TEST REPORT # EMCC-040197BB, 2014-10-31

EQUIPMENT UNDER TEST:

Trade Name:	T12
Type Designation(s):	S2
Serial Number:	Rotor: 153030053, Stator: 183270022
Equipment Class:	Low Power Transceiver
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Address:	Im Tiefen See 45 64293 Darmstadt Germany
Phone:	+49 6151 803-681
Fax:	+49 6151 803-98790

RELEVANT STANDARD(S): 47 CFR 15.225

MEASUREMENT PROCEDURE:

☐ RSS-Gen Issue 3 ☒ ANSI C63.10-2009 ☐ Other

TEST REPORT PREPARED BY:

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TEST PERSONNEL:

Ludwig Kraft

HEAD OF GROUP:

Wolfgang Döring

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1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR 15.225 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-12067-01-00
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Moggast, 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 January 18, 2008, Registration Number 878769. This 3 m & 10 m alternative test site is approved by Industry Canada under file number 3464C-1.
Phone:	+49 9194 9016
Fax:	+49 9194 8125
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 Koslowski
Phone:	+49 6151 803-681
Fax:	+49 6151 803-98790
E-Mail:	michael.koslowski@hbm.com

1.5 Dates and Test Location

Date of receipt of EUT: 2014-10-06
Test Date: CW 42/2014 till CW 44/2014
Test Location: Lab IV

1.6 Ordering Information

Purchase Order and Date: E60-4500492578, 2014-09-30
Vendor Number: 806266

1.7 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2014-10-14	24	53	970	IV	no
2014-10-15	23	52	968	IV	no
2014-10-20	22	57	975	IV	no
2014-10-22	22	48	968	IV	no
2014-10-23	21	47	978	IV	no
2014-10-28	22	43	979	IV	no
2014-10-29	22	42	975	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade Name:	T12
Type Designation(s):	S2
Serial Number(s):	153030053 (Rotor), 183270022 (Stator)
FCC ID:	2ADAT-T12S2
Application:	Low Power Transceiver
Transmit Frequency:	13.56 MHz
Modulation:	Load modulation
Emission Designator:	10K0A1D
Power Supply:	24 VDC
Ports :	Signal and supply - 7 pole binder industrial connector
Antennas:	Integrated loop antenna
Variants:	S3 was used for carrier frequency stability vs temperature measurement
Remarks:	None

The variant type S3 used for the carrier rrequency stability vs temperature measurement has the same electronic in the stator as the type S2. The carrier frequency controlling device is part of the stator and the same in the type S2 and S3.

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

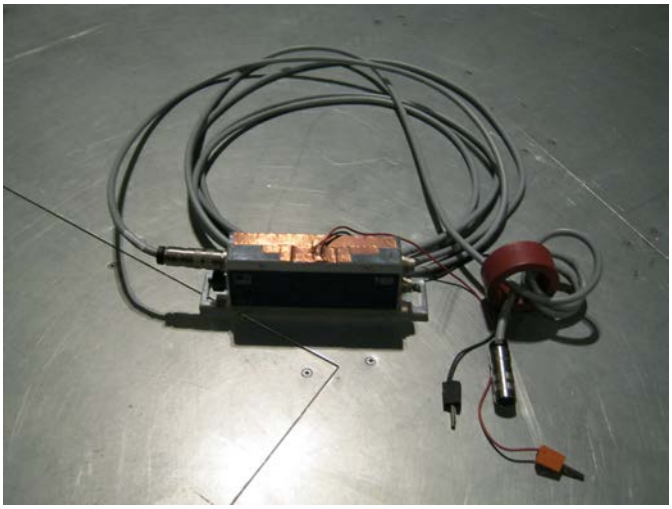
The EUT was tested connected with

- 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 3 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.

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 3 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

None.

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); 183270022 (Stator)

Requirement	47 CFR Section	Report Section	Result
Antenna Requirement	15.203	4	Passed
Conducted AC Power Line Emissions 150 kHz – 30 MHz	15.207	-	Passed
Spectrum Mask	15.225(a)-(d)	5	Passed
Radiated Emissions 9 kHz – 30 MHz	15.205, 15.209, 15.225(d)	6	Passed
Radiated Emissions 30 MHz – 149.16 MHz	15.205, 15.209, 15.225(d)	7	Passed
Carrier Frequency Stability	15.225(e)	8	Passed

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 C63.10-2009.
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: 2014-10-31

4 ANTENNA REQUIREMENT

Test Requirement: 47 CFR 15.203

4.1 Regulation

FCC 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.

