Report No. 433520-01-R02

Test Report

Product	Ship Station Maritime VHF DSC Class A
Name and address of the applicant	Thrane & Thrane A/S Lundtoftegaardsvej 93D 2800 Kgs. Lyngby, Denmark
Name and address of the manufacturer	Thrane & Thrane A/S Lundtoftegaardsvej 93D 2800 Kgs. Lyngby, Denmark
Model	SAILOR 7222
Rating	25W VHF DSC Class A
Trademark	SAILOR
Serial number	Prototype 2
Additional information	VHF, DSC class A
Tested according to	**FCC Part 80** Maritime VHF **Industry Canada RSS-182, Issue 6** Maritime Radio Equipment Operating in the 156-162.5 MHz Band
Order number	433520
Tested in period	2021-08-02 to 2021-10-05
Issue date	2022-09-27
Name and address of the testing laboratory	Nemko Instituttveien 6 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 ilac-MRA NORWEGIAN ACCREDITATION TEST 033 **An accredited technical test executed under the Norwegian accreditation scheme**

Prepared by [Frode Sveinsen]	Approved by [G.Suhantakumar]

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Template version: B

Revision history

Revision	Date	Comment	Sign
00	2022-02-15	First edition	FS
01	2022-09-13	Updated FCC/ISED ID	FS
02	2022-09-27	Updated to GVH and added some new measurements	FS

THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in “Summary of Test Data”.

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1 INFORMATION

1.1 Test Item

Name	**SAILOR**
FCC ID	**ROJ7226**
ISED ID	**6200B-7226G**
Model/version	**SAILOR 7222 VHF DSC Class A**
Serial number	**Prototype 2**
Hardware identity and/or version	**Interface board: 38-166437 rev B** **PSU board 38-166438 rev B** **CU application module 88-170462 rev A**
Software identity and/or version	**1.00**
Frequency Range	**156.025 – 157.640 MHz**
Type of Modulation	**Analogue (Phase Modulation)**
Rated Output Power	**25 W**
Type of Power Supply	**External DC Power (24V DC)**
Antenna Connector	**Main RX/TX connector: TNC (50 Ohm)** **DSC RX connector: TNC (50 Ohm)**

Theory of Operation

The EUT is 25W maritime VHF with a DSC Class A receiver.

The EUT consists of Control Unit 7224 VHF DSC CU and Transceiver Unit 7226 VHF Transceiver Unit

The DSC receiver has a separate antenna connector. All tests were performed on the main TX/RX connector, but Receiver Emissions were also measured on the DSC connector.

1.2 Normal test condition

Temperature:	**22 - 23 °C**
Relative humidity:	**30 - 50 %**
Normal test voltage:	**24.0 V_{DC}**

The values are the limit registered during the test period.

All tests were performed with a regulated DC Power Supply.

1.3 Test Engineer(s)

Frode Sveinsen

1.4 Test Equipment

See list of test equipment in clause 5.

1.5 Other Comments

All ports were populated during spurious emission measurements.

2 TEST REPORT SUMMARY

2.1 General

All measurements are tracable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 80 and Industry Canada RSS-182 Issue 6.

Radiated tests were conducted in accordance with ANSI C63.4-2014 and ANSI C63.26-2015.

Radiated tests were made in a semi-anechoic chamber at measuring distance of 3m.

A description of the test facility is on file with the FCC and Industry Canada.

☒ New Submission	☒ Production Unit
☐ Class II Permissive Change	☐ Pre-production Unit
GVH Equipment Code	☐ Family Listing

2.2 Test Summary

Name of test	FCC Part 2 and Part 80 reference	RSS-182 Issue 6, RSS-GEN Issue 5 reference	Test method ANSI C63.26-2015 reference	Result
Required operating frequencies	**80.371**	**5.3**		**Complies**
RF Power Output	**2.1046, 80.215**	**5.6**	**5.2**	**Complies**
Modulation Characteristics, - Audio Frequency Response - Modulation Limiting	**2.1047 80.213**	**5.4 5.8**	**5.4**	**Complies**
Occupied Bandwidth	**2.1049, 80.205**	**5.4 6.7 (RSS-GEN)**	**5.4**	**Complies**
Spurious Emissions at antenna terminals	**2.1051, 2.1057, 80.211**	**5.9**	**5.7**	**Complies**
Field Strength of Transmitter Spurious Radiations	**2.1053, 2.1057, 80.211**	**5.9**	**5.5**	**Complies**
Frequency Stability	**2.1055, 80.209**	**5.5**	**5.6**	**Complies**
Suppression of Interference Abord Ships	**80.217**	**-**		**Complies**
Suppression of Interference abord ships	**80.217**	**N/A**		**Complies**

[1] The tested equipment transmits voice and uses analogue modulation.

[2] The tested equipment has a 50 Ohm antenna connector.

3 TEST RESULTS

3.1 RF Output Power

FCC Part 2.1046, 80.215

ISED Canada RSS-182 Issue 6, Clause 5.6

Measurement Method: ANSI C63.26-2015 Clause 5.2

Test Results: Complies

Measurement Data:

Frequency	Min Power		Max Power	
	dBm	Watts	dBm	Watts
156.050 MHz	28.34	0.68	42.85	19.3
156.800 MHz	28.54	0.71	42.87	19.4
157.425 MHz	28.27	0.67	42.71	18.7

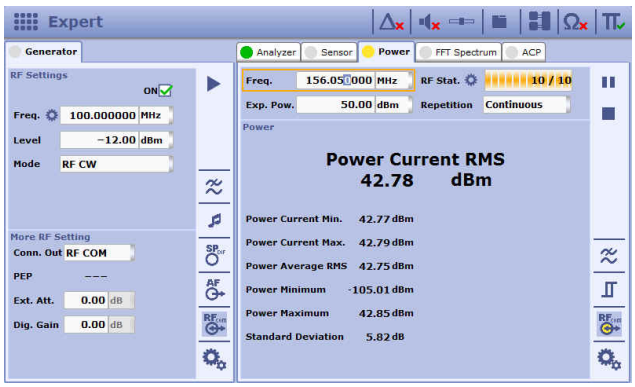
This measurement was performed with the R&S CMA180.

The measurement is performed with the EUT transmitting continuously and unmodulated.

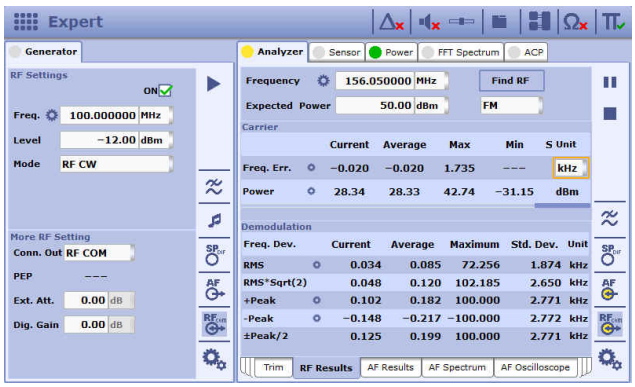
Requirements:

	FCC 80.215 RSS-182 Issue 6
Ship Stations	25 Watts[1]
Coast Stations	50 Watts
Ship borne hand-held portable transmitter	6 Watts

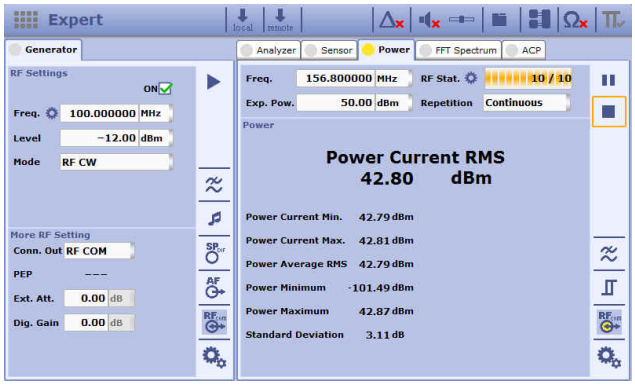
[1] Ship stations shall have built in feature to reduce power to 1 Watts or less



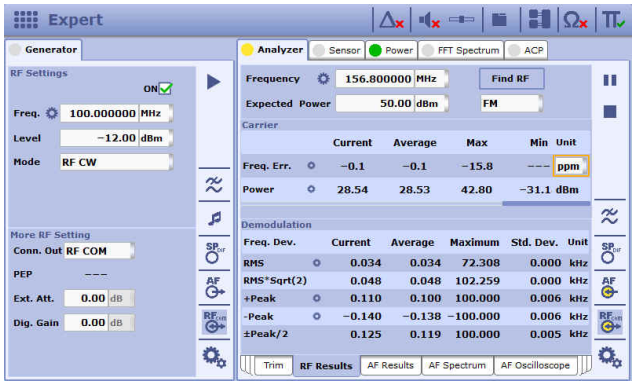
Output Power, Ch01, Full Power



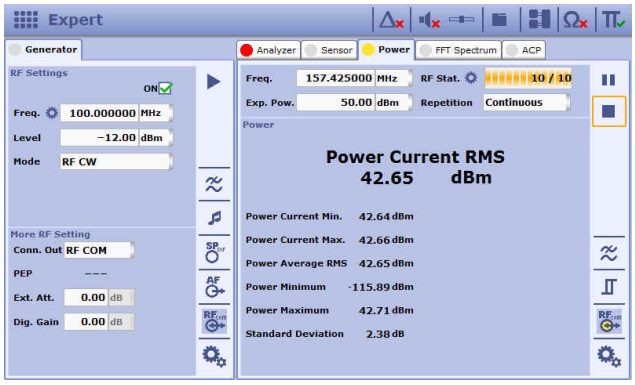
Output Power, Ch01, Low Power



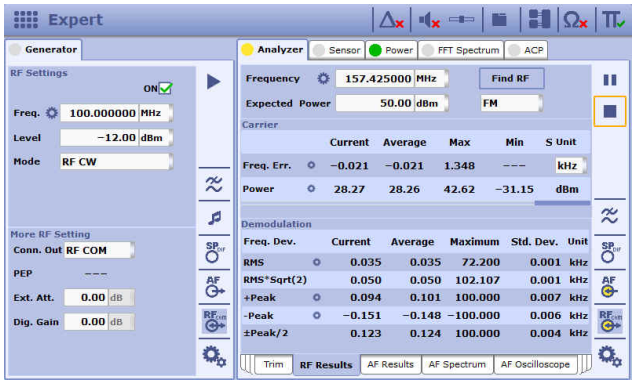
Output Power, Ch16, Full Power



Output Power, Ch16, Low Power



Output Power, Ch88, Full Power



Output Power, Ch88, Low Power

3.2 Modulation Characteristics - Audio Frequency Response

FCC Parts: 2.1047, 80.213

ISED Canada RSS-182 Issue 6, Clause 5.4

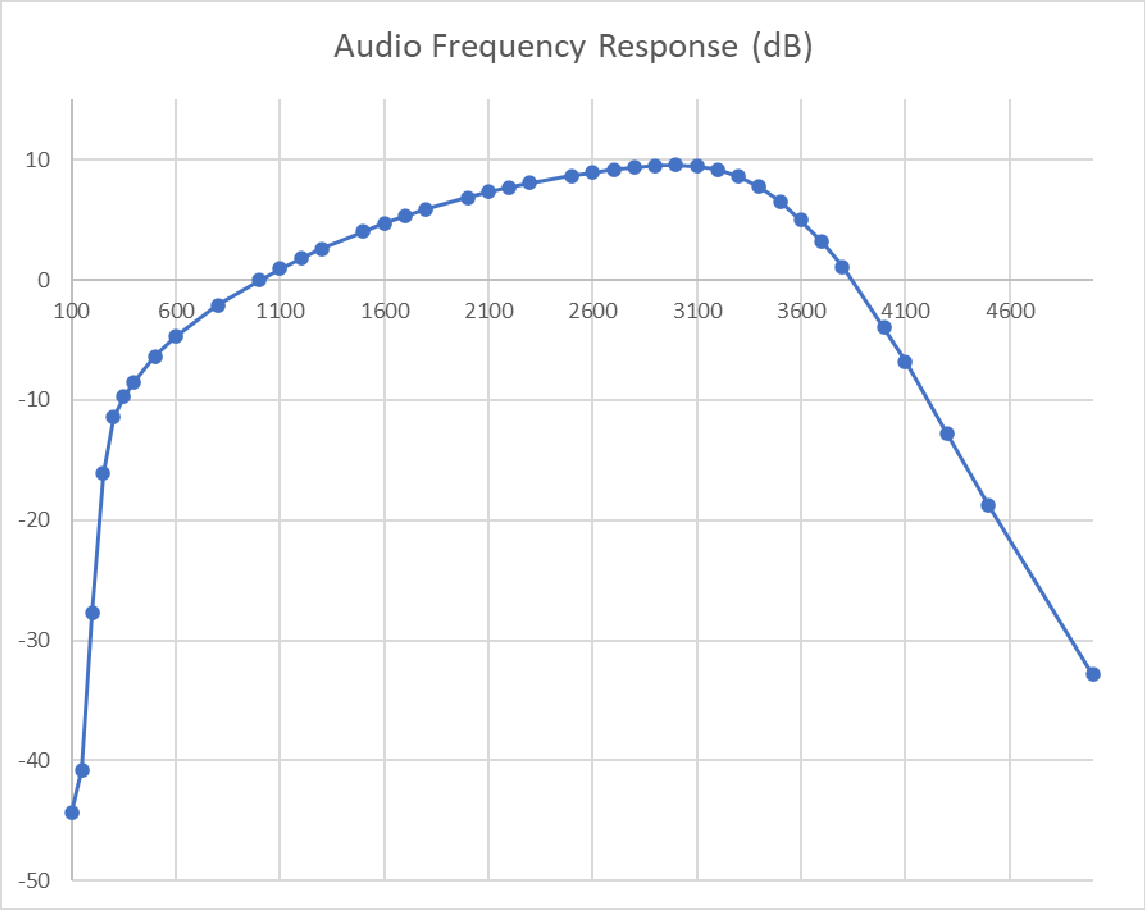
ANSI C63.26-2015, Clause 5.3

Test Results: Complies

Measurement Data:

