

Test Report

Product	Display Module for DeLaval Milking Automation communication and control device
Name and address of the applicant	DeLaval International AB Gustaf DeLavals väg15 P.O Box 39 SE-14741 Tumba, SWEDEN
Name and address of the manufacturer	DeLaval International AB Gustaf DeLavals väg15 P.O Box 39 SE-14741 Tumba, SWEDEN
Model	DM223
Rating	24 VDC (from AC/DC power supply 100-240 VAC 50-60 Hz)
Trademark	DeLaval
Additional information	Bluetooth Low Energy
Tested according to	FCC Part 15.247 Frequency Hopping Transmitters / Digital Transmission Systems Industry Canada RSS-247, Issue 3 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	PRJ0022268
Tested in period	2022-02-01 to 2022-05-30
Issue date	2023-08-15
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   NORWEGIAN ACCREDITATION TEST 033 An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Jan G Eriksen]  Approved by [Frode Sveinsen]	
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Revision history

Revision	Date	Comment	Sign
A	2023-07-27	First edition	JGER

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.

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1 INFORMATION

1.1 Test Item

Name	DeLaVal
Model/version	DM223
FCC ID	UCSDM223A
ISED ID	6576A-DM223A
Serial number	Radiated: 043 and 062 Conducted: 064
Hardware identity and/or version	DM223 PCBA; 215001706101
Software identity and/or version	Thor EMC test SW suite
Frequency Range	2402 – 2480 MHz
Number of Channels	40
Operating Modes	Bluetooth Low Energy ☒ 1Mb ☐ 2Mb
Type of Modulation	GFSK (1 MBPS)
Conducted Output Power	1.5 mW
Antenna Connector	None
Number of Antennas	1
Diversity or Smart Antennas	No
Power Supply	24 VDC 100-240C AC 50/60 Hz AC/DC Converter
Desktop Charger	N/A

Description of Test Item

The tested item is a display module containing a wireless Blue Tooth Low Energy radio which uses the 2402-2480 MHz range.

This device has been tested as a Digital Transmissions Systems device (DTS) and fulfils all requirements for DTS.

1.2 Normal test condition

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	24 V DC from 115AC 60 Hz V ACDC Converter

The values are the limit registered during the test period.

1.3 Test Engineer

Jan G Eriksen

1.4 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 only integral antennas. Conducted tests were performed with a temporary antenna connector.		

Requirement: FCC 15.203, 15.204

1.5 EUT Operating Modes

Description of 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.
Additional information	-

1.6 Comments

The measurements were done with the EUT powered by 115 V AC. It was checked that power variations between 85% and 115% did not have any influence on the measurements.

All measurements were done with the EUT powered from AC via an AC/DC converter.

All ports were populated during spurious emission measurements.

2 TEST REPORT SUMMARY

2.1 General

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and ISSED 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 performed in a semi-anechoic chamber at measuring distances of 3m.

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

☒ 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 3, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	Complied
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complied
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	Complied
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complied
DTS Bandwidth	15.247(a)(2)	5.2 (a) (RSS-247)	11.8 Option 2	Complied
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complied
Power Spectral Density	15.247(e)	5.2 (b) (RSS-247)	11.10.2 PKPSD (DTS)	Complied
Spurious Emissions (Antenna Conducted)	15.247(d)	5.5 (RSS-247)	6.7 11.11 (DTS)	Complied
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)	Complied

3 TEST RESULTS

3.1 Power Line Conducted Emissions

FCC Part 15.207

ISED RSS-GEN Issue 5, Clause 7.2 / 8.8

Measurement procedure: ANSI C63.4-2014 using 50 μ H/50 ohms LISN

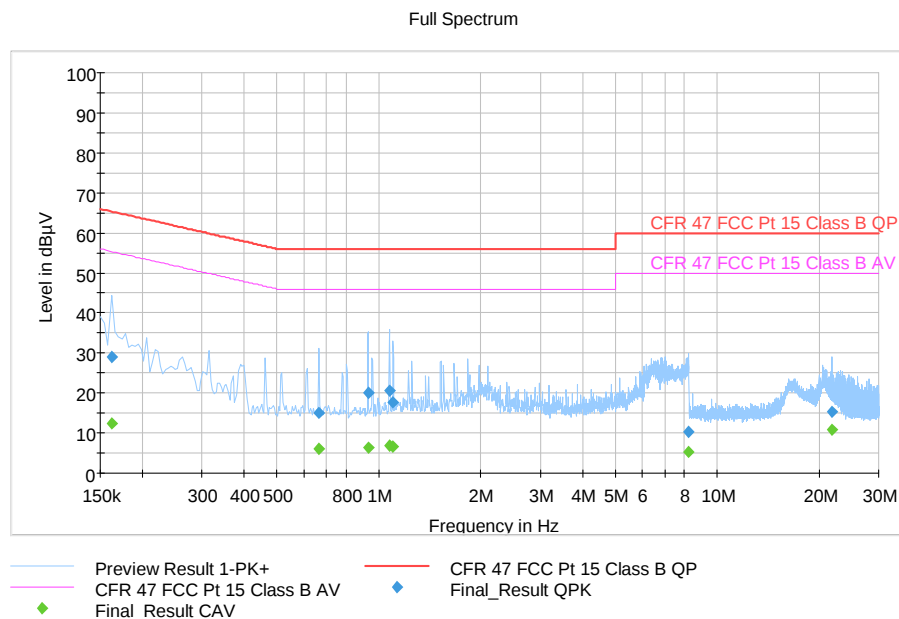
Test Results: Complies

Measurement Data: See attached plots

Highest measured value (L1 and N):

Frequency (MHz)	QuasiPeak (dB μ V)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.162000	28.94	---	65.36	36.42	15000.0	9.000	N	OFF	9.7
0.162000	---	12.43	55.36	42.93	15000.0	9.000	N	OFF	9.7
0.666000	14.98	---	56.00	41.02	15000.0	9.000	L1	OFF	9.6
0.666000	---	6.08	46.00	39.92	15000.0	9.000	L1	OFF	9.6
0.930000	20.08	---	56.00	35.92	15000.0	9.000	N	OFF	9.5
0.930000	---	6.43	46.00	39.57	15000.0	9.000	N	OFF	9.5
1.074000	20.57	---	56.00	35.43	15000.0	9.000	L1	OFF	9.7
1.074000	---	6.94	46.00	39.06	15000.0	9.000	L1	OFF	9.7
1.102000	17.69	---	56.00	38.31	15000.0	9.000	L1	OFF	9.7
1.102000	---	6.59	46.00	39.41	15000.0	9.000	L1	OFF	9.7
8.238000	10.25	---	60.00	49.75	15000.0	9.000	L1	OFF	9.8
8.238000	---	5.25	50.00	44.75	15000.0	9.000	L1	OFF	9.8
21.906000	---	10.74	50.00	39.26	15000.0	9.000	N	OFF	9.8
21.906000	15.24	---	60.00	44.76	15000.0	9.000	N	OFF	9.8

