T E S T R E P O R T
No.: 19-1-0062601T01a-C2

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

for

s.m.s, smart microwave sensors GmbH

Radar Sensor
UMRR-96 Type 153

FCC ID: W34UMRR9699
ISED ID: 10652A-UMRR9699

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

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Table of contents

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 opera-ting 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	1	1	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	1,2	1,2	passed
	RSS-251 (Section 10)	9 kHz – 40 GHz: see section 5.5. in the report 40 GHz – 162 GHz*: -30 dBm Here 73.5 GHz – 76 GHz: 0 dBm				
Frequency stability	FCC §95.3379 (b)	-	Nominal and extreme	1	1	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 19-1-0062601T01a-C2 replaces the Test Report 19-1-0062601T01a-C1 dated 11.10.2019. The replaced Test Report is herewith invalid.

markus.
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m.com
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05:08 +01'00'

.....
Dipl.-Ing. Markus Ridder
Responsible for test section

Digital unterschrieben
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.....
B.Sc. Piotr Sardyko
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:	Volker Wittmann
Deputy:	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 and project leader:	B.Sc. P. Sardyko
Receipt of EUT:	2019-07-18
Date(s) of test:	2019-07-29 to 2019-08-02
	2020-01-14 to 2020-01-15
Date of report:	2020-02-06
Version of template: 13.02	

2.4. Applicant’s details

Applicant’s name:	s.m.s, smart microwave sensors GmbH
Address:	In den Wasshainen 1 38108 Braunschweig Germany
Contact person:	Mr. Dr. Ralph Mende

2.5. Manufacturer’s details

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

3. Equipment under test (EUT)

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT*

Main function	Universal Medium Range Radar (UMRR)		
Transmit frequency	77 GHz to 81 GHz		
Number of modes	27 (3 TX antennas + 3 bandwidths + 3 frequencies)		
Antenna polarization	Vertical		
Type of modulation	FMCW		
Bandwidth (net sweep)	226 MHz (Waveform Mode 0 – long range) 512 MHz (Waveform Mode 1 – medium range) 1536 MHz (Waveform Mode 2 – short range)		
Antenna Type	☒ Integrated. Quantity of Tx antennas: 3 ☐ External, no RF- connector ☐ External, separate RF-connector		
Power supply	☒ DC power supply: 7 – 32 V		
Temperature	-40° C to +85° C		
Interfaces	CAN/CAN-FD		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☒ yes	☐ no	
UPN Number	UMRR9699		
Company Number	10652A		
Product Marketing Name (PMN)	Automotive 4D/UHD Demo 4D/UHD (Not tested) Generic A 4D/UHD (Not tested) Generic B 4D/UHD (Not tested) Generic C 4D/UHD (Not tested) Generic D 4D/UHD (Not tested) Generic E 4D/UHD (Not tested) Generic F 4D/UHD (Not tested)		
Hardware Version Identification Number (HVIN)	UMRR-96 Type 153		
Firmware Version Identification Number (FVIN)	5		
Host Marketing Name (HMN)	n/a		

*: 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 S02	Radar Sensor	UMRR-96 Type 153	0x00022e9EC	UMRR-96 Type 153	5

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

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

AE short descrip-tion *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	Notebook	Dell Latitude E6530	-	-	Windows 7 + DriveRecorder SW v2.2.9862.0**
AE 2 S05	Cable harness	-	-	-	-
AE 3 S06	CAN-USB converter	Vector VN1610	-	-	-

AE 4 S04	USB cable 1 m	-	-	-	-

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report. Please see photos in Annex 2.
**) SW was installed on the customers' notebook.

3.4. EUT set-ups

EUT set-up no.*)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 1 + AE 2	Radiated RF-setup without Laptop

*) 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
	Antenna type (Tx)**	Signal Frequency, [GHz]	Signal Bandwidth, [MHz]	
op. 1	2	79.8	1536	Continuously transmitting, FMCW
op. 2	0	77.85	226	Continuously transmitting, FMCW
op. 3	0	77.85	512	Continuously transmitting, FMCW
op. 4	0	77.85	1536	Continuously transmitting, FMCW
op. 5	0	78.85	226	Continuously transmitting, FMCW
op. 6	0	78.85	512	Continuously transmitting, FMCW
op. 7	0	78.85	1536	Continuously transmitting, FMCW
op. 8	0	79.8	226	Continuously transmitting, FMCW
op. 9	0	79.8	512	Continuously transmitting, FMCW
op. 10	0	79.8	1536	Continuously transmitting, FMCW
op. 11	1	77.85	226	Continuously transmitting, FMCW
op. 12	1	77.85	512	Continuously transmitting, FMCW
op. 13	1	77.85	1536	Continuously transmitting, FMCW
op. 14	1	78.85	226	Continuously transmitting, FMCW
op. 15	1	78.85	512	Continuously transmitting, FMCW
op. 16	1	78.85	1536	Continuously transmitting, FMCW
op. 17	1	79.8	226	Continuously transmitting, FMCW
op. 18	1	79.8	512	Continuously transmitting, FMCW
op. 19	1	79.8	1536	Continuously transmitting, FMCW
op. 20	2	77.85	226	Continuously transmitting, FMCW
op. 21	2	77.85	512	Continuously transmitting, FMCW
op. 22	2	77.85	1536	Continuously transmitting, FMCW
op. 23	2	78.85	226	Continuously transmitting, FMCW
op. 24	2	78.85	512	Continuously transmitting, FMCW
op. 25	2	78.85	1536	Continuously transmitting, FMCW
op. 26	2	79.8	226	Continuously transmitting, FMCW
op. 27	2	79.8	512	Continuously transmitting, FMCW

* EUT operating mode no. is used to simplify the test report.
** Please see chapter 5.2.

