



REPORT

issued by an FCC listed Laboratory Reg. no. 93866.
The test site complies with RSS-Gen, Issue 2,
file no: IC 3482A-2

Date
2011-08-10

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FX112895-F15C

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Equipment Authorization measurements on 2400-2483.5 MHz Transceiver Unit with digital modulation and no FHSS FCC ID: X2OSPB800 IC: 8713A-SPB800 (5 appendices)

Test objects

Product name: SPB800.

Product number: Unit for radiated tests: SPB800-B, unit for conducted tests: SPB800-D (There is also a evaluation unit: SPB800-E).

Serial number: A000776 (unit for radiated test)
A000944 (unit for conducted tests).

The test objects were tested stand alone as a module and connected to a PC Connection board SPB406, s/n: 94, during the test. The PC Connection board was powered by USB (3.3 V DC) from a PC which was powered with 120 V AC/60 Hz.

Summary

See Appendix 1 for general information and Appendix 5 for photos.

This is not a complete test, emission measurements as specified below have been performed.

Standard	Compliant	Appendix	Remarks
FCC 47 CFR Part 15 C (October 2010)			
15.247 Operation within the band 2400-2483.5 MHz			
IC RSS-210 Issue 8, June 2010			
15.247 (b) (3)/ RSS-210 A8.4(4) Maximum peak conducted power	Yes	2	
15.247 (d) / RSS-210 A8.5 20 dBc below fundamental	Yes	3	
15.247 (d) / RSS-210 A8.5 Restricted bands of operation	Yes	3	
2.1049 / RSS-210 A8.5 Band Edge	Yes	4	

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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FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 1

Performance test and requirements

The tests were performed to verify that SPB800 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 object

Transceiver:	SPB800
Antenna:	Chip antenna, Murata LDA312G7313F-237
Antenna gain (average) :	-2.3 dBi
Frequency range:	2412-2462 MHz
Frequencies used during test:	2412 MHz 2442 MHz 2462 MHz
Modulation:	OFDM
Data rate:	6 Mbit/s
Supply voltage:	3.3 V DC, via USB

The test objects were tested stand alone as a module and connected to an PC Connection board SPB406, s/n: 94, during the test. The PC Connection board was powered by USB (3.3 V DC) from a PC which was powered with 120 V AC/60 Hz.

PC laptop Acer Extensa 5230E with s/w: RF test software.

The PC was placed outside the anechoic chamber during the test.

Preliminary testing was performed at mid channel (2442 MHz) and all data rates (modulations). The measurements were then done at 6 Mbit/s mode since this mode had the highest conducted output power. See Appendix 2.

Measurement equipment

Measurement equipment	Calibration Due	SP number
Test site Edison	2011-12	504 114
EMI test receiver R&S ESIB 26	2012-07	503 885
Boonton RF Peak power meter 4500A	2011-10	503 144
Boonton Peak power sensor 56518-S/4	2011-10	503 145
Bilog antenna Chase CBL 6111A	2011-11	503 182
Antenna Schaffner CBL 6143	2013-04	504 079
Horn antenna EMCO 3115	2014-01	501 548
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	2012-08	503 277
Low Noise Amplifier Miteq	2012-08	504 160
High pass filter Wainwright WHKX	2012-08	504 200
120 V AC/60 Hz Power source Emtest Netwave	2012-04	900 681
Multimeter Fluke 85 III 625	2012-05	503 418
Temperature and humidity meter Testo 625	2012-05	504 117

Operational test mode

The following were set in the s/w RF test software, if not otherwise stated.

Rate: 6 Mbit/s (the rate with the highest output power, see Appendix 2)

Tx gain (output power): MAX

Idle time: 0

Number of frames: INF (continuous transmission)

Frame length: 1536 (default=1024)

Tx generate pattern: PRBS9 (9-bits Pseudo Random Bit Sequence)

For duty cycle measurements see appendix 2.

With the setting above the duty cycle was measured to $2.11/2.26 \text{ ms} = 0.934 = 93.4\%$.

The PRF was calculated to $PRF = 1/T = 1/2.26 \text{ ms} = 442 \text{ Hz}$, broad band, "pulse spectrum", $RBW > PRF = 1/T$.

$1/\tau = 1/2.11 \text{ ms} = 473 \text{ Hz}$, $1/\tau < RBW$.

Cabling during emission test:

EUT port	Cable type	Termination / use
USB	Multi-wire, shielded, 5.0 m length	Connected to the PC laptop

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 AC emission	3.5 dB

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

Reservation

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

Delivery of test object

The test objects were delivered on the 2011-07-16 and 2011-08-09.

Test engineers

Fredrik Isaksson, SP
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FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 2

Maximum peak conducted output power measurements according to FCC 47 CFR part 15.247 (b) (3)/ RSS-210 A8.4(4)

Date	Temperature	Humidity
2011-08-08	22 °C ± 3 °C	55 % ± 5 %
2011-08-12	21 °C ± 3 °C	49 % ± 5 %

Test set-up and procedure

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

Conducted measurements were performed at the antenna connector and with continuous transmission and with modulation.

Measurement equipment	SP number
Test site Edison	-
Boonton RF Peak power meter 4500A	503 144
Boonton Peak power sensor 56518-S/4	503 145
120 V AC/60 Hz Power source Emtest Netwave	900 681
DC power supply Agilent E3631A	503 997
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	504 117

Measurement uncertainty: 0.7 dB

Results

Duty cycle measurements can be found in the diagrams below:

Diagram 1:	2442 MHz, Tx on, 6 Mbit/s, Frame length=1536 (-> duty cycle 93.4 %)
Diagram 2:	2442 MHz, Period time, 6 Mbit/s, Frame length=1536 (-> duty cycle 93.4 %)

Preliminary test, 2442 MHz, conducted output power vs. data rates (modulation). The Frame length was 1024 byte (-> duty cycle 76.9 % for 6 Mbit/s) during this test:

Data rate (modulation)	Peak detector, dBm
DPSK, 1 Mbit/s	17.5
QDPSK, 2 Mbit/s	17.4
CCK/DPSK, 5.5 Mbits/s	17.4
OFDM, 6 Mbits/s	19.9
OFDM, 9 Mbit/s	19.9
OFDM, 12 Mbit/s	19.8
OFDM, 18 Mbit/s	19.6
OFDM, 24 Mbit/s	19.9
OFDM, 36 Mbit/s	19.8
OFDM, 48 Mbit/s	19.8
OFDM, 54 Mbit/s	19.9

Final test, 6 Mbit/s, Frame length=1536

		Max peak output power Peak/Average (dBm)		
		2412 MHz	2442 MHz	2462 MHz
T _{nom} 21°C	V _{nom} 3.300 V DC	20.7/13.5	19.8/12.7	19.2/12.4
T _{nom} 23°C	V _{min} 2.805 V DC Note 1	18.7/11.2	17.7/10.5	17.3/10.4
T _{nom} 21°C	V _{max} 3.795 V DC Note 1	21.1/11.7	20.1/11.1	19.7/11.0

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.

Limits

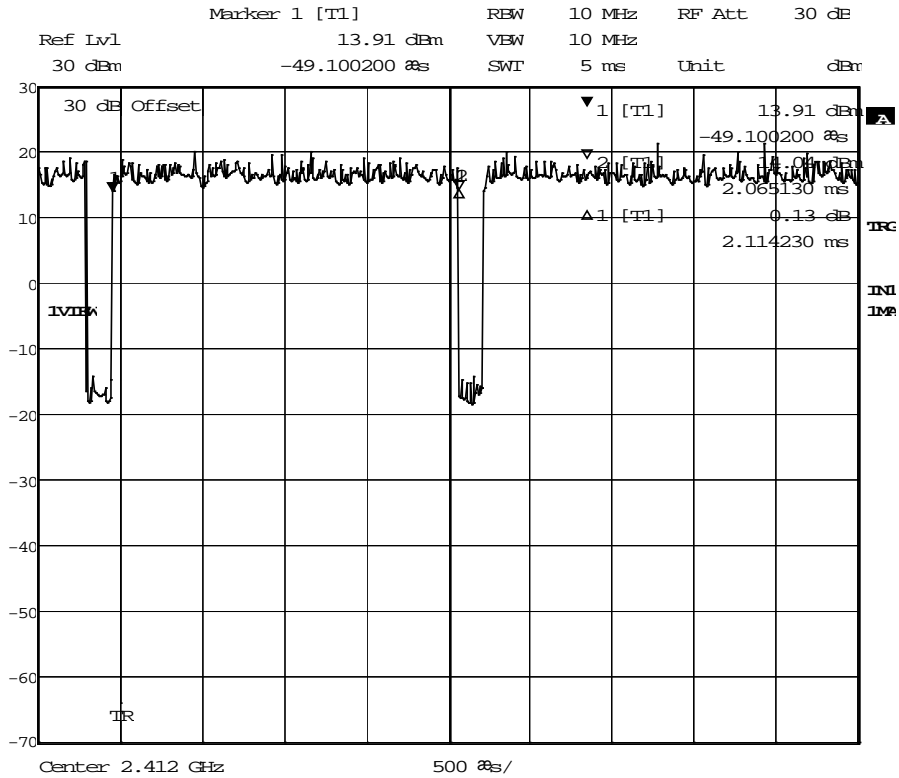
According to 47CFR 15.247(b)(3) and RSS-210 A8.4(4), for systems using digital modulation in the 2400-2483.5 MHz band: 1 Watt (30 dBm).

Complies?	Yes
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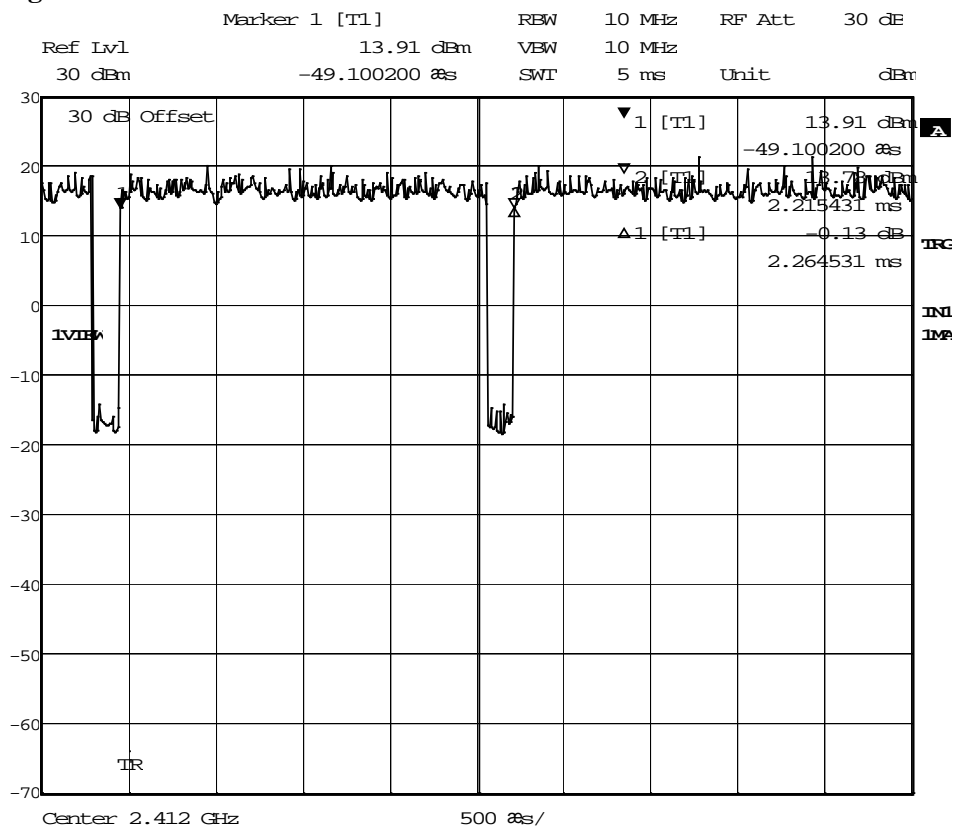
Appendix 2

Diagram 1



Date: 8.AUG.2011 11:12:58

Diagram 2



Date: 8.AUG.2011 11:14:11

20 dBc below fundamental and restricted bands of operation measurements according to FCC 47 CFR part 15.247 (d) / RSS 210-210 A8.5

Date	Temperature	Humidity
2011-08-08	22 °C ± 3 °C	55 % ± 5 %
2011-08-09	22 °C ± 3 °C	54 % ± 5 %
2011-08-10	23 °C ± 3 °C	50 % ± 5 %
2011-08-11	21 °C ± 3 °C	50 % ± 5 %

Test set-up and procedure

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

The test was performed with continuous transmission (93.4 % 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 during frequencies below 18 GHz and 1.0 m during frequencies above 18 GHz.

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.
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 during the tests can be found in Appendix 5.

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Appendix 3

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
Spectrum analyzer R&S ESI 26	503 885
EMI measurement computer	-
Software: R&S EMC32, ver. 8.51.0	503 745
Antenna Schaffner Bilog CBL6143	504 079
Horn antenna EMCO 3115	501 548
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	503 277
Low Noise Amplifier Miteq	504 160
Preamplifier Miteq, 1 18 GHz	504 160
High pass filter Wainwright WHKX	504 120
120 V AC/60 Hz Power source Emtest Netwave	900 681
Temperature and humidity meter Testo 625	504 117

Results

The pre-measurement emission spectra for the worst case configuration can be found in the diagrams below:

Diagram 1:	Ambient, 30-1000 MHz vertical and horizontal polarization
Diagram 2:	Ambient, 1-8.2 GHz vertical and horizontal polarization
Diagram 3:	30-1000 MHz, 2442 MHz, vertical and horizontal polarization
Diagram 4:	1-3 GHz, 2412 MHz, vertical and horizontal polarization
Diagram 5:	3-8.2 GHz, 2442 MHz, vertical and horizontal polarization
Diagram 6:	8.2-12 GHz, 2442 MHz, vertical and horizontal polarization
Diagram 7:	12-18 GHz, 2442 MHz, vertical and horizontal polarization
Diagram 8:	18-25 GHz, 2442 MHz, vertical polarization
Diagram 9:	18-25 GHz, 2462 MHz, horizontal polarization

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Appendix 3

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

2412 MHz

Frequency (MHz)	QP level (dB μ V/m)	AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
2406.763	N/A	82.1	93.1 *)	31.8	Carrier	3.06	225	Horizontal
4826.082	N/A	38.7	53.4	-10.1	54 (Av)	1.08	174	Vertical
9648.000	N/A	40.7	44.9	-15.7	62.8 (20 dBc)	1.05	243	Horizontal
19295.766	N/A	52.6	57.1	3.1	64 (Av) (**)	1.00	259	Vertical

*) With RBW 100 kHz the peak level was 82.8 dB μ V/m.

***) The tests in the frequency range 18-25 GHz was performed at 1.0 m antenna distance.

2442 MHz

Frequency (MHz)	QP level (dB μ V/m)	AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
42.496	27.6	N/A	-	16.7	20 dBc	1.00	56	Vertical
73.265	23.6	N/A	-	7.9	40 (QP)	1.37	0	Vertical
112.630	17.9	N/A	-	12.2	43.5 (QP)	1.32	0	Vertical
13.524	19.4	N/A	-	12.9	43.5 (QP)	1.00	151	Vertical
2436.884	N/A	79.4	90.5 *)	31.8	Carrier	1.30	4	Vertical
4882.234	N/A	39.8	55.8	-10.1	54 (Av)	1.05	173	Vertical
7329.469	N/A	32.6	-	-3.5	54 (Av)	1.55	307	Horizontal
9768.040	N/A	39.6	43.7	-15.7	58.6 (20 dBc)	1.00	248	Horizontal
19535.947	N/A	53.4	56.8	3.1	64 (Av) (**)	1.00	271	Vertical

*) With RBW 100 kHz the peak level was 78.6 dB μ V/m.

***) The tests in the frequency range 18-25 GHz was performed at 1.0 m antenna distance.

2462 MHz

Frequency (MHz)	QP level (dB μ V/m)	AV level (dB μ V/m)	Peak level (dB μ V/m)	Corr (dB)	Limit (dB μ V/m)	Height (m)	Azimuth (deg)	Polarization
2458.447	N/A	80.9	91.7 *)	31.9	(Carrier)	2.85	226	Horizontal
4921.974	N/A	39.5	54.5	-10.1	54 (Av)	1.00	172	Vertical
7384.980	N/A	33.5	-	-3.2	54 (Av)	1.46	307	Horizontal
9848.000	N/A	40.3	45.7	-15.7	60.3 (20 dBc)	1.03	243	Horizontal
19696.002	N/A	54.4	57.2	3.1	64 (Av) (**)	1.00	224	Vertical

*) With RBW 100 kHz the peak level was 80.3 dB μ V/m.

***) The tests in the frequency range 18-25 GHz was performed at 1.0 m antenna distance.



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IC: 8713A-SPB800

Appendix 3

Limits

According to 47CFR 15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

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 A8.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Complies?	Yes
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FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 3

Diagram 1

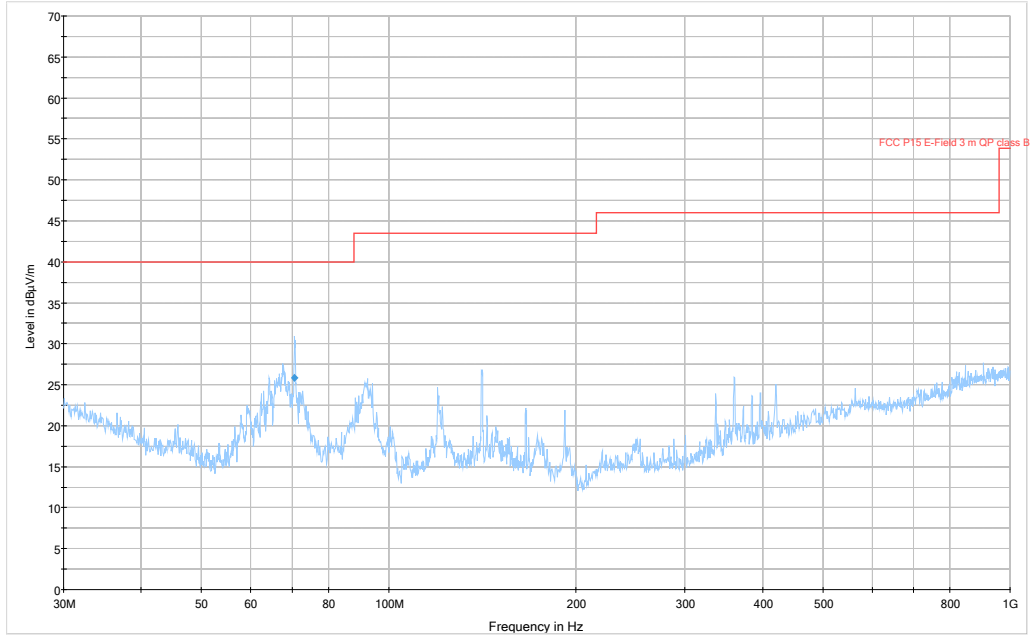
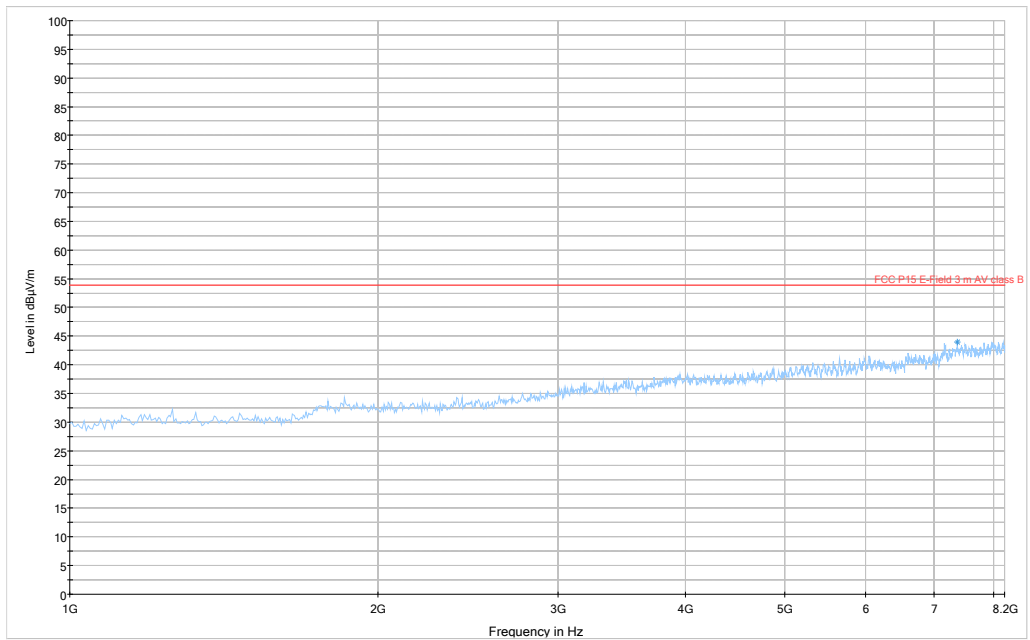


Diagram 2



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 3

Diagram 3

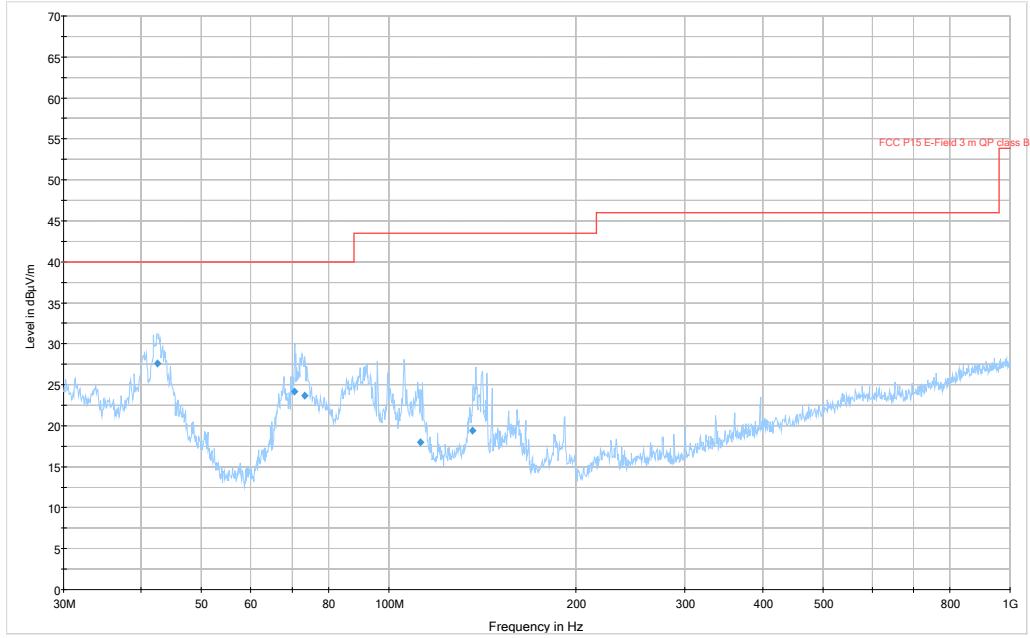
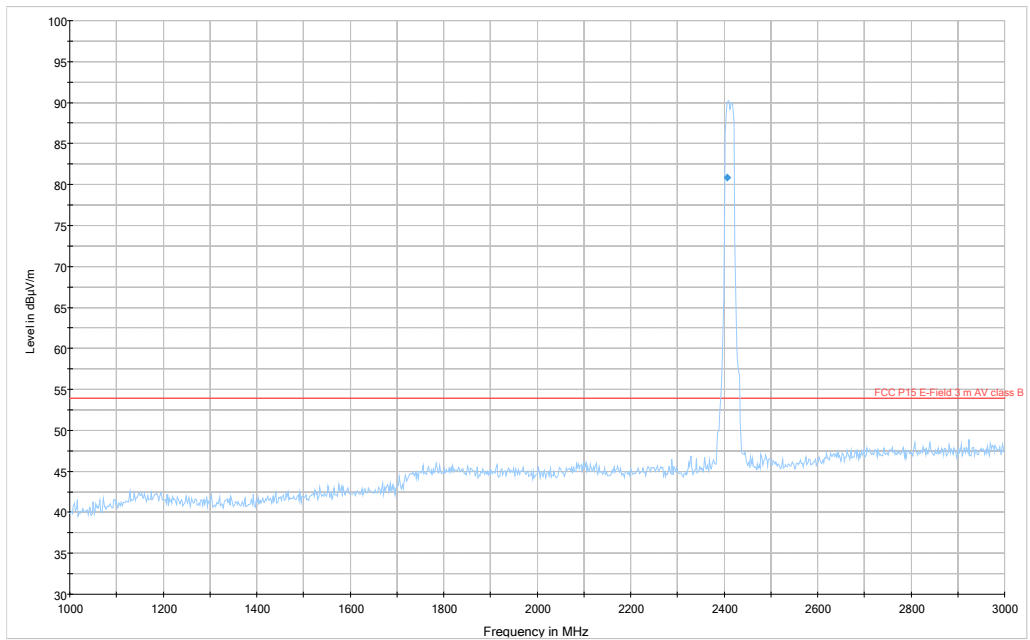


Diagram 4



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 3

Diagram 5

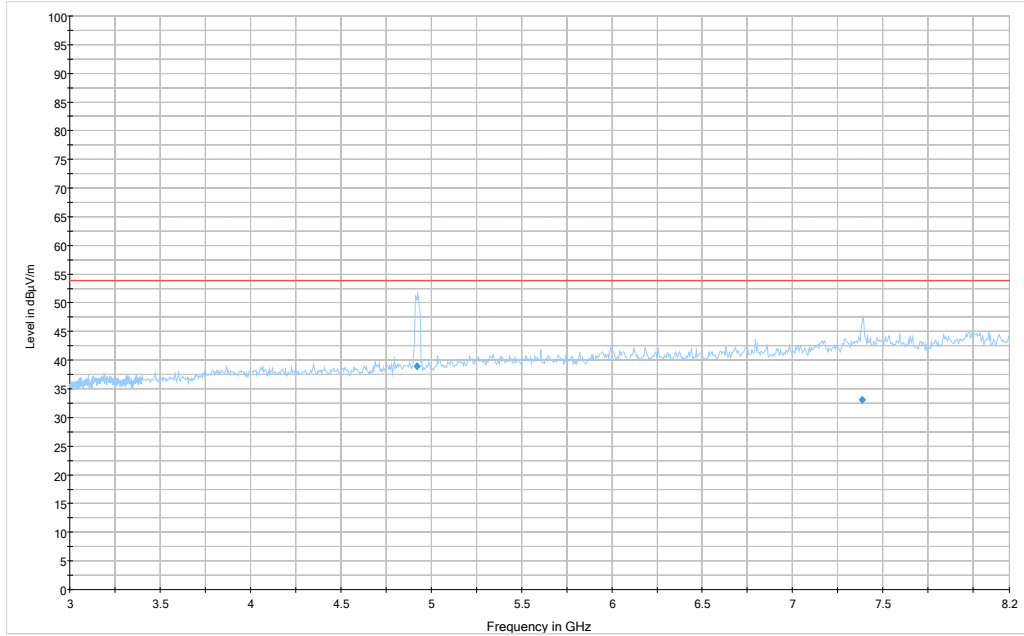
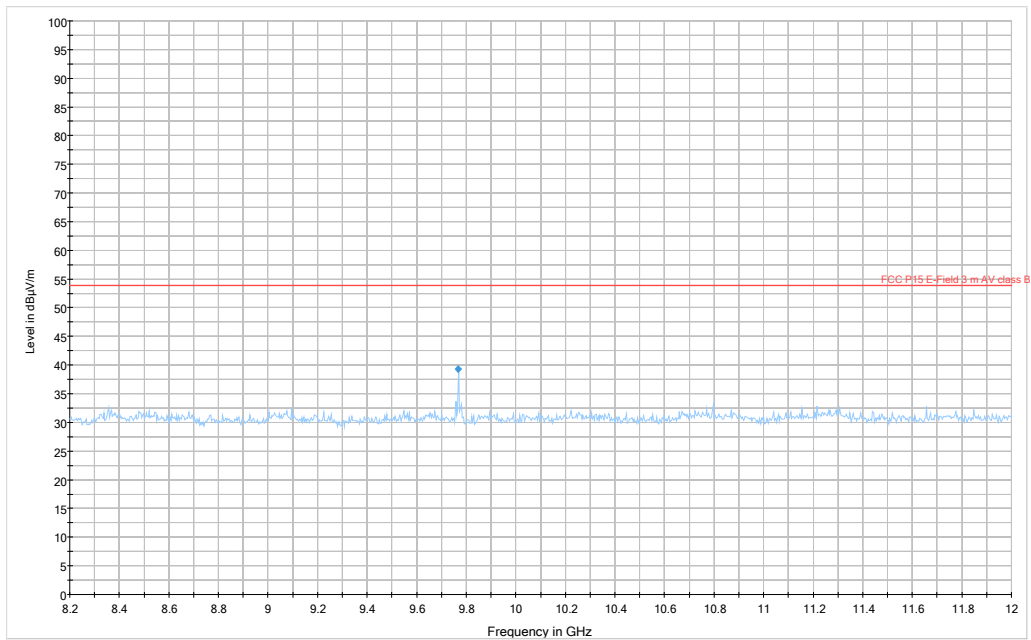


Diagram 6



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 3

Diagram 7

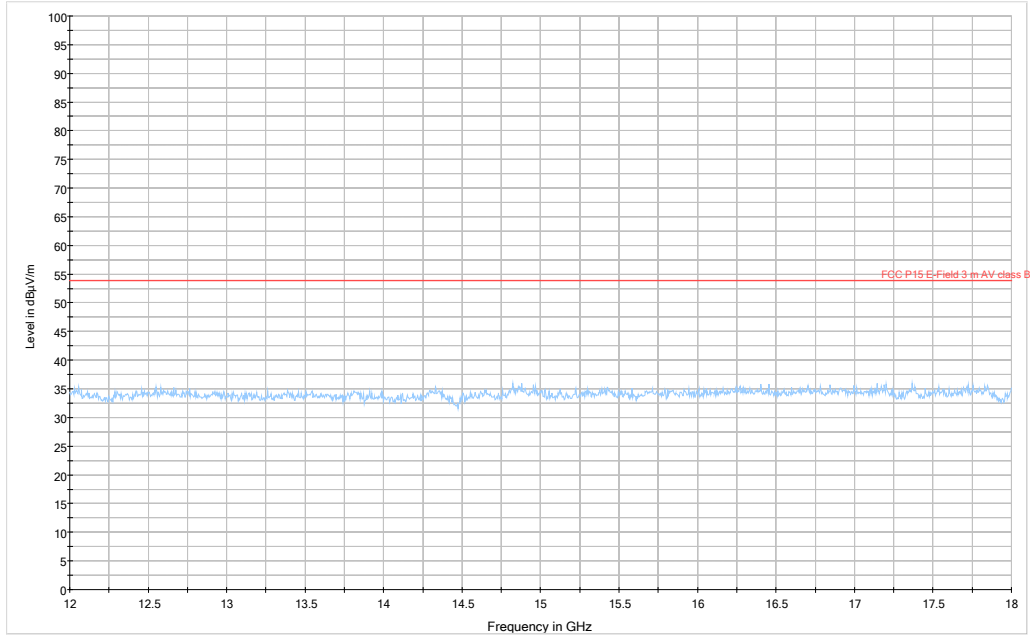
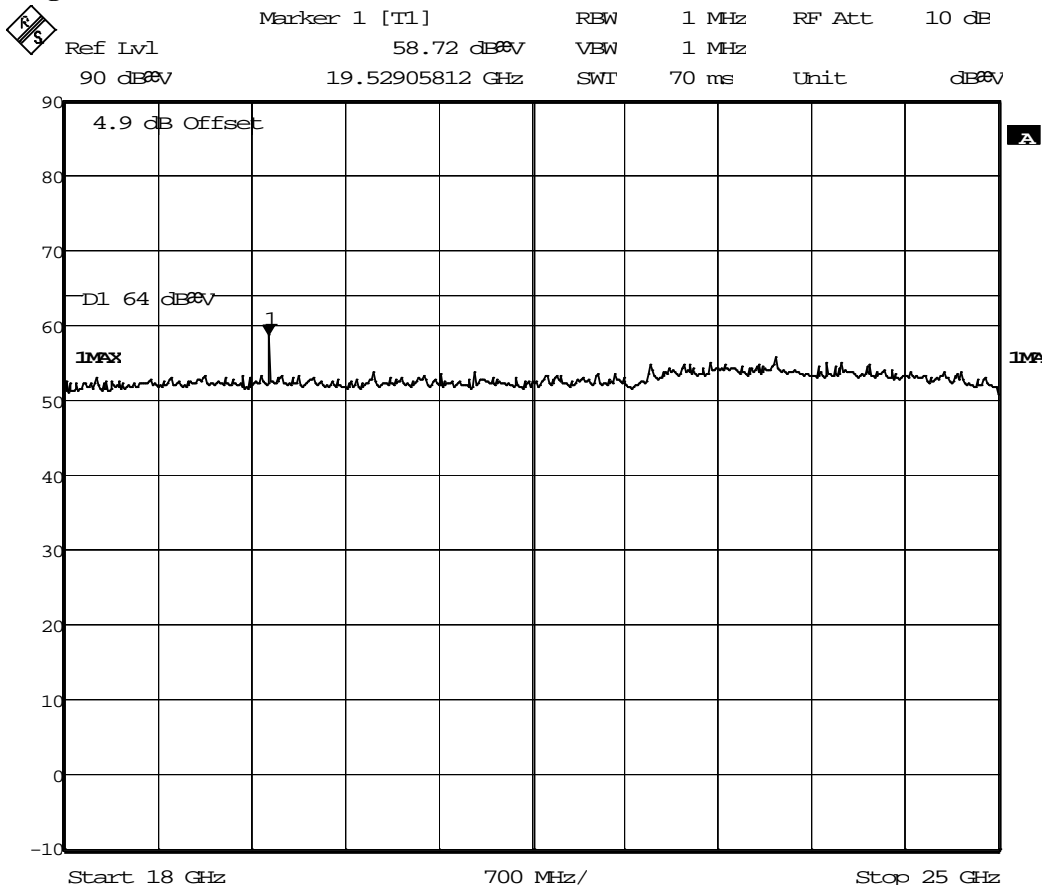


Diagram 8

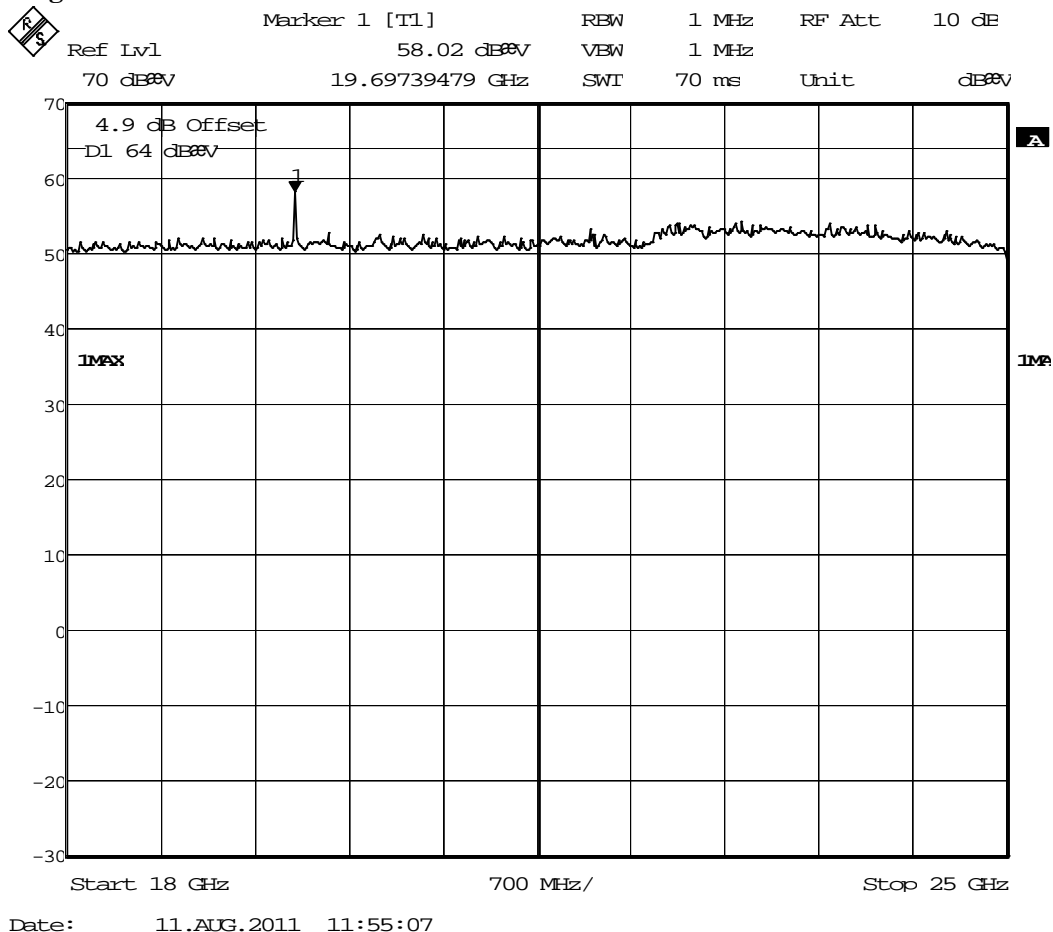


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IC: 8713A-SPB800

Appendix 3

Diagram 9



Band edge measurements according to 47CFR 2.1049 / RSS-210 A8.5

Date 2011-08-10	Temperature 23 °C ± 3 °C	Humidity 50 % ± 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 (93.4 % duty cycle) and with normal modulation.

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

The measurement was scanned with PEAK-detector with the antenna height 1-4 m and the turntable was varied between 0-360 degrees for maximum response, see Appendix 2. The antenna distance during the measurements was 3.0 m.

Test set-up photos during the tests can be found in Appendix 5.

Measurement equipment	SP number
Semi anechoic chamber, Edison	504 114
Spectrum analyzer R&S ESI 26	503 885
EMI measurement computer	-
Software: R&S EMC32, ver. 8.51.0	503 745
Horn antenna EMCO 3115	501 548
120 V AC/60 Hz Power source Emtest Netwave	900 681
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

Diagram 1	2412 MHz	Band edge at 2400 MHz (20 dBc)
Diagram 2	2412 MHz	Band edge at 2390 MHz (restricted band)
Diagram 3	2462 MHz	Band edge at 2483.5 MHz (restricted band)

Final measurements:

2412 MHz

Frequency (MHz)	AV level (dB μ V/m)	Peak level (dB μ V/m)	AV Limit (dB μ V/m)	Peak Limit (dB μ V/m)	dBc, peak det (limit=20dBc)	Polarization
2390.00 *)	36,8	55.0	54.0	74.0	N/A	Horizontal
2400.00 **)	N/A	N/A	N/A	N/A	30.0	Horizontal

*) Restricted band

***) 20 dBc

2462 MHz

Frequency (MHz)	AV level (dB μ V/m)	Peak level (dB μ V/m)	AV Limit (dB μ V/m)	Peak Limit (dB μ V/m)	dBc, peak det (limit=20dBc)	Polarization
2483.50 *)	38.6	60.7	54.0	74.0	N/A	Horizontal

*) Restricted band

Limits

Band edge at 2400 MHz:

According to 47CFR 15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating , 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Band edge at 2390 and 2483.5 MHz:

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

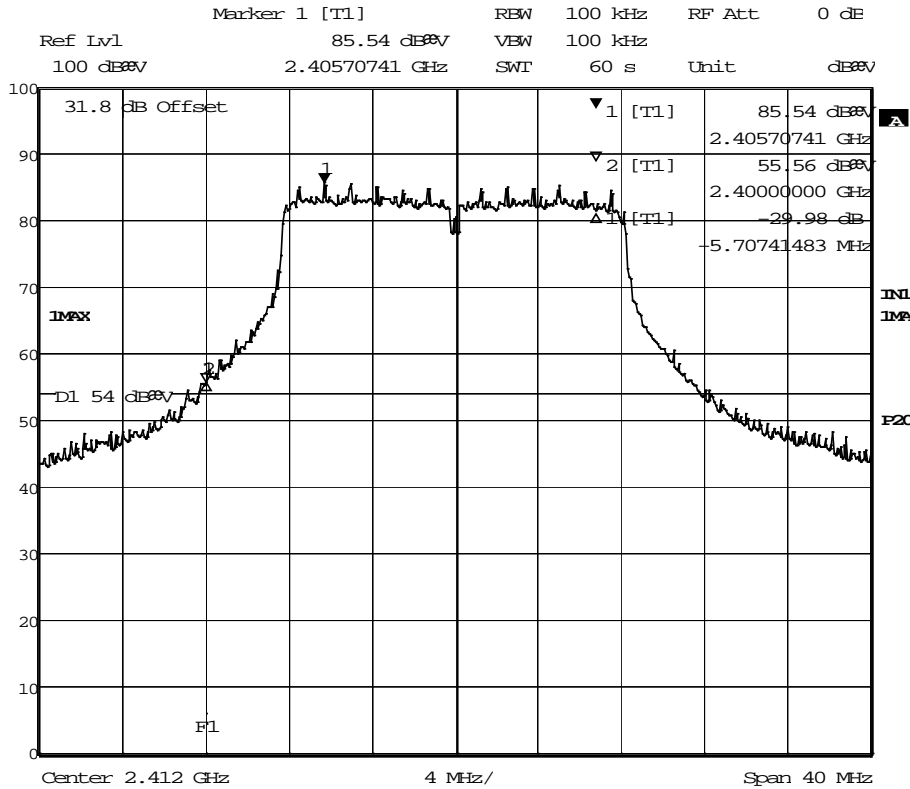
According to RSS-210 A8.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Complies?	Yes
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FCC ID: X2OSPB800 and
IC: 8713A-SPB800

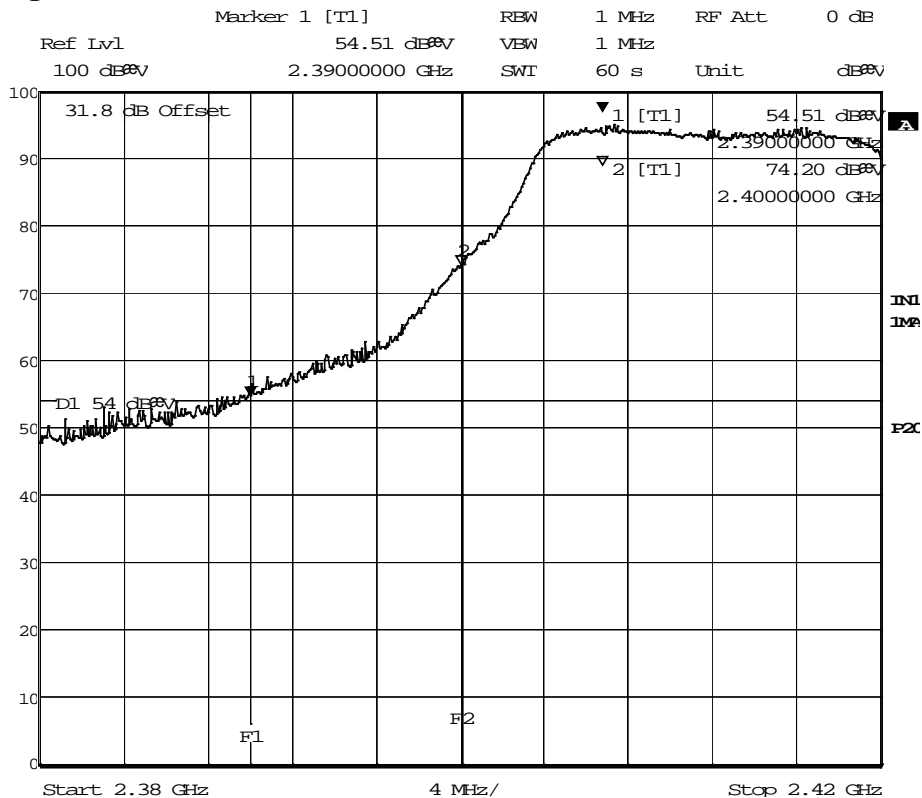
Appendix 4

Diagram 1



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Diagram 2

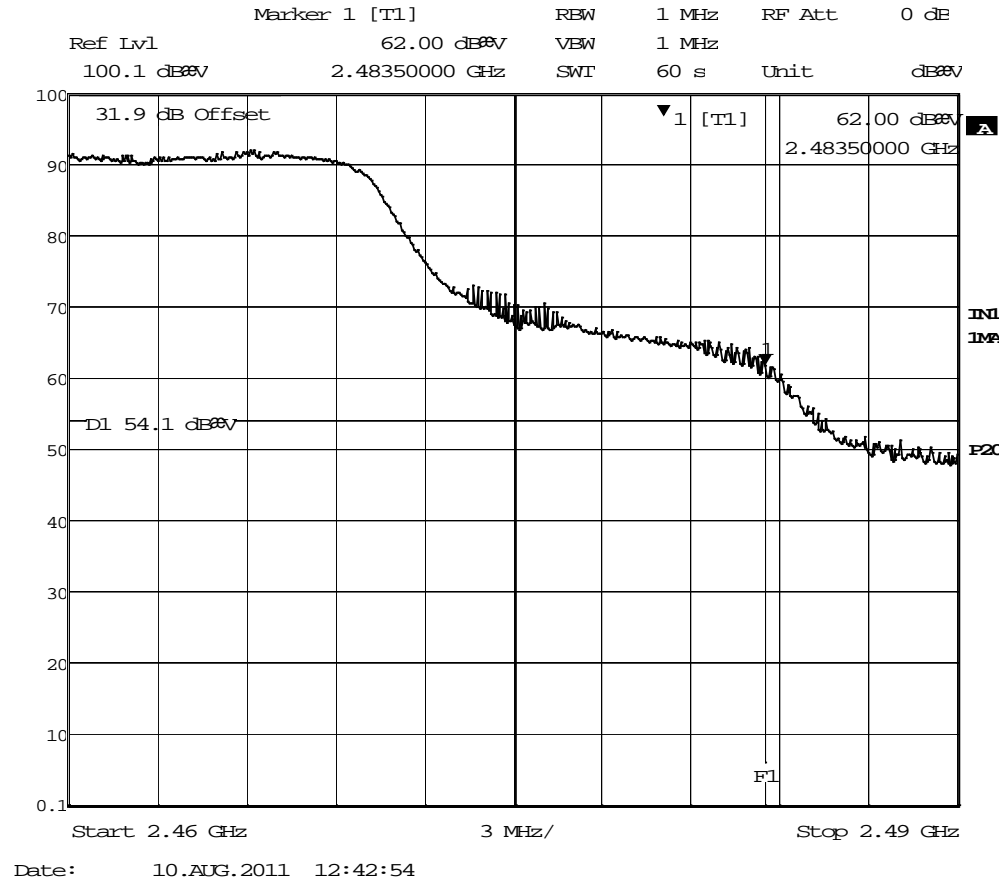


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FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 4

Diagram 3



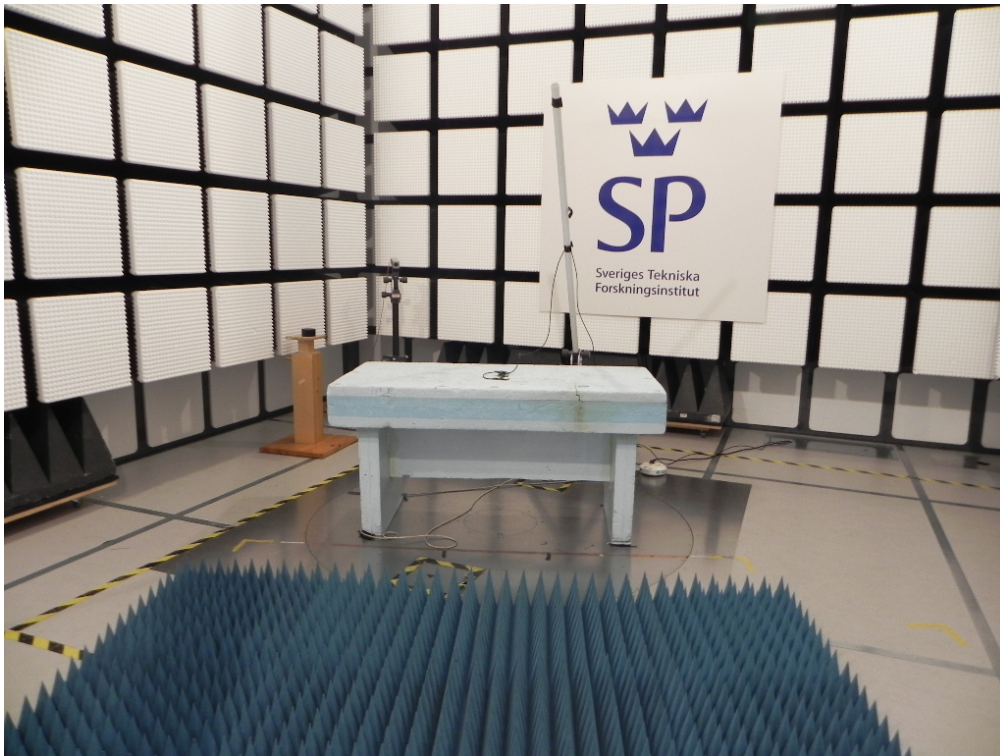
FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5

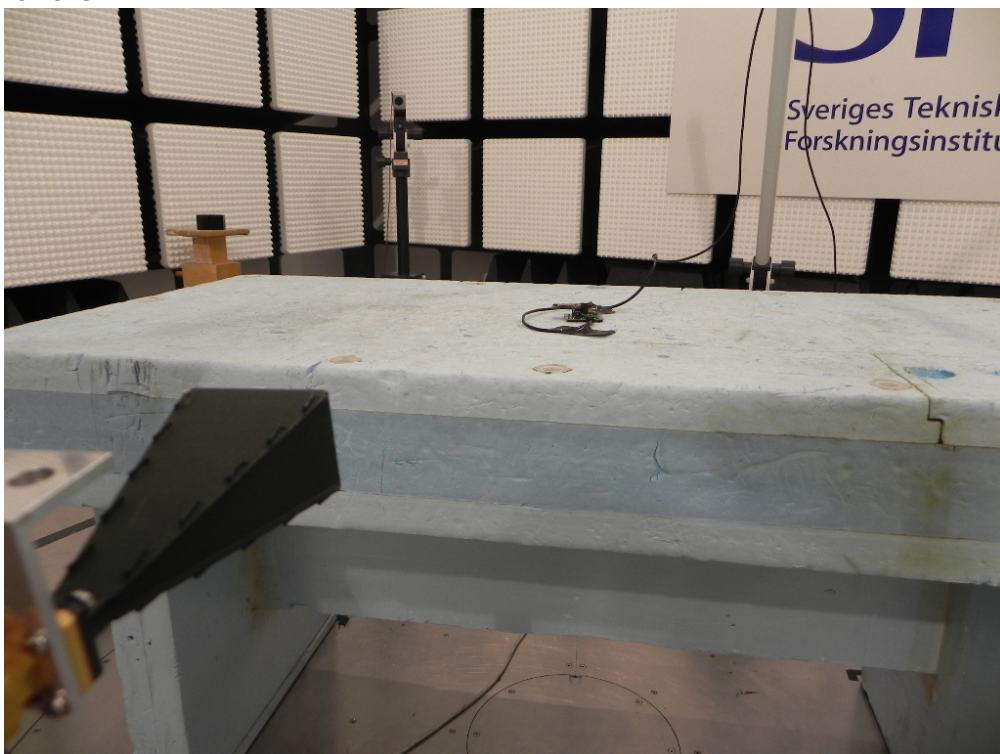
Photos

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

1-18 GHz



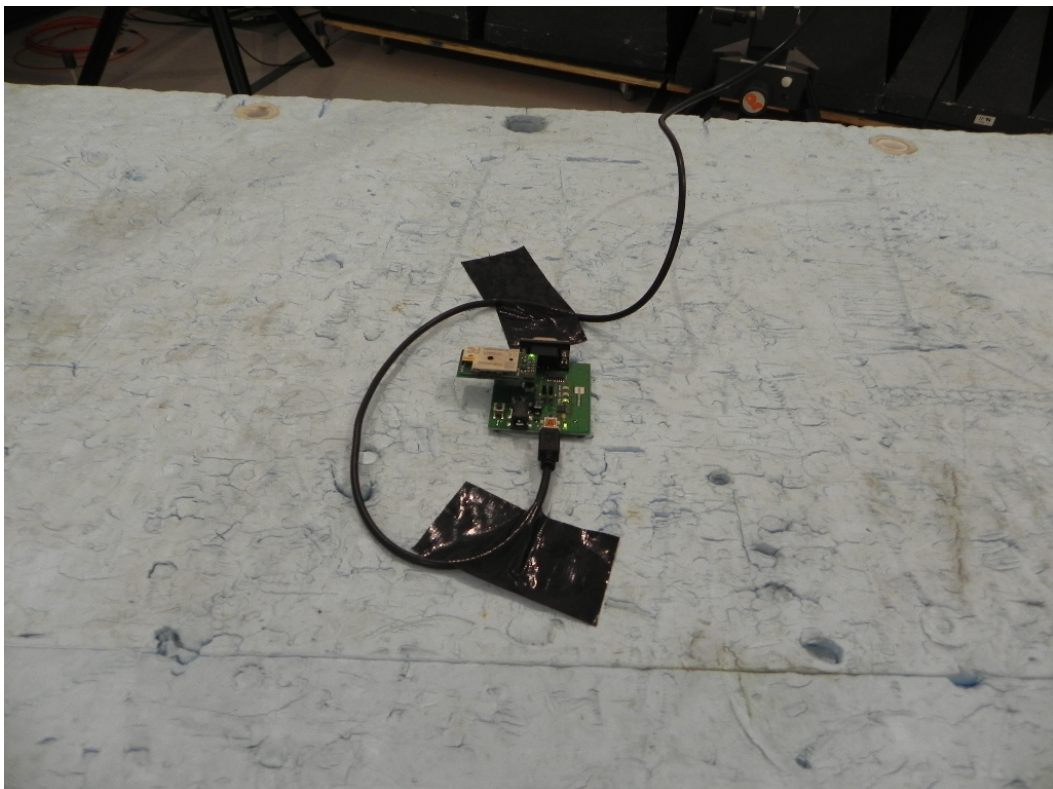
18-25 GHz



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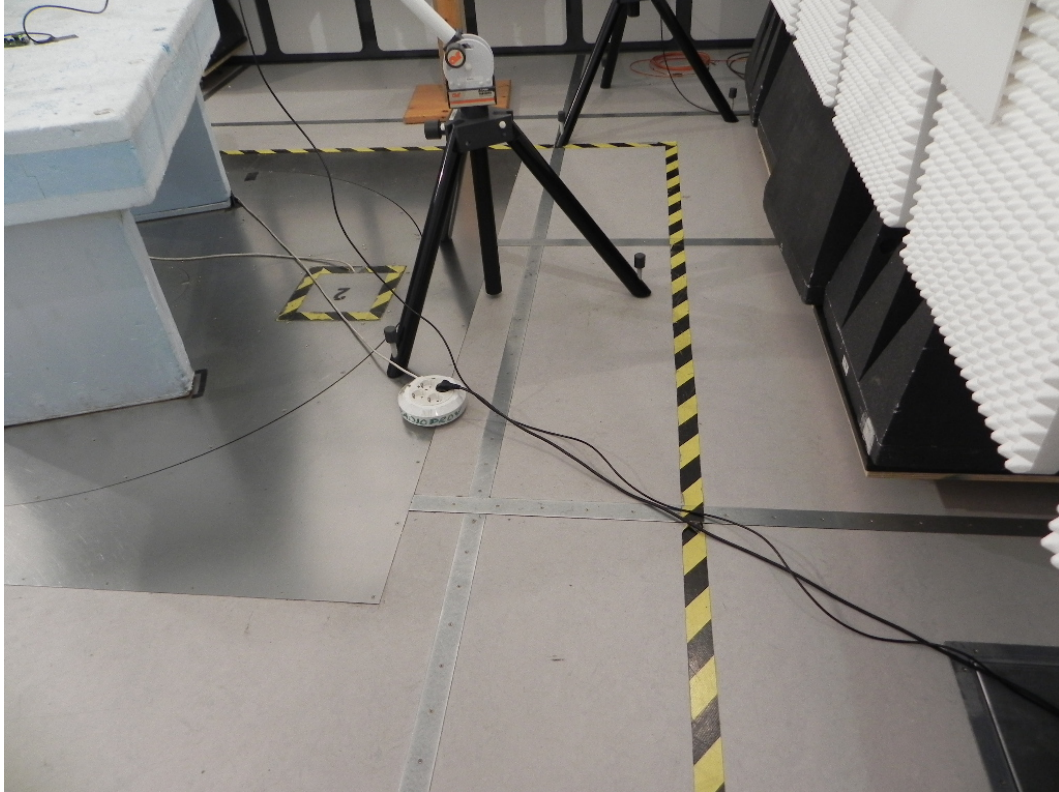
Appendix 5

Close up, EUT and cables



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5

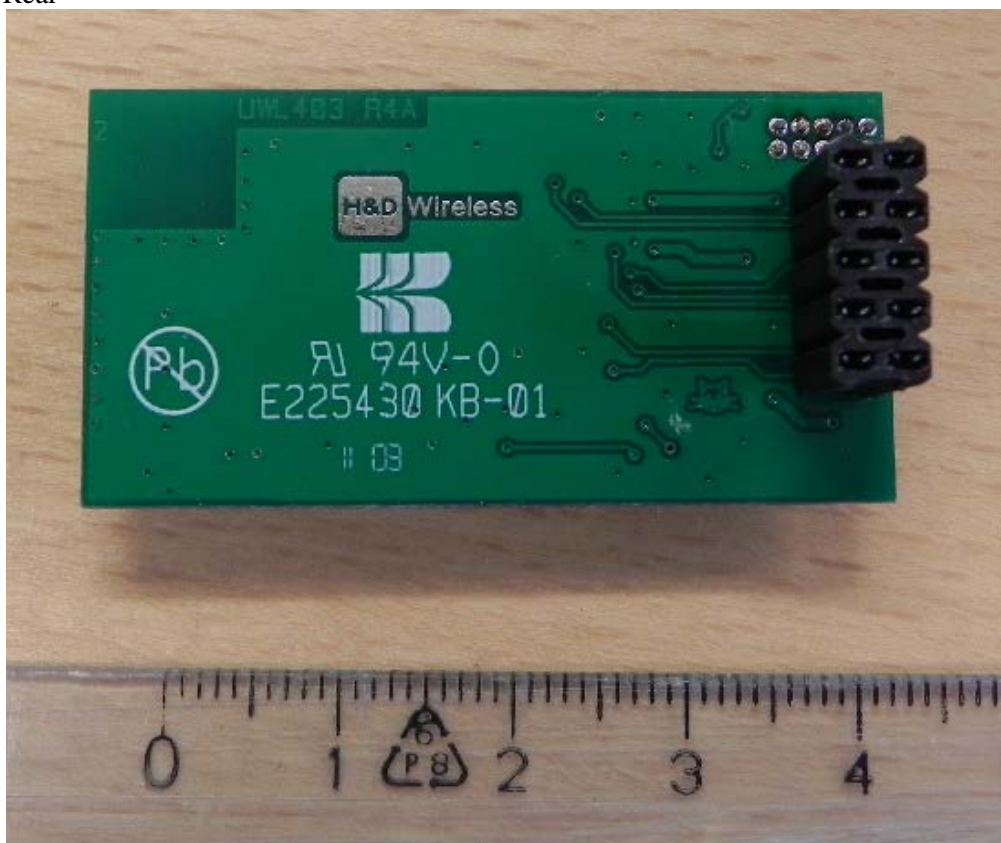
EUT:s

Unit for radiated tests

Top



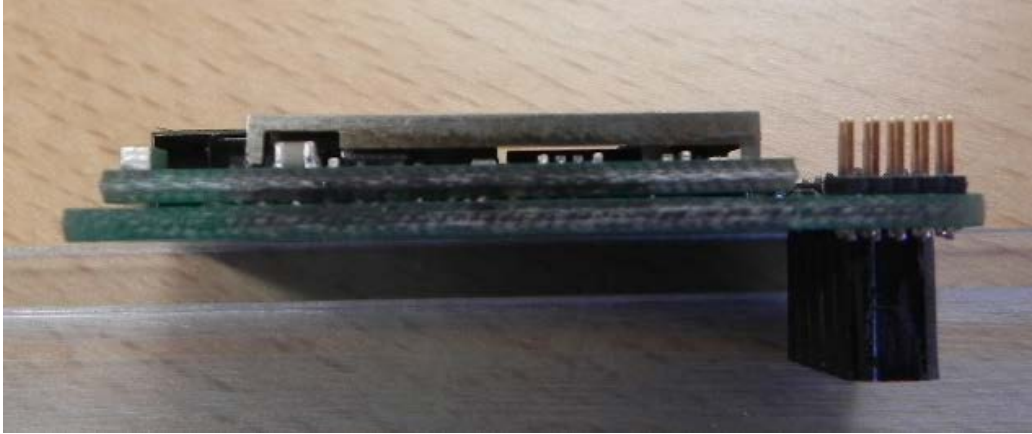
Rear



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5

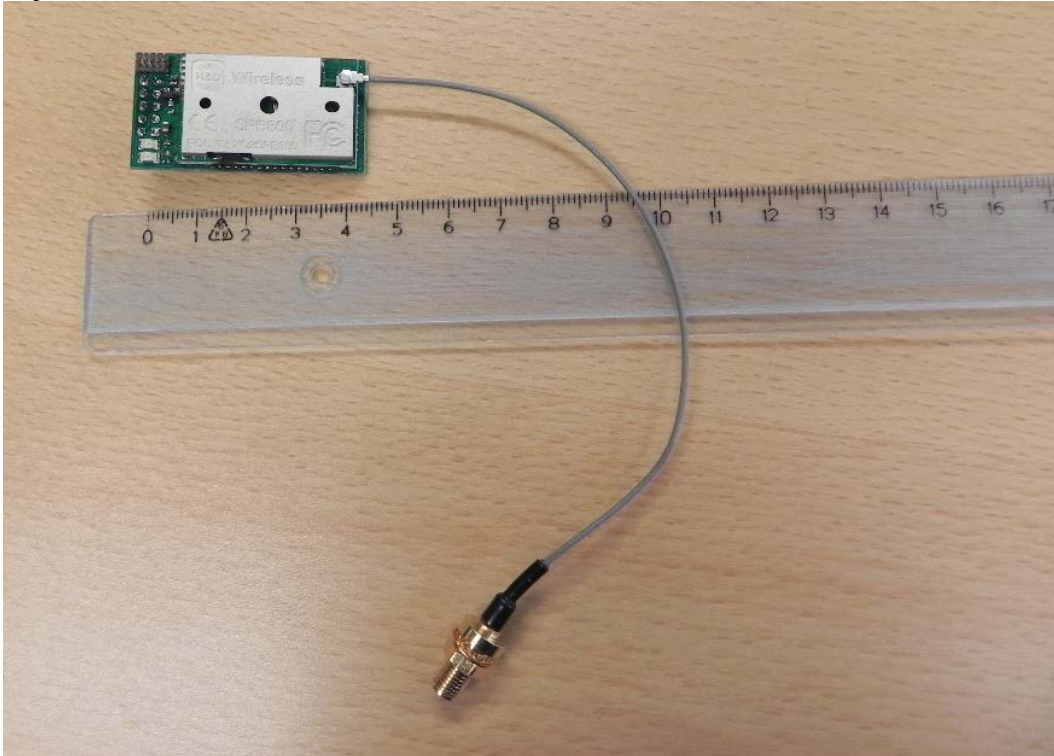
Side



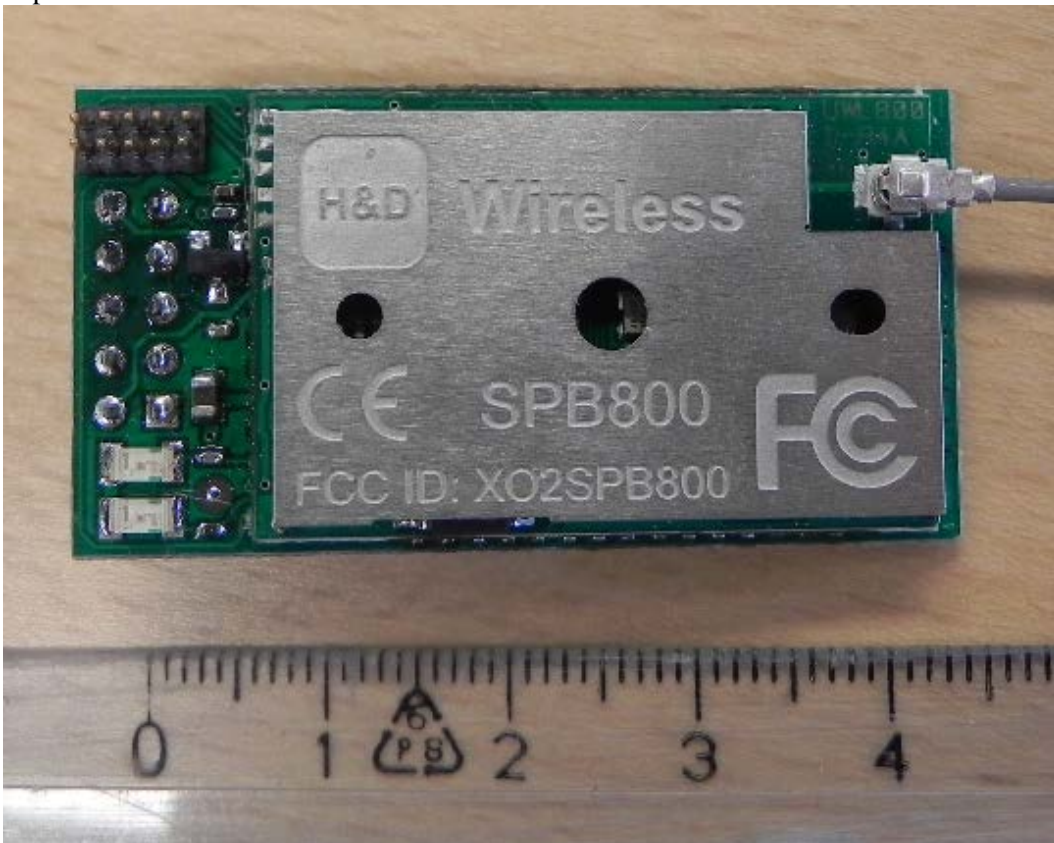
FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5

Unit for conducted tests
Top, overview



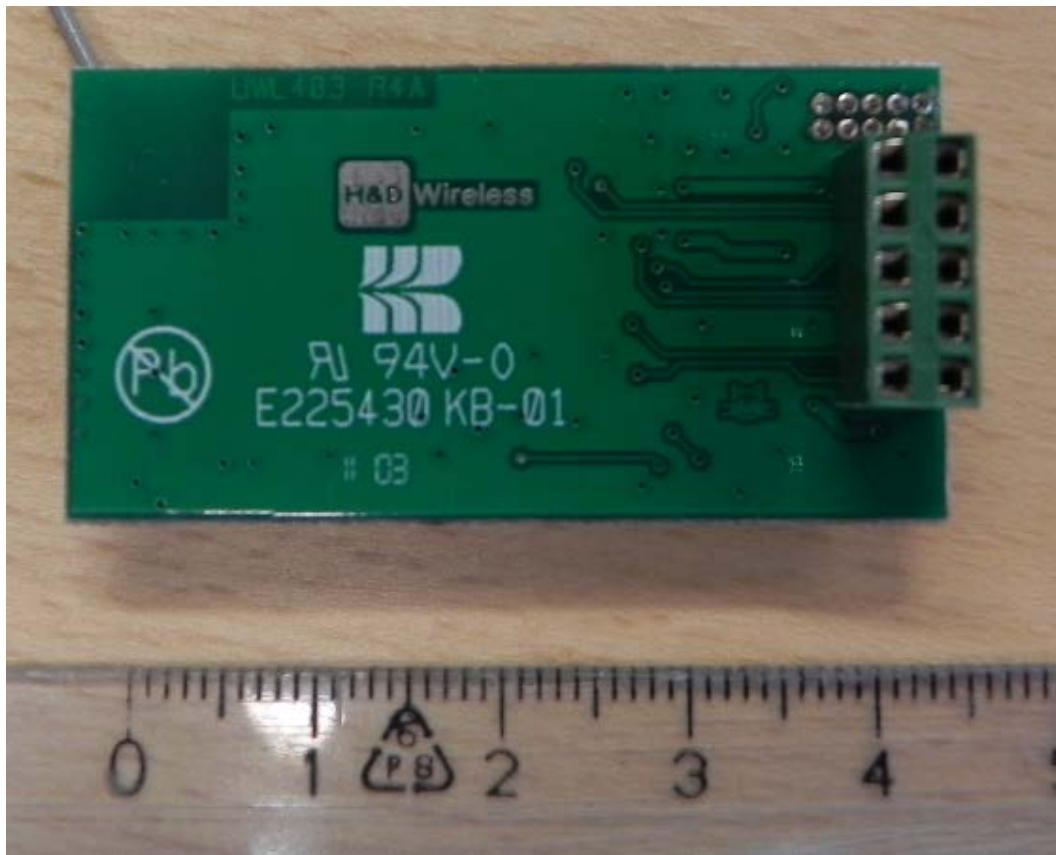
Top



FCC ID: X2OSPB800 and
IC: 8713A-SPB800

Appendix 5

Rear



Side

