TEST REPORT # EMCC-040197.1G, 2021-02-02

EQUIPMENT UNDER TEST:

Trade Name:	Torque meter T40CB
Type:	T40CB S2
Serial Number(s):	Rotor: 23444018, Stator: 233670005
Equipment Class:	Low Power Transceiver
FCC ID:	2ADAT-T40S2TOS6
ISED IC:	12438A-T40S2TOS6
Manufacturer:	Hottinger Brüel & Kjaer GmbH
Address:	Im Tiefen See 45 64293 Darmstadt GERMANY
Name:	Gesa Biegling
Phone:	+49 6151 803 8790
E-Mail:	Gesa.Biegling@hbkworld.com

RELEVANT STANDARD(S) : 47 CFR § 15.203, § 15.207, § 15.209,
RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013 ☒ SPR-002 Issue 1

TEST REPORT PREPARED BY:

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Tested:
Ludwig Kraft

Approved:
Reinhard Sauerschell

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0 REVISION HISTORY

Project number	Issue date	Chapter	Description
040197.1G	2021-02-02	n.a.	Initial issue

1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5 requirements applicable to intentional radiators.

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 Laboratory

Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG
Accreditation No.:	D-PL-12067-01-03 D-PL-12067-01-04
FCC Test Firm Registration No.:	368753
ISED CAB identifier:	DE0002
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Boelwiese 8 91320 Ebermannstadt GERMANY
ISED company number:	3464A
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
ISED company number:	3464C
Phone:	+49 9194 7262-0
Fax:	+49 9194 7262-199
E-Mail:	info@emcc.de
Web:	www.emcc.de

1.4 Customer

Company Name:	Hottinger Brüel & Kjaer GmbH
Street:	Im Tiefen See 45
City:	64293 Darmstadt
Country:	GERMANY
Name:	Ms Gesa Biegling
Phone:	+49 6151 803 8790
Fax:	
E-Mail:	Gesa.Biegling@hbkworld.com

1.5 Manufacturer

Company Name:	Hottinger Brüel & Kjaer GmbH
Street:	Im Tiefen See 45
City:	64293 Darmstadt
Country:	Germany
Phone:	+49 6151 803 8790
E-Mail:	Gesa.Biegling@hbkworld.com

1.6 Dates and Test Location

Date of receipt of EUT:	2020-12-08
Test Date:	CW 52/2020
Test Location:	Lab IV

1.7 Ordering Information

Purchase Order:	E70-45007449212/2000
Date:	2020-11-17
Vendor-Number:	806266

1.8 Climatic Conditions

Date	Temperature	Relative Humidity	Air Pressure	Lab	Customer attended tests
--	°C	%	hPa	--	--
2020-12-21	22	33	982	IV	No
2020-12-22	22	38	975	IV	No
2020-12-23	22	41	973	IV	No

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

The following data is based on customer's information.

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Trade Name:	Torque meter T40CB
Type:	T40CB S2
Serial No(s):	Rotor: 23444018, Stator: 233670005
Application:	Low Power Transceiver
FCC ID:	2ADAT-T40S2TOS6
ISED IC:	12438A-T40S2TOS6
Product Marketing Name:	T40CVS2
Hardware Version Identification Number:	T40CVS2
Firmware Version Identification Number:	N/A
Host Marketing Number:	N/A
Transmit Frequency:	522.85 kHz (wireless power transfer) 1.22 MHz (wireless data transfer)
Number of RF channels:	2
Modulation:	ASK (wireless power transfer) PSK (wireless data transfer)
Emission Designator:	N0N (522.85 kHz); 1M51G1D (1.22MHz)
Highest Internal Frequency	29.28 MHz
Power Supply:	24 VDC
Port 1:	Signal and power supply – 7 pole binder industrial connector
Port 2,3,4:	Not used for testing
Antenna types:	Integrated loop antenna
Remarks:	None

2.2 Intended Use

The following information was delivered by the customer.

The EUT is a torque meter with wireless measurement data transfer and wireless power supply. The measurement data transfer goes from rotor to stator. The wireless power supply goes the other way round. In the field the EUT is part of an engine test bench.

2.3 EUT Peripherals/Simulators

The EUT was tested connected with

- Power supply TRIO-PS/1AC/24DC/5 (Phoenix Contact)
- Data cable termination box T40B
- Data cable

2.4 Mode of operation during testing and test setup

The following information was delivered by the customer.

Normal operation:
The EUT is configured to start wireless power supply, measurement and data transfer as soon as supplied by external power.

For the radiated emission test the 24VDC power supply was operated outside of the test environment.

For the conducted emission test the EUT was powered with 24 VDC by the AC / DC supply TRIO-PS/1AC/24DC/5 delivered by the customer. The AC/DC power supply was connected to 120 V / 60 Hz.

2.5 Modifications required for compliance

None.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: Hottinger Brüel & Kjaer GmbH
Type, T40CB S2
Serial No. : Rotor: 23444018, Stator: 233670005

Requirement	47 CFR Section	RSS, Section	Report Section	Result
Antenna Requirement	§ 15.203	RSS-Gen, 6.8	4	Passed
AC Power Line Conducted Emissions	§ 15.207	RSS-Gen, 8.8	5	Passed
Occupied Bandwidth (99%)		RSS-Gen, 6.7	6	Passed
Radiated Emissions 9kHz – 30 MHz	§ 15.209 § 15.205	RSS-210, B.2 RSS-Gen, 8.9	7	Passed
Radiated Emissions 30 MHz – 1 GHz	§ 15.209 § 15.205	RSS-210, B.2 RSS-Gen, 6.13, 8.9	8	Passed
RF Exposure Evaluation		RSS-102, 4	9	Passed

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 all applicable Public Notices received prior to the date of testing. 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 personnel: Ludwig Kraft
Issuance date: 2021-02-02

4 ANTENNA REQUIREMENT

Test Requirement: FCC: 47 CFR §15.203
ISED: RSS-Gen, section 6.8

4.1 Regulation

47 CFR § 15.203 Antenna requirement

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

RSS-Gen: 6.8 Transmitter Antenna:
The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

> *This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.*

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

No applicable antenna requirement specified in RSS-210.

4.2 Test Procedures

None.

4.3 Test Result

The EUT is equipped with a fixed loop antenna.

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

5 AC POWER LINE CONDUCTED EMISSIONS

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

5.1 Regulation

47 CFR § 15.207 Conducted limits

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

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

*Decreases with the logarithm of the frequency.

(b) The 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

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device,

while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

Table 4 – AC Power Line Conducted Emissions Limits

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56[1]	56 to 46[1]
0.5–5	56	46
0.5-30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

(a) Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.

(b) Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

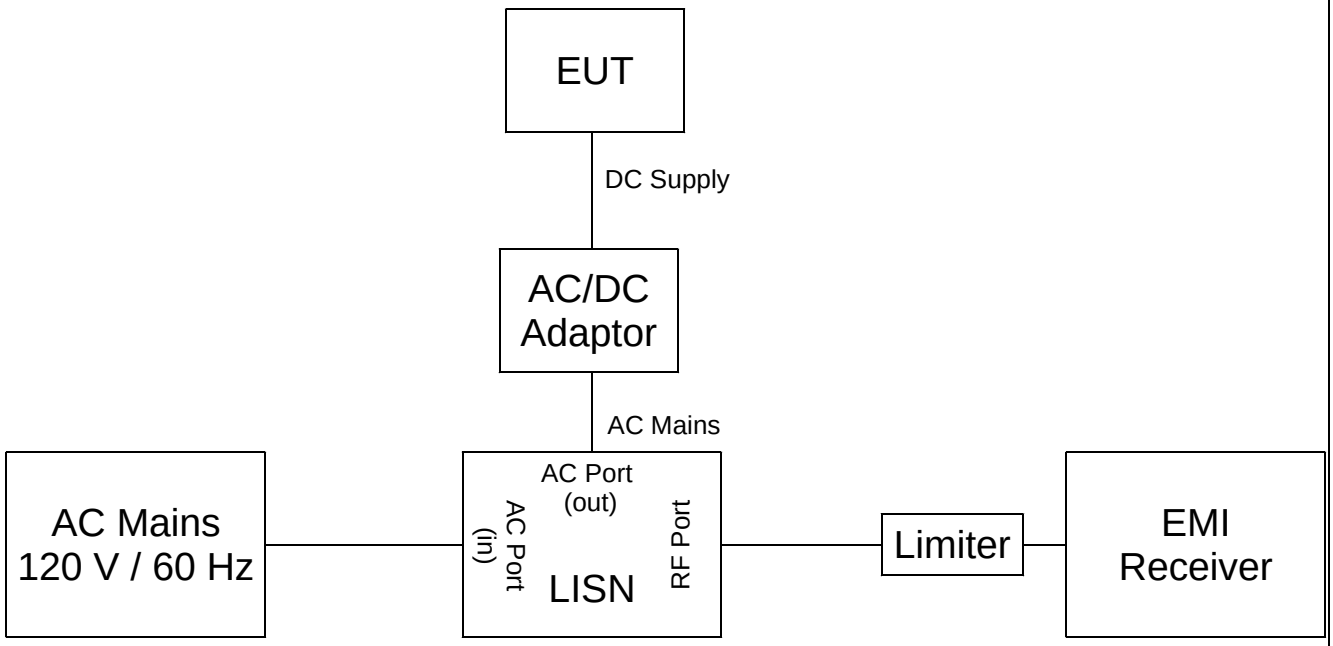
→ The ISED limits are equal to the FCC limits.

