EMCC DR. RAŠEK ™

TEST REPORT # EMCC-070318CA, 2016-09-13

EQUIPMENT UNDER TEST:

Type of Equipment:	Level Probing Radar
Type Designation(s):	NMR84 DN150
Serial Number:	none
Equipment Class:	Level Probing Radar
Applicant:	TUV SÜD Product Service GmbH
Manufacturer:	Endress + Hauser GmbH & Co. KG
Address:	Hauptstraße 1 79690 Maulberg Germany
Phone:	+49 7622 28 1890
Fax:	+49 7622 28 15890

RELEVANT STANDARD(S): 47 CFR 15.31(q), 15.207, 15.209

MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013
☒ alternative method according to KDB publication 890966 D01 Meas level Probing Radars v01r01
☐

TEST REPORT PREPARED BY:

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TEST PERSONNEL:

Ludwig Kraft

HEAD OF LABORATORY:

Reinhard Sauerschell

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1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR 15.31(q), 15.207, 15.209 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 24, 2013, Registration Number 878769. This 3 m & 10 m alternative test site is approved by Industry Canada under file number 3464C-1.
Phone:	+49 9194 7262-0
Fax:	+49 9194 7262-199
E-Mail:	info@emcc.de
Web:	www.emcc.de

1.4 Manufacturer

Company Name:	Endress + Hauser GmbH & Co. KG
Street:	Hauptstraße 1
City:	79690 Maulberg
Country:	Germany
Name for contact purposes:	Mr Ralf Reimelt
Phone:	+49 7622 28 1890
Fax:	+49 7622 28 15890
E-Mail:	ralf.reimelt@pcm.endress.com

1.5 Applicant

Company Name:	TÜV SÜD Product Service GmbH
Street:	Äußere Frühlingsstraße 45
City:	94315 Straubing
Country:	Germany

Mr Steindl from TÜV SÜD Product Service GmbH delivered the EUT and attended the tests.

1.6 Dates and Test Location

Date of receipt of EUT:	2016-09-05
Test Date:	CW 36/2016
Test Location:	Lab IV

1.7 Ordering Information

Purchase Order and Date:	4500291913, 2016-08-04
Vendor Number:	40117854

1.8 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2016-09-05	23	55	977	IV	Yes, Mr Steindl
2016-09-06	23	56	985	IV	Yes, Mr Steindl
2016-09-07	22	53	981	IV	Yes, Mr Steindl
2016-09-08	23	56	974	IV	Yes, Mr Steindl
2016-09-09	23	56	977	IV	Yes, Mr Steindl

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

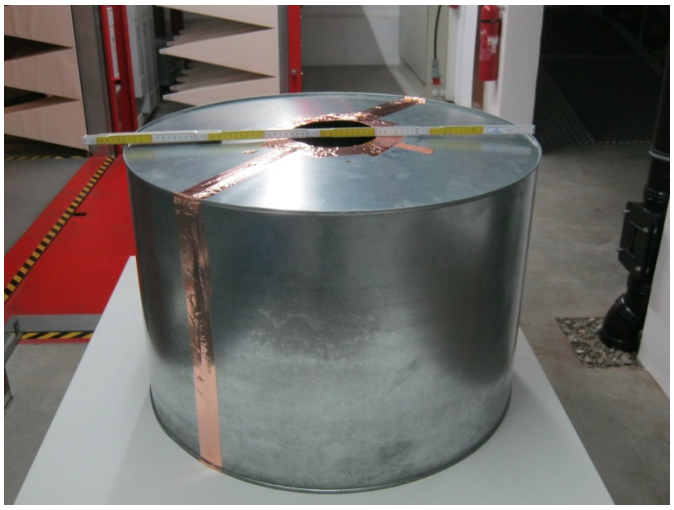
Type of Equipment:	Level Probing Radar
Type Designation(s):	NMR84 DN150
Serial Number(s):	none
FCC ID:	LCGNMR8XC
Application:	Level Probing Radar
Transmit Frequency:	5.925 – 7.250 GHz
Modulation:	FMCW
Power Supply:	10 – 32 VDC (nominal 24 VDC)
Antennas:	Planar antenna
Variants:	NRM84 DN100
Remarks:	Data transfer via HART protocol

2.2 Intended Use

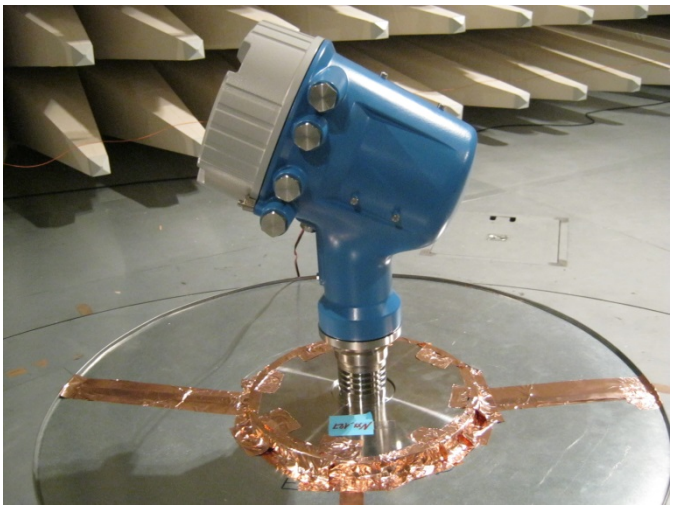
The EUT is a tank gauge for liquid level measurement. The standard use is tank mounted.

2.3 EUT Peripherals/Simulators

The EUT was tested mounted on top of a metal tank provided by the applicant.
For the power line conducted emission test the EUT was powered with 24 VDC by the AC / DC supply TRIO-PS/1AC/24DC/5.



Photograph 2.3-1: Metal tank used for testing



Photograph 2.3-2: Metal tank with EUT installed and shielded with copper foil.

Photograph 2.3-3: TRIO-PS/1AC/24DC/5

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 EUT was mounted on top of a metal tank in normal operation mode.

For the power line conducted emission test the EUT was powered with 24 VDC by the AC / DC supply TRIO-PS/1AC/24DC/5.

