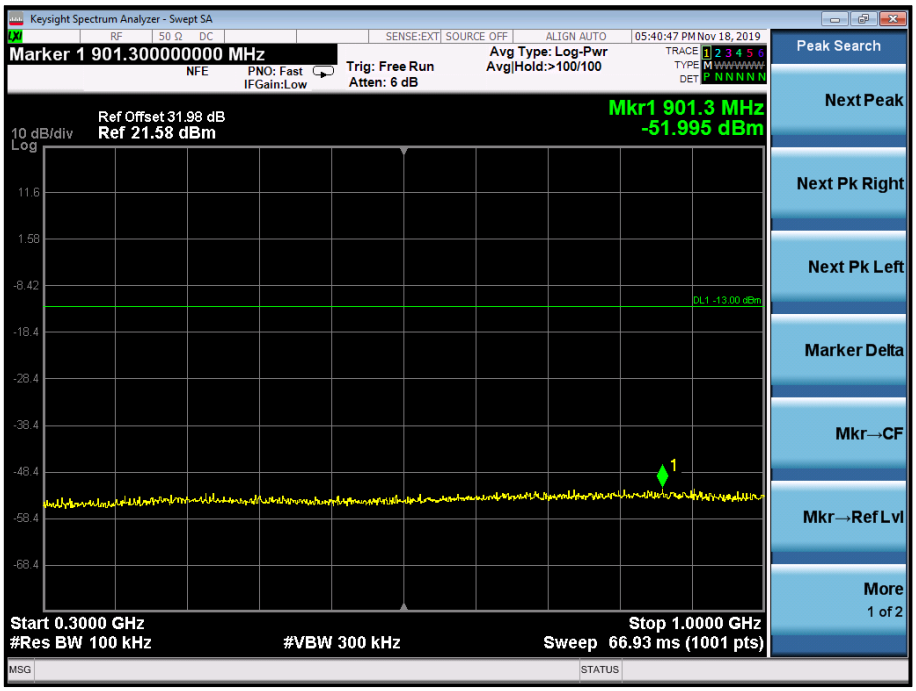


**Figure 16 - 162.025 MHz - 300 MHz to 1 GHz**

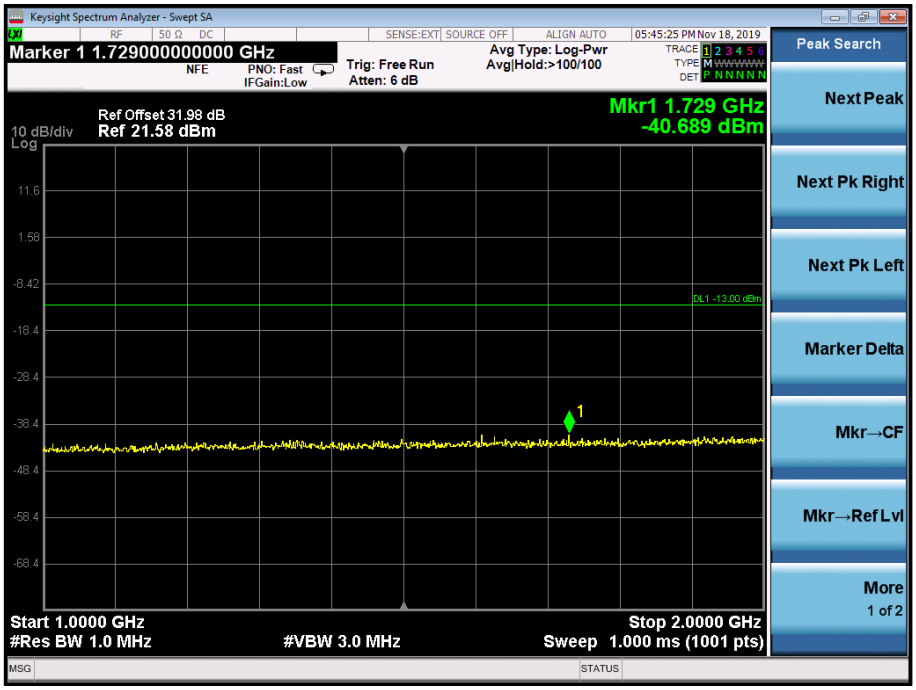


**Figure 17 - 156.025 MHz - 1 GHz to 2 GHz**

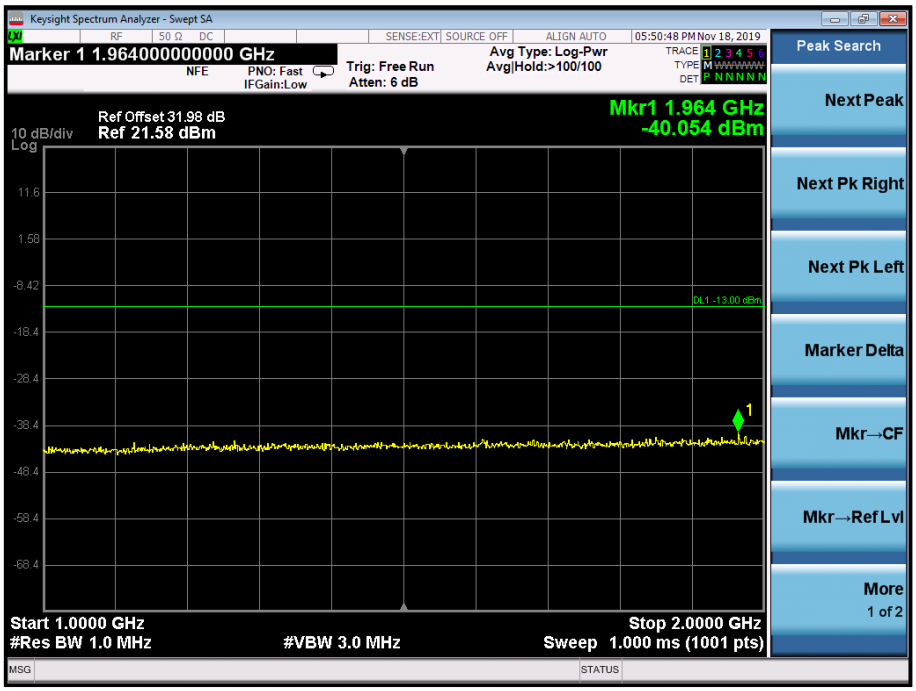


**Figure 18 - 162.025 MHz - 1 GHz to 2 GHz**

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

<u>DC Powered - 12 V DC - AIS Transmitter (Tx1)</u>

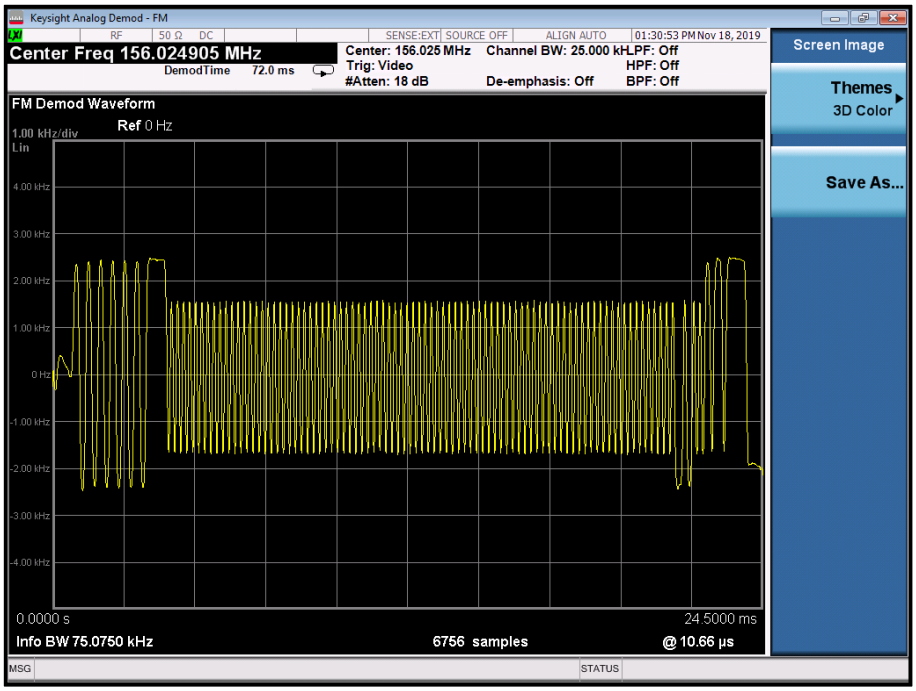


**Figure 19 - 156.025 MHz - 01010101**

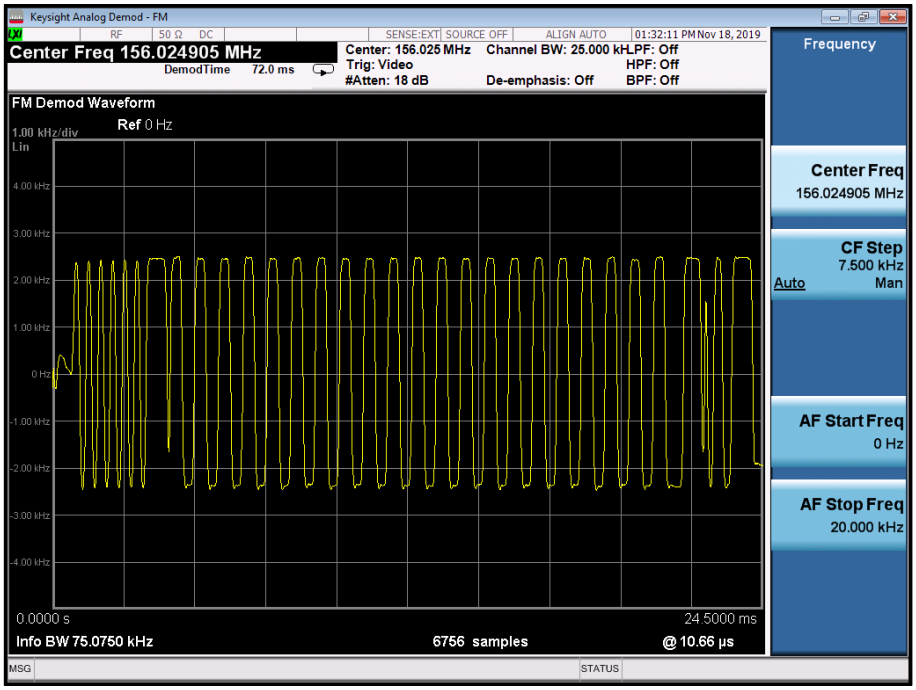


**Figure 20- 156.025 MHz - 00001111**

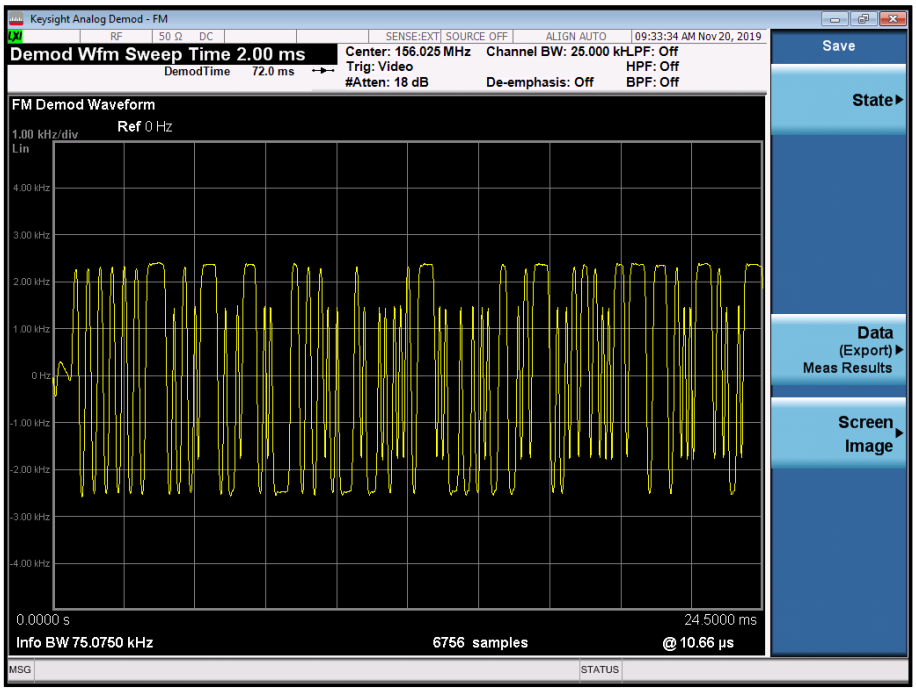


