

TEST REPORT

No.: 18-1-0048601T02a-C1

According to:
FCC Regulations
Part 15.205 & Part 15.209
Part 15.247

ISED-Regulations
RSS-Gen, Issue 5
RSS-247, Issue 2

for

Robert Bosch Car and Multimedia GmbH

AIVIV20
Car radio with navigation, WLAN and Bluetooth

FCC ID: YBN-AIVIV20
ISED: 9595A-AIVIV20

Laboratory Accreditation and Listings	
 Deutsche Akkreditierungsstelle D-PL 12047-01-01 D-PL 12047-01-03 D-PL 12047-01-04	
Accredited EMC-Test Laboratory	
 AUTHORIZED RF LABORATORY	 Authorized™ Test Lab Lab Code: 20011130-00
accredited according to DIN EN ISO/IEC 17025	
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	
Laboratory Accreditation and Listings	

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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. Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

The presented Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies with WLAN technology and operating frequency range at 2.412 to 2.462 GHz according to IEE 802.11 b/g/n. The EUT integrates a WLAN transmitter. Other implemented wireless technologies were not considered within this test report.

Following test cases have been performed to show compliance with valid Part 15.207/15.209/15.247 of the FCC CFR Title 47 Rules, Edition 2017 and ISSED RSS-247 Issue 2/RSS-Gen Issue 5 standards.

1.1. Tests measurement overview according of US CFR Title 47, Subpart 15C and Canada RSS-Standards:

Test cases	Port	References & Limits			EUT set-up	EUT opera - ting mode	Result
		FCC Standard	RSS Section	Test Limit			
TX-Mode							
Timing of transmitter (pulsed operation)	Antenna Terminal or enclosure	§15.35	RSS-Gen, Issue 5, Chapter 8.2	--	--	--	for Information only
6 dB bandwidth	Antenna terminal (conducted)	§15.247(a)(2)	RSS-247, Issue 2 Chapter 5.2 b	≥ 500 kHz for DTS systems	2	1	Pass
99% occupied bandwidth	Antenna terminal (conducted)	2.1049(h)	RSS-Gen, Issue 5, Chapter 6.7	99% Power bandwidth	2	1	Pass
Transmitter Peak output power	Antenna terminal (conducted)	§15.247(b)(3)	RSS-247, Issue 2 Chapter 5.1 d	1 Watt Peak	2	1	Pass
Transmitter Peak output power radiated	Enclosure + Inter-connecting cables (radiated)	§15.247(b)(4)	RSS-247, Issue 2 Chapter 5.1 d	< 4 Watt (EIRP) for antenna with directional gain less 6dBi	2	1	Pass (calculated)
Out-Of-Band RF- emissions Band-Edge emissions	Antenna terminal (conducted)	§15.247 (d)	RSS-Gen, Issue 5, Chapter 8.9	20 dBc or RSS-Gen, Issue 5, Table 5 limits	1	1	Pass
Power spectral density	Antenna terminal (conducted)	§15.247(e)	RSS-247, Issue 2 Chapter 5.2 b	8dBm in any 3 kHz band	2	1	Pass

Transmitter frequency stability	Antenna terminal (conducted)	--	RSS-Gen, Issue 5, Chapter 8.11	Occupied bandwidth entirely outside restricted bands and prohibited TV bands	2	1	Pass
General field strength emissions + restricted bands	Enclosure + Inter-connecting cables (radiated)	§15.247 (d) §15.205 §15.209	RSS-247, Issue 2, Chapter 5.5 RSS-Gen, Issue 5: §8.9 Table 5+6+7	Emissions in restricted bands must meet the general field-strength radiated limits	1	1	Pass
AC-Power Lines Conducted Emissions	AC-Power lines	§15.207	RSS-Gen, Issue 5: Chapter 8.8 Table 4	FCC §15.107 class B limits §15.207 limits ISED: Table 4, Chapter 8.8	--	--	Not applicable
RF-Exposure Evaluation (separation distance user to RF-radiating element greater 20cm)							
Test cases	Port	References & Limits			EUT set-up	EUT operating mode	Result
		FCC Standard	RSS Section	Test Limit			
Radio frequency radiation exposure requirements	Cabinet + Inter-connecting cables (radiated)	§1.1310(b) §2.1091 §2.1093	RSS-102 Issue 5	SAR-Limits FCC: 1.1310(b)	--	--	See separate test reports CETECOM_TR18-1-0048601T05a
				RF-Field Strength Limits: FCC: "general population/uncontrolled" environment Table 1 ISED: Table 4	1	1	

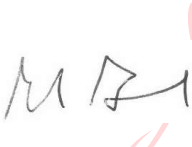
Remark

1.2. Attestation:

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All requirements as shown in above table are met in accordance with enumerated standards.

The current version of the Test Report CETECOM_TR18-1-0048601T02a-C1 replaces the Test Report CETECOM_TR18-1-0048601T02a dated 2018-12-28. The replaced test report is herewith invalid.


.....
Dipl.-Ing. Niels Jeß
Responsible for test section


.....
B.Sc. Mohamed Ahmed
Responsible for test report

Digital unterschrieben von B.Sc.
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Datum: 2019.02.20 10:54:27
+01'00'

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

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:	B.Sc. Mohamed Ahmed
Responsible for project:	Dipl.-Ing Ninovic Perez
Receipt of EUT:	2018-11-02
Date(s) of test:	2018-11-11 - 2018-12-18
Date of report:	2019-02-20

Version of template:	13.02

2.4. Applicant's details

Applicant's name:	Robert Bosch Car and Multimedia GmbH
Address:	Robert-Bosch-Straße 200 31139 Hildesheim Germany
Contact person:	Mr. Salvatore Miraglia

2.5. Manufacturer's details

Manufacturer's name:	see applicant's details
Address:	see applicant's details

3. Equipment under test (EUT)

3.1. Technical data of main EUT declared by applicant

Model Nr.	AIVIV20		
Type	Car radio with navigation, WLAN and Bluetooth		
FCC ID	YBN-AIVIV20		
IC/ISED	9595A-AIVIV20		
Frequency range (US/Canada -bands)	☒ 2412 MHz (Channel 1) to 2462 MHz (Channel 11) for 20MHz BW ☒ 2422 MHz (Channel 3) to 2452 MHz (channel 9) for 40MHz BW		
Type of modulation	See chapter 3.2		
Number of channels (USA/Canada -bands)	1 to 11		
Antenna Type	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector		
Antenna Model	PCB Antenna		
Antenna Gain	6.1 dBi		
Max. Conducted Output Power	Measured RMS Power 802.11b: 10.92dBm 802.11g: 8.40dBm 802.11n(20MHz): 8.37dBm 802.11n(40MHz): 8.61dBm		
EIRP WLAN	Calculated EIRP 802.11b: 10.92dBm +6.1dBi =17.02dBm 802.11g: 8.40dBm +6.1dBi =14.50dBm 802.11n(20MHz): 8.37dBm +6.1dBi = 14.47dBm 802.11n(40MHz): 8.61dBm +6.1dBi = 14.71dBm		
Installed options	☒ 802.11 a/n/ac (not tested within this report) ☒ 802.11 b/g/n ☒ Bluetooth LE (not tested within this report) ☒ Bluetooth EDR (not tested within this report)		
Power supply	☒ Nominal Test Voltage : 13.5 V DC VDC with external power supply		
Special EMI components	--		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

Remark:

3.2. IEEE 802.11 overview: modulation and data rates

The modulations and data rates defined for 802.11 b/g/n transmitters are identified in the table below. Also it shows which operational mode is possible for the device under test (EUT) according applicant's information.

802.11b-Mode (DSSS System)		
Data rate [Mbps]	Modulation type	Supported by EUT
1	DBPSK (Differential binary phase shift keying)	YES
2	DQPSK (Differential quadrature phase shift keying)	YES
5.5 / 11	CCK/PBCC (8-chip complementary code keying)	YES
22	ERP-PBCC (Packet binary convolutional coding)	NO

802.11g-Mode (OFDM system)		
Brutto data rate [Mbps]	Modulation type of subcarriers	Supported by EUT
6 / 9	BPSK	YES
12 / 18	QPSK	YES
24 / 36	16-QAM	YES
48 / 54	64-QAM	YES

Remark: 52 sub-carriers which can be modulated at different data-rates.