4.2 Result

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); 183270022 (Stator)

The EUT meets the requirements of this section.

5 POWER LINE CONDUCTED EMISSIONS TEST

Test Requirement: FCC 47 CFR, §15.207
Test Procedure: ANSI C63.10-2009

5.1 Regulation

FCC 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.

5.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	Rohde & Schwarz / ESU8	3846	2014-07	2015-07
V-LISN 50 Ω//(50 uH + 5 Ω)	Rohde & Schwarz / ESH2-Z5	1901	2013-10	2015-10
Protector Limiter	Rohde & Schwarz / ESH3-Z2	1519	2014-09	2015-09
AC Power Source	AEG	0001	n.a	n.a
Multimeter	Agilent / U1241A	2720	2012-12	2014-12

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

Freq [MHz]	Line	Detector	Result [dBµV]	Limit [dBµV]	Margin
0.685	L	AV	42.6	46.0	3.4
0.25	L	AV	48.1	51.7	3.6
0.185	L	AV	50.5	54.3	3.8
0.745	L	AV	41.5	46.0	4.5
0.685	N	AV	40.9	46.0	5.1
0.25	N	AV	45.9	51.7	5.8
0.495	N	AV	39.5	46.0	6.5
0.435	N	AV	40.5	47.1	6.6

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

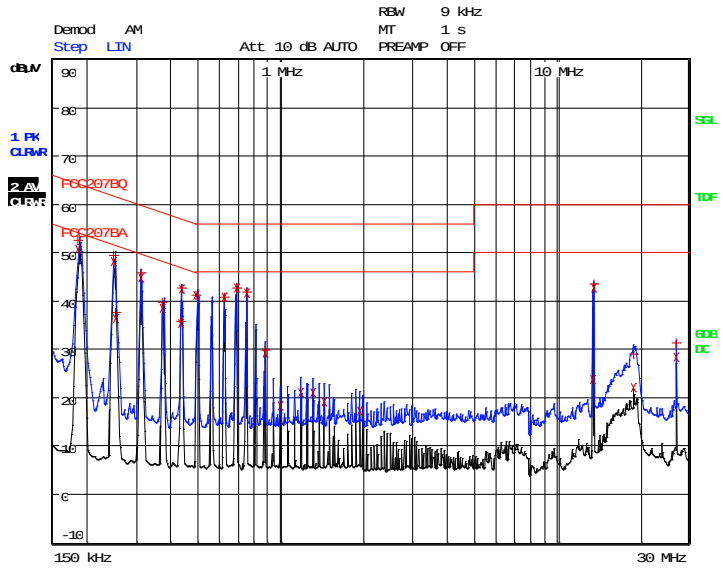
Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T12
Type(s): S2
Serial No(s): 153030053 (Rotor); 183270022 (Stator)

The EUT meets the requirements of this section.

5.5 Measurement Plots

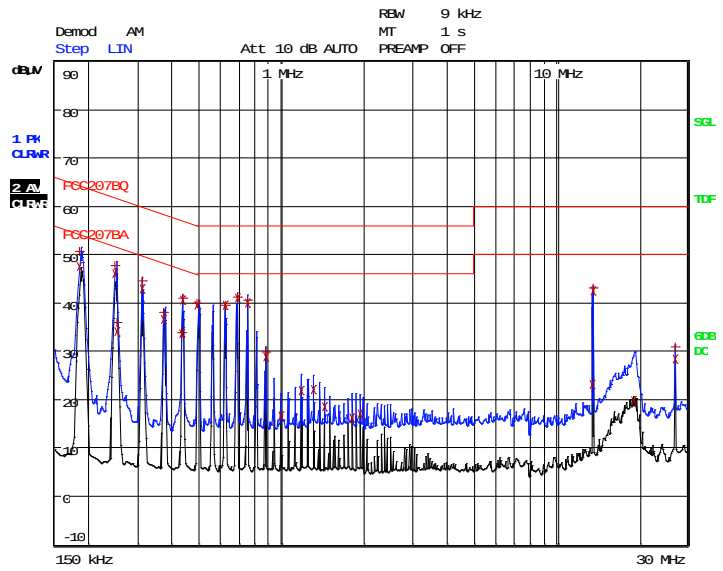
Refer to the following pages.

