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Test Report

Report Number: F123736E1

Applicant:

Harman Becker Automotive Systems GmbH

Manufacturer:

Harman Becker Automotive Systems GmbH

Equipment under Test (EUT):

MIB MAIN-UNIT

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

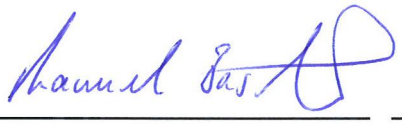
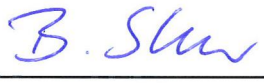
[3] **Publication Number 558074 (October 2012)** DTS Meas Guidance v02

[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

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.

	Name	Signature	Date
Test engineer:	Manuel BASTERT		15 October 2012
Authorized reviewer:	Bernd STEINER		15 October 2012

RESERVATION

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalizations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

Contents: Page

1 IDENTIFICATION

1.1 Applicant

Name:	Harman Becker Automotive Systems GmbH
Address:	Becker-Göring-Str. 16 76307 Karlsbad-Ittersbach
Country:	Germany
Name for contact purposes:	Mr. Stefan BLASCHEK
Phone:	+49 (0) 7248-71-3382
Fax:	+49 (0) 7248-71-4382
eMail Address:	Stefan.blaschek@harman.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Harman Becker Automotive Systems GmbH
Address:	Becker-Göring-Str. 16 76307 Karlsbad-Ittersbach
Country:	Germany
Name for contact purposes:	Mr. Stefan BLASCHEK
Phone:	+49 (0) 7248-71-3382
Fax:	+49 (0) 7248-71-4382
eMail Address:	Stefan.blaschek@harman.com
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: *	Car infotainment system
Type: *	MIB MAIN-UNIT
FCC ID: *	T8GA041
IC: *	6434A-A041
Serial numbers: *	A041HO0CB000633 (sample for radiated measurements) A041HO0CB000645 (sample for conducted measurements)
Hardware version: *	H40
Software version: *	BIOS mode

1.5 Technical data of equipment

Channel 1	RX:	2412 MHz	TX:	2412 MHz
Channel 2	RX:	2417 MHz	TX:	2417 MHz
Channel 3	RX:	2422 MHz	TX:	2422 MHz
Channel 4	RX:	2427 MHz	TX:	2427 MHz
Channel 5	RX:	2432 MHz	TX:	2432 MHz
Channel 6	RX:	2437 MHz	TX:	2437 MHz
Channel 7	RX:	2442 MHz	TX:	2442 MHz
Channel 8	RX:	2447 MHz	TX:	2447 MHz
Channel 9	RX:	2452 MHz	TX:	2452 MHz
Channel 10	RX:	2457 MHz	TX:	2457 MHz
Channel 11	RX:	2462 MHz	TX:	2462 MHz

Fulfills WLAN specification: *	802.11b, 802.11g		
Antenna type: *	Internal PCB antenna		
Antenna gain: *	-0.8 dBi		
Antenna connector: *	None (temporary connector for conducted measurements)		
Power supply: *	U_{nom} = 12.0 V_{DC}	U_{min} = 9.0 V_{DC}	U_{max} = 16.5 V_{DC}
	Automotive battery		
Type of modulation: *	802.11b: CCK, DQPSK, DBPSK 802.11g: OFDM		
Operating frequency range:*	2412 MHz to 2462 MHz		
Number of channels: *	11		
Temperature range: *	0 °C to +40 °C		
Lowest / highest Internal clock frequency: *	32 kHz (sleep clock) / 2.48 GHz (Bluetooth**)		

* declared by the applicant.
** device contains Bluetooth functionality also.

1.6 Dates

Date of receipt of test sample:	19 September 2012
Start of test:	04 October 2012
End of test:	11 October 2012

2 OPERATIONAL STATES

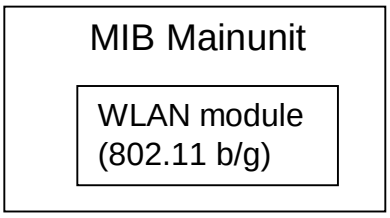
The tests were carried out on a test sample with internal antenna and on a sample with temporary antenna connector. The operation modes needed for the tests could be set by using an evaluation board connected with a fiber optic MOST bus to the EUT and via USB to a laptop computer. With test software installed on the computer the operation modes were set.

The EUT was set to its maximum available output power in each test case.

During the tests the test samples were powered by a automotive battery with 12 V_{DC}.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode	Modulation	Data rate / Mbps
1	Continuous transmitting on 2412 MHz	CCK (802.11b)	11
2	Continuous transmitting on 2437 MHz	CCK (802.11b)	11
3	Continuous transmitting on 2462 MHz	CCK (802.11b)	11
4	Continuous transmitting on 2412 MHz	OFDM (802.11g)	54
5	Continuous transmitting on 2437 MHz	OFDM (802.11g)	54
6	Continuous transmitting on 2462 MHz	OFDM (802.11g)	54



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

The following test modes were adjusted during the tests:

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

3 ADDITIONAL INFORMATION

None.

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	2400.0 - 2483.5	15.247 (a) (2)	A8.2 (a) [4]	passed	8 et seq.
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	A8.4 (4) [4]	passed	12 et seq.
Power spectral density	2400.0 - 2483.5	15.247 (e)	A8.2 (b) [4]	passed	13 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	A8.5 [4]	passed	15 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)	7.2.2 [5]	Not applicable *	

* Not applicable, because of automotive battery supply

5 TEST RESULTS

5.1 6 dB bandwidth

5.1.1 Method of measurement

Used measurement procedure as described in [3]:

Option 1:

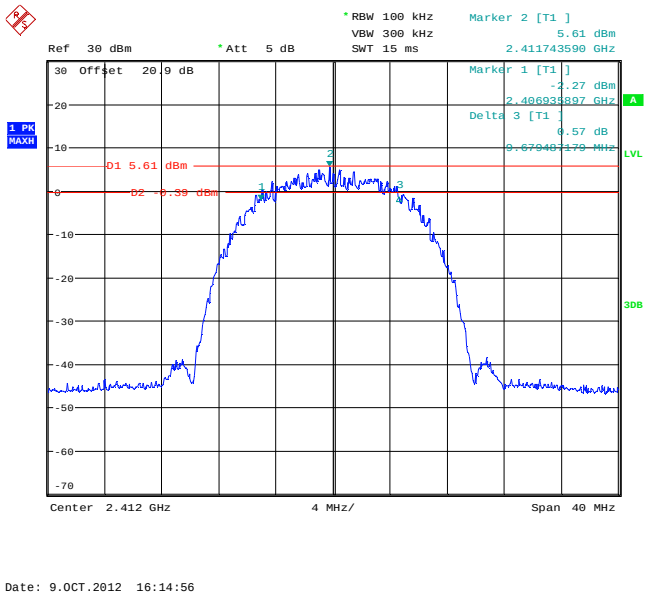
1. Set resolution bandwidth (RBW) = 1 - 5 % of DTS BW, not to exceed 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level of the fundamental emission.

5.1.2 Test results

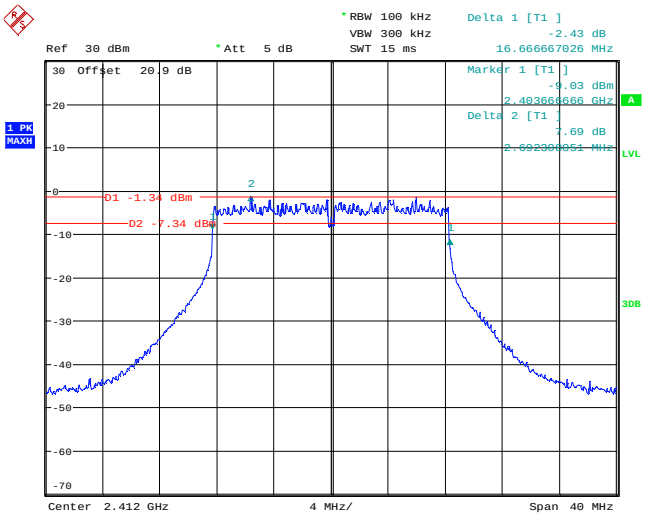
Measured conducted at the temporary antenna connector

Ambient temperature	20 °C	Relative humidity	40 %

123736_C2.wmf: 6 dB bandwidth channel 1 (b-mode)

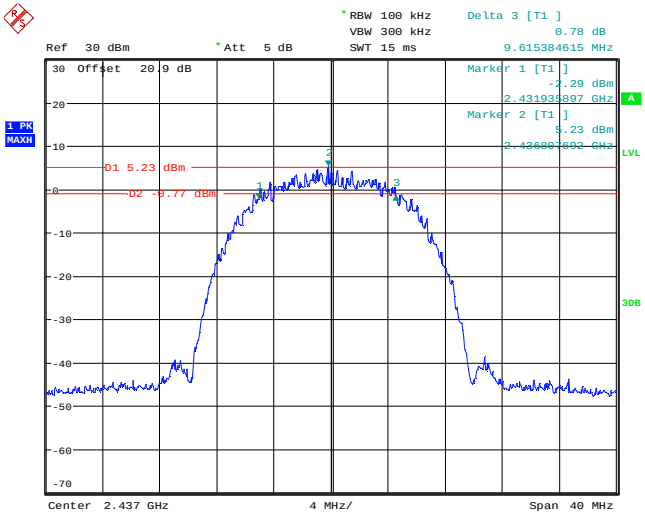


123736_C1.wmf: 6 dB bandwidth channel 1 (g-mode)



Date: 9.OCT.2012 15:36:44

123736_C3.wmf: 6 dB bandwidth channel 6 (b-mode)



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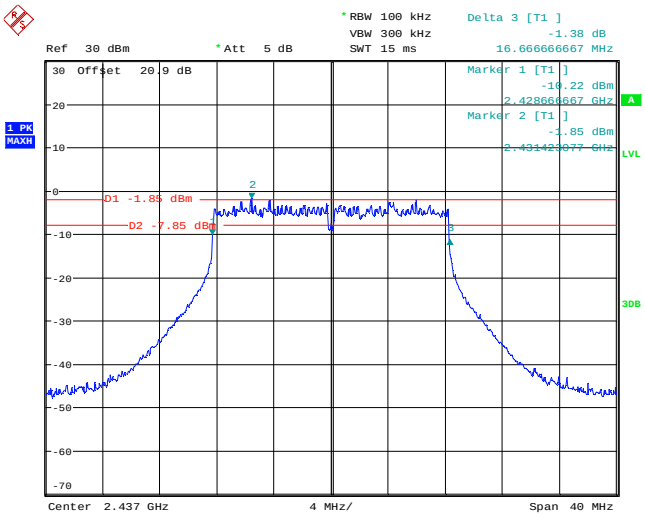
123736_C4.wmf: 6 dB bandwidth channel 6 (g-mode)



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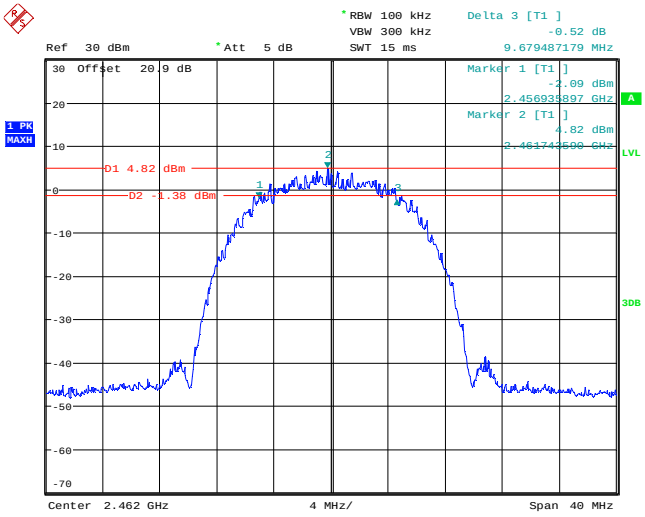
123736_C6.wmf: 6 dB bandwidth in the channel 11 (b-mode)



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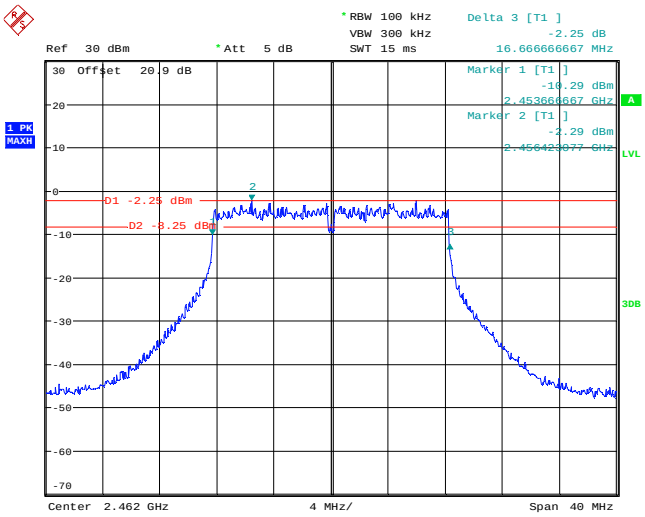
123736_C5.wmf: 6 dB bandwidth channel 11 (g-mode)



Test results 6 dB bandwidth			
	Ch. 1 (2412 MHz)	Ch. 6 (2437 MHz)	Ch. 11 (2462 MHz)
b-mode	9.679 MHz	9.615 MHz	9.679 MHz
g-mode	16.667 MHz	16.667 MHz	16.667 MHz
Measurement uncertainty: +0.66 dB / -0.72 dB			

Test result: Passed.

Test equipment used:

30, 75

5.2 Maximum peak conducted output power

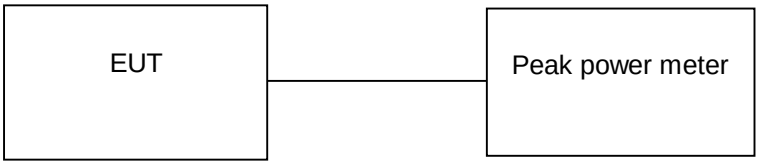
5.2.1 Method of measurement

Used measurement procedure as described in [3]:

Option 3: (Peak power meter method)

The maximum peak conducted output power can be measured using a broadband peak RF power meter. The power meter must have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast, average-responding diode type sensor.

Test set-up:



5.2.2 Test results

Measured conducted at the temporary antenna connector

Ambient temperature	20 °C	Relative humidity	40 %

Test results maximum peak conducted output power				
Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1 (b-Mode)	2412	16.3	-0.8	30.0
1 (g-Mode)	2412	17.2	-0.8	30.0
6 (b-Mode)	2437	16.0	-0.8	30.0
6 (g-Mode)	2437	16.7	-0.8	30.0
11 (b-Mode)	2462	15.6	-0.8	30.0
11 (g-Mode)	2462	16.5	-0.8	30.0
Measurement uncertainty			± 0.16 dB	

Test result: Passed

Test equipment used:

73, 74

5.3 Power spectral density

5.3.1 Method of measurement

A conducted power spectral density (PSD) limit of 8 dBm in any 3 kHz band segment within the DTS bandwidth is specified during any time interval of continuous transmission. By rule, the same method as used to determine the conducted output power shall be used to determine the power spectral density (i.e., if maximum peak conducted output power was measured then the peak PSD procedure shall be used and if maximum conducted output power was measured then the average PSD procedure shall be used).

If the average PSD is measured with a power averaging (RMS) detector or a sample detector, then the spectrum analyzer must be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW in order to ensure bin-to-bin spacing of ≤ RBW/2 so that narrowband signals are not lost between frequency bins.

Option 1
This procedure **must** be used if maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit, and is optional if the maximum (average) conducted output power was used to demonstrate compliance.

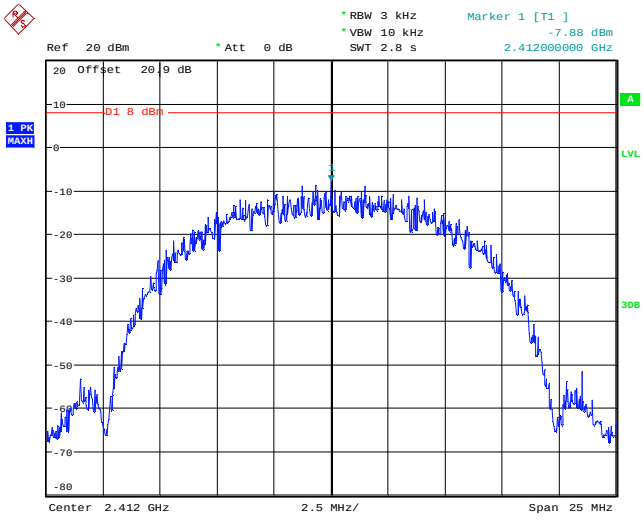
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW ≥ 3 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.3.2 Test results

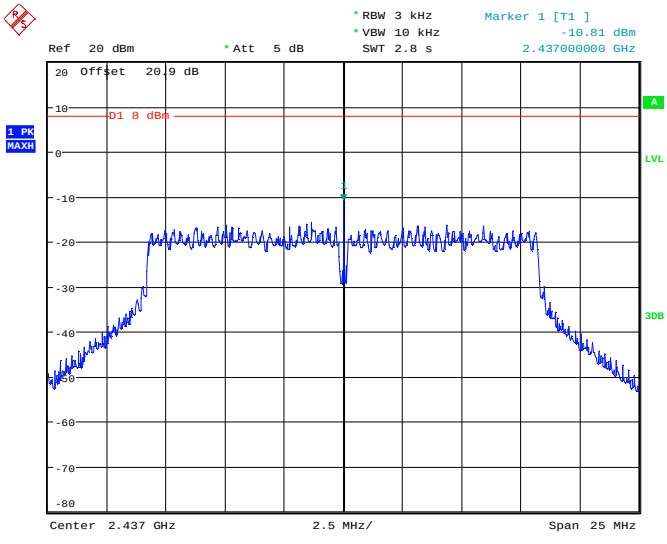
Measured conducted at the temporary antenna connector

Ambient temperature	20 °C	Relative humidity	40 %

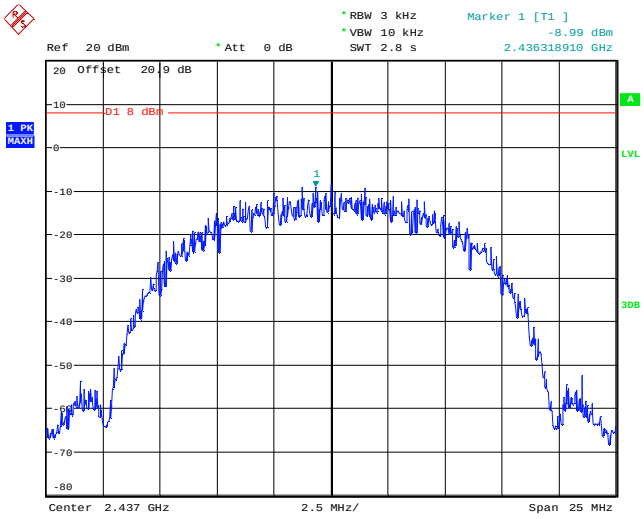
123736_C24.wmf: Power spectral density channel 1 (b-mode)



123736_C7.wmf: Power spectral density channel 6 (g-mode)

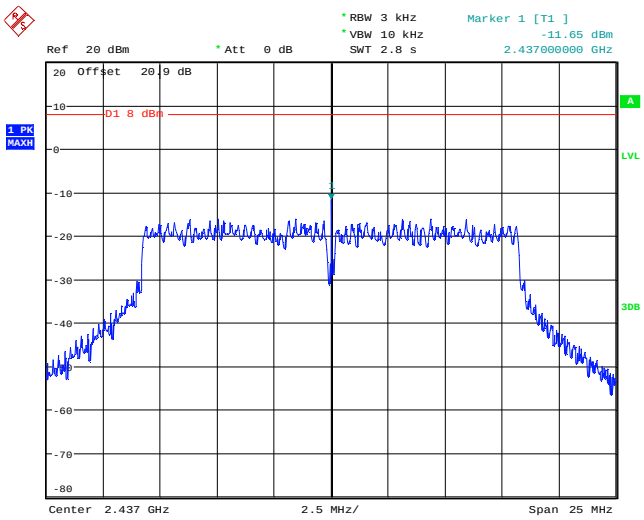


123736_C25.wmf: Power spectral density channel 6 (b-mode)



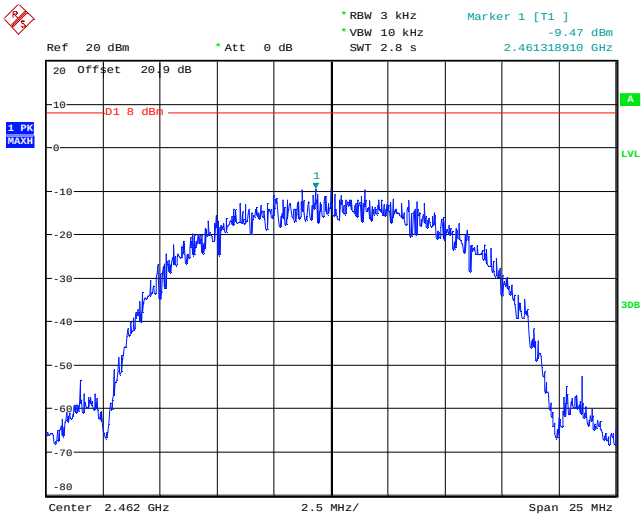
Date: 10.OCT.2012 17:07:30

123736_C26.wmf: Power spectral density channel 6 (g-mode)



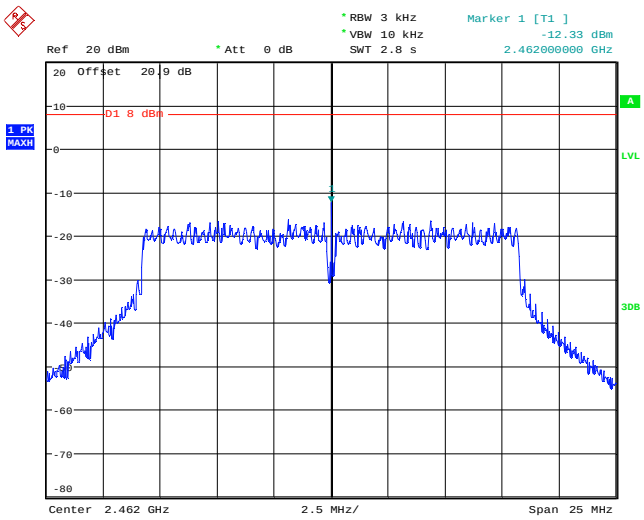
Date: 10.OCT.2012 17:08:29

123736_C27.wmf: Power spectral density channel 11 (b-mode)



Date: 10.OCT.2012 17:10:48

123736_C28.wmf: Power spectral density channel 11 (g-mode)



Date: 10.OCT.2012 17:09:52

Test results power spectral density			
	Ch. 1 (2412 MHz)	Ch. 6 (2437 MHz)	Ch. 11 (2462 MHz)
b-mode	-7.9 dBm	-9.0 dBm	-9.5 dBm
g-mode	-10.8 dBm	-11.7 dBm	-12.3 dBm
Limit: 8 dBm in any 3 kHz band segment			
Measurement uncertainty: +0.66 dB / -0.72 dB			

Test result: Passed

Test equipment used:
30, 75

5.4 Band-edge compliance

5.4.1 Method of measurement

The same test set-up as used for the final radiated emission measurement shall be used (refer also sub clause 5.5 of this test report).

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 first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency line shall be set on the edge of the assigned frequency band. Now set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge (use Marker count function). This frequency shall be measured with the EMI receiver as described in subclause 5.5 of this test report. 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.

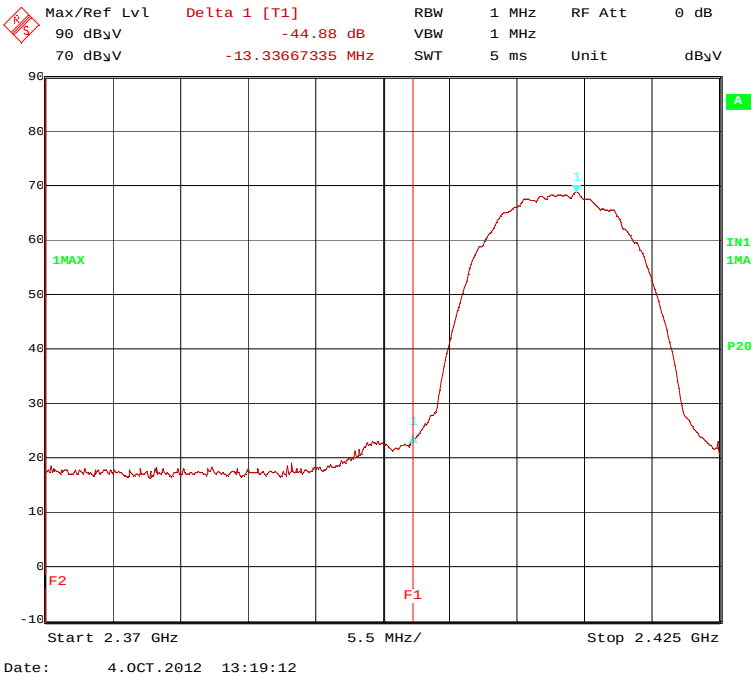
The measurement will be performed at the lower and the upper end of the assigned frequency band. For each WLAN mode the worst case configuration will be tested.

5.4.2 Test result

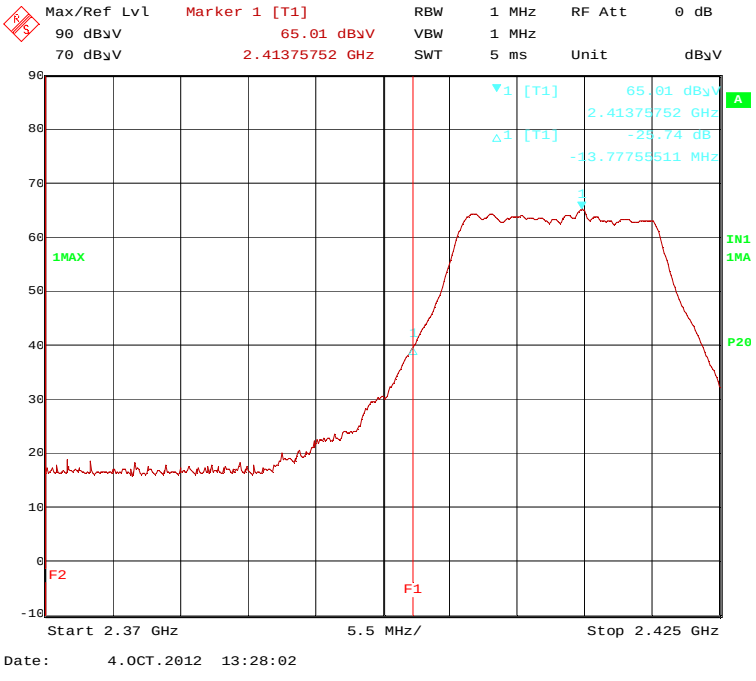
Measurement was carried out radiated at sample with integral antenna.

Ambient temperature	20 °C	Relative humidity	30 %

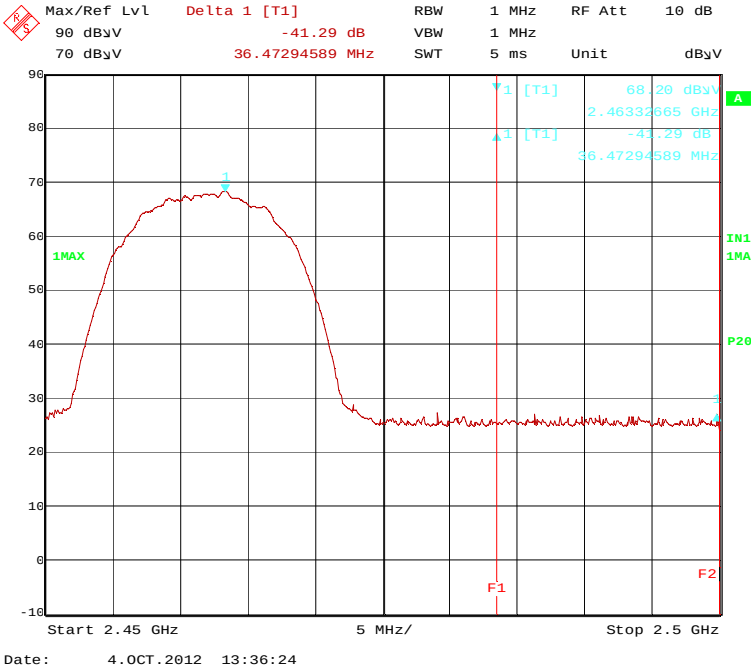
123736_13.wmf: Radiated band-edge compliance, lower band edge (b-mode):



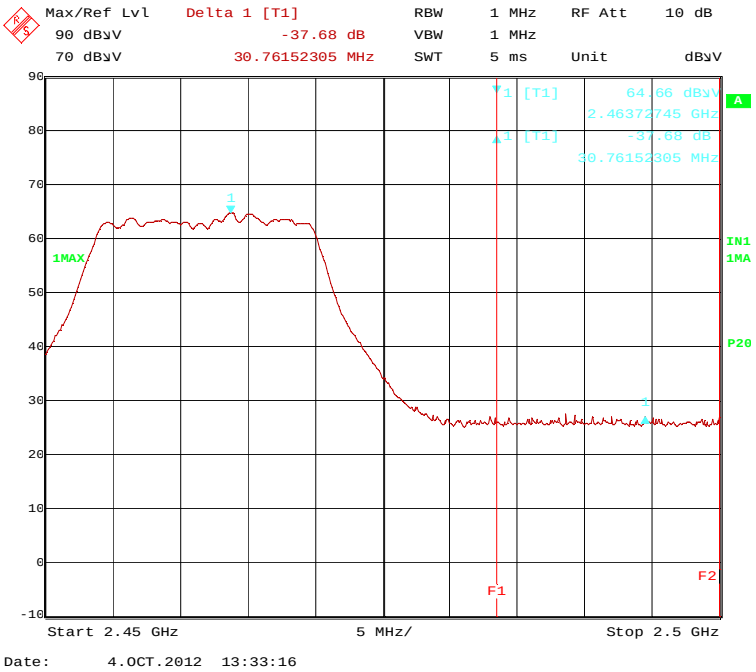
123736_14.wmf: Radiated band-edge compliance, lower band edge (g-mode):



123736_16.wmf: Radiated band-edge compliance, upper band edge (b-mode):



123736_15.wmf: Radiated band-edge compliance, upper band edge (g-mode):



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. b-mode)											
Result measured with the peak detector:											
Frequency MHz	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.
2413	99.5	-	-	67.4	28.4	0.0	3.7	150	Hor.	-	1
2400	58.7	79.5	20.8	26.7	28.3	0.0	3.7	150	Hor.	No	1
Result measured with the average detector:											
Frequency MHz	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.
2413	91.0	-	-	58.9	28.4	0.0	3.7	150	Hor.	-	1
2400	46.2	71.0	24.8	14.2	28.3	0.0	3.7	150	Hor.	No	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (lower band edge. g-mode)											
Result measured with the peak detector:											
Frequency MHz	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.
2414	95.9	-	-	63.8	28.4	0.0	3.7	150	Hor.	-	1
2400	69.4	75.9	6.5	37.4	28.3	0.0	3.7	150	Hor.	No	1
Result measured with the average detector:											
Frequency MHz	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.
2414	84.4	-	-	52.3	28.4	0.0	3.7	150	Hor.	-	1
2400	50.4	64.4	14.0	18.4	28.3	0.0	3.7	150	Hor.	No	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. b-mode)											
Result measured with the peak detector:											
Frequency MHz	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.
2463	99.3	-	-	67.1	28.5	0.0	3.7	150	Hor.	-	1
2500	57.8	74.0	16.2	25.5	28.5	0.0	3.8	150	Hor.	Yes	1
Result measured with the average detector:											
Frequency MHz	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.
2463	90.9	-	-	58.7	28.5	0.0	3.7	150	Hor.	-	1
2500	44.6	54.0	9.4	12.3	28.5	0.0	3.8	150	Hor.	Yes	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. g-mode)											
Result measured with the peak detector:											
Frequency MHz	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.
2464	95.5	-	-	63.3	28.5	0.0	3.7	150	Hor.	-	1
2494	58.4	74.0	15.6	26.1	28.5	0.0	3.8	150	Hor.	Yes	1
Result measured with the average detector:											
Frequency MHz	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.
2464	84.2	-	-	52.0	28.5	0.0	3.7	150	Hor.	carrier	1
2494	44.6	54.0	9.4	12.3	28.5	0.0	3.8	150	Hor.	Yes	1
Measurement uncertainty							+2.2 dB / -3.6 dB				

Test: Passed

Test equipment used:
29, 31 – 34, 36, 47

5.5 Radiated emissions

5.5.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into six 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.
- A final measurement carried out on an outdoor test site without reflecting ground plane and a fixed antenna height in the 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.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna heights in the 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 110 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

All measurements will be carried out with the EUT working on the middle and upper and lower edge of the assigned frequency band.

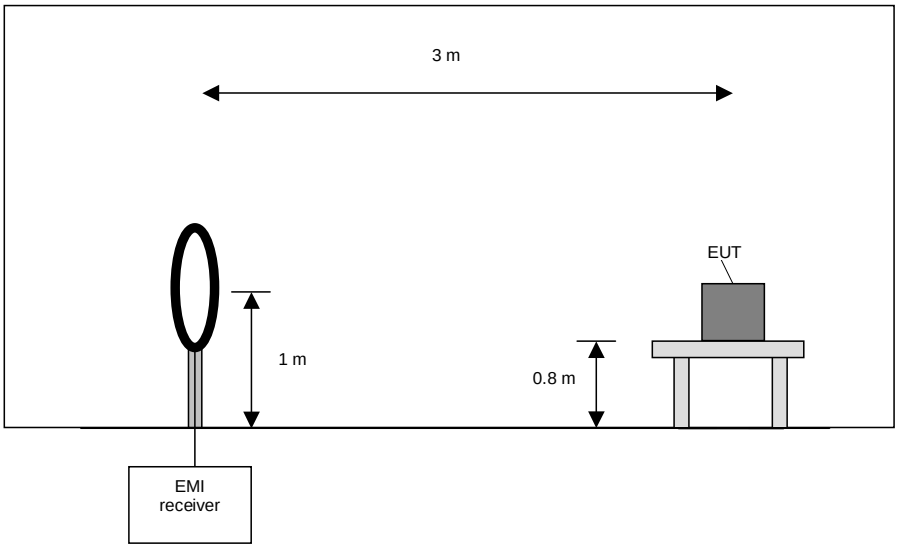
Preliminary measurement (9 kHz to 30 MHz):

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).

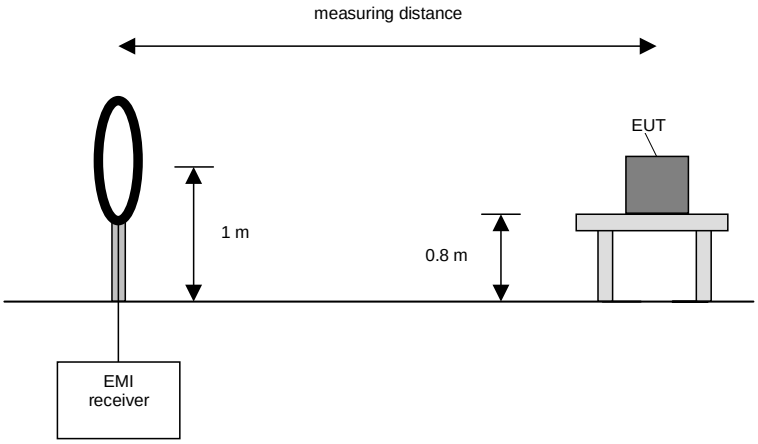
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an outdoor test site with no conducting ground plane in measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

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

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



Final measurement procedure:

The following procedure will be used:

1) Monitor the frequency range with the measuring antenna at “face-to-face” orientation parallel to the EUT at an azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
3) Rotate the measuring antenna to find the maximum and note the value.
4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT if applicable (handheld equipment).

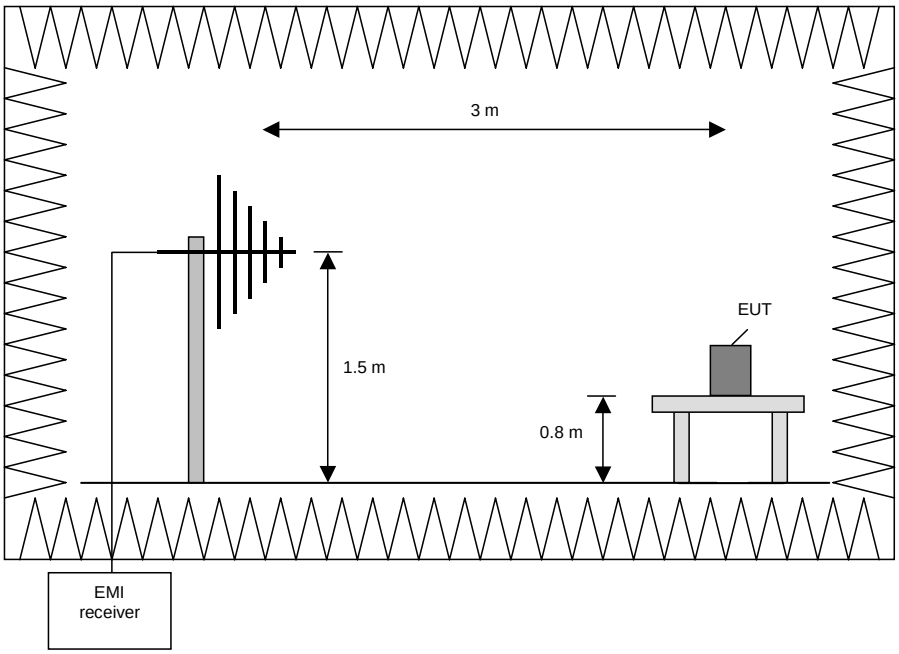
Preliminary measurement (30 MHz to 1 GHz)

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:

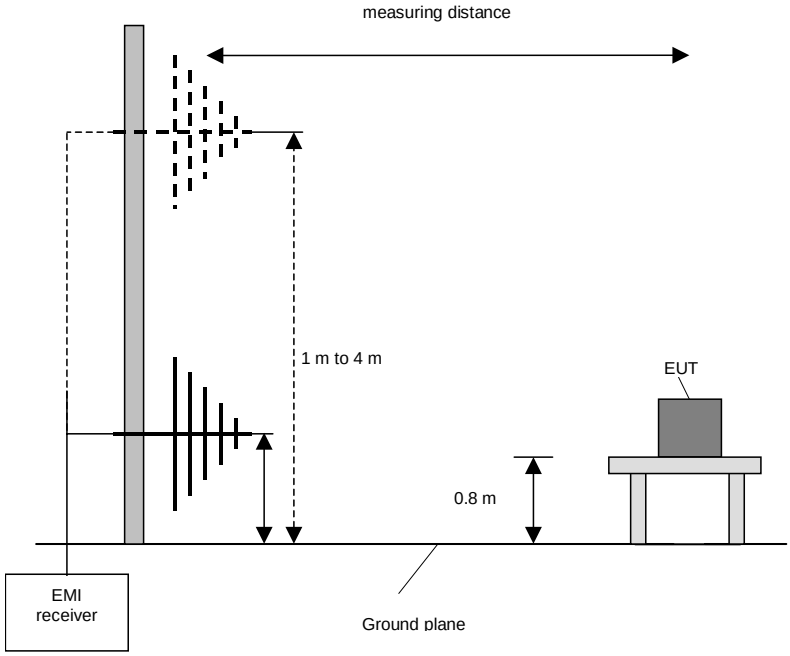
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the 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 (because of EUT is a module and might be used in a handheld equipment application).
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 (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 110 GHz)

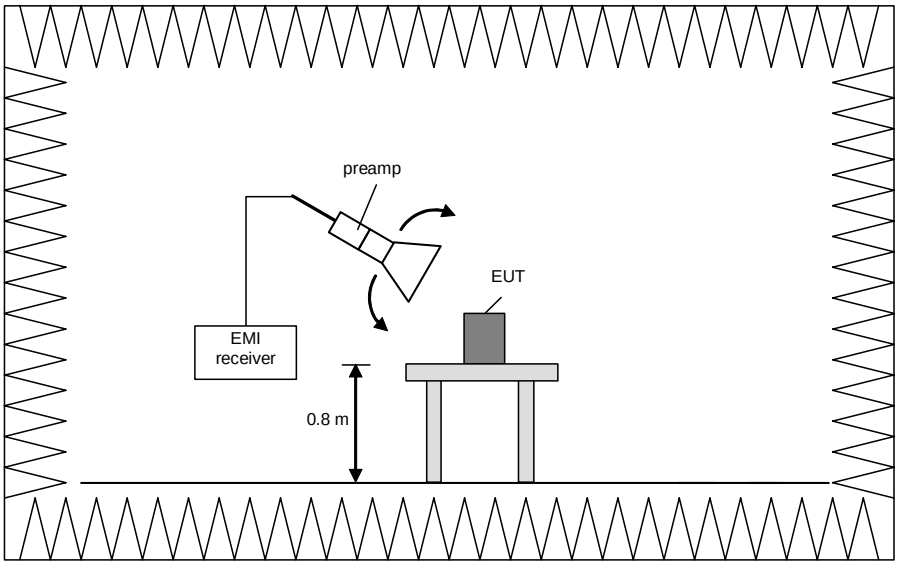
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 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 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz
40 GHz to 60 GHz	100 kHz
50 GHz to 75 GHz	100 kHz
75 GHz to 110 GHz	100 kHz

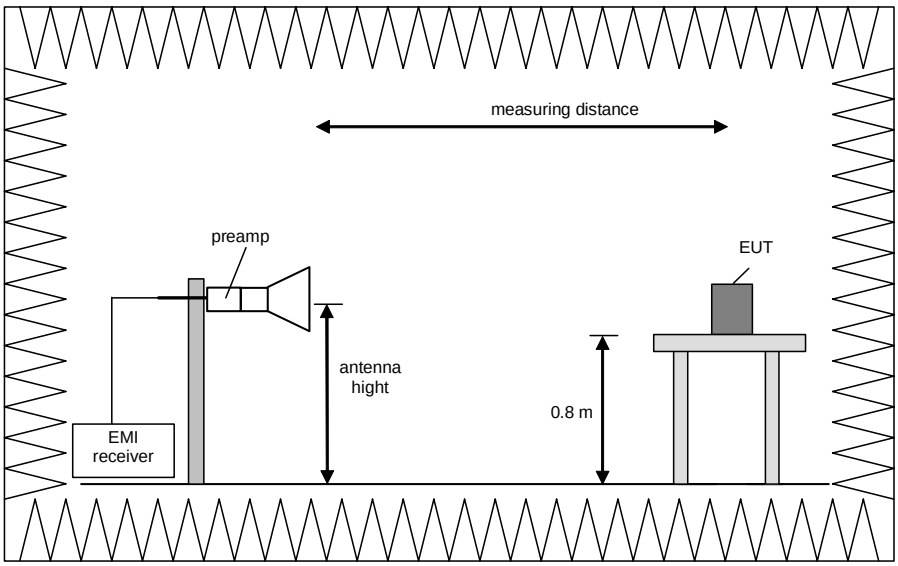


Final measurement (1 GHz to 110 GHz)

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 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 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 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 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

5.5.2.1 Preliminary radiated emission measurement (9 kHz to 1 GHz)

Ambient temperature	20 °C	Relative humidity	40 %

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.

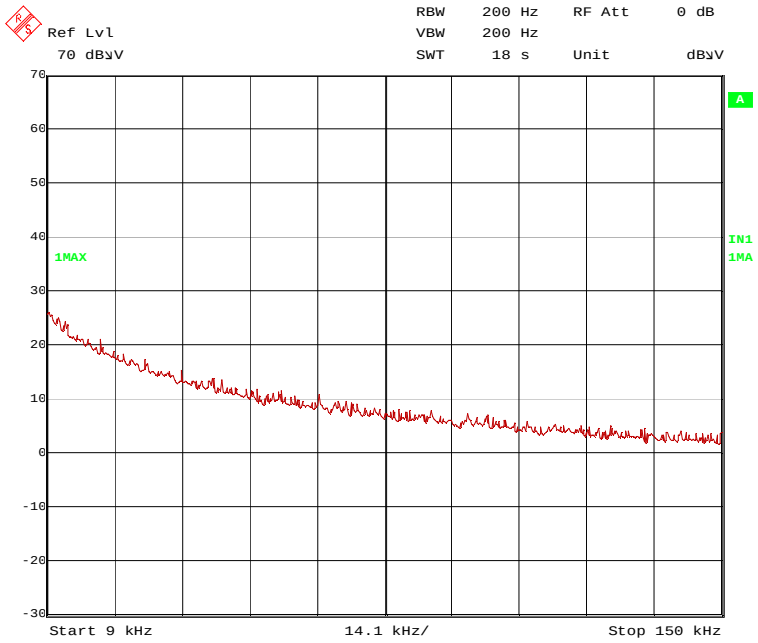
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

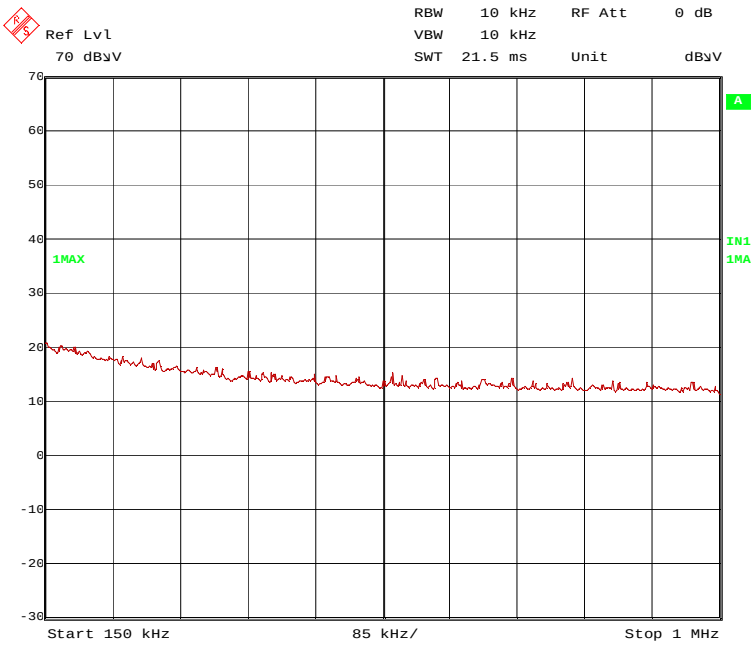
Supply voltage: During all measurements the EUT was supplied with 12 V_{DC}.

Remark: As pre-tests have shown the emission in the frequency range 9 kHz to 30 MHz are independent of the operation mode. Therefore all emission measurements were performed in operation mode 3.

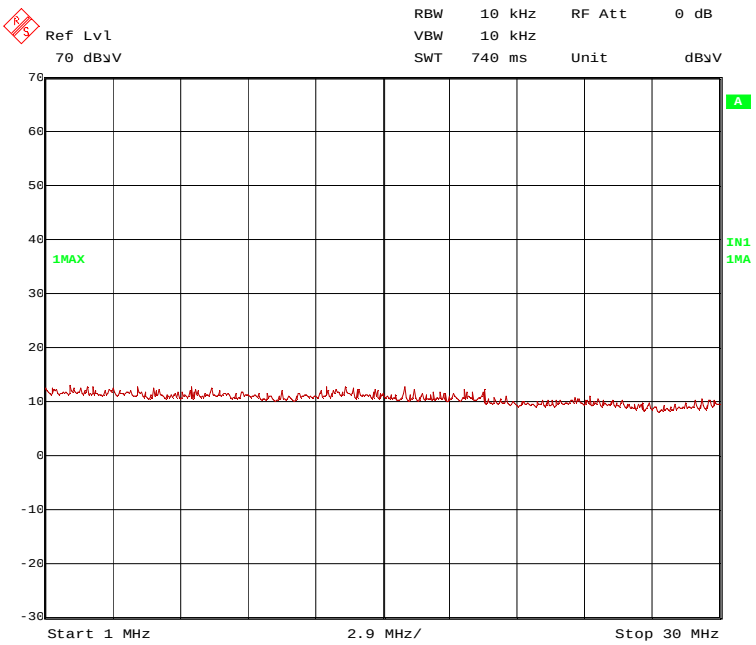
123736_31.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 3):



123736_32.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 3):



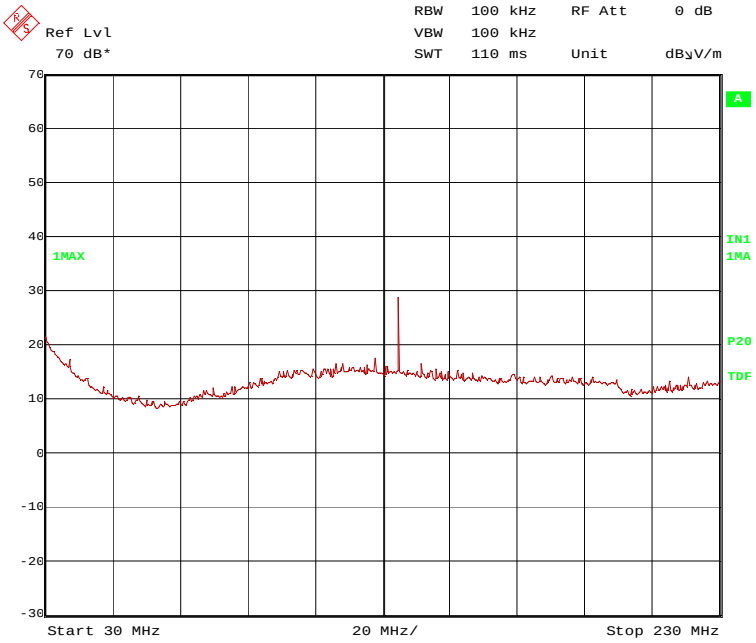
123736_33.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 3):



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.

