T E S T R E P O R T
No.: 20-1-0087101T03a-C2

According to:
47 CFR Part 95
RSS-Gen Issue 5
RSS-251 Issue 2

for

Hella GmbH & Co. KGaA

RS5.4
Advanced Driver Assistance System

FCC ID: NBG01RS54A
ISED ID: 2694A-RS54A

Laboratory Accreditation
ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01 D-PL-12047-01-03 D-PL-12047-01-04
accredited according to DIN EN ISO/IEC 17025: 2018

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Table of annex

The listed attachments are an integral part of this report.

Separate document annex 4: Internal photographs of EUT **to be supplied by the customer.**

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.

1.1. Tests measurement overview according of US CFR Title 47, Subpart 95:

Test cases	References & Limits		Test conditions (temperature and voltage)	EUT set-up	EUT operating mode	Result
	Standard	Test Limit				
Power density	FCC §95.3367 (a) (b)	50 dBm (Average) 55 dBm (Peak)	Nominal and extreme	1	1	passed
	RSS-251 (Section 8 and 9)	50 dBm (Average) 55 dBm (Peak)				
Modulation characteristics	FCC §2.1047 (d)	-	Nominal	1	1	passed
	RSS-251 (Section 6b)	-				
Occupied bandwidth	FCC §95.3379 (b)	76 GHz - 81 GHz	Nominal and extreme	1	1	passed
	RSS-251 (Section 7)	76 GHz - 81 GHz				
Field strength of emissions (band edge)	FCC §95.3379 (a)(2)(i)	600 pW/cm^2 ~ -1.7 dBm	Nominal	2	2	passed
	RSS-251 (Section 10)	lower BE: 0 dBm upper BE: -30 dBm				
Field strength of emissions (radiated spurious)	FCC §95.3379 (a)	9 kHz – 40 GHz: see section 5.5. and 5.6. in the report 40 GHz – 200 GHz: 600 pW/cm^2 ~ -1.7 dBm 200 GHz – 231 GHz: 1000 pW/cm^2 ~ 0.5 dBm	Nominal	2	2	passed
	RSS-251 (Section 10)	9 kHz – 40 GHz: see section 5.5. in the report 40 GHz – 162 GHz*: -30 dBm *) 73.5 GHz – 76 GHz: 0 dBm				
Frequency stability	FCC §95.3379 (b)	-	Nominal and extreme	2	2	passed
	RSS-251 (Section 11)	RSS-251 (Subsection 11.2)				

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 FCC and 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_TR20-1-0087101T03a_C2 replaces the Test Report CETECOM_TR20-1-0087101T03a_C1 dated 2021-Dec-06. The replaced test report is herewith invalid.

.....	.....
Dipl.-Ing. Ninovic Perez	M.Sc. Guangcheng. Huang
Responsible for test section	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:	Ninovic Perez

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:	G. Huang
Receipt of EUT:	2020-10-19
Date(s) of test:	2020-10-21 to 2020-11-24
Date of report:	2021-12-17
Version of template: 13.02	

2.4. Applicant's details

Applicant's name:	Hella GmbH & Co. KGaA
Address:	Rixbecker Str. 75 59552, Lippstadt Germany
Contact person:	Dan Mihai Berinde

2.5. Manufacturer's details

Manufacturer's name:	Hella GmbH & Co. KGaA
Address:	Römerstraße 66 59075 Hamm Bockum-Hövel Germany

3. Equipment under test (EUT)

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

*Main function	Automotive radar		
Transmit frequency	76 GHz to 77 GHz		
Antenna polarization	horizontal		
Type of modulation	fast chirp FMCW		
Bandwidth	< 1000 MHz		
Antenna Type	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector		
Power supply	☒ DC power supply: 9 – 32 V		
Temperature	-40° C to +85° C		
Emission classification	F0N (FMCW)		
Interfaces	CAN/CAN-FD		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering

*: customer information

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

Short descrip-tion**	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A S17_C02	RS5.4	Advanced Driver Assistance System	10140018115312	C2 (HW08)	X060 (C025)
EUT B S19_C02	RS5.4	Advanced Driver Assistance System	10140018113719	C2 (HW08)	X060 (C025) §

*: customer information

3.3. 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 S18_C01	Cable for power supply	-	-	-	-
AE 2 S20_C01	Gateway with power supply cable	CG-ARM7/R	SO DR 624	-	V1.2

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

3.4. EUT set-ups

EUT set-up no.*	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 1 + AE 2	Radiated test on the carrier signal
set. 2	EUT B + AE 2	Radiated test on the spurious emissions and frequency stability

* 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	Normal TXRX	Transmission at all channels
op. 2	TXRX at center frequency	Transmission fixed at center frequency

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

4. Description of test system set-up's

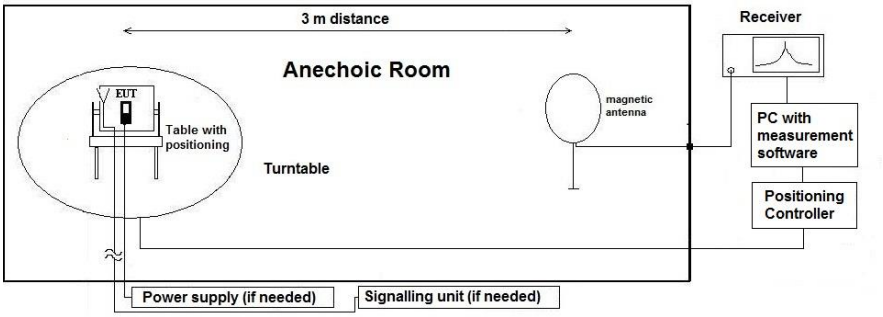
4.1. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.4-2014 §5.3, §8.2.1, §8.3.1.1+§8.3.2.1 , 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.

