

EUT: IMS-944
FCC ID: UXSIMS944

Date of issue: 2009-07-20



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
InnoSenT GmbH
IMS-944

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



DAT-P-225/96

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Manufacturer's details

Manufacturer	InnoSenT GmbH
Manufacturer's grantee code	UXS
Manufacturer's address	Am Roedertor 30
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Relevant standard used	47 CFR Part 15 C - Intentional Radiators
	ANSI C63.4-2003

Test Report prepared by

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Equipment Under Test (EUT)

Equipment category	field disturbance sensor
Trade name	InnoSenT
Type designation	IMS-944
Serial no.	944000239 / 944000240
Variants	---

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CFR Section	Report Chapter	Requirements Headline	Test result		
			Pass	Fail	N.t.
15.203	8.1	Antenna requirement	Pass	Fail	N.t.
15.205	8.2	Restricted bands of operation	Pass	Fail	N.t.
15.207	8.3	Conducted emissions	Pass	Fail	N.t.
15.209	8.4	Radiated emissions	Pass	Fail	N.t.
15.215	8.5	Bandwidth	Pass	Fail	N.t.
15.245	8.6	Field strength	Pass	Fail	N.t.

The equipment meets the requirements	Yes	No
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Signature
(Technical engineer)
Ralf TrepperSignature
(Manager)
Manfred Dudde

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2. Introduction

This test report consists of:

- Test result summary
- Table of contents
- Introduction and further information
- Detailed test information
- List of measurement equipment with calibration validity

All pages have been numbered consecutively and bear the m. dudde hochfrequenz-technik logo, the test report number, the date as well as the type designation of the EUT. The total number of pages in this report is **29**.

The tests were carried out at:

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

in a representative assembly and in accordance with the specifications stated in:

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

The sample of the product was received on:

- 2009-05-19

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

- 2009-05-29 – 2009-07-20

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3. Testing laboratory

Company name : m.dudde hochfrequenz-technik
Address : Rottland 5a
51429 Bergisch Gladbach
Country : Germany
Phone : +49 (0) 2207/9689-0
Fax : +49 (0) 2207/9689-20
Email : manfred.dudde@t-online.de
Web : <http://www.dudde.com>

The laboratory has been accredited by DATech Deutsche Akkreditierungsstelle Technik GmbH under the DAR-registration number: DAT-P-225/96.

The Laboratory's measurement facility has been registered at the FCC under Registration Number 699717. The registration has been renewed on May 29, 2008. All measurement data will be accepted in conjunction with applications for Certification under Parts 15 and 18 of the Commission's Rules.

4. Applicant

Company name : InnoSenT GmbH
Address : Am Roedertor 30
97499 Donnersdorf
Country : Germany
Telephone : 0049-9528-9518-65
Fax : 0049-9528-9518-99
Email : andreas.zirk@innosent.de
Date of order : 2009-05-15
References : Mr. Andreas Zirk

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5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer : InnoSenT GmbH
Type of equipment : Multifunctional K-Band Transceiver
Trademark : InnoSenT
Type designation : IMS-944
Hardware version : IMS-944
Serial number : 944000239 / 944000240
Software release : ---
Power used : + 5 V DC
RF output power : max. +26 dBm (min. +20 dBm AGC controlled)
Frequency range : 24.075 GHz ... 24.175 GHz (programmable)
Frequency used : typically: 24.160 GHz
Generated or used frequencies : 16.00 MHz (crystal), typically: 24.160 GHz (transmit frequency)
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For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the Equipment Under Test (EUT)	2009-07-09	Annex no. 1
Internal photographs of the Equipment Under Test (EUT)	2009-07-09	Annex no. 2
Occupied bandwidth plot	2009-07-09	Annex no. 3
FCC ID label sample	2009-07-09	Annex no. 4
Technical description	2009-07-09	Annex no. 5
Test setup photos	2009-07-09	Annex no. 6
Block diagram	2009-07-09	Annex no. 7
Schematics	2009-07-09	Annex no. 8a
Part list	2009-07-09	Annex no. 8b
Operational description	2009-07-09	Annex no. 9
Antenna description	2009-07-09	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 report.