Tested with Power Supply delivered by customer (Delta Electronics DRP-24V100W1NN, SN D124100NNI 19020193, Rev 01) and Multimeter (LR-1597)



Power line conducted emissions spectrum

3.2 Occupied Bandwidth (99% BW)

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.2

Test method: Conducted

Test Results: Complies

Measurement Data:

Carrier Frequency, Data Rate 1MBps	Occupied Bandwidth (99% BW)
2402	1086.175
2442	1094.614
2480	1107.864

Occupied Bandwidth is the similar for all channels

See attached plots

Requirements:

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



2402 MHz 99% Occupied BW



2480 MHz 99% Occupied BW



2442 MHz 99% Occupied BW

3.3 DTS Bandwidth

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 3, Clause 5.2 (a)

Measurement procedure: ANSI C63.10-2013 Clause 11.8

Test method: Conducted

Test Results: Complies

Measurement Data:

Modulation type and bitrate	Measured DTS Bandwidth (kHz)		
	2402 MHz	2442 MHz	2480 MHz
GFSK 1 Mbps	744.3	751.7	746.8

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, 2442 MHz, 1M



DTS BW, 2480 MHz, 1M

3.4 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 method: Conducted/Radiated

Test Results: Complies

Measurement Data GFSK (1MBPS):

Carrier Frequency	Peak Conducted Power, dBm	Peak Radiated Field Strength, dBuV/m @ 3 meter		Calculated EIRP dBm	Calculated antenna gain dBi
	(1MHz RBW)	HP	VP	*)	
2402 MHz	0.85	83.9	89.4	-5.8	-6.7
2442 MHz	1.24	85.4	91.2	-4.0	-5.3
2480 MHz	1.5	87.0	91.5	-3.7	-5.2

Note: *) Maximum field strength (VP) used

Output Power reported is Maximum Peak Power.

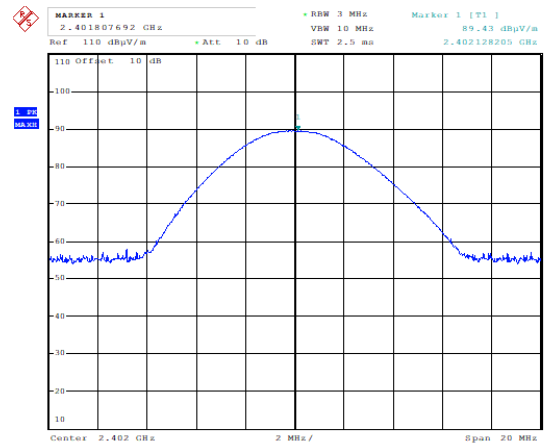
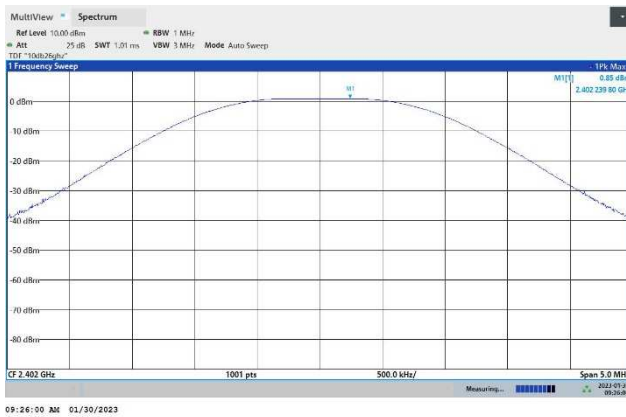
The Integrated Band Power Method was used to measure Output Power

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

Antenna Gain is less than 6 dBi.

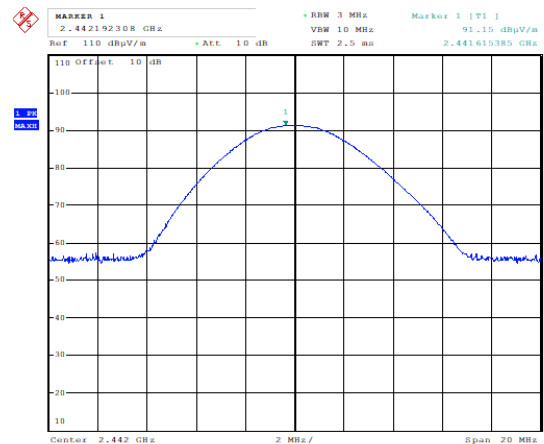
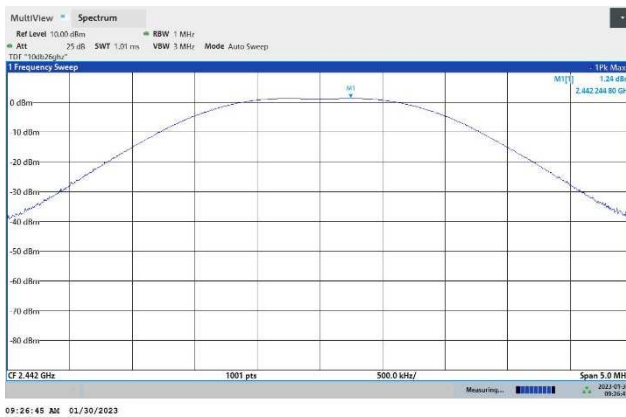
See attached plots.

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 <i>maximum conducted output power</i> 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.



