

Test Report

Product	USB Dongle with dual RF Transceivers	
Name and address of the applicant	Grundfos Management A/S Poul Due Jensens Vej 7 DK-8850 Bjerringbro, Denmark	
Name and address of the manufacturer	Same as above	
Model	MI301M01	
Rating	3.7V DC (Li-Ion Battery)	
Trademark	Grundfos	
Serial number	98046398	
Additional information	Zigbee (802.15.4), Bluetooth	
Tested according to	FCC Part 15.247 Frequency Hopping Transmitters / Digital Transmission Systems Industry Canada RSS-247, Issue 2 Low Power Licence-Exempt Radiocommunications Devices	
Order number	324520	
Tested in period	2017.02.09 to 2017.02.13	
Issue date	2017.03.29	
Name and address of the testing laboratory	 FCC No: 994405 IC OATS: 2040D-1 Instituttveien 6 Kjeller, Norway TEL: +47 22 96 03 30 FAX: +47 22 96 05 50	
	 Prepared by [Frode Sveinsen]	 Approved by [G.Suhandhakumar]
This report shall not be reproduced except in full without the written approval of Nemko. Opinions and interpretations expressed within this report are not part of the current accreditation. This report was originally distributed electronically with digital signatures. For more information contact Nemko.		

CONTENTS

1	INFORMATION	3
1.1	Test Item	3
1.2	Normal test condition	4
1.3	Test Engineer(s)	4
1.4	Description of modification for Modification Filing	4
1.5	Family List Rational	4
1.6	Antenna Requirement	4
1.7	Worst-Case Configuration and Mode	4
1.8	Comments	4
2	TEST REPORT SUMMARY	5
2.1	General	5
2.2	Test Summary	6
3	TEST RESULTS.....	7
3.1	Restricted Bands of operation.....	7
3.2	Spurious Emissions (Radiated)	8
4	Measurement Uncertainty.....	31
5	LIST OF TEST EQUIPMENT	32
6	BLOCK DIAGRAM	33
6.1	Power Line Conducted Emission	33
6.2	Test Site Radiated Emission.....	33

1 INFORMATION

1.1 Test Item

Name :	R10000 Universal Dongle
FCC ID :	OG3MI301M01
Industry Canada ID :	10447A-MI301M01
Model/version :	MI301M01
Serial number :	98046398
Hardware identity and/or version:	Rev 5.00
Software identity and/or version :	V2.3.0
Frequency Range :	2405 – 2480 MHz
Number of Channels :	16
Type of Modulation :	DSSS (O-QPSK)
Rated Output Power :	0.00043
Type of Power Supply :	3.7 VDC/ 560 mAh from a Lithium ion battery pack (rechargeable from USB port)
Antenna Connector :	Integrated chip antenna
Antenna Diversity Supported :	No
Charger :	Micro USB connector

Description of Test Item

The MI301M01 is a dual RF transceiver with a separate 2.4 GHz radio module per IEEE 802.15.4 with O-QPSK modulation (DSSS) and a Bluetooth module.

This test report does not cover the BT module (FCC ID: X3ZBTMOD5; IC: 8828A-MOD4).

The client supports the test pc model IBM ThinkPad (# L-no. 695) with Docklight test program for operate the EUT to enter the test mode and so on.

1.2 Normal test condition

Temperature: 20.1 – 22.3 °C

Relative humidity: 30 – 39 %

Normal test voltage: 3.7 V DC

The values are the limit registered during the test period.

1.3 Test Engineer(s)

Frode Sveinsen
Jan G. Eriksen

1.4 Description of modification for Modification Filing

Not applicable.

1.5 Family List Rational

Not Applicable.

1.6 Antenna Requirement

Is the antenna detachable?

Yes No

If detachable, is the antenna connector non-standard?

Yes No

Type of antenna connector: N/A

Ref. FCC §15.203

1.7 Worst-Case Configuration and Mode

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.

1.8 Comments

All measurements were done with the EUT powered by a fully charged battery and connected to the computer by USB.

All ports were populated during spurious emission measurements.

This test report covers only Radiated Spurious Emissions; these tests have been retested due to change of chip antenna for the Zigbee transceiver in the dongle.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-247 Issue 2.

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

Radiated tests were made in a semi-anechoic chamber at measuring distances of 1m, 3m and 10m.

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

- | | |
|--|---|
| <input type="checkbox"/> New Submission | <input checked="" type="checkbox"/> Production Unit |
| <input checked="" type="checkbox"/> Class II Permissive Change | <input type="checkbox"/> Pre-production Unit |
| DTS Equipment Code | <input type="checkbox"/> 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".

Nemko Group authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only. Any reproduction of parts of this report requires approval in writing from Nemko Group.

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 damages suffered by any third party as a result of decisions made or actions based on this report.

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 4 reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	Complies
Antenna Requirement	15.203	8.3 (RSS-GEN)	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	8.8 (RSS-GEN)	N/A
Occupied Bandwidth	N/A	6.6 (RSS-GEN)	N/A
Minimum 6 dB Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	N/A
Peak Power Output	15.247(b)	5.4 (RSS-247)	N/A
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	N/A
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	N/A
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 6.13 (RSS-GEN) 8.9 (RSS-GEN)	Complies

This test report covers only Radiated Spurious Emissions. All other tests are covered by the original test report (Nemko test report no: 208688-4).

3 TEST RESULTS

3.1 Restricted Bands of operation

Restricted Bands of operation for FCC and ISED are defined in FCC Part 15.205 and ISED 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 4, 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.

3.2 Spurious Emissions (Radiated)

FCC Part 15.247

Test Results: Complies

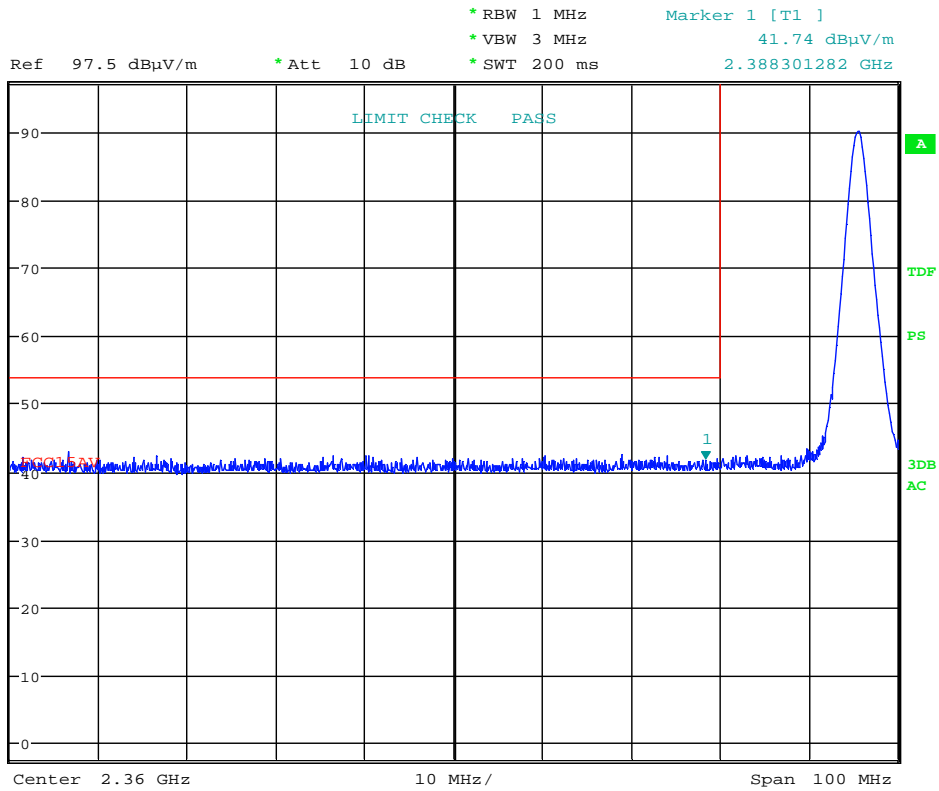
Measurement Data:

Band-edge conducted power

	Measured field strength (dB μ V/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB μ V/m	dB	
Peak Detector	41.7	55.3	74	32.3	18.7
Average Detector	41.7	51.2	54	12.3	2.8

All measurements are performed with the EUT transmitting with 100% duty cycle.

