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Test Report

Report Number: F120795E2

Applicant:

connectBlue AB

Manufacturer:

connectBlue AB

Equipment under Test (EUT):

Blukii

Laboratory (CAB) accredited by
Deutsche Gesellschaft für Akkreditierung mbH
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. DGA-PL-105/99-22,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

REFERENCES

[1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC CFR 47 Part 15 (August 2011)** Radio Frequency Devices

[3] **Publication Number 558074 (January 2012)** DTS Meas Guidance DR01

[4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radiocommunication Equipment

[6] **Publication Number 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Test engineer:	Paul NEUFELD		11.05.2012
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		11.05.2012
	Name	Signature	Date

RESERVATION

This test report is only valid in its original form.

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1 IDENTIFICATION

1.1 Applicant

Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	martin.engdahl@connectblue.se
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	martin.engdahl@connectblue.se
Applicant represented during the test by the following person:	-

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by DGA Deutsche Gesellschaft für Akkreditierung mbH in compliance with DIN EN ISO/IEC 17025 under Reg. No. DGA-PL-105/99-22, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment under Test)

Test object: *	**Bluetooth transceiver**
Model name: *	Blukii
Product number: *	10400
FCC ID: *	A6C-104000
IC: *	10231A-104000
Serial number: *	None
PCB identifier: *	23700
Hardware version: *	1.0
Software version: *	4.0

1.5 Technical data of equipment

Channel 0	RX:	2402 MHz	TX:	2402 MHz
Channel 20	RX:	2442 MHz	TX:	2442 MHz
Channel 39	RX:	2480 MHz	TX:	2480 MHz

Fulfills Bluetooth specification: *	4.0 (Bluetooth Low Energy single mode)					
Antenna type: *	Internal, ProAnt part number: 390					
Antenna gain: *	Peak gain = 0 dBi					
Antenna connector: *	None, test sample equipped with a temporary Hirose U.FL connector for test purposes.					
Power supply: *	U_{nom}=	3.0 V DC	U_{min}=	2.0 V DC	U_{max}=	3.6 V DC
Type of modulation: *	(GFSK), modulation index = 0.5, (1 Mbps)					
Operating frequency range:*	2402 MHz to 2480 MHz					
Number of channels: *	40					
Temperature range: *	-20 °C to +85 °C					
Lowest / highest Internal clock frequency: *	32.768 kHz / 32.000 MHz					

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
-	No cables were connectable to the EUT		-
-			-

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	13 April 2012
Start of test:	24 April 2012
End of test:	27 April 2012

2 OPERATIONAL STATES

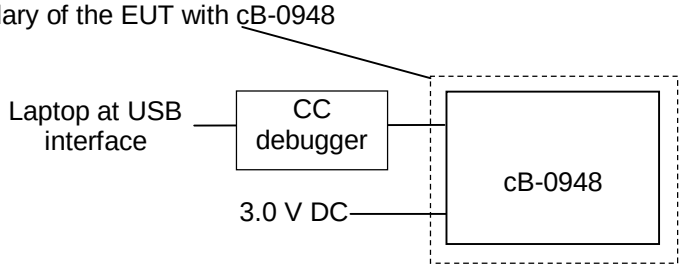
The tests were carried out with two modified samples, one with an internal antenna and one with a temporary antenna connector. At both samples the chip interface is wired to an external connector in order to change the operation mode with the help of a laptop PC with a test-software (provided by the applicant) and an adapter board (CC debugger). After adjusting the operation mode, the adapter board and the PC were removed.

During the tests the test sample was powered with 3.0 V DC via an external battery, temporary connected to the EUT.

The following operation modes were used during the tests in Bluetooth Low Energy (BLE) mode:

Operation mode	Description of the operation mode	Modulation	Data rate / Mbps
1	Continuous transmitting on 2402 MHz	GFSK	1
2	Continuous transmitting on 2442 MHz	GFSK	1
3	Continuous transmitting on 2480 MHz	GFSK	1
4	Transmitter hopping on all channels	GFSK	1

Physical boundary of the EUT with cB-0948



Preliminary tests were performed in different orthogonal directions, to find worst-case configuration and position. The following table shows a list of the test modes used for the measurements, documented in this report. The radiated emission measurement was carried out in the orthogonal direction that emits the highest spurious emission levels.

The 2 orthogonal axes were defined as Pos.1 EUT lying flat, Pos.2 EUT standing vertical.

The following test modes were adjusted during the tests:

Test items	Operation mode
6 dB bandwidth	1, 2, 3
Maximum peak output power	1, 2, 3
Power spectral density	1, 2, 3
Band edge compliance	1, 2, 3, 4
Radiated emissions (transmitter)	1, 2, 3

3 ADDITIONAL INFORMATION

Bluetooth Low Energy (BLE) fulfils not the requirements for a FCC CFR 47 Part 15.247 FHSS equipment, because in some cases less than 15 hopping channels were used. Due to this fact EUTs operating in this mode were classified as FCC CFR 47 Part 15.247 DTS equipment.

During the tests the sample was not labelled with an FCC / IC label.

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
6 dB bandwidth	General	15.247 (a) (2)	A8.2 (a) [4]	Passed	8 et seq.
Maximum peak output power	General	15.247 (b) (3), (4)	A8.4 (4) [4]	Passed	11 et seq.
Power spectral density	2400.0 - 2483.5	15.247 (e)	A8.2 (b) [4]	Passed	14 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	A8.5 [4]	Passed	17 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.205 (a) 15.209 (a)	7.2.2 [5], 2.5 [4]	Passed	23 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [5]	Not applicable *	-

*: Not applicable, because of battery powered device.

5 TEST RESULTS

5.1 6 dB bandwidth

5.1.1 Method of measurement (6 dB bandwidth)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed.
If antenna conducted tests cannot be performed on this device, radiated tests to show compliance with the peak output power limit specified in 15.247 are acceptable.
The EUT has to be switched on and the transmitter shall work with its maximum data rate.

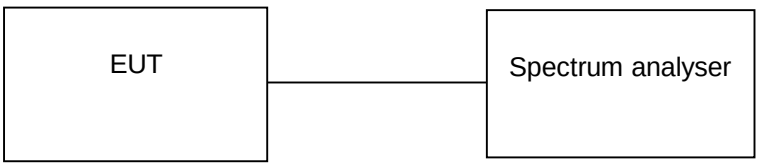
The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 6 dB bandwidth, centred on the actual channel.
- Resolution bandwidth: 1-5 % of the emission bandwidth.
- Video bandwidth: Three times the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 6 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band. For each WLAN mode the worst case configuration will be tested.

Test set-up:

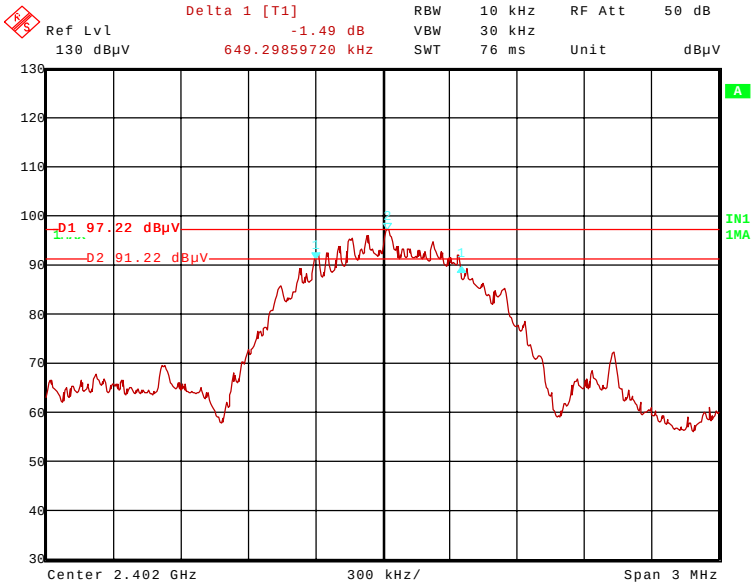


5.1.2 Test results (6 dB bandwidth)

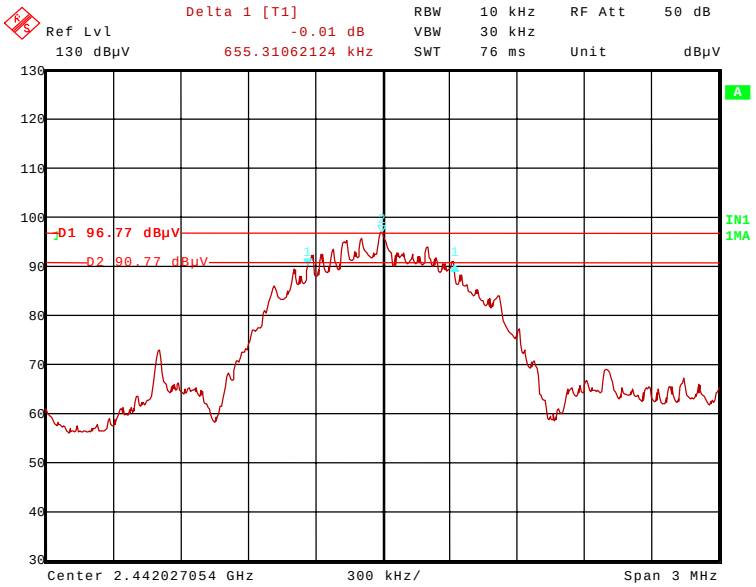
Ambient temperature	21.5 °C

Relative humidity	51 %

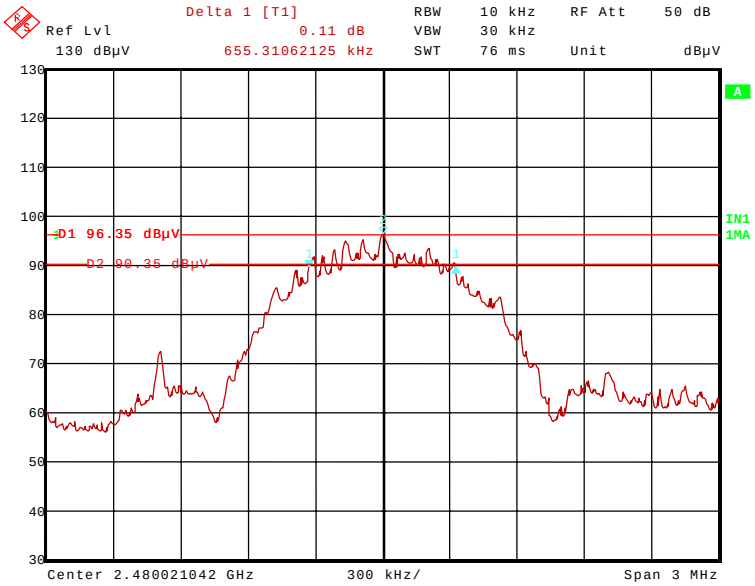
120795_29.wmf: 6 dB bandwidth at the lower end of the assigned frequency band (mode 1):



120795_30.wmf: 6 dB bandwidth at the middle of the assigned frequency band (mode 2):



120795_31.wmf: 6 dB bandwidth at the upper end of the assigned frequency band (mode 3):



Operation mode 1 to 3			
Channel number	Channel frequency [MHz]	6 dB bandwidth [kHz]	Bandwidth limit [kHz]
0	2402	649.299	>500 kHz
20	2442	655.311	>500 kHz
39	2480	655.311	>500 kHz
Measurement uncertainty		$< \pm 1*10^{-7}$	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.2 Maximum peak output power

5.2.1 Method of measurement (maximum peak output power)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on.

Measurement procedure PK1:

The following spectrum analyser settings shall be used (available RBW is ≥ EBW):

- Span: Zero.
- Resolution bandwidth: RBW ≥ EBW.
- Video bandwidth: Three times the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.
- Use marker function to determine the peak value

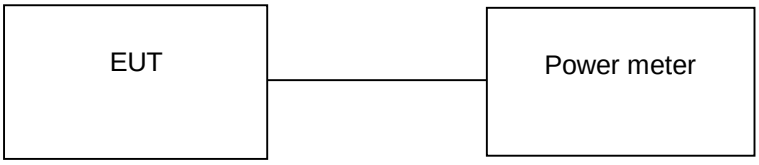
Measurement procedure PK2:

The following spectrum analyser settings shall be used (available RBW is < EBW):

- Span: 5-30 % > EBW.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.
- Use the spectrum analyser's integrated band power measurement function with band limits set equal to the EBW band edges.

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band. For each WLAN mode the worst case configuration will be tested.

Test set-up:

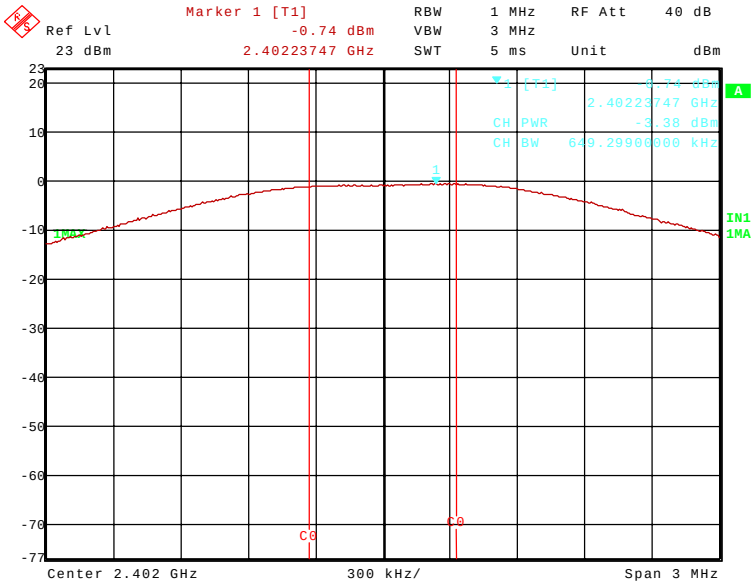


5.2.2 Test results (maximum peak conducted output power)

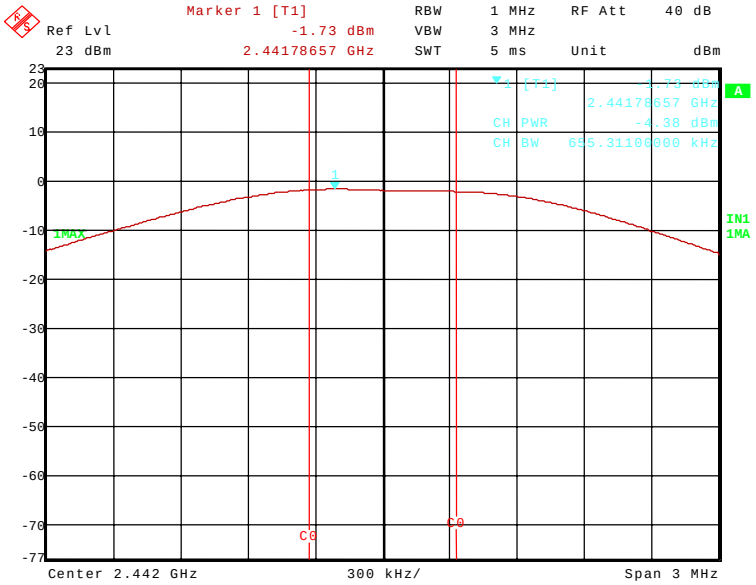
Ambient temperature	22 °C	Relative humidity	66 %

For the following measurements, measurement procedure PK2 was used.

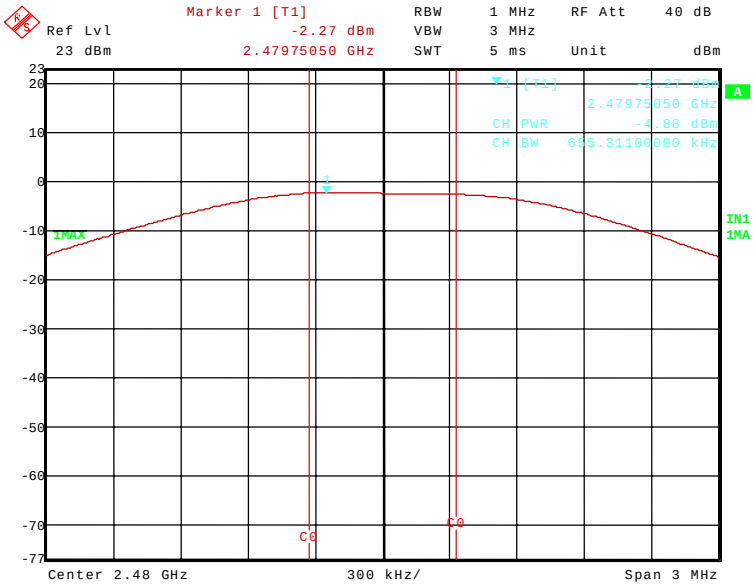
120795_55.wmf: Maximum peak conducted output power (mode 1):



120795_56.wmf: Maximum peak conducted output power (mode 2):



120795_57.wmf: Maximum peak conducted output power (mode 3):



Operation mode 1 to 3				
Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
0	2402	-3.38	0.0	30.0
20	2442	-4.38	0.0	30.0
39	2480	-4.88	0.0	30.0
Measurement uncertainty			+0.66 dB / -0.72 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.3 Power spectral density

5.3.1 Method of measurement (power spectral density)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed.

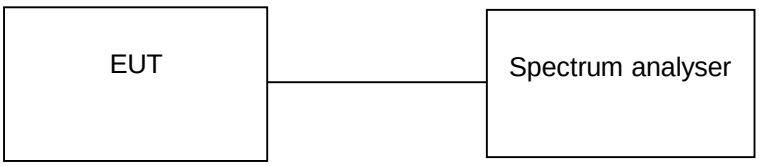
Measurement procedure PKPS (use this procedure in case of maximum peak conducted output power used to demonstrate compliance):

The following spectrum analyser settings shall be used:

- Span: 5 – 30 % greater than the EBW.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: 300 kHz.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.
- Use the peak marker to determine the maximuum power level in any 100 kHz band segment within the fundamental EBW.
- Scale the observed power level to an equivalent value in 3 kHz by adjusting the measured power by an bandwidth correction factor of -15.2 dB.

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band. For each WLAN mode the worst case configuration will be tested.

Test set-up:



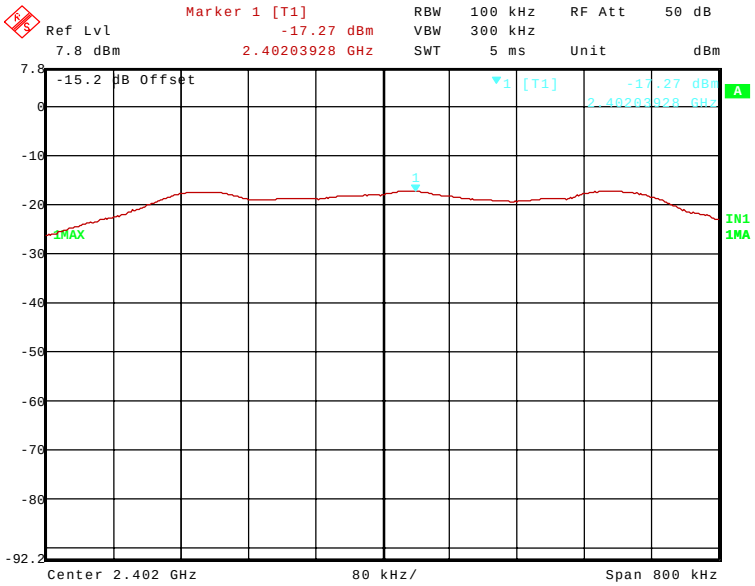
Test set-up (radiated measurement): The test set-up and the test procedure shall be according to the applicable test instruction as it is described in chapter 5.5.

5.3.2 Test results (power spectral density)

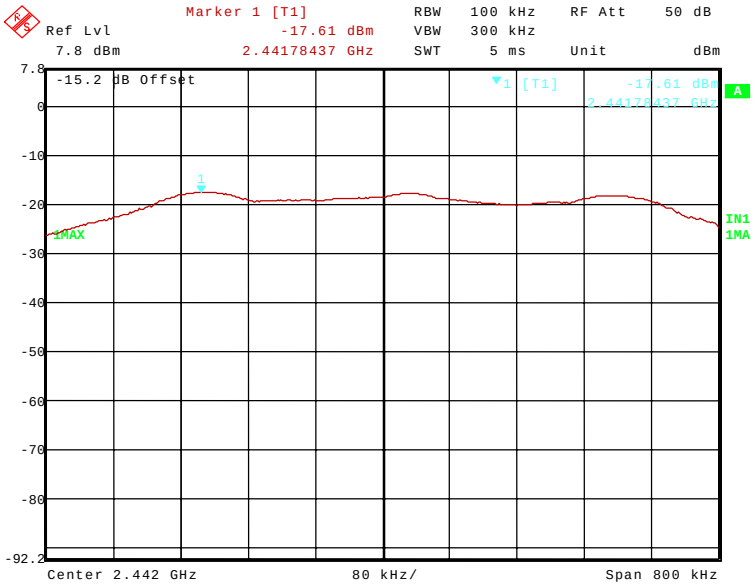
Ambient temperature	21.5 °C

Relative humidity	51 %

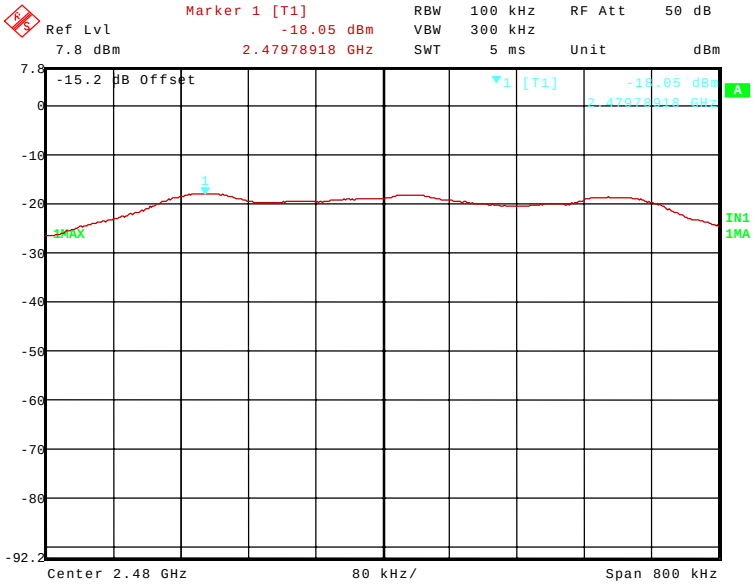
120795_35.wmf: Power spectral density at the lower end of the assigned frequency band (mode 1):



120795_36.wmf: Power spectral density at the middle of the assigned frequency band (mode 2):



120795_37.wmf: Power spectral density at the upper end of the assigned frequency band (mode 3):



Operation mode 1 to 3				
Channel number	Channel frequency [MHz]	Power spectral density [dBm / 3 kHz]	Antenna gain [dBi]	Power spectral density limit [dBm / 3 kHz]
0	2402	-17.27	0.0	8.0
20	2442	-17.61	0.0	8.0
39	2480	-18.05	0.0	8.0
Measurement uncertainty			+1.1 dB / -1.5 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.4 Band-edge compliance

5.4.1 Method of measurement (band-edge compliance (radiated))

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a radiated measurement in an anechoic chamber can be performed as well. The EUT has to be switched on and the hopping function has to be disabled.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the authorized band of operation.
- Resolution bandwidth: ≥ 1 % of the span
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak.. The frequency line shall be set on the applicable band edge. Set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band. The method to determine the difference between the highest peak inside and outside the band depends on the location of the highest peak outside the fundamental emissions.

1. If the highest modulation product outside of the used band is **not** within the first 1 MHz beyond the fundamental emissions, the power level of the highest in-band-peak and the highest modulation product outside of the band have to be measured according to the measurement method used for final measurement of the spurious emissions.

2. If the highest modulation product outside of the used band **is** within the first 1 MHz beyond the fundamental emissions, the marker-delta method, as described in KDB 913591 and in C63.10, can be used to perform band-edge measurements:

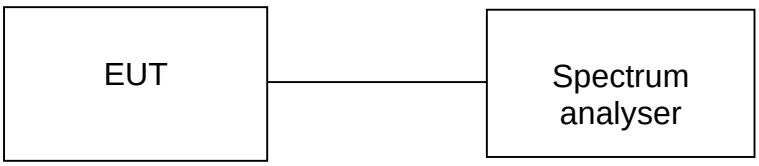
    1. Perform an in-band field strength measurement of the fundamental emission, using the measurement method as described in the spurious emissions measurement test procedure.
    2. Choose the spectrum analyser to encompass both the peak of the fundamental emission and the band-edge emission under investigation.
       RBW = 1 % to 5 % of the total span.
       VBW ≥ RBW (unless otherwise specified).
       Detector function: Peak.
       Trace mode: Max hold.
       Wait until trace is stabilized.
       Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission.
       (This is not an absolute field strength measurement. It is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.)
    3. Subtract the delta measured in (2.) from the field strengths measured in (1.). The resultant field strengths (CISPR QP, average or peak, as appropriate) are then used to determine band-edge compliance of the restricted bands, described in 5.9.

If the level of the measured field strength is below the general limits specified in § 15.205, the specified limits have to be considered instead of the calculated difference.

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 FCC - § 15.247, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

The measurement will be performed at the upper, as well as at the lower end of the assigned frequency band and with hopping on and off.

Test set-up (conducted measurement):



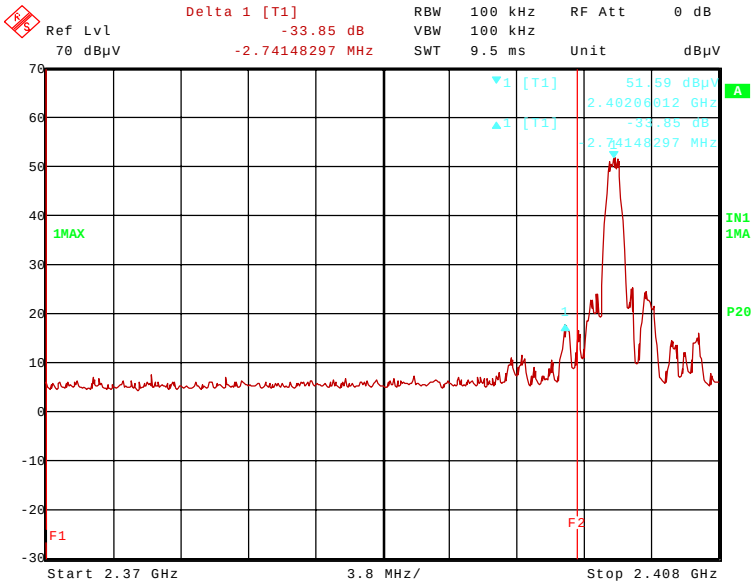
If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case emission will be required.

Test set-up (radiated measurement): The test set-up and the test procedure shall be according to the applicable test instruction in the document “radiated emissions measurement” F30.

