Radio Test Report

Vesper Marine Ltd
Marlin POD, Model: Cortex M1

In accordance with IEC 62287-2

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

Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Document 75943855-18 Issue 02

FCC ID: YJDVESPM1 IC: 9118A-M1

SIGNATURE			
Ryan Henley			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Ryan Henley	Sales Manager (RF & Telecoms)	Authorised Signatory	18 June 2020

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

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with IEC 62287-2: Edition 2 (2017) for the tests detailed in section 1.3.

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Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

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

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

Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	6 March 2020
2	FCC and IC ID's added to front page of report	18 June 2020

Table 1

1.2 Introduction

Applicant	Vesper Marine Ltd
Manufacturer	Vesper Marine Ltd
Model Number(s)	Cortex M1
Serial Number(s)	M1.00000069
Hardware Version(s)	revB
Software Version(s)	0.20
Number of Samples Tested	1
Test Specification/Issue/Date	IEC 62287-2: Edition 2 (2017)
Order Number Date	13976 20-September-2018
Date of Receipt of EUT	20-May-2019
Start of Test	16-September-2019
Finish of Test	20-January-2020
Name of Engineer(s)	Daniel Bishop and Jonathan Kenny

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with IEC 62287-2 is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: SOTDMA Transceiver				
2.1	11.1.1	Frequency Error	Pass	
2.2	11.1.2	Carrier Power	Pass	
2.3	11.1.3	Transmission Spectrum	Pass	
2.4	11.1.4	Modulation Accuracy	Pass	
2.5	11.1.5	Transmitter Output Power Versus Time Function	Pass	
2.6	11.2.1	Sensitivity	Pass	
2.7	11.2.2	Error Behaviour at High Input Levels	Pass	
2.8	11.2.3	Co-channel Rejection	Pass	
2.9	11.2.4	Adjacent Channel Selectivity	Pass	
2.10	11.2.5	Spurious Response Rejection	Pass	
2.11	11.2.6	Intermodulation Response Rejection	Pass	
2.12	11.2.7	Blocking or Desensitisation	Pass	
2.13	11.3.1	Spurious Emissions from the Receiver	Pass	
2.14	11.3.2	Spurious Emissions from the Transmitter	Pass	

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	VHF and Class B AIS transponder with integrated Wi-Fi and cellular Connectivity. VHF/DSC/AIS capable.
Manufacturer:	Vesper Marine Ltd
Model:	Cortex M1
Part Number:	M1
Hardware Version:	B
Software Version:	0.8

Transmitter Technical Characteristics – Frequency Characteristics

Transmitter frequency alignment range:	156.025-162.025 MHz
Transmitter channel switching frequency range:	156.025-162.025 MHz

Transmitter RF Power Characteristics

Maximum effective rated power (rated as stated by the manufacturer):	25 W
Average effected radiated power (rated as stated by the manufacturer):	25 W
Is transmitter intended for:	Continuous duty: Yes ☒VHF Only No ☐ Intermittent duty: Yes ☒ No ☐
If intermittent state DUTY CYCLE:	Transmitter ON: Varies by protocol seconds Transmitter OFF: Varies by protocol seconds
Is transmitter output power variable?	Continuous duty: Yes ☒VHF Only No ☐
Maximum power:	25 W VHF/DSC only 5W AIS Class B-SO Continuously variable ☐ Stepped ☒ 1W, 5W, 25W (based on protocol) dB per step
Maximum RF output power:	25 W
Minimum RF output power:	1 W

Transmitter Modulation Input Character Characteristics (FM)

Modulation input signal level for 60% of maximum deviation at:	Click to edit
Microphone socket: (Internal, not exposed) 60 mV	100,000 Impedance (Ohms)
Accessory socket: mV	Impedance (Ohms)
Other (4): Click to edit mV	Click to edit Impedance (Ohms)
Lowest audio modulation frequency transmitted by the equipment	300 Hz

Transmitter Modulation

Frequency ☒ Phase ☐ Other ☐ Please Detail: Click to edit	
Channel spacing	25kHz
State the maximum number of channels over which the equipment can operate: Marine band channels 0 - 88	

Receiver Technical Characteristics – Frequency Characteristics

Receiver frequency alignment range:	Click to edit
Receiver channel switching frequency:	Direct Conversion
Method of Frequency Generation	Crystal ☐ Synthesizer ☐ Other ☒ Please Detail: Digital Synthesizer
Intermediate Frequencies:	1st ☒ 2nd ☐ 3rd ☐
Is local oscillator injection frequency higher or lower than the receiver nominal frequency?	Higher ☐ Lower ☒

Receiver Audio (AF) Characteristics – Maximum Rated Audio (AF) Frequency Output Power

Into Loudspeaker:	10 W
Into Line:	Click to edit W
Into Earpiece:	1 W
Balanced:	Yes ☒ No ☐
Unbalanced:	Yes ☐ No ☒
Does connection carry DC voltage?	Yes ☐ No ☒ if Yes, please state voltage
Normal Audio load impedance:	At Loudspeaker: 4 Ohms
	At Line: Click or tap here to enter text. Ohms
	At Earpiece: 4 Ohms
At audio accessory connection or facility socket (if fitted):	Output: Click to edit W Impedance: Click to edit W
Max input level at audio accessory socket:	Output: Click to edit W Impedance: Click to edit W

AC Power Source

AC supply frequency: Click to edit (Hz)	
Click to edit V	Max current: Click to edit A
Single phase ☐ Three phase ☐	

DC Power Source

Nominal voltage: 12 V
Extreme upper voltage: 31.2V
Extreme lower voltage: 10.8V
Max current: 6 A

Battery Power Source

Voltage: Click to edit V
End-point voltage: Click or tap here to enter text V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*
Other ☐ Please detail: Click to edit

Temperature *(over which equipment is to be type tested)*

Minimum Temperature: -20 °C
Maximum Temperature: +55 °C
Other, please specify: Click to edit

Automatic Equipment Switch Off

If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
Applies ☒	Cut off voltage 10 V
Does not apply ☐	

Channel Identification

Each equipment, whether one or more submitted for tests shall carry clear identification (such as a serial number), together with the frequencies associated with the channel identification displayed on the equipment.			
Channel Position	Channel Number	Transmit Nominal Frequency (MHz)	Receive Nominal Frequency (MHz)
N/A	AIS1	161.975MHz	161.975MHz
N/A	AIS2	162.025MHz	162.025MHz
70	VHF	156.025 MHz	156.025 MHz

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

Name: Carl Omundsen
Position held: CTO
Date: 23-02-2020

1.5 Product Information

1.5.1 Technical Description

VHF and Class B AIS transponder with integrated Wi-Fi and cellular Connectivity. VHF/DSC/AIS capable.

1.6 Deviations from the Standard

The manufacturer states that the architecture of the VHF receiver is an SDR direct-conversion based design, and not a traditional analog superheterodyne receiver. It therefore does not depend on intermediate frequencies (IFs) and local oscillators (LOs) to mix the received RF signal down to baseband. For IEC 62287-2 clause 11.2.5, it follows that the 'limited frequency range' over which to sweep for Spurious Response Rejection (SRR) cannot be calculated as the specific frequencies of interest cannot be calculated (from traditional IF and LO frequencies). Instead the manufacturer declares a nominal frequency range which they deem to be reasonable and equivalent to a typical traditionally calculated sweep range. This range will capture any relevant spurious responses which may occur in the receiver design and SRR was tested using this range in accordance with the method of clause 11.2.5.5.

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

1.7 EUT Modification Record

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

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: Cortex M1, Serial Number: M1.00000069			
0	As supplied by the customer	Not Applicable	Not Applicable
1	• Receive HW: Receive analogue front end mathing optimised (L, C) Impact: Overall receive performance improvement to feed into intermodulation and blocking performance improvement. • Transmit HW: TX VCO Loop Filter tuned (R, C) Impact: improved phase noise of transmit envelope • FW Improvements and general bug fixes Impact: None	Vesper Marine Ltd	25-November-2019
2	DAC analogue supply rail had an extra 1 uF decoupling capacitor added to it.	Vesper Marine Ltd	20-January-2020

Table 3

1.8 Test Location

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

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: SOTDMA Transceiver		
Frequency Error	Daniel Bishop	UKAS
Carrier Power	Daniel Bishop	UKAS
Transmission Spectrum	Daniel Bishop	UKAS
Modulation Accuracy	Daniel Bishop	UKAS
Transmitter Output Power Versus Time Function	Daniel Bishop	UKAS
Sensitivity	Daniel Bishop	UKAS
Error Behaviour at High Input Levels	Daniel Bishop	UKAS
Co-channel Rejection	Daniel Bishop	UKAS
Adjacent Channel Selectivity	Daniel Bishop	UKAS
Spurious Response Rejection	Daniel Bishop	UKAS
Intermodulation Response Rejection	Daniel Bishop	UKAS
Blocking or Desensitisation	Daniel Bishop	UKAS
Spurious Emissions from the Receiver	Daniel Bishop	UKAS
Spurious Emissions from the Transmitter	Jonathan Kenny	UKAS

Table 4

Office Address:

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

2 Test Details

2.1 Frequency Error

2.1.1 Specification Reference

IEC 62287-2, Clause 11.1.1

2.1.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.1.3 Date of Test

15-October-2019 to 26-November-2019

2.1.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.1.1.2.

2.1.5 Environmental Conditions

Ambient Temperature	23.1 - 23.9 °C
Relative Humidity	51.4 - 59.0 %

2.1.6 Test Results

SOTDMA Transceiver

Test Conditions		156.025 MHz	162.025 MHz
Temperature	Voltage	Error (Hz)	Error (Hz)
+23.1 °C	16.0 V DC	132.0	142.8
-15.0 °C	10.8 V DC	-101.7	-104.1
+55.0 °C	31.2 V DC	-117.5	-133.9

Table 5 - Frequency Error Results

IEC 62287-2, Limit Clause 11.1.1.3

The frequency error shall not exceed ±0.5 kHz under normal and ± 1 kHz under extreme test conditions.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Thermometer	Digitron	T208	64	12	12-Jun-2020
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
True RMS Multimeter	Fluke	79 Series III	411	12	07-Oct-2020
Attenuator (30 dB, 50 W)	Bird	8321	494	12	24-Oct-2020
Modulation Analyser	Hewlett Packard	8901B	773	12	28-Jun-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Sensor	Hewlett Packard	11722A	2787	12	21-Oct-2020
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	23-Jul-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 6

O/P Mon – Output Monitored using calibrated equipment

2.2 Carrier Power

2.2.1 Specification Reference

IEC 62287-2, Clause 11.1.2

2.2.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.2.3 Date of Test

15-October-2019 to 27-November-2019

2.2.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.1.2.2.

2.2.5 Environmental Conditions

Ambient Temperature	23.1 - 23.9 °C
Relative Humidity	51.4 - 59.0 %

2.2.6 Test Results

SOTDMA Transceiver

Test Conditions		156.025 MHz	162.025 MHz
Temperature	Voltage	Power (dBm)	Power (dBm)
+23.1 °C	16.0 V DC	36.808	36.462
-15.0 °C	10.8 V DC	39.061	39.606
+55.0 °C	31.2 V DC	37.115	36.538

Table 7 - Carrier Power Results - High Power

Test Conditions		156.025 MHz	162.025 MHz
Temperature	Voltage	Power (dBm)	Power (dBm)
+23.1 °C	16.0 V DC	30.827	29.826
-15.0 °C	10.8 V DC	29.715	32.156
+55.0 °C	31.2 V DC	31.906	30.505

Table 8 - Carrier Power Results – Low Power

IEC 62287-2, Limit Clause 11.1.2.3

At all test frequencies, the carrier power shall be for high power 37 dBm ± 1.5 dBm and 30 dBm ± 1.5 dBm for low power under normal test conditions.

At all test frequencies, the carrier power shall be for high power 37 dBm ± 3.0 dBm and 30 dBm ± 3.0 dBm for low power under extreme test conditions.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1 and RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Thermometer	Digitron	T208	64	12	12-Jun-2020
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
True RMS Multimeter	Fluke	79 Series III	411	12	07-Oct-2020
Modulation Analyser	Hewlett Packard	8901B	773	12	28-Jun-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	23-Jul-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 9

O/P Mon – Output Monitored using calibrated equipment

2.3 Transmission Spectrum

2.3.1 Specification Reference

IEC 62287-2, Clause 11.1.3

2.3.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 1

2.3.3 Date of Test

18-December-2019

2.3.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.1.3.2.

2.3.5 Environmental Conditions

Ambient Temperature	23.9 °C
Relative Humidity	59.0 %

2.3.6 Test Results

SOTDMA Transceiver

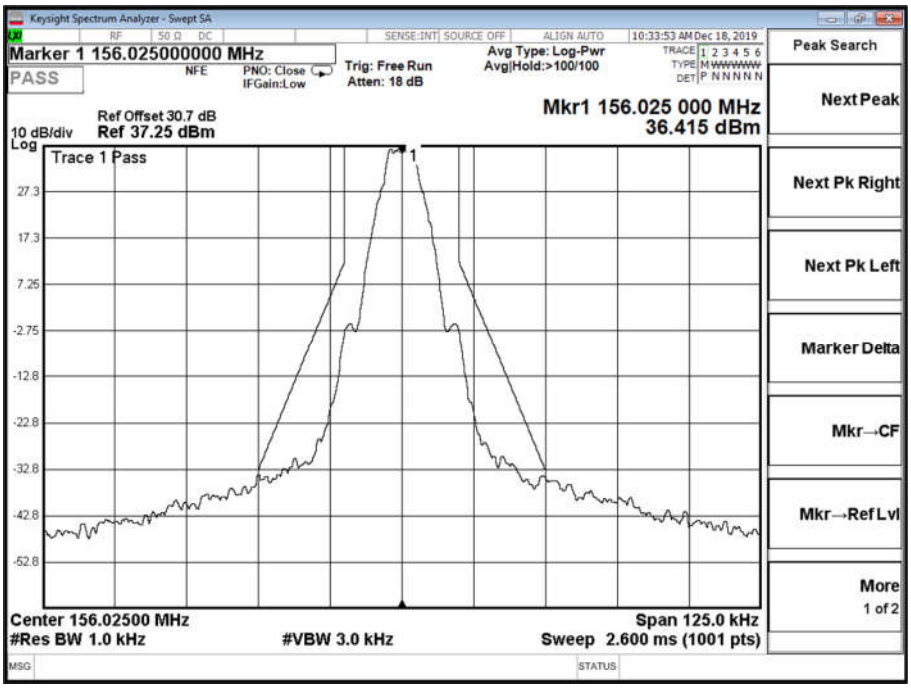

Figure 1 – 156.025 MHz

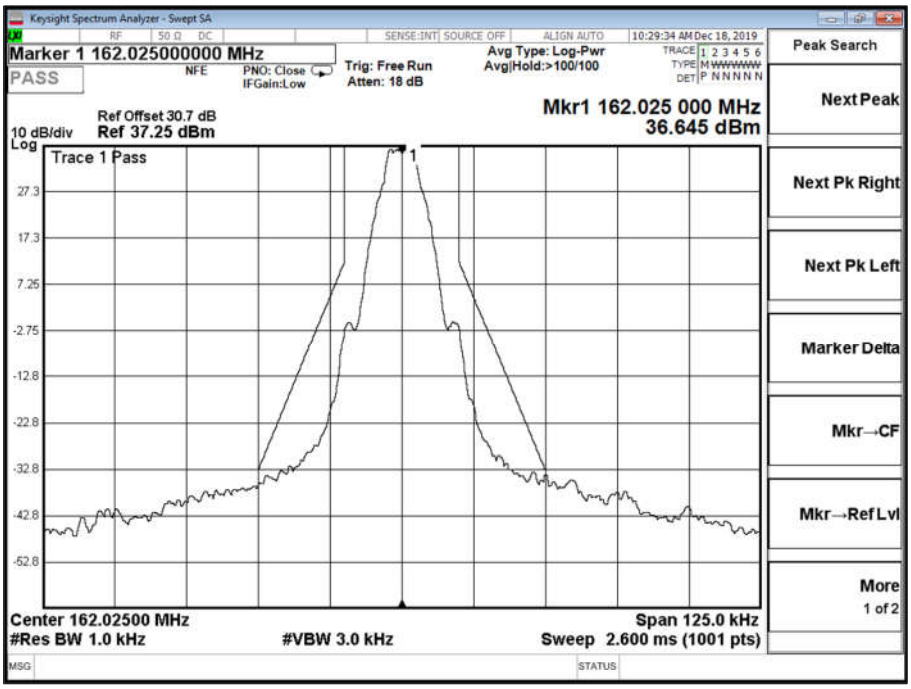

Figure 2 - 162.025 MHz

IEC 62287-2, Limit Clause 11.1.3.3

The spectrum for slotted transmission shall be within the emission mask as follows:

• in the region between the carrier and ±10 kHz removed from the carrier, the modulation and transient sidebands shall be below 0 dBc;
• at ±10 kHz removed from the carrier, the modulation and transient sidebands shall be below –25 dBc;
• at ±25 kHz to ±62,5 kHz removed from the carrier, the modulation and transient sidebands shall be below the lower value of –70 dBc;
• in the region between ±10 kHz and ±25 kHz removed from the carrier, the modulation and transient sidebands shall be below a line specified between these two points.

The reference level for the measurement shall be the carrier power (conducted) recorded for the appropriate test frequency in clause 11.1.2 of the test specification.

For information the emission mask specified above is shown below.

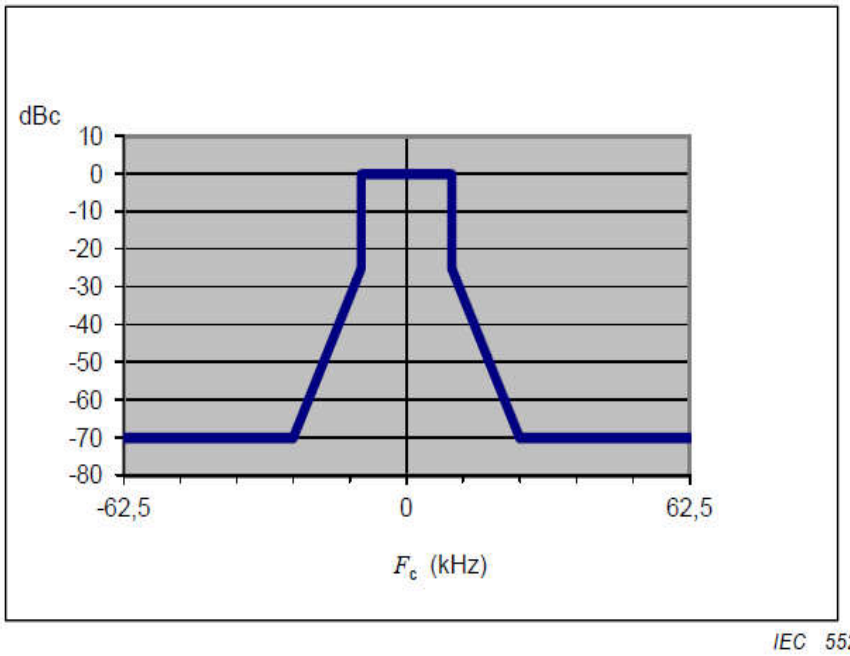

Figure 3 - Transmission Spectrum Mask Limit

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1 and RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
GPS/SBAS Simulator	Spirent	STR4500	3056	-	16-Oct-2020
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	21-Oct-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5424	6	13-Jun-2020

Table 10

O/P Mon – Output Monitored using calibrated equipment

2.4 Modulation Accuracy

2.4.1 Specification Reference

IEC 62287-2, Clause 11.1.4

2.4.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.4.3 Date of Test

16-October-2019 to 27-November-2019

2.4.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.1.4.2.

