RF TEST REPORT for Intentional Radiator
No. 160700132SHA-002

Applicant	:	Lenbrook Industries Limited
		633 Granite Court, Pickering Ontario, L1W 3K1, Canada
Manufacturer	:	Lenbrook Industries Limited
		633 Granite Court, Pickering Ontario, L1W 3K1, Canada
Product Name	:	HYBRID DIGITAL DAC AMPLIFIER
Type/Model	:	C 388
TEST RESULT	**:**	**PASS**

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2016): Radio Frequency Devices

ANSI C63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices

RSS-247 Issue 1(May 2015): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 4 (November 2014): General Requirements for Compliance of Radio Apparatus

Date of issue: October 26, 2016

Prepared by:

Wade Zhang (*Project Engineer*)

Reviewed by:

Daniel Zhao (*Reviewer*)

Description of Test Facility

Name:	Intertek Testing Services Limited Shanghai
Address:	Building No.86, 1198 Qinzhou Road(North), Shanghai 200233, P.R. China
FCC Registration Number:	236597
IC Assigned Code:	2042B-1
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Content

1. Test Summary

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Test Items	FCC Reference	IC Reference	Result
Minimum 6dB Bandwidth	15.247(a)(2)	RSS-247 Issue 1 Clause 5	Pass
Output power	15.247(b)	RSS-247 Issue 1 Clause 5	Pass
Power spectrum density	15.247(e)	RSS-247 Issue 1 Clause 5	Pass
Emissions in non-restricted frequency bands	15.247(d)	RSS-247 Issue 1 Clause 5	Pass
Emissions in restricted frequency bands	15.247(d) & 15.205 & 15.209	RSS-247 Issue 1 Clause 5	Pass
Power line conducted emission	15.207	RSS-Gen Issue 4 Clause 8.8	NA

2. General Information

2.1 Applicant Information

Applicant	:	Lenbrook Industries Limited 633 Granite Court, Pickering Ontario, L1W 3K1, Canada
Name of contact	:	Heather Yan
Tel	:	+1 905 831 0799
Fax	:	+1 905 837 6357
Manufacturer	:	Lenbrook Industries Limited 633 Granite Court, Pickering Ontario, L1W 3K1, Canada
Factory	:	Hansong (Nanjing) Technology Ltd. 8th Kangping Road, Jiangning Economy and Technology Development Zone, Nanjing, 211106, China.

2.2 Identification of the EUT and Technical specification

Equipment	:	HYBRID DIGITAL DAC AMPLIFIER
Type/model	:	C 388
Operation Frequency	:	2402-2480MHz
EUT Modes of Modulation	:	BT4.0 BLE
Type of Modulation	:	GFSK
Transfer Rate	:	1Mbps
Power Class	:	Class II
Channel Number	:	40 (0-39)
Antenna	:	2dBi Dipole antenna
Description of EUT	:	The EUT is an amplifier which supports BT4.0 function, and it has only one model, we tested it and listed the BLE result in this report.
Rating	:	100-120V/220-240V~ 50/60Hz 200W
Category of EUT	:	Class B
EUT type	:	☒ Table top ☐ Floor standing
Sample received date	:	July 04, 2016
Sample Identification No	:	*0160704-19-002*
Date of test	:	July 04, 2016 ~ September 19, 2016

2.3 Channel List

Frequency Band (MHz)				2402 ~ 2480			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	**19**	**2440**	29	2460	**39**	**2480**

2.4 Test software and Power Setting

The test setting software is offered by the manufactory. The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases.

Test software and Power Setting parameter			
Test Software	CSR Bluesuite 2.4.8		
Working Mode	BLE		
Test Channel	2402MHz	2440MHz	2480MHz
Power Setting	0	0	0

3. Test Specification

3.1 Instrument list

Selected	Equipment	Type	Manu.	Internal no.	Cal. Date	Due date
☒	PXA Analyzer	N9030A	Agilent	EC5338	2016/3/4	2017/3/3
☒	Vector SG	N5182B	Agilent	EC5175	2016/3/4	2017/3/3
☒	Power sensor	U2021XA	Agilent	EC5338-1	2016/3/4	2017/3/3
☒	MXG Analog SG	N5181A	Agilent	EC5338-2	2016/3/4	2017/3/3
☒	Power meter	N1911A/N1921A	Agilent	EC4318	2016/4/10	2017/4/9
☒	EMI Receiver	ESCS 30	R&S	EC 2107	2015/10/20	2016/10/19
☒	A.M.N.	ESH2-Z5	R&S	EC 3119	2015/12/16	2017/12/15
☒	I.S.N.	FCC-TLISN-T8-02	FCC	EC3756	2016/2/16	2017/2/15
☒	EMI chamber	3m	Albatross	EC 3048	2016/5/5	2017/5/4
☒	Test Receiver	ESIB 26	R&S	EC 3045	2015/10/20	2016/10/19
☒	Test Receiver	ESCI 7	R&S	EC4501	2016/2/24	2017/2/23
☒	Bilog Antenna	CBL 6112D	TESEQ	EC 4206	2016/5/30	2017/5/29
☒	Horn antenna	HF 906	R&S	EC 3049	2016/9/11	2017/9/10
☒	Horn antenna	HAP18-26W	TOYO	EC 4792-3	2014/6/12	2017/6/11
☒	Pre-amplifier	Pre-amp 18	R&S	EC 5262	2016/5/24	2017/5/23
☒	Pre-amplifier	Tpa0118-40	R&S	EC 4792-2	2016/4/11	2017/4/10
☒	Shielded room	-	Zhongyu	EC 2838	2016/1/9	2017/1/8

3.2 Test Standard

47CFR Part 15 (2016): Radio Frequency Devices

RSS-247 Issue 1(May 2015): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 4 (November 2014): General Requirements for Compliance of Radio Apparatus

ANSI C63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices

3.3 Mode of operation during the test / Test peripherals used

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

Radiated test mode:
Mode 1: EUT transmitted signal with BT antenna;

Conducted test mode:
Mode 2: EUT transmitted signal from BT RF port connected to SPA directly;

Test peripherals used:

Item No	Description	Band and Model	S/No
1	Laptop computer	HP ProBook 6470b	NA
Note: The accessories are used for configuration only and not used during test.			

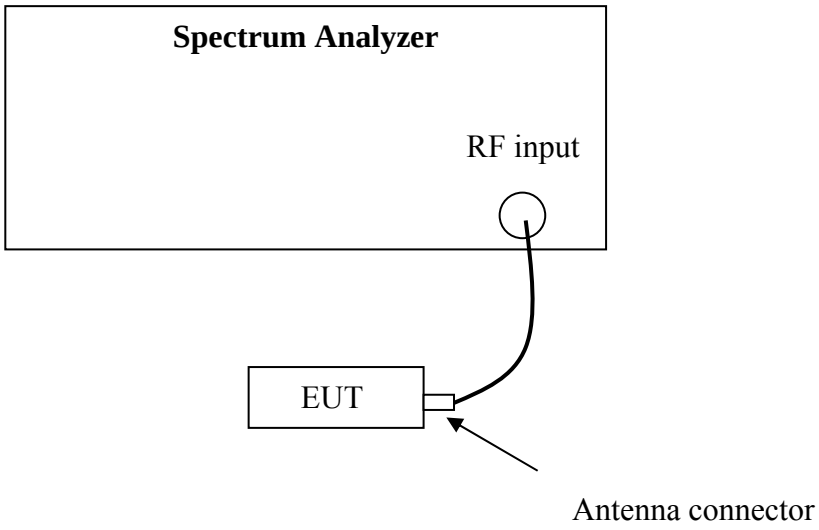
4. Minimum 6dB Bandwidth

Test result: PASS

4.1 Limit

For systems using digital modulation techniques that may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz bands, the minimum 6 dB bandwidth shall be at least 500 kHz.

4.2 Test Configuration



4.3 Test Procedure and test setup

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

4.4 Test Protocol

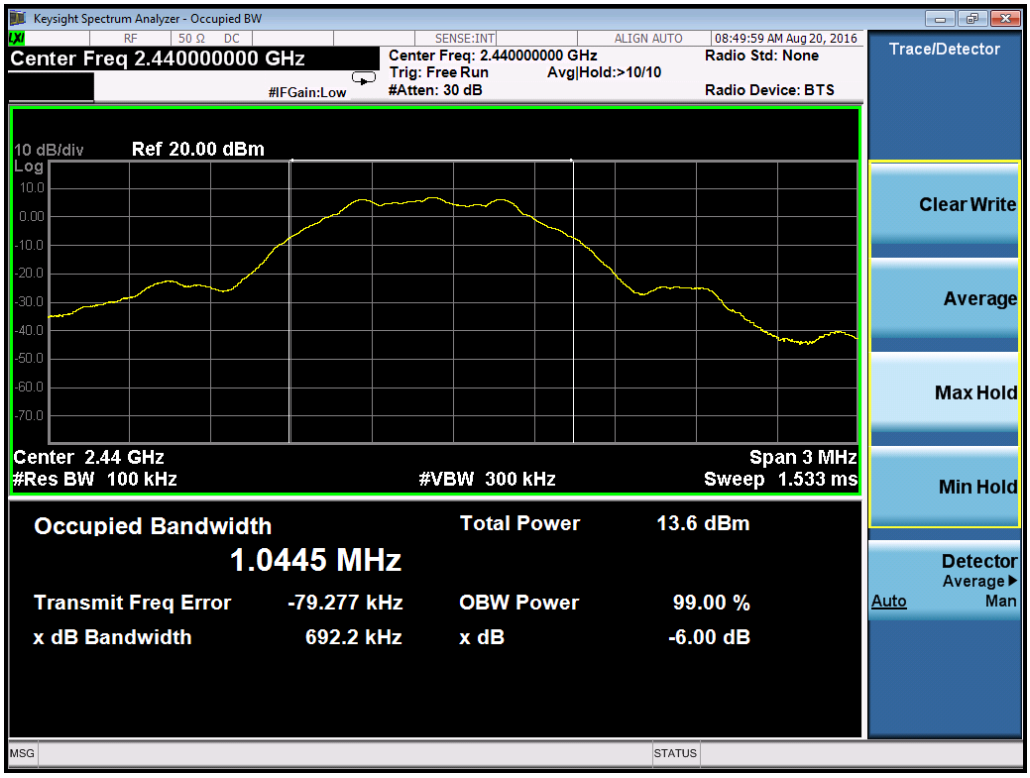
Temperature: 22°C
Relative Humidity: 53%

Modulation	Frequency (MHz)	Minimum 6dB Bandwidth (KHz)	Limits (KHz)
BLE	2402	702.7	> 500
	2440	692.2	> 500
	2480	698.4	> 500

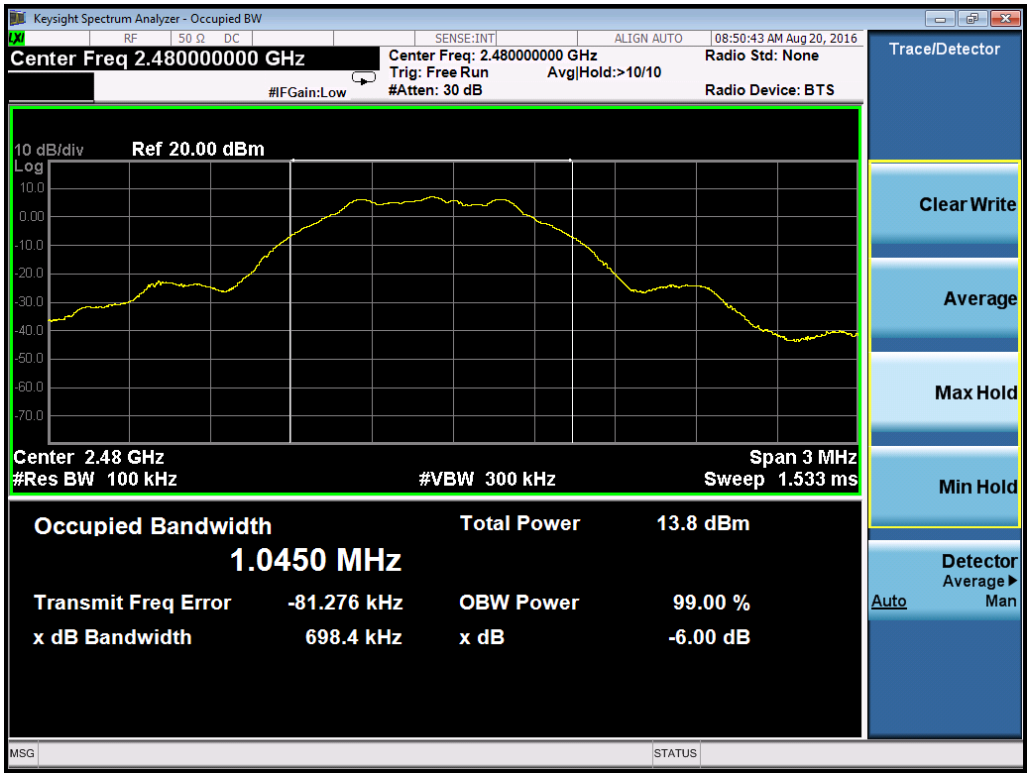
Modulation	Frequency (MHz)	99% Occupied Bandwidth (MHz)
BLE	2402	1.0492
	2440	1.0445
	2480	1.0450

Channel L

Channel M



Channel H



5. Maximum Conducted Output power

Test result: Pass

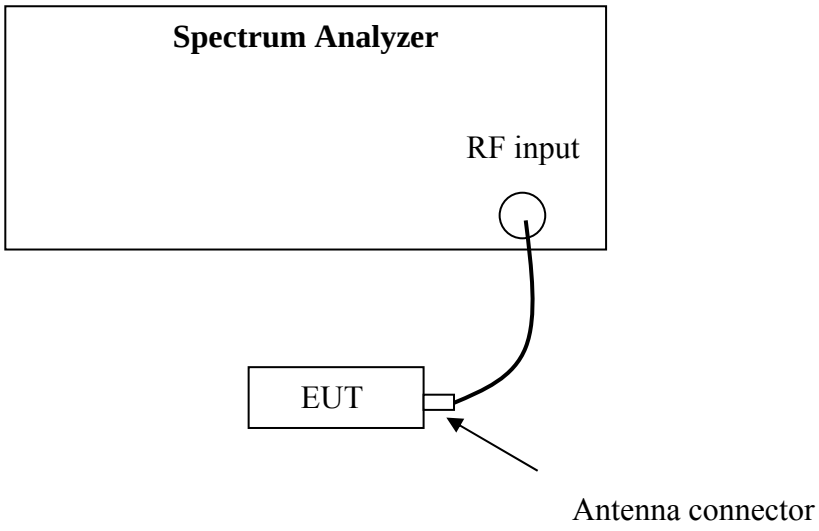
5.1 Test limit

☐ For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt

☐ For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

☒ For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

5.2 Test Configuration



5.3 Test procedure and test setup

a) Set the RBW ⩾ DTS bandwidth.

b) Set VBW ⩾ 3 × RBW.

c) Set span ⩾ 3 x RBW

d) Sweep time = auto couple.

e) Detector = peak.

f) Trace mode = max hold.

g) Allow trace to fully stabilize.

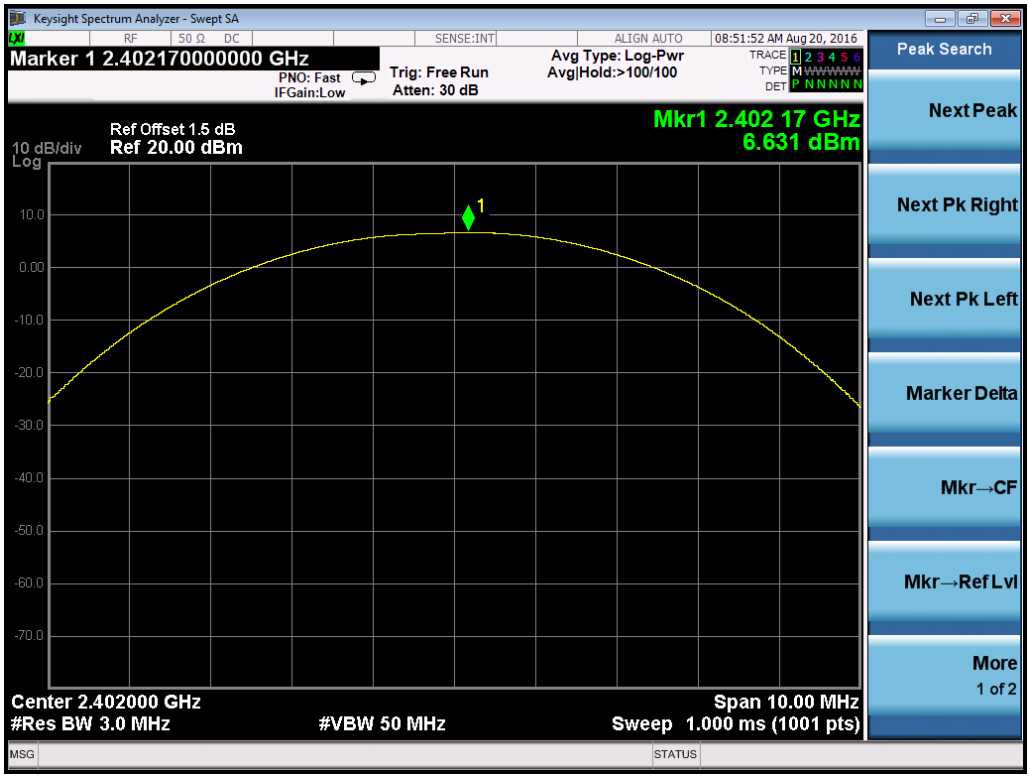
h) Use peak marker function to determine the peak amplitude level.

5.4 Test protocol

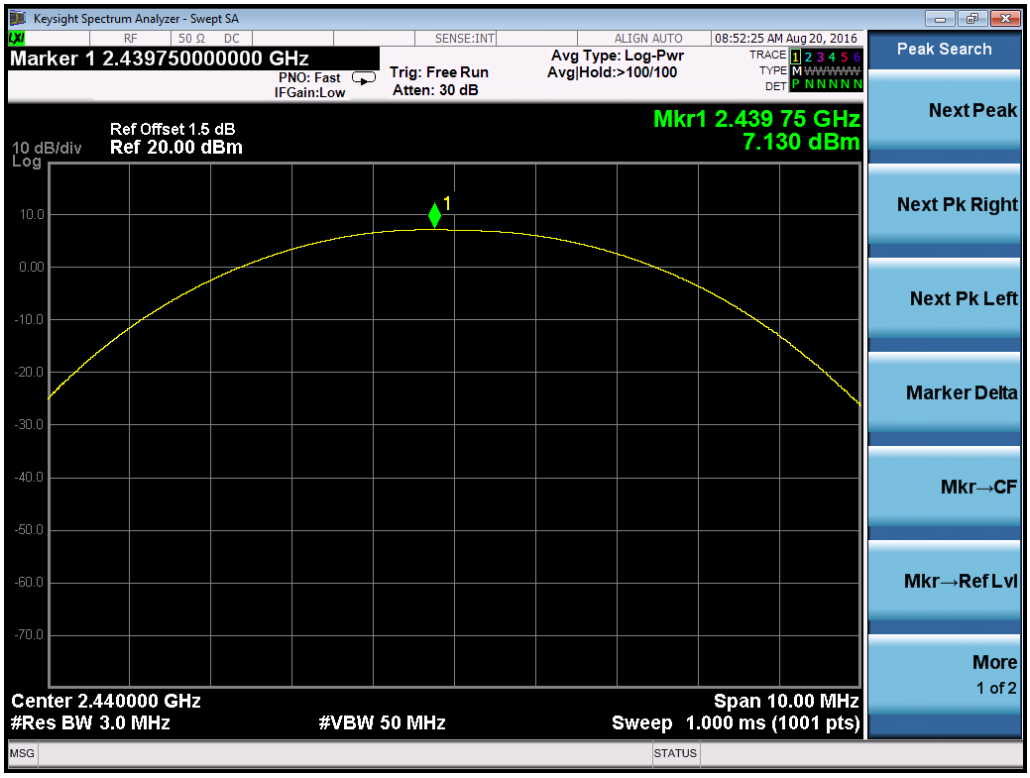
Temperature: 22 °C
Relative Humidity: 53 %

Modulation	Frequency (MHz)	MaxConducted Power (dBm)	Limit (dBm)
BLE	2402	6.631	30
	2440	7.130	30
	2480	7.202	30

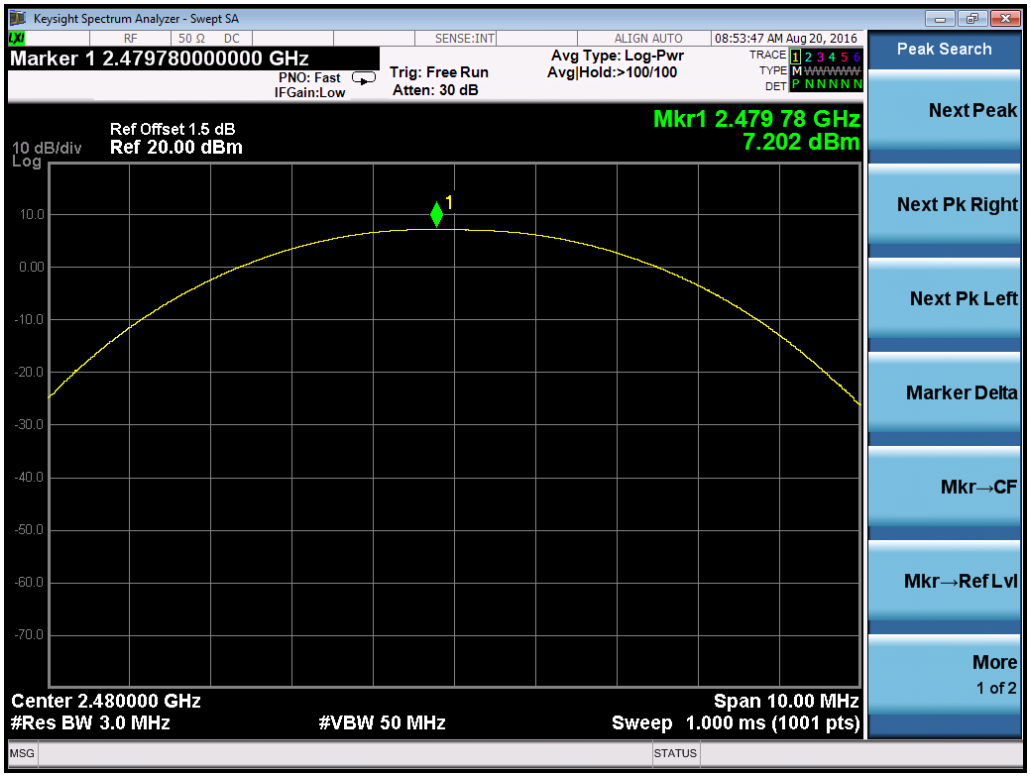
Channel L



Channel M



Channel H



6. Maximum Power spectrum density

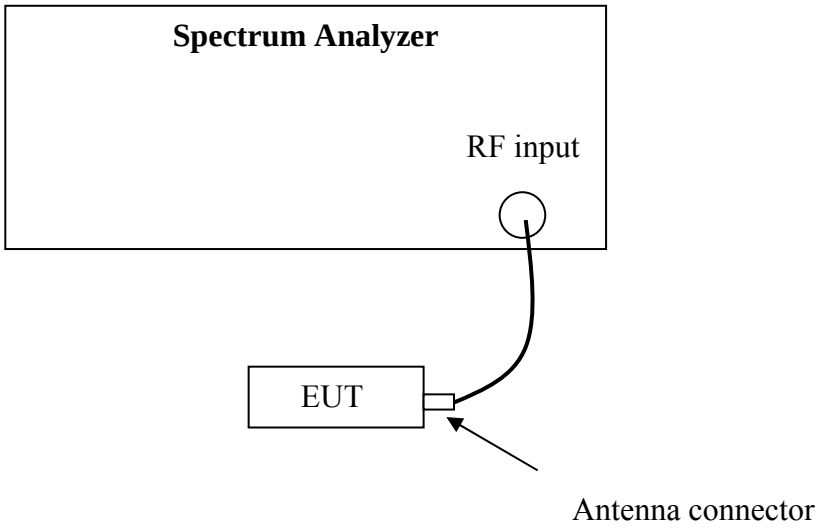
Test result: **Pass**

6.1 Test limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. If there have a beam forming type, the limit should be the minimum of 8dBm/MHz and 8+ (6 – antenna gain-beam forming gain).

6.2 Test Configuration



6.3 Test procedure and test setup

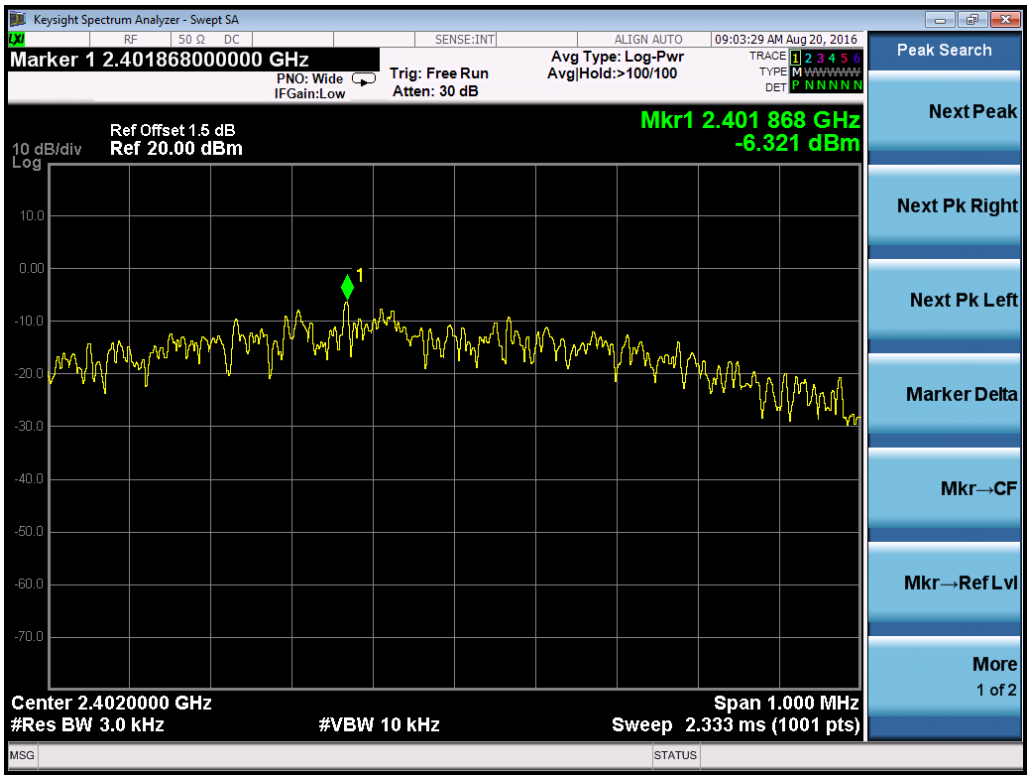
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 × RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.4 Test Protocol

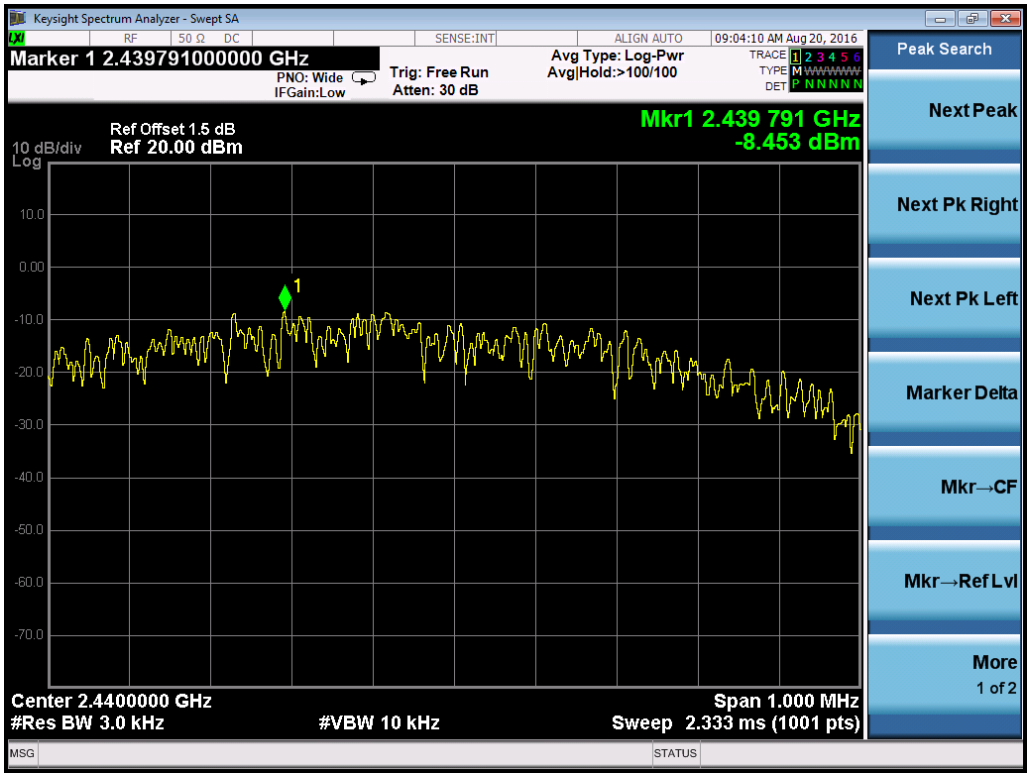
Temperature: 22 °C
Relative Humidity: 53 %

Modulation	Frequency (MHz)	Maximum Power spectrum density (dBm/3KHz)	Limit (dBm/3KHz)
BLE	2402	-6.321	8
	2440	-8.453	8
	2480	-7.359	8

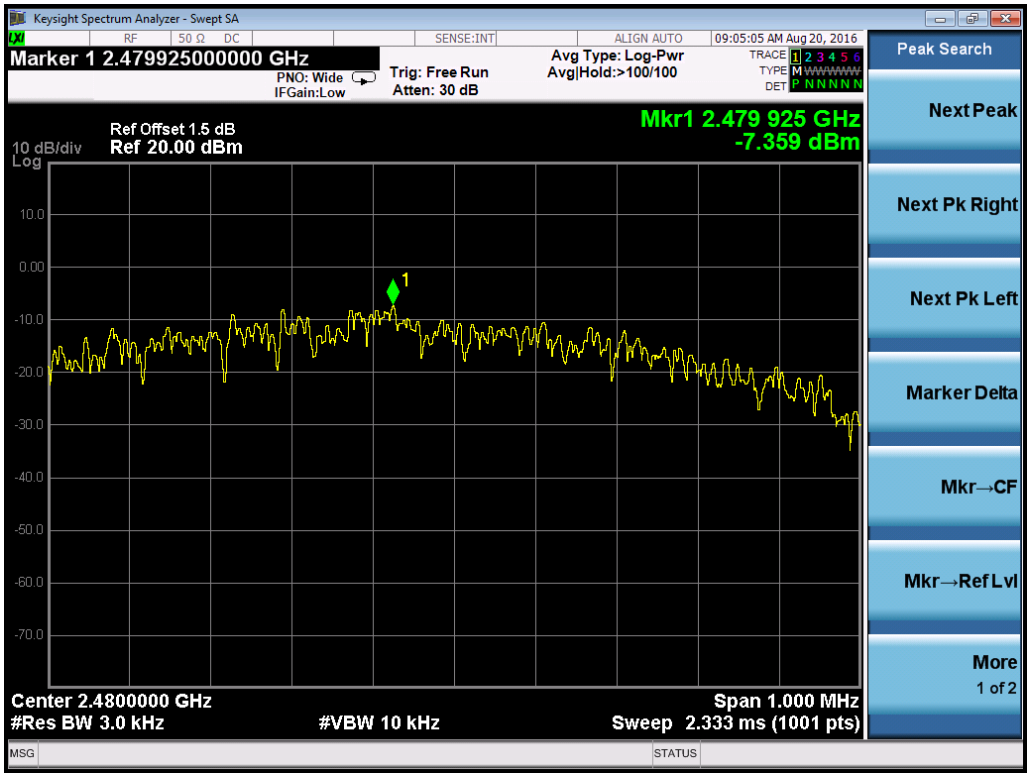
Channel L



Channel M



Channel H



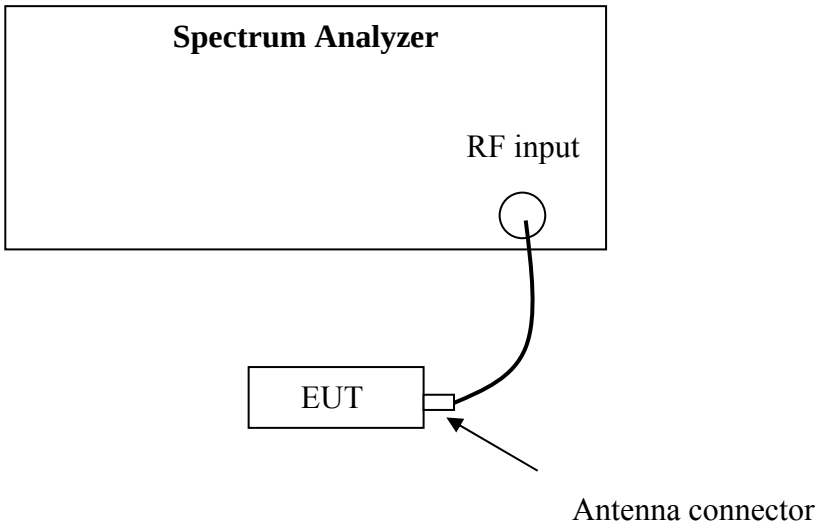
7. Emissions in non-restricted frequency bands

Test result: **Pass**

7.1 Test limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

7.2 Test Configuration



7.3 Test procedure and test setup

Reference level measurement

Establish a reference level by using the following procedure:

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the *DTS bandwidth*.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

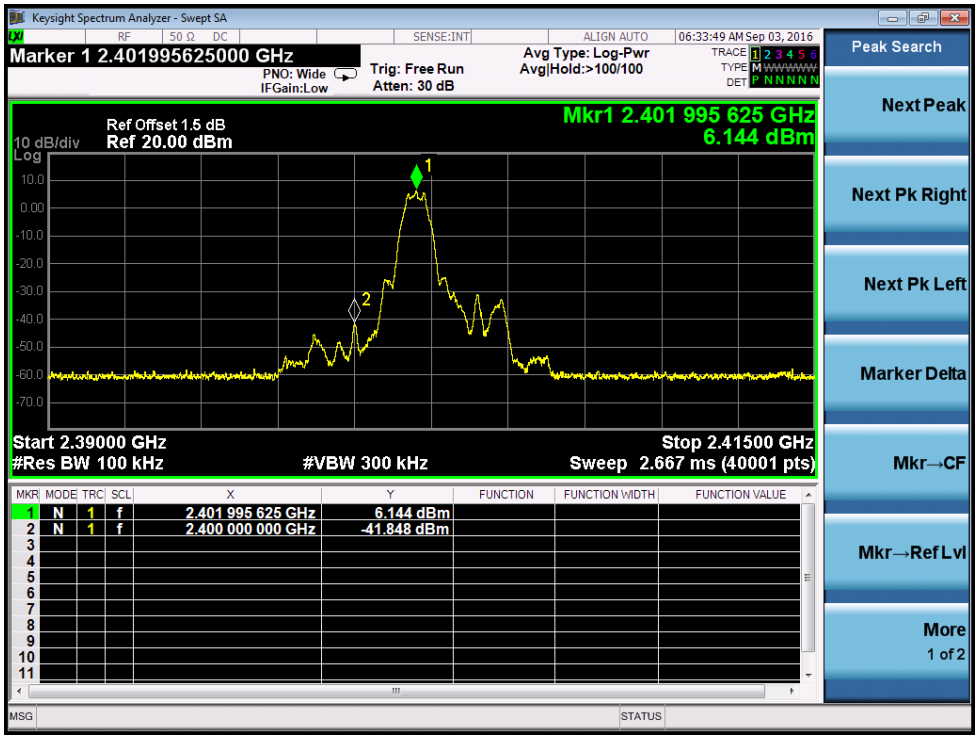
Emission level measurement

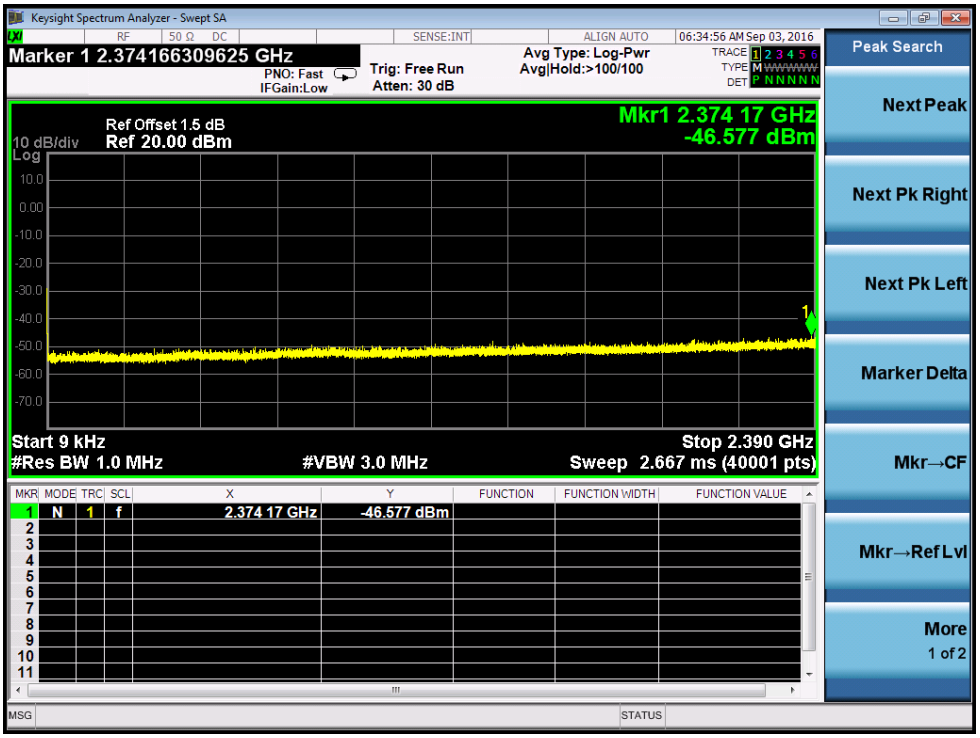
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Ensure that the number of measurement points ≥ span/RBW
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

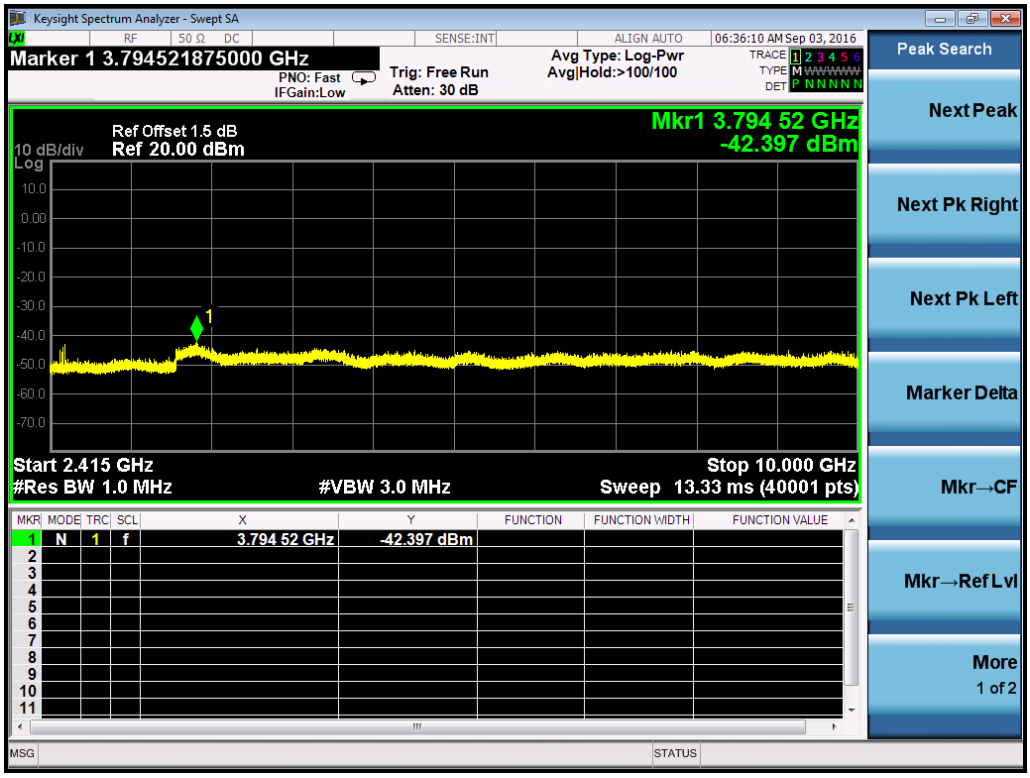
7.4 Test Protocol

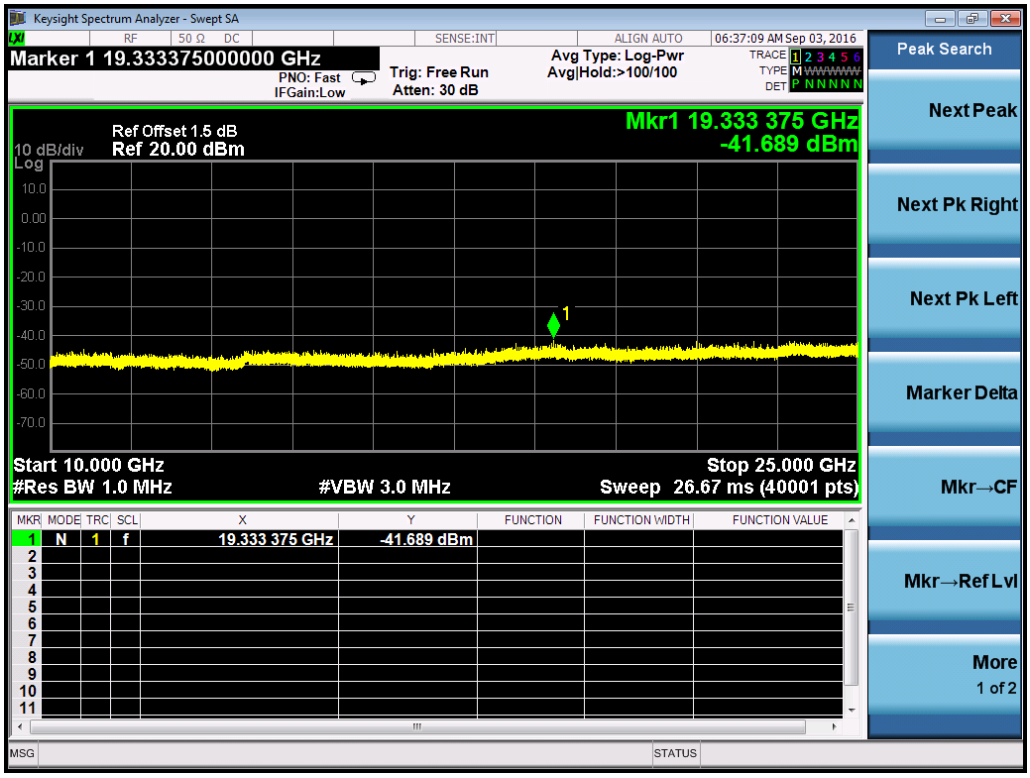
Temperature: 22 °C
Relative Humidity: 53 %

Channel L

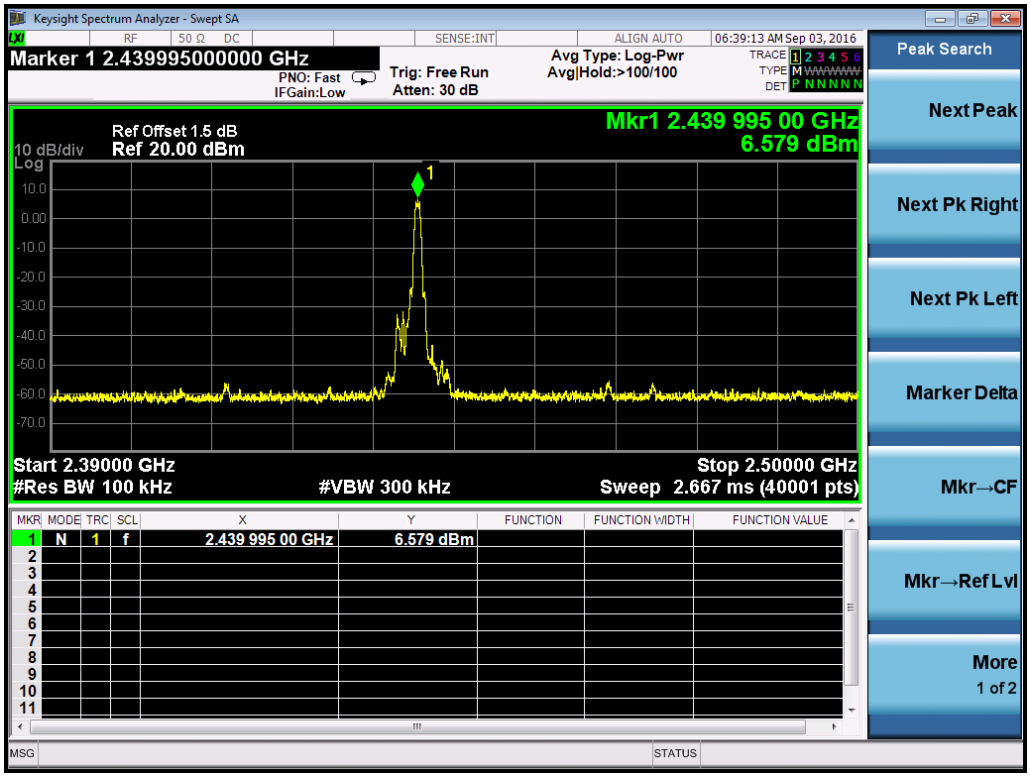


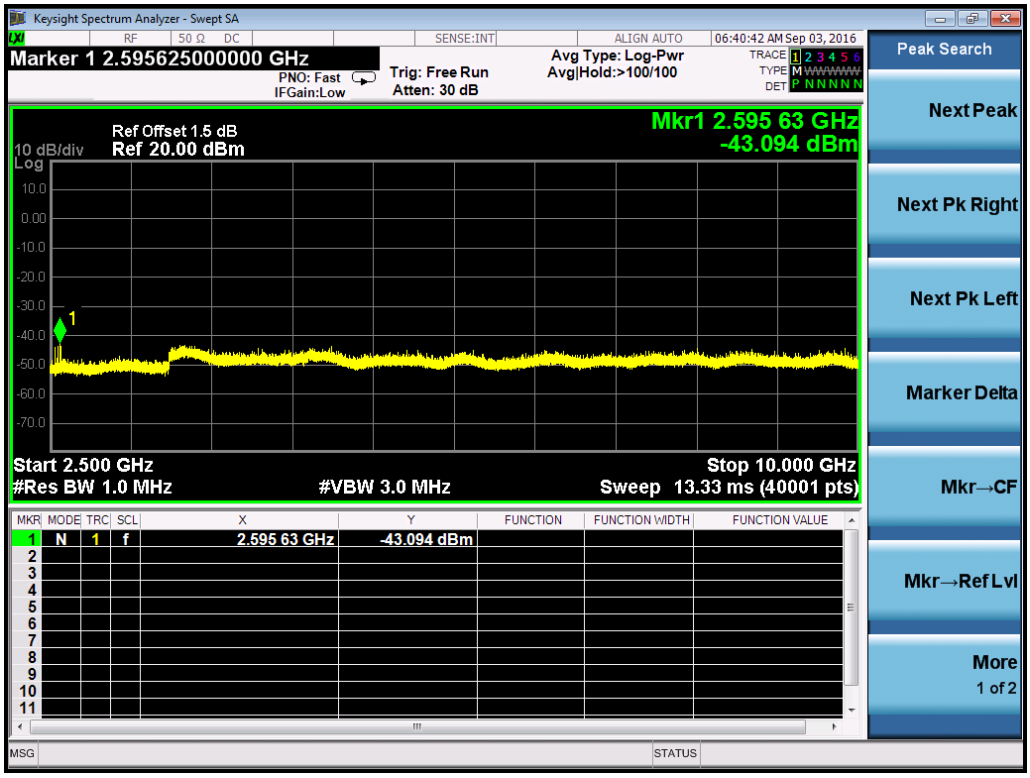


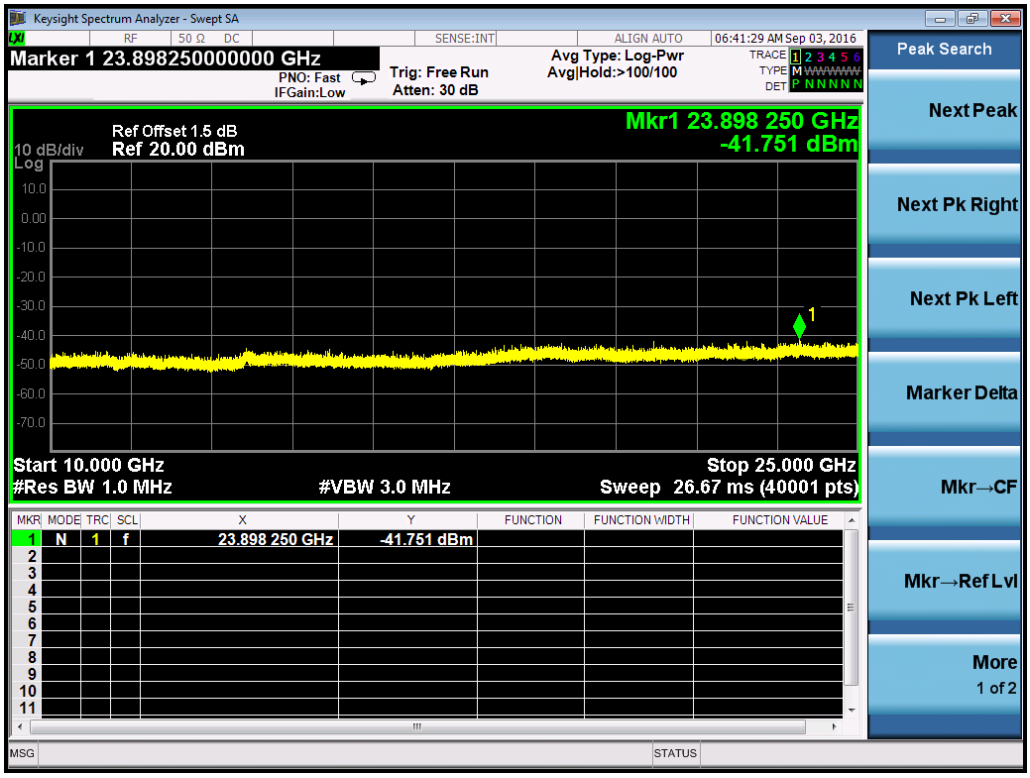




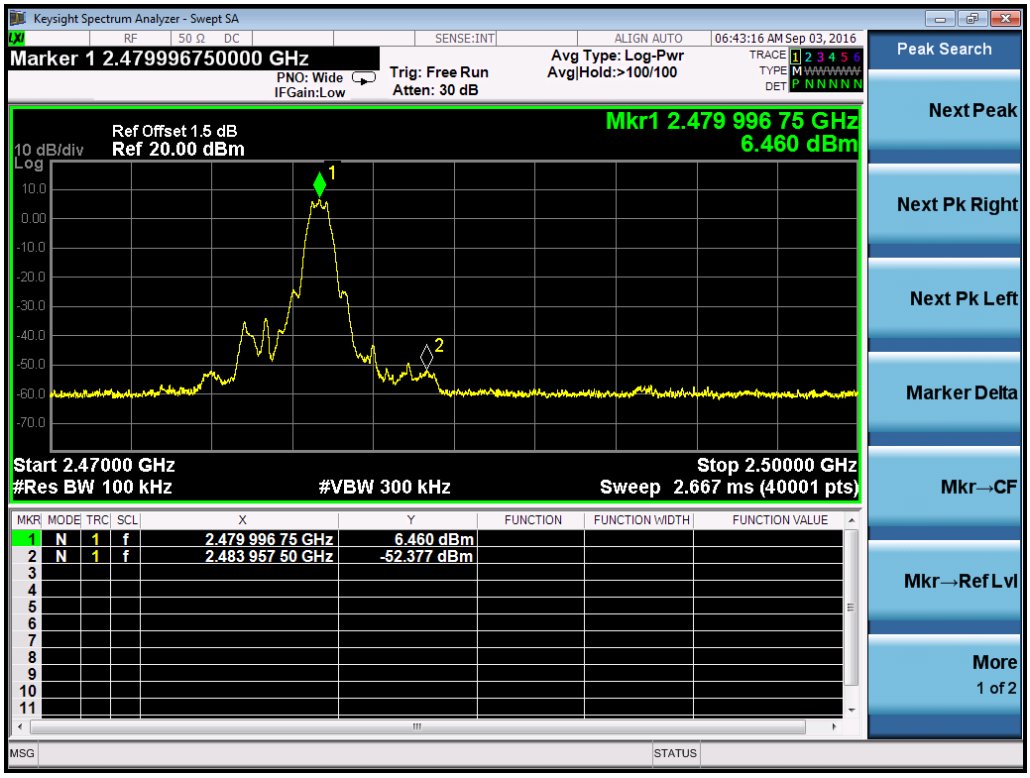
Channel M

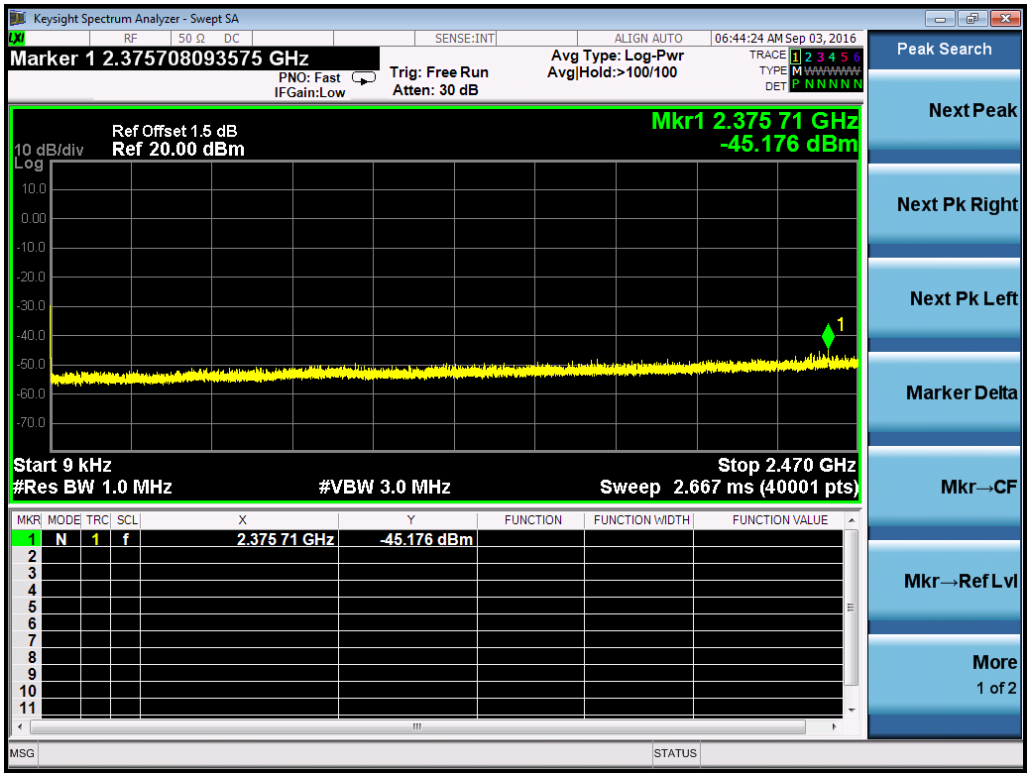


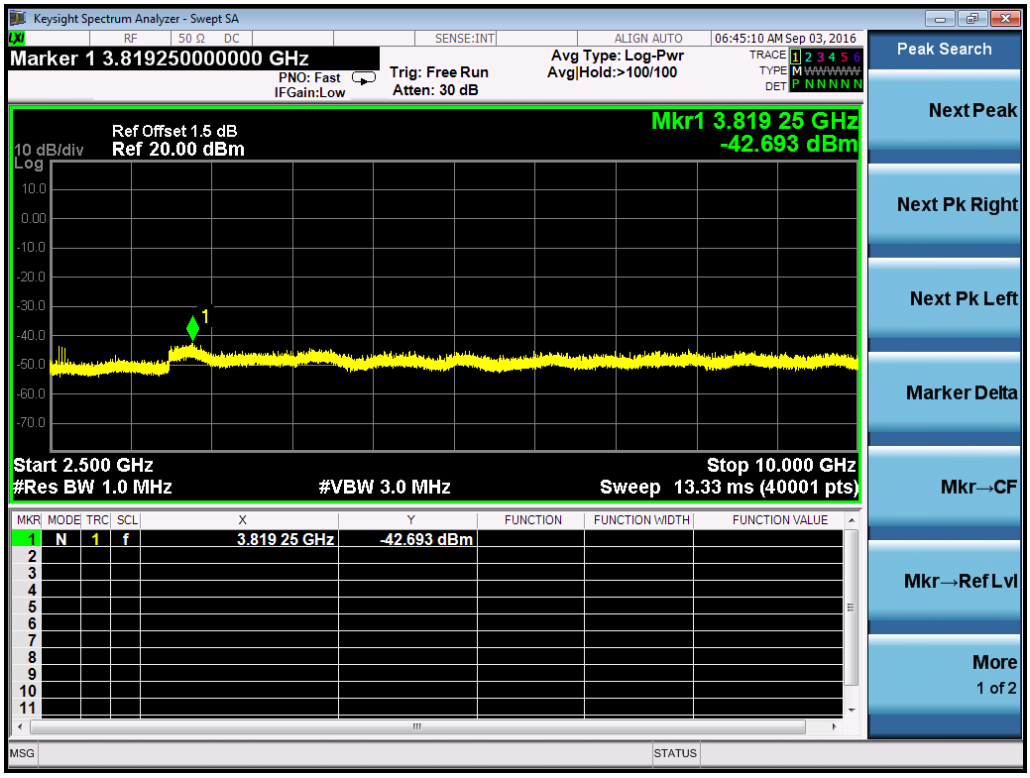


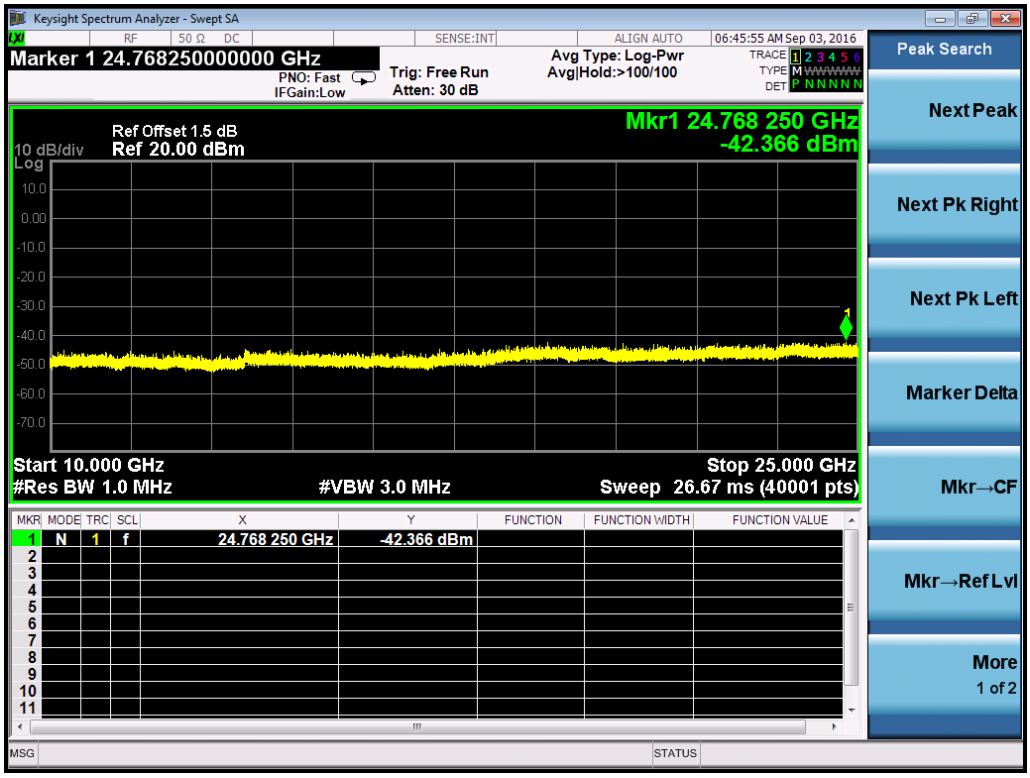


Channel H









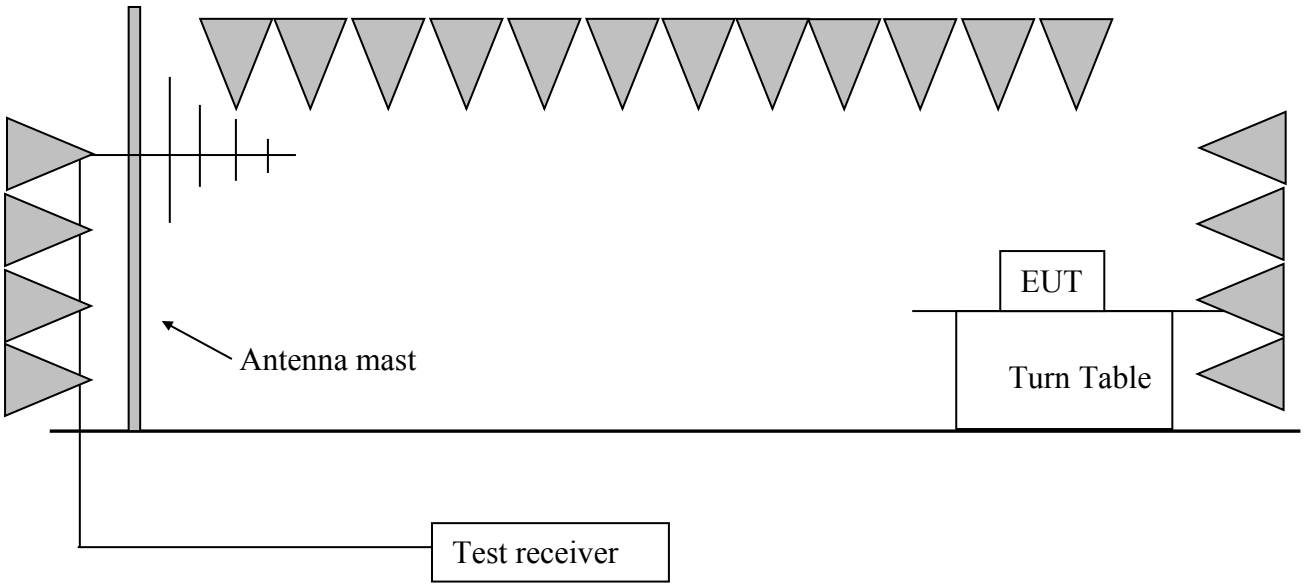
8. Radiated Emissions in restricted frequency bands

Test result: **Pass**

8.1 Test limit

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

8.2 Test Configuration



8.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.

Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m.

The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 100 kHz, VBW = 300 kHz (30MHz-1GHz)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);

Remark:
1. Factor= Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Measured level= Original Receiver Reading + Factor
3. Margin = limit – Measured level
4. If the PK measured level is lower than AV limit, the AV test can be elided.

Example:

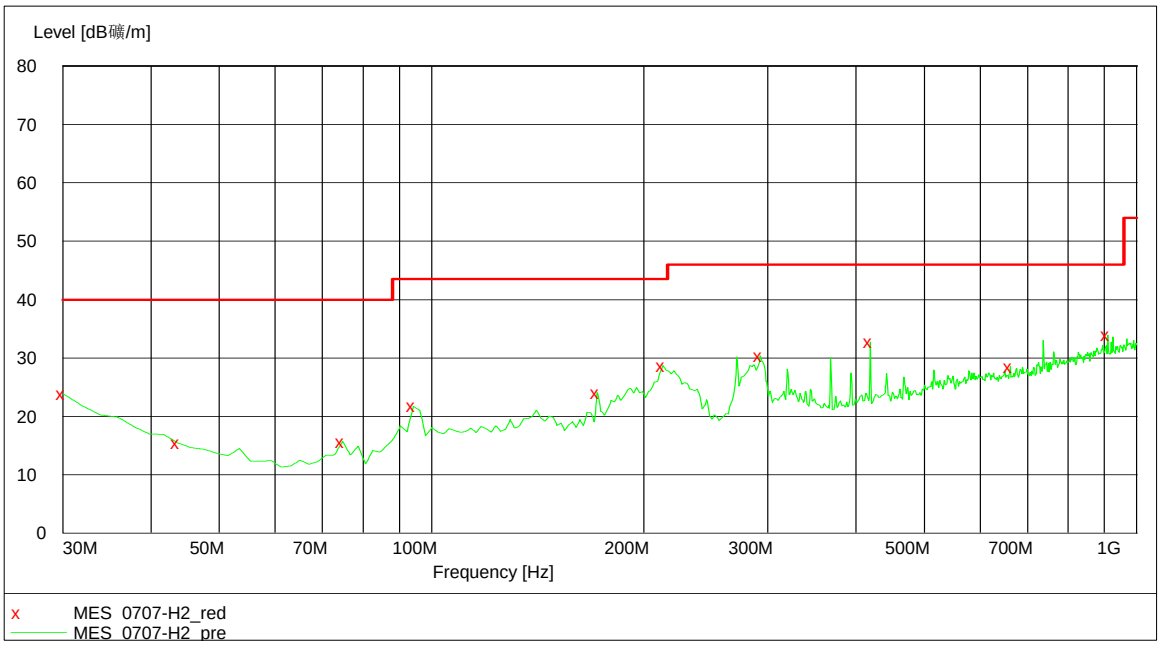
Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m;
Measured level = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m,
Measured level = 10.20dBuV/m, then Margin = 54 -10.20 = 43.80dBuV/m.

8.4 Test Protocol

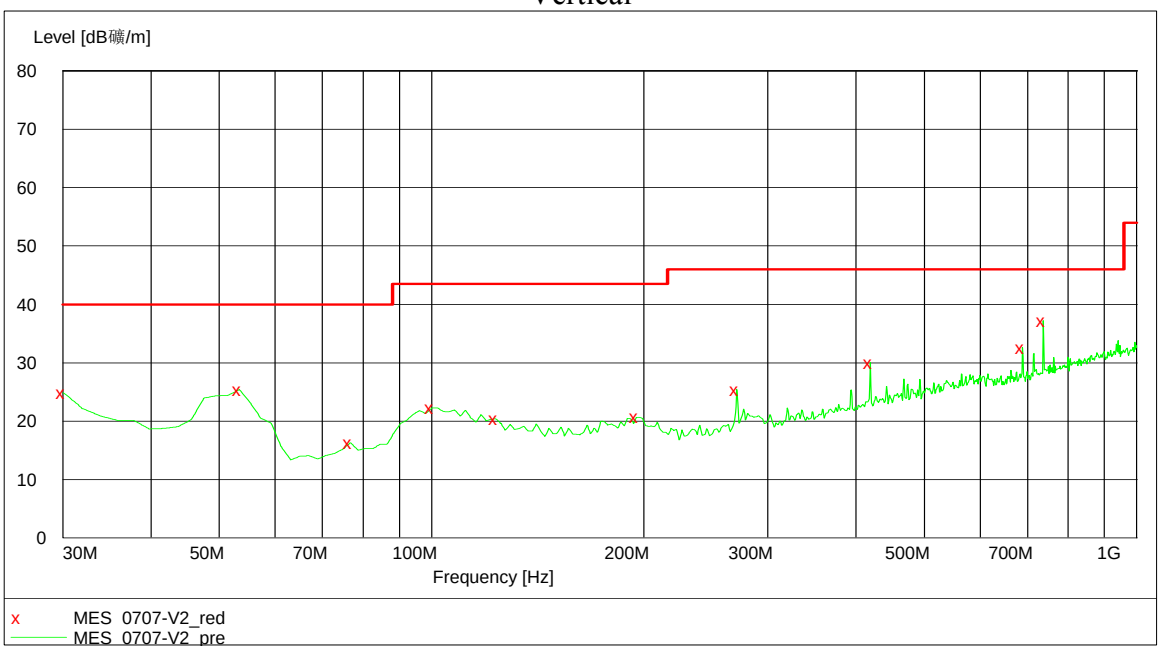
Temperature: 25 °C
Relative Humidity: 55 %

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line and not reported.

Horizontal



Vertical



Test data at 30MHz~1GHz (Channel H):

Polarization	Frequency (MHz)	Measured level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	30.00	23.8	40.0	16.2	PK
	43.61	15.4	40.0	24.6	PK
	74.71	15.7	40.0	24.3	PK
	94.15	21.7	43.5	21.8	PK
	171.90	24.1	43.5	19.4	PK
	212.73	28.7	43.5	14.8	PK
	292.42	30.4	46.0	15.6	PK
	418.78	32.7	46.0	13.3	PK
	661.76	28.5	46.0	17.5	PK
	910.58	33.9	46.0	12.1	PK
V	30.00	24.9	40.0	15.1	PK
	53.33	25.4	40.0	14.6	PK
	76.65	16.3	40.0	23.7	PK
	99.98	22.3	43.5	21.2	PK
	123.31	20.4	43.5	23.1	PK
	195.23	20.7	43.5	22.8	PK
	271.04	25.4	46.0	20.6	PK
	418.78	30.0	46.0	16.0	PK
	688.98	32.6	46.0	13.4	PK
	737.58	37.2	46.0	8.8	PK

Note: The test result (30MHz to 1GHz) of channel M (2480MHz) chosen to list in the report as representative.

Test result above 1GHz:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	97.30	Fundamental	/	PK
	V	2402.00	30.70	94.60	Fundamental	/	PK
	H	2390.00	30.30	48.20	74.00	25.80	PK
	H	2390.00	30.30	41.50	54.00	12.50	AV
	H	4804.00	-1.50	48.30	74.00	25.70	PK
	H	7206.00	3.50	49.10	74.00	24.90	PK
	V	2390.00	30.30	45.20	74.00	28.80	PK
	V	2390.00	30.30	37.80	54.00	16.20	AV
	V	4804.00	-1.50	44.60	74.00	29.40	PK
	V	7206.00	3.50	45.30	74.00	28.70	PK
M	H	2440.00	30.70	99.20	Fundamental	/	PK
	V	2440.00	30.70	95.30	Fundamental	/	PK
	H	4880.00	-1.10	47.60	74.00	26.40	PK
	H	7320.00	3.60	48.20	74.00	25.80	PK
	V	4880.00	-1.10	44.10	74.00	29.90	PK
	V	7320.00	3.60	45.60	74.00	28.40	PK
H	H	2480.00	30.70	98.60	Fundamental	/	PK
	V	2480.00	30.70	94.80	Fundamental	/	PK
	H	2483.50	30.80	48.20	74.00	25.80	PK
	H	2483.50	30.80	41.10	54.00	12.90	AV
	V	2483.50	30.80	46.40	74.00	27.60	PK
	V	2483.50	30.80	40.60	54.00	13.40	AV
	H	4960.00	-0.80	47.60	74.00	26.40	PK
	H	7440.00	3.80	48.70	74.00	25.30	PK
	V	4960.00	-0.80	45.30	74.00	28.70	PK
	V	7440.00	3.80	44.60	74.00	29.40	PK

Remark: 1. For fundamental emission, no amplifier is employed.
2. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
3. Corrected Reading = Original Receiver Reading + Correct Factor
4. Margin = limit – Corrected Reading
5. If the PK reading is lower than AV limit, the AV test can be elided.
6. The emission was conducted from 30MHz to 25GHz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m

Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 - 10.20 = 43.80dBuV/m

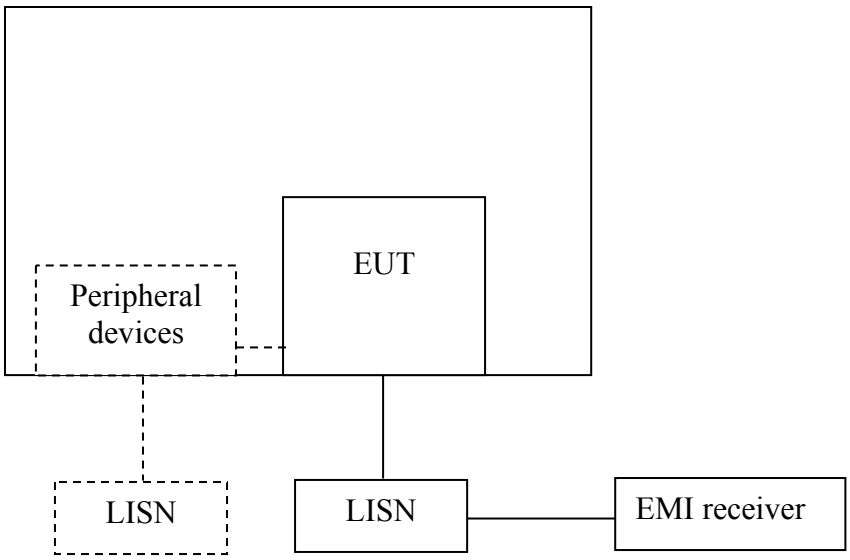
9. Power line conducted emission

Test result: **Pass**

9.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
0.15-0.5	66 to 56*	56 to 46 *
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

9.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.1m height rack.

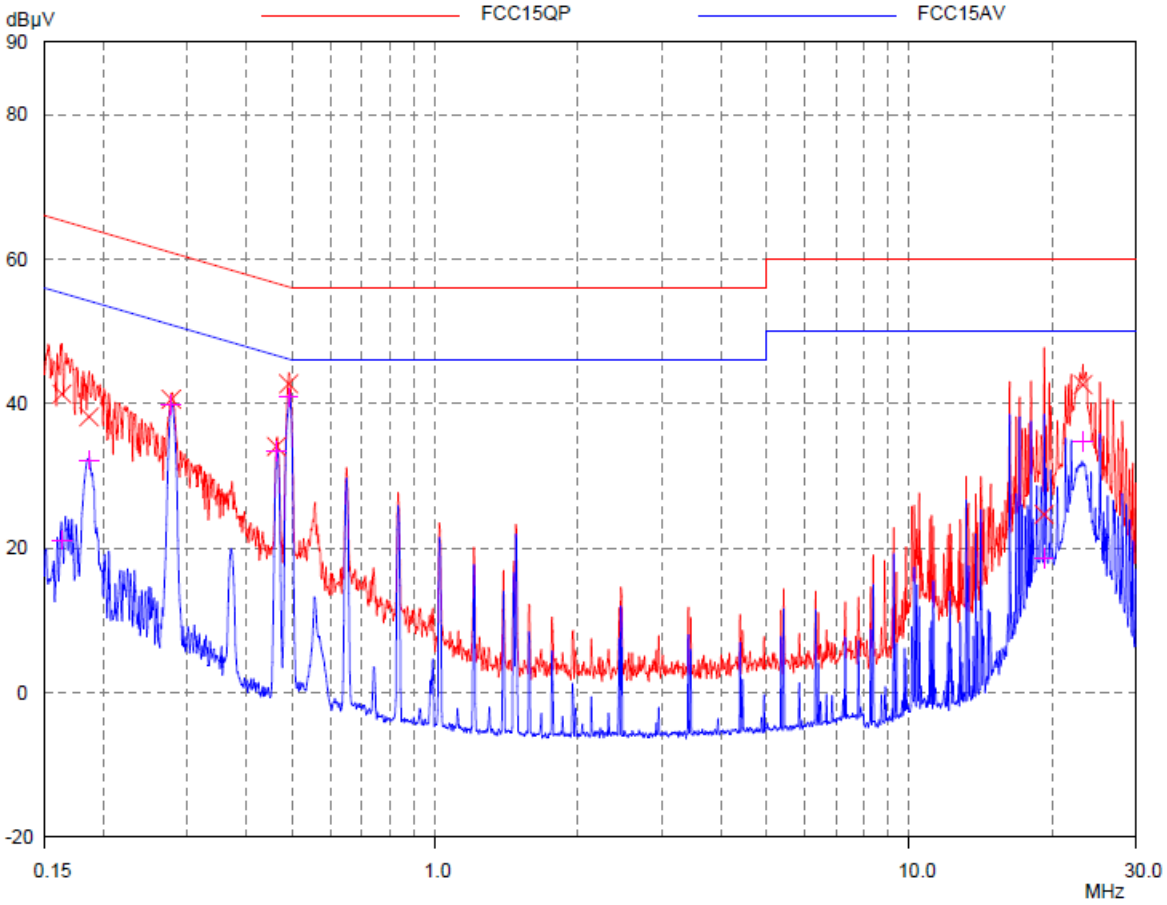
9.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to RSS-gen on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.

9.4 Test protocol

Temperature	:	25 °C
Relative Humidity	:	55 %

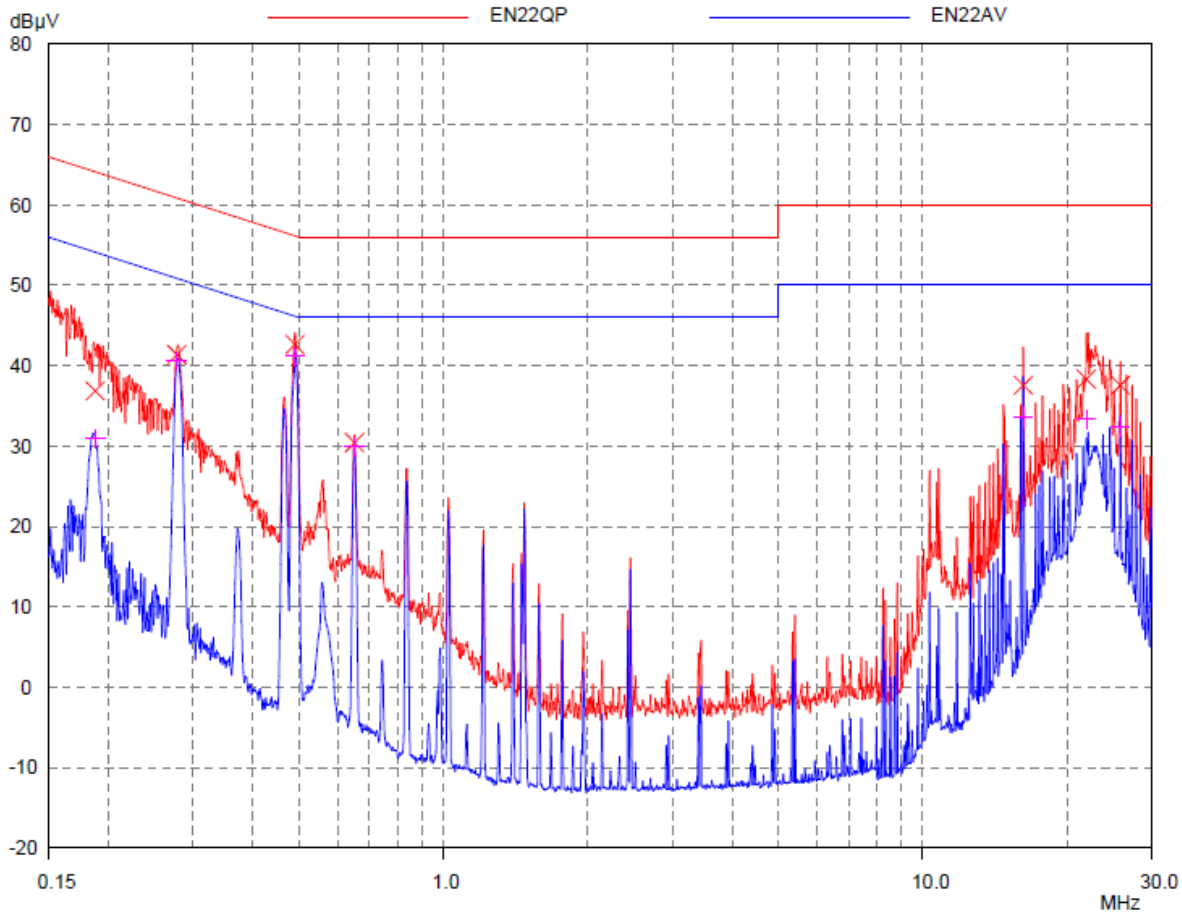
L line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.163	41.32	65.30	23.98	21.15	55.30	34.15
0.186	38.19	64.21	26.02	32.21	54.21	22.00
0.277	40.61	60.89	20.28	39.83	50.89	11.06
0.462	34.06	56.65	22.59	33.42	46.65	13.23
0.491	42.75	56.15	13.40	40.89	46.15	5.26
19.244	24.67	60.00	35.33	18.62	50.00	31.38
23.215	42.62	60.00	17.38	34.78	50.00	15.22

N line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.188	36.88	64.14	27.26	30.94	54.14	23.20
0.277	41.40	60.89	19.49	40.57	50.89	10.32
0.489	42.65	56.19	13.54	41.21	46.19	4.98
0.652	30.44	56.00	25.56	29.89	46.00	16.11
16.208	37.57	60.00	22.43	33.59	50.00	16.41
21.953	38.36	60.00	21.64	33.33	50.00	16.67
25.857	37.57	60.00	22.43	32.37	50.00	17.63

10. Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The manufacturer used a no-standard electrical connector, so fulfill this requirement.