REP011128

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 2.0**
Rating	**24VDC**
Trademark	**CPAC Systems AB**
Additional information	**WiFi, Bluetooth**
Tested according to	**FCC Part 15.247** Frequency Hopping Transmitters / Digital Transmission Systems **Industry Canada RSS-247, Issue 2** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	**PRJ0024292**
Tested in period	**2023-02-28 to 2023-03-15**
Issue date	**2023-06-28**
Name and address of the testing laboratory	Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO470 ISED No: 2040D-1 **An accredited technical test executed under the Norwegian accreditation scheme**

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

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Template version: C

Revision history

Revision	Date	Comment	Sign
A	2023-06-28	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.

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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

1.1 Test Item

Name	**CPAC Systems AB**
Model/version	**SID 2.0**
FCC ID	**AHV-SID2**
ISED ID	**10111-SID2**
Serial number	**HYD-3891**
Hardware identity and/or version	**P-01**
Software identity and/or version	**Hydra_BTSW_1.0**
Frequency Range	**2402 – 2480 MHz**
Number of Channels	**40**
Operating Modes	**Bluetooth Low Energy ☒ 1Mb ☐ 2Mb**
Type of Modulation	**GFSK**
Conducted Output Power	**1.05 mW**
Antenna Connector	**FAKRA**
Number of Antennas	**1**
Diversity or Smart Antennas	**No**
Power Supply	**External Power Supply, (8-32 V_{DC})**

Description of Test Item

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

Bluetooth Low Energy 2 Mb mode is not supported.

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 connectors.		

Requirement: FCC 15.203, 15.204

1.6 EUT Operating Modes

Operating modes	Radiated Emissions and Power Line Conducted Emissions were performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario.

1.7 Comments

The EUT uses Bluetooth Low Energy protocol and has been tested as a Digital Transmission System.

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 RSS-247 Issue 2 and RSS-GEN Issue 5.

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

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

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

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

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, 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
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complies
DTS Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	11.8 Option 2	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complies
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	11.10.2 PKPSD (DTS)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 11.11 (DTS)	Complies
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS)	Complies

3 TEST RESULTS

3.1 Occupied Bandwidth (99% BW)

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.2

Test Results: Complies

Measurement Data:

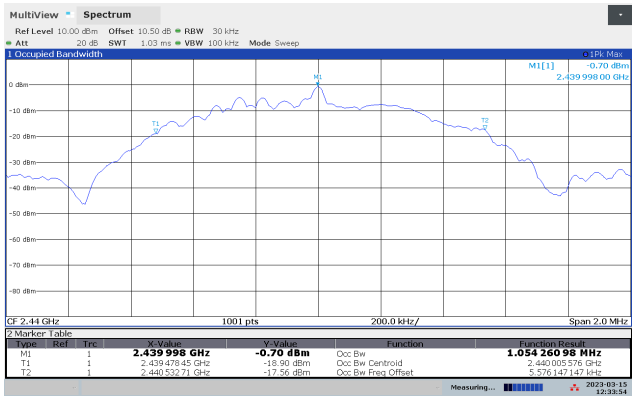
Carrier Frequency, Data Rate	Occupied Bandwidth (99% BW)
2440 MHz, 1Mb	1.05 MHz

Occupied Bandwidth is the same for all channels.

See attached plots.

Requirements:

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



99% Occupied BW, 1Mb

3.2 DTS Bandwidth

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 2, Clause 5.2 (a)

Measurement procedure: **ANSI C63.10-2013 Clause 11.8**

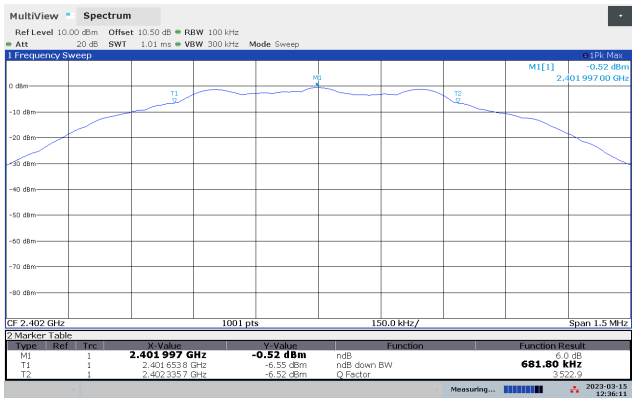
Test Results: **Complies**

Measurement Data:

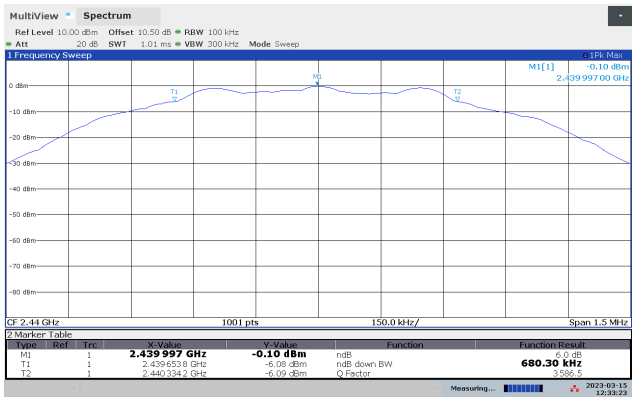
Modulation type and bitrate	Measured DTS Bandwidth		
	2402 MHz	2440 MHz	2480 MHz
GFSK 1 Mbps	682 kHz	680 kHz	673 kHz

Power supply variation within 85 % to 115% of nominal value has no influence on measured value.

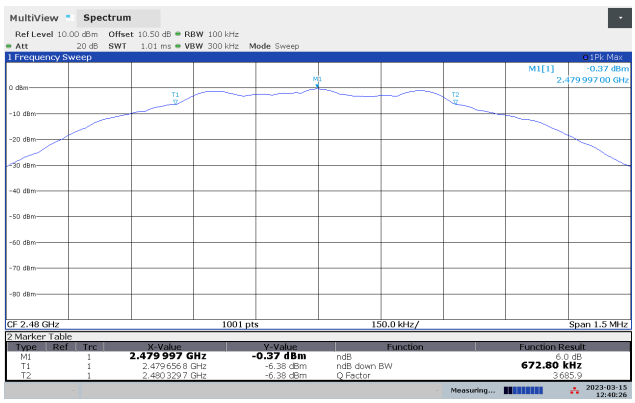
Frequency Band	Requirement for systems using Digital Modulation
902-928 MHz	The minimum 6 dB bandwidth shall be at least 500 kHz.
2400-2483.5 MHz	
5725-5850 MHz	



DTS BW, 2402 MHz, 1M



DTS BW, 2440 MHz, 1M



DTS BW, 2480 MHz, 1M

3.3 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 2, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

Carrier Frequency	Peak Conducted Power, dBm	Peak EIRP, Combi Antenna, dBm	Peak EIRP, Whip Antenna, dBm	Gain Combi Antenna, dBi	Gain Whip Antenna, dBi
2402 MHz	-0.19	1.46	-0.80	1.7	-0.6
2440 MHz	0.20	4.96	1.10	4.8	0.9
2480 MHz	-0.12	3.31	-1.36	3.4	-1.2

Output Power reported is Maximum Peak Power.

