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TEST REPORT

FCC/ISED 60 GHz Wireless Module Test for KSS104M
Certification

APPLICANT
LG Electronics Inc.

REPORT NO.
HCT-RF-2009-FI012-R7

DATE OF ISSUE
November 6, 2020

Tested by
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Accredited by KOLAS, Republic of KOREA

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TEST REPORT
FCC/ISED 60 GHz Wireless Module Report

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Additional Model
-

Applicant	**LG Electronics Inc.** 222, LG-ro, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713, South Korea
Product Name Model Name	Wireless module KSS104M
FCC ID IC	BEJKSS104M 2703H-KSS104M
Date of Test	September 07, 2020 ~ October 28, 2020
Test Standard Used	FCC Part 15.255 RSS-GEN issue 5, RSS-210 issue 10
Frequency Range	57.1 GHz ~ 63.9 GHz (Center Frequency of Channel: 60.952 GHz)
FCC Classification	Short-Range Device (SRD)
Max. RF Output Power	Peak: 8.86 dBm Aver: 7.16 dBm

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	September 23, 2020	Initial Release
1	October 05, 2020	Added Peak Conducted Output Power Data. We retested the OBW.
2	October 20, 2020	We tested a 6 dB bandwidth.
3	October 26, 2020	We retested the Output Power and OBW.
4	October 28, 2020	We retested the OBW.
5	October 29, 2020	We have corrected the frequency information.
6	November 06, 2020	Revised the 'Type of modulation'.
7	November 06, 2020	Added 6 dB Bandwidth plot.

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

Engineering Statement:
The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC / ISED Rules under normal use and maintenance.

This laboratory is not accredited for the test results marked *.

The above Test Report is the accredited test result by (KS Q) ISO/IEC 17025 AND KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA.(HCT Accreditation No.: KT197)

CONTENTS

1. EUT DESCRIPTION

Model	KSS104M	
EUT Type	Wireless Module	
EUT Serial Number	EBT66539301	
Power Supply	1.2 Vdc	
Frequency Range	57.1 GHz ~ 63.9 GHz (Center Frequency of Channel: 60.952 GHz)	
EIRP	Peak	8.86 dBm
	Average	7.16 dBm
Modulation Type	ASK (Amplitude Shift Keying)	
Antenna Specification	Antenna type: Differential patch antenna Peak Gain(dBi): 5.3 dBi	
Host device Model Name	LSAB009	
Date(s) of Tests	September 07, 2020 ~ October 28, 2020	
PMN (Product Marketing Number)	Wireless Module	
HVIN (Hardware Version Identification Number)	KSS014M	
FVIN (Firmware Version Identification Number)	1.0	
HMN (Host Marketing Name)	N/A	

2. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) Operating Under § 15.255" were used in the measurement.

2.1 EUT CONFIGURATION

The EUT configuration for testing is installed on EIRP measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx Frequency that was for the purpose of the measurements.

2.3 GENERAL TEST PROCEDURES

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above the ground plane below 1 GHz and 1.5 m above 1 GHz with absorbers between the EUT and receiving antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set far-field distance away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

2.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.
Especially, all antennas(Up to 40 GHz) for measurement are calibrated in accordance with the requirements of C63.5 (Version : 2006).

4. FACILITIES AND ACCREDITATIONS

4.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil,
Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.
The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.
Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).
For ISED, test facility was accepted dated February 14, 2019 (CAB identifier: KR0032).

4.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR § 15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of this E.U.T are permanently attached.
- The E.U.T Complies with the requirement of § 15.203 / RSS-Gen

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Expanded Uncertainty (± dB)
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05
Radiated Disturbance (40 GHz ~ 200 GHz)	4.59

7. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	ISED	Test Limit	Test Condition	Test Result
Occupied Bandwidth	§ 2.1049	RSS-GEN, Section 6.7 RSS-210, Annex J.4(c)	FCC: 57-71 GHz ISED: 57-71 GHz	RADIATED	PASS
Radiated Power	§ 15.255(c)	RSS-210, Annex J.2	< EIRP 40 dBm (Average) < EIRP 43 dBm (Peak)		PASS
Unwanted emissions	§ 15.255(d)	RSS-GEN, Section 6.13, 8.9 RSS-210, Annex J.3	0.009 – 0.490 MHz: 2400/F[kHz] 0.490 – 1.705 MHz: 24000/F[kHz] 1.705 – 30.0 MHz: 29.5 dBuV/m 30 – 88 MHz: 40.0 dBuV/m 88 – 216 MHz: 43.5 dBuV/m 216 – 960 MHz: 46.0 dBuV/m 960 – 40 000 MHz: 54.0 dBuV/m 40 – 200 GHz: -< EIRP -9.96 dBm		PASS
Fundamental Emissions(Frequency stability)	§ 15.255(f)	RSS-GEN, Section 6.11, 8.11 RSS-210, Annex J.6	57–71 GHz		PASS

NOTE:

1. All tests were performed by radiated measurement and applied below conditions.

: Used measurement distance with far field of test such as EIRP, OBW and Band edge are as follow.

2. The EUT was tested with the host product, LSAB009.

Wavelength = Speed of light / Measurement frequency = 30 / 6 390 = 0.0047

(2 X (Max antenna length of EUT)^2) / Wavelength = (2 X (0.000986)^2 / 0.004695 = 0.000414 m

: Spurious emissions measurement distance is shown in table below. (Far field)

Frequency Rage (GHz)	Wavelength (cm)	Far Field Distance (m)	Measured Distance (m)
18 ~ 40	0.75	0.19	1.0
40 ~ 60	0.50	0.28	1.0
60 ~90	0.33	0.42	1.0
90 ~ 140	0.21	0.65	1.0
140 ~ 220	0.13	1.02	1.5
220 ~ 243	0.12	1.13	1.5

8. TEST RESULT

8.1 OCCUPIED BANDWIDTH MEASUREMENT

FCC Rules

Test Requirements and limit, § 2.1049

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

ISED Rules

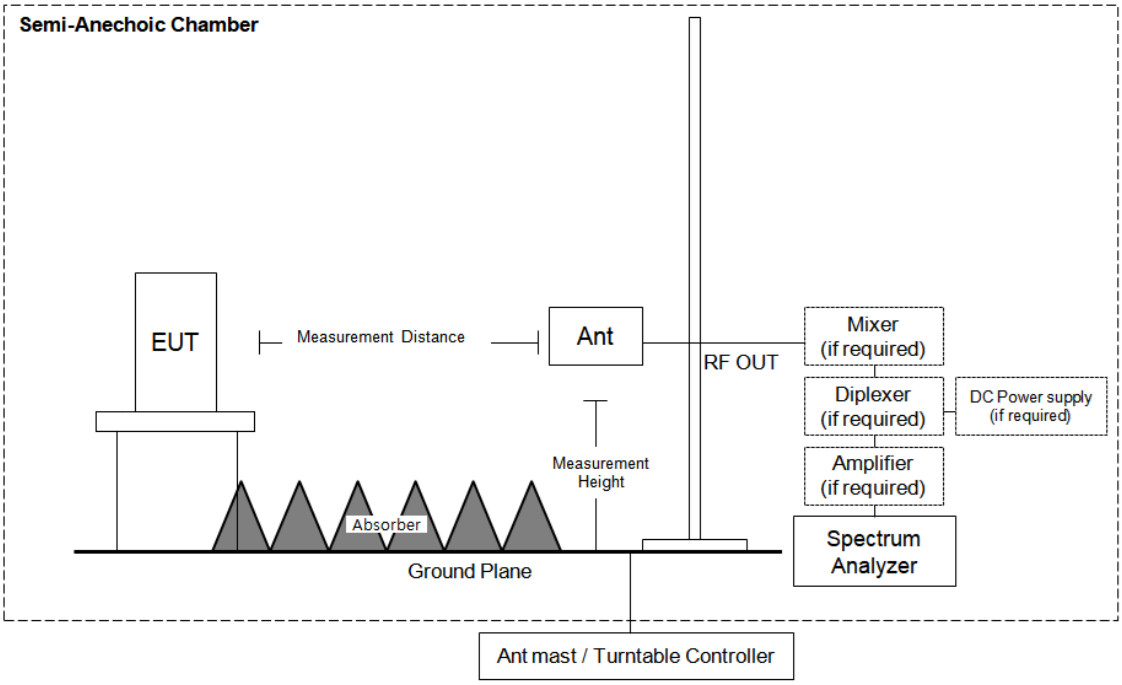
RSS-GEN, Section 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs

RSS-210, Annex J.4(c)

For the purpose of this standard, emission bandwidth is defined as the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density shall be 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth. The centre frequency must be stationary during the measurement interval, even if not stationary during normal operation.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

RBW = 10 MHz

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note:

1. It was measured as the maximum RBW value of the equipment we used.

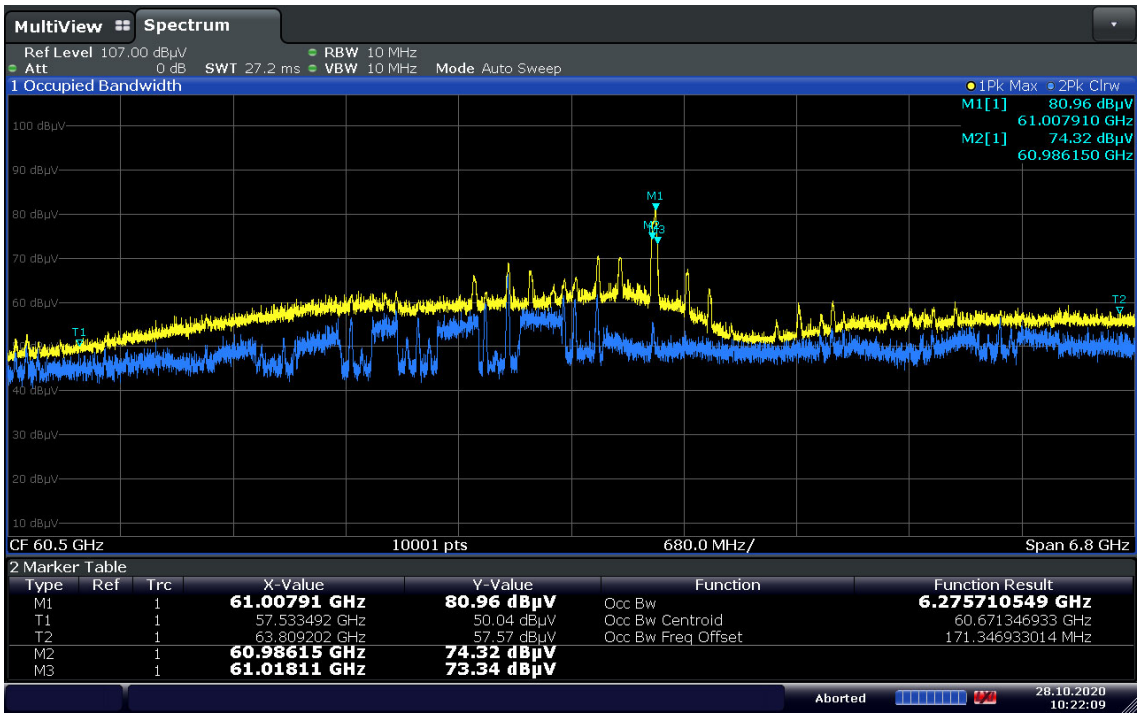
▣ TEST RESULTS

TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	6.27 GHz

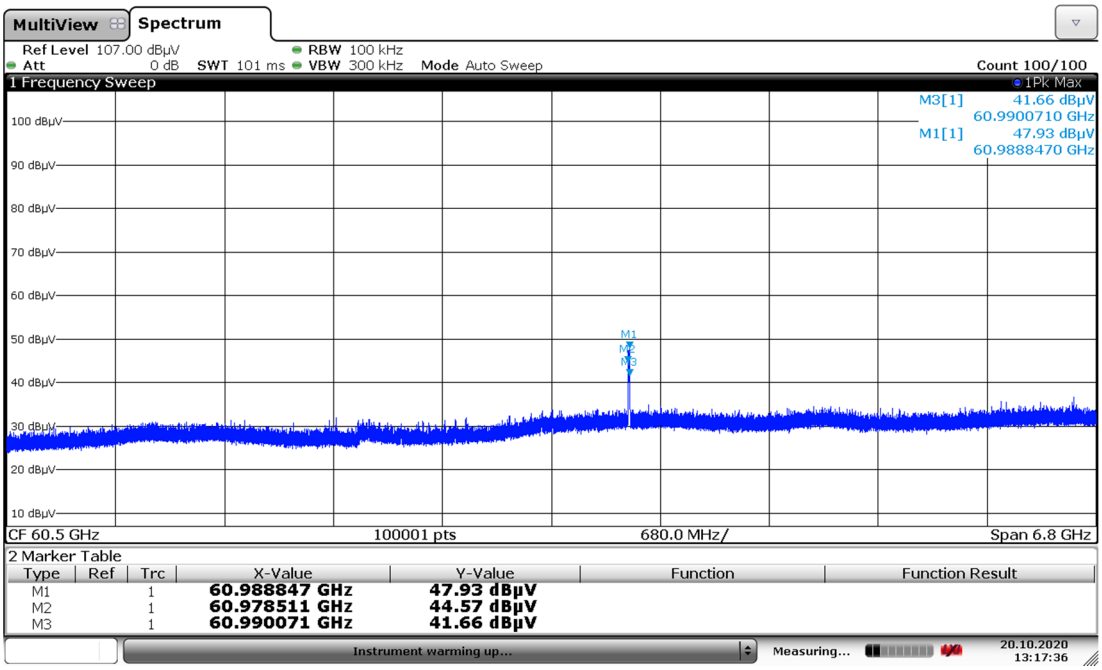
TEST CONDITIONS:		6 dB Bandwidth
T nom	V nom	11.56 MHz

▣ RESULT PLOTS

Occupied Bandwidth & 6 dB Bandwidth plot



6 dB Bandwidth plot



8.2 Radiated Power

FCC Rules

Test Requirements and limit, § 15.255(c)

Within the 57-71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(1) Products other than fixed field disturbance sensors and short-range devices for interactive motion sensing shall comply with one of the following emission limits, as measured during the transmit interval:

(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

§ 15.255(e)

(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

§ ANSI 63.10 9.11 Measurement of the fundamental emission using an RF detector

The following procedure shall be used for measuring the fundamental emission using an RF detector:

a) Set up the test as follows:

1) The measurement instrument shall be either a mm-wave RF detector that has an RF bandwidth encompassing the entire authorized frequency band or a mm-wave downconverter connected to a microwave RF detector, such that the RF input of the downconverter encompasses the entire authorized frequency band and both the IF output of the downconverter and the RF input of the detector encompass the entire downconverted authorized frequency band. The input VSWR of the mm-wave detector or mm-wave downconverter shall be less than 3:1. If the detector or downconverter as a stand-alone device does not meet this requirement, then a mm-wave isolator shall be connected to the input RF port, and the input VSWR of the combination of isolator plus detector, or isolator plus

downconverter, shall be less than 3:1.

2) For conducted measurements of transmitter output power, connect the mm-wave RF detector or the downconverter, with appropriate attenuation as needed to prevent damage or overload to the measurement instrumentation, to the output port of the EUT.

3) For radiated emissions measurements, connect the test antenna for the fundamental frequency band to the mm-wave RF detector or the downconverter. Place the test horn in the main beam of the EUT at a distance that will provide a signal within the operating range of the RF detector or downconverter.

b) Connect the video output of the detector to the 50 Ω input of a DSO. The video bandwidth of the combination of the detector and DSO must be greater than 10 MHz. When connected to the 50 Ω input of the DSO, the video bandwidth will typically be greater than 10 MHz, in which case a low-pass filter (LPF) with a cutoff frequency of at least 10 MHz may be inserted between the output of the detector and the input of the DSO. Due to the input capacitance of the DSO, the video bandwidth will normally be less than 10 MHz when the output of the detector is connected to the high impedance (e.g., 1 MΩ) input of the DSO.

c) Set the sampling rate of the DSO to at least twice the cutoff frequency of any LPF used or to at least twice the signal bandwidth without a LPF. Adjust the memory depth, the triggering, and the sweep speed to obtain a display that is representative of the signal considering the type of modulation. If the signal is noncontinuous, then identify the segment of the signal that has the highest amplitude, and then adjust the triggering and the sweep speed to capture that segment. If the emission consists of RF bursts, then identify the highest level burst and adjust the triggering and sweep rate of the DSO to display the entire burst without blanking intervals.

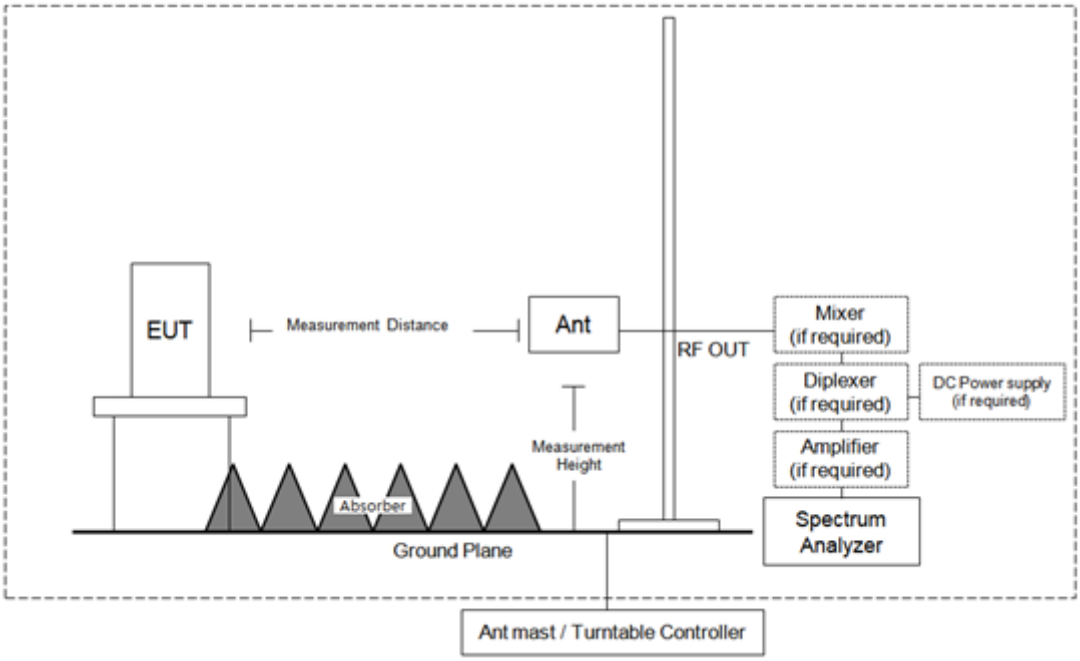
ISED Rules

RSS-210, Annex J.2.2(b)

(b) For other devices, the average and peak e.i.r.p. of any emission shall not exceed 40 dBm and 43 dBm, respectively.

▣ Test Configuration

40 GHz – 200 GHz



▣ TEST RESULTS

Frequency [GHz]	Reading [mV]	Ant. Pol. [H/V]	Total [dBm]	Limit [dBm]	Margin [dB]	Measurement Type
60.952	223	H	8.86	43	34.14	PK
60.952	125	H	7.16	40	32.84	AV

Note :

1. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Peak Conducted Output Power

Frequency [GHz]	Peak EIRP [dBm]	Antenna Gain [dBi]	Peak Conducted Output Power [mW]	6 dB Bandwidth [MHz]	Limit [mW]	Measurement Type
60.952	8.86	5.3	2.27	11.56	57.8	PK

Note :

1. Limit: (6 dB BW/100)*500 mW

8.3 Unwanted emissions

FCC Rules

Test Requirements and limit, § 15.255(d)

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters.

(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meter)
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

ISED Rules

RSS-210, Annex J.3 Spurious emissions

The power of any emissions outside the band 57-71 GHz shall consist solely of spurious emissions and shall not exceed:

a. the fundamental emission levels
b. the general field strength limits specified in RSS-Gen for emissions below 40 GHz
c. 90 pW/cm2 at a distance of 3 m for emissions between 40 GHz and 200 GHz

RSS GEN, 6.13 Transmitter unwanted emissions

6.13.1 Detector

When the unwanted emissions limits are defined in relative terms, the same parameter, peak power or average power, shall be used as the reference for both the transmitter's output power and the unwanted emissions measurements.

When the unwanted emissions limits are expressed in absolute terms, unless otherwise stated in the applicable RSS, the following conditions shall apply:

Below 1 GHz, compliance with the limits shall be demonstrated using a CISPR quasi-peak detector and the related measurement bandwidth (see section 6.10).

Above 1 GHz, compliance with the limits shall be demonstrated using a linear average detector (see section 6.10) with a minimum resolution bandwidth of 1 MHz.

6.13.2 Frequency range for measuring unwanted emission

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the applicable frequency given below:

a. If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
b. If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.
c. If the equipment operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise in the applicable RSS.
d. If the equipment contains a digital device that is exclusively used for enabling the operation of the radio apparatus: the spectrum shall be investigated according to the conditions specified in paragraphs (a) through (c) of this section or the range applicable to the digital device, as shown in table 2, whichever is the higher frequency range of investigation.

RSS GEN, 8.9 Transmitter emission limits

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Frequency (MHz)	Magnetic field strength (microamperes/meter)	Measurement distance (meter)
0.009 ~ 0.490	6.37/F(kHz)	300
0.490 ~ 1.705	63.7/F(kHz)	30
1.705 ~ 30.0	0.08	30
Frequency (MHz)	**Field strength (microvolts/meter)**	**Measurement distance (m)**
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

▣ Test Procedure

For below 40 GHz

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until the measurements for all frequencies are complete.

For Above 40 GHz

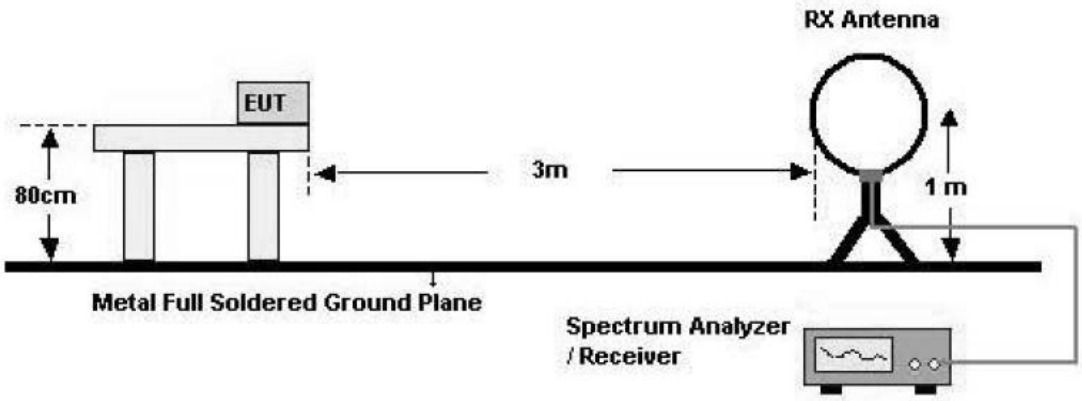
1. Connect the test antenna covering the appropriate frequency range toa spectrum analyzer via anexternal mixer to the spectrum analyzer.
2. Set spectrum analyzer RBW = 1 MHz, VBW =3MHz,averagedetector.
3. Calculate the distance to the far field boundaryand determine the maximum measurement distance.
4. Perform an exploratory search for emissions and determine the approximate direction at whicheach observed emission emanates from the EUT.
5. Exploratory measurements be made at a closer distance than the validated maximum measurement distance.
6. Perform a final measurement; begin with the test antenna at the approximate position where the maximum leveloccurred during the exploratory scan.
7. Slowly scan the test antenna around this position, slowly vary the test antennapolarization by rotating through at least 0° to 180°, and slowly vary the orientation ofthe test antenna to find thefinal position, polarization, and orientation at which the maximum level of theemission is observed.

h. Record the measured reading with the test antenna fixed at this maximized position, polarization, andorientation. Record the measurement distance.

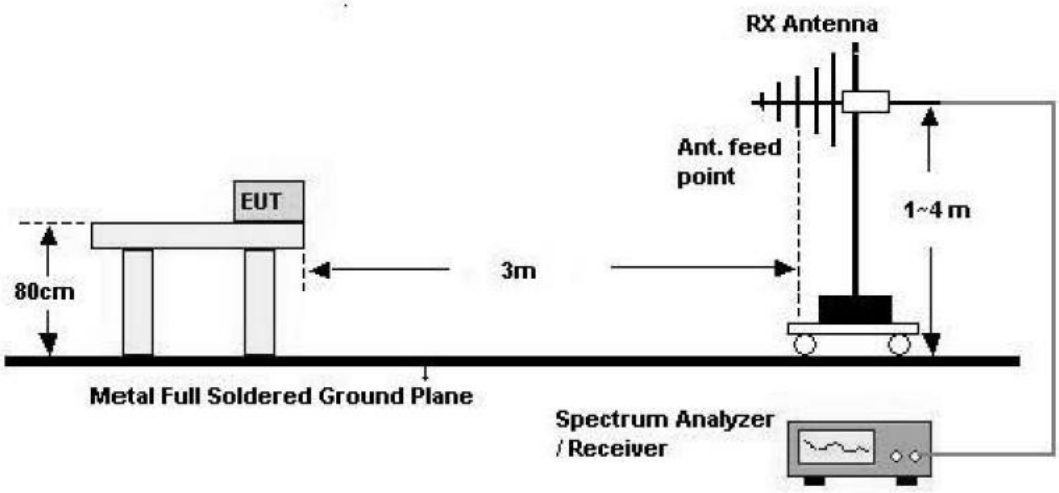
8. Calculate the maximum field strength of the emission at the measurement distance and the adjusted/corrected power at the output of the test antenna.
9. Calculate the EIRP from the measured field strength andthen convert to the linear.
10. Calculate the power density at the distance specified by the limit from thefield strength at the distance specified by the limit.
11. Repeat the preceding sequence for every emission observed in the frequency band underinvestigation.

Test Configuration

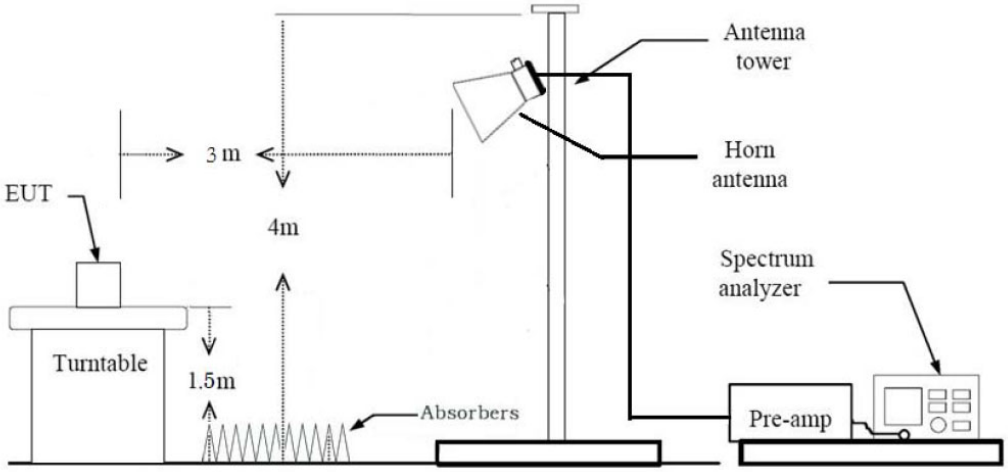
Below 30 MHz



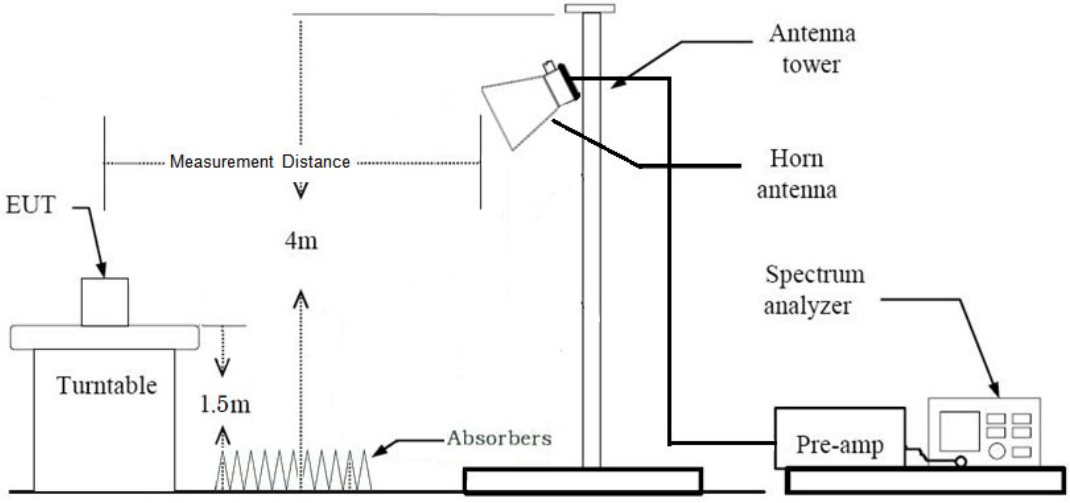
30 MHz - 1 GHz



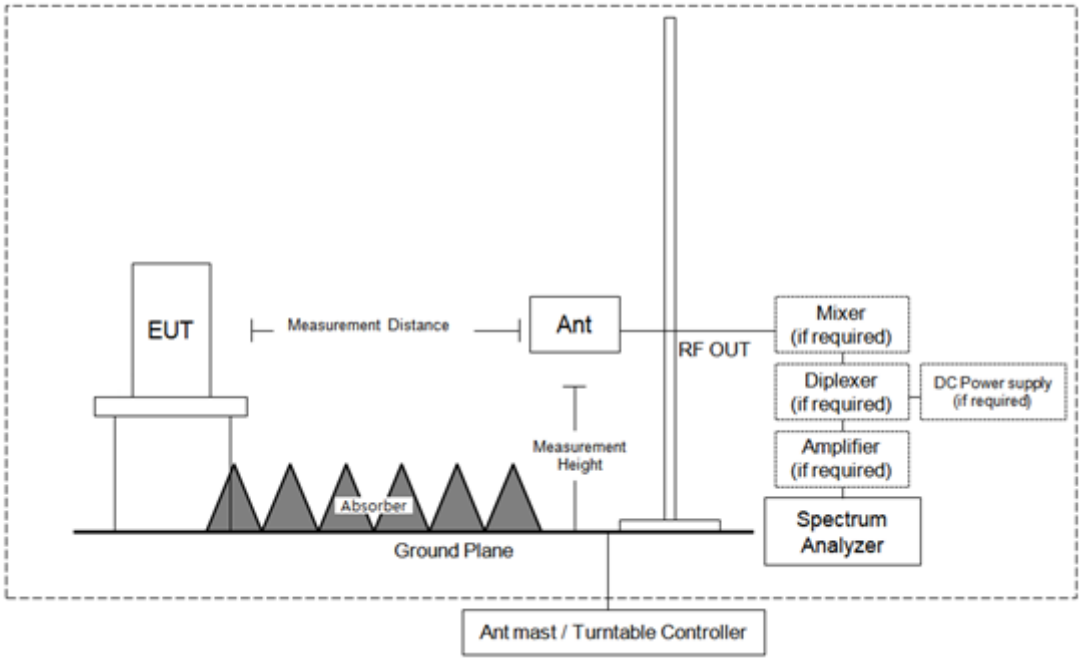
1 GHz – 18 GHz



18 GHz – 40 GHz



40 GHz – 200 GHz



▣ TEST RESULTS

9 kHz – 30MHz

Operation Mode: Continuous TX Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
6. The test results for below 30 MHz is correlated to an open site.
   The result on OFTS is about 2 dB higher than semi-anechoic chamber(10 m chamber)

Below 1 GHz

Operation Mode: Continuous TX Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

1 GHz – 18 GHz

Operation Frequency: Continuous TX Mode

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 5th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

18 GHz – 40 GHz

Operation Frequency: Continuous TX Mode

Frequency [GHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G [dB]	Ant. Pol. [H/V]	D.E.F [dB]	Ducy Cycle Factor	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found									

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Note :

1. Total = Reading Value + Antenna Factor + Cable Loss + Distance Factor – Amp Gain
2. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
   Worst case is y plane and vertical polarization.

40 GHz – 90 GHz

Operation Frequency: Continuous TX Mode

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

Note :

1. Total(dBμV/m) = Reading Value(dBm) + AFCL(dB)
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
   Worst case is y plane and horizontal polarization.
3. In this test, AFCL factor consists of antenna factor, cable loss, mixer loss, amplifier gain
4. AV: Average

90 GHz – 200 GHz

Operation Frequency: Continuous TX Mode

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 5th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Receiver Spurious Emissions Test Result:

ISED Rule(s):	**RSS-Gen**
Test Requirements:	**The table below**
Operating conditions:	**Under normal test conditions**
Method of testing:	**Radiated**

S/A. Settings: **F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)**

F > 1 GHz: RBW: 1 MHz, VBW: 1 MHz (Peak)

Mode of operation: **Receive**

Frequency (MHz)	Field Strength (microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

Operation Mode: Receiver

30 MHz ~ 1 GHz

Frequency (MHz)	Reading (dB μV)	Ant. factor (dB /m)	Cable loss (dB)	Ant. POL (H/V)	Total (dB μV/m)	Limit (dB μV/m)	Margin (dB)
No critical peaks found							

Above 1 GHz

Frequency (MHz)	Reading (dB μV)	Ant. factor (dB /m)	Cable loss (dB)	Ant. POL (H/V)	Total (dB μV/m)	Limit (dB μV/m)	Margin (dB)
No critical peaks found							

8.4 Fundamental emissions (Frequency Stability)

FCC Rules

§ 15.255(f) Frequency stability.

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range − 20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

ISED Rules

RSS-210, Annex J.6 Transmitter frequency stability

Fundamental emissions shall be contained within the 57-71 GHz frequency band during all conditions of operation when tested at the temperature and voltage variations specified for the frequency stability measurement in RSS-Gen.

RSS-GEN, 6.11 Transmitter frequency stability

For licence-exempt devices, the following conditions apply:

a. at the temperatures of -20°C (-4°F), +20°C (+68°F) and +50°C (+122°F), and at the manufacturer's rated supply voltage
b. at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage

RSS-GEN, 8.11 Frequency stability

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In addition, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-602 MHz, unless otherwise indicated.

▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

RBW ≤ 100 kHz.

VBW ≥ 300 MHz

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

The frequency drift was investigated for every 10 °C increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -20 to 50 °C.
Voltage supplied to EUT is 1.2 V and reference temperature was done at 20°C.
The voltage was varied in 1.14 V to 1.3 V which manufacturers declare.

▣ TEST RESULTS

Reference: 230 V at 20°c **Freq.** = 60.95 GHz

Voltage	Temp. (°C)	Frequency Rage (GHz)	Limit (GHz)	Result
1.2 V	+20(Ref)	60.951 ~ 60.964	57.1 ~ 63.9	Pass
	-20	61.106 ~ 61.120		Pass
	-10	61.065 ~ 61.080		Pass
	0	61.047 ~ 61.061		Pass
	+10	61.009 ~ 61.022		Pass
	+30	60.950 ~ 60.963		Pass
	+40	60.929 ~ 60.943		Pass
	+50	60.905 ~ 60.917		Pass
1.14 V	+20	60.936 ~ 60.948		Pass
1.3 V	+20	60.958 ~ 60.971		Pass

9. LIST OF TEST EQUIPMENT

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Schwarzbeck	BBHA 9170 / Horn Antenna	11/29/2019	Biennial	BBHA9170541
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Rohde&Schwarz	FSW / Spectrum Analyzer	09/09/2020	Annual	101256
Rohde&Schwarz	FSP / Spectrum Analyzer	06/08/2020	Annual	100843
Emco	2090 / Controller	N/A	N/A	060520
Ets	Turn Table	N/A	N/A	N/A
Rohde & Schwarz	Loop Antenna	05/12/2020	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	09/04/2020	Biennial	9168-0895
Schwarzbeck	BBHA 9120D / Horn Antenna	06/28/2019	Biennial	9120D-1300
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M19RH-160419-2
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M19RH-160419-1
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M12RH-160419-1
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M12RH-160419-2
OML INC.	WR-08 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M08RH-160419-2
OML INC.	WR-08 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M08RH-160419-1
OML INC.	WR-05 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M05RH-160419-1
OML INC.	WR-05 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M05RH-160419-2
OML INC.	OML WR19 / Harmonic Mixer	09/09/2020	Annual	M19HWD
OML INC.	OML WR12 / Harmonic Mixer	09/09/2020	Annual	M12HWD
OML INC.	OML WR08 / Harmonic Mixer	09/09/2020	Annual	M08HWD
OML INC.	OML WR05 / Harmonic Mixer	09/09/2020	Annual	M05HWD
OML INC.	WR-19 / Source Module	09/09/2020	Annual	S19MS-A-160516-1
OML INC.	WR-12 / Source Module	09/09/2020	Annual	S12MS-A-160419-1
OML INC.	WR-08 / Source Module	09/09/2020	Annual	S08MS-A-160419-1
OML INC.	WR-05 / Source Module	09/09/2020	Annual	S05MS-A-160419-1
Rohde & Schwarz	SMV100A / Signal Generator	07/13/2020	Annual	177633
Tektronix	TDS2022C / Digital Storage Oscilloscope	03/10/2020	Annual	C041625
Millitech	DET-15-RPFW0 / RF detector	08/14/2019	Biennial	2008525

Note:

All equipment is calibrated with traceable calibrations.

Each calibration is traceable to the national or international standards.

10. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2009-FI012-P