

FCC Test Report (Spot Check: Part 27: 5GNR n38)

Report No.: RF200109E02E-15
FCC ID: 2AQ68T99W175M
Original FCC ID: 2AQ68T99W175
Test Model: T99W175M
Received Date: May 29, 2020
Test Date: Jul. 21 ~ Aug. 11, 2020
Issued Date: Aug. 11, 2020

Applicant: Hon Lin Technology Co., Ltd.
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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
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FCC Registration / Designation Number: 788550 / TW0003



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Release Control Record

Issue No.	Description	Date Issued
RF200109E02E-15	Original release	Aug. 11, 2020

1 Certificate of Conformity

Product: 5G WWAN Module

Brand: Foxconn

Test Model: T99W175M

Sample Status: Engineering Sample

Applicant: Hon Lin Technology Co., Ltd.

Test Date: Jul. 21 ~ Aug. 11, 2020

Standards: FCC Part 27, Subpart M

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Pettie Chen, **Date:** Aug. 11, 2020
Pettie Chen / Senior Specialist

Approved by : Bruce Chen, **Date:** Aug. 11, 2020
Bruce Chen / Senior Project Engineer

2 Summary of Test Results

Applied Standard: FCC Part 27 & Part 2			
FCC Clause	Test Item	Result	Remarks
n38			
2.1046 27.50 (h)(2)	Equivalent Isotropically Radiated Power / Equivalent Radiated Power	Pass	Meet the requirement of limit.
2.1053 27.53 (m)(4)(6)	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -21.0dB at 5190.00MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (\pm)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.04 dB
	30MHz ~ 200MHz	3.63 dB
	200MHz ~ 1000MHz	3.64 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.29 dB
	18GHz ~ 40GHz	2.29 dB

2.2 Test Site and Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver KEYSIGHT	N9038A	MY55420137	Apr. 16, 2020	Apr. 15, 2021
Spectrum Analyzer ROHDE & SCHWARZ	FSP40	100039	Jun. 12, 2020	Jun. 11, 2021
BILOG Antenna SCHWARZBECK	VULB9168	9168-160	Nov. 07, 2019	Nov. 06, 2020
HORN Antenna SCHWARZBECK	BBHA 9120 D	9120D-1169	Nov. 24, 2019	Nov. 23, 2020
HORN Antenna SCHWARZBECK	BBHA 9170	BBHA9170241	Nov. 24, 2019	Nov. 23, 2020
Preamplifier Agilent (Below 1GHz)	8447D	2944A10638	Jun. 08, 2020	Jun. 07, 2021
Preamplifier Agilent (Above 1GHz)	8449B	3008A02367	Feb. 18, 2020	Feb. 17, 2021
RF signal cable HUBER+SUHNER&EMCI	SUCOFLEX 104 & EMC104-SM- SM8000	CABLE-CH9-02 (248780+171006)	Jan. 18, 2020	Jan. 17, 2021
RF signal cable HUBER+SUHNER	SUCOFLEX 104	CABLE-CH9-(250795/4)	Jan. 18, 2020	Jan. 17, 2021
RF signal cable Woken	8D-FB	Cable-CH9-01	Jun. 08, 2020	Jun. 07, 2021
Software BV ADT	ADT_Radiated_ V7.6.15.9.5	NA	NA	NA
Antenna Tower EMCO	2070/2080	512.835.4684	NA	NA
Turn Table EMCO	2087-2.03	NA	NA	NA
Antenna Tower & Turn BV ADT	AT100	AT93021705	NA	NA
Turn Table BV ADT	TT100	TT93021705	NA	NA
Turn Table Controller BV ADT	SC100	SC93021705	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA
WIT Standard Temperature And Humidity Chamber	TH-4S-C	W981030	Jun. 01, 2020	May 31, 2021
JFW 20dB attenuation	50HF-020-SMA	NA	NA	NA
True RMS Clamp Meter Fluke	325	31130711WS	Jun. 06, 2020	Jun. 05, 2021
DC power supply	U8002A	MY56330015	NA	NA

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa Chamber 9.

3 General Information

3.1 General Description of EUT

Product	5G WWAN Module						
Brand	Foxconn						
Test Model	T99W175M						
Status of EUT	Engineering Sample						
Power Supply Rating	5 Vdc (Host equipment) 3.135Vdc~3.63Vdc (Module)						
Modulation Type	$\pi/2$ BPSK, QPSK, 16QAM, 64QAM, 256QAM						
Waveform Type	CP-OFDM, DFT-s-OFDM						
Operating Frequency	n38	Channel Bandwidth 20MHz	2580.0MHz ~ 2610.0MHz				
Max. EIRP Power			$\pi/2$ BPSK	QPSK	16QAM	64QAM	256QAM
	n38	Channel Bandwidth 20MHz	668.344mW (28.25dBm)	660.693mW (28.20dBm)	642.688mW (28.08dBm)	586.138mW (27.68dBm)	355.631mW (25.51dBm)
Emission Designator			$\pi/2$ BPSK	QPSK	16QAM	64QAM	256QAM
	n38	Channel Bandwidth 20MHz	17M9G7D	17M9G7D	17M9D7W	17M9D7W	17M9D7W
Antenna Type	Refer to Note as below						
Antenna Connector	Refer to Note as below						
Accessory Device	NA						
Cable Supplied	NA						

Note:

- This report is a supplementary report to the original BV CPS report no.: RF200109E02A-2. The difference compared with original report is only adding mmWave hardware, mmWave function is disabled by software. Exhibit prepared for FCC Spot Check Verification report, the format, test items and amount of spot-check test data are decided by applicant's engineering judgment, for more details please refer to declaration letter exhibit. Radiated emission and output power verification worst test refer to original report.
- There are four Difference HW of T99W175M.

Brand	Model	HW
Foxconn	T99W175M	1. 3G+LTE+Sub6+mmWave+eSIM
		2. 3G+LTE+Sub6+mmWave+w/o eSIM
		3. 3G+LTE+Sub6+mmWave+eSIM+GNSS connector
		4. 3G+LTE+Sub6+mmWave+w/o eSIM+GNSS connector

*After pre-testing, "HW: 1. 3G+LTE+Sub6+mmWave+eSIM" is the worst for the final tests.

- After pre-testing, "DFT-s-OFDM" is the worst for the final tests.

4. The following antennas were provided to the EUT.

Antenna No.	RF Chain No.	Brand	Model	Antenna Net Gain(dBi)	Frequency range (MHz)	Antenna Type	Connector Type
1		WHA YU	C107-511720-A	4.41	660~803	PCB	I-PEX
2		WHA YU	C107-511721-A	3.81 4.03	791~960 1447.9~1606	PCB	I-PEX
3		WHA YU	C107-511722-A	4.27 5.31	1710~2170 2500~2690	PCB	I-PEX
4		WHA YU	C107-511723-A	2.99 0.92	2300~2400 3500~3700	PCB	I-PEX
5		WHA YU	C107-511724-A	6.45	5150~5925	PCB	I-PEX
6		WHA YU	C107-511725-A	4.89	3400~3700	PCB	I-PEX
7		AVX	5000106-R1-X01	2.91	699~803	Monopole	I-PEX
8		AVX	5000107-R1-X01	2.59	791~960	Monopole	I-PEX
9		AVX	5000108-R1-X01	2.85	1427~1610	Monopole	I-PEX
10		AVX	5000109-R1-X01	2.23 2.94	1710~2200 5150~5925	Monopole	I-PEX
11		AVX	5000110-R1-X01	0.9	2300~2690	Monopole	I-PEX
12		AVX	5000111-R1-X01	0.87	3300~5000	Monopole	I-PEX
13	Tx1/ Rx1	Ethertronics	5003806	0.4 -1.61 0.39 2.95 1.98 0.38 0.83 2.31	698-821 824-960 1425-1515 1710-2200 2300-2690 3300-4200 4400-5000 5150-5925	PIFA	I-PEX
	Rx2	Ethertronics	5003807	-2.24 -4.52 2.87 2.99 2.93 2.91 2.23 -0.85 -3.04	716-821 824-960 1425-1515 1557-1610 1805-2200 2300-2690 3300-4200 4400-5000 5150-5925	PIFA	I-PEX
	Tx2/ Rx3	Ethertronics	5003806	2.21 2.25 -0.45 2.6	1710-2200 2300-2690 3300-4200 4400-5000	PIFA	I-PEX
	Rx4	Ethertronics	5003700	1.38 2.87 0.6 -2.09	1805-2200 2300-2690 3300-4200 4400-5000	PIFA	I-PEX

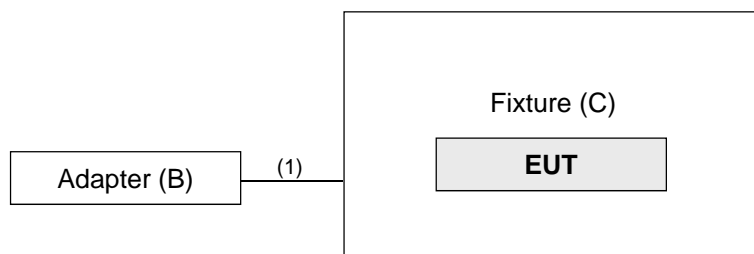
Antenna No.	RF Chain No.	Brand	Model	Antenna Net Gain(dBi)	Frequency range (MHz)	Antenna Type	Connector Type
14	Ant. 0 (TX/RX)	Master Wave	NA	2.4 2.2 2.9 2.9 2.9 NA	880~960 1020~2170 2545~2595 3565~3600 3900~4000 GPS	PCB	I-PEX
	Ant. 2 (TX/RX)	Master Wave	NA	NA 2.2 2.8 2.9 2.8 NA	880~960 1020~2170 2545~2595 3565~3600 3900~4000 GPS	PCB	I-PEX
	Ant. 1 (RX)	Master Wave	NA	NA 5.3 5.1 4.3 4.5 NA	880~960 1020~2170 2545~2595 3565~3600 3900~4000 GPS	PCB	I-PEX
	Ant. 3 (RX)	Master Wave	NA	1.3 6.8 3.7 6.4 6.2 3.7	880~960 1020~2170 2545~2595 3565~3600 3900~4000 GPS	PCB	I-PEX

*The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

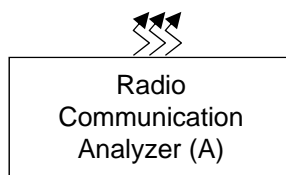
*The antenna for the final tests as following table.

	Band	Antenna
5GNR	38 (30kHz) /20	Antenna 3

3.2 Configuration of System under Test



Remote site



3.2.1 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Radio Communication Analyzer	Anritsu	MT8821C	6261806803	NA	-
B.	Adapter	LITEON	PA-1050-39	NA	NA	-
C.	Fixture	NA	NA	NA	NA	Provided by client.

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as a communication partner to transfer data.

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB cable	1	1.5	Y	0	-

3.3 Test Mode Applicability and Tested Channel Detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports. The worst case was found when positioned on Z-plane. Following channel(s) was (were) selected for the final test as listed below.

n38

EUT Configure Mode	Test item	Available channel	Tested channel	Channel Bandwidth	Modulation	Mode
-	EIRP	512000 to 522000	516000(2580.0MHz), 519000(2595.0MHz), 522000(2610.0MHz)	20MHz	$\pi/2$ BPSK / QPSK / 16QAM / 64QAM / 256QAM	1 RB / 0 RB Offset 1 RB / 50 RB Offset 1 RB / 99 RB Offset 50 RB / 0 RB Offset 50 RB / 25 RB Offset 50 RB / 50 RB Offset 100 RB / 0 RB Offset
-	Radiated Emission Below 1GHz	512000 to 522000	519000(2595.0MHz)	20MHz	$\pi/2$ BPSK	1 RB / 0 RB Offset
-	Radiated Emission Above 1GHz	512000 to 522000	519000(2595.0MHz)	20MHz	$\pi/2$ BPSK	1 RB / 0 RB Offset

Test Condition:

Test Item	Environmental Conditions	Input Power	Tested By
EIRP / ERP	25deg. C, 70%RH	5Vdc	James Yang
Radiated Emission	22deg. C, 66%RH 22deg. C, 65%RH	120Vac, 60Hz	Greg Lin

3.4 EUT Operating Conditions

The EUT makes a call to the communication simulator. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency

3.5 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and References:

Test Standard:

FCC 47 CFR Part 2

FCC 47 CFR Part 27

ANSI/TIA/EIA-603-E 2016

ANSI 63.26-2015

All test items have been performed and recorded as per the above standards.

References Test Guidance:

KDB 971168 D01 Power Meas License Digital Systems v03r01

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Output Power Measurement

4.1.1 Limits of Output Power Measurement

Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

4.1.2 Test Procedures

Conducted Power Measurement:

The EUT was set up for the maximum power with 5GNR link data modulation and link up with simulator. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

Maximum EIRP / ERP

The relevant equation for determining the maximum ERP or EIRP from the measured RF output power is

given in Equation as follows:

$$\text{ERP or EIRP} = P_{\text{Meas}} + G_T$$

where

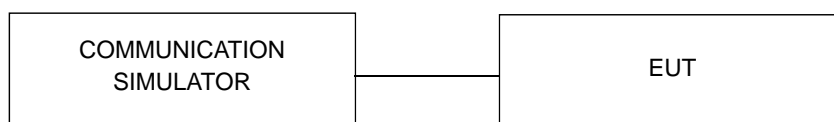
ERP or EIRP effective radiated power or equivalent isotropically radiated power, respectively
(expressed in the same units as P_{Meas} , e.g., dBm or dBW)

P_{Meas} measured transmitter output power or PSD, in dBm or dBW

G_T gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP)

4.1.3 Test Setup

Conducted Power Measurement:



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.4 Test Results

Conducted Output Power (dBm)

n38						
BW	MCS Index	Channel		516000	519000	522000
		Frequency (MHz)		2580	2595	2610
20M	$\pi/2$ BPSK	1	0	22.84	22.94	22.80
		1	12	22.75	22.84	22.68
		1	24	22.62	22.54	22.67
		25	0	22.14	22.20	22.45
		25	12	22.17	22.74	22.46
		25	25	22.23	22.39	22.12
		51	0	22.63	22.13	22.65
	QPSK	1	0	22.69	22.69	22.89
		1	12	22.52	22.59	22.70
		1	24	22.58	22.45	22.83
		25	0	22.46	22.45	22.64
		25	12	22.47	22.42	22.23
		25	25	22.30	22.28	22.58
		51	0	22.53	22.60	22.19
	16QAM	1	0	22.55	22.69	22.46
		1	12	22.51	22.58	22.68
		1	24	22.77	22.50	22.61
		25	0	22.68	22.27	22.65
		25	12	22.47	22.36	22.27
		25	25	22.54	22.15	22.27
		51	0	22.49	22.37	22.38
	64QAM	1	0	22.04	22.33	22.37
		1	12	21.78	21.93	22.27
		1	24	22.05	22.07	22.10
		25	0	22.05	21.94	22.09
		25	12	21.91	21.84	21.78
		25	25	21.59	22.22	22.02
		51	0	22.03	21.88	21.92
	256QAM	1	0	19.60	19.74	19.77
		1	12	19.55	19.45	19.98
1		24	20.10	19.81	20.20	
25		0	19.30	19.51	19.17	
25		12	19.71	19.52	18.73	
25		25	19.29	19.83	19.08	
51		0	19.28	19.02	18.84	

EIRP Power(dBm)

		n38				
BW	MCS Index	Channel		516000	519000	522000
		Frequency (MHz)		2580	2595	2610
20M	$\pi/2$ BPSK	1	0	28.15	28.25	28.11
		1	12	28.06	28.15	27.99
		1	24	27.93	27.85	27.98
		25	0	27.45	27.51	27.76
		25	12	27.48	28.05	27.77
		25	25	27.54	27.70	27.43
		51	0	27.94	27.44	27.96
	QPSK	1	0	28.00	28.00	28.20
		1	12	27.83	27.90	28.01
		1	24	27.89	27.76	28.14
		25	0	27.77	27.76	27.95
		25	12	27.78	27.73	27.54
		25	25	27.61	27.59	27.89
		51	0	27.84	27.91	27.50
	16QAM	1	0	27.86	28.00	27.77
		1	12	27.82	27.89	27.99
		1	24	28.08	27.81	27.92
		25	0	27.99	27.58	27.96
		25	12	27.78	27.67	27.58
		25	25	27.85	27.46	27.58
		51	0	27.80	27.68	27.69
	64QAM	1	0	27.35	27.64	27.68
		1	12	27.09	27.24	27.58
		1	24	27.36	27.38	27.41
		25	0	27.36	27.25	27.40
		25	12	27.22	27.15	27.09
		25	25	26.90	27.53	27.33
		51	0	27.34	27.19	27.23
	256QAM	1	0	24.91	25.05	25.08
		1	12	24.86	24.76	25.29
1		24	25.41	25.12	25.51	
25		0	24.61	24.82	24.48	
25		12	25.02	24.83	24.04	
25		25	24.60	25.14	24.39	
51		0	24.59	24.33	24.15	

*EIRP = Conducted + antenna gain (5.31dBi)

4.2 Radiated Emission Measurement

4.2.1 Limits of Radiated Emission Measurement

In the FCC 27.53(m)(4), On any frequency outside a licensee's frequency block, The power of any emission shall be attenuated below the transmitter power (P) by at least $55 + 10 \log (P)$ dB. The emission limit equal to -25dBm .

4.2.2 Test Procedure

- a. The power was measured with R&S Spectrum Analyzer. All measurements were done at 3 channels (low, middle and high channel of operational frequency range.)
- b. Substitution method is used for E.I.R.P measurement. In the semi-anechoic chamber, EUT placed on the 0.8m (below or equal 1 GHz) and/or 1.5 m (above 1 GHz) height of Turn Table, rotated the table around 360 degrees to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power. The "Read Value" is the spectrum reading the maximum power value.
- c. The substitution antenna is substituted for EUT at the same position and signals generator export the CW signal to the substitution antenna via a TX cable. Rotated the Turn Table and moved receiving antenna to find the maximum radiation power. Adjust output power level of S.G to get a Value of spectrum reading equal to "Read Value" of step b. Record the power level of S.G
- d. $\text{EIRP} = \text{Output power level of S.G} - \text{TX cable loss} + \text{Antenna gain of substitution antenna}$.

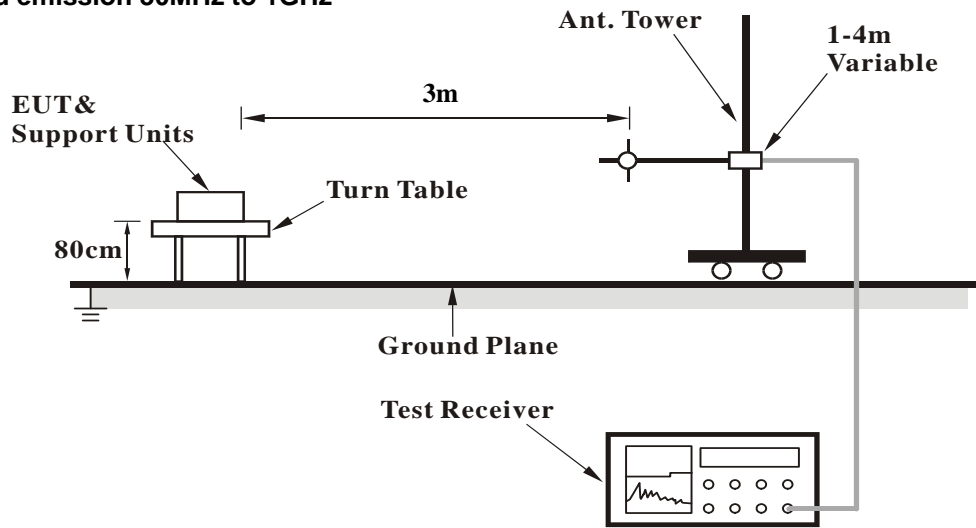
Note: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1MHz/3MHz.

4.2.3 Deviation from Test Standard

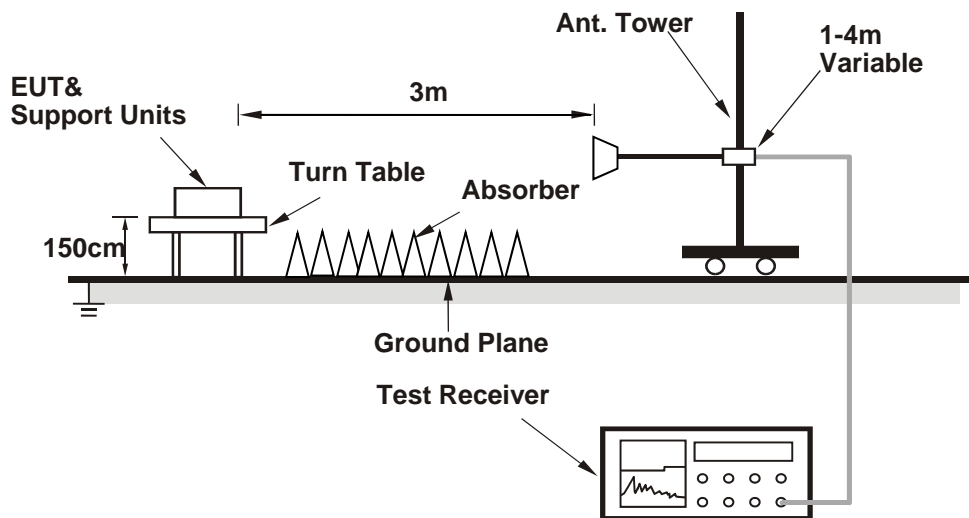
No deviation.

4.2.4 Test Setup

For radiated emission 30MHz to 1GHz



For radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.5 Test Results

Below 1GHz

n38, Channel Bandwidth: 20MHz

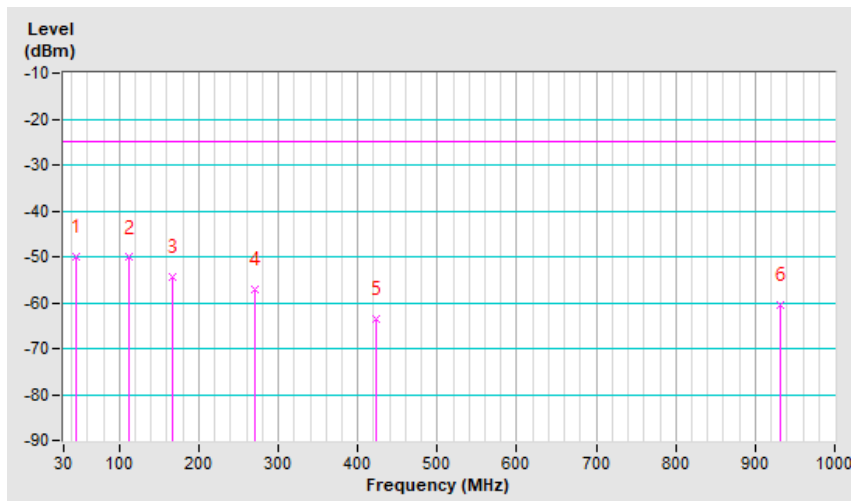
Mode	TX channel 519000 (2595.0MHz)	Frequency Range	Below 1000 MHz
Environmental Conditions	22deg. C, 66%RH	Input Power	120Vac, 60Hz
Tested By	Greg Lin		

Antenna Polarity & Test Distance: Horizontal at 3 M

No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	45.46	-51.9	-40.1	-10.0	-50.1	-25.0	-25.1
2	112.94	-42.0	-50.5	0.3	-50.2	-25.0	-25.2
3	167.77	-47.7	-55.7	1.3	-54.4	-25.0	-29.4
4	270.39	-53.0	-62.3	5.3	-57.0	-25.0	-32.0
5	423.62	-63.8	-68.8	5.2	-63.6	-25.0	-38.6
6	932.52	-69.1	-64.4	3.9	-60.5	-25.0	-35.5

Remarks:

1. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) - Cable Loss (dB).

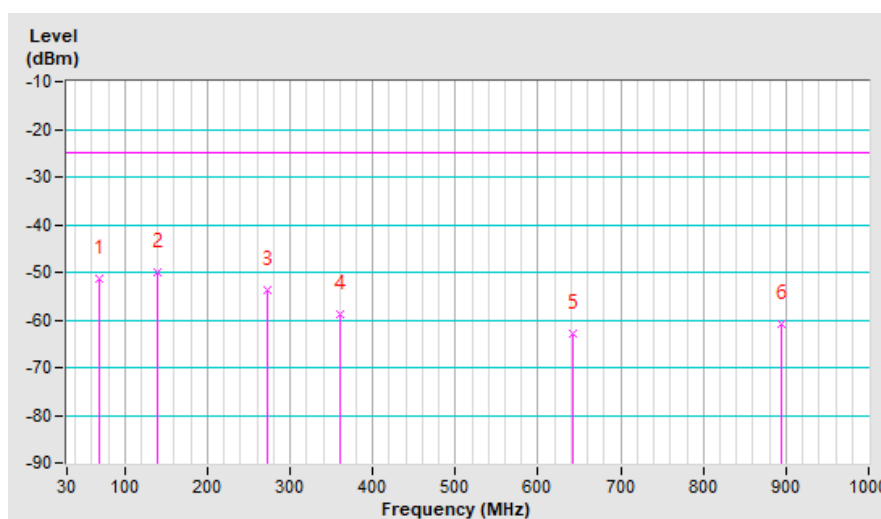


Mode	TX channel 519000 (2595.0MHz)	Frequency Range	Below 1000 MHz
Environmental Conditions	22deg. C, 66%RH	Input Power	120Vac, 60Hz
Tested By	Greg Lin		

Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	69.36	-44.4	-46.3	-5.2	-51.5	-25.0	-26.5
2	139.65	-47.0	-49.8	-0.3	-50.1	-25.0	-25.1
3	273.20	-55.5	-59.1	5.3	-53.8	-25.0	-28.8
4	360.36	-58.4	-64.1	5.2	-58.9	-25.0	-33.9
5	641.52	-69.1	-67.5	4.7	-62.8	-25.0	-37.8
6	894.57	-69.5	-64.7	3.9	-60.8	-25.0	-35.8

Remarks:

1. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) - Cable Loss (dB).



Above 1GHz
n38, Channel Bandwidth: 20MHz

Mode	TX channel 519000 (2595.0MHz)	Frequency Range	1GHz ~ 27GHz
Environmental Conditions	22deg. C, 65%RH	Input Power	120Vac, 60Hz
Tested By	Greg Lin		

Antenna Polarity & Test Distance: Horizontal at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	5190.00	-61.1	-49.4	1.4	-48.0	-25.0	-23.0
Antenna Polarity & Test Distance: Vertical at 3 M							
No.	Freq. (MHz)	Reading (dBm)	S.G Power Value (dBm)	Correction Factor (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1	5190.00	-59.6	-47.4	1.4	-46.0	-25.0	-21.0

Remarks:

1. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) - Cable Loss (dB).

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

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The address and road map of all our labs can be found in our web site also.

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