

Test Report

Test report no.: 24070316-41144-1

Date of issue: 2024-11-29

Test result: The test item - **passed** - and complies with below listed standards.

Applicant

Symeo GmbH

Manufacturer

Symeo GmbH

Test Item

BSW200291

RF-Spectrum Testing according to:

特定無線設備の技術基準適合証明等に関する規則

Ordinance concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment

Article 2, Clause 1, Item 8

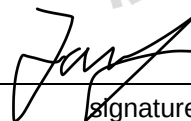
無線設備規則

Ordinance Regulating Radio Equipment

Article 49.14.12 and dedicated articles

Tested by
(name, function, signature)

Sebastian Janoschka
Head of Department RF


signature

Approved by
(name, function, signature)

Karsten Gerald
Lab Manager RF


signature

Applicant and Test item details

Applicant	Symeo GmbH Professor-Messerschmitt-Str. 3a 85579, Neubiberg / München, Germany Phone: +49 89 6607796-0 Fax: +49 89 6607796-190
Manufacturer	Symeo GmbH Professor-Messerschmitt-Str. 3a 85579, Neubiberg / München, Germany
Test item description	Radar
Model/Type reference	BSW200291

Standard specific information

Technology	FDS – Field Disturbance Sensor / Short Range Radar Device
Frequency	57.0 GHz to 64.0 GHz
Antenna	integrated patch antenna with lens
Power supply	11.0 to 36.0 V DC
Temperature range	-40 °C to +75 °C

Disclaimer and Notes

The content of this report relates to the mentioned test sample(s) only.

IBL-Lab GmbH does not take samples. The samples used for testing are provided by the applicant.

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Signatures are done electronically, if signer does not match stated signer, it is signed per order.

Information supplied by the applicant can affect the validity of results. The data is marked accordingly.

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Within this test report, a ☒ point / ☐ comma is used as a decimal separator.

If otherwise, a detailed note is added adjoined to its use.

Decision rule:

Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor $k=2$ according to ILAC-G8:09/2019

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2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	IBL-Lab GmbH Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: https://ib-lenhardt.com/ E-Mail: info@ib-lenhardt.com
Accreditation / Designation	<p>The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018.</p> <p>Scope of testing and registration number:</p> <ul style="list-style-type: none">• Attachment to the accreditation certificate D-PL-21375-01-00<ul style="list-style-type: none">○ Electronics○ Electromagnetic Compatibility○ Radio○ Electromagnetic Compatibility and Telecommunication (FCC requirements)○ Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards○ Automotive EMC <p>Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement.</p> <ul style="list-style-type: none">• Designations<ul style="list-style-type: none">○ FCC Testing Laboratory Designation Number DE0024○ ISED ISED Company Number 27156 Testing Laboratory CAB Identifier DE0020○ Kraftfahrt-Bundesamt KBA-P 00120-23
Testing location	IBL-Lab GmbH Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2024-10-02
Start – End of tests	2024-10-08 – 2024-10-23

2.2 Possible test case verdicts

Test sample meets the requirements	P (PASS) – the measured value is below the acceptance limit, AL = TL
Test sample does not meet the requirements	F (FAIL) – the measured value is above the acceptance limit, AL = TL
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and Interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision history

-0 Initial Version

- 1 Revision: Hardware status corrected.

This test report 24070316-41144-1 replaces the previous test report 24070316-41144-0
Utilisation, publication and control of previous report editions is under applicant's responsibility.

2.6 Further documents

List of further applicable documents belonging to the present test report:
– no additional documents –

3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions

Temperature	20°C ± 5°C
Relative humidity	25-75% r.H.
Barometric Pressure	860-1060 mbar
Power supply	230 V AC ± 5%

3.2 Normal and extreme test conditions

	minimum	normal	maximum
Temperature	-40 °C	+20 °C	+75 °C
Relative humidity	-/-	45 % r.h.	-/-
Power supply	11.0 V DC	24.0 V DC	36.0 V DC

4 TEST STANDARDS AND REFERENCES

Test standard (not accredited)

Ordinance Regulating Radio Equipment

Standard: 無線設備規則

Ordinance Regulating Radio Equipment

Chapter I General Provision

Chapter II Transmitting Equipment

Chapter III Receiving Equipment

Chapter IV Equipment Classification, Article 49.14.12

With test method as described in OCTR (特定無線設備の技術基準適合証明等に関する規則),

Annex 1, Appendix 22-14 (according to Notification 88) or alternative test method considered as equivalent.

Reference	Description
– none –	– none –

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product description

Radar

5.2 Description of test item

Model name*	BSW200291
Serial number*	F44AJN0357
PCB identifier*	N/A
Hardware status*	V1.01
Software status*	v4.0.0-15-g380d81b.LPR1DHP200-1363_country_settings_japan

*: as declared by applicant

5.3 Technical data of test item

Operational frequency band*	57.0 GHz to 64.0 GHz
Type of radio transmission*	modulated carrier
Modulation type*	FMCW
Number of channels*	1
Channel bandwidth*	<6 GHz
Channel spacing*	N/A
Receiver category*	N/A
Receiver bandwidth*	N/A
Duty cycle*	~10%
Antenna*	integrated patch antenna with lens
Rated RF output power*	<13 dBm
Power supply*	11.0 to 36.0 V DC
Temperature range*	-40 °C to +75 °C

*: as declared by applicant

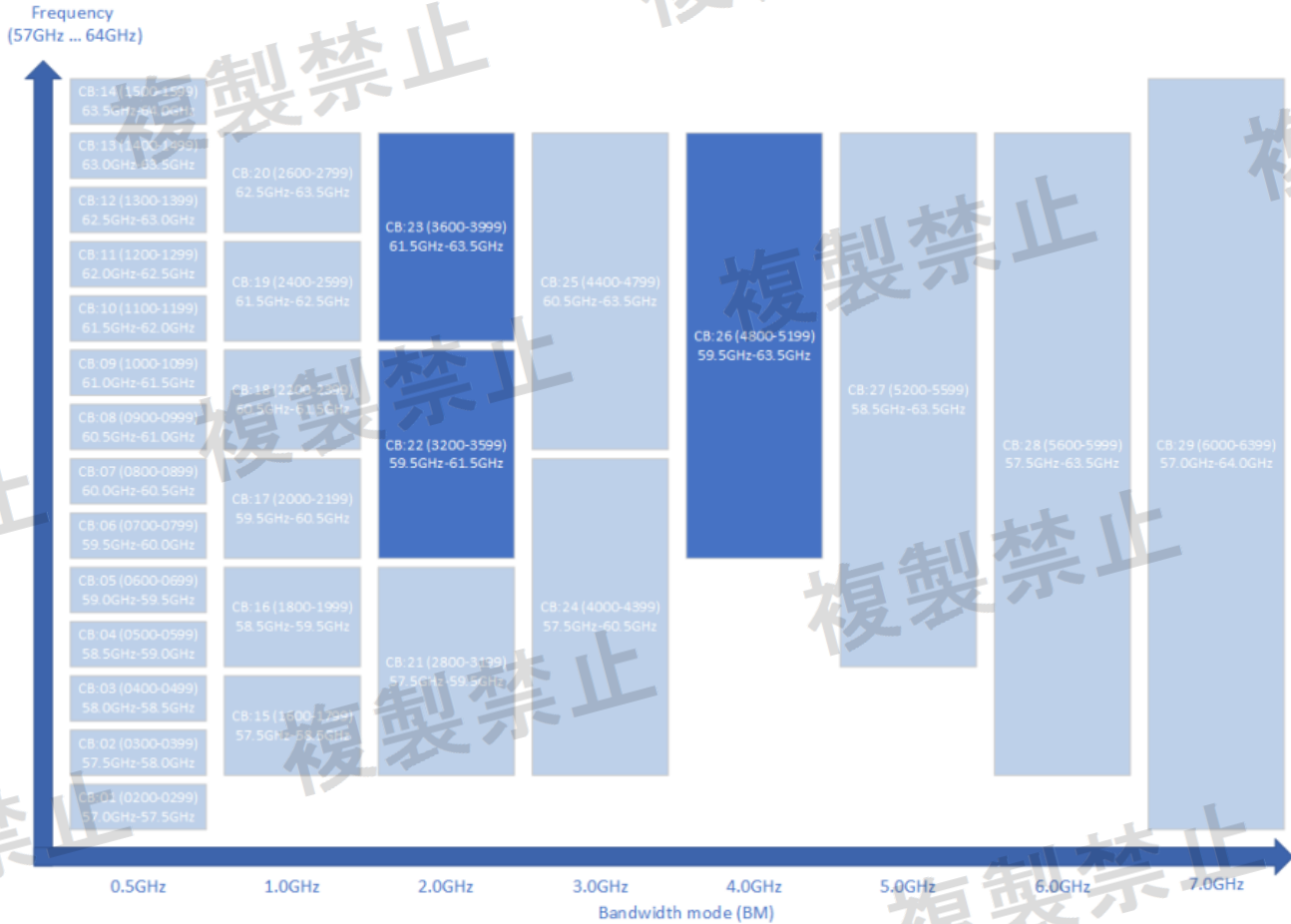
5.4 Additional information

Model differences	-
Ancillaries tested with	-
Additional equipment used for testing	Notebook with LAN connection to configure channel and mode

5.5 Operating conditions

Following information is derived from document “DOC.PRIV.000708.0002.LPR-1DHP-291_Test_Manual_Japan.pdf”, provided by applicant.

3 frequency ranges are declared as operating modes for Japan:



Measurements will be done accordingly with the following naming pattern:

CB22
CB23
CB26

Two Radar modes are possible:

3.3.1 Primärradar

Im Primärradarmodus werden nur Up- und Downsweeps in den jeweiligen Messkanälen gesendet, z.B., 2GHz Rampen von $f_{\text{Start}} = 61.5\text{GHz}$ bis $f_{\text{Stop}} = 63.5\text{GHz}$.

Der Messzyklus wird in einem festen Zeitraster wiederholt und gliedert sich in:

Schritt	Beschreibung	Signalfrequenz	Dauer	TX Ampl.
1	Messrampe (up)	FMCW $f_{\text{Start}} \rightarrow f_{\text{Stop}}$	1ms (davon 0.82ms Rampe)	EIN
2	Messrampe (down)	FMCW $f_{\text{Stop}} \rightarrow f_{\text{Start}}$	1ms (davon 0.82ms Rampe)	EIN
3	Rechenzeit / Pause	CW f_{Start}	31ms	AUS
				TX On: 2ms TX Off: 29.9ms All: 31.9ms

Während der zur Datenauswertung und Pause benötigten Zeit verbleibt das HF-Signal auf der Startfrequenz und der Sendeverstärker (TX-Ampl.) wird abgeschaltet.

3.3.2 Sekundärradar

Im Sekundärradarmodus wird zusätzlich ein Synchronisationssweep mit 4MHz Bandbreite am unteren Ende des Messkanals gesendet, der zur groben zeitlichen Synchronisation benötigt wird. Der Slave sendet nur, wenn er sich erfolgreich auf den Master synchronisiert hat.

Schritt	Beschreibung	Signalfrequenz	Dauer	TX Ampl. Master	TX Ampl. Slave
1	Messrampe (up)	FMCW $f_{\text{Start}} \rightarrow f_{\text{Stop}}$	1ms (davon 0.82ms Rampe)	AUS	EIN (1ms)
2	Messrampe (down)	FMCW $f_{\text{Stop}} \rightarrow f_{\text{Start}}$	1ms (davon 0.82ms Rampe)	AUS	EIN (1ms)
3	Pause	CW f_{Start}	23.9ms	AUS	AUS
4	Syncrampe (up)	FMCW $f_{\text{Start}} \rightarrow f_{\text{Stop}}$	1ms (davon 0.82ms Rampe)	EIN (0.82ms)	AUS
5	Syncrampe (down)	FMCW $f_{\text{Stop}} \rightarrow f_{\text{Start}}$	1ms (davon 0.82ms Rampe)	EIN (0.82ms)	AUS

6	Syncrampe (up)	FMCW fStart → fStart + 4MHz	1ms (davon 0.82ms Rampe)	EIN (0.82ms)	AUS
7	Syncrampe (down)	FMCW fStart + 4MHz → fStart	1ms (davon 0.82ms Rampe)	EIN (0.82ms)	AUS
8	Rechenzeit	CW fStart	3.1ms	AUS	AUS
				TX On: 3.28ms TX Off: 29.72ms All: 33ms	TX On: 2ms TX Off: 31ms All: 33ms

Während der zur Datenauswertung und Pause benötigten Zeit verbleibt das HF-Signal auf der Startfrequenz und der Sendeverstärker wird abgeschaltet.

5.6 Antenna characteristics

Following information is derived from document "[DOC.EDO.000536.0002.LPR-1DHP-291_Antenna_Radiation_Pattern.docx](#)", provided by applicant.

4 Antenna radiation pattern

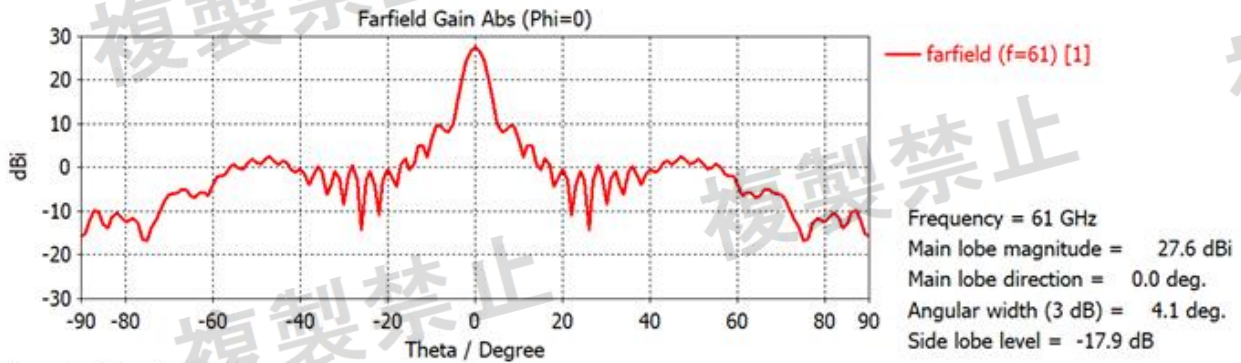


Figure 2: Azimuth 61 GHz

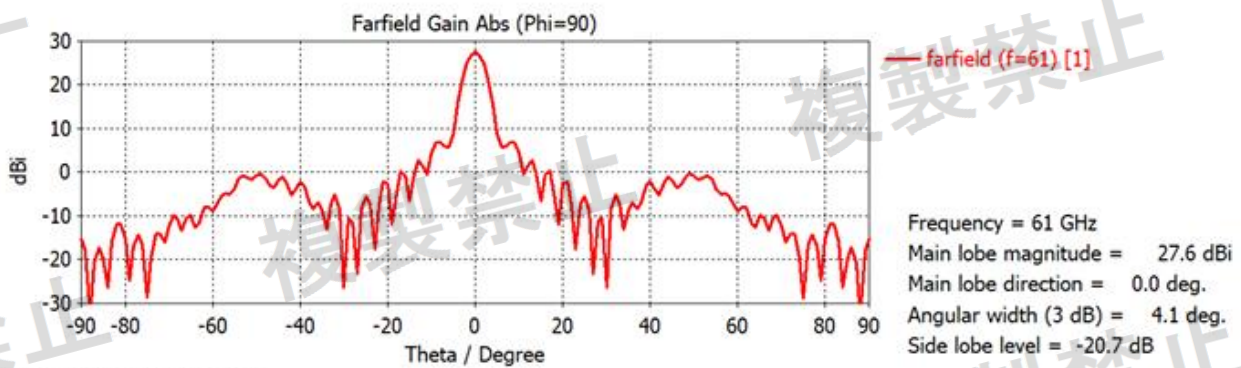


Figure 3: Elevation 61 GHz

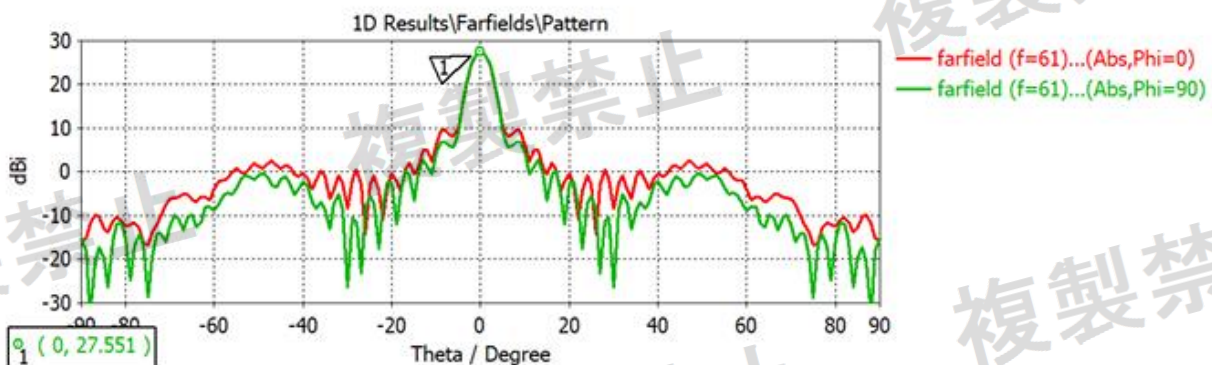


Figure 4: Azimuth/Elevation 61 GHz

6 SUMMARY OF TEST RESULTS

Test specification

Ordinance regulating radio equipment Article 2, Item 8

Clause	Requirement / Test Case	Test Conditions	Result / Remark	Verdict
7.1	Frequency allocation / Frequency tolerance / 99 % Occupied bandwidth	Nominal Extreme	3962 MHz	- PASS -
7.2	Antenna power (radiated) / Antenna power tolerance (+50%/-70%)	Nominal	13.65 dBm	- PASS -
7.3	Transmitter antenna gain (Antenna characteristics)	Nominal	28 dBi	- PASS -
7.4	Antenna power (conducted) / Antenna power tolerance (+50%/-70%)	Nominal	-14.62	- PASS -
7.5	Transmission Time Restriction	Nominal	3.3 ms within 33 ms	- PASS -
7.6	Spurious emissions and Unwanted emissions Secondary radiated emissions	Nominal	see note 1	- PASS -
7.7	Automatic stop function radio waves	Nominal		- N/A -

Notes

Note 1:

Secondary emissions are emissions at any frequency when the equipment is in receive mode. Consequently, secondary emission testing applies only when the equipment can work in a receive-only mode or is a receive only device. In cases where receivers are used in combination with permanently co-located transmitters the receivers will be tested together with the transmitter in operating mode as part of the transmitter spurious.

Comments and observations

Master EUT was determined to be the mode with the highest duty cycle. Therefore, measurements were done in this mode, according to channel plan.

7 TEST RESULTS

7.1 Frequency allocations / Frequency tolerance / 99 % Occupied bandwidth

Description

The operating frequency range is the frequency range over which the equipment is transmitting. The occupied frequency range of the equipment is determined by the lowest (f_L) and the highest frequency (f_H) as occupied by the power envelope.

Limits

The upper and lower limits of the operating frequency range shall meet the following conditions:
 $f_L \geq 57 \text{ GHz}$ // $f_H \leq 64 \text{ GHz}$

Test procedure

A spectrum analyser with the following settings is used as measuring receiver in the test set-up:

- Start frequency: lower than the lower edge of the permitted frequency range.
- Stop frequency: higher than the upper edge of the permitted frequency range.
- Resolution Bandwidth: 1 MHz.
- Video Bandwidth: $\geq 3 \text{ MHz}$.
- Detector mode: RMS (see Recommendation ITU-R SM.328-11).
- Display mode: Maxhold.
- Averaging time: $\geq 1 \text{ ms}$ per sweep point.

The 99 % OBW function is then used to determine the operating frequency range.

- f_H is determined. f_H is the frequency of the upper marker resulting from the OBW.
- f_L is determined. f_L is the frequency of the lower marker resulting from the OBW.
- f_c is the centre frequency.

Note

Measurements with the peak detector are also suitable to demonstrate compliance of an EUT, as long as the required resolution bandwidth is used, because peak detection will yield amplitudes equal to or greater than amplitudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results (see ANSI C63.10).

Test setup: 8.3

Test results

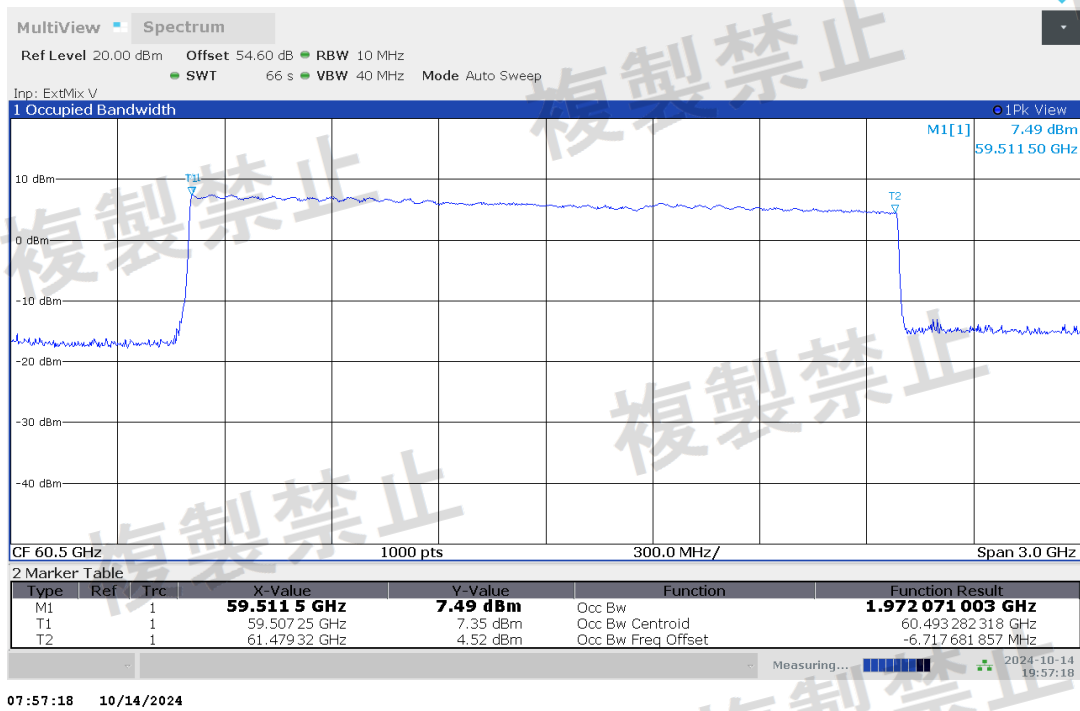
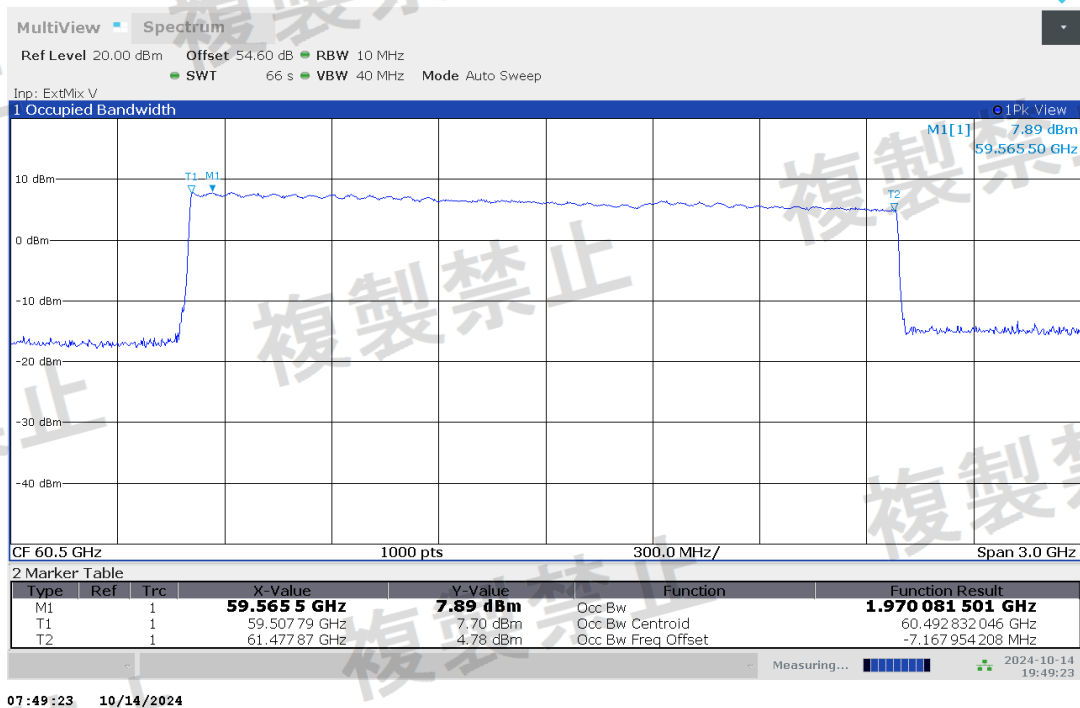
EUT mode	Test conditions	f_L [GHz]	f_H [GHz]	99% OBW [GHz]
master mode – CB 22	Extreme conditions	59.507	61.479	1.972
master mode – CB 23	Extreme conditions	61.493	63.489	1.996
master mode – CB 26	Extreme conditions	59.514	63.476	3.962

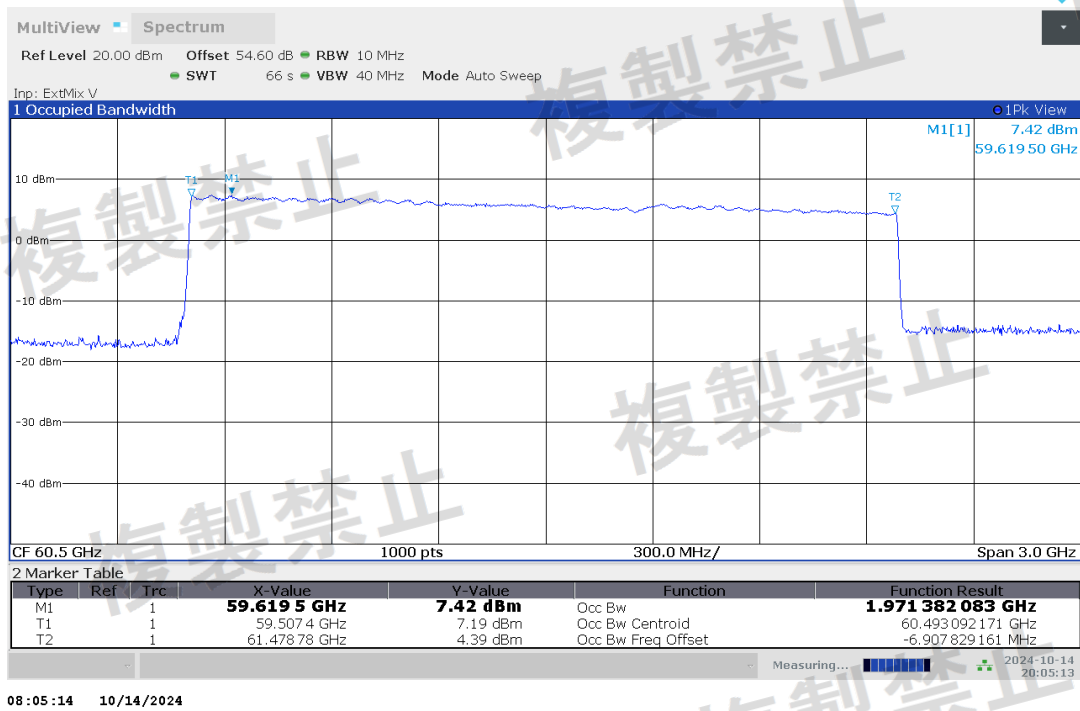
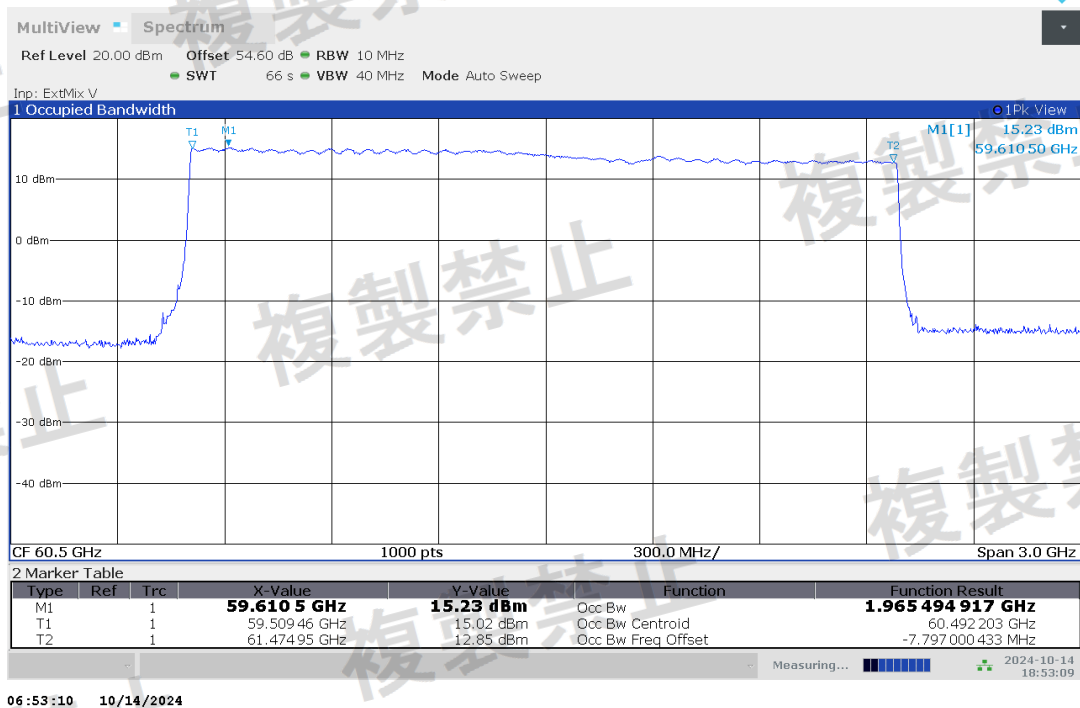
Note:

- To accomplish a correct value, RBW was set to 10 MHz due to pulse desensitisation
- measurements were done after exposition to humidity with high temperature, as well as exposition to vibrations.

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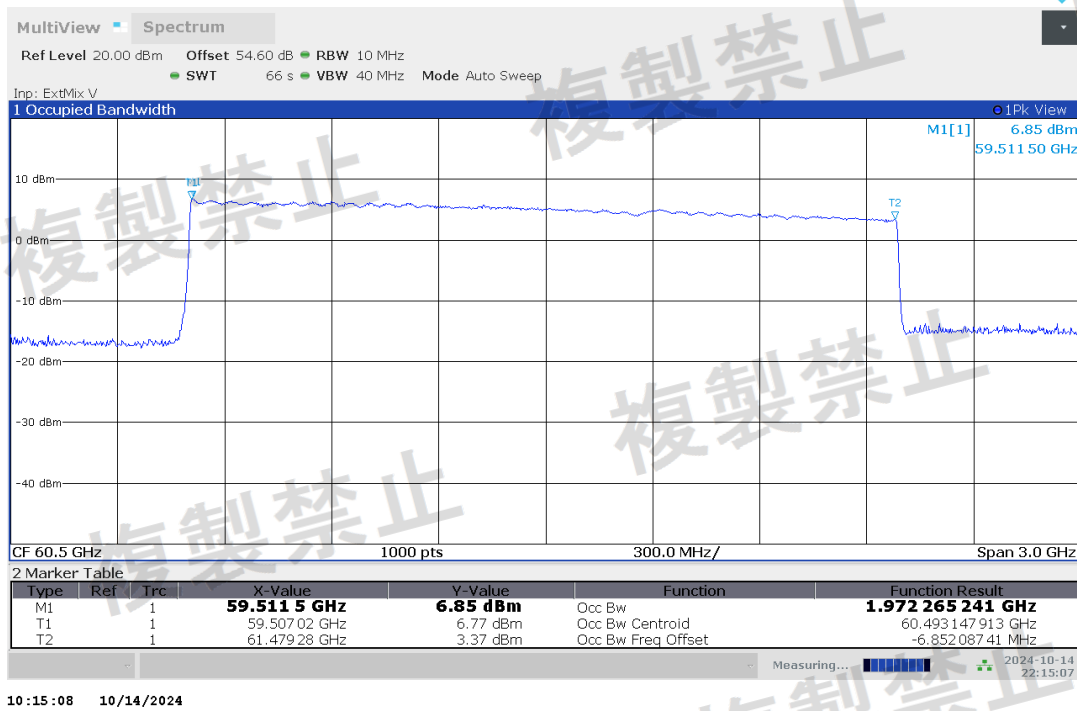
Plot no. 1: OBW, Peak detector, CB 22, $T_{\text{nom}}/V_{\text{min}}$ Plot no. 2: OBW, Peak detector, CB 22, $T_{\text{nom}}/V_{\text{nom}}$ 

Plot no. 3: OBW, Peak detector, CB 22, $T_{\text{nom}}/V_{\text{max}}$ Plot no. 4: OBW, Peak detector, CB 22, T_{min} 

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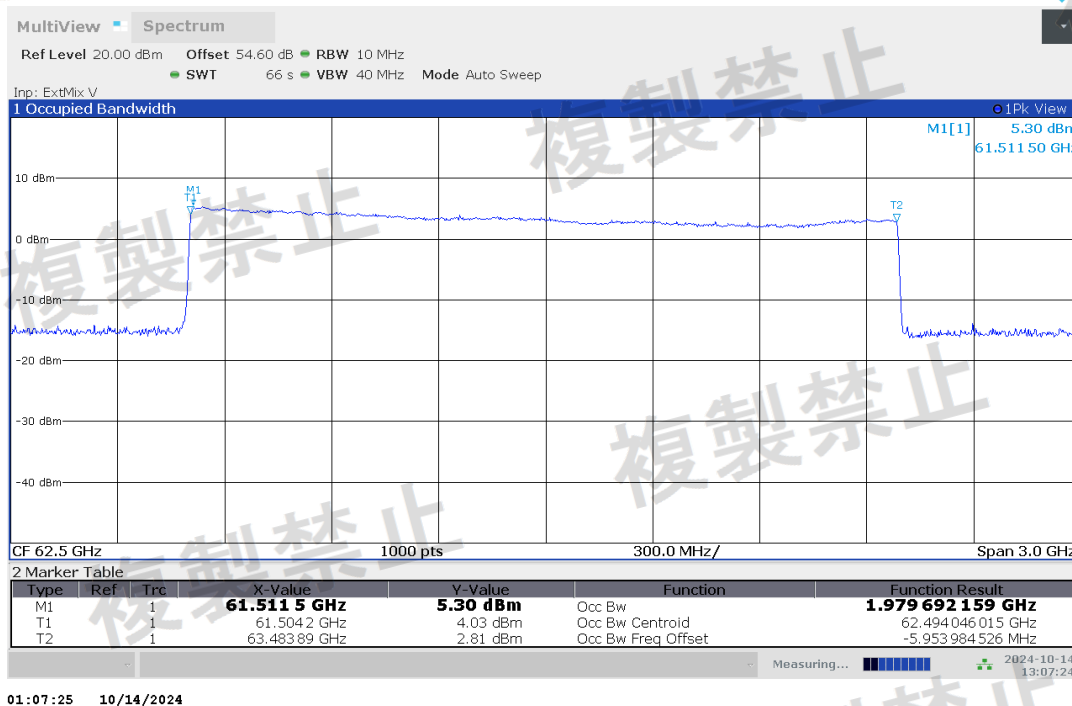
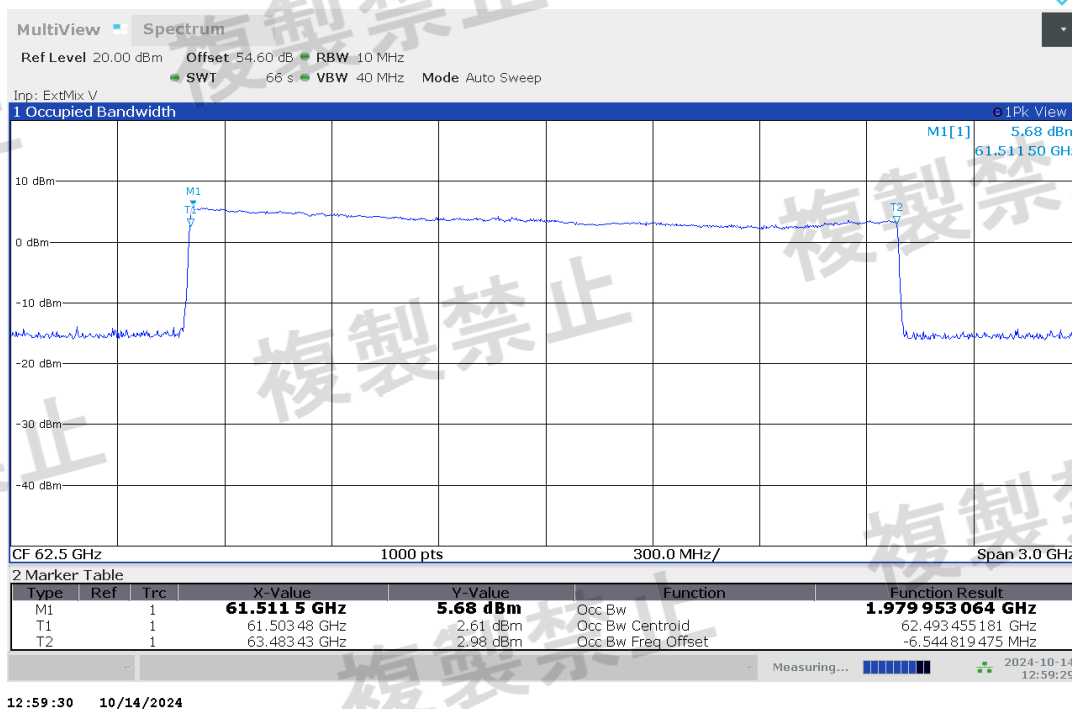
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Plot no. 5: OBW, Peak detector, CB 22, $T_{\max}$



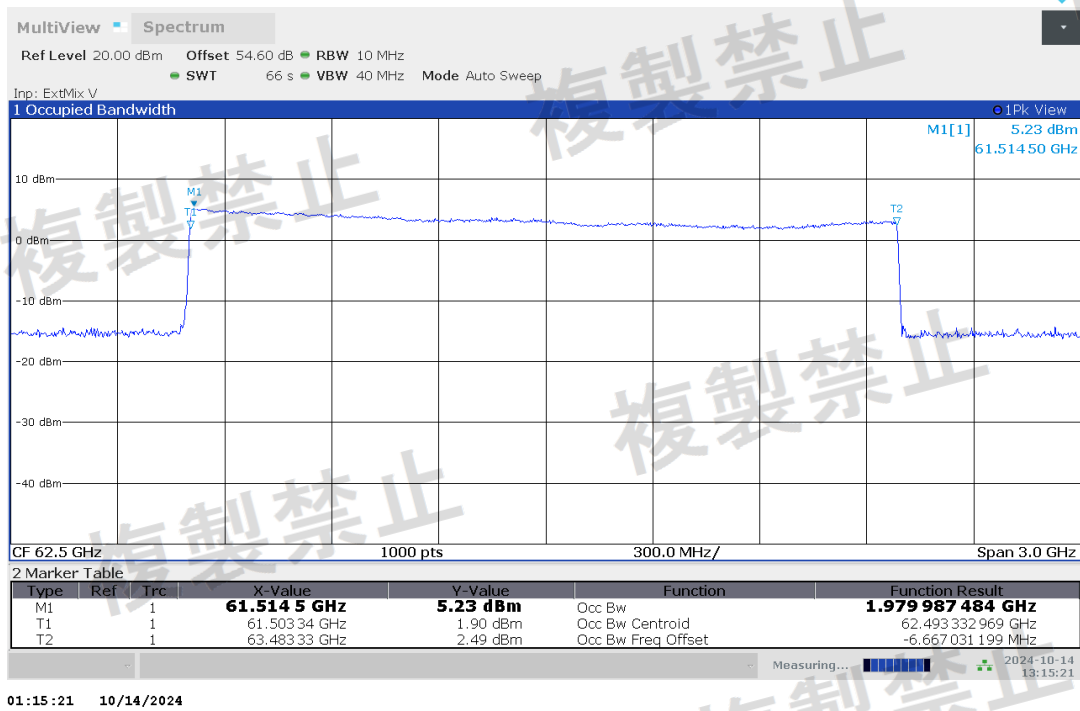
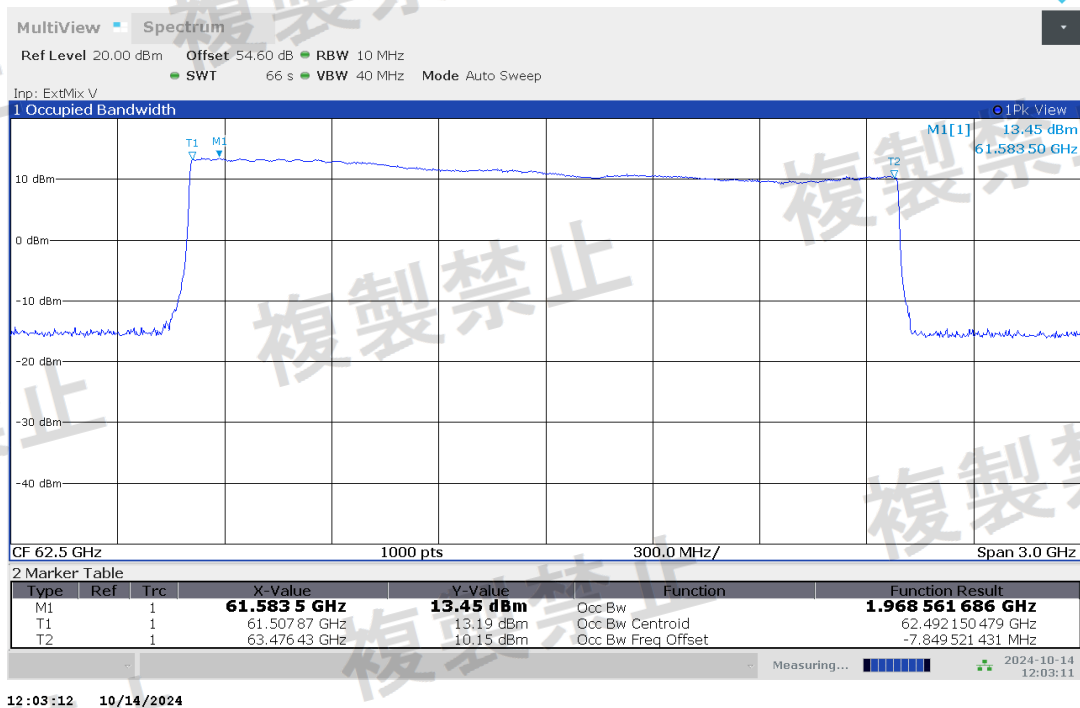
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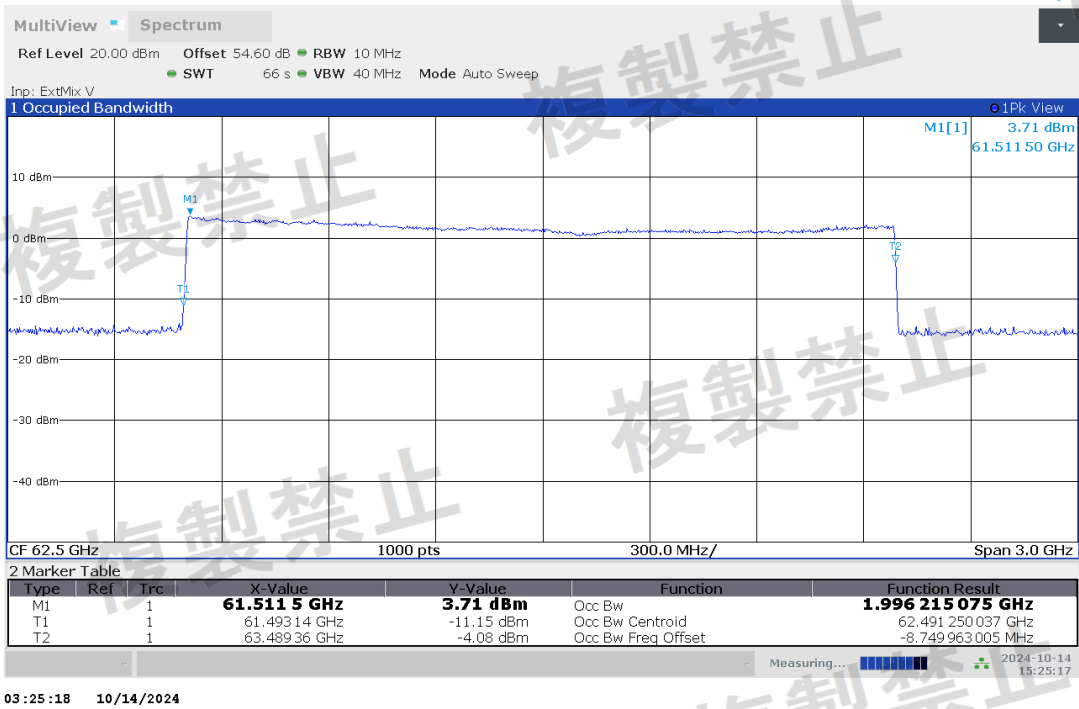
Plot no. 6: OBW, Peak detector, CB 23, $T_{\text{nom}}/V_{\text{min}}$ Plot no. 7: OBW, Peak detector, CB 23, $T_{\text{nom}}/V_{\text{nom}}$ 

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Plot no. 8: OBW, Peak detector, CB 23, $T_{\text{nom}}/V_{\text{max}}$ Plot no. 9: OBW, Peak detector, CB 23, T_{min} 

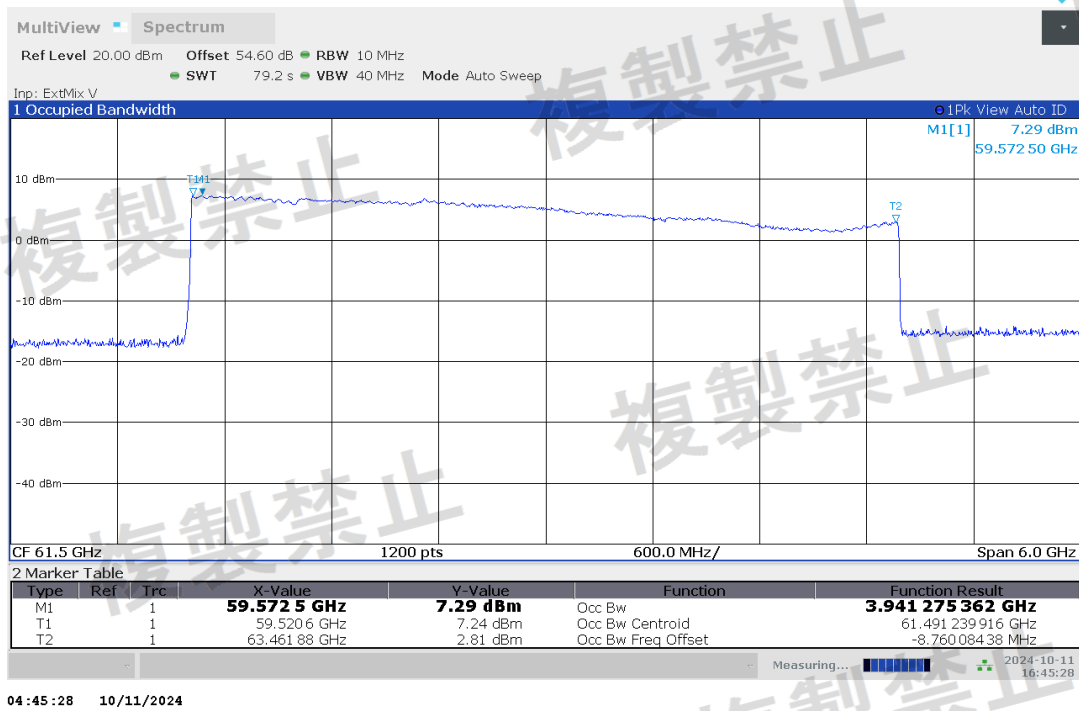
Plot no. 10: OBW, Peak detector, CB 23, T_{max}



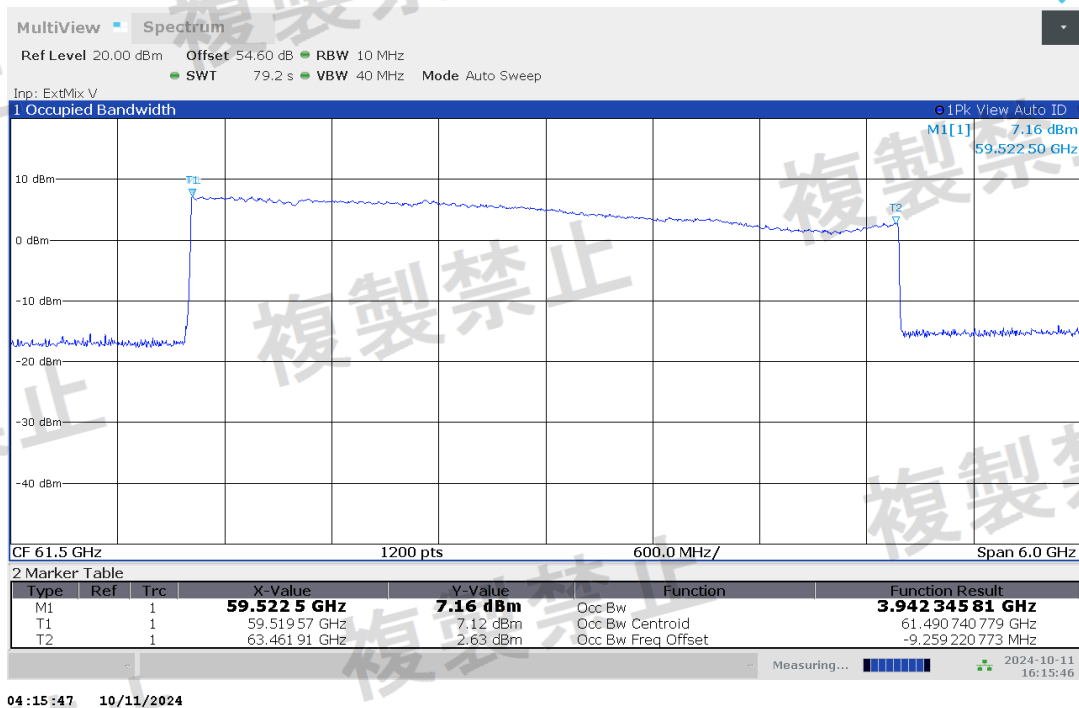
TR No.: 24070316-41144-1

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Plot no. 11: OBW, Peak detector, CB 26, T_{nom}/V_{min}



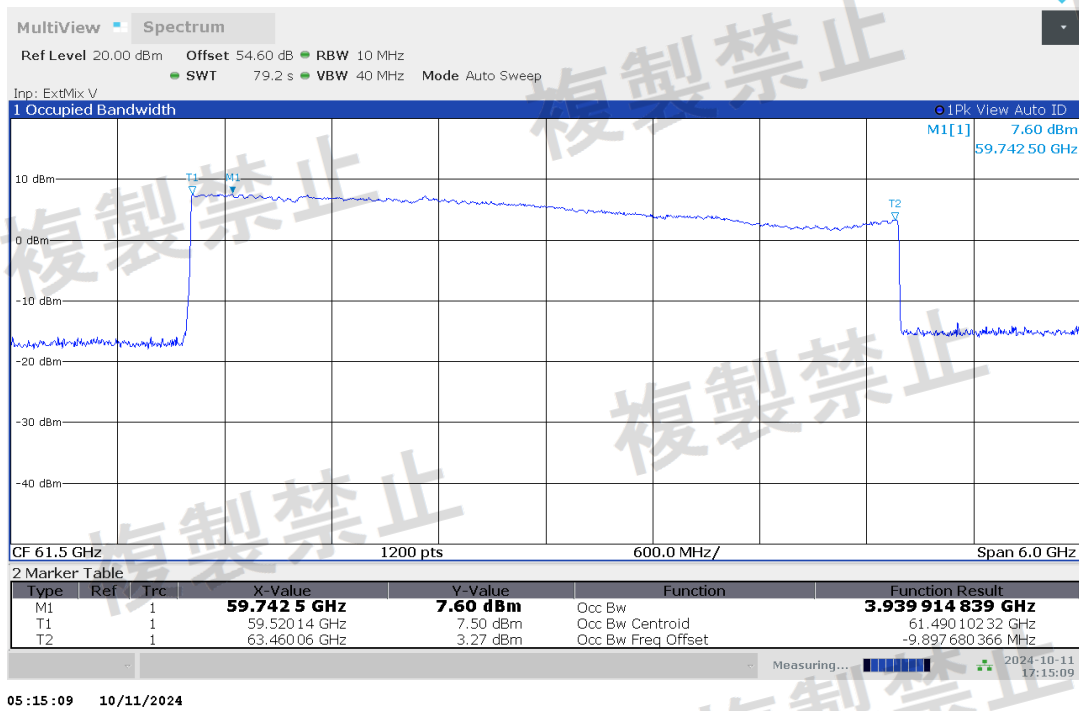
Plot no. 12: OBW, Peak detector, CB 26, T_{nom}/V_{nom}



