

TEST REPORT

No.: 3-0071-13-5-2b

According to:
FCC Regulations
Part 15.209,
Part 15.247

IC-Regulations
RSS-Gen, Issue 3
RSS-210, Issue 8

for

Harman International

Automotive Infotainment Unit -
Model: VP4 940

in Bluetooth® Mode

FCC ID: QNG-BE2807
IC: 6434C-BE2807







Laboratory Accreditation and Listings			
 Deutsche Akkreditierungsstelle D-PL-12047-01-01	 Reg. No.: 736496 MRA US-EU 0003	 Industry Canada Reg. No.: 3462D-1 Reg. No.: 3462D-2 Reg. No.: 3462D-3	 Voluntary Controls for Electromagnetic Emissions Reg. No.: R-2665, R-2666 C-2914, T-1967, G-301
 AUTHORIZED RF LABORATORY	 Authorized Test Lab LAB CODE 20011130-00		
accredited according to DIN EN ISO/IEC 17025			
<p>CETECOM GmbH Laboratory Radio Communications & Electromagnetic Compatibility Im Teelbruch 116 • 45219 Essen • Germany Registered in Essen, Germany, Reg. No.: HRB Essen 8984 Tel.: + 49 (0) 20 54 / 95 19-954 • Fax: + 49 (0) 20 54 / 95 19-964 E-mail: info@cetecom.com • Internet: www.cetecom.com</p>			

Table of contents

1. SUMMARY OF TEST RESULTS.....	3
1.1. Tests overview US Government (FCC) and Canada IC Standards (RSS)	3
2. ADMINISTRATIVE DATA	4
2.1. Identification of the testing laboratory	4
2.2. Test location	4
2.3. Organizational items	4
2.4. Applicant's details	4
2.5. Manufacturer's details	4
3. EQUIPMENT UNDER TEST (EUT).....	5
3.1. Technical data of main EUT declared by applicant	5
3.2. EUT: Type, S/N etc. and short descriptions used in this test report	6
3.3. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions	6
3.4. EUT set-ups	6
3.5. EUT operating modes	6
3.6. Configuration of cables used for testing	6
4. DESCRIPTION OF TEST SYSTEM SET-UP'S	7
4.1. Test system set-up for radiated magnetic field measurements below 30 MHz	7
4.2. Test system set-up for radiated electric field measurement 30 MHz to 1 GHz	8
4.3. Test system set-up for radiated electric field measurement above 1 GHz	9
4.4. Test system set-up for conducted RF-measurements at antenna port	10
5. MEASUREMENTS	11
5.1. General Limit - Radiated field strength emissions below 30 MHz	11
5.2. General Limit - Radiated field strength emissions, 30 MHz - 1 GHz.....	13
5.3. General Limit - Radiated emissions, above 1 GHz.....	15
5.4. RF-Parameter - 20 db Bandwidth and 99% occupied Bandwidth	16
5.5. RF-Parameter - Channel carrier frequency separation for FHSS-systems.....	18
5.6. RF-Parameter - Radiated Band Edge compliance measurements	19
5.7. RF-Parameter - Specification for hopping channel numbers for FHSS systems	20
5.8. RF-Parameter - Time of occupancy for FHSS systems	21
5.9. RF-Parameter – RF Power Conducted and Radiated (EIRP).....	22
5.10. RF Parameter - 20dBc Emission specification and Band-Edge (conducted)	24
5.11. Measurement uncertainties	26
6. ABBREVIATIONS USED IN THIS REPORT	26
7. ACCREDITATION DETAILS OF CETECOM'S LABORATORIES AND TEST SITES	27
8. INSTRUMENTS AND ANCILLARY.....	28
8.1. Used equipment "CTC"	28

Table of annex

Total pages

Annex 1: Internal EUT Photographs	5
Annex 2: External EUT Photographs	7
Annex 3: Test set-up Photographs	5
Annex 4: Measurement Diagrams	47

The listed attachments are an integral part of this report.

1. Summary of test results

The test results apply exclusively to the test samples as presented in this Report. The CETECOM GmbH does not assume responsibility for any conclusions and generalizations taken in conjunction with other specimens or samples of the type of the item presented to tests.

The presented Equipment Under Test (in this report, hereinafter referred as EUT) integrates a Bluetooth[®] transmitter. Other implemented wireless technologies are not considered within this test report.

Following test cases have been performed to show compliance with applicable FCC Part 2 and Part 15 rules of the FCC CFR 47 Rules, Edition 1st October 2012 and IC RSS-210 Issue 8/ RSS-Gen Issue 3 standards.

1.1. Tests overview US Government (FCC) and Canada IC Standards (RSS)

Test cases	Port	References and Limits			EUT set-up	EUT op. mode	Result
		FCC Standard	RSS Section	Test limit			
TX-Mode							
20 dB bandwidth	Antenna terminal (conducted)	§15.247 (a)(1)	RSS-210, Issue 8: A8.1 (a) (b)	At least 25 kHz or 2/3 of 20 dB bandwidth	3	1	passed
Channel carrier frequency separation					3	2	
99% occupied bandwidth	Antenna terminal (conducted)	--	RSS-210, Issue 8: Chapter 4.6.1	99% Power bandwidth	3	1	no pass/fail criteria
Channel average Occupancy time and number of channels	Antenna terminal (conducted)	§15.247 (a)(1) (iii)	RSS-210, Issue 8: A8.1 (d)	0.4 seconds	3	2	passed
Transmitter Peak output power	Antenna terminal (conducted)	§15.247 (b)(1)	RSS-210, Issue 8: A8.4 (2)	< 125 mW	3	1	passed
Transmitter Peak output power radiated	Cabinet (radiated)	§15.247 (b)(4)	RSS-210, Issue 8: A8.4 (4)	< 125 mW (EIRP) for antenna with directional gain less 6 dBi	2	1	passed
Out-Of-Band RF- emissions Band-Edge emissions	Antenna terminal (conducted)	§15.247 (d)	RSS-210, Issue 8: A8.5	20 dBc and Emissions in restricted bands must meet the general fieldstrength radiated limits	3	1+2	passed
General field strength emissions + restricted bands	Cabinet + Interconnecting cables (radiated)	§15.247 (d) §15.205 §15.209	RSS-210, Issue 3, Chapter 2.5 RSS-Gen: Issue 3: §7.2.5 Table 5+6	Emissions in restricted bands must meet the general field-strength radiated limits	1+ 2	1	passed
AC-Power Lines Conducted Emissions	AC-Power lines	§15.207	RSS-Gen, Issue 3: Chapter 7.2.4, Table 4	FCC §15.107 class B limits §15.207 limits IC: Table 4, Chapter 7.2.4	--	--	N/A ¹⁾

Remark: 1) Only DC power supplied (car environment) no connection to AC power lines.

