

Test Report

Product	SmartBadge™	
Name and address of the applicant	Sonitor Technologies AS Drammensveien 288, 0283 Oslo, Norway	
Name and address of the manufacturer	Sonitor Technologies AS Drammensveien 288, 0283 Oslo, Norway	
Model	Tag-L	
Rating	3.0Vdc, 550mAH	
Trademark	Sonitor Sense™	
Serial number	000962091002	
Additional information	Contains Microchip RN-171-I/RM wi-fi module and 125kHz Low frequency receiver: FCC ID: T9J-RN171, IC ID: 6514A-RN171	
Tested according to	FCC Part 15.247 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	321527	
Tested in period	2017.06.06 to 2017.06.30	
Issue date	2017.07.05	
Name and address of the testing laboratory	 <div style="display: inline-block; vertical-align: top; margin-left: 20px;"> FCC No: 994405 IC OATS: 2040D-1 TEL: +47 22 96 03 30 FAX: +47 22 96 05 50 </div> <div style="display: inline-block; vertical-align: top; margin-left: 20px;"> Instituttveien 6 Kjeller, Norway </div>	
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Prepared by [G.Suhanthakumar] </div> <div style="text-align: center;">  Approved by [Frode Sveinsen] </div> </div>		
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1 INFORMATION

1.1 Test Item

Name :	Sonitor
FCC ID :	2AD7T11117060601
Industry Canada ID :	20330-11117060601
Model/version :	L422
Serial number :	000962091002
Hardware identity and/or version:	V1.1
Software identity and/or version :	-
Frequency Range :	2412 - 2462 MHz
Number of Channels :	11
Operating Modes :	IEEE 802.11g
Type of Modulation :	OFDM
User Frequency Adjustment :	None
Output Power :	0.0082W (Conducted)
Type of Power Supply :	3.0Vdc , Battery
Number of Antennas :	1
Antenna Type :	Johanson Technology, Part number 2450AT42A100
Antenna Gain (Peak) :	1.8 dBi

Description of Test Item

The Sonitor Sense™ SmartBadge series has been designed focusing on ease of use, hygiene, long battery life and reliability. The badge is equipped with two buttons that can be pressed to initiate a variety of alerts and notifications through third party software applications. Examples of alerts and notifications are attention, help and rounding. The badge's multi-colored LED is lit as a visual confirmation when a button is pressed. It can be used as personnel tags or as equipment tag to track the location of the person or the equipment in real time.

Theory of Operation

The SmartBadge supports industry standard 802.11 positioning and communication, which means that it can be deployed in virtually any existing or new enterprise Wi-Fi infrastructure. By means of Wi-Fi trilateration alone the SmartBadge can be positioned down to a resolution of 15 - 30 feet. In areas requiring a higher degree of accuracy, the SmartBadge supports ultrasound and low frequency RF assisted positioning. In ultrasound mode, using the Sonitor virtual divider functionality, the SmartBadge series can be reliably and accurately positioned at room level as well as sub room level, such as bay, at a rate of one update per second.

In positioning mode the SmartBadge uses one-way 802.11 communication to the 802.11 access point infrastructure achieving a combination of fast communication, low consumption of bandwidth and good battery life. In configuration mode the SmartBadge supports two way 802.11 communication, enabling remote configuration and firmware upgrades.

1.2 Test Environment

1.2.1 Normal test condition

Temperature:	20 - 23 °C
Relative humidity:	20 - 47 %
Normal test voltage:	3.0Vdc

The values are the limit registered during the test period.

1.3 Test Engineer(s)

G.Suhandhakumar

1.4 Description of modification for Modification Filing

Not applicable.

1.5 Family List Rational

The following model variations are using the same LF receiver.

VA no.	Variant	Comment
1	Tag-L422	Ultrasound, wi-fi, Low Frequency Receiver
2	Tag-J432	Ultrasound, wi-fi, Low Frequency Receiver, Duress. Buttons can be used to activate an alert signal.
3	Tag-L433	Ultrasound, wi-fi, Low Frequency Receiver, Duress. The red pull bridge can be used to activate an alert signal.

Note: Items that are shaded have been subject to testing documented in this report. Opinions expressed regarding application of test results to variant models are not part of our current accreditation.

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

1.6 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.

The is the only data rates were used:

802.11g mode : 6 Mbps

1.7 Comments

Fully charged battery is used.

All ports were populated during spurious emission measurements.

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 15.247 and ISSED RSS-247 Issue 2.

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 distances of 3m and 10m.

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

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

DTS 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-247 Issue 2, RSS-GEN Issue 4 reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	N/A ¹
Antenna Requirement	15.203	8.3 (RSS-GEN)	N/A ²
Power Line Conducted Emission	15.107(a) 15.207(a)	8.8 (RSS-GEN)	N/A ³
20 dB Bandwidth	N/A	6.6 (RSS-GEN)	N/A
Peak Power Output	15.247(b)	5.4 (RSS-247)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	Complies
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

¹ Fully charged battery is used

² Integral antenna

³ EUT is battery powered only

3 TEST RESULTS

3.1 Minimum 20 dB Bandwidth

Para. No.: 15.247 (a)(2)

Test Performed By: G.Suwanthakumar	Date of Test: 2017.06.06
------------------------------------	--------------------------

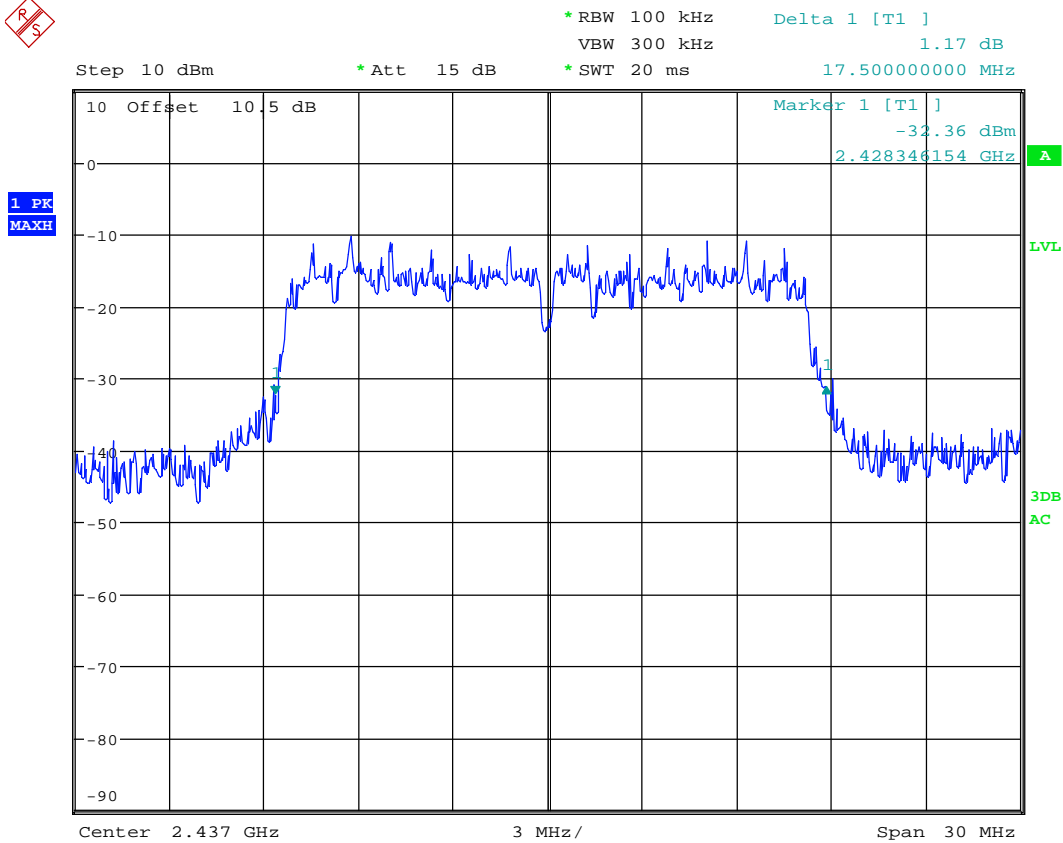
Test Results: Complies

Measurement Data:

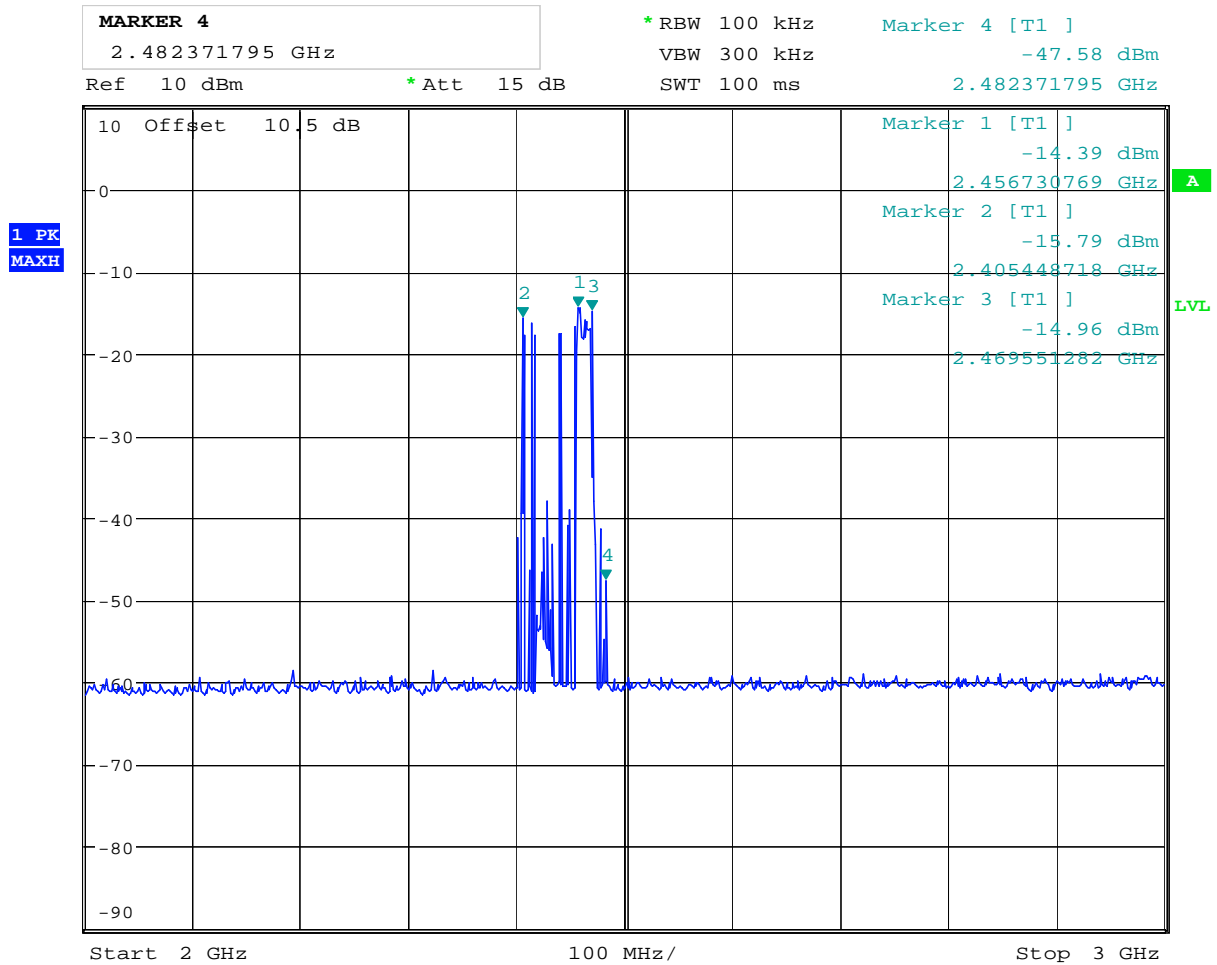
Measured 20 dB Bandwidth (MHz)		
-	2437 MHz, Ch 6	-
-	17.5	-

Requirements:

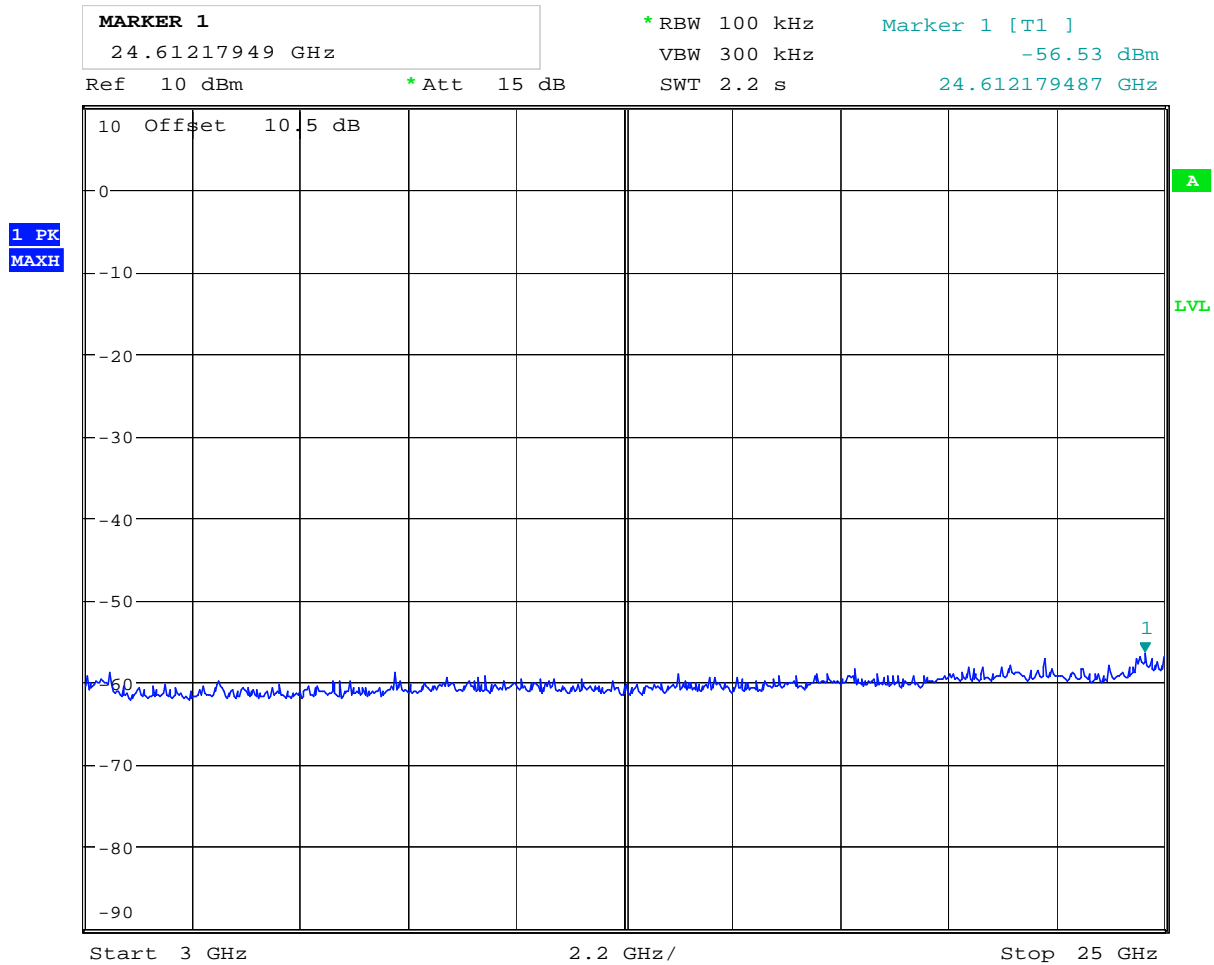
No requirements, reported for information only.