2.5 Modifications required for compliance

None.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: Endress + Hauser GmbH & Co. KG
Device: Level Probing Radar
Type(s): NMR84 DN150
Serial No(s): none

Requirement	47 CFR Section	Report Section	Result
Antenna Requirement	15.203	4	Passed
Conducted AC Power Line Emissions 150 kHz – 30 MHz	15.207	5	Passed
Radiated Emissions 9 kHz – 30 MHz	15.205, 15.209	7	Passed
Radiated Emissions 30 MHz – 100 GHz	15.205, 15.209	8	Passed

N.A. – not applicable; N.T. – Not tested acc. to applicant's order.

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

Test Personal: Ludwig Kraft
Issuance Date: 2016-09-13

4 ANTENNA REQUIREMENT

Test Requirement: 47 CFR, §15.203

4.1 Regulation

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

4.2 Result

Manufacturer:	Endress + Hauser GmbH & Co. KG
Device:	Level Probing Radar
Type(s):	NMR84 DN150
Serial No(s):	none
Test date:	2016-09-13

The EUT meets the requirements of this section.

5 POWER LINE CONDUCTED EMISSIONS TEST

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

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.

5.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESU8	3846	2016-09	2017-09
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
BNC cable	EMCC / BNC003m	5551	2016-04	2017-04
AC Power Source	AEG / DAMK4/DAGK4a	0001	n.a	n.a
DC Power Supply	Phoenix / TRIO-PS/1AC/24DC/5	none	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

5.3 Test Procedures

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

5.4 Test Result

Freq [MHz]	Line	Detector	Result [dBµV]	Limit [dBµV]	Margin
0.680	L	AV	32.7	46.0	13.3
0.740	L	AV	30.5	46.0	15.5
0.680	L	QP	39.1	56.0	16.9
0.740	L	QP	36.2	56.0	19.8
0.245	N	QP	40.3	61.9	21.7
0.310	N	QP	39.2	60.0	20.7
0.185	N	QP	43.7	64.3	20.6
0.745	N	QP	36.2	56.0	19.8

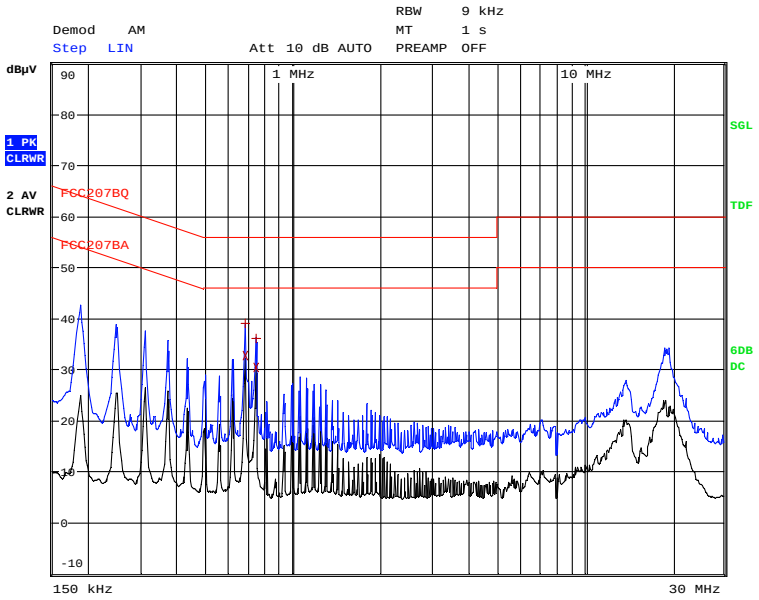
The table above contains worst-case emissions, only. For further details refer to the test plots.

Manufacturer: Endress + Hauser GmbH & Co. KG
Device: Level Probing Radar
Type(s): NMR84 DN150
Serial No(s): none
Test date: 2016-09-07

The EUT meets the requirements of this section.

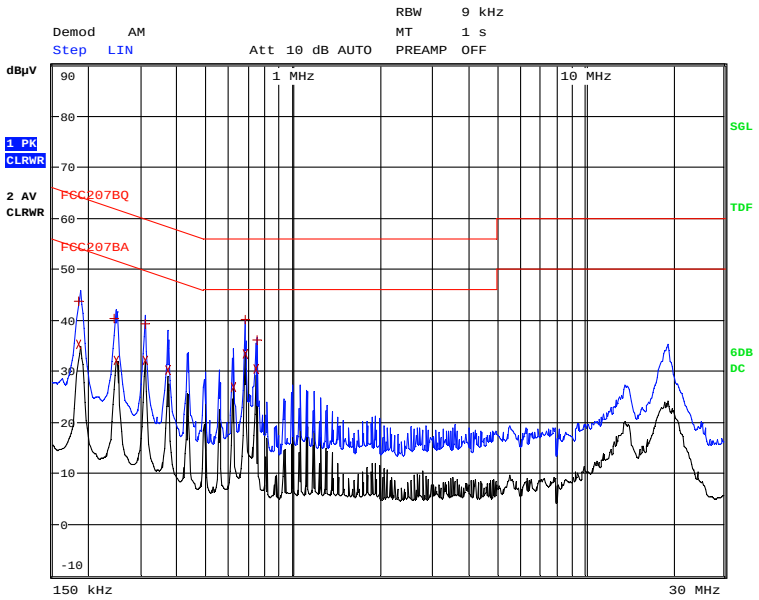
Measurement

Test on line L:



NMR84; Line: L
Date: 7.SEP.2016 13:57:01

Test on line N:



NMR84; Line: N
Date: 7.SEP.2016 13:53:41

6 RADIATED EMISSIONS 9 kHz – 30 MHz

Test requirement: FCC 47 CFR, §15.205, 15.209
Test procedure: ANSI C63.10-2013

6.1 Regulation

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

§ 15.35 Measurement detector functions and bandwidths.

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

§ 15.205 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.
(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.
[…]

§ 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.

