



中认信通

CHINA CERTIFICATION ICT CO., LTD (DONGGUAN)



TEST REPORT

Applicant: AUTOEQUIPS TECH CO., LTD.

Address: Rm 04/11F, Block C, Wanhai Building, No. 1030 Nanhai Avenue,
Nanshan District, Shenzhen City, Guangdong Province, China

FCC ID: 2AGPO-AE-RD-BS05

Product Name: Motor Millimeter Wave Radar

Standard(s): 47 CFR Part 95, Subpart M
ANSI C63.26-2015
KDB 653005 D01 76-81 GHz Radars v01r02

The above equipment has been tested and found compliant with the requirement of the relative standards
by China Certification ICT Co., Ltd (Dongguan)

Report Number: CR230311651-00B

Date Of Issue: 2023/6/26

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Test Facility

The Test site used by China Certification ICT Co., Ltd (Dongguan) to collect test data is located on the No. 113, Pingkang Road, Dalang Town, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 442868, the FCC Designation No. : CN1314.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0123.

Declarations

China Certification ICT Co., Ltd (Dongguan) is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol “▲”. Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
1.0	CR230311651-00B	Original Report	2023/6/7
2.0	CR230311651-00B	Update Section 1.1.2 and Section 5	2023/6/26

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

1.1.1 General:

EUT Name:	Motor Millimeter Wave Radar
EUT Model:	AE-RD-BS05
Multiple Model:	AE-RD-BS06, AE-RD-BS07, AE-RD-BS08, AE-RD-BS09, AE-RD-BS10, AE-RD-BS11, AE-RD-BS12, AE-RD-BS13, AE-RD-BS14, AE-RD-BS15, AE-RD-BS16, AE-RD-BS17, AE-RD-BS18, AE-RD-BS19, AE-RD-BS20, QRS001, QRS002, QRS003, QRS004, QRS005
Operation Frequency:	78.45GHz
Maximum Average Output Power (Radiated):	42.42 dBm
Modulation Type:	FMCW
Sweep Period:	103ms
Sweep Bandwidth ▲:	2000 MHz(77.45-79.45GHz)
Chirp Time ▲:	31μs
Antenna Number:	4TX4RX
Rated Input Voltage:	DC 12/24V
Serial Number:	231I_1
EUT Received Date:	2023/3/14
EUT Received Status:	Good
Note: The Multiple model is electrically identical with test model, please refer to the declaration letter for more detail, which was provided by manufacturer.	

1.1.2 Antenna Information Detail ▲:

Antenna Type	input impedance (Ohm)	Antenna Gain /Frequency Range
Patch Antenna	Unknown	3 dBi/77~81GHz

1.1.3 Accessory Information:

No.

1.2 Description of Test Configuration

1.2.1 EUT Operation Condition:

EUT Operation Mode:	The system was configured for testing in Engineering Mode, which was provided by the manufacturer. The device has 4T4R, 4TX only simultaneously transmit.
Equipment Modifications:	No
EUT Exercise Software:	No
Engineering Mode was provided by manufacturer▲. The maximum power was configured default setting.	

1.2.2 Support Equipment List and Details

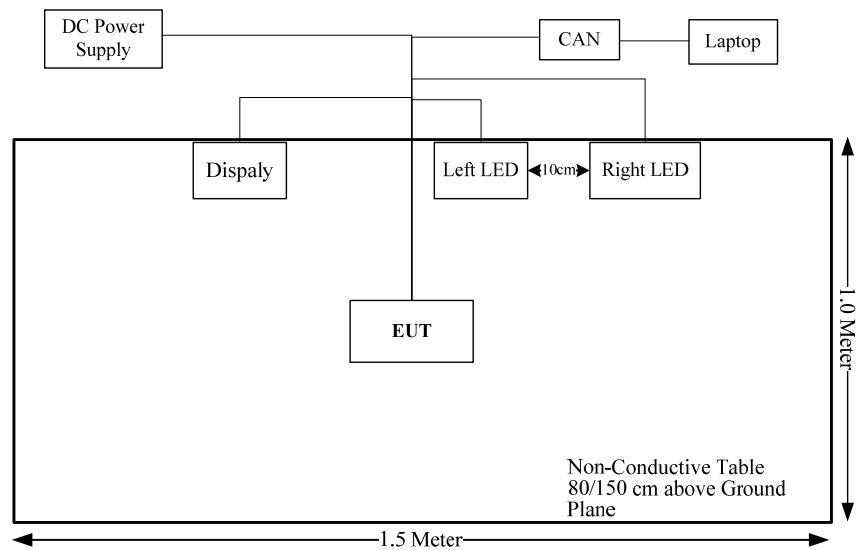
Manufacturer	Description	Model	Serial Number
Lenovo	Laptop	T460S	60PDTEK8
ZHAOXIN	DC Power Supply	RXN-6010D	21R6010D0912386
/	USB CAN Tool	CANalyst-II	31F0001C04B

1.2.3 Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
Main Line	No	No	1.5	DC power supply	M12-8 PIN Port
Radar Cable	No	No	1.5	M12-8 PIN Port	EUT
Left LED Cable	No	No	0.12	Main Line	Left LED
Right LED Cable	No	No	0.12	Main Line	Right LED
Display Cable	No	No	0.2	Main Line	Display
USB Cable	No	No	10	CAN	Laptop

1.2.4 Block Diagram of Test Setup

Unwanted Emissions:



1.3 Measurement Uncertainty

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
Radiated Emissions	9kHz~30MHz: 4.12dB 30M~200MHz: 4.15 dB, 200M~1GHz: 5.61 dB, 1G~6GHz: 5.14 dB, 6G~18GHz: 5.93 dB, 18G~26.5G: 5.47 dB, 26.5G~40G: 5.63 dB, 40~60G: 4.83dB, 60G~90G: 4.94dB, 90G-140G: 5.46dB, 140G-220G: 6.00dB, 220G-325G: 7.35dB
Temperature	±1 °C
Humidity	±5%
DC and low frequency voltages	±0.4%
AC Power Lines Conducted Emission	2.8 dB (150 kHz to 30 MHz)

2. SUMMARY OF TEST RESULTS

Standard(s) Section	Test Items	Result
FCC§2.1046, §95.3367	Radiated Power	Compliant
FCC§2.1053, §95.3379	Unwanted Emissions	Compliant
FCC§2.1055(d), §95.3379	Frequency Stability	Compliant
FCC§2.1049	Occupied Bandwidth	Compliant
FCC §1.1310,§2.1091, §95.3385	Maximum Permissible Exposure (MPE)	Compliant

3. REQUIREMENTS AND TEST PROCEDURES

3.1 Radiated Power

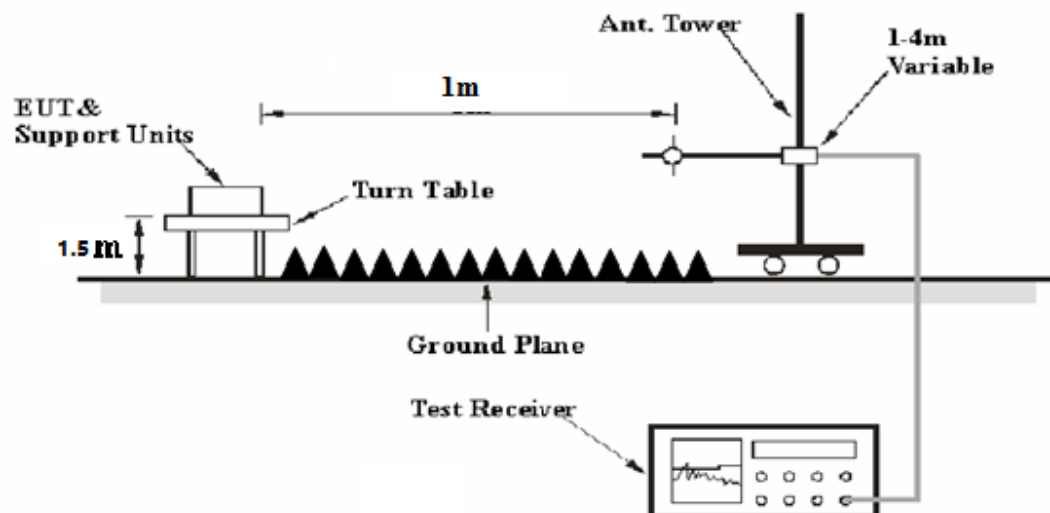
3.1.1 Applicable Standard

FCC §2.1046, §95.3367;

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

- (a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).
- (b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

3.2.2 EUT Setup



3.2.3 Test Procedure

Refer to ANSI C63.26-2015 Clause 5.2.7

Connect the test antenna for the fundamental frequency band to a spectrum analyzer via an external mixer.

Set spectrum analyzer RBW, VBW, detector, span, and so on, to the proper values.

Maximize the fundamental emission, noting that multiple peaks may be found at different beam orientations and/or polarizations

Calculate the EIRP from the measured field strength using equation as follows:

$$\text{EIRP (dBm)} = E (\text{dB}\mu\text{V/m}) + 20\log(D) - 104.8$$

EIRP is the equivalent isotropically radiated power

E is the field strength of the emission at the measurement distance

D is the measurement distance

3.2 Unwanted Emissions

3.2.1 Applicable Standard

FCC §2.1053 and §95.3379;

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

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

(i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

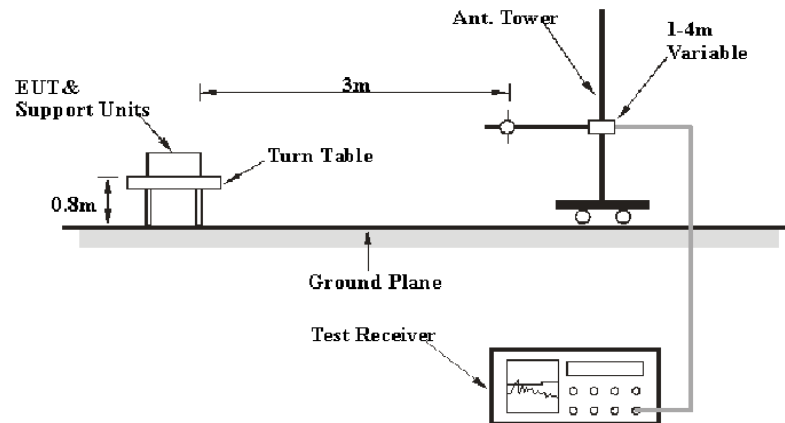
(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