Date: 23.JUN.2017 19:29:22



Date: 5.JAN.2000 00:18:44



Date: 5.JAN.2000 00:22:23

20 dB BW, Ch2437MHz

3.2 Peak Power Output

Para. No.: 15.247 (b)

Test Results: Complies

Measurement Data:

RF channel	2412 MHz	2437 MHz	2462 MHz
Measured Maxium Field strength (dBμV/m) –HP	104.1	103.5	106.13
Calc. Radiated Power (dBm)	8.90	8.23	10.90
Calc. Radiated Power (mW)	7.76	6.65	12,31
Measured Conducted Power (dBm)	8.7	9.1	9.1
Measured Conducted Power (mW)	7.3	8.2	8.2
Calculated Antenna Gain (dBi)	0.3	-0.9	1.8

Antenna gain = $10 \cdot \log(\text{EIRP}/\text{Conducted power})$ dBi

EIRP is calculated from measured field strength by the formulas in KDB 412172 D01 Determining ERP and EIRP v01.

The maximum field strength is obtained in Horizontal polarization.

See attached graph.

Requirements:

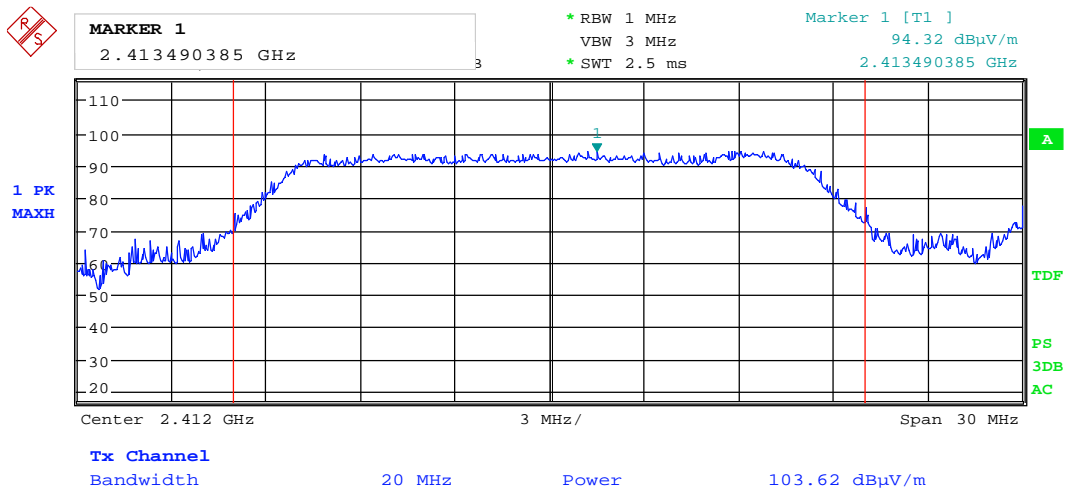
The maximum peak output power shall not exceed the following limits:

For frequency hopping systems employing at least 75 hopping channels: 1 Watt

For all other frequency hopping systems in the 2400 - 2483.5 MHz band: 0.125 Watts

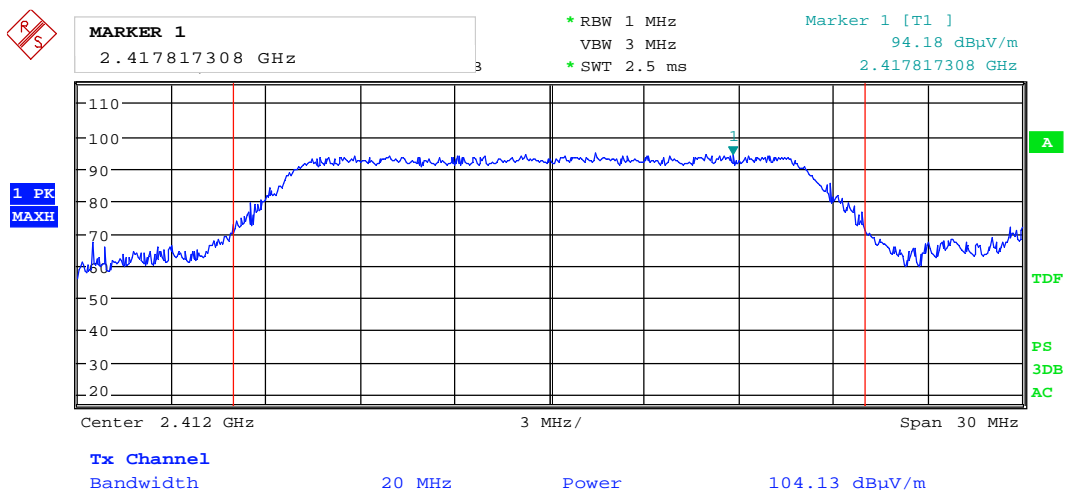
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



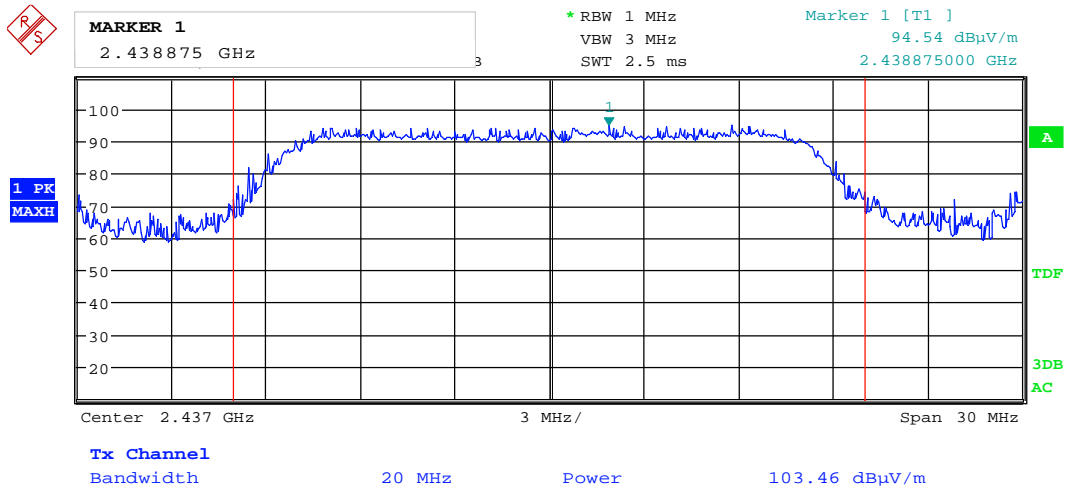
Date: 6.JUN.2017 15:02:52

Field strength 2412 MHz, ch01 – HP



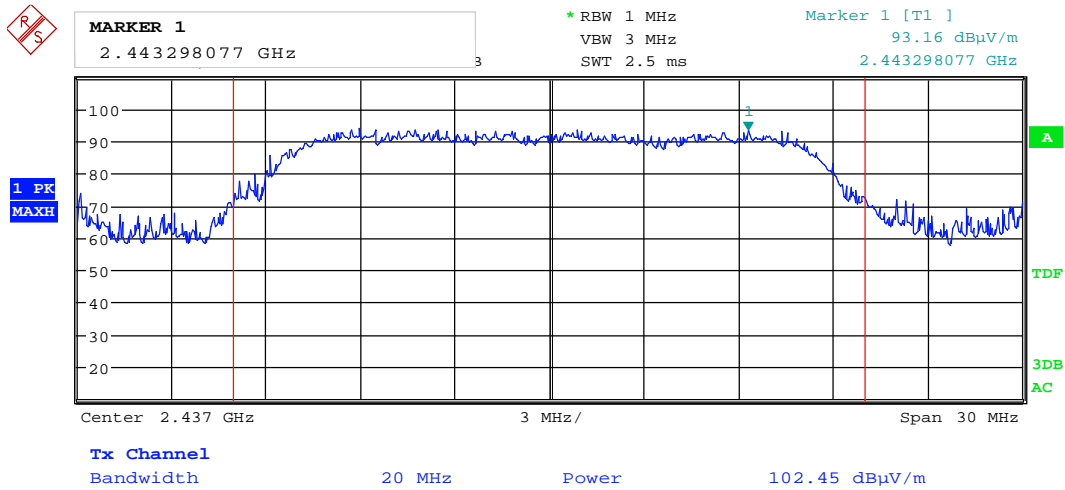
Date: 6.JUN.2017 14:54:04

Field strength 2412 MHz, ch01 - VP



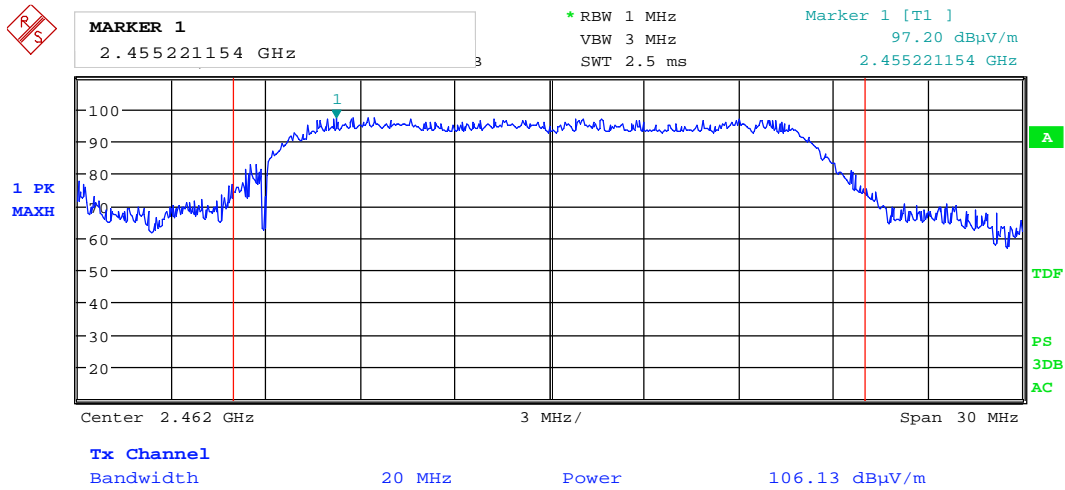
Date: 6.JUN.2017 15:36:29

Field strength 2437 MHz, ch01 – HP



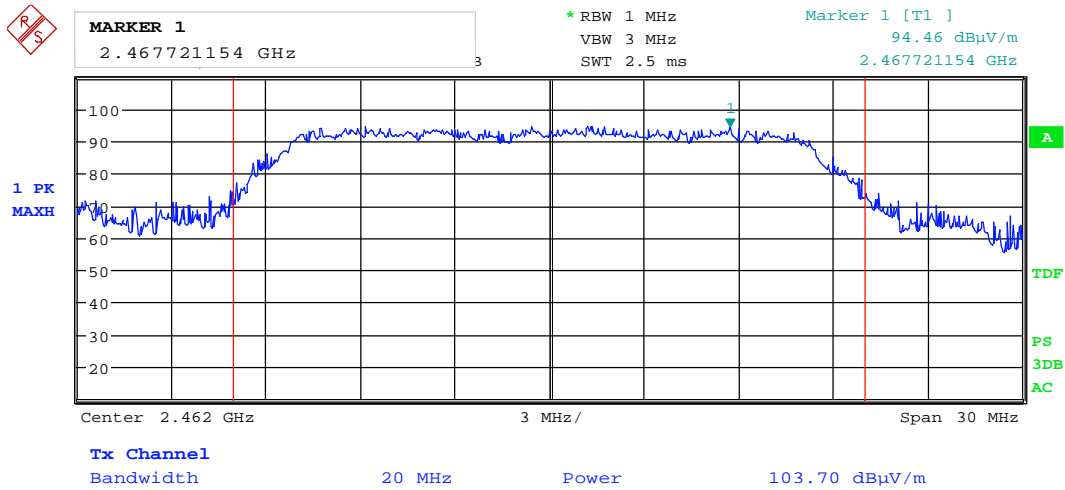
Date: 6.JUN.2017 15:33:20

Field strength 2437 MHz, ch01 - VP



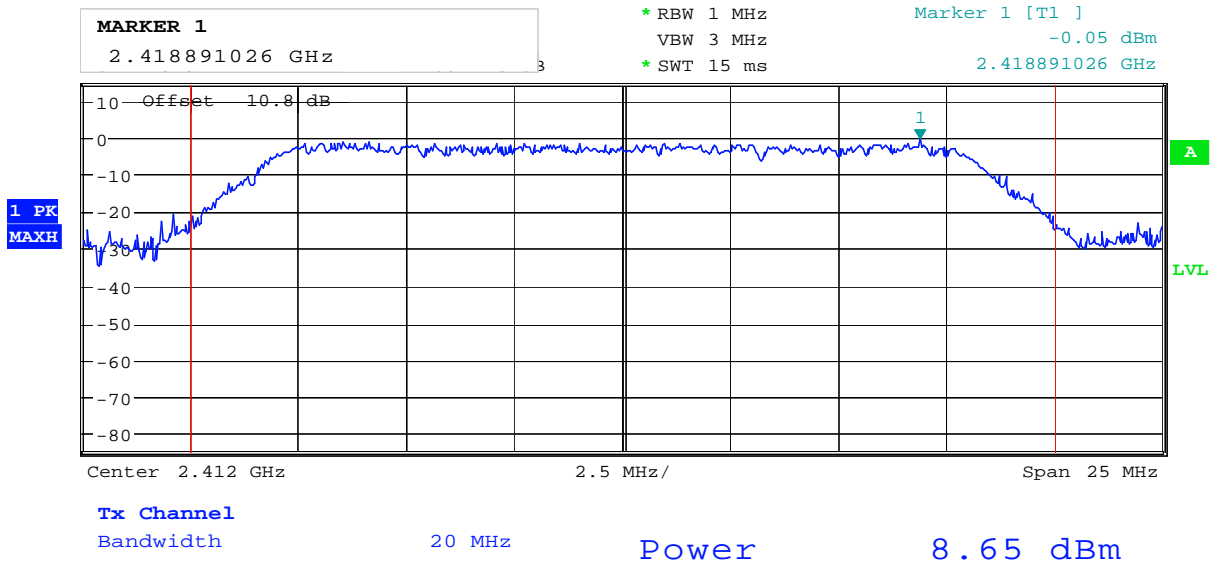
Date: 23.JUN.2017 09:59:01

Field strength 2462 MHz, ch01 – HP



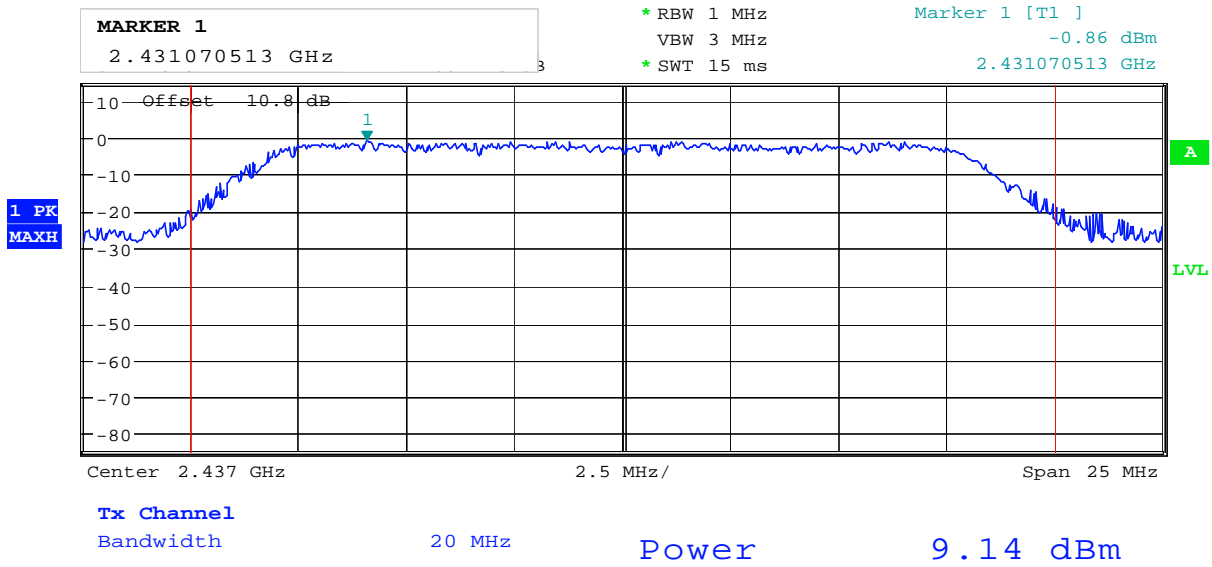
Date: 23.JUN.2017 09:51:15

Field strength 2462 MHz, ch01 - VP



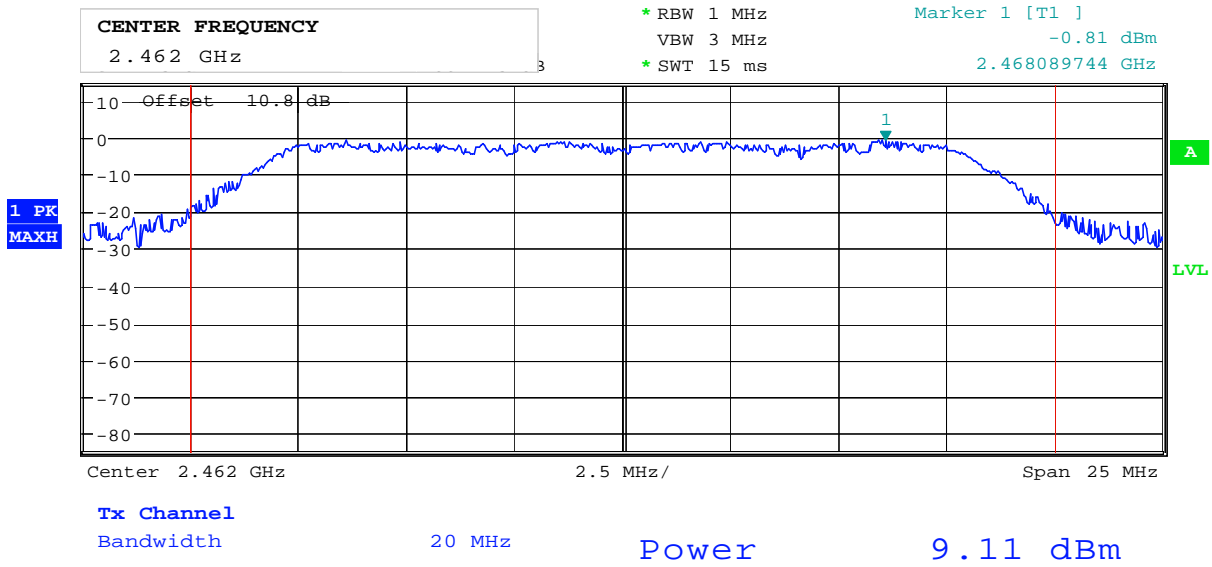
Date: 7.JUN.2017 09:49:21

Conducted power 2412 MHz, ch01



Date: 7.JUN.2017 09:42:40

Conducted power 2437 MHz, ch06



Date: 7.JUN.2017 09:45:55

Conducted power 2462 MHz, ch11

3.3 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Results: Complies

Measurement Data:

Band-edge conducted power

	Measured field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dBμV/m	dB	
Peak Detector	55.2	63.7	74	18.8	10.3
Average Detector	-	43.7	54	-	10.3

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

See attached plots.

Measured :

Duty Cycle Correction Factor Calculation:

Duty Cycle = $123.19\mu\text{s} / (123.19\mu\text{s} + 5.076\text{ms})$

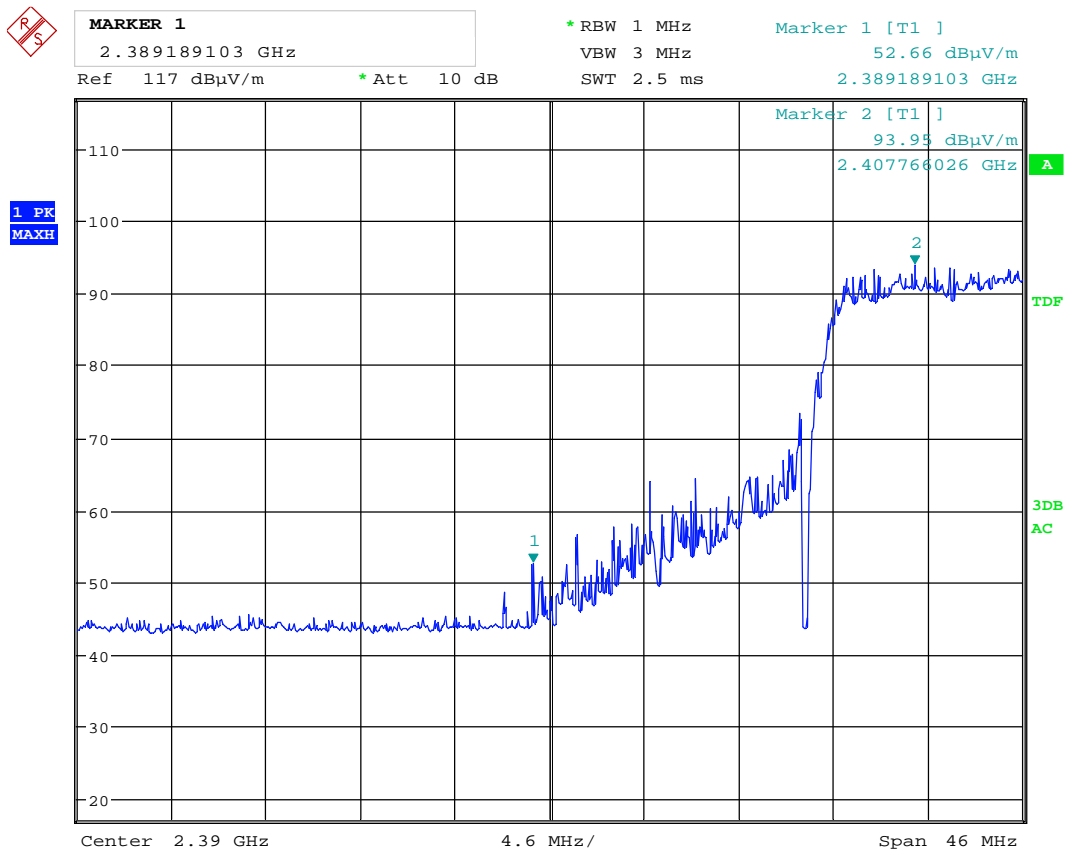
Duty Cycle Correction factor = $-20 \times \log(0.0237) = 32.5 \text{ dB}$

Declared duty cycle by the manufacturer:

0.14% in normal use

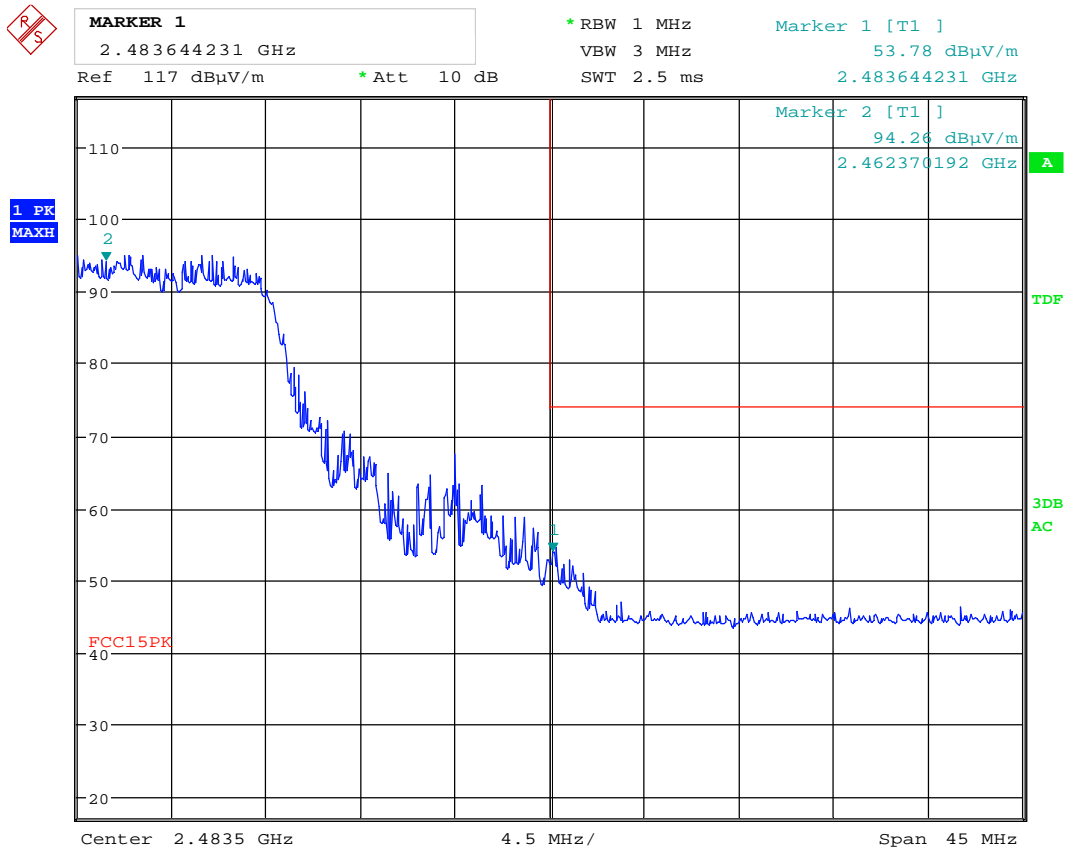
Duty Cycle Correction factor = $-20 \times \log(0.014) = 37.1 \text{ dB}$

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



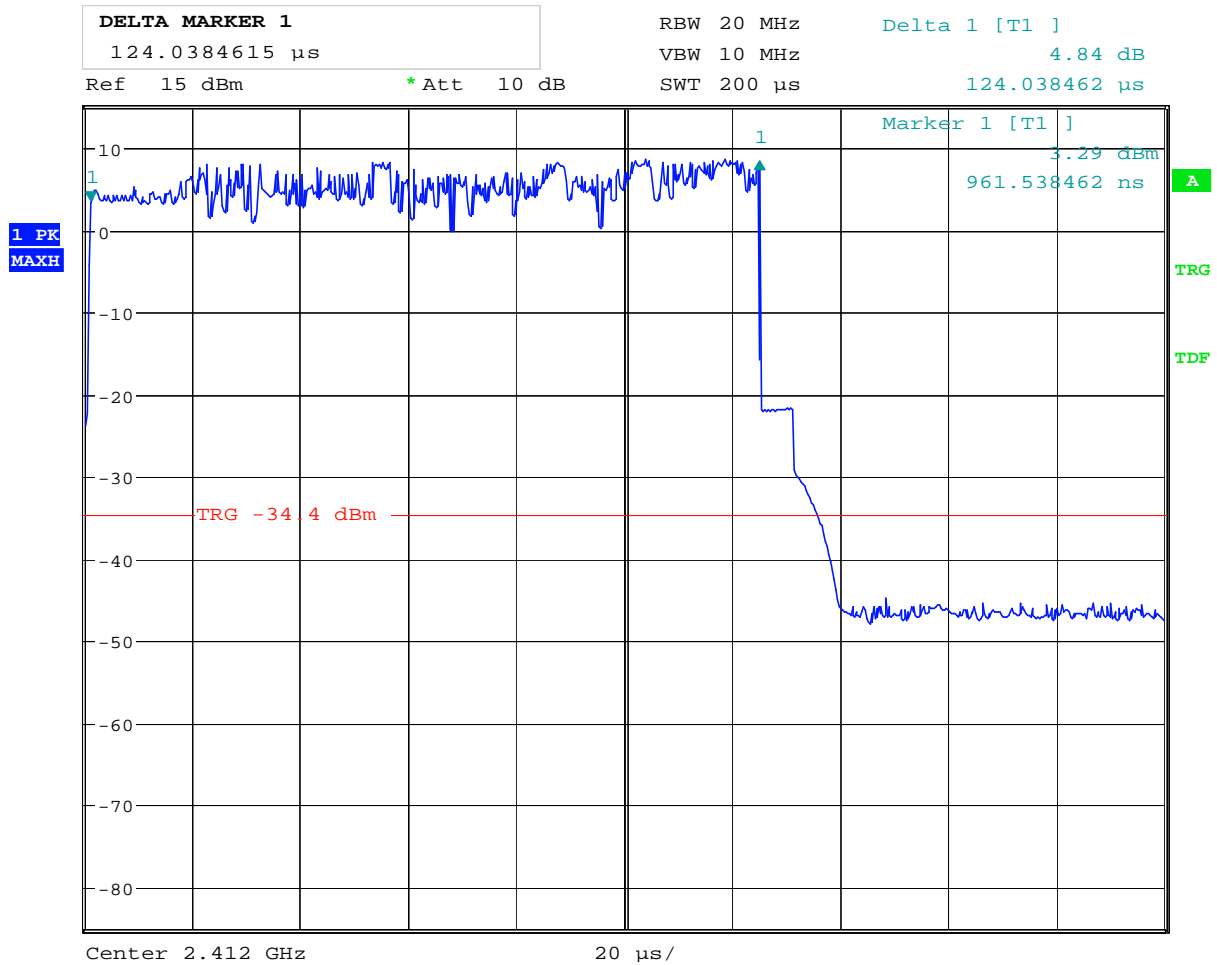
Date: 6.JUN.2017 15:14:48

Lower Band Edge, Ch01, 2412MHz, PK



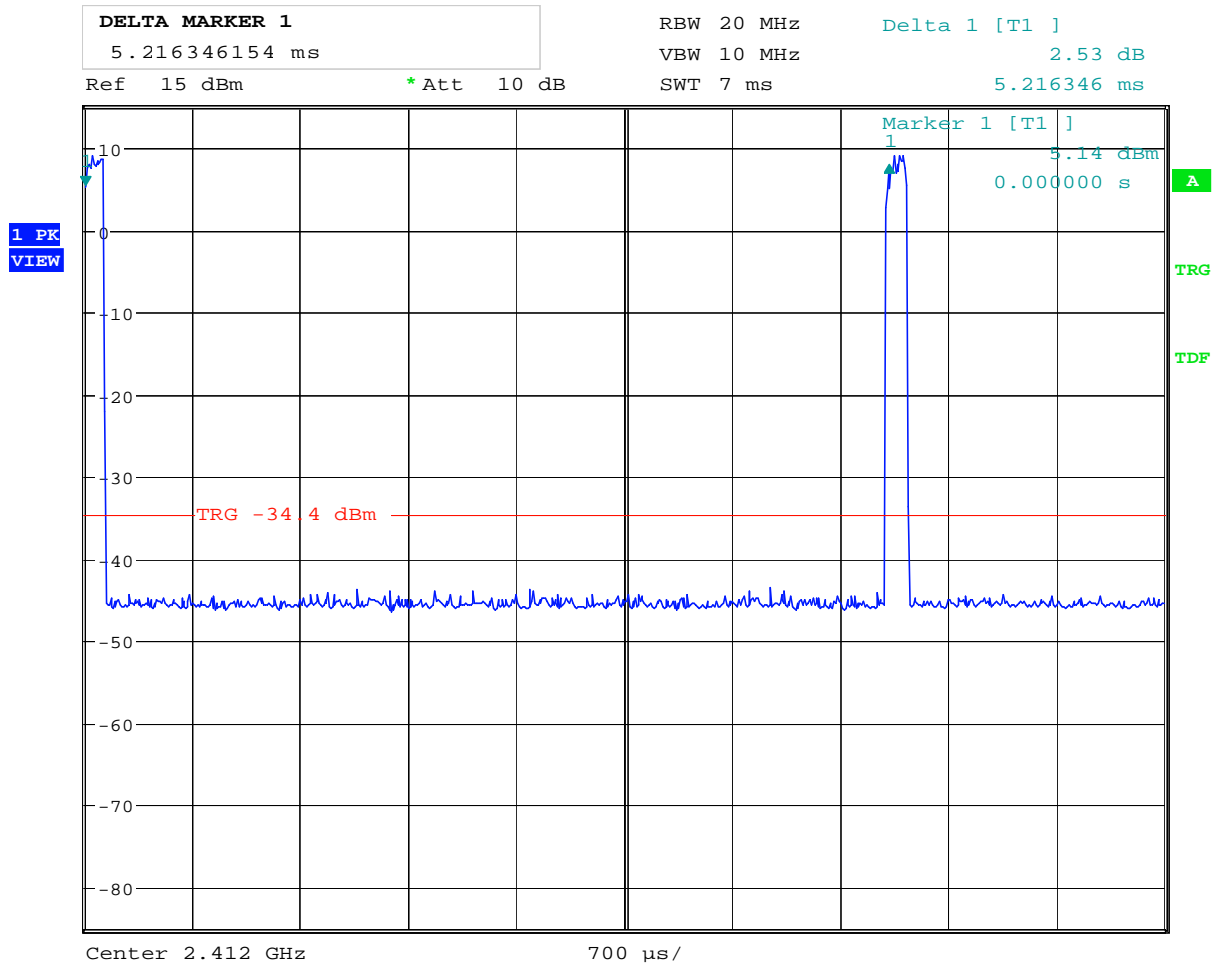
Date: 6.JUN.2017 15:22:35

Upper Band Edge ch11, 2462MHz, PK



Date: 6.JUN.2017 08:56:49

Burst ON-time



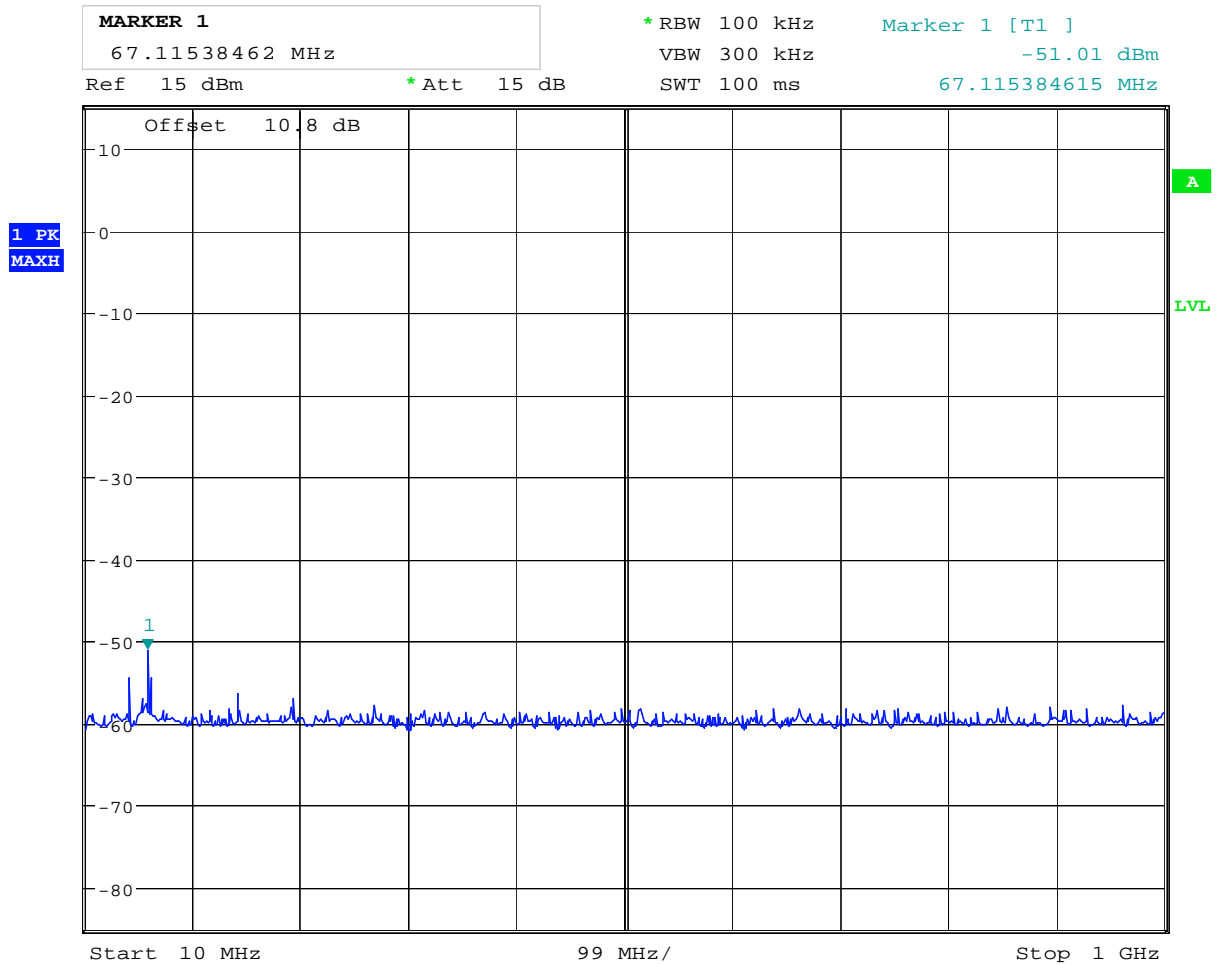
Date: 6.JUN.2017 08:55:31

Burst ON +OFF-time

RF conducted power to 25 GHz see attached graph.

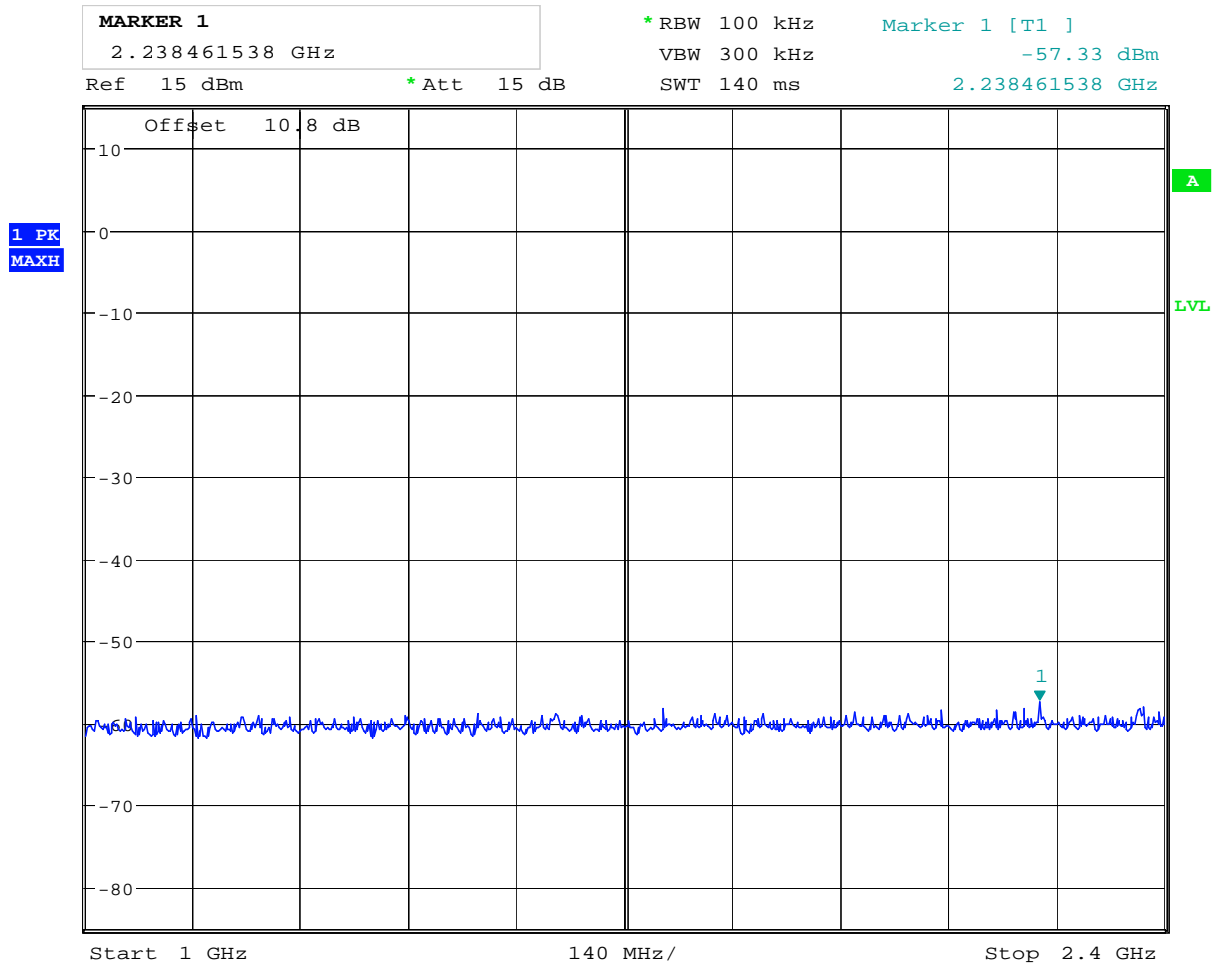
Maximum RF level outside operating band:

RF ch ch01, ch06 & ch11: 47 dB/C, margin >20 dB



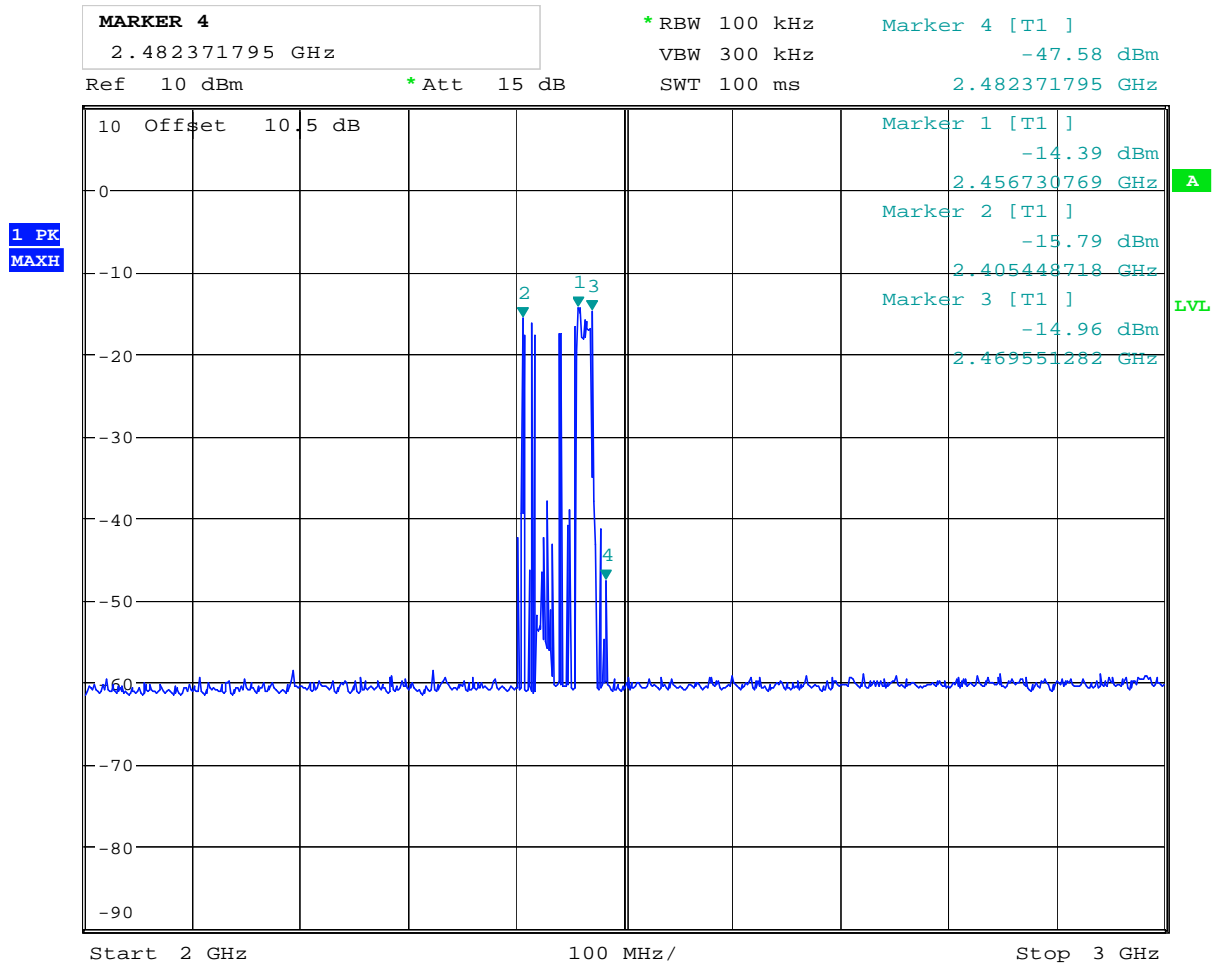
Date: 7.JUN.2017 09:17:08

Conducted spurious emissions, 10MHz – 1GHz



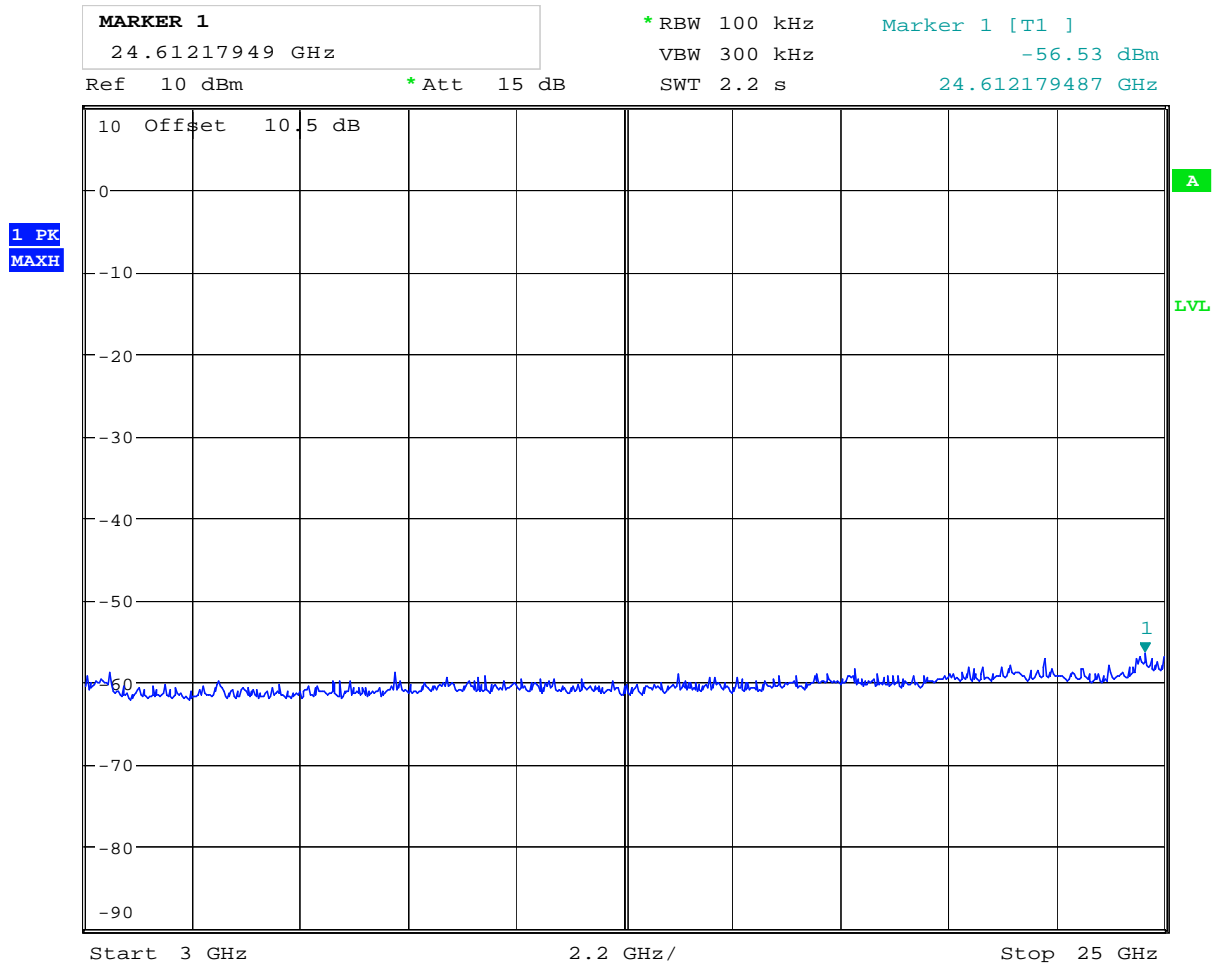
Date: 7.JUN.2017 09:20:46

Conducted spurious emissions, 1MHz – 2.4GHz



Date: 5.JAN.2000 00:18:44

Conducted spurious emissions, 2Hz – 3GHz



Date: 5.JAN.2000 00:22:23

Conducted spurious emissions, 3Hz – 25GHz

Radiated emission 30 – 1000 MHz.

Detector: Quasi-Peak

Measuring distance 3 m according to ANSI C63.4-2014.

All values are below the limit even when measured with Peak Detector.

Frequency	Operational condition	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz		$\text{dB}\mu\text{V/m}$	metres	$\text{dB}\mu\text{V/m}$	dB
All freqs	TX on	/	3	/	>10

Tested only with Peak Detector.

See attached graphs.

Antenna factor, amplifier gain and cable loss are included in Spectrum Analyzer “Transducer factor”.

See attached graphs.



MARKER 1

180.78 MHz

RBW 120 kHz

Marker 1 [T1]

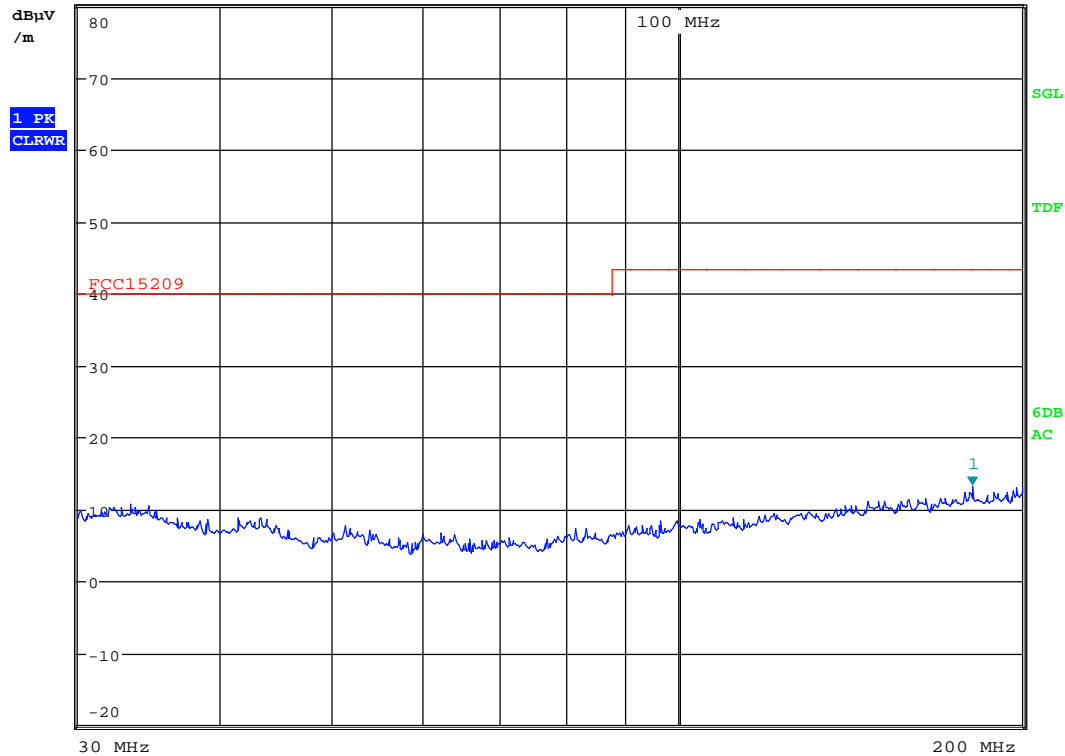
MT 1 s

13.32 dBμV/m

Step TD AUTO PULSE Att 10 dB AUTO

PREAMP ON

180.78000000 MHz



Date: 6.JUN.2017 16:34:54

VP: 30 - 200MHz



MARKER 1

198.3 MHz

RBW 120 kHz

Marker 1 [T1]

MT 50 ms

14.38 dBμV/m

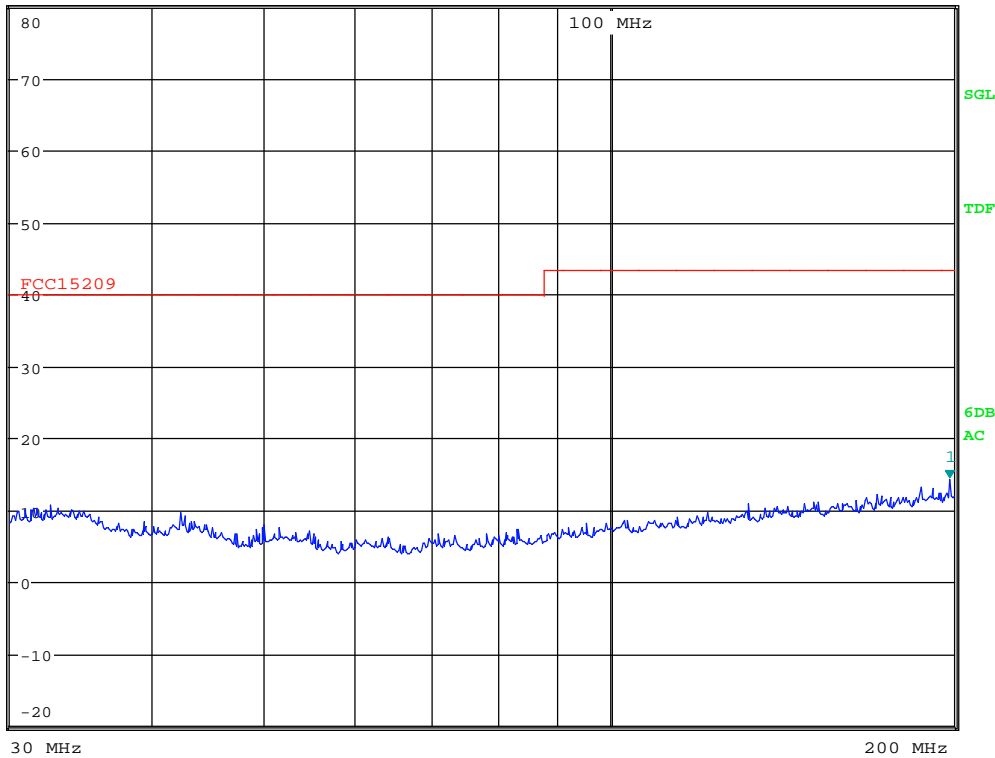
Step TD AUTO PULSE Att 10 dB AUTO

PREAMP ON

198.30000000 MHz

dBμV
/m

1 PK
CLRWR



Date: 6.JUN.2017 16:38:02

HP: 30 - 200MHz



MARKER 1

996.62 MHz

RBW 120 kHz

Marker 1 [T1]

MT 50 ms

23.70 dBμV/m

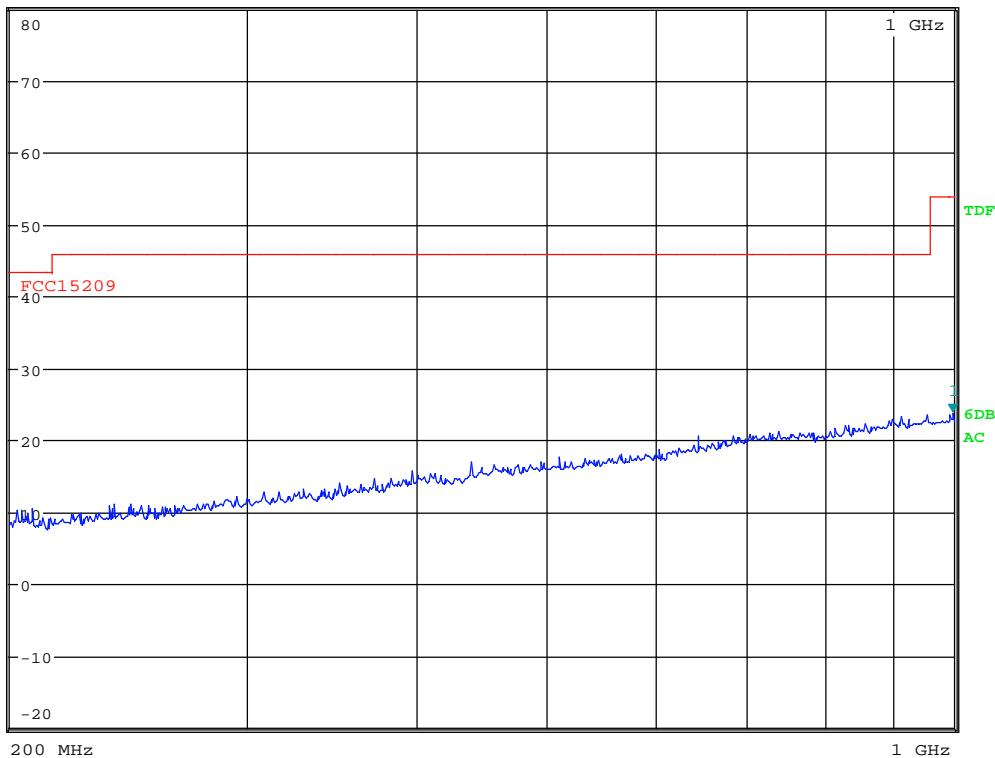
Step TD AUTO PULSE Att 10 dB AUTO

PREAMP ON

996.62000000 MHz

dBμV
/m

1 PK
CLRWR



Date: 6.JUN.2017 16:43:12

VP: 200 - 1000MHz



MARKER 1

999.2 MHz

RBW 120 kHz

Marker 1 [T1]

MT 1 s

23.65 dBμV/m

Step TD AUTO PULSE

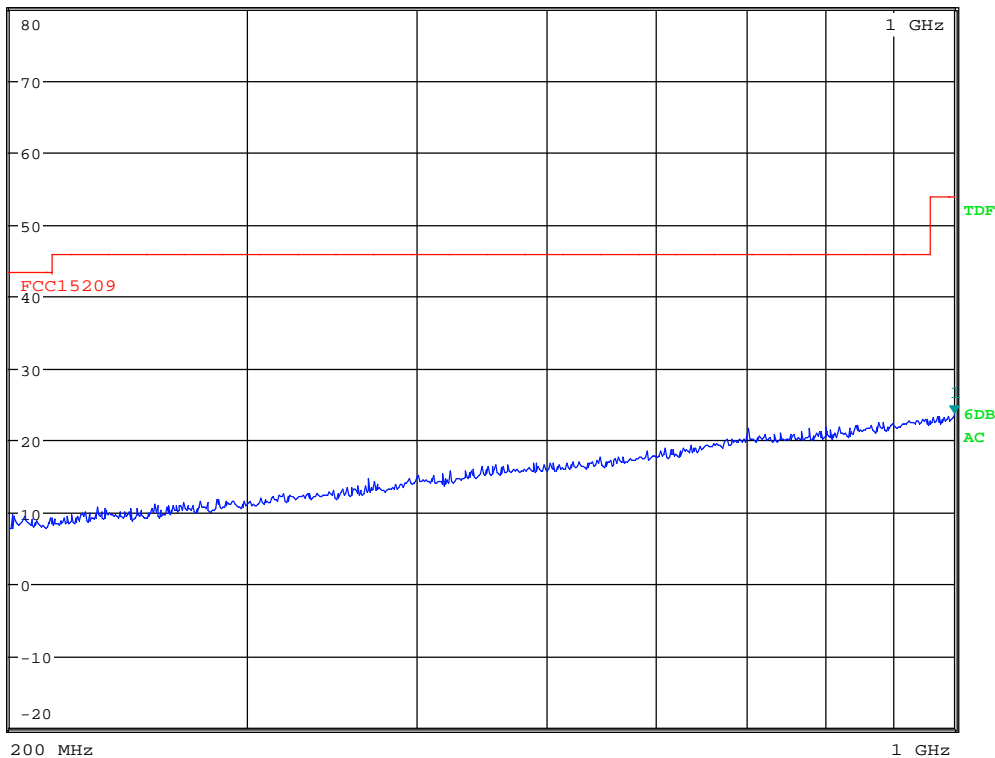
Att 10 dB AUTO

PREAMP ON

999.200000000 MHz

dBμV
/m

1 PK
CLRWR



Date: 6.JUN.2017 16:46:22

HP: 200 - 1000MHz

Radiated Emissions, 1-25 GHz

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

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

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 1m	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dB μ V/m	dB	dB μ V/m	dB
4.824	L	-9.5*	37.63	0	74	>20
4.874	M	-9.5*	37.75	0	74	>20
4.924	H	-9.5*	37.61	0	74	>20
7.236	L	-9.5*	41.75	0	74	>20
7.311	M	-9.5*	40.90	0	74	>20
7.386	H	-9.5*	40.90	0	74	>20
Other freqs	L,M,H	-9.5*	None detected	0	74	>20

Average Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 1m	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dB μ V/m	dB	dB μ V/m	dB
4.824	L	-9.5*	37.63	20	54	>30
4.874	M	-9.5*	37.75	20	54	>30
4.924	H	-9.5*	37.61	20	54	>30
7.236	L	-9.5*	41.75	20	54	>30
7.311	M	-9.5*	40.90	20	54	>30
7.386	H	-9.5*	40.90	20	54	>30
Other freqs	L,M,H	-9.5*	None detected	20	54	>30

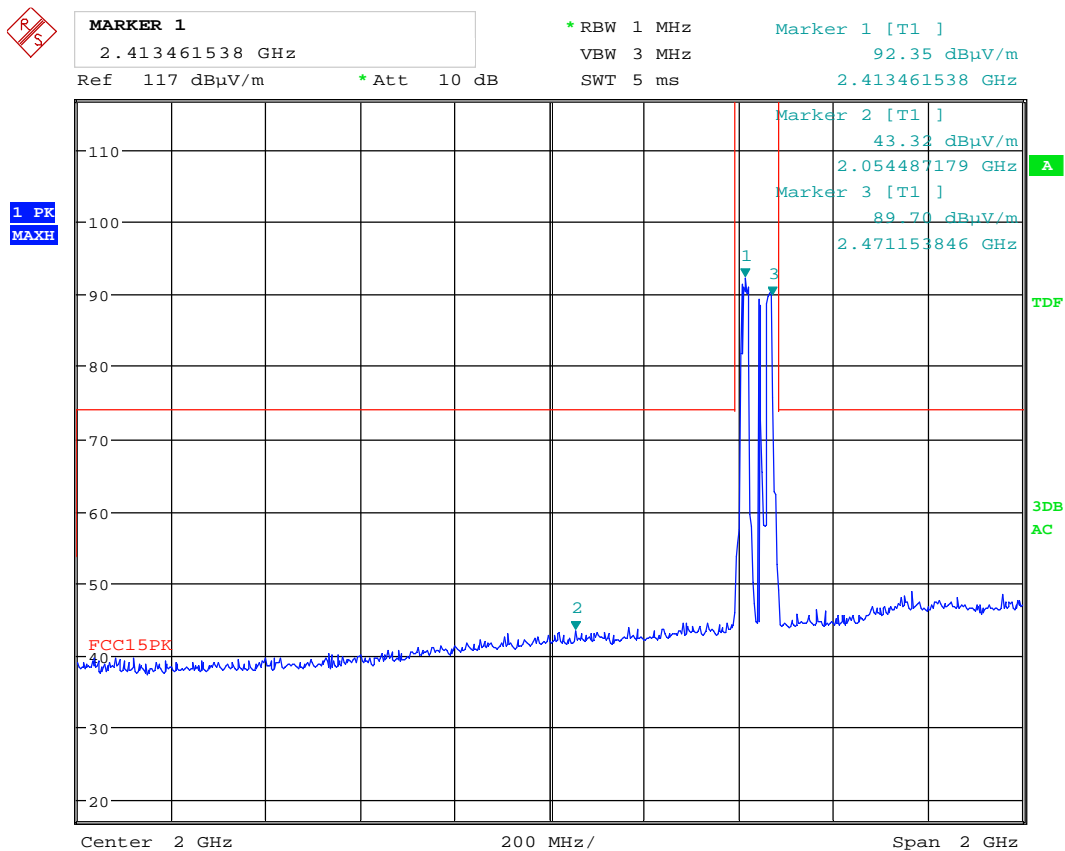
*distance correction is included in the measured value

EUT was positioned on a 1.5m high stand for all tests above 1 GHz.

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

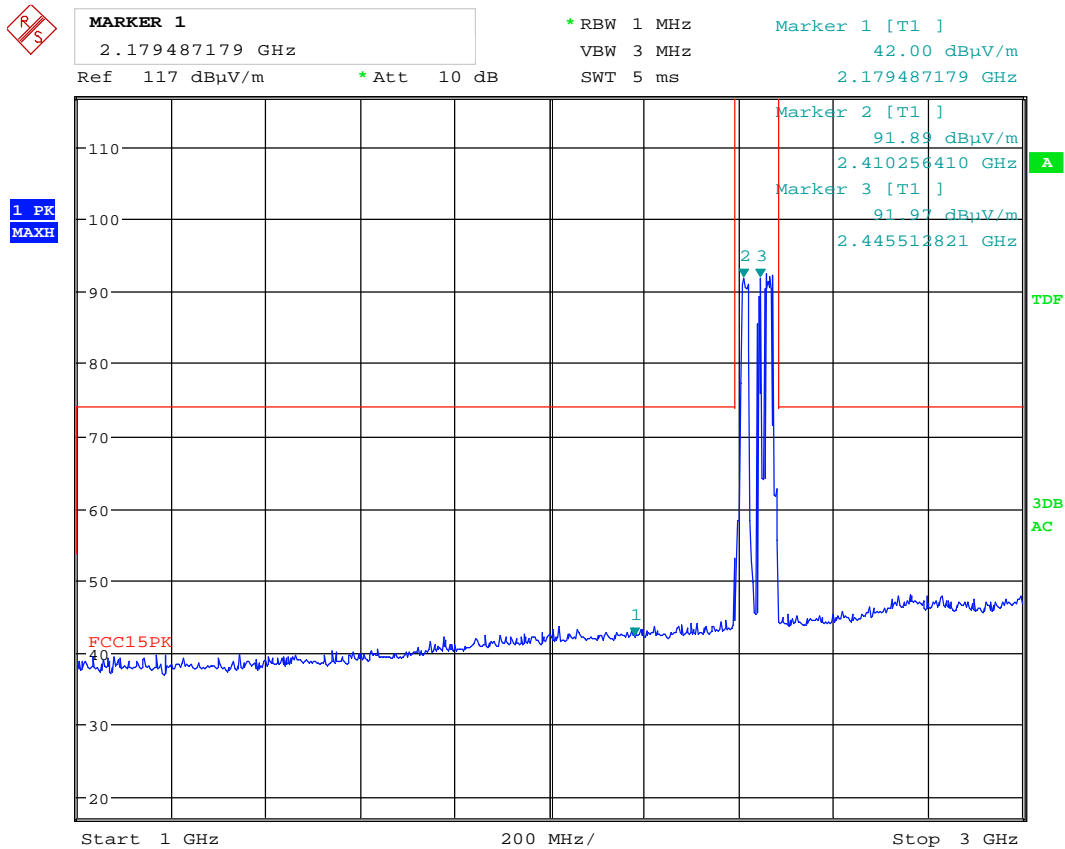
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

See plots.



Date: 6.JUN.2017 15:17:19

VP: Ch01, Ch06 & Ch11, 1 - 3GHz, Pk scan, @3m



Date: 6.JUN.2017 15:19:39

HP: Ch01, Ch06 & Ch11, 1 - 3GHz, Pk scan, @3m



MARKER 1
7.366987179 GHz

*RBW 1 MHz

Marker 1 [T1]

VBW 3 MHz

49.28 dBμV/m

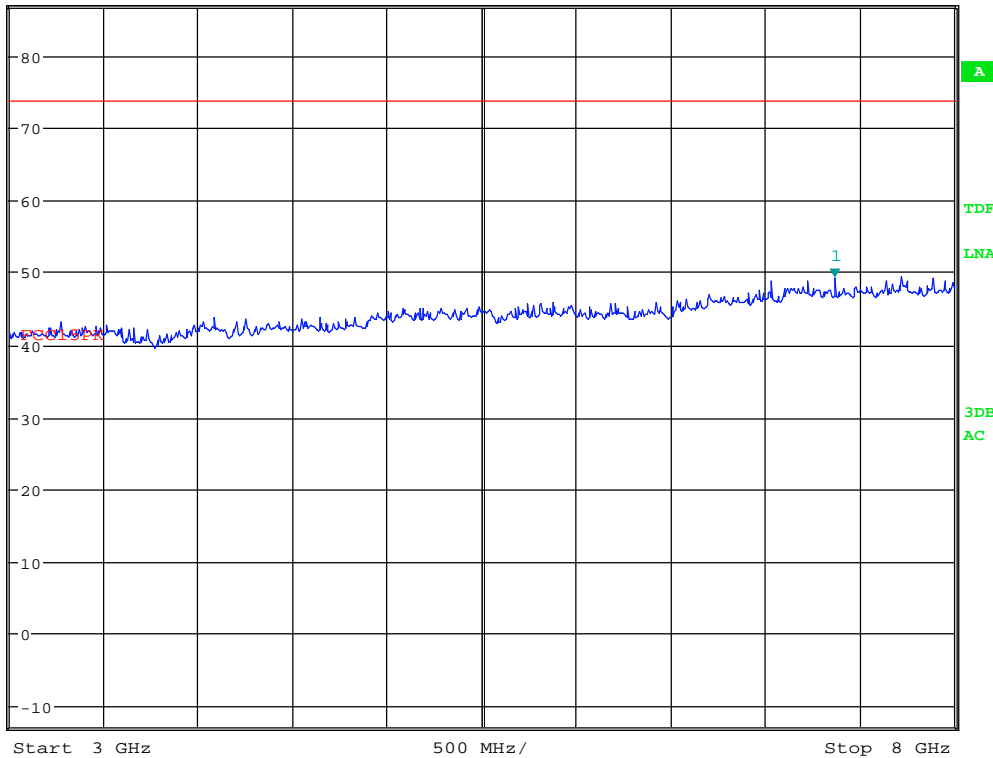
SWT 30 ms

7.366987179 GHz

Ref 87 dBμV/m

*Att 10 dB

1 PK
MAXH



Date: 6.JUN.2017 15:29:08

VP: Ch01, Ch06 & Ch11, 3 - 8GHz, Pk scan



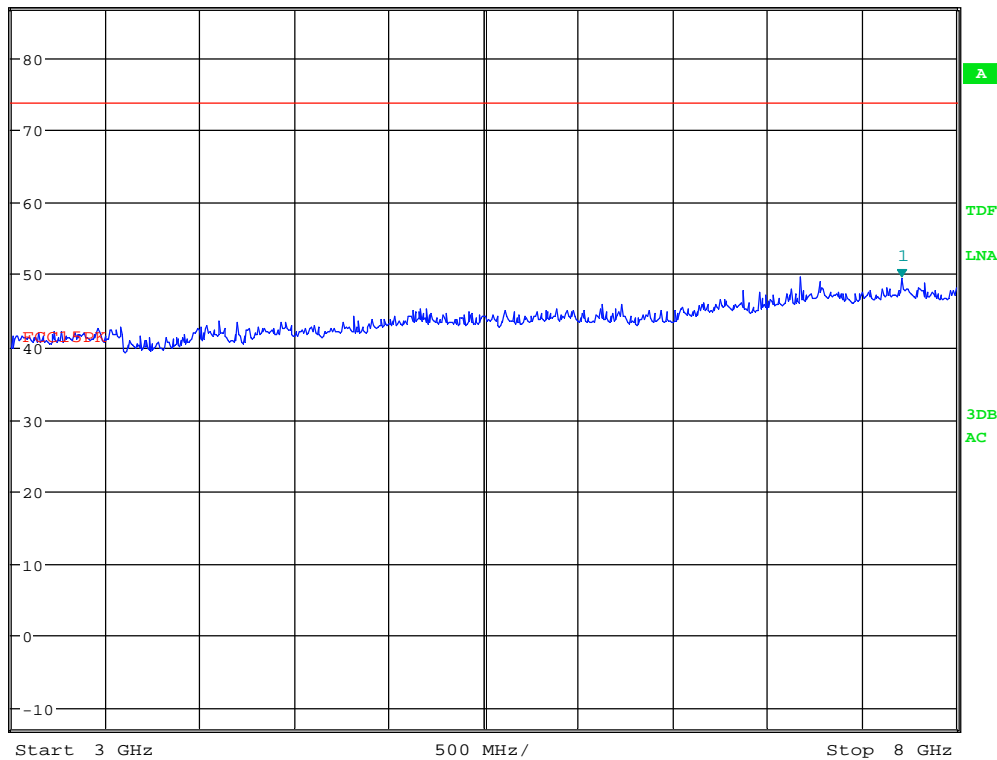
MARKER 1
7.711538462 GHz

* RBW 1 MHz
VBW 3 MHz
SWT 30 ms

Marker 1 [T1]
49.48 dBμV/m
7.711538462 GHz

Ref 87 dBμV/m * Att 10 dB

1 PK
MAXH



Date: 6.JUN.2017 15:27:36

HP: Ch01, Ch06 & Ch11, 3 - 8GHz, Pk scan



MARKER 1
10.99358974 GHz

* RBW 1 MHz

Marker 1 [T1]

VBW 3 MHz

49.94 dBμV/m

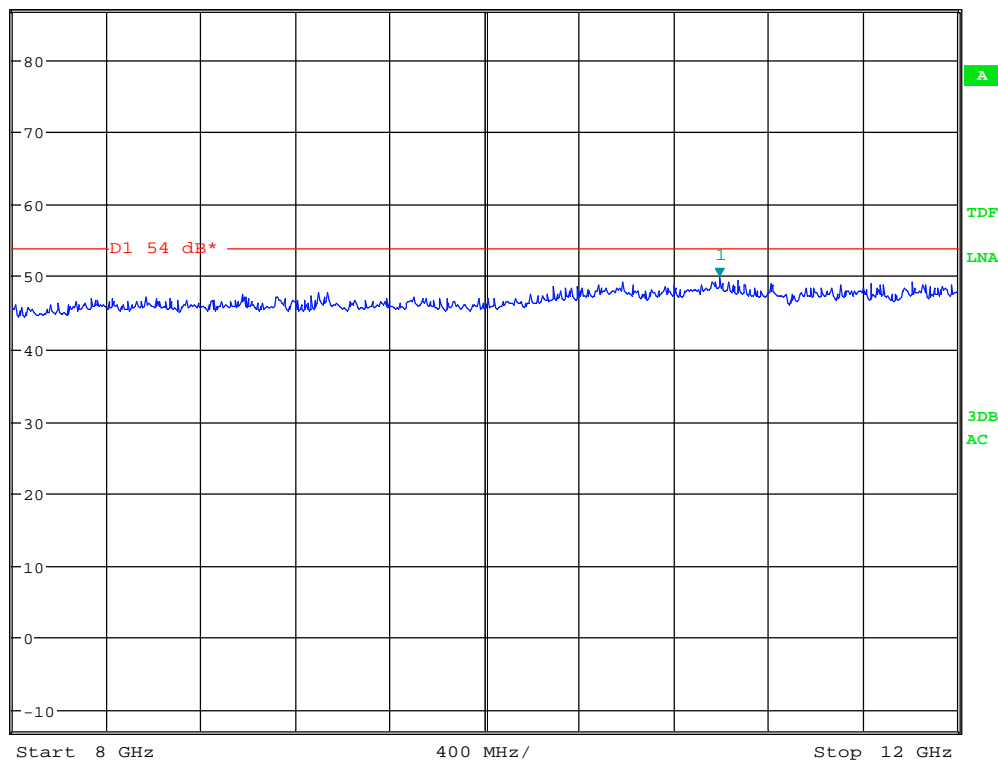
Ref 87 dBμV/m

* Att 10 dB

SWT 25 ms

10.993589744 GHz

1 PK
MAXH



Date: 6.JUN.2017 15:47:26

VP: Ch01, Ch06 & Ch11, 8 - 12GHz, Pk scan

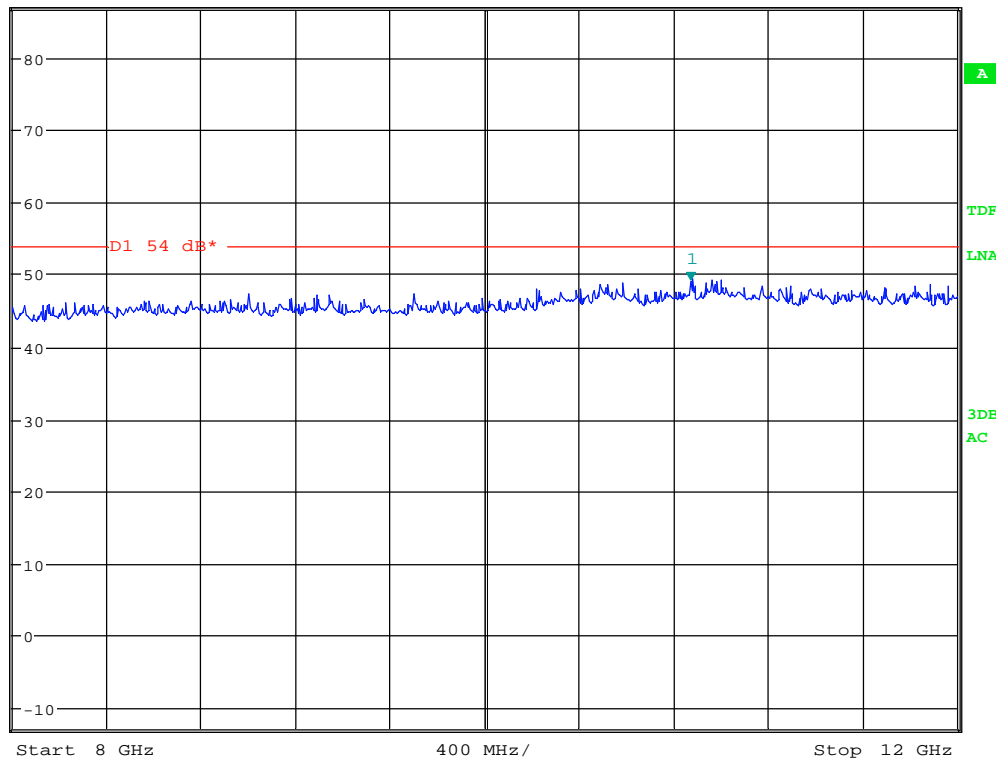


MARKER 1
10.87179487 GHz
Ref 87 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 25 ms

Marker 1 [T1]
49.00 dBμV/m
10.871794872 GHz

1 PK
MAXH



Date: 6.JUN.2017 15:48:17

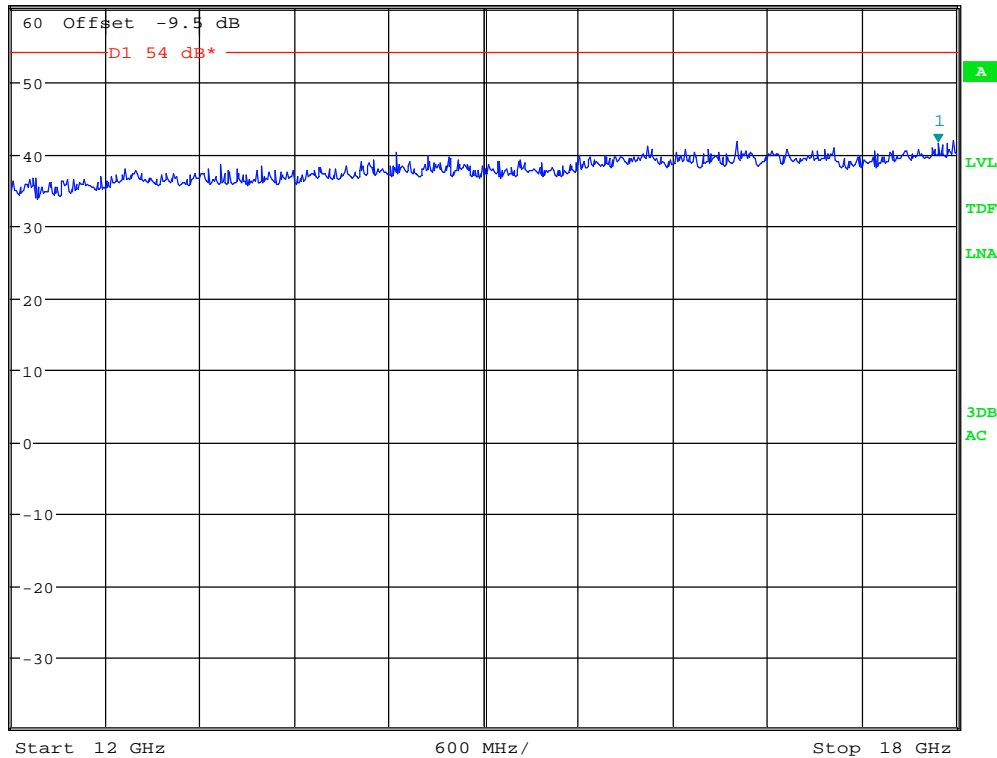
HP: Ch01, Ch06 & Ch11, 8 - 12GHz, Pk scan



MARKER 1
17.88461538 GHz
Ref 60.5 dBμV/m * Att 5 dB

* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 41.57 dBμV/m
SWT 35 ms 17.884615385 GHz

1 PK
MAXH



Date: 6.JUN.2017 15:53:57

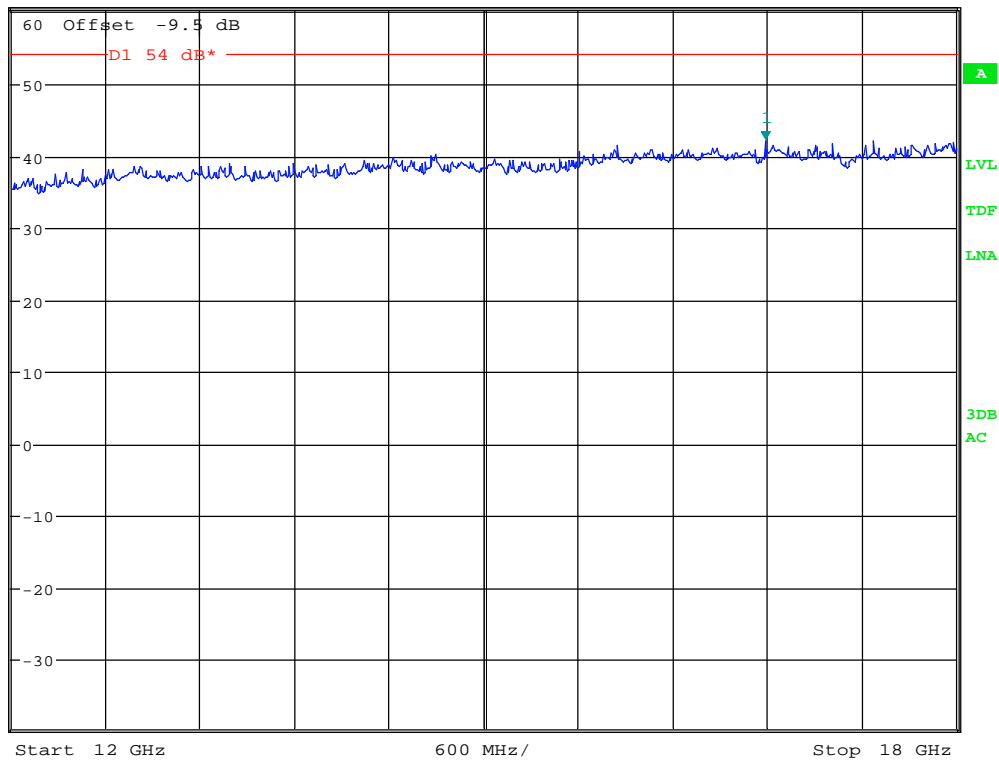
VP: Ch01, Ch06 & Ch11, 12 - 18GHz, Pk scan, @1m (distance correction is given in the graph)



MARKER 1
16.78846154 GHz
Ref 60.5 dBμV/m * Att 5 dB

* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 42.04 dBμV/m
SWT 35 ms 16.788461538 GHz

1 PK
MAXH



Date: 6.JUN.2017 15:53:36

HP: Ch01, Ch06 & Ch11, 12 - 18GHz, PK scan, @1m (distance correction is given in the graph)



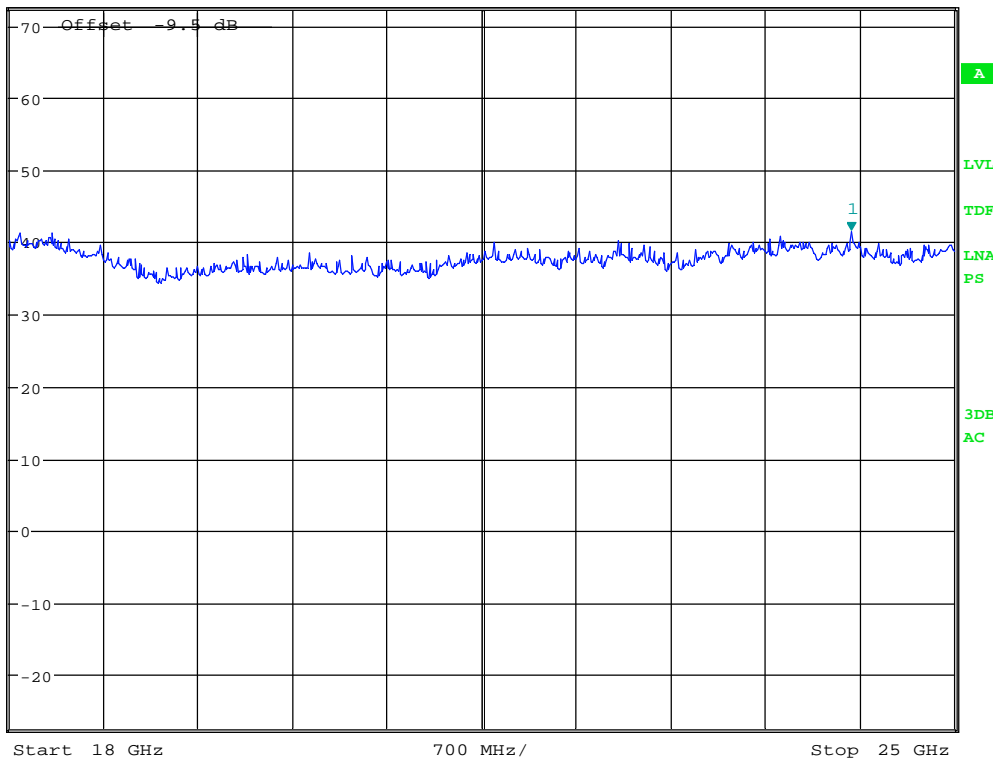
MARKER 1
24.23717949 GHz

*RBW 1 MHz
VBW 3 MHz
SWT 45 ms

Marker 1 [T1]
41.57 dBμV/m
24.237179487 GHz

Ref 72.5 dBμV/m *Att 10 dB

1 PK
MAXH



Date: 23.JUN.2017 10:04:04

VP/HP: Ch01, Ch06 & Ch11, 18 - 25GHz, Pre-Scan, @1m (distance correction is given in the graph)

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

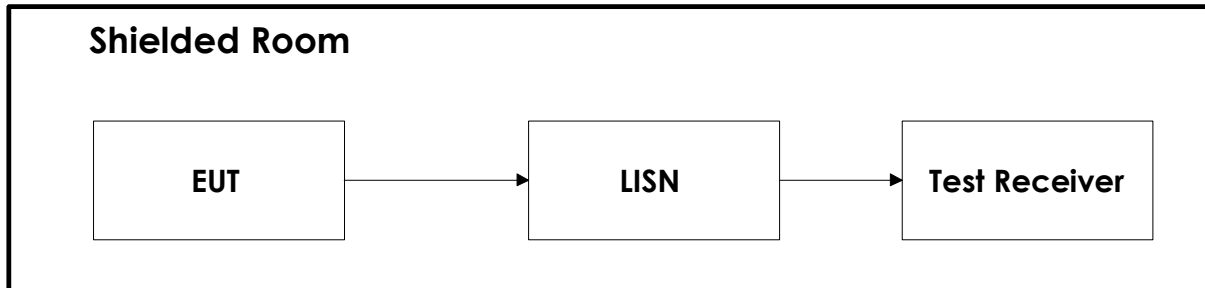
5 LIST OF TEST EQUIPMENT

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.

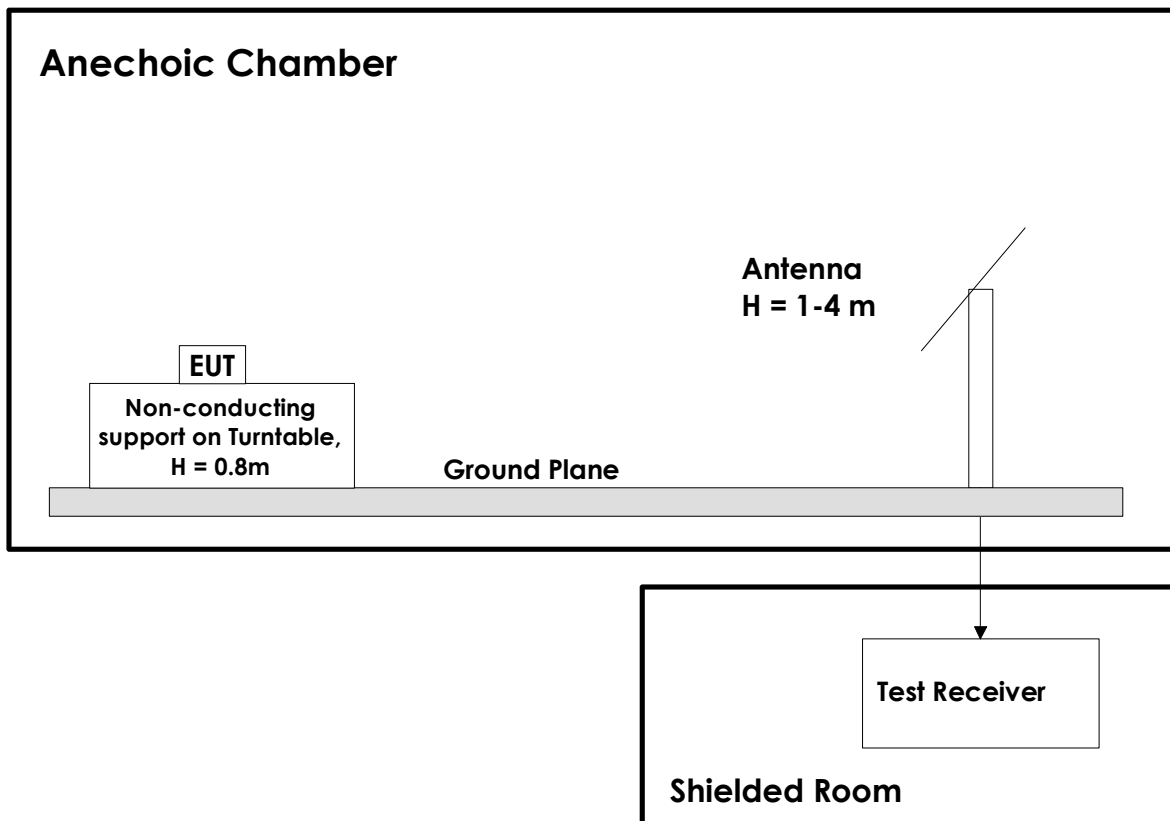
No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1.	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2016.11	2017.11
2.	FSW26	Spectrum Analyzer	Rohde & Schwarz	LR 1640	2015.11	2017.11
3.	HFH2-Z2	Active Loop antenna	Rohde & Schwarz	LR1660	2014.10	2017.10
4.	3115	Antenna horn	EMCO	LR 1330	2010.08	2017.08
5.	HK116	Biconical Antenna	Rohde & Schwarz	LR 1260	2016.12	2018.12
6.	HL223	Log Periodic antenna	Rohde & Schwarz	LR 1261	2016.12	2018.12
7.	643	Antenna Horn	Narda	LR 093	2009.10	2019.10
8.	PM7320X	Antenna Horn	Sivers Lab	LR 102	2009.10	2019.10
9.	DBF-520-20	Antenna Horn	Systron Donner	LR 100	2009.10	2019.10
10.	638	Antenna Horn	Narda	LR 1480	2009.10	2019.10
11.	4768-10	Attenuator	Narda	LR 1356	Cal b4 use	
12.	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	Cal b4 use	
13.	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2016.10	2017.10
14.	317	Pre-amplifier	Sonoma	LR 1687	2016.9	2017.9
15.	Model 87 V	Multimeter	Fluke	LR 1597	2016.10	2018.10
16.	6812B	Power source	Agilent	LR 1515	2015.12	2017.12
17.	CPX400S	DC power supply	AIM TTI	LR 1710	Cal b4 use	

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
00	2017.07.05	First issued	GNS