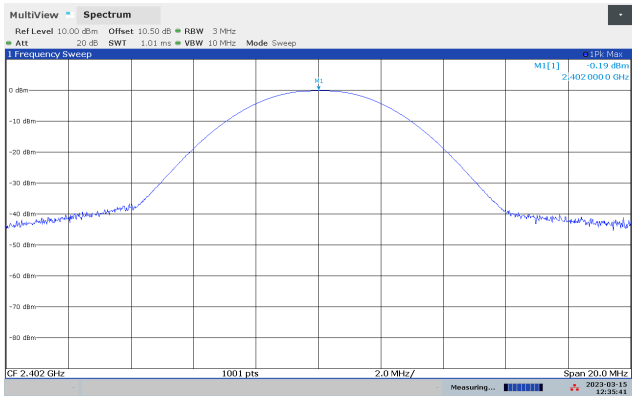
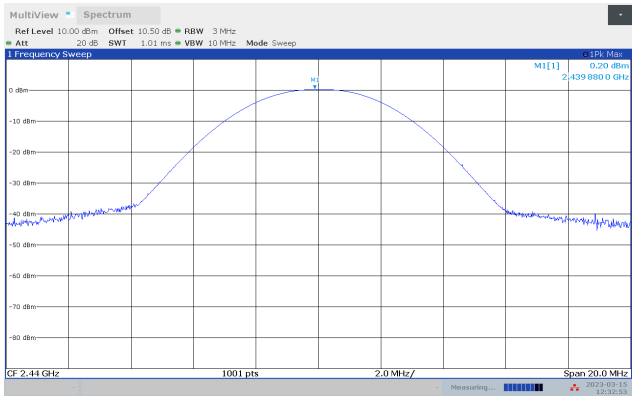
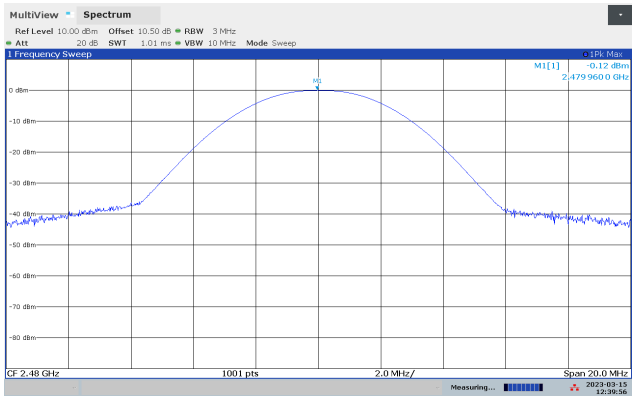
The Integrated Band Power Method was used to measure Output Power

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

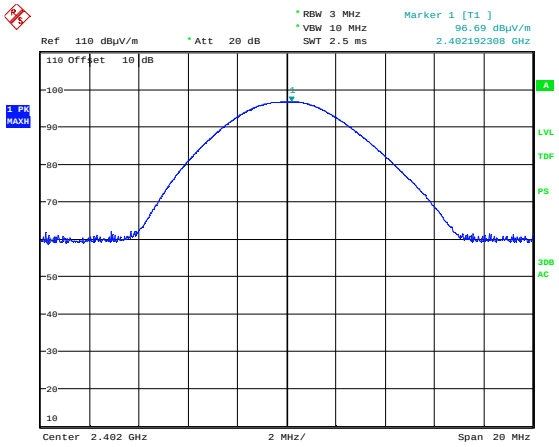
Antenna Gain is less than 6 dBi.

See attached plots.

Requirements for Digital Modulation systems
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the 1 Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
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 Measurements	
 Peak Power, 2402 MHz, 1Mb	 Peak Power, 2440 MHz, 1Mb
 Peak Power, 2480 MHz, 1Mb	

Combi Antenna



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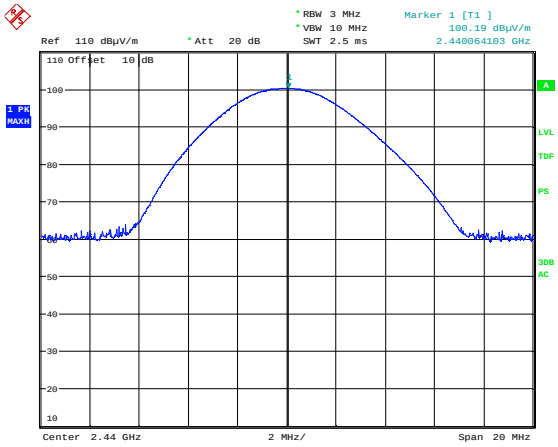
Peak EIRP, 2402 MHz, 1Mb



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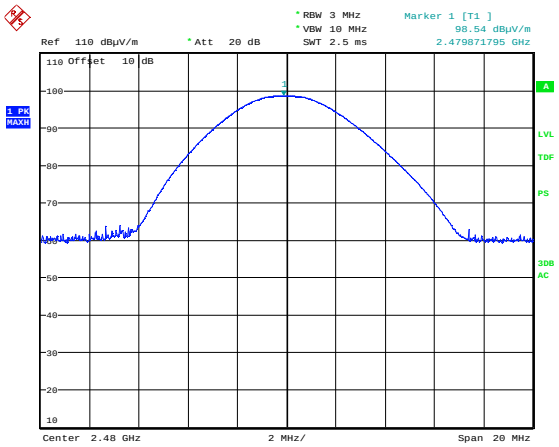
Peak EIRP, 2440 MHz, 1Mb



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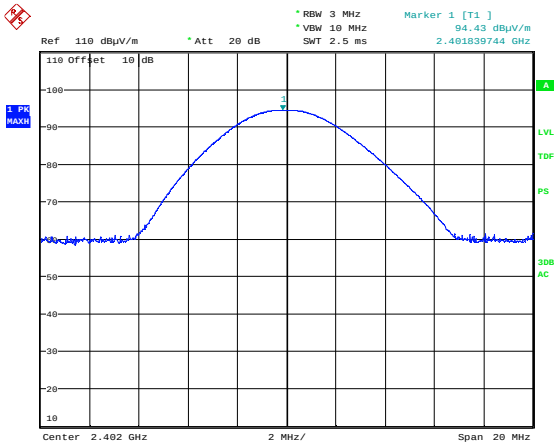
Peak EIRP, 2480 MHz, 1Mb