Audio Frequency (Hz)	Peak Dev (kHz)	Voltmeter Reading (mV)	Calculated value (dB)
100	0.006	0.04	-44.3
200	0.04	0.27	-27.8
250	0.16	1.03	-16.1
300	0.27	1.77	-11.4
400	0.38	2.48	-8.5
500	0.48	3.16	-6.4
800	0.79	5.18	-2.1
1000	1.00	6.59	0.0
1100	1.11	7.33	0.9
1200	1.23	8.09	1.8
1300	1.35	8.87	2.6
1500	1.59	10.50	4.0
1600	1.72	11.32	4.7
1700	1.84	12.15	5.3
1800	1.97	12.96	5.9
2000	2.21	14.54	6.9
2300	2.53	16.66	8.1
2500	2.71	17.89	8.7
2800	2.94	19.39	9.4
3000	3.01	19.82	9.6
3200	2.88	18.95	9.2
3400	2.44	16.06	7.7
3500	2.12	13.98	6.5
3800	1.132	7.46	1.1
4000	0.634	4.18	-4.0
4500	0.115	0.76	-18.8
5000	0.023	0.15	-32.9

See attached graph.



Audio Frequency Response

3.3 Modulation Characteristics - Modulation Limiting

Measurement Procedure:

FCC Parts: 2.1047, 80.213

ISED Canada RSS-182 Issue 6, Clause 5.4

ANSI C63.26-2015, Clause 5.3

Test Results: Complies

Measurement Data:

Input Level (dB)	Maximum Modulation (kHz)			
	300 Hz	1000 Hz	2500 Hz	3000 Hz
0	0.85	3.00 (ref)	4.66	4.22
5	1.45	4.54	4.66	4.24
10	2.52	4.51	4.67	4.25
15	4.27	4.54	4.67	4.24
20	4.28	4.52	4.66	4.21

The EUT is a ship station. See attached graph.

Requirements:

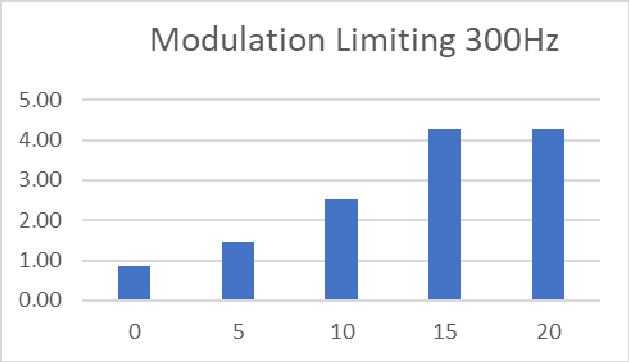
§80.213

(a)(2) When phase or frequency modulation is used in the 156-162 MHz band the peak modulation must be maintained between 75 and 100 percent. A frequency deviation of ±5 kHz is defined as 100 percent peak modulation

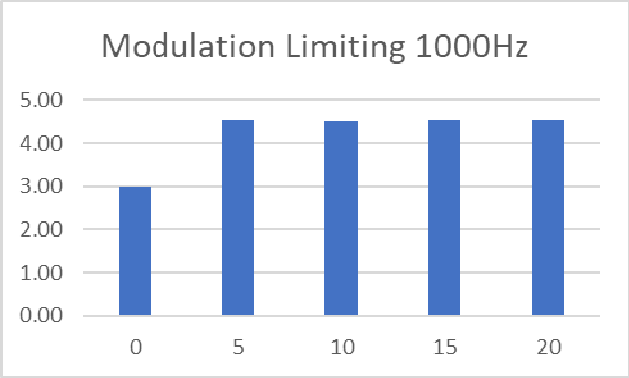
(b) Radiotelephone transmitters using A3E, F3E and G3E emission must have a modulation limiter to prevent any modulation over 100 percent.

(d) Ship and coast station transmitters operating in the 156-162 MHz and 216-220 bands must be capable of proper operation with a frequency deviation that does not exceed ±5 kHz when using any emission authorized by §80.207.

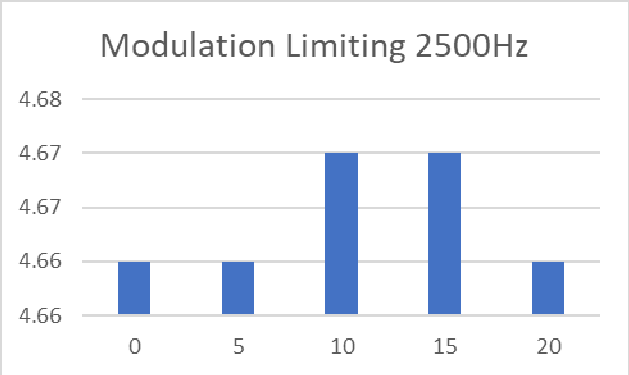
(e) Coast station transmitters operated in the 156-162 MHz band must be equipped with an audio low-pass filter. The filter must be installed between the modulation limiter and the modulated radio frequency stage. At frequencies between 3 kHz and 20 kHz it must have an attenuation greater than at 1 kHz by at least $60\log_{10}(f/3)$ dB where "f" is the audio frequency in kilohertz. At frequencies above 20 kHz the attenuation must be at least 50 dB greater than at 1 kHz.



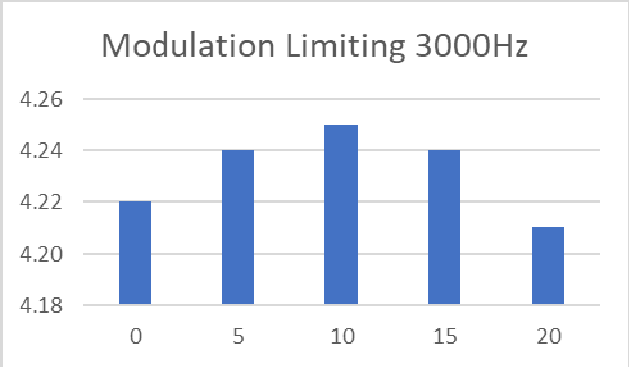
Modulation Limitation 300Hz



Modulation Limitation 1000Hz



Modulation Limitation 2500Hz



Modulation Limitation 3000Hz

3.4 Occupied Bandwidth

FCC Parts 2.1049, 80.205

ISED Canada RSS-182 Issue 6, Clause 5.4
ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement Method: ANSI C63.26-2015, Clause 5.4

Test Results: Complies

Measurement Data:

Carrier Frequency: 156.800 MHz

	99% OBW kHz	20dB Emission BW kHz
G3E Modulation	15.079	15.465
G2B Modulation DSC	15.128	15.465

See attached graph.

For this test, the EUT was made to transmit continuously with modulation activated.

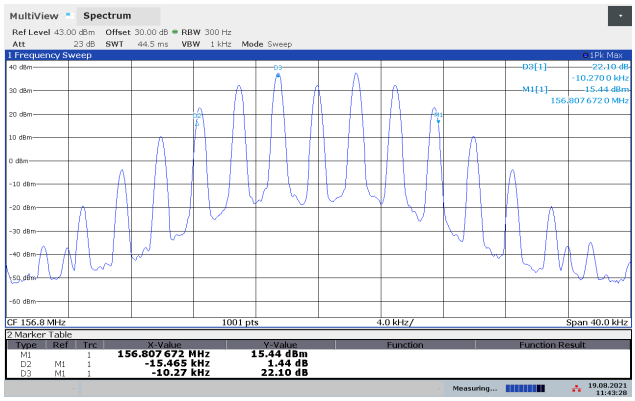
Requirements:

FCC Part 80:

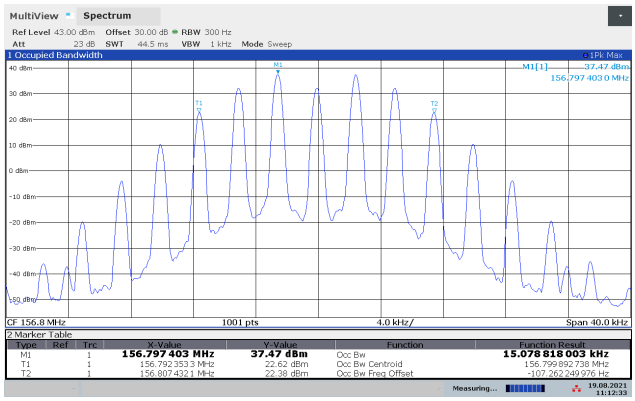
Class of Emission	Emission Designator	Authorized Bandwidth
G3E	16K0G3E	20.0 kHz
G2B	16K0G2B	20.0 kHz

ISED Canada RSS-182 Issue 6:

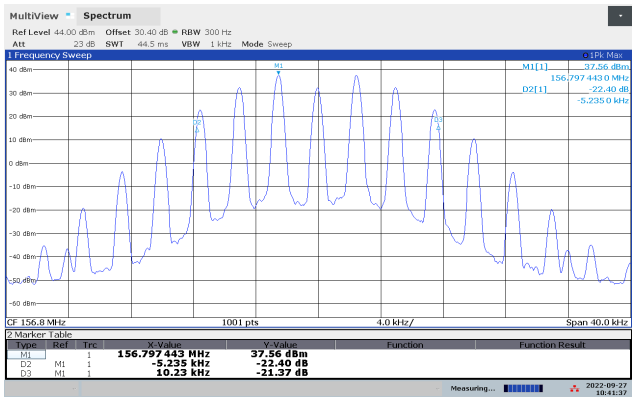
Class of Emission	Emission Designator	Authorized Bandwidth
G3E	16K0G3E	16.0 kHz



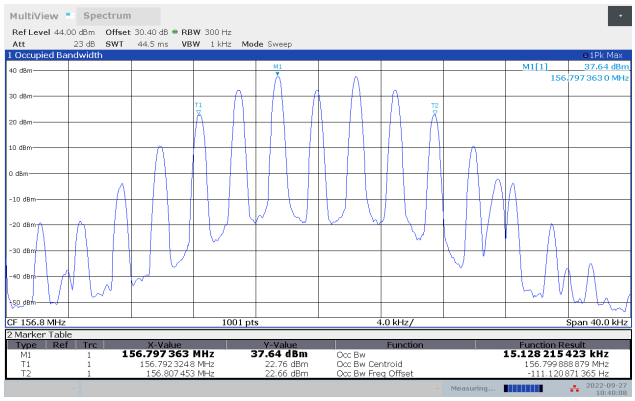
OBW 20dB, 156.800MHz, 2500Hz, G3E



OBW 99%, 156.800MHz, 2500Hz, G3E



OBW 20dB, 156.800MHz, 2500Hz, G2B



OBW 99%, 156.800MHz, 2500Hz, G2B

3.5 Spurious Emissions at Antenna Terminal

Measurement Procedure:

FCC Parts: 2.1051, 80.211(f)

ISED Canada RSS-182 Issue 6, Clause 5.9.1

ISED Canada RSS-GEN Issue 5, Clause 6.11

ANSI C63.26-2015, Clause 5.6

Test Results: Complies

Measurement Data:

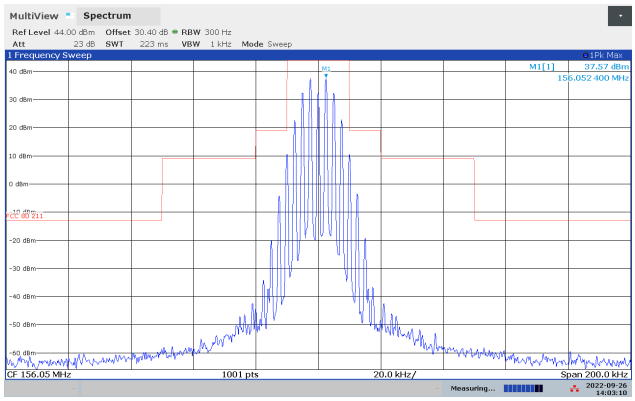
Carrier Frequency MHz	Spurious Frequency MHz	Measured Value dBm	Limit dBm	Margin dB
156.050	185.725	-34.8	-13	21.8
156.800	187.217	-34.7	-13	21.7
157.425	188.475	-34.5	-13	21.5
Any	All other	< -40	-13	> 27

Requirements, FCC §80.211(f):

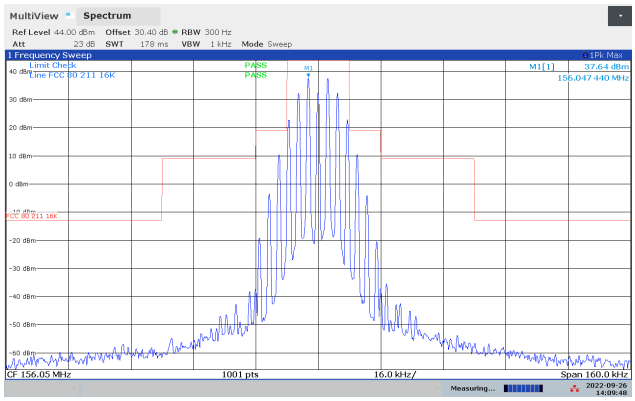
Frequency relative to Channel Centre Frequency	Measuring Bandwidth	Attenuation Relative to Carrier
More than 50% up to 100% of channel BW	300 Hz	At least 25 dB
More than 100% up to 250% of channel BW	300 Hz	At least 35 dB
More than 250% of channel BW	≥ 3 kHz	At least 43 + 10 $\log_{10}$(P) dB

P is Average Conducted Power in Watts

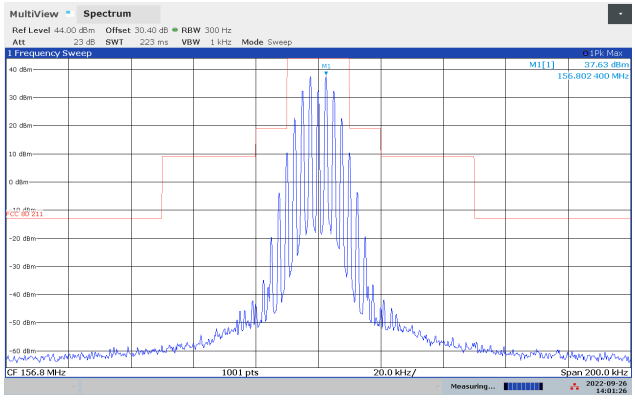
In all of the measurements set forth in 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.



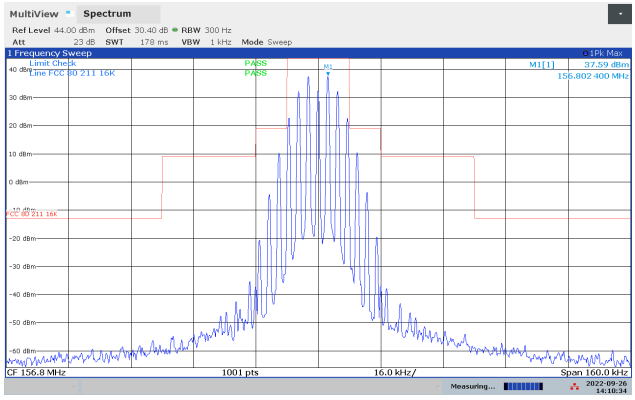
Spectrum Mask FCC, 156.050MHz, 2500Hz, 25W



ISED Emission Mask B 16kHz, 156.050MHz, 2500Hz, 25W



Spectrum Mask FCC, 156.800MHz, 2500Hz, 25W



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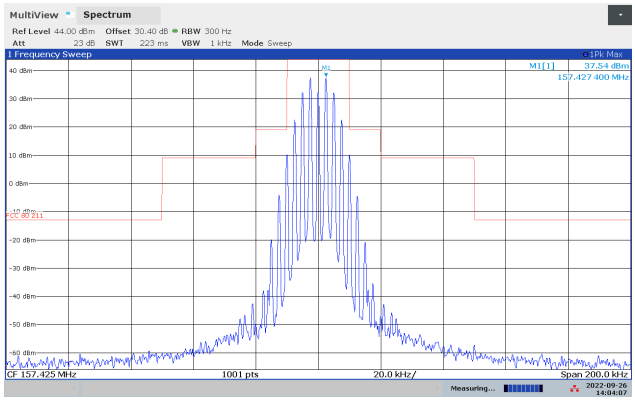
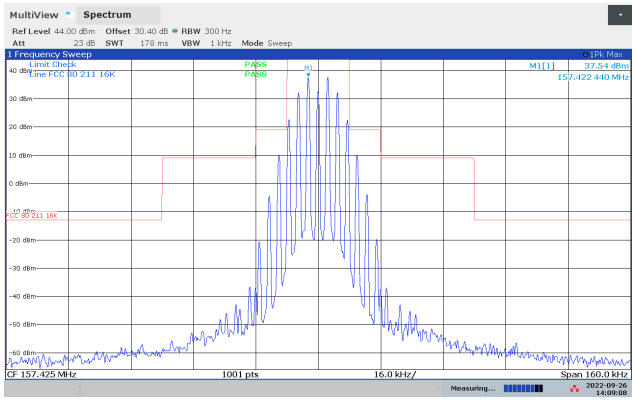
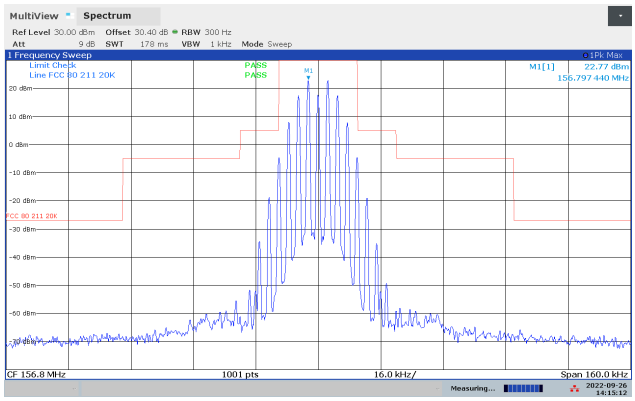


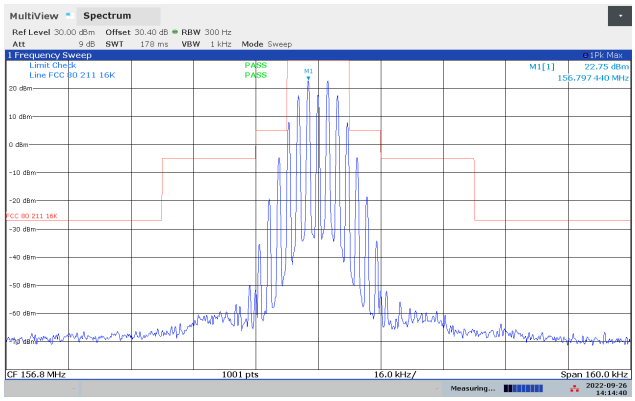
Spectrum Mask FCC, 157.425MHz, 2500Hz, 25W



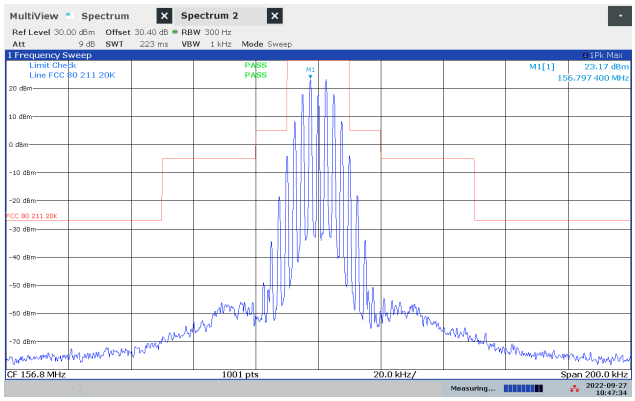
ISED Emission Mask B 16kHz, 157.425MHz, 2500Hz, 25W



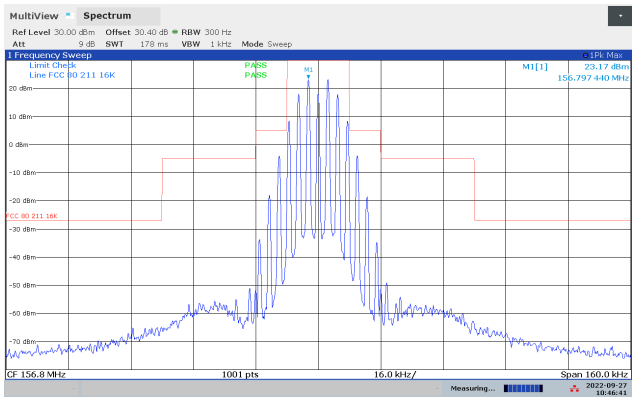
Spectrum Mask FCC, 156.800MHz, 2500Hz, 1W



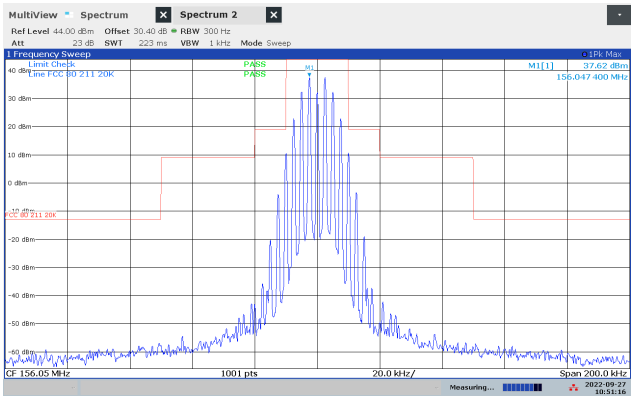
ISED Emission Mask B 16kHz, 156.800MHz, 2500Hz, 1W



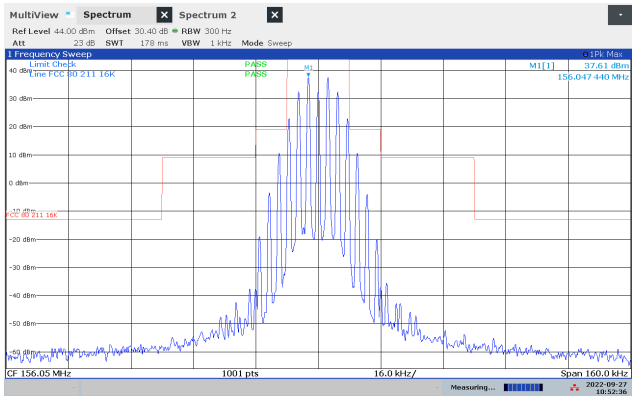
Spectrum Mask FCC, 156.800MHz, 2500Hz, 1W, DSC