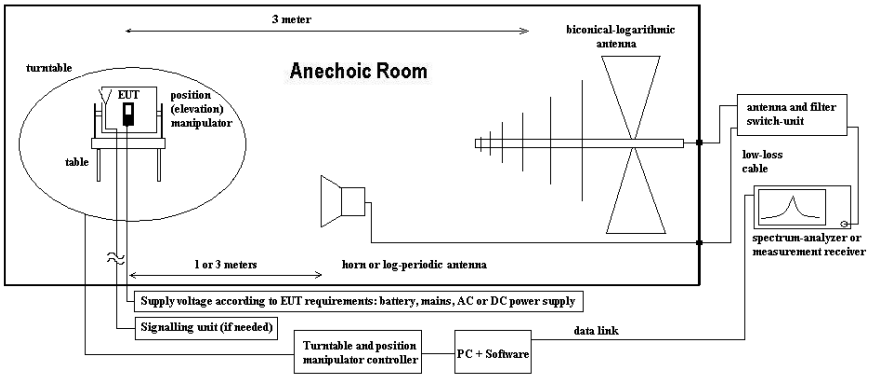
Distance correction: Reference for applied correction (extrapolating) factors due to reduced measurement distance:
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

4.2. Test system set-up for radiated electric field measurement 30 MHz to 960MHz

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 chamber (SAC) 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 it's 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 10 m OATS or 3 m 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:

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

$M = L_T - E_C$ (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

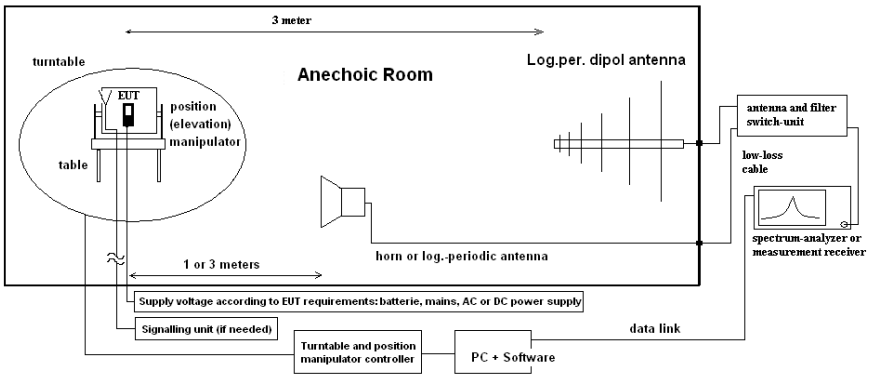
All units are dB-units, positive margin means value is below limit.

4.3. Test system set-up for radiated electric field measurement above 960MHz

Specification: ANSI C63.10-2013, chapter 10.3

General Description: The tests are performed in a CISPR 16-1-4:2010 compliant fully anechoic chamber (FAC) recognized by the regulatory commission. The measurement distance was set to 1 m or 3 m. 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 continuously (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 and it's 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. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Formula:

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

$M = L_T - E_C$ (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. Measurements

5.1. The maximum peak power EIRP / peak EIRP spectral density. The maximum power EIRP/ average EIRP.

5.1.1. Test location and equipment

Ambient Climatic conditions			Temperature: 21 °C		Rel. humidity: (45±15)% rH	
test site	☐ 443 FAC Spuri	☐ 348 EMI cond.	☐ 443 EMI FAC	☐ 347 Radio.lab.	☐ 337 OATS	☒ 412 FAC 2
equipment	☒ 869 VT 4002	☐	☐	☐	☐	☐
spectr. Analyz.	☒ 732 FSW67	☐ 264 FSEK	☐ 264 FSEK	☐ 584 FSU		☐
antenna meas f > 50 GHz	☐ 813 FH-PP 075		☒ 815 FH-PP 110		☐ 816 SGH-26-WR	
antenna meas f > 90 GHz	☐ 814 FH-PP 140		☐ 767 FH-PP 220			
antenna meas f > 220 GHz	☐ 812 FH-PP-325					
Other:	☐ Adapter Q-Band to 1.85mm					
mixer	☐ 731 FS-Z75	☒ 730 FS-Z110	☐ 729 FS-Z140	☐ 733 FS-Z220	☐ 734 FS-Z325	
multimeter	☒ 341 Fluke 112	☐	☐	☐	☐	☐
DC power	☐ 086 LNG50-10	☒ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 Car battery	☐
line voltage	☐ 230 V 50 Hz via public mains		☐060 120 V 60 Hz via PAS 5000			

5.1.2. Reference

FCC/RSS	See section 1.1.
ANSI	C63.10-2013

5.1.3. Limits

See section 1.1. in the report.

