

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT

Test Report No. : OT-20N-RWD-005
Reception No. : 2009003841
Applicant : Samsung Electronics Co Ltd
Address : 19 Chapin Rd., Building D, Pine Brook, New Jersey, 07058, United States
Manufacturer : Samsung Electronics Co Ltd
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do 16677, Korea
Type of Equipment : Wall Cableless_Rx
FCC ID. : A3LCTRAK3I02
Model Name : CTRAK3I02
Serial number : N/A
Total page of Report : 33 pages (including this page)
Date of Incoming : September 18, 2020
Date of issue : November 02, 2020

SUMMARY

The equipment complies with the regulation; *FCC CFR 47 PART 15 SUBPART C Section 15.255*

This test report only contains the result of a single test of the sample supplied for the examination.

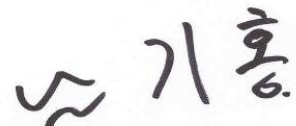
It is not a generally valid assessment of the features of the respective products of the mass-production.



Tested by
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Revision History

| Rev. No. | Issue Report No. | Issued Date | Revisions | Section Affected |
|----------|------------------|-------------------|-----------------|------------------|
| 0 | OT-20N-RWD-005 | November 02, 2020 | Initial Release | All |
| | | | | |
| | | | | |

1. VERIFICATION OF COMPLIANCE

Applicant : Samsung Electronics Co Ltd
 Address : 19 Chapin Rd., Building D, Pine Brook, New Jersey, 07058, United States
 Contact Person : Youngjoong Noh / Principal Engineer
 Telephone No. : +82-31-277-0598
 FCC ID : A3LCTRAK3I02
 Model Name : CTRAK3I02
 Brand Name : 
 Serial Number : N/A
 Date : November 02, 2020

| | |
|--|--|
| DEVICE TYPE | DXT – Part 15 Low Power Transceiver, Rx Verified |
| E.U.T. DESCRIPTION | Wall Cableless_Rx |
| THIS REPORT CONCERNS | Original Grant |
| MEASUREMENT PROCEDURES | ANSI C63.10: 2013 |
| TYPE OF EQUIPMENT TESTED | Pre-Production |
| KIND OF EQUIPMENT AUTHORIZATION REQUESTED | Certification |
| EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S) | FCC CFR47 Part 15 Subpart C Section 15.255 |
| Modifications on the Equipment to Achieve Compliance | None |
| Final Test was Conducted On | 3 m, Semi Anechoic Chamber |

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. GENERAL INFORMATION

2.1 Test items and results

| SECTION | TEST ITEMS | RESULTS |
|----------------------------|------------------------------------|------------------------|
| 15.255 (e) (1) | Emission & Occupied Bandwidth | Met the Limit / PASS |
| 15.255 (c) (1)(i) | Peak and Average EIRP Output Power | Met the Limit / PASS |
| 15.255 (e) | Peak Output Power | Met the Limit / PASS |
| 15.255 (d) (1) (2) (3) (4) | Spurious Emissions | Met the Limit / PASS |
| 15.255 (f) | Frequency Stability | Met the Limit / PASS |
| 15.207 | Conducted Limits | Met the Limit / PASS |
| 15.203 | Antenna Requirement | Met requirement / PASS |

2.2 Product Description

The Samsung Electronics Co Ltd, Model CTRAK3I02 (referred to as the EUT in this report) is an Wall Cableless_Rx, Product specification information described herein was obtained from product data sheet or user’s manual.

| | |
|------------------------|--------------------------------|
| DEVICE TYPE | Motion Detection Sensor Module |
| TRANSMITTING FREQUENCY | 57 GHz ~ 64 GHz |
| ANTENNA TYPE | Chip Antenna |
| ANTENNA Gain | 5.30 dBi |

2.2.1 Description of Test Mode

| Frequency (GHz) |
|-----------------|
| 58.5 ~ 62.0 |

2.3 Model Differences:

-. None

2.4 Related Submittal(s) / Grant(s)

Original submittal only

2.5 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.255.

2.6 Test Methodology

Testing was performed according to the procedures in ANSI C63.10-2013, Clause 9 – Procedures for testing millimeter-wave systems.

2.7 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. SYSTEM TEST CONFIGURATION

3.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

| DEVICE TYPE | MANUFACTURER | MODEL/PART NUMBER | FCC ID |
|-------------|--------------|------------------------------|--------|
| Main Board | N/A | 20y_wall_cableless_kss104 RX | N/A |

3.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested: None

| Model | Manufacturer | Description | Connected to |
|-----------|----------------------------|-------------------------|--------------|
| CTRAK3I02 | Samsung Electronics Co Ltd | Wall Cableless_Rx (EUT) | - |
| N/A | Samsung Electronics Co Ltd | Test Jig | EUT |
| A4819_FDY | N/A | AC/DC ADAPTOR | Test Jig |

3.3 Mode of operation during the test

- The EUT has continuous transmission mode during the test.
- Duty Cycle

| Mode | Tx On Time [ms] | Tx Off Time [ms] | Duty Cycle [%] | Correction Factor [dB] |
|-------------------|----------------------|-----------------------|---------------------|-----------------------------|
| Transmitting Mode | 5.522 | 6.092 | 90.64 | 0.43 |

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

- Test Plot



3.4 Equipment Modifications

- None

3.5 Configuration of Test System

Line Conducted Test

The EUT was tested in a Transmitter mode. The EUT was connected to DC Power Supply.

All supporting equipment were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

Radiated Emission Test

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available XYZ axis, and antenna ports. The worst case was found when positioned as the table below. Following was (were) selected for the final test as listed below:

| Testing Mode | EIRP Output Power | Radiated Emission |
|-------------------|-------------------|-------------------|
| Transmitting Mode | X-axis | X-axis |

3.6 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The transmitter antenna of the EUT is a Chip Antenna so there is no consideration of replacement by the user.

4. PRELIMINARY TEST

4.1 AC Power line Conducted Emissions Tests

During Preliminary Tests, the following operating modes were investigated

| Operation Mode | The Worse operating condition (Please check one only) |
|-------------------|---|
| Transmitting Mode | X |

4.2 Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

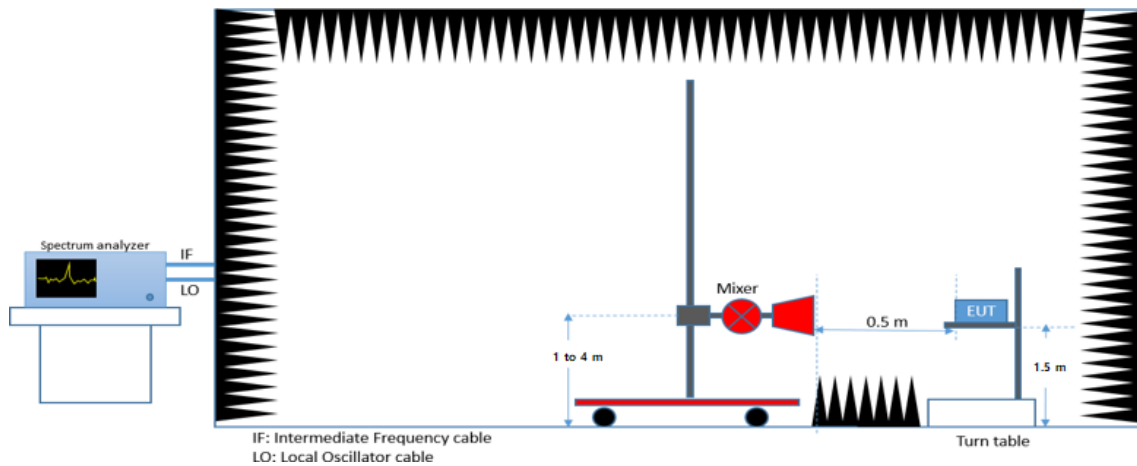
| Operation Mode | The Worse operating condition (Please check one only) |
|-------------------|---|
| Transmitting Mode | X |

5. Test & System Description

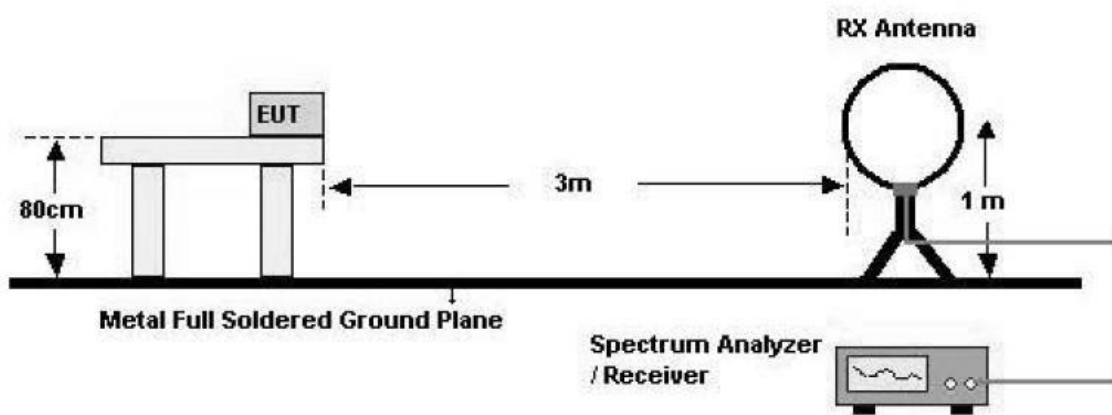
5.1 Measurement System

Measurements were performed using the following setups, made in accordance to the general provisions of ANSI C63.10-2013, Clause 9 – Procedures for testing millimeter-wave systems.