5.2 Test Procedures

The EUT was placed on a wooden table, raised 80 cm above the reference ground plane.
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 from 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.

The measurement receiver is connected to the 50 Ω RF port of the LISN.

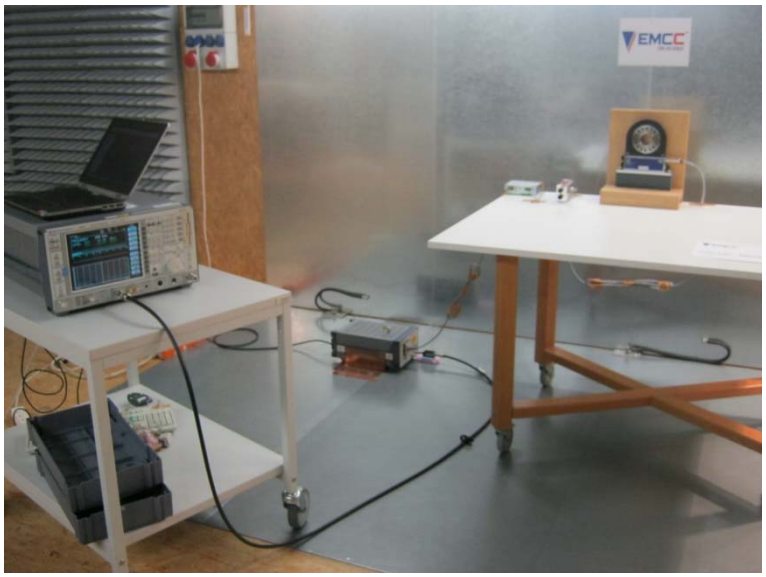
5.3 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.207 RSS-Gen, 8.8
Procedure:	ANSI C63.10-2013
Power source:	#34
Receiver:	#516
LISN:	#1470

TEST EQUIPMENT USED:
Refer to chapter 10 of this document.
34, 516, 1470, 1519, 1890, 2721, 4018, 4717, 5392, 5551

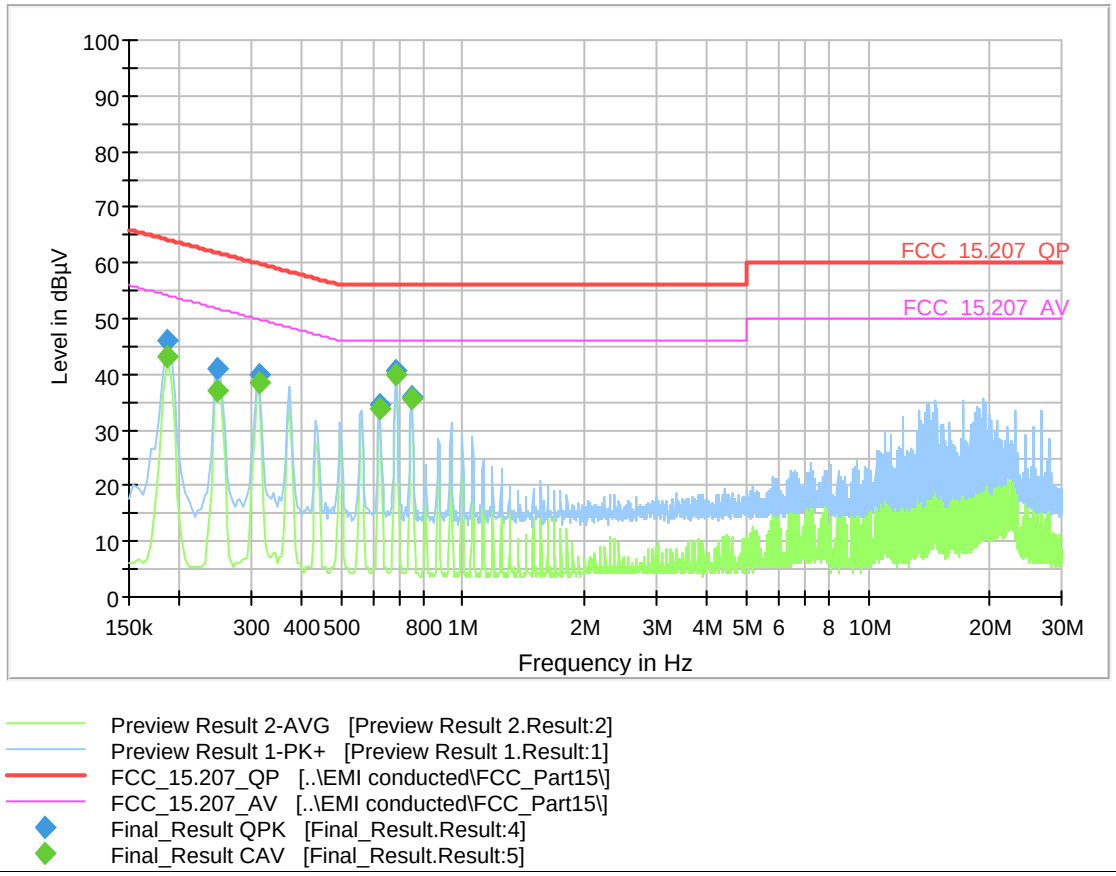


Sample photo of setup

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

5.3.1 Detailed Test Data

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No:	Rotor: 23444018, Stator: 233670005
Mode:	Normal operation
Line:	L and N (max hold)



Final Result:

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.19	---	43.1	54.2	11.1	1000	9	L1	10
0.19	46.2	---	64.2	18.0	1000	9	L1	10
0.25	---	37.2	51.8	14.6	1000	9	N	10
0.31	40.0	---	59.9	19.9	1000	9	L1	10
0.31	---	38.4	49.9	11.5	1000	9	L1	10
0.62	---	33.9	46.0	12.1	1000	9	L1	10
0.69	40.6	---	56.0	15.4	1000	9	L1	10

5.4 Test Result

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-21
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

6 OCCUPIED BANDWIDTH (99 %)

Test Requirement: ISED: RSS-Gen Issue 5, section 6.7
Test Procedure: ISED: RSS-Gen Issue 5, section 6.7

6.1 Regulation

RSS-Gen: 6.7 Occupied Bandwidth (or 99% emission bandwidth) and x dB bandwidth
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and 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 occupied bandwidth (or the 99% emission bandwidth).

6.2 Test Procedures

6.2.1 Test Procedure 523 kHz Carrier for Energy Transfer

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. The antenna was positioned with its plane vertical at about 3 m distance from the EUT. The analyzer was setup at the nominal centre frequency of the EUT. For the 522.88 kHz carrier the span was 100 Hz, the resolution bandwidth 10 Hz and the video bandwidth 30 Hz. A max peak hold was used to measure the occupied bandwidth.
There was no torque applied to the EUT during the test.

6.2.2 Test Procedure 1.22 MHz Carrier for Data Transmission

The occupied bandwidth of the data transfer carrier (1.22 MHz) was calculated according to TRC-43, Issue 3, November 2012. The measured signal level was too low for a measurement with sufficient signal to noise distance.

Formula for PSK: $B_n = \frac{2 \times R \times K}{\log_2 S}$

R = 1.2 Mbps[1]
K = 1
S = 3 [1]

B_n = 1.514 MHz

Note [1]: Information provided by customer

6.3 Test Result

Occupied Bandwidth (99%), 523 kHz carrier	[Hz]	22.1
Occupied Bandwidth (6 dB), 523 kHz carrier	[Hz]	14.4
Occupied Bandwidth (20 dB), 523 kHz carrier	[Hz]	26.0
Occupied Bandwidth (99%), 1.22 MHz carrier	[MHz]	1.514 *

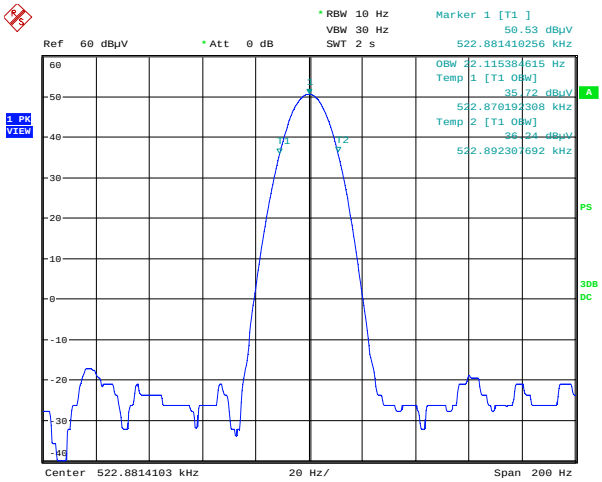
** calculated*

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-23
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