2.4.5 Environmental Conditions

Ambient Temperature	51.2 - 59.0 °C
Relative Humidity	23.2 - 23.9 %

2.4.6 Test Results

SOTDMA Transceiver

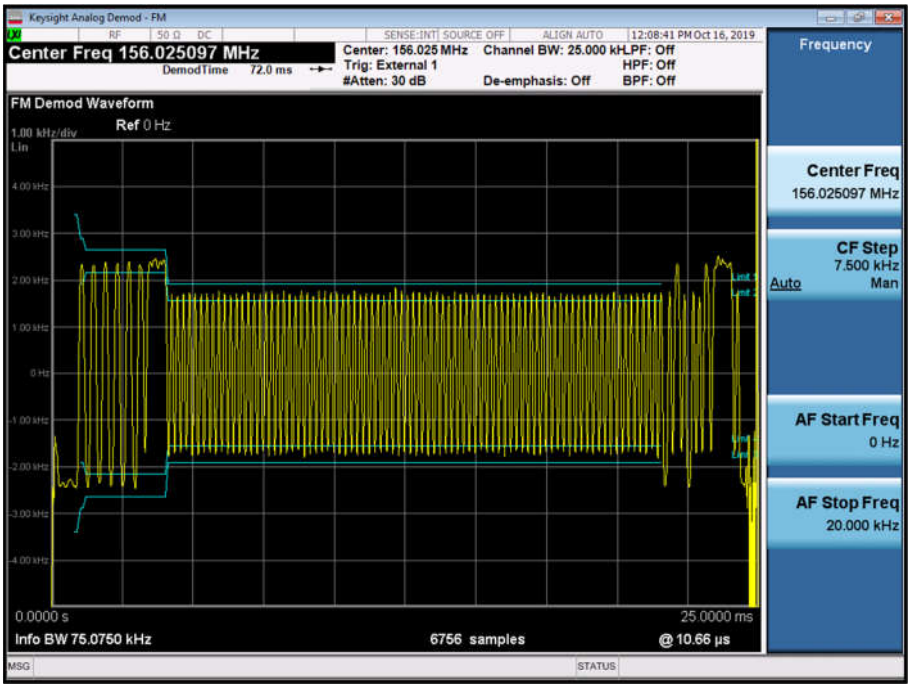

Figure 4 – 156.025 MHz, Test Signal #1, +23.2 °C, 16.0 V DC

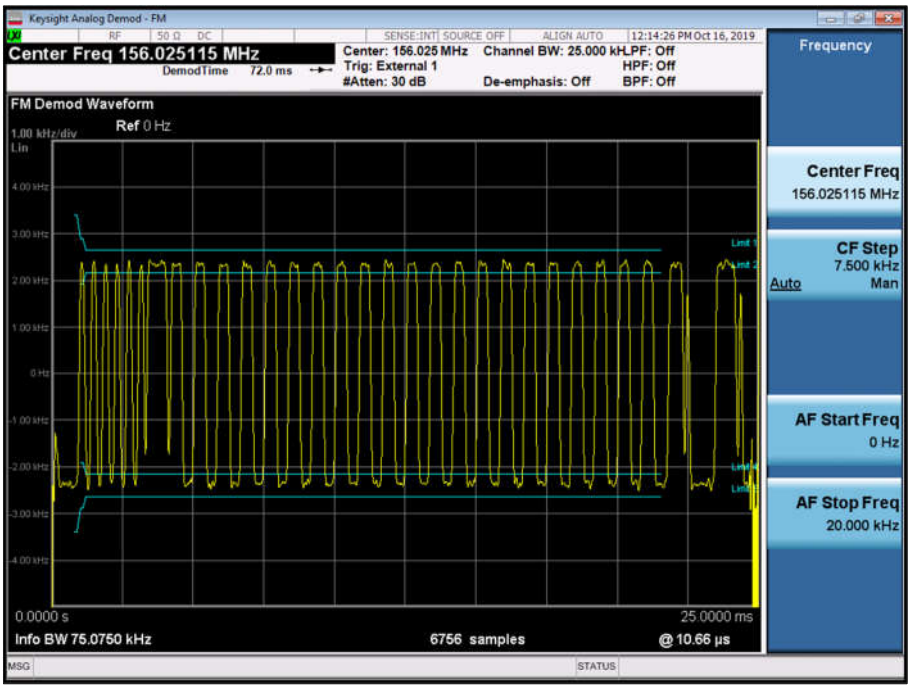

Figure 5 – 156.025 MHz, Test Signal #2, +23.2 °C, 16.0 V DC

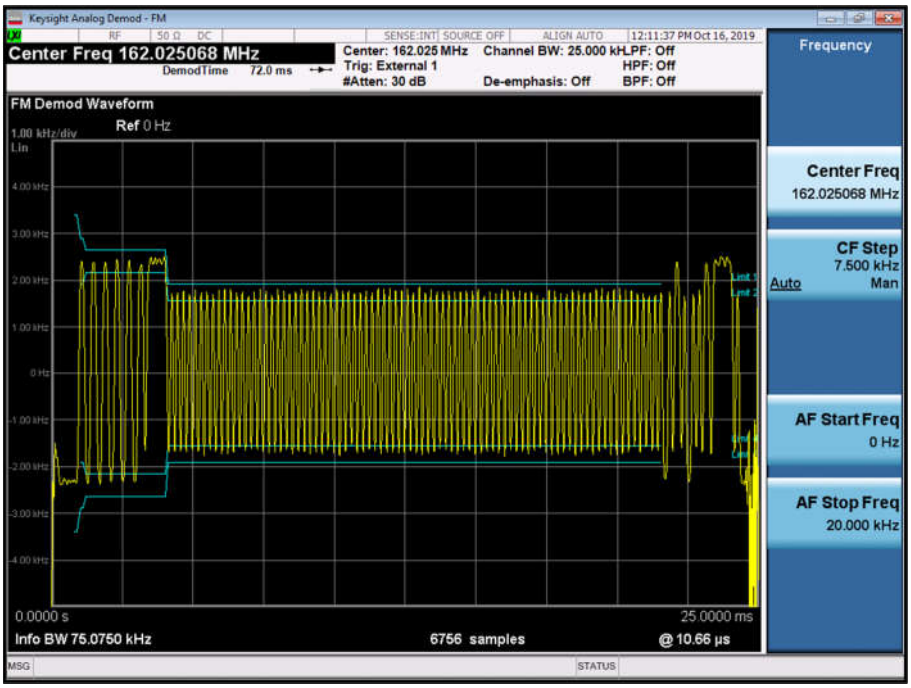

Figure 6 – 162.025 MHz, Test Signal #1, +23.2 °C, 16.0 V DC

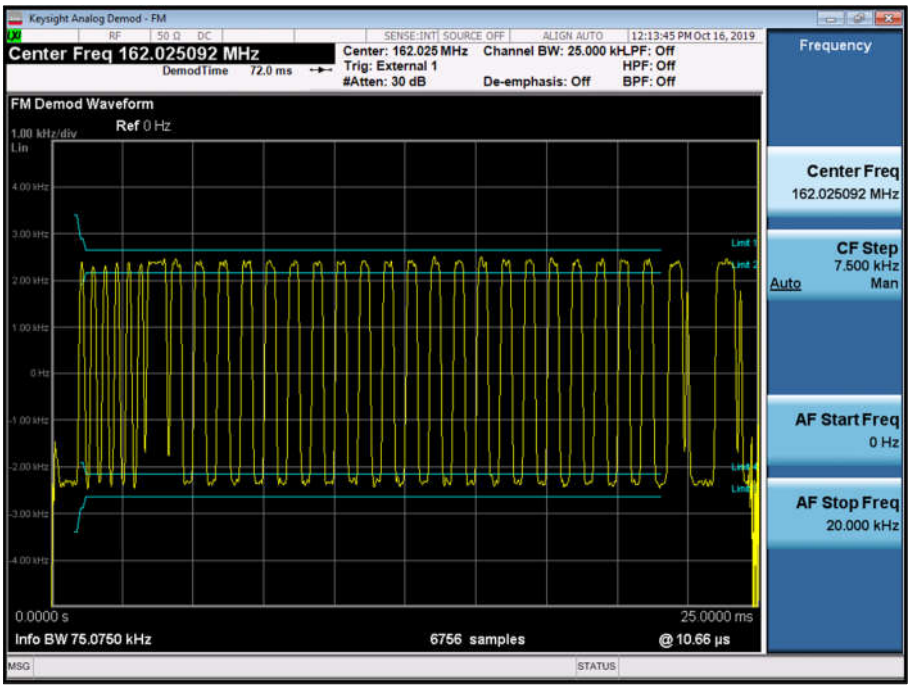

Figure 7 – 162.025 MHz, Test Signal #2, +23.2 °C, 16.0 V DC

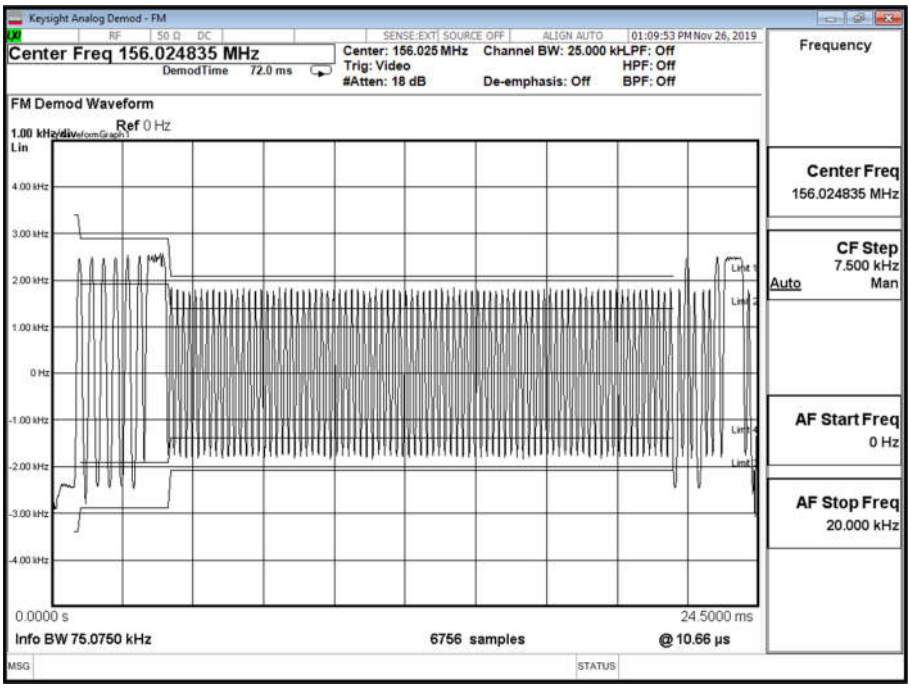

Figure 8 - 156.025 MHz, Test Signal #1, -20.0 °C, 10.8 V DC

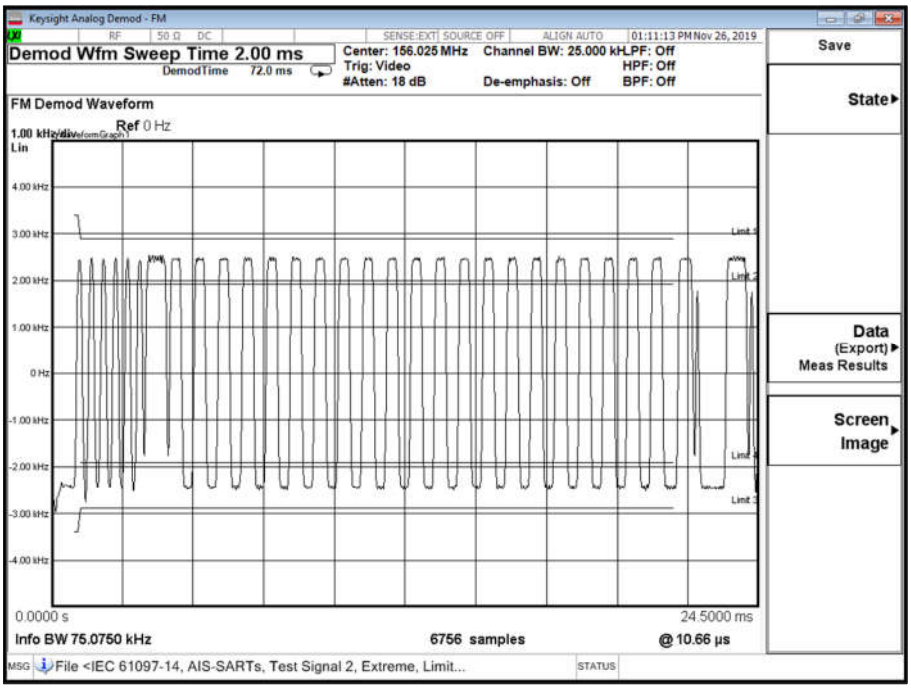

Figure 9 - 156.025 MHz, Test Signal #2, -20.0 °C, 10.8 V DC

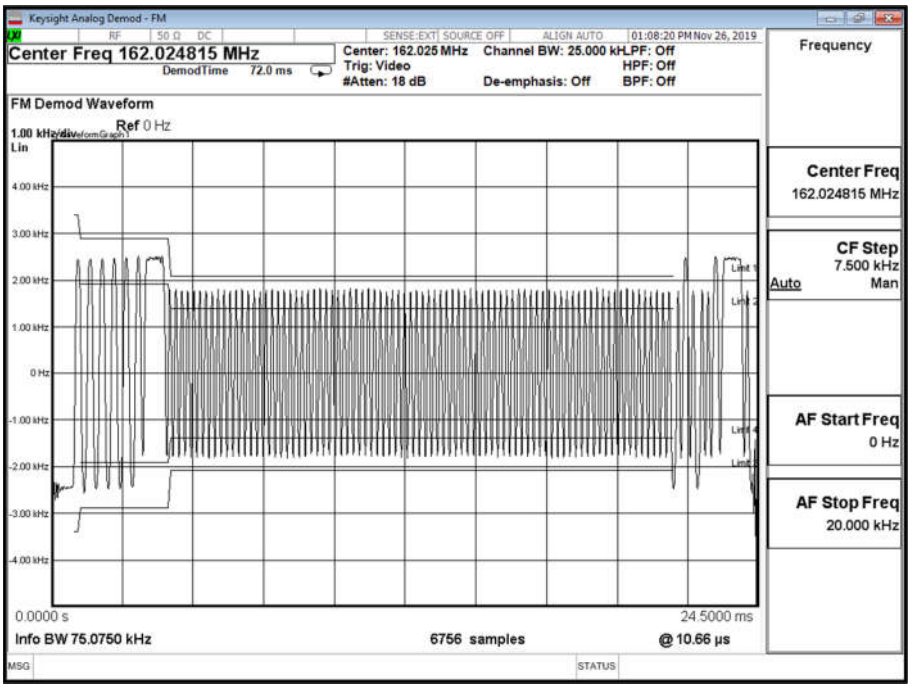

Figure 10 - 162.025 MHz, Test Signal #1, -20.0 °C, 10.8 V DC

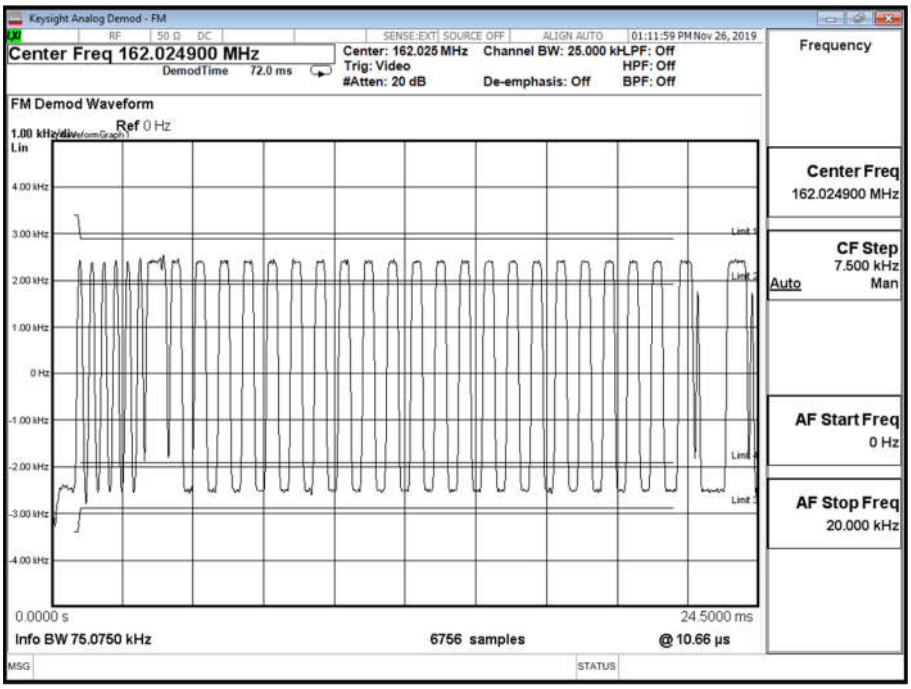

Figure 11 - 162.025 MHz, Test Signal #2, -20.0 °C, 10.8 V DC

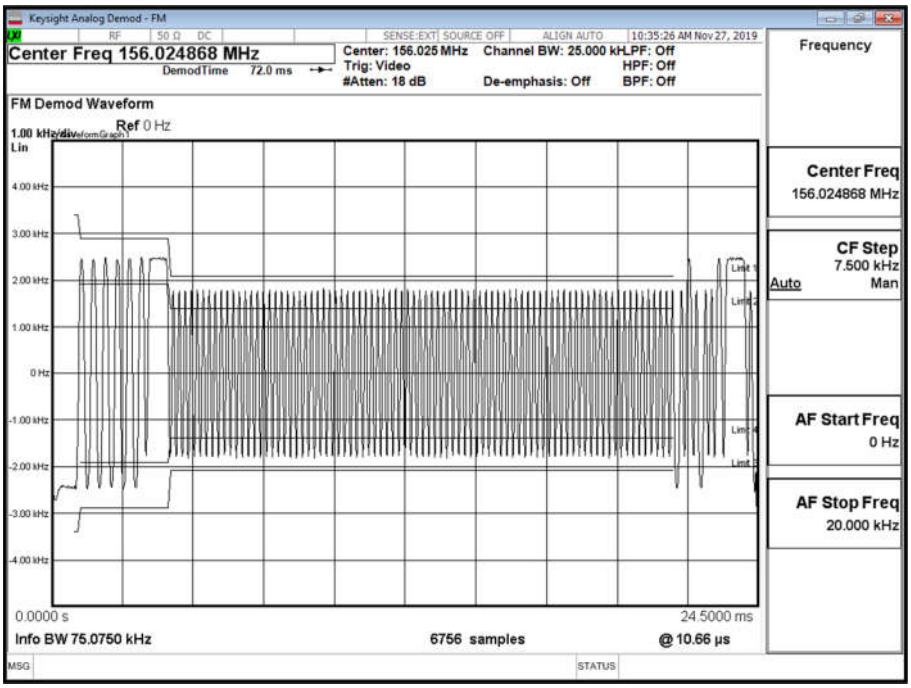

Figure 12 - 156.025 MHz, Test Signal #1, +55.0 °C, 31.2 V DC

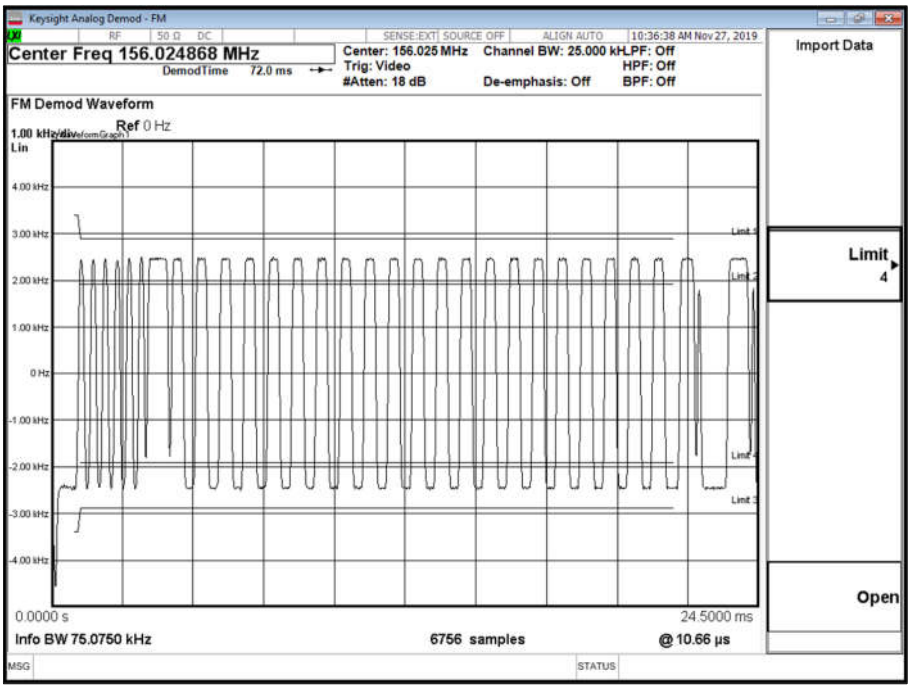

Figure 13 - 156.025 MHz, Test Signal #2, +55.0 °C, 31.2 V DC

