EUT: 5WK48801
FCC ID: KR55WK48801

Date of issue: 2009-02-11

Deutscher Akkreditierungs Rat DAR

DAT-P-225/96

Test Report
acc. to the relevant standard
47 CFR Part 15 C – Intentional Radiators
Measurement Procedure:
ANSI C63.4-2003
relating to
Continental Automotive GmbH
5WK48801

Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz

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DATech

DAT-P-225/96

m. dudde hochfrequenz - technik Rottland 5a D-51429 Bergisch Gladbach Tel. +49 2207-96890 Fax +49 2207 968920

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Manufacturer's details	
Manufacturer	**Continental Automotive GmbH**
Manufacturer's grantee code	**KR5**
Manufacturer's address	**Continental Automotive GmbH**
	Siemensstrasse 12
	D-93005 Regensburg
	Germany
	Phone: +49 0941 790 6699
	Fax: +49 0941 790 136699
	dagmar.kolar@continental-corporation.com
Relevant standard used	47 CFR Part 15C - Intentional Radiators
	ANSI C63.4-2003

Test report prepared by	
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	Rottland 5a
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Equipment Under Test (EUT)	
Equipment category	Transmitter
Trade name	Continental
Type designation	5WK48801
Serial no.	---
Variants	

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1. Test result summary

CFR Section	Report Chapter	Requirements Headline	Test result		
15.203	11.1	Antenna requirement	Pass	~~Fail~~	~~N.t.~~
15.205	11.2	Restricted bands of operation	Pass	~~Fail~~	~~N.t.~~
15.209	11.3	Radiated emission limits, general requirements	Pass	~~Fail~~	~~N.t.~~
15.231(a)	11.4	Periodic operation characteristics	Pass	~~Fail~~	~~N.t.~~
15.231(b)	11.5	Fundamental frequencies / Field strength limits	Pass	~~Fail~~	~~N.t.~~
15.231(c)	11.6	Bandwidth (20 dB)	Pass	~~Fail~~	~~N.t.~~
15.201 (a) 15.209	11.7	Equipment authorization requirement	Pass	~~Fail~~	~~N.t.~~

The equipment meets the requirements	Yes	~~No~~

Signature
Technician Ralf Trepper

Signature
Manager Manfried Dudde

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2. Test laboratory

Company name	: m.dudde hochfrequenz-technik
Street	: Rottland 5a
City	: 51429 Bergisch Gladbach
Country	: Germany
Laboratory	: FCC Registration Number: 699717 This site has been fully described in a report submitted to the FCC, and renewed with letter dated July 12, 2008, Registration Number 699717.
Phone	: +49-2207-9689-0
Fax	: +49-2207-9689-20
E-Mail	: manfred.dudde@t-online.de
Web	: http://www.dudde.com

3. Introduction

The test report 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.

This report contains the result of tests performed by m. dudde hochfrequenz - technik for the purpose of a type approval. The order for carrying out these tests has been placed by:

Applicant

Company name	: Continental Automotive GmbH
Address	: Siemensstrasse 12
Postcode	: D-93055
City/town	: Regensburg
Country	: Germany
Telephone	: +49 941 790 6699
Telefax	: +49 941 790 136699
E-mail	: dagmar.kolar@continental-corporation.com
Date of order	: 2008-11-19
References	: Mrs. Kolar

4. Product

Samples of the following apparatus were submitted for testing:

Type of equipment	: Transmitter
Trademark	: Continental
Type designation	: **5WK48801**
Hardware version	: **5WK48801**
Variants	:
Serial number	: ---
Software release	: ---
Power used	: 3.0 VDC
Frequency used	: 433.589 MHz, 433.920 MHz, 434.251 MHz,
Generated or used frequencies	: 433.589 MHz, 433.920 MHz, 434.251 MHz, (Carrier) / 13.08 MHz (crystal)
ITU emission class	: 84K8 F1D
FCC ID	**: KR55WK48801**

5. Test schedule

The tests were carried out in accordance with the specifications detailed in chapter 7 “Summary“ of this report at:

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

The test sample was received on:

- 2008-12-29

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

- 2009-01-30 - 2009-02-09

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6. Product and measurement documentation

For issuing this report the following product documentation was used and the following annexes were created:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est	2009-02-10	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est	2009-02-10	Annex no. 2
Occupied bandwidth plot	2009-02-10	Annex no. 3
FCC ID label sample	2009-02-10	Annex no. 4
Functional description / User Manual	2009-02-10	Annex no. 5
Test setup photos	2009-01-30	Annex no. 6
Block diagram	2009-02-10	Annex no. 7
Schematics	2009-02-10	Annex no. 8a
Parts list	2009-02-10	Annex no. 8b
Operational description	2009-02-10	Annex no. 9
Periodic operation characteristic	2009-02-10	Annex No. 10

The above mentioned documentation will be filed at m. dudde hochfrequenz - technik for a period of 10 years following the issue of this test report.

7. Observations and comments

8. Summary

The product is intended for the use in the following areas of application:

Radio-Noise Emissions from Low- Voltage Electrical and Electronic Equipment in the frequency range of 9 kHz to 40 GHz

The samples were tested according to the following specification:

47 CFR Part 15 – Intentional Radiators, ANSI C63.4-2003

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9. Conclusions

Samples of the apparatus were found to **CONFORM WITH** the specifications stated in chapter 8 "Summary" of this report.

In the opinion of m. dudde hochfrequenz - technik, the samples satisfied all applicable requirements relating to the network interface types specified in chapter 8.

The results of the type tests as stated in this report are exclusively applicable to the product item as identified in this report. m. dudde hochfrequenz - technik does not accept any responsibility for the results stated in this report, with respect to the properties of product items not involved in these tests.

This report consists of a main module, modules with test results and annexes listed in chapter 6. All pages have been numbered consecutively and bear the m. dudde hochfrequenz - technik logo, the report number and sub-numbers.

The total number of pages in this report is **40.**

Technical inspector:

Date : 2009-02-11

Name : Ralf Trepper

Signature : 

Technical responsibility for area of testing:

Date : 2009-02-11

Name : Manfried Dudde

Signature : 

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10. Operational description

10.1 EUT details

See Annex no. 5 (Technical description)

10.2 EUT configuration

The ***Radio frequency transmitter 5WK48801*** operated in the continuous transmitting mode after pressing a bottom.

10.3 EUT measurement description

The ***Radio frequency transmitter 5WK48801*** was tested in a typical fashion. During preliminary emission tests the ***Radio frequency transmitter 5WK48801*** was operated in the continuous transmitting mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with ***Radio frequency transmitter Type 5WK48801*** operated in continuous modes.
All tests were performed with the applicant's declared maximal voltage: 3.0 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.

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11.1 Antenna requirement

11.1.1 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 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.

11.1.2 Result

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

Integrated antennas as part on the PCB

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11.2 Restricted bands of operation

11.2.1 Regulation

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

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.

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

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

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

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

(4) Any equipment operated under the provisions of § 15.253, § 15.255 or § 15.257 of this part.

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

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

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

(8) Devices operated in the 24.075-24.175 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in § 15.245(b).

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

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

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

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

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

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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 § 15.257 of this part.

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

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

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

(8) Devices operated in the 24.075-24.175 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in § 15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under § 15.249 are exempt from 83 complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in § 15.249(a).

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

11.2.2 Result

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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11.3 Radiated emission limits, general requirements

11.3.1 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:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
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

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

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

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

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

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

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11.3.2 Test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration
Receiver (9 kHz –18.0 GHz)	Rohde & Schwarz Spectrum Analyzer FSL 18 (171a)	100.117	2008/10	2010/10
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	2008/02	2010/02
Pre-amplifier (1GHz - 18GHz)	Narda --- (345)	---	2008/02	2010/02
Magnetic loop antenna (9 kHz - 30 MHz)	Schwarzbeck FMZB 1516 (23)	---	2008/09	2010/09
Bilog antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	2007/02	2013/02
Horn antenna (0.86-8.5 GHz)	Schwarzbeck BBHA 9120 A (284)	236	2008/01	2013/01
Horn antenna (2.0-14.0 GHz)	Schwarzbeck BBHA 9120 C (169)	305	2008/01	2013/01
RF- cable	Kabelmetal 18m [N]	K1	2008/01	2009/01
RF- cable	Aircell 0.5m [BNC]	K40	2008/01	2009/01
RF- cable	Aircell 1m [BNC/N]	K56	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K75	2008/01	2009/01

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11.3.3 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 degrees 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: 2003 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4-2003. The C63.4-2003 measurement procedure consists of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. Subclause 8.3.1.2 of C63.4-2003 states that the measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beamwidth of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in C63.4-2003, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beamwidth of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTS, measuring system sensitivity, etc.

C63.4-2003 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	
Frequency range	30 MHz - 4,000 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1000 MHz - 4,000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

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

11.3.4 Calculation of the field strength

The field strength is calculated by the following calculation:

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

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

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

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

Level in µV/m = Common Antilogarithm (35.91/20) = 39.8

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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11.3.5 Test result

For all emission other than harmonic spurious emissions (e.g. oscillator frequencies, crystals, microcontroller)

TRANSMITTER SPURIOUS RADIATION BELOW 30 MHz (Section 15.205, 15.209)									
f (MHz)	Bandwidth (kHz) Type of detector	Noted receiver level **dBµV**	Test distance **m**	Correction factor **dB**	Distance extrapol. factor **dB**	Level corrected **dBµV/m**	Limit **dBµV/m**	Margin **dBµV/m**	Polarisation EUT / antenna orientation
0.1200	*PK/0.2kHz*	*< 4.0*	*10*	20.2	*-59.1*	-34.90	*Pk46.0- @ 300*	80.90	V, H/0-360°
	AV/0.2kHz	*< 4.0*	*10*	20.2	*-59.1*	-34.90	*AV26.0 @ 300*	80.90	V, H/0-360°
0.5000	*AV/0.2kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV33.6 @ 30*	28.5	V, H/0-360°
1.5000	*AV/0.2kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV24.1 @ 30*	19.00	V, H/0-360°
3.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
5.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
8.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
10.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
20.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
30.0000	*AV/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°
No emissions detected									
Measurement uncertainty		4 dB							

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).

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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For all emission other than harmonic spurious emissions (e.g. oscillator frequencies, crystals, microcontroller)

TRANSMITTER SPURIOUS RADIATION ABOVE 30 MHz (Section 15.205, 15.209)

f (MHz)	Bandwidth (kHz) Type of detector	Noted receiver level **dBµV**	Test distance **m**	Correction factor **dB**	Distance extrapol. factor **dB**	AV Correction factor **dB**	Level corrected **dBµV/m**	Limit **dBµV/m**	Margin **dBµV/m**	Polaris. EUT / antenna	Antenna height **cm**
30.0000	100, AV	≤ 3.5	3	-2.60	0	0	0.90	40.00	39.10	H,V/H,V	100-400
88.0000	100, AV	≤ 3.5	3	-10.80	0	0	-7.30	40.00	47.30	H,V/H,V	100-400
216.0000	100, AV	≤ 3.5	3	-10.30	0	0	-6.80	43.50	50.30	H,V/H,V	100-400
960.0000	100, AV	≤ 3.5	3	8.50	0	0	12.00	43.50	31.50	H,V/H,V	100-400
1700.0000	1000, AV	≤ 4.5	3	3.80	0	0	8.30	54.00	45.70	H,V/H,V	100-400
2250.0000	1000, AV	≤ 10	3	8.00	0	0	18.00	54.00	36.00	H,V/H,V	100-400
4000.0000	1000, AV	≤ 10	3	8.40*[6]	0	0	18.40	54.00	35.60	H,V/H,V	100-400
5000.0000	1000, AV	≤ 10	3	9.10*[6]	0	0	19.40	54.00	34.60	H,V/H,V	100-400
7500.0000	1000, AV	≤ 14	3	12.9*[6]0	0	0	26.90	54.00	27.10	H,V/H,V	100-400
8300.0000	1000, AV	≤ 14	3	14.80*[6]	0	0	28.80	54.00	25.20	H,V/H,V	100-400
9400.0000	1000, AV	≤ 14	3	16.00*[6]	0	0	30.00	54.00	24.00	H,V/H,V	100-400
11000.0000	1000, AV	≤ 14	3	18.25*[6]	0	0	32.25	54.00	21.75	H,V/H,V	100-400
No emissions detected											
Measurement uncertainty	4 dB										

Bandwidth = the measuring receiver bandwidth

Remark: *[1] noise floor noise level of the measuring instrument ≤ 4.0dBµV @ 10m distance (0.009 – 30 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 6.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10 dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 17 dBµV @ 3m distance (2,000 – 5,500 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

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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11.4 Periodic operation characteristics

11.4.1 Regulation

(a) The provisions of this Section are restricted to periodic operation within the band 40.66 - 40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this Section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

11.4.2 Test results

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	**Yes**	~~**No**~~	Annex no: 11

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	**Yes**	~~**No**~~	Annex no: 11

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

The equipment meets the requirements	~~**Yes**~~	~~**No**~~	**N.t.**

Further test results are attached	~~**Yes**~~	**No**	

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(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

The equipment meets the requirements	~~Yes~~	~~No~~	N.t.

Further test results are attached	~~Yes~~	No	

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmission are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

The equipment meets the requirements	~~Yes~~	~~No~~	N.t.

Further test results are attached	~~Yes~~	No	

(6) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) and may be employed for any type of operation, including operation prohibited in paragraph (a), provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this Section, except the field strength table in paragraph (b) is replaced.

The equipment meets the requirements	~~Yes~~	~~No~~	N.t.

Further test results are attached	~~Yes~~	No	

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11.5 Fundamental frequencies / Field strength limits

11.5.1 Regulation

(e) In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750 **	125 to 375 **
174 - 260	3,750	375
260 - 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

** linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, uV/m at 3 meters = 56.81818(F) - 6136.3636; for the band 260-470 MHz, uV/m at 3 meters = 41.6667(F) - 7083.3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

(2) Intentional radiators operating under the provisions of this Section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Section 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Section 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

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11.5.2 Test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration
Receiver (9 kHz –18.0 GHz)	Rohde & Schwarz Spectrum Analyzer FSL 18 (171a)	100.117	2008/10	2010/10
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	2008/02	2010/02
Pre-amplifier (1GHz - 18GHz)	Narda --- (345)	---	2008/02	2010/02
Magnetic loop antenna (9 kHz - 30 MHz)	Schwarzbeck FMZB 1516 (23)	---	2008/09	2010/09
Bilog antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	2007/02	2013/02
Horn antenna (0.86-8.5 GHz)	Schwarzbeck BBHA 9120 A (284)	236	2008/01	2013/01
Horn antenna (2.0-14.0 GHz)	Schwarzbeck BBHA 9120 C (169)	305	2008/01	2013/01
RF- cable	Kabelmetal 18m [N]	K1	2008/01	2009/01
RF- cable	Aircell 0.5m [BNC]	K40	2008/01	2009/01
RF- cable	Aircell 1m [BNC/N]	K56	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K75	2008/01	2009/01

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11.5.3 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a turn table which is 0.8m above the ground. The turn table would be allowed to rotate 360 degrees to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna are 3m. To find the maximum emission, the polarization of the receiving antenna are changed in horizontal and vertical polarization, the position of the EUT was changed in different orthogonal determinations.

ANSI C63.4: 2003 Section 8 “Radiated emission measurements”

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4-2003. The C63.4-2003 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 8.3.1.2 of C63.4-2003 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 C63.4-2003, 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.

C63.4-2003 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 beam width of the antenna so that the maximum emission from the EUT is measured.

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Radiated emissions test characteristics	
Frequency range	30 MHz - 4,000 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1000 MHz - 4,000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

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

11.5.4 Calculation of field strength limits

For example: Transmitter working on 315 MHz
Limit for average measurements → 41.6667*(315 MHz) – 7083.3333 = 6041.677µV/m = 75.6dBµV/m @3m
Limit for peak measurements → Limit for average measurements + 20dB = 95.6dBµV/m @3m

11.5.5 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.

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11.5.6 Calculation of the field strengths

The field strength is calculated by the following calculation:

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

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

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

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

Level in µV/m = Common Antilogarithm (35.91/20) = 39.8

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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11.5.7 Test result

Lowest channel: 433.589 MHz

TRANSMITTER SPURIOUS RADIATION (Section 15.231(b))

f (MHz)	Bandwidth (kHz) / Type of detector	Noted receiver level dBµV	Test distance m	Correction factor dB	Averaging correction Factor *7 dB	Level corrected dBµV/m	Limit dBµV/m	Margin dBµV/m	Polarisation EUT / antenna	Antenna height cm
433.578	***120, PK***	**82.4**	**3**	**-2.7**	**0**	**79.7**	**80.8**	**1.1**	**V 15° / V**	**112**
867.156	***120, PK***	**38.7**	**3**	**6.3**	**0**	**45.0**	**60.8**	**15.8**	**V 15° / V**	**108**
1300.734	***1000, PK***	**52.8**	**3**	**0.6**	**0**	**53.4**	**54.0**	**0.6**	**V 15° / V**	**114**
1734.312	***1000, PK***	**53.7**	**3**	**4.2**	**0**	**57.9**	**60.8**	**2.9**	**V 15° / V**	**134**
2167.890	***1000, PK***	**44.1**	**3**	**7.3**	**0**	**51.4**	**60.8**	**9.4**	**V 15° / V**	**110**
2601.468	***1000, PK***	**47.9**	**3**	**9.6**	**0**	**57.5**	**60.8**	**3.3**	**V 15° / V**	**122**
3035.046	***1000, PK***	**36.6**	**3**	**11.1**	**0**	**47.7**	**60.8**	**13.1**	**V 15° / V**	**108**
3468.624	*1000, PK*	≤ 17.0	3	12.1	0	29.1	60.8	31.7	H,V/H,V	100-400
3902.202	*1000, PK*	≤ 17.0	3	16.0	0	33.0	54.0	21.0	H,V/H,V	100-400
4335.780	*1000, PK*	≤ 17.0	3	17.5	0	34.5	54.0	19.5	H,V/H,V	100-400
4769.358	*1000, PK*	≤ 17.0	3	18.5	0	35.5	54.0	18.5	H,V/H,V	100-400

The frequencies fall into the restricted bands are blue marked

Measurement uncertainty	4 dB

Bandwidth = the measuring receiver bandwidth

Remark: *1 noise floor noise level of the measuring instrument ≤ 4.0dBµV @ 10m distance (0.009 – 30 MHz)
Remark: *2 noise floor noise level of the measuring instrument ≤ 6.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *3 noise floor noise level of the measuring instrument ≤ 10 dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *4 noise floor noise level of the measuring instrument ≤ 17 dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *5 for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *7 for periodic operated transmitter

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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Middle channel: 433.920 MHz

TRANSMITTER SPURIOUS RADIATION (Section 15.231(b))

f (MHz)	Bandwidth (kHz) / Type of detector	Noted receiver level dBµV	Test distance m	Correction factor dB	Averaging correction Factor *7 dB	Level corrected dBµV/m	Limit dBµV/m	Margin dBµV/m	Polarisation EUT / antenna	Antenna height cm
433.921	***120, PK***	**82.5**	**3**	**-2.7**	**0**	**79.8**	**80.8**	**1.0**	**V 15° / V**	**114**
867.842	***120, PK***	**36.5**	**3**	**6.3**	**0**	**42.8**	**60.8**	**18.0**	**V 15° / V**	**107**
1301.763	***1000, PK***	**50.8**	**3**	**0.6**	**0**	**51.4**	**54.0**	**2.6**	**V 15° / V**	**117**
1735.684	***1000, PK***	**49.9**	**3**	**4.2**	**0**	**54.1**	**60.8**	**6.7**	**V 15° / V**	**142**
2169.605	***1000, PK***	**43.0**	**3**	**7.3**	**0**	**50.3**	**60.8**	**10.5**	**V 15° / V**	**107**
2603.526	***1000, PK***	**42.6**	**3**	**9.6**	**0**	**52.2**	**60.8**	**8.6**	**V 15° / V**	**133**
3037.447	***1000, PK***	**35.2**	**3**	**11.1**	**0**	**46.3**	**60.8**	**14.5**	**V 15° / V**	**102**
3471.368	*1000, PK*	≤ 17.0	3	12.1	0	29.1	60.8	31.7	H,V/H,V	100-400
3905.289	*1000, PK*	≤ 17.0	3	16.0	0	33.0	54.0	21.0	H,V/H,V	100-400
4339.210	*1000, PK*	≤ 17.0	3	17.5	0	34.5	54.0	19.5	H,V/H,V	100-400
4773.131	*1000, PK*	≤ 17.0	3	18.5	0	35.5	54.0	18.5	H,V/H,V	100-400

The frequencies fall into the restricted bands are blue marked

Measurement uncertainty	4 dB

Bandwidth = the measuring receiver bandwidth

Remark: *[1] noise floor noise level of the measuring instrument ≤ 4.0dBµV @ 10m distance (0.009 – 30 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 6.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10 dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 17 dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[5] for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *[7] for periodic operated transmitter

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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Highest channel: 434.251 MHz

TRANSMITTER SPURIOUS RADIATION (Section 15.231(b))

f (MHz)	Bandwidth (kHz) / Type of detector	Noted receiver level dBµV	Test distance m	Correction factor dB	Averaging correction Factor *7 dB	Level corrected dBµV/m	Limit dBµV/m	Margin dBµV/m	Polarisation EUT / antenna	Antenna height cm
434.252	***120, PK***	**81.6**	**3**	**-2.7**	**0**	**78.9**	**80.8**	**1.9**	**V 15° / V**	**111**
868.504	***120, PK***	**34.5**	**3**	**6.3**	**0**	**40.8**	**60.8**	**20.0**	**V 15° / V**	**106**
1302.756	***1000, PK***	**49.2**	**3**	**0.6**	**0**	**49.8**	**54.0**	**4.2**	**V 15° / V**	**123**
1737.008	***1000, PK***	**51.3**	**3**	**4.2**	**0**	**55.5**	**60.8**	**5.3**	**V 15° / V**	**137**
2171.260	***1000, PK***	**46.0**	**3**	**7.3**	**0**	**53.3**	**60.8**	**7.5**	**V 15° / V**	**115**
2605.512	***1000, PK***	**41.8**	**3**	**9.6**	**0**	**51.4**	**60.8**	**9.4**	**V 15° / V**	**126**
3039.764	***1000, PK***	**34.0**	**3**	**11.1**	**0**	**45.1**	**60.8**	**15.7**	**V 15° / V**	**108**
3474.016	*1000, PK*	≤ 17.0	3	12.1	0	29.1	60.8	31.7	H,V/H,V	100-400
3908.268	*1000, PK*	≤ 17.0	3	16.0	0	33.0	54.0	21.0	H,V/H,V	100-400
4342.520	*1000, PK*	≤ 17.0	3	17.5	0	34.5	54.0	19.5	H,V/H,V	100-400
4776.772	*1000, PK*	≤ 17.0	3	18.5	0	35.5	54.0	18.5	H,V/H,V	100-400

The frequencies fall into the restricted bands are blue marked

Measurement uncertainty	4 dB

Bandwidth = the measuring receiver bandwidth

Remark: *[1] noise floor noise level of the measuring instrument ≤ 4.0dBµV @ 10m distance (0.009 – 30 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 6.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10 dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 17 dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[5] for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *[7] for periodic operated transmitter

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	~~**Yes**~~	**No**	

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11.6 Bandwidth (20 dB)

11.6.1 Regulation

(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

11.6.2 Calculation of the 20 dB bandwidth limit

The 20 dB bandwidth limit for channel one is = 0.0025 * 433.589 MHz = 1.084 MHz
The 20 dB bandwidth limit for channel two is = 0.0025 * 433.920 MHz = 1.085 MHz
The 20 dB bandwidth limit for channel three is = 0.0025 * 434.251 MHz = 1.086 MHz

11.6.3 Test equipment

Type	**Manufacturer/ Model no.**	**Serial no.**	**Last calibration**	**Next calibration**
Receiver (9 kHz –18 GHz)	**Rhode & Schwarz Spectrum Analyzer FSL18 (171a)**	**100117**	**2008/08**	**2009/08**
Test fixture	m.dudde hochfrequenz-technik	---	Verification previous to the measurement	

11.6.4 Test procedure

ANSI C63.4-2003 Section 13.1.7 Occupied bandwidth measurements. The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. Once the reference level is established, the equipment is conditioned with typical modulating signals to produce worst-case (i.e., the widest) bandwidth. In order to measure the modulated signal properly, a resolution bandwidth that is small compared to the bandwidth required by the procuring or regulatory agency shall be used on the measuring instrument. However, the 6 dB resolution bandwidth of the measuring instrument shall be set to a value greater than 5% of the bandwidth requirements.

11.6.5 Test result

The measured 20 dB bandwidth for channel one is: 83.80 kHz
The measured 20 dB bandwidth for channel two is: 79.80 kHz
The measured 20 dB bandwidth for channel three is: 88.80 kHz

The equipment meets the requirements	**Yes**	~~**No**~~	~~**N.t.**~~

Further test results are attached	**Yes**	~~**No**~~	Annex no: 3

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11.7 Radiated emission

(Measurement of the LF part of the EUT)

11.7.1 Regulation

Test Requirement: FCC CFR47, Part 15B Test Procedure: ANSI C63.4:2003

15.201(a) Intentional radiators operated as carrier current systems, devices operated under the provisions of §§ 15.211, 15.213 and 15.221, and devices operating below 490 kHz in which all emissions are at least 40 dB below the limits in Section 15.209 shall be verified pursuant to the procedures in Subpart J of Part 2 of this Chapter prior to marketing.

Test Requirement: FCC CFR47, Part 15C Test Procedure: ANSI C63.4:2003

Section 15.209 (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:

Frequency (MHz)	**Field strength (microvolts/meter)**	**Measurement distance (meters)**
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

(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.

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

11.7.2 Test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration
Receiver (9 kHz –18.0 GHz)	Rohde & Schwarz Spectrum Analyzer FSL 18 (171a)	100.117	2008/10	2010/10
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	2008/02	2010/02
Pre-amplifier (1GHz - 18GHz)	Narda --- (345)	---	2008/02	2010/02
Magnetic loop antenna (9 kHz - 30 MHz)	Schwarzbeck FMZB 1516 (23)	---	2008/09	2010/09
Bilog antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	2007/02	2013/02
Horn antenna (0.86-8.5 GHz)	Schwarzbeck BBHA 9120 A (284)	236	2008/01	2013/01
Horn antenna (2.0-14.0 GHz)	Schwarzbeck BBHA 9120 C (169)	305	2008/01	2013/01
RF- cable	Kabelmetal 18m [N]	K1	2008/01	2009/01
RF- cable	Aircell 0.5m [BNC]	K40	2008/01	2009/01
RF- cable	Aircell 1m [BNC/N]	K56	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	2008/01	2009/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K75	2008/01	2009/01

11.7.3 Test procedures

The EUT and this peripheral (when additional equipment exist) are placed on a turn table which is 0.8 m above the ground. The turn table would be allowed to rotate 360 degrees 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: 2003 Section 8 “Radiated Emissions Testing”

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Radiated emissions test characteristics	
Frequency range	30 MHz - 4,000 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 - 12,000 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 - 12,000 MHz)
Receive antenna polarization	vertical/horizontal (30 MHz - 12,000 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 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

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11.7.4 Calculation of field strength Section 15.209 below 30 MHz

The Receiver reading gives not directly the field strength result in (dBµV/m). The antenna factors of the loop antenna and cable losses must be added to find the correct result.

For frequencies below 30 MHz and for an test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (2) the field strength is calculated by adding additionally an extrapolation factor of 40 dB/decade (inverse linear distance for field strength measurements).

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor

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

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

FS = 40.7 - 40 = 0.7 [dBµV/m]

Level in µV/m Common Antilogarithm (0.7/20) = 1.1

11.7.5 Calculation of field strength Section 15.209 above 30 MHz

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of an Pre-amplifier)

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

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

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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11.7.6 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of an Pre-amplifier)

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

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

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

Level in µV/m = Common Antilogarithm (35.91/20) = 39.8

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).

11.7.7 Calculation of 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*Iog (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, there for the correction factor is 20*Iog(50/100) = - 6 dB. The maximum correction factor to be applied is 20 dB per section 15.35 of the FCC rules.

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LF PART SPURIOUS RADIATION BELOW 30 MHz (Section 15.109)									
f (MHz)	Bandwidth (kHz), Type of detector	Noted receiver level **dBµV**	Test distance **m**	Correction factor **dB**	Distance extrapol. factor **dB**	Level corrected **dBµV/m**	Limit **dBµV/m**	Margin **dBµV/m**	Polarisation EUT / antenna orientation
0.1200	*QPK/0.2kHz*	*< 4.0*	*10*	20.2	*-59.1*	-34.90	*26.0 @ 300*	80.90	V, H/0-360°
0.5000	*QPK/0.2kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*33.6 @ 30*	49.4	V, H/0-360°
1.5000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*24.1 @ 30*	39.9	V, H/0-360°
3.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
5.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
8.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
10.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
20.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
30.0000	*QPK/9kHz*	*< 4.0*	*3*	20.2	*-40.0*	-15.8	*29.5 @ 30*	45.3	V, H/0-360°
All emissions lower than the noise level of the measuring instruments!									
Measurement uncertainty			4 dB						

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).

The equipment meets the requirements	**yes**	~~**no**~~	~~**n.a.**~~

Further test results are attached	~~yes~~	**no**	page no:

n.a [x] see page no. 39

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LF PART SPURIOUS RADIATION ABOVE 30 MHz (Section 15.209)

f (MHz)	Bandwidth (kHz)/Type of detector	Noted receiver level **dBµV**	Test distance **m**	Correction factor **dB**	Distance extrapol. factor **dB**	AV Correction factor **dB**	Level corrected **dBµV/m**	Limit **dBµV/m**	Margin **dBµV/m**	Polaris. EUT / antenna	Antenna height **cm**
30.0000	100, QPK	≤ 3.5	1	-2.6	9.5	0	-8.6	40.00	48.6	H,V/H,V	100-400
88.0000	100, QPK	≤ 3.5	1	-10.8	9.5	0	-16.8	40.00	56.8	H,V/H,V	100-400
216.0000	100, QPK	≤ 3.5	1	-10.3	9.5	0	-16.3	43.50	59.8	H,V/H,V	100-400
960.0000	100, QPK	≤ 3.5	1	8.5	9.5	0	2.5	43.50	41.0	H,V/H,V	100-400
All emissions lower than the noise level of the measuring instruments!											
Measurement uncertainty	4 dB										

* Bandwidth = the measuring receiver bandwidth

Remark: *[1] noise floor noise level of the measuring instrument ≤ 3.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 4.5 dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10 dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 14 dBµV @ 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 4.0 GHz and 18.0 GHz

The equipment meets the requirements	**yes**	~~**no**~~	~~**n.a.**~~

Further test results are attached	~~yes~~	**no**	page no:

n.a [x] see page no. 39

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12. Additional information to the test report

Remarks

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 for this type of equipment

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End of test report

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