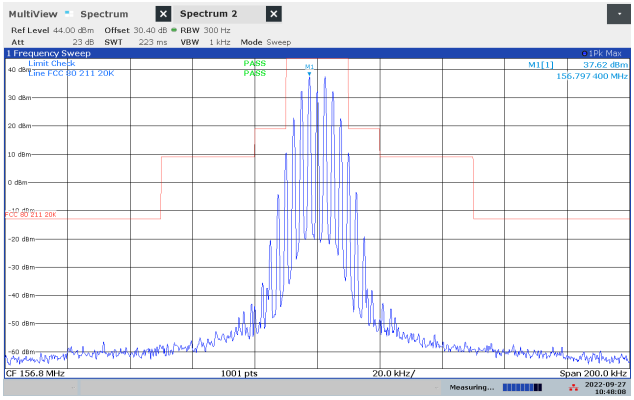
ISED Emission Mask B 16kHz, 156.800MHz, 2500Hz, 1W, DSC



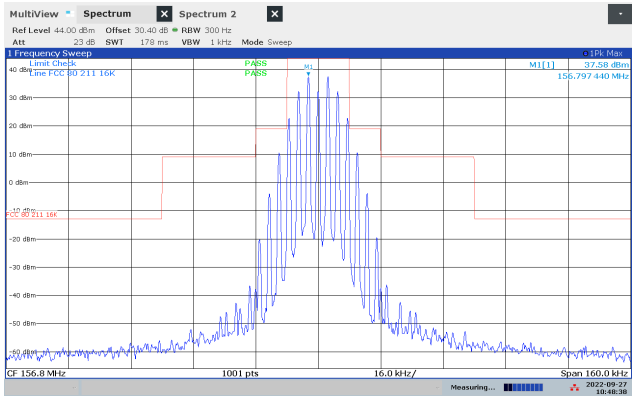
Spectrum Mask FCC, 156.050MHz, 2500Hz, 25W, DSC



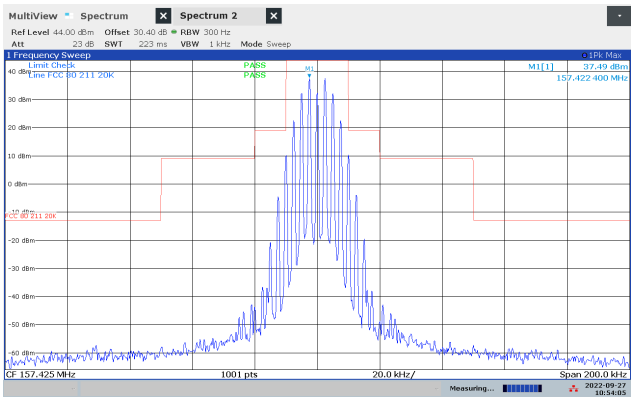
ISED Emission Mask B 16kHz, 156.050MHz, 2500Hz, 25W, DSC



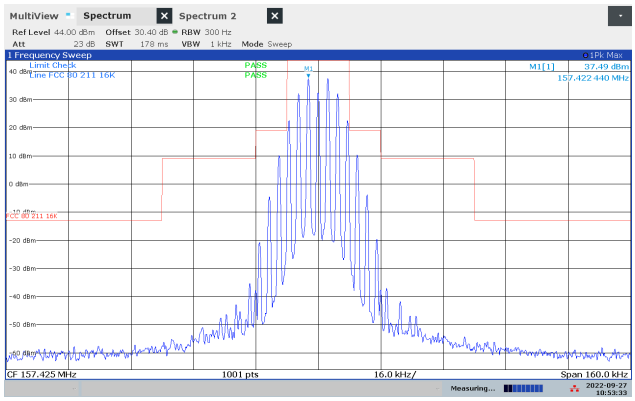
Spectrum Mask FCC, 156.800MHz, 2500Hz, 25W, DSC



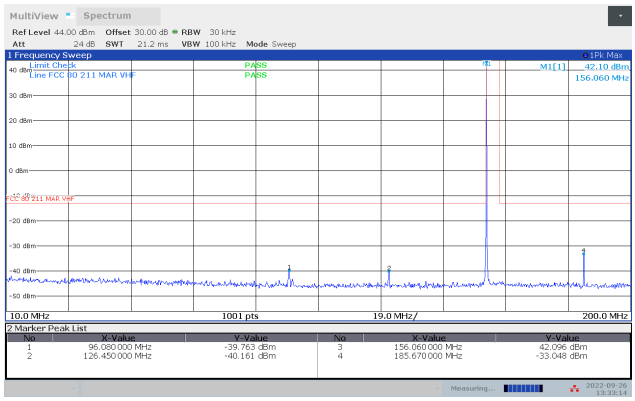
ISED Emission Mask B 16kHz, 156.800MHz, 2500Hz, 25W, DSC



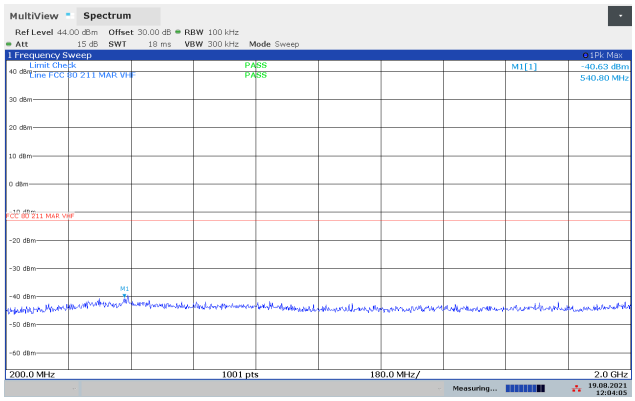
Spectrum Mask FCC, 157.425MHz, 2500Hz, 25W, DSC



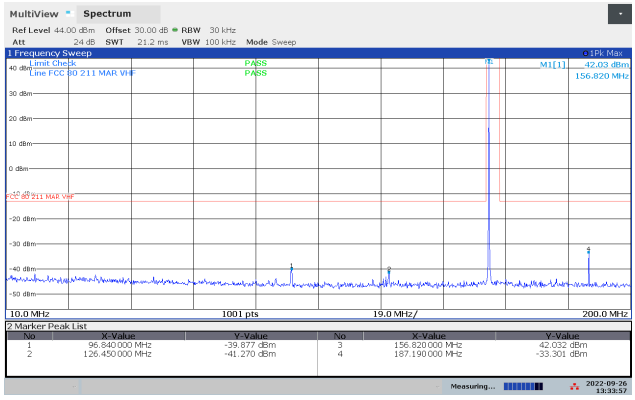
ISED Emission Mask B 16kHz, 157.425MHz, 2500Hz, 25W, DSC



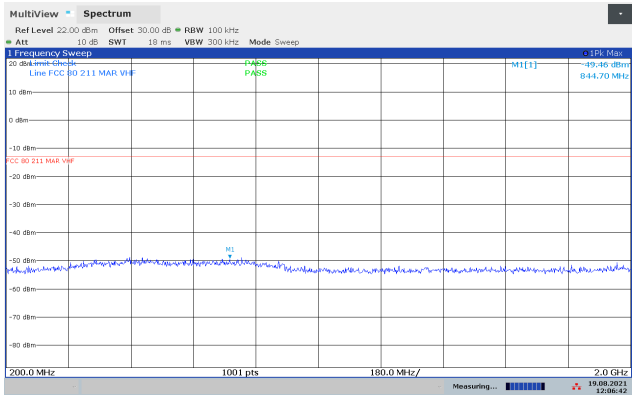
Emissions 10 -200MHz, 156.050MHz



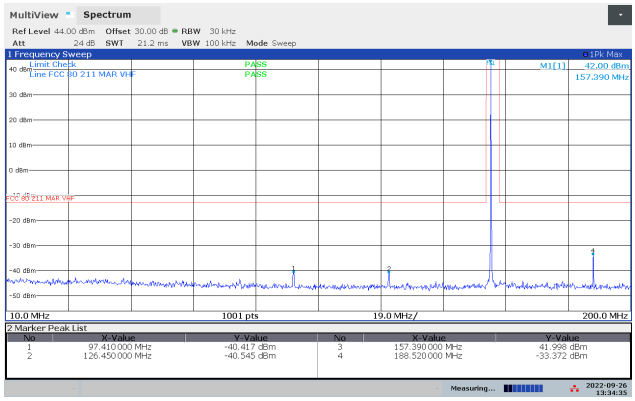
Emissions 200 -2000MHz, 156.050MHz



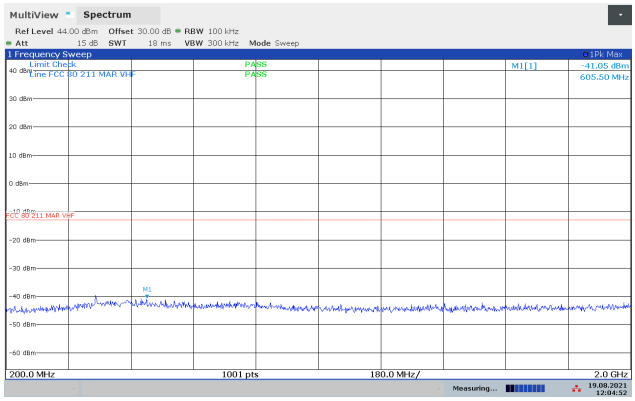
Emissions 10 -200MHz, 156.800MHz



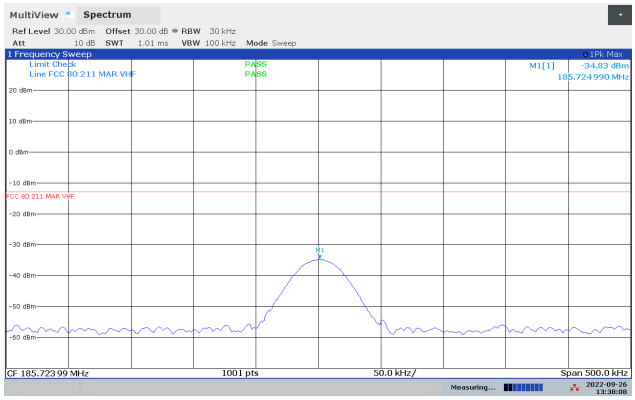
Emissions 200 -2000MHz, 156.800MHz



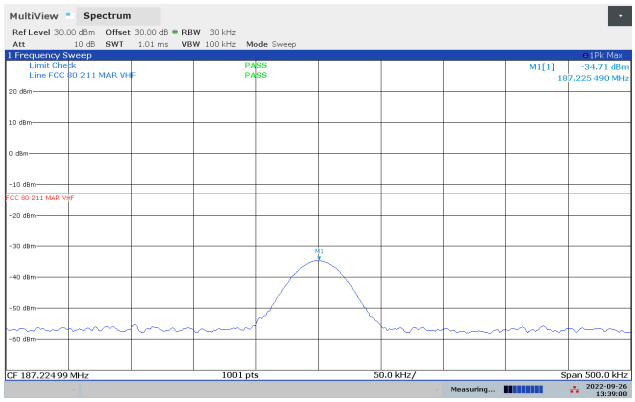
Emissions 10 -200MHz, 157.425MHz



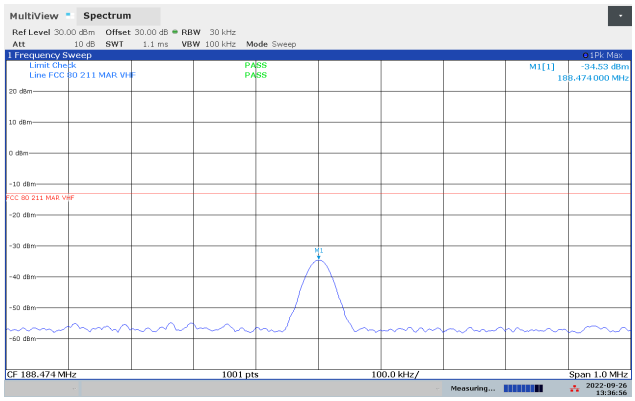
Emissions 200 -2000MHz, 157.425MHz



Emissions 185.725MHz, 156.050MHz



Emissions 187.225MHz, 156.800MHz



Emissions 188.475MHz, 157.425MHz

3.6 Field Strength of Transmitter Spurious Radiations

FCC Part 2.1053, 2.1057, 80.211

ISED Canada RSS-182 Issue 6, Clause 5.9.1

Measurement Method: ANSI C63.26-2015 Clause 5.5

Test Results: Complies

Measurement Data:

Carrier Frequency (MHz)	Spurious Frequency (MHz)	Measurement Bandwidth (MHz)	Measured Value (dBµV/m @3m)	Calculated Value (dBm)	Limit (dBm)	Margin (dB)
156.800	85.7	0.100	41.0	-54.2	-13	41.2
	250	0.100	51.2	-44.0	-13	31.0
	500	0.100	50.1	-45.1	-13	32.1
	875	0.100	41.4	-53.8	-13	40.8
	1375	1.0	50.6	-44.6	-13	31.6
	1625	1.0	48.1	-47.1	-13	34.1

EUT was transmitting continuously with modulation activated.

