
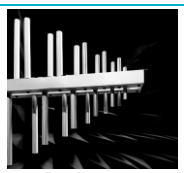
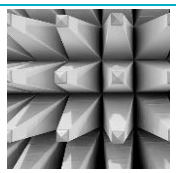

CTC advanced
member of RWTÜV group

TEST REPORT

Test report no.: 1-4079/17-01-10

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
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Phone: + 49 681 5 98 - 0
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Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

Applicant

KROHNE Innovation GmbH
Ludwig-Krohne-Straße 5
47058 Duisburg / GERMANY
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Fax: +49 0 234 58880 101
Contact: Charalambos Ouzounis
e-mail: c.ouzounis@krohne.com
Phone: +49 0 234 58880 152

Manufacturer

KROHNE Innovation GmbH
Ludwig-Krohne-Straße 5
47058 Duisburg / GERMANY

Test standard/s

RSS-211	Level Probing Radar Equipment

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**Tank Level Probing Radar**
Model name:	**Optiwave x400 series**
IC:	**1991D-FMCW24GX4T**
Frequency:	24.05 GHz – 29.00 GHz
Antenna:	Metallic Horn / Drop Antenna
Power supply:	14.0 – 30.0 V DC, 30 mA
Temperature range:	-40 °C to +85 °C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

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Lab Manager
Radio Communications & EMC

Test performed:

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Meheza Walla
Lab Manager
Radio Communications & EMC

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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2017-07-25
Date of receipt of test item:	2017-07-24
Start of test:	2017-07-24
End of test:	2017-10-25
Person(s) present during the test:	Mr. Charalambos Ouzounis

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
RSS-211	2015-03	Level Probing Radar Equipment

Reference	Version	Description
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices
Antennas-for-lpr-applications_v1-3.pdf	Issue 0.1 of 2017-10-04	Antenna pattern provided by manufacturer
Operational description OPTIWAVE x400 series.pdf	Issue 0.5 of 2018-01-29	Technical description of device under test provided by manufacturer

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +85 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	24.0 V DC, 30 mA 30.0 V 14.0 V

5 Test item

5.1 General description

Kind of test item	:	Tank Level Probing Radar
Type identification	:	Optiwave x400 series
HMN	:	NA
PMN	:	OPTIWAVE x400 series
HVIN	:	24GHZ-T-C
FVIN	:	NA
S/N serial number	:	Radiated test sample with HART 7 Bus: Prototype Radiated test sample with Profibus PA / Foundation Fieldbus (FF): Prototype Conducted special test sample: Prototype
HW hardware status	:	Display: 4002905801 A Converter Profibus PA / Foundation Fieldbus (FF): Prototype Converter HART 7 Bus: 4002260702 _ Sensor 24GHz: 4002332102 _ RF Module: 4002558501 C Terminal board: 4002522101 _
SW software status	:	Sensor V1.24.02_ Converter V1.24.02_
Frequency band	:	24.05 GHz – 29.00 GHz
Type of modulation	:	FMCW
Number of channels	:	1
Antenna	:	Metallic Horn / Drop Antenna
Power supply	:	14.0 V to 30.0 V DC, 30 mA
Temperature range	:	-40 °C to +85 °C

Note:
Following antennas can be used as TLPR application:

Antennas	Aperture area	Gain
316L / DN40 (1,5”) Metallic Horn	39 mm	19.4 dB
316L / DN50 (2”) Metallic Horn	43 mm	19.9 dB
316L / DN65 (2,5”) Metallic Horn	65 mm	23.3 dB
PEEK / Hygienic antenna	49 mm	20.5 dB

5.2 Additional information

Optiwave x400 series is available as LPR and TLPR configuration. The radar system is identical except the antenna which has to be selected depending on the application.
Two different interfaces are available: HART 7 Bus and Profibus PA / Foundation Fieldbus (FF).

The customer provided three test samples for the measurements:

- Two test samples with integrated antenna for radiated spurious: HART 7 Bus and Profibus PA / Foundation Fieldbus (FF);
- Special test mode with frequency sweep stopped at f_{low}, f_{mid}, f_{high} as per §15.31(c)

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup- and EUT-photos are included in test report:	1-4079/17-01-01_AnnexA
	1-4079/17-01-01_AnnexB
	1-4079/17-01-01_AnnexD

6 Sequence of testing

6.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

6.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

6.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

6.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

6.5 Sequence of testing radiated spurious above 50 GHz with external mixers

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate for far field (e.g. 0.25 m).
- The EUT is set into operation.

Premeasurement

- The test antenna with external mixer is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.
- Caution is taken to reduce the possible overloading of the external mixer.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

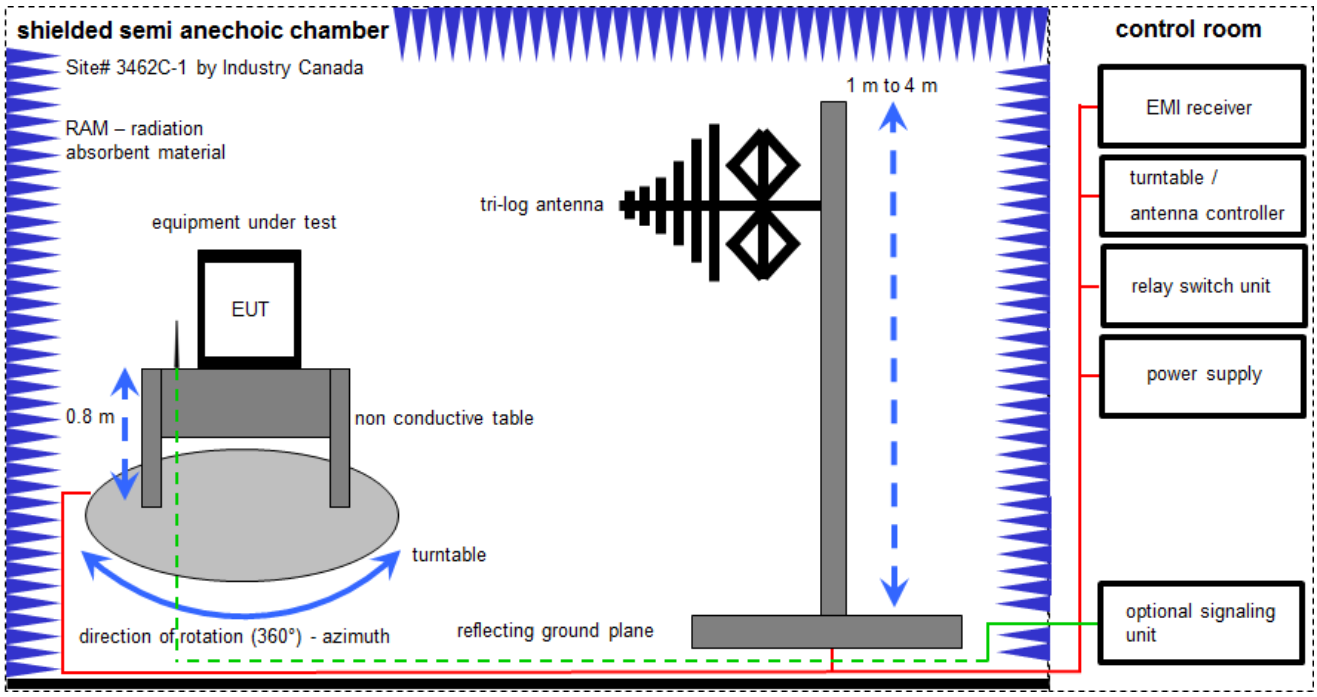
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are confirmed with specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



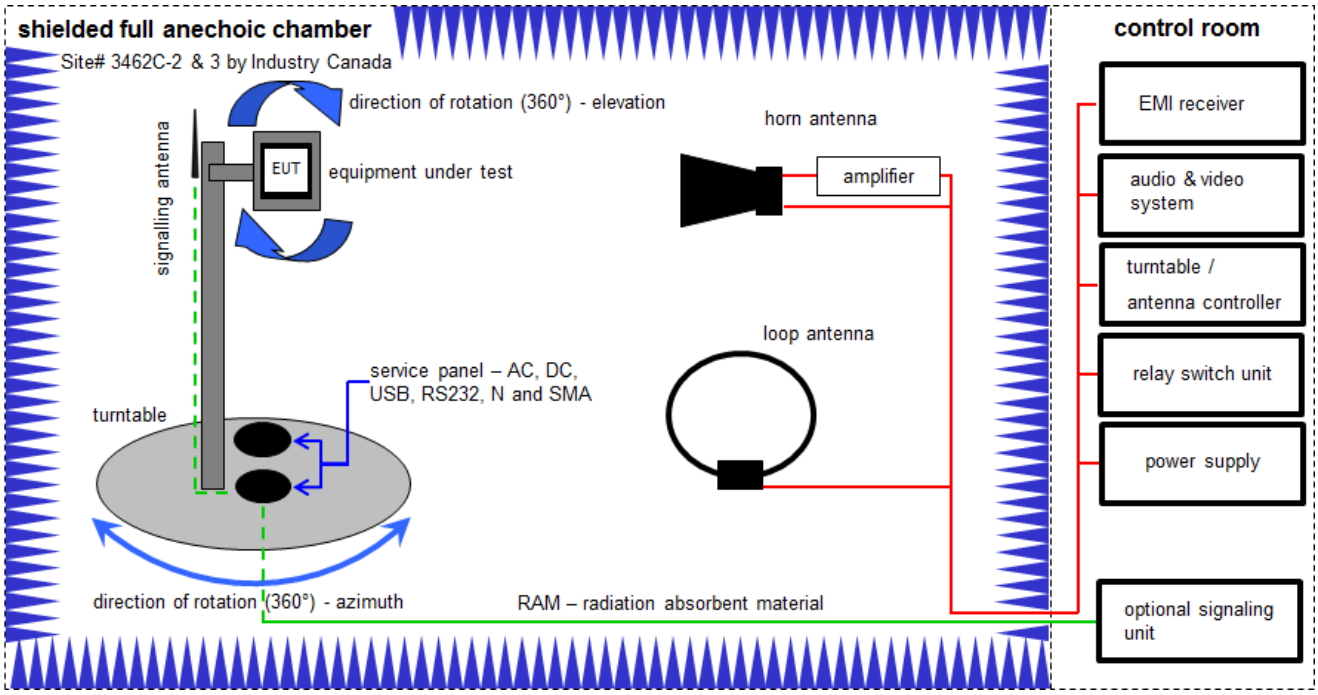
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	n. a.	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	01.02.2017	31.01.2018
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	02.02.2016	01.02.2018
6	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
7	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
8	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
9	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018
10	n. a.	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	31.01.2017	30.01.2018

