RADIO TEST REPORT

No. 917671-2

EQUIPMENT UNDER TEST

Equipment:	RF Power Source
Type / model:	3LC S01 US
Manufacturer:	Velux A/S
Tested by request of:	Velux A/S

SUMMARY

The equipment complies with the requirements of the following standards:

47 CFR, Part 15, Subpart B (2009) and Subpart C (2009);

RSS-GEN, Issue 2 (June 2007)
RSS-210, Issue 7 (June 2007)

Industry Canada listed test facility No. IC 2042G-2

Date of issue: March 09, 2010

Tested by: Stefan Andersson Approved by: Niklas Boström

Stefan Andersson Niklas Boström

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1. CLIENT INFORMATION

The EUT has been tested by request of

Company:	Velux A/S Aadaljsvej 99 DK-2970 Hörsholm Denmark
Name of contact:	Jens Philipsen

2. EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT according to the manufacturer/client declaration

Equipment:	RF Power Source
Type/Model:	3LC S01 US
Brand name:	Velux
Serial number:	No visible serial number on EUT
Manufacturer:	Velux A/S
Rating/Supplying voltage:	120 V AC, 60 Hz
Rating RF output power:	13 dBm
Antenna gain:	1 dBi
External antenna connector:	NO
Operating temperature range:	5 to 35 °C
Frequency range:	2425 – 2475 MHz
Number of channels:	3
Channel spacing	25 MHz
Modulation characteristics:	DSSS 802.15.4
Stand by mode supported:	Yes

3. TEST SPECIFICATIONS

3.1 Standards

FCC 47 CFR part 15 (2009) Subpart B – Unintentional radiators

FCC 47 CFR part 15 (2009) Subpart C – Intentional Radiators; §15.247 Operation within the bands 902-928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz.

Measurements methods according to ANSI C63.4-2003 - Methods of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

RSS-Gen, Issue 2 (june 2007): General Requirements and Information for the Certification of Radiocommunication Equipment

RSS-210, Issue 7 (June 2007): Low Power Licence-Exempt Radio communication Devices (All Frequency Bands): Category I Equipment.

3.2 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standards.

3.3 Test set-up

Measurement set-ups for the test of out-of-band spurious emissions test are described in corresponding sections. During other tests the EUT was connected to the spectrum analyzer by cable.

3.4 Operating environment

If not additionally specified, the tests were performed under the following environmental conditions:

Air temperature:	20-25	°C
Relative humidity:	25-65	%

4. TEST SUMMARY

The results in this report apply only to the sample tested.

FCC reference	IC reference	Test	Result	Note
15.247(b)	RSS-210 A8.4	Peak output power	PASS	
15.247(a)	RSS-210 A8.2	6 dB Bandwidth	PASS	
15.247(e)	RSS-210 A8.2	Spectral power density	PASS	
15.247(d)	RSS-210 A8.5	Band edge compliance	PASS	
15.247(d)	RSS-210 A8.5	Out of band spurious emissions, radiated	PASS	1
15.247(d)	RSS-210 A8.5	Out of band spurious emissions, conducted	PASS	
15B	RSS-Gen Table 1	Out of band spurious emissions, radiated	PASS	1
15B	RSS-Gen Table 2	Conducted emission at AC port	PASS	
	RSS-GEN 4.6.1	Occupied Bandwidth	PASS	

1) The measured result is below the limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95 % level of confidence. However, the result indicates that compliance is more probable than non-compliance with the specification limit.

5. PEAK OUTPUT POWER

5.1 Test protocol

Date of test: 2010-02-25

EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

Span: 5 MHz
RBW: 5 MHz
VBW: 5 MHz
Sweep time: Auto
Detector: Peak
Trace: Max Hold

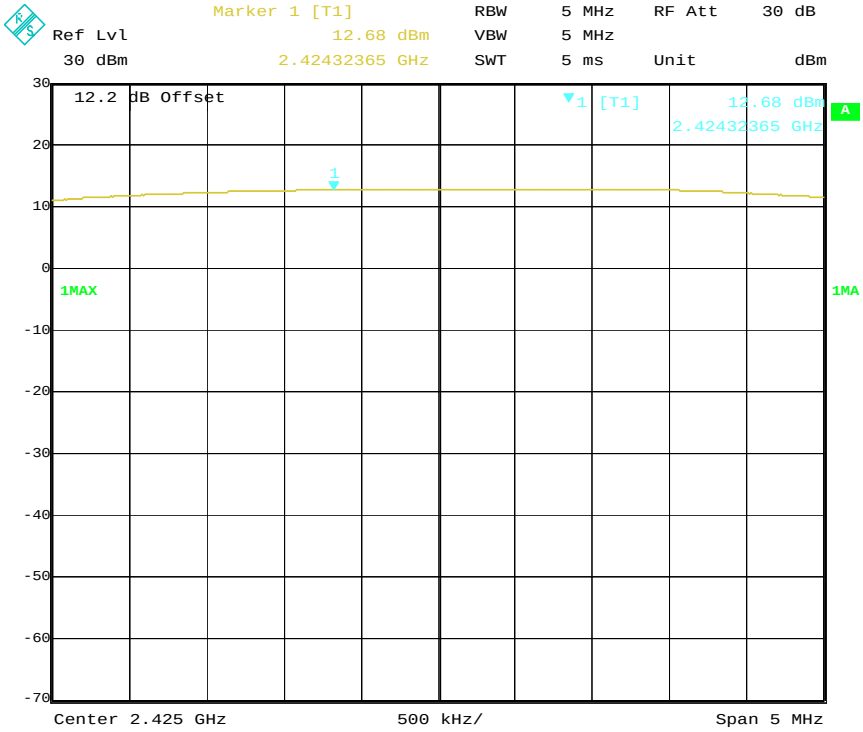
Channel (MHz)	Peak Output Power (dBm)	Plot	Limit value (dBm)
2425	12.7	plot P5.1	30
2450	12.1	plot P5.2	
2475	11.9	plot P5.3	

Measurement results are corrected for attenuation in the set-up configuration and antenna gain declared by the manufacturer.

Example calculation:

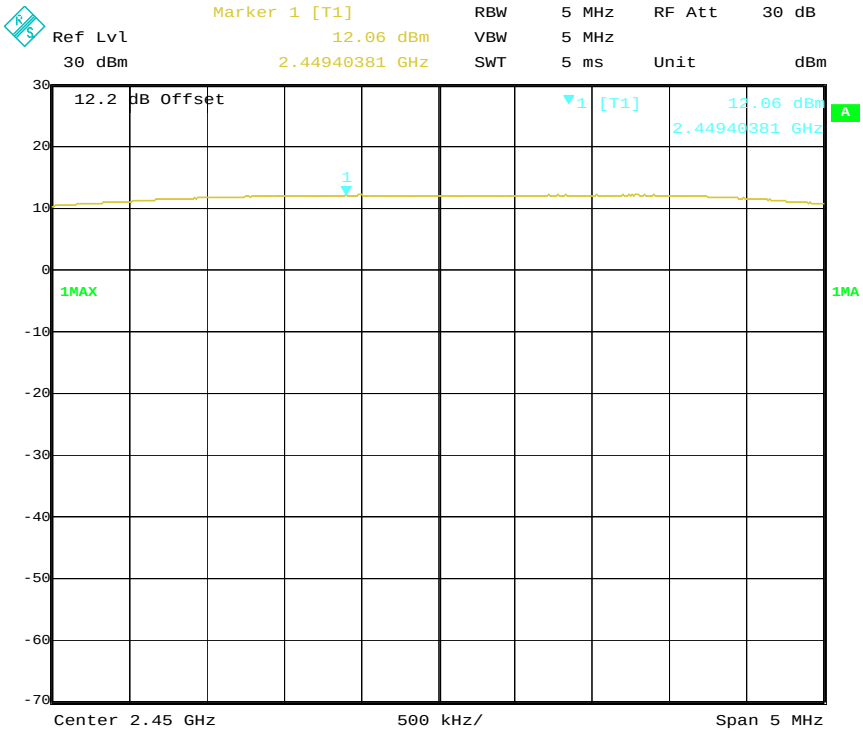
Peak output power [dBm] = Analyser reading [dBm] + cable loss [dB] + EUT antenna gain [dBi]

Plot P5.1



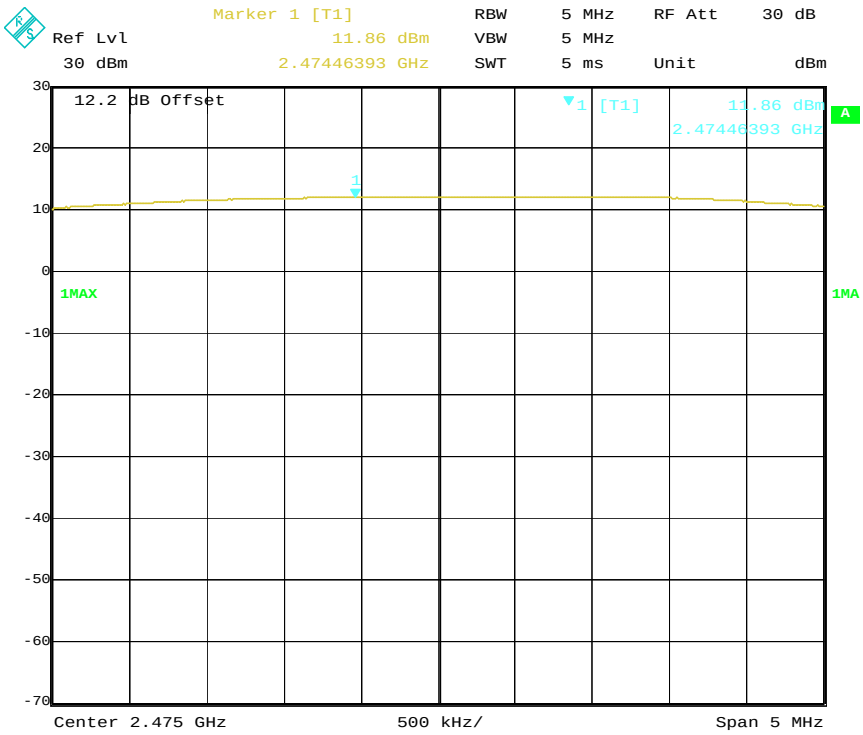
Date: 25.FEB.2010 09:30:58

Plot P5.2



Date: 25.FEB.2010 09:32:05

Plot P5.3


Marker 1 [T1]
RBW 5 MHz
RF Att 30 dB
Ref Lvl
11.86 dBm
VBW 5 MHz
30 dBm
2.47446393 GHz
SWT 5 ms
Unit dBm
12.2 dB Offset
1 [T1]
11.86 dBm
2.47446393 GHz
A
1MAX
1MA
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 2.475 GHz
500 kHz/
Span 5 MHz
Date: 25.FEB.2010 09:35:46

6. 6 dB BANDWIDTH

6.1 Test protocol

Date of test: 2010-02-25

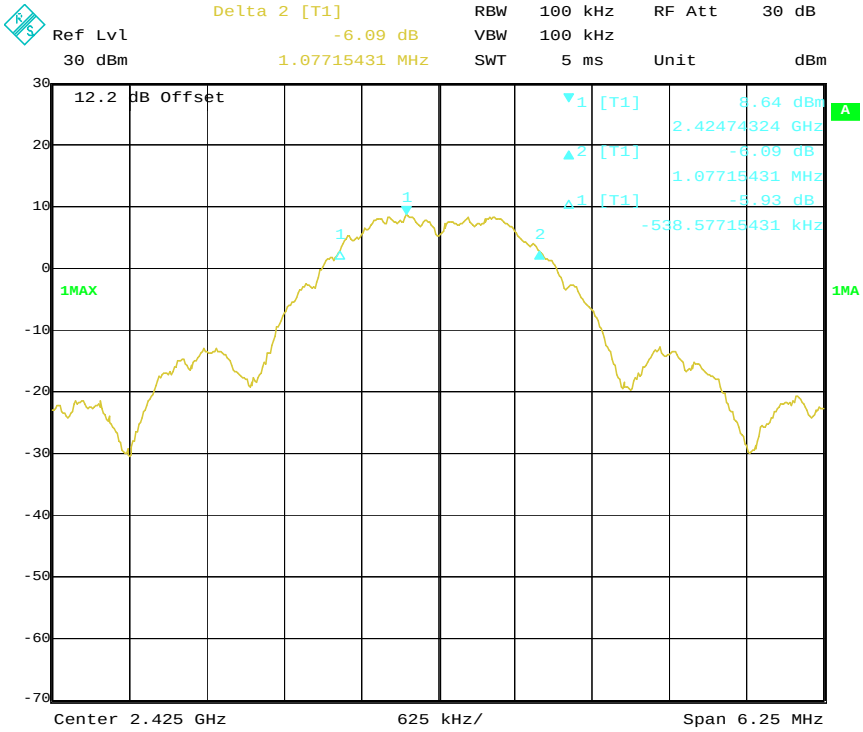
EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

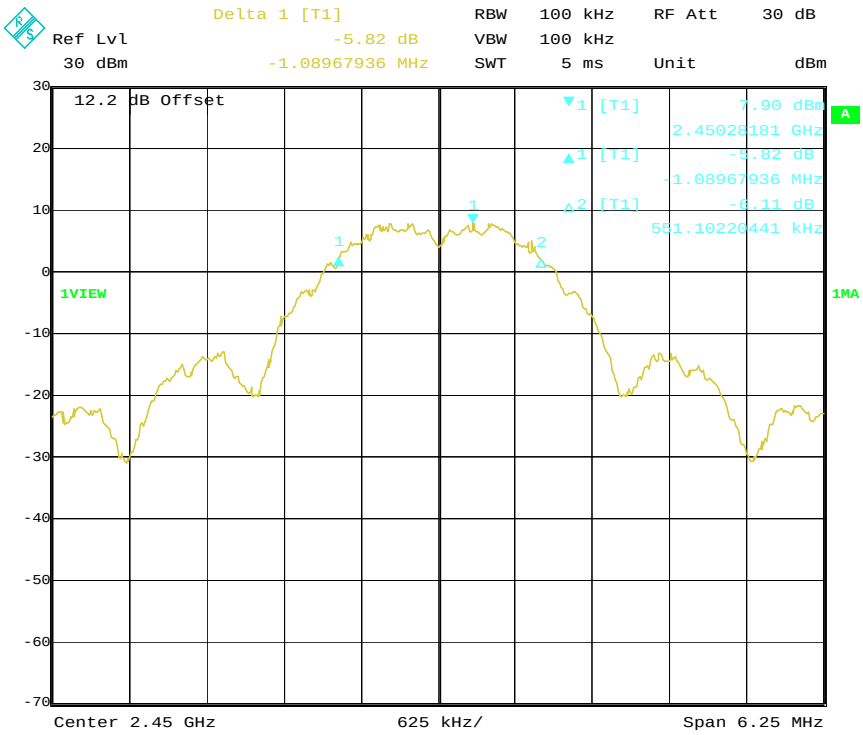
Span: 6.25 MHz
RBW: 100 kHz
VBW: 100 kHz
Sweep time: 5 ms
Detector: Peak
Trace: Max Hold

Channel (MHz)	6 dB Bandwidth (MHz)	Plot	Limit value (MHz)
2425	1,615	plot P6.1	> 0.5
2450	1,640	plot P6.2	
2475	1,615	plot P6.3	

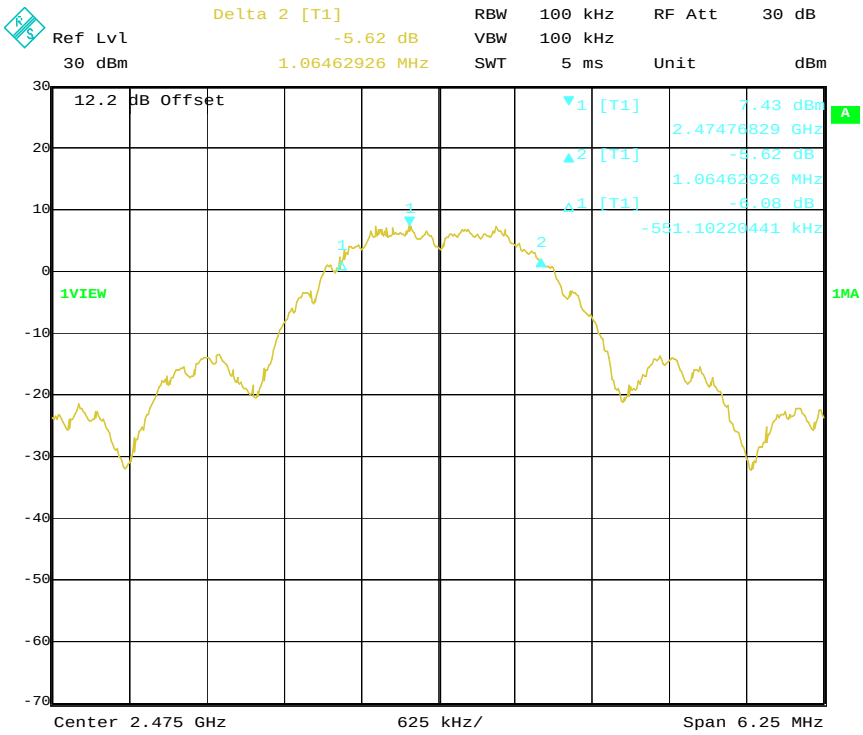
Plot P6.1



Plot P6.2



Plot P6.3


Delta 2 [T1]
RBW 100 kHz
RF Att 30 dB
Ref Lvl
-5.62 dB
VBW 100 kHz
30 dBm
1.06462926 MHz
SWT 5 ms
Unit dBm
12.2 dB Offset
1 [T1] 7.43 dBm
2.47476829 GHz
2 [T1] -5.62 dB
1.06462926 MHz
1 [T1] -6.08 dB
-591.10226441 kHz
A
1VIEW
1MA
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 2.475 GHz
625 kHz/
Span 6.25 MHz
Date: 25.FEB.2010 10:20:06

7. SPECTRAL POWER DENSITY

7.1 Test protocol

Date of test: 2010-02-25

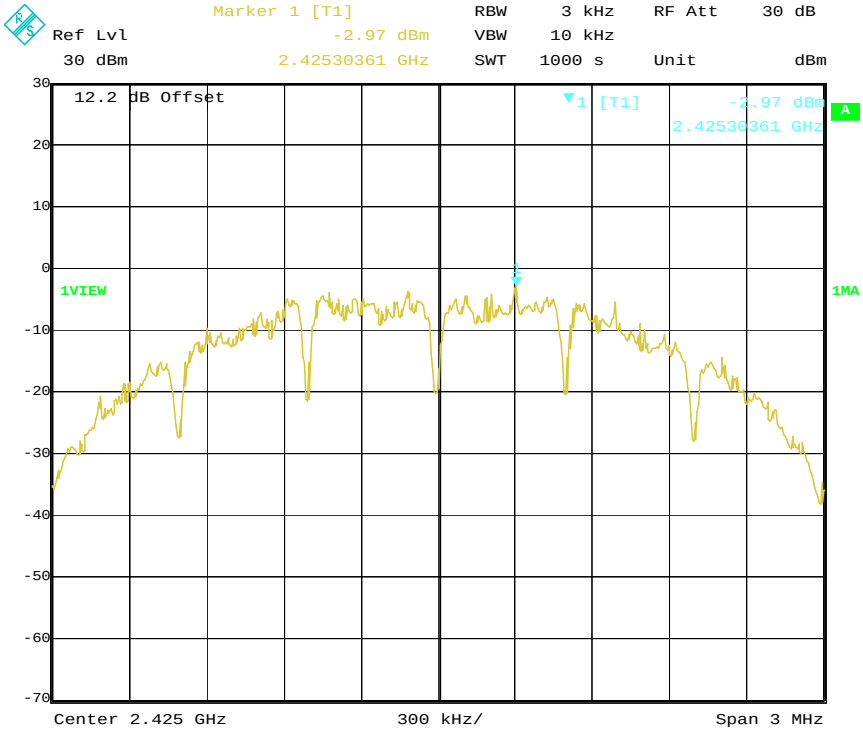
EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

Span: 3 MHz
RBW: 3 kHz
VBW: 10 kHz
Sweep time: 1000 s
Detector: Peak
Trace: Max Hold

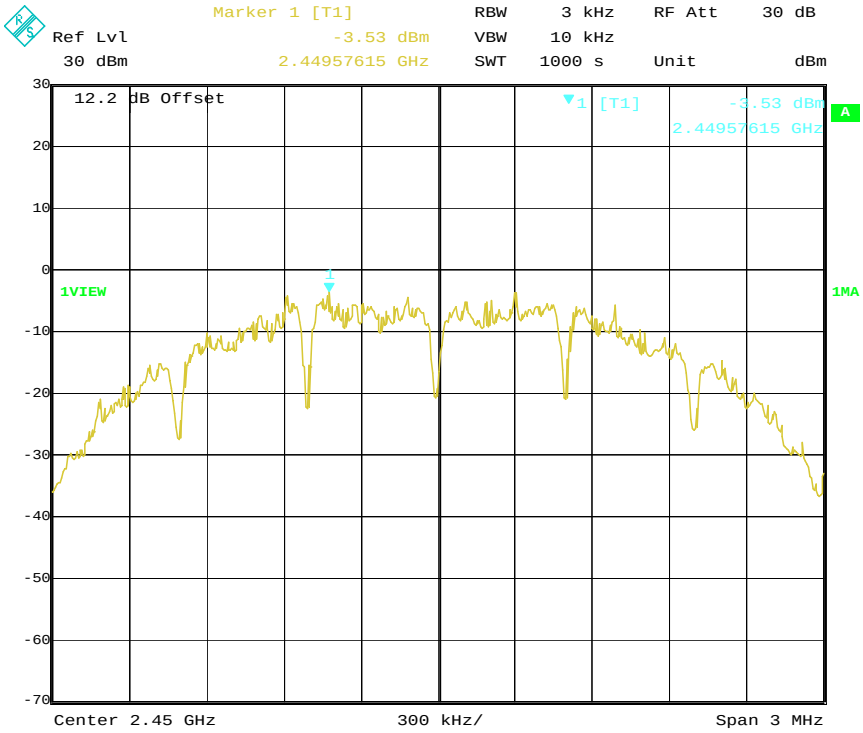
Channel	Power spectral density (dBm)	Plot	Limit value (dBm)
Low	-3.0	plot P7.1	8
Mid	-3.5	plot P7.2	8
High	-3.8	plot P7.3	8

PlotP7.1



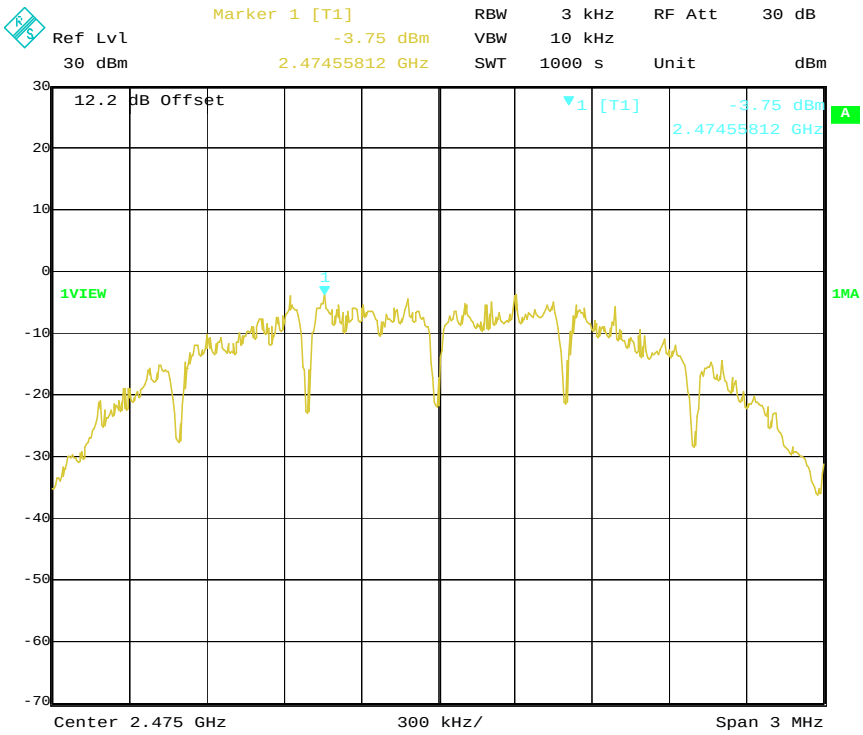
Date: 25.FEB.2010 10:46:07

Plot P7.2



Date: 25.FEB.2010 11:16:33

Plot P7.3


Marker 1 [T1]
RBW 3 kHz
RF Att 30 dB
Ref Lvl
-3.75 dBm
VBW 10 kHz
30 dBm
2.47455812 GHz
SWT 1000 s
Unit dBm
12.2 dB Offset
1 [T1]
-3.75 dBm
2.47455812 GHz
A
1VIEW
1MA
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 2.475 GHz
300 kHz/
Span 3 MHz
Date: 25.FEB.2010 11:34:55

8. BAND EDGE COMPLIANCE

8.1 Test protocol

Date of test: 2010-02-25

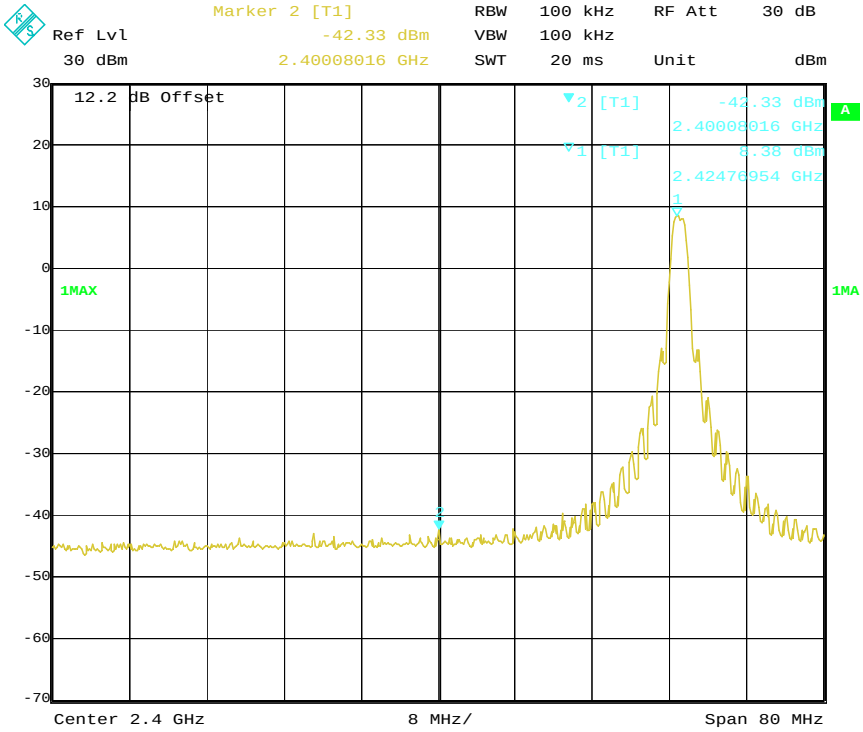
EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

Span: 80 MHz
RBW: 100 kHz
VBW: 100 kHz
Sweep time: Auto
Detector: Peak
Trace: Max Hold

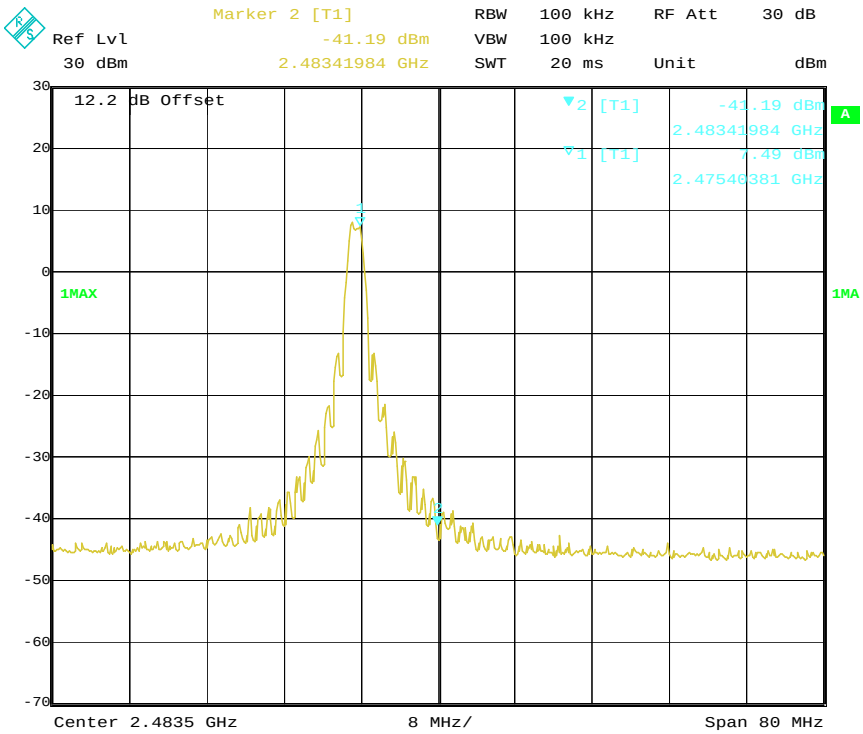
Channel	Plot	Results	Limit value (dBc)
Low	plot P8.1	PASS	20
High	plot P8.2	PASS	20

Plot P8.1



Date: 25.FEB.2010 12:30:51

Plot P8.2



Date: 25.FEB.2010 12:33:17

9. RADIATED SPURIOUS EMISSIONS

9.1 Operating environment

Temperature: 20-25 °C (10 – 40 °C)
Relative Humidity: 25-45 % (10 - 90 %)

9.2 Measurement uncertainty

Radiated disturbance electric field intensity, 30 – 1000 MHz: ± 4,6 dB
Radiated disturbance electric field intensity, 1000 – 26000 MHz: ± 6,0 dB

The measurement uncertainty describes the overall uncertainty of the given measured value during operation of the EUT.

Measurement uncertainty is calculated in accordance with EA-4/02-1997.
The measurement uncertainty is given with a confidence of 95%.

9.3 Test equipment

Equipment	Manufacturer	Type	SEMKO No.
Test site: Semi-anechoic shielded chamber			30300
Software:	Rohde & Schwarz	EMC 32	
Measurement receiver:	Rohde & Schwarz	ESU 8	12866
Antenna, bilog:	Chase	CBL6111B	12474
Test site: Radio anechoic shielded chamber			12285
Software:	Rohde & Schwarz	ES-K1, V1.70	
Signal analyser:	Rohde & Schwarz	FSIQ 40	40023
Preamplifier:	MITEQ	AFS6/AFS44	12335
Antennas:			
Double Ridge Guide Horn:	EMCO	3115	4936
Horn antenna:	EMCO	3160-08	30099
Horn antenna:	EMCO	3160-09	30101
High pass filter	K & L	4410-X4500/18000-0	5133
Band rejection filter	K & L	6N45-2450/T 100-0/0	12389
Transformer	Tufvassons	AFM-1500	30317

9.4 Measurement set-up

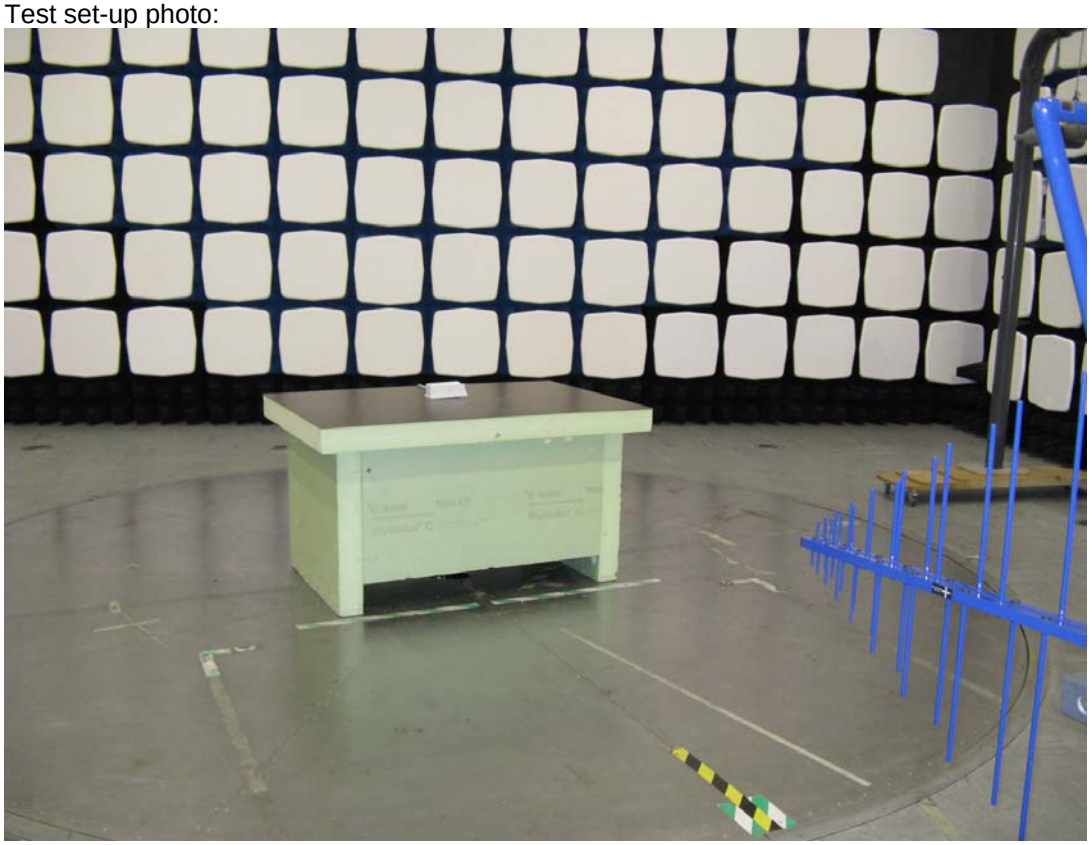
Test site: Semi-anechoic shielded chamber (30 – 1000 MHz)

The radiated disturbance electric field intensity was measured in a semi-anechoic chamber at a distance of 3 m and the EUT was placed on a non-metallic table, 0,8 m above the reference ground plane. The specified test mode was enabled. Test set-up photo is given below.

An overview sweep with peak detection of the electric field intensity was performed with the measurement receiver in max-hold and with the antenna placed 1,5 m, 2,5 m and 3,5 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps.

At the frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration new measurements were carried out.

Test set-up photo:



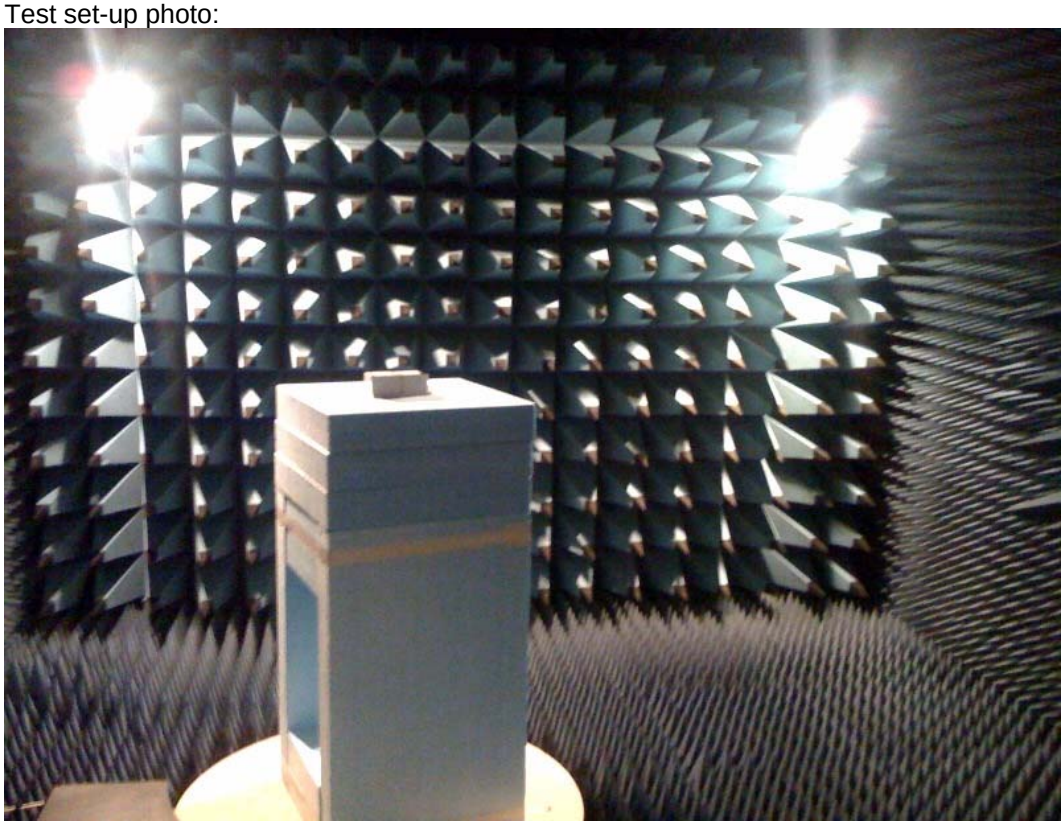
Test site: Radio anechoic shielded chamber (1 – 26 GHz)

In the Radio anechoic chamber the EUT was placed on a non-metallic table, 1,4 m above the floor. The radiated disturbance electric field intensity was measured at a distance of 3 m. The specified test mode was enabled.

An overview sweep with peak detection of the electric field intensity was performed with the spectrum analyser in max-hold and with the antenna placed 1,4 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps.

At the frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration new measurements were carried out.

Test set-up photo:



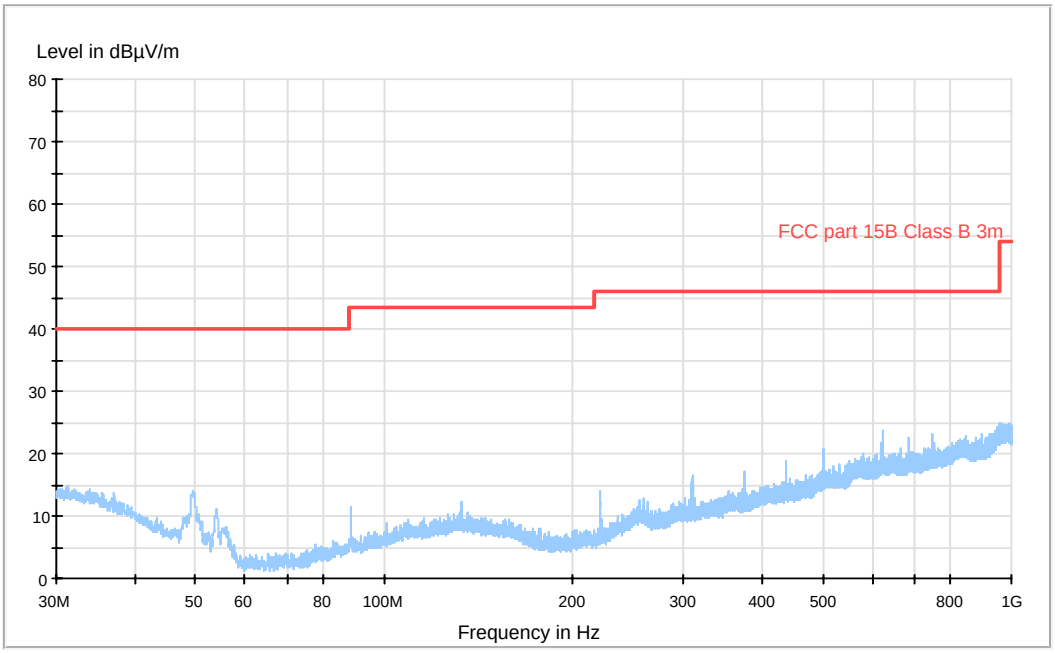
9.5 Test protocol

Semi-anechoic shielded chamber

Date of test: 2010-01-29

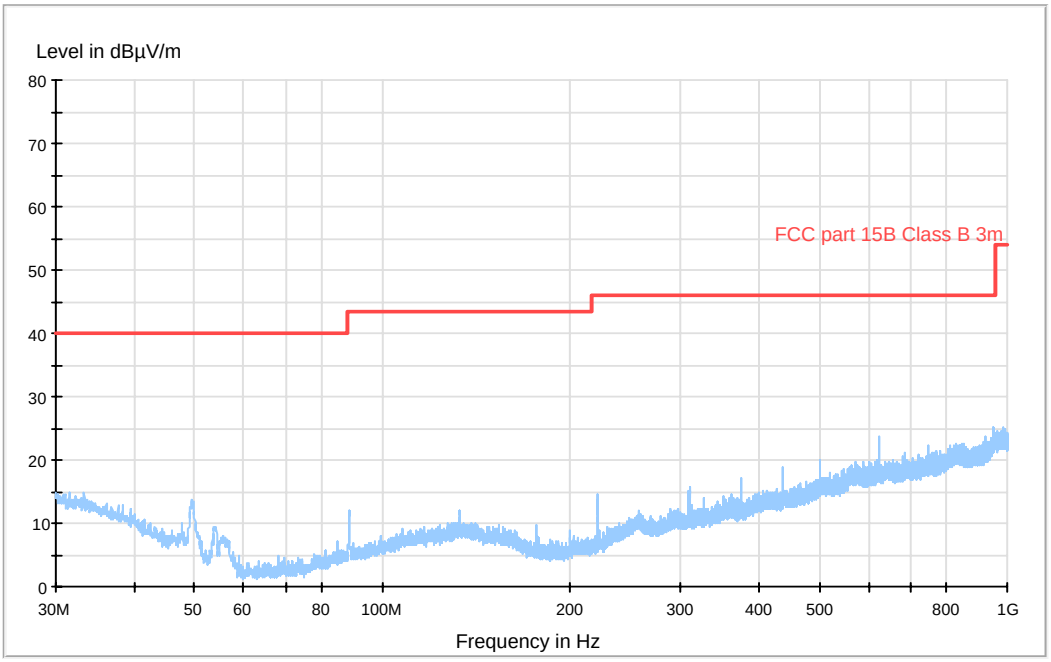
30 – 1000 MHz, max peak at a distance of 3 m on the lower TX channel

FCC 30 - 1000 MHz FCC class B 3m Fast scan



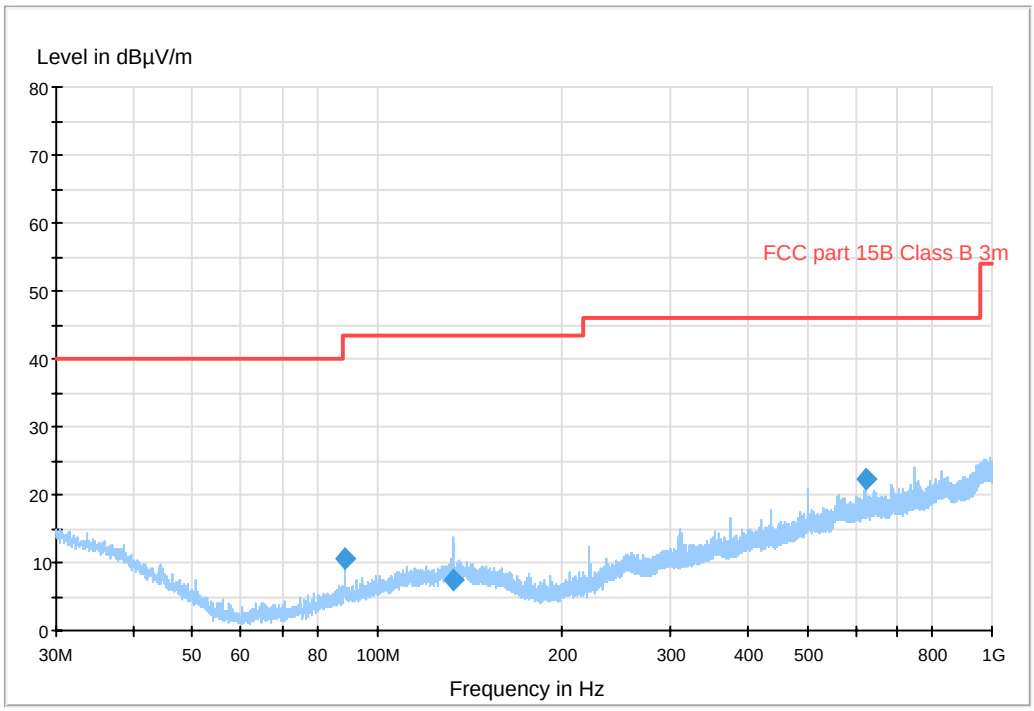
30 – 1000 MHz, max peak at a distance of 3 m on the middle TX channel

FCC 30 - 1000 MHz FCC class B 3m Fast scan



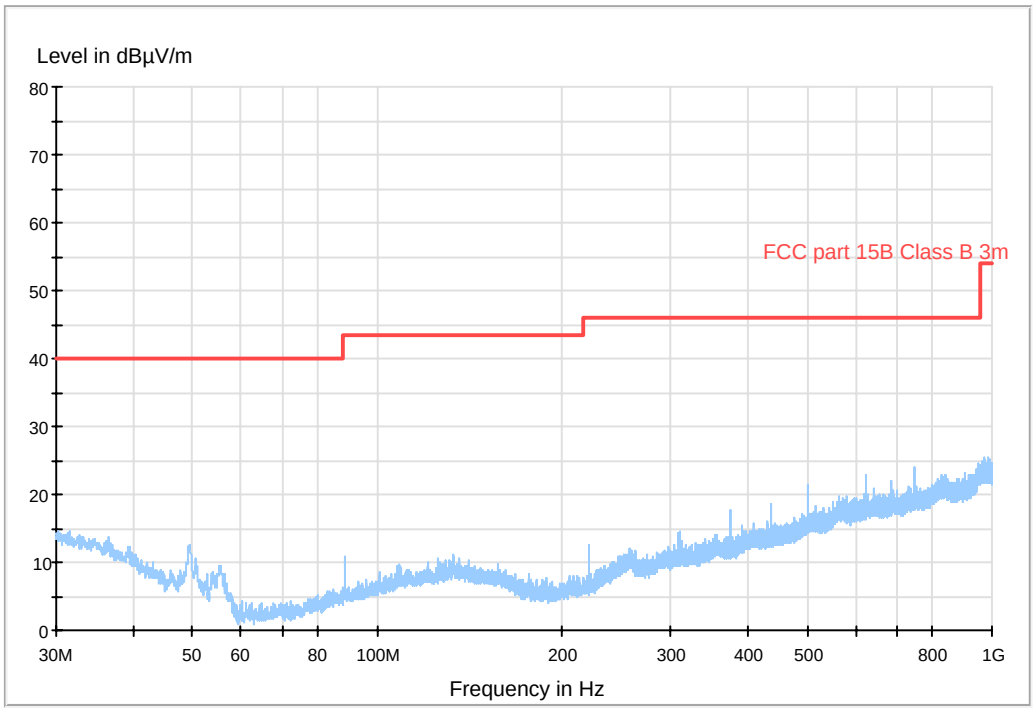
30 – 1000 MHz, max peak at a distance of 3 m on the upper TX channel

FCC 30 - 1000 MHz FCC class B 3m Fast scan



30 – 1000 MHz, max peak at a distance of 3 m in the stand by mode

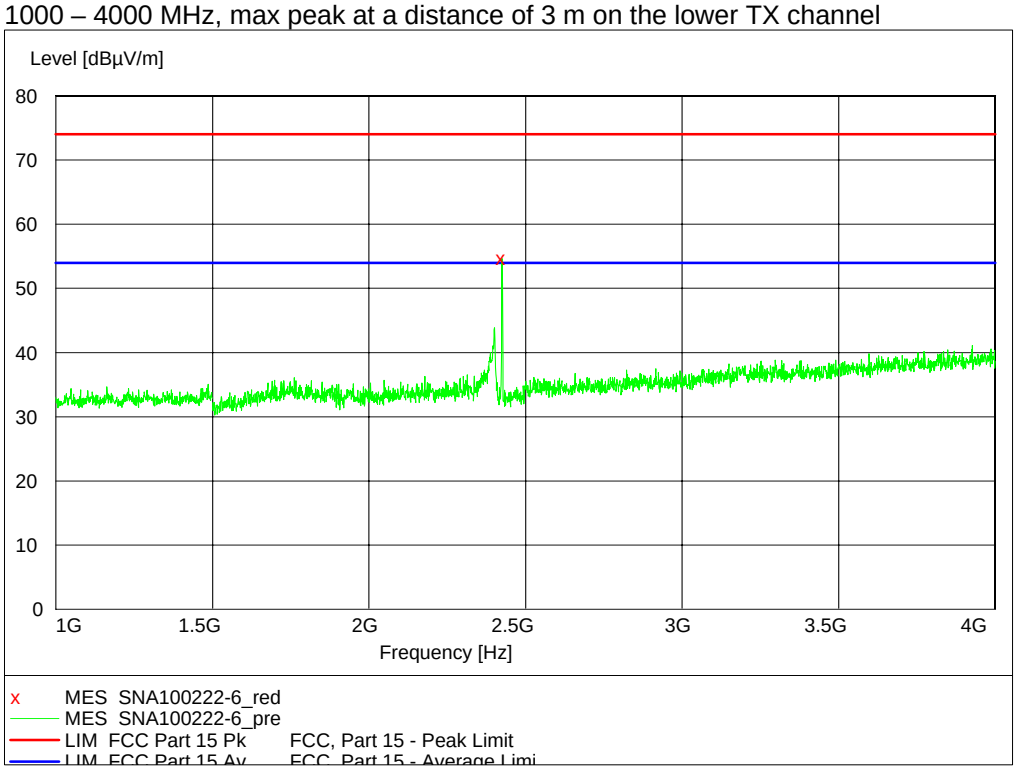
FCC 30 - 1000 MHz FCC class B 3m Fast scan



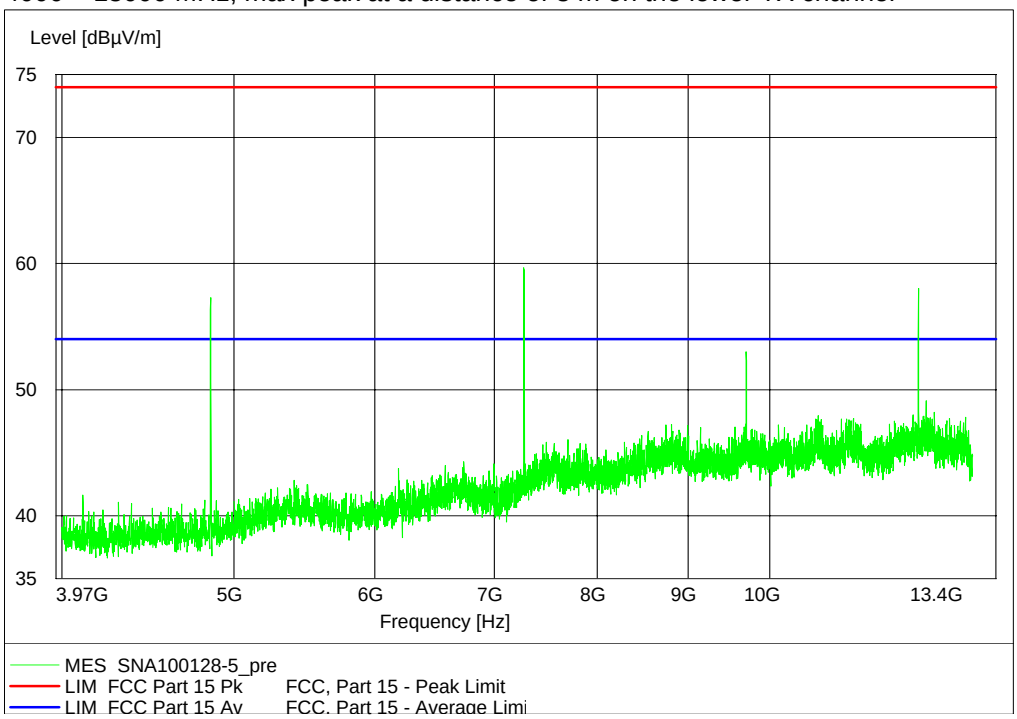
Radio anechoic shielded chamber

Date of test: 2010-02-16 – 2010-02-24

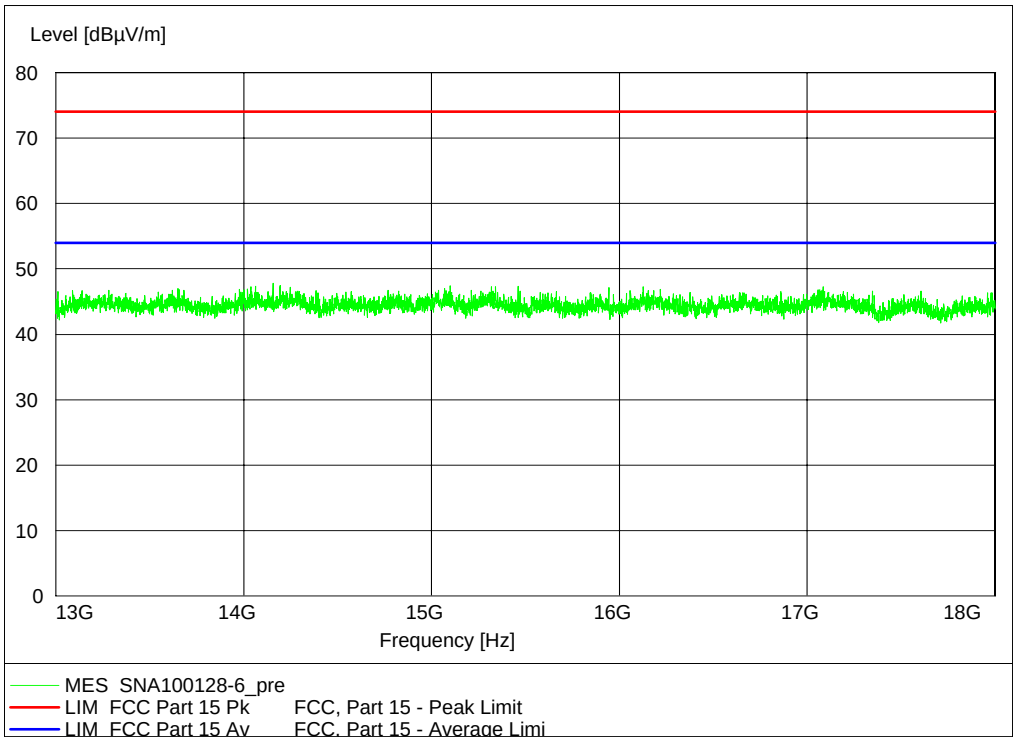
1000 – 4000 MHz, max peak at a distance of 3 m on the lower TX channel



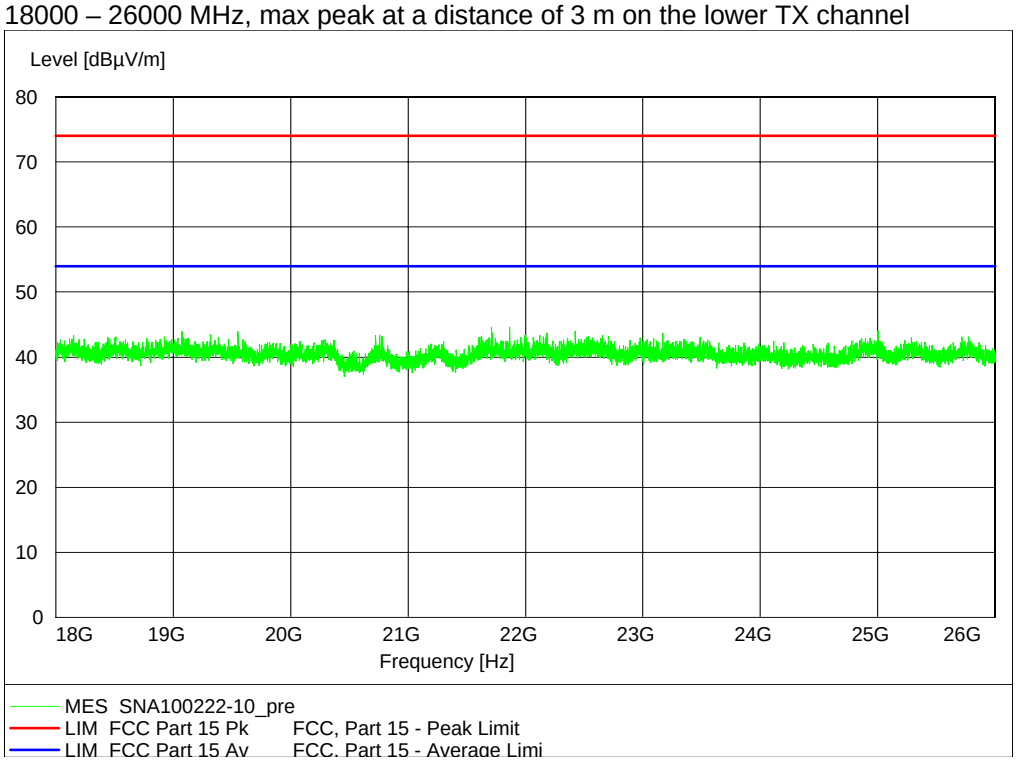
4000 – 13000 MHz, max peak at a distance of 3 m on the lower TX channel



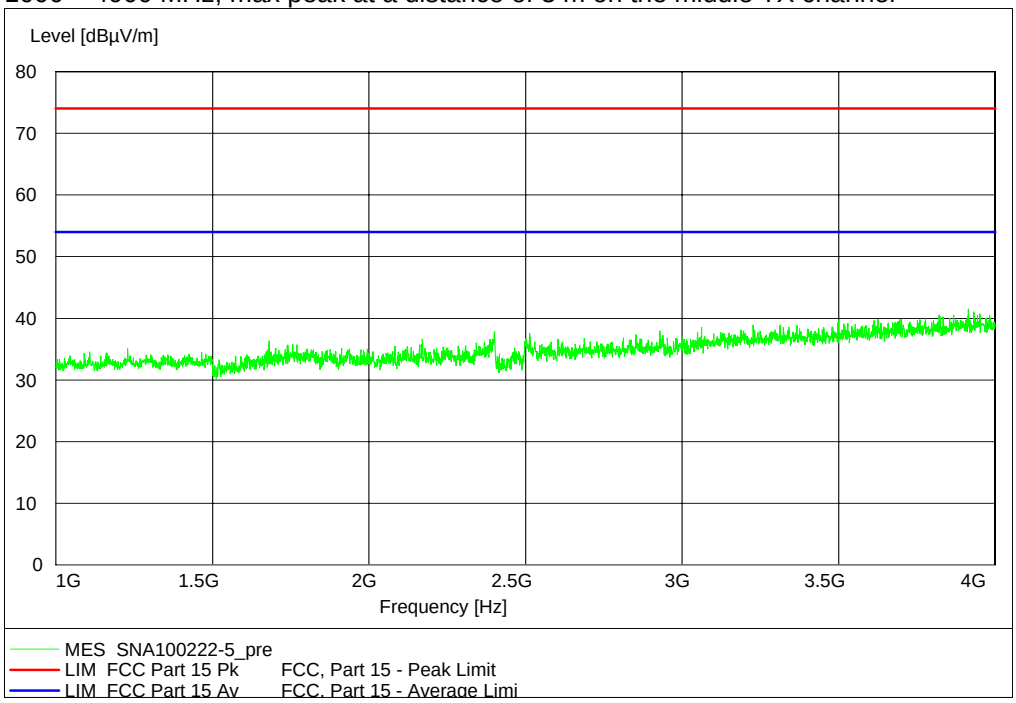
13000 – 18000 MHz, max peak at a distance of 3 m on the lower TX channel



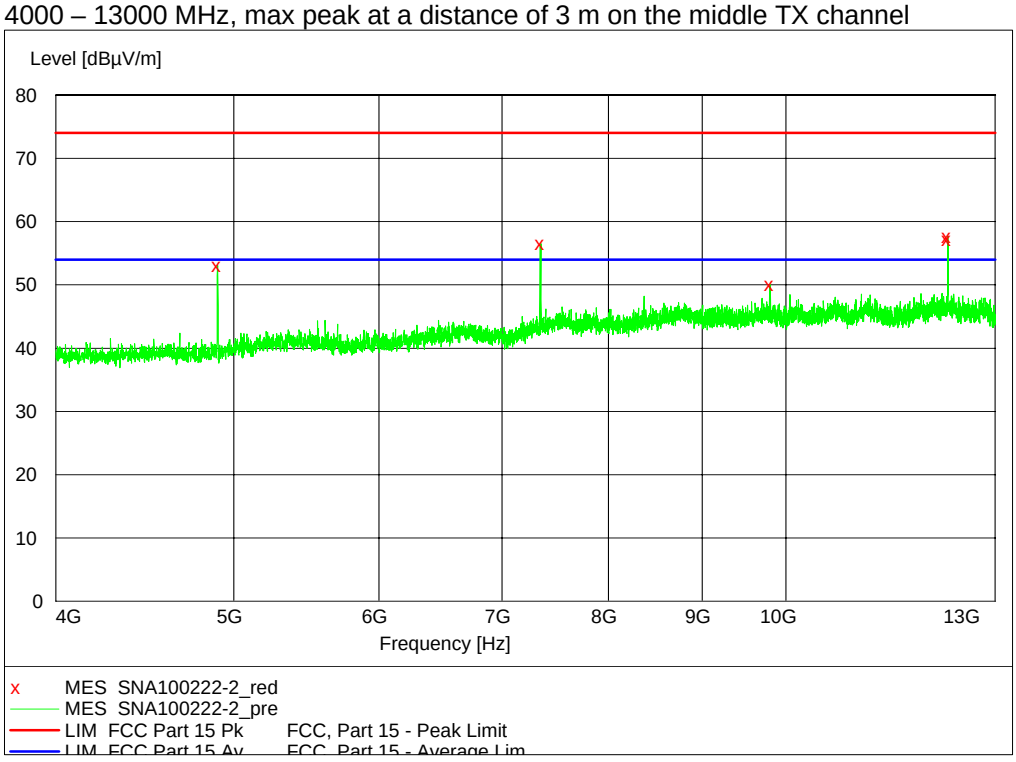
18000 – 26000 MHz, max peak at a distance of 3 m on the lower TX channel



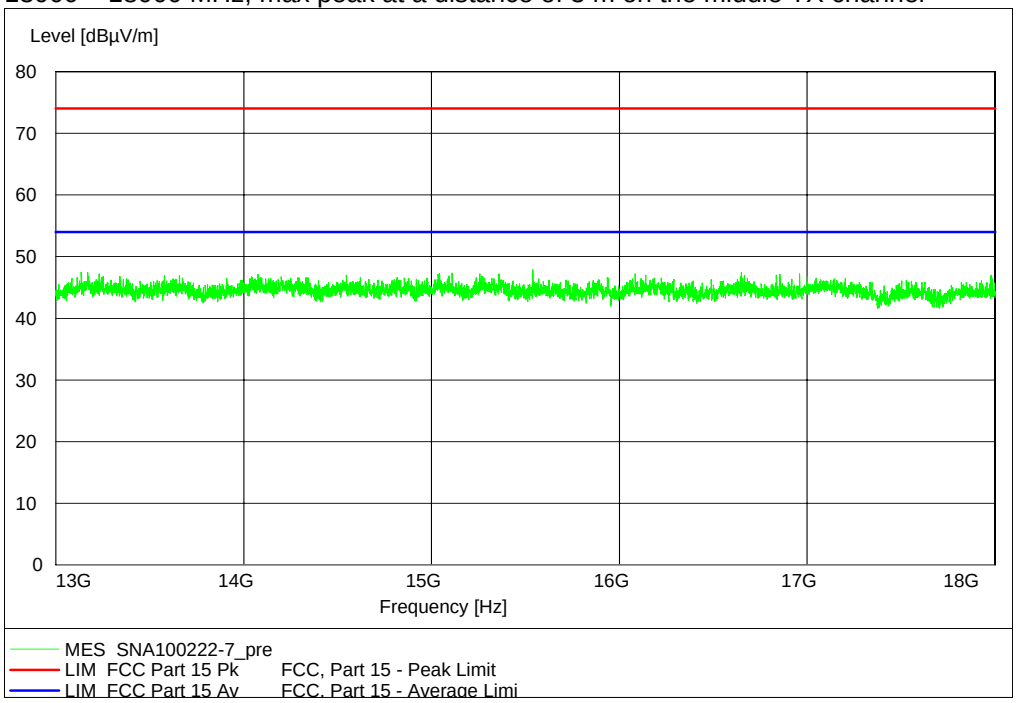
1000 – 4000 MHz, max peak at a distance of 3 m on the middle TX channel



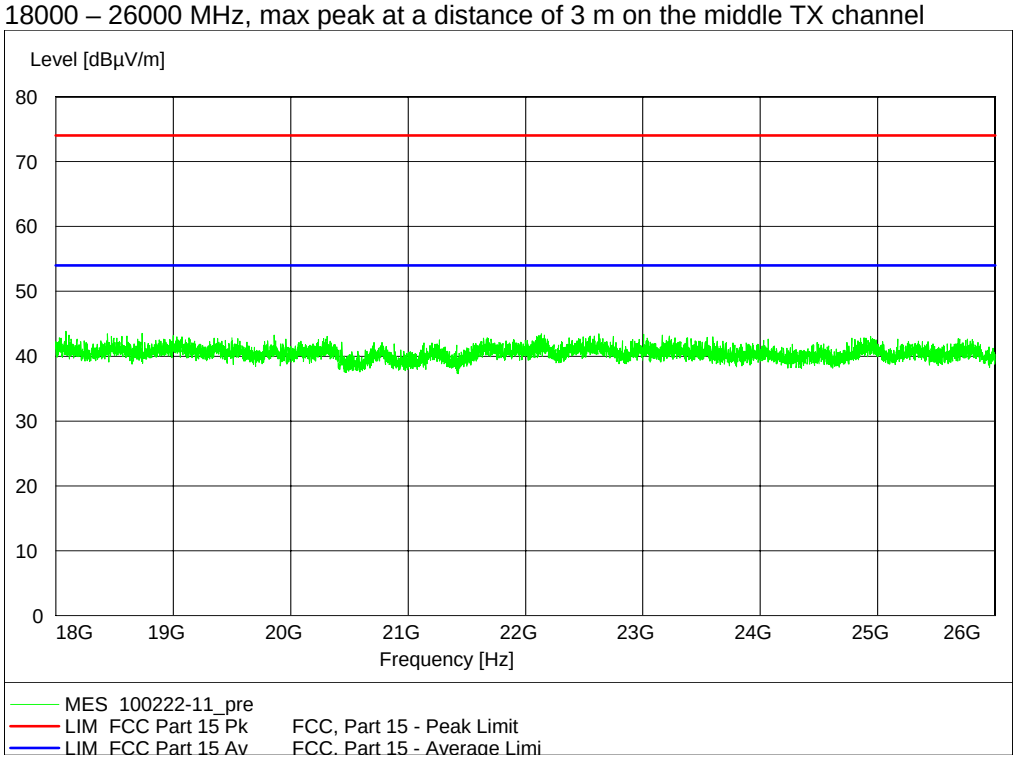
4000 – 13000 MHz, max peak at a distance of 3 m on the middle TX channel



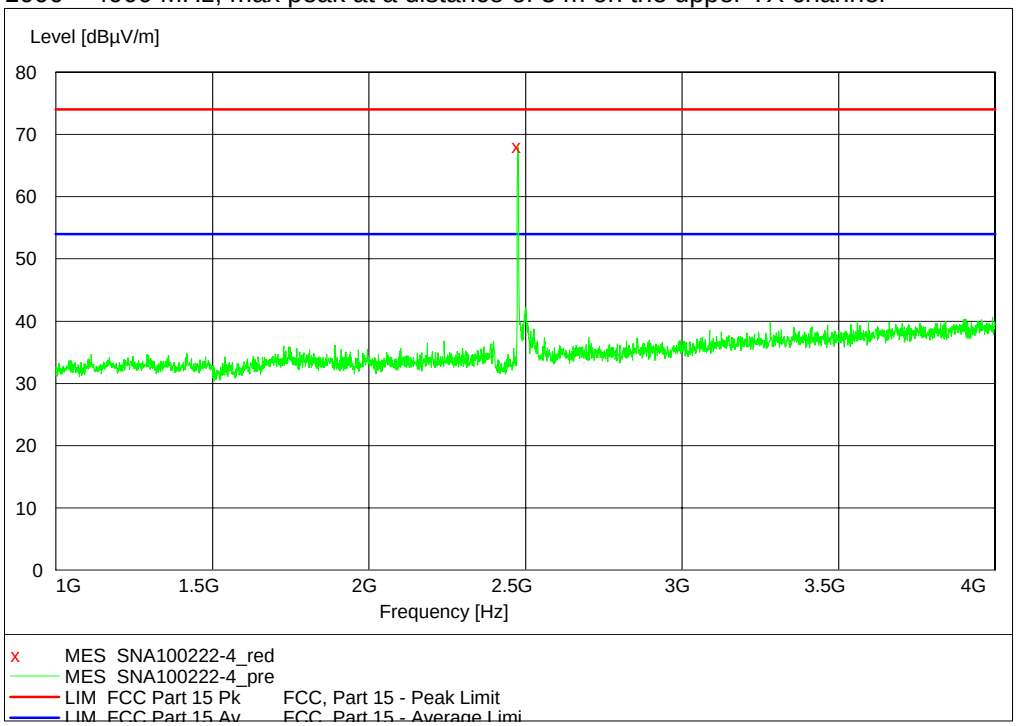
13000 – 18000 MHz, max peak at a distance of 3 m on the middle TX channel



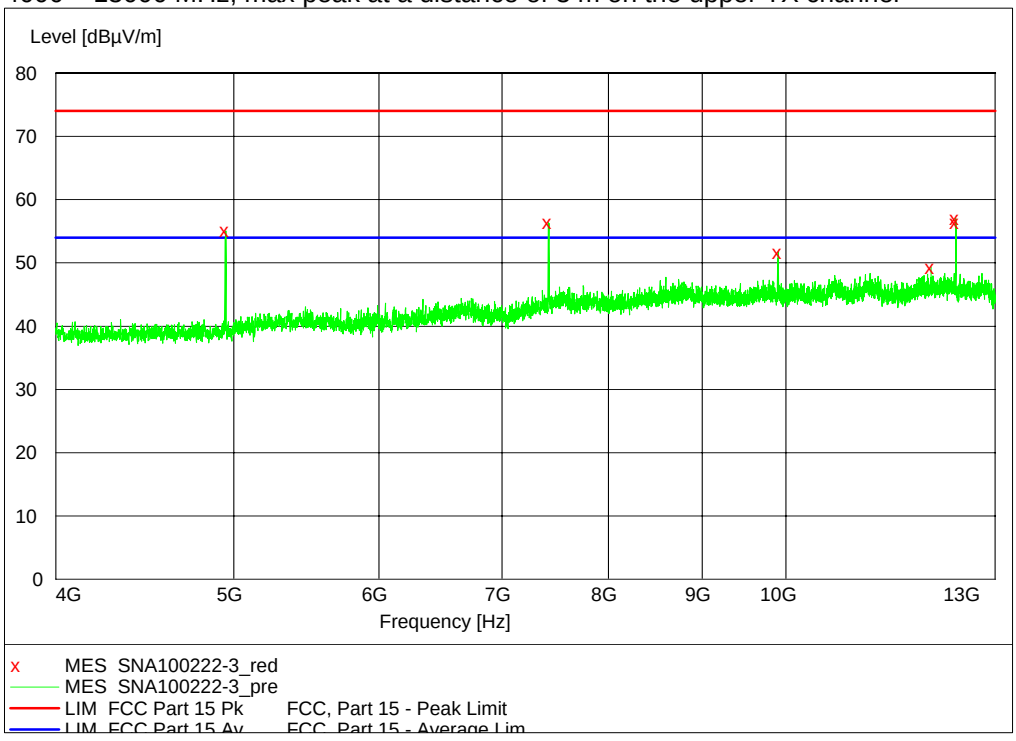
18000 – 26000 MHz, max peak at a distance of 3 m on the middle TX channel



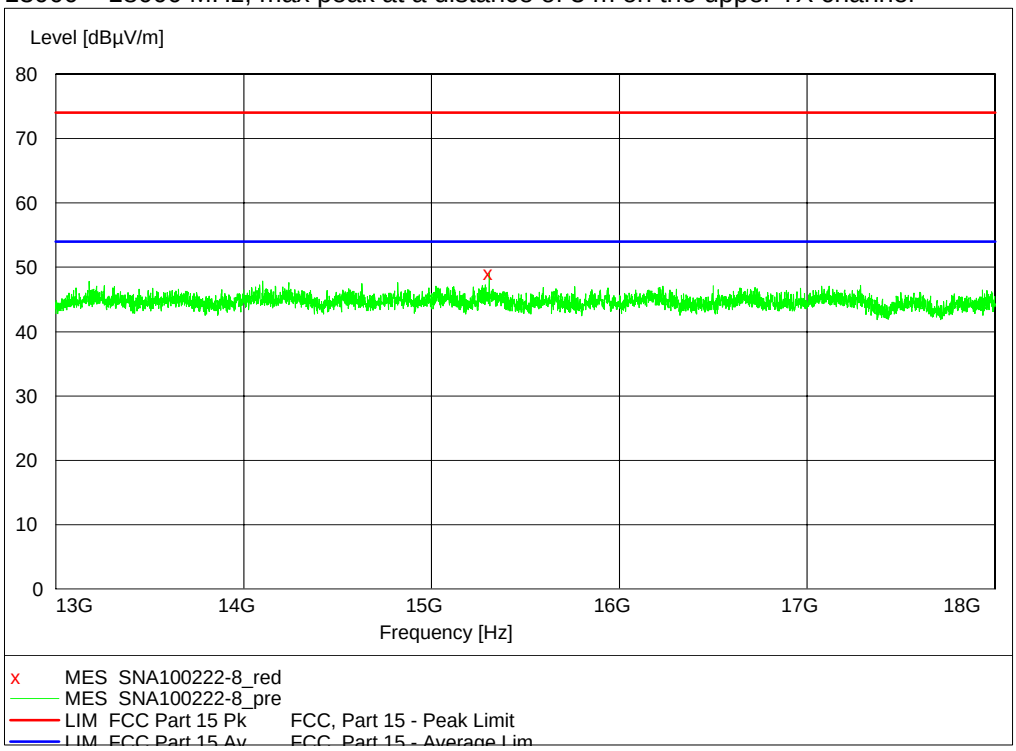
1000 – 4000 MHz, max peak at a distance of 3 m on the upper TX channel



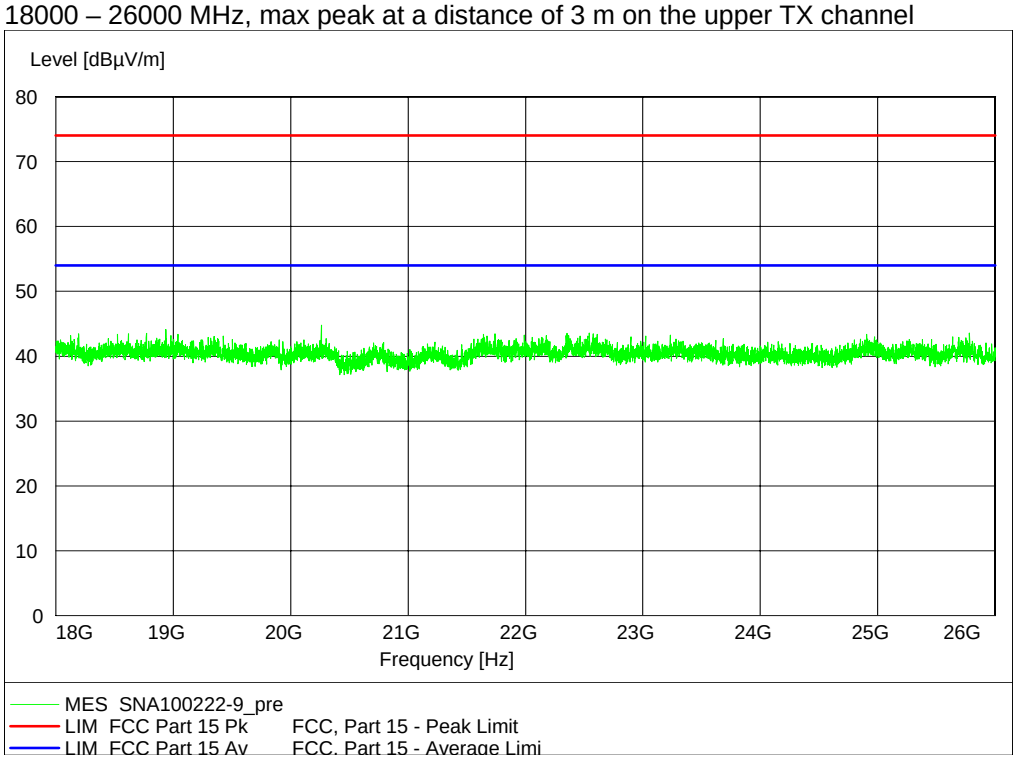
4000 – 13000 MHz, max peak at a distance of 3 m on the upper TX channel



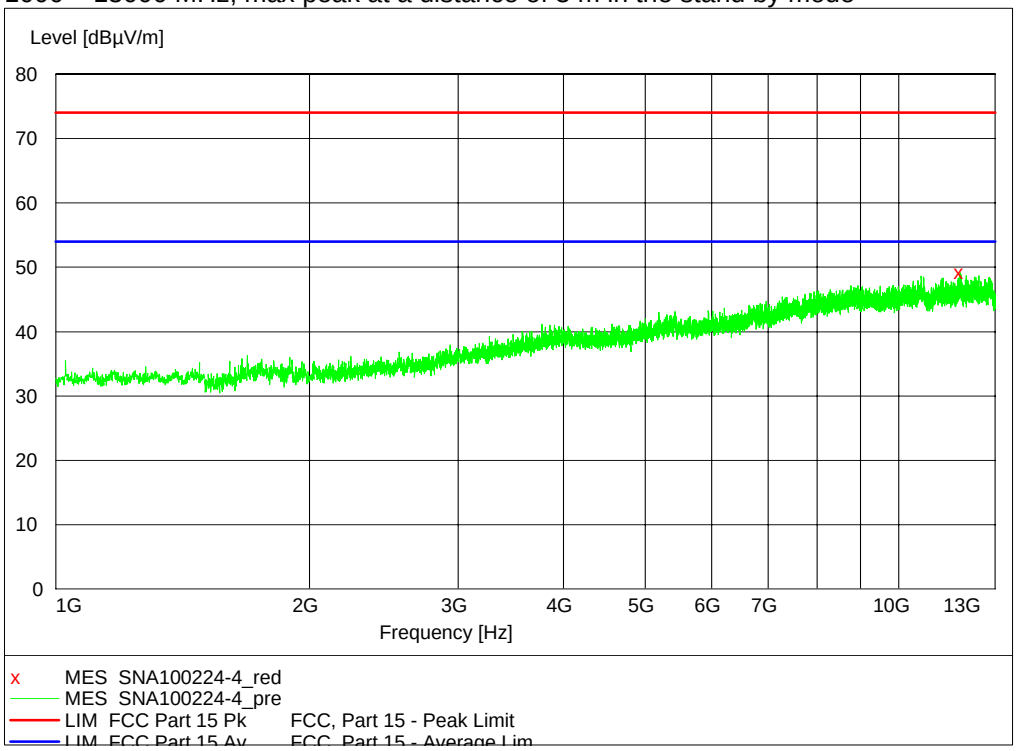
13000 – 18000 MHz, max peak at a distance of 3 m on the upper TX channel



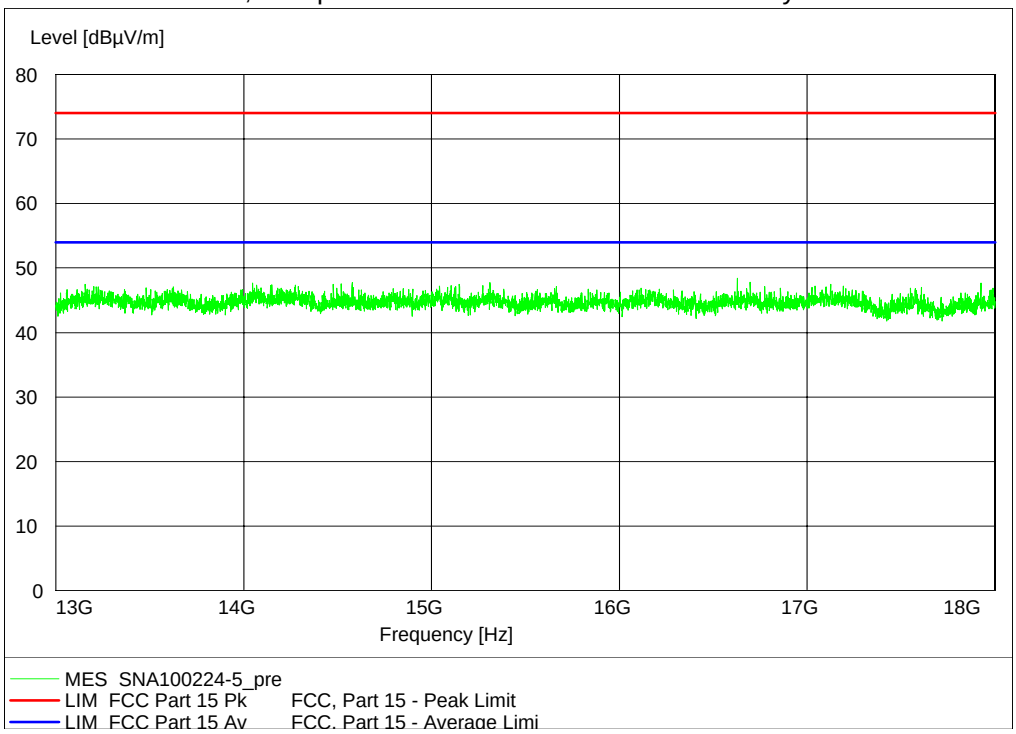
18000 – 26000 MHz, max peak at a distance of 3 m on the upper TX channel



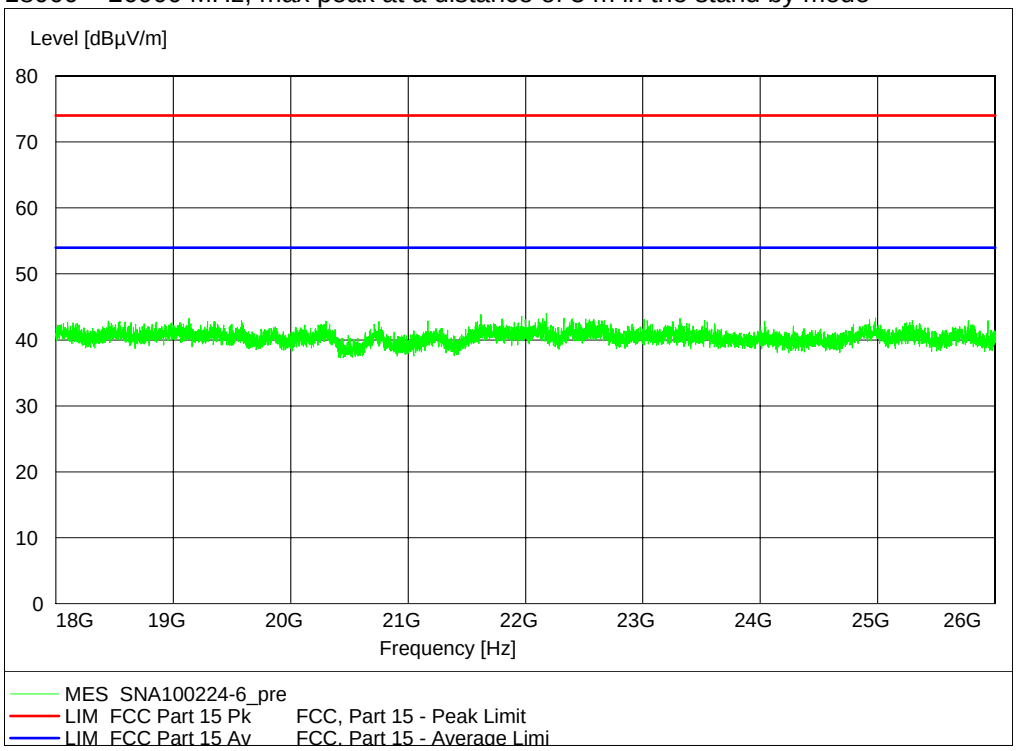
1000 – 13000 MHz, max peak at a distance of 3 m in the stand by mode



13000 – 18000 MHz, max peak at a distance of 3 m in the stand by mode



18000 – 26000 MHz, max peak at a distance of 3 m in the stand by mode



Data summary

Field strength of spurious emissions low channel						
Frequency	RBW	Measured level		Limit		Note
		QP/Peak	AV	Peak	AV	
[MHz]	[kHz]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	
4849.00	1000	53.4	44.4	74.0	54.0	
7273.50	1000	60.2	51.2	74.0	54.0	1
9698.00	1000	52.8	43.8	74.0	54.0	2
12122.50	1000	58.4	49.4	74.0	54.0	1

Field strength of spurious emissions middle channel						
Frequency	RBW	Measured level		Limit		Note
		QP/Peak	AV	Peak	AV	
[MHz]	[kHz]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	
4901.00	1000	56.6	47.6	74.0	54.0	
7351.50	1000	61.1	52.1	74.0	54.0	1
9802.00	1000	56.8	47.8	74.0	54.0	2
12252.50	1000	61.9	52.9	74.0	54.0	1

Field strength of spurious emissions high channel						
Frequency	RBW	Measured level		Limit		Note
		QP/Peak	AV	Peak	AV	
[MHz]	[kHz]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	
4951.00	1000	58.1	49.1	74.0	54.0	1
7426.5	1000	60.0	51.0	74.0	54.0	1
9902.00	1000	58.0	49.0	74.0	54.0	2
12377.50	1000	62.2	53.5	74.0	54.0	1

Field strength of spurious emissions standby						
Frequency	RBW	Measured level		Limit		Note
		QP/Peak	AV	Peak	AV	
[MHz]	[kHz]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	[dB(μV/m)]	
30-1000	120	-	-	-	-	No significant peaks above the noise floor
1000-26000	1000	-	-	-	-	No significant peaks above the noise floor

1) The measured result is below the limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95 % level of confidence. However, the result indicates that compliance is more probable than non-compliance with the specification limit.

2) Not within restricted band.

Example calculation:
Measured level [dBμV/m] = Analyser reading [dBμV] + cable loss [dB] – preamplifier gain [dB] + antenna factor [1/m]

10. OUT OF BAND SPURIOUS EMISSIONS, CONDUCTED AT ANTENNA PORT

Date of test: 2010-02-25

EUT mode of operation: continuous TX.

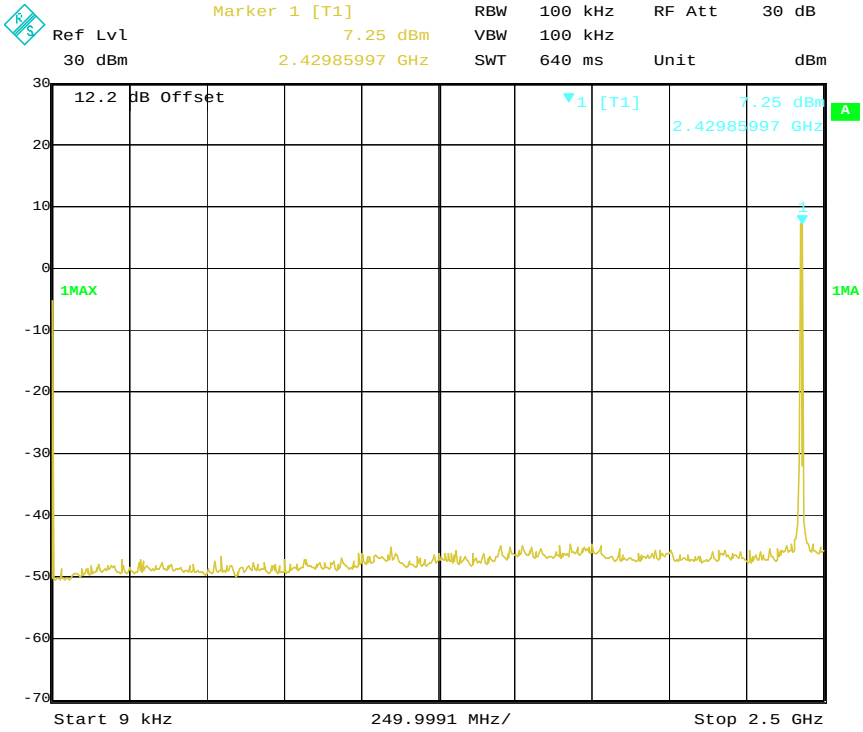
Spectrum analyzer settings:

RBW: 100 kHz
VBW: 100 kHz
Sweep time: Auto
Detector: Peak
Trace: Max Hold

Channel	Plot	Results	Limit value (dBc)
Low	10.1 – 10.4	PASS	20
Middle	10.5 – 10.8	PASS	20
High	10.9 – 10.12	PASS	20

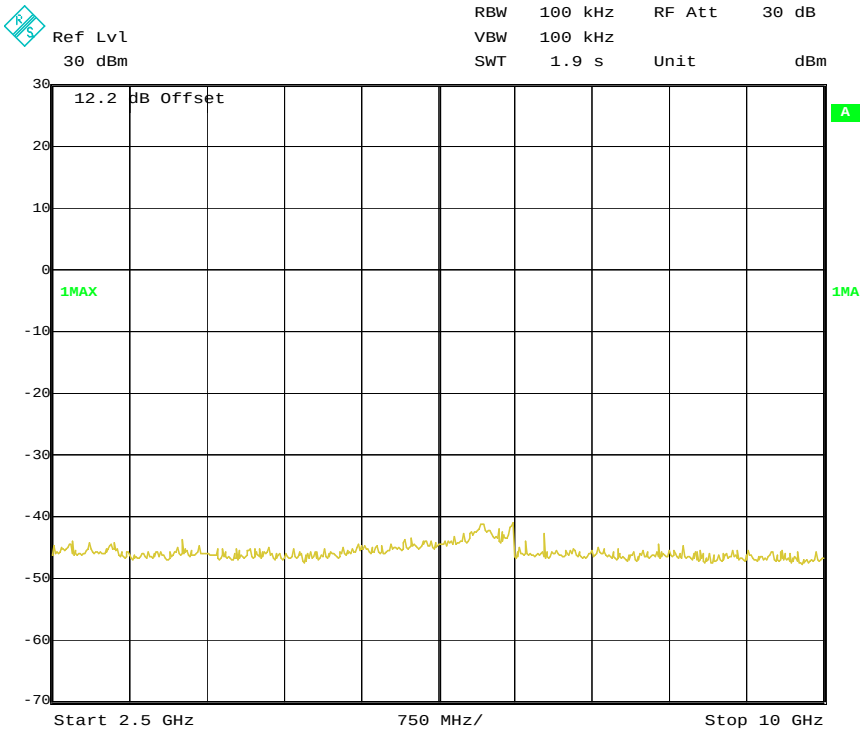
Limit: In any 100 kHz bandwidth outside the operating frequency band (2400 – 2483.5 MHz), the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

Plot P10.1



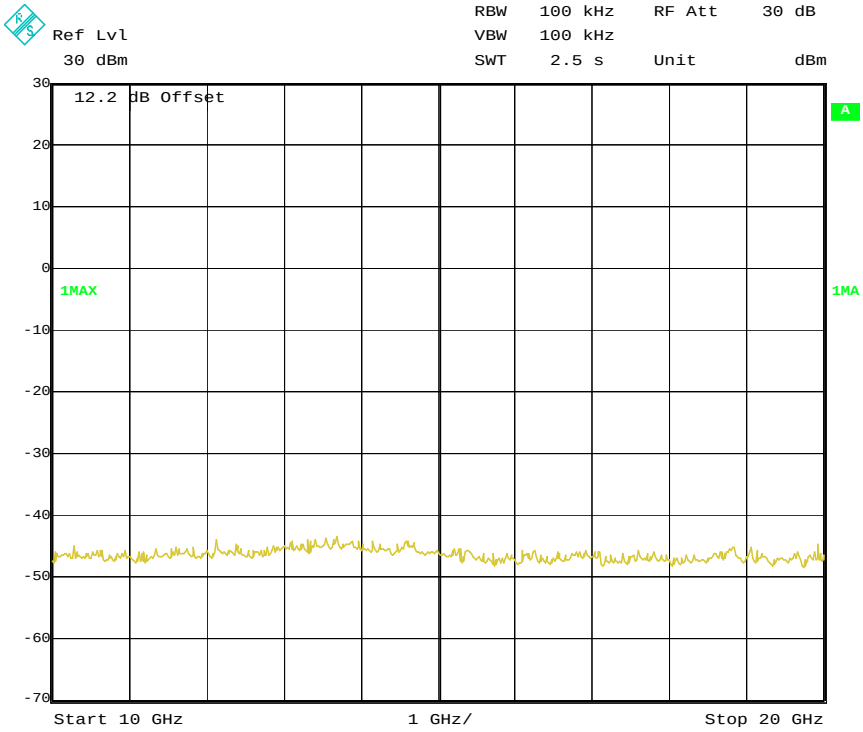
Date: 25.FEB.2010 12:37:25

Plot P10.2



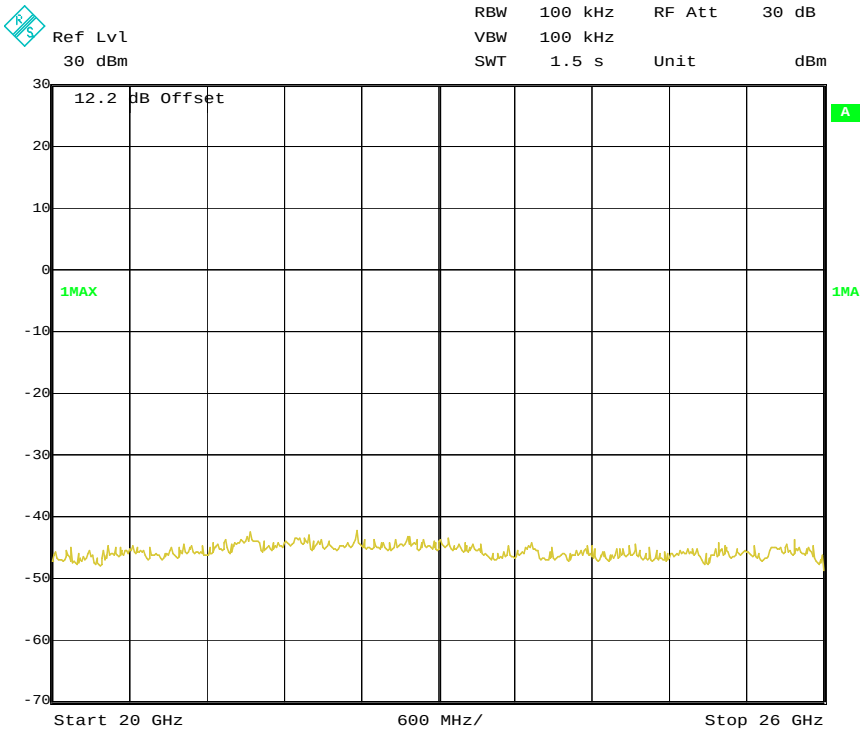
Date: 25.FEB.2010 12:38:18

Plot P10.3



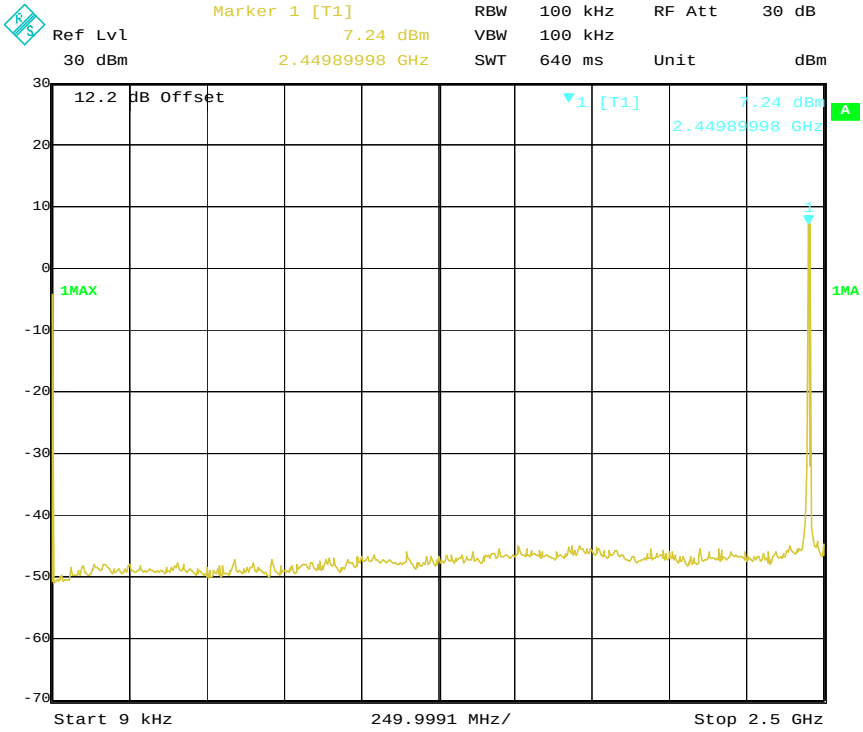
Date: 25.FEB.2010 12:39:04

Plot P10.4



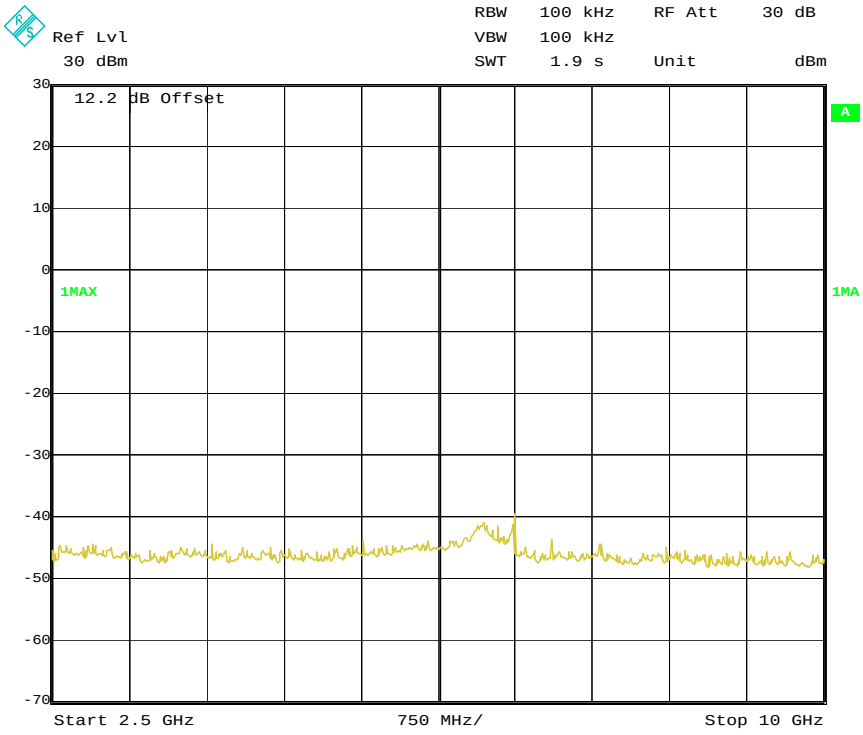
Date: 25.FEB.2010 12:39:33

Plot P10.5



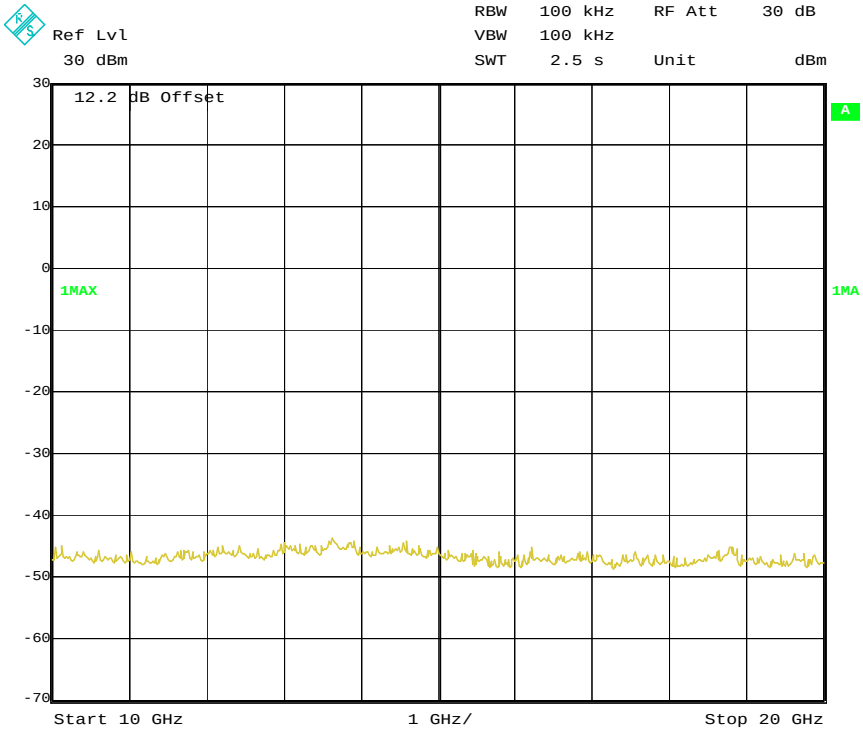
Date: 25.FEB.2010 12:40:35

Plot P10.6



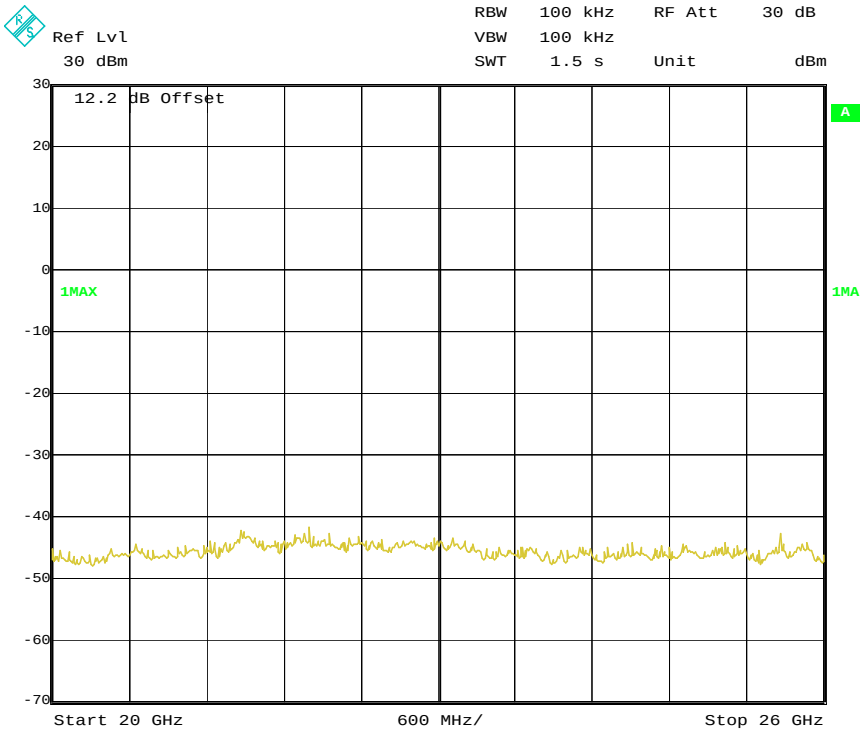
Date: 25.FEB.2010 12:41:09

Plot P10.7



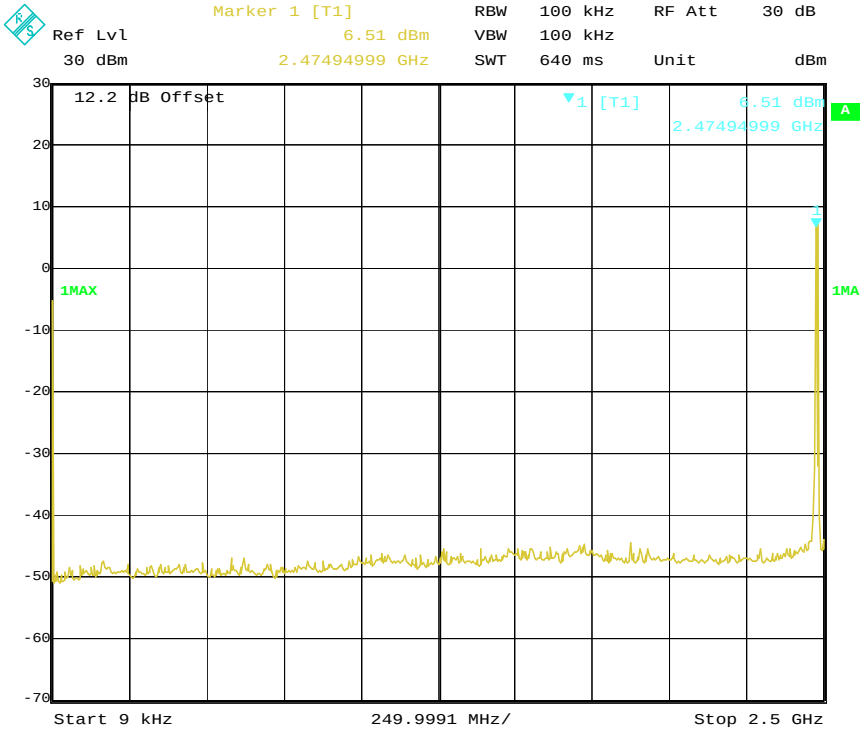
Date: 25.FEB.2010 12:41:44

Plot P10.8



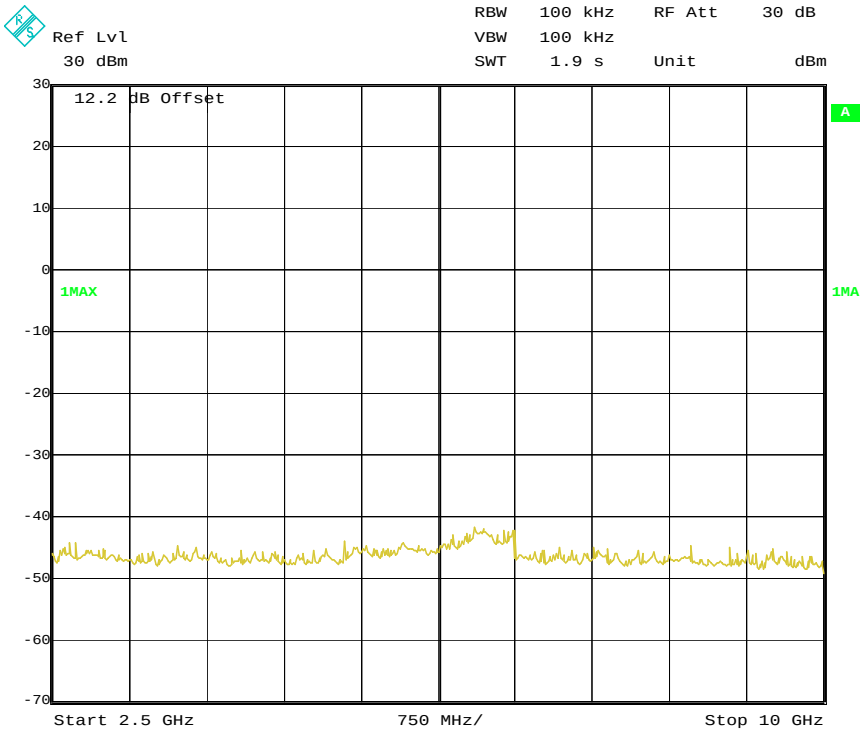
Date: 25.FEB.2010 12:42:11

Plot P10.9



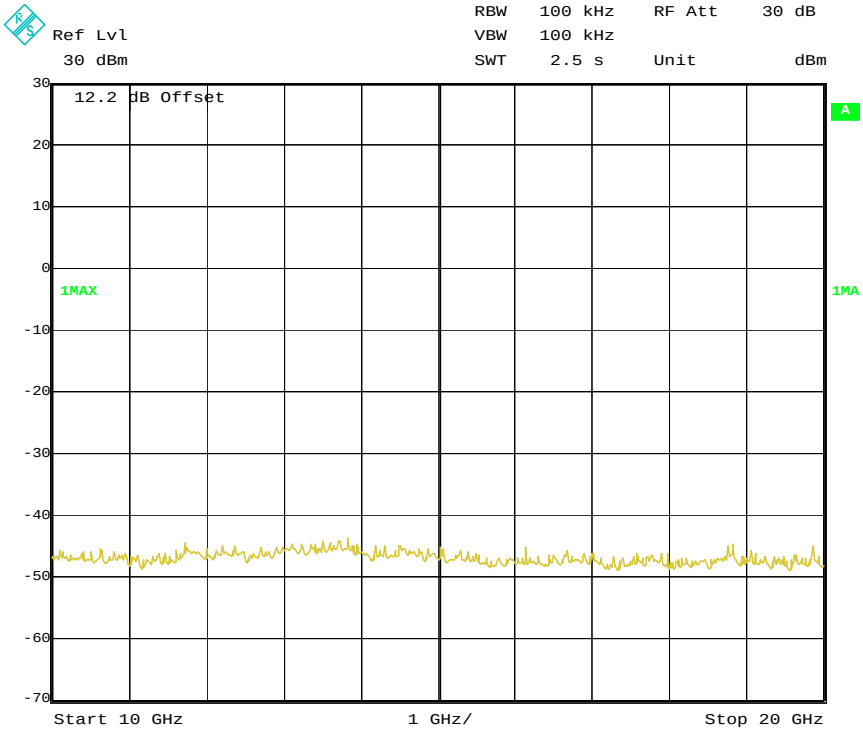
Date: 25.FEB.2010 12:44:28

Plot P10.10



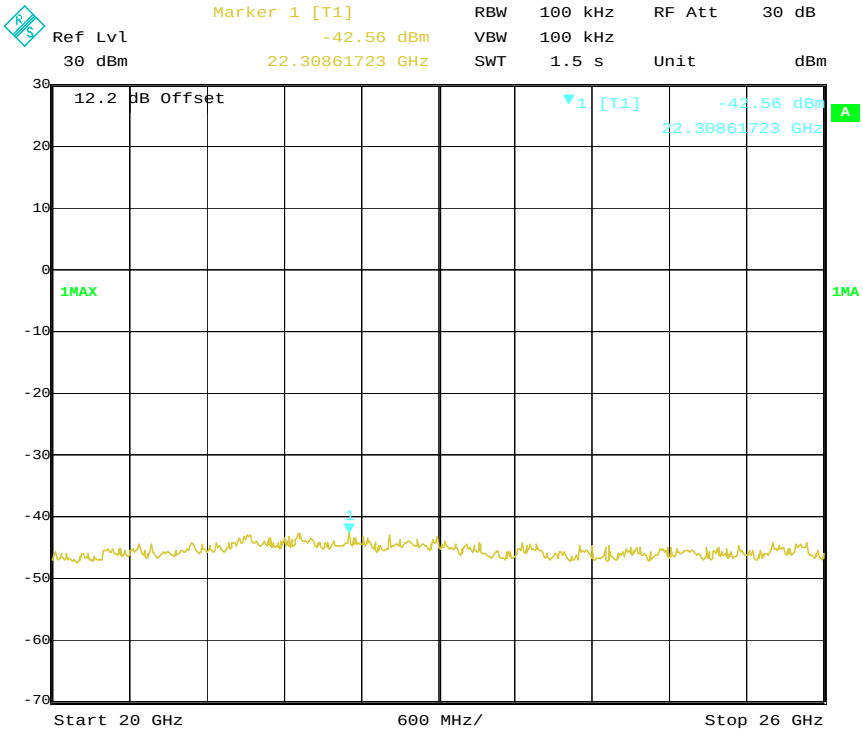
Date: 25.FEB.2010 12:45:11

Plot P10.11



Date: 25.FEB.2010 12:45:37

Plot P10.12



Date: 25.FEB.2010 12:46:25

11. 99% BANDWIDTH

11.1 Test protocol

Date of test: 2010-02-25

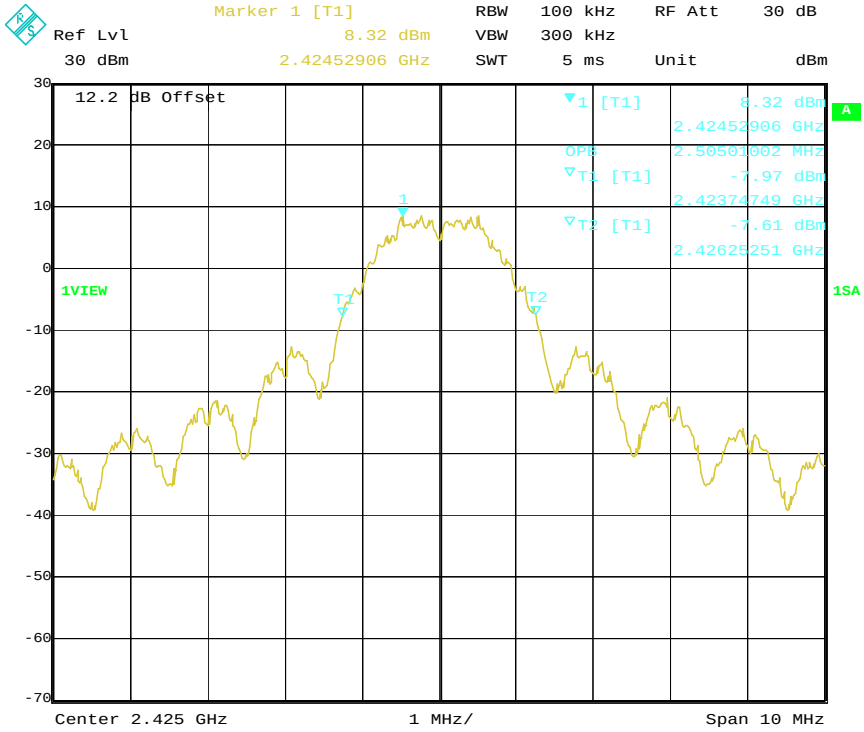
EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

Span: 10 MHz
RBW: 100 kHz
VBW: 300 kHz
Sweep time: Auto
Detector: Sample
Trace: Max Hold

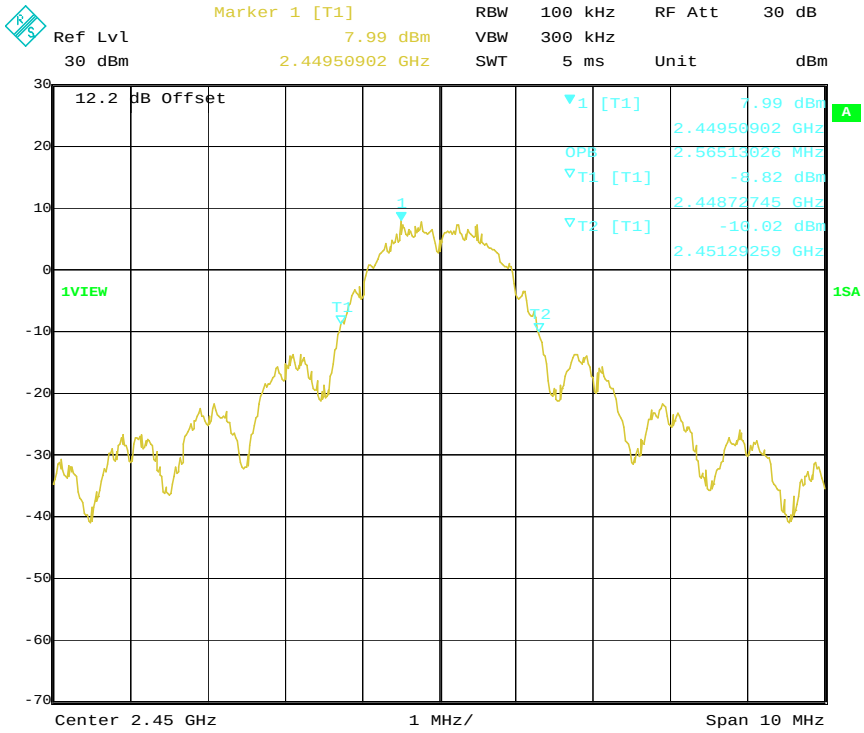
Channel	Plot	Measured value MHz	Limit value MHz
Low	plot P11.1	2.51	-
Middle	plot P11.2	2.57	-
High	plot P11.3	2.59	-

Plot P11.1



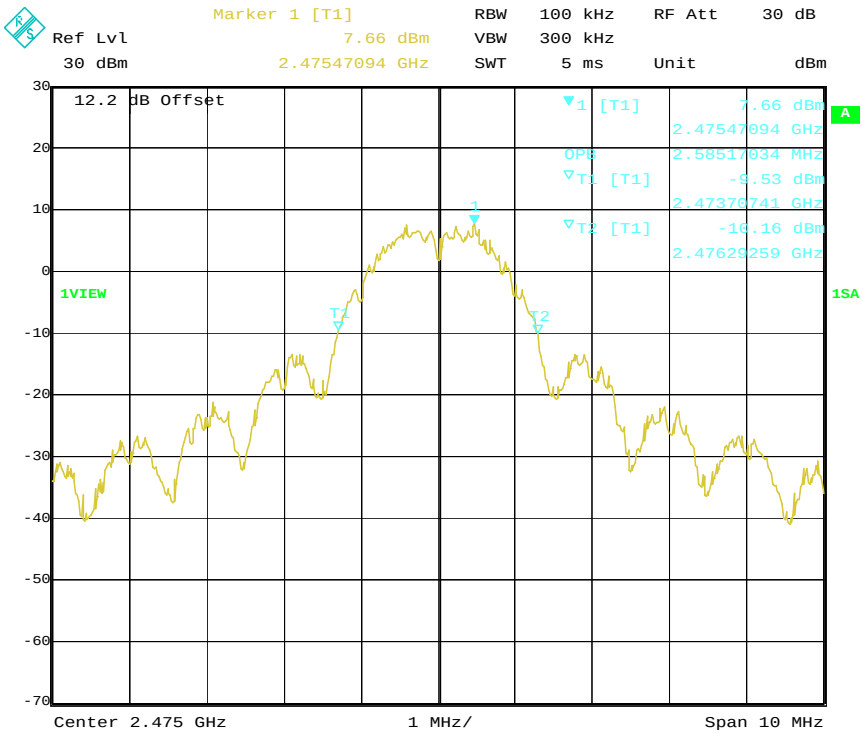
Date: 25.FEB.2010 12:49:40

Plot P11.2



Date: 25.FEB.2010 12:52:18

Plot P11.3


Marker 1 [T1]
RBW 100 kHz
RF Att 30 dB
Ref Lvl
7.66 dBm
VBW 300 kHz
30 dBm
2.47547094 GHz
SWT 5 ms
Unit dBm
12.2 dB Offset
1 [T1] 7.66 dBm
2.47547094 GHz
OBW 2.58517034 MHz
T1 [T1] -9.53 dBm
2.47376741 GHz
T2 [T1] -10.16 dBm
2.47629259 GHz
1VIEW
1SA
A
Center 2.475 GHz
1 MHz/
Span 10 MHz
Date: 25.FEB.2010 12:53:02

11. CONDUCTED EMISSION FROM AC-MAINS

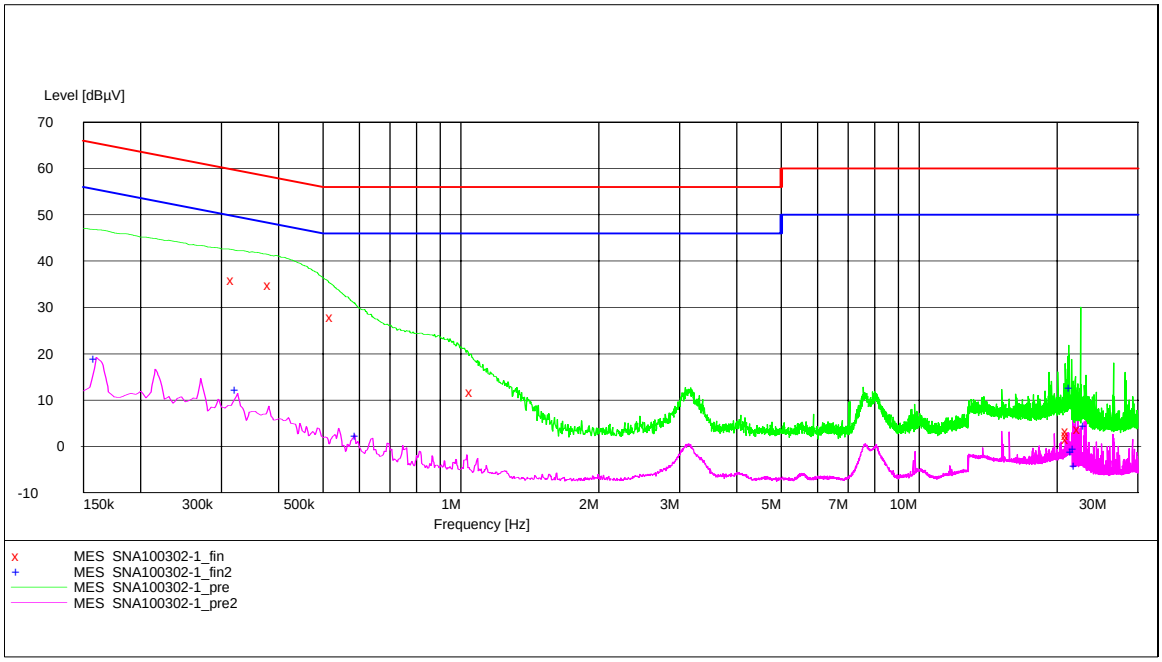
11.1 Test protocol

Date of test: 2010-03-02

Measurement receiver settings:

Start Frequency	Stop Frequency	Step Width	Detector	IF Bandw	Meas. Time	Tranducer
150.0 kHz	30.0 MHz	5.0 kHz	QuasiPeak Average	10 kHz	1.0 s	ESH3-Z5 No. 2727

The EUT is placed on 80 cm high non conductive table and 40 cm from ground reference plane. EUT mains cable is connected to a LISN.



Data summary

Conducted emission AC mains				
Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Detector
0.320	35.9	59.7	23.8	QP
0.385	34.8	58.2	23.4	QP
0.525	27.8	56.0	28.2	QP
1.060	11.7	56.0	44.3	QP
22.455	3.7	56.0	56.3	QP

Conducted emission AC mains				
Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Detector
0.160	18.9	55.5	36.6	Av
0.325	12.1	49.6	37.5	Av
0.595	2.2	46.0	43.8	Av
21.505	12.6	46.0	37.4	Av

APPENDIX – PHOTOS OF THE EUT