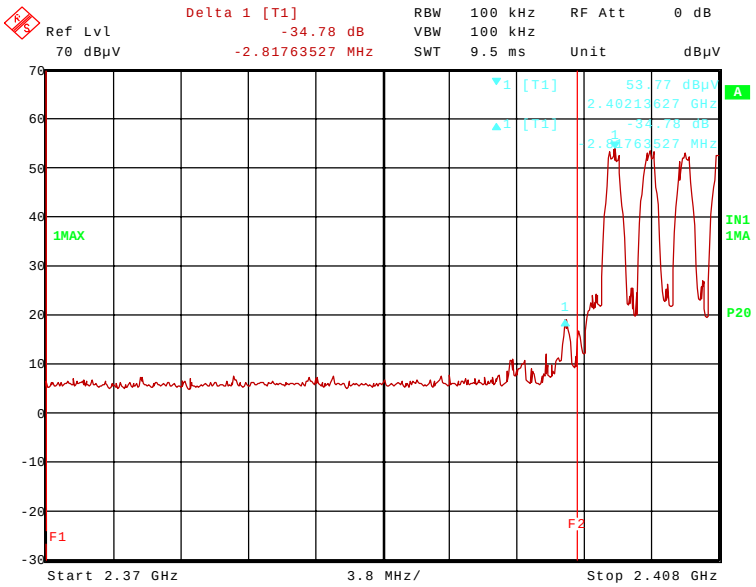
5.4.2 Test result (band-edge compliance (radiated))

Ambient temperature	21.5 °C		Relative humidity	51 %

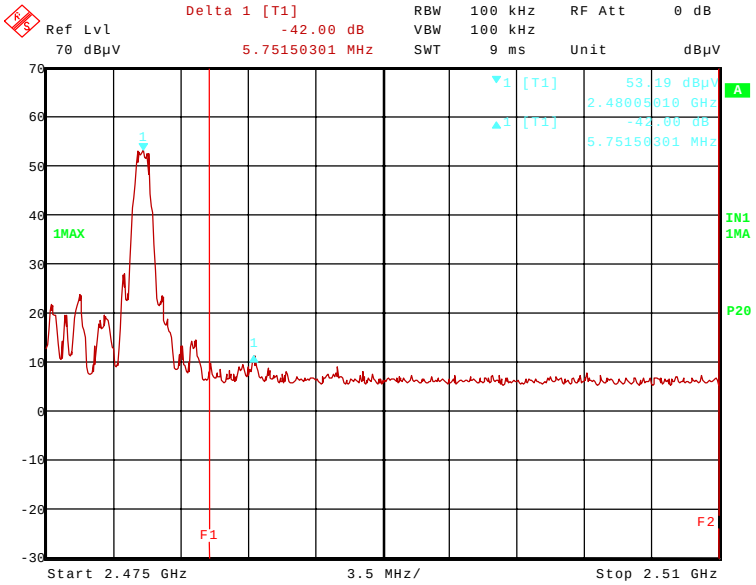
120795_38.wmf: Radiated band-edge compliance, lower band edge, hopping off (operation mode 1):



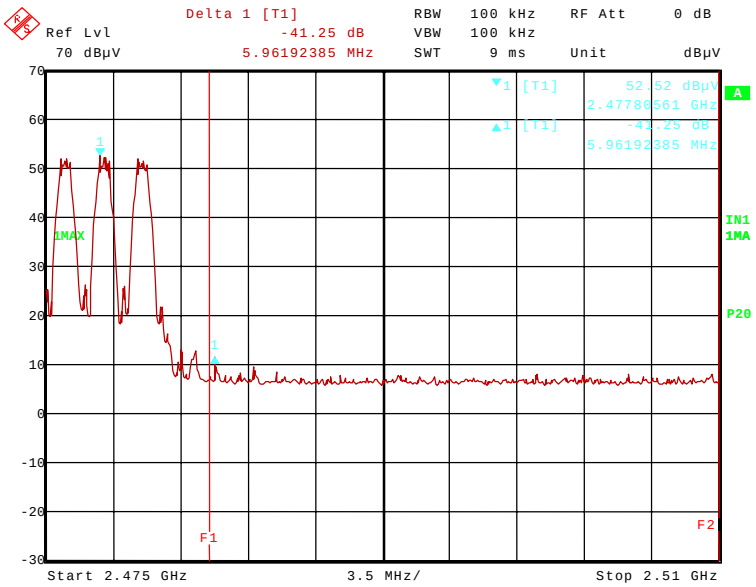
120795_39.wmf: Radiated band-edge compliance, lower band edge, hopping on (operation mode 4):



120795_41.wmf: Radiated band-edge compliance, upper band edge, hopping off (operation mode 3):



120795_40.wmf: Radiated band-edge compliance, upper band edge, hopping on (operation mode 4):



The plots on the pages before are showing the radiated band-edge compliance for the lower and upper band-edge. The frequency line 1 (F1) shows the upper and the frequency line 2 (F2) shows the lower edge of the assigned frequency band.

Band-edge compliance (lower band edge. hopping disabled)											
Result measured with the peak detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	90.4	-	-	58.4	28.3	0.0	3.7	150	Hor.	carrier	1
2399	56.6	74.0	17.5	24.6	28.3	0.0	3.7	150	Vert.	No	1
Result measured with the average detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	83.8	-	-	51.8	28.3	0.0	3.7	150	Hor.	carrier	1
2399	50.0	63.8	13.9	18.0	28.3	0.0	3.7	150	Hor.	No	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (lower band edge. hopping enabled)											
Result measured with the peak detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	90.4	-	-	58.4	28.3	0.0	3.7	150	Hor.	carrier	1
2399	55.6	74.0	18.4	23.6	28.3	0.0	3.7	150	Vert.	No	1
Result measured with the average detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	83.8	-	-	51.8	28.3	0.0	3.7	150	Hor.	carrier	1
2399	49.0	63.8	14.8	17.0	28.3	0.0	3.7	150	Hor.	No	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. hopping disabled)											
Result measured with the peak detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	85.6	-	-	53.3	28.5	0.0	3.8	150	Hor.	carrier	1
2486	51.0	74.0	23.0	18.7	28.5	0.0	3.8	150	Vert.	Yes	1
Result measured with the average detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	73.5	-	-	41.2	28.5	0.0	3.8	150	Hor.	carrier	1
2486	37.2	54.0	16.8	4.9	28.5	0.0	3.8	150	Vert.	Yes	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. hopping enabled)											
Result measured with the peak detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	87.7	-	-	55.4	28.5	0.0	3.8	150	Hor.	carrier	1
2484	46.5	74.0	27.6	14.2	28.5	0.0	3.8	150	Vert.	Yes	1
Result measured with the average detector:											
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Reading dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	81.3	-	-	49.0	28.5	0.0	3.8	150	Hor.	2480	1
2484	40.1	54.0	14.0	7.8	28.5	0.0	3.8	150	Vert.	2484	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 34, 36, 41, 42

5.5 Radiated emissions

5.5.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- Final measurements were omitted, because no emissions were found in the observed frequency range 9 kHz to 30 MHz.
- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- Final measurements were omitted, because no emissions were found in the observed frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 25 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 GHz.

All measurements will be carried out with the EUT working on the middle and upper and lower edge of the assigned frequency band. For this reason the hopping function of the EUT has to be disabled.

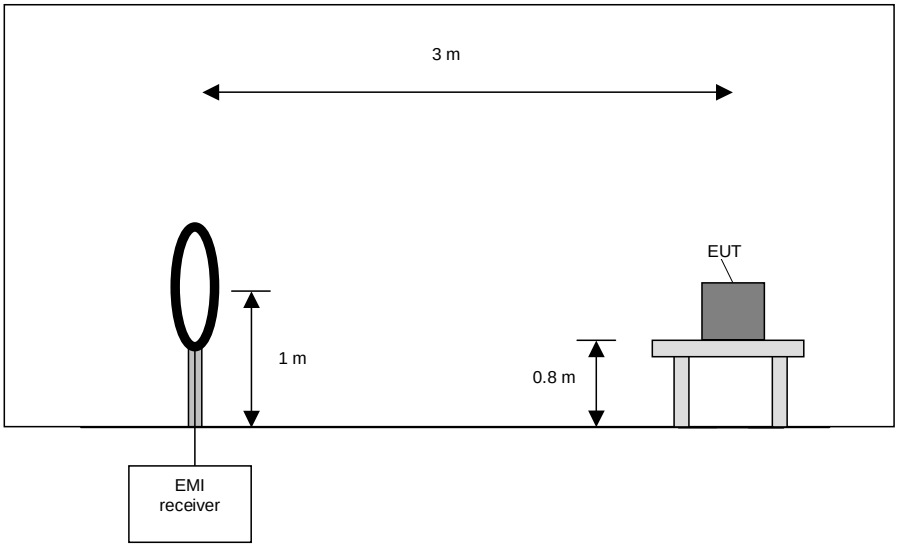
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to find the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

1) Monitor the frequency range at “face-to-face” polarisation and a EUT azimuth of 0 °.
2) Manipulate the system cables within the range to produce the maximum level of emission.
3) Rotate the EUT by 360 ° to maximize the detected signals.
4) Make a hardcopy of the spectrum.
5) Measure the frequencies of the highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6) Repeat steps 1) to 4) with the other orthogonal axes of the EUT.
7) Rotate the measuring antenna and repeat steps 1) to 5).