7.2 Shielded fully anechoic chamber



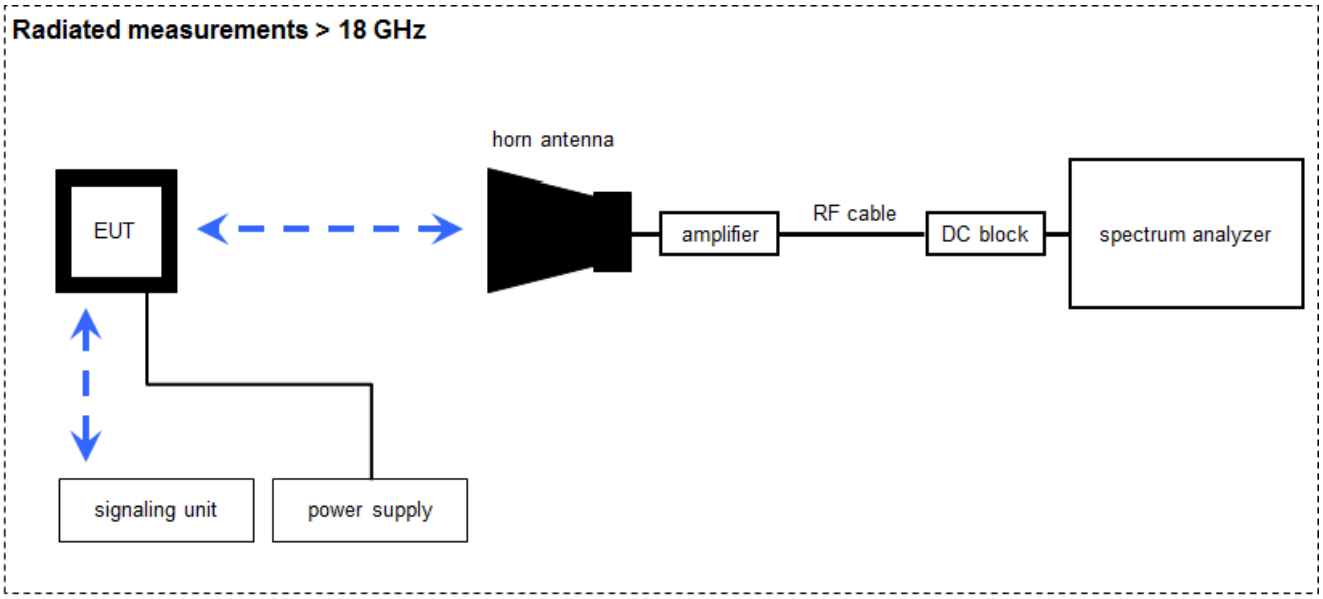
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

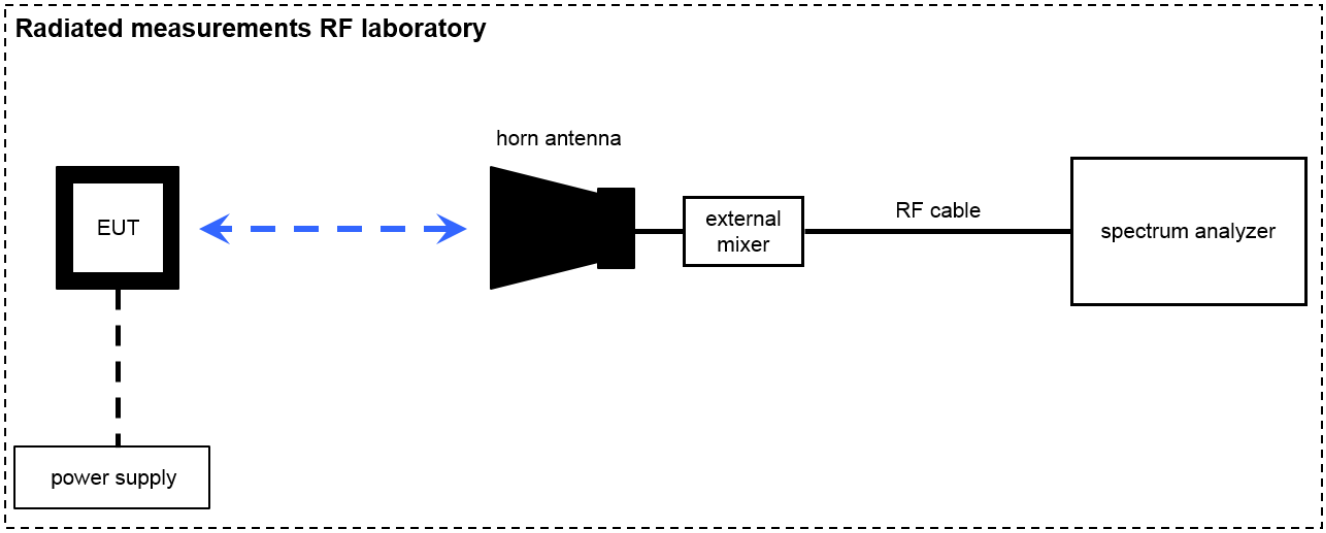
Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	CTC no.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	20.01.2015	19.01.2018
2	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	19	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	14.02.2017	13.02.2019
4	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	31.01.2017	30.01.2018
6	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
7	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vIKI!	29.10.2014	29.10.2017
8	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
9	n. a.	Broadband Amplifier 5-13 GHz	CBLU5135235	CERNEX	22010	300004491	ev	-/-	-/-
10	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
12	n. a.	PC	ExOne	F+W		300004703	ne	-/-	-/-
13	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-

7.3 Radiated measurements > 18 GHz



7.4 Radiated measurements > 50 GHz

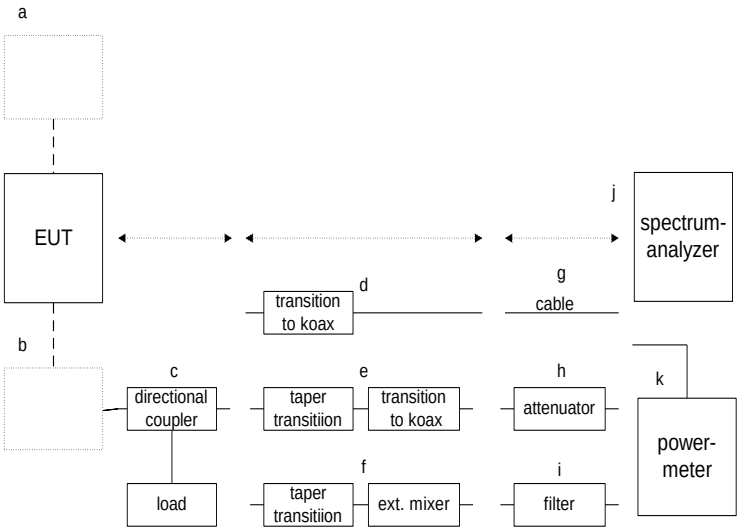


OP = AV + D - G
(OP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

Example calculation:
OP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 µW)

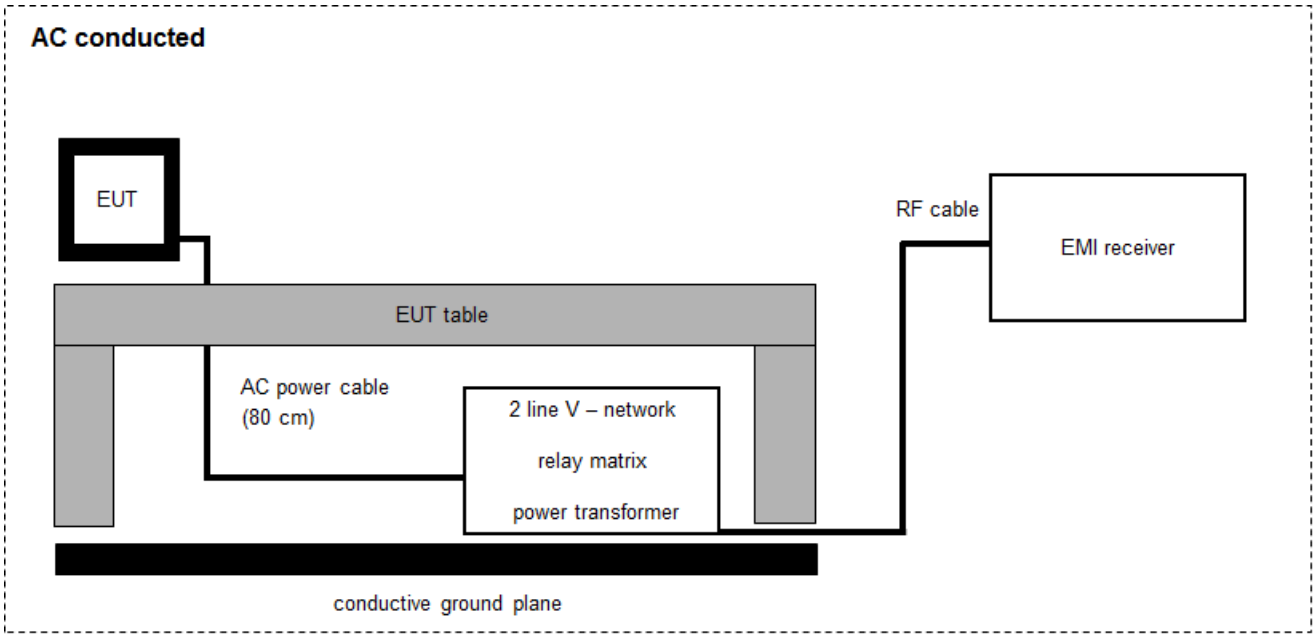
Note: conversion loss of mixer is already included in analyzer value.

7.5 Conducted measurements in test lab



No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
2	n. a.	Harmonic Mixer 2-Port, 50-75 GHz	FS-Z75	R&S	100099	300003949	k	30.06.2017	29.06.2018
3	n. a.	Harmonic Mixer 3-Port, 60-90 GHz	FS-Z90	R&S	101555	300004691	k	30.06.2017	29.06.2018
4	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	03.07.2017	02.07.2018
5	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	Ve	28.10.2016	27.10.2018
6	n. a.	Std. Gain Horn Antenna 12.4-18.0 GHz	639	Narda	8402	300000787	ne	-/-	-/-
7	n. a.	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	ne	-/-	-/-
8	n. a.	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	ne	-/-	-/-
9	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
10	n. a.	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001983	ne	-/-	-/-
11	n. a.	Std. Gain Horn Antenna 60-90 GHz	COR 60_90	Thomson CSF		300000814	ne	-/-	-/-
12	n. a.	Std. Gain Horn Antenna 75-110 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-

7.6 AC conducted



FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1		Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	893045/004	300000584	k	31.01.2017	30.01.2018
2		RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
3		Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	08.04.2008	-/-
4		Power Supply	NGSM 32/10	R&S	3939	400000192	vIKI!	31.01.2017	30.01.2020
5		MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	16.08.2016	16.08.2018
6		Wideband Radio Communication Tester	CMW500	R&S	102375	300004187	k	14.12.2015	13.12.2017

8 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Spectrum bandwidth	span/1000
Conducted output power	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 dB
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

9 Summary of measurement results

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC identifier	Description	verdict	date	Remark
RF-Testing	RSS-211	see below	2018-02-08	-/-

Test Specification Clause	Test Case	Temperature Conditions	Power Source Voltages	C	NC	NA	NP	Results
RSS-Gen 6.11	Frequency stability	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	complies
RSS-211, 2.4	Fundamental emission bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
RSS-211,5.2b	Fundamental emissions limits	Nominal	Nominal	☒	☐	☐	☐	complies
RSS-211,5.1d	Unwanted emissions limit	Nominal	Nominal	☒	☐	☐	☐	complies
RSS-Gen, 7.1	Receiver radiated limit	Nominal	Nominal	☒	☐	☐	☐	complies
RSS-Gen, 8.8	AC power line conducted emissions limits	Nominal	Nominal	☒	☐	☐	☐	complies

Note: C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

10 Test results

10.1 Frequency stability and fundamental bandwidth

Description:

RSS-Gen, 6.11
In circumstances when the transmitter frequency stability is not stated in the applicable RSS or reference measurement method, the following applies:

- Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage. Unless specified otherwise in an RSS applicable to the device, the reference temperature for radio transmitters is +20°C (+68°F);
- A hand-held device that is only capable of operating using internal batteries shall be tested at the battery's nominal voltage, and again at the battery's operating end-point voltage, which must be specified by the equipment manufacturer. For this test, either a battery or an external power supply can be used; and
- The operating carrier frequency shall be set up in accordance with the manufacturer's published operation and instruction manual prior to the commencement of these tests. No adjustment of any frequency-determining circuit element shall be made subsequent to this initial set-up.

With the transmitter installed in an environmental test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement. The following temperatures and supply voltage ranges apply, unless specified otherwise in the applicable RSS:
(a) at the temperatures of −30°C (−22°F), +20°C (+68°F) and +50°C (+122°F), and at the manufacturer's rated supply voltage; and
(b) at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage.
If the frequency stability limits are only met within a temperature range that is smaller than the −30°C to +50°C range specified in (a), the frequency stability requirement will be deemed to be met if the transmitter is automatically prevented from operating outside this smaller temperature range and if the published operating characteristics for the equipment are revised to reflect this restricted temperature range.
In addition, if an unmodulated carrier is not available, the measurement method shall be described in the test report.
RSS-211, 2.4
Operating frequency range refers to the frequency band of operation defined as f_H - f_L, where the frequency points are designated as f_L where the power falls 10 dB below the fM level, and as f_H where the power falls 10 dB above the f_M level.
RSS-211, 5.1 a)
The minimum fundamental emission bandwidth shall be 50 MHz.

Measurement:

f_C is the point in the radiation where the power is at maximum. The frequency points where the power falls 10 dB below the f_C level and above f_C level are designated as f_L and f_H respectively.
The operating frequency range (i.e. the frequency band of operation) is defined as f_H - f_L.

Measurement parameters:

Resolution bandwidth:	1 MHz
Video bandwidth:	≥1 MHz
Detector:	Pos-Peak
Trace:	Max hold

Limits:

Wanted signal has to stay within the band

Results:

Test Conditions	Transmitter Frequency Range (GHz)		10 dB bandwidth (GHz)
	f_L	f_H	
-40 °C / V_{nom}	24.076	26.080	2.004
-30 °C / V_{nom}	24.076	26.080	2.004
-20 °C / V_{nom}	24.076	26.086	2.010
-10 °C / V_{nom}	24.076	26.080	2.004
0 °C / V_{nom}	24.076	26.086	2.010
10 °C / V_{nom}	24.076	26.086	2.010
20 °C / V_{min} - V_{max}	24.076	26.086	2.010
30 °C / V_{nom}	24.076	26.080	2.004
40 °C / V_{nom}	24.076	26.080	2.004
50 °C / V_{nom}	24.076	26.080	2.004
60 °C / V_{nom}	24.076	26.086	2.010
70 °C / V_{nom}	24.076	26.080	2.004
80 °C / V_{nom}	24.076	26.080	2.004
85 °C / V_{nom}	24.076	26.086	2.010
deviation based on 20 °C	±1.0 kHz (±0.04 ppm)	-6.0 MHz (-230 ppm)	

10.2 Fundamental emissions

Description:
RSS-211, 5.3
a) The device shall be installed inside a closed container or in a still pipe by qualified installers.
b) The leakage of the RF field outside the container at 3 m from the container or still pipe walls shall not exceed the values outlined in Table 3. The levels shall be assessed using the procedures defined in ETSI EN 302 372.

Limits:

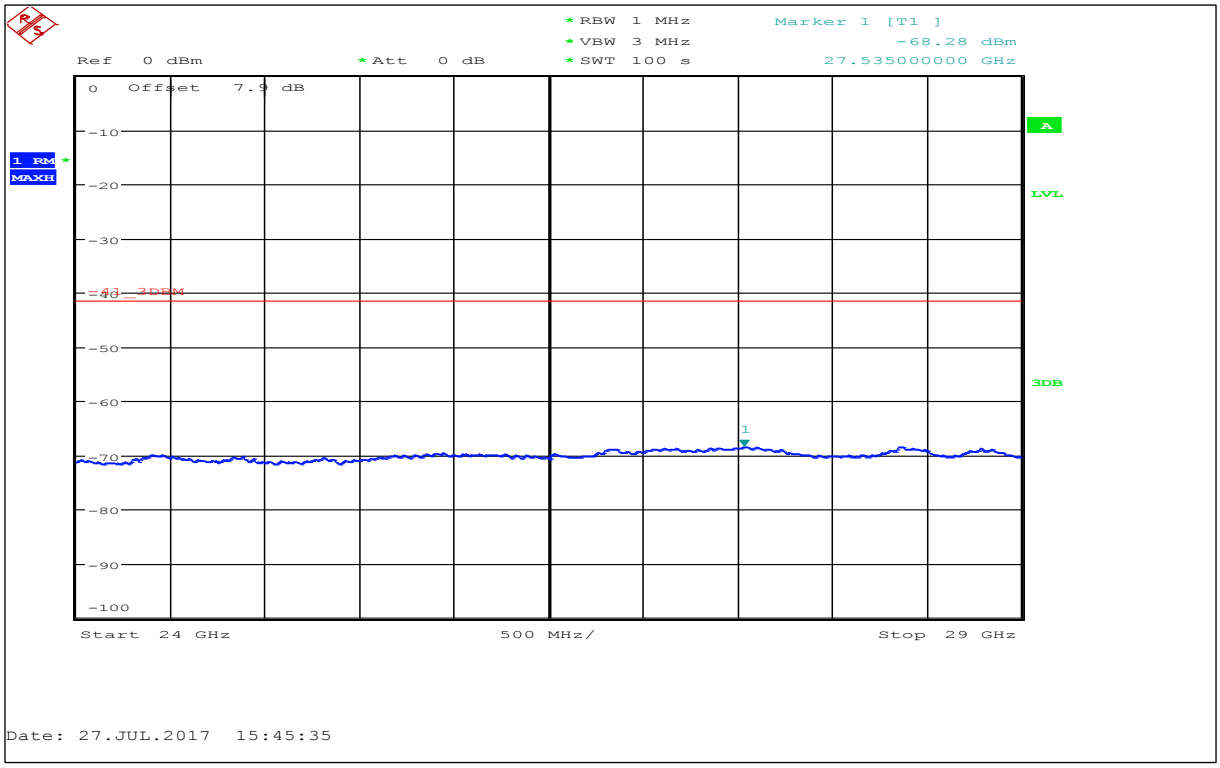
Frequency range (GHz)	Average EIRP (dBm / MHz)
5.65 to 8.50	-41.3
8.50 to 10.55	
24.05 to 29.00	
75.00 to 85.00	

Measurement parameters:

Resolution bandwidth: 1 MHz
Video bandwidth: ≥1 MHz
Span: depends on DUT
Detector: RMS
Trace: Max hold

Results:

Plot 1: 24 – 29 GHz, RMS measurement



10.3 Unwanted emissions limit

Description:

RSS-211, 5.1 d)
Unwanted emissions shall not exceed the general field strength limits set out in RSS-Gen.

Measurement parameters:

Resolution bandwidth:	100 kHz / 1 MHz
Video bandwidth:	≥ resolution bandwidth
Detector:	Quasi Peak / Average (RMS)
Trace:	Max hold

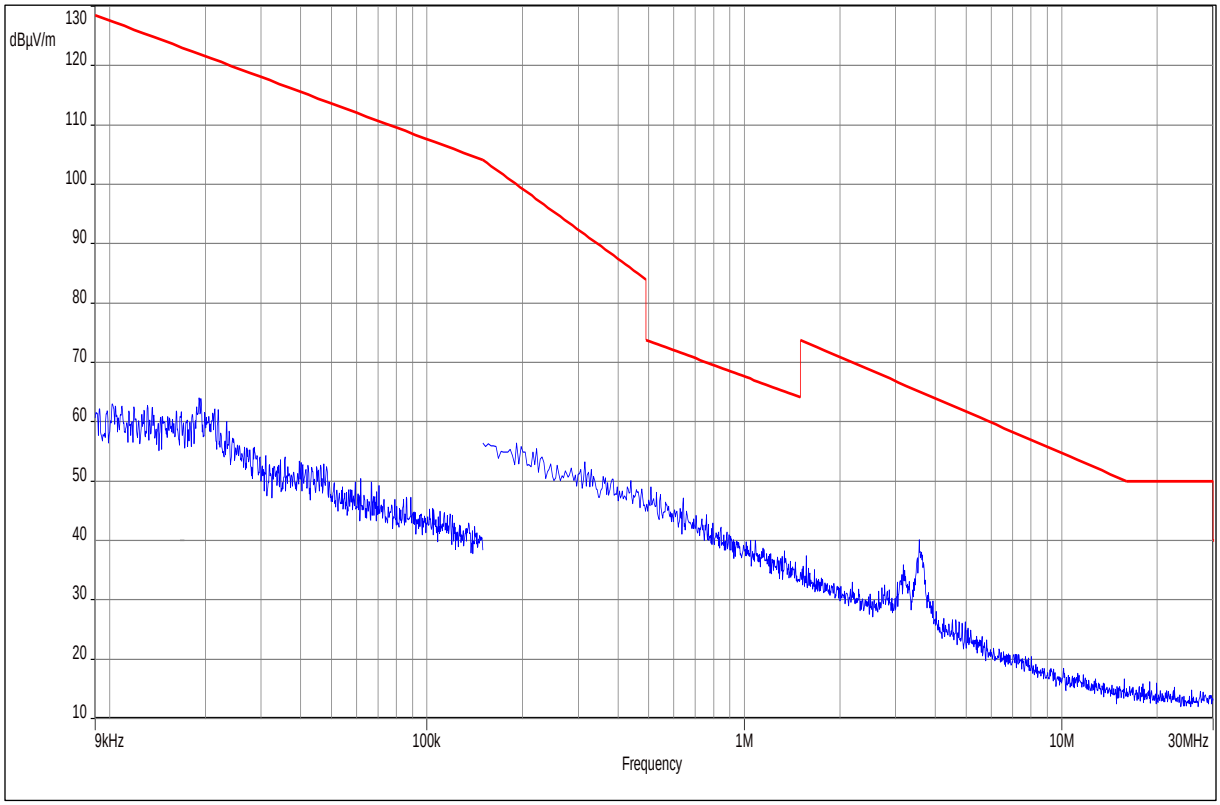
Limits:

RSS-Gen		
Field strength of the harmonics and spurious.		
Frequency (MHz)	**Field strength (µV/m)**	**Measurement distance (m)**
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30 (29.5 dBµV/m)	30
30 – 88	100 (40 dBµV/m)	3
88 – 216	150 (43.5 dBµV/m)	3
216 – 960	200 (46 dBµV/m)	3
>960	500 (54 dBµV/m)	3

Results:

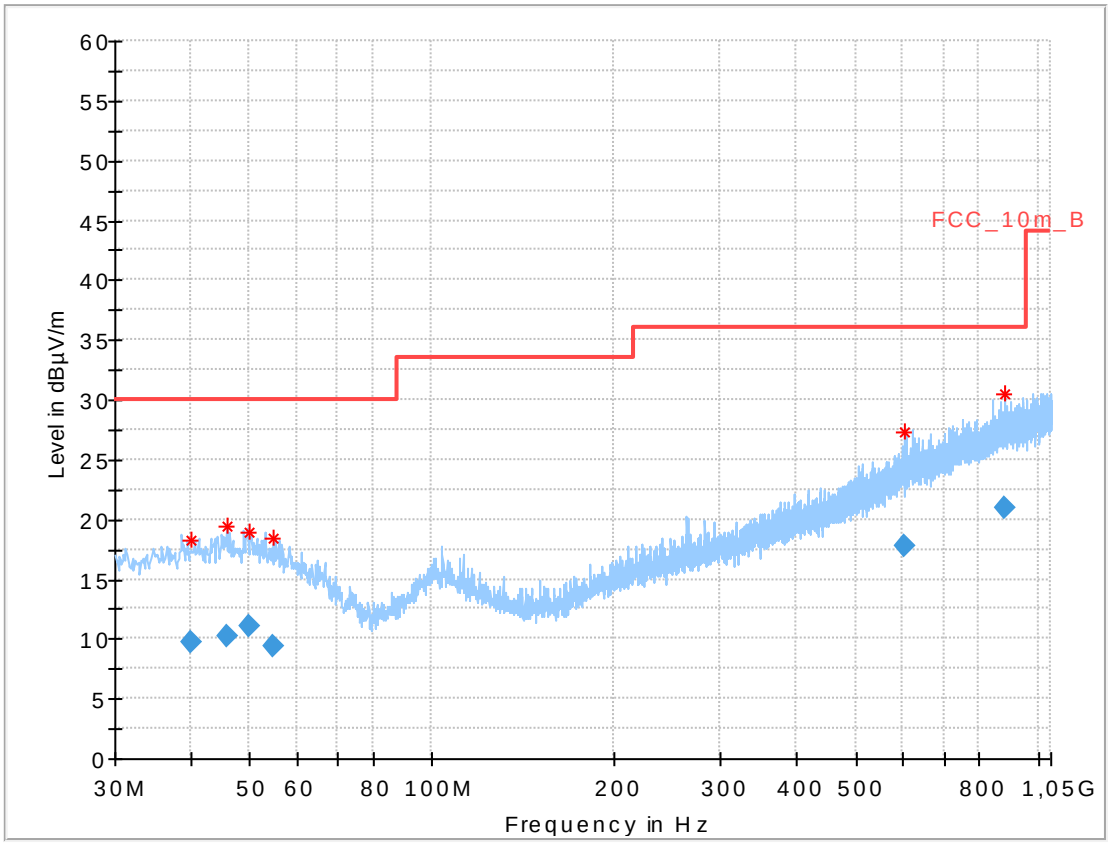
Spurious emission level (dBm)								
-/-			-/-			-/-		
Frequency [GHz]	BW [kHz]	Level [dBm]	Frequency [GHz]	BW [kHz]	Level [dBm]	Frequency [GHz]	BW [kHz]	Level [dBm]
see plots								

Plot 2: 9 kHz – 30 MHz, special test mode, $f_{low}/f_{mid}/f_{high}$



Plot 3: 30 MHz – 1000 MHz, normal operation mode

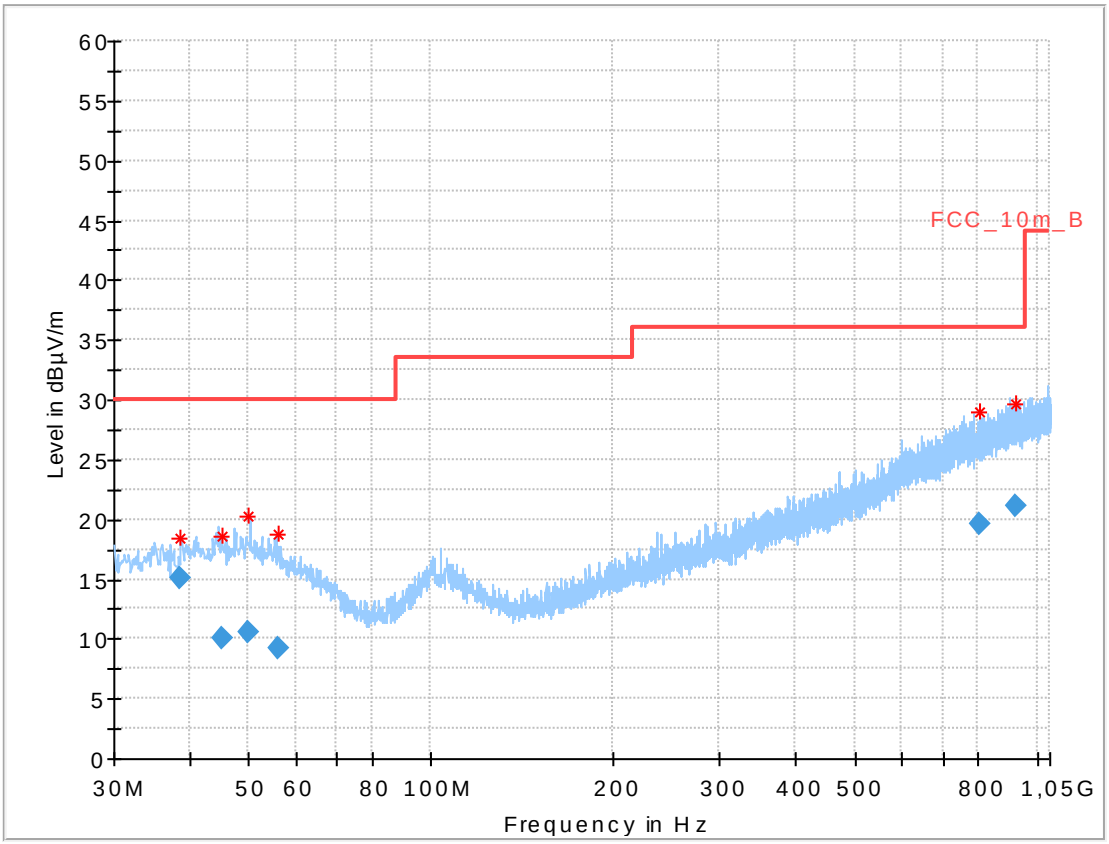
EUT:	OPTIWAVE 7400 C (HART)
Serial number:	F17XXXXXXXXXXX
Test description:	FCC part 15 class B @ 10 m
Operating condition:	normal mode
Operator name:	Hennemann
Comment:	DC 24 V