4. Description of test system set-up's

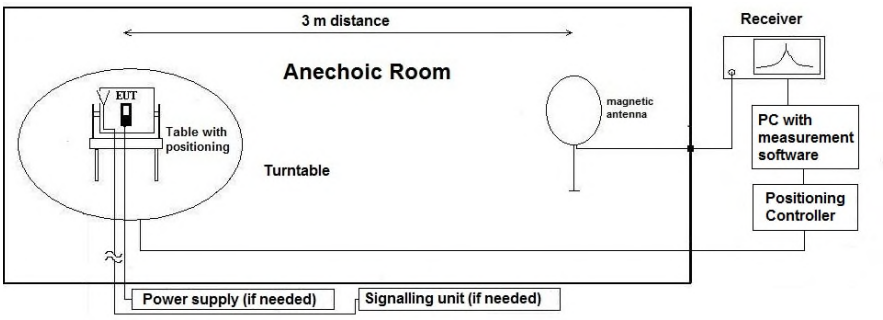
4.1. Test system set-up for radiated magnetic field measurements below 30 MHz

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.

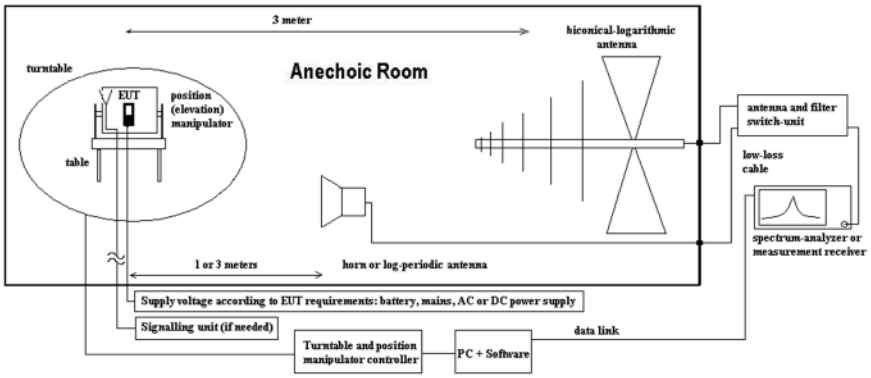
Distance correction: Reference for applied correction (extrapolating) factors due to reduced measurement distance:
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

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 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 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:

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

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

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

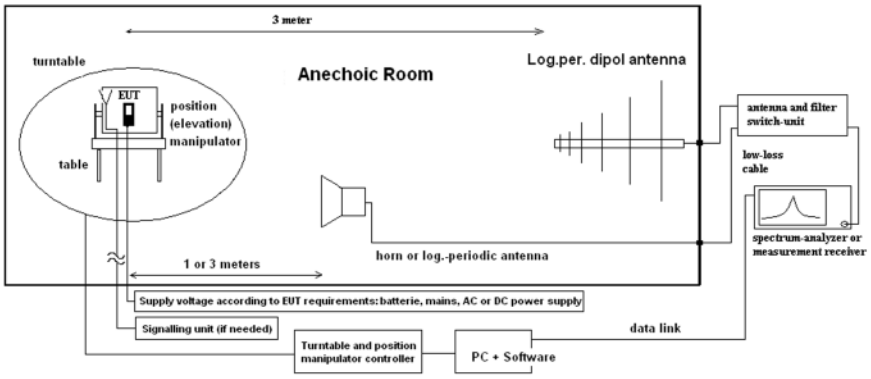
All units are dB-units, positive margin means value is below limit.

4.3. 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 room (FAR) 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 20° C nominal and extreme		Rel. humidity: (45±15)% rH	
test site	☐ 443 FAR Spuri	☐ 348 EMI cond.	☐ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☒ 412 FAR 2/ OTA1
equipment	☒ 833 VT4002	☐	☐	☐	☐	☐
spectr. Analyz.	☒ 714 FSW67	☐ 264 FSEK	☐ 264 FSEK	☐ 584 FSU		☐
antenna meas < 18 GHz	☐ 574 BTA-L	☐ 289 CBL 6141	☐ 439 HL 562	☐ 549 HL 025		☐
antenna meas 18-40 GHz	☐ 302 BBHA9170	☐ 13254-01 / Q-Band SAR-2309-22-S2				
antenna meas f > 40 GHz	☐ 748 FH-PP 4060					
antenna meas f > 50 GHz	☐ 792 FH-PP 075		☒ 794 FH-PP 110		☐ 795 SGH-26-WR	
antenna meas f > 90 GHz	☐ 793 FH-PP 140		☐ 750 FH-PP 220			
antenna meas f > 220 GHz	☐ 791 FH-PP3-25					
antenna subst	☐ 071 HUF-Z2	☐ 020 EMCO3115	☐ 063 LP 3146	☐ 303 BBHA9170	☐ 1144 SGH-26-WR	☐
power meter	☐ 009 NRV	☐ 010 URV5-Z2	☐ 011 URV5-Z2	☐ 100 984 NRT-T110	☐	☐
Other:	☐ Adapter Q-Band to 1.85 mm					
Signalgener.	☐ 008 SMG	☐ 140 SMHU	☐ 263 SMP04	☐	☐	☐
mixer	☐ 713 FS-Z75	☒ 712 FS-Z110	☐ 711 FS-Z140	☐ 715 FS-Z220	☐ 716 FS-Z325	
power meter	☐ 262 NRV-S	☐ 266 NRV-Z31	☐ 265 NRV-Z33	☐ 261 NRV-Z55	☐ 356 NRV-Z1	☐ 261 NRP-T110
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: 12 V Extreme, min.: 7 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
Detector	Peak detector with max peak search. RMS with channel power measurement.
Sweep mode	Continuance sweep, MAX-HOLD