802.11n-Mode (OFDM)		
Brutto data rate [Mbps]	Modulation type	Supported by EUT
7.2/14.4/21.7/28.9/43.3/57.8/65/72.2 Mbps	HT20 (MCS0..MCS7)	YES
14.444/28.889/43.333/57.778/86.667/115.556/130/144.444 Mbps	HT20 (MCS8..MCS7)	NO
15/30/45/60/90/120/135/150 Mbps	HT40 (MCS0..MCS7)	YES
30/60/90/120/180/240/270/300 Mbps	HT40 (MCS8..MCS15)	NO

Comments: For additional details please refer to "A-IVI_Scope2_TechnicalPassport_0706207"

3.3. 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 S06	AIVIV20	Navigationsystem with WLAN and Bluetooth	0005021	Version D	283C37820R
EUT B S04	AIVIV20	Navigationsystem with WLAN and Bluetooth	0005013	Version D	283C37820R

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

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

3.4.1. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

AE short description *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	USB-cable (Dongle)	0,38m	S7291GC000379	Version-D1	--
AE 2	Harness	Test Cable	--	--	--
AE 3	Notebook	Lenovo X200S	LVZT1DG	--	--

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

3.5. EUT set-ups

EUT set-up no. *)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 1 + AE 2	Radiated measurement set-up
set. 2	EUT B + AE 1 + AE 2	Conducted measurement set-up

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

3.6. EUT operating modes

EUT operating mode no.*1)	Description of operating modes	Additional information
op. 1	TX-Mode Burst 20MHz	With help of special test firmware WLAN is switched to a bandwidth of 20MHz and a continuous traffic mode in burst mode (duty cycle >98%) was set-up *2)
op. 2	TX-Mode Burst 40MHz	With help of special test firmware WLAN is switched to a bandwidth of 40MHz and a continuous traffic mode in burst mode (duty cycle >98%) was set-up *2)

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

*2) Please refer to document Instructions_RadioTypeApproval_9_6_2017 "Instructions for setting Operating Modes of WLAN, BT and BT-LE for Radio Type Approval."

3.6.1. Test tool information

Labtool version: 2.0.0.75

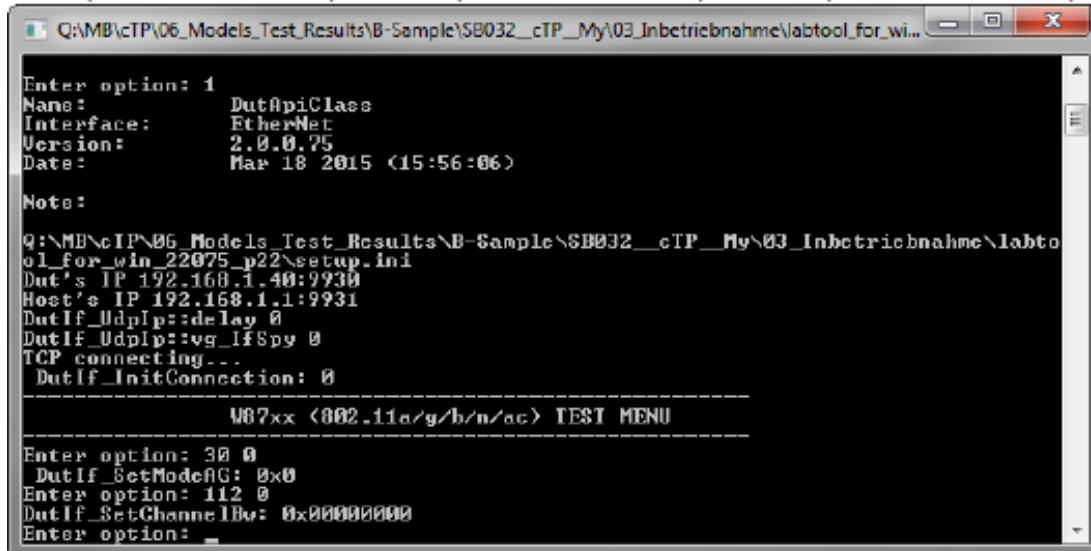
Labtool date: Mar 18 2015 (15:56:06)

The following settings have been done under SW Labtool:

Make the main settings which only have to be set once (per session):

30 0 (Choose the 2,4G band) or 30 1 (Choose the 5G band)

112 0 (20 MHz Bandwidth) or 112 1 (40 MHz Bandwidth) or 112 4 (80 MHz Bandwidth)



```

Q:\MB\cTP\06_Models_Test_Results\B-Sample\SB032_cTP_My\03_Inbetriebnahme\labtool_for_wi...
Enter option: 1
Name:          DutApiClass
Interface:     EtherNet
Version:       2.0.0.75
Date:         Mar 18 2015 (15:56:06)

Note:
Q:\MB\cTP\06_Models_Test_Results\B-Sample\SB032_cTP_My\03_Inbetriebnahme\labto
ol_for_win_22075_p22\setup.ini
Dut's IP 192.168.1.40:9930
Host's IP 192.168.1.1:9931
DutIf_UdpIp::delay 0
DutIf_UdpIp::vg_ifsps 0
TCP connecting...
DutIf_InitConnection: 0

-----
W07xx <802.11a/g/b/n/ac> TEST MENU
-----

Enter option: 30 0
DutIf_SetModeAG: 0x0
Enter option: 112 0
DutIf_SetChannelBw: 0x00000000
Enter option: _
  
```

Now the parameters for **Channel**, **Power level** and **modulation group** has to be done:

22 1 14 0



```

Enter option: 22 1 17 0
DutIf_SetRfChannel: 0x0
DutIf_SetRfPowerCal: 0x0
Enter option:
  
```

For 802.11b the Power level is always 14 and the modulation group is 0

For 802.11g the Power level is always 11 and the modulation group is 1

For 802.11n (2,4GHz) the Power level is always 11 and the modulation group is 1

For 802.11n (5GHz) the Power level is always 10 and the modulation group is 1

For 802.11a the Power level is always 10 and the modulation group is 1

For 802.11ac the Power level is always 6 and the modulation group is 1

If a continuous burst is required use instead of the command 25 the command 17:

17 1 4

```
Enter option: 17 1 4
DutIf_SetTxDataRate: 0x00000000
TRPC ID: 2
DutIf_SetTxContMode: 0x00000000
Enter option:
```

11b		11g/a		11n		11ac	
ID	DataRate	ID	DataRate	ID	DataRate	ID	DataRate
1	1M	6	6M	15	MCS0	101	VHT_SS1_MCS0
2	2M	7	9M	16	MCS1	102	VHT_SS1_MCS1
3	5.5M	8	12M	17	MCS2	103	VHT_SS1_MCS2
4	11M	9	18M	18	MCS3	104	VHT_SS1_MCS3
		10	24M	19	MCS4	105	VHT_SS1_MCS4
		11	36M	20	MCS5	106	VHT_SS1_MCS5
		12	48M	21	MCS6	107	VHT_SS1_MCS6
		13	54M	22	MCS7	108	VHT_SS1_MCS7
						109	VHT_SS1_MCS8
						110	VHT_SS1_MCS9

In order to stop the TX:

17 0

```
Enter option: 17 0
DutIf_SetTxContMode: 0x00000000
Enter option:
```

3.7. Worst case identification

The following WLAN modes were used for testing

WLAN Mode	Data Rate
802.11b	2Mbit
802.11g	12Mbit
802.11n, 20MHz bandwidth	MCS0
802.11n, 40MHz bandwidth	MCS0

4. Description of test system set-up's

4.1. Test system set-up for conducted measurements on antenna port

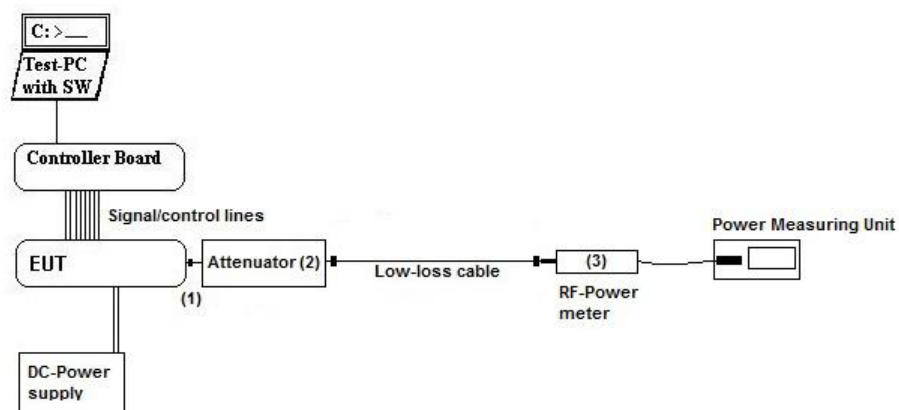
Conducted Set-up W1

W-LAN conducted RF-Setup 1 (W1 Set-up)

General description:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to the power meter (3) for conducted power measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings.

Schematic:



Testing method:

ANSI C63.10:2013, KDB 558074 D01 DTS Meas.Guidance v04

Used Equipment

Passive Elements	Test Equipment	Remark:
☒ 20 dB Attenuator	☒ Power Meter	See List of equipment under each test case and chapter 8 for calibration info
☒ Low loss RF-cables	☒ DC-Power Supply	
☒	☒ Spectrum-Analyser	

Measurement uncertainty

See chapter 5.10

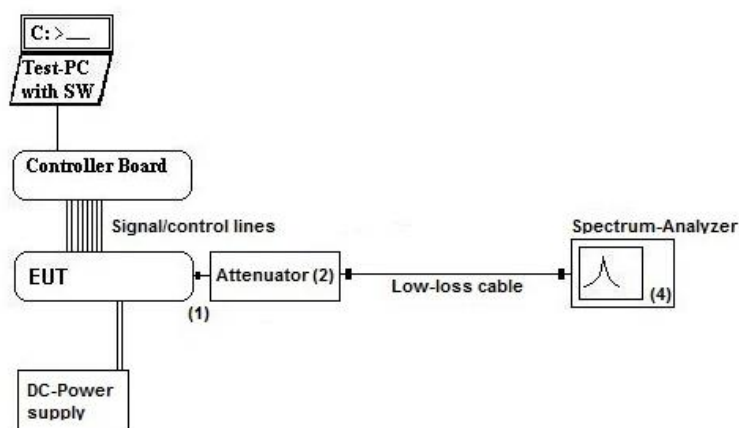
Conducted Set-up W2

W-LAN conducted RF-Setup 2 (W2 Set-up)

General description:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to spectrum-analyzer (4) for RF-conducted measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings of the spectrum-analyzer.

