
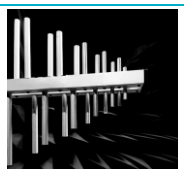
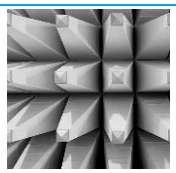

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-1291/20-01-02-B

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://www.ctcadvanced.com
e-mail: mail@ctcadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

CIAS Elettronica S.r.l.
Via G. Durando, 38
20158 Milano (MI) / ITALY
Phone: +39 02 37 67 16 237
Contact: Ing. Manzoli Romano
e-mail: manzoli.romano@cias.it
Phone: +39 02 37 67 16 237

Manufacturer

CIAS Elettronica S.r.l.
Via G. Durando, 38
20158 Milano (MI) / ITALY

Test standard/s

47 CFR Part 15	Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 210 Issue 10	Radio Standards Specification - Licence-Exempt Radio Apparatus: Category II Equipment

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

Test Item

Kind of test item:	**External Microwave Protection Barrier**
Model name:	**MICRORAY**
FCC ID:	**OIFMICRO-RAY**
IC:	**3325A-MICRORAY**
Frequency:	24.075 GHz – 24.175 GHz
Antenna:	2 antennas (1 TX and 1 RX)
Power supply:	11.5 V to 16.0 V DC by external power supply
Temperature range:	-35°C to +65°C

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

Test report authorized:

M. Walla
cn=Meheza Walla, o=CTC advanced GmbH, ou=WAL-200806, email=meheza.walla@ctcadvanced.com, c=DE
2021.07.13 17:29:24 +02'00'

Meheza Walla
Lab Manager
Radio Communications

Test performed:

p.o. Thomas Vogler
cn=Thomas Vogler, o=CTC advanced GmbH, ou=VOG-161125, email=thomas.vogler@ctcadvanced.com, c=DE
2021.07.13 17:26:39 +02'00'

Sebastian Janoschka
Lab Manager
Radio Communications

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

This test report replaces the test report with the number 1-1291/20-01-02 and dated 2021-01-25

2.2 Application details

Date of receipt of order:	2020-10-22
Date of receipt of test item:	2020-11-11
Start of test:*	2020-11-12
End of test:*	2020-12-21
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 15		Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 210 Issue 10	12-2019	Radio Standards Specification - Licence-Exempt Radio Apparatus: Category II Equipment
RSS-GEN	03-2019	General Requirements for Compliance of Radio Apparatus

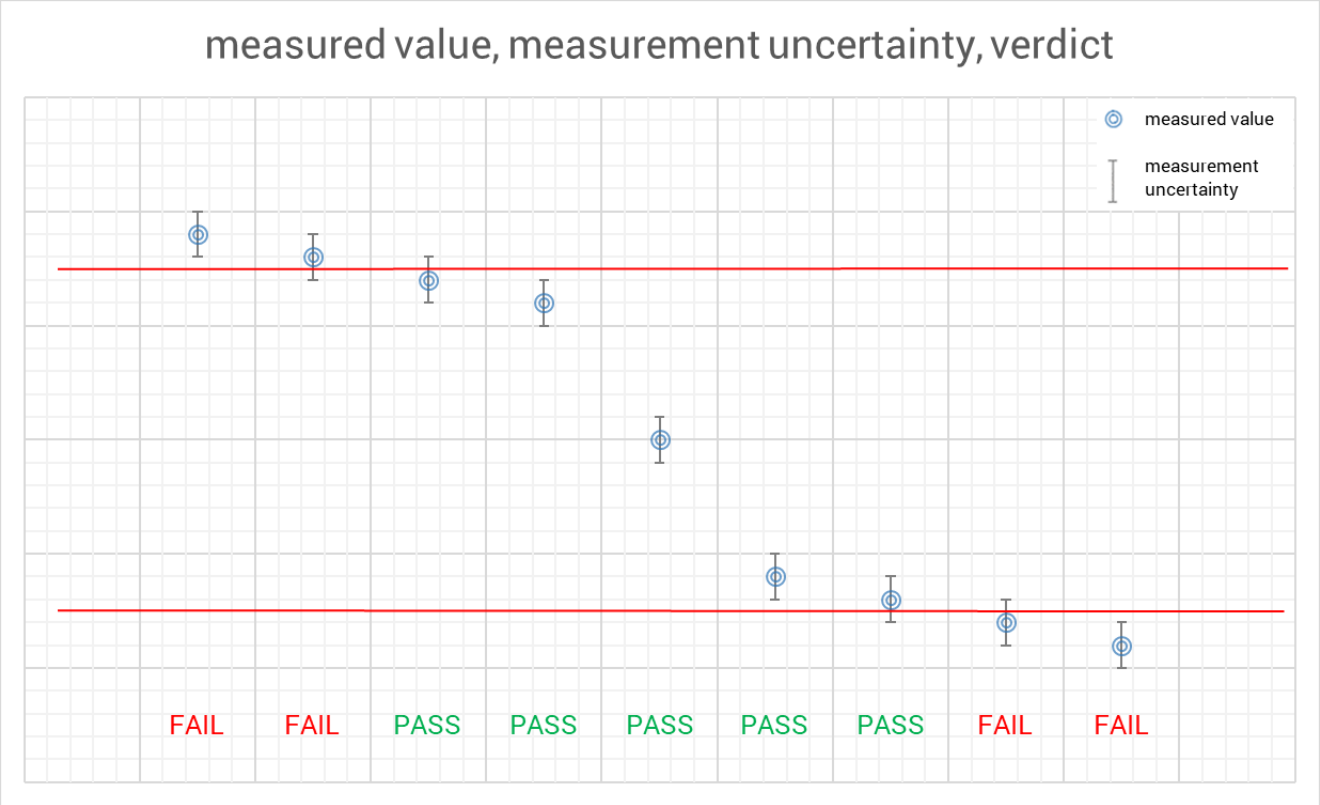
Guidance	Version	Description
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+20 °C during room temperature tests +50 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		48 %
Barometric pressure	:		1000 hPa
Power supply	:	V_{nom} V_{max} V_{min}	13.8 V DC by external power supply 16.0 V 11.5 V

5 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 8, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong.



6 Test item

6.1 General description

Kind of test item	:	External Microwave Protection Barrier
Type identification	:	MICRORAY
S/N serial number	:	R1-A 20KIMRA0001 (Transmitter), R1-B 20KIMRB0001 (Receiver)
HVIN	:	MICRORAY
PMN	:	MICRORAY
FVIN	:	TRANSMITTER HEAD = Ver. 1.02 RECEIVER HEAD = Ver. 1.02
HMN	:	-/-
HW hardware status	:	Transmitter head = N001 ; Receiver head = N001
SW software status	:	None
Firmware version		Transmitter head = Receiver head = Ver. 1.02
Frequency band	:	24.075 GHz – 24.175 GHz
Type of modulation	:	on/off
Number of channels	:	16
Number of modes	:	-/-
Antenna	:	2 antennas (1 TX and 1 RX)
Power supply	:	11.5 V to 16.0 V DC by external power supply
Temperature range	:	-35°C to +65°C

6.2 Additional information

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

Test setup- and EUT-photos are included in test report: 1-1291/20-01-01_AnnexA
1-1291/20-01-01_AnnexB
1-1291/20-01-01_AnnexD

7 Description of the test setup

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

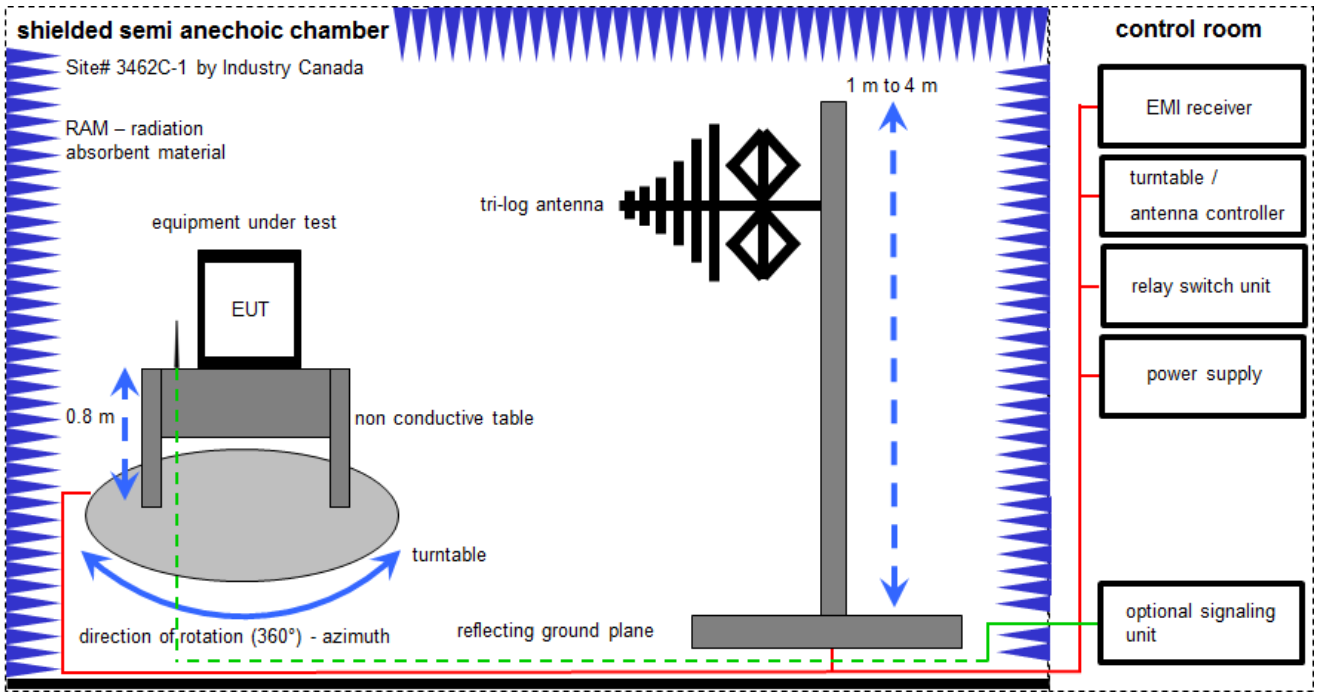
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter

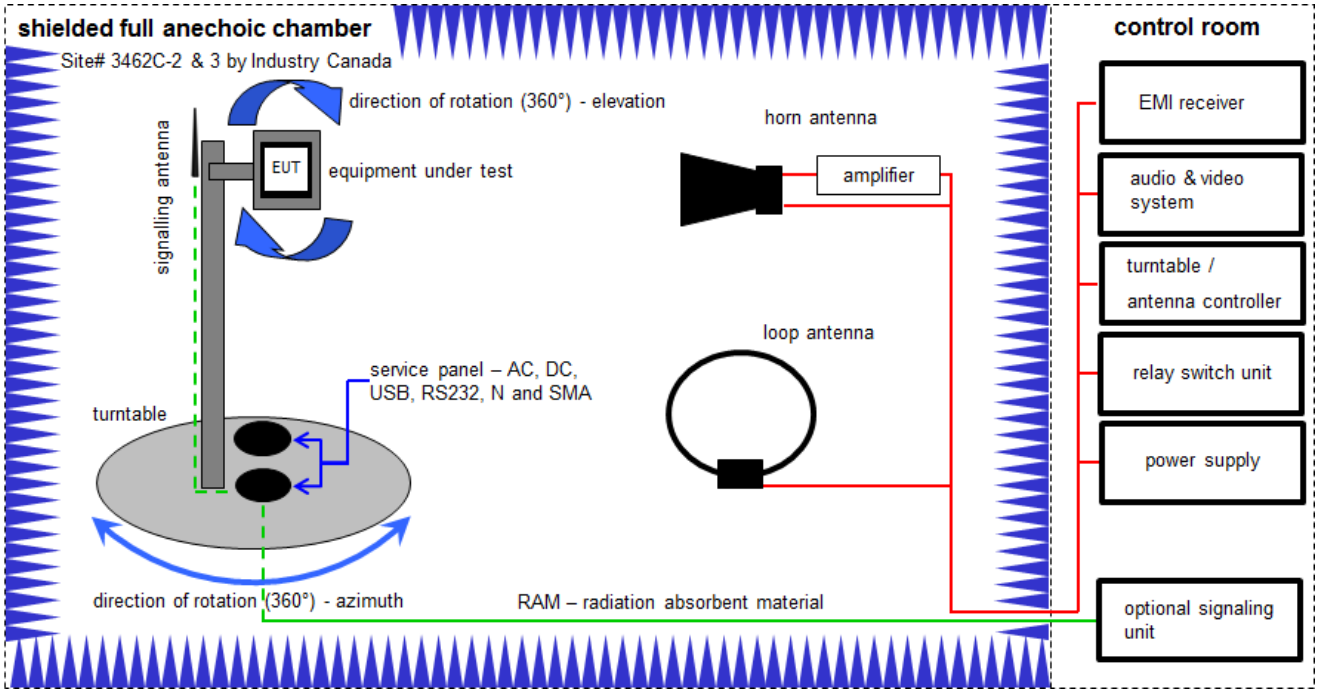
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	93	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
5	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
6	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	295	300003787	vlKl!	19.02.2019	18.02.2021
7	n. a.	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	10.12.2020	09.06.2022
8	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	17.01.2020	16.01.2022
9	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-

7.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

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

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

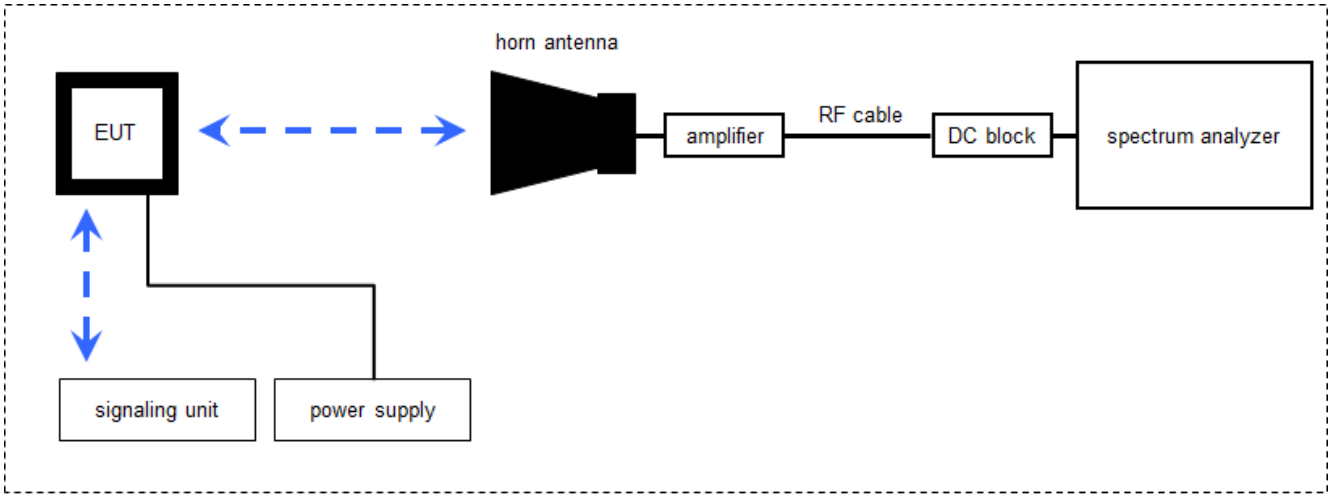
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

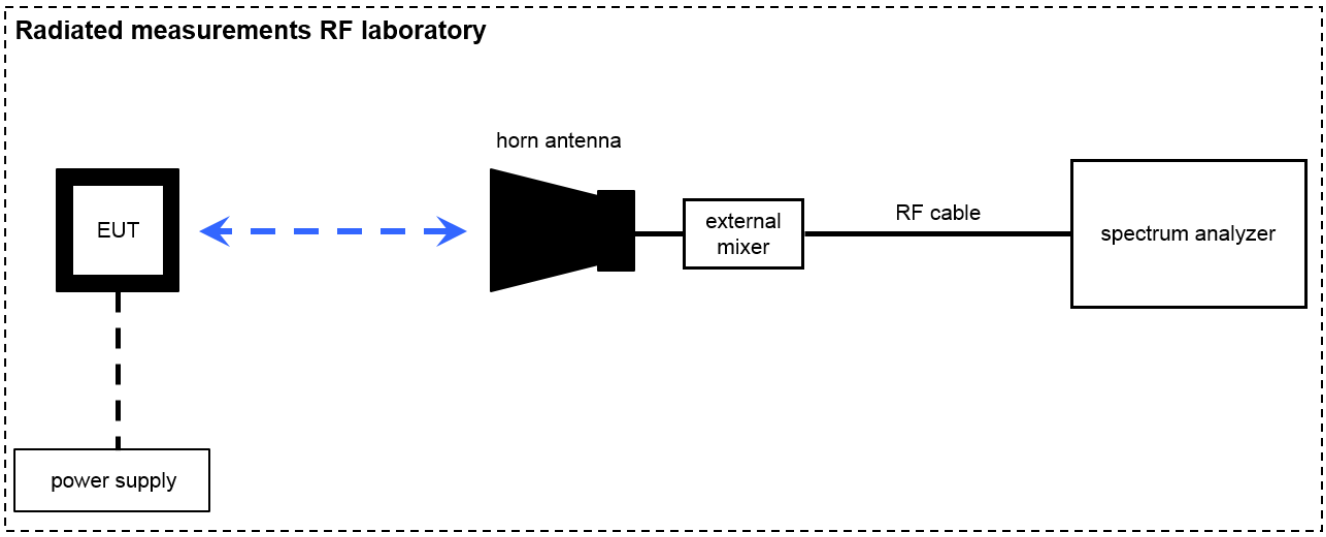
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vIKI!	27.02.2019	26.02.2021
3	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-
4	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22050	300004482	ev	-/-	-/-
5	n. a.	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
6	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
7	n. a.	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	09.12.2020	08.12.2021
8	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
9	n. a.	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
10	n. a.	NEXIO EMV-Software	BAT EMC V3.20.0.13	EMCO		300004682	ne	-/-	-/-
11	n. a.	Anechoic chamber		TDK		300003726	ne	-/-	-/-
12	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04590	300001041	vIKI!	09.12.2020	08.12.2023

7.3 Radiated measurements > 18 GHz



7.4 Radiated measurements > 50/85 GHz



Measurement distance: horn antenna e.g. 25 cm

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

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

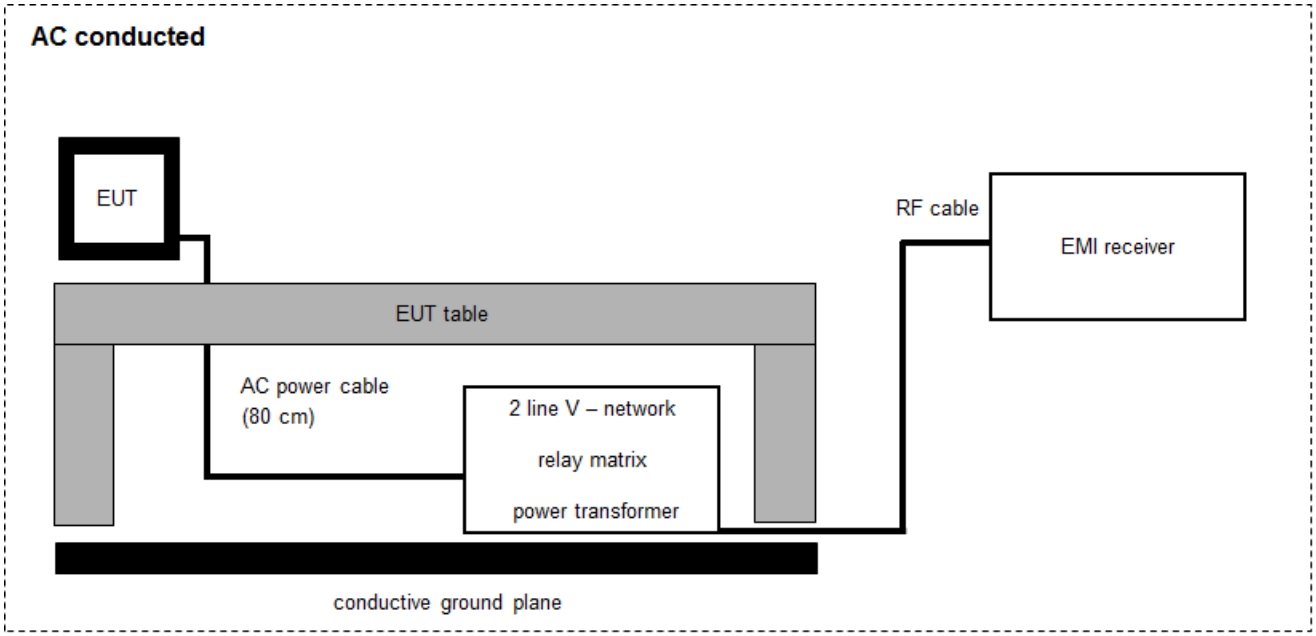
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance;
G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Spectrum Analyzer	FSW50	Rohde & Schwarz	101332	300005935	k	26.02.2020	25.02.2021
2	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	09.03.2020	08.03.2022
3	n.a.	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-021	300001747	vlKl!	18.02.2019	17.02.2022
4	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	01096	300000486	vlKl!	21.01.2020	20.01.2022
5	A031	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vlKl!	23.01.2020	22.01.2022
6	n. a.	Std. Gain Horn Antenna 33.0-50.1 GHz	2324-20	Flann	57	400000683	ne	-/-	-/-
7	n. a.	Harmonic Mixer 3-Port, 50-75 GHz	FS-Z75	Rohde & Schwarz	101578	300005788	k	17.06.2020	16.06.2021
8	A026	Std. Gain Horn Antenna 49.9-75.8 GHz	2524-20	Flann	*	300001986	ne	-/-	-/-
9	n. a.	Harmonic Mixer 3-Port, 75-110 GHz	FS-Z110	R&S	101411	300004959	k	19.06.2020	18.06.2021
10	A027	Std. Gain Horn Antenna 73.8-112 GHz	2724-20	Flann	*	300001988	ne	-/-	-/-

7.5 AC conducted



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

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	101	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	893045/004	300000584	k	10.12.2020	09.12.2021
2	67	RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
3	27	EM-Injection Clamp	FCC-203i	emv	232	300000626	ev	18.05.2001	-/-
4	n. a.	Magnetfeldantenne	MS 100	EM-Test	-----	300002659	ev	24.04.2000	-/-
5	n. a.	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	vlKl!	26.05.2020	25.05.2021
6	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	17.01.2020	16.01.2022
7	n. a.	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	08.04.2008	-/-
8	n. a.	Power Supply	NGSM 32/10	R&S	3939	400000192	vlKl!	11.12.2019	10.12.2022
9	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	09.12.2020	08.12.2021

8 Measurement uncertainty

Measurement uncertainty	
Occupied channel bandwidth	±5 %
RF power, conducted	±1.5 dB
Conducted spurious emission of transmitter, valid up to 6 GHz	±3 dB
Conducted emission of receivers	±3 dB
Radiated emission of transmitter, valid up to 6 GHz	±6 dB
Radiated emission of receiver, valid up to 6 GHz	±6 dB
RF level uncertainty for a given BER	±1.5 dB
Occupied channel bandwidth	±5 %
Temperature	±2.5 °C
Humidity	±10 %

9 Sequence of testing

9.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

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

Premeasurement*

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

Final measurement

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

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

9.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

9.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

9.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

9.5 Sequence of testing radiated spurious above 50/85 GHz with external mixers

Setup

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

Premeasurement

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

Final measurement

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

10 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	FCC 47 CFR Part 15 RSS-210 Issue 10	Passed	2021-07-13	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	C	NC	NA	NP	Results (max.)
§15.245(b) / RSS-210, F.1(a)	Field strength of fundamental emission	Nominal	Nominal	☒	☐	☐	☐	
§2.1049	Occupied bandwidth (99% bandwidth)	Nominal	Nominal	☒	☐	☐	☐	
§15.209(a) / §15.245(b) / RSS-210, F.1	Field strength of emissions (radiated spurious)	Nominal	Nominal	☒	☐	☐	☐	
§15.207(a) RSS-Gen 8.8	Conducted emissions < 30 MHz	Nominal	Nominal	☒	☐	☐	☐	
§15.215(c) RSS-Gen 8.11	Frequency Stability	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	

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

11 Measurement results

11.1 Field strength of fundamental emission

Description:

Measurement of the maximum radiated field strength of the wanted signal.

Measurement:

Measurement parameter	
Detector:	Pos-Peak / Average
Sweep time:	10 s
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	150 MHz
Trace-Mode:	Max Hold
Measurement uncertainty	± 3 dB

This test was performed on a shorter test distance. A correction factor of 20*log(x m/3 m) is already considered in the plots.

Limits:

FCC		IC
CFR Part 15.245(b)		RSS-210, F.1 (a)
Field strength of emissions		
The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:		
Frequency	Field Strength	Measurement distance
24.075 GHz – 24.175 GHz	128 dBµV/m (Average) 148 dBµV/m (PEAK)	3 m

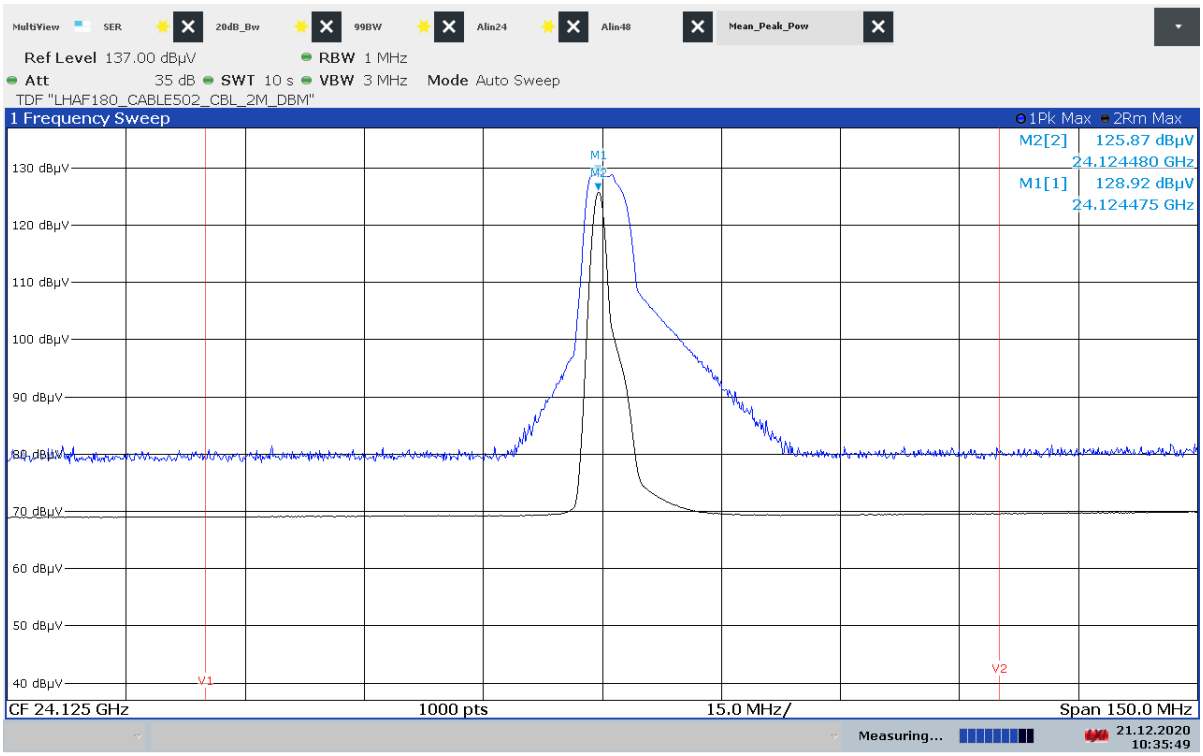
§15.245 (b) (4) The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

§15.31 (c) Except as otherwise indicated in §15.256, for swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

Measurement results:

Test condition	Maximum field strength (Peak) (dBµV/m @3m)	Maximum field strength (Average) (dBµV/m @3m)
T_{nom} / V_{nom}	128.92	125.87

Plot No. 1: Field strength



11.2 Occupied bandwidth (99% bandwidth)

Description:

Measurement of the 99% bandwidth of the wanted signal.

Measurement:

Parameter	
Detector:	Pos-Peak
Sweep time:	20 s
Resolution bandwidth:	50 Hz
Video bandwidth:	1 kHz
Span:	10 MHz
Trace-Mode:	Clear Write
Measurement uncertainty	± Span/1000

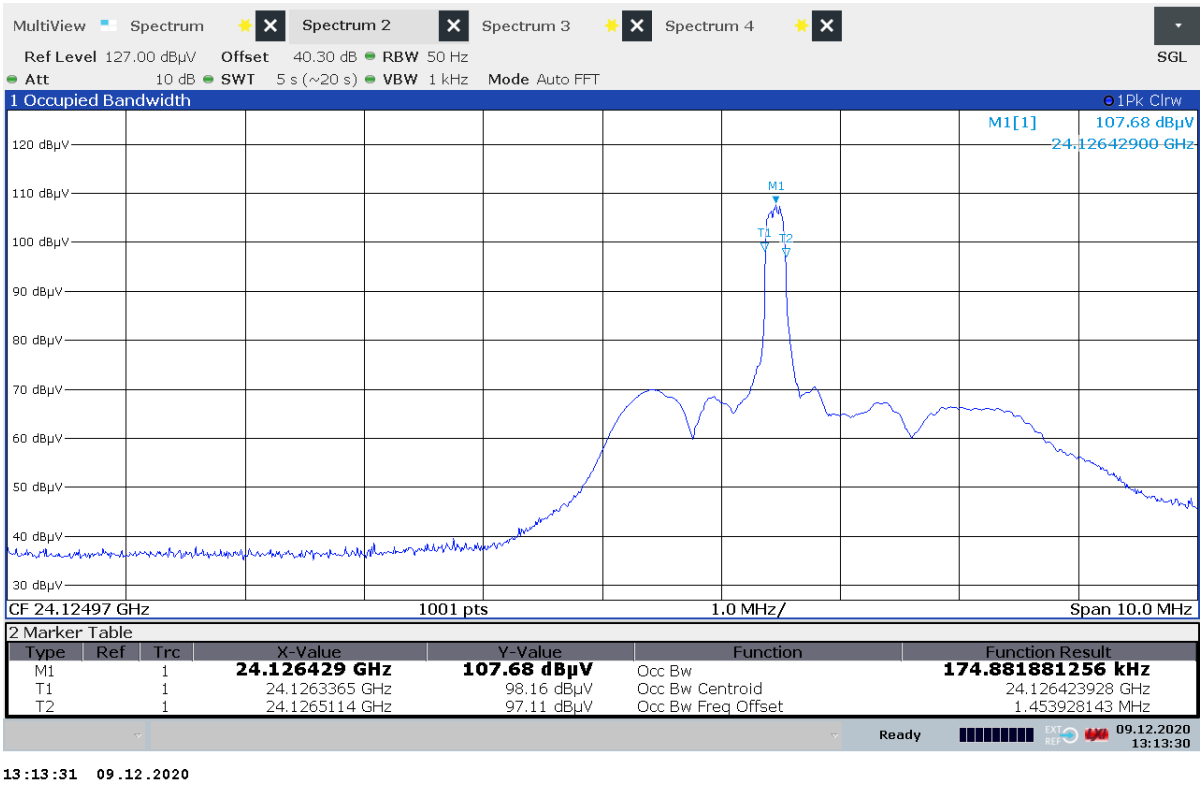
Limits:

FCC	IC	
CFR Part 15.245(b)	RSS-210, F.1(a)	
The field strength of emissions from intentional radiators operated within the specified frequency band shall comply with the following		
Frequency range	f_L	f_H
100 MHz	> 24.075 GHz	< 24.175 GHz

Measurement results:

Test condition	f_L (GHz)	f_H (GHz)	Occupied bandwidth (kHz)
T_{nom} / V_{nom}	24.1263365	24.1265114	175

Plot No. 2: Occupied bandwidth (99% bandwidth)



11.3 Field strength of emissions (radiated spurious)

Description:

Measurement of the radiated spurious emissions.

Measurement:

Parameter	
Detector:	Quasi-Peak / Pos-Peak / Average
Sweep time:	Auto
Resolution bandwidth:	100 kHz / 1 MHz
Video bandwidth:	300 kHz / 3 MHz
Trace-Mode:	Max Hold
Measurement uncertainty	± 3 dB

Limits:

FCC	IC	
CFR Part 15.209(a) / CFR Part 15.245(b)	RSS-210, F.1 / RSS - GEN	
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.		
Frequency (MHz)	Field Strength (µV/m)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

§15.245 (b) (1) Regardless of the limits shown in the table of §15.245 (b), harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:
(i) For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

§15.245 (b)(4) The emission limits shown in §15.245 (b) are based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

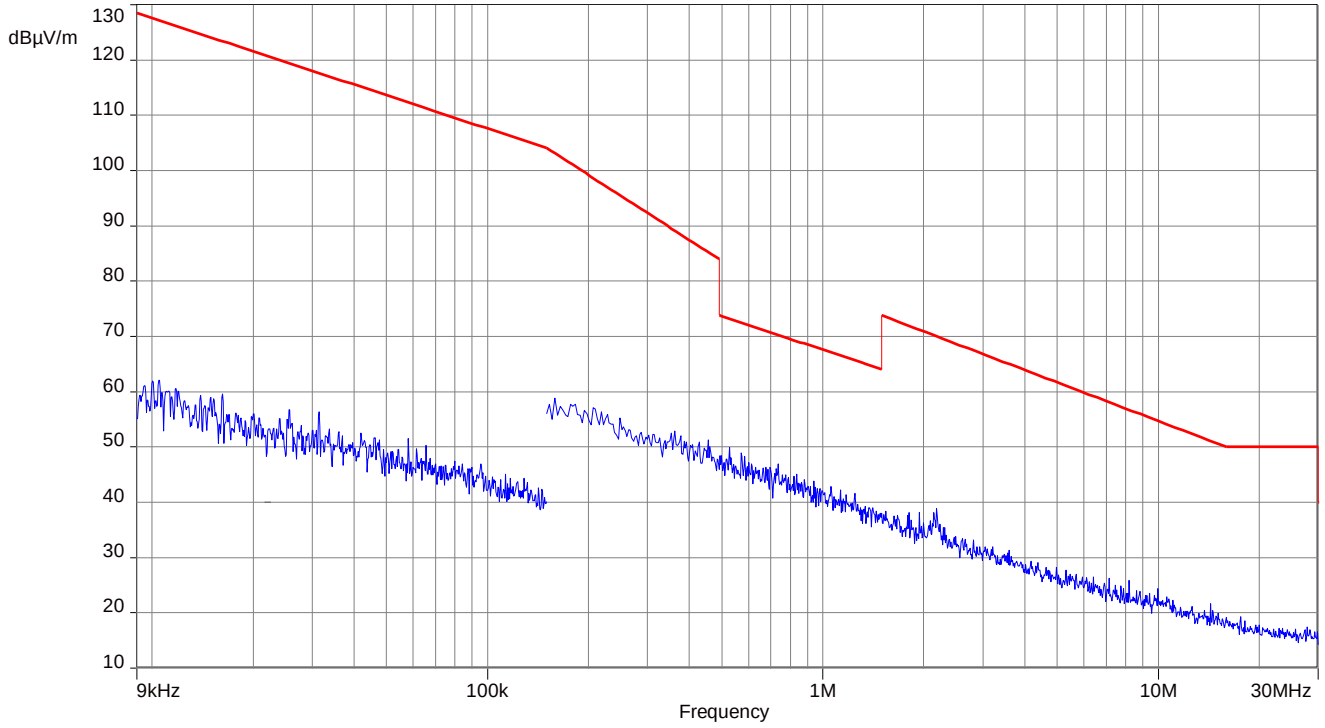
§15.31 (c) Except as otherwise indicated in §15.256, for swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

Measurement results:

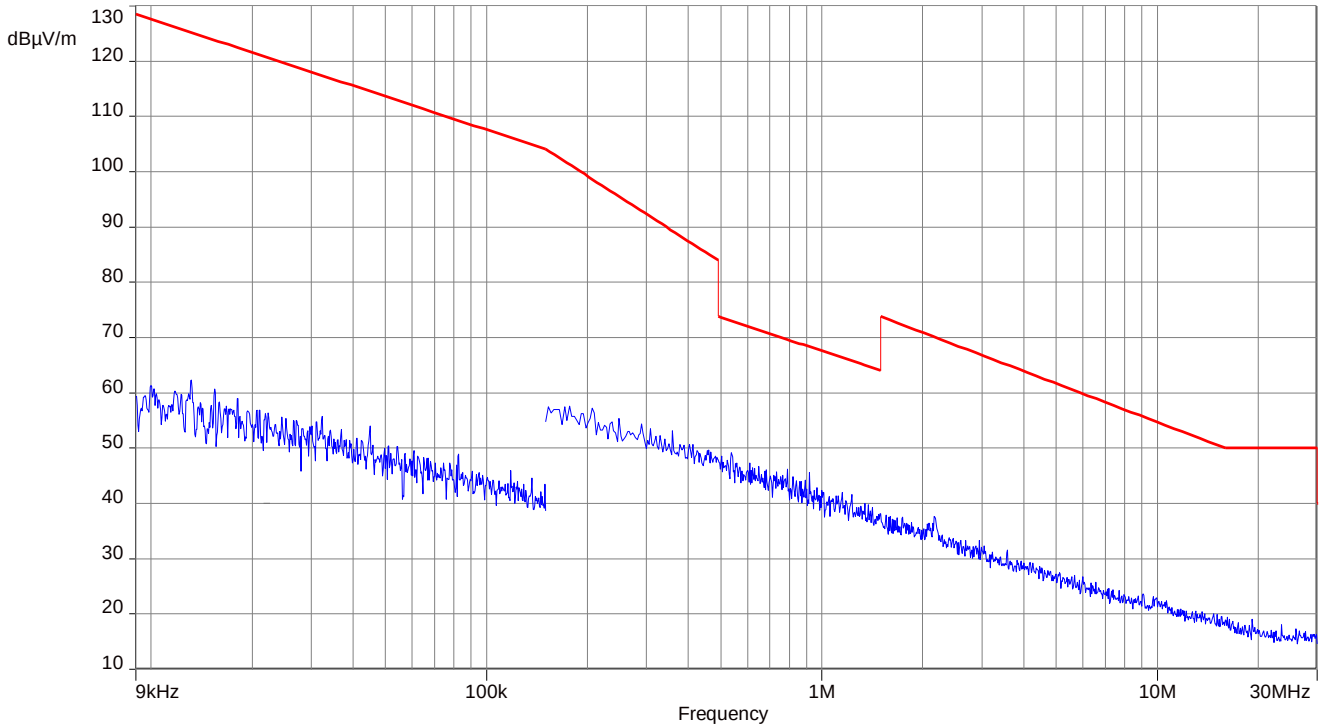
f [GHz]	Detector	Measured level [dBµV/m]	Margin
48.2484	Average	51.95	36.05
48.2484	Pos-Peak	66.34	41.66

Note:
Measurements above 50 GHz were performed on a short measurement distance (≤1m) to improve the minimum sensitivity of the test system. A correction factor of 20*log(d/3m) is already considered in the plots.

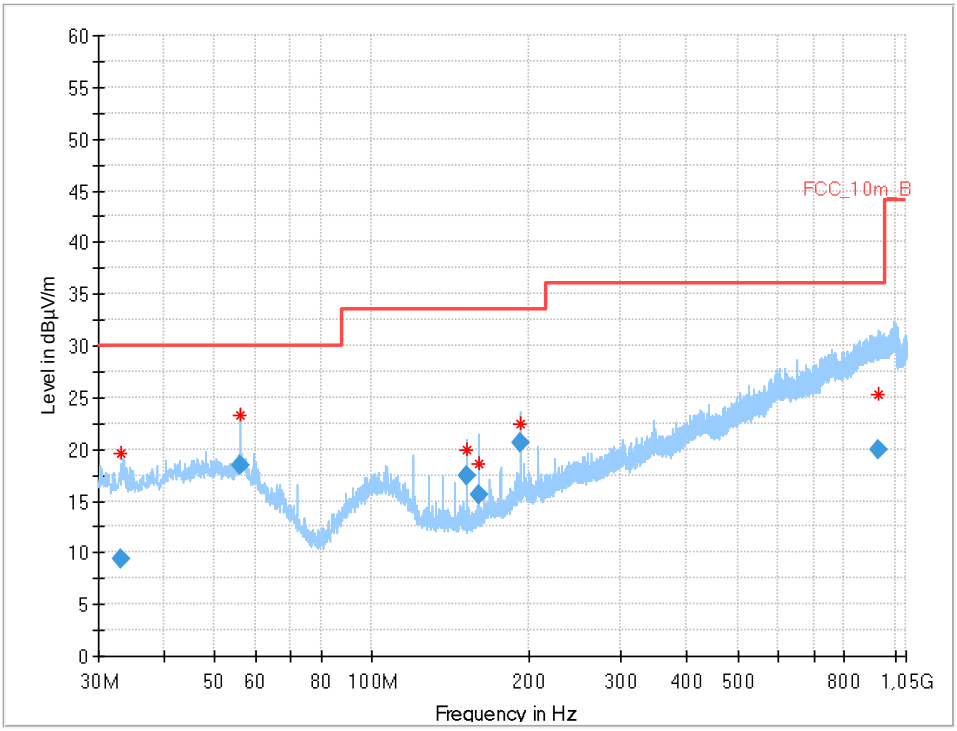
Plot No. 3: 9 kHz to 30 MHz, Transmitter



Plot No. 4: 9 kHz to 30 MHz, Receiver



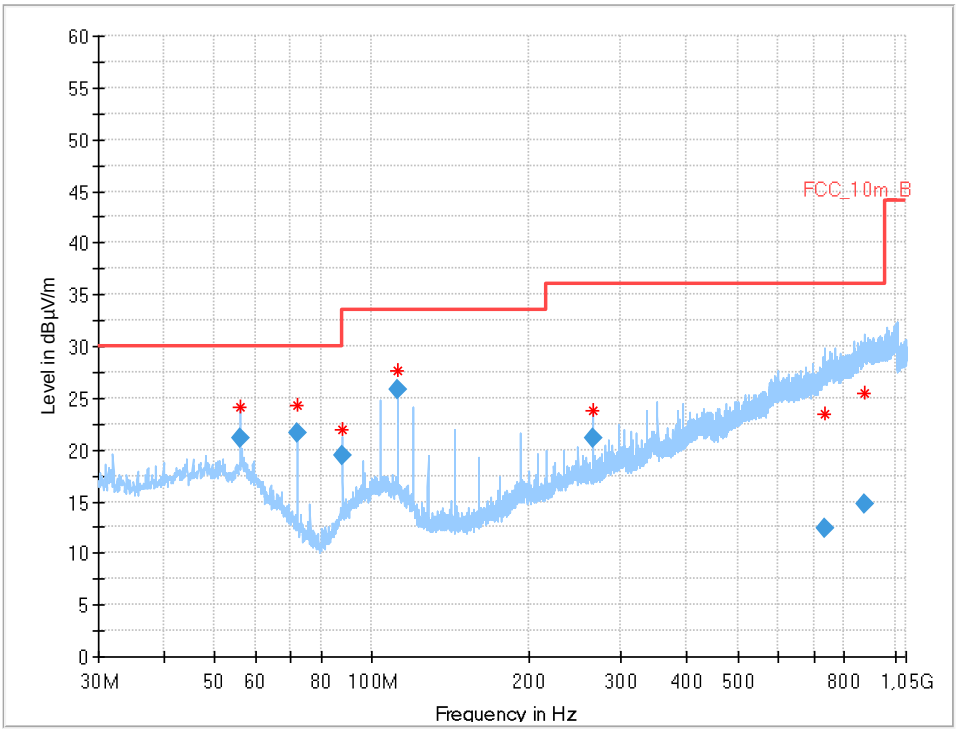
Plot No. 5: 30 MHz to 1 GHz, Transmitter



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.219	9.35	30.0	20.7	1000	120.0	200.0	V	135	12
56.049	18.47	30.0	11.5	1000	120.0	329.0	V	180	15
152.144	17.44	33.5	16.1	1000	120.0	127.0	V	48	9
160.153	15.59	33.5	17.9	1000	120.0	103.0	V	90	9
192.196	20.61	33.5	12.9	1000	120.0	100.0	V	331	11
927.069	19.99	36.0	16.0	1000	120.0	200.0	V	228	24

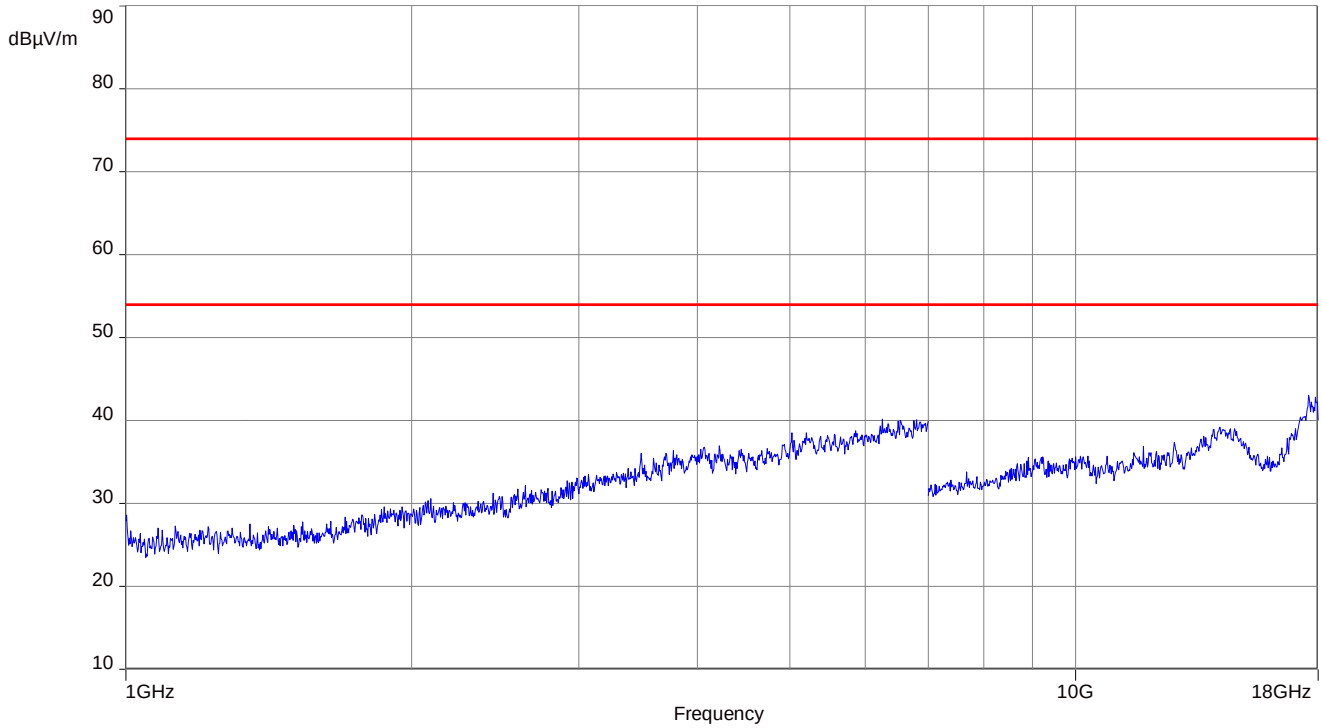
Plot No. 6: 30 MHz to 1 GHz, Receiver



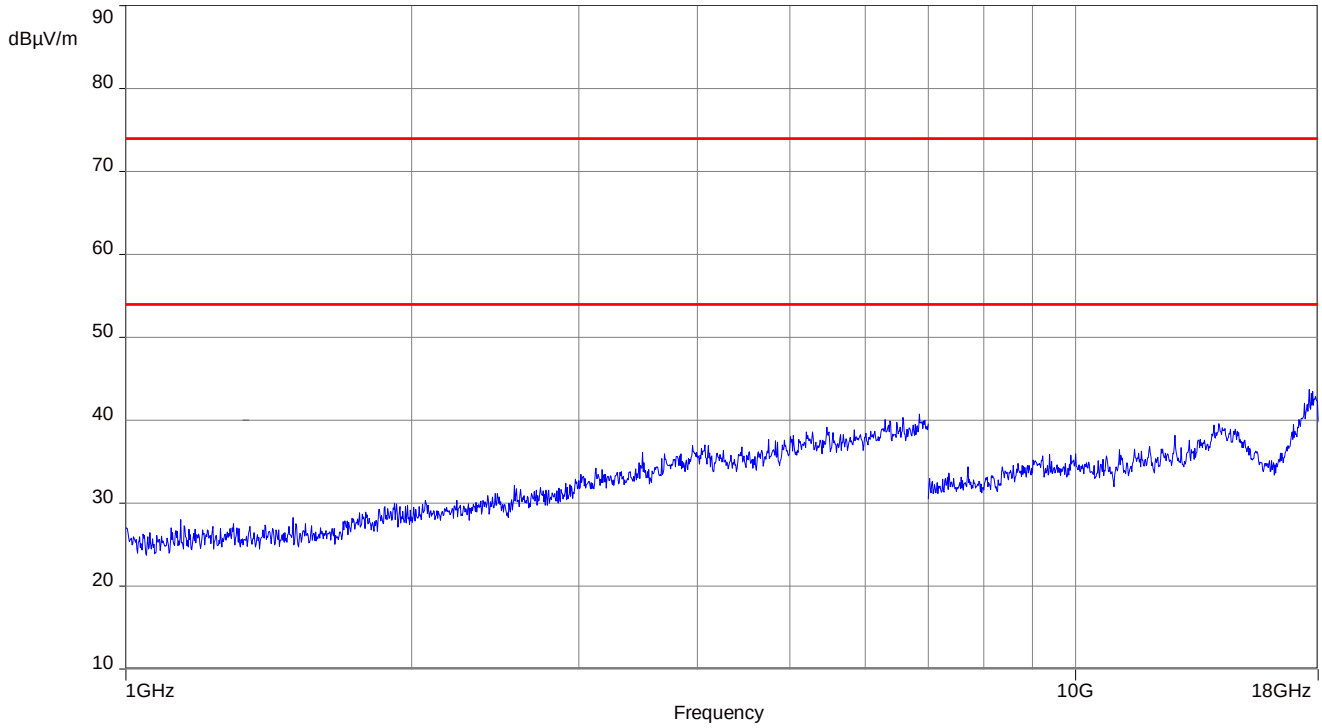
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
55.995	21.14	30.0	8.9	1000	120.0	284.0	V	51	15
72.007	21.63	30.0	8.4	1000	120.0	211.0	V	99	9
88.023	19.50	33.5	14.0	1000	120.0	115.0	V	90	10
112.018	25.77	33.5	7.7	1000	120.0	130.0	V	180	12
264.049	21.11	36.0	14.9	1000	120.0	100.0	V	198	13
734.753	12.47	36.0	23.5	1000	120.0	264.0	V	45	22
874.604	14.76	36.0	21.2	1000	120.0	300.0	V	180	23

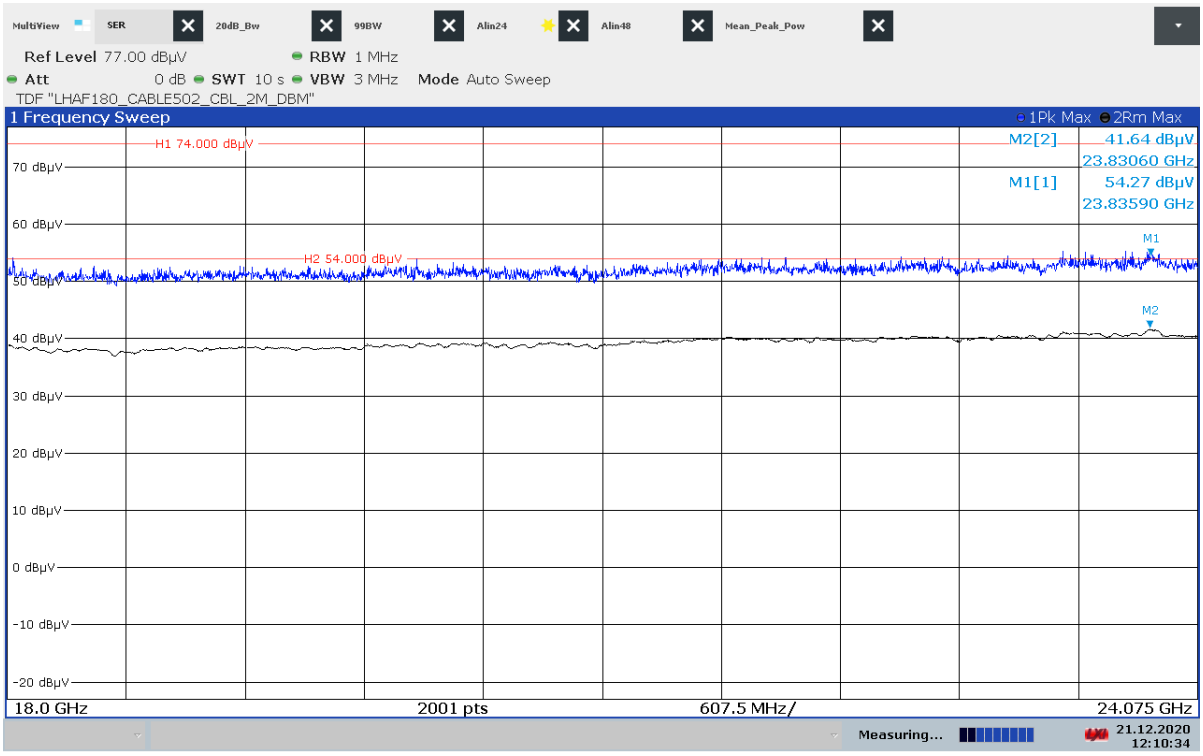
Plot No. 7: 1 GHz to 18 GHz, Transmitter



Plot No. 8: 1 GHz to 18 GHz, Receiver

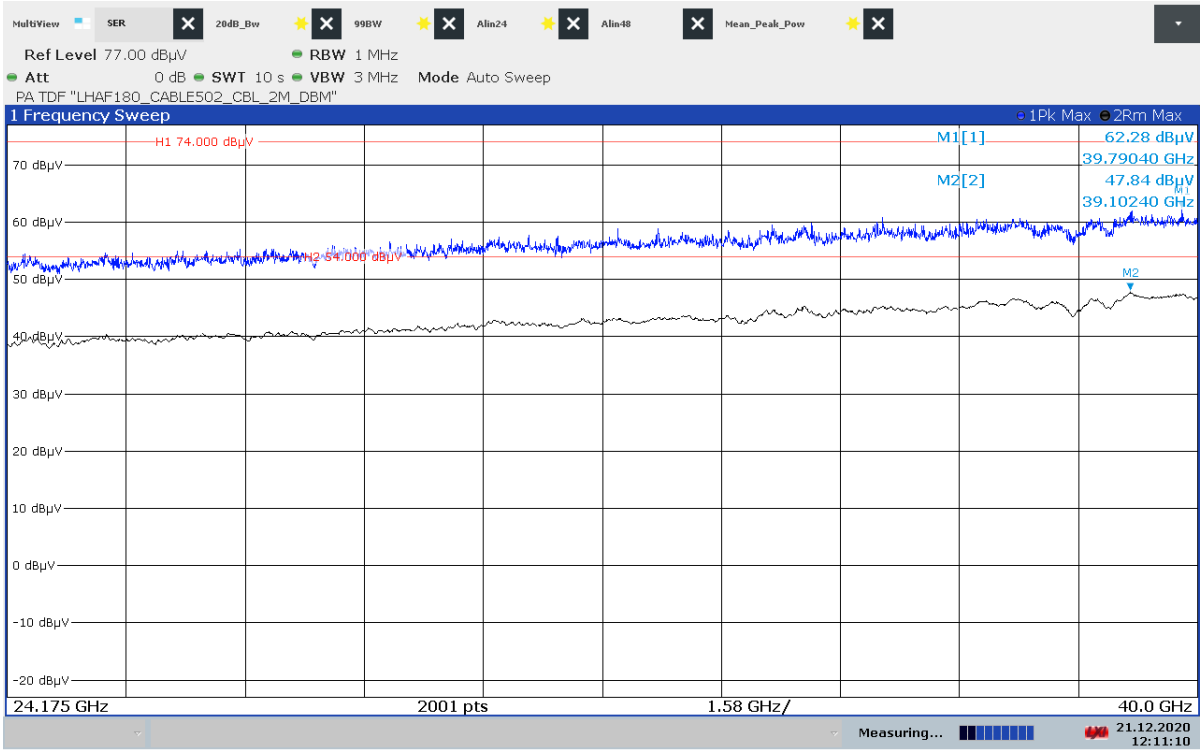


Plot No. 9: 18 GHz to 24.075 GHz



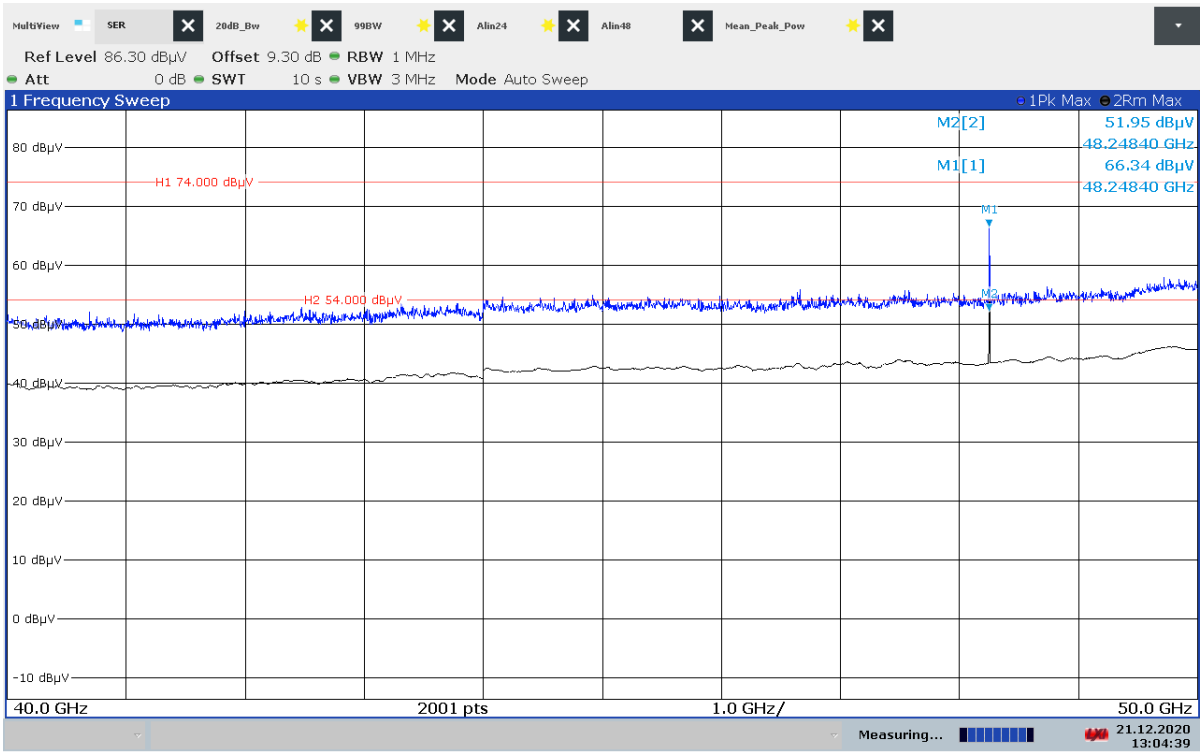
12:10:34 21.12.2020

Plot No. 10: 24.175 GHz to 40 GHz



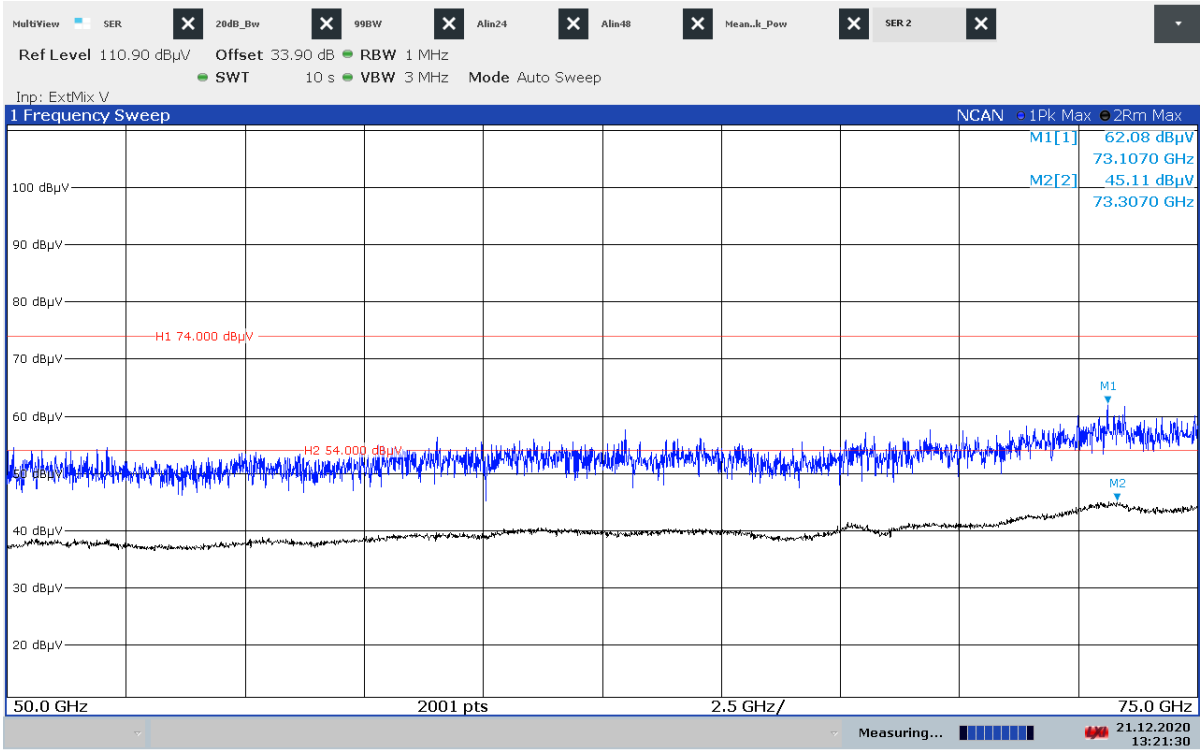
12:11:11 21.12.2020

Plot No. 11: 40 GHz to 50 GHz



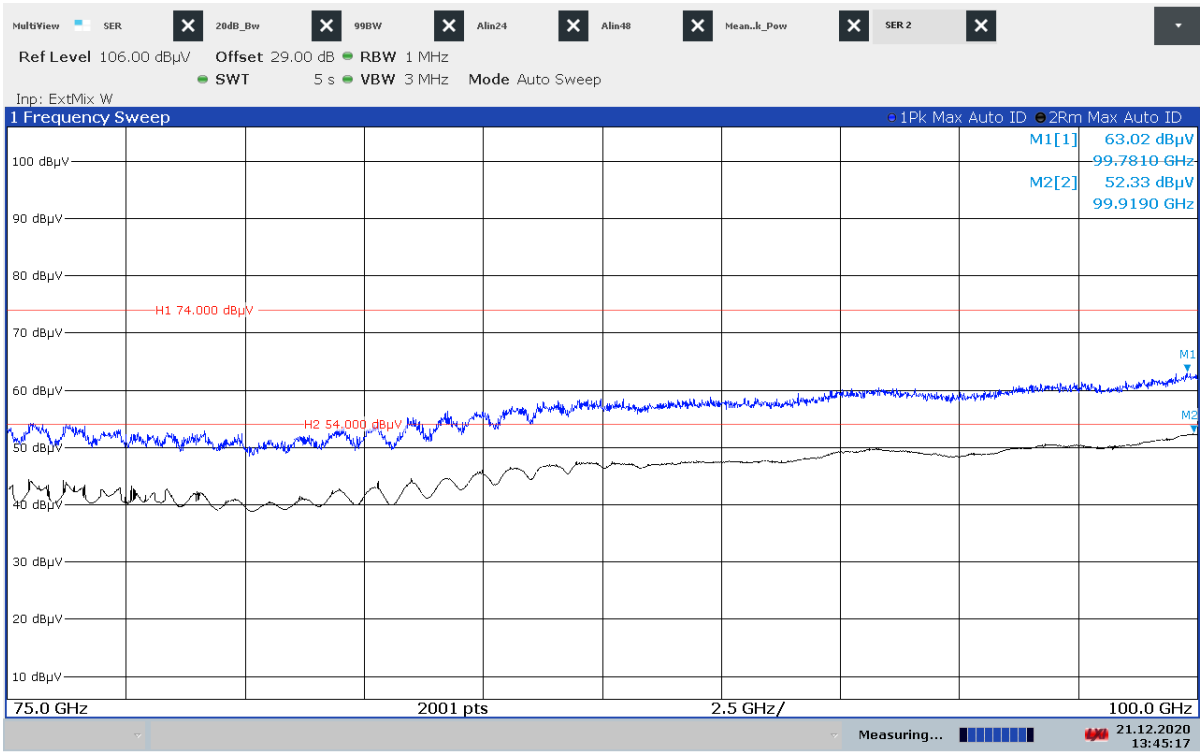
13:04:40 21.12.2020

Plot No. 12: 50 GHz to 75 GHz



13:21:30 21.12.2020

Plot No. 13: 75 GHz to 100 GHz



11.4 Conducted emissions < 30 MHz

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. Both power lines, phase and neutral line, are measured. Found peaks are re-measured with average and quasi peak detection to show compliance to the limits.

Measurement:

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

Limits:

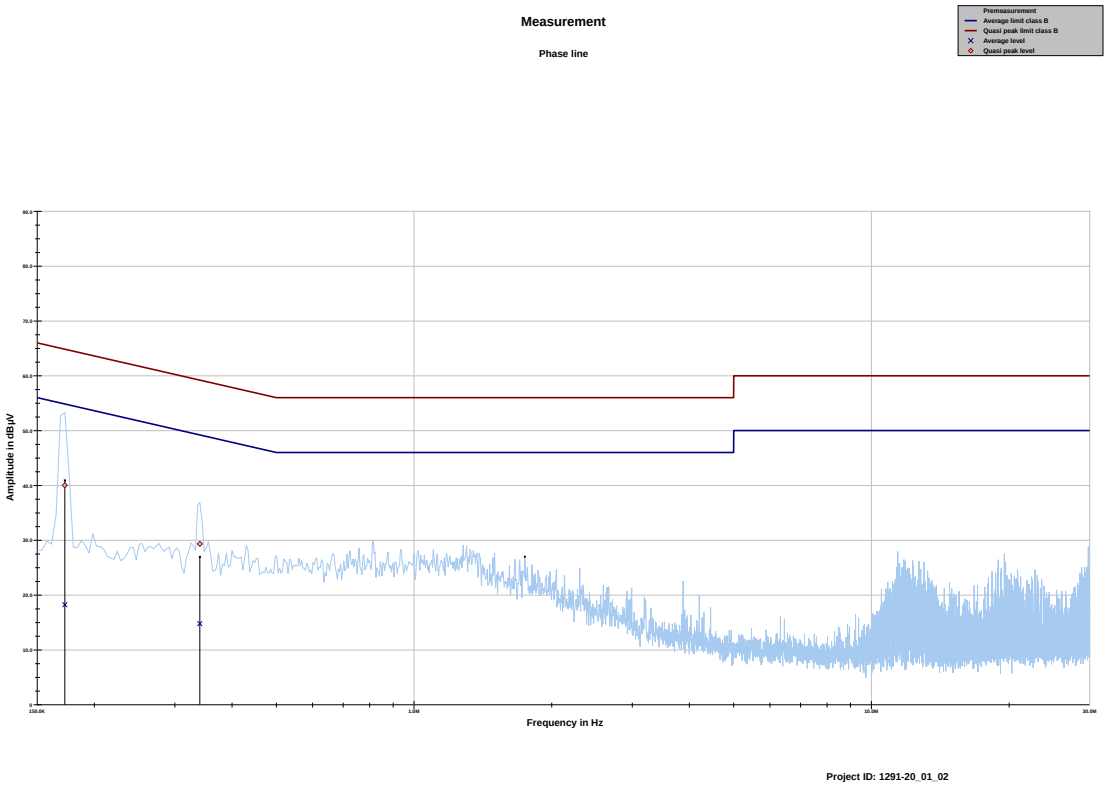
FCC		IC
CFR Part 15.207(a)		RSS-Gen 8.8
Conducted Spurious Emissions < 30 MHz		
Frequency (MHz)	Quasi-Peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

*Decreases with the logarithm of the frequency

Measurement results:

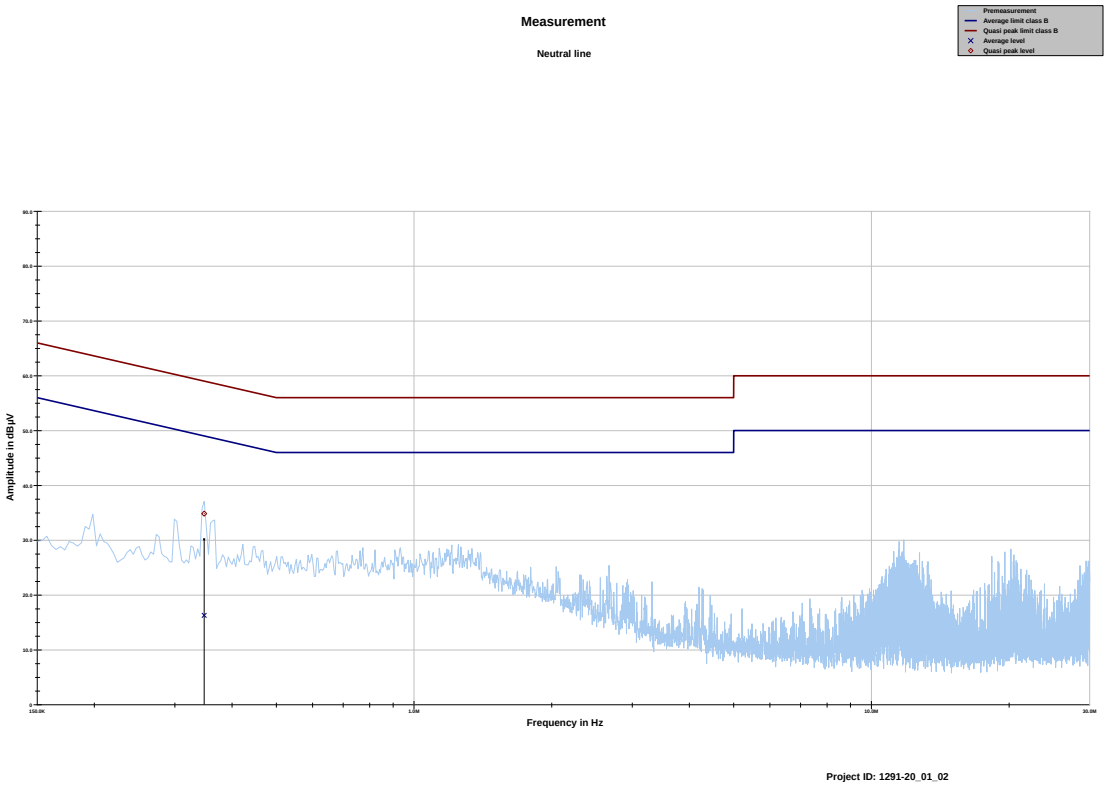
See plots below.

Plot 14: Phase line, Transmitter



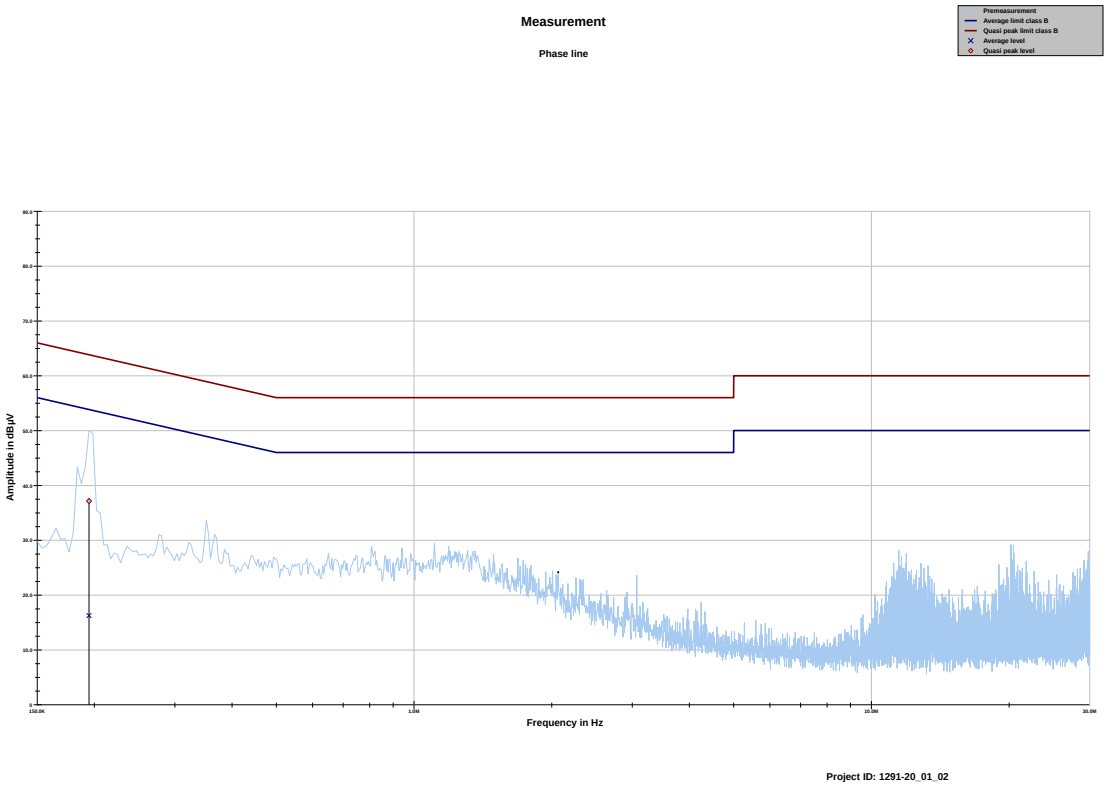
Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.172387	40.02	24.83	64.845	18.24	37.12	55.360
0.340294	29.32	29.88	59.196	14.78	35.78	50.563

Plot 15: Neutral line, Transmitter



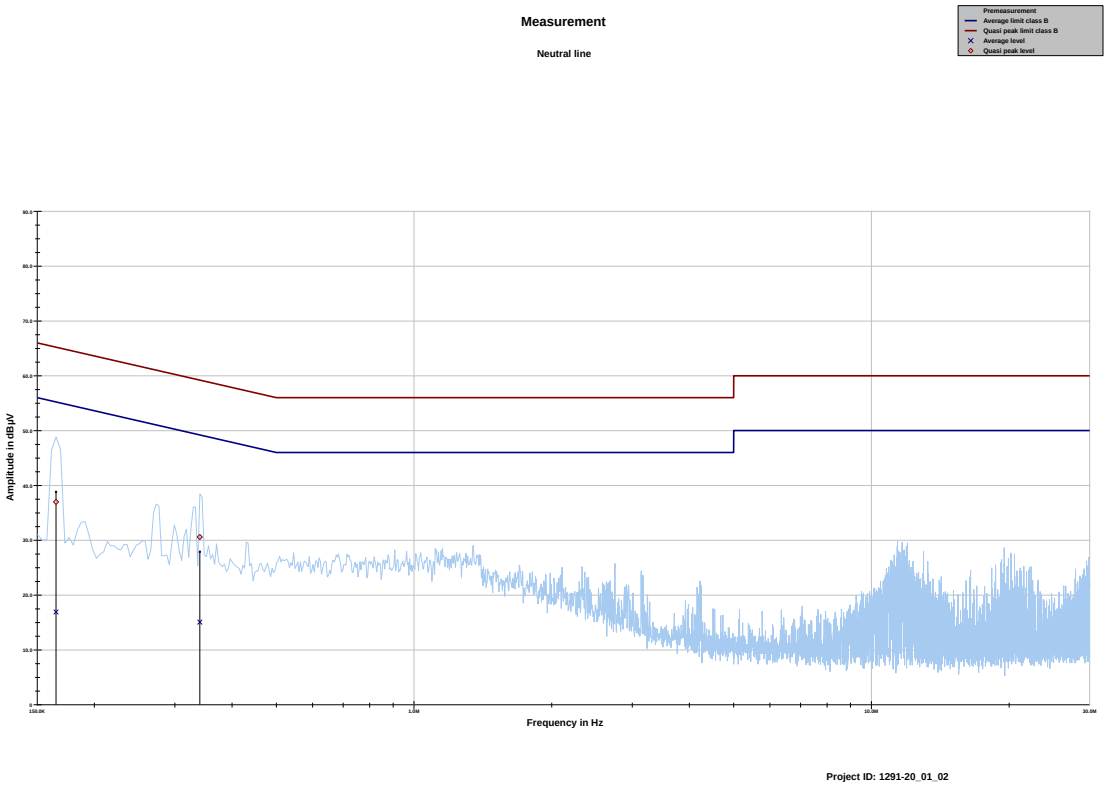
Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.347756	34.84	24.18	59.016	16.30	34.05	50.350

Plot 16: Phase line, Receiver



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.194775	37.13	26.70	63.830	16.26	38.46	54.721

Plot 17: Neutral line, Receiver



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.164925	36.99	28.22	65.212	16.90	38.67	55.574
0.340294	30.58	28.62	59.196	15.06	35.51	50.563

11.5 Frequency Stability

Description:

§15.215(c) 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.

RSS-Gen 8.11 Frequency stability: If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In addition, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-602 MHz, unless otherwise indicated.

Measurement:

Parameter	
Detector:	Pos-Peak / RMS
Sweep time:	10 s
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold
Measurement uncertainty	Span/1000

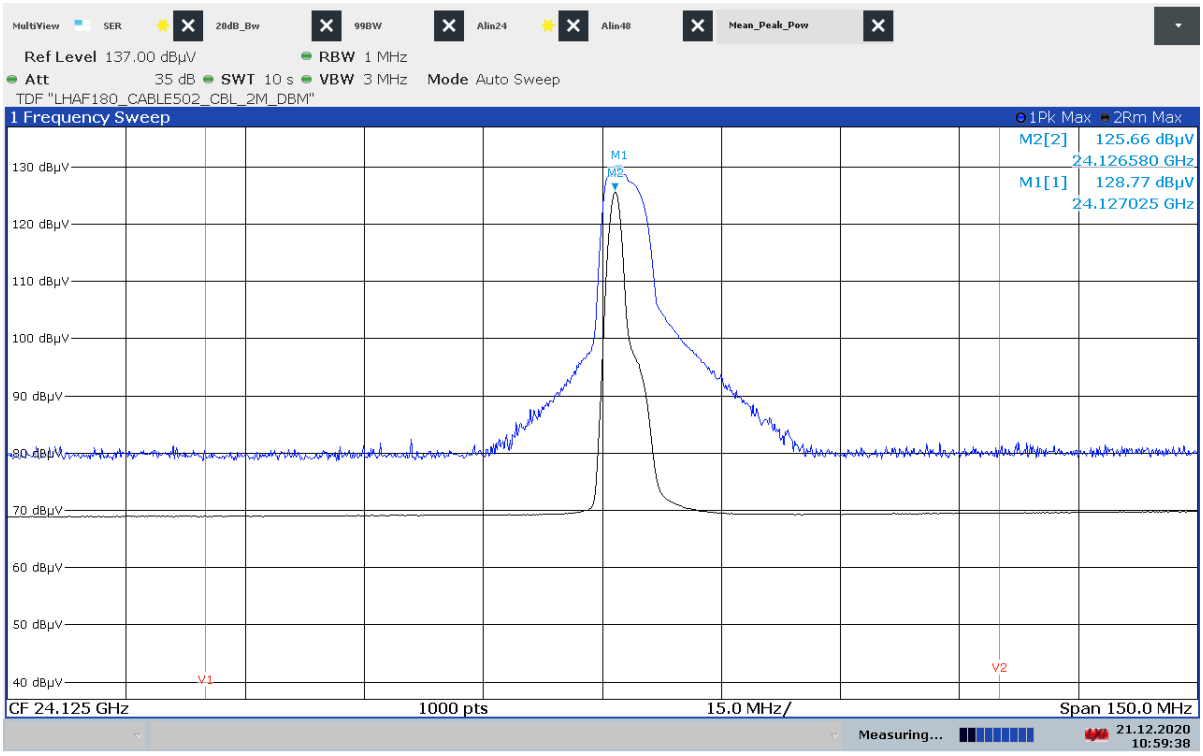
Limits:

FCC	IC
CFR Part 15.215(c)	RSS-Gen 8.11
Frequency Stability	
As specified in section 15.215(c) / RSS-Gen, the bandwidth of the fundamental emission must be contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage.	

Measurement results:

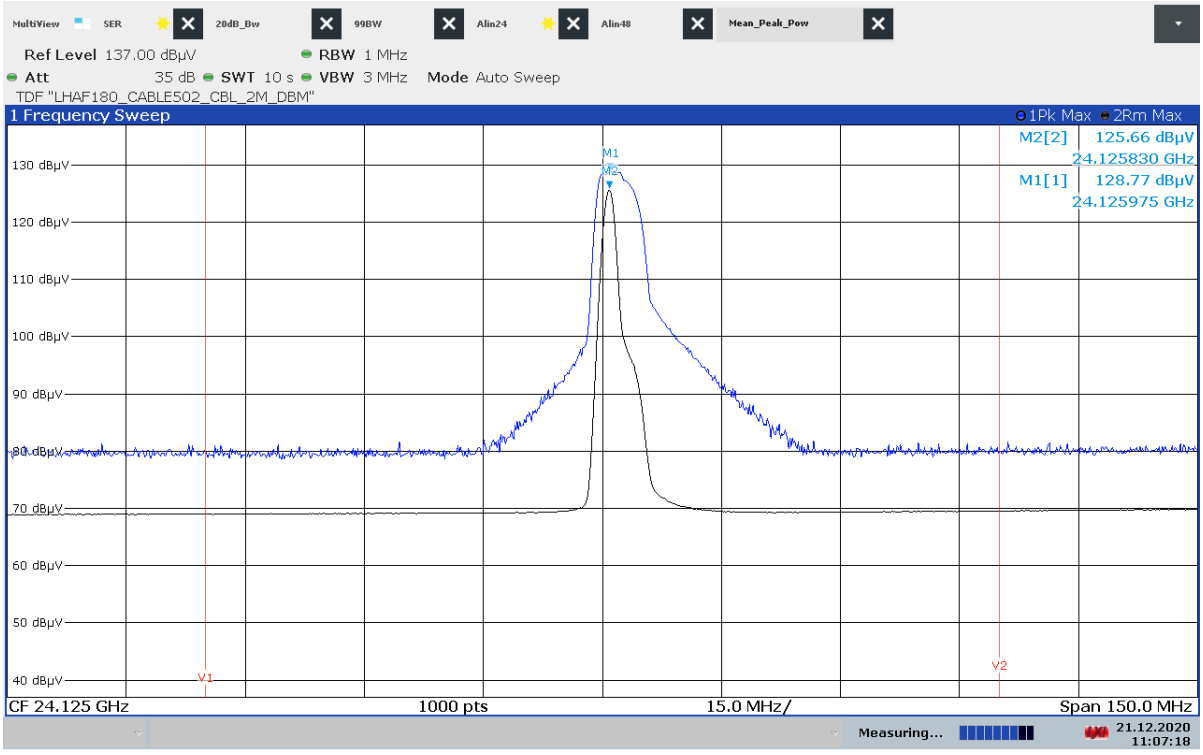
Test Conditions	Center frequency (GHz)
-20 °C / V_{nom}	24.126580
-10 °C / V_{nom}	24.125830
0 °C / V_{nom}	24.124780
+10 °C / V_{nom}	24.124480
+20 °C / V_{min}	24.124480
+20 °C / V_{nom}	24.124480
+20 °C / V_{max}	24.124480
+30 °C / V_{nom}	24.123580
+40 °C / V_{nom}	24.120580
+50 °C / V_{nom}	24.118030

Plot 18: -20 °C, V_{nom}



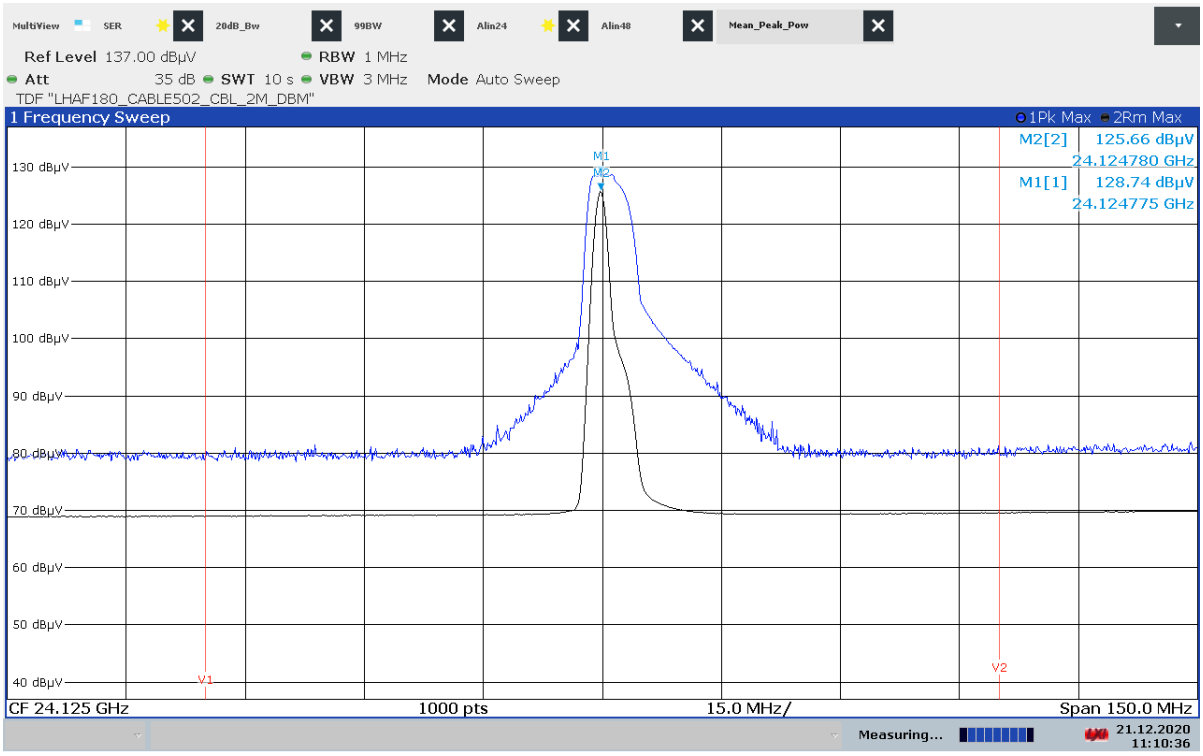
10:59:38 21.12.2020

Plot 19: -10 °C, V_{nom}



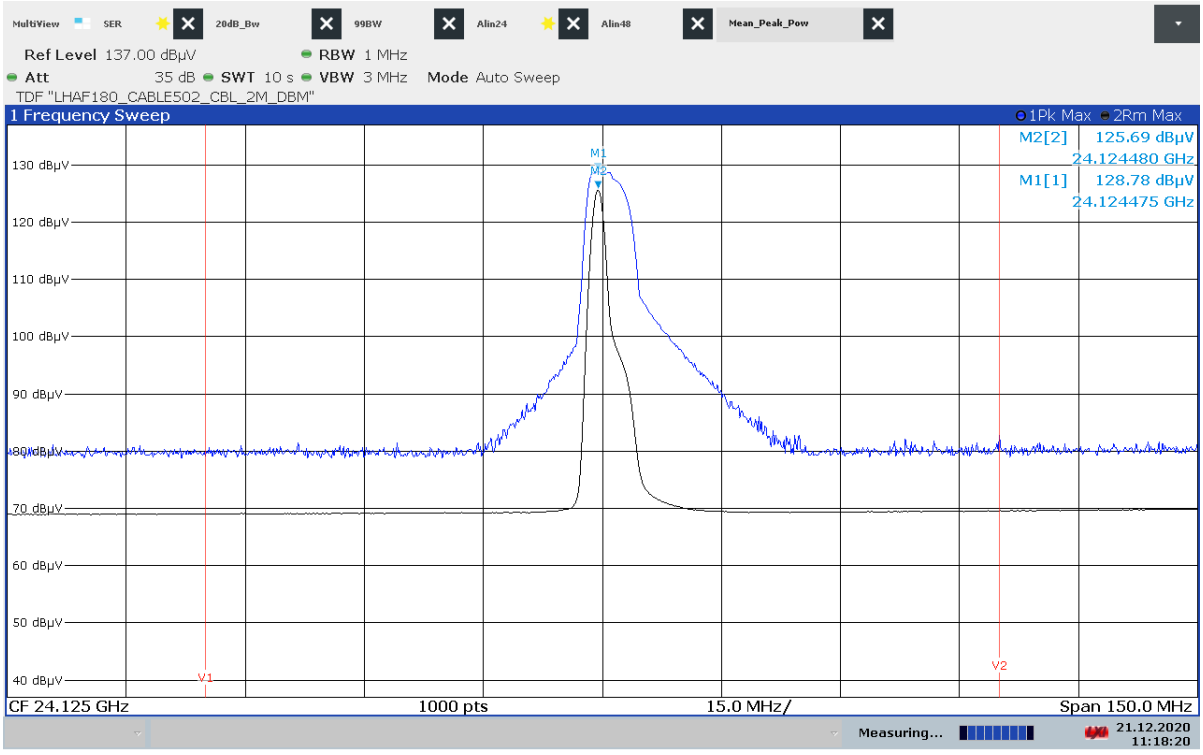
11:07:19 21.12.2020

Plot 20: 0 °C, V_{nom}



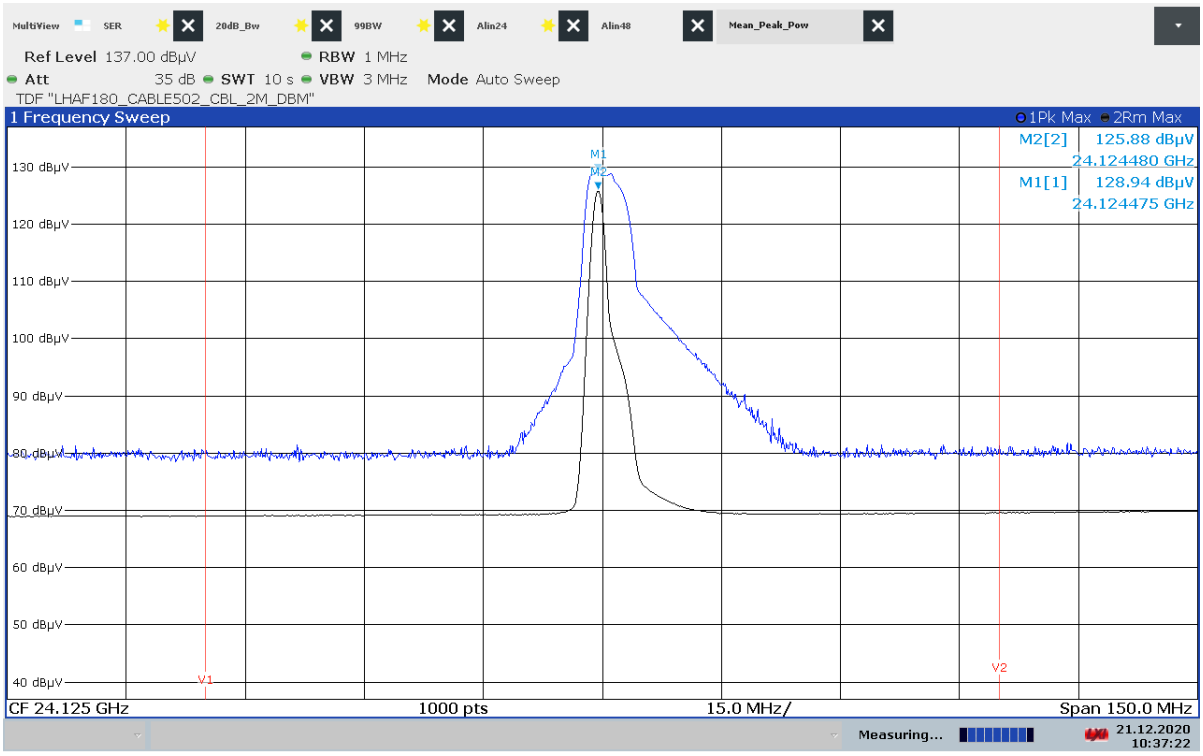
11:10:36 21.12.2020

Plot 21: +10 °C, V_{nom}



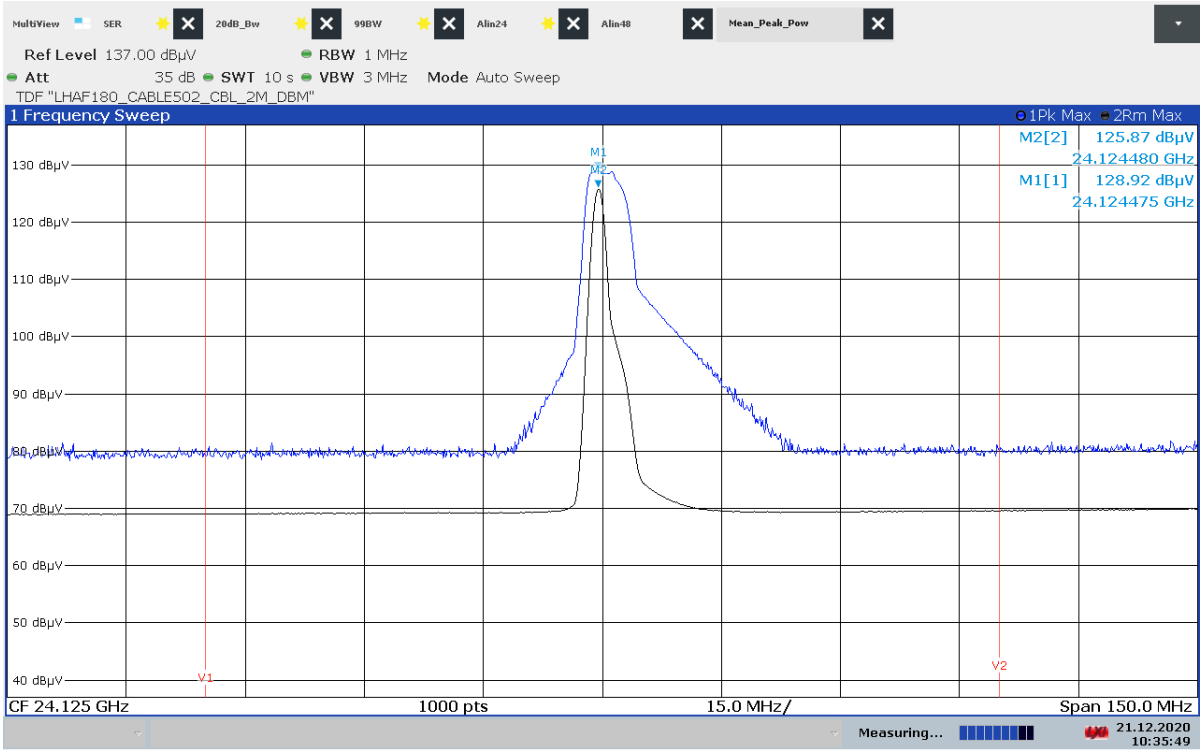
11:18:20 21.12.2020

Plot 22: +20 °C, V_{min}



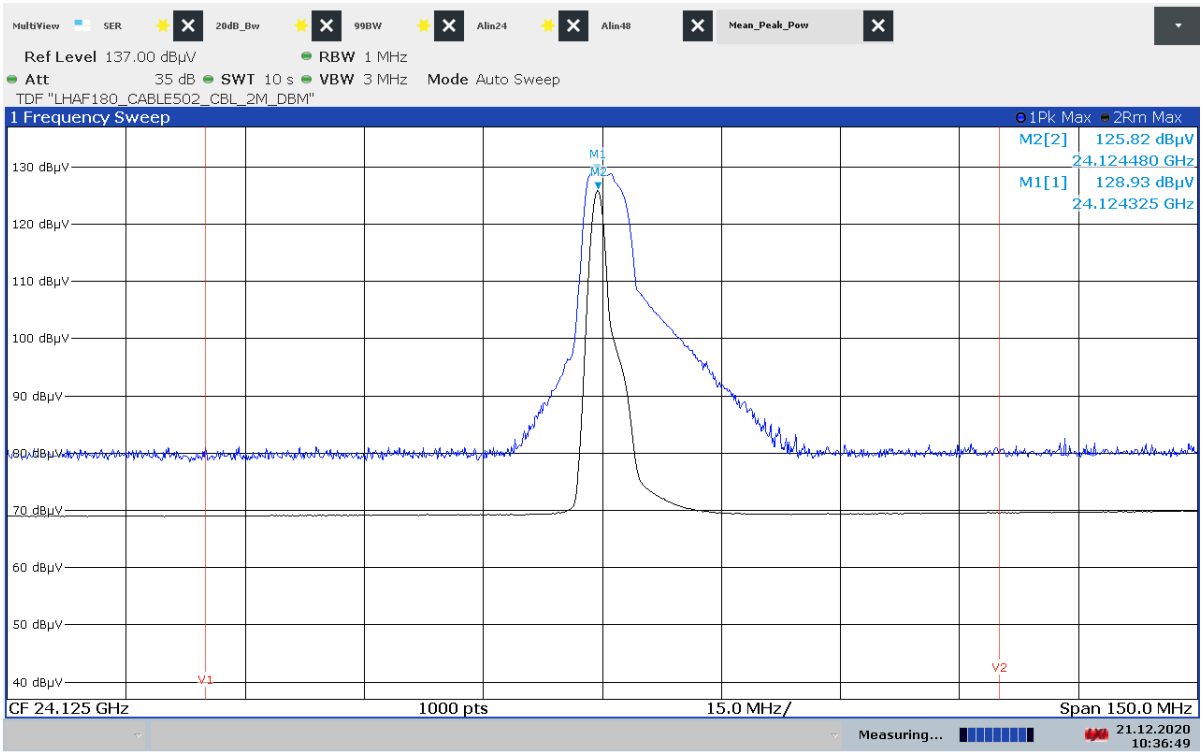
10:37:23 21.12.2020

Plot 23: +20 °C, V_{nom}



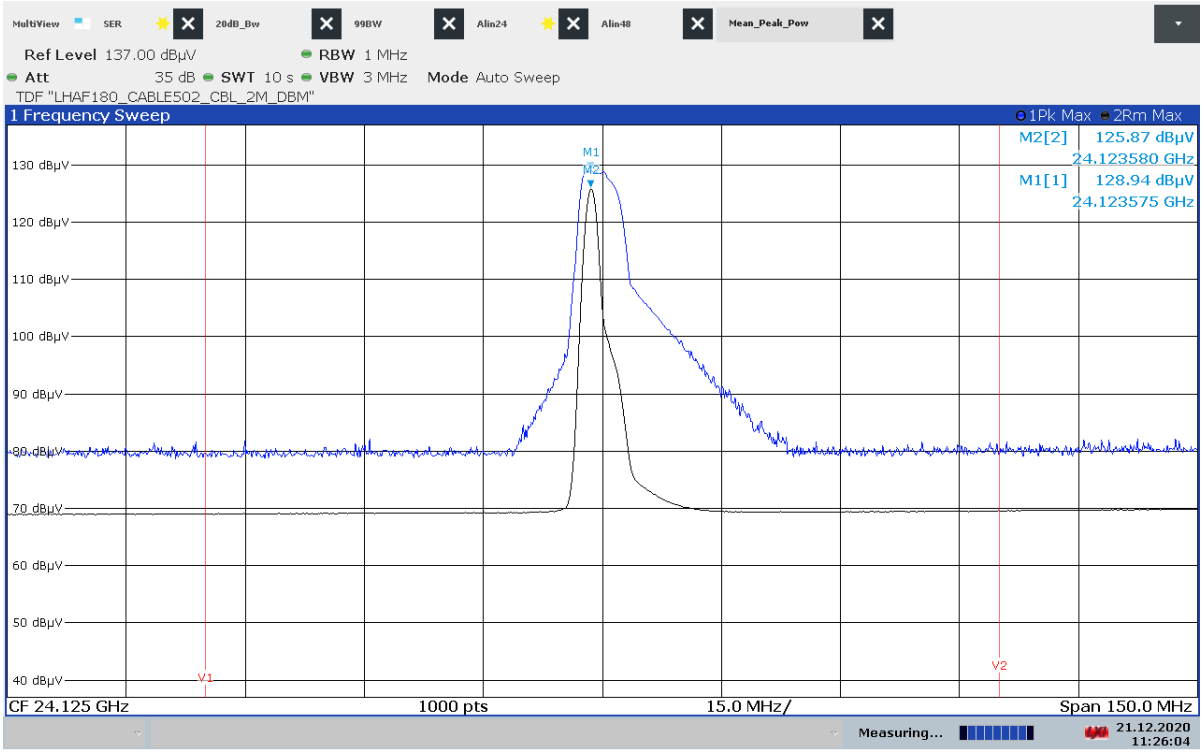
10:35:49 21.12.2020

Plot 24: +20 °C, V_{max}



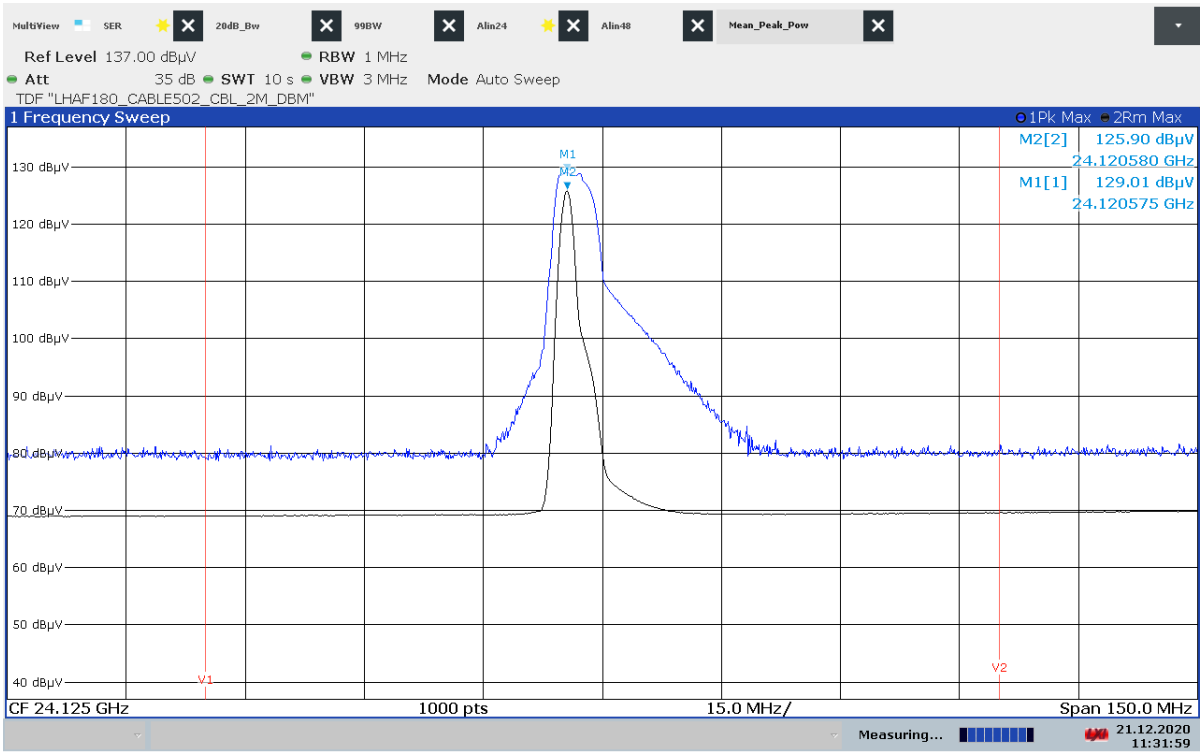
10:36:49 21.12.2020

Plot 25: +30 °C, V_{nom}



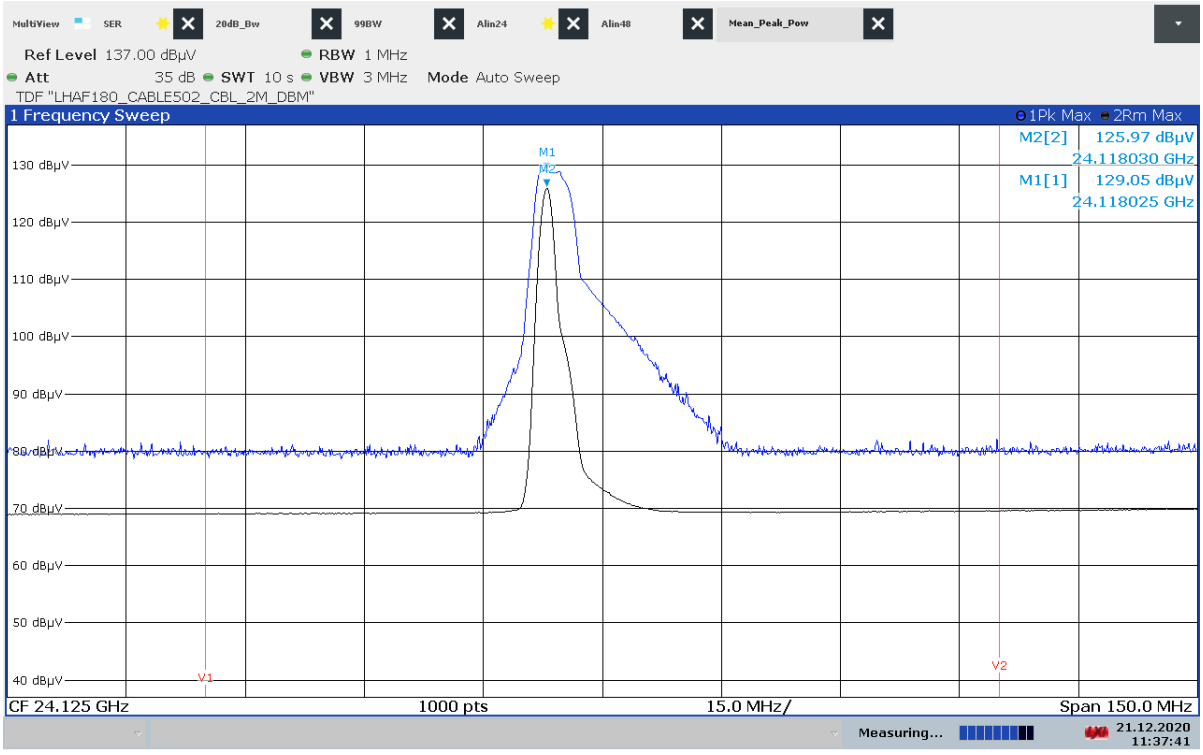
11:26:04 21.12.2020

Plot 26: +40 °C, V_{nom}



11:31:59 21.12.2020

Plot 27: +50 °C, V_{nom}



11:37:41 21.12.2020

Annex A Glossary

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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-01-21
-A	Editorial Changes (UPN, PMN, HVIN changed to MICRORAY)	2021-03-15
-B	Editorial Changes (Photo documentation)	2021-06-08
-C	Update chapter 11.2 & 11.5	2021-07-13

Annex C Accreditation Certificate

first page	last page
	

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

https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

END OF TEST REPORT