5.1.4. Test environment

Temperature	Nominal: 22±3° C Extreme, min.: -40° C Extreme, max.: +85° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 24 V Extreme, min.: 9 V Extreme, max.: 32 V

5.1.5. Spectrum-Analyzer settings:

Span	> 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	Auto / 61 s @ 1 GHz
Detector	Peak detector with max peak search. RMS with channel power measurement.
Sweep mode	Continuous sweep, MAX-HOLD / single sweep

5.1.6. Measurement method:

All the measurements are done according to standards and rules listed in subsection 5.1.2. The measured power is EIRP*.
The EUT is ON and set to default mode: FMCW modulation. At first the EUT is tested under nominal condition. Then it is tested under extreme conditions (extreme temperatures and voltages) with the help of a climate cabinet and a variable power supply.
For the maximum peak power EIRP / peak EIRP spectral density test function Signal-ID is activated to exclude ghost signals (product of the mixer).
*EIRP: Equivalent Isotropic Radiated Power

5.1.7. Results

Power measurement				Verdict
Setup / Op. Mode / measuring distance	Nominal condition			
	Peak detector, max peak search (marker) [dBm]	Peak detector, max peak search (marker frequency) [GHz]	RMS detector, channel power measurement [dBm], sweep time 120 s @ 1 GHz	
Set. 1 / Op. 1 / 2 m / TnomVnom	23.58	76.0558	15.58	**Pass**
Extreme conditions				
Set. 1 / Op. 1 / 1.5 m TminVmin	26.39	76.0588	18.36	**Pass**
Set. 1 / Op. 1 / 1.5 m TminVmax	21.87	76.0903	17.31	**Pass**
Set. 1 / Op. 1 / 1.5 m TmaxVmin	22.38	76.0558	15.20	**Pass**
Set. 1 / Op. 1 / 1.5 m TmaxVmax	19.32	76.2733	13.32	**Pass**

Remark: For graphical results, pls. see annex 1 to this test report.

5.2. Modulation characteristics

5.2.1. Test location and equipment

See section 5.1.1.

5.2.2. Reference

Standard	FCC §2.1047 (d) RSS-251 (Section 6b)

5.2.3. Description:

FCC §2.1047 (d): *Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.*
RSS-251 (Section 6b): *Non-pulsed radar (e.g. frequency modulated continuous wave (FMCW)): modulation type (i.e. sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).*

5.2.4. Test environment

Temperature	Nominal: 22±3° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 24 V

5.2.5. Spectrum-Analyzer settings:

Span	> 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	120 s @ 1 GHz
Detector	Peak detector
Sweep mode	Single sweep

5.2.6. Measurement method:

Start and stop frequency was measured for all operating modes and all frequency bands with nominal conditions. Wave form and sweep characteristics were supplied by applicant.

5.2.7. Results

For graphical results for start and stop frequency pls. see annex 1 to this test report.
The applicant supplied following information about wave form and sweep characteristics:

Operating frequency range	*76000 MHz ... 77000 MHz*
Modulation bandwidth	*< 1000 MHz*
Modulation	*FMCW (fast chirps)*
Antenna type	*Microstrip patch array*
Duration of one radar cycle	*approx. 60 ms*
Number of chirp groups contained in one radar cycle	*3 (used sequentially as given in the following lines)*
Chirp group 1: Antenna	*Tx1*
Chirp group 1: Bandwidth	*300 MHz*
Chirp group 1: No of chirps	*256*
Chirp group 1: Duration of a single chirp	*34 µs*
Chirp group 2: Antenna	*Tx1*
Chirp group 2: Bandwidth	*870 MHz*
Chirp group 2: No of chirps	*16*
Chirp group 2: Duration of a single chirp	*33 µs*
Time slot with no emission	*12.5 ms*
Chrip group 3: Antenna	*Tx1 / Tx2 alternating*
Chirp group 3: Bandwidth	*720 MHz*
Chirp group 3: No of chirps	*84 / 84*
Chirp group 3: Duration of a single chirp	*45 µs*
Time slot with no emission	*30 ms*

Equipment power duty cycle	*Approx. 30%*
Modulation type:	*Sawtooth*

5.3. Occupied bandwidth

5.3.1. Test location and equipment

See section 5.1.1.

5.3.2. Reference

Standard	See section 1.1. in the report.

5.3.3. Limits

See section 1.1. in the report.