**Figure 21- 156.025 MHz - PRBS**

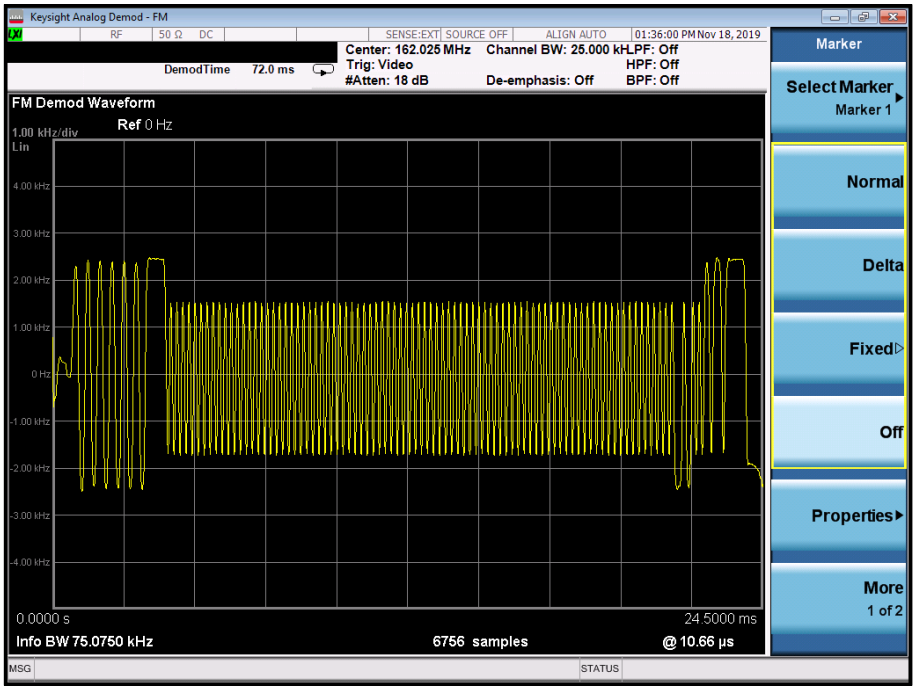


**Figure 22 - 162.025 MHz - 01010101**

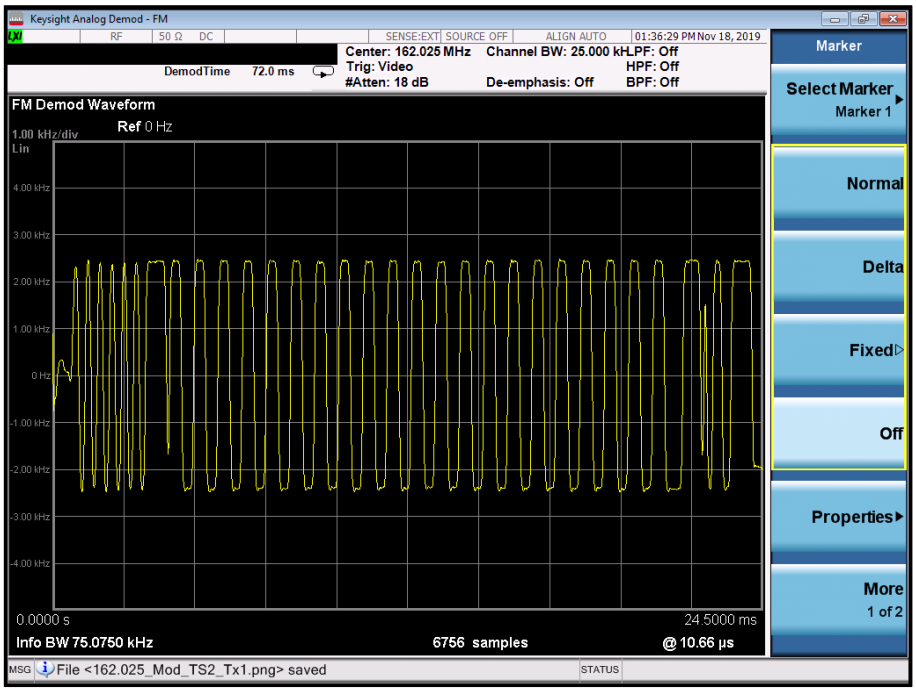


**Figure 23- 162.025 MHz - 00001111**

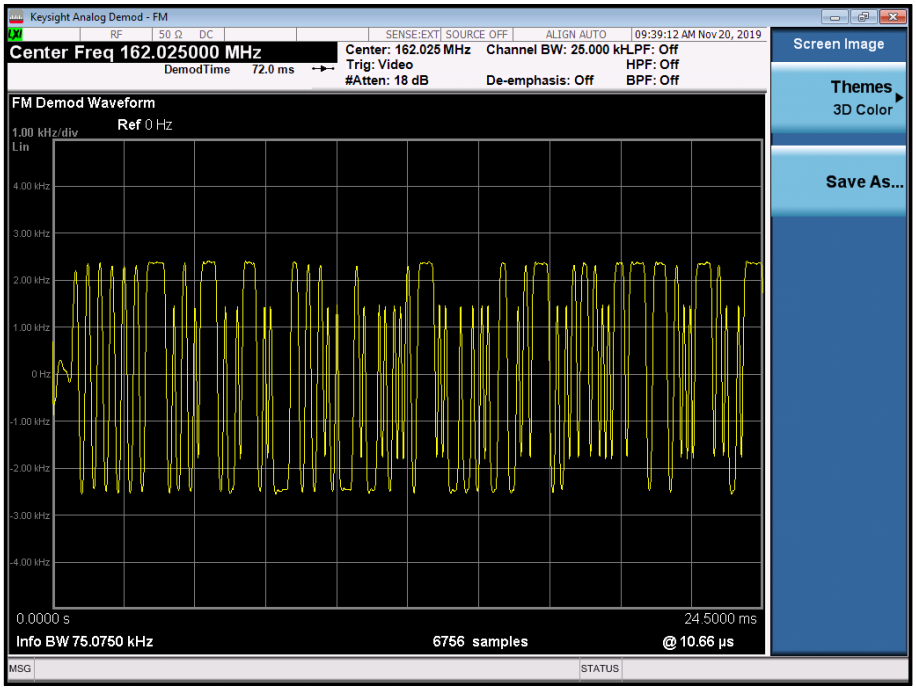


**Figure 24- 162.025 MHz - PRBS**

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

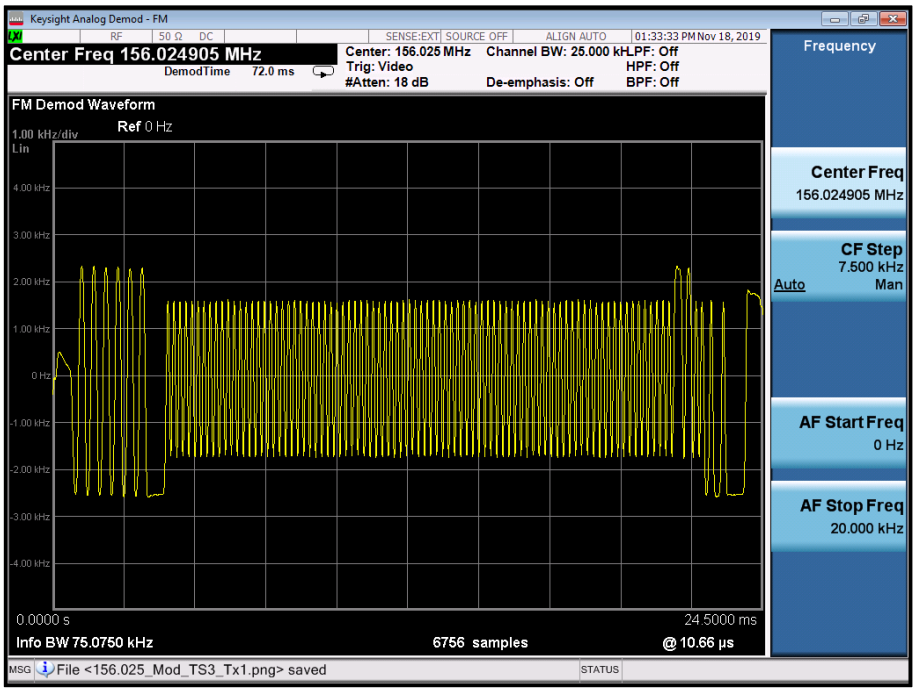


**Figure 25 - 156.025 MHz - 01010101**

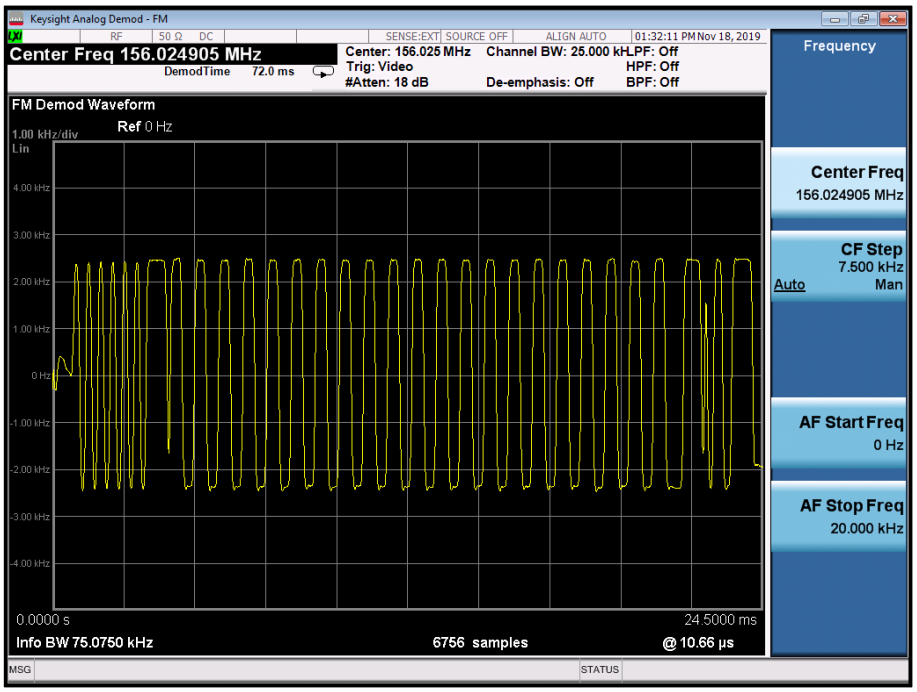


**Figure 26- 156.025 MHz - 00001111**

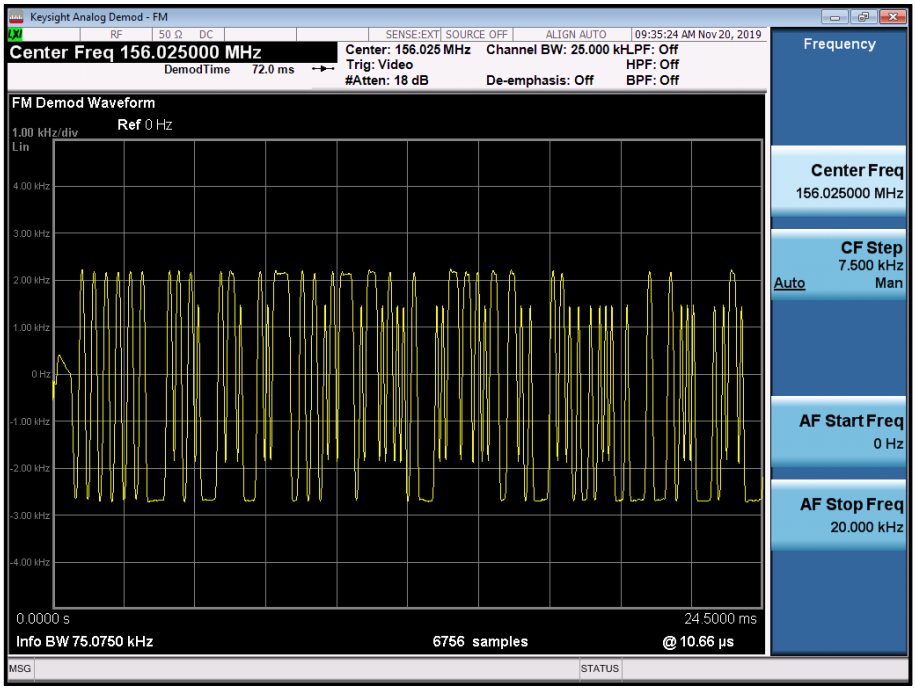