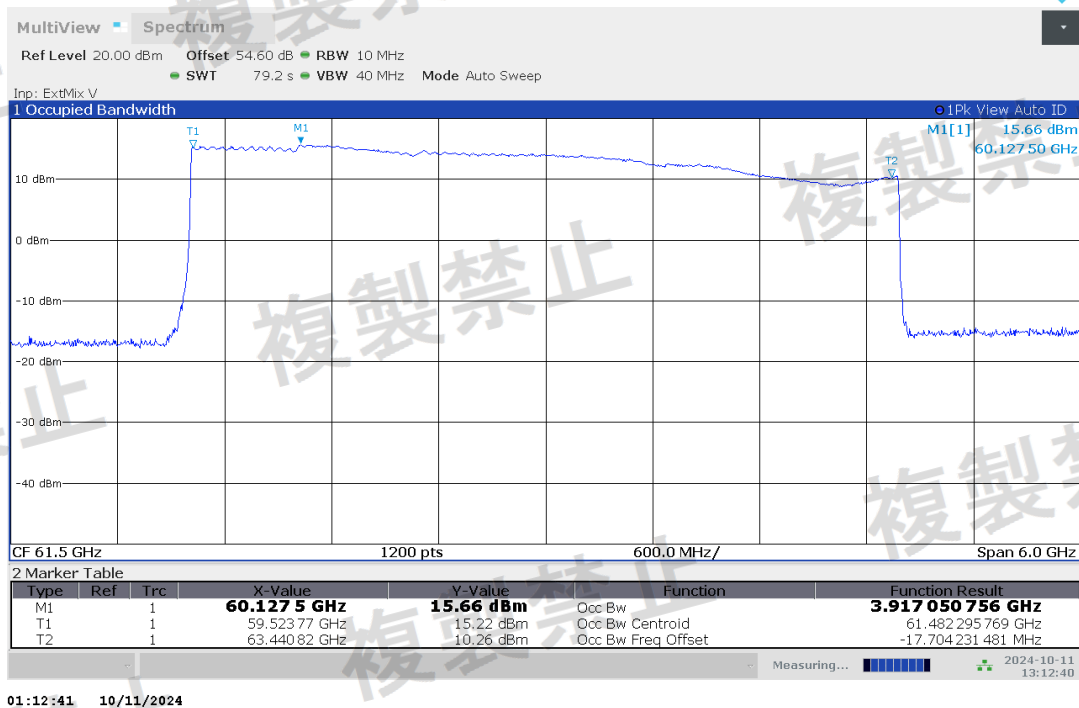
TR No.: 24070316-41144-1

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Plot no. 13: OBW, Peak detector, CB 26, $T_{\text{nom}}/V_{\text{max}}$



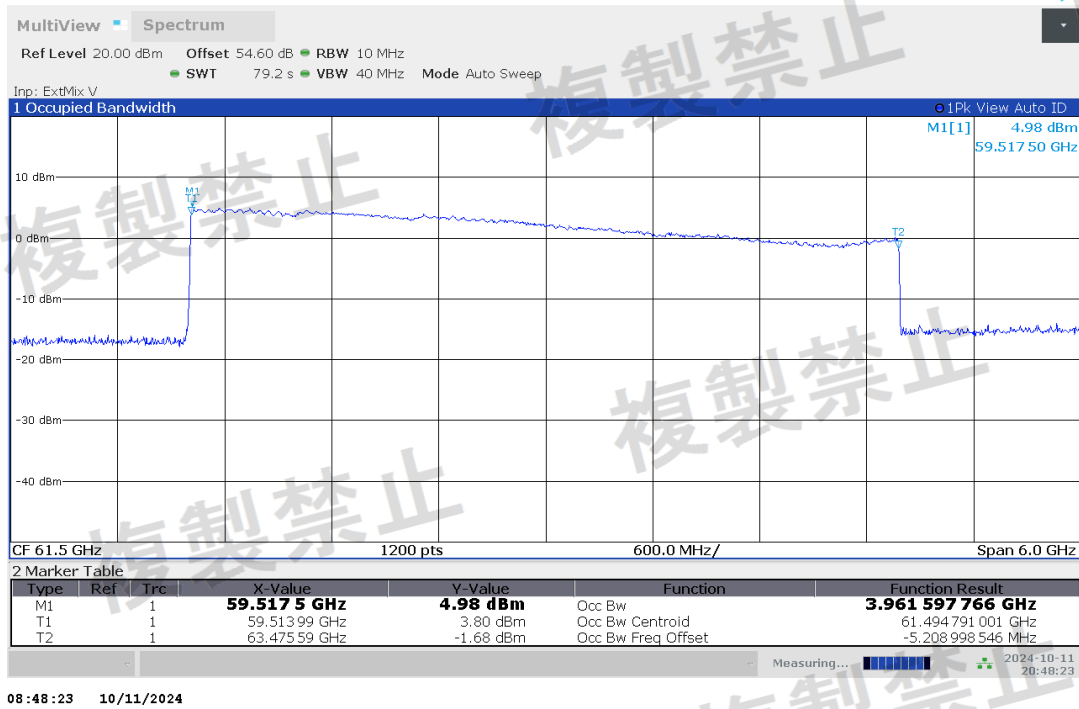
Plot no. 14: OBW, Peak detector, CB 26, T_{min}



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Plot no. 15: OBW, Peak detector, CB 26, $T_{\max}$



7.2 Antenna power (radiated) / Antenna power tolerance

Description

The radiated mean (average) power (e.i.r.p.) of the EUT, at a particular frequency is the product of the mean power supplied to the antenna times the antenna gain in a given direction relative to an isotropic antenna under the specified conditions of measurement. The maximum mean power (e.i.r.p.) is the mean power radiated in the direction of the maximum level (usually the boresight of the antenna) under the specified conditions of measurement. This radiated power is to be measured in the operating frequencies ranges
The value is given in dBm.

Limits

The radar device's mean EIRP shall not exceed 13 dBm within the occupied bandwidth.
The antenna power tolerance is limited to nominal antenna power +50% and -70%.

Test procedure

Method with spectrum analyser

A spectrum analyser with the following settings is used as measuring receiver in the test set-up described in clause 5:

- Start frequency: lower than the lower edge of the operating frequency range.
 - Stop frequency: higher than the upper edge of the operating frequency range.
 - Resolution bandwidth: 1 MHz.
 - Video bandwidth: VBW $\geq$ RBW.
 - Detector mode: RMS.
 - Display mode: clear write.
 - Averaging time: larger than one EUT cycle time.
 - Sweep time: averaging time $\times$ number of sweep points.
- Channel Power function needs to be used to calculate the average power. Boundaries for the calculation needs to be defined. This is typically the operating frequency range.

Method with power meter

The power meter shall be connected to the measurement antenna. The frequency correction factor shall be taken into account. The power meter shall be a true RMS power meter (see clause D.2). The measurement time shall be equal or longer than the EUT cycle time.

Test setup: 8.3

Test results:

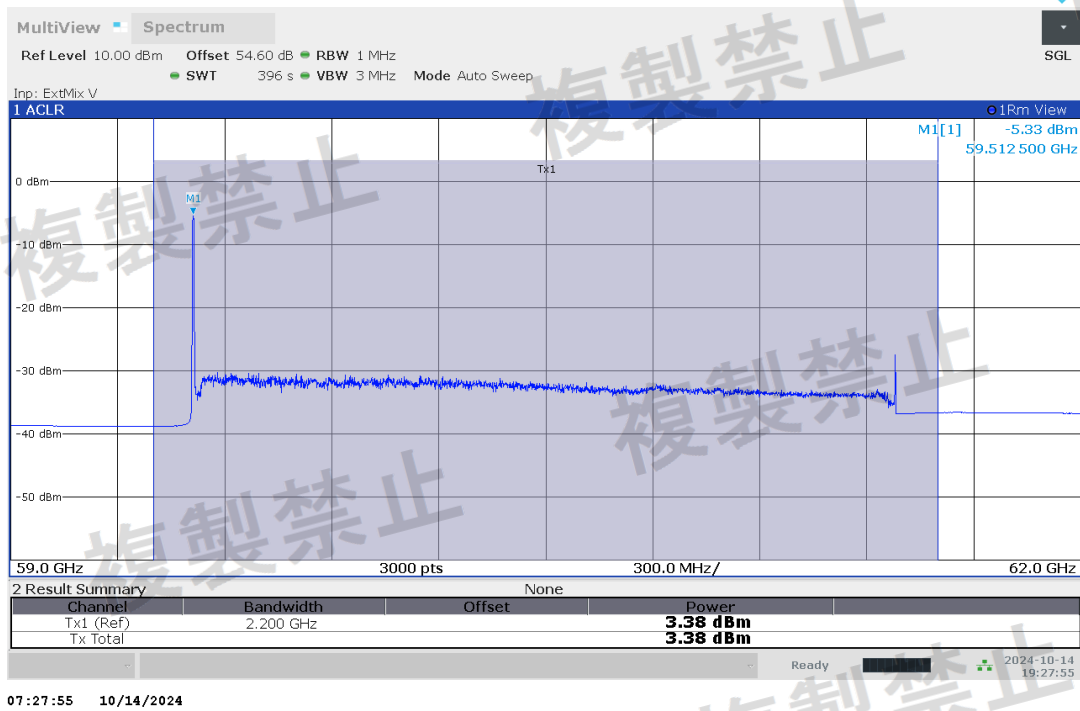
EUT mode	Test distance	Mean power (EIRP) [dBm]
CB 22, master	2 m	3.38
CB 23, master	2 m	1.34
CB 26, master	2 m	1.08

calculated results:

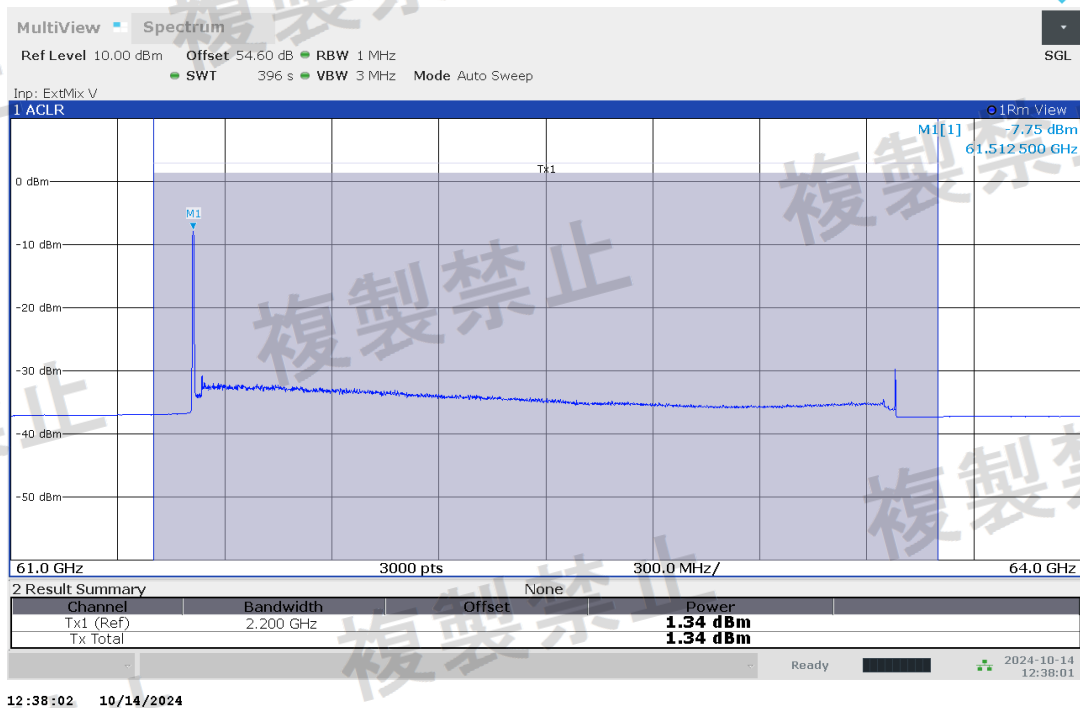
EUT mode	Duty Cycle correction factor	Mean power in burst (EIRP) [dBm]
CB 22, master	10.27	13.65
CB 23, master	10.27	11.61
CB 26, master	10.27	11.35

Note: mean power is meant to be measured gated in burst, therefore a DCCF is applied.

Plot no. 16: Mean Power EIRP, RMS detector / Channel Power, CB 22, master



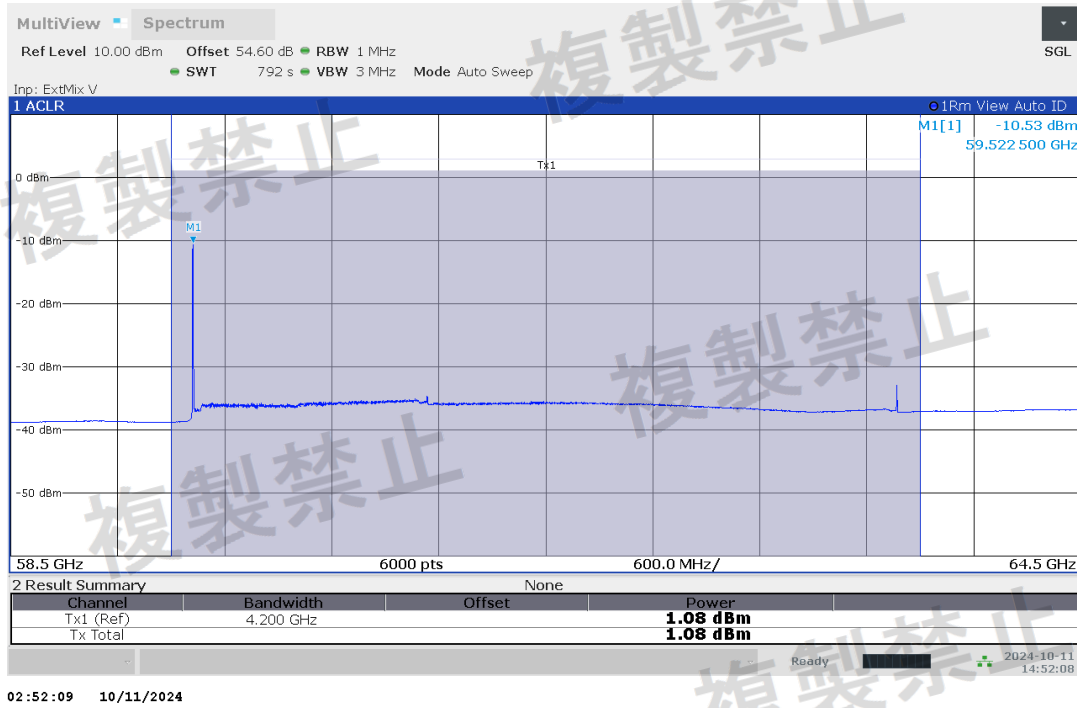
Plot no. 17: Mean Power EIRP, RMS detector / Channel Power, CB 23, master



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Plot no. 18: Mean Power EIRP, RMS detector / Channel Power, CB 26, master



7.3 Transmitter antenna gain (Antenna characteristics)

Description

The transmit antenna gain is limited to value shown below.

Limits

The transmit antenna gain is limited to max. 40 dBi.

Test results:

See chapter 5.2!

7.4 Antenna power (conducted) / Antenna power tolerance

Description

The conducted antenna power is defined as the mean power during the active transmission burst. It is calculated, based on radiated antenna power (mean equivalent isotropically radiated power (EIRP)), EUT's duty cycle and antenna gain as declared by applicant / manufacturer.

Limits

The radar device's conducted mean power shall not exceed 10 mW / 10 dBm within the occupied bandwidth. The antenna power tolerance is limited to nominal antenna power +50% and -70%. The Antenna gain is limited to max. 40 dBi.

Calculation of conducted antenna power

Conducted mean power during active transmission [dBm] = radiated mean power [dBm]
+ duty cycle correction (DCCF) [dB]
- antenna gain [dBi]

Test results:

EUT Mode	Radiated mean EIRP [dBm]	Duty cycle [%]	DCCF [dB]	Antenna gain [dBi] *)	Conducted antenna power [dBm]
CB 22, master	3.38	9.73	10.27	28	-14.62
CB 23, master	1.34	9.73	10.27	28	-16.66
CB 26, master	1.08	9.73	10.27	28	-16.92

Note: Antenna Gain declared by customer

7.5 Transmission time restriction

Description

The duty cycle is determined by dividing the total maximum “ON time” by the period of the pulse train.

Measurement procedure

Duty cycle is measured with an Oscilloscope and peak power diode encompassing the whole band

Limits

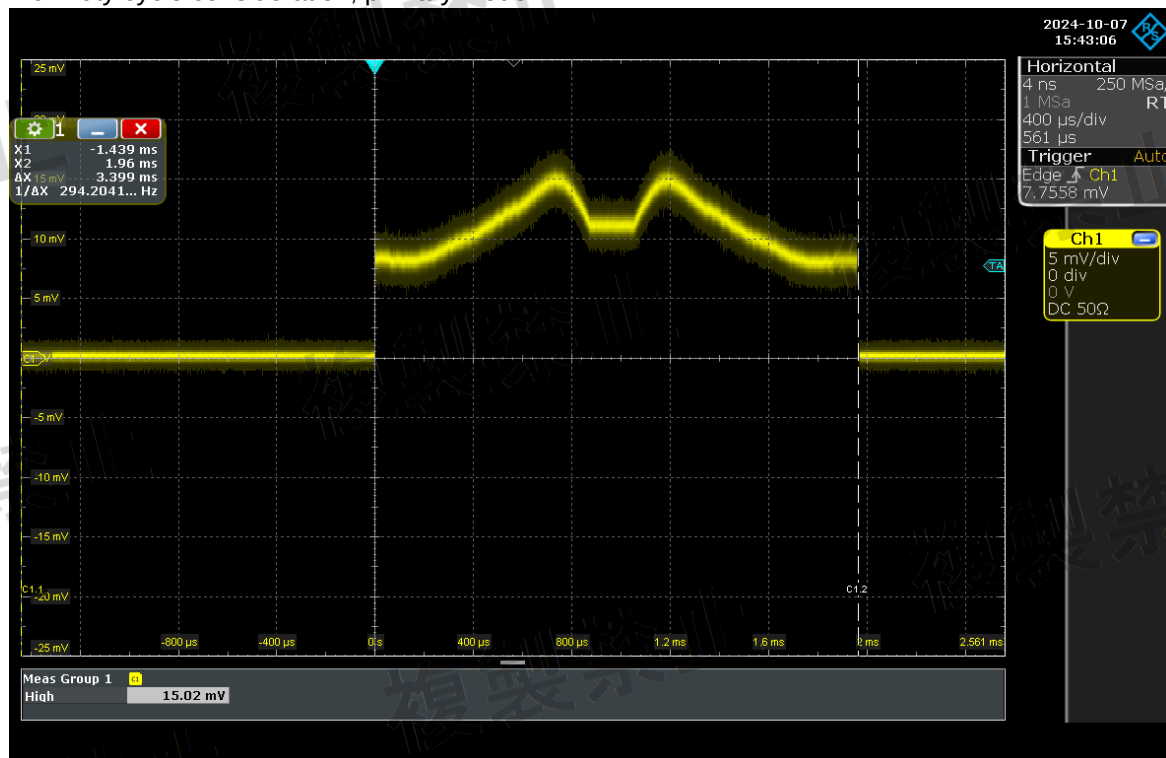
Transmission limit is 3.3 ms or less within 33 ms

Calculation of conducted antenna power

Conducted mean power during active transmission [dBm] = radiated mean power [dBm]
+ duty cycle correction (DCCF) [dB]
- antenna gain [dBi]

EUT Mode	SUM Tx _{on} [ms]	SUM Tx _{off} [ms]	Observed time window / Period [ms]	Duty cycle [%]
Primary mode	3.20	10	33	9.70
slave	1.96	10	33	5.94
master	3.21	10	33	9.73

Plot no. 19: Duty cycle consideration, primary mode

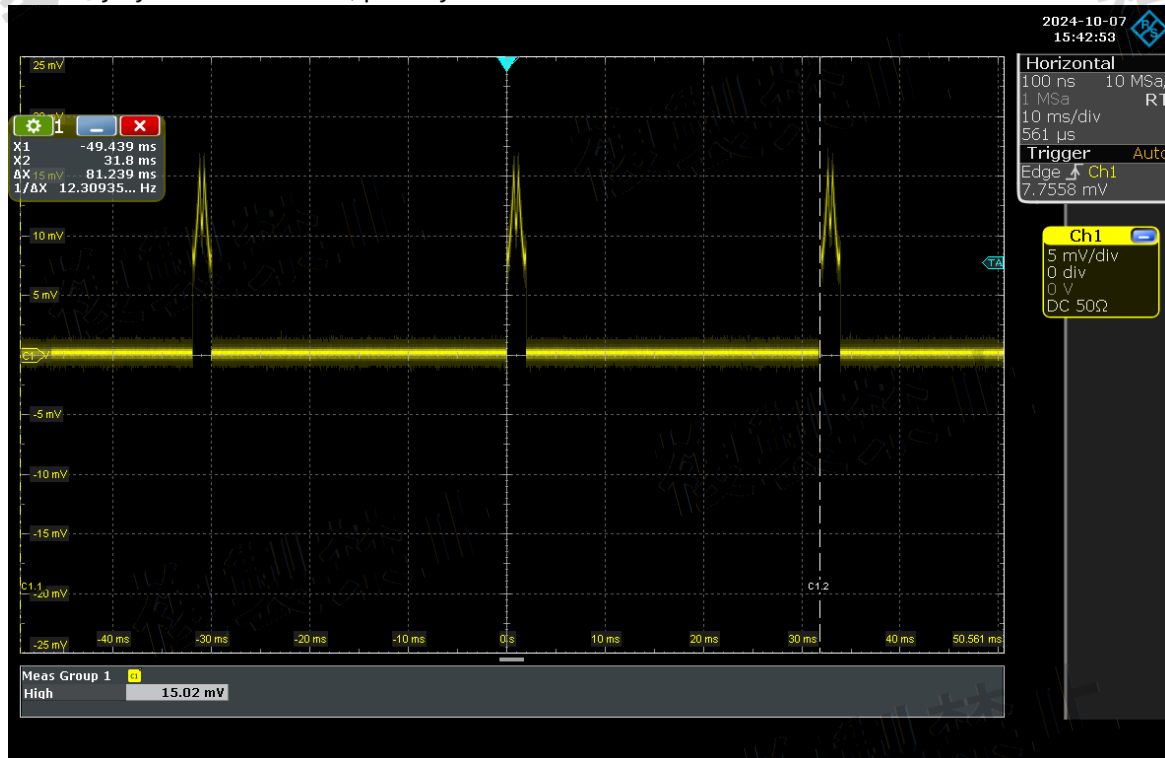


複製禁止

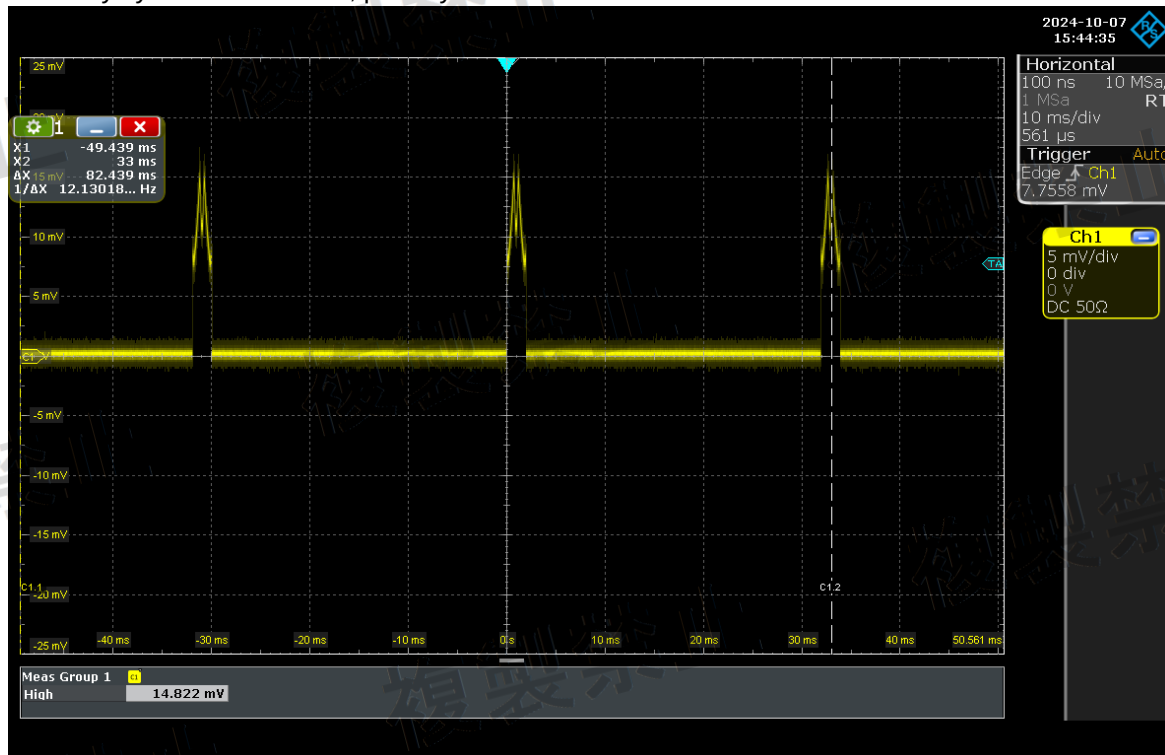
TR No.: 24070316-41144-1

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Plot no. 20: Duty cycle consideration, primary mode