Schematic:



Testing method:

ANSI C63.10:2013, KDB 558074 D01 DTS Meas.Guidance v04

Used Equipment

Passive Elements	Test Equipment	Remark:
☒ 20 dB Attenuator	☒ Power Meter	See List of equipment under each test case and chapter 8 for calibration info
☒ Low loss RF-cables	☒ DC-Power Supply	
	☒ Spectrum-Analyser	

Measurement uncertainty

See chapter 5.10

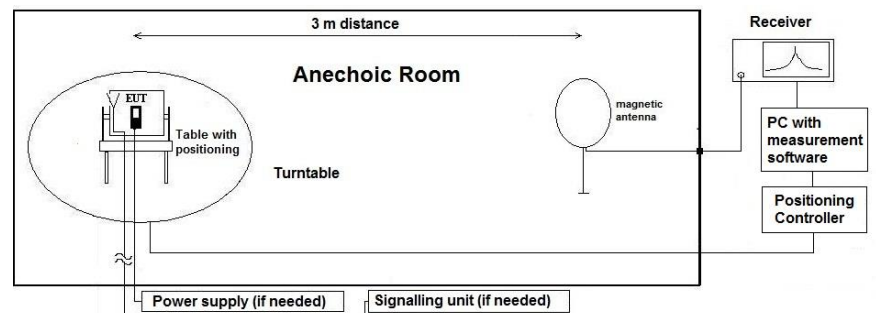
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.10-2013 chapter 6.4 (§6.4.4.2)

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 due to reduced measurement distance:

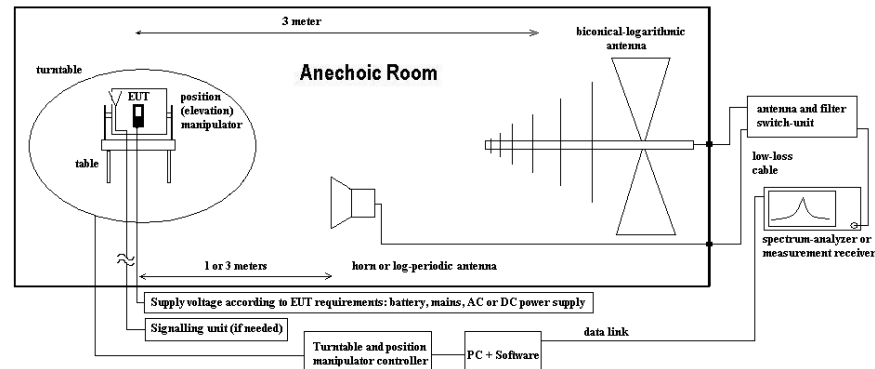
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

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

Specification: ANSI C63.4-2014 chapter 8.2.3, ANSI C63.10-2013 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 determined by an exploratory emission measurements. 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. either on 10m OATS or 3m semi-anechoic room.

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 = Limit

M = Margin

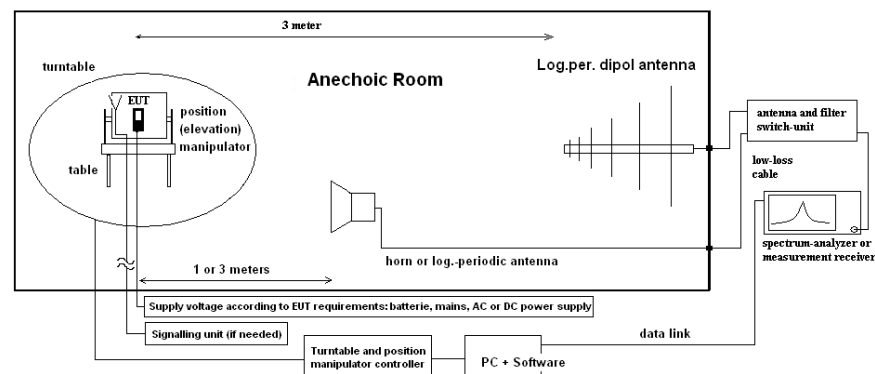
All units are dB-units, positive margin means value is below limit.

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

Specification: ANSI C63.4-2014 chapter 8.3, ANSI C63.10-2013 chapter 6.6.3.3 & 6.6.4

General Description: Evaluating the 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 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

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 15°) 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 over 3-orthogonal axis and the height for EUT with large dimensions.

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

5. Measurement results

5.1. Duty-Cycle

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

Ambient Climatic conditions			Temperature: (22±2)°C		Rel. humidity: (45±15)%	
test site	☐ 441 EMI SAR	☐ 348 EMI cond.	☐ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☒ TS 8997
equipment	☐ 331 HC 4055	☐	☐	☐	☐	☐
spectr. analys.	☐ 683 FSU26	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
power meter	☐ 262 NRV-S	☐ 266 NRV-Z31	☐ 265 NRV-Z33	☐ 261 NRV-Z55	☐ 356 NRV-Z1	☐
multimeter	☐ 341 Fluke 112	☐	☐	☐	☐	☐
DC power	☐ 086 LNG50-10	☐ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 Car battery	☒ 463 HP3245A
line voltage	☒ 13.5 V DC		☐ 060 120 V 60 Hz via PAS 5000			
otherwise	☐ 530 Attenuator 10dB	☒ K4 Cable				

The necessary duty-cycle correction factor is determined on nominal conditions on one channel in each operable frequency-band. It is assumed that no noticeable changes occur when tested on other channels or climatic conditions. The Duty-Cycle was constant, means without variations.

5.1.2. Results

- ☐ The results were corrected in order to evaluate for worst-case result each time when average values are necessary for example average radiated emissions or similar
- ☒ No correction necessary: Duty-Cycle > 98%

5.2. RF-Parameter – 6dB and 99% Occupied Bandwidth

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ 443 System CTC-FAR-EMI-	☐ Please see Chapter. 2.2.3
test site	☐ 441 EMI SAR	☐ 487 SAR NSA	☐ 337 OATS ☒ 347 Radio.lab.
receiver	☐ 377 ESCS30	☐ 001 ESS	☐ 489 ESU 40 ☐ 620 ESU 26
otherwise	☐ 600 NRVD	☐ 357 NRV-Z1	☒ 693 TS8997
spectr. analys.	☒ 683 FSU	☐ 120 FSEM	☐ 264 FSEK ☐ 714 FSW 67
power supply	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50 ☐ 268 EA- 3050 ☐ 494 AG6632A ☐ 354 NGPE 40
otherwise	☒ 613 20 dB Attenuator	☐ 248 6 dB Attenuator	☐ 529 Power divider ☐ - cable OTA20 ☐ 530 10dB Atten ☐ K5 Cable
Supply voltage	☐ 230 V 50 Hz via public mains	☒ 13.5 V DC	

5.2.2. Requirements:

FCC	☒ §15.247(a)(2), RSS-247, Chapter 5.2(1)
ISED	☒ RSS-Gen, Issue5 , Chapter 6.7
Remark	The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

5.2.3. 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.

5.2.4. Measurement method

The measurement was performed with the RBW set to 30kHz. 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 99% OBW measurement function was used to measure the bandwidth compared 99% of the highest In-Band power. The operating modes have been varied (e.g. data rate, modulation scheme, etc.). The hopping-mode is switched off.

5.2.5. 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

5.2.6. 6dB Occupied Bandwidth Results:

0.2.10: 6dB Occupied Bandwidth Results:

6dB Occupied Bandwidth Measurements				
Temperature :+21 °C		Voltage Supply 13.5 V DC	Setup: 2	Op. Mode: 1
Mode	Frequency	6 dB Emission Bandwidth Measurements		Plot No.
	[MHz]	[MHz]		Remark 1
b	2412	10.20		
b	2437	10.20		
b	2462	10.30		
g	2412	16.50		
g	2437	16.60		
g	2462	16.60		
n20	2412	17.50		
n20	2437	17.50		
n20	2462	17.50		
n40	2422	35.90		
n40	2437	35.90		
n40	2452	35.90		
Remark 1: For further details please refer → Annex 1: Test results - CETECOM_TR18-1-0048601T03a-A1				

5.2.7. 6dB Occupied Bandwidth Verdict: For Information only

5.2.8. 99% Occupied Bandwidth Results:

99% Occupied Bandwidth Results:

99% Occupied Bandwidth Measurements				
Temperature :+21 °C		Voltage Supply 13.5 V DC	Setup: 2	Op. Mode: 1
Mode	Frequency	99% Emission Bandwidth Measurements		Plot No.
	[MHz]	[MHz]		Remark 1
b	2412	13.40		
b	2437	13.30		
b	2462	13.25		
g	2412	17.50		
g	2437	17.45		
g	2462	17.40		
n20	2412	18.50		
n20	2437	18.40		
n20	2462	18.65		
n40	2422	37.40		
n40	2437	37.20		
n40	2452	37.45		
Remark 1: For further details please refer → Annex 1: Test results - CETECOM_TR18-1-0048601T03a-A1				

5.2.9. 99% Occupied Bandwidth Verdict: For Information only

5.3. General Limit – Maximum power output conducted

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ 443 System CTC-FAR-EMI-	☐ Please see Chapter. 2.2.3
test site	☐ 441 EMI SAR ☐ 487 SAR NSA ☐ 347 Radio.lab. ☒ TS 8997	☐	☐
receiver	☐ 377 ESCS30 ☐ 001 ESS ☐ 489 ESU 40	☐	☐
spectr. analys.	☐ 584 FSU ☐ 120 FSEM ☐ 264 FSEK ☐ 489 ESU 40	☐	☐
antenna	☐ 574 BTA-L ☐ 133 EMCO3115 ☐ 302 BBHA9170 ☐ 289 CBL 6141 ☐ 030 HFH-Z2 ☐ 477 GPS	☐	☐
signaling	☐ 392 MT8820A ☐ 436 CMU ☐ 547 CMU	☐	☐
otherwise	☐ 266 NRV-Z31 ☐ 600 NRVD ☐ 110 USB LWL ☐ 482 Filter Matrix ☐ 378 RadiSense ☒ 693 TS8997	☐	☐
DC power	☒ 671 EA-3013S ☐ 463 HP3245A ☐ 459 EA 2032-50 ☐ 268 EA- 3050 ☐ 494 AG6632A ☐ 498 NGPE 40	☐	☐
otherwise	☐ 331 HC 4055 ☐ 248 6 dB Attenuator ☐ 529 Power divider ☐ - cable OTA20	☐	☐
line voltage	☒ 13.5 V DC ☐ K 4 Cable kit ☐ 060 110 V 60 Hz via PAS 5000	☐	☐

5.3.2. Reference

FCC	☒ §15.247(b) (3) + KDB 558074 D01 DTS Meas Guidance v04
ISED	☒ RSS-247, Chapter 5.4(4)
ANSI	☒ ANSI 63.10:2013
Specification	For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

5.3.3. EUT settings:

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.

5.3.4. Test condition and measurement test set-up

Signal ink to test system (if used):	☐ air link ☐ cable connection ☒ none
EUT-grounding	☒ none ☐ with power supply ☐ additional connection
Equipment set up	☒ table top 1.5m height ☐ floor standing
Climatic conditions	Temperature: (22±3°C) Rel. humidity: (40±20)%
General measurement procedures	Please see chapter “Test system set-up for conducted RF-measurement at antenna Port” (W1 Set-up)

5.3.5. Measurement method and analyzer settings:

The measurement was performed in non-hopping transmission mode with the carrier set to lowest/middle and highest channel.

MEASUREMENT METHOD/ SPECTRUM-ANALYZER SETTINGS:

Measurement Method ^{1.)}	§15.247(b) (3) Maximum Peak	1.) ☐ PK1-Method RBW > 6dB-bandwidth of the signal, ANSI 63.10: 2013, chapter 2.) ☐ PK2-Method (§5.2.1.2): Channel integration method (ANSI 63.10:2013) 3.) ☐ PK1-Method (§9.1.2 KDB): Peak Power Meter Method
	§15.247(b) (3) Maximum Average	4.) ☐ AVG1 - power averaging over EBW + integrated band power measurement 5.) ☐ AVG2 - trace averaging over EBW + integrated band power measurement 6.) ☒ RMS power meter method: Chapter 9.2.3.2 AVGPM-G
	MIMO	7.) ☐ Method as described in Chapter 3.8 was used for measurements on two available RF-Antenna ports.
Center Frequency	Nominal channel frequency	
Span	30% higher than the EBW measured before	
Resolution Bandwidth (RBW)	20MHz	
Video Bandwidth (VBW)	30MHz	
Sweep time	coupled	
Detector	Peak, Max hold mode for method PK1/PK2 or RMS and trace average for method AVG1/AVG2	
Sweep Mode	Repetitive mode, allow trace to stabilize	
Analyzer-Mode	☐ normal ☐ activated channel integration method with limits set to the EBW of the signal	

Remark 1: guidance 558074 D01 measurement DTS guidance v04

5.3.6. RESULTS

APPLICANT'S DECLARED 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

Maximum declared antenna gain [isotropic]: 1.24 dBi

Different modulation types and data rates were tested in order to find the maximum peak conducted output power.
Enclosed are only the maximum values for each modulation format, pls. compare separate document A1 for all results.

Max. Peak power (conducted) [dBm]				Limit [dBm]	Result
Set-up no.: 2 Op-Mode: 1	Channel = 1 (2412 MHz)	Channel = 6 (2427 MHz)	Channel = 11 (2462 MHz)		
Measured Level b mode, 1Mbit, 20MHz	10.92	10.30	10.60	30	passed
g mode, 12Mbit, 20MHz	8.14	7.82	8.40	30	passed
n mode, MCS0, 20MHz	8.36	7.79	8.37	30	passed
	Channel = 3 (2422MHz)	Channel = 6 (2437MHz)	Channel = 9 (2452 MHz)		
n mode, MCS0, 40MHz	8.18	8.61	8.52	30	passed

Remark: Please refer to Annex A for complete other results

5.4. RF-Parameter - Power Spectral Density

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ Please see Chapter. 2.2.2	☐ Please see Chapter. 2.2.3
test site	☐ 441 EMI SAR ☐ 487 SAR NSA ☐ 337 OATS ☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30 ☐ 001 ESS ☐ 489 ESU ☒ 683 FSU26	☐	☐
spectr. analys.	☐ 489 ESU ☐ 120 FSEM ☐ 264 FSEK ☐	☐	☐
power supply	☒ 671 EA-3013S ☐ 457 EA 3013A ☐ 463 ☐ 268 EA- 3050 ☐ 494 AG6632A ☐ 498 NGPE 40		
otherwise	☒ 530 10dB Attenuator	☒ cable K4	

5.4.2. REFERENCES: §15.247(e), RSS-247, Chapter 5.2(2)

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.4.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

Signal link to test system (if used):	☐ air link ☐ cable connection ☒ none
EUT-grounding	☒ none ☐ with power supply ☐ additional connection
Equipment set up	☒ table top ☐ floor standing
Climatic conditions	Temperature: (22±3°C) Rel. humidity: (40±20)%
General measurement procedures	Please see chapter "Test system set-up for conducted RF-measurement at antenna Port" (W2 Set-up)

5.4.4. EUT SETTINGS:

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.

5.4.5. MEASUREMENT METHOD/ SPECTRUM-ANALYZER SETTINGS

Measurement Method	☐ ANSI 63.10:2009 ☒ PKPSD-Method ☐ AVGPSD Method
	☒ guidance 558074 D01 measurement DTS guidance v04
Center Frequency	Nominal channel frequency
Span	5..30% higher than the EBW measured before
Resolution Bandwidth (RBW)	> 3 kHz (at least 3 times RBW) - pls. see diagram
Video Bandwidth (VBW)	> 10 kHz - pls. see diagram
Sweep time	coupled
Detector	Peak, Max hold mode for method PKPSD or RMS method AVGPSD
Sweep Mode	Repetitive mode, allow trace to stabilize (PKPSD) or single (AVGPSD)
Addition of correction factors	external measuring set-up path-loss

Remarks:--

5.4.6. RESULTS

Set-up no.: Op-Mode:	POWER SPECTRAL DENSITY [dBm/3 kHz]		
	Low channel = 1 (2412 MHz)	Middle channel = 6 (2437 MHz)	High channel = 11 (2462 MHz)
Measured Level b-Mode @1Mbps	-7.030	-7.241	-6.837
Measured Level g-Mode @12Mbps	-15.018	-14.858	-14.922
Measured Level n-Mode 20MHz @MCS0	-13.826	-14.061	-13.854
Set-up no.: Op-Mode:	Low channel = 3 (2422 MHz)	Channel = 6 (2437MHz)	High channel = 9 (2452 MHz)
Measured Level n-Mode 40MHz @MCS0	-18.963	-18.609	-18.599
Limit	< 8dBm/3 kHz		

Remark: see diagrams for details on frequency in separate annex A1

5.4.7. VERDICT: PASS

5.5. RF-Parameter – Out-of-Band 20 dBc Conducted Emissions

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ 443 System CTC-FAR-EMI-		☐ Please see Chapter. 2.2.3	
test site	☐ 441 EMI SAR	☐ 487 SAR NSA	☐ 337 OATS	☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 683 FSU 26	☐ 714 FSW67	☐	☐
spectr. analys.	☐ 489 ESU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
power supply	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☒ 354 NGPE 40
otherwise	☒ 530 10dB Attenuator		☒ RTK161		☐ Directional Coupler 1539R-10	
Supply voltage	☒ 24 V DC					

5.5.2. Requirements:

FCC	☒ §15.247 (d)
ISED	☒ RSS-247. Issue 2. Chapter 5.5
Remark	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under FCC15.247 paragraph (b)(3) / RSS-247section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB

5.5.3. EUT settings

Fixed Channel Mode:

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.

Hopping Mode:

For FHSS-systems Hopping mode was switched- ON so emissions from hopping 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 measurements were performed with the RBW set to 100kHz & maximum carrier level was indicated with MAX-Hold positive peak detector using markers. Then a frequency line was set 20 dB below this measured maximum carrier level.

Then using RBW 100 kHz & spectrum analyzer span from 150 kHz to 25 GHz in three steps spurious emissions were measured with MAX-Hold positive peak detector.

The sweep time set as long as necessary to capture the full signal burst per hopping channel. The burst on-period is captured by setting appropriate markers in the rising and falling edges.

5.5.5. TABLE OF MEASUREMENT RESULTS:

5.5.5.1. Op. Mode: b-Mode

Set-up no.: 1 Op-Mode: 1	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel = 1 (2412 MHz) Level Reference (In-Band)= 0.98 dBm Limit= -19.02 dBm		Middle channel = 6 (2437 MHz) Level Reference (In-Band) = -- dBm Limit= -- dBm		High channel = 11 (2462MHz) Level Reference (In-Band)= -- dBm Limit= -- dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
150kHz to 30MHz	*1)	>40	--	--	--	--
30MHz to 2.8 GHz	*1)	>40	--	--	--	--
2.8 to 25 GHz	*1)	>35	--	--	--	--
Band-Edge	--	>40	--	--	--	--

Remark: see diagrams in separate document A1

The limit on the diagrams is 20dB under the reference level measured In-Band for each channel

*1) only noise, no remarkable peak found

5.5.5.2. Op. Mode: g-Mode

Set-up no.: 1 Op-Mode: 1	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel = 1 (2412 MHz) Level Reference (In-Band)= -- dBm Limit= -- dBm		Middle channel = 6 (2437 MHz) Level Reference (In-Band) = -3.47 dBm Limit= -23.47 dBm		High channel = 11 (2462MHz) Level Reference (In-Band)= -- dBm Limit= -- dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
150kHz to 30MHz	--	--	*1)	>40	--	--
30MHz to 2.8 GHz	--	--	*1)	>40	--	--
2.8 to 25 GHz	--	--	*1)	>35	--	--
Band-Edge	--	--	--	>40	--	--

Remark: see diagrams in separate document A1

The limit on the diagrams is 20dB under the reference level measured In-Band for each channel

*1) only noise, no remarkable peak found

5.5.5.3. Op. Mode: n-Mode 20MHz

Set-up no.: 1 Op-Mode: 1	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel =1 (2412 MHz) Level Reference (In-Band)= -- dBm Limit= -- dBm		Middle channel = 6 (2437 MHz) Level Reference (In-Band) = -- dBm Limit= -- dBm		High channel = 11 (2462MHz) Level Reference (In-Band)= -3.73 dBm Limit= -33.73 dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
150kHz to 30MHz	--	--	--	--	*1)	>40
30MHz to 2.8 GHz	--	--	--	--	*1)	>40
2.8 to 25 GHz	--	--	--	--	*1)	>35
Band-Edge	--	--	--	--	--	>40

Remark: see diagrams in separate document A1

The limit on the diagrams is 20dB under the reference level measured In-Band for each channel

*1) only noise, no remarkable peak found

5.5.5.4. Op. Mode: n-Mode 40MHz

Set-up no.: 1 Op-Mode: 1	RF-Conducted test: 20 dBc spurious emissions					
Frequency Range	Low channel =3 (2422 MHz) Level Reference (In-Band)= -3.67 dBm Limit= -23.67 dBm		Middle channel = 6 (2437 MHz) Level Reference (In-Band) = -- dBm Limit= -- dBm		High channel = 9 (2452MHz) Level Reference (In-Band)= -3.77 dBm Limit= -23.77 dBm	
	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]	Frequency [MHz]	Value [dBc]
150kHz to 30MHz	*1)	>40	--	--	*1)	>40
30MHz to 2.8 GHz	*1)	>40	--	--	*1)	>40
2.8 to 25 GHz	*1)	>35	--	--	*1)	>35
Band-Edge	--	>40	--	--	--	>40

Remark: see diagrams in separate document A1

The limit on the diagrams is 20dB under the reference level measured In-Band for each channel

*1) only noise, no remarkable peak found

5.5.6. TEST RESULT: PASS

5.6. RF-Parameter – Frequency Stability

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ 443 System CTC-FAR-EMI-	☐ Please see Chapter. 2.2.3
test site	☐ 441 EMI SAR ☐ 487 SAR NSA ☐ 337 OATS ☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30 ☐ 001 ESS ☒ 489 ESU 40 ☐ 620 ESU 26	☐	☐
otherwise	☐ 600 NRVD ☐ 357 NRV-Z1 ☐ 693 TS8997		
spectr. analys.	☐ 683 FSU ☐ 120 FSEM ☐ 264 FSEK ☐ 714 FSW 67	☐	☐
power supply	☐ 456 EA 3013A ☐ 457 EA 3013A ☐ 459 EA 2032-50 ☐ 268 EA- 3050 ☐ 494 AG6632A ☐ 354 NGPE 40		
otherwise	☒ 613 20 dB Attenuator ☐ 248 6 dB Attenuator ☐ 529 Power divider ☐ - cable OTA20 ☐ 530 10dB Atten ☐ K5 Cable		
Supply voltage	☐ 230 V 50 Hz via public mains ☒ 13.5 V DC		

5.6.2. Requirements:

ISED	☒ RSS-Gen, Issue5 , Chapter 6.11
Remark	Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

5.6.3. EUT settings

For FHSS-systems hopping mode was switched-off so fixed two different channels could be measured.
The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.

5.6.4. Measurement method

1. The First Measurement was done at Normal Temperature +20°C and ±15% of the supply voltage.
2. The Second Measurement was done at 3 different Temperatures -20°C (-4°F), +20°C (+68°F) and +50°C (+122°F), and the nominal supply Voltage
3. Also the 99% emission bandwidth was measured. 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.

5.6.5. 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

5.6.6. Tmin – Vnom

Modulation	Channel	99% OBW Tnom - Vnom in MHZ	Tnom - Vnom		Tmin - Vnom	
			left Bandedge in HZ	right Bandedge in HZ	left Bandedge in HZ	right Bandedge in HZ
b-mode	2412	13.40	2405125000	2418525000	2405175000	2418525000
	2437	13.30	2430275000	2443575000	2430225000	2443525000
	2462	13.25	2455275000	2468525000	2455425000	2468625000
verdict					Pass	
g-mode	2412	17.50	2403175000	2420675000	2403775000	2420175000
	2437	17.45	2428175000	2445625000	2428775000	2445175000
	2462	17.40	2453175000	2470575000	2453775000	2470175000
verdict					Pass	
n20-mode	2412	18.50	2402675000	2421175000	2403175000	2420725000
	2437	18.40	2427725000	2446125000	2428175000	2445725000
	2462	16.65	2452525000	2471175000	2453175000	2470775000
verdict					Pass	
n40-mode	2422	37.40	2403125000	2440525000	2403925000	2439825000
	2442	37.20	2428325000	2465525000	2433975000	2469975000
	2452	37.45	2433125000	2470575000	2433975000	2469975000
verdict					Pass	

5.6.7. Tmax – Vnom

Modulation	Channel	99% OBW Tnom - Vnom in MHZ	Tnom - Vnom		Tmax - Vnom	
			left Bandedge in HZ	right Bandedge in HZ	left Bandedge in HZ	right Bandedge in HZ
b-mode	2412	13.40	2405125000	2418525000	2405175000	2418475000
	2437	13.30	2430275000	2443575000	2430175000	2443525000
	2462	13.25	2455275000	2468525000	2455375000	2468575000
verdict					Pass	
g-mode	2412	17.50	2403175000	2420675000	2403725000	2420125000
	2437	17.45	2428175000	2445625000	2428725000	2445125000
	2462	17.40	2453175000	2470575000	2453725000	2470125000
verdict					Pass	
n20-mode	2412	18.50	2402675000	2421175000	2403125000	2420675000
	2437	18.40	2427725000	2446125000	2428125000	2445725000
	2462	16.65	2452525000	2471175000	2453175000	2470725000
verdict					Pass	
n40-mode	2422	37.40	2403125000	2440525000	2403875000	2439825000
	2442	37.20	2428325000	2465525000	2433925000	2469925000
	2452	37.45	2433125000	2470575000	2433925000	2469925000
verdict					Pass	

5.6.8. Tnom – Vmin

Modulation	Channel	99% OBW	Tnom - Vnom		Tnom - Vmin	
			left Bandedge	right Bandedge	left Bandedge	right Bandedge
		in MHZ	in HZ	in HZ	in HZ	in HZ
b-mode	2412	13.40	2405125000	2418525000	2405150000	2418600000
	2437	13.30	2430275000	2443575000	2430250000	2443650000
	2462	13.25	2455275000	2468525000	2455200000	2468550000
verdict					Pass	
g-mode	2412	17.50	2403175000	2420675000	2403700000	2420200000
	2437	17.45	2428175000	2445625000	2428700000	2445200000
	2462	17.40	2453175000	2470575000	2453700000	2470150000
verdict					Pass	
n20-mode	2412	18.50	2402675000	2421175000	2403150000	2420750000
	2437	18.40	2427725000	2446125000	2428150000	2445750000
	2462	16.65	2452525000	2471175000	2453100000	2470750000
verdict					Pass	
n40-mode	2422	37.40	2403125000	2440525000	2403825000	2439925000
	2442	37.20	2428325000	2465525000	2433925000	2469775000
	2452	37.45	2433125000	2470575000	2433925000	2469825000
verdict					Pass	

5.6.9. Tnom – Vmax

Modulation	Channel	99% OBW	Tnom - Vnom		Tnom - Vmax	
			left Bandedge	right Bandedge	left Bandedge	right Bandedge
		in MHZ	in HZ	in HZ	in HZ	in HZ
b-mode	2412	13.40	2405125000	2418525000	2392175000	2431875000
	2437	13.30	2430275000	2443575000	2430025000	2443975000
	2462	13.25	2455275000	2468525000	2455025000	2468575000
verdict					Pass	
g-mode	2412	17.50	2403175000	2420675000	2403725000	2420175000
	2437	17.45	2428175000	2445625000	2428725000	2445175000
	2462	17.40	2453175000	2470575000	2453725000	2470125000
verdict					Pass	
n20-mode	2412	18.50	2402675000	2421175000	2403125000	2420725000
	2437	18.40	2427725000	2446125000	2428125000	2445775000
	2462	16.65	2452525000	2471175000	2453125000	2470675000
verdict					Pass	
n40-mode	2422	37.40	2403125000	2440525000	2403825000	2439925000
	2442	37.20	2428325000	2465525000	2433675000	2469775000
	2452	37.45	2433125000	2470575000	2433975000	2469825000
verdict					Pass	

5.6.10. Frequency Stability Verdict: pass

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

5.7.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ Please see Chapter. 2.2.2	☐ Please see Chapter. 2.2.3
test site	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.
receiver	☐ 377 ESCS30	☒ 001 ESS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL
DC power	☐ 671 EA-3013S	☒ 457 EA 3013A	☐ 459 EA 2032-50
line voltage	☒ 13.5 VDC	☐ 060 120 V 60 Hz	☐ via PAS 5000

5.7.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
ISED	RSS-Gen: Issue 5: §8.9 Table 6			
ANSI	C63.10-2013			
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

5.7.3. Test condition and test set-up

Signal link to test system (if used):	☐ air link	☐ cable connection	☐ none
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top	☐ floor standing	
Climatic conditions	Temperature: (22±3°C) Rel. humidity: (40±20)%		
EMI-Receiver or Analyzer Settings	Scan data	☒ 9 – 150 kHz RBW/VBW = 200 Hz Scan step = 80 Hz ☒ 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz ☐ other:	
	Scan-Mode	☒ 6 dB EMI-Receiver Mode ☐ 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"	

5.7.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

The EUT is put on operation on middle channel only. If critical peaks are found (Margin <10 dB) the lowest and highest channels will be performed too. 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	
2.01a	Low	01	9 kHz - 30 MHz	1	1	b-Mode-1Mbps-CH01-laying	☒	☐	☐	Pass
2.01b	Low	01	9 kHz - 30 MHz	1	1	b-Mode-1Mbps-CH01-standing	☒	☐	☐	Pass
2.02a	Mid	06	9 kHz - 30 MHz	1	1	g-Mode-12Mbps-CH06-laying	☒	☐	☐	Pass
2.02b	Mid	06	9 kHz - 30 MHz	1	1	g-Mode-12Mbps-CH06-standing	☒	☐	☐	Pass
2.03a	High	11	9 kHz - 30 MHz	1	1	n20-Mode-MCS0-CH11-laying	☒	☐	☐	Pass
2.03b	High	11	9 kHz - 30 MHz	1	1	n20-Mode-MCS0-CH11-standing	☒	☐	☐	Pass
2.04a	Mid	06	9 kHz - 30 MHz	1	1	n40-Mode-MCS0-CH06-laying	☒	☐	☐	Pass
2.04b	Mid	06	9 kHz - 30 MHz	1	1	n40-Mode-MCS0-CH06-standing	☒	☐	☐	Pass

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

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of $0.625 \times \text{Lambda}$. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors.

Frequency -Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < D _{near-field})	2'te Condition (Limit distance bigger d _{near-field})	Distance Correction accord. Formula
kHz	9,00E+03	33333,33	5305,17	300	fulfilled	not fulfilled	-80,00
	1,00E+04	30000,00	4774,65		fulfilled	not fulfilled	-80,00
	2,00E+04	15000,00	2387,33		fulfilled	not fulfilled	-80,00
	3,00E+04	10000,00	1591,55		fulfilled	not fulfilled	-80,00
	4,00E+04	7500,00	1193,66		fulfilled	not fulfilled	-80,00
	5,00E+04	6000,00	954,93		fulfilled	not fulfilled	-80,00
	6,00E+04	5000,00	795,78		fulfilled	not fulfilled	-80,00
	7,00E+04	4285,71	682,09		fulfilled	not fulfilled	-80,00
	8,00E+04	3750,00	596,83		fulfilled	not fulfilled	-80,00
	9,00E+04	3333,33	530,52		fulfilled	not fulfilled	-80,00
	1,00E+05	3000,00	477,47		fulfilled	not fulfilled	-80,00
	1,25E+05	2400,00	381,97		fulfilled	not fulfilled	-80,00
	2,00E+05	1500,00	238,73		fulfilled	fulfilled	-78,02
	3,00E+05	1000,00	159,16		fulfilled	fulfilled	-74,49
	4,00E+05	750,00	119,37		fulfilled	fulfilled	-72,00
	4,90E+05	612,24	97,44		fulfilled	fulfilled	-70,23
	5,00E+05	600,00	95,49		fulfilled	not fulfilled	-40,00
	6,00E+05	500,00	79,58		fulfilled	not fulfilled	-40,00
MHz	7,00E+05	428,57	68,21	30	fulfilled	not fulfilled	-40,00
	8,00E+05	375,00	59,68		fulfilled	not fulfilled	-40,00
	9,00E+05	333,33	53,05		fulfilled	not fulfilled	-40,00
	1,00	300,00	47,75		fulfilled	not fulfilled	-40,00
	1,59	188,50	30,00		fulfilled	not fulfilled	-40,00
	2,00	150,00	23,87		fulfilled	fulfilled	-38,02
	3,00	100,00	15,92		fulfilled	fulfilled	-34,49
	4,00	75,00	11,94		fulfilled	fulfilled	-32,00
	5,00	60,00	9,55		fulfilled	fulfilled	-30,06
	6,00	50,00	7,96		fulfilled	fulfilled	-28,47
	7,00	42,86	6,82		fulfilled	fulfilled	-27,13
	8,00	37,50	5,97		fulfilled	fulfilled	-25,97
	9,00	33,33	5,31		fulfilled	fulfilled	-24,95
	10,00	30,00	4,77		fulfilled	fulfilled	-24,04
	10,60	28,30	4,50		fulfilled	fulfilled	-23,53
	11,00	27,27	4,34		fulfilled	fulfilled	-23,21
	12,00	25,00	3,98		fulfilled	fulfilled	-22,45
	13,56	22,12	3,52		fulfilled	fulfilled	-21,39
	15,00	20,00	3,18		fulfilled	fulfilled	-20,51
	15,92	18,85	3,00		fulfilled	fulfilled	-20,00
	17,00	17,65	2,81		not fulfilled	fulfilled	-20,00
	18,00	16,67	2,65		not fulfilled	fulfilled	-20,00
	20,00	15,00	2,39		not fulfilled	fulfilled	-20,00
	21,00	14,29	2,27		not fulfilled	fulfilled	-20,00
	23,00	13,04	2,08		not fulfilled	fulfilled	-20,00
	25,00	12,00	1,91		not fulfilled	fulfilled	-20,00
	27,00	11,11	1,77		not fulfilled	fulfilled	-20,00
	29,00	10,34	1,65		not fulfilled	fulfilled	-20,00
	30,00	10,00	1,59		not fulfilled	fulfilled	-20,00

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

5.8.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ Please see Chapter. 2.2.2	☐ Please see Chapter. 2.2.3
test site	☒ 441 EMI SAR ☒ 487 SAR NSA		
receiver	☐ 377 ESCS30 ☒ 001 ESS	☐ 489 ESU 40 ☐ 620 ESU 26	
spectr. analys.	☐ 584 FSU ☐ 120 FSEM	☐ 264 FSEK	
antenna	☒ 574 BTA-L ☐ 133 EMCO3115	☐ 302 BBHA9170 ☐ 289 CBL 6141	☐ 030 HFH-Z2 ☐ 477 GPS
signaling	☐ 392 MT8820A ☐ 371 CBT32	☐ 547 CMU ☐ 594 CMW	
otherwise	☐ 400 FTC40x15E ☐ 401 FTC40x15E	☐ 110 USB LWL ☒ 482 Filter Matrix	
DC power	☐ 456 EA 3013A ☒ 457 EA 3013A	☐ 459 EA 2032-50 ☐ 268 EA- 3050	☐ 494 AG6632A ☐ 498 NGPE
line voltage	☒ 13.5V DC	☐ 060 120 V 60 Hz via PAS 5000	

5.8.2. Requirements/Limits

FCC		☐ Part 15 Subpart B, §15.109, class B ☒ Part 15 Subpart C, §15.209 @ frequencies defined in §15.205	
ISED (IC)		☒ RSS-Gen., Issue 5, Chapter 8.9, Table 5+7 (licence-exempt radio apparatus) ☐ RSS-Gen., Issue 5, Chapter 7.1.2, Table 2 (receiver) ☐ ICES-003, Issue 6, Table 5 (Class B) ☒ RSS-247, Issue 2, Chapter 5.5 ☐ RSS-247, Issue 2, Chapter 6.2	
ANSI		☐ C63.4-2014 ☒ C63.10-2013	
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	54.0

5.8.3. Restricted bands of operation (FCC §15.205/ RSS-Gen, Issue 5 Chapter 8.10, Table 7)

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

5.8.4. Test condition and measurement test set-up

Signal link to test system (if used):		☐ air link	☐ cable connection	☐ none
EUT-grounding		☒ none	☐ with power supply	☐ additional connection
Equipment set up		☒ table top 0.8m height	☐ floor standing	
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Scan frequency range:	☒ 30 – 1000 MHz ☐ other:		
	Scan-Mode	☒ 6 dB EMI-Receiver Mode ☐ 3 dB spectrum analyser mode		
	Detector	Peak / Quasi-peak		
	RBW/VBW	100 kHz/300 kHz		
	Mode:	Repetitive-Scan, max-hold		
	Scan step	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"		

5.8.5. MEASUREMENT RESULTS

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

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	
3.01a	Low	01	30 MHz – 1 GHz	1	1	b-Mode-1Mbps-CH01-laying	☒	☐	☒	Pass
3.01b	Low	01	30 MHz – 1 GHz	1	1	b-Mode-1Mbps-CH01-standing	☒	☐	☒	Pass
3.02a	Mid	06	30 MHz – 1 GHz	1	1	g-mode-12Mbps-CH06-standing	☒	☐	☒	Pass
3.02b	Mid	06	30 MHz – 1 GHz	1	1	g-mode-12Mbps-CH06-laying	☒	☐	☒	Pass
3.03a	High	01	30 MHz – 1 GHz	1	1	n20-mode-MCS0-CH11-standing	☒	☐	☒	Pass
3.03b	High	01	30 MHz – 1 GHz	1	1	n20-mode-MCS0-CH1s1-laying	☒	☐	☒	Pass
3.04a	Low	03	30 MHz – 1 GHz	1	1	n40-mode-MCS0-CH03-standing	☒	☐	☒	Pass
3.04b	Low	03	30 MHz – 1 GHz	1	1	n40-mode-MCS0-CH03-laying	☒	☐	☒	Pass
3.05a	High	09	30 MHz – 1 GHz	1	1	n40-mode-MCS0-CH09-standing	☒	☐	☒	Pass
3.05b	High	09	30 MHz – 1 GHz	1	1	n40-mode-MCS0-CH09-laying	☒	☐	☒	Pass

Remark:

5.9. General Limit - Radiated emissions, above 1 GHz

5.9.1. Test location and equipment FAR

test site	☐ 441 EMI SAR	☐ 348 EMI cond.	☒ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☒ 489 ESU 40	☐	☐
antenna meas.	☐ 574 BTA-L	☐ 289 CBL 6141	☐ 608 HL 562	☒ 549 HL025	☒ 302 BBHA9170	☐ 477 GPS
antenna meas.	☐ 123 HUF-Z2	☐ 132 HUF-Z3	☐ 030 HFH-Z2	☒ 376 BBHA9120E		☐
antenna subst.	☐ 071 HUF-Z2	☐ 020 EMCO3115	☐ 063 LP 3146	☐ 303 BBHA9170	☐	☐
multimeter	☐ 341 Fluke 112	☐	☐	☐	☐	☐
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW		
DCpower	☐ 086 LNG50-10	☒ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 Car battery	☐
line voltage	☒ 13.5V DC		☐ 060 120 V 60 Hz via PAS 5000			

5.9.2. Requirements/Limits

FCC	☐ Part 15 Subpart B, §15.109 class B ☒ Part 15 Subpart C, §15.209 for frequencies defined in §15.205 ☐ Part 15 Subpart C, §15.407(b)(1)(2)(3)(4)			
ISED	☒ RSS-Gen., Issue 5, Chapter 8.9, Table 5+7 (transmitter licence exempt) ☐ RSS-Gen., Issue 5, Chapter 7.3, Table 3 (receiver) ☐ ICES-003, Issue 6, Chapter 6.2.2, Table 7 (class B) ☒ RSS-247, Issue 2, Chapter 5.5 ☐ RSS-247, Issue 2, Chapter 6.2			
ANSI	☐ C63.4-2014 ☒ C63.10-2013			
Frequency [MHz]	Limits			
	AV [µV/m]	AV [dBµV/m]	Peak [µV/m]	Peak [dBµV/m]
above 1 GHz for frequencies as defined in §15.205 or RSS-Gen., Issue 9, §8.9 - Table 5	500	54.0	5000	74.0

5.9.3. Test condition and measurement test set-up

Signal link to test system (if used):		☐ air link	☐ cable connection	☐ none
EUT-grounding		☒ none	☐ with power supply	☐ additional connection
Equipment set up		☒ table top 1.5m height		☐ floor standing
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
Spectrum-Analyzer settings	Scan frequency range:	☒ 1 – 18 GHz ☐ 18 – 25 GHz ☐ 18 – 40 GHz ☐ other:		
	Scan-Mode	☒ 6 dB EMI-Receiver Mode ☐ 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"		

5.9.4. Measurement Results

5.9.4.1. Measurement Results 1GHz to 18GHz

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Dia-gram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
8.01a	Low	01	1 GHz – 18 GHz	1	1	b-Mode-2Mbps-CH01	☒	☒	☐	Pass
8.02a	Mid	06	1 GHz – 18 GHz	1	1	g-mode-12Mbit-CH06	☒	☒	☐	Pass
8.03a	High	11	1 GHz – 18 GHz	1	1	n20-mode-MCS0-CH11	☒	☒	☐	Pass
8.04a	Low	03	1 GHz – 18 GHz	1	1	n40-mode-MCS0-CH03	☒	☒	☐	Pass
8.05a	High	09	1 GHz – 18 GHz	1	1	n40-mode-MCS0-CH09	☒	☒	☐	Pass

Remark: --

5.9.4.2. Measurement Results 18GHz to 26.5GHz

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Dia-gram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
8.01b	Low	01	1 GHz – 18 GHz	1	1	b-Mode-2Mbps-CH01	☒	☒	☐	Pass
8.02b	Mid	06	1 GHz – 18 GHz	1	1	g-mode-12Mbit-CH06	☒	☒	☐	Pass
8.03b	High	11	1 GHz – 18 GHz	1	1	n20-mode-MCS0-CH11	☒	☒	☐	Pass
8.04b	Low	03	1 GHz – 18 GHz	1	1	n40-mode-MCS0-CH03	☒	☒	☐	Pass
8.05b	High	09	1 GHz – 18 GHz	1	1	n40-mode-MCS0-CH09	☒	☒	☐	Pass

Remark: --

5.10. RF-Parameter - Band Edge compliance measurements

5.10.1. Test location and equipment FAR

test site	☐ 441 EMI SAR	☐ 348 EMI cond.	☒ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☒ 264 FSEK	☐ 489 ESU 40	☐	☐
antenna meas	☐ 574 BTA-L	☐ 289 CBL 6141	☐ 608 HL 562	☒ 549 HL025	☐ 302 BBHA9170	☐ 477 GPS
antenna meas	☐ 123 HUF-Z2	☐ 132 HUF-Z3	☐ 030 HFH-Z2	☐	☐	☐
antenna subst	☐ 071 HUF-Z2	☐ 020 EMCO3115	☐ 063 LP 3146	☐ 303 BBHA9170	☐	☐
multimeter	☐ 341 Fluke 112	☐	☐	☐	☐	☐
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW	☐	☐
DC power	☐ 086 LNG50-10	☒ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 Car battery	☐
line voltage	☒ 13.5 V DC ☐ 060 120 V 60 Hz via PAS 5000					

5.10.2. Requirements/Limits

FCC	☐ Part 15 Subpart B, §15.109 class B ☒ Part 15 subpart C, §15.209 @ frequencies defined in §15.205
ISED	☐ RSS-210, Issue 8, Annex 8 ☒ RSS-247, Issue 1, Chapter 5.5 ☒ RSS-Gen: Issue 5: §8.9, Table 5+7
ANSI	☐ C63.4-2009 ☐ C63.4-2014 ☐ C63.10-2009 ☒ C63.10-2013, Chapter 6.10.6

5.10.3. Test condition and measurement test set-up

Signal link to test system (if used):	☐ air link	☐ cable connection	☒ none
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top 1.5m height ☐ floor standing		
Climatic conditions	Temperature: (22±3°C) Rel. humidity: (40±20)%		
Spectrum-Analyzer settings	Scan frequency range: ☐ 1 – 18 GHz ☐ 18 – 25 GHz ☐ 18 – 40 GHz ☒ other: see diagrams Scan-Mode: ☐ 6 dB EMI-Receiver Mode ☒ 3 dB Spectrum analyzer Mode Detector: Peak and Average RBW/VBW: Left band-edge: 100kHz/300kHz Right band-edge: 1 MHz / 3 MHz Mode: Repetitive-Scan, max-hold Scan step: 40kHz or 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" for general measurements procedures in anechoic chamber.		

