Test Report acc. to FCC Title 47 CFR Part 15
relating to
s.m.s, smart microwave sensors GmbH
UMRR-12 Type 48

Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure:
ANSI C63.10-2013

ilac-MRA

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-12053-01-00

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
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MANUFACTURER	
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Manufacturer's grantee code	W34
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TESTING LABORATORY	
Test engineer	Mr. Ralf Trepper
Testing laboratory name	TÜV NORD Hochfrequenztechnik GmbH & Co. KG
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RELEVANT STANDARD	
Title	47 - Telecommunication
Part	15 - Radio Frequency Devices
Subpart	Subpart C – Intentional Radiators – Section 15.249
Measurement procedure	ANSI C63.10-2013

EQUIPMENT UNDER TEST (EUT)	
Equipment category	Field Disturbance Sensor
Trade name	smartmicro
Type designation	**UMRR-12 Type 48**
Serial no.	0x0002FBB0
Variants	---

1. Test results

Clause	Requirements headline	FCC Rule	Test result		
8.1	Antenna requirement	§15.203	**Pass**	~~Fail~~	~~N.t.~~*
8.2	Restricted bands of operation	§15.205	**Pass**	~~Fail~~	~~N.t.~~*
8.3	Conducted limits	§15.207	**Pass**	~~Fail~~	~~N.t.~~*
8.4	Radiated emission limits, general requirements	§15.209	**Pass**	~~Fail~~	~~N.t.~~*
8.5	Field strength of fundamental and harmonics	§15.249	**Pass**	~~Fail~~	~~N.t.~~*
8.6	Bandwidth	§15.249	**Pass**	~~Fail~~	~~N.t.~~*
8.7	Band edge measurement	§15.249	**Pass**	~~Fail~~	~~N.t.~~*

** Not tested*

The equipment passed all the conducted tests	Yes	~~No~~

Signature	Digital unterschrieben von Ralf Trepper DN: cn=Ralf Trepper, o=TÜV NORD Hochfrequenztechnik GmbH & Co. KG, ou=Labor, email=rtrepper@tuev-nord.de, c=DE	Digital unterschrieben von Abdelouahid Ftouhi DN: cn=Abdelouahid Ftouhi, o=TUEV NORD Hochfrequenztechnik, ou, email=aftouhi@tuev-nord.de, c=DE
Name	**Mr. Ralf Trepper**	**Mr. Abdelouahid Ftouhi**
Designation	**RF Test Engineer**	**Laboratory-Manager**
Date of issue	**2020-11-09**	**2020-11-09**

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TÜV NORD Hochfrequenztechnik GmbH & Co. KG
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2. Introduction

This test report **is not an expert opinion** and consists of:

- Test result summary
- List of contents
- Introduction and further information
- Performance assessment
- Detailed test information

All pages have been numbered consecutively and bear the TÜV NORD Hochfrequenztechnik GmbH & Co. KG logo, the test report number, the date, the test specification in its current version as well as the type designation of the EUT. The total number of pages in this report is **41**.

The tests were carried out at:

- TÜV NORD Hochfrequenztechnik GmbH & Co. KG, D-51069 Köln

in a representative assembly and in accordance with the test methods and/or requirements stated in:

FCC Title 47 CFR Part 15 Subpart C & ANSI C63.10-2013

The sample of the product was received on:

- 2019-06-28

The tests were carried out in the following period of time:

- 2019-11-05 – 2020-11-09

3. Testing laboratory

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Germany

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- FCC Registration Number: **763407**

Accredited by:

DAkkS Deutsche Akkreditierungsstelle GmbH
DAkkS accreditation number: D-PL-12053-01

4. Applicant

Company name	: s.m.s, smart microwave sensors GmbH
Address	: In den Waashainen 1
	38108 Braunschweig
Country	: Germany
Telephone	: +49 (0) 531 390 23 0
Fax	: +49 (0) 531 390 23 599
Email	: ralph.mende@smartmicro.de
Date of order	: 2019-04-16
References	: Dr. Ralph Mende

5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer	: s.m.s, smart microwave sensors GmbH
Trademark	: smartmicro
Type designation	: **UMRR-12 Type 48**
Serial number	: 0x0002FBB0
Hardware versions	: UMRR-12 Type 48
Variants	: ---
Software release	: 6
Type of equipment	: Field Disturbance Sensor
Power used	: 7 - 32 V DC (Nominal 24 VDC)
Frequency used	: 24.050 GHz – 24.250 GHz
Generated or used frequencies	: 50 MHz (crystal), 100 MHz (Ramp Generator)
	24.075 GHz – 24.175 GHz (carrier, WF0) //24.050 GHz – 24.250 GHz (carrier, WF1)
ITU emission class	: 89M3N0N (WF0) // 181M3N0N (WF1)
FCC ID	: W34UMRR1230X

For issuing this report the following product documentation was used:

Title	Description	Version
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For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est (EUT)	2019-12-03	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est (EUT)	2019-12-03	Annex no. 2
Channel occupancy / bandwidth	2019-12-03	Annex no. 3
Label sample	2019-12-03	Annex no. 4
Functional description / User manual	2019-12-03	Annex no. 5
Test setup photos	2019-12-03	Annex no. 6
Block diagram	2019-12-03	Annex no. 7
Operational description	2019-12-03	Annex no. 8
Schematics	2019-12-03	Annex no. 9
Parts list	2019-12-03	Annex no. 10
Test results	2019-12-03	Annex no. 11

6. Conclusions, observations and comments

The test report will be filed at TÜV NORD Hochfrequenztechnik GmbH & Co. KG for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of TÜV NORD Hochfrequenztechnik GmbH & Co. KG.

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. TÜV NORD Hochfrequenztechnik GmbH & Co. KG cannot be held liable for properties of the EUT that have not been observed during these tests.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15 for the respective test sector, if the test results turn out positive.

Comments: This test report 20012124 replaces the test report number 19011906!
The test report number 19011906 loses its validity!

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7. Operational description

7.1 EUT details

The EUT is a general purpose universal medium range radar.

7.2 EUT configuration

The EUT starts to run when connected to the power supply.

7.3 EUT measurement description

Radiated measurements

The device uses different FMCW transmit signal waveforms (WF) for distance and speed measurement, therefore the two waveforms closest to the band boundaries were considered for the measurements. The EUT was tested in a typical fashion. During preliminary emission tests the EUT was operated in the continuous measuring mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous measuring mode. All tests were performed with the EUT's typical voltage: 24 V DC.

In order to establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test samples, secondly the test ample have been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical had been varied.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas, which may have a smaller beam width (main lobe) than do the antennas used for frequencies below 1 GHz. The measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal.

AC Powerline Conducted measurements (LAN and RS485 Ports)

The EUT was directly connected to the artificial mains network. It has been tested with the activated EUT in continuous measuring mode.

The EUT is connected via the LAN and RS485 to a laptop with the laptop directly connected to the artificial mains network. It has been tested in three runs: first with Laptop (inactive EUT), second with activated EUT via RS485 port of the laptop and third with activated EUT via LAN port of the laptop.

