

Test Report

Product	Tool Recognition Module with Bluetooth LE Transceiver		
Name and address of the applicant	SVAB Hydraulik AB Ulvsättersgatan 2 69491 Hallsberg, Sweden		
Name and address of the manufacturer	SVAB Hydraulik AB Ulvsättersgatan 2 69491 Hallsberg, Sweden		
Model	Quantum TRM		
Rating	3.6V _{DC}		
Trademark	SVAB		
Serial number	/		
Additional information	Bluetooth Low Energy		
Tested according to	FCC Part 15.249 Low Power Device Industry Canada RSS-210, Issue 10 Licence-Exempt Radio Apparatus: Category I Equipment		
Order number	371810		
Tested in period	2019-07-23 to 2019-07-23		
Issue date	2020-12-18		
Name and address of the testing laboratory	 Instituttveien 6 Kjeller, Norway CAB Number: FCC: NO0001 ISED: NO0470   An accredited technical test executed under the Norwegian accreditation scheme		
 Prepared by [Frode Sveinsen]  Approved by [G.Suhanthakumar]			
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1 INFORMATION

1.1 Test Item

Name	SVAB Hydraulik
FCC ID	2AUTR-966
ISED ID	25895-966
Model/version	Quantum TRM
Serial number	N/A
Hardware identity and/or version	2.5.0
Software identity and/or version	2.1.1
Frequency Range	2402–2480 MHz
Number of Channels	40
Operating Modes	Bluetooth Low Energy
Type of Modulation	Digital (Gaussian Frequency Shift Keying)
Conducted Output Power	0.77 mW (Peak)
Antenna Connector	None
Number of Antennas	1
Antenna Diversity Supported	No
Power Supply	Primary Battery (3.6V AA Lithium Cell)

Description of Test Item

The tested device is a BT Low Energy Tool Recognition Module.

Description	Brand	Model	Regulatory Information
Bluetooth Controller	Texas Instruments	Dual-Mode Bluetooth Controller	N/A

1.2 Normal test condition

Temperature:	20–25 °C
Relative humidity	20–50 %
Normal test voltage	3.6 V _{DC} (Nominal BatteryVoltage)

All tests were performed with the EUT powered from a new battery.

Values above are the limit registered during the test period.

1.3 Test Engineer

Frode Sveinsen

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 with a temporary antenna connector.		

Requirement: FCC 15.203, 15.204

1.5 Test configuration

The EUT was programmed from a computer with the Texas Instruments SmartRF Studio software via a USB interface and the TI test-jig.

The EUT was programmed to transmit continuously with GFSK modulation on the selected channel during all tests.

All tests were performed with Maximum Output Power selected.

1.6 Comments

All tested parameters are passed.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.249 and Industry Canada RSS-210 Issue 9 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 of 3m.

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

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

DXT Equipment Code

☐ Family Listing



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

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

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2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 Issue 10, RSS-GEN Issue 5 reference	Test Method ANSI C63.10-2013 Reference	Result
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complies
Field Strength of Fundamental	15.249(a)(c)(e)	B.10(a) (RSS-210)	6.6	Complies
Spurious Emissions (Radiated)	15.249(a)(c)(d)(e) 15.209(a)	B.10(a)(b) (RSS-210) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6 6.10.5	Complies

¹ The EUT is powered from a primary battery

Revision history

Revision	Date	Comment	Sign
00	2020-08-21	First edition	FS
01	2020-11-26	Added Test Configuration Information	FS
02	2020-12-18	Updated test configuration info	FS

3 TEST RESULTS

3.1 Occupied Bandwidth (99% BW)

ISED Canada RSS-GEN Issue 5, Clause 6.7

Test Results: Complies

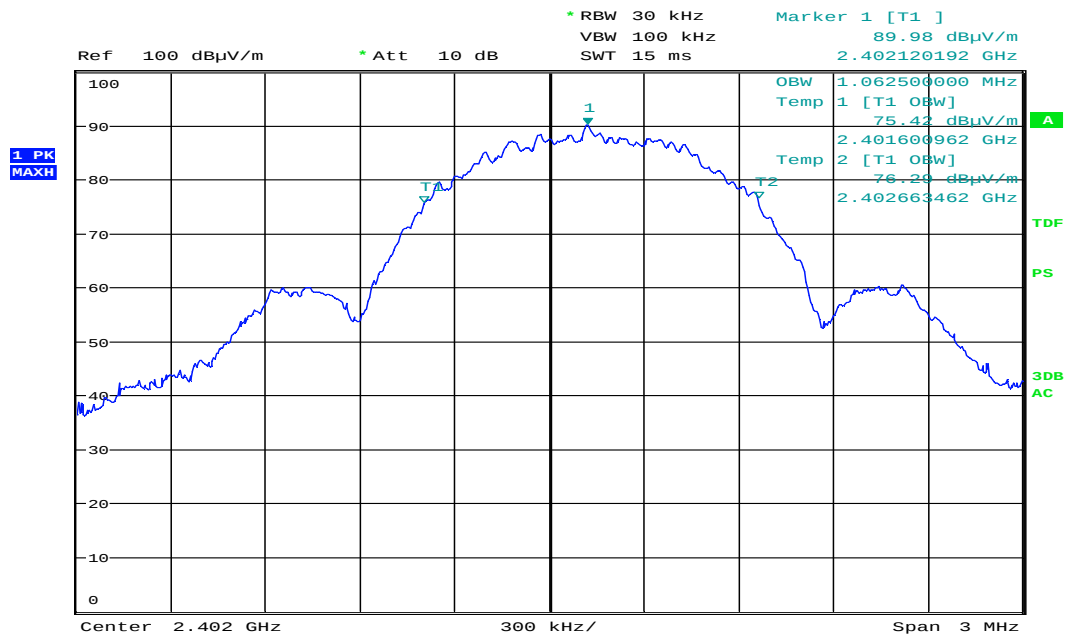
Measurement Data:

Carrier Frequency	Occupied Bandwidth (99% BW)
2402 MHz	1.06 MHz
2440 MHz	1.07 MHz
2480 MHz	1.06 MHz

See attached plots.

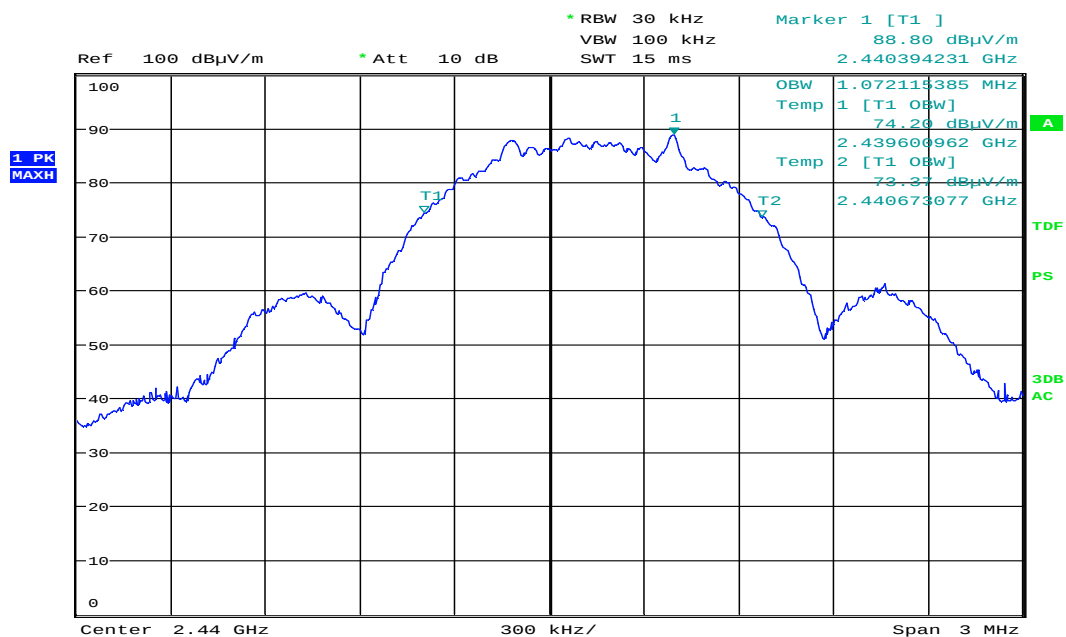
Requirements:

No limit specified.



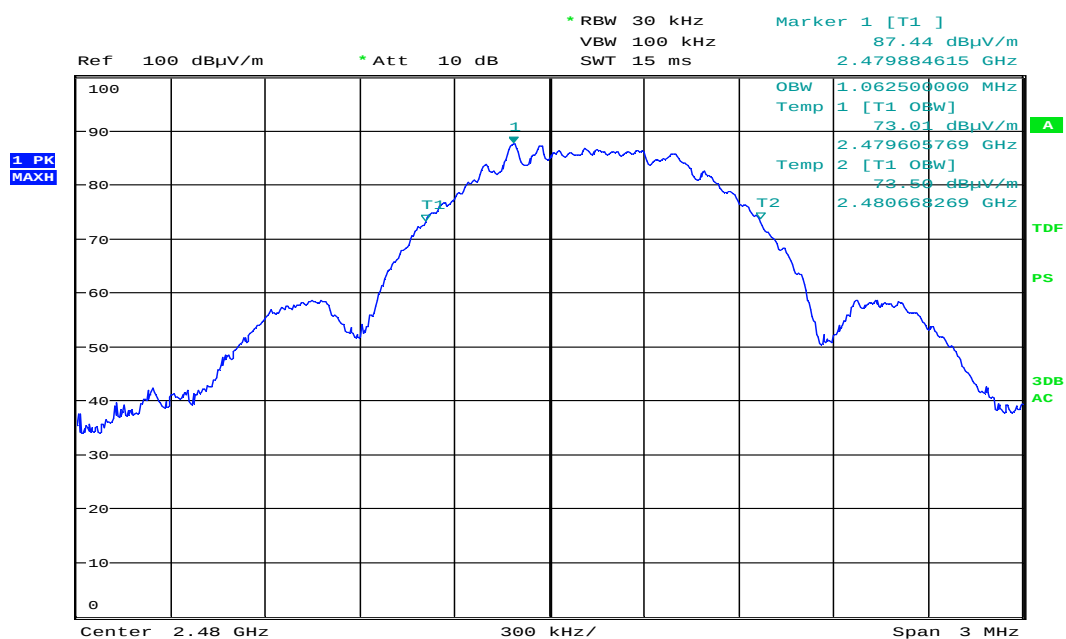
Date: 23.JUL.2019 10:40:26

Occupied Bandwidth, 99%, 2402 MHz



Date: 23.JUL.2019 10:43:51

Occupied Bandwidth, 99%, 2440 MHz



Date: 23.JUL.2019 10:46:21

Occupied Bandwidth, 99%, 2480 MHz

3.2 Field Strength of Fundamental

FCC 15.249 (a)(c)(e)

ISED Canada RSS-210 Issue 10, B.10(a)

Test Results: Complies

Measurement Data:

Maximum Field Strength @3m, Max Power			
	2402 MHz	2440 MHz	2480 MHz
Peak Field Strength (dB μ V/m)	94.1	93.2	92.9
Average Field Strength (dB μ V/m)	74.1	73.2	72.9
Calculated Peak EIRP (mW)	0.77	0.63	0.58
Limit, Average Field Strength	94 dB μ V/m		

