PHOENIX TESTLAB
Königswinkel 10
32825 Blomberg, Germany
Phone +49 (0) 52 35 95 00-0
Fax +49 (0) 52 35 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F160090E1

Equipment under Test (EUT):

Harman/Becker Audi MIB 2
Main Unit of Modular Infotainment Kit

Applicant:

Harman Becker Automotive Systems GmbH

Manufacturer:

Harman Becker Automotive Systems GmbH

ilac-MRA DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.10-2013,** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

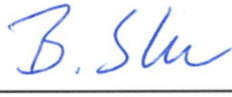
[2] **FCC CFR 47 Part 15 (June 2015),** Radio Frequency Devices

[3] **RSS-247 (May 2015),** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 4 (November 2014),** General Requirements for Compliance of Radio Apparatus

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		29.04.2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		29.04.2016
	Name	Signature	Date

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 generalisations 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.

This test report is valid in hardcopy form as well as in electronic form.

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1 Identification

1.1 Applicant

Name:	Harman Becker Automotive Systems GmbH
Address:	Becker-Göring-Str. 16, 76307 Karlsbad
Country:	Germany
Name for contact purposes:	Mr. Stefan BLASCHEK
Phone:	+49 7248 71 3382
Fax:	+49 7248 71 3802
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
Country:	Germany
Name for contact purposes:	Mr. Stefan BLASCHEK
Phone:	+49 7248 71 3382
Fax:	+49 7248 71 3802
eMail Address:	stefan.blaschek@harman.com
Applicant represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02.

1.4 EUT (Equipment Under Test)

Test object: *	IEEE 802.11/b/g/n WLAN / BT 3.0 + HS transceiver
Model / PMN: *	MIB2 Main-Unit
Host Marketing Name: *	N. A.
FCC ID: *	T8GA270
IC: *	6434A-A270
Serial number: *	P074KB0FB000474
PCB identifier / HVIN: *	MIB2 Main-Unit
Hardware version: *	HW50
Software version / FVIN: *	R5447

WLAN channels:

Channel 01	RX:	2412 MHz	TX:	2412 MHz
Channel 02	RX:	2417 MHz	TX:	2417 MHz
Channel 03	RX:	2422 MHz	TX:	2422 MHz
Channel 04	RX:	2427 MHz	TX:	2427 MHz
Channel 05	RX:	2432 MHz	TX:	2432 MHz
Channel 06	RX:	2437 MHz	TX:	2437 MHz
Channel 07	RX:	2442 MHz	TX:	2442 MHz
Channel 08	RX:	2447 MHz	TX:	2447 MHz
Channel 09	RX:	2452 MHz	TX:	2452 MHz
Channel 10	RX:	2457 MHz	TX:	2457 MHz
Channel 11	RX:	2462 MHz	TX:	2462 MHz

Bluetooth channels

Channel 0	RX:	2402 MHz	TX:	2402 MHz
Channel 39	RX:	2441 MHz	TX:	2441 MHz
Channel 78	RX:	2480 MHz	TX:	2480 MHz