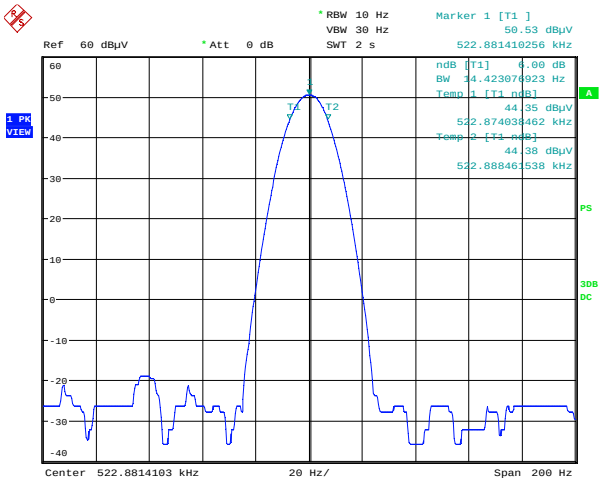
6.3.1 Measurement Plots

Plot carrier 523 kHz, Occupied Bandwidth 99 %:



Date: 22.DEC.2020 16:35:53

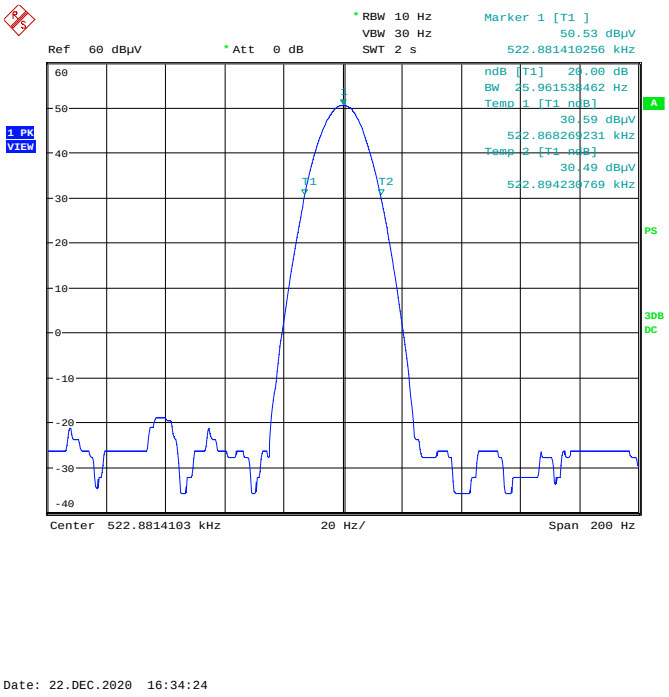
Plot carrier 523 kHz, Occupied Bandwidth 6 dB:



Date: 22.DEC.2020 16:34:00

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

Plot carrier 523 kHz, Occupied Bandwidth 20 dB:



7 RADIATED EMISSIONS 9 kHz – 30 MHz

Test requirement: FCC: 47 CFR §15.205, §15.209
ISED: RSS-210, section B.2; RSS-Gen Issue 5, section 8.9
Test procedure: ANSI C63.10-2013, ISED: RSS-Gen

7.1 Regulation

47 CFR § 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). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

47CFR § 15.33 Frequency range of radiated measurements

(a) 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.

47 CFR § 15.35 Measurement detector functions and bandwidths.

(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 instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). 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 as long at the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

§15.205 Restricted bands of operation.

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

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

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

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

47 CFR § 15.209 Radiated emission limits; general requirements.

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

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

(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-Gen, 8.9 Transmitter Emission Limits
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Field Strength	Equivalent Field Strength[2]	Measurement distance
	[µA/m]	[µV/m]	[m]
9 – 490 kHz[1]	6.37/F[kHz]	2401/F[kHz]	300
490 – 1705 kHz	63.7/F[kHz]	24015/F[kHz]	30
1.705–30 MHz	0.08	30.16	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

Note 2: Equivalent electrical field strength according to ANSI C63.10-2013 chapter 4.3.2:
"For the United States, the regulatory limits below 30 MHz are in terms of µV/m. By convention, magnetic field strength is converted to an electric field strength based on free-space impedance [1 µV/m = (1 / 377 Ω) × 1 µA/m]."

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

7.2 Test Procedures

ANSI C63.10-2013, 6.4.3 Measuring antenna selection, location, and test distance
Radiated emission tests shall be performed in the frequency range of 9 kHz to 30 MHz, using a calibrated loop antenna as specified in 4.3.2, at a suitable site and measurement distance as specified in 5.3. This method is applicable for measuring radiated RF emissions from all units, cables, power cords and interconnect cabling or wiring of the EUT, by applying the guidance provided in 5.10 along with guidance provided subsequently.

ANSI C63.10-2013, 6.4.6 Exploratory radiated emission tests
The tests shall be performed in the frequency range specified in 5.5 and 5.6, using the procedures in Clause 5, applying the appropriate modulating signal to the EUT, to determine cable or wire positions of the EUT system that produce the emission with the highest amplitude relative to the limit.
Exploratory measurements below 30 MHz are useful in determining the maximum level of emissions while manipulating and rotating the EUT; however, exploratory and final measurements may be made concurrently, provided care is taken to determine the maximum level of emissions for all configurations and orientations.
The test arrangement, measuring antenna guidelines and operational configurations in 6.3.1 and 6.3.2, shall be followed. The measurement antenna shall be positioned with its plane perpendicular to the ground at the specified distance. When perpendicular to the ground plane, the lowest height of the magnetic antenna shall be 1 m above the ground and shall be positioned at the specified distance from the EUT. When the EUT contains a loop antenna that can only be placed in a vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, and then orthogonal to the axis. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. When the EUT contains a loop antenna that can be placed in a horizontal or vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, orthogonal to the axis, and then with the measurement antenna horizontal. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. The report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB, then the following statement shall be made: “all emissions were greater than 20 dB below the limit.”

ANSI C63.10-2013, 6.4.7 Final radiated emission tests
Using the orientation and equipment arrangement of the EUT determined in 6.4.6, and applying the appropriate modulating signal to the EUT, perform final radiated emission measurements on the fundamental and highest spurious emissions.
Unless otherwise specified by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	9 kHz – 30 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	200 Hz (9 kHz - 150 kHz) 9 kHz (150 kHz - 30 MHz)
Receive antenna height	1 m
Angular steps size during prescan:	90 °
Receive antenna orientations	3
Measurement chamber	Semi anechoic chamber (SAC)

* 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.

7.3 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.

7.4 Field Strength Calculation

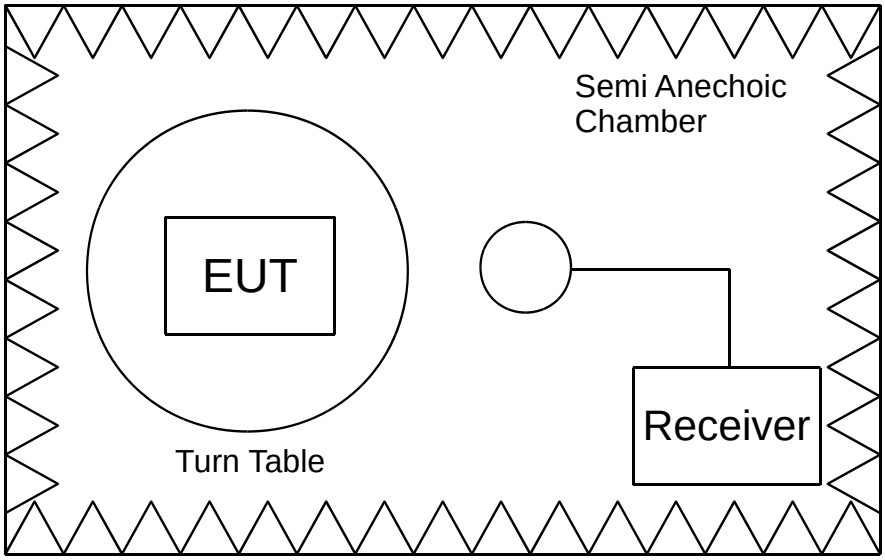
All emission measurements performed using the EMI test program's transducer factor setting capability, i.e. the field strength value measured directly without the necessity of additional correction factors.
For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (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
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 52.5 dBµV/m is obtained. The Distance Factor of -40 dB is added giving a field strength of 12.5 dBµV/m. The 12.5 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 52.5 - 40= 12.5 [dBµV/m]
Level in µV/m = Common Antilogarithm (12.5/20) = 4.2

