

Test Report

Product	Electronic Control Unit for vehicle Integration		
Name and address of the applicant	CPAC Systems AB Bergskroken 3 431 37 Mölndal, Sweden		
Name and address of the manufacturer	CPAC Systems AB Bergskroken 3 431 37 Mölndal, Sweden		
Model	SID 2.0M		
Rating	24VDC		
Trademark	CPAC Systems AB		
Additional information	WiFi, Bluetooth		
Tested according to	FCC Part 15.247 Frequency Hopping Transmitters / Digital Transmission Systems ISED Canada RSS-247, Issue 3 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices		
Order number	PRJ0043386		
Tested in period	2023-02-28 to 2023-05-04		
Issue date	2023-11-15		
Name and address of the testing laboratory	 Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 ISED No: 2040D-1   An accredited technical test executed under the Norwegian accreditation scheme		
	 Prepared by [Frode Sveinsen]  Approved by [Jan G Eriksen]		
This report was originally distributed electronically with digital signatures. For more information, please contact Nemko Scandinavia AS.			

Revision history

Revision	Date	Comment	Sign
A	2023-11-15	First edition	FS

GENERAL REMARKS

This report applies only to the sample(s) tested. It is the manufacturer's responsibility to ensure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is solely responsible for any modifications to the product that could result in non-compliance with the relevant regulations.

This report shall not be reproduced, except in full, without the written approval of Nemko.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Group accepts no responsibility for damage suffered by any third party because of decisions made or actions based on this report.

Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither are opinions expressed regarding model variants covered by the testing of this report.

CALIBRATION

All instruments used in the tests given in this test report are calibrated and traceable to national or international standards. Between calibrations all test set-ups are controlled and verified on a regular basis by periodic checks to ensure, with 95% confidence, that the instruments remain within the calibrated levels.

MEASUREMENT UNCERTAINTY

Measurement uncertainties are calculated or considered for all instruments and instrument set-ups used during these tests. Uncertainty figures are found in a separate clause in this report.

CONTENTS

1	INFORMATION	4
1.1	Test Item	4
1.2	Antenna Types	5
1.3	Normal test condition.....	5
1.4	Test Engineer.....	5
1.5	Antenna Requirement.....	5
1.6	EUT Operating Modes.....	5
1.7	Comments.....	5
2	TEST REPORT SUMMARY	6
2.1	General	6
2.2	Test Summary	6
3	TEST RESULTS.....	7
3.1	20dB Bandwidth	7
3.2	Pseudorandom Hopping Algorithm	10
3.3	Hopping Bandwidth	11
3.4	Occupancy Time.....	12
3.5	Occupied Bandwidth (99% BW).....	14
3.6	Peak Power Output	16
3.7	Conducted Emissions at Antenna Connector.....	20
3.8	Restricted Bands of operation.....	25
3.9	Radiated Emissions, Band Edge.....	26
3.10	Radiated Emission, 30 – 1000 MHz.....	29
3.11	Radiated Emissions, 1-26 GHz.....	31
4	Measurement Uncertainty.....	34
5	LIST OF TEST EQUIPMENT.....	35
6	BLOCK DIAGRAM	36
6.1	Power Line Conducted Emission	36
6.2	Test Site Radiated Emission.....	36

1 INFORMATION

1.1 Test Item

Name	CPAC Systems AB
Model/version	SID 2.0M
FCC ID	AHV-SID2M
ISED ID	10111A-SID2M
Serial number	HYD-3891
Hardware identity and/or version	P-01
Software identity and/or version	Hydra_BT SW_1.0
Frequency Range	2402–2480 MHz
Number of Channels	79
Operating Modes	Bluetooth Basic Rate, Bluetooth 2-EDR and Bluetooth 3-EDR
Type of Modulation	BT Basic Rate: GFSK BT 2-EDR: $\pi/4$ -DPSK BT 3-EDR: 8-DPSK
Conducted Output Power	BT Basic Rate: 1.03 mW (Peak) BT 2-EDR: 0.83 mW (Peak) BT 3-EDR: 1.98 mW (Peak)
Antenna Connector	FAKRA
Number of Antennas	1
Diversity or Smart Antennas	No
Power Supply	External Power Supply, 12-24 V _{DC}

Description of Test Item

The EUT is an electronic control unit for vehicle integration. The EUT contains WiFi, Bluetooth, and LTE modules.

Model Overview						
Model Name	U-NII	Marine	LTE	FCC ID	IC ID	Description
SID 2.0	☐	☐	☒	AHV-SID2	10111A-SID2	Model without 5GHz WiFi
SID 2.0	☒	☐	☒	AHV-SID2B	10111A-SID2B	Model with 5GHz WiFi
SID 2.0M	☒	☒	☐	AHV-SID2M	10111A-SID2M	Marine Model without LTE
SID 2.0MLTE	☒	☒	☒	AHV-SID2MLTE	10111A-SID2MLTE	Marine Model with LTE

All models are electrically identical, except SID 2.0M does not have the LTE module installed.

1.2 Antenna Types

Name	P/N	Function	Number of inputs	Description
2J 2× 4G/3G/2G MIMO, +2× 2.4/5.0 GHz MIMO and GNSS	2J #2J4A50PCFa	2.4GHz Wifi+BT	2	COMBI ANT
		2G+3G+4G	2	
TE ANTENNA BASE FULL FEAT	Volvo #23311779	2.4GHz Wifi+BT	1	WHIP ANT
		2G+3G+4G	1	
TE ANTENNA INTERIOR WLAN	Volvo #23311706	2.4GHz Wifi+BT	1	PATCH ANT

1.3 Normal test condition

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	24 V DC

The values are the limit registered during the test period.

The EUT was powered from a regulated power supply during all tests.

1.4 Test Engineer

Frode Sveinsen

1.5 Antenna Requirement

Does the EUT have detachable antenna(s)?	☒ YES	☐ NO
If detachable, is the antenna connector(s) non-standard?	☒ YES	☐ NO
The tested equipment has FAKRA antenna connectors.		

Requirement: FCC 15.203, 15.204

1.6 EUT Operating Modes

Operating modes	Continuous TX and Hopping, Basic Rate, 2-EDR and 3-EDR
Additional information	The following settings were used for all tests: Bit Pattern: PSRB Frame Type: DH1, 2-DH1, 3-DH1

1.7 Comments

The EUT uses the Bluetooth protocol as a Frequency Hopping Spread Spectrum Device.

All ports were populated during spurious emission measurements.

Test Voltages between 85% and 115% of the nominal voltage were checked and did not influence the output power.

2 TEST REPORT SUMMARY

2.1 General

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and ISED Canada RSS-247 Issue 3 and RSS-GEN Issue 5.

Tests were performed in accordance with ANSI C63.4-2014 and ANSI C63.10-2013.

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

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

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

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 3, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	Complies
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	N/A
Channel Separation and 20 dB BW	15.247(a)(1)	5.1 (4) (RSS-247)	7.8.2 (FHSS)	Complies
Number of Hopping Frequencies	15.31(m)	5.1 (6) (RSS-247)	7.8.3 (FHSS)	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)	5.1 (3) (RSS-247)	N/A (FHSS)	Complies
Time of Occupancy (dwell time)	15.247(a)(1)(iii)	5.1 (5) (RSS-247)	7.8.4 (FHSS)	Complies
Occupied Bandwidth	15.247(a)(1)	5.1 (7) (RSS-247)	6.9.2 FHSS)	Complies
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 7.8.6 (FHSS) 7.8.8 (FHSS)	Complies
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	3.3 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12	Complies

3 TEST RESULTS

3.1 20dB Bandwidth

FCC Part 15.247(a)(1)

ISED RSS-247 Issue 3, Clause 5.1 (b)

Measurement procedure: ANSI C63.10-2013 Clause 7.8.2

Test Results: Complies

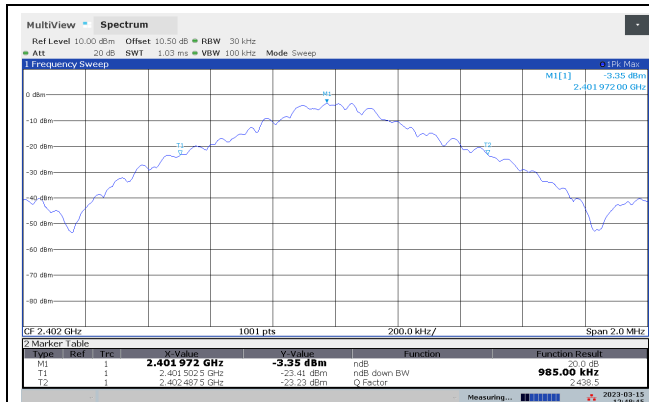
Measurement Data:

Modulation	20dB Bandwidth		
	2402 MHz	2441 MHz	2480 MHz
Basic Rate (GFSK)	0.985 MHz	0.987 MHz	0.989 MHz
2-EDR ($\pi/4$ -DPSK)	1.41 MHz	1.41 MHz	1.41 MHz
3-EDR (8-DPSK)	1.41 MHz	1.41 MHz	1.41 MHz

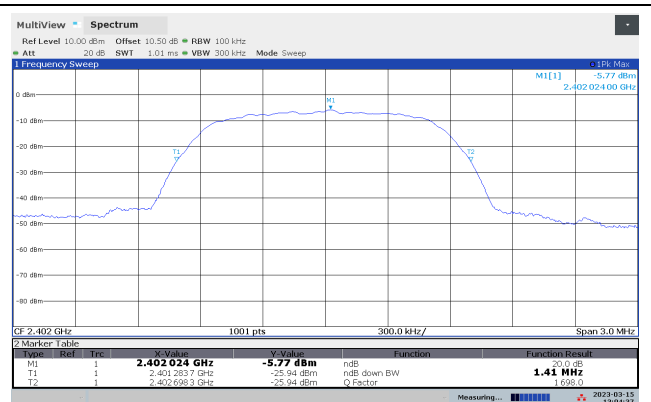
RF channel has no influence on 20 dB bandwidth.

See attached plots.

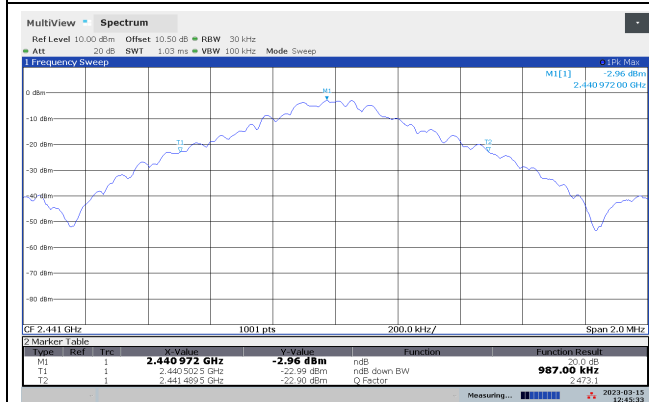
Frequency Band	Requirement for Frequency Hopping
2400-2483.5 MHz	The maximum 20 dB bandwidth shall be less than channel separation, alternatively, less than 150% of channel separation if output power is less than 125 mW.



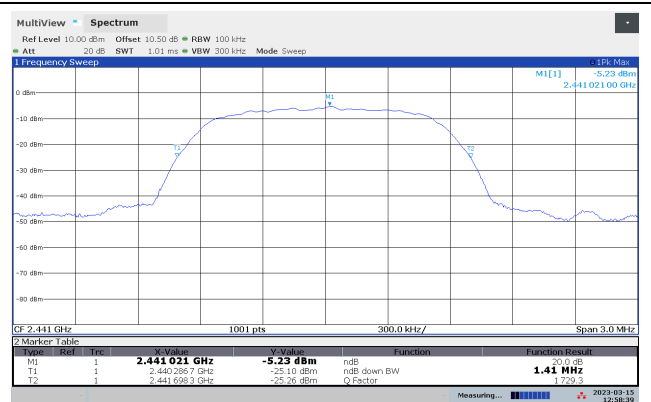
20dB Bandwidth 2402 MHz, GFSK



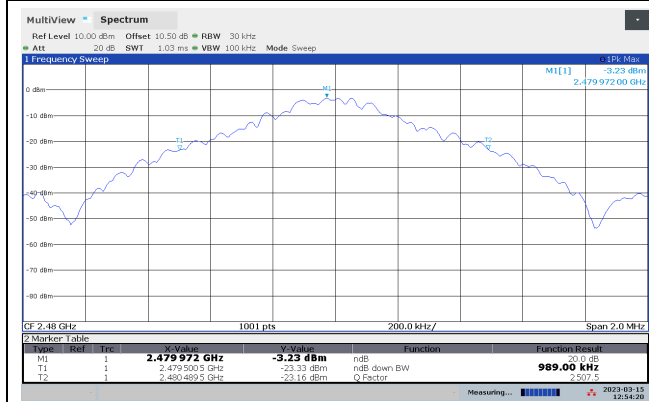
20dB Bandwidth 2402 MHz, $\pi/4$ -DPSK



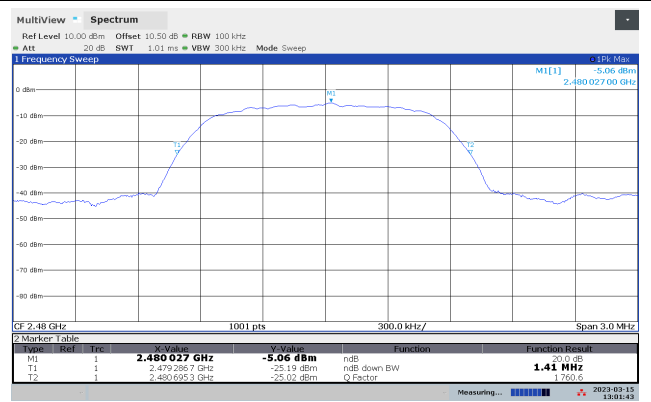
20dB Bandwidth 2441 MHz, GFSK



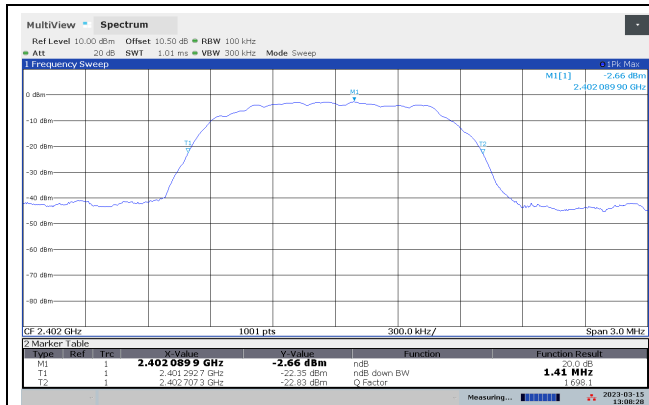
20dB Bandwidth 2441 MHz, $\pi/4$ -DPSK



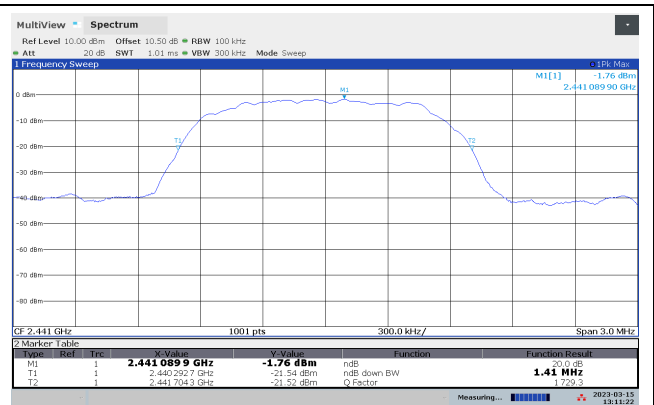
20dB Bandwidth 2480 MHz, GFSK



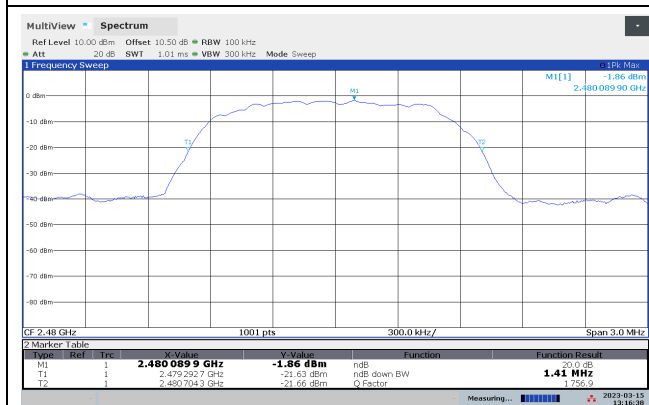
20dB Bandwidth 2480 MHz, $\pi/4$ -DPSK



20dB Bandwidth 2402 MHz, 8-DPSK



20dB Bandwidth 2441 MHz, 8-DPSK



20dB Bandwidth 2480 MHz, 8-DPSK

3.2 Pseudorandom Hopping Algorithm

FCC Part 15.247 (a)(1)

ISED Canada RSS-247 Issue 3, Clause 5.1

Test Results: **Complies**

Requirements
The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

Base Table Hopping Sequence

The hopping sequence is according to the Bluetooth standard.

3.3 Hopping Bandwidth

FCC Part 15.247 (a)(1)(iii)

ISED Canada RSS-247 Issue 3, Clause 5.1

Measurement procedure: ANSI C63.10-2013 Clause 6.9.2 / 7.8.3

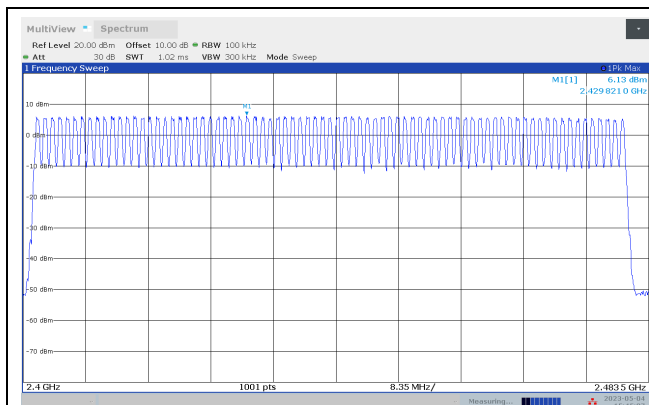
Test Results: Complies

Measurement Data:

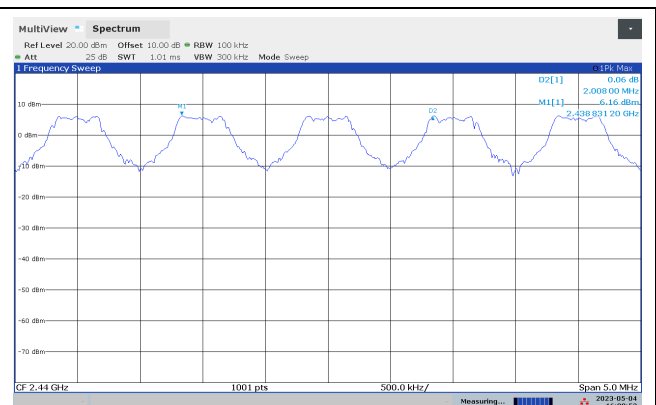
Number of RF Channels in use	20 to 79
Channel Centre Frequencies	2402 to 2480 MHz
Channel Separation	1 MHz

See attached plots.

Frequency Band	Requirement for Frequency Hopping
2400-2483.5 MHz	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.



RF Channels in Use, Basic Rate



Channel Separation, Basic Rate

3.4 Occupancy Time

FCC Part 15.247 (a)(1)(iii)

ISED Canada RSS-247 Issue 3, Clause 5.1 (c)

Measurement procedure: ANSI C63.10-2013 Clause 7.8.4

Test Results: Complies

Measurement Data:

Frame Type and Data Rate	Burst Length (ms)	Frame Length (ms)	Time of Occupancy (ms)	Verdict
DH1	0.384	1.25	123	Complies
DH3	1.64	3.75	175	Complies
DH5	2.89	6.25	185	Complies

Burst length is the same for all data rates.

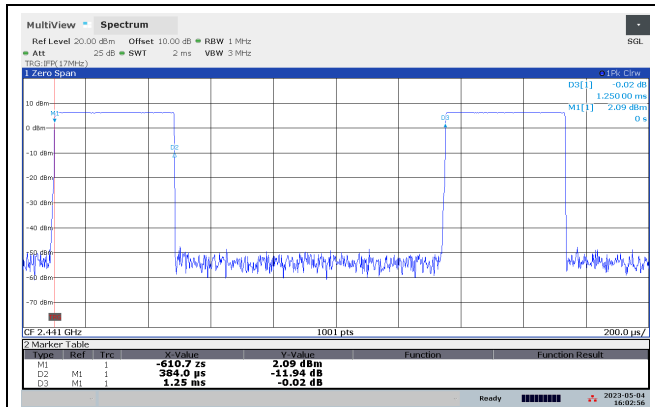
Time between RF burst on same channel = Frame Length * Number of Channels

Time of occupancy = (Burst Length * Number of Channels * 400 ms) / Time Between Burst on Same Channel
= (Burst Length * 400 ms) / Frame Length

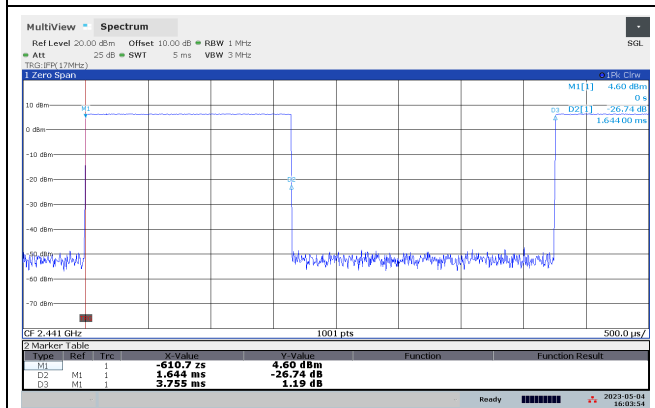
Number of RF channels is minimum 20 and maximum 78.

See attached plots.

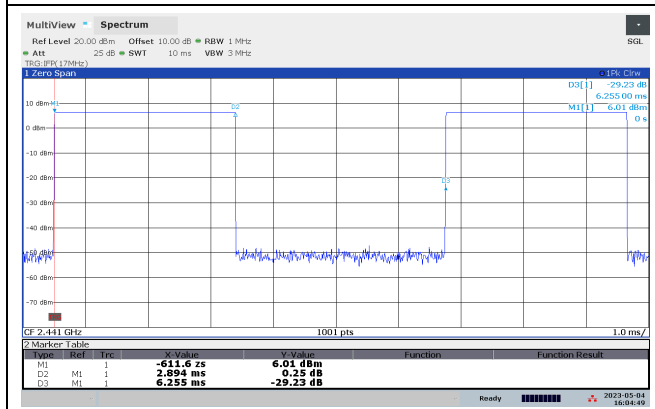
Frequency Band	Requirement for Frequency Hopping
2400-2483.5 MHz	The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.



