EMCC™ DR. RAŠEK

TEST REPORT # EMCC-040197RA, 2017-06-23

This report replaces Test Report # EMCC-040197R, 2017-05-24

EQUIPMENT UNDER TEST:

Trade Name:	T40HS Torquemeter
Type Designation(s):	T40HS-S0
Serial Number:	none
Equipment Class:	Low Power Transceiver
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Address:	Im Tiefen See 45 64293 Darmstadt Germany
Phone:	+49 6151 803-8281
Fax:	+49 6151 803-98281

RELEVANT STANDARD(S): 47 CFR §15.207, §15.209, RSS-210 Issue 9; RSS-102 Issue 5

MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013 ☒ RSS-Gen Issue 4 ☒ SPR-02 Issue 1

TEST REPORT PREPARED BY:

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i.A. Ludwig Kraft

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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 §15.207, §15.209 and Innovation, Science and Economic Development Canada (ISED) RSS-210 requirements for the certification of licence-exempt 15C Intentional Radiator.

1.2 Limits and Reservations

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1.3 Test Location

Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG
Accreditation No.:	D-PL-12067-01-02
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Boelwiese 8 91320 Ebermannstadt GERMANY
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
Laboratory:	Test Laboratory IV The 3 m & 10 m semi-anechoic chamber site has been fully described in a report submitted to the FCC and accepted in the letter dated December 23, 2016, Registration Number 878769. This 3 m & 10 m alternative test site is approved by Industry Canada under file number 3464C-1.
Phone:	+49 9194 7262-0
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E-mail:	info@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 Jens Dexheimer
Phone:	+49 6151 803-8281
Fax:	+49 6151 803-98281
E-mail:	jens.dexheimer@hbm.com

1.5 Dates and Test Location

Date of receipt of EUT:	2017-03-29; 2017-05-17
Test Date:	CW 13/2016
Test Location:	Lab IV

1.6 Ordering Information

Purchase Order and Date:	D29-4500586639/2000, 2017-01-17
Vendor Number:	806266

1.7 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2017-03-29	23	32	985	IV	no
2017-03-30	24	33	986	IV	no
2017-03-31	24	33	977	IV	no
2017-05-22	25	38	979	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade Name:	T40HS Torquemeter
Type Designation(s):	T40HS-S0
Serial Number(s):	none
FCC ID:	2ADAT-T40S0TOS1
IC:	12438A-T40S0TOS1
Application:	Low Power Transceiver
Transmit Frequency:	522.85 kHz; 1.22 MHz
Modulation:	522.85 kHz unmodulated; 1.22MHz PSK
Emission Designator:	N0N (522.85 kHz); 1M51G1D (1.22MHz)
Highest Internal Frequency	29.28 MHz
Power Supply:	24 VDC
Ports:	Signal and supply – 7 pole binder industrial connector
Antennas:	Integrated loop antenna
Variants:	T40HS-S0, T40HS-S1, T40HS-S0-MPZ1402013
Remarks:	none

The tested T40HS-S0 sample is a variant of the T40HS-S0 documented in the report EMCC-040197BPA, dated 2015-11-27. According to the customer the rotor is equipped with a modified pcb layout, but with the same RF circuit. All other parts including the stator are the same as in original tested T40HS-S0.

The modified rotor pcb is also used in the variants T40HS-S1 and T40HS-S0-MPZ1402023. The T40HS-S0 is used as an example to show the compliance with the modified rotor pcb.

According to the customer the variants T40HS-S0, T40HS-S1 and T40HS-S0-MPZ1402023 share the same electronic in the stator with different antenna diameters. The rotors of these variants do as well share the same electronic, but have different diameters which are used for different torque levels. The variant T40HS-S0-MPZ1402023 consists of two stators and antennas. The rotor contains two times the same electronic in one rotor. The duplicated system is to achieve a redundancy for the measurement.

The test results of the original rotor pcb of the variants T40HS-S0, T40HS-S1 and T40HS-S0-MPZ1402023 is documented in the report EMCC-040197BPA, dated 2015-11-27.