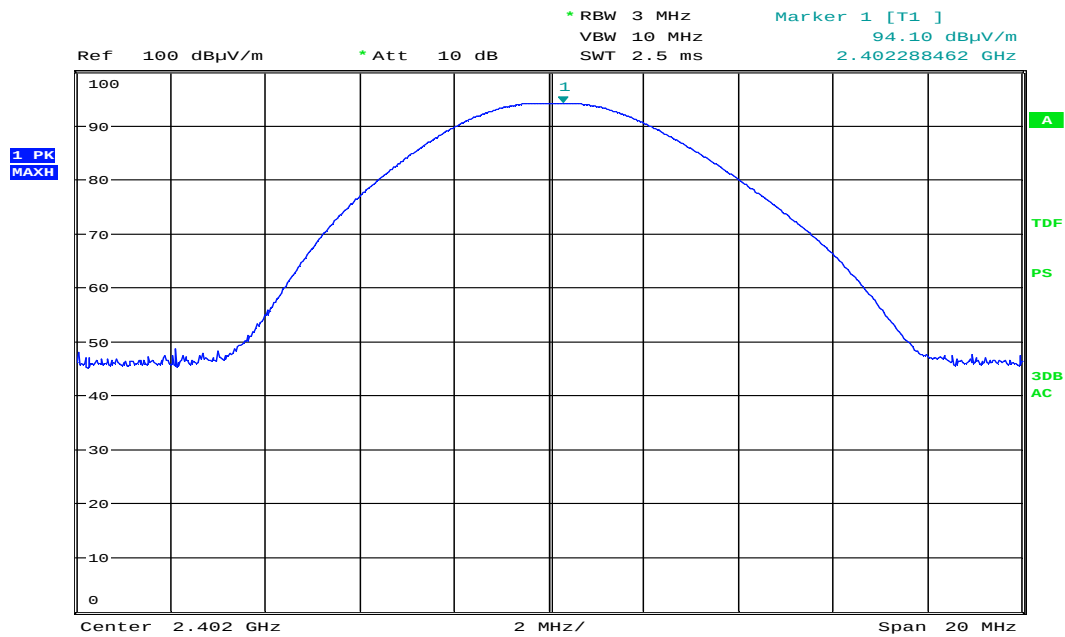
Field Strength reported is Maximum Field Strength.

See attached plots.

Requirements:

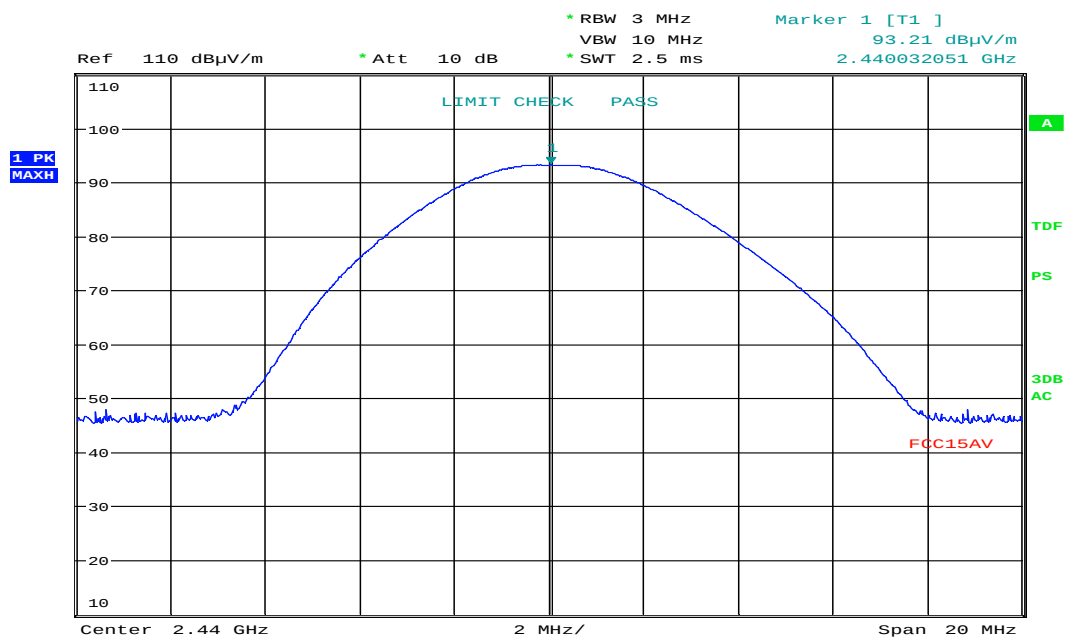
The field strength of fundamental, measured at 3 m, shall not exceed 50 mV/m (94 dB μ V/m).

The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.



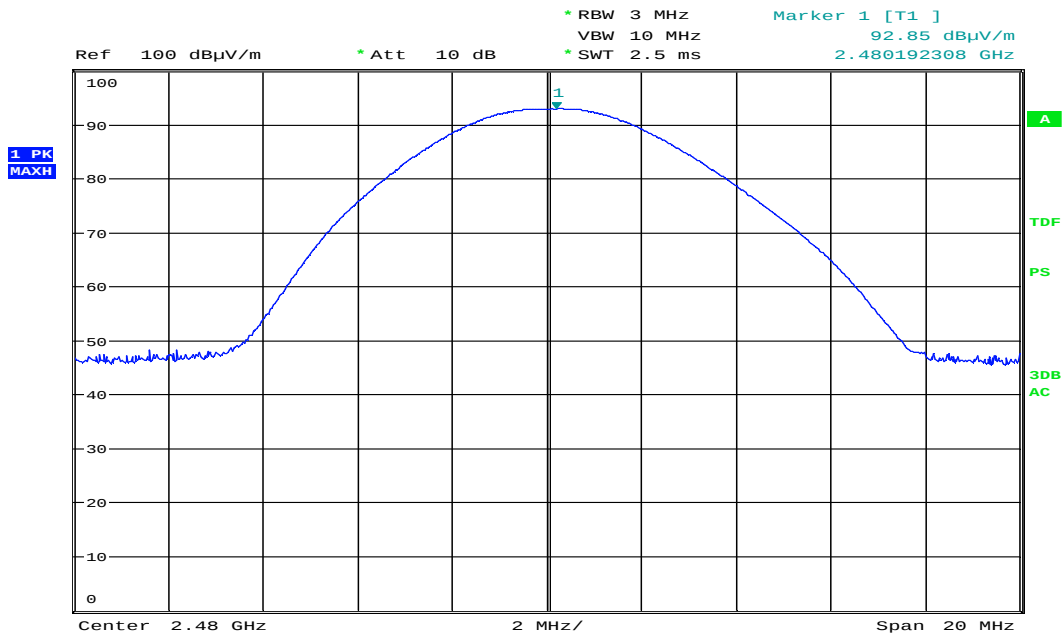
Date: 22.JUL.2019 12:13:35

Maximum Field Strength, 2402 MHz



Date: 22.JUL.2019 11:20:49

Maximum Field Strength, 2440 MHz



Date: 22.JUL.2019 11:31:40

Maximum Field Strength, 2480 MHz

3.3 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 4 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)	ISSED (MHz)	FCC (GHz)	ISSED (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.

3.4 Radiated Emissions, Band Edge

FCC Part 15.249 (a)(d)(e)

FCC Part 15.209(a)(c)(d)(e)

ISED Canada RSS-210 issue 10, B.10 (a)(b)

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

Measurement procedure: ANSI C63.10-2013 Clause 6.10.4 / 6.10.5 / 6.10.6

Test Results: Complies

Measurement Data:

	Measured field strength (dBμV/m)		Limit	Margin	
	2400 MHz	2483.5 MHz	(dBμV/m)	(dB)	
Peak Detector	68.9	54.3	74	5.1	19.7
Average Detector	54.0	39.4	54	0.0	14.6

Band Edge is measured with the EUT transmitting on 2402 and 2480 MHz

Average values are calculated from Peak Values using the Duty Cycle correction factor.

See attached plots.

Limit:

The field strength of harmonic emissions, measured at 3 m, shall not exceed 0.5 mV/m (54 dBμV/m).

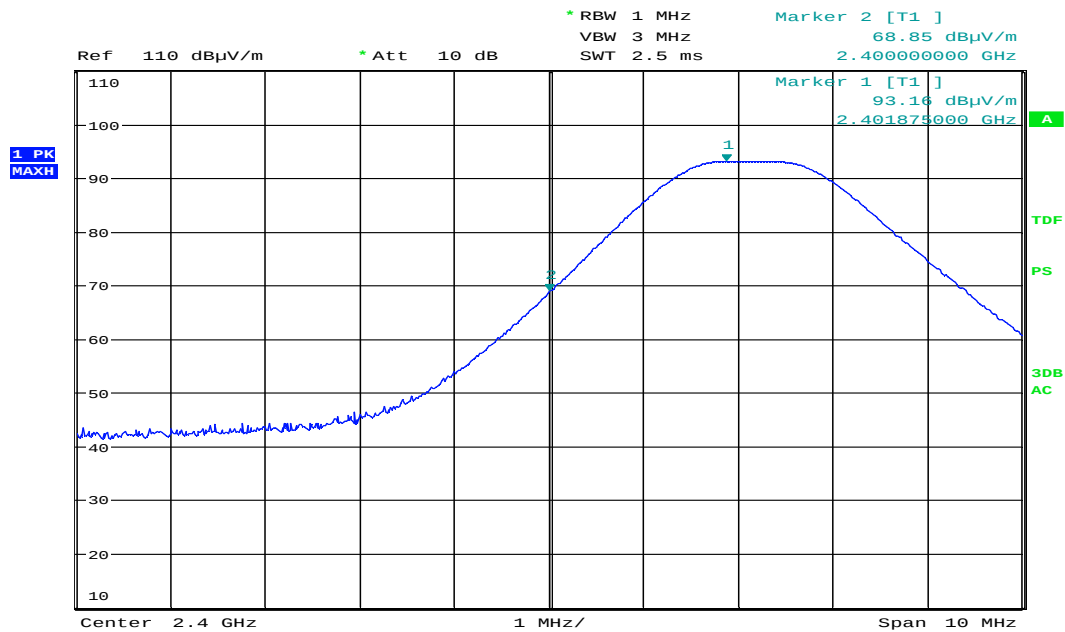
The field strength limits shall be measured using an average detector.

Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen or §15.209, whichever is less stringent.

Duty Cycle Correction Factors

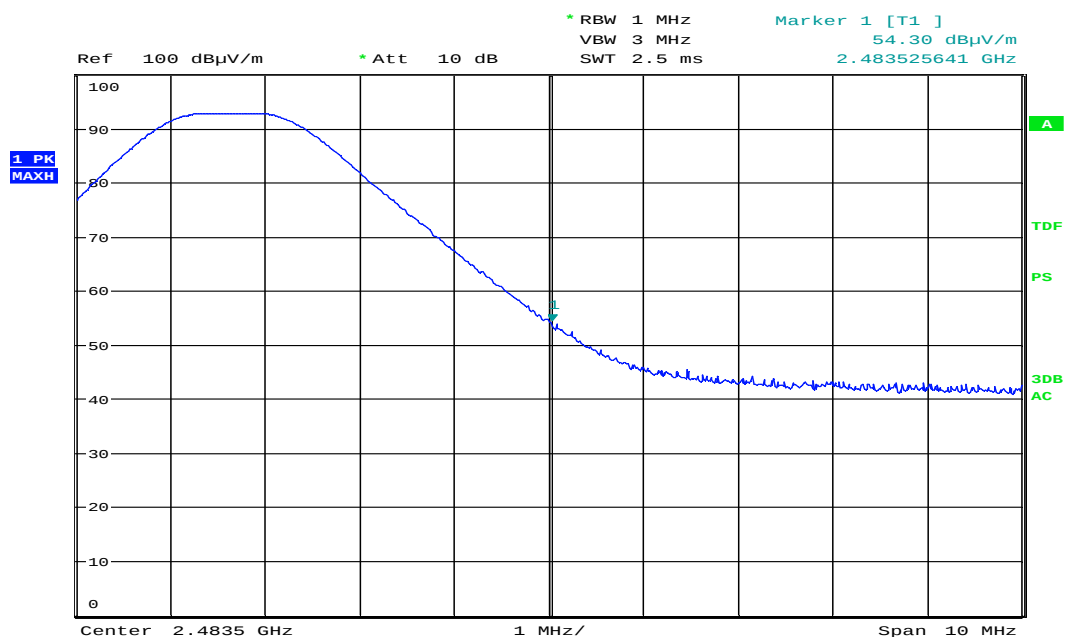
Maximum Duty Cycle: 17.92%

Duty Cycle Correction Factor: $-20 \times \log_{10}(17.92\%) = 14.9$ dB



Date: 23.JUL.2019 10:35:50

Band Edge, Lower, Peak, 2402 MHz, Max Power



Date: 22.JUL.2019 11:33:15

Band Edge, Upper, Peak, 2480 MHz, Max Power

3.5 Radiated Emissions, 30 – 1000 MHz

FCC Part 15.209(a) / 15.249(a)

ISED Canada RSS-210 issue 10, B.10 (a)(b)

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

Measurement procedure: ANSI C63.10-2013 Clause 6.5

Test Results: Complies

Measurement Data:

Measuring distance: 3m

Detector: Peak

Tested in test mode with EUT transmitting on channel 19.

