

FCC Test Report

Report No.: RF170419E07A-3

FCC ID: HD5-3GSTTHALPC1

Test Model: 3G-ST-THALP-C1

Received Date: Apr. 24, 2017

Test Date: May 31 to June 02, 2017

Issued Date: June 15, 2017

Applicant: Honeywell International Inc.

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
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Release Control Record

Issue No.	Description	Date Issued
RF170419E07A-3	Original release.	June 15, 2017

1 Certificate of Conformity

Product: Gateway

Brand: Honeywell

Test Model: 3G-ST-THALP-C1

Sample Status: ENGINEERING SAMPLE

Applicant: Honeywell International Inc.

Test Date: May 31 to June 02, 2017

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.225)
47 CFR FCC Part 15, Subpart C (Section 15.215)
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 :



Date:

June 15, 2017

Wendy Wu / Specialist

Approved by :



Date:

June 15, 2017

May Chen / Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.225, 15.215)			
FCC Clause	Test Item	Result	Remarks
15.207	Conducted emission test	PASS	Meet the requirement of limit. Minimum passing margin is -11.01dB at 0.44688MHz.
15.225 (a)	The field strength of any emissions within the band 13.553-13.567 MHz	PASS	Meet the requirement of limit. Minimum passing margin is -39.4dB at 13.36MHz.
15.225 (b)	The field strength of any emissions within the bands 13.410-13.553 MHz and 13.567-13.710 MHz	PASS	Meet the requirement of limit.
15.225 (c)	The field strength of any emissions within the bands 13.110-13.410 MHz and 13.710-14.010 MHz	PASS	Meet the requirement of limit.
15.225 (d)	The field strength of any emissions appearing outside of the 13.110-14.010 MHz band	PASS	Meet the requirement of limit. Minimum passing margin is -3.4dB at 747.00MHz.
15.225 (e)	The frequency tolerance	PASS	Meet the requirement of limit.
15.215 (c)	20dB Bandwidth	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	5.30 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.16 dB
	6GHz ~ 18GHz	4.91 dB
	18GHz ~ 40GHz	5.30 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Gateway
Brand	Honeywell
Test Model	3G-ST-THALP-C1
Status of EUT	ENGINEERING SAMPLE
Power Supply Rating	DC 5V from power adapter or DC 3.6V from battery
Modulation Type	ASK
Operating Frequency	13.56MHz
Number of Channel	1
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	Adapter x1
Data Cable Supplied	NA

Note:

1. The EUT is a WLAN, Buletooth, NFC, WWAN and Zigbee device.
2. Simultaneously transmission condition.

Condition	Technology		
1	WLAN	WWAN	Zigbee
2	Bluetooth	WWAN	Zigbee

Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.

3. The EUT must be supplied with a battery as following table:

Brand	Model No.	Spec.
Palladium Energy Inc.	CT50-BTSC	3.6Vdc, 4040mAh

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

Brand	Model No.	Spec.
Phihong	PSA10F-050Q	AC Input: 100-240V, 0.35A, 50-60Hz DC Output: 5V, 2A

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

Item	Antenna Type	Antenna Gain (dBi)	Antenna Connector	Frequency range
WLAN	PIFA	2.7	NA	2.4~2.4835GHz
Zigbee	PIFA	3.7	NA	2.4~2.4835GHz
WWAN	PIFA	2	UFL ipex	800~900MHz
		2.5		1800~2100MHz
GPS	Chip	2.72	NA	1575MHz
		4.38		1602MHz
Buletooth	PIFA	2.7	NA	2.4~2.4835GHz

6. For radiated emission test, the EUT was pre-tested under the following test modes :

Pre-test Mode	Power
Mode A	Power from Adapter
Mode B	Power from Battery

The worst radiated emission was found in **Mode A**. Therefore only the test data of the modes were recorded in this report.

7. The NFC technology was pre-tested under following test modes:

Mode	Type
Mode A	Type A
Mode B	Type B
Mode C	Type F

From the above modes, the worse case was found in **Mode A and Mode C**. Therefore only the test data of the modes were recorded in this report individually.

8. 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

One channel was provided to this EUT:

Channel	FREQ. (MHz)
1	13.56

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to				Description
	RE	PLC	FS	EB	
1	√	√	√	√	Power from adapter
2	-	√	-	-	Power from Laptop

Where **RE_{≥1G}**: Radiated Emission above 1GHz **PLC**: Power Line Conducted Emission
FS: Frequency Stability **EB**: 20dB Bandwidth measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.

Radiated 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.

Available Channel	Tested Channel	Modulation Type
1	1	ASK

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.

Available Channel	Tested Channel	Modulation Type
1	1	ASK

Frequency Stability:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ 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.

Available Channel	Tested Channel	Modulation Type
1	1	ASK

20dB Bandwidth:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ 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.

Available Channel	Tested Channel	Modulation Type
1	1	ASK

TEST CONDITION:

Applicable To	Environmental Conditions	Input Power	Tested By
RE $\geq$ 1G	22deg. C, 65%RH	120Vac, 60Hz	Rey Chen
RE<1G	25deg. C, 64%RH	120Vac, 60Hz	Rey Chen
PLC	25deg. C, 75%RH	120Vac, 60Hz	Andy Ho
APCM	25deg. C, 60%RH	120Vac, 60Hz	Robert Cheng

3.3 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.	SIM Card	R&S CMW-Z04	Mini UICC Test Card	NA	NA	Provided by Lab
B.	Laptop	DELL	E5430	4YV4VY1	FCC DoC	Provided by Lab

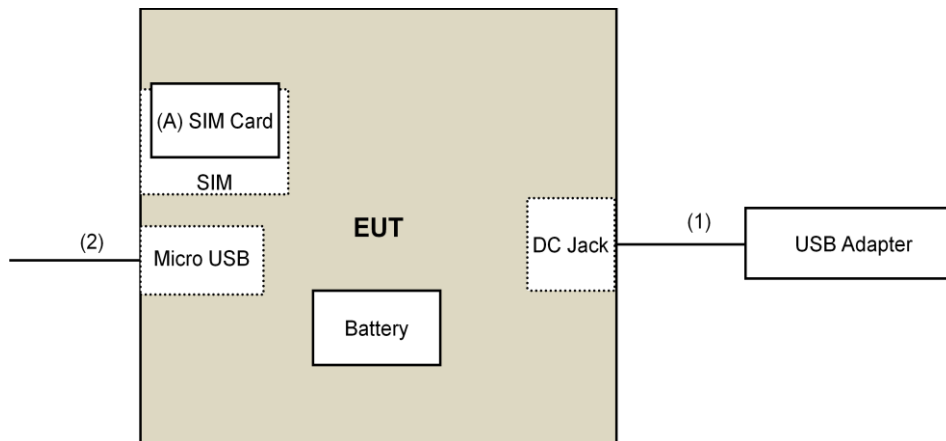
Note:

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

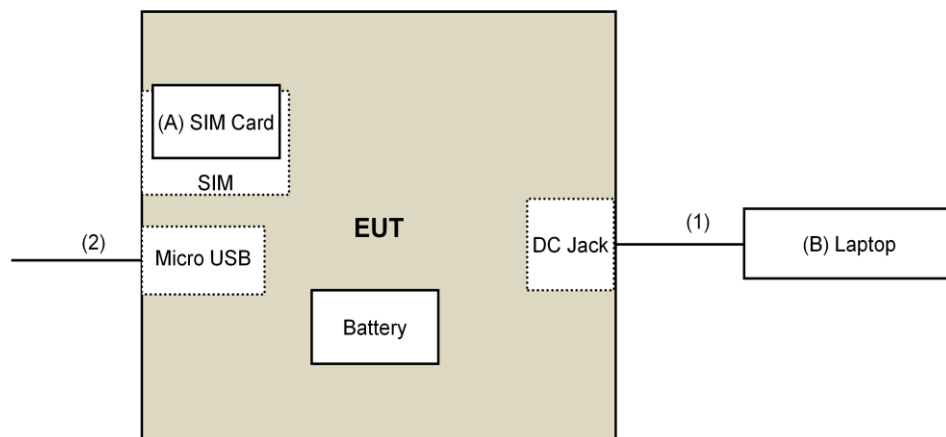
ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB Cable	1	1.5	No	0	Supplied by client
2.	Micro USB Cable	1	1	No	0	Provided by Lab

3.3.1 Configuration of System under Test

Mode 1:



Mode 2:



3.4 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 (15.225)

FCC Part 15, Subpart C (15.215)

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 Measurement

4.1.1 Limits of Radiated Emission Measurement

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209 as below table:

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 20, 2016	July 19, 2017
Pre-Amplifier ^(*) EMCI	EMC001340	980142	Jan. 20, 2016	Jan. 19, 2018
Loop Antenna ^(*) Electro-Metrics	EM-6879	264	Dec. 16, 2016	Dec. 15, 2018
RF Cable	NA	LOOPCAB-001 LOOPCAB-002	Jan. 17, 2017	Jan. 16, 2018
Pre-Amplifier Mini-Circuits	ZFL-1000VH2 B	AMP-ZFL-01	Nov. 10, 2016	Nov. 09, 2017
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-406	Dec. 13, 2016	Dec. 12, 2017
RF Cable	8D	966-4-1 966-4-2 966-4-3	Apr. 01, 2017	Mar. 31, 2018
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-4-01	Oct. 05, 2016	Oct. 04, 2017
Software	ADT_Radiated _V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208410	NA	NA
Spectrum Analyzer R&S	FSv40	100964	June 28, 2016	June 27, 2017

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 FCC Site Registration No. is 292998
5. The CANADA Site Registration No. is 20331-2
- 6 Loop antenna was used for all emissions below 30 MHz.
7. Tested Date: May 31 to June 02, 2017

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. Both X and Y axes 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 detect 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 $\geq 1/T$ (Duty cycle < 98%) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

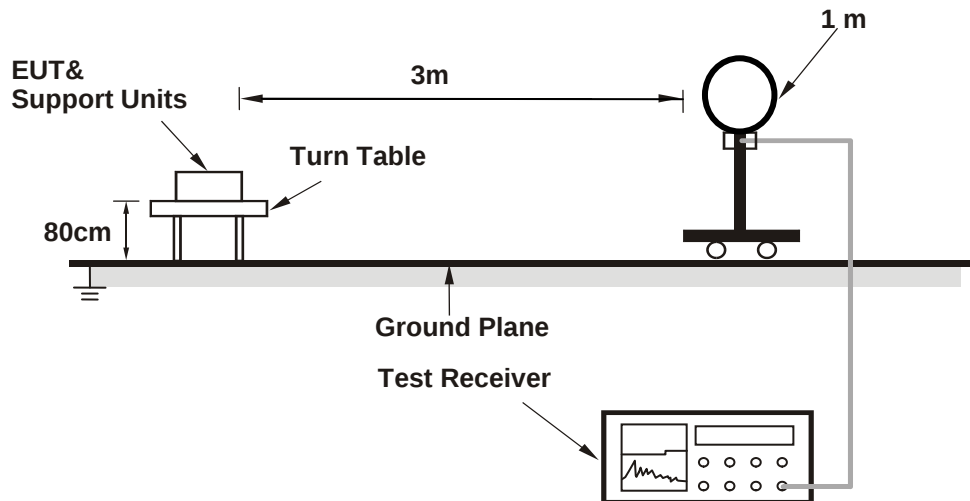
All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

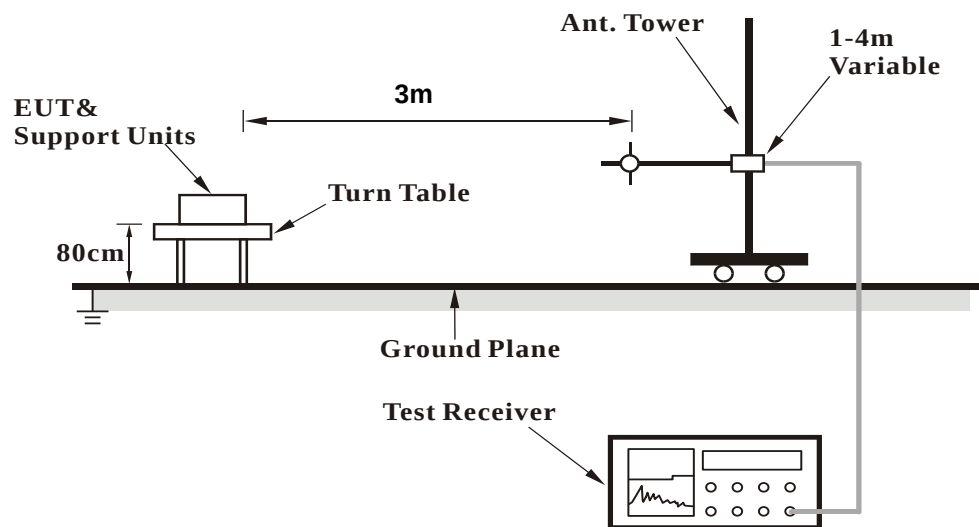
No deviation.

4.1.5 Test Setup

For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



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

4.1.6 EUT Operating Conditions

- Placed the EUT on the testing table.
- Set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Type A

Frequency Range	13.110 ~ 14.010MHz	Detector Function	Quasi-Peak
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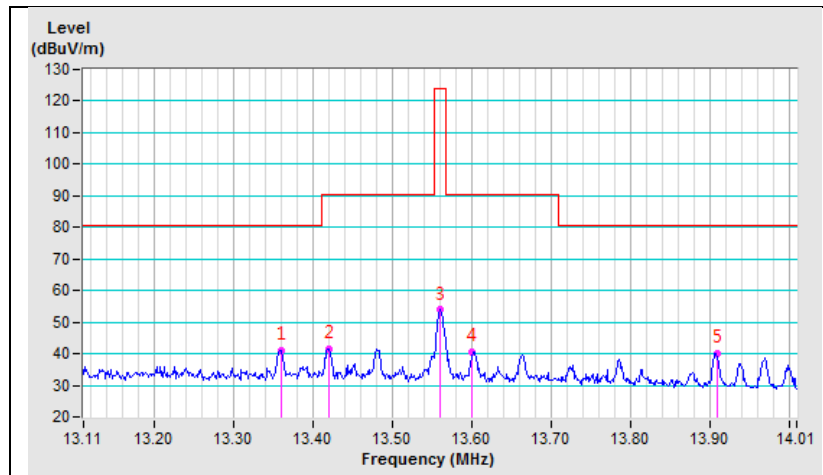
Antenna Polarity & Test Distance: Loop Antenna Open At 3m								
No.	Freq. (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	13.36	41.1 QP	80.5	-39.4	1.02 H	125	44.4	-3.3
2	13.42	41.6 QP	90.5	-48.9	1.02 H	214	44.9	-3.3
3	13.56	53.9 QP	124.0	-70.1	1.02 H	134	57.2	-3.3
4	13.60	40.7 QP	90.5	-49.8	1.02 H	125	44.0	-3.3
5	13.91	40.1 QP	80.5	-40.4	1.02 H	107	43.5	-3.4

- 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. Above limits have been translated by the formula

The measured field strength was extrapolated to distance 30 meters, using the formula that the limit of field strength varies as the inverse distance square (40dB per decade of distance)

Example:

$$\begin{aligned}
 13.56\text{MHz} &= 15848\mu\text{V/m} & 30\text{m} \\
 &= 84\text{dBuV/m} & 30\text{m} \\
 &= 84+20\log(30/3)^2 & 3\text{m} \\
 &= 124\text{dBuV/m}
 \end{aligned}$$



Frequency Range	13.110 ~ 14.010MHz	Detector Function	Quasi-Peak
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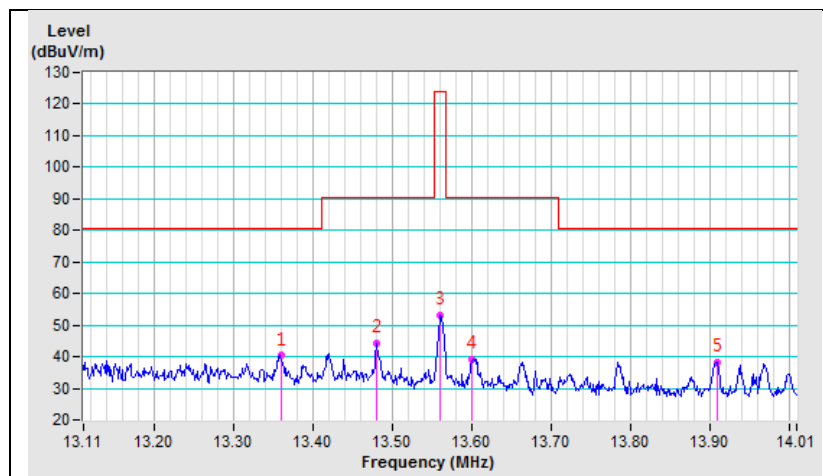
Antenna Polarity & Test Distance: Loop Antenna Close At 3m								
No.	Freq. (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	13.36	40.3 QP	80.5	-40.2	1.02 V	314	43.6	-3.3
2	13.48	44.2 QP	90.5	-46.3	1.02 V	300	47.5	-3.3
3	13.56	53.2 QP	124.0	-70.8	1.00 V	200	56.5	-3.3
4	13.60	39.3 QP	90.5	-51.2	1.02 V	217	42.6	-3.3
5	13.91	38.4 QP	80.5	-42.1	1.02 V	289	41.8	-3.4

- 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. Above limits have been translated by the formula

The measured field strength was extrapolated to distance 30 meters, using the formula that the limit of field strength varies as the inverse distance square (40dB per decade of distance)

Example:

$$\begin{aligned}
 13.56\text{MHz} &= 15848\mu\text{V/m} & 30\text{m} \\
 &= 84\text{dBuV/m} & 30\text{m} \\
 &= 84+20\log(30/3)^2 & 3\text{m} \\
 &= 124\text{dBuV/m}
 \end{aligned}$$



Frequency Range	Below 30MHz	Detector Function	Quasi-Peak
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Antenna Polarity & Test Distance: Loop Antenna Open At 3m								
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	0.13	50.2 QP	105.3	-55.1	1.02 H	125	34.2	16.0
2	0.73	49.7 QP	70.3	-20.6	1.02 H	214	46.8	2.9
3	7.27	39.9 QP	69.5	-29.6	1.02 H	301	42.8	-2.9
4	14.22	45.3 QP	69.5	-24.2	1.02 H	152	48.7	-3.4
5	23.13	62.3 QP	69.5	-7.2	1.02 H	258	65.9	-3.6
6	26.61	56.8 QP	69.5	-12.7	1.02 H	308	59.6	-2.8
Antenna Polarity & Test Distance: Loop Antenna Close At 3m								
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	0.70	45.6 QP	70.7	-25.1	1.02 V	175	42.5	3.1
2	1.45	42.2 QP	64.4	-22.2	1.02 V	302	42.4	-0.2
3	12.16	35.2 QP	69.5	-34.3	1.02 V	200	38.3	-3.1
4	18.24	31.7 QP	69.5	-37.8	1.02 V	322	35.7	-4.0
5	23.13	50.6 QP	69.5	-18.9	1.02 V	235	54.2	-3.6
6	26.61	44.9 QP	69.5	-24.6	1.02 V	222	47.7	-2.8

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

Frequency Range	30MHz ~ 1000MHz	Detector Function	Quasi-Peak
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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	93.75	28.1 QP	43.5	-15.4	3.00 H	127	47.0	-18.9
2	182.56	24.3 QP	43.5	-19.2	1.00 H	60	39.3	-15.0
3	316.80	29.0 QP	46.0	-17.0	1.00 H	160	41.2	-12.2
4	415.02	28.8 QP	46.0	-17.2	2.00 H	111	38.6	-9.8
5	747.00	42.6 QP	46.0	-3.4	2.00 H	76	45.6	-3.0
6	829.98	35.5 QP	46.0	-10.5	2.00 H	76	37.6	-2.1
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	39.92	22.9 QP	40.0	-17.1	1.00 V	45	36.5	-13.6
2	264.01	33.0 QP	46.0	-13.0	2.00 V	169	47.0	-14.0
3	414.99	26.1 QP	46.0	-19.9	1.00 V	104	36.0	-9.9
4	580.98	30.0 QP	46.0	-16.0	2.00 V	177	36.2	-6.2
5	747.00	40.0 QP	46.0	-6.0	2.00 V	139	43.0	-3.0
6	830.01	33.7 QP	46.0	-12.3	1.00 V	104	35.8	-2.1

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

Type F

Frequency Range	13.110 ~ 14.010MHz	Detector Function	Quasi-Peak
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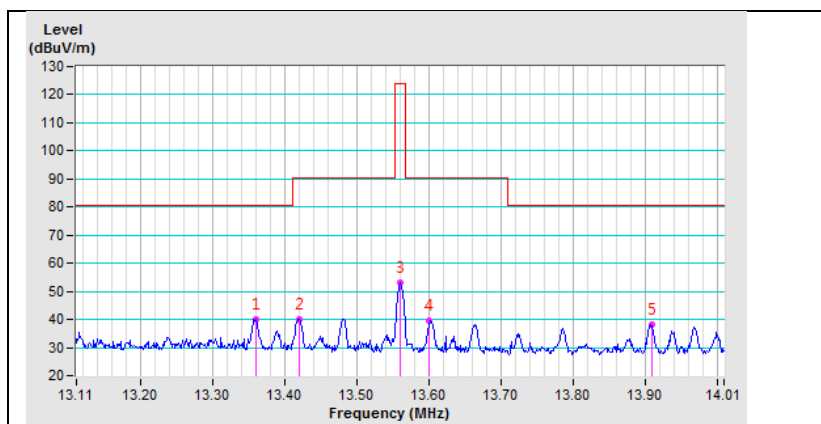
Antenna Polarity & Test Distance: Loop Antenna Open At 3m								
No.	Freq. (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	13.36	40.0 QP	80.5	-40.5	1.02 H	103	43.3	-3.3
2	13.42	40.2 QP	90.5	-50.3	1.02 H	158	43.5	-3.3
3	13.56	53.0 QP	124.0	-71.0	1.02 H	214	56.3	-3.3
4	13.60	39.7 QP	90.5	-50.8	1.02 H	318	43.0	-3.3
5	13.91	38.1 QP	80.5	-42.4	1.02 H	338	41.5	-3.4

- 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. Above limits have been translated by the formula

The measured field strength was extrapolated to distance 30 meters, using the formula that the limit of field strength varies as the inverse distance square (40dB per decade of distance)

Example:

$$\begin{aligned}
 13.56\text{MHz} &= 15848\text{uV/m} & 30\text{m} \\
 &= 84\text{dBuV/m} & 30\text{m} \\
 &= 84+20\log(30/3)^2 & 3\text{m} \\
 &= 124\text{dBuV/m}
 \end{aligned}$$



Frequency Range	13.110 ~ 14.010MHz	Detector Function	Quasi-Peak
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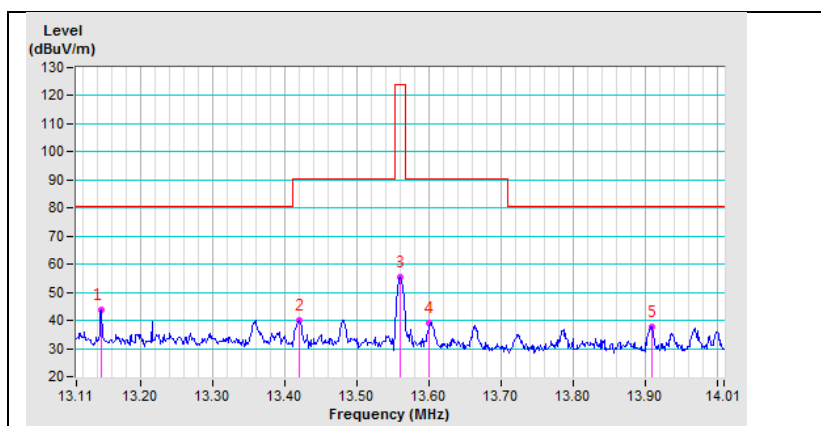
Antenna Polarity & Test Distance: Loop Antenna Close At 3m								
No.	Freq. (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	13.14	44.0 QP	80.5	-36.5	N/A V	N/A	47.3	-3.3
2	13.42	40.2 QP	90.5	-50.3	1.02 V	301	43.5	-3.3
3	13.56	55.4 QP	124.0	-68.6	1.02 V	258	58.7	-3.3
4	13.60	39.3 QP	90.5	-51.2	1.02 V	222	42.6	-3.3
5	13.91	37.7 QP	80.5	-42.8	1.02 V	196	41.1	-3.4

- 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. Above limits have been translated by the formula

The measured field strength was extrapolated to distance 30 meters, using the formula that the limit of field strength varies as the inverse distance square (40dB per decade of distance)

Example:

$$\begin{aligned}
 13.56\text{MHz} &= 15848\mu\text{V/m} & 30\text{m} \\
 &= 84\text{dBuV/m} & 30\text{m} \\
 &= 84+20\log(30/3)^2 & 3\text{m} \\
 &= 124\text{dBuV/m}
 \end{aligned}$$



Frequency Range	Below 30MHz	Detector Function	Quasi-Peak
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Antenna Polarity & Test Distance: Loop Antenna Open At 3m								
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	0.73	50.0 QP	70.3	-20.3	1.02 H	354	47.1	2.9
2	1.45	39.9 QP	64.4	-24.5	1.02 H	268	40.1	-0.2
3	7.30	38.4 QP	69.5	-31.1	1.02 H	302	41.3	-2.9
4	14.22	44.7 QP	69.5	-24.8	1.02 H	268	48.1	-3.4
5	23.13	61.1 QP	69.5	-8.4	1.02 H	321	64.7	-3.6
6	26.61	58.6 QP	69.5	-10.9	1.02 H	235	61.4	-2.8
Antenna Polarity & Test Distance: Loop Antenna Close At 3m								
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	0.70	44.6 QP	70.7	-26.1	N/A V	N/A	41.5	3.1
2	1.45	42.4 QP	64.4	-22.0	N/A V	N/A	42.6	-0.2
3	7.30	32.6 QP	69.5	-36.9	N/A V	N/A	35.5	-2.9
4	13.56	42.6 QP	69.5	-26.9	N/A V	N/A	45.9	-3.3
5	23.13	59.7 QP	69.5	-9.8	N/A V	N/A	63.3	-3.6
6	26.61	55.5 QP	69.5	-14.0	N/A V	N/A	58.3	-2.8

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

Frequency Range	Below 1000MHz	Detector Function	Quasi-Peak
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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	92.25	24.9 QP	43.5	-18.6	2.00 H	6	38.9	-14.0
2	249.00	28.0 QP	46.0	-18.0	1.00 H	50	37.5	-9.5
3	415.02	27.7 QP	46.0	-18.3	2.00 H	121	32.4	-4.7
4	581.01	29.8 QP	46.0	-16.2	1.00 H	134	30.9	-1.1
5	747.00	42.2 QP	46.0	-3.8	2.00 H	233	40.1	2.1
6	830.01	36.0 QP	46.0	-10.0	3.00 H	111	33.0	3.0
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	75.44	23.0 QP	40.0	-17.0	1.00 V	113	34.3	-11.3
2	264.01	34.8 QP	46.0	-11.2	2.00 V	131	43.8	-9.0
3	415.02	27.5 QP	46.0	-18.5	1.00 V	50	32.2	-4.7
4	581.01	29.6 QP	46.0	-16.4	1.00 V	360	30.7	-1.1
5	749.98	39.5 QP	46.0	-6.5	1.00 V	116	37.3	2.2
6	900.02	35.6 QP	46.0	-10.4	1.00 V	135	31.7	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.

3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.2.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver R&S	ESCS 30	847124/029	Oct. 24, 2016	Oct. 23, 2017
Line-Impedance Stabilization Network (for EUT) R&S	ESH3-Z5	848773/004	Oct. 26, 2016	Oct. 25, 2017
Line-Impedance Stabilization Network (for Peripheral) R&S	ENV216	100072	June 13, 2016	June 12, 2017
50 ohms Terminator	N/A	EMC-02	Sep. 29, 2016	Sep. 28, 2017
RF Cable	5D-FB	COCCAB-001	Sep. 30, 2016	Sep. 29, 2017
10 dB PAD Mini-Circuits	HAT-10+	CONATT-004	June 20, 2016	June 19, 2017
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 Shielded Room No. 1.
3. Tested Date: June 01, 2017

4.2.3 Test Procedures

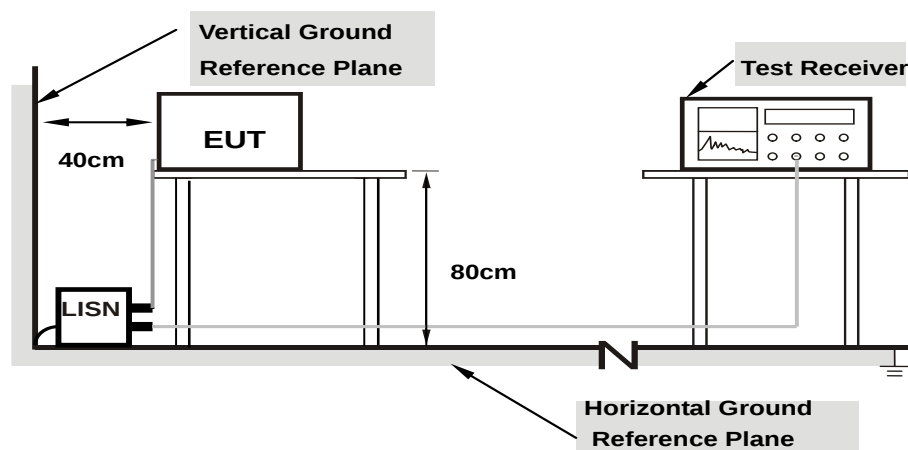
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance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

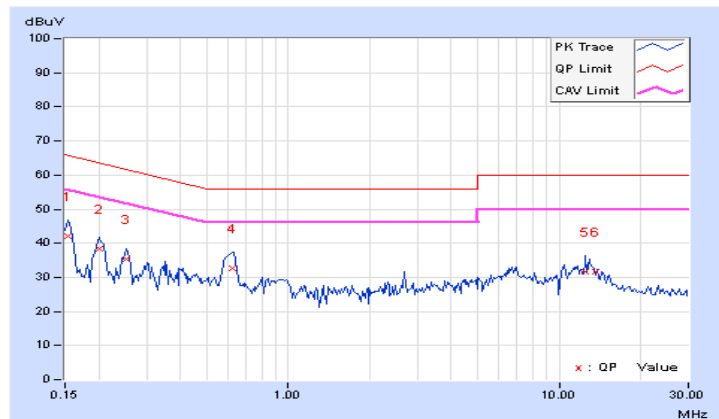
4.2.7 Test Results (Mode 1)

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15391	10.20	31.89	19.85	42.09	30.05	65.79	55.79	-23.70	-25.74
2	0.20078	10.20	28.09	18.47	38.29	28.67	63.58	53.58	-25.29	-24.91
3	0.25156	10.21	25.29	13.86	35.50	24.07	61.71	51.71	-26.21	-27.64
4	0.61875	10.26	22.32	13.04	32.58	23.30	56.00	46.00	-23.42	-22.70
5	12.52734	11.02	20.55	8.56	31.57	19.58	60.00	50.00	-28.43	-30.42
6	13.56000	11.14	20.49	8.48	31.63	19.62	60.00	50.00	-28.37	-30.38

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.

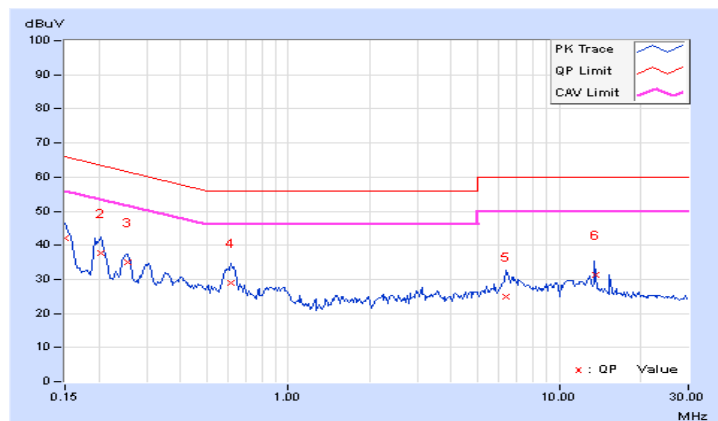


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr.	Reading Value		Emission Level		Limit		Margin	
		Factor	[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	10.19	31.98	19.87	42.17	30.06	66.00	56.00	-23.83	-25.94
2	0.20469	10.17	27.48	16.67	37.65	26.84	63.42	53.42	-25.77	-26.58
3	0.25547	10.19	24.92	11.99	35.11	22.18	61.58	51.58	-26.47	-29.40
4	0.61484	10.25	18.60	11.04	28.85	21.29	56.00	46.00	-27.15	-24.71
5	6.35547	10.38	14.53	5.10	24.91	15.48	60.00	50.00	-35.09	-34.52
6	13.55981	10.96	20.32	15.36	31.28	26.32	60.00	50.00	-28.72	-23.68

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.



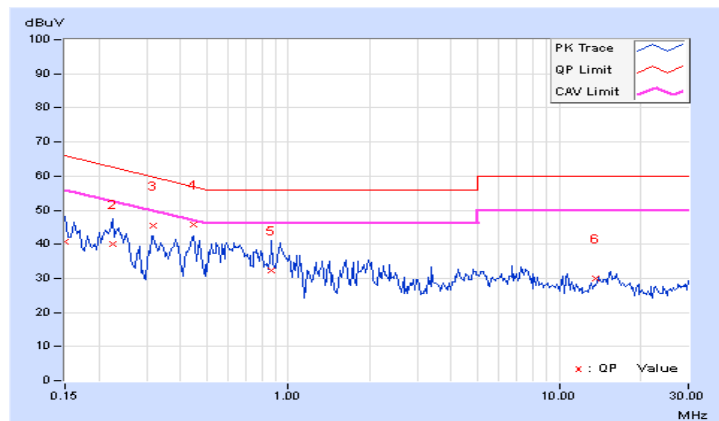
4.2.8 Test Results (Mode 2)

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	10.19	30.54	20.48	40.73	30.67	66.00	56.00	-25.27	-25.33
2	0.22422	10.19	29.89	21.67	40.08	31.86	62.66	52.66	-22.58	-20.80
3	0.31797	10.21	35.17	17.28	45.38	27.49	59.76	49.76	-14.38	-22.27
4	0.44688	10.22	35.70	19.78	45.92	30.00	56.93	46.93	-11.01	-16.93
5	0.86484	10.25	21.97	16.29	32.22	26.54	56.00	46.00	-23.78	-19.46
6	13.56000	10.91	19.17	16.40	30.08	27.31	60.00	50.00	-29.92	-22.69

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.

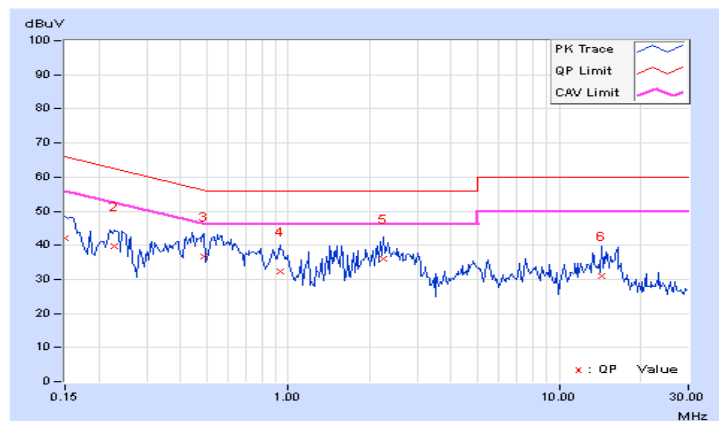


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr.	Reading Value		Emission Level		Limit		Margin	
		Factor	[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
		(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	10.18	32.02	23.70	42.20	33.88	66.00	56.00	-23.80	-22.12
2	0.22812	10.17	29.70	20.12	39.87	30.29	62.52	52.52	-22.65	-22.23
3	0.48984	10.21	26.44	9.31	36.65	19.52	56.17	46.17	-19.52	-26.65
4	0.93125	10.23	22.04	13.37	32.27	23.60	56.00	46.00	-23.73	-22.40
5	2.25391	10.26	25.87	18.57	36.13	28.83	56.00	46.00	-19.87	-17.17
6	14.41406	10.83	20.03	11.59	30.86	22.42	60.00	50.00	-29.14	-27.58

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.

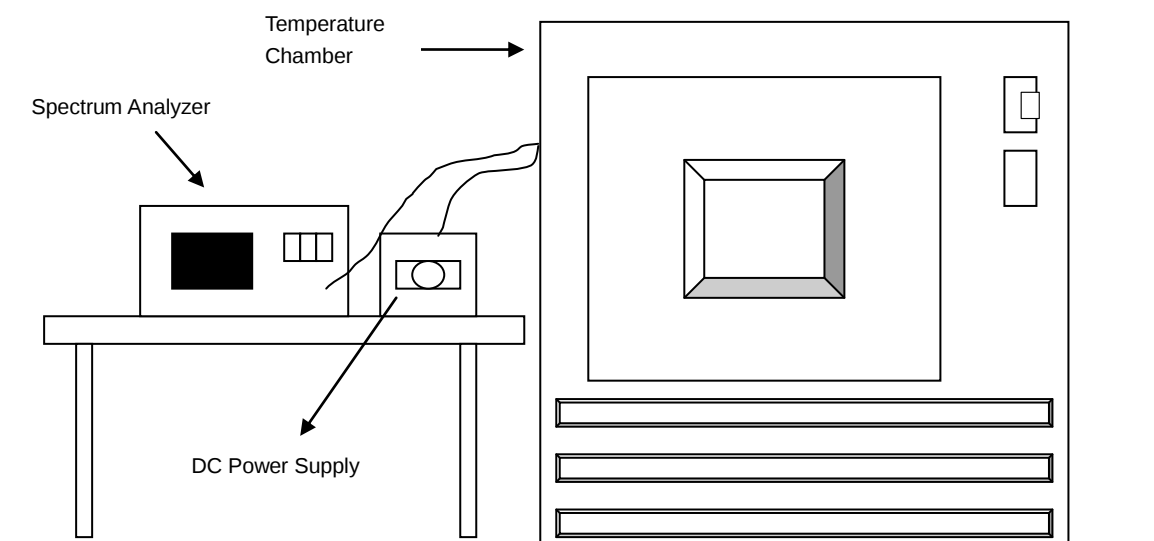


4.3 Frequency Stability

4.3.1 Limits of Frequency Stability Measurement

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

4.3.2 Test Setup



4.3.3 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSV40	100964	June 28, 2016	June 27, 2017
Temperature & Humidity Chamber Giant Force	GTH-150-40-SP-AR	MAA0812-008	Jan. 11, 2017	Jan. 10, 2018
DC Power Supply Topward	6603D	795558	NA	NA
Digital Multimeter FLUKE	87III	73680266	Nov. 10, 2016	Nov. 09, 2017

- NOTE:**
1. The test was performed in Oven room 2.
 2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
 3. Tested Date: June 02, 2017

4.3.4 Test Procedure

- a. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
- b. Turned the EUT on and coupled its output to a spectrum analyzer.
- c. Turned the EUT off and set the chamber to the highest temperature specified.
- d. Allowed sufficient time (approximately 30 min) for the temperature of the chamber to stabilize then turned the EUT on and measured the operating frequency after 2, 5, and 10 minutes.
- e. Repeated step 2 and 3 with the temperature chamber set to the lowest temperature.
- f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

Same as Item 4.1.6.

4.3.7 Test Result

Frequency Stability Versus Temp.									
TEMP. (°C)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift
		(MHz)	%	(MHz)	%	(MHz)	%	(MHz)	%
50	3.6	13.55995	-0.00037	13.55995	-0.00037	13.55995	-0.00037	13.55995	-0.00037
40	3.6	13.55999	-0.00007	13.55999	-0.00007	13.55998	-0.00015	13.55999	-0.00007
30	3.6	13.56004	0.00029	13.56004	0.00029	13.56004	0.00029	13.56003	0.00022
20	3.6	13.56	0.00000	13.56001	0.00007	13.56001	0.00007	13.56001	0.00007
10	3.6	13.55998	-0.00015	13.55998	-0.00015	13.55999	-0.00007	13.55999	-0.00007
0	3.6	13.55995	-0.00037	13.55996	-0.00029	13.55995	-0.00037	13.55995	-0.00037
-10	3.6	13.55996	-0.00029	13.55996	-0.00029	13.55997	-0.00022	13.55996	-0.00029
-20	3.6	13.56	0.00000	13.55999	-0.00007	13.56	0.00000	13.56001	0.00007

Frequency Stability Versus Voltage									
TEMP. (°C)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift	Measured Frequency	Frequency Drift
		(MHz)	%	(MHz)	%	(MHz)	%	(MHz)	%
20	3.6	13.56	0.00000	13.56001	0.00007	13.56001	0.00007	13.56001	0.00007
	3.6	13.56	0.00000	13.56001	0.00007	13.56001	0.00007	13.56001	0.00007
	3.6	13.56	0.00000	13.56001	0.00007	13.56001	0.00007	13.56001	0.00007

4.4 20dB bandwidth

4.4.1 Limits Of 20dB BANDWIDTH Measurement

The 20dB bandwidth shall be specified in operating frequency band.

4.4.2 Test Setup

Same as Item 4.1.5.

4.4.3 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSV40	100964	June 28, 2016	June 27, 2017

- NOTE:**
1. The test was performed in Oven room 2.
 2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
 3. Tested Date: June 02, 2017

4.4.4 Test Procedures

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 1kHz RBW and 3kHz VBW. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

4.4.5 Deviation from Test Standard

No deviation.

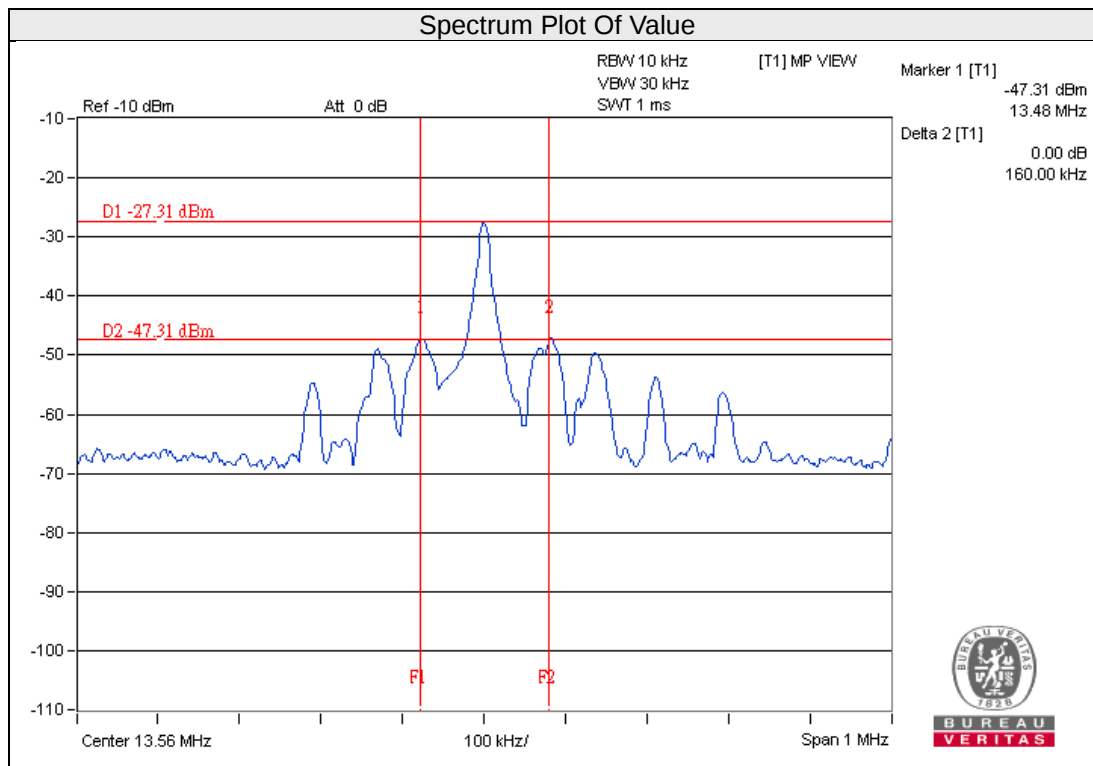
4.4.6 EUT Operating Conditions

Same as Item 4.1.6.

4.4.7 Test Results

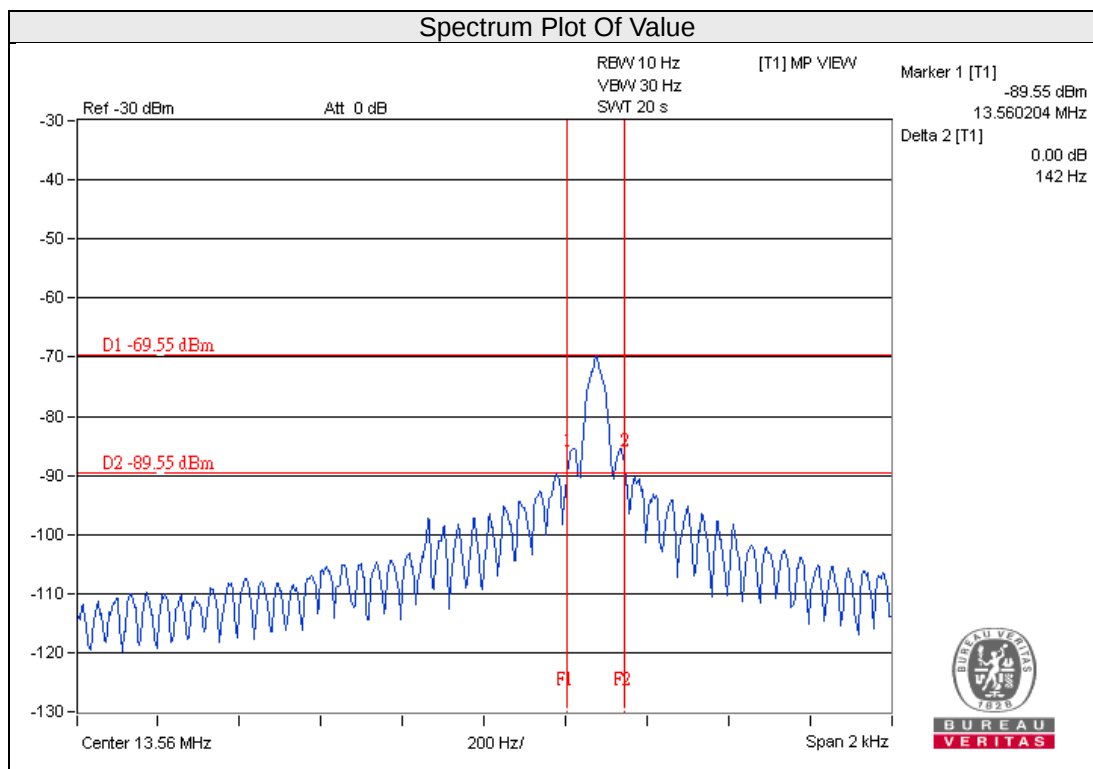
Type A

20dBc point (Low) (MHz)	20dBc point (High) (MHz)	Operating frequency band (MHz)	Pass/Fail
13.48	13.64	13.11 – 14.01	Pass



Type F

20dBc point (Low) (MHz)	20dBc point (High) (MHz)	Operating frequency band (MHz)	Pass/Fail
13.560204	13.560346	13.11 – 14.01	Pass



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 accredited and approved according to ISO/IEC 17025.

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

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Fax: 886-2-26051924

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Web Site: www.bureauveritas-adt.com

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

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