5.3.4. Test environment

Temperature	Nominal: 22±3° C Extreme, min.: -40° C Extreme, max.: +85° C
Rel. humidity	(40±20)%
Power supply	Nominal: 24 V Extreme, min.: 9 V Extreme, max.: 32 V

5.3.5. Spectrum-Analyzer settings:

Span	> 1 GHz
Resolution Bandwidth (RBW)	FCC: 1 MHz IC: RSS-Gen Issue 5 March 2019 Amendment 1 Section 6.7.: "*The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.*" Actual occupied bandwidth (99% emission bandwidth) of the EUT is app. 911 MHz. So RBW = 10 MHz was chosen.
Video Bandwidth (VBW)	FCC: 3 MHz IC: 28 MHz
Sweep time	Auto / 120 s @ 1 GHz
Detector	Peak detector
Sweep mode	Continuance sweep, MAX-HOLD / single sweep

5.3.6. Measurement method:

Occupied bandwidth was measured for operating mode 1 under nominal and extreme conditions. Occupied bandwidth (99 %) function is activated in spectrum analyzer for this measurement.

5.3.7. Results

Nominal condition				Verdict
Setup / Op. Mode	Low edge [GHz]	High edge [GHz]	Occ. bandwidth [MHz]	
Set. 1 / Op. 1 / RBW = 1 MHz	76.054584	76.976148	921.564	**Pass**
Set. 1 / Op. 1 / RBW = 10 MHz (for ISED Canada)	76.033553	76.970881	937.328	**Pass**
Extreme conditions				
Set. 1 / Op. 1 TminVmin / RBW = 1 MHz	76.056772	76.966883	910.111	**Pass**
Set. 1 / Op. 1 TminVmax / RBW = 1 MHz	76.050590	76.966263	915.674	**Pass**
Set. 1 / Op. 1 TmaxVmin / RBW = 1 MHz	76.051996	76.960422	908.426	**Pass**
Set. 1 / Op. 1 TmaxVmax / RBW = 1 MHz	76.049418	76.974051	924.633	**Pass**

Remark: For graphical results pls. see annex 1 to this test report.

5.4. Field strength of emissions (band edge)

5.4.1. Test location and equipment

See section 5.2.1.

5.4.2. Reference

Standard	See section 1.1. in the report.

5.4.3. Limits:

See section 1.1. in the report.

5.4.4. Test environment

Temperature	Nominal: 22±3° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 24 V

5.4.5. Spectrum-Analyzer settings:

Span	> 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	120 s @ 1 GHz / auto / 1 s
Detector	RMS detector
Sweep mode	Single/continuous sweep, MAX-HOLD

5.4.6. Measurement method:

For low and high band edge see “Field strength of emission (radiated spurious)” in the corresponding frequency range.

5.4.7. Verdict

Pass. For graphical results pls. see annex 1 to this test report.

5.5. Radiated field strength emissions, below 30 MHz

5.5.1. 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	☒ 901 EMI SAC	☐ 487 SAC NSA	☐ 347 Radio.lab.		☐	☐
receiver	☒ 620 ESU 26		☐	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☒ 25038 HFH2-Z2	
DC power	☒ 885 EA 3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 120 V 60 Hz via PAS 5000			

5.5.2. Requirements

FCC/RSS	See section 1.1.			
ANSI	C63.10-2013			
Frequency [MHz]	Field strength limit [µV/m]	[dBµV/m]	Distance [m]	Remarks
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

5.5.3. Test condition and test set-up

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)% rH
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 Detector Mode: Sweep-Time	☒ 6 dB EMI-Receiver Mode ☐ 3dB Spectrum analyzer Mode 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"	

5.5.4. Measurement method:

Measurement is done for op. mode 1.

5.5.5. 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 radiated spurious results:

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBµV/m]	Limit [dBm]
5.1	2	2	20 *	**
5.2	2	2	20 *	**

* Noise level

** See subsection 5.5.2.

Measurement distance:

Frequency range:	Distance [m]:
9 kHz – 30 MHz	3

5.5.6. Verdict

Pass. No emissions above the limit line. Pls. see annex 1 to this test report.

5.6. Radiated field strength emissions, 30 MHz – 960 MHz

5.6.1. 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	☒ 901 EMI SAC	☐				
receiver	☐ 377 ESCS30	☐ 001 ESS	☐ 489 ESU 40	☒ 620 ESU 26		
spectr. analyz.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK			
antenna	☒ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☐ 477 GPS
signalling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW		
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☒ 482 Filter Matrix		
DC power	☐ 456 EA 3013A	☒ 885 EA 3632A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 120 V 60 Hz via PAS 5000			

5.6.2. Requirements/Limits

FCC/RSS		See section 1.1.	
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

5.6.3. Restricted bands of operation (FCC §15.205/ RSS-Gen, Issue 5 Chapter 8.9, Table 4)

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
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	-
13.36-13.41	-	-	-
Remark: only spurious emissions are allowed within these frequency bands not exceeding the limits per §15.209			

5.6.4. Test condition and measurement test set-up

EUT-grounding		☒ none	☐ with power supply	☐ additional connection
Equipment set up		☒ table top 0.8 m height		☐ floor standing
Climatic conditions		Temperature: (22±3° C)		Rel. humidity: (40±20)% rH
EMI-Receiver (Analyzer) Settings	Scan frequency range:	☒ 30 – 1000 MHz ☐ other:		
	Scan-Mode	☒ 6 dB EMI-Receiver Mode ☐ 3 dB spectrum analyzer mode		
	Detector	Peak / Quasi-peak		
	RBW/VBW	100 kHz/300 kHz		
	Mode:	Repetitive-Scan, max-hold		
	Scan step	80 kHz		
	Sweep-Time	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"		

5.6.5. Measurement method:

Measurement is done for op. mode 2.

