
EUT: UMRR-0C Type 40 FCC ID: W34UMRR0C28 FCC Title 47 CFR Part 15 C Date of issue: 2016-08-16



Deutsche
Akkreditierungsstelle
D-PL-12053-01-00

**Test Report acc. to FCC Title 47 CFR Part 15
relating to
s.m.s, smart microwave sensors GmbH
UMRR-0C Type 40**

**Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure:
ANSI C63.4-2014
ANSI C63.10-2013**

EUT: UMRR-0C Type 40 FCC ID: W34UMRR0C28 FCC Title 47 CFR Part 15 C Date of issue: 2016-08-16

MANUFACTURER

Manufacturer name	s.m.s, smart microwave sensors GmbH
Manufacturer's grantee code	W34
Manufacturer's address	In den Waashainen 1, 38108 Braunschweig Germany
Phone	+49 (0) 531 390 23 0
Fax	+49 (0) 531 390 23 599
Email	Ralph.Mende@smartmicro.de

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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Email	m.duddelabor@dudde.com

RELEVANT STANDARD

Title	47 - Telecommunication
Part	15 - Radio Frequency Devices
Subpart	Subpart C – Intentional Radiators
Measurement procedure	ANSI C63.4-2014 & ANSI C63.10-2013

EQUIPMENT UNDER TEST (EUT)



Equipment category	Field Disturbance Sensor
Trade name	Smartmicro
Type designation	UMRR-0C Type 40
Serial no.	0x000288DF
Variants	---

1. Test results

Clause	Requirements headline	Test result			Report page number
		Pass	Fail	Not*	
8.1	Antenna requirement	Pass	Fail	Not*	9
8.2	Conducted limits	Pass	Fail	Not*	10 - 12
8.3	Restricted bands of operation	Pass	Fail	Not*	13 - 14
8.4	Radiated emission limits, general requirements	Pass	Fail	Not*	15 - 20
8.5	Fundamental frequencies / Field strength limits	Pass	Fail	Not*	21 - 24
8.6	Bandwidth	Pass	Fail	Not*	25

* Not tested

The equipment passed all the conducted tests	Yes	No
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Signature		
Name	Mr. Ralf Trepper	Mr. Manfred Dudde
Designation	RF Test Engineer	Laboratory-Manager
Date of issue	2016-08-16	2016-08-16


 Ralf Trepper
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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 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 number of pages in this report is **32**.

The tests were carried out at:

- m. dudde hochfrequenz-technik, D-51429 Bergisch Gladbach

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 C63.4-2014 & ANSI C63.10-2013

The sample of the product was received on:

- 2016-05-27

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

- 2016-07-26 – 2016-06-29

3. Testing laboratory

m. dudde hochfrequenz-technik
Rottland 5a, 51429 Bergisch Gladbach, Germany

Phone: +49 - (0) 22 07 / 96 89-0

Fax: +49 - (0) 22 07 / 96 89-20

- FCC Registration Number: **699717**

Accredited by:

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

EUT: UMRR-0C Type 40 FCC ID: W34UMRR0C28 FCC Title 47 CFR Part 15 C Date of issue: 2016-08-16

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 : 2016-05-27
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-0C Type 40
Serial number : 0x000288DF
Hardware versions : UMRR-0C Type 40
Variants : ---
Software release : 003
Type of equipment : Non specific SRD
Power used : 13 – 32 V DC
Frequency used : 24.075 – 24.175 GHz
Generated or used frequencies : 16, 25, 40, 66.67, 76.56, 100 and 250 MHz (Generated by clock chip)
: 5.2, 6, 10, 40, 41.5, 80, 76.56 MHz (Internal used clock rates)
24.075 – 24.175 GHz (carrier)
ITU emission class : 91M5F0N
FCC ID : W34UMRR0C28

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For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the Equipment Under Test (EUT)	2016-08-16	Annex no. 1
Internal photographs of the Equipment Under Test (EUT)	2016-08-16	Annex no. 2
Channel occupancy / bandwidth	2016-08-16	Annex no. 3
Label sample	2016-08-16	Annex no. 4
Functional description / User manual	2016-08-16	Annex no. 5
Test setup photos	2016-08-16	Annex no. 6
Block diagram	2016-08-16	Annex no. 7
Operational description	2016-08-16	Annex no. 8
Schematics	2016-08-16	Annex no. 9
Parts list	2016-08-16	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: This test report 16010506a replaces the test report number 16010506!
The test report number 16010506 loses its validity!**

Date : 2016-08-16

Name : Ralf Trepper

Function : RF Test Engineer

Signature : 

Date : 2016-08-16

Name : Manfred Dudde

Function : Laboratory Manager

Signature : 

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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 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.

