



REPORT No.: SZ23100077E01

TEST REPORT

APPLICANT : MiMOMax Wireless Limited

PRODUCT NAME : 700MHz Upper A Block Tornado Transceiver

MODEL NAME : MWL-TORNADO-*H A/B/C *

BRAND NAME : MiMOMax Wireless

STANDARD(S) : 47 CFR Part 15 Subpart A and B

FCC ID : XMK-MMXTRNB006

RECEIPT DATE : 2021-01-28

TEST DATE : 2021-02-25 to 2021-04-15

ISSUE DATE : 2023-11-21



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Change History		
Version	Date	Reason for change
1.0	2023-11-21	First edition



1. Technical Information

Note: Provide by applicant

1.1. Applicant and Manufacturer Information

Applicant:	MiMOMax Wireless Limited
Applicant Address:	540 Wairakei Road, Christchurch 8053, New Zealand
Manufacturer:	MiMOMax Wireless Limited
Manufacturer Address:	540 Wairakei Road, Christchurch 8053, New Zealand

1.2. Equipment Under Test (EUT) Description

Product Name:	700MHz Upper A Block Tornado Transceiver
Serial No.:	N/A
Hardware Version:	IP001
Software Version:	TRN-04.06.02
Tx Frequency:	757MHz ~ 758MHz; 787 MHz ~ 788 MHz
Rx Frequency:	757MHz ~ 758MHz; 787 MHz ~ 788 MHz
Operating Voltage:	10.5V~60V DC(Isolated)

Note:

1. This test report is variant from the original report (Report No.: SZ21010246E01, Model Name: MWL-TORNADO-*H A/B/C *) based on the similarity between before, only added a Bandwidth 75KHz, the others are the same as before. We evaluated the above changes, which had no impact on the test results. The test results in this report still refer to the test results of the original test report.
2. For a more detailed description, please refer to specification or user's manual supplied by the applicant and/or manufacturer.



2. Test Results

2.1. Applied Reference Documents

The objective of the report is to perform testing according to 47 CFR Part 15 Subpart A and B:

No.	Identity	Document Title
1	47 CFR Part 15	Radio Frequency Devices

Test detailed items/section required by FCC rules and results are listed as below:

No.	Section	Description	Test Date	Test Engineer	Result	Method Determination Remark
1	15.101	Equipment authorization requirement	Receiver contained within a FCC Part 27 transceiver that has been certified. The receiver has therefore been verified.			No deviation
2	15.103	Exempted devices	Device is not exempt as it is a receiver that contains a digital device			No deviation
3	15.107	Conducted Emission	Not applicable			N/A ^{Note 1}
4	15.109	Radiated Emissions	2021.02.25	Yang Jie	PASS ^{Note 5}	No deviation
5	15.111	Antenna Terminal Disturbance	2021.04.15	Huang Zhiye	PASS ^{Note 5}	No deviation

Note 1: The test item is not applicable.

Note 2: Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.

Note 3: TORNADO TRANSCEIVER complies with FCC Part 15 Subparts A and B as a Class B Unintentional Radiator. Tests were performed according to the method of measurements prescribed in ANSI C63.4-2014.

Note 4: When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

Note 5: The test results of these test items in this report refer to the test report (Report No.: SZ21010246E01).



2.2. EUT Setup and Operating Conditions

Test Item	
Radiated Emission	
Mode 1	: EUT + RJ45 Link + 10.5V DC Power + Working
Mode 2	: EUT + RJ45 Link + 24V DC Power + Working
Mode 3	: EUT + RJ45 Link + 60V DC Power + Working
Remark: The above test mode in boldface (Mode 3) was the worst case of radiated emission test, only the test data of these modes were reported.	

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 - 35
Relative Humidity (%):	30 - 60
Atmospheric Pressure (kPa):	86 - 106

Receiver Test Frequencies:

Transmit Frequency (MHz)	Receiver Frequency (MHz)	Channel Bandwidth (KHz)	Modes of operation
757.050	787.950	12.5, 25.0, 50.0, 75.0	QPSK,16QAM,64QAM,256QAM
787.950	757.050	12.5, 25.0, 50.0, 75.0	QPSK,16QAM,64QAM,256QAM

3. 47 CFR Part 15B Requirements

3.1. Radiated Emission

3.1.1. Requirement

According to FCC section 15.109 (a), the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency range (MHz)	Field Strength Limitation at 3m Measurement Distance	
	($\mu\text{V/m}$)	(dB $\mu\text{V/m}$)
30.0 - 88.0	100	20log 100
88.0 - 216.0	150	20log 150
216.0 - 960.0	200	20log 200
Above 960.0	500	20log 500

As shown in FCC section 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector. When average radiated emission measurements are specified in this part, including emission measurements below 1000MHz, there also is a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

Note:

- 1) The tighter limit shall apply at the boundary between two frequency range.
- 2) Limitation expressed in dB $\mu\text{V/m}$ is calculated by $20\log \text{Emission Level}(\mu\text{V/m})$.



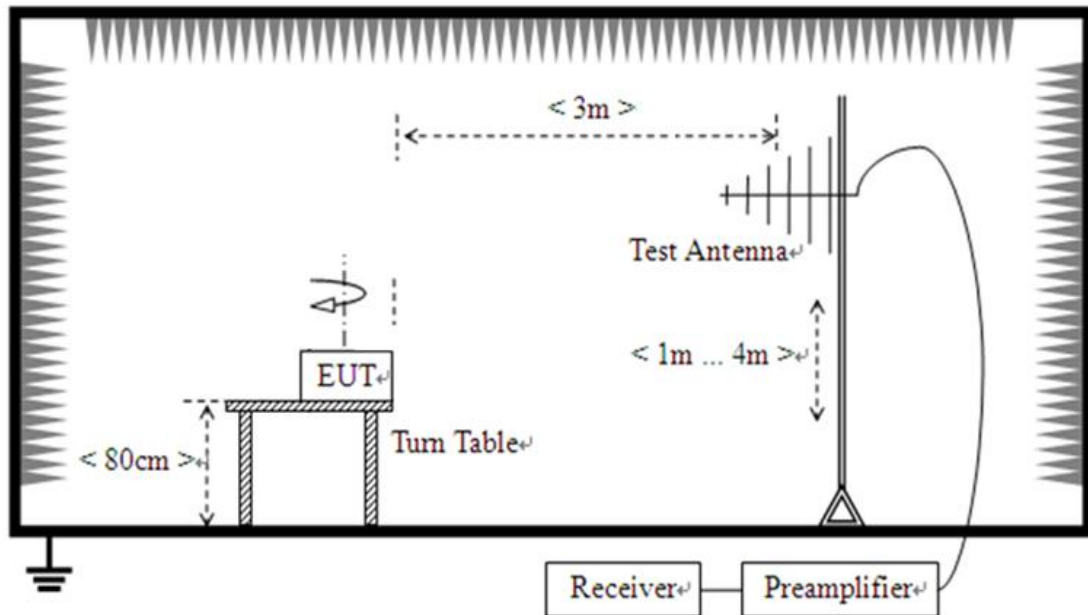
3.1.2. Frequency range of measurement

According to 15.33(b)(1), the frequency range of radiated measurement for the EUT is listed in the following table:

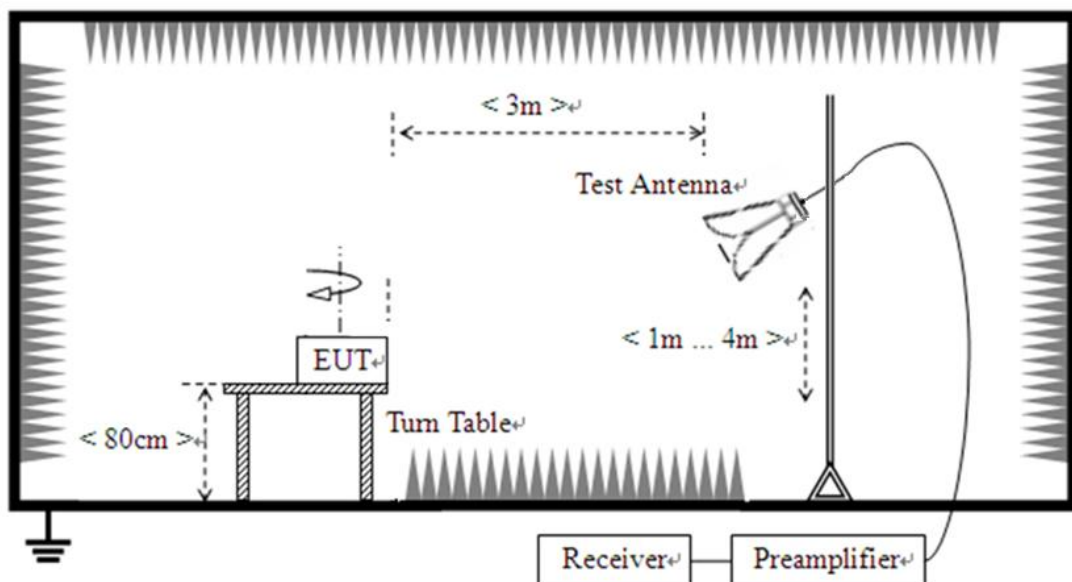
Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30.
1.705 – 108	1000.
108 – 500	2000.
500 – 1000	5000.
Above 1000	5 th harmonic of the highest frequency or 40GHz, whichever is lower

3.1.3. Test Setup

- 1) For radiated emissions from 30MHz to 1GHz



- 2) For radiated emissions above 1GHz





The test is performed in a 3m Semi-Anechoic Chamber, the antenna factor, cable loss and so on of the site (factors) is calculated to correct the reading. The EUT is placed on a 0.8m high insulating Turn Table, and keeps 3m away from the Test Antenna, which is mounted on a variable-height antenna master tower.

For the test Antenna:

In the frequency range above 30MHz, Bi-Log Test Antenna (30MHz to 1GHz) and Horn Test Antenna (above 1GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the ground to determine the maximum value of the field strength. The emission levels at both horizontal and vertical polarizations should be tested.

For measurements below 1GHz the resolution bandwidth is set to 120 kHz for peak detection measurements or 120kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1GHz the resolution bandwidth is set to 1MHz, the video bandwidth is set to 3MHz for peak measurements and as applicable for average measurements.



3.1.4. Test Result

The maximum radiated emission is searched using PK, QP and AV detectors; the emission levels more than the limits, and that have narrow margins from the limits will be re-measured with AV and QP detectors. Both the vertical and the horizontal polarizations of the Test Antenna are considered to perform the tests. All test modes are considered, refer to recorded points and plots below.

The amplitude of emissions which are attenuated more than 20 dB below the permissible value need not be reported.

The measurement results are obtained as below:

$$E [\text{dB}\mu\text{V}/\text{m}] = U_R [\text{dB}\mu\text{V}] + A_T [\text{dB}] + A_{\text{Factor}} [\text{dB}]; A_T = L_{\text{Cable loss}} [\text{dB}] - G_{\text{preamp}} [\text{dB}]$$

A_T : Total correction Factor except Antenna

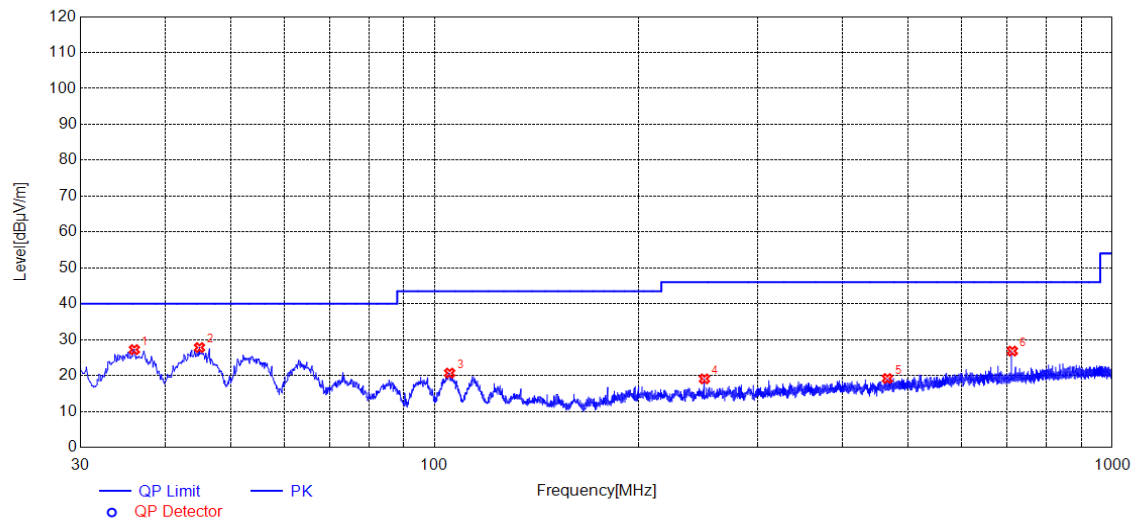
U_R : Receiver Reading

G_{preamp} : Preamplifier Gain

A_{Factor} : Antenna Factor at 3m

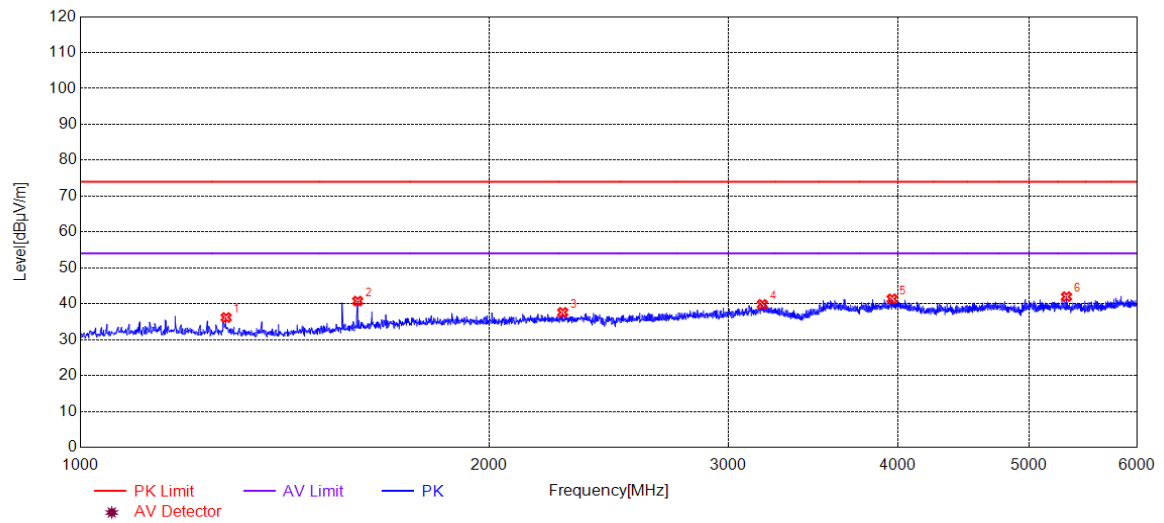
During the test, the total correction Factor A_T and A_{Factor} were built in test software.

Note: All radiated emission tests were performed in X, Y, Z axis direction, and only the worst axis test condition was recorded in this test report.



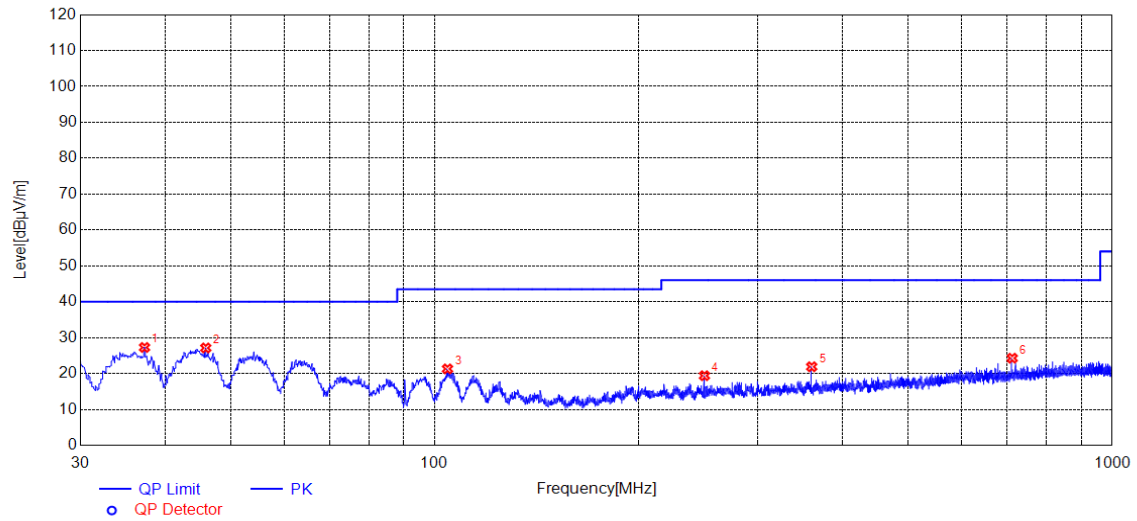
(Plot A: ANT-Vertical,30MHz - 1GHz)

No.	Fre. MHz	Pk dBμV/m	QP dBμV/m	AV dBμV/m	Limit-PK dBμV/m	Limit-QP dBμV/m	Limit-AV dBμV/m	ANT	Verdict
1	36.0146	27.23	N.A.	N.A.	N.A.	40.00	N.A.	V	PASS
2	44.9395	27.80	N.A.	N.A.	N.A.	40.00	N.A.	V	PASS
3	105.1825	20.69	N.A.	N.A.	N.A.	43.50	N.A.	V	PASS
4	250.0180	19.07	N.A.	N.A.	N.A.	46.00	N.A.	V	PASS
5	465.6706	19.18	N.A.	N.A.	N.A.	46.00	N.A.	V	PASS
6	711.9782	26.82	N.A.	N.A.	N.A.	46.00	N.A.	V	PASS



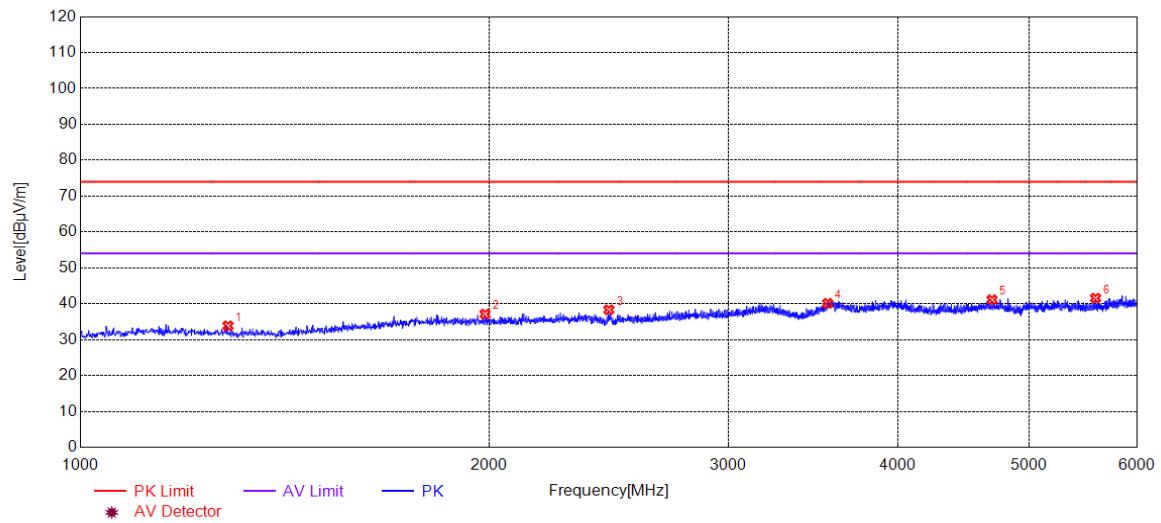
(Plot B: ANT-Vertical, 1GHz - 6GHz)

No.	Fre. MHz	Pk dBμV/m	QP dBμV/m	AV dBμV/m	Limit-PK dBμV/m	Limit-QP dBμV/m	Limit-AV dBμV/m	ANT	Verdict
1	1280.0560	36.16	N.A.	N.A.	74.00	N.A.	54.00	V	PASS
2	1600.1200	40.74	N.A.	N.A.	74.00	N.A.	54.00	V	PASS
3	2266.2533	37.60	N.A.	N.A.	74.00	N.A.	54.00	V	PASS
4	3179.4359	39.82	N.A.	N.A.	74.00	N.A.	54.00	V	PASS
5	3962.5925	41.36	N.A.	N.A.	74.00	N.A.	54.00	V	PASS
6	5326.8654	41.97	N.A.	N.A.	74.00	N.A.	54.00	V	PASS



(Plot C:ANT- Horizontal, 30MHz - 1GHz)

No.	Fre. MHz	Pk dBμV/m	QP dBμV/m	AV dBμV/m	Limit-PK dBμV/m	Limit-QP dBμV/m	Limit-AV dBμV/m	ANT	Verdict
1	37.2757	27.27	N.A.	N.A.	N.A.	40.00	N.A.	H	PASS
2	45.9096	27.13	N.A.	N.A.	N.A.	40.00	N.A.	H	PASS
3	104.4064	21.30	N.A.	N.A.	N.A.	43.50	N.A.	H	PASS
4	250.0180	19.40	N.A.	N.A.	N.A.	46.00	N.A.	H	PASS
5	360.0270	21.89	N.A.	N.A.	N.A.	46.00	N.A.	H	PASS
6	711.8812	24.28	N.A.	N.A.	N.A.	46.00	N.A.	H	PASS



(Plot D:ANT- Horizontal, 1GHz - 6GHz)

No.	Fre. MHz	Pk dBμV/m	QP dBμV/m	AV dBμV/m	Limit-PK dBμV/m	Limit-QP dBμV/m	Limit-AV dBμV/m	ANT	Verdict
1	1284.0568	33.86	N.A.	N.A.	74.00	N.A.	54.00	H	PASS
2	1986.1972	37.13	N.A.	N.A.	74.00	N.A.	54.00	H	PASS
3	2450.2901	38.33	N.A.	N.A.	74.00	N.A.	54.00	H	PASS
4	3552.5105	40.13	N.A.	N.A.	74.00	N.A.	54.00	H	PASS
5	4694.7389	41.14	N.A.	N.A.	74.00	N.A.	54.00	H	PASS
6	5595.9192	41.57	N.A.	N.A.	74.00	N.A.	54.00	H	PASS

**The test result for CB receiver RSE (25-30MHz) .**

Test mode	Fre. MHz	QP dBμV/m	Limit-QP dBμV/m	ANT	Verdict
Mode 3	25.63	23.33	32.04	V	PASS
	26.11	23.15			PASS
	27.95	24.49			PASS
	28.33	23.24			PASS
	28.54	24.96			PASS
	29.29	23.48			PASS
	25.34	21.35	32.04	H	PASS
	26.55	21.73			PASS
	27.71	21.95			PASS
	28.18	20.45			PASS
	28.93	21.51			PASS
	29.42	20.96			PASS



3.2. Antenna Terminal Disturbance

3.2.1. Requirement

In addition to the radiated emission limits, receivers that operate (tune) in the frequency range 30 to 960 MHz and CB receivers that provide terminals for the connection of an external receiving antenna may be tested to demonstrate compliance with the provisions of §15.109 with the antenna terminals shielded and terminated with a resistive termination equal to the impedance specified for the antenna, provided these receivers also comply with the following: With the receiver antenna terminal connected to a resistive termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements specified in §15.33 shall not exceed 2.0 nanowatts(-57dBm).

Measurements were attempted over the range of 30 MHz – 5 GHz



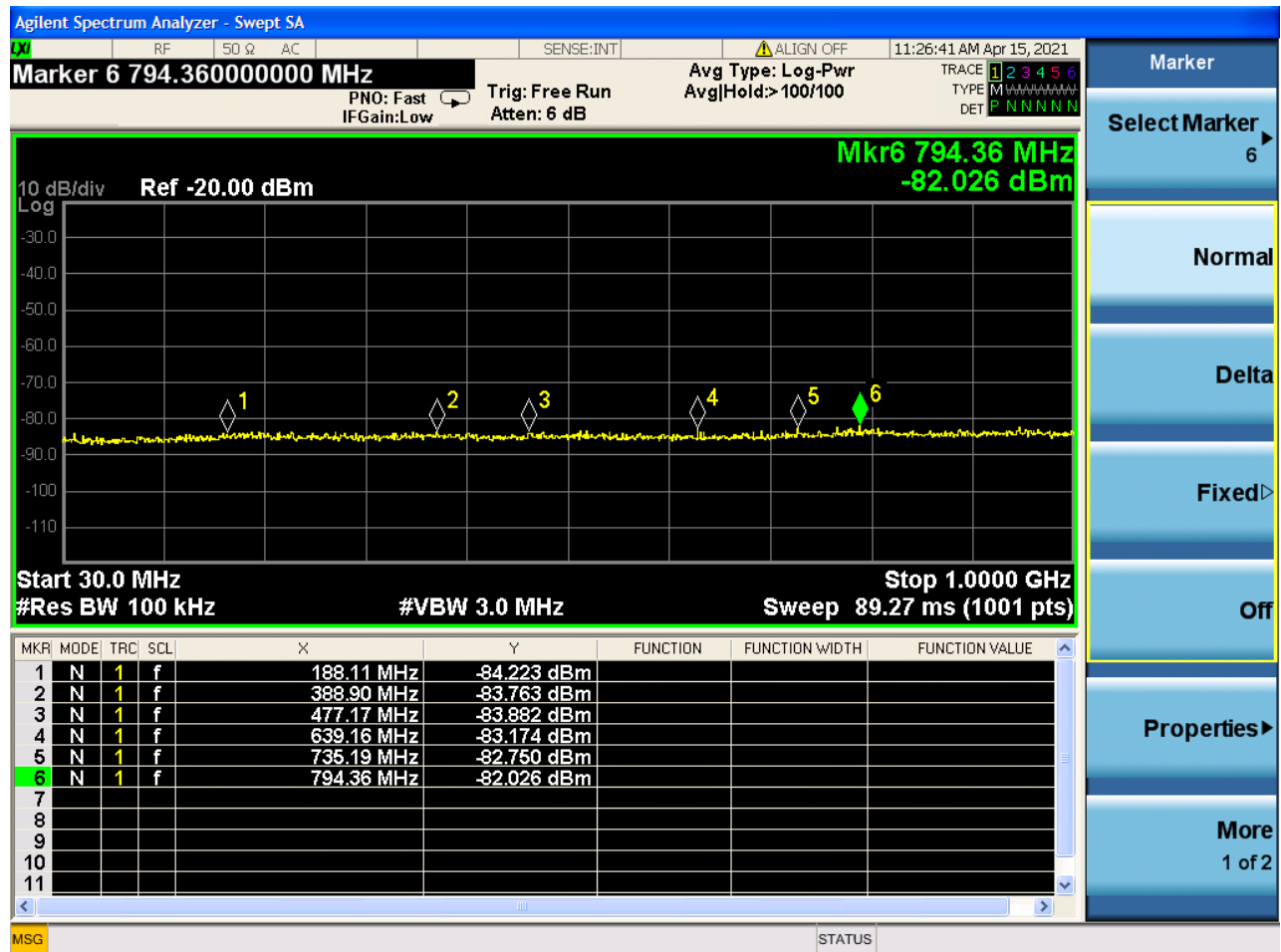
3.2.2. Test Result

Note: $P_{\text{Final value}}(\text{dBm}) = P_{\text{Reading value}}(\text{dBm}) + \text{Factor}(\text{dB})$,
Factor = 6dB (6 dB attenuator is used) + Cable loss(dB)

H port, Operate at 757.050MHz, 30MHz -1000MHz

Fre. MHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
188.11	-84.223	6.17	-78.053	-57	PASS
388.9	-83.763	6.24	-77.523	-57	PASS
477.17	-83.882	6.27	-77.612	-57	PASS
639.16	-83.174	6.33	-76.844	-57	PASS
735.19	-82.75	6.36	-76.39	-57	PASS
794.36	-82.026	6.38	-75.646	-57	PASS

Attach spectrum pictures of P_{Reading value} for this test here:

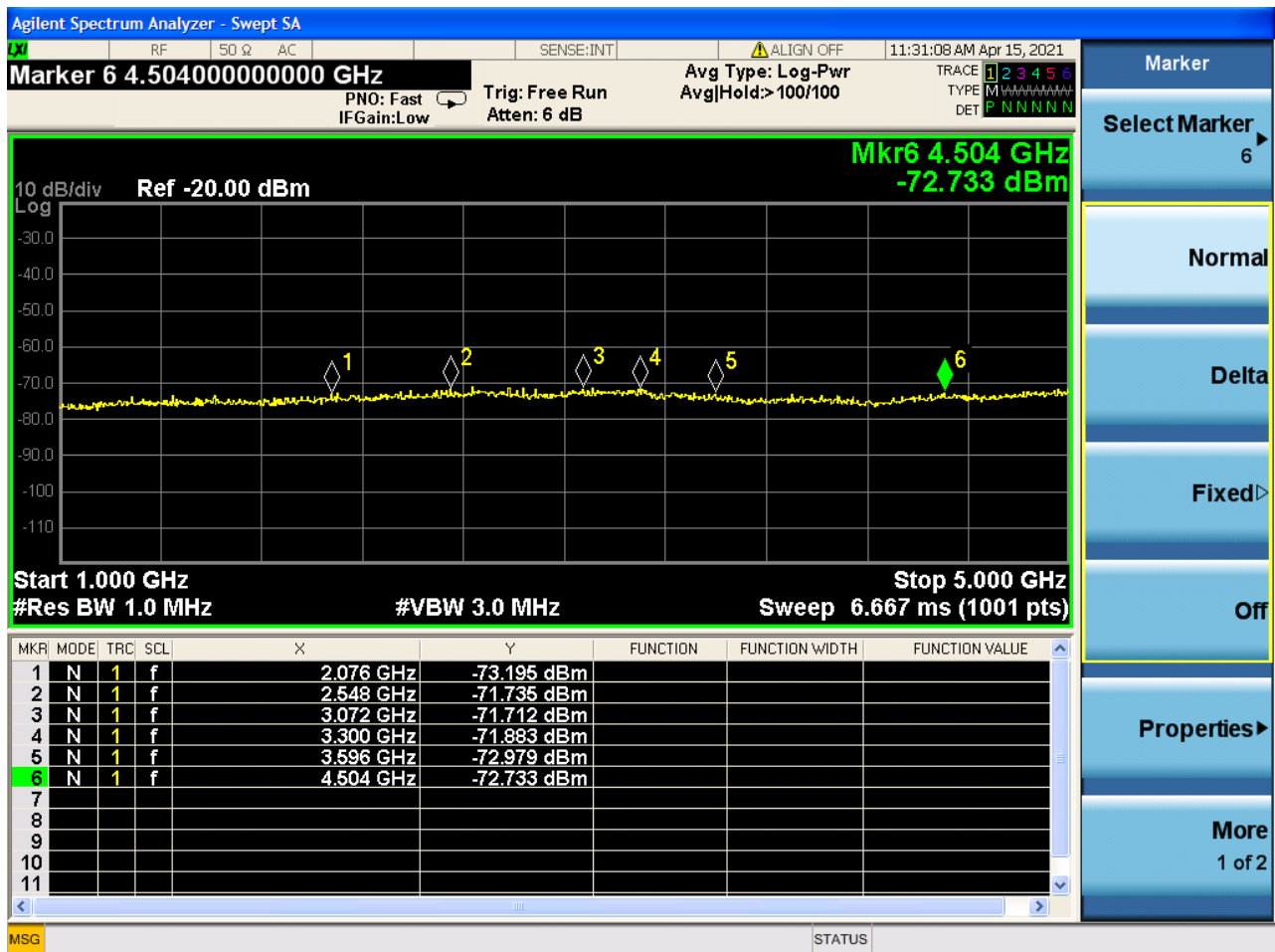




H port, Operate at 757.050MHz, 1GHz -5GHz

Fre. GHz	P _{Reading} value dBm	Factor dB	P _{Final} value dBm	Limit dBm	Verdict
2.076	-73.195	6.83	-66.365	-57	PASS
2.548	-71.935	6.99	-64.945	-57	PASS
3.072	-71.712	7.17	-64.542	-57	PASS
3.3	-71.883	7.25	-64.633	-57	PASS
3.596	-72.979	7.36	-65.619	-57	PASS
4.504	-72.733	7.67	-65.063	-57	PASS

Attach spectrum pictures of P_{Reading} value for this test here:

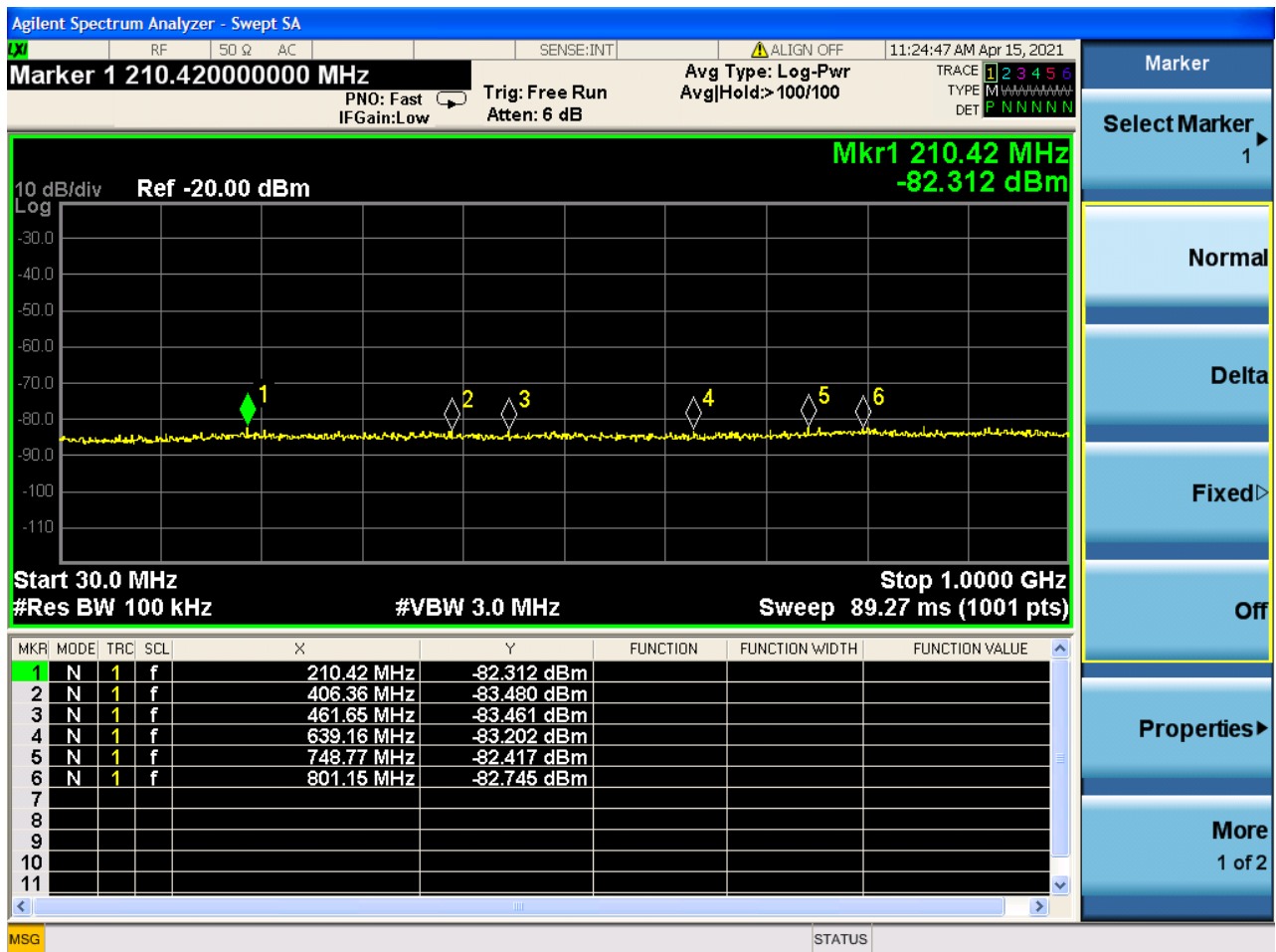




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V port, Operate at 757.050MHz, 30MHz -1000MHz

Fre. MHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
210.42	-82.312	6.18	-76.132	-57	PASS
406.36	-83.48	6.25	-77.23	-57	PASS
461.65	-83.461	6.27	-77.191	-57	PASS
639.16	-83.202	6.33	-76.872	-57	PASS
748.77	-82.417	6.37	-76.047	-57	PASS
801.15	-82.745	6.38	-76.365	-57	PASS

Attach spectrum pictures of P_{Reading value} for this test here:



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V port, Operate at 757.050MHz, 1GHz -5GHz

Fre. GHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
2.108	-74.093	6.84	-67.253	-57	PASS
2.528	-70.894	6.98	-63.914	-57	PASS
3.056	-71.764	7.17	-64.594	-57	PASS
3.192	-71.382	7.22	-64.162	-57	PASS
3.576	-73.684	7.35	-66.334	-57	PASS
4.344	-73.182	7.62	-65.562	-57	PASS

Attach spectrum pictures of P_{Reading value} for this test here:

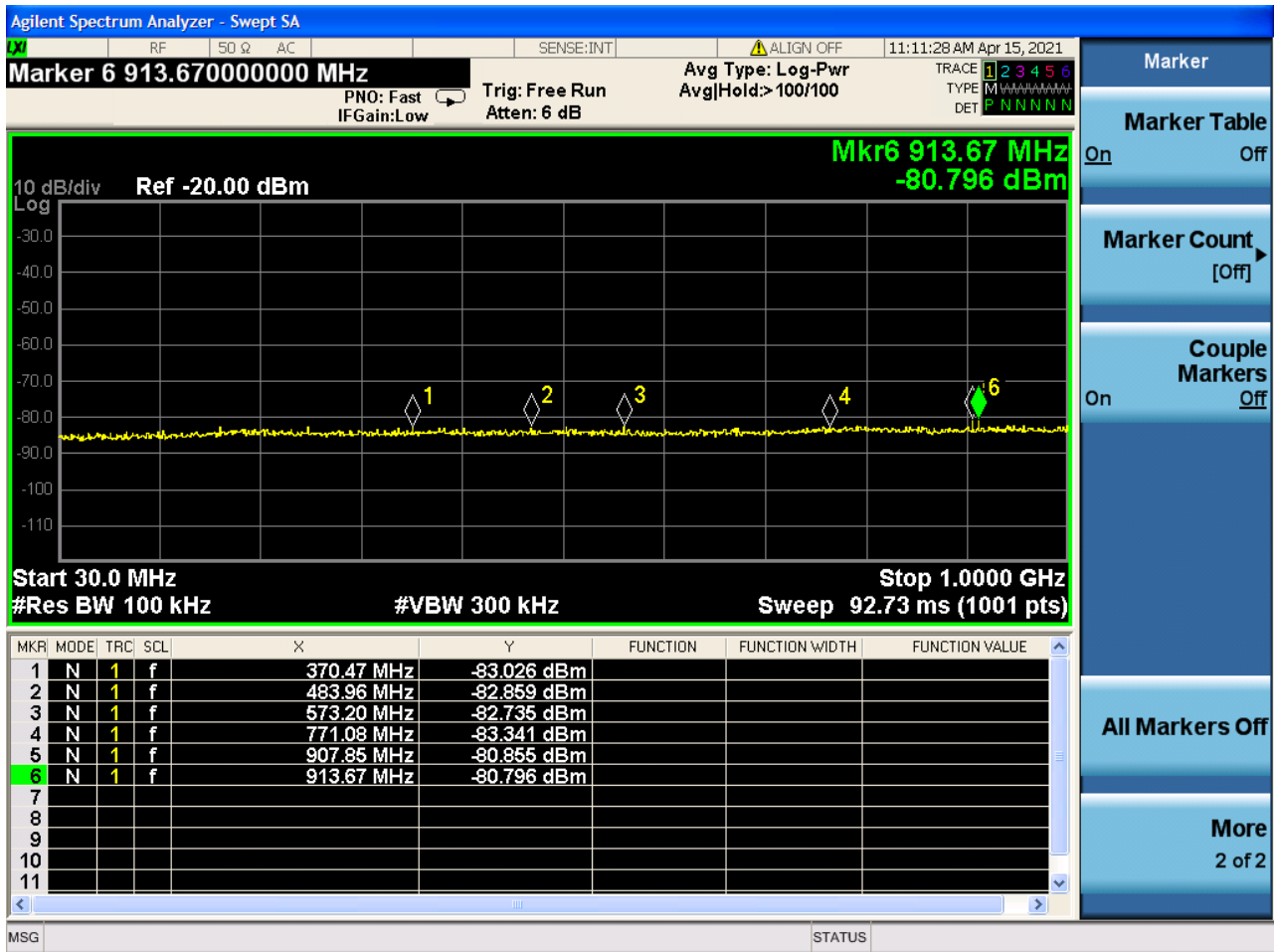


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H port, Operate at 787.950MHz, 30MHz -1000MHz

Fre. MHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
370.47	-83.026	6.23	-76.796	-57	PASS
483.96	-82.859	6.27	-76.589	-57	PASS
573.2	-82.735	6.3	-76.435	-57	PASS
771.08	-83.341	6.37	-76.971	-57	PASS
907.85	-80.855	6.42	-74.435	-57	PASS
913.67	-80.796	6.43	-74.366	-57	PASS

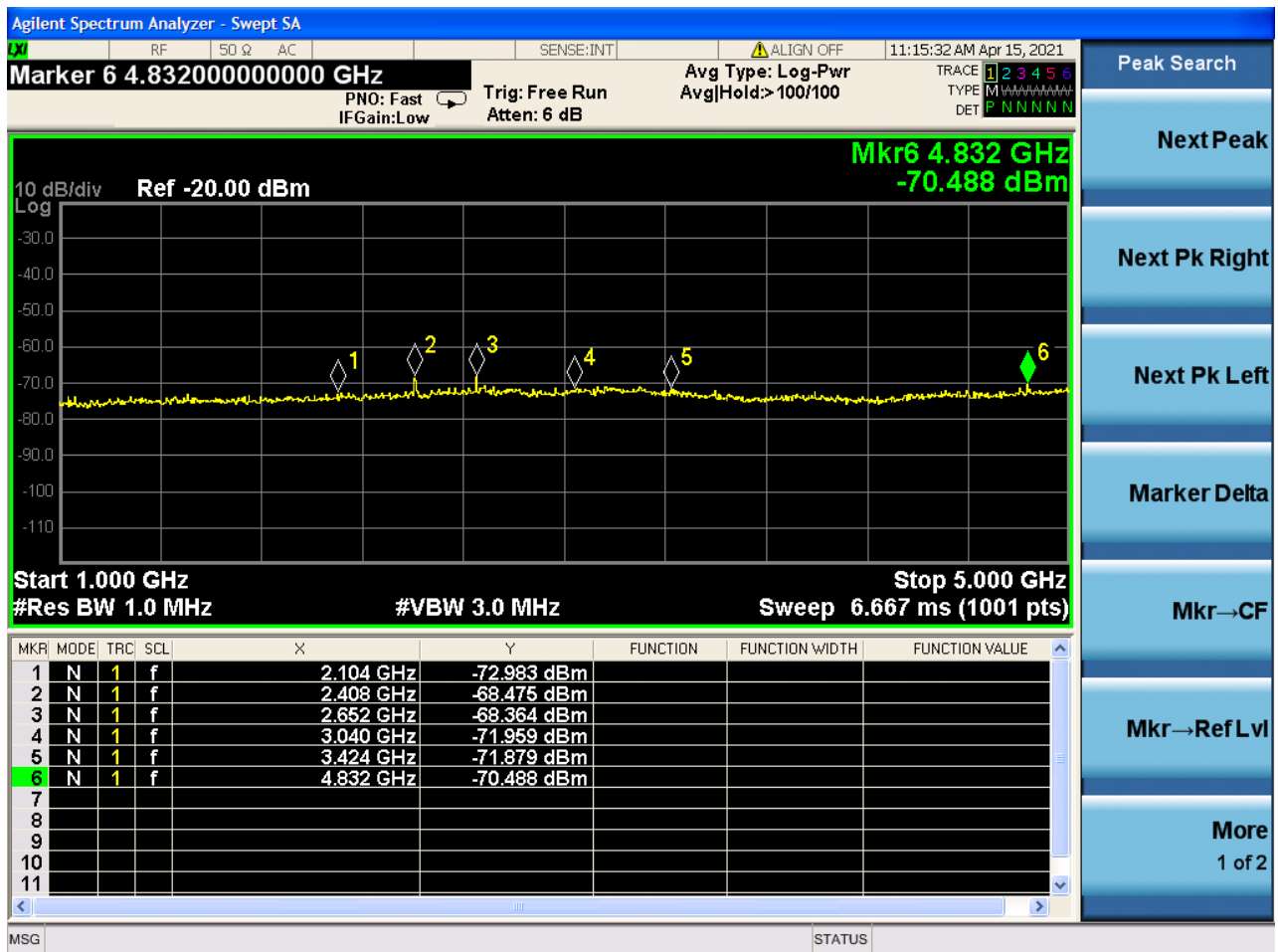
Attach spectrum pictures of P_{Reading value} for this test here:





H port, Operate at 787.950MHz, 1GHz -5GHz

Fre. GHz	P _{Reading} value dBm	Factor dB	P _{Final} value dBm	Limit dBm	Verdict
2.104	-72.983	6.84	-66.143	-57	PASS
2.408	-68.475	6.94	-61.535	-57	PASS
2.652	-71.959	7.32	-64.639	-57	PASS
3.04	-71.879	7.16	-64.719	-57	PASS
3.424	-71.897	7.3	-64.597	-57	PASS
4.832	-70.488	7.79	-62.698	-57	PASS

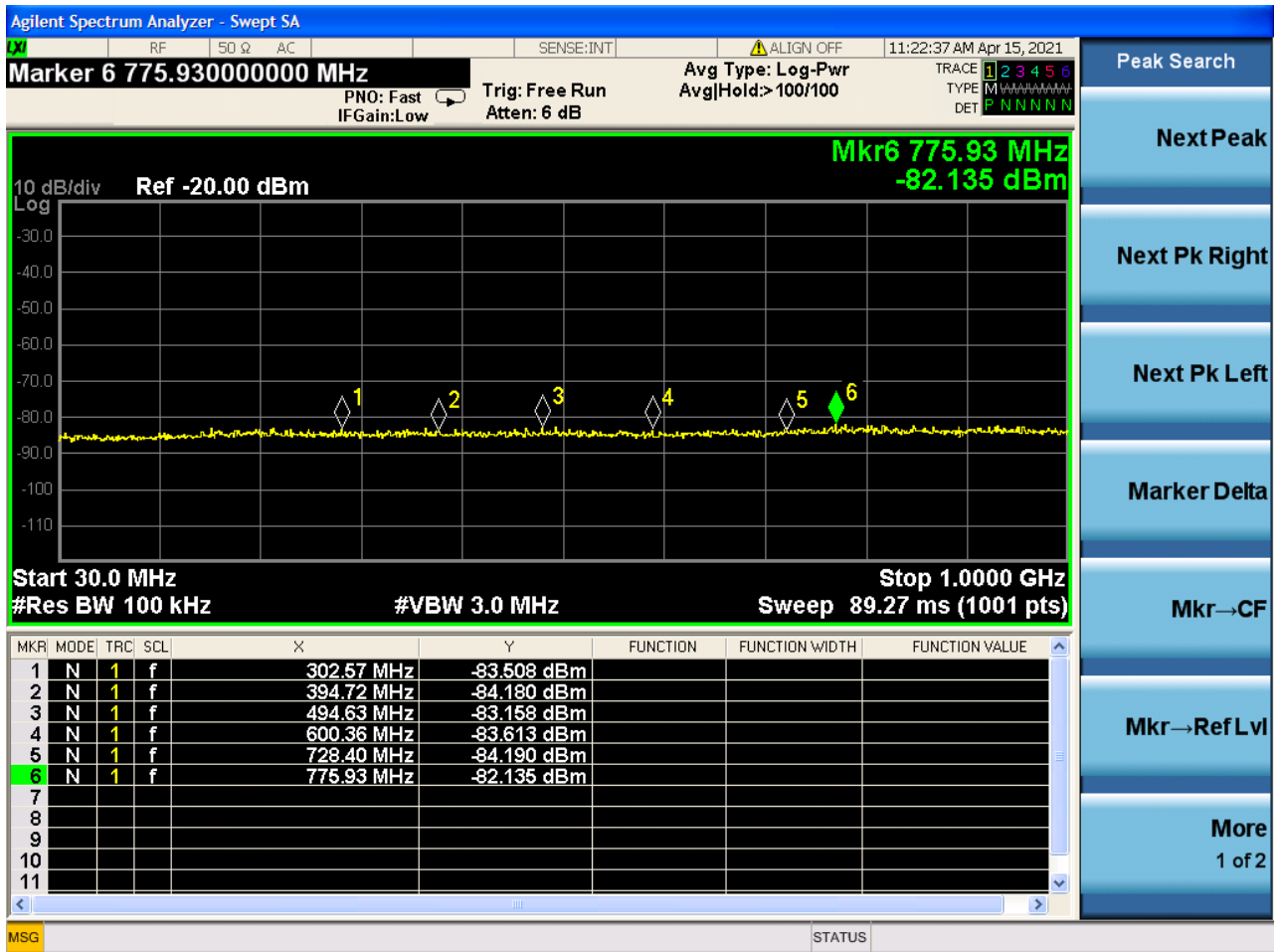
Attach spectrum pictures of P_{Reading} value for this test here:



V port, Operate at 787.950MHz, 30MHz -1000MHz

Fre. MHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
302.57	-83.508	6.21	-77.298	-57	PASS
394.72	-84.18	6.24	-77.94	-57	PASS
494.63	-83.158	6.28	-76.878	-57	PASS
600.36	-83.613	6.31	-77.303	-57	PASS
728.4	-84.19	6.36	-77.83	-57	PASS
775.93	-82.135	6.38	-75.755	-57	PASS

Attach spectrum pictures of P_{Reading value} for this test here:





V port, Operate at 787.950MHz, 1GHz -5GHz

Fre. GHz	P _{Reading value} dBm	Factor dB	P _{Final value} dBm	Limit dBm	Verdict
2.104	-75.165	6.84	-68.325	-57	PASS
2.468	-71.463	6.96	-64.503	-57	PASS
2.796	-70.834	7.08	-63.754	-57	PASS
3.04	-71.927	7.16	-64.767	-57	PASS
3.316	-71.684	7.26	-64.424	-57	PASS
4.628	-71.431	7.72	-63.711	-57	PASS

Attach spectrum pictures of P_{Reading value} for this test here:



Annex A Test Uncertainty

The uncertainty is calculated using the methods suggested in the "Guide to the Expression of Uncertainty in Measurement" (GUM) published by ISO.

Uncertainty of Radiated Emission Measurement

Measuring Uncertainty for a Level of Confidence of 95%(U=2Uc(y))	30MHz-200MHz	±5.06dB
	200MHz-1000MHz	±5.04dB
	1GHz-6GHz	±5.18dB
	6GHz-18GHz	±5.48dB



Annex B Testing Laboratory Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block67, BaoAn District, ShenZhen ,GuangDong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block67, BaoAn District, ShenZhen ,GuangDong Province, P. R. China

3. Accreditation Certificate

Accredited Testing Laboratory:	The FCC designation number is CN1192. Test firm registration number is 226174. (Shenzhen Morlab Communications Technology Co., Ltd.)
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4. Test Software Utilized

Model	Version Number	Producer
TS+ -[JS32-RE]	Version 2.5.1.5	Tonscend

**5. Test Equipments Utilized**

Description	Manufacturer	Model	Serial No.	Cal. Date	Due. Date
MXE EMI Receiver	Agilent	N9038A	MY54130016	2020.07.21	2021.07.20
Test Receiver	R&S	ESPI	101052	2020.07.21	2021.07.20
LISN	Schwarzbeck	NSLK 8127	8127449	2021.03.09	2022.03.08
Pulse Limiter (10dB)	Schwarzbeck	VTSD 9561-F	VTSD 9561 F-B #206	2020.07.24	2021.07.23
Test Antenna - Bi-Log	Schwarzbeck	VULB 9163	9163-519	2019.05.24	2022.05.23
Test Antenna - Horn	Schwarzbeck	BBHA 9120D	01774	2019.07.26	2022.07.25
6 dB attenuator	Mini-circuits	BW-N6W5+	E191001	2020.10.20	2021.10.19
Semi-Anechoic Chamber	CRT	9m*6m*6m	N/A	2020.01.06	2023.01.05

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