Whip Antenna



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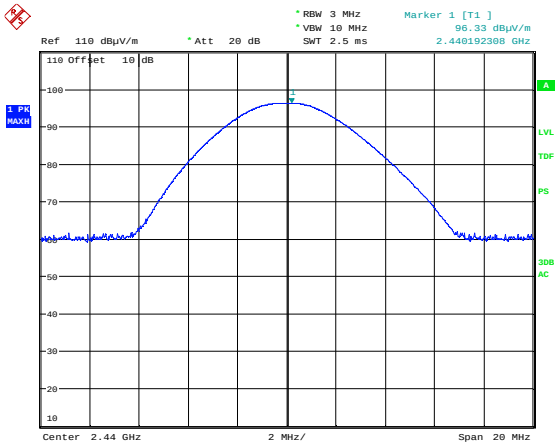
Peak EIRP, 2402 MHz, 1Mb



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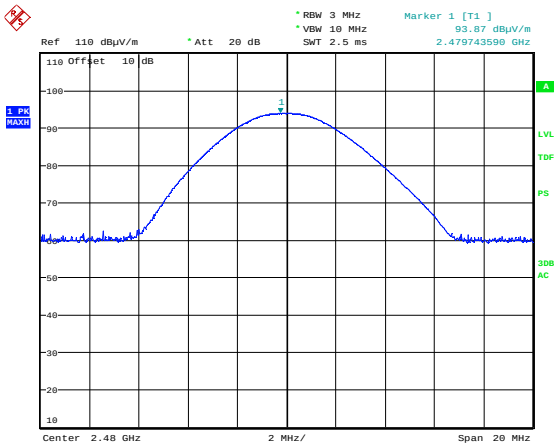
Peak EIRP, 2440 MHz, 1Mb



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Peak EIRP, 2480 MHz, 1Mb

3.4 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 2, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

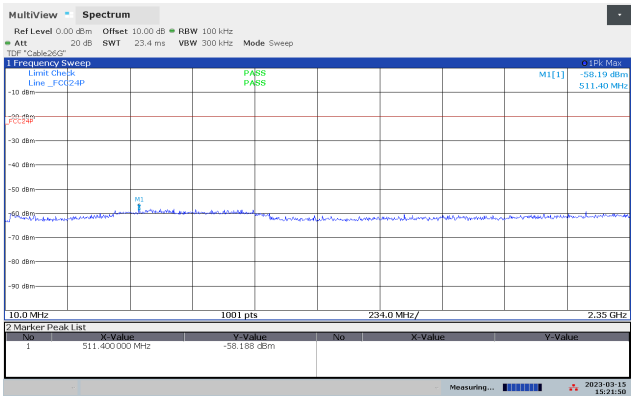
Measurement Data:

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2402 MHz	> 40	> 20	Pass
2440 MHz	> 40	> 20	Pass
2480 MHz	> 40	> 20	Pass

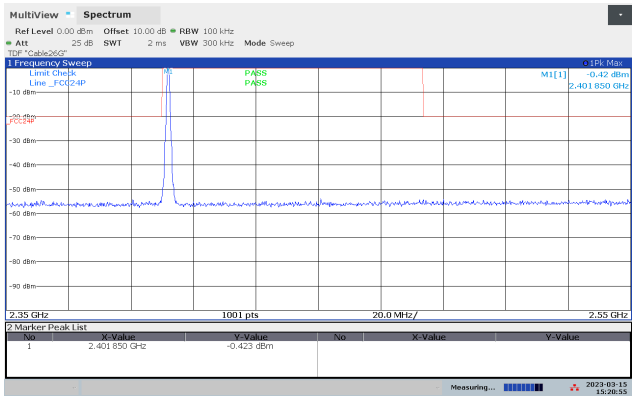
Measured with Peak Detector

RF conducted power to 25 GHz: see attached plots.

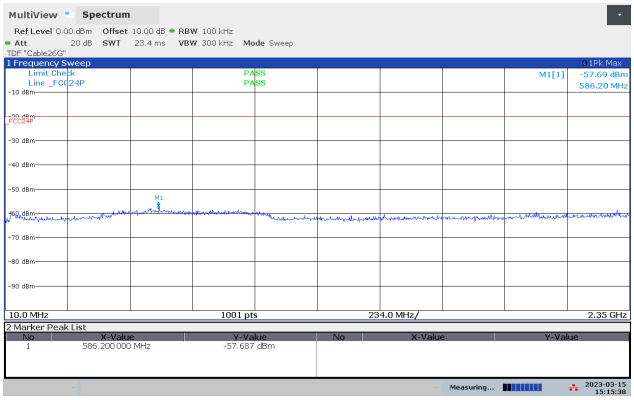
Requirements for all systems	
Peak measurement	**RMS averaging (alternative measurement)**
20 dB or more below carrier measured in 100 kHz bandwidth	30 dB or more below carrier measured in 100 kHz bandwidth
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally 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.	



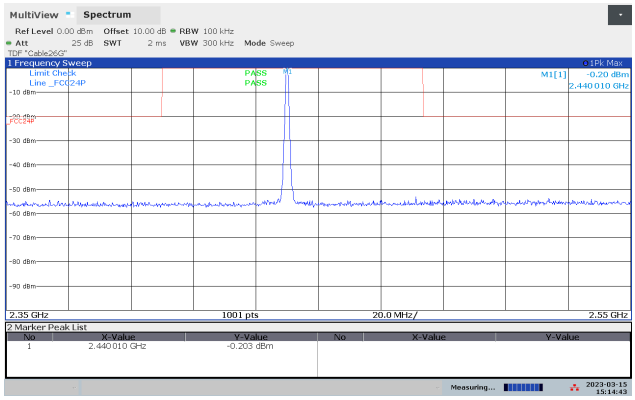
Conducted Emissions 10-2350 MHz, 2402 MHz, 1Mb



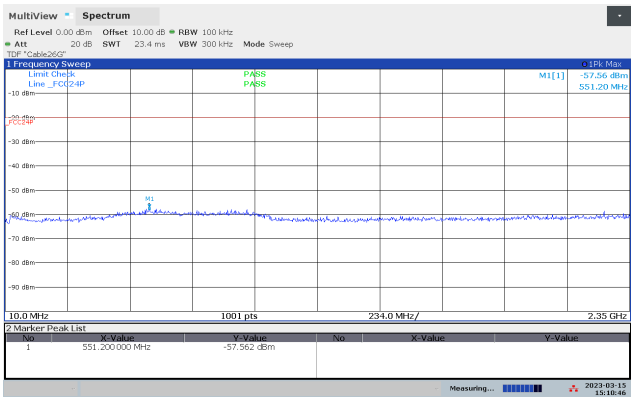
Conducted Emissions 2350-2550 MHz, 2402 MHz, 1Mb



