

FCC and ISEDC Test Report

SRT Marine Systems

AIS Class B Transceiver, Model: VMS-100s

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

Prepared for: SRT Marine Systems plc
Wireless House
Westfield Industrial Estate
Midsomer Norton
Bath, BA3 4BS
United Kingdom



Add value.
Inspire trust.

FCC ID: UYW-4290002

IC: 7075A-4290002A

COMMERCIAL-IN-CONFIDENCE

Document Number: 75946230-04 | Issue: 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Matthew Russell	RF Team Leader	Authorised Signatory	10 October 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.

SIGNATURE

NAME	RESPONSIBLE FOR	DATE
Daniel Bishop	Testing	10 October 2019
Graeme Lawler	Testing	10 October 2019

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 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 Amendment 1 (2019-03) for the tests detailed in section 1.3.



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD. No part of this document may be reproduced without the prior written approval of TÜV SÜD. © 2019 TÜV SÜD. This report relates only to the actual item/items tested.

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).

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

TÜV SÜD Ltd is a
TÜV SÜD Group Company

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

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



Contents

1	Report Summary	2
1.1	Report Modification Record.....	2
1.2	Introduction.....	2
1.3	Brief Summary of Results	3
1.4	Application Form	4
1.5	Product Information	6
1.6	Deviations from the Standard.....	6
1.7	EUT Modification Record	6
1.8	Test Location.....	7
2	Test Details	8
2.1	Bandwidths	8
2.2	Transmitter Frequency Tolerances	12
2.3	Spurious Emissions at Antenna Terminals	16
2.4	Radiated Spurious Emissions	25
2.5	Modulation Requirements	34
2.6	Transmitter Power	42
2.7	Suppression of Interference Aboard Ships	44
3	Photographs	51
3.1	Test Setup Photographs	51
4	Measurement Uncertainty	57



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	10 October 2019

Table 1

1.2 Introduction

Applicant	SRT Marine Systems plc
Manufacturer	SRT Marine Systems plc
Model Number(s)	VMS-100s
Serial Number(s)	EP2-15
Hardware Version(s)	V3
Software Version(s)	150201.01.xx.xx
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) ISED RSS-GEN: Issue 5 Amendment 1 (2019-03)
Order Number	POR007580
Date	06-June-2019
Date of Receipt of EUT	25-July-2019
Start of Test	02-August-2019
Finish of Test	10-September-2019
Name of Engineer(s)	Daniel Bishop and Graeme Lawler
Related Document(s)	ANSI C63.26: 2015



1.3 Brief Summary of Results

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

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 80	Part 2	RSS-182	RSS-GEN			
Configuration and Mode: DC Powered - 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	< 250% of authorised BW only.
2.5	80.213	2.1047	7.7	-	Modulation Requirements	Pass	
2.6	80.215	2.1046	7.5	6.12	Transmitter Power	Pass	
Configuration and Mode: DC Powered - 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	< 250% of authorised BW only.
2.5	80.213	2.1047	7.7	-	Modulation Requirements	Pass	
2.6	80.215	2.1046	7.5	6.12	Transmitter Power	Pass	
Configuration and Mode: DC Powered - AIS Transmitter (Tx1 and Tx2)							
2.3	80.211	2.1051	7.9	6.13	Spurious Emissions at Antenna Terminals	Pass	> 250% of authorised BW only.
2.4	80.211	2.1051	7.9	6.13	Radiated Spurious Emissions	Pass	
Configuration and Mode: DC Powered - AIS Receiver Operating							
2.7	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
Manufacturer:	SRT Marine Systems plc
Model:	VMS-100s
Part Number:	429-0002
Hardware Version:	V3
Software Version:	150201.01.xx.xx
FCC ID (if applicable)	UYW-4290002
IC ID (if applicable)	7075A-4290002A

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	5825 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	136.37 MHz
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:		dBI
External antenna ☒	Type:	Marine VHF vertical	dBI

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: 04/09/2019



1.5 Product Information

1.5.1 Technical Description

Class B SOTDMA AIS Transceiver.

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: VMS-100S: Serial Number: EP2-15			
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 - 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
Configuration and Mode: DC Powered - 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
Configuration and Mode: DC Powered - AIS Transmitter (Tx1 and Tx2)		
Spurious Emissions at Antenna Terminals	Daniel Bishop	UKAS
Radiated Spurious Emissions	Graeme Lawler	UKAS
Configuration and Mode: DC Powered - 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
ISED RSS-GEN, Clause 6.7

2.1.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.1.3 Date of Test

02-August-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, ISED RSS-GEN Clause 6.6 and ANSI C63.26 clause 5.4.4.

The EUT was transmitting at maximum power, modulated by the standard AIS test signals 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 52.6 %

2.1.6 Test Results

DC Powered - AIS Transmitter (Tx1)

99% Occupied Bandwidth (kHz)	
156.025 MHz	162.025 MHz
9.517	9.642

Table 5 - Occupied Bandwidth Results



Figure 1 - 156.025 MHz Occupied Bandwidth



Figure 2 - 162.025 MHz Occupied Bandwidth



DC Powered - AIS Transmitter (Tx2)

99% Occupied Bandwidth (kHz)	
156.025 MHz	162.025 MHz
9.590	9.589

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

< 20 kHz

ISED RSS-GEN, Limit Clause

None Specified.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
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
ISED RSS-GEN, Clause 6.11

2.2.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.2.3 Date of Test

06-August-2019 to 07-August-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 frequency counter using an external 10 MHz frequency reference. The difference between the frequency of the fundamental and the frequency of the assigned channel in accordance with the manufacturer's documentation was recorded. In accordance with 2.1055, the temperature was varied from -20°C to +50°C in 10° steps and at 20°C for both minimum and maximum voltage extremes.

2.2.5 Environmental Conditions

Ambient Temperature	24.0 °C
Relative Humidity	55.8 %



2.2.6 Test Results

DC Powered - AIS Transmitter (Tx1)

Voltage	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
27.6 V DC	-0.103	-0.890
10.2 V DC	-0.616	-0.594

Table 8 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
+50.0 °C	-0.822	-0.791
+40.0 °C	-0.822	-0.890
+30.0 °C	-0.514	-0.594
+20.0 °C	0.103	-0.198
+10.0 °C	1.541	1.286
0 °C	2.054	1.780
-10.0 °C	2.979	2.770
-20.0 °C	2.989	2.770

Table 9 - Frequency Stability Under Temperature Variations



DC Powered - AIS Transmitter (Tx2)

Voltage	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
27.6 V DC	0	0.692
10.2 V DC	0.411	0.297

Table 10 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)	
	156.025 MHz	162.025 MHz
+50.0 °C	0.924	0.692
+40.0 °C	0.719	0.890
+30.0 °C	0.411	0.495
+20.0 °C	-0.103	-0.297
+10.0 °C	-1.643	-1.583
0 °C	-2.157	-2.078
-10.0 °C	-3.287	-3.066
-20.0 °C	-3.801	-3.561

Table 11 - Frequency Stability Under Temperature Variations

FCC 47 CFR Part 80, Limit Clause 80.209

± 10 ppm.



2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
Digital Temperature Indicator	Fluke	51	1385	12	17-Jan-2020
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
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
ISED RSS-GEN, Clause 6.13

2.3.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.3.3 Date of Test

05-August-2019

2.3.4 Test Method

This test was performed in accordance with ANSI C63.26, clause 5.7.

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 300 MHz and 2 GHz a 300 MHz high pass filter was used.

2.3.5 Environmental Conditions

Ambient Temperature	23.3 °C
Relative Humidity	66.9 %



2.3.6 Test Results

DC Powered - AIS Transmitter (Tx1)

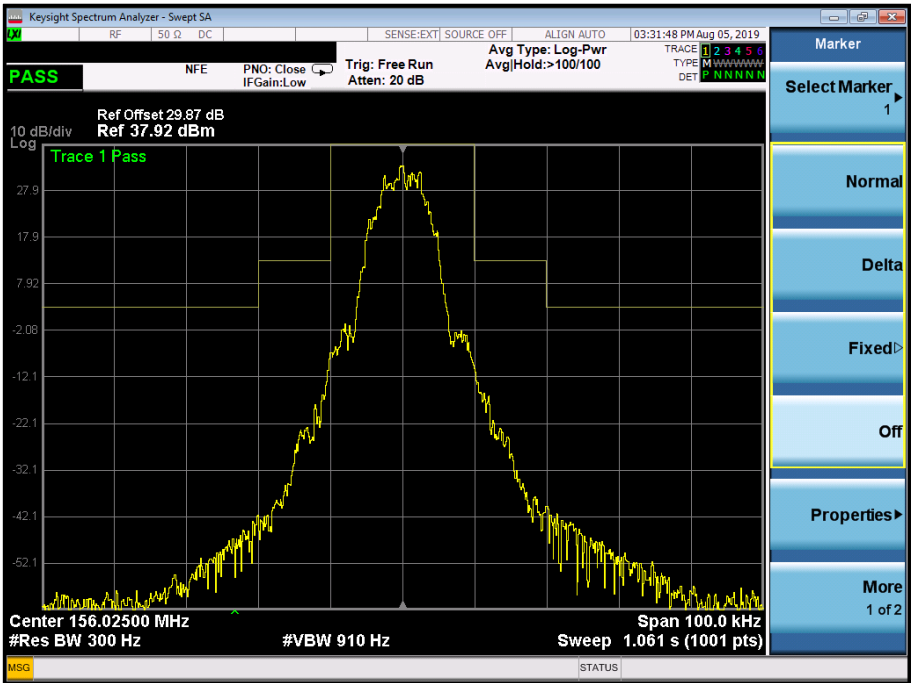


Figure 5 - 156.025 MHz - Transmitter Spectrum Mask

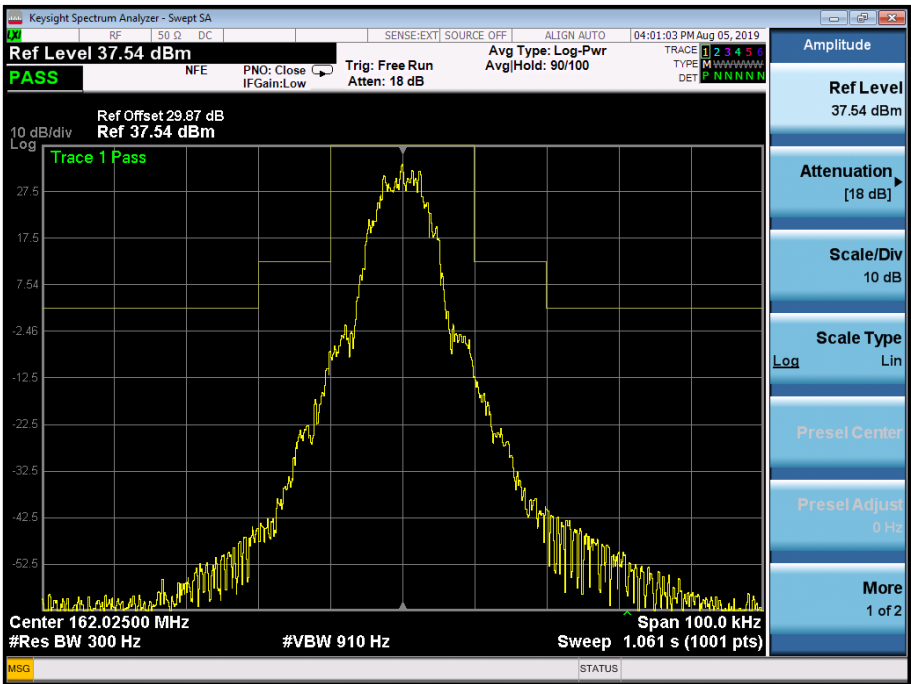


Figure 6 - 162.025 MHz - Transmitter Spectrum Mask



DC Powered - AIS Transmitter (Tx2)

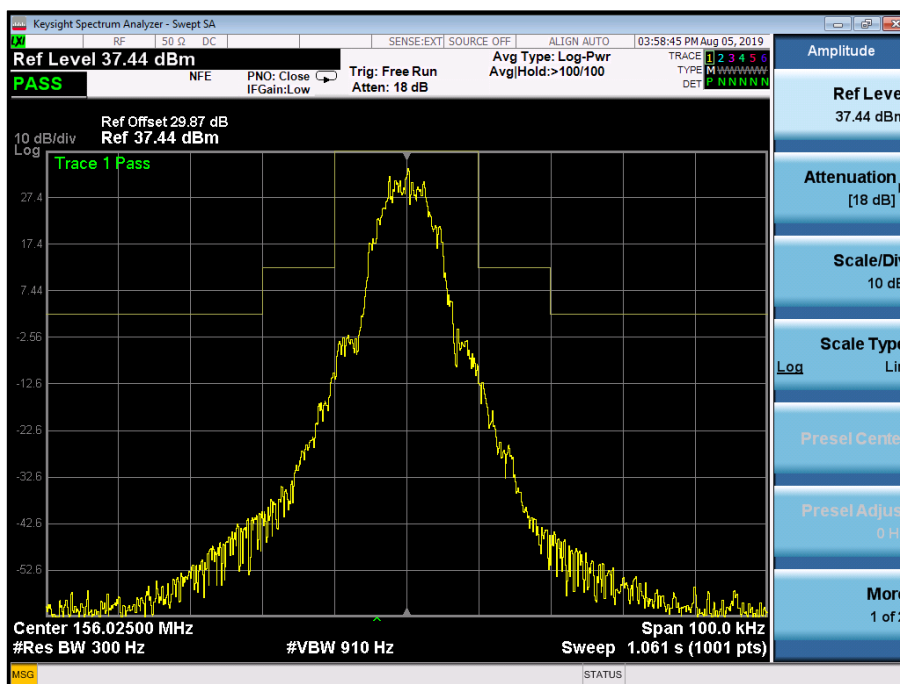


Figure 7 - 156.025 MHz - Transmitter Spectrum Mask

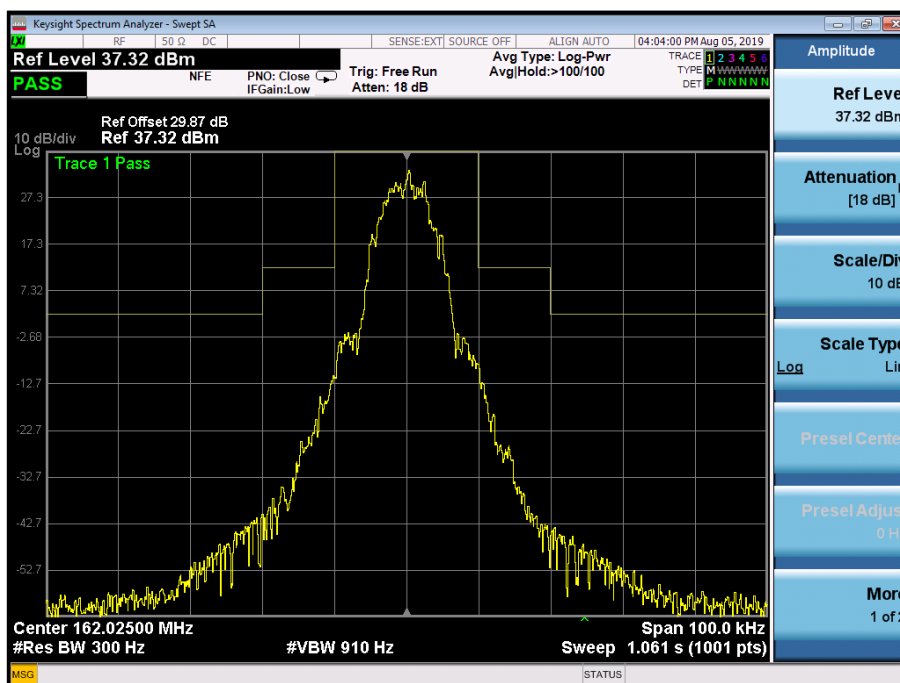


Figure 8 - 162.025 MHz - Transmitter Spectrum Mask



DC Powered - AIS Transmitter (Tx1 and Tx2)