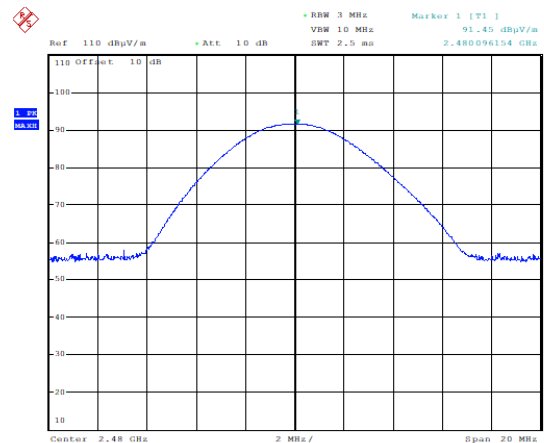
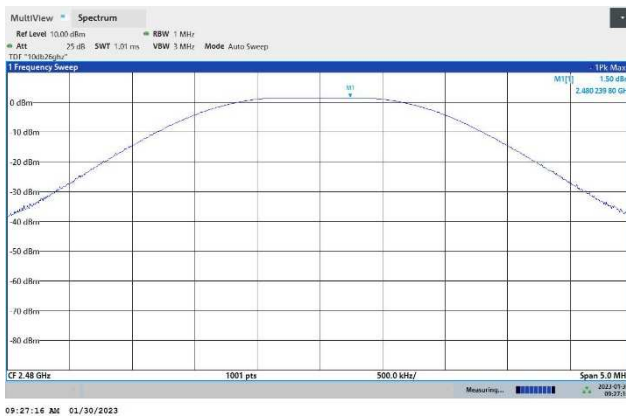
Date: 29.MAR.2023 13:50:59

Conducted Peak Power, 2402 MHz, 1MBPS



Date: 29.MAR.2023 13:49:57

Conducted Peak Power, 2442 MHz, 1Mb



Date: 29.MAR.2023 13:32:42

Conducted Peak Power, 2480 MHz, 1Mb

3.5 Power Spectral Density (PSD)

FCC part 15.247(e)

ISED Canada RSS-247 Issue 3, Clause 5.2 (b)

Measurement procedure: ANSI C63.10-2013 Clause 11.10

Test method: Conducted

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	2442 MHz	2480 MHz
GFSK 1Mb	-15.75	-15.48	-15.18

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.



PSD, 2402 MHz, 1Mb



PSD, 2442 MHz, 1Mb



PSD, 2480 MHz, 1Mb

3.6 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 method: Conducted

Test Results: Complies

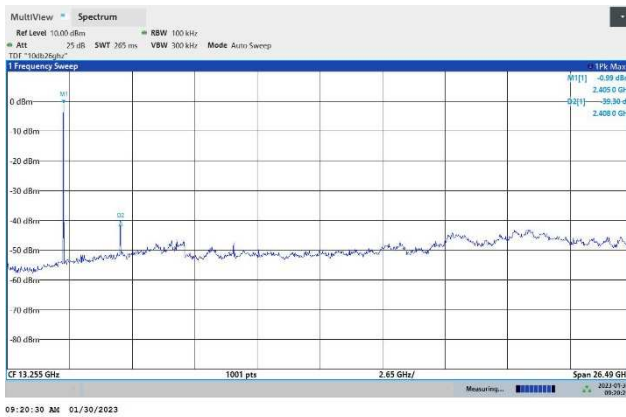
Measurement Data:

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2402 MHz	> 35	> 5	Pass
2442 MHz	> 35	> 5	Pass
2480 MHz	> 35	> 5	Pass

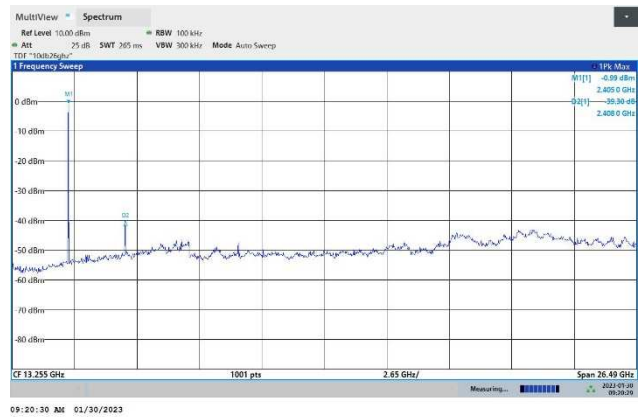
Measured with Peak Detector

RF conducted power to 25 GHz: see attached plots.

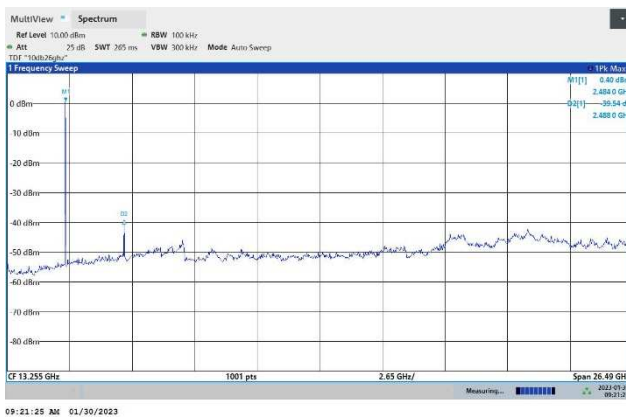
Requirements for all systems	
Peak measurement	RMS averaging (alternative measurement)
20 dB or more below carrier measured in 100 kHz bandwidth	30 dB or more below carrier measured in 100 kHz bandwidth
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated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



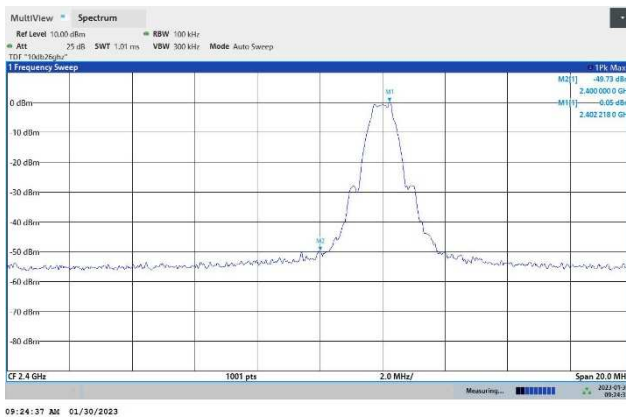
TX 2402: 10 – 26000 MHz



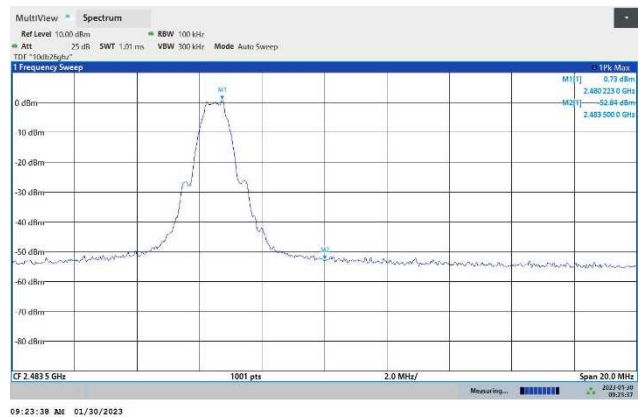
TX 2442: 10 – 26000 MHz



TX 2480: 10 – 26000 MHz



TX 2402: Lower Band Edge



TX 2480: Upper Band Edge

3.7 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED 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 ISSED, all other frequencies are common.