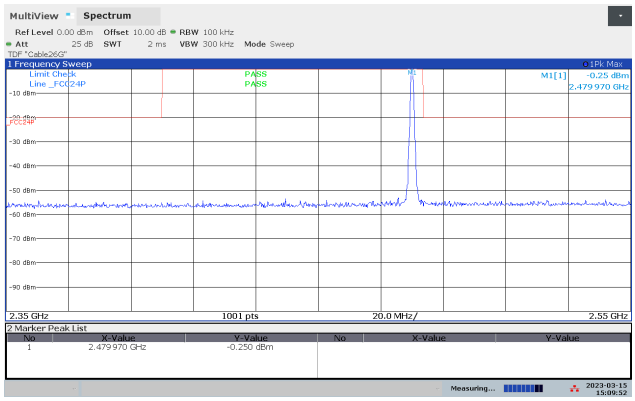
Conducted Emissions 10-2350 MHz, 2440 MHz, 1Mb



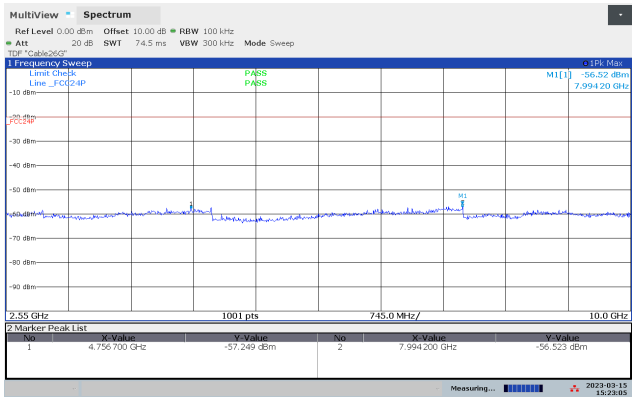
Conducted Emissions 2350-2550 MHz, 2440 MHz, 1Mb



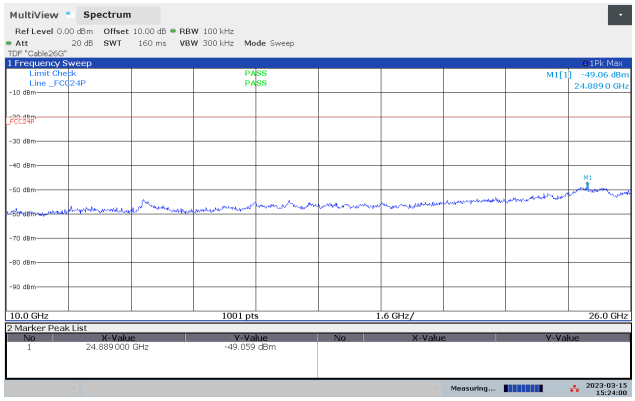
Conducted Emissions 10-2350 MHz, 2480 MHz, 1Mb



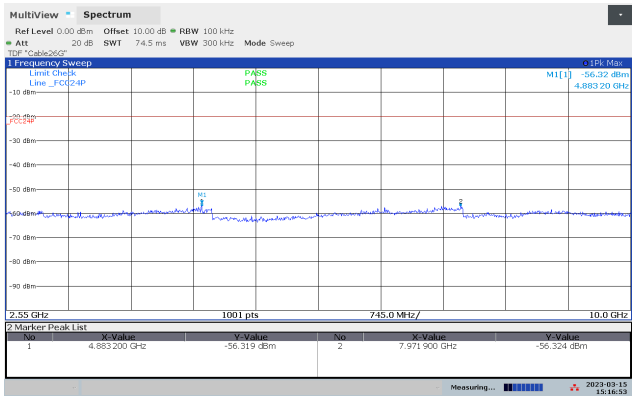
Conducted Emissions 2350-2550 MHz, 2480 MHz, 1Mb



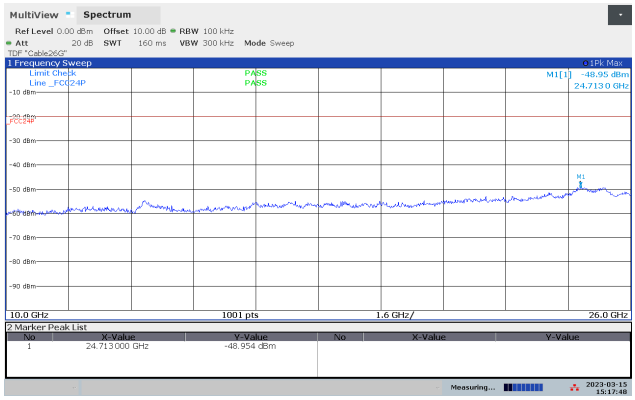
Conducted Emissions 2.55-10 GHz, 2402 MHz, 1Mb



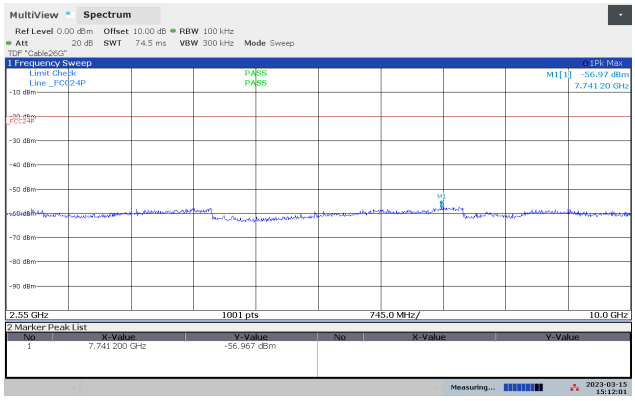
Conducted Emissions 10-26 GHz, 2402 MHz, 1Mb



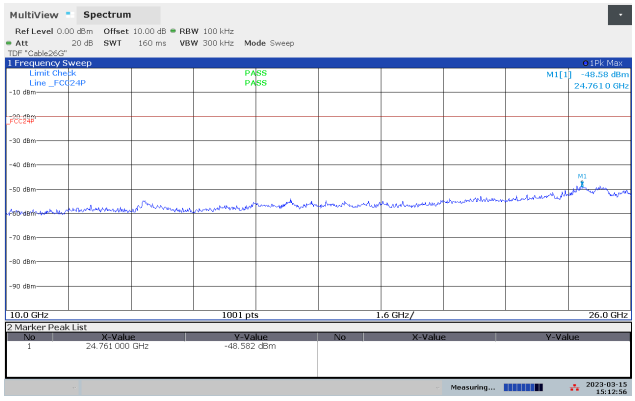
Conducted Emissions 2.55-10 GHz, 2440 MHz, 1Mb



Conducted Emissions 10-26 GHz, 2440 MHz, 1Mb



Conducted Emissions 2.55-10 GHz, 2480 MHz, 1Mb



Conducted Emissions 10-26 GHz, 2480 MHz, 1Mb

3.5 Restricted Bands of operation

Restricted Bands of operation for FCC and ISED are defined in FCC Part 15.205 and ISED 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 (MHz)	FCC (GHz)	ISED (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 ISED, all other frequencies are common.