Conducted measurements

The EUT was directly connected to the artificial mains network. The complete system has been tested in three runs: first, with laptop only, second, EUT with laptop over LAN port, and finally EUT with laptop over RS485.

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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 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

Integrate patch array antenna!

The equipment passed the conducted tests	Yes	No	N.t.*
Test setup photos / test results are attached	Yes	No	Annex no.:2

N.t.* see clause: 9

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 μ H /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	dB μ V	dB μ V
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 μ V within the frequency band 535–1705 kHz, as measured using a 50 μ H /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.

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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 C63.4-2014 Section 7.

Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

8.2.3 Result

Conducted emissions (Section 15.207) - Tested with Laptop only								
Tested Line	Frequency	Bandwidth	QP Value	QP Limit	Margin	AV Value	AV Limit	Margin
L1 / N	MHz	kHz	dB μ V	dB μ V	dB	dB μ V	dB μ V	dB
L1 / N	0.153	9	51	66	15	**		
L1 / N	0.241	9	48	62	14	**		
L1 / N	0.372	9	43	58	15	**		
L1 / N	1.128	9	35	56	21	**		
L1 / N	1.355	9	35	56	21	**		
L1 / N	1.790	9	35	56	21	**		
Measurement uncertainty $\pm 2\text{ dB}$								
**The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary.								

Conducted emissions (Section 15.207) - Tested with a Laptop over LAN port								
Tested Line	Frequency	Bandwidth	QP Value	QP Limit	Margin	AV Value	AV Limit	Margin
L1 / N	MHz	kHz	dB μ V	dB μ V	dB	dB μ V	dB μ V	dB
L1 / N	0.153	9	51	66	15	**		
L1 / N	0.241	9	48	62	14	**		
L1 / N	0.372	9	43	58	15	**		
L1 / N	0.757	9	37	56	19	**		
L1 / N	1.012	9	38	56	18	**		
L1 / N	1.128	9	35	56	21	**		
L1 / N	1.355	9	35	56	21	**		
L1 / N	1.790	9	35	56	21	**		
Measurement uncertainty $\pm 2\text{ dB}$								
**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	72, 272, 428, 429, Laptop HP Compaq nx6325 (SN: CNU64907PD)

The equipment passed the conducted tests	Yes	No	N.t.*
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Test setup photos / test results are attached	Yes	No	Annex no.:6
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N.t.* see clause: 9

Date: 2016-08-04

Created: P6

Reviewed: P9

Released: P1

Vers. no. 1.16

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Conducted emissions (Section 15.207) - Tested with a Laptop over RS485 port								
Tested Line	Frequency	Bandwidth	QP Value	QP Limit	Margin	AV Value	AV Limit	Margin
L1 / N	MHz	kHz	dB μ V	dB μ V	dB	dB μ V	dB μ V	dB
L1 / N	0.153	9	51	66	15	**		
L1 / N	0.241	9	48	62	14	**		
L1 / N	0.372	9	43	58	15	**		
L1 / N	1.128	9	35	56	21	**		
L1 / N	1.355	9	35	56	21	**		
L1 / N	1.790	9	35	56	21	**		
Measurement uncertainty $< \pm 2$ 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	72, 272, 428, 429, Laptop HP Compaq nx6325 (SN: CNU64907PD)

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 clause: 9

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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.

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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 § 15.245 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 § 15.245 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 § 15.245(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 15.245 shall not exceed the limits specified in Section 15.245(b).

8.3.2 Result

Test Cables used	K1a, K40, K50, K51, K56, K83, K84, K147, K148
Test equipment used	103, 166a, 171a, 345, 406, 445a, 280, 359a, 223a, 443

The equipment passed the conducted tests	Yes**	No	N.t.*
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Test setup photos / test results are attached	Yes	No	Annex no.:6
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****All emissions in the restricted bands of operation are lower than the noise level of the measuring equipment! The noise level is at least 10 dB below the limits**

N.t.* see clause: 9

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	$\mu\text{V} / \text{m}$	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. If 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 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 C63.4-2014 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions from 9kHz - 1 GHz & 1 GHz - 40 GHz are covered in Clause 8 of ANSI C63.4-2014. The ANSI C63.4-2014 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. Sub clause 8.3.2 of ANSI C63.4-2014 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 beam width of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in ANSI C63.4-2014, 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 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.

ANSI C63.4-2014 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.

The measurement procedure for harmonics and spurious emissions above 40 GHz is taken from ANSI C63.10-2013.

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Radiated emissions test characteristics	
Frequency range	9 kHz – Above 960 MHz
Test distance	3 m*
Test instrumentation minimum resolution bandwidth	10 kHz (Below 30 MHz)
	100 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).

8.4.3 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 dB μ V. 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 35.91dB μ V/m. The 35.91dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

Level in μ V/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	**	3			**					
Measurement uncertainty: ± 4 dB												
**All emissions are lower than the noise level of the measuring equipment! The noise level is at least 10 dB below the limits												
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).												

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	cm
79.15	QP	120	23.9	3	-11.6	0	0	12.3	40.0	27.7	235	H	127
159.55	QP	120	24.3	3	-6.9	0	0	17.4	43.5	26.1	140	V	100
181.51	QP	120	29.6	3	-10.0	0	0	19.6	43.5	23.9	145	V	102
198.61	QP	120	15.3	3	-10.0	0	0	5.3	43.5	38.2	5	V	115
			**										
Measurement uncertainty: ± 4 dB													
** All other spurious emissions are lower than the noise level of the measuring equipment. The noise level is at least 10 dB below the limits													
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, K50, K51, K56, K62, K83, K84, K147, K148, K501
Test equipment used	103, 166a, 171a, 345, 406, 445a, 280, 359a, 223a, 443, 501, 502, 545, 547, 559

The equipment passed the conducted tests	Yes	No	N.A. [≠]
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Test setup photos / test results are attached	Yes	No	Annex no.:6
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N.t.* see clause: 9

8.5 Field strength limits of Fundamental frequencies and harmonics

8.5.1 Regulation

(a) Operation under the provisions of this section is limited to intentional radiators used as field disturbance sensors, excluding perimeter protection systems.

(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in § 15.205, shall not exceed the field strength limits shown in § 15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

- (i) For the second and third harmonics of field disturbance sensors operating in the 24075–24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.
- (ii) For all other field disturbance sensors, 7.5 mV/m.
- (iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075– 24175 MHz band, fully comply with the limits given in § 15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as fork lifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

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

(3) 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.

(4) The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in § 15.35 for limiting peak emissions apply.

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8.5.2 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 C63.4-2014 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions from 9kHz - 1 GHz & 1 GHz - 40 GHz are covered in Clause 8 of ANSI C63.4-2014. The ANSI C63.4-2014 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. Sub clause 8.3.2 of ANSI C63.4-2014 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 beam width of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in ANSI C63.4-2014, 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 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.

ANSI C63.4-2014 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.

The measurement procedure for harmonics and spurious emissions above 40 GHz is taken from ANSI C63.10-2013.

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 dB μ V. 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 35.91dB μ V/m.

The 35.91dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

Level in μ V/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 15.245)										
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
24.0799	1000 / PK	96.7	3	18.8	0	115.5	148	32.5	0° / V	156
24.1253	1000 / PK	95.4	3	18.9	0	114.3	148	33.7	0° / V	156
24.1677	1000 / PK	94.1	3	18.9	0	113.0	148	35.0	0° / V	156
24.0799	1000 / PK	70.2	3	18.8	0	89.0	148	59.0	0° / H	143
24.1253	1000 / PK	68.8	3	18.9	0	87.7	148	60.3	0° / H	143
24.1677	1000 / PK	69.4	3	18.9	0	88.3	148	59.7	0° / H	143
24.0805	1000 / AV	69.1	3	18.8	0	87.9	128	40.1	0° / V	156
24.1247	1000 / AV	70.0	3	18.9	0	88.9	128	39.1	0° / V	156
24.1674	1000 / AV	59.2	3	18.9	0	78.1	128	49.9	0° / V	156

Measurement uncertainty: 4 dB

Transmitter Field Strengths - Harmonics (Section 15.245)										
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 dBμV/m	Direction EUT* ¹ / Antenna- polarisation U, L, OE, / H, V	Antenna height cm
48.3	1000	≤ 23.3	1	32.6	-9.5	46.4	88	41.6	U / H	112
72.4	1000	≤ 27.1	1	34.2	-9.5	51.8	88	36.2	U / H	112
96.5	1000	≤ 28.9	1	38.2	-9.5	57.6	78	20.4	U / V	112

Measurement uncertainty | ± 6 dB

Bandwidth = the measuring receiver bandwidth

Remark: *¹ U = Upright / L = Lying / OE = On Edge

All harmonics can be found on page no. 29-31

- 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	K62, K147, K148, K501
Test equipment used	103, 280, 359a, 223a, 443, 501, 502, 545, 547, 559

The equipment passed the conducted tests	Yes	No	N.t.*
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Test setup photos / test results are attached	Yes	No	Annex no.:6
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N.t.* see clause: 9

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

ANSI C63.10-2013 Section 6.9.3 Occupied bandwidth measurements.

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 $[10 \log (\text{OBW}/\text{RBW})]$ 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.

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- 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).
- 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 downamplitude” 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 labeled. Tabular data may be reported in addition to the plot(s).

8.6.4 Result

Measured 20 dB Bandwidth
MHz
91.5

Test Cables used	K102
Test equipment used	87, 144, 226, 280, 552

The equipment passed the conducted tests	Yes	No	N.t.*
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Test setup photos / test results are attached	Yes	No	Annex no.:6
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N.t.* see clause: 9

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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

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Calibration executed by
Test fixture	Dudde	---	---	---	Dudde
Magnetic loop antenna (9 kHz - 30 MHz)	Schwarzbeck FMZB 1516 (23)	---	05/2014	05/2017	Dudde
OATS (CISPR 16) to 1.0 GHz)	Dudde (103)	---	10/2015	10/2017	Dudde
OATS	Dudde (104)	---	06/2015	06/2017	Dudde
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	07/2016	07/2018	Dudde
Spektrumanalyzer 9 kHz - 18 GHz	Rohde & Schwarz (171a)	---	06/2015	06/2017	Rhode & Schwarz
Miteq Amplifier - 26.5 – 40 GHz G: 32 dB	Miteq (223a)	---	02/2015	02/2017	Schwarzbeck
Mixer WR22 Q-Band (33-50 GHz)	OM Labs MA2742A (269a)	Q40512-1	03/2016	03/2019	Dudde
Broadband Horn Antenna 14 – 40 GHz 15 – 20 dBi 10 – 25 W	Schwarzbeck BBHA 9170(280)	---	08/2015	08/2017	Schwarzbeck
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	03/2016	03/2019	Dudde
Pre-amplifier (1GHz - 18GHz)	Narda (345)	---	02/2015	02/2017	Dudde
Receiver (9 kHz –40.0 GHz) (40.0 GHz -110 GHz)	Anritsu Spectrum Analyzer MS2668 (359a)	6200163244	06/2014	06/2017	Rohde & Schwarz
Bilog antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	05/2015	05/2018	Schwarzbeck
Logt. Per, Antenne (1- 18 GHz)	Schwarzbeck STLP 9148 (445a)	---	10/2015	10/2018	Schwarzbeck
Horn antenna (15.0-40.0 GHz)	Schwarzbeck BBHA 9170 (280)	BBHA9170378	08/2014	08/2017	Schwarzbeck
Microwave Amplifier	Schwarzbeck BBV 9719 (443)	----	01/2014	01/2017	Schwarzbeck
Log. Per, Antenne (1- 18 GHz)	Schwarzbeck STLP 9148 (445a)	---	10/2015	10/2018	Schwarzbeck
Harmonic Mixer E-Band 60-90 GHz	Rohde & Schwarz FSZ-90 (501)	100062	08/2010	08/2016	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	02/2016	02/2018	Rohde & Schwarz

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Dual Mode Potter Horn Antenna 90 - 140 GHz	Radiometer Physics FH-PP-140 WR8 (547)	---	02/2014	02/2017	Dudde
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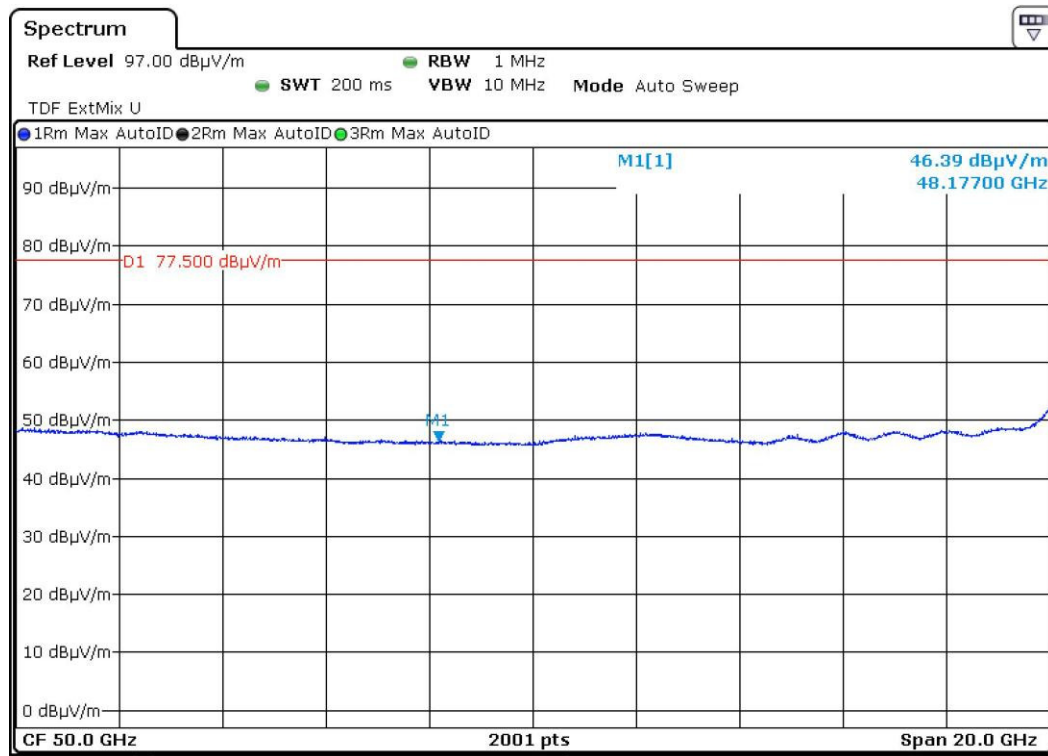
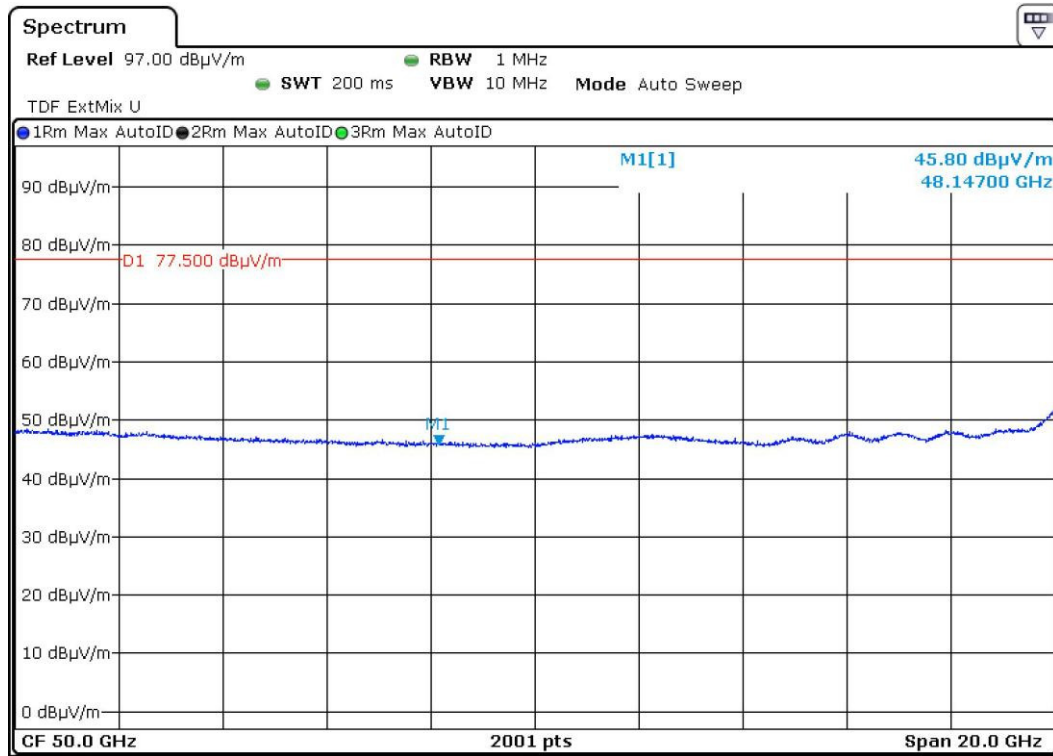
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11. Cable list

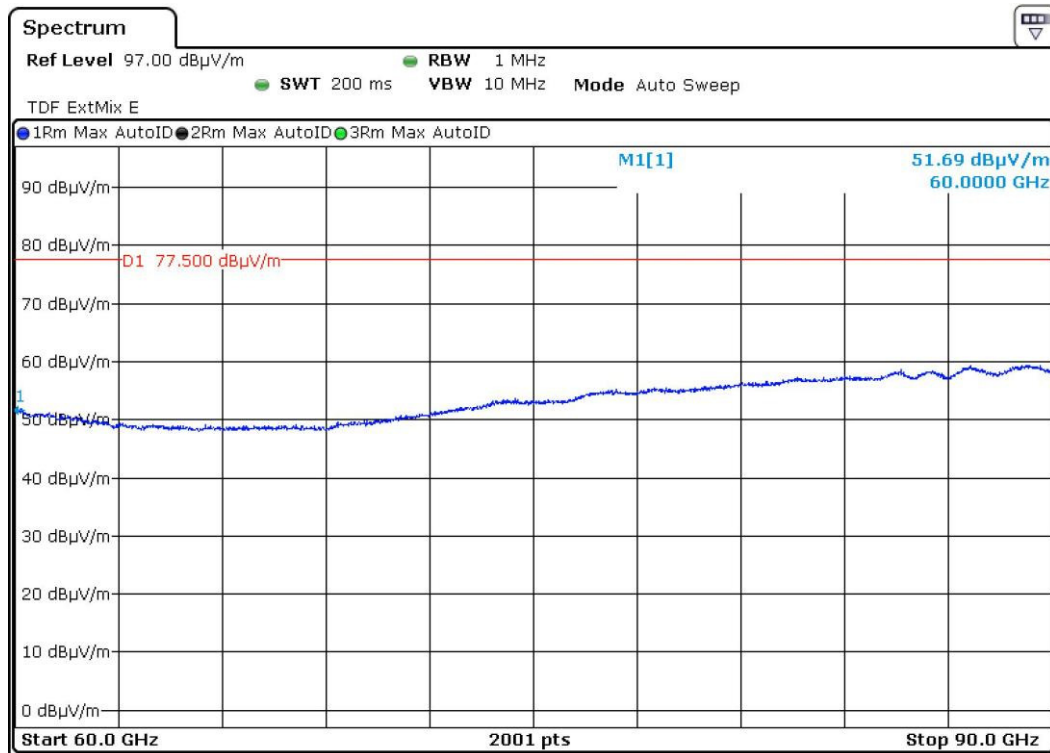
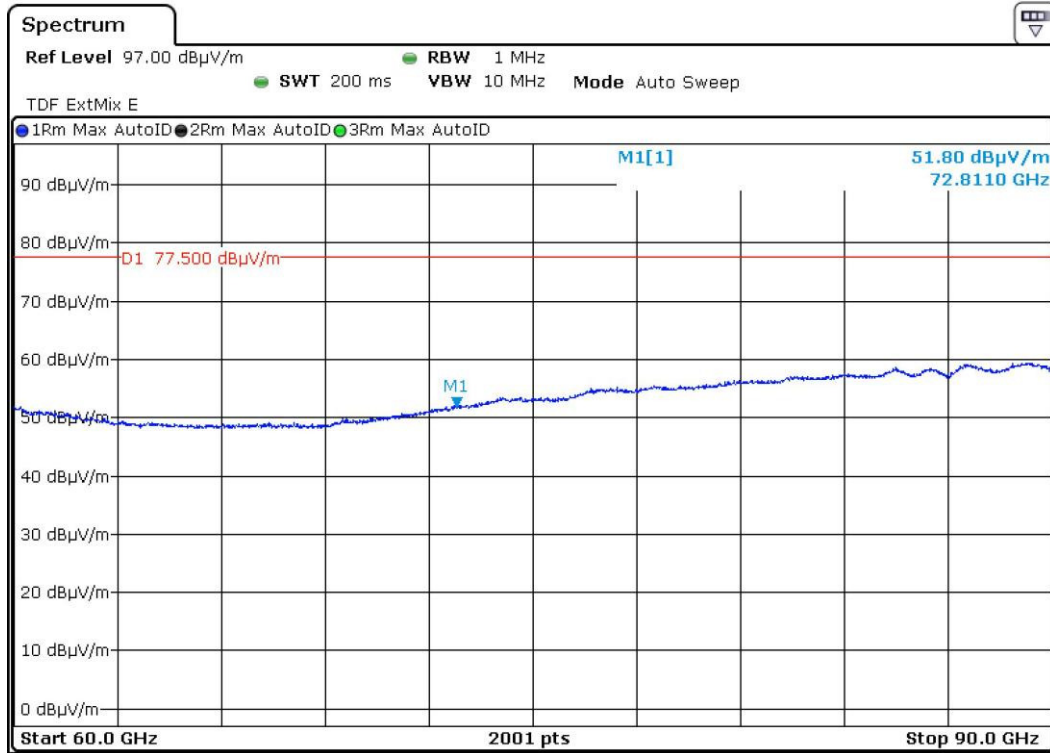
Type	Manufacturer/ Model no.	Cable no.	Last calibration	Next calibration	Calibration executed by
RF- cable	Kabelmetal 18m [N]	K1a	10/2015	10/2016	Dudde
RF- cable	Sucoflex 104 2m [APC]	K17a	10/2015	10/2016	Dudde
RF- cable	Sucoflex 104 2m [APC]	K18a	10/2015	10/2016	Dudde
RF- cable	Aircell 0.5m [BNC]	K40	10/2015	10/2016	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K50	10/2015	10/2016	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K51	10/2015	10/2016	Dudde
RF- cable	Aircell 1m [BNC/N]	K56	10/2015	10/2016	Dudde
RF- cable	Sucoflex 100 Suhner [N] 1 m	K61	10/2015	10/2016	Dudde
RF- cable	Sucoflex 100 Suhner [SMA] 0.5 m	K62	10/2015	10/2016	Dudde
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K83	10/2015	10/2016	Dudde
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K84	11/2015	11/2016	Dudde
RF- cable	Sucoflex Suhner 13 m [N]	K144	10/2015	10/2016	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K145	10/2015	10/2016	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K146	10/2015	10/2016	Dudde
RF- cable	Jyebao 1.5 m [APC]	K147	10/2015	10/2016	Dudde
RF- cable	Jyebao 3 m [APC]	K148	10/2015	10/2016	Dudde
RF- cable	Jyebao 3 m [APC]	K501	10/2015	10/2016	Dudde

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Test results: Harmonics & Spurious emissions 40 GHz – 60 GHz (Horizontal and Vertical respectively)

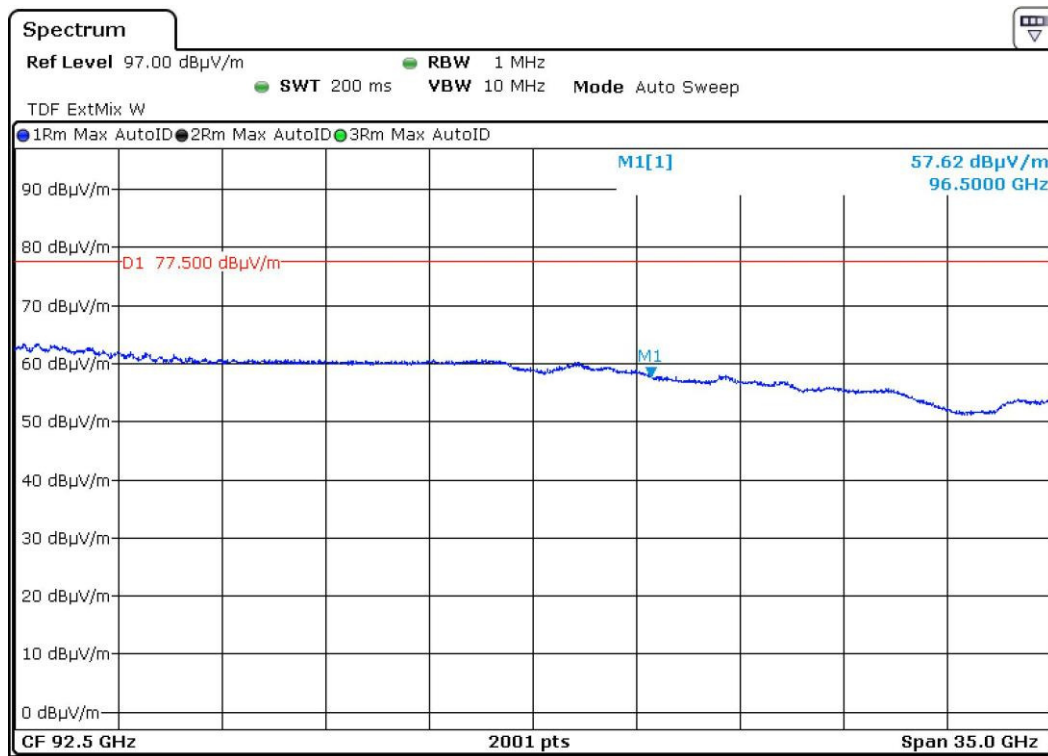
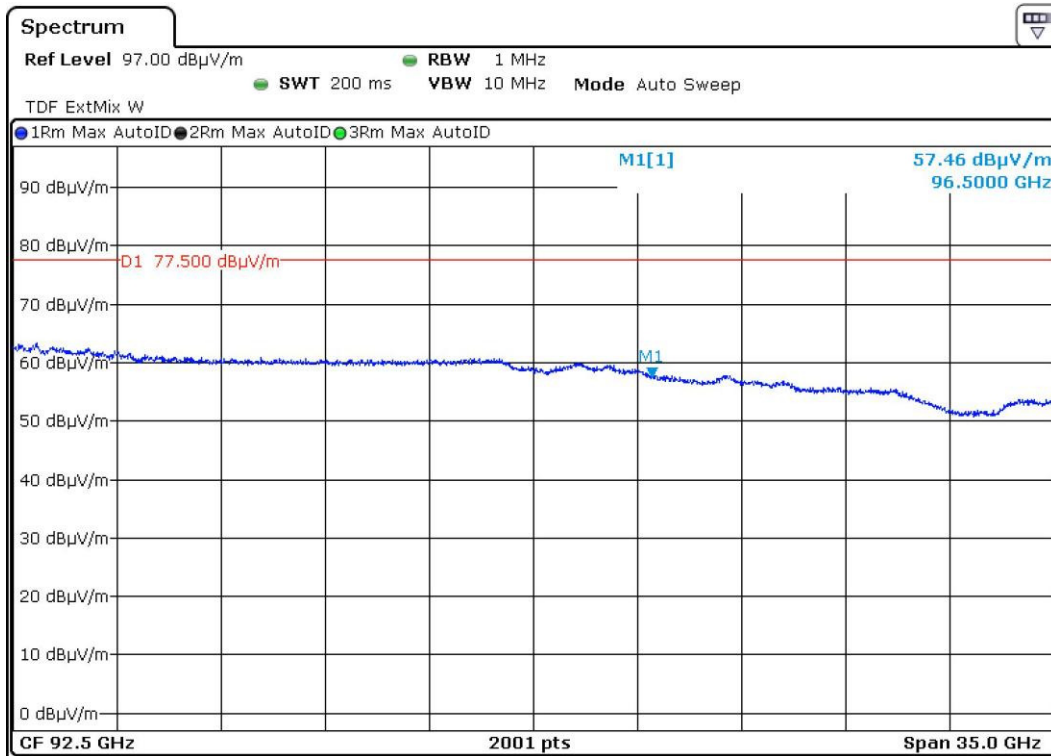


Test results: Harmonics & Spurious emissions 60 GHz – 90 GHz (Horizontal and Vertical respectively)



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Test results: Harmonics & Spurious emissions 90 GHz – 110 GHz (Horizontal and Vertical respectively)



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End of test report