Test on line L:



Manufacturer: HBM, EUT #2, Power 115Vac / 60 Hz, Line: L, co
nfiguration: no cover, with ferrit
Date: 20.OCT.2014 17:13:44

Test on line N:



Manufacturer: HBM, EUT #2, Power 115Vac / 60 Hz, Line: N, co
nfiguration: no cover, with ferrit
Date: 20.OCT.2014 17:08:09

6 SPECTRUM MASK

Test Requirement: 47 CFR 15.225(a)-(d)

6.1 Regulation

FCC 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.

6.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Antenna (9 kHz – 30 MHz)	Rohde & Schwarz HFH-Z2	374	2014-06	2016-06
Receiver (20 Hz - 8 GHz)	Rohde & Schwarz ESU8	3846	2014-08	2015-08

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 C63.4 clause 4.1.5.1 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.

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 Final Test Result

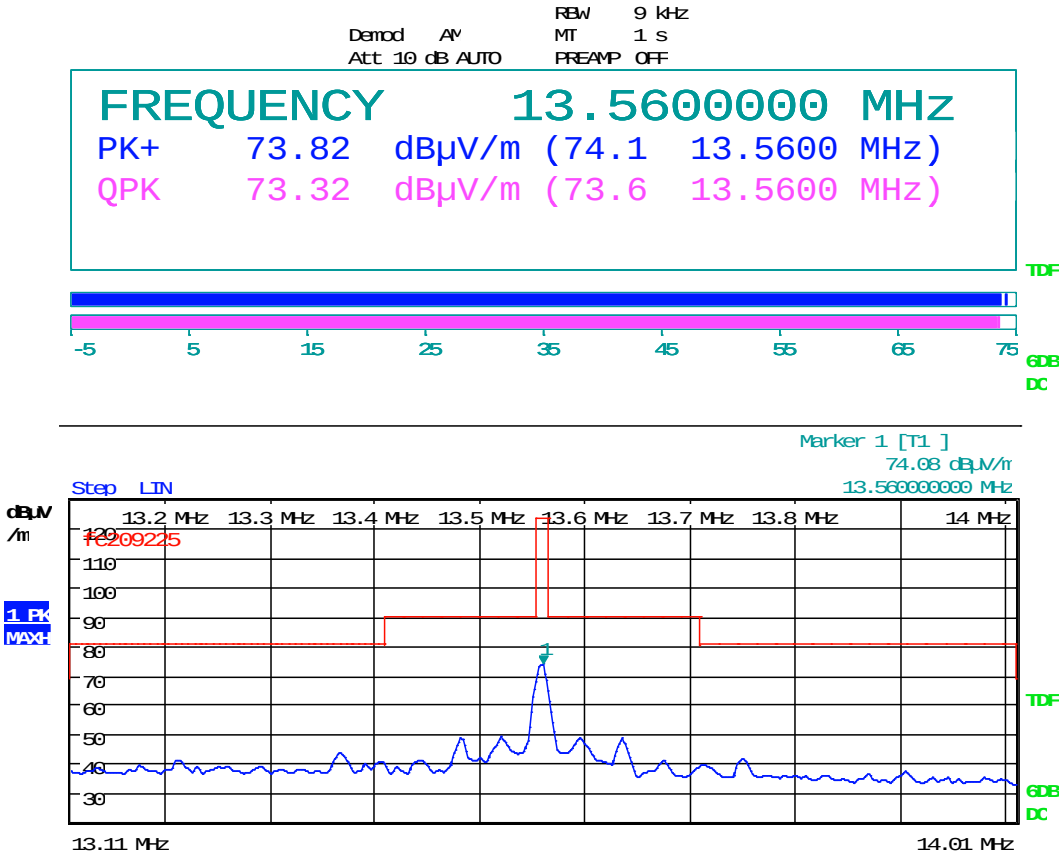
Frequency [MHz]	Detector	3m_Result [dB(µV/m)]	Distance Correction [dB]	30m_Result [dB(µV/m)]	30m_Limit [dB(µV/m)]	Margin [dB]
13.56	QP	73.6	-40	33.6	50.5	16.9

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); 183270022 (Stator)

The EUT meets the requirements of this section.

6.5 Pre-scan Plot(s)



Manufacturer: HBM, EUT: #2, normal operation, EUT in max H-F
ield position
Date: 29.OCT.2014 12:40:06

7 RADIATED EMISSIONS 9 kHz – 30 MHz

Test requirement: FCC 47 CFR, §15.205, 15.209, 15.225(d)
Test procedure: ANSI C63.10-2009

7.1 Regulation

FCC 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 […]

FCC 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.