3.6 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					
Detector	Measured field strength (dBµV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB	dB	
Peak	52.9	58.9	74	21.1	15.1
Average	*	53.7	54	/	0.3

Whip Antenna					
Detector	Measured field strength (dBµV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB	dB	
Peak	53.1	54.8	74	20.9	19.2
Average	*	49.0	54	/	5.0

*Measured Peak value is below average limit

Average values were measured using SA-2 method and correcting for Duty Cycle.

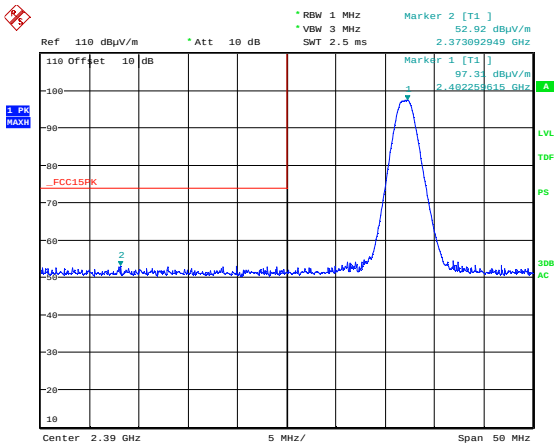
See attached plots.

Duty Cycle Correction

Burst (µs)	Frame (µs)	Duty Cycle	DC Correction (dB)
408	625	0.6528	1.9

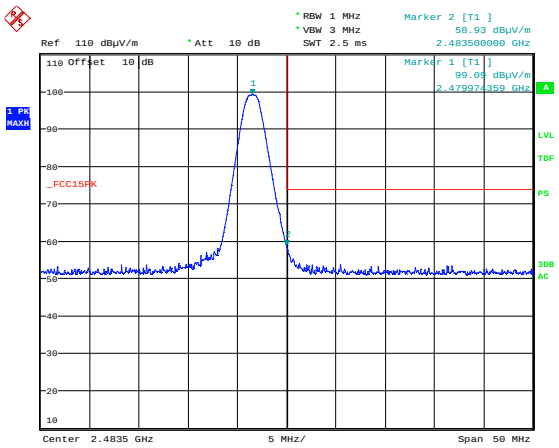
DC Correction = -10*log(Duty Cycle)

Combi Antenna



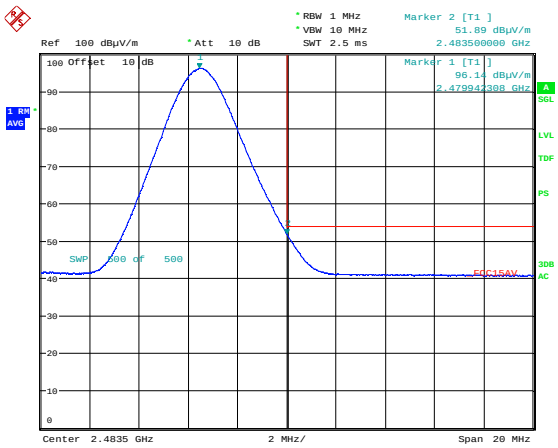
Date: 28.FEB.2023 15:51:53

Lower Band Edge, 2402 MHz, 1Mb, Peak



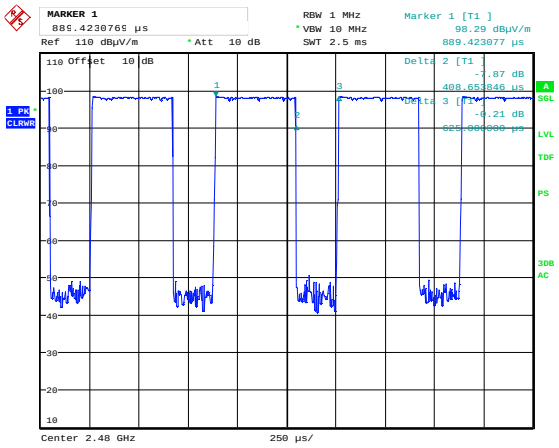
Date: 28.FEB.2023 15:34:32

Upper Band Edge, 2480 MHz, 1Mb, Peak



Date: 28.FEB.2023 15:35:54

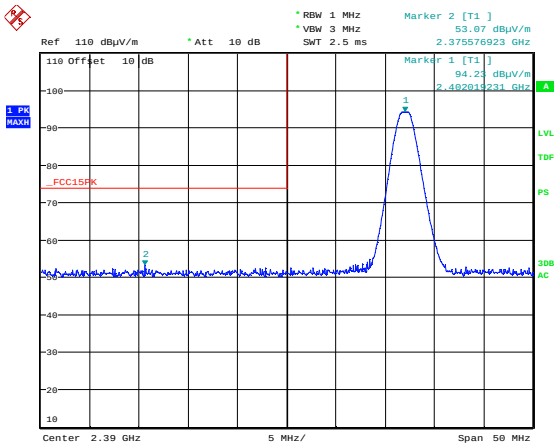
Upper Band Edge, 2480 MHz, 1Mb, Average



Date: 28.FEB.2023 15:46:17

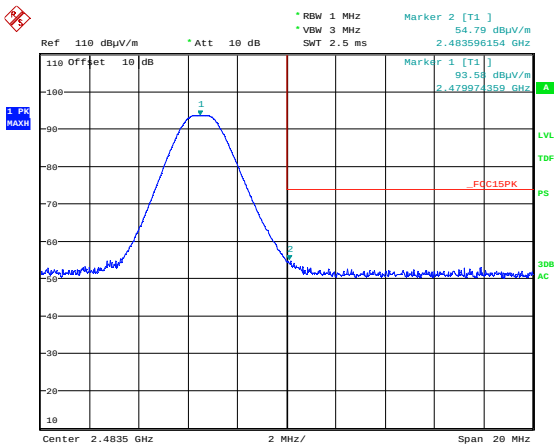
BLE, 1Mb, Duty Cycle

Whip Antenna



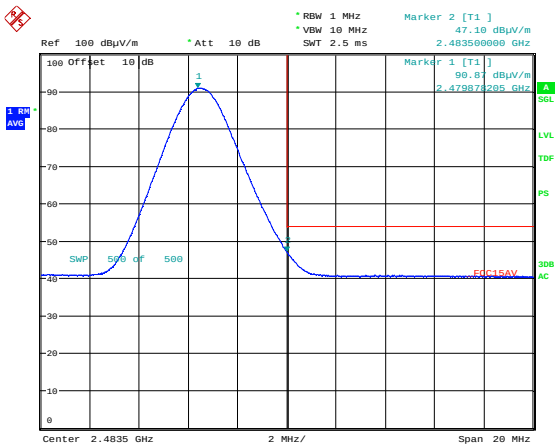
Date: 2.MAR.2023 13:04:06

Lower Band Edge, 2402 MHz, 1Mb, Peak



Date: 2.MAR.2023 13:36:12

Upper Band Edge, 2480 MHz, 1Mb, Peak



Date: 2.MAR.2023 13:38:28

Upper Band Edge, 2480 MHz, 1Mb, Peak

3.7 Radiated Emissions, 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: Quasi-Peak (Pre-scan with Peak Detector)

Measuring distance 3m.

