Test Report acc. to FCC Title 47 CFR Part 15
relating to
Schulte-Schlagbaum AG
LSW400

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

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

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MANUFACTURER	
Manufacturer name	**Schulte-Schlagbaum AG**
Manufacturer's grantee code	**Q3I**
Manufacturer's address	Nevigeser Str. 100-110, 42553 Velbert, Germany
Phone	+49 (0) 20512086518
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Email	Helmut.guth@sag-schlagbaum.com

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 - Section 15.247**
Measurement procedure	**ANSI C63.4-2014 & ANSI C63.10-2013**

EQUIPMENT UNDER TEST (EUT)	
Equipment category	Electronic furniture lock
Trade name	SAFE-O-TRONIC access LSW
Type designation	**LSW400**
Serial no.	---
Sample no.	EUT # 1, EUT # 2, EUT # 3
Variants	---

1. Test result summary

Clause	Requirements headline	Test result			Page number
8.1	Antenna requirement	**Pass**	~~Fail~~	~~N.t.~~*	10
8.2	Conducted limits	~~Pass~~	~~Fail~~	**N.t.**[2]	11 - 13
8.3	Restricted bands of operation	**Pass**	~~Fail~~	~~N.t.~~*	14 - 15
8.4	Radiated emission limits, general requirements	**Pass**	~~Fail~~	~~N.t.~~*	16 - 20
8.5	Bandwidth	**Pass**	~~Fail~~	~~N.t.~~*	21 - 22
8.6	Peak output power	**Pass**	~~Fail~~	~~N.t.~~*	23 - 27
8.7	Out of band emissions	**Pass**	~~Fail~~	~~N.t.~~*	28 - 31
8.8	Power spectral density	**Pass**	~~Fail~~	~~N.t.~~*	32 - 33
8.9	Radio frequency hazard	**Pass**	~~Fail~~	~~N.t.~~*	34

* Not tested

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

Signature		
Name	**Mr. Ralf Trepper**	**Mr. Manfried Dudde**
Designation	**RF Test engineer**	**Laboratory-Manager**
Date of issue	**2017-03-29**	**2017-03-29**

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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 numbers of pages in this report is **37**.

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 Section 15.247, ANSI C63.4-2014 & ANSI C63.10-2013

The sample of the product was received on:

- 2017-03-03

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

- 2017-03-16 - 2017-03-21

3. Testing laboratory

m. dudde hochfrequenz-technik,
Rottland 5a,
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FCC Registration Number: 699717

Accredited by:

DAkkS Deutsche Akkreditierungsstelle GmbH
DAkkS accreditation number: D-PL-12053-01-00

4. Applicant

Company name	: Schulte-Schlagbaum AG
Address	: Nevigeser Str. 100-110 42553 Velbert
Country	: Germany
Telephone	: +49 (0) 20512086518
Fax	: +49 (0) 20512086915
Email	: Helmut.guth@sag-schlagbaum.com
Date of order	: 2017-02-22
References	: Mr. Helmut Guth

5. Product

Sample of the following apparatus was submitted for testing:

Manufacturer	: Schulte-Schlagbaum AG
Trademark	: SAFE-O-TRONIC access LSW
Type designation	: LSW400
Serial number	: ---
Sample number	: EUT # 1, EUT # 2, EUT # 3
Hardware version	: ---
Variant	: ---
Software release	: ---
Type of equipment	: Electronic furniture lock
Power used	: 4.5 V DC
Frequency used	: 2.400 GHz – 2.4835 GHz
Generated or used frequencies	: 32.0 MHz (crystal), 2.405 GHz – 2.480 GHz (carrier)
ITU emission class	: 2M83G7D
FCC ID	: Q3ILSW

For issuing this report the following product documentation was used:

Title	Description	Version
User Manual	LSW_6-703-2 33S1 1	Edition: 20170207 Version: 1.1

For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est (EUT)	2017-03-29	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est (EUT)	2017-03-29	Annex no. 2
Channel occupancy / bandwidth	2017-03-29	Annex no. 3
Label sample	2017-03-29	Annex no. 4
Functional description / User Manual	2017-03-29	Annex no. 5
Test setup photos	2017-03-29	Annex no. 6
Block diagram	2017-03-29	Annex no. 7
Operational description	2017-03-29	Annex no. 8
Schematics	2017-03-29	Annex no. 9
Parts list	2017-03-29	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 : 2017-03-29

Name : Ralf Trepper

Designation : RF Test Engineer

Signature : ....

Date : 2017-03-29

Name : Manfried Dudde

Designation : Manager

Signature : ....

dudde hochfrequenz-technik **Rottland 5a** **D-51429 Bergisch Gladbach/ Germany** **Tel: +49 2207-96890** **Fax +49 2207-968920**

7. Operational description

7.1 EUT details

The EUT is a furniture locking system.

7.2 EUT configuration

The EUT starts to run when connected to 4.5 V DC. There are different mode of operation for this furniture locking system. For testing purpose continuous sending mode and EUT with external antenna connector is arranged from the manufacturer.

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: 4.5 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.

8.1 Antenna requirement

8.1.1 Regulation

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

8.1.2 Result

Antenna Type	Antenna description	Frequency	Gain*	Number of Antennas
Integrated Antenna	PCB antenna	**2.400 GHz - 2.4835 GHz**	**-2.6 dBi**	1

For the testing purpose temporary antenna connectors are made available by the manufacturer, but not available for the end user!
* Gain here represent the difference in measured radiated power and conducted power

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

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

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 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

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

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

(2) For all other carrier current systems: 1000 µV within the frequency band 535–1705 kHz, as measured using a 50 µH/50 ohms 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 C63.4-2014 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 - 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						
		9						
		9						
		9						
Measurement uncertainty < ± 2 dB								

Conducted emissions - Tested with a Laptop only								
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						
		9						
		9						
		9						
Measurement uncertainty < ± 2 dB								

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

The equipment passed the conducted tests	~~Yes~~	~~No~~	**N.t.**[2]

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

N.t.* see clause: 9

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Conducted emissions - 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**	**dBµV**	**dBµV**	**dB**	**dBµV**	**dBµV**	**dB**
		9						
		9						
		9						
		9						
		9						
Measurement uncertainty < ± 2 dB								

Conducted emissions - Tested with a Laptop over USB 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**
		9						
		9						
		9						
		9						
		9						
Measurement uncertainty < ± 2 dB								

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

The equipment passed the conducted tests	~~Yes~~	~~No~~	**N.t.**[2]

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

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 MHz	**Frequency Band MHz**	**Frequency Band MHz**	**Frequency Band 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) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e) of this section, 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) of this section, the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a) of this section, and the fundamental emission is outside of the bands listed in paragraph (a) of this section 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 §15.213.

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

(5) Biomedical telemetry devices operating under the provisions of §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 subparts 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).

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

8.3.2 Result

Test Cables used	K1a, K40, K56, K83, K84, K147, K148
Test equipment used	23, 103, 166a, 171a, 280, 345, 359a, 406, 443, 445a

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

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

**All emissions that falls under the restricted bands of operations are included in clause 8.4 and are maked blue.

N.t.* see clause: 9

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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 §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 §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 §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 §15.109 that are applicable to the incorporated digital device.

(g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

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.

Radiated emissions test characteristics	
Test distance	3 m*
Test instrumentation resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 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. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

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 35.91 dBµV/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).

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8.4.4 Result

Transmitter spurious radiation below 30 MHz (Section 15.205, 15.247, 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			**					
	QP	120	**	10			**					
Measurement uncertainty: ± 4 dB												
**No emissions detected												
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 ≤ 4.0 dBµV@10m distance (0.009 MHz –30 MHz) Remark: *[2] Peak Limit according to Section 15.35 (b). Unless otherwise specified, e.g., see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519 of this part, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.												

Test Cables used	K1a, K56, K83
Test equipment used	23, 103

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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Transmitter spurious radiation above 30 MHz (Section 15.205, 15.247, 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	8.5*5	0	0	**12.0**	43.5	**31.5**	0-360	H / V	1-4
1700.00	PK	100	≤ 4.5	3	3.8*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	8.0*6	0	0	**18.0**	54.0	**36.0**	0-360	H / V	1-4
4000.00	PK	100	≤ 10	3	8.4*6	0	0	**18.4**	54.0	**35.6**	0-360	H / V	1-4
5000.00	PK	100	≤ 10	3	9.1*6	0	0	**19.1**	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													

Radiation emissions are measured till 24 GHz

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

Blue marked are restricted band

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, K56, K83, K84, K147, K148
Test equipment used	23, 103, 166a, 171a, 280, 345, 359a, 406, 443, 445a

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

8.5 Bandwidth

8.5.1 Regulation

Section 15.247 (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.5.2 Result

Operating Frequency	Minimum Measured 6 dB Bandwidth
MHz	MHz
2405	1.621
2440	1.609
2480	1.593

Operating Frequency	Maximum Measured 20 dB Bandwidth
MHz	MHz
2405	2.795
2440	2.830
2480	2.786

Test Cables used	K144
Test equipment used	144, 226a, 502

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

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

N.t.* see clause: 9

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8.6 Peak output power

8.6.1 Regulation

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, *i.e.*, the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

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8.6.2 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.

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Radiated emissions test characteristics	
Test distance	10m, 3 m*
Test instrumentation resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1000 MHz)
	1 MHz (Above 1000 MHz)
Receive antenna scan height	1 m (Below 30 MHz)
	1 m - 4 m (30 MHz - 15000 MHz)
	1 m – 2.5 m (18000 MHz - 40000 MHz)
	1 m (Above 40000 MHz)
Receive antenna polarization	0° or 90° (Below 30 MHz)
	vertical/horizontal (Above 30 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).

8.6.3 Calculation of the peak power (radiated)

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 : field attenuation + cable loss

For example:
The receiver reading is +1.0 dBm. The field attenuation for the measured frequency is +19.5 dB and the cable factor for the measured frequency is 2.1 dB, giving a power of +22.6 dBm.
The +22.6dBm value can be mathematically converted to its corresponding level in W.

+22.6 dBm = 0.182 W = 182 mW

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8.6.4 Result

Peak output power at antenna port (Section 15.247)							
f	**Detct**	**BW**	**Rx Level**	**CF**	**LC**	**Limit**	**Margin**
MHz	**Type**	**kHz**	**dBm**	**dB**	**dBm**	**dBm**	**dB**
2405	PK	100	**0.4**	0.7	**1.1**	30	**28.9**
2440	PK	100	**0.5**	0.7	**1.2**	30	**28.8**
2480	PK	100	**0.9**	0.7	**1.6**	30	**28.4**
Measurement uncertainty: ± 1.2 dB							
f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | CF : Correction factor | LC : Level corrected |							

Test Cables used	K114
Test equipment used	144, 226, 502, 356

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

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

N.t.* see clause: 9

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8.7 Out of band emission

8.7.1 Regulation

Section 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

8.7.2 Calculation of the "Out of band emissions"

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 : field attenuation + cable loss

For example:
The receiver reading in a 100 kHz bandwidth is -45.0 dBm. The field attenuation for the measured frequency is +10.5 dB and the cable factor for the measured frequency is 1.5 dB, giving a power of -33.0 dBm.
The measured peak power in a 100 kHz bandwidth is +3.6dBm. Therefore the Attenuation can be calculated as follows:

Attenuation = measured peak power – out of band emission receiver reading = +3.6 dBm – (-33.0 dBm) =36.6 dB

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8.7.3 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.

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8.7.4 Result

Out of band emissions - Conducted (Transmitter) (Section 15.247) / frequency, 2405 MHz							
f	**Detct**	**BW**	**Rx Level**	**CF**	**LC**	**Limit**	**Margin**
MHz	**Type**	**kHz**	**dBm**	**dB**	**dBm**	**dBm**	**dB**
63.995	PK	100	**-54.5**	0.3	-54.2	-18.9	**35.3**
2399.742	PK	100	**-64.0**	0.7	-63.3	-18.9	**44.4**
7216.373	PK	100	**-59.0**	0.8	-58.2	-18.9	**39.3**

Out of band emissions - Conducted (Transmitter) (Section 15.247) / frequency, 2440 MHz							
f	**Detct**	**BW**	**Rx Level**	**CF**	**LC**	**Limit**	**Margin**
MHz	**Type**	**kHz**	**dBm**	**dB**	**dBm**	**dBm**	**dB**
63.995	PK	100	**-55.1**	0.3	-54.8	-18.8	**36.0**
7321.440	PK	100	**-55.8**	0.8	-55.0	-18.8	**36.2**

Out of band emissions - Conducted (Transmitter) (Section 15.247) / frequency, 2480 MHz							
f	**Detct**	**BW**	**Rx Level**	**CF**	**LC**	**Limit**	**Margin**
MHz	**Type**	**kHz**	**dBm**	**dB**	**dBm**	**dBm**	**dB**
63.995	PK	100	**-54.7**	0.3	-54.4	-18.4	**36.0**
2483.437	PK	100	**-55.4**	0.7	-54.7	-18.4	**36.3**
7441.400	PK	100	**-54.3**	0.8	-53.5	-18.4	**35.1**
Measurement uncertainty: ± 1.2 dB							
---							
f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | CF : Correction factor | LC : Level corrected							

Test Cables used	K114
Test equipment used	144, 226, 502, 356

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

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

N.t.* see clause: 9

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8.8 Power spectral density

8.8.1 Regulation

Section 15.247 (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

8.8.2 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.

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8.8.3 Result

Power Spectral Density (Conducted, section 15.247)						
Frequency (MHz)	Bandwidth Type of detector kHz	Noted receiver level dBm	Correction factor dB	Level corrected dBm	Limit Peak dBm	Margin dB
2405	**3, PK**	**-18.0**	**0.7**	**-17.3**	**8**	**25.3**
2440	**3, PK**	**-17.1**	**0.7**	**-16.3**	**8**	**24.3**
2480	**3, PK**	**-16.7**	**0.7**	**-16.0**	**8**	**24.0**
Measurement uncertainty: ±1.2 dB						

Bandwidth = the measuring receiver bandwidth

Test Cables used	K144
Test equipment used	144, 226, 356, 502

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

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

N.t.* see clause: 9

8.9 Radio frequency hazard

8.9.1 Regulation

15.247(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

8.9.2 Test result

MPE calculation to the FCC ID:

These equations are generally accurate in the far field of an antenna but will over predict power density in the near field, where they could be used for making a "worst case" prediction.

$$S = PG/4\pi R^2 \quad \text{Or} \quad S = EIRP/(4\pi R^2)$$

Where
S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units e.g. mW)
G = power gain of the antenna in the direction of interest relative to the isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units e.g. cm)
EIRP = equivalent isotropically radiated power

Calculation:

Radio frequency hazard (Section 15.247)					
Max. EIRP		**Distance**	**Calculated Power Density**	**Limit**	**Margin**
dBm	**mW**	**cm**	**mW / cm^2**	**mW / cm^2**	**mW / cm^2**
-1.4	**0.724**	20	**0.000144**	1*	**0.999856**
***Limit: the reference level for general public exposure according to the OET Bulletin 65, edition 97-01 Table 1.**					

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

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

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

N.t.* see clause: 9

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9. Additional information to the test report

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

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10. List of test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Calibration executed by
Digital Multimeter	GW GDM 8045G (144)	0090256	08/2016	08:2019	Testo
Power Supply	Hewlett Packard 6034L (226)	2322A-00442	---	---	---
DC Block Adapter (0,45 -26,5 GHz)	Hewlett Packard 11742A (356)	10410	04/2015	04/2018	Dudde
OATS	Dudde (103)	---	06/2016	06/2018	Dudde
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	07/2016	07/2018	Dudde
Pre-amplifier (1GHz - 18GHz)	Narda (345)	---	02/2016	02/2018	Dudde
Pre-amplifier (18GHz – 26.5GHz)	Schwarzbeck BBV 9719 (443)	---	02/2016	02/2018	Dudde
Receiver (9 kHz –18.0 GHz)	Rohde & Schwarz Spectrum Analyzer FSL 18 (171a)	100.117	03/2016	09/2017	Rohde & Schwarz
Signal Analyzer (9 kHz –30.0 GHz)	Rohde & Schwarz FSV 30 (502)	100932	06/2016	06/2019	Rohde & Schwarz
Spectrum Analyzer (9 kHz –40.0 GHz)	Anritsu MS2668C (359a)	100932	06/2016	06/2019	Rohde & Schwarz
Magnetic Loop Antenna (0,09-30MHz)	Schwarzbeck FMLK 1518	1516-23	08/2016	08/2019	Seibersdorf
Bilog-antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	04/2016	04/2019	Seibersdorf
Log. Per, Antenne (1- 18 GHz)	Schwarzbeck STLP 9148 (445a)	---	03/2016	03/2019	Seibersdorf
Horn antenna (15.0-40.0 GHz)	Schwarzbeck BBHA 9170 (280)	BBHA9170378	08/2014	08/2017	Dudde

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Calibration executed by
V-LISN 50 ohms//(50 uH+5 ohms)	EMCO (49b)	9512-1227	08/2014	08/2017	Dudde
V-LISN 50 ohms//(50 uH+5 ohms)	RFT NNB 11 (72)	13835240	09/2016	09/2019	Rohde & Schwarz
Protector limiter 9 kHz - 30MHz 10 dB	Rhode & Schwarz ESH 3Z2 (272)	357,881052	02/2016	02/2019	Dudde
Receiver (9 kHz - 30MHz)	Schwarzbeck FMLK 1518 (428)	1518294 9360	08/2016	08/2019	Testo
Panorama- Monitor FMLK / VUMA	PAZ1550 (429)	---	---	---	---
RF- cable	Aircell 1.5m [BNC/N]	K30	10/2016	10/2017	Dudde

11. List of test cables

Type	Manufacturer/ Model no.	Cable no.	Last calibration	Next calibration	Calibration executed by
RF- cable	Kabelmetal 18m [N]	K1a	10/2016	10/2017	Dudde
RF- cable	Aircell 0.5m [BNC]	K40	10/2016	10/2017	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K52	10/2016	10/2017	Dudde
RF- cable	Aircell 1m [BNC/N]	K56	10/2016	10/2017	Dudde
RF- cable	Sucoflex 100 Suhner [N] 1 m	K61	10/2016	10/2017	Dudde
RF- cable	Sucoflex 106 Suhner 6.4m [N]	K83	10/2016	10/2017	Dudde
RF- cable	Sucoflex 106 Suhner 6.4m [N]	K84	10/2016	10/2017	Dudde
RF- cable	Sucoflex Suhner [SMA] 0.3 m	K114	10/2016	10/2017	Dudde
RF- cable	Sucoflex Suhner 13 m [N]	K144	10/2016	10/2017	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K145	10/2016	10/2017	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K146	10/2016	10/2017	Dudde
RF- cable	Jyebao [APC 3,5] 1.5 m	K147	10/2016	10/2017	Dudde
RF- cable	Jyebao [APC 3,5] 3.0 m	K148	10/2016	10/2017	Dudde

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End of test report

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