FCC 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.

FCC 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.

FCC 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.

7.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Antenna (9 kHz – 30 MHz)	Rohde & Schwarz HFH-Z2	374	2014-06	2016-06
Receiver (20 Hz - 8 GHz)	Rohde & Schwarz ESU8	3846	2014-08	2015-08

7.3 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 C63.4 clause 4.1.5.1 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.

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.

7.4 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.

7.5 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
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
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 58.8 dBµV/m is obtained. The Distance Factor of -40 dB is added, giving a field strength of 18.8 dBµV/m. The 18.8 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 58.8 - 40 = 18.8 [dBµV/m]
Level in µV/m = Common Antilogarithm (18.8/20) = 8.7

7.6 Final Test Results

Frequency [MHz]	Detector	3m_Result [dB(µV/m)]	Distance Correction [dB]	30m_Result [dB(µV/m)]	30m_Limit [dB(µV/m)]	Margin [dB]
13.56	QP	73.8	- 40	33.8	50.5	16.7
27.12		49.1	- 40	9.1	29.5	20.4

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

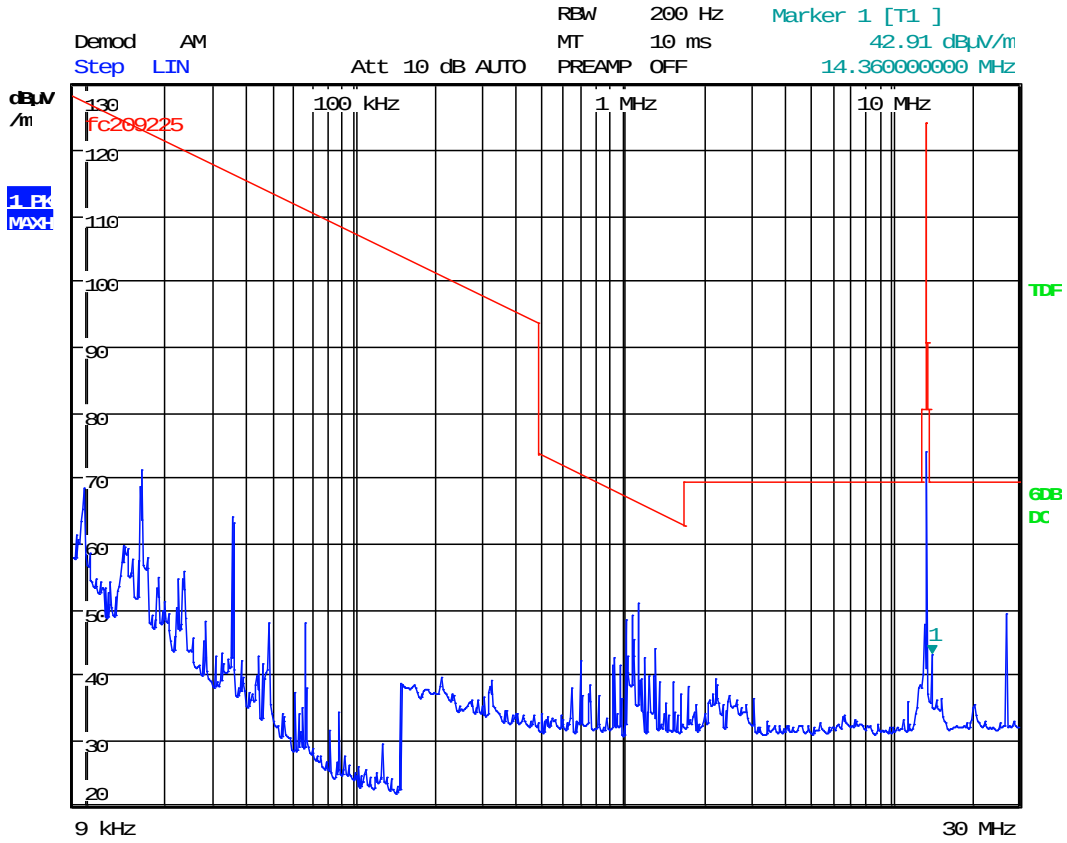
Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T12
Type(s): S2
Serial No(s): 153030053 (Rotor); 183270022 (Stator)

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

The EUT meets the requirements of this section.