Measurement distance:

Frequency range:	Distance [m]:
30 MHz – 1 GHz	3

5.6.6. 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 radiated spurious results:

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBµV/m]	Limit [dBµV/m]
5.3	2	2	30.84 (QP)	**
5.4	2	2	30.69 (QP)	**

* Noise level
** See subsection 5.6.2.

5.6.7. Verdict

Pass. No emissions above the limit line. Pls. see annex 1 to this test report.

5.7. Radiated field strength emissions, 960 MHz – 40 GHz

5.7.1. Test location and equipment

Ref.-No.	Equipment	Type	Serial-No.
Frequency range 960 MHz – 8 GHz			
Measurement in FAC 2 with the distance between the EUT and the antenna 3 m			
732	Spectrum Analyzer	R&S FSW67	104023
133	Antenna	EMCO 3115	9012-3629
877	RF Amplifier	JS42-08001800-16-8P	2079991 / 2079992
Frequency range 8 GHz – 18000 MHz			
Measurement in FAC 2 with the distance between the EUT and the antenna 3 m			
732	Spectrum Analyzer	R&S FSW67	104023
133	Antenna	EMCO 3115	9012-3629
836	RF Amplifier	ASG18B-4010 1-18GHz	0001
Frequency range 18000 MHz – 40000 MHZ			
Measurement in FAC 2 with the distance between the EUT and the antenna 1 m			
732	Spectrum Analyzer	R&S FSW67	104023
302	Antenna	BBHA9170	155

5.7.2. Requirements/Limits

FCC/RSS	See section 1.1.
ANSI	☐ C63.4-2014 ☒ C63.10-2013
Limits, EIRP in dBm	Field strength limit [dBµV/m] for 3 m is 54 dBµV/m. EIRP limit is -41.23 dBm. EIRP limit was calculated according to the equation (38) in ANSI C63.10-2013: EIRP[dBm] = E[dBµV/m]+ 20log(d [m])−104.77 $EIRP_{limit}$ = [54 + 20log(3)−104.77] dBm = [54 + 9.54−104.77] dBm = -41.23 dBm

5.7.3. Test condition and measurement test set-up

EUT-grounding		☒ none	☐ with power supply	☐ additional connection
Equipment set up		☒ table top 1.5 m height		☐ floor standing
Climatic conditions		Temperature: (22±3° C)		Rel. humidity: (40±20)% rH
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 analyzer Mode		
	Detector	RMS		
	RBW/VBW	1 MHz / 3 MHz		
	Mode:	max-hold		
	Sweep-Time	≤ 1 s over each measurement bin		
General measurement procedures		Please see chapter “Test system set-up for radiated electric field measurements above 1 GHz”		

5.7.4. Measurement method:

Measurement is done for op. mode 2.

Measurement distance:

Frequency range:	Distance [m]:
1 GHz – 8 GHz	3
8 GHz – 18 GHz	3
18 GHz – 40 GHz	1

5.7.5. 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 radiated spurious results:

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBm]	Frequency [GHz]	Limit [dBm]
5.5	2	2	-46.11	1.8426 **	-41.23
5.6	2	2	-43.46	*	-41.23
5.7	2	2	-44.83	*	-41.23

* Noise level
** The emission at this frequency is external, thus irrelevant to the limit.

5.7.6. Verdict

Pass. No emissions above the limit line. Pls. see annex 1 to this test report.

5.8. Radiated field strength emissions, above 40 GHz

5.8.1. 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)% rH		
test site	☐ 443 FAC Spuri	☐ 348 EMI cond.	☐ 443 EMI FAC	☐ 347 Radio.lab.	☐ 337 OATS	☒ 412 OTA1
spectr. Analyz.	☒ 732 FSW67	☐ 264 FSEK	☐ 264 FSEK	☐ 584 FSU		☐
antenna meas f > 40 GHz	☒ 765 FH-PP 40-60					
antenna meas f > 50 GHz	☒ 813 FH-PP 075		☒ 815 FH-PP 110		☐ 816 SGH-26-WR	
antenna meas f > 90 GHz	☒ 814 FH-PP 140		☒ 767 FH-PP 220			
antenna meas f > 220 GHz	☒ 812 FH-PP3-25					
antenna subst	☐ 071 HUF-Z2	☐ 020 EMCO3115	☐ 063 LP 3146	☐ 303 BBHA9170	☐ 1144 SGH-26-WR	☐
Other:	☒ Adapter Q-Band to 1.85mm		☒ RF cable PFA61-B1B1-1M0 TESTeLINK C03411			
Signalgener.	☐ 008 SMG	☐ 140 SMHU	☐ 263 SMP04	☐	☐	☐
mixer	☒ 731 FS-Z75	☒ 730 FS-Z110	☒ 729 FS-Z140	☒ 733 FS-Z220	☒ 734 FS-Z325	
multimeter	☒ 341 Fluke 112	☐	☐	☐	☐	☐
DC power	☐ 086 LNG50-10	☒ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 car battery	☐
line voltage	☐ 230 V 50 Hz via public mains		☐060 120 V 60 Hz via PAS 5000			

5.8.2. Reference

Standard	See section 1.1. in the report.

