EMCC™ DR. RAŠEK

TEST REPORT # EMCC-040197MAA, 2016-09-29

EQUIPMENT UNDER TEST:

Trade Name:	T12
Type Designation(s):	S2
Serial Number:	Rotor: 153030053, Stator: none
Equipment Class:	Low Power Transceiver
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Address:	Im Tiefen See 45 64293 Darmstadt Germany
Phone:	+49 6151 803-0
Fax:	+49 6151 803-9100

RELEVANT STANDARD(S): 47 CFR 15.225, RSS-210 Issue 9

MEASUREMENT PROCEDURE:

☒ RSS-Gen Issue 4 ☒ ANSI C63.10-2013 ☐ Other

TEST REPORT PREPARED BY:

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TEST PERSONNEL: **HEAD OF GROUP:**

Ludwig Kraft Wolfgang Döring

CONTENTS

1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR 15.225 and Innovation, Science and Economic Development Canada (ISED) RSS-210 requirements for the certification of licence-exempt 15C Intentional Radiator.

1.2 Limits and Reservations

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report. This test report shall not be reproduced except in full without the written permission of EMCCons DR. RAŠEK GmbH & Co. KG.

1.3 Test Location

Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG
Accreditation No.:	D-PL-12067-01-02
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Boelwiese 8 91320 Ebermannstadt GERMANY
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
Laboratory:	Test Laboratory IV The 3 m & 10 m semi-anechoic chamber site has been fully described in a report submitted to the FCC and accepted in the letter dated December 24, 2013, Registration Number 878769. This 3 m & 10 m alternative test site is approved by Industry Canada under file number 3464C-1.
Phone:	+49 9194 7262-0
Fax:	+49 9194 7262-199
E-mail:	emc.cons@emcc.de
Web:	www.emcc.de

1.4 Manufacturer

Company Name:	Hottinger Baldwin Messtechnik GmbH
Street:	Im Tiefen See 45
City:	64293 Darmstadt
Country:	GERMANY
Name for contact purposes:	Mr Michael Korner
Phone:	+49 6151 803-294
Fax:	+49 6151 803-598
E-mail:	Michael.korner@hbm.com

1.5 Dates and Test Location

Date of receipt of EUT: 2016-06-01
Test Date: see list below
Test Location: Lab IV

1.6 Ordering Information

Purchase Order and Date: E41-4500558660/2000, 2016-05-17
Vendor Number: 806266

1.7 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2016-07-05	24	50	975	IV	no
2016-07-27	25	64	976	IV	no
2016-08-01	24	54	979	IV	no
2016-08-29	25	55	977	IV	no
2016-08-30	24	52	984	IV	no
2016-09-14	24	54	974	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade Name:	T12
Type Designation(s):	S2
Serial Number(s):	153030053 (Rotor), none (Stator)
FCC ID:	2ADAT-T12S2
ISED:	IC:12438A-T12S2
Equipment Class:	Low Power Transceiver
Transmit Frequency:	13.56 MHz
Modulation:	Load modulation
Emission Designator:	3K11A1D
Power Supply:	24 VDC
Ports:	Signal and supply - 7 pole binder industrial connector
Antennas:	Integrated loop antenna
Variants:	The tested T12S2 sample is a variant of the T12S2 documented in the report EMCC-040197BBA. The T12S2 type in this report was tested with 6 turns on a ferrite on the signal and supply cable.
Remarks:	None

The tested T12S2 sample is a variant of the T12S2 documented in the report EMCC-040197BBA dated 2014-11-04. According to the customer the stator head was mechanically modified and there were minor changes in the electronic components. All other parts including the rotor are the same as the T12S2 documented in report EMCC-040197BBA.

The carrier frequency stability measurement was done with the variant type S3. The carrier frequency stability results for the T12S3 in report EMCC-040197MAB dated 2016-09-29 was reused for this report.

According to the customer the variant type S3 used for the carrier frequency stability measurement uses the same electronics in the stator as the type S2. The carrier frequency controlling device is part of the stator and the same in the type S3 and S2.The stator of the S2 and S3 are equipped with different stator heads, which are used for different torque levels and rotor diameters.

2.2 Intended Use

The EUT is a complete measuring system to measure torque on a rotating shaft. The standard use is inside a test stand.

2.3 EUT Peripherals/Simulators

The EUT was tested connected with

- Power supply TRIO-PS/1AC/24DC/5 (Phoenix Contact),
- Junction box with termination resistor and connectors for the power supply,
- Ferrite (VITROPERM 500 F, Type: T60006-L2063-W517) with 6 turns at the signal and supply connector to port 1.

Photograph 2.3-1: Power supply TRIO-PS/1AC/24DC/5

Photograph 2.3-2: Power supply TRIO-PS/1AC/24DC/5, front view


Photograph 2.3-3: Junction box with signal and supply cable and ferrite connected


Photograph 2.3-4: Junction box with signal and supply cable and ferrite

2.4 Mode of Operation during Testing and Test Set-up

The equipment under test (EUT) was operated during the tests under the following conditions:
Normal operating mode.
The rotor of the EUT was fixed and there was no torque applied to the EUT.

Under normal test conditions the EUT was powered with 24 VDC by the AC / DC supply TRIO-PS/1AC/24DC/5 delivered by the customer. A ferrite (VITROPERM 500 F, Type: T60006-L2063-W517) was attached with 6 turns to the signal and supply cable connected to port 1.
All peripherals/simulators were operated outside of the test environment.

2.5 Modifications Required for Compliance

The T12S2 type in this report was tested with 6 turns on a ferrite (VITROPERM 500 F, Type: T60006-L2063-W517) on the signal and supply cable while the tests of the T12S2 variant documented in the report EMCC-040197BBA were done with 4 turns on a ferrite.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T12
Type(s): S2
Serial No(s): 153030053 (Rotor); none (Stator)

Requirement	RSS, Section	47 CFR Section	Report Section	Result
Antenna Requirement	RSS-Gen, 8.3	15.203	4	Passed
Conducted AC Power Line Emissions 150 kHz – 30 MHz	RSS-Gen, 8.8	15.207	5	Passed
Spectrum Mask	RSS-210, B.6	15.225(a)-(d)	6	Passed
Occupied Bandwidth (99%)	RSS-Gen, 6.6		7	Passed
Radiated Emissions 9 kHz – 30 MHz	RSS-210, B.6 RSS-Gen, 8.9	15.205, 15.209, 15.225(d)	8	Passed
Radiated Emissions 30 MHz – 150 MHz	RSS-210, B.6 RSS-Gen, 6.13, 8.9	15.205, 15.209, 15.225(d)	9	Passed
Carrier Frequency Stability	RSS-210, B.6 RSS-Gen 6.11	15.225(e)	10	Passed*

* Carrier Frequency Stability was measured on variant S3. Refer to section 2.1.
N.A. – not applicable; N.T. – Not tested acc. to applicant's order.

The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units and meet the requirements of the specifications referenced herein. Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.
The measurements contained in this report were made in accordance with the procedures described in ANSI C63.10-2013 and RSS-Gen Issue 4.
All requirements were found to be within the limits outlined in this report.
The test results in this report apply only to the particular equipment under test (EUT) as declared in this report.

Test Personal: Ludwig Kraft
Issuance Date: 2016-09-29

4 ANTENNA REQUIREMENT

Test Requirement: 47 CFR 15.203, IC RSS-Gen

4.1 Regulation

§ 15.203 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.

RSS-Gen: 8.3 Transmitter Antenna for Licence-Exempt Radio Apparatus
The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.
Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus. Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.[8] When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer. User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:
This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

[8] Compliance is required under all operational combinations of transmitter output power and antenna gain.

No applicable antenna requirement specified in **RSS-210**.

4.2 Result

The EUT is equipped with a fixed magnetic antenna.

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); none (Stator)

The EUT meets the requirements of this section.

5 POWER LINE CONDUCTED EMISSIONS TEST

Test Requirement: FCC 47 CFR, §15.207, ISED RSS-Gen, 8.8
Test Procedure: ANSI C63.10-2013, ISED RSS-Gen

5.1 Regulation

§ 15.207 (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
0.5-30	60	50

*Decreases with the logarithm of the frequency.

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz.

In lieu thereof, these carrier current systems shall be subject to the following standards:

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

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

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

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

RSS-Gen: 8.8 AC Power Line Conducted Emissions Limits
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits in Table 3.
Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the

frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 3 below. The more stringent limit applies at the frequency range boundaries.
The conducted emissions shall be measured in accordance with the reference publication mentioned in Section 3.

Table 3 – AC Power Line Conducted Emissions Limits

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
0.5-30	60	50

* The level decreases linearly with the logarithm of the frequency.
** A linear average detector is required

→ The ISED limits are equal to the FCC limits.

5.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	Rohde & Schwarz / ESU8	3846	2016-09	2017-09
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
V-LISN 50 Ω//(50 uH + 5 Ω)	Rohde & Schwarz / ESH2-Z5	1901	2015-09	2017-09
Protector Limiter	Rohde & Schwarz / ESH3-Z2	1519	2015-09	2017-09
AC Power Source	AEG	0001	n.a	n.a
Multimeter	Agilent / U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

5.3 Test Procedures

The EUT was placed on a wooden table of nominal size 1 m by 1.5 m, raised 80 cm above the reference groundplane. The vertical conducting wall of the screened room was located 40 cm to the rear of the EUT.
The excess length of the power cord of the ac adapter to the EUT was folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.
LISN housing, measuring instrument case, reference ground plane and the vertical conducting wall of the screened room was bonded together.

5.4 Test Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.186	---	43.3	54.2	10.9	1000	9	L1	10.0
0.249	---	39.9	51.8	11.9	1000	9	L1	10.0
0.309	---	36.3	50.0	13.7	1000	9	L1	10.0
0.621	---	32.7	46.0	13.3	1000	9	L1	10.0
0.681	---	38.7	46.0	7.3	1000	9	L1	10.0
0.745	---	35.9	46.0	10.1	1000	9	L1	10.0
13.557	---	32.9	50.0	17.1	1000	9	L1	10.0

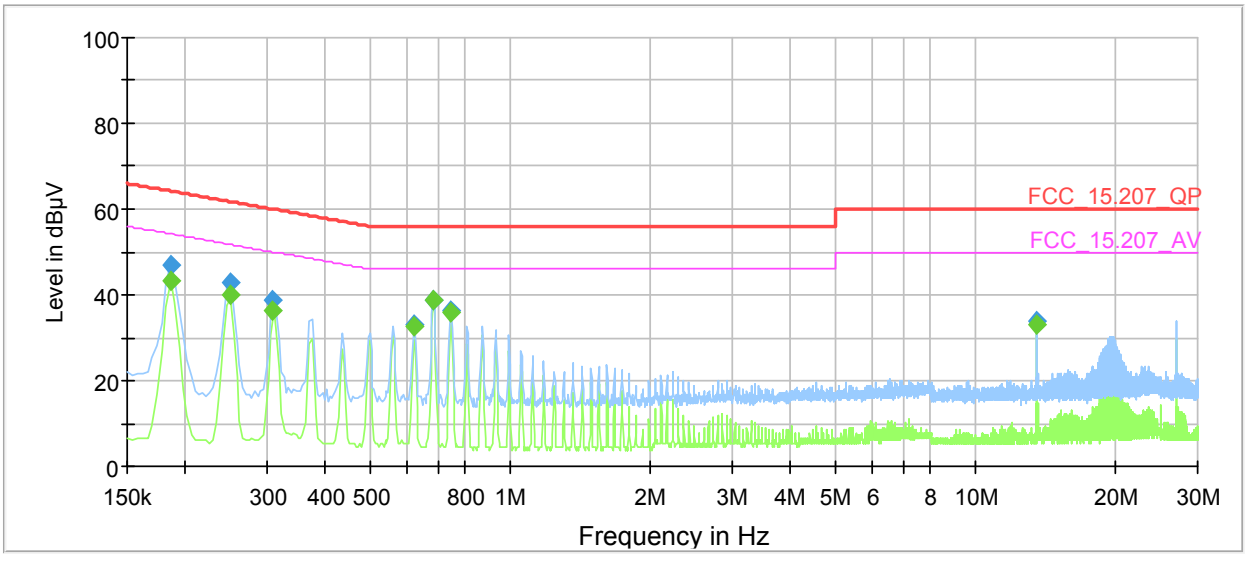
The table above contains worst-case emissions, only. For further details refer to the test plots.

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); none (Stator)
Test date:	2016-08-01

The EUT meets the requirements of this section.

5.5 Measurement Plots

Test on line L and N (worst case):



Preview Result 2-AVG [Preview Result 2.Result:2]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.207_QP [..\FCC_Part15_CE\]
FCC_15.207_AV [..\FCC_Part15_CE\]
Final_Result QPK [Final_Result.Result:4]
Final_Result CAV [Final_Result.Result:5]

6 SPECTRUM MASK

Test Requirement: FCC 47 CFR, §15.225(a)-(d), ISED RSS-210, B.6

6.1 Regulation

§15.225 (a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15,848 microvolts/ meter at 30 meters.

(b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110– 14.010 MHz band shall not exceed the general radiated emission limits in§ 15.209.

RSS-210 B.6 Band 13.110-14.010 MHz
The field strength of any emission shall not exceed the following limits:
(a) 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz;
(b) 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz;
(c) 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz; and
(d) RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.
…

→ The ISED limits are equal to the FCC limits.

6.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
EMI Test Software	R&S / EMC32 V9.25.00	5392	n.a.	n.a.
Loop Antenna with cable set	R&S / HFH-Z2	374	2016-07	2018-07
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

6.3 Test Procedures

Measurement was performed in a semi-anechoic room at a test distance of 3 m. A calibrated loop antenna as specified in ANSI C63.10 clause 4.3.2 was positioned with its plane vertical at the test distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna may also need to be positioned horizontally at the specified distance from the EUT. Instead of changing the loop antenna polarization to horizontal the EUT antenna was rotated by 90 degrees. I.e. tests performed for 2 EUT antenna polarizations. The center of the loop antenna was 1 m above the ground.
The EUT was tested on a 0.8 meter high tabletop.
The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter.

In certain applications, a remotely located device may be connected to the EUT. In these cases, it is permissible for cabling from the remotely located device to the EUT or accessories to be placed directly on the reference groundplane or, if normally installed beneath the reference groundplane, beneath it. The remotely located device shall be located at a distance sufficient to ensure that it does not contribute to the measured level. This procedure evaluates the interference potential of the EUT, its accessories, and interconnecting cables or wires standing apart from the remotely located device, which in turn shall be evaluated separately, if required.
Measurement initially performed as a pre-scan in the full frequency range in order to find worst case emissions. Final measurement performed at worst-case emission frequencies in a FCC and IC listed semi-anechoic room at the specified 3 m test distance. Pre-scan and final measurement performed in modulated mode.
Worst case emissions are listed under chapter: Final test results.

6.3.1 Test Site Correlation for H Field Measurement in Semi-Anechoic Chamber (SAC)

Test procedure following KDB 937606.

The carrier at 13.56 MHz was measured in the semi-anechoic room (SAC) at a test distance of 3m and at an open field site at a test distance of 3m and 10 m with the same calibrated loop antenna. The measurement was performed on EUT T12 S2 and S6.
These measurements were used to evaluate a correction of the open field measurement to the semi-anechoic room measurement.

EUT	Freq	Detector	Distance	F_{SAC}	F_{open}	f_C
	[MHz]		[m]	[dBµV/m]	[dBµV/m]	dB
S2	13.56	QP	3	72.2	70.8	-1.4
S6	13.56	QP	3	71.8	68.5	-3.3

Test date: 2016-09-14
The f_C value of -1.4 dB was used as this was the result for the type S2.

$f_C = F_{open} - F_{SAC}$

f_C is correlation factor from SAC to open field site field strength
F_{open} measured field strength at open field site
F_{SAC} measured field strength at SAC

Radiated Emissions Test Characteristics	
Frequency range	13.11 MHz – 14.01 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	10 kHz (150 kHz - 30 MHz)
Receive antenna height	1 m
Receive antenna polarization	Vertical

* According to section 15.31 (f)(2): At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper

extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The 40 dB/decade factor was used.

6.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for the band 13.553–13.567 MHz:
µV/m at 30 meters = 15848
15848 µV/m corresponds with 84 dBµV/m.

6.5 Field Strength Calculation

All emission measurements performed using the EMI test program's transducer factor setting capability, i.e. the field strength value measured directly without the necessity of additional correction factors.
For 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 basic equation with a sample calculation is as follows:

FS = FST + DF + fc
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
f_C = correlation factor from SAC to open field site field strength
DF = Distance Extrapolation Factor in dB,
where DF = 40 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance

Assume the tests performed at a reduced Test Distance of 3 m instead of the Specified Distance of 30 m giving a Distance Extrapolation Factor of DF = 40 log (3 m/30 m) = -40 dB.
Assuming a measured field strength level of 62.9 dBµV/m is obtained. The Distance Factor of -40 dB and the correlation factor fc of -2.6 dB is added giving a field strength of 20.3 dBµV/m. The 20.3 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 62.9 - 40 - 2.6 = 20.3 [dBµV/m]
Level in µV/m = Common Antilogarithm (20.3/20) = 10.4

6.6 Final Test Result

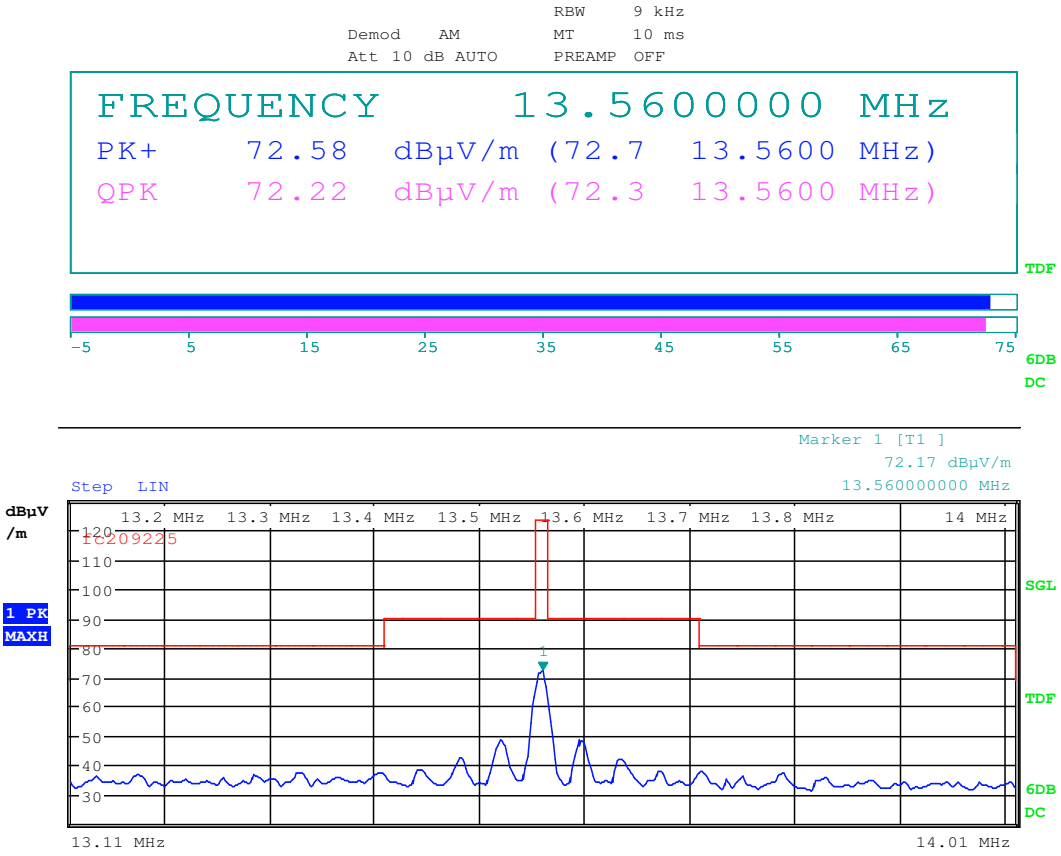
Frequency [MHz]	Detector	3m_Result [dB(µV/m)]	Distance Correction [dB]	f_c [dB]	30m_Result [dB(µV/m)]	30m_Limit [dB(µV/m)]	Margin [dB]
13.56	QP	72.3	40	-1.4	30.9	84	53.1

The table above contains worst-case emissions, only. For further details refer to the test plots.

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); none (Stator)
Test date:	2016-07-27

The EUT meets the requirements of this section.

6.7 Pre-scan Plot(s)



Manufacturer: HBM, EUT: #41.1 Rotor, #41.3 Stator, normal op
eration, EUT in max H-Field position
Date: 27.JUL.2016 15:35:49

7 OCCUPIED BANDWIDTH (99%)

Test Requirement: ISED RSS-Gen, 6.6
Test Procedure: ISED RSS-Gen, 6.6

7.1 Regulation

RSS-Gen 6.6 Occupied Bandwidth
…
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

• 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 (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.
Note: Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

7.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
EMI Test Software	R&S / EMC32 V9.25.00	5392	n.a.	n.a.
Loop Antenna with cable set	R&S / HFH-Z2	374	2016-07	2018-07
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

7.3 Test Procedures

Measurement was performed in a semi-anechoic room. The EUT was tested on a 0.8 meter high tabletop and was connected to its associated peripherals. A calibrated loop antenna was positioned with its plane vertical at about 1.5m distance from the EUT. For certain applications, the loop antenna may also need to be positioned horizontally at the specified distance from the EUT. The analyzer was setup at the nominal centre frequency of the EUT. The span was 20 kHz, the resolution bandwidth 100 Hz and the video bandwidth 300 Hz. A max peak hold was used to measure the occupied bandwidth.

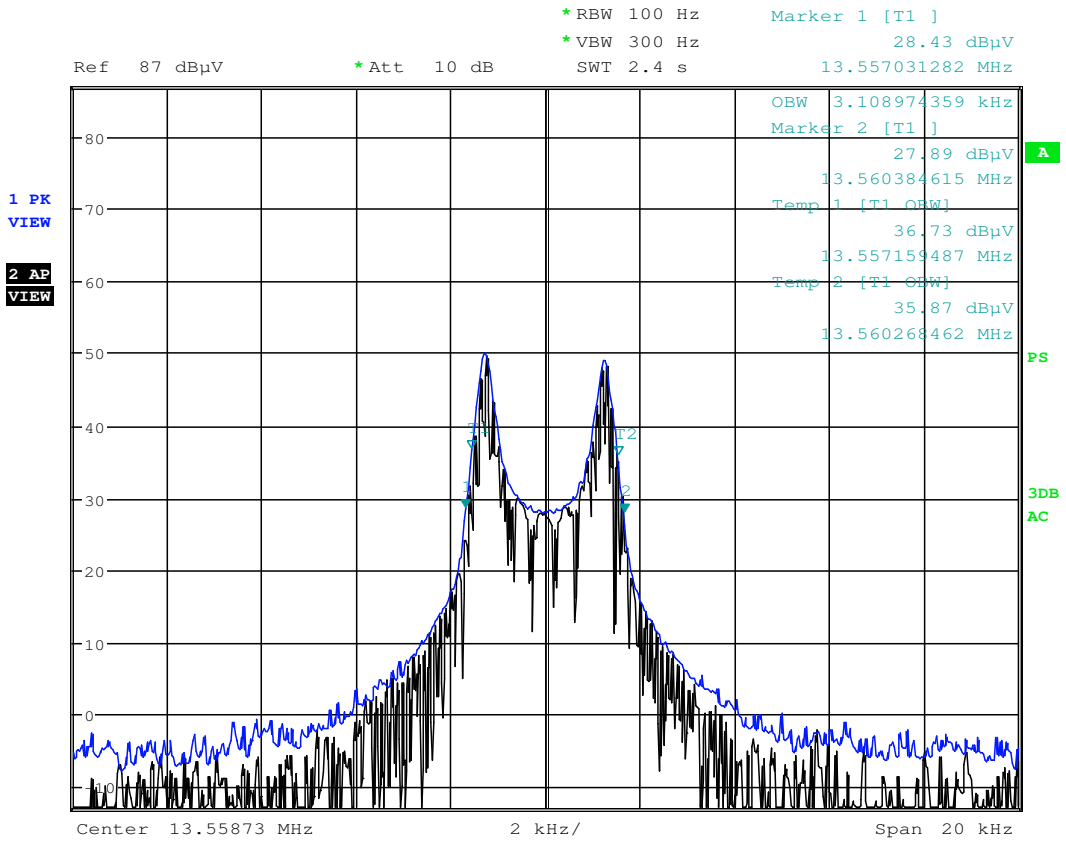
7.4 Test Result

Occupied Bandwidth (99%)	[kHz]	3.11

Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T12
Type(s): S2
Serial No(s): 153030053 (Rotor); none (Stator)
Test date: 2016-07-27

The EUT meets the requirements of this section.

7.5 Measurement Plot



EUT: #41.1 Rotor, #41.3 Stator, Manufacturer: HBM GmbH, MODE
: normal operation
Date: 27.JUL.2016 15:46:00

8 RADIATED EMISSIONS 9 kHz – 30 MHz

Test Requirement: FCC 47 CFR, §15.205, 15.209, 15.225(d)
ISED RSS-Gen Issue 4, 8.9, RSS-210 B.6
Test Procedure: ANSI C63.10-2013, ISED RSS-Gen

8.1 Regulation

§ 15.33 Frequency range of radiated measurements:
(a) Unless otherwise noted in the specific rule section under which the equipment operates for an intentional radiator the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz […]

§ 15.35 Measurement detector functions and bandwidths.
The conducted and radiated emission limits shown in this Part are based on the following, unless otherwise specified elsewhere in this Part:
(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified.
(c) Unless otherwise specified, e.g. Section 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

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

§ 15.225 Operation within the band 13.110–14.010 MHz.
(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

§ 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	Field Strength		Measurement distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
0.009–0.490	2400/F[kHz]	67.6 – 20 logF[kHz]	300
0.490–1.705	24000/F[kHz]	87.6 – 20 logF[kHz]	30
1.705–30.0	30	29.5	30

(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.

RSS-210 B.6 Band 13.110-14.010 MHz
The field strength of any emission shall not exceed the following limits:

(a) 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz;
(b) 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz;
(c) 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz; and
(d) RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

RSS-Gen, 8.9 Transmitter Emission Limits for Licence-Exempt Radio Apparatus
Except when the requirements applicable to a given device state otherwise, emissions from licence‑exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.
…

Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz

Frequency	Electric Field Strength (µV/m)	Magnetic Field Strength (H-Field) (µA/m)	Measurement Distance (metres)
9-490 kHz	2,400/F (F in kHz)	2,400/377F (F in kHz)	300
490-1,705 kHz	24,000/F (F in kHz)	24,000/377F (F in kHz)	30
1,705-30 MHz	30	N/A	30

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

8.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
EMI Test Software	R&S / EMC32 V9.25.00	5392	n.a.	n.a.
Loop Antenna with cable set	R&S / HFH-Z2	374	2016-07	2018-07
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

8.3 Test Procedures

Measurement was performed in a semi-anechoic room at a test distance of 3 m. A calibrated loop antenna as specified in ANSI C63.10 clause 4.3.2 was positioned with its plane vertical at the test distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna may also need to be positioned horizontally at the specified distance from the EUT. Instead of changing the loop antenna polarization to horizontal the EUT antenna was rotated by 90 degrees. I.e. tests performed for 2 EUT antenna polarizations. The center of the loop antenna was 1 m above the ground.
The EUT was tested on a 0.8 meter high tabletop.
The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter.
In certain applications, a remotely located device may be connected to the EUT. In these cases, it is permissible for cabling from the remotely located device to the EUT or accessories to be placed directly on the reference groundplane or, if normally installed beneath the reference groundplane, beneath it. The remotely located device shall be located at a distance sufficient to ensure that it does not contribute to the measured level. This procedure evaluates the interference potential of the EUT, its accessories, and interconnecting cables or wires standing apart from the remotely located device, which in turn shall be evaluated separately, if required.
Measurement initially performed as a pre-scan in the full frequency range in order to find worst case emissions. Final measurement performed at worst-case emission frequencies in a FCC and IC listed semi-anechoic room at the specified 3 m test distance. Pre-scan and final measurement performed in modulated mode.
Worst case emissions are listed under chapter: Final test results.

8.3.1 Test Site Correlation for H Field Measurement in Semi-Anechoic Chamber (SAC)

Test procedure following KDB 937606.

The carrier at 13.56 MHz was measured in the semi-anechoic room (SAC) at a test distance of 3m and at an open field site at a test distance of 3m and 10 m with the same calibrated loop antenna. The measurement was performed on EUT T12 S2 and S6.
These measurements were used to evaluate a correction of the open field measurement to the semi-anechoic room measurement.

EUT	Freq	Detector	Distance	F_{SAC}	F_{open}	f_c
	[MHz]		[m]	[dBµV/m]	[dBµV/m]	dB
S2	13.56	QP	3	72.2	70.8	-1.4
S6	13.56	QP	3	71.8	68.5	-3.3

Test date: 2016-09-14
The f_C value of -1.4 dB was used as this was the result for the type S2.

$f_C = F_{open} - F_{SAC}$

f_C is correlation factor from SAC to open field site field strength
F_{open} measured field strength at open field site
F_{SAC} measured field strength at SAC

Radiated Emissions Test Characteristics	
Frequency range	9 kHz - 30 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	200 Hz (9 kHz - 150 kHz)
	10 kHz (150 kHz - 30 MHz)
Receive antenna height	1 m
Receive antenna polarization	Vertical

* According to Section 15.31 (f)(2): At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The 40 dB/decade factor was used.

8.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for the band 1.705–30.0 MHz:

µV/m at 30 meters = 30

30 µV/m corresponds with 29.5 dBµV/m.

8.5 Field Strength Calculation

All emission measurements performed using the test receiver's transducer factor setting capability, i.e. the field strength value measured directly without the necessity of additional correction factors.
For 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 basic equation with a sample calculation is as follows:

FS = FST + DF + fc
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
f_C = correlation factor from SAC to open field site field strength
DF = Distance Extrapolation Factor in dB
where DF = 40 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance

Assume the tests performed at a reduced Test Distance of 3 m instead of the Specified Distance of 30 m giving a Distance Extrapolation Factor of DF = 40 log (3 m/30 m) = -40 dB.
Assuming a measured field strength level of 62.9 dBµV/m is obtained. The Distance Factor of -40 dB and the correlation factor fc of -2.6 dB is added giving a field strength of 20.3 dBµV/m. The 20.3 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 62.9 - 40 - 2.6 = 20.3 [dBµV/m]
Level in µV/m = Common Antilogarithm (20.3/20) = 10.4

8.6 Final Test Results

Frequency [MHz]	Detector	3m_Result [dB(µV/m)]	Distance Correction [dB]	f_c	30m_Result [dB(µV/m)]	30m_Limit [dB(µV/m)]	Margin [dB]
13.56	QP	72.2	- 40	-1.4	30.8	84.0	53.2
27.12		48.4	- 40	-	8.4	29.5	21.1

The table above contains worst-case emissions, only. For further details refer to the measurement plot.

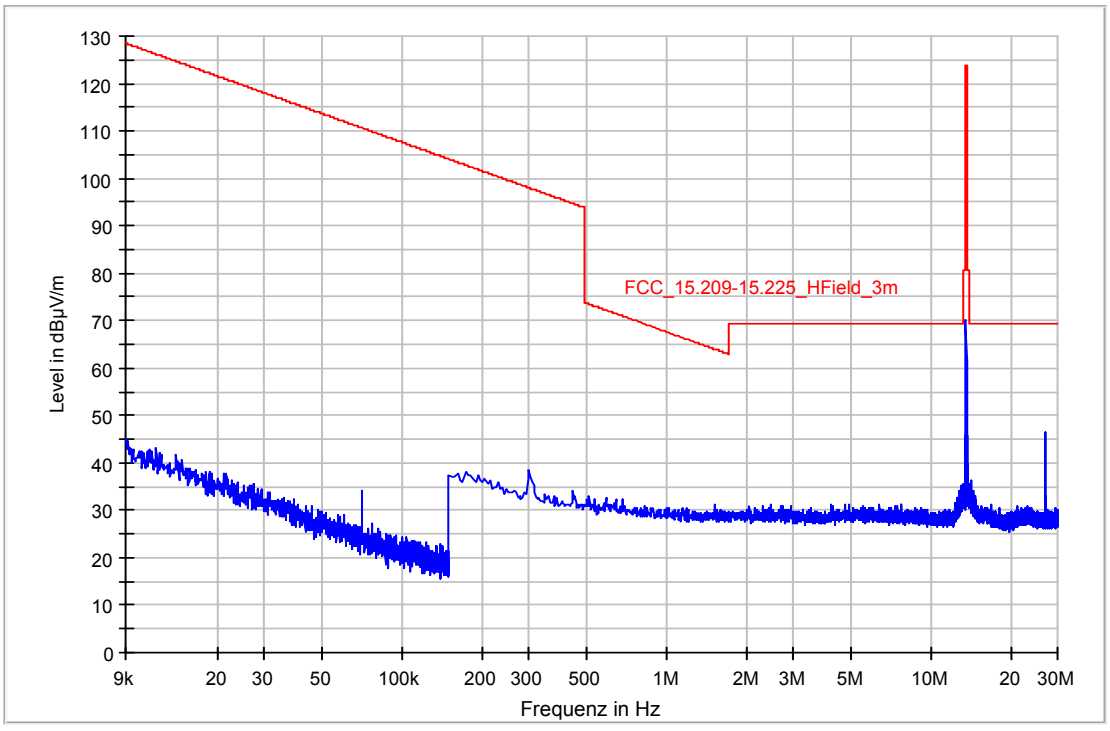
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); none (Stator)
Test date:	2016-07-27

All emissions in the range 9 kHz to 30 MHz are below the specified limits.

The EUT meets the requirements of this section.

8.7 Measurement Plot

Test distance d = 3 m



Note: The plot shows field strength reading at 3 m distance. In order to compare the 3 m reading with the specified field strength limits a distance correction as described in chapter 6.5 (40 dB/decade) was applied to the limit (represented by the limit line „FCC_15.209_HField_3m“).

9 RADIATED EMISSIONS 30 MHZ – 150 MHZ

Test Requirement: FCC 47 CFR, §15.205, 15.209, 15.225(d)
ISED RSS-Gen Issue 4, 6.13, 8.9, RSS-210 B.6
Test Procedure: ANSI C63.10-2013, ISED RSS-Gen

9.1 Regulation

§ 15.33 Frequency range of radiated measurements:
(a) Unless otherwise noted in the specific rule section under which the equipment operates for an intentional radiator the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1)-(a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this Section, whichever is the higher frequency range of investigation.

§ 15.35 Measurement detector functions and bandwidths.
The conducted and radiated emission limits shown in this Part are based on the following, unless otherwise specified elsewhere in this Part:
(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission. As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, as long as the same bandwidths as indicated for CISPR quasi-peak measurements are employed.
Note: For pulse modulated devices with a pulse-repetition frequency of 20 Hz or less and for which CISPR quasi-peak measurements are specified, compliance with the regulations shall be demonstrated using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, using the same measurement bandwidths that are indicated for CISPR quasi-peak measurements.

§ 15.225 Operation within the band 13.110–14.010 MHz.
(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

§ 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	Field Strength		Measurement Distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
30–88	100	40.0	3
88–135.6	150	43.5	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.
(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.

RSS-Gen 6.13
In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency given below:

(a) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

…

RSS-Gen, 8.9 Transmitter Emission Limits for Licence-Exempt Radio Apparatus
Except when the requirements applicable to a given device state otherwise, emissions from licence‑exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz	
Frequency (MHz)	Field Strength (µv/m at 3 metres
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

…

RSS-210 B.6 Band 13.110-14.010 MHz

The field strength of any emission shall not exceed the following limits:

…

(d)RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

→ The ISED limits for radiated spurious emissions are equal to the FCC limits.

9.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
VHF Test Dipole RX	Schwarzbeck VHA 9103	899	2015-05	2017-05
N-Cable N/50	R&S / HFU2-Z4	55	2016-08	2017-08
EMI Test Software	R&S / EMC32 V10.0.000	5392	n.a.	n.a.
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

9.3 Test Procedures

The EUT was tested on a 0.8 meter high tabletop.
In certain applications, a remotely located device may be connected to the EUT. In these cases, it is permissible for cabling from the remotely located device to the EUT or accessories to be placed directly on the reference groundplane or, if normally installed beneath the reference groundplane, beneath it. The remotely located device shall be located at a distance sufficient to ensure that it does not contribute to the measured level. This procedure evaluates the interference potential of the EUT, its accessories, and interconnecting cables or wires standing apart from the remotely located device, which in turn shall be evaluated separately, if required.
With the EUT operating in "worst case" mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions *[Remark: Not applicable]*. All tests performed with the EUT placed in both vertical and horizontal polarizations on the nonconductive table.

Measurement initially performed as a pre-scan in the full frequency range in order to find worst case emissions. Final measurement performed at worst-case emission frequencies in a FCC and IC listed semi-anechoic room at the specified 3 m test distance. Pre-scan and final measurement performed in modulated mode.
Final measurement performed up to the tenth harmonic of the carrier according to FCC Section 15.33 and ISED RSS-Gen 6.13 a.

Worst case emissions are listed under chapter: test results.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 150 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 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 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

9.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for the restricted band 108-121.94 MHz:

µV/m at 3 meters = 150

150 µV/m corresponds with 43.5 dBµV/m.

9.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB
Assume a receiver reading of 23.5 dBµV is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]
Level in µV/m = Common Antilogarithm (32/20) = 39.8

Using EMC32 software both corrections (AF and CF) are combined in the Corr.
Factor as listed in the results table: “Result” represents the FS result, “Corr.” is the combined correction factor. Receiver Amplitude (reading) is not listed separately.

9.6 Final Test Results

Frequency (MHz)	Result QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.66	36.6	40.0	3.4	1000	120	100.1	V	-71.0	14.4
54.22	34.1	40.0	5.9	1000	120	100.2	V	-97.0	10.4
67.78	21.5	40.0	18.5	1000	120	103.4	V	94.0	6.7
81.34	36.3	40.0	3.7	1000	120	112.8	V	91.0	8.3
81.42	31.6	40.0	8.4	1000	120	114.0	V	113.0	8.4
94.90	28.9	43.5	14.6	1000	120	121.1	V	110.0	9.9

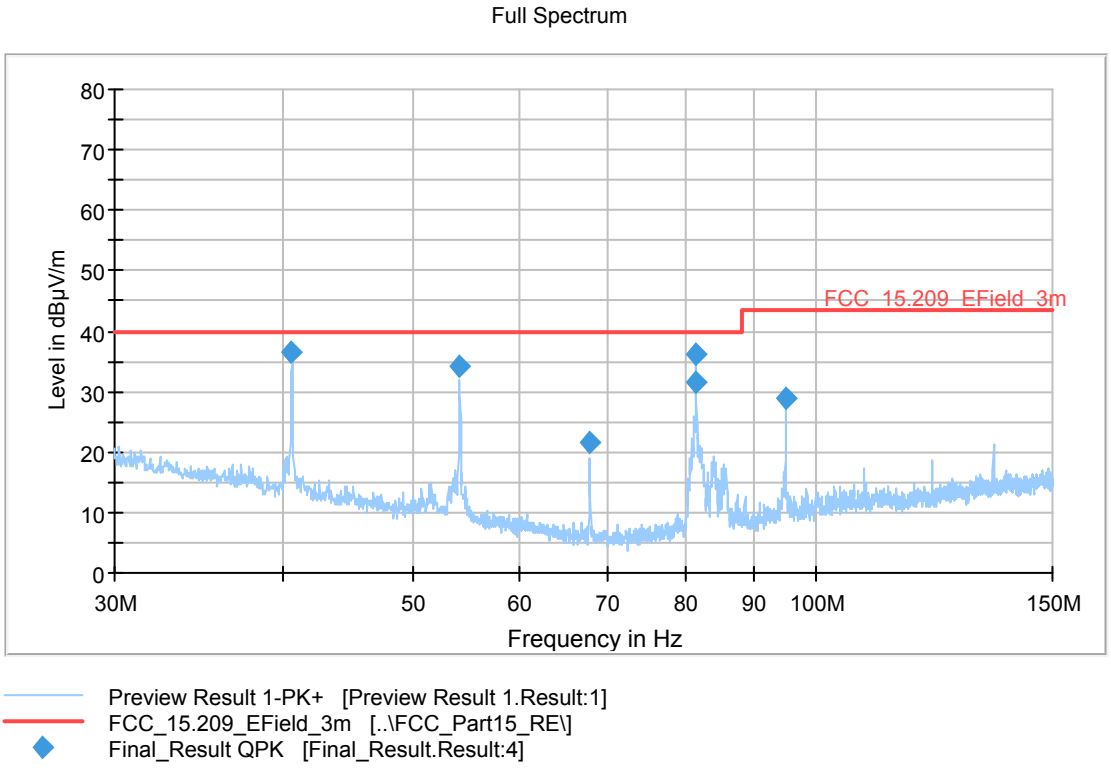
All tests performed at 3 m distance. The table above contains worst-case emissions for the normal mode, only. For further details refer to the pre-scan test plots.

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); none (Stator)
Test date:	2016-07-27

All emissions in the range 30 MHz to 150 MHz are below the specified limits.

The EUT meets the requirements of this section.

9.7 Pre-scan Plot(s)



10 CARRIER FREQUENCY STABILITY

Test Requirement: FCC 47 CFR, §15.225(e)
ISED RSS-210 B.6

10.1 Regulation

§ 15.225 Operation within the band 13.110–14.010 MHz.
(e) The frequency tolerance of the carrier signal shall be maintained within +/- 0.01 % of the operating frequency over a temperature variation of –20 degrees to +50 degrees 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 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-210 B.6 Band 13.110-14.010 MHz
…
Carrier frequency stability shall be maintained to ±0.01% (±100 ppm).

RSS-Gen 6.11 Transmitter Frequency Stability
…
With the transmitter installed in an environmental test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement. The following temperatures and supply voltage ranges apply, unless specified otherwise in the applicable RSS:
(a) at the temperatures of -30°C (-22°F), +20°C (+68°F) and +50°C (+122°F), and at the manufacturer's rated supply voltage; and
(b) at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage.
…

10.2 Test Procedures

Frequency stability with respect to ambient temperature:
The EUT was supplied with the nominal dc voltage (24 V). The EUT was placed in the centre of the environmental test chamber. The measurement antenna was placed in front of the environmental test chamber in about 0.5 meter distance and connected to a receiver. It was verified that the receiver had an adequate signal level to allow the measurement.
The temperature control of the environmental test chamber was set to the highest temperature for sufficient time to allow the EUT to stabilize at the temperature.

a) While maintaining a constant temperature inside the environmental chamber, the EUT was turned on and the operating frequency was measured at startup, two, and ten minutes after the EUT was energized. Three measurements in total were made.
b) The EUT was switched off.
c) The chamber temperature was lowered by 10 °C and sufficient time was waited until the test chamber and the EUT did stabilize at the temperature.
d) The step a) through step c) were repeated down to the lowest specified temperature.
The highest deviation from the nominal carrier frequency was reported in the test result table.

Frequency stability when varying supply voltage:
The tests were made at ambient room temperature (+15 °C to +25 °C).The EUT was placed on a wooden table 0.8 meter high tabletop.

The EUT was connected to a dc power supply and dc supply voltage was measured with a multimeter. An antenna was placed about 3 meter from the EUT and connected to receiver. It was verified that the receiver had an adequate signal level to allow the measurement.

The input voltage was set from 18 V to 30 V in 1 V steps. The measurement of the centre frequency was measured at each voltage step.

10.3 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
EMI Test Receiver	R&S / ESIP40	516	2016-02	2017-02
Loop antenna with cable set	Rohde & Schwarz HFH-Z2	2965	2016-02	2018-02
Loop antenna with cable set	Rohde & Schwarz HFH-Z2	374	2016-07	2018-07
Climatic Chamber	Binder/ MK 720	4463	not applicable	not applicable
Data Logger	Ahlborn/ MA25904AS	4934	2015-01	2017-01
Temperature Sensor	EMCC/ ZA9020-FS	4961	2015-01	2017-01
Temperature Sensor	EMCC/ ZA9020-FS	4681	2016-03	2018-03
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
DC Power Supply	Goobay / DF-1730LCD	3489	n.a	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

10.4 Test Results

10.4.1 Carrier Frequency Stability vs Temperature

Test conditions: Supply voltage = 24 VDC
f_{nom} = 13.55873 MHz

Temperature	Frequency	Deviation from nominal		Limit	Lower limit	Upper Limit
[°C]	[MHz]	[kHz]	[%]	[%]	[MHz]	[MHz]
50	13.55875	0.05	0.000	+- 0.01	13.5573	13.5601
40	13.55875	0.05	0.000	+- 0.01	13.5573	13.5601
30	13.55883	0.13	0.001	+- 0.01	13.5573	13.5601
20	13.55886	0.16	0.001	+- 0.01	13.5573	13.5601
10	13.55891	0.21	0.002	+- 0.01	13.5573	13.5601
0	13.55891	0.21	0.002	+- 0.01	13.5573	13.5601
-10	13.55892	0.22	0.002	+- 0.01	13.5573	13.5601
-20	13.55894	0.24	0.002	+- 0.01	13.5573	13.5601
-30	13.55889	0.19	0.001	+- 0.01	13.5573	13.5601

Test performed at nominal supply voltage and within the temperature range of -30 °C up to +50 °C starting at nominal ambient temperature and continuing with the highest specified temperature and proceeding with temperature lowered in 10 degree steps down to the lowest specified

Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T12
Type(s): S3
Serial No(s): 161030036 (Rotor); none (Stator)
Test date: 2016-08-29/30

Carrier frequency stability vs temperature is within the specified limits.

The EUT meets the requirements of this section.

10.4.2 Carrier Frequency Stability vs Supply Voltage

Test conditions: Temperature = 23 °C
f_{nom} = 13.55873 MHz

Supply voltage	Frequency	Deviation from nominal		Limit	Lower Limit	Upper Limit
[V]	[MHz]	[kHz]	[%]	[%]	[MHz]	[MHz]
18	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601
19	13.5587	0.04	0.000	+- 0.01	13.5573	13.5601
20	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601
21	13.5587	0.04	0.000	+- 0.01	13.5573	13.5601
22	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601
23	13.5587	0.025	0.000	+- 0.01	13.5573	13.5601
24	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601
25	13.5587	0.04	0.000	+- 0.01	13.5573	13.5601
26	13.5587	0.03	0.000	+- 0.01	13.5573	13.5601
27	13.5587	0.03	0.000	+- 0.01	13.5573	13.5601
28	13.5587	0.04	0.000	+- 0.01	13.5573	13.5601
29	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601
30	13.5587	0.035	0.000	+- 0.01	13.5573	13.5601

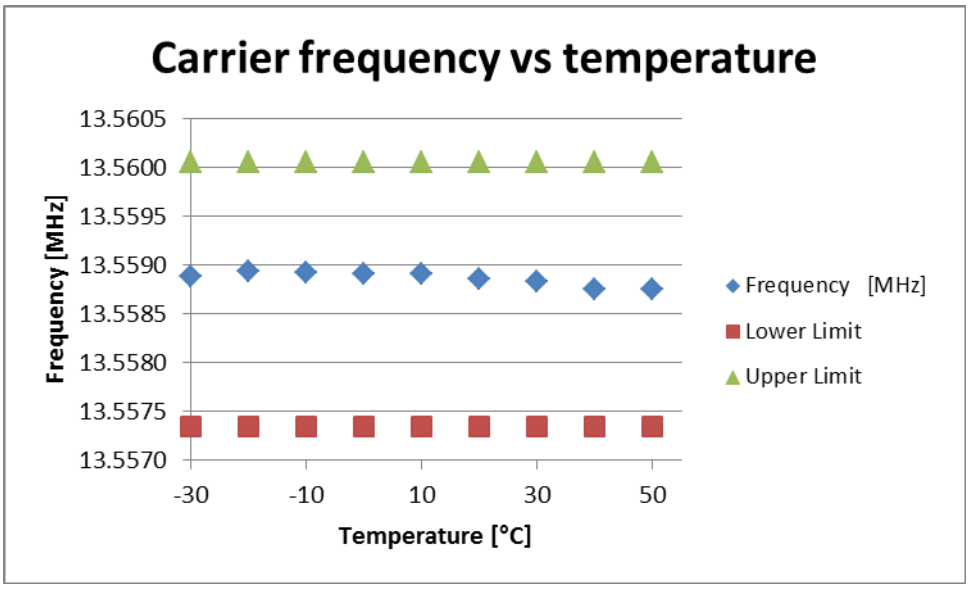
Test performed at normal ambient temperature and within the manufacture's specified supply voltage range.

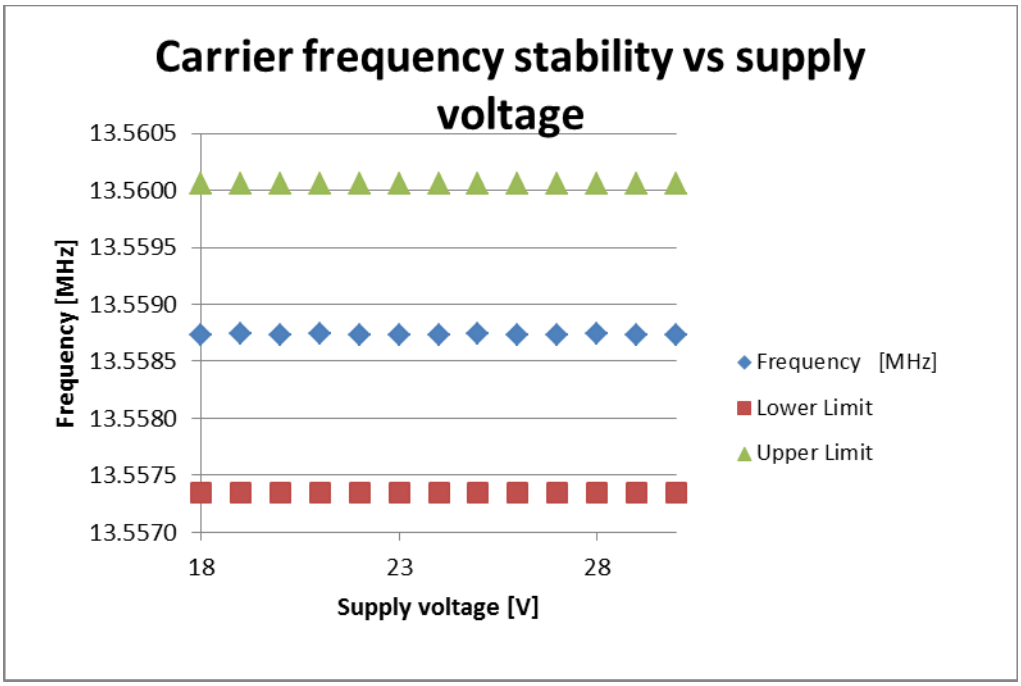
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S3
Serial No(s):	161030036 (Rotor); none (Stator)
Test date:	2016-07-05

Carrier frequency stability vs supply voltage is within the specified limits.

The EUT meets the requirements of this section.

10.5 Measurement Plots





11 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Conducted emissions (9 kHz – 30 MHz)	± 3.5 dB
Radiated emissions, H field (9 kHz – 30 MHz)	± 3.0 dB
Radiated Emissions (30 MHz – 1 GHz)	± 5.7 dB
Temperature	± 0.9 K
RF Frequency	$\pm 1 \times 10^{-5}$

The reported uncertainty values are based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of 95%.

If not otherwise stated, the given values are worst case values calculated on the basis of the following documents:
TR 100 028-1 V1.4.1 (2001-12)
TR 100 028-2 V1.4.1 (2001-12)
ISO: Guide to the Expression of Uncertainty in Measurement: 1993.

12 LIST OF ANNEXES

Following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test set-up	3
Annex 2: Photographs of equipment under test (EUT)	5