7.5 Test Setup



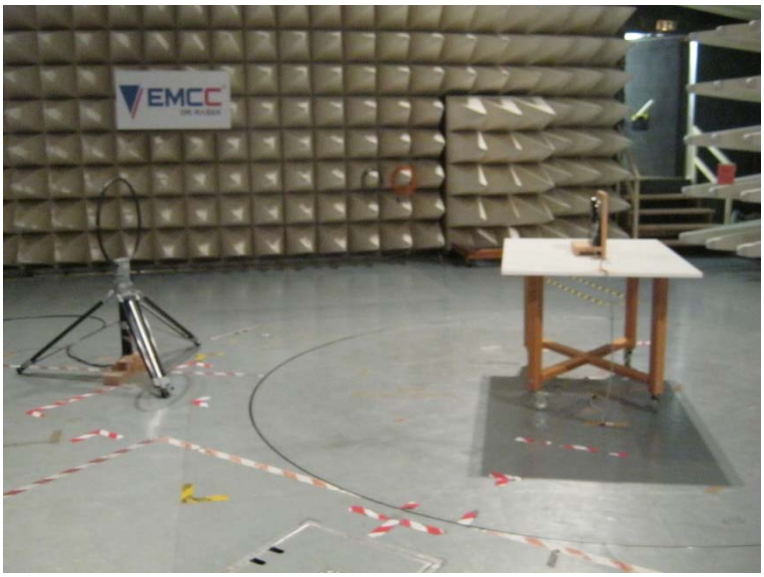
SCHEMATIC TEST SETUP

Requirement: 47 CFR, § 15.209
Procedure: ANSI C63.10-2013

Receiver: #3846
Antenna: #374

Test distance: 3 m

TEST EQUIPMENT USED:
Refer to chapter 10 of this document.
374, 1292, 1416, 1889, 2721, 3493, 3846, 4075, 4717, 5392

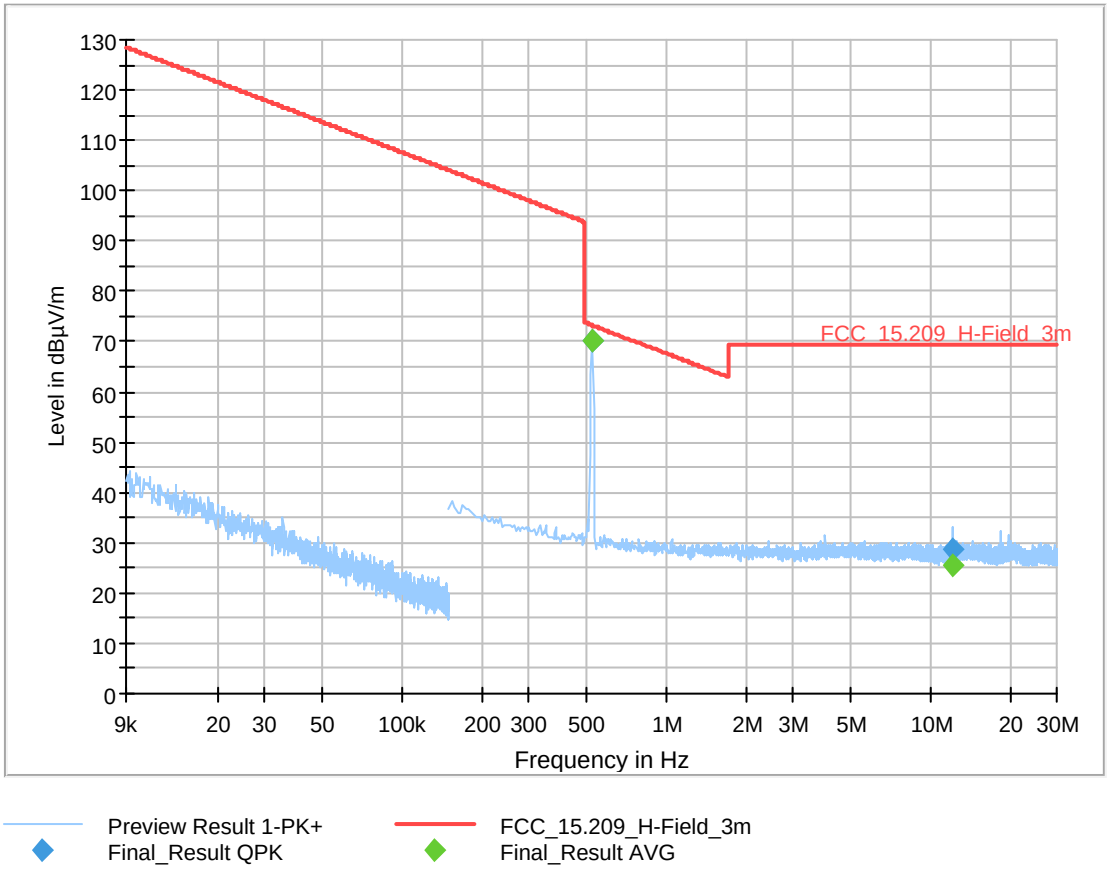


Sample photo of setup at SAC

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

7.5.1 Detailed Test Data

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No:	Rotor: 23444018, Stator: 233670005
Mode:	Normal Operation



Final Result:

Frequency (MHz)	Detector	3 m Result (dBµV/m)	Distance Correction (dB)	30 m Result (dBµV/m)	30m Limit (dBµV/m)	Margin
0.52	QP	70.2	-40	30.2	33.3	3.1

Worst case results listed, only.

Note: No final meaurement at an open field site performed as the history of comparison measurement between SAC and open field sites shows higher results at open field site.

7.6 Test Result

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-22
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

8 RADIATED EMISSIONS 30 MHz – 1 GHz

Test Requirement: FCC: 47 CFR §15.205, §15.209
ISED: RSS-210, section B.2; RSS-Gen Issue 5, section 6.13, 8.9
Test Procedure: ANSI C63.10-2013, ISED: RSS-Gen

8.1 Regulation

§ 15.33 Frequency range of radiated measurements:
(a) 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) through (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.
(b) For unintentional radiators:
(1) Except as otherwise indicated in paragraphs (b)(2) or (b)(3) of this section, for an unintentional radiator, including a digital device, the spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a radiated emission limit is specified, up to the frequency shown in the following table:

Highest frequency generated or used in the device or on which the device operates or tunes	**Upper frequency of measurement range (MHz)**
[MHz]	**[MHz]**
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower.

§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.

§15.209(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:

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

Frequency	Field Strength		Measurement Distance
(MHz)	(µV/m)	(dB(µV/m))	(m)
30–88	100	40.0	3
88–216	150	43.5	3
216-960	200	46	3
Above 960	500	54	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 8.9 Transmitter emission limits

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency	Field Strength
[MHz]	[µV/m at 3 m]
30–88	100
88–216	150
216–960	200
above 960	500

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

8.2 Test Procedures

ANSI C63.10-2013 6.5 Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz

This subclause specifies conditions for compliance testing in the frequency range above 30 MHz and below 1 GHz. The following subclauses describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies between 30 MHz and 1000 MHz. Measurements may be performed at a distance closer than that specified in the requirements, provided the measuring antenna is beyond its near-field range as determined by the Rayleigh criteria.

ANSI C63.10-2013, 6.5.3 Exploratory radiated emission tests

Exploratory measurements are used to identify the frequencies and amplitudes of the emissions while manipulating and rotating the EUT.

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. Exploratory measurements shall be made on a test site per 5.2. Shielded rooms, not treated with RF absorption material, shall not be used for exploratory measurements.

For each mode of operation required to be tested, the frequency spectrum shall be monitored. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.

ANSI C63.10-2013, 6.5.4 Final radiated emission tests

Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Variations in cable or wire placement shall be explored to maximize the measured emissions.

Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz – 1 GHz
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz
Receive antenna height	1 m - 4 m
Angular steps size during prescan:	90 °
Receive antenna polarization	Vertical/Horizontal
Measurement location	Semi Anechoic Chamber (SAC)

8.3 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for frequencies above 88 MHz:

µV/m at 3 meters = 150

150 µV/m corresponds with 43.5 dBµV/m.

8.4 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

Corr. = 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
- Corr = Transducer factor in dB

Assume a receiver reading of 23.4 dBµV is obtained. The Antenna Factor and a Cable Factor are added (Corr. = 13.6 dB), giving a field strength of 37.0 dBµV/m. The 37.0 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

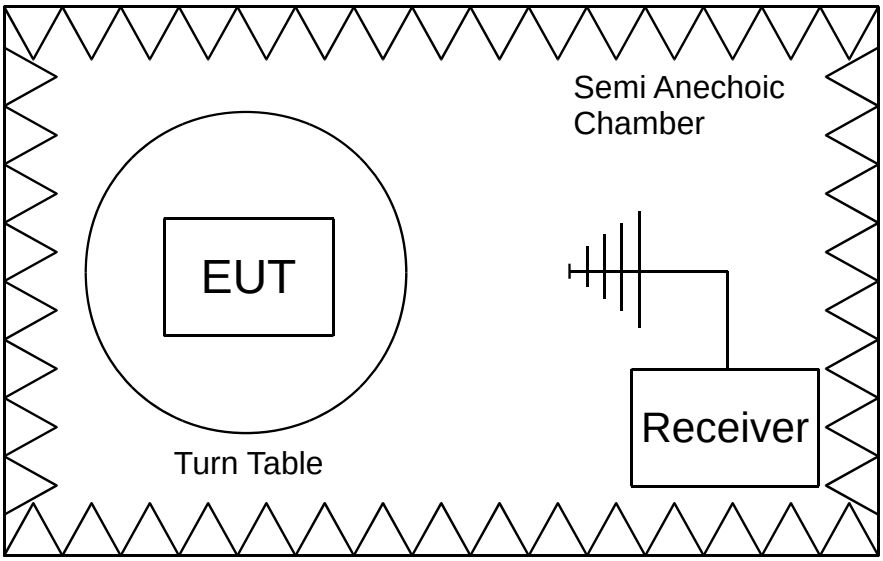
FS = 23.4 + 13.6 = 37.0 [dBµV/m]

Level in µV/m = Common Antilogarithm (37/20) = 70.8

All emission measurements described in this chapter performed using the EMI test program transducer factor setting capability, i.e. the field strength value at the test distance was measured directly without the necessity of additional correction factors. The transducer factor includes both, Antenna Factor and Cable Factor.