.....
Dipl.-Ing. Ch. Lorenz
Responsible for test section


GmbH
Im Teelbruch 116
45219 Essen
Tel.: + 49 (0) 20 54 / 95 19 - 0
Fax: + 49 (0) 20 54 / 95 19 - 347

.....
Dipl.-Ing. B. Taslica
Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Dipl.-Ing. Niels Jeß
Deputy:	Dipl.-Ing. Rachid Acharkaoui

2.2. Test location

2.2.1. Test laboratory "CTC"

Company name:	see chapter 2.1. Identification of the testing laboratory
---------------	---

2.3. Organizational items

Responsible for test report and project leader:	Dipl.-Ing. B. Taslica
Receipt of EUT:	2013-05-13
Date(s) of test:	2013-05-14 – 2013-05-28
Date of report:	2013-06-04

Version of template:	12.11 Taslica

2.4. Applicant's details

Applicant's name:	Harman International
Address:	39001 West Twelve Mile Road Farmington Hills MI 48331 USA
Contact person:	Mr. Shain Chmura

2.5. Manufacturer's details

Manufacturer's name:	please see Applicant's details
Address:	please see Applicant's details

3. Equipment under test (EUT)

3.1. Technical data of main EUT declared by applicant

Main function	Automotive Infotainment Unit with integrated Bluetooth® Transceiver		
Model	VP4 940		
Frequency range and channels (US/Canada -bands)	2402 MHz to 2480 MHz <input checked="" type="checkbox"/> Ch. 0 to Ch. 78 <input type="checkbox"/> Ch. 0 to Ch. 40		
Type of modulation (packet types)	<input checked="" type="checkbox"/> BT 1.0 / BT 1.1: DH1/DH3/DH5 – GFSK <input checked="" type="checkbox"/> BT 2.0: 2DH1/2DH3/2DH5 – Pi/4 DQPSK <input checked="" type="checkbox"/> BT 2.1: 3DH1/3DH3/3DH5 – 8DPSK <input checked="" type="checkbox"/> BT 3.0: (GFSK, Pi/4 DQPSK, 8DPSK) + EPC (HS) <input type="checkbox"/> BT 4.0: DH1/DH3/DH5 – GFSK		
Number of channels (USA/Canada -bands)	<input checked="" type="checkbox"/> 0 to 78 <input type="checkbox"/> 0 to 40		
Antenna Type	<input checked="" type="checkbox"/> Integrated <input type="checkbox"/> External, no RF- connector <input type="checkbox"/> External, separate RF-connector		
Antenna Gain	Max. -4.00 dBi gain according applicants information in 2.4 GHz band		
MAX Output power (conducted):	10.02 dBm (10.05 mW) on nominal 2440 MHz		
MAX EIRP (radiated):	6.02 dBm (4.00 mW) on nominal 2440 MHz		
MAX Field-strength of spurious emission (TX-mode)	37.9 dBµV/m (QP) @ 3m distance at 128MHz		
Emission designator (TRC-43)	846KFXD (GFSK), 1M14GXD (Pi/4 DQPSK), 1M12GXD (8DPSK)		
FCC-ID	QNG-BE2807		
IC-ID	6434C-BE2807		
Installed options	<input checked="" type="checkbox"/> GPS (Receiver only, not tested within this test report) <input checked="" type="checkbox"/> FM-Radio (Receiver only, not tested within this test report)		
Power supply	<input checked="" type="checkbox"/> DC power nominal: 13.2 Volt (Voltage range 9 -16 V DC)		
Special EMI components	--		
EUT sample type	<input type="checkbox"/> Production	<input checked="" type="checkbox"/> Pre-Production	<input type="checkbox"/> Engineering
Firmware	<input type="checkbox"/> for normal use		<input checked="" type="checkbox"/> Special version for test execution
FCC label attached	<input type="checkbox"/> yes <input checked="" type="checkbox"/> no		

3.2. EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	Automotive Infotainment Unit	VP4 940	#sample 1 T00BE093371102	ED	13.20.2
EUT B	Automotive Infotainment Unit	VP4 940	#sample 5 T00BE093371102	ED	13.20.2
EUT C	Automotive Infotainment Unit	VP4 940	#sample 4 T00BE093371102	ED	13.20.2

*) EUT short description is used to simplify the identification of the EUT in this test report.

3.3. Configuration of cables used for testing

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	Power supply lines and Interface cables	Harman signalling/data cables	--	--	~1.70 m

3.4. EUT set-ups

EUT set-up no. *)	Combination of EUT and AE	Remarks
Set. 1	EUT A + Cable no. 1	Used for radiated tests below 1 GHz
Set. 2	EUT B + Cable no. 1	Used for radiated tests above 1 GHz
Set. 3	EUT C + Cable no. 1	Used for conducted tests

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

3.5. EUT operating modes

EUT operating mode no. *)	Description of operating modes	Additional information
op. 1	TX-Mode	With help of special test firmware a continuous traffic mode could be established with help of a Bluetooth base simulator. (R&S CBT32)
op. 2	TX-Mode hopping on	Hopping mode was activated with help of a Bluetooth base simulator. (R&S CBT32)

*) EUT operating mode no. is used to simplify the test report.

4. Description of test system set-up's

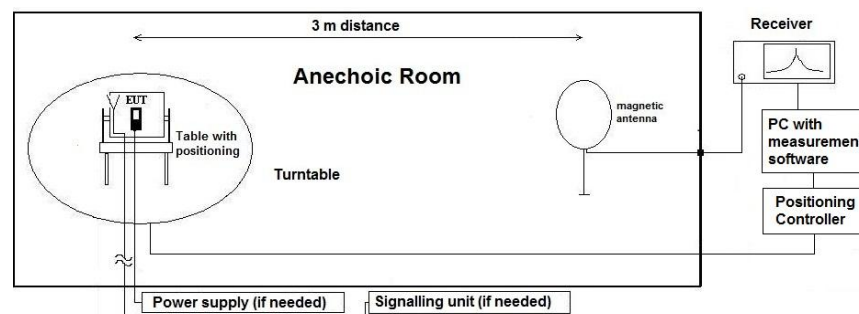
4.1. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.4-2009 chapter 8.2.1, ANSI C63.10-2009 chapter 6.4

General Description: Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

Exploratory, preliminary measurement

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0° to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded. The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A$$

$$M = L_T - E_C$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

Distance correction:

Reference for applied correction (extrapolating) factors:

IEEC Transaction EMC, Vol. 47, No. 3, Aug. 2005, Journal Paper

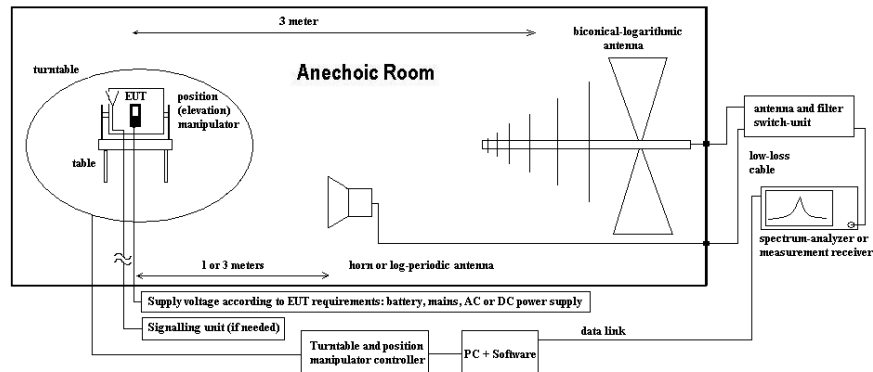
"Extrapolating Near-field emissions of low frequency loop transmitters".

4.2. Test system set-up for radiated electric field measurement 30 MHz to 1 GHz

Specification: ANSI C63.4-2009 chapter 8, ANSI C63.10-2009 chapter 6.5

General Description: Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a NSA-compliant semi anechoic room (SAR) recognized by the regulatory commissions.

Schematic:



Testing method:

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case height found out. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A \quad (1)$$

$$M = L_T - E_C \quad (2)$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

$$L_T = \text{Limit}$$

M = Margin

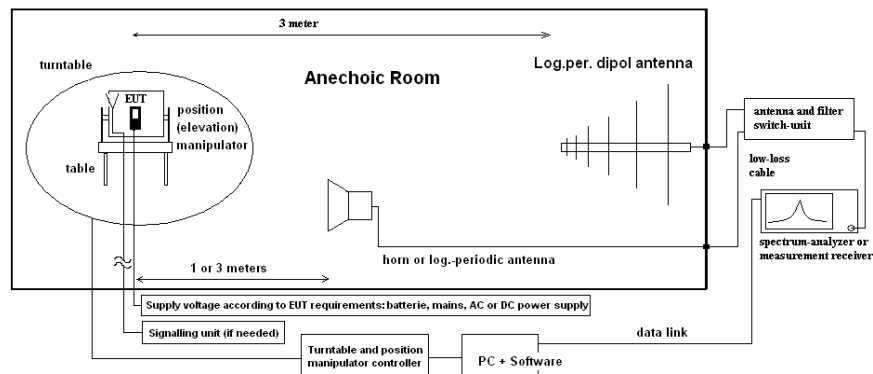
All units are dB-units, positive margin means value is below limit.

4.3. Test system set-up for radiated electric field measurement above 1 GHz

Specification: ANSI C63.4-2009 chapter 8, ANSI C63.10-2009 chapter 6.6

General Description: Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-4 compliant fully anechoic room (FAR) recognized by the regulatory commissions. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 1 meter above 18 GHz. Logarithmic periodic antenna is used for frequency range 1 GHz to 18 GHz, above 18 GHz a horn antenna is used. The antennas are set to fixed antenna height of 1.55 m. The fully anechoic room meets the 6 dB site validation criteria accordance CISPR 16-1-4 (2012-07) instead of the height of receiving antenna not applicable for fully anechoic room and the EUT aligned within 3 dB cone of radiation pattern.

Schematic:



Testing method:

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 45°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height is fixed to 1.55 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A \quad (1)$$

$$M = L_T - E_C \quad (2)$$

E_C = Electrical field – corrected value

E_R = Receiver reading

M = Margin

L_T = Limit

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

G_A = Gain of pre-amplifier (if used)

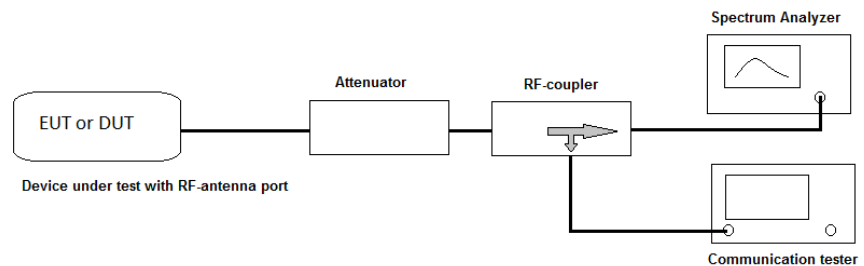
All units are dB-units, positive margin means value is below limit.

4.4. Test system set-up for conducted RF-measurements at antenna port

Specification: ANSI C63.10-2009

General Description: The EUT's RF-signal is first attenuated before it is connected to the input of the RF-coupler. The direct output branch is connected to the spectrum – analyzer, the coupled branch to the communication tester. The specific attenuation is determined prior to the measurement within a set-up calibration. The value is taken into account by correcting the measurement readings on the spectrum-analyzer either by a transducer factor (TDF) or an relative offset to reference level.

Schematic:



Testing method: According to ANSI 63.10-2009 for each individual test, see more details in each chapter.

5. Measurements

5.1. General Limit - Radiated field strength emissions below 30 MHz

5.1.1. Test location and equipment

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input type="checkbox"/> Please see Chapter. 2.2.2		<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input checked="" type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 347 Radio.lab.		<input type="checkbox"/>	<input type="checkbox"/>
spectr. analys.	<input type="checkbox"/> 584 FSU	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input checked="" type="checkbox"/> 001 ESS	<input type="checkbox"/>	<input type="checkbox"/>
antenna	<input type="checkbox"/> 574 BTA-L	<input type="checkbox"/> 133 EMCO3115	<input type="checkbox"/> 302 BBHA9170	<input type="checkbox"/> 289 CBL 6141	<input checked="" type="checkbox"/> 030 HFH-Z2	<input type="checkbox"/> 477 GPS
signaling	<input type="checkbox"/> 392 MT8820A	<input type="checkbox"/> 436 CMU	<input checked="" type="checkbox"/> 547 CBT32	<input type="checkbox"/> 594 CMW		
otherwise	<input type="checkbox"/> 400 FTC40x15E	<input type="checkbox"/> 401 FTC40x15E	<input type="checkbox"/> 110 USB LWL	<input type="checkbox"/> 482 Filter Matrix	<input type="checkbox"/> 378 RadiSense	
DC power	<input checked="" type="checkbox"/> 456 EA 3013A	<input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50	<input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A	<input type="checkbox"/> 498 NGPE 40
line voltage	<input type="checkbox"/> 230 V 50 Hz via public mains		<input type="checkbox"/> 060 120 V 60 Hz via PAS 5000			

5.1.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
IC	RSS-Gen., Issue 3			
ANSI	C63.10-2009			
Frequency [MHz]	Field strength limit		Distance [m]	Remarks
	[μV/m]	[dBμV/m]		
0.009 – 0.490	2400/f (kHz)	67.6 – 20Log(f) (kHz)	300	Correction factor used due to measurement distance of 3 m
0.490 – 1.705	24000/f (kHz)	87.6 – 20Log(f) (kHz)	30	Correction factor used due to measurement distance of 3 m
1.705 – 30	30	29.5	30	Correction factor used due to measurement distance of 3 m

5.1.3. Test condition and test set-up

Signalink to test system (if used):		<input checked="" type="checkbox"/> air link	<input type="checkbox"/> cable connection	<input type="checkbox"/> none
EUT-grounding		<input checked="" type="checkbox"/> none	<input type="checkbox"/> with power supply	<input type="checkbox"/> additional connection
Equipment set up		<input checked="" type="checkbox"/> table top	<input type="checkbox"/> floor standing	
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver or Analyzer Settings	Scan data	<input checked="" type="checkbox"/> 9 – 150 kHz RBW/VBW = 200 Hz Scan step = 80 Hz <input checked="" type="checkbox"/> 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz <input type="checkbox"/> other:		
	Scan-Mode	<input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 3dB Spectrum analyser Mode		
	Detector Mode: Sweep-Time	Peak (pre-measurement) and Quasi-PK/Average (final if applicable) Repetitive-Scan, max-hold Coupled – calibrated display if continuous signal otherwise adapted to EUT's individual transmission duty-cycle		
General measurement procedures		Please see chapter "Test system set-up radiated magnetic field measurements below 30 MHz"		

5.1.4. Measurement Results

The results are presented below in summary form only. For more information please see the diagrams.

Table of measurement results:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.01 (DH1)	Low	0	9 kHz-30 MHz	1	1	No critical peaks detected	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	passed
2.02 (2-DH1)	Middle	38	9 kHz-30 MHz			No critical peaks detected	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	passed
2.03 (3-DH1)	High	78	9 kHz-30 MHz			No critical peaks detected	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	passed

Remark: Please see diagrams at annex 4.

5.1.5. Correction factors due to reduced meas. distance ($f < 30$ MHz)

The used correction factors when the measurement distance is reduced, are taken from IEEC Transaction EMC, Vol 47, No.3, Aug. 2005, Journal Paper “*EXTRAPOLATING NEAR-FIELD EMISSIONS OF LOW-FREQUENCY LOOP TRANSMITTERS*”.

[illegible]

5.2. General Limit - Radiated field strength emissions, 30 MHz - 1 GHz

5.2.1. Test location and equipment

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)	<input type="checkbox"/> Please see Chapter. 2.2.2	<input type="checkbox"/> Please see Chapter. 2.2.3
test site	<input checked="" type="checkbox"/> 441 EMI SAR <input checked="" type="checkbox"/> 487 SAR NSA		
receiver	<input type="checkbox"/> 377 ESCS30 <input checked="" type="checkbox"/> 001 ESS	<input type="checkbox"/> 489 ESU 40 <input type="checkbox"/> 620 ESU 26	
spectr. analys.	<input type="checkbox"/> 584 FSU <input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	
antenna	<input checked="" type="checkbox"/> 574 BTA-L <input type="checkbox"/> 133 EMCO3115	<input type="checkbox"/> 302 BBHA9170 <input type="checkbox"/> 289 CBL 6141	<input type="checkbox"/> 030 HFH-Z2 <input type="checkbox"/> 477 GPS
signaling	<input type="checkbox"/> 371 CBT32 <input type="checkbox"/> 436 CMU	<input type="checkbox"/> 547 CMU <input type="checkbox"/> 594 CMW	
otherwise	<input type="checkbox"/> 400 FTC40x15E <input type="checkbox"/> 401 FTC40x15E	<input type="checkbox"/> 110 USB LWL <input checked="" type="checkbox"/> 482 Filter Matrix	
DC power	<input checked="" type="checkbox"/> 456 EA 3013A <input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50 <input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A <input type="checkbox"/> 498 NGPE
line voltage	<input type="checkbox"/> 230 V 50 Hz via public mains	<input type="checkbox"/> 060 120 V 60 Hz via PAS 5000	

5.2.2. Requirements/Limits

FCC		<input type="checkbox"/> Part 15 Subpart B, §15.109, class B <input checked="" type="checkbox"/> Part 15 Subpart C, §15.209 @ frequencies defined in §15.205	
IC		RSS-Gen., Issue 3	
ANSI		<input type="checkbox"/> C63.4-2009 <input checked="" type="checkbox"/> C63.10-2009	
Limit	Frequency [MHz]	Radiated emissions limits, 3 meters	
		QUASI Peak [µV/m]	QUASI-Peak [dBµV/m]
	30 - 88	100	40.0
	88 - 216	150	43.5
	216 - 960	200	46.0
	above 960	500	49.0

5.2.3. Restricted bands of operation, §15.205

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.20725-4.20775	37.5-38.25	1645.5-1646.5	9.3-9.5
6.215-6.218	73-74.6	1660-1710	10.6-12.7
6.26775-6.26825	74.8-75.2	1718.8-1722.2	13.25-13.4
6.31175-6.31225	108-121.94	2200-2300	14.47-14.5
8.291-8.294	123-138	2310-2390	15.35-16.2
8.362-8.366	149.9-150.05	2483.5-2500	17.7-21.4
8.37625-8.38675	156.52475-156.52525	2690-2900	22.01-23.12
8.41425-8.41475	156.7-156.9	3260-3267	23.6-24.0
12.29-12.293	162.0125-167.17	3332-3339	31.2-31.8
12.51975-12.52025	167.72-173.2	3345.8-3358	36.43-36.5
12.57675-12.57725	240-285	3600-4400	--
13.36-13.41	322-335.4	--	--

Remark: only spurious emissions are allowed within these frequency bands not exceeding the limits per §15.209

5.2.4. Test condition and measurement test set-up

Signalink to test system (if used):		<input checked="" type="checkbox"/> air link	<input type="checkbox"/>	<input type="checkbox"/>
EUT-grounding		<input checked="" type="checkbox"/> none	<input type="checkbox"/> with power supply	<input type="checkbox"/> additional connection
Equipment set up		<input checked="" type="checkbox"/> table top 0.8m height		<input type="checkbox"/> floor standing
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Scan frequency range:	<input checked="" type="checkbox"/> 30 – 1000 MHz <input type="checkbox"/> other:		
	Scan-Mode	<input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 3 dB spectrum analyser mode		
	Detector	Peak / Quasi-peak		
	RBW/VBW	100 kHz/300 kHz		
	Mode:	Repetitive-Scan, max-hold		
		80 kHz		
		Coupled – calibrated display if continuous tx-signal otherwise adapted to EUT's individual duty-cycle		
General measurement procedures		Please see chapter "Test system set-up for electric field measurement in the range 30 MHz to 1 GHz"		

5.2.5. MEASUREMENT RESULTS

The results are presented below in summary form only. For more information please see diagrams.

Table of measurement results:

Diagram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
3.01 (DH1)	Low	0	30 MHz – 1 GHz	1	1	worst-case critical peak detected: At frequency 128 MHz was final-measured.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	passed
3.02 (2-DH1)	Middle	38		1	1	worst-case critical peak detected: At frequency 128 MHz was final-measured.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	passed
3.03 (3-DH1)	High	78		1	1	no critical peaks detected below 6 dB margin to limit	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	passed

Remark: Please refer the diagrams at annex.

5.3. General Limit - Radiated emissions, above 1 GHz

5.3.1. Test location and equipment FAR

test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 348 EMI cond.	<input checked="" type="checkbox"/> 443 EMI FAR	<input type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/> 337 OATS	<input type="checkbox"/>
spectr. analys.	<input type="checkbox"/> 584 FSU	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input checked="" type="checkbox"/> 489 ESU 40	<input type="checkbox"/>	<input type="checkbox"/>
antenna meas	<input type="checkbox"/> 574 BTA-L	<input type="checkbox"/> 289 CBL 6141	<input checked="" type="checkbox"/> 608 HL 562	<input checked="" type="checkbox"/> 549 HL025	<input checked="" type="checkbox"/> 302 BBHA9170	<input type="checkbox"/> 477 GPS
antenna meas	<input type="checkbox"/> 123 HUF-Z2	<input type="checkbox"/> 132 HUF-Z3	<input type="checkbox"/> 030 HFH-Z2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
antenna subst	<input type="checkbox"/> 071 HUF-Z2	<input type="checkbox"/> 020 EMCO3115	<input type="checkbox"/> 063 LP 3146	<input checked="" type="checkbox"/> 303 BBHA9170	<input type="checkbox"/>	<input type="checkbox"/>
multimeter	<input type="checkbox"/> 341 Fluke 112	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
signaling	<input type="checkbox"/> 392 MT8820A	<input checked="" type="checkbox"/> 371 CBT32	<input type="checkbox"/> 547 CMU	<input type="checkbox"/> 594 CMW	<input type="checkbox"/>	<input type="checkbox"/>
DCpower	<input type="checkbox"/> 086 LNG50-10	<input checked="" type="checkbox"/> 087 EA3013	<input checked="" type="checkbox"/> 354 NGPE 40	<input type="checkbox"/> 349 car battery	<input type="checkbox"/> 350 Car battery	<input type="checkbox"/>

5.3.2. Requirements/Limits

FCC	<input type="checkbox"/> Part 15 Subpart B, §15.109 class B <input checked="" type="checkbox"/> Part 15 subpart C, §15.209 @ frequencies defined in §15.205			
IC	RSS-Gen., Issue 3			
ANSI	<input type="checkbox"/> C63.4-2009 <input checked="" type="checkbox"/> C63.10-2009			
Frequency [MHz]	Limits, 3 meters			
	AV [μV/m]	AV [dBμV/m]	Peak [μV/m]	Peak [dBμV/m]
above 1 GHz	500	54.0	5000	74.0

5.3.3. Test condition and measurement test set-up

Signal link to test system (if used):		<input checked="" type="checkbox"/> air link	<input type="checkbox"/> cable connection
EUT-grounding		<input checked="" type="checkbox"/> none	<input type="checkbox"/> with power supply <input type="checkbox"/> additional connection
Equipment set up		<input checked="" type="checkbox"/> table top 1.5m height	<input type="checkbox"/> floor standing
Climatic conditions		Temperature: (22±3°C)	Rel. humidity: (40±20)%
Spectrum-Analyzer settings	Scan frequency range:	<input checked="" type="checkbox"/> 1 – 18 GHz <input checked="" type="checkbox"/> 18 – 25 GHz <input type="checkbox"/> 18 – 40 GHz <input type="checkbox"/> other:	
	Scan-Mode	<input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 3 dB Spectrum analyser Mode	
	Detector	Peak and Average	
	RBW/VBW	1 MHz / 3 MHz	
	Mode:	Repetitive-Scan, max-hold	
Scan step		400 kHz	
Sweep-Time		Coupled – calibrated display if CW signal otherwise adapted to EUT's individual duty-cycle	
General measurement procedures		Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz"	

5.3.4. Measurement Results

The results are presented below in summary form only. For more information please see diagrams at Annex 4

Diagram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
4.01 (DH1)	Low	0	1 – 18 GHz	2	1	no critical peaks detected	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed
4.02 (2-DH1)	Middle	38		2	1	no critical peaks detected	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed
4.03 (3-DH1)	High	78		2	1	no critical peaks detected	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed
4.04 (DH1)	Low	0	18-25 GHz	2	1	no critical peaks detected, only noise-floor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed
4.05 (2-DH1)	Middle	38		2	1	no critical peaks detected, only noise-floor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed
4.06 (3-DH1)	High	78		2	1	no critical peaks detected, only noise-floor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	passed

5.4. RF-Parameter - 20 db Bandwidth and 99% occupied Bandwidth

5.4.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input type="checkbox"/> Please see Chapter. 2.2.2		<input type="checkbox"/> Please see Chapter. 2.2.3
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input checked="" type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/>
receiver	<input type="checkbox"/> 377 ESCS30	<input type="checkbox"/> 001 ESS	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>
otherwise	<input type="checkbox"/> 530 10dB Att.	<input checked="" type="checkbox"/> 613 20dB Att.	<input checked="" type="checkbox"/> 1259 Directional-coupler	<input checked="" type="checkbox"/> cable K4	<input checked="" type="checkbox"/> cable K5

5.4.2. Requirements:

FCC	<input checked="" type="checkbox"/> §15.247 (a) (1)
IC	<input checked="" type="checkbox"/> RSS-210 A 8.1 (b)
Remark	<i>(1) <u>Frequency hopping systems</u> shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.</i>

5.4.3. EUT settings

For FHSS-systems hopping mode was switched-off so fixed three different channels could be measured. The EUT was instructed to send with maximum power (if adjustable) according applicants instructions. Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

5.4.4. Measurement method

The measurement was performed with the RBW set to 10kHz. The span was set to cover the complete carrier. Three carrier frequencies (low/middle/high) were used for showing the compliance with this requirement. A DELTA Marker method was set to measure the bandwidth compared to the highest In-Band power. The operating modes have been varied (e.g. data rate, modulation scheme, etc.). The hopping-mode is switched off.

Also the **99% emission bandwidth** was measured. Two carrier frequencies (low/high) and RMS detector was used. Two markers are placed on frequency points such that left to lower f-marker and right to higher f-marker only 1% of the TX-power is contained. Between the markers, 99% of the power is laying.

5.4.5. Spectrum-Analyzer Settings

Span	Set as to fully display the emissions and approximate 20dB below the PEAK level
Resolution Bandwidth (RBW)	Set to approx 1% ...3%of the emission width
Video Bandwidth (VBW)	3 times the resolution bandwidth
Sweep time	Coupled and low enough to have no gaps within power envelope
Detector	Sample (if bin width: Span/no. of frequency points SA < 0.5*RBW SA otherwise Peak detector)
Sweep mode	Repetitive Mode, Max hold

5.4.6. Measurement Results 20 dB Bandwidth

DH1 Modulation

Set-up no.: 3 Op. mode: 1	20 dB Bandwidth [kHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 38 (2440 MHz)	High channel = 78 (2480 MHz)
Maximum Value	932.69	907.05	913.46

2-DH1 Modulation

Set-up no.: 3 Op. mode: 1	20 dB Bandwidth [MHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 38 (2440 MHz)	High channel = 78 (2480 MHz)
Maximum Value	1.153	1.128	1.153

3-DH1 Modulation

Set-up no.: 3 Op. mode: 1	20 dB Bandwidth [MHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 38 (2440 MHz)	High channel = 78 (2480 MHz)
Maximum Value	1.201	1.201	1.169

General remark: see diagrams in separate document A4

LIMITS: For all packet types and modulation variants < 1500 kHz

RESULT 20 dB Bandwidth : passed

5.4.7. 99% Bandwidth

The maximum results of 20dBc channels have been re-measured also for 99% bandwidth.

DH1 Modulation

Set-up no.: 3 Op. mode: 1	99 % Bandwidth [kHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 39 (2441 MHz)	High channel = 78 (2480 MHz)
Maximum Value	846.15	--	846.15

Remark: see diagrams in separate document A4

2-DH1 Modulation

Set-up no.: 3 Op. mode: 1	99% Bandwidth [MHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 39 (2441 MHz)	High channel = 78 (2480 MHz)
Maximum Value	1.125	--	1.144

Remark: see diagrams in separate document A4

3-DH1 Modulation

Set-up no.: 3 Op. mode: 1	99% Bandwidth [kHz]		
T _{Nom} = 21°C V _{Nom} = 13,2 V	Low channel = 0 (2402 MHz)	Middle channel = 39 (2441 MHz)	High channel = 78 (2480 MHz)
Maximum Value	1.125	--	1.118

Remark: see diagrams in separate document A4

5.5. RF-Parameter - Channel carrier frequency separation for FHSS-systems

5.5.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input type="checkbox"/> Please see Chapter. 2.2.2		<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/>	<input type="checkbox"/>
receiver	<input type="checkbox"/> 377 ESCS30	<input type="checkbox"/> 001 ESS	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
spectr. analys.	<input type="checkbox"/> 381 380 FSBS	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
otherwise	<input type="checkbox"/> 530 10dB Att.	<input checked="" type="checkbox"/> 613 20dB Att.	<input checked="" type="checkbox"/> 1259 Directional-coupler	<input checked="" type="checkbox"/> cable K4	<input checked="" type="checkbox"/> cable K5	

5.5.2. Requirements:

FCC	<input checked="" type="checkbox"/> §15.247 (a) (1)
IC	<input checked="" type="checkbox"/> RSS-210 A 8.1 (b)
Remark	<i>(1) FHSS Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.</i>

5.5.3. EUT settings

For FHSS-systems hopping mode was switched-off so fixed three different channels could be measured. The EUT was instructed to send with maximum power (if adjustable) according applicants instructions. Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

5.5.4. Measurement method

The measurement to prove this requirement was performed with a low RBW of 100 kHz, peak detector and trace Hold-Max function in order to resolve each frequency carrier separately.

The span of the frequency analyzer was set to cover the carrier investigated as well as its neighbour channels. A frequency DELTA Marker method was set to measure the frequency separation between the channels.

5.5.5. Limits

- Either:
1. 25 kHz or 20dB BW
 - or
 2. 25 kHz and 2/3 of BW if Power < 125mW

5.5.6. Measurement Results

Set-up no.:	3	Channel separation
Op. mode:	2	
T _{Nom} =	21°C	Measured around middle channel (2441 MHz)
V _{Nom} =	13,2 V	
Measured Result valid for DH3, 2DH3 and 3DH5		~1 MHz
Applicants declared value		1 MHz according BT-core spec.

Remark: see diagrams enclosed in annex A4 for different modulations

5.5.7. Result: passed

5.6. RF-Parameter - Radiated Band Edge compliance measurements

5.6.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)	<input type="checkbox"/> Please see Chapter. 2.2.2			<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input checked="" type="checkbox"/> 443 EMI FAR	<input type="checkbox"/>	<input type="checkbox"/>
spectr. analys.	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>
power supply	<input type="checkbox"/> 456 EA 3013A	<input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50	<input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A	<input checked="" type="checkbox"/> 498 NGPE 40
otherwise	<input checked="" type="checkbox"/> 371 CBT32			<input type="checkbox"/> cable K4	<input type="checkbox"/> cable K5	

5.6.2. Requirements

FCC	<input checked="" type="checkbox"/> § 15.205 (a), § 15.209 (a) <input checked="" type="checkbox"/> § 15.247 (d)
IC	<input checked="" type="checkbox"/> RSS-Gen, Issue 3, § 7.2.2

5.6.3. Measurement Method

A Delta marker method was used for showing compliance to restricted bands according §15.205. The method is according Public Notice “Marker-Delta method”, Extract from ANSI C63.10:2009. The method consists of three independent steps:

1. **Step:** Prior to the measurement the fundamental radiated In-Band field strength was performed. The determined value is used as reference value.
2. **Step:** Second step consist of finding the relative attenuation between the fundamental emission and the maximum local out-of-band emission (within 2 MHz range around the band edge either on the band-edge directly or some modulation product if the level is greater than that on the band-edge) when measured with lower resolution bandwidth.
3. **Step:** The delta value recorded in step 2 will be subtracted from value recorded in step 1, thus giving the required field strength at the band-edge. This value must fulfil the requirements for radiated spurious emissions in restricted bands in §15.205 with the general limits of §15.209.

5.6.4. EUT settings

The EUT was instructed to send with maximum power according to measurements of max. conducted power.

5.6.5. Measurements results:

Set-up: 2 Op. Mode: 1							
Tnom= 21°C Vnom= 13,2 V		Delta Marker Value [dB]	Fundamental field strength-radiated [dBµV/m]	Subtraction: Fund. field strength – Delta value [dBc]	Value at Band-Edge [dBµV/m]	Limit	Result
Diagram No.	Channel No.						
9.01_...	Low 0 (DH1)	94.3 (PK_h) -48.4 (PK_l) =45.9	94.3 (PK) 87.2 (AV)	94.3 (PK) -45.9 =49.4	--	>20dBc	passed
9.02_...	High 78 (DH1)	97.3 (PK_h) -43.1 (PK_l) =54.2	97.3 (PK) 90.0 (AV)	96.6(PK) -54.2 =>	42.4 (PK)	74 dBµV/m	passed
				90.0 (AV) -54.2 =>	45.8 (AV)	54 dBµV/m	passed
9.03_...	Low 0 (2-DH1)	92.5 (PK_h) -48.4 (PK_l) =44.1	92.5 (PK) 81.0 (AV)	92.5 (PK) -44.1 = 48.4	--	>20dBc	passed
9.04_...	High 78 (2-DH1)	97.3 (PK_h) -43.1 (PK_l) =54.2	95.8 (PK) 84.0 (AV)	96.0 (PK) -54.2 =>	41.8 (PK)	74 dBµV/m	passed
				88.9 (AV) -54.2 =>	34.7(AV)	54 dBµV/m	
9.05_...	Low 0 (3-DH1)	92.2 (PK_h) -48.46 (PK_l) =48.46	92.2 (PK) 81.0 (AV)	92.2 (PK) -48.46 =>	43.74 (PK)	>20dBc	passed
9.06_...	High 78 (3-DH1)	95.9 (PK_h) -43.84 (PK_l) =52.06	95.9 (PK) 84.1 (AV)	95.9 (PK) -52.06 =>	43.84 (PK)	74 dBµV/m	passed
				84.1 (AV) -52.06 =>	32.04 (AV)	54 dBµV/m	

5.7. RF-Parameter - Specification for hopping channel numbers for FHSS systems

5.7.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input type="checkbox"/> Please see Chapter. 2.2.2		<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input checked="" type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/>	<input type="checkbox"/>
receiver	<input type="checkbox"/> 377 ESCS30	<input type="checkbox"/> 001 ESS	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
spectr. analys.	<input type="checkbox"/> 489 ESU	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>
power supply	<input type="checkbox"/> 456 EA 3013A	<input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50	<input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A	<input type="checkbox"/> 498 NGPE 40
otherwise	<input checked="" type="checkbox"/> 613 20dB Attenuator			<input checked="" type="checkbox"/> cable K4		
				<input checked="" type="checkbox"/> cable K5		

5.7.2. Requirements

FCC	<input checked="" type="checkbox"/> §15.247 (a) (1) iii
IC	<input checked="" type="checkbox"/> RSS-210 A 8.1 (d)
Remark	<i>Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used..</i>

5.7.3. Method for measurement of the channel numbers:

The measurement was performed with spectrum analyzer's RBW set to 500kHz. The device was set to work within the defined specification with frequency hopping mode set to on. The spectrum-analyzer was set to MAX-Hold positive peak detector mode. After a trace stabilization period the trace is recorded and the number of channels counted.

5.7.4. Results

Set-up no. 3 Op. Mode 2	Number of channels
T _{NOM} = 21°C V _{NOM} = 13,2 V	79

Remark: see diagrams enclosed in the separate annex A4, for better accuracy reading the sweep was splitted in two separated sweeps.

RESULT: Passed

5.8. RF-Parameter - Time of occupancy for FHSS systems

5.8.1. Requirements:

FCC	<input checked="" type="checkbox"/> §15.247 (a) (1) iii
IC	<input checked="" type="checkbox"/> RSS-210 A 8.1 (d)
Remark	<i>Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.</i>

5.8.2. Method for measuring the occupancy time:

For Bluetooth® devices no measurements mandatory depending on the fixed requirements according to the Bluetooth® Core Specifications.

5.8.3. Calculations:

Formula for calculating the dwell time (pseudo-hopping sequence over all channels assumed):

$$\text{Average Dwell Time: } \text{Timeslot length} \cdot \frac{\text{Hop rate}}{\text{number of hopping channels}} \cdot \text{time period}$$

For Bluetooth® following is valid:

The maximum staying time of 0.4 seconds within a 31.6 second period in data mode is constant for Bluetooth® devices and independent from the packet type. For longer packet types the hopping data rate is reduced according the packet type length in order to comply with this requirement.

Calculated according mentioned-above formula:					
Packet types	Hop rate[1/s]	Channels	Hop rate/channels	Time periode	Transmissions
DH1/2DH1/3DH1	1600	79	20.25	31.6	640
DH3/2DH3/3DH3	533.33		6.75		214
DH5/2DH5/3DH5	320		4.05		128

Pulse width for different packet types/modulations:			
Packet types	Dwell time	Transmissions	Average Dwell time [ms] (approx transmissions on one channel per one milli second)
DH1/DH3/DH5:	366 µs	640	234.2
DH3/2DH3/3DH3:	1.622 ms	214	347.1
DH5/2DH5/3DH5:	2.870ms	128	367.4

5.8.5. Test result: passed < 400 msec.

5.9. RF-Parameter – RF Power Conducted and Radiated (EIRP)

5.9.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input checked="" type="checkbox"/> 443 System CTC-FAR-EMI-		<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input checked="" type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/>	<input type="checkbox"/>
spectr. analys.	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/> 120 FSEM	<input type="checkbox"/> 264 FSEK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
power supply	<input type="checkbox"/> 456 EA 3013A	<input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50	<input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A	<input checked="" type="checkbox"/> 498 NGPE 40
otherwise	<input checked="" type="checkbox"/> 613 20dB Attenuator		<input checked="" type="checkbox"/> 1259 Directional-coupler		<input checked="" type="checkbox"/> cable K4	

5.9.2. Requirements:

FCC	<input checked="" type="checkbox"/> § 15.247 (b) (1) for FHSS <input type="checkbox"/> § 15.247 (b) (3) for DSSS
IC	<input checked="" type="checkbox"/> RSS-210 A 8.4
ANSI	<input checked="" type="checkbox"/> C63.10-2009 (chapt 6.101) <input type="checkbox"/> C63.10-2009 (chapt 6.102)

5.9.3. Reference: EUT antenna characteristics:

- ☒ Directional Gain < 6 dBi (measured: difference between measured conducted and radiated eirp. power)
☐ Directional Gain > 6 dBi (measured / applicant's declaration) -> conducted power reduction necessary

5.9.4. EUT settings:

For FHSS-systems hopping mode was switched-off so fixed three different channels could be measured. The EUT was instructed to send with maximum power (if adjustable) according applicants instructions. Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

5.9.5. Measurement method:

The measurement was performed in non-hopping transmission mode with the carrier set to lowest/middle and highest channel. The power was also checked for different modulations and packet types if applicable.

The results were corrected with well-known cable losses within the measurement set-up.

5.9.6. Settings on Spectrum-Analyzer:

Center Frequency	Nominal channel frequency
Span	5 MHz
Resolution Bandwidth (RBW)	3 MHz > 20dB-Bandwidth of the signal
Video Bandwidth (VBW)	3 times the resolution bandwidth = 10 MHz
Sweep time	coupled
Detector	Peak, Max hold mode
Sweep Mode	Repetitive mode

5.9.7. Conducted measurement: Max. Peak Power

- Maximum declared antenna gain [isotropical]: -4.0 dBi
- External Path Loss: 22.9 dB at 2.4 GHz-> set as correction in spectrum-analyzer as TDF
- Pre-measurement done for all packet types with slot extension 1, 3 and 5 and mentioned-below shows the highest output power only, taken for all other measurements as reference here extension time slot = 1

	PEAK POWER (conducted) [dBm]		
Set-up no.: 3 Op-Mode: 1 Voltage: 13,2 V DC	Low channel = 0 (2402 MHz)	Middle channel = 38 (2440 MHz)	High channel = 78 (2480 MHz)
Packet type DH 1	8,35	10,02	9,49
Packet type 2-DH 1	6,25	8,29	7,91
Packet type 3-DH 1	5,69	7,70	7,65
Correction factor - Path loss: [dB]	include as TDF at the spectrum analyzer		
Resulting Max. Peak Power	8,35 dBm 6,84 mW	10,02 dBm 10,05 mW	9,49dBm 8,89 mW
Limit (conducted)	1 Watt (30dBm) Peak		
Limit EIRP	1 Watt (30dBm) Peak + max. 6 dBi antenna gain		

Remark: here only the maximum power value is reported, see separate document A4 for full results

5.9.8. Test Result for EIRP:

Maximum power **conducted** value among all modulation => **10,02 dBm Peak (10,05 mW)**

Maximum EIRP value among all modulation as calculated for DH1 => 10,02 dBm – 4,00 dBi (PK)

Maximum EIRP = 6,02 dBm PK (4 mW) the antenna gain is < 6 dBi

FINAL TEST RESULT: Passed

5.10. RF Parameter - 20dBc Emission specification and Band-Edge (conducted)

5.10.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	<input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1)		<input type="checkbox"/> Please see Chapter. 2.2.2		<input type="checkbox"/> Please see Chapter. 2.2.3	
test site	<input type="checkbox"/> 441 EMI SAR	<input type="checkbox"/> 487 SAR NSA	<input type="checkbox"/> 337 OATS	<input checked="" type="checkbox"/> 347 Radio.lab.	<input type="checkbox"/>	<input type="checkbox"/>
receiver	<input type="checkbox"/> 377 ESCS30	<input type="checkbox"/> 001 ESS	<input checked="" type="checkbox"/> 489 ESU	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
power supply	<input type="checkbox"/> 456 EA 3013A	<input type="checkbox"/> 457 EA 3013A	<input type="checkbox"/> 459 EA 2032-50	<input type="checkbox"/> 268 EA- 3050	<input type="checkbox"/> 494 AG6632A	<input checked="" type="checkbox"/> 498 NGPE 40
otherwise	<input checked="" type="checkbox"/> 613 20dB Attenuator			<input checked="" type="checkbox"/> cable K15		<input checked="" type="checkbox"/> 1259 Directional-coupler

5.10.2. References: §15.247, §15.205, RSS-210: A8.5

FCC	<input checked="" type="checkbox"/> §15.247(d)
IC	<input checked="" type="checkbox"/> RSS-210: A8.5
ANSI	<input type="checkbox"/> -
Remark	<i>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. Attenuation below the general limits specified in § 15.209(a) is not required.</i>

5.10.3. EUT settings:

The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.

5.10.4. Measurement method:

The frequency spectrum was investigated for **conducted** spurious emissions values lower than 20 dB related to the RF-carrier power value. Three carrier frequencies (low/middle/high channel) were used for showing the compliance with this requirement. The detector were chosen according §15.209(d). The video bandwidth (VBW) was chosen 3 times to the resolution bandwidth (RBW). The frequency scan was up to 10 times the highest channel frequency within the operational mode. The spectrum-analyzer was set to MAX-PEAK Detector, MAX-Hold Mode.

For FHSS-systems three different channels were measured and for band-edge switched to hopping-on and -off.

5.10.5. Results

DH1

Set-up no.: 3 Op. mode: 1&2	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel =0 (2402 MHz)		Middle channel = 38 (2440 MHz)		High channel = 78 (2480 MHz)	
	Level Ref. (In-Band) = 7.36 dBm		Level Reference (In-Band) = 7.47 dBm		Level Reference (In-Band) = 8.73 dBm	
	Freq. [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
0.150 to 25000 MHz	--	No remarkable peaks found Margin>10 dB to limit -12.6 dBm	--	No remarkable peaks found Margin>10 dB to limit -12.5 dBm	--	No remarkable peaks found Margin> 10 dB to limit -11.3 dBm
Lower band edge -hop.off	--	>20 dB	--	--	--	--
Lower band edge -hop.on	--	>20 dB	--	--	--	--
Higher band edge -hop.off	--	--	--	--	--	>20 dB
Higher band edge -hop.on	--	--	--	--	--	>20 dB

2-DH1

Set-up no.: 1 Op. mode: 1&2	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel =0 (2402 MHz)		Middle channel = 38 (2440 MHz)		High channel = 78 (2480 MHz)	
	Level Reference (In-Band) = 5.93 dBm		Level Reference (In-Band) = 7.54 dBm		Level Reference (In-Band) = 6.98 dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
0.150 to 25000 MHz	--	No remarkable peaks found Margin>10 dB to limit -14.1 dBm	--	No remarkable peaks found Margin>10 dB to limit -12.5 dBm	--	No remarkable peaks found Margin> 10 dB to limit -13.0 dBm
Lower band edge – hop.off	--	>20 dB	--	--	--	--
Lower band edge –hop.on	--	>20 dB	--	--	--	--
Higher band edge – hop.off	--	--	--	--	--	>20 dB
Higher band edge –hop.on	--	--	--	--	--	>20 dB

3-DH1

Set-up no.: 1 Op. mode: 1&2	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel =0 (2402 MHz)		Middle channel = 38 (2440 MHz)		High channel = 78 (2480 MHz)	
	Level Reference (In-Band) = 5.95 dBm		Level Reference (In-Band) = 7.40 dBm		Level Reference (In-Band) = 6.94 dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
0.150 to 25000 MHz	--	No remarkable peaks found Margin>10 dB to limit -14.1 dBm	--	No remarkable peaks found Margin>10 dB to limit -12.6 dBm	--	No remarkable peaks found Margin> 10 dB to limit -13.1 dBm
Lower band edge – hop.off	--	>20 dB	--	--	--	--
Lower band edge –hop.on	--	>20 dB	--	--	--	--
Higher band edge – hop.off	--	--	--	--	--	>20 dB
Higher band edge –hop.on	--	--	--	--	--	>20 dB

5.11. Measurement uncertainties

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved.