5.10.4. Measurement Method

For uncritical results where a measurement resolution bandwidth of 1MHz can clearly show the compliance without influencing the results, a field strength measurement was performed to show compliance.

For critical results a Marker-Delta marker method was used for showing compliance to restricted bands. The method is according ANSI C63.10:2013, Chapter 6.10.6 "Marker-Delta method". 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 FCC §15.205 with the general limits of FCC §15.209.

5.10.5. EUT settings

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

5.10.6. Results: for non-restricted bands near-by

5.10.6.1. Non-restricted bands near-by - limits according FCC §15.407 and RSS-247, Issue 1, Chapter 5.5

Diagramm no.	Channel no.	Restricted band ?	Fundamental Value [dBuV/m]		Peak-Value at Band-Edge [dBuV/m]	Difference [dB]	Limit [dBc]	Margin [dB]	Verdict	Remark:
			Peak-Value	Average-Value						
9.01	1	no	99,76	91,76	54,54	45,22	20	25,22	PASS	b-mode, PWR-LVL=14
9.02	1	no	91,82	84,93	55,71	36,11	20	16,11	PASS	g-mode, PWR-LVL=11
9.01	1	no	91,89	85,59	56,38	35,51	20	15,51	PASS	n20-mode, PWR-LVL=11
9.02	3	no	88,33	81,86	54,90	33,43	20	13,43	PASS	n40-mode, PWR-LVL=11

5.10.7. Restricted bands near-by

(§15.205 with limits accord. FCC §15.209) and (RSS-Gen, Issue4, Chapter 8.10)

Diagramm no.	Channel no.	Restricted band ?	Fundamental Value [dBuV/m]		Value at Band-Edge [dBuV/m]		Limits [dBuV/m]		Duty-Cycle Correctio [dB]	Margin [dB]		Verdict	Remark:
			Peak-Value	Average-Value	Peak-Value	Average-Value	Peak-Value	Average-Value		Peak	Average		
9.03	11	yes	103,07	100,41	56,91	45,80	74	54	0	17,09	8,20	PASS	b-mode, PWR-LVL=14
9.04	11	yes	102,22	93,82	62,48	49,89	74	54	0	11,52	4,11	PASS	g-mode, PWR-LVL=11
9.03	11	yes	102,55	93,66	66,48	51,03	74	54	0	7,52	2,98	PASS	n20-mode, PWR-LVL=11
9.04	9	yes	97,59	88,80	64,60	50,61	74	54	0	9,40	3,39	PASS	n40-mode, PWR-LVL=11

Remark : The EUT complies to the band edge requirement under provision that the power level is adjusted to those listed in the table above.

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 to its statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%							Remarks
Conducted emissions (U _{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB							E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	-	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--		
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable	
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--		
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
			See above: 0.70 dB							Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB							Magnetic field E-field Substitution
		30 MHz - 1 GHz	4.2 dB							
		1 GHz - 20 GHz	3.17 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 Measur.	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
487 550 348 348	R-2666 G-301 C-2914 T-1967	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 Measur.	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

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

8.1. 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
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
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
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
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
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
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=
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. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
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
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
607	Signal Generator	SMR 20	832033/011	V1.25
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
670	Univ. Radio Communication Tester	CMU 200	106833	µP1 =V8.50, Firmware = V.20
689	Vector Signal Generator	SMU200	100970	02.20.360.142
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)
699	Audio Analyzer	UPL16	833494/005	3.06

8.2. 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	-	16.05.2019
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	16.05.2019
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	16.05.2019
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	15.05.2019
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.07.2021
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.05.2021
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	15.05.2019
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1 a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
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	
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	-	30.05.2021
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.05.2021
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	30.05.2019
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1 c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
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	-	30.05.2020
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	30.05.2019
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	30.05.2019
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	30.05.2020
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	30.05.2020
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	
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	12 M	-	17.05.2019
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	-	14.03.2020
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	20.03.2020
331	Climatic Test Chamber -40/+180 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.10.2019
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2020
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	17.05.2019
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	
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	24.05.2019
371	Bluetooth Tester	CBT32	100153	R&S	36 M	-	30.05.2019
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	17.05.2019
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	30.05.2019
389	Digital Multimeter	Keithley 2000	0583926	Keithley	pre-m	-	
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	30.06.2019
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.22	LUFFT Mess u. Regeltechnik GmbH	24 M	-	30.03.2019
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	06.03.2019
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020
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	-	30.05.2019

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2020
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.05.2019
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2021
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	16.05.2019
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1 d	
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.03.2019
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	30.06.2019
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-60/10SS	SN 5	Wainwright	pre-m	2	
517	relais switch matrix	HF Relais Box Keithley System	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	18.05.2019
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	-	30.07.2019
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	30.07.2019
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2021
550	System CTC S-VSWR Verification SAR-EMI	System EMI Field SAR S-VSWR	-	ETS Lindgren/CETECOM	24 M	-	30.03.2019
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1 c	30.06.2017
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	30.09.2016
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	08.08.2019
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	30.05.2019
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	17.05.2019
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	15.05.2019
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
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	-	30.05.2020
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	-	30.05.2019
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	201.0999.9302.6.4.1.43	G. Lufft GmbH	24 M	-	30.03.2019
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
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 1,5m	-	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	-	24.05.2019
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	30.05.2020
671	DC-power supply 0-5 A	EA-3013S	-	Elektro Automatik	pre-m	2	
678	Power Meter	NRP	101638	Rohde&Schwarz	pre-m	-	
683	Spectrum Analyzer	FSU 26	200571	Rohde & Schwarz	12 M	-	30.05.2019
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	29.03.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.05.2019
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	24 M	-	16.05.2019
691	OSP120 Base Unit	OSP120	106833	Rohde & Schwarz	12 M	-	30.05.2019
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
693	TS8997	CTC-Radio Lab 1_TS8997	-	Rohde&Schwarz	12 M	5	30.05.2019
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
701	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	12 M	-	30.07.2019
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-ZSS3	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/384105 16/L	INNCO Systems GmBh	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	36 M	-	22.02.2020
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	36 M	-	22.02.2020
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	36 M	-	22.05.2020
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	28.02.2020
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	36 M	-	03.08.2020
716	Harmonic Mixer 220 GHz to 325 GHz	FS-Z325	101005	RPG Radiometer Physics	36 M	-	13.02.2020
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	30.05.2019
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physics	36 M	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	
751	Digital Optical System	optoCAN-FD Transceiver	17-010416	mk-messtechnik GmbH	-	-	
752	Digital Optical System	optoCAN-FD Transceiver	17-010083	mk-messtechnik GmbH	-	-	
753	Digital Optical System	optoCAN-FD Transceiver	17-010084	mk-messtechnik GmbH	-	-	
754	Digital Optical System	optoCAN-FD Transceiver	17-010415	mk-messtechnik GmbH	-	-	
755	Digital Optical System	optoLAN-100-MAX Transceiver	17-010795	mk-messtechnik GmbH	-	-	
758	Signal Generator	SMU 200A	100754	Rohde & Schwarz	24 M	-	11.10.2019
780	Spectrum Analyzer	FSH3	101726	Rohde & Schwarz	24 M	-	19.07.2019
781	Power Supply	PS 2042-10 B	2815450369	Elektro-Automatik GmbH & Co.KG	-	-	
782	Power Supply	PS 2042-10 B	2815450348	Elektro-Automatik GmbH & Co.KG	-	-	
783	Spectrum Analyzer	FSU 26	100414	Rohde & Schwarz	12 M	-	30.05.2019
784	Power Supply	NGSM 32/10	00196	Rohde & Schwarz	12 M	-	
785	RSP	RF Step Attenuator 0...139.9dB	860712/012	Rohde & Schwarz	12 M	-	
786	SAR Probe	ES3DV3	3340	Speag	36 M	-	14.02.2021
787	OSP	OSP B157WX	101264	Rohde & Schwarz	12 M	-	30.05.2019
788	Precision Omnidirectional Dipole	POD 618	6182558/Q	Seibersdorf Laboratories	36 M	-	30.06.2021
789	Precision Omnidirectional Dipole	POD 16	162496/Q	Seibersdorf Laboratories	36 M	-	30.06.2021

8.3. 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

9. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2018-12-28
C1	Accreditation details updated	2019-02-20

END OF TEST REPORT