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Equipment Authorization measurements on 2440 MHz Transceiver Unit

(10 appendices)

Test objects

Ink machine RPS-600, consisting of three different transmitters.

EUT 1: Base unit

Product name: RPS-600

Serial number: 01-0114

The EUT was powered by an AC/DC-adaptor during the test, Nordic Power, Model: ATS065, out 24 VDC/2.7 A

The AC/DC-adaptor was powered by 120 V AC/60 Hz.

EUT 2: Power pack attached on an ink machine Dragonfly tattoo machine

Serial number: 03-0114

EUT 3: Foot pedal

Product name: WFS

Serial number: 02-0114

Summary

See Appendix 1 for general information and Appendix 10 for photos.

Emission measurements as specified below have been performed.

Standard	Compliant	Appendix	Remarks
FCC 47 CFR Part 15 C			
15.249 Operation within the band 2400-2483.5 MHz	Yes		
IC RSS-210 Issue 8, December 2010	Yes		
Duty cycle measurements	N/A	2	
15.249 (a) / RSS-210 A2.9(a) Field strength of fundamental	Yes	3	
15.249 (d) (e) / RSS-210 A2.9(b) Radiated emission	Yes	4	
15.215 (c) 20 dB bandwidth	Yes	5	
15.207 / RSS-Gen 7.2.4 Conducted emission limits	Yes	6	
2.1049 / RSS-Gen 4.6.1 Occupied bandwidth	Yes	7	
2.1049 / RSS-210 A2.9(b) Band Edge	Yes	8	
RF Safety / RSS-102 2.5.1 SAR Evaluation	Yes	9	

Note: Above RSS items are given as cross-reference only. Measurements were performed according to ANSI procedures referenced by FCC and covered by SP's accreditation.

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SP Technical Research Institute of Sweden**Electronics - EMC**

Performed by

Examined by



Fredrik Isaksson



Jan Carlsson

Appendix 1

Performance test and requirements

The tests were performed to verify that RPS-600 meets the electromagnetic compatibility requirements of FCC 47 CFR part 15 C.

Test facility

The used anechoic chamber is compliant with the requirements of section 2.948 of the FCC rules and listed, registration number 96866, as a facility accepted for certification under parts 15 and 18. The site complies with RSS Gen, Issue 2 and is accepted by Industry Canada for the performance of radiated measurements, IC-file number 3482A-2.

Test objects

Transceiver 1:	Base unit
Transceiver 2:	Power pack
Transceiver 3:	Foot pedal
Antenna:	Integral, PCB
Antenna gain, average, typical:	0.6 dBi
Antenna gain, peak, typical:	1.3 dBi
Frequency:	2440 MHz
Frequency used during test:	2440 MHz
Modulation:	O-QPSK
Data rate:	250 kbit/s
Supply voltage, Transceiver 1:	24 V DC via external AC/DC-adapter
Supply voltage, Transceiver 2:	7.4 V DC, internal batteries
	2xLithium Polymer, 3.7 VDC/820 mAh
Supply voltage, Transceiver 3:	3.0 V DC, internal battery
	Coin cell CR2450, Lithium Manganese Dioxide

Measurement equipment

Measurement equipment	Calibration Due	SP number
Test site Edison	2013-12	504 114
EMI test receiver R&S ESI 26	2014-07	503 292
EMI test receiver R&S ESU 26	2014-08	902 210
LISN Schwarzbeck NNLA 8120	2015-02	504 129
Antenna Schaffner CBL 6143	2016-09	504 079
Horn antenna EMCO 3115	2016-03	902 212
Standard gain horn Flann 16240-25	-	503 939
Standard gain horn Flann 18240-25	-	503 900
Standard gain horn Flann 20240-20	-	503 674
Low Noise Amplifier Miteq	2014-09	503 285
Low Noise Amplifier Miteq	2014-10	504 160
High pass filter Wainwright WHKY	2014-07	504 200
AC Power Source HP 6813B	2013-10	503 091
Multimeter Fluke 83	2014-08	501 522
Temperature and humidity meter Testo 625	2014-06	504 117

Appendix 1

Operational test mode

Justification measurements for the Ink machine were performed with rotation of the EUT through three orthogonal axis to determine in which orientation the radio module had the highest emission levels, see photos in Appendix 11.

The test was performed with continuous transmission (100% duty cycle), if not otherwise stated, and with normal modulation.

For normal duty cycle measurements see appendix 2.

EUT 1: In normal mode the duty cycle was varied between 0.07-0.4 %

EUT 2: In normal mode the duty cycle was varied between 0.3-2.4 %

EUT 3: No continuous duty cycle, the transmitter was activated by the foot pedal, one transmission, Tx on=1.06 ms

Cabling during emission test:

Base unit RPS-600:

EUT port	Cable type	Termination / use
DC port	2 wire unshielded 1.5 m, bundled to 1.0 m	Connected to the AC/DC-adaptor (Cable length of the AC cable of the adaptor was 1.75 m)
2x phono	2 wire shielded 2.0 m, (bundled to 0.5 m)	Unterminated
USB	No cable connected. Not used during normal operation, just for service.	N/A

Uncertainties

Measurement and test instrument uncertainties are described in the quality assurance documentation "SP QD 10885". The measurement uncertainties can be found in the table below. The uncertainties are calculated with a coverage factor $k=2$ (95% level of confidence). The measurement uncertainties can be found in the table below:

Method	Uncertainty
Radiated emission, 30 – 1000 MHz	4.8/5.6 dB (V/H-pol)
Radiated emission, 1 – 40 GHz	2.6 dB
Conducted emission	3.5 dB

Compliance evaluation is based on a shared risk principle with respect to the measurement uncertainty.

Appendix 1

Reservation

The test results in this report apply only to the particular test object as declared in the report.

Delivery of test objects

The test objects were delivered: 2013-10-11

Test engineer

Fredrik Isaksson, SP

Appendix 2

Duty cycle measurements

Date 2013-10-21	Temperature 22 °C ± 3 °C	Humidity 34 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.

The test was performed with normal duty cycle and with normal modulation.

The radiated measurements were performed in a semi anechoic chamber.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
Horn antenna EMCO 3115	902 212
Temperature and humidity meter Testo 625	504 117

Results

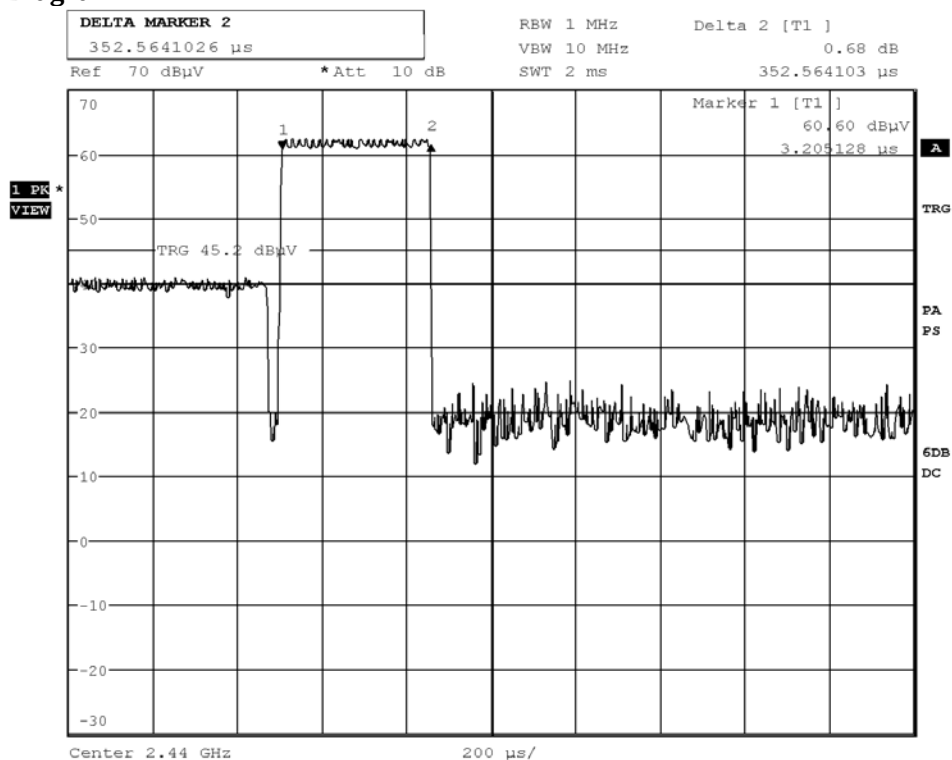
The duty cycle measurements can be found in the diagrams below:

Diagram 1	EUT 1	2440 MHz	Tx on with normal duty cycle
Diagram 2	EUT 1	2440 MHz	Period time with normal duty cycle
Diagram 3	EUT 2	2440 MHz	Tx on with normal duty cycle
Diagram 4	EUT 2	2440 MHz	Period time with normal duty cycle
Diagram 5	EUT 3	2440 MHz	Tx on with normal duty cycle
			No continuous duty cycle, the transmitter was activated by the foot pedal, one transmission

Complies?	N/A
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Appendix 2

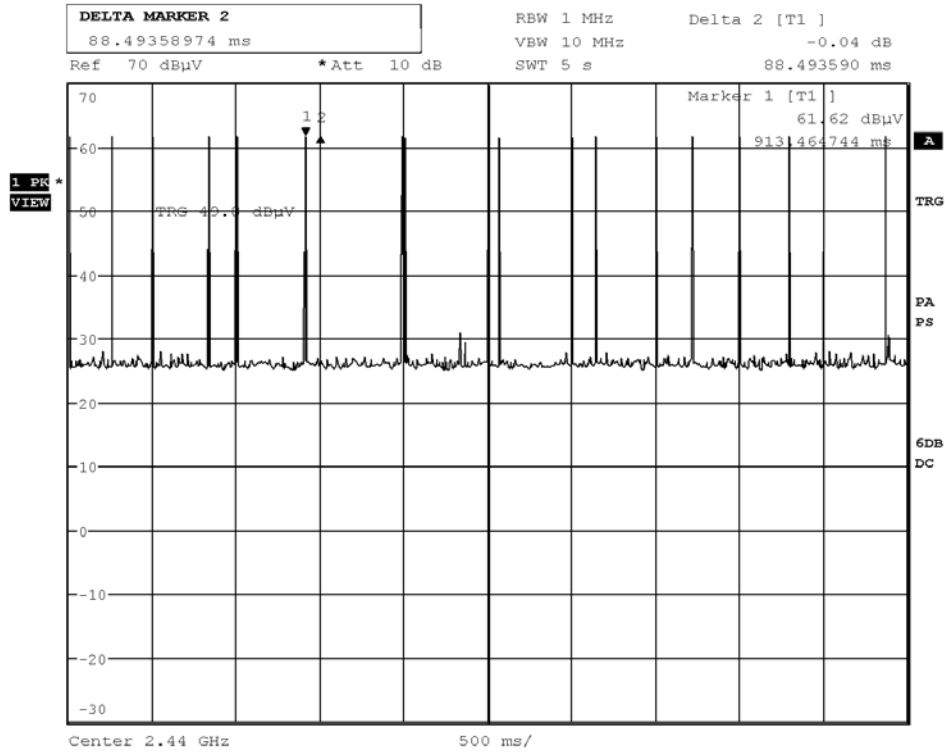
Diagram 1



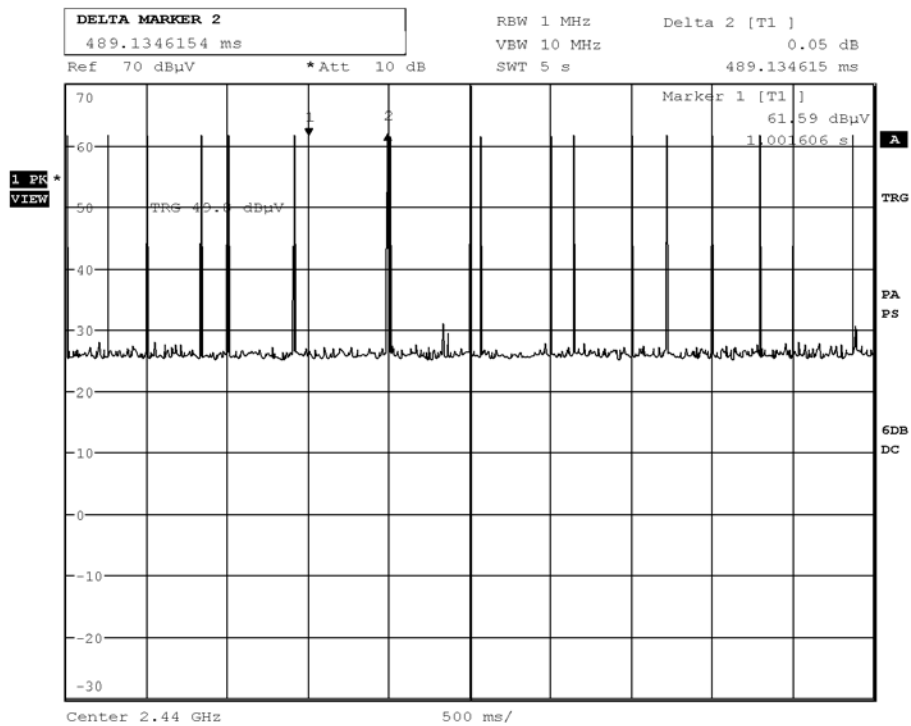
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Appendix 2

Diagram 2



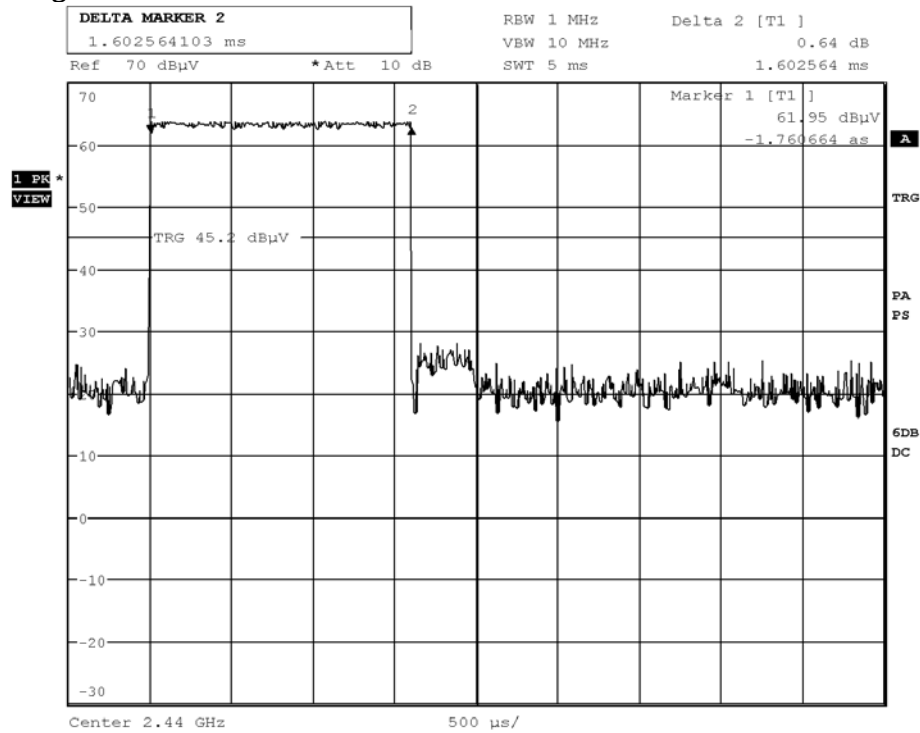
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Date: 21.OCT.2013 14:09:38

Appendix 2

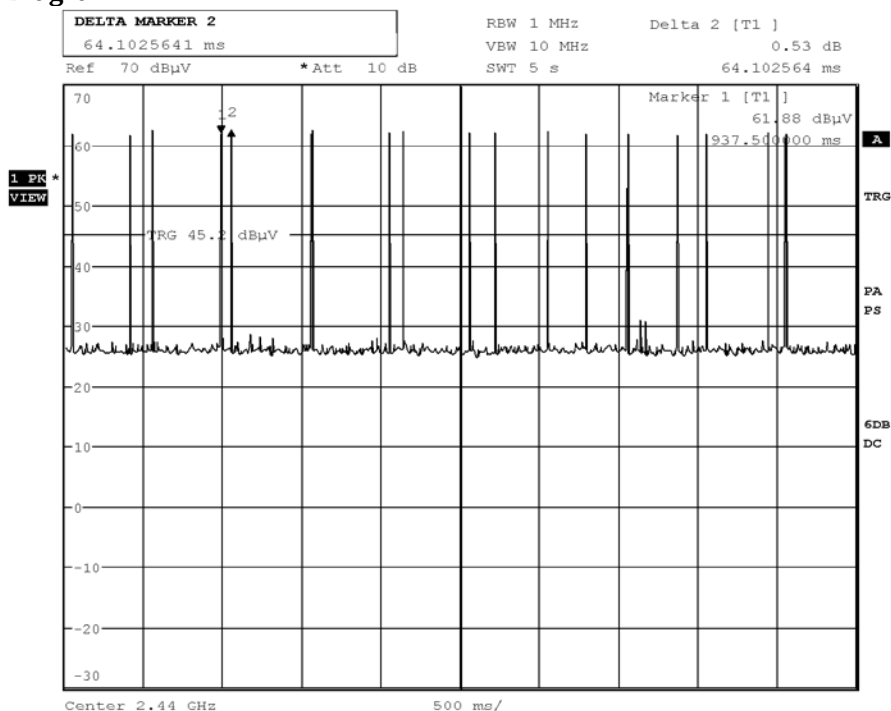
Diagram 3



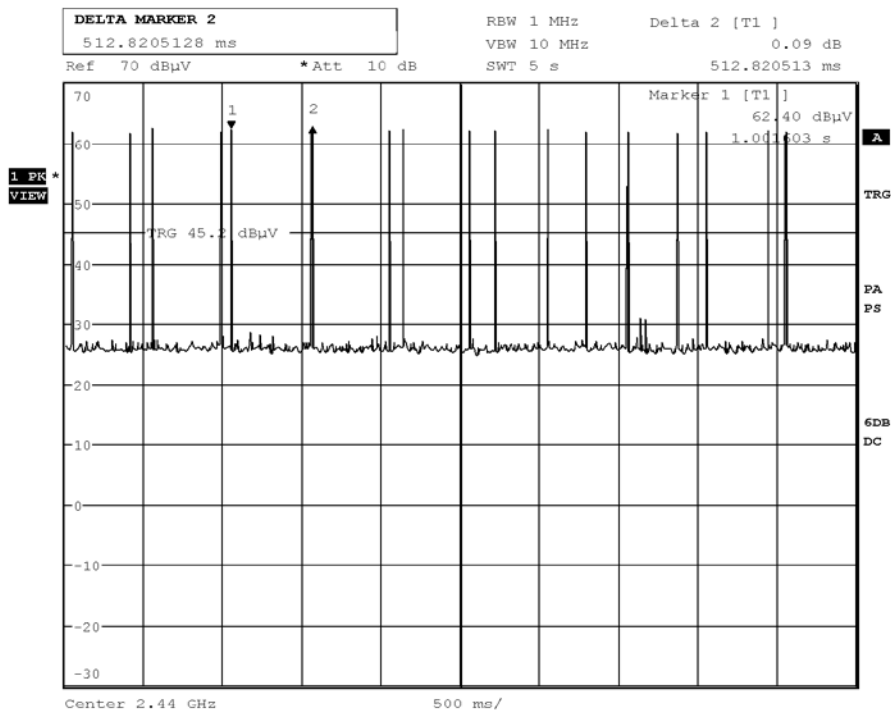
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Appendix 2

Diagram 4



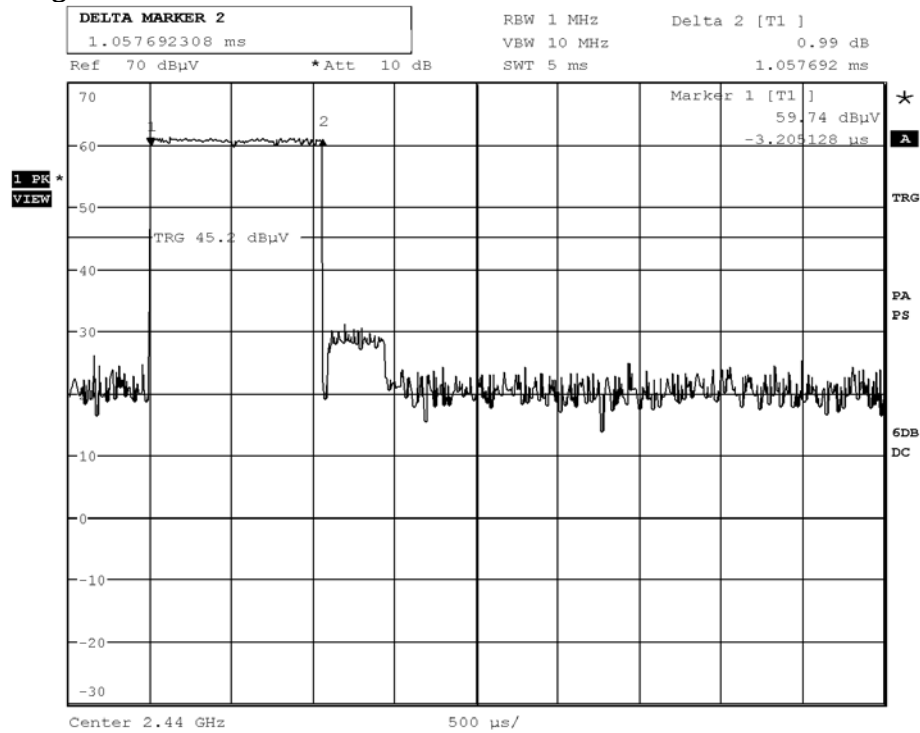
Date: 21.OCT.2013 13:50:02



Date: 21.OCT.2013 13:50:52

Appendix 2

Diagram 5



Date: 21.OCT.2013 13:58:56

Appendix 3

Field strength of fundamental measurements according to FCC 47 CFR part 15.249 (a) / RSS-210 A2.9(a)

Date 2013-10-14	Temperature 23 °C ± 3 °C	Humidity 40 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.
The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

The maximum peak radiated output power measurements were performed in the semi-anechoic chamber.

The fundamental was scanned with peak-detector and the antenna height 1-4 m and the turntable was varied between 0-360 degrees for maximum response. The antenna distance during the measurements was 3.0 m.

Final measurement was performed with detector according to the FCC rules.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
EMI measurement computer	-
Software: R&S EMC32, ver. 8.53.0	503 745
Horn antenna EMCO 3115	902 212
AC Power Source HP 6813B	503 091
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 117

Appendix 3

RBW=1 MHz

		Max peak radiated output power CISPR average detector (Peak detector)		
		EUT 1 2440 MHz	EUT 2 2440 MHz	EUT 3 2440 MHz
	EUT axes	N/A	X	N/A
	Antenna height	2.48	2.42	2.42
	Azimuth	270	265	265
	Polarization	Horizontal	Horizontal	Horizontal
		83.7 dB μ V/m (89.1 dB μ V/m)	84.3 dB μ V/m (89.8 dB μ V/m)	84.1 dB μ V/m (89.8 dB μ V/m)
T _{nom} 23°C		V _{nom} 120 V AC	V _{nom} 7.4 V DC	V _{nom} 3.0 V DC
T _{nom} 23°C	V _{min} 102 V AC Note 2	83.6 dB μ V/m (89.0 dB μ V/m)	N/A	N/A
T _{nom} 23°C	V _{max} 138 V DC Note 2	83.6 dB μ V/m (89.0 dB μ V/m)	N/A	N/A

Note 1: According 47CFR 15.31(e), for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.
For battery operated equipment, the equipment tests shall be performed using a new battery.

Limits

According to 47CFR 15.249(a), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

According to RSS-210 A2.9(a), the field strength measured at 3 meter shall not exceed the following:

Fundamental Frequency	Field strength of fundamental	Field strength of harmonics
2400-2483.5 MHz	50 mV/m = 94 dB μ V/m	500 μ V/m = 54 dB μ V/m

Complies?	Yes
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Appendix 4

Radiated emission measurements according to FCC 47 CFR part 15.249 (d) (e) / RSS 210-210 A2.9(b)

Date	Temperature	Humidity
2013-10-14	23 °C ± 3 °C	40 % ± 5 %
2013-10-15	23 °C ± 3 °C	33 % ± 5 %
2013-10-21	22 °C ± 3 °C	34 % ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10.

The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

The test of radiated emission was performed in a semi anechoic chamber. The measurements were performed with both horizontal and vertical polarizations of the antenna. The antenna distance was 3.0 m.

The fundamental was scanned with PEAK-detector and the antenna height was varied between 1-4 m and the turntable was rotated between 0-360 degrees for maximum response. The antenna distance during the measurements was 3.0 m

The test of radiated emission was performed in a semi anechoic chamber. The measurements were performed with both horizontal and vertical polarizations of the antenna. The antenna distance was 3.0 m.

The measurement procedure is as follows:

1. A pre-measurement is performed with peak detector. The test object is measured in eight directions with the antenna at three heights, 1.0 m, 1.5 m and 2.0 m (above 1 GHz pre-measurement was only performed at 1.0 m due to the small EUT size).
2. If the emission is close or above the limit during the pre-measurement, the test object is scanned 360 degrees and the antenna height scanned from 1 to 4 m for maximum response. Then the emission is measured with the quasi-peak detector on frequencies below 1 GHz and with the average detector above 1 GHz.

The measurement was first performed with peak detector.

The following RBW were used:

30 MHz-1 GHz: RBW=120 kHz

1-25 GHz: RBW=1 MHz

Test set-up photos can be found in Appendix 10.

Appendix 4

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESI 26	503 292
EMI test receiver R&S ESU 26	902 210
EMI measurement computer	-
Software: R&S EMC32, ver. 8.53.0	503 745
Antenna Schaffner Bilog CBL6143	504 079
Horn antenna EMCO 3115	902 212
Standard gain horn Flann 16240-25	503 939
Standard gain horn Flann 18240-25	503 900
Standard gain horn Flann 20240-20	503 674
Low Noise Amplifier Miteq	503 285
Low Noise Amplifier Miteq, 1 18 GHz	504 160
High pass filter Wainwright WHKY	504 200
Temperature and humidity meter Testo 625	504 117

Results

The pre-measurement emission spectra with EUT set at 2440 MHz can be found in the diagrams below:

Diagram 1:	30-1000 MHz, Ambient, vertical and horizontal polarization
Diagram 2:	30-1000 MHz, EUT 1, vertical and horizontal polarization
Diagram 3:	30-1000 MHz, EUT 2, X-axis, vertical and horizontal polarization
Diagram 4:	30-1000 MHz, EUT 3, vertical and horizontal polarization
Diagram 5:	1-3 GHz, Ambient, vertical and horizontal polarization
Diagram 6:	1-3 GHz, EUT 1, vertical and horizontal polarization
Diagram 7:	1-3 GHz, EUT 2, X-axis, vertical and horizontal polarization
Diagram 8:	1-3 GHz; EUT 3, vertical and horizontal polarization
Diagram 9:	3-8.2 GHz, Ambient, vertical and horizontal polarization
Diagram 10:	3-8.2 GHz, EUT 1, vertical and horizontal polarization
Diagram 11:	3-8.2 GHz, EUT 2, X-axis, vertical and horizontal polarization
Diagram 12:	3-8.2 GHz; EUT 3, vertical and horizontal polarization
Diagram 13:	8.2-12 GHz, EUT 1, vertical and horizontal polarization
Diagram 14:	8.2-12 GHz, EUT 2, X-axis, vertical and horizontal polarization
Diagram 15:	8.2-12 GHz; EUT 3, vertical and horizontal polarization
Diagram 16:	12-18 GHz, EUT 1+EUT 2, X-axis,+EUT3, vertical and horizontal polarization
Diagram 17:	18-25 GHz EUT 1+EUT 2, X-axis,+EUT3, vertical polarization
Diagram 18:	18-25 GHz, EUT 1+EUT 2, X-axis,+EUT3, horizontal polarization

Note: Worst-case plots (axes) for EUT 2 are attached.

Appendix 4

The highest detected levels during the final measurement in the frequency range 30 MHz-25 GHz are listed in the tables below.

EUT 1, 2440 MHz

Frequency (MHz)	QP level (dB μ V/m)	CISPR AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
192.110	31.4	N/A	N/A	12.0	43.5	100	199	Vertical
257.245	34.9	N/A	N/A	11.1	46.0	100	96	Horizontal
371.235	37.4	N/A	N/A	8.6	46.0	100	131	Horizontal
4880.978	N/A	43.8	51.8	-10.9	53.9 (AV)	105	211	Vertical
7318.413	N/A	49.0	56.9	-2.8	53.9 (AV)	119	136	Horizontal
9762.037	N/A	38.9	53.9	-2.8	53.9 (AV)	119	136	Horizontal

EUT 2, X-axis, 2440 MHz

Frequency (MHz)	QP level (dB μ V/m)	CISPR AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
4880.962	N/A	35.0	45.1	-10.9	53.9 (AV)	199	41	Vertical
9761.748	N/A	37.8	46.2	-15.2	53.9 (AV)	100	338	Vertical

EUT 3, 2440 MHz

Frequency (MHz)	QP level (dB μ V/m)	CISPR AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
4881.010	N/A	42.4	50.5	-10.9	53.9 (AV)	100	157	Vertical
9761.957	N/A	29.1	39.2	-15.2	53.9 (AV)	100	302	Horizontal

Appendix 4

Limits

According to 47CFR 15.249(a), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field strength of harmonics
2400-2483.5 MHz	500 μ V/m = 54 dB μ V/m

According to 47CFR 15.249(d), emission radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in section 15.209, whichever is the lesser attenuation.

According to 47CFR 15.249(e), the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

According to RSS-210 A2.9(b), emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to table 2 limits, whichever is the less stringent.

Complies?	Yes
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Appendix 4

Diagram 1

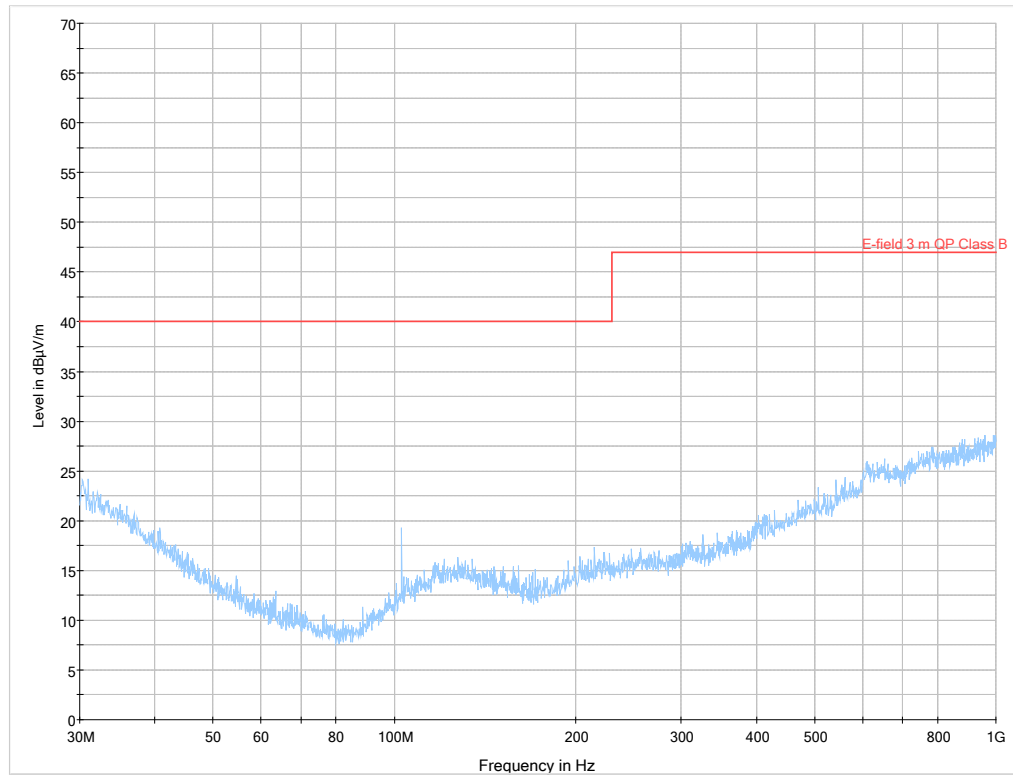
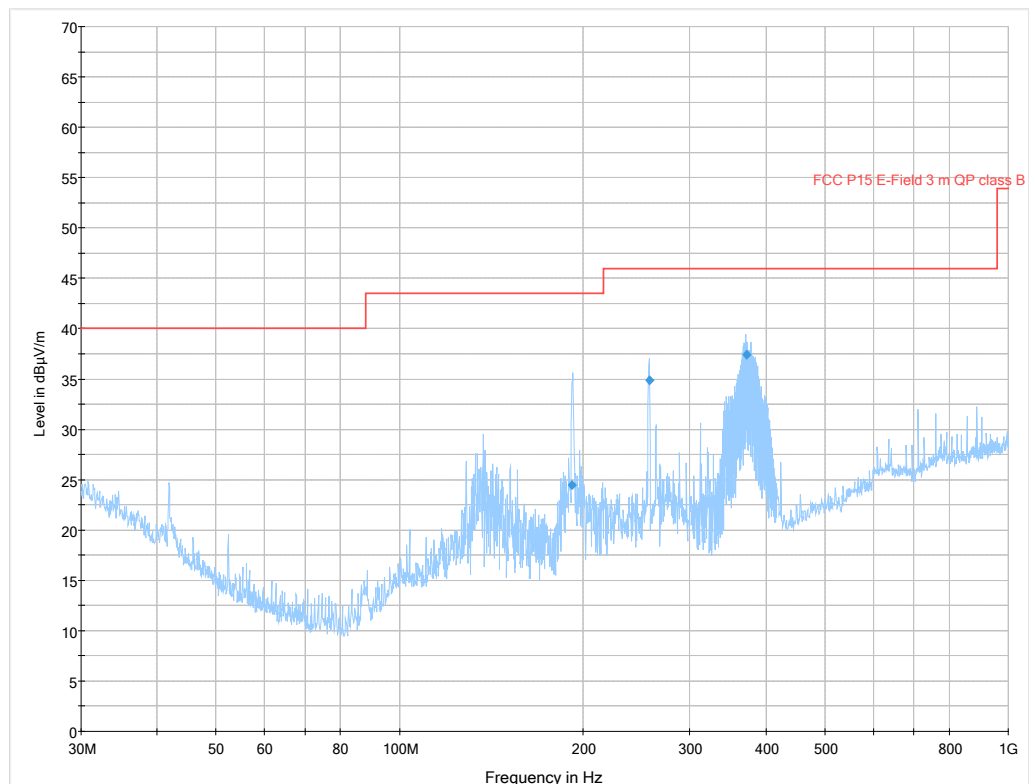


Diagram 2



Appendix 4

Diagram 3

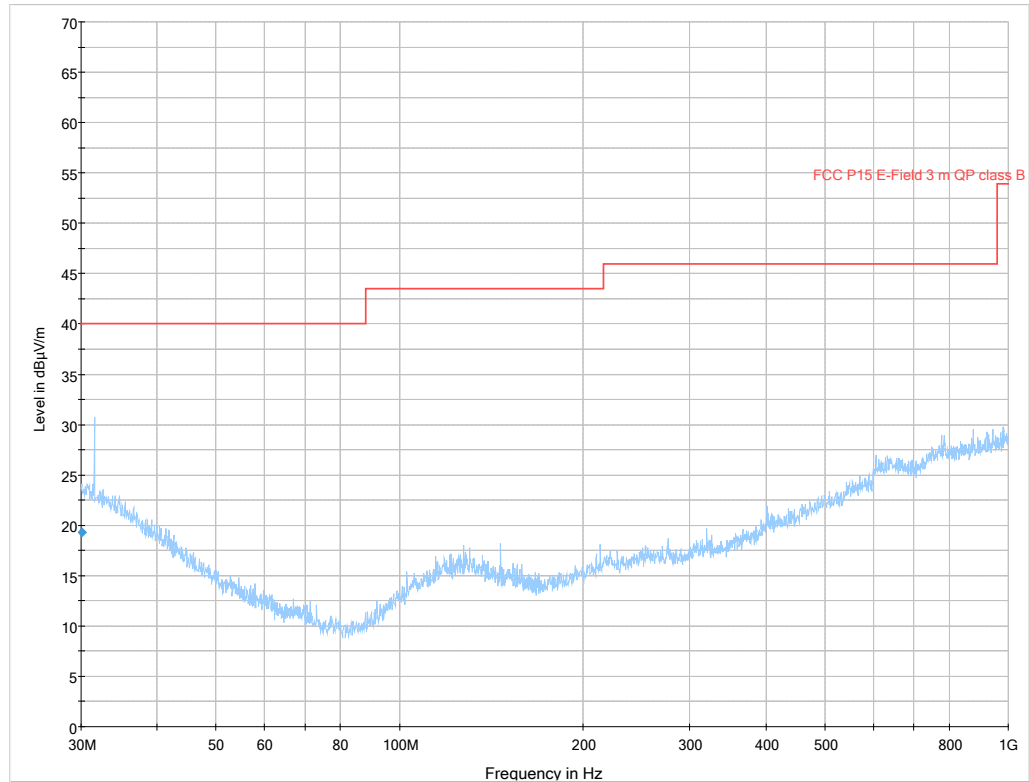
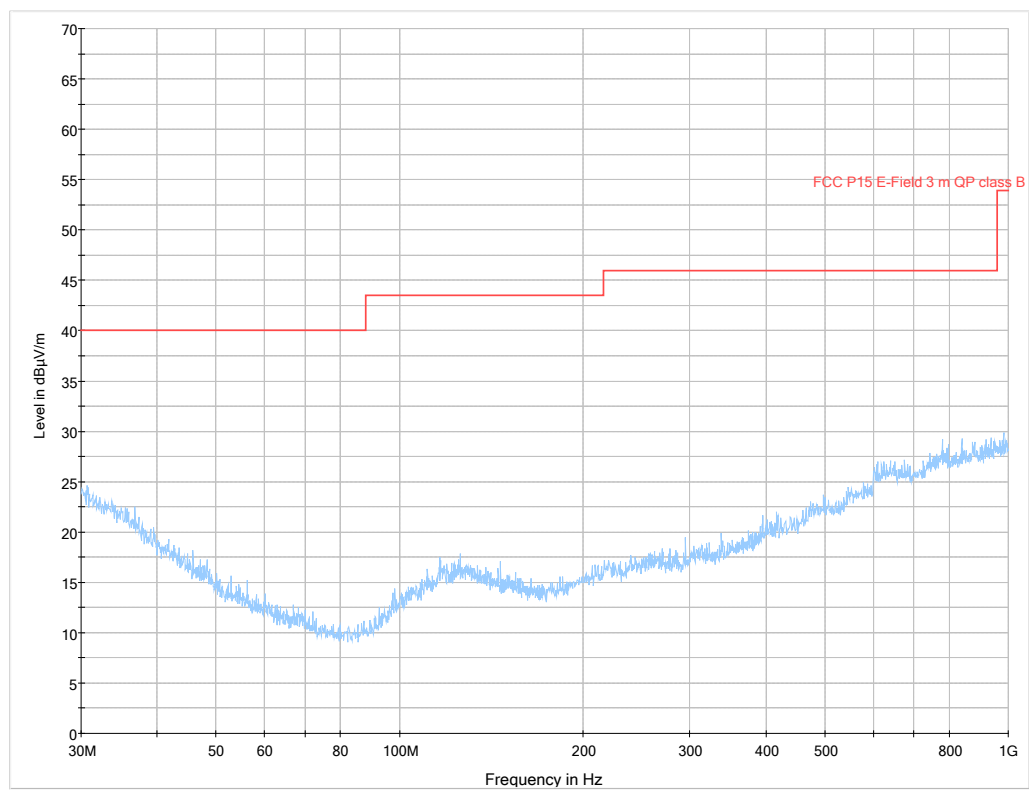


Diagram 4



Appendix 4

Diagram 5

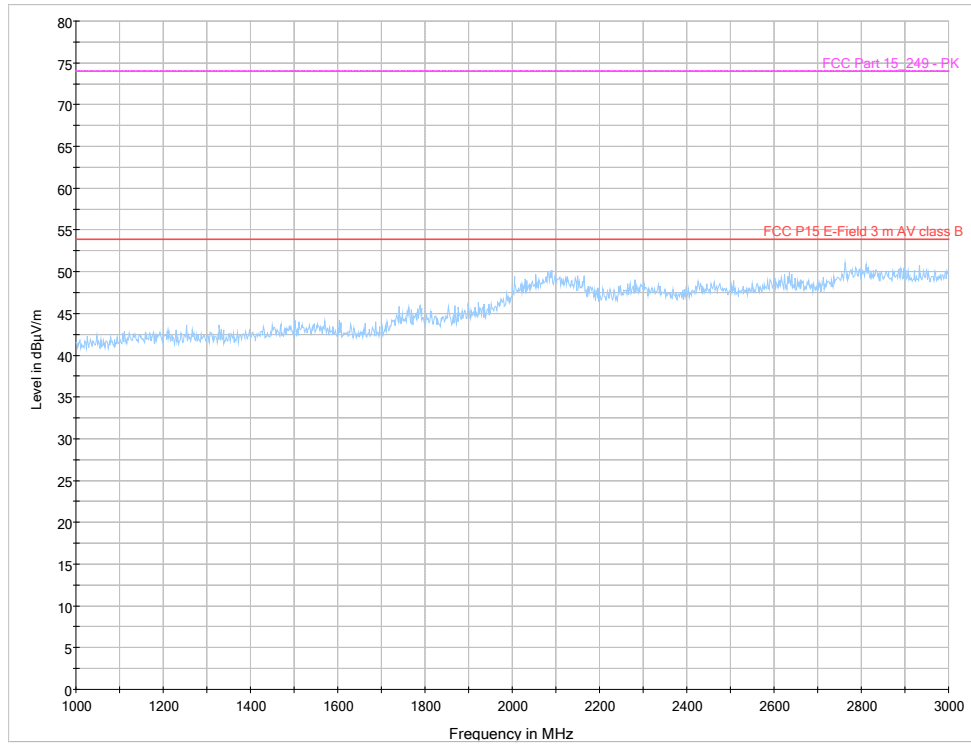
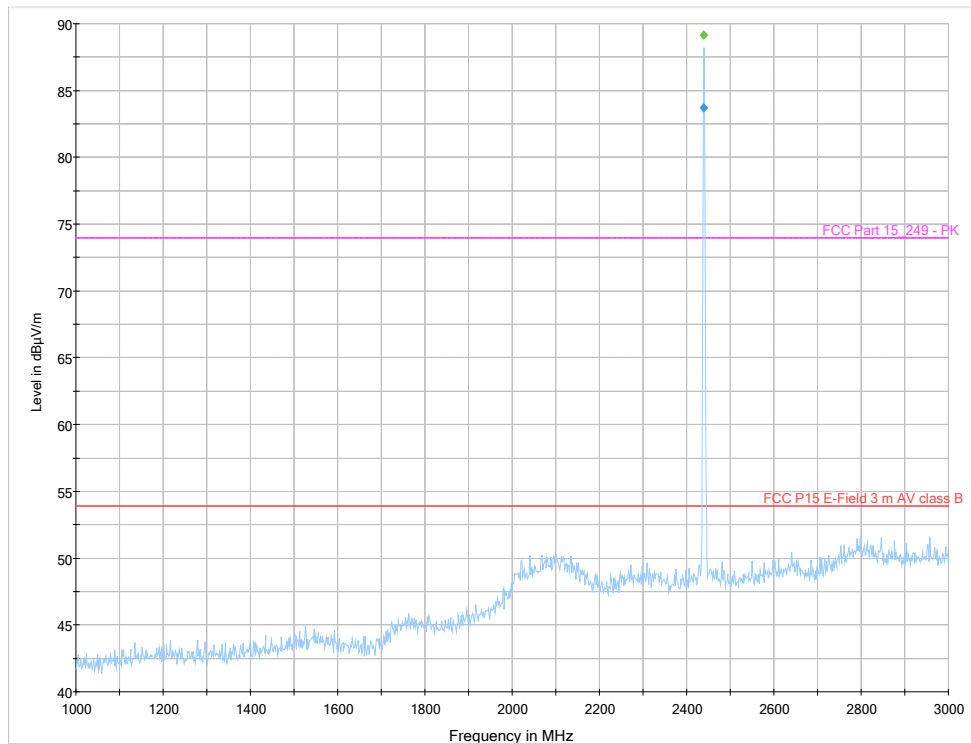


Diagram 6



Appendix 4

Diagram 7

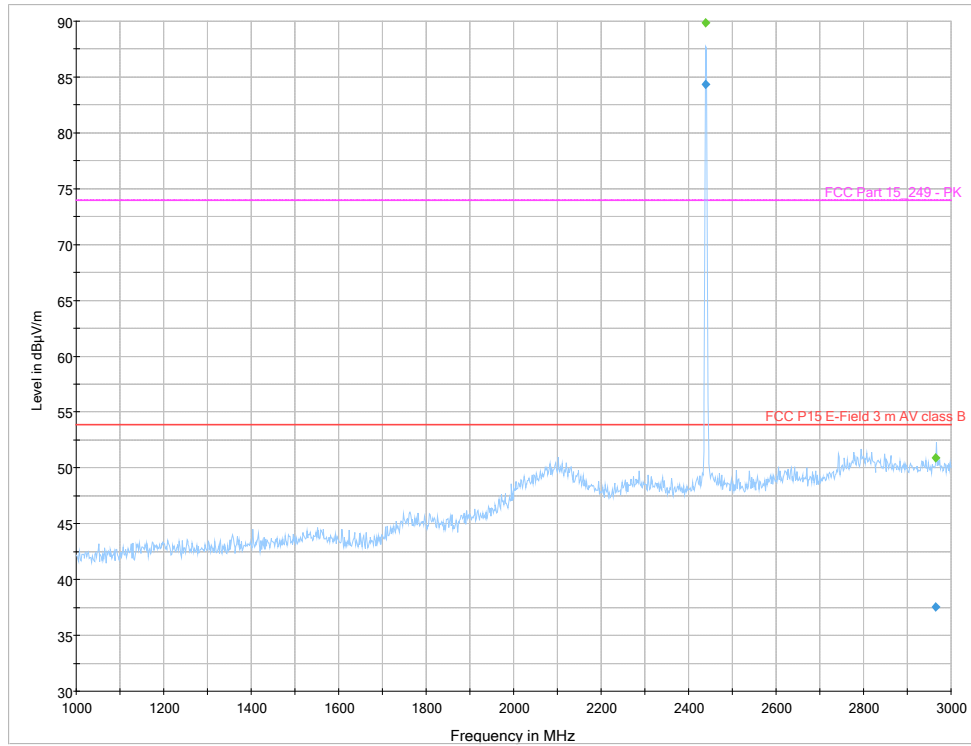
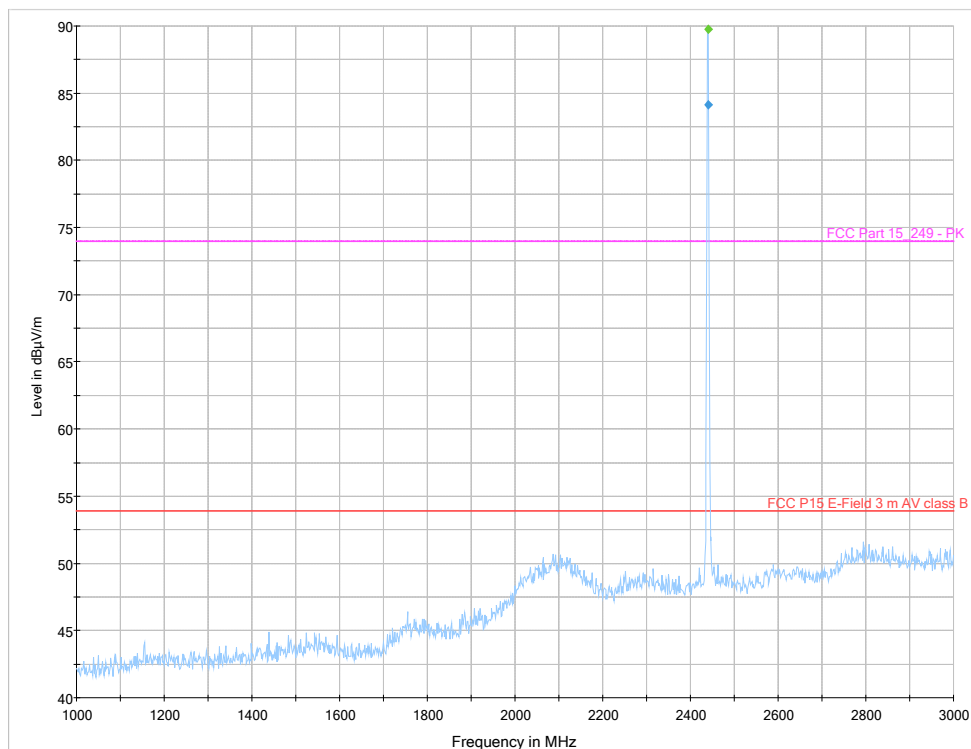


Diagram 8



Appendix 4

Diagram 9

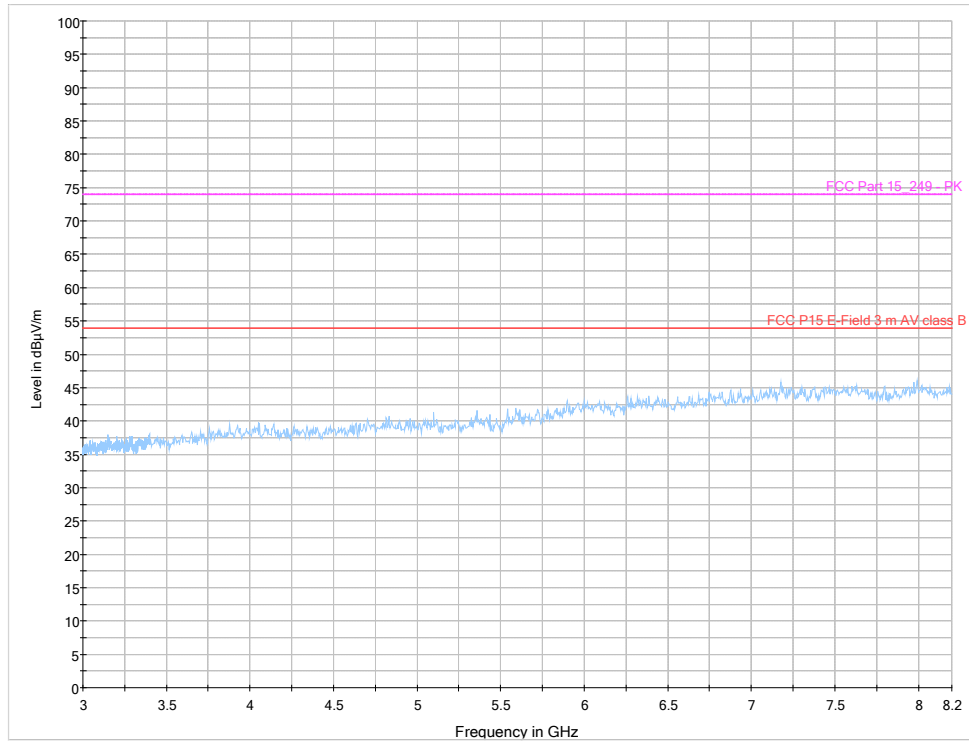
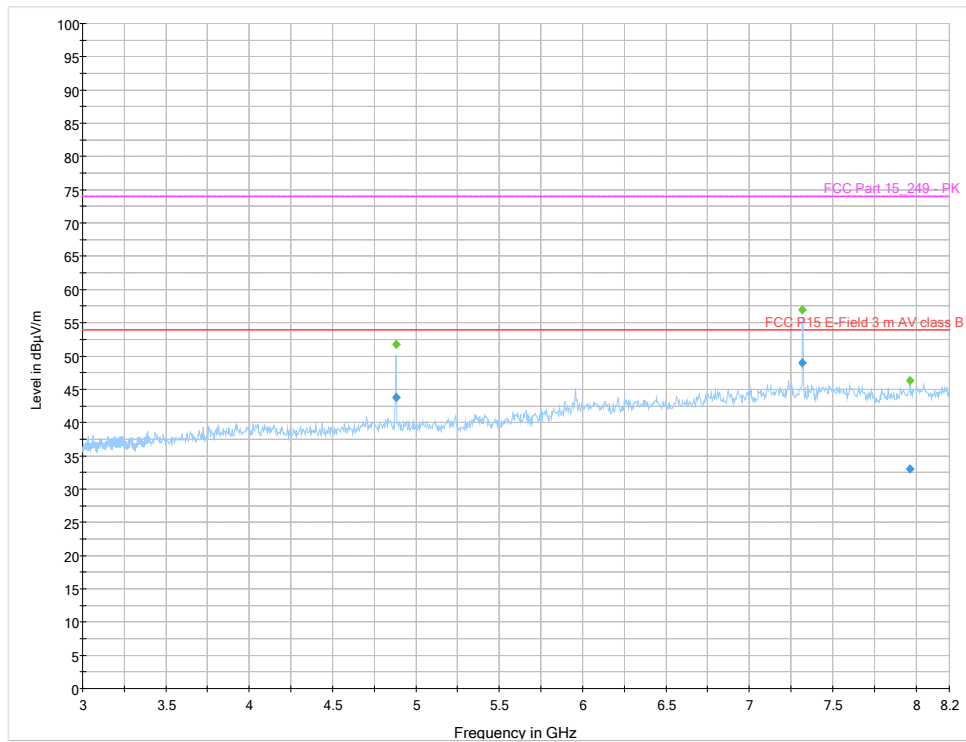


Diagram 10



Appendix 4

Diagram 11

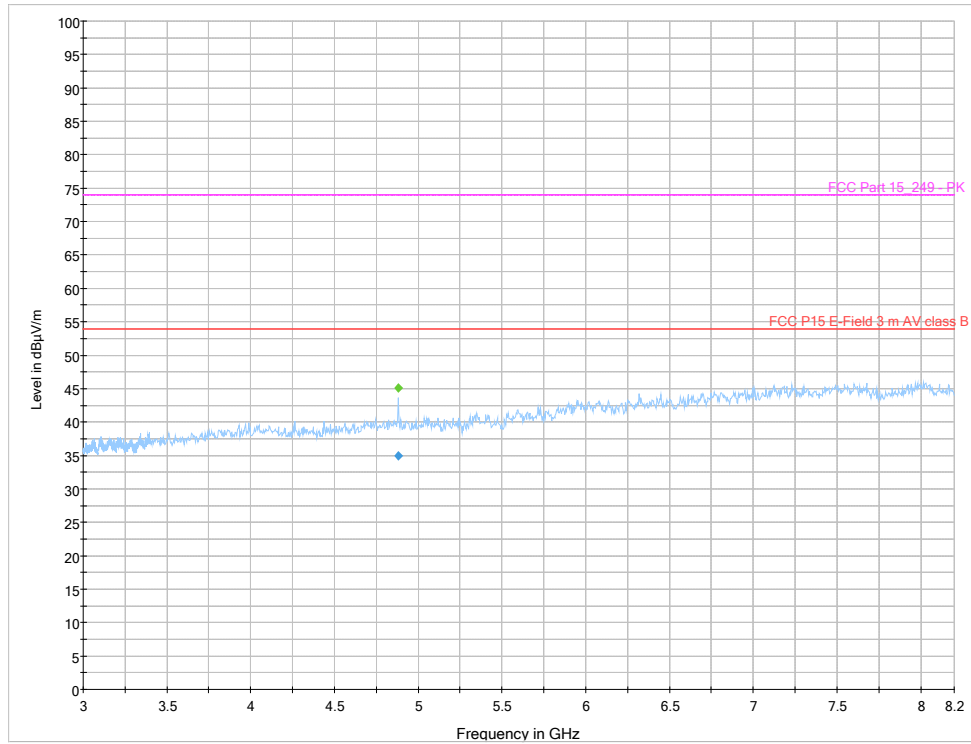
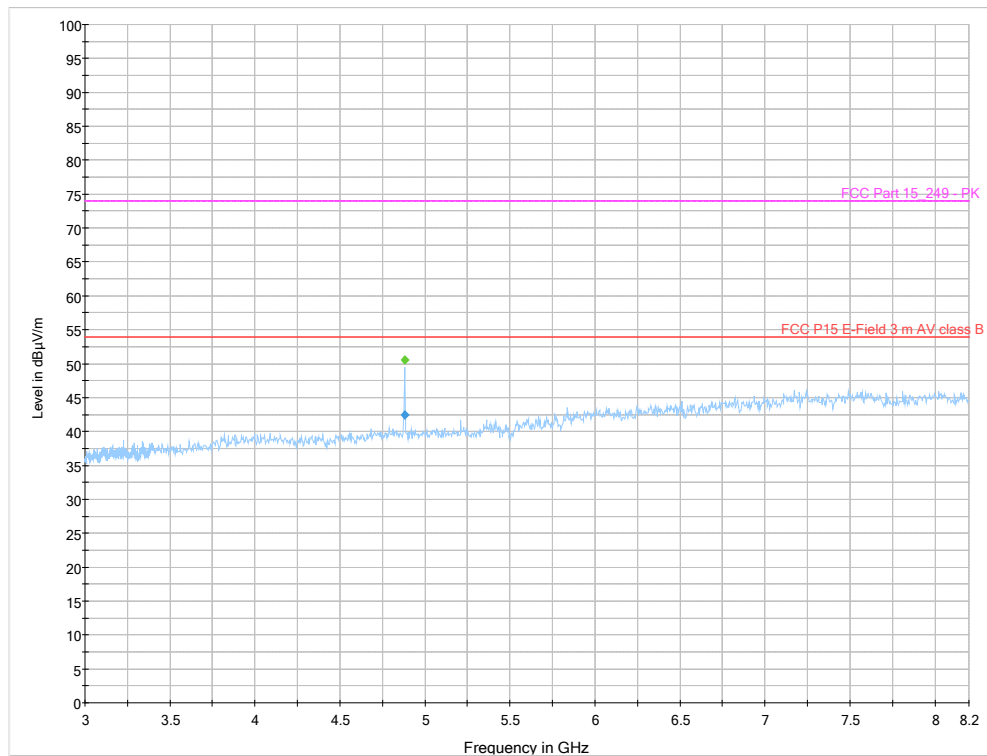


Diagram 12



Appendix 4

Diagram 13

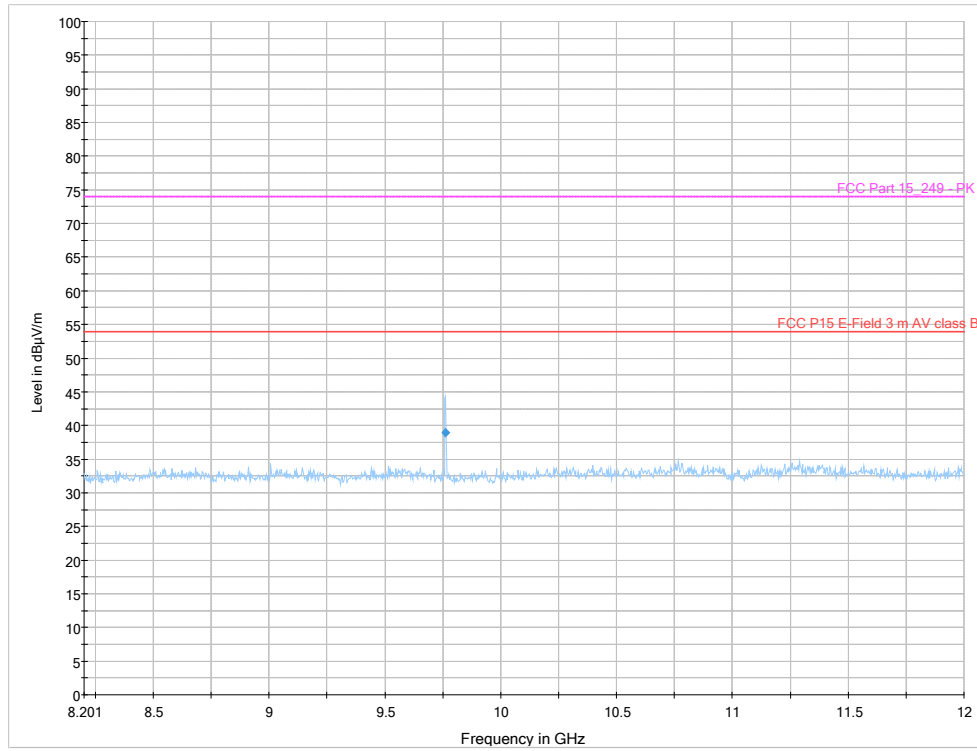
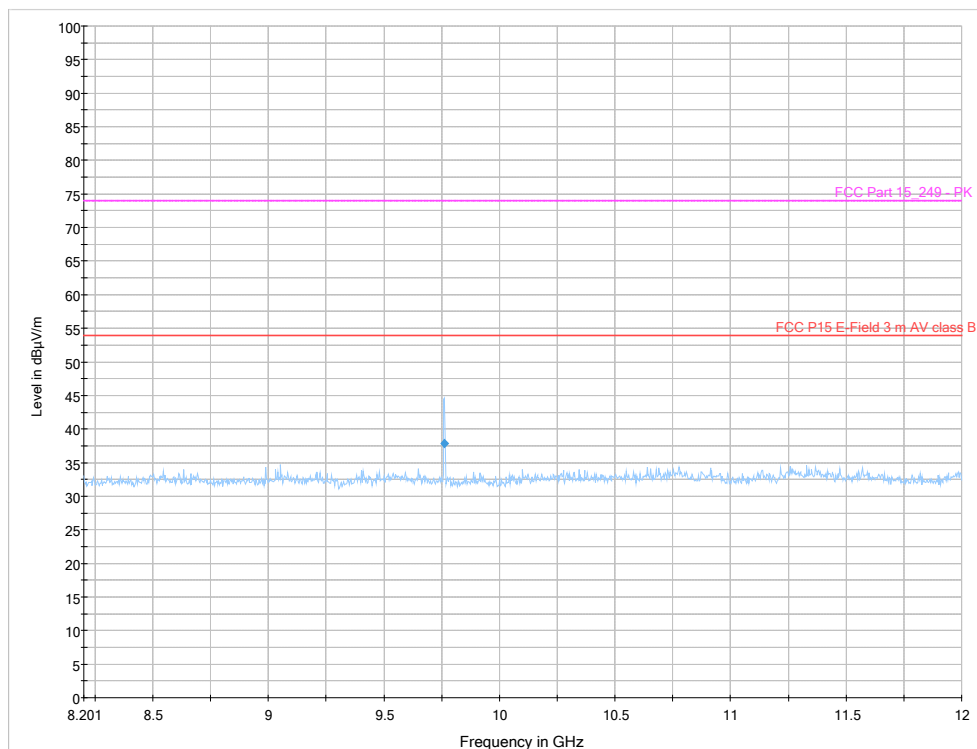


Diagram 14



Appendix 4

Diagram 15

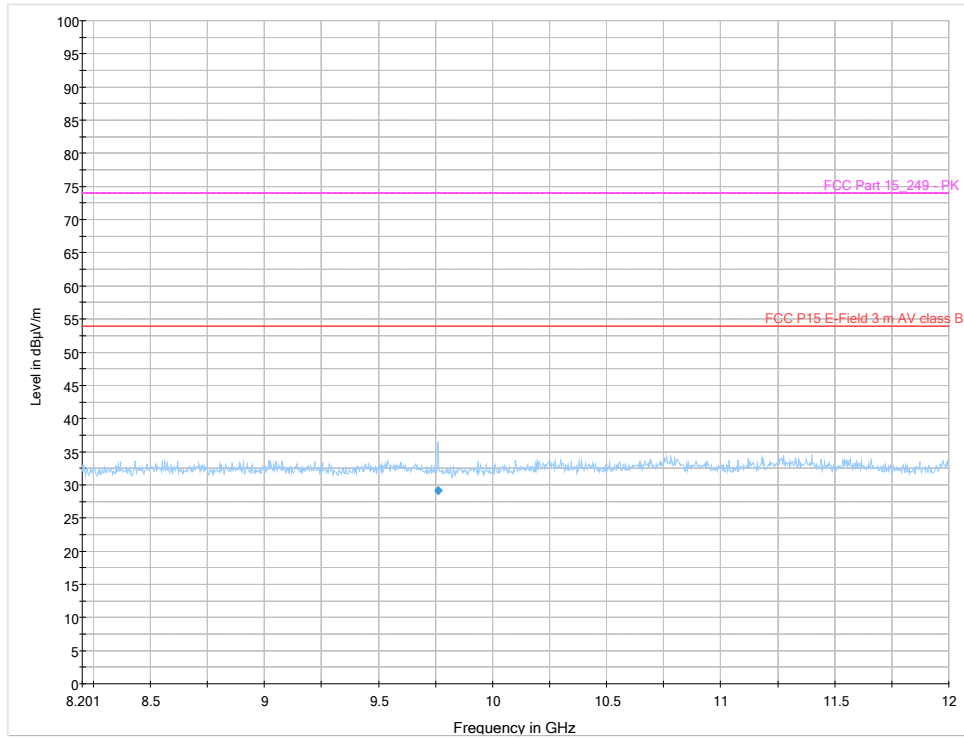
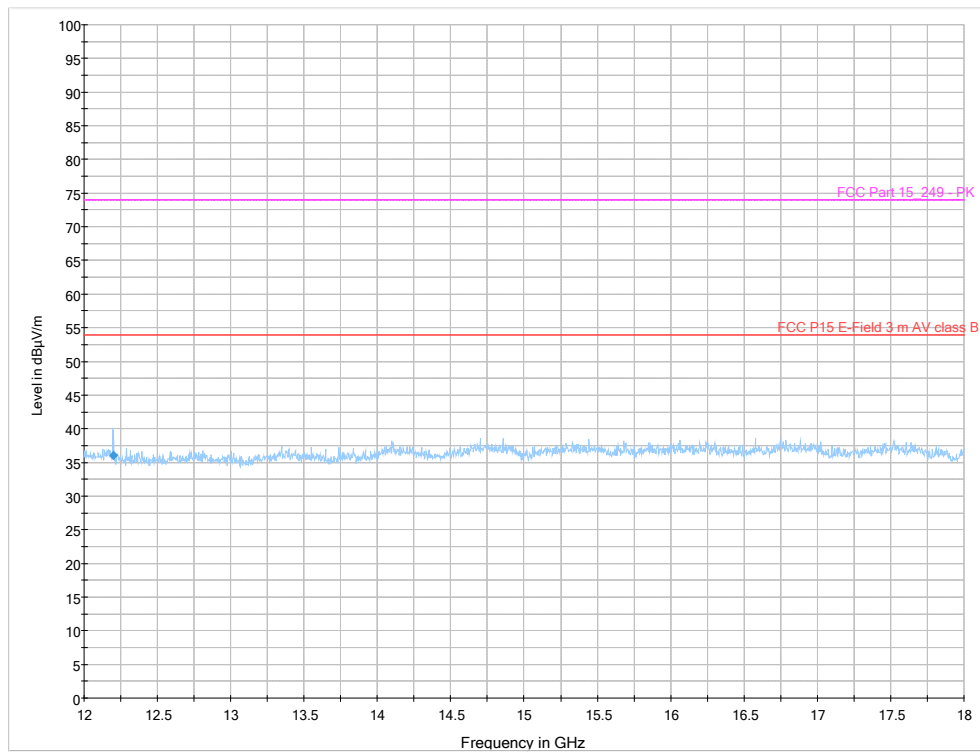
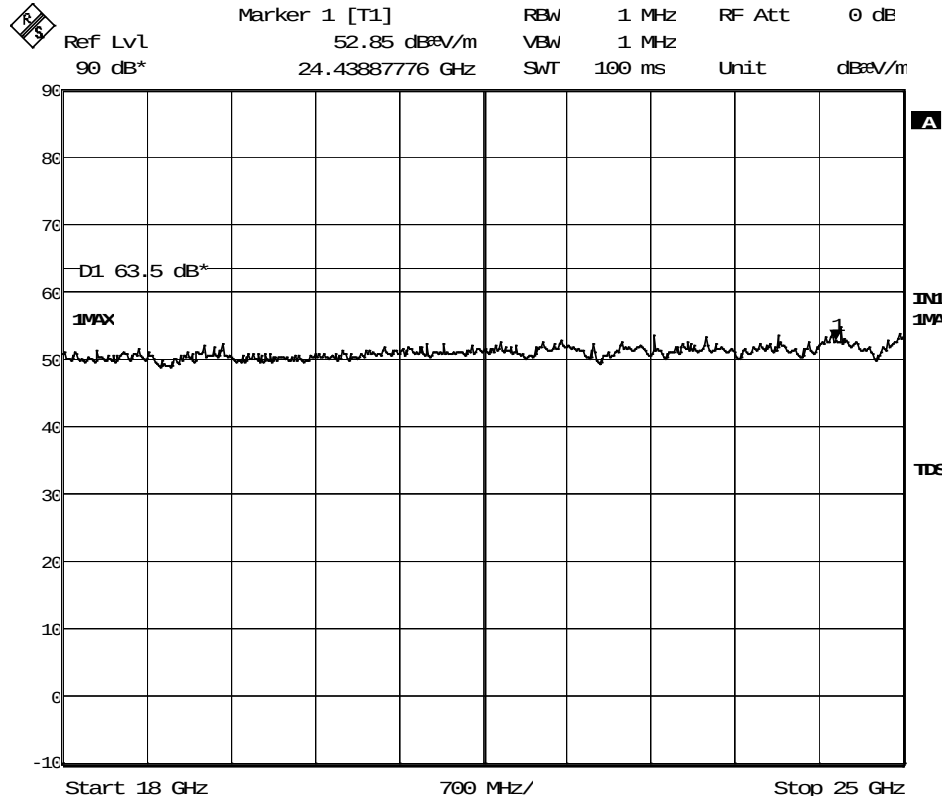


Diagram 16



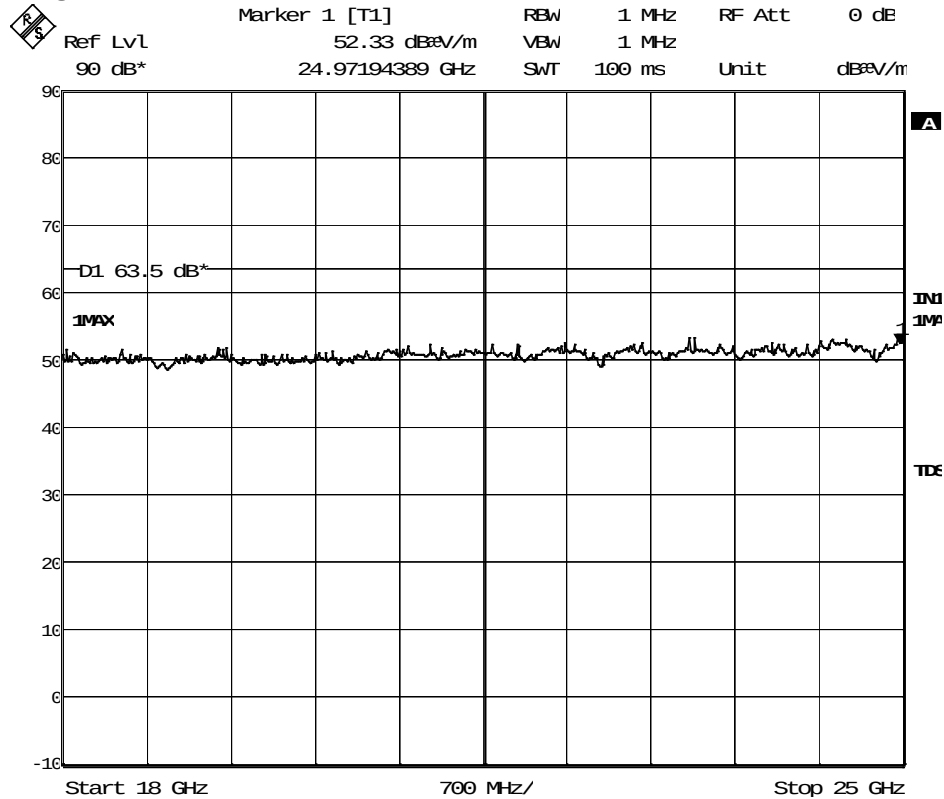
Appendix 4

Diagram 17



Date: 21.OCT.2013 12:53:17

Diagram 18



Date: 21.OCT.2013 12:55:34

Appendix 5

20 dB bandwidth measurements according to FCC 47 CFR part 15.215 (c)

Date 2013-10-14	Temperature 23 °C ± 3 °C	Humidity 40 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.

The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

The radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the EUT-axis, antenna at the position, polarization and the turntable in the position giving the highest level at the fundamental, see Appendix 3. The antenna distance was 3.0 m.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
Software: R&S EMC32, ver. 8.53.0	503 745
Horn antenna EMCO 3115	902 212
Temperature and humidity meter Testo 625	504 117

Measurement uncertainty: 2.6 %

Results

The 20 dB BW measurements can be found in the diagrams below:

Diagram 1	EUT 1	2440 MHz	20 dB BW = 2.29 MHz
Diagram 2	EUT 2	2440 MHz	20 dB BW = 2.35 MHz
Diagram 3	EUT 3	2440 MHz	20 dB BW = 2.29 MHz

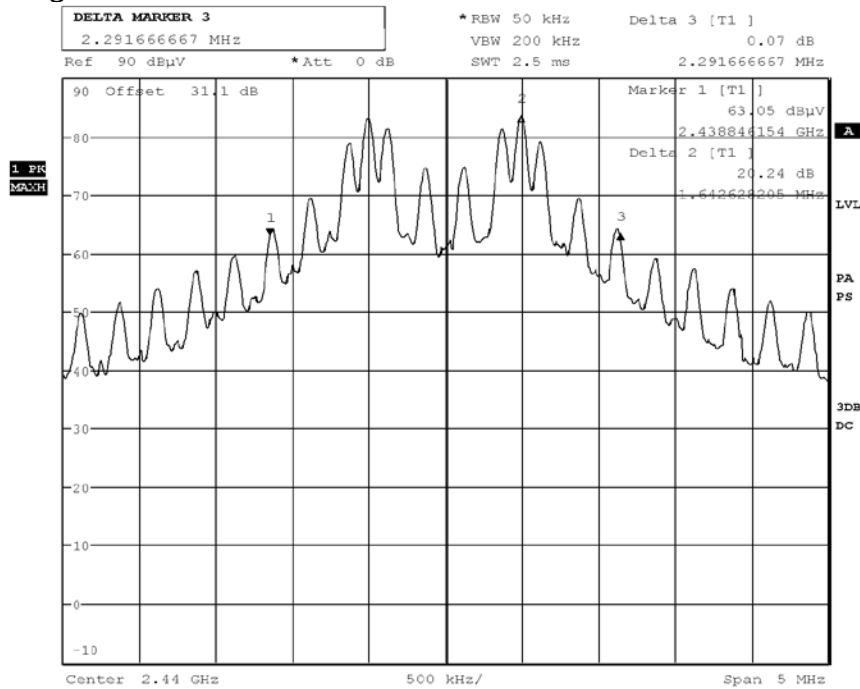
Limits

According to 47CFR 15.215(c), intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Complies?	Yes
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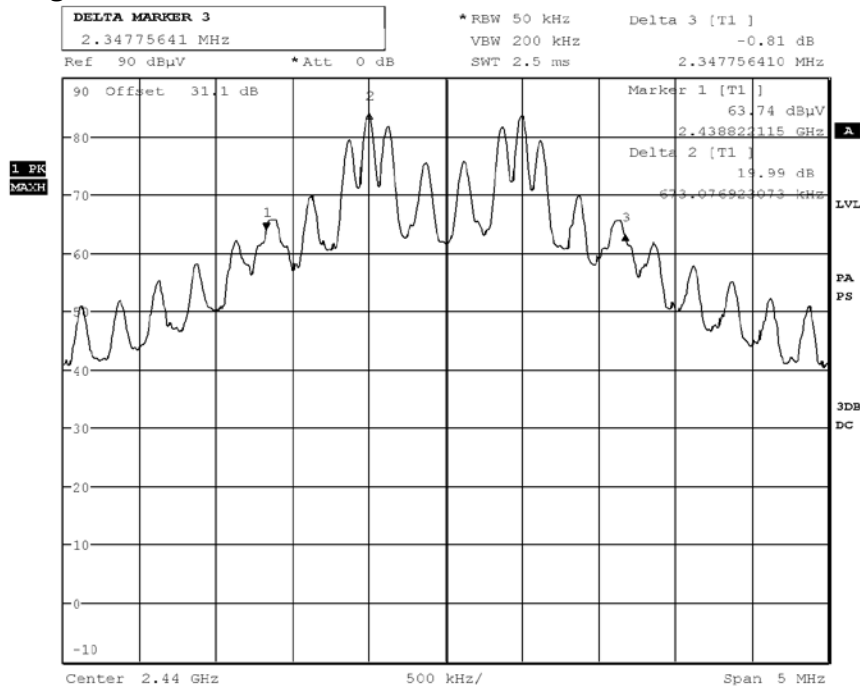
Appendix 5

Diagram 1



Date: 14.OCT.2013 15:26:30

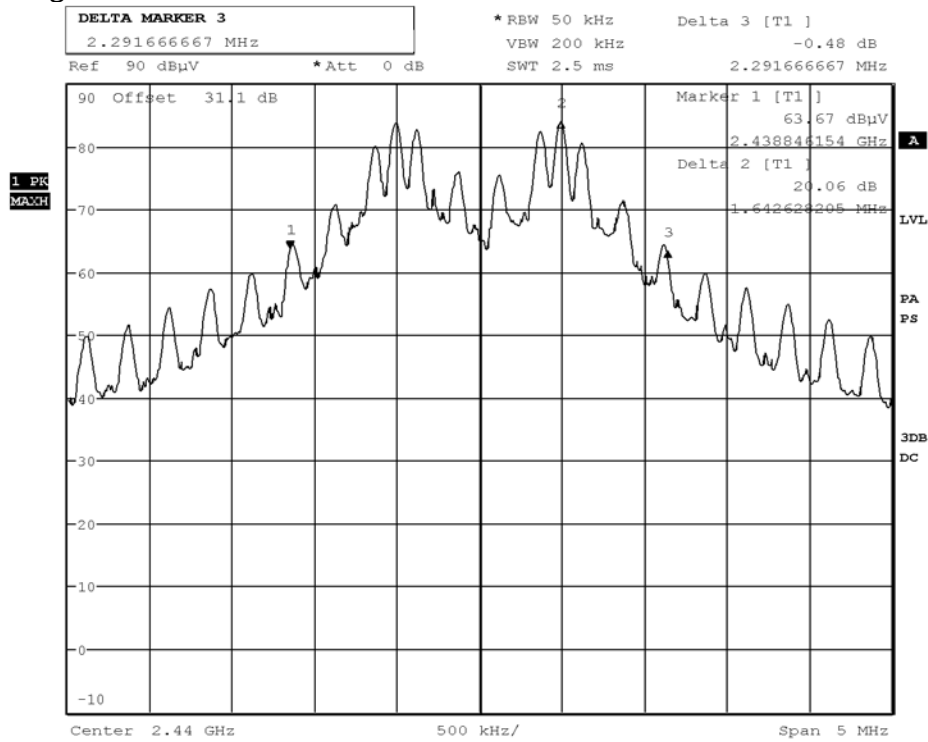
Diagram 2



Date: 14.OCT.2013 14:02:32

Appendix 5

Diagram 3



Date: 14.OCT.2013 15:07:12

Appendix 6

Conducted emission measurements according to FCC 47 CFR part 15.207, class B / RSS-Gen 7.2.4

Date 2013-10-15	Temperature 23 °C ± 3 °C	Humidity 33 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.

The test was only relevant on EUT 1. The other EUT were only battery powered.
The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

Measurements were performed on the 120 V AC/60 Hz, phase and neutral terminals of the AC/DC adapter.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
EMI measurement computer	-
Software: R&S EMC32, ver. 8.53.0	503 745
LISN Schwartzbeck NNLA20	504 129
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 117

Result

The conducted emission spectra can be found in the diagrams below:

Diagram 1 EUT 1 2440 MHz Ambient, 120 V AC, phase terminal,
120 V AC power off

Diagram 2 EUT 1 2440 MHz 120 V AC, phase terminal

Diagram 3 EUT 1 2440 MHz 120 V AC, neutral terminal

The limit lines indicated as Voltage on Mains in the diagrams are the same limit lines as of FCC part 15.

Limits

According to 47CFR 15.207 and according to RSS-Gen 7.2.4,

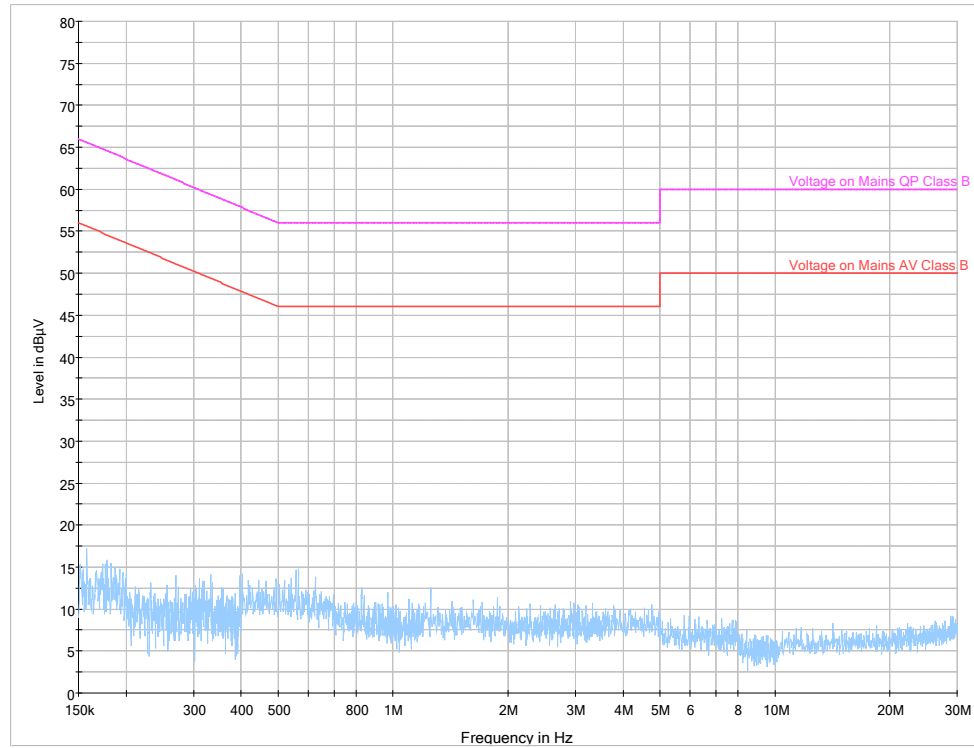
Frequency (MHz)	Quasi-peak value (dBµV)	Average value (dBµV/m)
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

*=Decreases with the logarithm of the frequency

Complies?	Yes
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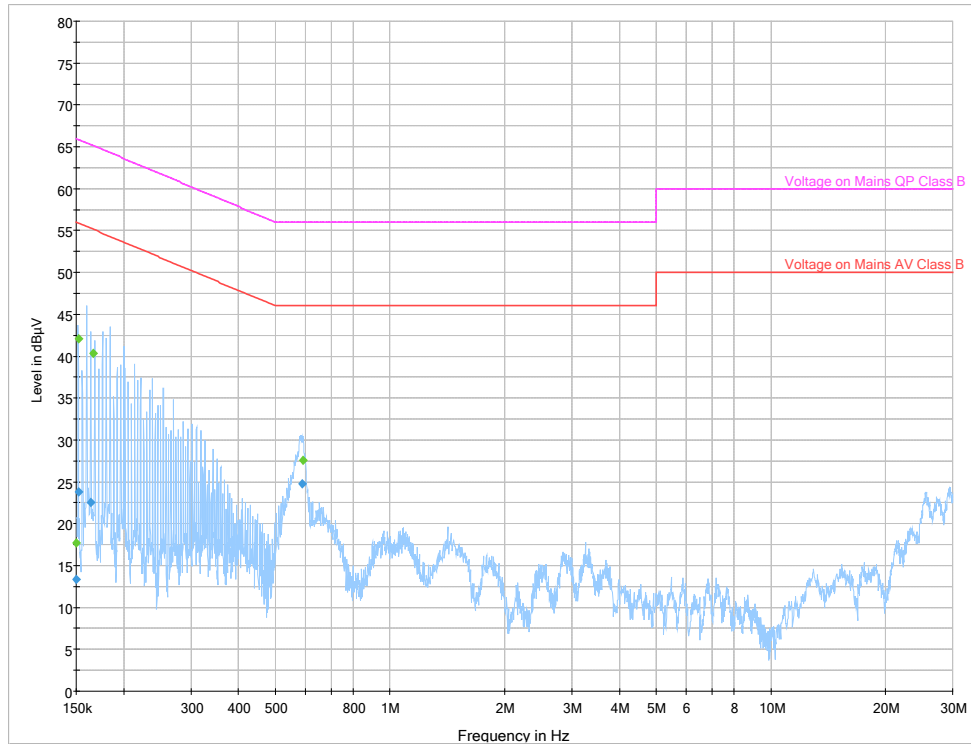
Appendix 6

Diagram 1



Appendix 6

Diagram 2



Final result, CISPR Average

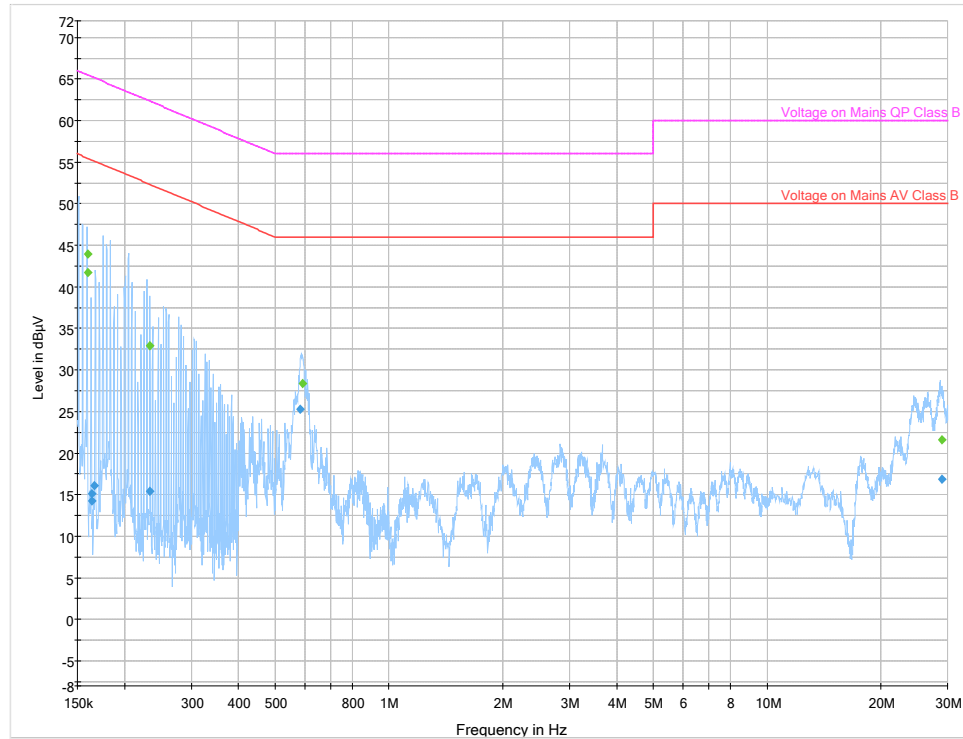
Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.150000	13.3	5000.0	0.200	GN	L1	0.2	42.7	56.0	
0.152000	23.8	5000.0	9.000	GN	L1	0.1	32.1	55.9	
0.164167	22.6	5000.0	9.000	GN	L1	0.1	32.7	55.3	
0.587744	24.7	5000.0	9.000	GN	L1	0.1	21.3	46.0	

Final result, Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.150000	17.7	5000.0	0.200	GN	L1	0.2	48.3	66.0	
0.152000	42.0	5000.0	9.000	GN	L1	0.1	23.9	65.9	
0.166167	40.3	5000.0	9.000	GN	L1	0.1	24.8	65.1	
0.589744	27.6	5000.0	9.000	GN	L1	0.1	28.4	56.0	

Appendix 6

Diagram 3



Final result, CISPR Average

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.163487	15.1	5000.0	9.000	GN	N	0.1	40.2	55.3	
0.164000	14.3	5000.0	9.000	GN	N	0.1	41.0	55.3	
0.166000	16.1	5000.0	9.000	GN	N	0.1	39.0	55.2	
0.233205	15.4	5000.0	9.000	GN	N	0.1	37.0	52.3	
0.581051	25.3	5000.0	9.000	GN	N	0.1	20.7	46.0	
28.921173	16.8	5000.0	9.000	GN	N	1.6	33.2	50.0	

Final result, Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.159487	43.9	5000.0	9.000	GN	N	0.1	21.5	65.5	
0.160000	41.7	5000.0	9.000	GN	N	0.1	23.8	65.5	
0.233205	32.9	5000.0	9.000	GN	N	0.1	29.5	62.3	
0.591051	28.3	5000.0	9.000	GN	N	0.1	27.7	56.0	
28.949173	21.6	5000.0	9.000	GN	N	1.6	38.4	60.0	

Appendix 7

Occupied bandwidth measurements according to 47CFR 2.1049 / RSS-Gen 4.6.1

Date 2013-10-14	Temperature 23 °C ± 3 °C	Humidity 40 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.

The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

The radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the EUT-axis, antenna at the position, polarization and the turntable in the position giving the highest level at the fundamental, see Appendix 3. The antenna distance was 3.0 m.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
Software: R&S EMC32, ver. 8.53.0	503 745
Horn antenna EMCO 3115	902 212
Temperature and humidity meter Testo 625	504 117

Measurement uncertainty: 2.6 %

Results

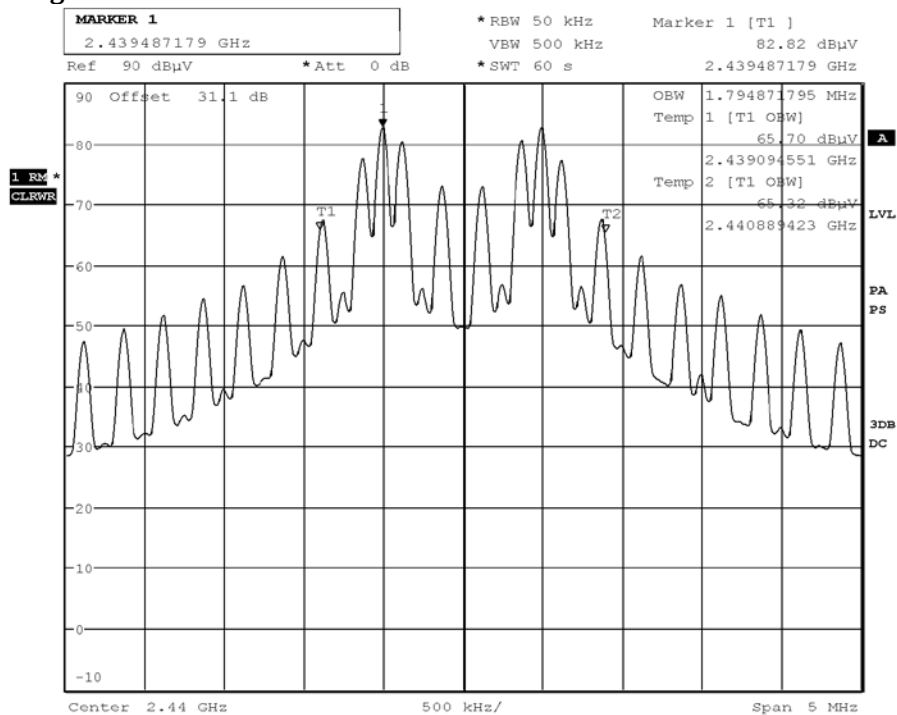
The OBW measurements can be found in the diagrams below:

Diagram 1	EUT 1	2440 MHz	OBW = 1.79 MHz (99%)
Diagram 2	EUT 2	2440 MHz	OBW = 1.81 MHz (99%)
Diagram 3	EUT 3	2440 MHz	OBW = 1.79 MHz (99%)

Complies?	Yes
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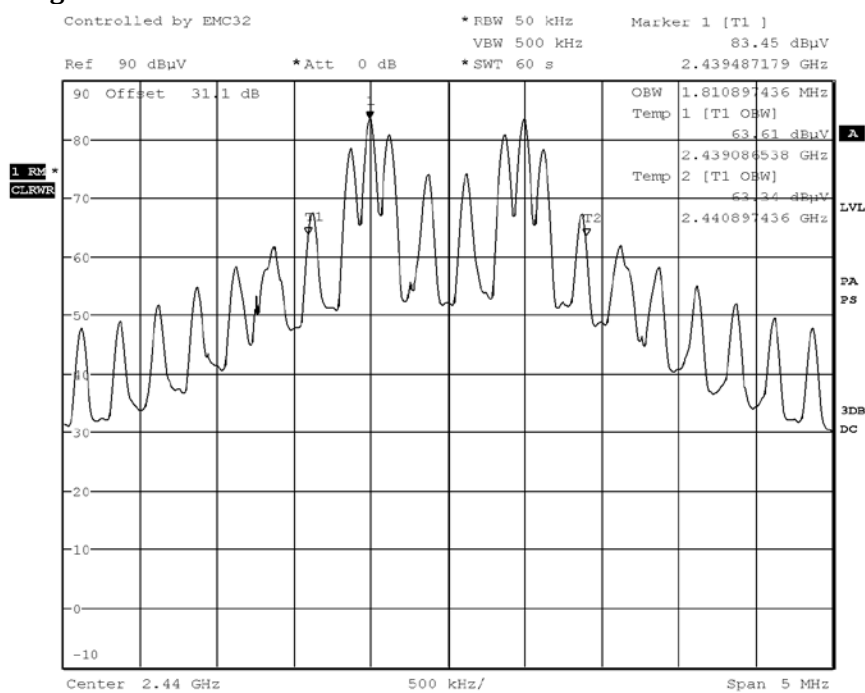
Appendix 7

Diagram 1



Date: 14.OCT.2013 11:50:36

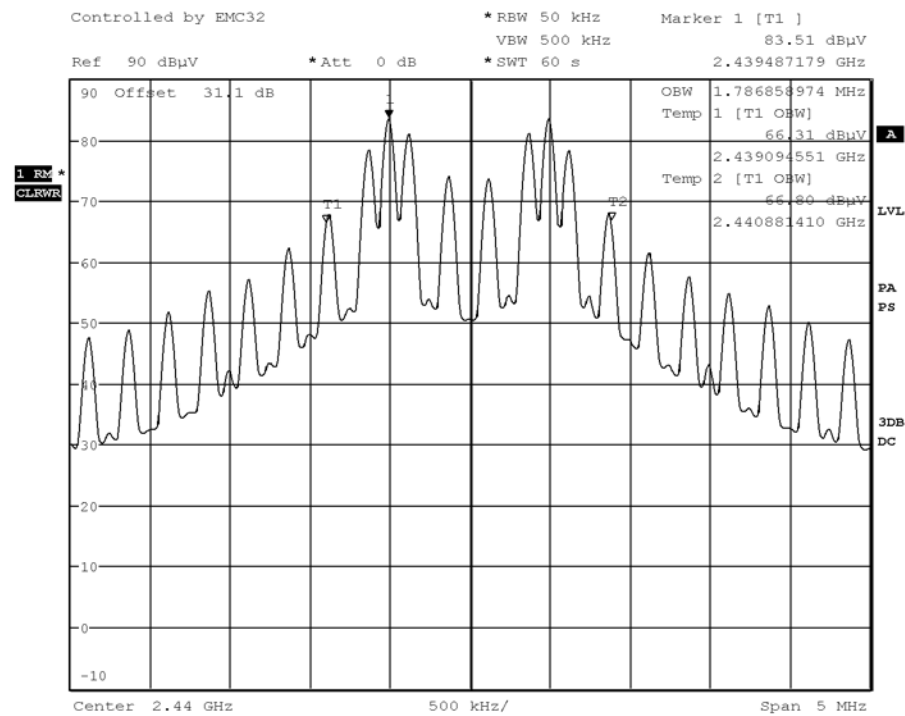
Diagram 2



Date: 14.OCT.2013 14:04:53

Appendix 7

Diagram 3



Date: 14.OCT.2013 15:08:55

Appendix 8

Band edge measurements according to 47CFR 2.1049 / RSS-210 A2.9(b)

Date 2013-10-14	Temperature 23 °C ± 3 °C	Humidity 40 % ± 5 %
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Test set-up and procedure

The measurements were performed according to ANSI C63.10-2009.

The test was performed with continuous transmission (100% duty cycle) and with normal modulation.

The radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the EUT-axis, antenna at the position, polarization and the turntable in the position giving the highest level at the fundamental, see Appendix 3. The antenna distance was 3.0 m.

Test set-up photos can be found in Appendix 10.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
EMI test receiver R&S ESU 26	902 210
Software: R&S EMC32, ver. 8.53.0	503 745
Horn antenna EMCO 3115	902 212
Temperature and humidity meter Testo 625	504 117

Results

Operation band 2400-2483.5 MHz

The pre-measurement diagrams with peak detector can be found in the diagrams below

EUT 1

Diagram 1 2440 MHz Band edge at 2400 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2400 MHz = 35.7 dB μ V/m (noise floor)
 Band edge at 2483.5 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2483.5 MHz = 36.0 dB μ V/m (noise floor)

EUT 2

Diagram 2 2440 MHz Band edge at 2400 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2400 MHz = 35.7 dB μ V/m (noise floor)
 Band edge at 2483.5 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2483.5 MHz = 36.0 dB μ V/m (noise floor)

EUT 3

Diagram 3 2440 MHz Band edge at 2400 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2400 MHz = 35.7 dB μ V/m (noise floor)
 Band edge at 2483.5 MHz (limit=54.0 dB μ V/m (CAverage)
CAV level at 2483.5 MHz = 36.0 dB μ V/m (noise floor)

Appendix 8

Limits

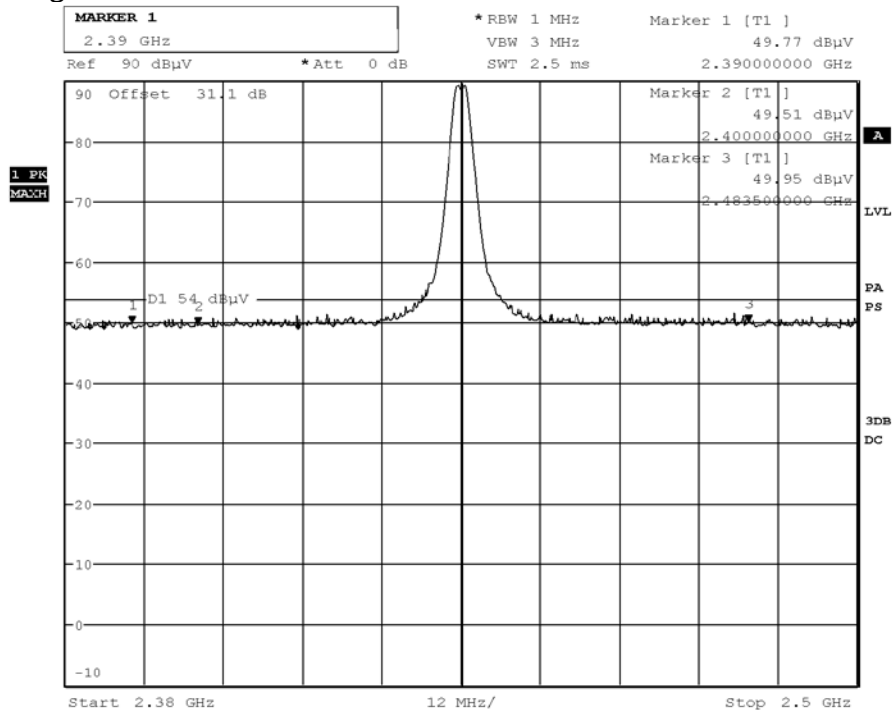
According to 47CFR 15.249(d), emission radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in section 15.209, whichever is the lesser attenuation.

According to RSS-210 A2.9(b), emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen, whichever is the less stringent.

Complies?	Yes
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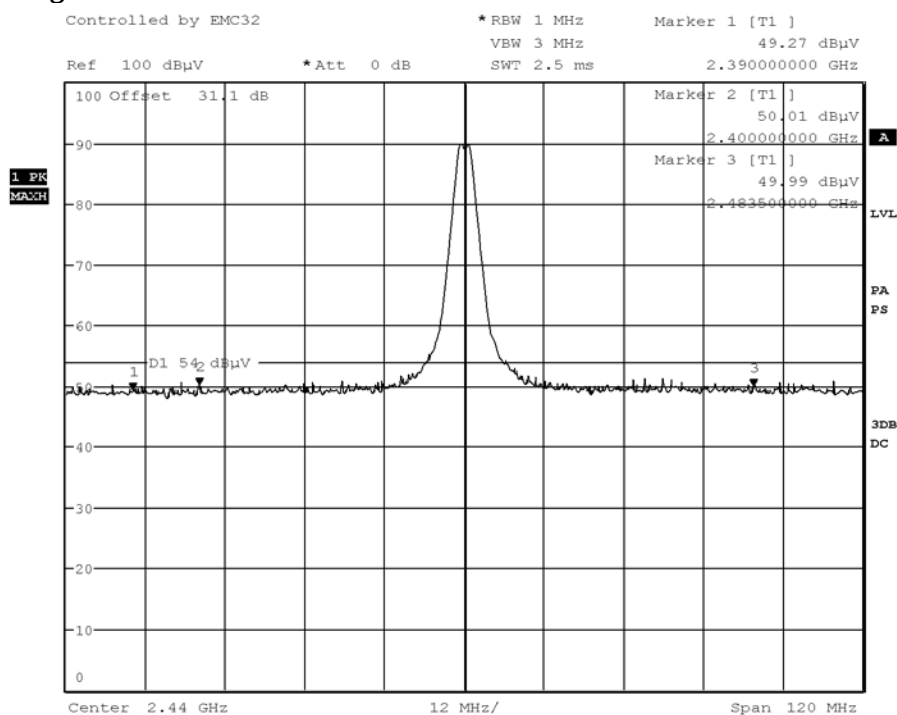
Appendix 8

Diagram 1



Date: 14.OCT.2013 11:57:02

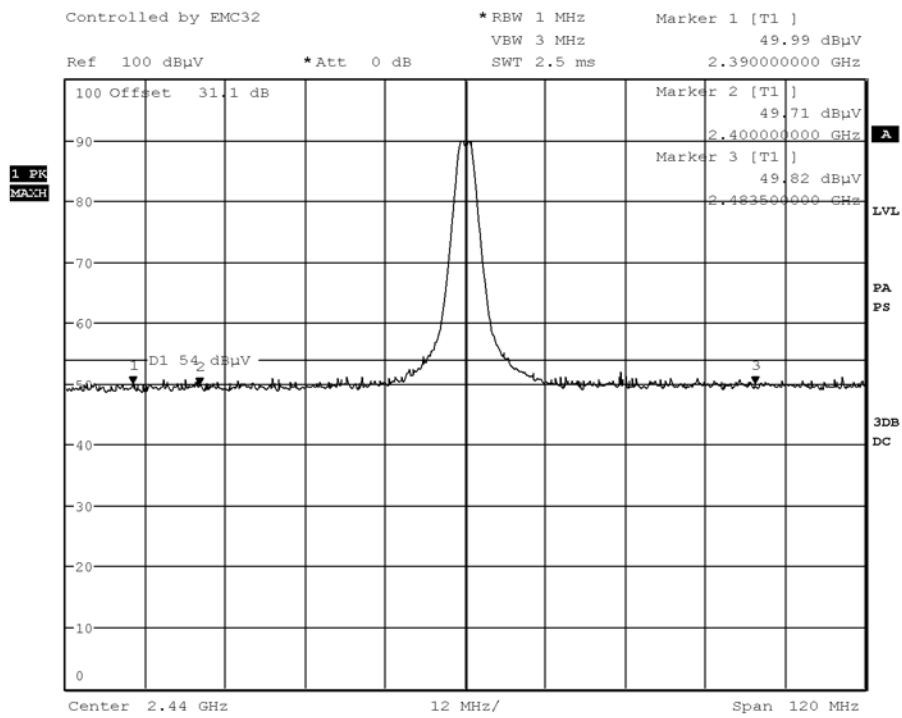
Diagram 2



Date: 14.OCT.2013 14:07:42

Appendix 8

Diagram 3



Date: 14.OCT.2013 15:10:19

Appendix 9

RF exposure evaluation: 2.1091 Mobile devices / KDB 447498/ RSS-102 2.5.1 and 2.1093 Portable devices / KDB 447498/ RSS-102 2.5.1

Date 2013-10-14	Temperature 23 °C ± 3 °C	Humidity 40 % ± 5 %
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Procedure

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device (EUT 1) whereby a distance of 20 cm normally can be maintained between the user and the device.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1093 this devices (EUT 2 and EUT 3) have been defined as a portable device to be used within 20 centimetres of the body of the user.

Appendix 9

ResultsMobile devices: EUT 1:

The following formula was used to calculate the RF exposure,
 $P_d = P_{out} \times G / (4 \times \pi \times r^2_{cm})$

where,

P_d = power density in mW/cm^2

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

$\pi = 3.1416$

r = distance between observation and center of the radiator in cm

From the peak EUT RF output power, the minimum mobile separation distance, $r=20$ cm, as well as the gain of the used antenna, the RF power density can be obtained.

The maximum radiated peak output power from appendix 3 was used for calculation of Maximum Permissible Exposure, MPE.

EUT 1:

Antenna Gain (dBi)	Antenna Gain (numeric)	EIRP Peak output power (dBm)	Peak output power (mW)	Power density, P_d [S] (mW/cm^2)	Limit of power density (mW/cm^2)
Note 1	Note 1	-6.1 Note 2	0.245	0.000049	1.0

Note 1: The antenna gain is not used in the MPE calculation as the EIRP value (including the antenna) is used.

Note 2: The measurements were performed in field strength in $dB\mu V/m$. The EIRP level was then calculated by the formula $P = (E_{fd})^2 / 30 \times G$, with G as unity gain of 1.

Appendix 9

Portable devices: EUT 2 and EUT 3:

The following formula was used to calculate the RF exposure SAR exclusion threshold,
 $Thld = [P_{out} / r] \times [\sqrt{f}]$

where,

Thld= SAR exclusion threshold

Pout = Peak output power, in mW

r = minimum test separation distance, in mm

f=frequency, in GHz

EUT	Frequency f, (GHz)	Peak output power Pout, (mW)	Distance r, (mm)	Exclusion threshold Thld	Limit Threshold 1-g SAR	Limit Threshold 10-g SAR
2	2.44	0.288	5	0.0012	< 3	< 7.5
3	2.44	0.288	5	0.0012	< 3	< 7.5

The maximum radiated peak output power from Appendix 3 was used for calculation.

EUT	EIRP Peak output power (dBm)	Peak output power (mW)
2	-5.4 Note 1	0.288
3	-5.4 Note 1	0.288

Note 1: The measurements were performed in field strength in dBμV/m. The EIRP level was then calculated by the formula $P = (Exd)^2 / 30 \times G$, with G as unity gain of 1.

Appendix 9

LimitsMobile devices: EUT 1:

(A) Limits for Occupational/Controlled Exposure

Frequency range (MHz)	Electric field strength [E] (V/m)	Magnetic field strength [H] (A/m)	Power density [S] (mW/cm ²)	Averaging time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency range (MHz)	Electric field strength [E] (V/m)	Magnetic field strength [H] (A/m)	Power density [S] (mW/cm ²)	Averaging time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f=frequency in MHz, *Plane-wave equivalent power density

According to RSS-102 2.5.1, SAR evaluation is required if the separation distance between the user and the radiating element of the device is less than or equal to 20 cm, except when the device operates as follows:

- above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled use;

Appendix 9

Portable devices: EUT 2 and EUT 3:

FCC- 2.1093 / KDB 447498 (ver 5 rev 1) 4.3.1:

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \times [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following,

a) $[\text{Power allowed at numeric threshold for 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \times (f(\text{MHz})/150)] \text{ mW}$, at 100 MHz to 1500 MHz

b) $[\text{Power allowed at numeric threshold for 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \times 10] \text{ mW}$ at > 1500 MHz and ≤ 6 GHz

RSS-102 2.5.1 Exemption from Routine Evaluation Limits – SAR Evaluation

SAR evaluation is required if the separation distance between the user and the radiating element of the device is less than or equal to 20 cm, except when the device operates as follows:

above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled use;

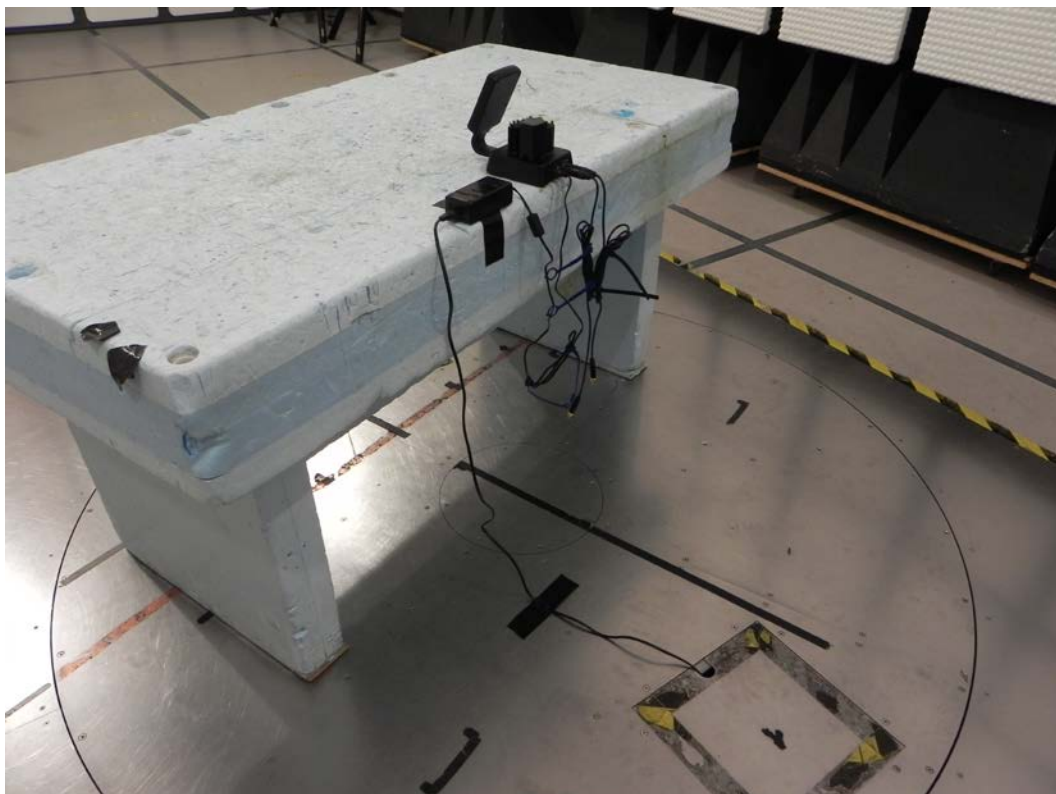
Complies?	Yes
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Appendix 10

Photos

The test set-up during all the radiated tests can be seen in the pictures below.

EUT 1, 30-1000 MHz:



Appendix 10

EUT 2, 30-1000 MHz, X-axis:

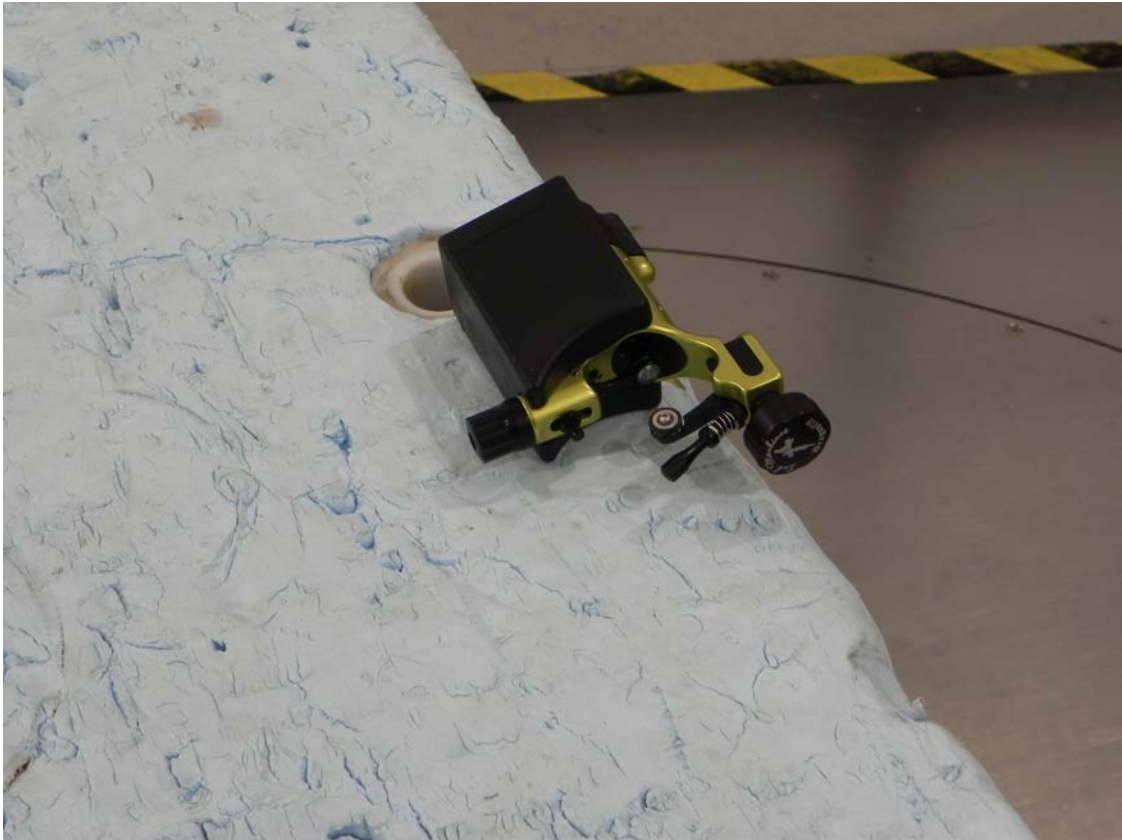


X-axis:

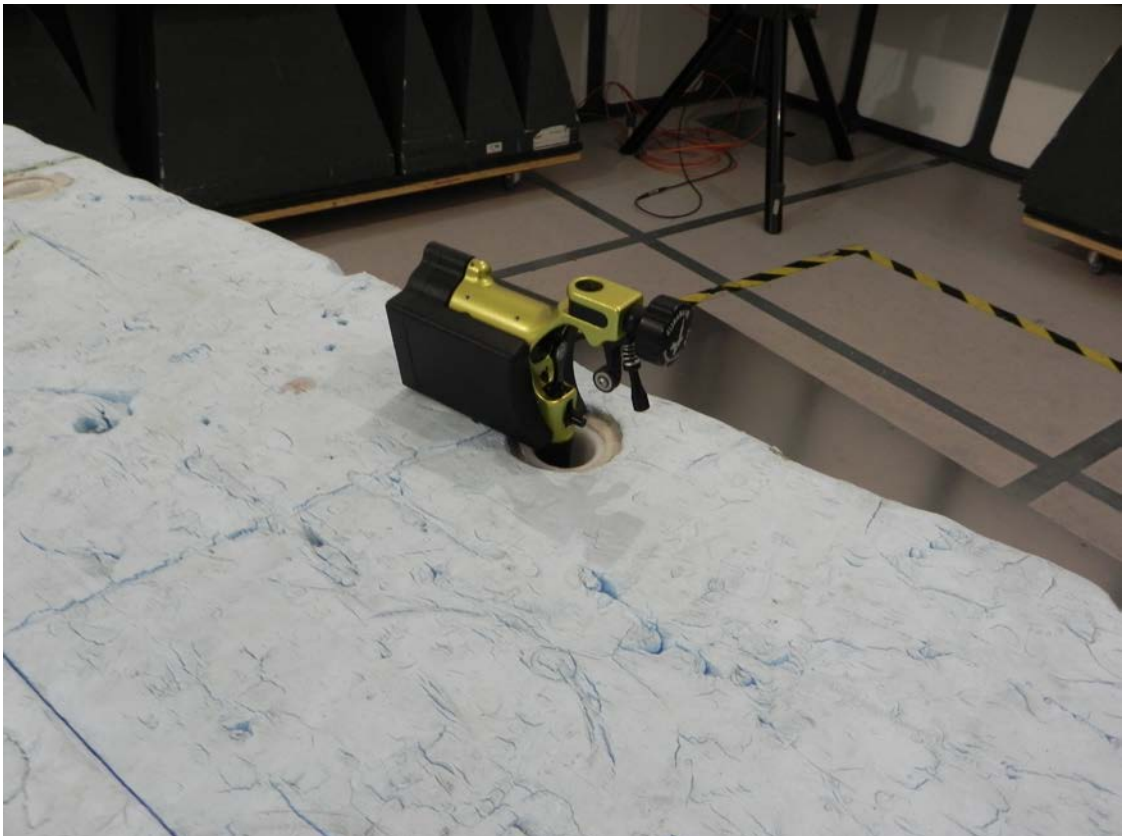


Appendix 10

Y-axis:

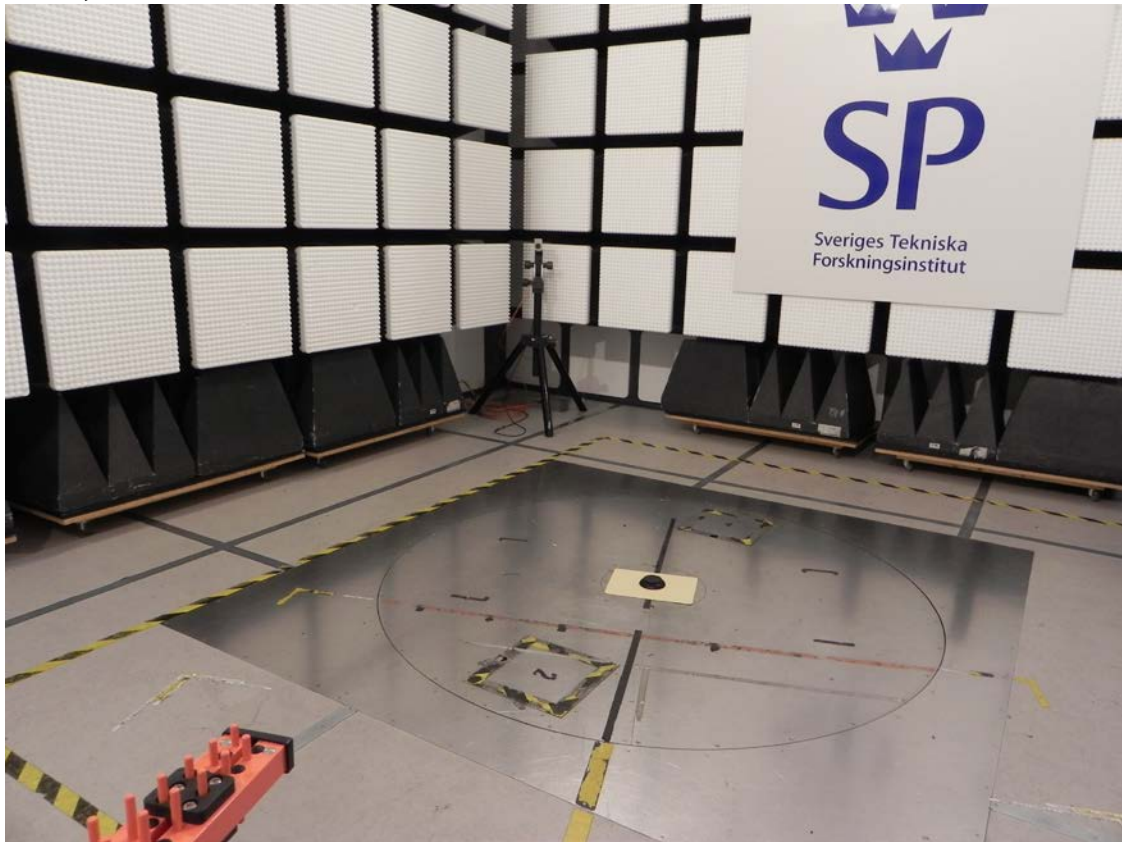


Z-axis:



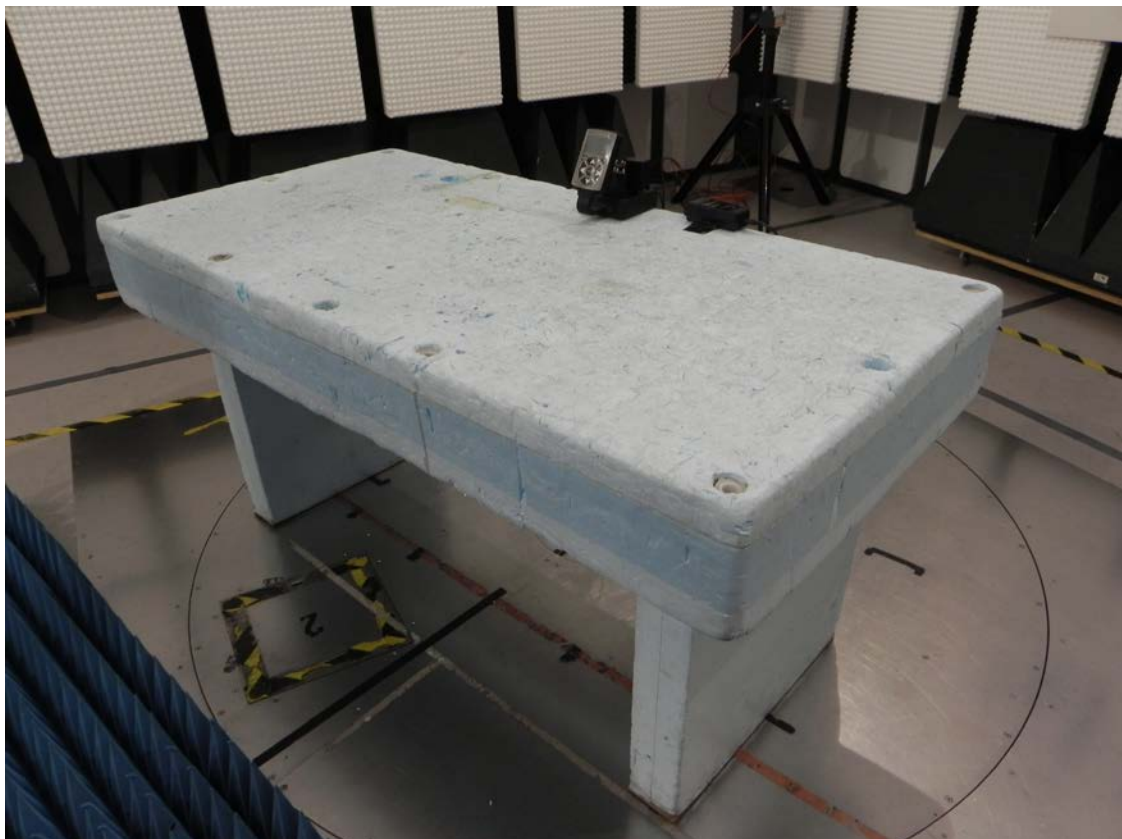
Appendix 10

EUT 3, 30-1000 MHz:



Appendix 10

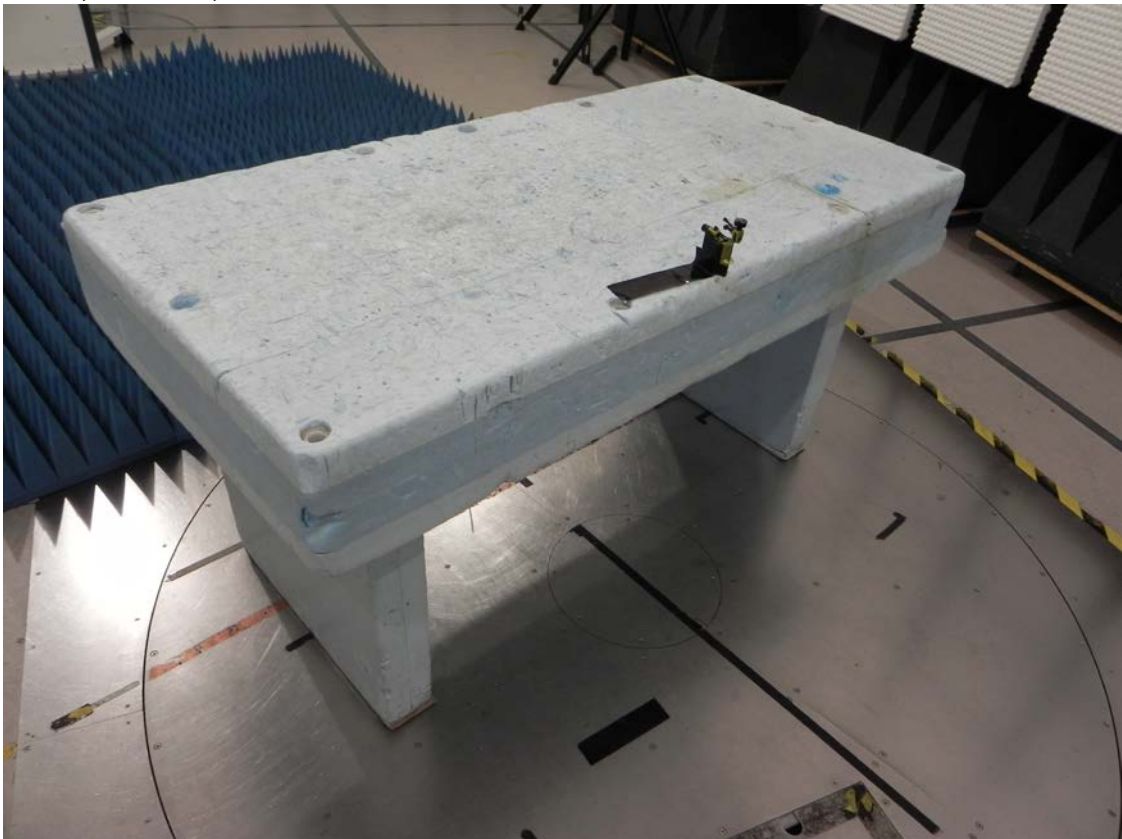
EUT 1, 1-8 GHz:



Appendix 10

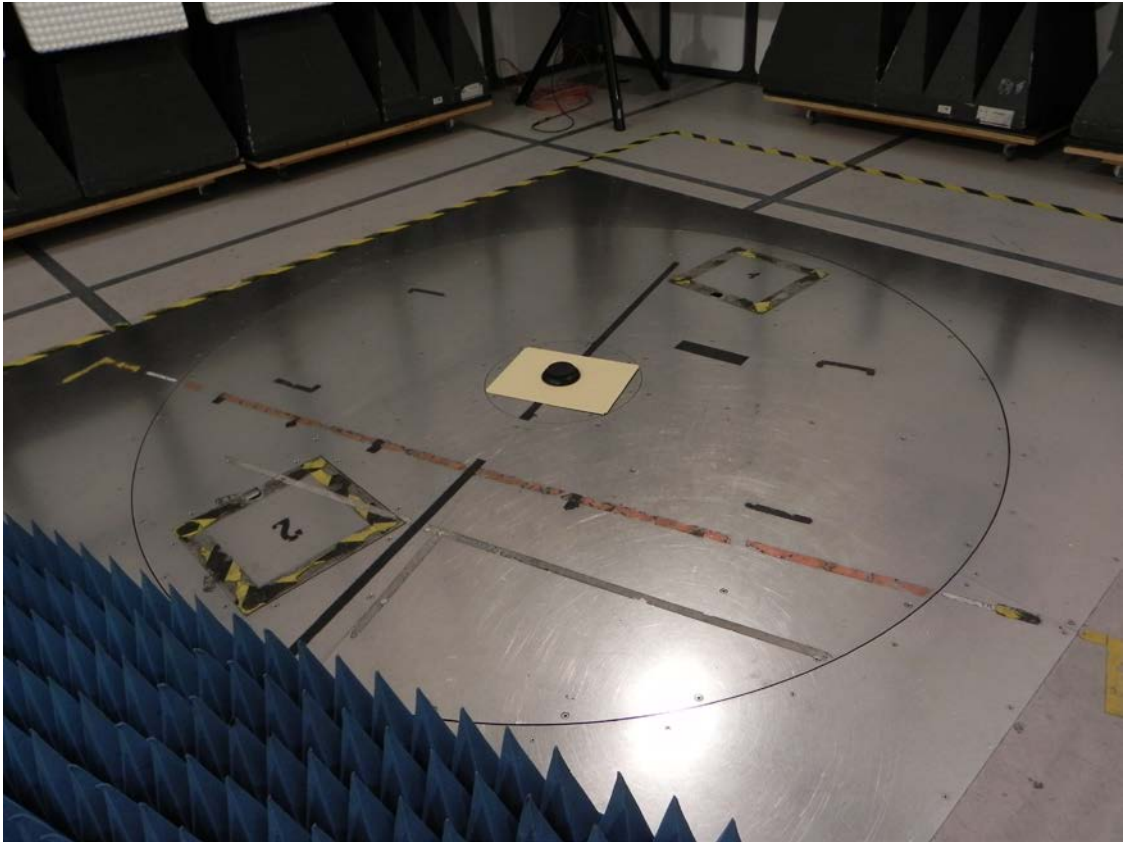


EUT 2, 1-12 GHz, X-axis:



Appendix 10

EUT 3, 1-12 GHz:

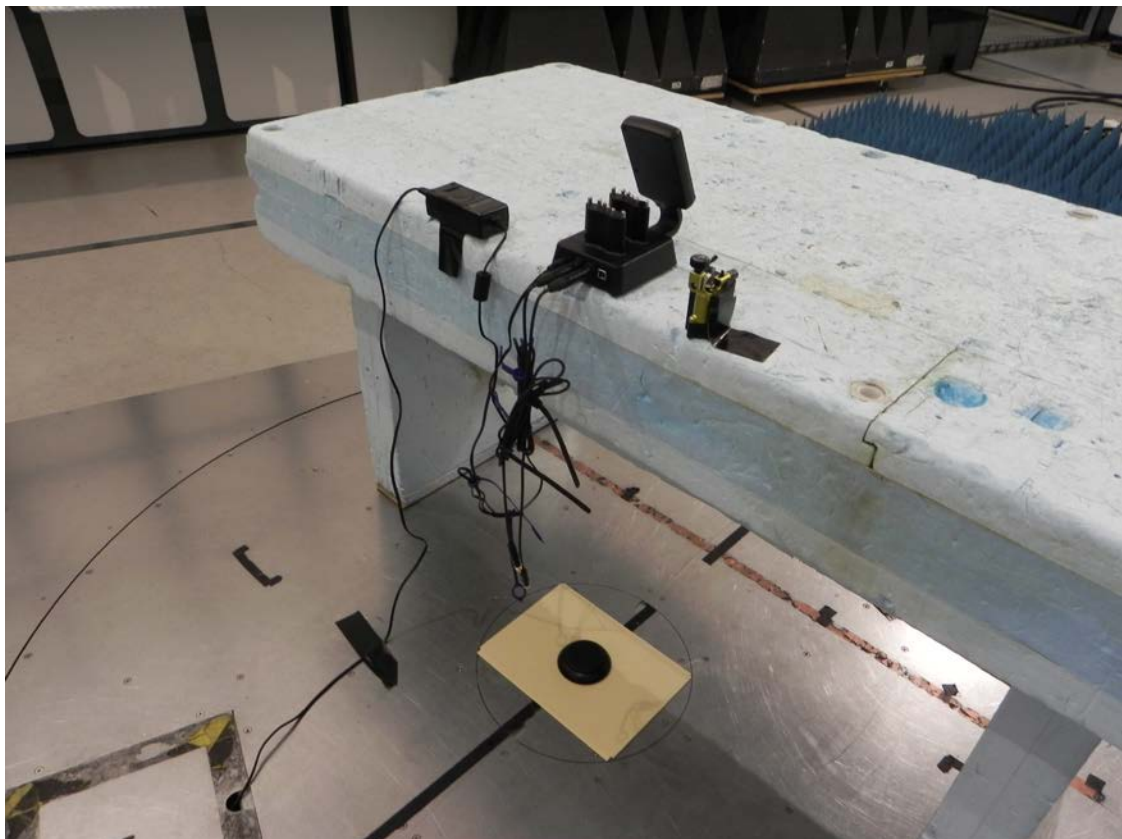


EUT 1, 8-12 GHz:



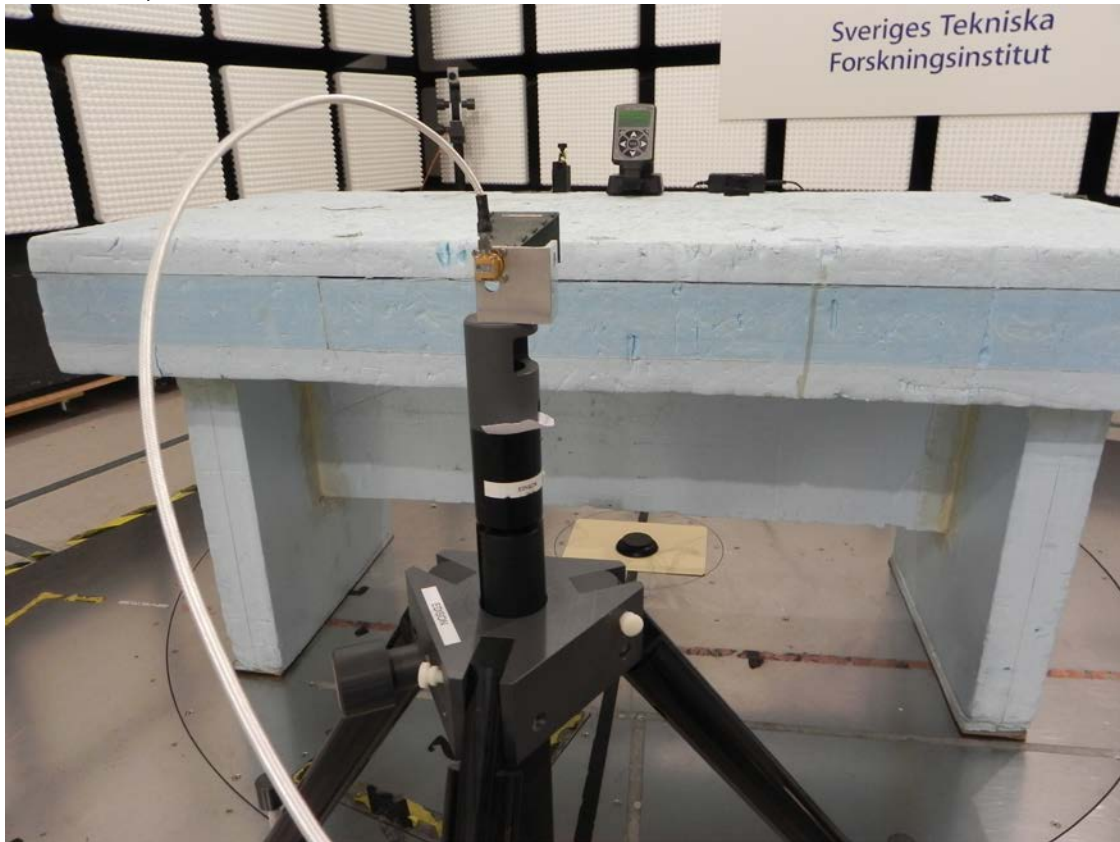
Appendix 10

EUT 1+2+3, 12-18 GHz:



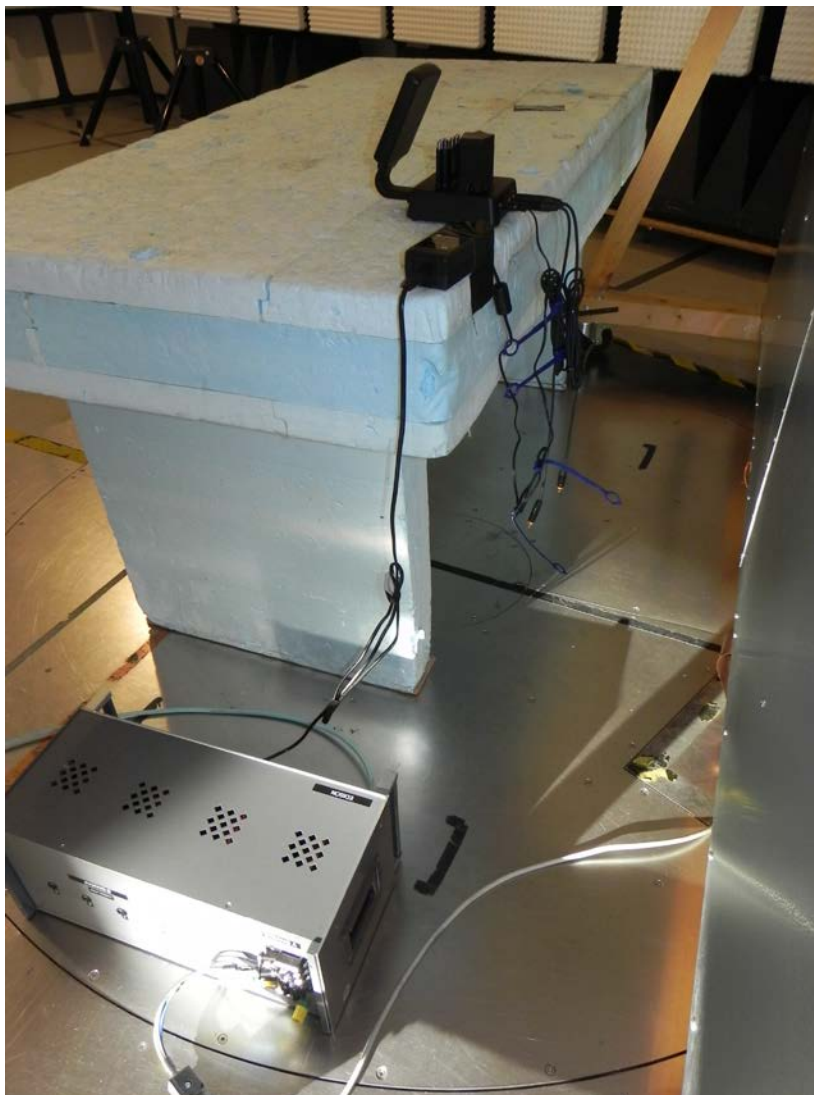
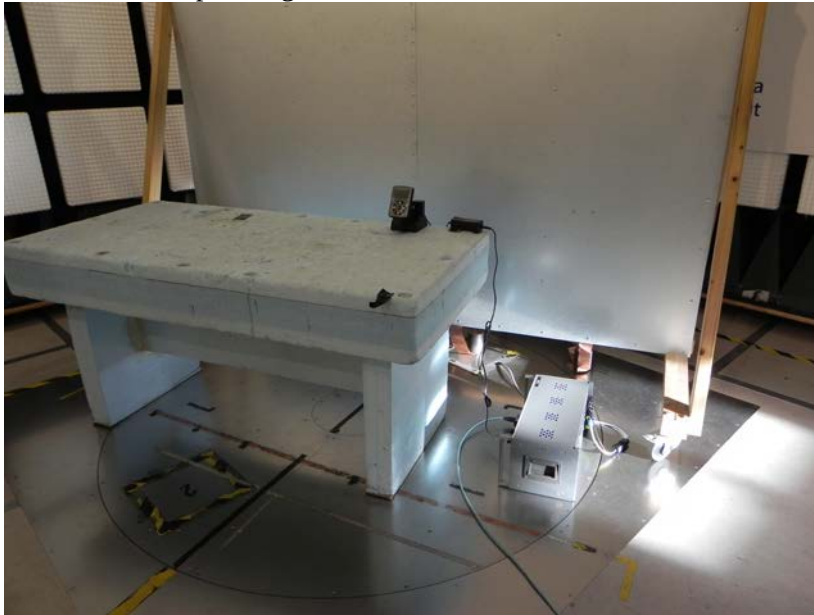
Appendix 10

EUT 1+2+3, 18-25 GHz:



Appendix 10

EUT 1 test set-up during the conducted AC emissions tests can be seen in the pictures below:



Appendix 10

EUT 1:



Appendix 10

EUT 2:



Appendix 10



Appendix 10

EUT 3:

