Test Report acc. to FCC Title 47 CFR Part 15
relating to
FEIG ELECTRONIC GmbH
cVEND PIN

Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure:
ANSI C63.4-2014
ANSI C63.10-2013

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12053-01-03

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

MANUFACTURER	
Manufacturer name	**FEIG ELECTRONIC GmbH**
Manufacturer's grantee code	**PJMCVPIN**
Manufacturer's address	Industriestrasse 1a 35781 Weilburg Germany
Phone	+49 6471 3109 428
Fax	+49 6471 3109 99
Email	Reinhard.Monno@feig.de

TESTING LABORATORY	
Test engineer	Mr. Dominik Gottardi
Testing laboratory name	**TÜV NORD Hochfrequenztechnik GmbH & Co. KG**
Testing laboratory address	LESKANPARK, Gebäude 10
	Waltherstr. 49-51, 51069 Köln, Germany
Phone	+49 221 8888950
Email	**dgottardi@tuev-nord.de**

RELEVANT STANDARD	
Title	**47 - Telecommunication**
Part	**15 - Radio Frequency Devices**
Subpart	**Subpart C – Intentional Radiators - Section 15.225**
Measurement procedure	**ANSI C63.4-2014 & ANSI C63.10-2013**

Equipment **U**nder **T**est **(EUT)**	
Equipment description	RFID
Trade name	FEIG ELECTRONIC GmbH
Type designation / model name	cVEND PIN
Serial no.	5927
Variants	---

1. Test results

Clause	Requirements headline	Test result		
8.1	Antenna Requirement	**Pass**	~~Fail~~	~~N.t.~~*
8.2	Conducted limits	**Pass**	~~Fail~~	~~N.t.~~*
8.3	Restricted bands of operation	**Pass**	~~Fail~~	~~N.t.~~*
8.4	Radiated emission limits	**Pass**	~~Fail~~	~~N.t.~~*
8.5	Frequency tolerance	**Pass**	~~Fail~~	~~N.t.~~*
8.6	20 dB Bandwidth	**Pass**	~~Fail~~	~~N.t.~~*

* Not tested

For the decision rules on conformity statements the requirements of the standard apply. If necessary the IEC Guideline 115 is taken into account.

The equipment passed all the conducted tests	**Yes**	~~**No**~~

Signature	p.p. TÜV NORD Digital unterschrieben von Shrestha Anup Datum: 2022.07.19 15:16:18 +02'00'	TÜV NORD Digital unterschrieben von Trepper Ralf Datum: 2022.07.19 15:41:46 +02'00'
Name	**Mr. Dominik Gottardi**	**Mr. Ralf Trepper**
Designation	**RF Test engineer**	**Laboratory-Manager**
Date of issue	**2022-06-17**	**2022-06-17**

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

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TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

1.1 Table of contents

Revision	Date of issue	Creator	Content of change
00	06.17.22	DG	Initial release
01	06.30.22	AS	Change of address, correction of measurement results @ 13.56 MHz and power supply
02	07.19.22	DR	Editing of ANSI C63.10-2013 at clause 8.4

Table 0-1: Table of contents

Note: If the document has been changed by revision number, all previous documents are no longer valid and must be destroyed.

2. Introduction

This test report **is not an expert opinion** and consists of:

- Test result summary
- Teble of contents
- Introduction and further information
- Performance assessment
- Detailed test information

All pages have been numbered consecutively and bear the TÜV NORD Hochfrequenztechnik GmbH & Co. KG logo, the test report number, the date, the test specification in its current version as well as the type designation of the EUT.

The tests were carried out at:

- TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANKPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany

in a representative assembly and in accordance with the test methods and/or requirements stated in:

FCC Title 47 CFR Part 15 Subpart C Section 15.225, ANSI C63.4-2014 & ANSI C63.10-2013

The sample of the product was received on:

- 2022-04-25

The tests were carried out in the following period of time:

- 2022-05-03 - 2022-05-30

3. Testing laboratory

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10
Waltherstr. 49-51
51069 Köln
Germany

Phone: +49 221 8888 950

- FCC Registration Number: 763407

Accredited by:

DAkkS Deutsche Akkreditierungsstelle GmbH
DAkkS accreditation number: D-PL-12053-01

4. Applicant

Company name	: Feig Electronic GmbH
Address	: Industriestrasse 1a 35781 Weilburg
Country	: Germany
Telephone	: +49 6471 3109 428
Fax	: +49 6471 3109 99
Email	: Reinhard.Monno@feig.de
Date of order	: **2022-02-23**
Contact Person	: Reinhard Monno

5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer	: Feig Electronic GmbH
Trademark	: Feig Electronic GmbH
Type designation	: **cVEND PIN**
Variants	: ---
Antennas	: RFID loop antenna at display
Serial number	: 5927
Hardware version	: cVEND PIN
Software version	: 02.03.01
Type of equipment	: Payment Terminal
Power supply used	: 24 V nominal; 12 – 42 V extreme
Frequency used	: 13.56 MHz
Generated frequencies	: 25 MHz Oscillator for Ethernet Transceiver 8 MHz Oscillator for MDB Bus Controller 24 MHz Oscillator for µController, 32.768 kHz Real Time Clock 27.12 MHz Oscillator reader for ASIC reader
ITU emission class	: 564HA1D
FCC-ID	: PJMCVPIN

For issuing this report the following product documentation was used:

Title	Description	Version
cVEND_PIN - Dokumente_FCC_IC_v2	cVEND PIN documentation	V2

For issuing this report the following product documentation was used:

Description	Date	Identifications
External Photographs of the **E**quipment **U**nder **T**est (EUT)	2022-06-17	Annex no. 1
Internal Photographs of the **E**quipment **U**nder **T**est (EUT)	2022-06-17	Annex no. 2
Channel Occupancy / Bandwidth	2022-06-17	Annex no. 3
Label Sample	2022-06-17	Annex no. 4
Functional Description / User Manual	2022-06-17	Annex no. 5
Test Setup Photos	2022-06-17	Annex no. 6
Block Diagram	2022-06-17	Annex no. 7
Operational Description	2022-06-17	Annex no. 8
Schematics	2022-06-17	Annex no. 9
Parts List	2022-06-17	Annex no. 10

6. Conclusions, observations and comments

The test report will be filed at TÜV NORD Hochfrequenztechnik GmbH & Co. KG for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of TÜV NORD Hochfrequenztechnik GmbH & Co. KG.

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. TÜV NORD Hochfrequenztechnik GmbH & Co. KG cannot be held liable for properties of the EUT that have not been observed during these tests.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15 for the respective test sector, if the test results turn out positive.

Comments: ---

7. Operational description

7.1 EUT details

The EUT is a modified electronic payment terminal. It is prepared in a way that testing the conformance of the 13.56 MHz RFID part of the device is possible.

7.2 EUT configuration

After connecting to the power supply 24 V DC the EUT starts to run. The user is then guided through a GUI to setup the different testing modes.

7.3 EUT measurement description

Radiated measurements

The EUT was tested in a typical fashion. During preliminary emission tests the EUT was operated in the continuous measuring mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous measuring mode. All tests were performed with the EUT's typical voltage: 24 V DC/AC

In order to establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test samples, secondly the test ample have been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical had been varied.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane as mentioned in ANSI C63.4-2014.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas as specified in ANSI C63.4-2014, which may have a smaller beamwidth (main lobe) than do the antennas used for frequencies below 1 GHz. The measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal.

AC Powerline Conducted measurements

The EUT was directly connected to the artificial mains network. It has been tested with the activated EUT in continuous measuring mode.

The EUT is connected via the LAN, USB and Serial Port to a laptop with the laptop directly connected to the artificial mains network. It has been tested in four runs: first with Laptop (inactive EUT), second with activated EUT via LAN port of the laptop, third with activated EUT via USB port of the laptop and finally with activated EUT via serial port of the laptop.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

8. Compliance assessment

8.1 Antenna requirement

8.1.1 Regulation

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 this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, 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 §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 §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.

8.1.2 Result

The loop antenna is mounted under the display housing cover of the device. The connector for connecting the antenna to the mainboard is mounted on the back of the display shield. This can be seen on the photos in the annex.

Antenna Type	Antenna description	Frequency	Gain	Number of Antennas
Loop Antenne	See above	**13.56 MHz**	**---**	1

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.*~~

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 2

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TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

8.2 Conducted limits

8.2.1 Regulation

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

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

*Decreases with the logarithm of the frequency

(b) The shown limit 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 systems 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 Section 15.205 and Section 15.209, 15.221, 15.223, 15.225 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 provision for, the use of battery chargers which permit operating while charging, AC adaptors 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.