Figure 9 - 156.025 MHz - 9 kHz to 150 kHz

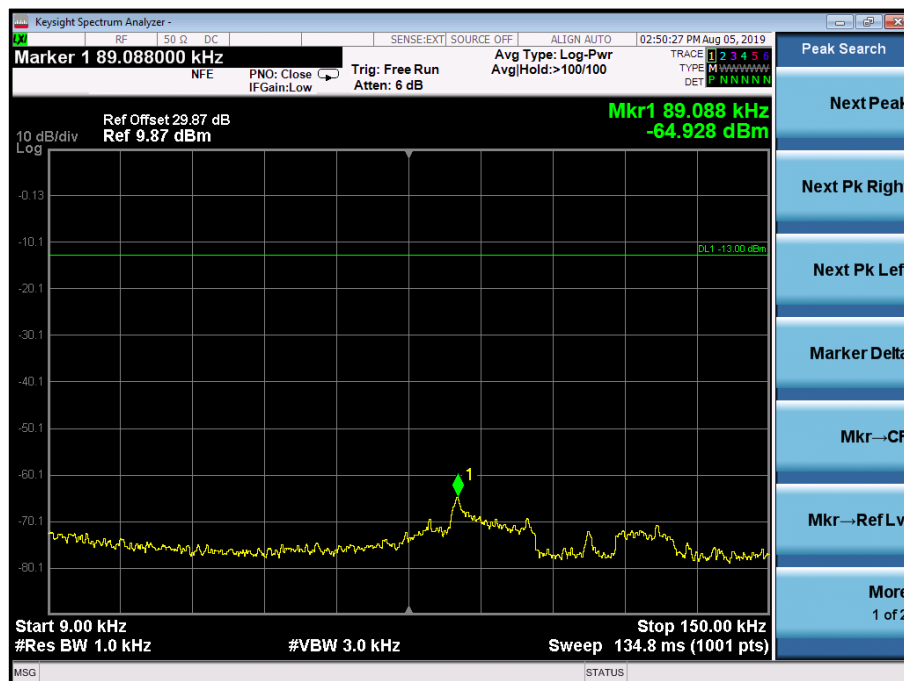


Figure 10 - 162.025 MHz - 9 kHz to 150 kHz

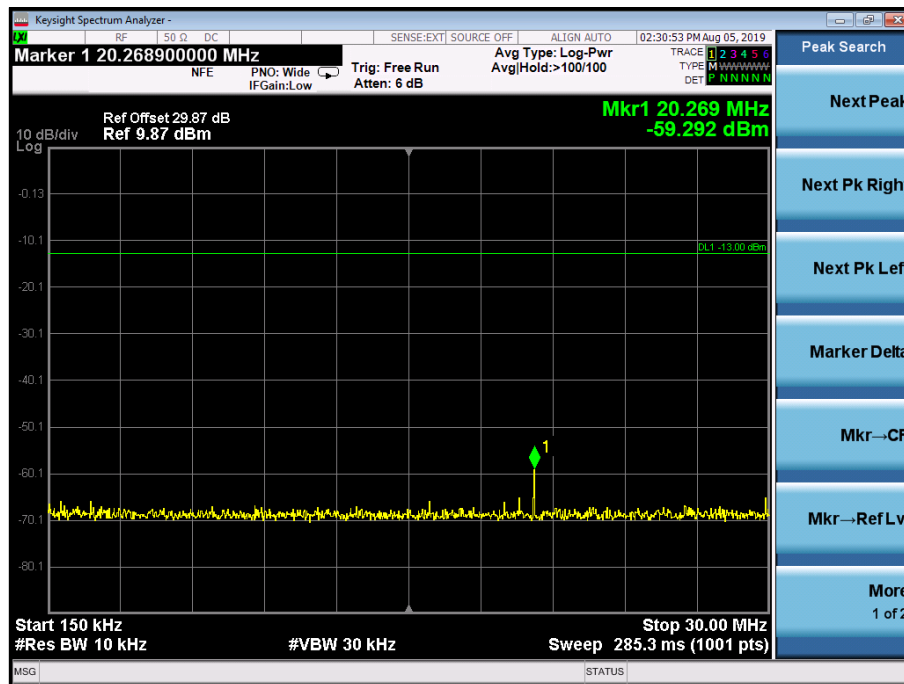


Figure 11 - 156.025 MHz - 150 kHz to 30 MHz

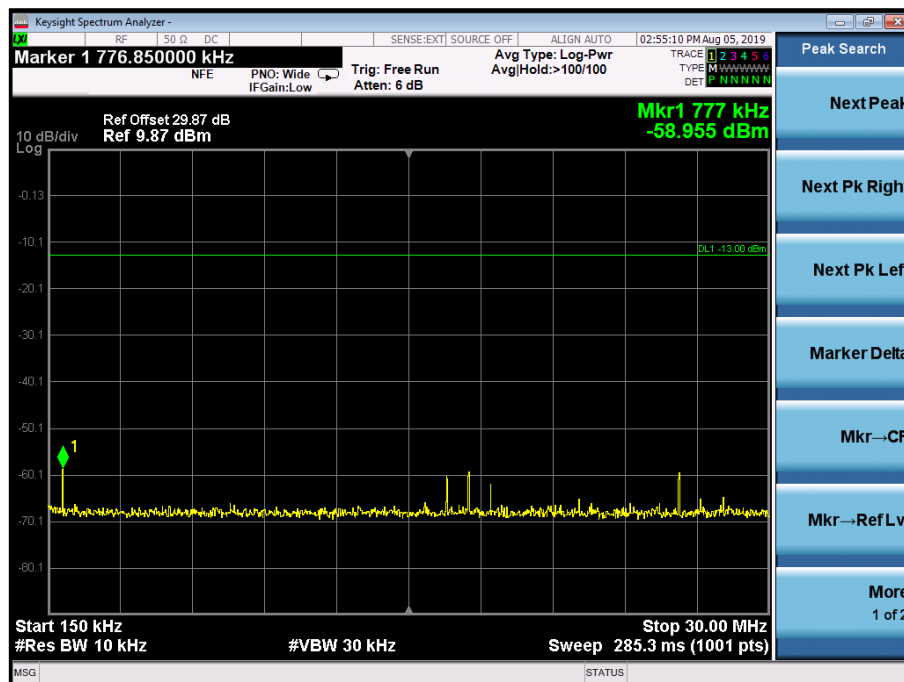


Figure 12 - 162.025 MHz - 150 kHz to 30 MHz

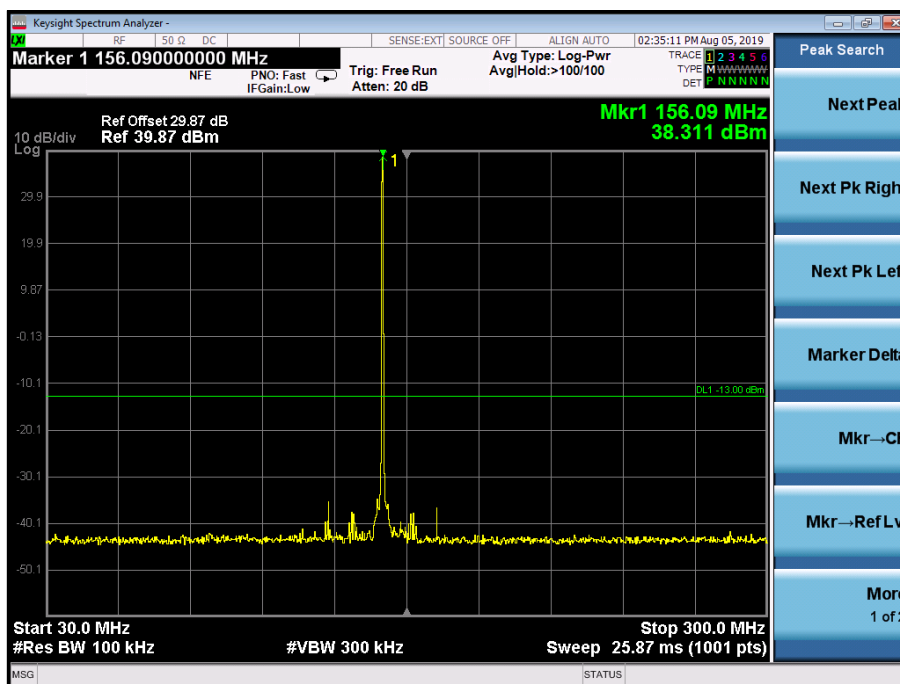


Figure 13 - 156.025 MHz - 30 MHz to 300 MHz

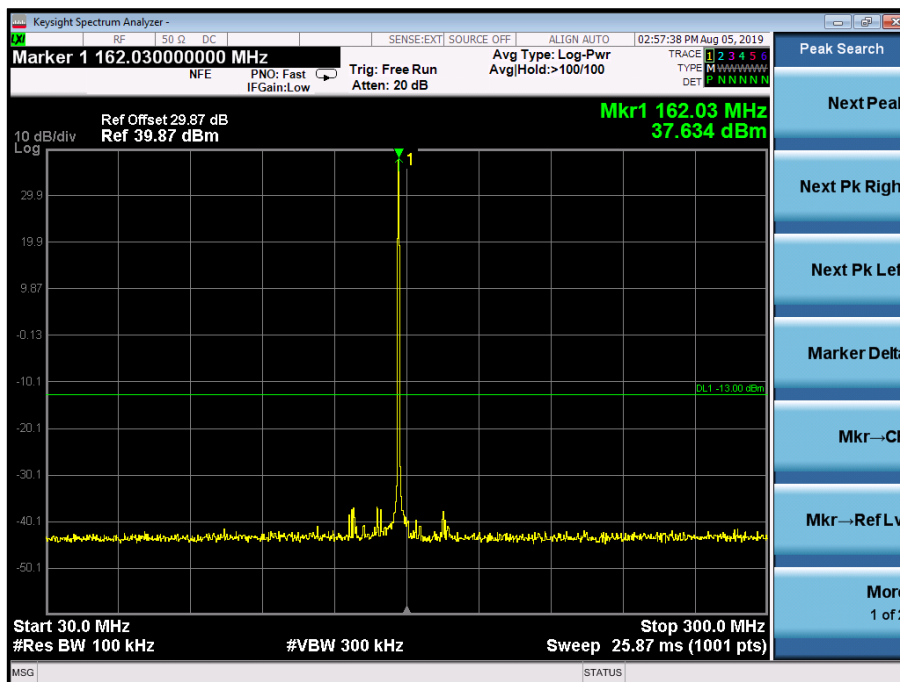


Figure 14 - 162.025 MHz - 30 MHz to 300 MHz

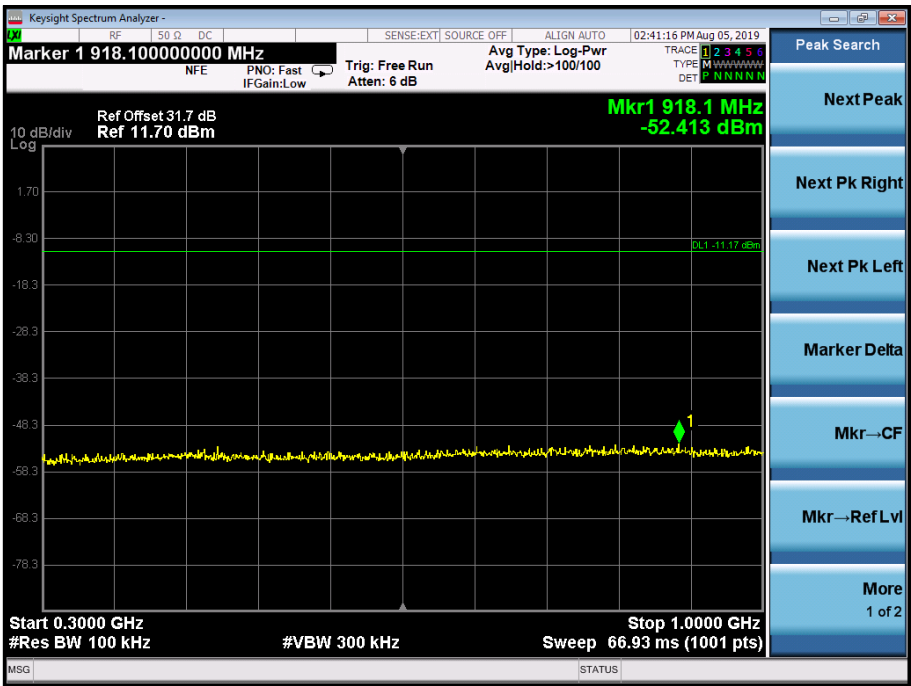


Figure 15 - 156.025 MHz - 300 MHz to 1 GHz

Remark: The limit for the above measurement is -13 dBm

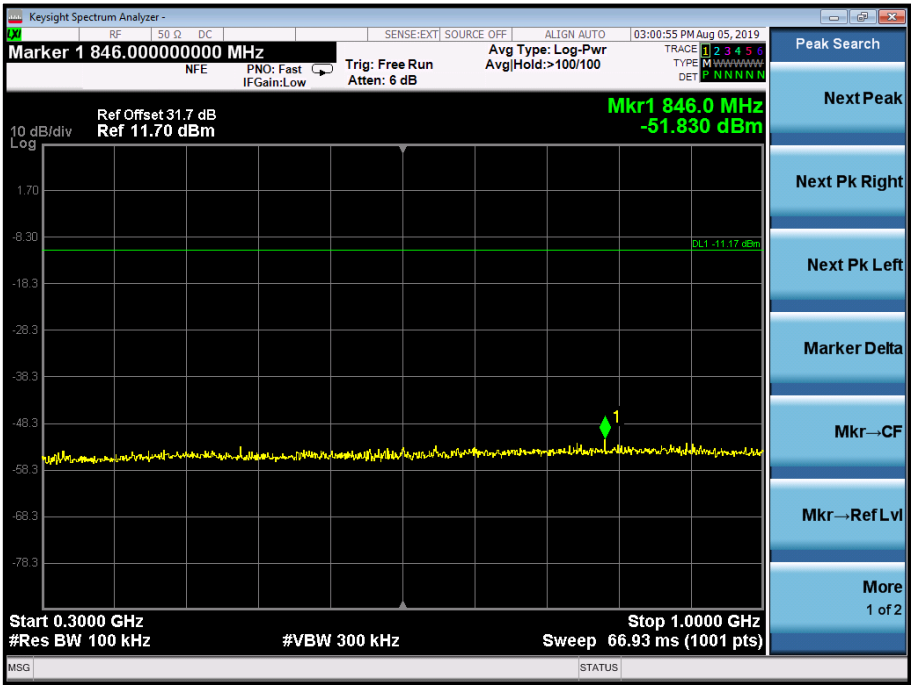


Figure 16 - 162.025 MHz - 300 MHz to 1 GHz

Remark: The limit for the above measurement is -13 dBm

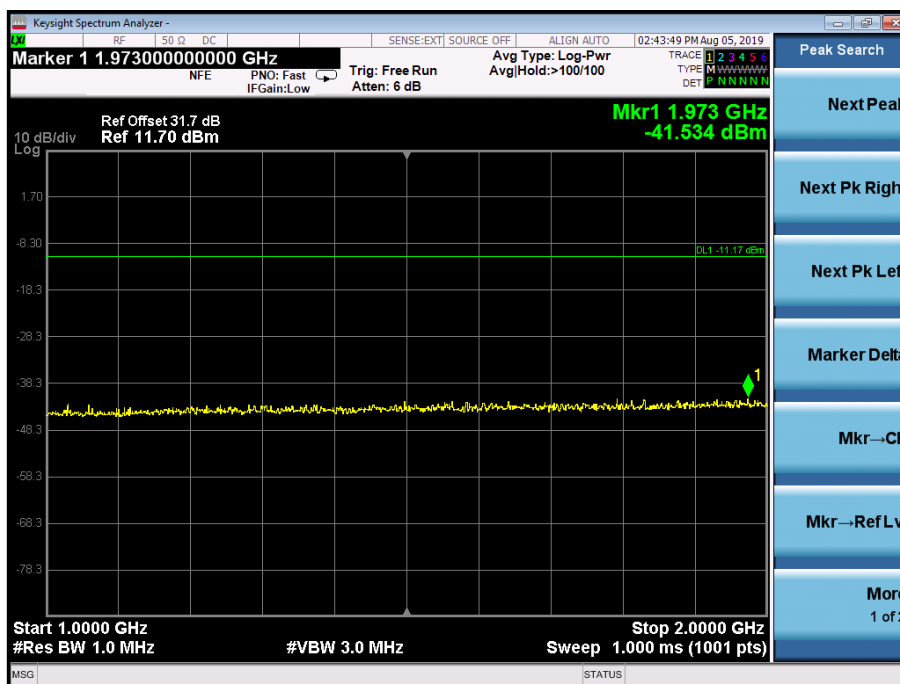


Figure 17 - 156.025 MHz - 1 GHz to 2 GHz

Remark: The limit for the above measurement is -13 dBm

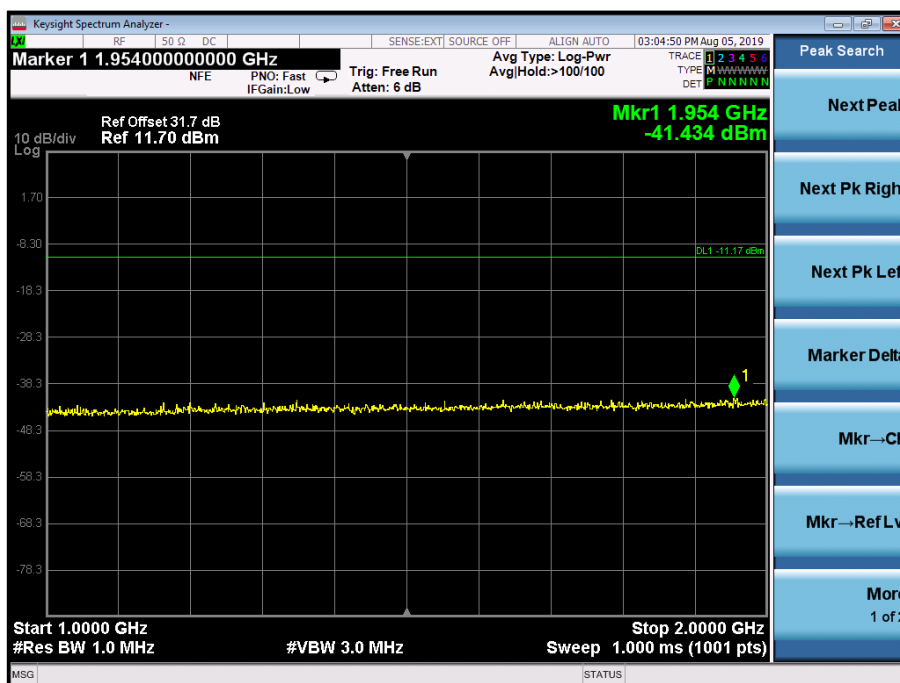


Figure 18 - 162.025 MHz - 1 GHz to 2 GHz

Remark: The limit for the above measurement is -13 dBm



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 $43 + 10 \log_{10} p(\text{watts})$ 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 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
High Pass Filter	Mini-Circuits	NHP-300	1640	12	23-Oct-2019
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 13

O/P Mon – Output Monitored using calibrated equipment



2.4 Radiated Spurious Emissions

2.4.1 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
ISED RSS-GEN, Clause 6.13

2.4.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.4.3 Date of Test

10-September-2019

2.4.4 Test Method

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

Pre-scans were performed using the Direct Field Strength method. Any emissions found to be within 10dB of the specification limit were formally measured using the Direct Field Strength method.

The rule part limit of -13dBm was converted to a field strength limit using equation c) in ANSI C63.26 clause 5.2.7

$E \text{ (dBuV/m)} = \text{EIRP (dBm)} - 20\log(D) + 104.8$ where D is the measurement distance.

For a measurement distance of 3 m:

$E \text{ (dBuV/m)} = -13 - 20\log(3) + 104.8 = 82.2\text{dBuV/m}$.

This limit line is found on the pre-scan plots.

The EUT was set to transmit on maximum power with both Tx1 and Tx2 operating in turn.

For any emissions found the EUT was then removed from the chamber and replaced with a substitution antenna. Using a signal generator, the level was adjusted to achieve the same value on the measuring instrument as previously recorded with the EUT. The final result was determined by a calculation using the signal generator level, antenna gain and cable loss.

2.4.5 Environmental Conditions

Ambient Temperature	16.2 °C
Relative Humidity	80.0 %



2.4.6 Test Results

DC Powered - AIS Transmitter (Tx1 and Tx2)