5.8.3. Limits:

Limits, EIRP in dBm	FCC §95.3379 (a)	9 kHz – 40 GHz: see section 5.5. in the report 40 GHz – 200 GHz: 600 pW/cm² ~ -1.7 dBm 200 GHz – 231 GHz: 1000 pW/cm² ~ 0.5 dBm
	RSS-251 (Section 10)	9 kHz – 40 GHz: see section 5.5. and 5.6. in the report 40 GHz – 162 GHz*: -30 dBm * Here 73.5 GHz – 76 GHz: 0 dBm
Limit conversion (pW/cm² to dBm):	P[dBm]=10*log(4*pi*d²*P[W/m²]) d- distance of the limit defined in W/m². Here: 3 m. --- 600 pW/cm²: P[dBW]=10*log(4*pi*(3m)²*6*10⁻⁶W/m²) 600 pW/cm²: P[dBW]= -31.7 dBW P[dBm] = P[dBW] + 30 600 pW/cm²: P[dBm]= -31.7 dBW + 30 600 pW/cm²: P[dBm]= -1.7 dBm --- 1000 pW/cm²: P[dBW]=10*log(4*pi*(3m)²*1*10⁻⁵W/m²) 1000 pW/cm²: P[dBW]= -29.5 dBW P[dBm] = P[dBW] + 30 1000 pW/cm²: P[dBm]= -29.5 dBW + 30 1000 pW/cm²: P[dBm]= +0.5 dBm	

5.8.4. Test environment

Temperature	Nominal: 22±3° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 24 V

5.8.5. Spectrum-Analyzer settings*:

Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≤ 1 s / auto / 120 s @ 1 GHz
Detector	RMS detector.
Sweep mode	Single/ continuance sweep, MAX-HOLD

* See also settings on the screenshots from the spectrum analyzer in Annex 1

5.8.6. Measurement method:

Measurement is done for op. mode 1. The measuring sweeps are repeated with Maxhold function activated. Thus the measuring diagrams in annex 1 covers emissions of the EUT in all 3D directions. The alignment where the EUT transmits the maximum power is also determined.

The measurements are made with the mixer. There is a ref level line in all measurements. This line is not to be mistaken for limit line.

There are many image signals and mixer products to see on the measurement graphs. Signal ID function is used for the most measurement above 55 GHz for the purpose to distinguish these image signals and mixer products from the real signals. Here is the description of Signal ID function from user manual for R&S FSW Signal and Spectrum Analyzer (1173.9411.02 ─ 31):

two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep), trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

*The reference sweep is performed using an LO setting shifted downwards by 2*IF/<Harmonic order>. Input signals in the desired sideband that are converted using the specified harmonic are displayed in both traces at the same position on the frequency axis. Image signals and mixer products caused by other harmonics are displayed at different positions in both traces. The user identifies the signals visually by comparing the two traces.*

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from the test sweep. Therefore the signal level should only be measured in the test sweep (trace 1).

According to the description of the Signal ID function above the following measurement procedure was developed: the measurement was done with Signal ID function ON, when there are any emissions on the measurement graph or with Signal ID function OFF, when there are no emissions at all. On the measurement graph with Signal ID function ON there are two traces at first, LSB and USB. These traces can cover each other. For this reason two more graphs are made and included in the test report for each measurement. One graph with only USB trace and one graph with only LSB trace. These two already saved graphs are opened and compared on the wide enough screen. The scaling of the both graphs is the same. So the graphs can be easily compared by the switching between them (at first one graph is showed on the screen and then the second one). Each area of both traces is compared manually in this way. When there is an emission at the same frequency at LSB as well as at USB trace then it is a real signal. Such signal will be flagged with a marker and later re-measured.

Calculation of the boundary near/far field:

The aperture dimensions of the antenna shall be small enough so that the measurement distance in m is equal to or greater than the Rayleigh (**far-field**) distance (i.e., $R_m = 2D^2 / \lambda$), where D is the largest dimension of the antenna aperture in m and λ is the free-space wavelength in m at the frequency of measurement.

Antenna range, [GHz]	D, [m]	Highest frequency in the measurement, [GHz]	Lowest wavelength λ in the measurement, [m]	Boundary for near/far field, [m]
40-60	0.0384	55	0,005450772	0.54
55-75	0.0307	75	0.003997233	0.47
75-110	0.0208	78	0.003944638	0.22
75-110	0.0208	96	0.002725386	0.28
90-140	0.0165	140	0.002141375	0.25
140-220	0.0107	220	0.001362693	0.17
220-243	0.00705	243	0.001297803	0.08

Measurement distance:

Measurement frequency range:	Measurement distance, [m]	Boundary for near/far field, [m]
40 GHz – 55 GHz	2	0.54
55 GHz – 75 GHz	0.5	0.47
75 GHz – 76 GHz	0.5	0.22
77 GHz – 96 GHz	0.5	0.28
96 GHz – 110 GHz	0.5	0.20
110 GHz – 140 GHz	0.25	0.25
140 GHz – 162 GHz	0.12	0.12
162 GHz – 220 GHz	0.17	0.17
220 GHz – 243 GHz	0.5	0.08