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]	
Set. 1 / Op. 1 / 1 m / TnomVnom	28.11	80.6635	21.75	**Pass**
Set. 1 / Op. 2 / 1 m / TnomVnom	20.19	77.9745	14.09	**Pass**
Set. 1 / Op. 3 / 1 m / TnomVnom	20.73	78.1355	14.42	**Pass**
Set. 1 / Op. 4 / 1 m / TnomVnom	20.59	78.7125	14.48	**Pass**
Set. 1 / Op. 5 / 1 m / TnomVnom	20.79	78.9995	15.09	**Pass**
Set. 1 / Op. 6 / 1 m / TnomVnom	21.59	79.1355	15.38	**Pass**
Set. 1 / Op. 7 / 1 m / TnomVnom	21.99	79.7125	15.49	**Pass**
Set. 1 / Op. 8 / 1 m / TnomVnom	21.59	79.9505	16.45	**Pass**
Set. 1 / Op. 9 / 1 m / TnomVnom	22.13	80.1425	16.37	**Pass**
Set. 1 / Op.10 / 1 m / TnomVnom	22.18	80.6625	16.15	**Pass**
Set. 1 / Op.11 / 1 m / TnomVnom	19.33	77.9745	13.82	**Pass**
Set. 1 / Op.12 / 1 m / TnomVnom	20.31	78.1925	14.21	**Pass**
Set. 1 / Op.13 / 1 m / TnomVnom	20.76	78.7125	14.46	**Pass**
Set. 1 / Op.14 / 1 m / TnomVnom	20.91	78.9995	15.11	**Pass**
Set. 1 / Op.15 / 1 m / TnomVnom	21.67	79.1925	15.42	**Pass**
Set. 1 / Op.16 / 1 m / TnomVnom	22.75	79.7115	15.75	**Pass**
Set. 1 / Op.17 / 1 m / TnomVnom	21.80	79.9495	16.89	**Pass**
Set. 1 / Op.18 / 1 m / TnomVnom	22.7	80.1425	16.97	**Pass**
Set. 1 / Op.19 / 1 m / TnomVnom	22.4	80.6625	16.65	**Pass**
Set. 1 / Op.20 / 1 m / TnomVnom	26.52	78.0005	19.86	**Pass**
Set. 1 / Op.21 / 1 m / TnomVnom	26.99	78.1935	20.43	**Pass**
Set. 1 / Op.22 / 1 m / TnomVnom	27.6	78.7125	20.34	**Pass**
Set. 1 / Op.23 / 1 m / TnomVnom	26.48	78.9995	21.16	**Pass**
Set. 1 / Op.24 / 1 m / TnomVnom	27.68	79.1355	21.49	**Pass**
Set. 1 / Op.25 / 1 m / TnomVnom	27.48	79.7115	21.32	**Pass**
Set. 1 / Op.26 / 1 m / TnomVnom	25.82	79.9245	21.64	**Pass**
Set. 1 / Op.27 / 1 m / TnomVnom	27.13	80.1425	21.68	**Pass**
	Extreme conditions			
Set. 1 / Op. 1 / 1 m TminVnom	28.16	80.6625	22.36	**Pass**
Set. 1 / Op. 1 / 1 m TmaxVnom	27.06	80.6625	21.52	**Pass**
Set. 1 / Op. 1 / 1 m TnomVmin	27.66	80.6625	21.75	**Pass**
Set. 1 / Op. 1 / 1 m TnomVmax	27.18	80.8015	21.48	**Pass**

Remark: For graphical results, pls. see annex 1 to this test report.
* Op. mode 1 shows the highest value of the power measurement among all op. modes. Therefore, all other tests are conducted with this op. mode.

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: 12 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	auto
Detector	Peak detector
Sweep mode	continuance sweep, MAX-HOLD

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:
The UMRR transmit frequency is in the band from 77 GHz to 81 GHz, the used bandwidth is smaller than 4 GHz. Antenna type 153 consists of three transmit and four receive antennas, which are linear polarized. The Tx0 and Tx1 have the same antenna characteristics but different center position on the board. The Tx2 squints in azimuth with -30° comparing to Tx0 and Tx1. The 2 way 20 dB cut-off angle in azimuth (Az.) and 6dB cut-off angle in elevation (El.) please see below.

Two way cut-off angle of the Tx antennas

	Tx 0 /Tx 1	*Tx 2*
Az. -20 dB	*± 67°*	*± 55°*
El. -6 dB	*± 8°*	*± 11°*
Squint in Az.	*0°*	*-30°*

Waveform parameters supplied by applicant:

Waveform Mode 0 – long range – 226 MHz

Waveform	AB
Frequency Hub	226 MHz
Used BW (measured)	335 MHz
T_{chirp}	63.2 µs
Transmit period	16.43 ms = 29.9%
Non-Transmit period	38.57 ms = 70.1%
Cycle Time	Typically 55 ms

Waveform Mode 1 – medium range – 512 MHz

Waveform	AB
Frequency Hub	512 MHz
Used BW (measured)	682 MHz
T_{chirp}	63.2 µs
Transmit period	16.43 ms = 29.9%
Non-Transmit period	38.57 ms = 70.1%
Cycle Time	Typically 55 ms

Waveform Mode 2 – short range – 1536 MHz

Waveform	AB
Frequency Hub	1536 MHz
Used BW (measured)	1910 MHz
T_{chirp}	66.4 µs
Transmit period	17.264 ms = 37.5%
Non-Transmit period	37.736 ms = 62.5%
Cycle Time	Typically 55 ms

TX Antenna information supplied by applicant:

Antennas Used	Tx0, Tx1, Tx2
Frequency Band	77 GHz – 81 GHz
Bandwidth	< 4 GHz

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: 12 V Extreme, min.: 7 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. 1860 MHz. So RBW = 20 MHz was chosen.
Video Bandwidth (VBW)	Here 50 MHz. More than VBW=50 MHz is not possible with current spectrum analyzer.
Sweep time	auto
Detector	Peak detector
Sweep mode	Continuance sweep, MAX-HOLD

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	79.02403	80.88311	1859.01	**Pass**
Set. 1 / Op. 1 / RBW = 20 MHz (for ISED Canada)	79.01236	80.88909	1876.72	**Pass**
Set. 1 / Op. 2 / RBW = 1 MHz	77.73421	78.01649	282.27	**Pass**
Set. 1 / Op. 3 / RBW = 1 MHz	77.58962	78.22901	639.38	**Pass**
Set. 1 / Op. 4 / RBW = 1 MHz	77.07313	78.93286	1859.72	**Pass**
Set. 1 / Op. 5 / RBW = 1 MHz	78.73378	79.01689	283.10	**Pass**
Set. 1 / Op. 6 / RBW = 1 MHz	78.58969	79.23011	640.41	**Pass**
Set. 1 / Op. 7 / RBW = 1 MHz	78.0738	79.93249	1858.69	**Pass**
Set. 1 / Op. 8 / RBW = 1 MHz	79.68362	79.96613	282.50	**Pass**
Set. 1 / Op. 9 / RBW = 1 MHz	79.53995	80.17935	639.40	**Pass**
Set. 1 / Op. 10 / RBW = 1 MHz	79.02535	80.88195	1856.6	**Pass**
Set. 1 / Op. 11 / RBW = 1 MHz	77.73388	78.01634	282.46	**Pass**
Set. 1 / Op. 12 / RBW = 1 MHz	77.58967	78.22966	639.98	**Pass**
Set. 1 / Op. 13 / RBW = 1 MHz	77.07232	78.93345	1861.13	**Pass**
Set. 1 / Op. 14 / RBW = 1 MHz	78.73417	79.01688	282.70	**Pass**

Set. 1 / Op. 15 / RBW = 1 MHz	78.59007	79.23061	640.54	**Pass**
Set. 1 / Op. 16 / RBW = 1 MHz	78.07562	79.9337	1858.07	**Pass**
Set. 1 / Op. 17 / RBW = 1 MHz	79.68348	79.96592	282.44	**Pass**
Set. 1 / Op. 18 / RBW = 1 MHz	79.53999	80.17953	639.546	**Pass**
Set. 1 / Op. 19 / RBW = 1 MHz	79.02565	80.88149	1855.84	**Pass**
Set. 1 / Op. 20 / RBW = 1 MHz	77.73389	78.01625	282.36	**Pass**
Set. 1 / Op. 21 / RBW = 1 MHz	77.59035	78.22981	639.46	**Pass**
Set. 1 / Op. 22 / RBW = 1 MHz	77.07619	78.93333	1857.14	**Pass**
Set. 1 / Op. 23 / RBW = 1 MHz	78.73354	79.01619	282.65	**Pass**
Set. 1 / Op. 24 / RBW = 1 MHz	78.58992	79.23	640.08	**Pass**
Set. 1 / Op. 25 / RBW = 1 MHz	78.07415	79.93054	1856.39	**Pass**
Set. 1 / Op. 26 / RBW = 1 MHz	79.6836	79.96609	282.48	**Pass**
Set. 1 / Op. 27 / RBW = 1 MHz	79.54006	80.17985	639.78	**Pass**
Set. 1 / Op. 1 TnomVmin / RBW = 1 MHz	79.02374	80.88211	1858.36	**Pass**
Set. 1 / Op. 1 TnomVmax / RBW = 1 MHz	79.02327	80.88189	1858.61	**Pass**
Set. 1 / Op. 1 TmaxVnom / RBW = 1 MHz	79.0229	80.88213	1859.23	**Pass**
Set. 1 / Op. 1 TminVnom / RBW = 1 MHz	79.02449	80.8812	1856.70	**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: 12 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	60 s @ 1 GHz / auto
Detector	RMS detector
Sweep mode	Single/continuance sweep, MAX-HOLD

5.4.6. Measurement method:

Low band edge was measured for mode 1 and mode 22. For 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	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.		☐	☐
receiver	☒ 377 ESCS30	☐ 001 ESS	☐	☐	☐	☐
spectr. analyz.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☒ 021 EMCO6502
signaling	☐ 757 CMW500	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW500		
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☒ 456 EA 3013A	☐ 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. The mode 1 was chosen due to the fact, that it shows the highest value of the power measurement among all op. modes.

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 [dBm]	Limit [dBm]
5.1	1	1	8 *	**
5.2	1	1	8 *	**

* 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.

5.5.7. 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 0.625xLambda. 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	30	fulfilled	not fulfilled	-40,00
	6,00E+05	500,00	79,58		fulfilled	not fulfilled	-40,00
	7,00E+05	428,57	68,21		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
MHz	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

5.6. 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	☒ 441 EMI SAR	☒ 487 SAR NSA				
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
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	☐ 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 4 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
4.20725-4.20775	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			

5.6.4. 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 1. The mode 1 was chosen due to the fact, that it shows the highest value of the power measurement among all op. modes.

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	1	1	40 *	**
5.4	1	1	39.3 *	**

* 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 – 12400 MHz			
Measurement in FAR 2 with the distance between the EUT and the antenna 3 m			
714	Spectrum Analyzer	R&S FSU67	104023
133	Antenna	EMCO 3115	9012-3629
812	RF Amplifier	Wright Technologies ASG18B-4010	0001
Frequency range 12400 MHz – 18000 MHz			
Measurement in FAR 2 with the distance between the EUT and the antenna 3 m			
714	Spectrum Analyzer	R&S FSU67	104023
133	Antenna	EMCO 3115	9012-3629
338	RF Amplifier	Narda Miteq JS42-08001800-16-8P	2079990
Frequency range 18000 MHz – 40000 MHZ			
Measurement in FAR 2 with the distance between the EUT and the antenna 1.5 m			
714	Spectrum Analyzer	R&S FSU67	104023
302	Antenna	BBHA9170	155
688	RF Amplifier	Miteq JS-18004000-40-8P	1750117

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:	Repetitive-Scan, 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 1. The mode 1 was chosen due to the fact, that it shows the highest value of the power measurement among all op. modes.

Measurement distance:

Frequency range:	Distance [m]:
1 GHz – 12.4 GHz	3
12.4 GHz – 18 GHz	3
18 GHz – 40 GHz	1.5

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	1	1	-52	4.799880	-41.23
5.6	1	1	-46.23	*	-41.23
5.7	1	1	-43.1	26.145500	-41.23
5.8	1	1	-47.35	26.173990	-41.23
5.9	1	1	-46.63	26.8875	-41.23
5.9	1	1	-45.6	26.88737	-41.23

* Noise level

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 FAR Spuri	☐ 348 EMI cond.	☐ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☒ 412 OTA1
equipment	☐ 331 HC 4055	☐	☐	☐	☐	☐
spectr. Analys.	☒ 714 FSW67	☐ 264 FSEK	☐ 264 FSEK	☐ 584 FSU		☐
antenna meas f > 40GHz	☒ 748 FH-PP 4060					
antenna meas f > 50GHz	☒ 792 FH-PP 075		☒ 794 FH-PP 110		☐ 795 SGH-26-WR	
antenna meas f > 90GHz	☒ 793 FH-PP 140		☒ 750 FH-PP 220			
antenna meas f > 220GHz	☒ 791 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	☒ 713 FS-Z75	☒ 712 FS-Z110	☒ 711 FS-Z140	☒ 715 FS-Z220	☒ 716 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/cm^2 ~ -1.7 dBm 200 GHz – 231 GHz: 1000 pW/cm^2 ~ 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/cm^2 to dBm):	P[dBm]=10*log(4*pi*d^2*P[W/m^2]) d- distance of the limit defined in W/m^2. Here: 3 m. --- 600 pW/cm^2: P[dBW]=10*log(4*pi*(3m)^2*6*10^{-6}W/m^2) 600 pW/cm^2: P[dBW]= -31.7 dBW P[dBm] = P[dBW] + 30 600 pW/cm^2: P[dBm]= -31.7 dBW + 30 600 pW/cm^2: P[dBm]= -1.7 dBm --- 1000 pW/cm^2: P[dBW]=10*log(4*pi*(3m)^2*1*10^{-5}W/m^2) 1000 pW/cm^2: P[dBW]= -29.5 dBW P[dBm] = P[dBW] + 30 1000 pW/cm^2: P[dBm]= -29.5 dBW + 30 1000 pW/cm^2: P[dBm]= +0.5 dBm	

5.8.4. Test environment

Temperature	Nominal: 22±3° C
Rel. humidity	(40±20)% rH
Power supply	Nominal: 12 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 / 60 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 mode 1 was chosen due to the fact, that it shows the highest value of the power measurement among all op. modes. 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 remeasured. **No image signals and mixer products are flagged with the marker.** There are too many image signals and mixer products. When all they will be flagged with the marker then it looks not clearly.