Plot no. 21: Duty cycle consideration, primary mode

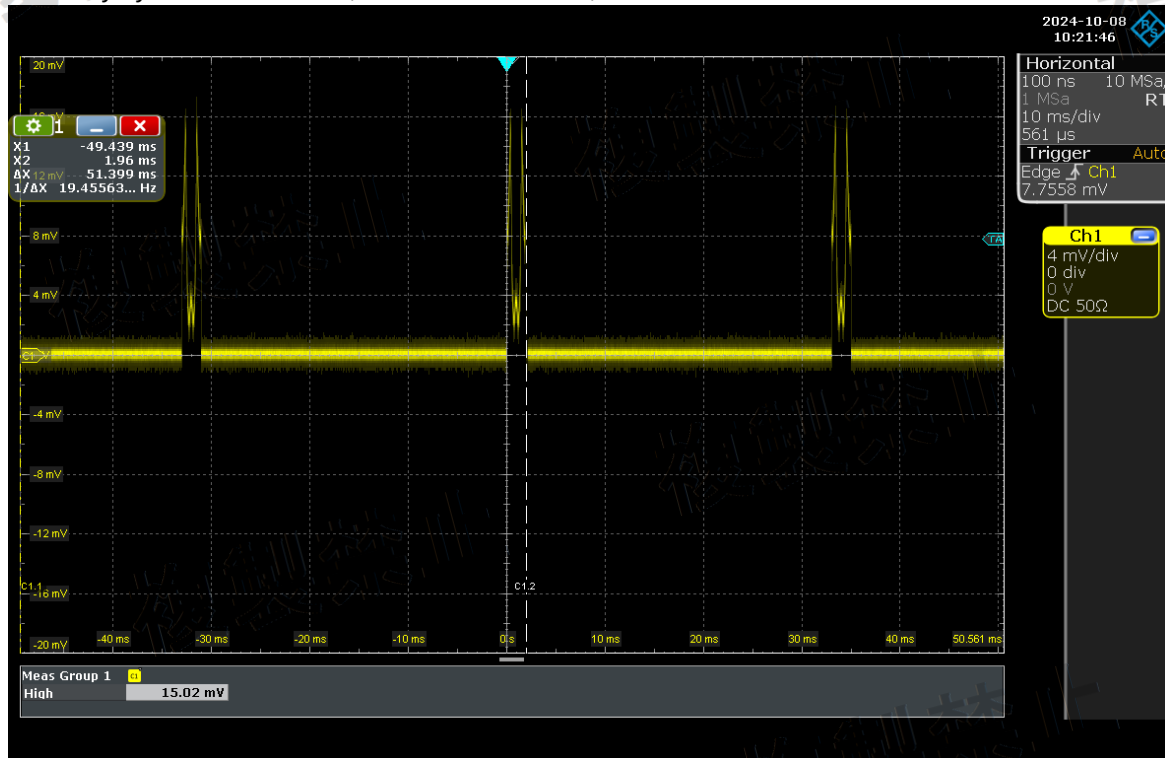


複製禁止

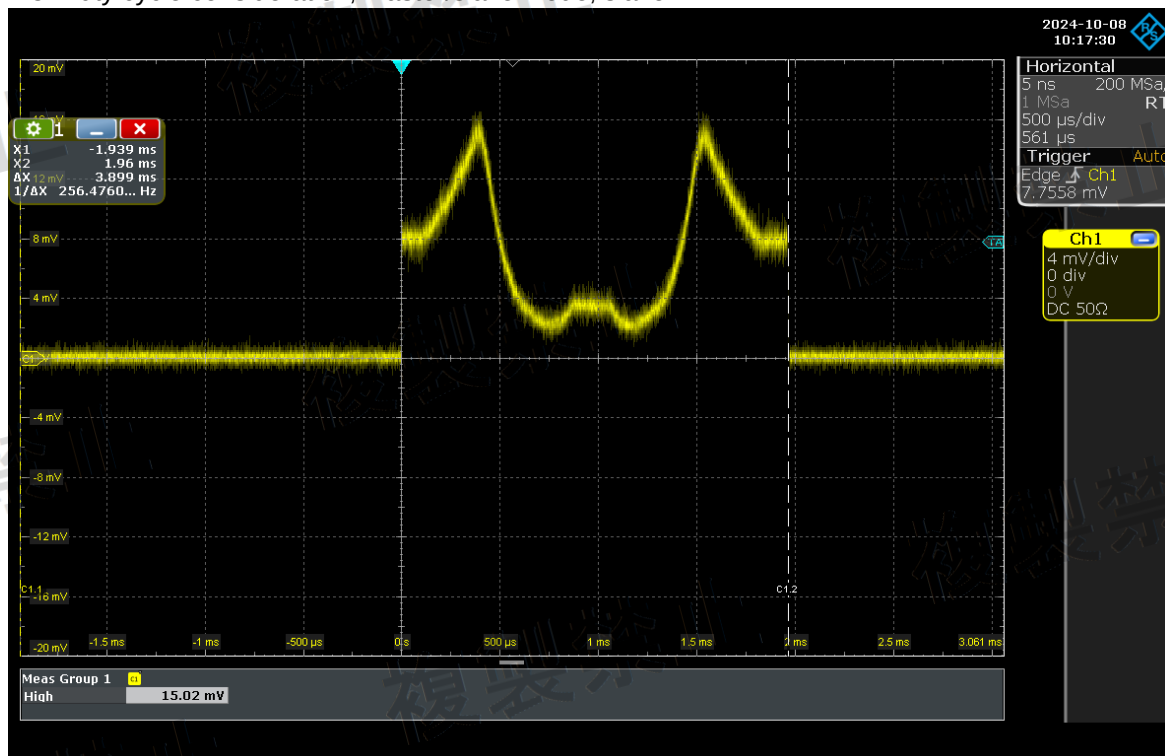
TR No.: 24070316-41144-1

2024-11-29

Plot no. 22: Duty cycle consideration, master/slave mode, slave



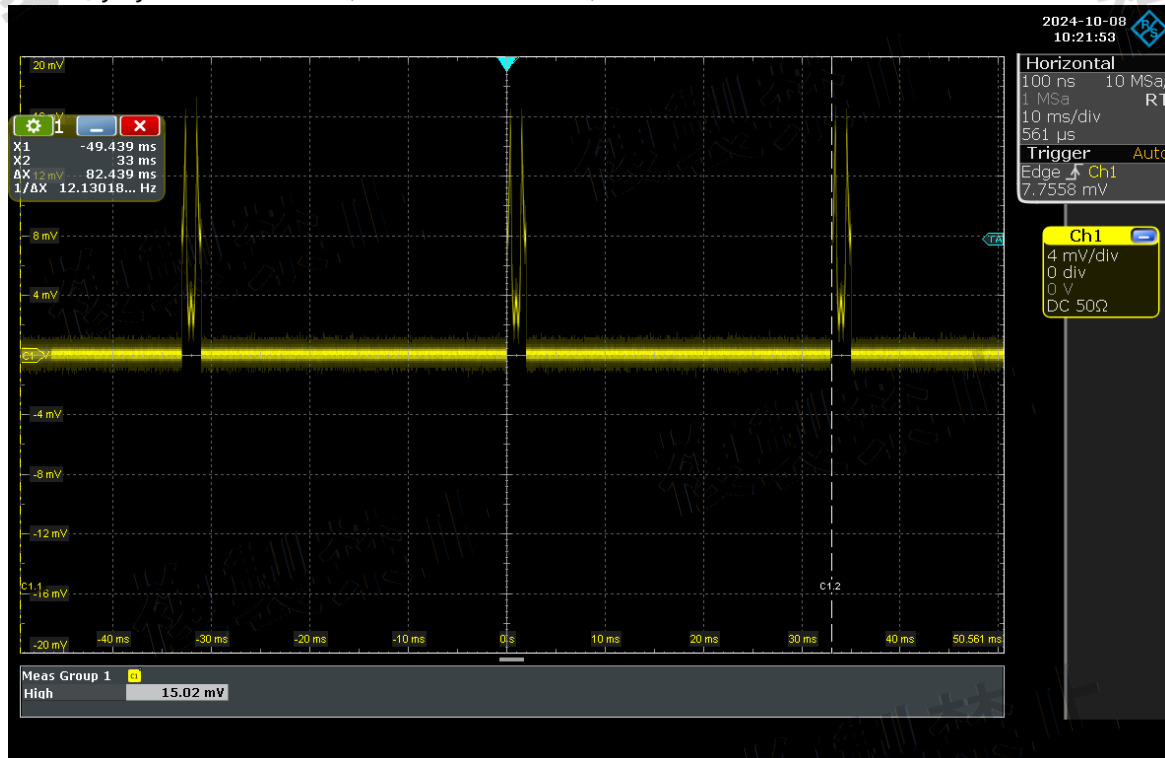
Plot no. 23: Duty cycle consideration, master/slave mode, slave



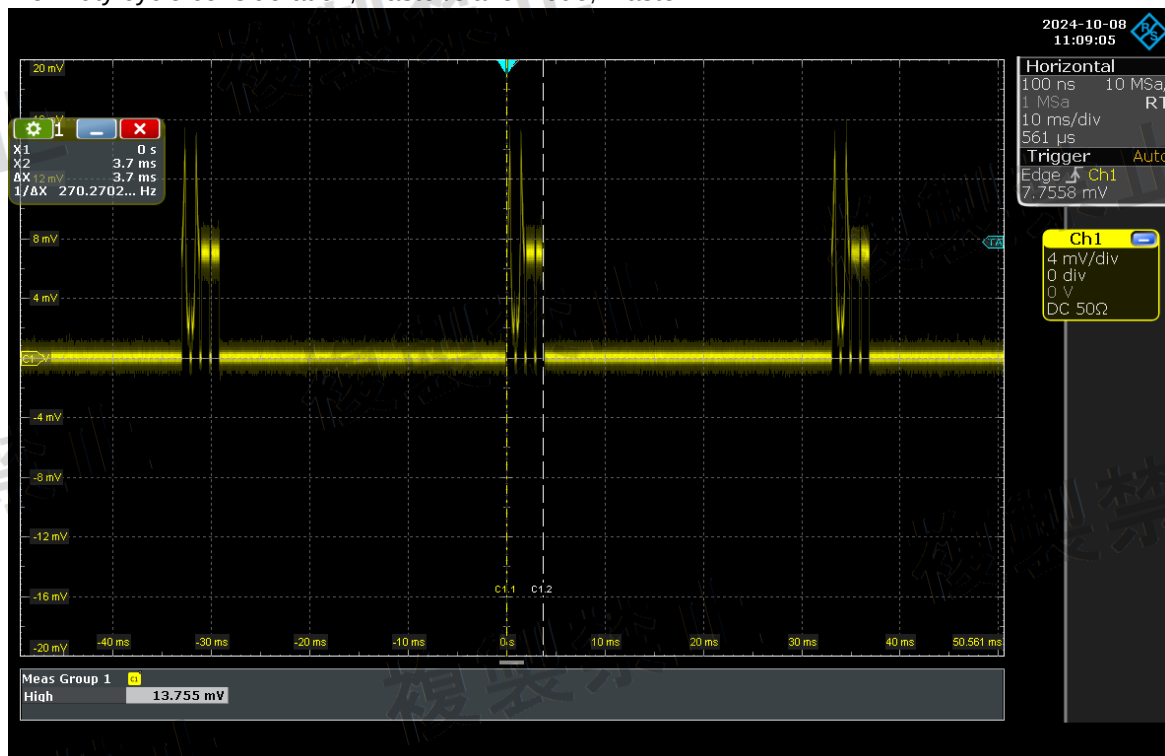
TR No.: 24070316-41144-1

2024-11-29

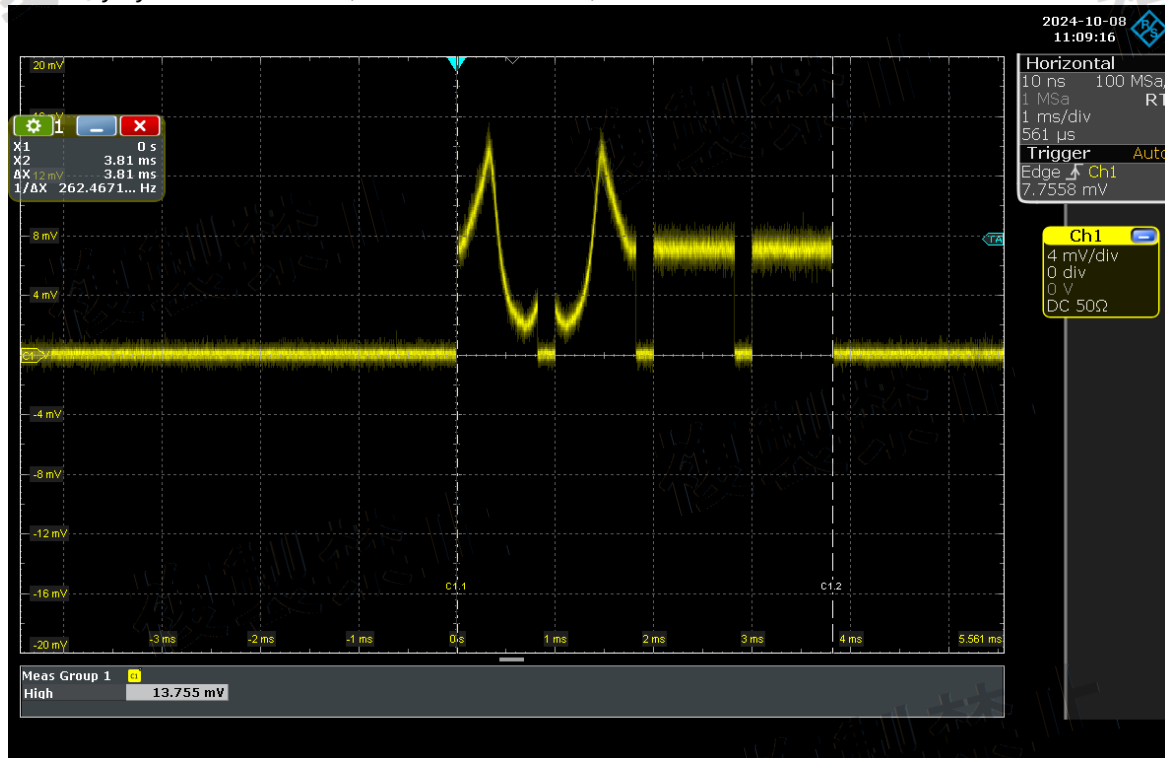
Plot no. 24: Duty cycle consideration, master/slave mode, slave



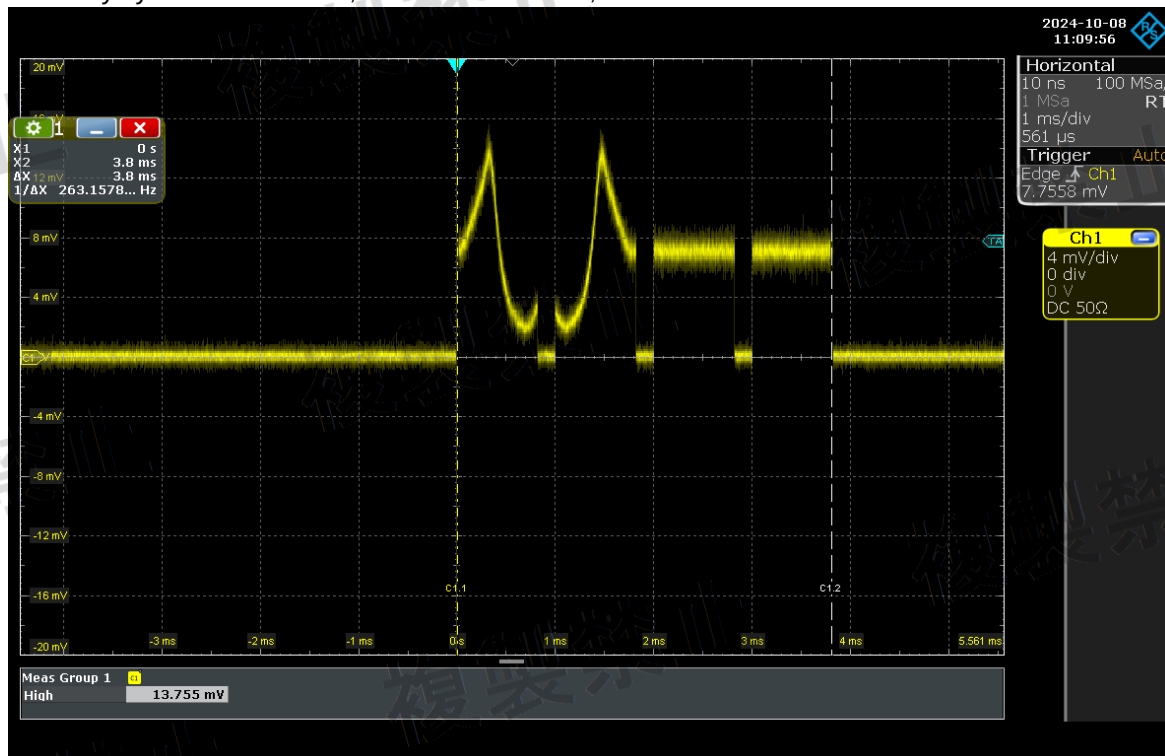
Plot no. 25: Duty cycle consideration, master/slave mode, master



Plot no. 26: Duty cycle consideration, master/slave mode, master



Plot no. 27: Duty cycle consideration, master/slave mode, master

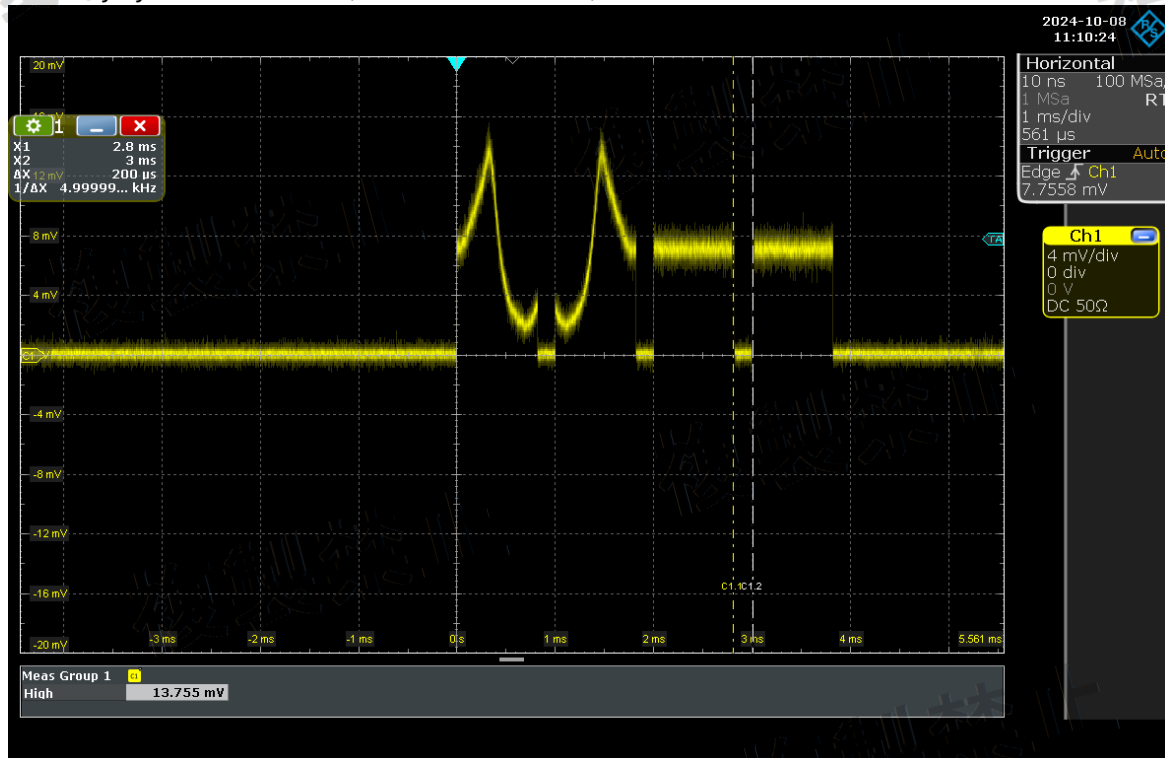


複製禁止

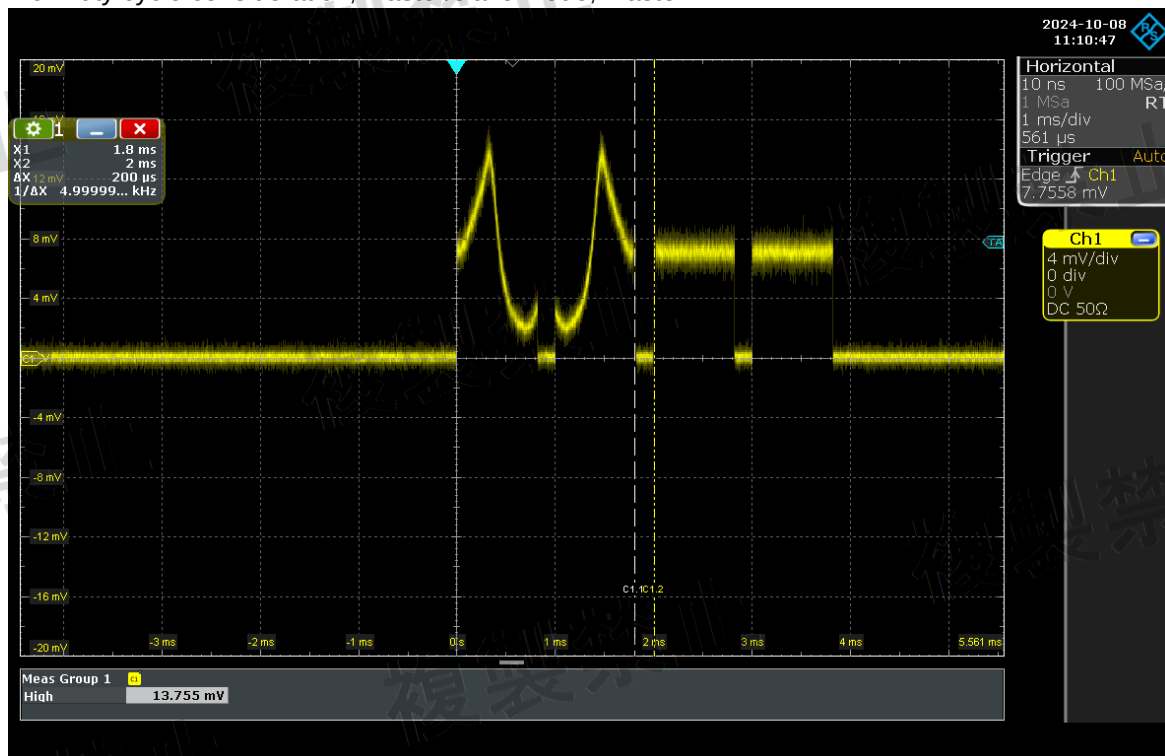
TR No.: 24070316-41144-1

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Plot no. 28: Duty cycle consideration, master/slave mode, master

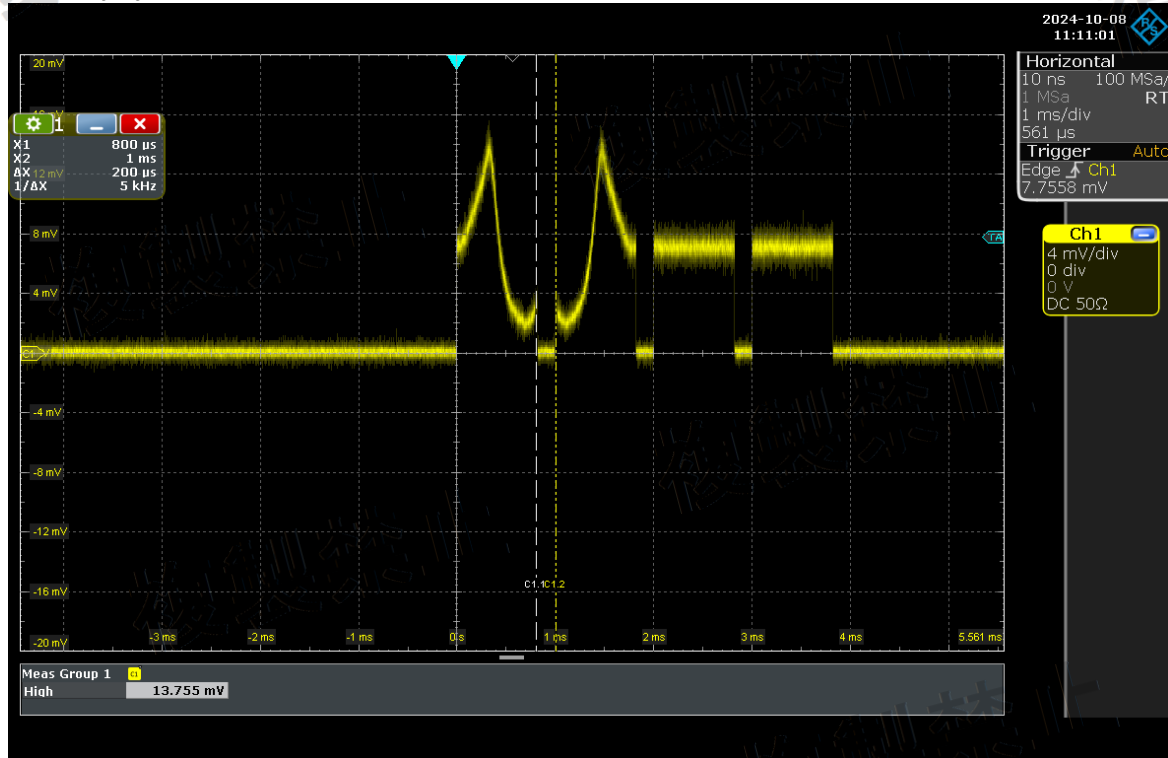


Plot no. 29: Duty cycle consideration, master/slave mode, master



複製禁止

Plot no. 30: Duty cycle consideration, master/slave mode, master



7.6 Spurious emissions and Unwanted emissions

Description

OOB emissions are emissions on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

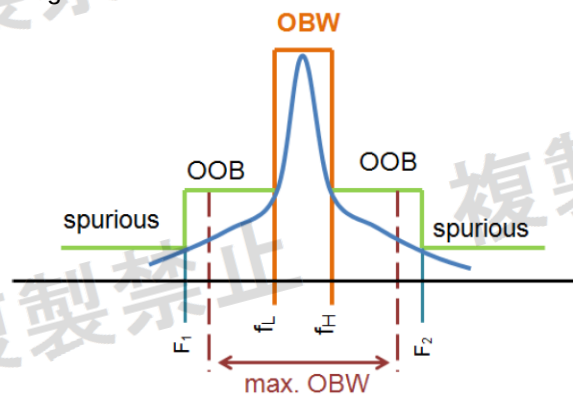
The measurement results of f_H and f_L of the occupied bandwidth measurement will be used to determine the operating BW of the device.

The operating bandwidth ($f_H - f_L$) will be used to calculate the ranges of OOB and spurious domain.

Spurious emission is an emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

According to CEPT/ERC/Recommendation 74-01, and Recommendation ITU-R SM.329-12, the boundary between the out-of-band and spurious domains is $\pm 250\%$ of the operating bandwidth (OBW) from the centre frequency of the emission. Out-of-band and spurious emissions are measured as spectral power density under normal operating conditions.

Overview OOB/spurious, depending on OBW:



The borders are calculated as follows:

$$\begin{aligned}
 f_L &= 57.0 \text{ GHz} \\
 f_H &= 64.0 \text{ GHz} \\
 F_1 &= 55.62 \text{ GHz} \\
 F_2 &= 67.5 \text{ GHz}
 \end{aligned}$$

This calculation taken into account that the border between OOB and spurious may be larger or smaller than the maximum permitted range of operation.

NOTE: The out-of-band domain may be larger or smaller than the maximum permitted range of operation.

Limits

The effective radiated power of any radiated spurious emission shall be not greater than the values given in table below:

Frequency range	Limit
Unwanted emissions < 55.62 GHz / > 67.5 GHz	-30 dBm
Unwanted emissions within 55.62 and 67.5 GHz	-26 dBm

Calculation of the far field distance (Rayleigh distance):

The aperture dimensions of these horn antennas shall be small enough so that the measurement distance in meters is equal to or greater than the Rayleigh distance (i.e. $R_m = 2D^2 / \lambda$), where D is the largest linear dimension (i.e. width or height) of the antenna aperture in m and λ is the free-space wavelength in meters at the frequency of measurement.

Antenna type	Frequency range [GHz]	D [m]	Highest frequency in use [GHz]	Far field distance R_m [m]
20240-20	18.0 – 26.5	0.0520	26.5	0.478
22240-20	26.5 – 40.0	0.0342	40	0.312
23240-20	33.0 – 50.0	0.0280	50	0.261
24240-20	40.0 – 60.0	0.0230	60	0.212
25240-20	50.0 – 75.0	0.0185	75	0.171
26240-20	60.0 – 90.0	0.0150	90	0.135
27240-20	75.0 – 110	0.0124	110	0.113
28240-20	90.0 – 140	0.0100	140	0.093
29240-20	110 – 170	0.0085	170	0.082
30240-20	140 – 220	0.0068	220	0.068
32240-20	220 – 325	0.00446	243	0.032

Typical test distances

Up to 18 GHz: 3.00 m
18 – 50 GHz: 1.00 m
50 – 75 GHz: 2.00 m
075 – 110 GHz: 0.50 m
110 – 170 GHz: 0.25 m
In-band / OOB: 2.00 m

Test setup: 8.1 – 8.3**Test results:**

Channel / EUT Mode	Frequency [GHz]	Detector	Test distance [m]	Level [dBm]	Limit [dBm]	Margin [dB]
no critical peaks found – refer to plots						

Plot no. 31: radiated emissions 30 MHz – 1 GHz, CB 22, polarization vertical / horizontal

Spectrum Overview



EMI Final Results

Rg	Frequency [MHz]	QPK Level [dBm]	Correction [dB]	Polarization	Elevation [deg]	Azimuth [deg]	Meas. BW [kHz]	Time of Meas.
1	138,378	-68,75	22,22	H	30	86	120,000	15:13:08
1	326,630	-64,53	24,75	H	95,2	117,4	120,000	15:14:34

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Plot no. 32: radiated emissions 30 MHz – 1 GHz, CB 23, polarization vertical / horizontal

Spectrum Overview

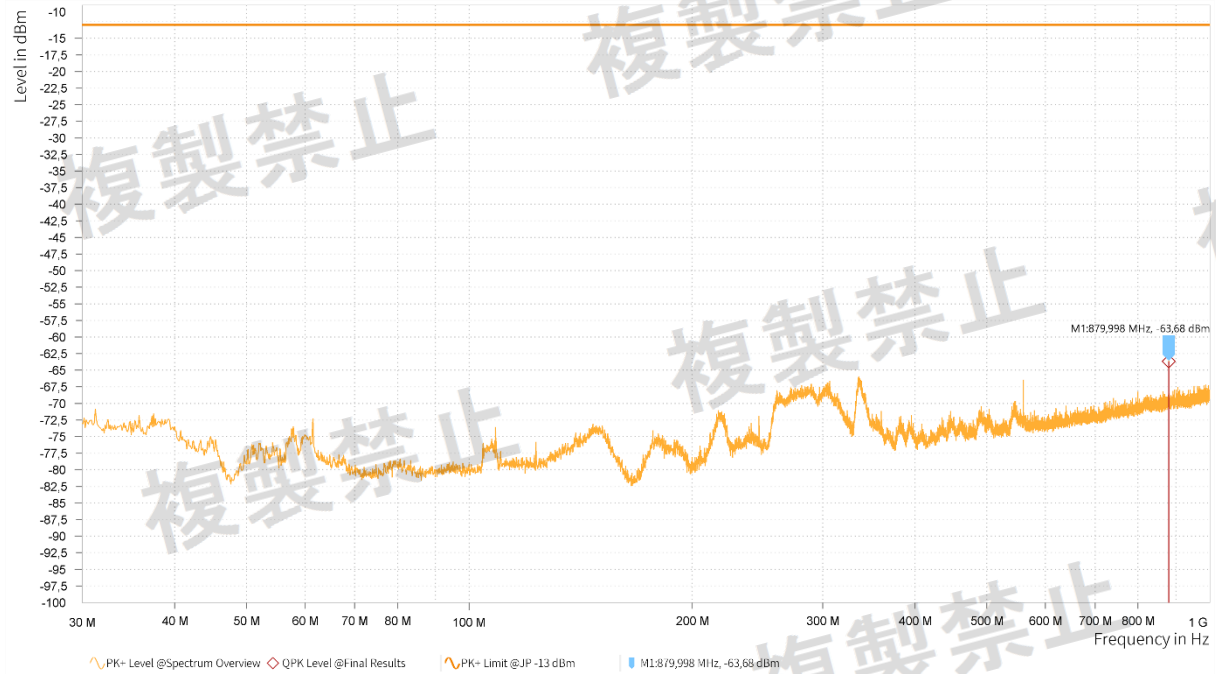


EMI Final Results

Rg	Frequency [MHz]	QPK Level [dBm]	Correction [dB]	Polarization	Elevation [deg]	Azimuth [deg]	Meas. BW [kHz]	Time of Meas.
1	243,257	-69,51	22,64	H	34,4	71,6	120,000	15:21:55
1	493,335	-65,86	28,35	V	105	215,6	120,000	15:23:48

Plot no. 33: radiated emissions 30 MHz – 1 GHz, CB 26, polarization vertical / horizontal

Spectrum Overview

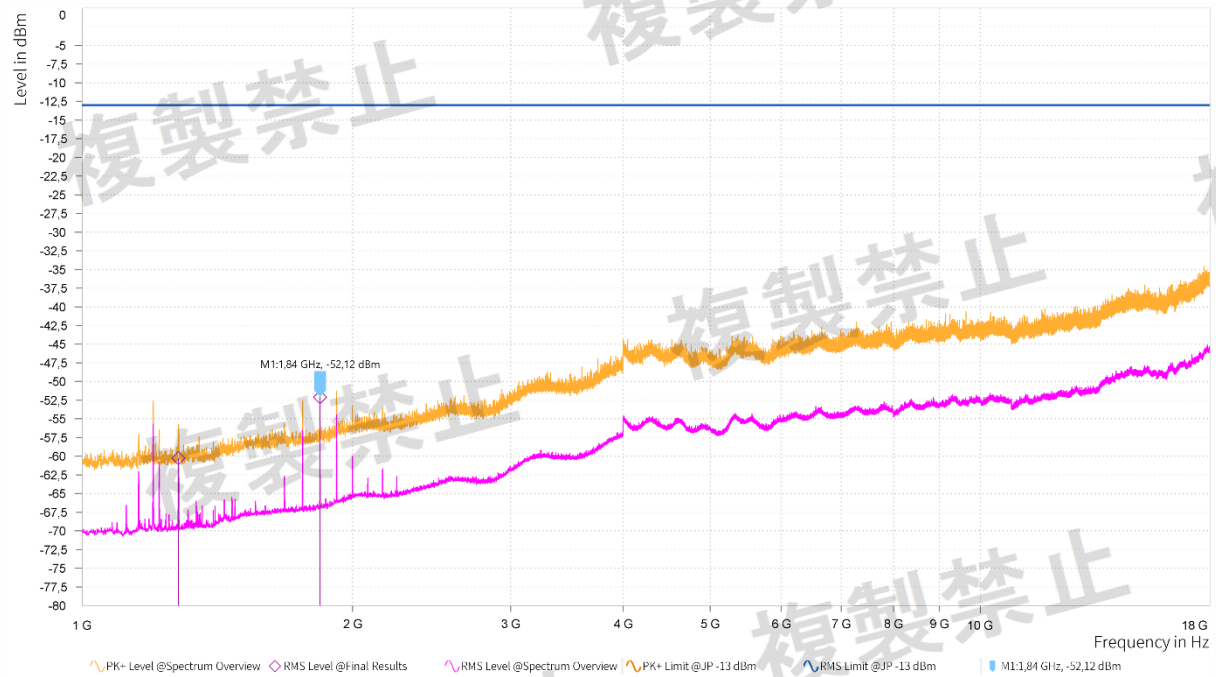


EMI Final Results

Rg	Frequency [MHz]	QPK Level [dBm]	Correction [dB]	Elevation [deg]	Azimuth [deg]	Antenna Height [m]	Time of Meas.
1	879,998	-63,68	32,86	30	52	1,50	15:50:22

Plot no. 34: radiated emissions 1 GHz – 18 GHz, CB 22, polarization vertical / horizontal

Spectrum Overview

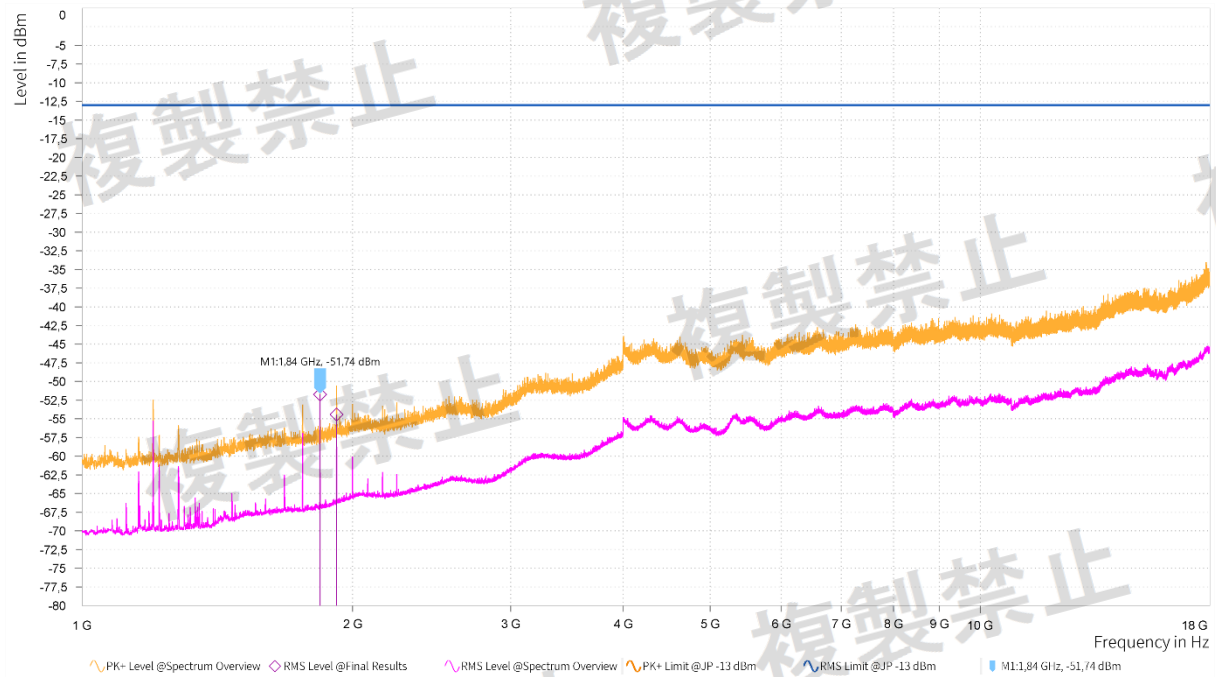


EMI Final Results

Rg	Frequency [MHz]	RMS Level [dBm]	RMS Limit [dBm]	RMS Margin [dB]	Correction [dB]	Elevation [deg]	Azimuth [deg]	Antenna Height [m]	Time of Meas.
1	1.280,000	-60,25	-13,00	47,25	36,77	100	188,9	1,34	17:02:38
1	1.840,100	-52,12	-13,00	39,12	39,08	80	217,6	1,34	17:01:28

Plot no. 35: radiated emissions 1 GHz – 18 GHz, CB 23, polarization vertical / horizontal

Spectrum Overview

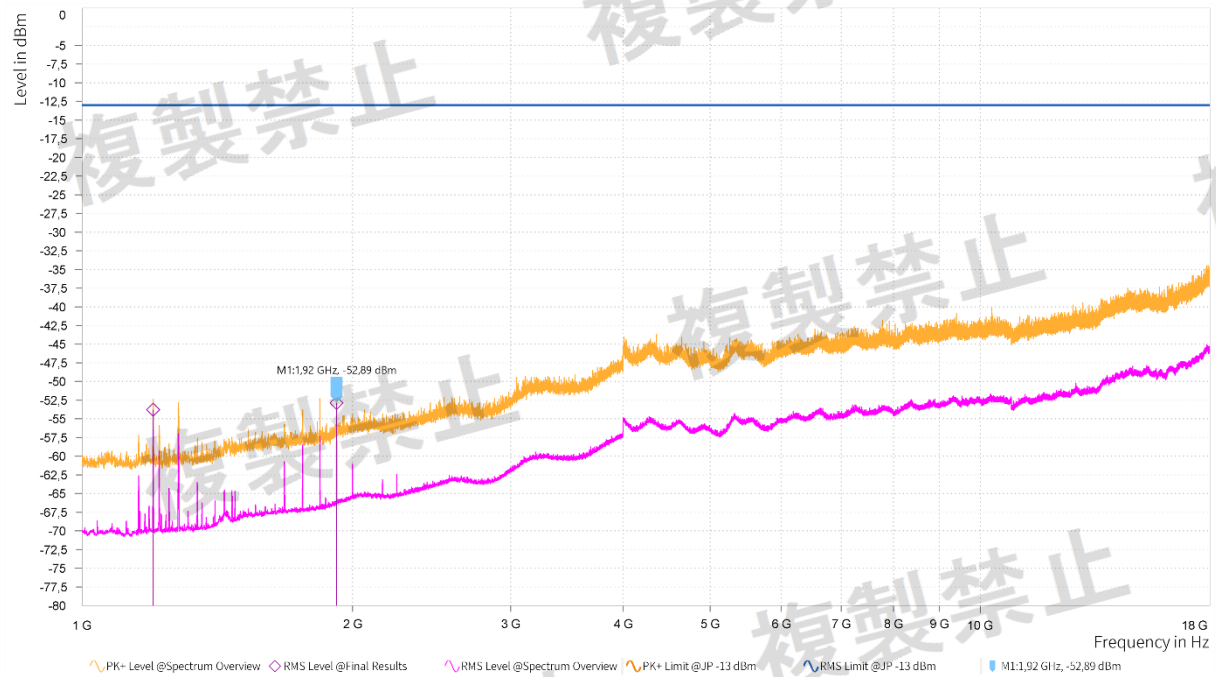


EMI Final Results

Rg	Frequency [MHz]	RMS Level [dBm]	RMS Limit [dBm]	RMS Margin [dB]	Correction [dB]	Elevation [deg]	Azimuth [deg]	Antenna Height [m]	Time of Meas.
1	1.839,900	-51,74	-13,00	38,74	39,08	80	222,7	1,34	16:50:05
1	1.920,000	-54,41	-13,00	41,41	39,77	55	242,3	1,34	16:49:03

Plot no. 36: radiated emissions 1 GHz – 18 GHz, CB 26, polarization vertical / horizontal

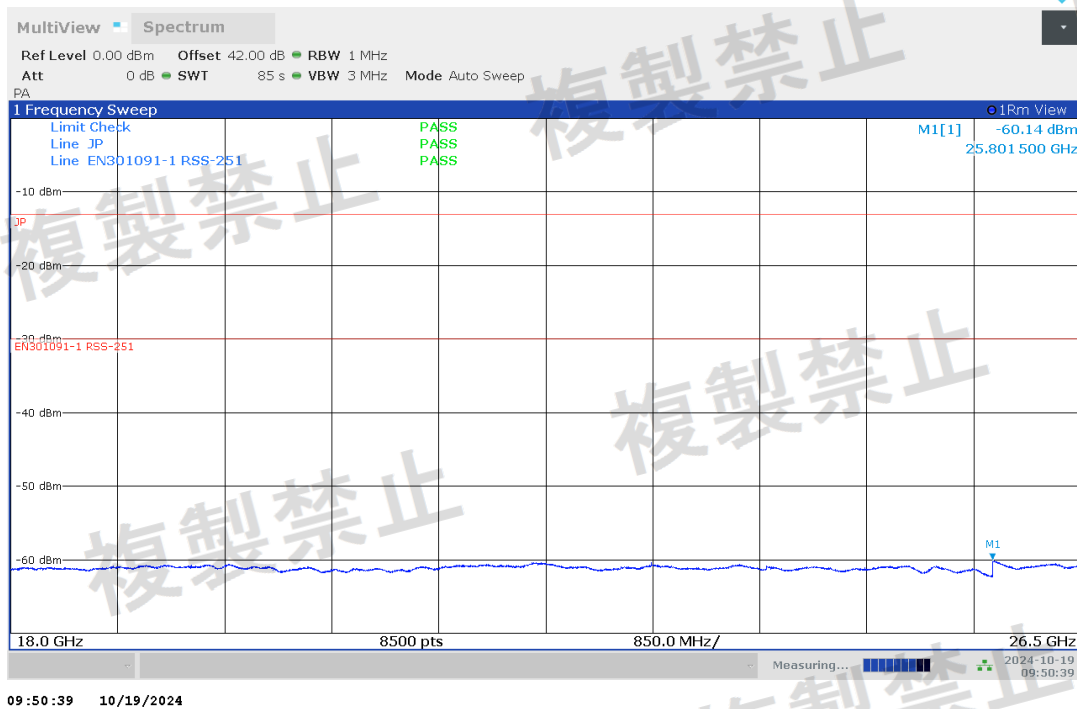
Spectrum Overview



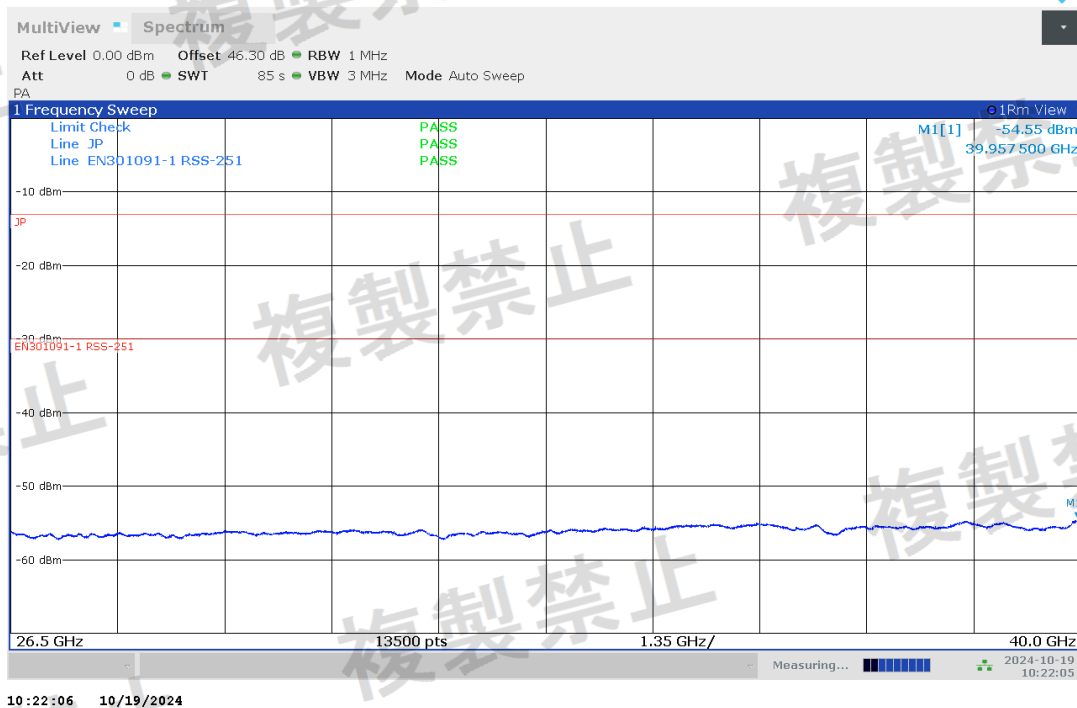
EMI Final Results

Rg	Frequency [MHz]	RMS Level [dBm]	RMS Limit [dBm]	RMS Margin [dB]	Correction [dB]	Elevation [deg]	Azimuth [deg]	Time of Meas.
1	1.200,000	-53,77	-13,00	40,77	36,65	92,6	137,4	16:13:08
1	1.920,000	-52,89	-13,00	39,89	39,77	7,9	233,9	16:11:49

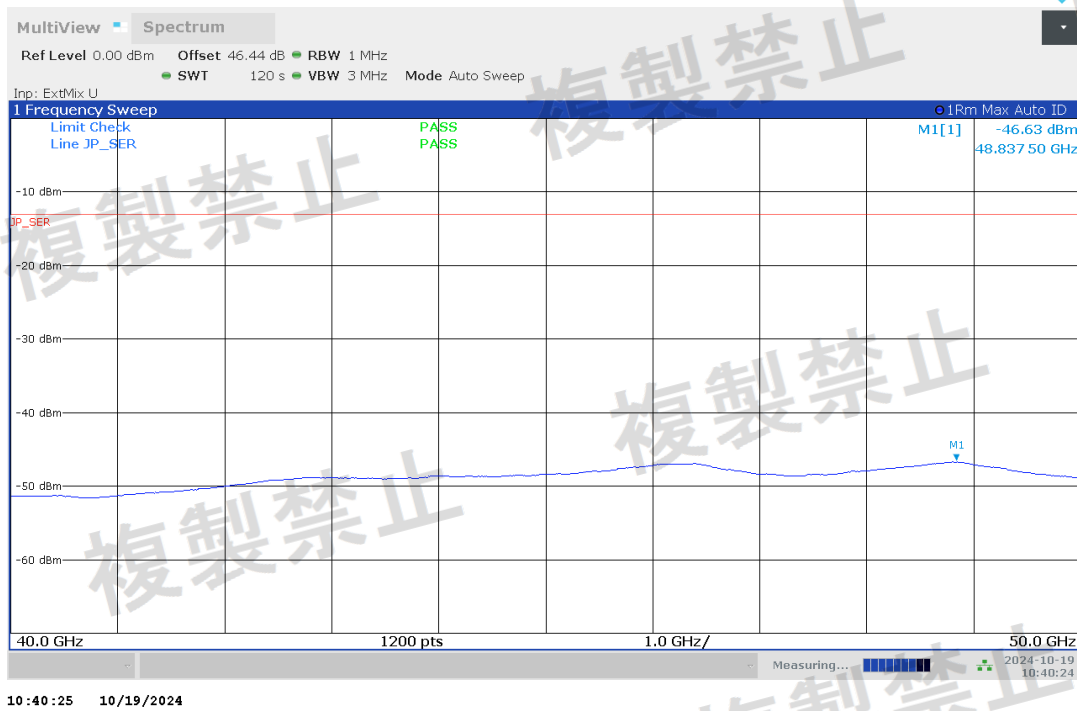
Plot no. 37: radiated emissions 18 GHz – 26.5 GHz, CB 22, polarization vertical / horizontal



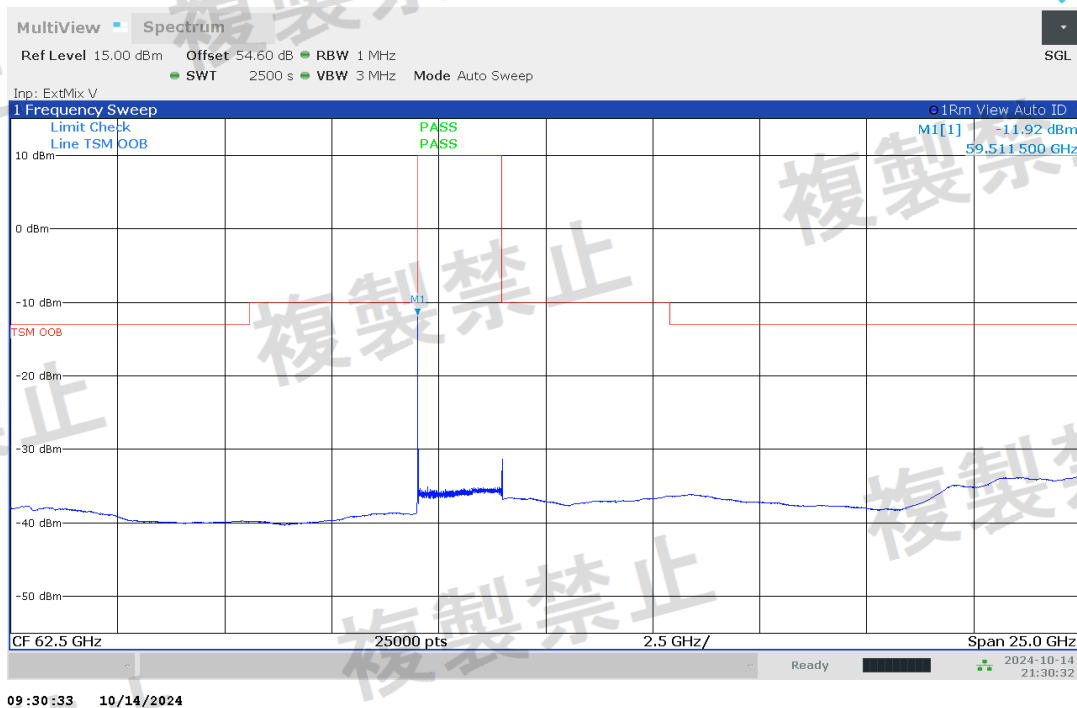
Plot no. 38: radiated emissions 26.5 GHz – 40 GHz, CB 22, polarization vertical / horizontal



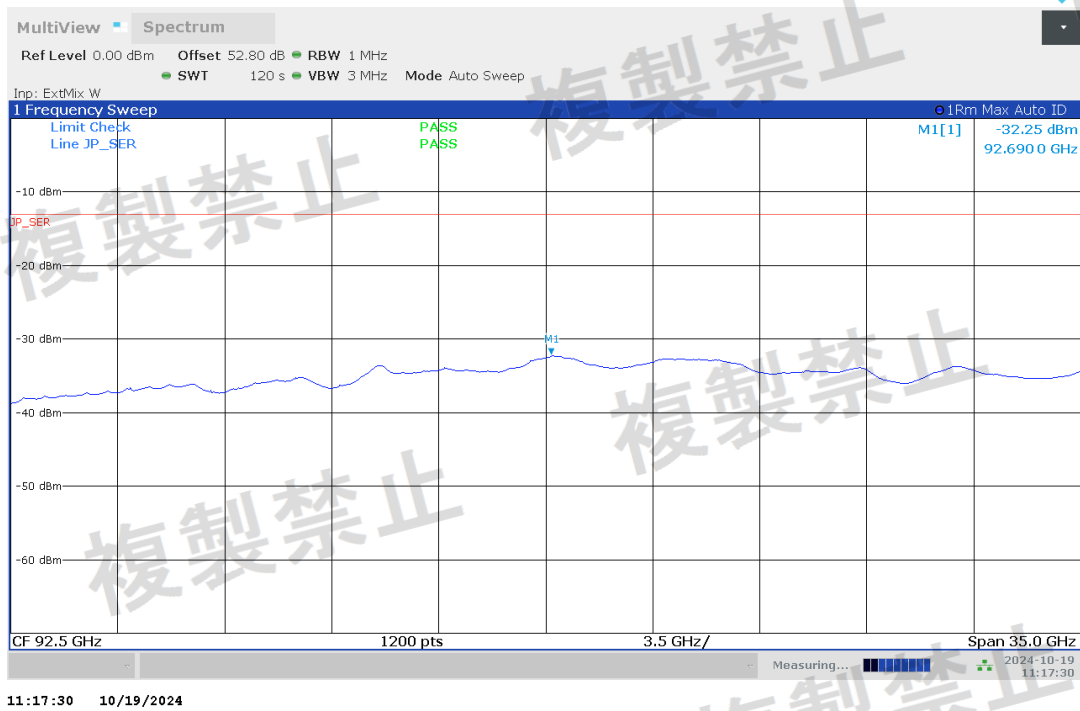
Plot no. 39: radiated emissions 40 GHz – 50 GHz, CB 22, polarization vertical / horizontal



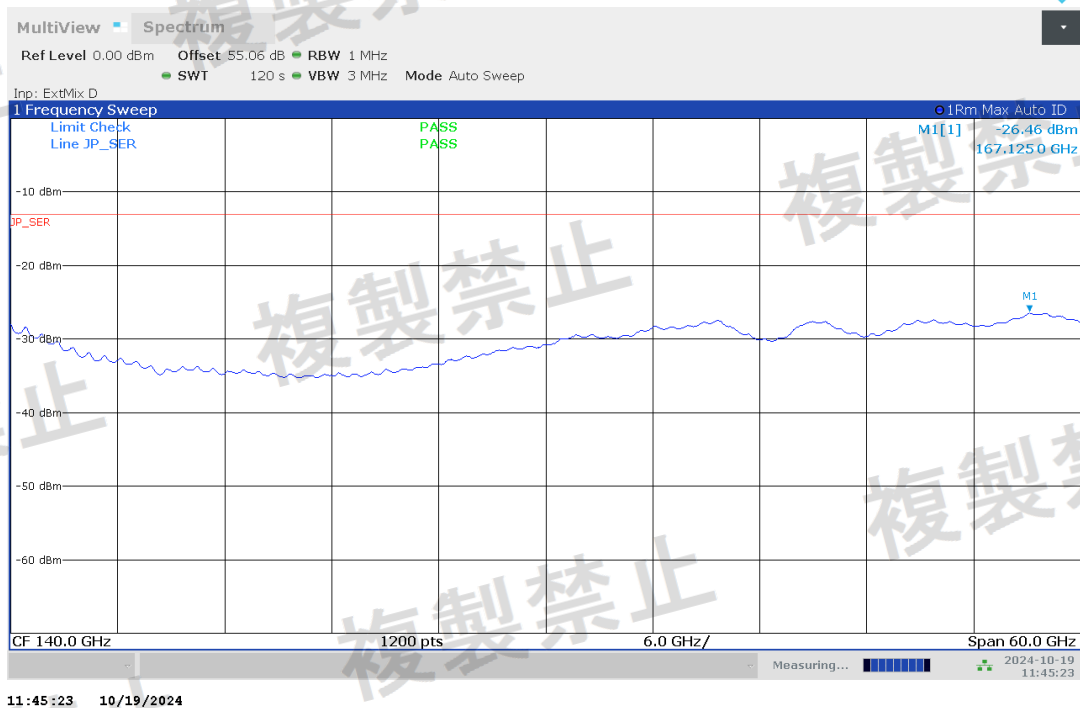
Plot no. 40: radiated emissions, OOB Mask, CB 22, polarization aligned with radar sensor



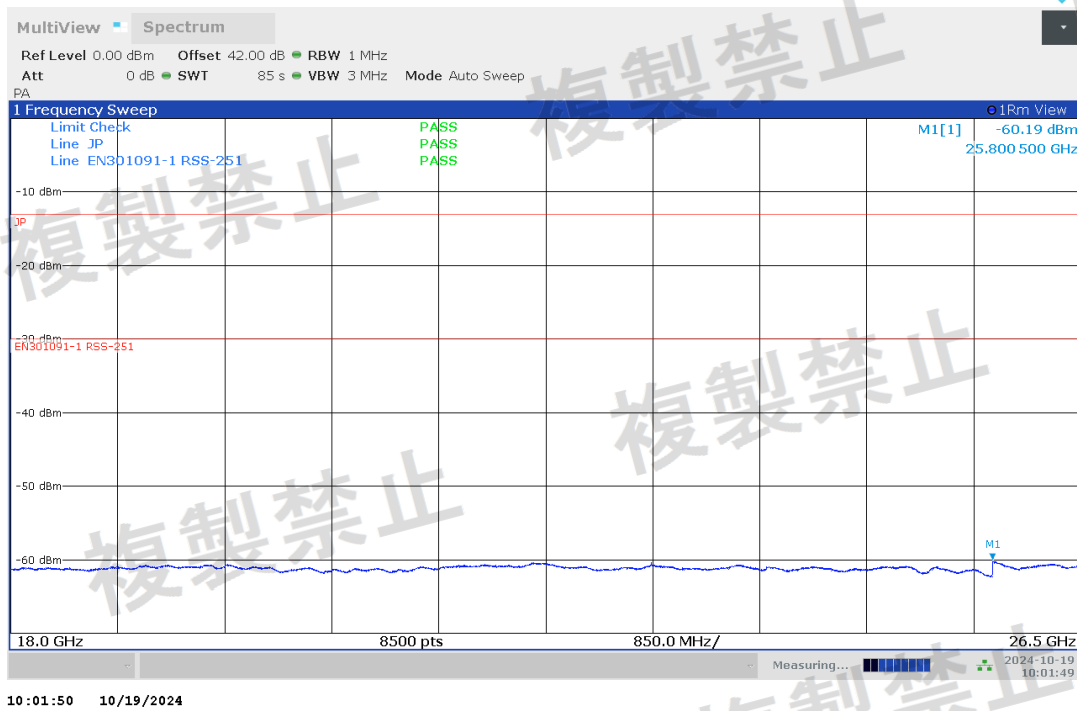
Plot no. 41: radiated emissions 75 GHz – 110 GHz, CB 22, polarization vertical / horizontal



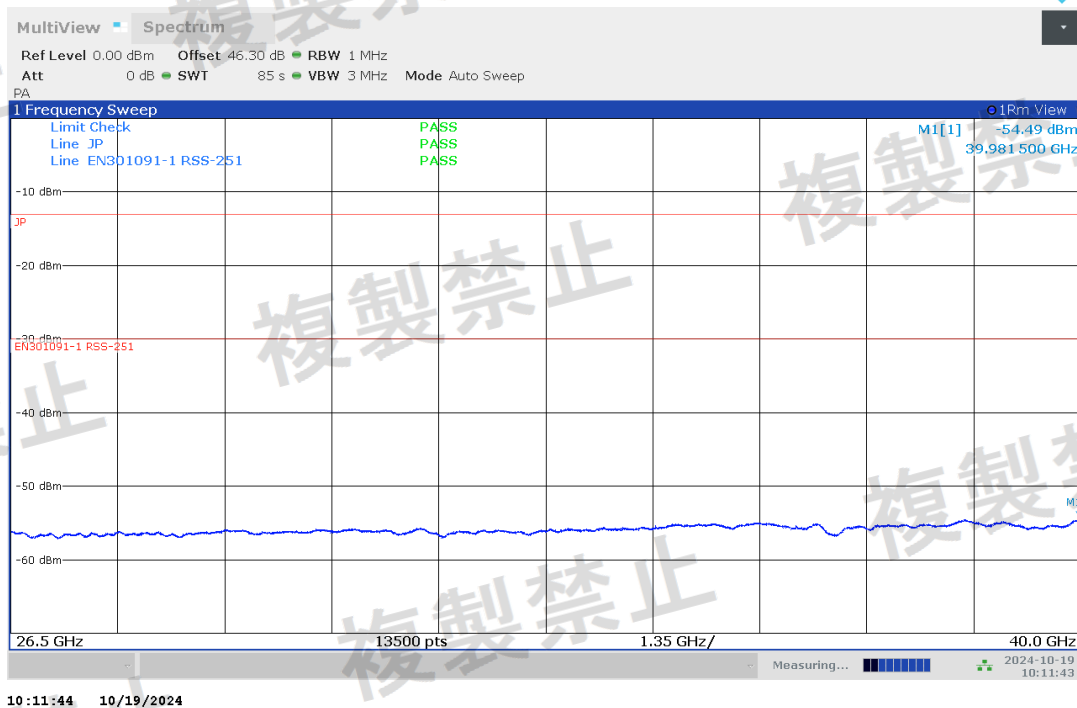
Plot no. 42: radiated emissions 110 GHz – 170 GHz, CB 22, polarization vertical / horizontal



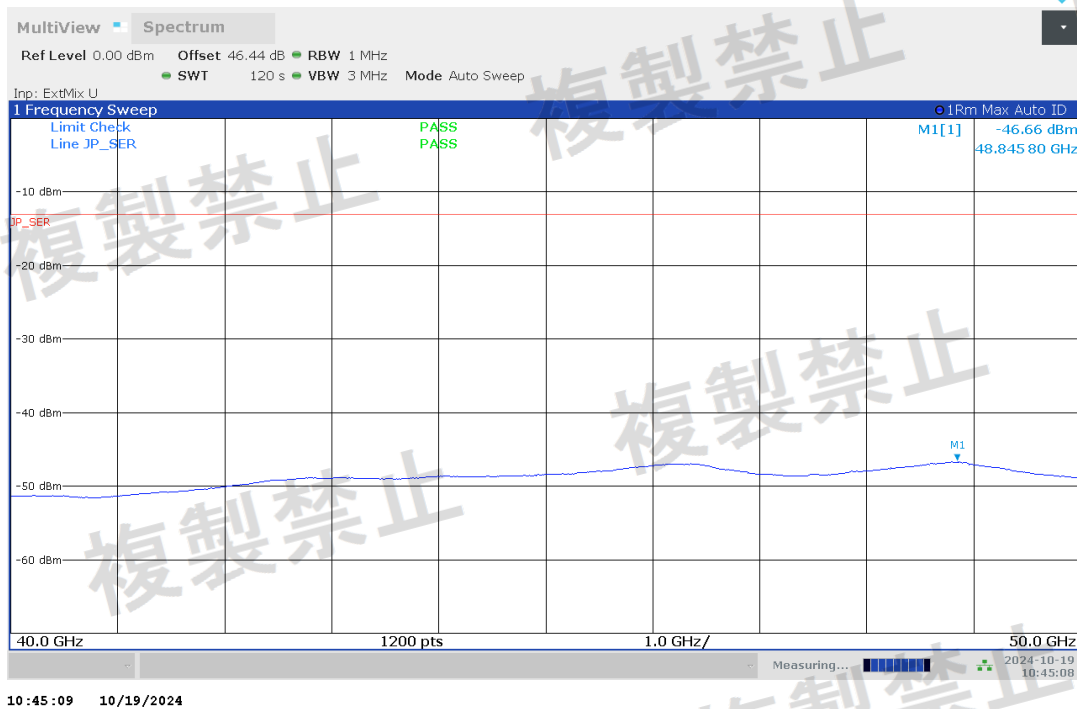
Plot no. 43: radiated emissions 18 GHz – 26.5 GHz, CB 23, polarization vertical / horizontal



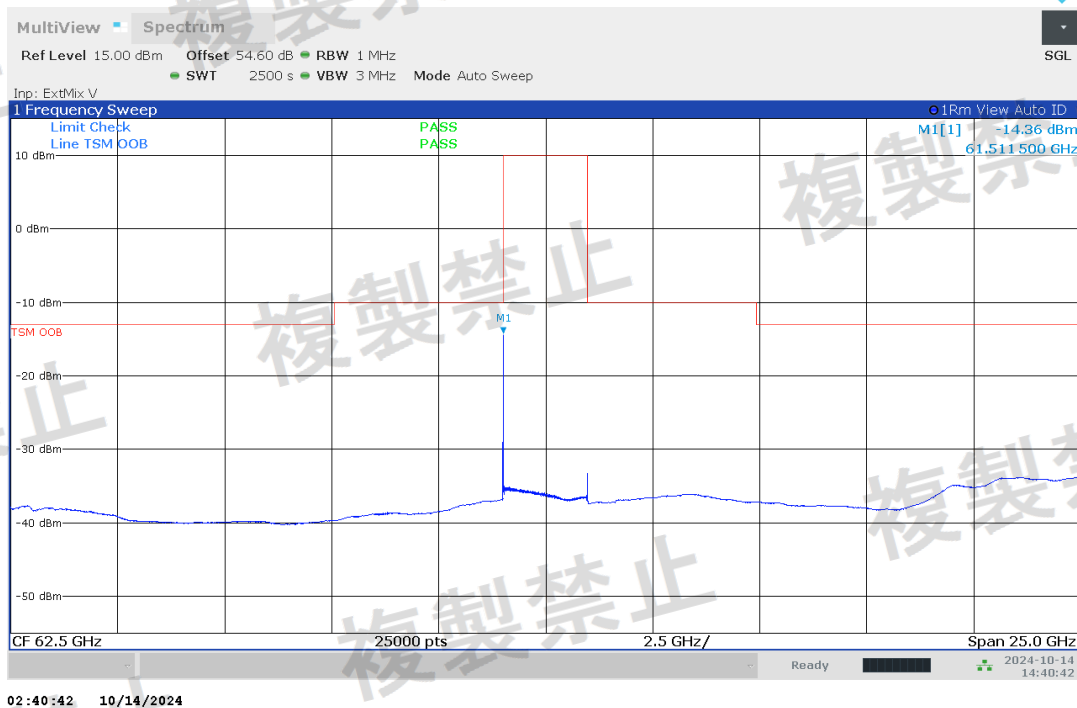
Plot no. 44: radiated emissions 26.5 GHz – 40 GHz, CB 23, polarization vertical / horizontal



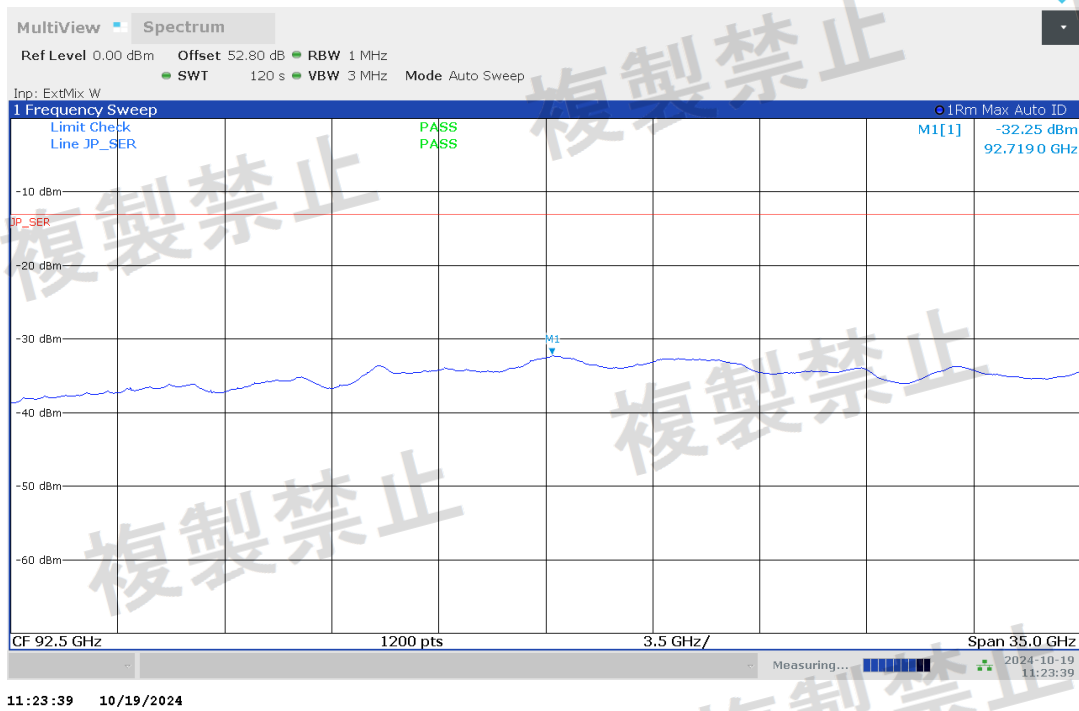
Plot no. 45: radiated emissions 40 GHz – 50 GHz, CB 23, polarization vertical / horizontal



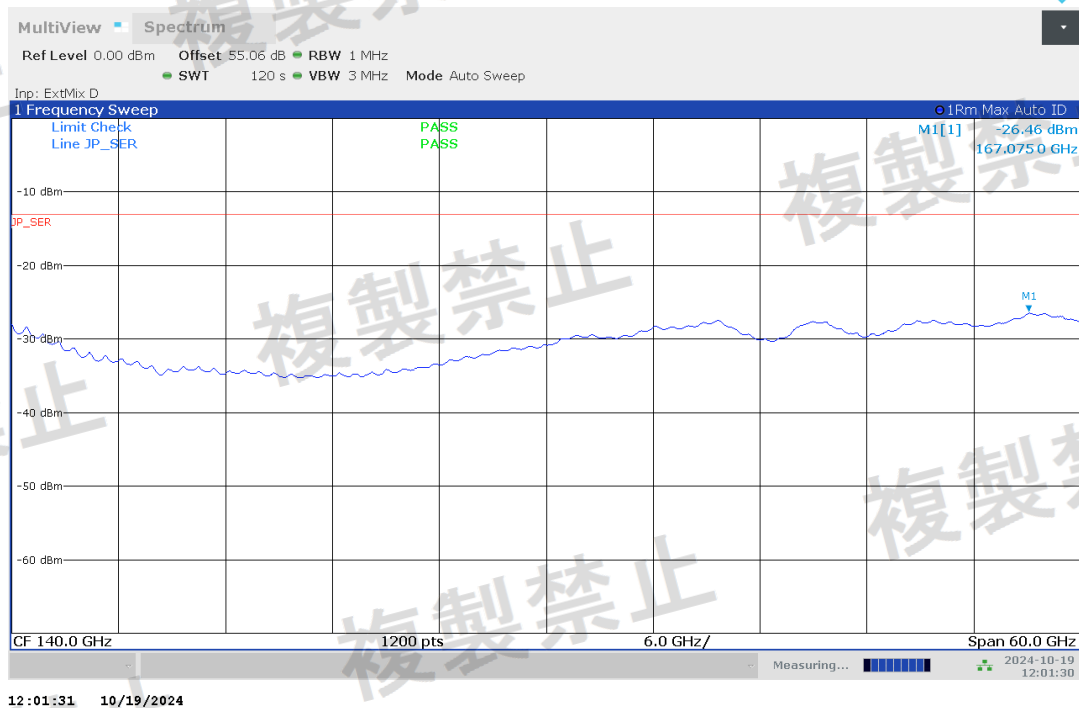
Plot no. 46: radiated emissions, OOB Mask, CB 23, polarization aligned with radar sensor



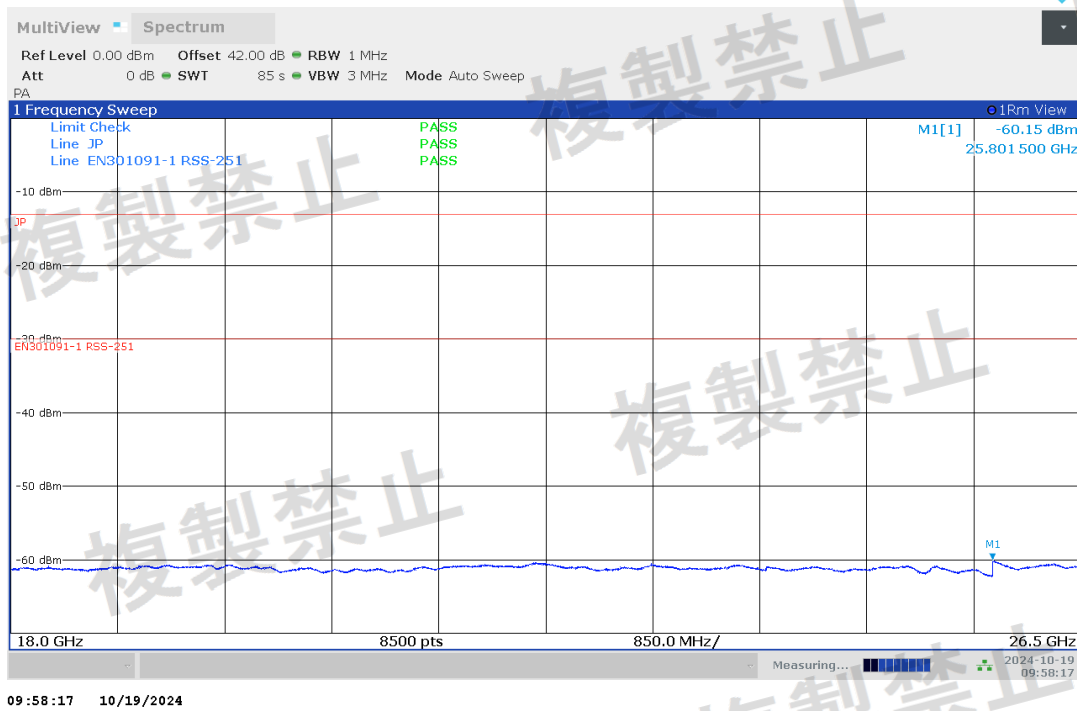
Plot no. 47: radiated emissions 75 GHz – 110 GHz, CB 23, polarization vertical / horizontal



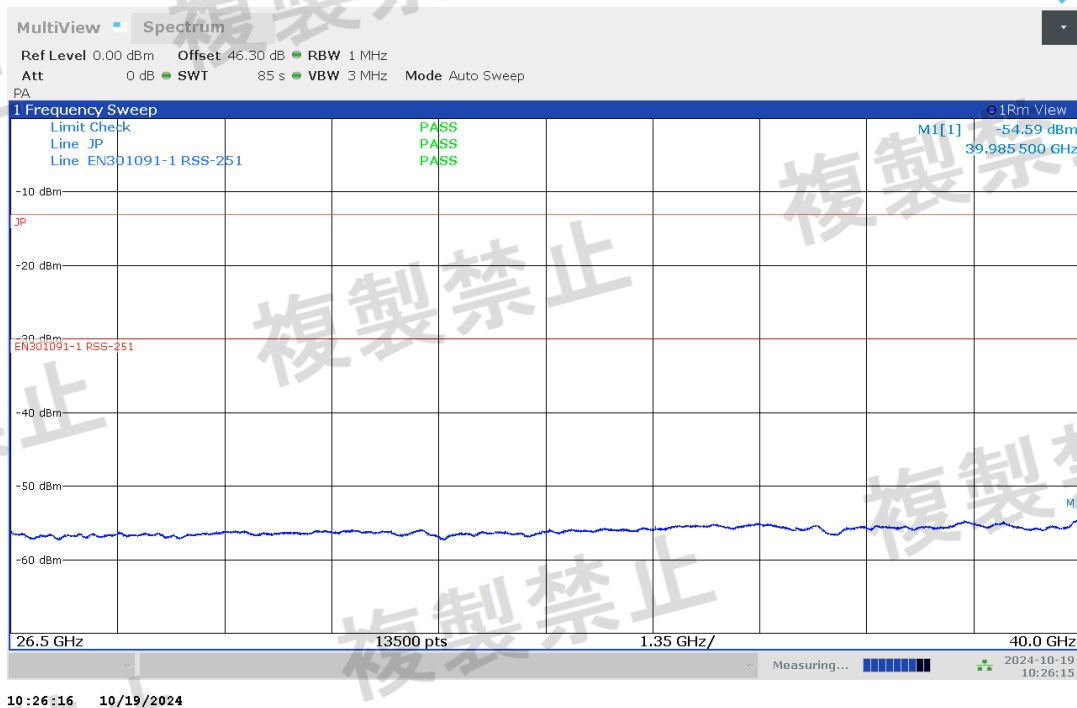
Plot no. 48: radiated emissions 110 GHz – 170 GHz, CB 23, polarization vertical / horizontal



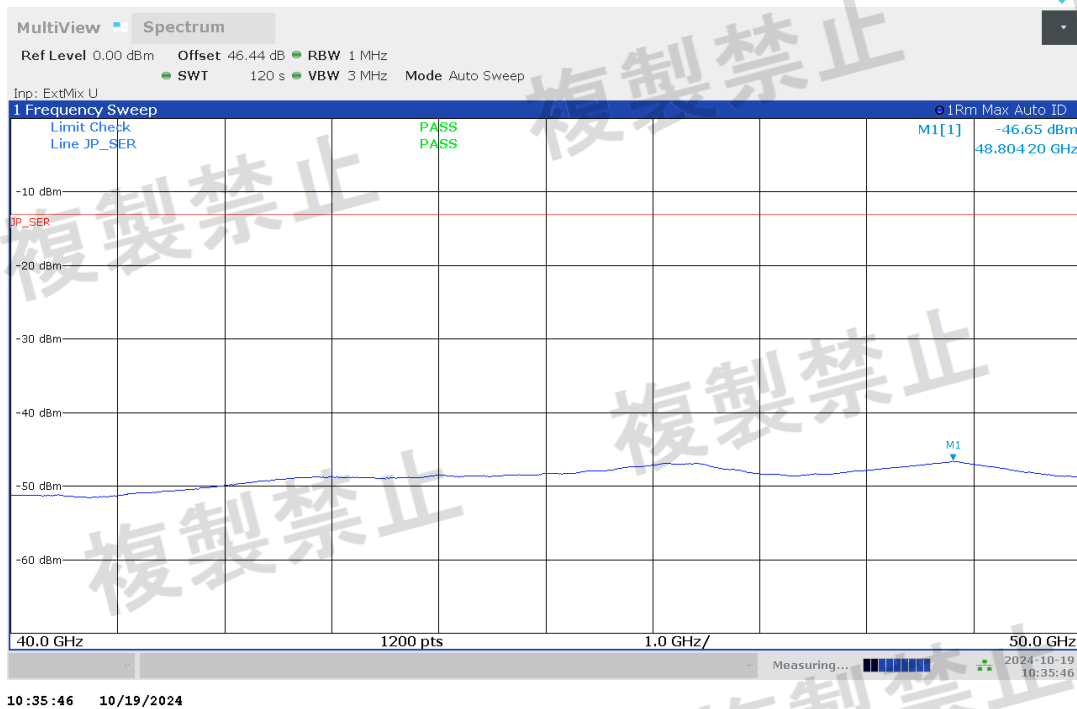
Plot no. 49: radiated emissions 18 GHz – 26.5 GHz, CB 26, polarization vertical / horizontal