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)

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: Connection cable with 3 m length used for the tests

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2.4 Mode of Operation during Testing and Test Set-Up

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

Under normal test conditions the EUT was powered with 24 VDC by the AC / DC supply TRIO-PS/1AC/24DC/5 delivered by the customer.
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: T40HS Torquemeter
Type(s): T40HS-S0
Serial No(s): none

Requirement	47 CFR Section	RSS, Section	Report Section	Result
Antenna Requirement	15.203	RSS-Gen, 8.3	4	Passed
Conducted AC Power Line Emissions 150 kHz – 30 MHz	15.207	RSS-Gen, 8.8	5	Passed
Occupied Bandwidth (99%)		RSS-Gen, 6.6	6	Passed
Radiated Emissions 9 kHz – 30 MHz	15.205, 15.209	RSS-210, 4.3 RSS-Gen, 8.9	7	Passed
Radiated Emissions 30 MHz – 110 MHz	15.205, 15.209	RSS-210, 4.3 RSS-Gen, 6.13, 8.9	8	Passed
RF Exposure Evaluation		RSS-102, 4	9	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 C63.10-2013 and RSS-Gen Issue 4.
All requirements were found to be within the limits outlined in this report.
The test results in this report apply only to the particular equipment under test (EUT) as declared in this report.

Test Personal: Ludwig Kraft
Issuance Date: 2017-06-23

4 ANTENNA REQUIREMENT

Test Requirement: FCC: 47 CFR §15.203
ISED: RSS-Gen, 8.3

4.1 Regulation

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

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

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

No applicable antenna requirement specified in RSS-210.

4.2 Result

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T40HS Torquemeter
Type(s):	T40HS-S0
Serial No(s):	none
Test date:	2017-06-23

The EUT meets the requirements of this section.

5 POWER LINE CONDUCTED EMISSIONS TEST

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

5.1 Regulation

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

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

* Decreases with the logarithm of the frequency.

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

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

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

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

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

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

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

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

Table 3 – AC Power Line Conducted Emissions Limits

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

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

→ The ISED limits are equal to the FCC limits.

5.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2017-01	2018-01
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
V-LISN 50 Ω//(50 uH + 5 Ω)	Rohde & Schwarz / ESH2-Z5	1901	2015-09	2017-09
Protector Limiter	Rohde & Schwarz / ESH3-Z2	1519	2015-09	2017-09
AC Power Source	California	0034	n.a	n.a
Multimeter	Agilent U1241A	2721	2015-05	2017-05
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

5.3 Test Procedures

The EUT was placed on a wooden table of nominal size 1 m by 1.5 m, raised 80 cm above the reference groundplane. The vertical conducting wall of the screened room was located 40 cm to the rear of the EUT.
The excess length of the power cord 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.

5.4 Test Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.18	---	39.9	54.3	14.3	1000	9	L1	10.0
0.25	---	37.8	51.9	14.1	1000	9	L1	10.0
0.31	---	36.5	50.0	13.4	1000	9	L1	10.0
0.37	---	34.7	48.5	13.8	1000	9	L1	10.0
0.68	---	39.0	46.0	7.0	1000	9	L1	10.0
0.74	---	37.2	46.0	8.9	1000	9	L1	10.0

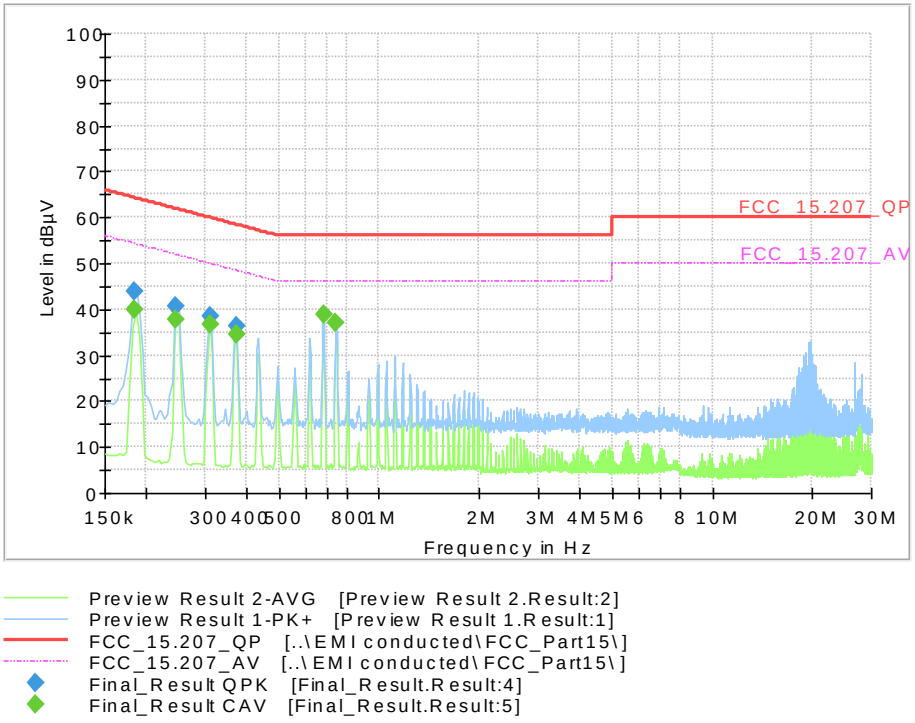
The table above contains worst-case emissions, only. For further details refer to the test plots.

