Test Report acc. to FCC Title 47 CFR Part 15
relating to
s.m.s. smart microwave sensors GmbH
UMRR-0C0103-282201-070704
UMRR-0C0104-282201-070704

Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure:
ANSI C63.4-2009

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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	**m. dudde hochfrequenz-technik**
Testing laboratory address	Rottland 5a, 51429 Bergisch Gladbach, Germany
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RELEVANT STANDARD	
Title	**47 - Telecommunication**
Part	**15 - Radio Frequency Devices**
Subpart	**Subpart C – Intentional Radiators**
Measurement procedure	ANSI C63.4-2009

EQUIPMENT UNDER TEST (EUT)	
Equipment category	Field Disturbance Sensor / Non specific SRD
Trade name	smartmicro
Type designation	**UMRR-0C0103-282201-070704**
Serial no.	---
Variants	**UMRR-0C0104-282201-070704**

1. Test results

Clause	Requirements headline	Test result			Page number
8.1	Antenna requirement	**Pass**	~~Fail~~	~~N.t.*~~	9
8.2	Conducted limits	**Pass**	~~Fail~~	~~N.t.*~~	10 - 12
8.3	Restricted bands of operation	**Pass**	~~Fail~~	~~N.t.*~~	13 - 15
8.4	Radiated emission limits, general requirements	**Pass**	~~Fail~~	~~N.t.*~~	16 - 20
8.5	Fundamental frequencies / Field strength limits	**Pass**	~~Fail~~	~~N.t.*~~	21 - 25
8.6	Bandwidth	**Pass**	~~Fail~~	~~N.t.*~~	26

* Not tested

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

Signature		
Name	**Mr. Ralf Trepper**	**Mr. Manfried Dudde**
Designation	**Technician**	**Laboratory-Manager**
Date of issue	**2015-04-01**	**2015-04-01**

Table of contents

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 m. dudde hochfrequenz-technik 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 numbers of pages in this report are **34**.

The tests were carried out 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 C63.4-2009

The sample of the product was received on:

- 2015-02-05

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

- 2015-03-24 - 2015-03-27

3. Testing laboratory

m. dudde hochfrequenz-technik,
Rottland 5a,
D-51429 Bergisch Gladbach
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FCC Registration Number: 699717

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	: 2014-12-15
References	: Mr. 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-0C0103-282201-070704**
Serial number	: ---
Hardware versions	: ---
Variants	: **UMRR-0C0104-282201-070704**
Software release	: ---
Type of equipment	: Field Disturbance Sensor / Non specific SRD
Power used	: 24 V DC
Frequency used	: 24.0056 GHz – 24.1955 GHz
Generated or used frequencies	:
Carrier Frequency:	24.0056 GHz – 24.1955 GHz
Frequencies generated by Clock Chip:	16.0 MHz, 25.0 MHz, 40.00 MHz, 66.67 MHz , 100 MHz , 250 MHz
Internal used clock rates:	5.33 MHz, 6 MHz, 10 MHz, 25 MHz, 40 MHz, 41.5 MHz, 80 MHz, 87.5 MHz
ITU emission class	: **187MF0N**
FCC ID	: **W34UMRR0C28X**

For issuing this report the following product documentation was used:

Title	Version
UMRR-0C0103-282201-070704 Radar Sensor Documentation	1

For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est (EUT)	2015-04-01	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est (EUT)	2015-04-01	Annex no. 2
Channel occupancy / bandwidth	2015-04-01	Annex no. 3
Label sample	2015-04-01	Annex no. 4
Functional description / User Manual	2015-04-01	Annex no. 5
Test setup photos	2015-04-01	Annex no. 6
Block diagram	2015-04-01	Annex no. 7
Operational description	2015-04-01	Annex no. 8
Schematics	2015-04-01	Annex no. 9
Parts list	2015-04-01	Annex no. 10

6. Conclusions, observations and comments

The test report will be filed at m. dudde hochfrequenz-technik 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 m. dudde hochfrequenz-technik.

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. m. dudde hochfrequenz-technik cannot be held liable for properties of the EUT that have not been observed during these tests.

m. dudde hochfrequenz-technik 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: ---

Date	: 2015-04-01	Date	: 2015-04-01
Name	: Ralf Trepper	Name	: Manfried Dudde
Function	: Technician	Function	: Laboratory Manager
Signature	:	Signature	: .....

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7. Operational description

7.1 EUT details

UMRR-0C0103-282201-070704 : Transceiver, Field disturbance sensor
UMRR-0C0104-282201-070704 : Transceiver, Field disturbance sensor

The main task of the UMRR is detection of any reflectors in the field of view, to measure the distance, the relative speed and the angle to the shortest reflector (and to other reflectors), to detect motion and to track (filter) the results over time.

For this **general purpose measurement application**, range and relative radial speed and the angle value of each reflector inside the antenna beam are measured and the results are reported via the communication links cycle by cycle.

7.2 EUT configuration

Operation: As soon as the equipment is powered up, TX starts operating. The channel is switched via software.
Purpose of operation: see user manual

7.3 EUT measurement description

Radiated measurements

The EUT **UMRR-0C0103-282201-070704** has been tested as a standalone device. In order to establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test sample. Secondly the test sample (**UMRR-0C0103-282201-070704**) has been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical has been varied. All generated frequencies, the lowest and the highest frequency of the equipment have been viewed. The device was tested on a standalone basis. The spurious emissions were measured up to 140 GHz!

In all measurement distances the 3 dB beam width of the measuring antenna, for measurements above 1 GHz, is greater than the EUT's dimensions. 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.

Conducted measurements

The device was connected via LAN cable to the LAN port from a notebook and this to the artificial mains network. First it has been tested in with inactive **UMRR-0C0103-282201-070704** and secondly with active **UMRR-0C0103-282201-070704**.

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 Sections 15.211, 15.213, 15.217, 15.219, or 15.221. 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 Section 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 details	Frequency	Gain
Internal Patch Array	RF board: 282201 Type: 40	**24.000 - 24.250 GHz**	**19.4 dBi**

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

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

N.t.* See page no. 27

8.2 Conducted limits

8.2.1 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
*Limit 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.

8.2.2 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 C63.4-2009 Section 7. Additional equipment must also be connected to a second LISN with the same specifications described in the above sentence (if required).

8.2.3 Result

Conducted emissions (Section 15.107) - Tested with external AC power supply								
Tested Line	**Frequency**	**Bandwidth**	**QP Value**	**QP Limit**	**Margin**	**AV Value**	**AV Limit**	**Margin**
L1 / N	**MHz**	**kHz**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
---	---	9	---	---	---	---	---	---
---	---	9	---	---	---	---	---	---
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---	---	9	---	---	---	---	---	---
---	---	9	---	---	---	---	---	---
Measurement uncertainty < ± 2 dB								

Test Cables used	---
Test equipment used	---

The equipment passed the conducted tests	~~Yes~~	~~No~~	**N.t.**[3]

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

N.t.* See page no. 27

Conducted emissions (Section 15.107) – with only Laptop*								
Tested Line	**Frequency**	**Bandwidth**	**QP Value**	**QP Limit**	**Margin**	**AV Value**	**AV Limit**	**Margin**
L1 / N	**MHz**	**kHz**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
L1 / N	**0.1566**	9	**64.0**	**65.6**	**1.6**	**52.0**	**55.6**	**3.6**
L1 / N	**0.2334**	9	**53.0**	**62.3**	**9.3**	**41.0**	**52.3**	**11.3**
L1 / N	**0.3075**	9	**43.0**	**60.0**	**17.0**	**	**50.0**	---
L1 / N	**1.1529**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**1.3854**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**1.7712**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**11.7997**	9	**35.0**	**60.0**	**25.0**	**	**50.0**	---
Measurement uncertainty < ± 2 dB								
****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary.**								

Conducted emissions (Section 15.107) - Tested with EUT + Laptop* over 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**
L1 / N	**0.1566**	9	**64.0**	**65.6**	**1.6**	**52.0**	**55.6**	**3.6**
L1 / N	**0.2334**	9	**53.0**	**62.3**	**9.3**	**41.0**	**52.3**	**11.3**
L1 / N	**0.3075**	9	**43.0**	**60.0**	**17.0**	**	**50.0**	---
L1 / N	**1.1529**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**1.3854**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**1.7712**	9	**35.0**	**56.0**	**21.0**	**	**46.0**	---
L1 / N	**11.7997**	9	**35.0**	**60.0**	**25.0**	**	**50.0**	---
Measurement uncertainty < ± 2 dB								
****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary.**								

Test Cables used	K30
Test equipment used	28, 72, 272, 428, 429, Laptop* (S/N: CNV 250 9011)

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

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

N.t.* See page no. 27

8.3 Restricted bands of operation

8.3.1 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.

(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 § 15.257 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 § 15.245 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 § 15.245(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(a).

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 15.245 shall not exceed the limits specified in Section 15.245(b).

(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.

(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 § 15.257 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 § 15.245 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 § 15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under § 15.249 are exempt from 83 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(a).

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 15.245 shall not exceed the limits specified in Section 15.245(b).

8.3.2 Result

Test Cables used	K1a, K40, K46, K50, K56, K62, K75, K144, K147, K148, K501
Test equipment used	103, 166a, 171a, 223a, 280,345, 359a, 406, 430, 443, 445,
	501, 502, 515, 518, 545, 547, 549

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

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

N.t.* See page no. 27

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.

8.4.2 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a turn table which is 0.8 m above the ground. 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 are 3m. 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.

ANSI C63.4: 2009 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4-2009. The C63.4-2009 measurement procedure consists 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. Subclause 8.3.1.2 of C63.4-2009 states that 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 beamwidth of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in C63.4-2009, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beamwidth 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.

C63.4-2009 requires that 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 emissions test characteristics	
Frequency range	30 MHz - 4,000 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1000 MHz - 4,000 MHz)
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).

8.4.3 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).

8.4.4 Result

Transmitter spurious radiation below 30 MHz (Section 15.205, 15.209)												
f	**Detct**	**BW**	**Rx Level**	**MD**	**CF**	**DEF**	**LC**	**Limit**	**Margin**	**EP**	**Antenna**	
											Pol	**H**
MHz	**Type**	**kHz**	**dBµV**	**m**	**dB**	**dB**	**dBµV/m**	**dBµV/m**	**dB**	**°**	**H/V**	**m**
	QP	120	**	10			**		---		H/V	1
	QP	120	**	10			**		---		H/V	1
	QP	120	**	10			**		---		H/V	1
	QP	120	**	10			**		---		H/V	1
	QP	120	**	10			**		---		H/V	1
Measurement uncertainty: ± 4 dB												
**** All radiated spurious 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 | LC : Level corrected | EP: EUT Position | Pol:Antenna polarization | H: Antenna height |												
Remark: *[1] Noise level of the measuring instrument ≤ 4.0dBµV@10m distance (0.009 MHz –30 MHz) Remark: * Peak Limit according to Section 15.35 (b).												

Test Cables used	K1a, K56, K75
Test equipment used	23, 103, 171a

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

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

N.t.* See page no. 27

Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209)

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**
30.00	PK	100	≤ 3.5	3	-2.6*[5]	0	0	**≤0.9**	40.0	**≥39.1**	0-360	H / V	1-4
88.00	PK	100	≤ 3.5	3	-10.8*[5]	0	0	**≤-7.3**	40.0	**≥47.3**	0-360	H / V	1-4
216.00	PK	100	≤ 3.5	3	-10.3*[5]	0	0	**≤-6.8**	43.5	**≥50.3**	0-360	H / V	1-4
960.00	PK	100	≤ 3.5	3	8.50*[5]	0	0	**≤12.0**	43.5	**≥31.5**	0-360	H / V	1-4
1700.00	PK	100	≤ 4.5	3	3.80*[6]	0	0	**≤8.3**	54.0	**≥45.7**	0-360	H / V	1-4
1805.50	PK	100	≤ 10	3	9.5*[6]	0	0	**≤19.5**	54.0	**≥34.5**	0-360	H / V	1-4
2250.00	PK	100	≤ 10	3	8.00*[6]	0	0	**≤18.0**	54.0	**≥36.0**	0-360	H / V	1-4
4000.00	PK	100	≤ 10	3	8.40*[6]	0	0	**≤18.4**	54.0	**≥35.6**	0-360	H / V	1-4
5000.00	PK	100	≤ 10	3	9.10*[6]	0	0	**≤19.4**	54.0	**≥34.6**	0-360	H / V	1-4
7500.00	PK	100	≤ 14	3	12.9*[6]	0	0	**≤26.9**	54.0	**≥27.1**	0-360	H / V	1-4
8300.00	PK	100	≤ 14	3	14.8*[6]	0	0	**≤28.8**	54.0	**≥25.2**	0-360	H / V	1-4

Measurement uncertainty: ± 4 dB

**** For the following frequency ranges:**
30 MHz – 1 GHz | 1 GHz – 15 GHz | 15 GHz – 40 GHz | 40 GHz – 60 GHz | 60 GHz – 90 GHz | 90 GHz – 110 GHz
All spurious 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 |

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	K1a, K40, K46, K50, K56, K62, K144, K147, K148, K501
Test equipment used	103, 104, 166a, 171a, 223a, 280,345, 359a, 406, 430, 443, 445,
	501, 502, 515, 518, 545, 547, 549

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

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

N.t.* See page no. 27

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8.5 Fundamental frequencies / Field strength limits

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.

8.5.2 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a turn table which is 0.8m above the ground. 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 are 3m. To find the maximum emission, the polarization of the receiving antenna are changed in horizontal and vertical polarization, the position of the EUT was changed in different orthogonal determinations.

ANSI C63.4: 2009 Section 8 “Radiated emission measurements”

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4-2009. The C63.4-2009 measurement procedure consists 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. Subclause 8.3.1.2 of C63.4-2009 states that 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 beamwidth of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in C63.4-2009, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beamwidth 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.

C63.4-2009 requires that 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 emissions test characteristics	
Frequency range	9 kHz - 100,000 MHz
Test distance	10m, 3 m*
Test instrumentation resolution bandwidth	9 kHz (20 kHz – 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1000 MHz - 100,000 MHz)
Receive antenna height	1 m (20 kHz – 30 MHz)
Receive antenna polarization	0° - 90° (20 kHz – 30 MHz)
Receive antenna scan height	1 m - 4 m (30 MHz - 15,000 MHz) 1 m – 2.5 m (18,000 MHz - 40,000 MHz)
Receive antenna polarization	vertical/horizontal (30 MHz - 100,000 MHz)

*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).

8.5.3 Calculation of the average correction factor

The average correction factor is computed by analyzing the "worst case" on time in any 100msec time period and using the formula: Corrections Factor + 20*log (worst case on time/100msec). Analysis of the remote transmitter worst case on time in any 100msec time period is an on time of 50msec, therefore the correction factor is 20*log (50/100) = - 6 dB. The maximum correction factor to be applied is 20 dB per section 15.35 of the FCC rules.

8.5.4 Calculation of the field strengths

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).

8.5.5 Result

Transmitter Field Strengths - Fundamental Emissions (Section 15.249)												
f	**Detct**	**BW**	**Rx Level**	**MD**	**CF**	**DEF**	**LC**	**Limit**	**Margin**	**EP**	**Antenna**	
											Pol	**H**
GHz	**Type**	**kHz**	**dBµV**	**m**	**dB**	**dB**	**dBµV/m**	**dBµV/m**	**dB**	**°**	**H / V**	**m**
24.0056	PK	1000	**94.5**	3	18.7	0	**113.2**	127.9	**14.7**	0	V	1.4
24.0986	PK	1000	**94.3**	3	18.7	0	**113.0**	127.9	**14.9**	0	V	1.4
24.1700	PK	1000	**93.8**	3	18.9	0	**112.7**	127.9	**15.2**	0	V	1.4
24.1955	PK	1000	**92.7**	3	19.3	0	**112.0**	127.9	**15.9**	0	V	1.4
24.0056	AV	1000	**79.2**	3	18.7	0	**97.9**	107.9	**10.0**	0	V	1.4
24.0986	AV	1000	**78.5**	3	18.7	0	**97.2**	107.9	**10.7**	0	V	1.4
24.1700	AV	1000	**78.0**	3	18.9	0	**96.9**	107.9	**11.0**	0	V	1.4
24.1955	AV	1000	**77.6**	3	19.3	0	**96.9**	107.9	**11.0**	0	V	1.4
Measurement uncertainty: ± 4 dB												
PK : Peak Detector							**AV : Average Detector**					
f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | MD: Measurement distance | CF : Correction factor | DEF :Distance extrapolation factor | LC : Level corrected | EP: EUT Position | Pol:Antenna polarization | H: Antenna height |												
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												
Remark: *[7] for periodic operated transmitter												

Test Cables used	K147, K148
Test equipment used	103, 280, 359a, 443

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

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

N.t.* See page no. 27

Transmitter Field Strengths - Harmonic Emissions (Section 15.249)

f	Detct	BW	Rx Level	MD	CF	DEF	LC	Limit	Margin	EP	Antenna	
											Pol	H
GHz	**Type**	**kHz**	**dBµV**	**m**	**dB**	**dB**	**dBµV/m**	**dBµV/m**	**dB**	**°**	**H / V**	**m**
48.0112	AV	1000	**	0.5	32.5	-15.5	**	67.9	---	0-360	H / V	1.0
48.1972	AV	1000	**	0.5	32.5	-15.5	**	67.9	---	0-360	H / V	1.0
48.3400	AV	1000	**	0.5	32.7	-15.5	**	67.9	---	0-360	H / V	1.0
48.3910	AV	1000	**	0.5	32.7	-15.5	**	67.9	---	0-360	H / V	1.0

Measurement uncertainty: ± 4 dB

AV : Average Detector | **** All other harmonic 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 | LC : Level corrected | EP: EUT Position | Pol:Antenna polarization | H: Antenna height |

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
Remark: *[7] for periodic operated transmitter

Test Cables used	K501
Test equipment used	501, 502,515, 518, 549

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

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

N.t.* See page no. 27

8.6 Bandwidth (20 dB)

8.6.1 Regulation

(c) 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. 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 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

ANSI C63.4-2009 Section 13.1.7 Occupied bandwidth measurements. The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. Once the reference level is established, the equipment is conditioned with typical modulating signals to produce worst-case (i.e., the widest) bandwidth. In order to measure the modulated signal properly, a resolution bandwidth that is small compared to the bandwidth required by the procuring or regulatory agency shall be used on the measuring instrument. However, the 6 dB resolution bandwidth of the measuring instrument shall be set to a value greater than 5 % of the bandwidth requirements.

8.6.3 20 dB Bandwidth limit

Intentional radiator- 20 dB Bandwidth limit : within the designated frequency band

8.6.4 Result

Intentional radiator- Measured Maximum 20 dB Bandwidth		
Frequency Band	**Measured Maximum 20 dB Bandwidth**	**20 dB Bandwidth limit**
GHz	**MHz**	**MHz**
24.000 – 24.250	**187.34**	**250**

Test Cables used	K18a
Test equipment used	87, 144, 226, 280, 433, 502

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

Test results are attached	**Yes**	~~No~~	Annex no.:3

N.t.* See page no. 27

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

10. List of test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Calibration executed by
Test fixture	Dudde	---	04/2014	04/2015	Dudde
Magnetic loop antenna (9 kHz - 30 MHz)	Schwarzbeck FMZB 1516 (23)	---	05/2013	05/2016	Dudde
OATS (CISPR 16) to 1.0 GHz)	Dudde (103)	---	09/2013	09/2015	Dudde
OATS	Dudde (104)	---	06/2014	06/2016	Dudde
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	07/2014	07/2016	Dudde
Horn antenna (2.0-14.0 GHz)	Schwarzbeck BBHA 9120 C (169)	305	09/2012	*	Dudde
Horn antenna (14-40.0 GHz)	Schwarzbeck BBHA 9170 (280)		09/2012	*	Dudde
Spektrumanalyzer 9 kHz - 18 GHz	Rohde & Schwarz (171a)	---	06/2014	06/2016	Rhode & Schwarz
Mixer WR22 Q-Band (33-50 GHz)	OM Labs MA2742A (269a)	Q40512-1	03/2013	03/2016	Dudde
Mixer WR15 V-Band (50-75 GHz)	OM Labs MA2744A (295a)	V41027-1	08/2014	08/2017	Dudde
Mixer WR10 W-Band (75-110 GHz)	OM Labs MA2746A (296a)	W40706-2	03/2013	03/2016	Dudde
Pre-amplifier (1GHz - 18GHz)	Narda (345)	---	02/2014	02/2016	Dudde
Receiver (9 kHz –40.0 GHz) (40.0 GHz -110 GHz)	Anritsu Spectrum Analyzer MS2668 (359a)	6200163244	06/2014	06/2017	Rohde & Schwarz
Gain Horn antenna (33-50 GHz)	Dorado GH-22-25 (383)	040810	04/2012	*	Dorado
Gain Horn antenna (50-75 GHz)	Dorado GH-15-25 (384)	031003	04/2012	*	Dudde
Gain Horn antenna (75-110 GHz)	Dorado GH-10-25 (385)	040808	04/2012	*	Dudde
Bilog antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	04/2011	04/2015	Schwarzbeck
Logt. Per, Antenne (1- 18 GHz)	Schwarzbeck STLP 9148 (445)	---	09/2012	09/2015	Schwarzbeck
Horn antenna (15.0-40.0 GHz)	Schwarzbeck BBHA 9170 (280)	BBHA9170378	08/2014	08/2017	Schwarzbeck
Microwave Amplifier	Schwarzbeck BBV 9719 (443)	----	01/2013	01/2016	Schwarzbeck
Harmonic Mixer U-Band (40-60 GHz)	Farran FSZ-60 (515)	100037	08/2010	08/2016	Farran
Harmonic Mixer E-Band 60-90 GHz	Rohde & Schwarz FSZ-90 (501)	100062	08/2010	03/2016	Rohde & Schwarz

Harmonic Mixer F-Band 90-140 GHz	Radiometer Physics SAM-140 (545)	20006	05/2013	05/2017	Rohde & Schwarz
Harmonic Mixer F-Band 140-220 GHz	Radiometer Physics SAM-140 (546)	20002	02/2013	02/2017	Rohde & Schwarz
Harmonic Mixer F-Band 220-325 GHz	Radiometer Physics SAM-325 (591)	20029	02/2013	02/2017	Rohde & Schwarz
Signal Analyzer (9 kHz –30.0 GHz)	Rohde & Schwarz FSV 30 (502)	100932	02/2013	02/2016	Rohde & Schwarz
Gain Horn antenna (40-60 GHz)	Dorado GH-19-20 (518)	070106	08/2010	*	Dudde
Dual Mode Potter Horn Antenna 60 - 90 GHz	Radiometer Physics FH-PP-90-WR12 (549)	---	09/2011	*	Dudde
Dual Mode Potter Horn Antenna 90 - 140 GHz	Radiometer Physics FH-PP-140 WR8 (547)	---	02/2013	*	Dudde
Dual Mode Potter Horn Antenna 140 - 220 GHz	Radiometer Physics FH-PP-220 WR5.1 (548)	---	02/2013	*	Dudde
Dual Mode Potter Horn Antenna 220 - 325 GHz	Radiometer Physics FH-PP-140 WR8 (592)	---	02/2013	*	Dudde
*Standard-gain horn antennas have gain characteristics that are established by the physical dimensions and dimensional tolerances. Consequently, standard-gain horn antennas need not be calibrated beyond the dimensional characteristics that are provided by the manufacturer, unless damaged or deterioration is suspected, or if used at distances closer than (2D2)/λ. This is also described in NRL Report 4433!					

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11. List of test cables

Type	Manufacturer/ Model no.	Cable no.	Last calibration	Next calibration	Calibration executed by
RF- cable	Kabelmetal 14.5m [N]	K1	04/2014	04/2015	Dudde
RF- cable	Kabelmetal 18m [N]	K1a	04/2014	04/2015	Dudde
RF- cable	Sucoflex 104 2m [APC]	K17a	04/2014	04/2015	Dudde
RF- cable	Sucoflex 104 2m [APC]	K18a	04/2014	04/2015	Dudde
RF- cable	Aircell 0.5m [BNC]	K40	04/2014	04/2015	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K52	04/2014	04/2015	Dudde
RF- cable	Aircell 1m [BNC/N]	K56	04/2014	04/2015	Dudde
RF- cable	Sucoflex 100 Suhner [N] 1 m	K61	04/2014	04/2015	Dudde
RF- cable	Sucoflex 100 Suhner [SMA] 0.5 m	K62	04/2014	04/2015	Dudde
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	04/2014	04/2015	Dudde
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K75	04/2014	04/2015	Dudde
RF- cable	Sucoflex Suhner 13 m [N]	K144	04/2014	04/2015	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K145	04/2014	04/2015	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K146	04/2014	04/2015	Dudde
RF- cable	Jyebao 1.5 m [APC]	K147	04/2014	04/2015	Dudde
RF- cable	Jyebao 3 m [APC]	K148	04/2014	04/2015	Dudde

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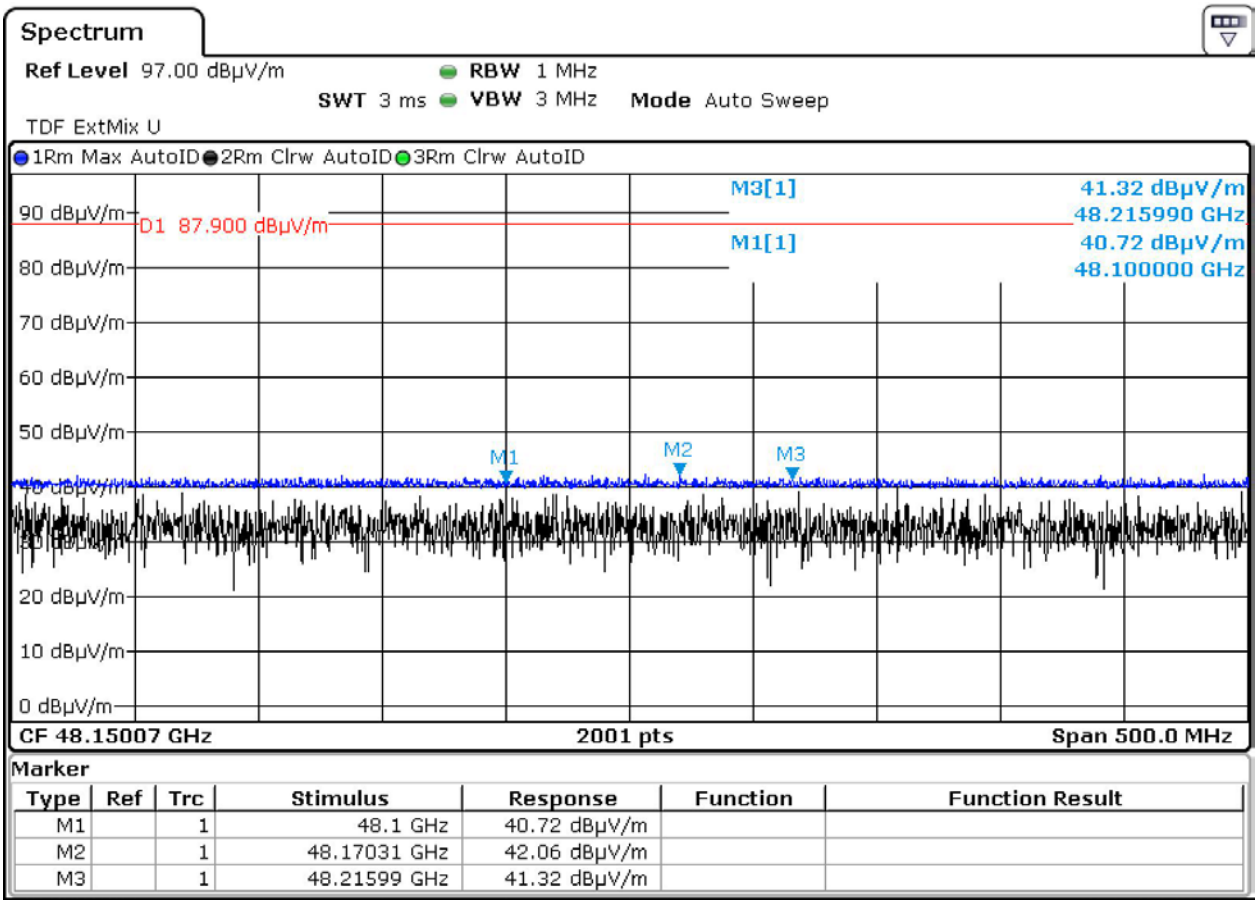
Test results: Harmonics & Spurious emissions 40 GHz – 60 GHz



Marker

Type	Ref	Trc	Stimulus	Response	Function	Function Result
M1		1	48.1 GHz	40.72 dBµV/m		
M2		1	48.17031 GHz	42.06 dBµV/m		
M3		1	48.21599 GHz	41.32 dBµV/m		

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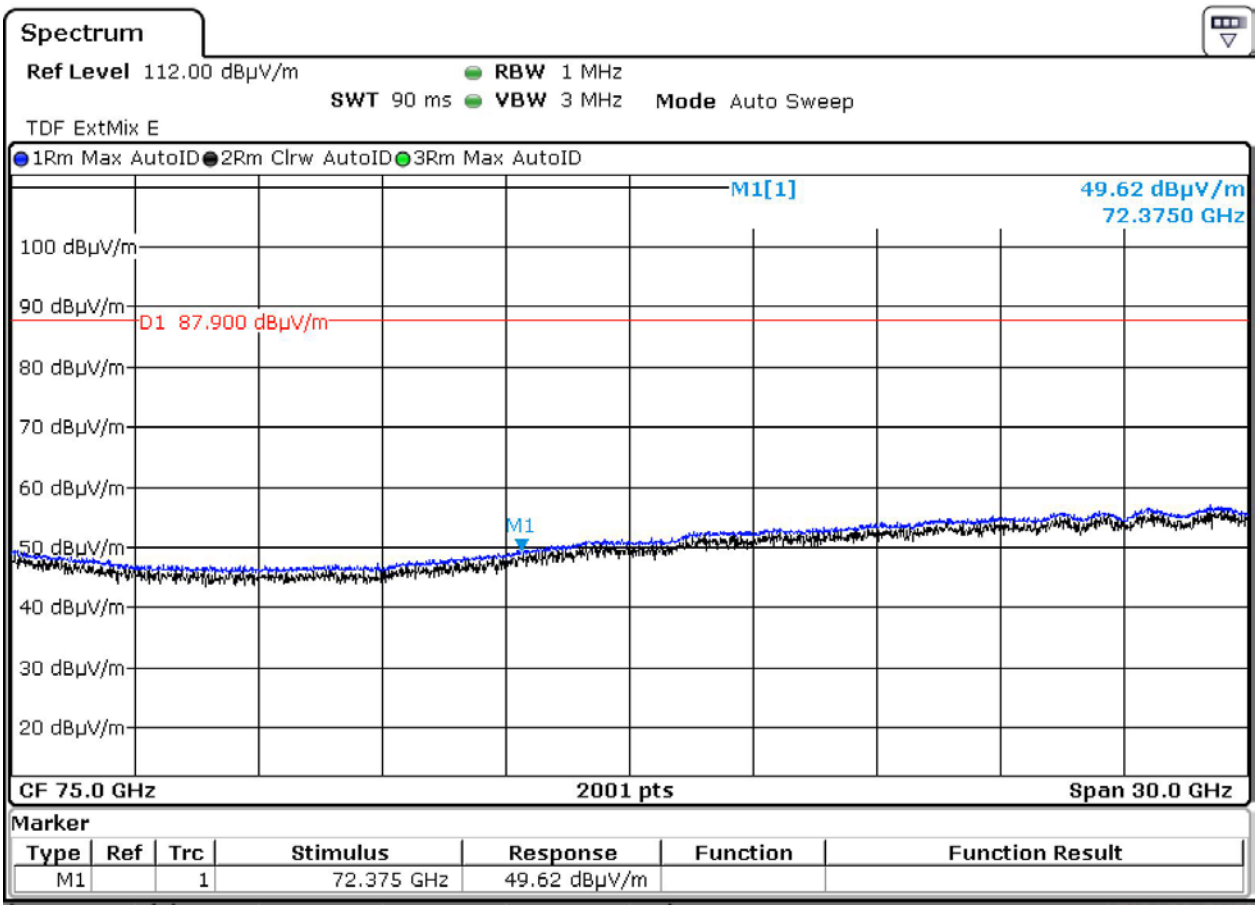
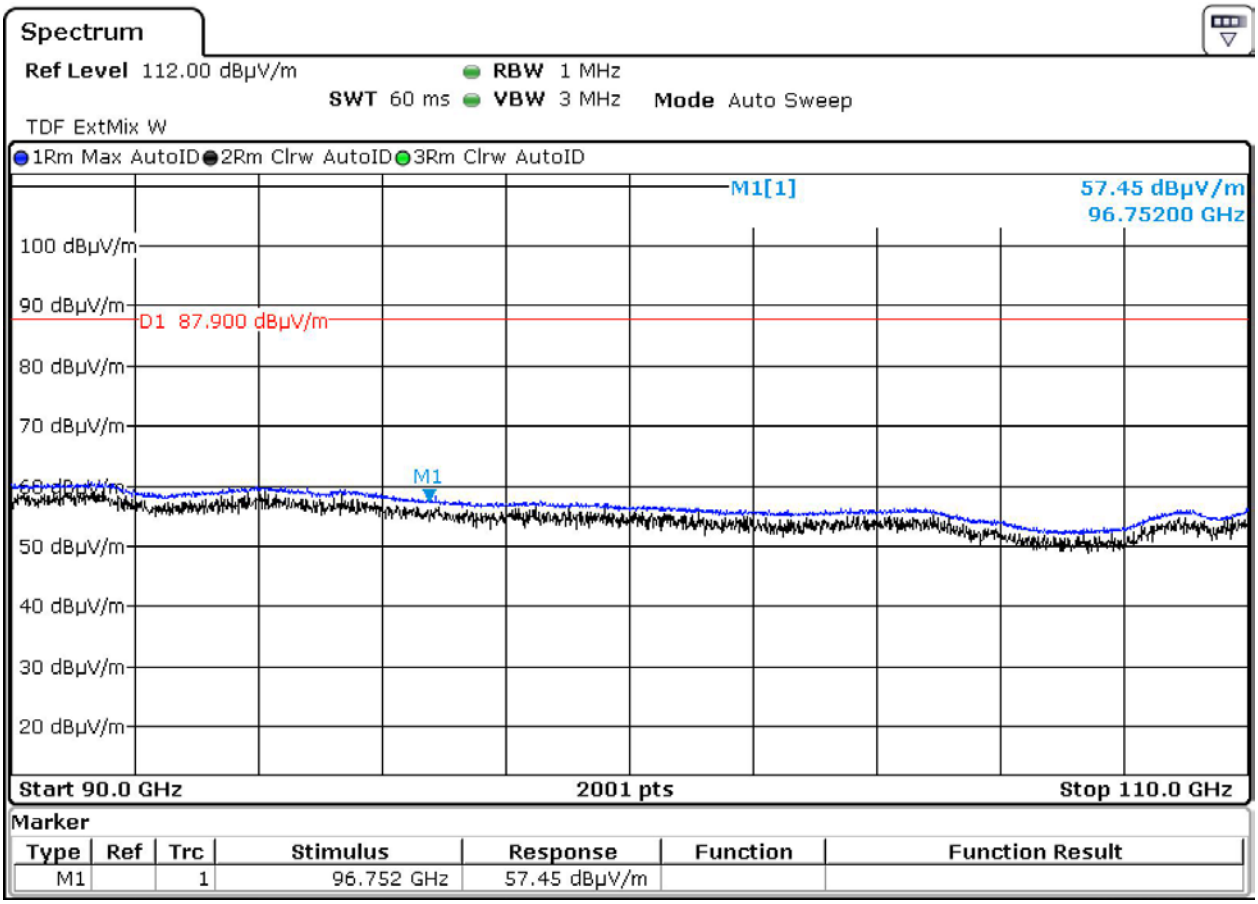
Test results: Harmonics & Spurious emissions 60 GHz – 90 GHz



Test results: Harmonics & Spurious emissions 90 GHz – 110 GHz



End of test report

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