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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 **47 CFR Part 15 C–Intentional Radiators and ANSI C63.4-2003** for the respective test sector, if the test results turn out positive.

Additional equipment for the tests to carry on the Model IMS-944

Rhode & Schwarz Power supply

Type: NGR 20

Technical inspector:

Date : 2009-07-20

Name : Ralf Trepper

Signature : 

Technical responsibility for area of testing:

Date : 2009-07-20

Name : Manfred Dudde

Signature : 

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7. Operation description

7.1 EUT details

Field disturbance sensor, see User Manual in Annex No. 5

7.2 EUT configuration

Operation: : As soon as the equipment is powered up, TX start operating with his maximum output power! Only when Pin 4 (Low Power, IN-digital) of the Low insertion Force (FFC) Connector will be grounded, the equipment works with his AGC controlled lower output level.

Purpose of operation : see User Manual in Annex No. 5

7.3 EUT measurement description

Radiated emission test

As soon as the EUT connected to the power supply it starts, after a short delay, to operate in continuous mode. The maximum radiation will be achieved, if the EUT is adjusted as described by the manufacturer in the manual. The inclination of the test sample will be brought into a prescribed angle to the aerial antenna.

Conducted emission test

The device was connected to the artificial mains network via a **Rhode & Schwarz power supply**. It has been tested in two runs: first, with inactive **IMS-944**, second with activated **IMS-944**. L1 and N have been viewed too.

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8.1 Antenna requirement

8.1.1 Regulation

Section 15.203 Antenna requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of Part 15C. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31 (d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

8.1.2 Result

The equipment meets the requirements	Yes	No	N.t.
Further test results are attached	Yes	No	Page no:

N.t. * See page no. 28

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8.2 Restricted bands of operation

8.2.1 Regulation

Section 15.205 Restricted bands of operation

(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).

8.2.2 Result

The equipment meets the requirements	Yes	No	N.t.
Further test results are attached	Yes	No	Page no: 17-18

N.t. * See page no. 28

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8.3 Conducted emissions

8.3.1 Regulation

Section 15.207(a) For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50ohms line impedance stabilization network (LISN). Compliance with this provision 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.

Frequency of emission(MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.50	66 to 56*	56 to 46*
0.50-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency

Section 15.207(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 provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or connected to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

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Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Remarks
Receiver (9 kHz - 30MHz)	Schwarzbeck FMLK 1518 (428)	1518-294	06 / 2009	06 / 2011	---
Protector limiter 9 kHz - 30MHz, 10 dB	Rhode & Schwarz ESH 3Z2 (272)	357,881052	03 / 2008	03 / 2010	---
V-LISN 50 ohms/(50 uH+5 ohms)	RFT NNB 11 (72)	13835240	03 / 2007	03 / 2010	---
V-LISN 50 ohms/(50 uH+5 ohms)	emco 3810/2 LISN (49b)	---	03 / 2007	03 / 2010	---

8.3.3 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: 2003 Section 7. Additional equipment must also be connected to a second LISN with the same specifications described in the above sentence (if required).

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8.3.4 Test results

Power supply (IMS-944 not activated)

TRANSMITTER CONDUCTED EMISSIONS (Section 15.207)						
Tested line	Emission frequency [MHz]	Receiver bandwidth [kHz]	Result Quasi-peak [dBμV]	Spec Limit Average [dBμV]	Margin [dB]	Remarks
L1	0.150	10	≤-2	53.2	-55.2	* ¹
N	0.150	10	≤-2	53.2	-55.2	* ¹
L1	0.350	10	≤-2	51.7	53.7	* ¹
N	0.350	10	≤-2	51.7	53.7	* ¹
L1	0.475	10	≤-2	47	49	* ¹
N	0.475	10	≤-2	47	49	* ¹
L1	0.600	10	≤-2	46	48	* ¹
N	0.600	10	≤-2	46	48	* ¹
L1	0.725	10	≤-2	46	48	* ¹
N	0.725	10	≤-2	46	48	* ¹
L1	0.850	10	≤-2	46	48	* ¹
N	0.850	10	≤-2	46	48	* ¹
L1	1.000	10	≤-2	46	48	* ¹
N	1.000	10	≤-2	46	48	* ¹
L1	1.125	10	≤-2	46	48	* ¹
N	1.125	10	≤-2	46	48	* ¹
L1	2.000	10	≤-2	46	48	* ¹
N	2.000	10	≤-2	46	48	* ¹
L1	4.000	10	≤-2	46	48	* ¹
N	4.000	10	≤-2	46	48	* ¹
L1	6.7644	10	≤-2	50	52	* ¹
N	6.7644	10	≤-2	50	52	* ¹
L1	13.5288	10	≤-2	50	52	* ¹
N	13.5288	10	≤-2	50	52	* ¹
L1	24.0041	10	≤-2	50	52	* ¹
N	24.0041	10	≤-2	50	52	* ¹
L1	27.0575	10	≤-2	50	52	* ¹
N	27.0575	10	≤-2	50	52	* ¹
Measurement uncertainty			< ± 2 dB			

Remark: *¹ Noise level of the measuring instrument ≤ -2 dBμV (0.009 – 30MHz)Remark: *² Quasi peak measurements lower than "Specified Average Limit"

The equipment meets the requirements	yes	no	not
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Further test results are attached	yes	no	page no:
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Power supply with active IMS-944

TRANSMITTER CONDUCTED EMISSIONS (Section 15.207)						
Tested line	Emission frequency [MHz]	Receiver bandwidth [kHz]	Result Quasi-peak [dBμV]	Spec Limit (Average) [dBμV]	Margin [dB]	Remarks
L1	0.150	10	≤-2	53.2	-55.2	* ¹
N	0.150	10	≤-2	53.2	-55.2	* ¹
L1	0.350	10	≤-2	51.7	53.7	* ¹
N	0.350	10	≤-2	51.7	53.7	* ¹
L1	0.475	10	≤-2	47	49	* ¹
N	0.475	10	≤-2	47	49	* ¹
L1	0.600	10	≤-2	46	48	* ¹
N	0.600	10	≤-2	46	48	* ¹
L1	0.725	10	≤-2	46	48	* ¹
N	0.725	10	≤-2	46	48	* ¹
L1	0.850	10	≤-2	46	48	* ¹
N	0.850	10	≤-2	46	48	* ¹
L1	1.000	10	≤-2	46	48	* ¹
N	1.000	10	≤-2	46	48	* ¹
L1	1.125	10	≤-2	46	48	* ¹
N	1.125	10	≤-2	46	48	* ¹
L1	2.000	10	≤-2	46	48	* ¹
N	2.000	10	≤-2	46	48	* ¹
L1	4.000	10	≤-2	46	48	* ¹
N	4.000	10	≤-2	46	48	* ¹
L1	6.7644	10	≤-2	50	52	* ¹
N	6.7644	10	≤-2	50	52	* ¹
L1	13.5288	10	≤-2	50	52	* ¹
N	13.5288	10	≤-2	50	52	* ¹
L1	24.0041	10	≤-2	50	52	* ¹
N	24.0041	10	≤-2	50	52	* ¹
L1	27.0575	10	≤-2	50	52	* ¹
N	27.0575	10	≤-2	50	52	* ¹
Measurement uncertainty			< ± 2 dB			

Remark: *¹ Noise level of the measuring instrument ≤ -2 dBμV (0.009 – 30MHz)Remark: *² Quasi peak measurements lower than “Specified Average Limit”

The equipment meets the requirements	yes	no	not
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Further test results are attached	yes	no	page no:
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8.4 Radiated emissions

8.4.1 Regulation

Section 15.209 Radiated emission limits, general requirements.

(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

** 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., Sections 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 Sections 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. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in Section 15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in Section 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in Section 15.109 that are applicable to the incorporated digital device.

(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 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
Receiver (9 kHz –40.0 GHz)	Anritsu Spectrum Analyzer MS2668C (359a)	6200163244	2009/04	2011/04
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
Pre-amplifier (12GHz - 28GHz)	Schwarzbeck BBV 9719 (443)	9719-004	2008/06	2010/06
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	2009/01	2010/01
RF- cable	Aircell 0.5m [BNC]	K40	2009/01	2010/01
RF- cable	Aircell 1m [BNC/N]	K56	2009/01	2010/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	2009/01	2010/01
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K75	2009/01	2010/01

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Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration
Horn antenna (15-40 GHz)	Schwarzbeck BBHA 9170 (281)	41	2000/01	2010/01
Gain Horn antenna (33-50 GHz)	Dorado GH-22-25 (383)	040810	2005/04	2015/04
Gain Horn antenna (50-75 GHz)	Dorado GH-15-25 (384)	031003	2005/04	2015/04
Gain Horn antenna (75-110 GHz)	Dorado GH-10-25 (385)	040808	2005/04	2015/04
Anritsu Mixer WR22 Q-Band (33-50 GHz)	OM Labs MA2742A (269a)	Q40512-1	2008/04	2010/04
Anritsu Mixer WR15 V-Band (50-75 GHz)	OM Labs MA2744A (295a)	V41027-1	2008/04	2010/04
Anritsu Mixer WR10 W-Band (75-110 GHz)	OM Labs MA2746A (296a)	W40706-2	2008/04	2010/04
Horn antenna (15-40 GHz)	Schwarzbeck BBHA 9170 (281)	41	2000/01	2010/01
RF- cable	Sucoflex 100 Suhner 2,0m [APC 3.5]	K17a	2009/01	2010/01
RF- cable	Sucoflex 100 Suhner 2,0m [APC 3.5]	K18a	2009/01	2010/01
RF- cable	QMI 0.6m [APC 3.5]	K67	2009/01	2010/01
RF- cable	QMI 0.6m [APC 3.5]	K68	2009/01	2010/01

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8.4.3 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 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 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).

8.4.4 Calculation of the field strength

The field strength is calculated by the following calculation:

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

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

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

For example:

The receiver reading is 32.7 dB μ V. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dB μ V/m.

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

Level in μ V/m = Common Antilogarithm (35.91/20) = 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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8.4.6 Test result

For all emission other than harmonic spurious emissions

TRANSMITTER SPURIOUS RADIATION BELOW 30 MHz (Section 15.205, 15.209, 15.245(b)(3))									
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	No
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Further test results are attached	Yes	No	Page no.
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For all emission other than harmonic spurious emissions

TRANSMITTER SPURIOUS RADIATION ABOVE 30 MHz (Section 15.205, 15.209, 15.245(b)(3))

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	39.1	H,V/H,V	100-400
88.0000	100, AV	≤ 3.5	3	-10.80	0	0	-7.30	40.00	47.3	H,V/H,V	100-400
216.0000	100, AV	≤ 3.5	3	-10.30	0	0	-6.80	43.50	50.3	H,V/H,V	100-400
960.0000	100, AV	≤ 3.5	3	8.50	0	0	12.00	43.50	31.5	H,V/H,V	100-400
1700.0000	1000, AV	≤ 4.5	3	3.80	0	0	8.30	54.00	45.7	H,V/H,V	100-400
2250.0000	1000, AV	≤ 10	3	8.00	0	0	18.00	54.00	36.0	H,V/H,V	100-400
4000.0000	1000, AV	≤ 10	3	8.40* ⁶	0	0	18.40	54.00	35.6	H,V/H,V	100-400
5000.0000	1000, AV	≤ 10	3	9.10* ⁶	0	0	19.40	54.00	34.6	H,V/H,V	100-400
7500.0000	1000, AV	≤ 14	3	12.9* ⁶	0	0	26.90	54.00	27.1	H,V/H,V	100-400
8300.0000	1000, AV	≤ 14	3	14.80* ⁶	0	0	28.80	54.00	25.2	H,V/H,V	100-400
9400.0000	1000, AV	≤ 14	3	16.00* ⁶	0	0	30.00	54.00	24.0	H,V/H,V	100-400
11000.0000	1000, AV	≤ 14	3	18.25* ⁶	0	0	32.25	54.00	21.7	H,V/H,V	100-400
22500.0000	300, AV	< 28.0	1	16.2* ⁷	-9.5	0	34.7	54.00	19.3	H,V/H,V	100-400
28000.0000	300, AV	< 28.0	1	19.0* ⁷	-9.5	0	37.5	54.00	16.5	H,V / H	100-200

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
 Remark: *⁷ for using a pre-amplifier in the range between 12.0 GHz and 28.0 GHz

The equipment meets the requirements

Yes**No****N.t.**

Further test results are attached

Yes**No**

Page no:

N.t. * See page no. 28

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8.5 Bandwidth

8.5.1 Regulation

Section 15.215 Additional provisions to the general radiated emission limitations.

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

8.5.2 Result

The equipment meets the requirements	Yes	No	Not
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Further test results are attached	Yes	No	Page no:
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8.6 Field strengths

8.6.1 Regulation

Section 15.245 Operation within the bands 902 - 928 MHz, 2435 - 2465 MHz, 5785 - 5815 MHz, 10500 - 10550 MHz, and 24075 - 24175 MHz.

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

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

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

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

(i) For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

(ii) For all other field disturbance sensors, 7.5 mV/m.

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

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

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

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

*Input Voltage 4.5 V DC***TRANSMITTER SPURIOUS RADIATION (Section 15.245(b))**

f (GHz)	Bandwidth (kHz) Type of detector	Noted receiver level dBμV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBμV/m	Limit @ 3 m dBμV/m	Margin	Polarisation EUT / antenna	Antenna height cm
24.08062	1000, PK	101.9	3	21.2^{*3}	0	123.1	127.9	4.8	V, 0° / V	105
48.16124	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.24186	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.08062	1000, PK	75.2	3	21.2^{*3}	0	96.4	127.9	31.5	V, 0° / H	107
48.16124	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.24186	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.16064	1000, PK	100.0	3	21.2^{*3}	0	121.2	127.9	6.7	V, 0° / V	106
48.32128	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.48192	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.16064	1000, PK	74.6	3	21.2^{*3}	0	95.8	127.9	32.1	V, 0° / H	107
48.32128	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.48192	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
Measurement uncertainty			± 6 dB							

Bandwidth = the measuring receiver bandwidth

Remark: ^{*1} noise floor noise level of the measuring instrument ≤ 28dBμV @ 1m distance (33.00 – 50.00 GHz)Remark: ^{*2} noise floor noise level of the measuring instrument ≤ 23dBμV @ 0.5m distance (50.00 – 75.00 GHz)Remark: ^{*3} for using a pre-amplifier in the range between 12 GHz and 28 GHz**8.6.2 Result**

The equipment meets the requirements	Yes	No	No
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Further test results are attached	Yes	No	Page no:
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Input Voltage 5.5 V DC

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f (GHz)	Bandwidth (kHz) Type of detector	Noted receiver level dBμV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBμV/m	Limit @ 3 m dBμV/m	Margin	Polarisation EUT / antenna	Antenna height cm
24.08065	1000, PK	101.7	3	21.2^{*3}	0	122.9	127.9	5.0	V, 0° / V	105
48.16130	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.24195	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.08065	1000, PK	75.3	3	21.2^{*3}	0	96.5	127.9	31.4	V, 0° / H	107
48.16130	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.24195	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.16068	1000, PK	102.1	3	21.2^{*3}	0	123.3	127.9	4.6	V, 0° / V	106
48.32136	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.48204	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
24.16068	1000, PK	74.9	3	21.2^{*3}	0	96.1	127.9	31.8	V, 0° / H	107
48.32136	1000, PK	< 28.0 ^{*1}	1	38.7	-9.5	57.2	77.5	20.3	V, 0° / V	100-200
72.48204	1000, PK	< 23.0 ^{*2}	0.5	40.2	-15.5	47.7	77.5	29.8	V, 0° / V	100-200
Measurement uncertainty			± 6 dB							

Bandwidth = the measuring receiver bandwidth

Remark: ^{*1} noise floor noise level of the measuring instrument ≤ 28dBμV @ 1m distance (33.00 – 50.00 GHz)Remark: ^{*2} noise floor noise level of the measuring instrument ≤ 23dBμV @ 0.5m distance (50.00 – 75.00 GHz)Remark: ^{*3} for using a pre-amplifier in the range between 12 GHz and 28 GHz**8.6.2 Result**

The equipment meets the requirements	Yes	No	No
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Further test results are attached	Yes	No	Page no:
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9. 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

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End of test report