Frequency (MHz)	Level (dBm)
*	

Table 14 - 156.025 MHz - Emissions Results

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

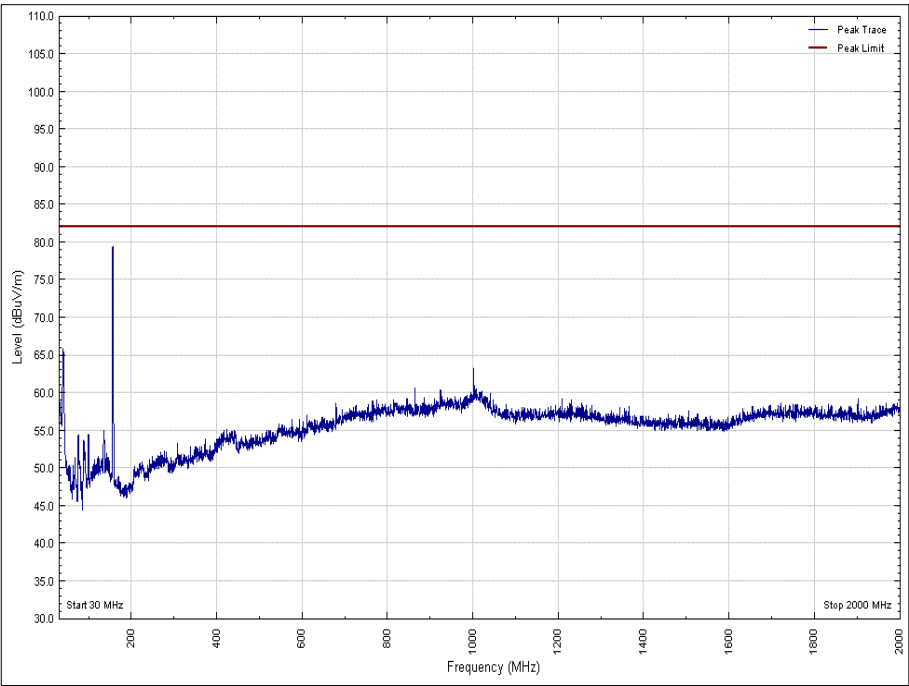


Figure 19 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

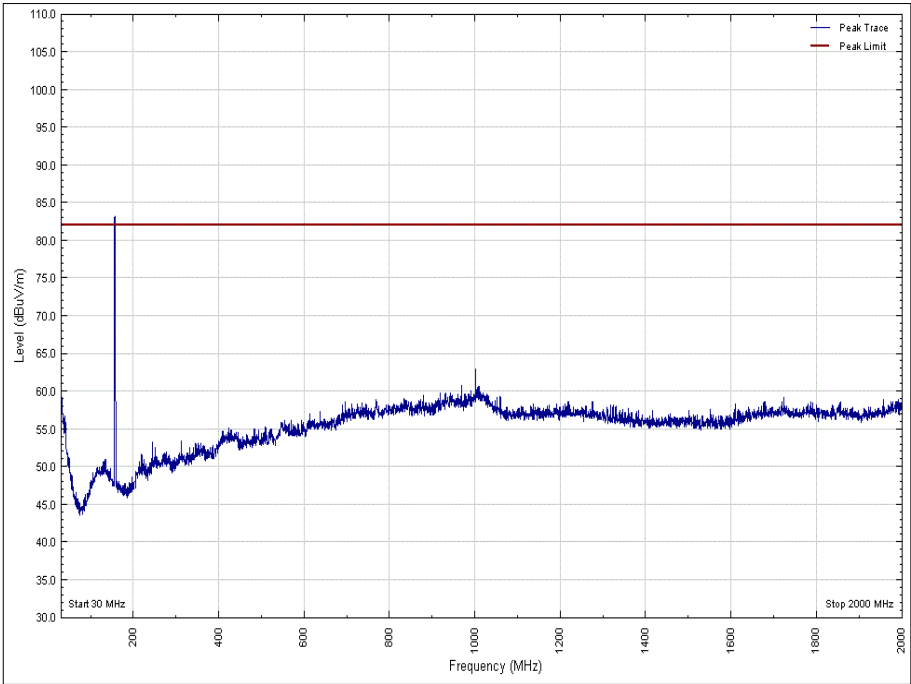


Figure 20 - 156.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

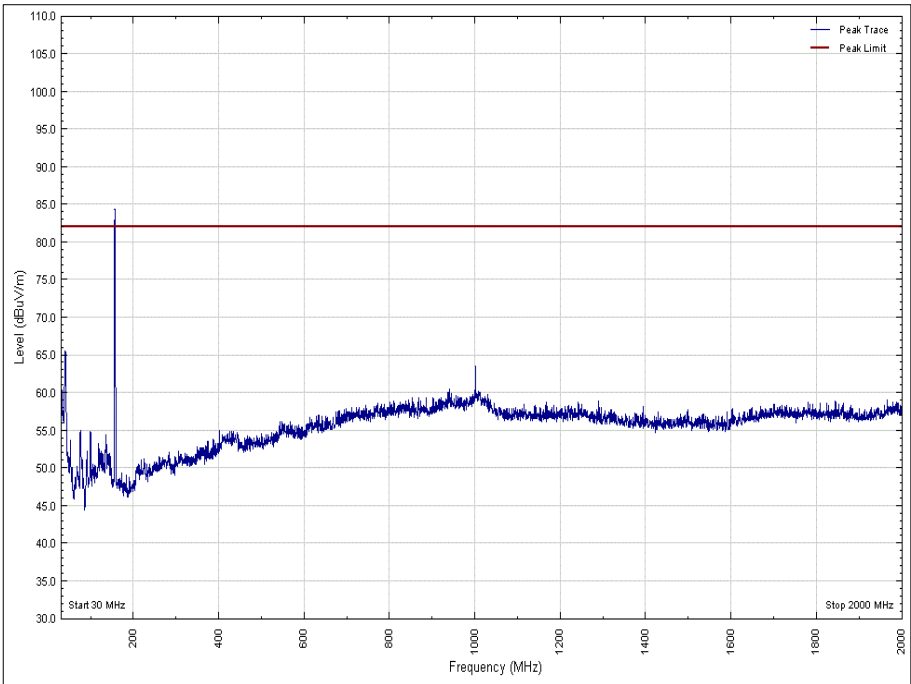


Figure 21 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

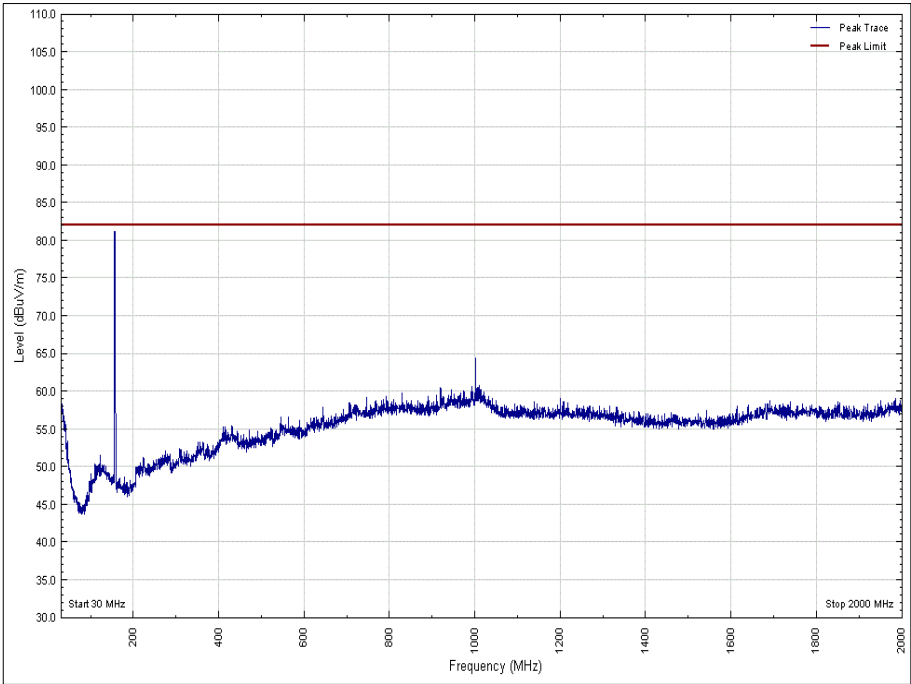


Figure 22 - 156.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

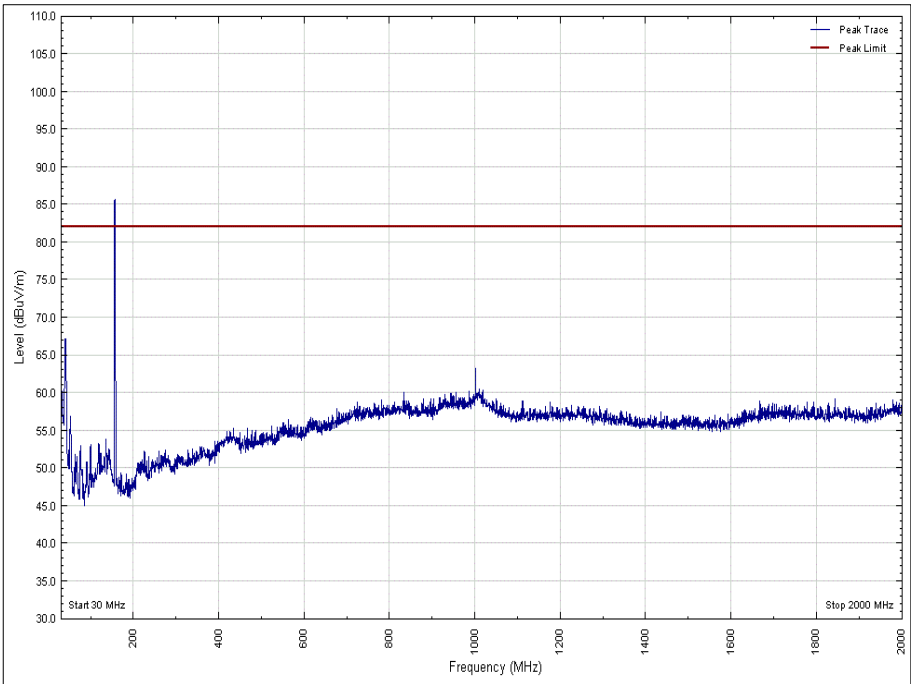


Figure 23 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

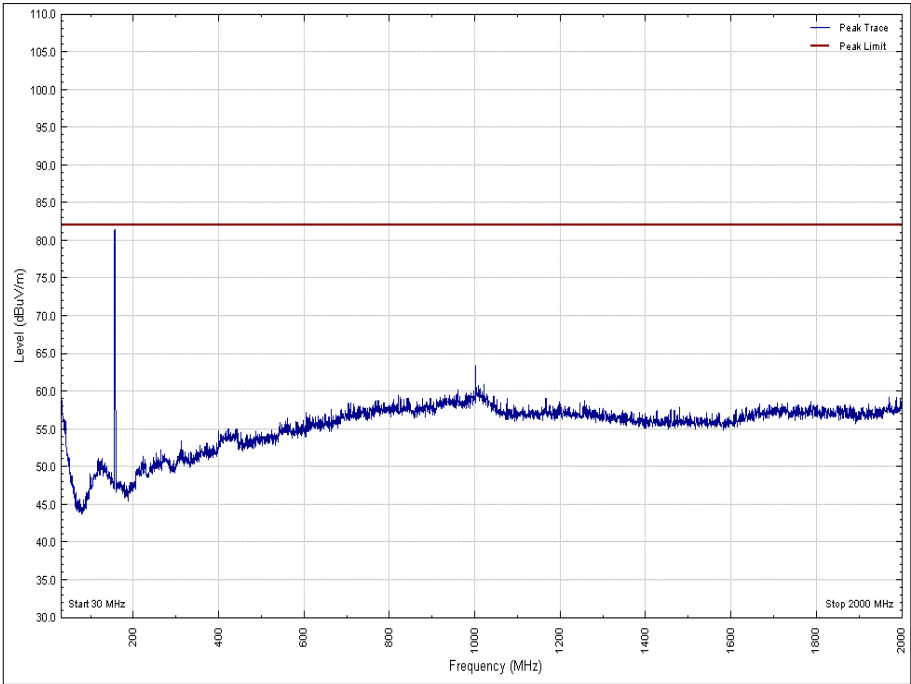


Figure 24 - 156.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal



Frequency (MHz)	Level (dBm)
*	

Table 15 - 162.025 MHz - Emissions Results

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

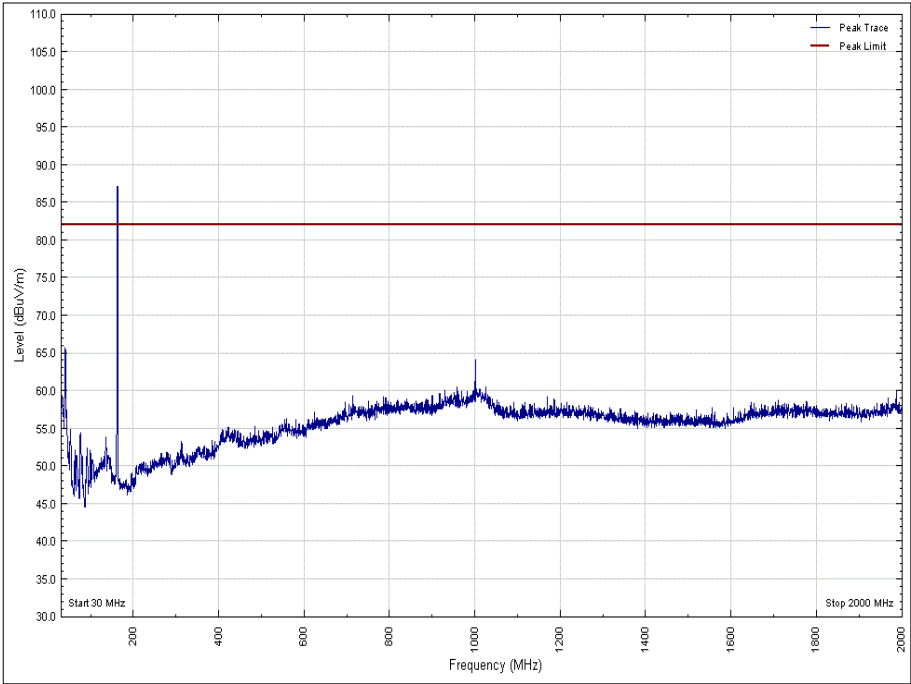


Figure 25 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Vertical

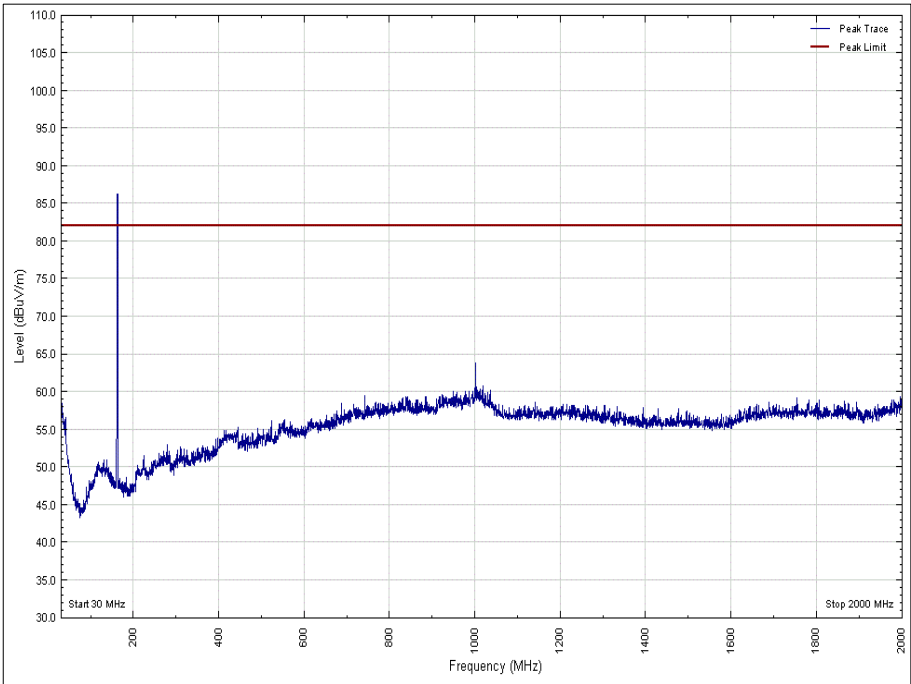


Figure 26 - 162.025 MHz - 30 MHz to 2 GHz - X Orientation Horizontal

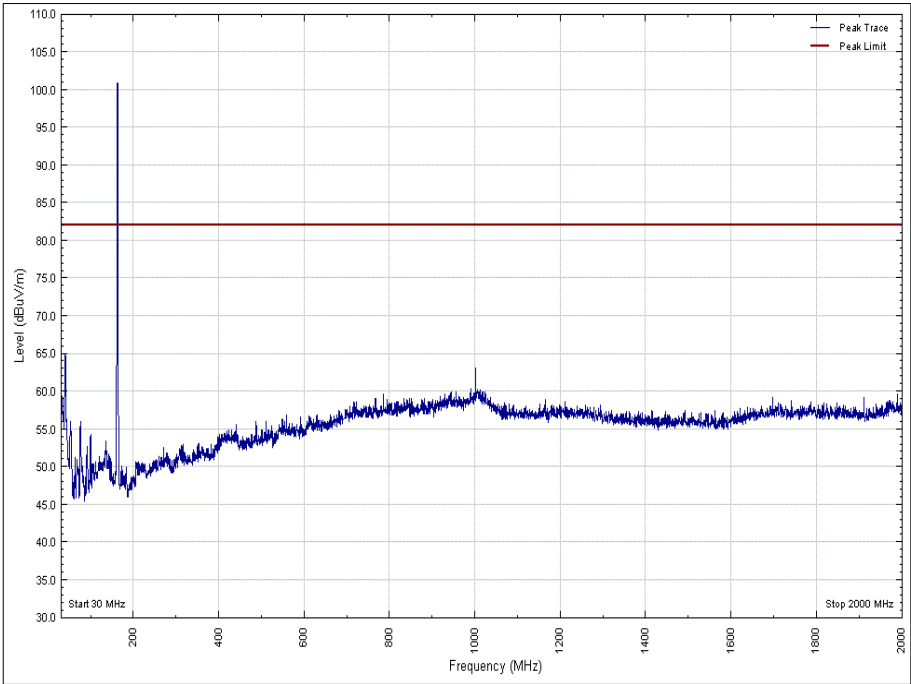


Figure 27 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Vertical

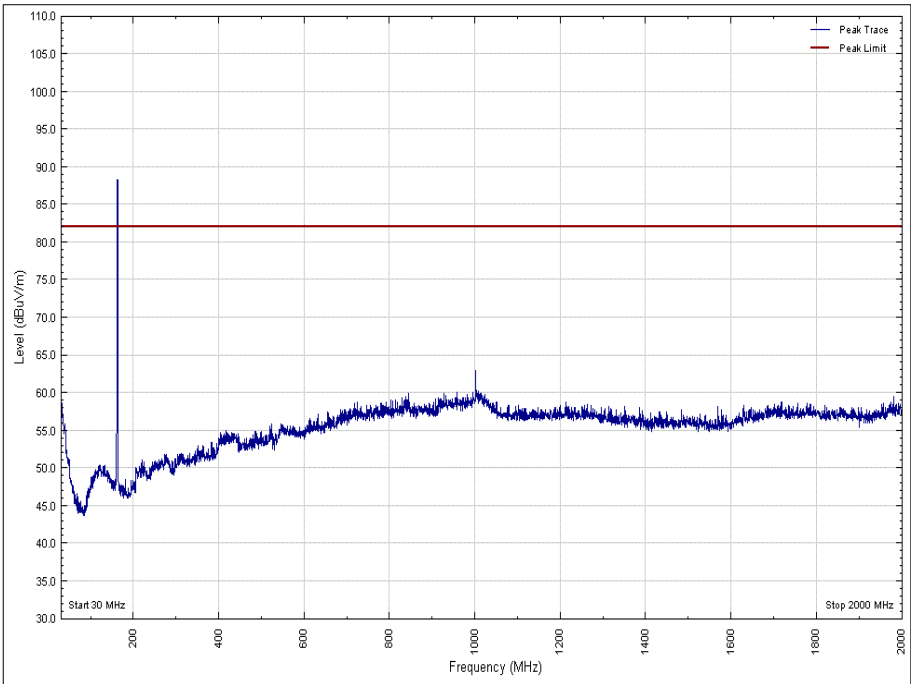


Figure 28 - 162.025 MHz - 30 MHz to 2 GHz - Y Orientation Horizontal

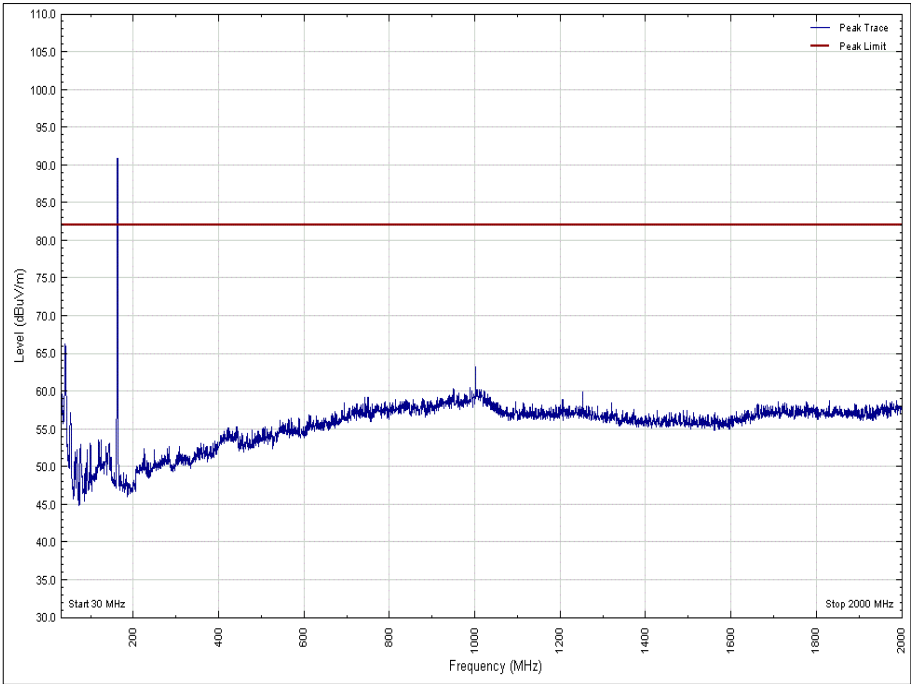