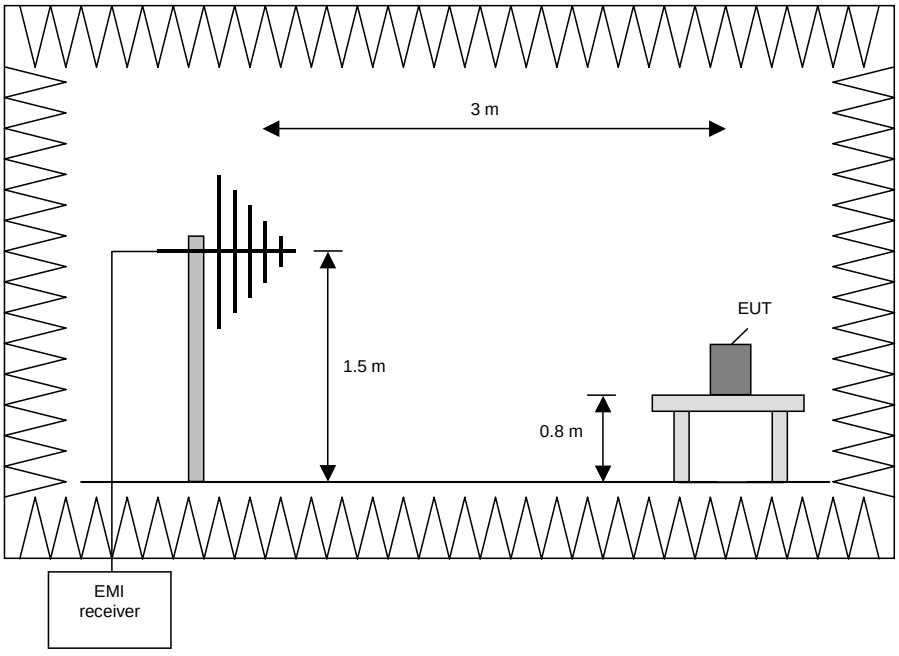
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

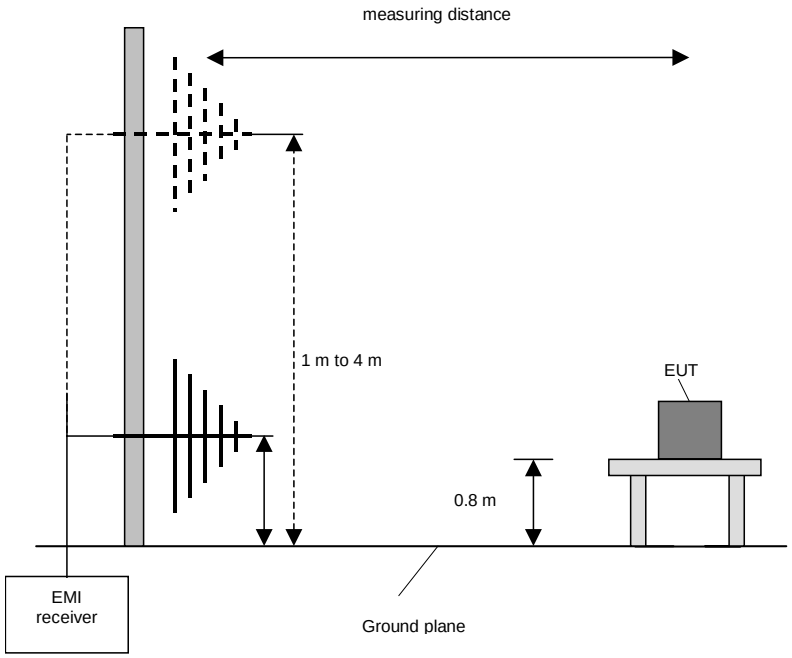
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) with the other orthogonal axes of the EUT if handheld equipment.
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
4) Repeat 1) to 3) for the other orthogonal antenna polarization.
5) Move the antenna and the turntable to the position where the maximum value is detected.
6) Measure while moving the antenna slowly +/- 1 m.
7) Set the antenna to the position where the maximum value is found.
8) Measure while moving the turntable +/- 45 °.
9) Set the turntable to the azimuth where the maximum value is found.
10) Measure with Final detector (QP and AV) and note the value.
11) Repeat 5) to 10) for each frequency.
12) Repeat 1) to 11) for each orthogonal axes of the EUT if handheld equipment.

Final measurement (1 GHz to 25 GHz)

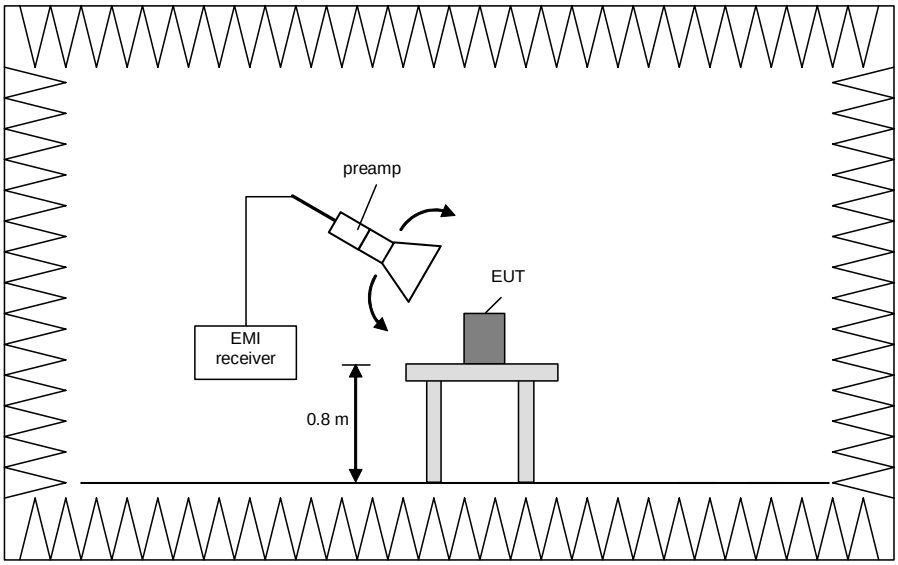
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

Preliminary measurement (1 GHz to 25 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 GHz	100 kHz

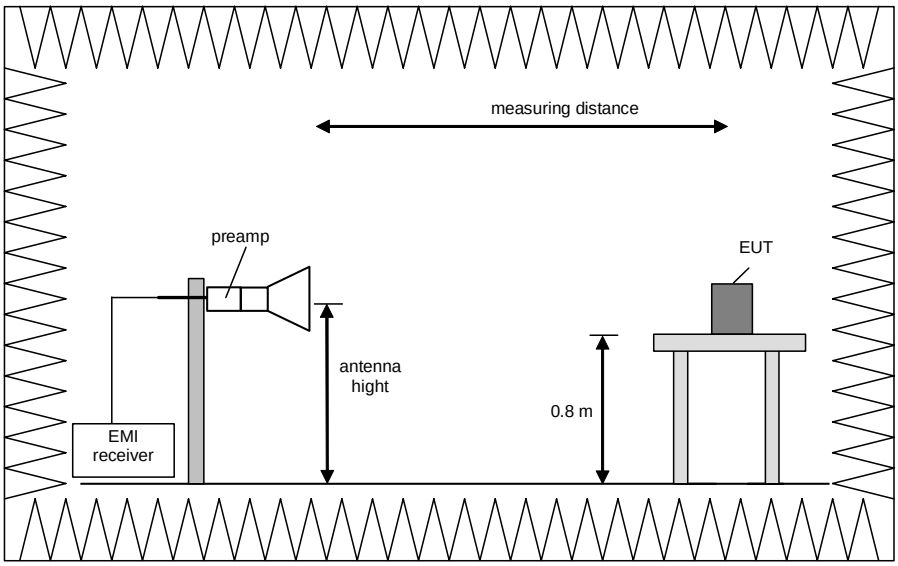


Final measurement (1 GHz to 25 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 25 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 GHz.
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
2) Change the antenna polarisation and repeat 1) with vertical polarisation.
3) Make a hardcopy of the spectrum.
4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
5) Change the analyser mode to Clear / Write and found the cone of emission.
6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

Step 1) to 6) are defined as preliminary measurement.