3.8 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 method: Radiated

Test Results: Complies

Measurement Data:

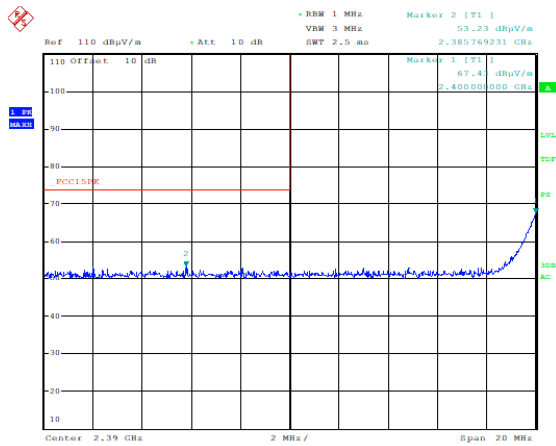
Peak Detector					
Modulation and Bitrate	Measured field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB	dB	
GFSK, 1Mb	53.23	55.12	74	20.77	18.88

Average Detector					
Modulation and Bitrate	Measured *) field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB	dB	
GFSK, 1Mb	41.23	43.12	54	12.77	10.88

*) Calculated value based on DC factor given by manufacturer.

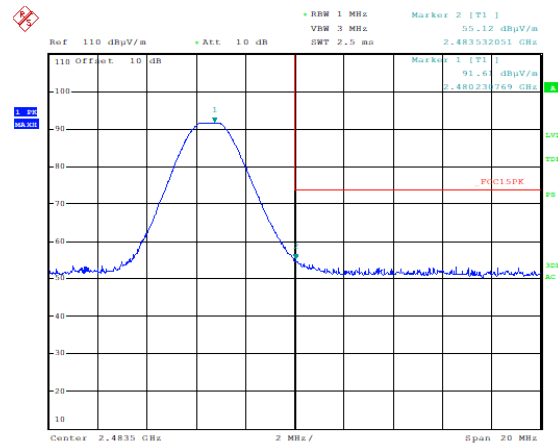
Average values were calculated using Duty Cycle information given by the manufacturer (Duty Cycle ≈25%) – resulting in an Duty Cycle Correction Factor of $20 \cdot \log(0.25) = -12.0$ dB

See attached plots.



Date: 29.MAR.2023 13:09:59

Lower Band Edge, 2402 MHz, 1Mb, Peak



Date: 29.MAR.2023 13:16:50

Upper Band Edge, 2480 MHz, 1Mb, Peak

3.9 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

Measuring distance 3 m

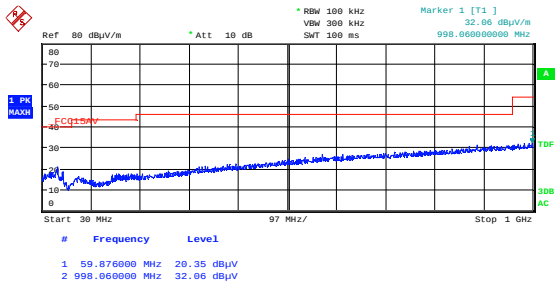
Tested in test mode with EUT transmitting on 2402, 2442, and 2480 MHz respectively.

Measured Frequency (MHz)	Carrier Frequency (MHz)	Modulation	Measured Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
30 – 88	2402 / 2442 / 2480	GFSK	< 25	40.0	> 15
88 – 216	2402 / 2442 / 2480	GFSK	< 20	43.5	> 13.5
216 – 960	2402 / 2442 / 2480	GFSK	< 35	46.0	> 11
960 – 1000	2402 / 2442 / 2480	GFSK	< 35	54.0	> 19

See attached plots

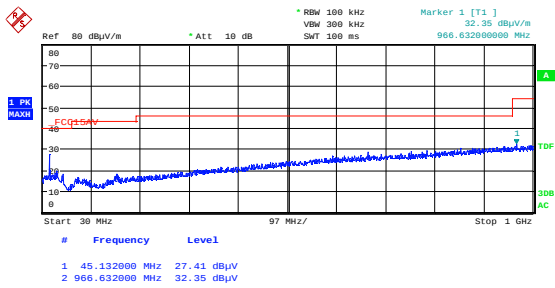
Requirements/Limit

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 μ V/m	40.0 dB μ V/m
88 – 216 MHz	150 μ V/m	43.5 dB μ V/m
216 – 960 MHz	200 μ V/m	46.0 dB μ V/m
960 – 1000 MHz	500 μ V/m	54.0 dB μ V/m
	Limits above are with Quasi Peak Detector	



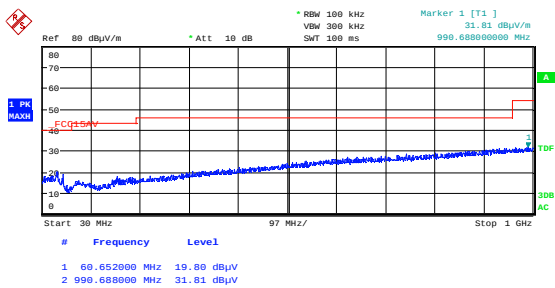
Date: 31.MAR.2023 09:30:44

TX 2402 MHz: Radiated Emissions 30 – 1000 MHz, VP



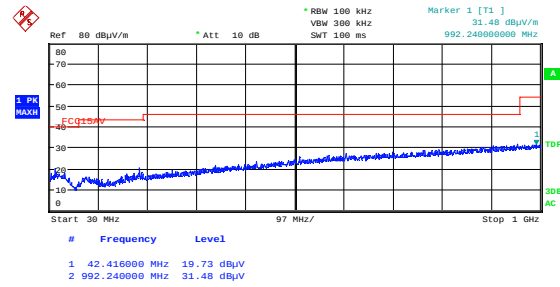
Date: 31.MAR.2023 09:25:10

TX 2442 MHz: Radiated Emissions 30 – 1000 MHz, VP



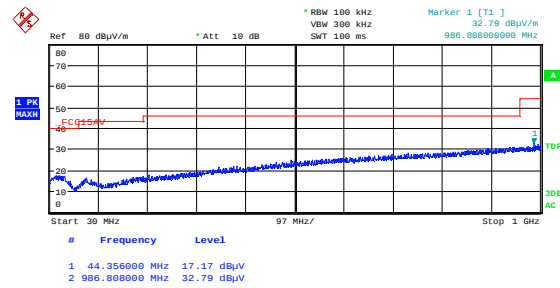
Date: 31.MAR.2023 09:38:48

TX 2480 MHz: Radiated Emissions 30 – 1000 MHz, VP



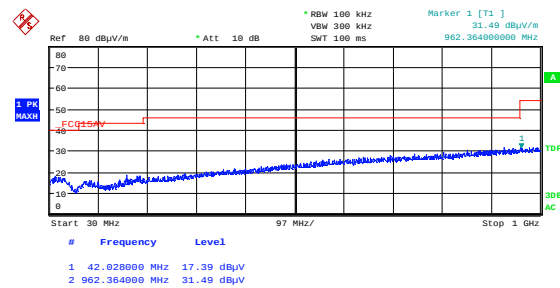
Date: 31.MAR.2023 09:32:40

TX 2402 MHz: Radiated Emissions 30 – 1000 MHz, HP



Date: 31.MAR.2023 09:27:06

TX 2442 MHz: Radiated Emissions 30 – 1000 MHz, HP



Date: 31.MAR.2023 09:40:44

TX 2480 MHz: Radiated Emissions 30 – 1000 MHz, HP

3.10 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 method: Radiated

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)

A pre-scan was performed above 18 GHz and no spurious emissions were detected.

RBW=1 MHz

Carrier Frequency (MHz)	Measured Frequency (GHz)	Mode	Measured Emissions (dBμV/m)		Limit (dBμV/m)		Margin (dB)	
			Peak	Average *)	Pk	Av	Pk	Av
2402	4804	GFSK	61.4	49.4	74	54	12.6	4.6
2442	4884	GFSK	62.0	50.0	74	54	12.0	4.0
2480	4960	GFSK	60.6	48.6	74	54	13.4	5.4
2442	7326	GFSK	53.8	41.8	74	54	20.2	12.2
2480	4804	GFSK	56.7	44.7	74	54	17.3	9.3
2402 / 2442 / 2480	Other freqs 1000 - 18000	GFSK	< 56	< 44	74	54	> 18	> 36
2402 / 2442 / 2480	18000-26000	GFSK	< 66 **)	< 54 **)	74	54	> 8	> 0

*) Calculated using a Duty Cycle value of 25% as given by manufacturer.

**) Measured at 1 meter distance, -9.5 dB to be added to the measured levels – see plots below.

Average values were calculated using Duty Cycle information given by the manufacturer (Duty Cycle ≈25%) – resulting in an Duty Cycle Correction Factor of $20 \cdot \log(0.25) = -12.0$ dB.

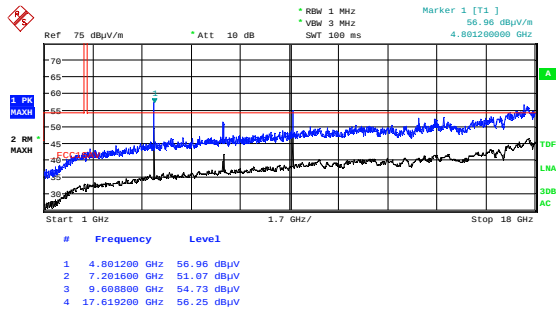
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz

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

See plots.

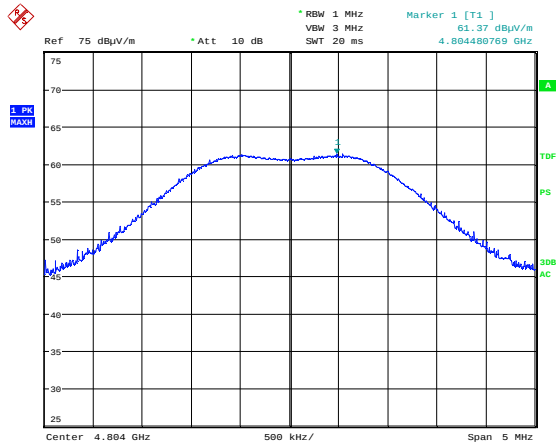
Requirements/Limit

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



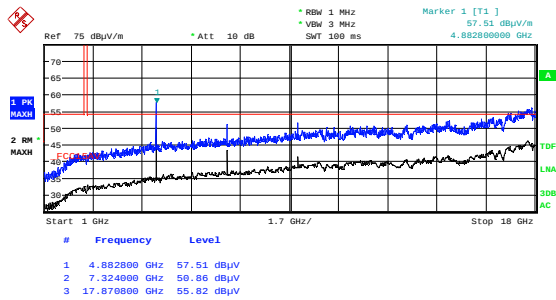
Date: 29.MAR.2023 11:06:28

2402 MHz: Radiated Emissions 1 - 18 GHz XY-plane, VP



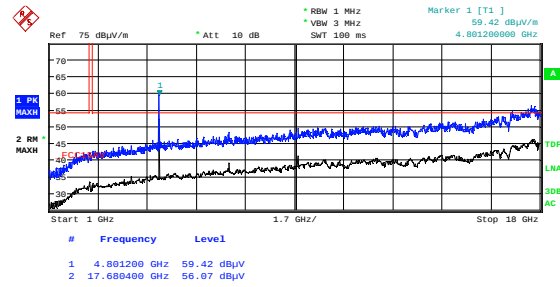
Date: 29.MAR.2023 12:47:37

2402 MHz: 2nd harmonics VP



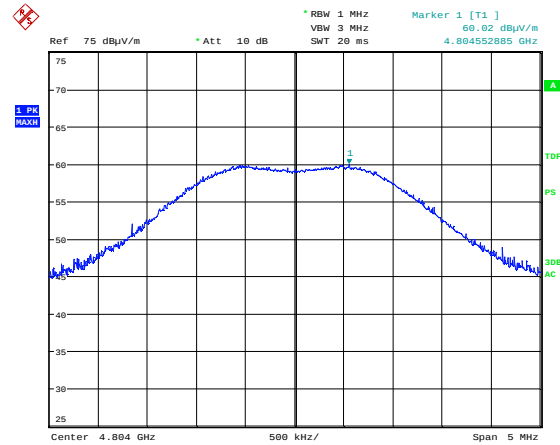
Date: 29.MAR.2023 11:22:36

2442 MHz: Radiated Emissions 1 - 18 GHz XY-plane, VP



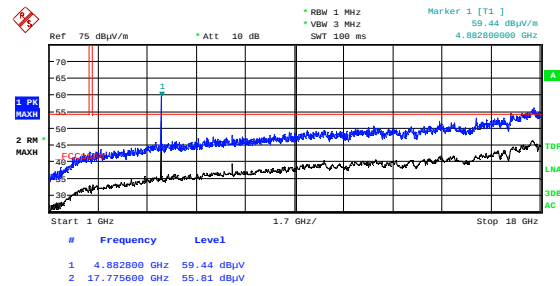
Date: 29.MAR.2023 11:08:19

2402 MHz: Radiated Emissions 1 - 18 GHz XY-plane, HP



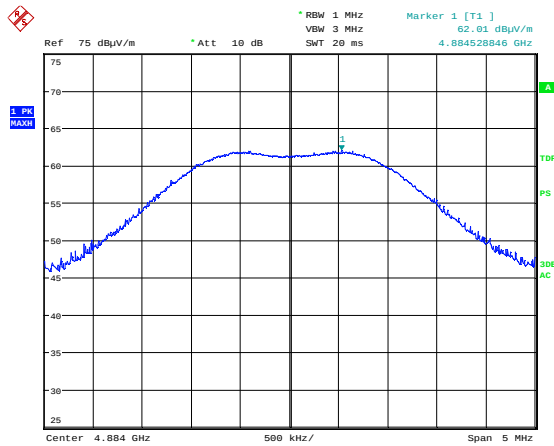
Date: 29.MAR.2023 12:45:19

2402 MHz: 2nd harmonics HP



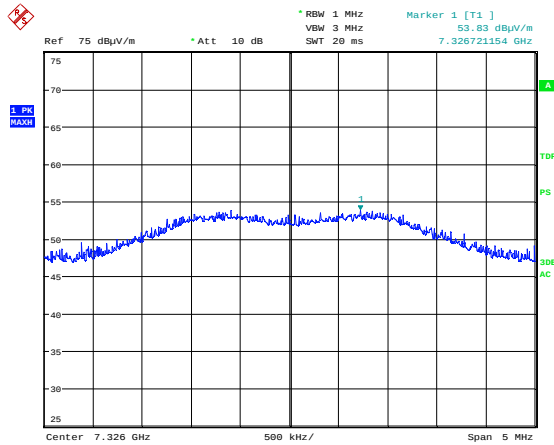
Date: 29.MAR.2023 11:24:27

2442 MHz: Radiated Emissions 1 - 18 GHz XY-plane, HP



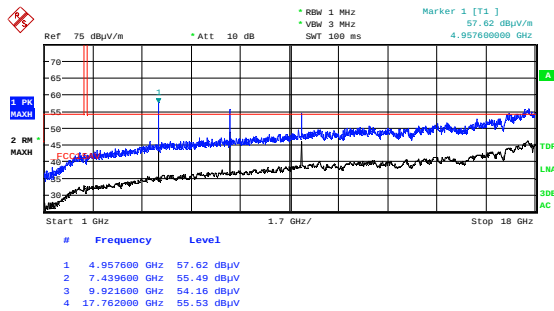
Date: 29.MAR.2023 12:00:33

2442 MHz: 2nd harmonics VP



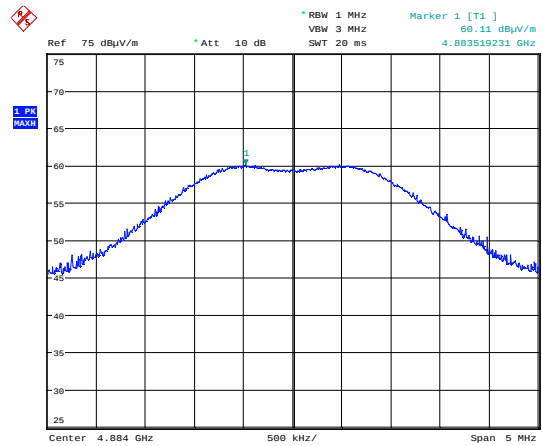
Date: 29.MAR.2023 12:15:29

2442 MHz: 3rd harmonics VP



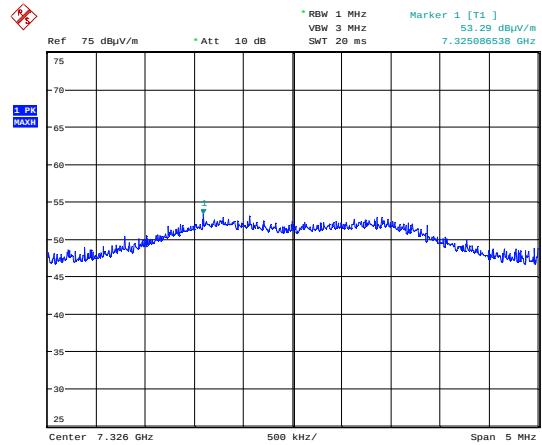
Date: 29.MAR.2023 10:48:02

2480 MHz: Radiated Emissions 1 – 18 GHz XY-plane, VP



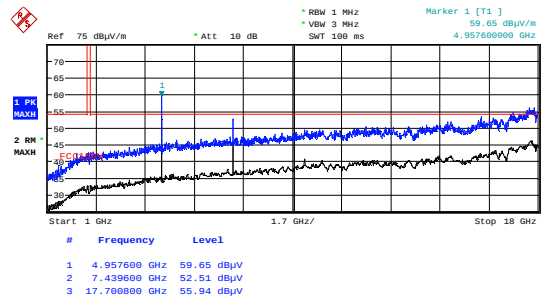
Date: 29.MAR.2023 12:02:37

2442 MHz: 2nd harmonics HP



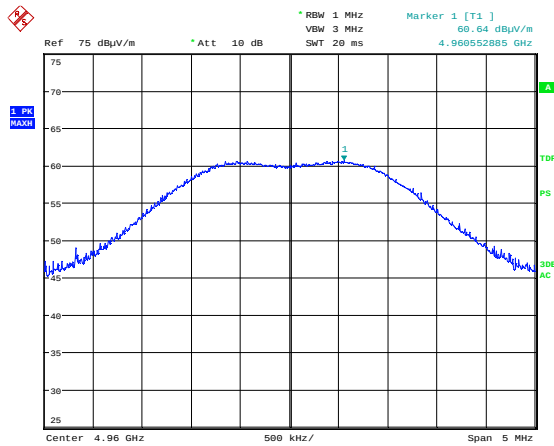
Date: 29.MAR.2023 12:17:23

2442 MHz: 3rd harmonics HP



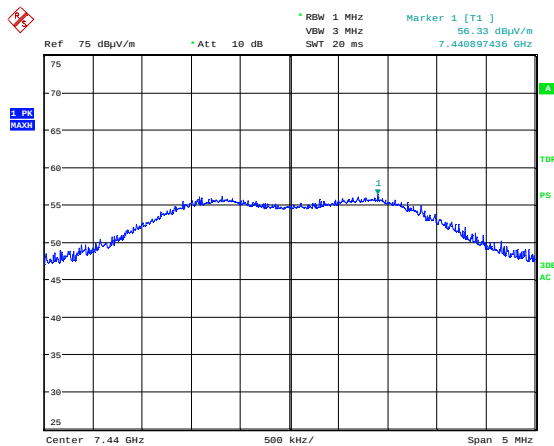
Date: 29.MAR.2023 10:49:52

2480 MHz: Radiated Emissions 1 – 18 GHz XY-plane, HP



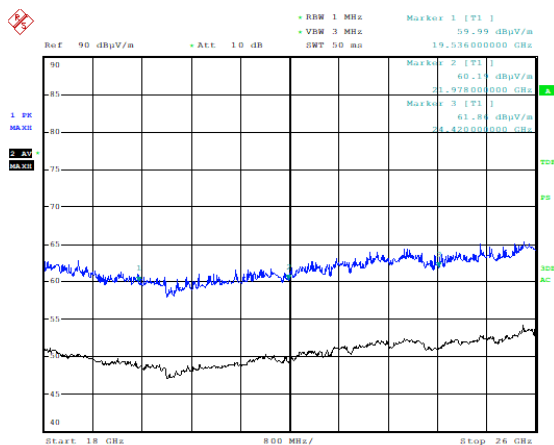
Date: 29.MAR.2023 12:25:42

2480 MHz: 2nd harmonics VP



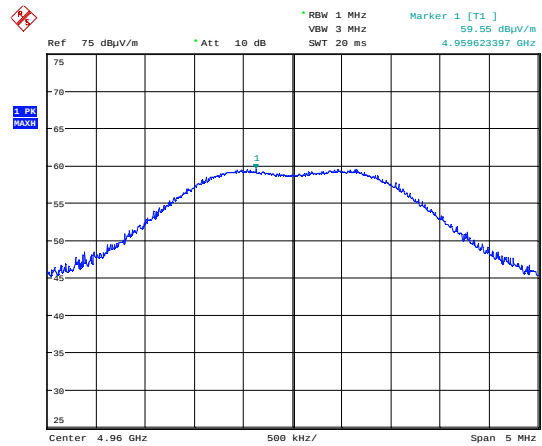
Date: 29.MAR.2023 12:35:51

2480 MHz: 3rd harmonics VP



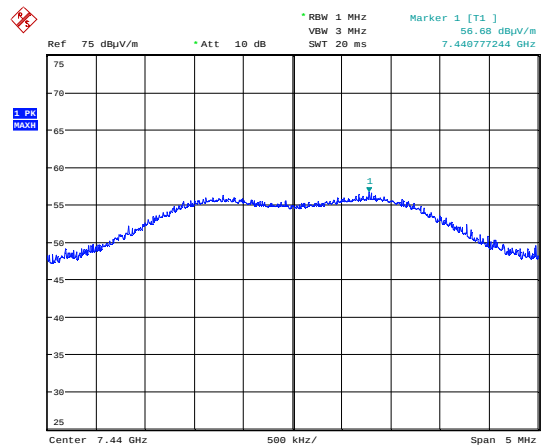
Date: 8.MAY.2023 06:36:07

2402 MHz: Radiated Emissions 18 – 26 GHz XY-plane, VPHP
1 meter measurement distance, -9.5 dB correction to be added



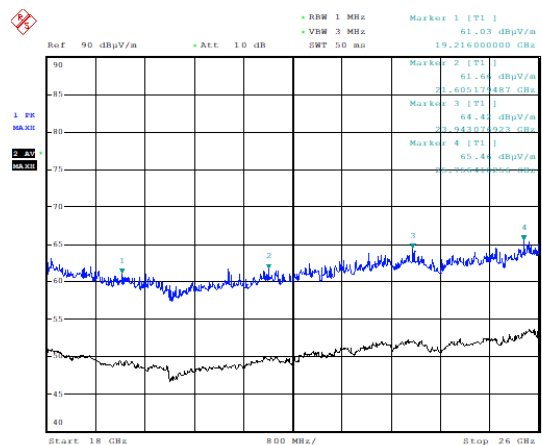
Date: 29.MAR.2023 12:27:48

2480 MHz: 2nd harmonics HP



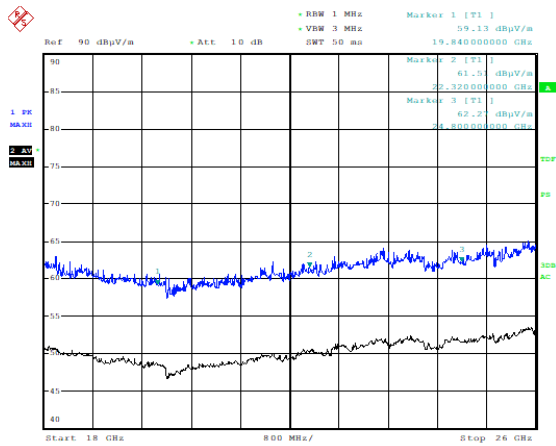
Date: 29.MAR.2023 12:37:56

2480 MHz: 3rd harmonics HP



Date: 8.MAY.2023 06:38:32

2442 MHz: Radiated Emissions 18 – 26 GHz XY-plane, VPHP
1 meter measurement distance, -9.5 dB correction to be added



Date: 9.MAY.2023 06:40:50

2480 MHz: Radiated Emissions 18 – 26 GHz XY-plane, VPHP
1 meter measurement distance, -9.5 dB correction to be added

3.11 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

4 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.

