On your side







# **TEST REPORT**

FCC/ISED BT LE Test for IAGL-NHT1 Certification

APPLICANT LG Electronics Inc.

**REPORT NO.** HCT-RF-2112-FI003-R1

DATE OF ISSUE December 24, 2021

> Tested by Jin Gwan Lee

Mary -

**Technical Manager** Jong Seok Lee

Accredited by KOLAS, Republic of KOREA

HCT CO., LTD. Bonejai Huh BongJai Huh / CEO

HCT CO., LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA Tel. +82 31 634 6300 Fax. +82 31 645 6401 The report shall not be reproduced except in full(only partly) without approval of the laboratory.

F-TP22-03(Rev.04)

1/66



HCT Co., Ltd.



74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA Tel. +82 31 634 6300 Fax. +82 31 645 6401

TEST REPORT FCC/ISED BT LE Test for IAGL-NHT1	REPORT NO. HCT-RF-2112-F1003-R1 DATE OF ISSUE December 24, 2021 Additional Model
Applicant	<b>LG Electronics Inc.</b> 222, LG-ro, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713, Republic of Korea
Eut Type Model Name	Lotus Gamma2 IAGL-NHT1
FCC ID IC	BEJIAGL-NHT1 2703H-IAGLNHT1
Max. RF Output Power	3.364 dBm (2.17 mW)
Modulation type	GFSK
FCC Classification	Digital Transmission System(DTS)
FCC Rule Part(s)	Part 15.247
ISED Rule Part(s)	RSS-247 Issue 2 (February 2017) RSS-Gen Issue 5_Amendment 2 (February 2021)
	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.	Revision No. Date of Issue Descri	
0	December 14, 2021 Initial Release	
1	December 24, 2021	Revised IC number on page 2

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.

#### KOLAS Statement:

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. (KOLAS Accreditation No. KT197)

If this report is required to confirmation of authenticity, please contact to www.hct.co.kr



# CONTENTS

1. EUT DESCRIPTION	5
2. TEST METHODOLOGY	7
EUT CONFIGURATION	7
EUT EXERCISE	7
GENERAL TEST PROCEDURES	7
DESCRIPTION OF TEST MODES	8
3. INSTRUMENT CALIBRATION	8
4. FACILITIES AND ACCREDITATIONS	8
FACILITIES	8
EQUIPMENT	8
5. ANTENNA REQUIREMENTS	9
6. MEASUREMENT UNCERTAINTY	9
7. DESCRIPTION OF TESTS	10
8. SUMMARY TEST OF RESULTS	29
9. TEST RESULT	31
9.1 DUTY CYCLE	31
9.2 6 dB BANDWIDTH & 99 % BANDWIDTH	33
9.3 OUTPUT POWER	43
9.4 POWER SPECTRAL DENSITY	45
9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS	48
9.7 RADIATED SPURIOUS EMISSIONS	57
9.8 RADIATED RESTRICTED BAND EDGES	61
9.9 RECEIVER SPURIOUS EMISSIONS	63
10. LIST OF TEST EQUIPMENT	64
11. ANNEX A_ TEST SETUP PHOTO	66



## **1. EUT DESCRIPTION**

Model	IAGL-NHT1			
Additional Model	-			
EUT Type	Lotus Gamma	2		
Power Supply	DC 12.0 V			
Frequency Range	2 402 MHz – 2 4	480 MHz		
	Peak	3.364 dBm (2.17 mW)		
Max. RF Output Power	Average	3.23 dBm (2.10 mW)		
Modulation Type	GFSK	·		
Bluetooth Version	5.0	5.0		
Number of Channels	40 Channels	40 Channels		
Antenna Specification	Antenna type: dipole antenna			
	Peak Gain : 0.11 dBi			
Date(s) of Tests	November 02, 2021 ~ December 13, 2021			
PMN (Product Marketing Number)	Lotus Gamma2			
HVIN (Hardware Version Identification Number)	IAGL-NHT1			
FVIN (Firmware Version Identification Number)	IP10			
HMN (Host Marketing Name)	N/A			
EUT serial numbers	Radiated : IAGL-NHT1002 Conducted : IAGL-NHT1001			
Manufacturer	LG Electronics Inc. 222, LG-ro, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, 451-713, Republic of Korea			







	1. LG INNOTEK YANTAI CO., LTD.
	No. 36, Taibei North Road, Development Zone, Yantai 264006 Shandong P.R.
	China
	2. LG Electronics Vietnam Hai Phong Co., Ltd.
	Lot CN2, Trang Due Industrial Park, Le Loi Commune, An Duong District, Hai
	Phong City, Vietnam
	3. LG Electronics Inc.
	222, LG-ro, Jinwi-myeon Pyeongtaek-si, Gyeonggi-do 17709 Republic of
	Korea
	4. LG Electronics Mława Sp. z o.o.
	ul. LG Electronics 706-500 Mława Poland
	5. LG Electronics(Kunshan) Co., Ltd.
Factory	No. 88, Qianjin East Road, Kunshan City 215300 Jiangsu P.R. China
	6. LG ELECTRONICS DO BRASIL LTDA
	LG - FILIAL MANAUS
	RUA JAVARI 1004 DISTRITO INDUSTRIAL MANAUS - AM, 69075-110, Brazil
	7. LG Electronics Nanjing Vehicle Component Co., Ltd.
	No.346, Yaoxinda Road, Nanjing Economic and Technological Development
	Zone, 210038, P.R. China
	8. Hitachi-LG Data Storage(Huizhou), Ltd.
	Huifeng Fourth Road 42, Zhongkai Hi-Tech Industry Development Zone,
	Huizhou, Guangdong, 516006 P.R. China
	9. HITACHI ELECTRONIC PRODUCTS (M) SDN. BHD
	No. 12, Jalan Kemajuan, Bangi Industrial Estate, 43650 Bandar Baru Bangi,
	Selangor Darul Ehsan, Malaysia



# 2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r02 dated April 02, 2019 entitled "guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

## **EUT CONFIGURATION**

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

## **EUT EXERCISE**

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C. / RSS-Gen issue 5, RSS-247 issue 2.

## **GENERAL TEST PROCEDURES**

#### **Conducted Emissions**

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and average detector modes.

#### **Radiated Emissions**

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1 GHz. Above 1 GHz with 1.5 m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m 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 6.6.5 of ANSI C63.10. (Version: 2013)



## **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 antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

## 4. FACILITIES AND ACCREDITATIONS

#### 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 January 26, 2021 (CAB identifier: KR0032).

#### 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 / RSS-Gen(Issue 5) Section 8:

"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."

(1) The antennas of this E.U.T are permanently attached.

(2) The E.U.T Complies with the requirement of § 15.203

## **6. MEASUREMENT UNCERTAINTY**

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

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

The measurement data shown herein meets or exceeds the  $U_{CISPR}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

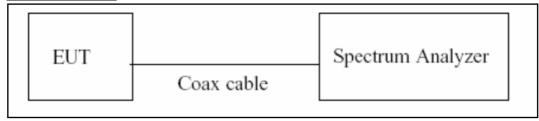
Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82 (Confidence level about 95 %, k=2)
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40 (Confidence level about 95 %, k=2)
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80 (Confidence level about 95 %, k=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70 (Confidence level about 95 %, k=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05 (Confidence level about 95 %, k=2)



# 7. DESCRIPTION OF TESTS

7.1. Duty Cycle

## **Test Configuration**



## **Test Procedure**

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v05r02.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T  $\leq$  6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/T.

- 1. RBW = 8 MHz (the largest available value)
- 2. VBW = 8 MHz ( $\geq$  RBW)
- 3. SPAN = 0 Hz
- 4. Detector = Peak
- 5. Number of points in sweep > 100
- 6. Trace mode = Clear write
- 7. Measure  $T_{total}$  and  $T_{on}$
- 8. Calculate Duty Cycle =  $T_{on}/T_{total}$  and Duty Cycle Factor = 10log(1/Duty Cycle)

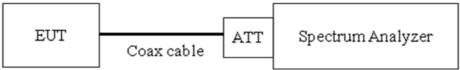


### 7.2. 6 dB Bandwidth & 99 % Bandwidth(ISED)

#### Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

## **Test Configuration**



#### **Test Procedure**

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.2 in KDB 558074 v05r02,

Procedure 11.8.1 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW  $\geq$  3 x RBW
- 3) Detector = Peak
- 4) Trace mode = Max hold
- 5) Sweep = auto couple
- 6) Allow the trace to stabilize
- 7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

#### Test Procedure (99 % Bandwidth for ISED)

The transmitter output is connected to the spectrum analyzer.

RBW =  $1 \% \sim 5 \%$  of the occupied bandwidth VBW  $\Rightarrow 3 \times$  RBW Detector = Peak Trace mode = max hold Sweep = auto couple Allow the trace to stabilize

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

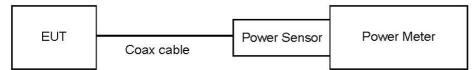


## 7.3. Output Power

#### Limit

The maximum permissible conducted output power is 1 Watt.

#### **Test Configuration**



#### **Test Procedure**

The transmitter output is connected to the Power Meter.

- Peak Power (Procedure 11.9.1.3 in ANSI 63.10-2013)
- : Measure the peak power of the transmitter.
- Average Power (Procedure 8.3.2.3 in KDB 558074 v05r02, Procedure 11.9.2.3 in ANSI 63.10-2013)
  - 1) Measure the duty cycle.
  - 2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
  - 3) Add 10  $\log(1/x)$ , where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

#### Sample Calculation

- Conducted Output Power(Peak) = Measured Level + ATT loss + Cable loss
- Conducted Output Power(Average) = Measured Level + ATT loss + Cable loss + Duty Cycle Factor

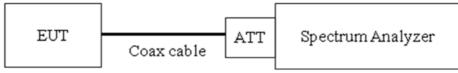


### 7.4. Power Spectral Density

#### Limit

The transmitter power density average over 1-second interval shall not be greater than 8 dBm in any 3 kHz BW.

#### **Test Configuration**



#### **Test Procedure**

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

- 1) Set analyzer center frequency to DTS channel center frequency.
- 2) Set span to at least 1.5 times the OBW.
- 3) RBW = 3 kHz  $\leq$  RBW  $\leq$  100 kHz.
- 4) VBW  $\geq$  3 x RBW.
- 5) Sweep = auto couple
- 6) Detector = Peak
- 7) Trace mode = Max hold
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum amplitude level.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
  If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

#### **Sample Calculation**

• Power Spectral Density = Measured Level + ATT loss + Cable loss



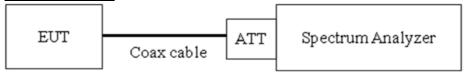


### 7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

#### Limit

The maximum conducted (Peak) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz. [Conducted > 20 dBc]

#### **Test Configuration**



#### **Test Procedure**

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 v05r02, Procedure 11.11 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW  $\geq$  3 x RBW
- 3) Set span to encompass the spectrum to be examined
- 4) Detector = Peak
- 5) Trace Mode = Max hold
- 6) Sweep time = auto couple
- 7) Ensure that the number of measurement points  $\geq$  2 x Span/VBW
- 8) Allow trace to fully stabilize.
- 9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.





## Factors for frequency

Freq(MHz)	Factor(dB)
30	20.09
100	20.14
200	20.18
300	20.23
400	20.29
500	20.29
600	20.30
700	20.31
800	20.32
900	20.34
1000	20.39
2000	20.54
2400	20.69
2412	20.88
2437	20.88
2462	20.88
2500	21.04
3000	21.12
4000	21.35
5000	21.64
5700	21.89
5800	21.89
6000	21.92
7000	22.05
8000	22.05
9000	22.13
10000	22.23
11000	22.32
12000	22.41
13000	22.42
14000	22.45
15000	22.55
16000	22.63
17000	22.84
18000	22.97
19000	22.89
20000	22.56
21000	22.69
22000	22.68
23000	22.69
24000	22.70
25000	22.80

Note : 1. 2400 ~ 2500 MHz is fundamental frequency range.

2. Factor = Attenuator loss(20 dB) + Cable loss



#### 7.6. Radiated Test

## FCC

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 – 30	30	30

# ISED

Frequency (MHz)	Field Strength (uA/m)	Measurement Distance (m)
0.009 - 0.490	6.37/F(kHz)	300
0.490 - 1.705	63.7/F(kHz)	30
1.705 – 30	0.08	30

## FCC&ISED

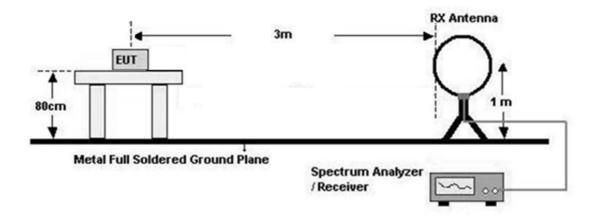
Frequency (MHz)	Field Strength ( $\mu$ V/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3



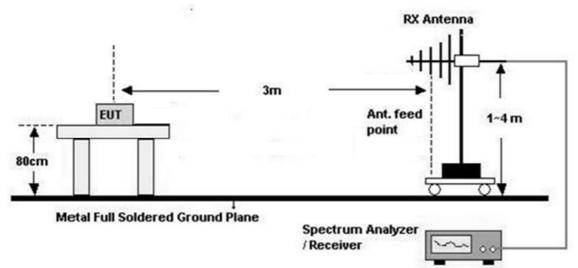
Report No. HCT-RF-2112-FI003-R1

## **Test Configuration**

Below 30 MHz



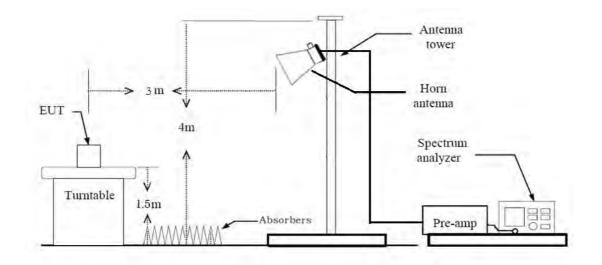
30 MHz - 1 GHz



Report No. HCT-RF-2112-FI003-R1



Above 1 GHz



#### Test Procedure of Radiated spurious emissions(Below 30 MHz)

- 1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
- 2. The loop antenna was placed at a location 3 m from the EUT
- 3. The EUT is placed on a turntable, which is 0.8 m above ground plane.
- 4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
- 5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
- 6. Distance Correction Factor(0.009 MHz 0.490 MHz) = 40log(3 m/300 m) = 80 dB
  - Measurement Distance : 3 m
- 7. Distance Correction Factor(0.490 MHz 30 MHz) =  $40\log(3 \text{ m}/30 \text{ m})$  = 40 dB
  - Measurement Distance : 3 m
- 8. Spectrum Setting
  - Frequency Range = 9 kHz ~ 30 MHz
  - Detector = Peak
  - Trace = Max hold
  - RBW = 9 kHz
  - VBW  $\geq$  3 x RBW
- 9. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)



10. Measurement value 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.

## KDB 414788 OFS and Chamber Correlation Justification

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.



#### Test Procedure of Radiated spurious emissions(Below 1 GHz)

- 1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
- 2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
- 3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
- 4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 6. Spectrum Setting
  - (1) Measurement Type(Peak):
    - Measured Frequency Range : 30 MHz 1 GHz
    - Detector = Peak
    - Trace = Max hold
    - RBW = 100 kHz
    - VBW  $\geq$  3 x RBW
  - (2) Measurement Type(Quasi-peak):
    - Measured Frequency Range : 30 MHz 1 GHz
    - Detector = Quasi-Peak
    - RBW = 120 kHz

In general, (1) is used mainly

7. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L)

8. Measurement value 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.



#### Test Procedure of Radiated spurious emissions (Above 1 GHz)

- 1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
- 2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
- 5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 7. The unit was tested with its standard battery.
- 8. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013)
  - (1) Measurement Type(Peak):
    - Measured Frequency Range : 1 GHz 25 GHz
    - Detector = Peak
    - Trace = Max hold
    - RBW = 1 MHz
    - VBW  $\geq$  3 x RBW
  - (2) Measurement Type(Average):
    - Duty cycle < 98 %, duty cycle variations are less than  $\pm 2$  %
    - Measured Frequency Range : 1 GHz 25 GHz
    - Detector = RMS
    - Averaging type = power (*i.e.*, RMS)
    - RBW = 1 MHz
    - VBW  $\geq$  3 x RBW
    - Sweep time = auto.
    - Trace mode = average (at least 100 traces).
    - Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1

9. Measurement value 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.

10. Distance extrapolation factor = 20log (test distance / specific distance) (dB)



#### 11. Total (Measurement Type : Peak)

```
= Peak Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance
```

Factor(D.F)

Total (Measurement Type : Average)

- = Average Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) Amp Gain(G)
  - + Distance Factor(D.F) + Duty Cycle Factor

#### Test Procedure of Radiated Restricted Band Edge

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.

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

3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
- 5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 7. Spectrum Setting
  - (1) Measurement Type(Peak):
    - Measured Frequency Range : 2310 MHz  $\sim$  2390 MHz/ 2483.5 MHz  $\sim$  2500 MHz
    - Detector = Peak
    - Trace = Max hold
    - RBW = 1 MHz
    - VBW  $\geq$  3 x RBW
  - (2) Measurement Type(Average):
    - Duty cycle < 98 %, duty cycle variations are less than  $\pm 2~$  %
    - Measured Frequency Range : 2310 MHz  $\sim$  2390 MHz/ 2483.5 MHz  $\sim$  2500 MHz
    - Detector = RMS
    - Averaging type = power (*i.e.*, RMS)
    - RBW = 1 MHz
    - VBW  $\geq$  3 x RBW
    - Sweep time = auto.
    - Trace mode = average (at least 100 traces).
    - Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.



- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

- 8. Measurement value 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.
- 9. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
- 10. Total(Measurement Type : Peak)

= Peak Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) Total(Measurement Type : Average)

- = Average Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)
- + Duty Cycle Factor



### 7.7. Receiver Spurious Emissions

#### Limit

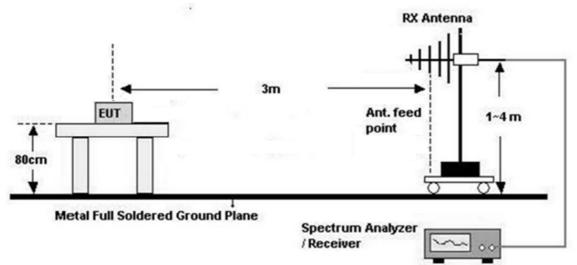
Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### Note:

Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

## **Test Configuration**

## 30 MHz - 1 GHz





## Test Procedure of Receiver Spurious Emissions (Below 1 GHz)

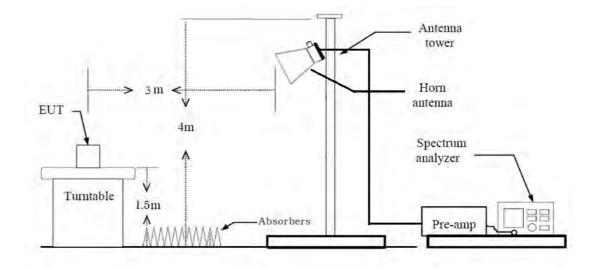
- 1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
- 2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
- 3. The Hybrid antenna was placed at a location 3m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
- 4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 6. Spectrum Setting
  - (1) Measurement Type(Peak):
    - Measured Frequency Range : 30 MHz 1 GHz
    - Detector = Peak
    - Trace = Max hold
    - RBW = 100 kHz
    - VBW  $\geq$  3 x RBW
  - (2) Measurement Type(Quasi-peak):
    - Measured Frequency Range : 30 MHz 1 GHz
    - Detector = Quasi-Peak
    - RBW = 120 kHz
- 7. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L)



Above 1 GHz



#### Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.

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

3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
- 5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 7. Spectrum Setting
  - (1) Measurement Type(Peak):
    - Measured Frequency Range : 1 GHz 25 GHz
    - Detector = Peak
    - Trace = Max hold
    - RBW = 1 MHz
    - VBW  $\geq$  3 x RBW
  - (2) Measurement Type(Average):



- We performed using a reduced video BW method was done with the analyzer in linear mode
- Measured Frequency Range : 1 GHz 25 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW  $\geq 1/\tau$  Hz, where  $\tau$  = pulse width in seconds
- The actual setting value of VBW = 1 kHz
- 8. Measurement value 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.
- 9. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
- 10. Total = Measured Level + Antenna Factor(A.F) + Cable Loss(C.L) Amp Gain(G) + Distance

Factor(D.F)



### 7.8. Worst case configuration and mode

### **Radiated Test**

1. All modes of operation were investigated and the worst case configuration results are reported.

- Mode : Stand alone
- Worstcase : Stand alone
- 2. EUT Axis:
  - Radiated Spurious Emissions : Y
  - Radiated Restricted Band Edge : X
- 3. All packet length of operation were investigated and the test results are worst case in lowest

packet length.

(Worst case : 1M 37 Bytes))

4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.

- Position : Horizontal, Vertical, Parallel to the ground plane

#### **AC Power line Conducted Emissions**

1. All modes of operation were investigated and the worst case configuration results are reported.

- Mode : Stand alone + External accessories (Notebook)

#### **Conducted test**

1. The EUT was configured with packet length of highest power. (Worst case : 1 M 37 Bytes)



## 8. SUMMARY TEST OF RESULTS

## FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§ 15.247(a)(2)	> 500 kHz		PASS
Conducted Maximum Output Power	§ 15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§ 15.247(e)	< 8 dBm / 3 kHz Band	Conducted	PASS
Band Edge (Out of Band Emissions)	§ 15.247(d)	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§ 15.207	cf. Section 7.7		N/A (#Note1)
Radiated Spurious Emissions	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§ 15.247(d), 15.205, 15.209	cf. Section 7.6		PASS



#### ISED Part

Test Description	escription ISED Part Test Limit Section(s)		Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz		PASS
99% Bandwidth	RSS-GEN, 6.7	N/A		PASS
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.b	< 1 Watt <4 Watt(e.i.r.p.)	Conducted	PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	RSS-GEN section 8.8 table 4		N/A (#Note1)
Radiated Spurious Emissions	RSS-GEN, 8.9	RSS-GEN section 8.9 table 5, 6		PASS
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.3	RSS-GEN section 7.3 table 3	Radiated	PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	RSS-GEN section 8.10 table 7		PASS

#Note1 : Not Tested



## 9. TEST RESULT

9.1 DUTY CYCLE

Data rate (Bit/s)	Packet length (Byte)	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
114	37	0.390	0.626	0.6235	2.05
1M	255	2.135	2.500	0.8540	0.69



## I MBit/s (37 Byte) Test Plots

RL	R	Analyzer - Swept SA F 50 Ω AC 2.40200000		SENSE IN Trig: Free Run Atten: 10 dB	#Avg Ty		12 PM 12 07, 2021 TRACE 2 3 4 5 TYPE WWWWWWW DET PNNNNN	Frequency
10 dB/div		f Offset 20.88 d				ΔMkr	3 625.7 µs 3.48 dB	Auto Tun
10 0			Xa			304		Center Fre 2.402000000 GH
-20.0						N		Start Fre 2,402000000 GH
-50 0 -60 0 -70 8		Whendahapel	Harryard		- ANIN	entilebytenenet		Stop Fre 2.402000000 GH
Res BW	8 MH			BW 8.0 MHz		Sweep 1.267 m	A	CF Stej 8.000000 MH uto Ma
MKR MODE 1 2 F 3 Δ4 4 F 5	1 t 1 t	(Δ) (Δ)	390.1 µs ( 416.7 µs 625.7 µs ( 416.7 µs	-1.77 dBm	FUNCTION FU	INCTION WIDTH	ICTION VALUE	Freq Offse 0 H
6 7 8								Scale Typ

I MBit/s (255 Byte) Test Plots

Duty Cycle (Low-CH 0)

RL enter Fr	req 2.4020000		Trig: Free Run Atten: 10 dB	#Avg	Type: RMS	09:34:39 PM 12 07, 2021 TRACE 2 3 4 5 TYPE DET P NNNN	Frequency
0 dB/div	Ref Offset 20.88 Ref 20.00 dBi	dB			Δ	Mkr3 2.500 ms 0.04 dB	
og			X.		i - ) - fin (		Center Fre 2.402000000 GH
ນບຸ ນບຸ ນບ			Alination				Start Fre 2.402000000 GH
00			1996 St. 10				Stop Fre 2.402000000 GH
enter 2.4 es BW 8		#VBV	V 8.0 MHz	TUNTION		Span 0 Hz .000 ms (1001 pts)	CF Ste 8.000000 Mi Auto Mi
1 Δ2 1 2 F 1 3 Δ4 1 4 F 1	t (Δ) t (Δ) t (Δ)	X 2.135 ms (Δ) 2.420 ms 2.500 ms (Δ) 2.420 ms	0.20 dB 1.67 dBm 0.04 dB 1.67 dBm	FUNCTION	FUNCTION WADTH	FUNCTION VALUE	Freq Offs 0 F
6 7 8 9							Scale Typ
		-	100			-	Log



## 9.2 6 dB BANDWIDTH & 99 % BANDWIDTH

FCC

Mode (Bit/s)	Channel	6 dB Bandwidth (kHz)	Limit (kHz)
114	0	712.7	
1M 27 Dute	19	712.5	
37 Byte	39	712.4	
114	0	672.0	> 500
1M	19	678.4	-
255 Byte	39	669.3	

# I MBit/s (37 Byte) Test Plots

RL RF 50Ω AC Center Freq 2.402000000	Trig: I	SENSE:INT r Freq: 2.402000000 GHz Free Run Avg Hold: h: 20 dB	ALIGN AUTO	Radio Std		Fi	requency
0 dB/div Ref 20.00 dBm			_				
5.00 6.0		~				100 100 100	Center Free 2000000 GH:
0.0							
0.0			1				
2.0 management and a second			- mare	man	man		
0.0							
enter 2.402000 GHz Res BW 100 kHz	#	VBW 300 kHz			.000 MHz 2.533 ms		CF Ster 500.000 kH
Occupied Bandwidth	1	Total Power	8.33	3 dBm		Auto	Mar
1.0	0881 MHz						a second s
Transmit Freq Error	-3.522 kHz	% of OBW Powe	er 99	9.00 %			0 H;
x dB Bandwidth	712.7 kHz	x dB	-6.	00 dB			
ansmit Freq Error	-3.522 kHz						Freq Offse 0 Hz

## 6 dB Bandwidth plot (Low-CH 0)

#### 6 dB Bandwidth plot (Mid-CH 19)





Report No. HCT-RF-2112-FI003-R1

RL RF 50Ω AG enter Freq 2.480000000	Trig: I	SENSE:INT      4LI        r Freq: 2.48000000 GHz      Free Run        Free Run      Avg Hold: 1/        n: 20 dB      Avg	GN AUTO 09:32:50 PM 1 Radio Std: N Radio Devic	None Frequency
D dB/div      Ref 20.00 dBm        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00        00      00			-	Center Fre 2.480000000 GH
enter 2.480000 GHz Res BW 100 kHz Occupied Bandwidtl		VBW 300 kHz Total Power	Span 5.0 Sweep 2 9.87 dBm	
1.1 Transmit Freq Error x dB Bandwidth	0900 MHz 4.691 kHz 712.4 kHz	% of OBW Power x dB	99.00 % -6.00 dB	Freq Offse 0 H

# 6 dB Bandwidth plot (High-CH 39)



# I MBit/s (255 Byte) Test Plots



## 6 dB Bandwidth plot (Low-CH 0)

#### 6 dB Bandwidth plot (Mid-CH 19)







### 6 dB Bandwidth plot (High-CH 39)



# 99 % Bandwidth(ISED)

Mode (Bit/s)	Packet length (Byte)	Channel	99 % Bandwidth (MHz)	
		0	1.0642	
	37 Byte	19	1.0636	
114		39	1.0649	
1M		0	1.0613	
	255 Byte	19	1.0621	
		39	1.0622	



### I MBit/s (37 Byte) Test Plots



### 99 % Bandwidth plot (Low-CH 0)

### 99 % Bandwidth plot (Mid-CH 19)





RL RF 50 Ω AC Senter Freq 2.480000000	Trig:	SENSE:INT r Freq: 2.480000000 GHz Free Run Avg Hol n: 20 dB	d: 1/1	Radio Std		Frequency
0 dB/div Ref 20.00 dBm			_			
100 5.00		m				Center Fre 2.480000000 GH
a.)	m		1			
0.0 0.0 0.0			~	the second	mmm	
enter 2.480000 GHz Res BW 30 kHz	#	VBW 91 kHz			5.000 MHz 5.333 ms	CF Ste 500.000 kH
Occupied Bandwidth 1.0	649 MHz	Total Power	10.	2 dBm		Auto Ma Freq Offs
Transmit Freq Error x dB Bandwidth	7.651 kHz 628.7 kHz	% of OBW Pow x dB		9.00 % 5.00 dB		01
			STAT			

# 99 % Bandwidth plot (High-CH 39)



### I MBit/s (255 Byte) Test Plots

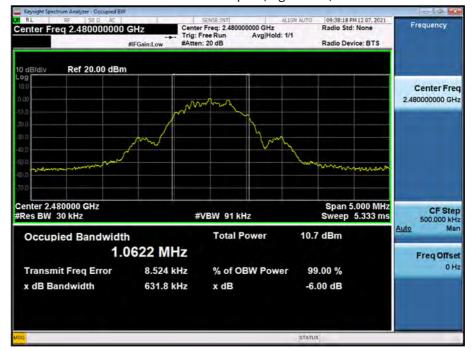


### 99 % Bandwidth plot (Low-CH 0)

### 99 % Bandwidth plot (Mid-CH 19)







### 99 % Bandwidth plot (High-CH 39)



### 9.3 OUTPUT POWER

Peak Power

Data rate	Packet length	LE M	lode	Measured	Limit	
(Bit/s)	(Byte)	Frequency [MHz]	Channel	Power(dBm)	(dBm)	
		2402	0	1.848		
	37	2440	19	3.044		
1.14		2480	39	3.364	20	
1M		2402	0	1.818	- 30	
	255	2440	19	3.017		
		2480	39	3.250		



### Average Power

Data rate	Packet length	LE Mode		Measured Power	Duty Cycle Factor	Result	Limit (dBm
(Bit/s)	(Byte)	Frequency [MHz]	Channel	(dBm)	(dB)	(dBm)	)
		2402	0	-0.36	2.05	1.69	
	37	2440	19	0.82	2.05	2.87	
1M		2480	39	1.18	2.05	3.23	- 30
TIM		2402	0	0.92	0.69	1.61	
	255	2440	19	2.19	0.69	2.88	
		2480	39	2.35	0.69	3.04	

# Note :

1. Power meter offset = Attenuator loss + Cable loss

2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 11.71 dB is offset for 2.4 GHz Band.



### 9.4 POWER SPECTRAL DENSITY

			Test Res	ult
Frequency (MHz)	Channel No.	Mode (Bit/s)	Measured Power(dBm)	Limit (dBm/3kHz)
2402	0		-12.321	
2440	19	1 MBit/s 37 Byte	-11.169	
2480	39	57 Dyte	-10.792	0
2402	0		-13.889	8
2440	19	1 MBit/s 225 Byte	-12.828	
2480	39	ZZJ Dyte	-12.468	

# Note :

1. The PSD measured results in plot is already including the actual values of loss for the attenuator and cable combination.

2. Spectrum offset = Attenuator loss + Cable loss

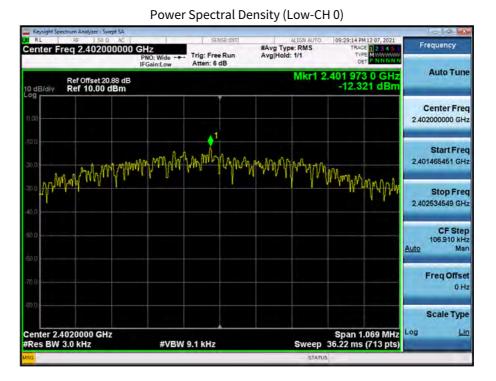
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.

So, 20.88 dB is offset for 2.4 GHz Band.

4. Worst case test Plot Only : 1 kBit/s (37 Byte)



### I MBit/s (37 Byte) Test Plots



### Power Spectral Density (Mid-CH 19)





Center Freq 2.48000000	PNO: Wide	sense INT	#Avg Type: RMS Avg Hold: 1/1	09:33:40 PM 12 07, 2021 TRACE 1 2 3 4 5 TYPE MWWWWW DET P NNNNN	Frequency
Ref Offset 20.88 dE 0 dB/div Ref 10.00 dBm	il daniesii	intent o de	Mkr1 2	2.479 981 2 GHz -10.792 dBm	Auto Tune
0.00					Center Free 2.480000000 GH
no A Manna	A When when the	where	Mantalyhtersta	Million at	Start Fre 2.479465668 GH
100 May Myre 44			- · · · · ·	n. An Maruhala	Stop Free 2.480534332 GH
10.0					CF Ste 106.866 kH <u>Auto</u> Ma
/6.0					Freq Offse 0 H
0.0					Scale Type
Center 2.4800000 GHz Res BW 3.0 kHz	#VBW 9.	kHz	Sweep	Span 1.069 MHz 36.21 ms (712 pts)	

Power Spectral Density (High-CH 39)





# 9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Result : please refer to the plot below. In order to simplify the report, attached plots were only the worst case channel and data rate.



### Low-CH 0 Keysight Spectrum Analyzer - Swept SA 09:30:34 PM 12 07, 2021 #Avg Type: RMS Avg|Hold: 1/1 Frequency TRACE 1 2 3 4 5 1 TYPE M WANNAWA ΔMkr1 4.050 MHz 50.118 dB Auto Tune Ref Offset 20.88 dB Ref 20.00 dBm 0 dB/d Center Freq 2.40000000 GHz ♦1∆2 Start Freq 2.392500000 GHz Stop Freq 2.407500000 GHz CF Step 1.500000 MHz Man Auto X Freq Offset 0 Hz Scale Type Center 2.400000 GHz #Res BW 100 kHz Span 15.00 MHz Sweep 1.000 ms (1001 pts) Log Lin #VBW 300 kHz

### I MBit/s (37 Byte) Test Plots -BandEdge

Higl	h-CH	39
		55

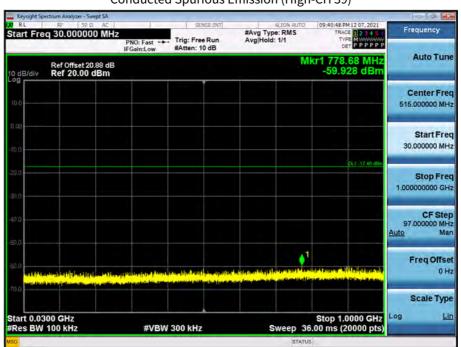






# I MBit/s (37 Byte) Test Plots -Conducted Spurious Emission

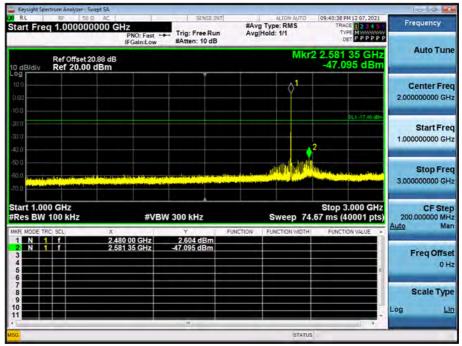
 $30 \text{ MHz} \sim 1 \text{ GHz}$ 



### Conducted Spurious Emission (High-CH 39)

### 1 GHz ~ 3 GHz

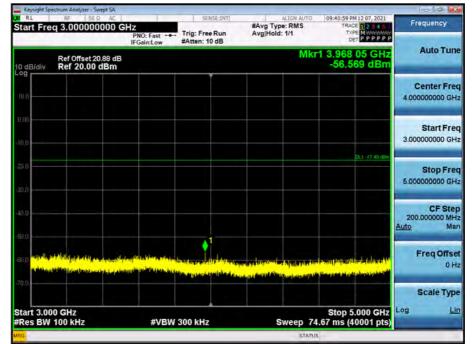
# Conducted Spurious Emission (High-CH 39)



Page 51 of 66



### $3 \text{ GHz} \sim 5 \text{ GHz}$



### Conducted Spurious Emission (High-CH 39)

### 5 GHz ~ 7 GHz

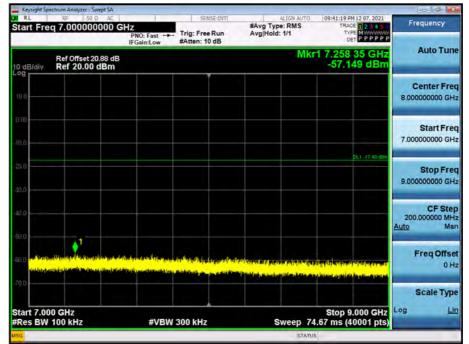
### Conducted Spurious Emission (High-CH 39)

Rt RF 09:41:09 PM 12 07, 2021 #Avg Type: RMS Avg|Hold: 1/1 Frequency Start Freq 5.000000000 GHz PNO: Fast ----IFGain:Low #Atten: 10 dB DET PPPPP 6.244 20 GHz -57.219 dBm Auto Tune Ref Offset 20.88 dB Ref 20.00 dBm IO dB/ Center Freq 6.00000000 GHz Start Freq 5.00000000 GHz Stop Freq 7.00000000 GHz CF Step 200.000000 MHz to Man uto Freq Offset 0 Hz Scale Type Start 5.000 GHz #Res BW 100 kHz Stop 7.000 GHz Sweep 74.67 ms (40001 pts) Log Lin #VBW 300 kHz



Page 52 of 66

# 7 GHz ~ 9 GHz



### Conducted Spurious Emission (High-CH 39)

### 9 GHz ~ 11 GHz

### Conducted Spurious Emission (High-CH 39)

Rt RF 09:41:29 PM 12 07, 2021 Start Freq 9.000000000 GHz PNO: Fast ----IFGain:Low #Atten: 10 dB #Avg Type: RMS Avg|Hold: 1/1 Frequency DET PPPPP Auto Tune Mkr 10.477 00 GHz -57.182 dBm Ref Offset 20.88 dB Ref 20.00 dBm IO dB/ Center Freq 10.00000000 GHz Start Freq 9.00000000 GHz Stop Freq 11.00000000 GHz CF Step 200.000000 MHz to Man uto **1** Freq Offset 0 Hz Scale Type Start 9.000 GHz #Res BW 100 kHz Stop 11.000 GHz Sweep 74.67 ms (40001 pts) Log Lin #VBW 300 kHz



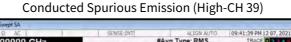
Page 53 of 66

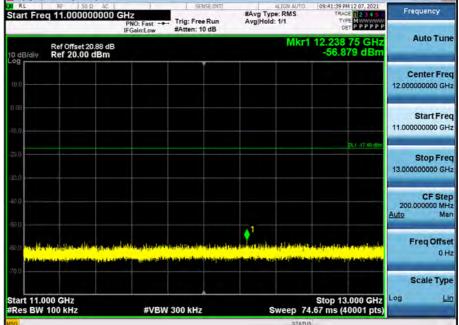
6

# 11 GHz ~ 13 GHz

Keysight Sp

RI





### 13 GHz ~ 15 GHz

# Conducted Spurious Emission (High-CH 39)

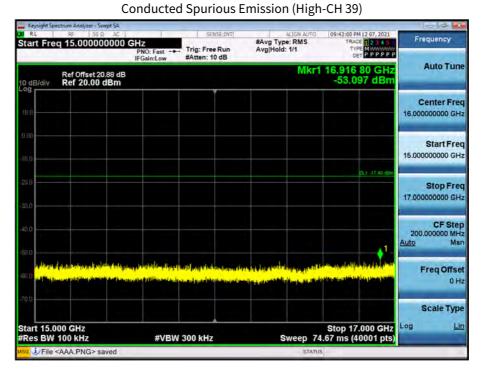
Reysight Spe 09:41:50 PM 12 07, 2021 Start Freq 13.000000000 GHz PNO: Fast ----IFGain:Low #Atten: 10 dB #Avg Type: RMS Avg|Hold: 1/1 Frequency DET P P P P P Auto Tune Mkr 4.625 40 GH -54.465 dBm Ref Offset 20.88 dB Ref 20.00 dBm IO dB/ Center Freq 14.00000000 GHz Start Freq 13.00000000 GHz Stop Freq 15.00000000 GHz CF Step 200.000000 MHz to Man uto 1 Freq Offset 0 Hz Scale Type Start 13.000 GHz #Res BW 100 kHz Stop 15.000 GHz Sweep 74.67 ms (40001 pts) Log Lin #VBW 300 kHz



Page 54 of 66

F-TP22-03 (Rev. 04)





### 17 GHz ~ 19 GHz

# Conducted Spurious Emission (High-CH 39)

Keysight Spectrum Analyzer - Swept SA RL RF 50 Ω AC	-	SENSE:INT	4LIGN AUTO	09:42:11 PM 12 07, 2021	0 6 2
Start Freq 17.000000000	PNO: Fast	Trig: Free Run #Atten: 10 dB	#Avg Type: RMS Avg Hold: 1/1	TRACE 2345 TYPE MWWWWWW DET PPPPP	Frequency
Ref Offset 20.88 dB 0 dB/div Ref 20.00 dBm			Mkr1	17.125 85 GHz -51.553 dBm	Auto Tun
10.0					Center Fre 18.000000000 GH
10,0					Start Fre 17.000000000 GH
20.0				DL1 -17 40 dBm	Stop Fre 19.000000000 GH
40.0					CF Ste 200.000000 MH Auto Ma
Martinella approximited from the local design	diter derivet indirer weber ander Madianner	And the second s	lan berland di bilan di bilan barra bilan di <mark>Sepanakan di bilan di bilan barra da yang barra da bilan di bilan di bilan di bilan barra da yang barra da bilan Barra di bilan di bila</mark>	- annedword a nord of	Freq Offse 0 H
70.0 Start 17.000 GHz				Stop 19.000 GHz	Scale Typ
#Res BW 100 kHz	#VBW	300 kHz	Sweep 74	.67 ms (40001 pts)	



Report No. HCT-RF-2112-FI003-R1

Page 55 of 66

ъ

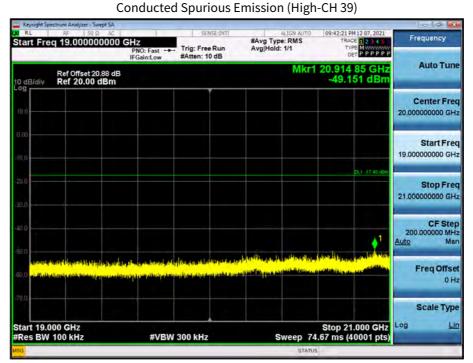
객

CUSTOMER SECRET

밀

비





### 21 GHz ~ 23 GHz

# Conducted Spurious Emission (High-CH 39)

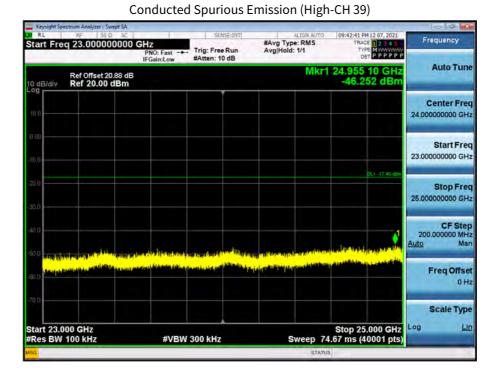
Keysight Spectrum Analyzer - Swept SA RL RF 50 0 AC	SENSE:INT	ALIGN AUTO	09:42:31 PM 12 07, 2021	Frequency
tart Freq 21.0000000	PNO: Fast Trig: Free Run IFGain:Low #Atten: 10 dB	#Avg Type: RMS Avg Hold: 1/1	TRACE 1 2 3 4 5 5 TYPE MWWWWWW DET P P P P P P	
Ref Offset 20.88 o 0 dB/div Ref 20.00 dBn		Mkr1	22.904 30 GHz -49.060 dBm	Auto Tun
10.0				Center Fre 22.000000000 GH
100				Start Fre 21.000000000 GH
20.0			CL1 -17 40 dBm	Stop Fre 23.000000000 GH
40.0			<b>↓</b> 1	CF Ste 200.000000 MH Auto Ma
	n a serie and a selection of logical discover of the data in this par- gramming production and any participation of the series in the second second second second second second second			Freq Offse 0 H
70,0				Scale Typ
tart 21.000 GHz Res BW 100 kHz	#VBW 300 kHz	Sweep 74	Stop 23.000 GHz .67 ms (40001 pts)	Log <u>Li</u>
5G		STATU	5	



ъ



### 23 GHz ~ 25 GHz



# Note :

Limit : -17.40 dBm



### 9.7 RADIATED SPURIOUS EMISSIONS

### Frequency Range : 9 kHz – 30MHz

Frequency	Measured Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin		
MHz	dBµV/m	dB/m	dB	(H/V)	dBµV/m	dBµV/m	dB		
	No Critical peaks found								

### Note:

1. The Measured Level of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.

- 2. Distance extrapolation factor = 40log (specific distance / test distance) (dB)
- 3. Limit line = specific Limits ( $dB\mu V$ ) + Distance extrapolation factor

Frequency	Measured Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin		
MHz	dBµV/m	dB/m	dB	(H/V)	dBµV/m	dBµV/m	dB		
	No Critical peaks found								

### Frequency Range : Below 1 GHz

### Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.



# Frequency Range : Above 1 GHz

# Mode: 1 MBit/s (37 Byte)

Operation Mode: CH Low

Frequency	Measured Level	Duty Cycle Factor	AF+CL+DF-AG	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBµV]	[dB]	[dB/m]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	Туре
4804	43.39	0.00	2.76	V	46.15	73.98	27.83	PK
4804	32.21	2.05	2.76	V	37.02	53.98	16.96	AV
7206	39.11	0.00	8.96	V	48.07	73.98	25.91	PK
7206	27.16	2.05	8.96	V	38.17	53.98	15.81	AV
4804	44.37	0.00	2.76	Н	47.13	73.98	26.85	PK
4804	33.37	2.05	2.76	Н	38.18	53.98	15.80	AV
7206	39.27	0.00	8.96	Н	48.23	73.98	25.75	PK
7206	27.27	2.05	8.96	Н	38.28	53.98	15.70	AV

### Operation Mode: CH Mid

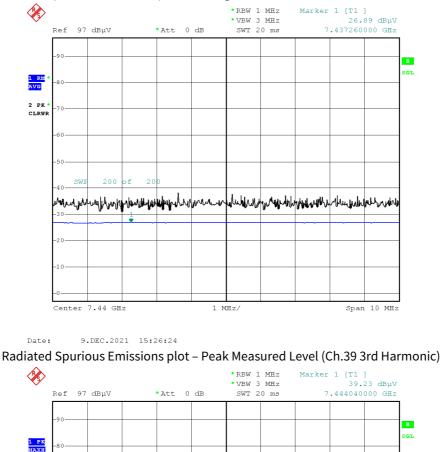
Frequency	Measured Level	Duty Cycle Factor	AF+CL+DF-AG	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBµV]	[dB]	[dB/m]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	Туре
4880	42.59	0.00	3.15	V	45.74	73.98	28.24	PK
4880	30.96	2.05	3.15	V	36.16	53.98	17.82	AV
7320	39.99	0.00	9.45	V	49.44	73.98	24.54	PK
7320	27.69	2.05	9.45	V	39.20	53.98	14.78	AV
4880	43.97	0.00	3.15	Н	47.12	73.98	26.86	PK
4880	32.39	2.05	3.15	Н	37.59	53.98	16.39	AV
7320	40.09	0.00	9.45	Н	49.54	73.98	24.44	PK
7320	27.74	2.05	9.45	Н	39.25	53.98	14.73	AV



Opera	tion Mode: C	H High						
Frequency	Measured Level	Duty Cycle Factor	AF+CL+DF-AG	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBµV]	[dB]	[dB/m]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	Туре
4960	42.07	0.00	2.23	V	44.30	73.98	29.68	PK
4960	30.09	2.05	2.23	V	34.37	53.98	19.61	AV
7440	39.19	0.00	10.35	V	49.54	73.98	24.44	PK
7440	26.75	2.05	10.35	V	39.15	53.98	14.83	AV
4960	42.49	0.00	2.23	Н	44.72	73.98	29.26	PK
4960	31.30	2.05	2.23	Н	35.58	53.98	18.40	AV
7440	39.23	0.00	10.35	Н	49.58	73.98	24.40	PK
7440	26.89	2.05	10.35	Н	39.29	53.98	14.69	AV



### I MBit/s (37 Byte) Test Plots (Worst case : Z-H)



Radiated Spurious Emissions plot - Average Measured Level (Ch.39 3rd Harmonic)

 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90
 -90</td

Date: 9.DEC.2021 15:26:36

### Note:

Plot of worst case are only reported.



### 9.8 RADIATED RESTRICTED BAND EDGES

# Mode : 1 MBit/s (37 Byte)

Channel No.

Operating Frequency

2402 MHz & 2480 MHz 0 & 39

Frequency	Measured Level	Duty Cycle Factor	AF+CL+DF	Ant. Pol.	Total	Limit	Margin	Measurement Type
[MHz]	[dBµV]	[dB]	[dB/m]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	
2390.0	19.76	0.00	33.78	Н	53.53	73.98	20.45	PK
2390.0	8.85	2.05	33.78	Н	44.68	53.98	9.30	AV
2390.0	19.57	0.00	33.78	V	53.35	73.98	20.63	PK
2390.0	8.82	2.05	33.78	V	44.65	53.98	9.33	AV
2483.5	21.40	0.00	34.10	Н	55.50	73.98	18.48	PK
2483.5	10.28	2.05	34.10	Н	46.43	53.98	7.55	AV
2483.5	20.37	0.00	34.10	V	54.47	73.98	19.51	PK
2483.5	9.25	2.05	34.10	V	45.40	53.98	8.58	AV

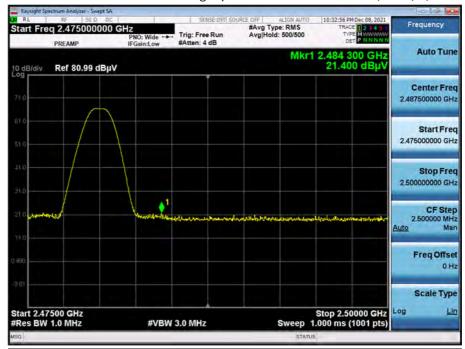


### Mode : 1 MBit/s (37 Byte) Test Plots

Radiated Restricted Band Edges plot - Average Measured Level (Ch.39,H)

Keysight Sp REAMP IFGain:Low Trig: Free Run PREAMP IFGain:Low #Avg Type: RMS Avg|Hold: 500/500 52:59 PM Dec 08, 2021 Frequency TYP Mkr1 2.484 100 GHz 10.275 dBµV Auto Tune Ref 80.99 dBµV 0 dB/di Center Freq 2.487500000 GHz Start Freq 2.475000000 GHz Stop Freq 2.50000000 GHz CF Step 2.500000 MHz Man ●1 Auto Freq Offset 0 Hz Scale Type Start 2.47500 GHz #Res BW 1.0 MHz Stop 2.50000 GHz Sweep 1.000 ms (1001 pts) Log Lin #VBW 3.0 MHz\*

Radiated Restricted Band Edges plot - Peak Measured Level (Ch.39, H)



### Note:

Plot of worst case are only reported.



### 9.9 RECEIVER SPURIOUS EMISSIONS

## Frequency Range : Below 1 GHz

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

## Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

### Frequency Range : Above 1 GHz

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



Conducted Test	-				
Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	08/23/2022	Annual
Test Receiver	ESCI	Rohde & Schwarz	100033	06/15/2022	Annual
Temperature Chamber	SU-642	ESPAC	0093008124	03/15/2022	Annual
Signal Analyzer	N9020A	Agilent	MY47380318	01/28/2022	Annual
Signal Analyzer	N9030A	Agilent	MY49431210	01/11/2022	Annual
Power Meter	N1911A	Agilent	MY45100523	04/08/2022	Annual
Power Sensor	N1921A	Agilent	MY57820067	04/08/2022	Annual
Directional Coupler	87300B	Agilent	3116A03621	11/02/2022	Annual
Power Splitter	11667B	Hewlett Packard	05001	05/20/2022	Annual
DC Power Supply	E3632A	Hewlett Packard	KR75303960	06/10/2022	Annual
Attenuator	5910-N-50-010	H+S	00801	10/29/2022	Annual
Software	EMC32	Rohde & Schwarz	N/A	N/A	N/A
FCC WLAN&BT&BLE Conducted Test Software v3.0	FCC WLAN&BT&BLE Conducted Test Software v3.0	HCT CO., LTD.	N/A	N/A	N/A
Bluetooth Tester	CBT	Rohde & Schwarz	100422	05/04/2022	Annual

# **10. LIST OF TEST EQUIPMENT**

### Note:

1. Equipment listed above that calibrated during the testing period was set for test after the

calibration.

2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.



# **Radiated Test**

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Controller (Antenna mast)	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	N/A	N/A	N/A
Controller	2090	Emco	060520	N/A	N/A
Turn Table	Turn Table	Ets	N/A	N/A	N/A
Loop Antenna	Loop Antenna	Rohde & Schwarz	1513-333	03/19/2022	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	09/04/2022	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	9120D-1191	11/18/2023	Biennial
Horn Antenna (15 GHz ~ 40 GHz)	BBHA9170	Schwarzbeck	BBHA9170541	11/16/2023	Biennial
Spectrum Analyzer	FSP (9 kHz ~ 30 GHz)	Rohde & Schwarz	836650/016	09/13/2022	Annual
Spectrum Analyzer	FSV40-N	Rohde & Schwarz	101068-SZ	09/15/2022	Annual
Band Reject Filter	WRCJV2400/2483.5- 2370/2520-60/12SS	Wainwright Instruments	2	01/06/2022	Annual
Band Reject Filter	WRCJV5100/5850- 40/50-8EEK	Wainwright Instruments	1	02/08/2022	Annual
Attenuator 56-10	CBLU1183540B-01 56-10	CERNEX WEINSCHEL	N/A	12/23/2021	Annual
Broadband Low Noise Amplifier Attenuator (3 dB)	CBL06185030 18B-03	CERNEX Api tech.	N/A	12/23/2021	Annual
High Pass Filter	WHKX10-2700- 3000-18000-40SS	Wainwright Instruments	N/A	12/23/2021	Annual
High Pass Filter	WHKX8-6090-7000- 18000-40SS	Wainwright Instruments	N/A	12/23/2021	Annual
Thru	COAXIAL ATTENUATOR	T&M SYSTEM	N/A	12/23/2021	Annual
Power Amplifier	CBL18265035	CERNEX	22966	12/02/2022	Annual
Power Amplifier	CBL26405040	CERNEX	25956	03/23/2022	Annual
Bluetooth Tester	TC-3000C	TESCOM	3000C000276	03/09/2022	Annual

### Note:

**1**. Equipment listed above that calibrated during the testing period was set for test after the calibration.

2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

3. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5(Version : 2017).





# **11. ANNEX A\_ TEST SETUP PHOTO**

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

No.	Description			
1	HCT-RF-2112-FI003-P			