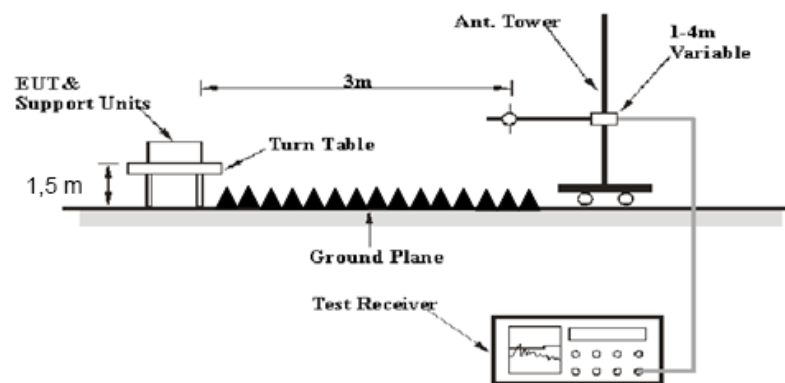
(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

3.2.2 EUT Setup

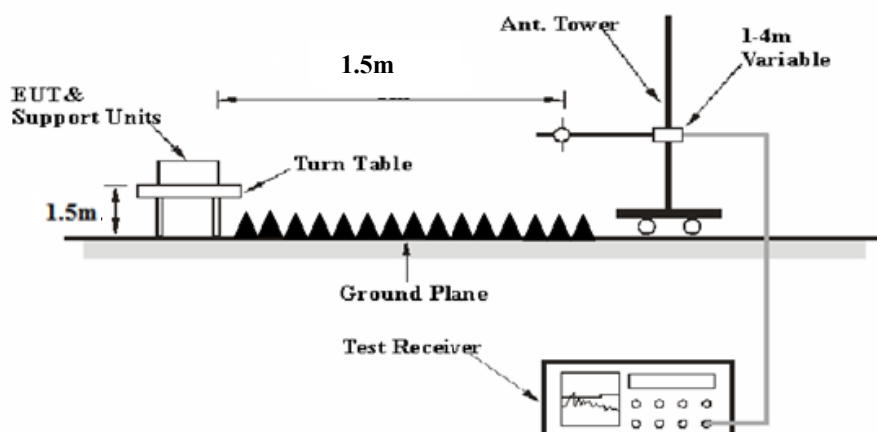
Below 1GHz:

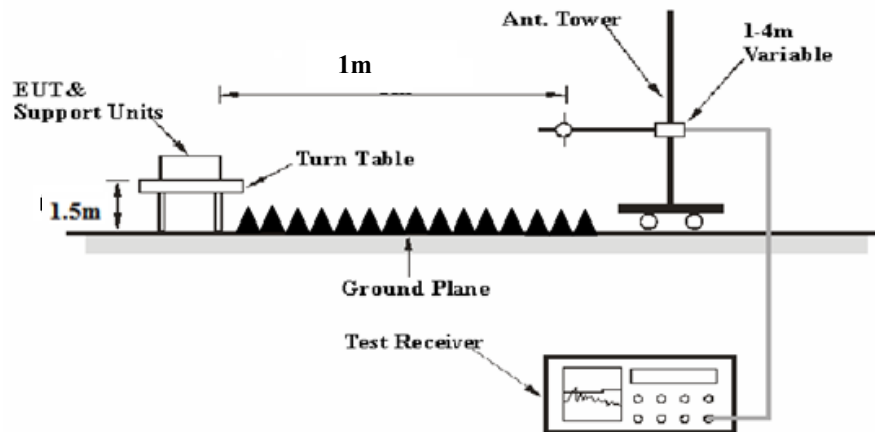
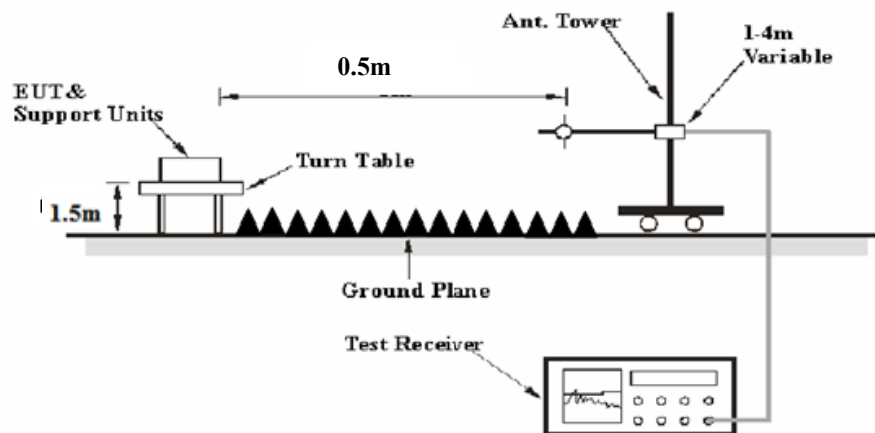


1-26.5 GHz:



26.5-40 GHz:



40-90 GHz:**90-231 GHz:**

The radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.26-2015. The specification used was the FCC 95.3379 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

3.2.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 231 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
9 kHz – 150 kHz	200 Hz	1 kHz	200 Hz	QP/Average
150 kHz – 30 MHz	9 kHz	30 kHz	9 kHz	QP/Average
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
1-40 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Average
Above 40 GHz	1MHz	3 MHz	/	Average

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

3.2.4 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The 26.5- 40GHz test result shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade from 3m to 1.5m

For 26.5-40GHz

Distance extrapolation factor = $20 \log (\text{specific distance [3m]}/\text{test distance [1.5m]})$ dB=6.02dB

For above 40GHz, external harmonic mixers are utilized. The antenna is scanned around the entire perimeter surface of the EUT, in both horizontal and vertical polarizations. The Mixers and it's RF cables is compose a system for calibration, the conversion factor was added into the test Spectrum Analyzer in testing.

The far-field boundary is given in ANSI C63.26-2015:

$$R_m = 2D^2 / \lambda$$

Where:

D is the largest dimension of the antenna aperture in m and

λ is the free-space wavelength in m at the frequency of measurement.

The minimum test distance for the frequency range 40GHz-231GHz determine as below:

Model	Frequency Range (GHz)	Largest Dimension of the Horn Antenna (mm)	Minimum Test Distance R_m (m)
M19RH	40-60	46.3	0.57
M12RH	60-90	30.02	0.36
M08RH	90-140	19.7	0.23
M05RH	140-220	12.5	0.15
M03RH	220-325	8.36	0.10

Note: the test distances used were 1.0 m from 40 GHz to 90 GHz, and 0.5 m from 90 GHz to 231GHz, it can be seen that the EUT was always in the Far-field of the Receive Antenna during all Radiated Emissions Tests.

3.2.5 Corrected Amplitude & Margin Calculation

The basic equation is as follows:

Factor = Antenna Factor + Cable Loss- Amplifier Gain

For 30MHz-26.5GHz:

Result = Reading + Factor

For 26.5GHz-40GHz

Result = Reading + Factor-Distance extrapolation Factor

The “Margin” column of the following data tables indicates the degree of compliance within the applicable limit. The equation for margin calculation is as follows:

Margin = Limit – Result

3.3 Frequency Stability:

3.3.1 Applicable Standard

FCC §95.3379 (b)

(b) 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.

3.3.3 Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external power supply and the RF output was connected to Test equipment via feed-through attenuators. The EUT was placed inside the temperature chamber. The power leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the Frequency Counter.

Frequency Stability vs. Voltage:

- 1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
- (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

The output frequency was recorded for each voltage.

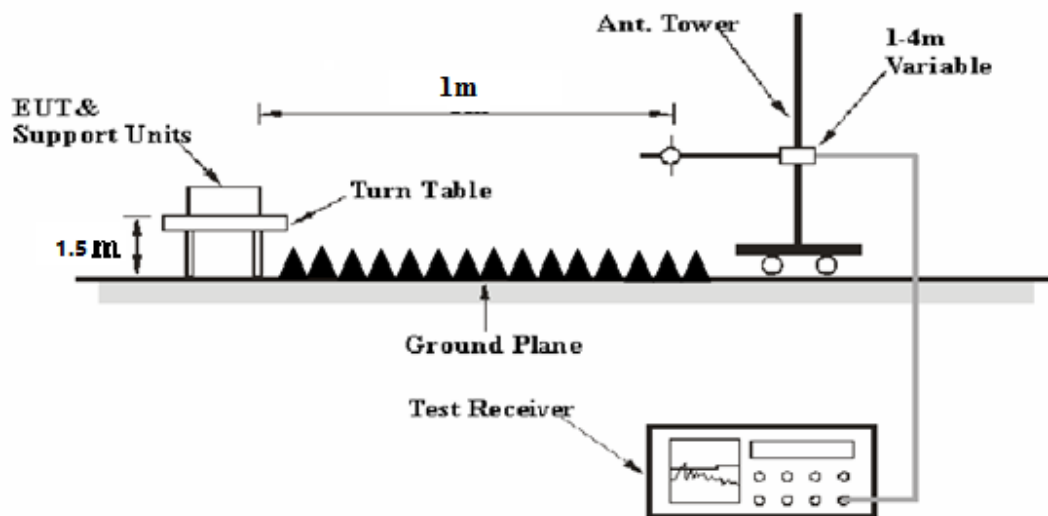
3.4 Occupied Bandwidth:

3.4.1 Applicable Standard

FCC §2.1049

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

3.4.2 EUT Setup



3.4.3 Test Procedure

The following procedure shall be used for measuring (99%) power bandwidth:

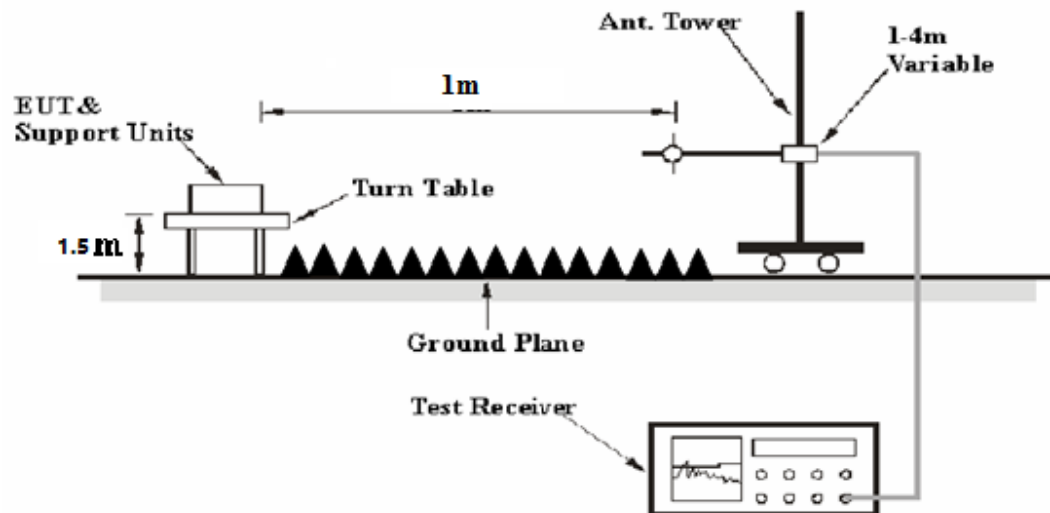
- The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (typically a span of $1.5 \times \text{OBW}$ is sufficient).
- The nominal IF filter 3 dB bandwidth (RBW) shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set $\geq 3 \times \text{RBW}$.
- Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation.