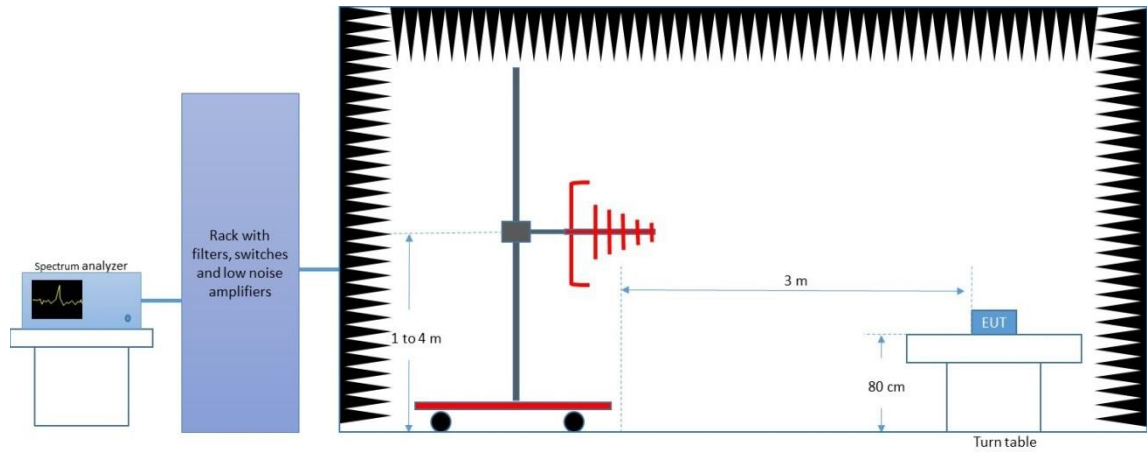
1) Emission & Occupied Bandwidth & Peak and Average EIRP Output Power (57 ~ 64 GHz)



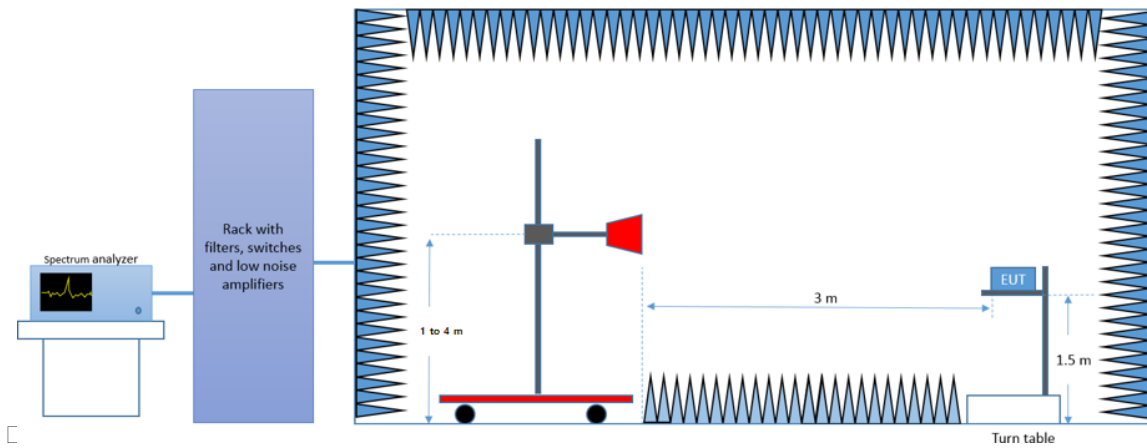
2) Radiated Setup (Below 30 MHz)



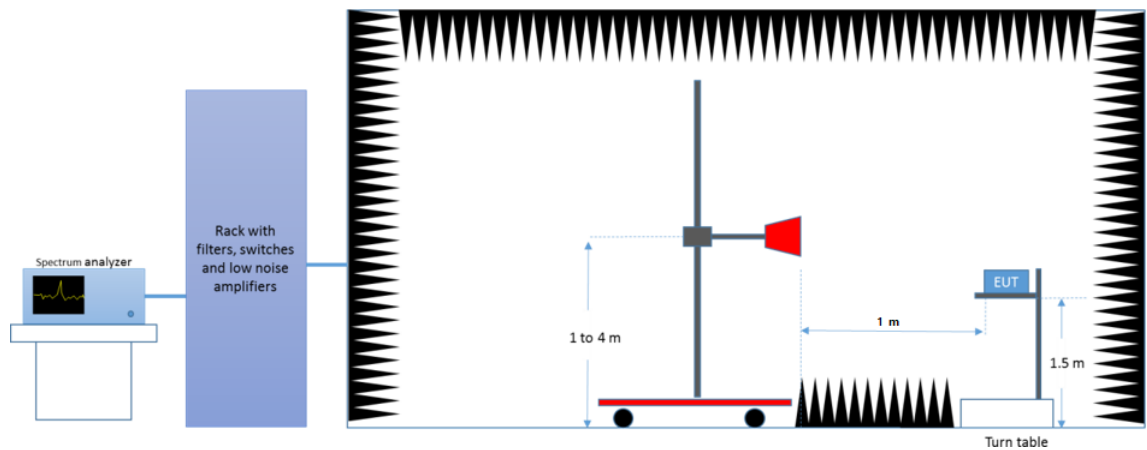
3) Radiated Setup (30 MHz ~ 1 GHz)



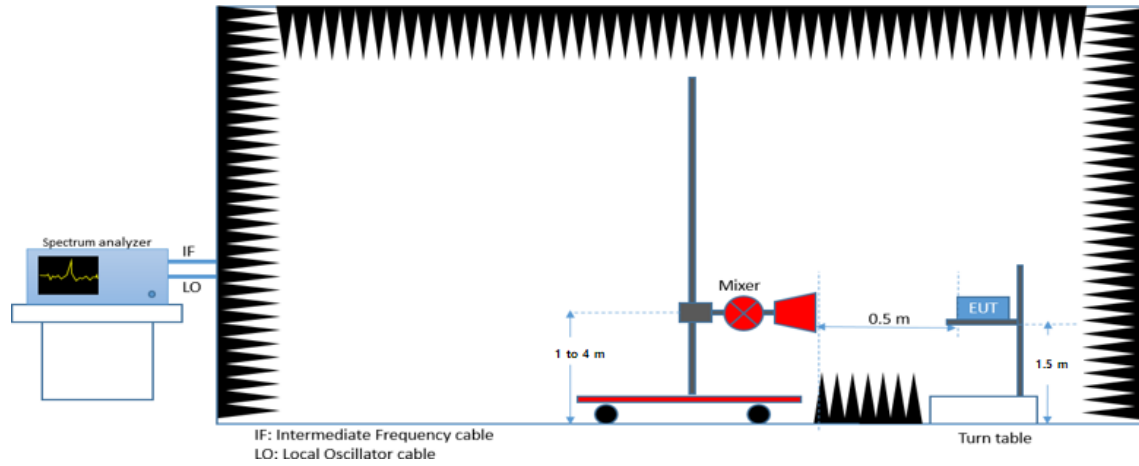
4) Radiated Setup (1 GHz ~ 18 GHz)



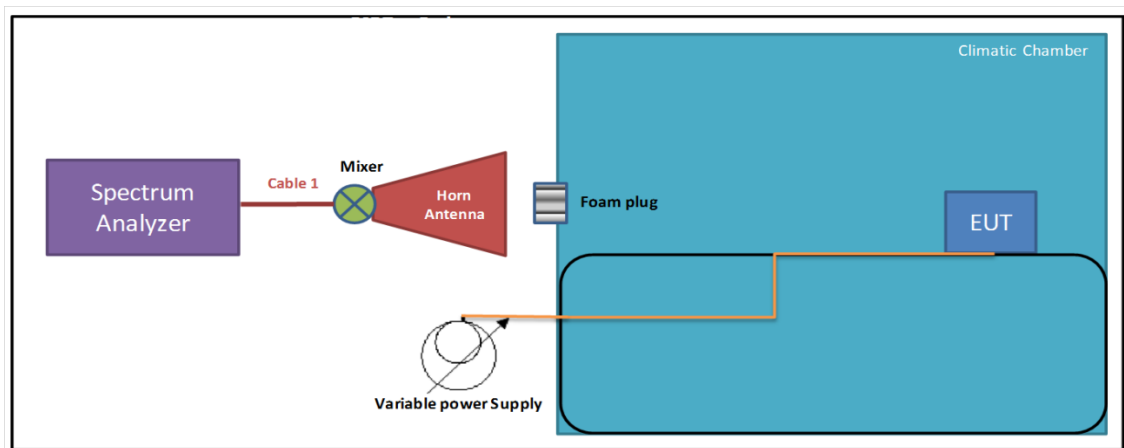
5) Radiated Setup (18 GHz ~ 40 GHz)



6) Radiated Setup (40 GHz ~ 200 GHz)



7) Frequency Stability Measurement Setup (57 – 71 GHz)



6. Test Results

6.1 Emission Bandwidth

6.1.1 Operating environment

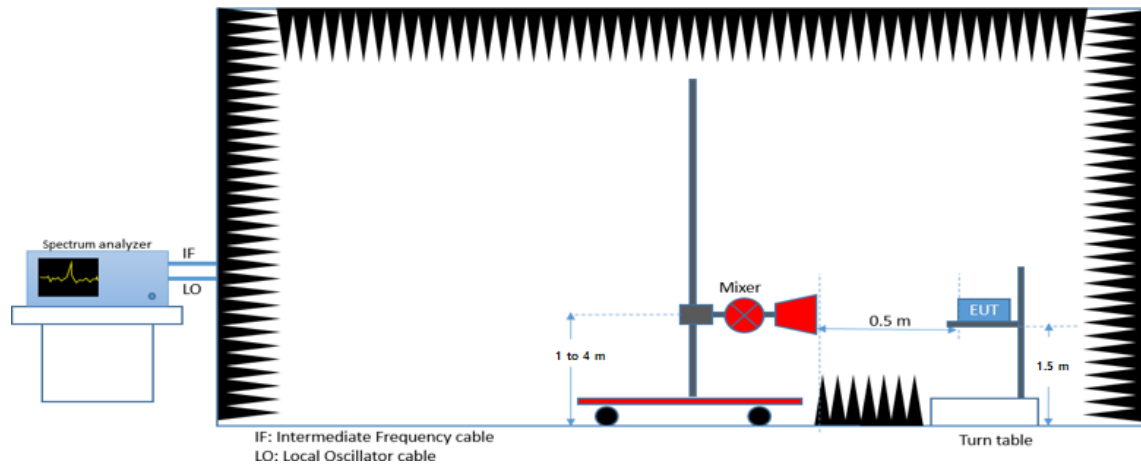
Temperature : 23 °C
 Relative humidity : 41 % R.H.

6.1.2 Test Date

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6.1.3 Test Procedure

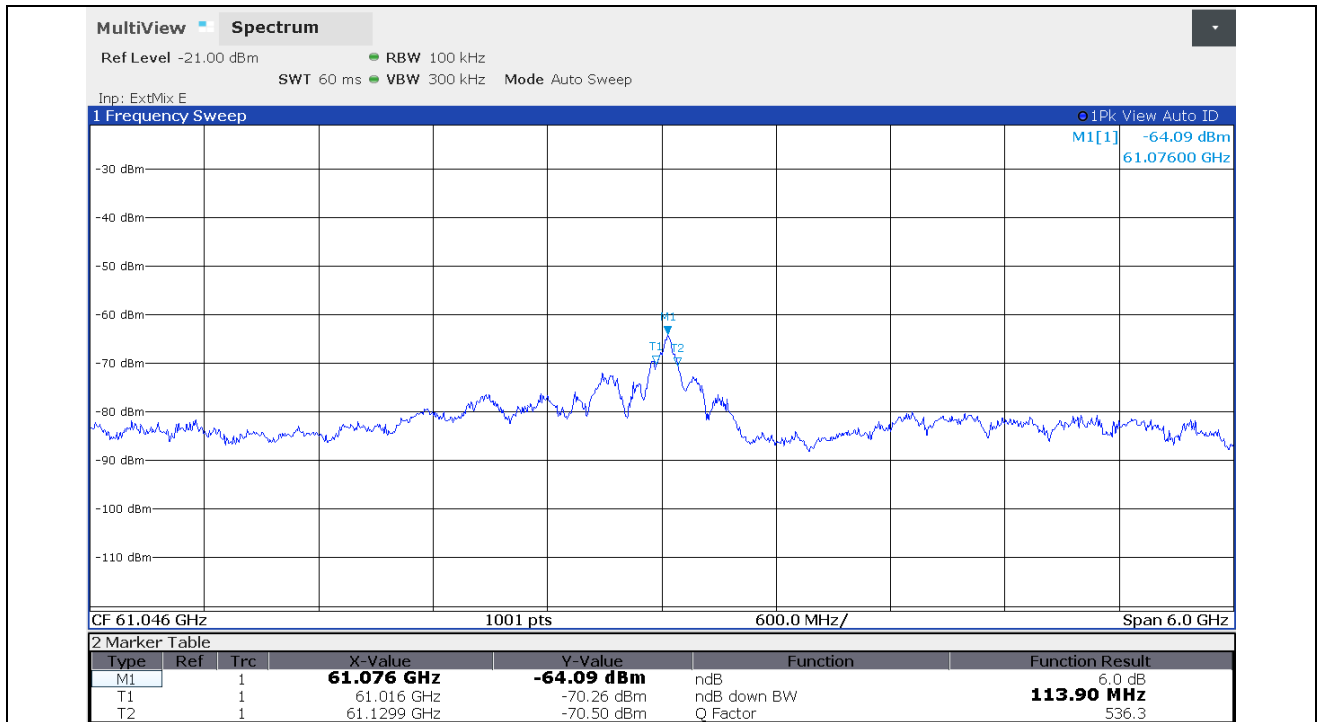
The setup below was used to measure the 6dB & 99% Bandwidth.



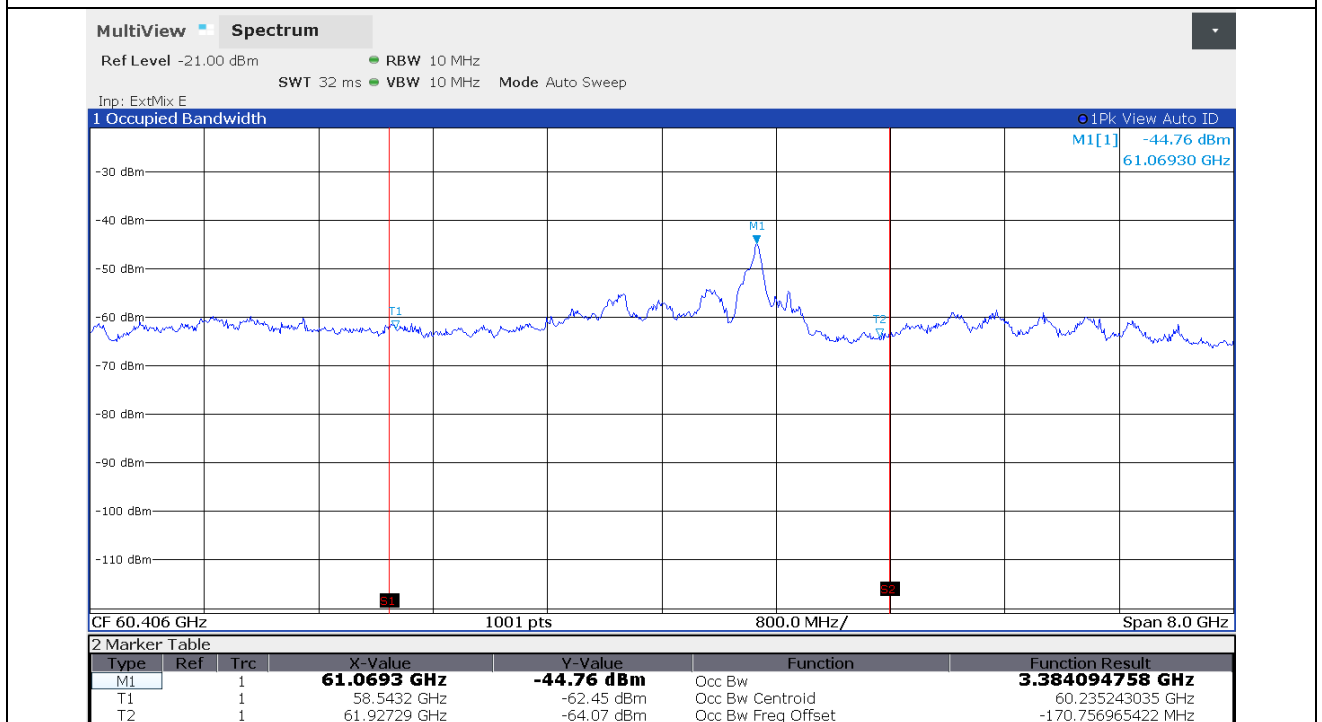
6.1.4 Test data Result

-. Test Result : Pass

| | | |
|-----------------------|----------------------|---------------------|
| Operating Freq. (GHz) | 6 dB Bandwidth (MHz) | 99% Bandwidth (GHz) |
| 57 ~ 64 | 113.90 | 3.384 |



20 dB Bandwidth



99% Bandwidth

6.2 Peak and Average EIRP Output Power

6.2.1 Operating environment

Temperature : 23 °C
 Relative humidity : 41 % R.H.