See attached plots.

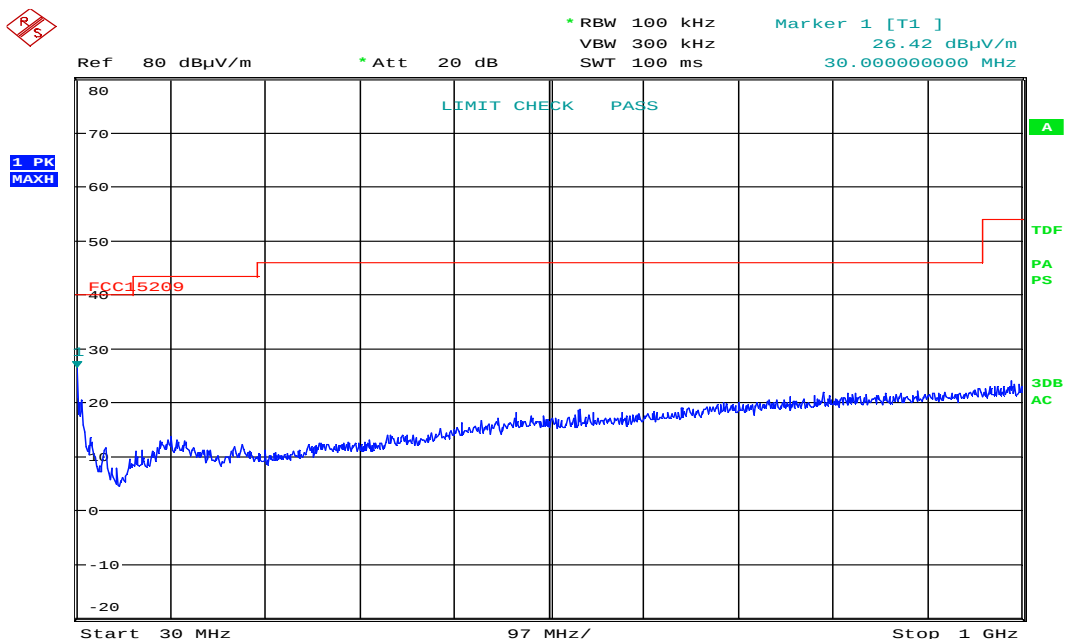
Requirements/Limit

The field strength of harmonic emissions, measured at 3 m, shall not exceed 0.5 mV/m (54 dB μ V/m).

The field strength limits shall be measured using an average detector.

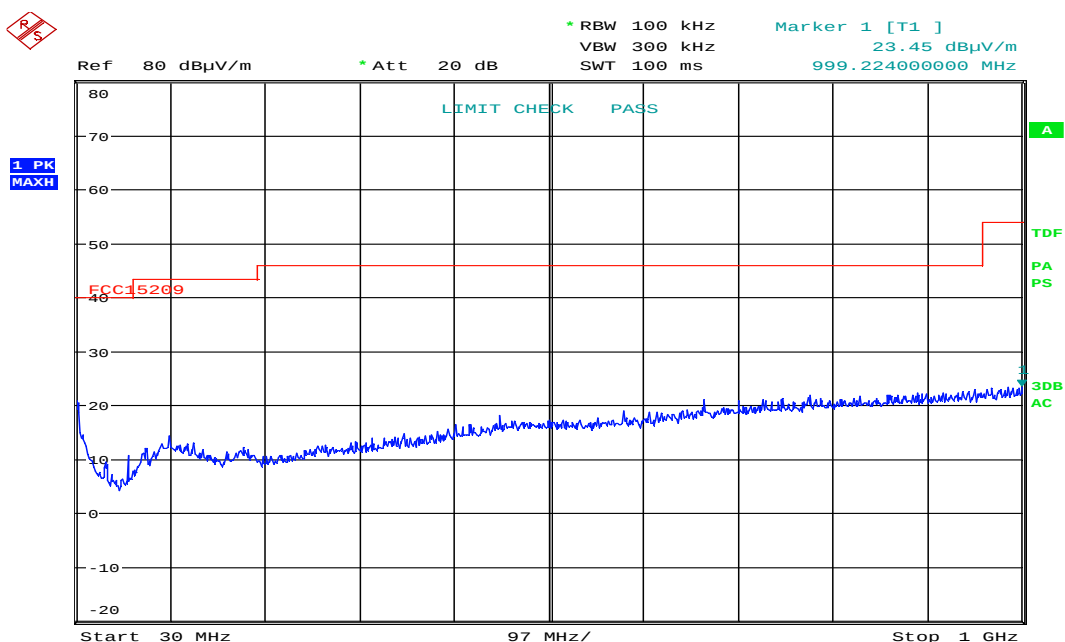
Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen or §15.209, whichever is less stringent.

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: 22.JUL.2019 08:39:42

Radiated Emissions, 30 – 1000 MHz, 2440 MHz, VP



Date: 22.JUL.2019 08:42:32

Radiated Emissions, 30 – 1000 MHz, 2440 MHz, HP

3.6 Radiated Emissions, 1 – 26 GHz

FCC Part 15.209(a)(c)(d)(e)

ISED Canada RSS-210 issue 10, B.10 (a)(b)

Test Results: Complies

Measurement Data:

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

Bandwidths: RBW=1MHz / VBW=3MHz

Measured values:

Frequency (MHz)	Channel	Polarization	Peak (dBμV/m)	Average (dBμV/m)	Peak Margin (dB)	Av Margin (dB)
7206	0	V	61.5	41.5	12.5	12.5
7320	19	V	62.8	42.8	11.2	11.2
7440	39	V	63.5	43.5	10.5	10.5
12010	0	H	70.7	50.7	3.3	3.3
12200	19	H	70.0	50.0	4.0	4.0
12400	39	H	68.4	48.4	5.6	5.6
14880	39	V	56.9	36.9	17.1	17.1

All measurements were performed with the EUT transmitting on a fixed channel.

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

See plots.

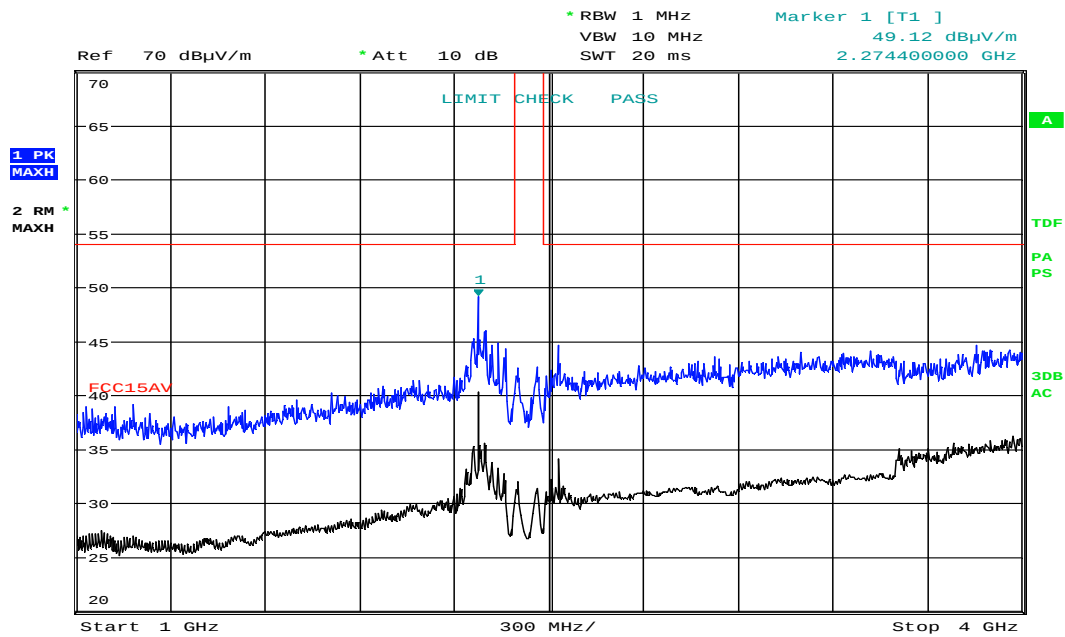
Requirements/Limit

The field strength of harmonic emissions, measured at 3 m, shall not exceed 0.5 mV/m (54 dBμV/m).

The field strength limits shall be measured using an average detector.

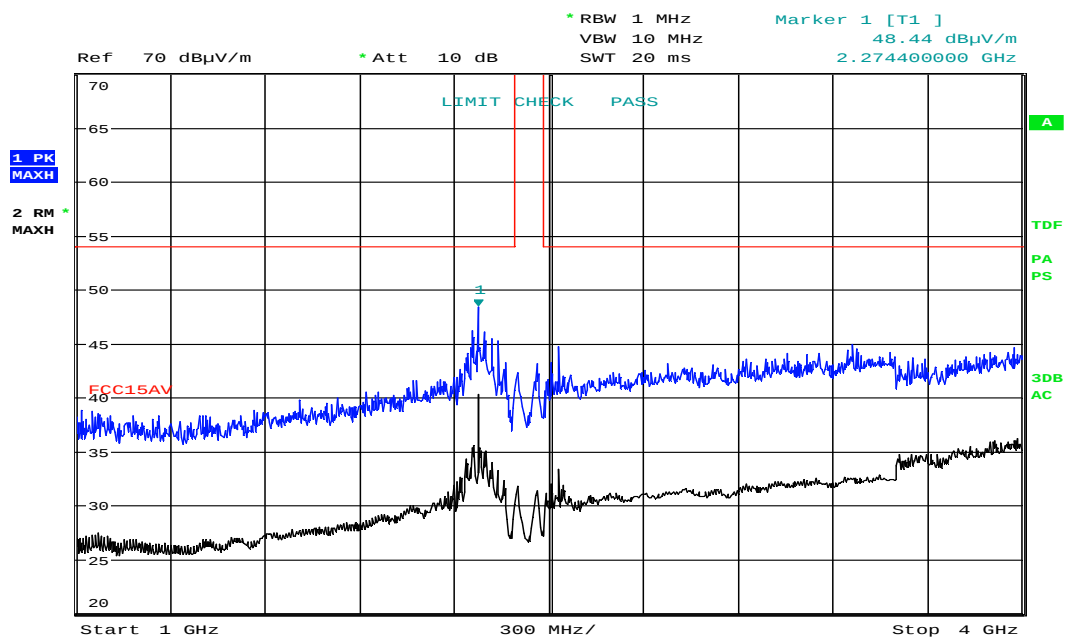
Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen or §15.209, whichever is less stringent.

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



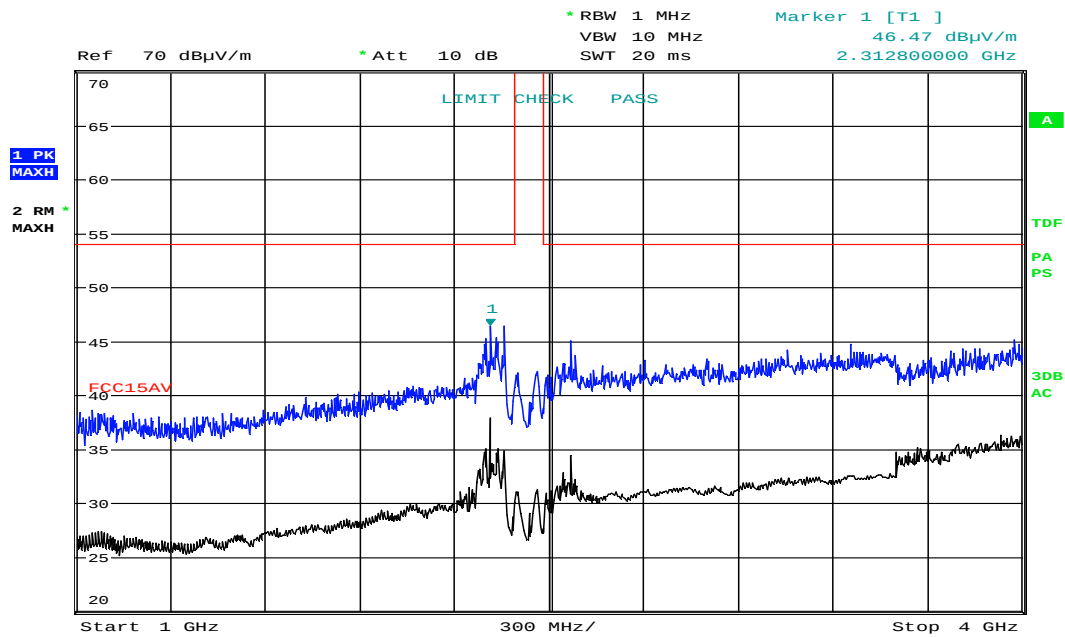
Date: 22.JUL.2019 12:07:21

Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, VP



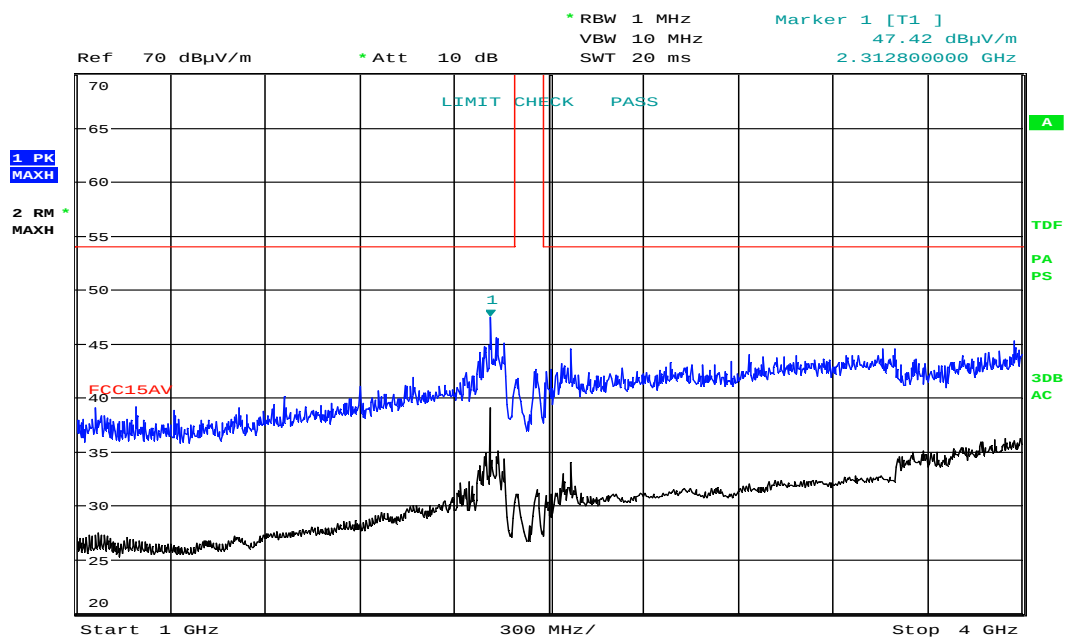
Date: 22.JUL.2019 12:09:16

Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, HP



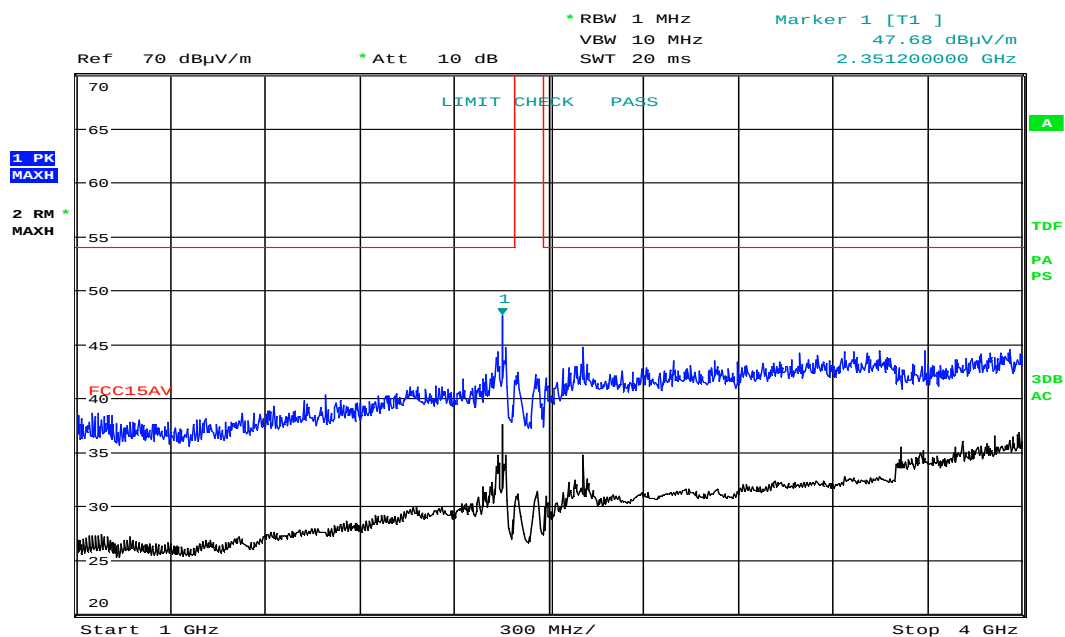
Date: 22.JUL.2019 12:19:45

Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, VP



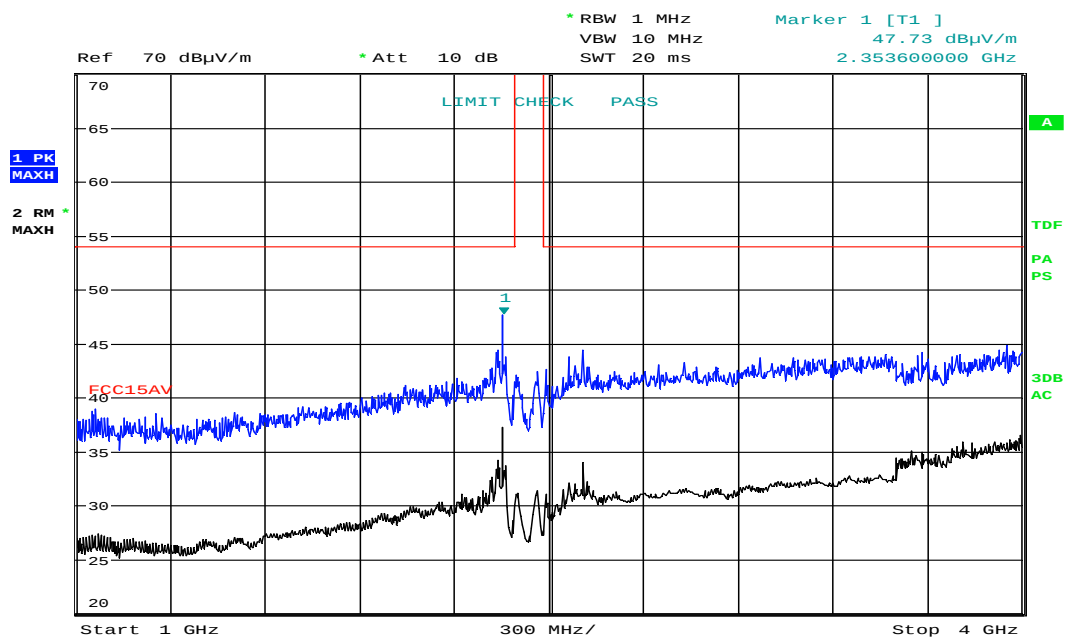
Date: 22.JUL.2019 12:21:40

Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, HP



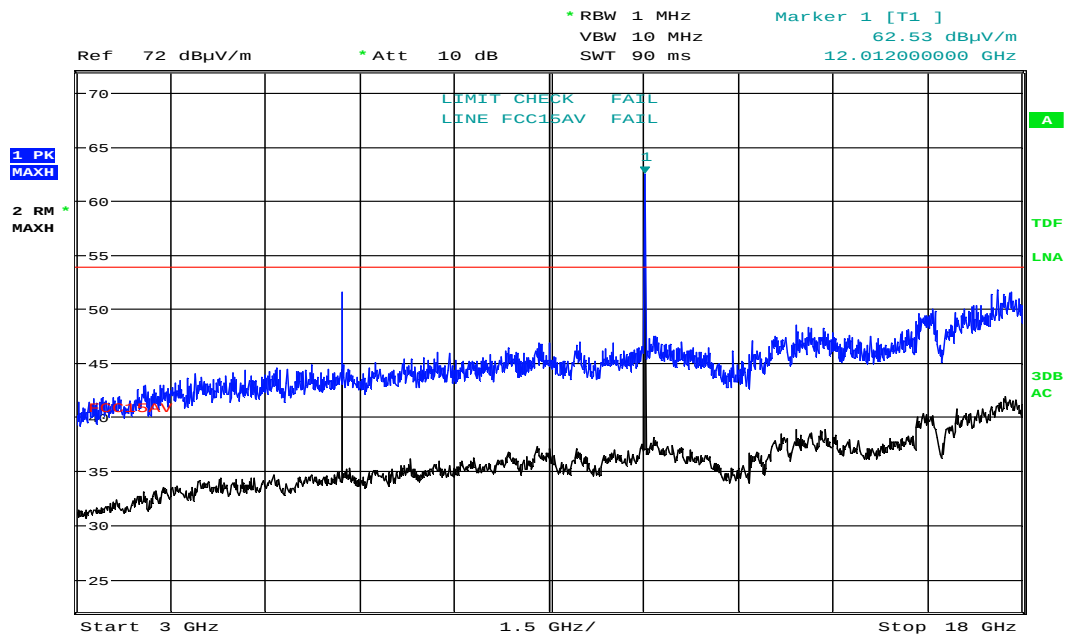
Date: 22.JUL.2019 11:37:16

Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, VP



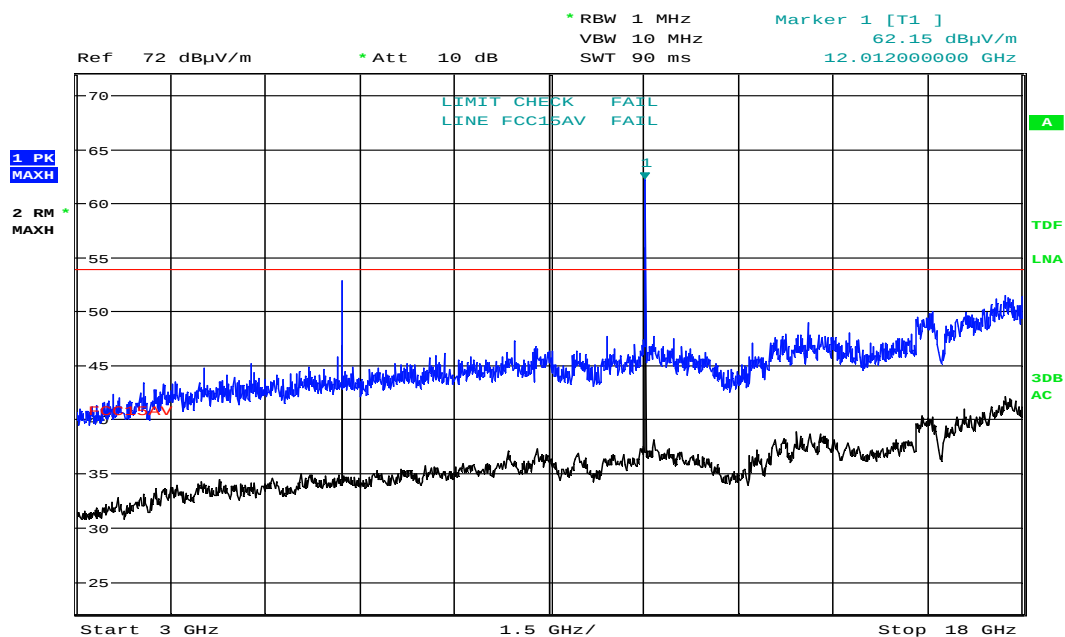
Date: 22.JUL.2019 11:39:11

Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, HP



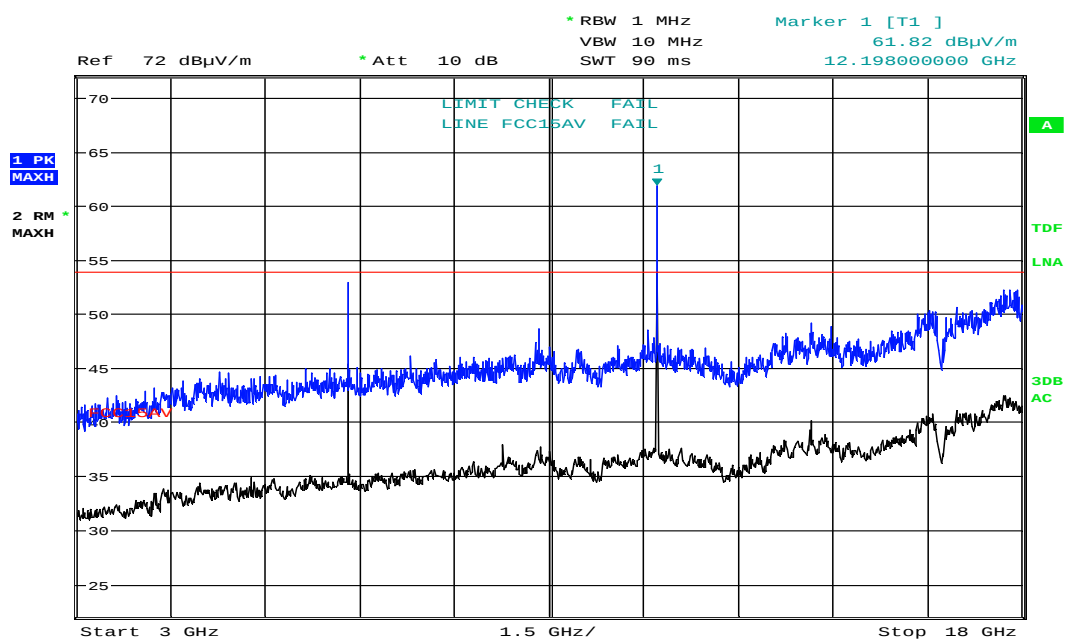
Date: 22.JUL.2019 13:13:09

Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, VP



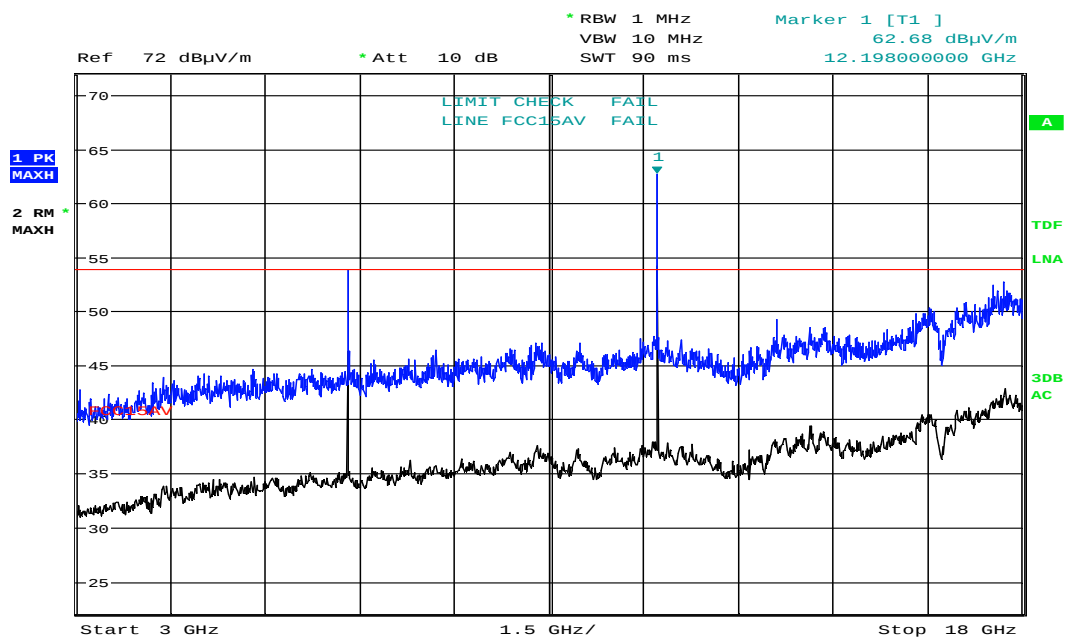
Date: 22.JUL.2019 13:15:05

Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, HP



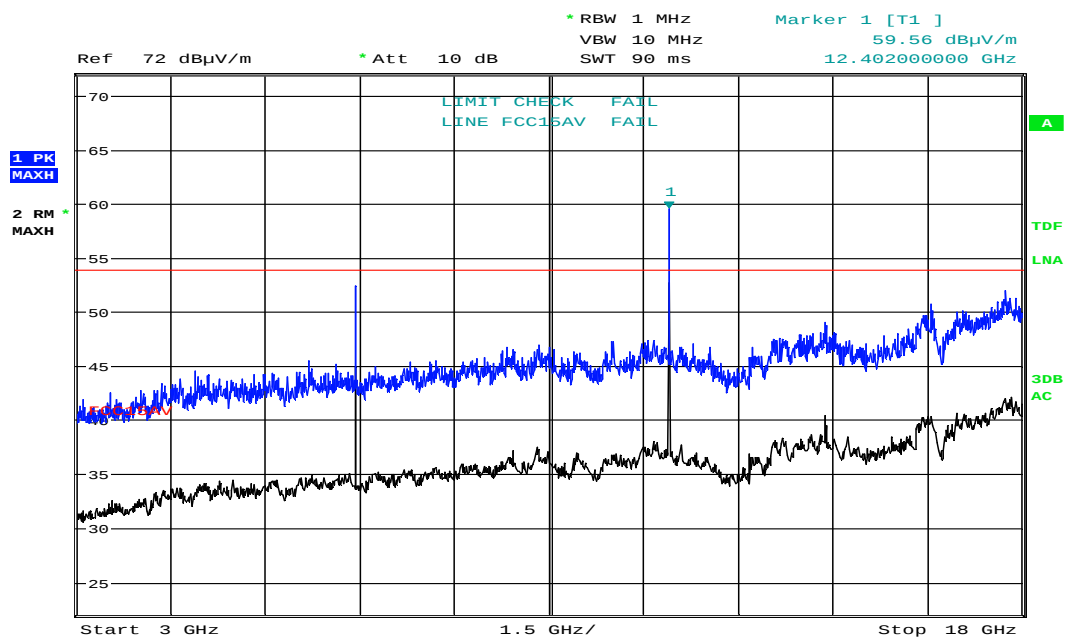
Date: 22.JUL.2019 12:36:01

Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, VP



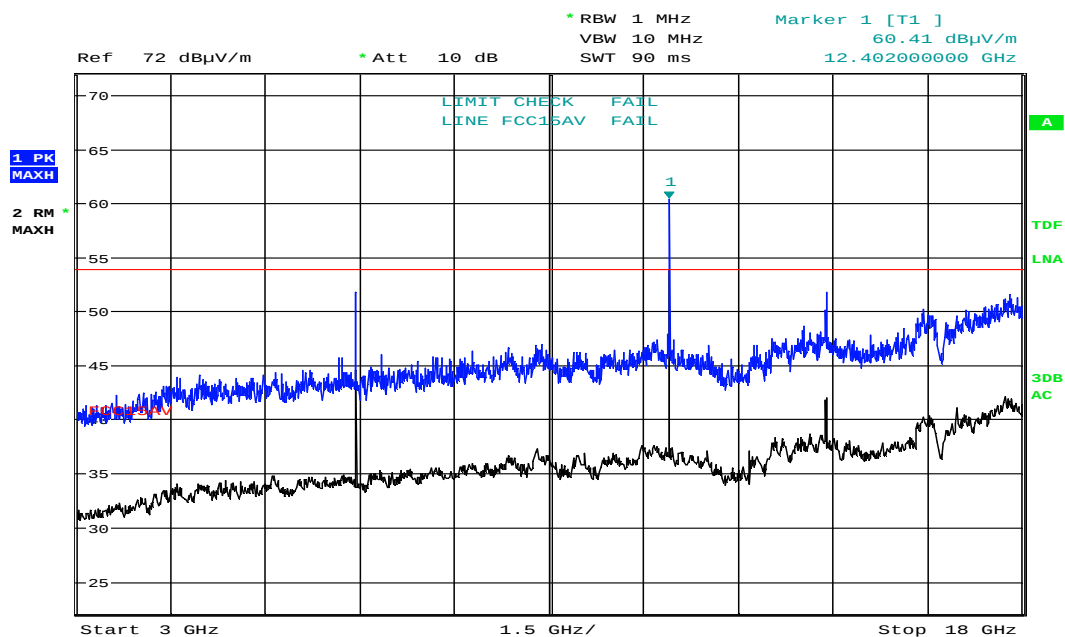
Date: 22.JUL.2019 12:37:56

Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, HP



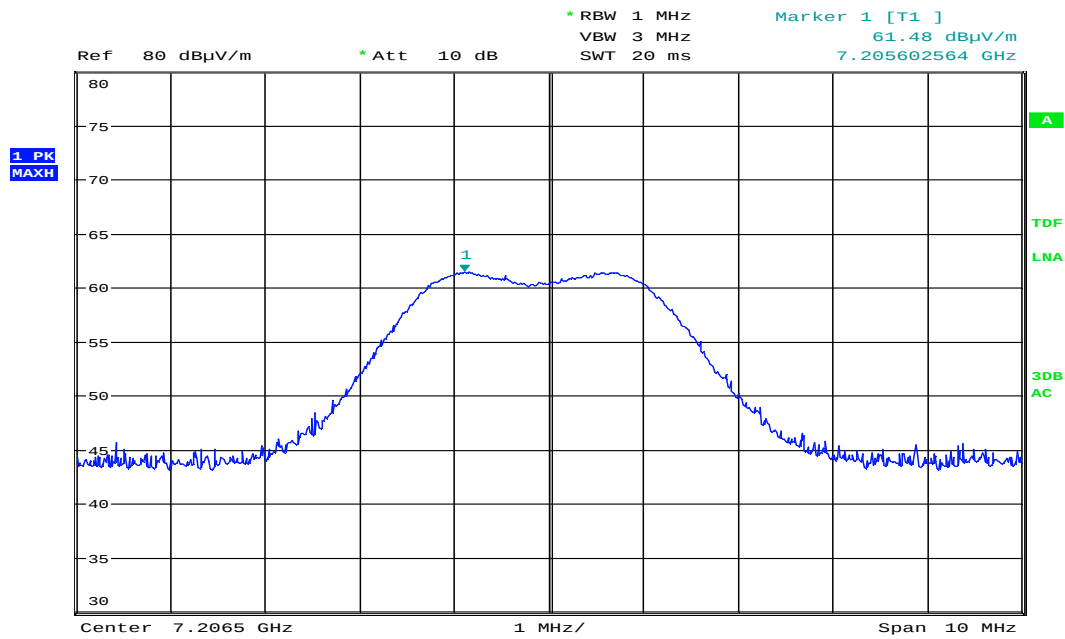
Date: 22.JUL.2019 13:28:59

Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, VP



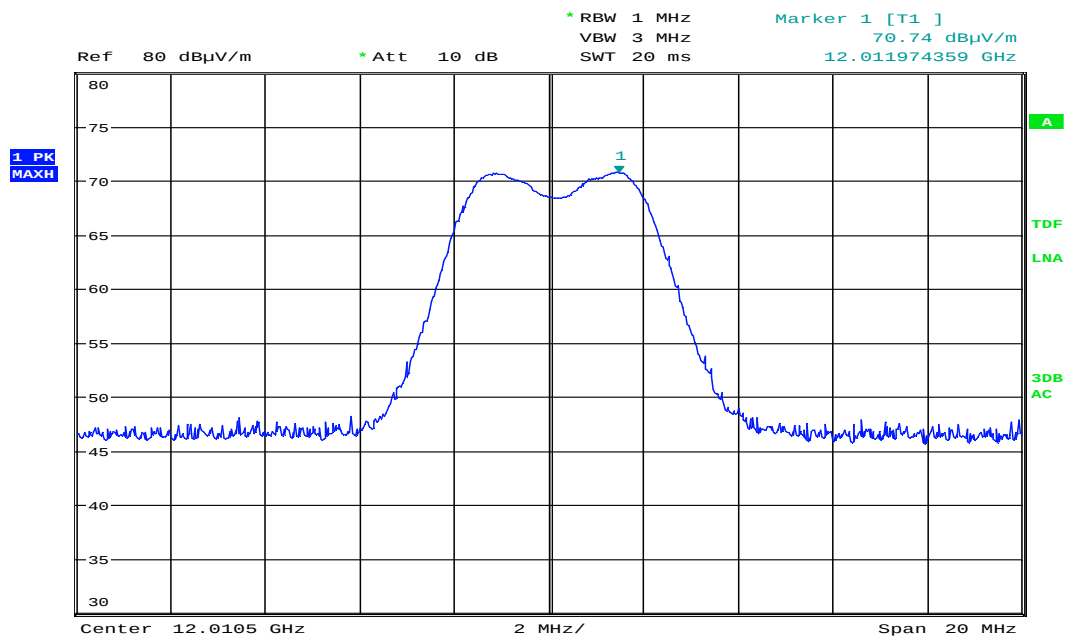
Date: 22.JUL.2019 13:30:54

Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, HP



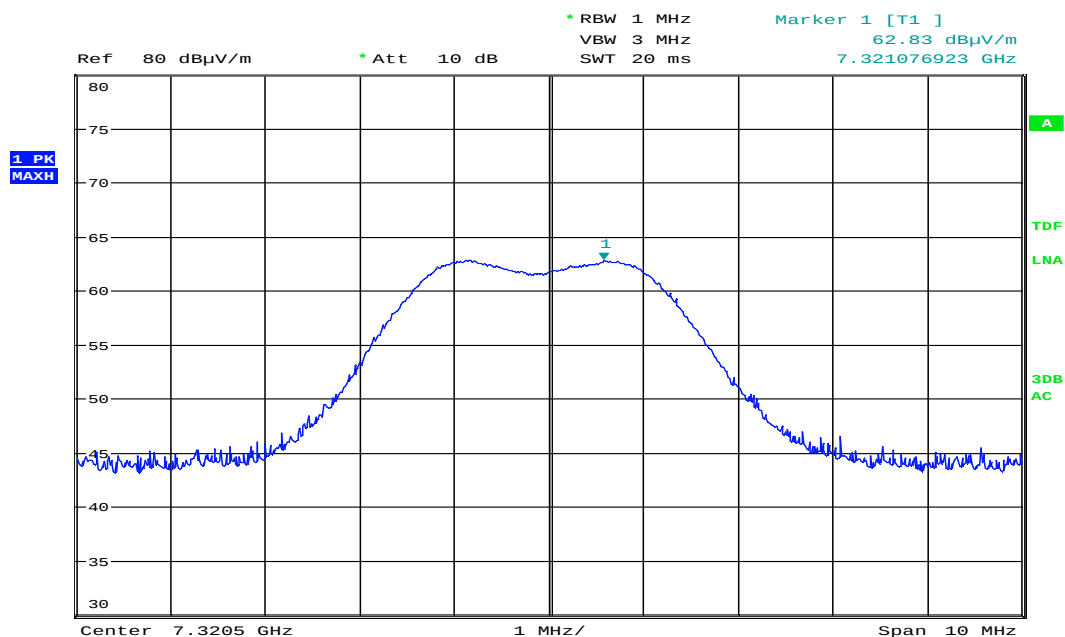
Date: 22.JUL.2019 13:24:41

Radiated Emissions, 7206 MHz, 2402 MHz (Max: VP)



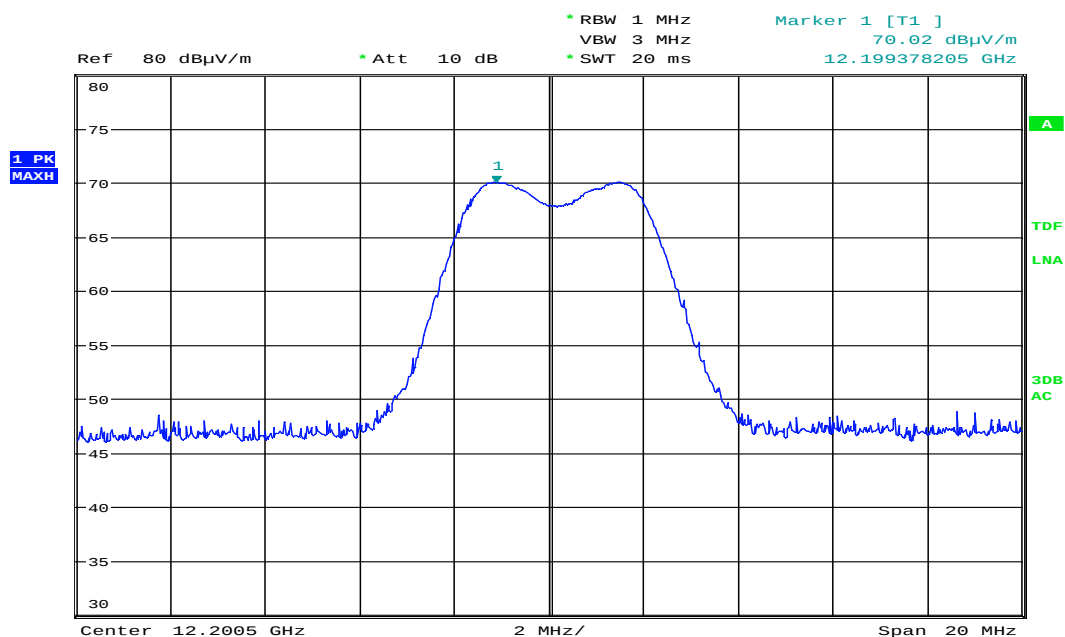
Date: 22.JUL.2019 13:21:22

Radiated Emissions, 12010 MHz, 2402 MHz (Max: HP)



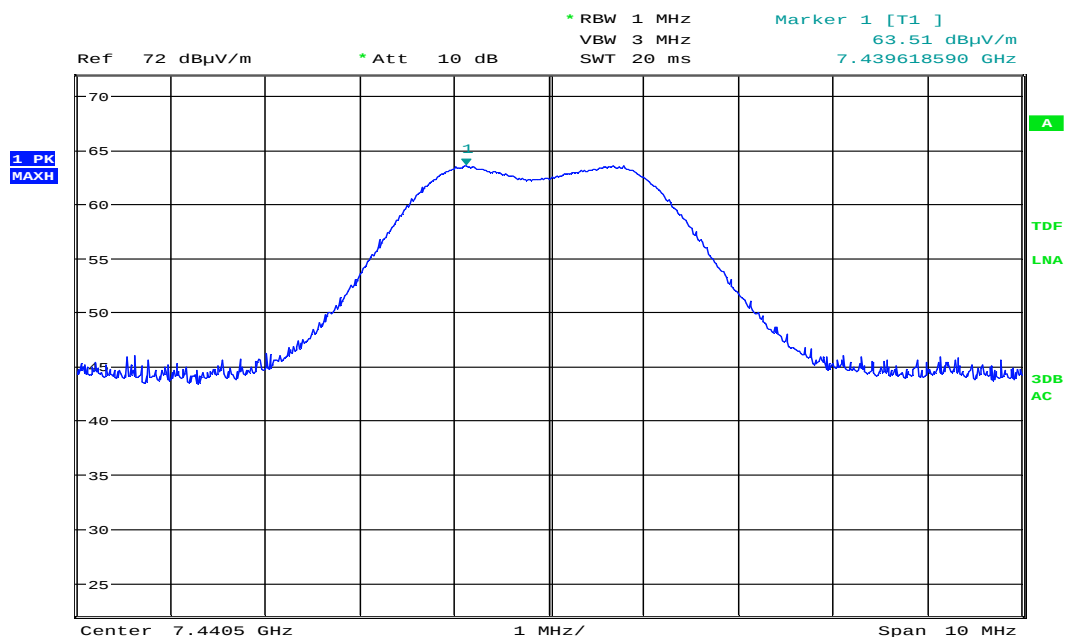
Date: 22.JUL.2019 13:04:12

Radiated Emissions, 7320 MHz, 2402 MHz (Max: VP)



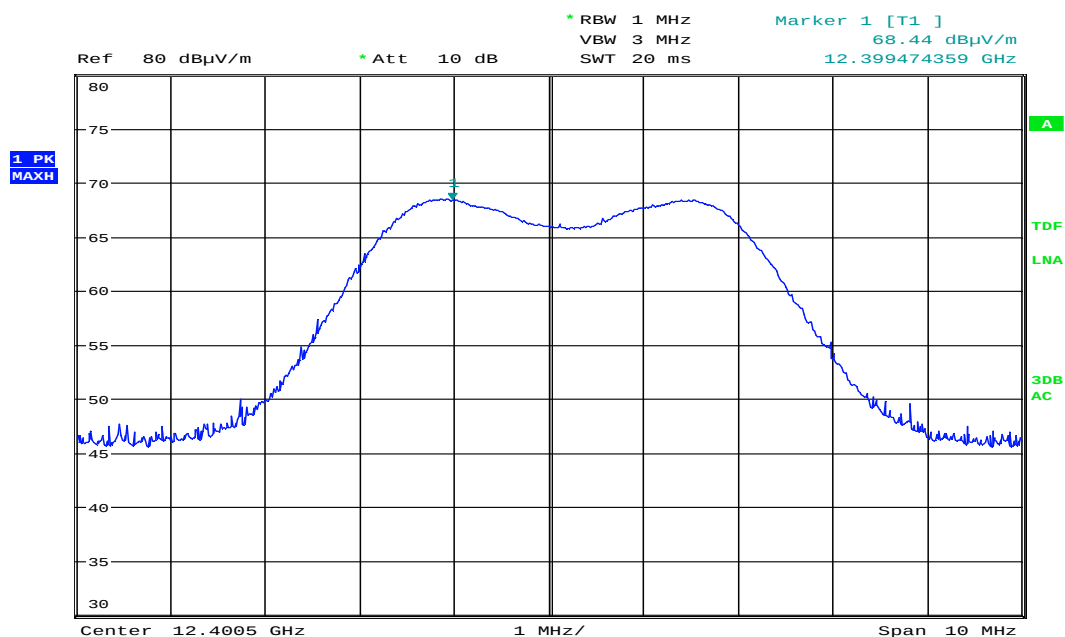
Date: 22.JUL.2019 12:52:37

Radiated Emissions, 12200 MHz, 2402 MHz (Max: HP)



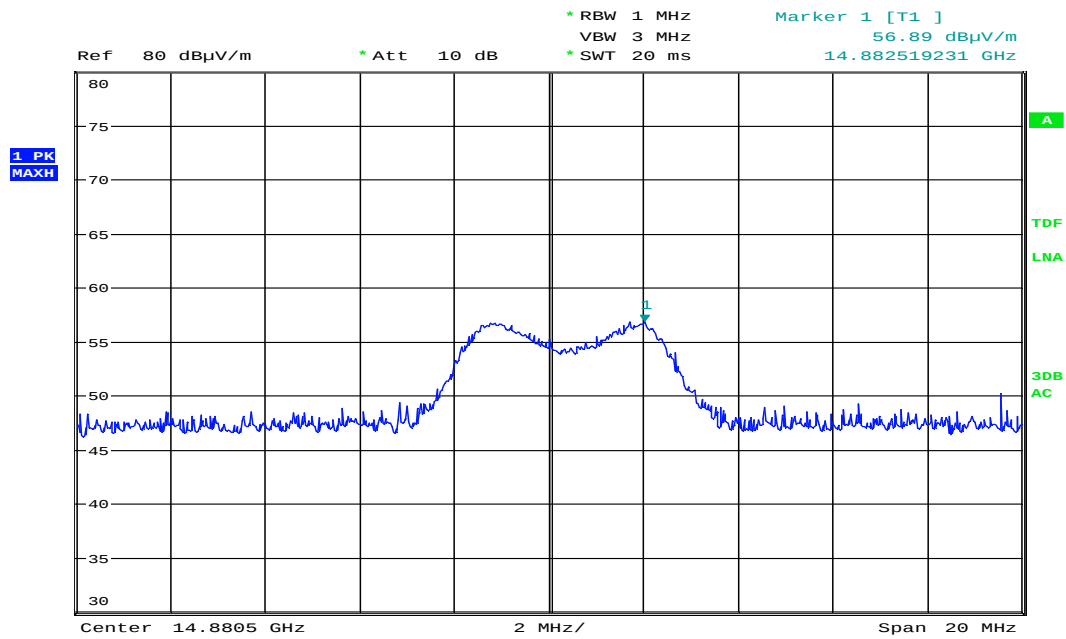
Date: 22.JUL.2019 13:38:01

Radiated Emissions, 7440 MHz, 2402 MHz (Max: VP)



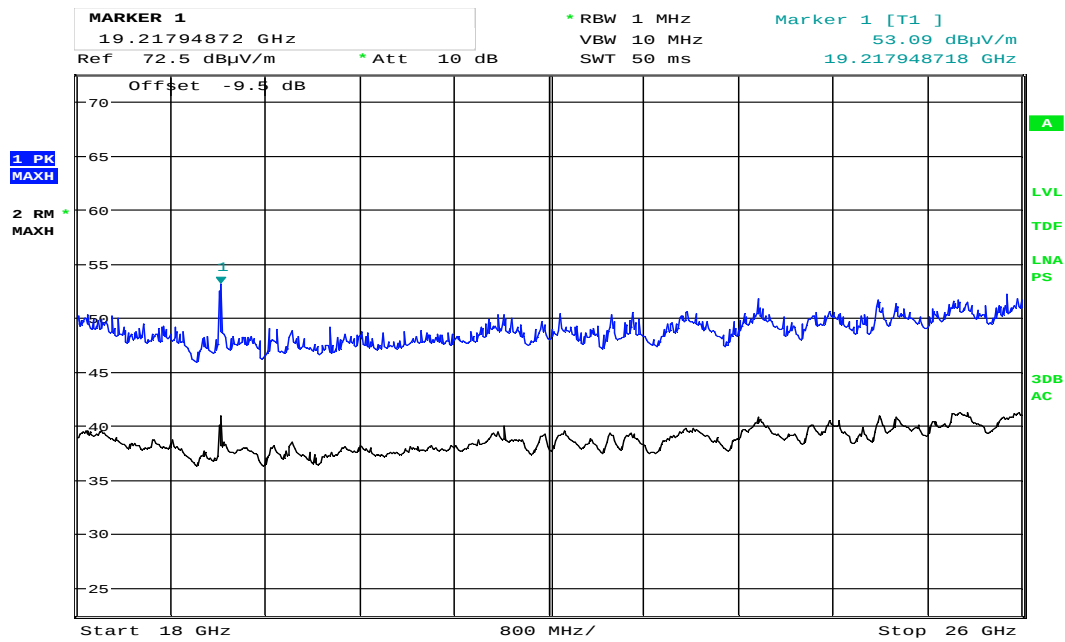
Date: 22.JUL.2019 13:41:58

Radiated Emissions, 12400 MHz, 2402 MHz (Max: HP)



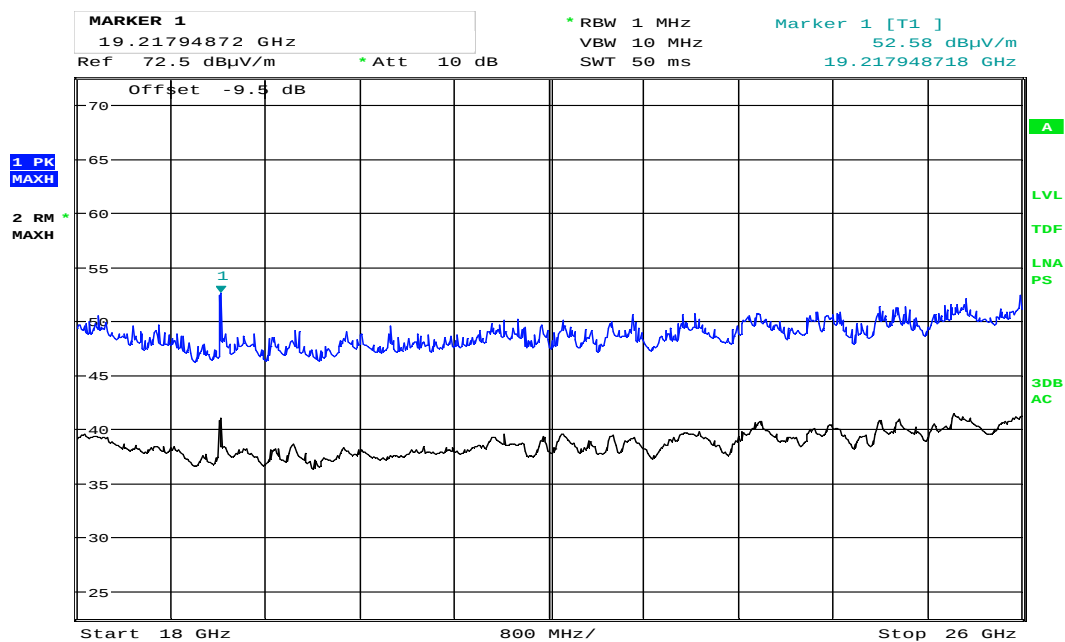
Date: 22.JUL.2019 13:51:39

Radiated Emissions, 14880 MHz, 2402 MHz (Max: HP)



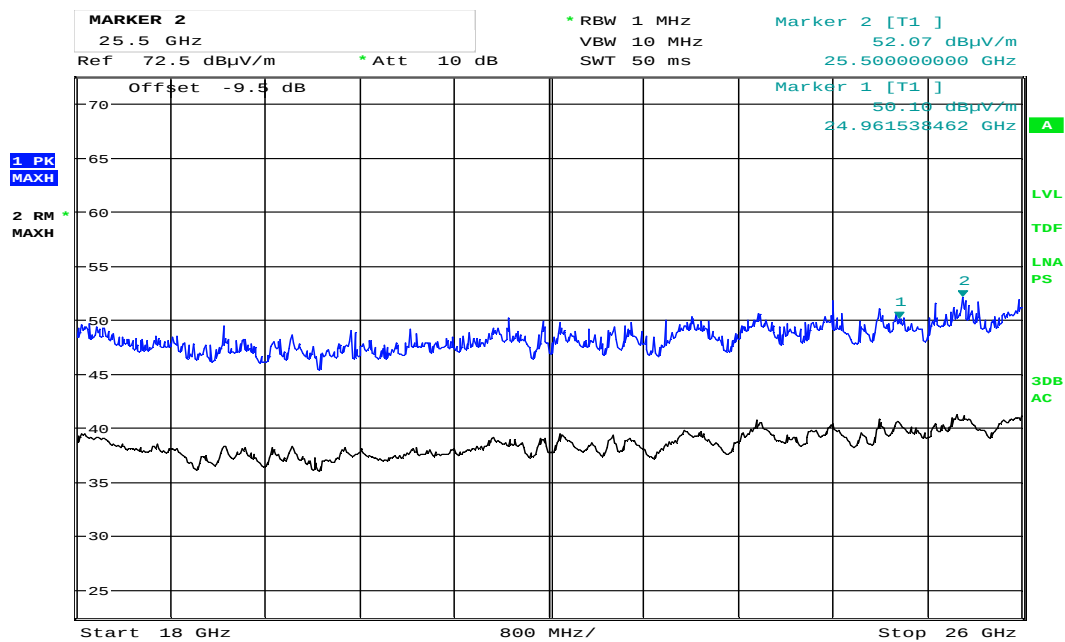
Date: 23.JUL.2019 09:07:06

Radiated Emissions, 18 – 26 GHz, 2402 MHz, VP, @1m



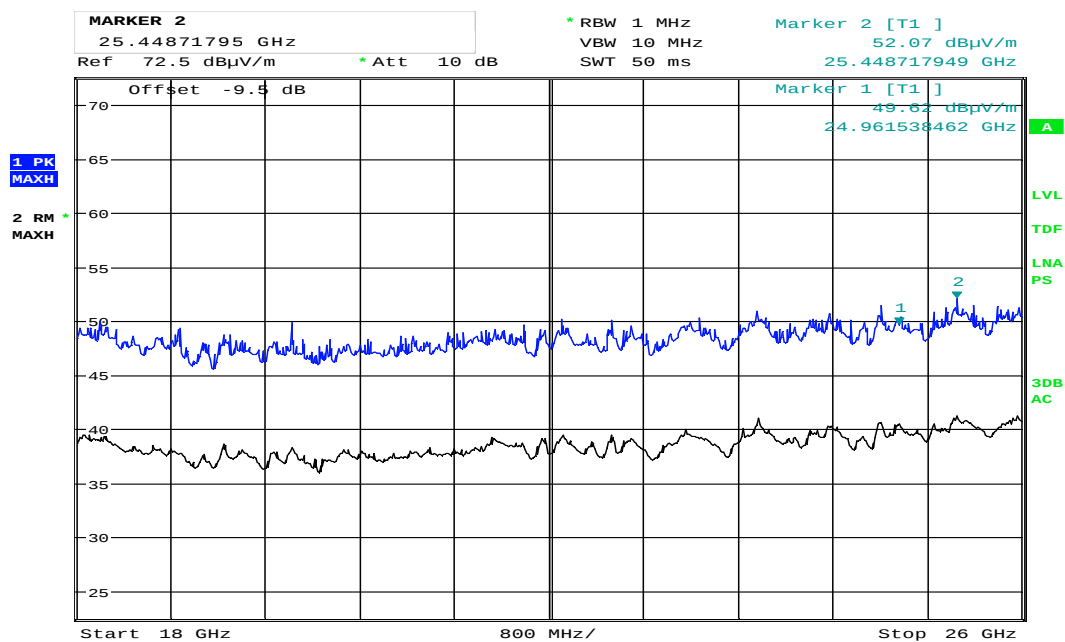
Date: 23.JUL.2019 09:04:18

Radiated Emissions, 18 – 26 GHz, 2402 MHz, HP, @1m



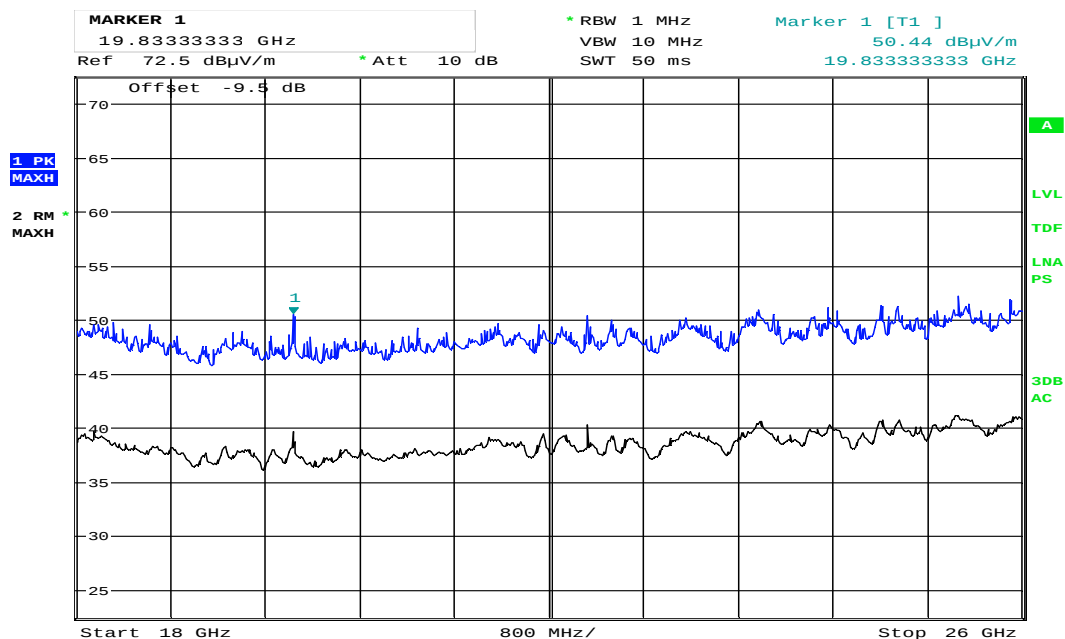
Date: 23.JUL.2019 09:13:31

Radiated Emissions, 18 – 26 GHz, 2440 MHz, VP, @1m



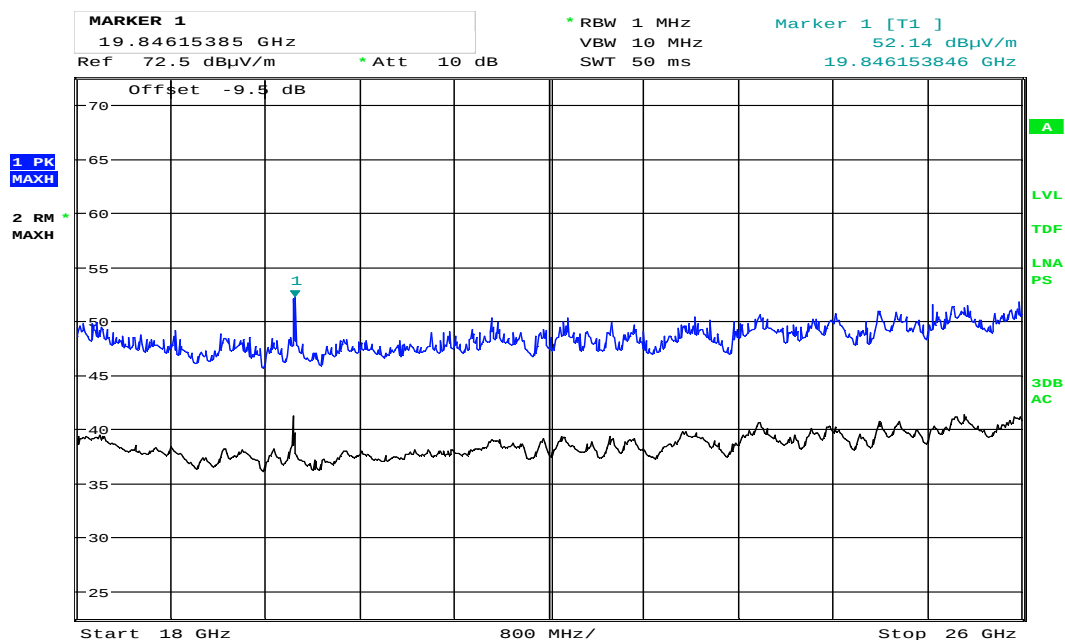
Date: 23.JUL.2019 09:12:28

Radiated Emissions, 18 – 26 GHz, 2440 MHz, HP, @1m



Date: 23.JUL.2019 09:17:44

Radiated Emissions, 18 – 26 GHz, 2480 MHz, VP, @1m



Date: 23.JUL.2019 09:19:04

Radiated Emissions, 18 – 26 GHz, 2480 MHz, HP, @1m

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
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
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	2019-01 2020-01	2020-01 2021-01
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2019-03 2020-01	2020-03 2021-01
3	6810.17B	Attenuator	Suhner	LR 1669	2019-07	2020-07
4	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	COU	
5	JB3	BiLog Antenna	Sunol Sciences	N-4525	2017-11	2020-11
6	317	Preamplifier	Sonoma Inst.	LR 1687	2019-07	2020-07
7	3115	Horn Antenna	EMCO	LR 1330	2016-10	2021-10
8	3117-PA	Horn Antenna with Preamp	EMCO	LR 1717	2017-12	2020-12
9	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2019-07	2020-07
10	638	Horn Antenna	Narda	LR 1480	2010-06	2020-06
11	WRCG2400/2483.5	Band Reject Filter	Wainwright Inst.	LR 1530	COU	
12	ST18/SMA/N/36	RF Cable	Suhner	LR 1627	COU	
13	SF102/1000MM	RF Cable	Suhner	SN 50113/2	COU	
14	SF102/2000MM	RF Cable	Suhner	SN 500100/2	COU	

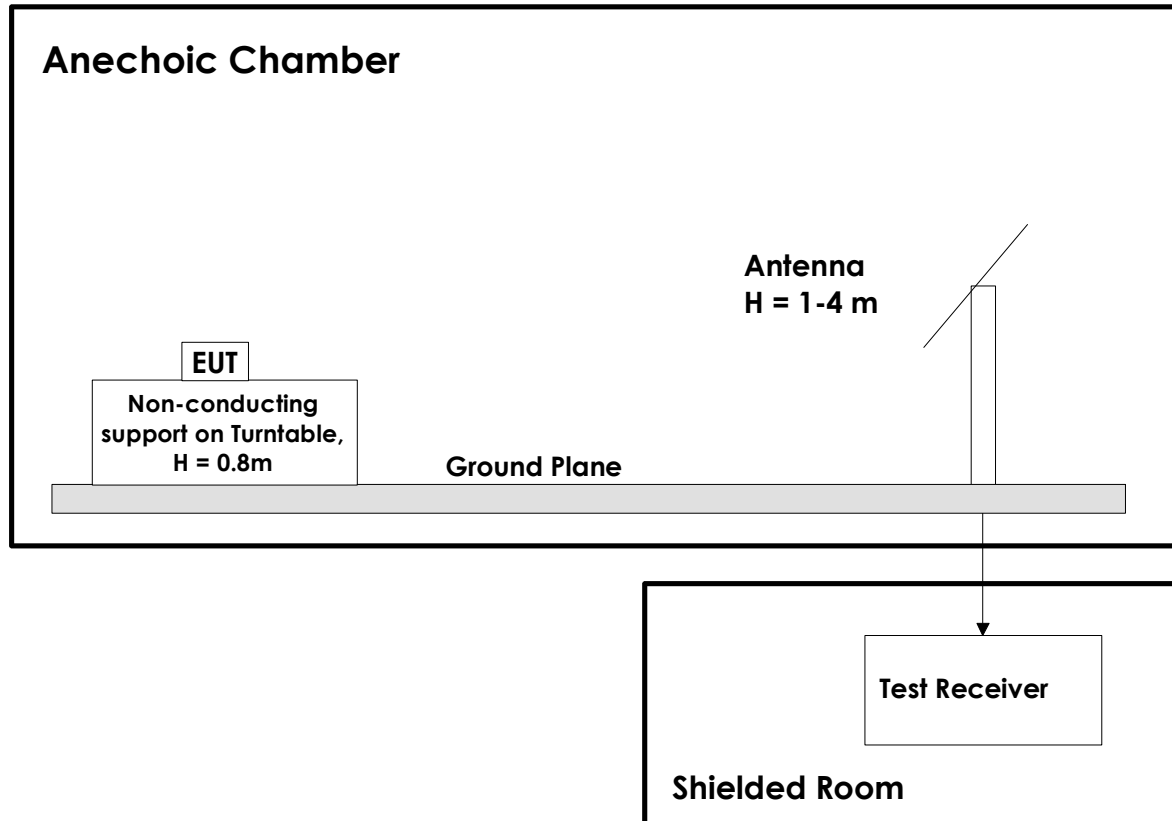
COU - Calibrate ON Use; N/A – Not Applicable

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

No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.10	Radiated Emission test software
2	Rohde & Schwarz	GPBShot	2.7	Screenshots from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. Measuring distance is 3m for all frequencies up to 18 GHz. Above 18 GHz measuring distance is 1m.

Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna.

All measurements at 1 GHz 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, and High-Pass filter is used for all harmonics.

Above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss.