FCC Test Report

Report No.:	RF190502E01
FCC ID:	2ACDX-LRR25
Test Model:	LRR-25
Received Date:	May 02, 2019
Test Date:	May 13 to 16, 2019
Issued Date:	June 19, 2019
Applicant:	MANDO corp.
Address:	21, Pangyo-ro 255 beon-gil, Bundang-gu, Gyeonggi-do, Seongnam-si, 463-400, Republic of Korea
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

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
RF190502E01	Original release.	June 19, 2019

1 Certificate of Conformity

Product:	Advanced Smart Cruise Control System
Brand:	Mando
Test Model:	LRR-25
Sample Status:	ENGINEERING SAMPLE
Applicant:	MANDO corp.
Test Date:	May 13 to 16, 2019
Standards:	47 CFR FCC Part 95, Subpart M 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 19, 2019

Wendy Wu / Specialist

Approved by : _____ , **Date:** June 19, 2019

May Chen / Manager

2 Summary of Test Results

47 CFR FCC Part 95, Subpart M			
FCC Clause	Test Item	Result	Remarks
95.3367 (a)/(b)	Equivalent Isotropically Radiated Power (EIRP)Test	PASS	Meet the requirement of limit.
95.3379(a)	Unwanted Emission Test	PASS	Meet the requirement of limit.
95.3379(b)	Frequency Stability Test	PASS	Meet the requirement of limit.
2.1049	Occupied Bandwidth Measurement	PASS	Meet the requirement of limit.
2.1047	Modulation characteristics	PASS	Meet the requirement

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

2.1 Measurement Uncertainty

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

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	5.1 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.1 dB
	6GHz ~ 18GHz	5.0 dB
	18GHz ~ 40GHz	5.2 dB
	40GHz ~ 231GHz	5.4 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Advanced Smart Cruise Control System
Brand	Mando
Test Model	LRR-25
Status of EUT	ENGINEERING SAMPLE
Power Supply Rating	12Vdc
Modulation Type	FMCW
Operating Frequency	76 ~ 77GHz
Emission designator	0G83F1N
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Data Cable Supplied	NA

Note:

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

Antenna No.	Frequency range (GHz)	Antenna Net Gain (dBi)	Antenna Type	Connector Type
TX 1	76 ~ 77	21	Patch	micro strip line
TX 2	76 ~ 77	14	Patch	micro strip line

2. 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

Frequency is 76.5GHz provided for test.

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	FS	OB	
-	√	√	√	√	-

Where **RE≥1G:** Radiated Emission above 1GHz– **RE<1G:** Radiated Emission below 1GHz
FS: Frequency Stability **OB:** Occupied Bandwidth measurement

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

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 69%RH 24deg. C, 63%RH	DC 12V	Andy Ho Weiwei Lo
RE<1G	25deg. C, 69%RH 24deg. C, 63%RH	DC 12V	Andy Ho Weiwei Lo
FS	24deg. C, 63%RH	DC 12V	Weiwei Lo
OB	24deg. C, 63%RH	DC 12V	Weiwei Lo

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.

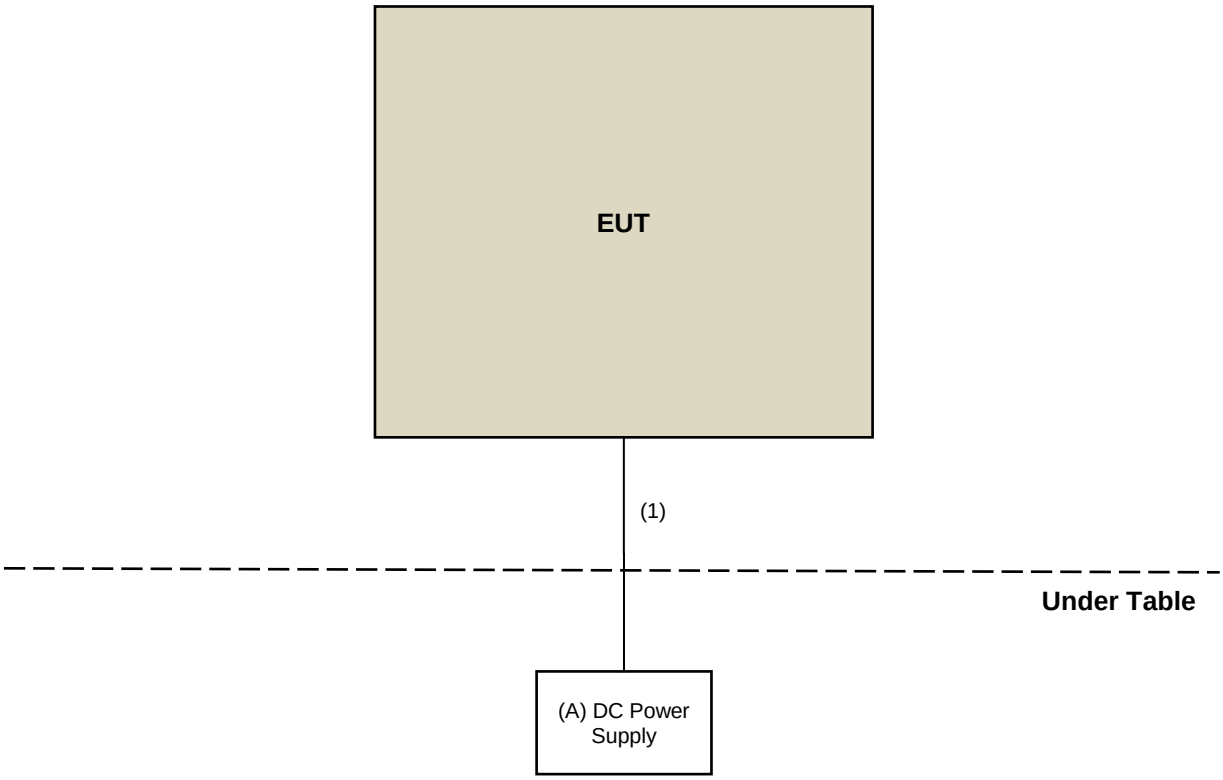
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	DC Power Supply	GOOD WILL INSTRUMENT CO., LTD.	GPC-3030D	7700087	NA	Proivded by Lab

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.	Signal Cable	1	4.3	No	0	Supplied by client

3.3.1 Configuration of System under Test



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 95, Subpart M

KDB 653005 D01 76-81 GHz Radars v01r01

ANSI 63.10-2013

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

4 Test Types and Results

4.1 Radiated Power and Unwanted Emission Measurement

4.1.1 Limits of Radiated Power and Unwanted Emission Measurement

According to 95.3367 the field strength of emissions from intentional radiators operated under these frequencies bands shall not exceed the following:

Fundamental Frequency (GHz)	Equivalent Isotropically Radiated Power (EIRP)	
	Peak	Average
76 ~ 81	55 dBm/MHz	50 dBm

According to 95.3379 the power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:
(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions 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 tighter limit applies at the band edges.
2. The limits are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
3. The emissions limits are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

4.1.2 Test Instruments

Below 40GHz test:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Agilent	N9038A	MY50010156	July 12, 2018	July 11, 2019
Pre-Amplifier EMCI	EMC001340	980142	Jan. 25, 2019	Jan. 24, 2020
Loop Antenna Electro-Metrics	EM-6879	269	Sep. 07, 2018	Sep. 06, 2019
RF Cable	NA	LOOPCAB-001	Jan. 14, 2019	Jan. 13, 2020
RF Cable	NA	LOOPCAB-002	Jan. 14, 2019	Jan. 13, 2020
Pre-Amplifier Mini-Circuits	ZFL-1000VH2B	AMP-ZFL-05	Apr. 30, 2019	Apr. 29, 2020
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-361	Nov. 22, 2018	Nov. 21, 2019
RF Cable	8D	966-3-1	Mar. 18, 2019	Mar. 17, 2020
RF Cable	8D	966-3-2	Mar. 18, 2019	Mar. 17, 2020
RF Cable	8D	966-3-3	Mar. 18, 2019	Mar. 17, 2020
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-3-01	Sep. 27, 2018	Sep. 26, 2019
Horn_Antenna SCHWARZBECK	BBHA9120-D	9120D-406	Nov. 25, 2018	Nov. 24, 2019
Pre-Amplifier EMCI	EMC12630SE	980384	Jan. 28, 2019	Jan. 27, 2020
RF Cable	EMC104-SM-SM-1200	160922	Jan. 28, 2019	Jan. 27, 2020
RF Cable	EMC104-SM-SM-2000	180601	June 12, 2018	June 11, 2019
RF Cable	EMC104-SM-SM-6000	180602	June 12, 2018	June 11, 2019
Spectrum Analyzer Keysight	N9030A	MY54490679	July 23, 2018	July 22, 2019
Pre-Amplifier EMCI	EMC184045SE	980387	Jan. 28, 2019	Jan. 27, 2020
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170519	Nov. 25, 2018	Nov. 24, 2019
RF Cable	EMC102-KM-KM-1200	160924	Jan. 28, 2019	Jan. 27, 2020
RF Cable	EMC102-KM-KM-1200	160925	Jan. 28, 2019	Jan. 27, 2020
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208406	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA

Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in 966 Chamber No. 3.
3. Loop antenna was used for all emissions below 30 MHz.
4. Tested Date: May 14 to 16, 2019

Above 40GHz test:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer Agilent	E4446A	MY48250253	Aug. 1, 2018	July 31, 2019
*Harmonic Mixer (33~55GHz) OML	M22HWD	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna (33~55GHz) OML	M22RH	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Harmonic Mixer (50~75GHz) OML	M15RH	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna (50~75GHz) OML	M15HWD	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Harmonic Mixer (75~110GHz) OML	M10HWD	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna (75~110GHz) OML	M10RH	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Harmonic Mixer (110~170GHz) OML	M06RH	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna(110~170GHz) OML	M06HWD	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Harmonic Mixer (140~220GHz) OML	M05HWD	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna (140~220GHz) OML	M05RH	110215-1	Oct. 17, 2017	Oct. 16, 2019
*Harmonic Mixer (220~325GHz) OML	M03HWA	M03HWA_140505-1	Oct. 17, 2017	Oct. 16, 2019
*Horn Antenna (220~325GHz) OML	M03RH	M03RH_140508-1	Oct. 17, 2017	Oct. 16, 2019
*Diplexer EMCI	DPL26	DPL26_01	Oct. 17, 2017	Oct. 16, 2019
*Diplexer EMCI	DPL26	DPL26_02	Oct. 17, 2017	Oct. 16, 2019
*Precision 30dB Attenuator Keysight	11708A	MY55260015	Oct. 17, 2017	Oct. 16, 2019
*Zero-Bias Detector (50~75GHz) Vdi	WR15ZBD	WR15R5 1-30	Oct. 17, 2017	Oct. 16, 2019
Digital Storage Oscilloscope Keysight	DSOX6002A+DSOX6000-AMG	MY56270092	Jan. 17, 2019	Jan. 16, 2020
*WR15CH Conical Horn Keysight	WR15CH	WR15CH-01	Oct. 17, 2017	Oct. 16, 2019
*WR10CH Conical Horn Keysight	WR10CH	WR10CH-01	Oct. 17, 2017	Oct. 16, 2019
*Millimeter-Wave Signal Generator Frequency Extension Module (50~75 GHz) Keysight	E8257DV15	US54250106	Oct. 17, 2017	Oct. 16, 2019
*Millimeter-Wave Signal Generator Frequency Extension Module (75~110 GHz) Keysight	E8257DV10	US53250009	Oct. 17, 2017	Oct. 16, 2019
PSG analog signal generator Keysight	E8257D	MY53401987	June 26, 2018	June 25, 2019
Antenna Tower & Turn Table CT	NA	NA	NA	NA

Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. *The 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. 3
4. Tested Date: May 13, 2019

4.1.3 Test Procedures

For Radiated emission: Below 30 MHz

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: 30 MHz ~ 40GHz

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 is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak detection (PK) at frequency from 1GHz to 40GHz.
3. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Average detection (AV) at frequency from 1GHz to 40GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

For Radiated emission: Above 40GHz

External mixers are utilized.

a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meters chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The distance at which limits are typically specified is 3 meter; however, closer measurement distances may be utilized.

c. Begin handheld measurements with the test antenna (horn) at a distance of 1 meter from the EUT, in a horizontally polarized position. Slowly adjust its position, entirely covering the plane 1 meter from the EUT.

d. Repeat (b) with the horn in a vertically polarized position.

e. If the emission cannot be detected at 1 meter, reduce the RBW in order to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.

f. Note the maximum level indicated on the Spectrum Analyzer.

g. Based on the distance at which the measurement was made and the calculated distance to the edge of the far field, determine the appropriate distance attenuation factor. Apply this factor to the calculated field strength in order to determine the equivalent field strength at the distance at which the regulatory limit is specified. Compare to the appropriate limits

h. Repeat (a) - (f) for every emission that must be measured, up through the required frequency range of investigation

NOTE:

1. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak and RMS detection for fundamental emission.
2. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for RMS detection at frequency above 40GHz.

Far Field Boundary Calculations

The far-field boundary is given as:
R far field = (2 * L^2) /λ
where: L = Largest Antenna Dimension, including the reflector, in meters
λ = wavelength in meters

FREQUENCY RANGE (GHz)	L (m)	Lambda (m)	R (Far Field) (m)
76.5	0.045	0.00392	1.033

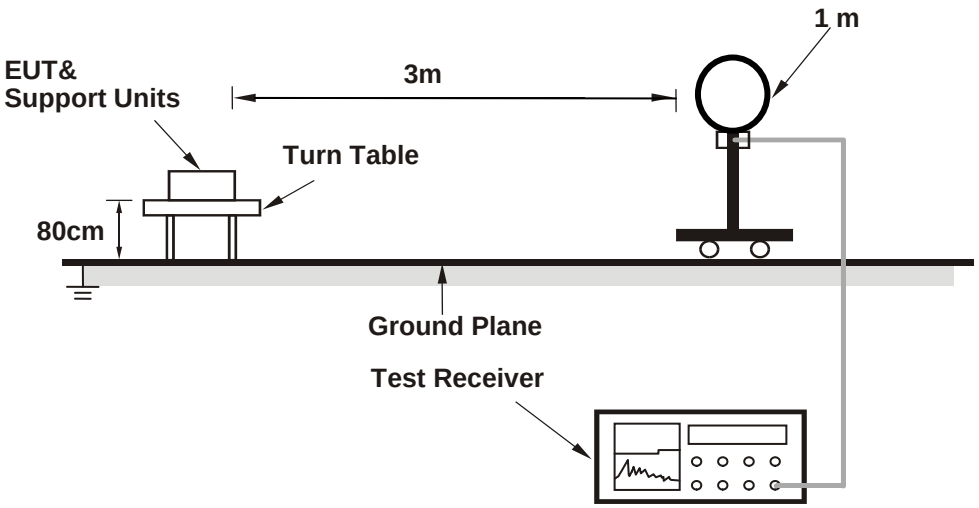
*Measurements made at 1.5 meter distance.

4.1.4 Deviation from Test Standard

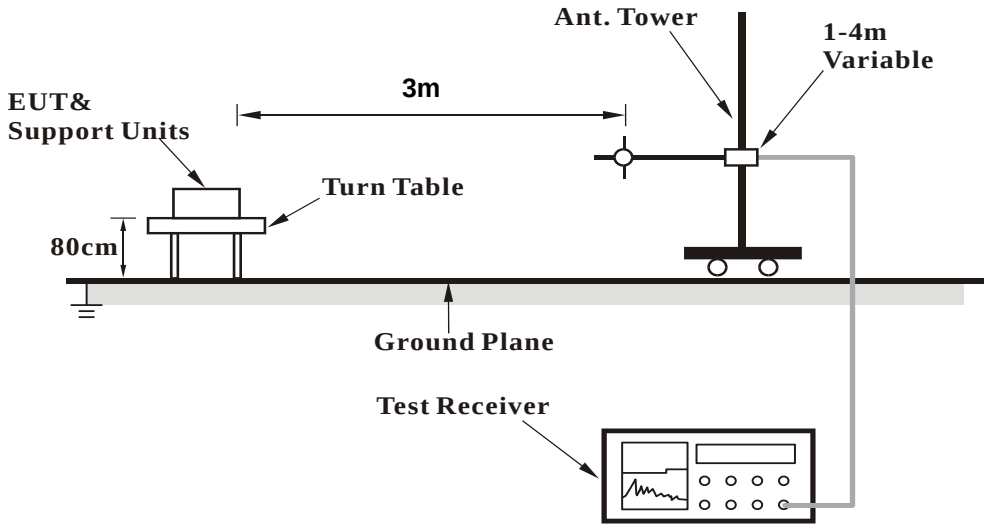
No deviation.

4.1.5 Test Setup

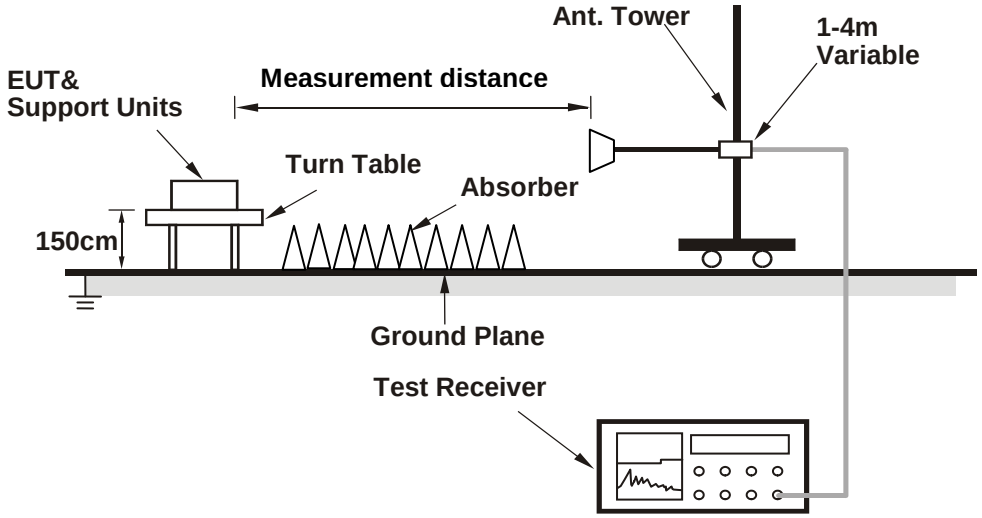
For Radiated emission below 30MHz



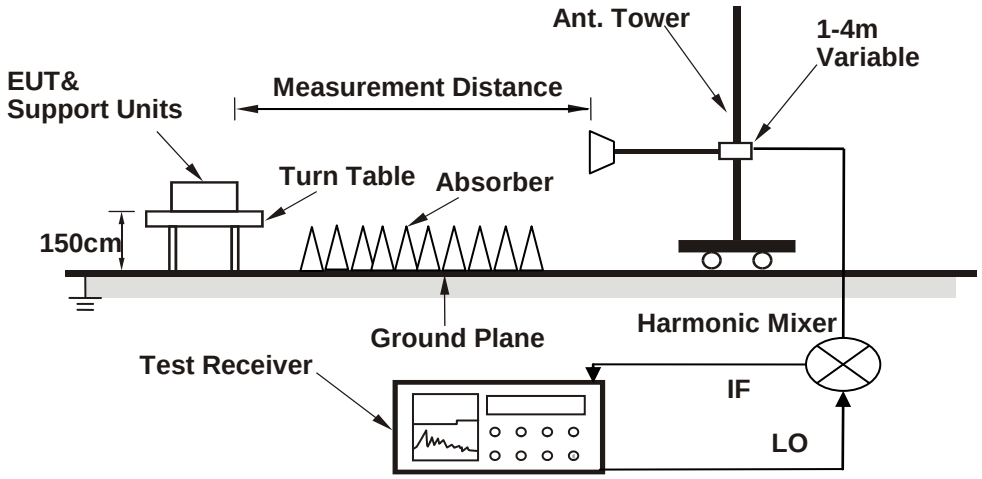
For Radiated emission 30MHz to 1GHz



For Radiated emission 1GHz to 40GHz



For Radiated emission above 40GHz



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

4.1.6 EUT Operating Conditions

Set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz Data

FREQUENCY RANGE	1GHz ~ 18GHz	DETECTOR FUNCTION	Peak (PK) 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	2209.15	36.8 PK	74.0	-37.2	2.00 H	278	38.4	-1.6
2	2209.15	23.2 AV	54.0	-30.8	2.00 H	278	24.8	-1.6
3	6544.07	38.5 PK	74.0	-35.5	2.00 H	35	32.2	6.3
4	6544.07	25.4 AV	54.0	-28.6	2.00 H	35	19.1	6.3
5	10250.05	44.6 PK	74.0	-29.4	2.20 H	99	32.7	11.9
6	10250.05	31.6 AV	54.0	-22.4	2.20 H	99	19.7	11.9
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	2158.57	36.1 PK	74.0	-37.9	1.50 V	212	38.1	-2.0
2	2158.57	23.5 AV	54.0	-30.5	1.50 V	212	25.5	-2.0
3	6624.82	39.4 PK	74.0	-34.6	2.00 V	288	33.0	6.4
4	6624.82	26.3 AV	54.0	-27.7	2.00 V	288	19.9	6.4
5	11136.57	44.4 PK	74.0	-29.6	2.00 V	225	31.6	12.8
6	11136.57	32.1 AV	54.0	-21.9	2.00 V	225	19.3	12.8

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	18GHz ~ 40GHz	DETECTOR FUNCTION	Peak (PK) 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	20463.00	42.1 PK	74.0	-31.9	1.55 H	46	52.1	-10.0
2	20463.00	29.3 AV	54.0	-24.7	1.55 H	46	39.3	-10.0
3	22014.00	43.5 PK	74.0	-30.5	1.69 H	59	52.2	-8.7
4	22014.00	30.0 AV	54.0	-24.0	1.69 H	49	38.7	-8.7
5	27800.00	44.6 PK	74.0	-29.4	1.58 H	46	53.4	-8.8
6	27800.00	30.4 AV	54.0	-23.6	1.58 H	46	39.2	-8.8
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	24916.00	43.4 PK	74.0	-30.6	1.77 V	269	50.4	-7.0
2	24916.00	29.9 AV	54.0	-24.1	1.77 V	269	36.9	-7.0
3	28968.00	42.2 PK	74.0	-31.8	1.76 V	218	50.4	-8.2
4	28968.00	29.4 AV	54.0	-24.6	1.76 V	218	37.6	-8.2
5	36228.00	45.0 PK	74.0	-29.0	1.54 V	176	51.8	-6.8
6	36228.00	30.3 AV	54.0	-23.7	1.54 V	176	37.1	-6.8

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	40GHz ~ 100GHz	DETECTOR FUNCTION	Average (AV)

ANTENNA POLARITY: HORIZONTAL								
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	Occupied Bandwidth (MHz)	Total EIRP Power (dBm)	EIRP Limit (dBm/MHz)	PASS/FAIL
1	76.5	19.3	-30.8	23.6	830.81	48.5	50	PASS
ANTENNA POLARITY: VERTICAL								
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	Occupied Bandwidth (MHz)	Total EIRP Power (dBm)	EIRP Limit (dBm/MHz)	PASS/FAIL
1	76.5	-7.6	-57.7	23.6	830.81	21.5	50	PASS

REMARKS:

1.The measured power level is converted to EIRP using the equation:

EIRP = Raw Value - Receiver Antenna Gain + 20*log(4*3.1416*D/λ)

where:

D is the measurement distance

λ is the wavelength

*Measurements made at 1.5 meter distance.

FREQUENCY RANGE	40GHz ~ 100GHz	DETECTOR FUNCTION	Peak (PK)

ANTENNA POLARITY: HORIZONTAL						
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	EIRP Limit (dBm/MHz)	PASS/FAIL
2	76.5	20.4	-29.6	23.6	55	PASS
ANTENNA POLARITY: VERTICAL						
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	EIRP Limit (dBm/MHz)	PASS/FAIL
2	76.5	-6.6	-56.7	23.6	55	PASS

REMARKS:

1.The measured power level is converted to EIRP using the equation:

EIRP = Raw Value - Receiver Antenna Gain + 20*log(4*3.1416*D/λ)

where:

D is the measurement distance

λ is the wavelength

*Measurements made at 1.5 meter distance.

FREQUENCY RANGE	100GHz ~ 231GHz	DETECTOR FUNCTION	Average (AV)

ANTENNA POLARITY: HORIZONTAL							
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	Power Density (pW/cm^2)	Power Density Limit (pW/cm^2)	PASS/FAIL
1	153	-24.7 AV	-80.7	23.7	2.996	600	PASS
2	231	-17.0 AV	-76.6	23.6	17.643	1000	PASS
ANTENNA POLARITY: VERTICAL							
NO.	Frequency (GHz)	EIRP Level (dBm/MHz)	Raw Value (dBm/MHz)	Receiver Antenna Gain (dBi)	Power Density (pW/cm^2)	Power Density Limit (pW/cm^2)	PASS/FAIL
1	153	-24.9 AV	-80.9	23.7	2.861	600	PASS
2	231	-17.5 AV	-77.1	23.6	15.724	1000	PASS

REMARKS:

1.The measured power level is converted to EIRP using the equation:

EIRP = Raw Value - Receiver Antenna Gain + 20*log(4*3.1416*D/λ)

where:

D is the measurement distance

λ is the wavelength

*Measurements made at 1.5 meter distance.

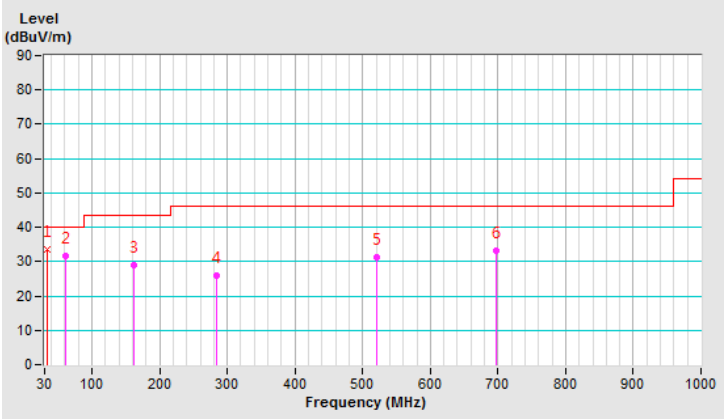
Below 1GHz Data

FREQUENCY RANGE	9kHz ~ 1GHz	DETECTOR FUNCTION	Quasi-Peak (QP)

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	33.43	33.5 QP	40.0	-6.5	2.00 H	356	42.9	-9.4
2	61.67	31.6 QP	40.0	-8.4	2.00 H	0	40.6	-9.0
3	160.95	28.8 QP	43.5	-14.7	4.00 H	26	36.8	-8.0
4	284.21	25.9 QP	46.0	-20.1	3.00 H	84	32.9	-7.0
5	520.19	31.4 QP	46.0	-14.6	3.00 H	316	32.5	-1.1
6	696.58	33.0 QP	46.0	-13.0	4.00 H	42	30.6	2.4

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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

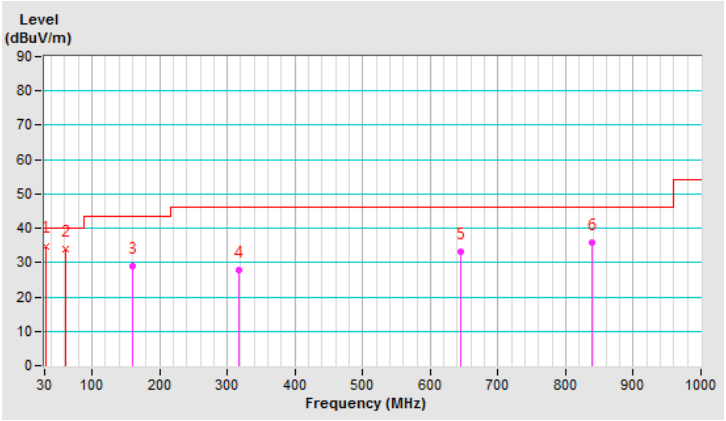


FREQUENCY RANGE	9kHz ~ 1GHz	DETECTOR FUNCTION	Quasi-Peak (QP)

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	**32.53**	**34.9 QP**	**40.0**	**-5.1**	**1.00 V**	**7**	**44.4**	**-9.5**
2	61.71	33.9 QP	40.0	-6.1	1.01 V	284	42.9	-9.0
3	159.83	29.1 QP	43.5	-14.4	1.50 V	108	37.1	-8.0
4	317.24	27.9 QP	46.0	-18.1	1.00 V	39	33.7	-5.8
5	644.37	33.3 QP	46.0	-12.7	3.00 V	17	31.6	1.7
6	839.08	35.9 QP	46.0	-10.1	3.00 V	0	30.8	5.1

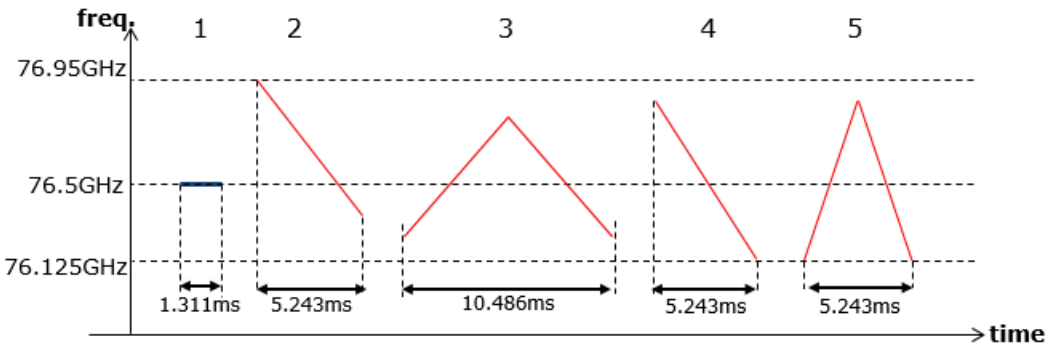
REMARKS:

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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



4.2 Modulation characteristics Measurement

In addition to the reporting requirements of FCC 2.1047, the following information shall be provided, as per the applicable modulation type:

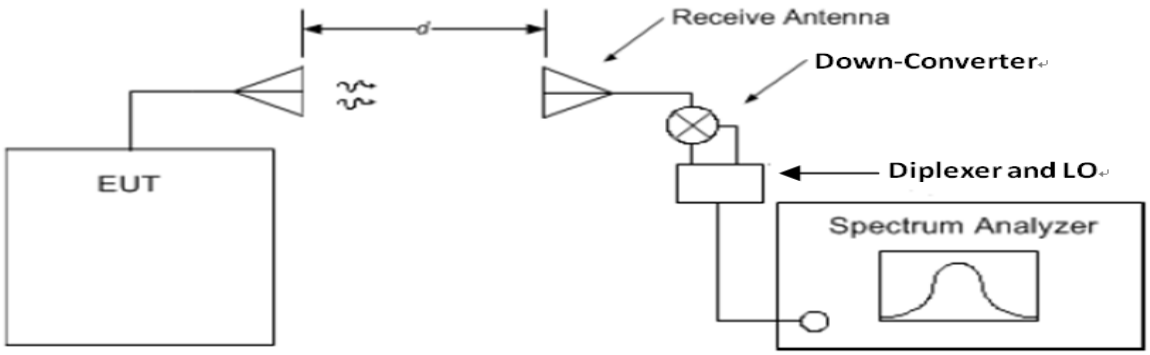


Chirp#	Modulation Type	Sweep Time	Sweep Bandwidth	Center Frequency
1	Unmodulated	1.311ms	-	76.5GHz
2	Negative sawtooth	5.243ms	500MHz	76.7GHz
3	Triangle	10.486ms	500MHz	76.5GHz
4	Negative sawtooth	5.243ms	750MHz	76.5GHz
5	Triangle	5.243ms	750MHz	76.5GHz

- Average cycle time: 60 ms
- RF on time : 27.53 ms
- Duty cycle: 55.1%

4.3 Occupied Bandwidth Measurement

4.3.1 Test Setup



4.3.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.3 Test Procedure

The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to PEAK. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5% of the total mean power of a given emission.

4.3.4 Deviation from Test Standard

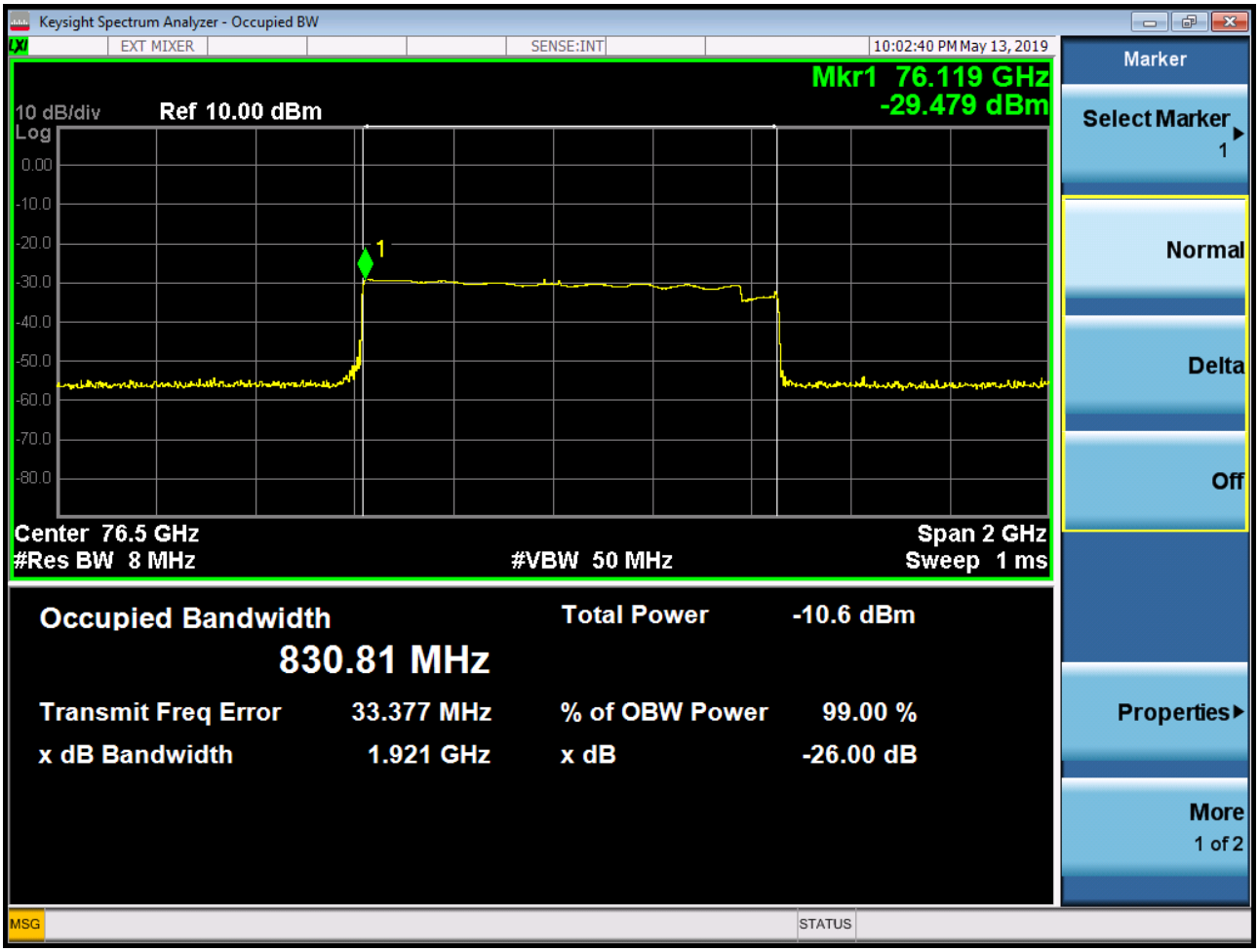
No deviation.

4.3.5 EUT Operating Conditions

Set the EUT under transmission condition continuously at specific channel frequency.

4.3.6 Test Results

Frequency Range (MHz)	Occupied Bandwidth (MHz)
76000~81000	830.81



4.4 Frequency Stability Measurement

4.4.1 Limits of Conducted Emission Measurement

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.

4.4.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
True RMS Clamp Meter FLUKE	325	31130711WS	May 22, 2018	May 21, 2019
Temperature & Humidity Chamber Giant Force	GTH-150-40-SP-AR	MAA0812-008	Jan. 09, 2019	Jan. 08, 2020
DC Power Supply Topward	6603D	795558	NA	NA
Spectrum Analyzer R&S	FSV40	100964	June 20, 2018	June 19, 2019
*Millimeter-Wave Signal Generator Frequency Extension Module (75~110 GHz) Keysight	E8257DV10	US53250009	Oct. 17, 2017	Oct. 16, 2019
*Waveguide Harmonic Mixer Keysight	M1971E	MY55270157	Oct. 17, 2017	Oct. 16, 2019

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. *The calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
4. Tested Date: May 13, 2019

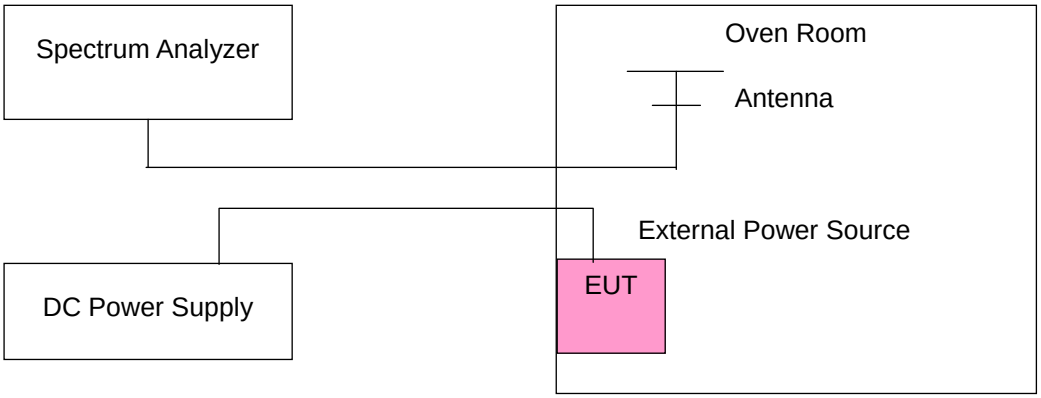
4.4.3 Test Procedure

a. Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.

b. EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.

c. The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the ±0.5 ℃ during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

4.4.4 Test Setup



4.4.5 Test Results

Frequency Stability Versus Temp.									
Operating Frequency: 76500 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minutes		5 Minutes		10 Minutes	
		Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail
50	12	76500.1615	PASS	76500.1683	PASS	76500.2024	PASS	76500.219	PASS
40	12	76499.9596	PASS	76499.9582	PASS	76499.9254	PASS	76499.9003	PASS
30	12	76499.7004	PASS	76499.6678	PASS	76499.702	PASS	76499.7283	PASS
20	12	76499.7593	PASS	76499.7605	PASS	76499.7627	PASS	76499.7721	PASS
10	12	76499.9626	PASS	76499.9605	PASS	76500.0108	PASS	76500.0102	PASS
0	12	76500.2703	PASS	76500.2399	PASS	76500.253	PASS	76500.2908	PASS
-10	12	76500.1262	PASS	76500.1362	PASS	76500.1366	PASS	76500.135	PASS
-20	12	76499.8022	PASS	76499.7723	PASS	76499.7327	PASS	76499.7372	PASS

Frequency Stability Versus Voltage									
Operating Frequency: 76500 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minutes		5 Minutes		10 Minutes	
		Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail
20	13.8	76499.7476	PASS	76499.7461	PASS	76499.7494	PASS	76499.7645	PASS
	12	76499.7593	PASS	76499.7605	PASS	76499.7627	PASS	76499.7721	PASS
	10.2	76499.7621	PASS	76499.7626	PASS	76499.7526	PASS	76499.7649	PASS

5 Pictures of Test Arrangements

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

Appendix – Information of the Testing Laboratories

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

Hsin Chu EMC/RF/Telecom Lab
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Fax: 886-3-6668323

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Email: service.adt@tw.bureauveritas.com
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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