Test Report acc. to FCC Title 47 CFR Part 15
relating to
mecorad GmbH
1224-FCC

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

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany

MANUFACTURER	
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Manufacturer's grantee code	**---**
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RELEVANT STANDARD	
Title	**47 - Telecommunication**
Part	**15 - Radio Frequency Devices**
Subpart	**Subpart C – Intentional Radiators - Section 15.258**
Measurement procedure	**ANSI C63.10-2013**

EQUIPMENT UNDER TEST (EUT)	
Equipment category	FMCW-Radar sensor
Trade name	mecorad
Type designation	**1224-FCC**
Serial no.	---
Variants	---

Test result summary

Clause	FCC Rules	Requirements headline	Test result		
8.1	§ 15.203	Antenna requirement	**Pass**	~~Fail~~	~~N.t.~~*
8.2	§ 15.207 (a)	AC power line conducted limits	**Pass**	~~Fail~~	~~N.t.~~*
8.3	§ 15.258 (b)	Radiated power (EIRP)	**Pass**	~~Fail~~	~~N.t.~~*
8.4	§ 15.258 (c)	Transmitter spurious emission	**Pass**	~~Fail~~	~~N.t.~~*
8.5	§ 15.258 (d)	Occupied Bandwidth	**Pass**	~~Fail~~	~~N.t.~~*
8.6	§ 15.258 (d)	Frequency stability	**Pass**	~~Fail~~	~~N.t.~~*
8.7	§ 1.1310 & § 2.1091	RF radiation exposure	**Pass**	~~Fail~~	~~N.t.~~*

* Not tested

If statements on conformity are made in this report, decision rules according to DIN EN ISO / IEC 17025: 2018, 7.8.6 have been applied. If these decision-making rules are not already specified in the applied standards, procedure 1 according to IEC Guide 115 ed.2.0 2021 (accuracy method) was used in the measurement / test procedures on which this report is based.

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

Signature	TÜVNORD Digital unterschrieben von Shrestha Anup Datum: 2024.01.17 10:02:31 +01'00'	TÜVNORD Digital unterschrieben von Trepper Ralf Datum: 2024.01.17 10:03:07 +01'00'
Name	**Mr. Anup Shrestha**	**Mr. Ralf Trepper**
Designation	**RF Test Engineer**	**Laboratory Manager**
Date of issue	**2024-01-05**	**2024-01-05**

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1. Revision History

Revision	Date of issue	Creator	Content of change
00	2023.12.07	RT	Initial release
01	2023.01.05	RT	Change of measurement 9 kHz – 30 MHz

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.

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2. Introduction

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

- Test result summary
- List 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 total numbers of pages in this report is **45**.

The tests were carried out 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 15.258, ANSI C63.10-2013

The sample of the product was received on:

- 2022-11-15

The tests were carried out in the following period:

- 2022-11-10 - 2024-01-05

3. Testing laboratory

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FCC Registration Number: 763407

Accredited by:

DAkkS Deutsche Akkreditierungsstelle GmbH
DAkkS accreditation number: D-PL-12053-01-00

4. Applicant

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Country	: Germany
Telephone	: +49 0174 2478820
Fax	: ---
Email	: andreas.heutz@mecorad.com
Date of order	: 2022-05-11
References	: Mr. Andreas Heutz

5. Product

Sample of the following apparatus was submitted for testing:

Manufacturer	: mecorad GmbH
Trademark	: mecorad
Type designation	: **1224-FCC**
Serial number	: ---
Article number	: MS122-4
Hardware version	: MS122-4_v 1.0
Variant	: ---
Software release	: MS122-4_v 1.0
Type of equipment	: FMCW-Radar sensor
Power used	: Power over Ethernet (PoE) (802.3af-2003); 36V DC – 57V DC
Frequency used	: 120 GHz – 123 GHz
Generated or used frequencies	: ---
	121.5 GHz (center frequency)
ITU emission class	: 3G66N0N
FCC ID	: 2BDO41224

For issuing this report the following product documentation was used:

Title	Description	Version
---	---	---

For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the **E**quipment **U**nder **T**est (EUT)	2023-12-07	Annex no. 1
Internal photographs of the **E**quipment **U**nder **T**est (EUT)	2023-12-07	Annex no. 2
Channel occupancy / bandwidth	2023-12-07	Annex no. 3
Label sample	2023-12-07	Annex no. 4
Functional description / User Manual	2023-12-07	Annex no. 5
Test setup photos	2023-12-07	Annex no. 6
Block diagram	2023-12-07	Annex no. 7
Operational description	2023-12-07	Annex no. 8
Schematics	2023-12-07	Annex no. 9
Parts list	2023-12-07	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 Mecorad MSS122-4 is a radar-based measuring system for industrial areas.

7.2 EUT configuration

The EUT is switched ON via Power-over-Ethernet at 48V DC nominal voltage. The EUT is directly accessed through the web-browser with an IP-Address and different parameters (minimum and maximum distance, magnitude threshold (signal strength)) were configured. The status of the Radar was observed.

7.3 EUT measurement description

AC Powerline conducted measurements

The EUT was directly connected with a PoE. It has been tested with the activated EUT in continuous measuring mode. The typical voltage of 120 V AC / 60 Hz is provided on the artificial mains network.

Radiated measurements

After switch on, the device is accessed through IP Address. The EUT starts to work. 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 in a semi-anechoic chamber (SAC) with the EUT's typical voltage: 48 V DC.

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 measurements from 9 kHz – 30 MHz, 30MHz – 1 GHz and above 1 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna and stacked Logarithmic-Periodic Broadband Antenna for linear polarized respectively with a measuring distance of 3 m inside SAC.

Radiated measurements above 1 GHz is made by placing loose-laid RF absorber material on the ground plane.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas, which may have a smaller beam width (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.

Environmental Conditions during the tests

Temperature: 21 – 26°C // Relative Humidity: 35 – 45 % // Air Pressure: 1005 – 1013 hPa

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8.1 Antenna requirement

8.1.1 Regulation

According to FCC §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of 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

Antenna Type	**Antenna description**	**Frequency GHz**	**Gain dBi**	**Number of Antennas**
Lens Antenna	---	**116 - 123**	**---**	1

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

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

8.2 AC line conducted limits

8.2.1 Regulation

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

Conducted Limits		
Frequency of Emission	**Quasi-Peak (QP)**	**Average (AV)**
MHz	**dBµV**	**dBµV**
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 limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

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

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

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

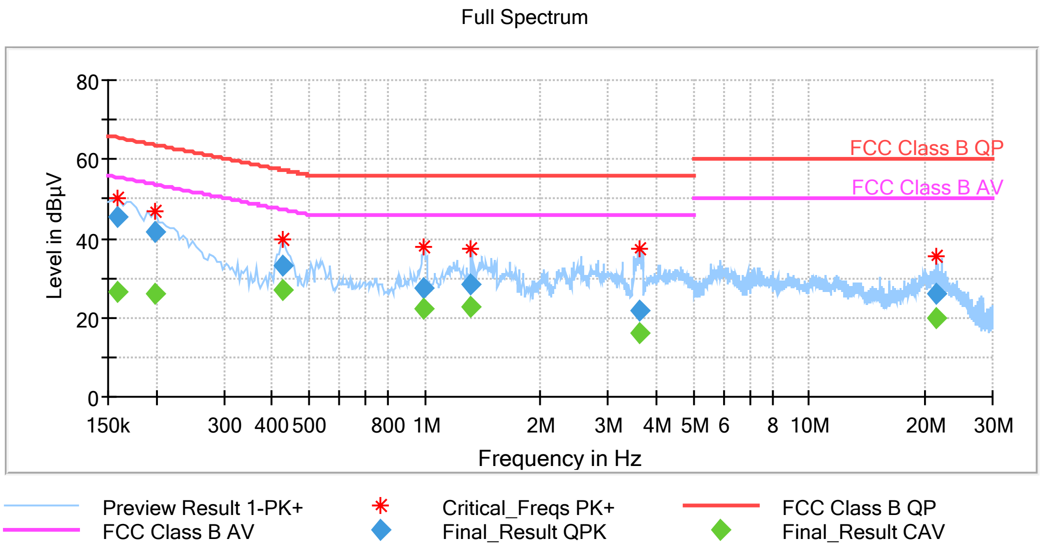
(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions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

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 C63.10-2013.
Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

8.2.3 Result

Conducted emissions - AC port acc to § 15.207 Tested with Laptop only									
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Lin e	PE	Corr. (dB)
0.159000	45.51	---	65.52	20.00	1000.0	9.000	N	GND	20.1
0.159000	---	26.69	55.52	28.83	1000.0	9.000	N	GND	20.1
0.199500	---	26.13	53.63	27.50	1000.0	9.000	L1	GND	20.1
0.199500	41.88	---	63.63	21.75	1000.0	9.000	L1	GND	20.1
0.429000	---	27.20	47.27	20.07	1000.0	9.000	L1	GND	20.1
0.429000	33.37	---	57.27	23.90	1000.0	9.000	L1	GND	20.1
0.996000	---	22.19	46.00	23.81	1000.0	9.000	N	GND	20.0
0.996000	27.55	---	56.00	28.45	1000.0	9.000	N	GND	20.0
1.315500	28.30	---	56.00	27.70	1000.0	9.000	N	GND	20.1
1.315500	---	22.52	46.00	23.48	1000.0	9.000	N	GND	20.1
3.624000	21.97	---	56.00	34.03	1000.0	9.000	N	GND	20.2
3.624000	---	16.00	46.00	30.00	1000.0	9.000	N	GND	20.2
21.484500	25.99	---	60.00	34.01	1000.0	9.000	L1	GND	21.1
21.484500	---	20.07	50.00	29.93	1000.0	9.000	L1	GND	21.1
Measurement uncertainty < ± 2 dB									