For this reason one more measurement will be done with the operating mode 1 with extended sweep time (ST). ST = 60 s @ 1 GHz. The measurement will be done in the position with the highest power determined in the first part of the measurement. Image signals and mixer products are easily distinguished on the plots for such a measurement. This measurement is not really demanded. Aber it acts as a good instrument to ensure and clarify the measurements results from the first part of the measurement.

Traces on all diagrams up to 200 GHz include all losses inclusive antenna gain and free-space path loss. The SW of the spectrum analyzer doesn't permit to include antenna gain and free-space path loss in the trace for frequency range above 200 GHz. The real noise level for the measurements above 200 GHz is calculated in the table below:

200 GHz – 220 GHz					
Column identification	A	B	C	D	-
Frequency [GHz]	Antenna gain [dBi]	Free-space path loss [dB] for 1 m	Noise level read by spectrum analyzer [dBm]	A + B + C Calculate noise level, [dBm]	Limit [dBm]/ Verdict
200	-23.75	78.52	-76.1	-21.33	0.5/ ok
210	-24.15	78.95	-77.13	-22.33	0.5/ ok
220	-24.5	79.35	-78.58	-23.73	0.5/ ok
220 GHz – 243 GHz					
Frequency [GHz]	Antenna gain [dBi]	Free-space path loss [dB] for 0.5 m	Noise level read by spectrum analyzer [dBm]	A + B + C Calculate noise level, [dBm]	Limit [dBm]/ Verdict
220	-19.8	73.33	-68.45	-14.92	0.5/ ok
231.5	-20	73,77	-72.31	-18.54	0.5/ ok
243	-20.2	74,19	-71.94	-17.95	0.5/ ok

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]
55-75	0.03072	73.5	0.004078809	0.46
55-75	0.03072	74.5	0.00402406	0.50
55-75	0.03072	75	0.003997233	0.54
75-110	0.020757	76	0.003944638	0.22
75-110	0.020757	78.5	0.003819012	0.25
75-110	0.020757	79.5	0.003770974	0.27
75-110	0.020757	81	0.003701141	0.30
75-110	0.020757	90	0.003331027	0.37
75-110	0.020757	98	0.003059107	0.43
75-110	0.020757	110	0.002725386	0.53
90-140	0.016696	122	0.002457315	0.23
90-140	0.016696	138	0.002172409	0.29
90-140	0.016696	140	0.002141375	0.33
140-220	0.010666	154	0.001946704	0.12
140-220	0.010666	162	0.001850571	0.15
140-220	0.010666	170	0.001763485	0.18
140-220	0.010666	200	0.001498962	0.25
140-220	0.010666	220	0.001362693	0.32
220-243	0.007046	243	0.001297803	0.08

Measurement distance:

Measurement frequency range:	Measurement distance, [m]	Boundary for near/far field, [m]
40 GHz – 55 GHz	1	0.54
55 GHz – 73.5/75 GHz	0.55/1	0.46
73.5 GHz – 75 GHz	1	0.54
75 GHz – 76/97 GHz	1	0.22
81 GHz – 90 GHz	1	0.37
90 GHz – 98 GHz	1	0.43
97/98 GHz – 110 GHz	0.55	0.53
110 GHz – 122/140 GHz	0.33/0.5	0.23
122 GHz – 138 GHz	0.33	0.29
138 GHz – 140 GHz	0.5	0.33
140 GHz – 162 GHz	0.25	0.15
162 GHz – 200 GHz	0.25	0.25
200 GHz – 220 GHz	0.5	0.32
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]
5.11	1	1	-40.90*	-1.7
5.12-5.14	1	1	-44*	-1.7
5.15-5.17	1	1	-45*	-1.7
5.18	1	1	-44*	-1.7
5.19-5.21	1	1	-36*	-1.7
5.22	1	1	-38*	-1.7
5.23-5.25	1	1	-38*	-1.7
5.26-5.28	1	1	-37.5*	-1.7
5.29-5.31	1	1	-38*	-1.7
5.32-5.34	1	1	-40*	-1.7
5.35-5.37	1	1	-36*	-1.7
5.38	1	1	-37.5*	-1.7
5.39-5.41	1	1	-36*	-1.7
5.42	1	1	-36*	-1.7
5.45	1	1	-36*	-1.7
5.46	1	1	-39*	-1.7
5.47	1	1	**	0.5
5.48	1	1	**	0.5

* Noise level
** For noise level above 200 GHz see calculation in the subsection 5.8.6.

