Test Report acc. to FCC Title 47 CFR Part 15
relating to
Hilti Corporation
GX 3, GX3-ME

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

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

Manufacturer's details	
Manufacturer	Hilti Corporation
Manufacturer's grantee code	**SDL**
Manufacturer's address	Hilti Entwicklungsgesellschaft mbH
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	86916 Kaufering
	Germany
	Telephone: +49 (0) 8191 90 6705
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	References: Mr. Juergen Nienstedt
Relevant standard used	47 CFR Part 15C - Intentional Radiators
	ANSI C63.4-2009

Test Report prepared by	
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Equipment **U**nder **T**est (**EUT**)	
Equipment category	**Inductive application / RFID (13.56 MHz)**
Trade name	Hilti
Type designation	**GX 3, GX3-ME**
Serial no.	000341
Variants	---

1. Test results

Clause	Requirements headline	Test result			Report page number
8.1	Antenna Requirement	**Pass**	~~Fail~~	~~N.t.*~~	9
8.2	Conducted limits	~~Pass~~	~~Fail~~	**N.t.**[1]	10 to 11
8.3	Restricted bands of operation	**Pass**	~~Fail~~	~~N.t.*~~	12 to 13
8.4	Radiated emission limits	**Pass**	~~Fail~~	~~N.t.*~~	14 to 20
8.5	Frequency tolerance	~~Pass~~	~~Fail~~	**N.t.**[2]	21 to 23
8.6	20 dB Bandwidth	**Pass**	~~Fail~~	~~N.t.*~~	24

* Not tested

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

Signature: ..... (RF Test Engineer)

Signature: ..... (Laboratory Manager)

Digital unterschrieben von Abdelouahid Ftouhi
DN: cn=Abdelouahid Ftouhi, o=m. dudde Hochfrequenztechnik, ou, email=m.duddelaborg@dudde.com, c=DE
Datum: 2016.02.15 09:49:52 +01'00'

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Table of contents

2. Introduction

This test report **is not an expert opinion** and consists of:

- Test result summary
- List of contents
- Introduction and further information
- Performance assessment
- Detailed test information

All pages have been numbered consecutively and bear the m. dudde hochfrequenz-technik logo, the test report number, the date, the test specification in its current version as well as the type designation of the EUT. The total number of pages in this report is **28**.

The tests were carried out at:

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

in a representative assembly and in accordance with the test methods and/or requirements stated in:

FCC Title 47 CFR Part 15 Subpart C & ANSI C63.4-2009

The sample of the product was received on:

- 2015-11-16

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

- **2015-11-16 - 2015-11-17**

3. Testing laboratory

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

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

- FCC Registration Number: **699717**

Accredited by:

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

4. Applicant

Company name	: Hilti Corporation
	Hilti Entwicklungsgesellschaft mbH
Address	: Hiltistr. 6
	86916 Kaufering,
Country	: Germany
Telephone	: +49 (0) 8191 90 6705
Fax	: +49 (0) 8191 90 1766705
Email	: Juergen.Nienstedt@hilti.com
Date of order	: 2015-11-13
References	: Mr. Juergen Nienstedt

5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer	: Hilti Corporation
Trademark	: Hilti
Type designation	: **GX 3, GX3-ME**
Variants	: ---
Antennas	: Internal Loop Antenna
Serial number	: 000341
Hardware version	: V6.3
Software version	: ---
Type of equipment	: Gas actuated nailing tools
Power used	: 3.0 V DC
Frequency used	: 13.560 MHz
Generated frequencies	: 8.00 MHz, 13.560 MHz (Oscillator), 13.560 MHz (carrier)
ITU emission class	: 376HA1D
FCC-ID	: **SDL-GXR01**

For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est (EUT)	2016-02-12	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est (EUT)	2016-02-12	Annex no. 2
Channel occupancy / bandwidth	2016-02-12	Annex no. 3
Label sample	---	Annex no. 4
Functional description / User manual	---	Annex no. 5
Test setup photos	2016-02-12	Annex no. 6
Block diagram	---	Annex no. 7
Operational description	---	Annex no. 8
Schematics	---	Annex no. 9
Parts list	---	Annex no. 10

6. Conclusions, observations and comments

The test report will be filed at m. dudde hochfrequenz-technik for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of m. dudde hochfrequenz-technik.

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

m. dudde hochfrequenz-technik assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15 for the respective test sector, if the test results turn out positive.

Comments:
This test report no. 16010276 replaces the test report no. 16010249!
The test report no. 16010249 loses its validity!

Date	: 2016-02-12	Date	: 2016-02-12
Name	: Ralf Trepper	Name	: Manfried Dudde
Function	: Technician	Function	: Laboratory Manager
Signature	:	Signature	: .....

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7. Operational description

7.1 EUT details

GX 3, GX3-ME: Gas actuated nailing tools

7.2 EUT configuration

The EUT was set in continuous transmitting mode

7.3 EUT measurement description

Radiated measurements

The EUT was tested in a typical fashion. During preliminary emission tests the EUT was operated in continuous transmitting mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous mode. All tests were performed with the applicant's typical 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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8. Compliance assessment

8.1 Antenna requirement

8.1.1 Regulation

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of 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 passed the conducted tests	**Yes**	~~No~~	~~N.t.~~

Further test results are attached	**Yes**	~~No~~	Annex no. 2

Internal loop coil antenna.

N.t.* See page no. 25

8.2 Conducted limits

8.2.1 Regulation

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission(MHz)	**Conducted limit (dBµV)**	
	Quasi-peak	**Average**
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 -30	60	50

*Decreases with the logarithm of the frequency

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

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

(2) For all other carrier current systems: 1000 µV within the frequency band 535-1705 kHz, as measured using a 50 µH/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in Section 15.205 and Section 15.209, 15.221, 15.223, 15.225 or 15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

8.2.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.4-2009 Section 7.
Additional equipment must also be connected to a second LISN with the same specifications described in the above sentence (if required).

8.2.3 Result

Tested with external AC power supply

Conducted emissions (Section 15.107)						
Tested line	f MHz	Bandwidth kHz	Noted receiver level dBµV	Spec. limit (average) dBµV	Margin dBµV	Remarks
L1	---	9	---	> 50.0	---	*[2]
N	---	9	---	> 50.0	---	*[2]
L1	---	9	---	> 50.0	---	*[2]
N	---	9	---	> 50.0	---	*[2]
L1	---	9	---	50.0	---	*[2]
N	---	9	---	50.0	---	*[2]
L1	---	9	---	50.0	---	*[2]
N	---	9	---	50.0	---	*[2]
L1	---	9	---	50.0	---	*[2]
N	---	9	---	50.0	---	*[2]
Measurement uncertainty			< ± 2 dB			

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

The equipment passed the conducted tests	~~Yes~~	~~No~~	**N.t.**[1]

Further test results are attached	~~Yes~~	**No**	Page no.

Test equipment used: ---

N.t.* See page no. 25

8.3 Restricted bands of operation

8.3.1 Regulation

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz
[2] Above 38.6

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

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

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

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

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

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

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

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

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

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

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

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

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

8.3.2 Result

****All emissions in the restricted bands are lower than the noise level of measuring equipment!**

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

Further test results are attached	**Yes**	~~No~~	Annex no. 6

Test equipment used: K1a, K40, K56, K83, K84, 23, 103, 166a, 171a, 406, 430

N.t.* See page no. 25

8.4 Radiated emission limits

8.4.1 Regulation

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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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8.4.2 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a turn table which is 0.8 m above the ground. The turn table would be allowed to rotate 360 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 C63.4-2009 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions above 1 GHz are covered in Clause 8 of ANSI C63.4-2009. The ANSI C63.4-2009 measurement procedure consists of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. Subclause 8.3.1.2 of ANSI C63.4-2009 states that the measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in ANSI C63.4-2009, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTS, measuring system sensitivity, etc.

ANSI C63.4-2009 requires that the measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

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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).

8.4.3 Calculation of the field strength

The field strength is calculated by the following calculation:

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

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

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

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

Level in µV/m = Common Antilogarithm (35.91/20) = 62.45

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

8.4.4 Result

RADIATION EMISSIONS 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 @ meter**	Margin **dBµV/m**	Polaris. EUT / antenna orientation height/cm	
0.2500	*QPK/10kHz*	*< 4.0*	*10*	20.2	*-59.1*	-34.9	*AV19.6 @ 300*	54.5	V, H/0-360°	
0.3750	*QPK/10kHz*	*< 4.0*	*10*	20.2	*-59.1*	-34.9	*AV16.1 @ 300*	51.0	V, H/0-360°	
0.5000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV33.6 @ 30*	28.5	V, H/0-360°	
0.6250	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV31.7 @ 30*	26.6	V, H/0-360°	
0.7500	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV30.1 @ 30*	25.0	V, H/0-360°	
0.8750	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV28.6 @ 30*	23.5	V, H/0-360°	
1.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV27.6 @ 30*	22.5	V, H/0-360°	
1.1250	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV27.6 @ 30*	22.5	V, H/0-360°	
1.2500	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV25.6 @ 30*	28.5	V, H/0-360°	
1.5000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV24.1 @ 30*	19.00	V, H/0-360°	
3.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
5.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
8.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
10.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
20.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
30.0000	*QPK/9.0kHz*	*< 4.0*	*10*	20.2	*-19.1*	5.10	*AV29.5 @ 30*	24.4	V, H/0-360°	
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).

****All emissions in the restricted bands are lower than the noise level of measuring equipment!**

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

Further test results are attached	**Yes**	~~No~~	Annex no. 6

Test equipment used: K1a, K56, K83, 23, 103, 171a, 430

N.t.* See page no. 25

RADIATION EMISSIONS 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
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 ≤ 4.5dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 10dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 14dBµV @ 3m distance (5,500 – 14,500 MHz)
Remark: *[5] for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *[6] for using a pre-amplifier in the range between 1.0 GHz and 18.0 GHz

****All emissions in the restricted bands are lower than the noise level of measuring equipment!**

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

Further test results are attached	**Yes**	~~No~~	Annex no. 6

Test equipment used: K1a, K40, K56, K83, K84, 23, 103, 166a, 171a, 406, 430

N.t.* See page no. 25

FUNDAMENTAL EMISSION & HARMONICS (Section 15.225)										
Frequency	**Bandwidth Type of detector**	**Noted receiver level**	**Test distance**	**Correction factor**	**Distance extrapol. factor**	**Level corrected**	**Limit @ meter**	**Margin**	**Polaris. EUT antenna orientation**	
MHz	**kHz**	**dBµV**	**m**	**dB**	**dB**	**dBµV/m**	**dBµV/m**	**dBµV/m**	**0° / 90° H / V**	**cm**
13.560	QPK/9kHz	**24.7**	10	20.2	-19.1	**25.9**	84.0 @ 30	**58.1**	0°	100
27.120	QPK/9kHz	**≤5.2**	10	20.2	-19.1	**6.3**	29.5 @ 30	**23.2**	0°	100
40.680	QPK/120kHz	**≤6.5**	3	-7.0	0	**-0.5**	40.0 @ 3	**40.5**	0-360°/V	100-400
54.240	QPK/120kHz	**≤6.5**	3	-7.6	0	**-1.1**	40.0 @ 3	**41.1**	0-360°/V	100-400
67.800	QPK/120kHz	**≤6.5**	3	-8.9	0	**-2.4**	40.0 @ 3	**42.4**	0-360°/V	100-400
81.360	QPK/120kHz	**≤6.5**	3	-11.2	0	**-4.7**	40.0 @ 3	**44.7**	0-360°/V	100-400
94.920	QPK/120kHz	**≤6.5**	3	-11.7	0	**-5.2**	43.5 @ 3	**48.7**	0-360°/V	100-400
108.480	QPK/120kHz	**≤6.5**	3	-10.2	0	**-3.7**	43.5 @ 3	**47.2**	0-360°/V	100-400
122.040	QPK/120kHz	**≤6.5**	3	-8.9	0	**-2.4**	43.5 @ 3	**45.9**	0-360°/V	100-400
135.600	QPK/120kHz	**≤6.5**	3	-8.1	0	**-1.6**	43.5 @ 3	**45.1**	0-360°/V	100-400
149.160	QPK/120kHz	**≤6.5**	3	-7.1	0	**-0.6**	43.5 @ 3	**44.1**	0-360°/V	100-400
Measurement uncertainty					4 dB					

Blue marked: restricted bands
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

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

Further test results are attached	**Yes**	~~No~~	Annex no. 6

Test equipment used: K1a, K40, K56, K83, K84, 23, 103, 166a, 171a, 406, 430

N.t.* See page no. 25

SPURIOUS RADIATION (Section 15.209)

Frequency MHz	Bandwidth Type of detector kHz	Noted receiver level dBµV	Test distance m	Correction factor dB	Distance extrapol. factor dB	Level corrected dBµV/m	Limit dBµV/m	Margin dBµV/m	Polaris. EUT antenna orientation H / V	cm
0.1200	0.2, AV	< 4.0	10	20.2	-59.1	-34.9	26.0 @ 300 m	80.90	V, H/ 360°	100-400
0.5000	0.2, AV	< 4.0	10	20.2	-19.1	5.1	33.6 @ 30 m	28.5	V, H/ 360°	100-400
1.5000	0.2, AV	< 4.0	10	20.2	-19.1	5.1	24.1 @ 30 m	19.00	V, H/ 360°	100-400
3.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
5.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
8.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
10.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
20.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
30.0000	9, AV	< 4.0	10	20.2	-19.1	5.1	29.5 @ 30 m	24.4	V, H/ 360°	100-400
35.0000	100, AV	≤ 3.5	3	-3.1*[6]	0	0	0.4	40.0	V, H/ 360°	100-400
88.0000	100, AV	≤ 3.5	3	-10.8*[6]	0	-7.3	40.0	47.3	V, H/ 360°	100-400
216.0000	100, AV	≤ 3.5	3	-10.3*[6]	0	-6.8	43.5	50.3	V, H/ 360°	100-400
960.0000	100, AV	≤ 3.5	3	8.5*[6]	0	12.0	43.5	31.5	V, H/ 360°	100-400
1700.0000	1000, AV	≤ 4.5	3	3.8*[7]	0	8.3	54.0	45.7	V, H/ 360°	100-400
2250.0000	1000, AV	≤ 10	3	8.0*[7]	0	18.0	54.0	36.0	V, H/ 360°	100-400
4000.0000	1000, AV	≤ 10	3	8.4*[7]	0	18.4	54.0	35.6	V, H/ 360°	100-400
5000.0000	1000, AV	≤ 10	3	9.1*[7]	0	19.4	54.0	34.6	V, H/ 360°	100-400
7500.0000	1000, AV	≤ 14	3	12.9*[7]	0	26.9	54.0	27.1	V, H/ 360°	100-400
8300.0000	1000, AV	≤ 14	3	14.0*[7]	0	28.8	54.0	25.2	V, H/ 360°	100-400
9400.0000	1000, AV	≤ 14	3	16.0*[7]	0	30.0	54.0	24.0	V, H/ 360°	100-400
11000.0000	1000, AV	≤ 14	3	18.3*[7]	0	32.3	54.0	21.7	V, H/ 360°	100-400
Measurement uncertainty		4 dB								

Blue marked: restricted bands
Bandwidth = the measuring receiver bandwidth
Remark: *[1] noise floor noise level of the measuring instrument ≤ 4.0dBµV @ 10m distance (0.009 MHz –30 MHz)
Remark: *[2] noise floor noise level of the measuring instrument ≤ 3.5dBµV @ 3m distance (30 – 1,000 MHz)
Remark: *[3] noise floor noise level of the measuring instrument ≤ 4.5dBµV @ 3m distance (1,000 – 2,000 MHz)
Remark: *[4] noise floor noise level of the measuring instrument ≤ 10dBµV @ 3m distance (2,000 – 5,500 MHz)
Remark: *[5] noise floor noise level of the measuring instrument ≤ 14dBµV @ 3m distance (5,500 – 14,500 MHz)
Remark: *[6] for using a pre-amplifier in the range between 100 kHz and 1,000 MHz
Remark: *[7] for using a pre-amplifier in the range between 1.0 GHz and 18.0 GHz

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

Further test results are attached	**Yes**	~~No~~	Annex no. 6

Test equipment used: K1a, K40, K56, K83, K84, 23, 103, 166a, 171a, 406, 430

N.t.* See page no. 25

8.5 Frequency tolerance

8.5.1 Regulation

(e) The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 °C to +55 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C.

8.5.2 Test procedures

Stability with respect to ambient temperature:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. Turn the EUT on, and couple its output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

Tune the EUT to any one of the number of frequencies specified. Turn the EUT off, and place it inside an environmental chamber if appropriate. Allow the chamber to stabilize at +20 °C before proceeding. Turn on the EUT, and record the operating frequency of the intentional radiator at startup and two, five, and ten minutes after startup. Turn the EUT off and allow it to cool to the ambient temperature, and then repeat this procedure for the number of the frequencies specified. Four measurements are made at each operating frequency.

Stability with respect to input voltage:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required.

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Turn the EUT off, and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.

Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.

While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized. Four measurements in total are made.

Repeat the above procedure until the number of frequencies specified has been measured. After all measurements have been made at the highest specified temperature, turn the EUT off. Repeat the above measurement process for the EUT with the test chamber set at the lowest temperature specified by the regulatory or procuring agency. Measurements shall be made at the number of frequencies specified.

8.5.3 Result

Frequency tolerance (Section 15.225(e))			
Test conditions T_{nom} **= +20° C**	**Frequency Measured (MHz)**	**Frequency Error**	
		(kHz)	**ppm**
V_{min} = 2.5 V DC			
V_{nom} = 3.0 V DC			
V_{max} = 3.6 V DC			
Maximum Frequency error (MHz)			
Measurement uncertainty		$\pm 5 * 10^{-8}$	

Frequency tolerance (Section 15.225(e))			
Test conditions V_{nom} **= 3.0 V DC**	**Frequency Measured (MHz)**	**Frequency Error**	
		(kHz)	**(ppm)**
T_{min} -20 °C			
T_{min} -10 °C			
T_{min} 0 °C			
T_{min} +10 °C			
T_{min} +20 °C			
T_{min} +30 °C			
T_{min} +40 °C			
T_{min} +50 °C			
Maximum frequency error (kHz)			
Measurement uncertainty		$\pm 5 * 10^{-8}$	

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

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

Test equipment used: ---

N.t.* See page no. 25

8.6 Bandwidth (20 dB)

8.6.1 Regulation

The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

8.6.2 Calculation of the 20 dB bandwidth limit

Within the specified band!

8.6.3 Test procedure

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

8.6.4 Result

The measured 20 dB bandwidth is: **0.376 kHz**

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

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

Test equipment used: K21, 144, 226, 502, test-fixture

N.t.* See page no. 25

9. Additional information to the test report

N.t.[1] Not tested, because not applicable for this type of equipment

N.t.[2] Not tested, because not ordered

N.t.[3] Not tested, because a permissive class 2 change is carried out

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10. List of test equipment

Type	Manufacturer/ Model no.	Serial no.	Last calibration	Next calibration	Calibration executed by
Field strength Antenna (0.09-30MHz)	Schwarzbeck FMZB1516 (23)	---	05/2013	05/2016	Dudde
OATS	Dudde (104)	---	06/2014	10/2016	Dudde
Pre-amplifier (100kHz - 1.3GHz)	Hewlett Packard 8447 E (166a)	1726A00705	07/2014	07/2016	Dudde
Receiver (9 kHz –18.0 GHz)	Rohde & Schwarz Spectrum Analyzer FSL 18 (171a)	100.117	06/2014	06/2016	Rohde & Schwarz
Bilog-antenna (30- 1000 MHz)	Schwarzbeck VULP 9168 (406)	---	04/2015	04/2018	Schwazbeck
Log. Per, Antenne (1- 18 GHz)	Schwarzbeck STLP 9148 (445a)	---	10/2015	10/2018	Schwarzbeck
Horn antenna (15.0-40.0 GHz)	Schwarzbeck BBHA 9170 (280)	BBHA9170378	08/2014	08/2017	Schwarzbeck
Signal Analyzer (9 kHz –30.0 GHz)	Rohde & Schwarz FSV 30 (502)	100932	02/2013	02/2016	Rohde & Schwarz

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11. Cable list

Type	Manufacturer/ Model no.	Cable no.	Last calibration	Next calibration	Calibration executed by
RF- cable	Kabelmetal 18m [N]	K1a	04/2015	04/2016	Dudde
RF- cable	Aircell 0.5m [BNC]	K40	04/2015	04/2016	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K50	04/2015	04/2016	Dudde
RF- cable	Aircell 1m [BNC/N]	K56	04/2015	04/2016	Dudde
RF- cable	Sucoflex 104 Suhner [N] 1 m	K51	04/2015	04/2016	Dudde
RF- cable	Sucoflex 106 Suhner 6,4m [N]	K74	04/2015	04/2016	Dudde
RF- cable	Sucoflex 106 Suhner 8m [N]	K84	04/2015	04/2016	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K145	04/2015	04/2016	Dudde
RF- cable	Sucoflex Suhner 8m [SMA]	K146	04/2015	04/2016	Dudde

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End of test report

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