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

8.5 Test Setup



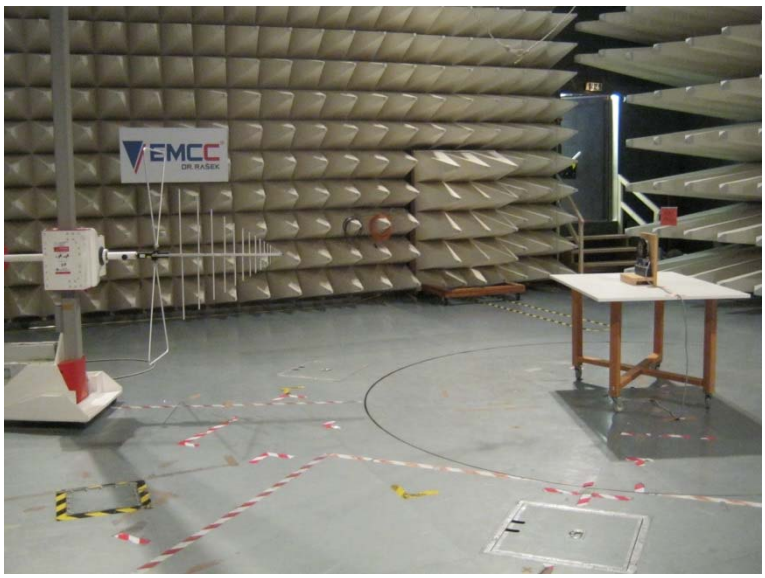
SCHEMATIC TEST SETUP

Requirement: 47 CFR, § 15.209
Procedure: ANSI C63.10-2013

Receiver: #3846
Antenna: #6041

Test distance: 3 m

TEST EQUIPMENT USED:
Refer to chapter 10 of this document.
55, 1291, 1292, 1889, 2721, 2724, 3493, 3846, 4075, 4717, 5392, 6041

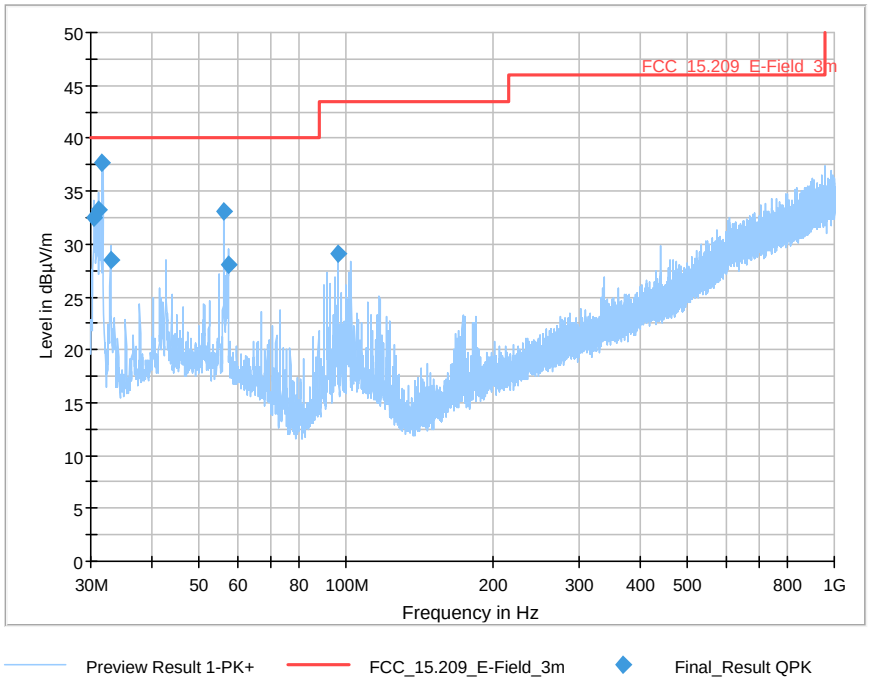


Sample photo of setup

Test on Hottinger Brüel & Kjaer GmbH T40CB S2 to 47 CFR § 15.203, § 15.207, § 15.209 and RSS-Gen Issue 5, RSS-210 Issue 10 Amendment 1, RSS-102 Issue 5

8.5.1 Detailed Test Data

Manufacturer: Type: Serial No: Mode:	Hottinger Brüel & Kjaer GmbH T40CB S2 Rotor: 23444018, Stator: 233670005 Normal operation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.52	32.5	40.0	7.5	1000	120.0	122.0	V	71	16.6
31.14	33.2	40.0	6.8	1000	120.0	114.0	V	93	16.5
31.70	37.7	40.0	2.3	1000	120.0	101.0	V	-152	16.5
32.94	28.5	40.0	11.6	1000	120.0	100.0	V	-136	16.6
56.14	33.1	40.0	6.9	1000	120.0	104.0	V	45	19.0
57.34	28.0	40.0	12.0	1000	120.0	100.0	V	10	18.6
96.38	29.1	43.5	14.4	1000	120.0	325.0	H	177	17.2

Worst case results listed, only.

8.6 Test Result

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-22
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

9 RF EXPOSURE

Test Requirement: RSS-102 Issue 5
Test Procedure: IEEE C95.3, SPR-002 Issue 1

9.1 Regulation

RSS-102 Chapter 4 Exposure Limits
For the purpose of this standard, Industry Canada has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6.[18]

[18] Health Canada's Safety Code 6: *Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz* (http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct/index-eng.php).

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m2)	Reference Period (minutes)
0.003-10	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

9.2 Test Procedures

Following SPR-002 an isotropic broadband E/H - field probe was used to scan the surface of the EUT. The maximum emission for E/H-field was recorded.
The distance between the E/H - field probe and the EUT was 20 cm and 0 cm (reduced to the possible minimum).

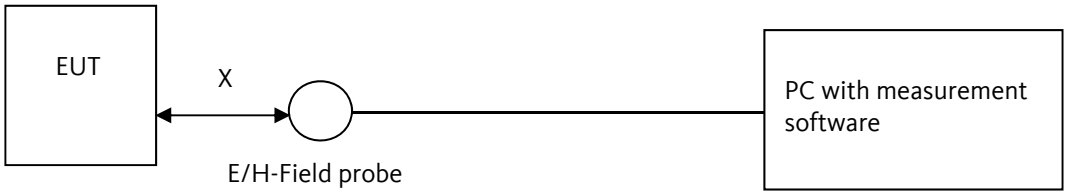
The RBW of the E/H-field analyzer was set to 30 kHz, which is greater than the 99% bandwidth of the 523 kHz carrier.

The test procedure for Nerve Stimulation was executed according to Notice 2020 – DRS0012.
The E- and H-field was scanned over the whole frequency range 0.003 - 10 MHz.

The test procedure for RF Exposure Evaluation covered the scan of the E and H-field over the whole frequency range 0.1 - 10 MHz.

9.3 Nerve Stimulation

9.3.1 Test Setup E/H-Field

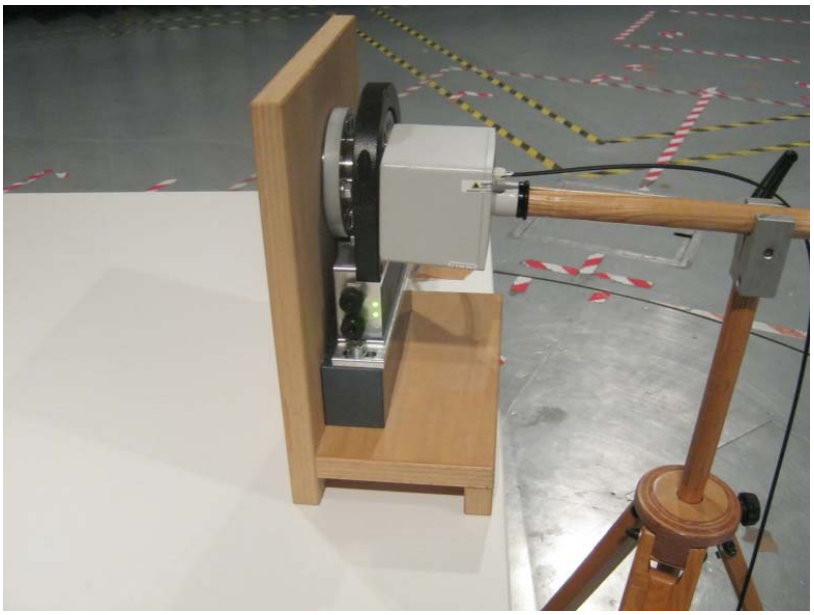


SCHEMATIC TEST SETUP OF ELECTRICAL FIELD STRENGTH MEASUREMENT

Requirement: RSS-102 Issue 5
Procedure: SPR-002 Issue 1

E/H-field probe: #3511, #4480

TEST EQUIPMENT USED:
Refer to chapter 10 of this document.
1889, 3511, 4018, 4480, 4717