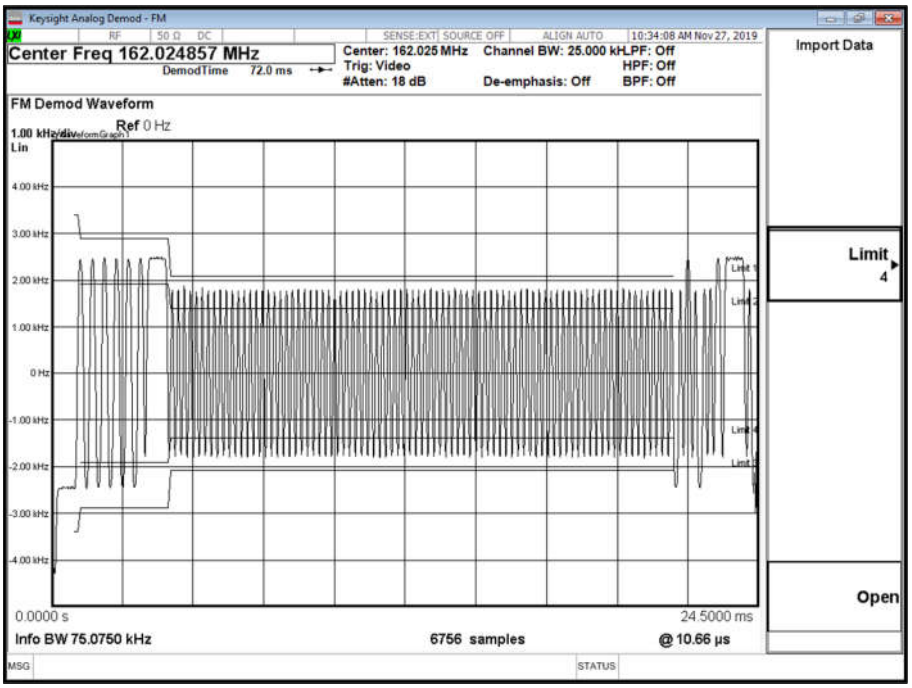

Figure 14 - 162.025 MHz, Test Signal #1, +55.0 °C, 31.2 V DC

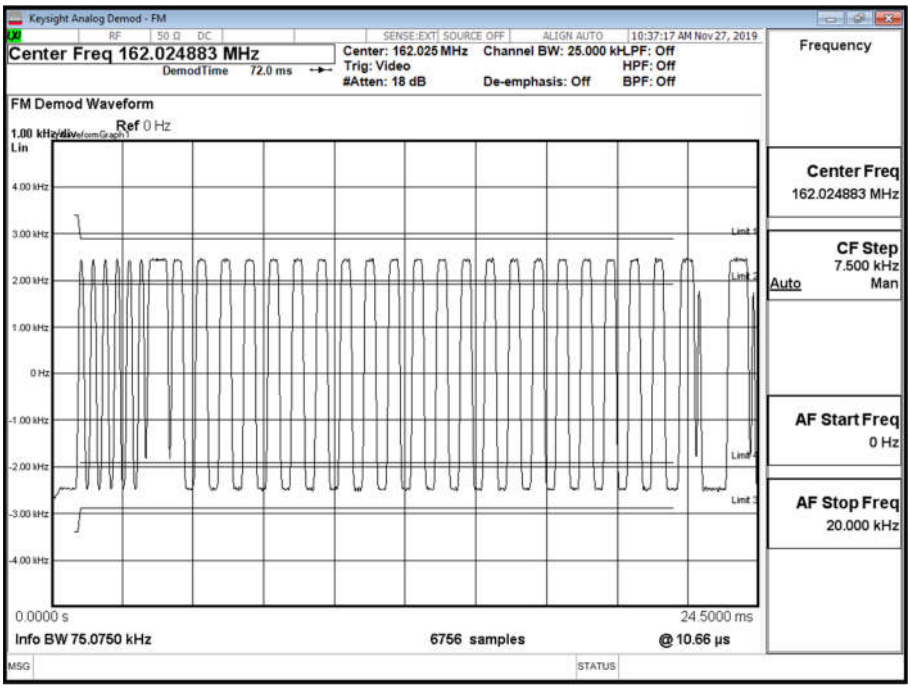

Figure 15 - 162.025 MHz, Test Signal #2, +55.0 °C, 31.2 V DC

IEC 62287-2, Limit Clause 11.1.4.3

Measurement Period from Centre to Centre of each Bit	Test Signal 1		Test Signal 2	
	Normal	Extreme	Normal	Extreme
Ramp Up	< 3400 Hz			
Bit 0 to Bit 1	< 3400 Hz			
Bit 2 to Bit 3	2400 ± 480 Hz			
Bit 4 to Bit 31	2400 ± 240 Hz	2400 ± 480 Hz	2400 ± 240 Hz	2400 ± 480 Hz
Bit 32 to Bit 199	1740 ± 175 Hz	1740 ± 350 Hz	2400 ± 240 Hz	2400 ± 480 Hz

Table 11 - Peak Frequency Deviation versus Time Limit

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Thermometer	Digitron	T208	64	12	12-Jun-2020
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	23-Jul-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 12

O/P Mon – Output Monitored using calibrated equipment

2.5 Transmitter Output Power Versus Time Function

2.5.1 Specification Reference

IEC 62287-2, Clause 11.1.5

2.5.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0

2.5.3 Date of Test

16-October-2019

2.5.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.1.5.2.

2.5.5 Environmental Conditions

Ambient Temperature	23.9 °C
Relative Humidity	59.0 %

2.5.6 Test Results

SOTDMA Transceiver

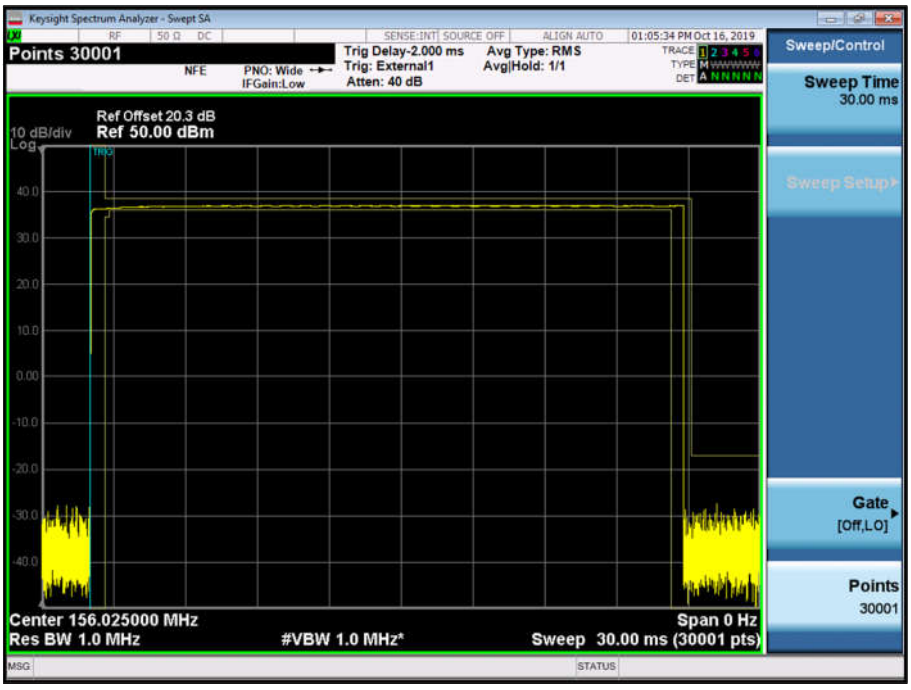

Figure 16 - 156.025 MHz - Complete Burst

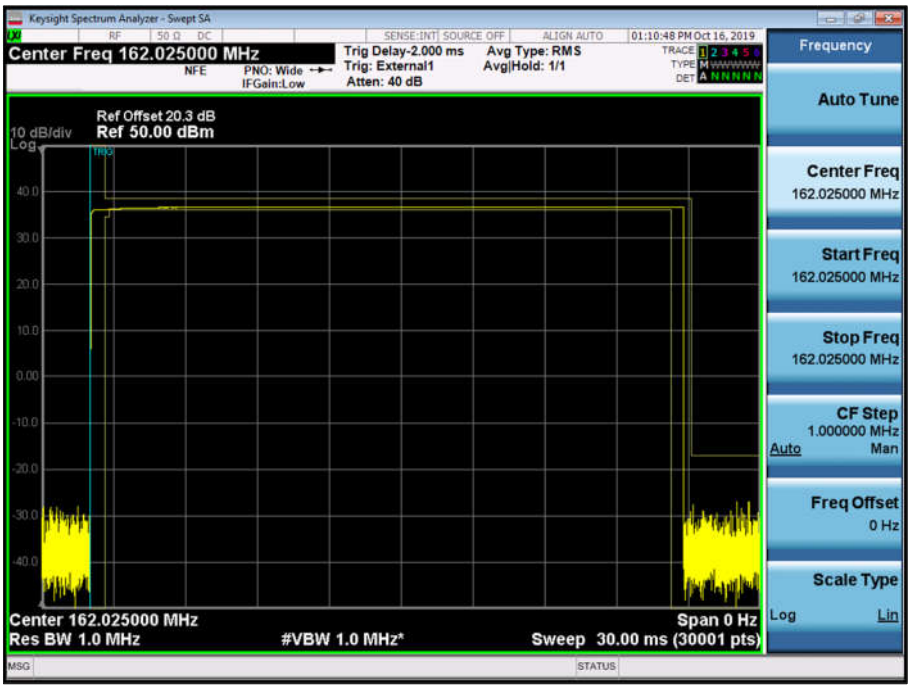

Figure 17 - 162.025 MHz - Complete Burst

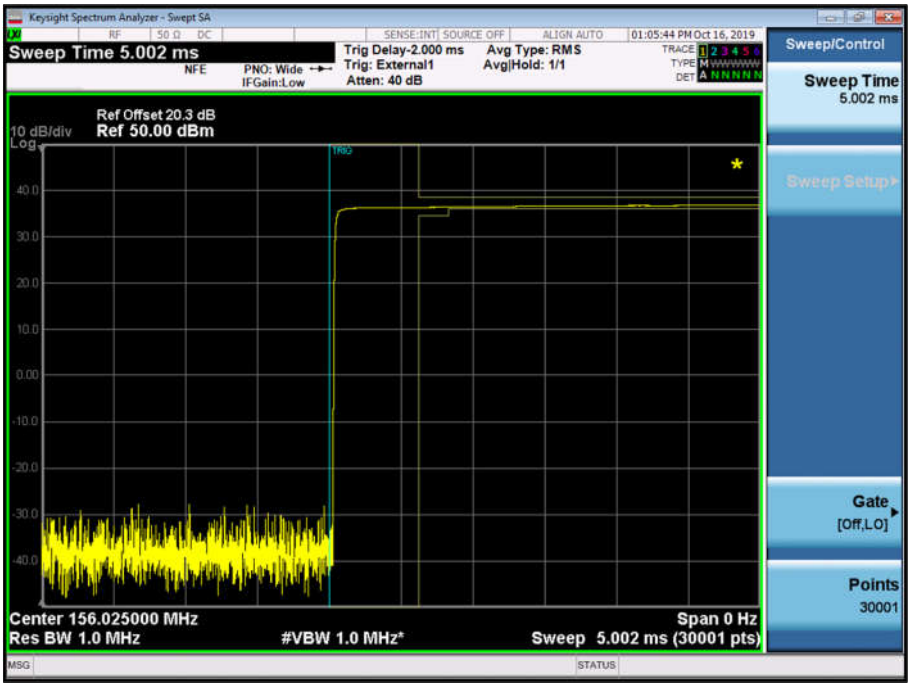

Figure 18 - 156.025 MHz - Ramp Up Zoomed

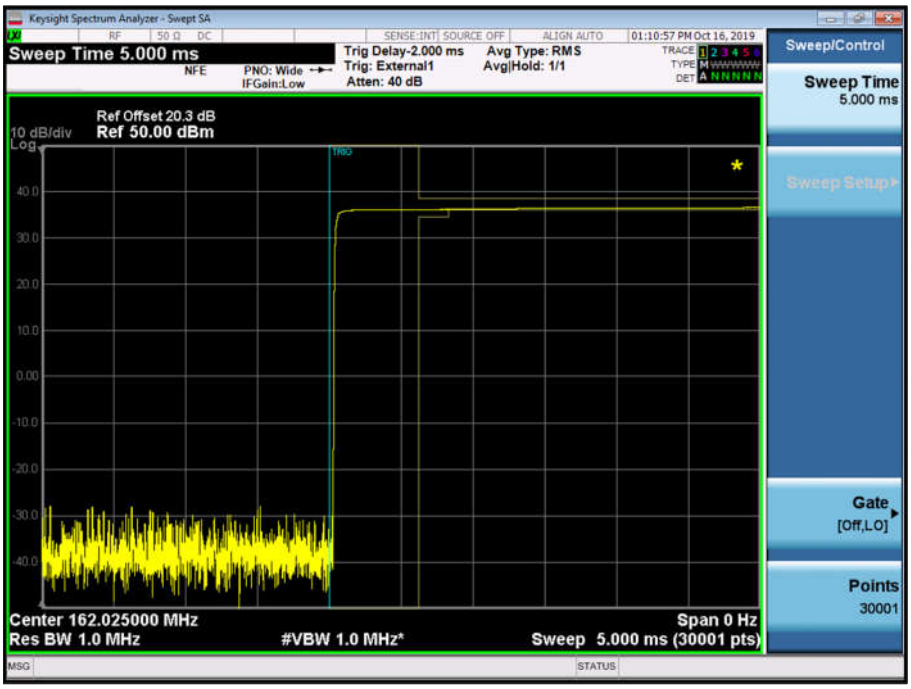

Figure 19 - 162.025 MHz - Ramp Up Zoomed

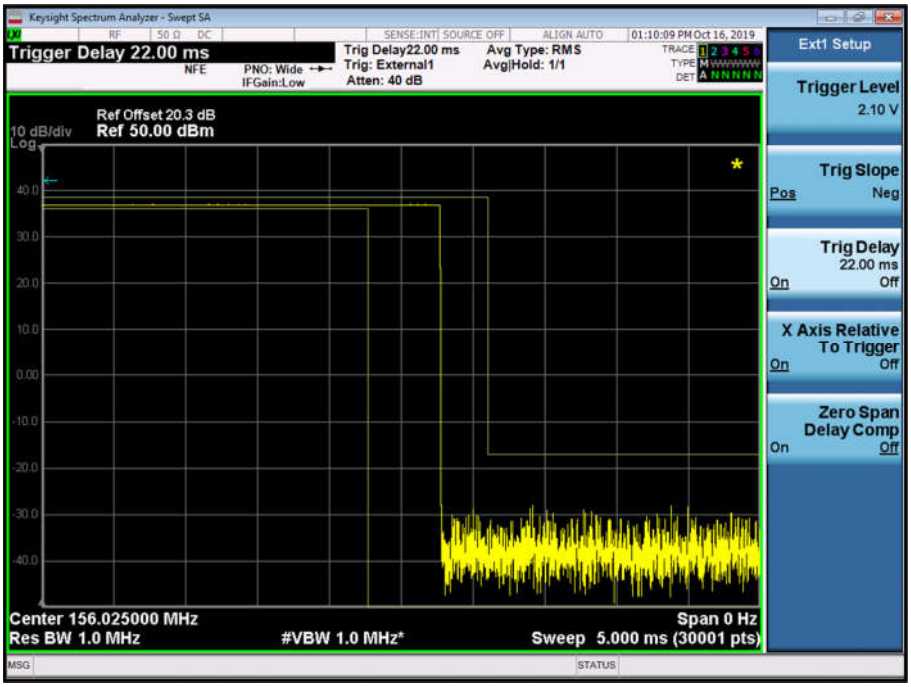

Figure 20 - 156.025 MHz - Ramp Down Zoomed

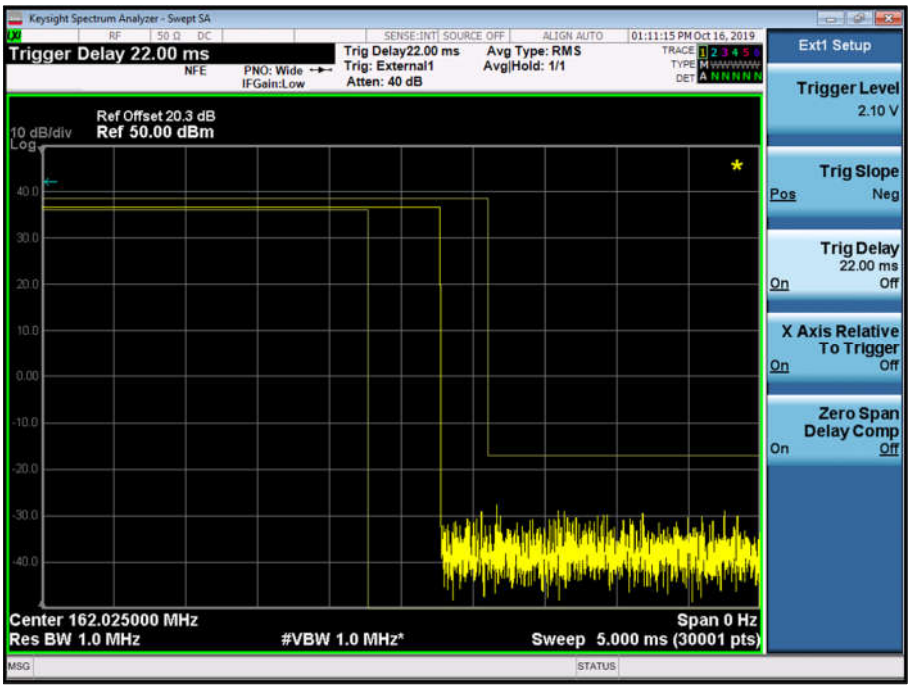

Figure 21 - 162.025 MHz - Ramp Down Zoomed

IEC 62287-2, Limit Clause 11.1.5.3

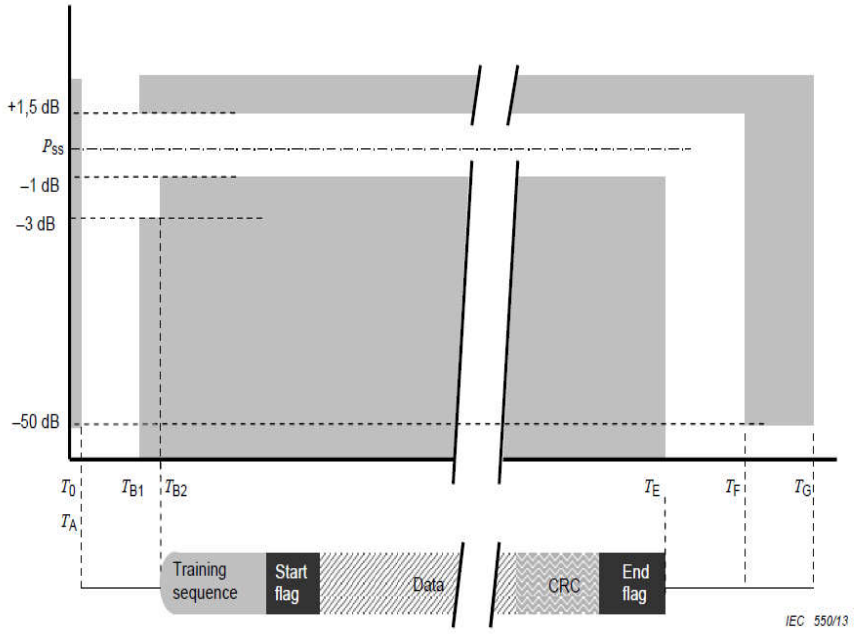

Figure 22 - Power Versus Time Mask

Reference		Bits	Time (ms)	Definitions
T_0		0	0	Start of transmission slot. Power shall NOT exceed -50 dB of P_{SS} before T_0
T_A		0 to 6	0 to 0.625	Power exceeds -50 dB of P_{SS}
T_B	T_{B1}	6	0.625	Power shall be within ±1.5 or -3 dB of P_{SS}
	T_{B2}	8	0.833	Power shall be within +1.5 or -1 dB of P_{SS} during the period T_{B2} to T_E (start of training sequence)
T_E (includes 1 stuffing bit)		233	24.271	Power shall remain within +1.5 or -1 dB of P_{SS} during the period T_{BE} to T_E
T_F (includes 1 stuffing bit)		241	25.104	Power shall be -50 dB of P_{SS} and stay below this
T_G		256	26.667	Start of next transmission time period

Table 13 - Definitions of Timing for Power Versus Time Mask

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 14

O/P Mon – Output Monitored using calibrated equipment

2.6 Sensitivity

2.6.1 Specification Reference

IEC 62287-2, Clause 11.2.1

2.6.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.6.3 Date of Test

16-September-2019 to 27-November-2019

2.6.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.1.2.

2.6.5 Environmental Conditions

Ambient Temperature	22.9 - 23.9 °C
Relative Humidity	45.2 - 59.0 %

2.6.6 Test Results

SOTDMA Transceiver

Frequency Offset (Hz)	156.025 MHz		162.025 MHz	
	PER (%) - Rx1	PER (%) - Rx2	PER (%) - Rx1	PER (%) - Rx2
-500	4.52	2.51	5.53	2.51
0	12.6	8.54	9.55	12.56
500	5.03	6.53	10.05	10.05

Table 15 - Sensitivity Results at 22.9 °C, 16.0 V DC

Test Conditions		156.025 MHz		162.025 MHz	
Temperature	Voltage	PER (%) - Rx1	PER (%) - Rx2	PER (%) - Rx1	PER (%) - Rx2
-15.0 °C	10.8 V DC	0.51	1.01	0.51	0.51
+55.0 °C	31.2 V DC	5.53	4.52	1.51	1.51

Table 16 - Sensitivity Results at Extreme Test Conditions

IEC 62287-2, Limit Clause 11.2.1.3

The PER shall not exceed 20 %.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Hewlett Packard	ESG4000A	61	12	17-Jul-2020
Thermometer	Digitron	T208	64	12	12-Jun-2020
Climatic Chamber	Votsch	VT4002	161	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	08-Oct-2019
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	23-Jul-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-036-2000	5036	12	06-Dec-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 17

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.7 Error Behaviour at High Input Levels

2.7.1 Specification Reference

IEC 62287-2, Clause 11.2.2

2.7.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0

2.7.3 Date of Test

17-October-2019

2.7.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.2.2.

2.7.5 Environmental Conditions

Ambient Temperature	24.5 °C
Relative Humidity	36.3 %

2.7.6 Test Results

SOTDMA Transceiver

Input Signal Level (dBm)	156.025 MHz		162.025 MHz	
	PER (%) - Rx1	PER (%) - Rx2	PER (%) - Rx1	PER (%) - Rx2
-77	0.50	1.51	1.51	1.00
-7	0	0	0	0

Table 18 - Error Behaviour at High Input Level Results

IEC 62287-2, Limit Clause 11.2.2.3

The PER shall not exceed 2% for an input signal level of -77 dBm and 10 % for an input signal level of -7 dBm.

2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Hewlett Packard	ESG4000A	61	12	17-Jul-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (30dB, 150W)	Narda	769-30	3369	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-036-2000	5036	12	06-Dec-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 19

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.8 Co-channel Rejection

2.8.1 Specification Reference

IEC 62287-2, Clause 11.2.3

2.8.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0

2.8.3 Date of Test

17-October-2019

2.8.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.3.2.

2.8.5 Environmental Conditions

Ambient Temperature 24.5 °C
Relative Humidity 36.0 %

2.8.6 Test Results

SOTDMA Transceiver

Unwanted Signal Frequency Offset (Hz)	156.025 MHz		162.025 MHz	
	PER (%) - Rx1	PER (%) - Rx2	PER (%) - Rx1	PER (%) - Rx2
-1000	2.01	0.50	3.02	5.53
0	5.53	2.51	0.50	2.51
+1000	4.52	2.51	4.02	5.03

Table 20 - Co-channel Rejection Results

IEC 62287-2, Limit Clause 11.2.3.3

The PER shall not exceed 20 %.

2.8.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Rohde & Schwarz	SMX	115	12	15-Jul-2020
AF Load (4ohm)	ASL (TUV)	4ohm	430	12	02-Apr-2020
Attenuator (30 dB, 50 W)	Bird	8321	494	12	24-Oct-2020
Audio Analyser	Hewlett Packard	8903B	576	12	17-Jan-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Signal Generator (250kHz to 4GHz)	Agilent Technologies	E4433B	2893	12	09-Sep-2020
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Signal Generator, 9kHz to 3GHz	Rohde & Schwarz	SMA 100A	3494	12	22-May-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
Combiner/Splitter	Weinschel	1506A	3878	12	23-Apr-2020
Coaxial Cable 5 m	Rosenberger	FA210B-1-050M-50X51	4045	6	29-Feb-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 21

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.9 Adjacent Channel Selectivity

2.9.1 Specification Reference

IEC 62287-2, Clause 11.2.4

2.9.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0

2.9.3 Date of Test

17-October-2019

2.9.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.4.2.

2.9.5 Environmental Conditions

Ambient Temperature	36.0 °C
Relative Humidity	24.5 %

2.9.6 Test Results

SOTDMA Transceiver

Unwanted Signal Frequency Offset (kHz)	156.025 MHz		162.025 MHz	
	PER (%) - Rx1	PER (%) - Rx2	PER (%) - Rx1	PER (%) - Rx2
-25	4.02	6.03	5.53	2.51
25	1.51	4.02	1.51	3.02

Table 22 - Adjacent Channel Selectivity Results

IEC 62287-2, Limit Clause 11.2.4.3

The PER shall not exceed 20 %.

2.9.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
AF Load (4ohm)	ASL (TUV)	4ohm	430	12	02-Apr-2020
Attenuator (30 dB, 50 W)	Bird	8321	494	12	24-Oct-2020
Audio Analyser	Hewlett Packard	8903B	576	12	17-Jan-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Signal Generator, 9kHz to 3GHz	Rohde & Schwarz	SMA 100A	3494	12	22-May-2020
Signal Generator, 9kHz - 3GHz	Rohde & Schwarz	SMA 100A	3504	12	02-Sep-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
Combiner/Splitter	Weinschel	1506A	3878	12	23-Apr-2020
Coaxial Cable 5 m	Rosenberger	FA210B-1-050M-50X51	4045	6	29-Feb-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 23

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.10 Spurious Response Rejection

2.10.1 Specification Reference

IEC 62287-2, Clause 11.2.5

2.10.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 1

2.10.3 Date of Test

23-October-2019 to 25-November-2019

2.10.4 Test Method

As described in section 1.6 of the present document, it was not possible to perform a search sweep using either PER/BER or SINAD. The manufacturer declared frequencies at which spurious responses may occur and these were measured using the method in 11.2.5.5.

The EUT does not use a 'traditional' LO based radio and therefore the SFI could not be calculated.

2.10.5 Environmental Conditions

Ambient Temperature	22.9 - 23.9 °C
Relative Humidity	45.2 - 59.0 %

2.10.6 Test Results

SOTDMA Transceiver

Frequency (MHz)	PER (%)
155.890	1.51
156.050	5.53
164.310	0.00

Table 24 - Spurious Responses - 156.025 MHz

No other responses were identified during the Limited Frequency Range Sweep.

Frequency (MHz)	PER (%)
155.895	13.57
160.280	4.52
161.940	3.02
162.680	1.51

Table 25 - Spurious Responses - 162.025 MHz

No other responses were identified during the Limited Frequency Range Sweep.

IEC 62287-2 Limit Clause 11.2.6.3

The PER shall not exceed 20%.

2.10.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
AF Load (4ohm)	ASL (TUV)	4ohm	430	12	02-Apr-2020
Attenuator (30 dB, 50 W)	Bird	8321	494	12	24-Oct-2020
Audio Analyser	Hewlett Packard	8903B	576	12	17-Jan-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Signal Generator, 9kHz to 3GHz	Rohde & Schwarz	SMA 100A	3494	12	22-May-2020
Signal Generator, 9kHz - 3GHz	Rohde & Schwarz	SMA 100A	3504	12	02-Sep-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
Combiner/Splitter	Weinschel	1506A	3878	12	23-Apr-2020
Coaxial Cable 5 m	Rosenberger	FA210B-1-050M-50X51	4045	6	29-Feb-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Hygrometer	Rotronic	HP21	4989	12	02-May-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020

Table 26

2.11 Intermodulation Response Rejection

2.11.1 Specification Reference

IEC 62287-2, Clause 11.2.6

2.11.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.11.3 Date of Test

18-October-2019 to 25-November-2019

2.11.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.6.2.

2.11.5 Environmental Conditions

Ambient Temperature	22.1 - 23.2 °C
Relative Humidity	47.2 - 51.7 %

2.11.6 Test Results

SOTDMA Transceiver

Test Number	Generator A (Wanted AIS Signal)	Generator B (Unmodulated ±50 kHz)	Generator C (Modulated ±100 kHz)	PER (%)	
				Rx1	Rx2
1	162.025 MHz	162.075 MHz	162.125 MHz	1.01	0.50
2	162.025 MHz	161.975 MHz	161.925 MHz	1.01	1.01
3	156.025 MHz	156.075 MHz	156.125 MHz	2.01	3.02
4	156.025 MHz	155.975 MHz	155.925 MHz	3.02	4.52

Table 27 - Intermodulation Results

IEC 62287-2 Limit clause 11.2.6.3

The PER shall not exceed 20%.

2.11.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Hewlett Packard	ESG4000A	61	12	17-Jul-2020
Power Divider	Weinschel	1506A	604	12	23-Apr-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Hygromer	Rotronic	Hygropalm	2404	12	02-May-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Signal Generator (250kHz to 4GHz)	Agilent Technologies	E4433B	2893	12	09-Sep-2020
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3160	12	07-Aug-2020
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (10dB, 150W)	Narda	769-10	3368	12	17-Jul-2020
Signal Generator, 9kHz - 3GHz	Rohde & Schwarz	SMA 100A	3504	12	02-Sep-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
Combiner/Splitter	Weinschel	1506A	3878	12	23-Apr-2020
1m N-Type Cable	Rhophase		4233	12	01-Nov-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-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
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 28

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.12 Blocking or Desensitisation

2.12.1 Specification Reference

IEC 62287-2, Clause 11.2.7

2.12.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0
Cortex M1, S/N: M1.00000069 - Modification State 1

2.12.3 Date of Test

18-October-2019 to 25-November-2019

2.12.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.2.7.2.

2.12.5 Environmental Conditions

Ambient Temperature	23.1 - 23.3 °C
Relative Humidity	43.0 - 51.0 %

2.12.6 Test Results

SOTDMA Transceiver

Unwanted Signal Frequency Offset (MHz)	Packet Error Ratio (%)			
	156.025 MHz		162.025 MHz	
	Rx1	Rx2	Rx1	Rx2
-10	1.51	2.01	3.52	1.51
-5	2.01	3.02	8.54	1.01
-2	5.03	1.51	1.01	2.01
-1	5.03	11.56	3.52	3.02
-0.5	2.01	1.51	2.51	3.52
0.5	3.02	2.01	2.51	2.51
1	3.02	5.03	5.03	2.01
2	2.01	5.03	2.51	3.02
5	2.51	6.03	3.02	2.01
10	1.01	1.51	1.01	1.01

Table 29 - Blocking Results

IEC 62287-2, Limit Clause 11.2.7.3

The maximum packet error rate shall not exceed 20 %.

2.12.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Power Divider	Weinschel	1506A	604	12	23-Apr-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Hygromer	Rotronic	Hygropalm	2404	12	02-May-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Signal Generator (250kHz to 4GHz)	Agilent Technologies	E4433B	2893	12	09-Sep-2020
Programmable Modulation Waveform Generator	Sine Qua Non	PMG1	3291	-	O/P Mon
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
Attenuator (10dB, 150W)	Narda	769-10	3368	12	17-Jul-2020
Signal Generator, 9kHz - 3GHz	Rohde & Schwarz	SMA 100A	3504	12	02-Sep-2020
DC to TTL Converter	TUV SUD	-	3599	-	TU
'N' - 'N' RF Cable (1m)	Rhophase	NPS-1803-1000-NPS	3701	12	18-Jul-2020
Combiner/Splitter	Weinschel	1506A	3878	12	23-Apr-2020
1m N-Type Cable	Rhophase		4233	12	01-Nov-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre N-Type Cable	Florida Labs	NMS-235SP-39.4-NMS	4511	12	18-Jul-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
Vector Signal Generator	Keysight Technologies	ESG E4438C	4731	12	19-Sep-2020
Vector Signal Generator	Rohde & Schwarz	SMBV100A	4886	36	11-May-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 30

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.13 Spurious Emissions from the Receiver

2.13.1 Specification Reference

IEC 62287-2, Clause 11.3.1

2.13.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 0

2.13.3 Date of Test

22-October-2019 to 10-December-2019

2.13.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.3.1.2.

2.13.5 Environmental Conditions

Ambient Temperature	22.1-24.4 °C
Relative Humidity	37.5-47.2 %

2.13.6 Test Results

SOTDMA Transceiver

Frequency (MHz)	Level (dBm)
3811.000	-50.723

Table 31 - Receiver Emissions Results

No other emissions were detected within 6 dB of the limit.

Figure 23 - 9 kHz to 150 kHz

Figure 24 - 150 kHz to 30 MHz

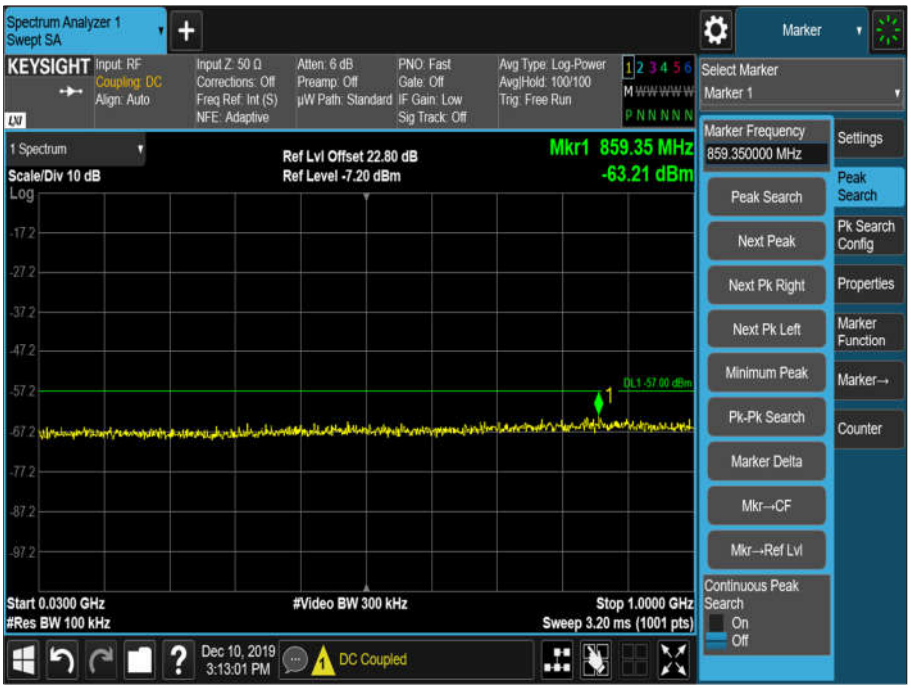

Figure 25 - 30 MHz to 1 GHz

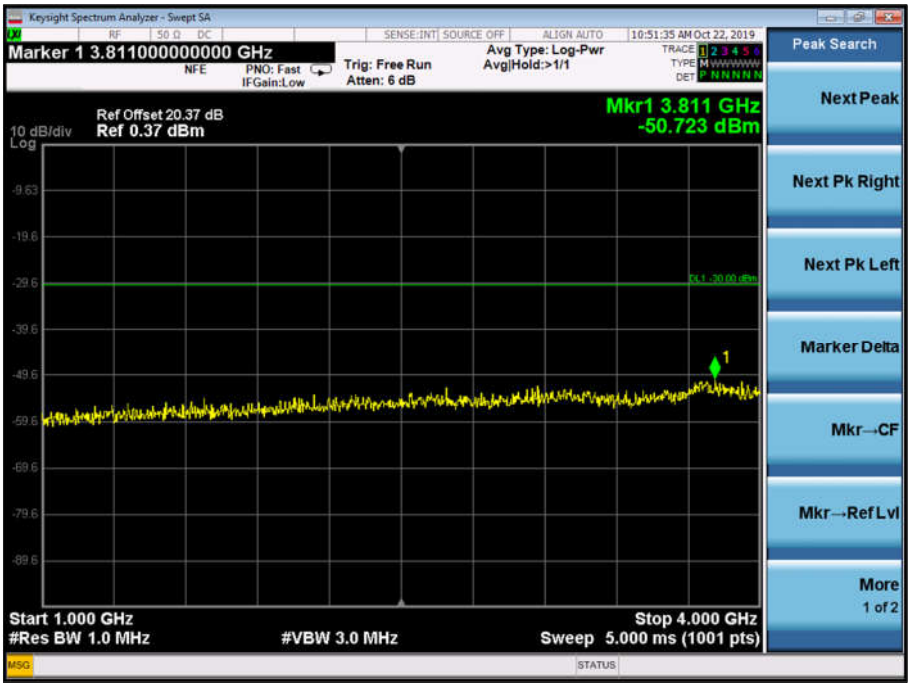

Figure 26 - 1 GHz to 4 GHz

Note: The limit for the conducted spurious emissions from the receiver in the frequency range 1 GHz to 4 GHz is -47 dBm not as per the display line on the plot above.

IEC 62287-2, Limit Clause 11.3.1.3

The power of any spurious emission in the specified range at the antenna terminal shall not exceed –57 dBm (2 nW) in the frequency range 9 kHz to 1 GHz and –47 dBm (20 nW) in the frequency range 1 GHz to 4 GHz.

2.13.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Power Supply Unit	Hewlett Packard	6267B	21	-	TU
Hygromer	Rotronic	Hygropalm	2404	12	02-May-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2019
Attenuator (20 dB, 150 W)	Narda	769-20	3367	12	17-Jul-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-Feb-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (18 GHz)	Rosenberger	LU7-071-1000	5098	12	06-Oct-2020
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	06-Oct-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020
Signal Analyzer	Keysight Technologies	PXA N9030B	5432	12	05-Dec-2020

Table 32

TU - Traceability Unscheduled

2.14 Spurious Emissions from the Transmitter

2.14.1 Specification Reference

IEC 62287-2, Clause 11.3.2

2.14.2 Equipment Under Test and Modification State

Cortex M1, S/N: M1.00000069 - Modification State 2

2.14.3 Date of Test

27-January-2020 to 29-January-2020

2.14.4 Test Method

This test was performed in accordance with IEC 62287-2, clause 11.3.2.2.

2.14.5 Environmental Conditions

Ambient Temperature	23.6 °C
Relative Humidity	31.4 %

2.14.6 Test Results

SOTDMA Transceiver

Frequency (MHz)	Level (dBm)
0.180	-41.81
157.974	-37.55
161.820	-38.45
162.098	-39.67
323.910	-41.25
486.070	-41.73

Table 33 - Transmitter Emissions Results - 162.025 MHz

No other emissions were detected within 6 dB of the limit.

Figure 27 - 162.025 MHz - 9 kHz to 150 kHz

Figure 28 - 162.025 MHz - 150 kHz to 30 MHz

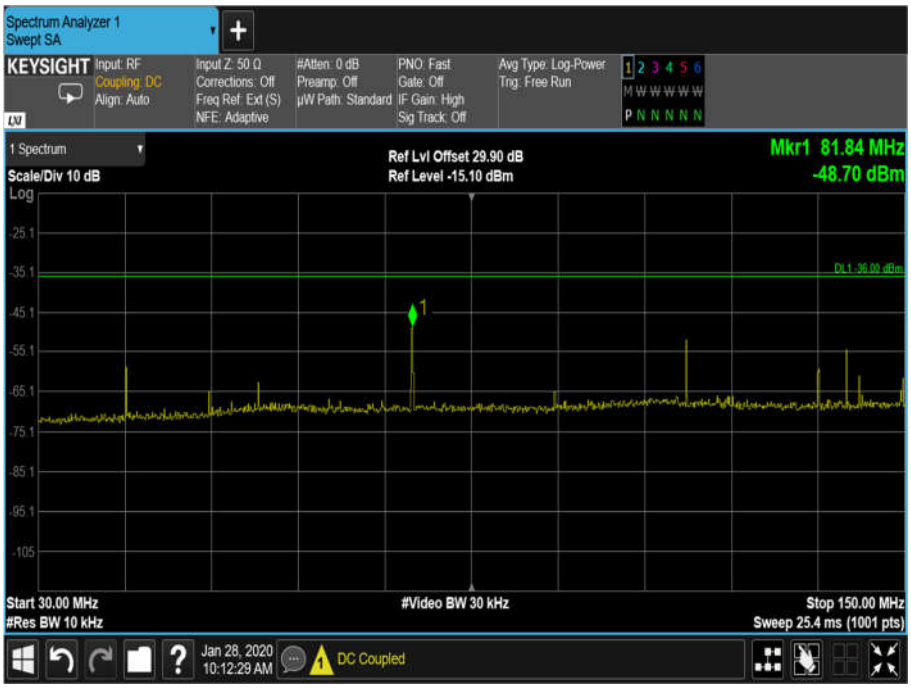

Figure 29 - 162.025 MHz - 30 MHz to 150 MHz

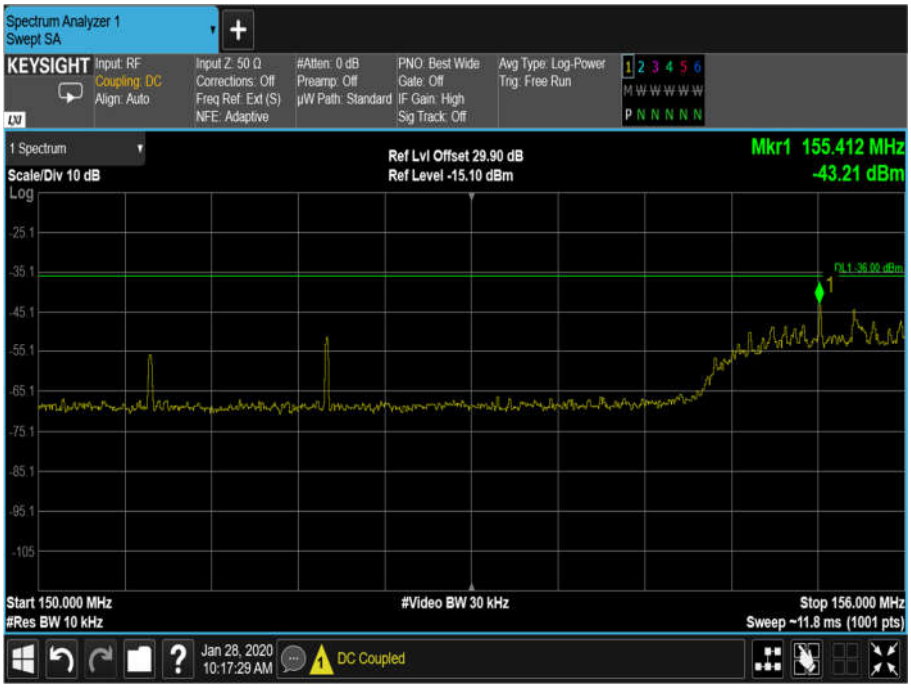

Figure 30 - 162.025 MHz - 150 MHz to 156 MHz

Figure 31 - 162.025 MHz – 155.775 MHz to 161.025 MHz

Figure 32 - 162.025 MHz - 161.000 MHz to 161.9625 MHz

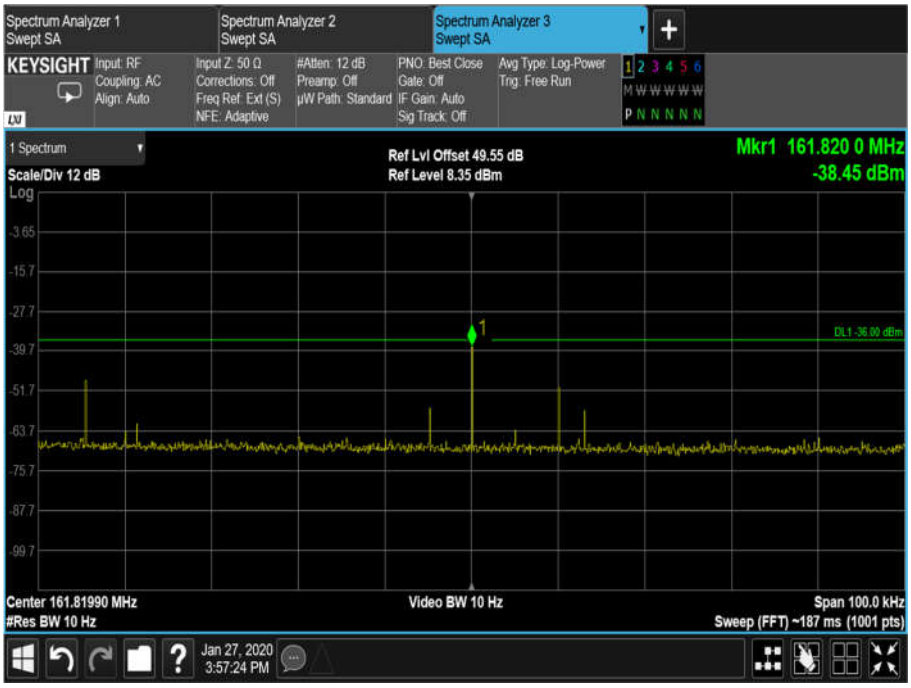

Figure 33 - 162.025 MHz – Spur at 161.820 MHz

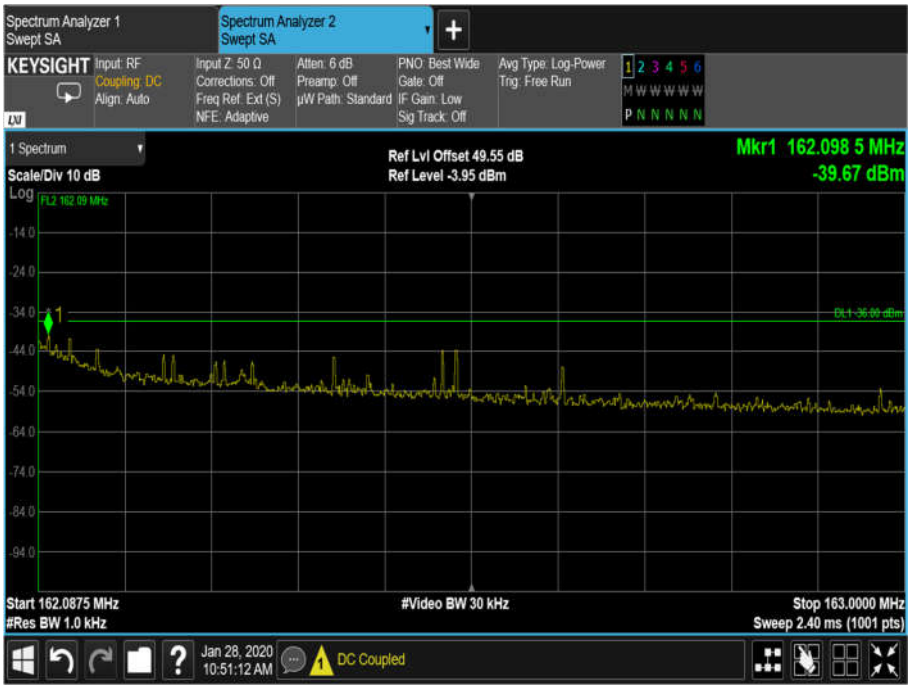

Figure 34 - 162.025 MHz - 162.0875 MHz to 163.000 MHz

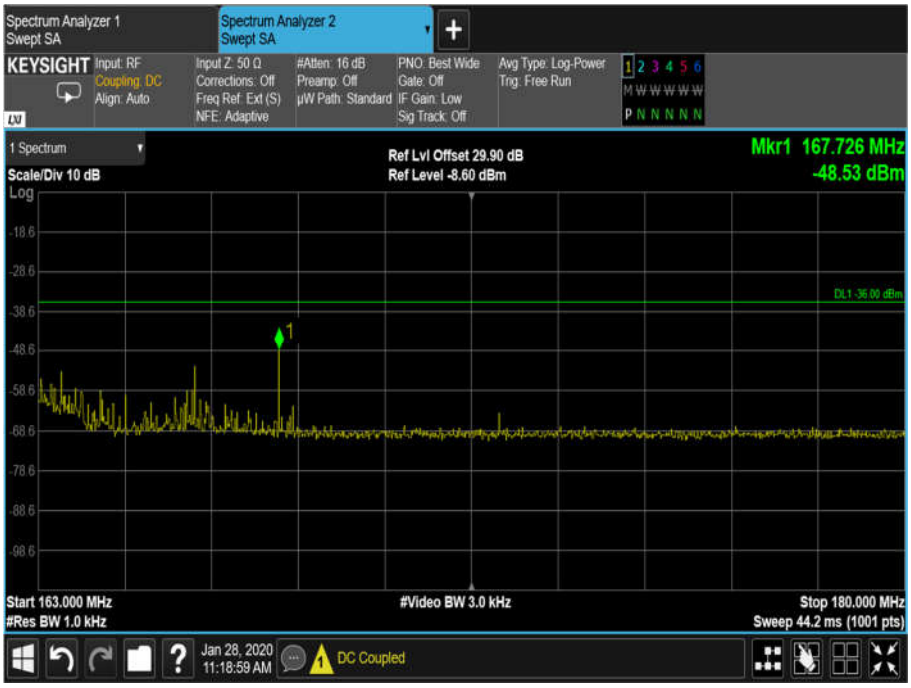

Figure 35 – 162.025 MHz, 163 MHz to 180 MHz

Figure 36 – 162.025 MHz, 180 MHz to 450 MHz

Figure 37 – 162.025 MHz, 450 MHz to 1 GHz

Figure 38 – 162.025 MHz, 1 GHz to 4 GHz

IEC 62287-2, Limit Clause 11.3.2.3

The power of any spurious emission on any discrete frequency shall not exceed 0,25 µW (–36 dBm) in the frequency range 9 kHz to 1 GHz and 1 µW (–30 dBm) in the frequency range 1 GHz to 4 GHz.

2.14.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
High Pass Filter	Mini-Circuits	NHP-300	1640	12	15-Jan-2021
Hygromer	Rotronic	A1	2138	12	5-Mar-2020
Multimeter	Iso-tech	IDM101	2419	12	28-Nov-2020
Multimeter	Fluke	79 Series II	3057	12	19-Aug-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
Attenuator (10dB, 100W)	Weinschel	48-10-43	4867	12	29-Nov-2020
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Attenuator 30dB 100W	Weinschel	48-30-43-LIM	5135	12	O/P Mon
Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5423	6	13-Jun-2020
Signal Analyzer	Keysight Technologies	PXA N9030B	5432	12	05-Dec-2020

Table 34

O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Equipment Under Test (EUT)

Figure 39 – Front View

Figure 40 – Rear View

4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Spurious Emissions from the Transmitter	± 3.45 dB
Spurious Emissions from the Receiver	± 3.45 dB
Blocking or Desensitisation	± 2.6 dB
Intermodulation Response Rejection	± 1.7 dB
Spurious Response Rejection	± 2.6 dB
Adjacent Channel Selectivity	± 2.6 dB
Co-channel Rejection	± 2.6 dB
Error Behaviour at High Input Levels	± 1.8 dB
Sensitivity	± 1.8 dB
Transmitter Output Power Versus Time Function	± 2.0 dB
Modulation Accuracy	± 2.0 dB
Transmission Spectrum	± 2.0 dB
Carrier Power	± 0.45 dB
Frequency Error	± 11 Hz

Table 35

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.