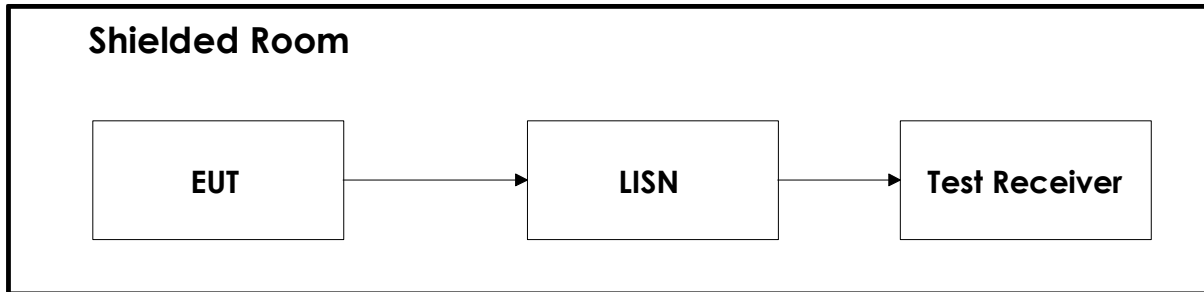
No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2023-02	2024-02
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2023-02	2024-02
3	6810.17B	Attenuator	Suhner	LR 1669	2022-08	2023-08
4	6HC1500/18000	Highpass Filter	Trilithic	LR 1612	COU	
5	JB3	BiLog Antenna	Sunol Sciences	N-4525	2023-04	2025-04
6	310	Preamplifier	Sonoma	LR 1686	2023-01	2024-01
7	3115	Horn Antenna	EMCO	LR 1330	2022-11	2027-11
8	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2023-02	2024-02
9	638	Horn antenna	Narda	LR 1480	2017-06	2023-06
10	Utiflex	Microwave cables 26GHz	Rosenberg	LR1565, 67	COU	
11	CPX 400S	Power Supply	Aim TTI	LR 1711	NA	NA
12	87 V	Multimeter	Fluke	LR-1597	2023-04	2025-04

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

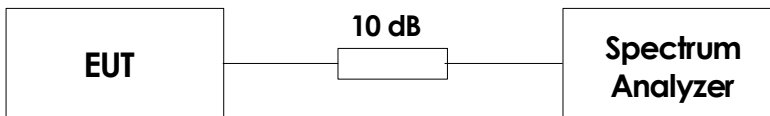
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.40	EMC test software
2	Rohde & Schwarz	GPBShot	2.7	Screenshots from R&S Spectrum Analyzers

5 BLOCK DIAGRAM

5.1 Power Line Conducted Emission

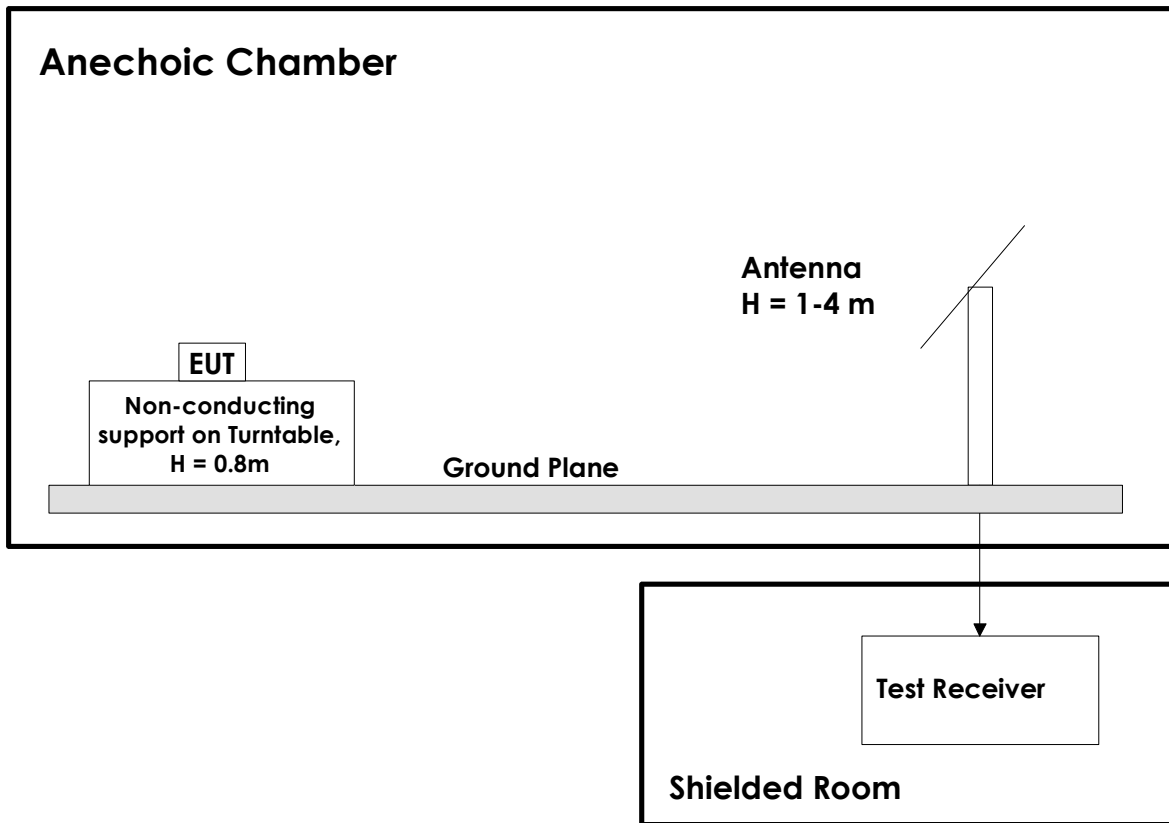


5.2 Conducted Tests



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

5.3 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.