

TEST REPORT

Test report no.: 1-9121-24-01-03_TR1-R01



Deutsche
Akkreditierungsstelle
D-PL-12047-01-00

Testing laboratory

cetecom advanced GmbH

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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 with the registration number:

D-PL-12047-01-00.

ISED Testing Laboratory Recognized Listing Number: DE0001

FCC designation number: DE0002

Applicant

OndoSense GmbH

Boetzinger Str. 60

79111 Freiburg / GERMANY

Phone: +49 761 79114763

Contact: Lars Clad

e-mail: lclad@ondosense.com

Manufacturer

OndoSense GmbH

Boetzinger Str. 60

79111 Freiburg / GERMANY

Test standard/s

FCC - Title 47 CFR Part 15 FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

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

Test Item

Kind of test item: **Radar Distance Sensor**
Model name: **Reach**
FCC ID: **2BOCG-R1**
Frequency: 122.625 GHz Band (122.25 GHz – 123.0 GHz)
Technology tested: Radar
Antenna: Integrated antenna
Power supply: 12 V to 30 V DC by external power supply
Temperature range: -40°C to +75°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.

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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom 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.

2.2 Application details

Date of receipt of order: 2025-01-21

Date of receipt of test item: 2025-03-10

Start of test:* 2025-03-10

End of test:* 2026-01-13

Person(s) present during the test: 2025-03-27 Rainer Waltersbacher (OndoSense)

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

2.3 Involved test locations

Saarbruecken lab		Essen lab	
☒	Untertuerkheimer Str. 6-10 66117 Saarbruecken Germany	☐	Im Teelbruch 116 45219 Essen Germany

2.4 Test laboratories sub-contracted

None

2.5 Laboratory listings and recognitions

	Saarbruecken	Essen
FCC	DE0002	DE0003
ISED	DE0001 3462C	DE0001 3462D

3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

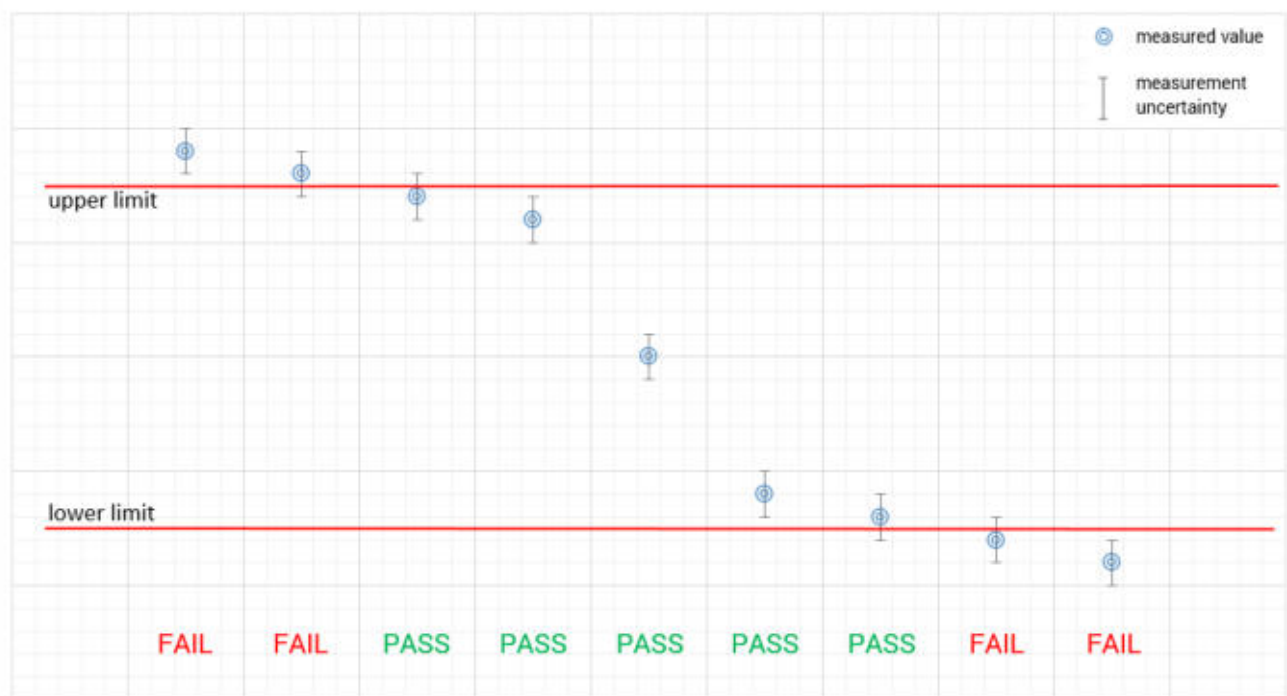
Guidance	Version	Description
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2020 + Cor. 1-2023 + C63.10a-2024 + Errata to C63.10a-2024	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

4 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 9, 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.

measured value, measurement uncertainty, verdict



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +50 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		49 %
Barometric pressure	:		990 hPa to 1010 hPa
Power supply	:	V_{nom} V_{max} V_{min}	24 V DC by external power supply 27.6 V DC by external power supply ($1.15 * V_{nom}$) 20.4 V DC by external power supply ($0.85 * V_{nom}$)

6 Test item

6.1 General description

Kind of test item	:	Radar Distance Sensor
Model name	:	Reach
S/N serial number	:	EUT Main2673: OSREA240002673 EUT Main2467: OSREA220002467 EUT Delta2406: OSREA220002406
Power setting	:	N/A
Hardware status	:	EUT Main2673: D-Line Rev. C Version 02 EUT Main2467: D-Line Rev. D Version 01 EUT Delta2406: C-Line Rev. D Version 01
Firmware status	:	EUT Main2673: 3.5.0 EUT Main2467: 3.5.0 EUT Delta2406: 3.5.0
Frequency band	:	122.625 GHz Band (122.25 GHz – 123.0 GHz)
Type of radio transmission	:	Modulated carrier
Use of frequency spectrum	:	
Type of modulation	:	FMCW
Number of modes	:	2
Antenna	:	Integrated antenna
Power supply	:	12 V to 30 V DC by external power supply
Temperature range	:	-40°C to +75°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:

- 1-9121-24-01-01_TR1-A101-R01 (External photographs of EUT)
- 1-9121-24-01-01_TR1-A103-R03 (Test set-up photographs)
- 1-9121-24-01-01_TR1-A104-R01 (Internal photographs of EUT, provided by customer)
- Note: The referenced photos show EUT delivered by the customer in this project, not necessarily the exact one used for the specific tests. EUT identification shown in the photos may differ.

Additional measurement reports:

- 1-9121-24-01-03_TR1-A201-R01 (Frequency Stability FCC §15.258)

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).

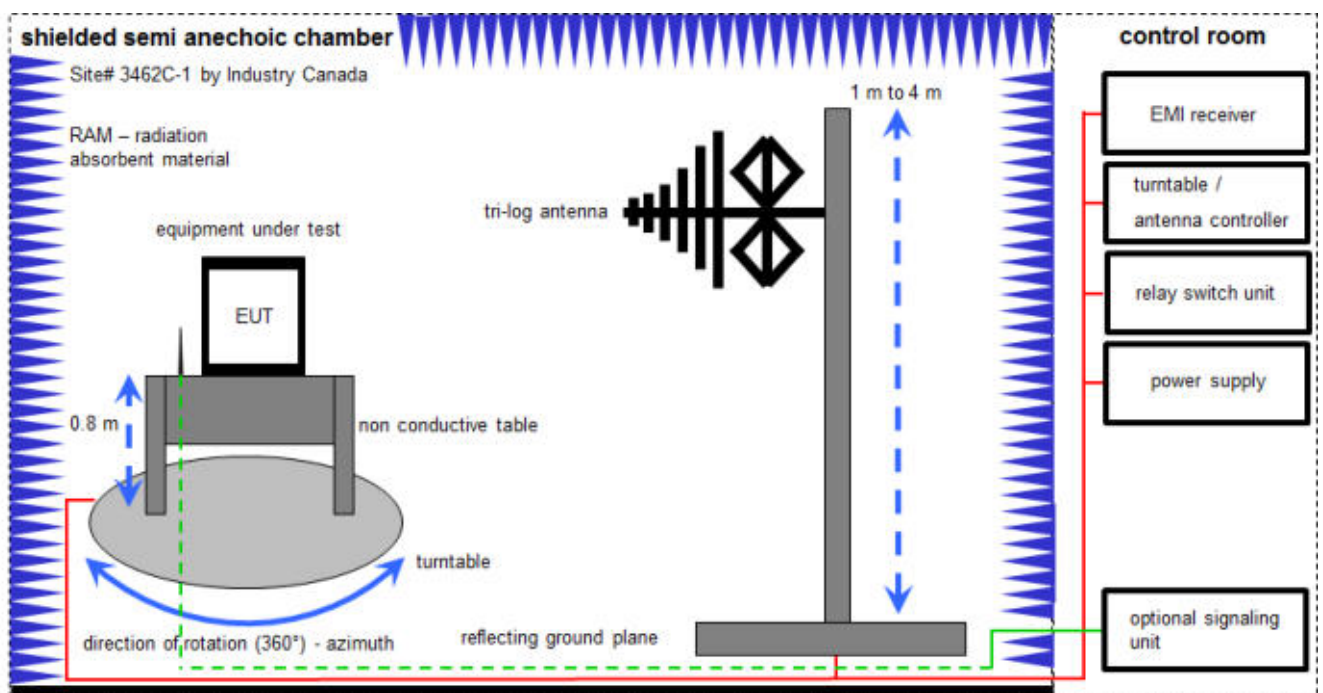
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k/cal	calibration / calibrated	EK	limited calibration
Ne/cnn	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
Ev/chk	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress
cpu	check prior usage		

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:

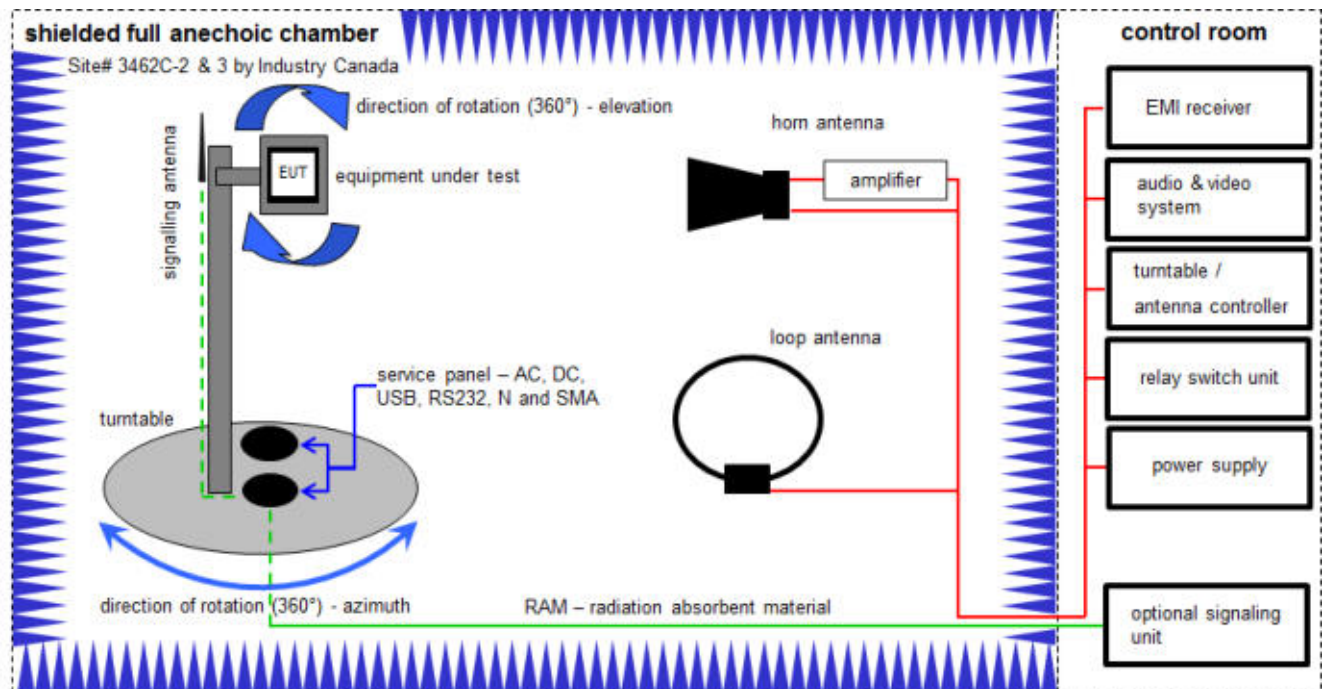
$$FS \text{ [dB}\mu\text{V/m]} = 12.35 \text{ [dB}\mu\text{V/m]} + 1.90 \text{ [dB]} + 16.80 \text{ [dB/m]} = 31.05 \text{ [dB}\mu\text{V/m]} \text{ (35.69 } \mu\text{V/m)}$$

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Semi anechoic chamber	Semi anechoic chamber 3000023	MWB AG	*	300000551	cnn	-/-	-/-
3	Turntable	Turntable 2089-4.0	EMCO Elektronik GmbH / Gilching	*	300004394	cnn	-/-	-/-
4	Switch-Unit	Switch-Unit 3488A	Hewlett Packard	2719A14505	300000368	cpu	-/-	-/-
6	Antenna Tower	Antenna Tower 2175	ETS-Lindgren GmbH / Taufkirchen	64762	300003745	cnn	-/-	-/-
7	Positioning Controller	Positioning Controller 2090	ETS-Lindgren GmbH / Taufkirchen	64672	300003746	cnn	-/-	-/-
10	EMI Test Receiver	EMI Test Receiver ESR3	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102587	300005771	cal	05.12.2024	05.12.2025
11	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck Mess-Elektronik OHG / Schönaun	295	300003787	cal	23.05.2023	23.05.2025

Relevant measurements performed during the calibration interval shown above.

7.2 Shielded fully anechoic chamber



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

$$FS = UR + CA + AF$$

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

Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-35.8) \text{ [dB]} + 32.9 \text{ [dB/m]} = 37.1 \text{ [dB}\mu\text{V/m]} (71.61 \mu\text{V/m})$$

$$OP = AV + D - G + CA$$

(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:

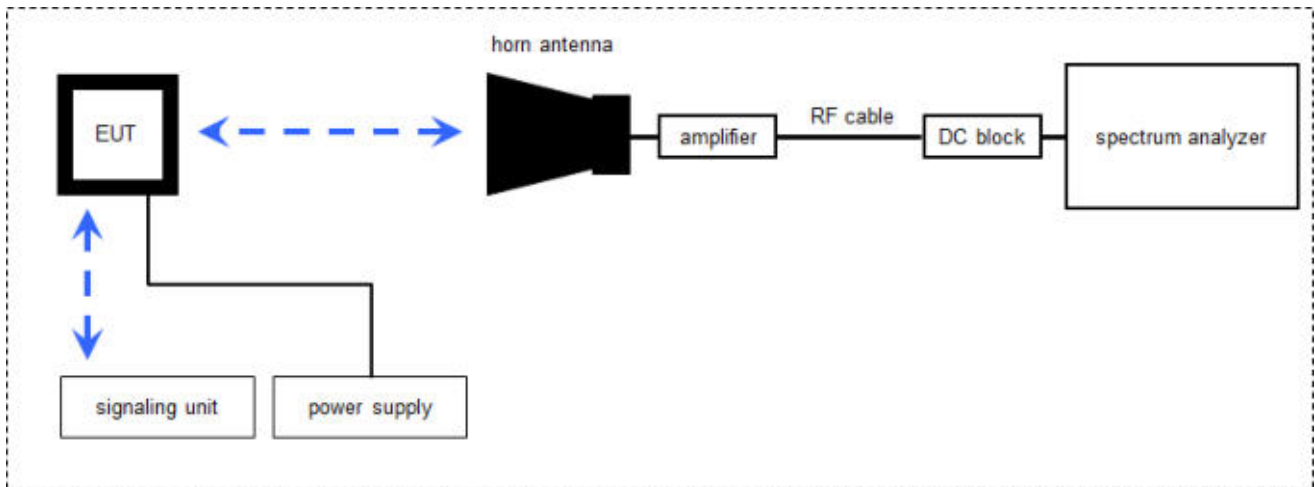
$$OP \text{ [dBm]} = -65.0 \text{ [dBm]} + 50 \text{ [dB]} - 20 \text{ [dBi]} + 5 \text{ [dB]} = -30 \text{ [dBm]} (1 \mu\text{W})$$

Equipment table:

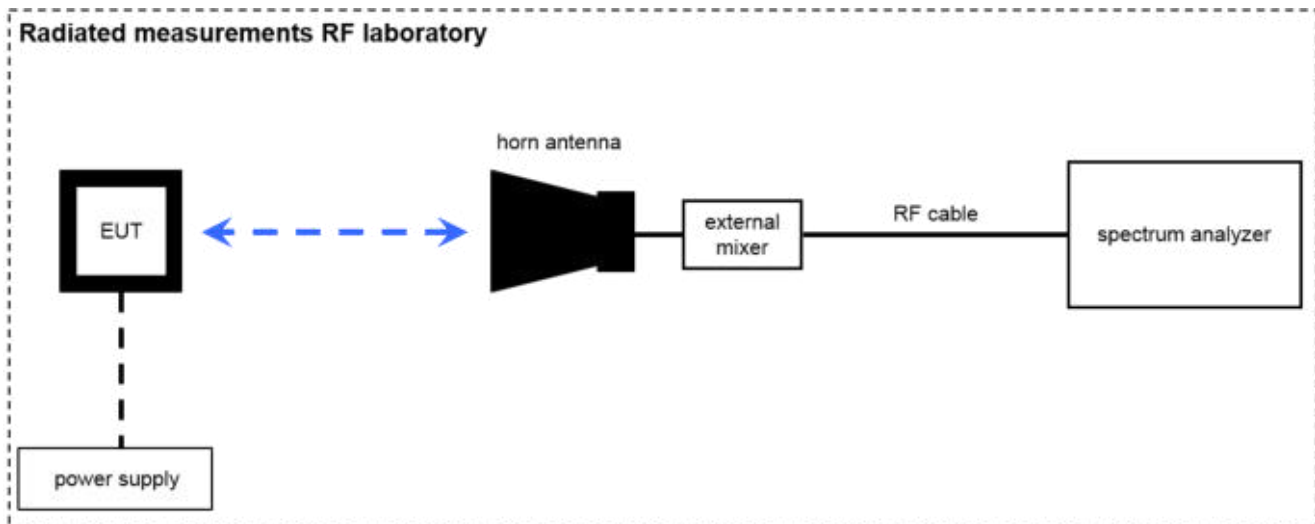
No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115	EMCO Elektronik GmbH / Gilching	8812-3089	300000307	cal	09.07.2024	09.07.2026
2	Anechoic chamber	Anechoic chamber FAC 3/5m	MWB / TDK	87400/02	300000996	cpu	-/-	-/-
3	Switch / Control Unit	Switch / Control Unit 3488A	Hewlett Packard	*	300000199	cnn	-/-	-/-
4	Highpass Filter	Highpass Filter WHKX7.0/18G-8SS	Wainwright Instruments GmbH / Andechs	19	300003790	cnn	-/-	-/-
5	Broadband Amplifier 0.5-18 GHz	Broadband Amplifier 0.5-18 GHz CBLU5184540	CERNEX	22049	300004481	cpu	-/-	-/-
6	4U RF Switch Platform	4U RF Switch Platform L4491A	Agilent Technologies Deutschland GmbH / Böblingen	MY50000037	300004509	cnn	-/-	-/-
7	NEXIO EMV-Software	NEXIO EMV-Software BAT EMC V2022.0.32.0	Nexio	*	300004682	cnn	-/-	-/-
8	RF-Amplifier	RF-Amplifier AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	cpu	-/-	-/-
9	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	2210	300001015	cal	02.08.2023	02.08.2025
10	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	8905-2342	300000256	cal	19.07.2023	31.07.2025
11	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100037	300003555	cal	10.12.2024	10.12.2025
12	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck Mess-Elektronik OHG / Schönaun	318	300003696	cal	31.01.2024	31.01.2026

Relevant measurements performed during the calibration interval shown above.

7.3 Radiated measurements > 18 GHz



7.4 Radiated measurements > 50/85 GHz



Measurement distance: horn antenna e.g. 75 cm

$$FS = UR + CA + AF$$

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

Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-60.1) \text{ [dB]} + 36.74 \text{ [dB/m]} = 16.64 \text{ [dB}\mu\text{V/m]} \text{ (6.79 } \mu\text{V/m)}$$

$$OP = AV + D - G + CA$$

(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:

$$OP \text{ [dBm]} = -59.0 \text{ [dBm]} + 44.0 \text{ [dB]} - 20.0 \text{ [dB]} + 5.0 \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

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

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Temperature Test Chamber	Temperature Test Chamber T-40/50	CTS Clima Temperatur Systeme GmbH / Hechingen	064023	300003540	calchk	11.07.2024	11.07.2026
2	Power Supply	Power Supply E3632A	Agilent Technologies Deutschland GmbH / Böblingen	MY40001320	400000396	cal	04.12.2024	04.12.2027
3	Signal- and Spectrum Analyzer 3 Hz - 50 GHz	Signal- and Spectrum Analyzer 3 Hz - 50 GHz PXA N9030A	Agilent Technologies Deutschland GmbH / Böblingen	US51350267	300004338	cal	02.01.2025	02.01.2026
4	Signal- and Spectrum Analyzer 2 Hz - 85 GHz	Signal- and Spectrum Analyzer 2 Hz - 85 GHz FSW85	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101333	300005568	cal	27.09.2024	27.09.2025
5	Signal- and Spectrum Analyzer 2 Hz - 50 GHz	Signal- and Spectrum Analyzer 2 Hz - 50 GHz FSW50	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101332	300005935	cal	09.01.2025	09.01.2026
6	Signal- and Spectrum Analyzer 2 Hz - 50 GHz	Signal- and Spectrum Analyzer 2 Hz - 50 GHz FSW50	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101560	300006179	cal	27.12.2024	27.12.2025
7	Std. Gain Horn Antenna 49.9-75.8 GHz	Std. Gain Horn Antenna 49.9-75.8 GHz 2524-20	Flann	*	300001983	cnn	-/-	-/-
8	Std. Gain Horn Antenna 114-173 GHz	Std. Gain Horn Antenna 114-173 GHz 2924-20	Flann	*	300001999	cnn	-/-	-/-
9	Std. Gain Horn Antenna 145-220 GHz	Std. Gain Horn Antenna 145-220 GHz 3024-20	Flann	*	300002000	cnn	-/-	-/-
10	Std. Gain Horn Antenna 60-90 GHz	Std. Gain Horn Antenna 60-90 GHz COR 60_90	Thomson CSF	*	300000814	cpu	-/-	-/-
11	Harmonic Mixer 3-Port, 110-170 GHz	Harmonic Mixer 3-Port, 110-170 GHz FS-Z170	Radiometer Physics GmbH	100014	300004156	cal	15.07.2024	15.07.2025
12	Harmonic Mixer 3-Port, 140-220 GHz	Harmonic Mixer 3-Port, 140-220 GHz SAM-220	Radiometer Physics GmbH	200001	300004157	cal	01.08.2024	01.08.2025
13	Harmonic Mixer 3-Port, 220-325 GHz	Harmonic Mixer 3-Port, 220-325 GHz SAM-325	Radiometer Physics GmbH	100002	300004158	cal	31.07.2024	31.07.2025
14	Std. Gain Horn Antenna 33.0-50.1 GHz	Std. Gain Horn Antenna 33.0-50.1 GHz 2324-20	Flann	57	400000683	cnn	-/-	-/-
15	Harmonic Mixer 3-Port, 60-90 GHz	Harmonic Mixer 3-Port, 60-90 GHz FS-Z90	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101555	300004691	cal	25.07.2024	25.07.2025
16	Std. Gain Horn Antenna 217-330 GHz	Std. Gain Horn Antenna 217-330 GHz 32240-20	Flann	233278	300004960	cnn	-/-	-/-
17	Harmonic Mixer 3-Port, 75-110 GHz	Harmonic Mixer 3-Port, 75-110 GHz FS-Z110	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101411	300004959	cal	30.08.2024	30.08.2025
18	Harmonic Mixer 3-port, 90-140 GHz	Harmonic Mixer 3-port, 90-140 GHz FS-Z140	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101119	300005581	cal	01.08.2024	01.08.2025
19	Harmonic Mixer 3-Port, 50-75 GHz	Harmonic Mixer 3-Port, 50-75 GHz FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101578	300005788	cal	10.07.2024	10.07.2025
20	Harmonic Mixer 3-Port, 325-500GHz	Harmonic Mixer 3-Port, 325-500GHz FS-Z500	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101016	300006096	cal	16.07.2024	16.07.2025
21	Std. Gain Horn Antenna 73.8-112 GHz	Std. Gain Horn Antenna 73.8-112 GHz 2724-20	Flann	*	300001988	cnn	-/-	-/-
22	Std. Gain Horn Antenna 92.3-140 GHz	Std. Gain Horn Antenna 92.3-140 GHz 2824-20	Flann	*	300001993	cnn	-/-	-/-
23	Standard Gain Horn 325-500 GHz	Standard Gain Horn 325-500 GHz 570240-20 1785-2a	Flann Microwave	273569	300006097	cpu	-/-	-/-
24	Horn Antenna 18,0-40,0 GHz	Horn Antenna 18,0-40,0 GHz LHAF180	Microw.Devel	39180-103-021	300001747	cal	24.01.2024	31.01.2026
25	Horn Antenna 18,0-40,0 GHz	Horn Antenna 18,0-40,0 GHz LHAF180	Microw.Devel	39180-103-022	300001748	cal	-/-	-/-

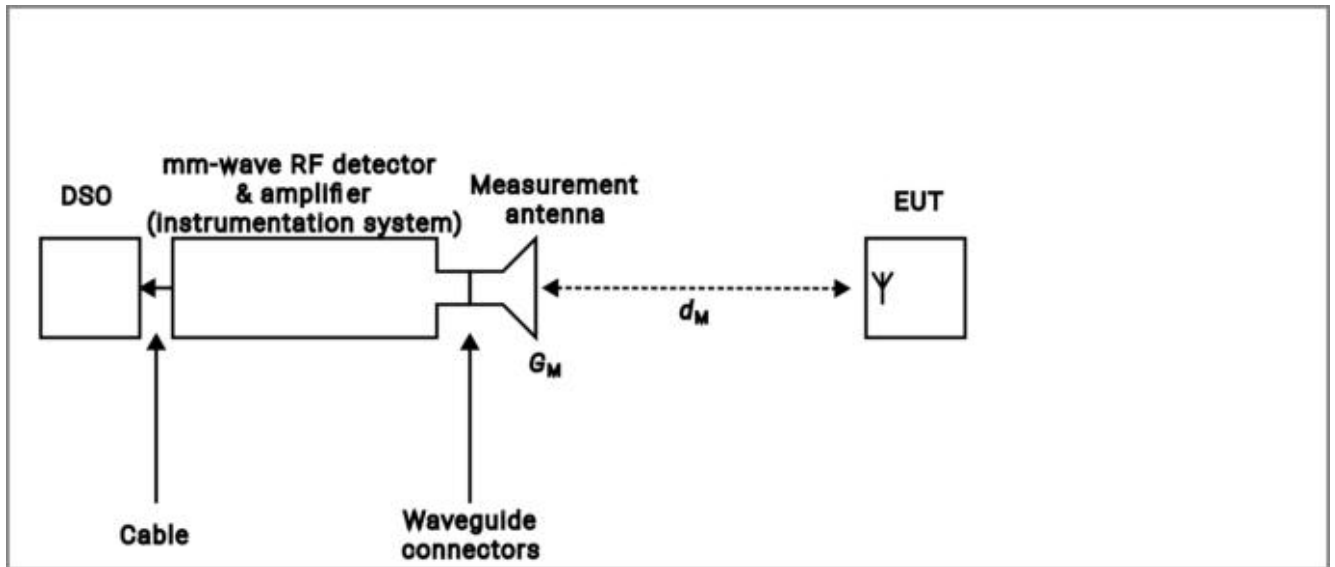
27	Low Noise Amplifier, Broadband 18-50 GHz	Low Noise Amplifier, Broadband 18-50 GHz BZT-18005000- 550835-SL2525-SL	B&Z Technologies	27887-27889	300006363	cpu	-/-	-/-
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Relevant measurements performed during the calibration interval shown above.

7.5 Fundamental emission measurement using an RF detector (ANSI C63.10-2020 9.9)

The measurements are performed according to ANSI C63.10-2020 chapter 9.9.

7.5.1 Step 1: ANSI C63.10-2020 9.9 a) – d.1)



Description of the measurement:

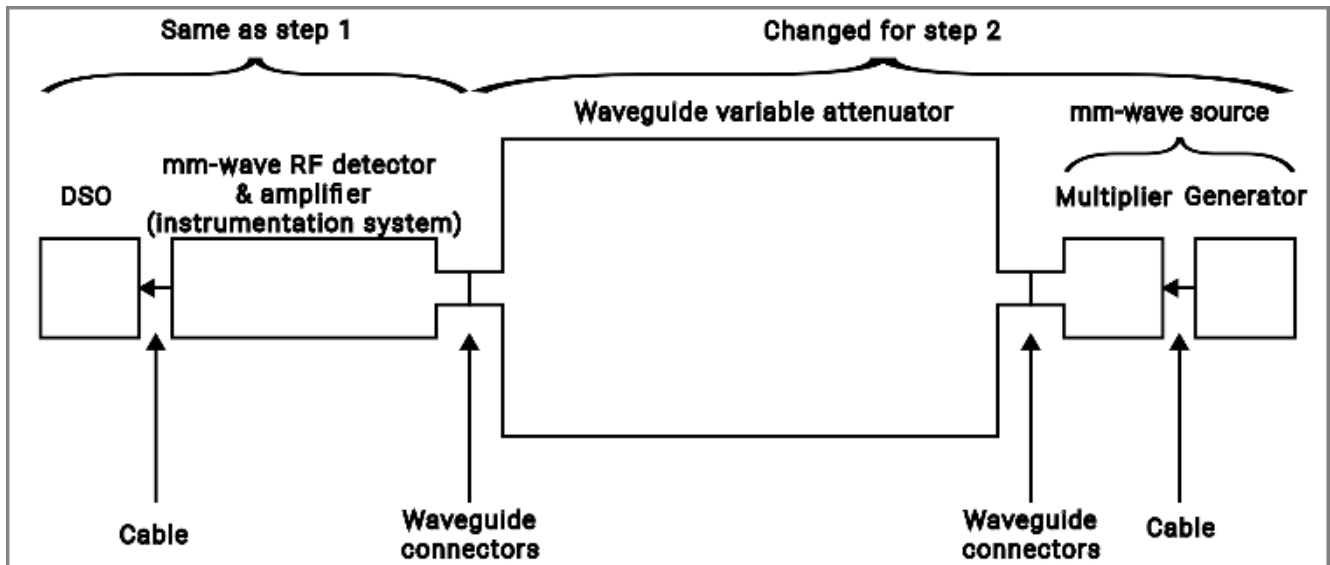
- The measurement instrument is a mm-wave RF detector, and an amplifier is inserted to increase the signal to noise ratio. The output is connected to the 50 Ω input of a DSO.
- To carry out radiated measurements, the measurement antenna for the fundamental frequency band is connected.
- Radiated measurements are performed by placing the measurement antenna at a distance to the EUT that meets the measurement distance requirements for final radiated measurements as specified in ANSI C63.10-2020 chapter 9.1.4. (see chapter 10).
- The measurement antenna is placed in the main beam of the EUT and then the measured signal of the fundamental emission is maximized.
- The peak voltage is recorded from the DSO and the average voltage during the ON time of the EUT is recorded from the DSO.
- This procedure is repeated for every relevant EUT operating configuration (e.g. different operating modes)

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Oscilloscope	Oscilloscope DPO5054	Tektronix UK Ltd. / Berkshire	C010174	300004169	cal	02.12.2025	31.12.2027
2	Std. Gain Horn Antenna 114-173 GHz	Std. Gain Horn Antenna 114-173 GHz 2924-20	Flann	*	300001999	cnn	-/-	-/-
3	F-Band Positive Amplitude Detector	F-Band Positive Amplitude Detector SFD-903144-08SF-P1	Sage Millimeter Inc.	07354-1	300006119	cpu	-/-	-/-
4	Waveguide Amplifier 90-140 GHz	Waveguide Amplifier 90-140 GHz VDI-WR8.0AMP	VDI	01.01.2013	300006234	cpu	-/-	-/-
5	Power Supply	HMP 2020	Rohde & Schwarz Messgerätebau GmbH / Memmingen	121993	140607641	cal	15.05.2025	15.05.2027

Relevant measurements performed during the calibration interval shown above.

7.5.2 Step 2: ANSI C63.10-2020 9.9 d.2) – d.6)



Description of the measurement:

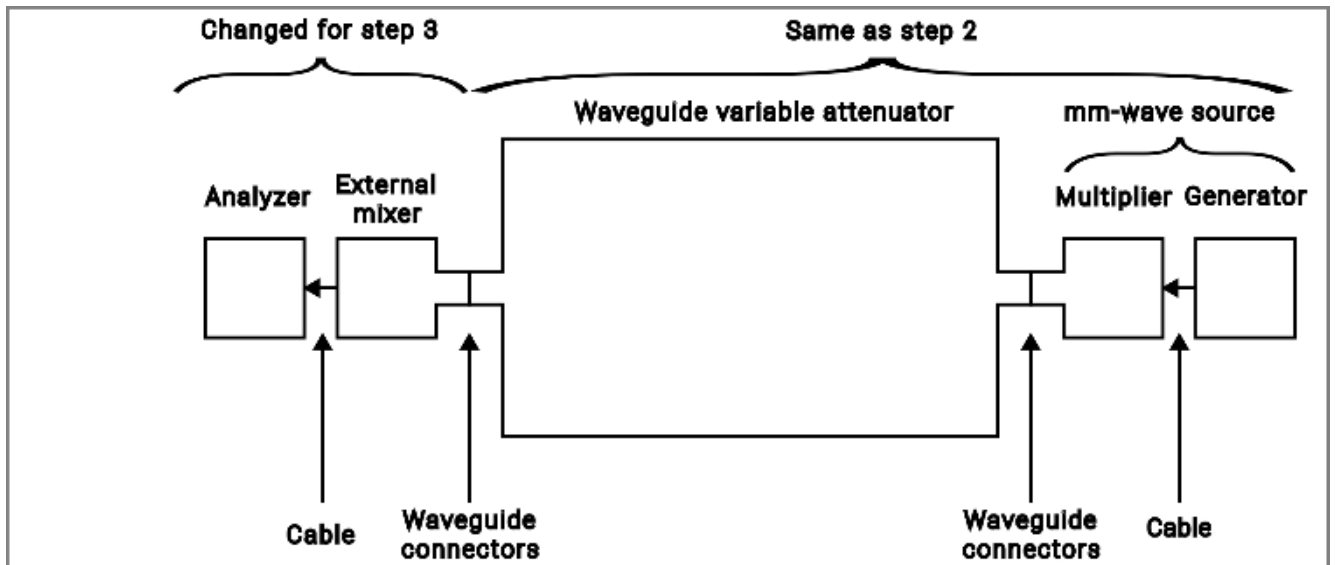
- The measurement antenna is disconnected from the RF input port of the instrumentation system (ANSI C63.10-2020 9.9 d.2)).
- Afterwards, a mm-wave source (consisting of a signal generator and a frequency multiplier) is connected to the RF input of the instrumentation system via a waveguide variable attenuator (ANSI C63.10-2020 9.9 d.3)).
- The output signal of the mm-wave source is unmodulated, and its frequency is adjusted to the center of the frequency range occupied by the transmitter.
- Finally, the amplitude of the mm-wave source and the variable attenuator is adjusted such that the DSO indicates a voltage equal to the peak voltage recorded in step 1.

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Oscilloscope	Oscilloscope DPO5054	Tektronix UK Ltd. / Berkshire	C010174	300004169	cal	02.12.2025	31.12.2027
2	Signal Generator 100 kHz - 40 GHz	Signal Generator 100 kHz - 40 GHz SMB100A	Rohde & Schwarz Messgerätebau GmbH / Memmingen	183320	300006330	cal	07.01.2025	07.01.2028
3	SG Extension Module 110 - 170 GHz	SG Extension Module 110 - 170 GHz E8257DV06	VDI	US53250018	300005540	cpu	-/-	-/-
4	Waveguide Amplifier 90-140 GHz	Waveguide Amplifier 90-140 GHz VDI-WR8.0AMP	VDI	01.01.2013	300006234	cpu	-/-	-/-
5	F-Band Positive Amplitude Detector	F-Band Positive Amplitude Detector SFD-903144-08SF-P1	Sage Millimeter Inc.	07354-1	300006119	cpu	-/-	-/-
6	Waveguide Variable Attenuator WR6	Precision Rotary Attenuator 29110	Flann	325183	140607514	cpu	-/-	-/-
7	Power Supply	HMP 2020	Rohde & Schwarz Messgerätebau GmbH / Memmingen	121993	140607641	cal	15.05.2025	15.05.2027

Relevant measurements performed during the calibration interval shown above.

7.5.3 Step 3: ANSI C63.10-2020 9.9 d.7) – d.10)



Description of the measurement:

- The waveguide variable attenuator is disconnected from the RF input port of the instrumentation system.
- Without changing any settings, the waveguide variable attenuator is connected to a power measurement system.
- As power measurement system, an external mixer (encompassing the frequency range of the unmodulated signal of the mm-wave source) combined with a spectrum analyzer is used. In case of the unmodulated signal of the mm-wave source, this power measurement system is equivalent to a wideband mm-wave power meter with a thermocouple detector.
- The power is measured and noted.
- Step 2 and step 3 are repeated for the average voltage recorded in step 1.

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	Signal Generator 100 kHz - 40 GHz	Signal Generator 100 kHz - 40 GHz SMB100A	Rohde & Schwarz Messgerätebau GmbH / Memmingen	183320	300006330	cal	07.01.2025	07.01.2028
2	SG Extension Module 110 - 170 GHz	SG Extension Module 110 - 170 GHz E8257DV06	VDI	US53250018	300005540	cpu	-/-	-/-
3	Waveguide Variable Attenuator WR6	Precision Rotary Attenuator 29110	Flann	325183	140607514	cpu	-/-	-/-
4	Signal- and Spectrum Analyzer 2 Hz - 85 GHz	Signal- and Spectrum Analyzer 2 Hz - 85 GHz FSW85	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101333	300005568	cal	28.08.2025	28.08.2026
5	Harmonic Mixer 3-Port, 110-170 GHz	Harmonic Mixer 3-Port, 110-170 GHz FS-Z170	Radiometer Physics GmbH	100014	300004156	cal	15.07.2025	15.07.2026

Relevant measurements performed during the calibration interval shown above.

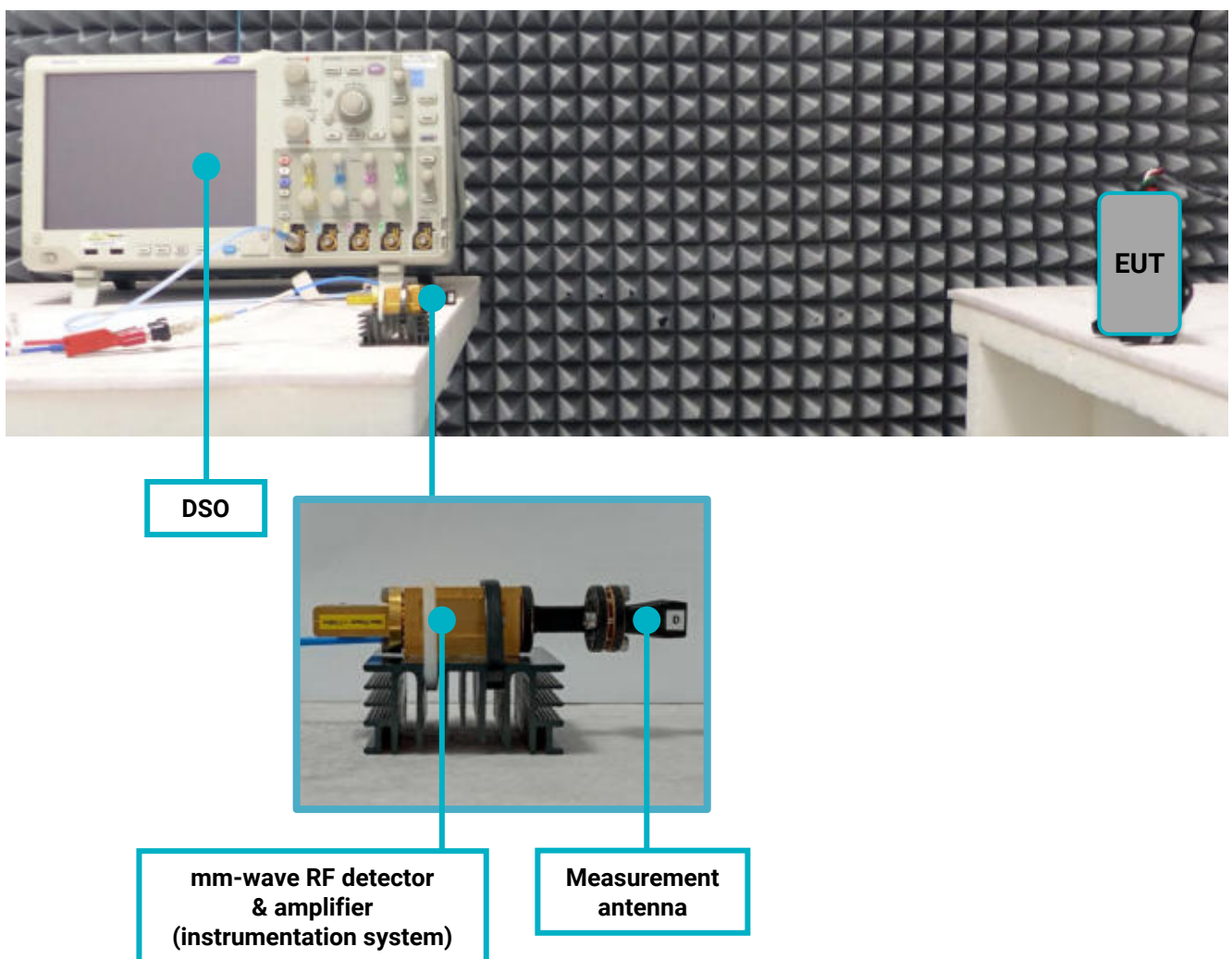
7.5.4 Step 4: ANSI C63.10-2020 9.9 e)

The final values of the peak and average output power of the EUT are calculated according to ANSI C63.10-2020 9.9 e).

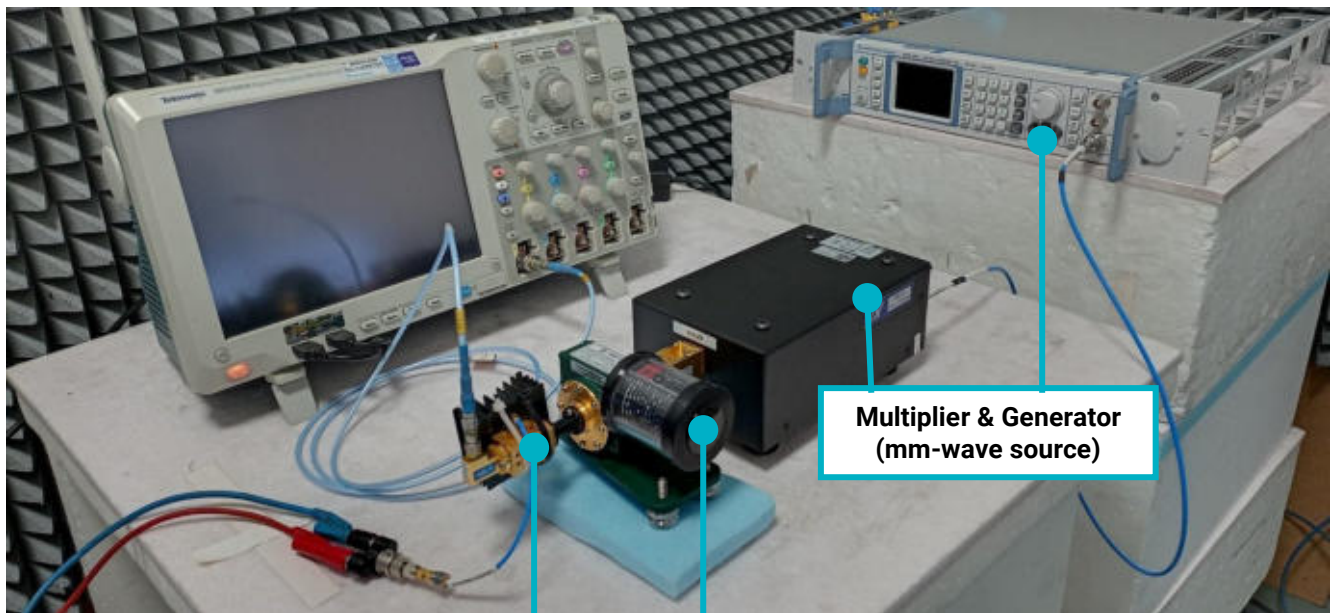
The peak and average substitution power at the input to the measurement instrument is corrected for any external gain and/or attenuation between the measurement antenna and the measurement instrument that was not included in the substitution power measurement.

7.5.5 Pictures of exemplary substitution, fundamental emission 116-123 GHz

Step 1 (see chapter 7.5.1):

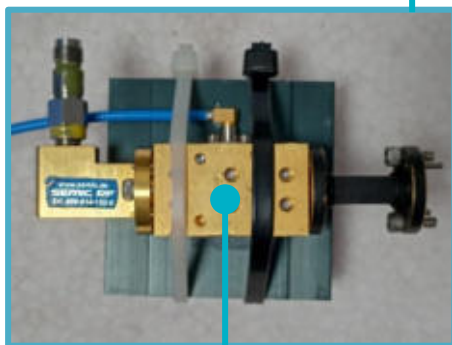


Step 2 (see chapter 7.5.2):



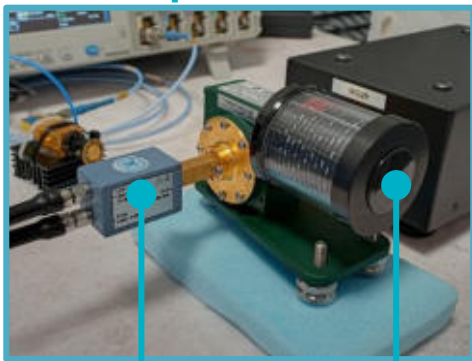
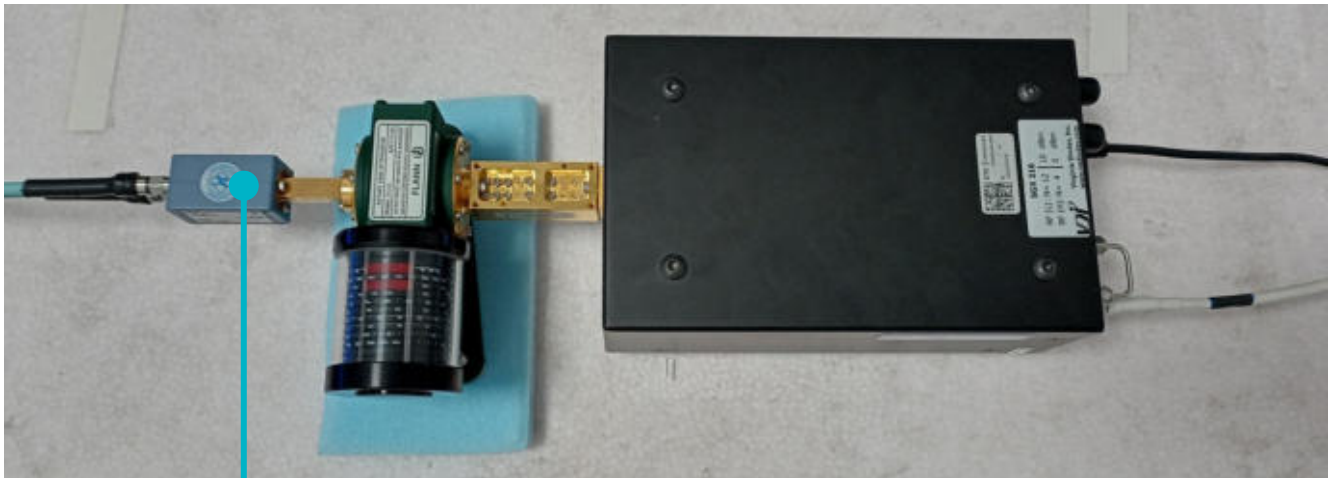
**Multiplier & Generator
(mm-wave source)**

**Waveguide variable
attenuator**



**mm-wave RF detector
& amplifier
(instrumentation system)**

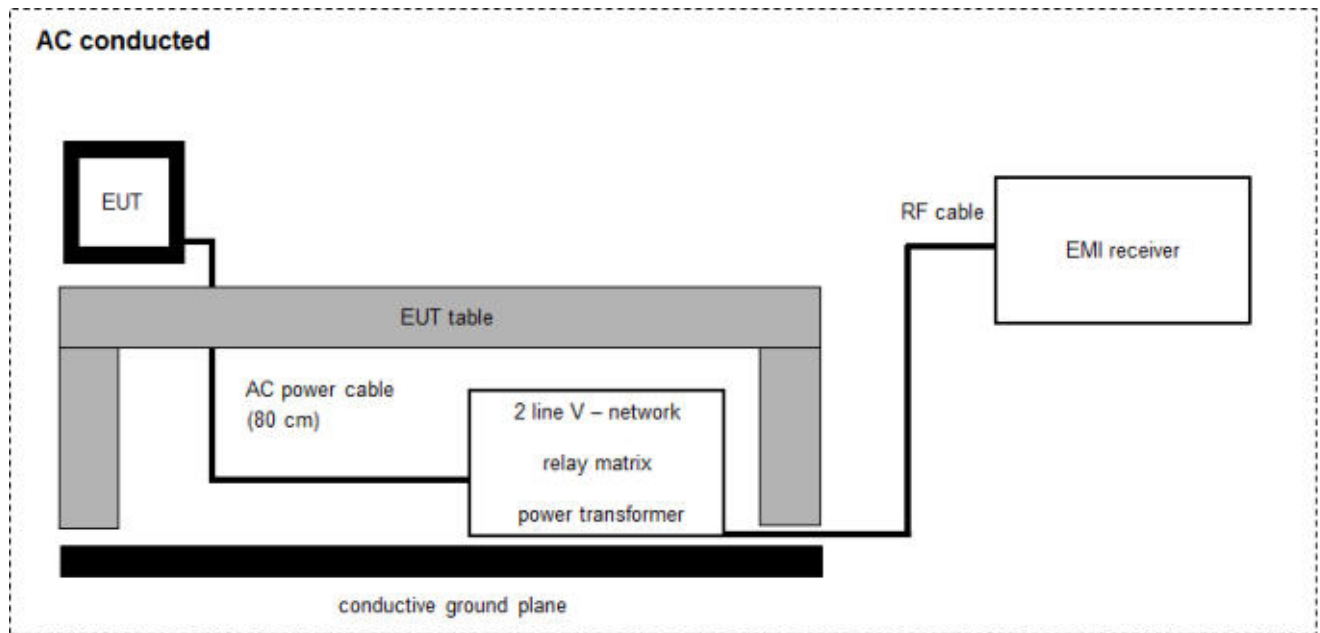
Step 3 (see chapter 7.5.3):



**External mixer (connected
to spectrum analyzer)**

**Waveguide variable
attenuator**

7.6 AC conducted



$$FS = UR + CF + VC$$

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

Example calculation:

$$FS [dB\mu V/m] = 37.62 [dB\mu V/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dB\mu V/m] (244.06 \mu V/m)$$

Equipment table:

No.	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	EMI Test Receiver	EMI Test Receiver ESR3	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102981	300006318	cal	03.12.2024	03.12.2025
2	Analyzer-Impedance-System	Analyzer-Impedance-System AIS16/1	MEC Import: Spitzenberger + Spies GmbH & Co. KG	U02076 07/0 1023	400001751	cal	19.10.2023	31.10.2025
3	Two-Line V-Network (LISN)	Two-Line V-Network (LISN) ESH3-Z5	Rohde & Schwarz Messgerätebau GmbH / Memmingen	892475/017	300002209	cal	12.12.2023	31.12.2025
4	Hochpass 150 kHz	Hochpass 150 kHz EZ-25	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100010	300003798	cpu	-/-	-/-

Relevant measurements performed during the calibration interval shown above.

8 Sequence of testing

8.1 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.

8.2 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 $\pm 45^\circ$ 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.

8.3 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.

8.4 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.

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

Setup

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

Premeasurement

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

Final measurement

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

9 Measurement uncertainty

Test case	Uncertainty
Equivalent isotropically radiated power (e.i.r.p.)	Conducted value ± 1 dB Radiated value ± 3.5 dB
Permitted range of operating frequencies	± 100 kHz
Conducted unwanted emissions in the spurious domain (up to 18 GHz)	± 1 dB
Radiated unwanted emissions in the spurious domain (up to 18 GHz)	± 3.5 dB
Conducted unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Radiated unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Conducted unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Radiated unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Conducted unwanted emissions in the spurious domain (above 50 GHz)	± 5 dB
Radiated unwanted emissions in the spurious domain (above 50 GHz)	± 5 dB
DC and low frequency voltages	± 3 %
Temperature	± 1 °C
Humidity	± 3 %

10 Far field consideration for measurements above 18 GHz

Far field distance calculation:

$$D_{ff} = 2 \times D^2 / \lambda$$

with

D_{ff} Far field distance

D Antenna dimension

λ wavelength

Spurious emission measurements:

Antenna frequency range in GHz	Highest measured frequency in GHz	D in cm	λ in cm	D_{ff} in cm
18 - 26.5	26.5	3.4	1.13	20.44
26.5 - 40	40	2.2	0.75	12.91
40 - 50	50	2.77	0.60	25.58
50 - 75	75	1.85	0.40	17.11
75 - 110	110	1.24	0.27	11.28
90 - 140	140	1.02	0.22	9.72
110 - 170	170	0.85	0.18	8.19
140 - 220	220	0.68	0.14	6.78
220 - 325	325	0.43	0.09	4.01
325 - 500	500	0.26	0.06	2.25

In band measurement (OBW):

Antenna frequency range in GHz	Highest measured frequency in GHz	Antenna dimension in cm	Wavelength in cm	Far Field distance in cm
110 - 170	170	0.85	0.18	8.19

11 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 (dated 2020-08-24)	see below	2026-01-19	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Remark
§15.258 (b)(4), §15.258 (d)	Occupied bandwidth & Emission bandwidth & Frequency stability	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	complies
§15.258 (b)	Maximum E.I.R.P. / Transmitter output power	Nominal	Nominal	☒	☐	☐	☐	complies
§15.258 (c)	Spurious Emissions / Transmitter unwanted emissions	Nominal	Nominal	☒	☐	☐	☐	complies
§15.207	Conducted emissions < 30 MHz (AC power line)	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not applicable; NP = Not performed

12 Basic information of the DUT

Basic information of the DUT as declared by the customer:

General information: see chapter “6 Test item”

- Equipment class:
- ☐ Fixed point-to-point transmitters located outdoors
 - ☐ Transmitters with an emission bandwidth of less than 100 MHz
 - ☒ Else

Note: Operation on board an aircraft or a satellite is prohibited. (§15.258 (d))

13 Additional comments

Reference documents:

- 2025-01_Beschreibung Gereate und Inbetriebnahme_Cetecom advanced_V3

Special test descriptions:

- 2025-01_Beschreibung Gereate und Inbetriebnahme_Cetecom advanced_V3

Configuration descriptions:

- 2025-01_Beschreibung Gereate und Inbetriebnahme_Cetecom advanced_V3

Test devices (EUT):

- **EUT Main2673:** EUT used for general testing. Beamwidth of 6° according to the customer (Lens type D)
- **EUT Main2467:** EUT used for general testing. Beamwidth of 6° according to the customer (Lens type D). As declared by the customer, the hardware revision is identical to EUT Main2673, apart from an alternative input protection diode, which allows for an increased input voltage range. According to the customer, this modification does not affect the test results relative to EUT Main2673.
- **EUT Delta2406:** EUT used for delta testing. Beamwidth of 16° according to the customer (Lens type C).

Associated equipment (AE):

- AE1: Connector board with shielded cable. Used for spurious emissions measurements (radiated) below 18 GHz.
- AE2: EUT Support
- AE3: Config Box. Used for configuring the EUT via ethernet.
- AE4: Connect PCB. Used to connect the Config Box to the EUT.
- AE5: 24V DC power supply.
- AE6: Unshielded cable. Used to connect the EUT to the connect PCB during tests above 18 GHz.

Normal operation modes (NM) according to customer declarations:

Abbreviation	Name	Features
MainMode1	Std. accuracy – long range	122.25 – 123 GHz chirped
MainMode2	Std. accuracy – mid range up to 20 m	122.25 – 123 GHz chirped

Additional test modes:

- ☐ No test modes available
☐ Special test modes/special software (see description below)
☒ Stop-Modes (see description below)

Stop-Modes as declared by customer:

In addition to the normal operation mode, Stop-Modes are used in accordance with CFR 47 Part §15.31 (c) & (m), in which the frequency sweep is stopped at the following positions in the range of operation:

- Stop-Mode, low frequency: 122.250 GHz
- Stop-Mode, middle frequency: 122.625 GHz
- Stop-Mode, high frequency: 123.0 GHz

Details on test mode settings:

According to the customer's instructions, the following steps and commands were used to configure the test modes:

- Connect the EUT to the Connect PCB, Config Box and DC Power supply.
- Connect a PC to the Config Box using an ethernet cable.
- Go to the URL „config.box“ in a browser and go to the „Sensor Configuration“ Tab.
- Select the desired test mode in the „Radar Profile“ section and activate the „Fast Mode“ to achieve the proper cycle time.

14 Measurement results

14.1 Occupied bandwidth & emission bandwidth & frequency stability

Description:

Measurement of the bandwidth and the frequency stability of the wanted signal (fundamental emission) under temperature and supply voltage variations.

Limits and provisions:

Designated frequency band
116 GHz – 123 GHz

§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.

Measurement:

Measurement parameter: 6 dB bandwidth	
Detector:	Pos-Peak
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Trace-Mode:	MaxHold

Measurement results:

6 dB bandwidth under normal conditions:

EUT	Mode	Test condition	f _L [GHz]	f _H [GHz]	Bandwidth [MHz]
Main2673	MainMode1	T _{nom} / V _{nom}	122.254	122.995	741.0
Main2673	MainMode2	T _{nom} / V _{nom}	122.255	122.996	741.0
Delta2406	MainMode1	T _{nom} / V _{nom}	122.254	122.993	739.0
Delta2406	MainMode2	T _{nom} / V _{nom}	122.256	122.995	739.0

Frequency stability (15.258(d)):

Mode for frequency stability tests: **MainMode1** (Mode with the widest bandwidth, ANSI C63.10-2020 5.6.2.2).

Bandwidth measurement for frequency stability tests: 6 dB bandwidth

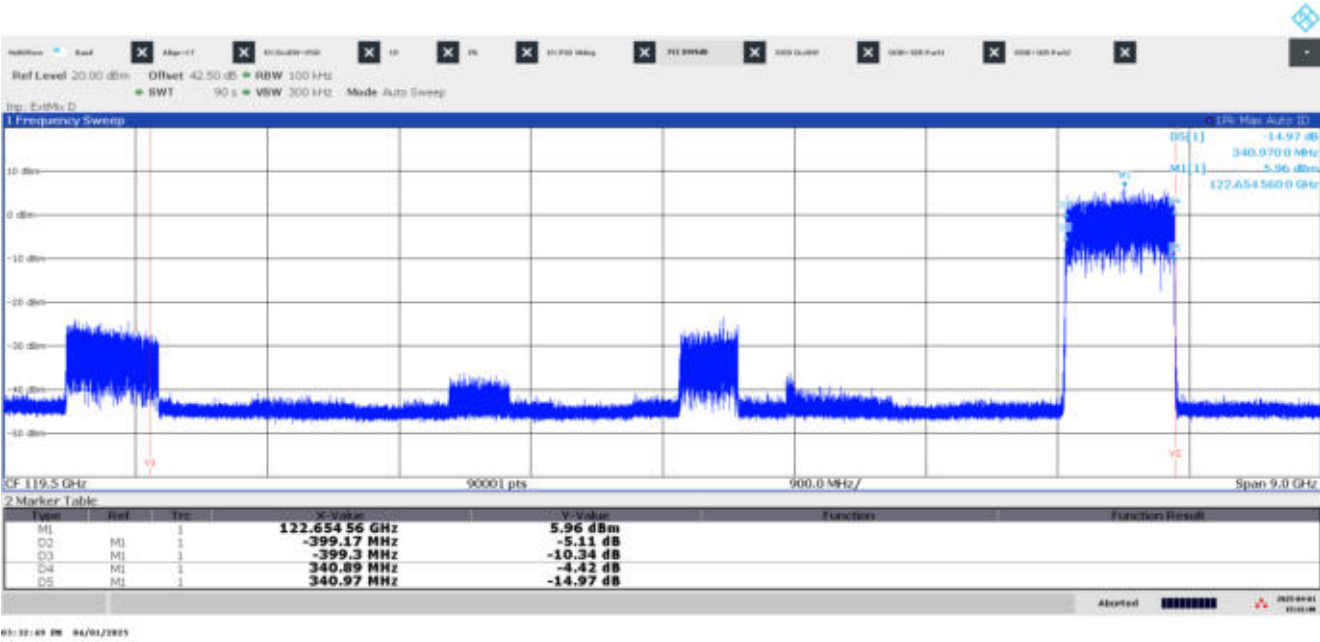
EUT	Test condition	Frequency f_L [GHz]	Frequency f_H [GHz]	Bandwidth [MHz]
Main2467	-20 °C / V_{nom}	122.254	122.995	741.7
Main2467	-10 °C / V_{nom}	122.254	122.995	741.4
Main2467	0 °C / V_{nom}	122.254	122.995	740.5
Main2467	10 °C / V_{nom}	122.254	122.995	741.5
Main2467	20 °C / 20.4 V	122.254	122.995	740.9
Main2467	20 °C / 27.6 V	122.254	122.995	740.9
Main2673	30 °C / V_{nom}	122.254	122.995	740.8
Main2673	40 °C / V_{nom}	122.254	122.995	740.7
Main2673	50 °C / V_{nom}	122.254	122.995	741.2

Note:

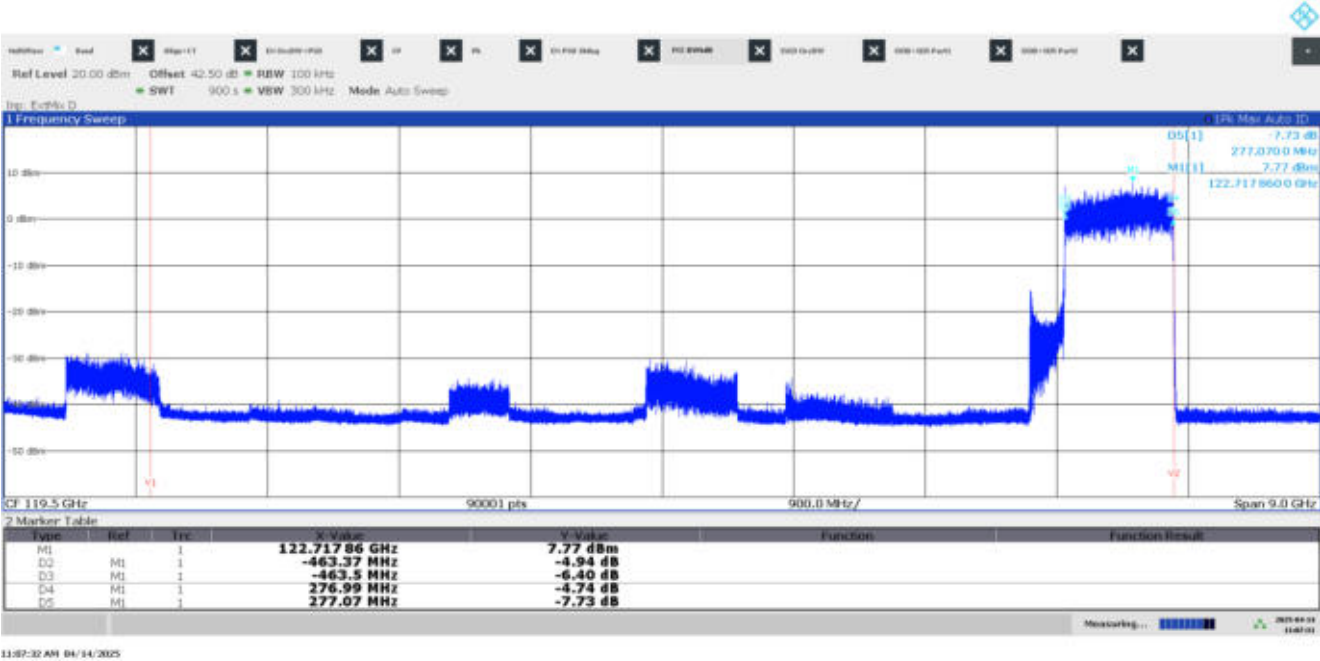
- Detailed measurement results:
 - see measurement report 1-9121-01-03_TR1-A201-R1 for Main2467 - MainMode1 and Main2673 - MainMode1 measurement plots
 - see plots below for measurement plots of other EUTs and modes

Verdict: Compliant

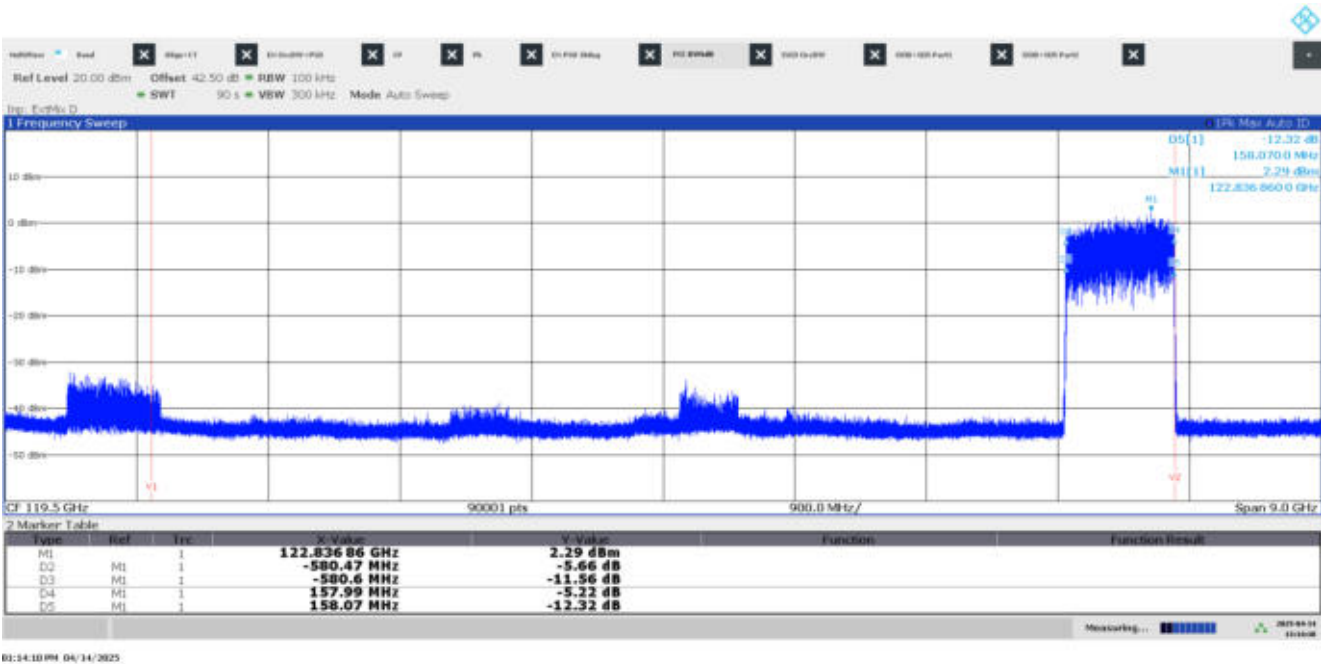
Plot 1: EUT Main2673, MainMode2, 6 dB bandwidth (RBW = 100 kHz)



Plot 2: EUT Delta2406, MainMode1, 6 dB bandwidth (RBW = 100 kHz)



Plot 3: EUT Delta2406, MainMode2, 6 dB bandwidth (RBW = 100 kHz)



14.2 Maximum E.I.R.P. / Transmitter output power

Description:

Measurement of the maximum radiated E.I.R.P. of the wanted signal.

Limits and provisions:

§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).

Measurement:

Measurement parameter	
Detector:	Pos-Peak (RF-Detector)
Video bandwidth:	10 MHz

Measurement procedures:

Fundamental emission using an RF detector: ANSI C63.10-2020 9.9

Measurement results:

EUT	Mode	Test condition	Peak E.I.R.P. [dBm]	Applicable Limit Peak E.I.R.P. [dBm]	Average E.I.R.P. [dBm]	Applicable Limit Average E.I.R.P. [dBm]
Main2467	MainMode1	T_{nom} / V_{nom}	18.52	43.0	17.99	40.0
Main2467	MainMode2	T_{nom} / V_{nom}	18.49	43.0	17.89	40.0
Delta2406	MainMode1	T_{nom} / V_{nom}	16.63	43.0	16.04	40.0
Delta2406	MainMode2	T_{nom} / V_{nom}	16.53	43.0	16.14	40.0

Verdict: Compliant

Detailed measurement steps (according to ANSI C63.10-2020 9.9):

The measurement is performed according to ANSI C63.10-2020 9.9.

Details on the measurement steps and block diagrams of the measurement setup can be found in chapter "7.5 Fundamental emission measurement using an RF detector (ANSI C63.10-2020 9.9)".

Measurement step	Measurement parameter	Formula [Unit]	EUT Main2467		EUT Delta2406	
			MainMode1	MainMode2	MainMode1	MainMode2
1)	Measurement distance	d_M [m]	0.35	0.35	0.35	0.35
	Gain of measurement antenna	G_M [dBi]	19.67	19.67	19.67	19.67
	Peak voltage	V_{peak} [mV]	17.20	17.04	10.24	10.08
	Average voltage during the ON time	V_{avg} [mV]	14.21	14.16	8.31	8.48
2)	Frequency of the mm-wave source	f_{source} [MHz]	122 625	122 625	122 625	122 625
3)	Power measured for the peak value*	P_{peak} [dBm]	-26.91	-26.94	-28.80	-28.90
	Power measured for the average value*	P_{avg} [dBm]	-27.44	-27.54	-29.39	-29.29
4)	Peak E.I.R.P. of the EUT	$E.I.R.P._{peak}$ [dBm]	18.52	18.49	16.63	16.53
	Average E.I.R.P. of EUT (during the ON time)	$E.I.R.P._{avg}$ [dBm]	17.99	17.89	16.04	16.14

Note:

- Duty-cycle of MainMode1: 1.0 (100%) – See Plot 4
- Duty-cycle of MainMode2: 1.0 (100%) – See Plot 5
- The frequency of the mm-wave source is adjusted to the center of the frequency range occupied by the transmitter.
- Calculation of the EIRP from the radiated measurement in the far-field using Equation (22) of ANSI C63.10-2020 9.2.2:

$$E.I.R.P. [dBm] = 21.98 - 20 \log(\lambda [m]) + 20 \log(d_M [m]) + P [dBm] - G_M [dBi]$$

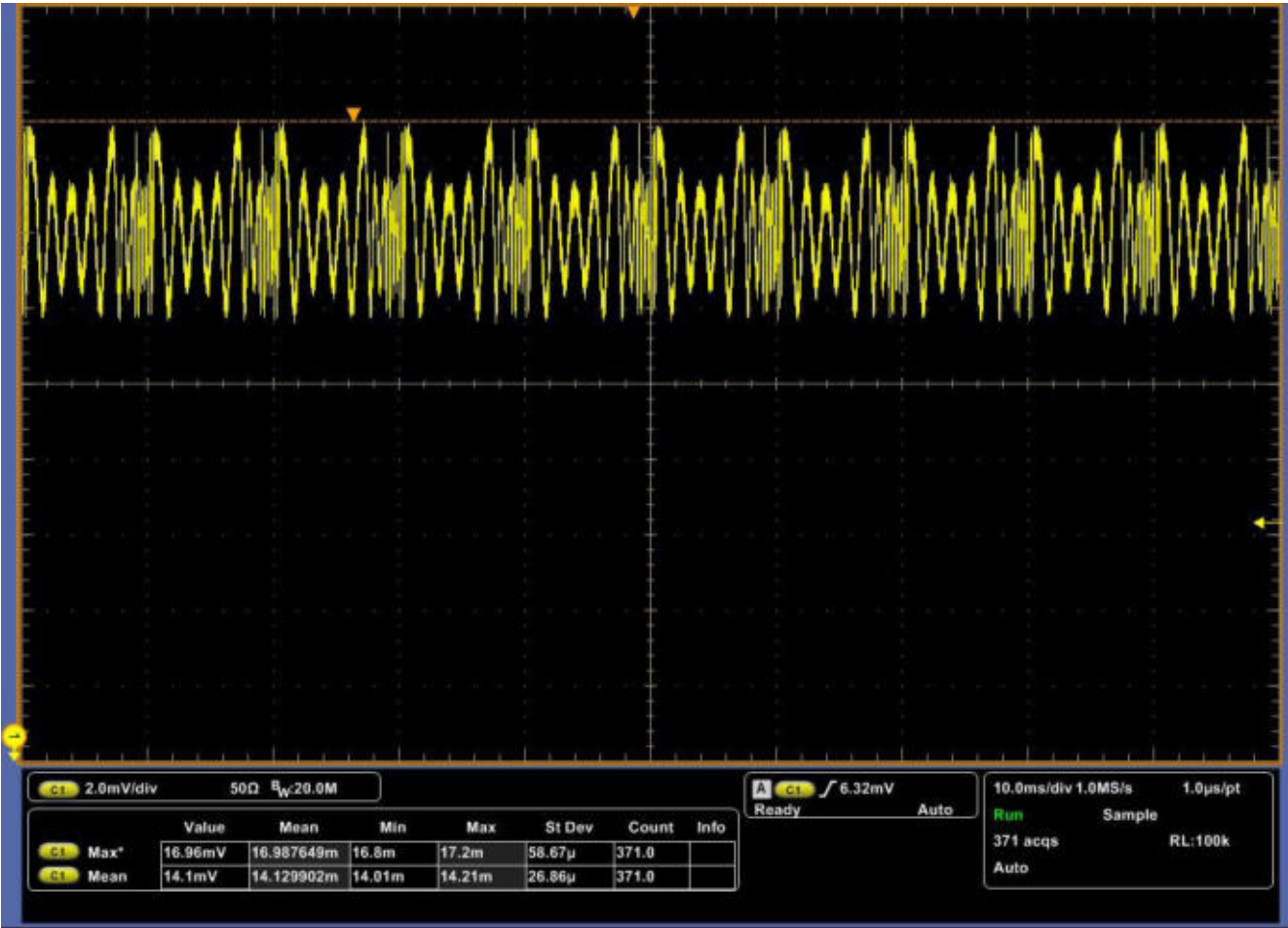
$$\lambda [m] = 300 / f_{source} [MHz]$$

where

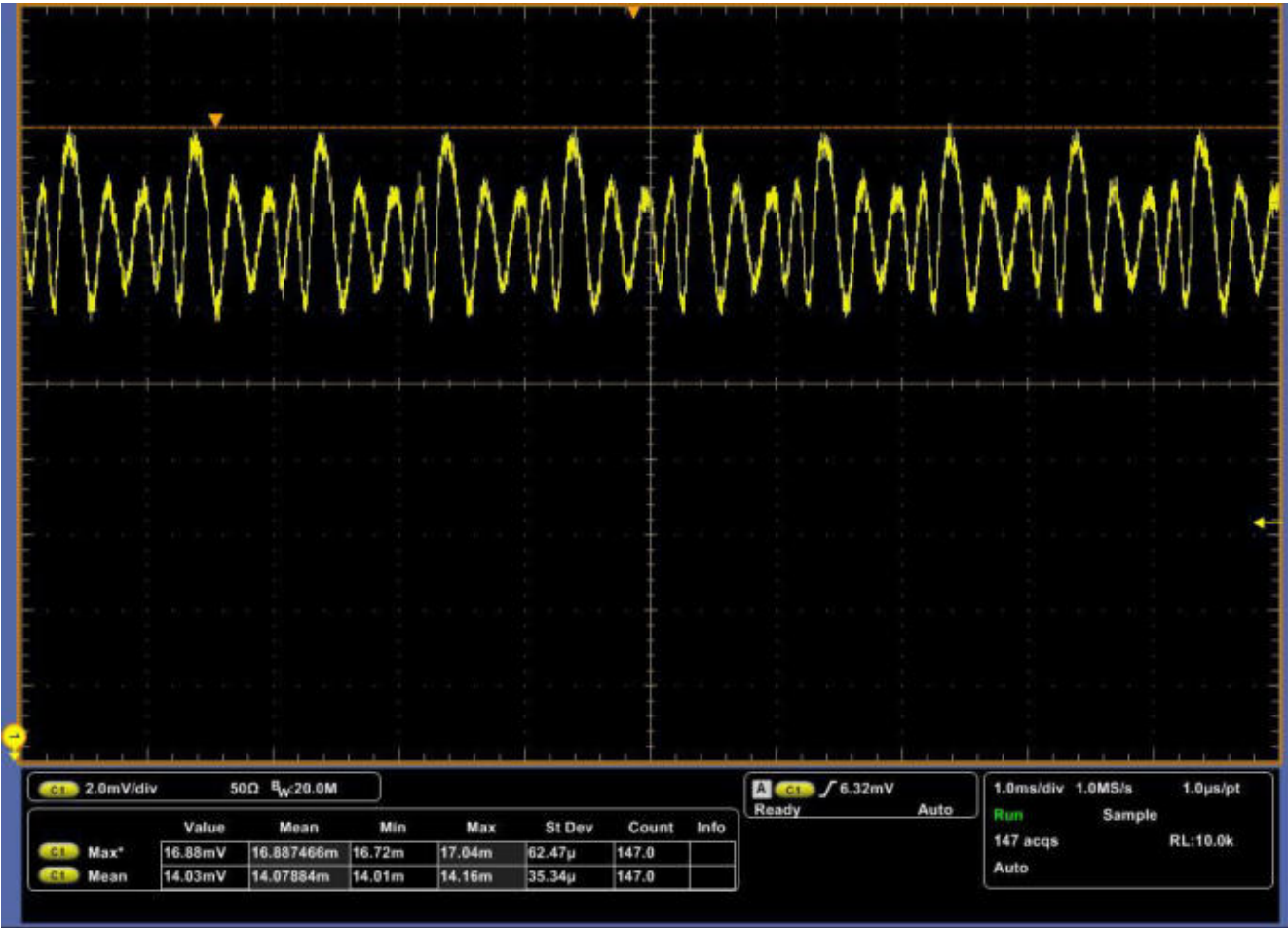
- $E.I.R.P.$ is the equivalent isotropic radiated power, in dBm
- λ is the wavelength of the emission under investigation ($300/f[MHz]$), in m
- d_M is the measurement distance, in m
- P is the power measured at the output of the waveguide variable attenuator, in dBm
- G_M is the gain of the measurement antenna, in dBi

*The measured power P includes all applicable instrument correction factors up to the connection to the waveguide connector (e.g. of the waveguide variable attenuator).

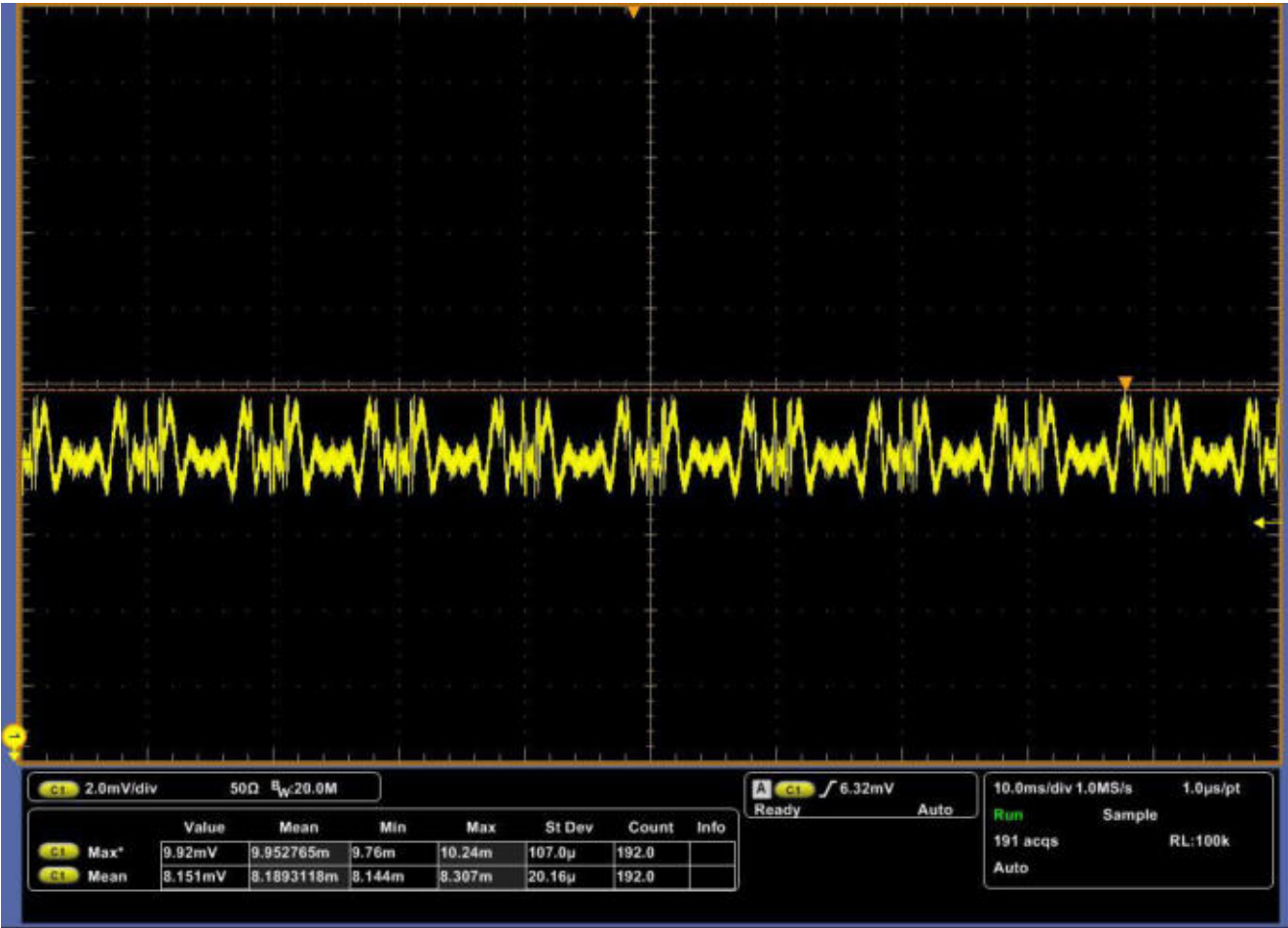
Plot 4: Step 1 - EUT Main2467, MainMode1, Peak and mean voltage (Oscilloscope)



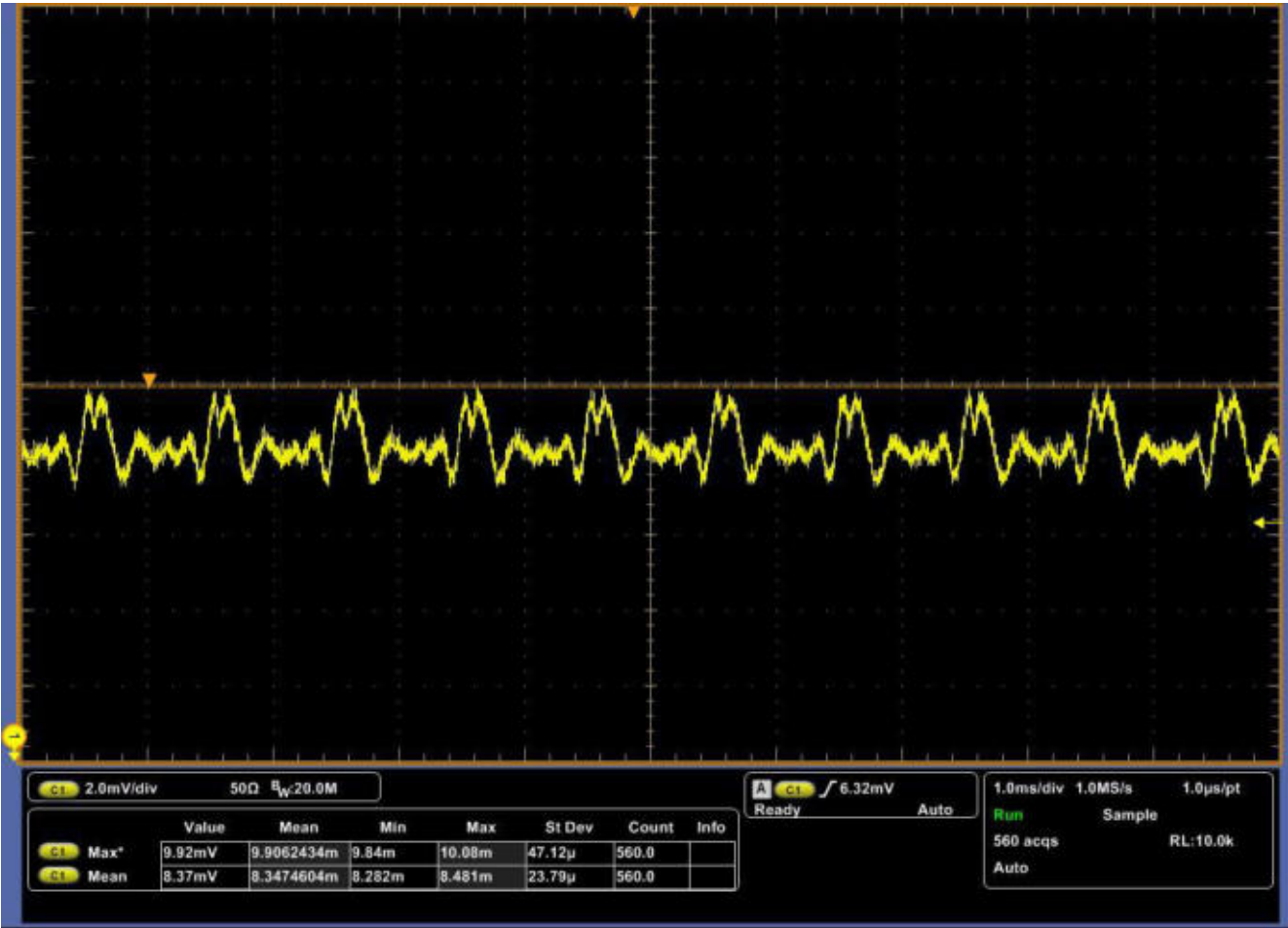
Plot 5: Step 1 - EUT Main2467, MainMode2, Peak and mean voltage (Oscilloscope)



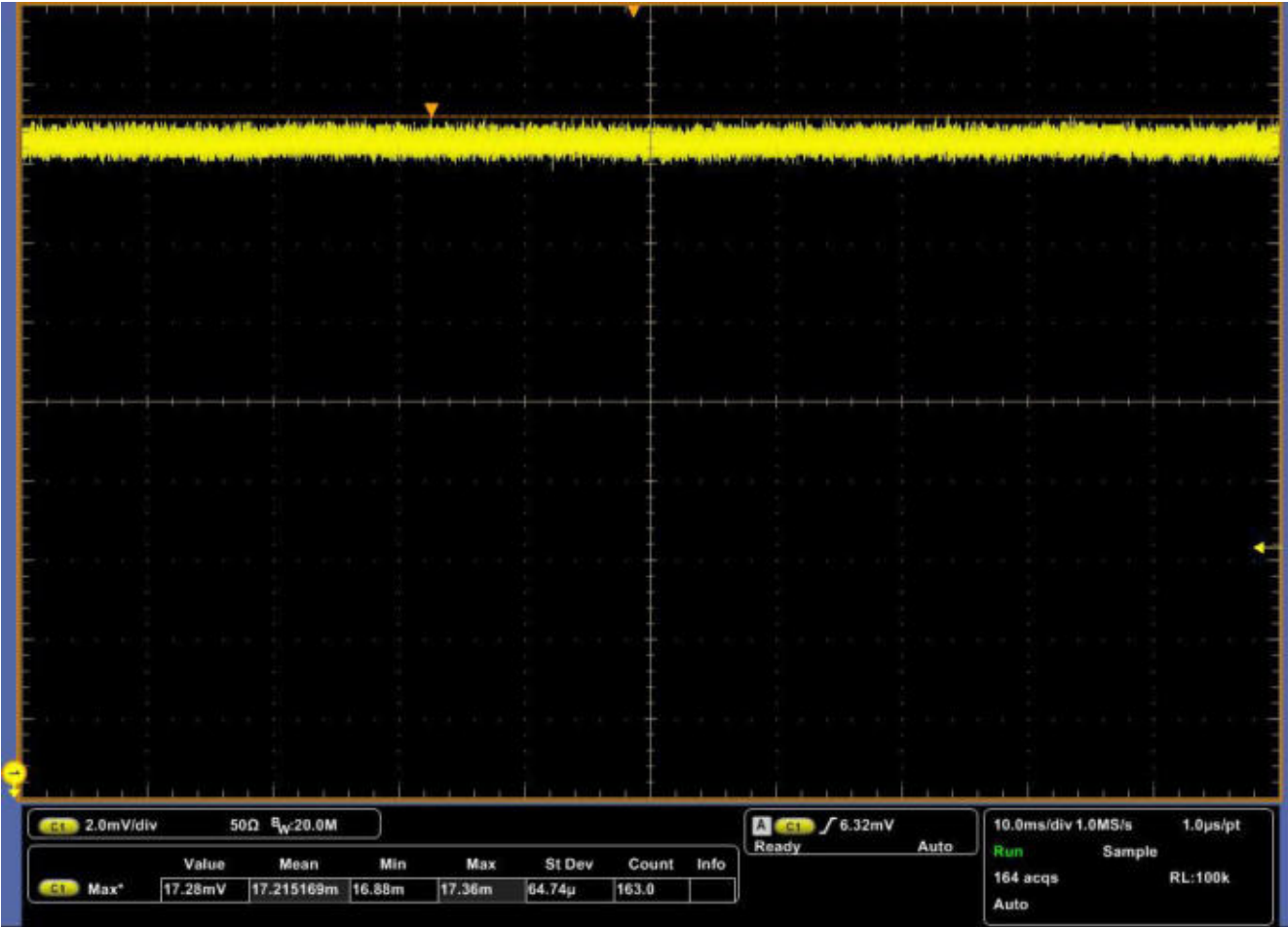
Plot 6: Step 1 - EUT Delta2406, MainMode1, Peak and mean voltage (Oscilloscope)



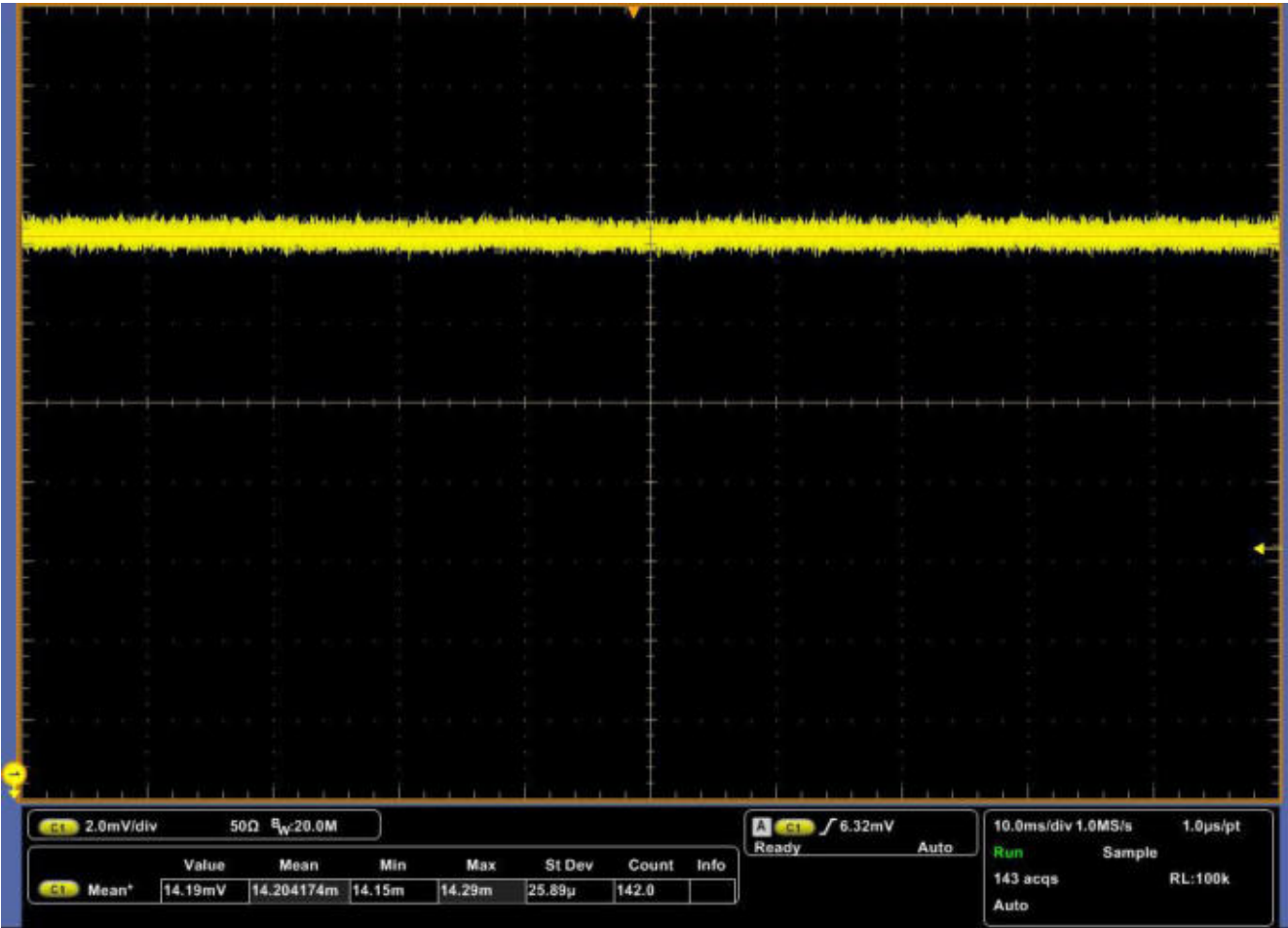
Plot 7: Step 1 - EUT Delta2406, MainMode2, Peak and mean voltage (Oscilloscope)



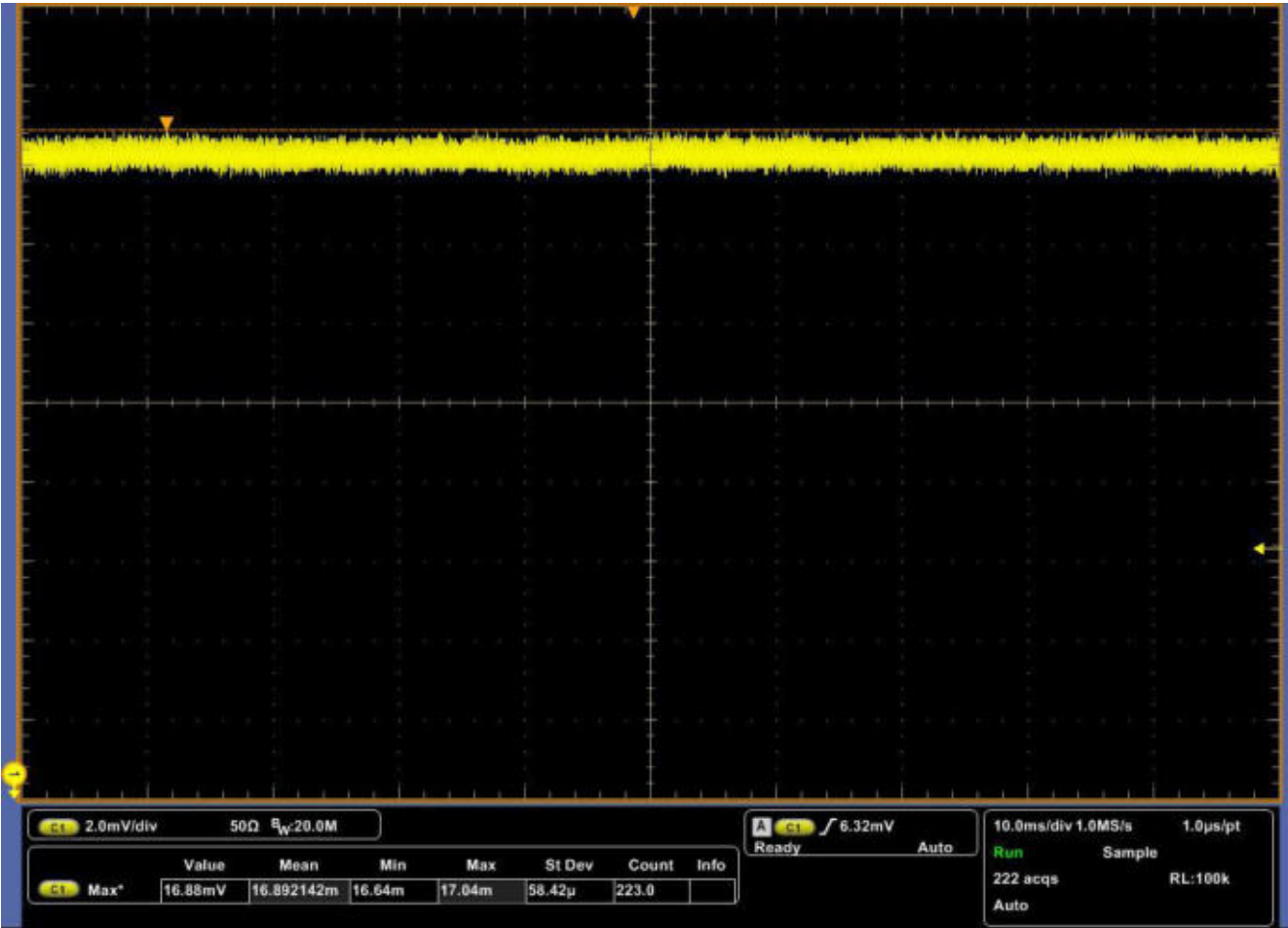
Plot 8: Step 2 - EUT Main2467, MainMode1, adjusted voltage equal to the peak voltage of step 1



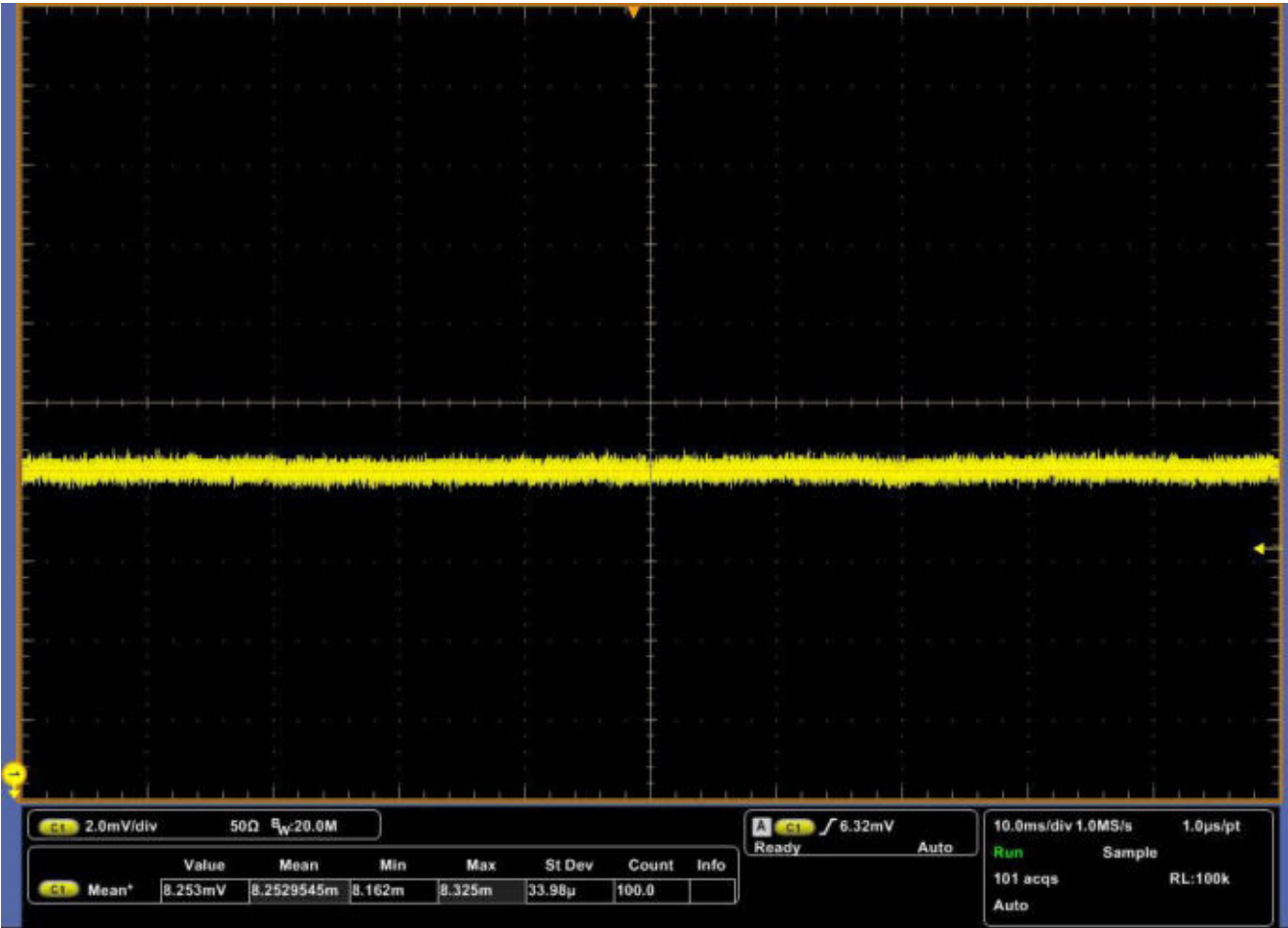
Plot 9: Step 2 - EUT Main2467, MainMode1, adjusted voltage equal to the mean voltage of step 1



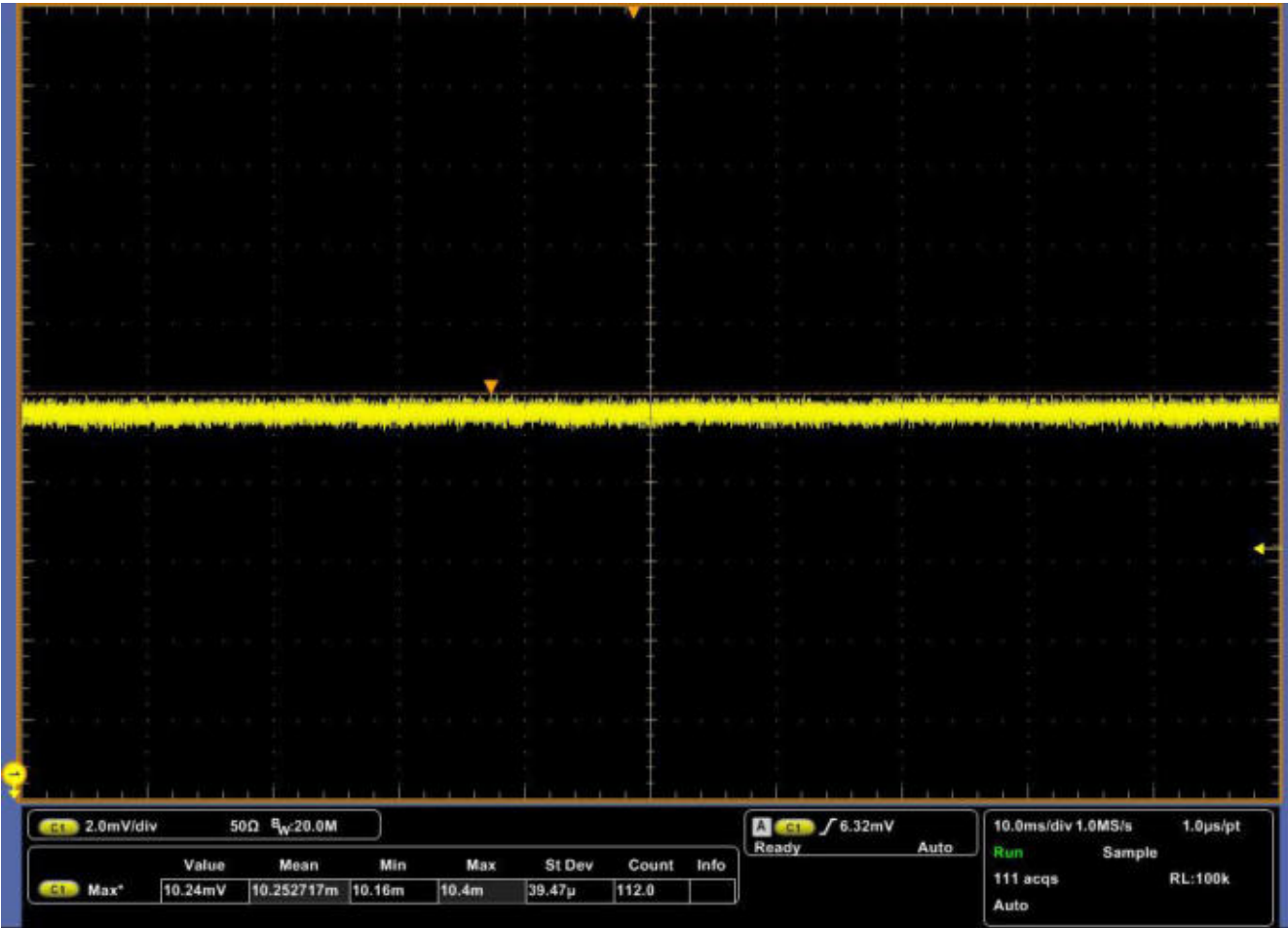
Plot 10: Step 2 - EUT Main2467, MainMode2, adjusted voltage equal to the peak voltage of step 1



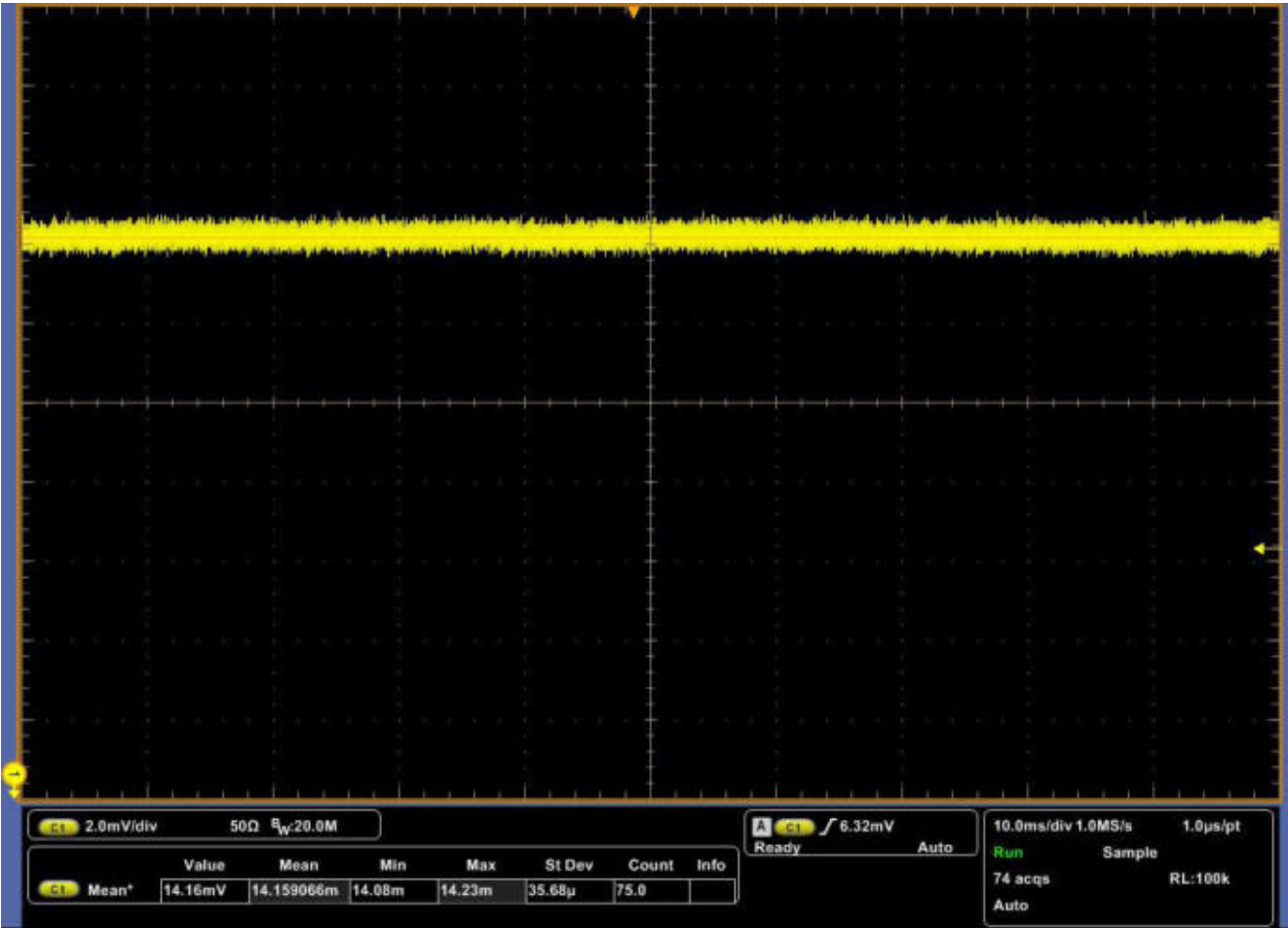
Plot 11: Step 2 - EUT Main2467, MainMode2, adjusted voltage equal to the mean voltage of step 1



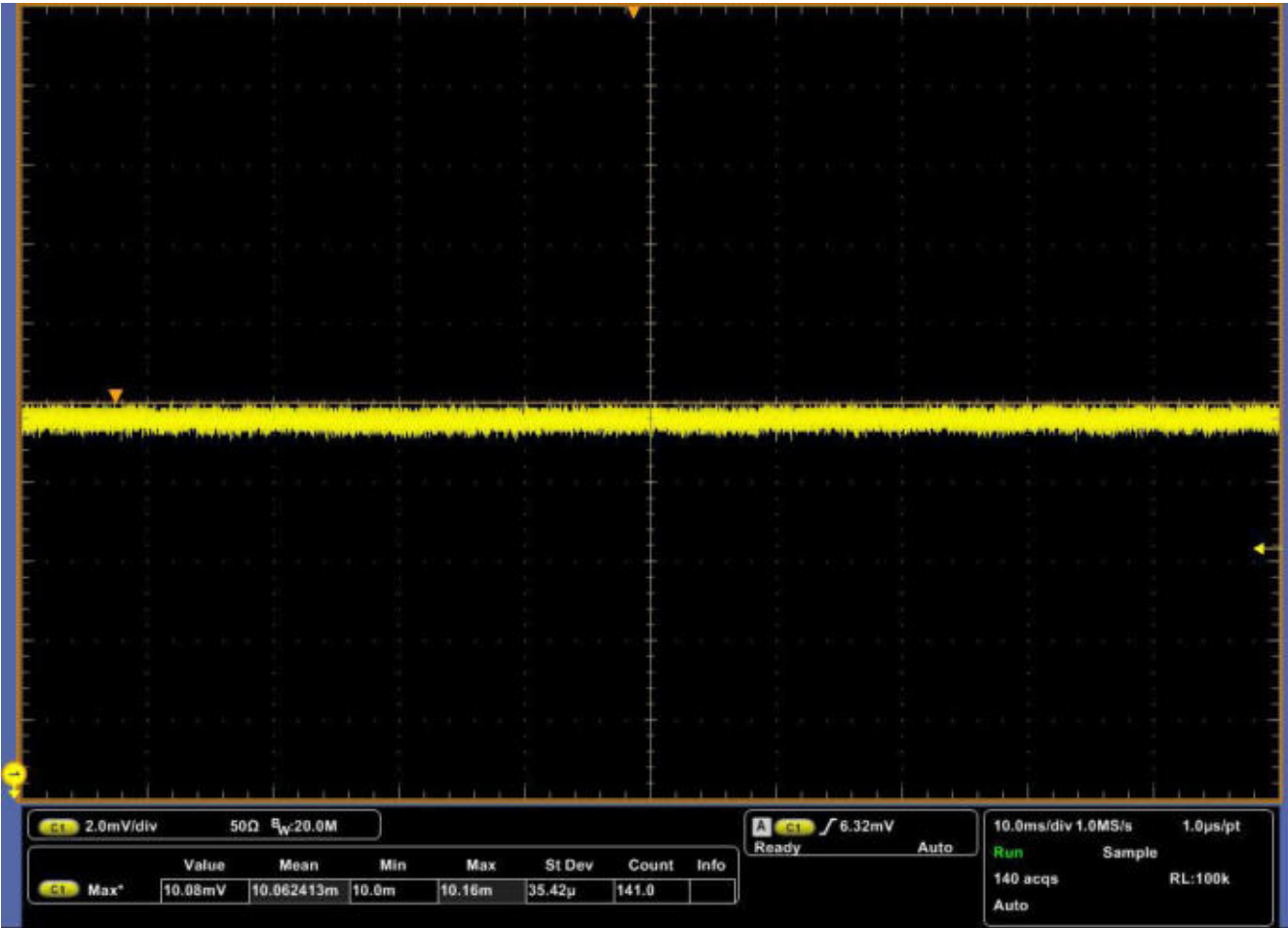
Plot 12: Step 2 - EUT Delta2406, MainMode1, adjusted voltage equal to the peak voltage of step 1



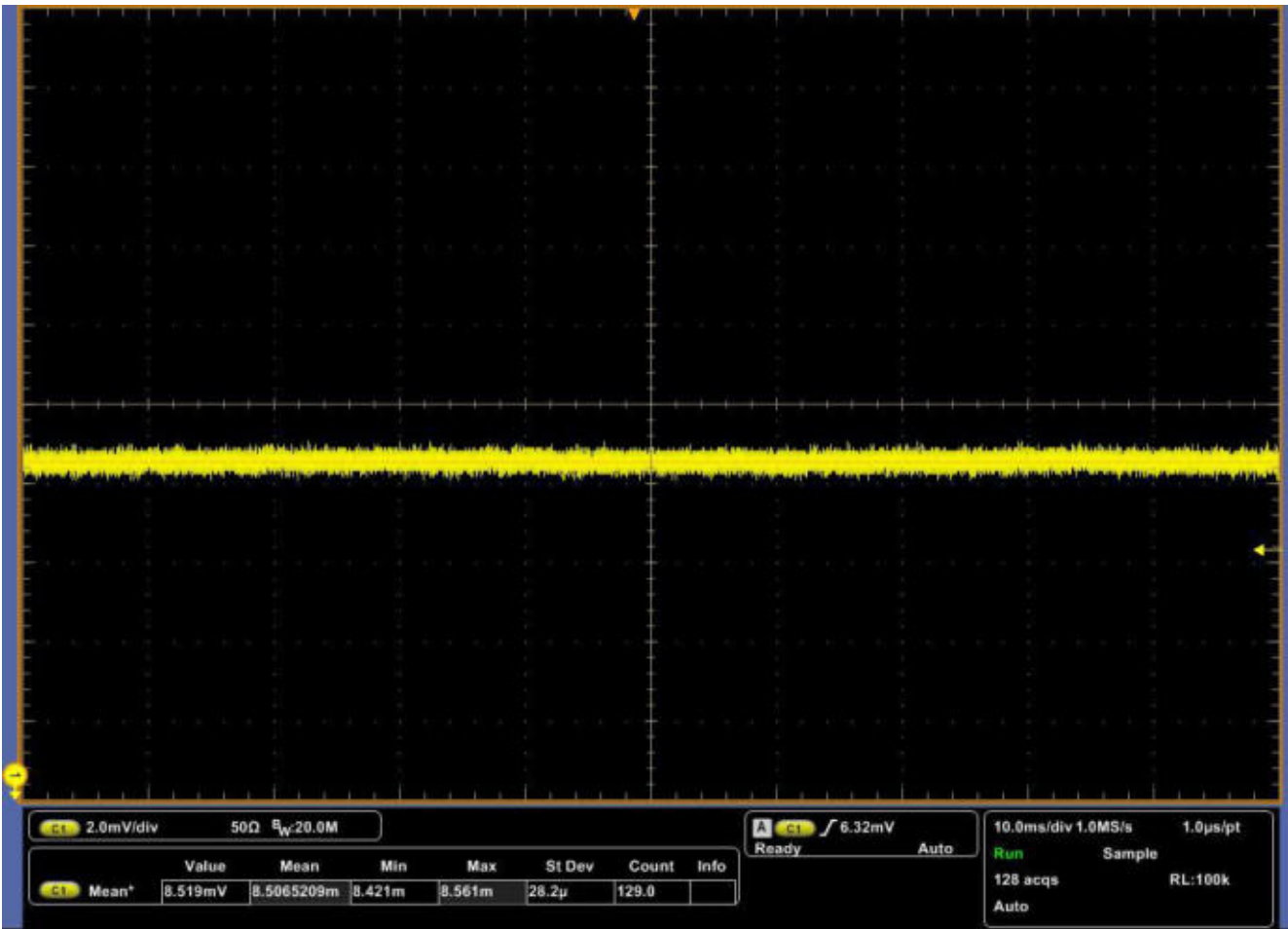
Plot 13: Step 2 - EUT Delta2406, MainMode1, adjusted voltage equal to the mean voltage of step 1



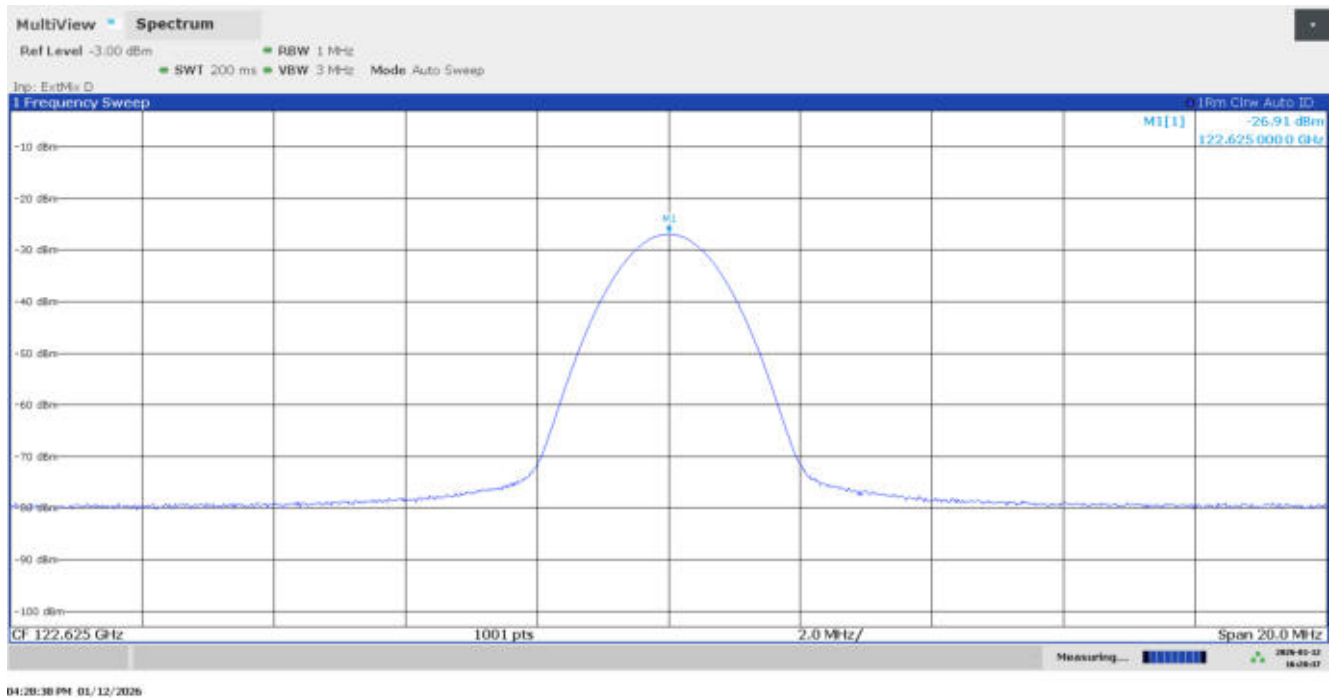
Plot 14: Step 2 - EUT Delta2406, MainMode2, adjusted voltage equal to the peak voltage of step 1



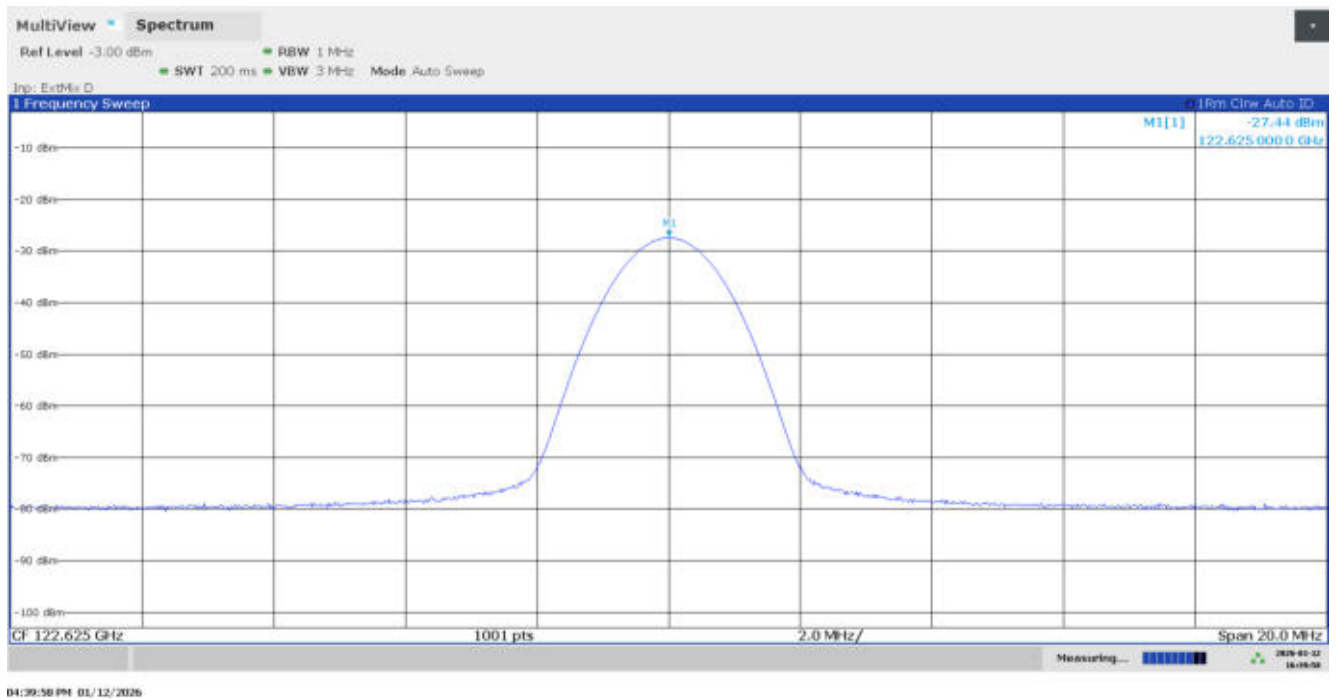
Plot 15: Step 2 - EUT Delta2406, MainMode2, adjusted voltage equal to the mean voltage of step 1



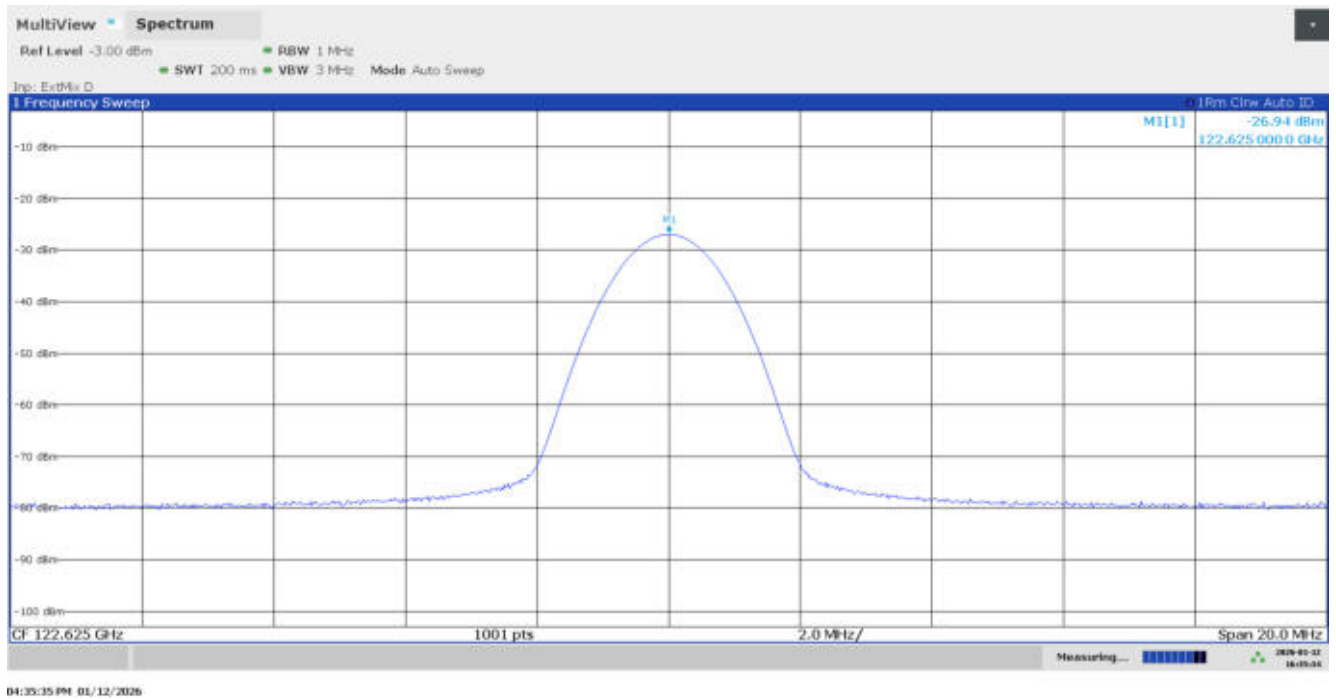
Plot 16: Step 3- EUT Main2467, MainMode1, Substitution, Power measured for the peak value (Mixer + Analyzer)



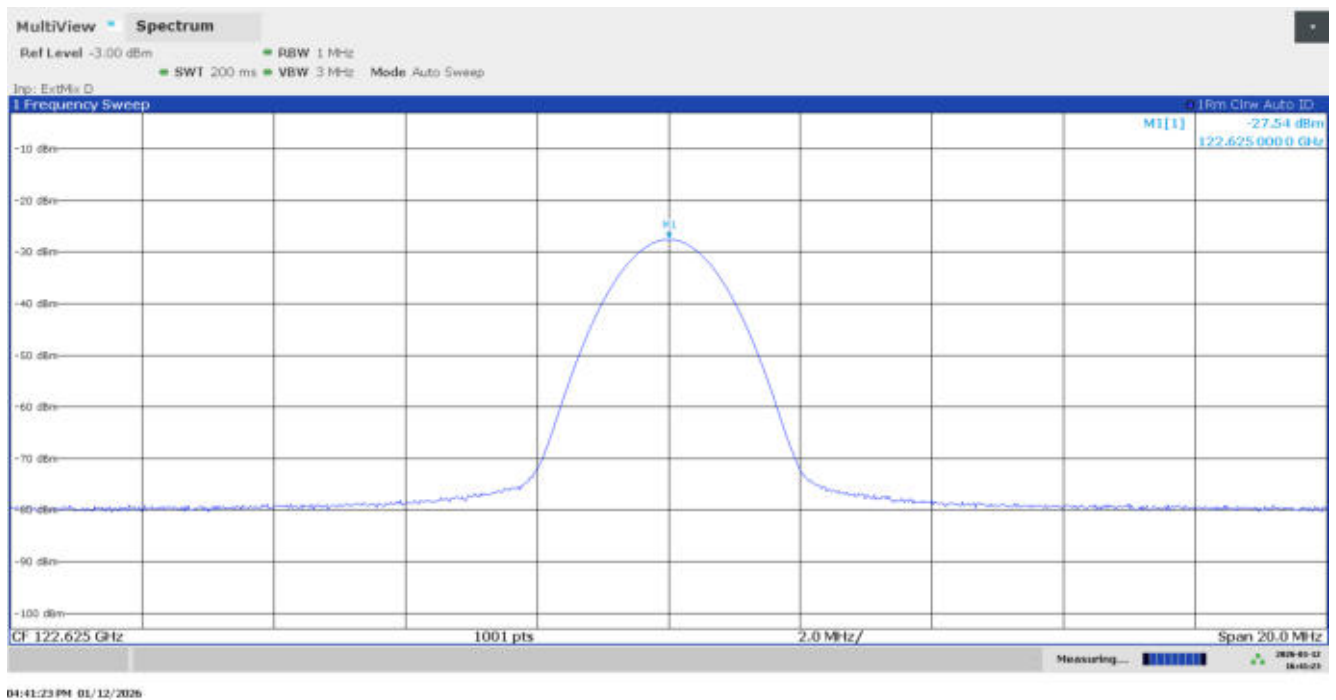
Plot 17: Step 3- EUT Main2467, MainMode1, Substitution, Power measured for the mean value (Mixer + Analyzer)



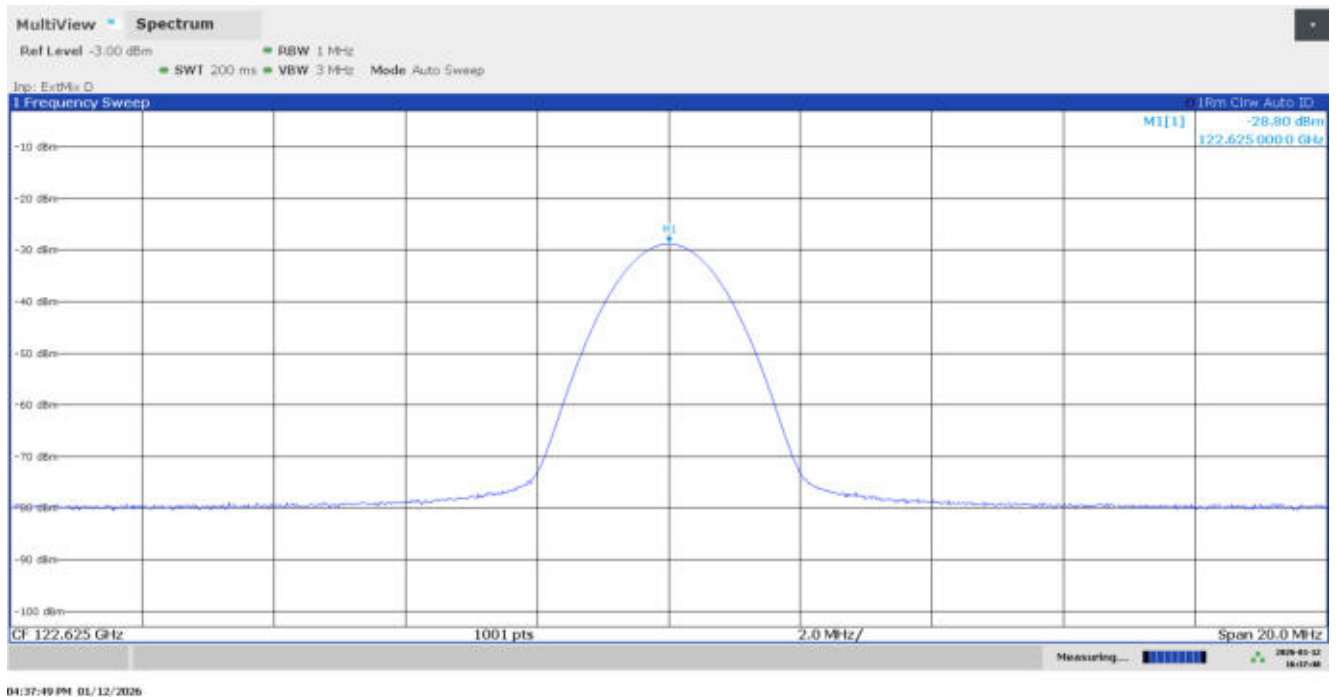
Plot 18: Step 3- EUT Main2467, MainMode2, Substitution, Power measured for the peak value (Mixer + Analyzer)



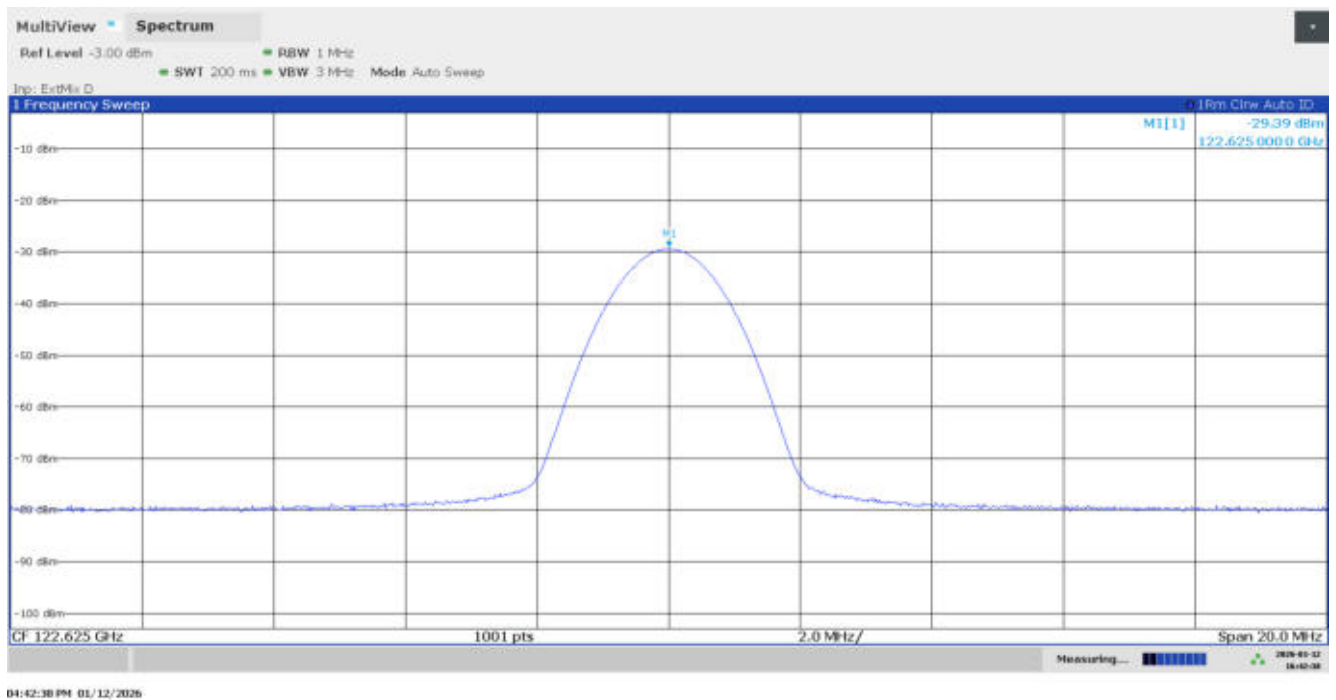
Plot 19: Step 3- EUT Main2467, MainMode2, Substitution, Power measured for the mean value (Mixer + Analyzer)

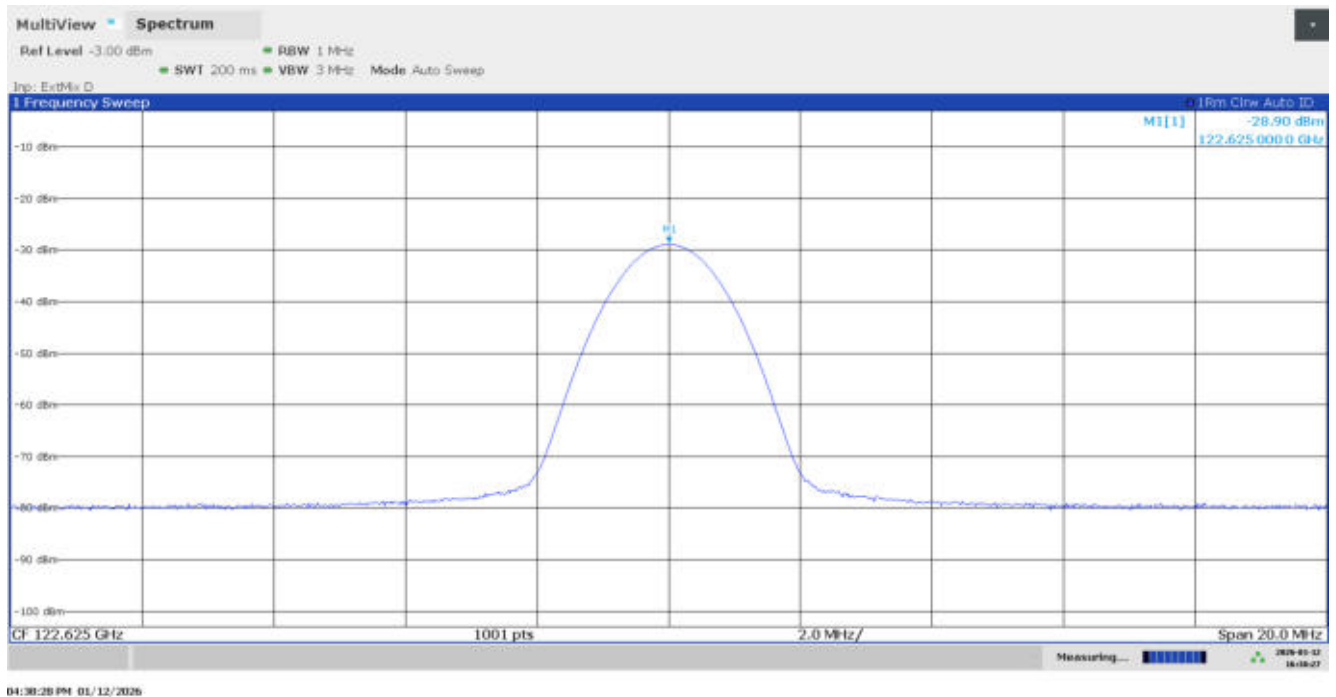
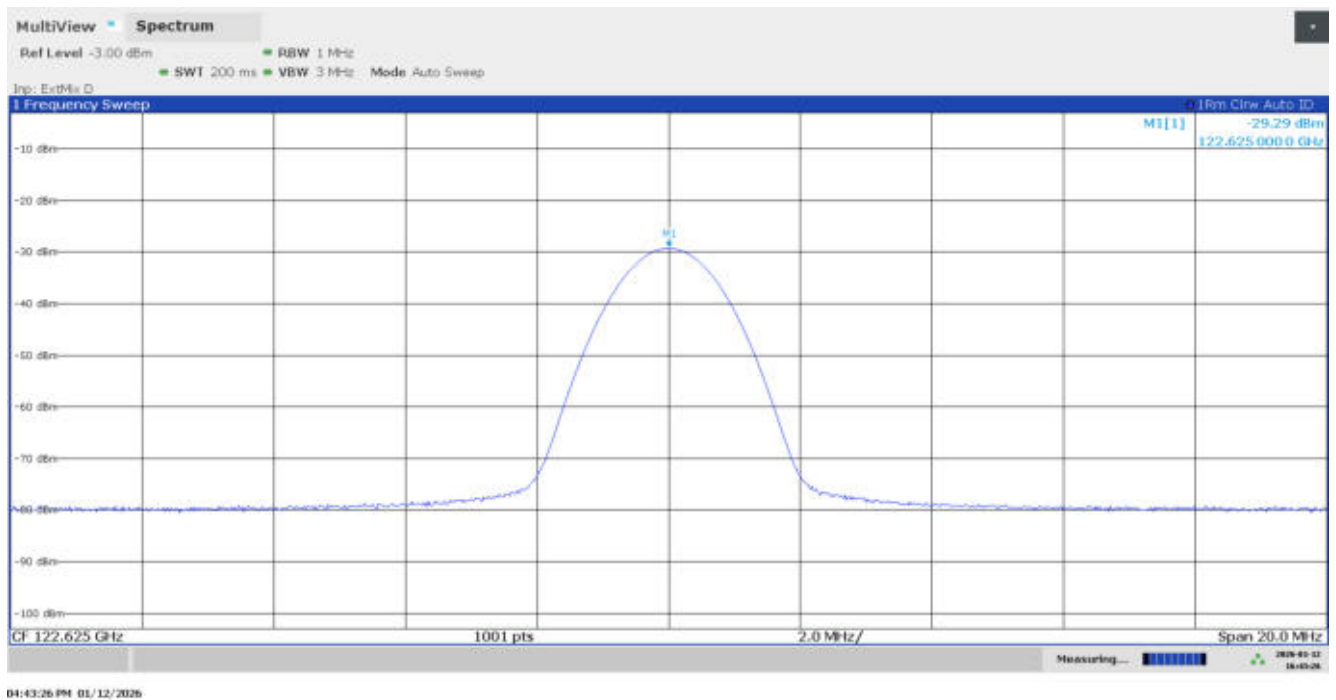


Plot 20: Step 3- EUT Delta2406, MainMode1, Substitution, Power measured for the peak value (Mixer + Analyzer)



Plot 21: Step 3- EUT Delta2406, MainMode1, Substitution, Power measured for the mean value (Mixer + Analyzer)



Plot 22: Step 3- EUT Delta2406, MainMode2, Substitution, Power measured for the peak value (Mixer + Analyzer)**Plot 23: Step 3- EUT Delta2406, MainMode2, Substitution, Power measured for the mean value (Mixer + Analyzer)**

14.3 Spurious emissions radiated / Transmitter unwanted emissions

Description:

Measurement of the radiated spurious emissions / transmitter unwanted emissions.

Limits and provisions:

§15.258 (c):

Spurious emissions shall be limited as follows:

- (1) The power density of any emissions outside the band of operation, e.g., 116-123 GHz, 174.8-182 GHz, 185-190 GHz or 244-246 GHz, shall consist solely of spurious emissions.
- (2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.
- (3) Between 40 GHz and the highest frequency specified in § 15.33, the level of these emissions shall not exceed 90 pW/cm² at a distance of 3 meters.
- (4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

FCC Part 15.33 (a)

For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:

- (4) If the intentional radiator operates at or above 95 GHz: To the third harmonic of the highest fundamental frequency or to 750 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.

§15.209(a)		
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

Limit conversion (ANSI C63.10-2020 9.2.3):

$$\text{EIRP[dBm]} = 10 \times \log(4 \times \pi \times d^2 \times 1000 \times \text{PD[W/m}^2])$$

- Power density at the distance specified by the limit: PD [W/m²]
- Equivalent isotropically radiated power: EIRP [dBm]
- Distance at which the power density limit is specified: d [m]

According to this formula, an emission limit of PD = 90 pW/cm² at a distance of d = 3 m corresponds to an equivalent isotropically radiated power of EIRP = -10 dBm.

Measurement:

Measurement parameter	
Detector:	Quasi Peak / Pos-Peak / linear-AV / RMS
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	F < 1 GHz: 300 kHz F > 1 GHz: 3 MHz
Trace-Mode:	Max Hold

Measurement results:

Note:

- (1) Measurements were performed in normal operation mode (frequency sweep) and in stop mode (frequency sweep stopped at three positions within the range of operation: near top, near middle, near bottom) in accordance with §15.31(c), (m).

Normal operation mode:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
-/-	-/-	-/-	-/-	-/-	-/-
Please refer to the following plots for more information on the level of spurious emissions					

Stop mode, low frequency:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
9.551	Lin. Average	1.0	51.02 dB μ V/m	54.0 dB μ V/m	2.98
28.63	Lin. Average	1.0	45.10 dB μ V/m	54.0 dB μ V/m	8.90
61.13	RMS	1.0	-12.36 dBm	-10.0 dBm	2.36
Please refer to the following plots for more information on the level of spurious emissions					

Stop mode, middle frequency:

Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
9.580	Lin. Average	1.0	51.99 dB μ V/m	54.0 dB μ V/m	2.01
61.31	RMS	1.0	-12.20 dBm	-10.0 dBm	2.20
Please refer to the following plots for more information on the level of spurious emissions					

Stop mode, high frequency:

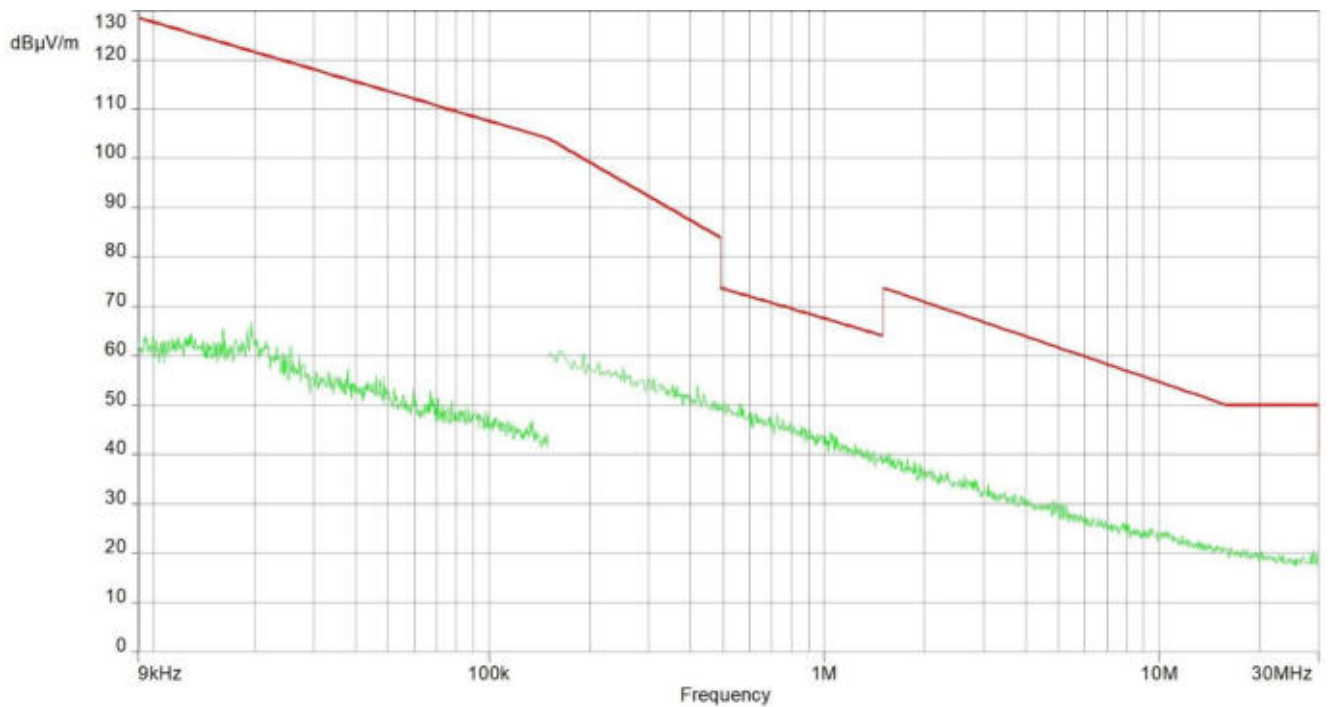
Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
61.50	RMS	1.0	-11.74 dBm	-10.0 dBm	1.74
Please refer to the following plots for more information on the level of spurious emissions					

Note:

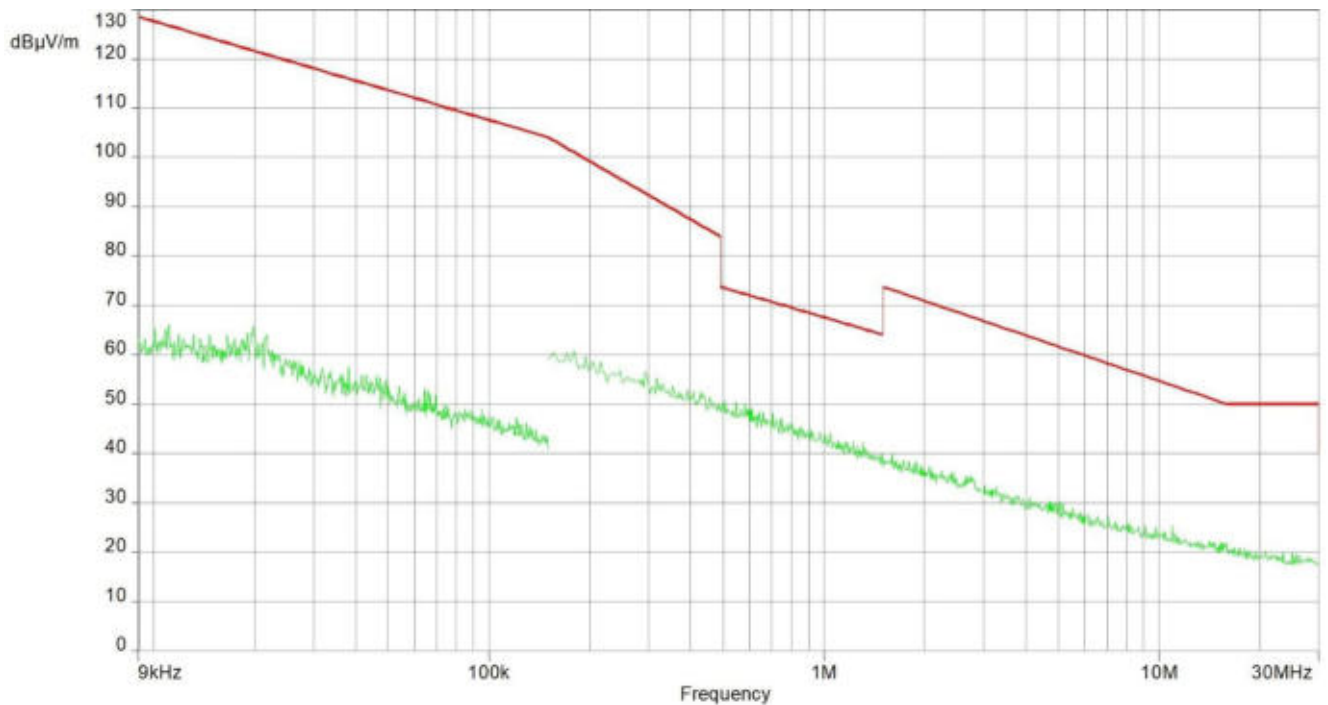
- Worst-case mode for spurious / unwanted emissions: **MainMode1** (Mode with the highest peak output power)
- Worst-case EUT / lens type for spurious / unwanted emissions: **Lens type D** (EUT **Main2673** and EUT **Main2467**, higher peak output power than EUT **Delta2406** using the same operation mode)

Verdict: Compliant

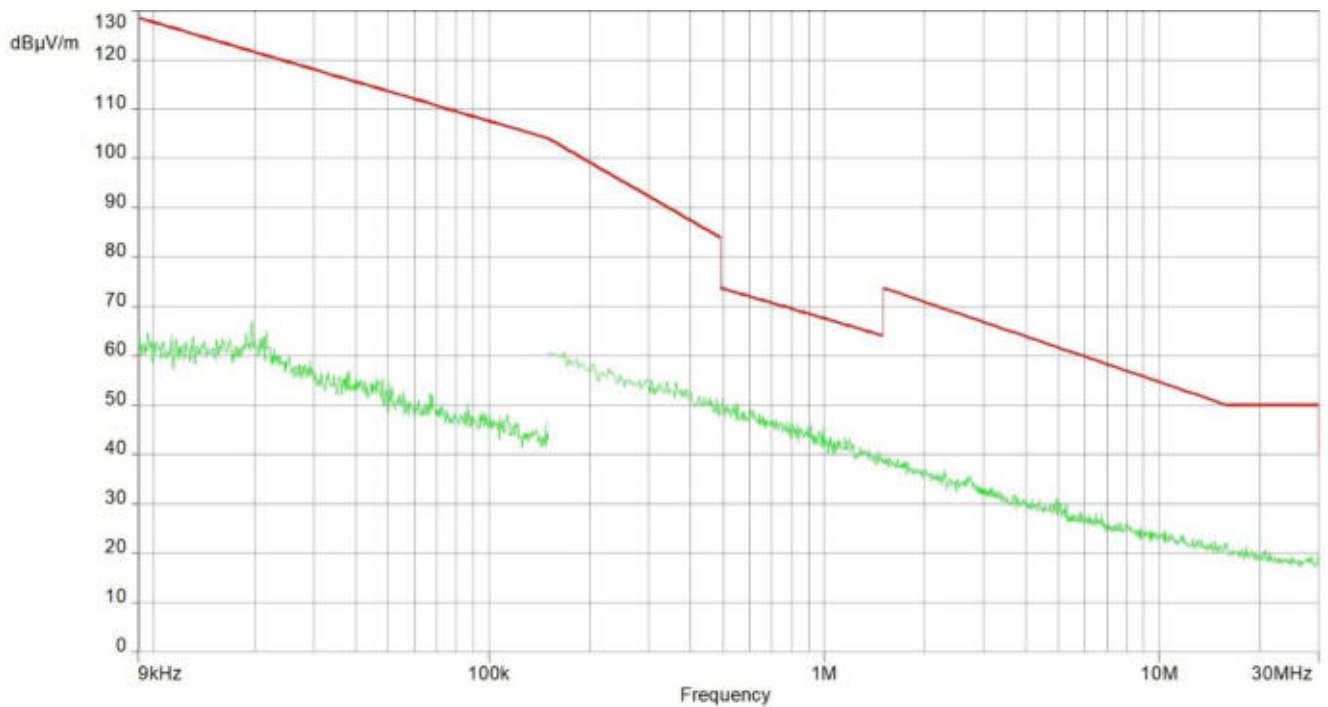
Plot 24: 9 kHz – 30 MHz, EUT Main2673, MainMode1 (using shielded cable AE1)



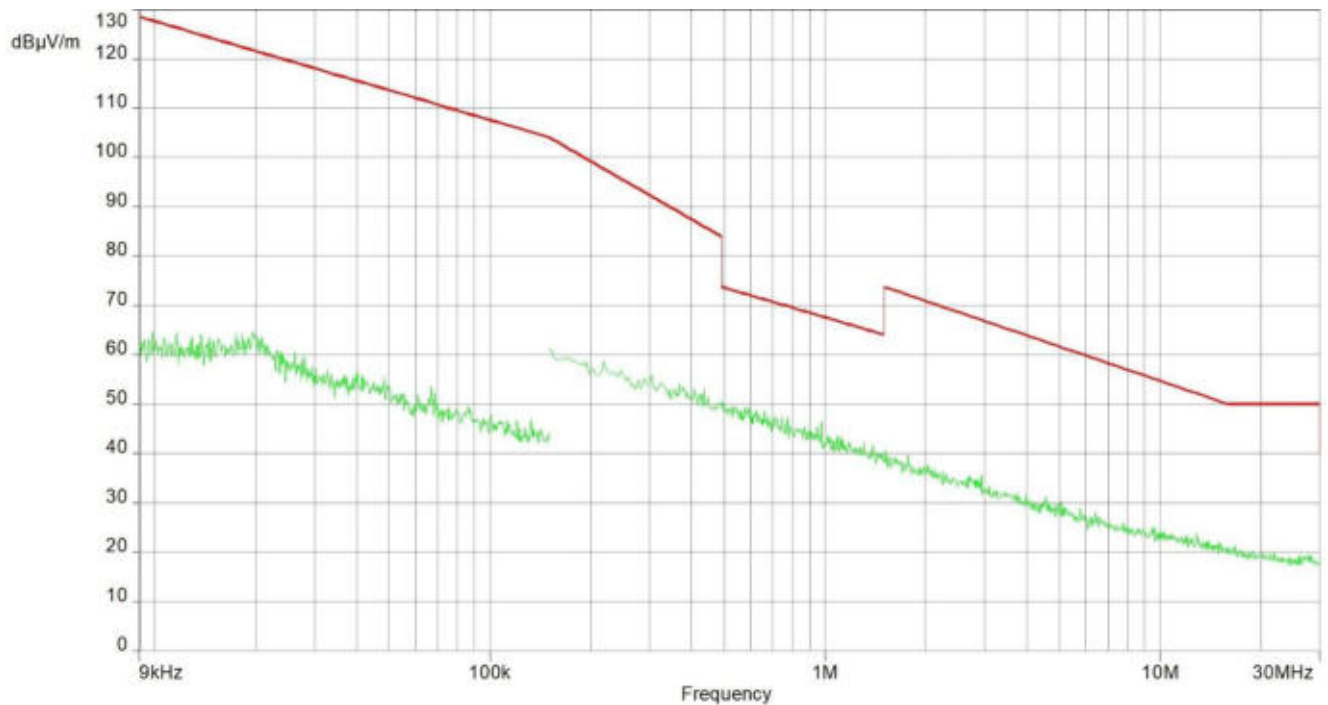
Plot 25: 9 kHz – 30 MHz, EUT Main2673, stop mode, low frequency (using shielded cable AE1)



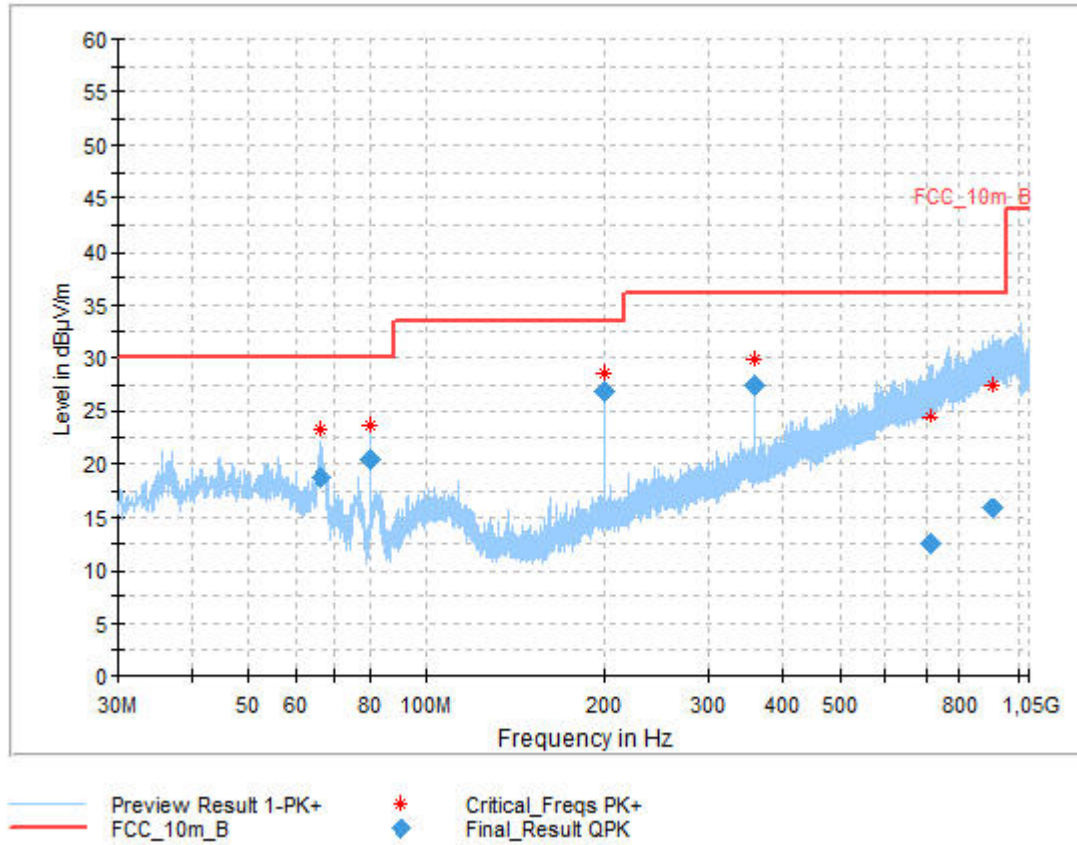
Plot 26: 9 kHz – 30 MHz, EUT Main2673, stop mode, middle frequency (using shielded cable AE1)



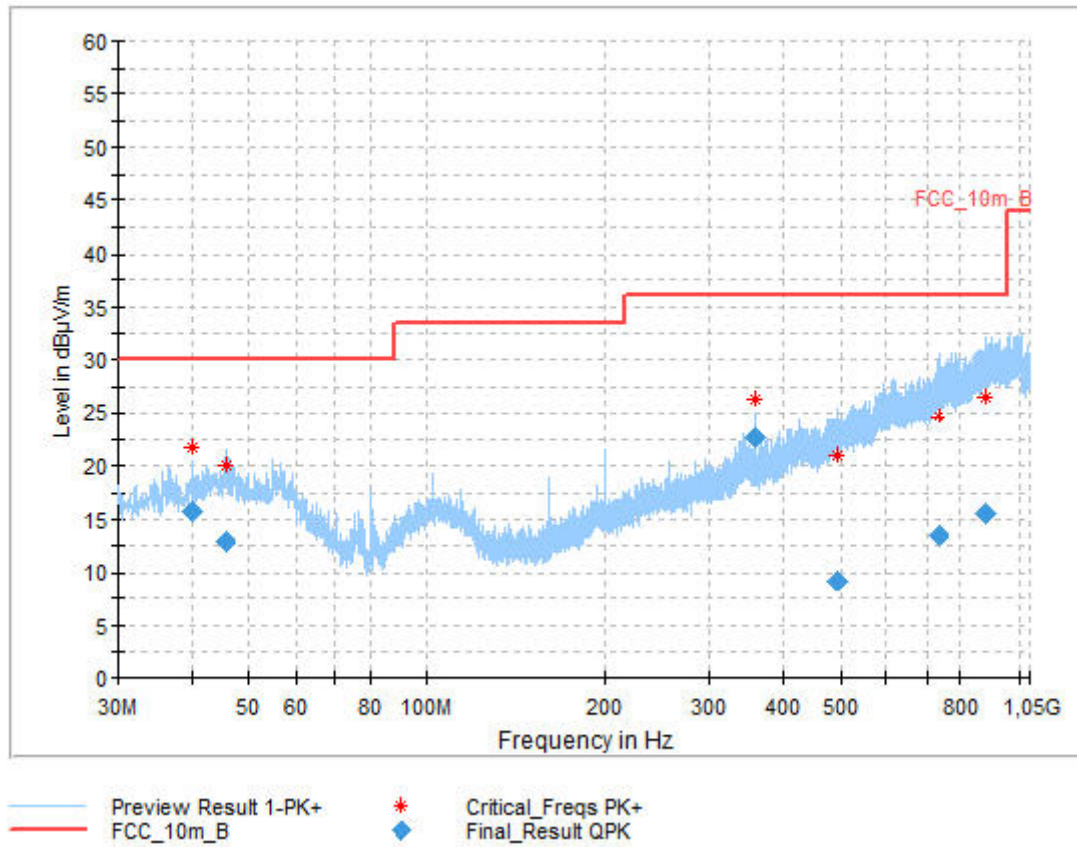
Plot 27: 9 kHz – 30 MHz, EUT Main2673, stop mode, high frequency (using shielded cable AE1)



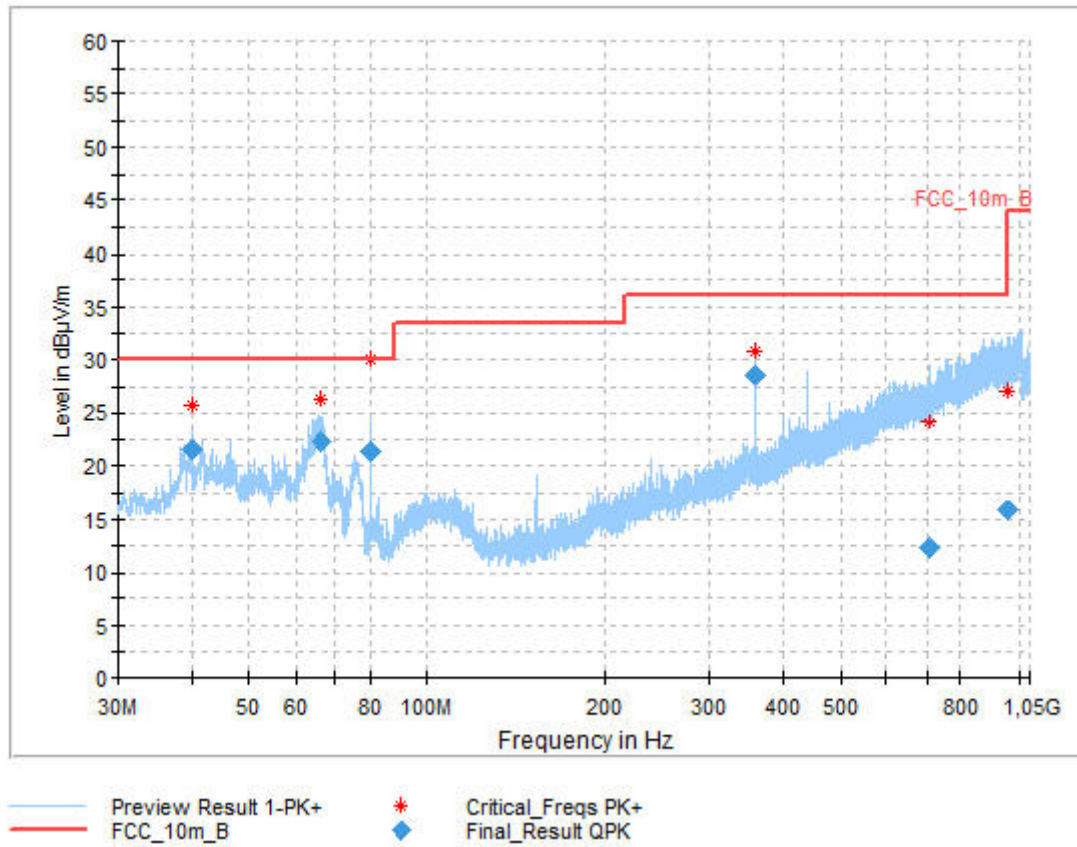
Plot 28: 30 MHz – 1GHz, EUT Main2467, MainMode1 (using shielded cable AE1)



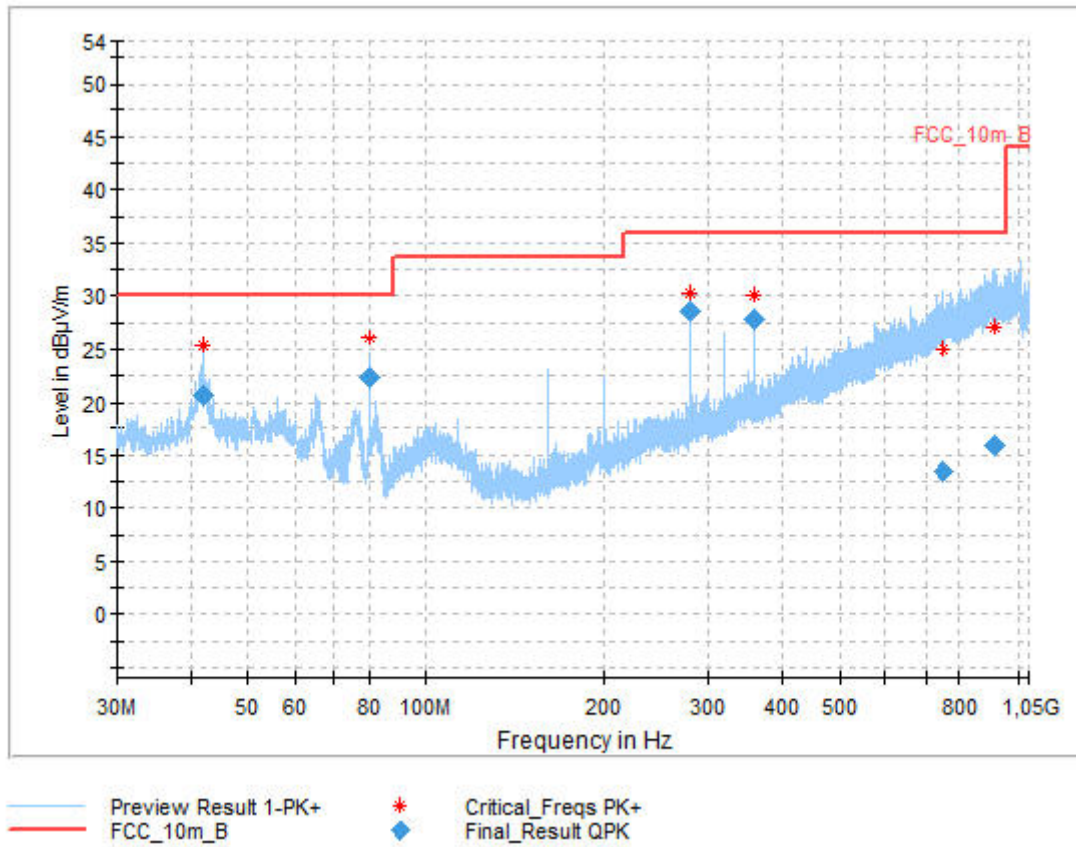
Plot 29: 30 MHz – 1GHz, EUT Main2467, stop mode, low frequency (using shielded cable AE1)



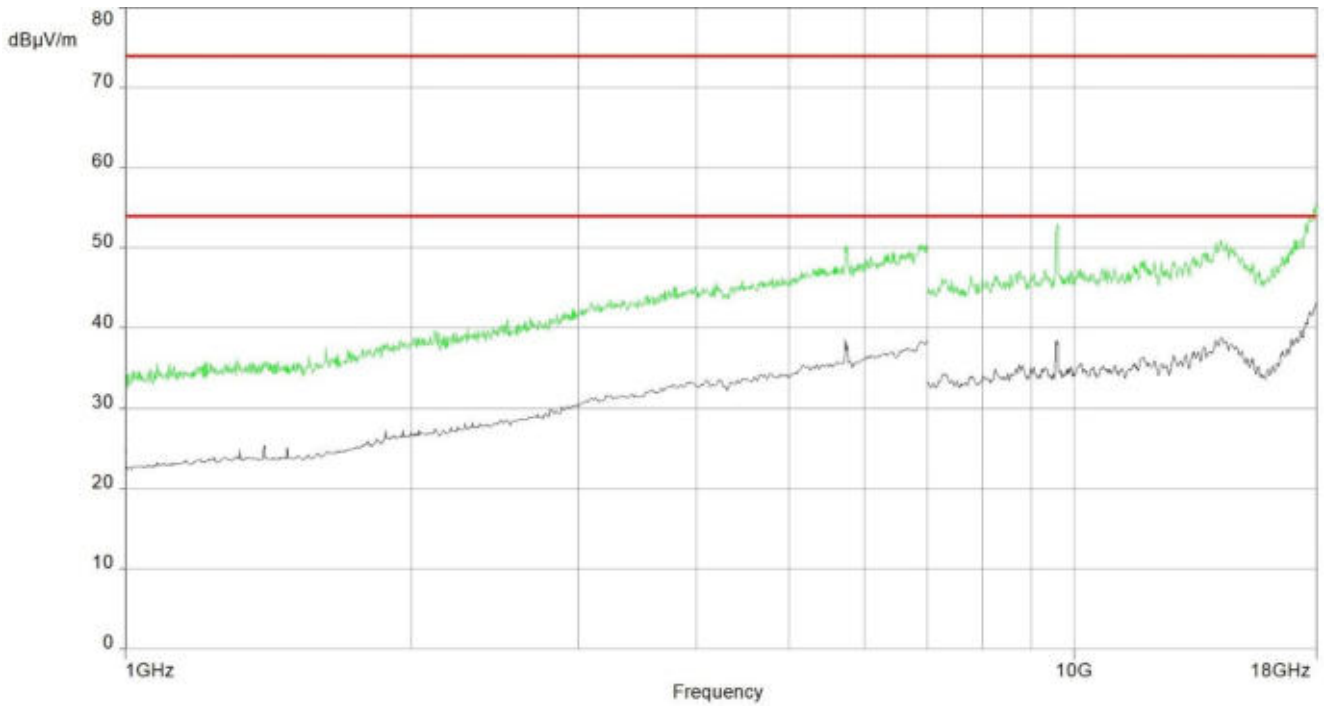
Plot 30: 30 MHz – 1GHz, EUT Main2467, stop mode, middle frequency (using shielded cable AE1)



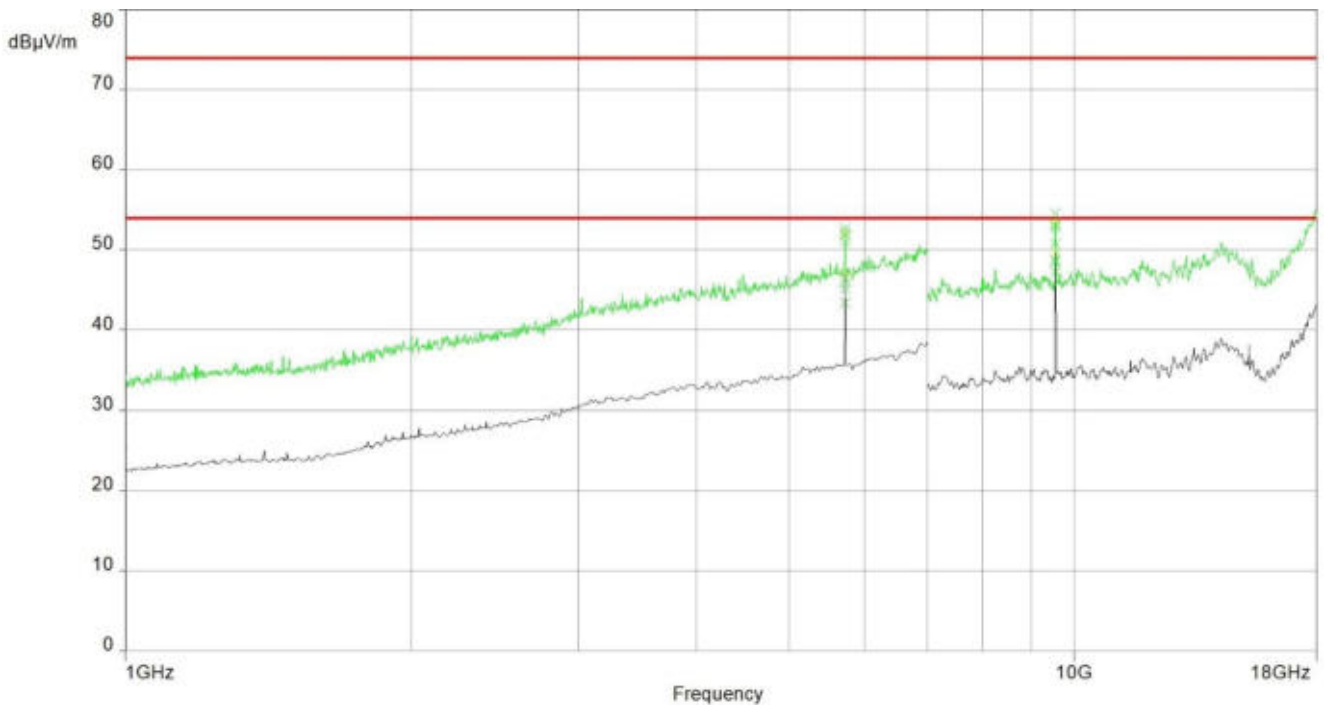
Plot 31: 30 MHz – 1GHz, EUT Main2467, stop mode, high frequency (using shielded cable AE1)



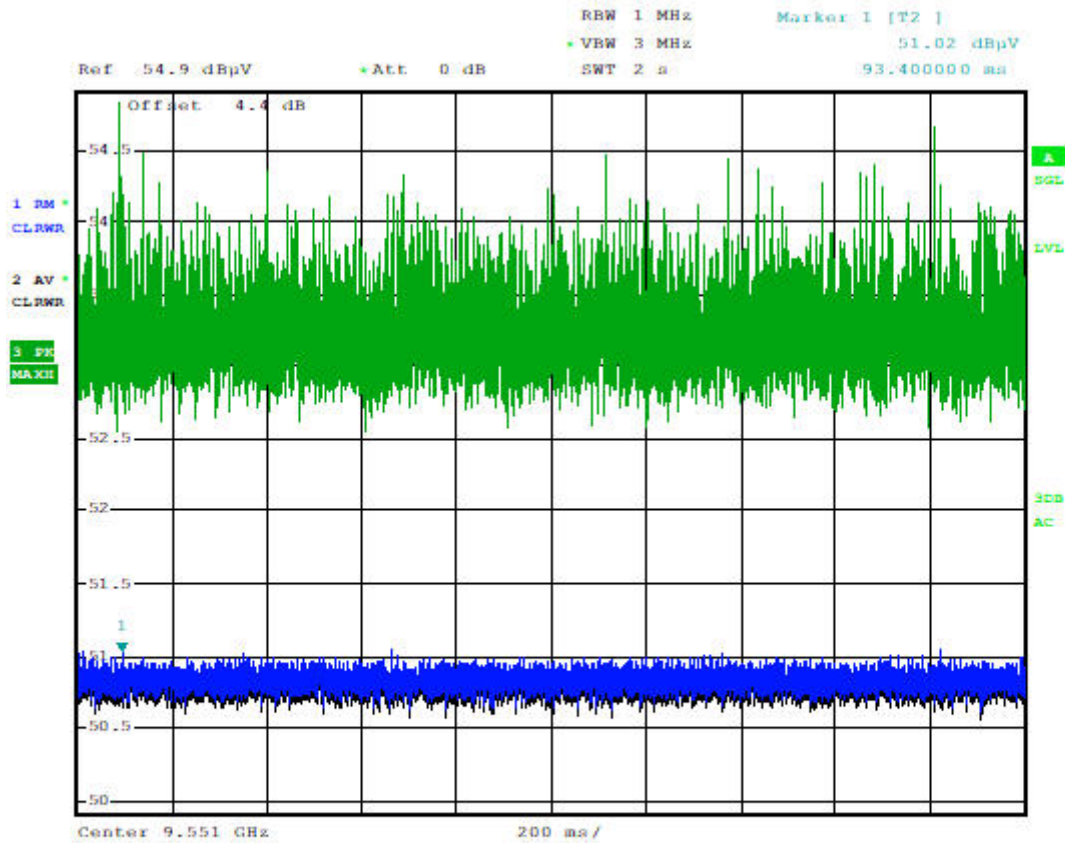
Plot 32: 1GHz – 18 GHz, EUT Main2673, MainMode1 (using shielded cable AE1)



Plot 33: 1GHz – 18 GHz, EUT Main2673, stop mode, low frequency (using shielded cable AE1)

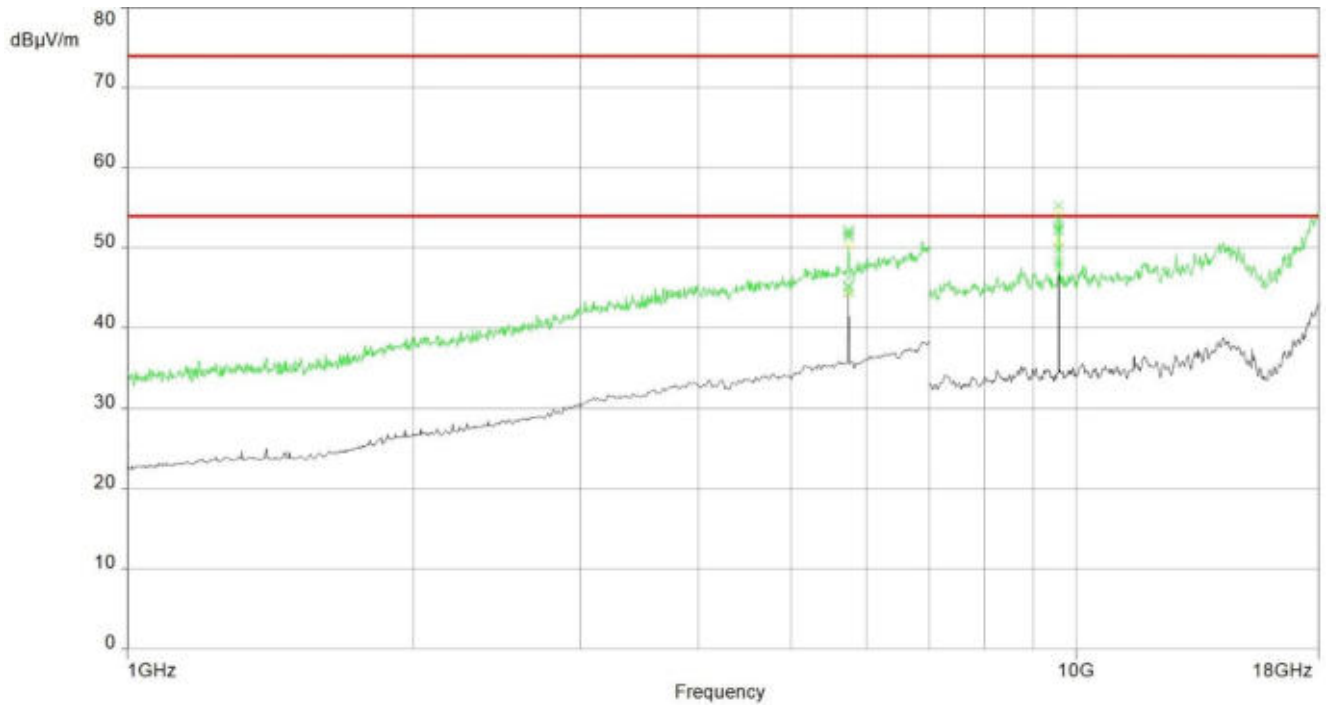


Plot 34: Emission at 9551 MHz (zero span), EUT Main2673, stop mode, low frequency (using shielded cable AE1)

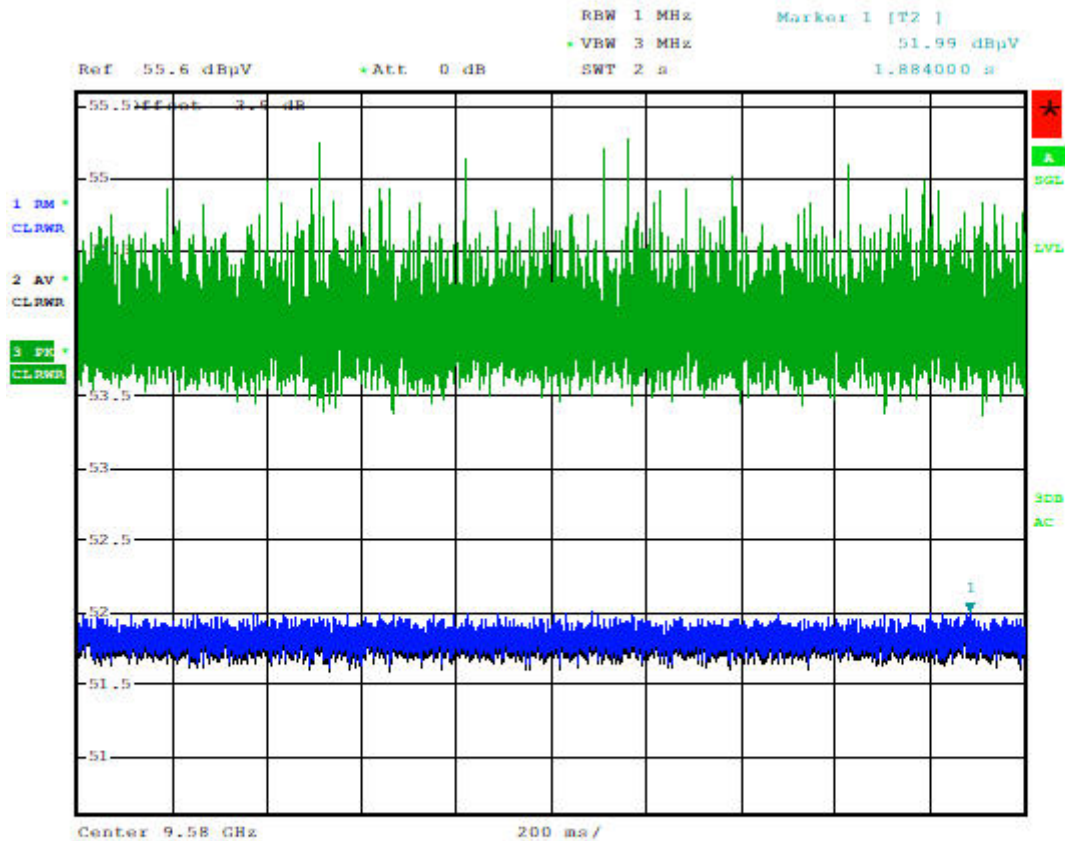


Date: 27.MAR.2025 10:53:25

Plot 35: 1GHz – 18 GHz, EUT Main2673, stop mode, middle frequency (using shielded cable AE1)



Plot 36: Emission at 9580 MHz (zero span), EUT Main2673, stop mode, middle frequency (using shielded cable AE1)



Date: 27.MAR.2025 12:43:12

MultiView **Spectrum**

Ref Level 100.00 dBuV RBW 1 MHz BW 3 MHz Mode Auto Sweep

ATT 0 dB SWT 220 s VSW 3.5 MHz

TOP "HWP180_CABLE_510_B2T_02_18-40G_1500M.DBUV"

1 Frequency Sweep

Line Check

Line FCC 18.206 PEAK

Line FCC 18.209 AV

124 Max 240 Max

M1 1 53.07 dBuV

M2 2 39.602 500 GHz

39.65 dBuV

39.718 500 GHz

FCC 18.206 PEAK

FCC 18.209 AV

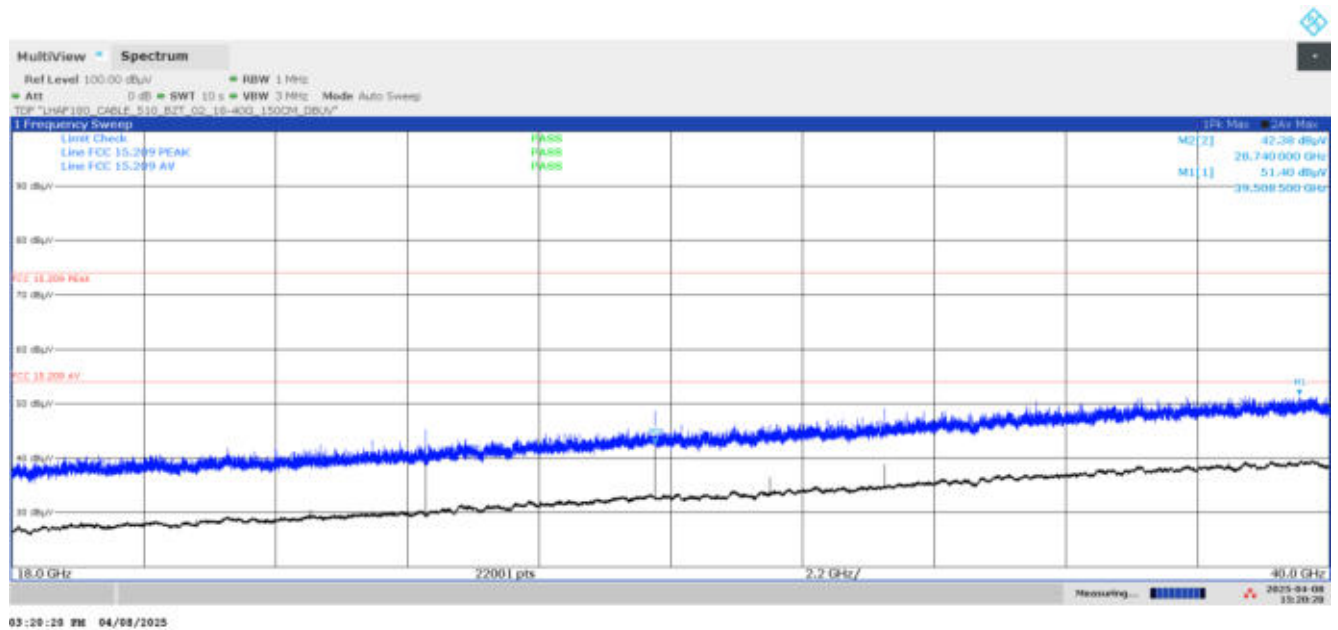
18.0 GHz 22001 pts 2.2 GHz/ 40.0 GHz

Measuring...

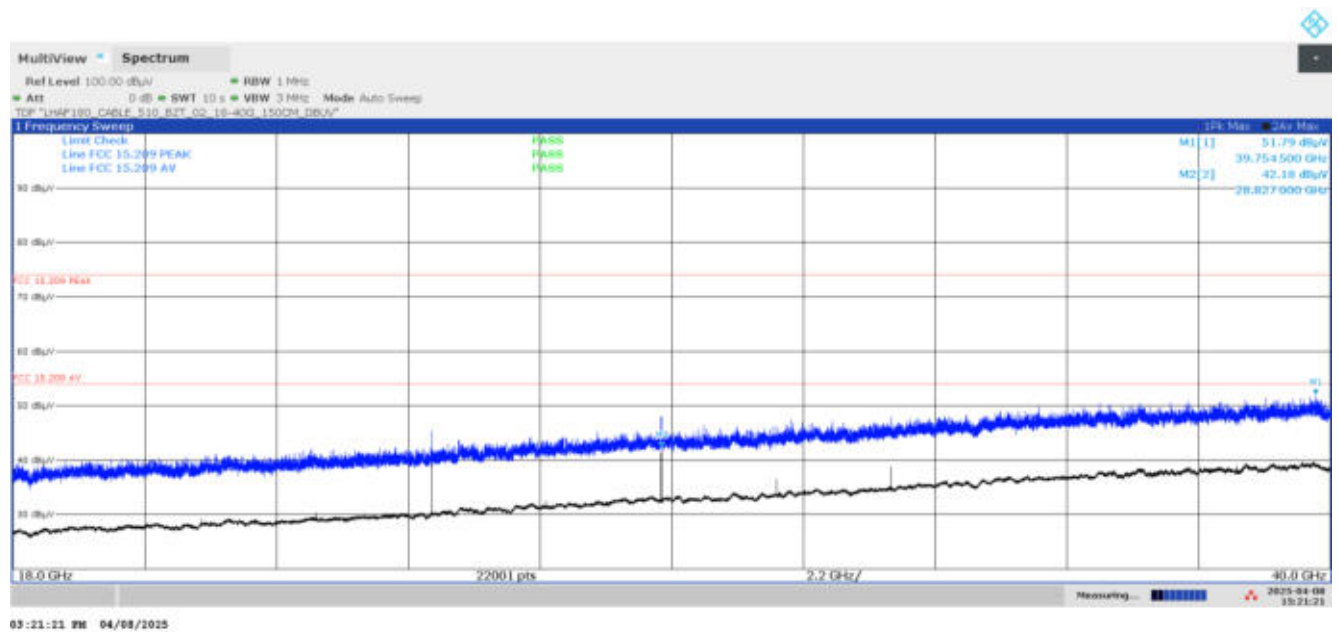
03:02:59 PM 04/08/2025



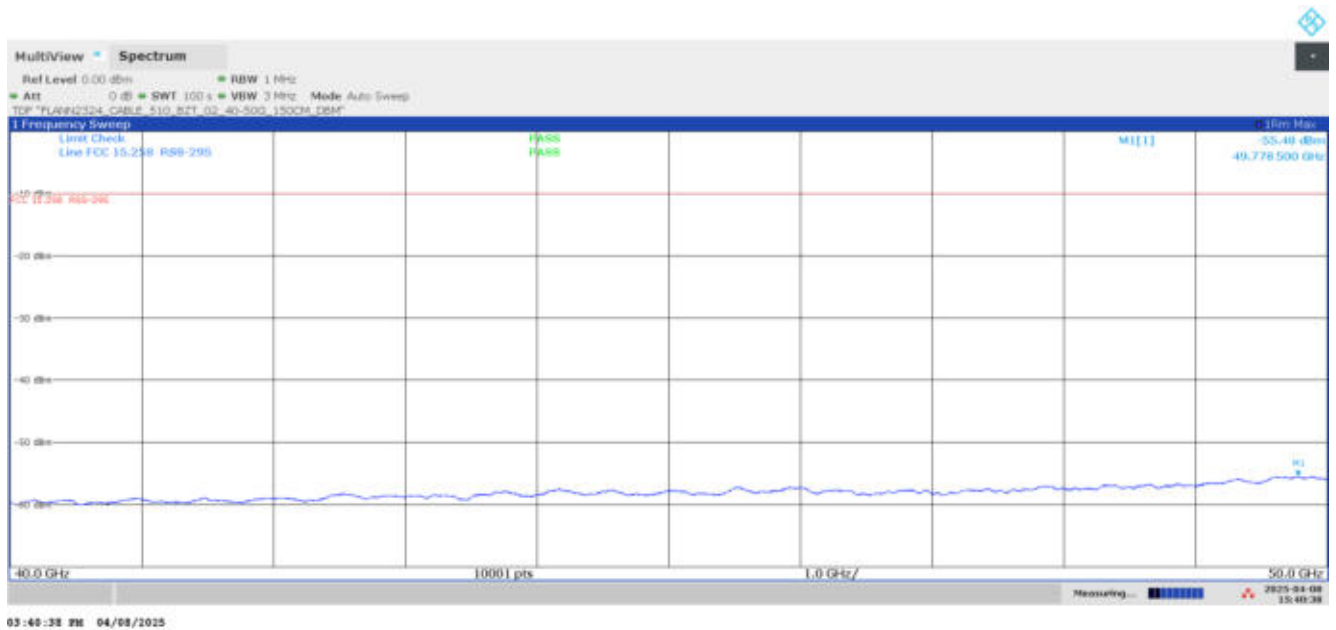
Plot 41: 18 GHz – 40 GHz, EUT Main2467, stop mode, middle frequency



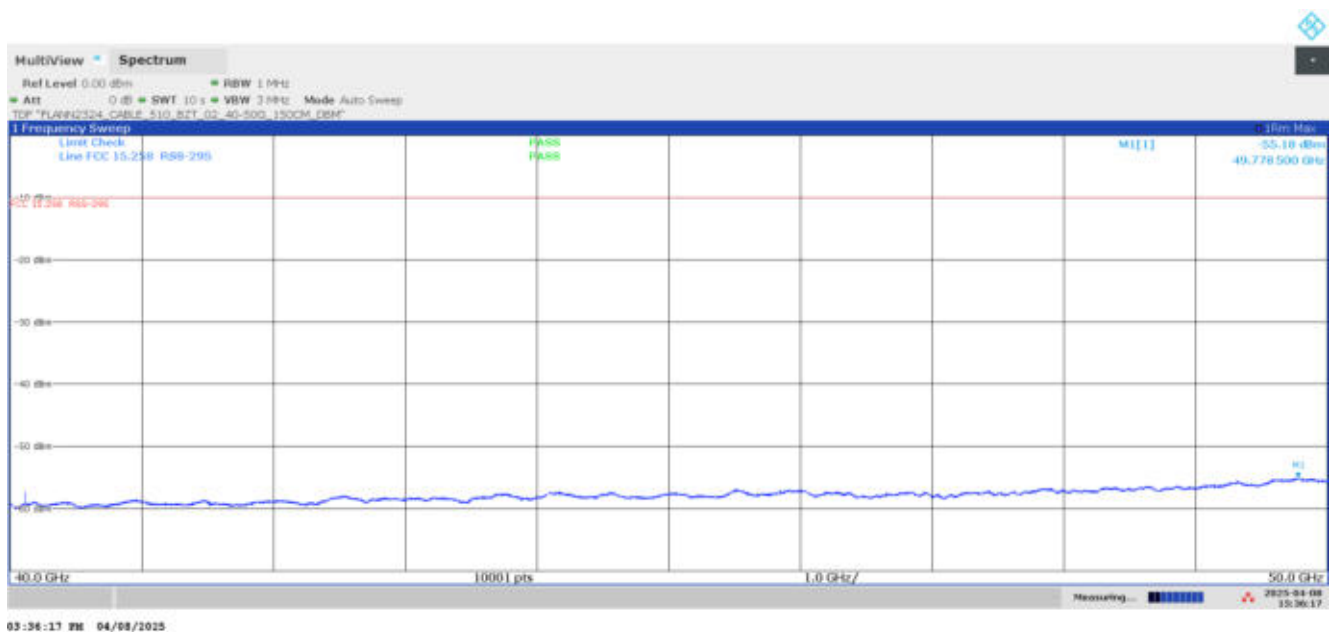
Plot 42: 18 GHz – 40 GHz, EUT Main2467, stop mode, high frequency



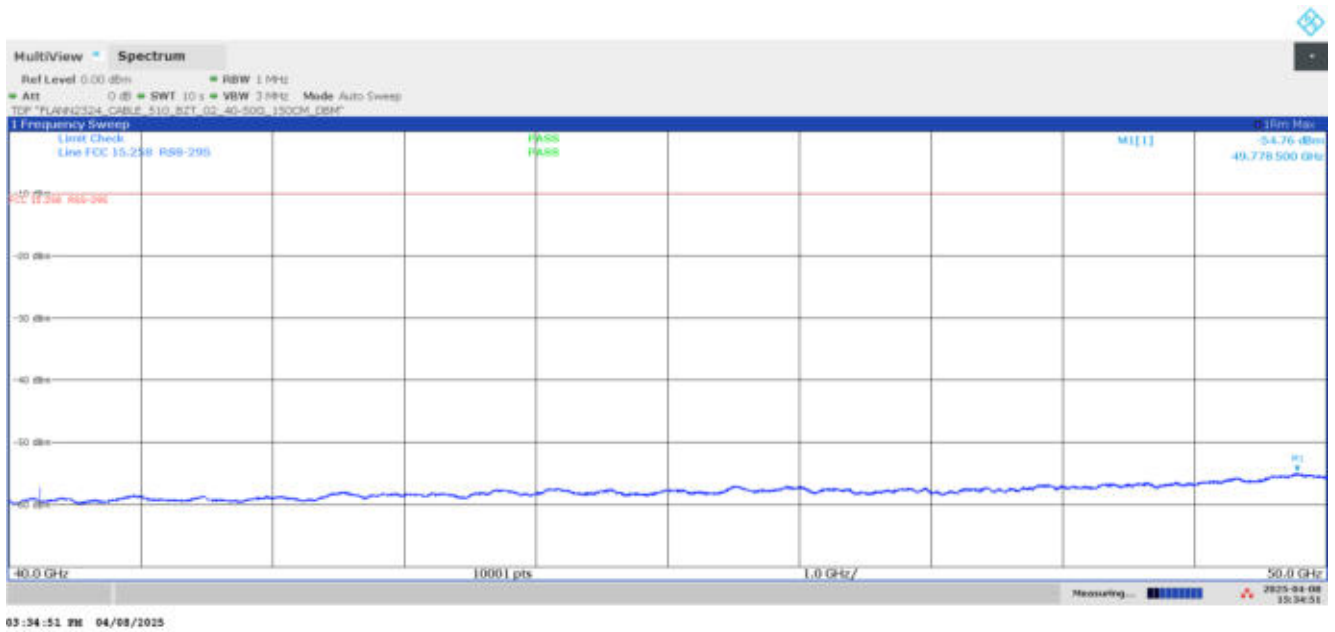
Plot 43: 40 GHz – 50 GHz, EUT Main2467, MainMode1



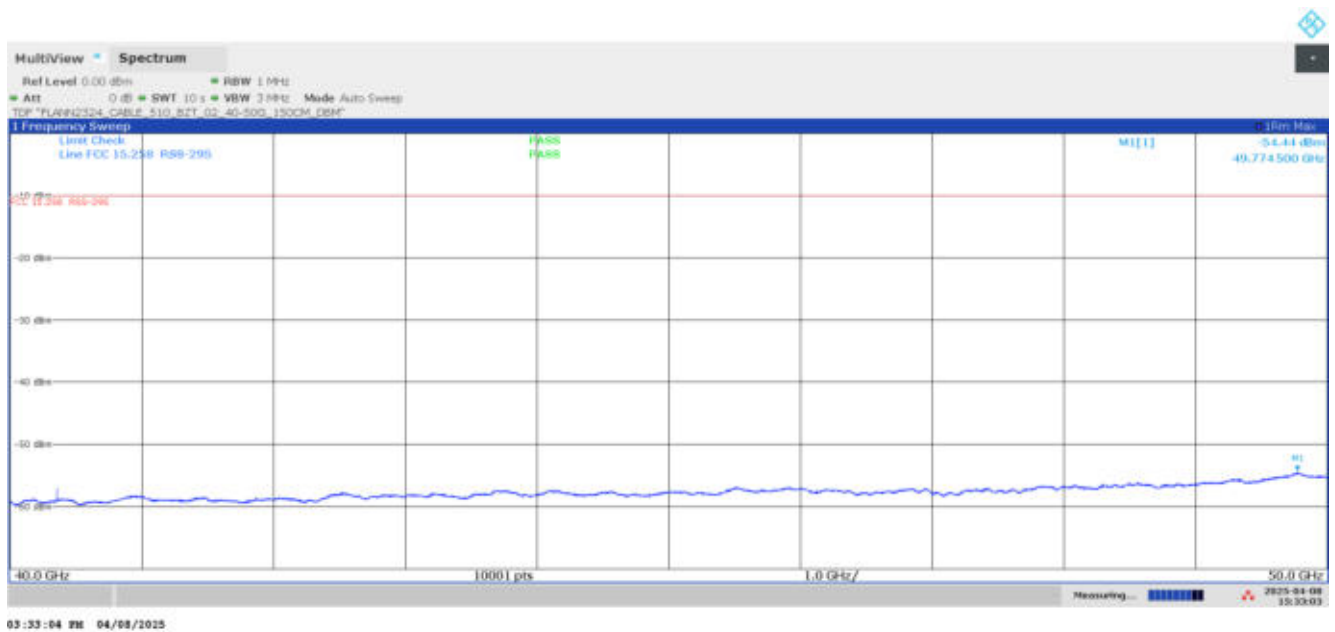
Plot 44: 40 GHz – 50 GHz, EUT Main2467, stop mode, low frequency



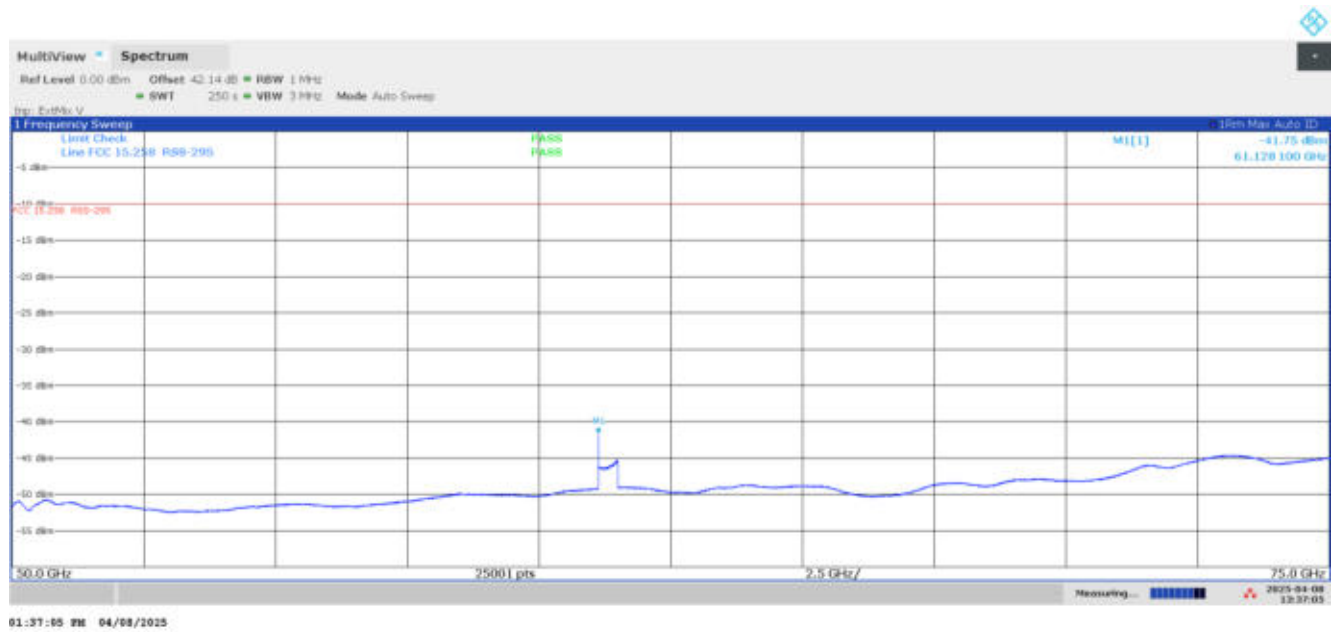
Plot 45: 40 GHz – 50 GHz, EUT Main2467, stop mode, middle frequency



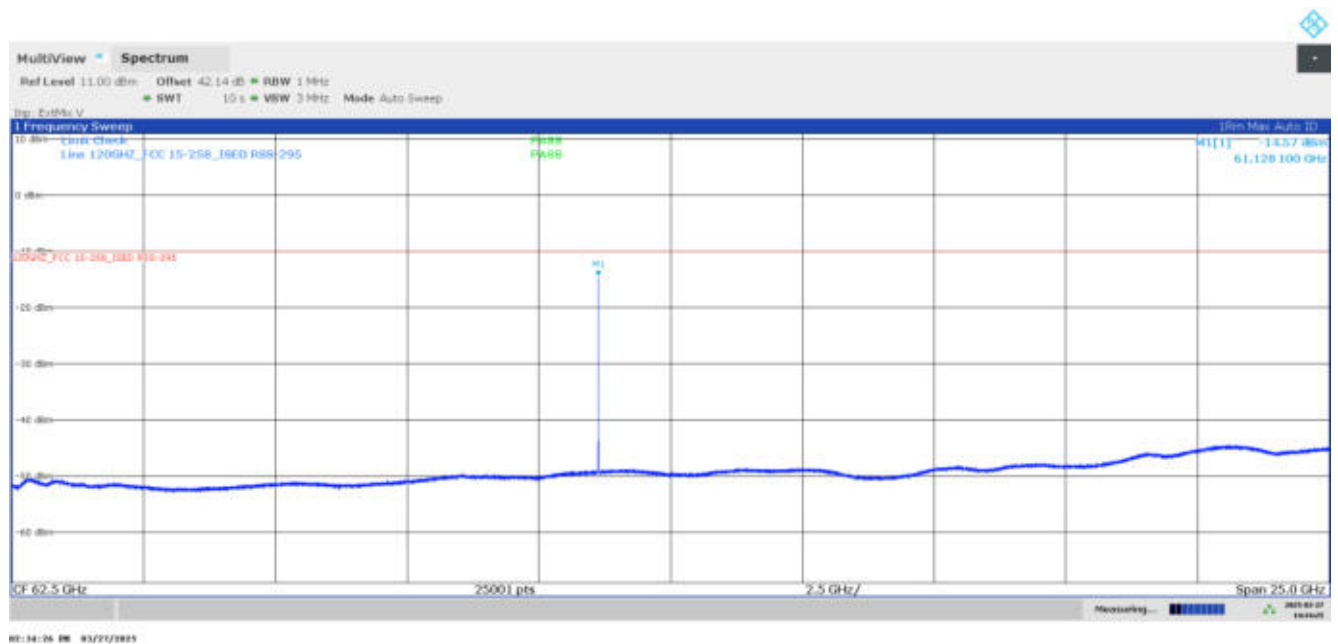
Plot 46: 40 GHz – 50 GHz, EUT Main2467, stop mode, high frequency



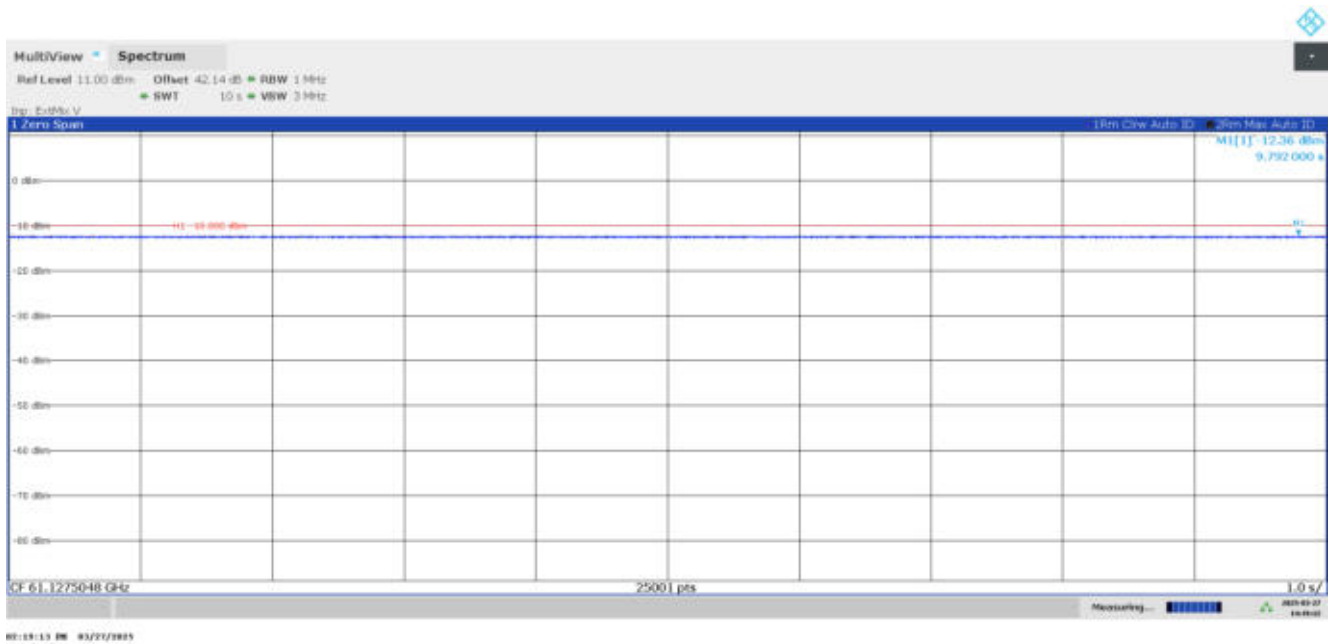
Plot 47: 50 GHz – 75 GHz, EUT Main2467, MainMode1



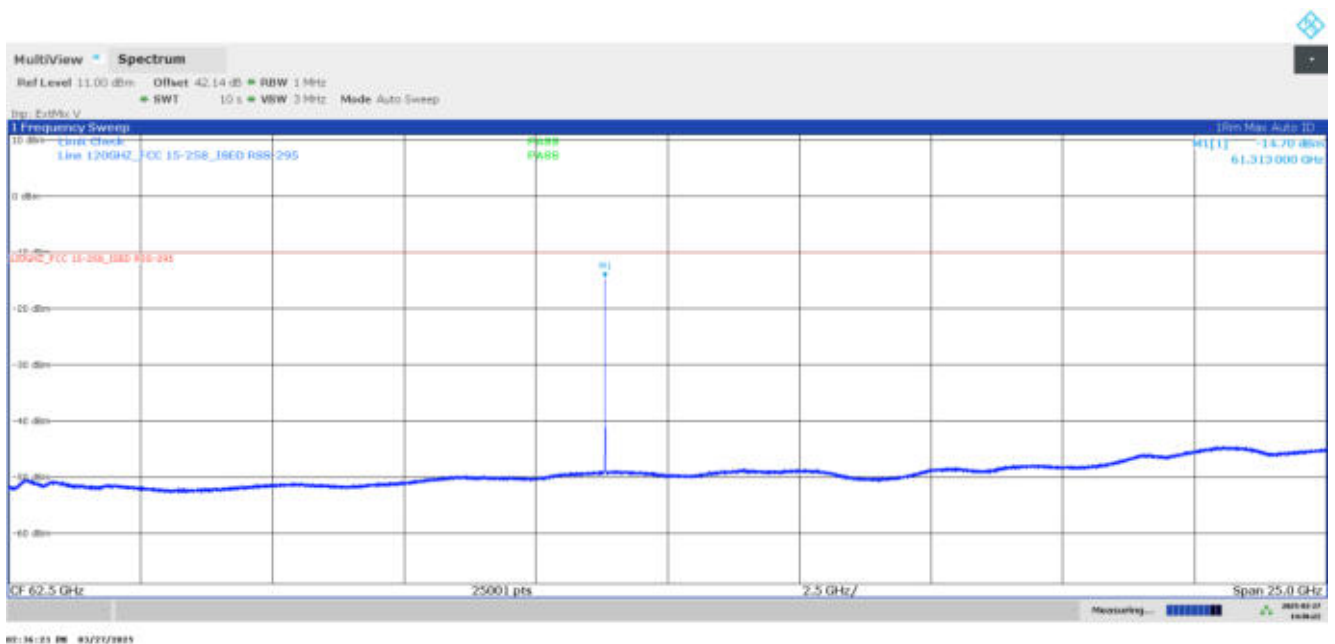
Plot 48: 50 GHz – 75 GHz, EUT Main2673, stop mode, low frequency



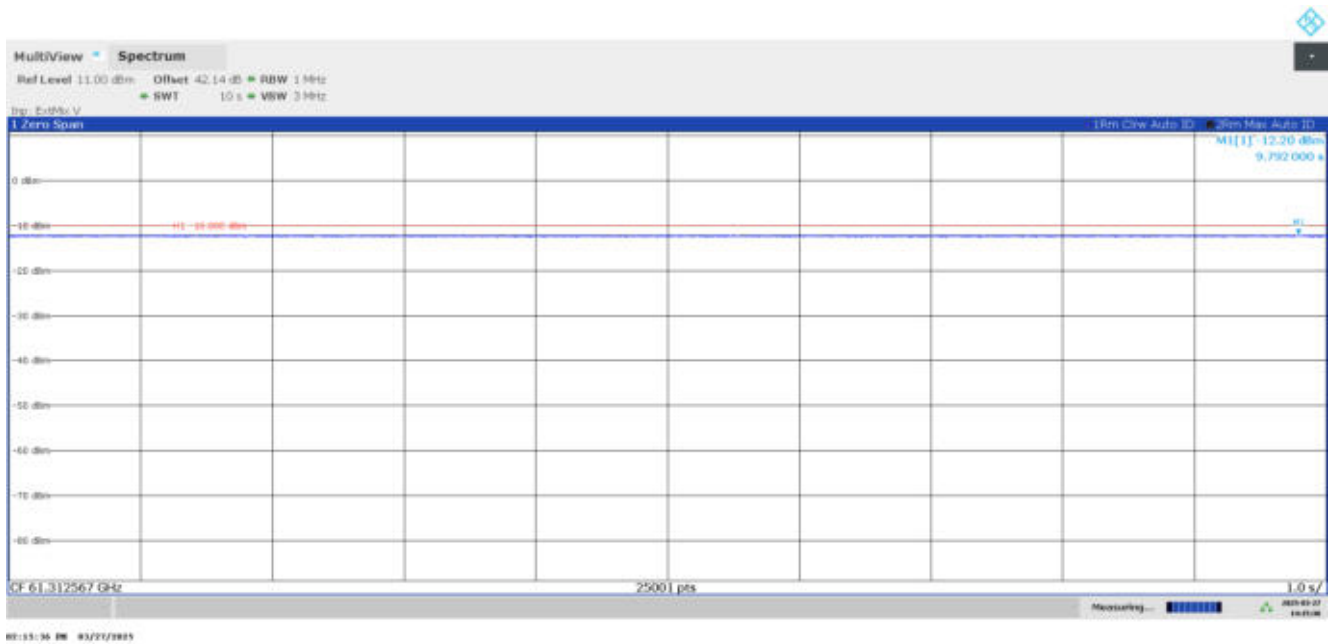
Plot 49: Emission at 61.127 GHz (zero span), EUT Main2673, stop mode, low frequency



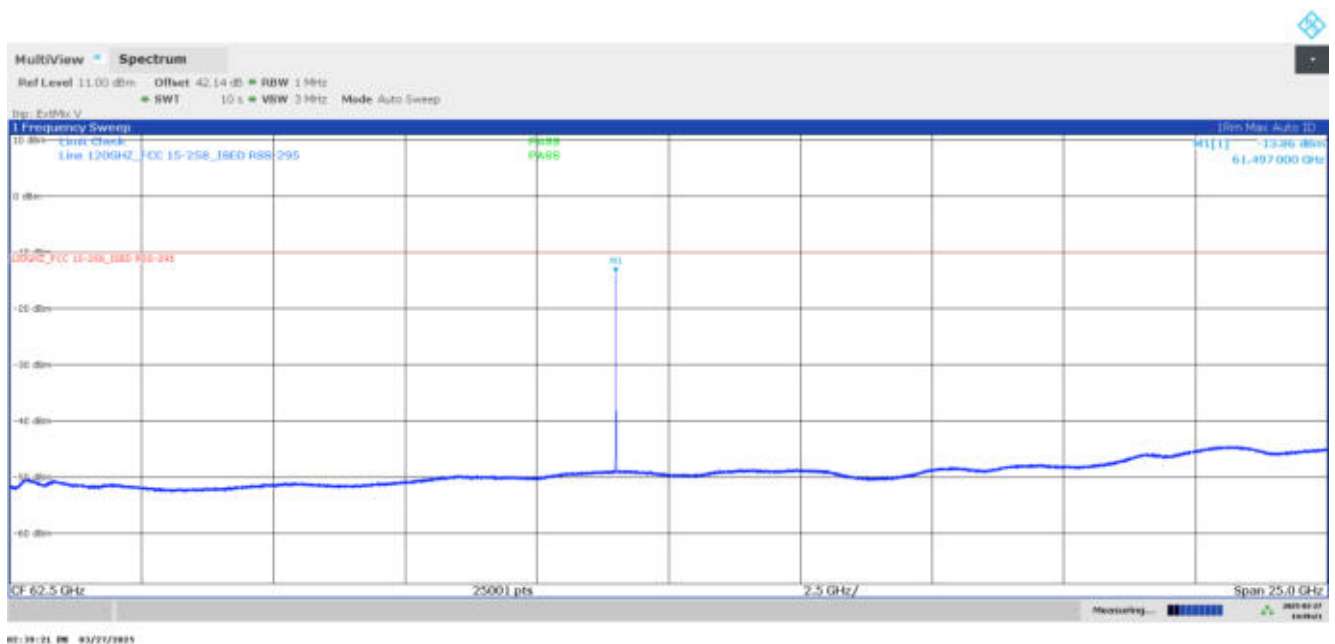
Plot 50: 50 GHz – 75 GHz, EUT Main2673, stop mode, middle frequency



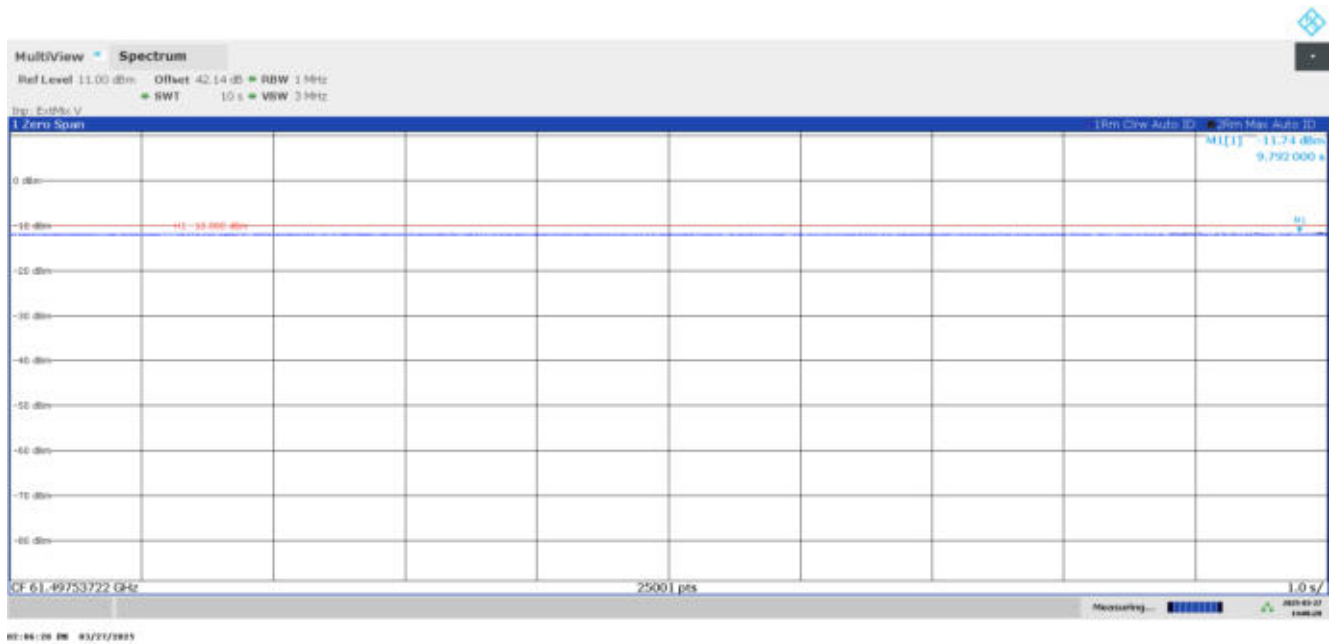
Plot 51: Emission at 61.312 GHz (zero span), stop mode, middle frequency



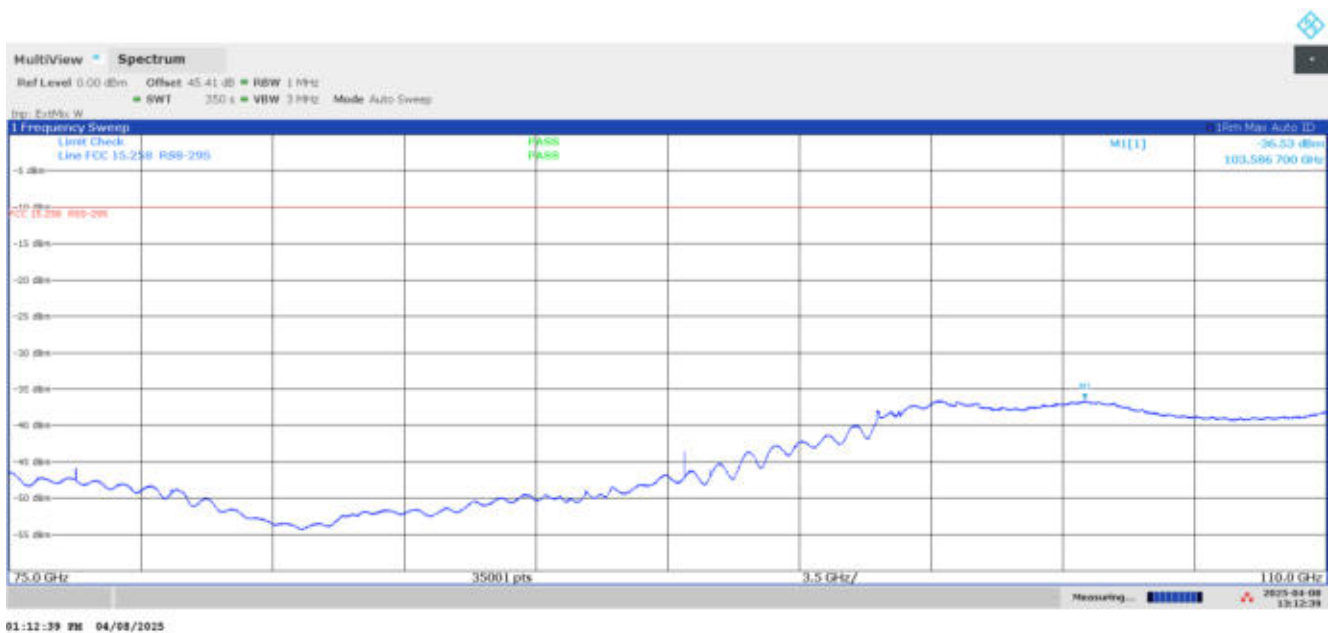
Plot 52: 50 GHz – 75 GHz, EUT Main2673, stop mode, high frequency



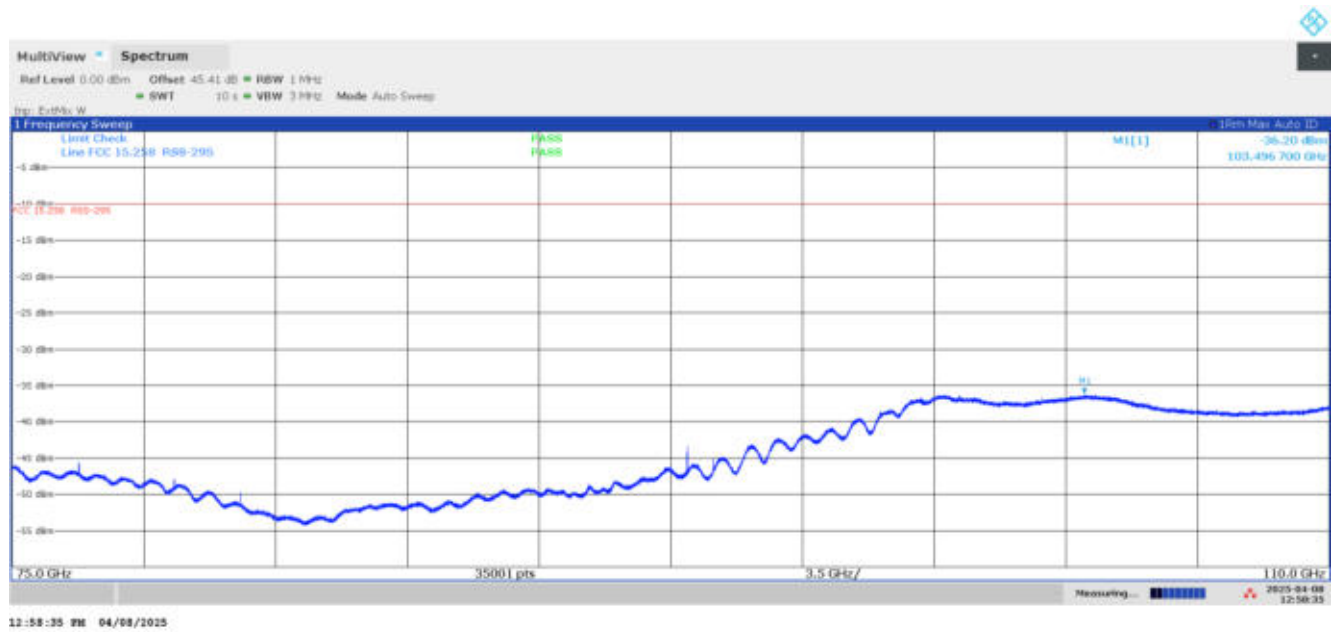
Plot 53: Emission at 61.5 GHz (zero span), stop mode, high frequency



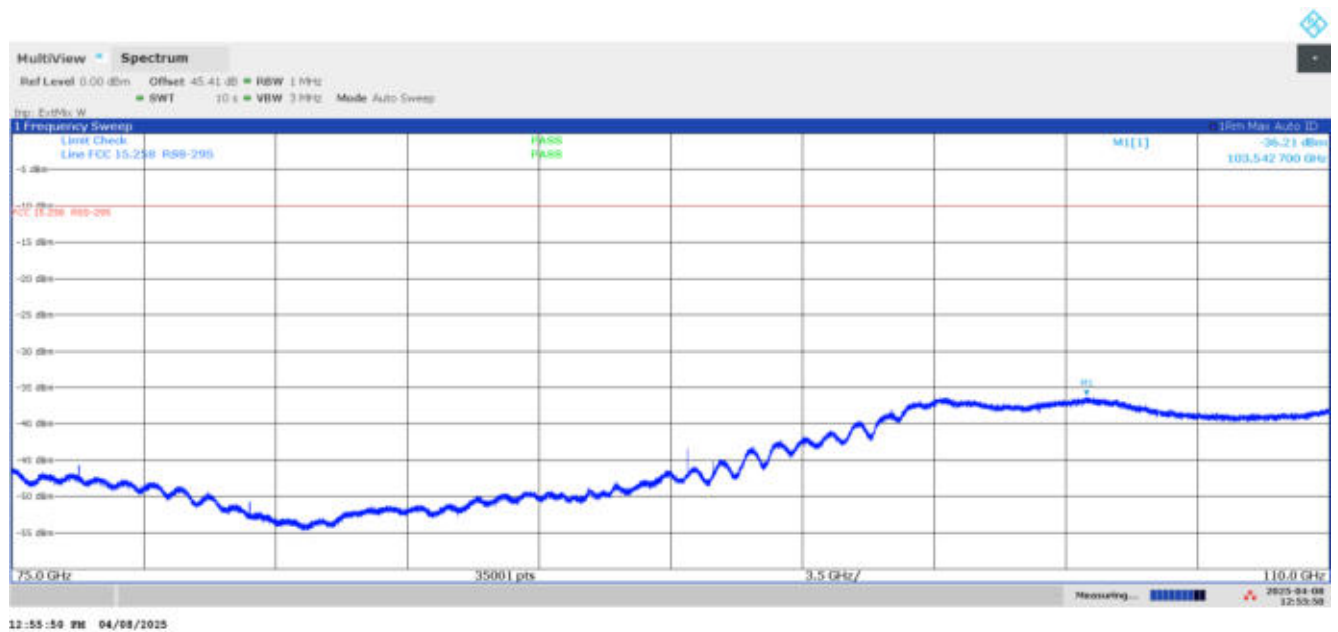
Plot 54: 75 GHz – 110 GHz, EUT Main2467, MainMode1



Plot 55: 75 GHz – 110 GHz, EUT Main2467, stop mode, low frequency

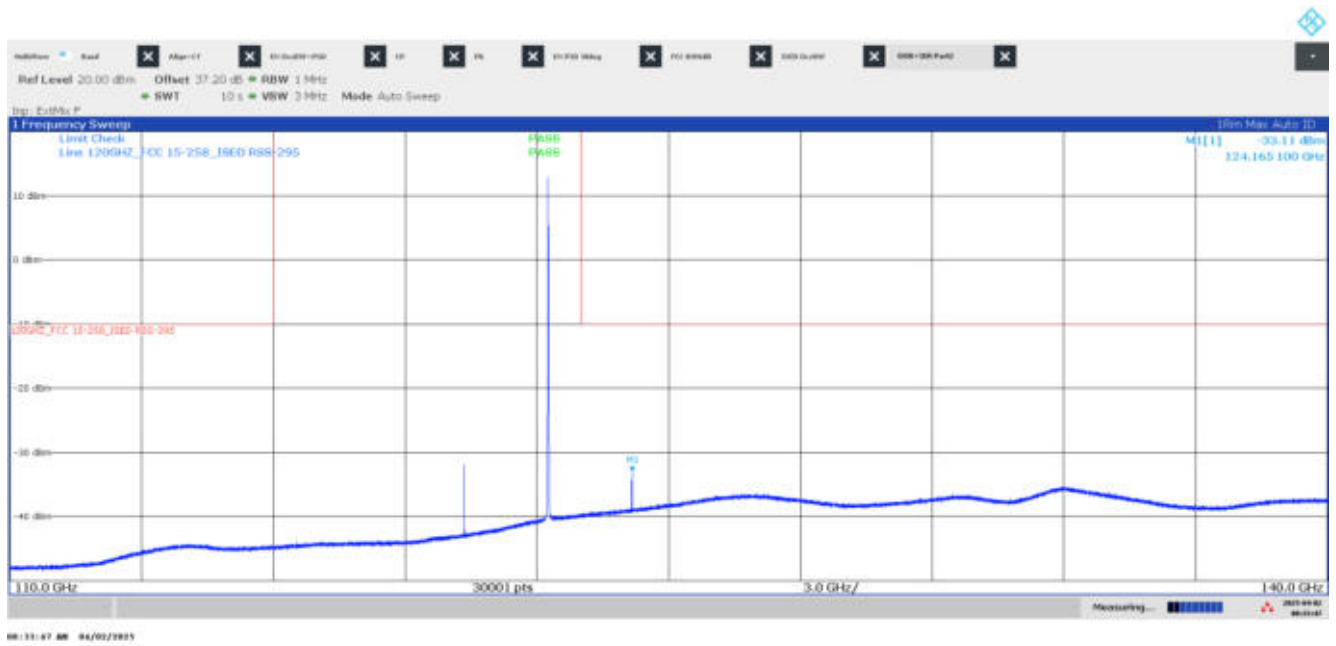


Plot 56: 75 GHz – 110 GHz, EUT Main2467, stop mode, middle frequency

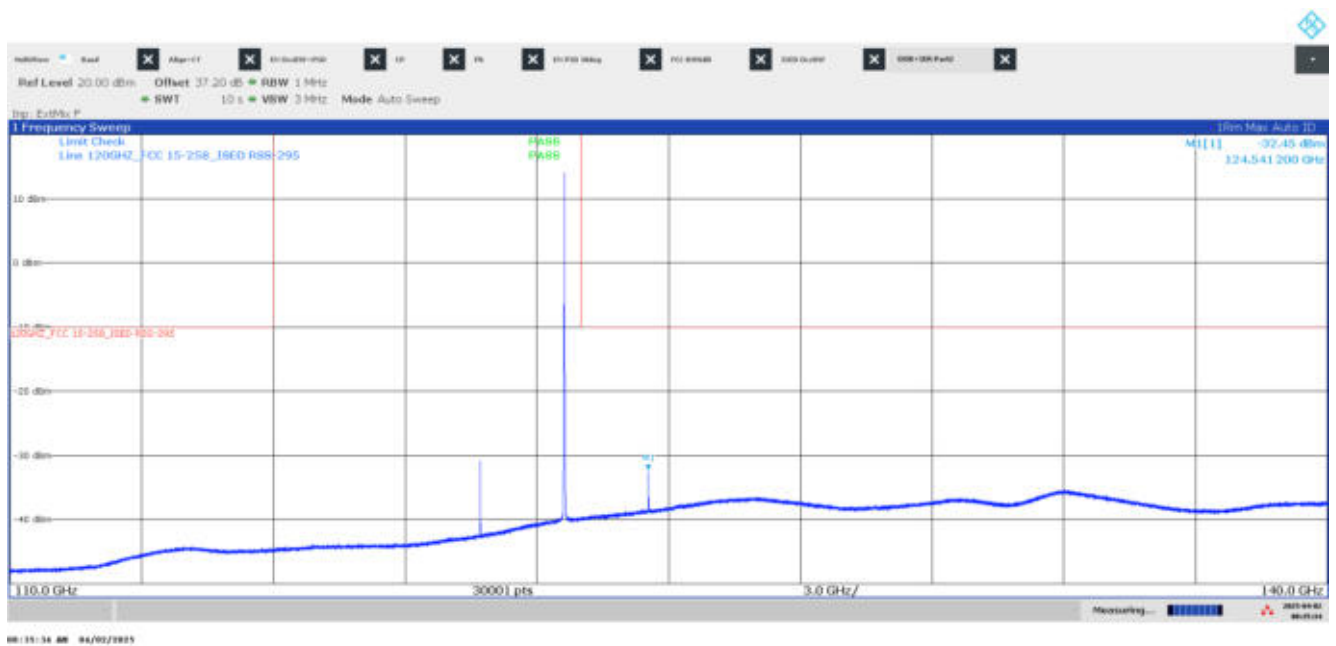




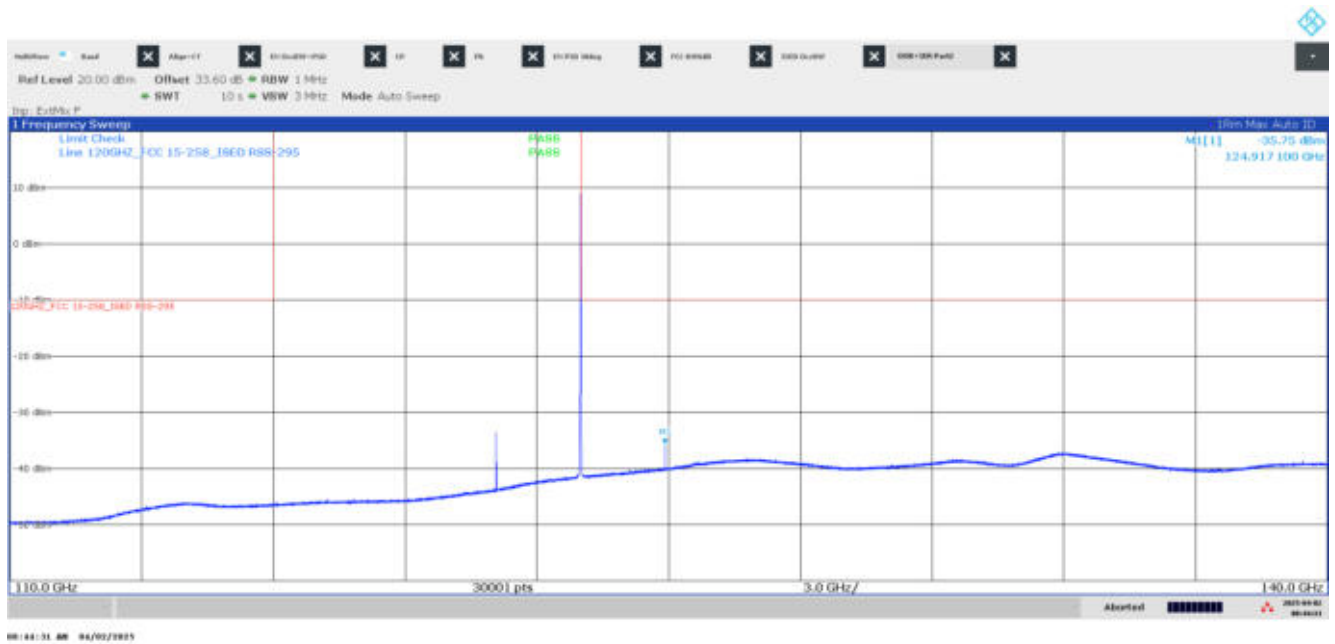
Plot 59: 110 GHz – 140 GHz, EUT Main2673, stop mode, low frequency



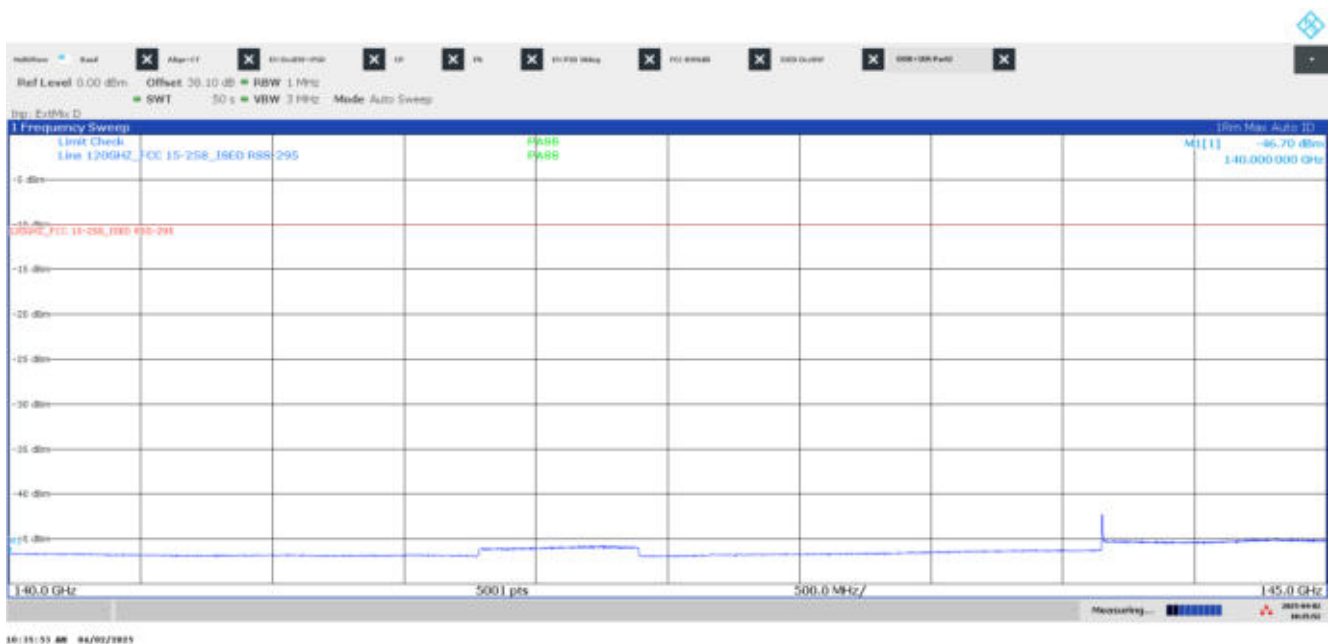
Plot 60: 110 GHz – 140 GHz, EUT Main2673, stop mode, middle frequency



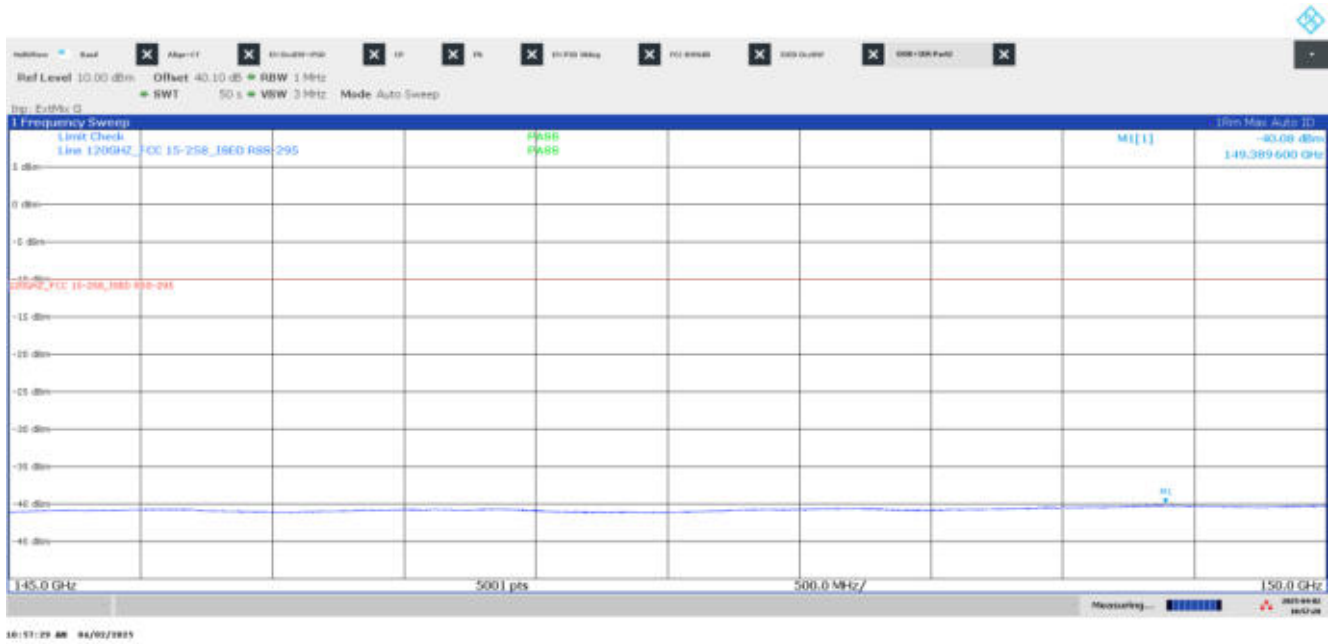
Plot 61: 110 GHz – 140 GHz, EUT Main2673, stop mode, high frequency



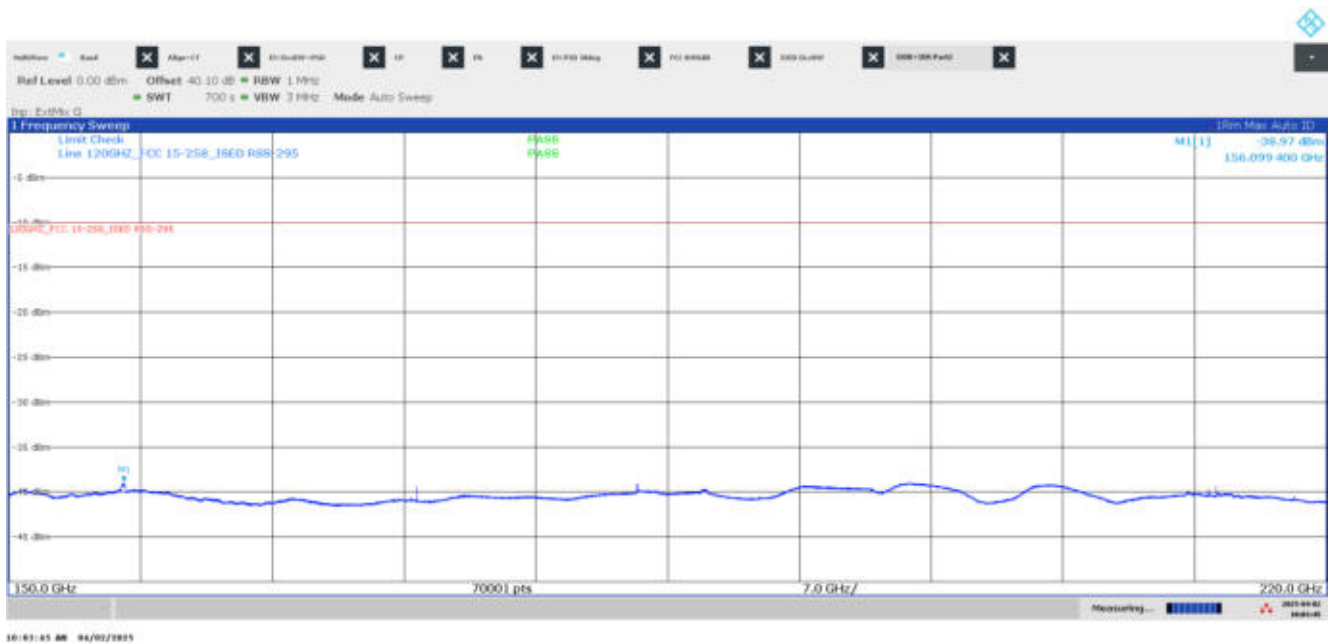
Plot 62: 140 GHz – 145 GHz, EUT Main2673, MainMode1



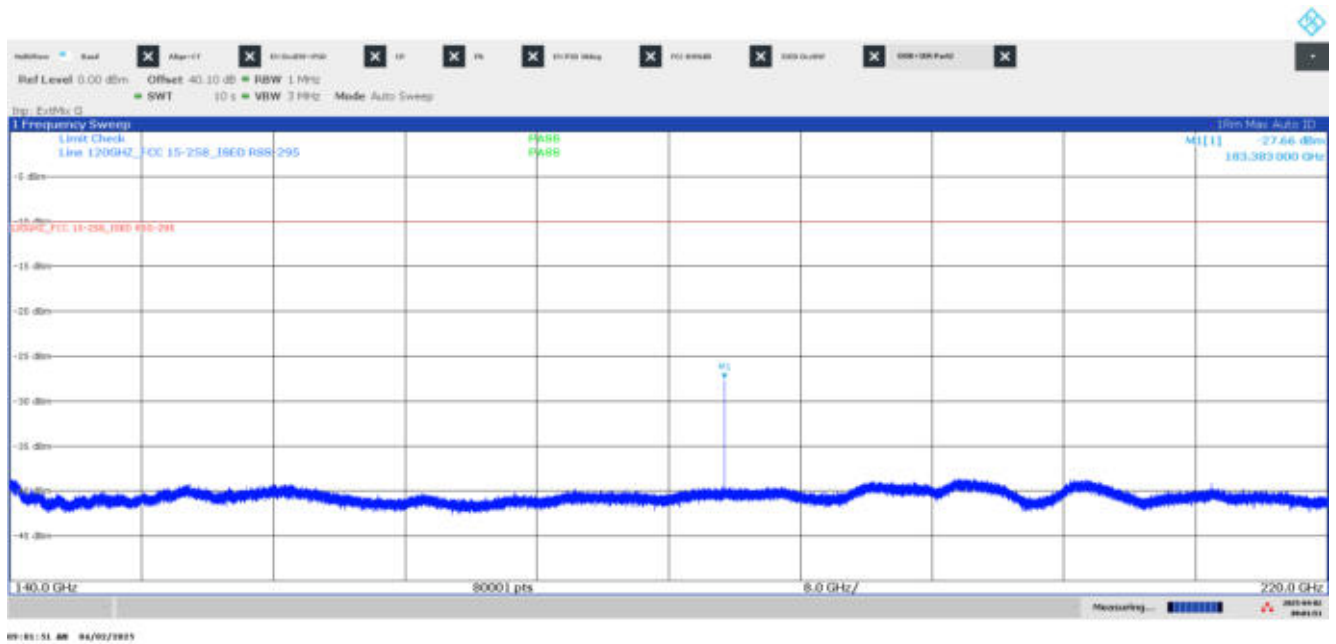
Plot 63: 145 GHz – 150 GHz, EUT Main2673, MainMode1



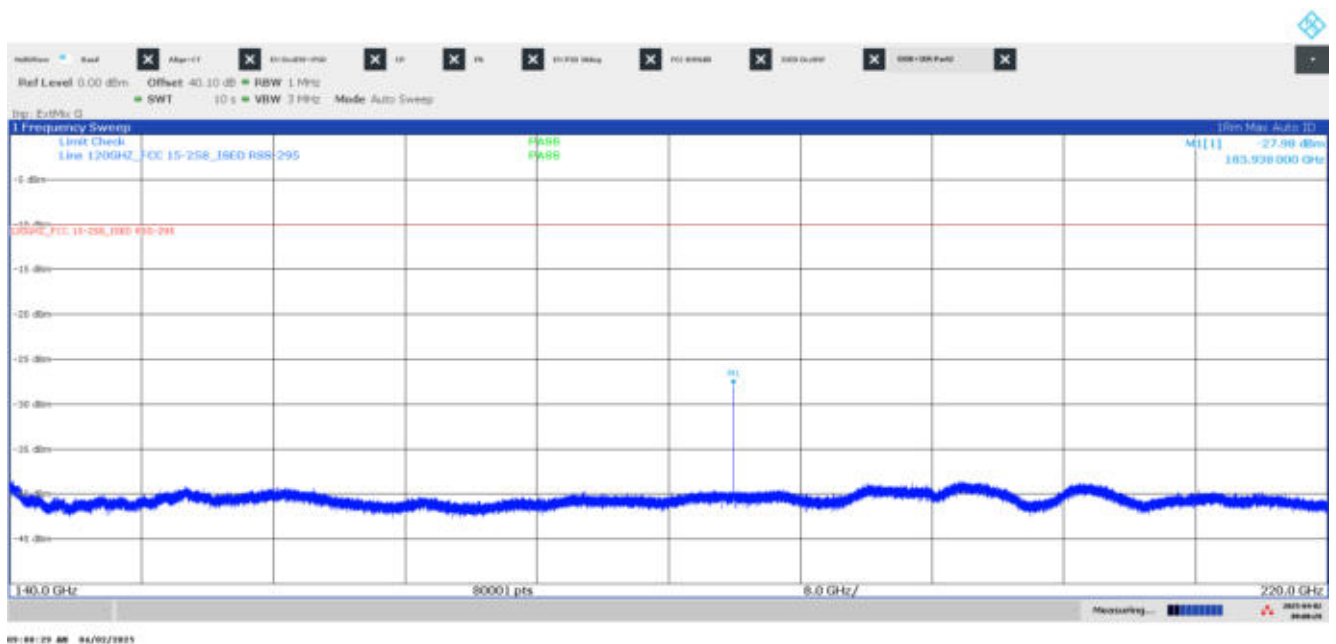
Plot 64: 150 GHz – 220 GHz, EUT Main2673, MainMode1



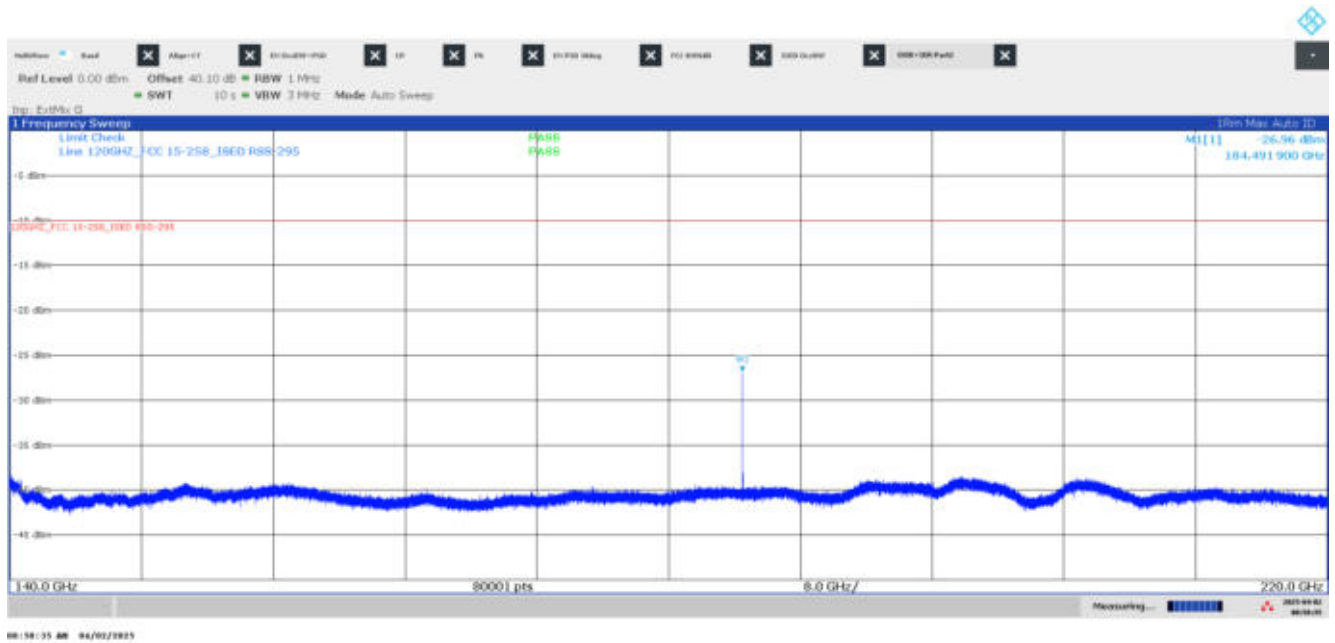
Plot 65: 140 GHz – 220 GHz, EUT Main2673, stop mode, low frequency



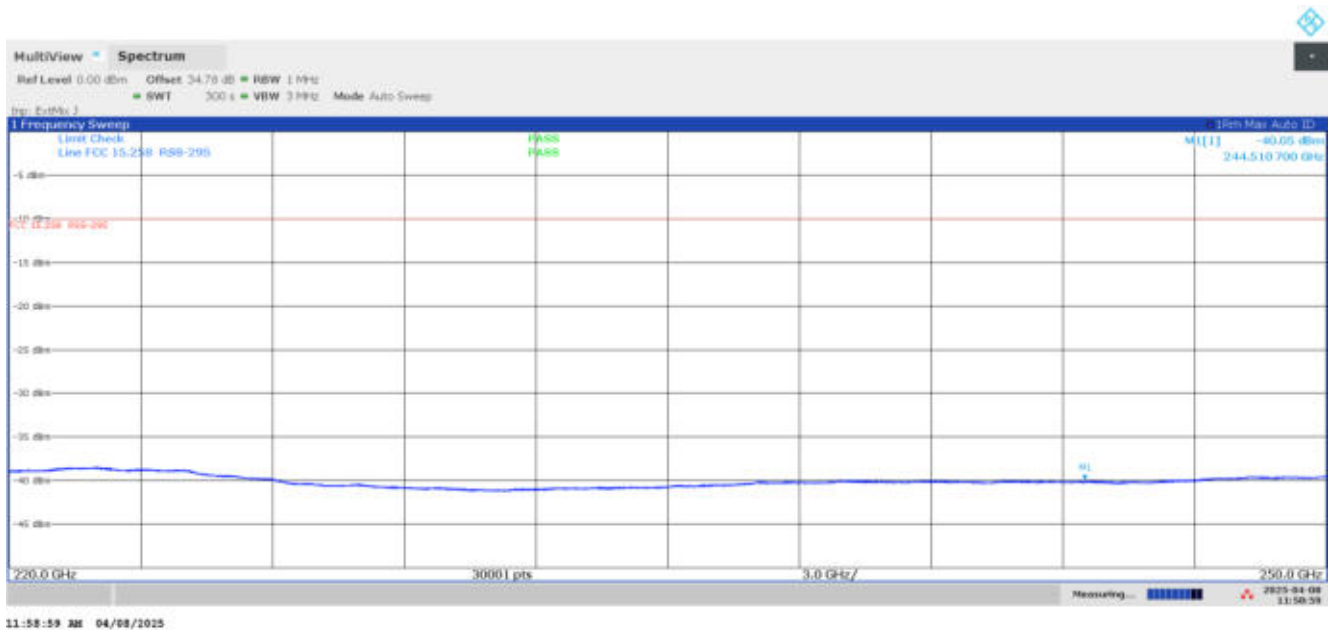
Plot 66: 140 GHz – 220 GHz, EUT Main2673, stop mode, middle frequency



Plot 67: 140 GHz – 220 GHz, EUT Main2673, stop mode, high frequency

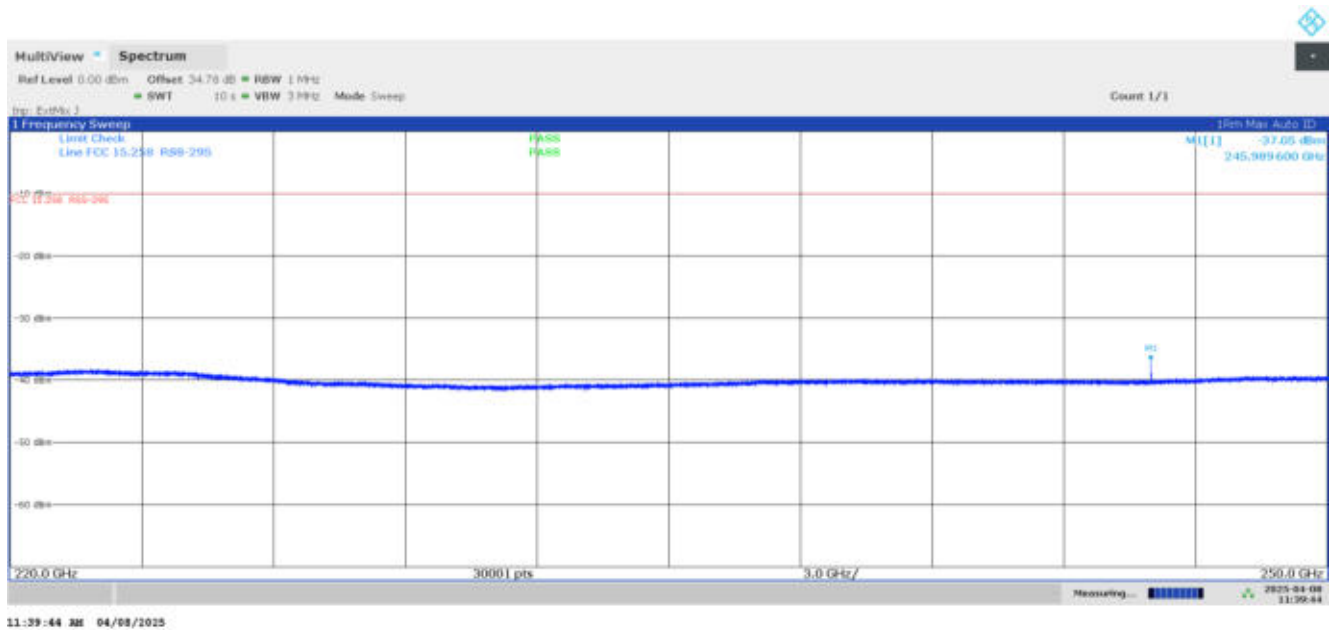


Plot 68: 220 GHz – 250 GHz, EUT Main2467, MainMode1

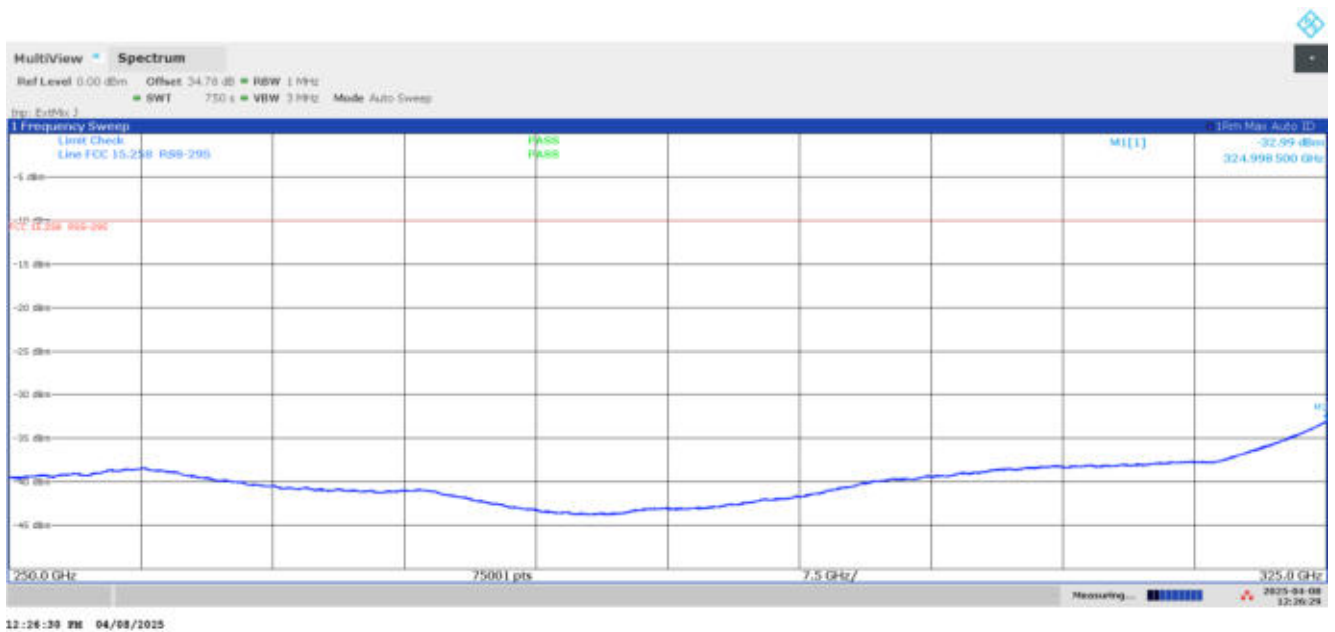




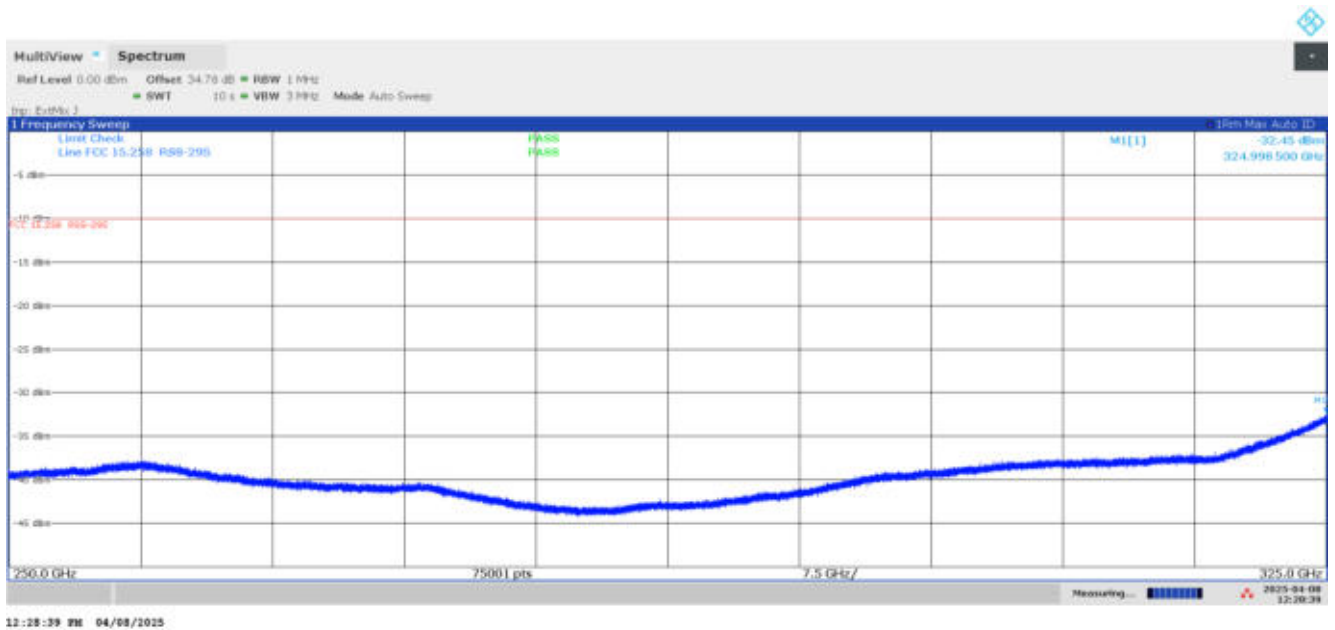
Plot 71: 220 GHz – 250 GHz, EUT Main2467, stop mode, high frequency



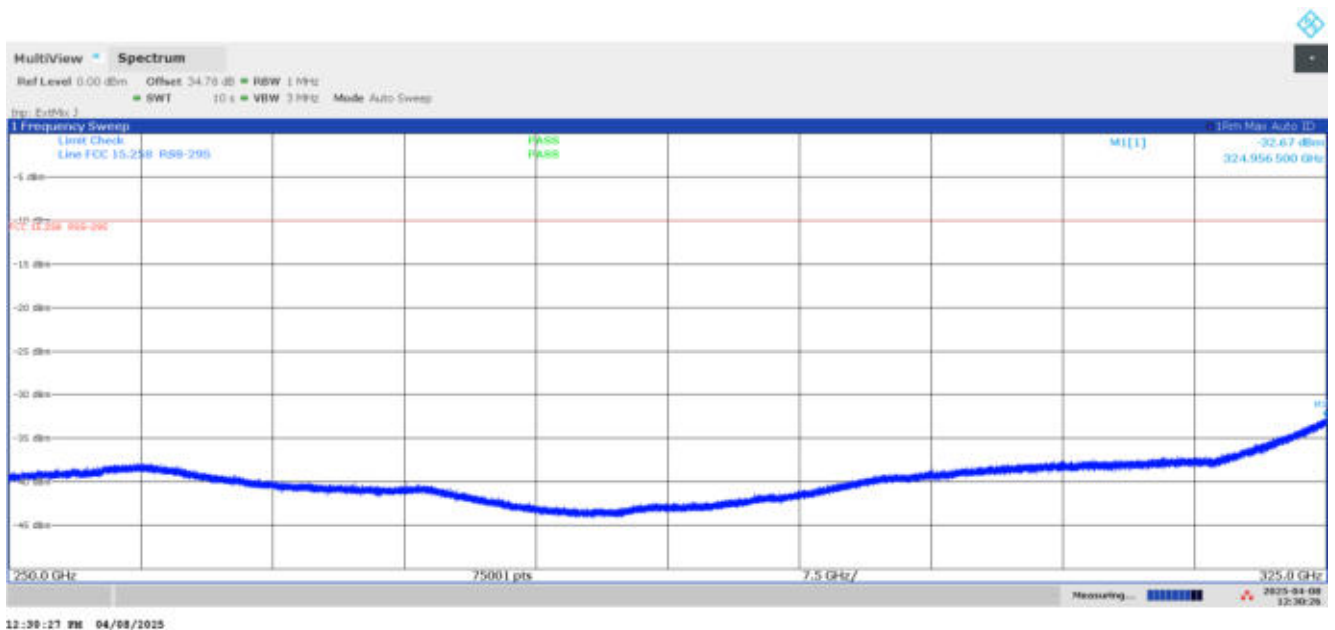
Plot 72: 250 GHz – 325 GHz, EUT Main2467, MainMode1



Plot 73: 250 GHz – 325 GHz, EUT Main2467, stop mode, low frequency

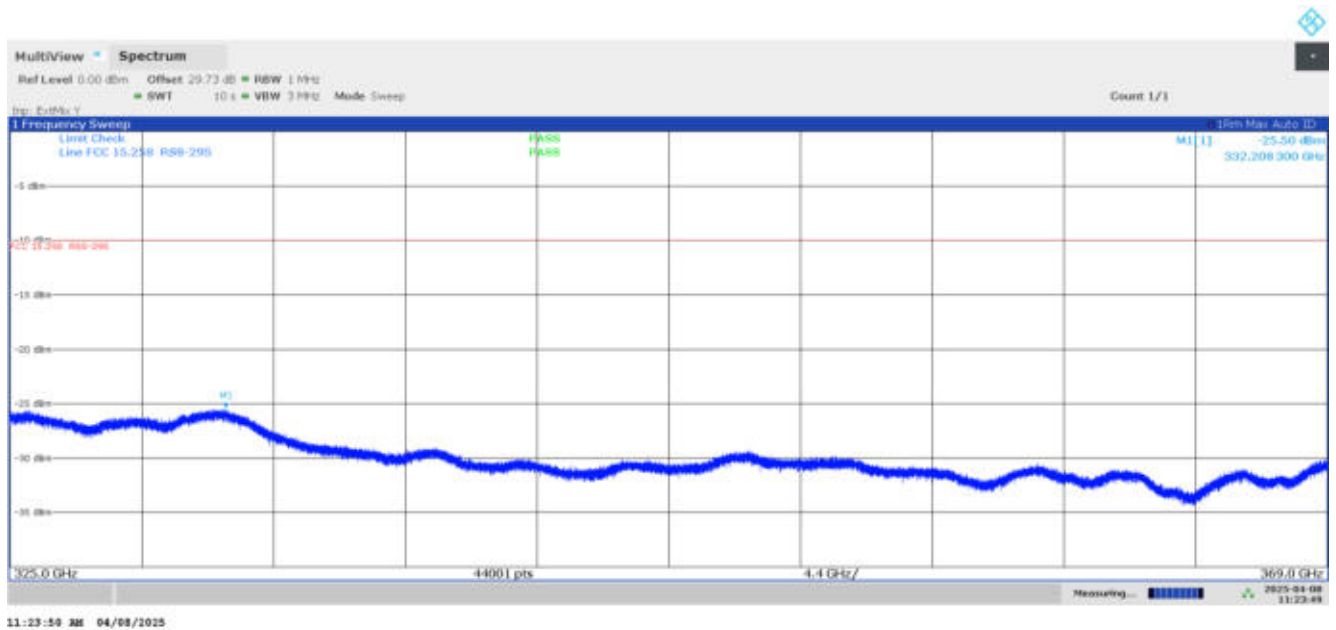


Plot 74: 250 GHz – 325 GHz, EUT Main2467, stop mode, middle frequency

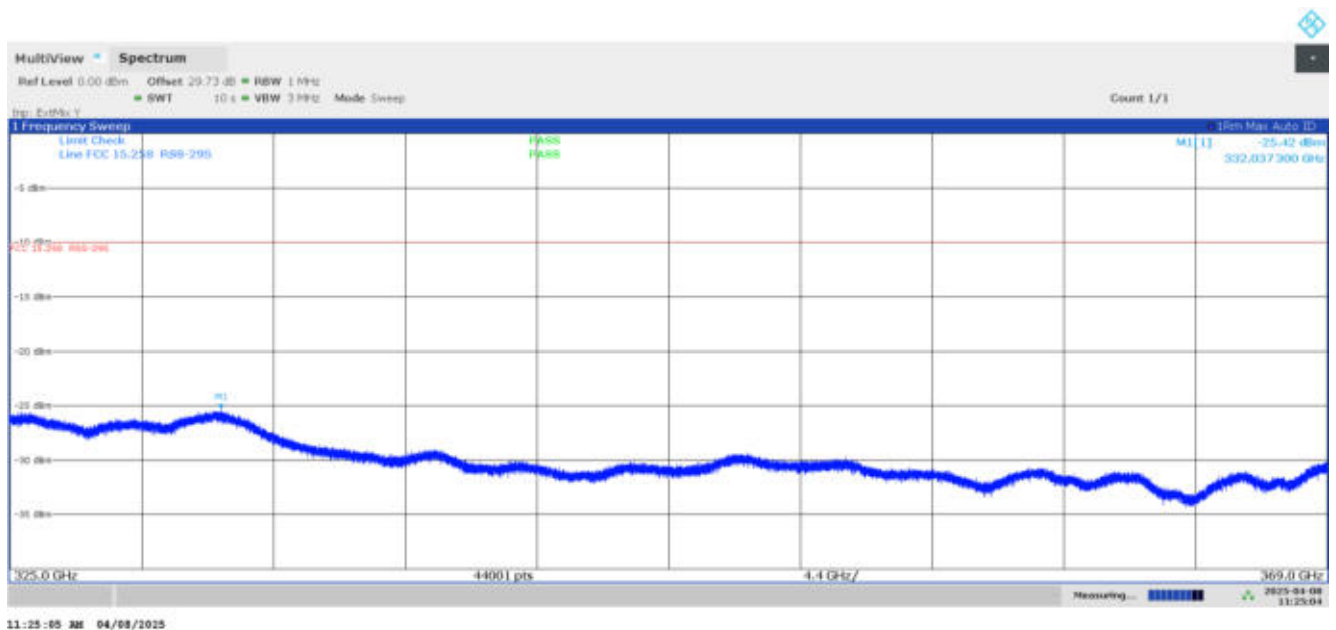




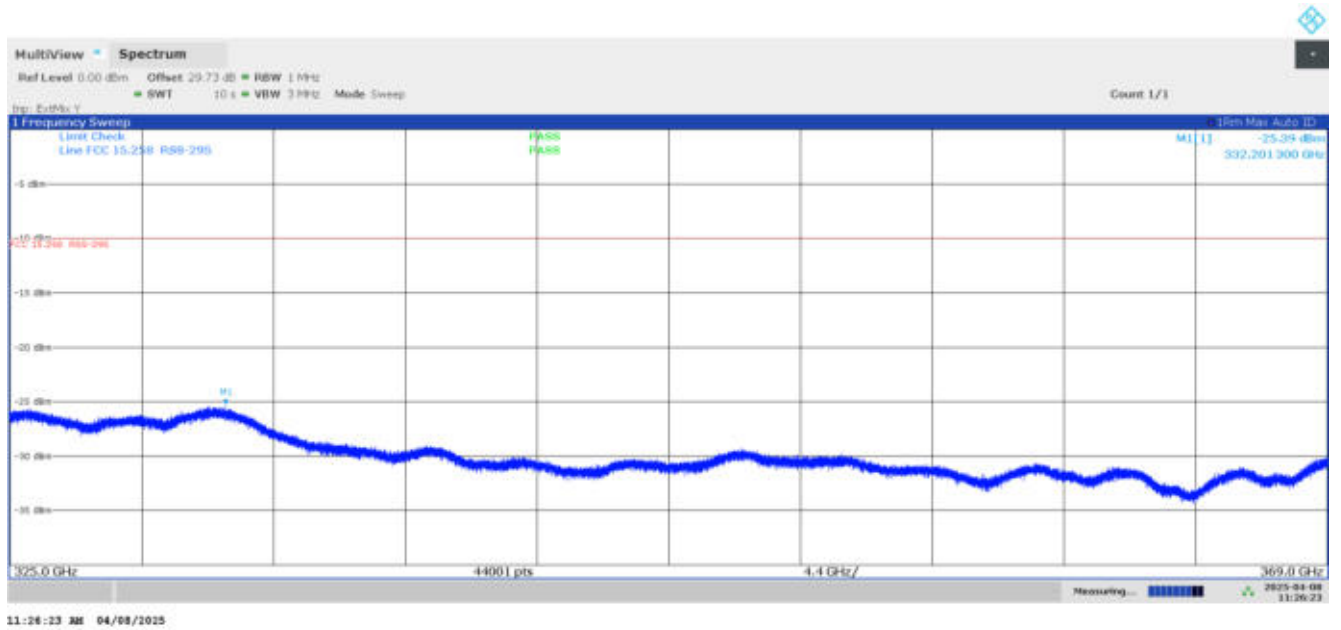
Plot 77: 325 GHz – 369 GHz, EUT Main2467, stop mode, low frequency



Plot 78: 325 GHz – 369 GHz, EUT Main2467, stop mode, middle frequency



Plot 79: 325 GHz – 369 GHz, EUT Main2467, stop mode, high frequency



14.4 Conducted emissions < 30 MHz (AC power line)

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.

Limits and provisions:

47 CFR 15.207(a)		
Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency

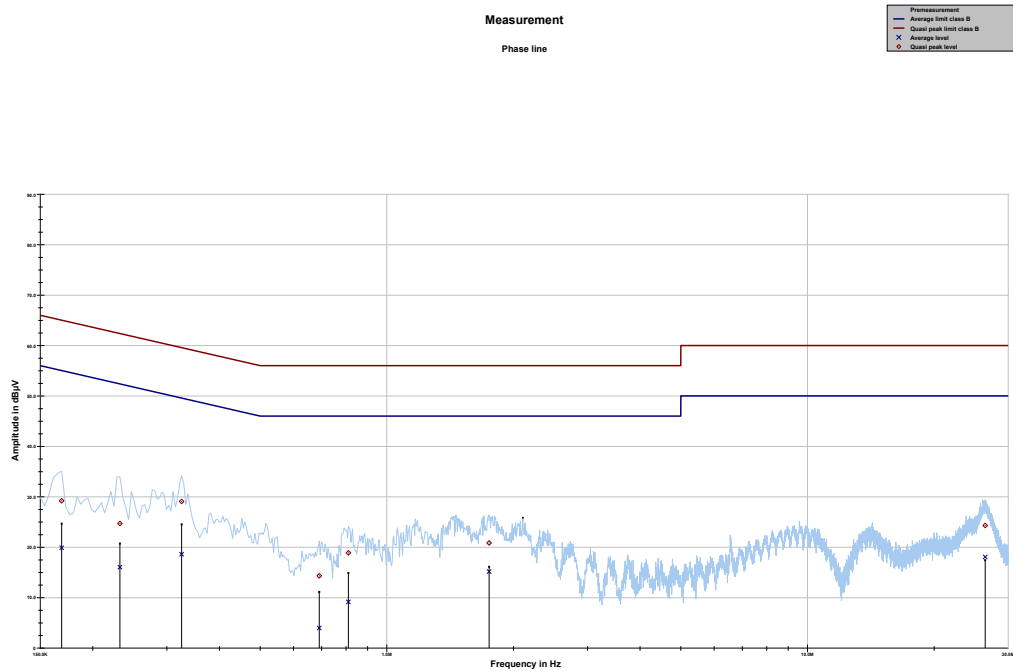
Measurement:

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

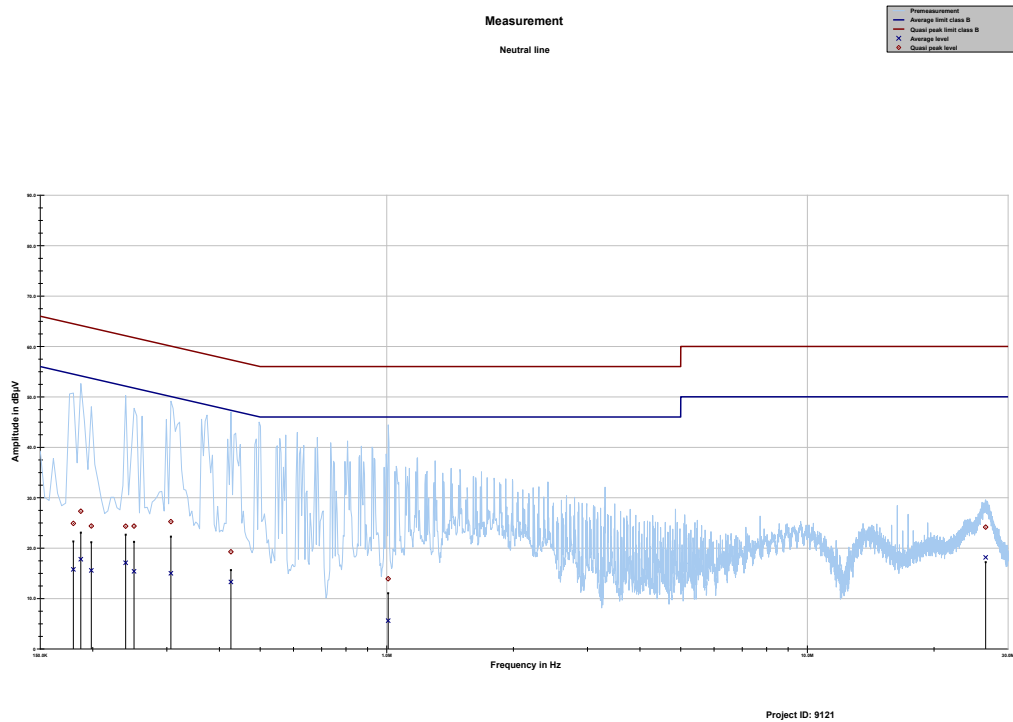
Verdict: Compliant

Measurement results:

Plot 80: Phase line



Plot 81: Neutral line



15 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	Continuous 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/N₀	Carrier to noise-density ratio, expressed in dB-Hz

16 Document history

Version	Applied changes	Date of release
R01-D1	Initial Draft release	2025-04-22
R01	Initial release	2026-01-19

END OF TEST REPORT