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T40HS Torquemeter
Type(s):	T40HS-S0
Serial No(s):	none
Test date:	2017-03-31

The EUT meets the requirements of this section.

5.5 Measurement

Test on line L and N (worst case):



6 OCCUPIED BANDWIDTH (99%)

Test Requirement: ISED: RSS-Gen Issue 4, 6.6
Test Procedure: ISED: RSS-Gen Issue 4, 6.6

6.1 Regulation

RSS-Gen: 6.6 Occupied Bandwidth
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth

6.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2017-01	2018-01
Loop Antenna	R&S / HFH-Z2	374	2016-07	2018-07
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

6.3 Test Procedures

6.3.1 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 200 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.

6.3.2 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

6.4 Test Result

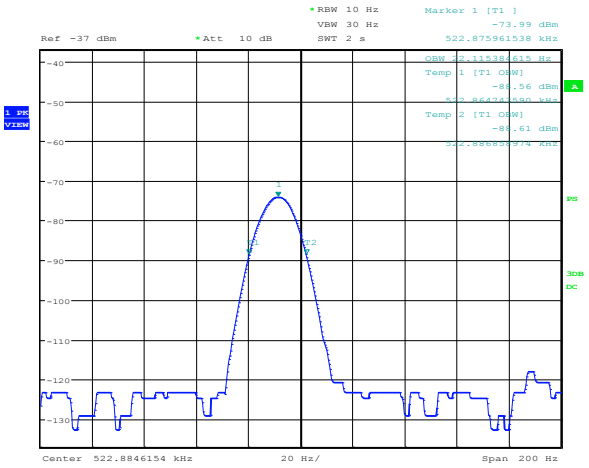
Occupied Bandwidth (99%), 523kHz carrier	[Hz]	22.1
Occupied Bandwidth (99%), 1.22 MHz carrier	[MHz]	1.514

Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T40HS Torquemeter
Type(s): T40HS-S0
Serial No(s): none
Test date: 2017-03-29

The EUT meets the requirements of this section.

6.4.1 Measurement Plot

Plot carrier 523 kHz:



Manufacturer: HBM, EUT: T40HS, EUT axis horizontal
Date: 30.MAR.2017 10:45:10

7 RADIATED EMISSIONS 9 kHz – 30 MHz

Test requirement: FCC: 47 CFR §15.205, §15.209
ISED: RSS-210, 4.3; RSS-Gen Issue 4, 8.9
Test procedure: ANSI C63.10-2013, ISED: RSS-Gen

7.1 Regulation

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

§15.35 Measurement detector functions and bandwidths.

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

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

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

(b) In the emission table above, the tighter limit applies at the band edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

RSS-210: 4.3 General Field Strength Limits
RSS-Gen includes the general field strength limits of unwanted emissions, where applicable, for transmitters and receivers operating in accordance with the provisions specified in this standard. Unwanted emissions of transmitters and receivers are permitted to fall within the restricted bands listed in RSS-Gen and TV bands 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-698 MHz; however, fundamental emissions are prohibited in these bands.

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

Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz			
Frequency	**Electric Field Strength (µV/m)**	**Magnetic Field Strength (H-Field) (µA/m)**	**Measurement Distance (metres)**
9-490 kHz	2,400/F (F in kHz)	2,400/377F (F in kHz)	300
490-1,705 kHz	24,000/F (F in kHz)	24,000/377F (F in kHz)	30
1.705-30 MHz	30	N/A	30

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

7.2 Test Equipment

Type	**Manufacturer/ Model No.**	**EMCC Ident No.**	**Last Calibration**	**Next Calibration**
EMI Test Receiver	R&S / ESU8	3846	2017-01	2018-01
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
Loop Antenna	R&S / HFH-Z2	374	2016-07	2018-07
Multimeter	Agilent U1241A	2721	2015-05	2017-05
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

7.3 Test Procedures

The measurement was performed in a semi-anechoic room at a test distance of 3 m. A calibrated loop antenna as specified in ANSI C63.10 clause 4.5.1 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. The center of the loop antenna was 1 m above the ground.
The EUT was tested on a wooden support on the groundplane, the axis was horizontal.
The EUT was 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.
There was no final measurement at an open field site performed as the pre scan result was more than 20 dB below the limit. All comparison measurements performed between the semi-anechoic room and the open field site showed that the semi-anechoic result is worst case result.
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 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

7.6 Final Test Results

Freq. (MHz)	Detector	3m Result (dB(µV/m))	30m Result (dB(µV/m))	Distance Correction (dB)	30m Result (dB(µV/m))	30m Limit (dB(µV/m))	300m Result (dB(µV/m))	300m Limit (dB(µV/m))	Margin (dB)
0.52	QP	52.5*		-40	12.5	33.2			20.7

The table above contains worst-case emissions, only. For further details refer to the measurement plot.
** No final measurement at an open field site performed as the pre scan result was more than 20 dB below the limit.*

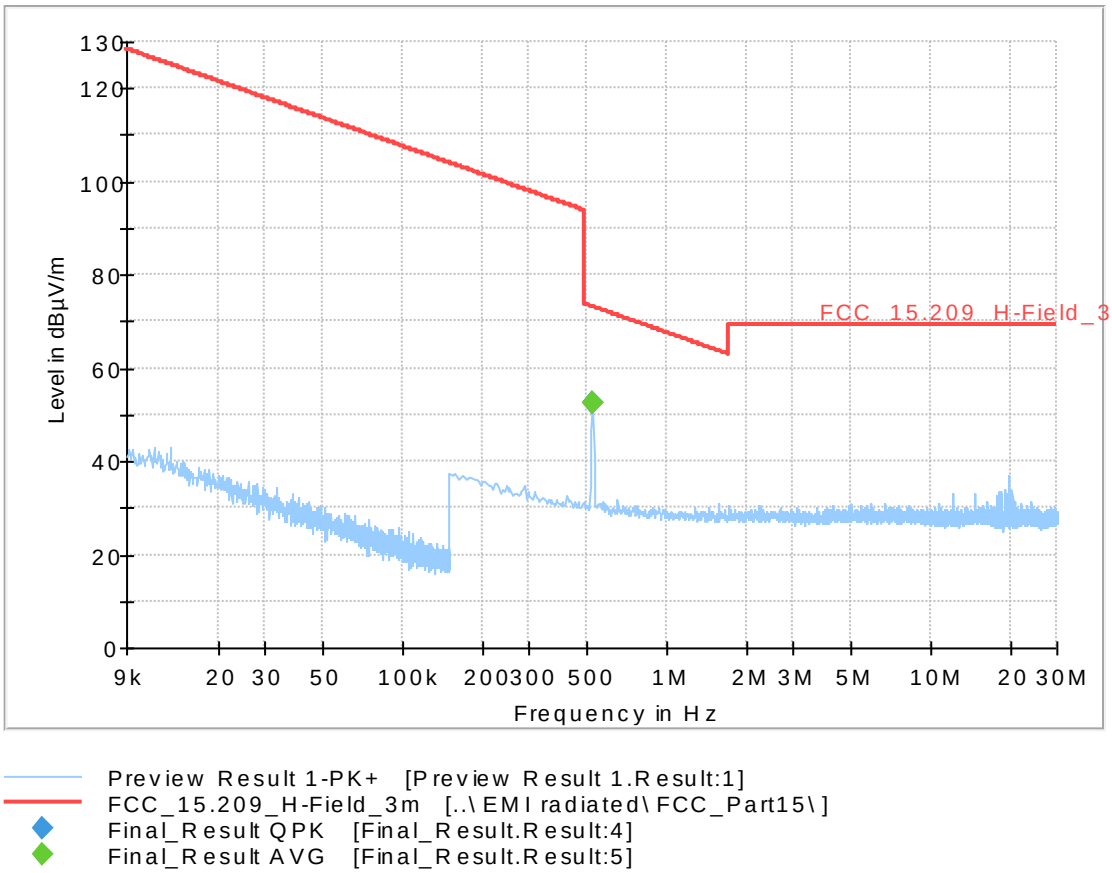
Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T40HS Torquemeter
Type(s):	T40HS-S0
Serial No(s):	none
Test date:	2017-03-30

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 Pre-scan Plot

Measured in the semi-anechoic room (SAC), Test distance d = 3 m:



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

8 RADIATED EMISSIONS 30 MHz – 1000 MHz

Test Requirement: FCC: 47 CFR §15.205, §15.209
ISED: RSS-210, 4.3; RSS-Gen Issue 4, 6.13, 8.9
Test Procedure: ANSI C63.10-2013, ISED: RSS-Gen

8.1 Regulation

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

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

§15.209(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
88–216	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-210: 4.3 General Field Strength Limits
RSS-Gen includes the general field strength limits of unwanted emissions, where applicable, for transmitters and receivers operating in accordance with the provisions specified in this standard. Unwanted emissions of transmitters and receivers are permitted to fall within the restricted bands listed in RSS-Gen and TV bands 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-698 MHz; however, fundamental emissions are prohibited in these bands.

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

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

…

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

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µV/m) at 3 metres
30-88	100
88-216	150
216-960	200
Above 960*	500

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

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

…

8.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2017-01	2018-01
VHF Test Dipole RX	Schwarzbeck VHA 9103	899	2015-05	2017-05
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
Multimeter	Agilent U1241A	2721	2015-05	2017-05
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

8.3 Test Procedures

The EUT was tested on a wooden support on the groundplane, the axis was horizontal.
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]*.

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

Worst case emissions are listed under chapter: test results.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 110 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 frequencies above 88 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

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.

8.6 Final Test Results

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.70	36.3	40.0	3.7	1000	120	100.1	V	-92	13.9
32.94	37.0	40.0	3.0	1000	120	100.1	V	-104	13.6
35.98	30.0	40.0	10.0	1000	120	100.1	V	159	12.9
42.70	26.8	40.0	13.2	1000	120	123.5	V	-86	11.3
61.02	27.3	40.0	12.7	1000	120	114.6	V	-117	10.1
102.50	19.7	43.5	23.8	1000	120	169.0	H	78	10.8
896.06	32.7	46.0	13.3	1000	120	226.2	H	137	24.6

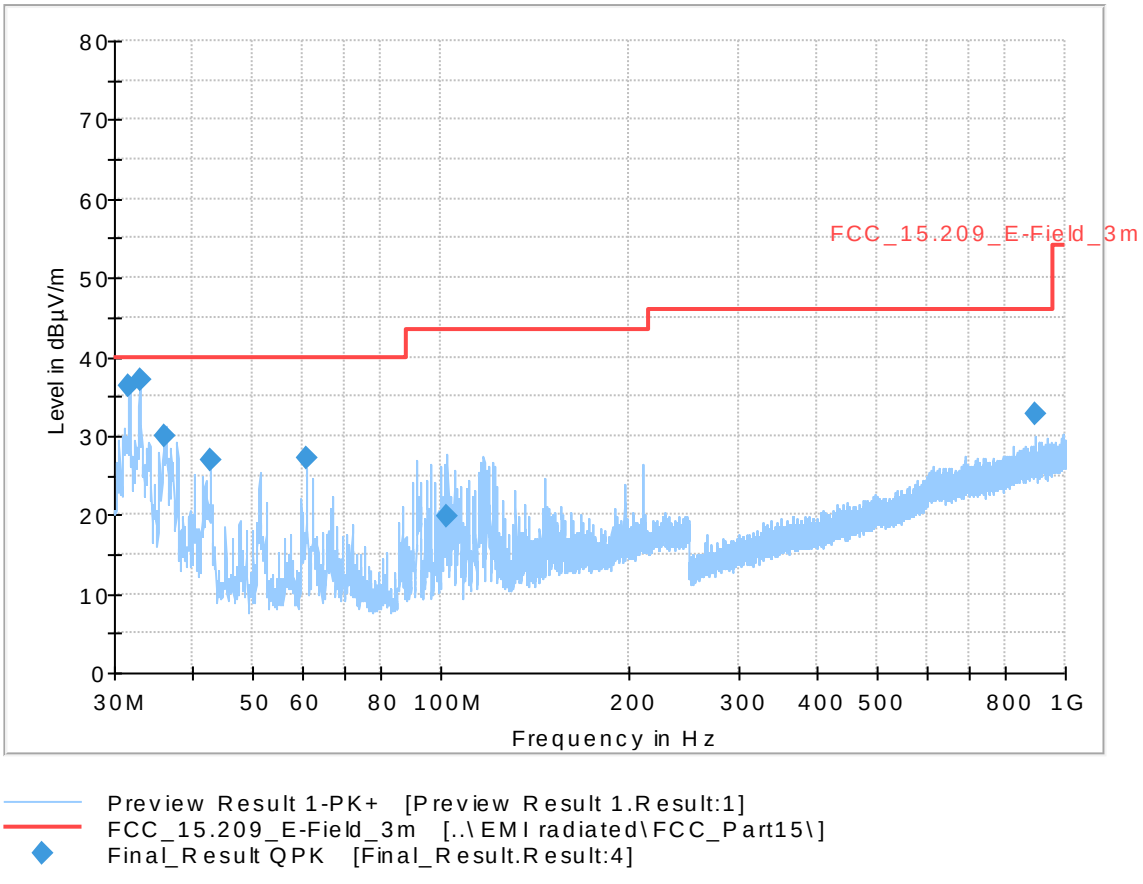
All tests performed at 3 m distance. The table above contains worst-case emissions for the normal mode, only. For further details refer to the pre-scan test plots. Corr. for information, only (already included in QP result).

Manufacturer:	Hottinger Baldwin Messtechnik GmbH
Device:	T40HS Torquemeter
Type(s):	T40HS-S0
Serial No(s):	none
Test date:	2017-03-29

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



9 RF EXPOSURE EVALUATION

Test Requirement: RSS-102 Issue 5, 4
Test Procedure: SPR-002 Issue 1

9.1 Regulation

RSS-102: 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]

Table 2: Internal Electric Field Strength Basic Restrictions (3 kHz-10 MHz)

Condition[19]	**Internal Electric Field Strength* (V/m) (any part of the body)**
Controlled Environment	$2.7 \times 10^{-4}\ f$
Uncontrolled Environment	$1.35 \times 10^{-4}\ f$
Note: f is frequency in Hz. *Instantaneous, RMS values apply.	

[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).
[19] For provisions related to instantaneous nerve stimulation measurements see Notice 2015-DRS001.

Table 3: SAR Limits for Devices Used by the General Public (Uncontrolled Environment)

Body Region	**Average SAR (W/kg)**	**Averaging Time (minutes)**[20]	**Mass Average (g)**
Whole Body	0.08	6	Whole Body
Localized Head, Neck and Trunk	1.6	6	1
Localized Limbs	4	6	10

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[21]	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	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

[20] Compliance measurements are carried out while the device under test is generally configured to continuously transmit at its highest output power. In addition, the SAR measurement procedures adopted within this standard

ensure that the exposure intensity variations are within the standardized power fluctuation requirements. Therefore, the six-minute time-averaging is not required when demonstrating compliance with the applicable localized SAR limits for the device under test.

[21] For provisions related to instantaneous nerve stimulation measurements see Notice 2015-DRS001.

9.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Notebook	Dell / Latitude E64308	4018	n.a.	n.a.
E/H-Field Analyzer	Narda / EHP 200	4480	2015-05	2017-05
DC Power supply	Goobay / DF-1730LCD	3489	n.a.	n.a.
Digital Multimeter	Agilent / U1241A	2721	2015-05	2017-05

9.3 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 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.

9.4 Final Test Results

	Level	Distance	Limit Whole Body / Torso / Head
Max. E-Field	1.08 V/m	0 cm	83 V/m
Max. H-Field	0.03 A/m	0 cm	90 A/m

Note: The measurement shows the worst case assessment, with the E/H – field probe as close to the EUT as possible.

Manufacturer: Hottinger Baldwin Messtechnik GmbH
Device: T40HS Torquemeter
Type(s): T40HS-S0
Serial No(s): none
Test date: 2017-05-22

The EUT meets the requirements of this section.

10 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Conducted emissions (9 kHz – 30 MHz)	± 3.5 dB
Radiated emissions, H field (9 kHz – 30 MHz)	± 3.0 dB
Radiated Emissions (30 MHz – 1 GHz)	± 5.7 dB
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%.

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

11 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)	2