Figure 29 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Vertical

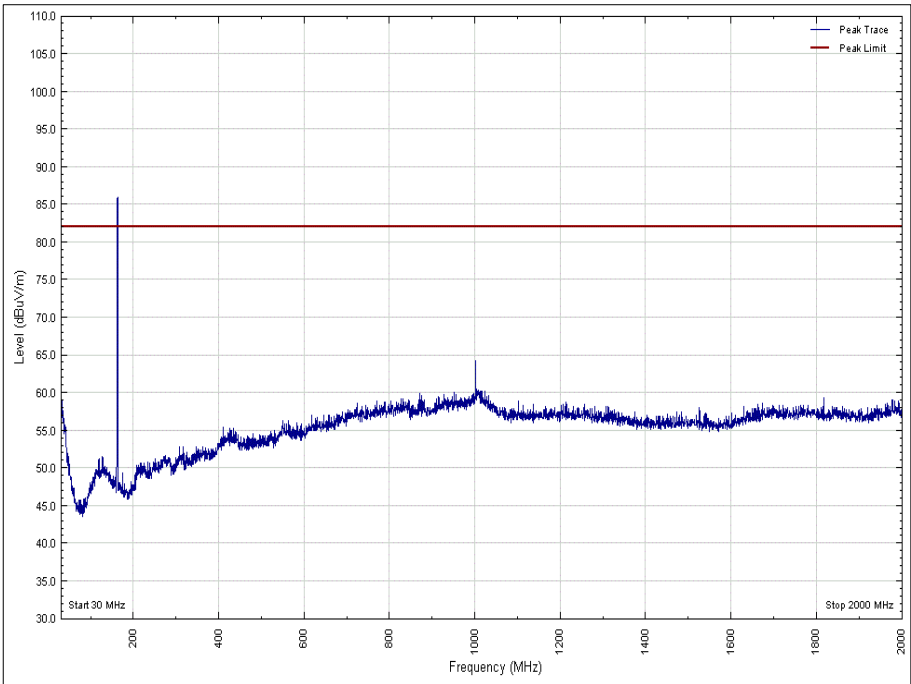


Figure 30 - 162.025 MHz - 30 MHz to 2 GHz - Z Orientation Horizontal



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 $43 + 10 \log_{10} p$ (watts) dB, measured with a bandwidth of 30 kHz.

2.4.7 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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
Antenna with permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	15-May-2020
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygrometer	Rotronic	A1	2677	12	20-Feb-2020
Comb Generator	Schaffner	RSG1000	3034	-	TU
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	11-Dec-2019
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	11-Mar-2020
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5093	12	04-Oct-2019
EmX Software	TUV SUD	EmX	5125	-	Software
Test Receiver (ESW)	Rohde & Schwarz	ESW44	5351	12	31-Jul-2020

Table 16

TU - Traceability Unscheduled



2.5 Modulation Requirements

2.5.1 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

2.5.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.5.3 Date of Test

05-August-2019

2.5.4 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 PRS 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.

2.5.5 Environmental Conditions

Ambient Temperature	23.3 °C
Relative Humidity	55.9 - 66.9 %

2.5.6 Test Results

DC Powered - AIS Transmitter (Tx1)

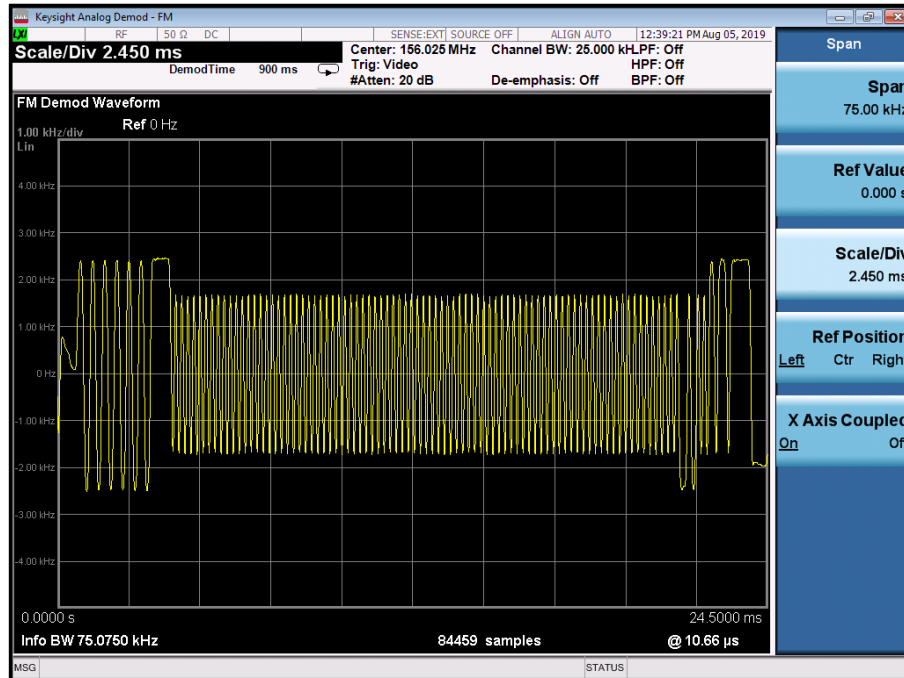


Figure 31 - 156.025 MHz - 01010101

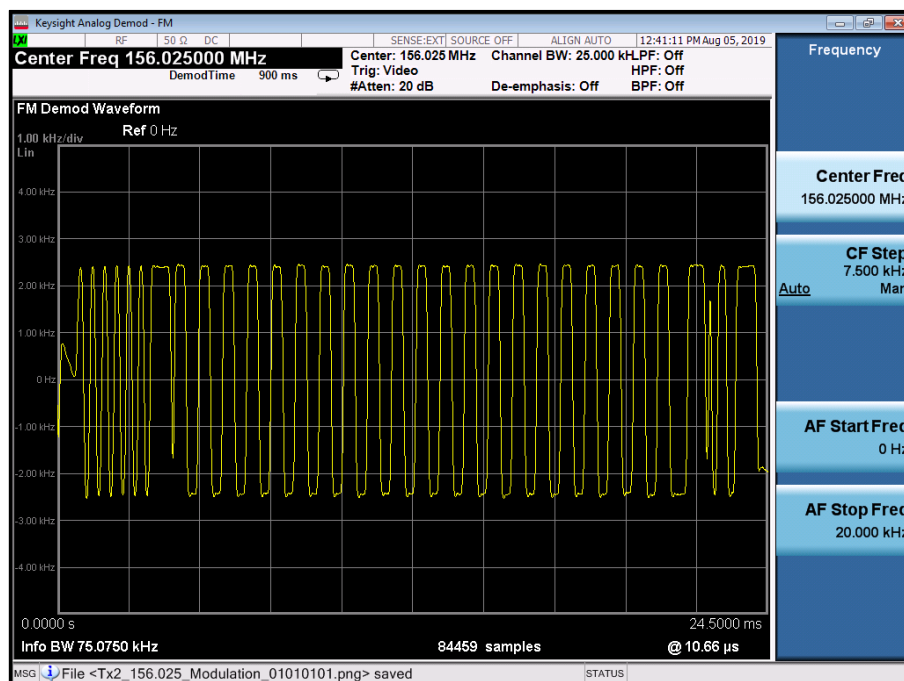


Figure 32- 156.025 MHz - 00001111

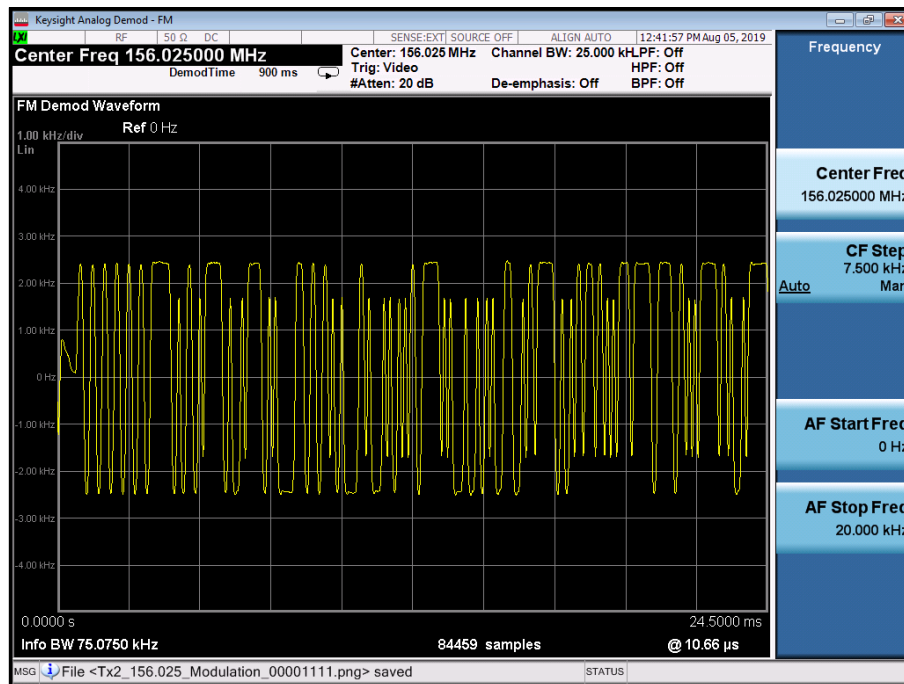


Figure 33- 156.025 MHz - PRBS

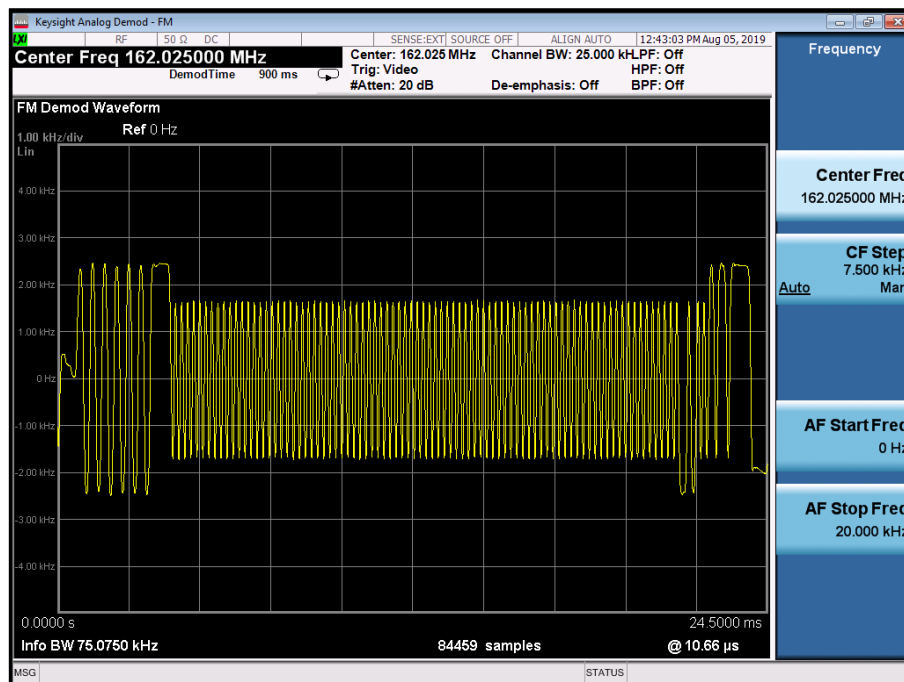


Figure 34 - 162.025 MHz - 01010101

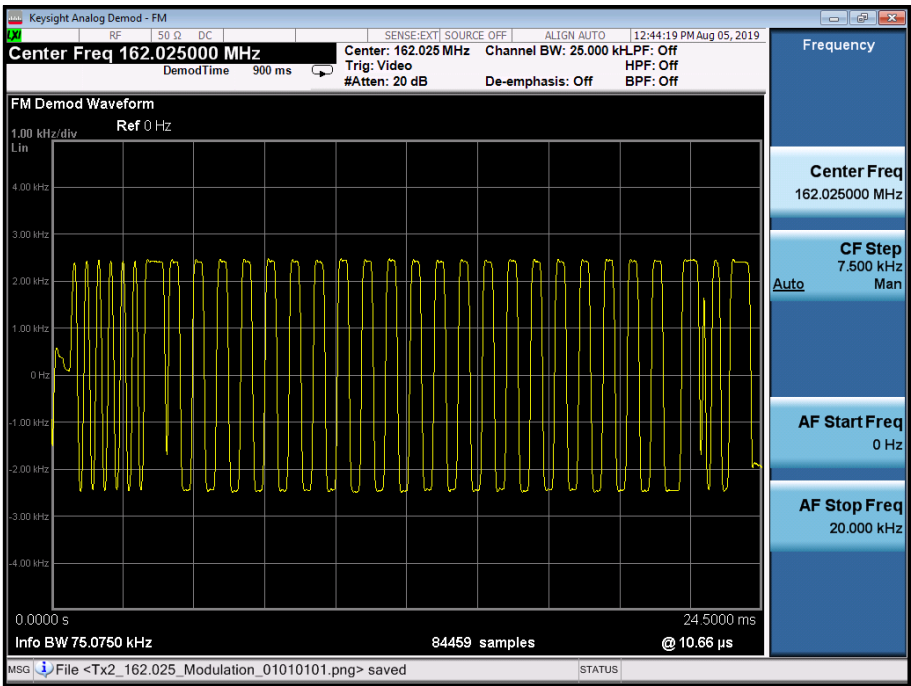


Figure 35- 162.025 MHz - 00001111

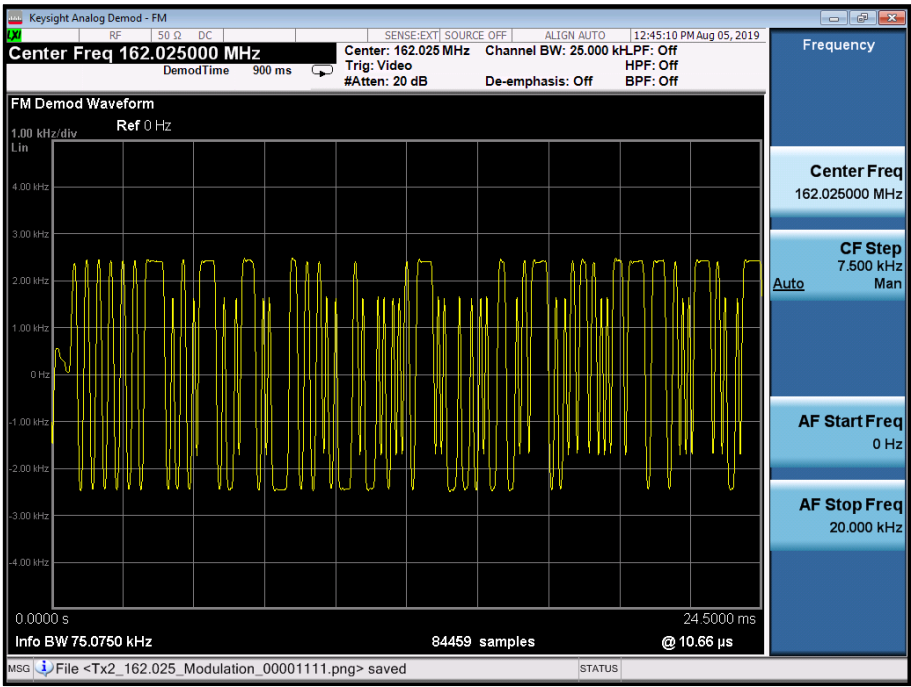


Figure 36- 162.025 MHz - PRBS



DC Powered - AIS Transmitter (Tx2)

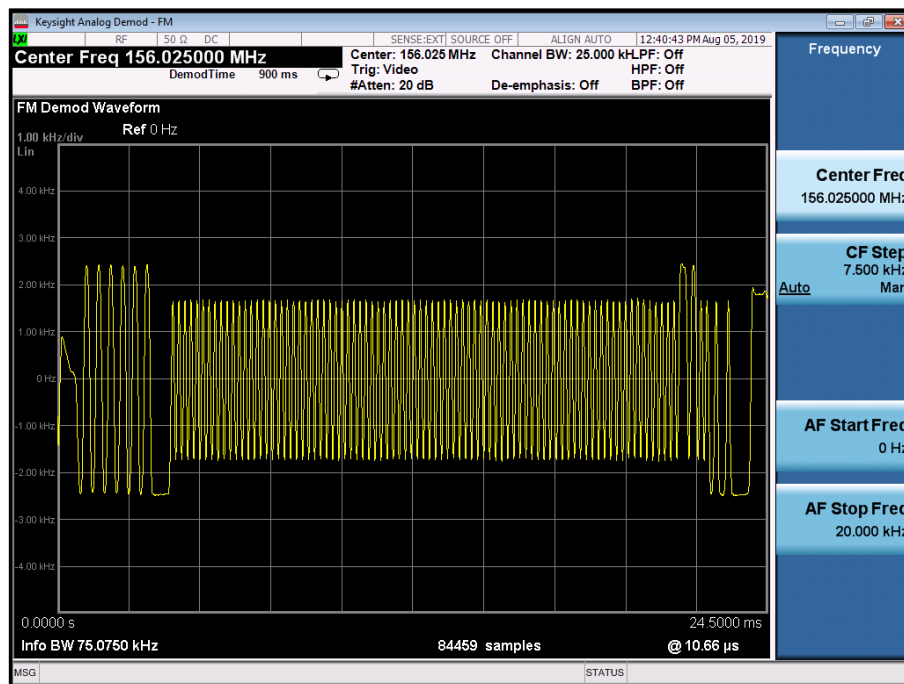


Figure 37 - 156.025 MHz - 01010101

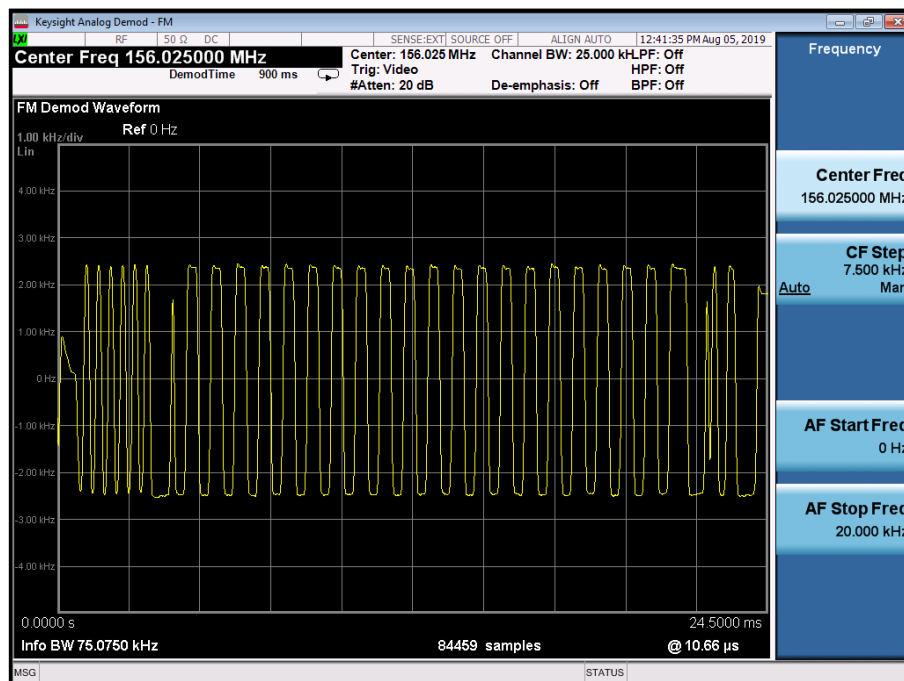


Figure 38- 156.025 MHz - 00001111

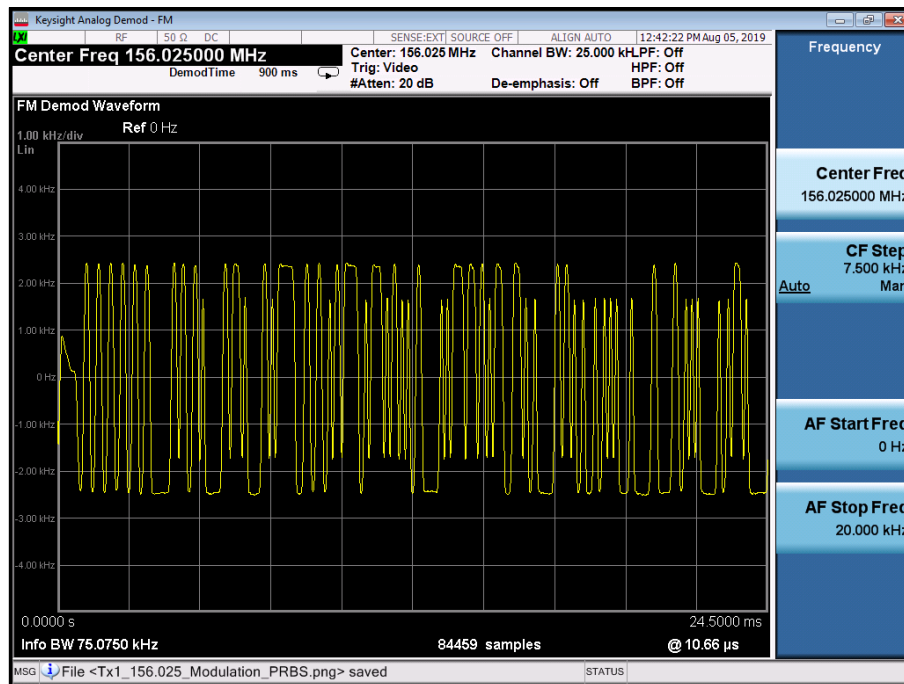


Figure 39- 156.025 MHz - PRBS

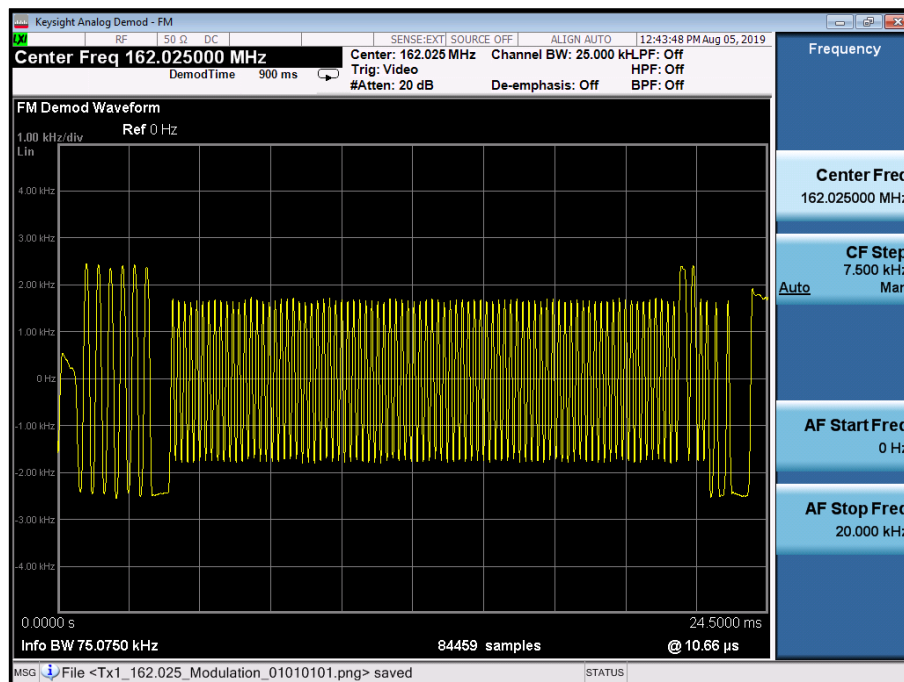


Figure 40 - 162.025 MHz - 01010101

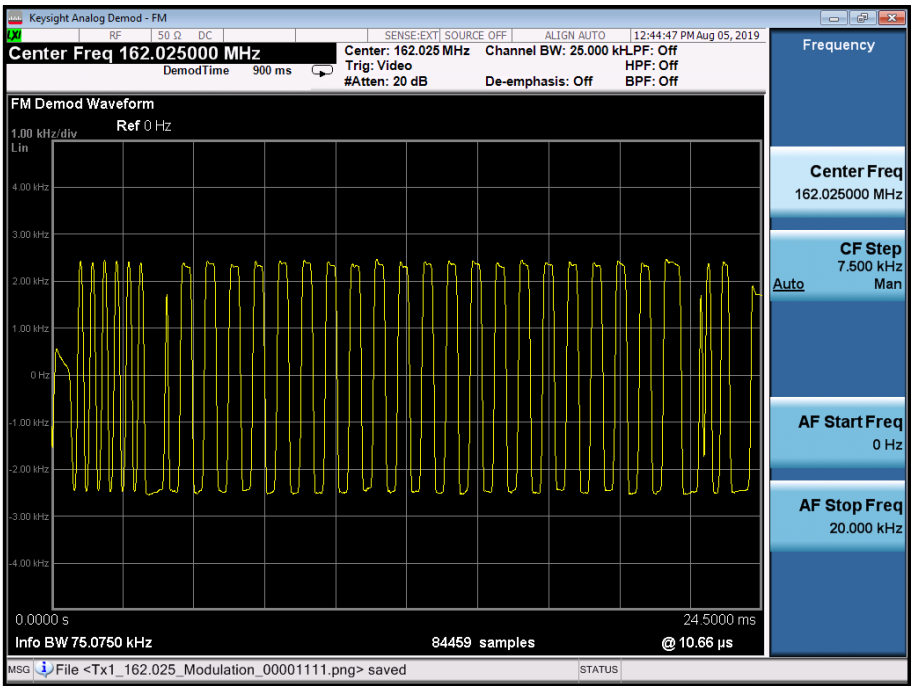


Figure 41- 162.025 MHz - 00001111

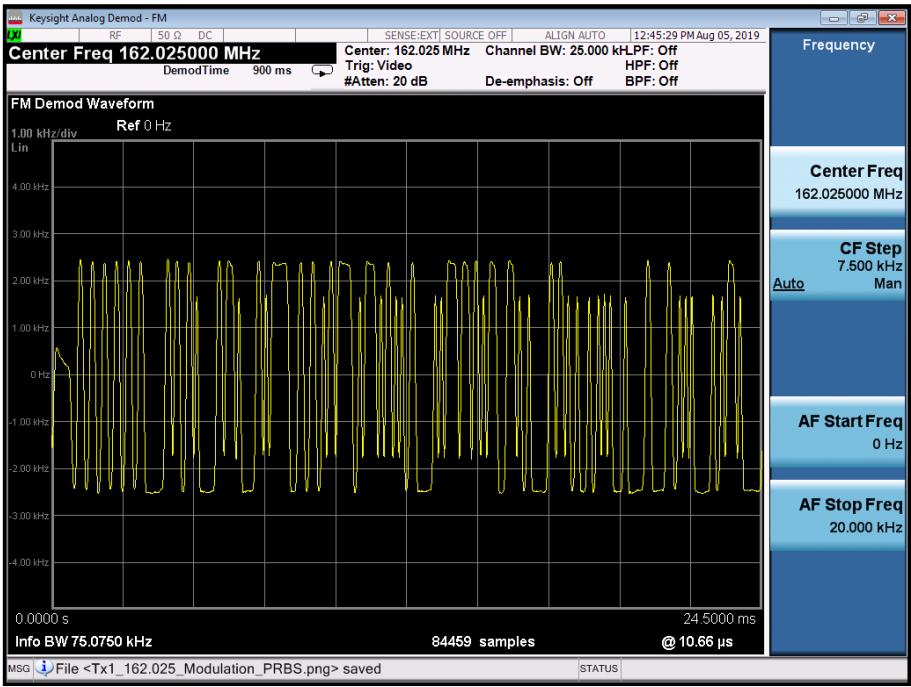


Figure 42- 162.025 MHz - PRBS



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

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 17

O/P Mon – Output Monitored using calibrated equipment



2.6 Transmitter Power

2.6.1 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
ISED RSS-GEN, Clause 6.12

2.6.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.6.3 Date of Test

05-August-2019

2.6.4 Test Method

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

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.

2.6.5 Environmental Conditions

Ambient Temperature 23.3 °C
Relative Humidity 66.9 %

2.6.6 Test Results

DC Powered - AIS Transmitter (Tx1)

156.025 MHz		162.025 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)
37.915	6.187	37.543	5.679

Table 18 - Transmitter Power Results

DC Powered - AIS Transmitter (Tx2)

156.025 MHz		162.025 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)
37.437	5.542	37.315	5.389

Table 19 - 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 20

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 21

O/P Mon – Output Monitored using calibrated equipment



2.7 Suppression of Interference Aboard Ships

2.7.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.217(b)

2.7.2 Equipment Under Test and Modification State

VMS-100S, S/N: EP2-15 - Modification State 0

2.7.3 Date of Test

05-August-2019

2.7.4 Test Method

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 80.217(b) and ANSI C63.26, clause 5.7.

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.

2.7.5 Environmental Conditions

Ambient Temperature 23.3 °C
Relative Humidity 66.9 %

2.7.6 Test Results

DC Powered

Frequency of Interfering Emissions	Maximum Power delivered to Artificial Antenna (dBm)	Maximum Power delivered to Artificial Antenna (μW)
9 kHz to 150 kHz (Receive on 156.025 MHz)	-77.708	16.951
150 kHz to 30 MHz (Receive on 156.025 MHz)	-92.392	0.577
30 MHz to 100 MHz (Receive on 156.025 MHz)	-77.889	16.259
100 MHz to 300 MHz (Receive on 156.025 MHz)	-77.749	16.792
300 MHz to 2 GHz (Receive on 156.025 MHz)	-54.977	3164.5
9 kHz to 150 kHz (Receive on 162.025 MHz)	-72.563	55.424
150 kHz to 30 MHz (Receive on 162.025 MHz)	-90.224	0.950
30 MHz to 100 MHz (Receive on 162.025 MHz)	-77.561	17.535
100 MHz to 300 MHz (Receive on 162.025 MHz)	-75.732	26.718
300 MHz to 2 GHz (Receive on 162.025 MHz)	-60.521	886.952

Table 22 - Receive Mode Spurious Emissions Results



Figure 43 - 9 kHz to 150 kHz (Receive on 156.025 MHz)

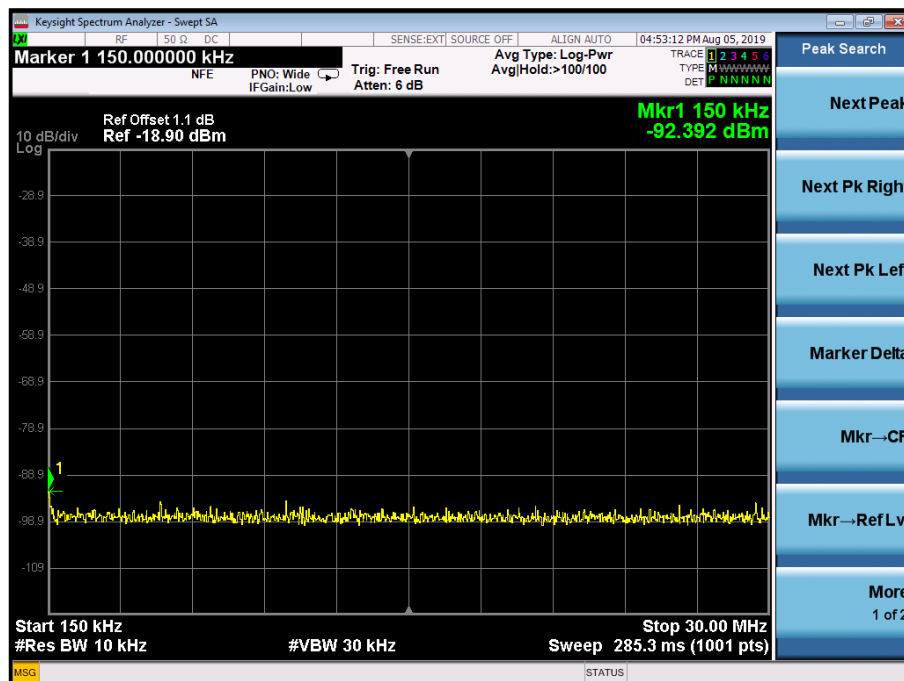


Figure 44 - 150 kHz to 30 MHz (Receive on 156.025 MHz)

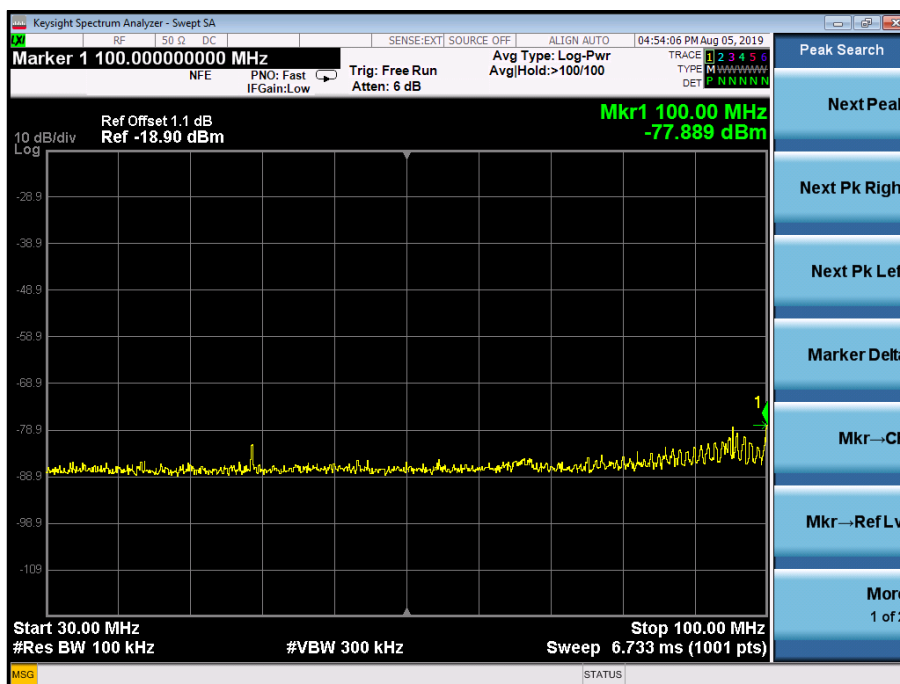


Figure 45 - 30 MHz to 100 MHz (Receive on 156.025 MHz)

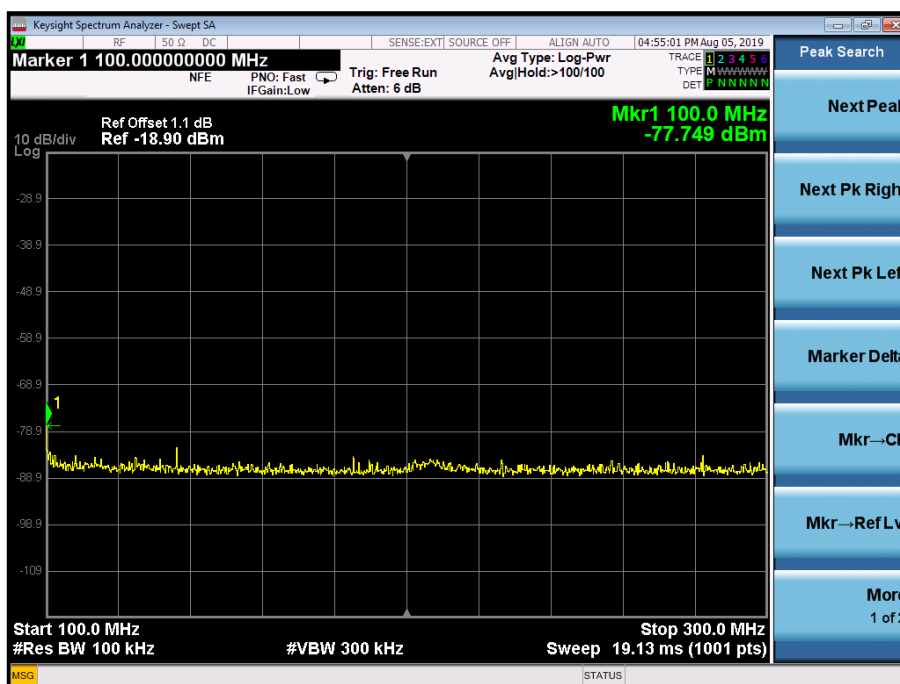


Figure 46 - 100 MHz to 300 MHz (Receive on 156.025 MHz)

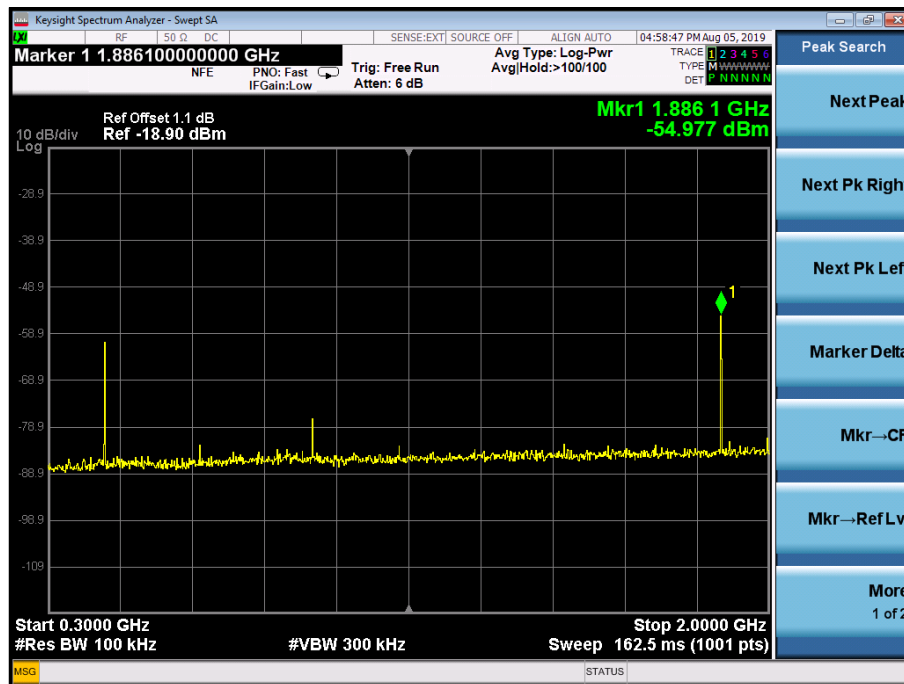


Figure 47 - 300 MHz to 2 GHz (Receive on 156.025 MHz)



Figure 48 - 9 kHz to 150 kHz (Receive on 162.025 MHz)

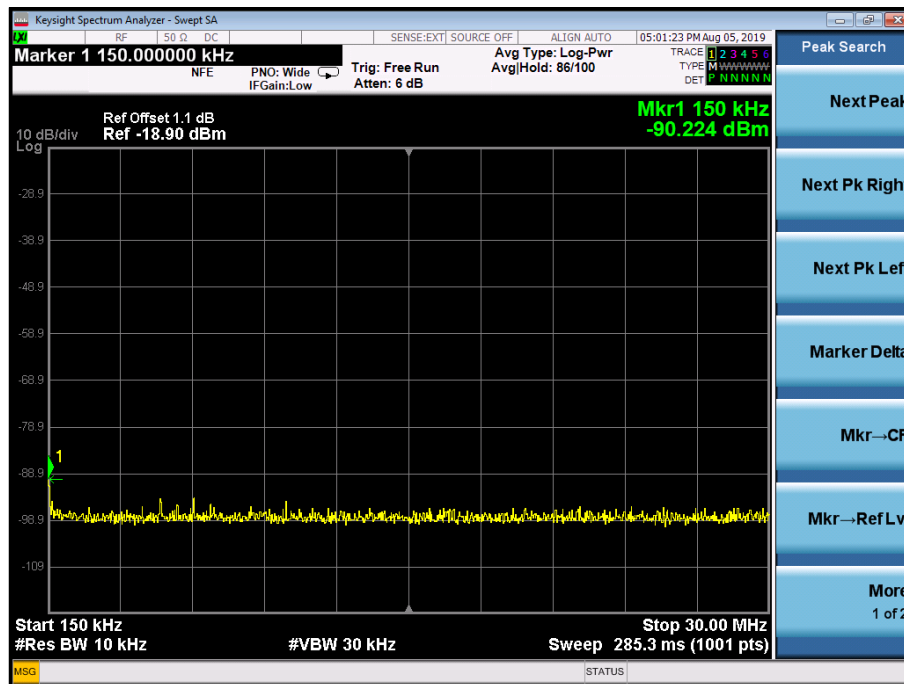


Figure 49 - 150 kHz to 30 MHz (Receive on 162.025 MHz)

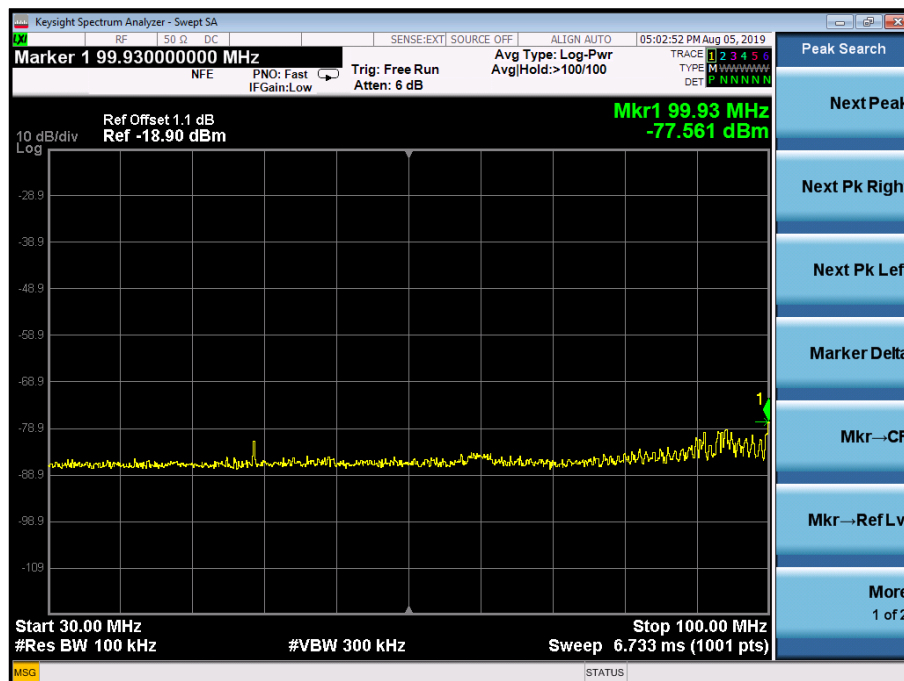


Figure 50 - 30 MHz to 100 MHz (Receive on 162.025 MHz)

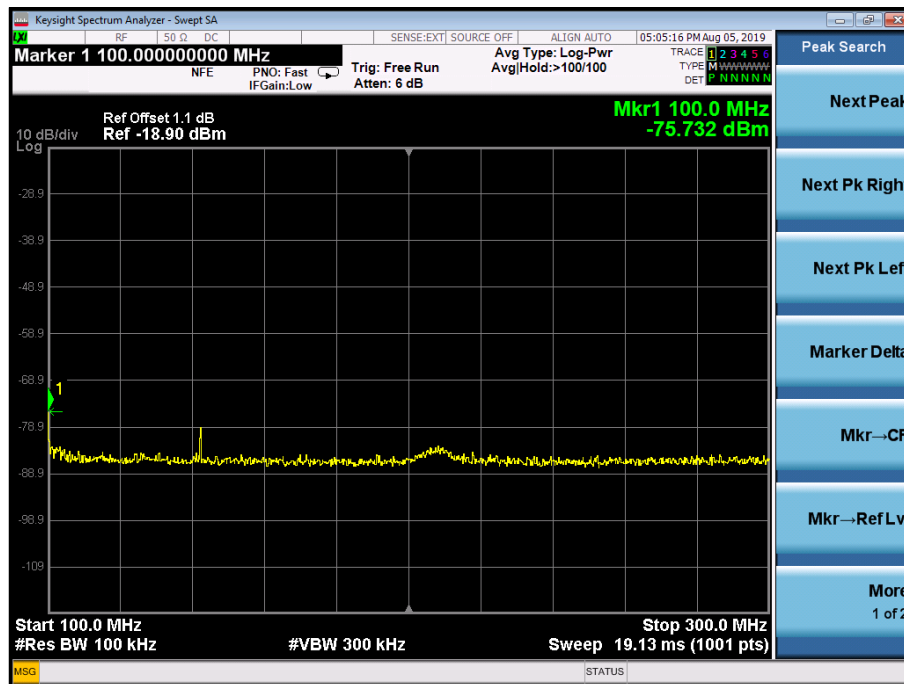


Figure 51 - 100 MHz to 300 MHz (Receive on 162.025 MHz)

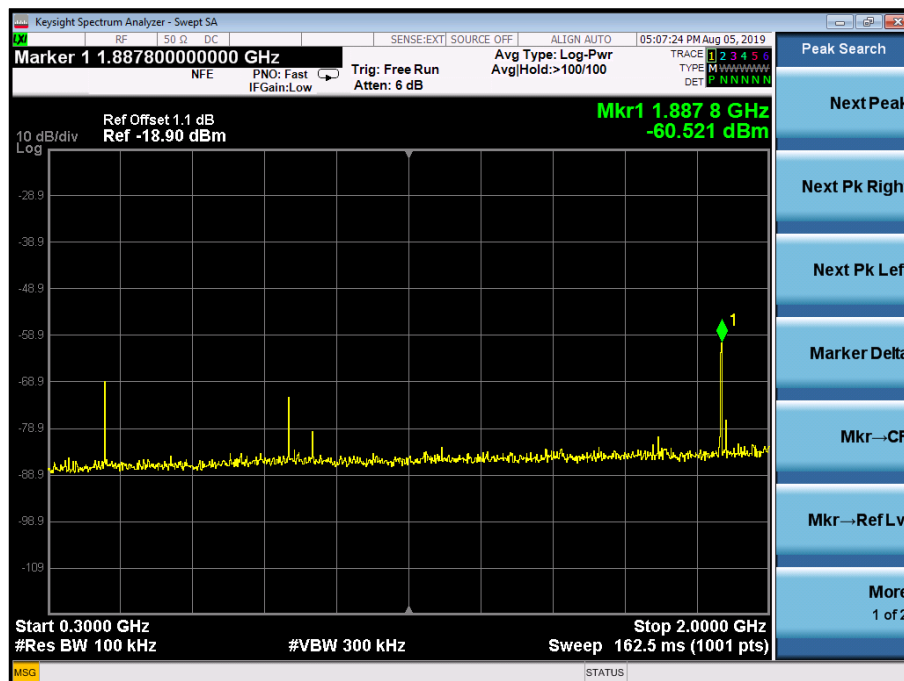


Figure 52 - 300 MHz to 2 GHz (Receive on 162.025 MHz)



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 μ W
Below 30 MHz	400
30 to 100 MHz	4,000
100 to 300 MHz	40,000
Over 300 MHz	400,000

Table 23

2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	15-Oct-2019
True RMS Multimeter	Fluke	179	4006	12	22-Jan-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4954	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	05-Oct-2019
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 24

O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

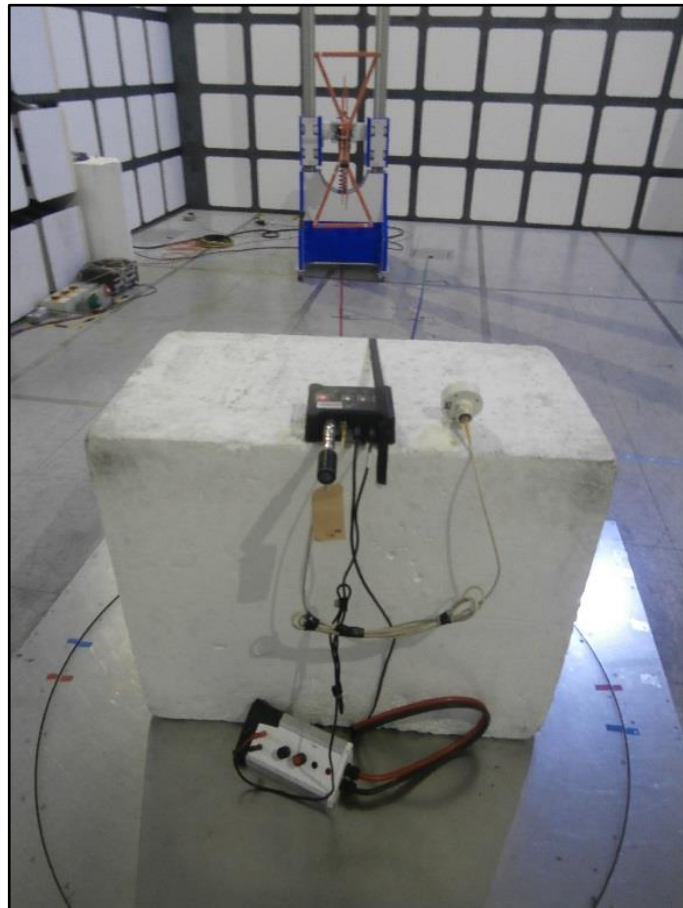


Figure 53 – 30 MHz to 1 GHz, EUT Orientation X



Figure 54 –1 GHz to 2 GHz, EUT Orientation X



Figure 55 – 30 MHz to 1 GHz, EUT Orientation Y



Figure 56 –1 GHz to 2 GHz, EUT Orientation Y

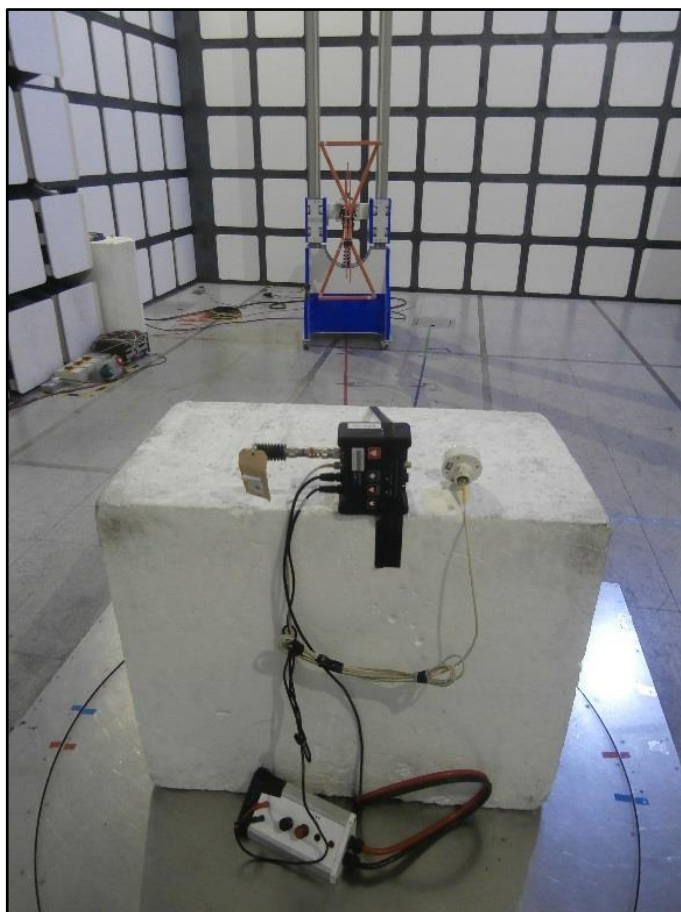


Figure 57 – 30 MHz to 1 GHz, EUT Orientation Z



Figure 58 –1 GHz to 2 GHz, EUT Orientation Z



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
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 18 GHz: ± 6.3 dB
Modulation Requirements	-
Transmitter Power	± 3.2 dB
Suppression of Interference Aboard Ships	± 3.45 dB

Table 25