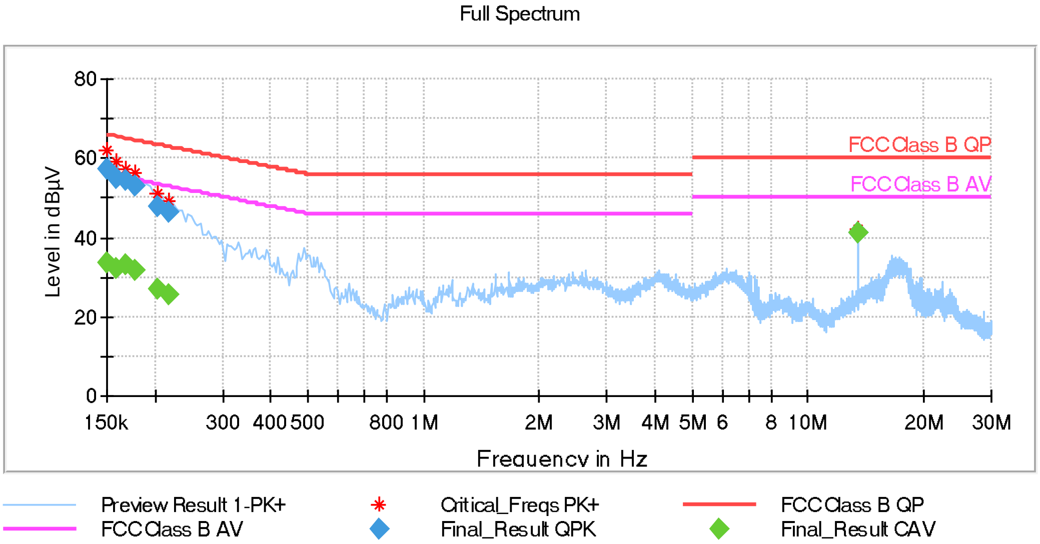
8.2.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.4-2014 Section 7.
Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

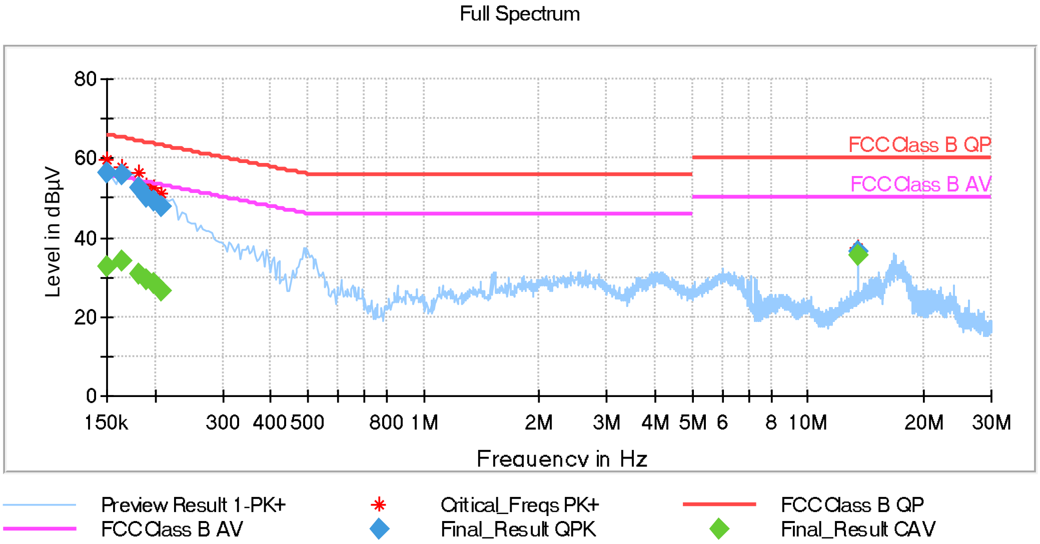
8.2.3 Result

8.2.3.1 120 V, 60 Hz, LAN Port via laptop



Conducted emissions (Section 15.207)								
Frequency (MHz)	**QuasiPeak (dBµV)**	**CAverage (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Bandwidth (kHz)**	**Line**	**PE**	**Corr. (dB)**
0.150000	57.37	---	66.00	8.63	9.000	N	GND	20.1
0.150000	---	33.78	56.00	22.22	9.000	N	GND	20.1
0.159000	54.97	---	6.52	10.55	9.000	N	GND	20.1
0.159000	---	32.25	55.52	23.26	9.000	N	GND	20.1
0.168000	---	33.32	55.06	21.74	9.000	L1	GND	20.1
0.168000	54.23	---	65.06	10.83	9.000	L1	GND	20.1
0.177000	53.01	---	64.63	11.61	9.000	N	GND	20.1
0.177000	---	31.76	54.63	22.86	9.000	N	GND	20.1
0.204000	48.03	---	63.45	15.42	9.000	L1	GND	20.1
0.204000	---	26.92	53.45	26.52	9.000	L1	GND	20.1
0.217500	46.62	---	62.91	16.29	9.000	N	GND	20.1
0.217500	---	25.67	52.91	27.25	9.000	N	GND	20.1
13.560000	41.39	---	60.00	18.61	9.000	L1	GND	20.8
13.560000	---	40.96	50.00	9.04	9.000	L1	GND	20.8
Measurement uncertainty < ± 2 dB								

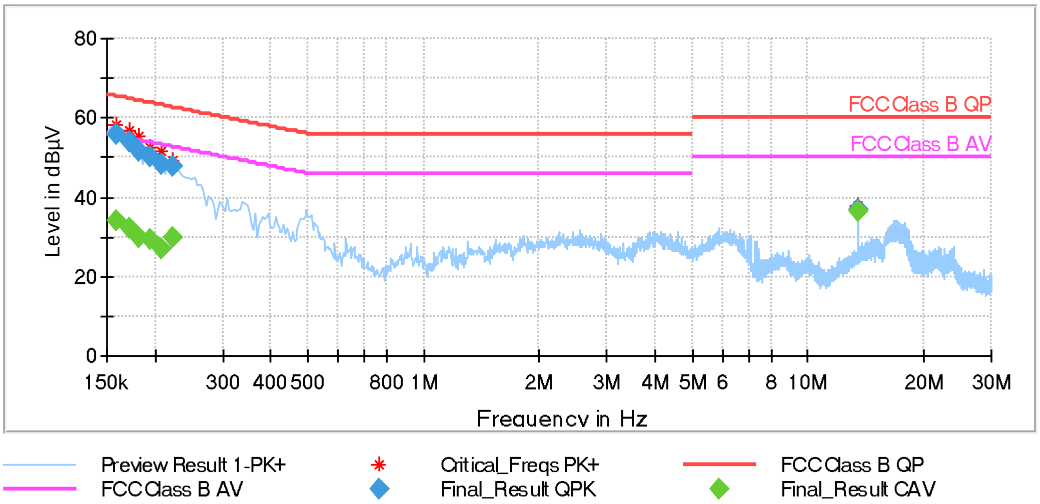
8.2.3.2 120V, 60 Hz, Seriell Port 1 via Laptop



Conducted emissions (Section 15.207)								
Frequency (MHz)	**QuasiPeak (dBµV)**	**CAverage (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Bandwidth (kHz)**	**Line**	**PE**	**Corr. (dB)**
0.150000	56.36	---	66.00	9.64	9.000	N	GND	20.1
0.150000	---	32.82	56.00	23.18	9.000	N	GND	20.1
0.163500	55.64	---	65.28	9.64	9.000	L1	GND	20.1
0.163500	---	34.09	55.28	21.19	9.000	L1	GND	20.1
0.181500	---	30.90	54.42	23.52	9.000	L1	GND	20.1
0.181500	52.55	---	64.42	11.86	9.000	L1	GND	20.1
0.190500	50.25	---	64.02	13.77	9.000	L1	GND	20.1
0.190500	---	29.34	54.02	24.67	9.000	L1	GND	20.1
0.199500	---	28.43	53.63	25.20	9.000	L1	GND	20.1
0.199500	49.28	---	63.63	14.35	9.000	L1	GND	20.1
0.208500	47.88	---	63.27	15.38	9.000	N	GND	20.1
0.208500	---	26.57	53.27	26.70	9.000	N	GND	20.1
13.560000	---	35.64	50.00	14.36	9.000	L1	GND	20.8
13.560000	36.49	---	60.00	23.51	9.000	L1	GND	20.8
Measurement uncertainty < ± 2 dB								