1.5 Technical Data of Equipment

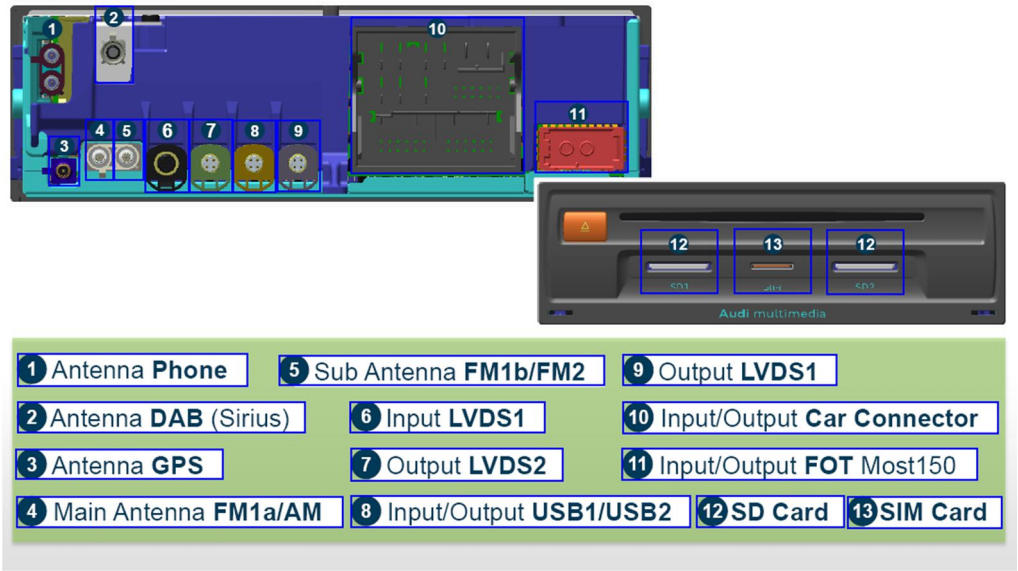
Fulfills Radio specification: *	WLAN IEEE, 802.11b, 802.11g, 802.11n, / Bluetooth 3.0 + HS
Antenna type (Bluetooth/WLAN) :*	PCB Antenna
Antenna gain (Bluetooth): *	-2.7 dBi
Antenna gain (WLAN): *	-0.8 dBi
Antenna connector: *	none
Power supply - EUT	12 V DC by vehicle
Type of modulation: *	DSSS; OFDM
Operating frequency range:*	2412 MHz to 2462 MHz
Number of channels: *	11
Temperature range: *	- 20 °C to +55 °C
Lowest / highest internal clock frequency: *	32.768 kHz / 900 MHz

*Declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
Cable Harness/Main-Connector DC Port Debug Interface AudioOutput CAN (I-CAN) to CAN-Box CAN (BT-MIB) to Display	10 Car Connector	PowerSupply Debug Interface (LevelShifterBoard) AudioOutput CAN (I-CAN) to CAN-Box CAN (BT-MIB) to Display	about 80cm about 20cm about 30cm about 30+90cm about 30+50cm
Antenna GPS	3 Antenna GPS	type „Wisi AG13“	About 180cm
LVDS Output	7 Output LVDS	Front Display	about 100cm
Most Bus	11 FOT MOST 150	No ext. MOST comp.	closed ring
USB	Level Shifter	To test PC	about 150cm

*: Length during the test if not other specified.



1.6 Dates

Date of receipt of test sample:	18.01.2016
Start of test:	05.02.2016
End of test:	29.02.2016

2 Operational States

The EUT is a main unit of a modular infotainment kit for cars with a GSM/UMTS module as well as a WLAN (802.11 b/g/n, 2.4 GHz) and Bluetooth module with separate integral antennas for WLAN and Bluetooth. In IEEE 802.11n mode it supports 20 MHz bandwidth channels (MCS7), providing 72.2 Mbit/s data rate.

The aim of this report is a class 2 permissive change, because the applicant has added an additional display in front of the EUT. For this the radiated output power is checked and on spot frequencies the spurious emission measurement was repeated.

The output power of the WLAN part was reduced intentionally by the grantee as documented in chapter 5.1.2 of this report.

Only the two worst case results for Bluetooth were repeated in this test report.