NOTE—Step a), step b), and step c) may require iteration to adjust within the specified tolerances.

- Set the detection mode to peak, and the trace mode to max-hold.
- The OBW shall be reported and plot(s) of the measuring instrument display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labeled. Tabular data can be reported in addition to the plot(s).

3.5 Duty Cycle:

3.5.1 EUT Setup



3.5.2 Test Procedure

According to ANSI C63.26-2015 Section 5.2.4.3.4

An oscilloscope with a diode detector that combined have sufficiently short response time to permit accurate measurements of the on and off times. A fundamental condition for all average power compliance measurements are that they be performed with the EUT transmitting continuously (duty cycle $\geq 98\%$) at maximum output power level. However, in those cases where this condition cannot be realized, then one of the alternative procedures must be selected based on whether the EUT transmitter exhibits a constant or a non-constant duty cycle. The measurement of transmitter duty cycle shall be performed using one of the following techniques:

- Off times of the transmitted signal.
- The zero-span mode on a spectrum analyzer if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

4. Test DATA AND RESULTS

4.1 Radiated Power

Serial Number:	231I_1	Test Date:	2023/05/12
Test Site:	966-1	Test Mode:	Transmitting
Tester:	Mack Huang, Coco Tian	Test Result:	Pass

Environmental Conditions:					
Temperature: (°C)	23	Relative Humidity: (%)	59	ATM Pressure: (kPa)	100.9

Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
OML	Harmonic Mixer	WR12/M12HWD	E60119-1	2020/10/17	2023/10/16
OML	Horn Antenna	M12RH	E60119-2	2020/10/18	2023/10/17
R&S	Spectrum Analyzer	FSV40	101943	2022/07/25	2023/07/24

** **Statement of Traceability:** China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Frequency (GHz)	Receiver		Polar (H/V)	Factor (dB/m)	EIRP (dBm)
	Reading (dBμV)	Detector			
78.45	95.94	PK	V	43.68	34.82
78.45	103.54	AV	V	43.68	42.42

Factor = Antenna Factor

EIRP = Reading + Factor + 20log(Measurement distance) - 104.8

Measurement distance = 1m

Detector	EIRP (dBm)	Chirps Correction Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dBm)
Peak	34.82	14.55	49.37	55	5.63
Average	42.42	/	42.42	50	7.58

Result = EIRP + Chirps Correction Factor

The chirps correction factor was calculated using the formula:

$$CF_{chirp} = 5 * \log \left(1 + K * \left(\frac{Span}{t * RBW^2} \right)^2 \right)$$

K = a correction factor for the setting process of the gaussian shaped filter (0.1947)

t = the length of the chirp

4.2 Radiation Spurious Emissions

Serial Number:	231I_1	Test Date:	2023/05/12~2023/06/05
Test Site:	966-1, 966-2	Test Mode:	Transmitting
Tester:	Mack Huang, Coco Tian, Vic Du	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	23~27.2	Relative Humidity: (%)	59~60	ATM Pressure: (kPa)	100.3~100.9
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Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
EMCO	Passive Loop Antenna	6512	9706-1209	2023/02/15	2026/02/14
Sunol Sciences	Antenna	JB6	A082520-5	2020/10/19	2023/10/18
R&S	EMI Test Receiver	ESR3	102724	2022/07/15	2023/07/14
TIMES MICROWAVE	Coaxial Cable	LMR-600-UltraFlex	C-0470-02	2022/07/17	2023/07/16
TIMES MICROWAVE	Coaxial Cable	LMR-600-UltraFlex	C-0780-01	2022/07/17	2023/07/16
Sonoma	Amplifier	310N	186165	2022/07/17	2023/07/16
Audix	Test Software	E3	201021 (V9)	N/A	N/A
ETS-Lindgren	Horn Antenna	3115	9912-5985	2020/10/13	2023/10/12
R&S	Spectrum Analyzer	FSV40	101591	2022/07/15	2023/07/14
MICRO-COAX	Coaxial Cable	UFA210A-1-1200-70U300	217423-008	2022/08/07	2023/08/06
MICRO-COAX	Coaxial Cable	UFA210A-1-2362-300300	235780-001	2022/08/07	2023/08/06
Mini	Pre-amplifier	ZVA-183-S+	5969001149	2022/11/09	2023/11/08
PASTERNAK	Horn Antenna	PE9852/2F-20	112002	2021/02/05	2024/02/04
Quinstar	Preamplifier	QLW-18405536-JO	15964001005	2022/9/16	2023/9/15
MICRO-COAX	Coaxial Cable	UFB142A-1-2362-200200	235772-001	2022/08/07	2023/08/06
PASTERNAK	Horn Antenna	PE9850/2F-20	072001	2021/02/05	2024/02/04
OML	Harmonic Mixer	WR19/M19HWD	U60314-1	2020/10/16	2023/10/15
OML	Horn Antenna	M19RH	11648-03	2020/10/16	2023/10/15
OML	Harmonic Mixer	WR12/M12HWD	E60119-1	2020/10/17	2023/10/16
OML	Horn Antenna	M12RH	E60119-2	2020/10/18	2023/10/17
OML	Harmonic Mixer	WR08/M08HWD	F60315-1	2020/10/22	2023/10/21
OML	Horn Antenna	M08RH	F60315-2	2020/10/24	2023/10/23
OML	Harmonic Mixer	WR05/M05HWD	G60107-1	2020/10/25	2023/10/24
OML	Horn Antenna	M05RH	G60107-2	2020/10/26	2023/10/25
OML	Harmonic Mixer	WR03/M03HWD	H60122-1	2020/11/10	2023/11/09

OML	Horn Antenna	M03RH	H60122-2	2020/11/06	2023/11/05
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** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Please refer to the below table and plots.

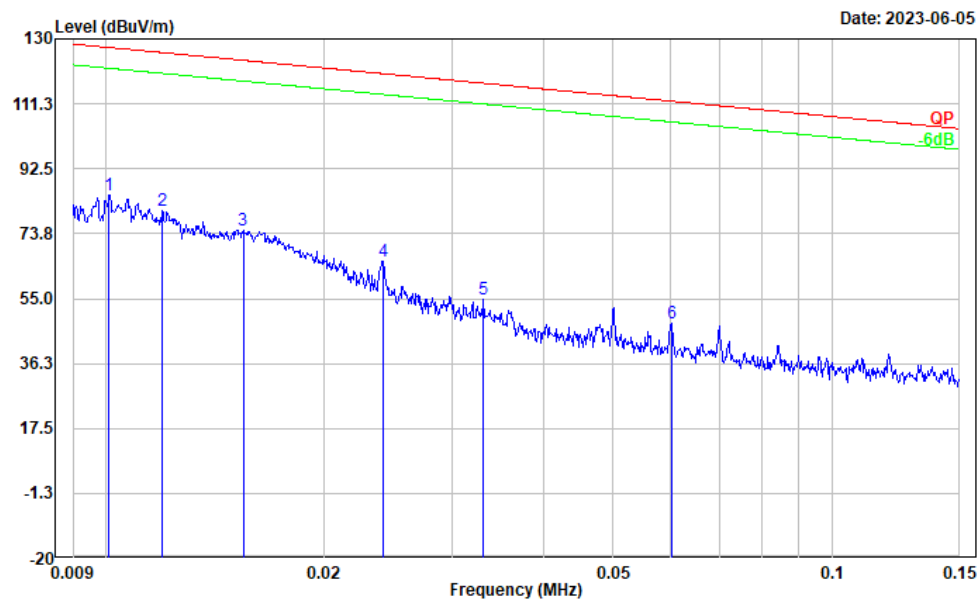
Note: The device can be mounted in multiple orientations, test was performed with X,Y, Z Axis, the worst orientation was photographed and it's data was recorded.

1) 9kHz-30MHz

Parallel:

DC 12V:

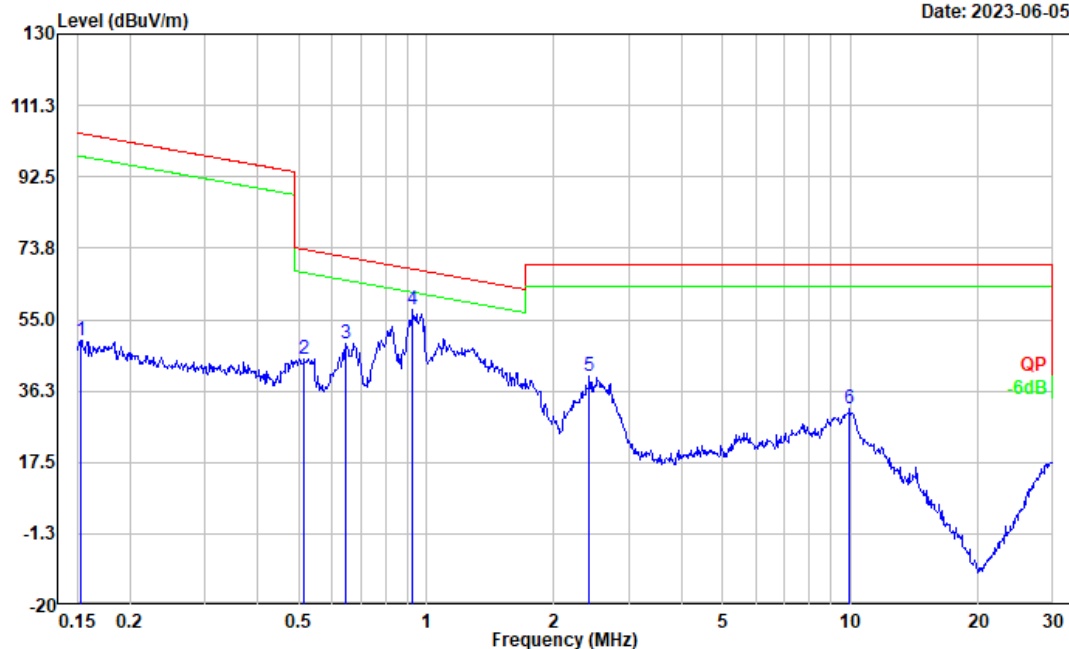
Test Mode: Transmitting
Polarization: Parallel
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.010	26.94	57.94	84.88	127.52	42.64	Peak
2	0.012	24.03	56.31	80.34	126.05	45.71	Peak
3	0.015	21.65	53.27	74.92	123.83	48.91	Peak
4	0.024	18.16	47.78	65.94	119.97	54.03	Peak
5	0.033	9.96	44.99	54.95	117.21	62.26	Peak
6	0.060	7.67	40.04	47.71	112.02	64.31	Peak