8.2.3.3 120V, 60 Hz, Seriell Port 2 via Laptop

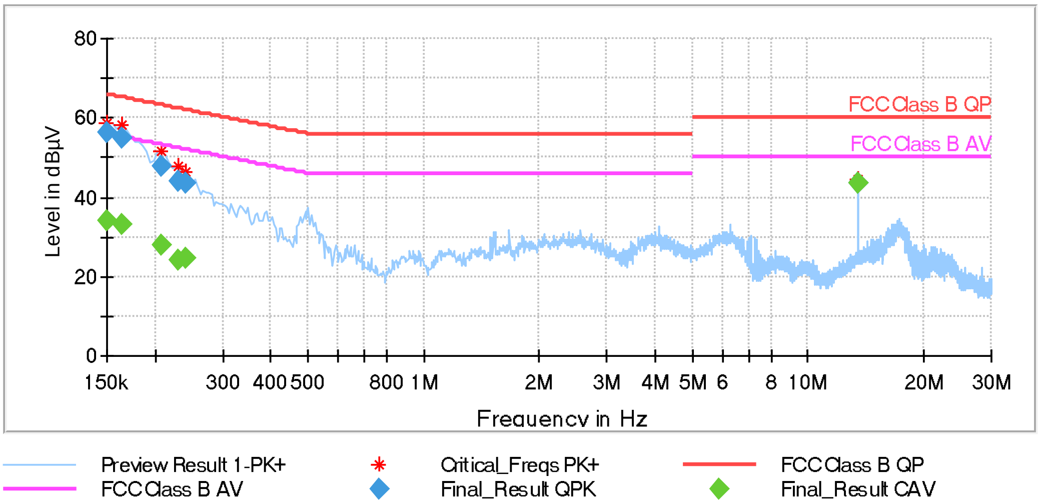
Full Spectrum



Conducted emissions (Section 15.207)								
Frequency (MHz)	**QuasiPeak (dBµV)**	**CAverage (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Bandwidth (kHz)**	**Line**	**PE**	**Corr. (dB)**
0.159000	---	33.88	55.52	21.64	9.000	L1	GND	20.1
0.159000	55.80	---	65.52	9.71	9.000	L1	GND	20.1
0.172500	---	32.26	54.84	22.58	9.000	N	GND	20.1
0.172500	54.17	---	64.84	10.67	9.000	N	GND	20.1
0.181500	---	29.78	54.42	24.64	9.000	L1	GND	20.1
0.181500	51.64	---	64.42	12.77	9.000	L1	GND	20.1
0.195000	50.15	---	63.82	13.67	9.000	L1	GND	20.1
0.195000	---	29.54	53.82	24.28	9.000	L1	GND	20.1
0.208500	48.48	---	63.27	14.79	9.000	L1	GND	20.1
0.208500	---	27.09	53.27	26.17	9.000	L1	GND	20.1
0.222000	48.02	---	62.74	14.73	9.000	L1	GND	20.1
0.222000	---	29.93	52.74	22.81	9.000	L1	GND	20.1
13.560000	37.12	---	60.00	22.88	9.000	L1	GND	20.8
13.560000	---	36.29	50.00	13.71	9.000	L1	GND	20.8
Measurement uncertainty < ± 2 dB								

8.2.3.4 120V, 60 Hz, USB Port via Laptop

Full Spectrum



Conducted emissions (Section 15.207)								
Frequency (MHz)	**QuasiPeak (dBµV)**	**CAverage (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Bandwidth (kHz)**	**Line**	**PE**	**Corr. (dB)**
0.150000	---	34.28	56.00	21.72	9.000	N	GND	20.1
0.150000	56.38	---	66.00	9.62	9.000	N	GND	20.1
0.163500	---	32.93	55.28	22.35	9.000	N	GND	20.1
0.163500	55.03	---	65.28	10.26	9.000	N	GND	20.1
0.208500	---	28.15	53.27	25.11	9.000	L1	GND	20.1
0.208500	48.04	---	63.27	15.23	9.000	L1	GND	20.1
0.231000	44.13	---	62.41	18.29	9.000	L1	GND	20.1
0.231000	---	23.97	52.41	28.45	9.000	L1	GND	20.1
0.240000	43.33	---	62.10	18.77	9.000	L1	GND	20.1
0.240000	---	24.75	52.10	27.34	9.000	L1	GND	20.1
13.560000	---	43.45	50.00	6.55	9.000	N	GND	20.9
13.560000	43.74	---	60.00	16.26	9.000	N	GND	20.9
Measurement uncertainty < ± 2 dB								

Test Cables used	KISN 2
Test equipment used	272, 665, 60, 551, 644

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.*~~

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

8.3 Restricted bands of operation

8.2.1 Regulation

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

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this Section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a), the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a), and the fundamental emission is outside of the bands listed in paragraph (a) more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to Section 15.213.

(4) Any equipment operated under the provisions of § 15.253, § 15.255 or § 15.256 of this part.

(5) Biomedical telemetry devices operating under the provisions of Section 15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of Subpart D or F of this part.

(7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

(8) Devices operated in the 24.075-24.175 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in § 15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under § 15.249 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in § 15.249(a).

(10) White space devices operating under subpart H of this part are exempt from complying with the requirements of this section for the 608-614 MHz band.

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 15.245 shall not exceed the limits specified in Section 15.245(b).

8.2.2 Result

Since the restricted bands are a subpart of 8.4, see 8.4 for detailed results.

Test Cables used	K166, K102, K60
Test equipment used	406, 23, 660, 665, 667, 668, 669

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

8.4 Radiated emission limits

8.4.1 Regulation

The device operating in the frequency band 13.110-14.010, the field strength of any emission shall not exceed the following limits.

Frequency	Field Strength	Measurements Distance
MHz	dBµV/m	m
13.553 - 13.567	84	30
13.410 - 13.553 and 13.567 - 13.710	50.5	30
13.110 - 13.410 and 13.710 - 14.010	40.5	30

(a) Outside the band 13.110-14.010, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

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

(c) In the emission table above, the tighter limit applies at the band edges.

(d) 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 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.

(f) 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.

(g) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

(h) Perimeter protection systems may operate in the 54–72 MHz and 76–88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

8.4.2 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a turn table which is 0.8 m above the ground. The turn table would be allowed to rotate 360° to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna are 3m. To find the maximum emission, the polarization of the receiving antenna is changed in horizontal and vertical polarization; the position of the EUT was changed in different orthogonal determinations.

ANSI C63.10-2013 Section 6 and ANSI C63.4-2014 Section 8 “Radiated Emissions Testing”

Measurement procedures for electric field radiated emissions from 9 kHz - 1 GHz & 1 GHz - 40 GHz are covered in ANSI C63.10-2013 and Clause 8 of ANSI C63.4-2014. The ANSI C63.4-2014 and ANSI C63.10-2013 measurement procedure consists of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. Sub clause 8.3.2 of ANSI C63.4-2014 states that the measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

While the “bore-sighting” technique is not explicitly mentioned in ANSI C63.4-2014, it is a useful technique for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTs, measuring system sensitivity, etc.

ANSI C63.4-2014 and ANSI C63.10-2013 requires that the measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 1,000 MHz
Test distance	10 m, 3 m*
Test instrumentation resolution bandwidth	9 kHz (20 kHz – 30 MHz)
	120 kHz (30 MHz – 1.000 MHz)
Receive antenna height	1 m (20 kHz – 30 MHz)
Receive antenna polarization	0° or 90° (20 kHz – 30 MHz)
Receive antenna scan height	1 m - 4 m (30 MHz – 1.000 MHz)
Receive antenna polarization	Vertical or Horizontal (30 MHz – 1.000 MHz)

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* 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 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

8.4.3 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors
Correction Factor : Antenna factor + cable loss

For example:
The receiver reading is 32.7 dBµV. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dBµV/m.
The 35.91dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm (35.91/20) = 62.44

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

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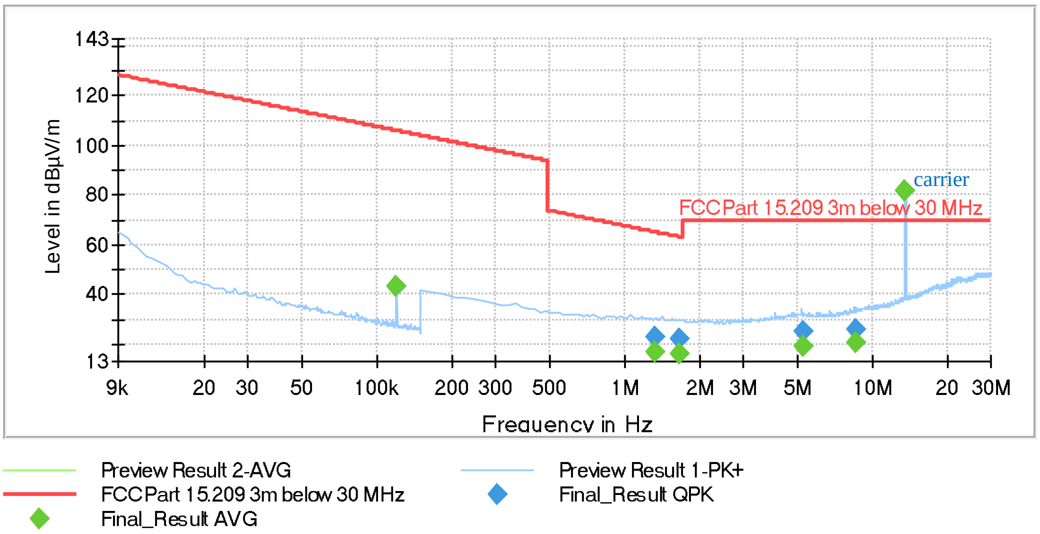
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

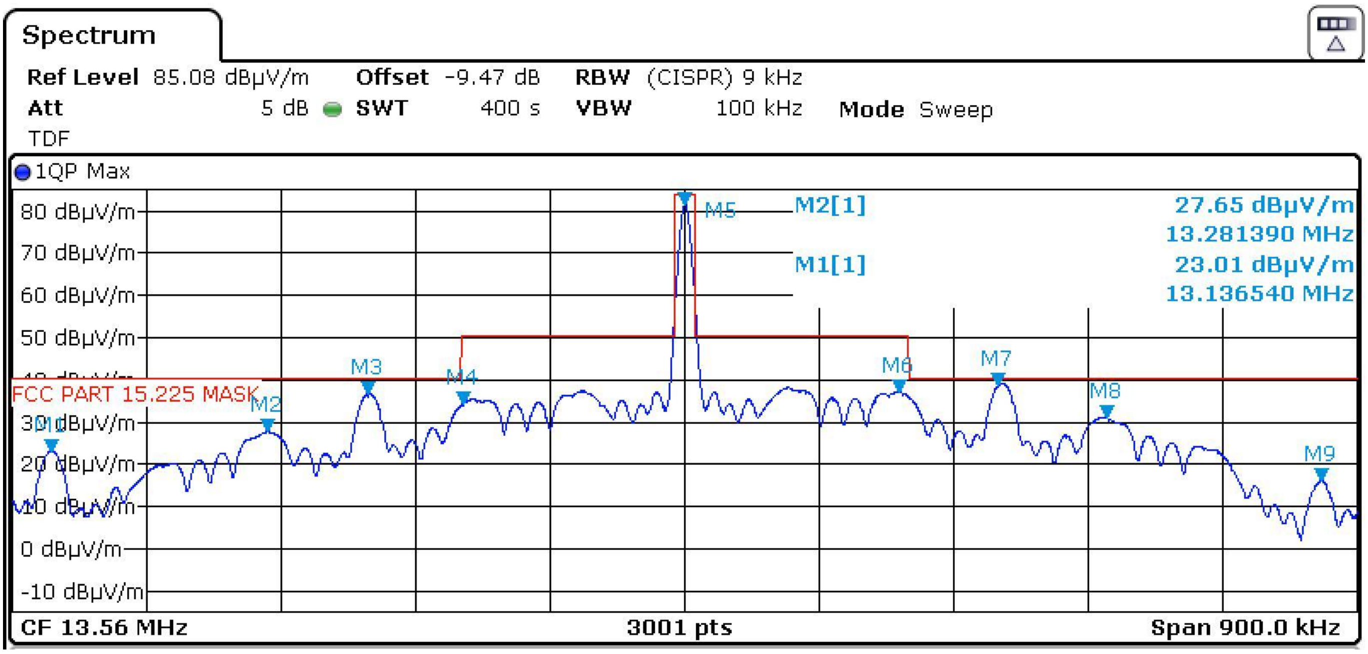
8.4.4 Result

8.4.4.1 Radiated emission limits below 30 MHz



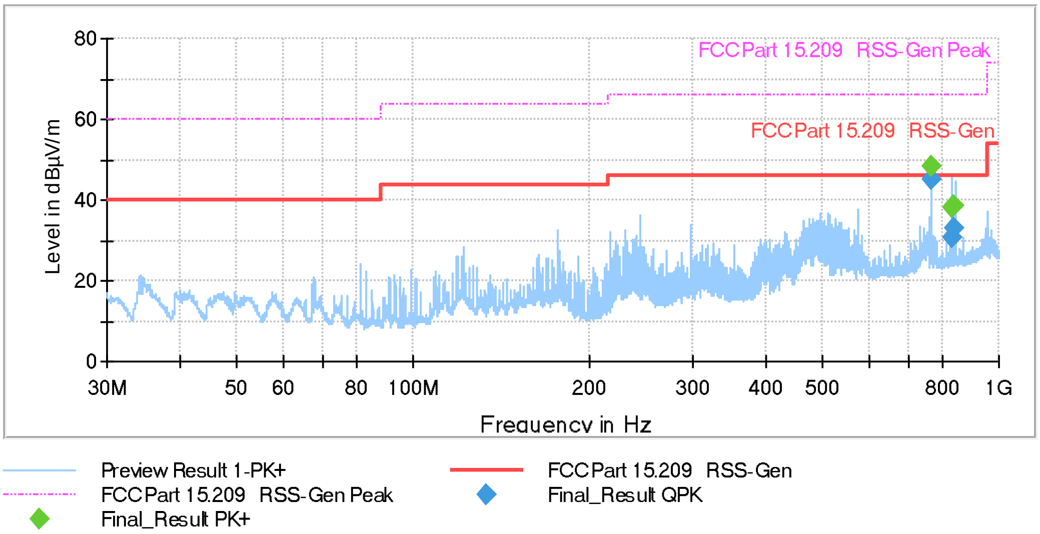
RADIATION EMISSIONS BELOW 30 MHz (Section 15.225, 15.205 and 15.209)								
Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
0.119590	42.93	---	106.04	63.12	0.200	H	121.0	17.9
0.119590	---	43.04	---	---	0.200	H	121.0	17.9
1.331250	---	17.02	---	---	9.000	H	253.0	18.1
1.331250	22.95	---	65.06	42.11	9.000	H	253.0	18.1
1.669250	---	16.22	---	---	9.000	H	58.0	18.2
1.669250	22.15	---	63.09	40.93	9.000	H	58.0	18.2
5.210250	---	18.77	---	---	9.000	H	180.0	21.3
5.210250	24.76	---	69.50	44.74	9.000	H	180.0	21.3
8.544250	26.15	---	69.50	43.35	9.000	H	137.0	23.0
8.544250	---	20.37	---	---	9.000	H	137.0	23.0
13.561250	---	81.47	124.0	42.53	9.000	V	182.0	27.7
13.561250	81.48	---	124.0	42.52	9.000	V	182.0	27.7
Measurement uncertainty ± 4 dB								

8.4.4.2 Radiated emission limits below 30 MHz



RADIATION EMISSIONS BELOW 30 MHz (Section 15.225)								
Marker	**Frequency (MHz)**	**QuasiPeak (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Bandwidth (kHz)**	**Pol**	**Azimuth (deg)**	**Corr. (dB/m)**
M1	13.13654	23.01	40.5	17.49	9.000	V	182.0	27.7
M2	13.28139	27.65	40.5	12.85	9.000	V	182.0	27.7
M3	13.34857	36.67	40.5	3.83	9.000	V	182.0	27.7
M4	13.41215	34.14	50.5	16.36	9.000	V	182.0	27.7
M5	13.56000	81.47	84.00	2.53	9.000	V	182.0	27.7
M6	13.70395	37.04	50.5	13.46	9.000	V	182.0	27.7
M7	13.76993	38.66	40.5	1.84	9.000	V	182.0	27.7
M8	13.84251	30.99	40.5	9.51	9.000	V	182.0	27.7
M9	13.98556	16.12	40.5	24.38	9.000	V	182.0	27.7
Measurement uncertainty ± 4 dB								

8.4.4.3 Radiated emission limits above 30 MHz



RADIATION EMISSIONS ABOVE 30 MHz (Section 15.225, 15.205 and 15.209)									
Frequency (MHz)	**QuasiPeak (dBµV/m)**	**MaxPeak (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Bandwidth (kHz)**	**Height (cm)**	**Pol**	**Azimuth (deg)**	**Corr. (dB/m)**
767.97000	---	48.20	66.00	17.80	120.000	100.0	H	178.0	25.1
767.97000	45.09	---	46.00	0.91	120.000	100.0	H	178.0	25.1
832.86000	---	38.02	66.00	27.98	120.000	400.0	V	209.0	25.9
832.86000	30.50	---	46.00	15.50	120.000	400.0	V	209.0	25.9
840.72000	---	38.80	66.00	27.20	120.000	104.0	V	175.0	26.0
840.72000	32.96	---	46.00	13.04	120.000	104.0	V	175.0	26.0
Measurement uncertainty ± 4 dB									

Test Cables used	K166, K102, K60
Test equipment used	406, 23, 660, 665, 667, 668, 669

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.6:

8.5 Frequency tolerance

8.5.1 Regulation

The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 °C to +55 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C.

8.5.2 Test procedures

Stability with respect to ambient temperature:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. Turn the EUT on, and couple its output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

Tune the EUT to any one of the number of frequencies specified. Turn the EUT off, and place it inside an environmental chamber if appropriate. Allow the chamber to stabilize at +20 °C before proceeding. Turn on the EUT, and record the operating frequency of the intentional radiator at startup and two, five, and ten minutes after startup. Turn the EUT off and allow it to cool to the ambient temperature, and then repeat this procedure for the number of the frequencies specified. Four measurements are made at each operating frequency.

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

Stability with respect to input voltage:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required.

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Turn the EUT off, and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.

Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.

While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized. Four measurements in total are made.

Repeat the above procedure until the number of frequencies specified has been measured. After all measurements have been made at the highest specified temperature, turn the EUT off. Repeat the above measurement process for the EUT with the test chamber set at the lowest temperature specified by the regulatory or procuring agency. Measurements shall be made at the number of frequencies specified.

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

8.5.3 Result

8.5.3.1 Result Tables

Frequency tolerance (Section 15.225)			
Test conditions T_{nom} = +20° C	Frequency Measured (MHz)	Frequency Error	
		(kHz)	ppm
V_{min} = 12 V DC	13.55975	0.24874	18.34
V_{nom} = 24 V DC	13.55975	0.24874	18.34
V_{max} = 42 V DC	13.55975	0.24874	18.34
Maximum Frequency error		0.24874	18.34
	Measurement uncertainty	$\pm 5*10^{-8}$	

Frequency tolerance (Section 15.225)			
Test conditions V_{nom} = 24 V DC	Frequency Measured (MHz)	Frequency Error	
		(kHz)	ppm
T_{min} -20 °C	13.55978	0.22187	16.36
T_{min} -10 °C	13.55978	0.22781	16.75
T_{min} 0 °C	13.55975	0.24874	18.34
T_{min} +10 °C	13.55975	0.24874	18.34
T_{min} +20 °C	13.55975	0.24874	18.34
T_{min} +30 °C	13.55975	0.24874	18.34
T_{min} +40 °C	13.55975	0.24874	18.34
T_{min} +50 °C	13.55975	0.24874	18.34
Maximum frequency error		0.24874	18.34
	Measurement uncertainty	$\pm 5*10^{-8}$	

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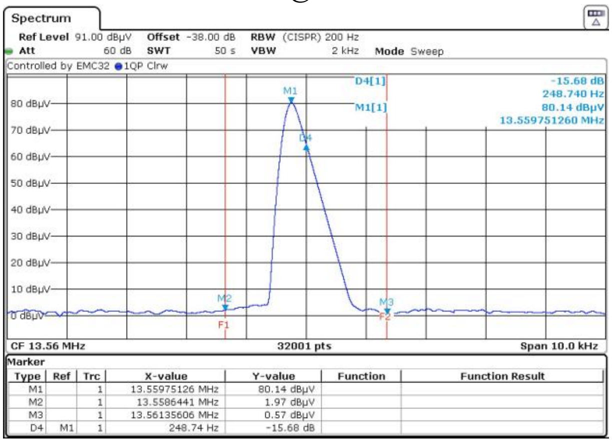
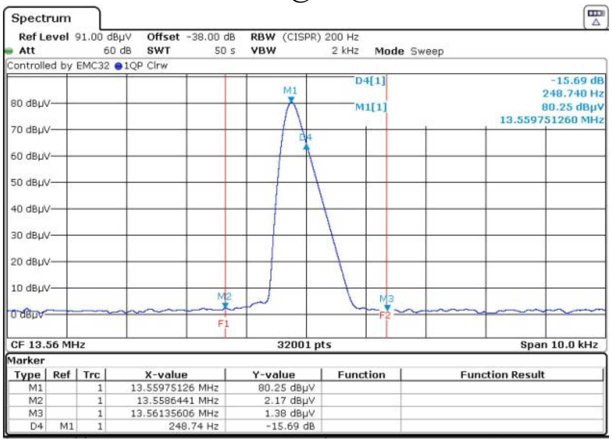
Tel.: +49 221 8888950

8.5.3.2 Screenshots of measurement results

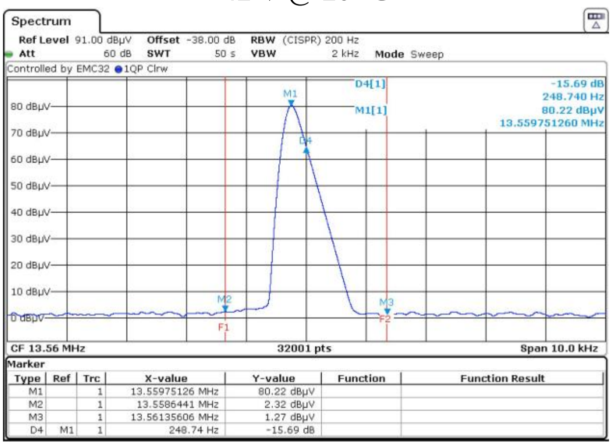
12 V @ 20 °C



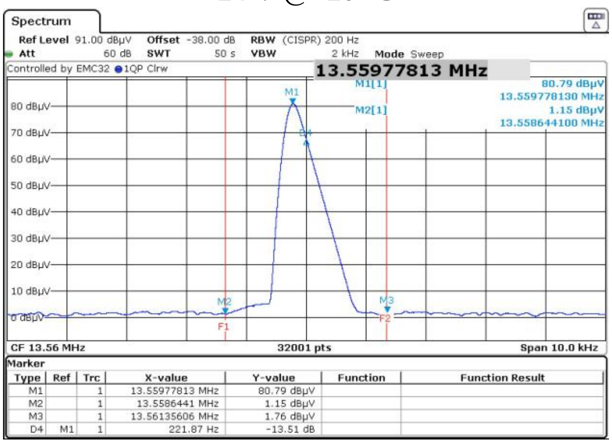
24 V @ 20 °C



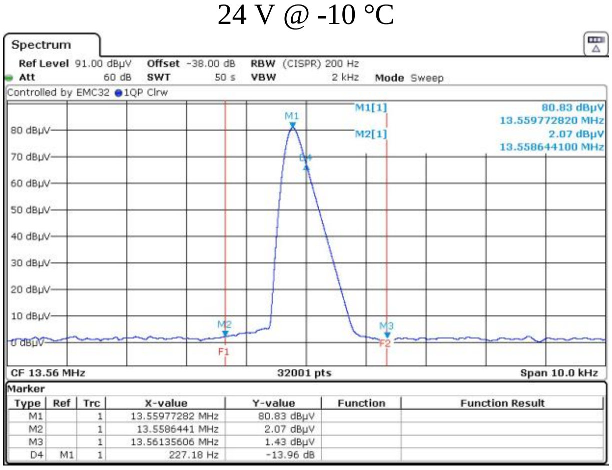
42 V @ 20 °C



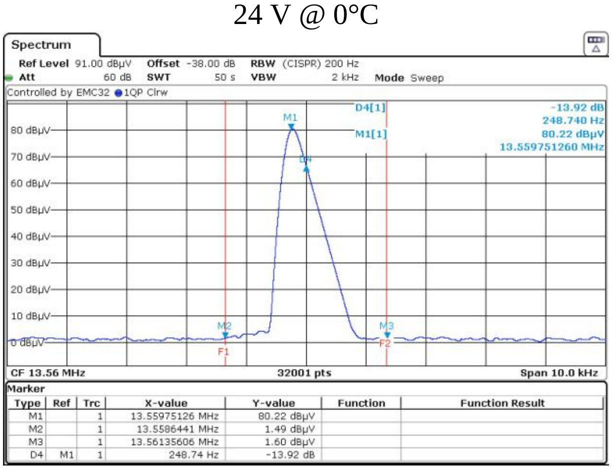
24 V @ -20 °C



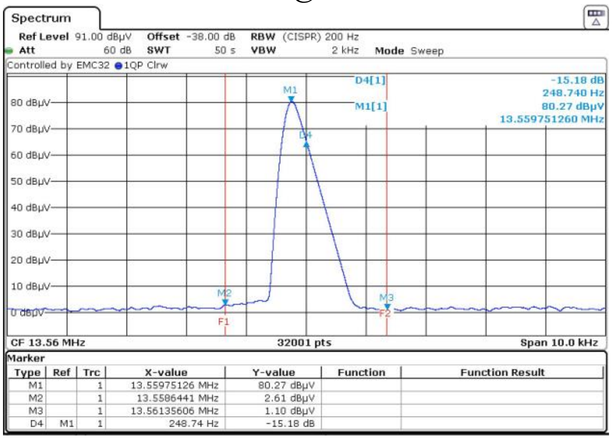
24 V @ -10 °C



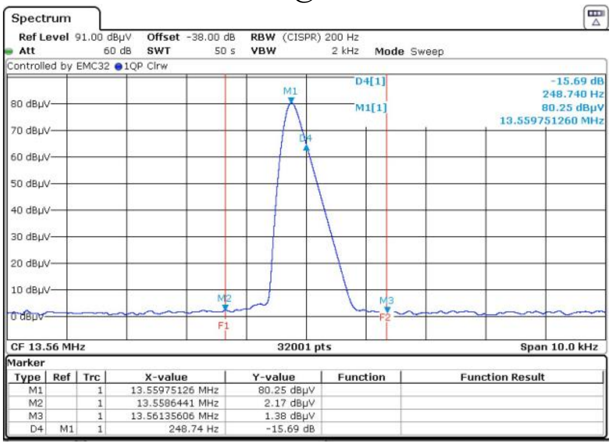
24 V @ 0°C



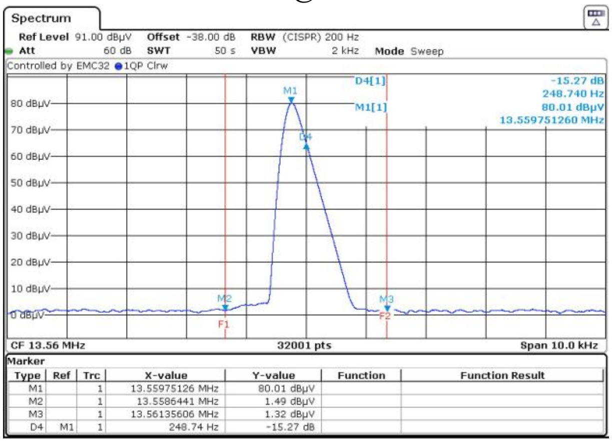
24 V @ 10°C



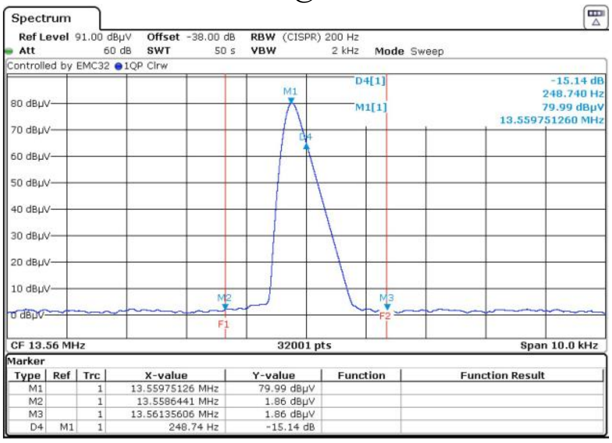
24 V @ 20°C



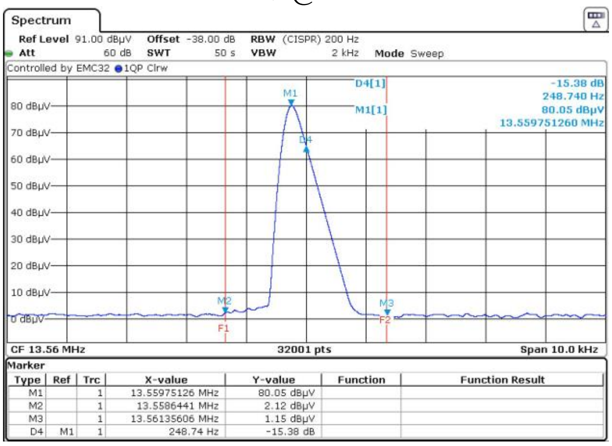
24 V @ 30°C



24 V @ 40°C



24 V @ 50°C



Test Cables used	K94, K96
Test equipment used	502, 401, 226, 102a

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

8.6 Bandwidth (20 dB)

8.6.1 Regulation

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

8.6.2 Calculation of the 20 dB bandwidth limit

Within the specified band!

8.6.3 Test procedure

ANSI C63.10-2013 Section 6.9.3 Occupied bandwidth measurements.
The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are -6 dB, -20 dB, and -26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this sub-clause, the ratio is designated by "-xx dB." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "-xx dB" bandwidth; other requirements might specify that the "−xx dB" bandwidth be entirely contained within the authorized or designated frequency band.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

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g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyser marker to the highest level of the displayed trace (this is the reference value).

h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum Analyser and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "- xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "-xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

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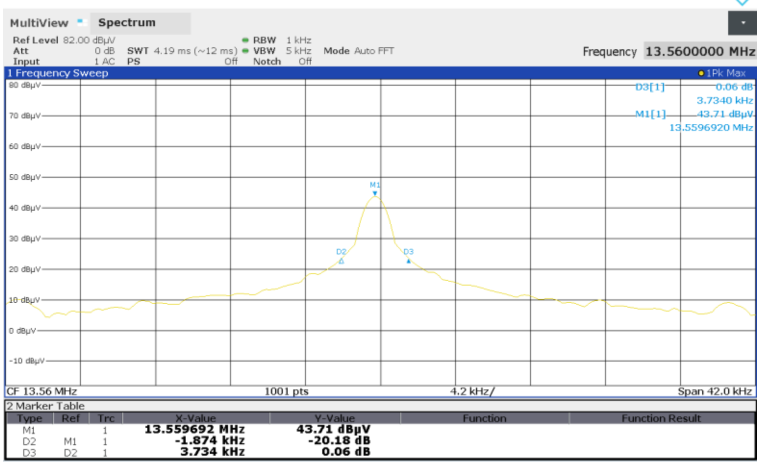
Tel.: +49 221 8888950

8.6.4 Result

The measured 20 dB bandwidth is: 3.764 kHz:



The measured 99% bandwidth is: 12.06 kHz

Test Cables used	K166, K102, K60
Test equipment used	23, 660, 665, 667, 668, 669

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

9. Additional information to the test report

Remark	Description
N.t.[1]	Not tested, because the antenna is part of the PCB
N.t.[2]	Not tested, because the EUT is directly battery powered
N.t.[3]	Not tested, because not applicable to the EUT
N.t.[4]	Not tested, because not ordered

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10. List of test equipment

State
Mai 31, 2022

Marking	Manufacturer	SW/Type/Serial-No.	Last Cal./Val.	Next Cal./Val.	No.
1 Measuring Instruments					
Attenuator	Radiall	---	Nov 19	Nov 22	62
Attenuator 3dB	Suhner	6803/17	Nov 19	Nov 22	137
Attenuator 3dB / 18 GHz	Suhner	3dB/18GHz	Nov 19	Nov 22	299
Terminator	Texcan	---	Nov 19	Nov 22	304
Attenuator 6dB / 18 GHz	Suhner	6dB/18GHz	Nov 19	Nov 22	344
Attenuator 20dB / 20GHz	Parzich	40AH-20	Nov 19	Nov 22	354
Terminator	KDI	T173CS	Nov 19	Nov 22	490
Variable transformer	RFT	LS 002	---	---	154a
Variable transformer	Schunt+Ben	---	---	---	155
Power sensor	Marconi	6914	Sep 20	Sep 22	258
Power sensor	Rohde & Schwarz	NRP18SN	Feb 22	Feb 24	651
3-Path Diode Power Sensor 10 MHz to 8 GHz	Rohde & Schwarz	NRP8S	Oct 20	Oct 22	663
3-Path Diode Power Sensor 10 MHz to 18 GHz	Rohde & Schwarz	NRP18S-20	Oct 20	Oct 22	664
Coaxial Directional Coupler	Narda	3003-20	Jan 21	Jan 24	370/342
Coaxial directional coupler	Mini Circuits	ZFDC-20-5	Mai 22	Mai 24	434
Coaxial directional coupler	Narda+Suhner	---	Mar 20	Mar 23	472/492
Coaxial High Pass Filter	Mini circuits	NHP-700	Apr 21	Apr 24	435
Coaxial High Pass Filter	Mini circuits	NHP-200	Apr 21	Apr 24	405
Coaxial High Pass Filter	Mini circuits	NHP-25+	Apr 21	Apr 24	455
High Pass Filter	Mini circuits	VHF-3500+	Apr 21	Apr 24	451
High Pass Filter	Mini circuits	VHF-1200+	Apr 21	Apr 24	452
Bandpass Filter	Schomandl	BN86871	Nov 21	Nov 24	66
Bandpass Filter	Schomandl	BN68673	Nov 21	Nov 24	67
Low Pass Filter	Mini circuits	SLP550	Apr 21	Apr 24	273
Low Pass Filter	Mini circuits	SLP550	Apr 21	Apr 24	274
RF Current Probe 9 kHz – 30 MHz	Rohde & Schwarz	ESH2-Z1	Aug 21	Aug 24	42
Passive Test Probe – 9 kHz – 30 MHz	TÜV NORD	VDE 0876	Apr 21	Apr 24	45
Coaxial Fixed Attenuator DC – 1 GHz	Texscan	HFP50/10	Jul 20	Jul 23	60
8 Wire Impedance Stabilisation Network	Schwarzbeck	CAT5 8158	Nov 21	Nov 23	71a
T-Section - 50 W	Rohde & Schwarz	BN 42441/50	Nov 21	Nov 24	93
RF Current Injection Clamp 0.15 – 1GHz	Lüthi GmbH	EM 101	Nov 19	Nov 22	156
Absorbing Clamp MDS 30MHz – 1GHz	Lüthi GmbH	MDS-21	Nov 19	Nov 22	160
Insertion Unit	Rohde & Schwarz	URV5-Z4	Mai 19	Mai 22	162
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 35	Nov 21	Nov 24	164
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 60	Nov 21	Nov 24	165
Fixed Attenuator - DC – 1.5GHz	Bird	Mod/ 8343-060	Apr. 20	Apr. 23	177
Rotary Step Attenuator DC – 2 GHz	Texscan	TA – 50	Mar20	Mar 23	184
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	Dec 21	Dec 23	264
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	Mai 19	Mai 22	272
Fixed Attenuator - DC – 18 GHz | 30 dB	MTS	---	Nov 20	Nov 23	275
Fixed Attenuator - DC – 18 GHz | 30 dB	MTS	---	Mai 22	Mai 24	276
Passive Probe - 9 kHz – 30 MHz | 2.5 kΩ	RFT	TK 121	Jun 20	Jun 23	302
Passive probe 1.5kΩ	Schwarzbeck	TK 9416	Oct 20	Oct 23	621
Termination Resistor 50 W	Radiall	404011	Nov 21	Nov 23	309
Branching device (4x) 50W	Rohde & Schwarz	892228/20	Sep 19	Sep 22	320
Dummy-Load - 2 – 18 GHz	Narda	MODEL 367NF	Nov 19	Nov 22	343
DC Block Adapter - 0.045 – 26.5 GHz	Hewlett-Packard	11742A	Apr 21	Apr 24	356
Insertion Unit 10V | 9 kHz 1000 MHz	Rohde & Schwarz	URV 5-Z2	Mai 19	Mai 22	367

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RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	395.2680.02	Mai 19	Mai 22	368
150W attenuator	Weinschel	49-20-33	Oct 19	Oct 22	374
Fixed Coaxial Attenuator - DC – 18 GHz	Weinschel	23-6-34	Feb 20	Feb 23	375
Insertion Unit 9 kHz – 2000 MHz	Rohde & Schwarz	URY-Z2	Oct 19	Oct 22	416
Panoramic Adapter (Monitoring)	Schwarzbeck	PAN1550	---	---	429
DC-BLOCK - DC – 6.0 GHz |50 W	Mini Circuits	BLK-6-N+	Nov 21	Nov 24	462
Terminating resistor 50Ω SMA	---	---	Nov 19	Nov 22	493
Terminating resistor 50Ω SMA	---	SC 60-601-0000-31	Nov 19	Nov 22	497
Fixed Attenuator –0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	504
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	505
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-6	Nov 19	Nov 22	506
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-3	Nov 19	Nov 22	507
Electric Dummy Load	RA-NAV Lab.	DA-75U	---	---	526
Power Splitter / Combiner	Mini Circuits	ZESC-2-11	Nov 19	Nov 22	527
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	529
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	530
RF-Attenuator - 6 dB	Haefely	---	Mar 20	Mar 23	540
RF-Attenuator - 1– 120 MHz | 12 dB	Haefely	---	Mar 20	Mar 23	541
RF-Attenuator - 1– 120 MHz | 39 dB	Haefely	---	Mar 20	Mar 23	542
LISN 9kHz – 30 MHz	Schwarzbeck	NNLA 8120	Aug 20	Aug 22	551
HV Probe P6013A	Tektronix	P6013A	Mai 19	Mai 22	559
VLISN 5µH	Schwarzbeck	8125-1944	Nov 21	Nov 23	585
VLISN 5µH	Schwarzbeck	8125-1945	Nov 21	Nov 23	586
20dB Attenuator, up to 18 GHz	Mini Circuit	BW-N20W5+	Nov 19	Nov 22	594
Step Attenuator - DC-18 GHz | 0 to 11 dB	Hewlett-Packard	8494B	Nov 19	Nov 22	604
Analyser Reference System	Spitzenberger & Spies	ARS 16/1	Mar 22	Mar 24	606a/b/c
Capacitive Coupling Clamp 5 kV	Schlöder	SFT 415	Mai 20	Mai 23	608
RF Probes for 50 Ω Receivers	Schwarzbeck	TK 9416	---	---	612
Current probe TRMS	BEHA APROB	CHB35	Oct 19	Oct 22	652
Semi Anechoic Chamber	COMTEST	SAC-3m	Apr 21	Apr 23	660
Maturo Turntable	Maturo	TT2.0SI (SN: TT2.05SI/817 SW: 1.0.0.4473)	---	---	667
Maturo Antenna Mast	Maturo	TAM4.5-E-10kg (SN: 10011/216/2588.01)	---	---	668
Maturo Controller	Maturo	FCU3.0/009/2588.01 (SN: 10014/2019)	---	---	669
Current probe 20 Hz – 100 MHz	Rohde & Schwarz	EZ-17 (0816.2063.03)	Mar 20	Mar 23	670
Coupling Decoupling Network	AMETEK	CDN ST08A	Aug 20	Aug 23	672
BONN HF Switch Matrix DC – 8 GHz	BONN Elektronik	BAS 0080-3	---	---	682
External Directional Coupler	BONN Elektronik	BDC 1060-40/500	Dec 20	Dec 22	683
BI-Directional Coax. Coup. 50-1000 MHz	Narda	3020A	Nov 21	Nov23	141
Vertical coupling plate	TÜV NORD HFT	---	---	---	265
Measuring table	TÜV NORD HFT	---	---	---	106
Data line coupling network	EM Test AG	CNV 504/ 508	---	---	285
2 Generators					
EFT/Burst Generator	Schlöder	SFT 1400	Mai 20	Mai 22	46a
ESD Generator	Schlöder	SESD 216	Dec 21	Dec 23	653
Signal Generator	Rohde & Schwarz	SMB100A SW 4.20.028.58	Jul 20	Jul 22	571
RF Generator	Rohde & Schwarz	SGT100A	Apr 20	Apr 22	636
Signal Generator	Rohde & Schwarz	SMG	Jun 21	Jun 23	136
Signal Generator	Marconi	2042	Mai 20	Mai 22	6
Signal Generator	Marconi	2024	Mai 20	Mai 22	213

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Puls Generator	EM Test	MPG 200	Cal. before use	Cal. before use	181
Surge Generator	H+H	MIG063 IN S-T	Apr 21	Apr 23	561
3. Antennas					
Loop Ant. 9kHz-30MHz	Schwarzbeck	FMZB1516	Oct 21	Oct 23	23
Biconical Ant. 30-300 MHz	Schwarzbeck	VHA9103/BBA9106	Mai 22	Mai 24	80/616
Double Ridged Horn	Schwarzbeck	BBHA9120C	Feb 22	Feb 24	169
Double Ridged Horn	Schwarzbeck	BBHA 9120A	Mai 20	Mai 24	284
Tri-Log Broadband	Schwarzbeck	VULB9168	Mai 21	Mai 23	406
Broadband Horn 14-40 GHz	Schwarzbeck	BBHA9170	Feb 22	Feb 24	442
Log Per Antenna 0.7-20 GHz	Schwarzbeck	STLP9148	Mai 21	Mai 23	445a
Bilog Ant.	CHASE	CBL6111	Cal. before use	Cal. before use	167
Spectrum analyser Mixer 220 – 325 GHz	Radiometer Physics	SAM325	Aug 21	Aug 23	591
Dual Mode Potter Horn 220-325 GHz	Radiometer Physics	325-WR2	---	---	592
Dual Mode Potter Horn 75-110 GHz	Radiometer Physics	---	---	---	649
Gain Horn Antenna 50-75 GHz	Dorado	GH-15-20	---	---	511
Standard Gain Horn 1.7 – 2.6 GHz	Narda	645	---	---	514
W-band active Sextupler with input drive amplifier	Spacek Labs Inc.	AW-6XW-0	---	---	221a
60 to 65 GHz active frequency quadrupler	Spacek Labs Inc.	A625-4XW-0	---	---	222a
Harmonic Mixer 40-60 GHz	Rohde & Schwarz	FS-Z60	Aug 21	Aug 23	515
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20	---	---	518
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140	Aug 21	Aug 23	545
Dual Mode Potter Horn 90-140 GHz	Radiometer Physics	140-WR8	---	---	547
Spectrum analyser Mixer 140-220GHz	Radiometer Physics	SAM220	Aug 21	Aug 23	450
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	548
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90	Aug 21	Aug 23	501
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	549
Gain Horn 33-55 GHz	Dorado	---	---	---	383
Gain Horn 50-75 GHz	Dorado	---	---	---	384
Gain Horn 75-110 GHz	Dorado	---	---	---	385
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	532/628
Waveguide Harmonic Mixer 50 – 75 GHz	Keysight	M1971V	Cal. before use	Cal. before use	763
Waveguide Harmonic Mixer 75 – 110 GHz	Keysight	M1971W	Cal. before use	Cal. before use	764
Stacked Log.-Per. Antenna 70 MHz – 10 GHz	Schwarzbeck	STLP 9129	---	---	662
Spectrum/Signal Analyzer Extension Module 110 GHz – 170 GHz (WR-6.5)	Virginia Diodes, Inc.	SAX 637	Mar 20	Mar 22	675
Spectrum/Signal Analyzer Extension Module 140 GHz – 220 GHz (WR-5.1)	Virginia Diodes, Inc.	SAX 636	Mar 20	Mar 22	677
Spectrum/Signal Analyzer Extension Module 220 GHz – 330 GHz (WR-3.4)	Virginia Diodes, Inc.	SAX 635	Mar 20	Mar 22	679
Conical Gain Horn Ant. 110 GHz – 170 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-6.5	---	---	687
Conical Gain Horn Ant. 140 GHz – 220 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-5.1	---	---	688
Diagonal Gain Horn Ant. 220 GHz – 330 GHz [26 dBi]	Virginia Diodes, Inc.	Diagonal Antenna WR-3.4	---	---	689
4. Amplifier					
RF-Power Amplifier 250 kHz – 150 MHz	ENI	3100LA	---	---	123
RF pre-amplifier 100kHz-1.3GHz	HP	8447E	Aug 20	Aug 22	166a
Mitteq amplifier 26.5-40 GHz	Mitteq	---	Apr 22	Apr 24	223a
RF pre-amplifier 1-18GHz	Narda	---	Apr 22	Apr 24	345
Mitteq Amplifier 18-26GHz	Mitteq	---	Apr 20	Apr 23	433
Microwave amplifier 12-28GHz	Schwarzbeck	BBV9719	Apr 22	Apr 24	443
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	Apr 21	Apr 23	444
RF-Power Amplifier 10kHz-1000 MHz	Poetschke	8100 (Band 1) BHED (Band 2) BHED (Band 3)	---	---	684

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RF-Power Amplifier 800 MHz – 4,2 GHz	Amplifier Research	10S1G4	---	---	685
RF-Power Amplifier 4 GHz – 8 GHz	Amplifier Research	35S4G8A	---	---	686
RF-Power Amplifier 0.69 GHz – 6 GHz	Rohde & Schwarz	BBA150-D110/E60	---	---	690
5. Power supplies					
Programmable Power Supply	Fluke	PM 2813	---	---	28a
Power Supply	HP	---	---	---	125
Power Supply	Sorensen	LM 30-6	---	---	134a
Power Supply	HP	6034L	---	---	226
Regulated Power Supply	Farnell	AP60-50	---	---	408
Power Supply	EA	PSI 8080-40-DT	---	---	560
Power Supply	HP	6032A	---	---	644
6. Meters					
Microwave Frequency Counter	Hewlett-Packard	5351B	Nov 20	Nov 22	432
Temperature test cabinet	Heraeus Vötsch	VMT04/35	---	---	102a
Temperature test cabinet	Brabender	TTE 32/40 H	---	---	87
Digital-Hygro-Thermometer	Greisinger	GFTH95	Nov 19	Nov 22	57a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Cal. before use	Cal. before use	161
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	Jul 20	Jul 22	171a
Multimeter	Gossen Metrawatt	Metrahit pro	Nov 21	Nov 23	215a
Humidity/Temperature Measuring device	TESTO	Testo 625	Nov 21	Nov 23	259a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Cal. before use	Cal. before use	271
Multimeter	Gossen Metrawatt	Metrahit 26S	Sep 20	Sep 22	313
Level and Power Meter - 9 kHz – 3 GHz	Rohde & Schwarz	URY	Apr 22	Apr 24	307
Temperature test device	Ahlhorn	Almemo 2390-5 PT100	Mar 20	Mar 23	401/402
Digital-Vacuum-/Barometer	Greisinger	GDH12AN	Oct 19	Oct 22	558
Digital Storage Oscilloscope	Tektronix	TDS 2012C	Cal. before use	Cal. before use	568
Miniature Flat, Zero-Biased Schottky Detector –0.1– 18 GHz	Narda	4503A-03	Val. before use	Val. before use	613
Digital-Vacuum-/Barometer	Greisinger	GDH-200-14	Nov 21	Nov 23	632
Signal & Spectrum Analyser 10 Hz-30 GHz	Rohde & Schwarz	FSV-30 SW 3.70	Aug 21	Aug 23	502
EMI Test receiver ESW26	Rohde & Schwarz	R&S ESW26 (SN: 101383/26 SW: R&S ESW2.10)	Nov 21	Nov 23	665
Signal analyser Keysight 50GHz	Keysight	UXA N9040B (SN: MY57213006 SW: A.27.02/2020 1.0)	Jan 22	Jan 24	666
7. test/control software					
EMC32	Rohde & Schwarz	V10.60.20	---	---	---
Maturo mcApp	Maturo	SW: V3.4.9.4537 (19.04.04)	---	---	---
SPS EMC	Spitzenberger & Spies	SW: V4.1.3	---	---	---
EMV-Soft	Schlöder GmbH	SW: V11.95	---	---	---
ISMISO	EM Test AG	SW:V3.63	---	---	---

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950

11. Cable list

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
3	N	0,5 - 8000	3	Cellflex
4	N	0,5 - 8000	3	Cellflex
4a	BNC	10 – 1500	0.50	Telemeter
12a	N	10 – 265000	6	Huber + Suhner
14a	BNC	10 – 1000	1.00	Telemeter
17a	APC3.5	10 – 26500	2.13	Huber + Suhner
18a	APC3.5	10 – 26500	2.13	Huber + Suhner
22	BNC	10 – 1000	1.50	---
27	BNC	10 – 1000	1.00	Fabrica Milanese Cond.
35	N	10 – 2000	1.10	Fujikura
40	BNC	---	0.50	Aircell
43	SMA	10 – 18000	0.50	Rosenberger
44	SMA	---	0.50	Huber + Suhner
45	SMA	10 – 18000	0.50	Huber + Suhner
48	SMA		0.50	Huber + Suhner
49	N	10 – 18000	1.00	Huber + Suhner
50	N	10 – 18000	1.00	Huber + Suhner
51	N	10 – 18000	1.00	Huber + Suhner
52	N	10 – 18000	1.00	Huber + Suhner
54	BNC	10 – 3500	1.00	Aircell
58	N	10 – 18000	2.00	Huber + Suhner
59	N	10 – 18000	1.00	Huber + Suhner
60	N	10 – 18000	2.00	Huber + Suhner
61	N	10 – 18000	1.00	Huber + Suhner
62	SMA	---	0.50	Huber + Suhner
63	SMA	10 – 18000	0.50	Huber + Suhner
64	SMA	10 – 18000	0.50	Huber + Suhner
65	APC3.5	10 – 26500	0.60	---
66	APC3.5	10 – 26500	0.60	---
67	APC3.5	10 – 26500	0.60	---
68	APC3.5	10 – 26500	0.60	---
72	BNC	---	0.40	---
73	BNC	---	0.40	---
76	SMA	10 – 30000	3.00	Gore
79	BNC/N	10 – 1000	5.00	---
80	SMA	---	0.25	Huber + Suhner
87	SMA	10 – 18000	0.15	Huber + Suhner
88	SMA	10 – 18000	0.15	Huber + Suhner
89	SMA	10 – 18000	0.15	Huber + Suhner
90	SMA	10 – 18000	0.15	Huber + Suhner
91	SMA	---	1.50	Huber + Suhner
94	BNC	---	1.10	---
95	BNC	---	0.80	---
96	BNC	---	0.80	---
100	N	10 – 26500	6.00	Rosenberg
101	N	10 – 18000	2.90	Huber + Suhner
102	SMA	10 – 18000	2.00	Huber + Suhner
111	BNC	10 – 1000	0.50	---
112	BNC	10 – 1000	0.50	---
114	SMA	10 – 18000	0.25	Huber + Suhner
116	SMA	10 – 18000	0.25	Huber + Suhner
119	N	10 – 20000	8.00	Jyebao
121	SMA	10 – 18000	1.50	Huber + Suhner
122	SMA	10 – 18000	2.00	Huber + Suhner

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
123	SMA	10 – 18000	2.00	Huber + Suhner
145	SMA	10 – 26500	8.00	Huber + Suhner
147	APC3.5	10 – 40000	1.50	Jyebao
148	APC3.5	10 – 40000	3.00	Jyebao
151	SMA	10 – 18000	0.50	Rosenberger
152	SMA	10 – 18000	0.50	Rosenberger
154	BNC	10 – 1000	1.00	---
155	N/BNC	---	0.85	---
157	BNC	---	0.50	---
158	SMA	10 – 26500	2.00	Huber + Suhner
160	SMA	10 – 18000	0.40	Nortel Networks
161	SMA	10 – 18000	1.00	Huber + Suhner
162	APC35	10 – 26500	2.00	Huber + Suhner
163	APC3.5	10 - 26500	2.00	Huber + Suhner
164	APC3.5	10 – 26500	2.00	Huber + Suhner
165	APC2.9	10 – 26500	2.00	Huber + Suhner
166	APC3.5	10 – 40000	---	---
167	APC3.5	10 – 40000	1.00	Jyebao
168	APC3.5	10 – 40000	1.00	Jyebao
169	APC3.5	10 – 40000	1.00	Jyebao
170	APC3.5	10 – 40000	1.00	Jyebao
171	APC3.5	10 – 40000	1.00	Jyebao
172	SAM	---	0.90	Huber + Suhner
173	APC	10 – 26500	2.00	Huber + Suhner
174	APC	10 – 26500	---	Huber + Suhner
175	SMA	10 – 18000	0.40	Huber + Suhner
176	N-SMA	10 – 18000	0.50	Huber + Suhner
188	N	10 – 18000	5.00	Huber + Suhner
EMV 1	BNC	---	2.00	Henn
EMV 2	BNC	10 – 1000	2.00	Henn
EMV 4	BNC	---	9.70	Henn
EMV 5	BNC	---	3.80	Henn
EMV 6	BNC/N	10 – 1000	5.00	Lüthi
EMV 7	BNC	10 – 1000	1.50	Henn
EMV 8	BNC	10 – 1500	1.70	Henn
EMV 9	BNC	10 – 1000	1.70	Henn
EMV 11	BNC	---	5.20	Hasselt
EMV 12	BNC	10 – 1000	2.40	Hasselt
EMV 13	BNC	10 – 1000	4.10	Hasselt
EMV 14	BNC	10 – 1000	2.50	Hasselt
EMV 15	BNC	---	0.90	Henn
EMV 16	Fischer	---	2.00	---
EMV 18a	Fischer	---	1.00	---
EMV 19a	Fischer	---	1.50	---
KISN2	BNC	10 – 2000	4.80	---

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
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End of test report

TÜV NORD Hochfrequenztechnik GmbH & Co. KG
LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany
Tel.: +49 221 8888950