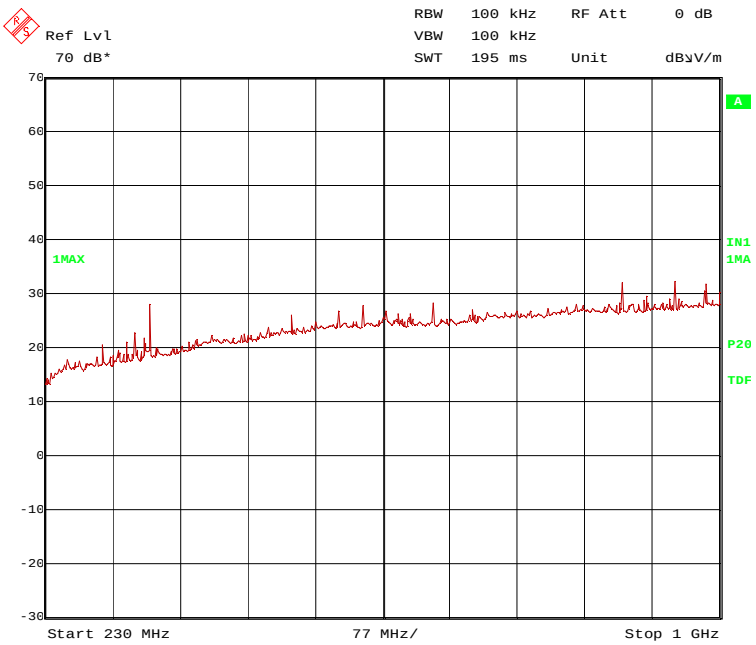
Test equipment used:
29, 31 – 34, 55

123736_17.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



The following frequency was found inside restricted bands during the preliminary radiated emission test: 134.556 MHz.

123736_18.wmf: Spurious emissions from 230 MHz to 1000 MHz (operation mode 3):



The following frequencies were found outside the restricted bands during the preliminary radiated emission test: 349.871 MHz, 888.096 MHz and 948.697 MHz.

It was necessary to carry out a final measurement on the open area test site at the frequencies found in the preliminary measurement. The results are shown in the following.

Test equipment used:
29, 31 – 34, 35

5.5.2.2 Final radiated emission measurement (30 MHz to 1 GHz)

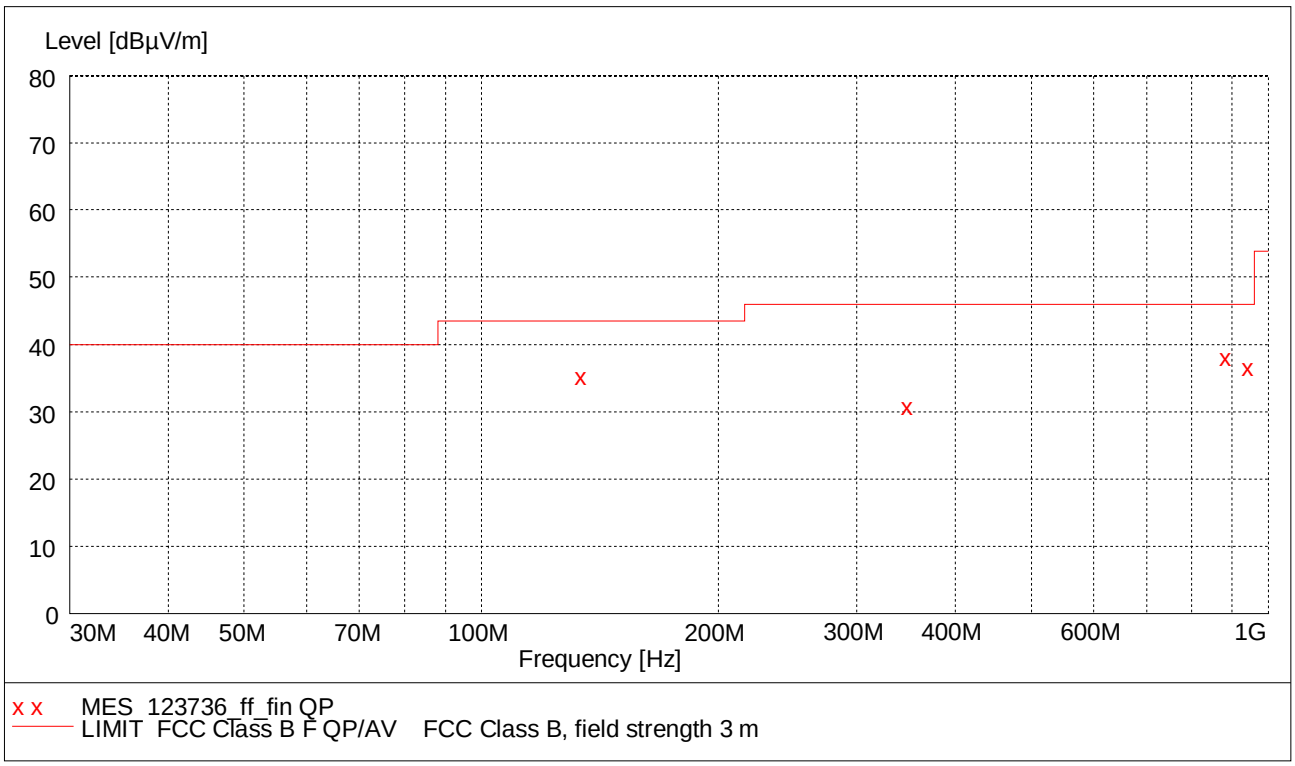
Ambient temperature	20 °C	Relative humidity	30 %

Position of EUT: The EUT was set up in its usually position.

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 battery supplied with 12 V_{DC}.



Result measured with the quasipeak detector (marked by an x):

Frequency MHz	Level dBµV/m	Transducer dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
134.556000	35.60	13.7	43.5	7.9	209.0	270.00	HORIZONTAL
349.871000	31.20	17.2	46.0	14.8	100.0	244.00	HORIZONTAL
888.096000	38.50	27.0	46.0	7.5	148.0	193.00	VERTICAL
948.697000	36.90	29.1	46.0	9.1	256.0	226.00	VERTICAL

Test result: Passed.

Test equipment used:
14 - 20

5.5.2.3 Preliminary radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	20 °C	Relative humidity	30 %

Position of EUT: The EUT was set up in its usually position.

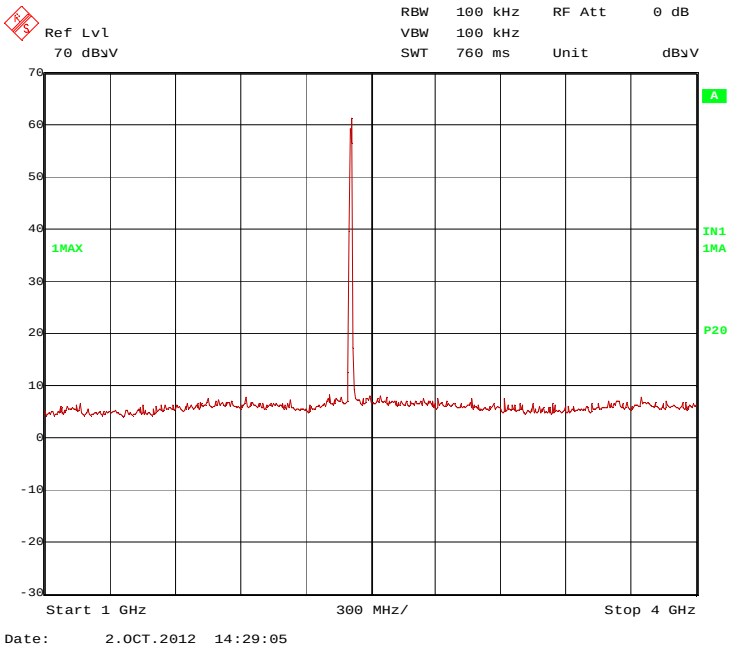
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

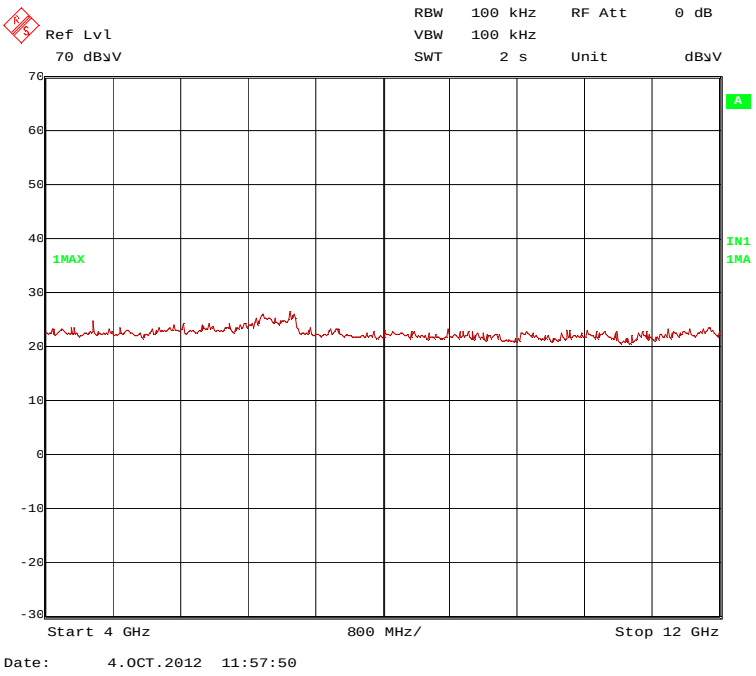
Supply voltage: During all measurements the EUT was supplied with 12 V_{DC}.

Transmitter operates at channel 1 (b-Mode)

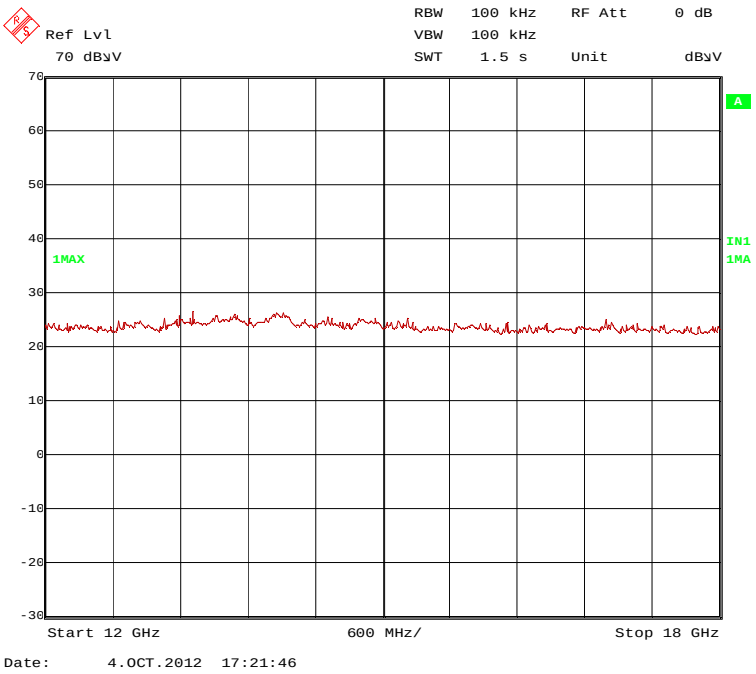
123736_1.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



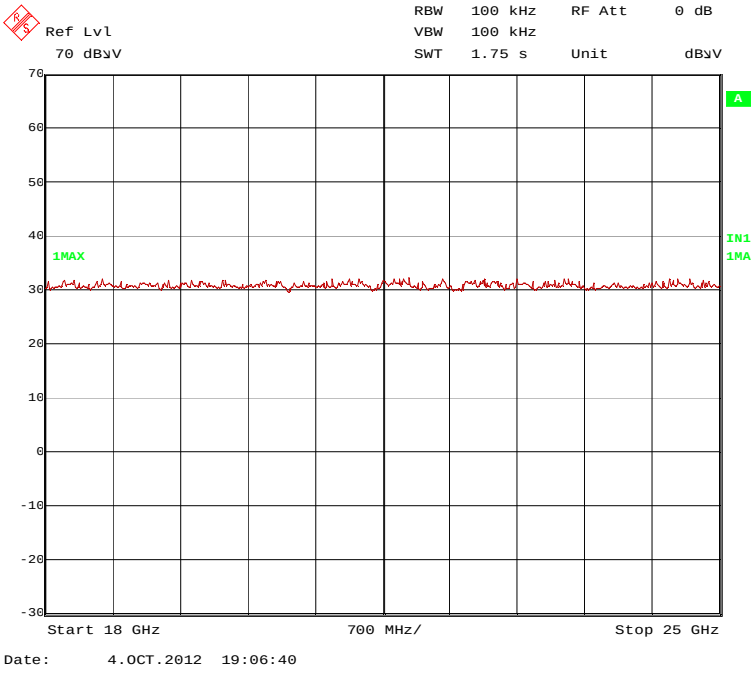
123736_7.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



123736_19.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):

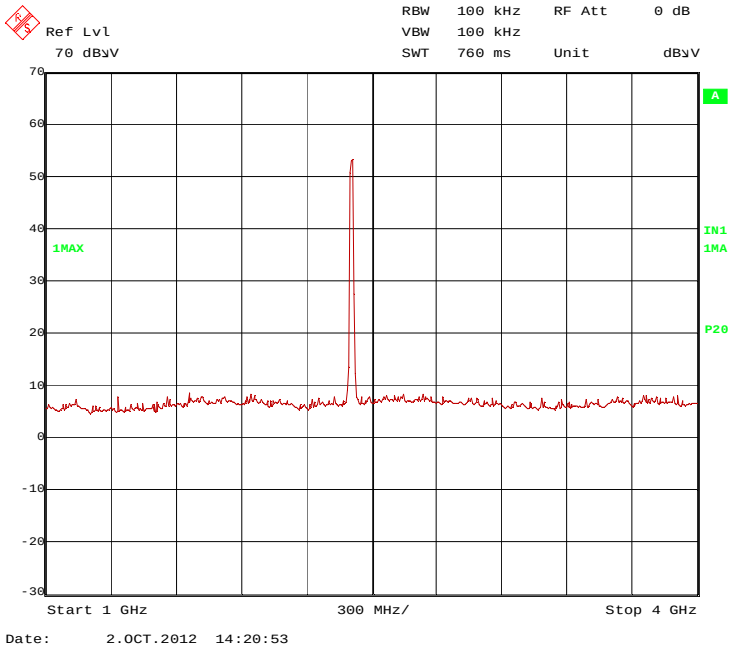


123736_30.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):

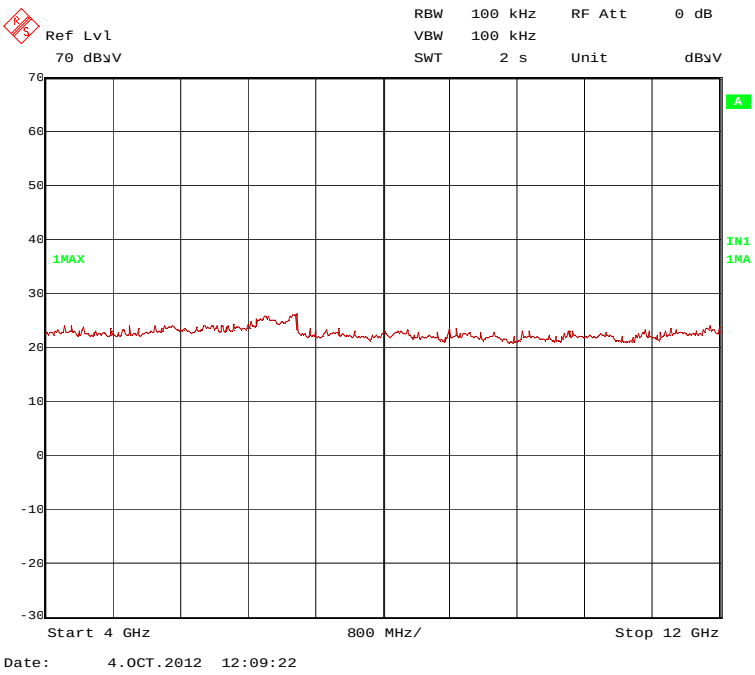


Transmitter operates at channel 1 (g-Mode)

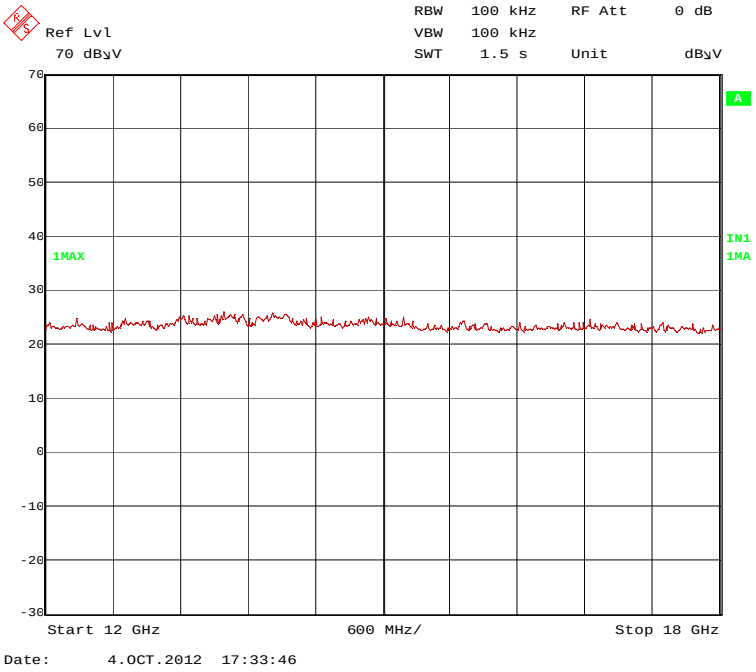
123736_2.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 4):



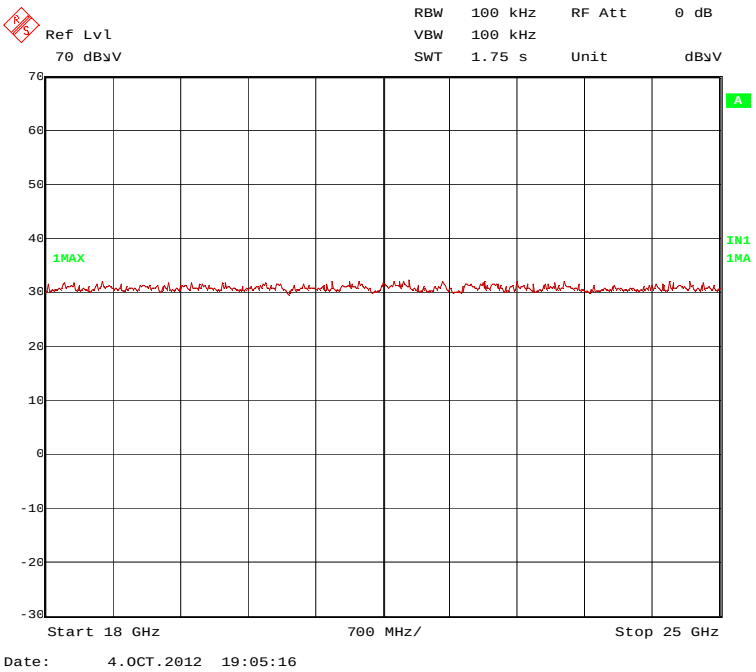
123736_8.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 4):



123736_20.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 4):

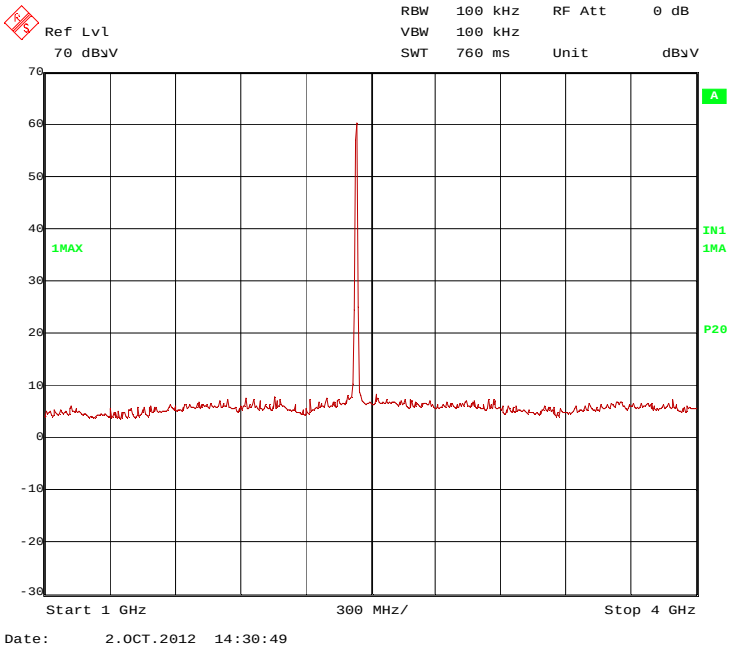


123736_29.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 4):

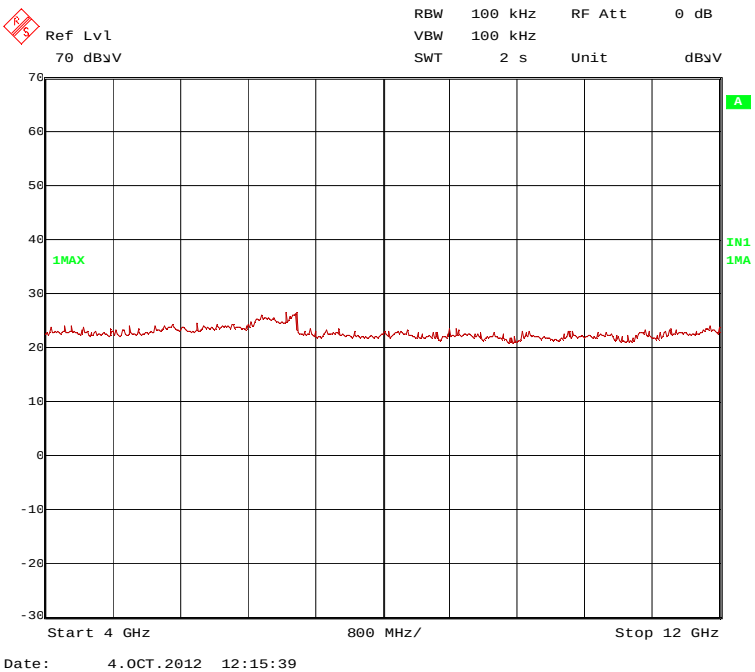


Transmitter operates at channel 6 (b-Mode)

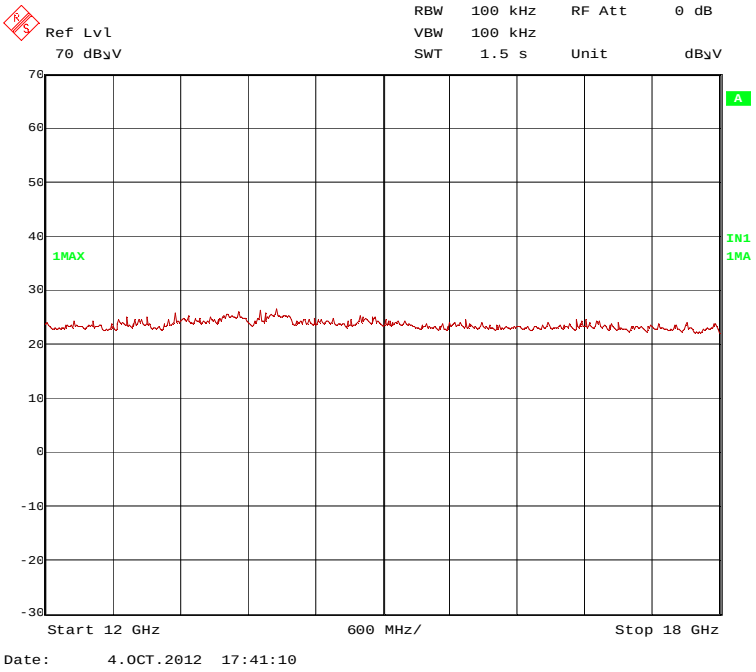
123736_3.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



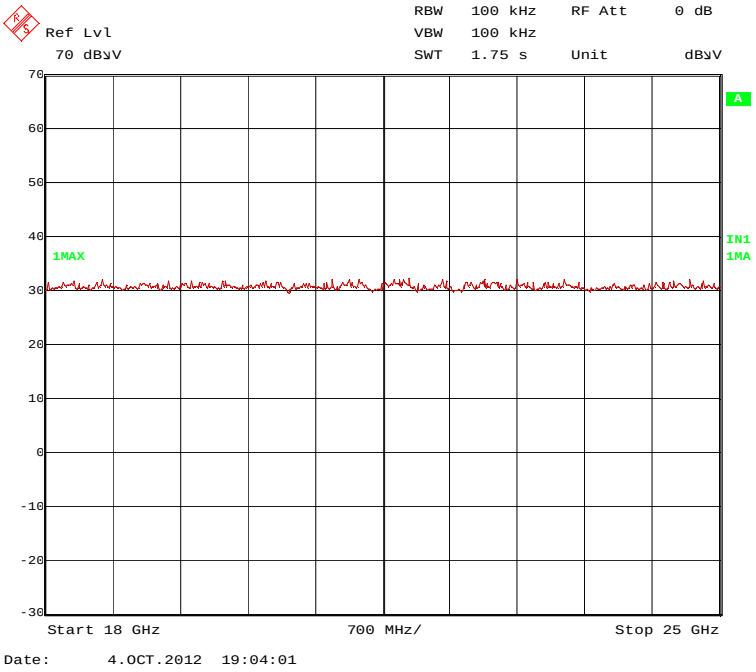
123736_9.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



123736_21.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):

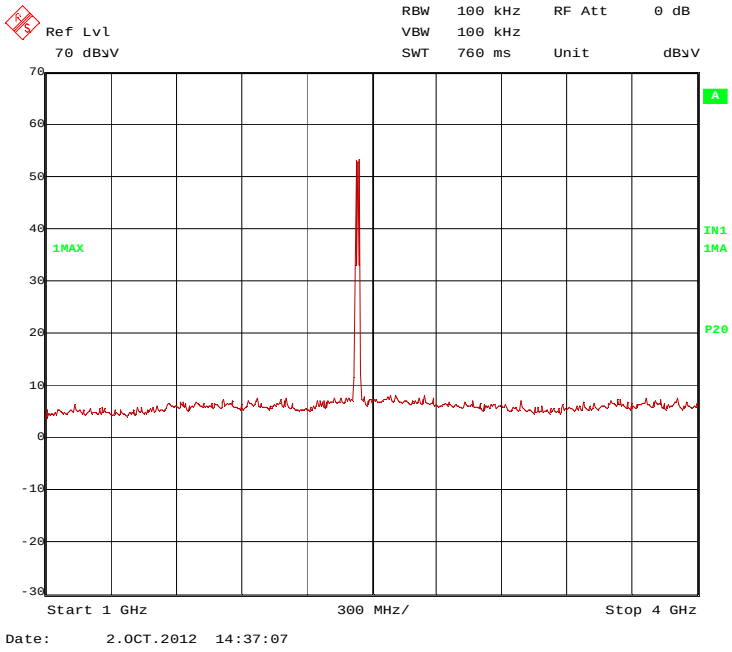


123736_28.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):

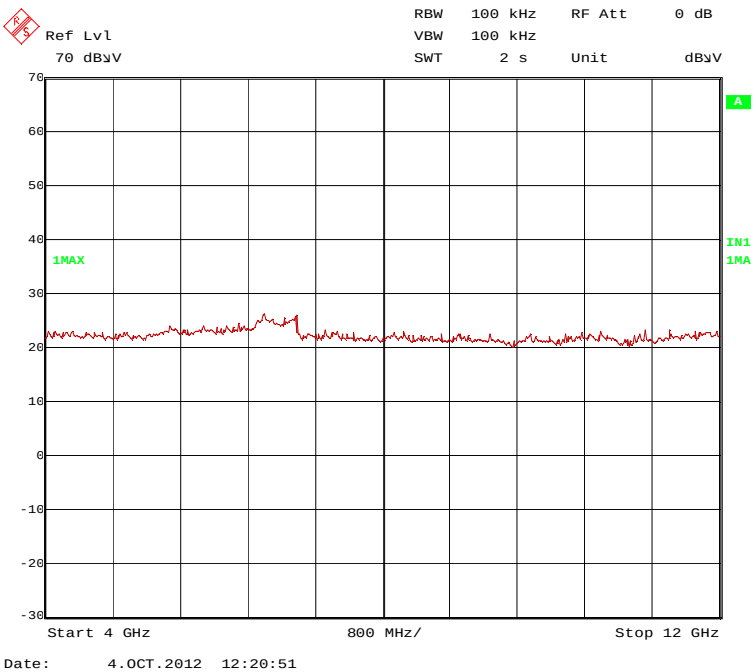


Transmitter operates aat channel 6 (g-Mode)

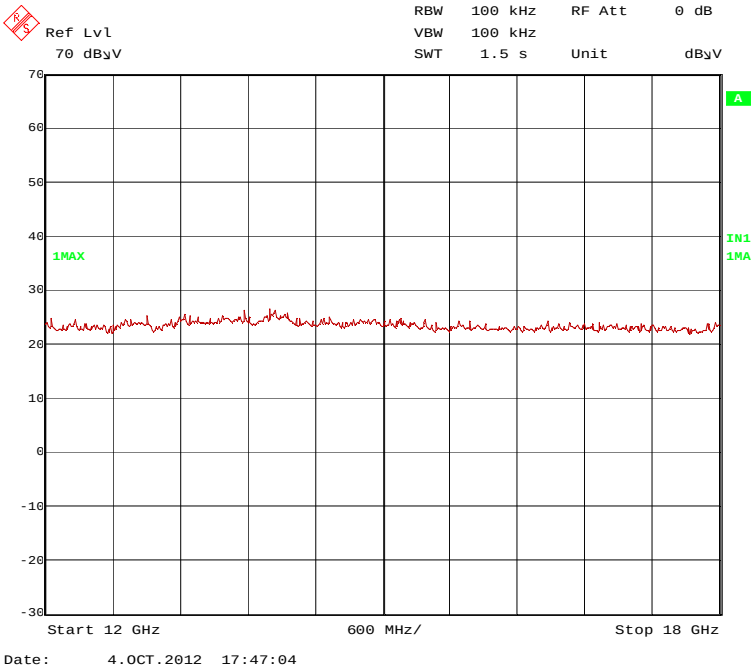
123736_4.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 5):



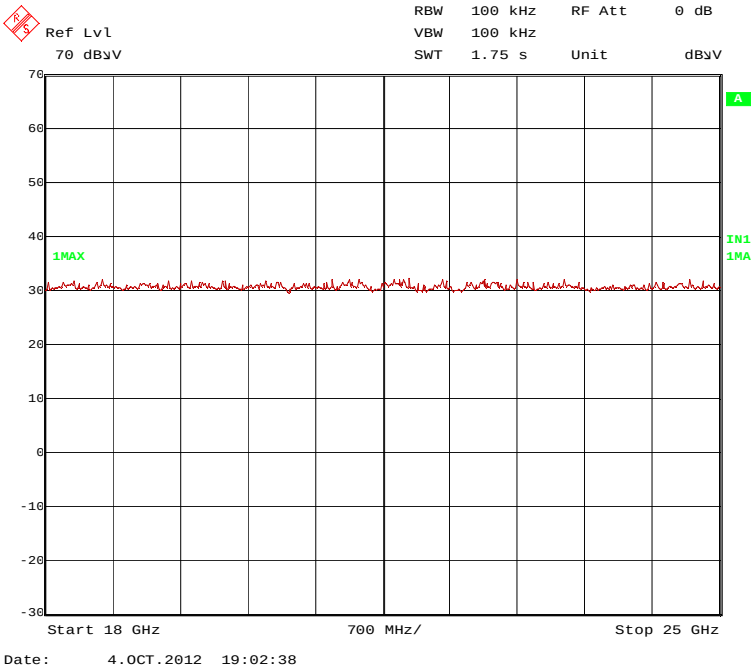
123736_10.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 5):



123736_22.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 5):

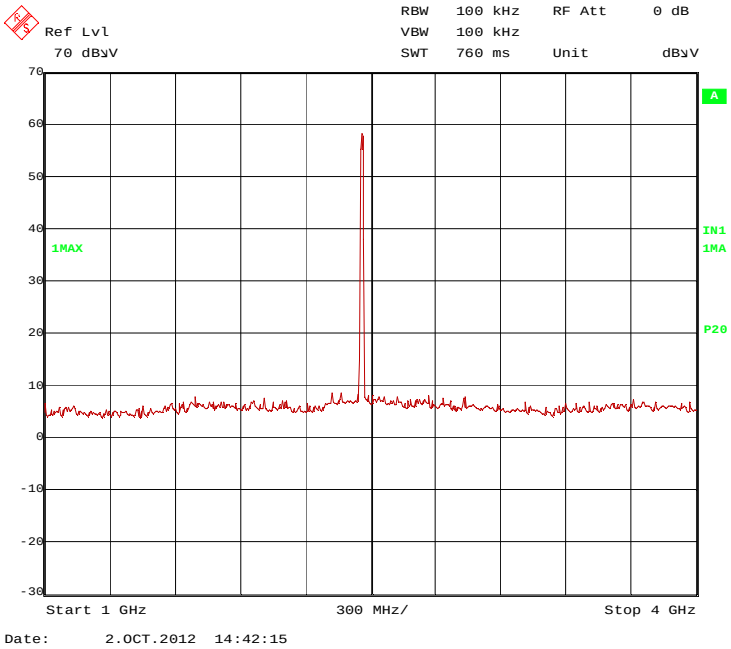


123736_27.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 5):

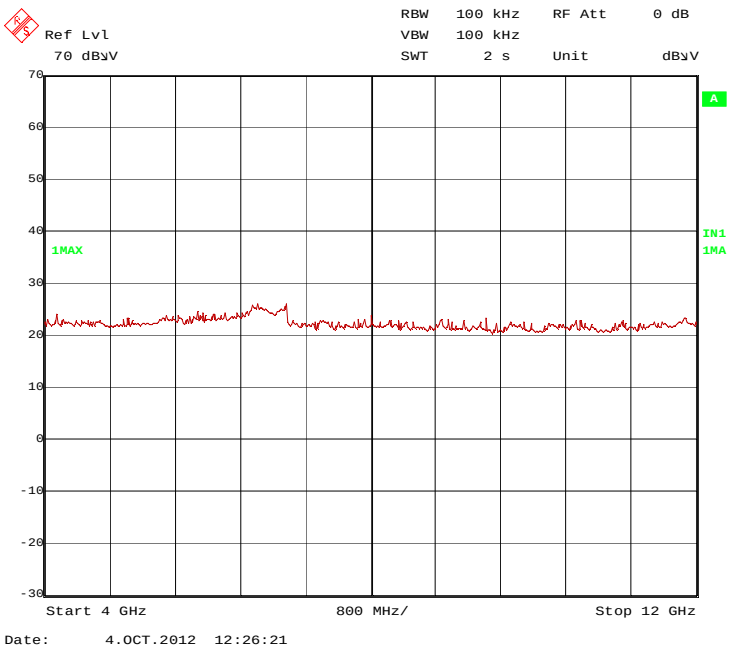


Transmitter operates channel 11 (b-Mode)

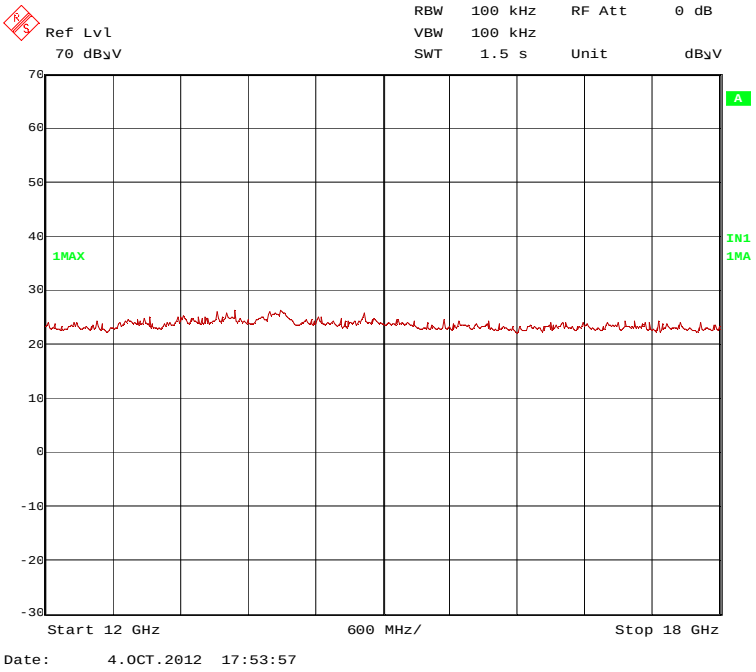
123736_6.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



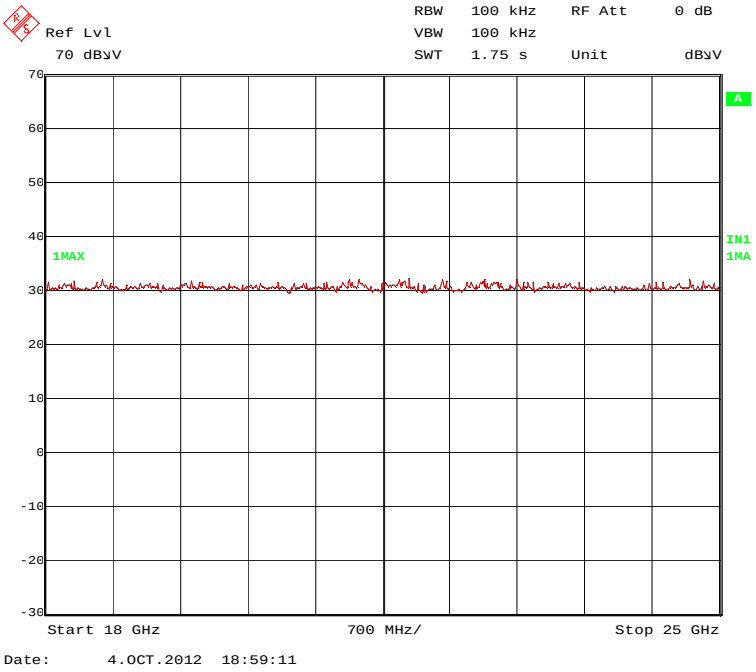
123736_11.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



123736_23.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):

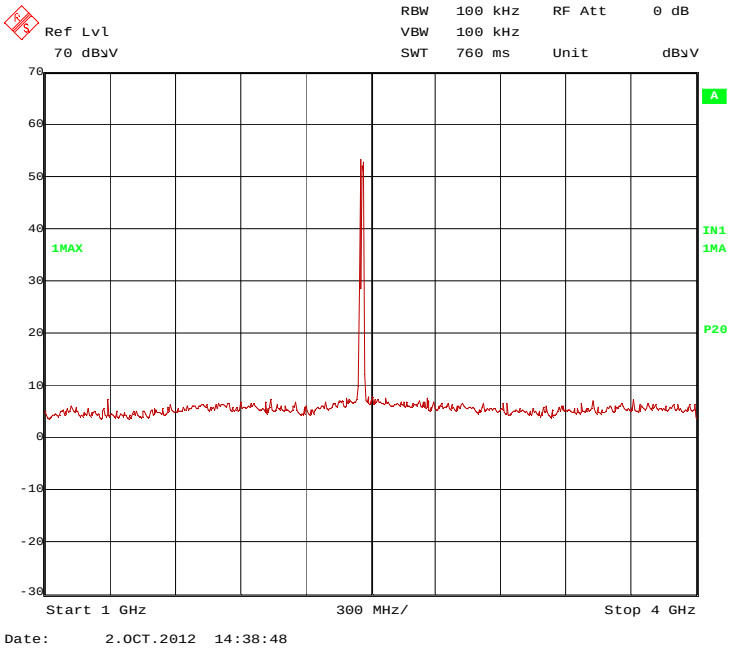


123736_26.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 3):

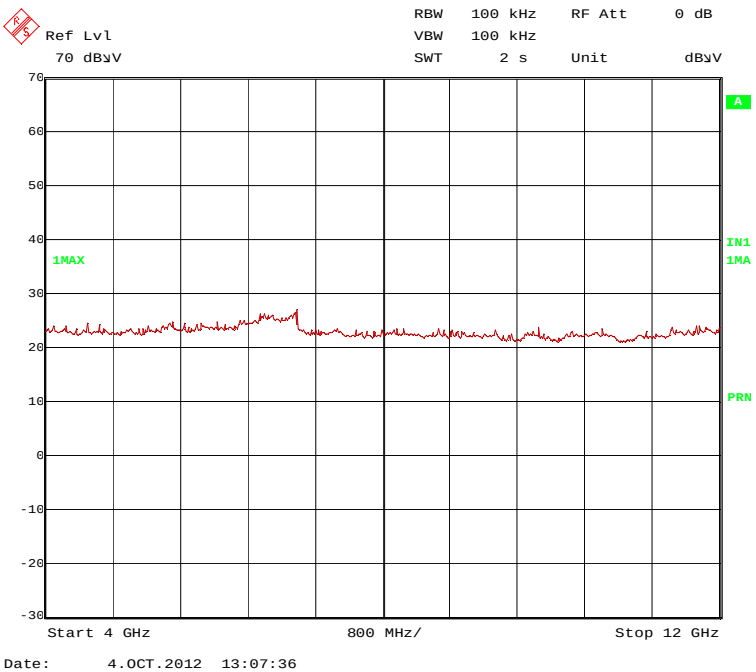


Transmitter operates at channel 11 (g-Mode)

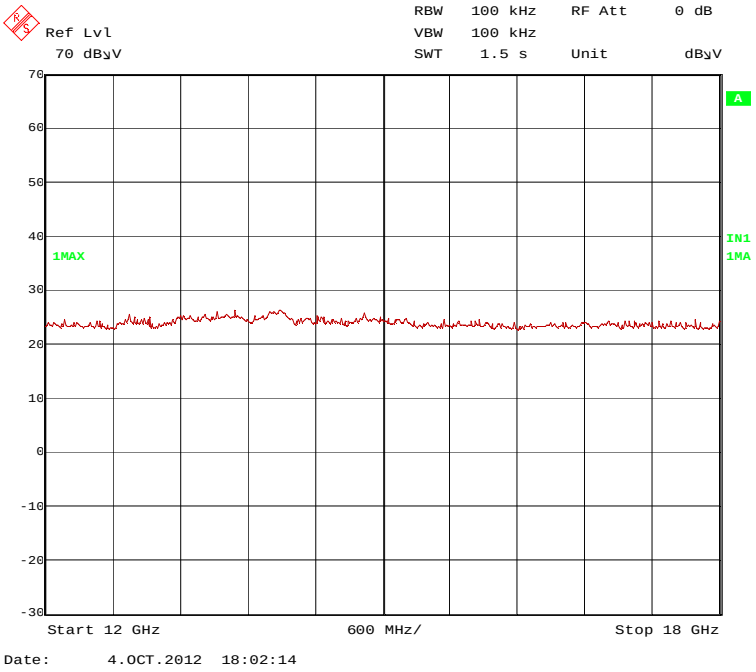
123736_5.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 6):



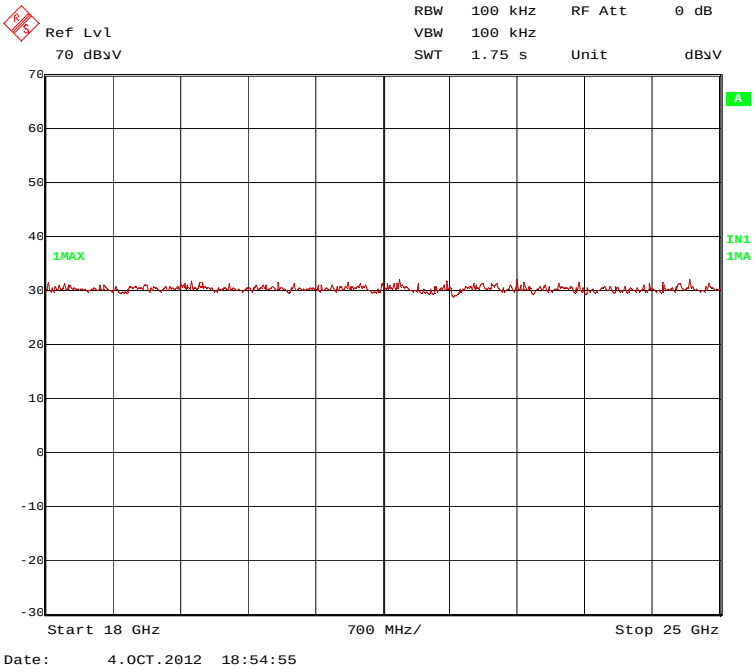
123736_12.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 6):



123736_24.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 6):



123736_25.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 6):



TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 34, 36, 37, 39, 41 - 43, 44, 46, 49 - 51, 72

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

Ambient temperature	20 °C	Relative humidity	30 %

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 12 V_{DC}.

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

Transmitter operates at channel 1 in b-mode (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.
2.412	98.3	-	-	66.2	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.412	90.9	-	-	58.8	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at channel 6 b-mode (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.
2.442	97.7	-	-	65.6	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.442	90.0	-	-	57.9	28.4	0.0	3.7	150	Hor..	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at channel 11 b-mode (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.
2.462	93.8	-	-	61.6	28.5	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.462	86.4	-	-	54.2	28.5	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at channel 1 g-mode (operation mode 4)

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.
2.412	108.2	-	-	76.1	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.412	97.2	-	-	65.1	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at channel 11 g-mode (operation mode 5)

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.
2.437	91.2	-	-	59.1	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.437	81.8	-	-	49.7	28.4	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at channel 11 g-mode (operation mode 6)

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.
2.462	91.0	-	-	58.8	28.5	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
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.
2.462	81.8	-	-	49.6	28.5	0.0	3.7	150	Hor.	-	1
No significant spurious emissions found.											
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
29, 31 –34, 36, 37, 39, 44, 49, 72

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
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	MCU	Maturo	MCU/043/971107	480832	-	-
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	28/09/2011	09/2014
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	480670	Weekly verification (system cal.)	
42	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B	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	480865	Weekly verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (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

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	
73	Power meter	NRVD	Rohde & Schwarz	833697/030	480589	02/15/2012	02/2014
74	Peak power sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	02/15/2012	02/2014
75	Attenuator	WA8/18-20-34	Weinschel	-	481451	Six month verification (system cal.)	

7 REPORT HISTORY

Report Number	Date	Comment
F123736E1	15 October 2012	Document created

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123736_5.jpg	Test set-up fully anechoic chamber
123736_6.jpg	Test set-up open area test site

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123736_25.jpg	Evaluation board, bottom view
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123736_21.jpg	Audi MIB, type plate 2, sample radiated measurements
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123736_28.jpg	Audi MIB, top view with removed UMTS module
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123736_30.jpg	Audi MIB, CD/DVD drive removed, top view
123736_31.jpg	Audi MIB, main PCB, bottom view
123736_32.jpg	Audi MIB, left hand view with removed top cover
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