Test Mode: Transmitting
Polarization: Parallel
Note:

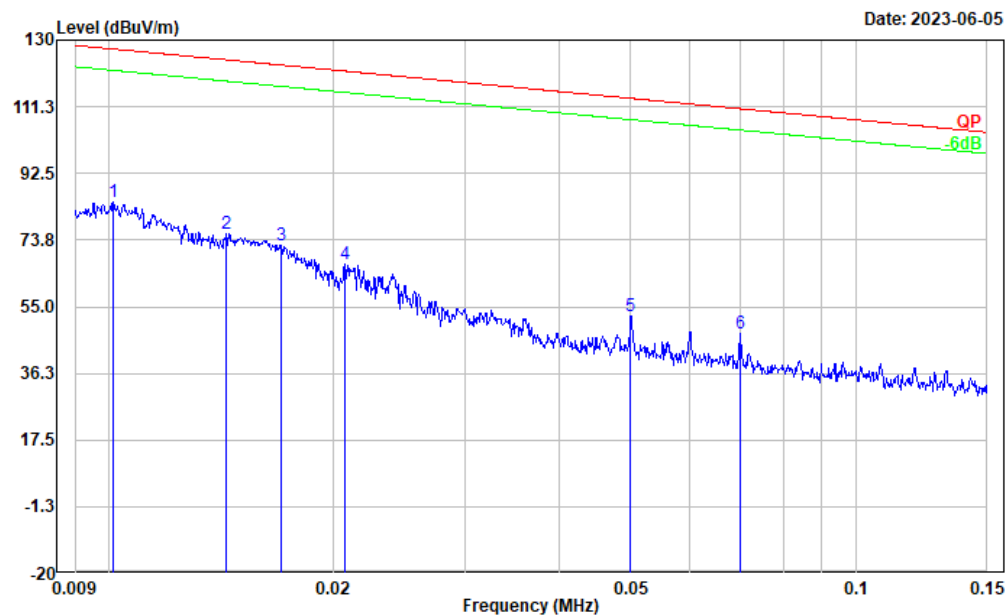
Date: 2023-06-05



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.153	17.26	32.24	49.50	103.90	54.40	Peak
2	0.516	22.71	22.03	44.74	73.35	28.61	Peak
3	0.644	28.47	20.36	48.83	71.38	22.55	Peak
4	0.928	40.12	17.51	57.63	68.13	10.50	Peak
5	2.422	30.33	10.00	40.33	69.54	29.21	Peak
6	9.966	27.23	4.45	31.68	69.54	37.86	Peak

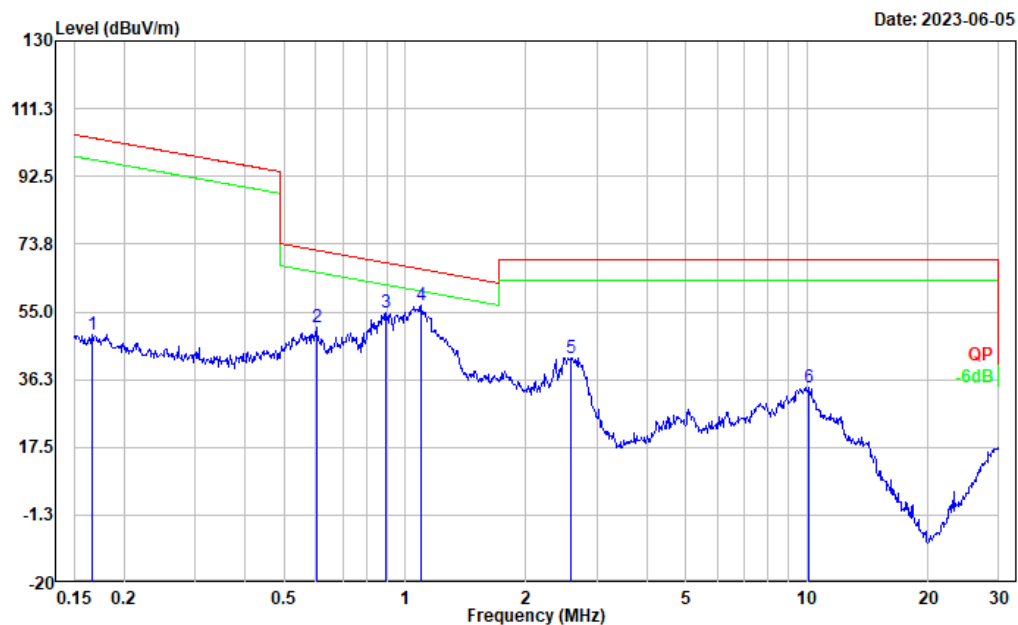
DC 24V:

Test Mode: Transmitting
Polarization: Parallel
Note:



No.	Frequency (MHz)	Reading (dB μ V)	Factor (dB/m)	Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Detector
1	0.010	26.62	57.91	84.53	127.49	42.96	Peak
2	0.014	21.47	54.21	75.68	124.46	48.78	Peak
3	0.017	20.35	51.91	72.26	123.00	50.74	Peak
4	0.021	18.01	49.02	67.03	121.29	54.26	Peak
5	0.050	10.14	42.29	52.43	113.64	61.21	Peak
6	0.070	9.17	38.25	47.42	110.70	63.28	Peak

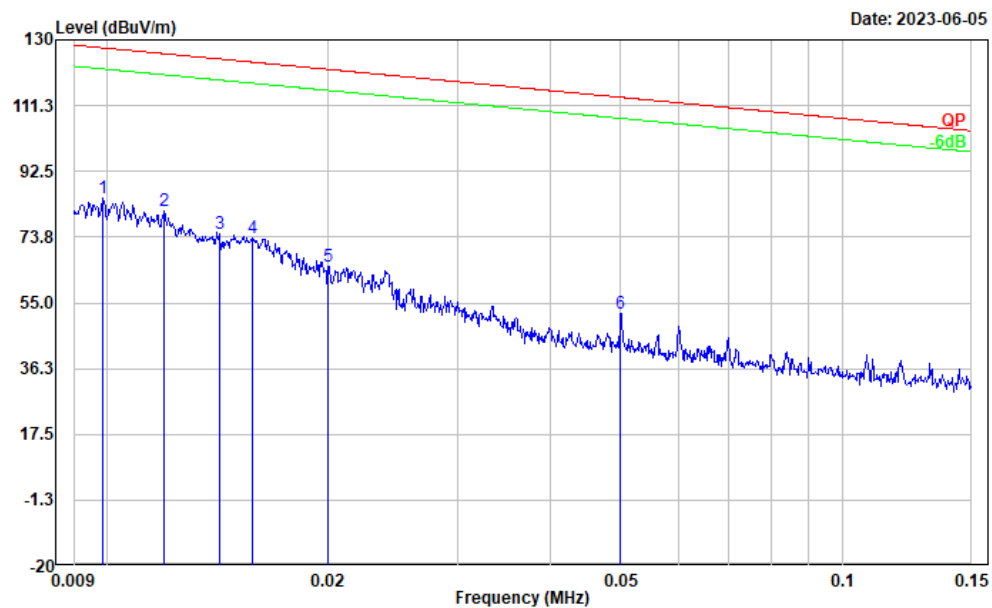
Test Mode: Transmitting
Polarization: Parallel
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.167	17.18	31.46	48.64	103.16	54.52	Peak
2	0.601	29.71	20.92	50.63	71.99	21.36	Peak
3	0.899	36.91	17.77	54.68	68.42	13.74	Peak
4	1.094	40.43	16.32	56.75	66.68	9.93	Peak
5	2.594	32.81	9.50	42.31	69.54	27.23	Peak
6	10.072	29.91	4.23	34.14	69.54	35.40	Peak

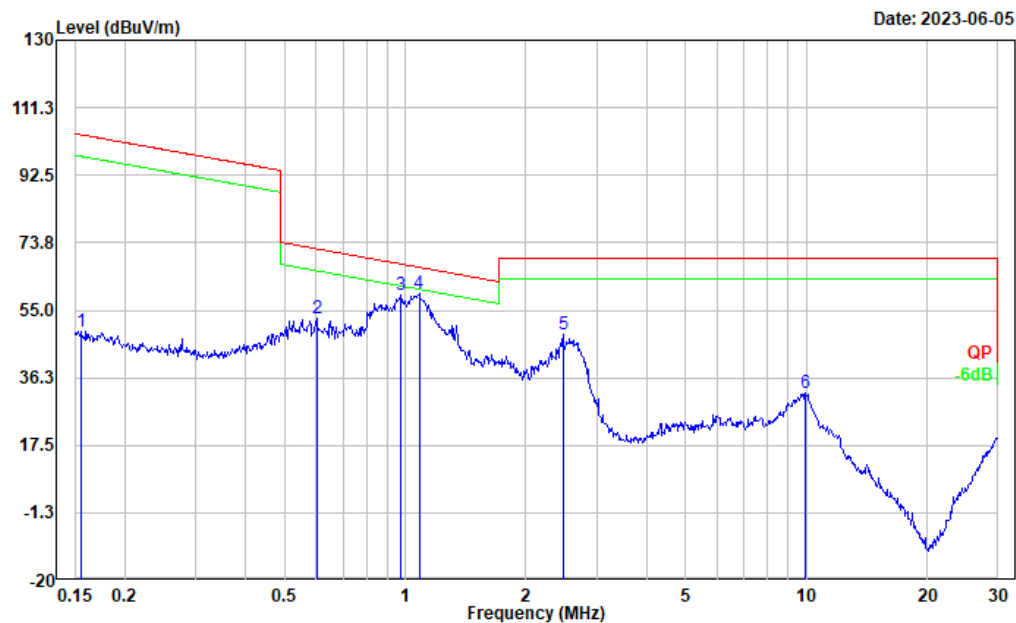
Perpendicular:
DC 12V:

Test Mode: Transmitting
Polarization: Perpendicular
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.010	26.59	58.16	84.75	127.71	42.96	Peak
2	0.012	24.84	56.31	81.15	126.05	44.90	Peak
3	0.014	20.53	54.35	74.88	124.56	49.68	Peak
4	0.016	20.51	52.99	73.50	123.66	50.16	Peak
5	0.020	16.14	49.28	65.42	121.58	56.16	Peak
6	0.050	9.48	42.29	51.77	113.64	61.87	Peak

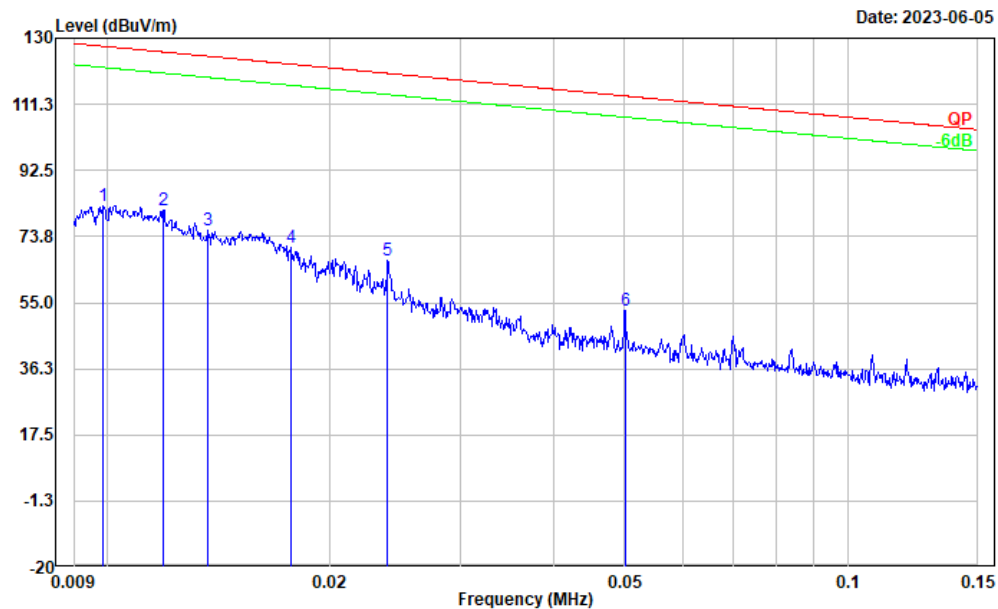
Test Mode: Transmitting
Polarization: Perpendicular
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.156	17.10	32.10	49.20	103.76	54.56	Peak
2	0.601	31.69	20.92	52.61	71.99	19.38	Peak
3	0.974	42.37	17.10	59.47	67.71	8.24	Peak
4	1.082	43.10	16.39	59.49	66.77	7.28	Peak
5	2.474	38.38	9.85	48.23	69.54	21.31	Peak
6	9.966	27.74	4.45	32.19	69.54	37.35	Peak

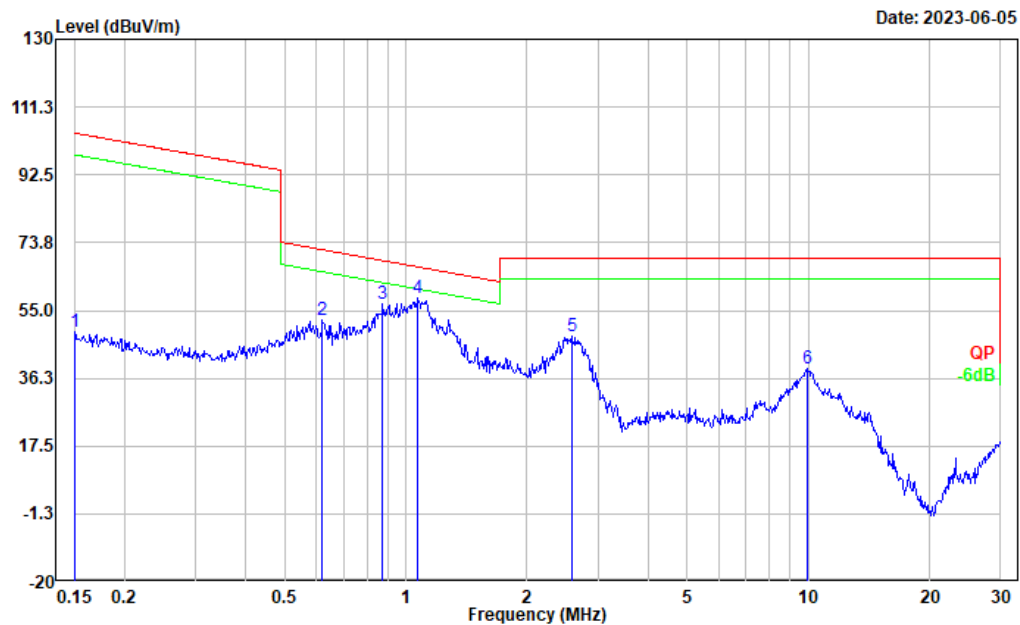
DC 24V:

Test Mode: Transmitting
Polarization: Perpendicular
Note:



No.	Frequency (MHz)	Reading (dB μ V)	Factor (dB/m)	Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Detector
1	0.010	24.47	58.16	82.63	127.71	45.08	Peak
2	0.012	24.73	56.37	81.10	126.10	45.00	Peak
3	0.014	20.62	54.79	75.41	124.88	49.47	Peak
4	0.018	19.25	51.26	70.51	122.63	52.12	Peak
5	0.024	18.98	47.85	66.83	120.04	53.21	Peak
6	0.050	10.60	42.26	52.86	113.61	60.75	Peak

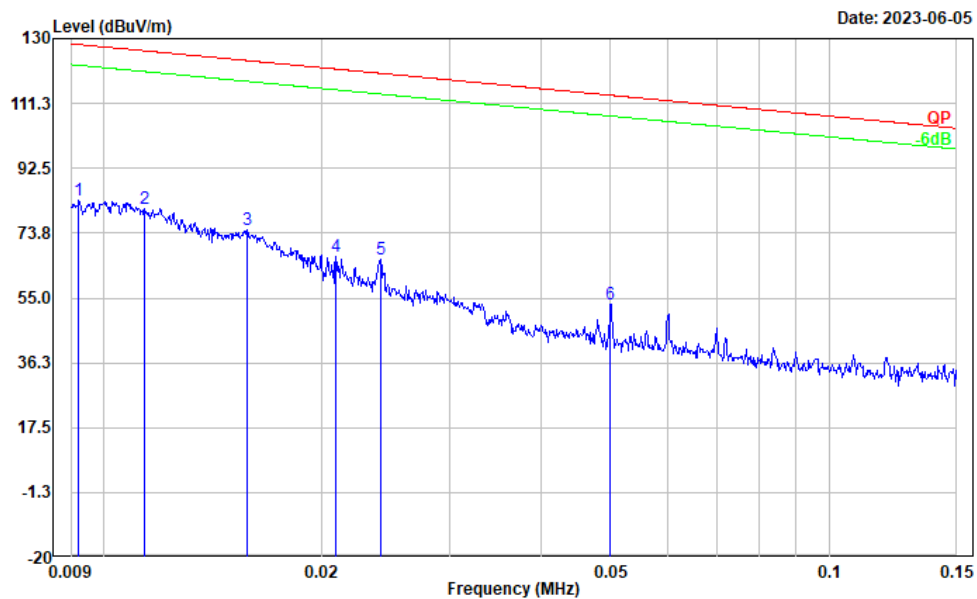
Test Mode: Transmitting
Polarization: Perpendicular
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.151	16.78	32.37	49.15	104.04	54.89	Peak
2	0.621	31.88	20.66	52.54	71.71	19.17	Peak
3	0.876	38.96	17.91	56.87	68.65	11.78	Peak
4	1.071	42.18	16.46	58.64	66.86	8.22	Peak
5	2.581	38.24	9.54	47.78	69.54	21.76	Peak
6	9.913	34.40	4.46	38.86	69.54	30.68	Peak

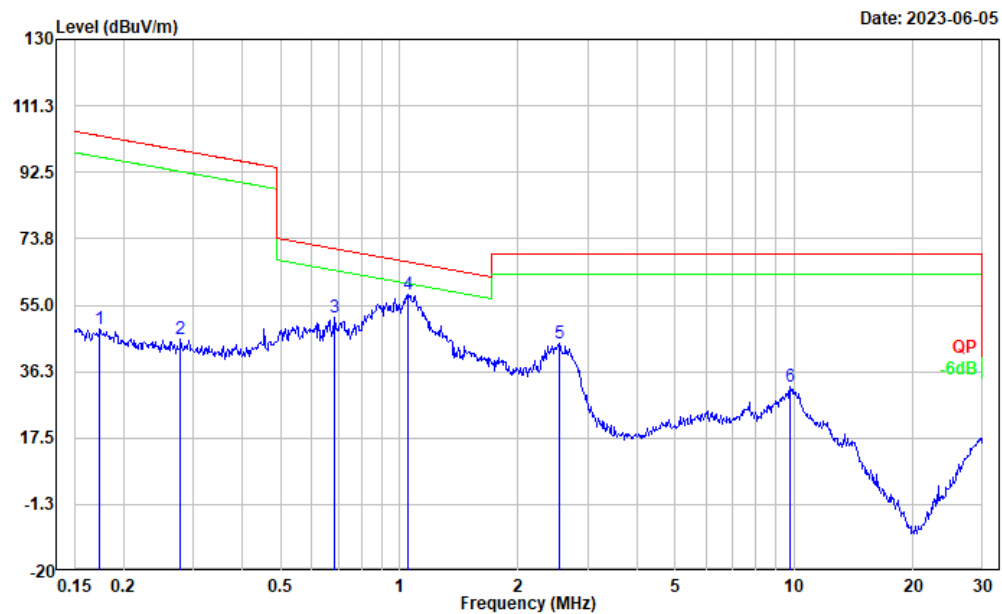
Ground-Parallel:
DC 12V:

Test Mode: Transmitting
Polarization: Ground-parallel
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.009	24.30	58.85	83.15	128.30	45.15	Peak
2	0.011	24.02	56.80	80.82	126.47	45.65	Peak
3	0.016	21.67	52.99	74.66	123.66	49.00	Peak
4	0.021	18.00	48.96	66.96	121.21	54.25	Peak
5	0.024	18.50	47.78	66.28	119.97	53.69	Peak
6	0.050	10.99	42.29	53.28	113.64	60.36	Peak

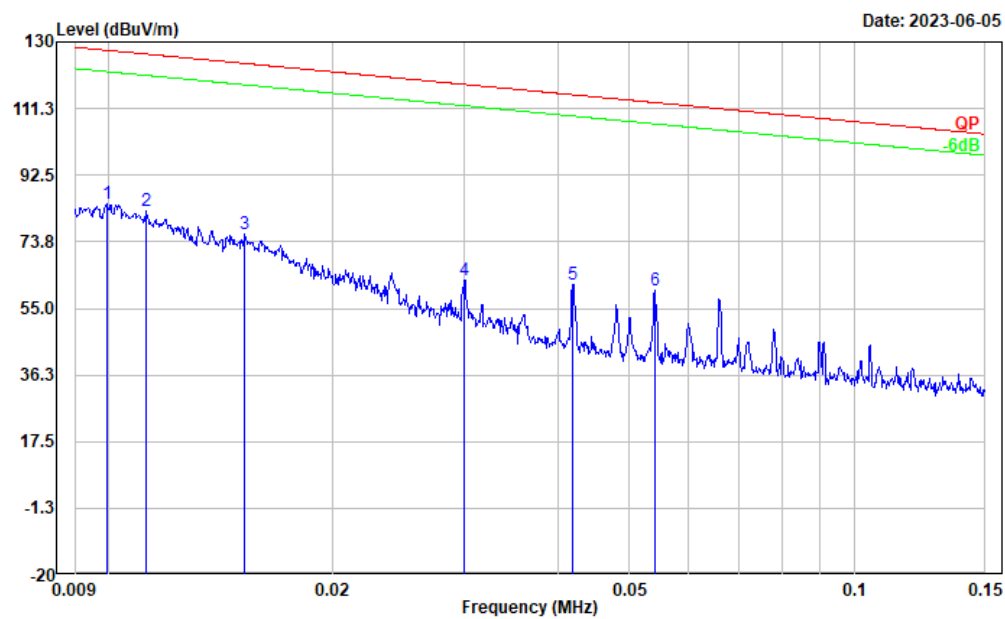
Test Mode: Transmitting
Polarization: Ground-parallel
Note:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	0.174	17.44	31.05	48.49	102.79	54.30	Peak
2	0.279	18.89	26.76	45.65	98.70	53.05	Peak
3	0.686	31.75	19.82	51.57	70.81	19.24	Peak
4	1.049	41.34	16.58	57.92	67.05	9.13	Peak
5	2.540	34.53	9.65	44.18	69.54	25.36	Peak
6	9.757	27.44	4.47	31.91	69.54	37.63	Peak

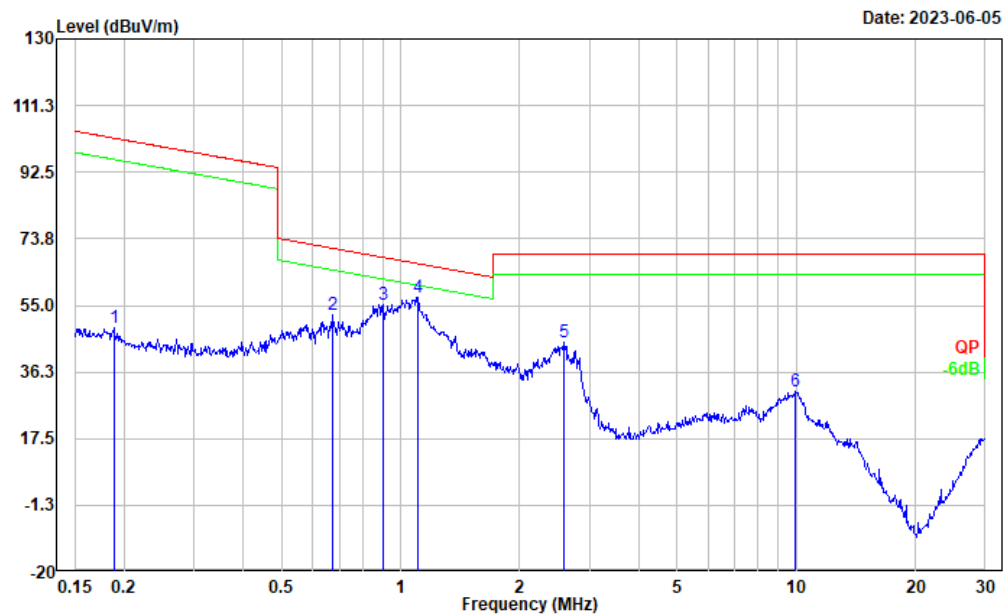
DC 24V:

Test Mode: Transmitting
Polarization: Ground-parallel
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.010	26.57	58.10	84.67	127.66	42.99	Peak
2	0.011	25.32	56.94	82.26	126.59	44.33	Peak
3	0.015	22.60	53.46	76.06	123.95	47.89	Peak
4	0.030	17.37	45.61	62.98	118.06	55.08	Peak
5	0.042	18.33	43.34	61.67	115.15	53.48	Peak
6	0.054	18.62	41.39	60.01	112.95	52.94	Peak

Test Mode: Transmitting
Polarization: Ground-parallel
Note:

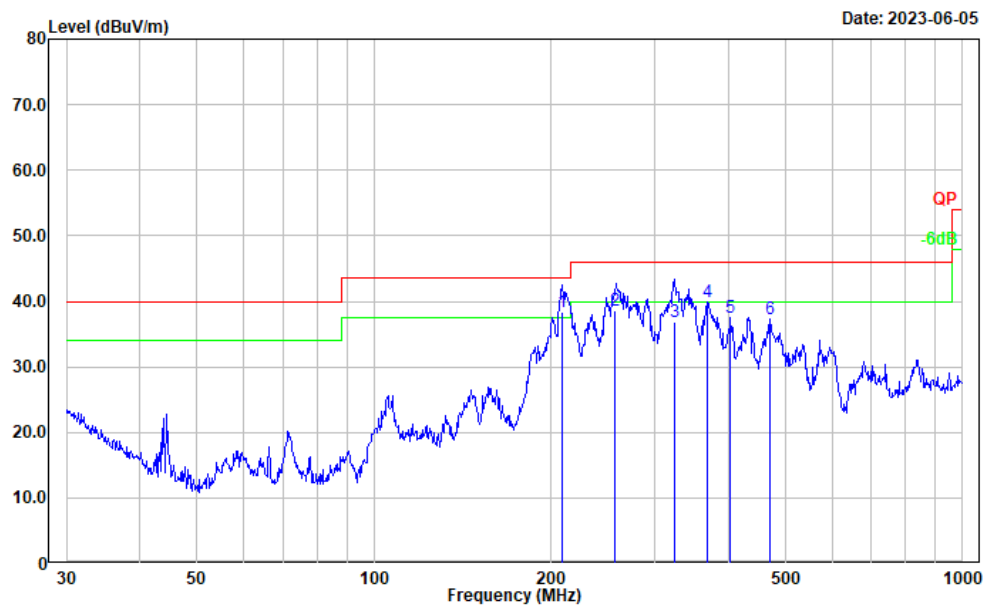


No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	0.188	18.38	30.24	48.62	102.10	53.48	Peak
2	0.672	32.26	20.01	52.27	71.00	18.73	Peak
3	0.904	37.59	17.72	55.31	68.37	13.06	Peak
4	1.106	41.03	16.27	57.30	66.58	9.28	Peak
5	2.594	35.04	9.50	44.54	69.54	25.00	Peak
6	9.913	26.25	4.46	30.71	69.54	38.83	Peak

2) 30MHz-1GHz

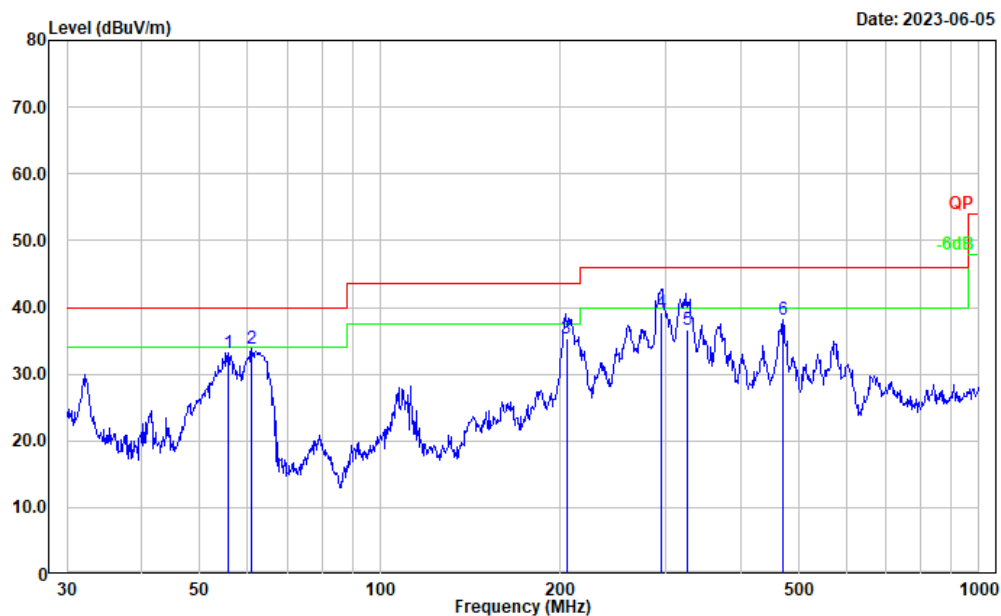
DC 12V:

Test Mode: Transmitting
Polarization: horizontal
Note:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	208.580	50.77	-12.44	38.33	43.50	5.17	QP
2	256.641	51.20	-12.69	38.51	46.00	7.49	QP
3	323.320	47.27	-10.44	36.83	46.00	9.17	QP
4	368.112	49.36	-9.57	39.79	46.00	6.21	Peak
5	403.250	46.19	-8.67	37.52	46.00	8.48	Peak
6	470.523	43.70	-6.33	37.37	46.00	8.63	Peak

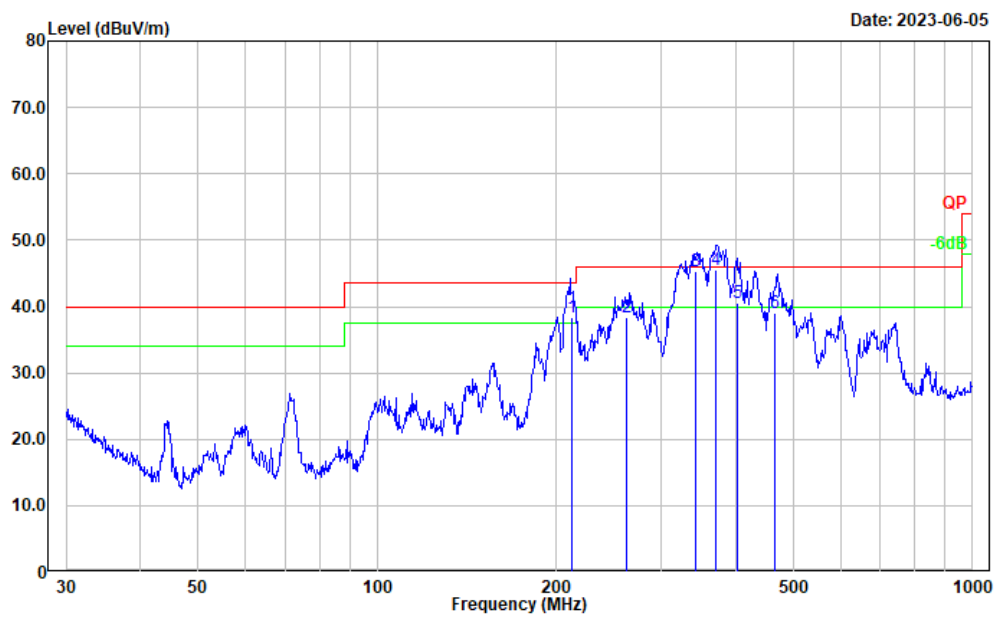
Test Mode: Transmitting
Polarization: vertical
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	55.805	50.46	-17.31	33.15	40.00	6.85	Peak
2	60.918	51.09	-17.37	33.72	40.00	6.28	Peak
3	204.727	47.61	-12.35	35.26	43.50	8.24	QP
4	295.406	50.07	-10.75	39.32	46.00	6.68	QP
5	326.098	46.99	-10.35	36.64	46.00	9.36	QP
6	470.523	44.50	-6.33	38.17	46.00	7.83	Peak

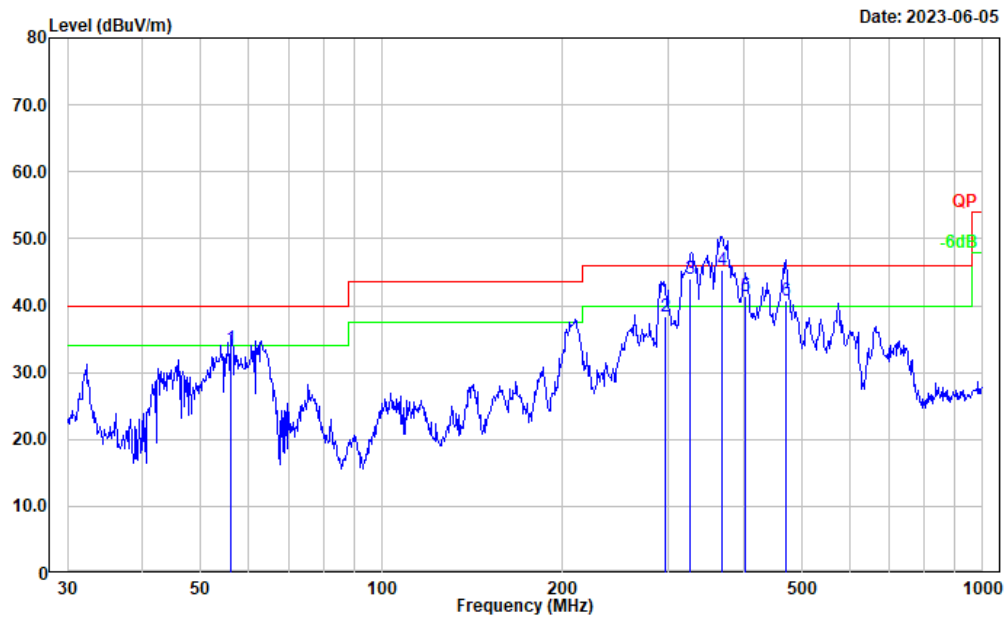
DC 24V:

Test Mode: Transmitting
Polarization: horizontal
Note:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	211.856	50.81	-12.52	38.29	43.50	5.21	QP
2	262.355	50.83	-12.35	38.48	46.00	7.52	QP
3	342.266	55.41	-10.04	45.37	46.00	0.63	QP
4	371.087	54.99	-9.48	45.51	46.00	0.49	QP
5	401.846	49.22	-8.71	40.51	46.00	5.49	QP
6	464.432	45.42	-6.50	38.92	46.00	7.08	QP

Test Mode: Transmitting
Polarization: vertical
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	56.197	50.97	-17.33	33.64	40.00	6.36	QP
2	296.913	49.07	-10.72	38.35	46.00	7.65	QP
3	326.184	54.42	-10.35	44.07	46.00	1.93	QP
4	367.423	54.91	-9.59	45.32	46.00	0.68	QP
5	403.153	50.02	-8.68	41.34	46.00	4.66	QP
6	470.527	47.09	-6.33	40.76	46.00	5.24	QP

3) 1GHz-40GHz:

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector					
7199.44	43.78	PK	H	14.17	57.95	74.00	16.05
7199.44	30.39	AV	H	14.17	44.56	54.00	9.44
7199.44	45.31	PK	V	14.17	59.48	74.00	14.52
7199.44	32.15	AV	V	14.17	46.32	54.00	7.68
24721.44	52.59	PK	H	6.78	59.37	74.00	14.63
24721.44	39.29	AV	H	6.78	46.07	54.00	7.93
21540.11	52.17	PK	V	5.05	57.22	74.00	16.78
21540.11	39.09	AV	V	5.05	44.14	54.00	9.86
34309.96	52.34	PK	H	13.82	60.14	74.00	13.86
34309.96	39.17	AV	H	13.82	46.97	54.00	7.03
39341.07	52.72	PK	V	16.31	63.01	74.00	10.99
39341.07	39.37	AV	V	16.31	49.66	54.00	4.34

Note:

For 26.5-40GHz:

Result = Reading + Factor- Distance extrapolation Factor

Distance extrapolation Factor = $20 \log (\text{specific distance [3m]}/\text{test distance [1.5m]})$ dB= 6.02 dB

3) 40GHz-231GHz:

Frequency (GHz)	Receiver	Polar (H/V)	Factor (dB/m)	Field Strength (dBμV/m)	Power Density (pW/cm ²)	Limit (pW/cm ²)
	Reading (dBμV)					
48.870	50.87	H	40.17	91.04	37.20	600.00
48.090	50.23	V	40.05	90.28	31.23	600.00
69.090	56.98	H	43.33	100.31	314.45	600.00
68.970	57.38	V	43.31	100.69	343.20	600.00
90.330	60.23	H	45.15	105.38	252.63	600.00
90.980	60.12	V	45.23	105.35	250.89	600.00
178.090	56.43	H	50.56	106.99	366.01	600.00
180.980	56.89	V	50.69	107.58	419.26	600.00
230.980	46.98	H	52.87	99.85	70.71	1000.00
230.120	47.98	V	52.84	100.82	88.41	1000.00

Factor = Antenna Factor

Field Strength = Reading + Factor

EIRP (dBm) = Field Strength (dBμV/m) + 20log(D) - 104.8

D is the measurement distance

$$EIRP_{Linear} = 10^{\left[\frac{(EIRP_{Log} - 30)}{10}\right]}$$

where

$EIRP_{Linear}$ is the equivalent isotropically radiated power, in watts

$EIRP_{Log}$ is the equivalent isotropically radiated power, in dBm

$$PD = \frac{EIRP_{Linear}}{4\pi d^2}$$

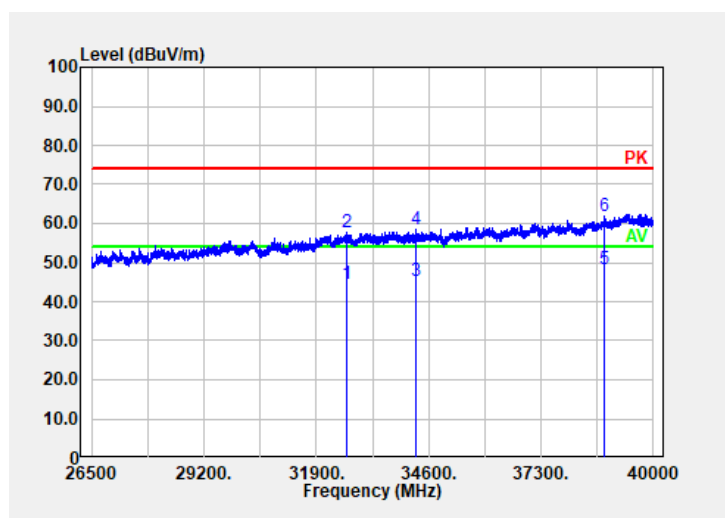
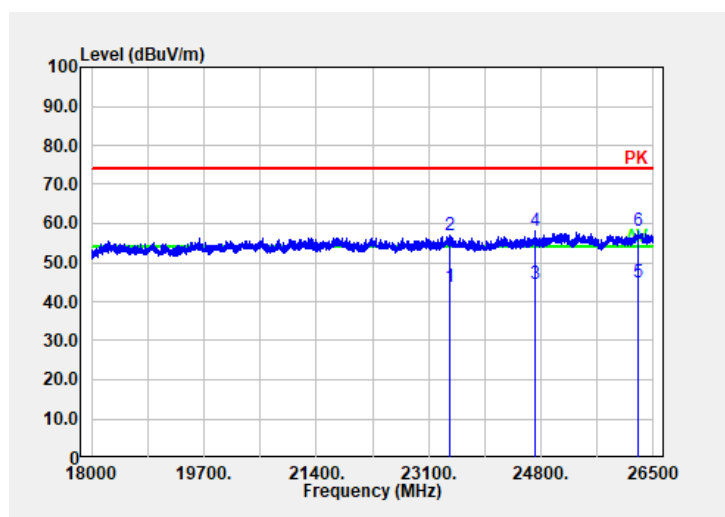
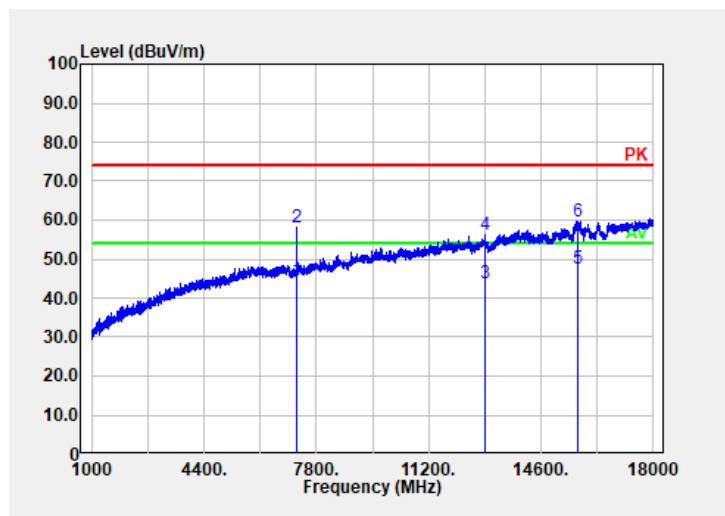
where