Operation mode	Description of the operation mode	BT mode	BT channel	Modulation	Data rate
1	Continuous transmitting on 2402 MHz	3DH5	0	8DQPSK	3 MBit/s
2	Continuous transmitting on 2441 MHz	2DH5	39	PI/4 DQPSK	2 MBit/s

Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate
3	Continuous transmitting on 2412 MHz	802.11b	1	DSSS	11 MBit/s
4	Continuous transmitting on 2437 MHz	802.11b	6	DSSS	11 MBit/s
5	Continuous transmitting on 2462 MHz	802.11b	11	DSSS	11 MBit/s
Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate
6	Continuous transmitting on 2412 MHz	802.11g	1	OFDM	6 MBit/s
7	Continuous transmitting on 2437 MHz	802.11g	6	OFDM	6 MBit/s
8	Continuous transmitting on 2462 MHz	802.11g	11	OFDM	6 MBit/s
Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate
9	Continuous transmitting on 2412 MHz	802.11n20	1	OFDM	72.2 MBit/s
10	Continuous transmitting on 2437 MHz	802.11n20	6	OFDM	72.2 MBit/s
11	Continuous transmitting on 2462 MHz	802.11n20	11	OFDM	72.2 MBit/s

Each test case was performed in the following operation modes:

Test case	Operation mode
Maximum Peak Output Power	1, 3 - 11
DTS Bandwidth	Not performed *
Peak Power Spectral Density	Not performed*
Band Edge Compliance	11
Maximum Unwanted Emissions	2, 6

* Not tested because not necessary for C2PC.

3 Additional Information

This report contains the results in WLAN and Bluetooth mode of the equipment under test.

Adapter Interface was modified to fit to the additional display. Circuit is the same, only changes in the PCB placement were made.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Maximum Peak Output Power	2400.0 - 2483.5	15.247 (b) (1), (3), (4)	5.4 (2) [3]	Passed	11 et seq
DTS Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (1) [3]	Not performed	-
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (2) [3]	Not performed	-
Band edge compliance	2400.0 - 2483.5	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	15 et seq.
Radiated emissions (transmitter)	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	16 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Not performed	-

5 Results

5.1 Maximum peak output power

5.1.1 Method of measurement

The EUT was measured in a radiated setup within an anechoic chamber. The radiated measurement setup was made according to chapter 5.3.1 of this test report.

Acceptable measurement configurations

Annex G of [1] is used for calculating radiated values to conducted values.

Procedure of clause 11.9.1.1 of [1] was used for the measurement in Bluetooth mode.
Procedure of clause 11.9.1.2 of [1] was used for the measurement in WLAN mode.

The measurement was performed at the upper and lower end and the middle of the assigned frequency band for WLAN and at the lower end of the assigned frequency band for Bluetooth.

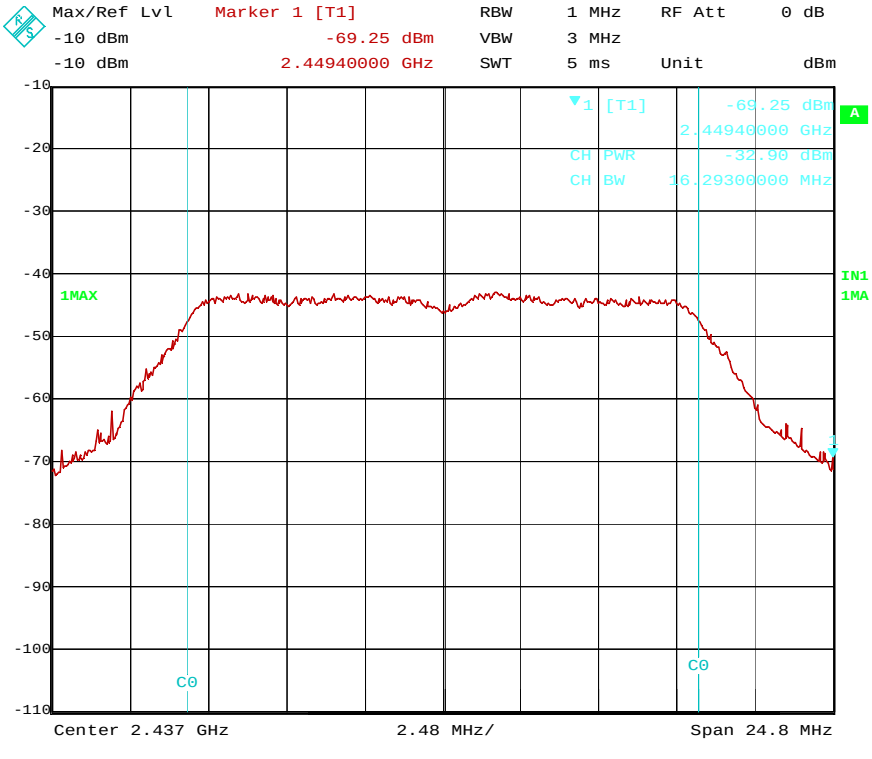
The measurement result in [dBµV/m] was calculated to [dBm] using the formula
in chapter 11.12.2.2 e) in [1].

5.1.2 Test results

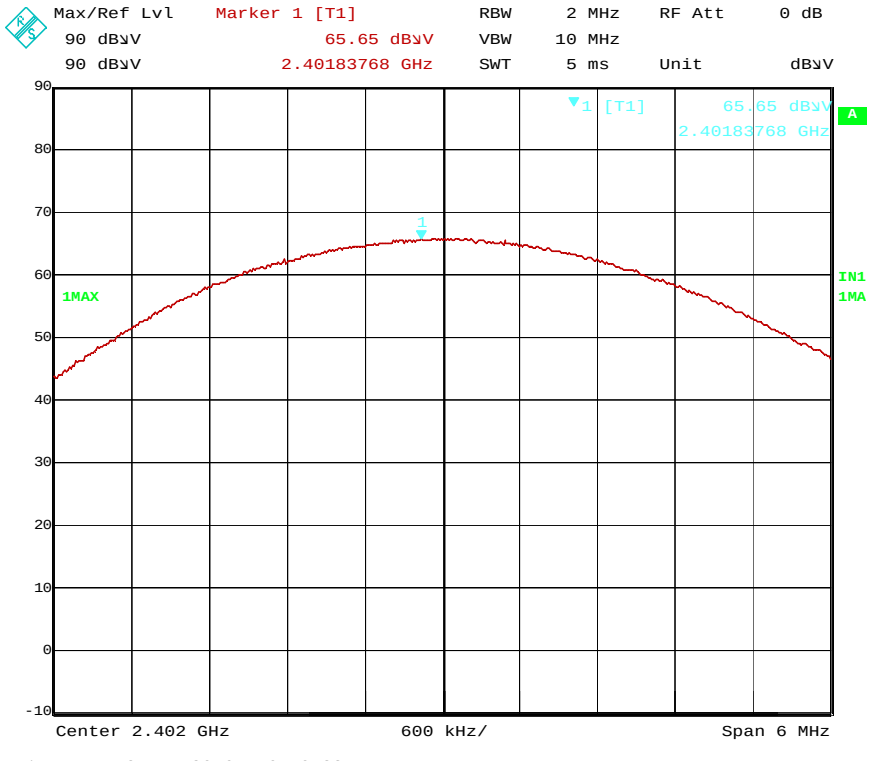
Ambient temperature	21 °C		Relative humidity	40 %

The following results were measured in a radiated setup. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Power_ch6_6M.wmf: Maximum peak output power (operation mode 11):



Power_2DH5_ch0.wmf: Maximum peak output power (operation mode 1):



The highest antenna gain for Bluetooth is -2.7 dBi. Therefore no reduction of the Peak power limit is necessary.

Results for Bluetooth:

Operation Mode	Frequency [MHz]	Antenna gain combined [dBi]	Reading [dBµV]	Antenna factor [1/m]	Cable Loss [dB]	Meas. Result [dBµV/m]	EIRP Peak Power [dBm]	Conducted Peak Power [dBm]	Limit [dBm]
1	2402	-2.7	65.7	28.3	3.0	97.0	1.8	4.5	30
Measurement uncertainty				+2.2 dB / -3.6 dB					

The highest antenna gain for WLAN is -0.8 dBi. Therefore no reduction of the Peak power limit is necessary.

Results for WLAN:

Operation Mode	Frequency [MHz]	Antenna gain combined [dBi]	Reading [dBm]	Antenna factor [1/m]	Cable Loss [dB]	EIRP Peak Power [dBm]	Conducted Peak Power [dBm]	Limit [dBm]
7	2412	-0.8	-37.8	28.2	3.0	6.0	6.8	30
8	2437	-0.8	-37.5	28.3	3.0	6.4	7.2	30
9	2462	-0.8	-38.2	28.4	2.9	5.8	6.6	30
10	2412	-0.8	-33.2	28.2	3.0	10.6	11.4	30
11	2437	-0.8	-32.9	28.3	3.0	11.0	11.8	30
12	2462	-0.8	-33.3	28.4	3.1	10.7	11.5	30
13	2412	-0.8	-33.4	28.2	3.0	10.4	11.2	30
14	2437	-0.8	-32.7	28.3	3.0	11.2	12.0	30
15	2462	-0.8	-33.3	28.4	2.9	10.7	11.5	30
Measurement uncertainty				+2.2 dB / -3.6 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18, 33

5.2 Band-edge compliance

5.2.1 Method of measurement (band edges next to restricted bands (radiated))

The EUT was measured in a radiated setup within an anechoic chamber. The radiated measurement setup was made according to chapter 5.3.1 of this test report.

After trace stabilisation the marker shall be set on the signal peak. The frequency line shall be set on the edge of the assigned frequency band. Now set the second 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. The level of the measured field strength shall be compared to the general limits specified in § 15.205.

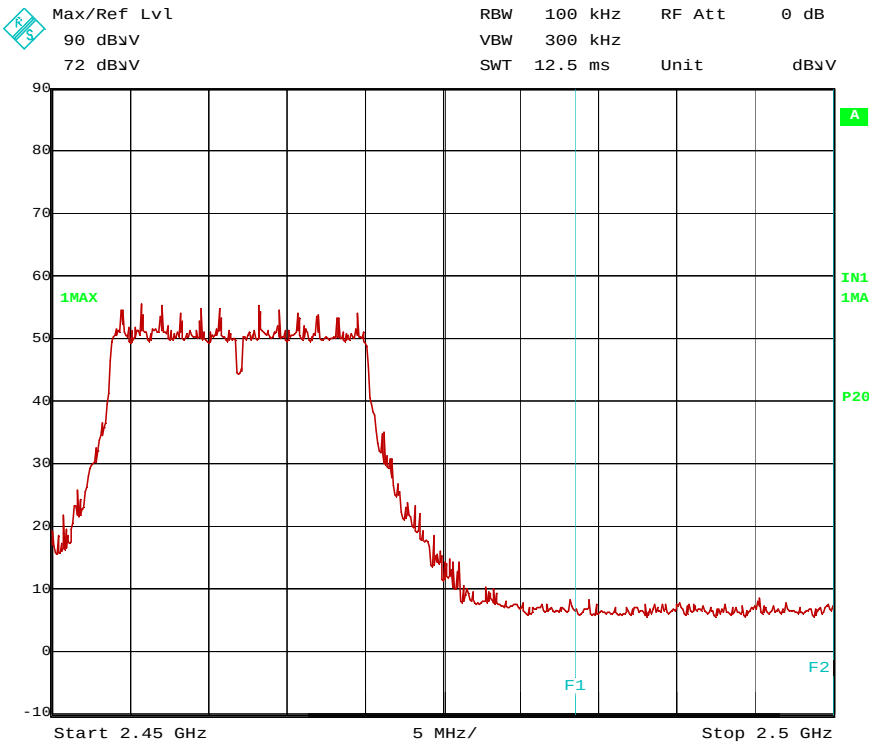
The measurement was performed only for WLAN at the upper end of the 2.4 GHz band.

5.2.2 Test result (band edges next to restricted bands (radiated))

Ambient temperature	22 °C	Relative humidity	59 %

The following plot shows the measurement result. No final measurement was performed, because no spurious emissions were detected during the preliminary measurement.