See attached plots.

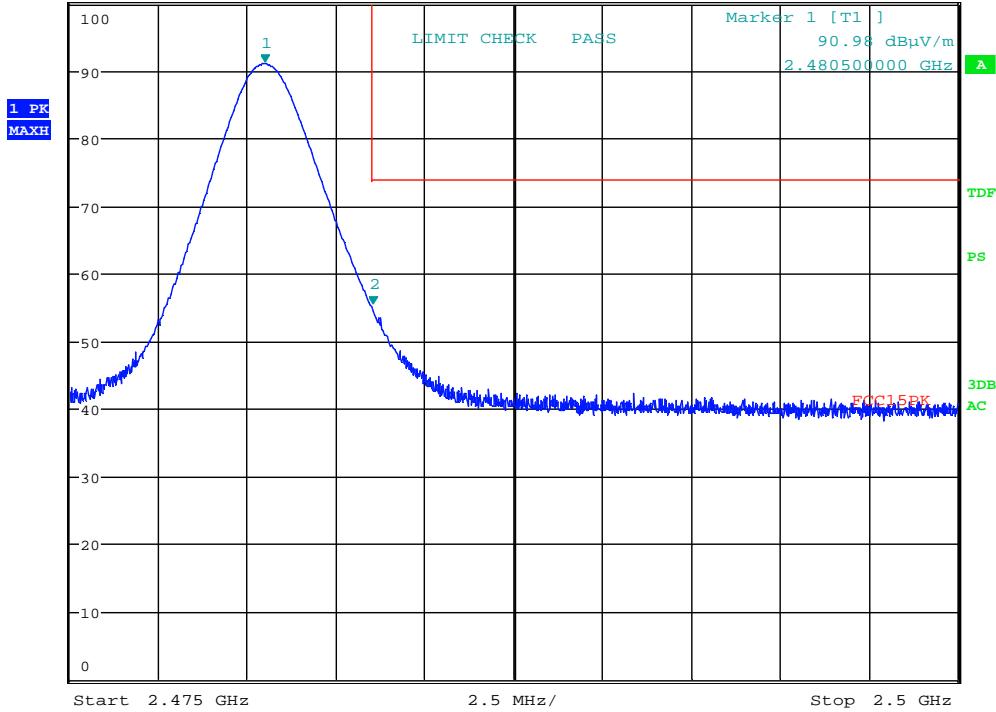


Date: 9.FEB.2017 15:28:34

Lower Band Edge, 2405MHz, Peak (Max: EUT H1, VP)



MARKER 2
 2.483534872 GHz *RBW 1 MHz Marker 2 [T1]
 Ref 100 dBµV/m *Att 10 dB VBW 3 MHz 55.26 dBµV/m
 SWT 15 ms 2.483534872 GHz



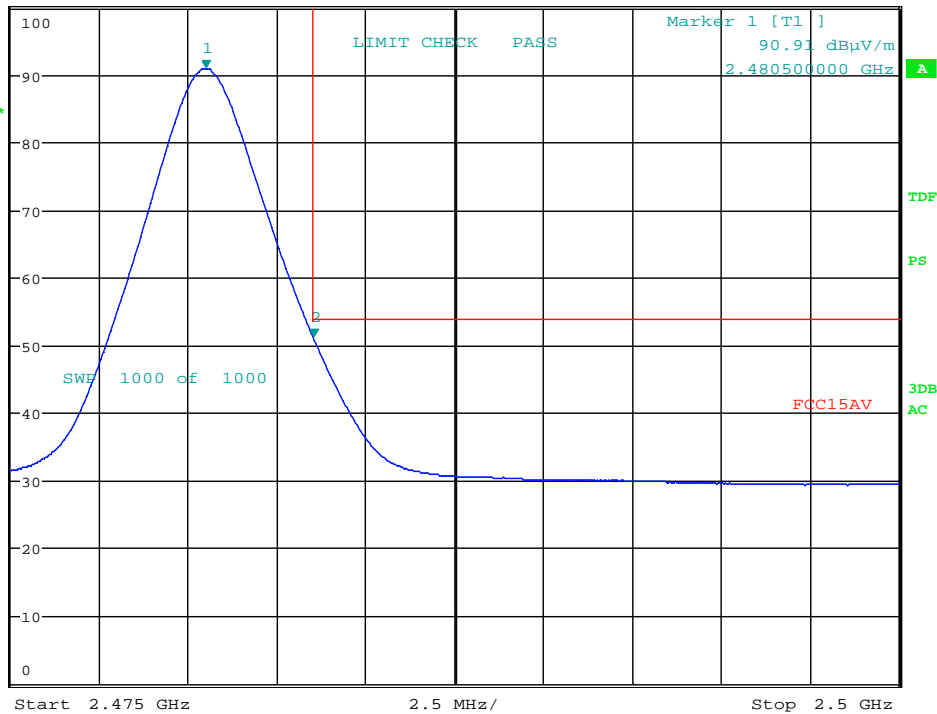
Date: 9.FEB.2017 16:54:16

Upper Band Edge, 2480MHz, Peak (Max: EUT H1, VP)



MARKER 2
 2.483534872 GHz * RBW 1 MHz Marker 2 [T1]
 Ref 100 dBµV/m * Att 10 dB VBW 10 MHz 51.20 dBµV/m
 SWT 15 ms 2.483534872 GHz

1 RM
 AVG



Date: 9.FEB.2017 16:56:47

Upper Band Edge, 2480MHz, Average (Max: EUT H1, VP)

Radiated emission 30 – 1000 MHz.

Detector: Quasi-Peak

Measuring distance 3m.

EUT was in test mode transmitting on 2440 MHz for this test.

No emissions were detected.

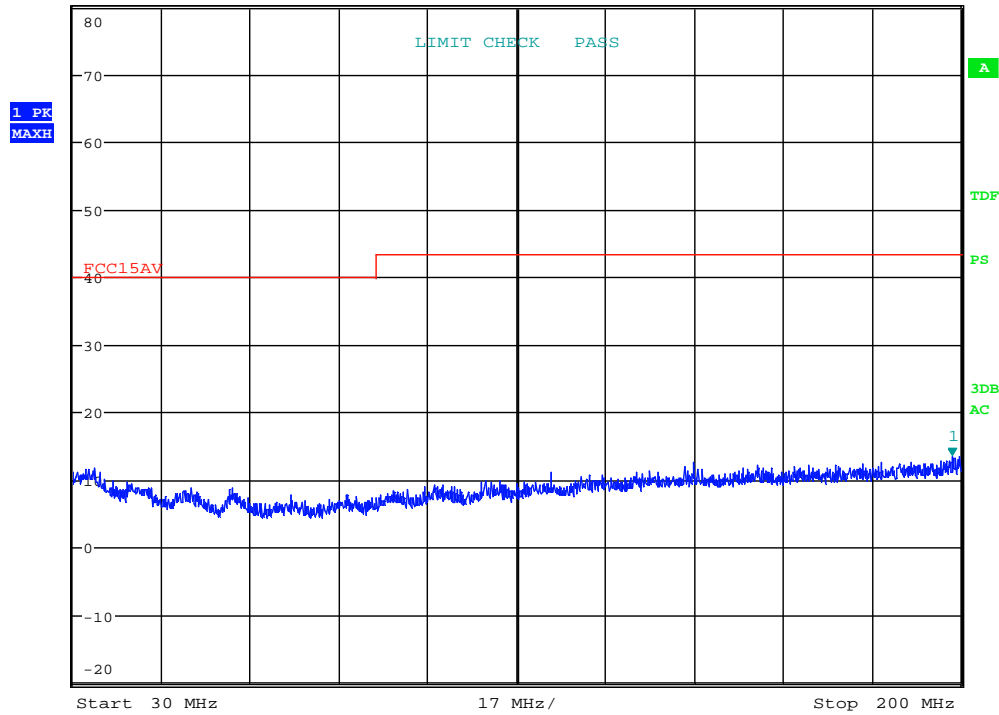
See attached graphs.

Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 4, Clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency (MHz)	Quasi Peak (µV/m)	Quasi Peak (dBµV/m)
30 – 88	100	40.0
88 – 216	150	43.5
216 – 960	200	46.0
Above 960	500	54.0



MARKER 1
 198.368 MHz
 Ref 80 dBµV/m * Att 10 dB * RBW 100 kHz Marker 1 [T1]
 VBW 300 kHz 13.58 dBµV/m
 SWT 20 ms 198.368000000 MHz

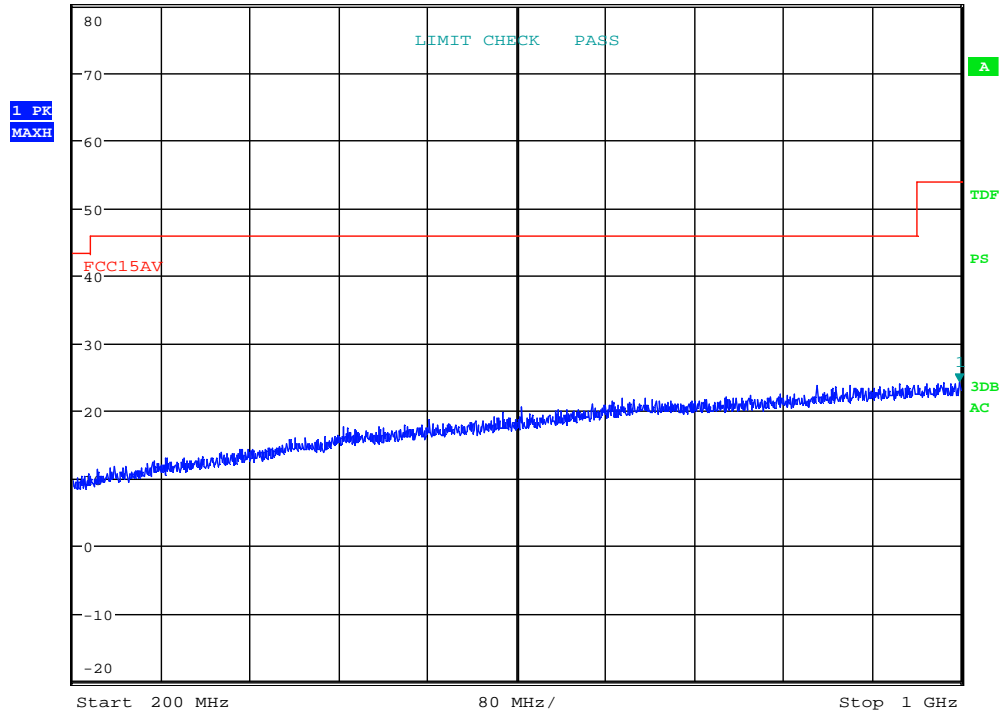


Date: 9.FEB.2017 13:00:03

Radiated Emissions, 30 -200MHz, HP



MARKER 1
 998.72 MHz *RBW 100 kHz Marker 1 [T1]
 Ref 80 dBµV/m *Att 10 dB VBW 300 kHz 24.21 dBµV/m
 SWT 80 ms 998.72000000 MHz



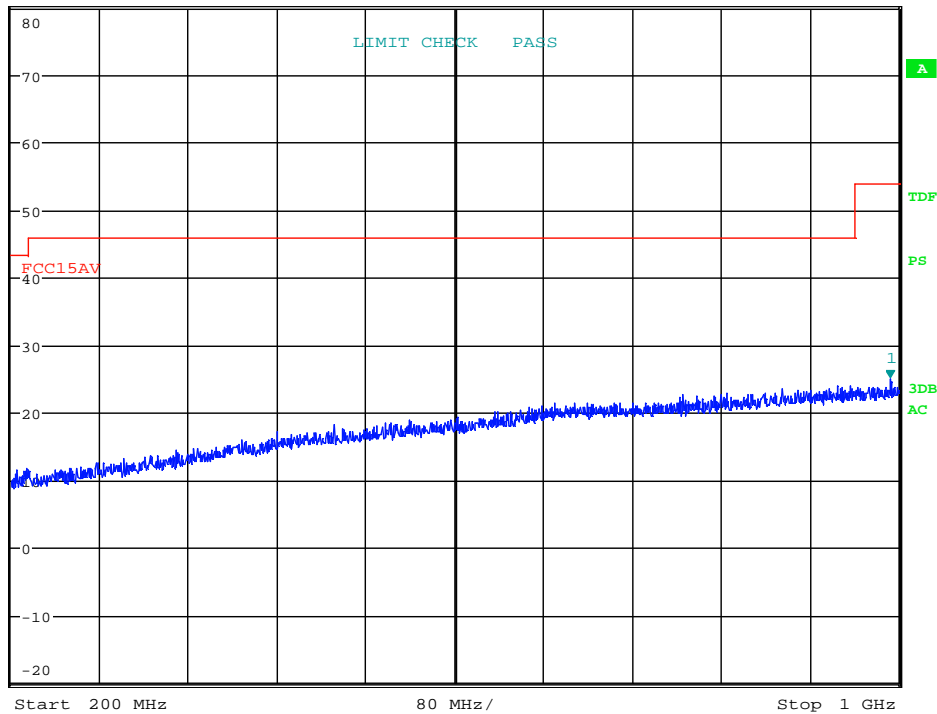
Date: 9.FEB.2017 12:49:43

Radiated Emissions, 200 -1000MHz, HP



MARKER 1
 992 MHz
 Ref 80 dBµV/m *Att 10 dB
 *RBW 100 kHz Marker 1 [T1]
 VBW 300 kHz 25.02 dBµV/m
 SWT 80 ms 992.000000000 MHz

1 PK
MAXH



Date: 9.FEB.2017 12:42:15

Radiated Emissions, 200 -1000MHz, VP

Radiated Emissions, 1-25 GHz

Measuring distance: 3m (1 – 8.5 GHz)
 1m (8.0 – 18 GHz)

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

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Duty cycle corr. factor	Limit	Margin
MHz	L,M,H	dB	dB μ V/m	dB	dB μ V/m	dB
4880	M	0	47.3	20	74 / 54	26.7 / 6.7
12200	M	9.5	43.8	20	74 / 54	30.2 / 10.2
Other freqs	L,M,H	0	None detected	20	74 / 54	/

All emissions are below the Average Limit, even when using Peak detector.

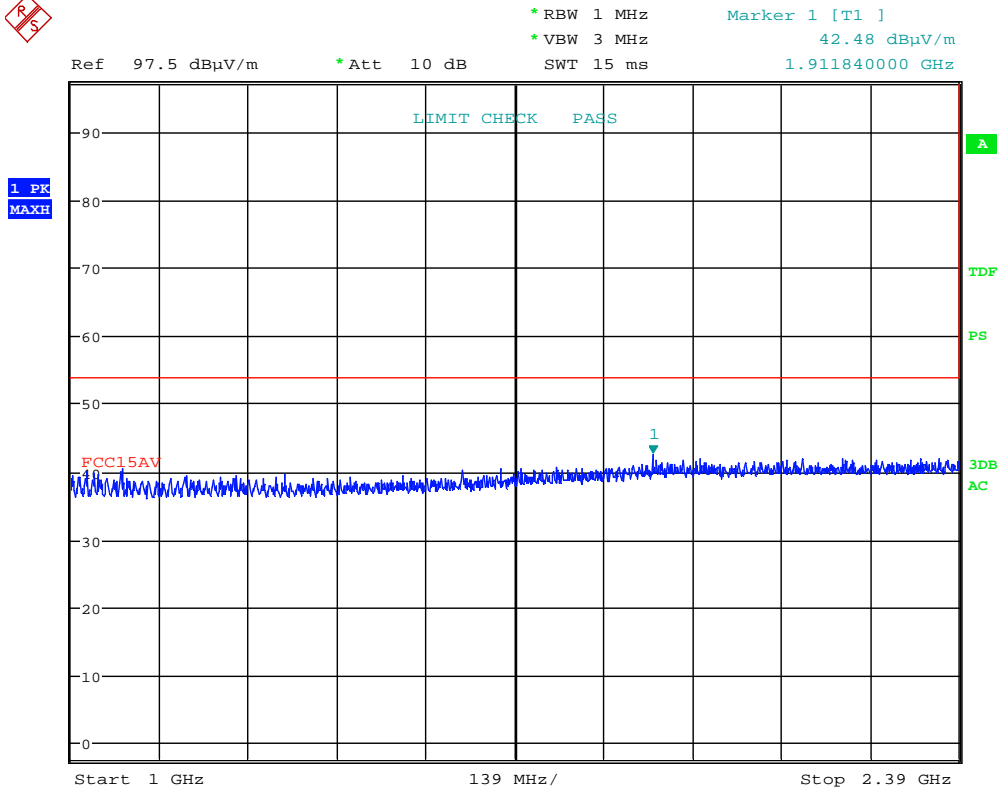
Average Detector values are calculated from Peak values by Duty Cycle Correction Factor.

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 4, Clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency (MHz)	AV (dBμV/m)	Peak (dBμV/m)
Above 1 GHz	54.0	74.0

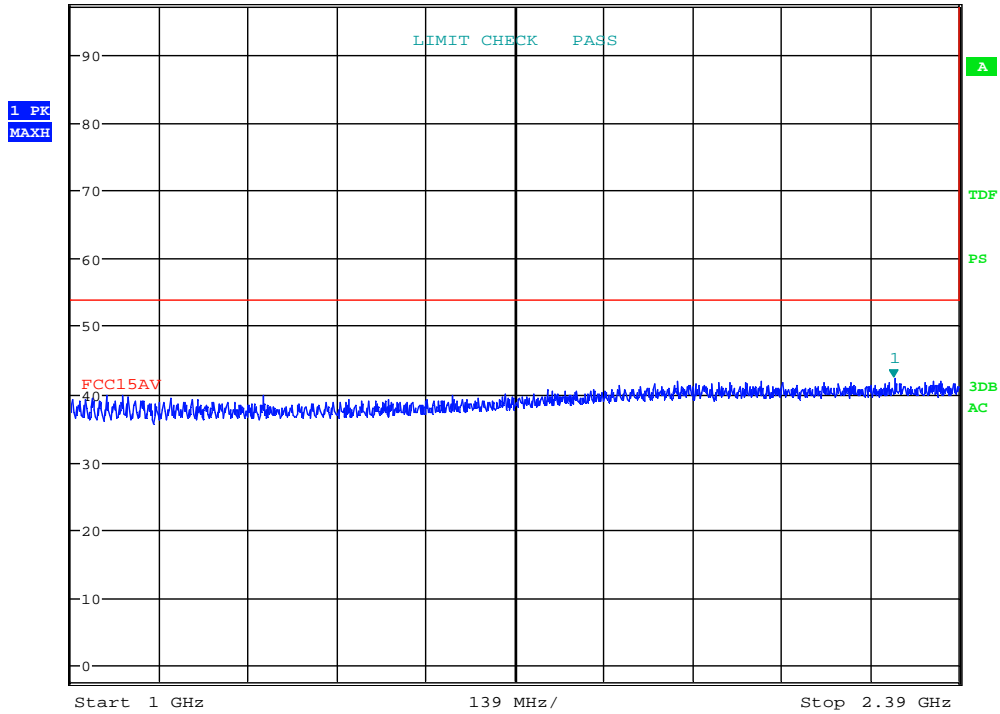


Date: 9.FEB.2017 13:36:09

Radiated Emissions, 1000 -2390MHz, 2405 MHz, HP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 42.42 dBµV/m
 *Att 10 dB SWT 15 ms 2.288252000 GHz

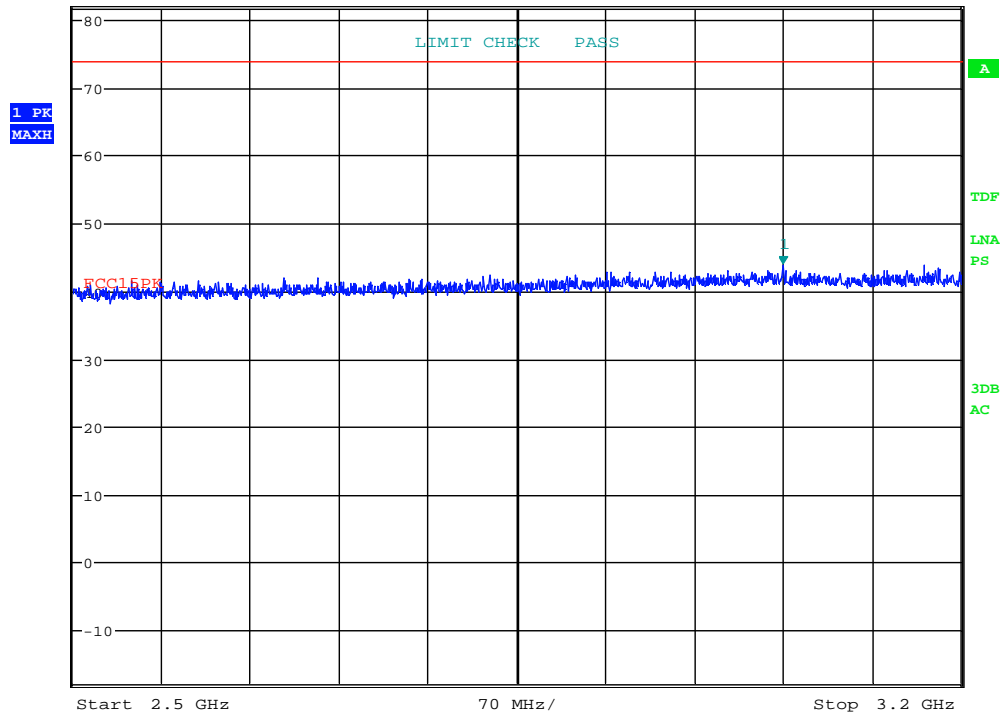


Date: 9.FEB.2017 13:34:17

Radiated Emissions, 1000 -2390MHz, 2405 MHz, VP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 43.90 dBµV/m
 *Att 10 dB SWT 15 ms 3.059720000 GHz
 Ref 82 dBµV/m

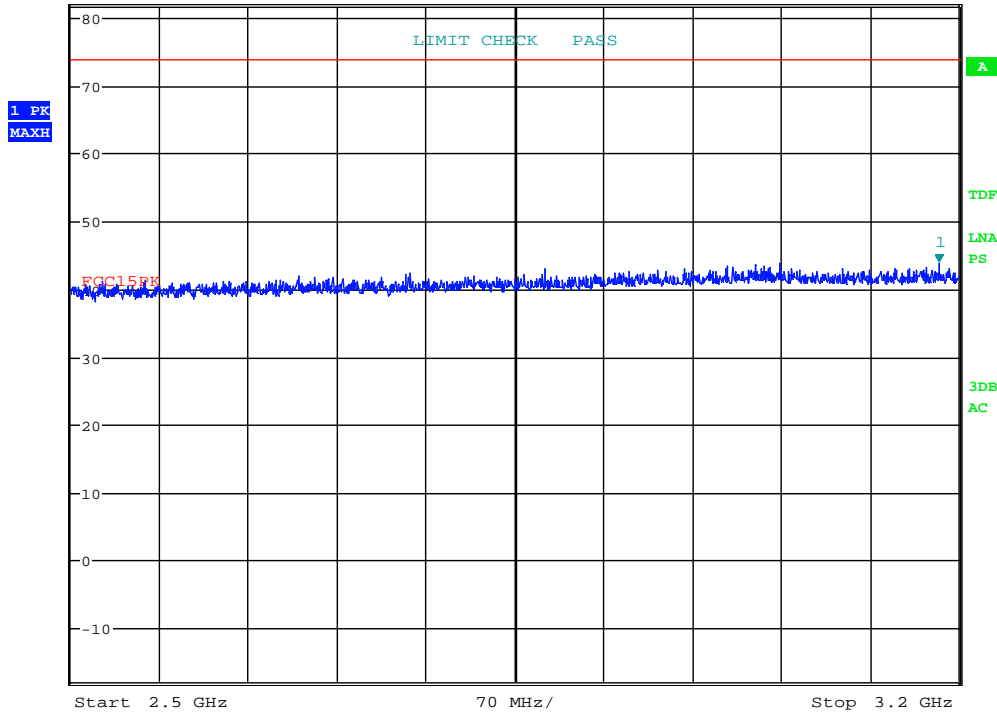


Date: 9.FEB.2017 17:17:23

Radiated Emissions, 2500 -3200MHz, 2480 MHz, HP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 43.92 dBµV/m
 *Att 10 dB SWT 15 ms 3.184320000 GHz

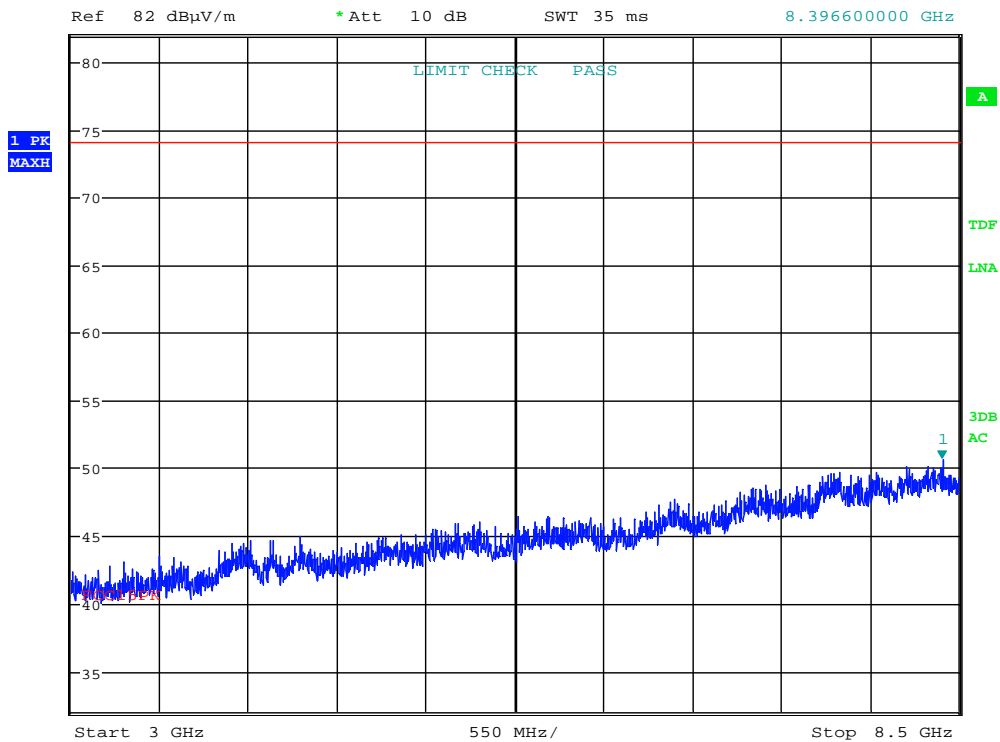


Date: 9.FEB.2017 17:15:31

Radiated Emissions, 2500 -3200MHz, 2480 MHz, VP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 50.67 dBµV/m
 *Att 10 dB SWT 35 ms 8.396600000 GHz

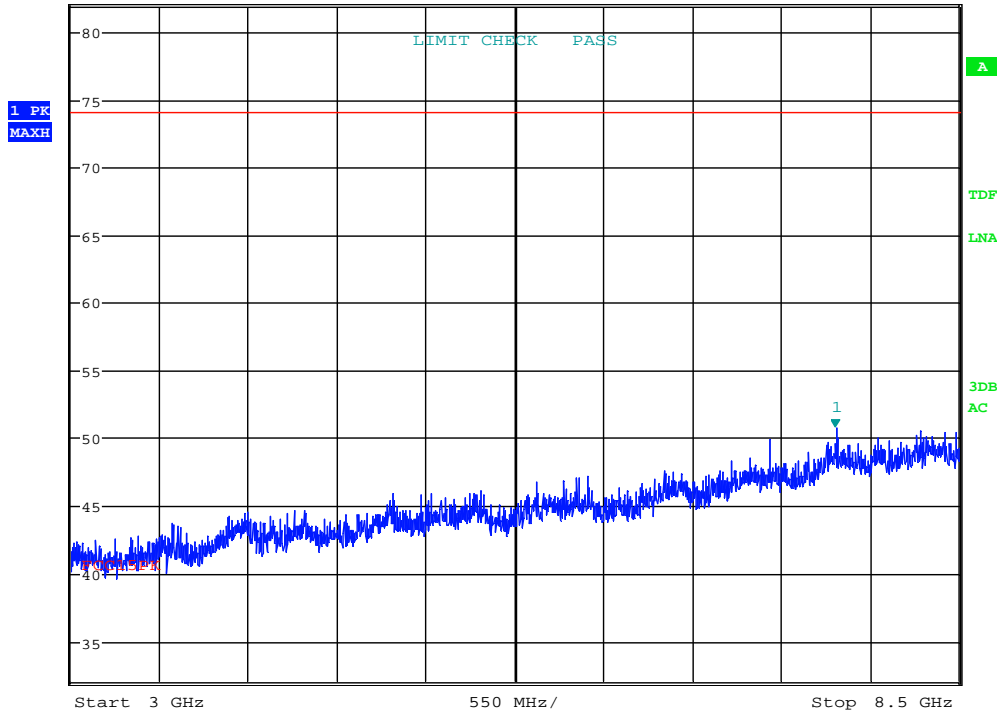


Date: 9.FEB.2017 17:25:15

Radiated Emissions, 3000 -8500MHz, 2440 MHz, HP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 50.73 dBµV/m
 *Att 10 dB SWT 35 ms 7.736600000 GHz

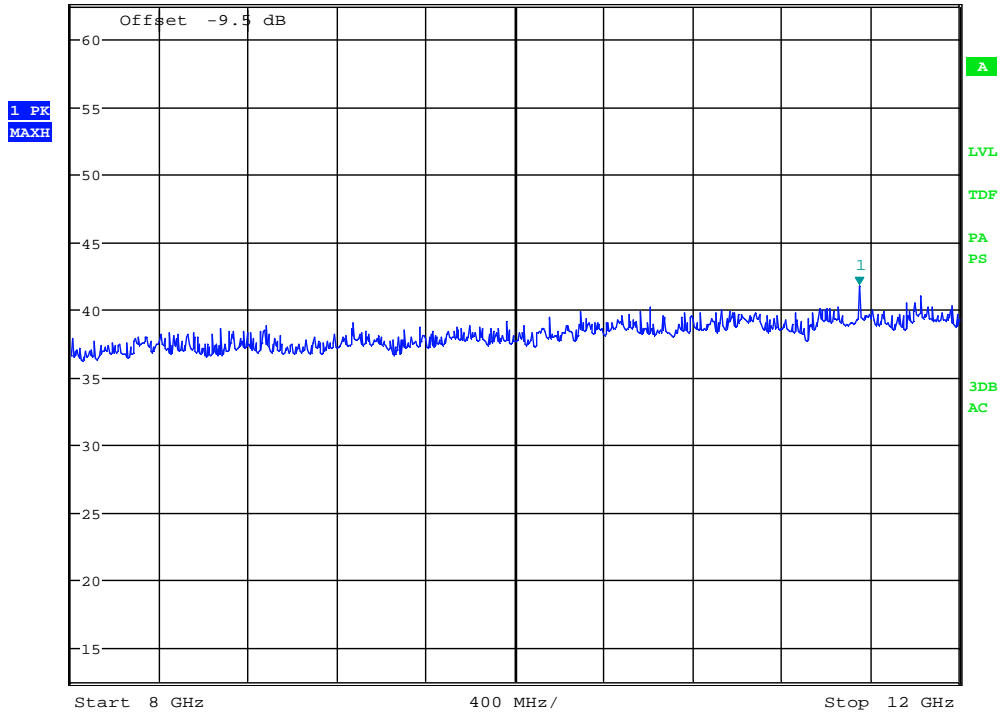


Date: 9.FEB.2017 17:23:22

Radiated Emissions, 3000 -8500MHz, 2440 MHz, VP



Ref 62.5 dBµV *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 41.74 dBµV
 SWT 25 ms 11.551282051 GHz

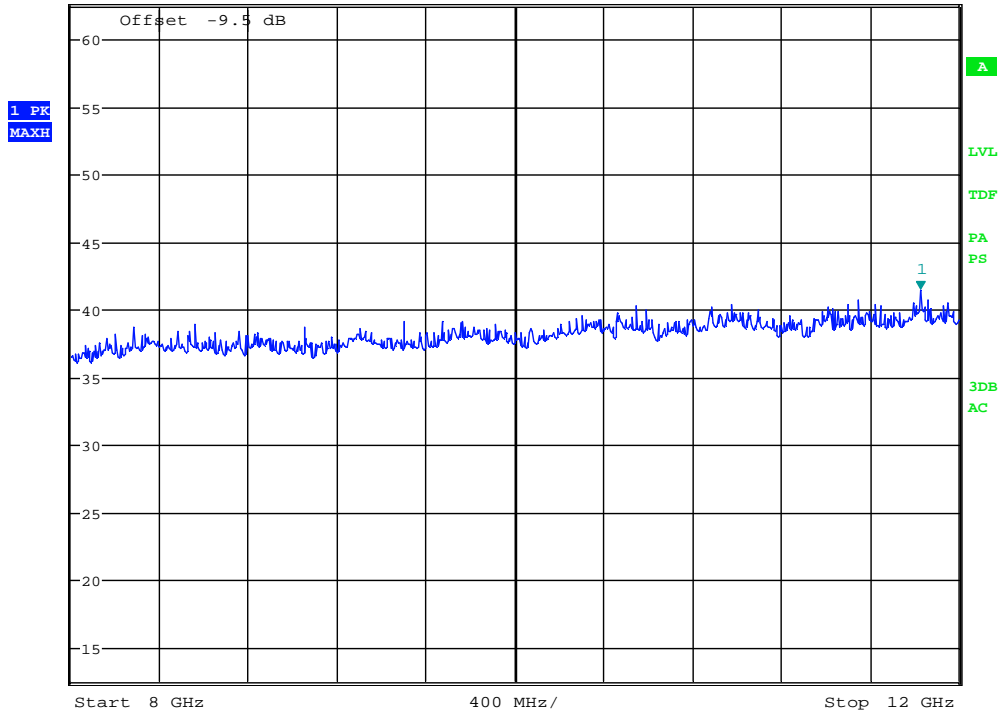


Date: 13.FEB.2017 12:34:46

Radiated Emissions, 8000 -12000MHz, 2440 MHz, HP



Ref 62.5 dBµV *Att 10 dB *RBW 1 MHz Marker 1 [T1] 41.48 dBµV
 *VBW 3 MHz SWT 25 ms 11.826923077 GHz

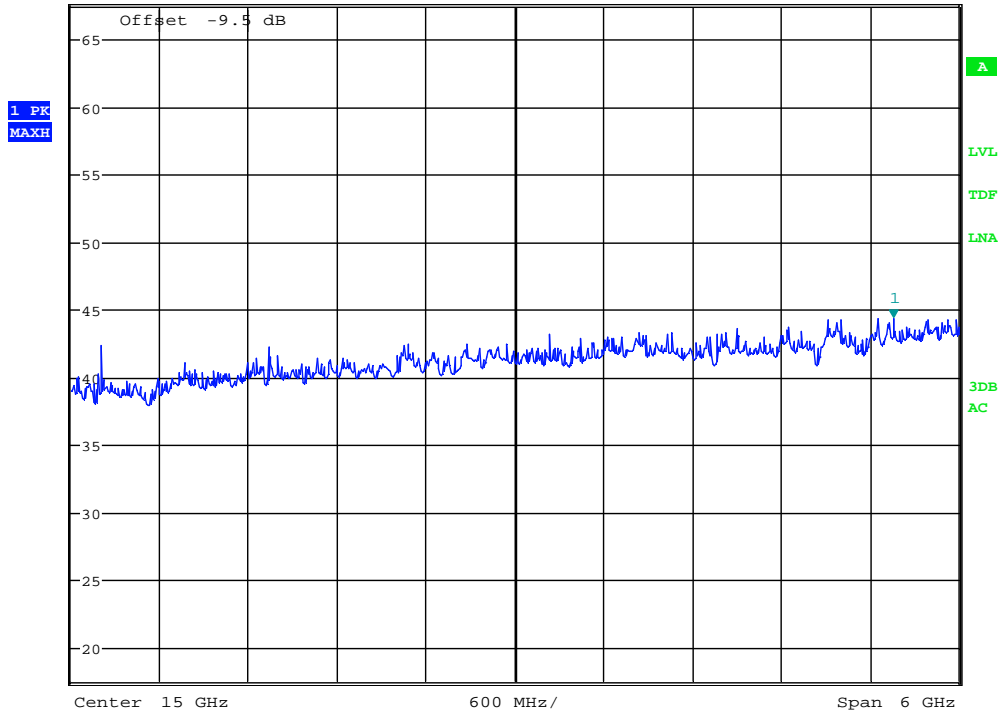


Date: 13.FEB.2017 12:32:53

Radiated Emissions, 8000 -12000MHz, 2440 MHz, VP



*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 44.32 dBµV
 *Att 10 dB SWT 35 ms 17.557692308 GHz
 Ref 67.5 dBµV Offset -9.5 dB

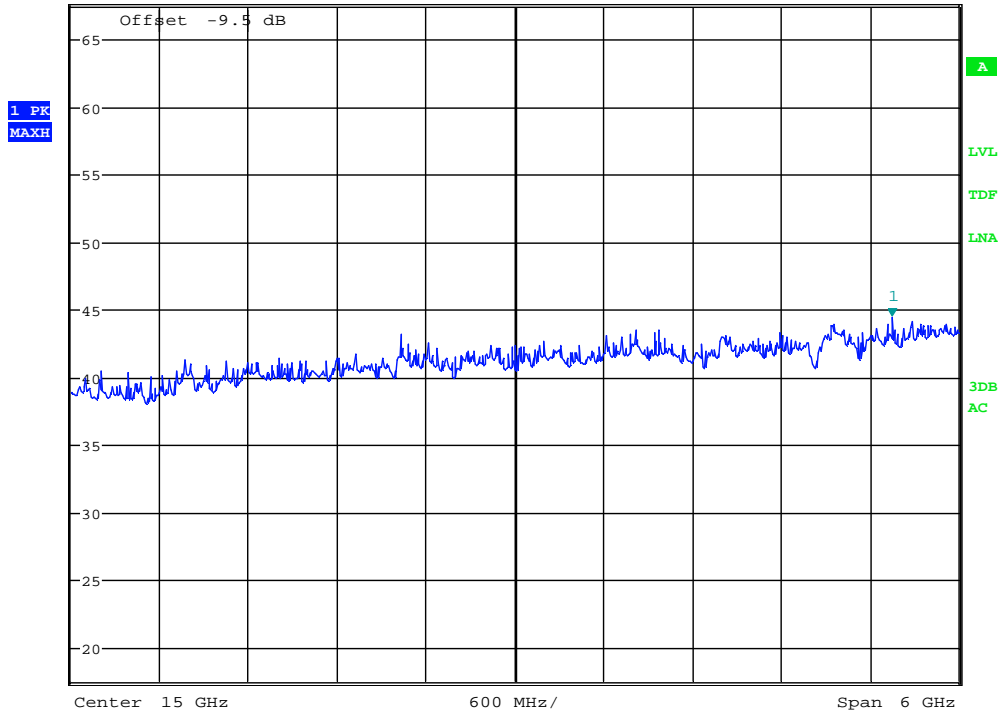


Date: 13.FEB.2017 13:15:49

Radiated Emissions, 12000 -18000MHz, 2440 MHz, HP



Ref 67.5 dBµV *Att 10 dB *RBW 1 MHz Marker 1 [T1] 44.45 dBµV
 *VBW 3 MHz SWT 35 ms 17.548076923 GHz



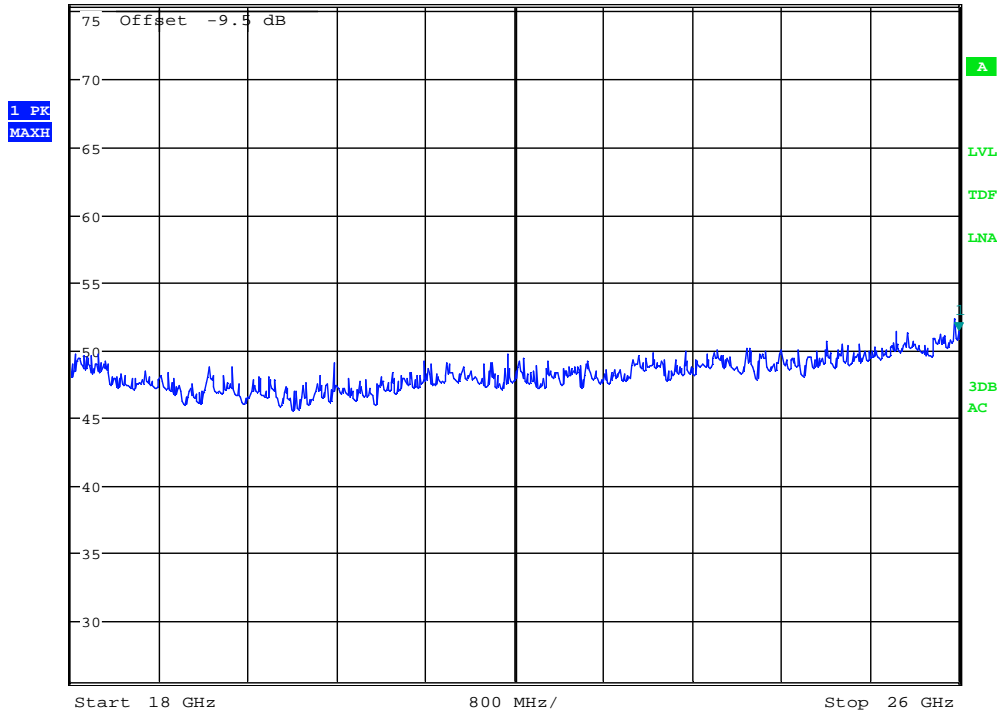
Date: 13.FEB.2017 13:13:57

Radiated Emissions, 12000 -18000MHz, 2440 MHz, VP



MARKER 1
 26 GHz
 Ref 75.5 dBµV/m *Att 10 dB

*RBW 1 MHz Marker 1 [T1]
 *VBW 3 MHz 51.37 dBµV/m
 SWT 50 ms 26.000000000 GHz



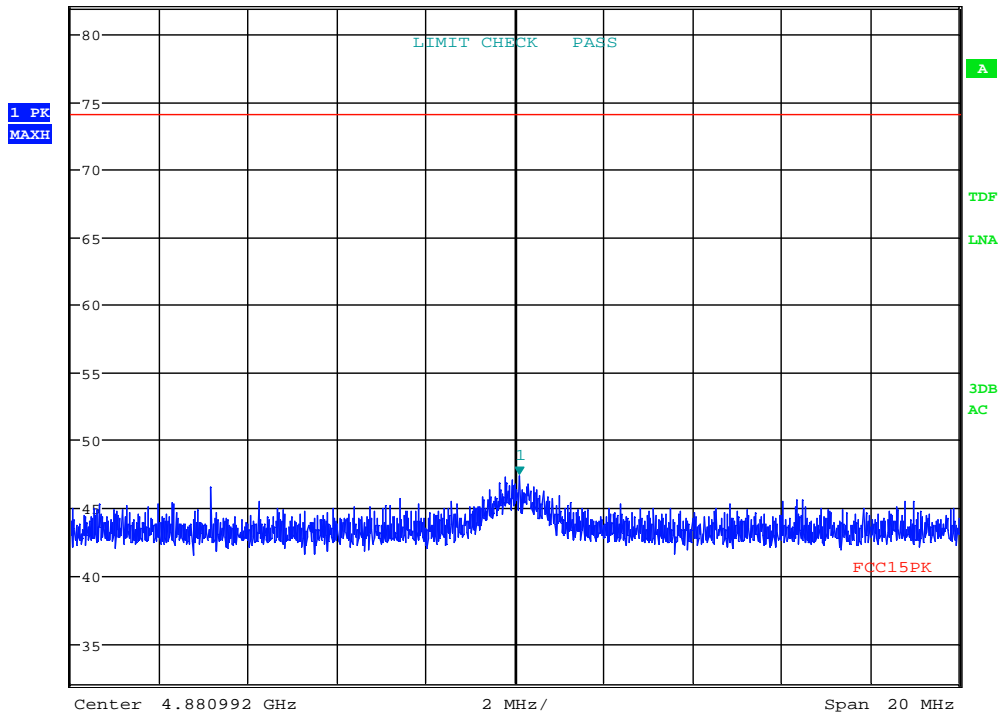
Date: 13.FEB.2017 14:01:31

Pre-scan, 18000 -26000MHz, 2440 MHz, 10cm



*RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 47.34 dBµV/m
 SWT 20 ms 4.881088000 GHz