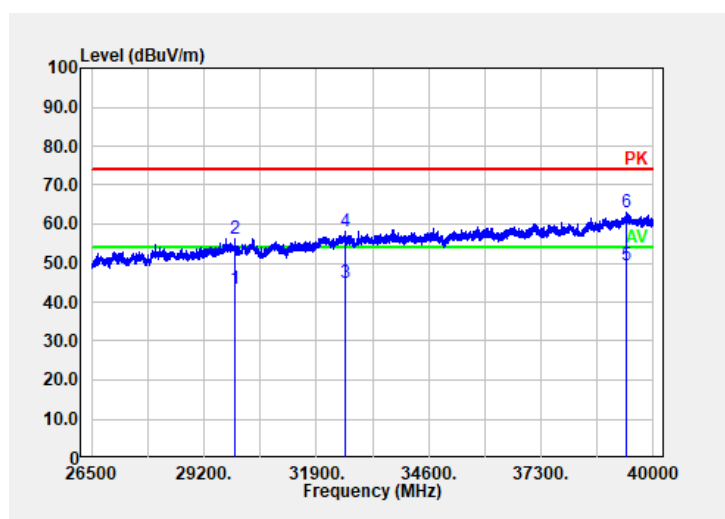
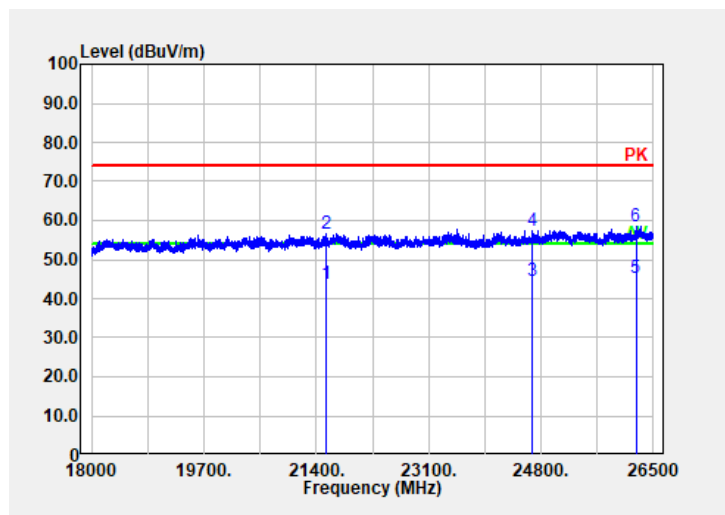
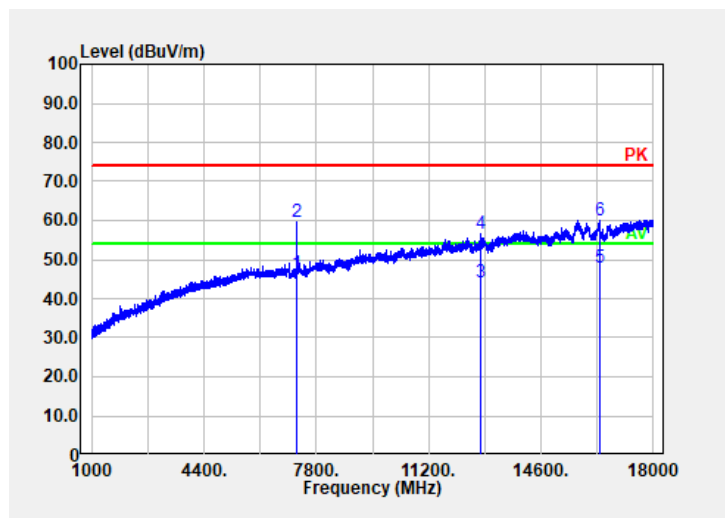
PD is the power density at the distance specified by the limit, in W/m²

$EIRP_{Linear}$ is the equivalent isotropically radiated power, in watts

d is the distance at which the power density limit is specified, in m

The Specified distance is 3m.

Test plots
Horizontal:

Vertical:

4.3 Frequency Stability:

Serial Number:	231I_1	Test Date:	2023/04/03
Test Site:	RF	Test Mode:	Transmitting
Tester:	Mack Huang	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	25.8	Relative Humidity: (%)	57	ATM Pressure: (kPa)	100.5
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Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101943	2022/07/25	2023/07/24
OML	Harmonic Mixer	WR12/M12HWD	E60119-1	2020/10/17	2023/10/16
OML	Horn Antenna	M12RH	E60119-2	2020/10/18	2023/10/17
BACL	TEMP&HUMI Test Chamber	BTH-150-40	30174	2023/3/31	2024/3/30
UNI-T	Multimeter	UT39A+	C210582554	2022/09/29	2023/09/28

** **Statement of Traceability:** China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Temperature	Voltage	Frequency (GHz)			
		f_L	f_H	f_L Limit	f_H Limit
-20	24	77.45290	79.45650	76	81
	12	77.45298	79.45649	76	81
-10	24	77.45330	79.45670	76	81
	12	77.4532	79.45668	76	81
0	24	77.45320	79.45660	76	81
	12	77.45321	79.45662	76	81
10	24	77.45320	79.45680	76	81
	12	77.45320	79.45681	76	81
20	24	77.45330	79.45670	76	81
	12	77.45331	79.45668	76	81
30	24	77.45300	79.45660	76	81
	12	77.45301	79.45660	76	81
40	24	77.45330	79.45660	76	81
	12	77.45329	79.45660	76	81
50	24	77.45310	79.45670	76	81
	12	77.45312	79.45672	76	81
20	10	77.45300	79.45680	76	81
20	32	77.45310	79.45660	76	81

4.4 Occupied Bandwidth:

Serial Number:	231I_1	Test Date:	2023/04/03
Test Site:	966-1	Test Mode:	Transmitting
Tester:	Mack Huang	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	26.1	Relative Humidity: (%)	55	ATM Pressure: (kPa)	100.5
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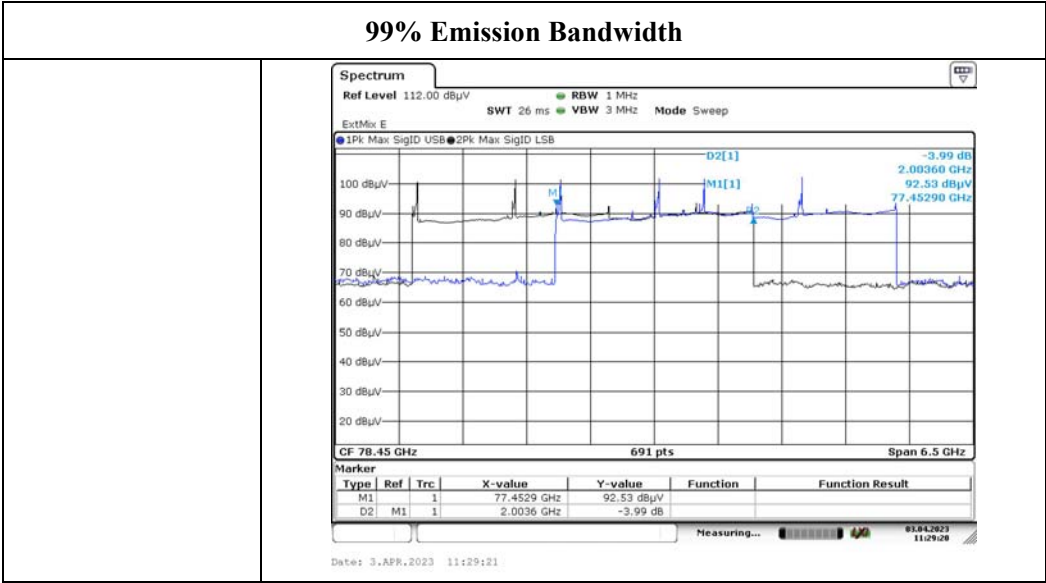
Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101943	2022/07/25	2023/07/24
OML	Harmonic Mixer	WR12/M12HWD	E60119-1	2020/10/17	2023/10/16
OML	Horn Antenna	M12RH	E60119-2	2020/10/18	2023/10/17

** **Statement of Traceability:** China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Test Frequency (MHz)	99% Occupied Bandwidth (MHz)
78450	2003.600



4.5 Duty Cycle:

Serial Number:	231I_1	Test Date:	2023/04/03
Test Site:	RF	Test Mode:	Transmitting
Tester:	Mack Huang	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	26.1	Relative Humidity: (%)	55	ATM Pressure: (kPa)	100.5
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Test Equipment List and Details:

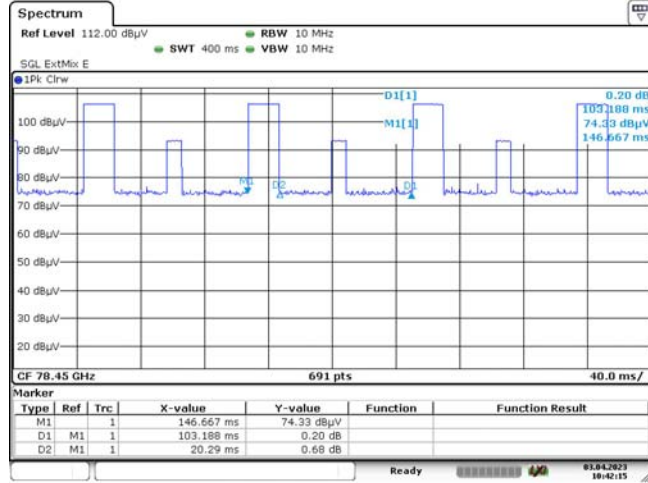
Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101943	2022/07/25	2023/07/24
OML	Harmonic Mixer	WR12/M12HWD	E60119-1	2020/10/17	2023/10/16
OML	Horn Antenna	M12RH	E60119-2	2020/10/18	2023/10/17

** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

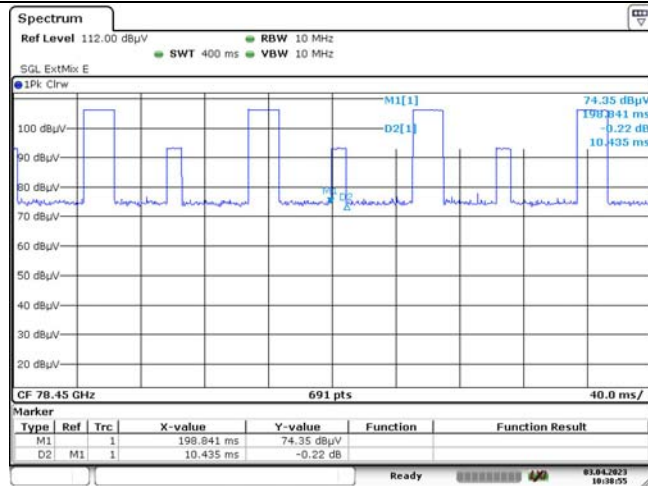
Test Data:

Test Frequency (MHz)	Ton (ms)	Ton+off (ms)	Duty cycle (%)
78450	30.73	103.19	29.78

Duty Cycle



Date: 3.APR.2023 10:42:15



Date: 3.APR.2023 10:38:56

5. RF EXPOSURE EVALUATION

5.1 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

5.1.1 Applicable Standard

FCC §95.3385 & §1.1310 & §2.1091

Regardless of the power density levels permitted under this subpart, devices operating under the provisions of this subpart are subject to the radiofrequency radiation exposure requirements specified in §§ 1.1307(b), 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of this chapter.

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

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

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

5.1.2 Procedure

Prediction of power density at the distance of the applicable MPE limit

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

5.2 Measurement Result

Frequency (GHz)	Antenna Gain		Conducted output power including Tune-up Tolerance		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
	(dBi)	(numeric)	(dBm)	(mW)			
77.45-79.45	3.00	2	40	10000	40	0.9947	1

Result: The device meet FCC MPE at 40 cm distance.

===== END OF REPORT =====