6.2.2 Test Date

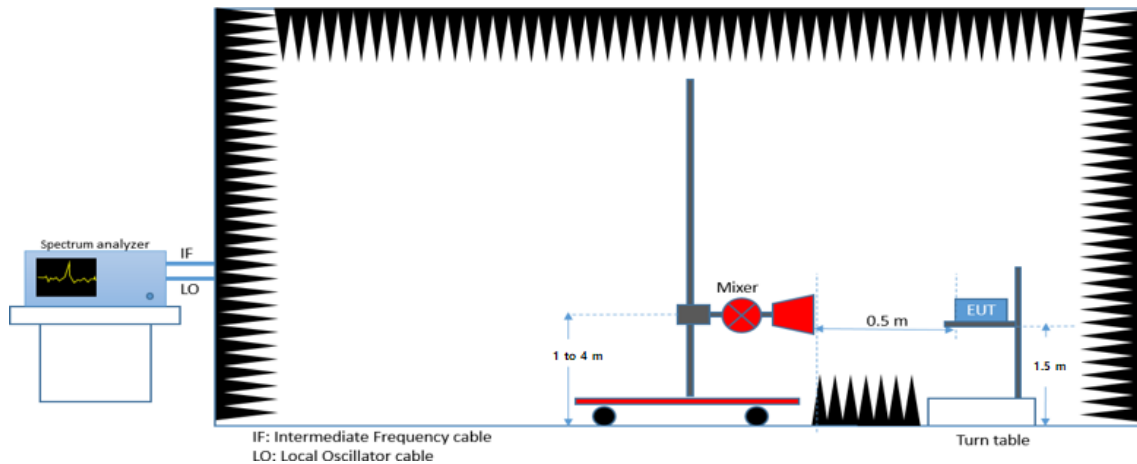
September 18, 2020 ~ September 29, 2020

6.2.3 Test Limits

| FCC part | Limits |
|-------------------|--|
| 15.255 (c) (1)(i) | The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm |

6.2.4 Test Procedure

For radiated measurements, connect the test antenna for the fundamental frequency band to a spectrum analyzer via an external mixer, or directly to the spectrum analyzer if the instrument supports the required frequency range.



According to ANSI C63.10-2013, Clause 9, the measurement should be performed at a distance greater than or equal to the far field boundary distance. This later is given by

$$R_{(Far\ Field)} = \frac{2L^2}{\lambda}$$

Where

L is the largest dimension of the transmit antenna in m

λ is the wavelength in m

| Far field boundary calculation | | | |
|--------------------------------|------------------------------|-------|-----------------|
| Frequency (GHz) | Wavelength (λ) (m) | L (m) | R far field (m) |
| 60.235 | 0.0049 | 0.004 | 0.006 |

Our measurement is performed at a minimum distance of 0.5 m > R far field

Perform radiated emission measurements to keep maximize the received signal from the EUT in the far field.

Using substitution measurement. Measured and note the power.

6.2.5 Test data Result

-. Test Result : Pass

| Peak EIRP Output Power | | | | |
|------------------------|-------------------|-------|-------|--------|
| Measure Level | Correction Factor | EIRP | Limit | Margin |
| (dBm) | (dB) | (dBm) | (dBm) | (dB) |
| -32.25 | 37.51 | 5.26 | 43.00 | 37.74 |

Remark:

1. The EIRP was evaluated on vertical and horizontal polarization, the worst case is Vertical polarization.
2. Correction Factor = Mixer Conversion Loss + Cable Loss + Air Loss – LNA Amp Gain

| Average EIRP Output Power | | | | |
|---------------------------|-------------------|-------|-------|--------|
| Measure Level | Correction Factor | EIRP | Limit | Margin |
| (dBm) | (dB) | (dBm) | (dBm) | (dB) |
| -42.19 | 37.94 | -4.25 | 40.00 | 44.25 |

Remark:

1. The EIRP was evaluated on vertical and horizontal polarization, the worst case is Vertical polarization.
2. Correction Factor = Mixer Conversion Loss + Cable Loss + Air Loss + Duty Correction Factor – LNA Amp Gain

6.3 Conducted Peak Output Power

6.3.1 Operating environment

Temperature : 23 °C
 Relative humidity : 41 % R.H.

6.3.2 Test Date

September 18, 2020 ~ September 29, 2020

6.3.3 Test Limits

| FCC part | Limits |
|------------|--|
| 15.255 (e) | The peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (b) of this section. |

6.3.4 Test Procedure

The peak output power in dBm is calculated by subtracting the DUT gain in dBi from the Peak EIRP in dBm found in section 6.2.

6.3.5 Test data Result

-. Test Result : Pass

| Peak Output Power | | | | | |
|-------------------|------------------|--------------|--------------|-------|--------|
| Peak EIRP | EUT Antenna Gain | Output Power | Output Power | Limit | Margin |
| (dBm) | (dBi) | (dBm) | (mW) | (mW) | (mW) |
| 5.26 | 5.30 | -0.04 | 0.99 | 500 | 499.01 |

Remark:

1. Output Power = EIRP – EUT Antenna Gain

6.4 Spurious Emissions

6.4.1 Operating environment

Temperature : 23 °C
 Relative humidity : 41 % R.H.

6.4.2 Test Date

September 18, 2020 ~ September 29, 2020

6.4.3 Test Limits

| FCC part | Limits | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------|--|-------------------------------|-----------------------------------|-------------------------------|-------------|-------------|-----|-------------|--------------|----|------------|----|----|-------|-----|---|--------|-----|---|---------|-----|---|-----------|-----|---|
| 15.255 (d) (1) (2) (3) (4) | (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/cm ² at a distance of 3 meters. (4) The levels of the spurious emissions shall not exceed the level of the fundamental emission. | | | | | | | | | | | | | | | | | | | | | | | | |
| 15.209 | Emissions radiated outside of the specified bands, shall be according to the general radiated limits in 15.209 as following: <table border="1" data-bbox="488 1209 1469 1536"> <thead> <tr> <th>Frequencies (MHz)</th> <th>Field strength (microvolts/meter)</th> <th>Measurement distance (meters)</th> </tr> </thead> <tbody> <tr> <td>0.009-0.490</td> <td>2400/F(kHz)</td> <td>300</td> </tr> <tr> <td>0.490-1.705</td> <td>24000/F(kHz)</td> <td>30</td> </tr> <tr> <td>1.705-30.0</td> <td>30</td> <td>30</td> </tr> <tr> <td>30-88</td> <td>100</td> <td>3</td> </tr> <tr> <td>88-216</td> <td>150</td> <td>3</td> </tr> <tr> <td>216-960</td> <td>200</td> <td>3</td> </tr> <tr> <td>Above 960</td> <td>500</td> <td>3</td> </tr> </tbody> </table> 1. The lower limit shall apply at the transition frequencies. 2. Emission level (dBuV/m) = 20 log Emission level (uV/m). 3. For average radiated emission measurements above 1000 MHz, there is also a limit specified when measuring with peak detector function, corresponding to 20 dB above the indicated values in the 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 |
| 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 | | | | | | | | | | | | | | | | | | | | | | | |

6.4.4 Test Procedure

For Radiated emission below 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3meterchamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3meters 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.

For Radiated emission 30MHzto 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 3meter 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(30MHz-18GHz) / 1 meters (18GHz-40GHz) 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 detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

- Note: 1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and Average detection (AV) at frequency above 1GHz.

For Radiated emission above 40GHz

- a. Connect the test antenna covering the appropriate frequency range to a spectrum analyzer via an external mixer to the spectrum analyzer.
- b. Set spectrum analyzer RBW = 1 MHz, VBW = 3 MHz, average detector.
- c. Calculate the distance to the far field boundary and determine the maximum measurement distance.
- d. Perform an exploratory search for emissions and determine the approximate direction at which each observed emission emanates from the EUT.
- e. Exploratory measurements be made at a closer distance than the validated maximum measurement distance.
- f. Perform a final measurement; begin with the test antenna at the approximate position where the maximum level occurred during the exploratory scan.
- g. Slowly scan the test antenna around this position, slowly vary the test antenna polarization by rotating through at least 0° to 180°, and slowly vary the orientation of the test antenna to find the final position, polarization, and orientation at which the maximum level of the emission is observed.
- h. Record the measured reading with the test antenna fixed at this maximized position, polarization, and orientation. Record the measurement distance.
- i. Calculate the maximum field strength of the emission at the measurement distance and the adjusted/corrected power at the output of the test antenna.
- j. Calculate the EIRP from the measured field strength and then convert to the linear.
- k. Calculate the power density at the distance specified by the limit from the field strength at the distance specified by the limit.

Power density formula as follows: $\text{Power density} = \text{EIRP} / (4 * \text{Pi} * r^2)$

r is the standard distance at 3 meter

- l. Repeat the preceding sequence for every emission observed in the frequency band under investigation.

6.4.5 Test data Result

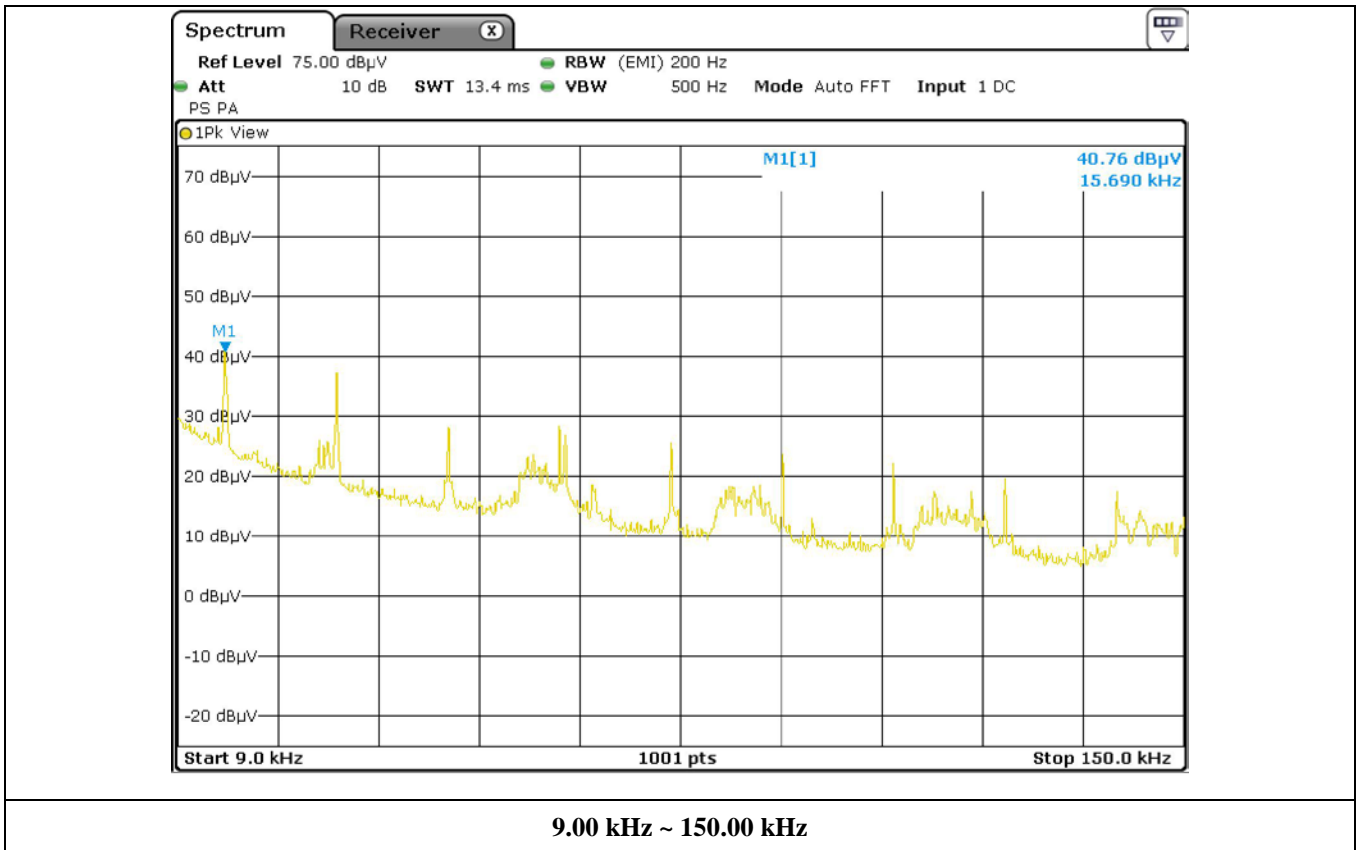
6.4.5.1 Spurious Radiated Emission Below 30 MHz

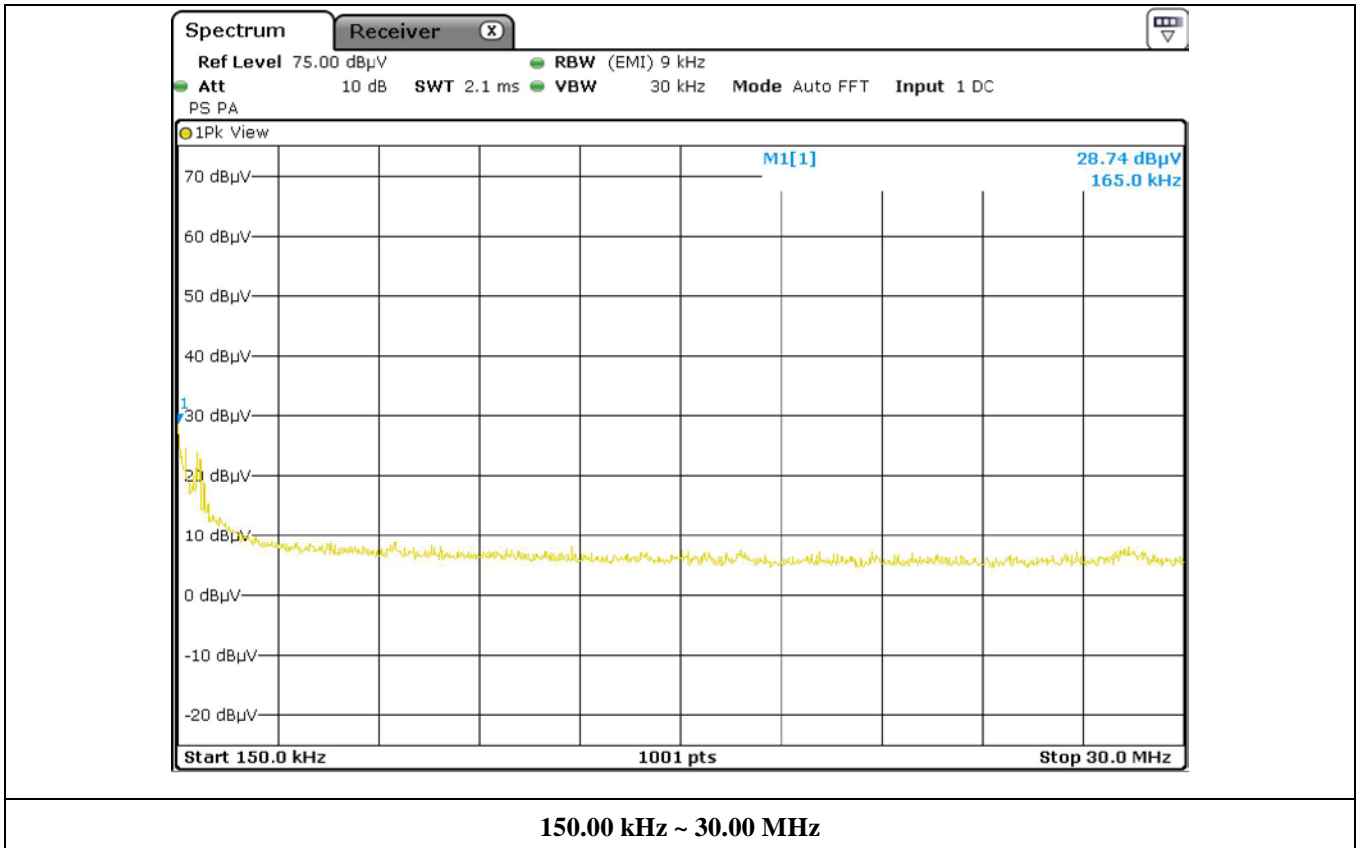
-. Test Result : Pass

| Radiated Emission | | Ant | Correction Factors | | Total | FCC | |
|-------------------|-----------------|------|--------------------|------------|--------------------|----------------|-------------|
| Freq. (kHz) | Amplitud (dBμV) | Pol. | Antenna (dB/m) | Cable (dB) | Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| 15.69 | 40.76 | H | 18.63 | 0.3 | 59.69 | 123.69 | 64.00 |
| 165.00 | 28.74 | H | 18.97 | 0.3 | 48.01 | 103.25 | 55.24 |

Limit calculation: Limit at specified distance + 40log (300/3) = Limit + 80 dB for up to 0.49 MHz

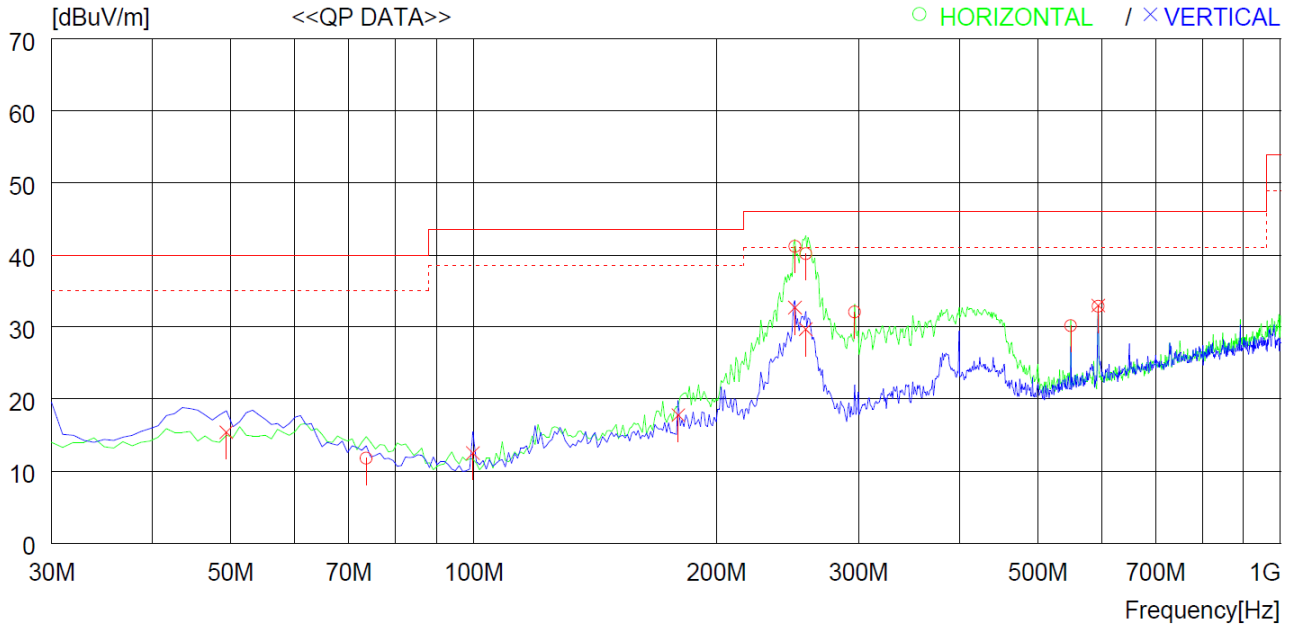
Limit at specified distance + 40log (30/3) = Limit + 40 dB for above 0.49 MHz