5.8.7. Measurement results:

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

According **FCC §95.3379 (a)**

Table of measurement radiated spurious results:

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBm]	Limit [dBm]
5.8	2	2	-38.45*	-1.7
5.9-5.11	2	2	-47*	-1.7
5.12	2	2	-41.1*	-1.7
5.13	2	2	-39.67*	-1.7
5.14-5.16	2	2	-38*	-1.7
5.17-5.19	2	2	-33*	-1.7
5.20-5.22	2	2	-38*	-1.7
5.23-5.25	2	2	-34*	-1.7
5.26-5.28	2	2	-34*	-1.7
5.29-5.31	2	2	-38*	0.5
5.32	2	2	-13.27*	0.5

* Noise level

According **RSS-251 (Section 10)**
Table of measurement radiated spurious results:

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBm]	Limit [dBm]
5.8	2	2	-38.45*	-30
5.9-5.11	2	2	-47*	-30
5.12	2	2	-41.1*	-30
5.13	2	2	-39.67*	-30
5.14-5.16	2	2	-38*	-30
5.17-5.19	2	2	-33*	-30
5.20-5.22	2	2	-38*	-30
5.23-5.25	2	2	-34*	-30

* Noise level

5.8.7.1. Verdict
Pass. No real emissions above the limit line. Pls. see annex 1 to this test report.

5.9. Frequency stability

5.9.1. Test location and equipment

See section 5.1.1.

5.9.2. Reference

Standard	See section 1.1. in the report. ANSI C63.10-2019 Chapter 6.8

5.9.3. Limits

RSS-251 Section 11.2	The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be maintained within the 76-81 GHz frequency band while subjected to all conditions of operation specified in RSS-Gen.

5.9.4. Test environment

Temperature	Nominal: 22±3° C Extreme, min.: -40° C Extreme, max.: +85° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 24 V Extreme, min.: 9 V Extreme, max.: 32 V

5.9.5. Spectrum-Analyzer settings:

Span	> 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	Auto
Detector	Peak detector
Sweep mode	Single sweep, MAX-HOLD

5.9.6. Measurement method:

Frequency stability was measured for operating mode 2 under nominal and extreme conditions. One marker was set on the low and high edge of the signal in each measurement. The frequency of the markers was compared for all measurements.

The measurement was done for following conditions:

Conditions No	Temperature [°C]	Voltage [V]
1	Nominal*	Nominal*
2	Nominal*	V_{min}*
3	Nominal*	V_{max}*
4	T_{min}*	Nominal*
5	-30	Nominal*
6	-20	Nominal*
7	-10	Nominal*
8	0	Nominal*
9	10	Nominal*
10	20	Nominal*
11	30	Nominal*
12	40	Nominal*
13	50	Nominal*
14	T_{max}*	Nominal*

* See subpart 5.9.4.

5.9.7. Results

Nominal condition		
Setup / Op. Mode	Low edge [GHz]	High edge [GHz]
Set. 2 / Op. 2	76.0399	76.9640
Extreme conditions		
Set. 2 / Op. 2 TmaxVnom	76.0393	76.9809
Set. 2 / Op. 2 T50ºCVnom	76.0409	76.9666
Set. 2 / Op. 2 T40ºCVnom	76.0394	76.9651
Set. 2 / Op. 2 T30ºCVnom	76.0409	76.9651
Set. 2 / Op. 2 TnomVmin	76.0380	76.9657
Set. 2 / Op. 2 TnomVmax	76.0395	76.9657
Set. 2 / Op. 2 T10ºCVnom	76.0394	76.9636
Set. 2 / Op. 2 T0ºCVnom	76.0394	76.9666
Set. 2 / Op. 2 T-10ºCVnom	76.0409	76.9651
Set. 2 / Op. 2 T-20ºCVnom	76.0414	76.9736
Set. 2 / Op. 2 TminVnom	76.0428	76.9834

Remark: For graphical results for conditions No 1, 2, 3, 4, 13 (see subpart 5.9.6.) pls. see annex 1 to this test report. The operating frequency was observed at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT was energized. There were no essential changes in operating frequency. So only one pair of values was recorded for each specified temperature.

5.9.8. Verdict

Pass

5.10. 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 its contribution to the overall uncertainty according it's 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
		24 GHz	3.24 dB						
		76-77GHz	3.32 dB						
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 GHz - 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 - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--	
Power density	-	1 – 2.8 GHz	1.40 dB						--
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB						Magnetic field
		30 MHz - 1 GHz	4.2 dB						E-field
		1 GHz - 18 GHz	3.17 dB						Substitution Method
		18-33 GHz	3.60 dB						
		33-50 GHz	3.99 dB						
		40-60 GHz	3.95 dB						
		50-75 GHz	3.24 dB						External Mixer
		75-90 GHz	3.32 dB						
		90-140 GHz	4.94 dB						
		140-225 GHz	5.42 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, Documents 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	(MRA US-EU 0003)	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAC) Radiated Measurements above 1 GHz, 3 m (FAC) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA
337 487 550 558	-- 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 (SAC) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAC) Radiated Measurements above 1 GHz, 3 m (FAC)	ISED, Industry Canada Certification and Engineering Bureau
487 550 348 348	R- 4452 G- 20013 C- 20009 T- 20006	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAC) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAC) 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, SAC = Semi Anechoic Chamber, FAC = Fully Anechoic Chamber			

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
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
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-SAC-EMI Cable Loss	System EMI field (SAC)	-	EMC 32 Version 8.52
442	CTC-SAC-EMS	System EMS field (SAC)	-	EMC 32 Version 8.40
443	CTC-FAC-EMI-RSE	System CTC-FAC-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 9.15.00
444	CTC-FAC-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
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

8.1.2. Single instruments and test systems

ID	Description	Manufacturer	SerNo	Cal date	Cal interval	Cal due date
	120901 - SAC - Radiated Emission <1GHz					**21.07.2025**
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	04.05.2019	36/12M	03.05.2022
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren Gmbh	-	16.07.2015	120/12M	15.07.2025
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	14.05.2020	12M	13.05.2021
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	-	Pre-m	-
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	-	Pre-m	-
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	07.04.2020	24/12M	06.04.2020
	120904 - FAC1 - Radiated Emissions					
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	26.05.2020	24/12M	25.05.2022
20720	EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	-	Pre-m	-
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	14.05.2020	12M	13.05.2021
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	20.07.2020	12M	19.07.2021
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	16.04.2020	36/12M	15.04.2023
20549	Log.Per-Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	01.08.2017	36/12M	31.07.2021
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	-	Pre-m	-
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	11.10.2020	6	10.10.2021
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	11.10.2020	6	10.10.2021
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	11.10.2020	6	10.10.2021
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	24.05.2019	24/12M	23.05.2021
20439	UltraLog-Antenna HL 562	Rohde & Schwarz Messgerätebau GmbH	100248	11.03.2017	72/12M	10.03.2023
	120907 - FAC2					
20087	DC - power supply, 0 - 5 A EA-3013 S	EA Elektro-Automatik GmbH & Co. KG	-	-	Pre-m	-
20133	Horn Antenna EMCO 3115	ETS-Lindgren	9012-3629	08.04.2020	36/12M	07.04.2023
20302	Horn Antenna BBHA9170	Schwarzbeck Mess-Elektronik OHG	155	15.04.2020	36/12M	14.04.2023
20730	FS-Z110	Rohde & Schwarz Messgerätebau GmbH	101468	20.06.2020	12M	19.06.2021
20729	FS-Z140	Rohde & Schwarz Messgerätebau GmbH	101004	27.05.2020	36/12M	26.05.2023
20731	FS-Z75	Rohde & Schwarz Messgerätebau GmbH	101022	06.07.2019	24/12M	05.07.2021
20733	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH	101009	09.02.2020	6	08.02.2021

20734	Harmonic Mixer FS-Z325	RPG-Radiometer Physics GmbH	101005	13.02.2020	6	12.02.2021
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	09.10.2018	36/12M	08.10.2021
20765	Pickett-Potter Horn Antenna FH-PP 40-60	RPG-Radiometer Physics GmbH	010001	15.09.2020	36/12M	14.09.2023
20767	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH	010011	09.02.2020	6	08.02.2021
20812	Pickett-Potter Horn Antenna FH-PP-325	RPG-Radiometer Physics GmbH	10024	13.02.2020	6	12.02.2021
20813	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH	10006	09.09.2020	36/12M	08.09.2023
20814	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH	10008	14.02.2020	6	13.02.2021
20815	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH	10014	04.09.2020	36/12M	03.09.2023
20816	SGH Antenna SGH-26-WR10	Anteral S.L.	1144	-	Pre-m	-
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH	104023	28.05.2020	12M	27.05.2021
20836	Amplifier ASG18B-4010 1-18GHz	Wright Technologies	0001	15.02.2020	6	14.02.2021
20851	Vibration Table Energizer Red	MB Dynamics GmbH	109098	20.09.2019	36/12M	19.09.2022
20869	VT4002 Klimaschrank	Vötsch Industrietechnik GmbH	521/79152	12.10.2020	6	11.10.2021
20877	Amplifier JS42-08001800-16-8P	Miteq Inc.	2079991 / 2079992	27.11.2020	7	26.02.2021

8.1.3. Legend

Note / remarks		Calibrated during system calibration:
	1a	System CTC-SAC-EMS (Ref.-No. 442)
	1b	System-CTC-EMS-Conducted (Ref.-No. 335)
	1c	System CTC-FAC-EMI-RSE (Ref.-No . 443)
	1d	System CTC-SAC-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-FAC-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
	6	Annual internal validation
	7	Internal validation every 3 months

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	2020-12-03
C1	FCC ID and ISED ID changed	2021-12-06
C2	Update emission level of the noise level and the spurious peak in sec.5.5.5 and 5.6.6 Correction of the typo on the cover page	2021-12-17

The End of the Report