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8. Compliance assessment

8.1 Antenna requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

8.1.2 Result

Antenna Type	Antenna description	Frequency	Gain	Number of Antennas
Integrated TX antenna	Patch array antenna	24.050 GHz - 24.250 GHz	11.1 dBi	2
Integrated RX antenna	Patch array antenna	24.050 GHz - 24.250 GHz	13.7 dBi	8

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 2

8.2 Restricted bands of operation

8.2.1 Regulation

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Restricted bands of operation			
Frequency Band	**Frequency Band**	**Frequency Band**	**Frequency Band**
MHz	**MHz**	**MHz**	**GHz**
0.090 - 0.110	**16.42 - 16.423**	**399.9 - 410**	**4.5 - 5.15**
[1]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**	**([2])**
13.36 - 13.41	**---**	**---**	**---**
[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz. **[2] Above 38.6**			

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR Quasi-Peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this Section:

> (1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a), the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a), and the fundamental emission is outside of the bands listed in paragraph (a) more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

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(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to Section 15.213.

(4) Any equipment operated under the provisions of § 15.253, § 15.255 or § 15.256 in the frequency band 75-85 GHz, or § 15.257 of this part

(5) Biomedical telemetry devices operating under the provisions of Section 15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of Subpart D or F of this part.

(7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

(8) Devices operated in the 24.075-24.175 GHz band under § 15.249 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in § 15.249(b).

(9) Devices operated in the 24.0-24.25 GHz band under § 15.249 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in § 15.249(b).

(10) White space devices operating under subpart H of this part are exempt from complying with the requirements of this section for the 608-614 MHz band.

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 15.249 shall not exceed the limits specified in Section 15.249(b).

8.2.2 Result

Test Cables used	K60, K68, K101, K119, K148, K163, K164
Test equipment used	23, 166a, 171a, 223a, 442, 313, 359a, 406, 443, 444, 445a, 501, 502, 515, 518, 545, 547, 549, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6, 11

****All emissions fall under restricted band are included in the clause 8.4 and are marked blue!**

8.3 Conducted limits

8.3.1 Regulation

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH /50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Conducted Limits		
Frequency of Emission	**Quasi-Peak (QP)**	**Average (AV)**
MHz	**dBµV**	**dBµV**
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 -30	60	50
*Decreases with the logarithm of the frequency		

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

1) For carrier current system containing their fundamental emission within the frequency band 535–1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 µV within the frequency band 535–1705 kHz, as measured using a 50 µH /50 Ω LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

8.3.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.10-2013 Section 6.
Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

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8.3.3 Result

Conducted emissions - Tested with external AC power supply *Tested with Laptop Compaq NX6325 (S/N: CN464907PP) with power supply (S/N: HP677774-003) with inactive EUT*								
Tested Line	**Frequency**	**Bandwidth**	**QP Value**	**QP Limit**	**Margin**	**AV Value**	**AV Limit**	**Margin**
L1/**N**	**MHz**	**kHz**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
N	0.1884	9	51.0	64.0	13.0	**	---	---
N	0.2621	9	47.0	61.0	14.0	**	---	---
N	0.3204	9	40.0	59.0	19.0	**	---	---
N	0.5084	9	37.0	56.0	19.0	**	---	---
L1	0.1884	9	51.0	64.0	13.0	**	---	---
L1	0.2621	9	46.0	61.0	15.0	**	---	---
L1	0.3204	9	40.0	59.0	19.0	**	---	---
L1	0.5084	9	38.0	56.0	18.0	**	---	---
Measurement uncertainty < ± 2 dB								
****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary. The results are valid for both waveforms.**								

Conducted emissions - Tested with external AC power supply *Tested with Laptop Compaq NX6325 (S/N: CN464907PP) with power supply (S/N: HP677774-003) with active EUT via LAN port*								
Tested Line	**Frequency**	**Bandwidth**	**QP Value**	**QP Limit**	**Margin**	**AV Value**	**AV Limit**	**Margin**
L1/**N**	**MHz**	**kHz**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
N	0.1884	9	52.0	64.0	12.0	**	---	---
N	0.2621	9	45.0	61.0	16.0	**	---	---
N	0.3204	9	37.0	59.0	22.0	**	---	---
N	0.5084	9	37.0	56.0	19.0	**	---	---
L1	0.1884	9	52.0	64.0	12.0	**	---	---
L1	0.2621	9	45.0	61.0	16.0	**	---	---
L1	0.3204	9	38.0	59.0	21.0	**	---	---
L1	0.5084	9	37.0	56.0	19.0	**	---	---
Measurement uncertainty < ± 2 dB								
****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary. The results are valid for both waveforms.**								

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Conducted emissions - Tested with external AC power supply *Tested with Laptop Compaq NX6325 (S/N: CN464907PP) with power supply (S/N: HP677774-003) with active EUT via RS485 port*								
Tested Line	**Frequency**	**Bandwidth**	**QP Value**	**QP Limit**	**Margin**	**AV Value**	**AV Limit**	**Margin**
L1/N	**MHz**	**kHz**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
N	0.1884	9	52.0	64.0	12.0	**	---	---
N	0.2621	9	45.0	61.0	16.0	**	---	---
N	0.3204	9	38.0	59.0	21.0	**	---	---
N	0.5084	9	38.0	56.0	18.0	**	---	---
L1	0.1884	9	52.0	64.0	12.0	**	---	---
L1	0.2621	9	44.0	61.0	17.0	**	---	---
L1	0.3204	9	38.0	59.0	21.0	**	---	---
L1	0.5084	9	38.0	56.0	18.0	**	---	---
Measurement uncertainty < ± 2 dB								
****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary. The results are valid for both waveforms.**								

Test Cables used	K79
Test equipment used	22a, 60, 272, 551

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

8.4 Radiated emission limits, general requirements

8.4.1 Regulation

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Intentional radiator- radiated emission limits		
Frequency	**Field Strength**	**Measurement distance**
MHz	**µV / m**	**m**
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
above 960	500	3
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76– 88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.		

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

(f) In accordance with Section 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. lf measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in Section 15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in Section 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in Section 15.109 that are applicable to the incorporated digital device.

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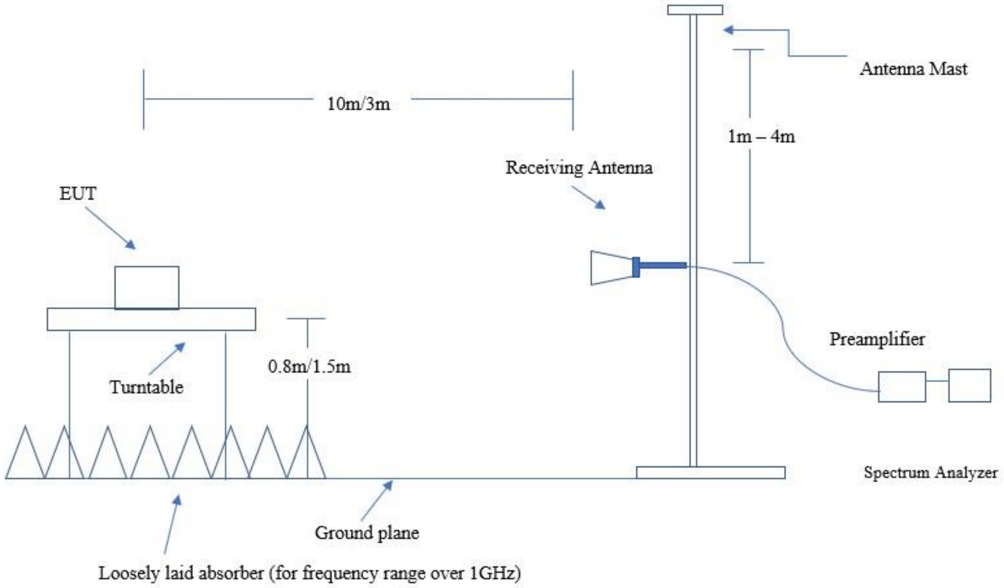
8.4.2 Test setup photo



8.4.3 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m turn table. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table would be allowed to rotate 360° to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna is 3m above 30 MHz and is 10m within frequency range 9kHz to 30 MHz. To find the maximum emission, the polarization of the receiving antenna is changed in horizontal and vertical polarization; the position of the EUT was changed in different orthogonal determinations.

Measurement procedures for electric field radiated emissions from frequency range within 9 kHz to 1 GHz & above 1 GHz are consisting of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. The measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

Bore-sighting technique is used for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTs, measuring system sensitivity, etc.

The measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane

Radiated emissions test characteristics	
Frequency range	9 kHz – 231 GHz
Test distance	10 m (below 30 MHz) 3 m* (above 30 MHz)
Test instrumentation minimum resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Detector Type	Quasi peak and Average based on frequency range
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

8.4.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors
Correction Factor : Antenna factor + cable loss

For example:
The receiver reading is 32.7 dBµV. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dBµV/m. The 35.91dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm (35.91/20) = 62.44

At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade

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(inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

For example: Distance limit (d_{limit}) = 3, Distance measured ($d_{measured}$) = 1
Distance Extrapolation Factor (DEF) = 20 * log ($d_{limit}/d_{measured}$) = 20 * log (3/1) = 9.5

At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

For example: Distance limit (d_{limit}) = 300, Distance measured ($d_{measured}$) = 10
Distance Extrapolation Factor (DEF) = 40 * log ($d_{limit}/d_{measured}$) = 40 * log (300/10) = 59.1

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8.4.5 Result

Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209) - WF0

f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dBµV	m	dB	dB	dBµV/m	dBµV/m @ meter	dBµV/m	height/m	
0.250	QPK/9.0kHz	< 4.0	10	20.2	-59.1	-34.9	19.6 @ 300	54.5	V, H/0-360°	1-4
0.375	QPK/9.0kHz	< 4.0	10	20.2	-59.1	-34.9	16.1 @ 300	51.0	V, H/0-360°	1-4
0.500	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	33.6 @ 30	28.5	V, H/0-360°	1-4
0.625	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	31.7 @ 30	26.6	V, H/0-360°	1-4
0.750	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	30.1 @ 30	25.0	V, H/0-360°	1-4
0.875	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	28.6 @ 30	23.5	V, H/0-360°	1-4
1.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	27.6 @ 30	22.5	V, H/0-360°	1-4
1.250	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	25.6 @ 30	28.5	V, H/0-360°	1-4
1.500	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	24.1 @ 30	19.0	V, H/0-360°	1-4
3.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
5.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
30.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
Measurement uncertainty					± 4 dB					

Blue marked: restricted bands

Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209) - WF1

f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dBµV	m	dB	dB	dBµV/m	dBµV/m @ meter	dBµV/m	height/m	
0.250	QPK/9.0kHz	< 4.0	10	20.2	-59.1	-34.9	19.6 @ 300	54.5	V, H/0-360°	1-4
0.375	QPK/9.0kHz	< 4.0	10	20.2	-59.1	-34.9	16.1 @ 300	51.0	V, H/0-360°	1-4
0.500	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	33.6 @ 30	28.5	V, H/0-360°	1-4
0.625	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	31.7 @ 30	26.6	V, H/0-360°	1-4
0.750	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	30.1 @ 30	25.0	V, H/0-360°	1-4
0.875	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	28.6 @ 30	23.5	V, H/0-360°	1-4
1.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	27.6 @ 30	22.5	V, H/0-360°	1-4
1.250	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	25.6 @ 30	28.5	V, H/0-360°	1-4
1.500	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	24.1 @ 30	19.0	V, H/0-360°	1-4
3.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
5.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
30.000	QPK/9.0kHz	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30	24.4	V, H/0-360°	1-4
Measurement uncertainty					± 4 dB					

Blue marked: restricted bands

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Test Cables used	K60, K101, K119
Test equipment used	23, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

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Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209) - WF0													
f	**Detct**	**BW**	**Rx Level**	**MD**	**CF**	**DEF**	**AVC**	**LC**	**Limit**	**Margin**	**EP**	**Antenna**	
												Pol	**H**
MHz	**Type**	**kHz**	**dBµV**	**m**	**dB**	**dB**	**dB**	**dBµV/m**	**dBµV/m**	**dB**	**°**	**H / V**	**m**
37.4	**QPK**	**120**	**39.7**	**3**	**-7.6*5**	**0**	**0**	**32.1**	**40.0**	**7.9**	**35°**	**V**	**1.72**
61.9	**PK**	**100**	**41.5**	**3**	**-7.5*5**	**0**	**0**	**34.0**	**40.0**	**6.0**	**302°**	**V**	**1.23**
88.0	PK	100	≤ 3.5**	3	-10.8*5	0	0	-7.3	40.0	47.3	0-360°	H / V	1-4
104.5	**PK**	**100**	**38.0**	**3**	**-8.0*5**	**0**	**0**	**30.0**	**43.5**	**13.5**	**47°**	**H**	**2.43**
139.4	**PK**	**100**	**30.9**	**3**	**-8.0*5**	**0**	**0**	**22.9**	**43.5**	**20.6**	**300°**	**V**	**1.30**
216.0	PK	100	≤ 3.5**	3	-10.3*5	0	0	-6.8	43.5	50.3	0-360°	H / V	1-4
960.0	PK	100	≤ 3.5**	3	8.5*5	0	0	12.0	43.5	31.5	0-360°	H / V	1-4
1700.0	PK	1000	≤ 4.5**	3	3.8*6	0	0	8.3	54.0	45.7	0-360°	H / V	1-4
1805.5	PK	1000	≤ 10**	3	9.5*6	0	0	19.5	54.0	34.5	0-360°	H / V	1-4
2250.0	PK	1000	≤ 10**	3	8.0*6	0	0	18.0	54.0	36.0	0-360°	H / V	1-4
4000.0	PK	1000	≤ 10**	3	8.4*6	0	0	18.4	54.0	35.6	0-360°	H / V	1-4
5000.0	PK	1000	≤ 10**	3	9.1*6	0	0	19.4	54.0	34.6	0-360°	H / V	1-4
7500.0	PK	1000	≤ 14**	3	12.9*6	0	0	26.9	54.0	27.1	0-360°	H / V	1-4
8300.0	PK	1000	≤ 14**	3	14.8*6	0	0	28.8	54.0	25.2	0-360°	H / V	1-4
Measurement uncertainty: ± 4 dB													
**** All other emissions are lower than the noise level of the measuring equipment!**													

f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | MD: Measurement distance | CF : Correction factor | DEF :Distance extrapolation factor | AVC : Averaging Correction factor | LC : Level corrected | EP: EUT Position | Pol:Antenna polarization | H: Antenna height |

Blue marked: restricted bands
Remark: *1 noise floor noise level of the measuring instrument ≤ 3.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *2 noise floor noise level of the measuring instrument ≤ 4.5dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *3 noise floor noise level of the measuring instrument ≤ 10dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *4 noise floor noise level of the measuring instrument ≤ 14dBµV @ 3m distance (5,500 – 14,500 MHz)
Remark: *5 for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *6 for using a pre-amplifier in the range between 1.0 GHz and 18.0 GHz

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Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209) - WF1													
f	Detct	BW	Rx Level	MD	CF	DEF	AVC	LC	Limit	Margin	EP	Antenna Pol	Antenna H
MHz	Type	kHz	dBµV	m	dB	dB	dB	dBµV/m	dBµV/m	dB	°	H / V	m
37.4	**QPK**	**120**	**39.7**	**3**	**-7.6*[5]**	**0**	**0**	**32.1**	**40.0**	**7.9**	**35°**	**V**	**1.72**
61.9	**PK**	**100**	**41.5**	**3**	**-7.5*[5]**	**0**	**0**	**34.0**	**40.0**	**6.0**	**302°**	**V**	**1.23**
88.0	PK	100	≤ 3.5**	3	-10.8*[5]	0	0	-7.3	40.0	47.3	0-360°	H / V	1-4
104.5	**PK**	**100**	**38.0**	**3**	**-8.0*[5]**	**0**	**0**	**30.0**	**43.5**	**13.5**	**47°**	**H**	**2.43**
139.4	**PK**	**100**	**30.9**	**3**	**-8.0*[5]**	**0**	**0**	**22.9**	**43.5**	**20.6**	**308°**	**V**	**1.27**
216.0	PK	100	≤ 3.5**	3	-10.3*[5]	0	0	-6.8	43.5	50.3	0-360°	H / V	1-4
960.0	PK	100	≤ 3.5**	3	8.5*[5]	0	0	12.0	43.5	31.5	0-360°	H / V	1-4
1700.0	PK	1000	≤ 4.5**	3	3.8*[6]	0	0	8.3	54.0	45.7	0-360°	H / V	1-4
1805.5	PK	1000	≤ 10**	3	9.5*[6]	0	0	19.5	54.0	34.5	0-360°	H / V	1-4
2250.0	PK	1000	≤ 10**	3	8.0*[6]	0	0	18.0	54.0	36.0	0-360°	H / V	1-4
4000.0	PK	1000	≤ 10**	3	8.4*[6]	0	0	18.4	54.0	35.6	0-360°	H / V	1-4
5000.0	PK	1000	≤ 10**	3	9.1*[6]	0	0	19.4	54.0	34.6	0-360°	H / V	1-4
7500.0	PK	1000	≤ 14**	3	12.9*[6]	0	0	26.9	54.0	27.1	0-360°	H / V	1-4
8300.0	PK	1000	≤ 14**	3	14.8*[6]	0	0	28.8	54.0	25.2	0-360°	H / V	1-4
Measurement uncertainty: ± 4 dB													

**** All other emissions are lower than the noise level of the measuring equipment!**

f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | MD: Measurement distance | CF : Correction factor | DEF :Distance extrapolation factor | AVC : Averaging Correction factor | LC : Level corrected | EP: EUT Position | Pol:Antenna polarization | H: Antenna height |

Blue marked: restricted bands

Remark: *[1] noise floor noise level of the measuring instrument ≤ 3.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 4.5dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 14dBµV @ 3m distance (5,500 – 14,500 MHz)
Remark: *[5] for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *[6] for using a pre-amplifier in the range between 1.0 GHz and 18.0 GHz

Test Cables used	K60, K68, K101, K119, K148, K163, K164
Test equipment used	23, 166a, 171a, 223a, 442, 313, 359a, 406, 443, 444, 445a, 501, 502, 515, 518, 545, 547, 549, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

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8.5 Field strength limits of Fundamental frequencies and harmonic

8.5.1 Regulation

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Intentional radiator- Fundamental frequencies / Field strength limits		
Frequency	**Field strength of fundamental**	**Field strength of harmonics**
MHz	**mV / m**	**µV / m**
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500
24.0-24.25	250	2500

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(2) The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 °C. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5°. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5°, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

(e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

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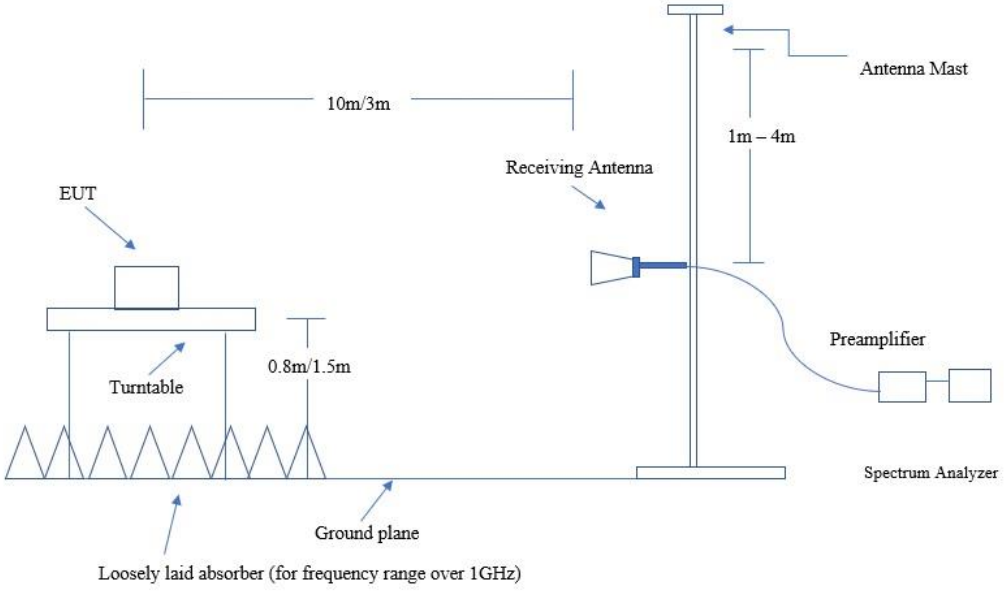
8.5.2 Test setup photo



8.5.3 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a non-conducting platform with nominal top surface dimensions 1 m by 1.5 m turn table. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table would be allowed to rotate 360° to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna is 3m above 30 MHz and is 10m within frequency range 9 kHz to 30 MHz. To find the maximum emission, the polarization of the receiving antenna is changed in horizontal and vertical polarization; the position of the EUT was changed in different orthogonal determinations.

Measurement procedures for electric field radiated emissions from frequency range within 9 kHz to 1 GHz & above 1 GHz are consisting of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. The measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

Bore-sighting technique is used for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTs, measuring system sensitivity, etc.

The measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to

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make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane

Radiated emissions test characteristics	
Frequency range	9 kHz – 231 GHz
Test distance	10 m (below 30 MHz) 3 m* (above 30 MHz)
Test instrumentation minimum resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Detector Type	Quasi peak and Average based on frequency range
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

8.5.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors
Correction Factor : Antenna factor + cable loss

For example:
The receiver reading is 32.7 dBµV. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dBµV/m. The 35.91dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm (35.91/20) = 62.44

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to

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be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

For example: Distance limit (d_{limit}) = 3, Distance measured ($d_{measured}$) = 1
Distance Extrapolation Factor (DEF) = 20 * log ($d_{limit}/d_{measured}$) = 20 * log (3/1) = 9.5

If the test distance is taken less than the recommended one, then the minimum distance of the receiving antenna should be calculated according to the $2D^2/\lambda$, where D is the antenna length.

At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

For example: Distance limit (d_{limit}) = 300, Distance measured ($d_{measured}$) = 10
Distance Extrapolation Factor (DEF) = 40 * log ($d_{limit}/d_{measured}$) = 40 * log (300/10) = 59.1

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8.5.5 Result

Field strength of fundamental and harmonic (Section 15.249) - WF0

Peak Measurement

Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
24.05546	1000 / PK	91.7	3	18.2	0	109.9	128.0	18.1	5°, V	145
24.10042	1000 / PK	91.5	3	18.3	0	109.8	128.0	18.2	5°, V	145
24.14138	1000 / PK	91.6	3	18.3	0	109.1	128.0	18.9	5°, V	145
****All emissions are lower than the noise level of the measuring equipment!**										
Measurement uncertainty: 4 dB										

Bandwidth = the measuring receiver bandwidth

Field strength of fundamental and harmonic (Section 15.249) - WF1

Peak Measurement

Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
24.06339	1000 / PK	91.7	3	18.2	0	109.9	128.0	18.1	5°, V	145
24.15000	1000 / PK	90.5	3	18.3	0	108.8	128.0	19.2	5°, V	145
24.23841	1000 / PK	91.0	3	18.4	0	109.4	128.0	18.6	5°, V	145
****All emissions are lower than the noise level of the measuring equipment!**										
Measurement uncertainty: 4 dB										

Bandwidth = the measuring receiver bandwidth

Test Cables used	K148, K167
Test equipment used	442, 443, 502, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

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Field strength of fundamental and harmonic (Section 15.249) - WF0

Average Measurement

Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
24.05634	1000 / AV	69.1	3	18.2	0	87.3	108.0	20.7	5°, V	145
24.10042	1000 / AV	60.4	3	18.3	0	78.7	108.0	29.3	5°, V	145
24.14218	1000 / AV	62.4	3	18.3	0	80.7	108.0	27.3	5°, V	145
****All emissions are lower than the noise level of the measuring equipment!**										
Measurement uncertainty: 4 dB										

Bandwidth = the measuring receiver bandwidth

Field strength of fundamental and harmonic (Section 15.249) - WF1

Average Measurement

Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
24.06339	1000 / AV	70.6	3	18.2	0	88.8	108.0	19.2	5°, V	145
24.14868	1000 / AV	61.7	3	18.3	0	80.0	108.0	28.0	5°, V	145
24.23841	1000 / AV	59.4	3	18.4	0	77.8	108.0	30.2	5°, V	145
****All emissions are lower than the noise level of the measuring equipment!**										
Measurement uncertainty: 4 dB										

Bandwidth = the measuring receiver bandwidth

Test Cables used	K148, K167
Test equipment used	442, 443, 502, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6; 11

Field strength of harmonic (Section 15.249) - WF0										
Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
48.162880	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
48.247992	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
48.333900	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.244320	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.371988	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.500850	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.325760	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.495984	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.667800	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.407200	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.619980	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.834750	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
The blue marked frequencies fall into the restricted bands										
**All emissions are lower than the noise level of the measuring equipment!										
Measurement uncertainty: 4 dB										

Field strength of harmonic (Section 15.249) - WF1										
Frequency GHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dB	Polaris. EUT / antenna H xx° / H	Antenna height cm
48.162880	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
48.247992	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
48.333900	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.244320	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.371988	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
72.500850	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.325760	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.495984	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
96.667800	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.407200	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.619980	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
120.834750	1000 / AV	---	1	---**	-9.5	≤ 43.0	68.0	≥ 25.0	0-360°, H/V	100-400
The blue marked frequencies fall into the restricted bands										
**All emissions are lower than the noise level of the measuring equipment!										
Measurement uncertainty: 4 dB										

Bandwidth = the measuring receiver bandwidth
Remark: *[1] noise floor noise level of the measuring instrument ≤ 3.5dBµV @ 3m distance (30 – 1,000 MHz)

Test Cables used	K163, K164
Test equipment used	501, 502, 515, 518, 545, 547, 549, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

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8.6 Bandwidth (20 dB)

8.6.1 Regulation

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

8.6.2 Test procedure

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are -6 dB, -20 dB, and -26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by “-xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “-xx dB” bandwidth; other requirements might specify that the “−xx dB” bandwidth be entirely contained within the authorized or designated frequency band.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “−xx dB down” requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

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h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "- xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "-xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

8.6.4 Result

Intentional radiator- Maximum Measured 20 dB Bandwidth			
Operating Frequency		Maximum Measured 20 dB Bandwidth	20 dB Bandwidth limit
GHz		MHz	MHz
WF0:	24.050 GHz - 24.250 GHz	89.31	< 200
WF1:	24.050 GHz - 24.250 GHz	181.26	< 200

Test Cables used	K148, K167
Test equipment used	442, 443, 502, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 3, 6

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8.7 Band edge measurement

8.7.1 Regulation

In the emission mentioned in clause 8.2 and 8.4, the tighter limit applies at the band edges.

8.7.2 Test procedure

In making radiated band-edge measurements, there can be a problem obtaining meaningful data because a measurement instrument that is tuned to a band-edge frequency might also capture some in-band signals when using the specified RBW. In an effort to compensate for this problem, the following technique (marker-delta method) has been developed for determining band-edge compliance.

a) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured. For example, for a device operating in the 902 MHz to 928 MHz band, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW alternatively may be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 3 MHz VBW, and a peak detector, as required. Repeat the measurement with an average detector (or alternatively, a peak detector and reduced VBW).

b) Choose an EMI receiver or spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the instrument RBW to 1% of the total span (but never less than 30 kHz), with a VBW equal to or greater than three times the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not an absolute field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.

c) Subtract the delta measured in step b) from the field strengths measured in step a). The resulting field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge emissions compliance, where required.

d) This method may be used only when the edge of the occupied bandwidth of the emission falls within two “standard bandwidths” of the restricted-band band-edge frequency, where “standard bandwidth” is the RBW required by the measurement procedure (generally, the “standard bandwidth,” i.e., reference bandwidth, is 10 kHz for measurements below 30 MHz, 100 kHz for measurements between 30 MHz and 1000 MHz, and 1 MHz for measurements above 1 GHz). For this purpose, the occupied bandwidth is based on the 99% power bandwidth. Therefore, you may use the delta technique for measuring emissions up to 2 MHz removed from the band edge. Radiated emissions that are removed by more than two standard bandwidths must be measured in the conventional manner.

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8.7.3 Result

On each operating frequency measured, band-edge emissions are reported by plots of the measuring instrument display as shown in the following annex.

Test Cables used	K148, K167
Test equipment used	442, 443, 502, 660

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 3

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9. Additional information to the test report

Remarks	Description
N.t.[1]	Not tested, because the antenna is part of the PCB
N.t.[2]	Not tested, because the EUT is directly battery powered
N.t.[3]	Not tested, because not applicable to the EUT
N.t.[4]	Not tested, because not ordered

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10. List of test equipment

State Dec. 06, 2019					
Marking	**Manufacturer**	**SW/Type/Serial-No.**	**Last Cal./Val.**	**Next Cal./Val.**	**No.**
1 Measuring Instruments					
EMI test receiver	Schwarzbeck	FMLK1518	*Nov 17*	*Nov 20*	*22a*
Attenuator	Radiall	---	*Nov 19*	*Nov 22*	*62*
Attenuator 3dB	Suhner	6803/17	*Nov 19*	*Nov 22*	*137*
Attenuator 3dB / 18 GHz	Suhner	3dB/18GHz	*Nov 19*	*Nov 22*	*299*
Terminator	Texcan	---	*Nov 19*	*Nov 22*	*304*
Attenuator 6dB / 18 GHz	Suhner	6dB/18GHz	*Nov 19*	*Nov 22*	*344*
Attenuator 20dB / 20GHz	Parzich	40AH-20	*Nov 19*	*Nov 22*	*354*
Terminator	KDI	T173CS	*Nov 19*	*Nov 22*	*490*
Power sensor	Rohde & Schwarz	NRV-Z2	*Feb 17*	*Feb 20*	*76a*
Variable transformer	RFT	LS 002	---	---	*154a*
Variable transformer	Schunt+Ben	---	---	---	*155*
Power sensor	Marconi	6914	*Aug 18*	*Aug 20*	*258*
Power sensor	Marconi	6913	*Aug 19*	*Aug 21*	*286*
Power sensor	Rohde & Schwarz	NRV-Z31	*Feb 17*	*Feb 20*	*391*
Power sensor	Rohde & Schwarz	NRP18SN	*Nov 19*	*Nov 21*	*651*
Coaxial Directional Coupler	Narda	3003-20	*Jan 18*	*Jan 21*	*370/342*
Coaxial directional coupler	Mini Circuits	ZFDC-20-5	*Mar 17*	*Mar 20*	*434*
Coaxial directional coupler	Narda+Suhner	---	*Mar 17*	*Mar 20*	*472/492*
Coaxial High Pass Filter	Mini circuits	NHP-700	*Mai 18*	*Mai 21*	*435*
Coaxial High Pass Filter	Mini circuits	NHP-200	*Mai 18*	*Mai 21*	*405*
Coaxial High Pass Filter	Mini circuits	NHP-25+	*Mai 18*	*Mai 21*	*455*
High Pass Filter	Mini circuits	VHF-3500+	*Mai 18*	*Mai 21*	*451*
High Pass Filter	Mini circuits	VHF-1200+	*Mai 18*	*Mai 21*	*452*
Bandpass Filter	Schomandl	BN86871	*Nov 18*	*Nov 21*	*66*
Bandpass Filter	Schomandl	BN68673	*Nov 18*	*Nov 21*	*67*
Low Pass Filter	Mini circuits	SLP550	*Mai 18*	*Mai 21*	*273*
Low Pass Filter	Mini circuits	SLP550	*Mai 18*	*Mai 21*	*274*
RF Current Probe 9 kHz – 30 MHz	Rohde & Schwarz	ESH2-Z1	*Jun 18*	*Jun 21*	*42*
VHF- Current Probe 9 kHz – 600 MHz	Rohde & Schwarz	ESV-Z1	*Jun 18*	*Jun 21*	*43*
Passive Test Probe – 9 kHz – 30 MHz	TÜV NORD	VDE 0876	*Mai 18*	*Mai 21*	*45*
Coaxial Fixed Attenuator DC – 1 GHz	Texscan	HFP50/10	*Jul 17*	*Jul 20*	*60*
8 Wire Impedance Stabilisation Network	Schwarzbeck	CAT5 8158	*Nov 19*	*Nov 21*	*71a*
T-Section - 50 W	Rohde & Schwarz	BN 42441/50	*Aug 18*	*Aug 21*	*93*
RF Current Injection Clamp 0.15 – 1GHz	Lüthi GmbH	EM 101	*Nov 19*	*Nov 22*	*156*
Absorbing Clamp MDS 30MHz – 1GHz	Lüthi GmbH	MDS-21	*Nov 19*	*Nov 22*	*160*
Insertion Unit	Rohde & Schwarz	URV5-Z4	*Mai 19*	*Mai 22*	*162*
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 35	*Nov 18*	*Nov 21*	*164*
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 60	*Nov 18*	*Nov 21*	*165*
Fixed Attenuator - DC – 1.5GHz	Bird	Mod/ 8343-060	*Feb 17*	*Feb 20*	*177*
Rotary Step Attenuator DC – 2 GHz	Texscan	TA – 50	*Mar 17*	*Mar 20*	*184*
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	*Nov 19*	*Nov 21*	*264*
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	*Mai 19*	*Mai 22*	*272*
Fixed Attenuator - DC – 18 GHz | 30 dB	MTS	---	*Nov 17*	*Nov 20*	*275*
Fixed Attenuator - DC – 18 GHz | 30 dB	MTS	---	*Mar 17*	*Mar 20*	*276*
Passive Probe - 9 kHz – 30 MHz | 2.5 kΩ	RFT	TK 121	*Jun 17*	*Jun 20*	*302*
Termination Resistor 50 W	Radiall	404011	*Nov 18*	*Nov 21*	*309*
Branching device (4x) 50W	Rohde & Schwarz	892228/20	*Sep 19*	*Sep 22*	*320*
Dummy-Load - 2 – 18 GHz	Narda	MODEL 367NF	*Nov 19*	*Nov 22*	*343*
DC Block Adapter - 0.045 – 26.5 GHz	Hewlett-Packard	11742A	*Apr 18*	*Apr 21*	*356*
Insertion Unit 10V | 9 kHz 1000 MHz	Rohde & Schwarz	URV 5-Z2	*Mai 19*	*Mai 22*	*367*

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RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	395.2680.02	*Mai 19*	*Mai 22*	*368*
150W attenuator	Weinschel	49-20-33	*Oct 19*	*Oct 22*	*374*
Fixed Coaxial Attenuator - DC – 18 GHz	Weinschel	23-6-34	*Feb 17*	*Feb 20*	*375*
Insertion Unit 9 kHz – 2000 MHz	Rohde & Schwarz	URY-Z2	*Oct 19*	*Oct 22*	*416*
Panoramic Adapter (Monitoring)	Schwarzbeck	PAN1550	---	---	*429*
DC-BLOCK - DC – 6.0 GHz |50 W	Mini Circuits	BLK-6-N+	*Aug 18*	*Aug 21*	*462*
Terminating resistor 50Ω SMA	---	---	*Nov 19*	*Nov 22*	*493*
Terminating resistor 50Ω SMA	---	SC 60-601-0000-31	*Nov 19*	*Nov 22*	*497*
Fixed Attenuator –0 – 40 GHz	Anritsu	41KC-10	*Nov 19*	*Nov 22*	*504*
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	*Nov 19*	*Nov 22*	*505*
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-6	*Nov 19*	*Nov 22*	*506*
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-3	*Nov 19*	*Nov 22*	*507*
Electric Dummy Load	RA-NAV Lab.	DA-75U	*Feb 17*	*Feb 20*	*526*
Power Splitter / Combiner	Mini Circuits	ZESC-2-11	*Nov 19*	*Nov 22*	*527*
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	*Mar 17*	*Mar 20*	*529*
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	*Mar 17*	*Mar 20*	*530*
RF-Attenuator - 6 dB	Haefely	---	*Mar 17*	*Mar 20*	*540*
RF-Attenuator - 1– 120 MHz | 12 dB	Haefely	---	*Mar 17*	*Mar 20*	*541*
RF-Attenuator - 1– 120 MHz | 39 dB	Haefely	---	*Mar 17*	*Mar 20*	*542*
LISN 9kHz – 30 MHz	Schwarzbeck	NNLA 8120	*Jul 17*	*Jul 20*	*551*
HV Probe P6013A	Tektronix	P6013A	*Mai 19*	*Mai 22*	*559*
VLISN 5µH	Schwarzbeck	8125-1944	*Nov 19*	*Nov 21*	*585*
VLISN 5µH	Schwarzbeck	8125-1945	*Nov 19*	*Nov 21*	*586*
20dB Attenuator, up to 18 GHz	Mini Circuit	BW-N20W5+	*Nov 19*	*Nov 22*	*594*
Step Attenuator - DC-18 GHz | 0 to 11 dB	Hewlett-Packard	8494B	*Nov 19*	*Nov 22*	*604*
Analyser Reference System	Spitzenberger & Spies	ARS 16/1	*Jan 17*	*Jan 20*	*606a/b/c*
Capacitive Coupling Clamp 5 kV	Schlöder	SFT 415	*Mai 17*	*Mai 20*	*608*
RF Probes for 50 Ω Receivers	Schwarzbeck	TK 9416	---	---	*612*
Current probe TRMS	BEHA APROB	CHB35	*Oct 19*	*Oct 22*	*652*
Semi Anechoic Chamber	COMTEST	SAC-3m	*Apr 19*	*Apr 20*	*660*
Maturo Turntable	Maturo	TT2.0SI (SN: TT2.05SI/817 SW: 1.0.0.4473)	---	---	*667*
Maturo Antenna Mast	Maturo	TAM4.5-E-10kg (SN: 10011/216/2588.01)	---	---	*668*
Maturo Controller	Maturo	FCU3.0/009/2588.01 (SN: 10014/2019)	---	---	*669*
2 Generators					
EFT/Burst Generator	Schlöder	SFT 1400	*Mai 17*	*Mai 20*	*46a*
Hybrid Generator	Schlöder	CWG1500	*Nov 16*	*Nov 19*	*522*
ESD Generator	Schlöder	SESD 200	*Jan 17*	*Jan 20*	*112a*
ESD Generator	Schlöder	SESD 216	*Oct 19*	*Oct 21*	*653*
Signal Generator	Rohde & Schwarz	SMB100A	*Jun 18*	*Jun 20*	*571*
RF Generator	Rohde & Schwarz	SGT100A	*Apr 18*	*Apr 20*	*636*
Signal Generator	Rohde & Schwarz	SMG	*Mai 19*	*Mai 21*	*136*
Signal Generator	Marconi	2042	*Mai 18*	*Mai 20*	*6*
Signal Generator	Marconi	2024	*Mai 18*	*Mai 20*	*213*
Puls Generator	EM Test	MPG 200	*Cal. before use*	*Cal. before use*	*181*
Surge Generator	H+H	MIG063 IN S-T	*Mar 18*	*Mar 20*	*561*
Voltage Interruption Simulator	Schlöder	VIS1700	*Mar 18*	*Mar 20*	*241a*
3. Antennas					
Loop Ant. 9kHz-30MHz	Schwarzbeck	FMZB1516	*Sep 19*	*Sep 21*	*23*
Biconical Ant. 30-300 MHz	Schwarzbeck	VHA9103/BBA9106	*Apr 17*	*Apr 20*	*80/616*
Double Ridged Horn	Schwarzbeck	BBHA9120C	*Oct 19*	*Oct 21*	*169*
Double Ridged Horn	Schwarzbeck	BBHA 9120A	*Mar 17*	*Mar 20*	*284*
Tri-Log Broadband	Schwarzbeck	VULB9168	*Mai 19*	*Mai 21*	*406*

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Broadband Horn 14-40 GHz	Schwarzbeck	BBHA9170	*Nov 19*	*Nov 21*	*442*
Log Per Antenna 0.7-20 GHz	Schwarzbeck	STLP9148	*Mai 19*	*Mai 21*	*445a*
Bilog Ant.	Schwarzbeck	CBL6111	*Cal. before use*	*Cal. before use*	*167*
Balun with biconical BBA9106 (TX)	Schwarzbeck [only for NSA]	VHBB9124	*Nov 19*	*Nov 21*	*0796*
Balun with biconical BBA9106 (RX)	Schwarzbeck [only for NSA]	VHBA9123	*Nov 19*	*Nov 21*	*9758*
Log periodic Ant (TX)	Schwarzbeck [only for NSA]	UHALP9108	*Nov 19*	*Nov 21*	*9002*
Log periodic Ant (RX)	Schwarzbeck [only for NSA]	UHALP9108	*Nov 19*	*Nov 21*	*9003*
Spectrum analyser Mixer 220 – 325 GHz	Radiometer Physics	SAM325	*Aug 19*	*Aug 21*	*591*
Dual Mode Potter Horn 220-325 GHz	Radiometer Physics	325-WR2	---	---	*592*
Dual Mode Potter Horn 75-110 GHz	Radiometer Physics	---	---	---	*649*
Harmonic Mixer 40-60 GHz	Rohde & Schwarz	FS-Z60	*Jul 19*	*Jul 21*	*515*
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20	---	---	*518*
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140	*Aug 19*	*Aug 21*	*545*
Dual Mode Potter Horn 90-140 GHz	Radiometer Physics	140-WR8	---	---	*547*
Spectrum analyser Mixer 140-220GHz	Radiometer Physics	SAM220	*Aug 19*	*Aug 21*	*546*
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	*548*
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90	*Jul 19*	*Jul 21*	*501*
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	*549*
Gain Horn 33-55 GHz	Dorado	---	---	---	*383*
Gain Horn 50-75 GHz	Dorado	---	---	---	*384*
Gain Horn 75-110 GHz	Dorado	---	---	---	*385*
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	*532/628*
4. Amplifier					
RF pre-amplifier 100kHz-1.3GHz	HP	8447E	*Aug 18*	*Aug 20*	*166a*
Mitteq amplifier 26.5-40 GHz	Mitteq	---	*Mar 17*	*Mar 20*	*223a*
RF pre-amplifier 1-18GHz	Narda	---	*Mar 18*	*Mar 20*	*345*
Mitteq Amplifier 18-26GHz	Mitteq	---	*Mai 17*	*Mai 20*	*433*
Microwave amplifier 12-18GHz	Schwarzbeck	BBV9719	*Mar 19*	*Mar 21*	*443*
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	*Mar 19*	*Mar 21*	*444*
5. Test/Control software					
Maturo mcApp	Maturo	SW: V3.4.9.4537 (19.04.04)	---	---	---
SPS EMC	Spitzenberger & Spies	SW: V4.1.3	---	---	---
EMV-Soft	Schlöder GmbH	SW: V11.95	---	---	---
ISMISO	EM Test AG	SW:V3.63	---	---	---
6. Power supplies					
Programmable Power Supply	Fluke	PM 2813	---	---	*28a*
Power Supply	HP	---	---	---	*125*
Power Supply	Sorensen	LM 30-6	---	---	*134a*
Power Supply	HP	6034L	---	---	*226*
Regulated Power Supply	Farnell	AP60-50	---	---	*408*
Power Supply	EA	PSI 8080-40-DT	---	---	*560*
Power Supply	HP	6032A	---	---	*644*
7. Meters					
Microwave Frequency Counter	Hewlett-Packard	5351A	*Nov 18*	*Nov 20*	*130*
Temperature test cabinet	Heraeus Vötsch	VMT04/35	---	---	*102a*
Temperature test cabinet	Brabender	TTE 32/40 H	---	---	*87*
Digital-Hygro-Thermometer	Greisinger	GFTH95	*Nov 19*	*Nov 21*	*57a*
Volt & RF Power Meter	Rohde & Schwarz	URV35	*Mai 19*	*Mai 21*	*161*
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	*Jul 18*	*Jul 20*	*171a*
Multimeter	Gossen Metrawatt	Metrahit pro	*Nov 16*	*Nov 19*	*215a*

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Radio communication Service Monitor 0.4 – 1000 MHz	Rohde & Schwarz	CMS 54	*Jun 17*	*Jun 20*	*229*
Humidity/Temperature Measuring device	TESTO	Testo 625	*Oct 19*	*Oct 21*	*259a*
Volt & RF Power Meter	Rohde & Schwarz	URV35	*Nov 19*	*Nov 21*	*271*
Multimeter	Gossen Metrawatt	Metrahit 26S	*Aug 17*	*Aug 20*	*313*
Spectrum Analyzer 9 kHz – 40 GHz	Anritsu	MS2668C	*Jan 17*	*Jan 20*	*359a*
Level and Power Meter - 9 kHz – 3 GHz	Rohde & Schwarz	URY	*Mai 19*	*Mai 21*	*307*
Temperature test device	Ahlhorn	Almemo 2390-5 PT100	*Feb 17*	*Feb 20*	*401*
Signal & Spectrum Analyser 10 Hz-30 GHz	Rohde & Schwarz	FSV-30	*Jul 19*	*Jul 21*	*502*
Digital-Vacuum-/Barometer	Greisinger	GDH12AN	*Oct 19*	*Oct 21*	*558*
Temperature test cabinet	Weiß Umwelttechnik	WKL 34/40	*Aug 18*	*Aug 21*	*562*
Digital Storage Oscilloscope	Tektronix	TDS 2012C	*Oct 19*	*Oct 21*	*568*
Miniature Flat, Zero-Biased Schottky Detector –0.1– 18 GHz	Narda	4503A-03	*Jun 17*	*Jun 20*	*613*
Diode Detector – 0.1 – 2.5 GHz	Spinner	BN 7545	*Sep 17*	*Sep 20*	*617*
Digital-Vacuum-/Barometer	Greisinger	GDH-200-14	*Oct 19*	*Oct 21*	*632*
EMI Test receiver ESW26	Rohde & Schwarz	R&S ESW26 (SN: 101383/26 SW: R&S ESW1.61))	*Nov 19*	*Nov 20*	*665*
Signal analyser Keysight 50GHz	Keysight	UXA N9040B (SN: MY57213006 SW: A.24.58/2019.0702)	*Nov 19*	*Nov 20*	*666*

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11. Cable list

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
4a	BNC	10 – 1500	0.50	Telemeter
14a	BNC	10 – 1000	1.00	Telemeter
17a	APC3.5	10 – 26500	2.13	Huber + Suhner
18a	APC3.5	10 – 26500	2.13	Huber + Suhner
22	BNC	10 – 1000	1.50	---
27	BNC	10 – 1000	1.00	Fabrica Milanese Cond.
40	BNC	---	0.50	Aircell
43	SMA	10 – 18000	0.50	Rosenberger
44	SMA	---	0.50	Huber + Suhner
45	SMA	10 – 18000	0.50	Huber + Suhner
48	SMA		0.50	Huber + Suhner
49	N	10 – 18000	1.00	Huber + Suhner
50	N	10 – 18000	1.00	Huber + Suhner
51	N	10 – 18000	1.00	Huber + Suhner
52	N	10 – 18000	1.00	Huber + Suhner
54	BNC	10 – 3500	1.00	Aircell
58	N	10 – 18000	2.00	Huber + Suhner
59	N	10 – 18000	1.00	Huber + Suhner
60	N	10 – 18000	2.00	Huber + Suhner
61	N	10 – 18000	1.00	Huber + Suhner
62	SMA	---	0.50	Huber + Suhner
63	SMA	10 – 18000	0.50	Huber + Suhner
64	SMA	10 – 18000	0.50	Huber + Suhner
65	APC3.5	10 – 26500	0.60	---
66	APC3.5	10 – 26500	0.60	---
67	APC3.5	10 – 26500	0.60	---
68	APC3.5	10 – 26500	0.60	---
72	BNC	---	0.40	---
73	BNC	---	0.40	---
76	SMA	10 – 30000	3.00	Gore
79	BNC/N	10 – 1000	5.00	---
80	SMA	---	0.25	Huber + Suhner
87	SMA	10 – 18000	0.15	Huber + Suhner
88	SMA	10 – 18000	0.15	Huber + Suhner
89	SMA	10 – 18000	0.15	Huber + Suhner
90	SMA	10 – 18000	0.15	Huber + Suhner
91	SMA	---	1.50	Huber + Suhner
94	BNC	---	1.10	---
95	BNC	---	0.80	---
96	BNC	---	0.80	---
100	N	10 – 26500	6.00	Rosenberg
101	N	10 – 18000	2.90	Huber + Suhner
102	SMA	10 – 18000	2.00	Huber + Suhner
111	BNC	10 – 1000	0.50	---
112	BNC	10 – 1000	0.50	---
114	SMA	10 – 18000	0.25	Huber + Suhner
116	SMA	10 – 18000	0.25	Huber + Suhner
119	N	10 – 20000	8.00	Jyebao
121	SMA	10 – 18000	1.50	Huber + Suhner
122	SMA	10 – 18000	2.00	Huber + Suhner
123	SMA	10 – 18000	2.00	Huber + Suhner
145	SMA	10 – 26500	8.00	Huber + Suhner
147	APC3.5	10 – 40000	1.50	Jyebao
148	APC3.5	10 – 40000	3.00	Jyebao
151	SMA	10 – 18000	0.50	Rosenberger

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Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
152	SMA	10 – 18000	0.50	Rosenberger
154	BNC	10 – 1000	1.00	---
155	N/BNC	---	0.85	---
157	BNC	---	0.50	---
158	SMA	10 – 26500	2.00	Huber + Suhner
160	SMA	10 – 18000	0.40	Nortel Networks
161	SMA	10 – 18000	1.00	Huber + Suhner
162	APC35	10 – 26500	2.00	Huber + Suhner
163	APC3.5	10 - 26500	2.00	Huber + Suhner
164	APC3.5	10 – 26500	2.00	Huber + Suhner
165	APC2.9	10 – 26500	2.00	Huber + Suhner
166	APC3.5	10 – 40000	---	---
167	APC3.5	10 – 40000	1.00	Jyebao
168	APC3.5	10 – 40000	1.00	Jyebao
169	APC3.5	10 – 40000	1.00	Jyebao
170	APC3.5	10 – 40000	1.00	Jyebao
171	APC3.5	10 – 40000	1.00	Jyebao
172	SAM	---	0.90	Huber + Suhner
173	APC	10 – 26500	2.00	Huber + Suhner
174	APC	10 – 26500	---	Huber + Suhner
175	SMA	10 – 18000	0.40	Huber + Suhner
176	N-SMA	10 – 18000	0.50	Huber + Suhner
188	N	10 – 18000	5.00	Huber + Suhner
EMV 1	BNC	---	2.00	Henn
EMV 2	BNC	10 – 1000	2.00	Henn
EMV 4	BNC	---	9.70	Henn
EMV 5	BNC	---	3.80	Henn
EMV 6	BNC/N	10 – 1000	5.00	Lüthi
EMV 7	BNC	10 – 1000	1.50	Henn
EMV 8	BNC	10 – 1500	1.70	Henn
EMV 9	BNC	10 – 1000	1.70	Henn
EMV 11	BNC	---	5.20	Hasselt
EMV 12	BNC	10 – 1000	2.40	Hasselt
EMV 13	BNC	10 – 1000	4.10	Hasselt
EMV 14	BNC	10 – 1000	2.50	Hasselt
EMV 15	BNC	---	0.90	Henn
EMV 16	Fischer	---	2.00	---
EMV 18a	Fischer	---	1.00	---
EMV 19a	Fischer	---	1.50	---
KISN2	BNC	10 – 2000	4.80	---

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End of test report

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