Tested in test mode with EUT transmitting on ch19.

Measured Frequency (MHz)	Carrier Frequency (MHz)	Modulation	Measured Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30 – 88	2440	GFSK	< 30	40.0	> 10
88 – 216	2440	GFSK	40.0	43.5	3.5
216 – 960	2440	GFSK	< 36	46.0	> 10
960 – 1000	2440	GFSK	< 35	54.0	> 19
120.010	2440	GFSK	40.0	43.5	3.5

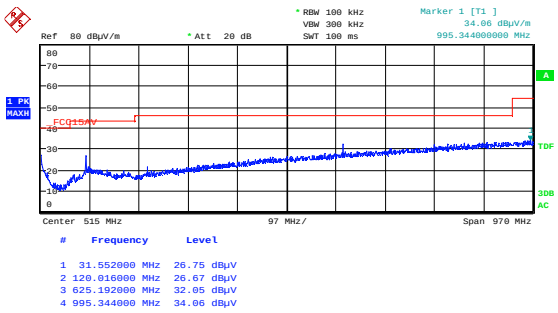
The spurious at 120.010 MHz is independent of RF signal or antenna type.

See attached plots.

Requirements/Limit

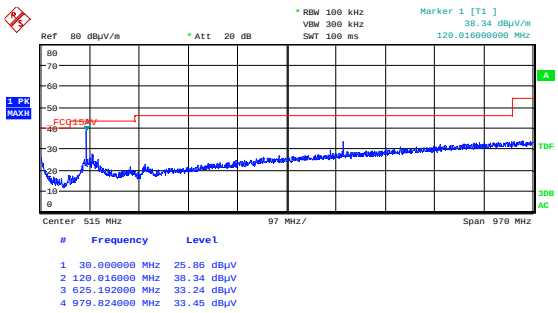
FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 µV/m	40.0 dBµV/m
88 – 216 MHz	150 µV/m	43.5 dBµV/m
216 – 960 MHz	200 µV/m	46.0 dBµV/m
960 – 1000 MHz	500 µV/m	54.0 dBµV/m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

Combi Antenna



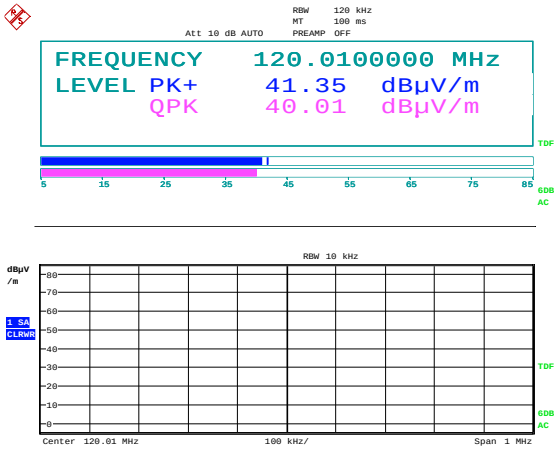
Date: 10.MAR.2023 16:17:31

Radiated Emissions 30 - 1000 MHz, 1Mb, HP



Date: 10.MAR.2023 16:15:08

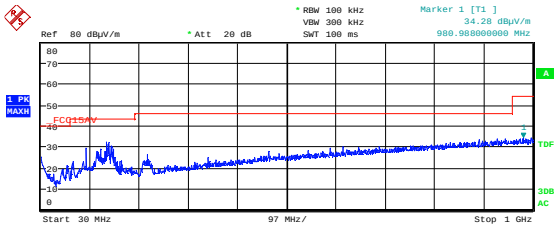
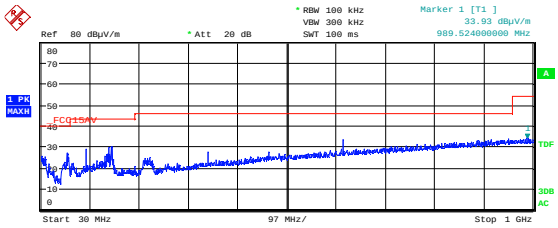
VP



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

Emission 120 MHz, 1Mb, Max: VP

Whip Antenna	


`#  Frequency  Level`
`1 30.776000 MHz 25.12 dBµV`
`2 94.408000 MHz 22.67 dBµV`
`3 120.016000 MHz 29.06 dBµV`
`4 148.728000 MHz 28.79 dBµV`
`5 160.368000 MHz 31.96 dBµV`
`6 164.636000 MHz 31.72 dBµV`
`7 168.904000 MHz 30.18 dBµV`
`8 189.856000 MHz 23.03 dBµV`
`9 239.908000 MHz 26.07 dBµV`
`10 980.988000 MHz 34.28 dBµV`
Date: 13.MAR.2023 10:32:41
	
	`#  Frequency  Level`
	`1 33.104000 MHz 25.36 dBµV`
	`2 47.072000 MHz 21.61 dBµV`
	`3 82.768000 MHz 26.71 dBµV`
	`4 120.016000 MHz 28.65 dBµV`
	`5 164.636000 MHz 29.55 dBµV`
	`6 168.904000 MHz 29.84 dBµV`
	`7 245.340000 MHz 24.70 dBµV`
	`8 359.800000 MHz 27.08 dBµV`
	`9 625.192000 MHz 33.11 dBµV`
	`10 989.524000 MHz 33.93 dBµV`
	Date: 13.MAR.2023 10:30:44

Radiated Emissions 30 - 1000 MHz, 1Mb, HP	**VP**

3.8 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 spuriouses were detected.

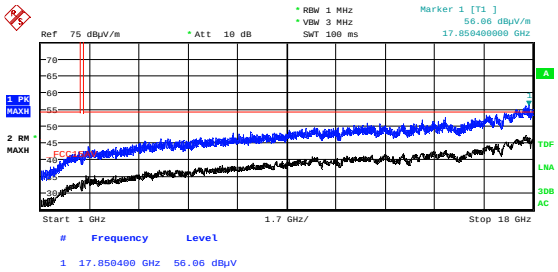
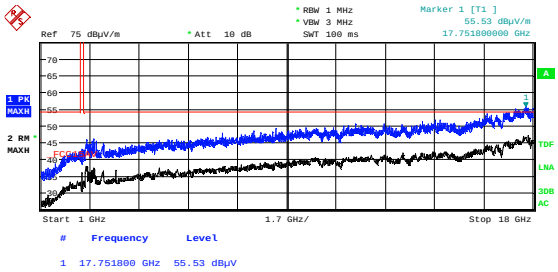
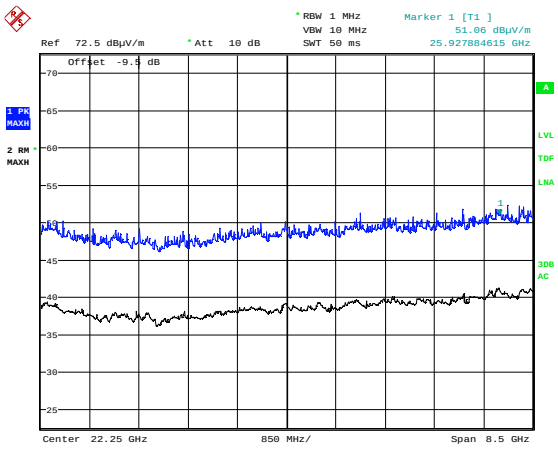
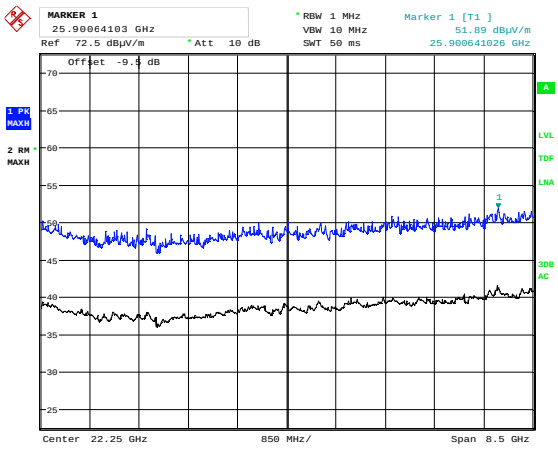
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz

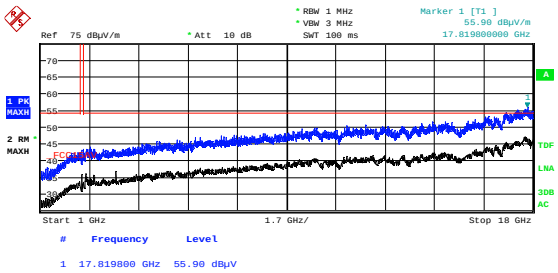
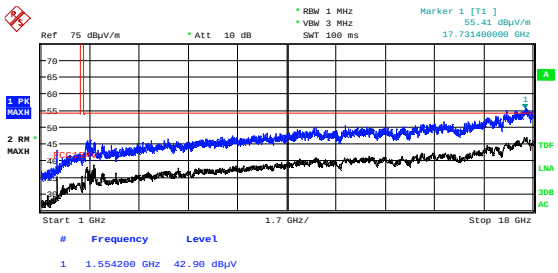
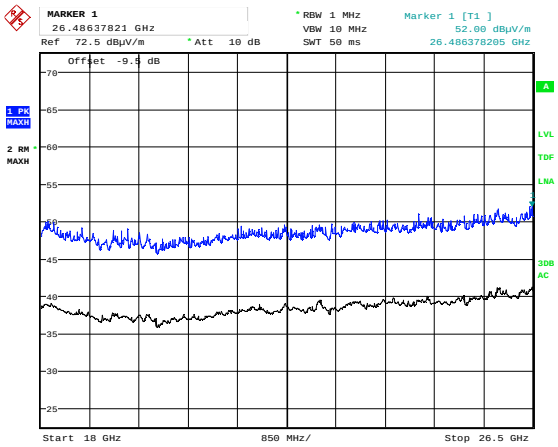
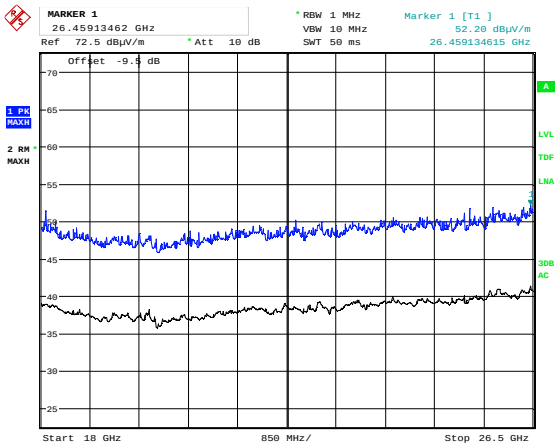
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.

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 14:51:59	 Date: 28.FEB.2023 14:49:34
Radiated Emissions 1 - 18 GHz, 2440 MHz, 1M, HP	**VP**
 Date: 14.MAR.2023 10:59:12	 Date: 14.MAR.2023 11:01:21
Emissions 18 - 26 GHz, 2440 MHz, 1M, HP, @1m	**VP**

Whip Antenna	
 Date: 2.MAR.2023 14:49:56	 Date: 2.MAR.2023 14:47:32
Radiated Emissions 1 - 18 GHz, 2440 MHz, 1M, HP	**VP**
 Date: 14.MAR.2023 16:14:05	 Date: 14.MAR.2023 16:17:16
Emissions 18 - 26 GHz, 2440 MHz, 1M, HP, @1m	**VP**

3.9 Power Spectral Density (PSD)

FCC part 15.247(d)

ISED Canada RSS-247 Issue 2, Clause 5.2 (2)

Measurement procedure: ANSI C63.10-2013 Clause 11.10

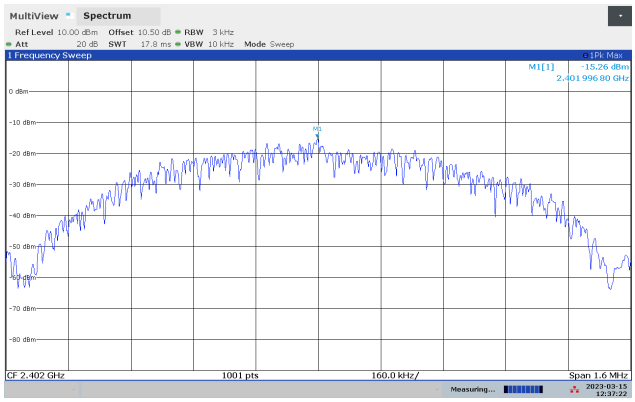
Test Results: Complies

Measurement Data:

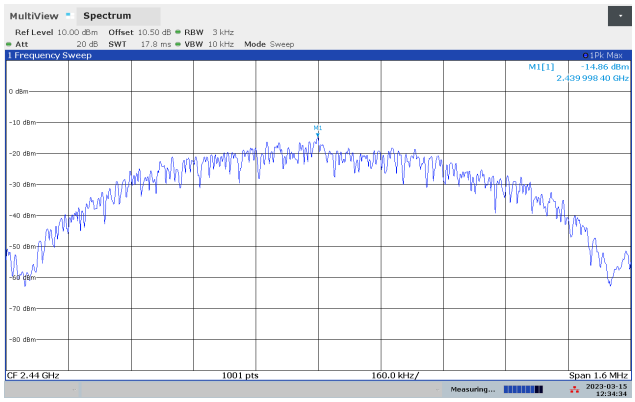
The measurement procedure PKPSD described in ANSI C63.10-2013 was used.

Modulation Type and Bitrate	Measured Power Spectral Density (dBm/3kHz)		
	2402 MHz	2440 MHz	2480 MHz
GFSK 1Mb	-15.3	-14.9	-15.0

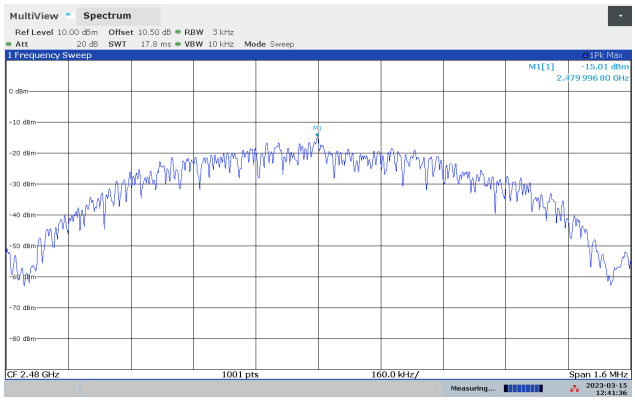
Requirement for systems using Digital Modulation
The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
No requirements for Frequency Hopping Systems.



PSD, 2402 MHz, 1Mb



PSD, 2440 MHz, 1Mb



PSD, 2480 MHz, 1Mb

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	

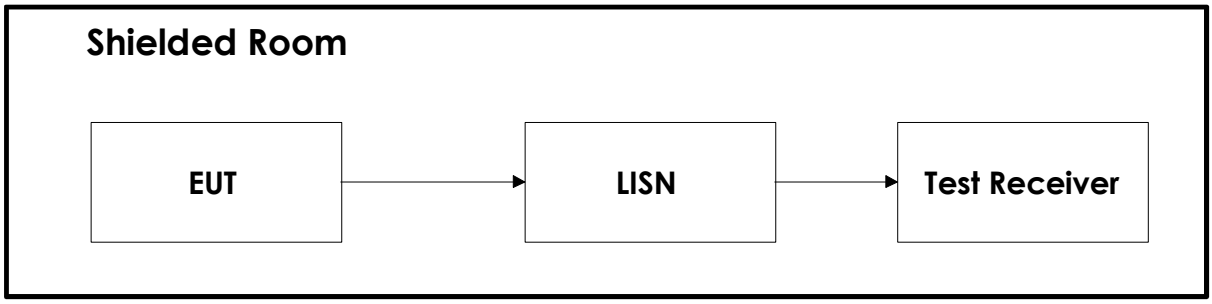
COU = Calibrate on Use

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

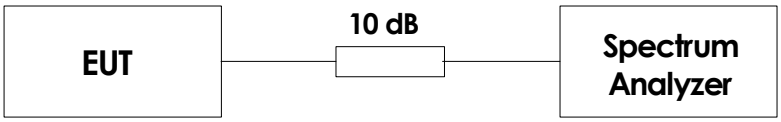
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.40	EMC test software
2	Nemko AS	RSPlot	1.0.8.0	Screen capture from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission

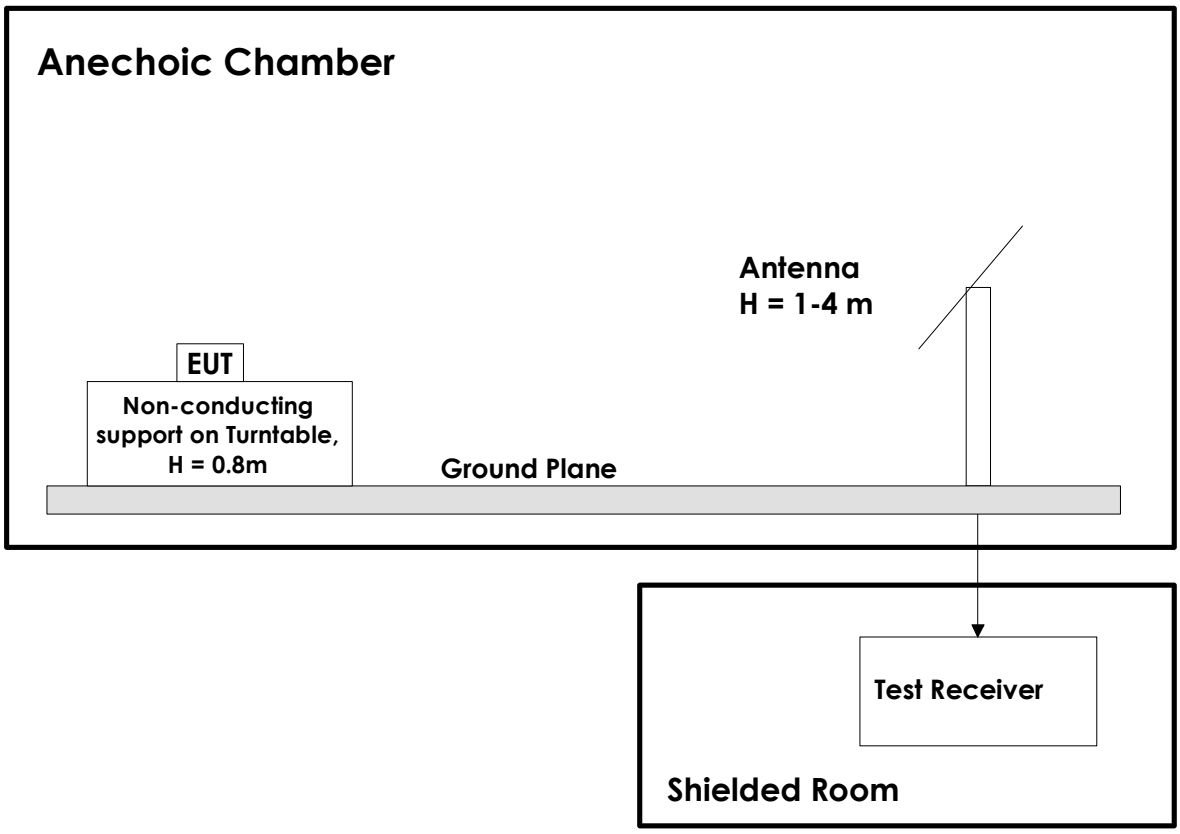


6.2 Conducted Tests



This test set-up is used for all Conducted tests.
For Frequency Stability test the EUT was placed in a climatic chamber.

6.3 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 High-Pass or Band-Pass filter is used for all harmonics.