6.4.5.2 Spurious Radiated Emission below 1 GHz

- Test Result : Pass



| No. | FREQ [MHz] | READING QP [dBuV] | ANT FACTOR [dB] | LOSS [dB] | GAIN [dB] | RESULT [dBuV/m] | LIMIT [dBuV/m] | MARGIN [dB] | ANTENNA [cm] | TABLE [DEG] |
|------------------------|---------------|-------------------------|-----------------------|--------------|--------------|--------------------|-------------------|----------------|-----------------|----------------|
| ----- Horizontal ----- | | | | | | | | | | |
| 1 | 73.650 | 26.2 | 16.8 | 1.4 | 32.6 | 11.8 | 40.0 | 28.2 | 200 | 306 |
| 2 | 250.190 | 53.3 | 17.6 | 2.7 | 32.4 | 41.2 | 46.0 | 4.8 | 200 | 359 |
| 3 | 257.950 | 52.0 | 17.8 | 2.8 | 32.4 | 40.2 | 46.0 | 5.8 | 100 | 0 |
| 4 | 296.750 | 42.3 | 19.2 | 3.0 | 32.4 | 32.1 | 46.0 | 13.9 | 100 | 0 |
| 5 | 549.919 | 33.9 | 24.6 | 4.0 | 32.3 | 30.2 | 46.0 | 15.8 | 200 | 154 |
| 6 | 594.538 | 35.7 | 25.5 | 4.2 | 32.5 | 32.9 | 46.0 | 13.1 | 300 | 0 |
| ----- Vertical ----- | | | | | | | | | | |
| 7 | 49.400 | 27.3 | 19.7 | 1.1 | 32.7 | 15.4 | 40.0 | 24.6 | 100 | 239 |
| 8 | 99.840 | 28.9 | 14.5 | 1.7 | 32.6 | 12.5 | 43.5 | 31.0 | 100 | 319 |
| 9 | 179.380 | 30.4 | 17.7 | 2.3 | 32.6 | 17.8 | 43.5 | 25.7 | 100 | 300 |
| 10 | 250.190 | 44.8 | 17.6 | 2.7 | 32.4 | 32.7 | 46.0 | 13.3 | 200 | 287 |
| 11 | 257.950 | 41.5 | 17.8 | 2.8 | 32.4 | 29.7 | 46.0 | 16.3 | 200 | 278 |
| 12 | 594.538 | 35.8 | 25.5 | 4.2 | 32.5 | 33.0 | 46.0 | 13.0 | 100 | 359 |

6.4.5.3 Spurious Radiated Emission 1 GHz ~ 18 GHz

-. Test Result : Pass

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | AMP Factor | Duty Correction Factor | Cable Loss | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|-----------------|----------------|---------------|-----------------|-------------|------------|------------------------|------------|----------------|-----------------|-------------|
| 1.050 | 48.80 | Peak | H | 24.60 | 32.89 | - | 10.81 | 51.32 | 74.00 | 22.68 |
| | 35.66 | Average | H | 24.60 | 32.89 | 0.43 | 10.81 | 38.61 | 54.00 | 15.39 |
| 1.670 | 44.70 | Peak | H | 25.10 | 32.89 | - | 10.83 | 47.74 | 74.00 | 26.26 |
| | 34.62 | Average | H | 25.10 | 32.89 | 0.43 | 10.81 | 38.07 | 54.00 | 15.93 |
| 2.289 | 44.42 | Peak | H | 28.70 | 32.94 | - | 10.82 | 51.00 | 74.00 | 23.00 |
| | 26.07 | Average | H | 28.70 | 32.94 | 0.43 | 10.82 | 33.08 | 54.00 | 20.92 |
| 3.577 | 35.22 | Peak | H | 28.80 | 34.73 | - | 11.86 | 41.15 | 74.00 | 32.85 |
| | 24.88 | Average | H | 28.80 | 34.73 | 0.43 | 11.86 | 31.24 | 54.00 | 22.76 |
| 14.096 | 29.50 | Peak | H | 41.90 | 32.20 | - | 11.86 | 51.06 | 74.00 | 22.94 |
| | 20.57 | Average | H | 41.90 | 32.20 | 0.43 | 11.86 | 42.56 | 54.00 | 11.44 |

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | AMP Factor | Duty Correction Factor | Cable Loss | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|-----------------|----------------|---------------|-----------------|-------------|------------|------------------------|------------|----------------|-----------------|-------------|
| 2.157 | 45.74 | Peak | V | 27.10 | 32.94 | - | 10.81 | 50.71 | 74.00 | 23.29 |
| | 30.73 | Average | V | 27.10 | 32.94 | 0.43 | 10.81 | 36.13 | 54.00 | 17.87 |
| 2.197 | 45.46 | Peak | V | 27.90 | 32.94 | - | 10.83 | 51.25 | 74.00 | 22.75 |
| | 31.81 | Average | V | 27.90 | 32.94 | 0.43 | 10.81 | 38.01 | 54.00 | 15.99 |
| 2.501 | 42.63 | Peak | V | 27.50 | 33.13 | - | 10.82 | 47.82 | 74.00 | 26.18 |
| | 35.70 | Average | V | 27.50 | 33.13 | 0.43 | 10.82 | 41.32 | 54.00 | 12.68 |
| 3.367 | 34.95 | Peak | V | 28.20 | 34.23 | - | 10.82 | 39.74 | 74.00 | 34.26 |
| | 24.96 | Average | V | 28.20 | 34.23 | 0.43 | 10.82 | 30.18 | 54.00 | 23.82 |
| 10.830 | 30.45 | Peak | V | 39.80 | 32.06 | - | 10.86 | 49.05 | 74.00 | 24.95 |
| | 20.44 | Average | V | 39.80 | 32.06 | 0.43 | 10.86 | 39.47 | 54.00 | 14.53 |

Remark - "H": Horizontal, "V": Vertical

Emission Level (dBμV/m) = Reading (dBμV) + Antenna Factor (dB/m) + Cable loss (dB) – AMP Factor (dB)

Margin (dB) = Limits (dBμV/m) - Emission Level (dBμV/m)

6.4.5.4 Spurious Radiated Emission 18 GHz ~ 40 GHz

-. Test Result : Pass

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | AMP Factor | Distance Factor | Duty Correction Factor | Cable Loss | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|-----------------|----------------|---------------|-----------------|-------------|------------|-----------------|------------------------|------------|----------------|-----------------|-------------|
| 18.904 | 60.42 | Peak | V | 37.80 | 54.90 | 9.54 | - | 13.48 | 47.26 | 74.00 | 26.74 |
| | 48.68 | Average | V | 37.80 | 54.90 | 9.54 | 0.43 | 13.48 | 35.95 | 54.00 | 18.05 |
| 23.993 | 55.28 | Peak | V | 39.40 | 50.50 | 9.54 | - | 18.21 | 52.85 | 74.00 | 21.15 |
| | 42.47 | Average | V | 39.40 | 50.50 | 9.54 | 0.43 | 18.21 | 40.47 | 54.00 | 13.53 |
| 35.136 | 57.78 | Peak | V | 41.20 | 55.00 | 9.54 | - | 21.31 | 55.75 | 74.00 | 18.25 |
| | 48.10 | Average | V | 41.20 | 55.00 | 9.54 | 0.43 | 21.31 | 46.50 | 54.00 | 7.50 |
| 39.786 | 54.68 | Peak | V | 43.00 | 53.70 | 9.54 | - | 22.35 | 56.79 | 74.00 | 17.21 |
| | 45.60 | Average | V | 43.00 | 53.70 | 9.54 | 0.43 | 22.35 | 48.14 | 54.00 | 5.86 |

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | AMP Factor | Distance Factor | Duty Correction Factor | Cable Loss | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|-----------------|----------------|---------------|-----------------|-------------|------------|-----------------|------------------------|------------|----------------|-----------------|-------------|
| 18.041 | 60.17 | Peak | H | 37.60 | 55.10 | 9.54 | - | 13.48 | 46.61 | 74.00 | 27.39 |
| | 48.55 | Average | H | 37.60 | 55.10 | 9.54 | 0.43 | 13.48 | 35.42 | 54.00 | 18.58 |
| 23.444 | 55.99 | Peak | H | 39.20 | 52.40 | 9.54 | - | 18.21 | 51.46 | 74.00 | 22.54 |
| | 43.98 | Average | H | 39.20 | 52.40 | 9.54 | 0.43 | 18.21 | 39.88 | 54.00 | 14.12 |
| 35.175 | 59.20 | Peak | H | 41.20 | 55.00 | 9.54 | - | 21.31 | 57.17 | 74.00 | 16.83 |
| | 47.96 | Average | H | 41.20 | 55.00 | 9.54 | 0.43 | 21.31 | 46.36 | 54.00 | 7.64 |
| 39.890 | 57.45 | Peak | H | 43.10 | 54.10 | 9.54 | - | 22.35 | 59.26 | 74.00 | 14.74 |
| | 46.84 | Average | H | 43.10 | 54.10 | 9.54 | 0.43 | 22.35 | 49.08 | 54.00 | 4.92 |

Remark - "H": Horizontal, "V": Vertical

Emission Level (dBμV/m) = Reading (dBμV) + Antenna Factor (dB/m) + Cable loss (dB) – AMP Factor (dB) – Distance Factor(dB)

Margin (dB) = Limits (dBμV/m) - Emission Level (dBμV/m)

Note : Shorter measurement distances was used to improve the measurement system’s noise floor. As standard description is based on the measurement in distance of 3 meters, the data obtained at 1-meterdistance was extrapolate results to the 3-mdistance:

Test value at 3 meter distance (dBuV) = Test value at 1 meter distance (dBuV) - 20log(3/1)(dB)

= Test value at 1 meter distance (dBuV) - 9.54 (dB).

6.4.5.5 Spurious Radiated Emission 40 GHz ~ 200 GHz

-. Test Result : Pass

| Frequency (GHz) | EIRP Level (dBm) | Result (pW/cm ²) | Limit (pW/cm ²) | Margin (pW/cm ²) |
|--------------------|---------------------|---------------------------------|--------------------------------|---------------------------------|
| 49.261 | -40.64 | 0.076 3 | 90.00 | 89.923 7 |
| 77.203 | -39.44 | 0.100 6 | 90.00 | 89.899 4 |

No other spurious identified up to 200 GHz with level above the value reported in the table.

6.5 FREQUENCY STABILITY

6.5.1 Operating environment

Temperature : 23 °C
 Relative humidity : 41 % R.H.

6.5.2 Test Date

September 18, 2020 ~ September 29, 2020

6.5.3 Test Limits

| FCC part | Limits |
|------------|--|
| 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. |

6.5.4 Test Procedure

1. These measurements are repeated for each step of temperature variation from (-20 to 50 °C) at the nominal voltage.
2. These measurements are repeated for an input voltage variation of 85% to 110% at the reference temperature
3. The frequency excursion is recorded by checking at each time if the 20 dB bandwidth of the fundamental emission is contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage.

6.5.5 FREQUENCY STABILITY WITH TEMPERATURE VARIATION

-. Test Result : Pass

| Power Supply (Vdc) | Temperature (°C) | Min Frequency(GHz) | Limit (GHz) |
|--------------------|------------------|--------------------|-------------|
| 3.30 | -20 | 58.542 870 | > 57 |
| 3.30 | -10 | 58.542 995 | > 57 |
| 3.30 | 0 | 58.542 887 | > 57 |
| 3.30 | 10 | 58.543 005 | > 57 |
| 3.30 | 20 | 58.543 200 | > 57 |
| 3.30 | 30 | 58.538 511 | > 57 |
| 3.30 | 40 | 58.533 455 | > 57 |
| 3.30 | 50 | 58.526 780 | > 57 |

| Power Supply (Vdc) | Temperature (°C) | Max Frequency(GHz) | Limit (GHz) |
|--------------------|------------------|--------------------|-------------|
| 3.30 | -20 | 61.914 150 | < 71 |
| 3.30 | -10 | 61.914 633 | < 71 |
| 3.30 | 0 | 61.914 765 | < 71 |
| 3.30 | 10 | 61.920 511 | < 71 |
| 3.30 | 20 | 61.927 290 | < 71 |
| 3.30 | 30 | 61.931 511 | < 71 |
| 3.30 | 40 | 61.939 618 | < 71 |
| 3.30 | 50 | 61.953 430 | < 71 |

6.5.6 FREQUENCY STABILITY WITH VOLTAGE VARIATION

-. Test Result : Pass

| Power Supply (Vdc) | Temperature (°C) | Min Frequency(GHz) | Limit (GHz) |
|--------------------|------------------|--------------------|-------------|
| 3.300 | 20 | 58.543 200 | > 57 |
| 2.805 | 20 | 58.543 316 | > 57 |
| 3.795 | 20 | 58.543 611 | > 57 |

| Power Supply (Vdc) | Temperature (°C) | Max Frequency(GHz) | Limit (GHz) |
|--------------------|------------------|--------------------|-------------|
| 3.300 | 20 | 61.927 290 | < 71 |
| 2.805 | 20 | 61.930 011 | < 71 |
| 3.795 | 20 | 61.929 568 | < 71 |

6.6 CONDUCTED EMISSION TEST

6.6.1 Operating environment

Temperature : 23 °C
Relative humidity : 41 % R.H.

6.6.2 Test set-up

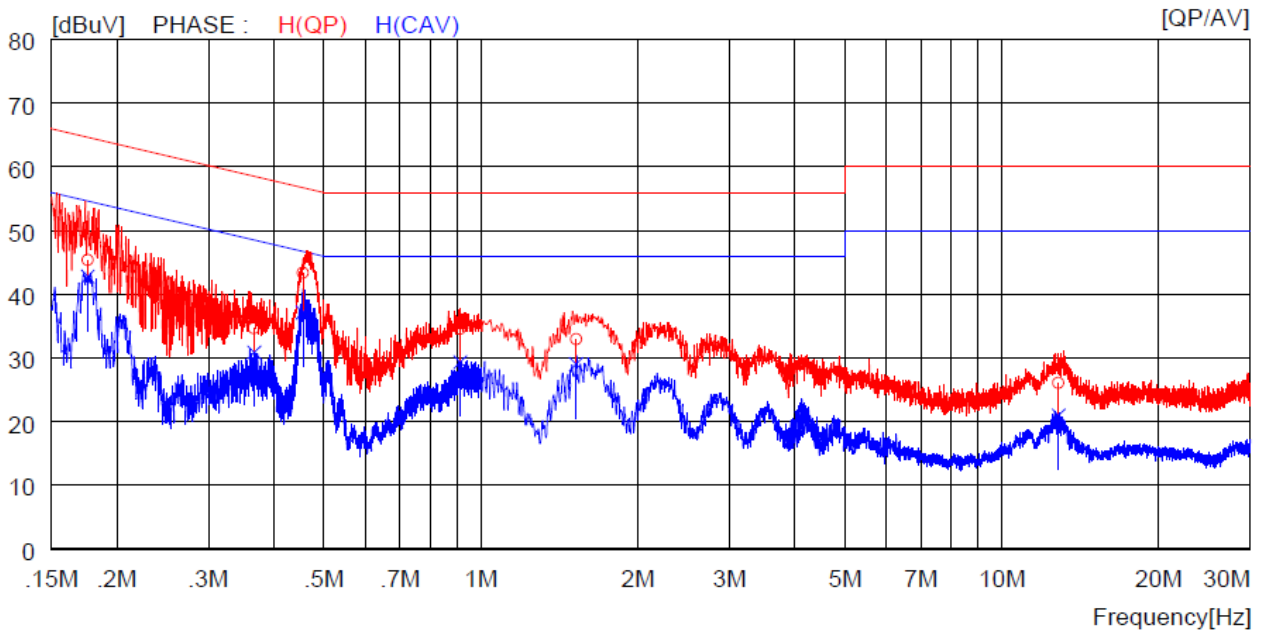
The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

6.6.3 Test Date

September 18, 2020 ~ September 29, 2020

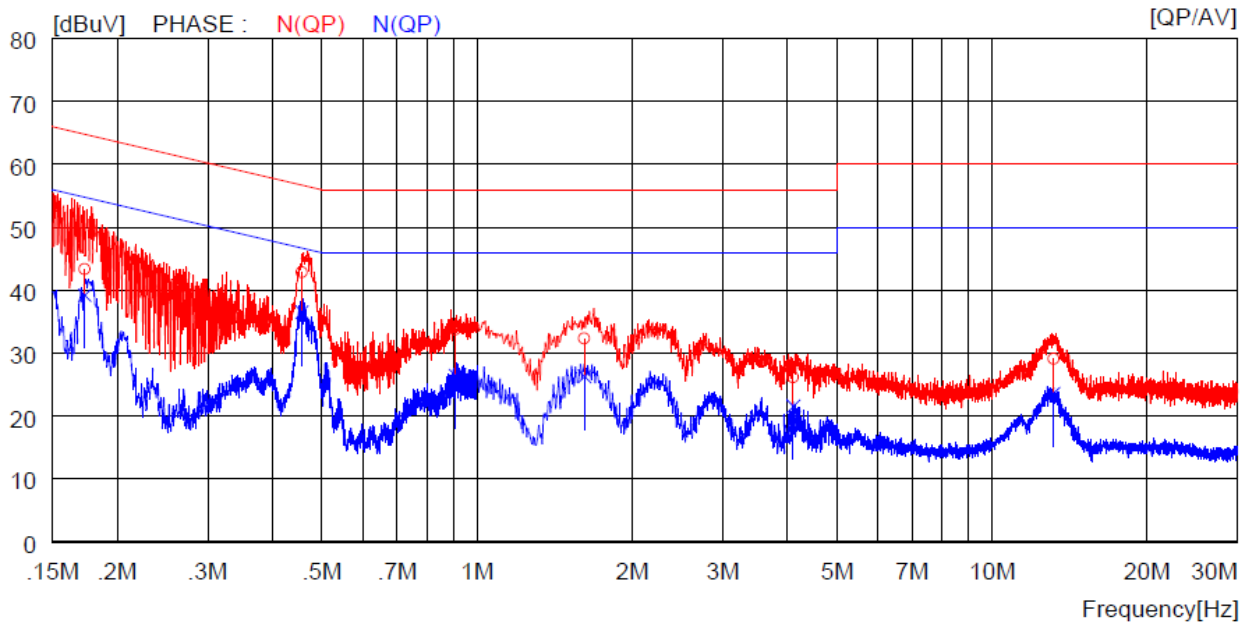
6.6.4 Test data

- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



| NO | FREQ [MHz] | READING | | C. FACTOR [dB] | RESULT | | LIMIT | | MARGIN | | PHASE |
|----|---------------|--------------|--------------|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------|
| | | QP [dBuV] | AV [dBuV] | | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | |
| 1 | 0.17600 | 35.4 | ---- | 10.0 | 45.4 | ---- | 64.7 | ---- | 19.3 | ---- | H (QP) |
| 2 | 0.36700 | 24.7 | ---- | 9.9 | 34.6 | ---- | 58.6 | ---- | 24.0 | ---- | H (QP) |
| 3 | 0.45500 | 33.4 | ---- | 9.9 | 43.3 | ---- | 56.8 | ---- | 13.5 | ---- | H (QP) |
| 4 | 0.91300 | 24.5 | ---- | 10.0 | 34.5 | ---- | 56.0 | ---- | 21.5 | ---- | H (QP) |
| 5 | 1.52400 | 22.8 | ---- | 10.1 | 32.9 | ---- | 56.0 | ---- | 23.1 | ---- | H (QP) |
| 6 | 12.86000 | 15.9 | ---- | 10.2 | 26.1 | ---- | 60.0 | ---- | 33.9 | ---- | H (QP) |
| 7 | 0.17600 | ---- | 32.8 | 10.0 | ---- | 42.8 | ---- | 54.7 | ---- | 11.9 | H (CAV) |
| 8 | 0.36700 | ---- | 21.0 | 9.9 | ---- | 30.9 | ---- | 48.6 | ---- | 17.7 | H (CAV) |
| 9 | 0.45500 | ---- | 27.2 | 9.9 | ---- | 37.1 | ---- | 46.8 | ---- | 9.7 | H (CAV) |
| 10 | 0.91300 | ---- | 19.4 | 10.0 | ---- | 29.4 | ---- | 46.0 | ---- | 16.6 | H (CAV) |
| 11 | 1.52400 | ---- | 18.9 | 10.1 | ---- | 29.0 | ---- | 46.0 | ---- | 17.0 | H (CAV) |
| 12 | 12.86000 | ---- | 10.8 | 10.2 | ---- | 21.0 | ---- | 50.0 | ---- | 29.0 | H (CAV) |

- Test Line : NEUTRAL LINE



| NO | FREQ [MHz] | READING | | C. FACTOR [dB] | RESULT | | LIMIT | | MARGIN | | PHASE |
|----|---------------|--------------|--------------|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------|
| | | QP [dBuV] | AV [dBuV] | | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | |
| 1 | 0.17300 | 33.3 | ---- | 10.0 | 43.3 | ---- | 64.8 | ---- | 21.5 | ---- | N (QP) |
| 2 | 0.45700 | 32.9 | ---- | 9.9 | 42.8 | ---- | 56.7 | ---- | 13.9 | ---- | N (QP) |
| 3 | 0.90800 | 23.7 | ---- | 10.0 | 33.7 | ---- | 56.0 | ---- | 22.3 | ---- | N (QP) |
| 4 | 1.61600 | 22.2 | ---- | 10.1 | 32.3 | ---- | 56.0 | ---- | 23.7 | ---- | N (QP) |
| 5 | 4.11200 | 16.1 | ---- | 10.1 | 26.2 | ---- | 56.0 | ---- | 29.8 | ---- | N (QP) |
| 6 | 13.17000 | 18.9 | ---- | 10.2 | 29.1 | ---- | 60.0 | ---- | 30.9 | ---- | N (QP) |
| 7 | 0.17300 | ---- | 29.2 | 10.0 | ---- | 39.2 | ---- | 54.8 | ---- | 15.6 | N (CAV) |
| 8 | 0.45700 | ---- | 26.6 | 9.9 | ---- | 36.5 | ---- | 46.7 | ---- | 10.2 | N (CAV) |
| 9 | 0.90800 | ---- | 16.4 | 10.0 | ---- | 26.4 | ---- | 46.0 | ---- | 19.6 | N (CAV) |
| 10 | 1.61600 | ---- | 16.2 | 10.1 | ---- | 26.3 | ---- | 46.0 | ---- | 19.7 | N (CAV) |
| 11 | 4.11200 | ---- | 11.5 | 10.1 | ---- | 21.6 | ---- | 46.0 | ---- | 24.4 | N (CAV) |
| 12 | 13.17000 | ---- | 13.4 | 10.2 | ---- | 23.6 | ---- | 50.0 | ---- | 26.4 | N (CAV) |

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

7. LIST OF TEST EQUIPMENT

| Model Number | Manufacturer | Description | Serial Number | Last Cal.(Interval) |
|---------------|-------------------|-------------------------------|---------------------------|---------------------|
| ESR | R/S | Test receiver | 101470 | Oct. 20, 2020(1Y) |
| FSW43 | R/S | Spectrum analyzer | 104544 | Jul. 15, 2020(1Y) |
| CO3000 | Innco System | Controller | CO3000/904/ 37211215/L | N/A |
| DT3000 | Innco System | Turn Table | 930611 | N/A |
| MA-4000XPET | Innco System | Antenna Master | MA4000/509 | N/A |
| 310N | Sonoma Instrument | Amplifier | 312544 | Mar. 16, 2020(1Y) |
| VULB9163 | Schwarzbeck | TRILOG Broadband Antenna | 9163-255 | Sep. 24, 2019(2Y) |
| FMZB 1513 | Schwarzbeck | Loop Antenna | 1513-235 | Mar. 24, 2020(2Y) |
| BBV 9718 B | Schwarzbeck | Broadband Preamplifier | 00009 | Mar. 16, 2020(1Y) |
| BBHA9120D | Schwarzbeck | Horn Antenna | BBHA9120D295 | Mar. 11, 2020(1Y) |
| SCU40A | R/S | Signal Conditioning unit | 100436 | Feb. 20, 2020(1Y) |
| BBHA9170 | Schwarzbeck | Horn Antenna | BBHA9170179 | Jan. 20, 2020(1Y) |
| M19HWD | OML, Inc. | Harmonic Mixer | 180912-1 | Jul. 26, 2020(1Y) |
| M12HWD | OML, Inc. | Harmonic Mixer | 180912-1 | Jul. 21, 2020(1Y) |
| M08HWD | OML, Inc. | Harmonic Mixer | 180912-1 | Jul. 24, 2020(1Y) |
| M05HWD | OML, Inc. | Harmonic Mixer | 180912-1 | Jul. 24, 2020(1Y) |
| S19MS-A | OML, Inc. | Millimeter Wave Source Module | 180912-1 | Jul. 21, 2020(1Y) |
| S12MS-A | OML, Inc. | Millimeter Wave Source Module | 180912-1 | Jul. 21, 2020(1Y) |
| S08MS-A | OML, Inc. | Millimeter Wave Source Module | 180912-1 | Jul. 22, 2020(1Y) |
| S05MS-A | OML, Inc. | Millimeter Wave Source Module | 180912-1 | Jul. 23, 2020(1Y) |
| PSL-2KP | ESPEC | Environmental Test Chamber | 14009407 | Feb. 21, 2020(1Y) |
| PWS-3003D | Protek | DC Power Supply | 4020409 | Jul. 15, 2020(1Y) |
| Test Receiver | Rohde & Schwarz | ESCI | 101012 | Oct. 19, 2020(1Y) |
| AMN(LISN) | Schwarzbeck | NSLK8128 | 8128-216 | Mar. 16, 2020(1Y) |
| AMN(LISN) | Schwarzbeck | NNLK 8121 | 8121-804 | Oct. 19, 2020(1Y) |
| Pulse Limiter | Rohde & Schwarz | ESH3Z2 | 100655 | Mar. 16, 2020(1Y) |