6.2 Test Equipment

Type	**Manufacturer/ Model No.**	**EMCC Ident No.**	**Last Calibration**	**Next Calibration**
EMI Test Receiver	R&S / ESIP40	516	2016-02	2017-02
EMI Test Software	R&S / EMC32 V10.00	5392	n.a.	n.a.
Loop Antenna (with cable set)	R&S / HFH-Z2	374	2016-07	2018-07
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

6.3 Test Procedures

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 4.3.2 was positioned with its plane vertical at the test distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. The center of the loop antenna was 1 m above the ground.
The EUT was tested mounted on a metal tank, with antenna orientation vertical downward. The metal tank was on a styrofoam support on the groundplane. The EUT was connected to the power supply which was placed outside of the semi-anechoic room.
In certain applications, a remotely located device may be connected to the EUT. In these cases, it is permissible for cabling from the remotely located device to the EUT or accessories to be placed directly on the reference groundplane or, if normally installed beneath the reference groundplane, beneath it. The remotely located device shall be located at a distance sufficient to ensure that it does not contribute to the measured level. This procedure evaluates the interference potential of the EUT, its accessories, and interconnecting cables or wires standing apart from the remotely located device, which in turn shall be evaluated separately, if required.
Measurement initially performed as a pre-scan in the full frequency range in order to find worst case emissions. Final measurement performed at worst-case emission frequencies in a FCC and IC listed semi-anechoic room at the specified 3 m test distance. Pre-scan and final measurement performed in modulated mode.
Worst case emissions are listed under chapter: Final test results.

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

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

6.4 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.

6.5 Field Strength Calculation

All emission measurements performed using the EMI test program's transducer factor setting capability, i.e. the field strength value measured directly without the necessity of additional correction factors.

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f)(2) the field strength is calculated by adding additionally an extrapolation factor of 40 dB/decade (inverse linear-distance for field strength measurements). The basic equation with a sample calculation is as follows:

FS = FST + DF

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 60.0 dBµV/m is obtained. The Distance Factor of -40 dB and the correlation factor fc of -1.2 dB is added giving a field strength of 18.8 dBµV/m. The 18.8 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 60.0 - 40 -1.2= 18.8 [dBµV/m]
Level in µV/m = Common Antilogarithm (18.8/20) = 8.7

6.6 Final Test

Freq. [MHz]	Detector	3m_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]
All emission more than 20dB below margin								

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

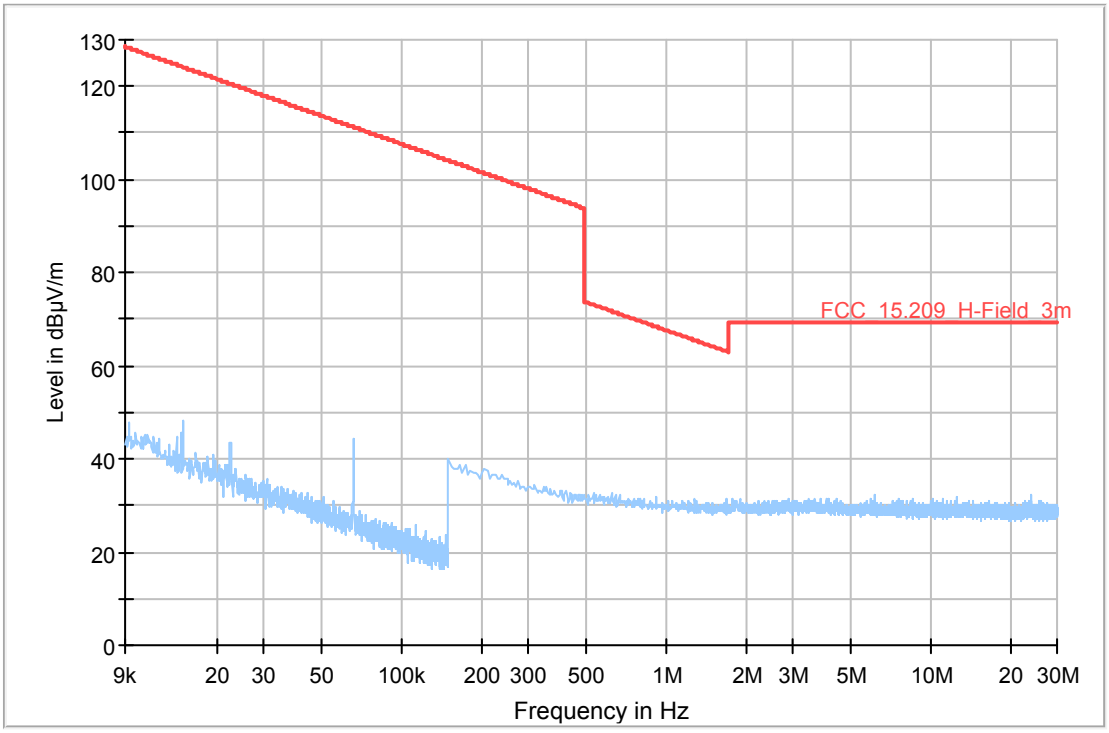
Manufacturer:	Endress + Hauser GmbH & Co. KG
Device:	Level Probing Radar
Type(s):	NMR84 DN150
Serial No(s):	none
Test date:	2016-09-05

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

The EUT meets the requirements of this section.

6.7 Measurement Plot

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



Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_H-Field_3m [..\EMI radiated\FCC_Part15\]
Final_Result QPK [Final_Result.Result:4]
Final_Result CAV [Final_Result.Result:5]

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“).

7 RADIATED EMISSIONS 30 MHz – 1000 MHz

Test Requirement: FCC 47 CFR, §15.205, 15.209
Test Procedure: ANSI C63.10-2013

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, 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.

§ 15.205 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.
(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.
[…]

§ 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	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.

7.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S / ESIP40	516	2016-02	2017-02
VHF Test Dipole RX	Schwarzbeck VHA 9103	899	2015-05	2017-05
Log Per. Antenna	Schwarzbeck VUSLP 9111B	3203	2015-05	2017-05
N-Cable N/50	Rohde & Schwarz	55	2016-08	2017-08
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

7.3 Test Procedures

The EUT was tested mounted on a metal tank, with antenna orientation vertical downward. The metal tank was placed on a styrofoam support on the groundplane. The EUT was connected to the power supply which was placed outside of the semi-anechoic room.
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.
Worst case emissions are listed under chapter: test results.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 1000 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).

7.4 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.

7.5 Field Strength Calculation

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

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

FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]

Level in µV/m = Common Antilogarithm (32/20) = 39.8

7.6 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)
122.060000	28.43	43.50	15.07	1000.0	120.000	100.6	V	17.0	13.5
129.460000	31.55	43.50	11.95	1000.0	120.000	100.6	V	-48.0	14.6
136.860000	29.05	43.50	14.45	1000.0	120.000	100.1	V	88.0	15.1
209.940000	27.46	43.50	16.04	1000.0	120.000	116.6	H	-80.0	17.6
292.260000	29.65	46.00	16.35	1000.0	120.000	103.5	V	-87.0	14.8
314.420000	31.56	46.00	14.44	1000.0	120.000	100.1	H	101.0	15.5

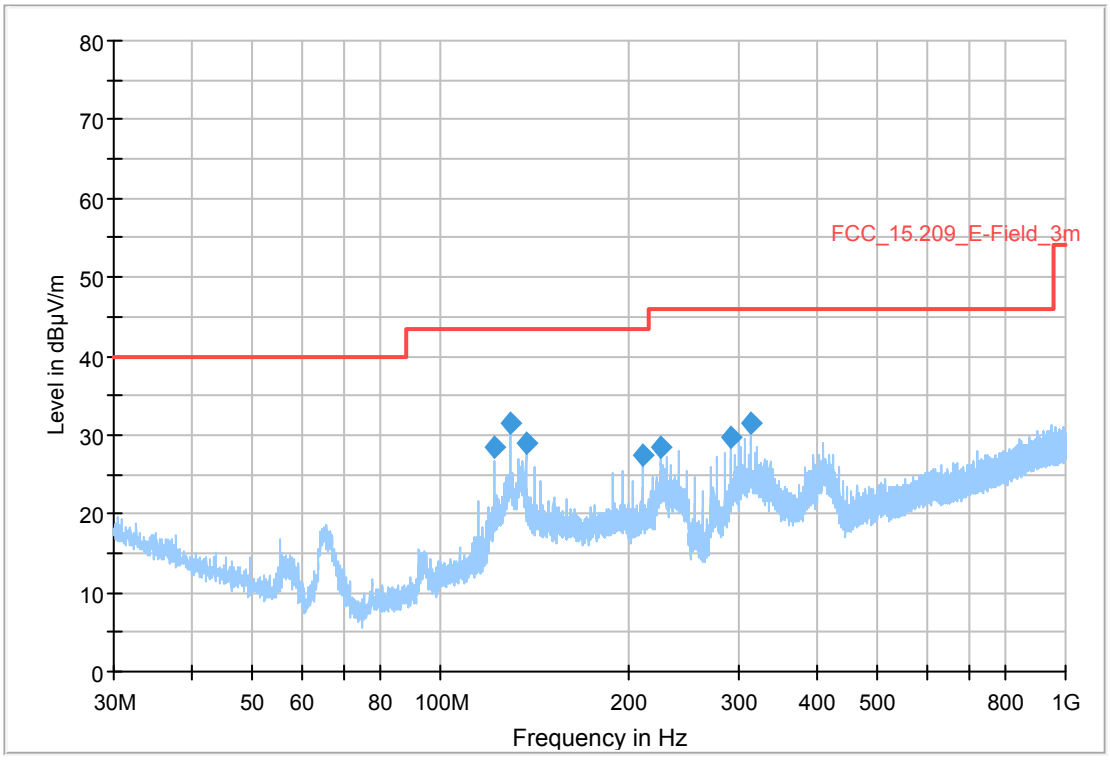
All tests performed at 3 m distance. The table above contains worst-case emissions for the normal mode, only. For further details refer to the pre-scan test plots. Corr. for information, only (already included in QP result).

Manufacturer:	Endress + Hauser GmbH & Co. KG
Device:	Level Probing Radar
Type(s):	NMR84 DN150
Serial No(s):	none
Test date:	2016-09-05

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

The EUT meets the requirements of this section.

7.7 Pre-scan Plot



Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]
Final_Result QPK [Final_Result.Result:4]

8 RADIATED EMISSIONS 1 GHz – 40 GHz

Test Requirement: FCC 47 CFR, §15.205, 15.209
Test Procedure: ANSI C63.10-2013

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.

§ 15.205 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.
(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.
[…]

§ 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	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.

8.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	R&S /FSU40	3831	2016-08	2017-08
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2015-06	2017-06
Standard Gain Horn	Mid Century	1300	2016-08	2018-08
Standard Gain Horn	Mid Century	1229	2016-08	2018-08
RF cable	Rosenberger	5612	2016-08	2017-08
RF cable	Rosenberger	5619	2016-08	2017-08
RF cable	Rosenberger	5616	2016-08	2017-08
EMI Test Software	R&S / EMC32 V10.00.00	5392	n.a.	n.a.
Programmable Power Source	R&S / NGPE40	519	n.a.	n.a.
Multimeter	Agilent U1241A	2720	2015-01	2017-01
Web-Thermo-Hygrobarograph	W&T / 57613 Web-T/Rh/P	4717	2016-04	2018-04

8.3 Test Procedures

The EUT was tested mounted on a metal tank, with antenna orientation vertical downward. The metal tank was on a styrofoam support on the groundplane. The EUT was connected to the power supply which was placed outside of the semi-anechoic room.
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]*.

Radiated Emissions Test Characteristics	
Frequency range	1 GHz – 40 GHz
Test distance	3 m*
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1.5 m - 4m
Receive antenna polarization	Vertical/Horizontal

* Test distance was reduced in order to fulfil the limit requirements, refer to final measurement table for details.

8.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for frequencies above 960 MHz:

µV/m at 3 meters = 500

500 µV/m corresponds with 54 dBµV/m.

8.5 Field Strength Calculation

The field strength is calculated by the equation as follows:

FS = FST + DF
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance on dBµV/m
DF = Distance Extrapolation Factor in dB

where DF = 20 log (Dtest/Dspec)
where
Dspec = Specified
Distance Dtest = Test Distance

Assume the tests performed at a reduced distance of 1.0 m instead of the Specified Distance if 3.0 m giving a Distance Extrapolation Factor of DF = 20 log (1.0 m / 3.0 m) = -9.5 dB.

8.6 Final Test Results

All tests performed at the denoted distance with the denoted resolution bandwidth. The table above contains worst-case emissions, only. For further details refer to the pre-scan and final measurement test plots.

Peak Results:

Freq. [GHz]	Dtest [m]	BW [MHz]	E-Field at test distance [dBm]	DF [dB]	Pk-Result [dBµV/m]	PK-Limit [dBµV/m]	Margin [dB]
5.605	3	1	55.49	0	55.49	74	18.51
5.777	3	1	53.08	0	53.08	74	20.92

Note: specified limits are based on average measurements. However, the peak value must not be more than 20 dB of the average limit.
The table above contains worst-case emissions for the normal mode, only. For further details refer to the pre-scan test plots.

Average Results:

Freq. [GHz]	Dtest [m]	BW [MHz]	E-Field at test distance [dBm]	DF [dB]	AV-Result [dBµV/m]	AV-Limit [dBµV/m]	Margin [dB]
5.605	3	1	44.74	0	44.74	54	9.26
5.777	3	1	34.60	0	34.60	54	19.40

The table above contains worst-case emissions for the normal mode, only. For further details refer to the pre-scan test plots.

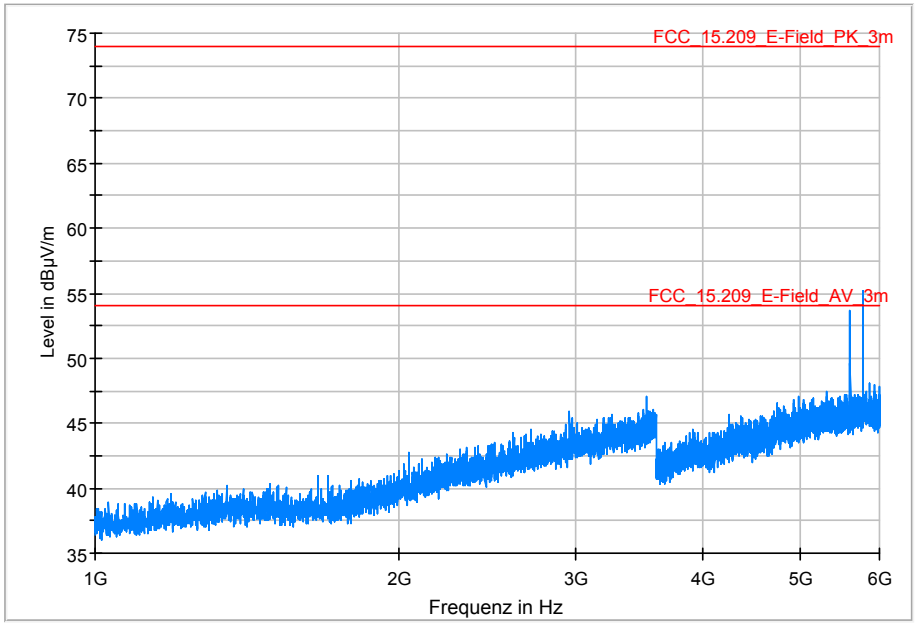
Manufacturer:	Endress + Hauser GmbH & Co. KG
Device:	Level Probing Radar
Type(s):	NMR84 DN150
Serial No(s):	none
Test date:	2016-09-06

All emissions in the range 1 GHz to 40 GHz are below the specified limits.

The EUT meets the requirements of this section.

8.7 Pre-scan plot 1 - 6 GHz

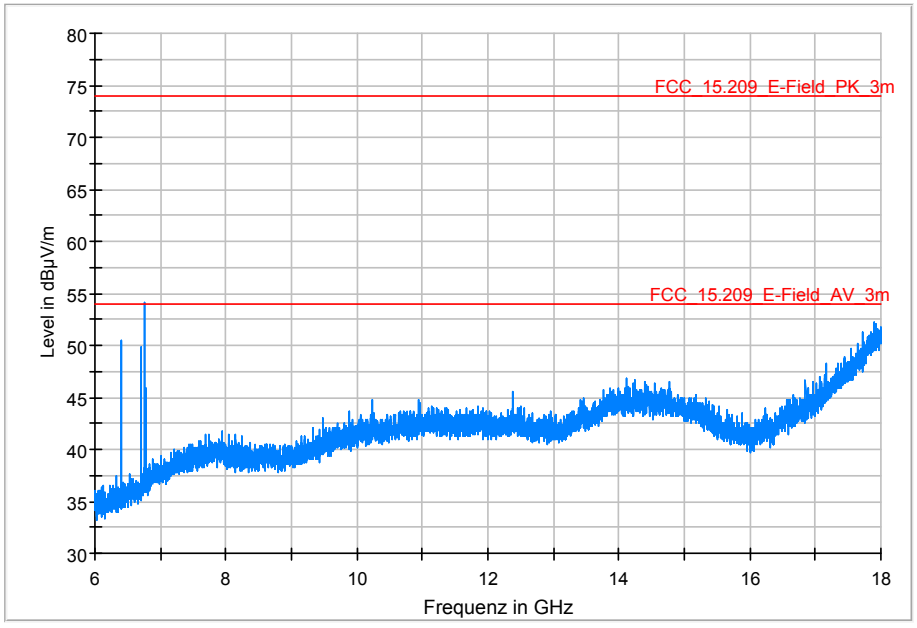
Test distance 3 m



PK+_MAXH@RE1-6GHz_003 [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

8.8 Pre-scan plot 6 - 18 GHz

Test distance 1m

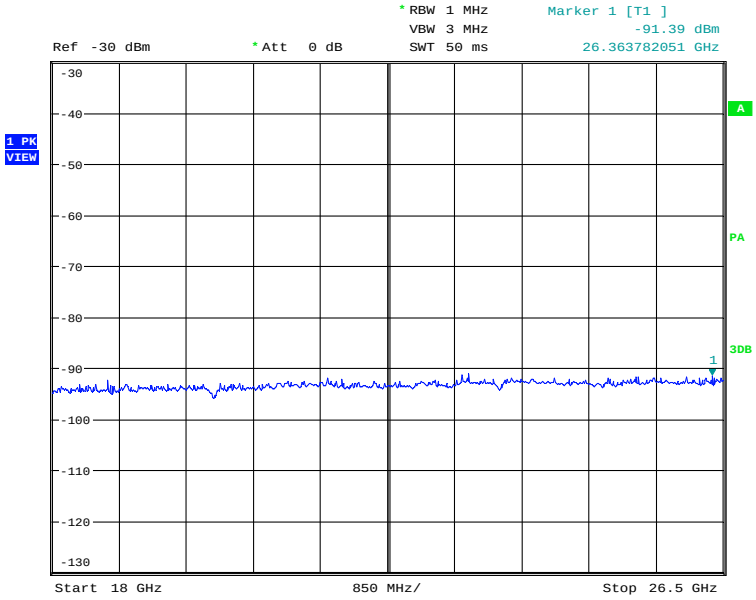


PK+_MAXH@RE6-18GHz_001 [Preview Result 1_corr_3-1m.Result:1]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]

Note: Pre-can measurements performed at 1 m distance, measurement plot is showing receiver's reading with additional distance correction factors.

8.9 Pre-scan plot 18 – 26.5 GHz

Test distance 1 m

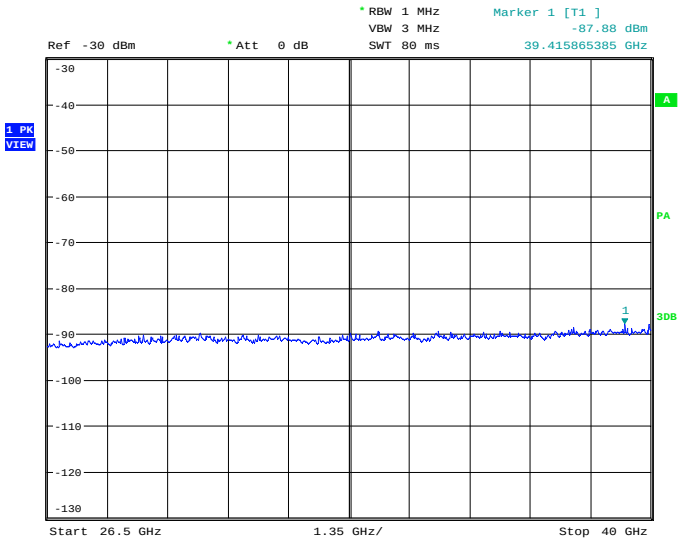


NMR84; d=1m; h= 1.5-2m
Date: 6.SEP.2016 11:54:58

Note: Pre-can measurements performed at 1 m distance with no additional correction factors, therefore the plot is just showing the measurement receiver's reading.

8.10 Pre-scan plot 26.5 - 40 GHz

Test distance 0.5 m



NMR84; d=0.5m; h= 1.5-2m
Date: 6.SEP.2016 12:23:35

Note: Pre-can measurements performed at 0.5 m distance with no additional correction factors, therefore the plots are just showing the measurement receiver's reading.

9 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Conducted Emissions (150 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
Radiated Emissions (1 GHz – 40 GHz)	±5.3 dB

The reported uncertainty values are based on a standard uncertainty multiplied by a coverage factor of k=2.0, providing a level of confidence of 95 %.

The given values have been calculated on the basis of the following documents:
CISPR 16-4: 2002;
UKAS: LAB34, The Expression of Uncertainty in EMC Testing, August 2002;
ISO: Guide to the Expression of Uncertainty in Measurement, 1993.

10 LIST OF ANNEXES

Following annexes are separated parts from this test report.

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

ANNEX 1 TO TEST REPORT # EMCC-070318CA, 2016-09-13

PHOTOGRAPHS OF TEST SET-UP

EQUIPMENT UNDER TEST:

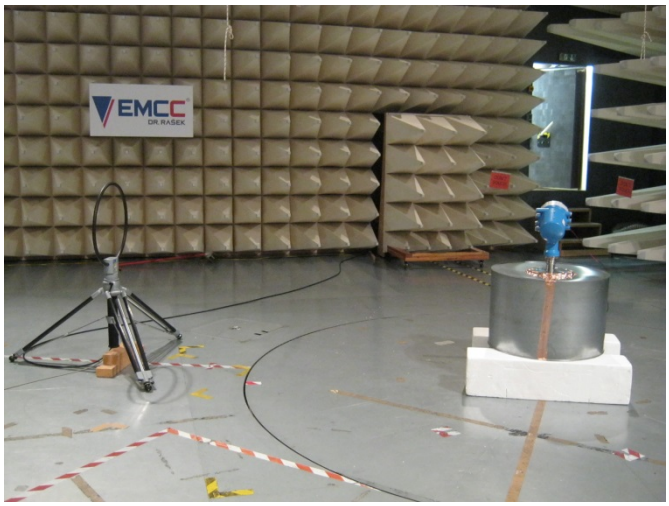
Trade Name:	Level Probing Radar
Type Designation(s):	NMR84 DN150
Serial Number:	none
Equipment Class:	Level Probing Radar
Manufacturer:	Endress + Hauser GmbH & Co. KG
Address:	Hauptstraße 1 79690 Maulberg Germany
Phone:	+49 7622 28 1890
Fax:	+49 7622 28 15890

RELEVANT STANDARD(S): 47 CFR 15.207, 15.209

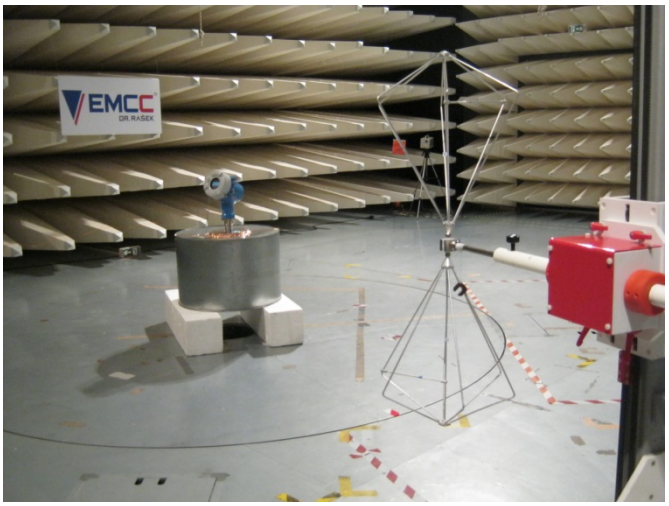
MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013 ☐ Other

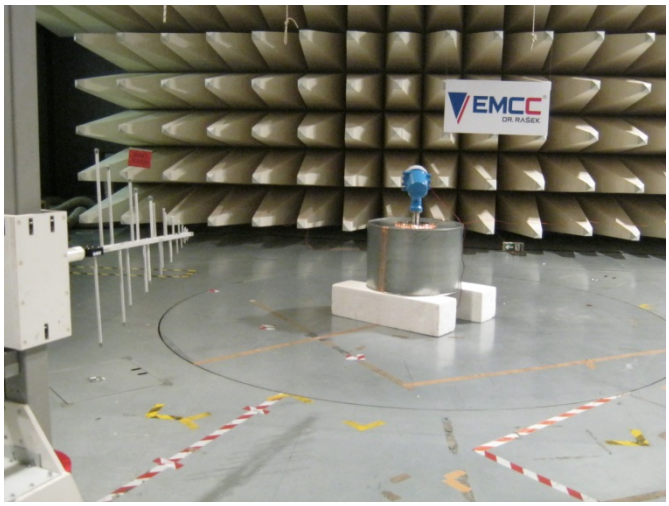
RADIATED AND CONDUCTED EMISSIONS TEST



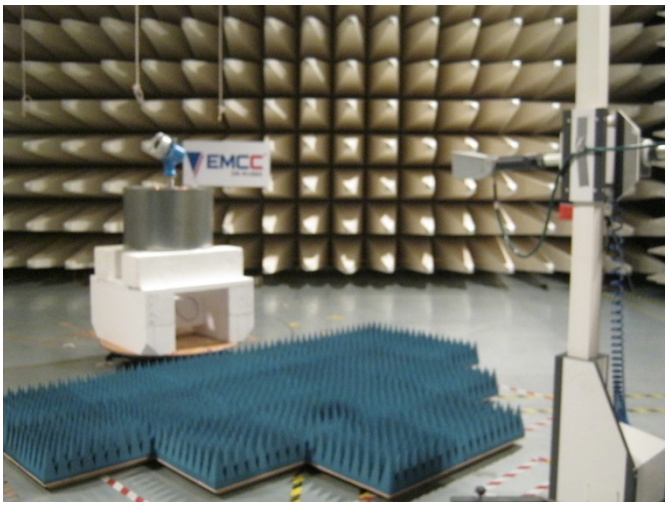
Radiated emissions measurement at 3 m distance
in semi anechoing chamber (SAC)9 kHz – 30 MHz



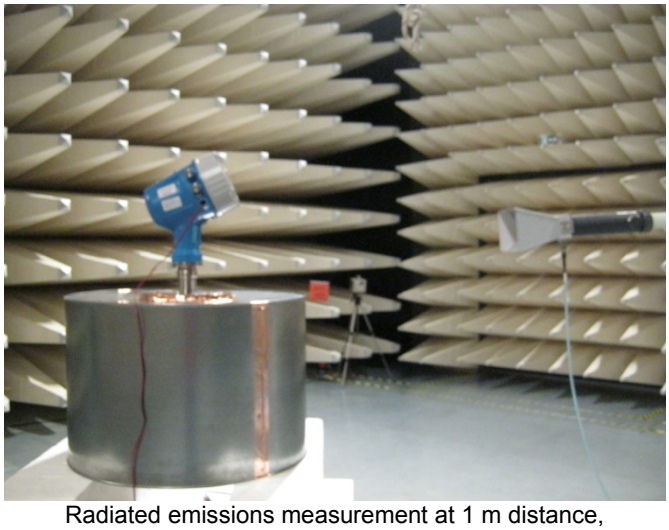
Radiated emissions measurement at 3 m distance
30 – 250 MHz



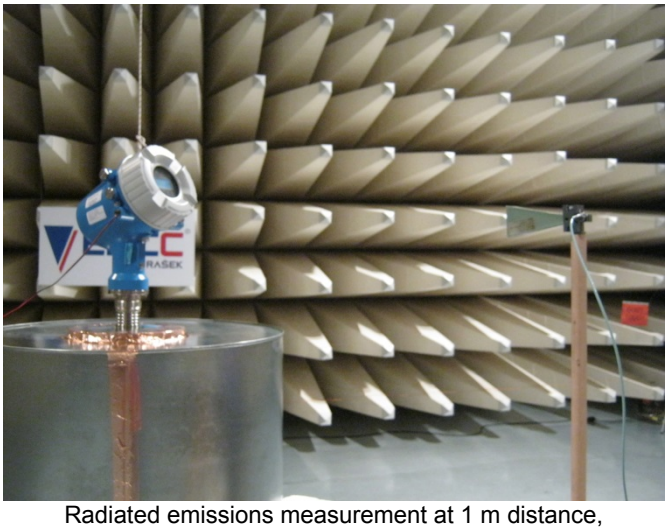
Radiated emissions measurement at 3 m distance
250 – 1000 MHz



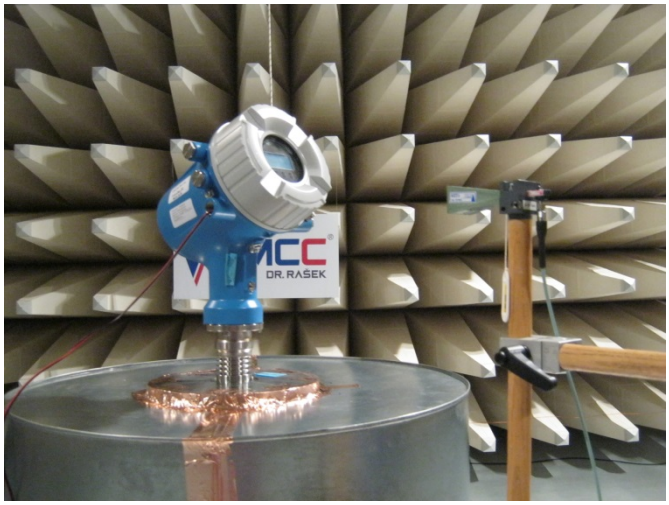
Radiated emissions measurement at 3 m distance,
1 GHz – 6 GHz



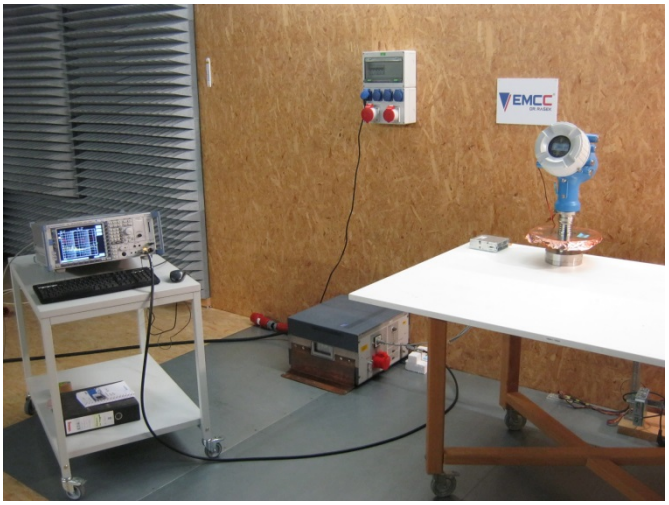
Radiated emissions measurement at 1 m distance, 6GHz – 18 GHz



Radiated emissions measurement at 1 m distance, 18GHz – 26.5 GHz



Radiated emissions measurement at 0.5 m distance, 26.5 GHz – 40 GHz



Powerline conducted emissions measurement

ANNEX 2 TO TEST REPORT # EMCC-070318CA, 2016-09-13

PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST:

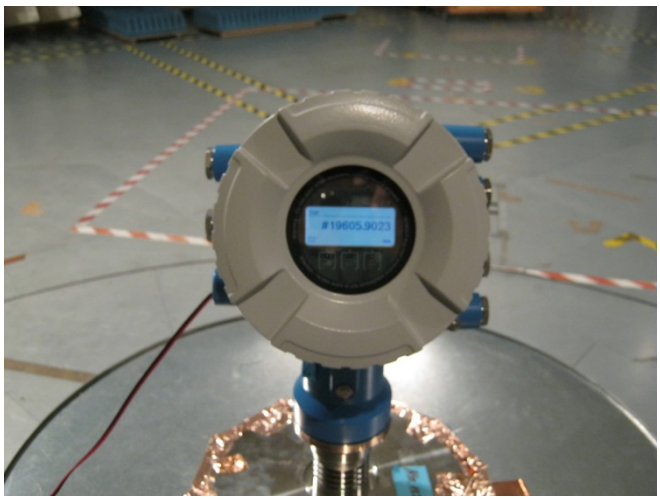
Trade Name:	Level Probing Radar
Type Designation(s):	NMR84 DN150
Serial Number:	none
Equipment Class:	Level Probing Radar
Manufacturer:	Endress + Hauser GmbH & Co. KG
Address:	Hauptstraße 1 79690 Maulberg Germany
Phone:	+49 7622 28 1890
Fax:	+49 7622 28 15890

RELEVANT STANDARD(S): 47 CFR 15.207, 15.209

MEASUREMENT PROCEDURE:

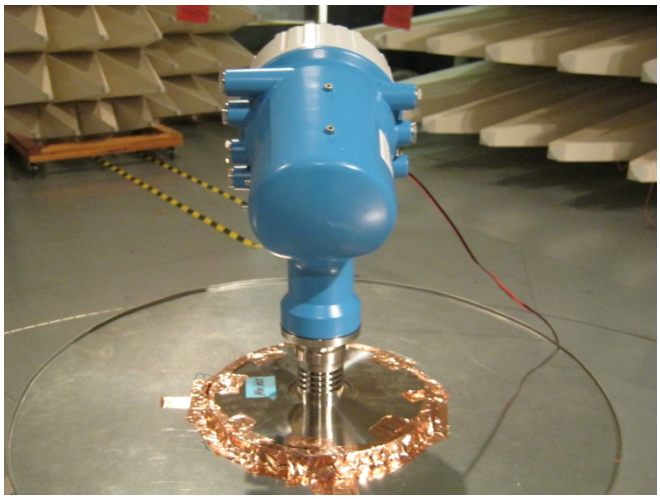
☒ ANSI C63.10-2013 ☐ Other

1 PHOTOS OF EUT

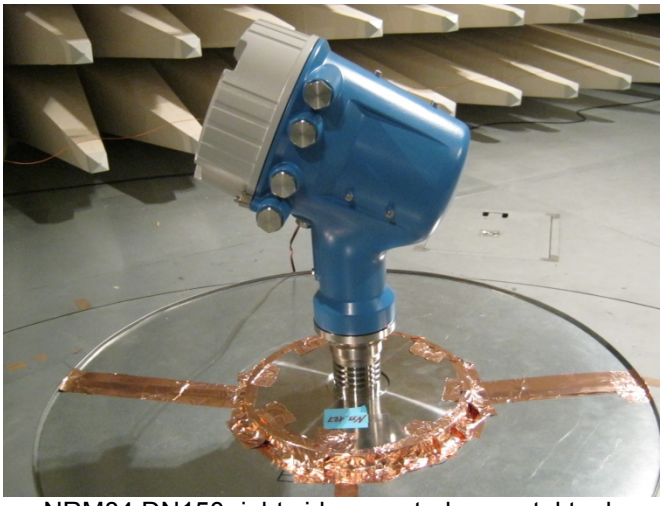


NRM84 DN150 front side mounted on metal tank

NRM84 DN150 left side mounted on metal tank



NRM84 DN150 back side mounted on metal tank



NRM84 DN150 right side mounted on metal tank