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.977550	9.72	30.00	20.28	1000.0	120.000	348.0	H	165.0	13.2
45.964500	10.24	30.00	19.76	1000.0	120.000	100.0	V	32.0	13.6
49.977150	11.02	30.00	18.98	1000.0	120.000	280.0	V	50.0	13.7
54.865200	9.36	30.00	20.64	1000.0	120.000	172.0	V	-15.0	13.1
602.368350	17.84	36.00	18.16	1000.0	120.000	103.0	V	78.0	20.7
879.684450	21.01	36.00	14.99	1000.0	120.000	171.0	H	-13.0	23.9

Plot 4: 30 MHz – 1000 MHz, special test mode, frequency sweep stopped at f_{low}

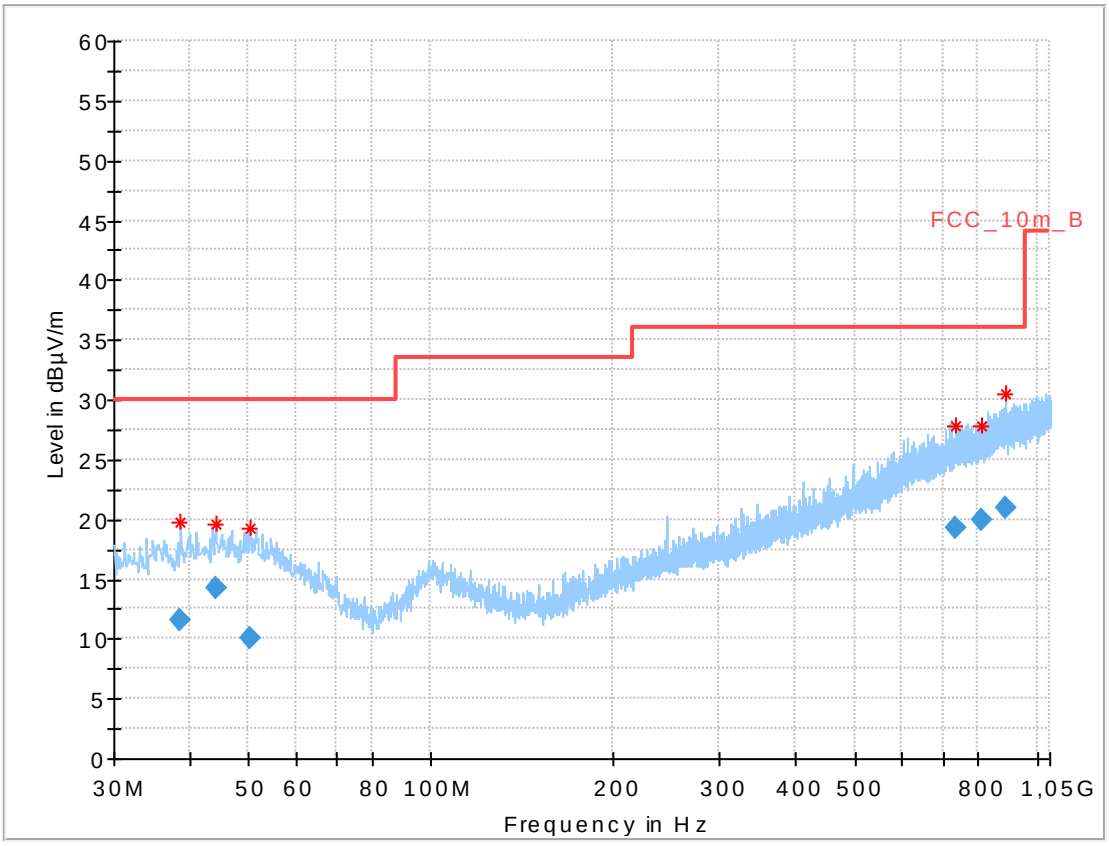
EUT:	OPTIWAVE 7400 C (HART)
Serial number:	F17XXXXXXXXXXX
Test description:	FCC part 15 class B @ 10 m
Operating condition:	TX low channel
Operator name:	Hennemann
Comment:	DC 24 V



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.707800	15.02	30.00	14.98	1000.0	120.000	102.0	V	30.0	13.1
45.375000	10.11	30.00	19.89	1000.0	120.000	202.0	V	53.0	13.6
49.971150	10.63	30.00	19.37	1000.0	120.000	349.0	V	99.0	13.7
55.967550	9.28	30.00	20.72	1000.0	120.000	100.0	H	140.0	12.8
802.801200	19.66	36.00	16.34	1000.0	120.000	362.0	V	60.0	22.8
920.487000	21.19	36.00	14.81	1000.0	120.000	200.0	V	167.0	24.3

Plot 5: 30 MHz – 1000 MHz, special test mode, frequency sweep stopped at f_{mid}

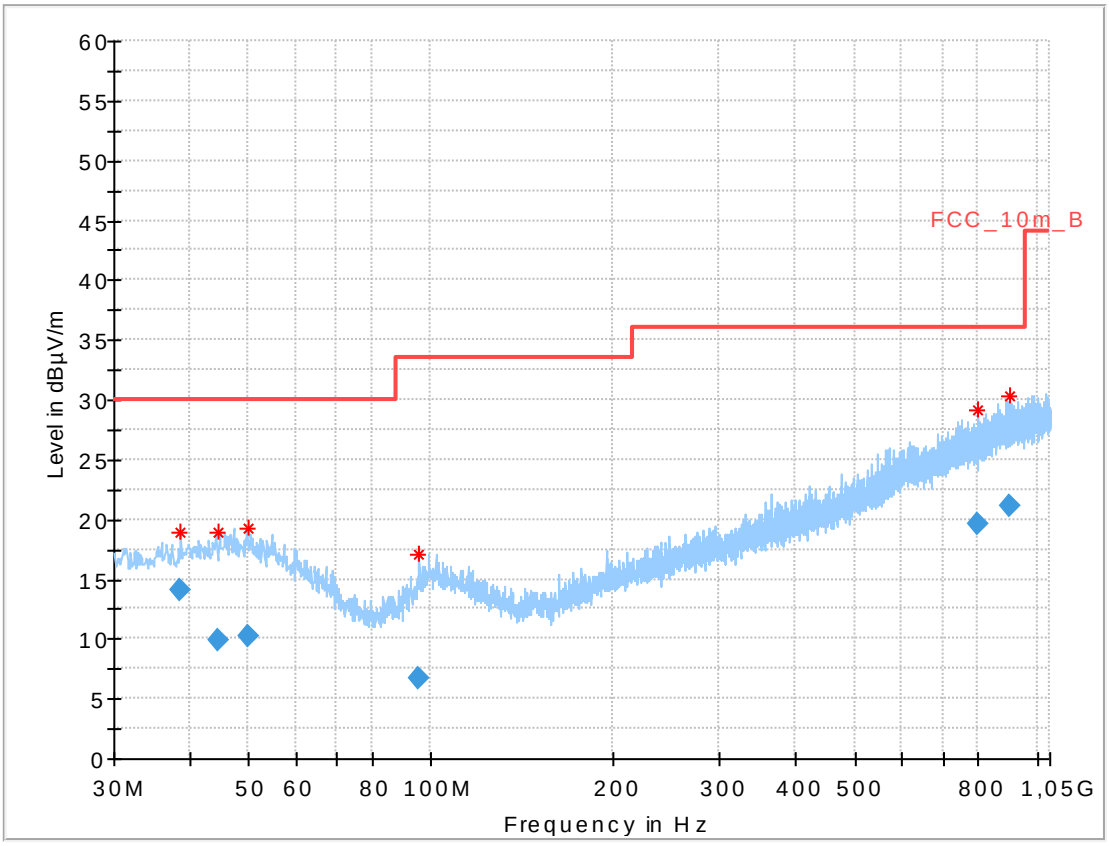
EUT:	OPTIWAVE 7400 C (HART)
Serial number:	F17XXXXXXXXXXX
Test description:	FCC part 15 class B @ 10 m
Operating condition:	TX middle channel
Operator name:	Hennemann
Comment:	DC 24 V



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.650800	11.49	30.00	18.51	1000.0	120.000	100.0	V	255.0	13.1
44.239050	14.19	30.00	15.81	1000.0	120.000	103.0	V	210.0	13.6
50.219850	10.10	30.00	19.90	1000.0	120.000	271.0	V	323.0	13.7
732.842400	19.31	36.00	16.69	1000.0	120.000	400.0	V	150.0	22.3
811.000800	19.88	36.00	16.12	1000.0	120.000	206.0	V	121.0	22.9
890.099100	20.99	36.00	15.01	1000.0	120.000	203.0	H	15.0	24.1

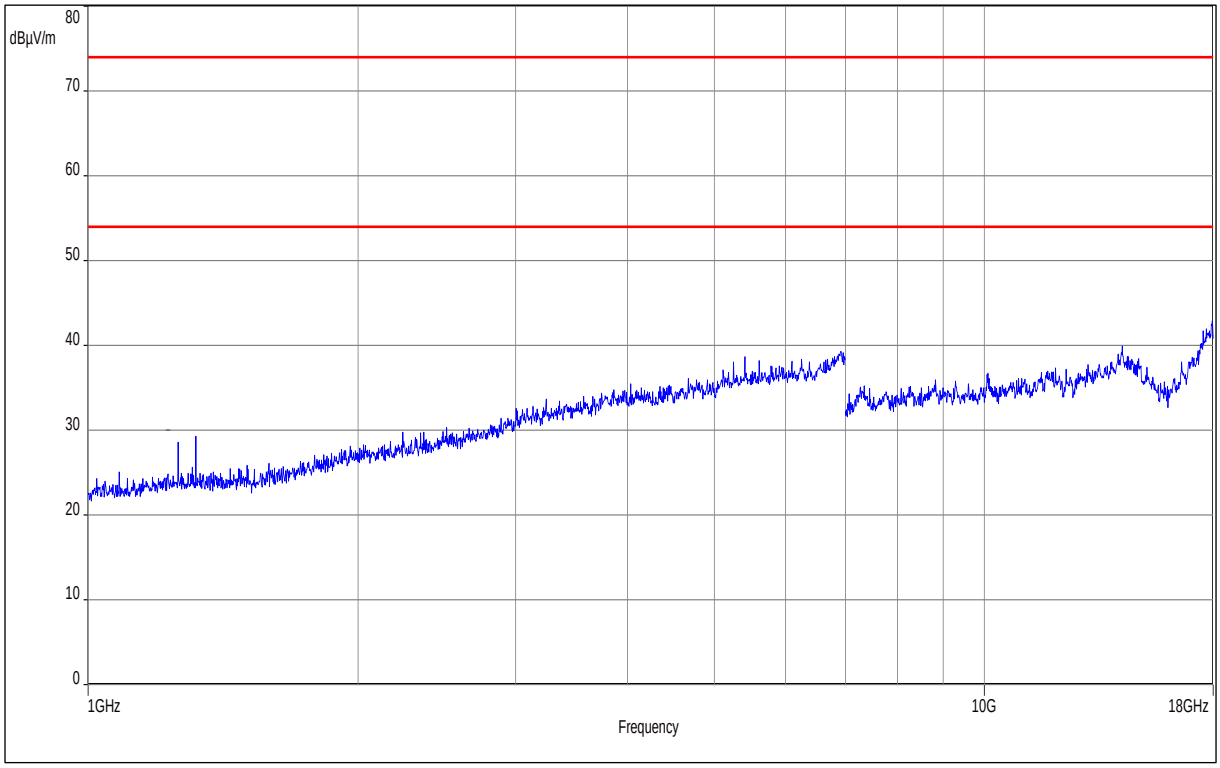
Plot 6: 30 MHz – 1000 MHz, special test mode, frequency sweep stopped at f_{high}

EUT:	OPTIWAVE 7400 C (HART)
Serial number:	F17XXXXXXXXXXX
Test description:	FCC part 15 class B @ 10 m
Operating condition:	TX high channel
Operator name:	Hennemann
Comment:	DC 24 V

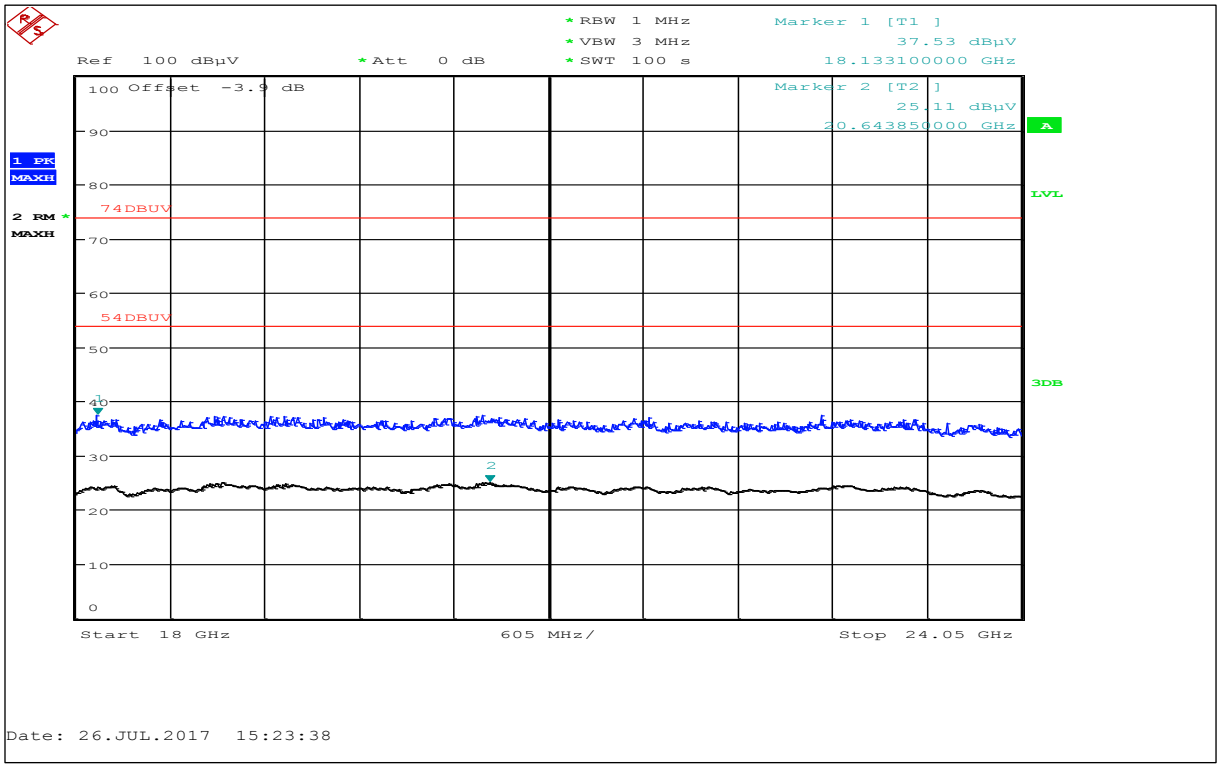


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.710950	14.05	30.00	15.95	1000.0	120.000	200.0	V	300.0	13.1
44.698500	9.86	30.00	20.14	1000.0	120.000	103.0	H	95.0	13.6
50.031300	10.25	30.00	19.75	1000.0	120.000	349.0	H	95.0	13.7
95.343600	6.74	33.50	26.76	1000.0	120.000	359.0	H	15.0	10.9
797.445900	19.61	36.00	16.39	1000.0	120.000	200.0	H	211.0	22.7
904.663950	21.07	36.00	14.93	1000.0	120.000	200.0	H	188.0	24.2

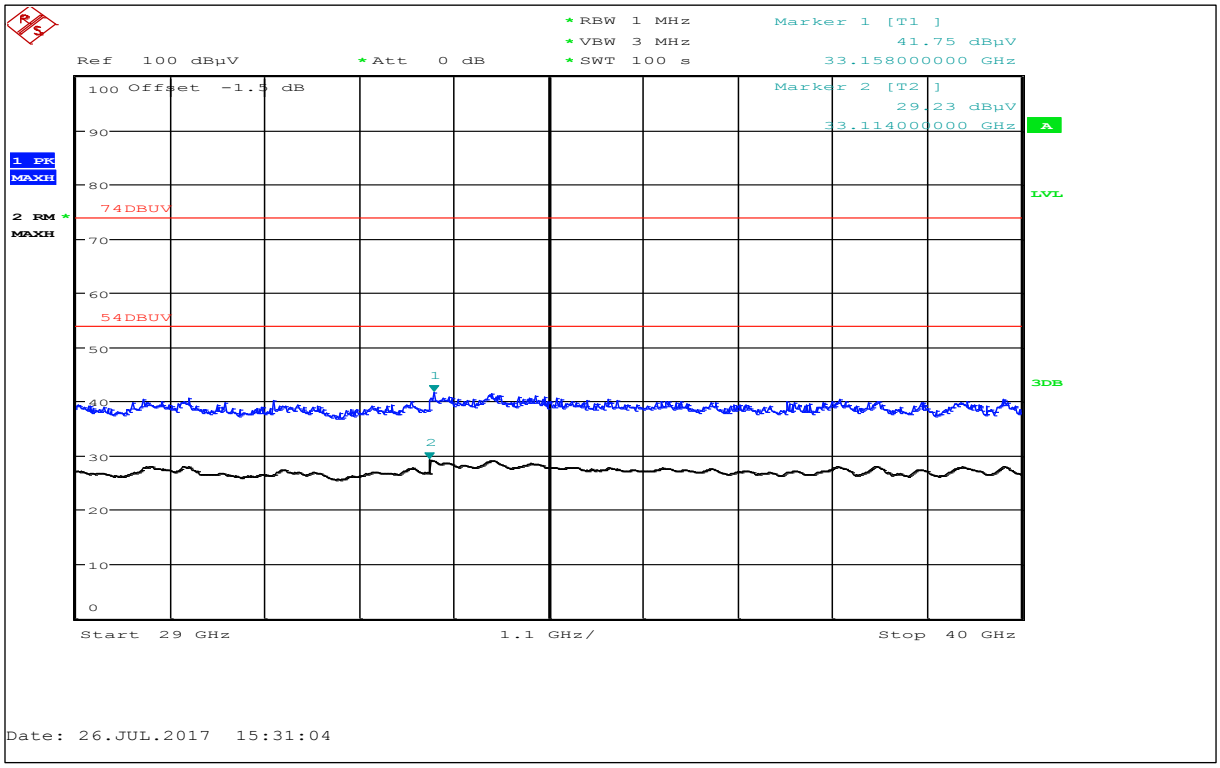
Plot 7: 1 GHz – 18 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