RF Burst, DH1



RF Burst, DH3



RF Burst DH5

3.5 Occupied Bandwidth (99% BW)

FCC Part 15.247 (a)(1)(iii)

ISED Canada RSS-247 Issue 3, Clause 5.1

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.3 / 7.8.3

Test Results: Complies

Measurement Data:

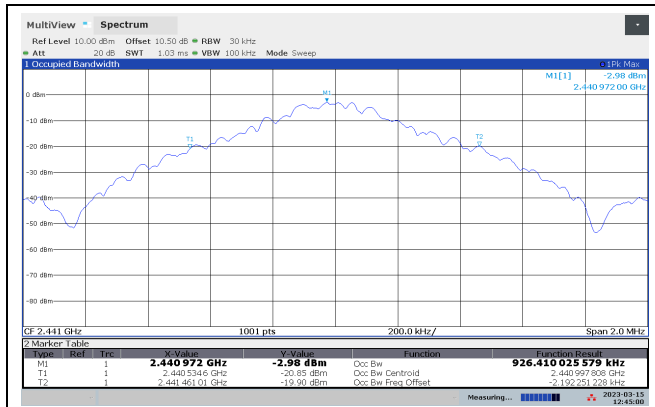
Data Rate and Modulation	Occupied Bandwidth (99% BW)
Basic Rate (GFSK)	0.926 MHz
2-EDR ($\pi/4$ -DPSK)	1.20 MHz
3-EDR (8-DPSK)	1.20 MHz

Occupied Bandwidth is the same for all channels.

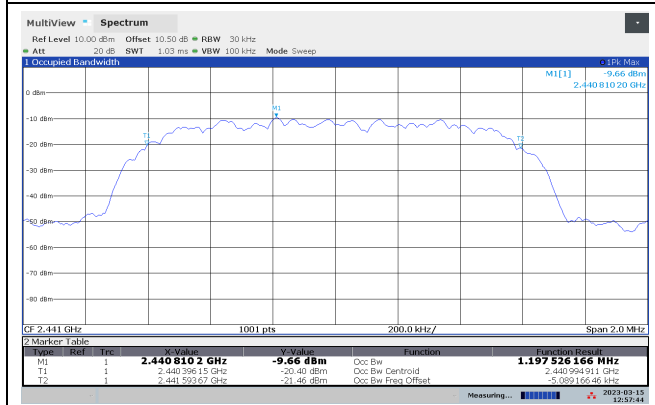
See attached plots.

Requirements:

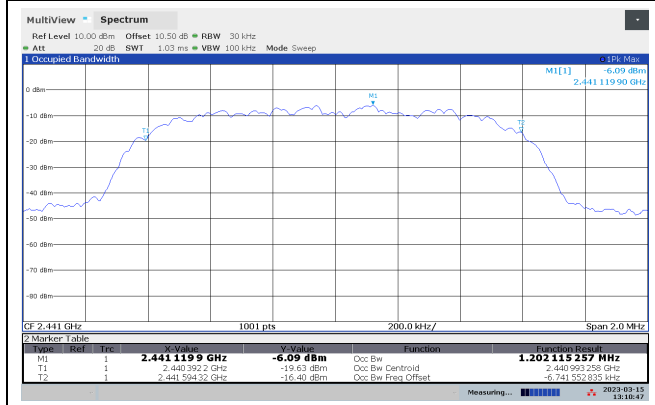
No requirement for 99% BW, reported for information only.



99% Occupied BW, GFSK



99% Occupied BW, $\pi/4$ -DPSK



99% Occupied BW, 8-DPSK

3.6 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 3, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

Modulation Type	Carrier Frequency (MHz)	Conducted Power (dBm)	Conducted Power (mW)	EIRP, Combi Antenna, dBm	EIRP, Whip Antenna, dBm	Gain Combi Antenna, dBi	Gain Whip Antenna, dBi
GFSK	2402	-0.23	0.95	1.41	-0.84	1.6	-0.6
	2441	0.14	1.03	5.00	1.24	4.9	1.1
	2480	-0.14	0.97	3.85	-1.13	4.0	-1.0
$\pi/4$ -DPSK	2402	-1.28	0.74	/	/	/	/
	2441	-0.83	0.83	/	/	/	/
	2480	-0.93	0.81	/	/	/	/
8-DPSK	2402	2.15	1.64	/	/	/	/
	2441	2.96	1.98	/	/	/	/
	2480	2.79	1.90	/	/	/	/

Output Power reported is Maximum Peak Power.

The Integrated Band Power Method was used to measure Output Power

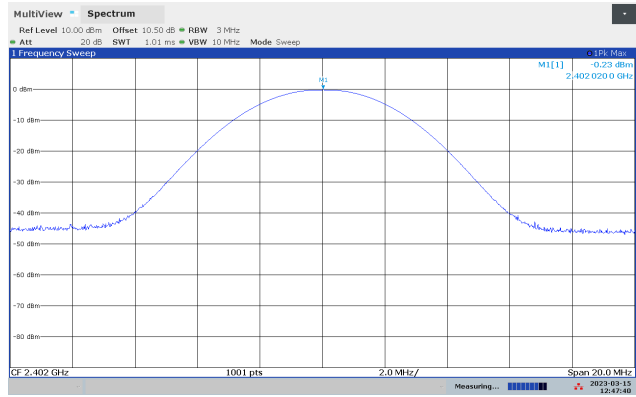
Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

Antenna Gain is less than 6 dBi.

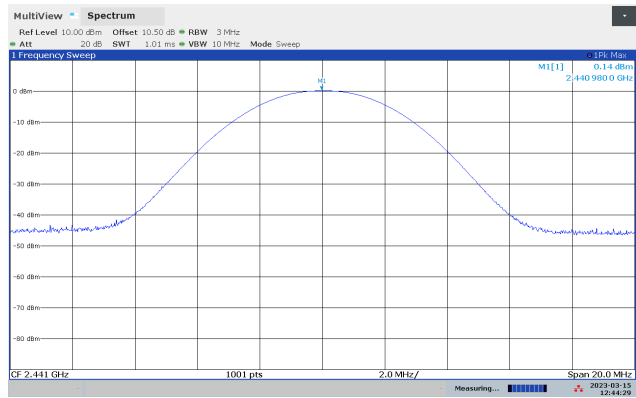
See attached plots.

Frequency Band	Requirements for Frequency Hopping systems
2400-2483.5 MHz	For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt
	For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts
Maximum allowed Antenna Gain	
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	

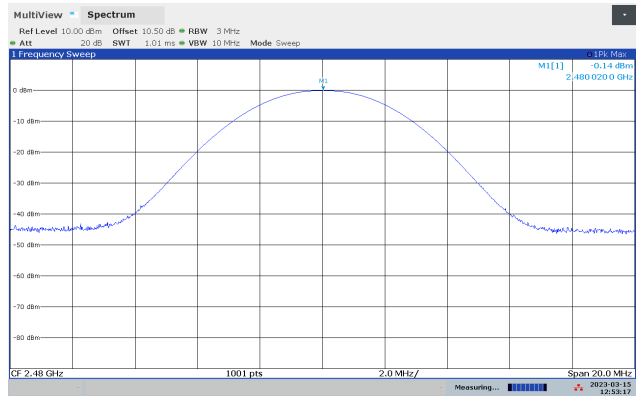
Conducted



Peak Power, 2402 MHz, GFSK

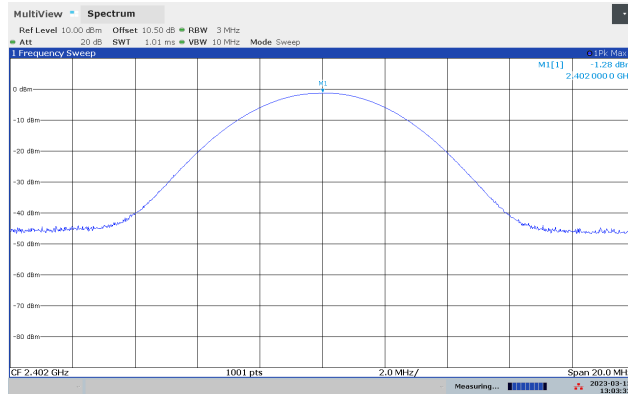


Peak Power, 2441 MHz, GFSK

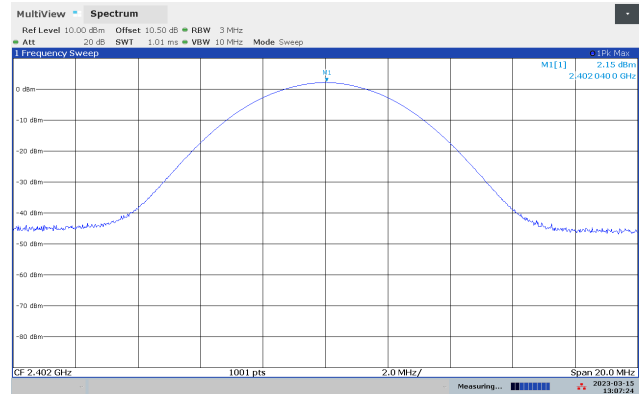


Peak Power, 2480 MHz, GFSK

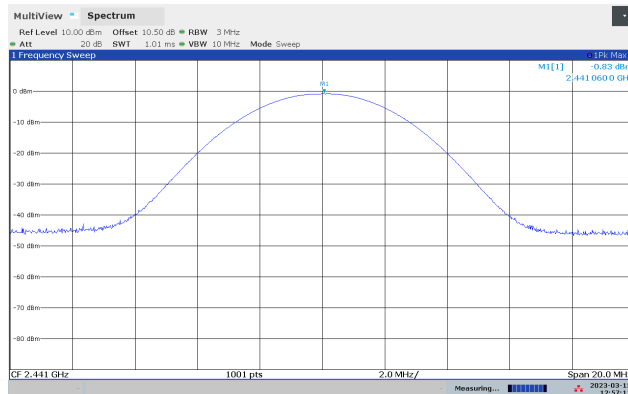
Conducted



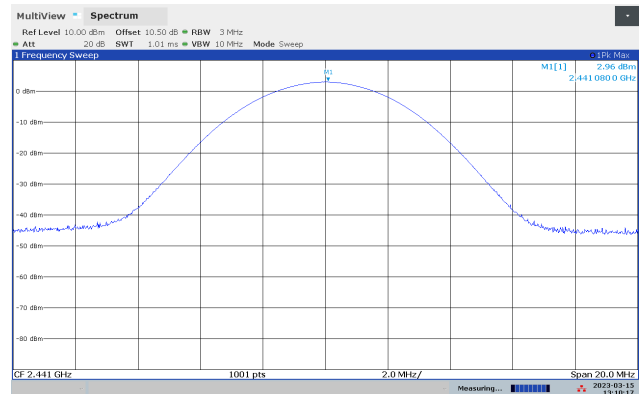
Peak Power, 2402 MHz, $\pi/4$ -DPSK



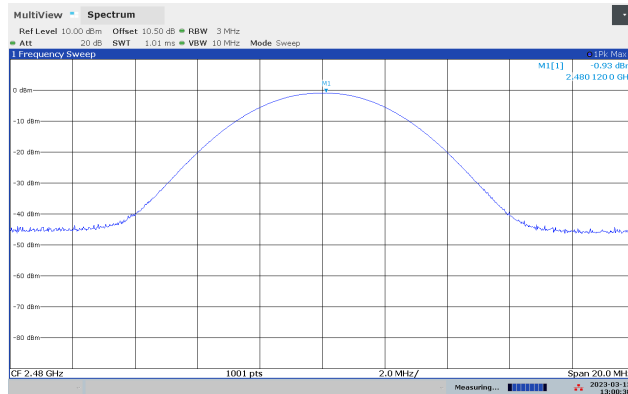
Peak Power, 2402 MHz, 8-DPSK



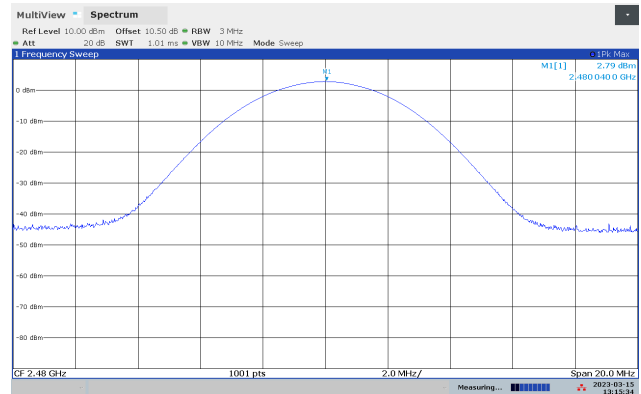
Peak Power, 2441 MHz, $\pi/4$ -DPSK



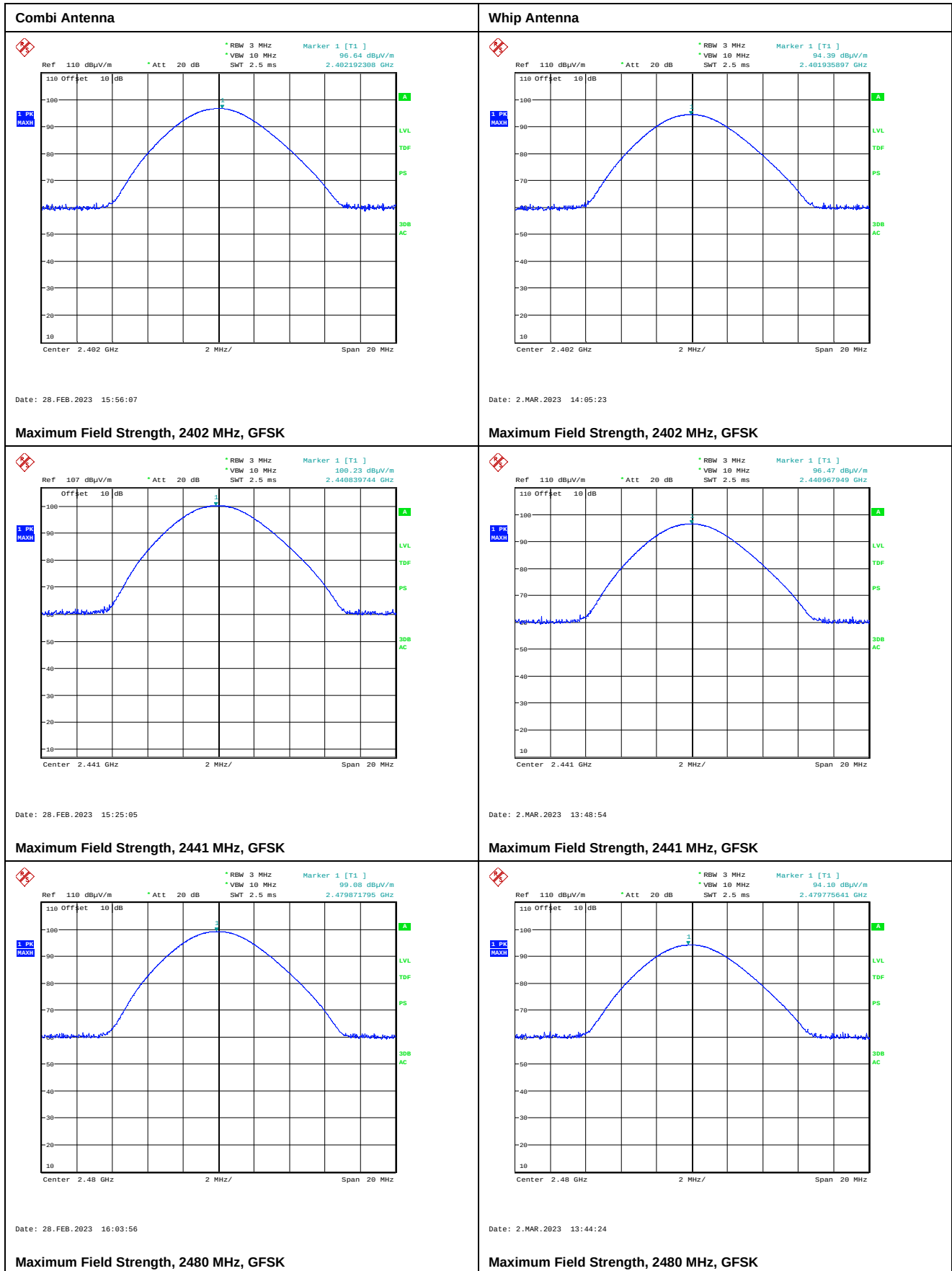
Peak Power, 2441 MHz, 8-DPSK



Peak Power, 2480 MHz, $\pi/4$ -DPSK



Peak Power, 2480 MHz, 8-DPSK



3.7 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 3, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

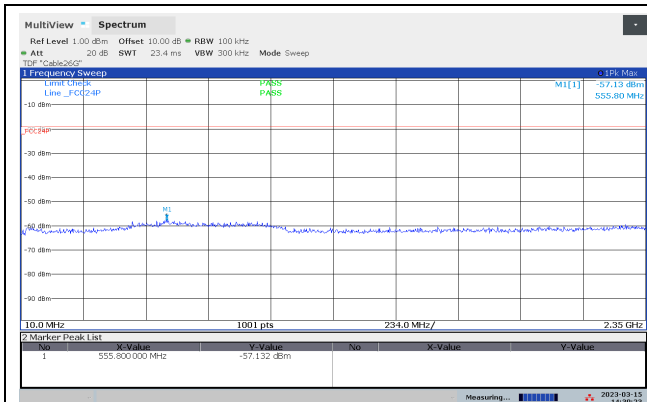
Measurement Data:

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2402 MHz	> 40	> 20	Pass
2441 MHz	> 40	> 20	Pass
2480 MHz	> 40	> 20	Pass

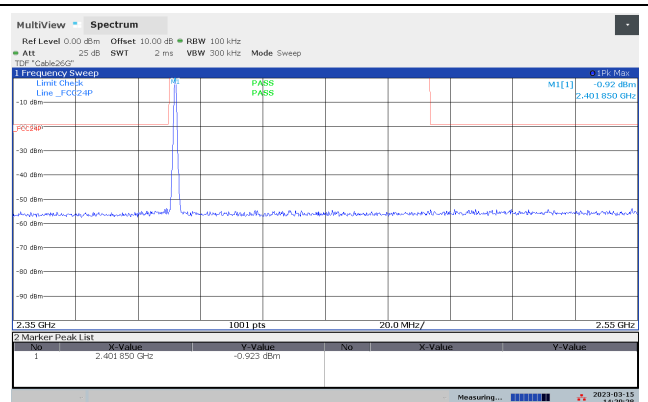
Measured with Peak Detector

RF conducted power to 25 GHz: see attached plots.

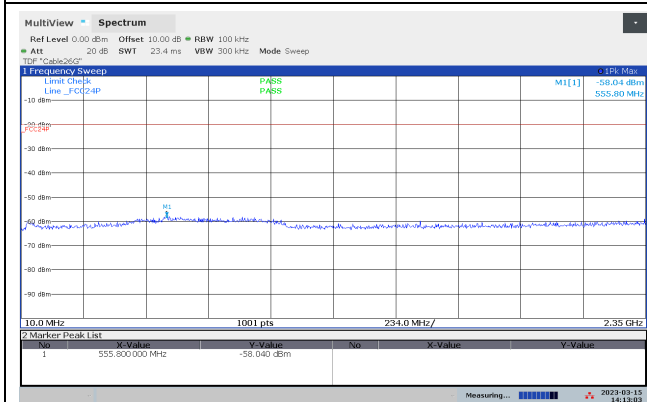
Requirements for all systems	
Peak measurement	RMS averaging (alternative measurement)
20 dB or more below carrier measured in 100 kHz bandwidth	30 dB or more below carrier measured in 100 kHz bandwidth
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.	



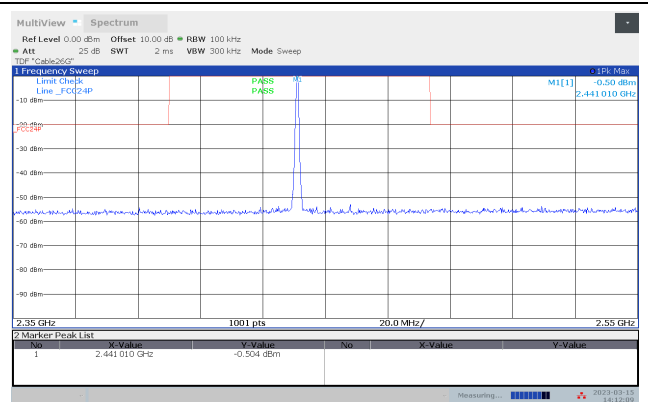
Conducted Emissions 10-2350 MHz, 2402 MHz, GFSK



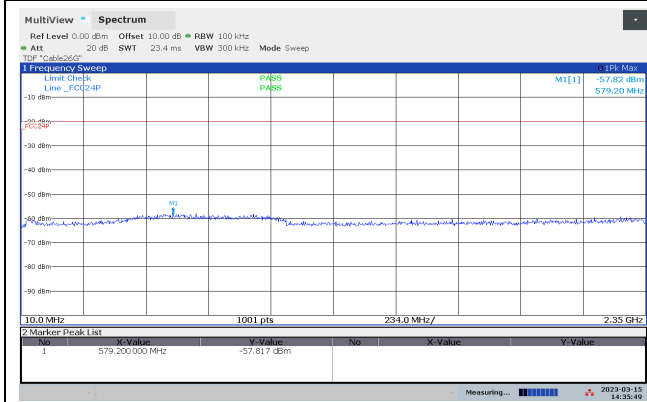
Conducted Emissions 2350-2550 MHz, 2402 MHz, GFSK



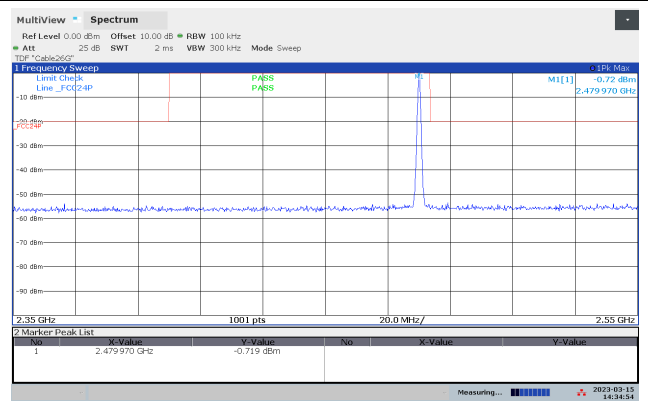
Conducted Emissions 10-2350 MHz, 2441 MHz, GFSK



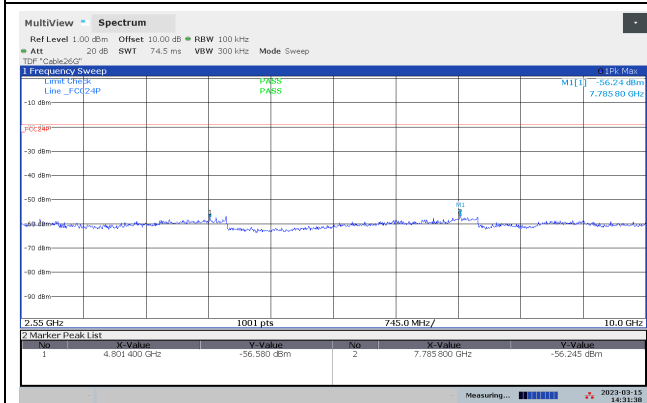
Conducted Emissions 2350-2550 MHz, 2441 MHz, GFSK



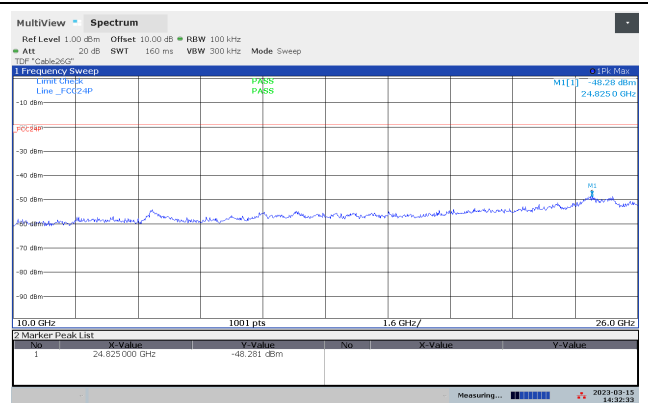
Conducted Emissions 10-2350 MHz, 2480 MHz, GFSK



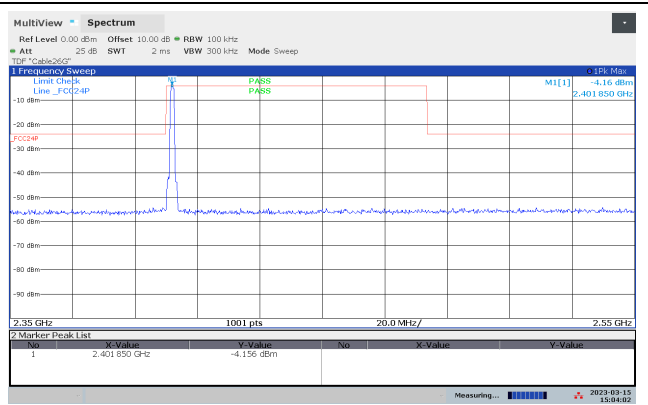
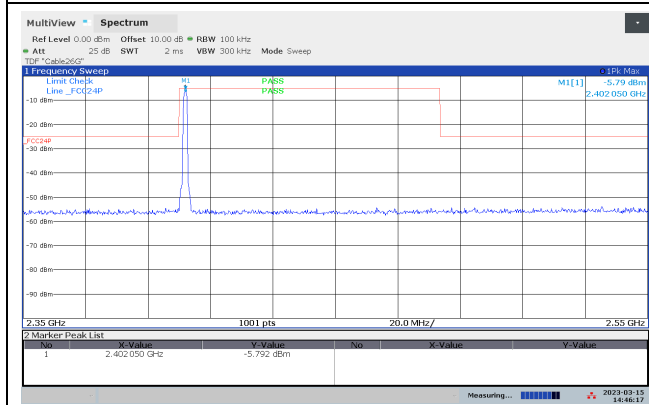
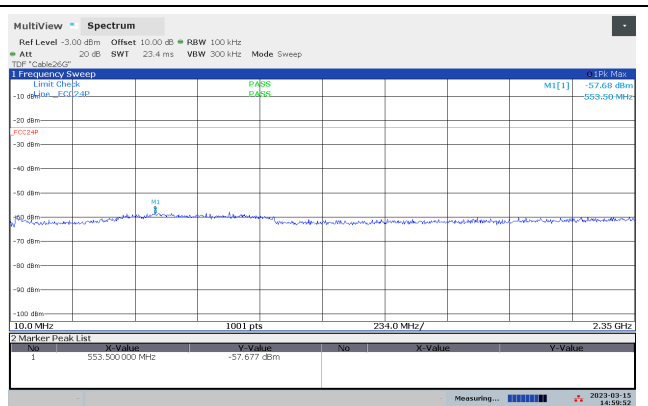
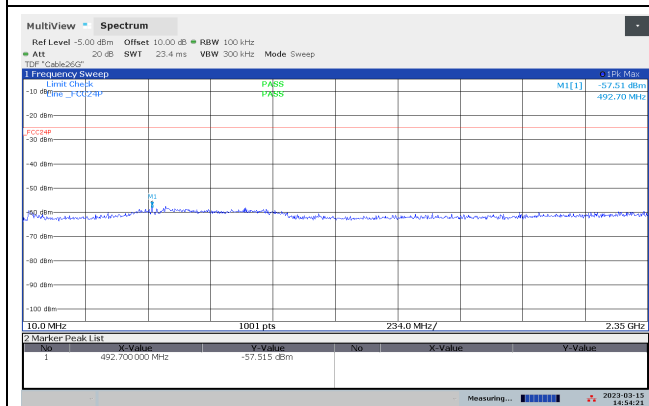
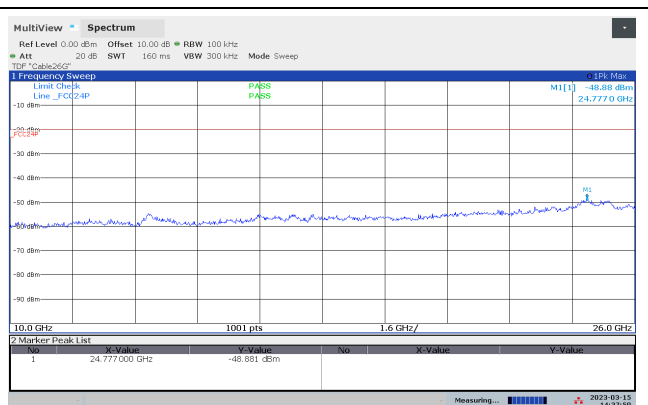
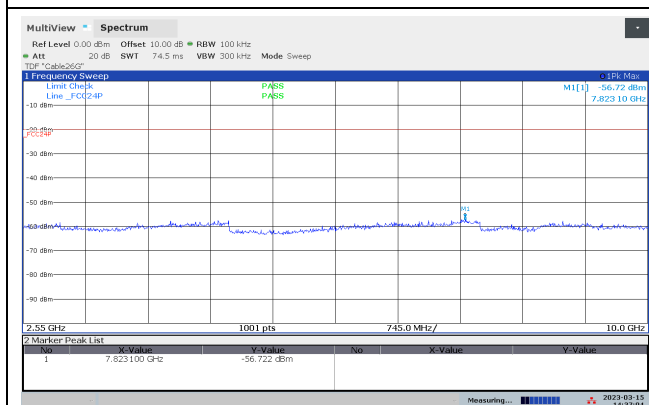
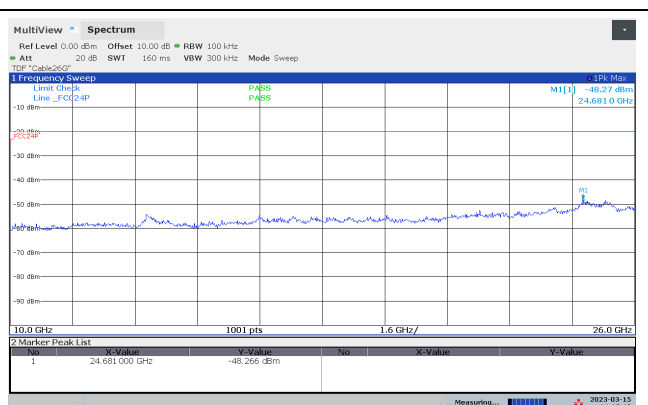
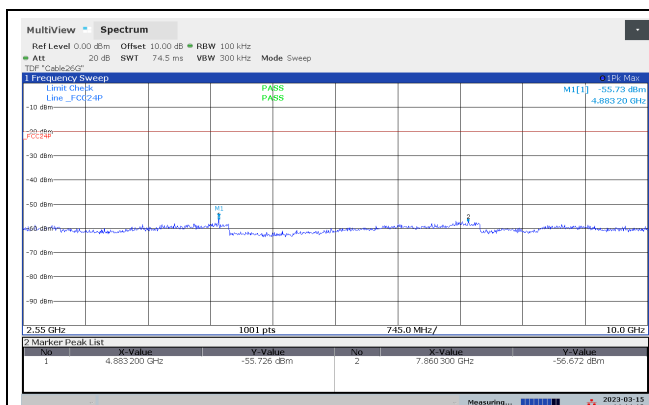
Conducted Emissions 2350-2550 MHz, 2480 MHz, GFSK

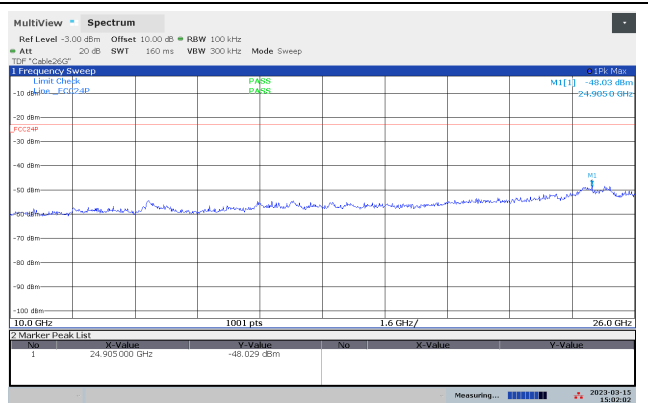
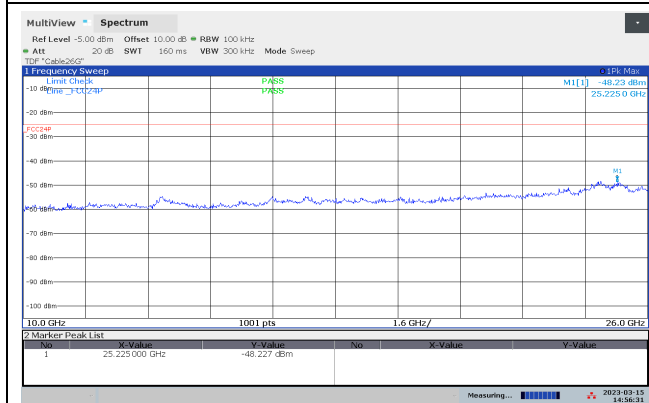
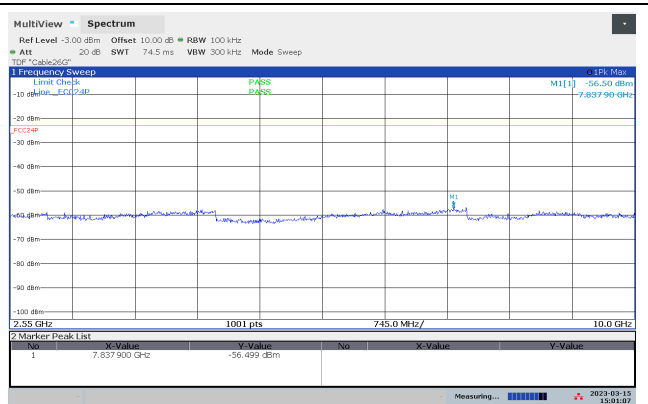
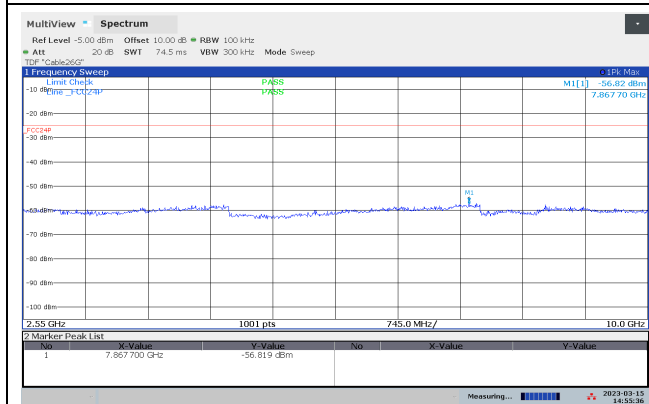
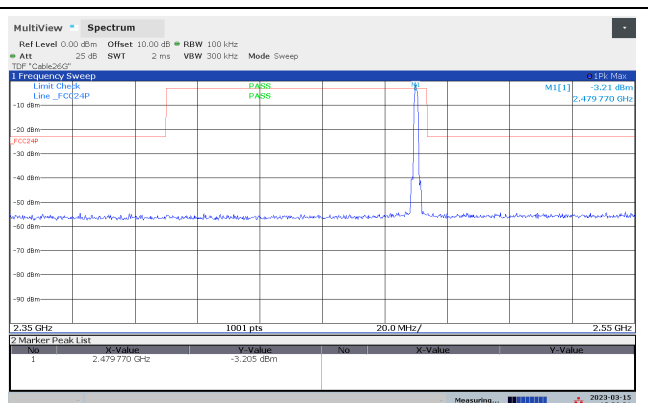
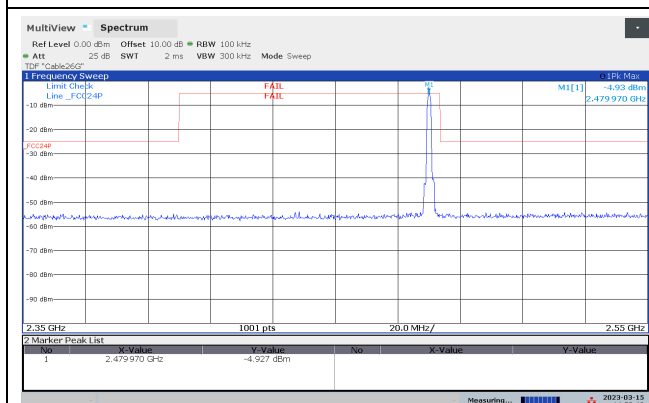
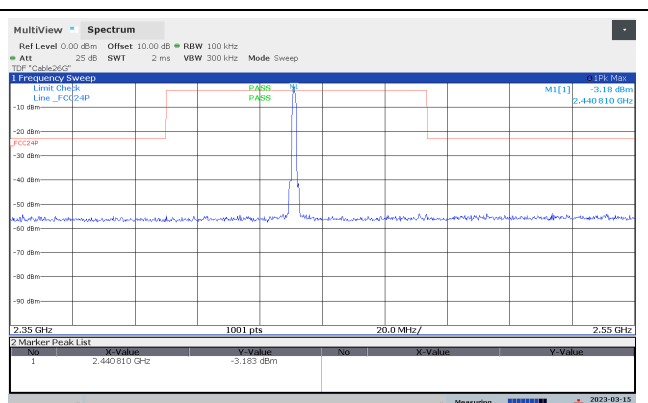
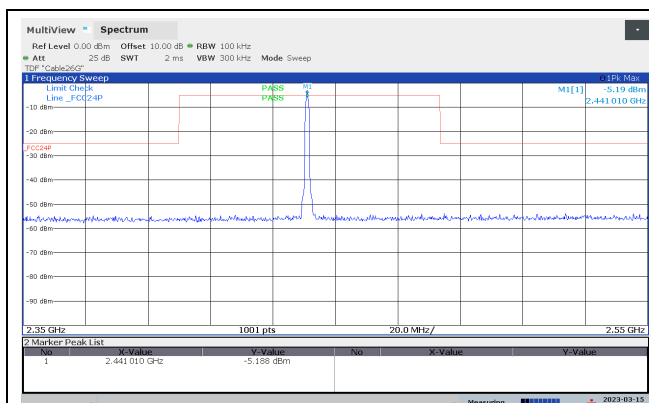


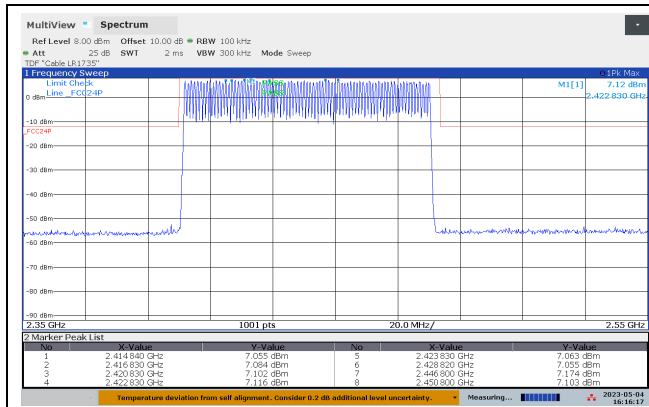
Conducted Emissions 2550-10000 MHz, 2402 MHz, GFSK



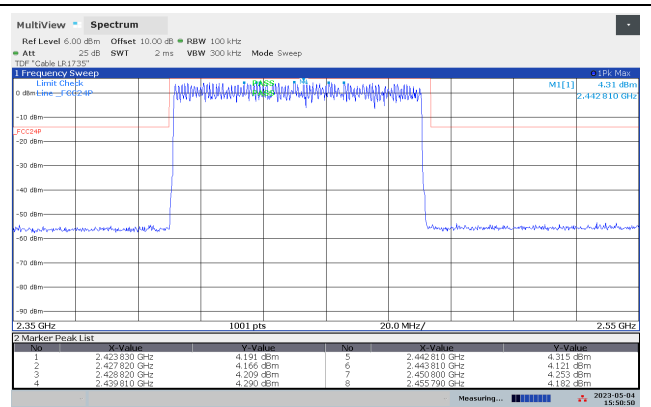
Conducted Emissions 10000-26000 MHz, 2402 MHz, GFSK



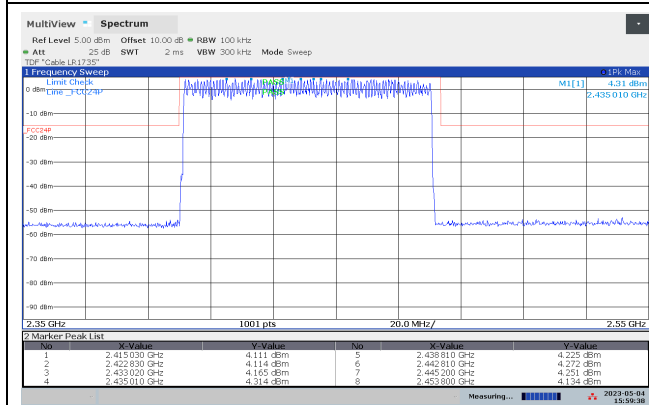




Conducted Emissions 2300-2600 MHz, Hopping, GFSK



Conducted Emissions 2300-2600 MHz, Hopping, $\pi/4$ -DPSK



Conducted Emissions 2300-2600 MHz, Hopping, 8-DPSK

3.8 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED Canada RSS-GEN, Issue 5 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISED Canada (MHz)	FCC (GHz)	ISED Canada (GHz)
0.090-0.110		0.96-1.24 1.3-1.427	0.96-1.427
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		2.69-2.9	2.655-2.9
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		3.6-4.4	3.5-4.4
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 123-138	108-138	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISSED, all other frequencies are common.

3.9 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Combi Antenna							
Carrier Frequency and Data Rate	Band Edge Frequency	Measured Field Strength (dBμV/m)		Limit (dBμV/m)		Margin (dB)	
		Peak Detector	Average Detector	Peak Det	Average Det	Peak Det	Average Det
2402 MHz GFSK	2390 MHz	52.9	32.9	74	54	21.1	21.1
2480 MHz GFSK	2483.5 MHz	57.2	37.2			16.8	

Whip Antenna							
Carrier Frequency and Data Rate	Band Edge Frequency	Measured Field Strength (dBμV/m)		Limit (dBμV/m)		Margin (dB)	
		Peak Detector	Average Detector	Peak Det	Average Det	Peak Det	Average Det
2402 MHz GFSK	2390 MHz	52.8	32.8	74	54	21.2	21.2
2480 MHz GFSK	2483.5 MHz	54.3	34.3			19.7	19.7
2402 MHz 2-EDR	2390 MHz	52.9	32.9			21.1	21.1
2480 MHz 2-EDR	2483.5 MHz	54.0	34.0			20.0	20.0
2402 MHz 3-EDR	2390 MHz	52.8	32.8			21.2	21.2
2480 MHz 3-EDR	2483.5 MHz	56.3	36.3			17.7	17.7

Average Detector values are measured with Peak Detector and corrected for Duty Cycle.

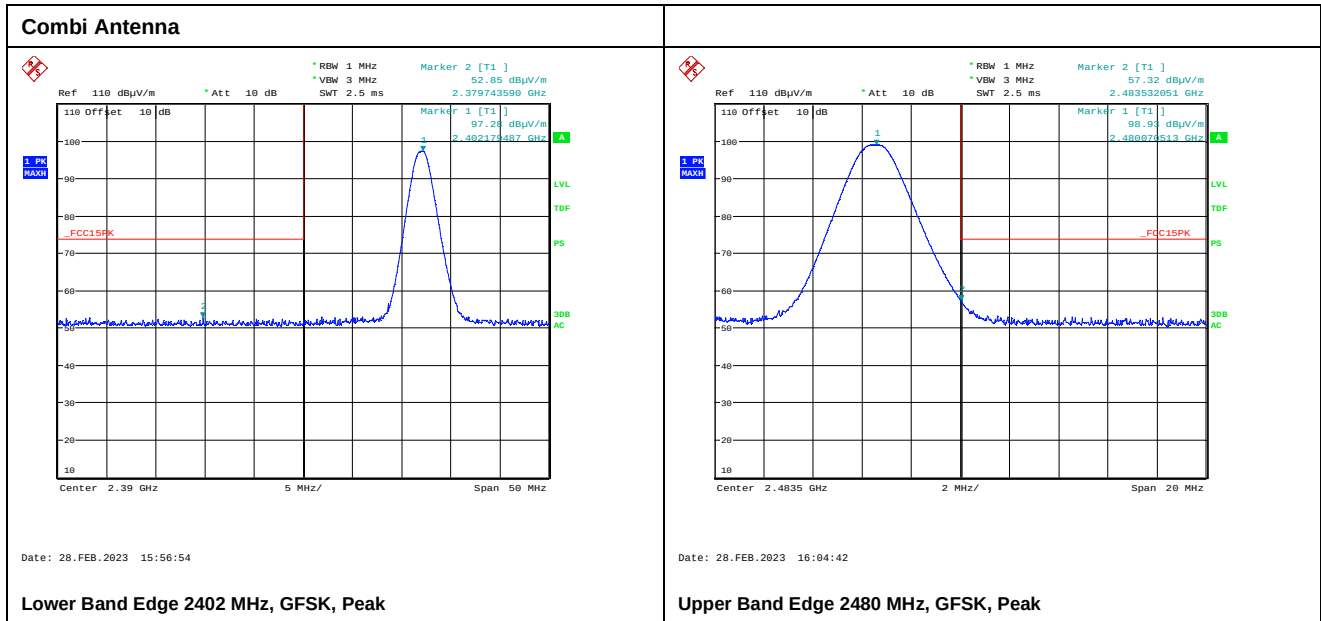
See attached plots.

Duty Cycle Correction Factor Calculation:

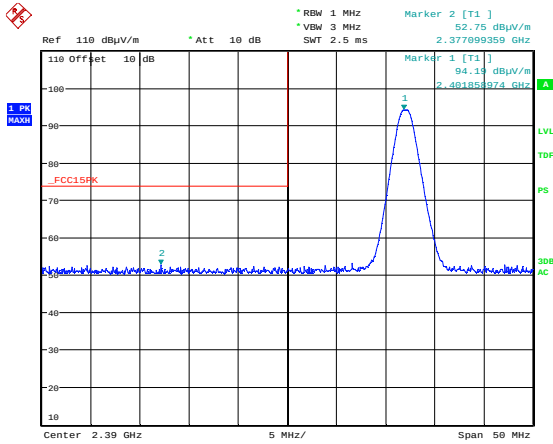
Duty Cycle = slot length / frame length

Duty Cycle Correction factor = $-20 \times \log(\text{Duty Cycle}) = 27.5 \text{ dB}$

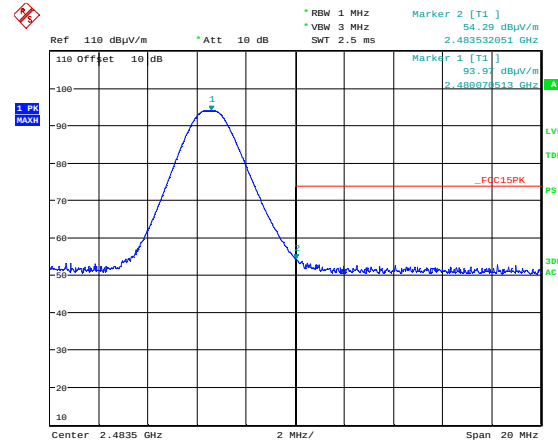
Maximum Duty Cycle Correction Factor according to Para 15.35 (b): 20 dB



Whip Antenna

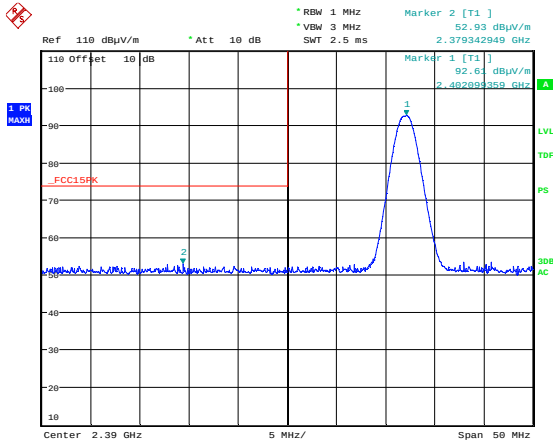


Date: 2.MAR.2023 14:06:09



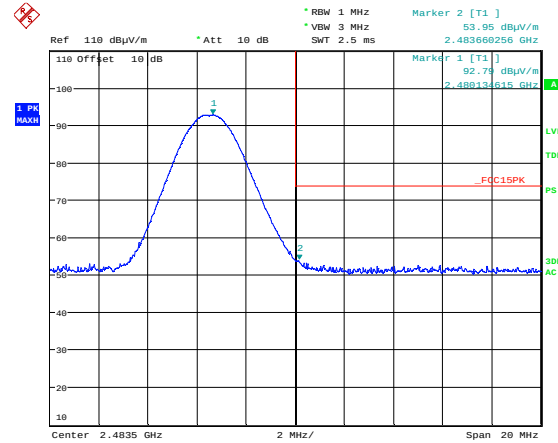
Date: 2.MAR.2023 13:45:10

Lower Band Edge 2402 MHz, GFSK, Peak



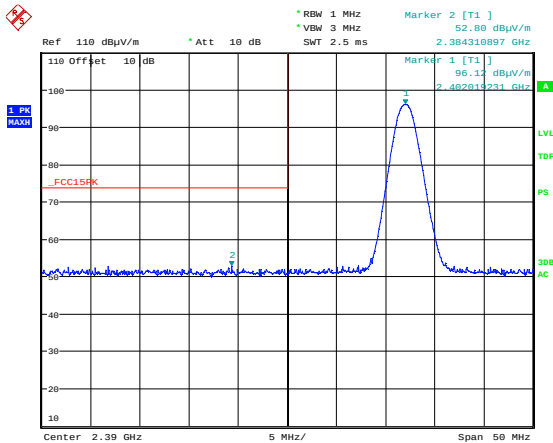
Date: 2.MAR.2023 14:08:46

Upper Band Edge 2480 MHz, GFSK, Peak



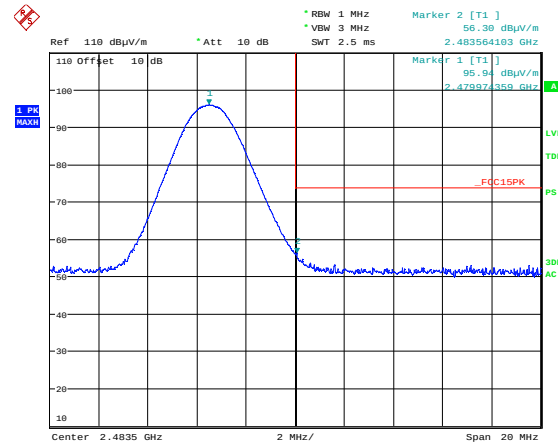
Date: 2.MAR.2023 14:00:51

Lower Band Edge 2402 MHz, π/4-DPSK, Peak



Date: 2.MAR.2023 14:11:19

Upper Band Edge 2480 MHz, π/4-DPSK, Peak



Date: 2.MAR.2023 13:58:01

Lower Band Edge 2402 MHz, 8-DPSK, Peak

Upper Band Edge 2480 MHz, 8-DPSK, Peak

3.10 Radiated Emission, 30 – 1000 MHz.

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Detector: Peak (found frequencies were measured with Quasi-Peak Detector)

Measuring distance 3 m

Tested in test mode with BT transmitting.

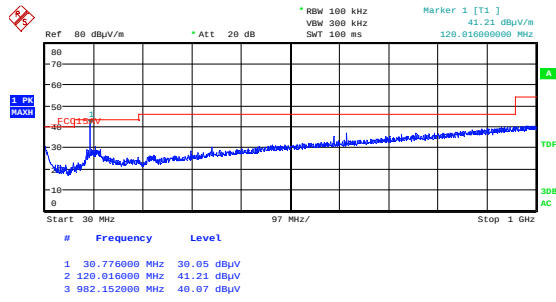
Measured Frequency (MHz)	Carrier Frequency (MHz)	Modulation	Measured Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30 – 88	Any	GFSK	< 35	40.0	> 5
88 – 216	Any	GFSK	< 40	43.5	> 3.5
216 – 960	Any	GFSK	< 40	46.0	> 6
960 – 1000	Any	GFSK	< 44	54.0	> 10
120.01	Any	Any	40.0	43.5	3.5

See attached plots

Requirements/Limit

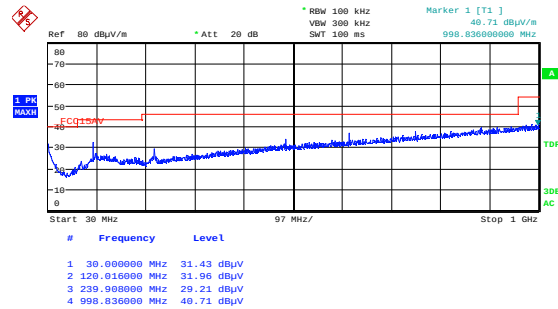
FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 µV/m	40.0 dBµV/m
88 – 216 MHz	150 µV/m	43.5 dBµV/m
216 – 960 MHz	200 µV/m	46.0 dBµV/m
960 – 1000 MHz	500 µV/m	54.0 dBµV/m
Limits above are with Quasi Peak Detector		

Combi Antenna



Date: 10.MAR.2023 15:48:44

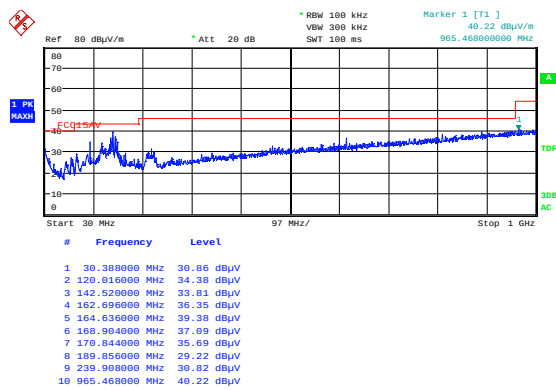
Radiated Emissions 30 - 1000 MHz, GFSK, HP



Date: 10.MAR.2023 15:50:41

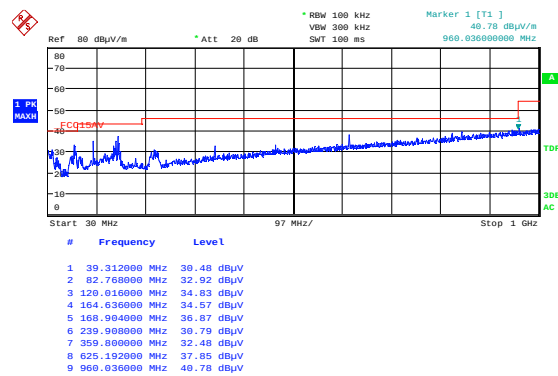
Radiated Emissions 30 - 1000 MHz, GFSK, VP

Whip Antenna



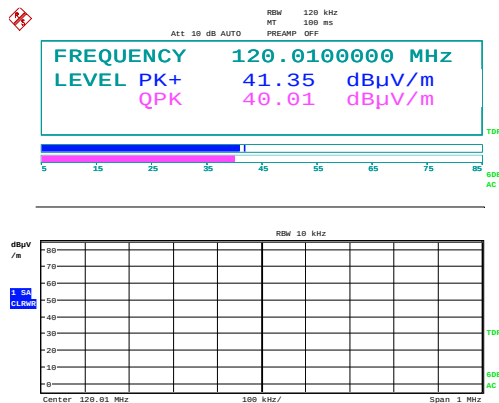
Date: 13.MAR.2023 10:26:18

Radiated Emissions 30 - 1000 MHz, GFSK, HP



Date: 13.MAR.2023 10:24:21

Radiated Emissions 30 - 1000 MHz, GFSK, VP



Date: 10.MAR.2023 16:05:41

Emission 120 MHz, Max: VP

3.11 Radiated Emissions, 1-26 GHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)
1m (18 – 26 GHz)

No spurious were detected.

Average Detector values are calculated from Peak values by Duty Cycle Correction Factor.

A Band Reject Filter was used for measurements from 1 GHz to 18 GHz.

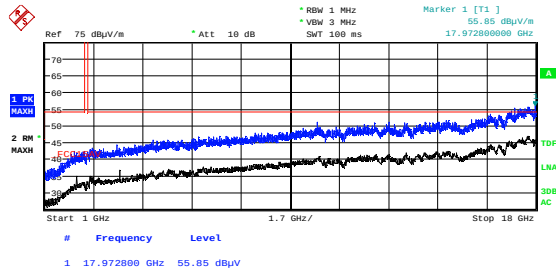
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

See plots.

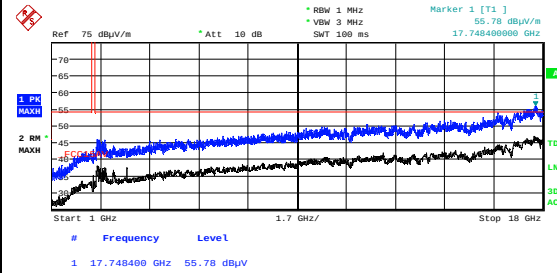
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBµV/m	74.0 dBµV/m

Combi Antenna

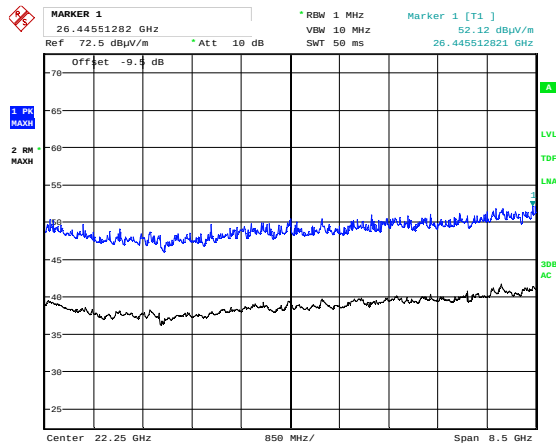


Date: 28.FEB.2023 15:04:44



Date: 28.FEB.2023 15:02:20

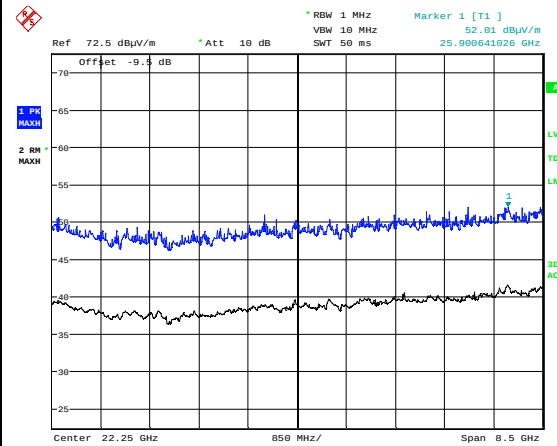
Radiated Emissions 1 - 18 GHz, 2441 MHz, GFSK, HP



Date: 14.MAR.2023 10:47:22

Radiated Emissions 18 - 26 GHz, 2441 MHz, GFSK, HP, @1m

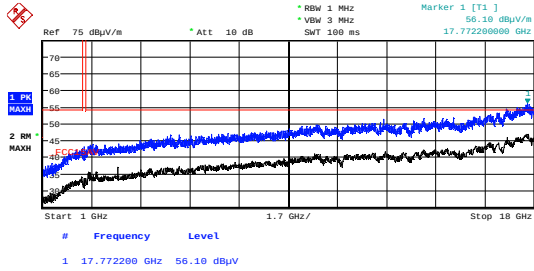
VP



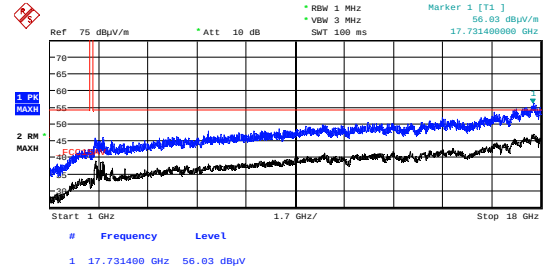
Date: 14.MAR.2023 10:44:37

VP

Whip Antenna

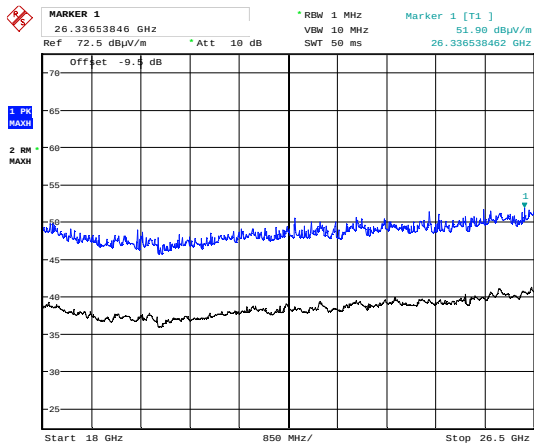


Date: 2.MAR.2023 14:30:39



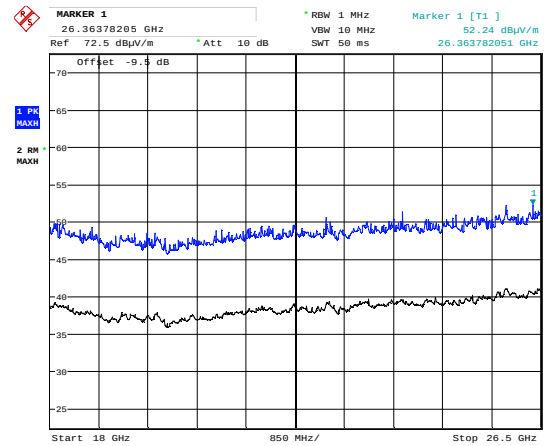
Date: 2.MAR.2023 14:28:16

Radiated Emissions 1 - 18 GHz, 2441 MHz, GFSK, HP



Date: 14.MAR.2023 16:10:00

VP



Date: 14.MAR.2023 16:07:40

Radiated Emissions 18 - 26 GHz, 2441 MHz, GFSK, HP

VP

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	< 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	2023-01	2024-01
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2023-01	2024-01
3	6810.17B	Attenuator	Suhner	LR 1669	2022-08	2023-08
4	NO324415	Band Reject Filter (2.4GHz)	Microwave Circuits	LR 1760	COU	
5	JB3	BiLog Antenna	Sunol	N-4525	2022-09	2025-09
6	317	Preamplifier	Sonoma Inst.	LR 1687	2022-08	2023-08
7	3117-PA	Horn Antenna +PreAmp	EMCO	LR 1717	2022-08	2023-08
8	3115	Horn Antenna	EMCO	LR 1226	2022-12	2027-12
9	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2022-08	2023-08
10	WLK5-1100-1485-7000-40SS	Low Pass Filter	Wainwright Inst.	LR 1761	COU	
11	638	Antenna Horn	Narda	LR 1480	N/A	
12	6032A	System Power Supply	Hewlett Packard	LR 1062	COU	
13	Model 87V	Multimeter	Fluke	LR 1600	2022-03	2024-03
14	ST18/SMA/N/36	RF Cable	Suhner	LR 1627	COU	

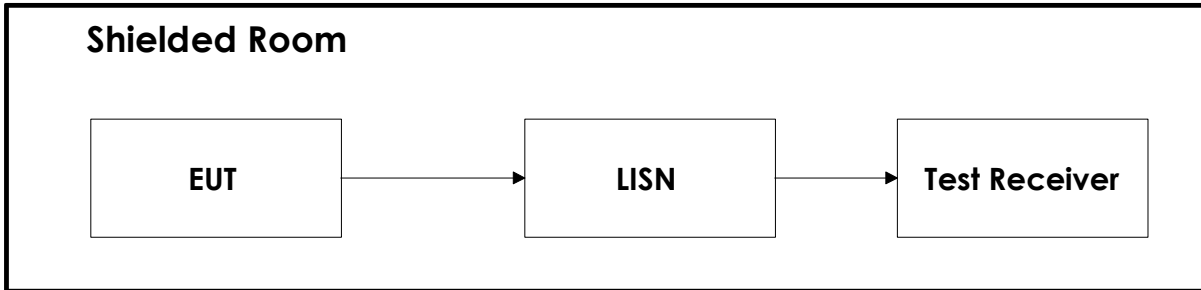
COU = Calibrate on Use

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

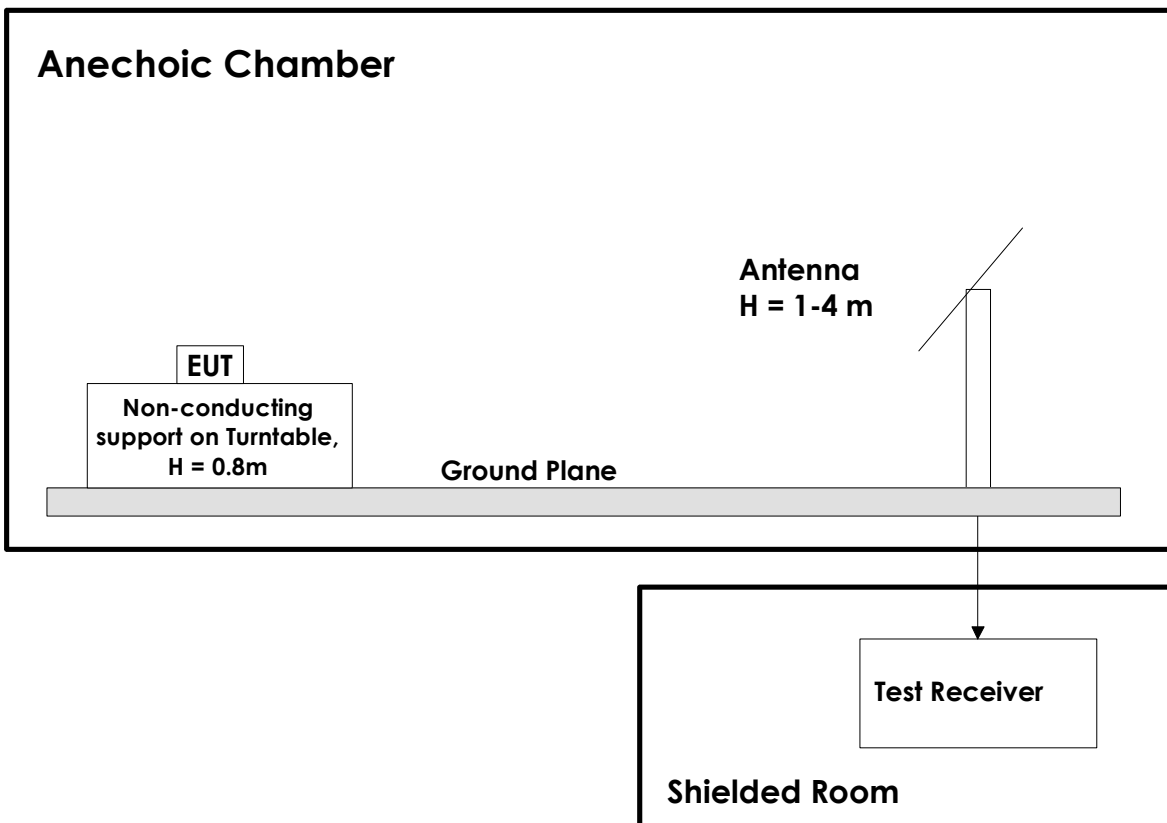
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.60.20	EMC test software
2	Nemko AS	RSPlot	1.0.8.0	Screen capture from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. For frequencies below 30 MHz the measuring distance is 10m, for all other frequencies it is 3m or 1m. Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna. For measurements above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss. All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers. A pre-amplifier is used for all measurements above 30 MHz, and a High-Pass or Band-Pass filter is used for all harmonics.