All values above are measured with **Peak** Detector.

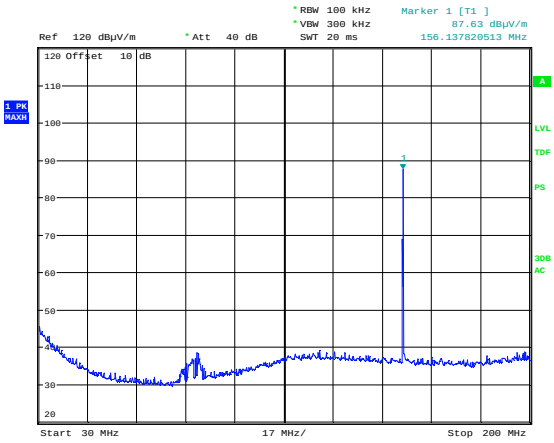
Values above are calculated using the formulas from **KDB 412172 D01 Determining ERP and EIRP v01r01**.

Requirements, FCC §80.211(f):

Frequency relative to Channel Centre Frequency	Measuring Bandwidth	Attenuation Relative to Carrier
More than 50% up to 100% of channel BW	300 Hz	At least 25 dB
More than 100% up to 250% of channel BW	300 Hz	At least 35 dB
More than 250% of channel BW	≥ 3 kHz	At least 43 + 10 $\log_{10}$(P) dB

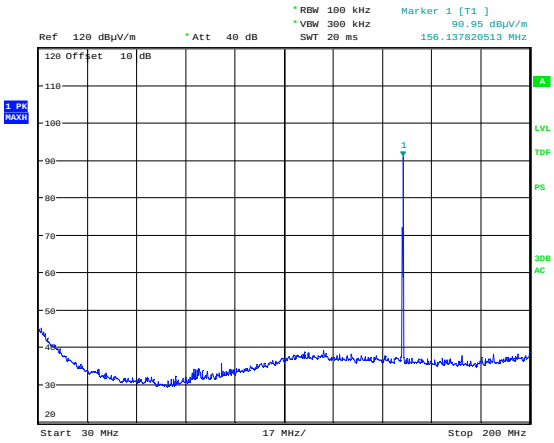
P is Average Conducted Power in Watts

In all of the measurements set forth in 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.