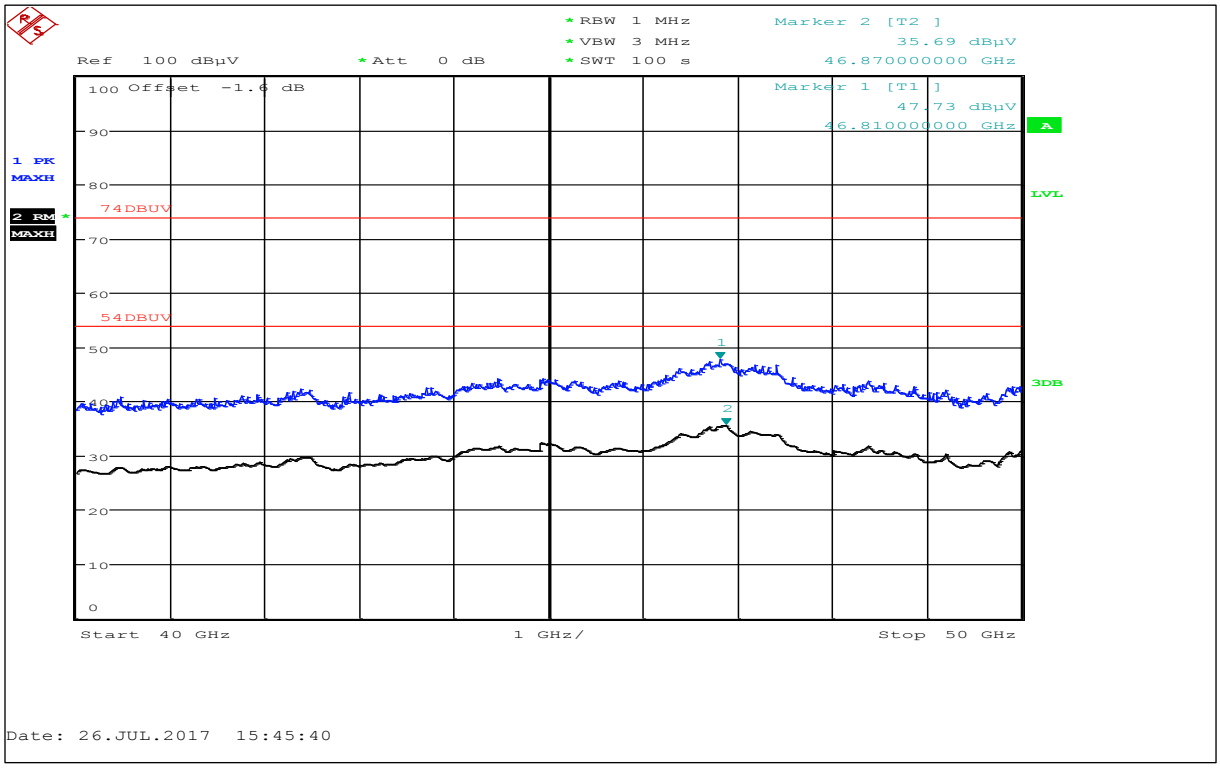
Plot 8: 18 GHz – 24.05 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



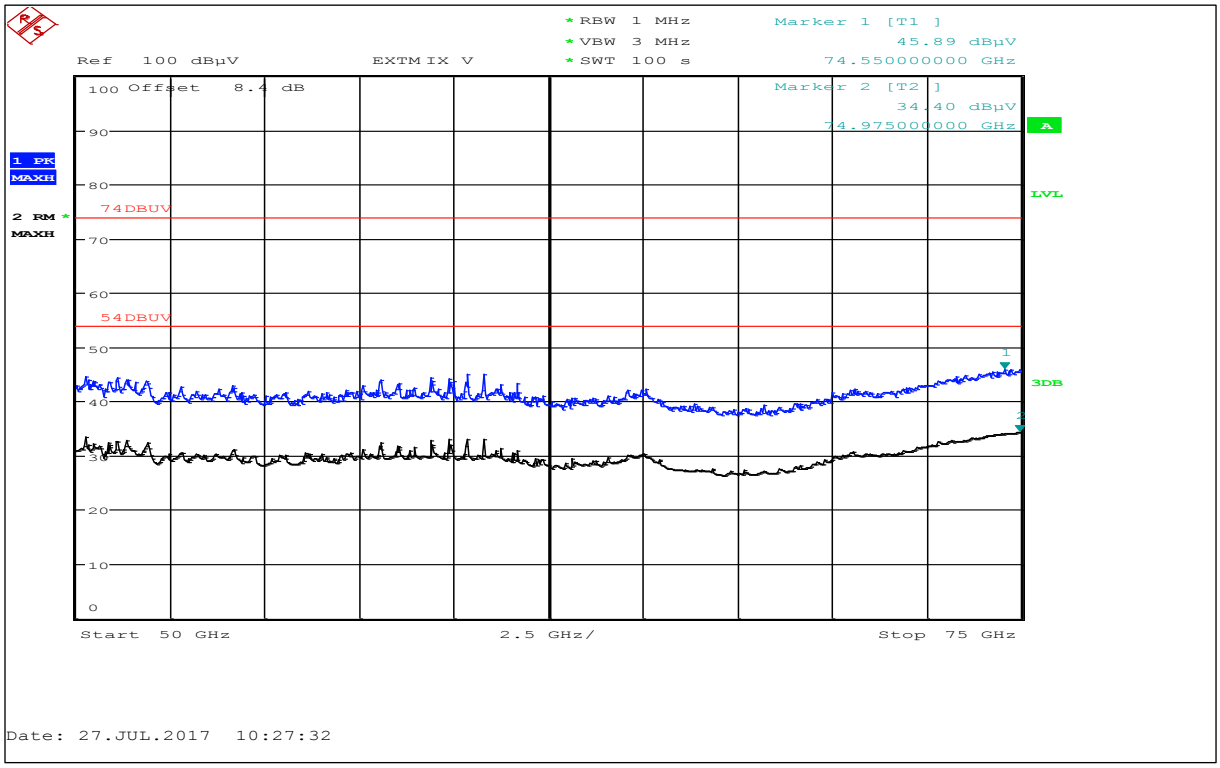
Plot 9: 29 GHz – 40 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



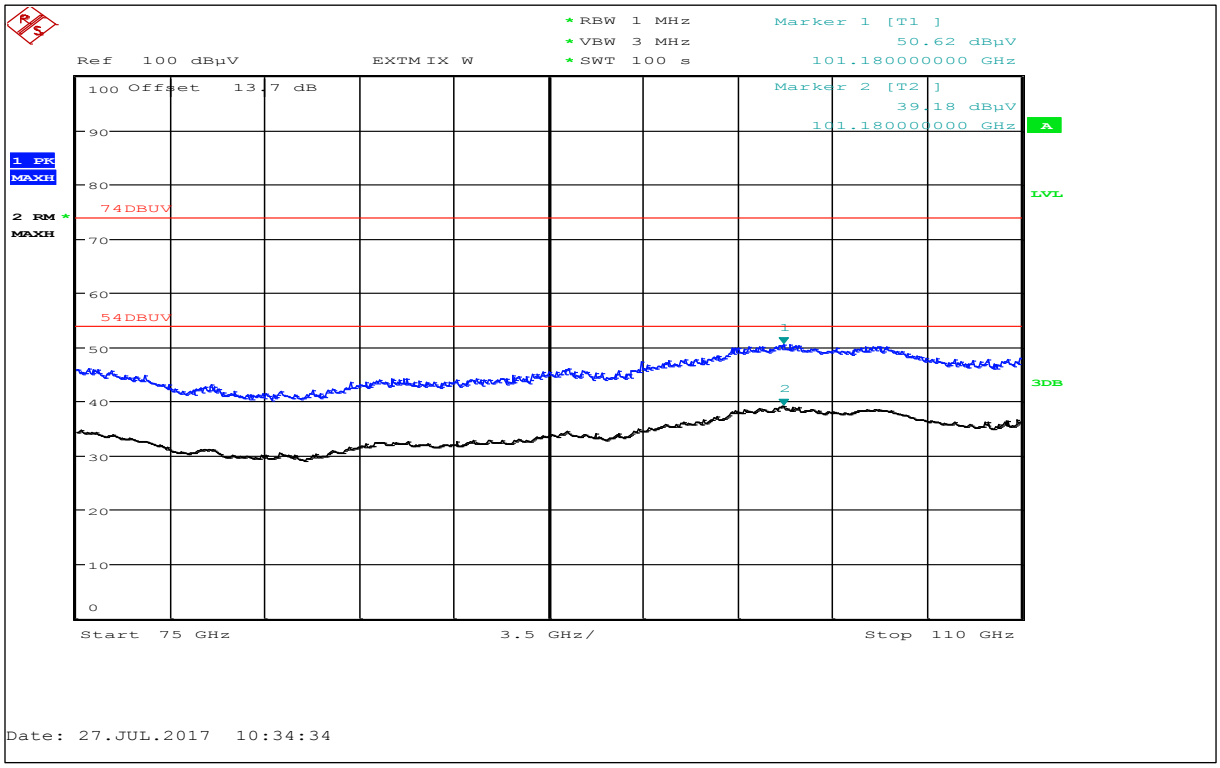
Plot 10: 40 GHz – 50 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



Plot 11: 50 GHz – 75 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



Plot 12: 75 GHz – 110 GHz, special test mode, $f_{low}/f_{mid}/f_{high}$



10.4 Receiver emission limits

Description:

RSS-Gen, 7.1 Receiver Emission Limits
Receivers, as defined in Section 5 of RSS-Gen, are required to comply with the limits of spurious emissions as set out in this section. Receiver emission measurements are to be performed as per the normative test method referenced in Section 3.
For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz
As an alternative to CISPR quasi-peak or average measurements, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization, as required, with a measurement bandwidth equal to, or greater than, the applicable CISPR quasi-peak bandwidth or 1 MHz bandwidth, respectively.