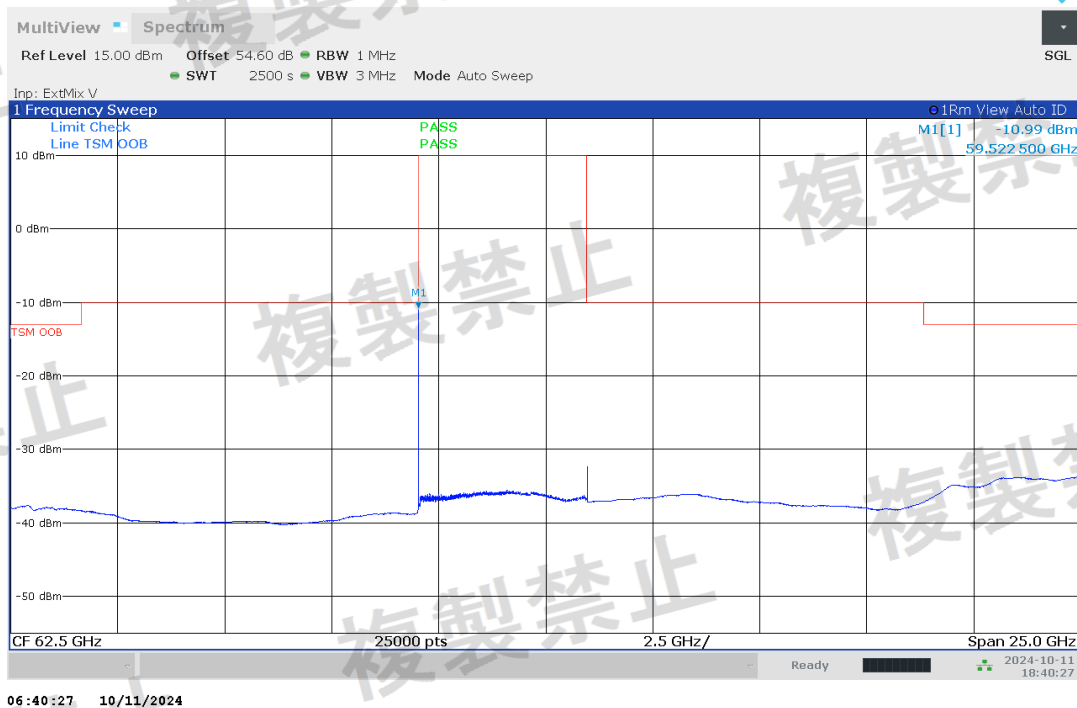
Plot no. 50: radiated emissions 26.5 GHz – 40 GHz, CB 26, polarization vertical / horizontal



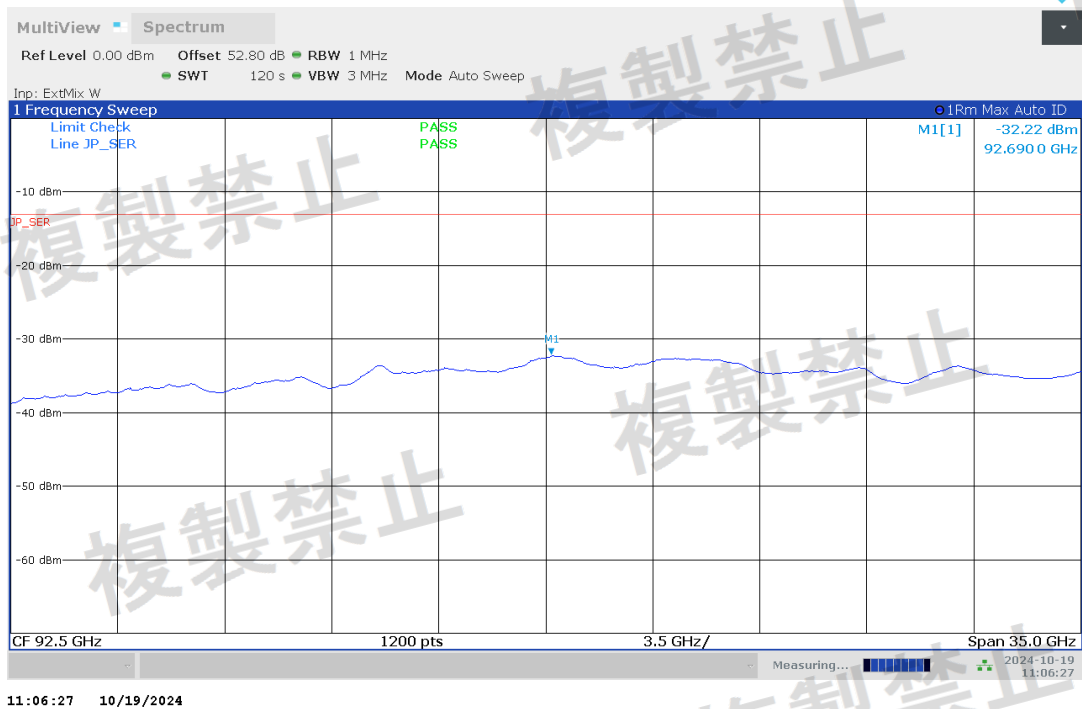
Plot no. 51: radiated emissions 40 GHz – 50 GHz, CB 26, polarization vertical / horizontal



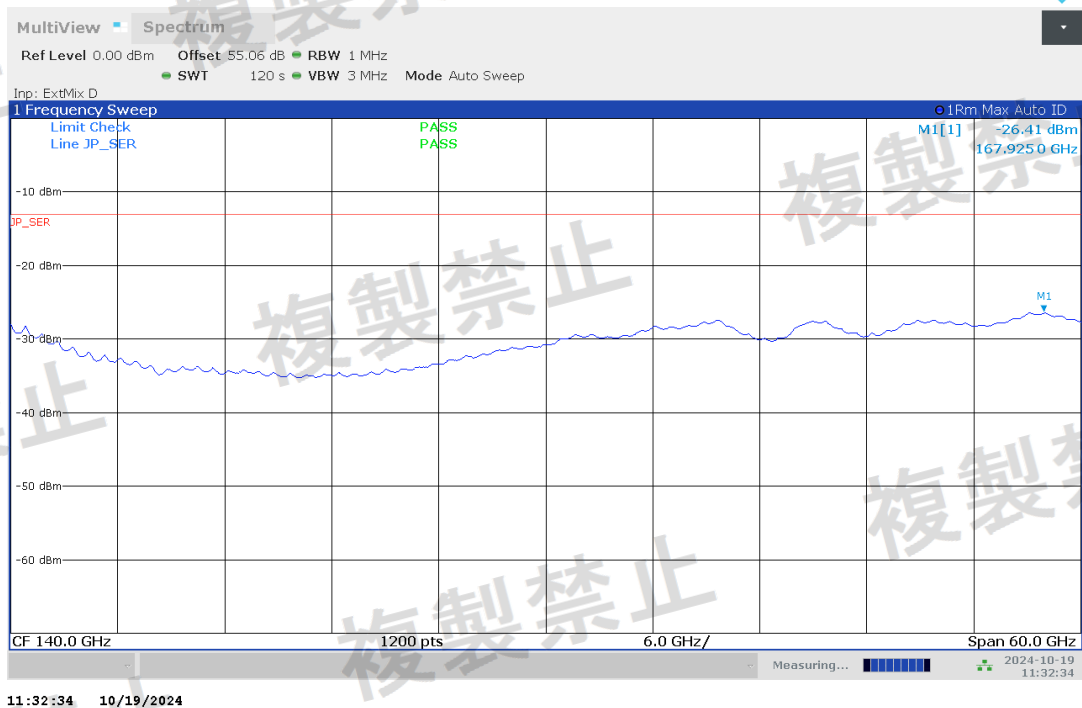
Plot no. 52: radiated emissions, OOB Mask, CB 26, polarization aligned with radar sensor



Plot no. 53: radiated emissions 75 GHz – 110 GHz, CB 26, polarization vertical / horizontal



Plot no. 54: radiated emissions 110 GHz – 170 GHz, CB 26, polarization vertical / horizontal



8 TEST SETUP DESCRIPTION

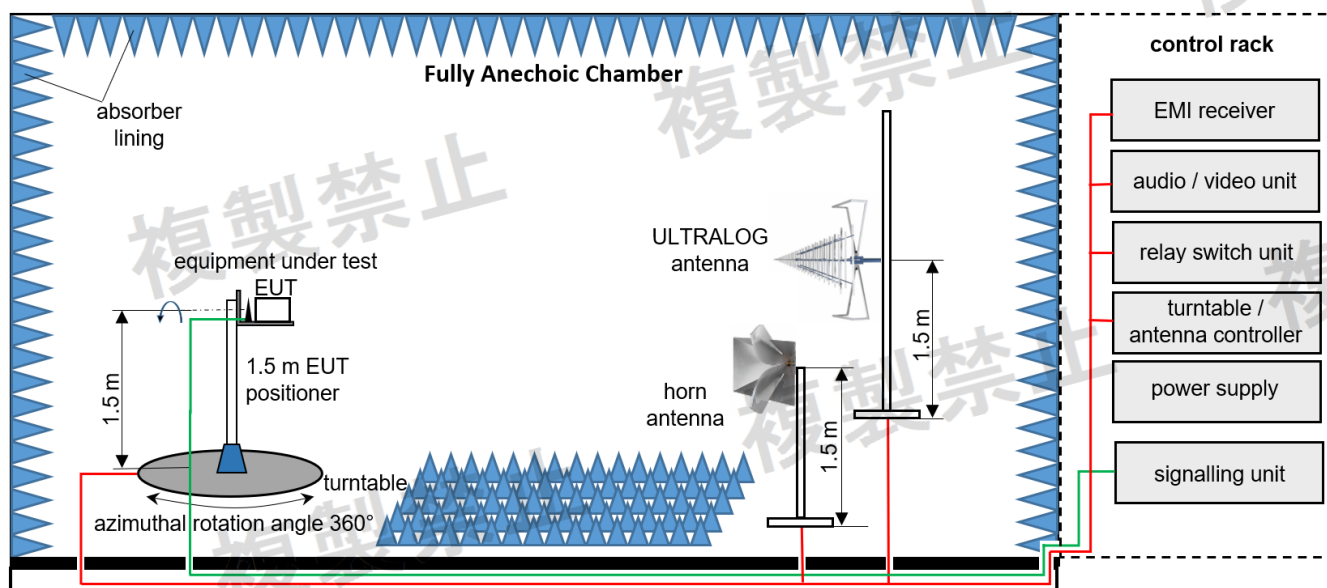
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Cyclic chamber inspections and range calibrations are performed. Where possible, RF generating and signalling equipment as well as measuring receivers and analysers 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).

Kind of calibration (abbreviations):

- C = calibrated
- CM = cyclic maintenance
- NR = not required
- L = locked

8.1 Fully Anechoic Chamber



Measurement distance: Ultralog antenna and horn antenna at 3 m

EMC32 software version: 11.20.00

$$\text{ROP} = \text{AV} + \text{D} - \text{G} + \text{CA}$$

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

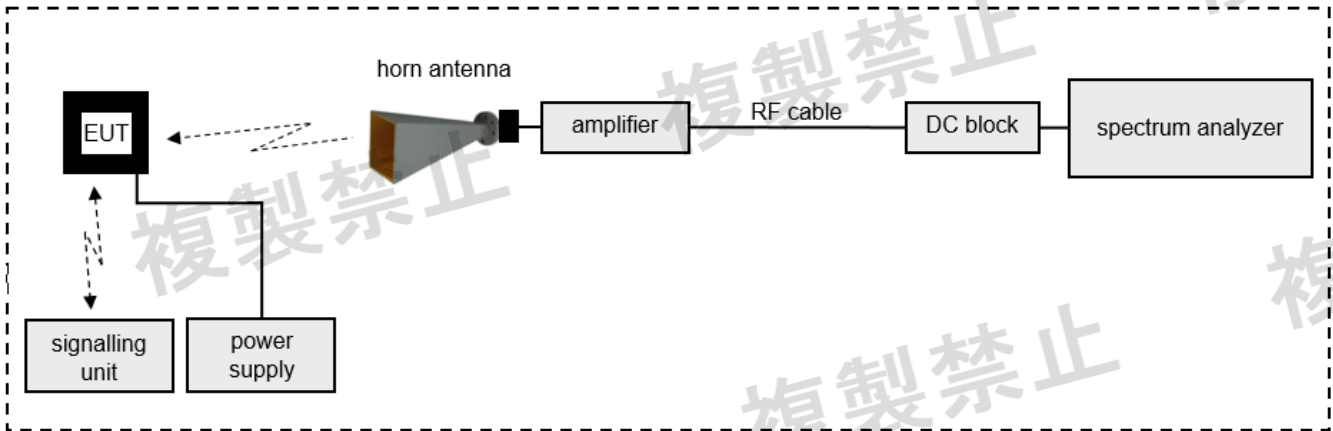
Example calculation:

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

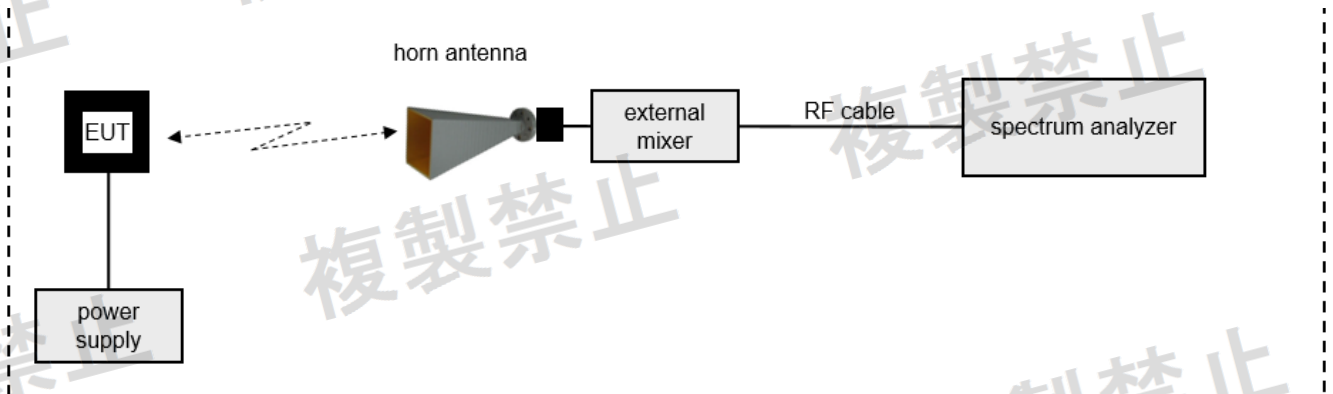
List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NR	–
2	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	NR	–
3	Power Supply	Chroma	61604	616040005416	LAB000285	NR	–
4	Positioner	matur GmbH	TD 1.5-10KG		LAB000258	NR	–
5	Compressed Air	Implotex	1-850-30	-	LAB000256	NR	–
6	EMI Test Receiver	Rohde & Schwarz	ESW26	101481	LAB000236	C	2024-07-18 → 12M → 2025-07-18
7	Semi/Fully Anechoic Chamber (SFAC)	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	NR	–
8	Measurement Software	Rohde & Schwarz	EMC32 V11.20		LAB000226	NR	–
9	Turntable	matur GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NR	–
10	Antenna Mast	matur GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NR	–
11	Antenna Mast	matur GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	NR	–
12	Controller	matur GmbH	FCU 3.0	10082	LAB000222	NR	–
13	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NR	–
14	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	C	2023-05-15 → 36M → 2026-05-15
15	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	C	2022-12-22 → 36M → 2025-12-22
16	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	NR	–

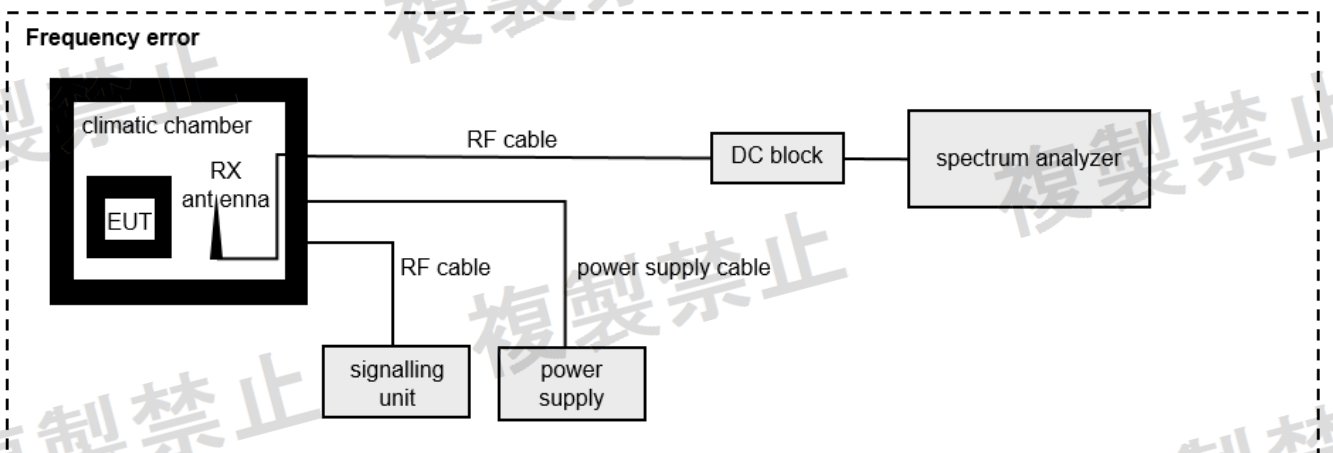
8.2 Radiated measurements > 18 GHz



8.3 Radiated measurements > 50 GHz



8.4 Radiated measurements under extreme conditions



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$$ROP = AV + D - G$$

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

Example calculation:

$$ROP \text{ [dBm]} = -54.0 \text{ [dBm]} + 64.0 \text{ [dB]} - 20.0 \text{ [dBi]} = -10 \text{ [dBm]} (100 \mu\text{W})$$

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

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Calibration
1	Test table	innco systems GmbH	PT0707-RH light	-	LAB000303	NR	-
2	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350255	LAB000189	NR	-
3	WG-Coax-Adapter	Flann Microwave Ltd	23373-TF30 UG383/U	273385	LAB000185	CM	2024-07-16 → 12M → 2025-07-16
4	WG-Coax-Adapter	Flann Microwave Ltd	22093-TF30 UG599/U	273263	LAB000183	CM	2024-07-16 → 12M → 2025-07-16
5	WG-Coax-Adapter	Flann Microwave Ltd	20093-TF30 UBR220	273374	LAB000181	CM	2024-07-16 → 12M → 2025-07-16
6	Antenna	Flann Microwave Ltd	30240-20	273390	LAB000178	CM	2024-07-16 → 12M → 2025-07-16
7	Coaxial Cable	Huber & Suhner	SF101/1.0m	503990/1	LAB000164	CM	2024-07-17 → 12M → 2025-07-17
8	Coaxial Cable	Rosenberger	LU7-022-1000	34	LAB000154	NR	-
9	Coaxial Cable	Rosenberger	LU7-022-1000	33	LAB000153	NR	-
10	Antenna	Flann Microwave Ltd	32240-20	273469	LAB000152	CM	2024-07-16 → 12M → 2025-07-16
11	Antenna	Flann Microwave Ltd	29240-20	273382	LAB000139	CM	2024-07-16 → 12M → 2025-07-16
12	Antenna	Flann Microwave Ltd	27240-20	273367	LAB000137	CM	2024-07-16 → 12M → 2025-07-16
13	Antenna	Flann Microwave Ltd	26240-20	273417	LAB000135	CM	2024-07-16 → 12M → 2025-07-16
14	Antenna	Flann Microwave Ltd	25240-20	272860	LAB000133	CM	2024-07-16 → 12M → 2025-07-16
15	Antenna	Flann Microwave Ltd	23240-20	273430	LAB000132	CM	2024-07-16 → 12M → 2025-07-16
16	Antenna	Flann Microwave Ltd	22240-20	270448	LAB000130	K	2024-07-16 → 12M → 2025-07-16
17	Antenna	Flann Microwave Ltd	20240-20	266403	LAB000128	K	2024-07-16 → 12M → 2025-07-16
18	Harmonic Mixer	Rohde & Schwarz	FS-Z170	100996	LAB000126	K	2024-05-07 → 12M → 2025-05-07
19	Harmonic Mixer	Rohde & Schwarz	FS-Z325	101015	LAB000117	K	2024-04-16 → 12M → 2025-04-16
20	Harmonic Mixer	Rohde & Schwarz	FS-Z220	101039	LAB000116	K	2024-04-03 → 12M → 2025-04-03
21	Harmonic Mixer	Rohde & Schwarz	FS-Z110	102000	LAB000114	K	2024-06-11 → 12M → 2025-06-11
22	Harmonic Mixer	Rohde & Schwarz	FS-Z090	102020	LAB000113	K	2024-04-06 → 12M → 2025-04-06
23	Harmonic Mixer	Rohde & Schwarz	FS-Z075	102015	LAB000112	K	2024-06-13 → 12M → 2025-06-13
24	Spectrum Analyser	Rohde & Schwarz	FSW50	101450	LAB000111	K	2024-07-25 → 12M → 2025-07-25
25	Climatic Chamber	CTS GmbH	T-65/50	204002	LAB000110	CM	2024-06-07 → 12M → 2025-06-07
26	Antenna Mast	Schwarzbeck Mess-Elektronik OHG	AM 9104	99	LAB000109	NR	-

9 MEASUREMENT UNCERTAINTIES

Radio frequency	$\leq \pm 10$ ppm
Radiated emission	$\leq \pm 6$ dB
Temperature	$\leq \pm 1$ °C
Humidity	$\leq \pm 5$ %
DC and low frequency voltages	$\leq \pm 3$ %

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor $k = 2$. It was determined in accordance with EA-4/01 m:2013. The true value is located in the corresponding interval with a probability of 95 %.

Annex 1 EUT Photographs, external

Photo No. 1:

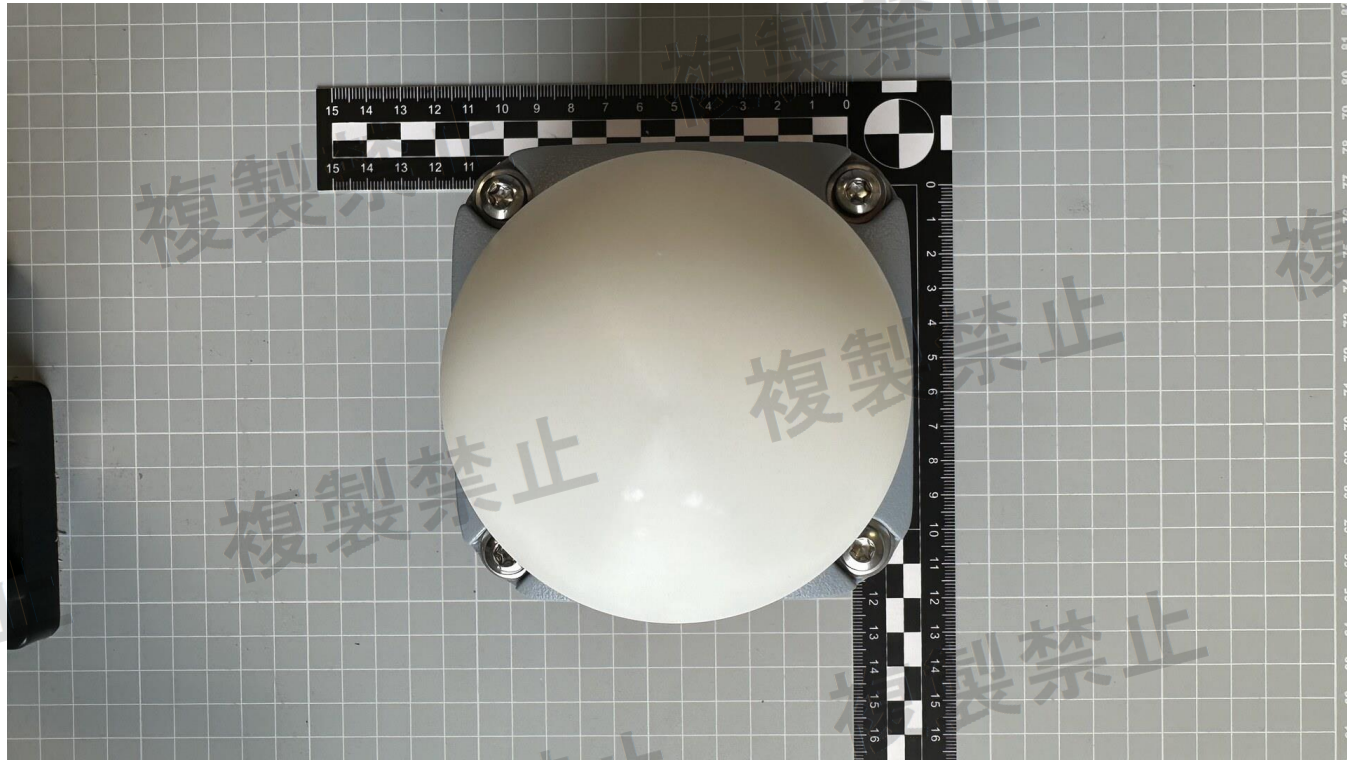


Photo No. 2:



Photo No. 3:



Photo No. 4:

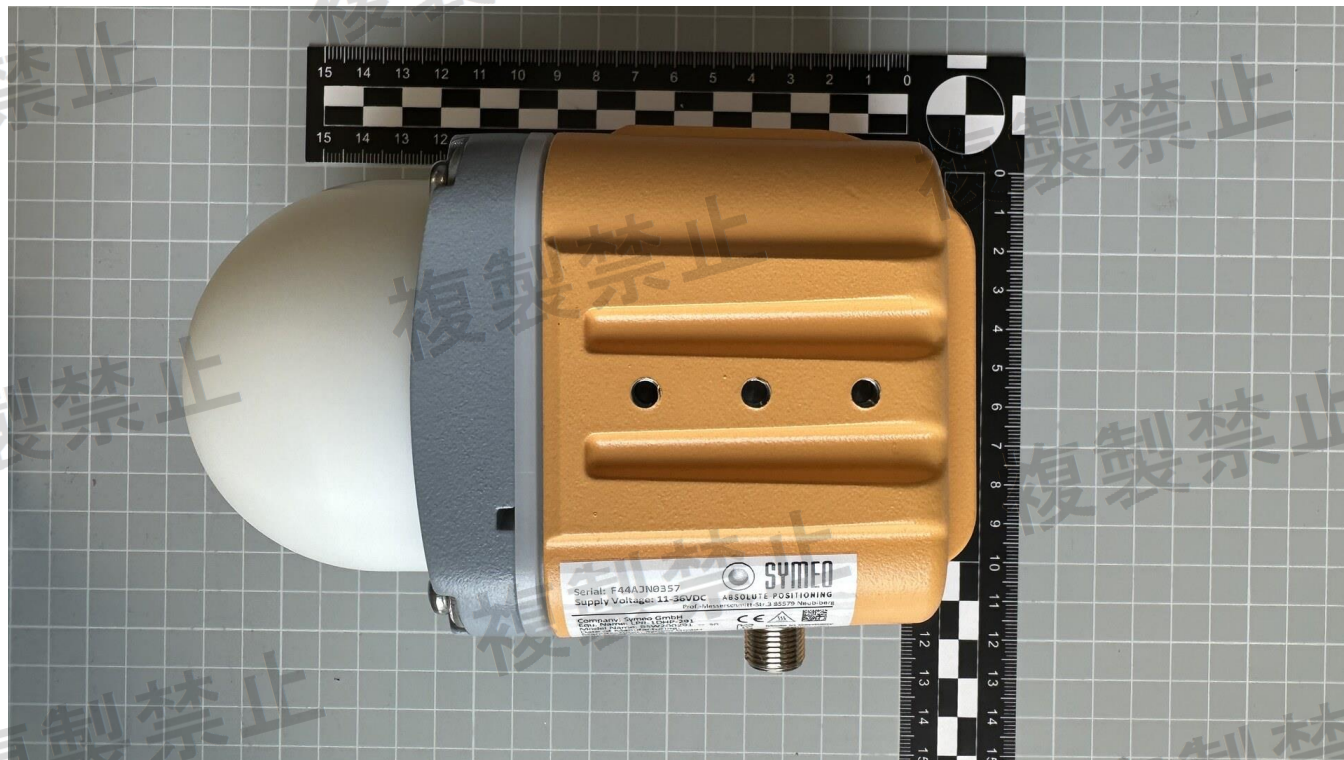


Photo No. 5:

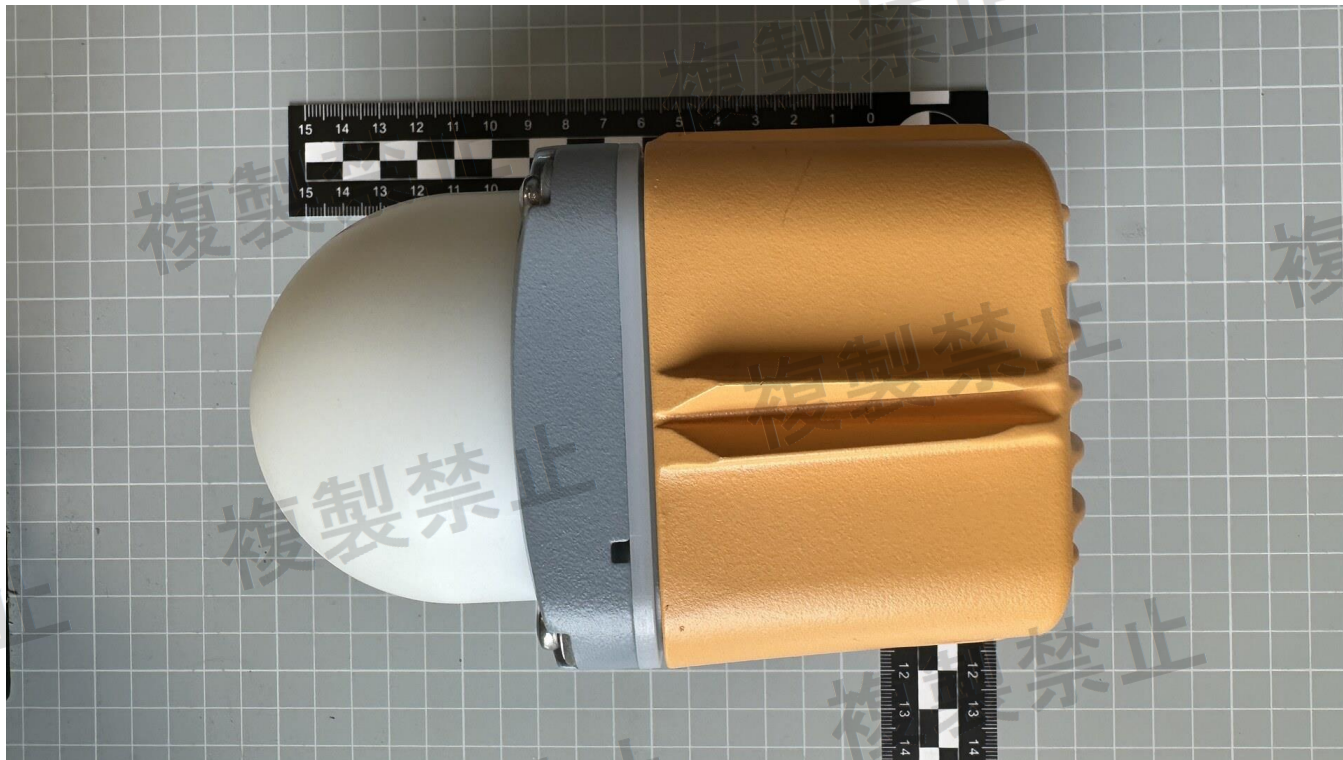


Photo No. 6:



Annex 2 Test Setup Photographs

Photo No. 7:

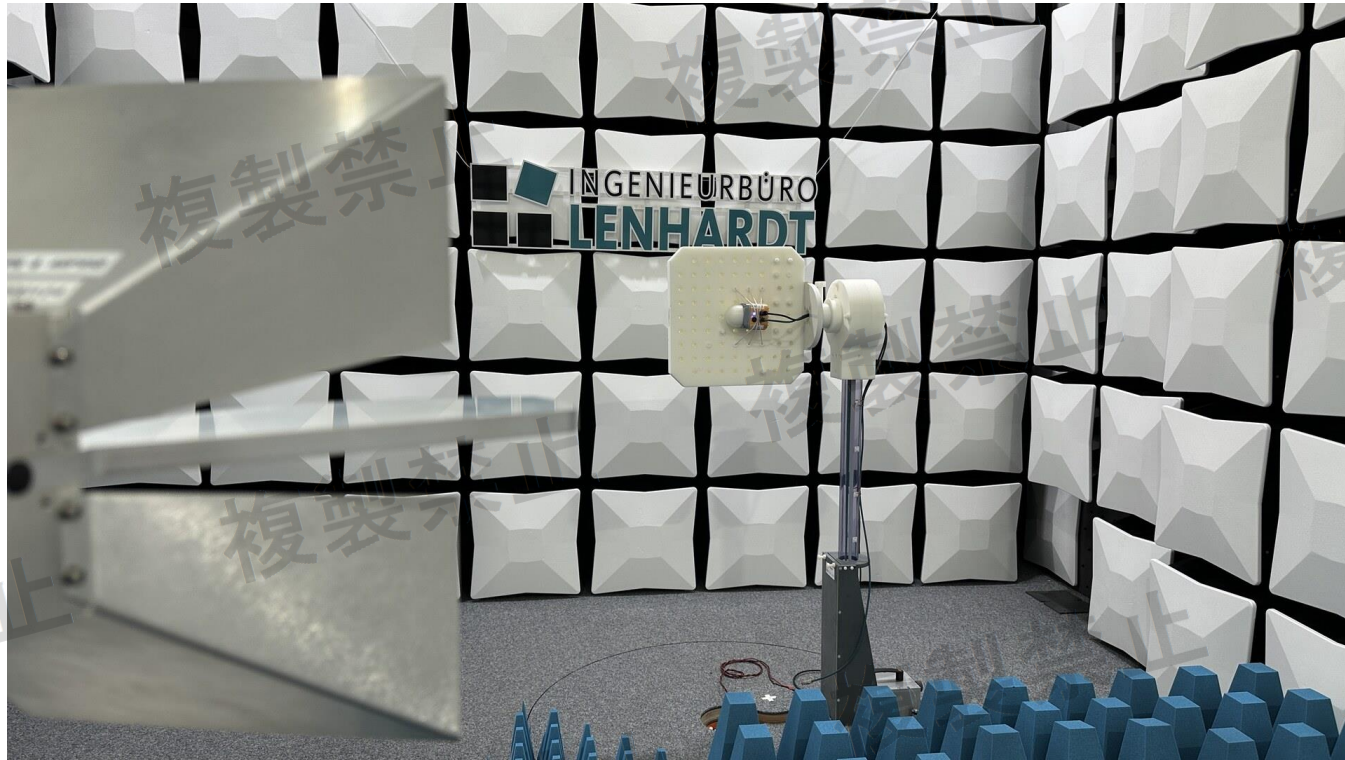


Photo No. 8:

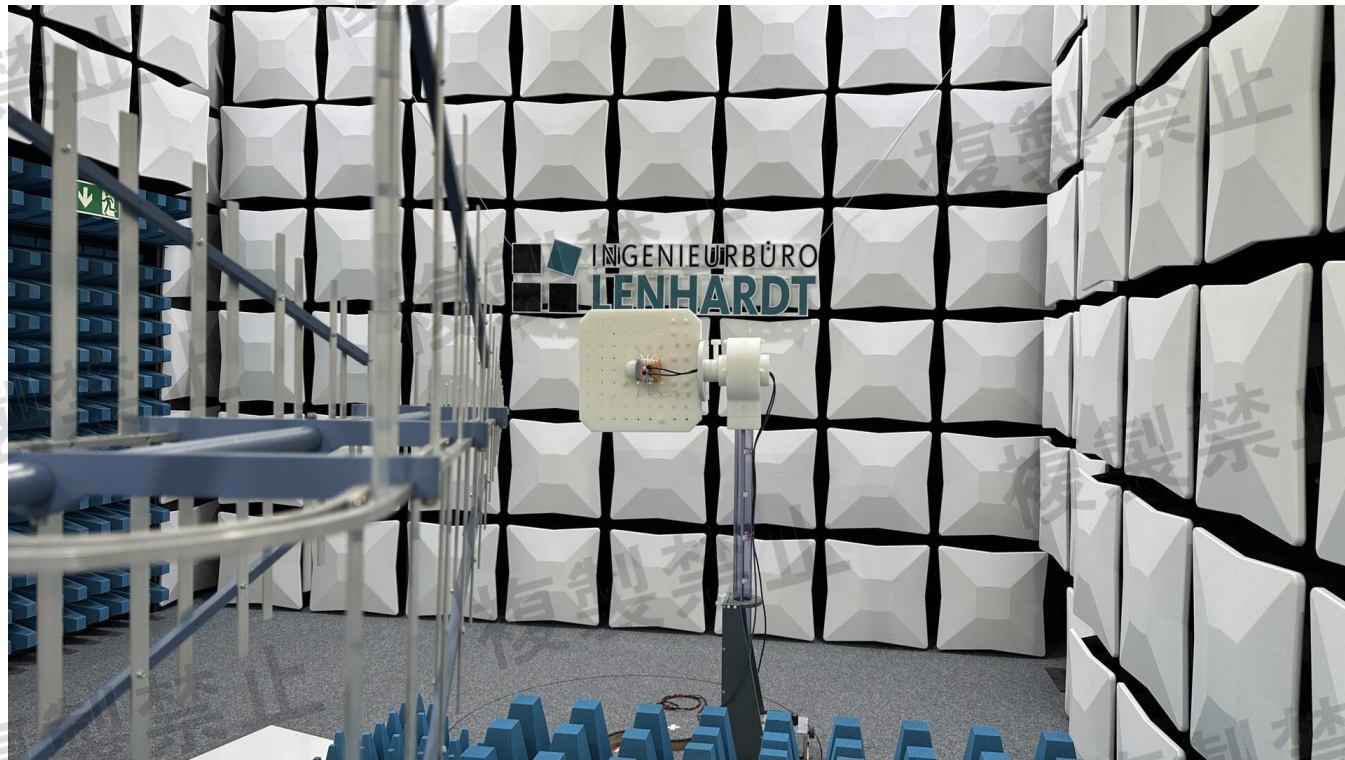


Photo No. 9:



Photo No. 10:

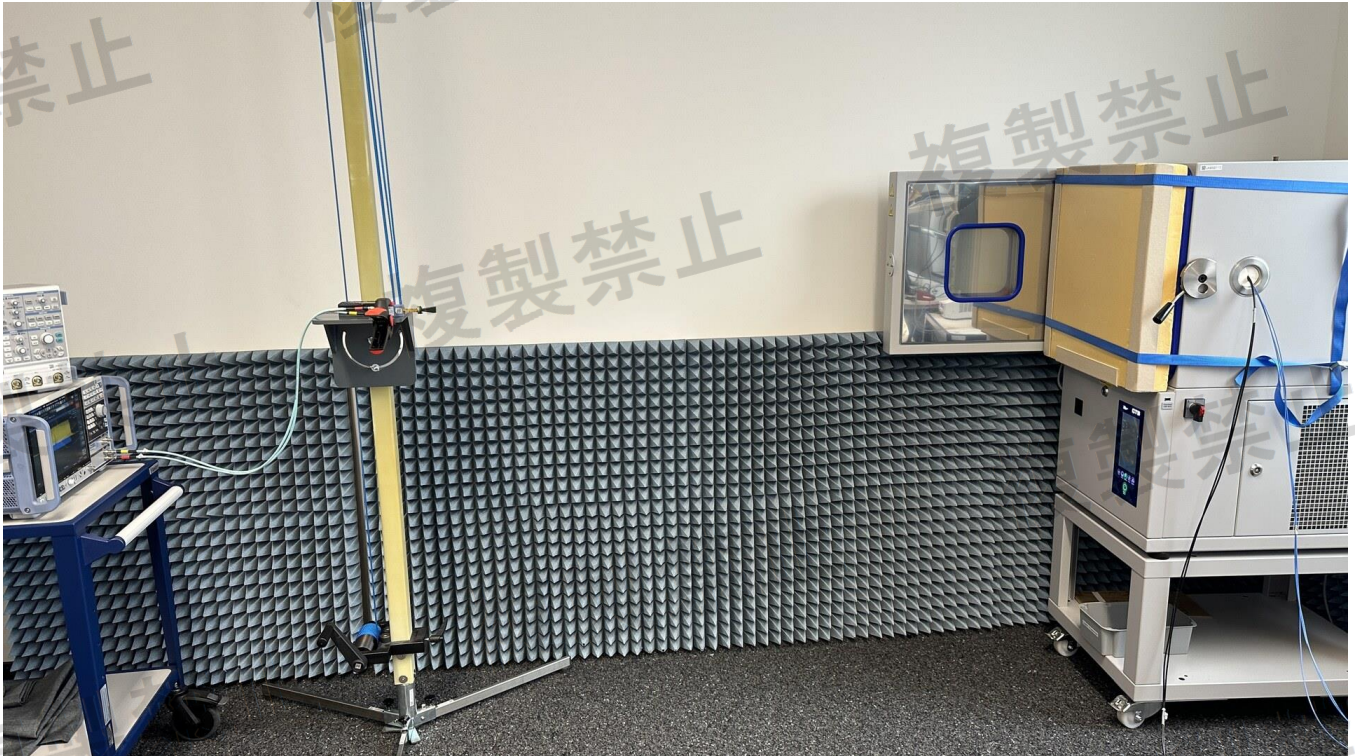


Photo No. 11:

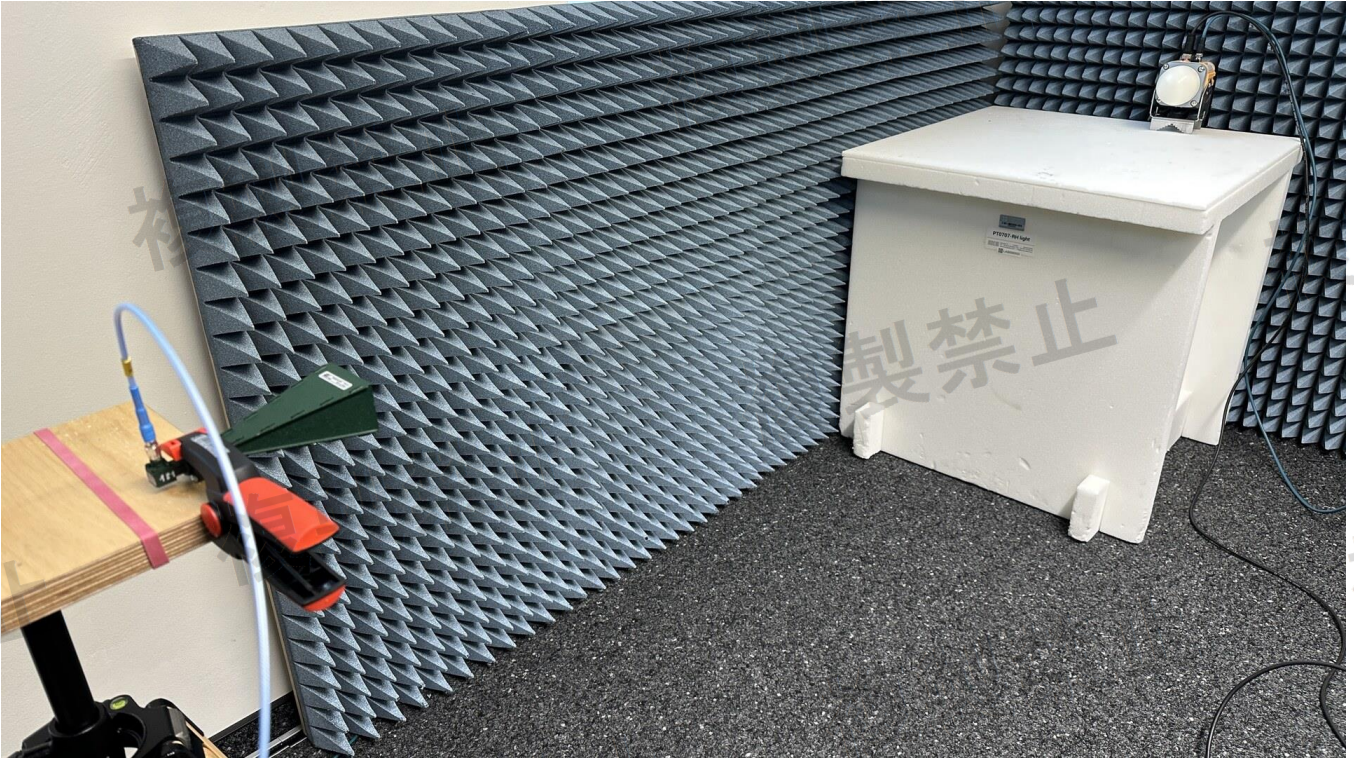


Photo No. 12:



Photo No. 13:

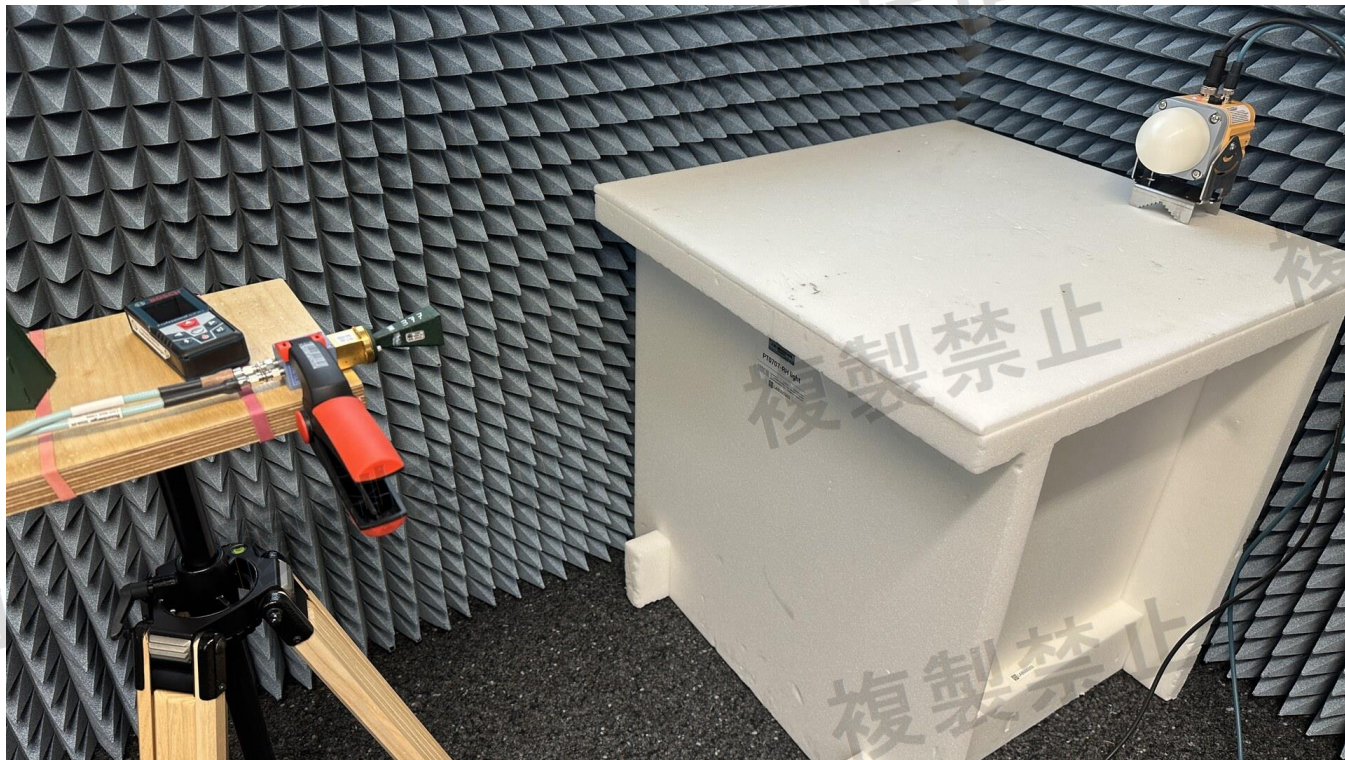


Photo No. 14:

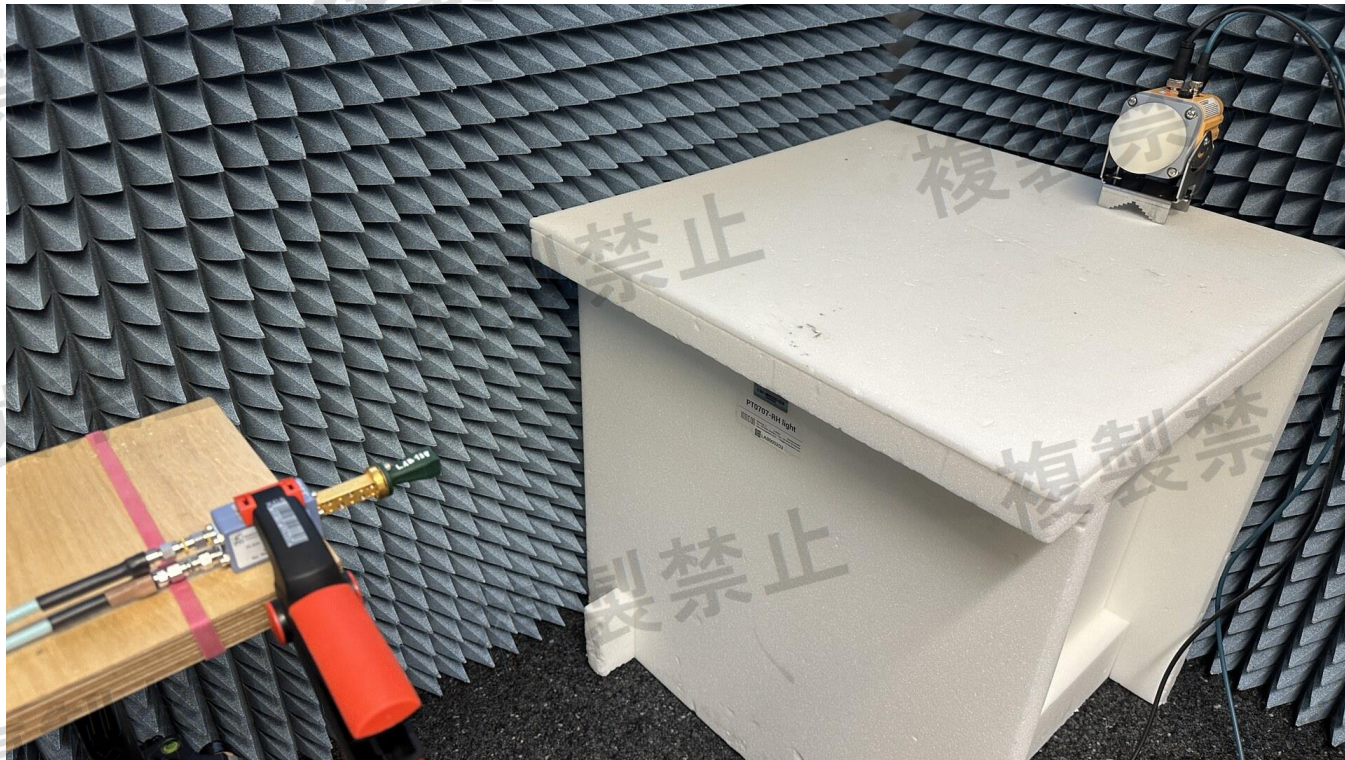
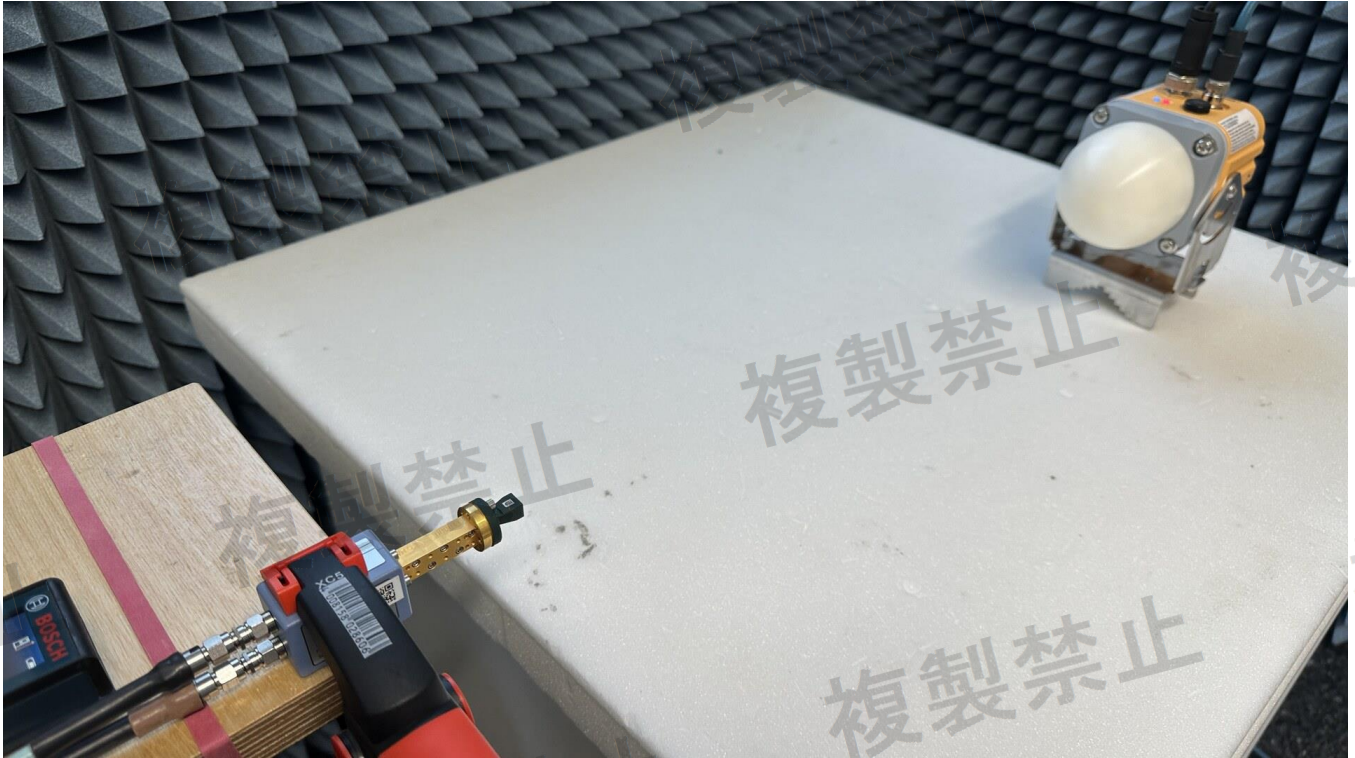


Photo No. 15:



End of Test Report