7.7 Measurement Plot

Test distance d = 3 m



Manufacturer: HBM, EUT: #2, EUT axis horizontal, H-antenna 2
directions, EUT 4 directions
Date: 22.OCT.2014 17:12:39

HBM_H_008.WMF

8 RADIATED EMISSIONS 30 MHz – 149.16 MHz

Test Requirement: FCC 47 CFR, §15.205, 15.209, 15.225(d)
Test Procedure: ANSI C63.10-2009

8.1 Regulation

FCC 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.

FCC 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.

FCC 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.

FCC 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
88–149.16	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.

8.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Antenna (30 MHz - 1 GHz)	EMCO Model 3143	898	2013-05	2015-05
Receiver (9 kHz - 1 GHz)	Rohde & Schwarz ESS	303	2014-02	2015-02

8.3 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 Section 15.33.

Worst case emissions are listed under chapter: test results.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz 149.16 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).

8.4 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.

8.5 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

8.6 Final Test Results

Frequency [MHz]	Reading [dB(µV)]	Antenna factor [dB(1/m)]	Result [dB(µV/m)]	Limit [dB(µV/m)]	Margin [dB]	Polarisation h / v	Remarks
40.67	26.1	10.7	36.8	40	3.2	v	
54.24	19.9	7.6	27.4	40	12.6	v	
67.80	18.7	8.6	27.3	40	12.7	v	
81.34	27.7	9.9	37.6	40	2.4	v	
94.90	21.8	9.4	31.2	43.5	12.3	v	
108.46	16.8	9.0	25.7	43.5	17.8	v	
122.02	17.7	9.4	27.1	43.5	16.4	v	
135.60	14.2	11.2	25.3	43.5	18.2	h	
149.13	13.6	12.3	25.9	43.5	17.6	v	

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); 183270022 (Stator)

All emissions in the range 30 MHz to 1000 MHz are below the specified limits.

The EUT meets the requirements of this section.

8.7 Pre-scan Plot(s)

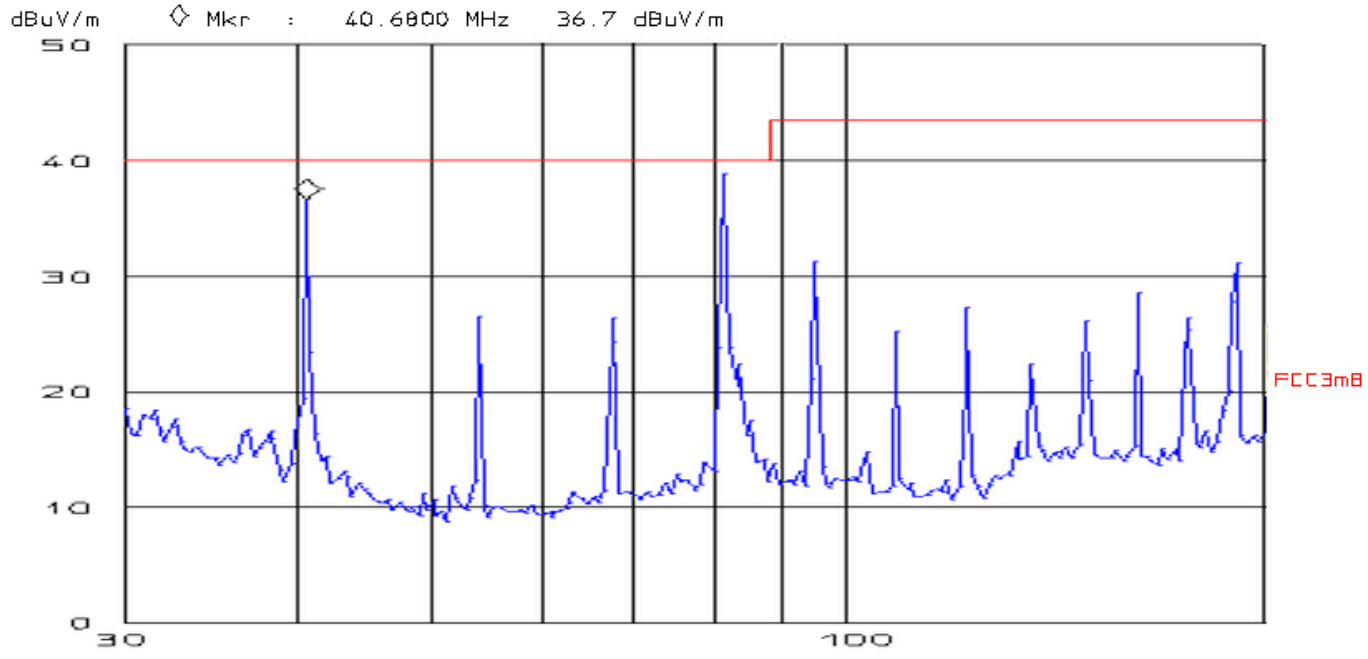
EMCC DR. RASEK 20. Oct 14 11:05
Radiated Emissions Prescan in SAR, d=3m

EUT: EUT #2
Manuf: HBM GmbH
Op Cond: normal
Operator: K.Kraft, L. Kraft
Test Spec: FCC 15 class B
Comment: EUT at center of a 1 x 1.5m table, 1 cabel with ferrit
Limit according to FCC

Fast Scan Settings (1 Range)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	200M	40k	120k	PK	0.10ms	0dBLN	ON	60dB

Transducer	No.	Start	Stop	Name
	21	30M	200M	89826K33



042.png

9 CARRIER FREQUENCY STABILITY

Test Requirement: FCC 47 CFR, §15.225(e)
Test Procedure: ANSI C63.10-2009

9.1 Regulation

FCC 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.

9.2 Test Procedures

Frequency stability with respect to ambient temperature:
a) Supply the EUT with a nominal dc voltage (24V).
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 on the EUT.
b) Couple the unlicensed wireless device output to the measuring instrument by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

c) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).
d) Turn the EUT off, and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.
e) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.
f) While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, two, and ten minutes after the EUT is energized. Three measurements in total are made.
g) Measure the centre frequency.
h) Switch off the EUT, but do not switch off the oscillator heater.
i) Lower the chamber temperature by not more than 10 °C and allow the temperature inside the chamber to stabilize.
j) Repeat step f) through step i) down to the lowest specified temperature.
k) The highest deviation from the nominal carrier frequency was reported in the test result table.

Frequency stability when varying supply voltage:
Unless other specified, these tests shall be made at ambient room temperature (+15 °C to +25 °C).
An antenna should be connected to the antenna output terminals of the EUT if possible. If the EUT is equipped with or uses an adjustable-length antenna, it should be fully extended.
a) Supply the EUT with nominal dc voltage (24V).
Turn on the EUT, and couple its output to a frequency counter or other frequency-measuring instrument.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

b) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).
c) Measure the centre frequency.
d) repeat the above procedure at the input voltage from 18 V to 30V in 1V steps.

9.3 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Receiver (20 Hz - 8 GHz)	Rohde & Schwarz ESU8	3846	2014-08	2015-08
Antenna (9 kHz – 30 MHz)	Rohde & Schwarz HFH-Z2	374	2014-06	2016-06
Climatic Chamber	Binder/ MK 720	4463	not applicable	not applicable
Data Logger	Ahlborn/ ALMEMO 2890-9	4493	not applicable	not applicable
Temperature Sensor	EMCC/ ZA9020-FS	4681	2014-02	2016-02
Power Supply	MC Voice/ DF-1730SBC-3A	2766	not applicable	not applicable
Multimeter	Hewlett-Packard/ 3478A	2483	2014-04	2016-04

9.4 Test Results

9.4.1 Carrier Frequency Stability vs Temperature

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

Temperatur	Frequency	Deviation from nominal		Limit		Lower limit	Upper Limit
[°C]	[MHz]	[kHz]	[%]	[%]		[MHz]	[MHz]
50	13.5584	-0.33	-0.002	+- 0.01		13.5574	13.5601
40	13.5585	-0.23	-0.002	+- 0.01		13.5574	13.5601
30	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
20	13.5587	-0.03	0.000	+- 0.01		13.5574	13.5601
10	13.5588	0.07	0.001	+- 0.01		13.5574	13.5601
0	13.5588	0.07	0.001	+- 0.01		13.5574	13.5601
-10	13.5589	0.17	0.001	+- 0.01		13.5574	13.5601
-20	13.5589	0.17	0.001	+- 0.01		13.5574	13.5601

Test performed at nominal supply voltage and within the temperature range of -20 °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): 161030037 (Rotor); Test sample - No serial no. (Stator)

9.4.2 Carrier Frequency Stability vs Supply Voltage

Test conditions: Temperature = 22 °C
f_{nom} = 13.55873 MHz

Supply voltage	Frequency	Deviation from nominal		Limit		Lower Limit	Upper Limit
[V]	[MHz]	[kHz]	[%]	[%]		[MHz]	[MHz]
18	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
19	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
20	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
21	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
22	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
23	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
24	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
25	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
26	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
27	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
28	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
29	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601
30	13.5586	-0.13	-0.001	+- 0.01		13.5574	13.5601

frequencydrift_#2.xls

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

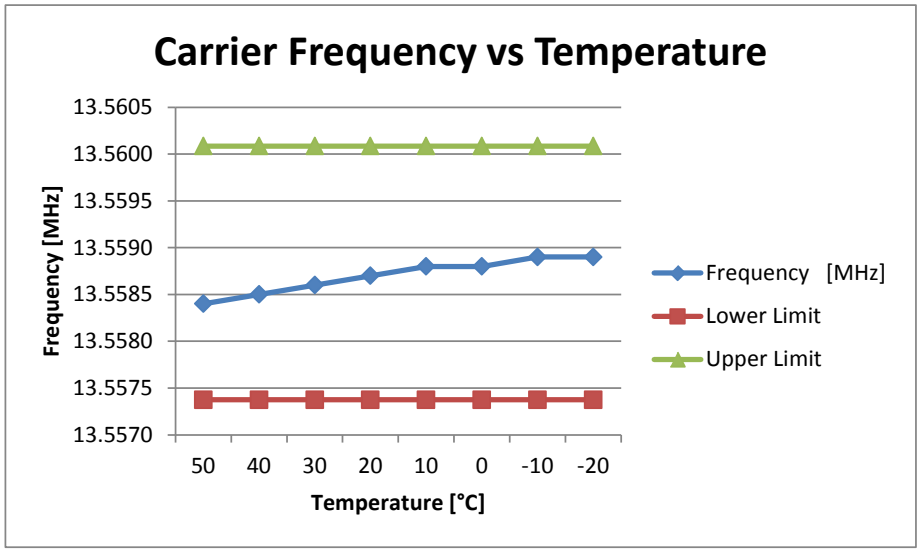
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T12
Type(s):	S2
Serial No(s):	153030053 (Rotor); 183270022 (Stator)

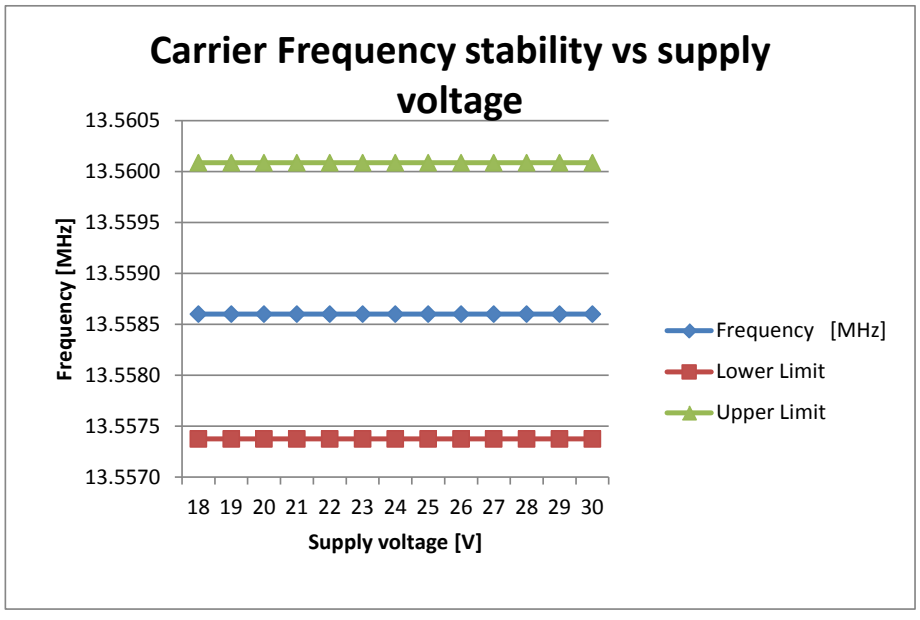
Carrier frequency stability is within the specified limits.

The EUT meets the requirements of this section.

9.5 Measurement Plots

Refer to the following page.





10 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