BandEdge_High120°.wmf: Radiated band-edge compliance (operation mode 15):



Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 11, 13, 17, 18, 33

5.3 Maximum unwanted emissions

5.3.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five stages.

- 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 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 / 40 GHz.

Preliminary and final measurement (1 GHz to 25 GHz)

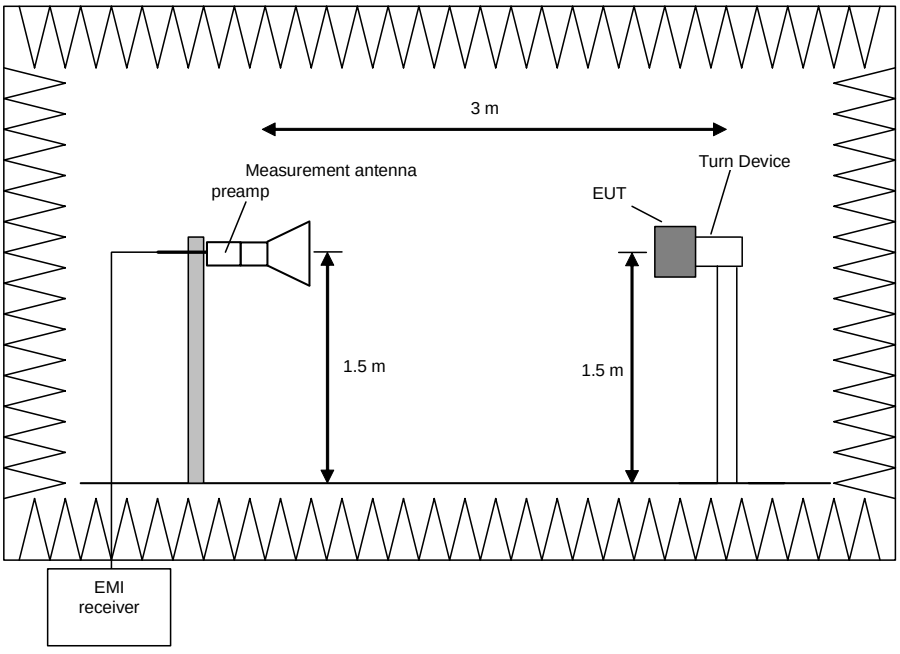
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

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 and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

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 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.
The following procedure will be used:

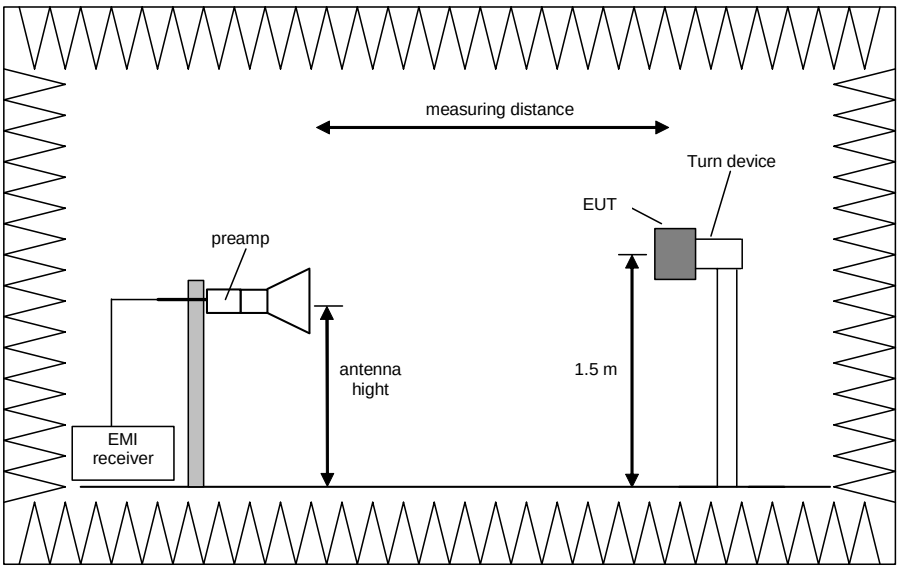
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 40 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 by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

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 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz and 26.5 – 40 GHz.
The following procedure will be used:

1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyser to EMI mode with peak and average detector activated.
4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
5) Note the highest displayed peak and average values
6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.3.2 Test results (radiated emissions) – antenna and cabinet emission

5.3.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	40 %

Position of EUT: The EUT was set-up on a turn device on a height of 1.5 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 the Annex A of the test report.

Test record: All results are shown in the following.

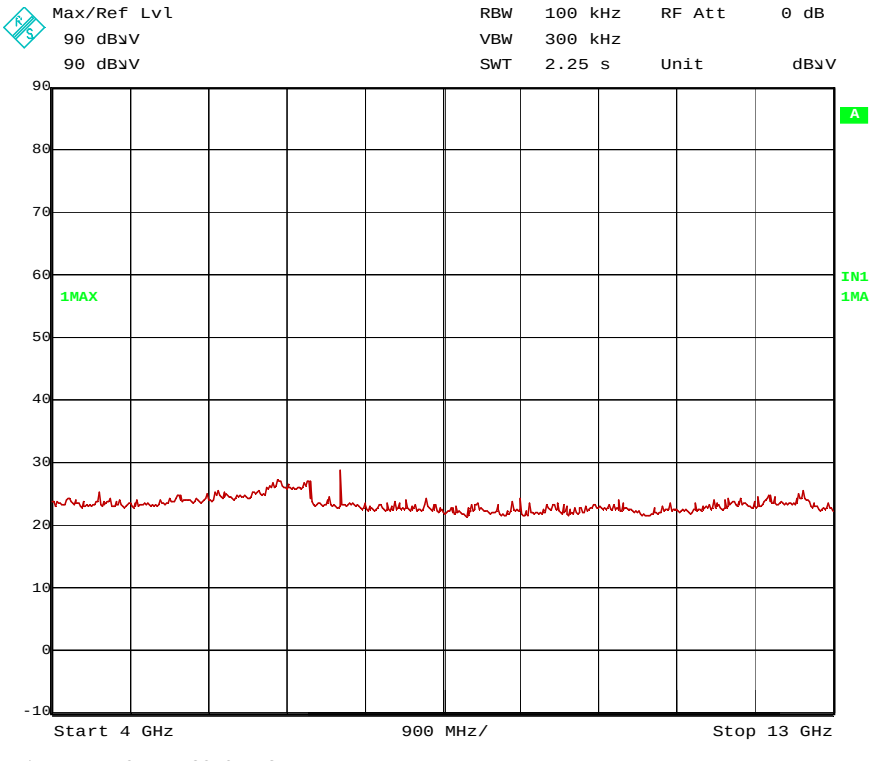
Supply voltage: During all measurements the host of the EUT was powered with 12 V DC via a car battery.

Remark: Only the worst case spurious emissions frequencies identified in the original report were repeated for this report.

Results for Bluetooth

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

154064_Low_1-4G_90°.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



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

- 7323 MHz.

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

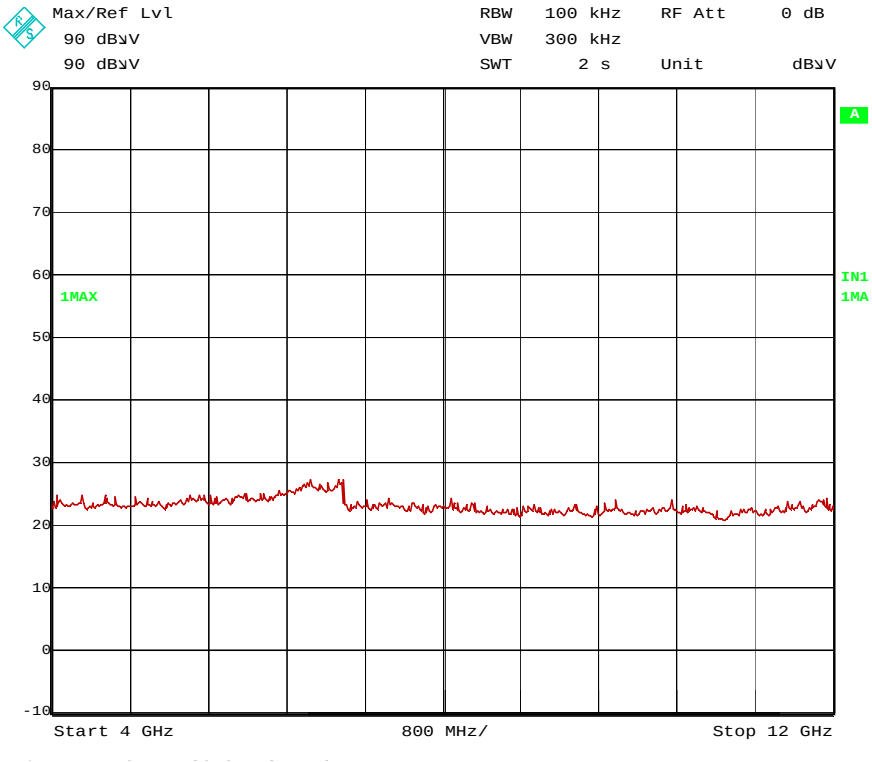
-

These frequency has to be measured in a final measurement. The results are presented in the following.

Results for WLAN

Transmitter operates at the middle of the assigned frequency band (operation mode 10)

SpurEm_ch1_6M 0°.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 10):



No spurious emissions were found during the preliminary measurement.Therefore no final measurement was performed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 11, 13, 17, 18, 33

5.3.2.2 Final radiated emission measurement (9 kHz to 1 GHz)

No emissions were found during the preliminary measurement. Therefore no results for the final measurements are submitted.

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

Ambient temperature	21 °C	Relative humidity	40 %

Position of EUT: The EUT was set-up on a turn device on a height of 1.5 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 the Annex A of the test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 12 V DC via a car battery.

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

Additional information: For simplification all values were compared to the restricted band limits.
All Emissions were measured in the EUT angle that had the highest spurious emissions.

Results for Bluetooth

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

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Angle / °
7323.0	54.0	74.0	20.0	35.8	36.1	24.7	6.8	150	Ver.	60
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Angle / °
7323.0	40.8	54.0	13.2	22.6	36.1	24.7	6.8	150	Ver.	60
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 11, 13, 17, 18, 33

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	21.03.2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	21.03.2014	03/2016
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
7	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	17.02.2016	02/2018
8	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	26.02.2014	02/2016
						03.02.2015	02/2017
9	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
10	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
11	Antenna support	AS615P	Deisel	615/310	480187	-	-
12	Antenna	CBL6112 B	Chase	2688	480328	14.04.2014	04/2017
13	Antenna	3115 A	EMCO	9609-4918	480183	11/2014	11/2017
14	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
15	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
16	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
17	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
18	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber&Suhner	500003/6B / Kabel 36-	481680	Weekly verification (system cal.)	
20	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480300	Six month verification (system cal.)	
21	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire		480302	Six month verification (system cal.)	
22	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
23	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
24	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/2014	02/2016
26	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	02/2016	07/2018
27	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	02/2016	07/2018
28	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

29	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
30	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	
31	Temperature Test Chamber	MK 240	Binder	05-79022	480462	18.02.2014	08/2015
32	Multimeter	Fluke 175	Fluke Deutschland GmbH	18660318	481515	10/2014	10/2016
33	Turn Device	TDF 1.5-10Kg	Maturo	-	482034	-	

7 Report History

Report Number	Date	Comment
F160090E1	29.04.2016	Initial Test Report

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