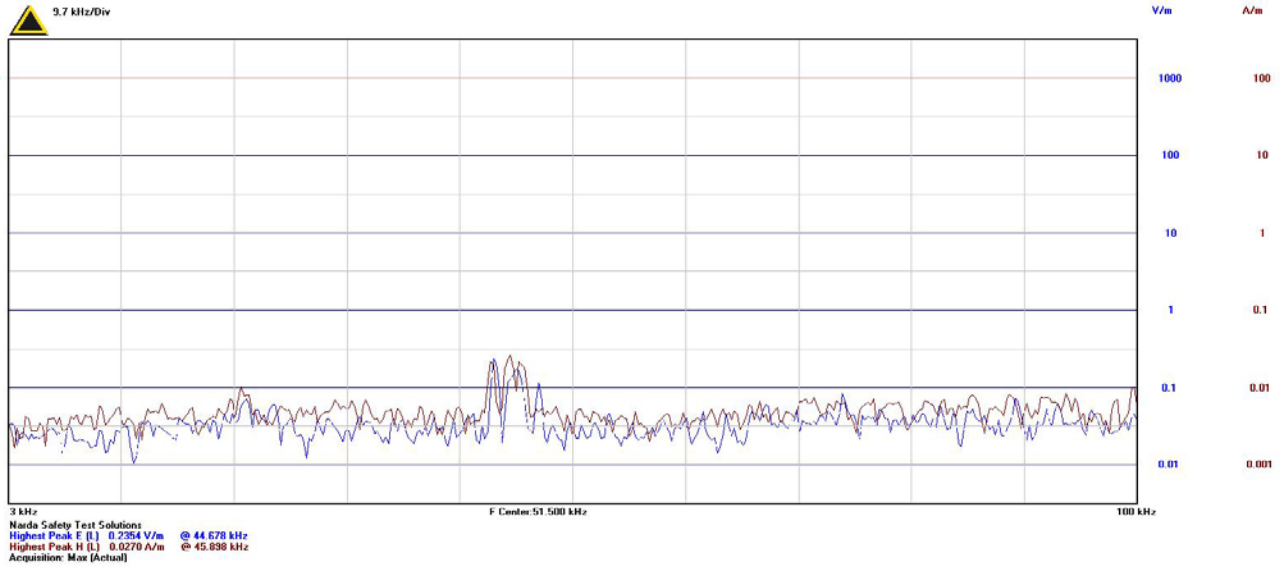


Sample photo of setup, test distance 0 cm

9.3.2 Test Result

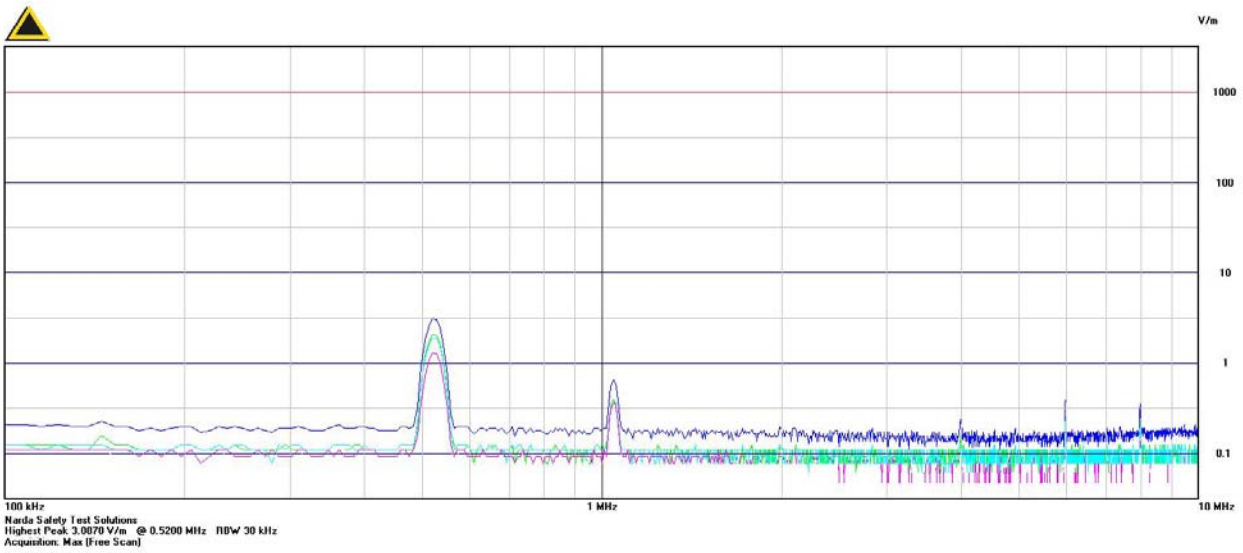
9.3.2.1 E-Field and H-Field Measurement Plots

Plot H and E-field 3 kHz to 100 kHz, Test distance 0cm

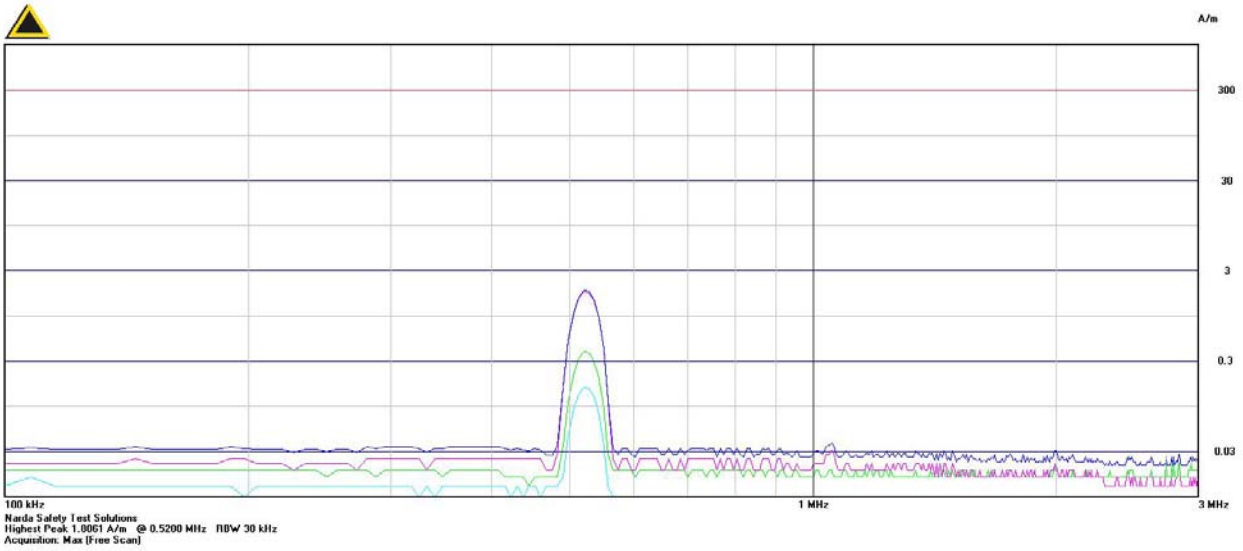


No emission identified above ambient noise.

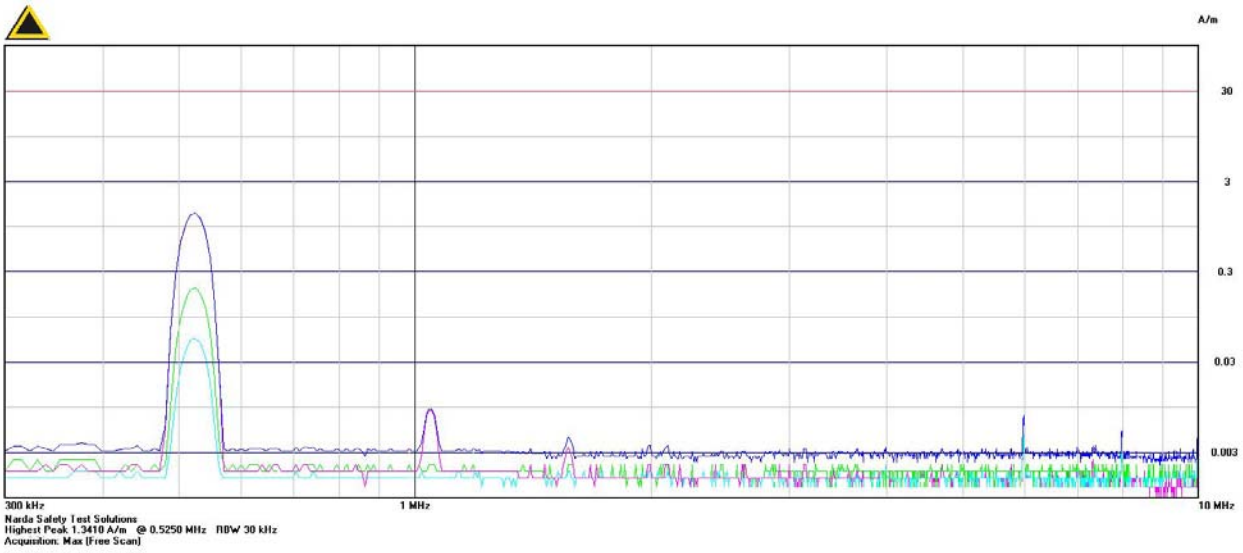
Plot E-field 100 kHz to 10 MHz, Test distance 0cm



Plot H-field 100 kHz to 3 MHz, Test distance 0cm



Plot H-field 300 kHz to 10 MHz, Test distance 0cm



Note:
The measurement shows the worst case assessment, with the E/H – field probe as close as possible to the EUT.
During a measurement period of 30 seconds the worst case value did not increase anymore.

9.3.3 Final Result

Multiple frequency summation according to SPR-002, chapter 6.2.2:

Σ (Em / ERL) ≤ 1

where:
Em = Measured electric field at a specific frequency
ERL = Reference level limit for the electric field at the measurement frequency

Σ (Hm / HRL) ≤ 1

where:
Hm = Measured magnetic field at a specific frequency
HRL = Reference level limit for the magnetic field at the measurement frequency

Result of multiple Frequency Summation E-Field

f_2 = 523 kHz; E_2 = 3.1 V/m
f_3 = 1.04 MHz; E_3 = 0.6 V/m
E_{RL} = 83 V/m

$$\sum_{i=1}^{4} \frac{E_i}{E_{RL}} = \frac{3.1 + 0.6}{83} = 0.045 \leq 1$$

According to SPR-002, chapter 6.2.2 the multiple frequency summation shall be less or equal to 1.

Result of multiple Frequency Summation H-Field

f_1 = 523 kHz; H_1 = 1.8 A/m
f_2 = 1.04 kHz; H_2 = 0.01 A/m
H_{RL} = 90 A/m

$$\sum_{i=1}^{4} \frac{H_i}{H_{RL}} = \frac{1.8 + 0.01}{90} = 0.02 \leq 1$$

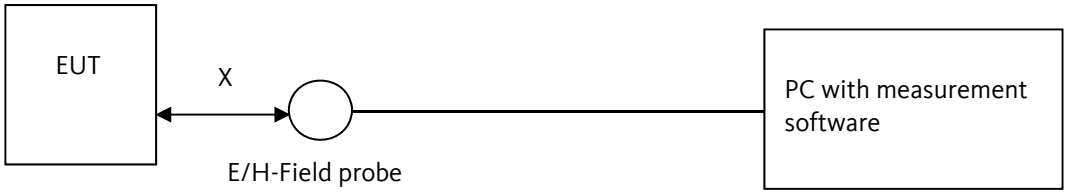
According to SPR-002, chapter 6.2.2 the multiple frequency summation shall be less or equal to 1.

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-23
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

9.3.4 Test Result RF Exposure Evaluation

9.3.5 Test Setup E/H-Field

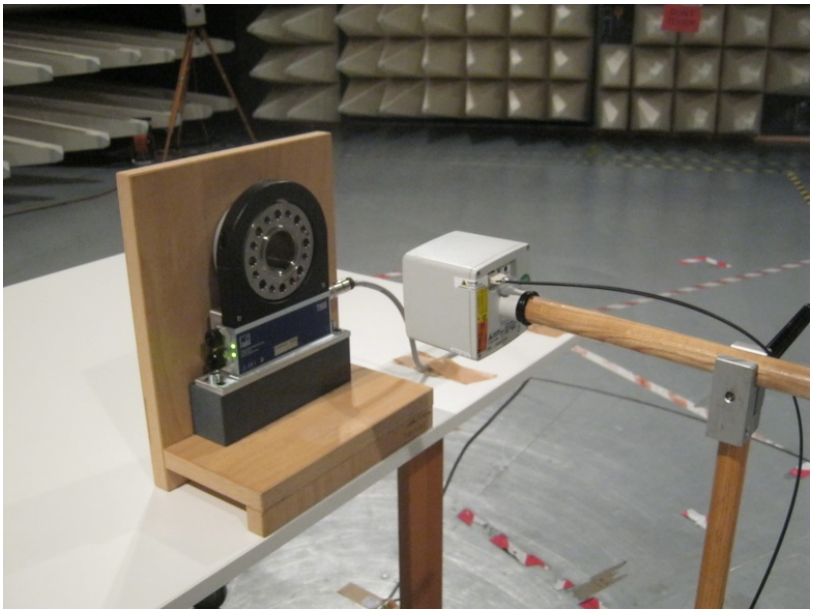


SCHEMATIC TEST SETUP OF ELECTRICAL FIELD STRENGTH MEASUREMENT

Requirement: RSS-102 Issue 5
Procedure: SPR-002 Issue 1

E/H-field probe: #3511, #4480

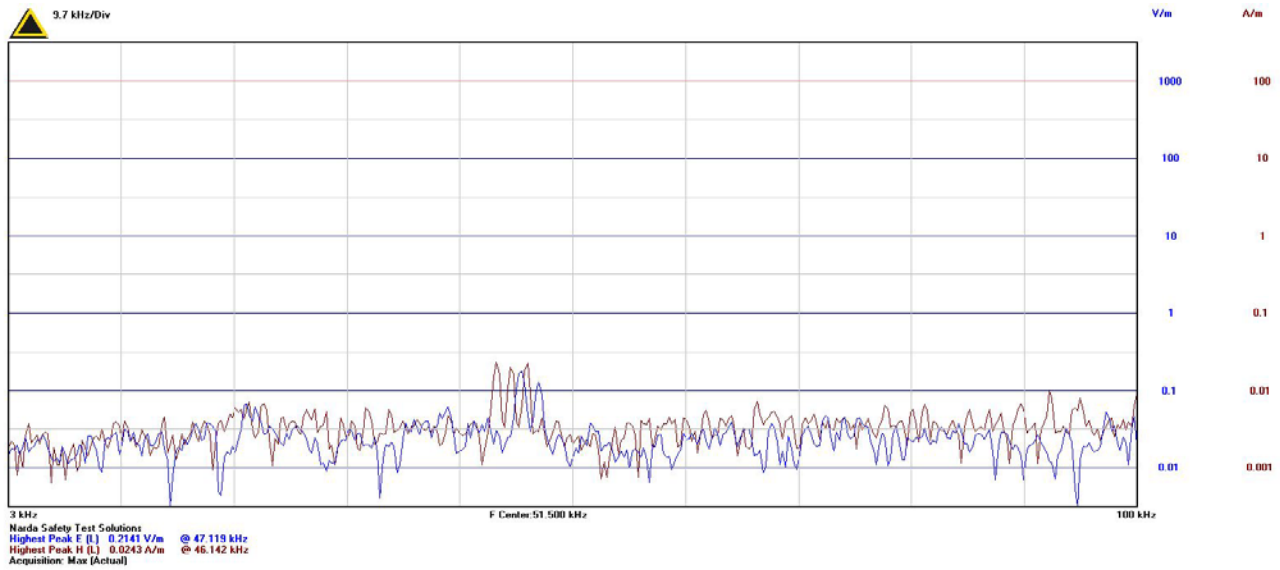
TEST EQUIPMENT USED:
Refer to chapter 10 of this document.
1889, 3511, 4018, 4480, 4717



