FCC Test Report (WLAN)

(Spot Check)

Report No.:	RF180611E01B
FCC ID:	2ABLK-GS2020
Original FCC ID:	2ABLK-GS2026
Test Model:	GS2020E
Received Date:	June 20, 2018
Test Date:	June 28 to July 06, 2018
Issued Date:	July 13, 2018
Applicant:	Calix Inc.
Address:	1035 N. McDowell Blvd. Petaluma, CA 94954 U.S.A.
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
FCC Registration / Designation Number:	723255 / TW2022

Testing Laboratory
2022

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Release Control Record

Issue No.	Description	Date Issued
RF180611E01B	Original release.	July 13, 2018

1 Certificate of Conformity

Product:	GigaSpire
Brand:	Calix
Test Model:	GS2020E
Sample Status:	MASS-PRODUCTION
Applicant:	Calix Inc.
Test Date:	June 28 to July 06, 2018
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) ANSI C63.10: 2013

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 EMC characteristics under the conditions specified in this report.

Prepared by : Mary Ko , **Date:** July 13, 2018

Mary Ko / Specialist

Approved by : , **Date:** July 13, 2018

May Chen / Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit. Minimum passing margin is -17.27dB at 0.33750MHz.
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -0.2dB at 2483.5MHz
15.247(b)	Conducted power	PASS	Meet the requirement of limit.

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) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	1.84 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	5.33 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.10 dB
	6GHz ~ 18GHz	4.85 dB
	18GHz ~ 40GHz	5.24 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT (WLAN)

Product	GigaSpire
Brand	Calix
Test Model	GS2020E
Status of EUT	MASS-PRODUCTION
Power Supply Rating	12Vdc from adapter
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM 256QAM for OFDM in 11ac mode and VHT (20/40) mode in 2.4GHz 1024QAM for OFDMA in 11ax HE mode
Modulation Technology	DSSS,OFDM,OFDMA
Transfer Rate	802.11b: up to 11Mbps 802.11a/g: up to 54Mbps 802.11n: up to 600Mbps 802.11ac: up to 1733.3Mbps 802.11ax: up to 4803.9Mbps
Operating Frequency	**2.4GHz:** 2.412 ~ 2.462GHz **5GHz:** 5.18GHz ~ 5.24GHz, 5.745GHz ~ 5.825GHz
Number of Channel	**2.4GHz:** 802.11b, 802.11g, 802.11n (HT20), VHT20, 802.11ax (HE20): 11 802.11n (HT40), VHT40, 802.11ax (HE40): 7 **5GHz:** 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20): 9 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40): 4 802.11ac (VHT80), 802.11ax (HE80): 2 802.11ac (VHT80+80), 802.11ax (HE80+80): 1 set
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	Adapter x 1
Data Cable Supplied	NA

Note:

1. 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 pleae refer to declaration letter exhibit.
2. The EUT has below radios as following table:

Radio 1	Radio 2
WLAN - 4TX (2.4GHz+5GHz)	WLAN - 4TX (5GHz)
Note: For WLAN- 5GHz based on Radio 1 + 2 operating at same time.	

3. Simultaneously transmission condition.

Condition	Technology	
1	WLAN 2.4GHz	WLAN 5GHz
Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.		

4. The EUT must be supplied with a power adapter as following table:

Brand	Model No.	Spec.
Frecom	F60-120500SPA	Input: 100-240Vac, 1.6A, 50/60Hz AC intput cable: Unshielded, 1.0m Output: 12V, 5A DC output cable: Unshielded, 1.5m
		Input: 100-240Vac, 1.6A, 50/60Hz AC intput cable: Unshielded, 1.5m Output: 12V, 5A DC output cable: Unshielded, 1.5m
Note: From the above spec., the radiated emissions worse case was found in **AC input cable: Unshielded, 1.0m**. Therefore only the test data of the mode was recorded in this report.		

5. The antennas provided to the EUT, please refer to the following table:

Frequency range (GHz)	Directional Antenna Gain (dBi)	Antenna Type	Antenna Connector
2.4 ~ 2.4835	7.41	Dipole	i-pex(MHF)
5.18 ~ 5.24	9.7		
5.26 ~ 5.32	9.9		
5.50 ~ 5.70	9.83		
5.745 ~ 5.825	10.27		
Note: More detailed information, please refer to opearating description.			

6. The EUT incorporates a MIMO function:

2.4GHz Band			
MODULATION MODE	**DATA RATE (MCS)**	**TX & RX CONFIGURATION**	
802.11b	1 ~ 11Mbps	4TX	4RX
802.11g	6 ~ 54Mbps	4TX	4RX
802.11n (HT20)	MCS 0~7	4TX	4RX
	MCS 8~15	4TX	4RX
	MCS 16~23	4TX	4RX
	MCS 24~31	4TX	4RX
802.11n (HT40)	MCS 0~7	4TX	4RX
	MCS 8~15	4TX	4RX
	MCS 16~23	4TX	4RX
	MCS 24~31	4TX	4RX
VHT20	MCS0~8 Nss=1	4TX	4RX
	MCS0~8 Nss=2	4TX	4RX
	MCS0~9 Nss=3	4TX	4RX
	MCS0~8 Nss=4	4TX	4RX
VHT40	MCS0~9 Nss=1	4TX	4RX
	MCS0~9 Nss=2	4TX	4RX
	MCS0~9 Nss=3	4TX	4RX
	MCS0~9 Nss=4	4TX	4RX
802.11ax (HE20)	MCS0~11 Nss=1	4TX	4RX
	MCS0~11 Nss=2	4TX	4RX
	MCS0~11 Nss=3	4TX	4RX
	MCS0~11 Nss=4	4TX	4RX
802.11 ax (HE40)	MCS0~11 Nss=1	4TX	4RX
	MCS0~11 Nss=2	4TX	4RX
	MCS0~11 Nss=3	4TX	4RX
	MCS0~11 Nss=4	4TX	4RX

5GHz Band (Radio 1 + 2)			
MODULATION MODE	**DATA RATE (MCS)**	**TX & RX CONFIGURATION**	
802.11a	6 ~ 54Mbps	8TX	8RX
802.11n (HT20)	MCS 0~7	8TX	8RX
	MCS 8~15	8TX	8RX
	MCS 16~23	8TX	8RX
	MCS 24~31	8TX	8RX
802.11n (HT40)	MCS 0~7	8TX	8RX
	MCS 8~15	8TX	8RX
	MCS 16~23	8TX	8RX
	MCS 24~31	8TX	8RX
802.11ac (VHT20)	MCS0~8 Nss=1	8TX	8RX
	MCS0~8 Nss=2	8TX	8RX
	MCS0~9 Nss=3	8TX	8RX
	MCS0~8 Nss=4	8TX	8RX
	MCS0~8 Nss=5	8TX	8RX
	MCS0~9 Nss=6	8TX	8RX
	MCS0~8 Nss=7	8TX	8RX
	MCS0~8 Nss=8	8TX	8RX
802.11ac (VHT40)	MCS0~9 Nss=1	8TX	8RX
	MCS0~9 Nss=2	8TX	8RX
	MCS0~9 Nss=3	8TX	8RX
	MCS0~9 Nss=4	8TX	8RX
	MCS0~9 Nss=5	8TX	8RX
	MCS0~9 Nss=6	8TX	8RX
	MCS0~9 Nss=7	8TX	8RX
	MCS0~9 Nss=8	8TX	8RX
802.11ac (VHT80)	MCS0~9 Nss=1	8TX	8RX
	MCS0~9 Nss=2	8TX	8RX
	MCS0~5 / 7~9 Nss=3	8TX	8RX
	MCS0~9 Nss=4	8TX	8RX
	MCS0~9 Nss=5	8TX	8RX
	MCS0~8 Nss=6	8TX	8RX
	MCS 0~5 / 7~9 Nss=7	8TX	8RX
	MCS0~9 Nss=8	8TX	8RX

802.11ac (VHT80+80)	MCS0~9 Nss=1	8TX	8RX
	MCS0~9 Nss=2	8TX	8RX
	MCS0~8 Nss=3	8TX	8RX
	MCS0~9 Nss=4	8TX	8RX
	MCS0~9 Nss=5	8TX	8RX
	MCS0~9 Nss=6	8TX	8RX
	MCS0~9 Nss=7	8TX	8RX
	MCS0~9 Nss=8	8TX	8RX
802.11ax (HE20)	MCS0~11 Nss=1	8TX	8RX
	MCS0~11 Nss=2	8TX	8RX
	MCS0~11 Nss=3	8TX	8RX
	MCS0~11 Nss=4	8TX	8RX
	MCS0~11 Nss=5	8TX	8RX
	MCS0~11 Nss=6	8TX	8RX
	MCS0~11 Nss=7	8TX	8RX
	MCS0~11 Nss=8	8TX	8RX
802.11ax (HE40)	MCS0~11 Nss=1	8TX	8RX
	MCS0~11 Nss=2	8TX	8RX
	MCS0~11 Nss=3	8TX	8RX
	MCS0~11 Nss=4	8TX	8RX
	MCS0~11 Nss=5	8TX	8RX
	MCS0~11 Nss=6	8TX	8RX
	MCS0~11 Nss=7	8TX	8RX
	MCS0~11 Nss=8	8TX	8RX
802.11ax (HE80)	MCS0~11 Nss=1	8TX	8RX
	MCS0~11 Nss=2	8TX	8RX
	MCS0~11 Nss=3	8TX	8RX
	MCS0~11 Nss=4	8TX	8RX
	MCS0~11 Nss=5	8TX	8RX
	MCS0~11 Nss=6	8TX	8RX
	MCS0~11 Nss=7	8TX	8RX
	MCS0~11 Nss=8	8TX	8RX
802.11ax (HE80+80)	MCS0~11 Nss=1	8TX	8RX
	MCS0~11 Nss=2	8TX	8RX
	MCS0~11 Nss=3	8TX	8RX
	MCS0~11 Nss=4	8TX	8RX
	MCS0~11 Nss=5	8TX	8RX
	MCS0~11 Nss=6	8TX	8RX
	MCS0~11 Nss=7	8TX	8RX
	MCS0~11 Nss=8	8TX	8RX

Note:
1. All of modulation mode support beamforming function except 2.4GHz & 802.11a/ax modulation mode.
2. The EUT support Beamforming and non-beamforming mode, therefore both mode were investigated and the worst case scenario was identified. The worst case data were presented in test report.
3. The modulation and bandwidth are similar for 802.11n mode for 20MHz (40MHz) and 802.11ac mode for 20MHz (40MHz), therefore investigated worst case to representative mode in test report. (Final test mode refer section 3.2.1)

7. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20), VHT20, 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

7 channels are provided for 802.11n (HT40), VHT40, 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
3	2422MHz	7	2442MHz
4	2427MHz	8	2447MHz
5	2432MHz	9	2452MHz
6	2437MHz		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	√	√	-

Where RE≥1G: Radiated Emission above 1GHz & Bandedge Measurement
RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission
APCM: Antenna Port Conducted Measurement

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	Data Rate Parameter
802.11ax (HE20)	1 to 11	1, 6, 11	OFDMA	BPSK	MCS0

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	Data Rate Parameter
802.11ax (HE20)	1 to 11	6	OFDMA	BPSK	MCS0

Power Line Conducted Emission Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	Data Rate Parameter
802.11ax (HE20)	1 to 11	6	OFDMA	BPSK	MCS0

Antenna Port Conducted Measurement:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	Data Rate Parameter
802.11ax (HE20)	1 to 11	1, 6, 11	OFDMA	BPSK	MCS0

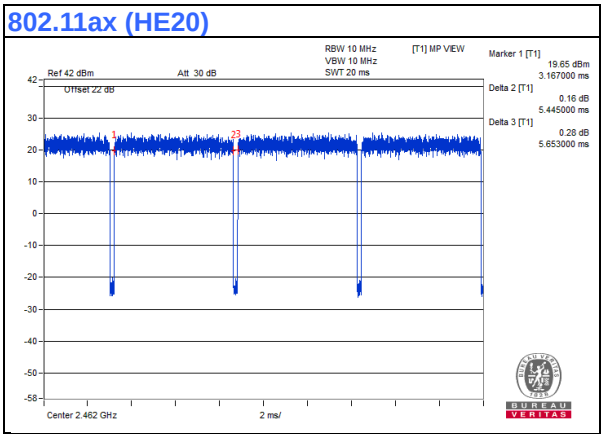
Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	21deg. C, 63%RH	120Vac, 60Hz	Eason Tseng
RE<1G	23deg. C, 67%RH	120Vac, 60Hz	Eason Tseng
PLC	24deg. C, 76%RH	120Vac, 60Hz	Andy Ho
APCM	25deg. C, 60%RH	120Vac, 60Hz	Jyunchun Lin

3.3 Duty Cycle of Test Signal

If duty cycle of test signal is < 98%, duty factor shall be considered.
802.11ax (HE20): Duty cycle = 5.445/5.653 = 0.963, Duty factor = 10 * log(1/0.963) = 0.16

802.11ax (HE20)



3.4 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.

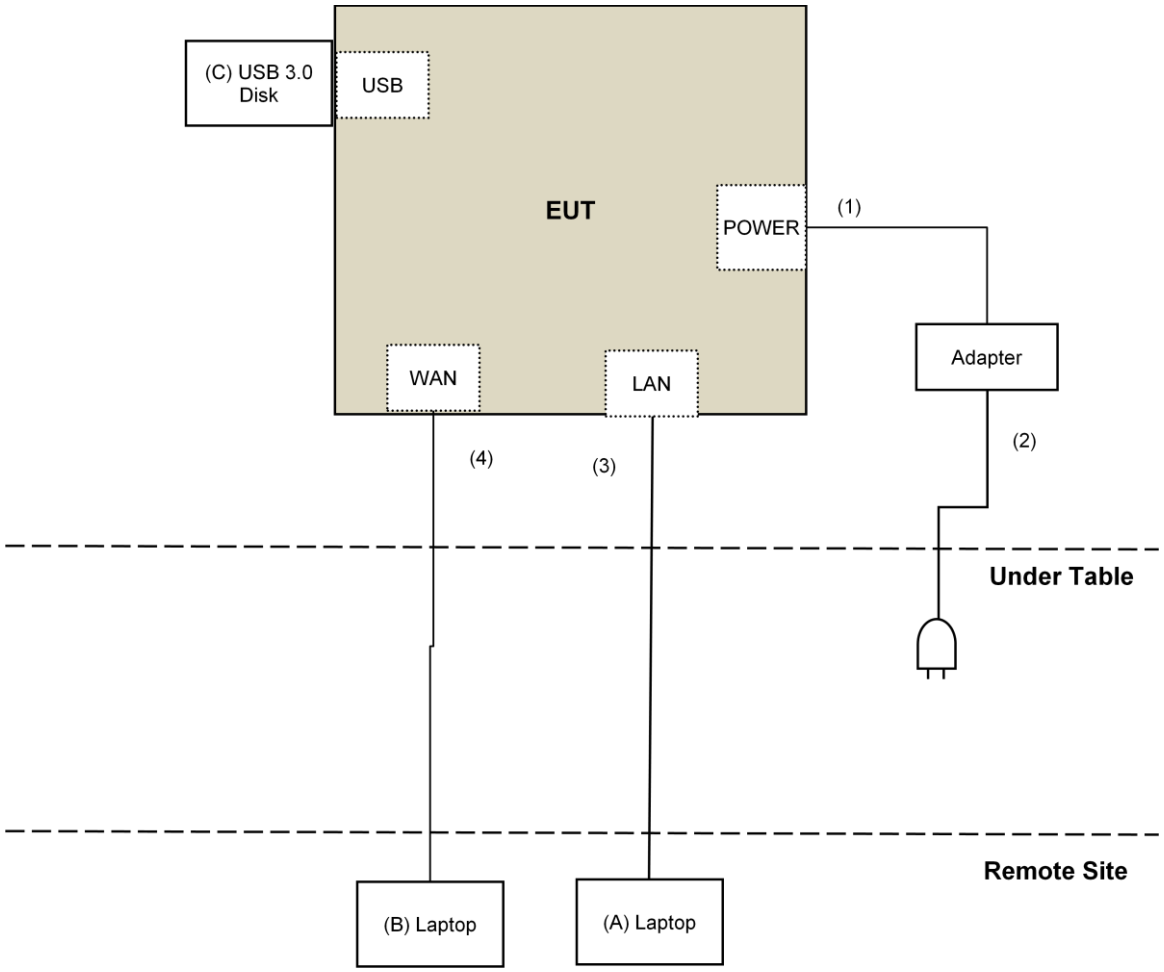
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	DELL	E5430	HYV4VY1	FCC DoC	Provided by Lab
B.	Laptop	DELL	E6420	B92T3R1	FCC DoC	Provided by Lab
C.	USB 3.0 Disk	Transcend	16GB	NA	NA	Provided by Lab

Note:

1. All power cords of the above support units are non-shielded (1.8m).

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	DC Cable	1	1.5	No	0	Supplied by client
2.	AC Cable	1	1.0	No	0	Supplied by client
3.	RJ-45 Cable	1	10	No	0	Provided by Lab
4.	RJ-45 Cable	1	10	No	0	Provided by Lab

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standards

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

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 DTS Meas Guidance v04
KDB 662911 D01 Multiple Transmitter Output v02r01
ANSI C63.10-2013

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

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 30dB below the highest level of the desired power:

Frequencies (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

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Keysight	N9038A	MY54450088	July 08, 2017	July 07, 2018
Pre-Amplifier EMCI	EMC001340	980142	Feb. 09, 2018	Feb. 08, 2019
Loop Antenna(*) Electro-Metrics	EM-6879	264	Dec. 16, 2016	Dec. 15, 2018
RF Cable	NA	LOOPCAB-001 LOOPCAB-002	Jan. 15, 2018	Jan. 14, 2019
Pre-Amplifier Mini-Circuits	ZFL-1000VH2B	AMP-ZFL-01	Nov. 09, 2017	Nov. 08, 2018
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-406	Nov. 29, 2017	Nov. 28, 2018
RF Cable	8D	966-4-1 966-4-2 966-4-3	Mar. 21, 2018	Mar. 20, 2019
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-4-01	Oct. 03, 2017	Oct. 02, 2018
Horn_Antenna SCHWARZBECK	BBHA 9120D	9120D-783	Dec. 12, 2017	Dec. 11, 2018
Pre-Amplifier EMCI	EMC12630SE	980385	Jan. 29, 2018	Jan. 28, 2019
RF Cable	EMC104-SM-SM-1200 EMC104-SM-SM-2000 EMC104-SM-SM-5000	160923 150318 150321	Jan. 29, 2018	Jan. 28, 2019
Pre-Amplifier EMCI	EMC184045SE	980387	Jan. 29, 2018	Jan. 28, 2019
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170608	Dec. 14, 2017	Dec. 13, 2018
RF Cable	EMC102-KM-KM-1200	160925	Jan. 29, 2018	Jan. 28, 2019
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Boresight Antenna Tower & Turn Table Max-Full	MF-7802BS	MF780208530	NA	NA
Spectrum Analyzer R&S	FSV40	100964	June 20, 2018	June 19, 2019
Power meter Anritsu	ML2495A	1014008	May 09, 2018	May 08, 2019
Power sensor Anritsu	MA2411B	0917122	May 09, 2018	May 08, 2019

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 calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. The test was performed in 966 Chamber No. 4.
4. The CANADA Site Registration No. is 20331-2
5. Loop antenna was used for all emissions below 30 MHz.
6. Tested Date: June 28 to July 06, 2018

4.1.3 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

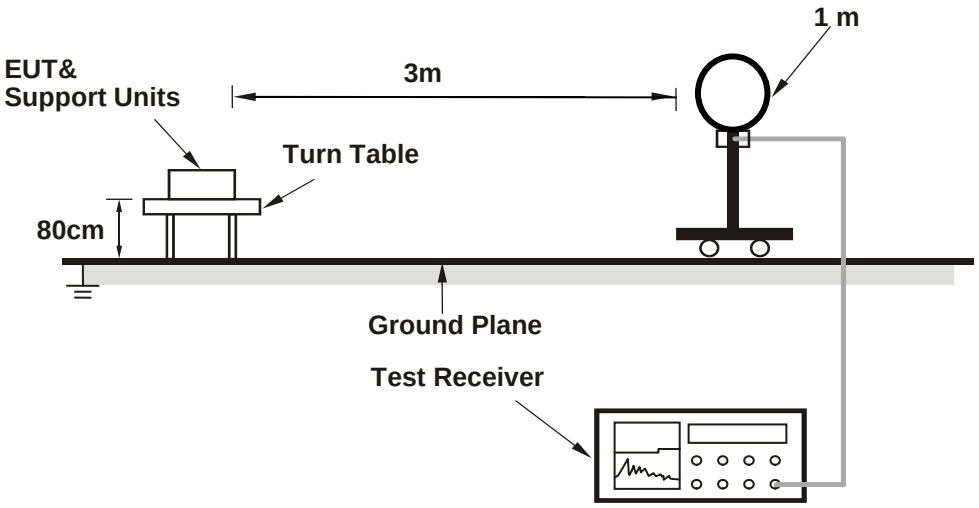
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

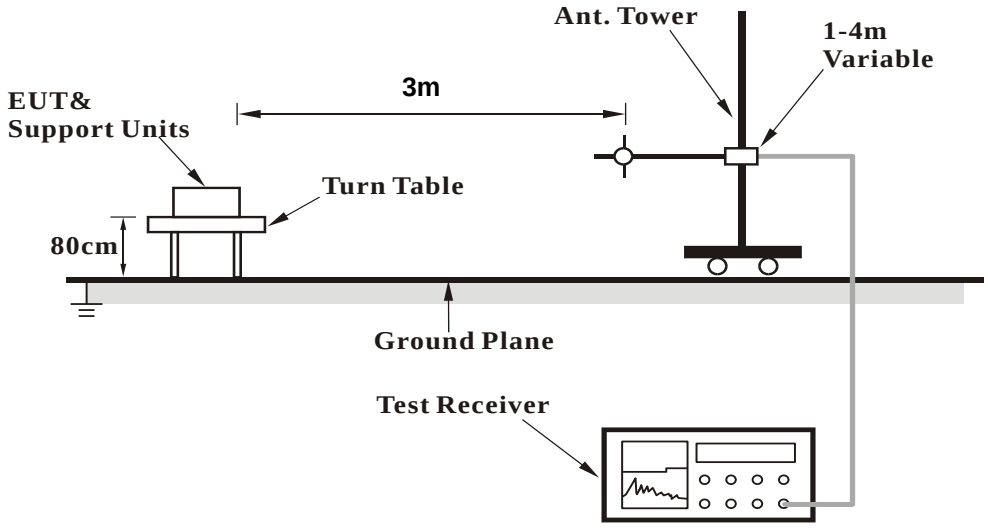
No deviation.

4.1.5 Test Setup

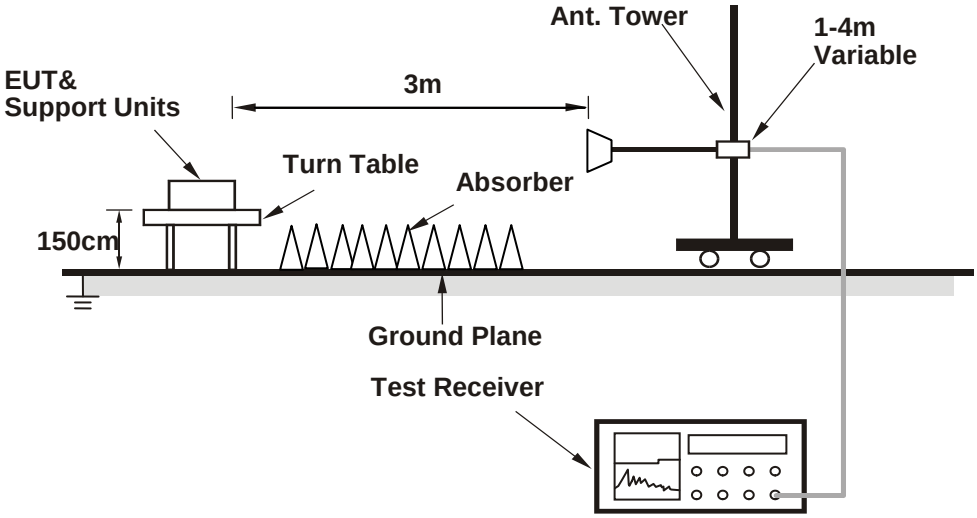
For Radiated emission below 30MHz



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).

4.1.6 EUT Operating Conditions

a. Connected the EUT with the Notebook Computer which is placed on remote site.
b. Controlling software (QSPR (5.0-00148)) has been activated to set the EUT on specific status.

4.1.7 Test Results

Above 1GHz Data：

CHANNEL	TX Channel 1	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	69.0 PK	74.0	-5.0	3.23 H	27	71.2	-2.2
2	2390.00	49.7 AV	54.0	-4.3	3.23 H	27	51.9	-2.2
3	*2412.00	115.2 PK			3.23 H	27	117.6	-2.4
4	*2412.00	102.6 AV			3.23 H	27	105.0	-2.4
5	4824.00	50.4 PK	74.0	-23.6	1.74 H	98	48.6	1.8
6	4824.00	38.0 AV	54.0	-16.0	1.74 H	98	36.2	1.8
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	73.6 PK	74.0	-0.4	1.35 V	80	75.8	-2.2
2	2390.00	50.5 AV	54.0	-3.5	1.35 V	80	52.7	-2.2
3	*2412.00	118.0 PK			1.35 V	80	120.4	-2.4
4	*2412.00	105.2 AV			1.35 V	80	107.6	-2.4
5	4824.00	49.9 PK	74.0	-24.1	1.67 V	98	48.1	1.8
6	4824.00	36.2 AV	54.0	-17.8	1.67 V	98	34.4	1.8

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

CHANNEL	TX Channel 6	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 25GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	69.0 PK	74.0	-5.0	3.21 H	30	71.2	-2.2
2	2390.00	48.8 AV	54.0	-5.2	3.21 H	30	51.0	-2.2
3	*2437.00	122.4 PK			3.21 H	30	125.0	-2.6
4	*2437.00	109.5 AV			3.21 H	30	112.1	-2.6
5	2483.50	65.3 PK	74.0	-8.7	3.21 H	30	67.7	-2.4
6	2483.50	45.9 AV	54.0	-8.1	3.21 H	30	48.3	-2.4
7	4874.00	59.9 PK	74.0	-14.1	1.87 H	123	57.9	2.0
8	4874.00	48.0 AV	54.0	-6.0	1.87 H	123	46.0	2.0
9	7311.00	51.2 PK	74.0	-22.8	3.59 H	149	42.8	8.4
10	7311.00	37.1 AV	54.0	-16.9	3.59 H	149	28.7	8.4
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2390.00	73.7 PK	74.0	-0.3	1.36 V	28	75.9	-2.2
2	2390.00	51.5 AV	54.0	-2.5	1.36 V	28	53.7	-2.2
3	*2437.00	124.3 PK			1.36 V	28	126.9	-2.6
4	*2437.00	110.5 AV			1.36 V	28	113.1	-2.6
5	2483.50	72.6 PK	74.0	-1.4	1.36 V	28	75.0	-2.4
6	2483.50	51.7 AV	54.0	-2.3	1.36 V	28	54.1	-2.4
7	4874.00	57.5 PK	74.0	-16.5	1.70 V	99	55.5	2.0
8	4874.00	44.9 AV	54.0	-9.1	1.70 V	99	42.9	2.0
9	7311.00	50.3 PK	74.0	-23.7	2.13 V	110	41.9	8.4
10	7311.00	37.3 AV	54.0	-16.7	2.13 V	110	28.9	8.4

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

CHANNEL	TX Channel 11	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2462.00	115.3 PK			3.25 H	56	117.9	-2.6
2	*2462.00	103.6 AV			3.25 H	56	106.2	-2.6
3	2483.50	67.9 PK	74.0	-6.1	3.25 H	56	70.3	-2.4
4	2483.50	48.9 AV	54.0	-5.1	3.25 H	56	51.3	-2.4
5	4924.00	55.9 PK	74.0	-18.1	1.50 H	124	53.9	2.0
6	4924.00	44.7 AV	54.0	-9.3	1.50 H	124	42.7	2.0
7	7386.00	50.6 PK	74.0	-23.4	3.61 H	147	42.0	8.6
8	7386.00	37.6 AV	54.0	-16.4	3.61 H	147	29.0	8.6
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2462.00	119.5 PK			1.26 V	35	122.1	-2.6
2	*2462.00	106.3 AV			1.26 V	35	108.9	-2.6
3	**2483.50**	**73.8 PK**	**74.0**	**-0.2**	**1.26 V**	**35**	**76.2**	**-2.4**
4	2483.50	51.5 AV	54.0	-2.5	1.26 V	35	53.9	-2.4
5	4924.00	56.6 PK	74.0	-17.4	1.77 V	95	54.6	2.0
6	4924.00	43.9 AV	54.0	-10.1	1.77 V	95	41.9	2.0
7	7386.00	49.9 PK	74.0	-24.1	2.09 V	114	41.3	8.6
8	7386.00	37.1 AV	54.0	-16.9	2.09 V	114	28.5	8.6

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

Below 1GHz Data:

CHANNEL	TX Channel 6	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	73.29	33.4 QP	40.0	-6.6	1.45 H	229	44.1	-10.7
2	125.47	38.4 QP	43.5	-5.1	1.82 H	79	47.8	-9.4
3	247.45	37.1 QP	46.0	-8.9	1.52 H	204	46.0	-8.9
4	321.64	41.8 QP	46.0	-4.2	1.97 H	64	48.1	-6.3
5	752.22	33.8 QP	46.0	-12.2	1.98 H	36	30.4	3.4
6	809.65	35.1 QP	46.0	-10.9	2.03 H	135	31.1	4.0
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	36.82	31.4 QP	40.0	-8.6	1.24 V	169	40.1	-8.7
2	76.59	33.8 QP	40.0	-6.2	1.39 V	61	45.3	-11.5
3	125.17	35.8 QP	43.5	-7.7	1.59 V	277	45.2	-9.4
4	327.97	36.2 QP	46.0	-9.8	1.54 V	248	42.4	-6.2
5	750.81	34.5 QP	46.0	-11.5	1.78 V	219	31.1	3.4
6	806.35	36.5 QP	46.0	-9.5	2.18 V	77	32.6	3.9

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver R&S	ESCS 30	847124/029	Nov. 01, 2017	Oct. 31, 2018
Line-Impedance Stabilization Network (for EUT) R&S	ESH3-Z5	848773/004	Nov. 15, 2017	Nov. 14, 2018
Line-Impedance Stabilization Network (for Peripheral) R&S	ENV216	100072	June 04, 2018	June 03, 2019
50 ohms Terminator	N/A	EMC-02	Sep. 22, 2017	Sep. 21, 2018
RF Cable	5D-FB	COCCAB-001	Sep. 29, 2017	Sep. 28, 2018
Fixed attenuator EMCI	STI02-2200-10	003	Mar. 16, 2018	Mar. 15, 2019
Software BVADT	BVADT_Cond_ V7.3.7.4	NA	NA	NA

Note:
1. The calibration interval of the above test instruments are 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in Conduction 1.
3. Tested Date: July 06, 2018

4.2.3 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

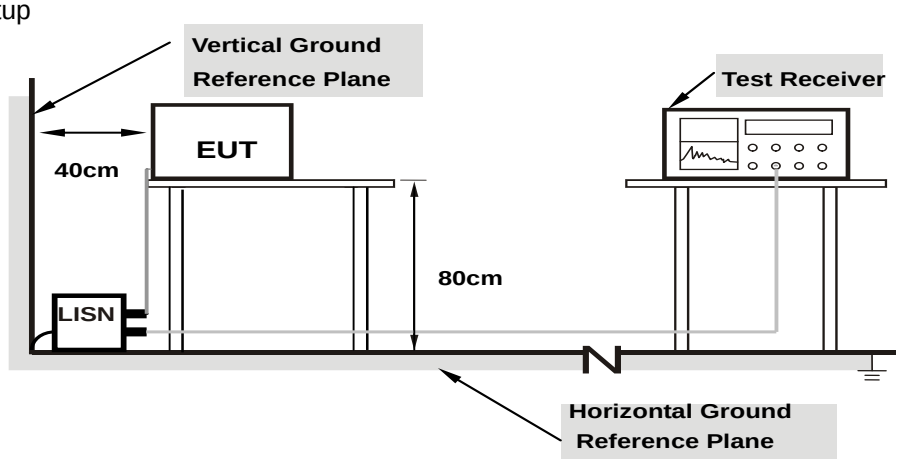
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

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

4.2.6 EUT Operating Conditions

Same as 4.1.6.

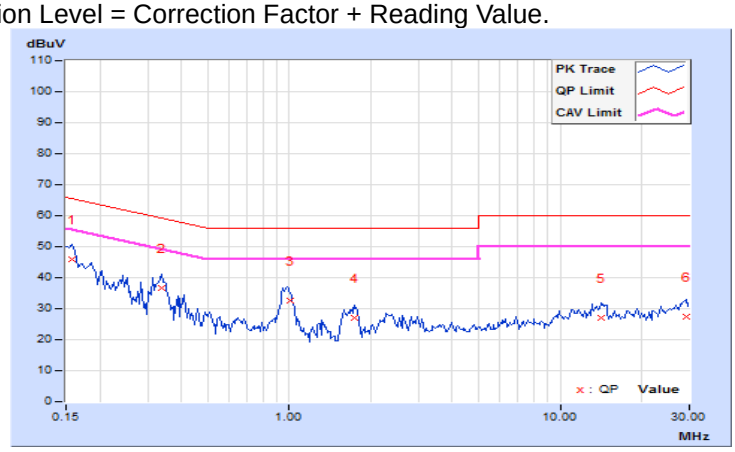
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15781	10.04	35.75	18.30	45.79	28.34	65.58	55.58	-19.79	-27.24
2	**0.33750**	**10.09**	**26.68**	**21.90**	**36.77**	**31.99**	**59.26**	**49.26**	**-22.49**	**-17.27**
3	1.00762	10.15	22.49	16.50	32.64	26.65	56.00	46.00	-23.36	-19.35
4	1.74219	10.18	16.86	9.38	27.04	19.56	56.00	46.00	-28.96	-26.44
5	14.10938	10.78	16.37	9.63	27.15	20.41	60.00	50.00	-32.85	-29.59
6	29.13672	11.22	16.22	10.76	27.44	21.98	60.00	50.00	-32.56	-28.02

REMARKS:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

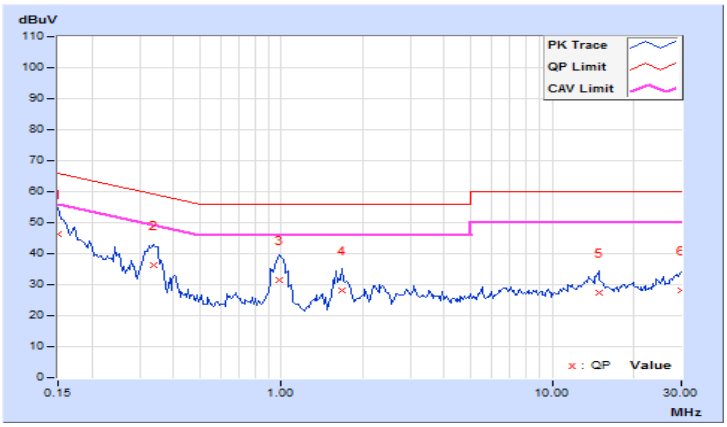


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.94	36.24	18.59	46.18	28.53	66.00	56.00	-19.82	-27.47
2	0.33750	9.99	26.17	21.43	36.16	31.42	59.26	49.26	-23.10	-17.84
3	0.98203	10.03	21.52	14.76	31.55	24.79	56.00	46.00	-24.45	-21.21
4	1.67578	10.06	18.18	12.23	28.24	22.29	56.00	46.00	-27.76	-23.71
5	14.82813	10.65	16.78	9.96	27.43	20.61	60.00	50.00	-32.57	-29.39
6	29.90234	10.99	17.03	11.71	28.02	22.70	60.00	50.00	-31.98	-27.30

REMARKS:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.



4.3 Conducted Output Power Measurement

4.3.1 Limits of Conducted Output Power Measurement

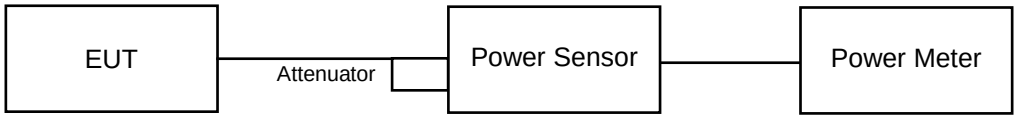
For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

Per KDB 662911 D01 Multiple Transmitter Output Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedures

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Results

Chan.	Chan. Freq. (MHz)	Average Power (dBm)				Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1	Chain 2	Chain 3				
1	2412	18.11	18.25	18.53	18.04	266.513	24.26	30.00	Pass
6	2437	22.61	22.57	23.33	22.47	754.989	28.78	30.00	Pass
11	2462	17.69	17.42	18.79	18.41	258.983	24.13	30.00	Pass

Note: 1. Max. gain = 5.78dBi < 6dBi, so the power limit shall not be reduced.

5 Pictures of Test Arrangements

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

Appendix – Information on 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 according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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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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