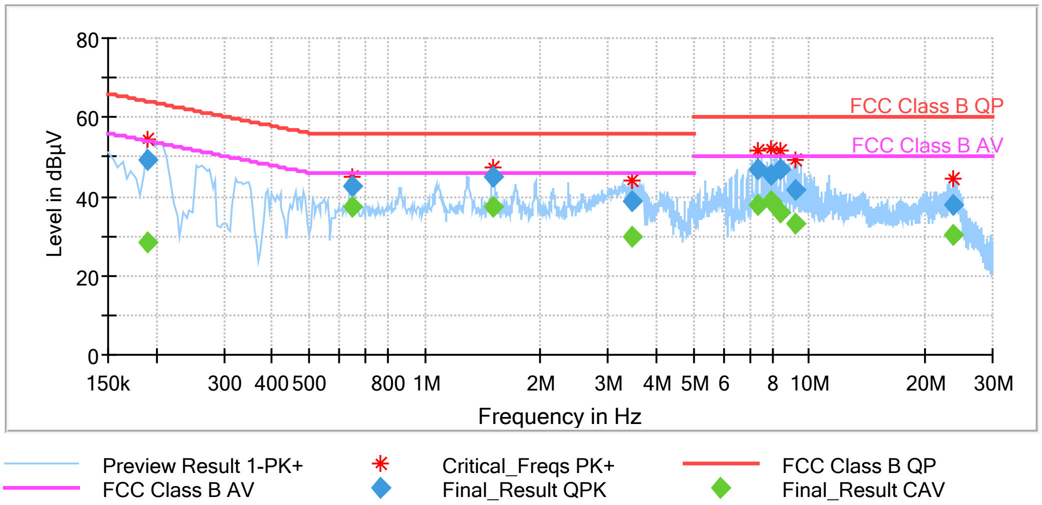


Conducted emissions - AC port acc to § 15.207
Tested with Laptop in connection with EUT

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.190500	---	28.26	54.02	25.75	1000.0	9.000	L1	GND	20.1
0.190500	49.18	---	64.02	14.83	1000.0	9.000	L1	GND	20.1
0.645000	---	37.51	46.00	8.49	1000.0	9.000	N	GND	20.0
0.645000	42.64	---	56.00	13.36	1000.0	9.000	N	GND	20.0
1.509000	44.98	---	56.00	11.02	1000.0	9.000	L1	GND	20.1
1.509000	---	37.22	46.00	8.78	1000.0	9.000	L1	GND	20.1
3.462000	38.90	---	56.00	17.10	1000.0	9.000	N	GND	20.2
3.462000	---	29.84	46.00	16.16	1000.0	9.000	N	GND	20.2
7.323000	47.08	---	60.00	12.92	1000.0	9.000	N	GND	20.3
7.323000	---	38.02	50.00	11.98	1000.0	9.000	N	GND	20.3
7.984500	45.26	---	60.00	14.74	1000.0	9.000	L1	GND	20.5
7.984500	---	38.72	50.00	11.28	1000.0	9.000	L1	GND	20.5
8.398500	46.80	---	60.00	13.20	1000.0	9.000	L1	GND	20.6
8.398500	---	36.10	50.00	13.90	1000.0	9.000	L1	GND	20.6
9.249000	41.56	---	60.00	18.44	1000.0	9.000	L1	GND	20.6
9.249000	---	33.30	50.00	16.70	1000.0	9.000	L1	GND	20.6
23.770500	---	30.52	50.00	19.48	1000.0	9.000	N	GND	21.2
23.770500	38.00	---	60.00	22.00	1000.0	9.000	N	GND	21.2

Measurement uncertainty < ± 2 dB

Full Spectrum



Test Cables used	KISN2
Test equipment used	272, 551, 665, 606

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

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

8.3 Radiated peak power (EIRP)

8.3.1 Regulation

According to FCC §15.258 (b) Emission levels within the 116-123 GHz, 174.8-182 GHz, 185-190 GHz and 244-246 GHz bands shall not exceed the following equivalent isotropically radiated power (EIRP) limits as measured during the transmit interval:

(1) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

(2) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The provisions in this paragraph (b)(2) for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (b)(1) of this section.

(3) The peak power shall be measured with a detection bandwidth that encompasses the entire occupied bandwidth within the intended band of operation, e.g., 116-123 GHz, 174.8-182 GHz, 185-190 GHz or 244-246 GHz. The average emission levels shall be measured over the actual time period during which transmission occurs.

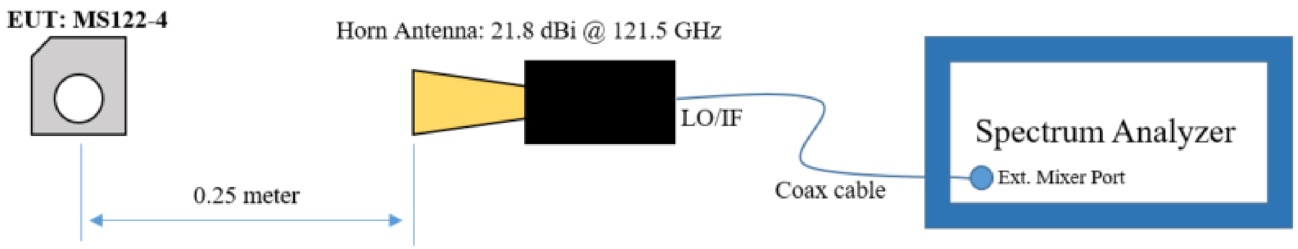
(4) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak radiated power to the product of the maximum permissible radiated power (in milliwatts) times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph (b)(4), emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

8.3.2 Test Procedure

Maximum measurement distance for the final radiated measurements above 40 GHz was determined according to ANSI C63.10-2013 section 9.8. To achieve maximum level of emission, maximizing procedure was applied according to ANSI C63.10-2013 section 9.8 where initially an exploratory search for emissions was carried out to determine the approximate direction at which each observed emissions emanates from the EUT. Secondly, for each emission observed a final measurement was executed to find the final position, polarization and orientation at which the maximum level of emission was observed. Measurement of the fundamental emission can be done using an RF detector according to the procedure ANSI C63.10-2013 section 9.11.

8.3.3 Test setup

Radiated measurements setup (Radiated peak output power)

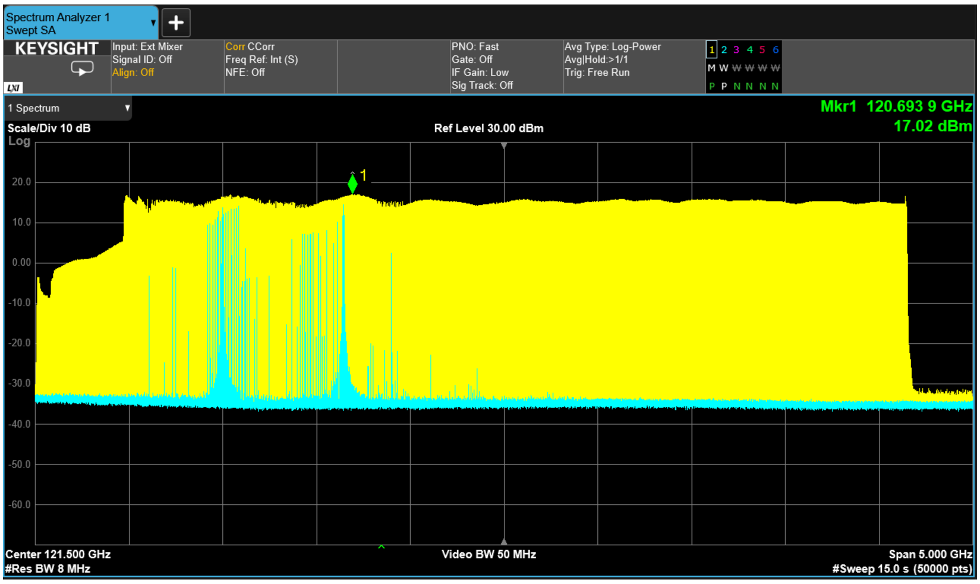


8.3.4 Result

Test Result:

Radiated peak output power acc. to FCC §15.258 (1)				
Frequency	**Detector**	**EIRP Power**	**EIRP Limit**	**Margin**
GHz	**Type**	**dBm**	**dBm**	**dB**
120.7	PK	17.0	43.0	26.0
Measurement uncertainty: ± 2.5 dB				

Test Plot:



Test Cables used	K163
Test equipment used	666, 675, 687

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

Test setup photos / test results are attached	~~Yes~~	**No**	---

8.4 Transmitter spurious emission

Transmitter spurious emission below 40 GHz

8.4.1 Regulation

According to FCC §15.258 (d), limits on spurious emissions:

(1) The power density of any emissions outside the 116-123 GHz band shall consist solely of spurious emissions.

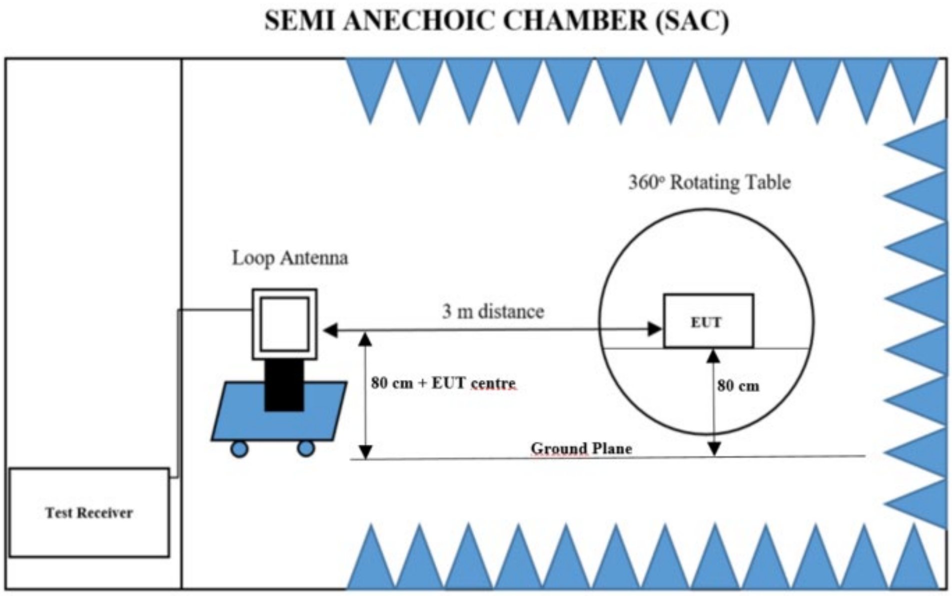
(1) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.

(2) Between 40 GHz and 365 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters.

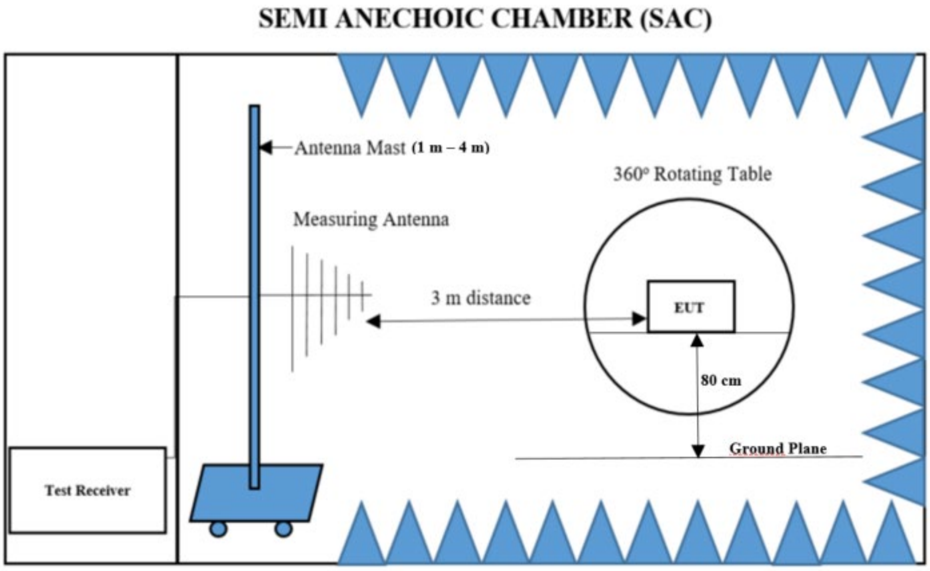
(3) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

8.4.2 Test setup

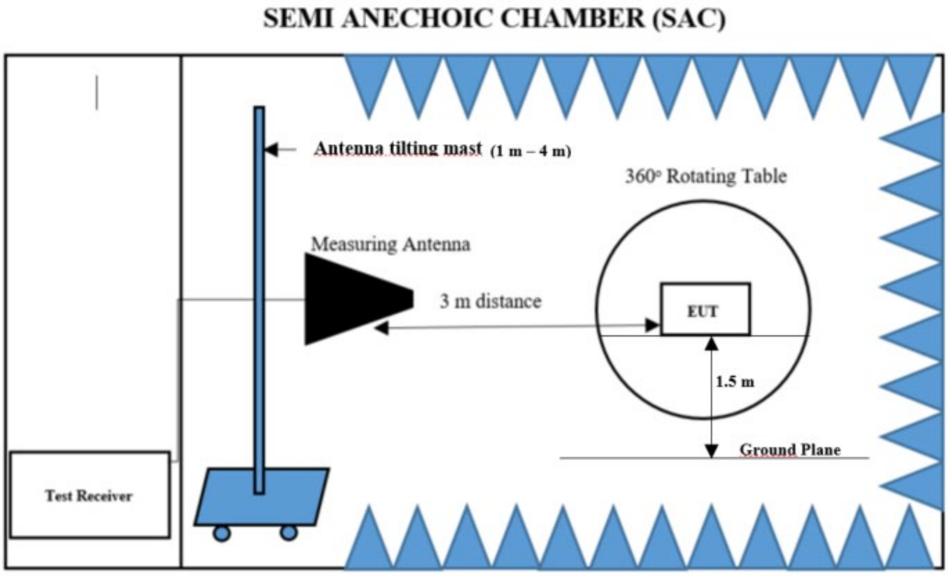
Radiated measurements setup (9 kHz – 30 MHz)



Radiated measurements setup (30 MHz – 1 GHz)



Radiated measurements setup (1 GHz – 40 GHz)



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Radiated measurements from 9 kHz – 30 MHz, 30MHz – 1 GHz, 1 GHz – 18 GHz and 18 GHz – 40 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna, stacked Logarithmic-Periodic Broadband Antenna for linear polarized and horn antenna respectively with a measuring distance of 3 m inside SAC as shown in the above test setup diagrams. Above 40 GHz, the measuring antenna is scanned around the entire perimeter of the EUT in both horizontal and vertical polarization, at the distance of 3.0 m from 40 GHz – 75 GHz, 1.0 m from 75 GHz – 110 GHz, 0.5 m from 110 GHz – 170 GHz and 0.25 m from 170 GHz – 365 GHz.

The radiated emission tests were performed in a 3 meter SAC using the setup accordance with the ANSI C63.10.

8.4.3 Test Procedure

The measurement of harmonic and spurious emissions at or below 40 GHz was performed in accordance with the standard test methods ANSI C63.10-2013 section 6.3 – 6.6. The measurement above 40 GHz was carried out in accordance with the test procedure ANSI C63.10-2013 section 9.12.

In accordance with the FCC subpart A §15.35, frequencies below or equal to 1 GHz, the measurements were done using a quasi-peak detector. For the frequencies above 1 GHz, all the radiated emission measurements were carried out using a average detector.

Radiated emissions test characteristics	
Test distance	10 m, 3 m , 1 m, 0.5 m *
Test instrumentation resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

* 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. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

8.4.4 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

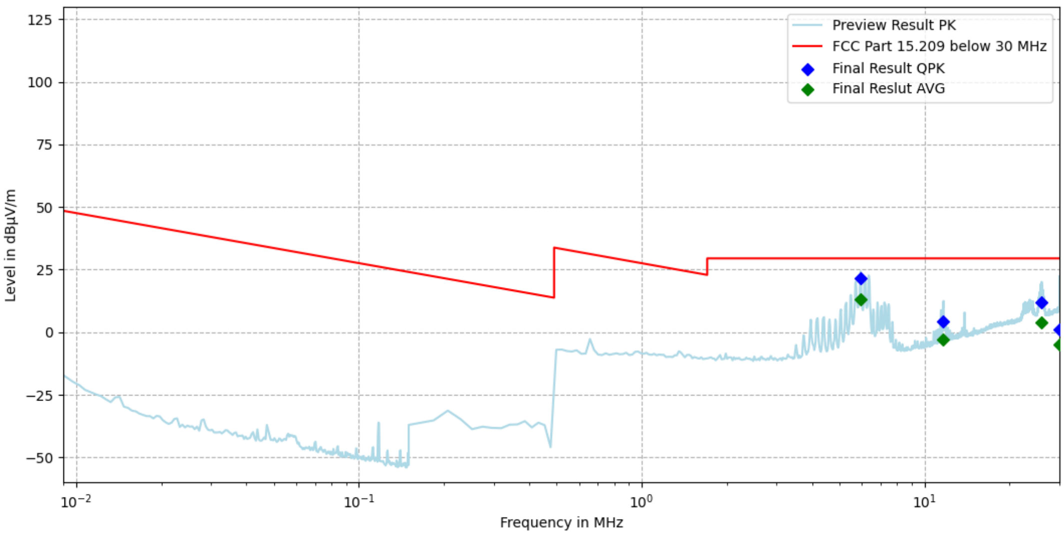
For example:
The receiver reading is 32.7 dBµV. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dBµV/m.
The 35.91 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

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).

8.4.5 Result

Transmitter spurious radiation (9 kHz – 30 MHz) (Section 15.209)								
Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol (deg)	Azimuth (deg)
5.941750	21.58	---	29.5	7.92	1000.0	9.000	90	289.0
5.941750	---	13.08	---	---	1000.0	9.000	90	289.0
11.659250	---	-3.02	---	---	1000.0	9.000	90	198.0
11.659250	4.51	---	29.5	24.99	1000.0	9.000	90	198.0
25.966750	11.82	---	29.5	17.68	1000.0	9.000	90	339.0
25.966750	---	14.03	---	---	1000.0	9.000	90	339.0
29.954000	---	-4,93	---	---	1000.0	9.000	90	80.0
29.954000	1.07	---	29.5	28.43	1000.0	9.000	90	80.0

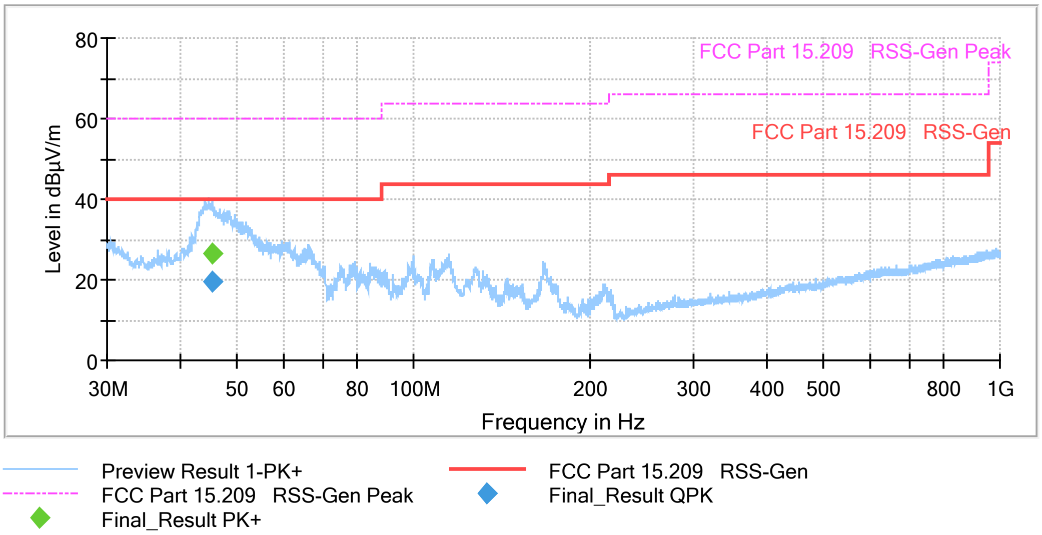


Test Cables used	K189
Test equipment used	23, 660, 665, 667, 668, 669

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

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

Transmitter spurious radiation (30 MHz – 1 GHz) (Section 15.209)									
Frequency (MHz)	**QuasiPeak (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**Height (cm)**	**Pol**	**Azimuth (deg)**	**Corr. (dB/m)**
45.2	19.58	40.0	20.42	1000.0	120	140	V	27	14.3
Measurement uncertainty: ± 4 dB									

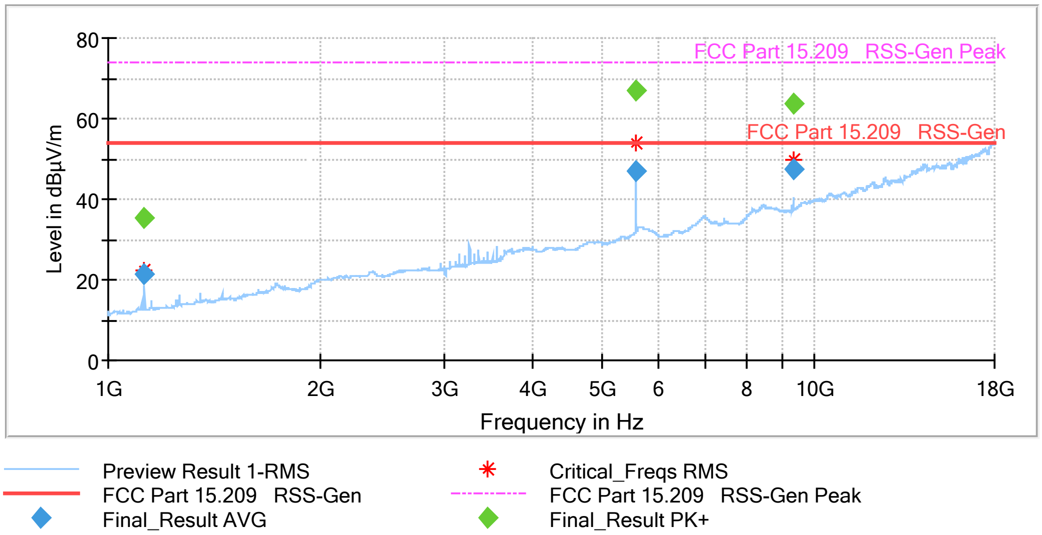


Test Cables used	K189, K193, K195
Test equipment used	406, 660, 665, 667, 668, 669

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

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

Transmitter spurious radiation (1 GHz – 18 GHz) (Section 15.209)										
Frequency (MHz)	**Average (dBµV/m)**	**MaxPeak (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**Height (cm)**	**Pol**	**Azimuth (deg)**	**Corr. (dB/m)**
1125.125000	---	35.55	74.00	38.45	1000.0	1000.000	217.0	H	339.0	26.4
1125.125000	21.41	---	54.00	32.59	1000.0	1000.000	217.0	H	339.0	26.4
5592.125000	---	67.15	74.00	6.85	1000.0	1000.000	113.0	H	339.0	45.3
5592.125000	46.91	---	54.00	7.09	1000.0	1000.000	113.0	H	339.0	45.3
9320.125000	---	63.69	74.00	10.31	1000.0	1000.000	312.0	V	-2.0	50.4
9320.125000	47.53	---	54.00	6.47	1000.0	1000.000	312.0	V	-2.0	50.4
Measurement uncertainty: ± 4.9 dB										

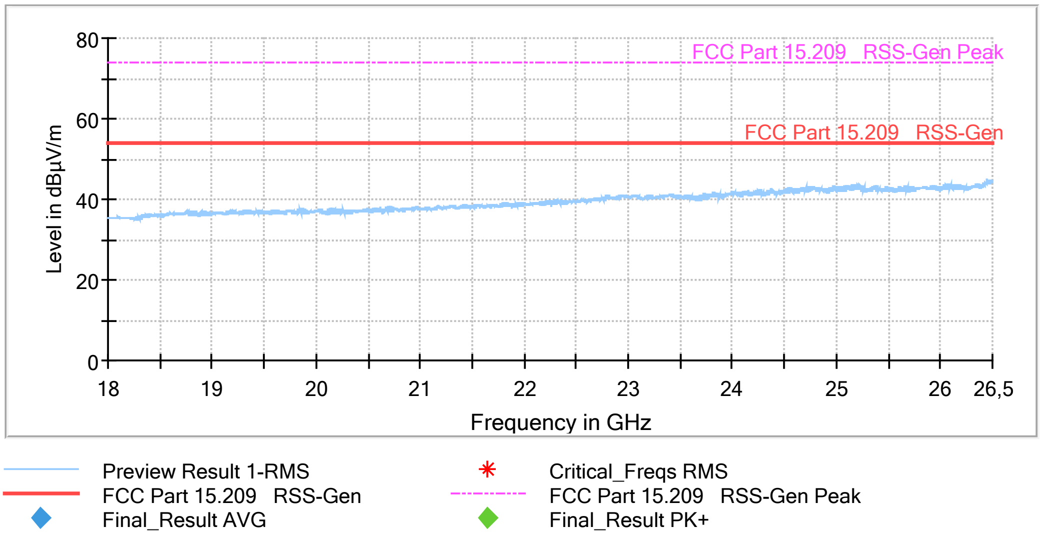


Test Cables used	K189, K193, K195
Test equipment used	445a, 660, 665, 667, 668, 669

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

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

Transmitter spurious radiation (18 GHz – 26.5 GHz) (Section 15.209)									
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---	---	---	---	---	---
Measurement uncertainty: ± 5.7 dB									

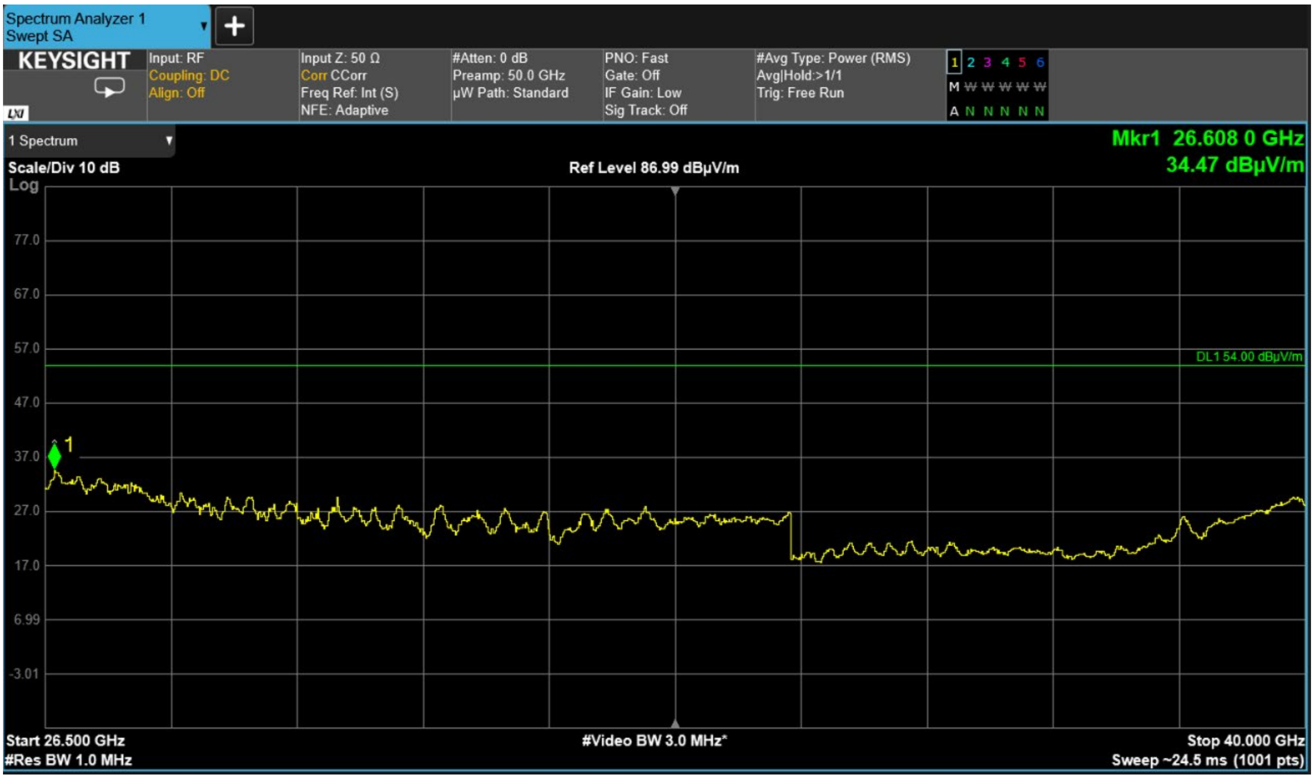


Test Cables used	K189
Test equipment used	442, 660, 665, 667, 668, 669

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

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

Transmitter spurious radiation (26.5 – 40 GHz) (Section 15.209)									
Frequency (MHz)	**Average (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**Height (cm)**	**Pol**	**Azimuth (deg)**	**Corr. (dB/m)**
---	---	---	---	---	---	---	---	---	---
Measurement uncertainty: ± 5.7 dB									



Test Cables used	K189
Test equipment used	223a, 442, 660, 666, 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 Transmitter spurious emission above 40 GHz