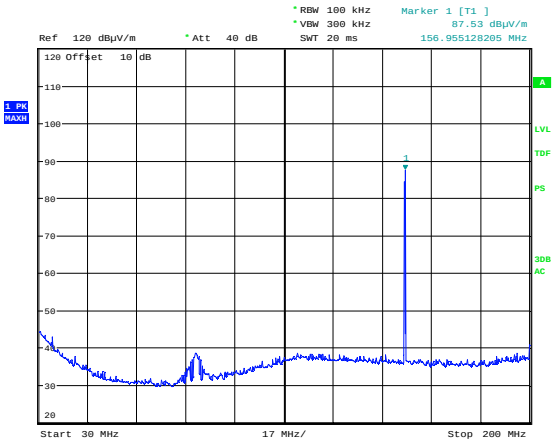
Date: 2.AUG.2021 16:02:06

Radiated Emissions, 30-200 MHz, ch01, VP



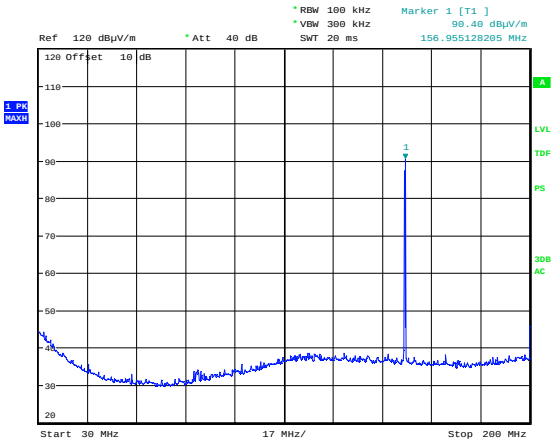
Date: 2.AUG.2021 16:03:54

Radiated Emissions, 30-200 MHz, ch01, HP



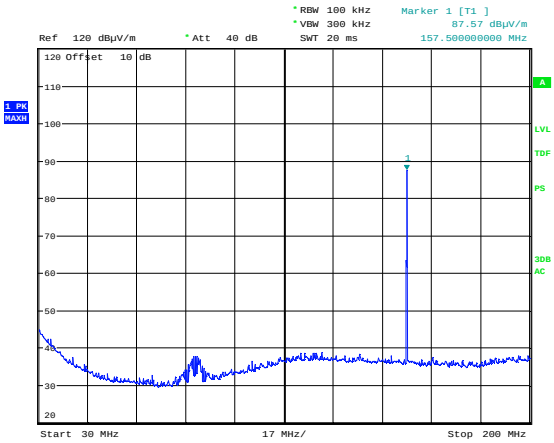
Date: 2.AUG.2021 14:32:24

Radiated Emissions, 30-200 MHz, ch16, VP



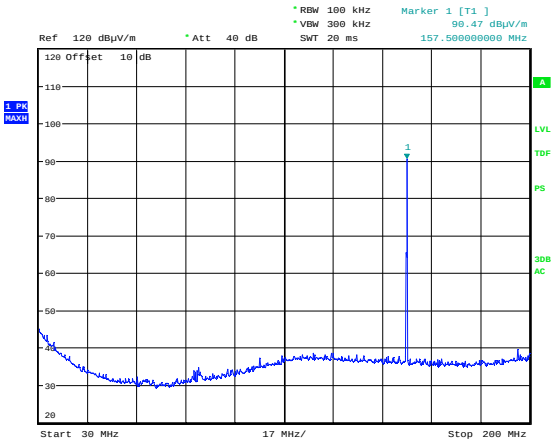
Date: 2.AUG.2021 14:34:12

Radiated Emissions, 30-200 MHz, ch16, HP



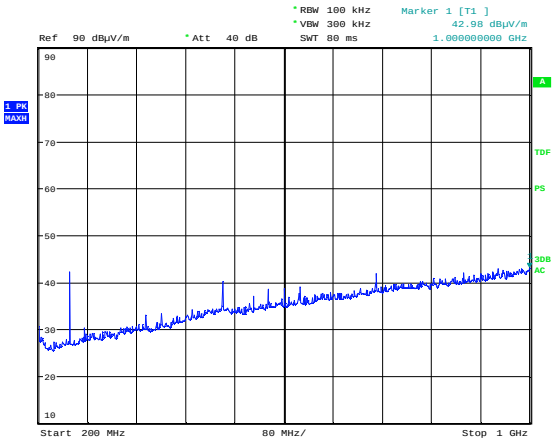
Date: 2.AUG.2021 15:56:47

Radiated Emissions, 30-200 MHz, ch88, VP



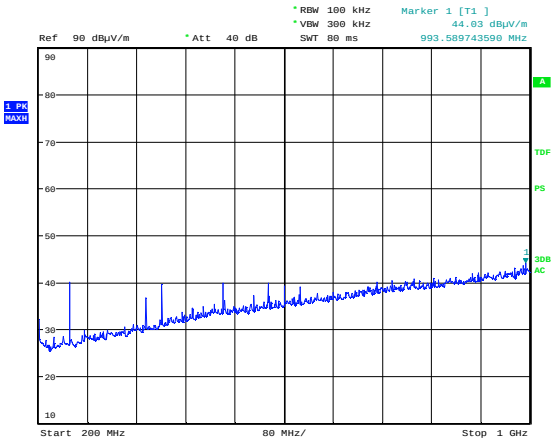
Date: 2.AUG.2021 15:58:36

Radiated Emissions, 30-200 MHz, ch88, HP



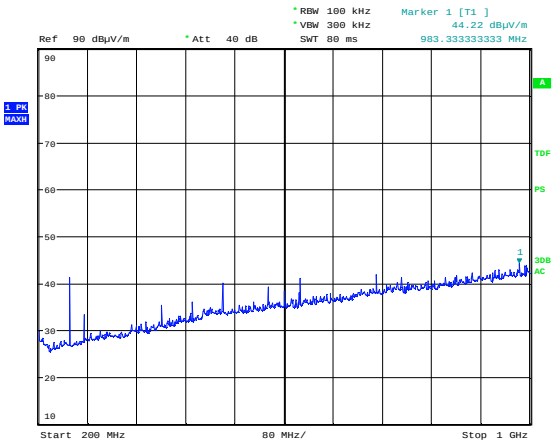
Date: 2.AUG.2021 15:25:26

Radiated Emissions, 200-1000 MHz, ch01, VP



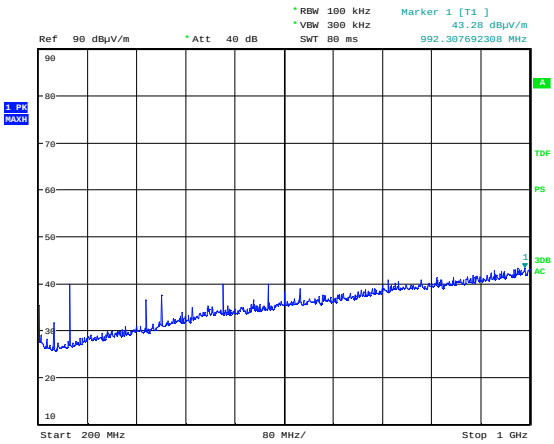
Date: 2.AUG.2021 15:31:16

Radiated Emissions, 200-1000 MHz, ch01, HP



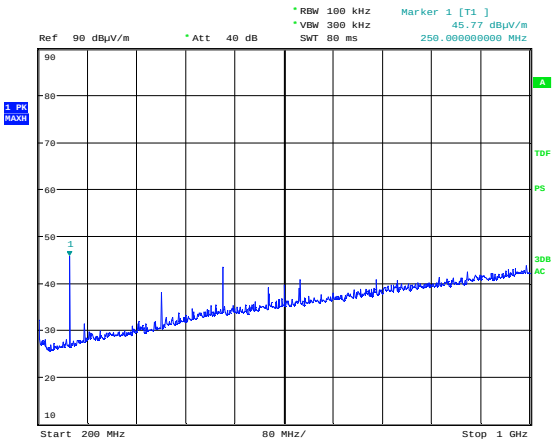
Date: 2.AUG.2021 14:47:35

Radiated Emissions, 200-1000 MHz, ch16, VP



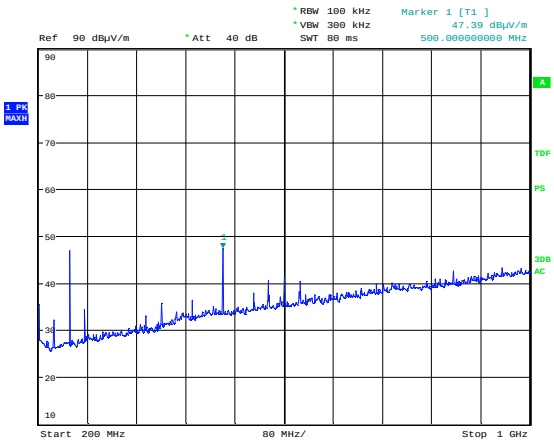
Date: 2.AUG.2021 14:53:23

Radiated Emissions, 200-1000 MHz, ch16, HP



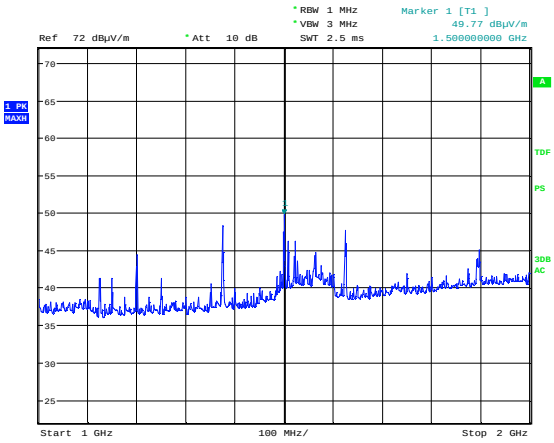
Date: 2.AUG.2021 15:35:26

Radiated Emissions, 200-1000 MHz, ch88, VP



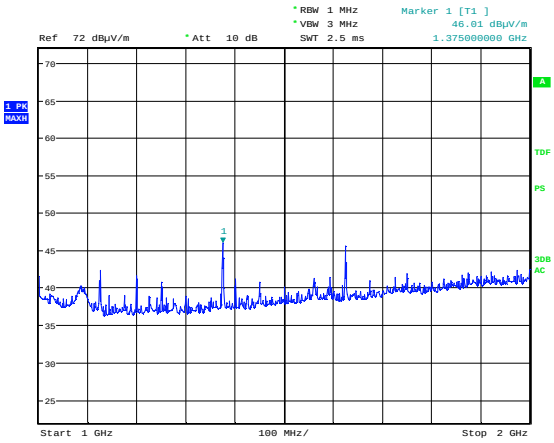
Date: 2.AUG.2021 15:37:15

Radiated Emissions, 200-1000 MHz, ch88, HP



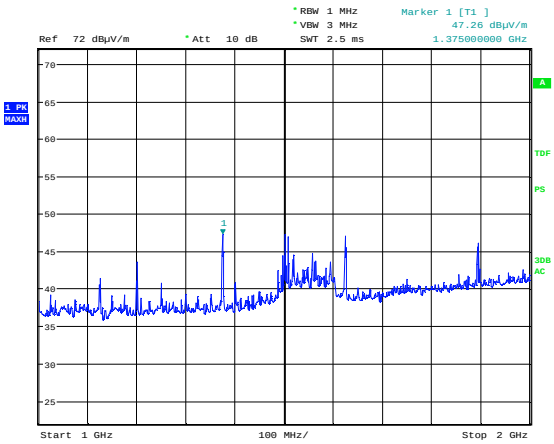
Date: 2.AUG.2021 16:37:59

Radiated Emissions, 1000-2000 MHz, ch01, VP



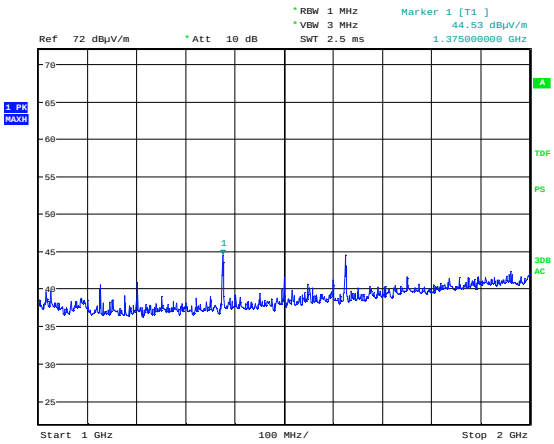
Date: 2.AUG.2021 16:39:47

Radiated Emissions, 1000-2000 MHz, ch01, HP



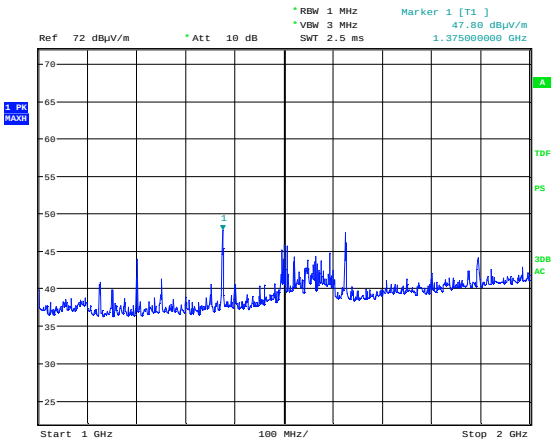
Date: 2.AUG.2021 17:01:16

Radiated Emissions, 1000-2000 MHz, ch16, VP



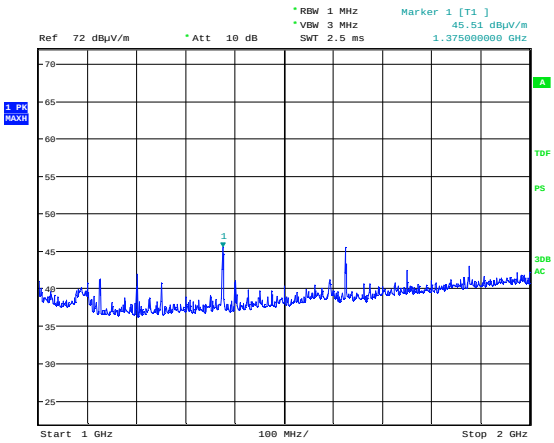
Date: 2.AUG.2021 17:07:04

Radiated Emissions, 1000-2000 MHz, ch16, HP



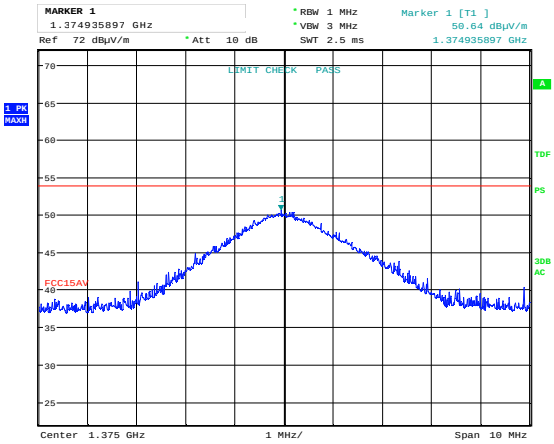
Date: 2.AUG.2021 16:43:22

Radiated Emissions, 1000-2000 MHz, ch88, VP



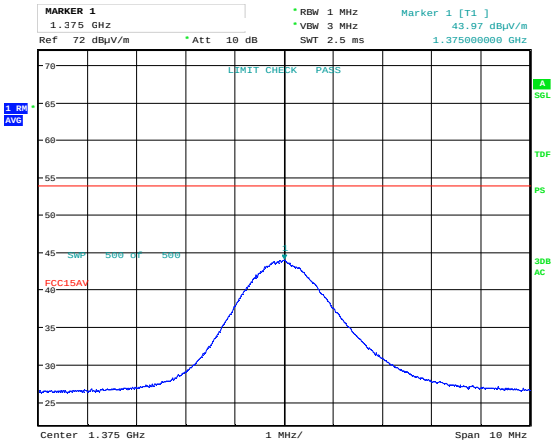
Date: 2.AUG.2021 16:45:10

Radiated Emissions, 1000-2000 MHz, ch88, HP



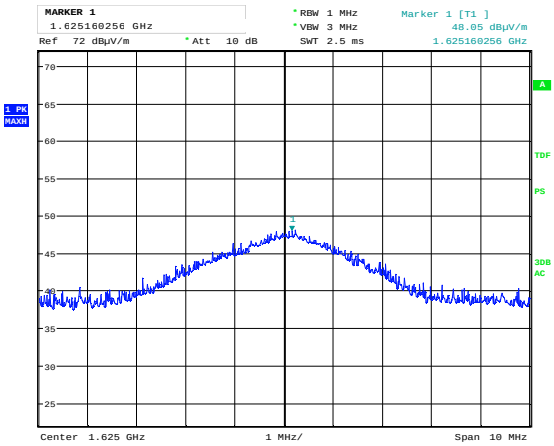
Date: 3.AUG.2021 09:31:32

Radiated Emissions, 1375MHz, ch16, HP, Pk



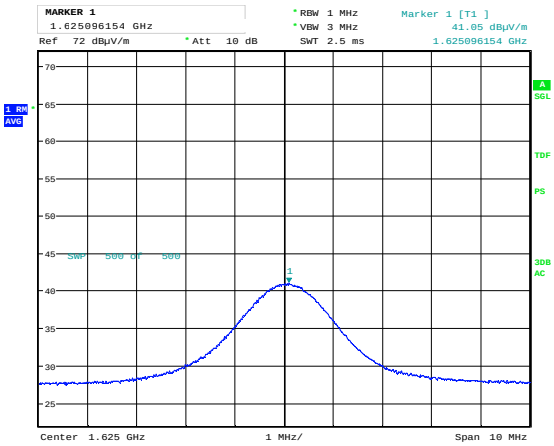
Date: 3.AUG.2021 09:33:20

Radiated Emissions, 1375MHz, ch16, HP, Av



Date: 3.AUG.2021 09:45:57

Radiated Emissions, 1625MHz, ch16, HP, Pk



Date: 3.AUG.2021 09:45:17

Radiated Emissions, 1625MHz, ch16, HP, Av

3.7 Frequency Stability

FCC Part 2.1055, 80.209(a)

ISED Canada RSS-182 Issue 6, Clause 5.5

ANSI C63.26-2015 Clause 5.6

Test Results: Complies

Measurement Data:

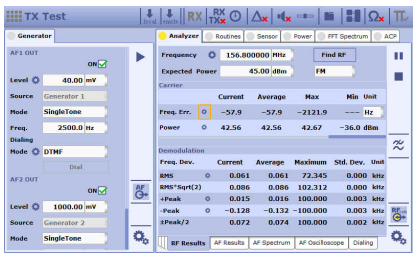
Temperature	Measured Frequency (MHz)	Deviation (Hz)	Deviation (ppm)
+50 °C	156.7999421	-57.9	-0.369
+40 °C	156.7999629	-37.1	-0.237
+30 °C	156.7999744	-25.6	-0.163
+20 °C	156.7999817	-18.3	-0.117
+10 °C	156.7999268	-73.2	-0.467
0 °C	156.7998920	-108.0	-0.689
-10 °C	156.7998917	-108.3	-0.691
-20 °C	156.7999175	-82.5	-0.526
-30 °C	156.7999630	-37.0	-0.236
Voltage	**Measured Frequency (MHz)**	**Deviation (Hz)**	**Deviation (ppm)**
20.4 Volts	156.7999817	-18.3	-0.117
24.0 Volts (Nominal)	156.7999828	-17.2	-0.110
27.6 Volts	156.7999843	-15.7	-0.100

Nominal Frequency = 156.800 MHz

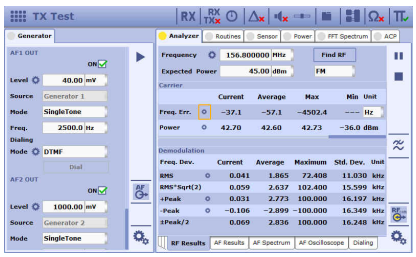
The measurement was performed with the counter function on the CMA180.

Requirements:

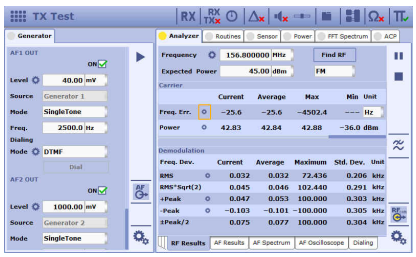
	Frequency Stability Limit
Ship Stations	± 10 ppm
Coast Station, Power less than 3 Watts	± 10 ppm
Coast Station, Power between 3 and 50 Watts	± 5 ppm



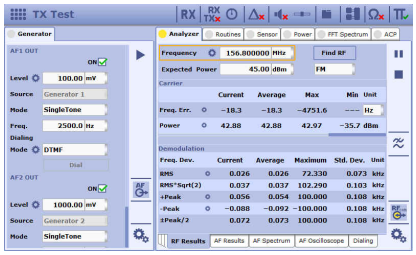
Frequency Error +50 °C



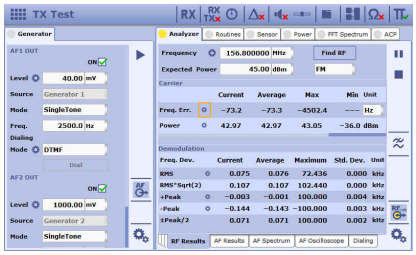
Frequency Error +40 °C



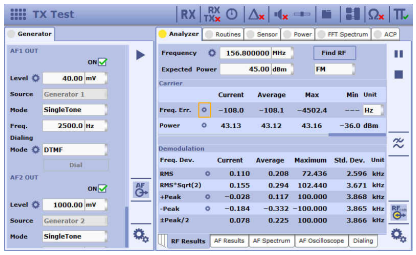
Frequency Error +30 °C



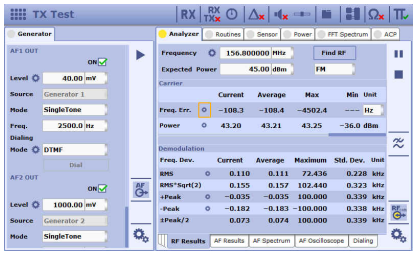
Frequency Error +20 °C, 24.0 V DC



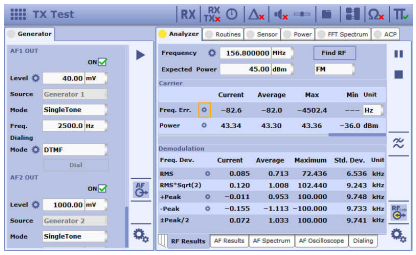
Frequency Error +10 °C



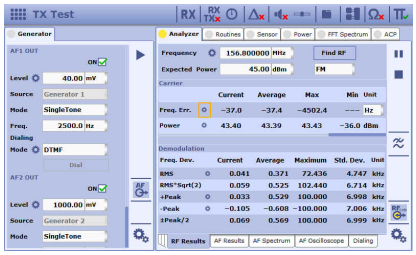
Frequency Error 0 °C



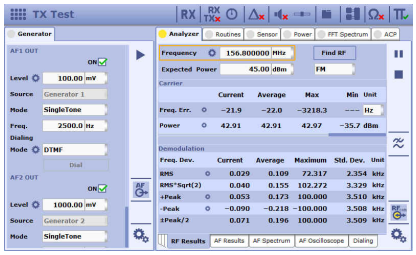
Frequency Error -10 °C



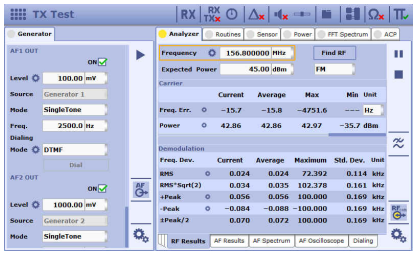
Frequency Error -20 °C



Frequency Error -30 °C



Frequency Error 21.4 V DC



Frequency Error 27.6 V DC

3.8 Suppression of Interference Aboard Ships / Receiver Emissions

Measurement Procedure:

FCC Part 80.217

Measurement Data:

Spurious Frequency	Measured Emissions @ Antenna Connector (dBm)	FCC 80.217 Limit (dBm)
0.1 – 30 MHz	< -20	-4.0
30 – 100 MHz	< -40	6.0
100 – 300 MHz	< -40	16.0
300 – 1000 MHz	< -40	26.0
1000 – 2000 MHz	< -40	26.0

Measured on 3 channels. All measurements are with Peak Detector.

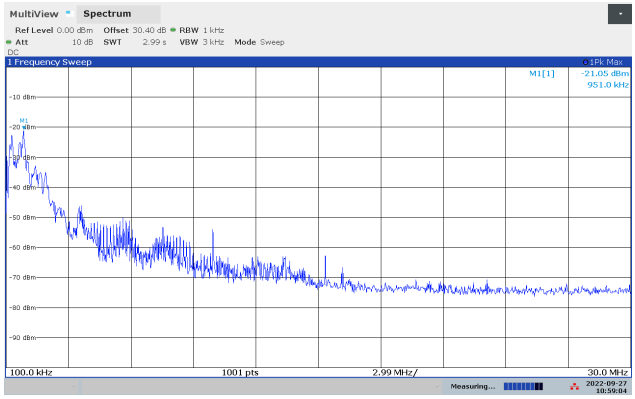
Results are valid for all 3 channels and for both antenna connectors.

See plots.

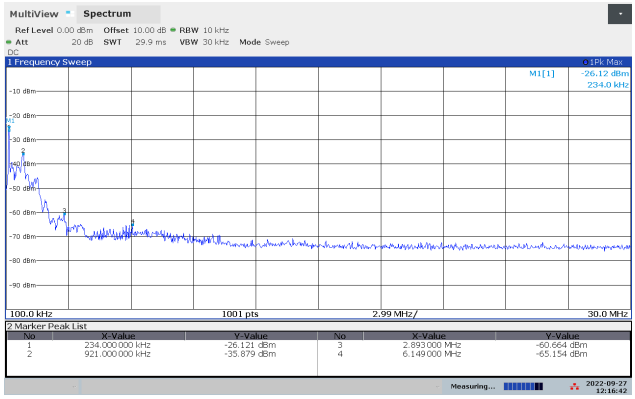
Requirements:

FCC Part 80.217:

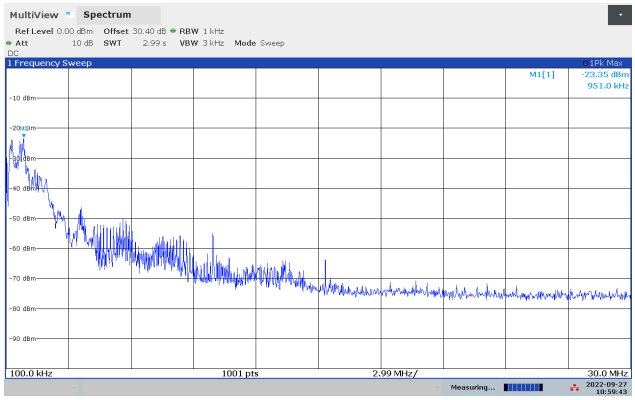
Frequency	FCC 80.217
	Conducted Emissions
0.1 – 30 MHz	-4.0 dBm
30 – 100 MHz	6.0 dBm
100 – 300 MHz	16.0 dBm
300 – 2000 MHz	26.0 dBm



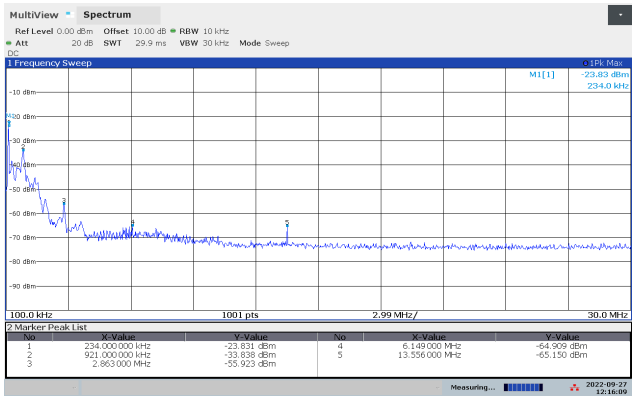
Receiver Emissions, 0.1-30 MHz, ch01



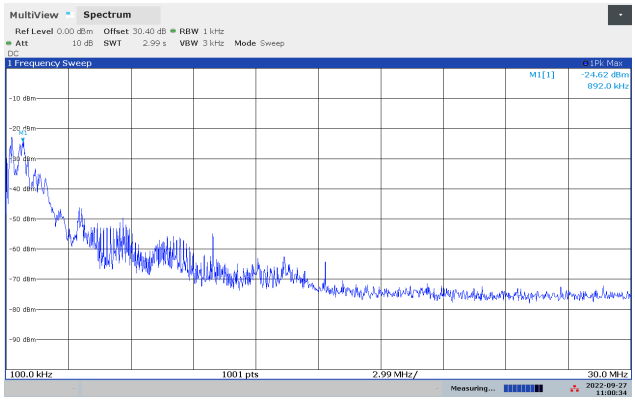
Receiver Emissions, 0.1-30 MHz, ch01, DSC Connector



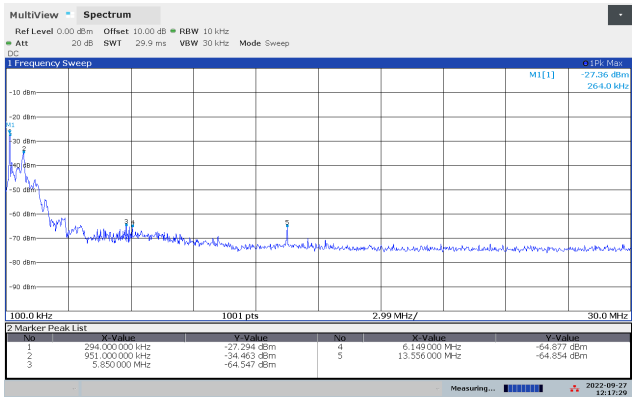
Receiver Emissions, 0.1-30 MHz, ch16



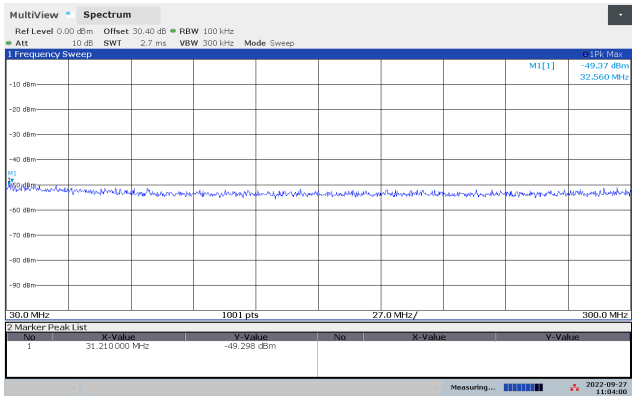
Receiver Emissions, 0.1-30 MHz, ch16, DSC Connector



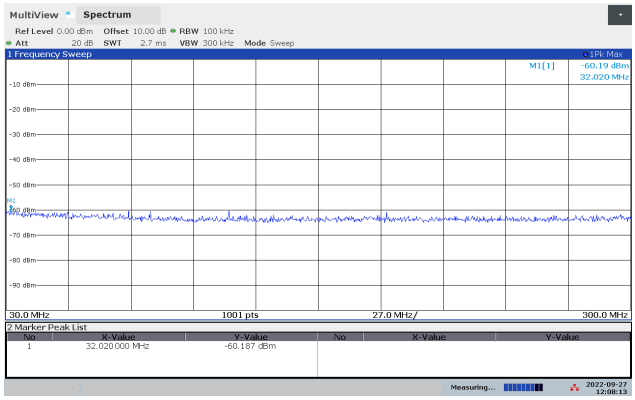
Receiver Emissions, 0.1-30 MHz, ch88



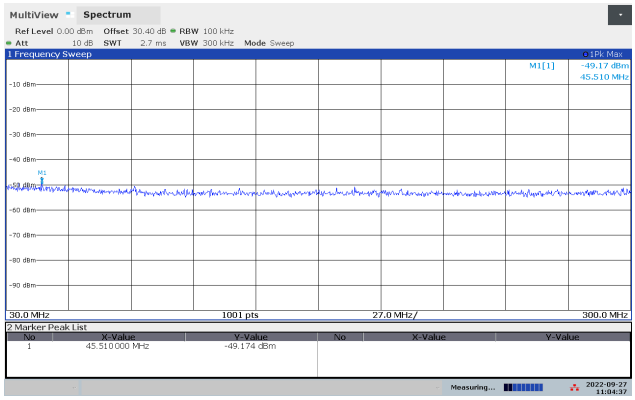
Receiver Emissions, 0.1-30 MHz, ch88, DSC Connector



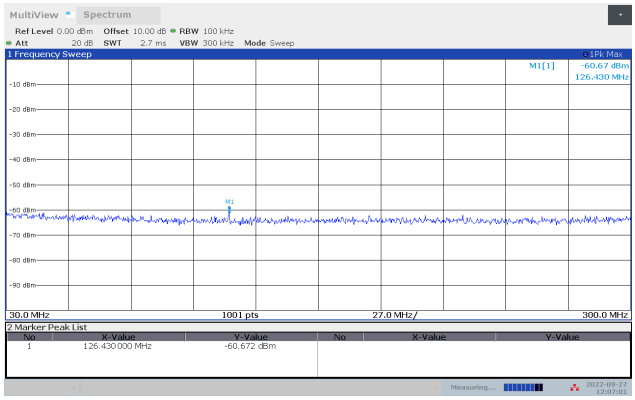
Receiver Emissions, 30-300 MHz, ch01



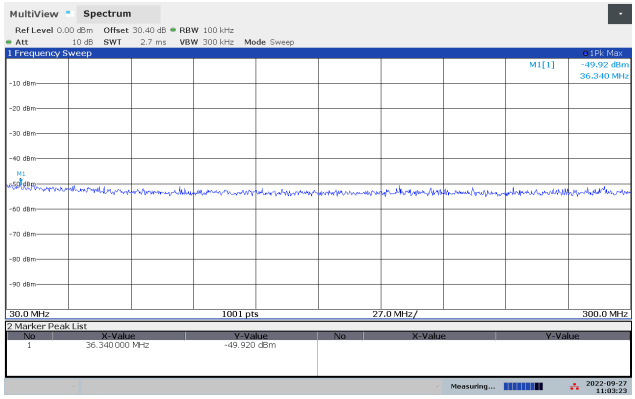
Receiver Emissions, 30-300 MHz, ch01, DSC Connector



