

Test Report

Report Number:

F250176E3

Equipment under Test (EUT):

Torque Transducer TCAS13

Applicant:

Hottinger Brüel & Kjaer GmbH

Manufacturer:

Hottinger Brüel & Kjaer GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D04 Interim General RF Exposure Guidance v01**
- [4] **KDB 680106 D01** Wireless Power Transfer v04

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account. However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

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The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

Name:	Hottinger Brüel & Kjaer GmbH
Address:	Im Tiefen See 45, 64293 Darmstadt
Country:	Germany
Name for contact purposes:	Mr. Alexander EHRHARD
Phone:	+49 6151 803 8346
eMail address:	info.de@hbkworld.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Hottinger Brüel & Kjaer GmbH
Address:	Im Tiefen See 45, 64293 Darmstadt
Country:	Germany
Name for contact purposes:	Mr. Alexander EHRHARD
Phone:	+49 6151 803 8346
eMail address:	info.de@hbkworld.com
Manufacturer represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

Test object: *	Torque transducer
Model name: *	TCAS13
Model number: *	MPZ2202012B
Order number: *	N/A
FCC ID: *	2ADAT-TCAS13

* Declared by the applicant

	EUT number TCAS13 Torque transducer rotor
	1
Serial number: *	Torque transducer:281340012 Control unit: 46123 Stator unit: 41273 Rotor amplifier:46455
PCB identifier: *	-
Hardware version: *	-
Software version: *	-

* Declared by the applicant

One EUT TCAS13 was used for all tests.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

General			
Power supply EUT: *	DC		
Supply voltage EUT: *	$U_{nom} = 24 \text{ V}_{DC}$	$U_{min} = 9 \text{ V}_{DC}$	$U_{max} = 30 \text{ V}_{DC}$
Temperature range: *	-10°C - +70°C		
Lowest / highest internal frequency: *	17.5 kHz / 10.7 MHz (< 108 MHz)		

* Declared by the applicant

Communication part	
Operating frequency: *	10.7 MHz
Number of channels: *	1
Type of modulation: *	FM
Data rate: *	Not available
Duty cycle: *	Not available
Antenna type: *	Loop antenna (540 mm diameter)
Antenna connector: *	Fixed

* Declared by the applicant

WPT part	
Operating frequency: *	17.5 kHz
Antenna type: *	Loop antenna (560 mm diameter)
Antenna connector: *	Screw 5 mm

* Declared by the applicant

Equipment used for testing	
Telemetry system: * ¹	Axon Systems Control Unit J1 Ser.No.:46123
AC Adapter: * ¹	Phoenix Contact TRIO-PS/1AC/24DC/5 Order.No: 2866310

*¹ Provided by the applicant

1.6 Dates

Date of receipt of test sample:	05.02.2025
Start of test:	14.02.2025
End of test:	14.02.2025

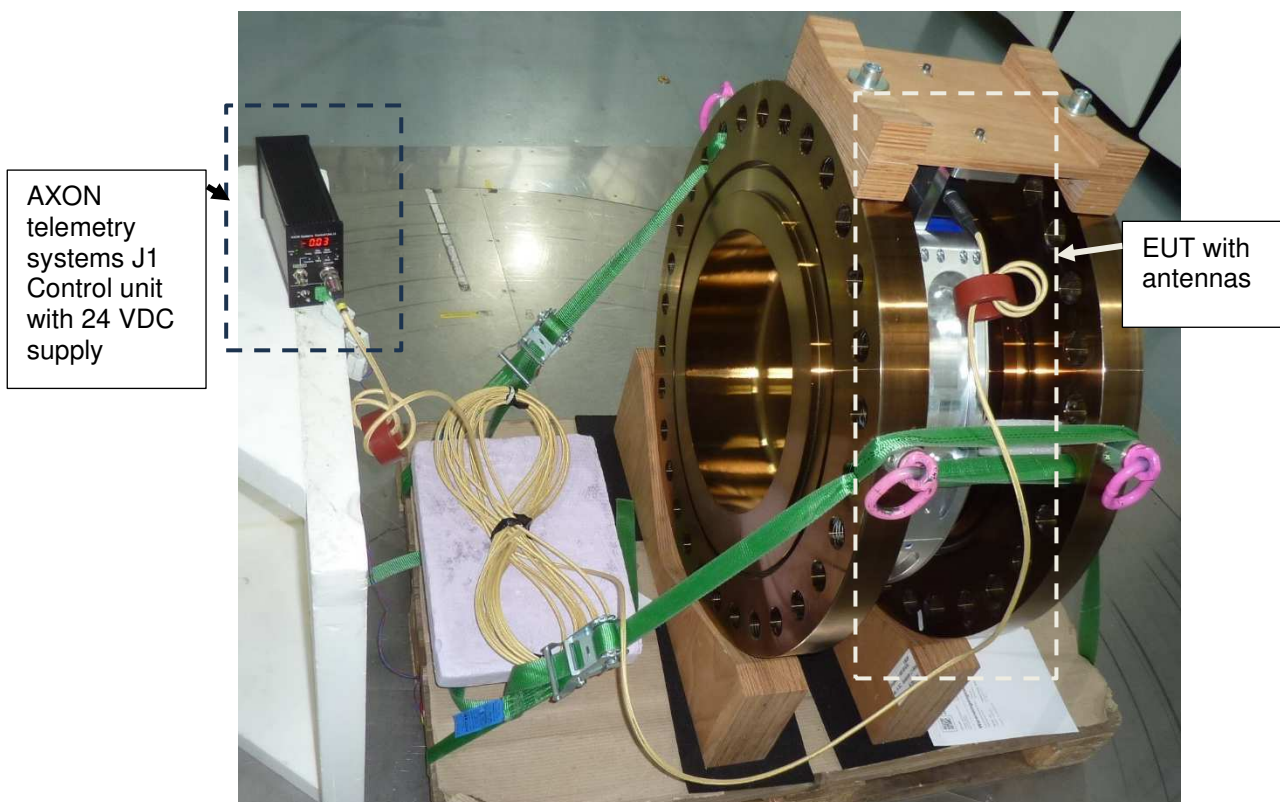
2 Operational States

Description of function of the EUT:

The EUT is a digital torque measurement system working with 10.7 MHz radio communication and 17.5 kHz wireless power transfer.

During all tests the EUT was powered with 24 V DC external power supply and internal via 17.5 kHz WPT.

The system was setup as follows:



3 Evaluation Method

3.1 RF exposure test exemptions for single sources

3.1.1 General Exemption CFR 47 §1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in [paragraph \(b\)\(3\)\(ii\)\(A\)](#) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

3.1.2 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges P_{th} is given by the following formulas

	0.5 cm ≤ d ≤ 20cm	20 cm < d ≤ 40 cm
0.2 GHz ≤ f < 1.5 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$
1.5 GHz ≤ f ≤ 6 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$

3.1.3 MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (d in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, d must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency [MHz]	Threshold ERP [W]
0.3 - 1.34	1920 d ²
1.34 – 30	3450 d ² /f ²
30 – 300	3.83 d ²
300 – 1500	0.0128 d ² /f
1500 - 100000	19.2 d ²

d: Minimal separation distance from antenna to the user

3.1.4 Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from CFR 47 §1.1310(e)1:

Frequency range [MHz]	Electric field strength (E) [V/m]	Magnetic field strength (H) [A/m]	Power density (S) [mW/cm ²]	Averaging time [min]
(i)Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	*(100)	≤6
3.0 – 30	1842/f	4.89/f	*(900/f ²)	<6
30 – 300	61.4	0.163	1.0	<6
300 – 1,500			f/300	<6
1,500 – 100,000			5	<6
(ii)Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*(100)	< 30
1.34 – 30	824/f	2.19/f	*(180/f ²)	< 30
30 – 300	27.5	0.073	0.2	< 30
300 – 1500			f/1500	< 30
1500 – 100,000			1.0	< 30

Note: f = frequency in MHz; * Plane – wave equivalent power density

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

d: Minimal separation distance from antenna to the user

3.2 RF exposure test exemptions for simultaneous transmission sources

3.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in CFR 47 §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period

This exemption may not be combined with any other exemption.

3.2.2 Simultaneous transmission SAR based and MPE based test exemptions

Although this is not a module integration in the sense of product approval, the procedure for simultaneous transmission specified in KDB 447498 D04 Interim General RF Exposure Guidance v01 [3] in chapter 2.2 was taken into account:

According to the RF exposure KDB 447498 D04 General RF Exposure Guidance v01 [3] in chapter 2.2.2: This case is described in detail in CFR 47 §1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formula is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

3.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where: SAR_1 and SAR_2 = highest reported SAR or estimated SAR values for the two sources in the pair i , and R_i is their distance in mm.

When $SPLSR \leq 0.0.4$ (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is $SPLSR \leq 0.10$.

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

4 Results of evaluation

4.1 Used evaluation methods

RF Exposure test exemptions for single sources			
Used	Method	See sub-clause	Comment
<input type="checkbox"/>	General Exemption acc. CFR 47 §1.1307(b)(3)(i)(A)	3.1.1	-
<input type="checkbox"/>	SAR Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(B)	3.1.2	-
<input type="checkbox"/>	MPE Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(C)	3.1.3	-
<input type="checkbox"/>	MPE Calculation	3.1.4	-
<input checked="" type="checkbox"/>	MPE Evaluation	3.1.4	-

RF Exposure test exemptions for simultaneous transmission sources			
Used	Method	See sub-clause	Comment
<input type="checkbox"/>	Not applicable		No simultaneous transmission possible
<input type="checkbox"/>	1 mW test Exemption acc. 2.2.1 [3]	3.2.1	-
<input type="checkbox"/>	SAR Based Exemption acc. 2.2.2 [3]	3.2.2	
<input checked="" type="checkbox"/>	MPE Based Exemption acc. 2.2.2 [3]	3.2.2	
<input type="checkbox"/>	SAR to Peak location separation ratio acc. 2.2.3 [3]	3.2.3	

4.2 Evaluation Distance

The device as declared by the applicant is a fixed installed device which is used at least at 20 cm separation distance between the device and the users.

4.3 Measurement of E field strength from the source with client at minimum distance

Ambient temperature:	22 °C
Relative humidity:	21 %

Date:	14.02.2025
Tested by:	M. DINTER

The EUT operates in the frequency range 17.5 kHz and 10.7 MHz.

Before the measurement, the environmental fields must be considered, and the field probe has to be zeroed. Because the EUT is fixed installed the safety distance between the user and the EUT is defined by the applicant with 20 cm. Therefore, the field probe was moved with a distance of 20 cm in all directions around the EUT and Therefore, the field probe was moved with a distance of 20 cm in all directions around the EUT and peak level of the field strength was observed. At the position of the maximum level the measurement was carried out. The EUT was in operation mode without mechanical load and non-rotating.

Operating frequency power transfer 17.5 kHz.

Parameter	Measured result	Limit *	Test result
Electric field strength	0.4972 V/m at 20 cm distance (temporal peak field strengths)	83 V/m	Passed **

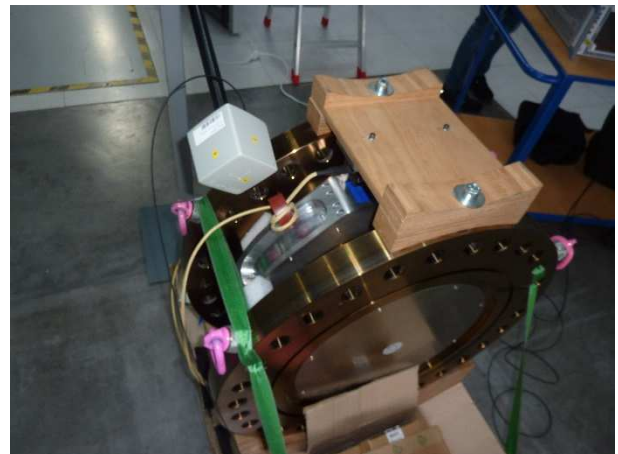
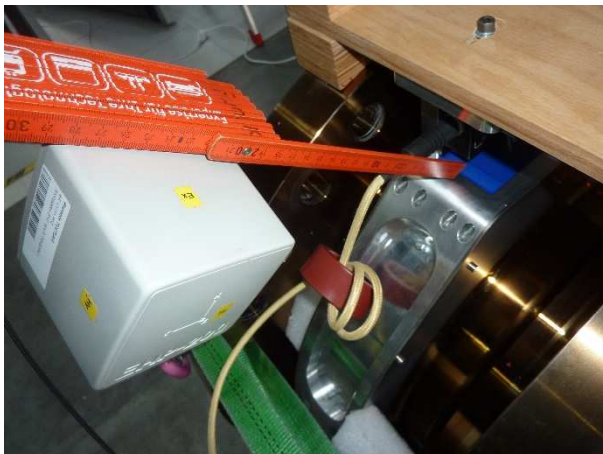
*: Limit for frequencies below 300 kHz according to clause 3.2 [4].

Operating frequency 10.7 MHz communication.

Parameter	Measured result	Limit *	Test result
Electric field strength	0.7890 V/m at 20 cm distance (averaging time of 6 minutes)	77 V/m	Passed **

*: Limit for frequencies 3 – 30 MHz according to clause CFR 47 §1.1310(e)1 [1].

** : The 2ADAT-TCAS13 generates an electric field strength, which is below the level for MPE of persons in General Population / Uncontrolled Exposure [1].



Test equipment (please refer to chapter 5 for details)

1 – 4

4.4 Measurement of H field strength from source with client at minimum distance

Ambient temperature:	22 °C
Relative humidity:	21 %

Date:	14.02.2025
Tested by:	M. DINTER

The EUT operates in the frequency range 17.5 kHz and 10.7 MHz.

Before the measurement the environmental fields must be considered, and the field probe has to be zeroed. Because the EUT is fixed installed the safety distance between the user and the EUT is defined by the applicant with 20 cm. Therefore, the field probe was moved with a distance of 20 cm in all directions around the EUT and Therefore, the field probe was moved with a distance of 20 cm in all directions around the EUT and peak level of the field strength was observed. At the position of the maximum level the measurement was carried out. The EUT was in operation mode without mechanical load and non-rotating.

Operating frequency power transfer 17.5 kHz.

Parameter	Measured result	Limit *	Test result
Electric field strength	0.0477 A/m at 20 cm distance (temporal peak field strengths)	90 A/m	Passed **

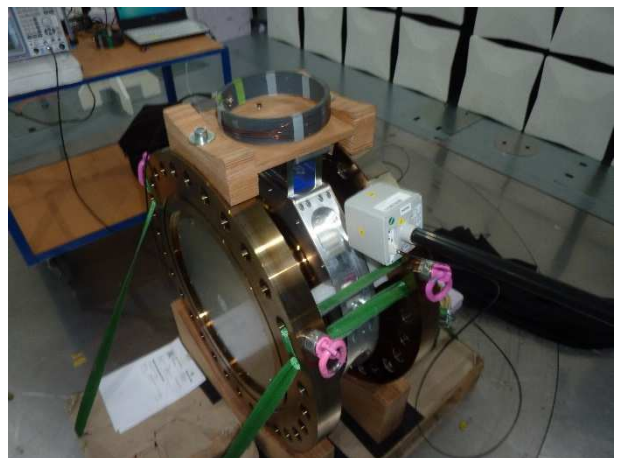
*: Limit for frequencies below 300 kHz according to clause 3.2 [4].

Operating frequency 10.7 MHz communication.

Parameter	Measured result	Limit *	Test result
Electric field strength	0.0037 A/m at 20 cm distance (averaging time of 6 minutes)	0.2047 A/m	Passed **

*: Limit for frequencies 3 – 30 MHz according to clause CFR 47 §1.1310(e)1 [1].

** : The 2ADAT-TCAS13 generates an electric field strength, which is below the level for MPE of persons in General Population / Uncontrolled Exposure [1].



Test equipment (please refer to chapter 5 for details)

1 – 4

6 Conclusion

The EUT complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 at a distance of 20 cm.

7 Measurement Uncertainties

Measurement method	Standard used for calculating measurement uncertainty	Expanded measurement uncertainty (95 %) U_{lab}
Measurements of electric and magnetic fields	DIN EN 50413, Ch. C2 DIN EN 62233, Ch. 5.6	20.6 % (H-F) 24.8 % (E-F)

8 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Isotropical E- and H-field analyser	EHP-200A	Narda	170WX80314	482643	27.01.2025	01.2027

9 Report History

Report Number	Date	Comment
F250176E3	09.04.2025	Initial Test Report
-	-	-
-	-	-

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