5.5.2 Test results (radiated emissions)

5.5.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	28 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

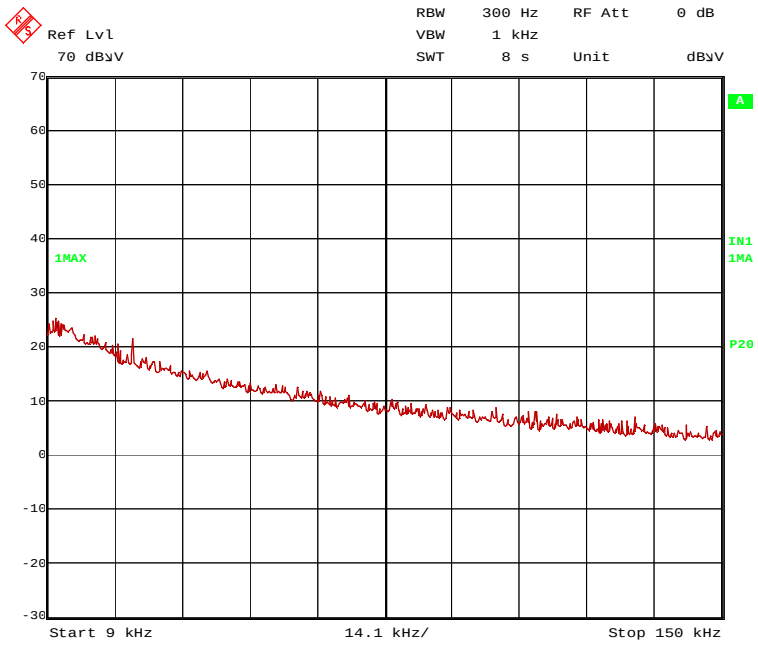
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

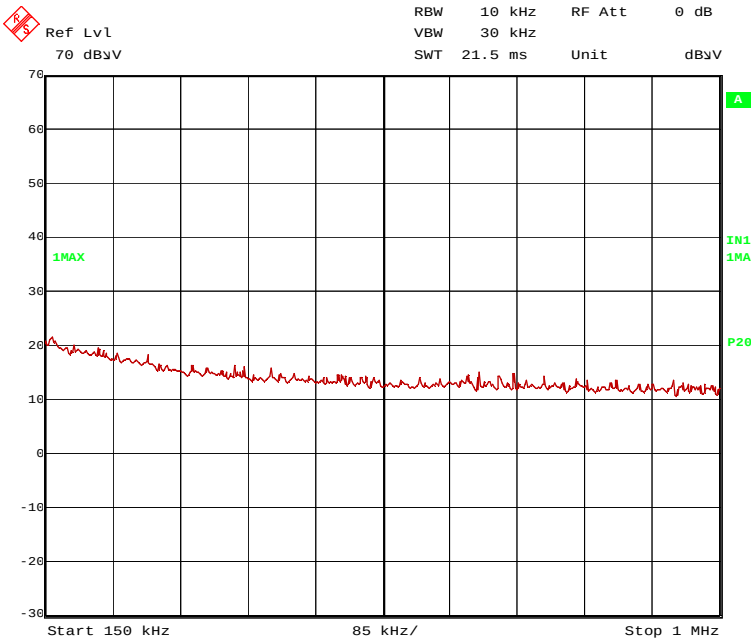
Supply voltage: During all measurements the EUT was supplied with 3.0 V DC by an external battery.

Remark: No emissions were emitted in the frequency range 9 kHz to 1 GHz independent of the transmitter operation mode. Therefore the emissions in this frequency range were documented only with the transmitter operates in operation mode 2.

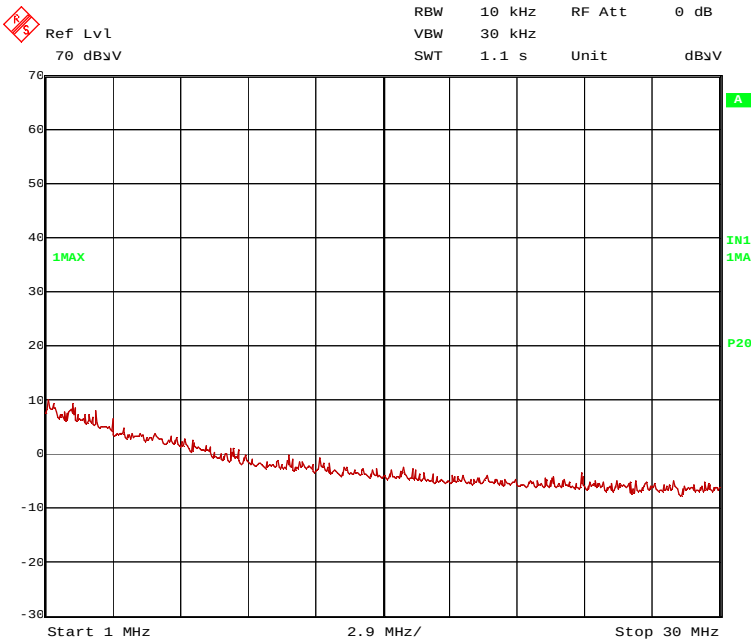
120795_1.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



120795_2.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

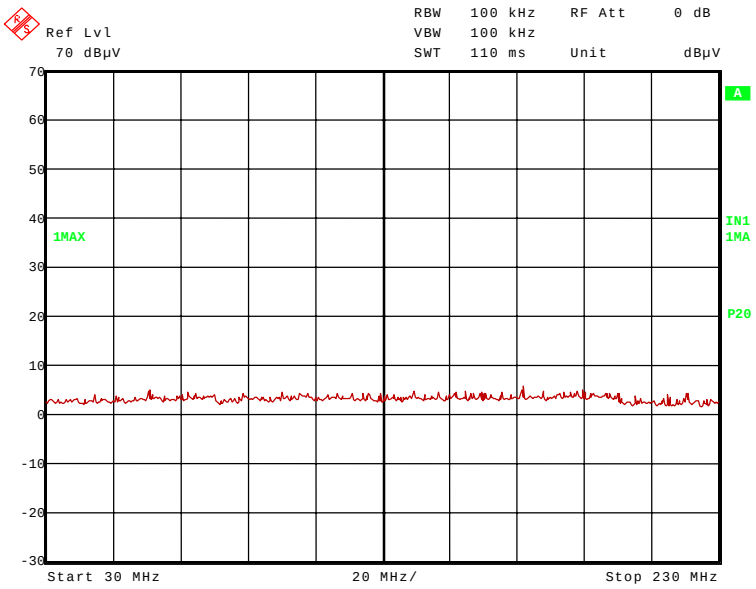


120795_3.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

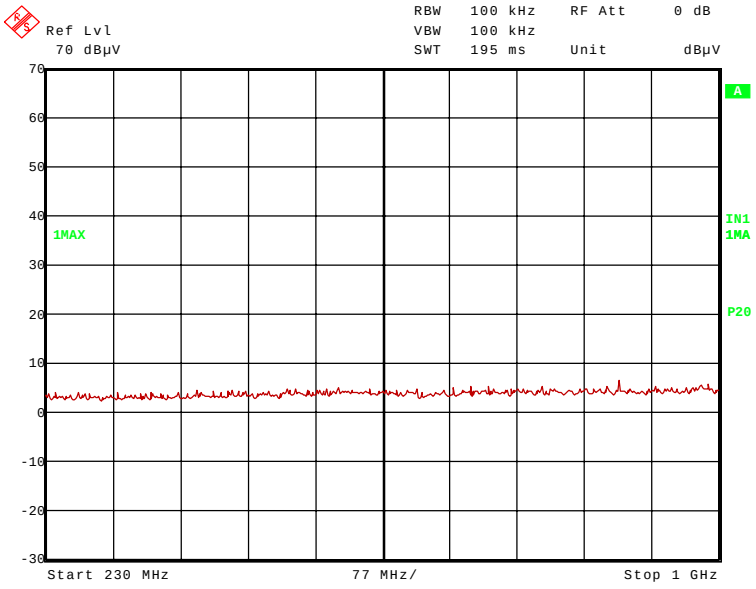


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

120795_26.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



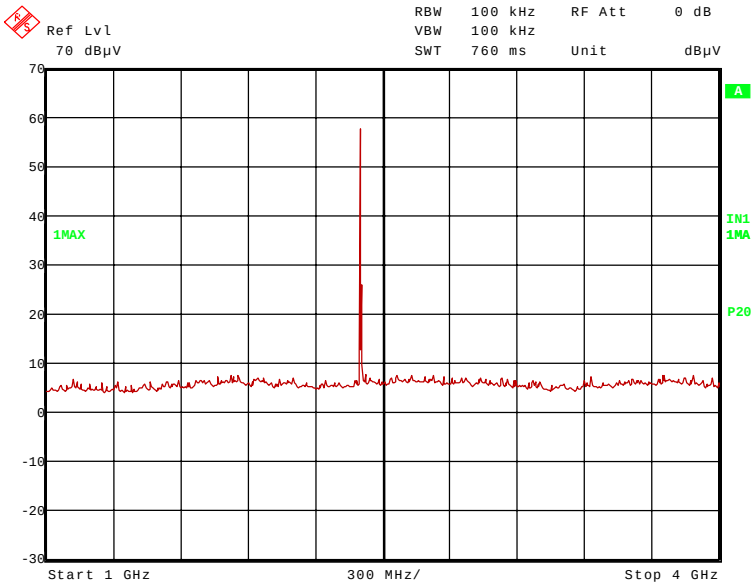
120795_28.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2):



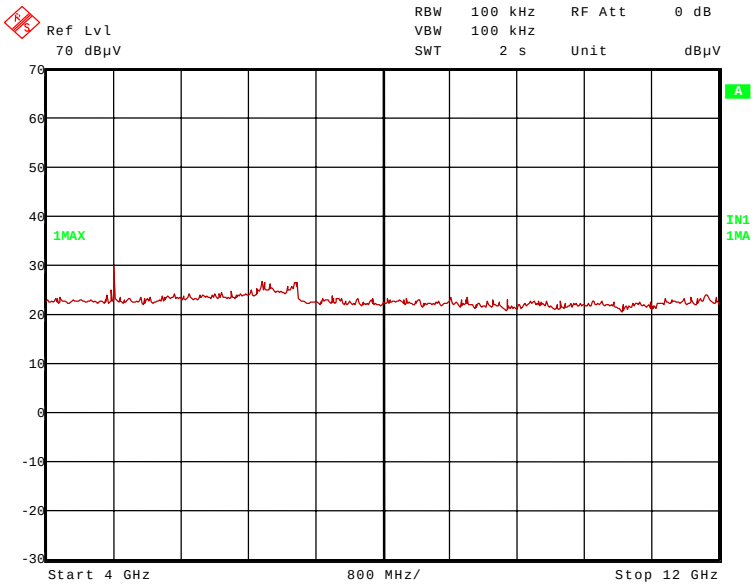
No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

Transmitter operates at the lower end of the assigned frequency band

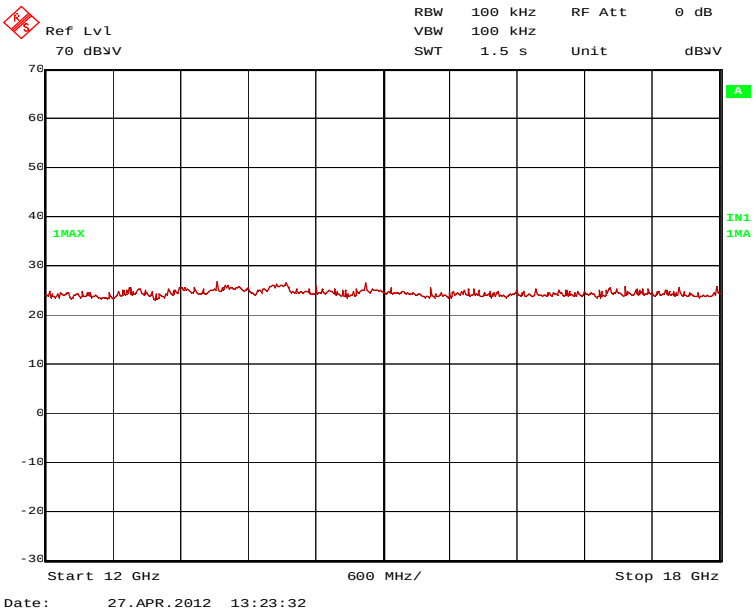
120795_12.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



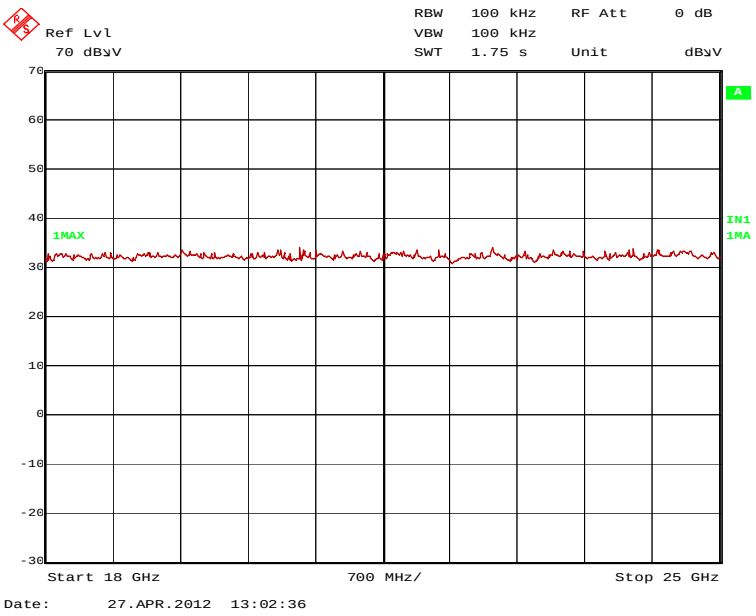
120795_17.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



120795_24.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



120795_23.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 4.804 GHz

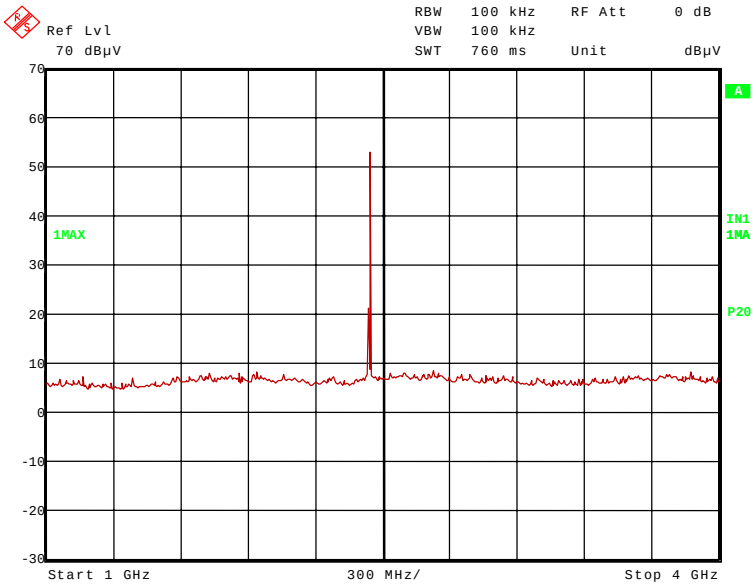
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 2.402 GHz.

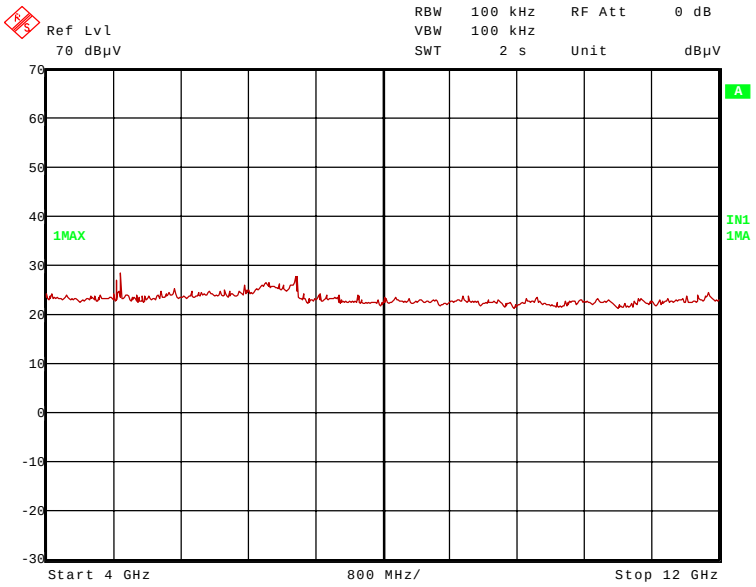
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the middle of the assigned frequency band

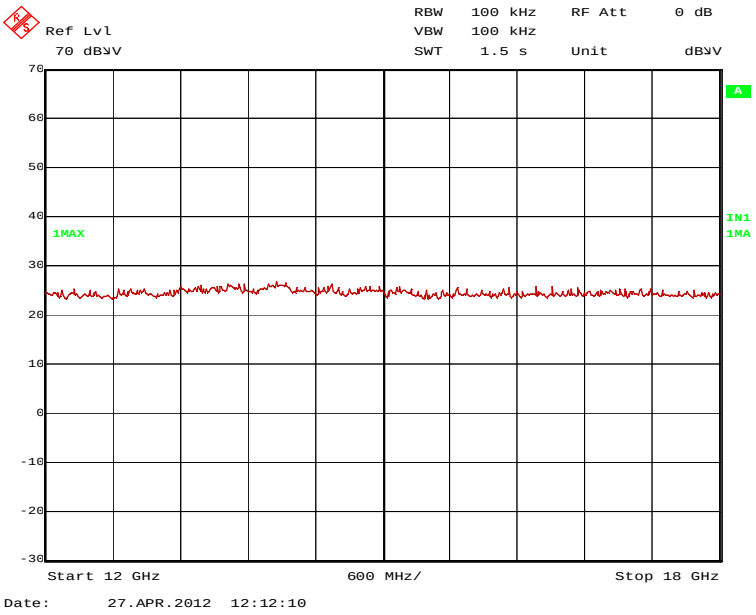
120795_13.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



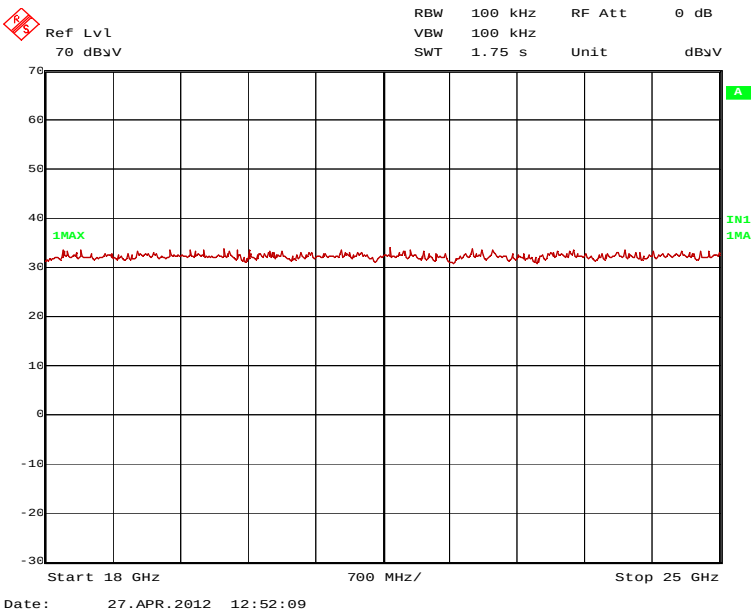
120795_16.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