8.5.1 Regulation

Note 1: According to FCC §15.258 (c)(3)
Note 2: The measurement distance is between 0.25 m and 3.0 m.
Note 3: The Mixers and it`s RF cables are calibratet as system, the conversion factor was added into the Spectrum Analyzer.
Note 5:Limit conversion at the specified distance of 3 m

$$EIRP[dBm] = 10\log10 (4*\pi\times d^2*PD[W/m^2])$$

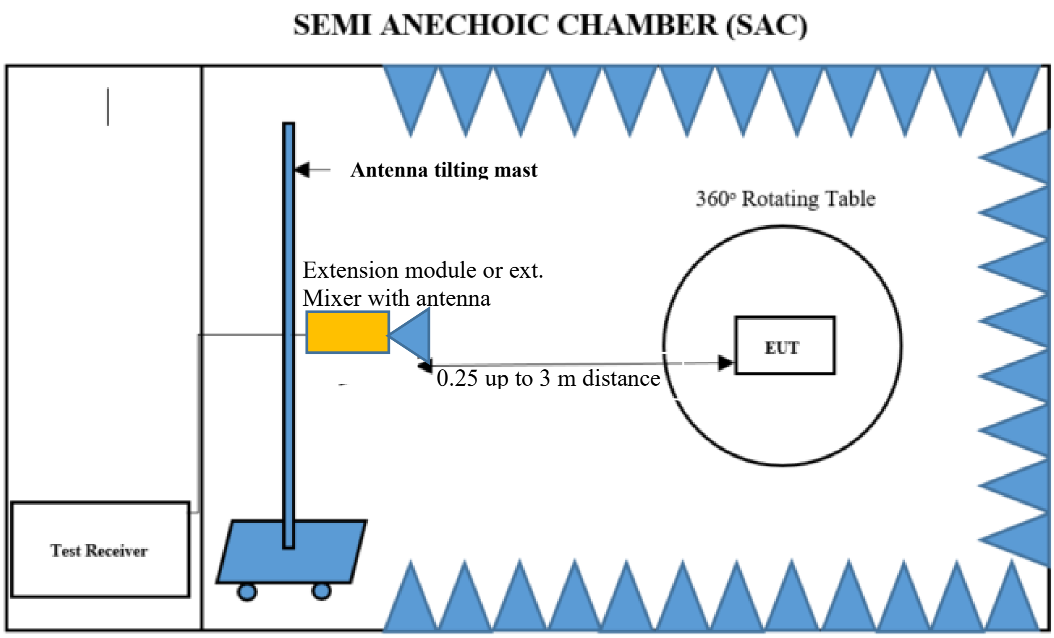
where,
PD = Power density at the distance specified by the limit = 90 [pW/cm²]
EIRP = Equivalent isotropically radiated power in [dBm]
d_{meas} : Distance at which the power density limit is specified = 3 [m]
The emission limit of PD = 90 pW/cm² at a distance of 3 meters corresponds to EIRP = -9.9 dBm.
Note 6: radiated output power calculation:

$$EIRP[dBm] = RL[dBm] + FSPL[dB] - G [dBi] + CL [dB]$$

where,
EIRP = Effective radiated power // RL = Receiver reading // FSPL = Free Space Loss at measurement distance (dB) // G = Antenna gain // CL = conversion loss signal path

8.5.2 Test Procedure

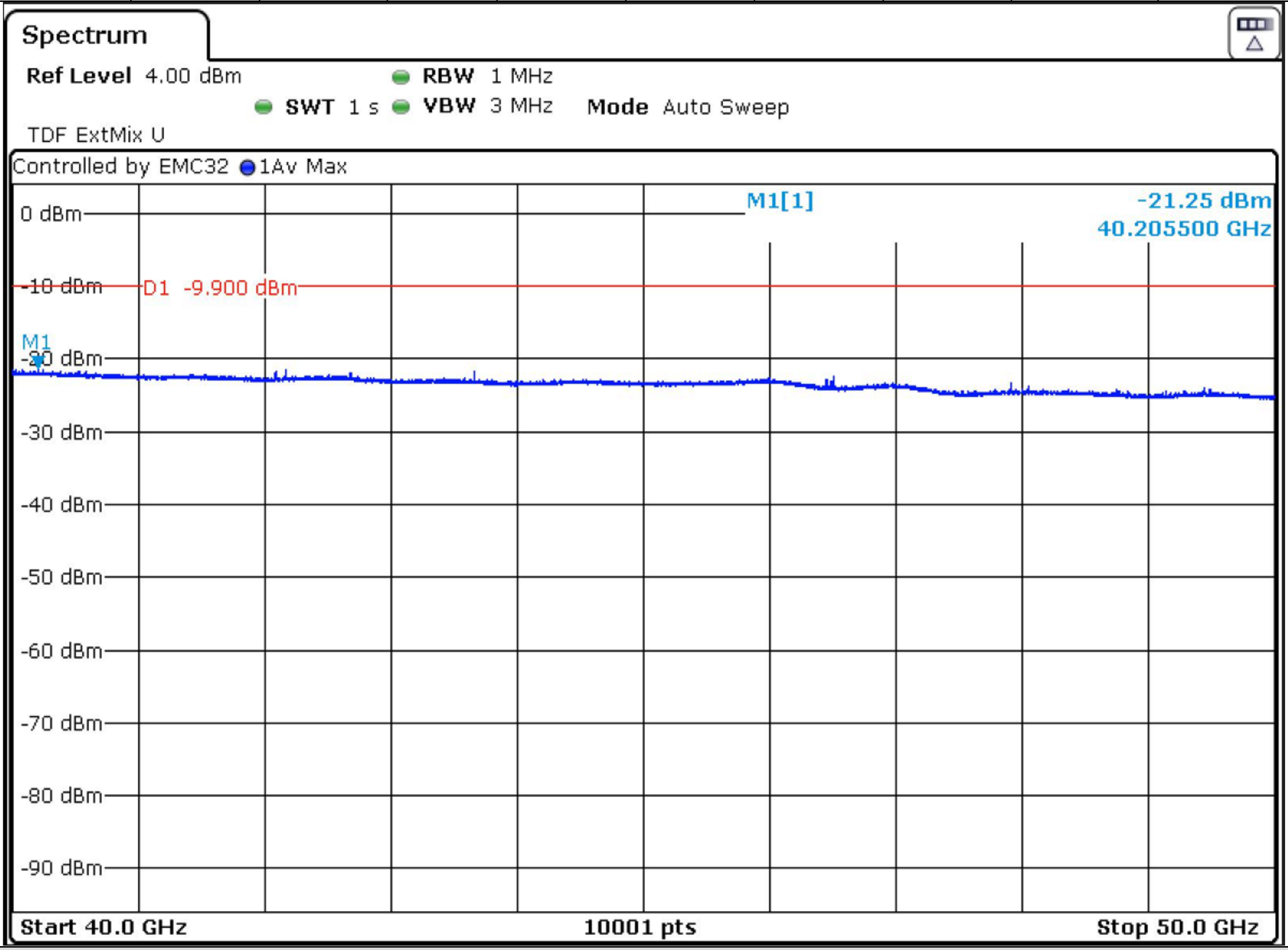
Radiated measurements setup above 40 GHz



The measurement of harmonic and spurious emissions above 40 GHz was carried out in accordance with the test procedure ANSI C63.10-2013 section 9.12.
In accordance with the FCC subpart A §15.35 and the FCC subpart C §15.258, the radiated emission measurements were made using a peak detector or average detector.

8.5.3 Result

Transmitter spurious radiation (40 GHz – 50 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Av erage Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**dB**	**dBm**	**dBm**	**dB**
**	---	---	---	---	---	---	---	---	---



Measurement uncertainty: ± 6.8 dB

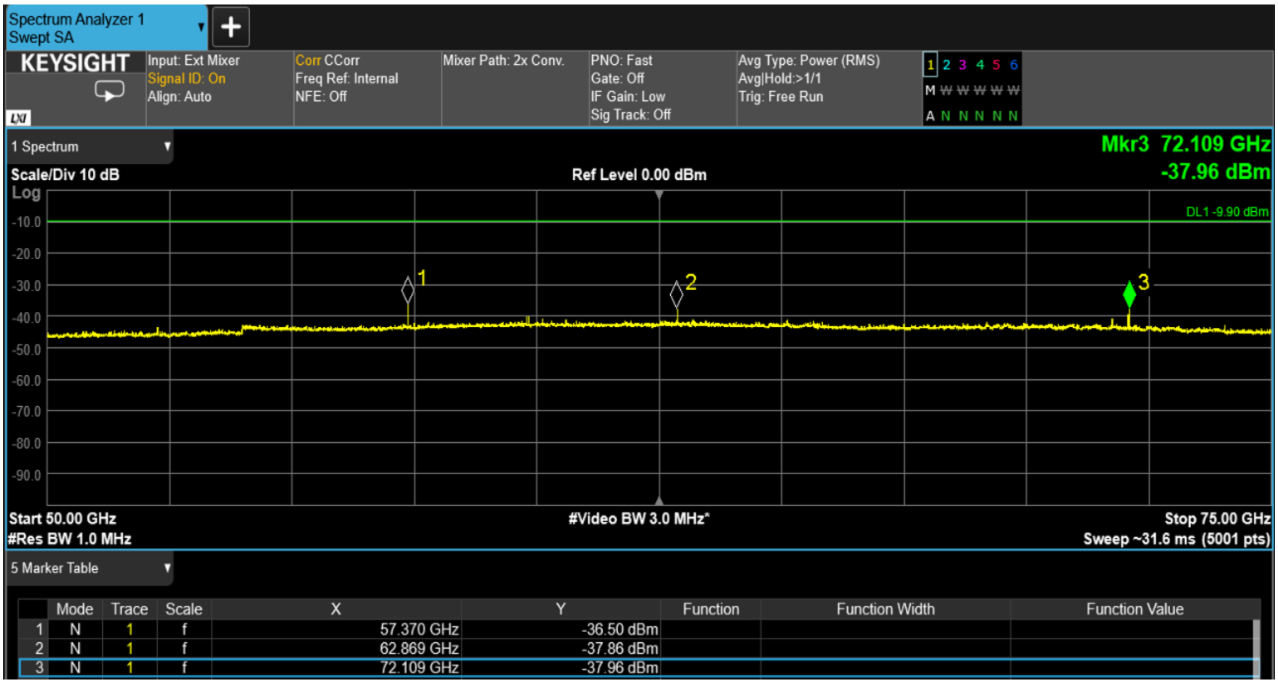
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K189
Test equipment used	502, 515, 518, 660, 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