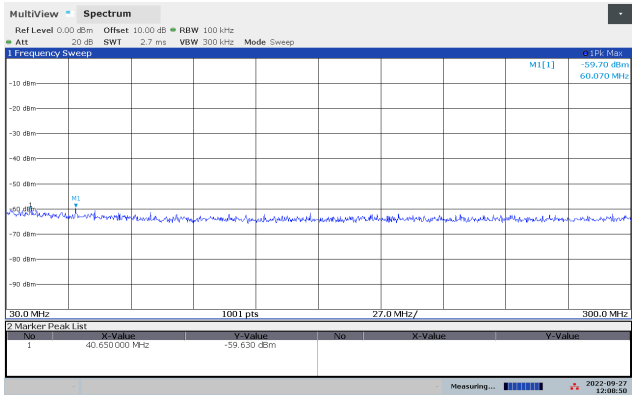
Receiver Emissions, 30-300 MHz, ch16



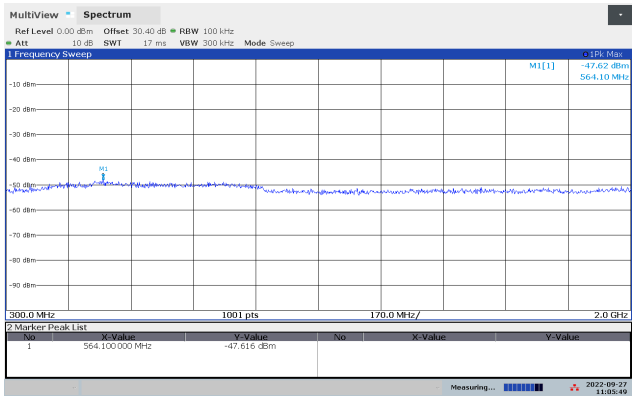
Receiver Emissions, 30-300 MHz, ch16, DSC Connector



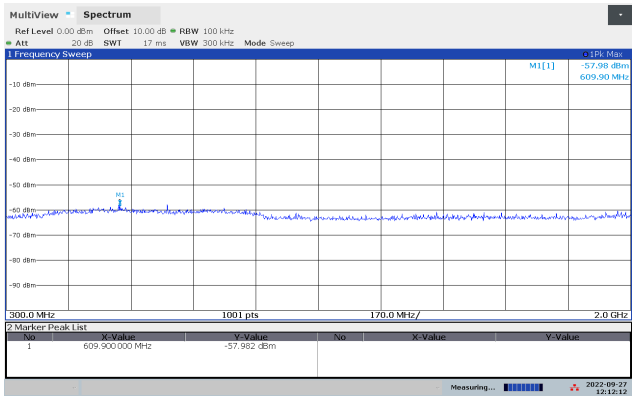
Receiver Emissions, 30-300 MHz, ch88



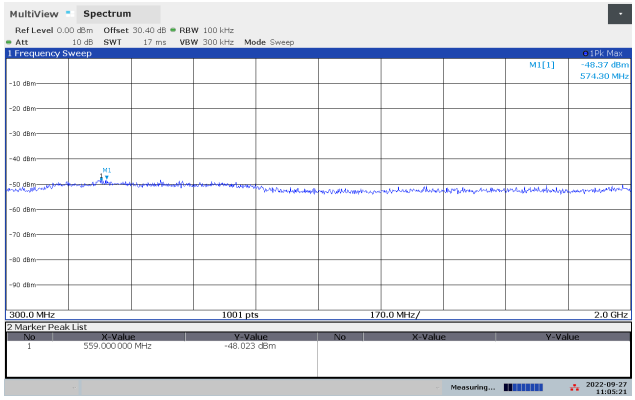
Receiver Emissions, 30-300 MHz, ch88, DSC Connector



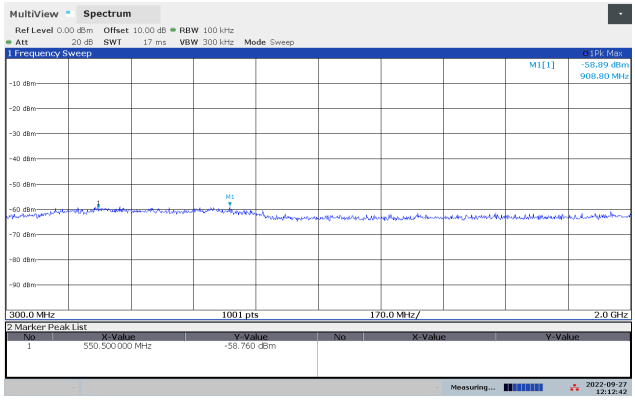
Receiver Emissions, 300-2000 MHz, ch01



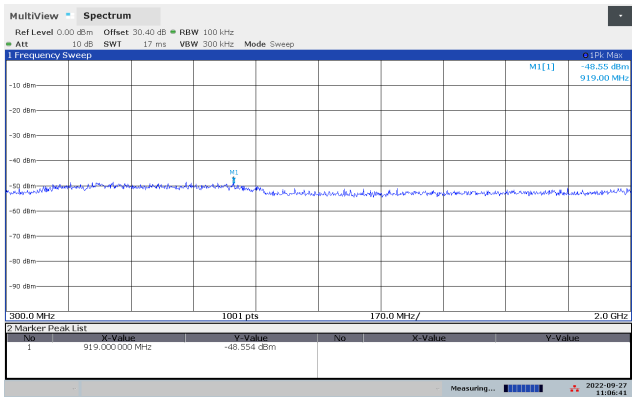
Receiver Emissions, 300-2000 MHz, ch01, DSC Connector



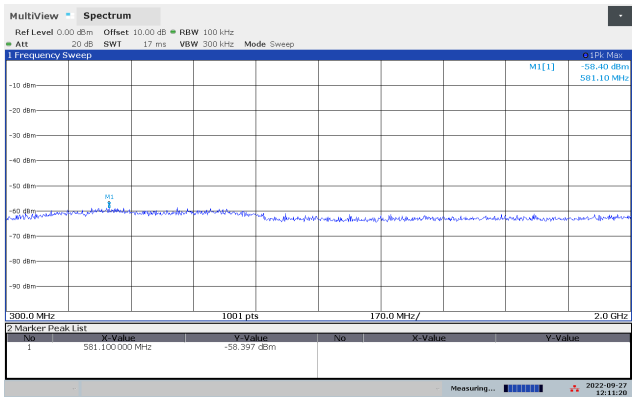
Receiver Emissions, 300-2000 MHz, ch16



Receiver Emissions, 300-2000 MHz, ch16, DSC Connector



Receiver Emissions, 300-2000 MHz, ch88



Receiver Emissions, 300-2000 MHz, ch88, DSC Connector

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		**Uncertainty**
Output Power		**±0.5 dB**
Power Spectral Density		**±0.5 dB**
Out of Band Emissions, Conducted (RBW < 100 kHz)	**< 3.6 GHz**	**±0.6 dB**
	> 3.6 GHz	**±0.9 dB**
Spurious Emissions, Radiated	**< 1 GHz**	**±2.5 dB**
	> 1 GHz	**±2.2 dB**
Emission Bandwidth		**±4 %**
Power Line Conducted Emissions		**+2.9 / -4.1 dB**
Spectrum Mask Measurements	**Frequency**	**±5 %**
	Amplitude	**±1.0 dB**
Frequency Error		**±0.6 ppm**
Temperature Uncertainty		**±1 °C**

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

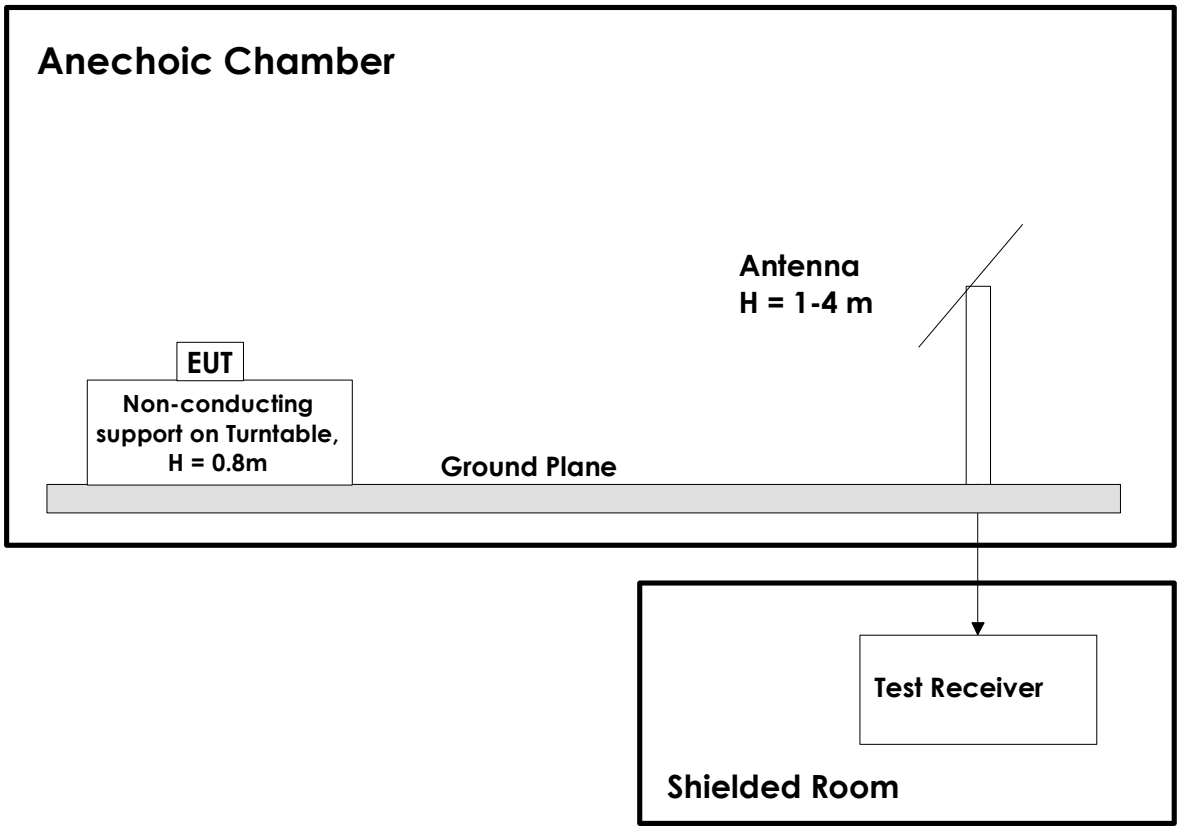
5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2021-01 222-01	2022-01 2023-01
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2021-02 2022-01	2022-02 2023-01
3	CMA180	Radiocomm Tester	Rohde & Schwarz	LR 1776	2021-01	2023-01
4	Model 765-10	Attenuator	Narda	LR 1007	COU	
5	Model 768-20	Attenuator	Narda	LR 1199	COU	
6	WHK-S200-10SS	HighPass Filter (200MHz)	Wainwright Inst.	LR 1620	COU	
7	JB3	BiLog Antenna	Sunol Sciences	N-4525	2020-03	2023-03
8	Model 317	Pre-Amplifier	Sonoma Inst.	LR 1687	2020-08 2021-08 2022-08	2021-08 2022-08 2023-08
9	5906_N-50-010	Attenuator (6dB)	Suhner	N-4904	2019-10	2022-10
10	3115	Horn Antenna	EMCO	LR 1330	2016-10	2026-10
11	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2020-08 2021-08 2022-08	2021-08 2022-08 2023-08
12	HP 6032A	Power Supply	Hewlett Packard	LR 1062	COU	
14	CPX400S	Power Supply	AimTTi	LR 1711	COU	
15	Model 87V	Multimeter	Fluke	LR 1599	2021-01	2023-01
16	50LH50 NF	50 Ohm Load	Alan	860519310	N/A	
17		RF Generator	Rohde & Schwarz		2022-01	2023-01
18	ST18/Nm/Nm/36	Cable	HuberSuhner	LR 1634	COU	

The software listed below has been used for one or more tests in this report.

No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.10	Radiated Emission test software
2	Nemko AS	RSPlot	1.0.8.0	Screenshots from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Test Site Radiated Emission