Ref 82 dBµV/m *Att 10 dB



Date: 9.FEB.2017 17:32:23

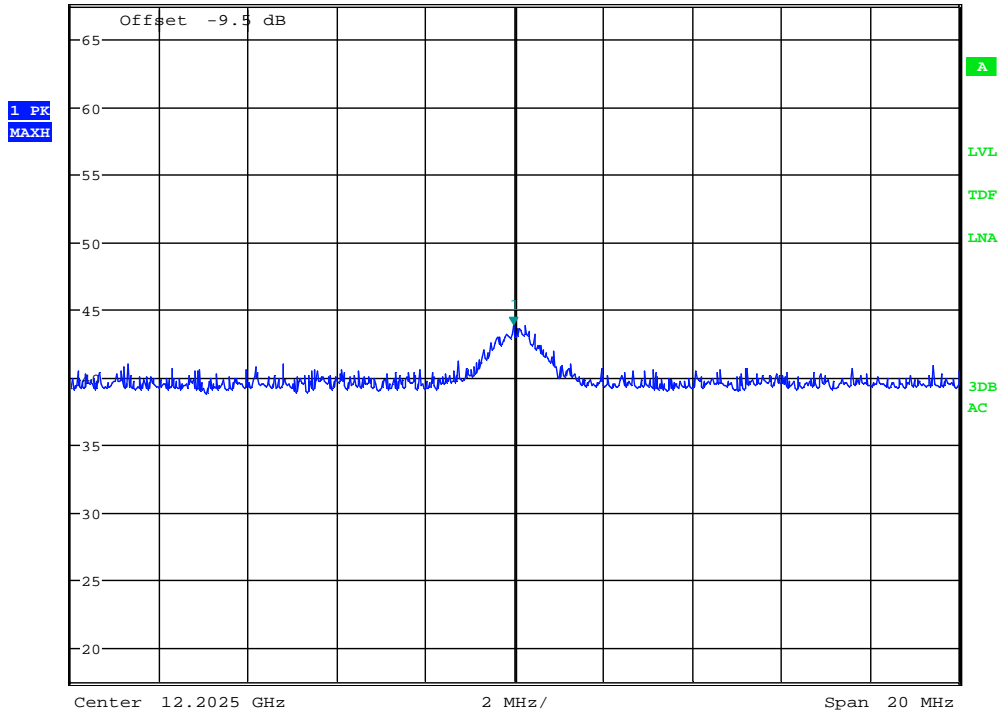
Radiated Emissions, 4880MHz, 2440 MHz, (Max: EUT H1, VP)



MARKER 1
12.20246795 GHz
Ref 67.5 dBμV *Att 0 dB

*RBW 1 MHz
*VBW 3 MHz
SWT 20 ms

Marker 1 [T1]
43.84 dBμV
12.202467949 GHz



Date: 13.FEB.2017 13:34:45

Radiated Emissions, 12200MHz, 2440 MHz, (Max: EUT V, 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

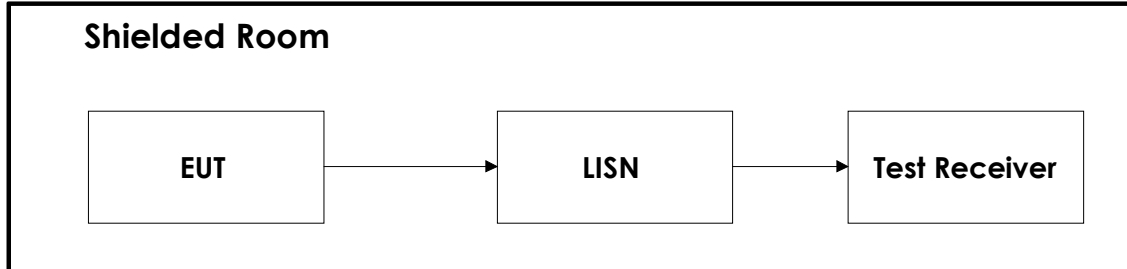
To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2016.12	2017.12
2	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	Cal b4 use	
3	HK116	Biconical Antenna	Rohde & Schwarz	LR 1260	2013.12	2018.12
4	HL223	LogPeriod Antenna	Rohde & Schwarz	LR 1261	2013.12	2018.12
5	317	Preamplifier	Sonoma Instrument	LR 1687	2016.05	2017.05
6	3115	Horn Antenna	EMCO	LR 1330	2016.10	2021.10
7	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2016.10	2017.10
8	PM7320X	Antenna Horn	Sivers Lab	LR 102	2009.01	2019.01
9	DBF-520-20	Antenna Horn	Systron Donner	LR 100	2009.01	2019.01
10	638	Antenna Horn	Narda	LR 1480	2010.06	2020.06

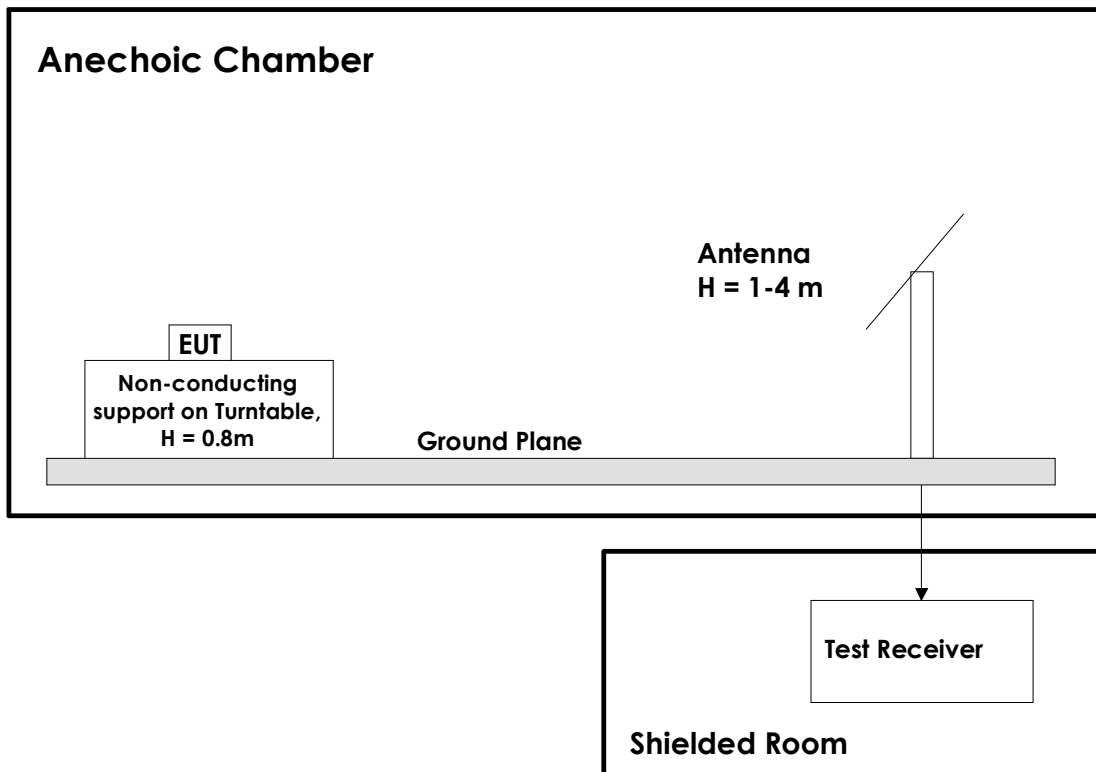
Test Software List			
Description	Manufacturer	Model	Version
/	/	/	/

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



Measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers.

Revision history

Version	Date	Comment	Sign
1.0	2017.03.29	First edition	FS