Sample photo of setup, test distance 20 cm

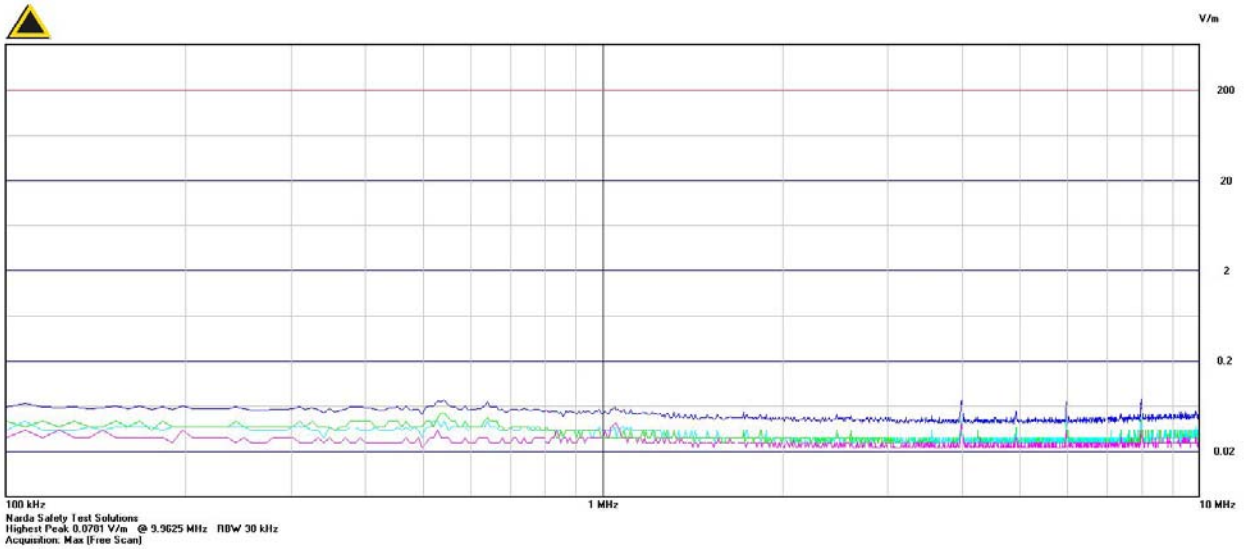
9.3.5.1 Measurement Plots

Plot H and E-field 3 kHz to 100 kHz, Test distance 20 cm



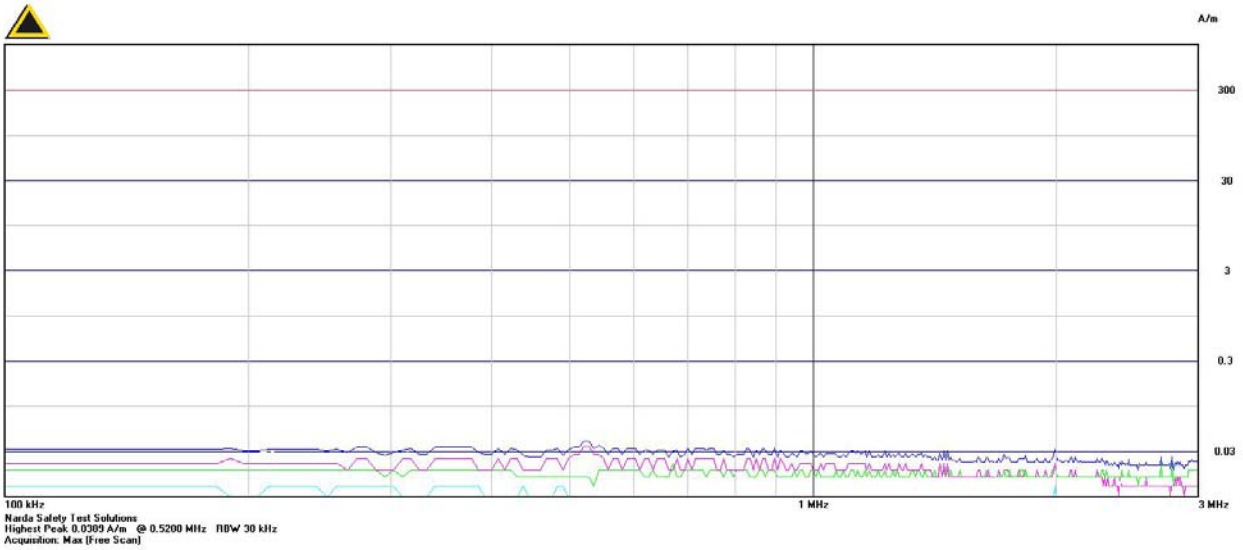
No emission identified above ambient noise.

Plot E-field 100 kHz to 10 MHz, Test distance 20 cm

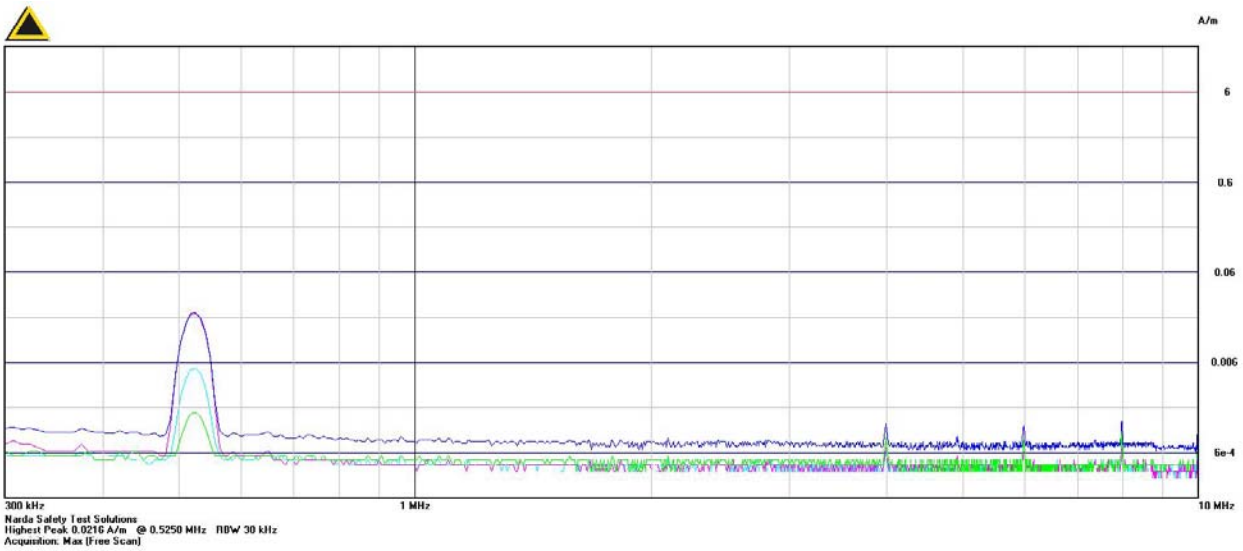


No emission identified above ambient noise.

Plot H-field 100 kHz to 3 MHz, Test distance 20 cm



Plot H-field 300 kHz to 10 MHz, Test distance 20 cm



Note:
The measurement shows the worst case assessment, with the E/H – field probe at 20 cm distance from the EUT. During a measurement period of 30 seconds the worst case value did not increase anymore.

9.3.6 Final Result

	Level	Distance	Frequency Range (MHz)	RF field strength limit, reference period 6 minutes
Max. H-Field	0.02 A/m	20 cm	0.1 - 10	1.4 A/m (0.73 / f @ 0.523 MHz)
Max. E-Field	0 V/m*	20 cm	0.1 - 10	120.3 V/m (87 / $f^{0.5}$ @ 0.523 MHz)

* No emission identified above ambient noise level

Note: No multiple frequency summation calculation performed, since no relevant emission beside the carrier measured.

Manufacturer:	Hottinger Brüel & Kjaer GmbH
Type:	T40CB S2
Serial No.:	Rotor: 23444018, Stator: 233670005
Test date:	2020-12-23
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

10 TEST INSTRUMENTS

Ident#	Instrument	Manufacturer	Model No	Last Calibration	Next Calibration
34	AC Power Source	California Instruments	HGA5001ih-400 5001ih-400 5001ih-400	n/a	n/a
55	N-Cable N/50	Rohde & Schwarz	HFU2-Z4	2020-10	2021-10
374	Loop Antenna	Rohde & Schwarz	HFH 2-Z2	2018-11	2021-02
516	EMI Test Receiver	Rohde & Schwarz	ESIB40	2019-04	2021-04
1291	Antenna Mast	Frankonia	FAM4	n/a	n/a
1292	Multi Device Controller	Frankonia	FC02	n/a	n/a
1416	Isolation Transformer	Daitron	J91097-11	n/a	n/a
1470	V-LISN 50 ohms//(50uH+5ohms)	Rohde & Schwarz	ESH3-Z5	2019-10	2021-10
1519	Pulse Limiter	Rohde & Schwarz	ESH3-Z2 357.8810.52	2020-09	2021-09
1889	SR-ULL-01, Semi-Anechoic Chamber (SAC)	EMCC/FRANK.	SAC-10	n/a	n/a
1890	SR-ULL-05, Absorber-Lined Shielded Chamber	EMCC / SIEM / FRANK	SC2-ULL	n/a	n/a
2721	Digital Multimeter	Agilent	U1241A	2019-07	2021-07
2724	5 W Attenuator 6dB	Weinschel	2	2019-07	2021-07
3493	DC Power Supply	Goobay	DF-1730SB3A	n/a	n/a
3511	E-/H-Field-Analyser	Narda / PMM	EHP-50C	2020-03	2022-03
3846	EMI Test Receiver	Rohde & Schwarz	ESU8	2020-03	2021-03
4018	Notebook	Dell	Latitude E6430	n/a	n/a
4075	Workstation	Dell	Optiplex 7010	n/a	n/a
4480	E-/H-Field Analyzer	NARDA	EHP-200A	2020-10	2022-10
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH WUT	57613 Web-T/Rh/P	2020-02	2021-02
5392	EMC Measurement Software	Rohde & Schwarz	EMC32	n/a	n/a
5551	BNC cable	EMCC	BNC003m0	n/a	n/a
6041	TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	2019-10	2021-10

11 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Conducted Emissions, AC mains (150 kHz – 30 MHz)	±3.5 dB
Radiated emissions, H field (9 kHz – 30 MHz)	± 3.0 dB
Radiated Emissions below 1000 MHz	±5.7 dB
Isotropic E-Field (100 kHz – 10 MHz)	± 1.2 dB
Isotropic H-Field (100 kHz – 3 MHz)	± 1.4 dB

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%.

The given values have been calculated on the basis of the following documents:

CISPR 16-4-2:2011+A1:2014, Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-2: Uncertainties, statistics and limit modelling - Measurement instrumentation uncertainty.

TR 100 028-1 V1.4.1 (2001-12), Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1

TR 100 028-2 V1.4.1 (2001-12), Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2

JCGM 100:2008, Evaluation of measurement data - Guide to the expression of uncertainty in measurement.

12 LIST OF ANNEXES

The following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test setup	4
Annex 2: External photographs of equipment under test	5
Annex 3: Photographs of ancillary equipment	4