120795_19.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



120795_22.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 4.884 GHz

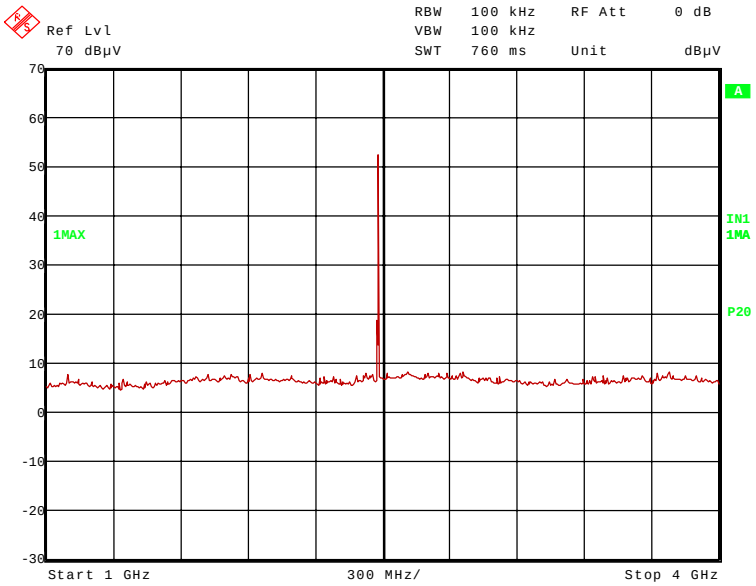
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 2.442 GHz.

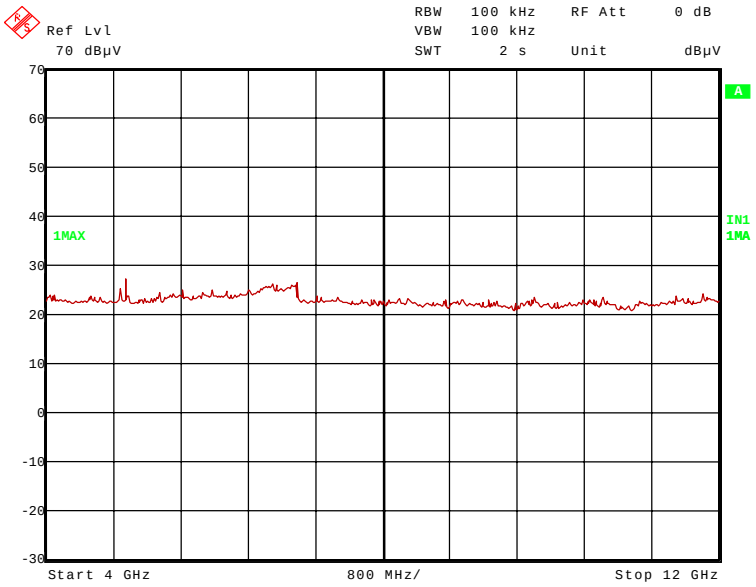
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency

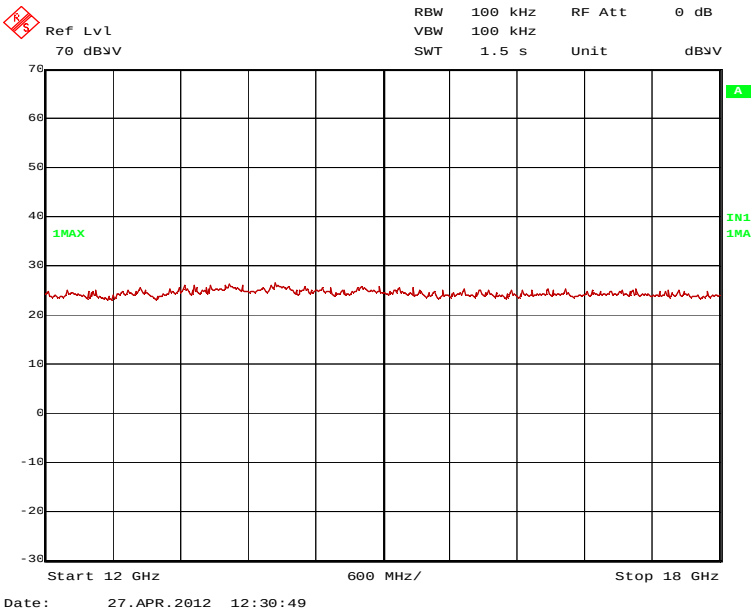
120795_14.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



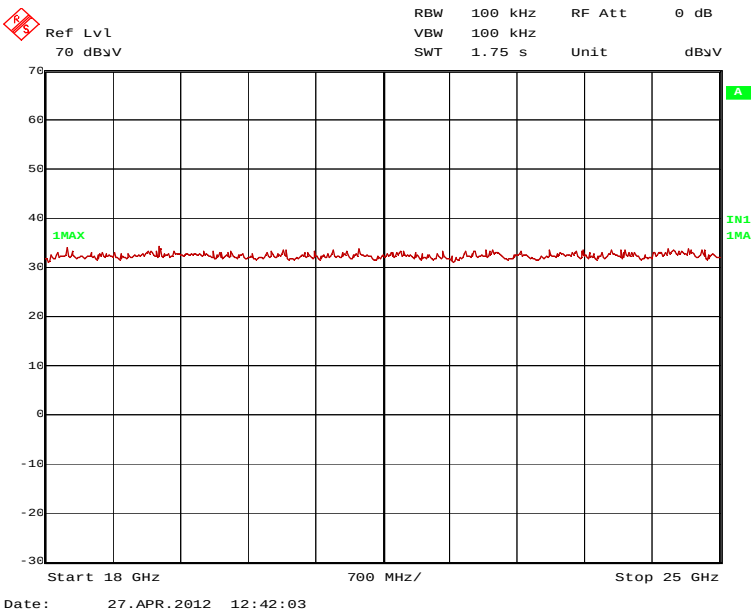
120795_15.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



120795_20.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



120795_21.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 3):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 4.960 GHz

The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 2.480 GHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

5.5.2.2 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	32 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 3.0 V DC by an external battery.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Result measured with the peak detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	90.4	-	-	58.4	28.3	0.0	3.7	150	Hor.	carrier	1
4806	47.9	74.0	26.1	35.7	32.6	25.7	5.3	150	Hor.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	83.8	-	-	51.8	28.3	0.0	3.7	150	Hor.	carrier	1
4806	38.7	54.0	15.3	26.5	32.6	25.7	5.3	150	Hor.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2442	87.4	-	-	55.3	28.4	0.0	3.7	150	Hor.	carrier	2
4882	47.9	74.0	26.1	35.5	32.8	25.7	5.3	150	Hor.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2442	81.0	-	-	48.9	28.4	0.0	3.7	150	Hor.	carrier	2
4882	38.9	54.0	15.1	26.5	32.8	25.7	5.3	150	Hor.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	87.7	-	-	55.4	28.5	0.0	3.8	150	Hor.	carrier	1
4958	46.5	74.0	27.5	33.9	32.9	25.6	5.3	150	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2480	81.3	-	-	49.0	28.5	0.0	3.8	150	Hor.	carrier	1
4958	36.6	54.0	17.4	24.0	32.9	25.6	5.3	150	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
29, 31 –34, 36, 37, 39, 41, 42, 44, 46, 49 - 51, 55, 72

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/09/2012	03/2014
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	12/13/2011	12/2012
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	02/15/2010	02/2014
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	MA240-0	Inn-Co GmbH	MA240-0/030/6600603	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894	09/18/2008	09/2012
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/15/2012	02/2014
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/13/2012	02/2014
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS620P	Deisel	620/375	480325	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/21/2011	04/2014
36	Antenna	3115 A	EMCO	9609-4918	480183	11/09/2011	11/2014
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
41	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
42	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141	Weekly verification (system cal.)	
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142	Weekly verification (system cal.)	
46	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480301	Six month verification (system cal.)	
47	RF-cable-No 36	Sucoflex 106B	Huber&Suhner	0587/6B / Kabel 36	480865	Weekly verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
50	Preamplifier	JS3-12001800-	Miteq	571667	480343	Six month verification	

		16-5A				(system cal.)	
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/16/2012	02/2014
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	
73	Coupling Plate	50 Ω system	PHOENIX TESTLAB GmbH	-	410160	-	

7 REPORT HISTORY

Report Number	Date	Comment
F120795E2	02 May 2012	Document created

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120795_1.JPG: Test set-up fully anechoic chamber – EUT lying flat (pos. 1)
120795_2.JPG: Test set-up fully anechoic chamber – EUT standing vertically (pos. 2)
120795_3.JPG: Test set-up fully anechoic chamber
120795_4.JPG: Test set-up fully anechoic chamber
120795_5.JPG: Test set-up conducted measurement

ANNEX B INTERNAL PHOTOGRAPHS 6 pages

120795_12.JPG: EUT w. antenna connector, w. programming interface, top view
120795_14.JPG: EUT w. antenna connector, w. programming interface, bottom view
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120795_8.JPG: EUT w. antenna connector, w. dc line / programming interface, top view
120795_9.JPG: EUT w. antenna connector, w. dc line / programming interface, bottom view
120795_17.JPG: EUT no lines connected, top view
120795_18.JPG: EUT no lines connected, bottom view