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

Diag. No.	Setup No.	Op. Mode	Max. Signal Level [dBm]	Limit [dBm]
5.11	1	1	-40.90*	-30
5.12-5.14	1	1	-44*	-30
5.15-5.17	1	1	-45*	-30
5.18	1	1	-44*	-30
5.19-5.21	1	1	-36*	-30
5.22	1	1	-38*	-30
5.23-5.25	1	1	-38*	-30
5.26-5.28	1	1	-37.5*	-30
5.29-5.31	1	1	-38*	-30
5.32-5.34	1	1	-40*	-30
5.35-5.37	1	1	-36*	-30
5.38	1	1	-37.5*	-30
5.39-5.41	1	1	-36*	-30
5.42	1	1	-36*	-30
5.45	1	1	-36*	-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: 12 V Extreme, min.: 7 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 1 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	-20	Nominal*
6	-10	Nominal*
7	0	Nominal*
8	10	Nominal*
9	20	Nominal*
10	30	Nominal*
11	40	Nominal*
12	50	Nominal*
13	T_{max}*	Nominal*

* See subpart 5.9.4.

5.9.7. Results

Nominal condition		
Setup / Op. Mode	Low edge [GHz]	High edge [GHz]
Set. 1 / Op. 1	79.0185	80.8852
Extreme conditions		
Set. 1 / Op. 1 TmaxVnom	79.0191	80.8852
Set. 1 / Op. 1 T50ºCVnom	79.0182	80.8869
Set. 1 / Op. 1 T40ºCVnom	79.0195	80.8877
Set. 1 / Op. 1 T30ºCVnom	79.0189	80.8865
Set. 1 / Op. 1 TnomVmin	79.0197	80.8862
Set. 1 / Op. 1 TnomVmax	79.0185	80.8852
Set. 1 / Op. 1 T10ºCVnom	79.0187	80.8864
Set. 1 / Op. 1 T0ºCVnom	79.0193	80.8879
Set. 1 / Op. 1 T-10ºCVnom	79.0181	80.8861
Set. 1 / Op. 1 T-20ºCVnom	79.0185	80.8879
Set. 1 / Op. 1 TminVnom	79.0199	80.8869

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 - 26.5 GHz	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 GHz – 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 GHz – 33 GHz	3.60 dB						
		33 GHz – 50 GHz	3.99 dB						
		40 GHz – 60 GHz	3.95 dB						
		50 GHz – 75 GHz	3.24 dB						External Mixer
		75 GHz - 90 GHz	3.32 dB						
		90 GHz - 140 GHz	4.94 dB						
		140 GHz – 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 Innovation, Science and Economic Development
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 (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA
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 (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	ISED, Innovation, Science and Economic Development Canada
487 550 348 348	R- 4452 G- 20013 C- 20009 T- 20006	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used equipment

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
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= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band to
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 No. 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software No. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software No. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software No. 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
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

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	23.05.2020
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	23.05.2020
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	23.05.2021
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	22.05.2022
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	-	23.05.2021
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	-	22.05.2022
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	-	30.05.2020
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	-	22.05.2020
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	-	10.01.2021
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2020
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	23.05.2021
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	-	21.05.2021
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	22.05.2020
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	22.05.2020
389	Digital Multimeter	Keithley 2000	0583926	Keithley	pre-m	-	
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	01.07.2020
396	Thermo/Hygrometer	Thermo/Hygrometer	-	Conrad	24 M	-	09.01.2021
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	25.05.2020
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	-	30.05.2020
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	-	30.05.2021
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2021

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	30.05.2021
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	-	16.04.2021
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	30.06.2020
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
517	relais switch matrix	HF Relais Box Keithley System	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	23.05.2021
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	-	05.08.2020
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	-	02.10.2021
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	24.01.2020
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	03.05.2022
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	26.06.2020
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	30.05.2021
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	-	30.05.2020
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
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	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
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	-	30.05.2020
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	-	-	
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.05.2020
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	24 M	-	30.05.2021
691	OSP120 Base Unit	OSP120	106833	Rohde & Schwarz	12 M	-	30.05.2020
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
693	TS8997	CTC-Radio Lab 1_TS8997	-	Rohde&Schwarz	12 M	5	07.01.2020
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
701	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	24 M	-	05.11.2021
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/38410516/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	12 M	-	04.11.2020
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	24 M	-	05.07.2021
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	12 M	-	04.07.2020
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	36 M	-	13.02.2020

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
				Physics			
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	04.07.2020
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physiscs	36 M	-	
750	Pickett-Potter Horn Antenna	FH-PP 220	010011	Radiometer Physics	36 M	-	
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	17-010795	mk-messtechnik GmbH	-	-	
757	WIDEBAND RADIO COMMUNICATION	CMW500	163673	Rohde&Schwarz	12 M	-	30.05.2020
758	Signal Generator	SMU 200A	100754	Rohde & Schwarz	24 M	-	11.10.2020
781	Power Supply	PS 2042-10 B	2815450369	Elektro-Automatik GmbH	-	-	
782	Power Supply	PS 2042-10 B	2815450348	lektro-Automatik GmbH &Co.KG	-	-	
783	Spectrum Analyzer	FSU 26	100414	Rohde & Schwarz	12 M	-	30.05.2020
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	24 M	-	30.05.2020
788	Precision Omnidirectional Dipole	POD 618	6182558/Q	Seibersdorf Labaratories	36 M	-	30.06.2021
789	Precision Omnidirectional Dipole	POD 16	162496/Q	Seibersdorf Laboratories	36 M	-	30.06.2021
790	Horn Antenna	ASY-SGH-124-SMA	29F14182337	Antenna System Solutions	36 M	-	08.10.2021
791	Pickett-Potter Horn Antenna	FH-PP-325	10024	Radiometer Physics	36 M	-	
792	Pickett-Potter Horn Antenna	FH-PP 075	10006	Radiometer Physics	36 M	-	
793	Pickett-Potter Horn Antenna	FH-PP 140	10008	Radiometer Physics	36 M	-	
794	Pickett-Potter Horn Antenna	FH-PP 110	10014	Radiometer Physics	36 M	-	
795	SGH Antenna	SGH-26-WR10	1144	Anteral S.L.	36 M	-	
798	WR-22 Rectangular Gain Horn	SAR-2309-22-S2	13254-01	SAGE Millimeter, Inc.	36 M	-	
799	Transceiver	optoLAN-Gb	18-014746	mk messtechnik	pre-m	-	
801	Spectrum Analyzer	FSP 13	100960	Rohde & Schwarz	24 M	-	14.01.2021
802	Exposure Level Tester	ELT-400	O-0026	NARDA Safety Solutions	24 M	-	30.01.2021
803	Probe	ELT probe 3cm²	O-0026	Narda Safety Test Solution	24 M	-	30.01.2021
805	Thermo-Hygrometer	Web-Thermo-Hygrometer	02749814	W&T	24 M	-	
806	AC2600 Smart Wifi Router	Netgear Nighthawk x4S	5K5188590067B	Netgear	-	-	
807	Direct Coupler	Direct Coupler C-05020-10	511	ET Industries	-	-	
808	Diode Power Sensor	NRV-Z1	829894/001	Rohde & Schwarz	24 M	-	24.05.2021
809	Standard gain Horn Antenna	WR-159 Horn Antenna	-	Pasternack Enterprises Inc.	-	-	
810	Horn Antenna WR90	90-HA20	J202064946	TACTRON Elektronik GmbH &	-	-	
811	Waveguide to Coax Adapter	ADP-WC-WR90-SMA-F-F	J504072436	TACTRON Elektronik GmbH &	-	-	
812	1-18 GHz Amplifier	ASG18B-4010	-	Wright Technologies, Inc.	pre-m	-	
813	Band Reject Filter	WRCJV10-5855-5875-5905-	10	Wainwright Instruments GmbH	pre-m	-	
814	Band Reject Filter	WRCJV10-5855-5875-5905-	11	Wainwright Instruments GmbH	pre-m	-	
816	GPIB-USB-HS	187965G-01L	16AE772	National Instruments	-	-	
817	GBIP-USB-HS	187965G-01L	16AC1EE	National Instruments	-	-	
818	GPIB-USB-HS	187965G-01L	16AE8D0	National Instruments	-	-	
819	GPIB-USB-HS	187965G-01L	16AB93C	National Instruments	-	-	
820	GPIB-USB-HS	187965G-01L	16AE294	National Instruments	-	-	
821	GPIB-USB-HS	187965G-01L	16ACB9C	National Instruments	-	-	
822	GPIB-USB-HS	187965G-01L	16AE5B2	National Instruments	-	-	
823	Broadband Field Meter	NBM-550	H-0929	NARDA Safety Test Solutions	36 M	-	19.07.2022
824	E-Field Probe	EF 0691	H-0851	Narda Safety Test Solutions	36 M	-	06.08.2022
825	H-Field Probe	HF 3061	D-0805	NARDA Safety Test	36 M	-	06.08.2022

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
				Solutions			
826	Electric and magnetic Field Analyzer	EHP-50F	510WY90125	NARDA Safety Test Solutions	36 M	-	01.10.2022
827	Transceiver	optoUSB-2.0	19-017001	mk-messtechnik GmbH	-	-	
828	Transceiver	optoUSB-2.0	19-017002	mk-messtechnik GmbH	-	-	
829	Battery Pack BP-84	Battery Pack BP-84	19-017271	mk-messtechnik GmbH	-	-	
830	SIGNAL ANALYZER	FSV3030	101247	Rohde&Schwarz	12 M	-	02.10.2020
831	Rubidium Frequency Standard	8040B CS-Rub5	100050	Rohde & Schwarz	36 M	-	
832	Climatic Chamber	VT4002	521/79152	Vötsch Industrietechnik	12 M	-	13.02.2020
833	Climatic Chamber	VT4002	521/79863	Vötsch industrietechnik	12 M	-	13.02.2020

8.1.3. Legend

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

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

9. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2019-08-27
C1	In subpart 5.9.2. ANSI C63.10-2019 was added. In subpart 5.9.7. a comment with the explanation to the measurement was added.	2019-10-11
C2	In subpart 5.1.: The maximum peak power EIRP / peak EIRP spectral density measurement is repeated for all modes with sweep time 133 s. The maximum power EIRP/ average EIRP is done for all modes with sweep time 133 s. Results are corrected accordingly. In subpart 5.3.: Occupied bandwidth measurement is repeated for all modes with sweep time 133 s. Results are corrected accordingly. In subpart 5.9.: Frequency stability measurement is repeated with sweep time 133 s. Results are corrected accordingly. Annex 1: Old diagrams for subpart 5.1., 5.3., 5.9. are replaced. New diagrams for subpart 5.3. are added.	2020-02-06

The End of the Report