**Figure 27- 156.025 MHz - PRBS**

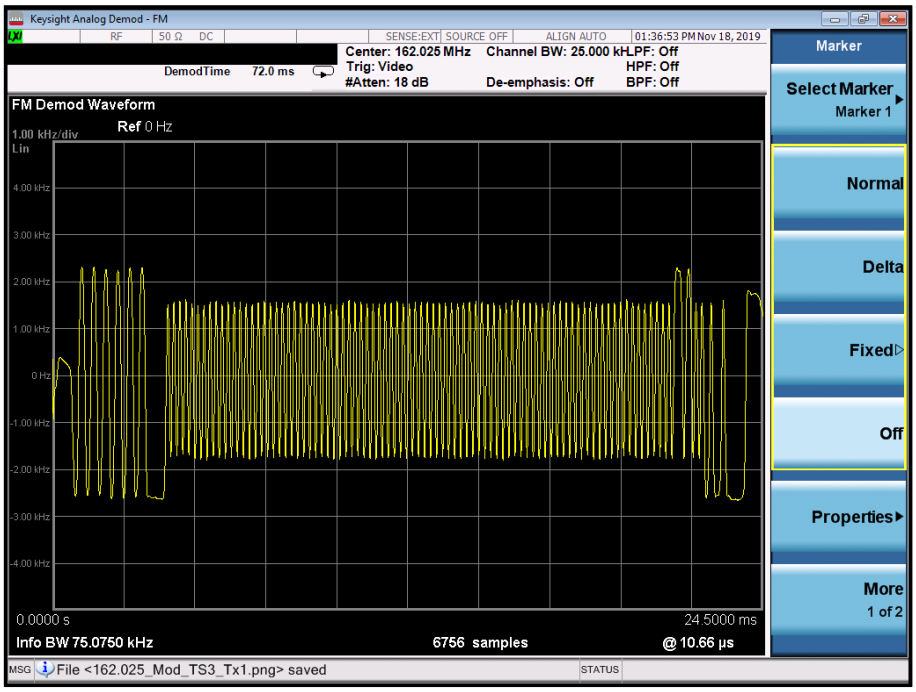


**Figure 28 - 162.025 MHz - 01010101**

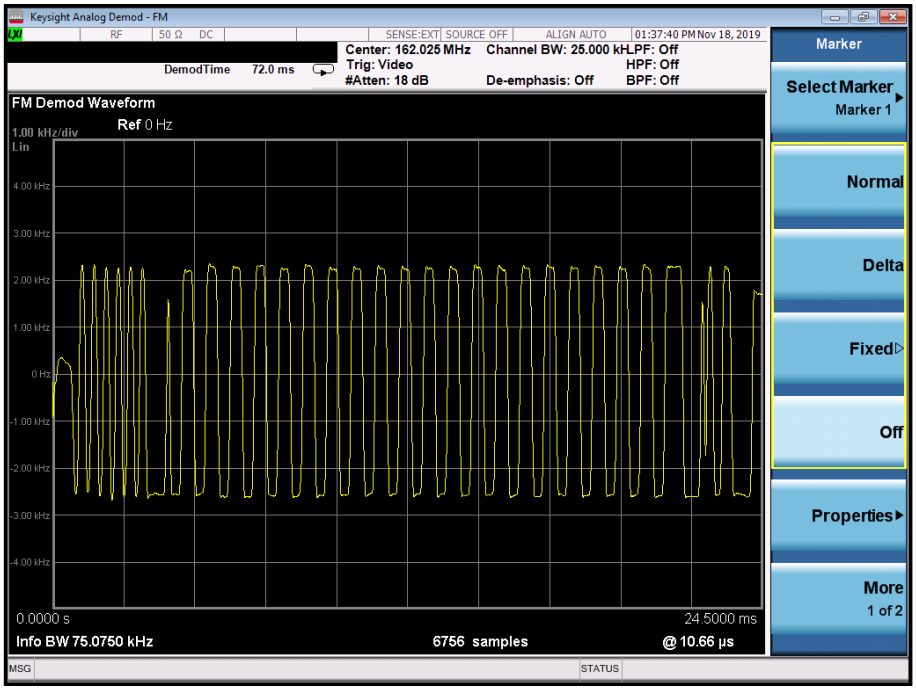


**Figure 29- 162.025 MHz - 00001111**

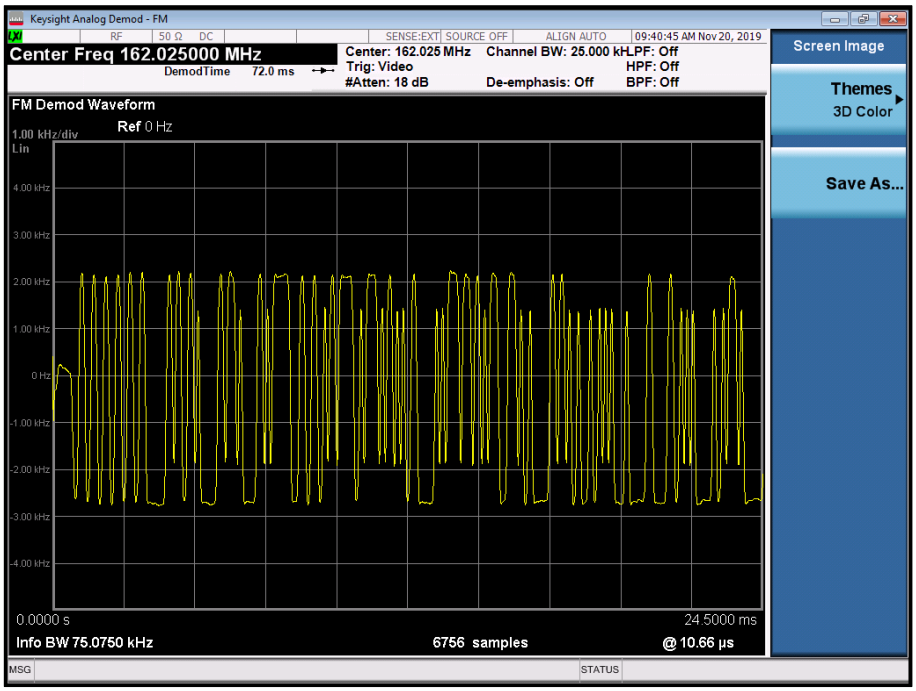


**Figure 30- 162.025 MHz - PRBS**

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)<br>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<br>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<br>Minimum<br>Maximum | <br>6 W<br>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**

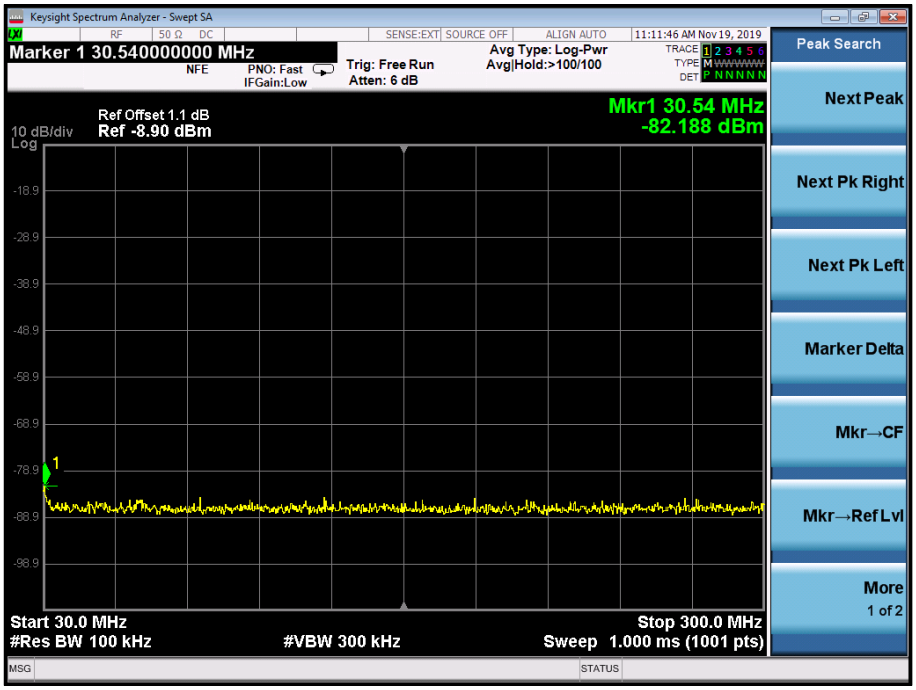


**Figure 33 - (156.025 MHz) 30 MHz to 300 MHz**

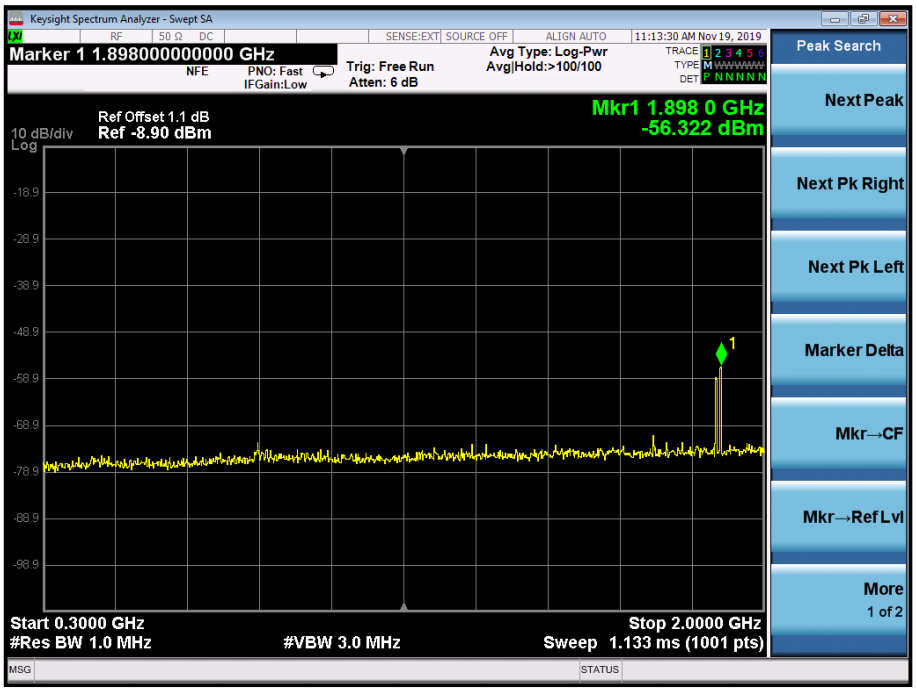


**Figure 34 - (156.025 MHz) 300 MHz to 2 GHz**

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

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

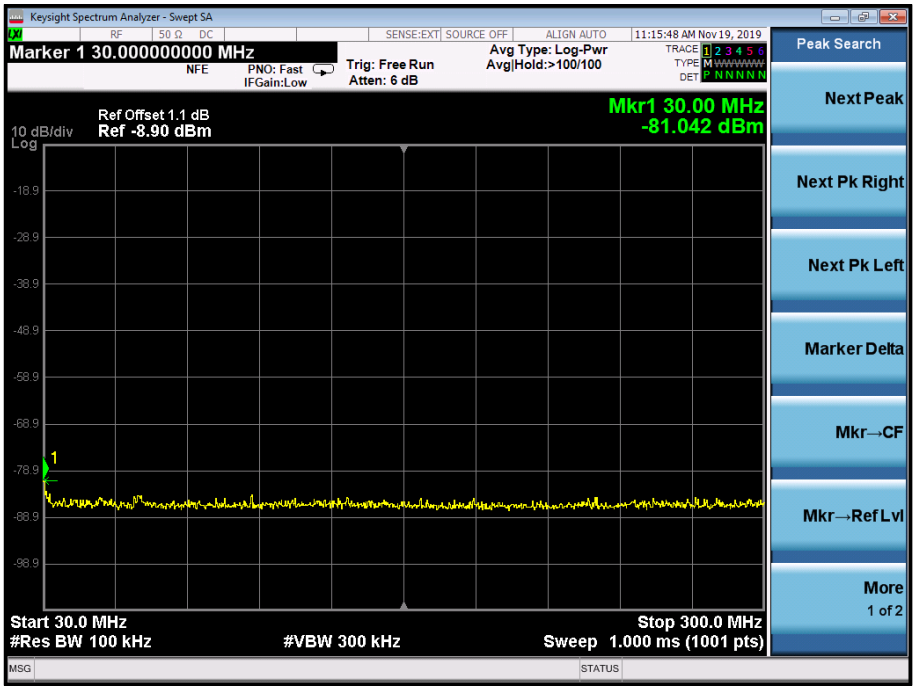


**Figure 37 - (162.025 MHz) 30 MHz to 300 MHz**

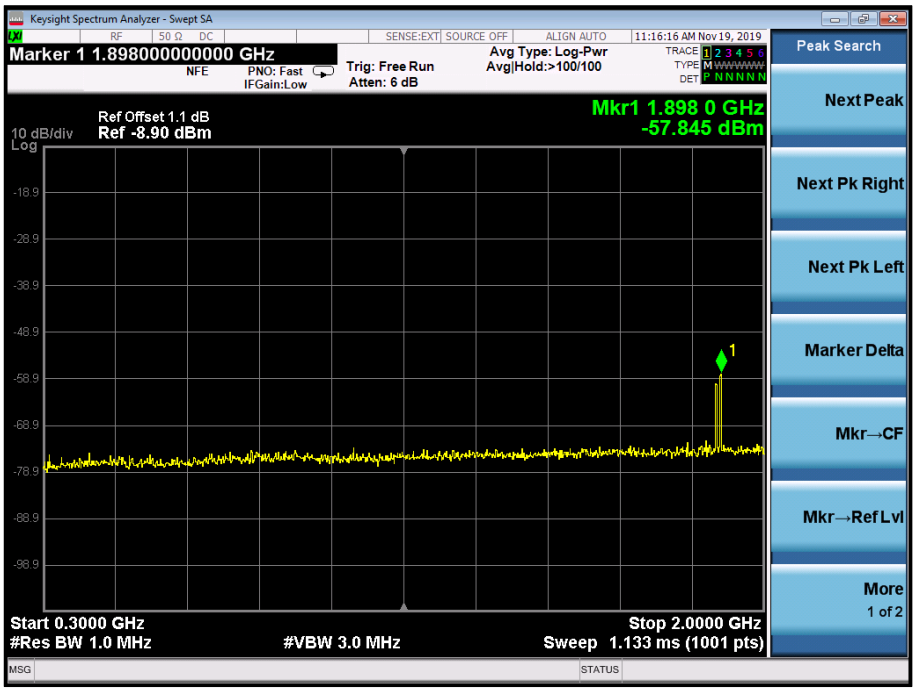


**Figure 38 - (162.025 MHz) 300 MHz to 2 GHz**

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

<u>DC Powered - 12 V DC - AIS Transmitter (Tx1)</u>

| Frequency (MHz) | Level (dBm) |
|---|---|
| * | |

**Table 22 - 156.025 MHz - Emissions Results**

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

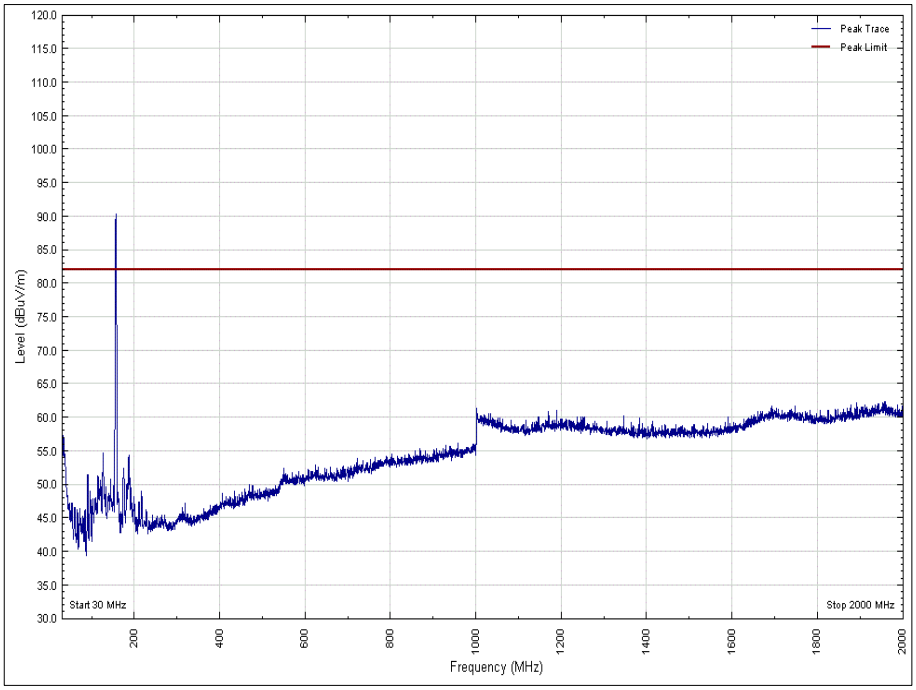


**Figure 39 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical**

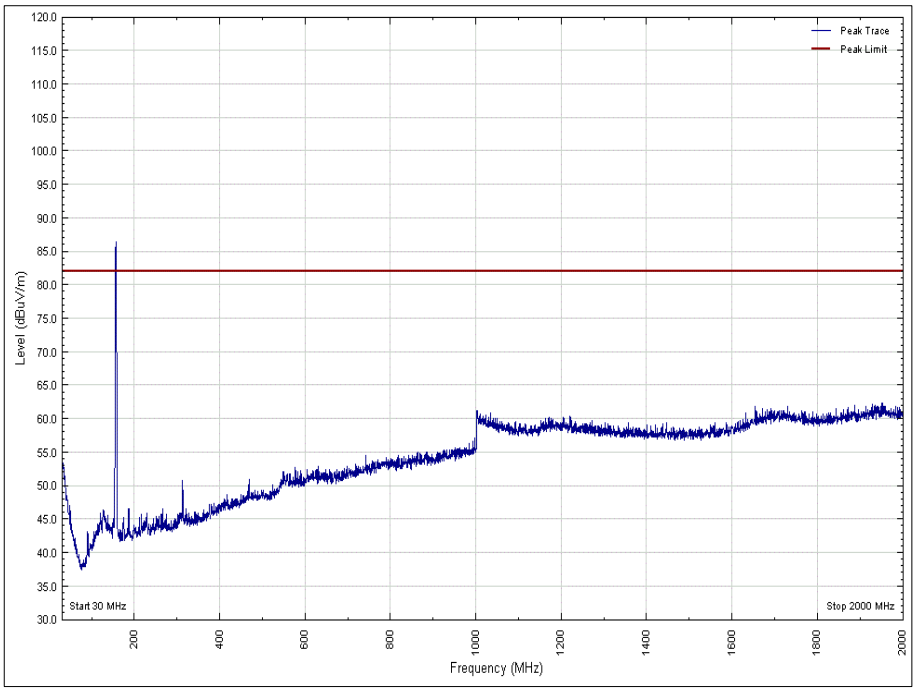


**Figure 40 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal**

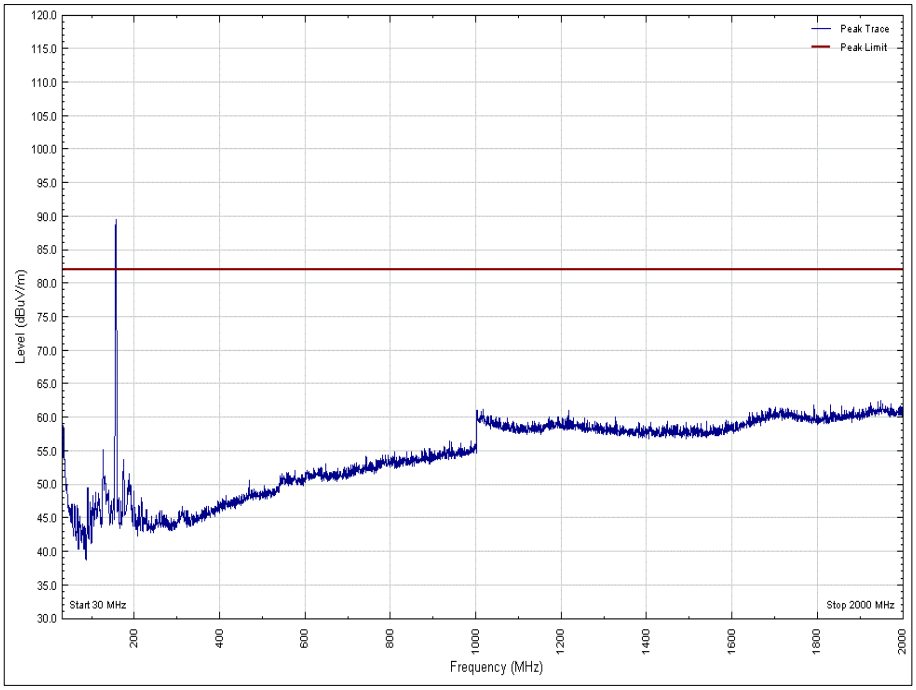


**Figure 41 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical**

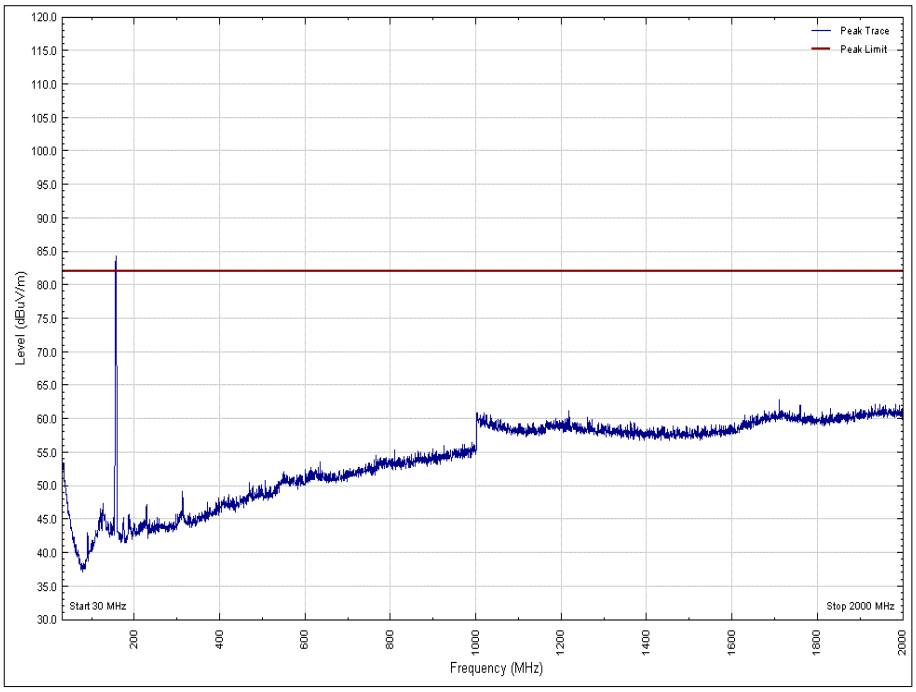


**Figure 42 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal**

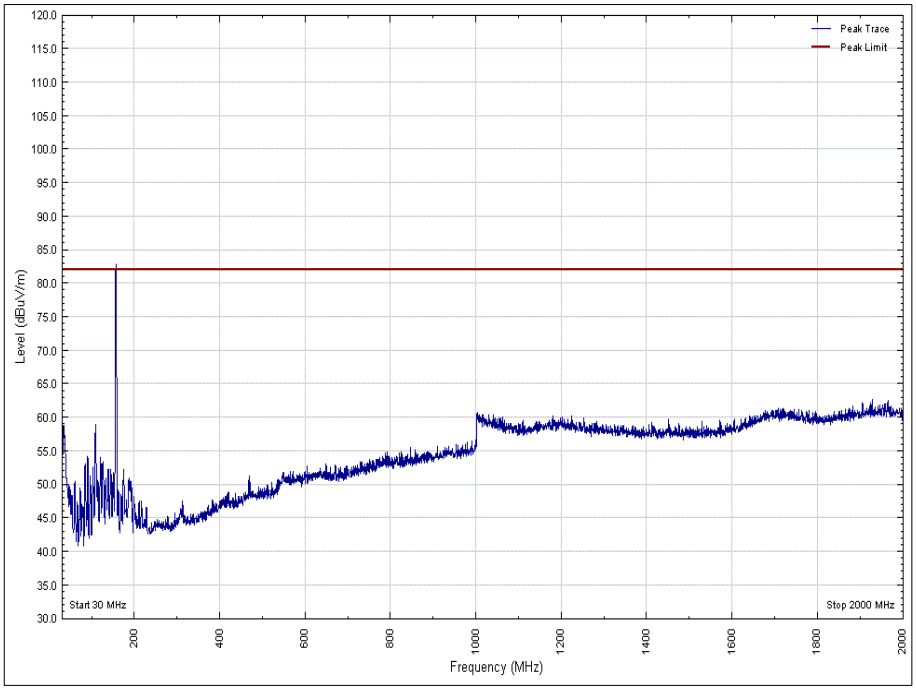


**Figure 43 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical**

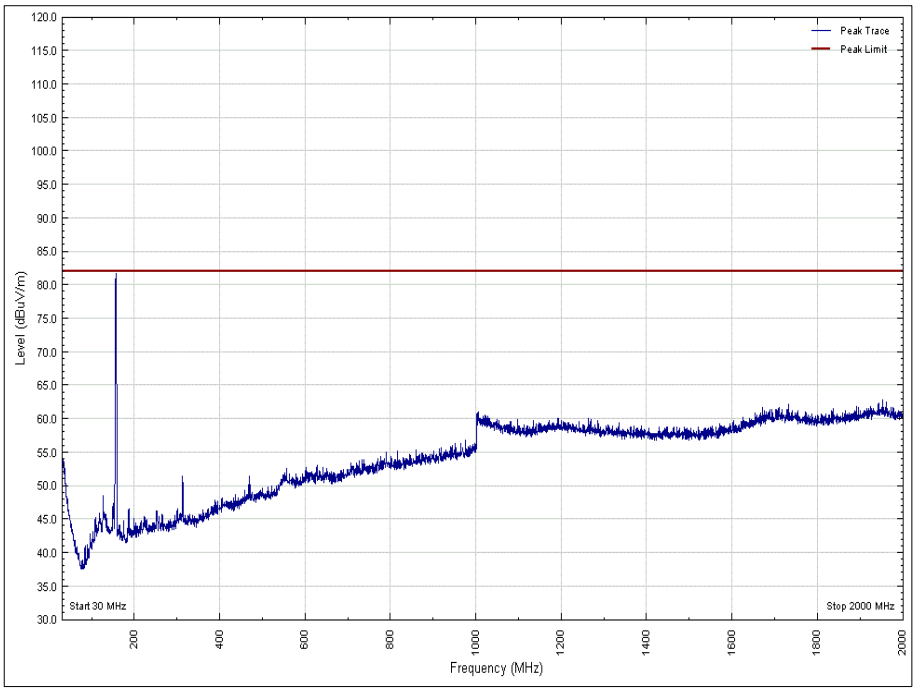


**Figure 44 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal**

| Frequency (MHz) | Level (dBm) |
|---|---|
| * | |

**Table 23 - 162.025 MHz - Emissions Results**

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

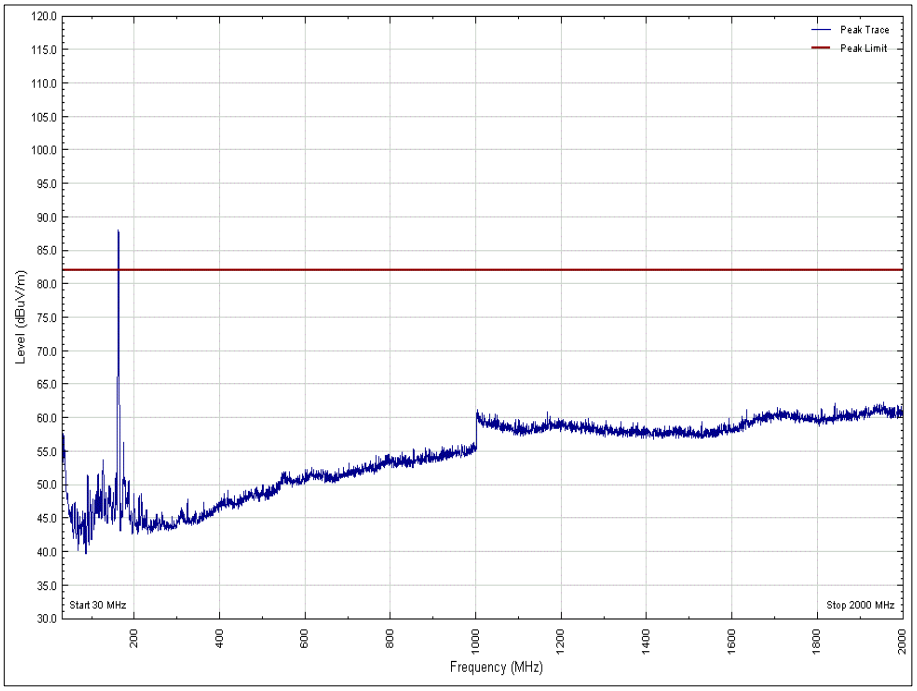


**Figure 45 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical**

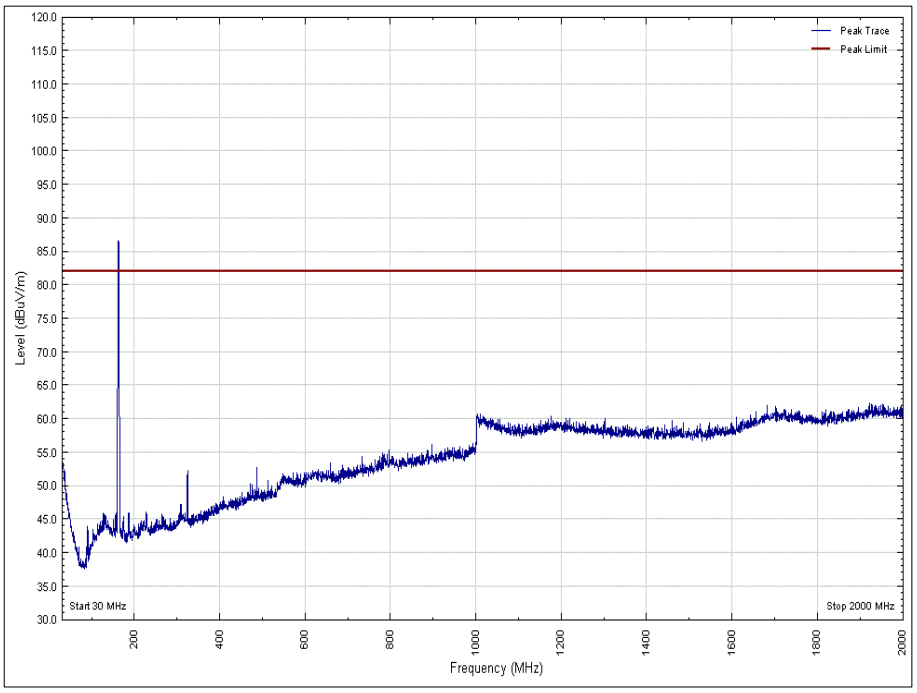


**Figure 46 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal**

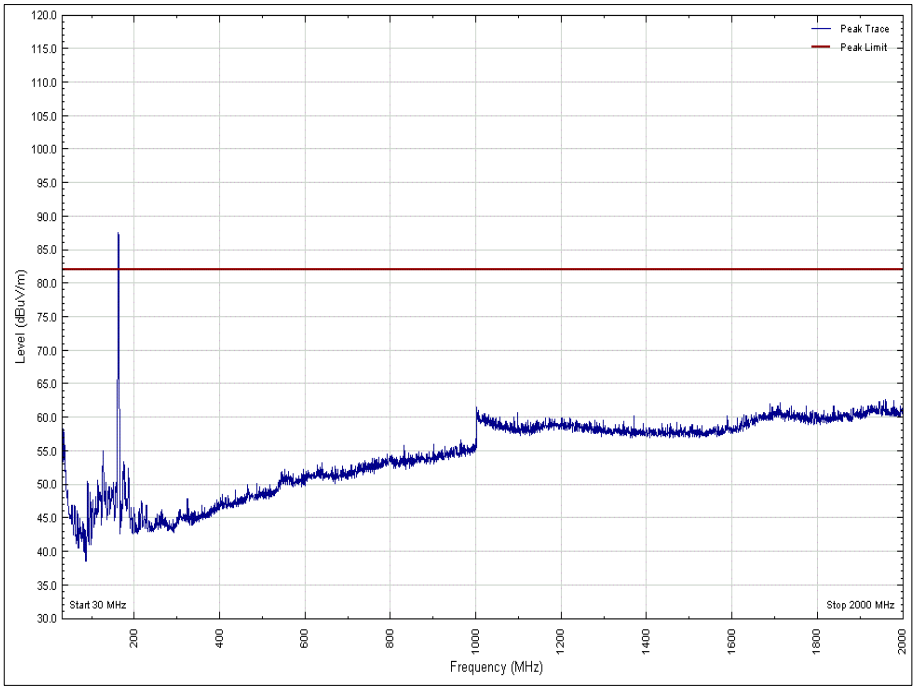


**Figure 47 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical**

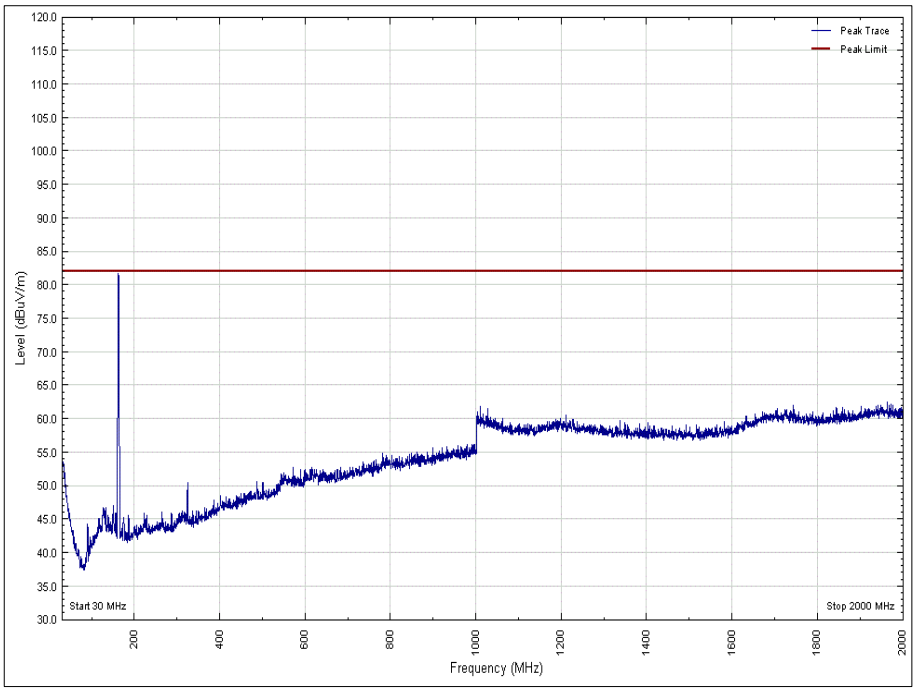


**Figure 48 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal**

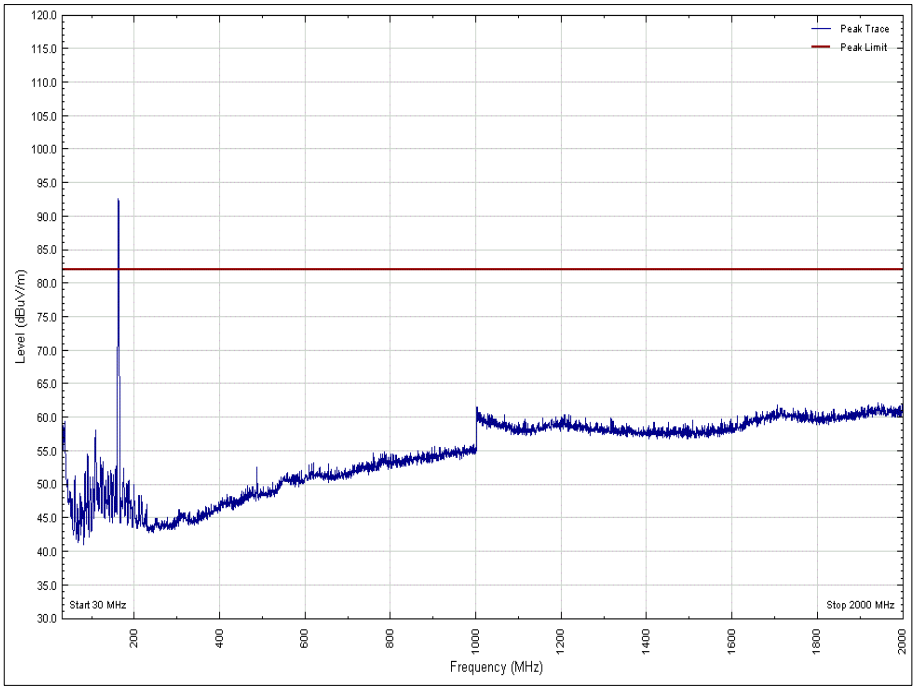


**Figure 49 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical**

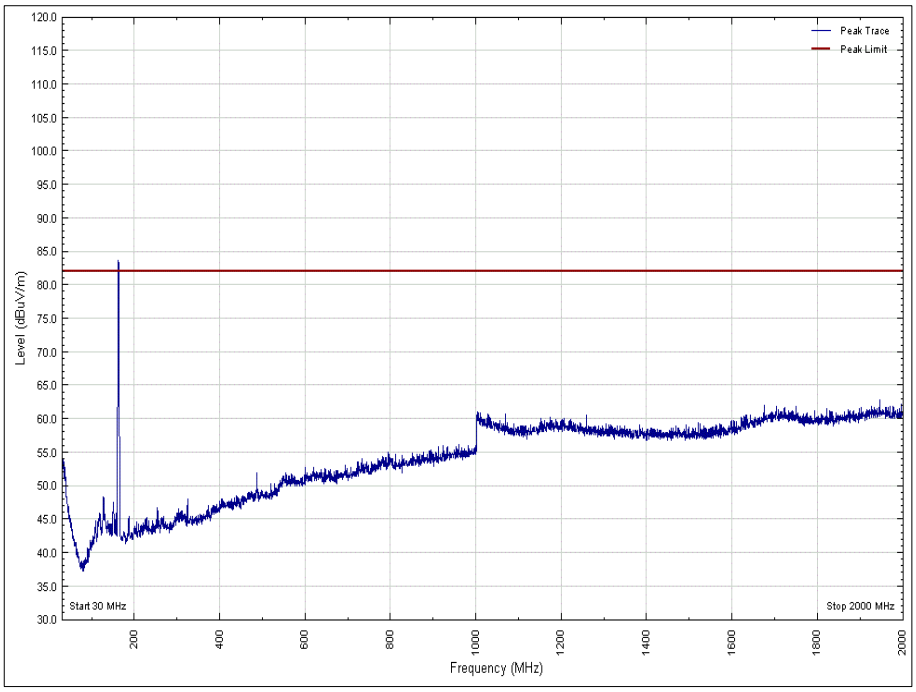


**Figure 50 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal**

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.

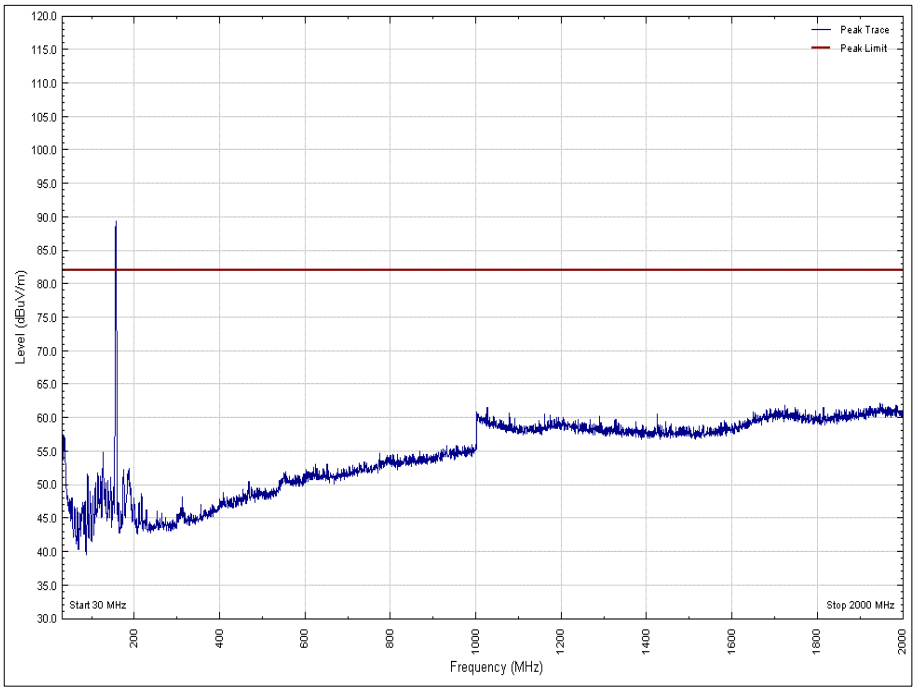


**Figure 51 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical**

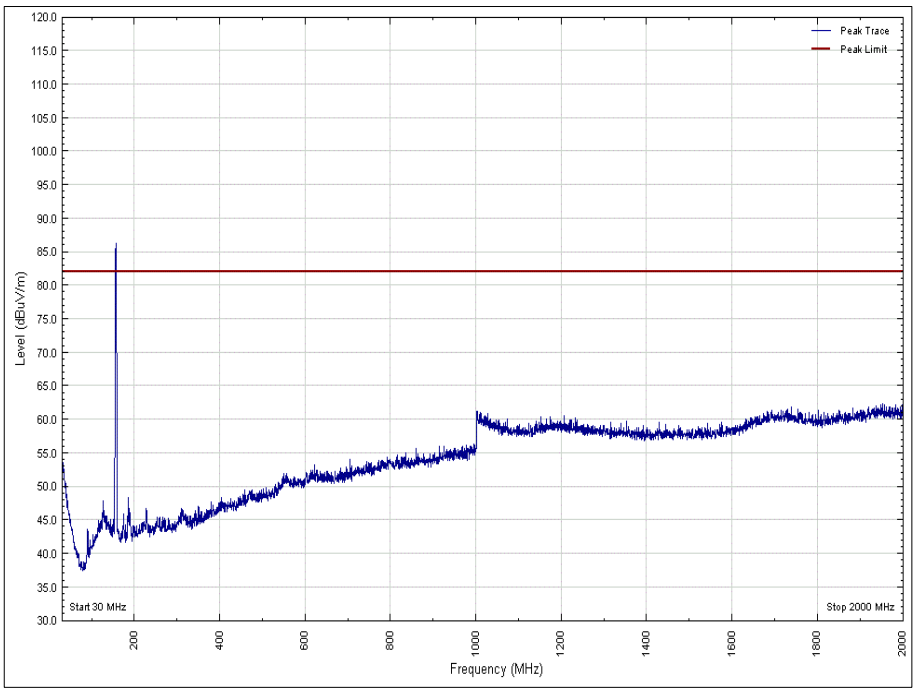


**Figure 52 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal**

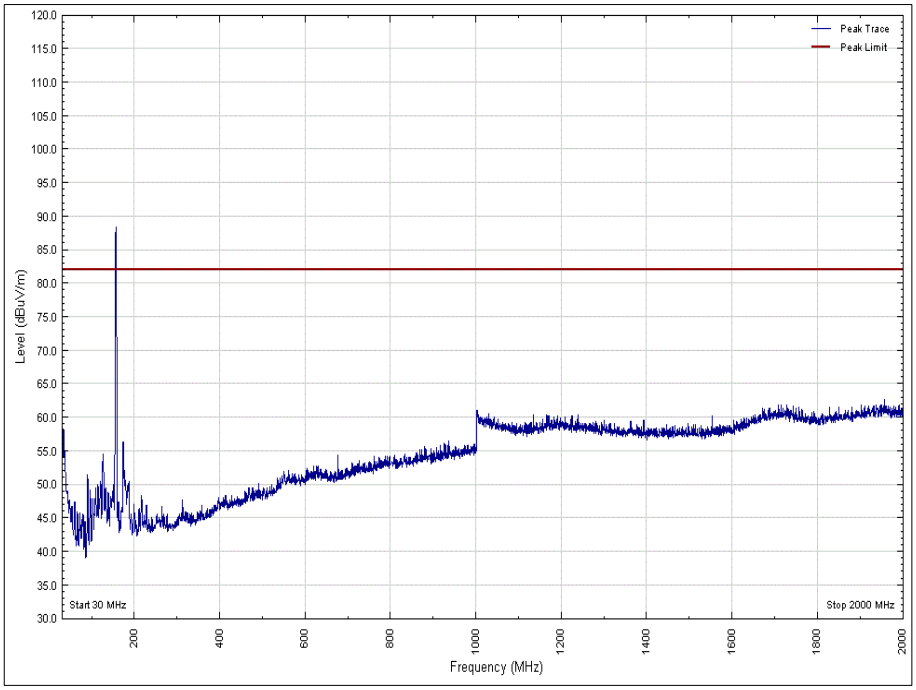


**Figure 53 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical**

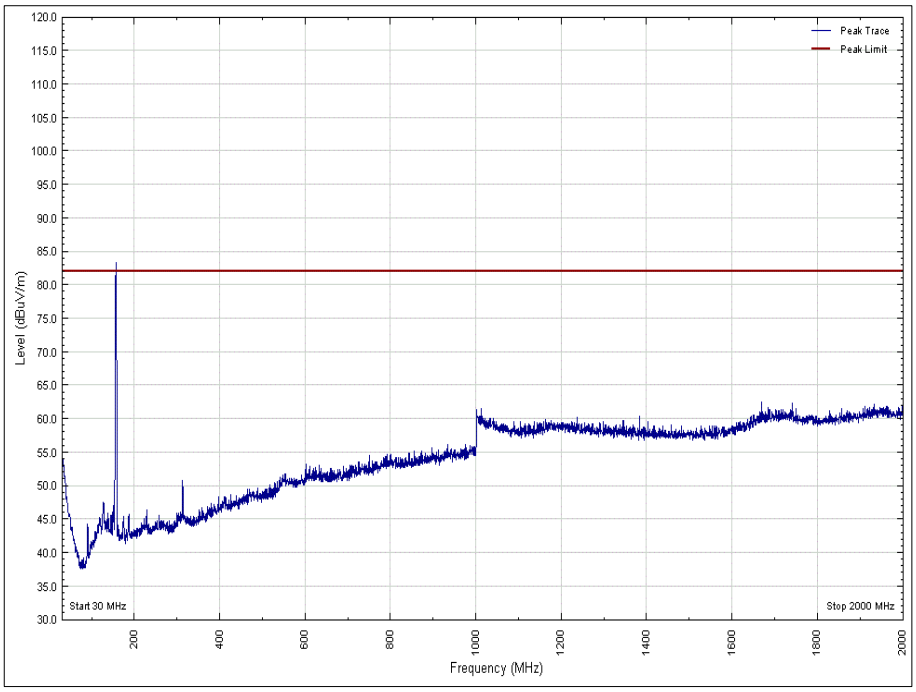


**Figure 54 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal**

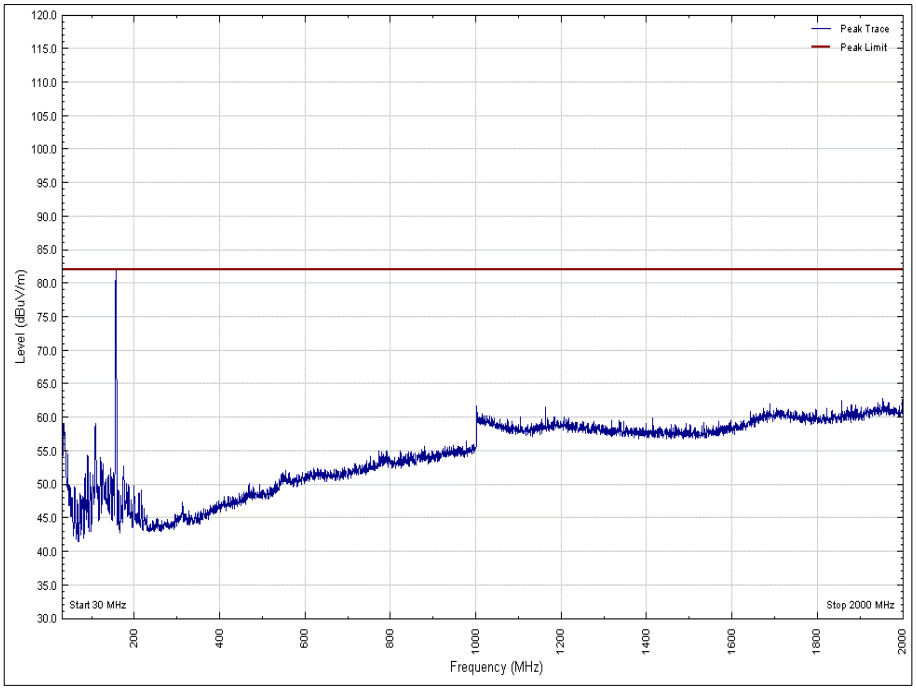


**Figure 55 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical**

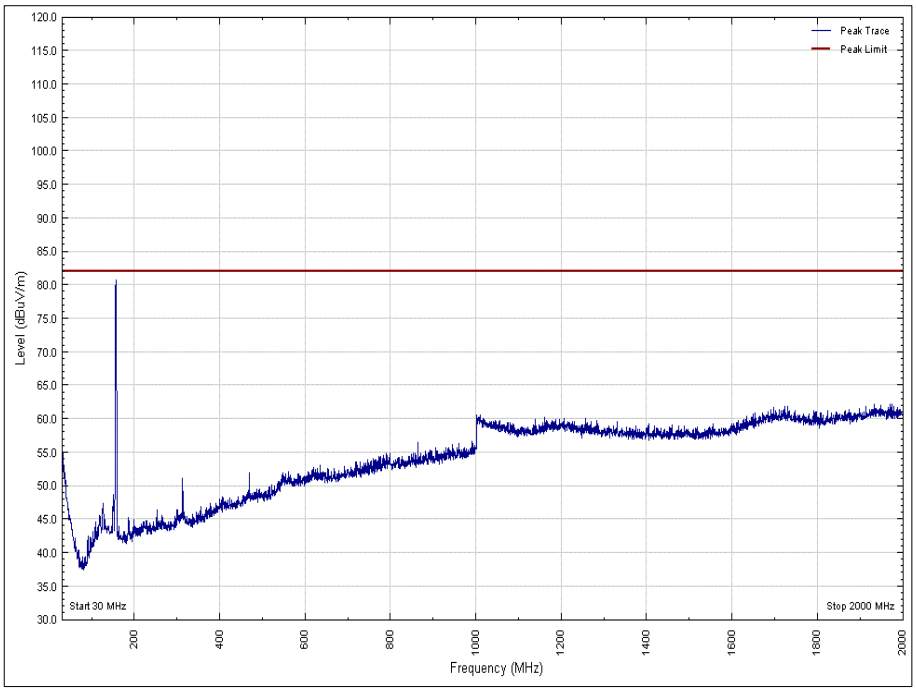


**Figure 56 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal**

| Frequency (MHz) | Level (dBm) |
|---|---|
| * | |

**Table 25 - 162.025 MHz - Emissions Results**

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

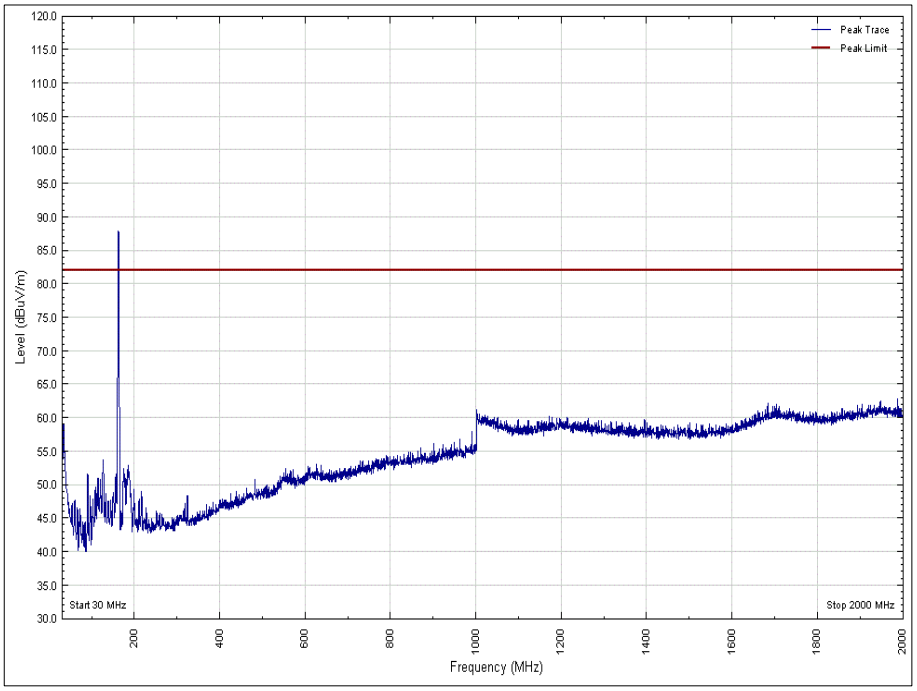


**Figure 57 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical**

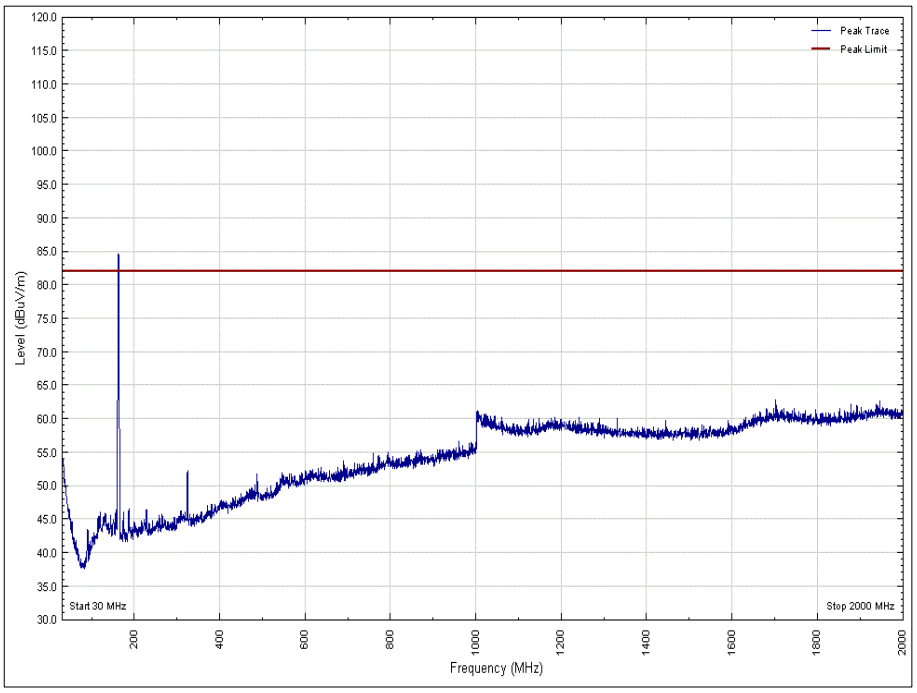


**Figure 58 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal**

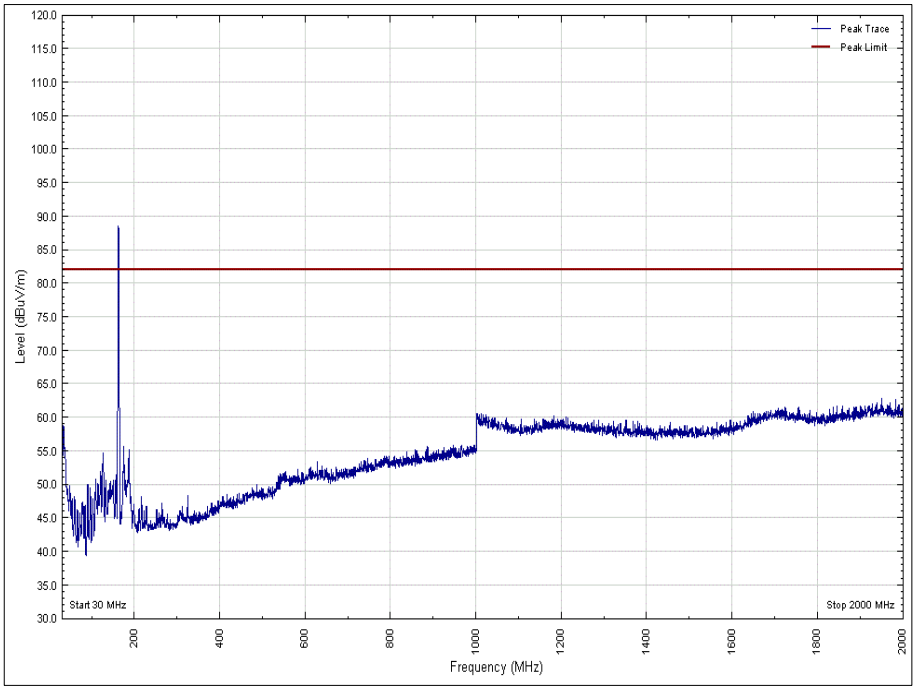


**Figure 59 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical**

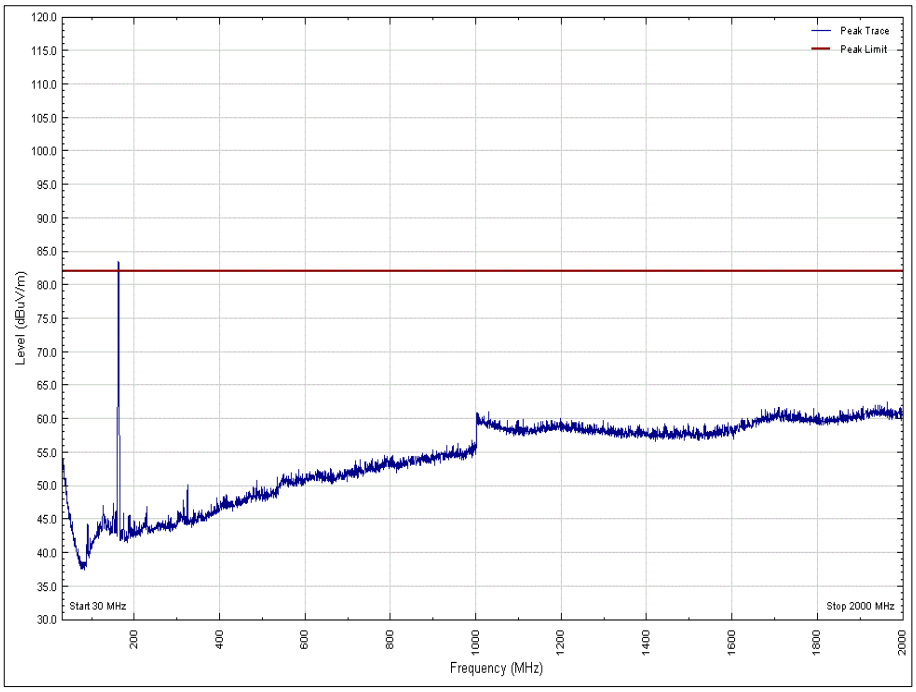


**Figure 60 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal**

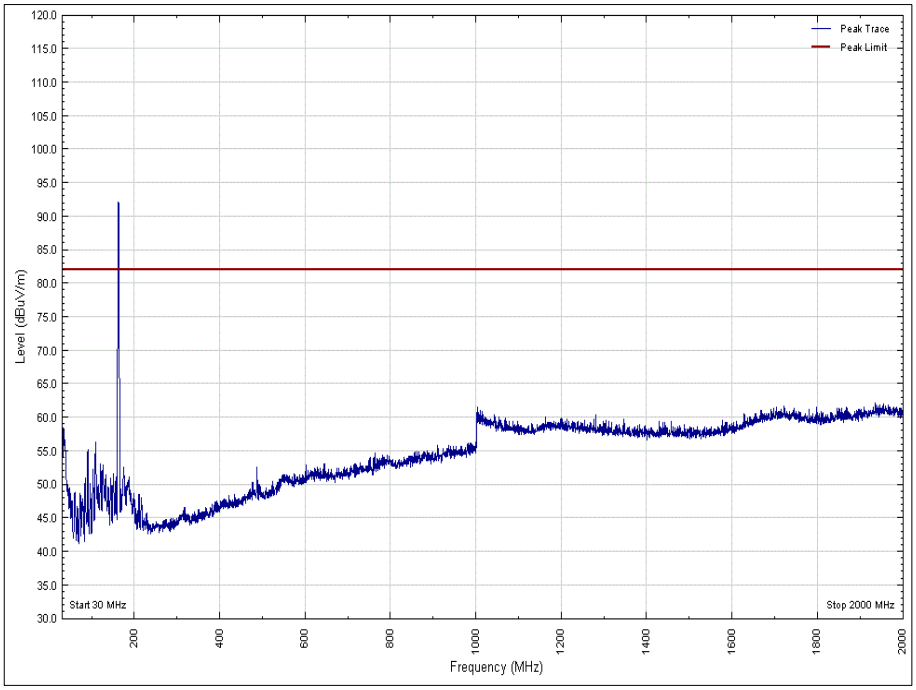


**Figure 61 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical**

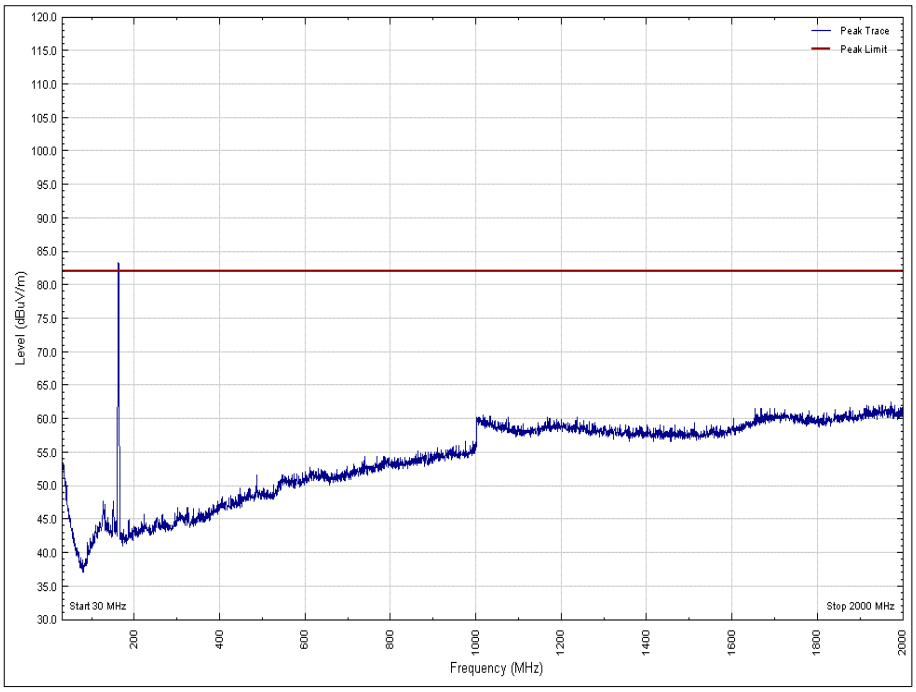


**Figure 62 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal**

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

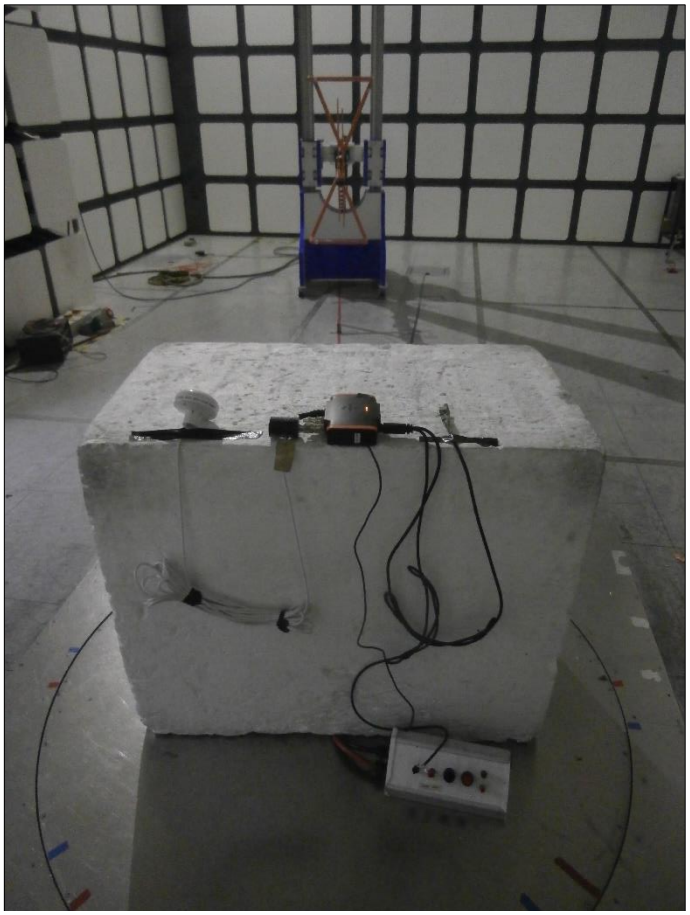

**Figure 63 - Test Setup - 30 MHz to 1 GHz**

**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<br>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.