RSS-Gen, 7.1.2 Receiver Radiated Limits
Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 5x the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.
Spurious emissions from receivers shall not exceed the radiated limits shown in Table 2 below:

Measurement:

Measurement parameter	
Detector:	Quasi Peak / Average (RMS)
Sweep time:	Auto
Resolution bandwidth:	100 kHz / 1 MHz
Video bandwidth:	> resbw
Trace-Mode:	Max-Hold

Limits:

RSS-Gen, 7.1		
Field strength of the harmonics and spurious.		
Frequency (MHz)	**Field strength (µV/m)**	**Measurement distance (m)**
30 – 88	100 (40 dBµV/m)	3
88 – 216	150 (43.5 dBµV/m)	3
216 – 960	200 (46 dBµV/m)	3
>960	500 (54 dBµV/m)	3

Results:

See 10.3 Unwanted emissions limit.

10.5 AC Power line conducted emissions limits

Description:

RSS-Gen, 8.8
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 below.
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 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 of RSS-Gen.

Measurement:

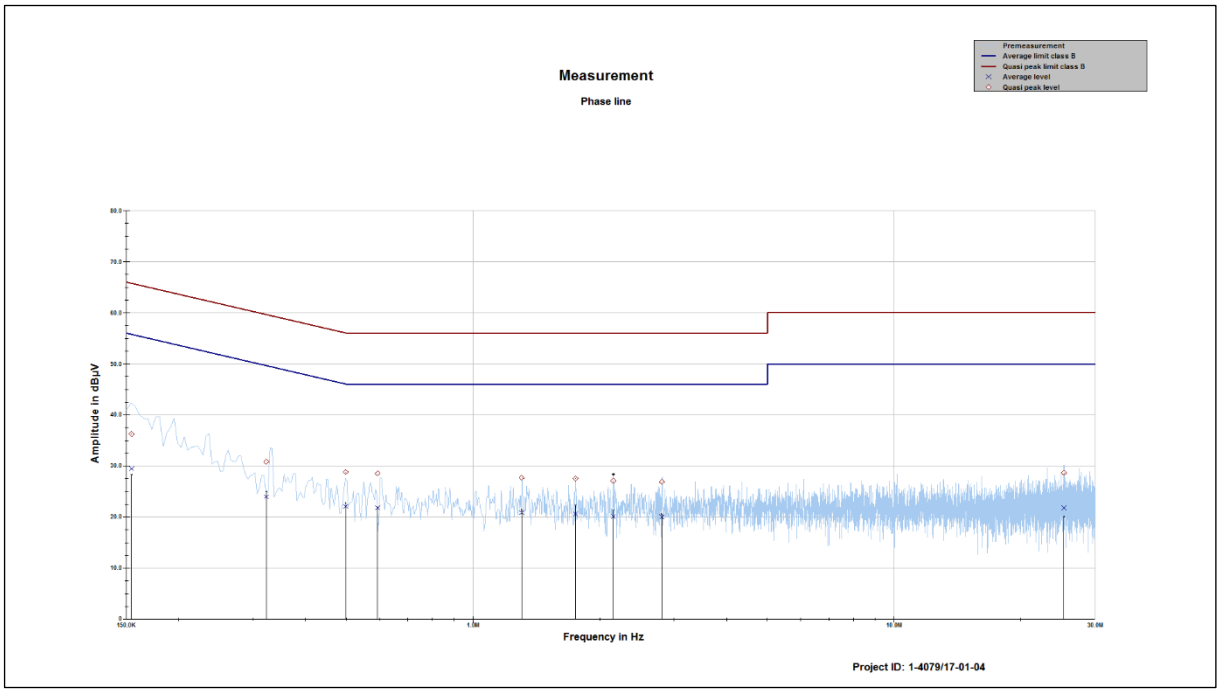
Measurement parameter	
Detector:	Peak - Quasi Peak / Average
Sweep time:	Auto
Resolution bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold

Limits:

RSS-Gen, 8.8		
Conducted 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
5 - 30	60	50

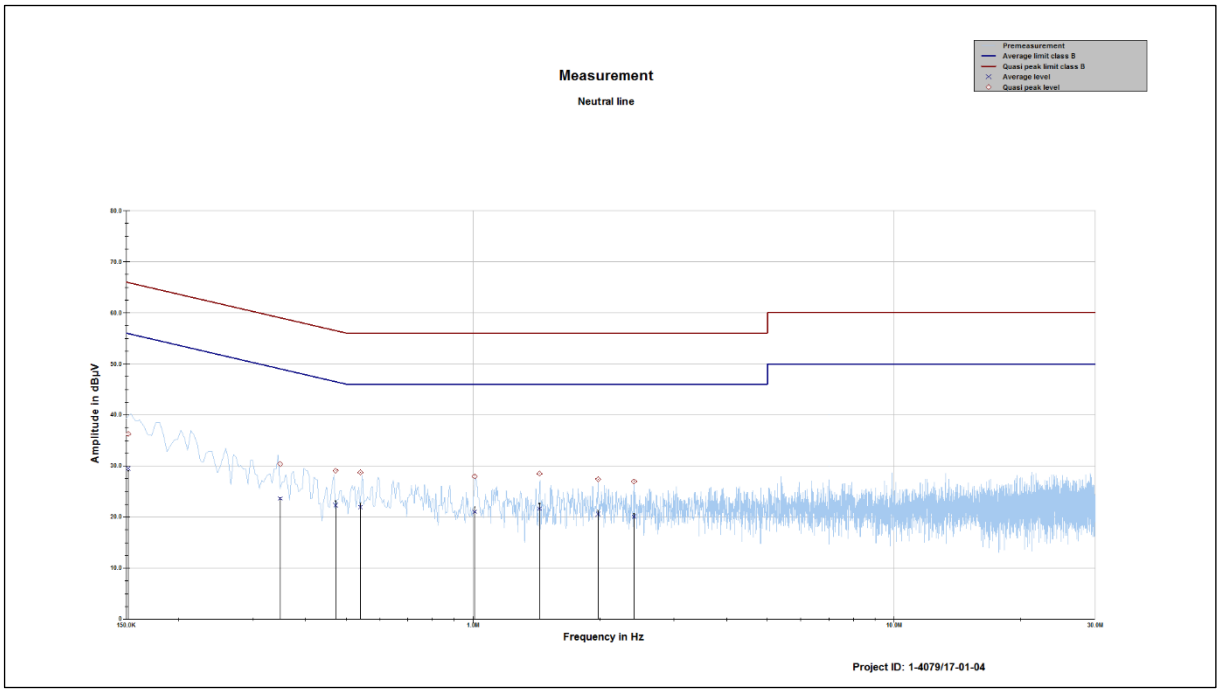
*Decreases with the logarithm of the frequency

Plot 13: Phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.154359	36.27	29.49	65.762	29.46	26.41	55.875
0.322495	30.82	28.82	59.642	23.98	27.09	51.072
0.497810	28.82	27.21	56.036	22.07	23.99	46.063
0.592864	28.57	27.43	56.000	21.81	24.19	46.000
1.303010	27.71	28.29	56.000	20.87	25.13	46.000
1.749159	27.54	28.46	56.000	20.64	25.36	46.000
2.150868	27.10	28.90	56.000	20.14	25.86	46.000
2.805003	26.88	29.12	56.000	20.00	26.00	46.000
25.304179	28.65	31.35	60.000	21.79	28.21	50.000

Plot 14: Neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.151583	36.26	29.66	65.913	29.48	26.47	55.955
0.347884	30.40	28.61	59.013	23.63	26.71	50.346
0.470843	29.08	27.42	56.499	22.29	24.54	46.833
0.539381	28.74	27.26	56.000	21.94	24.06	46.000
1.007782	27.97	28.03	56.000	21.04	24.96	46.000
1.436907	28.49	27.51	56.000	21.64	24.36	46.000
1.979927	27.42	28.58	56.000	20.62	25.38	46.000
2.408782	26.99	29.01	56.000	20.07	25.93	46.000

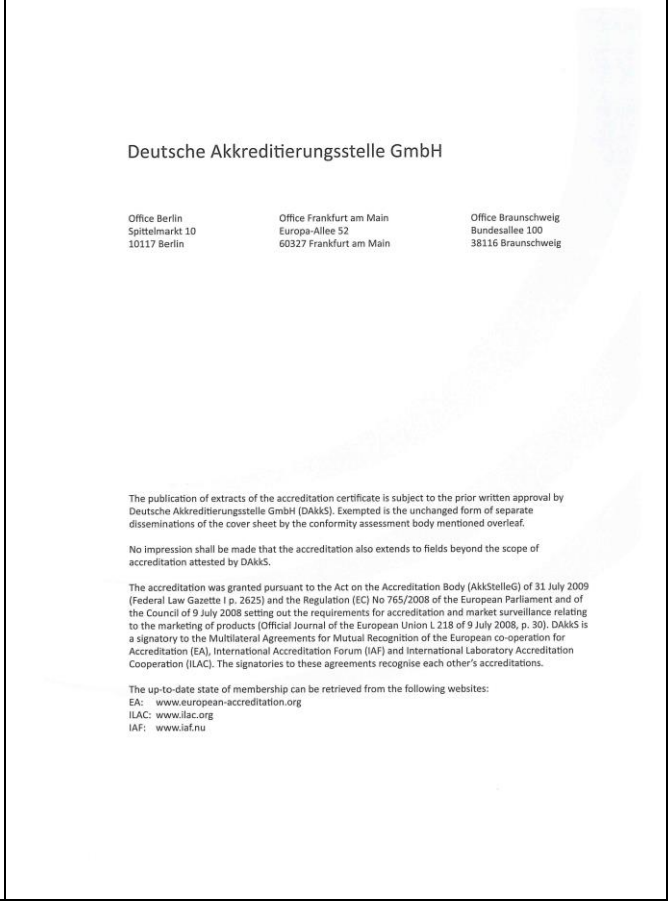
11 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

12 Document history

Version	Applied changes	Date of release
-/-	DRAFT	2018-02-08

13 Accreditation Certificate

first page	last page
	

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf