

RADIO TEST REPORT

No. 902530-2

EQUIPMENT UNDER TEST

Equipment: Window Operator
Type / model: 3MX S01 WW
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 (2008) and Subpart C (2008);

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

Industry Canada listed test facility No. IC 2042G-1

Date of issue: October 26, 2009

Tested by:  Approved by:
Stefan Andersson


Niklas Larsson

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1. CLIENT INFORMATION

The EUT has been tested by request of

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

2. EQUIPMENT UNDER TEST (EUT)**2.1 Identification of the EUT according to the manufacturer/client declaration**

Equipment: Window Operator
Type/Model: 3MX S01 WW
Brand name: Velux
Serial number: No visible serial number on EUT
Manufacturer: Velux A/S
Rating/Supplying voltage: 120 VAC
Rating RF output power: 3 dBm typical
Antenna gain: 0 dBi
External antenna connector: NO
Operating temperature range: -10 to +55 °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



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3. TEST SPECIFICATIONS

3.1 Standards

FCC 47 CFR part 15 (2008) Subpart B – Unintentional radiators

FCC 47 CFR part 15 (2008) 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 conducted disturbance voltage in the frequency range 0,15-30 MHz and 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 (1)	Peak output power	PASS	
15.247(a)	RSS-210 A8.1 (c)	6 dB Bandwidth	PASS	
15.247(a)	RSS-210 A8.1 (b)	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.



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5. PEAK OUTPUT POWER

5.1 Test protocol

Date of test: 2009-07-22

EUT mode of operation: continuous TX. Modulation on

Spectrum analyzer settings:

Span: 6,25 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	3.9	plot P5.1	< 30
2450	3.9	plot P5.2	
2475	4.0	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]



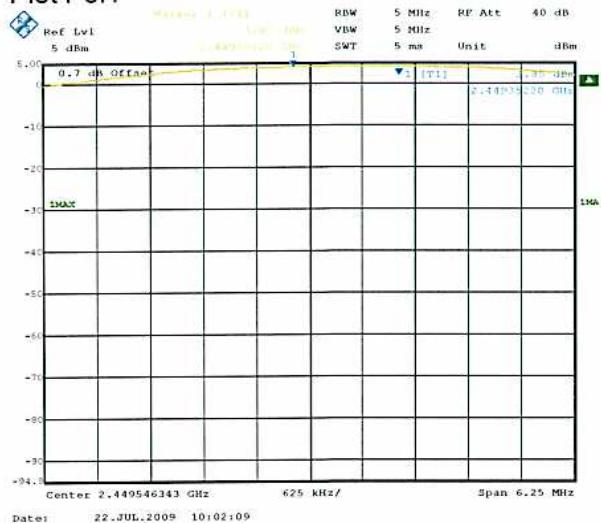
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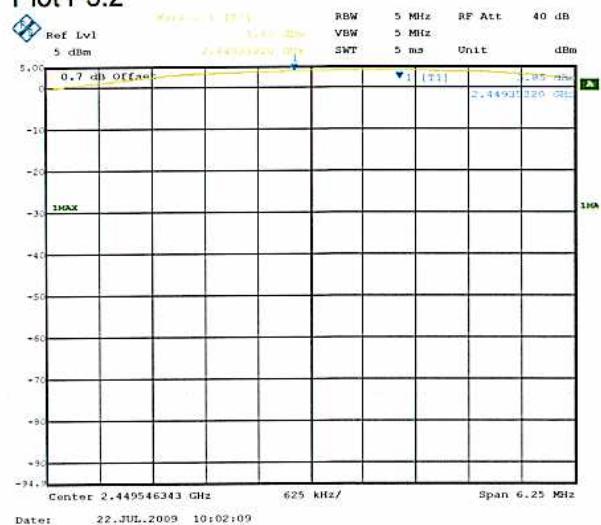
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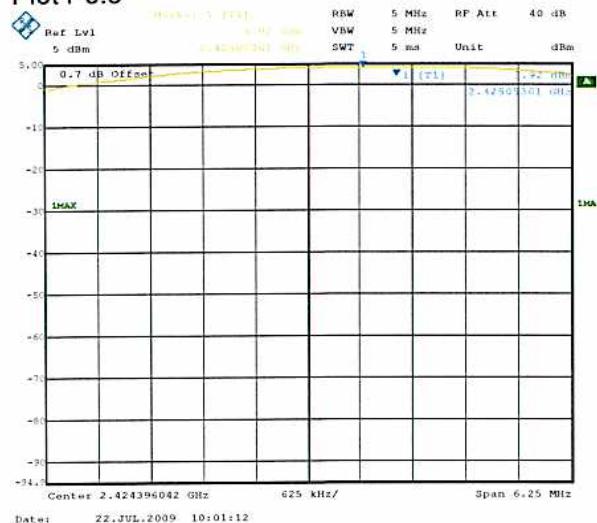
Plot P5.1



Plot P5.2



Plot P5.3



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6. 6 dB BANDWIDTH

6.1 Test protocol

Date of test: 2009-07-22

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	1.622	plot P6.1	> 0.5
2450	1.597	plot P6.2	
2475	1.635	plot P6.3	



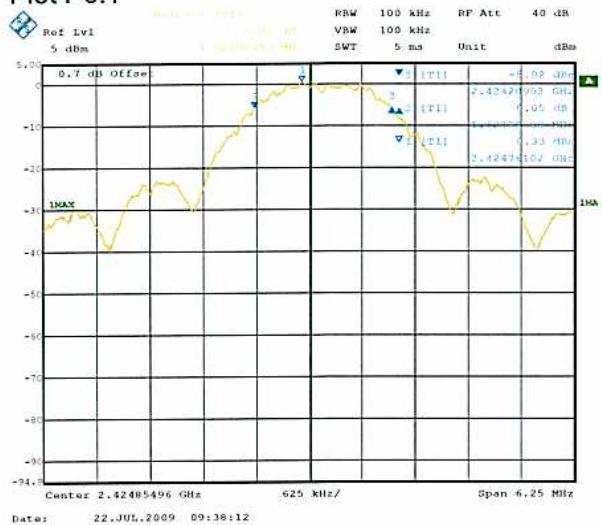
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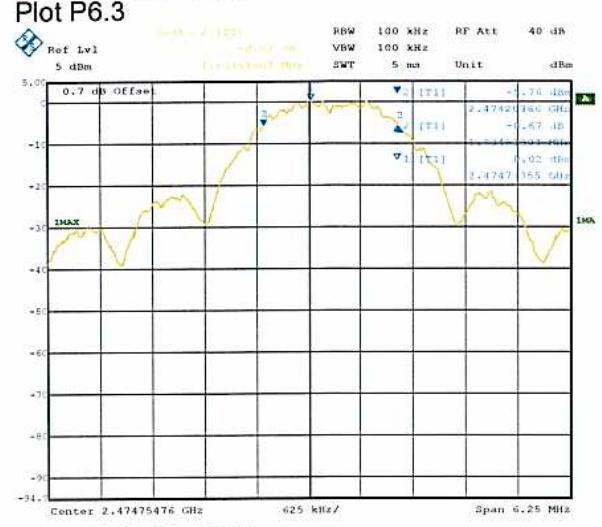
Plot P6.1



Plot P6.2



Plot P6.3



7. SPECTRAL POWER DENSITY

7.1 Test protocol

Date of test: 2009-07-22

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	-10.8	plot P7.1	8
Mid	-10.8	plot P7.2	8
High	-10.8	plot P7.3	8

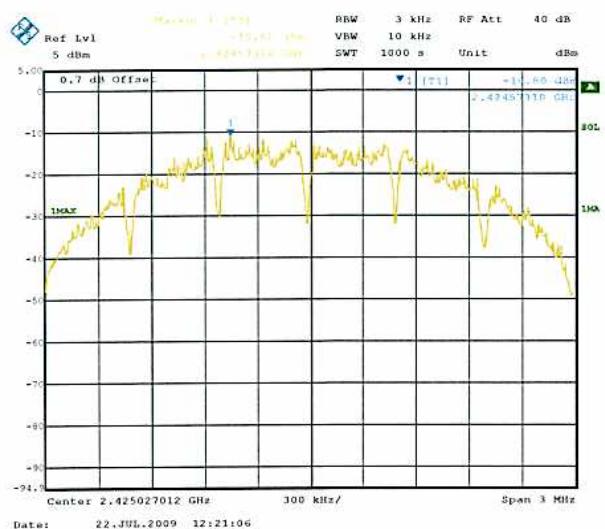
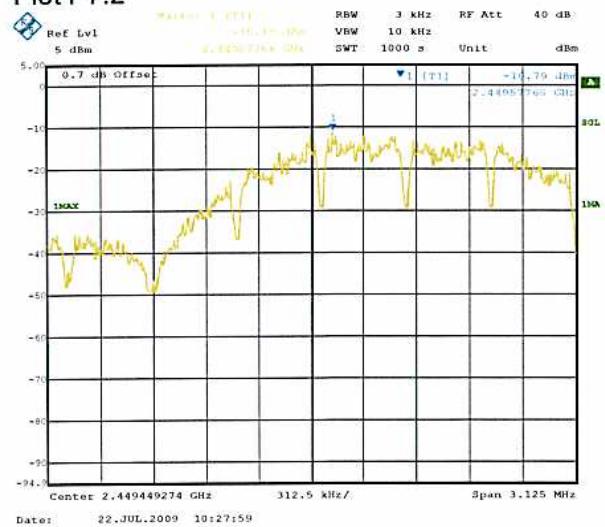
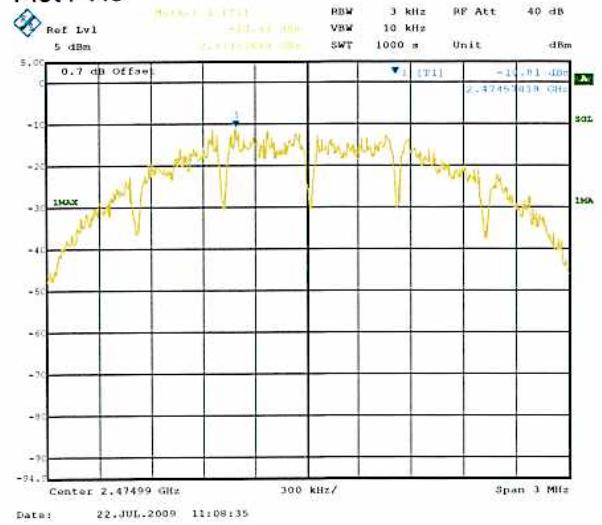


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PlotP7.1**Plot P7.2****Plot P7.3**

8. BAND EDGE COMPLIANCE

8.1 Test protocol

Date of test: 2009-07-22

EUT mode of operation: TX

Spectrum analyzer settings:

Span: 100 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



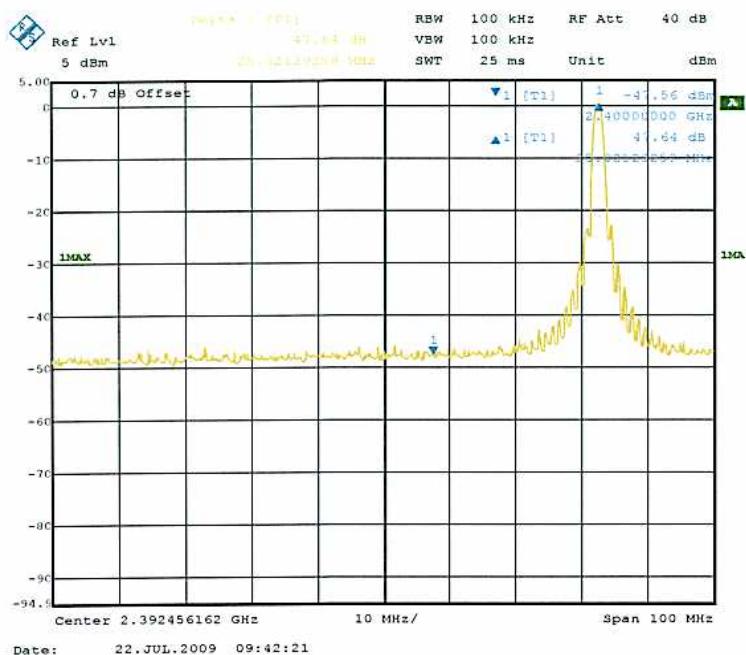
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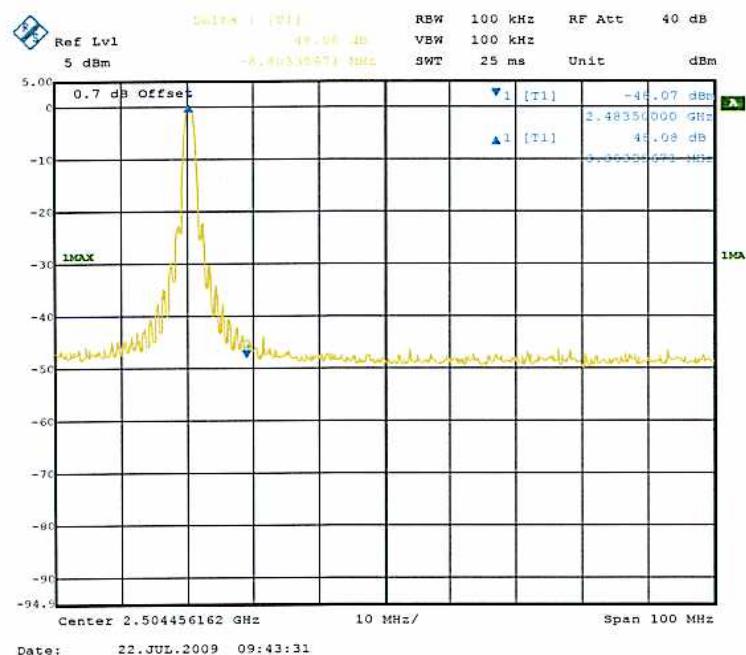
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Plot P8.1



Plot P8.2



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 – 13000 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.
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Test site: Semi-anechoic shielded chamber, 5,7 x 8,7 x 5,4 m (W x L x H)

Software:	Rohde & Schwarz	EMC32	
Measurement receiver:	Rohde & Schwarz	ESCI	12798
Integrated Measurement System:	Rohde & Schwarz	IMS	12800
Antenna: Ultra Broadband	Rohde & Schwarz	HL562	30711

Test site: Radio anechoic shielded chamber, 3,7 x 7,0 x 2,4 m (W x L x H)

Software:	Rohde & Schwarz	ES-K1, V1.70	
Signal analyser:	Rohde & Schwarz	FSIQ 40	12793
Preamplifier:	MITEQ	AFS6/AFS44	12335
Antenna: Double Ridge Guide Horn (1-13GHz)	EMCO	3115	4936
Transformer	Tufvassons	AFM-1500	30317



9.4 Measurement set-up

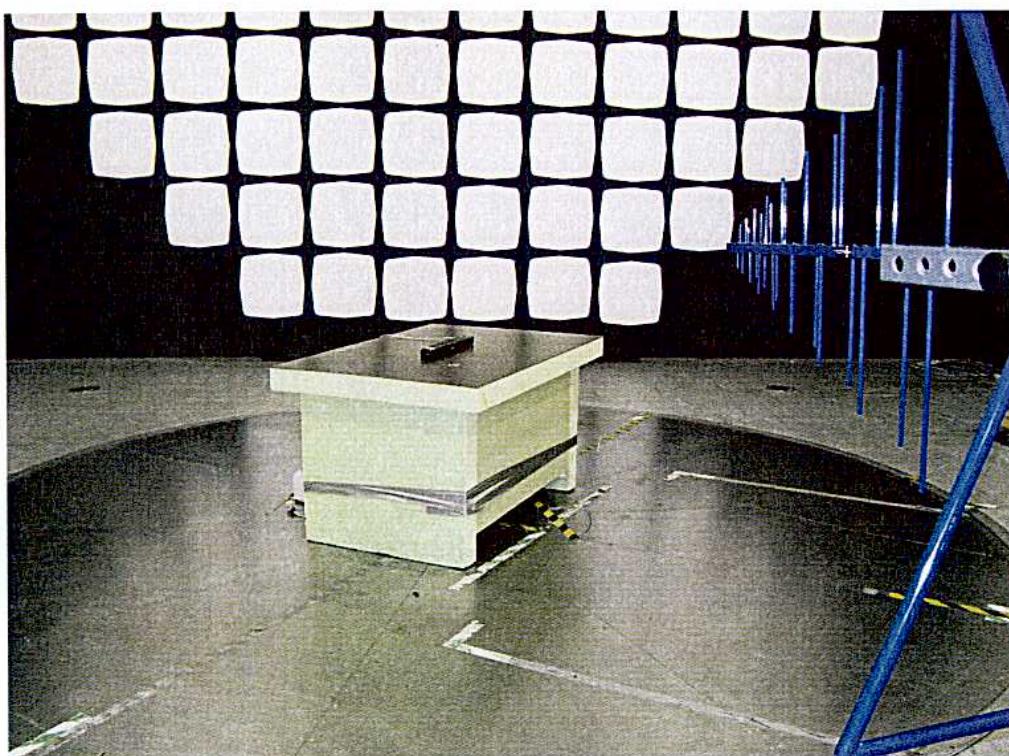
Test site: Semi-anechoic shielded chamber (30 – 1000 MHz)

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.



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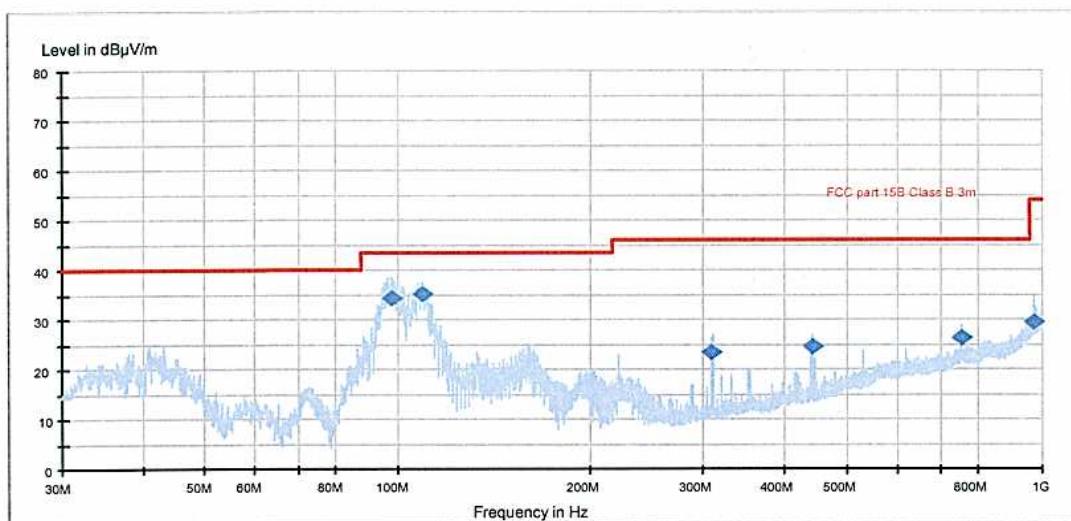
9.5 Test protocol

Semi-anechoic shielded chamber

Date of test: 2009-07-14

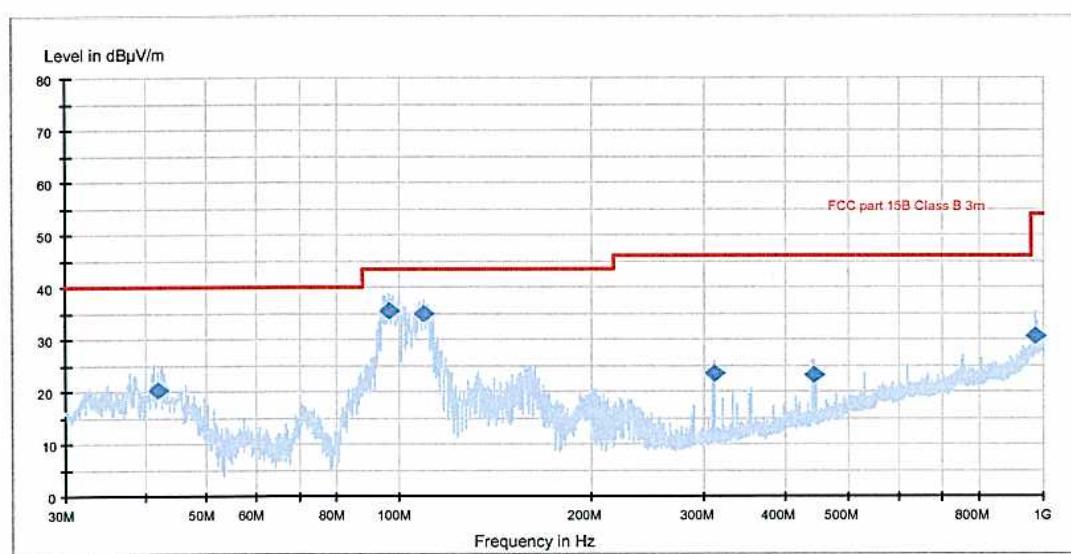
30 – 1000 MHz, max peak at a distance of 3 m on the lower TX channel

FCC 30 - 1000 MHz FCC class B 3m



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

FCC 30 - 1000 MHz FCC class B 3m



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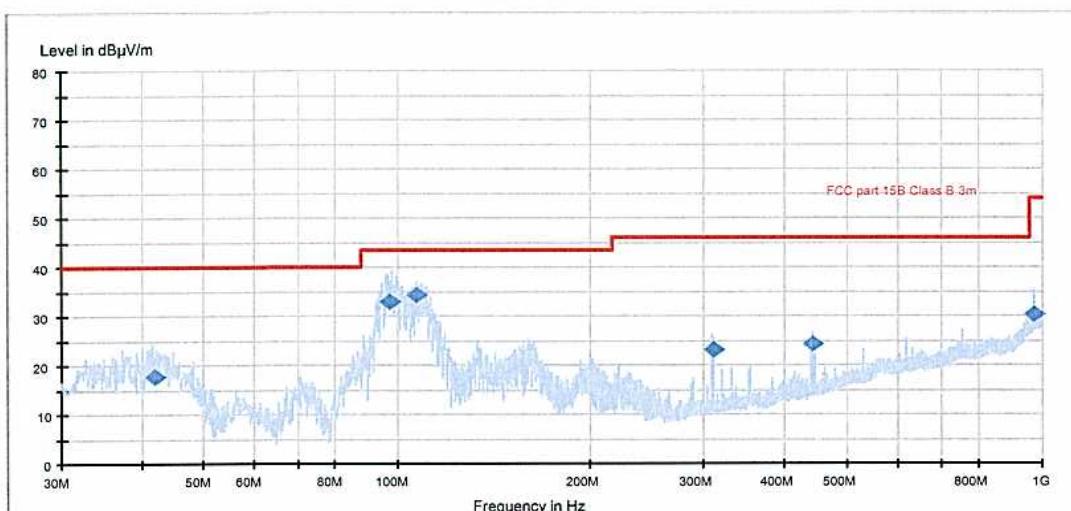
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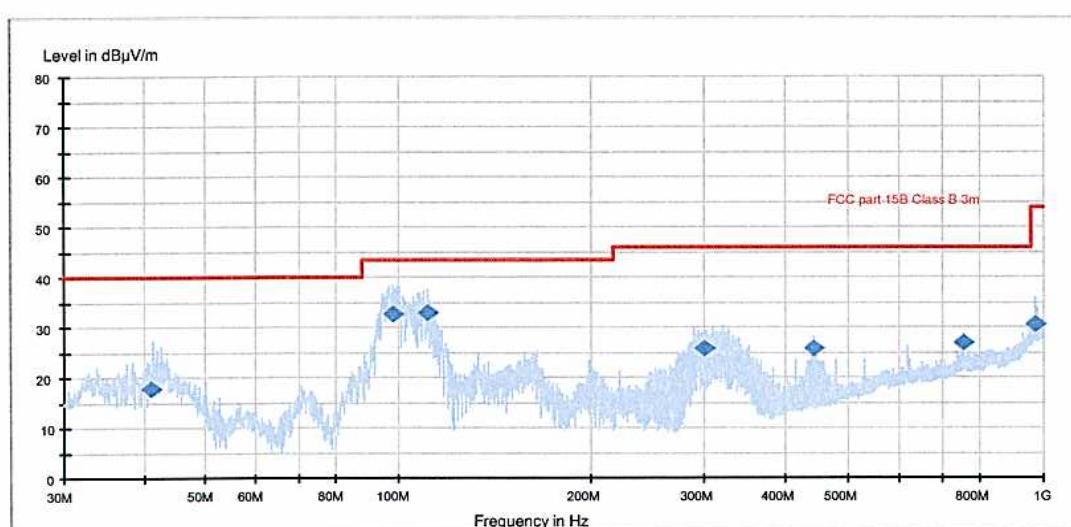
30 – 1000 MHz, max peak at a distance of 3 m on the upper TX channel

FCC 30 - 1000 MHz FCC class B 3m



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

FCC 30 - 1000 MHz FCC class B 3m



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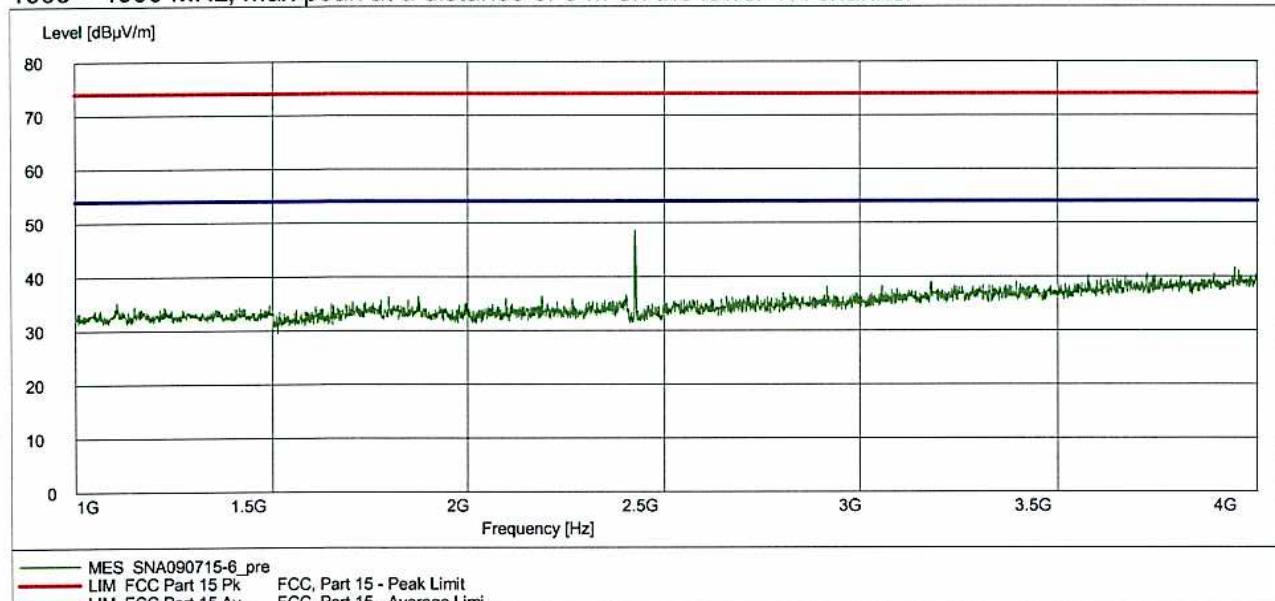
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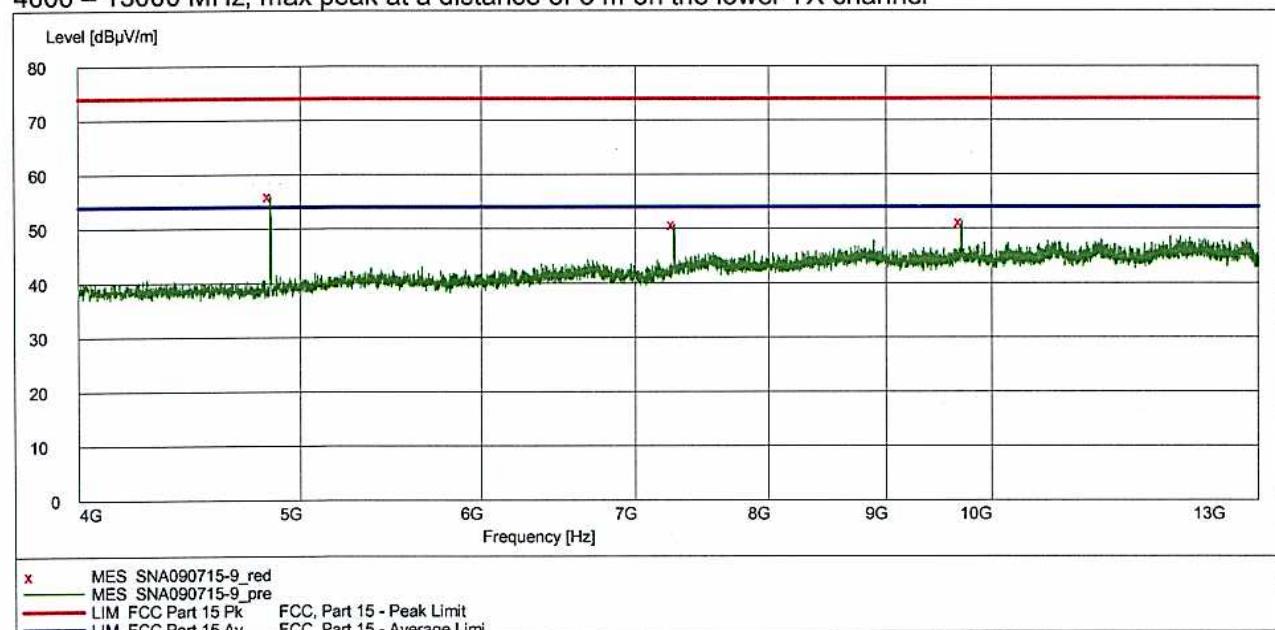
Radio anechoic shielded chamber

Date of test: 2009-07-15, 2009-07-20 & 2009-10-02

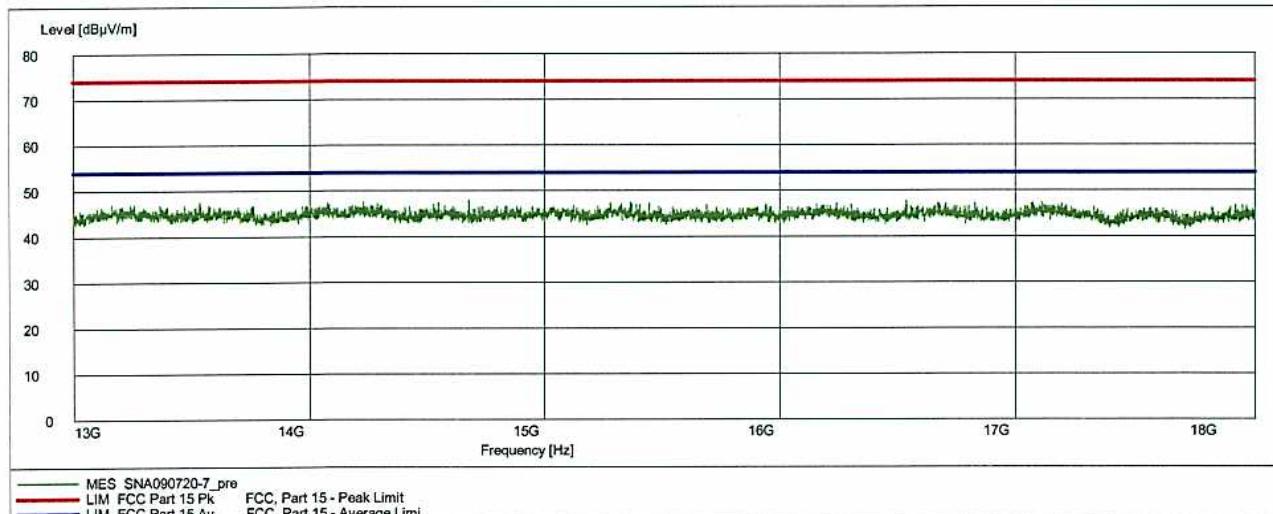
1000 – 4000 MHz, max peak at a distance of 3 m on the lower TX channel



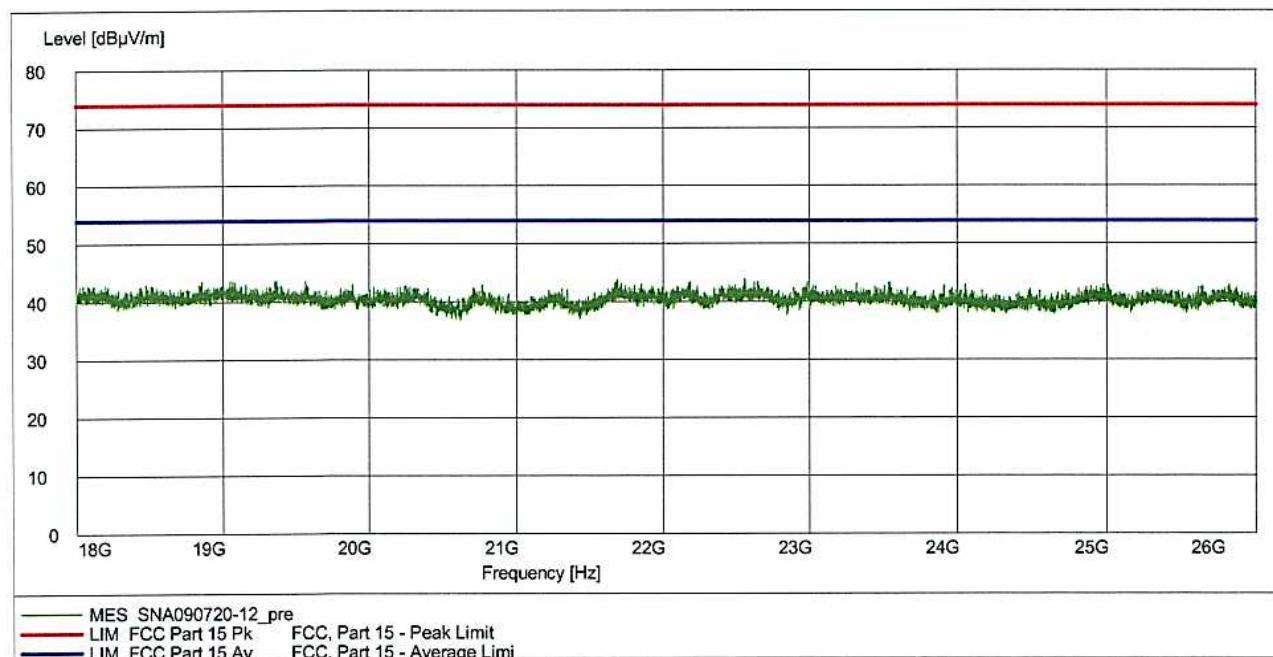
4000 – 13000 MHz, max peak at a distance of 3 m on the lower TX channel



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



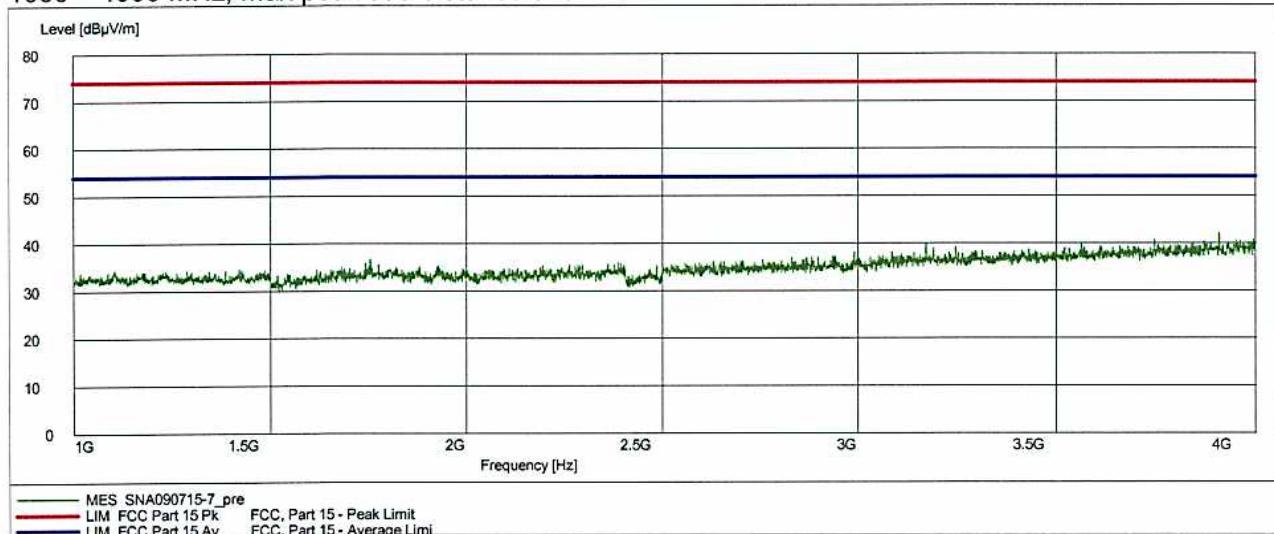
18000 - 26000 MHz, max peak at a distance of 3 m on the lower TX channel



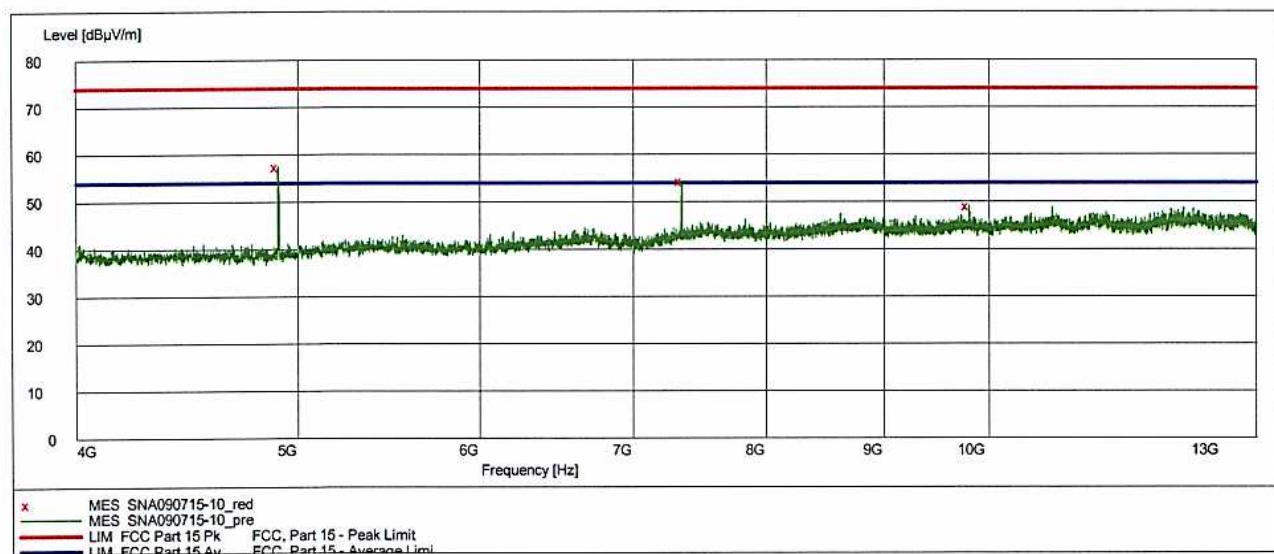
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1000 – 4000 MHz, max peak at a distance of 3 m on the middle TX channel



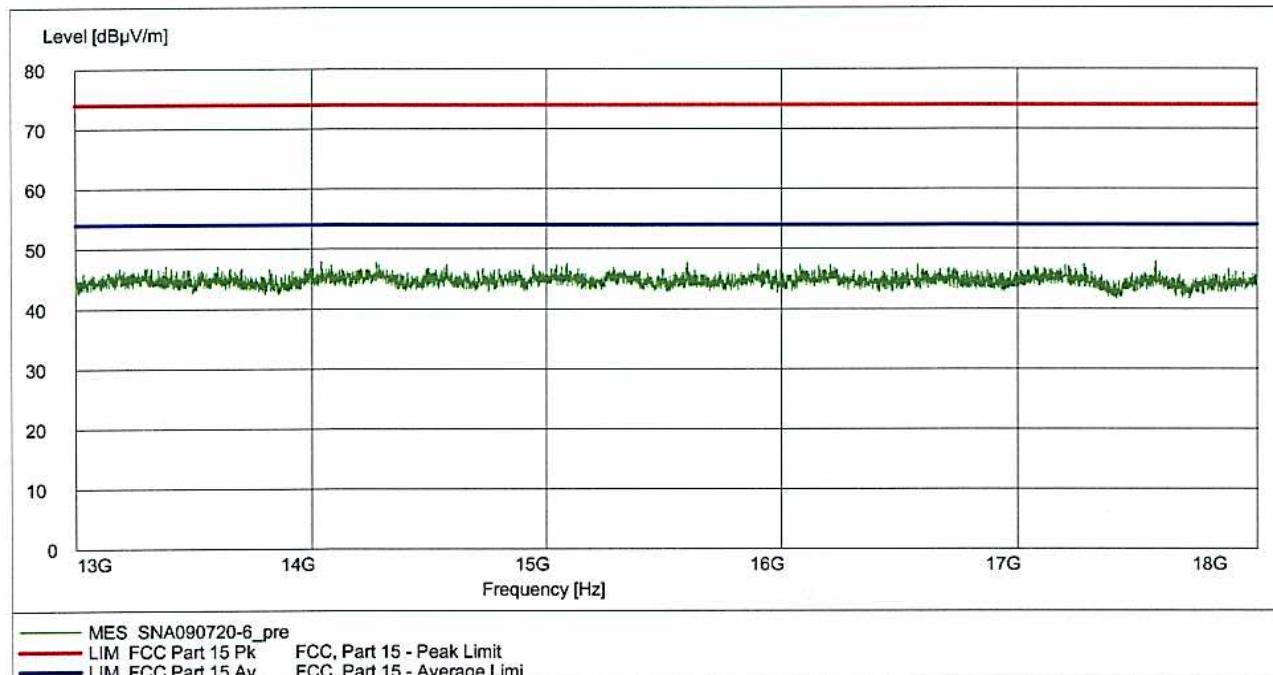
4000 – 13000 MHz, max peak at a distance of 3 m on the middle TX channel



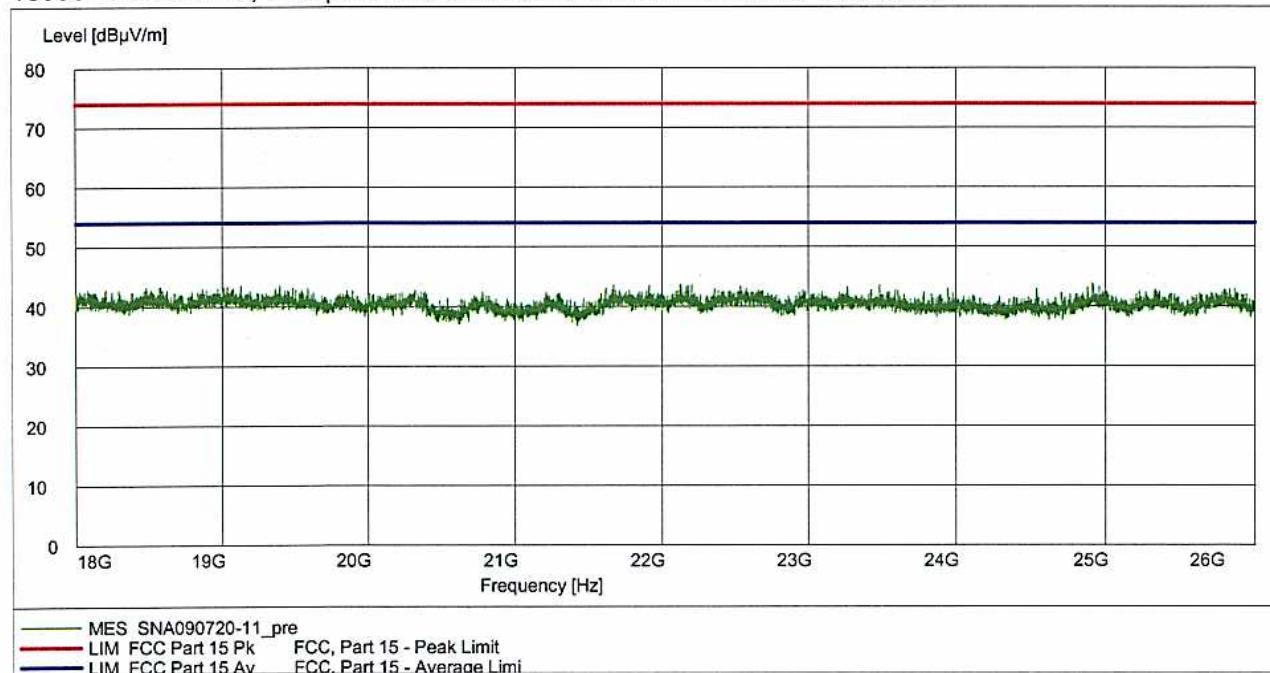
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13000 - 18000 MHz, max peak at a distance of 3 m on the middle TX channel



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



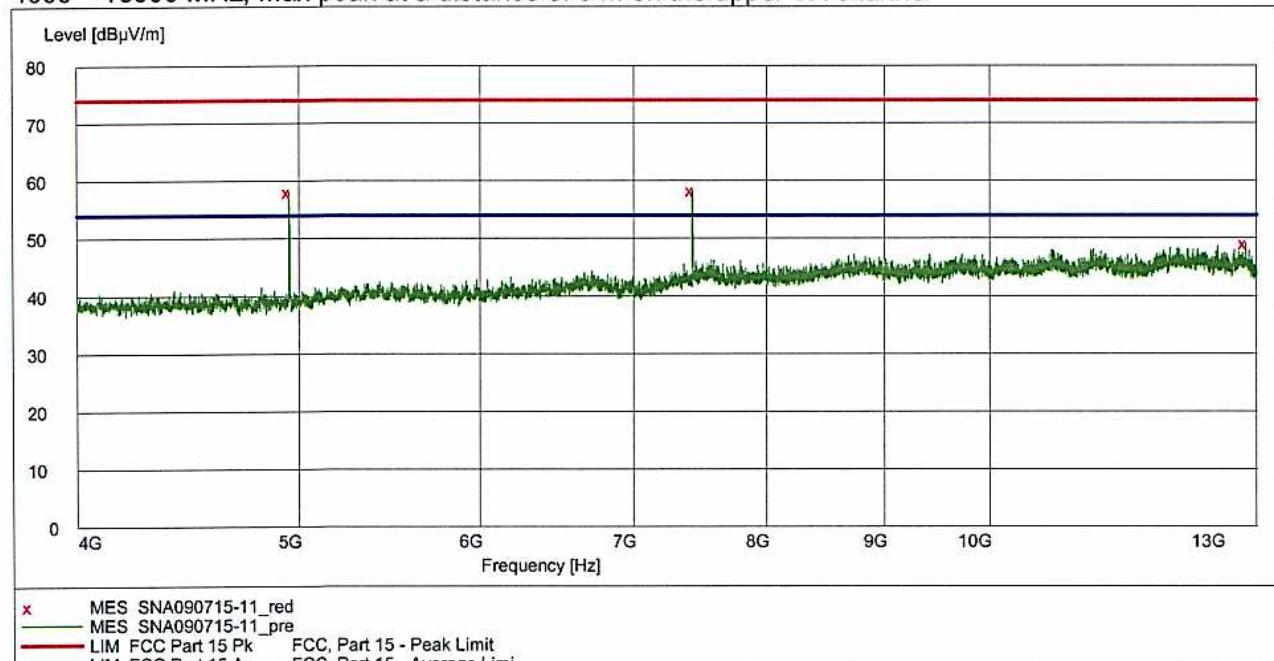
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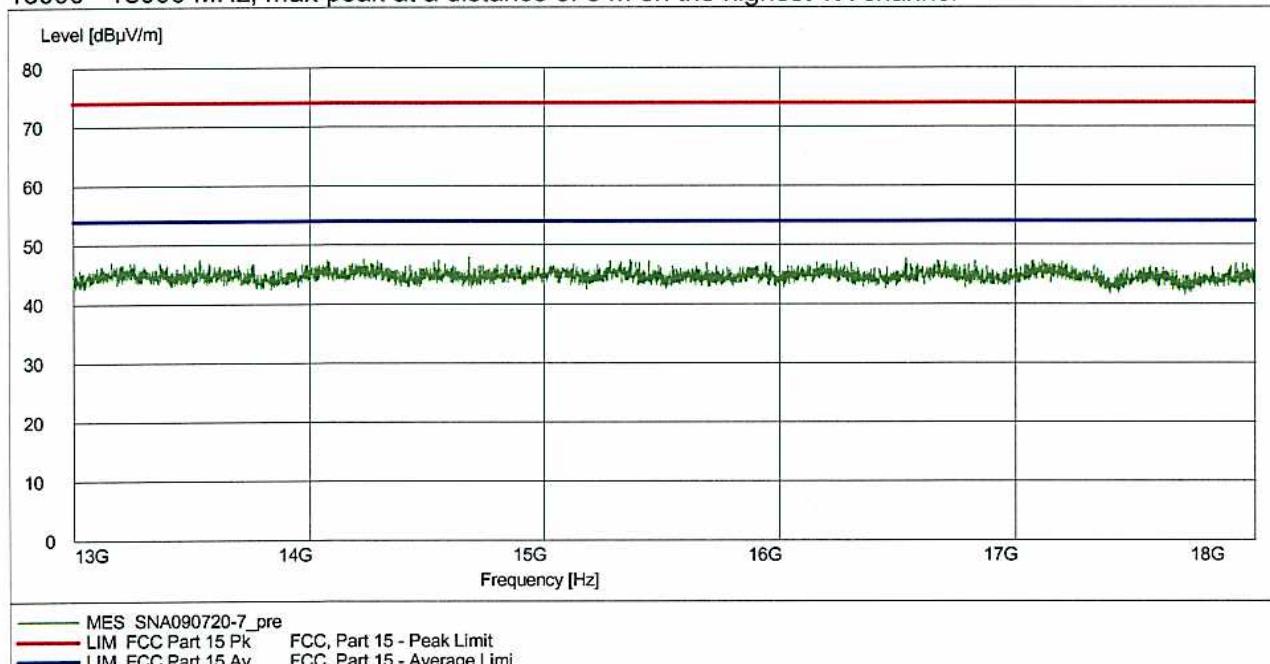
1000 – 4000 MHz, max peak at a distance of 3 m on the upper TX channel



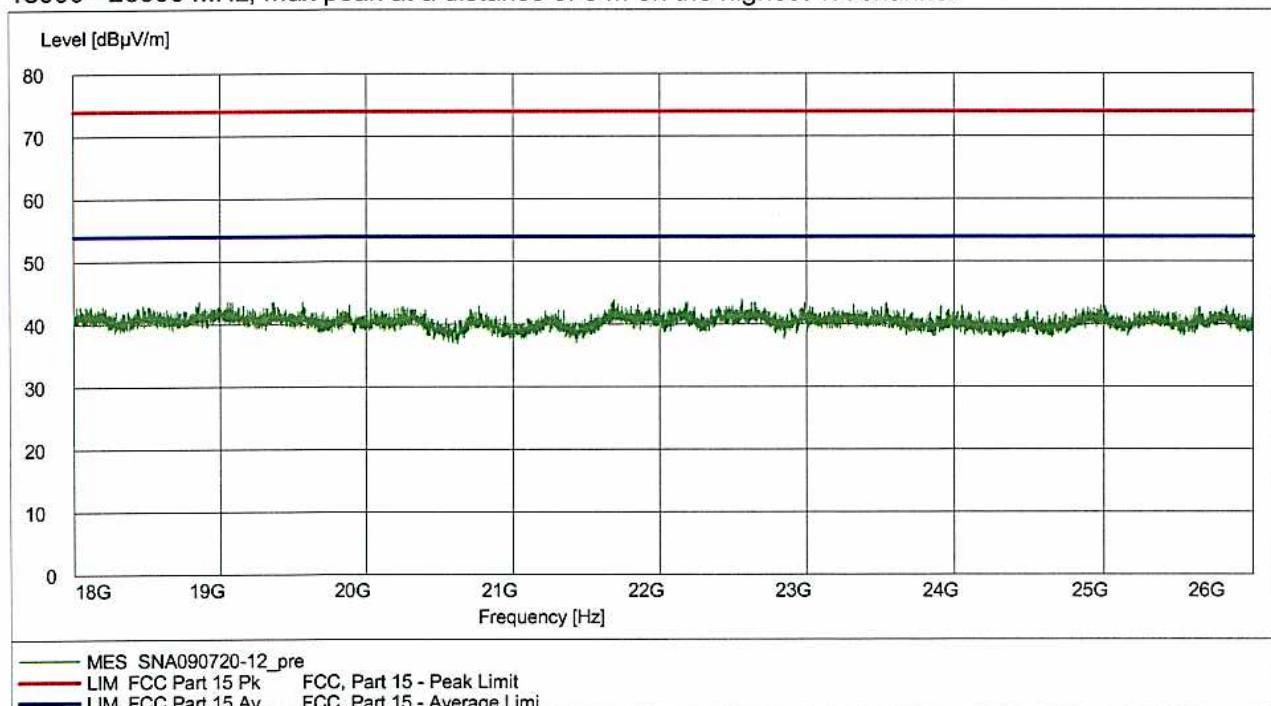
4000 – 13000 MHz, max peak at a distance of 3 m on the upper TX channel



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



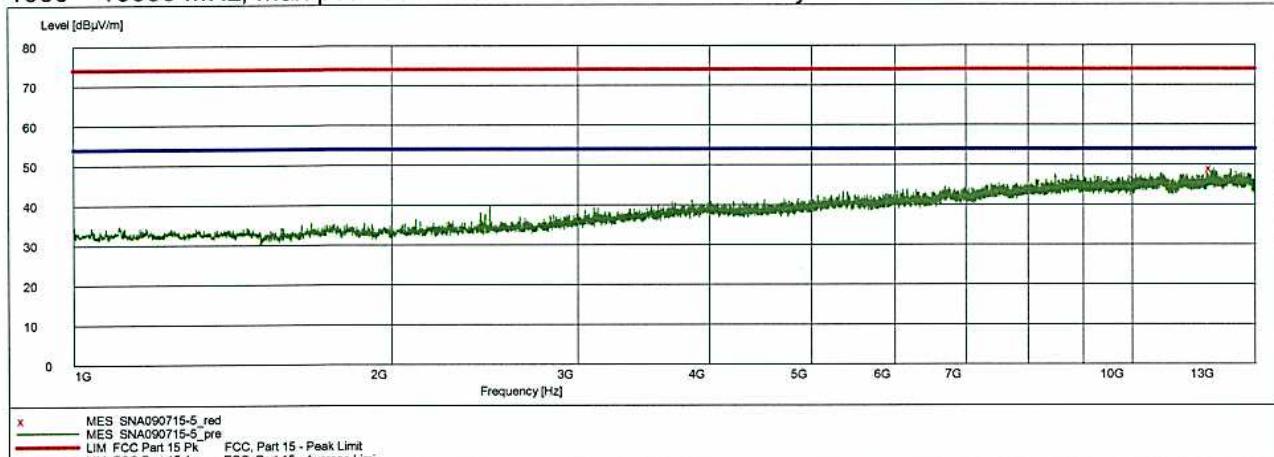
18000 - 26000 MHz, max peak at a distance of 3 m on the highest TX channel



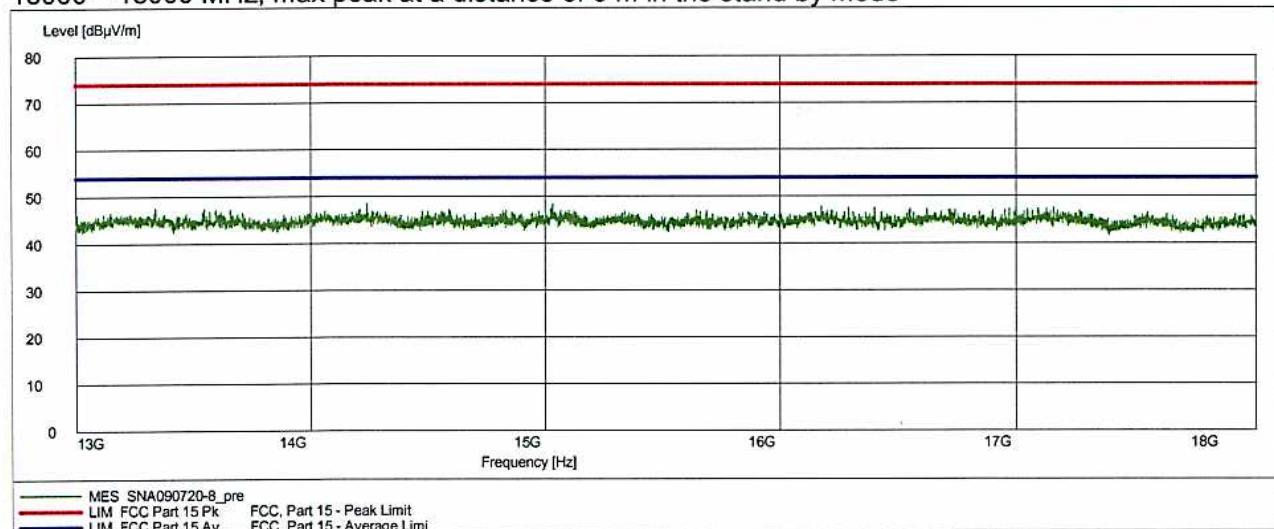
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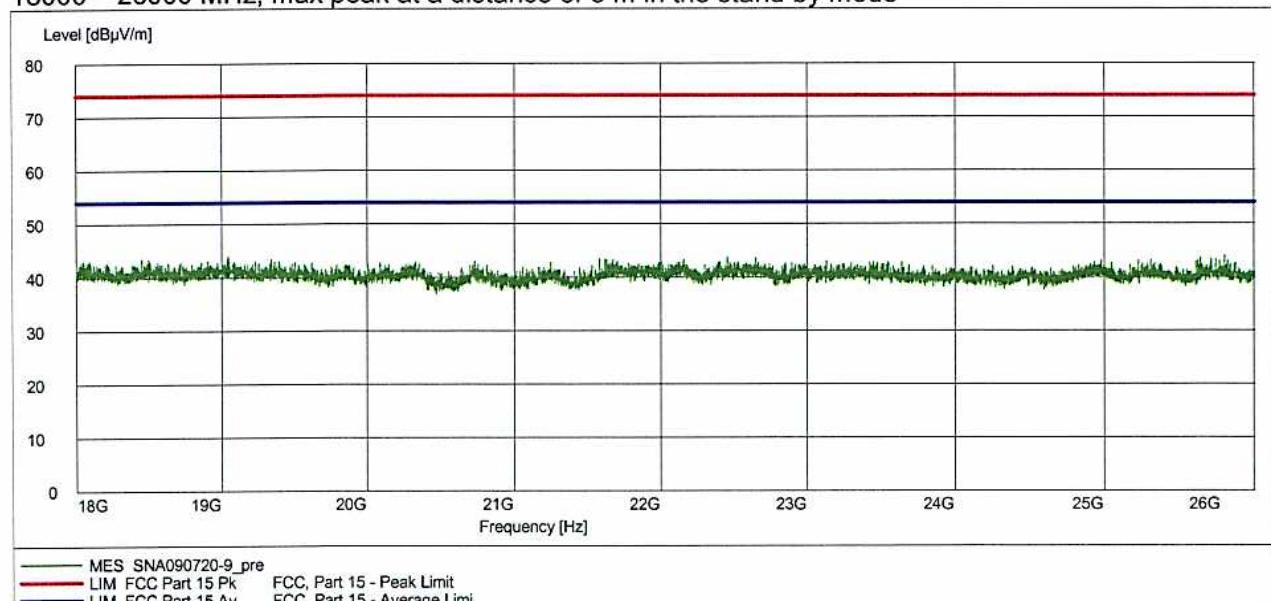
1000 – 13000 MHz, max peak at a distance of 3 m in the stand by mode



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 [MHz]	RBW [kHz]	Measured level		Limit		Note
		Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	
98.14	120		34.3		43.5	
109.18	120		35.2		43.5	
309.39	120		23.3		46.0	
442.19	120		24.5		46.0	
752.67	120		26.2		46.0	
972.10	120		29.5		54.0	
4851.0	1000	56.6	47.6	74	54	
7276.6	1000	50.8	41.8	74	54	
9702.4	1000	51.3	42.3	74	54	

Field strength of spurious emissions middle channel						
Frequency [MHz]	RBW [kHz]	Measured level		Limit		Note
		Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	
41.90	120		20.4		40.0	
96.35	120		35.5		43.5	
108.85	120		34.9		43.5	
309.59	120		23.5		46.0	
442.80	120		23.1		46.0	
973.15	120		30.4		54.0	
4901.0	1000	56.7	47.7	74	54	
7351.4	1000	61.8	52.8	74	54	1
9798.0	1000	53.2	44.2	74	54	

Field strength of spurious emissions high channel						
Frequency [MHz]	RBW [kHz]	Measured level		Limit		Note
		Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	
41.85	120		17.7		40.0	
97.52	120		32.8		43.5	
106.95	120		34.3		43.5	
309.85	120		23.2		46.0	
442.080	120		24.2		46.0	
973.58	120		30.4		54.0	
4951.0	1000	56,9	47.9	74	54	
7402.4	1000	61.3	52.3	74	54	1



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Field strength of spurious emissions standby						Note	
Frequency [MHz]	RBW [kHz]	Measured level		Limit			
		Peak [dB(μV/m)]	QP/AV [dB(μV/m)]	Peak [dB(μV/m)]	QP/AV [dB(μV/m)]		
41.000	120		17.8		40.0		
97.780	120		32.5		43.5		
110.879	120		32.8		43.5		
300.139	120		25.7		46.0		
442.228	120		25.6		46.0		
751.267	120		26.9		46.0		
972.988	120		30.6		54.0		

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.

Example calculation:

Measured level [dB μ V/m] = Analyser reading [dB μ V] + cable loss [dB] – preamplifier gain [dB] + antenna factor [1/m]



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

10.1 Test protocol

Date of test: 2009-07-22

EUT mode of operation: TX on one channel.

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.



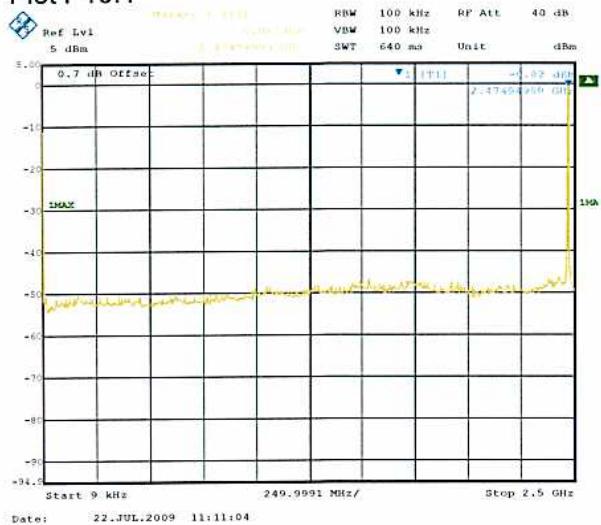
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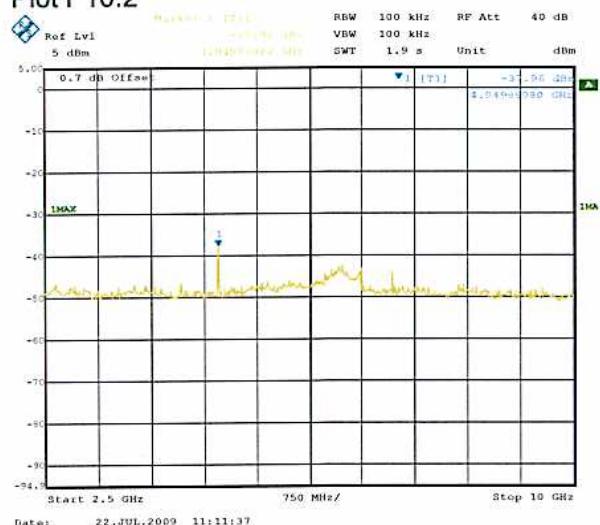
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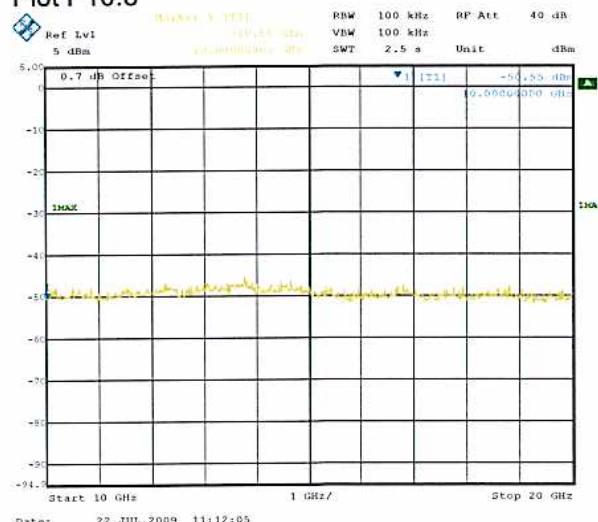
Plot P10.1



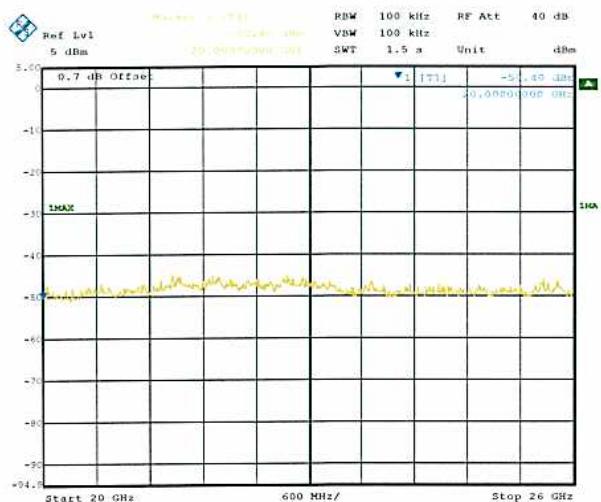
Plot P10.2



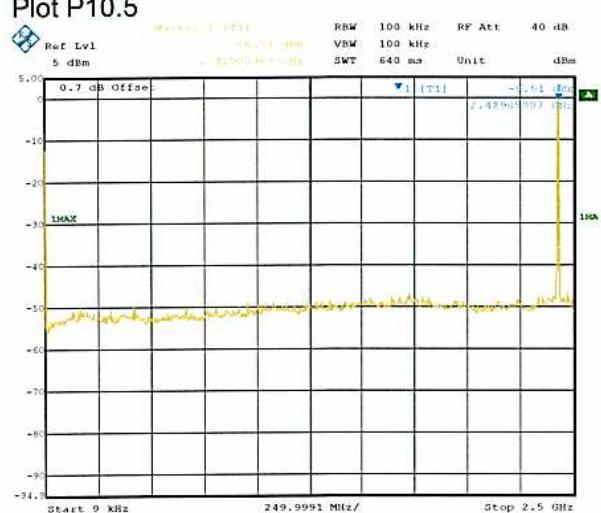
Plot P10.3



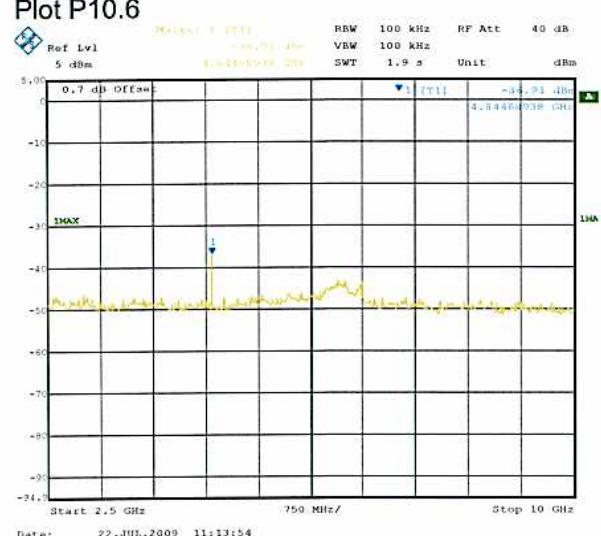
Plot P10.4



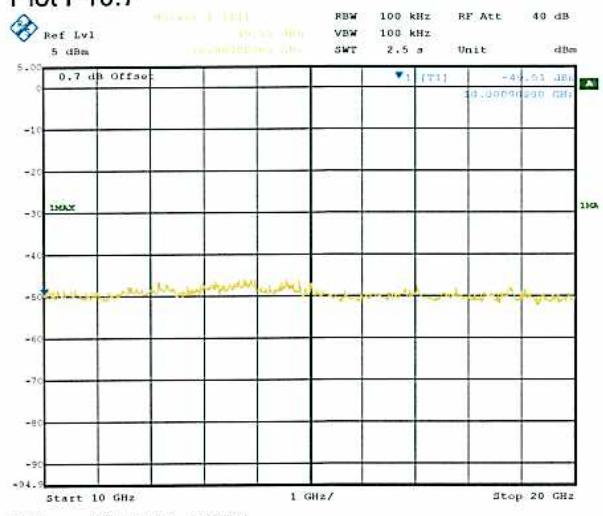
Plot P10.5



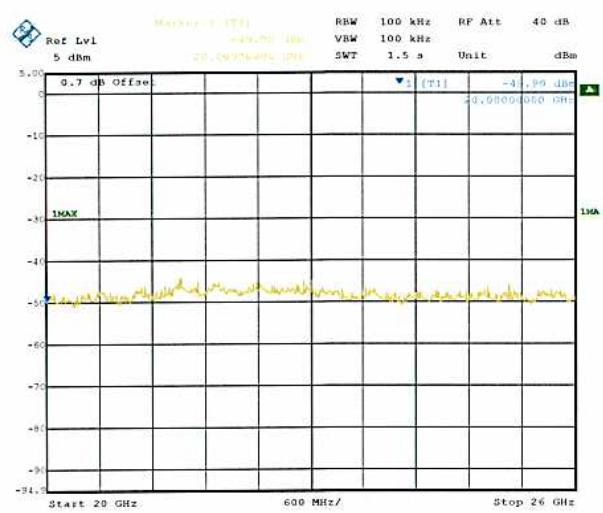
Plot P10.6



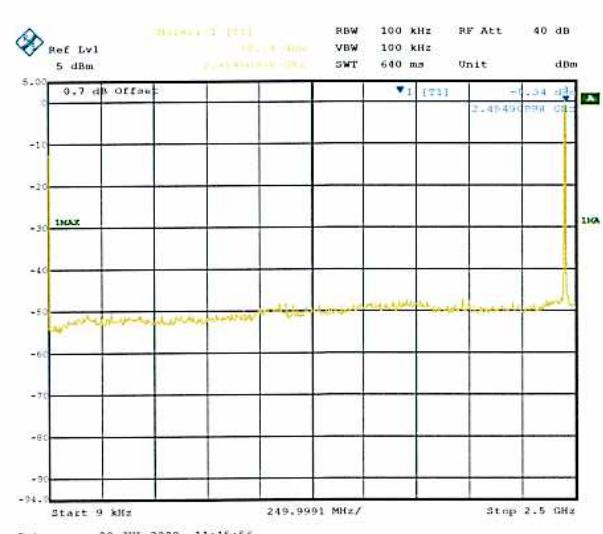
Plot P10.7



Plot P10.8



Plot P10.9



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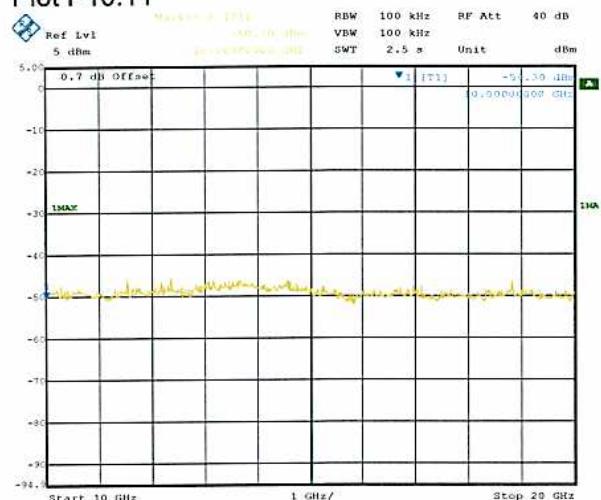
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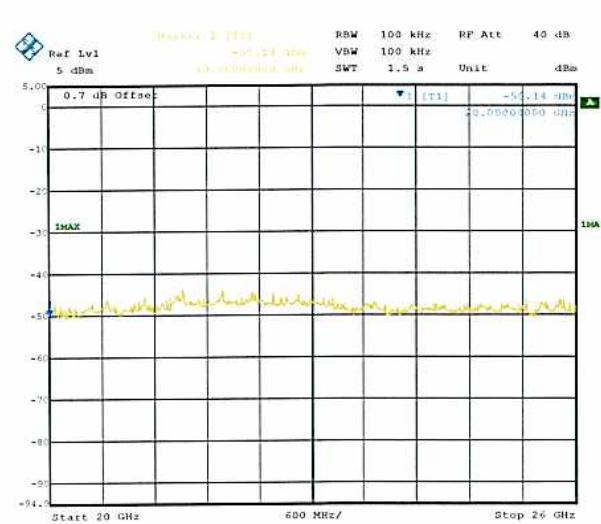
Plot P10.10



Plot P10.11



Plot P10.12



11. CONDUCTED EMISSION FROM AC-MAINS

11.1 Test protocol

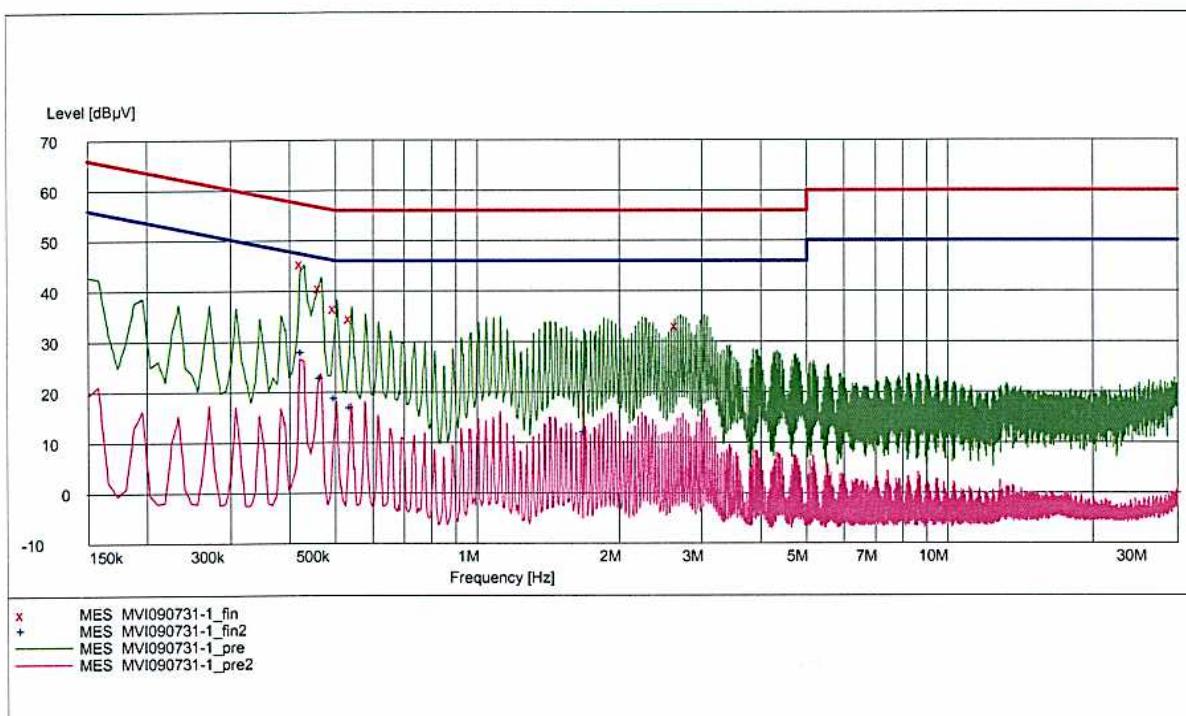
Date of test: 2009-07-31

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 dB μ V	Transd dB	Limit dB μ V	Margin dB	Detector	Line	PE
0.425	45.5	0.3	57	11.8	QP	L1	GND
0.465	40.7	0.3	57	15.9	QP	L1	GND
0.500	36.6	0.3	56	19.4	QP	L1	GND
0.540	34.6	0.3	56	21.4	QP	L1	GND
0.660	33.2	0.4	56	22.8	QP	L1	GND



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12. 99% BANDWIDTH

12.1 Test protocol

Date of test: 2009-10-07

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

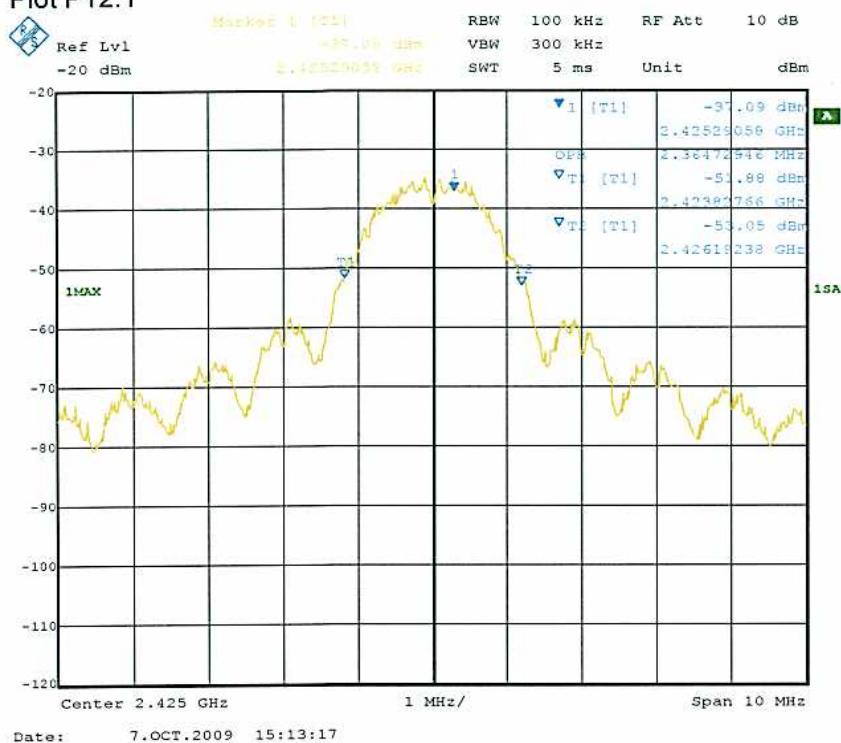
Channel	Plot	Measured	Limit value
		value MHz	MHz
Low	plot P12.1	2.36	-
Middle	plot P12.2	2.40	-
High	plot P12.3	2.40	-



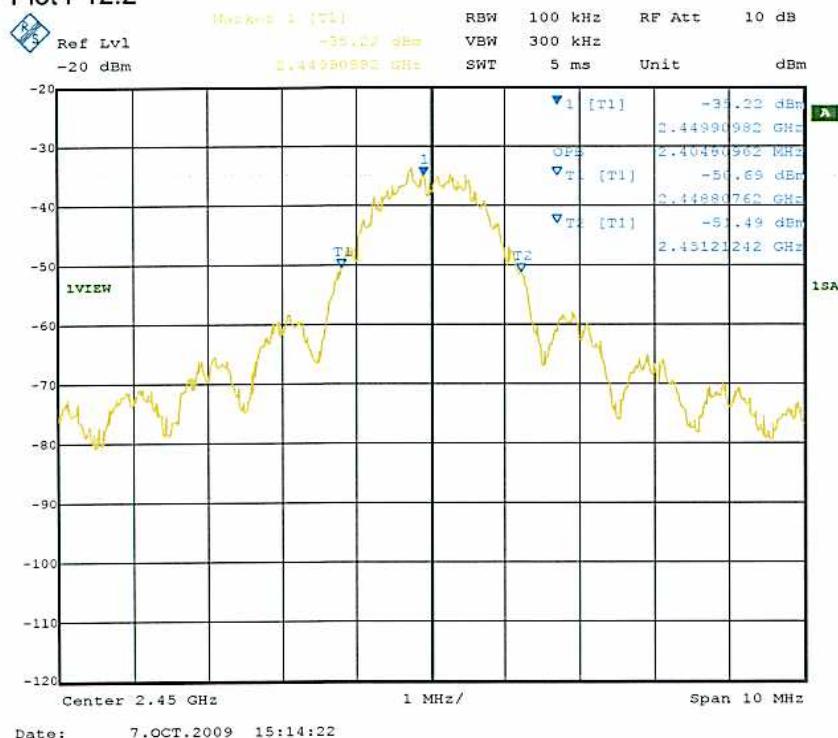
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Plot P12.1



Plot P12.2

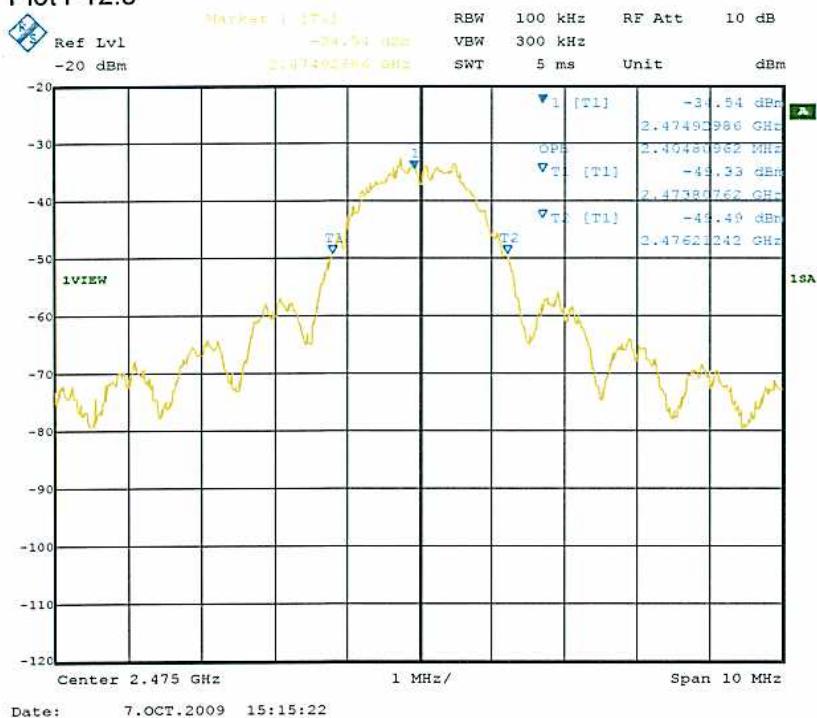


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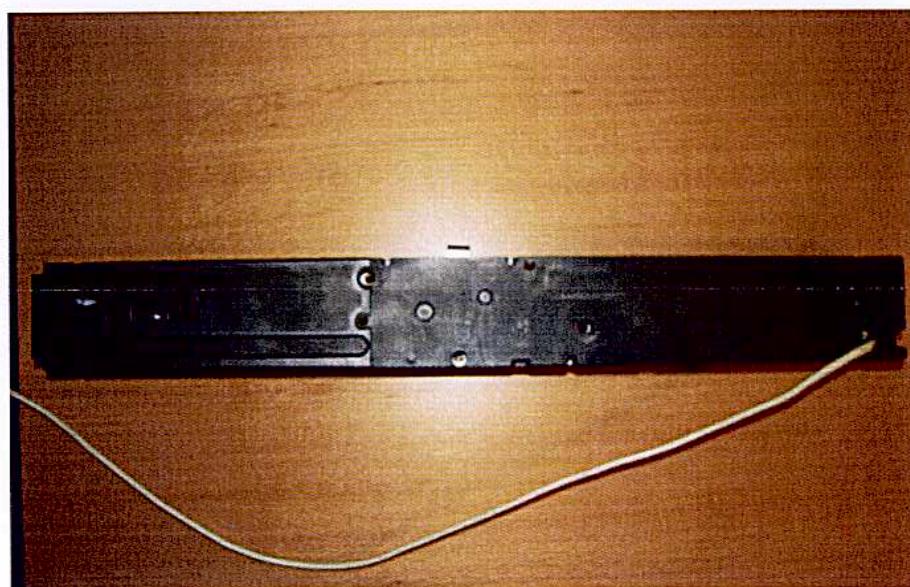
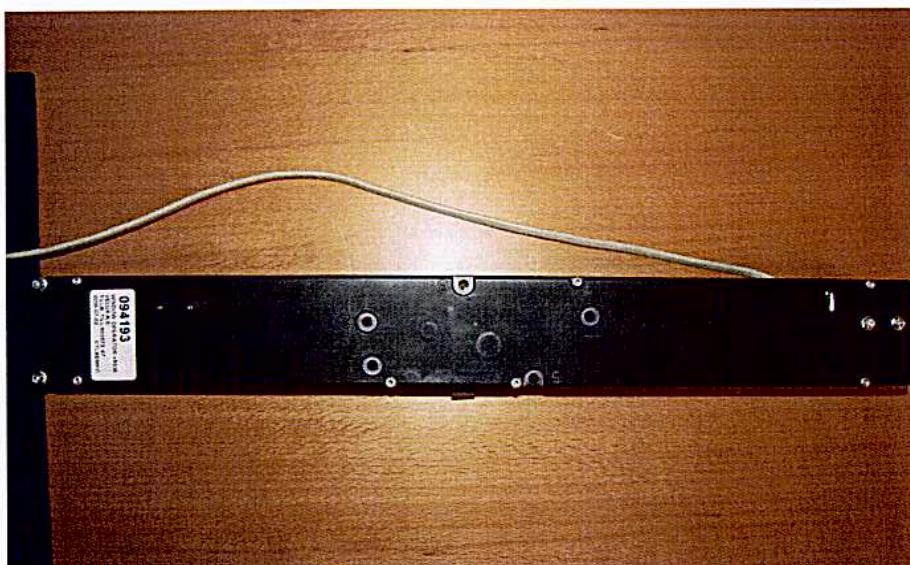
Plot P12.3



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APPENDIX – PHOTOS OF THE EUT



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