For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it's contribution to the overall uncertainty according it's statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Frequency range	Calculated uncertainty based on a confidence level of 95%	Remarks:
Power Output conducted	9 kHz .. 20 GHz	1.0 dB	--
Power Output radiated	30 MHz .. 4 GHz	3.17 dB	Substitution method
Conducted emissions on antenna ports	9 kHz .. 20 GHz	1.0 dB	--
Radiated emissions enclosure	150 kHz .. 30 MHz	5.0 dB	Magnetic field
	30 MHz .. 1 GHz	4.2 dB	E-Field
	1 GHz .. 20 GHz	3.17 dB	Substitution method
Occupied bandwidth	9 kHz .. 4 GHz	0.1272 ppm (Delta Marker)	Frequency error
		1.0 dB	Power
Emission bandwidth	9 kHz .. 4 GHz	0.1272 ppm (Delta Marker)	Frequency error
		1.0 dB	Power
Frequency stability	9 kHz .. 20 GHz	0.0636 ppm	--
Conducted emissions on AC-mains port (U _{CISPR})	9 kHz .. 150 kHz	4.0 dB	--
	150 kHz .. 30 MHz	3.6 dB	--

Table: measurement uncertainties, valid for conducted/radiated measurements

6. Abbreviations used in this report

The abbreviations	
ANSI	American National Standards Institute
AV , AVG, CAV	Average detector
EIRP	Equivalent isotropically radiated power, determined within a separate measurement
EGPRS	Enhanced General Packet Radio Service
EUT	Equipment Under Test
FCC	Federal Communications Commission, USA
IC	Industry Canada
n.a.	not applicable
Op-Mode	Operating mode of the equipment
PK	Peak
RBW	resolution bandwidth
RF	Radio frequency
RSS	Radio Standards Specification, Dokuments from Industry Canada
Rx	Receiver
TCH	Traffic channel
Tx	Transmitter
QP	Quasi peak detector
VBW	Video bandwidth
ERP	Effective radiated power

7. Accreditation details of CETECOM's laboratories and test sites

Ref.-No.	Accreditation Certificate	Valid for laboratory area or test site	Accreditation Body
-	D-PL-12047-01-01	All laboratories and test sites of CETECOM GmbH, Essen	DAkkS, Deutsche Akkreditierungsstelle GmbH
337 487 558 348 348	736496	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA (MRA US-EU 0003)
337 487 550 558	3462D-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
337 487 550 348 348	R-2665 R-2666 G-301 C-2914 T-1967	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used equipment “CTC”

The “Ref.-No” in the left column of the following tables allows the clear identification of the laboratory equipment.

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
264	Spectrum Analyzer	FSEK 30	826939/005	Bios=2.1, Analyzer= 3.20
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	TSI 1.53
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5.30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
383	Signal Generator	SME 03	842 828 /034	Firm.= 4.61
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001, OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.52
442	CTC-SAR-EMS	System EMS field (SAR)	-	EMC 32 Version 8.40
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 8.53
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 8.40
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr: 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
594	Wideband Radio Communication Tester	CMW500	101757	Firmware Base=2.0.20.9, LTE=2.0.20.8. CDMA= 2.0.10
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V02.12.01

8.1.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
001	EMI Test Receiver	ESS	825132/017	Rohde & Schwarz	12 M	-	31.03.2014
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	24/12 M	-	31.03.2014
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	24/12 M	-	31.03.2014
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	31.03.2015
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	31.03.2016
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.03.2014
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	31.03.2015
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	31.03.2015
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	31.03.2015
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
066	notch filter (WCDMA; FDD1)	WRCT 1900/2200-5/40-10EEK	5	Wainwright GmbH	12 M	1g	30.06.2013
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
090	Helmholtz coil: 2x10 coils in series	-	-	RWTÜV	-	4	
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	31.03.2015
100	passive voltage probe	Probe TK 9416	without		36 M	-	31.03.2015
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	31.03.2016
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	12 M	-	31.03.2014
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	31.03.2015
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	31.03.2014
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	31.03.2014
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	31.03.2014
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	31.03.2016
264	Spectrum Analyzer	FSEK 30	826939/005	Rohde & Schwarz	12 M	-	31.03.2014
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	31.03.2014
266	peak power sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	31.03.2014
267	notch filter GSM 850	WRCA 800/960-6EEK	9	Wainwright GmbH	pre-m	2	
270	termination	1418 N	BB6935	Weinschel	pre-m	2	
271	termination	1418 N	BE6384	Weinschel	pre-m	2	
272	attenuator (20 dB) 50 W	Model 47	BF6239	Weinschel	pre-m	2	
273	attenuator (10 dB) 100 W	Model 48	BF9229	Weinschel	pre-m	2	
274	attenuator (10 dB) 50 W	Model 47 (10 dB) 50 W	BG0321	Weinschel	pre-m	2	
275	DC-Block	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Block	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
287	pre-amplifier 25MHz - 4GHz	AMF-2D-100M4G-35-10P	379418	Miteq	12 M	1c	30.06.2013
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2013
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	24/12 M	-	31.03.2014
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	31.03.2014
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	31.03.2014
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.11.2014
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	31.03.2014
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	31.03.2015
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	31.03.2014
356	power sensor	NRV-Z1	882322/014	Rohde & Schwarz	24 M	-	31.03.2015
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	31.03.2015
371	Bluetooth Tester	CBT32	100153	R&S	24 M	-	31.03.2014
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	24/12 M	-	31.03.2014
376	Horn Antenna 6 GHz	BBHA9120 E	BBHA 9120 E 179	Schwarzbeck	12 M	-	31.03.2014
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	31.03.2014
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	31.03.2015
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	31.03.2014
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	31.03.2014
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR) Cable	-	CETECOM	12 M	5	31.10.2013

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	30.06.2013
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.06.2013
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.06.2013
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	31.03.2014
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	31.03.2014
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	24 M	-	31.03.2014
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	24 M	-	31.03.2014
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	31.03.2015
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
484	pre-amplifier 2,5 - 18 GHz	AMF-5D-02501800-25-10P	1244554	Miteq	12 M	-	30.06.2013
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	30.09.2013
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	31.03.2014
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwright	12 M	1c	30.06.2013
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	31.03.2015
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
546	Univ. Radio Communication Tester	CMU 200	106436	R&S	12 M	-	31.03.2014
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	31.03.2014
548	Digital-Barometer	GBP 2300	without	Greisinger GmbH	36 M	-	30.06.2015
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.03.2015
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	30.06.2013
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	31.07.2013
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2016
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	24 M	-	31.03.2014
594	Wideband Radio Communication Tester	CMW500	101757	Rohde & Schwarz	24 M	-	31.03.2014
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	12 M	-	31.03.2014
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Rohde & Schwarz	24 M	-	13.01.2015
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	31.03.2015
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	31.03.2015
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	31.03.2015
608	UltraLog-Antenna	HL 562	830547/009	Rohde & Schwarz	36/12 M	-	31.03.2014
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	31.03.2014
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	01.03.2014
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.4 3	G. Lufft GmbH	24 M	-	30.05.2014
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
636	Thermal Imaging camera	Ti32	Ti32-12060213	Fluke Corporation	24 M	-	31.07.2014
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	24 M	-	31.03.2014
644	Amplifier	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	12 M	-	31.03.2014

8.1.3. Legend

Note / remarks		Calibrated during system calibration:
	1a	System CTC-SAR-EMS (Ref.-No. 442)
	1b	System-CTC-EMS-Conducted (Ref.-No. 335)
	1c	System CTC-FAR-EMI-RSE (Ref.-No . 443)
	1d	System CTC-SAR-EMI (Ref.-No . 441)
	1e	System CTC-OATS (EMI radiated) (Ref.-No. 337)
	1 f	System CTC-CTIA-OTA (Ref.-No . 420)
	1 g	System CTC-FAR-EMS (Ref.-No . 444)
	2	Calibration or equipment check immediately before measurement
	3	Regulatory maintained equipment for functional check or support purpose
	4	Ancillary equipment without calibration e.g. mechanical equipment or monitoring equipment
	5	Test System

Interval of calibration	12 M	12 month
	24 M	24 month
	36 M	36 month
	24/12 M	Calibration every 24 months, between this every 12 months internal validation
	36/12 M	Calibration every 36 months, between this every 12 months internal validation
	Pre-m	Check before starting the measurement
	-	Without calibration