Transmitter spurious radiation (50 GHz – 75 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Av erage Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**dB**	**dBm**	**dBm**	**dB**
57.37	AV	1000	-98.23	67.63	24.0	18.1	-36.5	-9.9	26.6
62.87	AV	1000	-100.52	68.42	25.1	19.3	-37.9	-9.9	28.0
72.11	AV	1000	-99.48	69.58	26.9	18.8	-38.0	-9.9	28.1



Measurement uncertainty: ± 6.8 dB

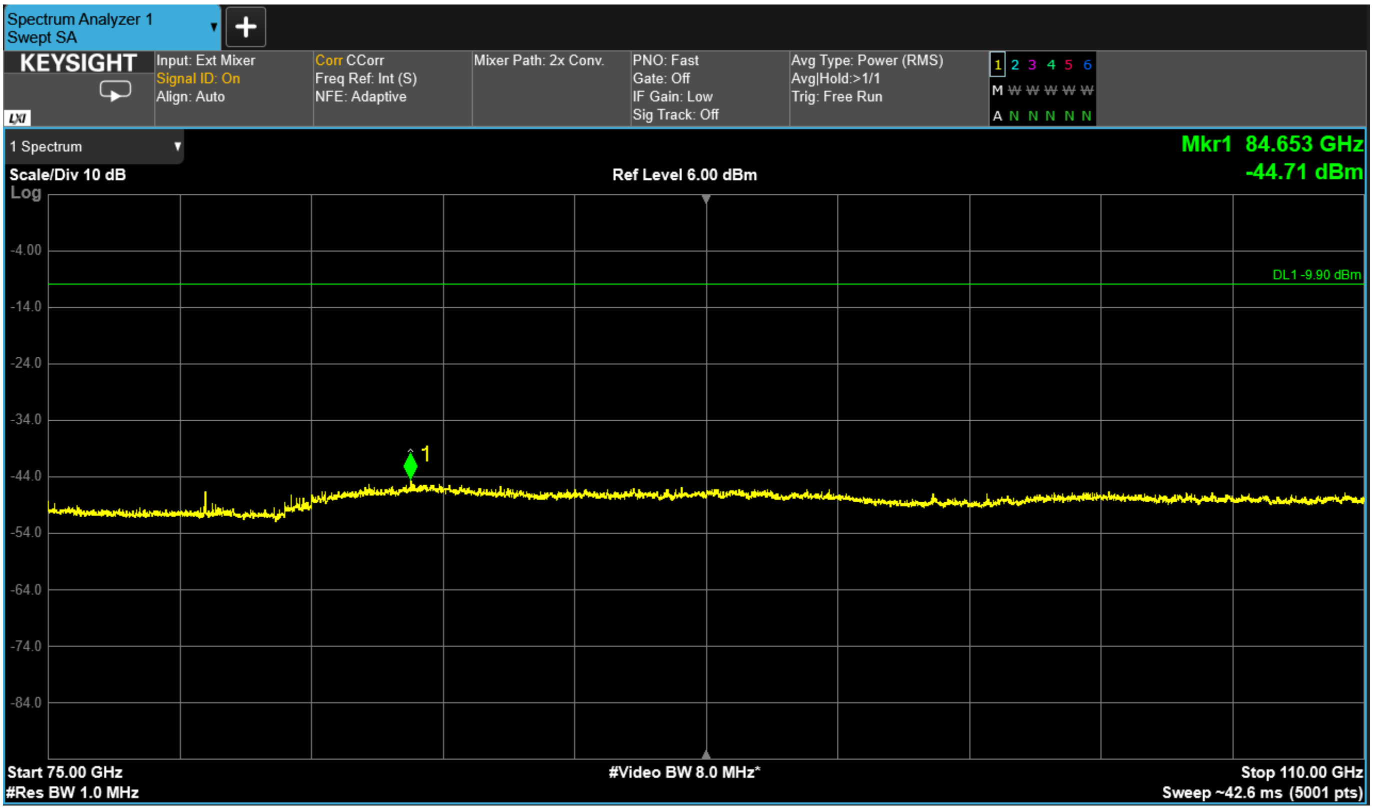
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	384, 673, 660, 666, 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

Transmitter spurious radiation (75 GHz – 110 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Receiver Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**db**	**dBm**	**dBm**	**dB**
**	---	---	---	---	---	---	---	---	---



Measurement uncertainty: ± 6.8 dB

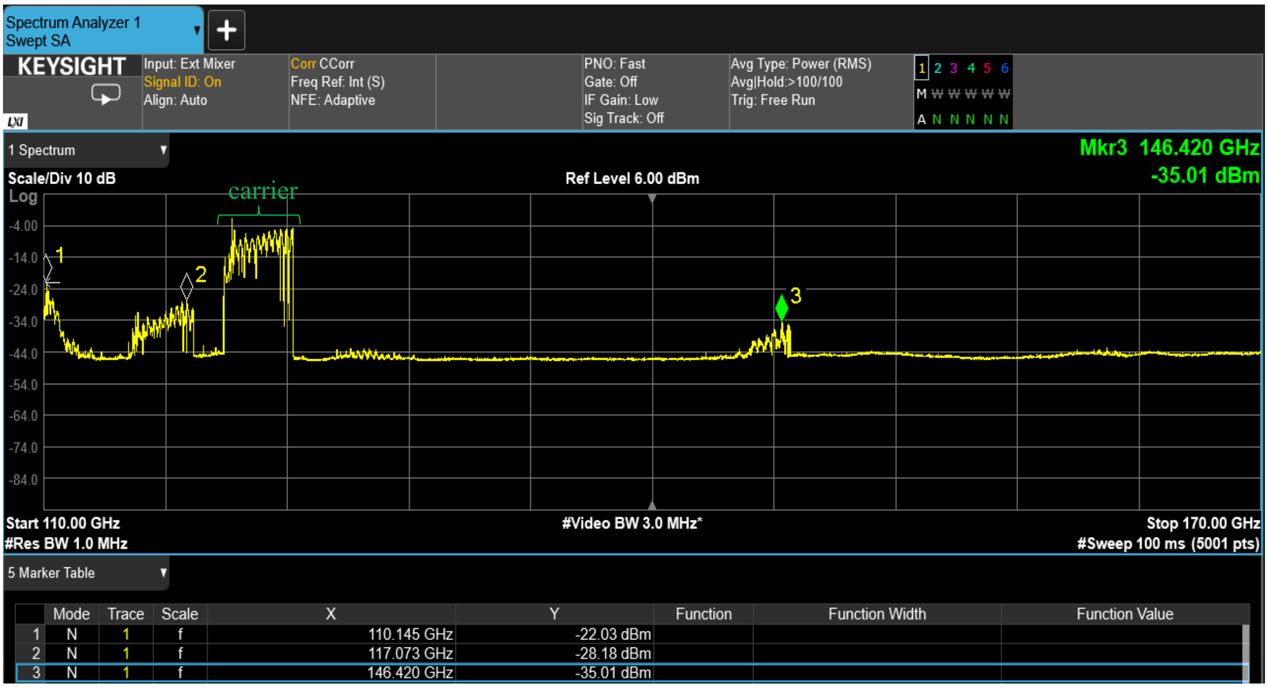
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	385, 674, 660, 666, 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

Transmitter spurious radiation (110 GHz – 170 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Receiver Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**db**	**dBm**	**dBm**	**dB**
110.15	AV	1000	-78.91	67.24	21.0	10.64	-22.03	-9.9	12.1
117.07	AV	1000	-85.12	67.79	21.5	10.65	-28.18	-9.9	18.3
146.42	AV	1000	-91.9	69.74	23.2	10.35	-35.01	-9.9	25.1



Measurement uncertainty: ± 6.8 dB

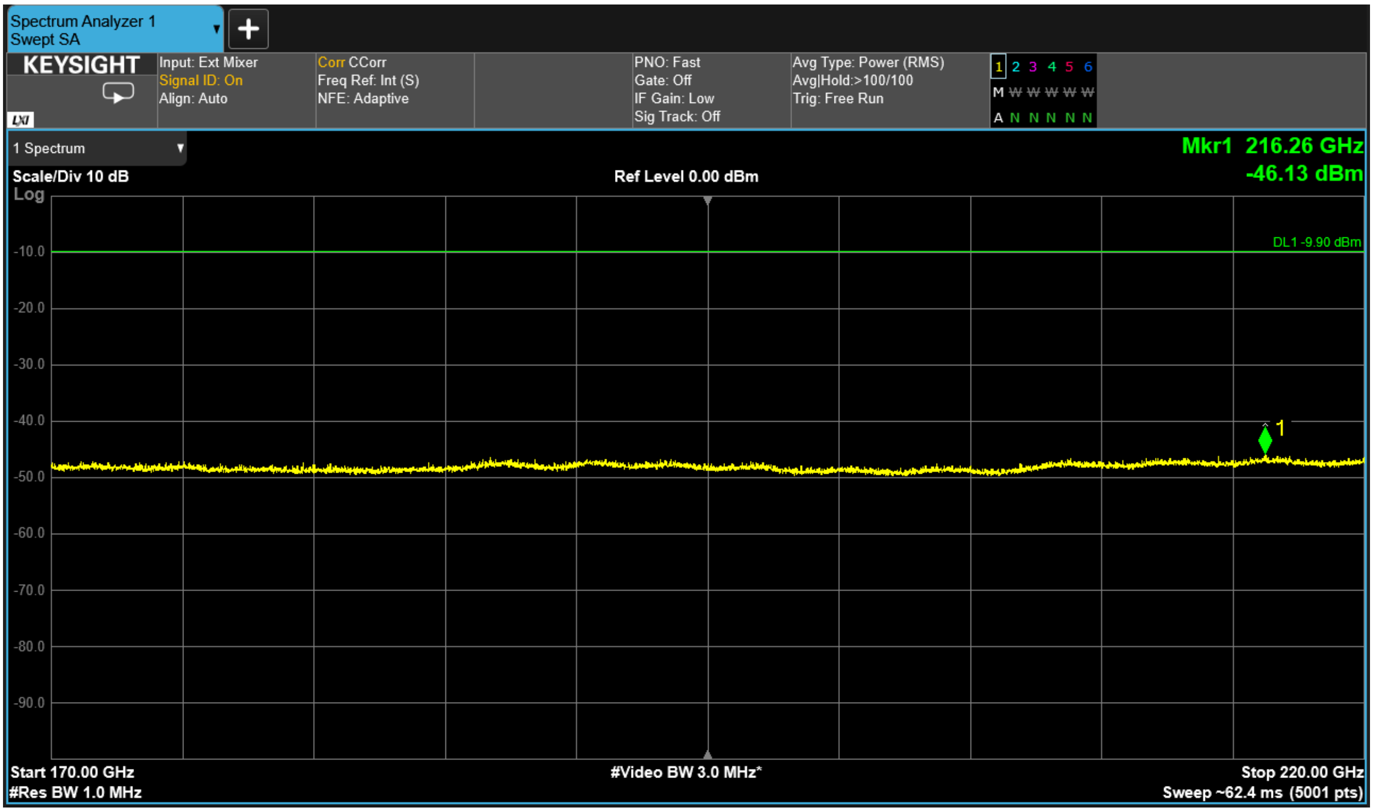
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	660, 666, 667, 668, 669, 675, 687

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

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

Transmitter spurious radiation (170 GHz – 220 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Receiver Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**db**	**dBm**	**dBm**	**dB**
**	---	---	---	---	---	---	---	---	---



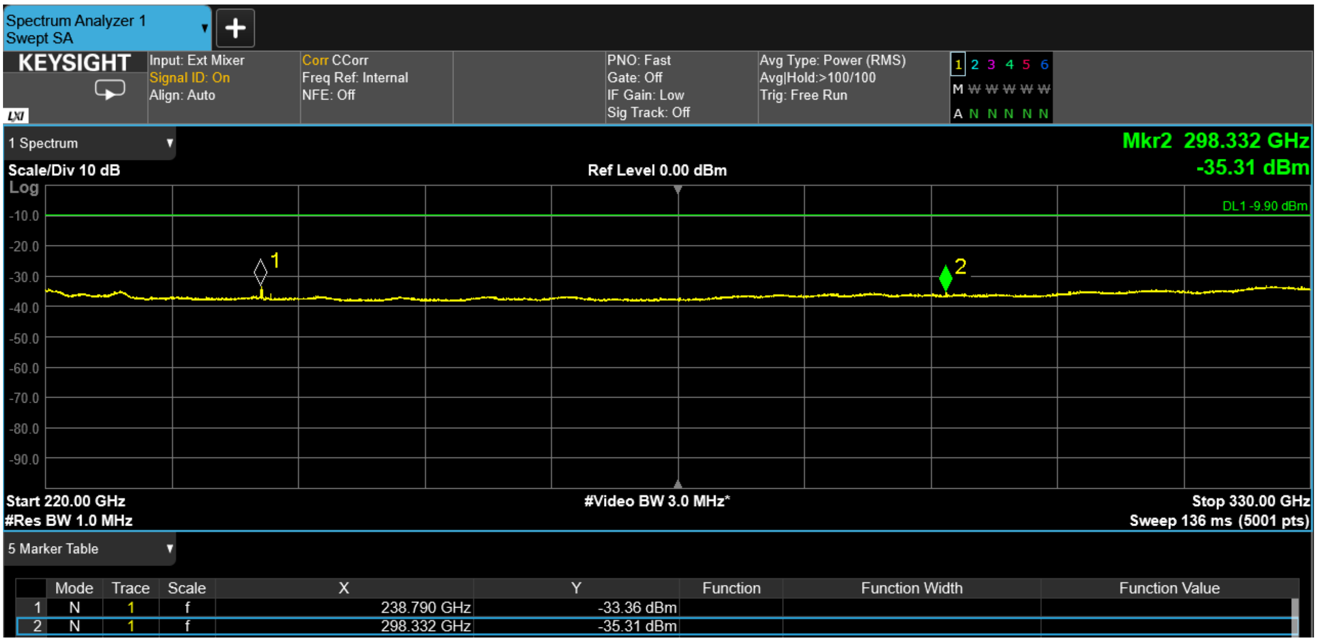
Measurement uncertainty: ± 6.8 dB
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	660, 666, 667, 668, 669, 677, 688

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

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

Transmitter spurious radiation (220 GHz – 330 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Receiver Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**db**	**dBm**	**dBm**	**dB**
238.79	Average	1000	-90.4	67.95	24.6	13.7	**-33.4**	-9.9	23.5
298.33	Average	1000	-93.11	69.91	26.4	14.3	**-35.3**	-9.9	25.4



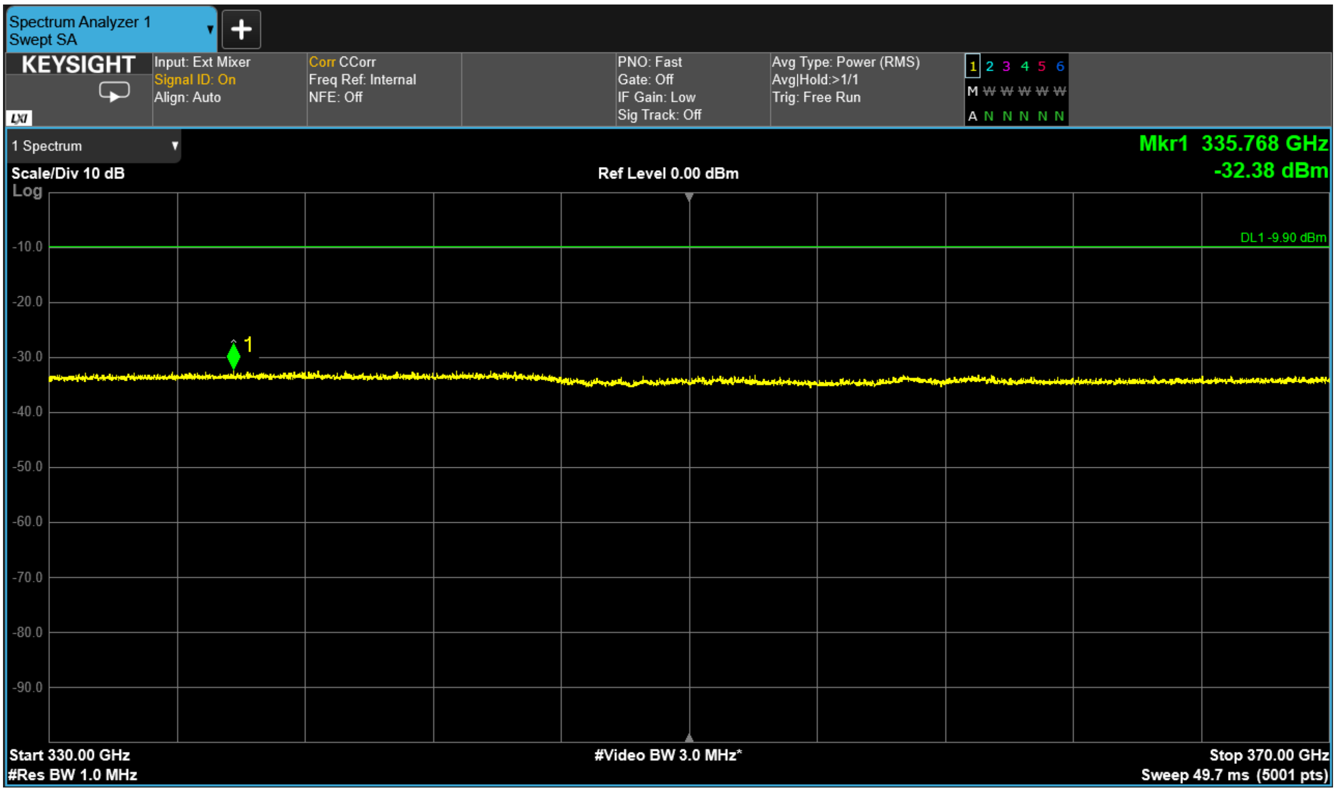
Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	660, 666, 667, 668, 669, 679, 689

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*
Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

Transmitter spurious radiation (330 GHz – 370 GHz) (FCC § 15.258 (c)(3))									
Frequency	**Receiver Detector**	**BW**	**RL**	**FSPL**	**G**	**CL**	**EIRP**	**Limit**	**Margin**
GHz	**Type**	**kHz**	**dBm**	**dB**	**dBi**	**db**	**dBm**	**dBm**	**dB**
**	---	---	---	---	---	---	---	---	---



Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	660, 666, 667, 668, 669, 679, 689

The equipment passed the conducted tests	**Yes**	~~No~~	~~N.t.~~*
Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 6

8.7 Bandwidth

8.7.1 Regulation

According to FCC § 15.258 (d) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

8.7.2 Test Procedure

6 dB Bandwidth and Occupied Bandwidth (99 % Bandwidth) were measured. The Occupied Bandwidth was measured directly from the spectrum analyzer's in-built measurement function with correct analyzer settings (RBW, VBW, detector, span and etc). For 6 dB Bandwidth, the measurement settings and procedure were carried out in accordance with the ANSI C63.10-2013 section 9.3. The bandwidth measurements were also performed in extreme environmental conditions.

8.7.3 Result

Measured 99% BW GHz	Measured 6dB BW GHz
3.95	**3.66**

Test Cables used	K163
Test equipment used	666, 675, 687

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

Test setup photos / test results are attached	**Yes**	~~No~~	Annex no.: 3

8.8 Frequency tolerance

8.8.1 Regulation

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

8.8.2 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.

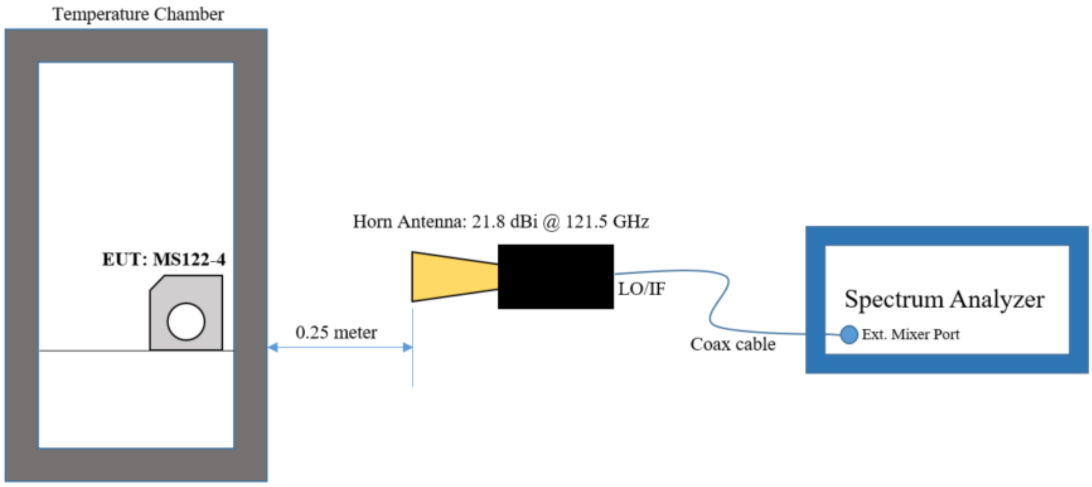
Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator,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

8.8.2 Test setup



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.

8.7.3 Result

Test conditions	Frequency tolerance			
	Frequency (GHz)			
T_{nom} = +19° C	f_L Measured	f_H Measured	f_L Limit	f_H Limit
V_{min} = 36 V DC	118.911300	122.88538	116.000	123.000
V_{nom} = 48 V DC	118.93403	122.88298	116.000	123.000
V_{max} = 57 V DC	118.91223	122.88588	116.000	123.000
Measurement uncertainty	$\pm 5*10^{-8}$			

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
V_{nom} = 48 V DC	f_L Measured	f_H Measured	f_L Limit	f_H Limit
T_{min} -20 °C	119.210966	122.88601	116.000	123.000
T_{min} -10 °C	119.06213	122.88744	116.000	123.000
T_{min} 0 °C	119.00923	122.88957	116.000	123.000
T_{min} +10 °C	188.96829	122.88812	116.000	123.000
T_{min} +20 °C	118.92178	122.88679	116.000	123.000
T_{min} +30 °C	118.91759	122.88652	116.000	123.000
T_{min} +40 °C	118.92298	122.88448	116.000	123.000
T_{min} +50 °C	118.89169	122.87776	116.000	123.000
T_{min} +60 °C	118.86107	122.88635	116.000	123.000
T_{min} +70 °C	118.88231	122.88678	116.000	123.000
Measurement uncertainty	$\pm 5*10^{-8}$			

Test Cables used	K163
Test equipment used	102a, 666, 675, 687, 401, 226

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

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

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LESKANPARK, Gebäude 10, Waltherstr. 49-51, 51069 Köln, Germany

8.8 RF radiation exposure

8.8.1 Regulation

According to FCC § 15.255 (g), Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Note 1: f = frequency in MHz; * = Plane-wave equivalent power density
Note 2: RF exposure calculation according to §1.1310 and §2.1091

8.8.2 Result

These equations are generally accurate in the far field of an antenna but will over predict power density in the near field, where they could be used for making a “worst case” prediction.

$S = PG/4\pi R^2$

where S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units e.g. mW)
G = power gain of the antenna in the direction of interest relative to the isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units e.g. cm)

OR, $S = EIRP/(4\pi R^2)$

where, EIRP = equivalent isotropically radiated power

Operating Frequency	EIRP		Power density (S) @ 20 cm	
			Calculated	Limit
GHz	dBm	mW	mW/cm^2	
121.5	17.0	50.1	0.0099	1.0

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

Test setup photos / test results are attached	~~Yes~~	No	---

9. Additional information to the test report

Remarks	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

10. List of test equipments

State Nov. 15, 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*
Diode Power Sensor 100 kHz – 6 GHz	Rohde & Schwarz	NRV-Z5 S/N: 829562/008	*Nov 22*	*Nov 24*	*390*
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	4246B-20	*Sep 22*	*Sep 25*	*472/492*
Coaxial directional coupler	Narda	3045C-10	*Sep 22*	*Sep 25*	*110a*
Coaxial directional coupler	Narda	3044B-10	*Sep 22*	*Sep 25*	*21a*
Coaxial directional coupler	Narda	3044B-30	*Sep 22*	*Sep 25*	*327*
Coaxial directional coupler	Narda	3022 / 50204	*Sep 22*	*Sep 25*	*303*
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+	*Sep 22*	*Sep 25*	*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	*Jul 22*	*Jul 24*	*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	*Oct 22*	*Oct 24*	*262*
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	*Dec 21*	*Dec 23*	*264*
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	*Jun 22*	*Jun 24*	*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 22*	*Sep 25*	*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*
RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	URY-Z7	*Aug 22*	*Aug 25*	*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*
Insertion Unit 100V | 100 kHz – 2 GHz	Rohde & Schwarz	URY-Z4	*Jun 22*	*Jun 24*	*417*
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 (SN: 8120499A)	*Oct 22*	*Oct 24*	*551*
HV Probe P6013A	Tektronix	P6013A	*Jul 22*	*Jul 24*	*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	PAS 1000 SyCore + 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	*Jun 22*	*Jun 24*	*612*
Current probe TRMS	BEHA APROB	CHB35	*Nov 22*	*Nov 24*	*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	*Oct 22*	*Oct 24*	*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	*Sep 22*	*Sep 24*	*46a*
ESD Generator	Schlöder	SESD 216	*Dec 21*	*Dec 23*	*653*

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Signal Generator	Rohde & Schwarz	SMB100A SW 4.20.028.58	*Sep 22*	*Sep 24*	*571*
RF Generator	Rohde & Schwarz	SGT100A	*Jun 22*	*Jun 24*	*636*
Signal Generator	Rohde & Schwarz	SMG	*Jun 22*	*Jun 24*	*136a*
Signal Generator	Marconi	2042	*Jul 22*	*Jul 24*	*6*
Signal Generator	Marconi	2024	*Jul 22*	*Jul 24*	*213*
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*
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500 S/N: 171332	*Aug 22* *Factory cal.*	*Aug 23*	*691*
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 / 20029	*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/ 100037	*Aug 21*	*Aug 23*	*515*
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20 / 070106	---	---	*518*
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140 / 20006	*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 / 20002	*Aug 21*	*Aug 23*	*546*
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	*548*
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90 / 100062	*Aug 21*	*Aug 23*	*501*
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	*549*
Gain Horn 33-55 GHz	Dorado	040810	---	---	*383*
Gain Horn 50-75 GHz	Dorado	031003	---	---	*384*
Gain Horn 75-110 GHz	Dorado	040808	---	---	*385*
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	*532/628*
Waveguide Harmonic Mixer 50 – 75 GHz	Keysight	M1971V	*Jan 22*	*Jan 24*	*673*
Waveguide Harmonic Mixer 75 – 110 GHz	Keysight	M1971W	*Jan 22*	*Jan 24*	*674*
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	Jun 22	Jun 24	675
Spectrum/Signal Analyzer Extension Module 140 GHz – 220 GHz (WR-5.1)	Virginia Diodes, Inc.	SAX 636	Jun 22	Jun 24	677
Spectrum/Signal Analyzer Extension Module 220 GHz – 330 GHz (WR-3.4)	Virginia Diodes, Inc.	SAX 635	Jun 22	Jun 24	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	*Sep 20*	*Sep 24*	*166a*

Mitteq amplifier 26.5-40 GHz	Mitteq	---	*Sep 22*	*Sep 24*	*223a*
RF pre-amplifier 1-18GHz	Narda	---	*Sep 22*	*Sep 24*	*345*
Mitteq Amplifier 18-26GHz	Mitteq	---	*Apr 20*	*Apr 23*	*433*
Microwave amplifier 12-28GHz	Schwarzbeck	BBV9719	*Sep 22*	*Sep 24*	*443*
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	*Sep 22*	*Sep 24*	*444*
RF-Power Amplifier 10kHz-1000 MHz	Poetschke	8100 (Band 1) BHED (Band 2) BHED (Band 3)	---	---	*684*
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	*Jun 22*	*Jun 25*	*161*
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	*Cal. before use*	*Cal. before use*	*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	*Oct 22*	*Oct 24*	*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	*Nov 22*	*Nov 24*	*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*
Network Analyser 9 kHz -6 GHz	Rohde & Schwarz	ZVL6 (SN: 101268)	*Sep 22*	*Sep 24*	*534*
Signal Analyser 10 Hz – 30 GHz	Rohde & Schwarz	FSV 30 S/N: 100932	*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	---	---	---

11. List of test cables

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
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

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
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	APC3.5	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 – 26500	5.70	Rosenberger
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
189	PC-PC	10 – 26500	6.00	Jyebao
190	PC-PC	10 – 26500	6.00	Jyebao
192	N-N	10 – 18000	3.0	Jyebao
193	N-N	10 – 18000	3.0	Jyebao
194	N-SMA	10 – 18000	2.0	Jyebao
195	N-SMA	10 – 18000	2.0	Jyebao
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	---

End of test report