

# TEST REPORT

of

FCC Part 15 Subpart F §15.503 and §15.519  
IC RSS-220 Issue 1 and RSS-Gen Issue 5

FCC ID: TQ8-FOB-4F81U44  
IC Certification: 5074A-FOB4F81U44

Equipment Under Test : FOB Smart Key  
Model Name : FOB-4F81U44  
Variant Model Name(s) : Refer to the page 3  
Applicant : FCC: HYUNDAI MOBIS CO., LTD.  
IC: Hyundai MOBIS Co., Ltd  
Manufacturer : Hyundai Mobis Co., Ltd.  
Date of Receipt : 2023.01.04  
Date of Test(s) : 2023.01.06 ~ 2023.02.06  
Date of Issue : 2023.02.10

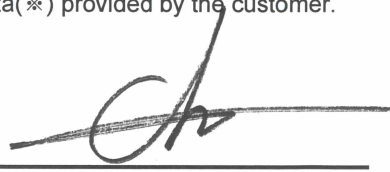
In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

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  - 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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- We are responsible for all the information of this test report except for the data(※) provided by the customer.

Tested by:

  
\_\_\_\_\_  
Teo Kim

Technical  
Manager:

  
\_\_\_\_\_  
Jinhyoung Cho

**SGS Korea Co., Ltd. Gunpo Laboratory**

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## 1. General Information

### 1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

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### 1.2. Details of Applicant

FCC Applicant : HYUNDAI MOBIS CO., LTD.

FCC Address : 203, Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977

IC Applicant : Hyundai MOBIS Co., Ltd

IC Address : 203, Teheran-ro, Gangnam-gu, Seoul, Korea (Republic Of), 135-977

Contact Person : Choe, Seung-hoon

Phone No. : +82 31 260 0098

### 1.3. Details of Manufacturer

Company : Same as Applicant

Address : Same as Applicant

### 1.4. Description of EUT

|                     |                                                                                                                     |
|---------------------|---------------------------------------------------------------------------------------------------------------------|
| Kind of Product     | FOB Smart Key                                                                                                       |
| Model Name          | FOB-4F81U44                                                                                                         |
| Variant Model Names | FOB-4F82U34, FOB-4F82U43, FOB-4F83U24, FOB-4F83U33, FOB-4F84U23, FOB-4F84U14, FOB-4F85U13, FOB-4F85U04, FOB-4F86U03 |
| Serial Number       | Conducted: 003<br>Radiated: 004                                                                                     |
| Power Supply        | DC 3.0 V                                                                                                            |
| Frequency Range     | Tx: 6 489.6 MHz, Rx: 6 489.6 MHz                                                                                    |
| Modulation Type     | BPM-BPSK                                                                                                            |
| Number of Channel   | 1                                                                                                                   |
| Antenna Type        | PCB Pattern Antenna                                                                                                 |
| Antenna Gain*       | 0.78 dB i                                                                                                           |
| H/W Version         | 1.00                                                                                                                |
| S/W Version         | 1.00                                                                                                                |

## 1.5. Test Equipment List

| Equipment                | Manufacturer                | Model                                | S/N                    | Cal. Date     | Cal. Interval | Cal. Due      |
|--------------------------|-----------------------------|--------------------------------------|------------------------|---------------|---------------|---------------|
| Signal Generator         | R&S                         | E8257D                               | MY51501169             | Mar. 04, 2022 | Annual        | Mar. 04, 2023 |
| Signal Generator         | R&S                         | SMBV100A                             | 255834                 | May 25, 2022  | Annual        | May 25, 2023  |
| Spectrum Analyzer        | R&S                         | FSV30                                | 100768                 | Dec. 07, 2022 | Annual        | Dec. 07, 2023 |
| Spectrum Analyzer        | Agilent                     | N9020A                               | MY53421758             | Aug. 26, 2022 | Annual        | Aug. 26, 2023 |
| DC Power Supply          | Agilent                     | U8002A                               | MY50020026             | Nov. 30, 2022 | Annual        | Nov. 30, 2023 |
| Spectrum Analyzer        | R&S                         | FSW67                                | 103242                 | Aug. 26, 2022 | Annual        | Aug. 26, 2023 |
| Preamplifier             | H.P.                        | 8447F                                | 2944A03909             | Aug. 04, 2022 | Annual        | Aug. 04, 2023 |
| Signal Conditioning Unit | R&S                         | SCU-18                               | 10117                  | Jun. 13, 2022 | Annual        | Jun. 13, 2023 |
| Pre Amplifier            | TESTEK                      | TK-PA1840H                           | 130016                 | Jan. 01, 2023 | Annual        | Jan. 01, 2024 |
| Loop Antenna             | Schwarzbeck Mess-Elektronik | FMZB 1519                            | 1519-039               | Aug. 23, 2021 | Biennial      | Aug. 23, 2023 |
| Bilog Antenna            | Schwarzbeck Mess-Elektronik | VULB 9163                            | 01126                  | Feb. 07, 2022 | Biennial      | Feb. 07, 2023 |
| Horn Antenna             | R&S                         | HF906                                | 100326                 | Feb. 18, 2022 | Annual        | Feb. 18, 2023 |
| Horn Antenna             | Schwarzbeck Mess-Elektronik | BBHA 9170                            | 9170-540               | Nov. 30, 2022 | Annual        | Nov. 30, 2023 |
| Test Receiver            | R&S                         | ESCI 7                               | 100911                 | Feb. 23, 2022 | Annual        | Feb. 23, 2023 |
| Turn Table               | Innco systems GmbH          | DS 1200 S                            | N/A                    | N.C.R.        | N/A           | N.C.R.        |
| Controller               | Innco systems GmbH          | CONTROLLER CO3000-4P                 | CO3000/963/3 8330516/L | N.C.R.        | N/A           | N.C.R.        |
| Antenna Mast             | Innco systems GmbH          | MA4640-XP-ET                         | MA4640/536/3 8330516/L | N.C.R.        | N/A           | N.C.R.        |
| Anechoic Chamber         | SY Corporation              | L × W × H<br>(9.6 m × 6.4 m × 6.6 m) | N/A                    | N.C.R.        | N/A           | N.C.R.        |
| Coaxial Cable            | RFONE                       | MWX221-NMSNMS (4 m)                  | J1023142               | Oct. 04, 2022 | Semi-Annual   | Apr. 04, 2023 |
| Coaxial Cable            | Qualwave Inc.               | QA500-18-NN-10 (10 m)                | 22200114               | Oct. 04, 2022 | Semi-Annual   | Apr. 04, 2023 |
| Coaxial Cable            | RFONE                       | PL360P-292M292M-1.5 M-A              | 20200324002            | Aug. 18, 2022 | Semi-Annual   | Feb. 18, 2023 |

### Note;

- Operating software of EUT has integrated test interface. No additional software was used.
- For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

## 1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

| APPLIED STANDARD: FCC Part15 subpart F, IC RSS-220 Issue 1 and RSS-Gen Issue 5 |                                          |                                          |                   |
|--------------------------------------------------------------------------------|------------------------------------------|------------------------------------------|-------------------|
| Section in FCC                                                                 | Section in IC                            | Test Item(s)                             | Result            |
| 15.519(e)<br>15.519(c)                                                         | RSS-220 Issue 1<br>5.3.1(d)(g)           | Maximum Peak Power and Average Emissions | Complied          |
| 15.209(a)<br>15.519(c)<br>15.519(d)                                            | RSS-220 Issue 1<br>3.4<br>5.3.1(d)(e)(f) | Radiated emissions                       | Complied          |
| 15.503<br>15.519(b)                                                            | RSS-220 Issue 1<br>2                     | 10 dB Bandwidth                          | Complied          |
| -                                                                              | RSS-Gen Issue 5<br>6.7                   | 99 % Bandwidth                           | Complied          |
| 15.519(a)(1)                                                                   | RSS-220 Issue 1<br>5.3.1(b)              | Cease Transmission Time                  | Complied          |
| 15.207                                                                         | RSS-Gen Issue 5<br>8.8                   | AC Conducted Emissions                   | N/A <sup>1)</sup> |

### Note;

1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

## 1.7. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Parameter                          | Uncertainty |         |
|------------------------------------|-------------|---------|
| Occupied Bandwidth                 | 3.90 kHz    |         |
| Radiated Emission, 9 kHz to 30 MHz | H           | 3.40 dB |
|                                    | V           | 3.40 dB |
| Radiated Emission, below 1 GHz     | H           | 4.50 dB |
|                                    | V           | 5.10 dB |
| Radiated Emission, above 1 GHz     | H           | 3.70 dB |
|                                    | V           | 3.90 dB |

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

### 1.8. Test Report Revision

| Revision | Report Number        | Date of Issue | Description |
|----------|----------------------|---------------|-------------|
| 0        | F690501-RF-RTL003796 | 2023.02.10    | Initial     |

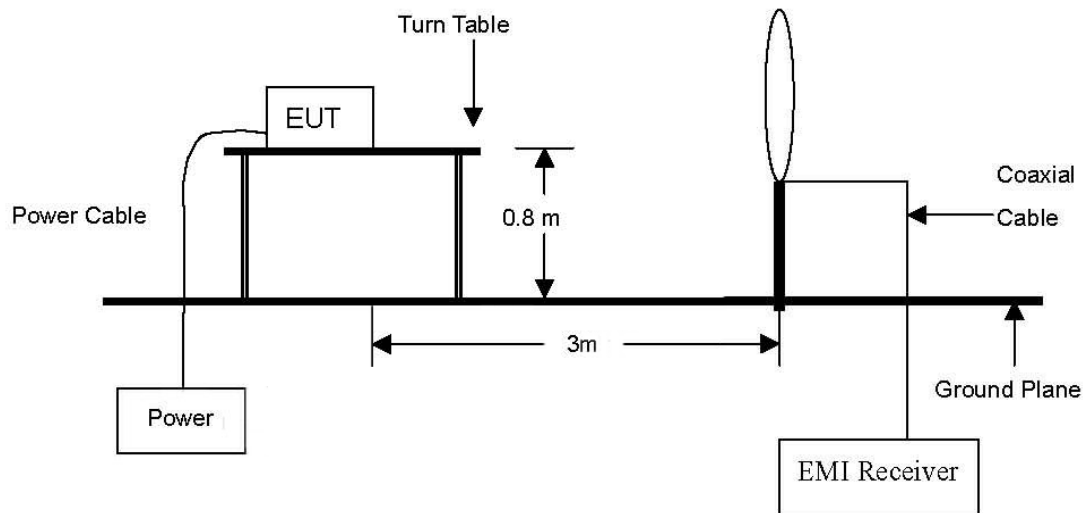
### 1.9. Description of Variant Models

| Model name     |             | Description                                                                                |
|----------------|-------------|--------------------------------------------------------------------------------------------|
| Basic model    | FOB-4F81U44 | - Basic model                                                                              |
| Variant models | FOB-4F82U34 | - Same as basic model, but the difference in the number of external buttons of the product |
|                | FOB-4F82U43 |                                                                                            |
|                | FOB-4F83U24 |                                                                                            |
|                | FOB-4F83U33 |                                                                                            |
|                | FOB-4F84U23 |                                                                                            |
|                | FOB-4F84U14 |                                                                                            |
|                | FOB-4F85U13 |                                                                                            |
|                | FOB-4F85U04 |                                                                                            |
|                | FOB-4F86U03 |                                                                                            |

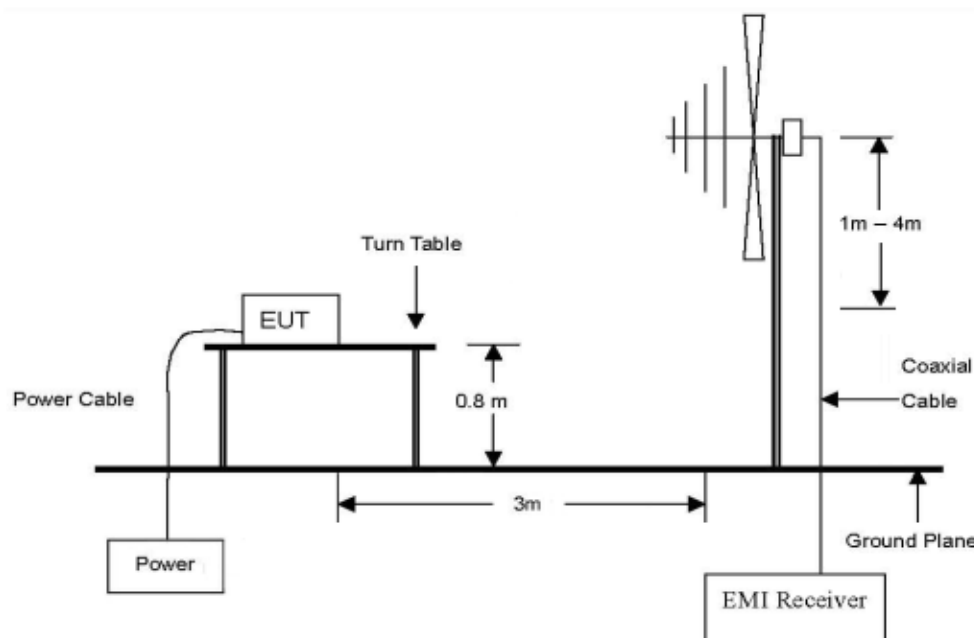
## 2. Maximum Peak Power and Radiated Emissions

### 2.1. Test Setup

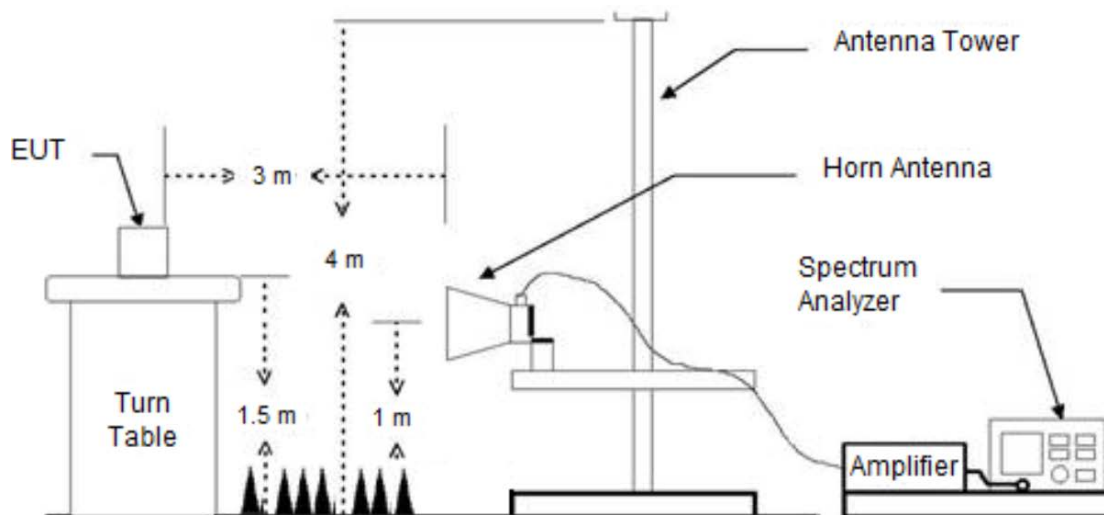
The diagram below shows the test setup that is utilized to make the measurements for emission below 30 MHz.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10<sup>th</sup> harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.





## 2.2. Limit

### 2.2.1. FCC

#### 2.2.1.1. Maximum Peak Power

According to §15.519(e), there is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

#### 2.2.1.2. Radiated Emissions at or below 960 MHz

According to §15.519(c), the radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209.

According to §15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency<br>(MHz) | Field Strength<br>(microvolts/meter) | Measurement Distance<br>(meter) |
|--------------------|--------------------------------------|---------------------------------|
| 0.009-0.490        | 2 400/F(kHz)                         | 300                             |
| 0.490-1.705        | 24 000/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                               |

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

### 2.2.1.3. Radiated Emissions above 960 MHz

According to §15.519(c), the radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

| Frequency in MHz | EIRP in dB m |
|------------------|--------------|
| 960-1 610        | -75.3        |
| 1 610-1 990      | -63.3        |
| 1 990-3 100      | -61.3        |
| 3 100-10 600     | -41.3        |
| Above 10 600     | -61.3        |

According to §15.519(d), in addition to the radiated emission limits specified in the table in paragraph I of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

| Frequency in MHz | EIRP in dB m |
|------------------|--------------|
| 1 164-1 240      | -85.3        |
| 1 559-1 610      | -85.3        |

## 2.2.2. IC

### 2.2.2.1. Maximum Peak Power

According to RSS-220 Issue 1 5.3.1(g), the peak level of the transmissions shall not exceed the peak equivalent of the average limit contained within any 50 MHz bandwidth, as defined in section 4 of the Annex.

According to RSS-220 Issue 1 section 4 of the Annex, peak measurements shall be made in addition to average measurements. Transmissions shall not exceed 0 dBm e.i.r.p. in any 50 MHz bandwidth when the average limit is -41.3 dBm/MHz. This is the equivalent peak limit as calculated by combining the 6 dB peak-to-average conversion with a resolution bandwidth (RBW) scaling factor of  $20 \log(1 \text{ MHz}/50 \text{ MHz})$ . Only the 50 MHz bandwidth, centred on the frequency  $f_M$  where the highest power occurs, needs to be measured to satisfy the peak requirements for all frequencies. A different resolution bandwidth and a correspondingly different peak limit may also be used, in which case the RBW may be set anywhere between 1 MHz and 50 MHz. The peak e.i.r.p. limit is then calculated as  $20 \log(\text{RBW}/50) \text{ dBm}$  where the RBW is in MHz. This may be converted to a peak field strength level at 3 metres using  $E(\text{dB}\mu\text{V/m}) = P(\text{e.i.r.p.}(\text{dBm})) + 95.2$ . If the RBW is greater than 3 MHz, the application for certification shall contain a detailed description of the test procedure, the calibration of the test set-up and the instrumentation used in the testing.

### 2.2.2.2. Radiated Emissions at or Below 960 MHz

According to RSS-220 Issue 1 3.4, radiated emissions at or below 960 MHz for all subclasses of UWB device shall not exceed the following limits. Measurements of radiated emissions at and below 960 MHz are to be made using a CISPR quasi-peak detector. CISPR measurement bandwidth specifications are to be used.

| Frequency<br>(MHz) | Field Strength<br>(Microvolts/m) | Measurement Distance<br>(Metres) | E.i.r.p.<br>(dBmW)                   |
|--------------------|----------------------------------|----------------------------------|--------------------------------------|
| 0.009-0.490        | 2 400/F<br>(F in kHz)            | 300                              | $10 \log(17.28 / F^2)$<br>(F in kHz) |
| 0.490-1.705        | 24 000/F<br>(F in kHz)           | 30                               | $10 \log(17.28 / F^2)$<br>(F in kHz) |
| 1.705-30.0         | 30                               | 30                               | -45.7                                |
| 30-88              | 100                              | 3                                | -55.2                                |
| 88-216             | 150                              | 3                                | -51.7                                |
| 216-960            | 200                              | 3                                | -49.2                                |

**Note 1:** The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

### 2.2.2.3. Radiated Emissions Above 960 MHz

According to RSS-220 Issue 1 5.3.1(d), radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

| Hand-held (Outdoor) Communication, Measurement, Location Sensing, and Tracking Devices |                                         |
|----------------------------------------------------------------------------------------|-----------------------------------------|
| Frequency                                                                              | EIRP in a Resolution Bandwidth of 1 MHz |
| 960-1 610 MHz                                                                          | -75.3 dB m                              |
| 1.61-4.75 GHz                                                                          | -70.0 dB m                              |
| 4.75-10.6 GHz                                                                          | -41.3 dB m                              |
| Above 10.6 GHz                                                                         | -61.3 dB m                              |

According to RSS-220 Issue 1 5.3.1(e), in addition to the limits specified in paragraph (d) of this section, radiated emissions shall not exceed the following average limits when measured using a resolution bandwidth greater than or equal to 1 kHz. The measurements shall demonstrate compliance with the stated limits at whatever resolution bandwidth is used.

| Frequency       | EIRP in a Resolution Bandwidth of 1 kHz |
|-----------------|-----------------------------------------|
| 1 164-1 240 MHz | -85.3 dB m                              |
| 1 559-1 610 MHz | -85.3 dB m                              |

## 2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

### 2.3.1. Test Procedures for emission below 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
- c. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

### 2.3.2. Test Procedures for emission from 30 MHz to 1 000 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
- c. The antenna is a broadband antenna, and its height 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 table was turned from 0 degrees to 360 degrees to find the maximum reading.

### 2.3.3. Test Procedures for emission above 1 GHz

- a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna is a horn antenna and its height 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 table was turned from 0 degrees to 360 degrees to find the maximum reading.

#### 1. Peak power Measurement

- The Peak power measurement refer to section 10.3.5 and 10.3.6

The RBW = less than 50 MHz (but no less than 1 MHz), VBW is set to at least 1 MHz (3 MHz is recommended),

When this approach is employed, the peak emissions EIRP limit (0 dBm / 50 MHz) is converted to a limit commensurate with the RBW by employing a  $[20 \log (RBW / 50 \text{ MHz})]$  relationship.

When a resolution bandwidth of less than 50 MHz is used, this measurement shall be performed over a 50 MHz span centered on the frequency associated with the highest detected average emission level.

#### 2. Average Measurement

- The Average Measurement refer to section 10.3.7

Set the RBW to 1 MHz (1 kHz for emission in the GPS bands), VBW to be at least 1 MHz (3 kHz for emission in the GPS bands), Detector = RMS, Sweep time = no more than a 1 ms integration period over each measurement bin.

## 2.4. Test Result

Ambient temperature : (23 ± 1) °C  
 Relative humidity : 47 % R.H.

### 2.4.1. Maximum peak power and Average emission

All emissions tested both horizontal and vertical. The following table shows the highest levels of radiated emissions on the worst polarization.

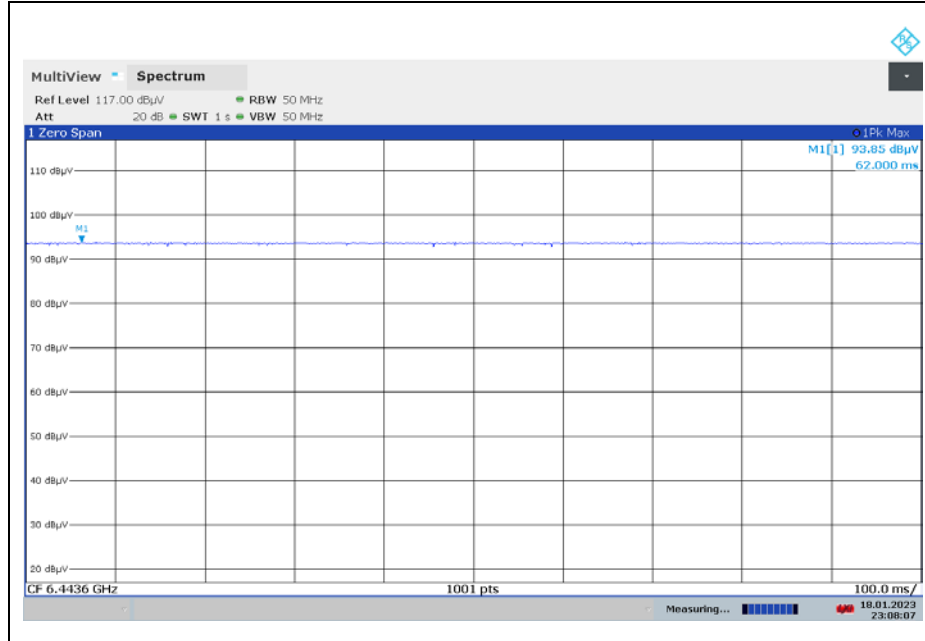
| Frequency (MHz) | Reading (dBμV) | Ant. Pol. | Detect Mode | AF (dB/m) | AMP+CL (dB) | E (dBμV/m) | CF (dB) | E.I.R.P. (dB m) | Limit (dB m) | Margin (dB) |
|-----------------|----------------|-----------|-------------|-----------|-------------|------------|---------|-----------------|--------------|-------------|
| 6 443.60        | 93.85          | H         | Peak        | 34.60     | -33.45      | 95.00      | -104.80 | -9.80           | 0            | 9.80        |
| 6 443.60        | 55.02          | H         | Average     | 34.60     | -33.45      | 56.17      | -104.80 | -48.63          | -41.3        | 7.33        |

#### Remark;

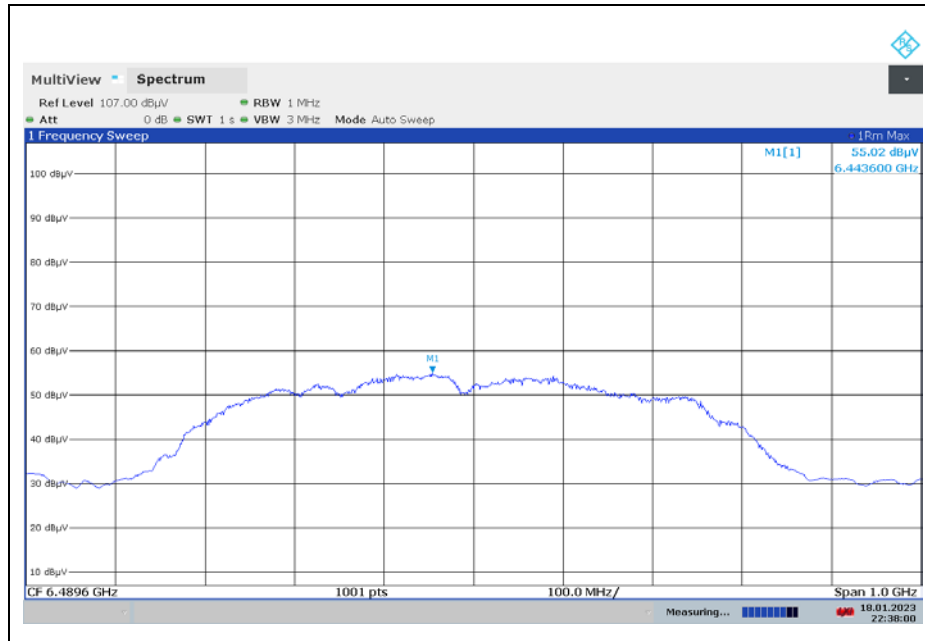
1.  $E \text{ (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Amp (dB)} + \text{Cable Loss (dB)}$ .
2.  $\text{E.I.R.P. (dB m)} = E \text{ (dB}\mu\text{V/m)} + 20 \log D - 104.8$ ; where D is the measurement distance in meters.
3.  $\text{CF (dB) (E.I.R.P.)} = 20 \log D - 104.8$ ;
4. All the emissions were measured at a 1 meter test distance.
5. AF = Antenna Factor, AMP = Amplifier, CL = Cable Loss.

## - Test plots

### Maximum Peak power



### Average emission



### 2.4.2. Radiated Spurious Emission below 960 MHz

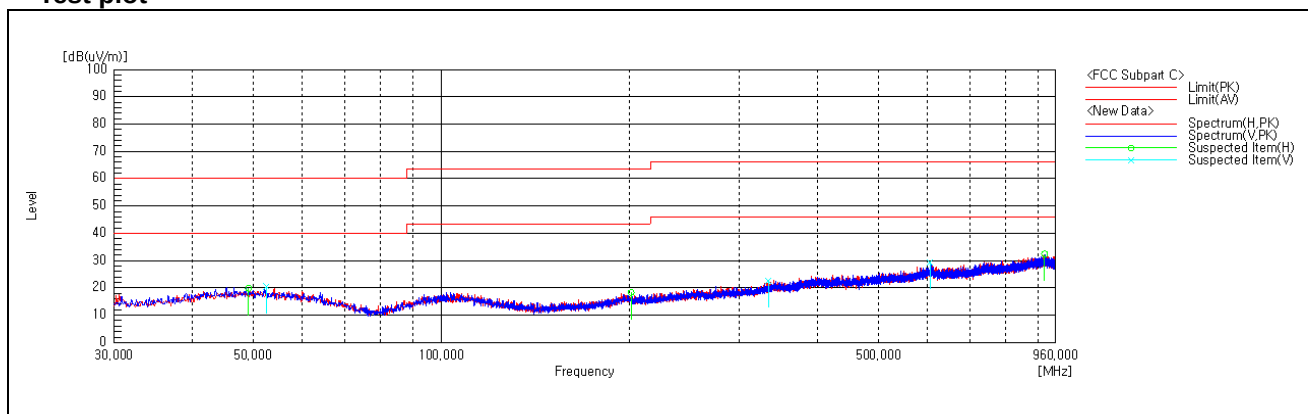
The frequency spectrum from 9 kHz to 960 MHz was investigated. All reading values are peak values.

| Radiated Emissions |                      |             | Ant  | Correction Factors |               | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP + CL (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| 52.55              | 28.40                | Peak        | V    | 19.55              | -27.45        | 20.50                 | 40.00                | 19.50       |
| 605.32             | 30.00                | Peak        | V    | 25.40              | -26.03        | 29.37                 | 46.00                | 16.63       |
| 923.27             | 29.20                | Peak        | H    | 28.30              | -25.09        | 32.41                 | 46.00                | 13.59       |

#### Remark;

1. Spurious emissions for all channels were investigated and almost the same below 960 MHz.
2. Radiated spurious emission measurement as below.  
(Actual = Reading + AF + AMP + CL)
3. According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

#### - Test plot





### 2.4.3. Radiated Spurious Emission above 960 MHz

All emissions tested both horizontal and vertical. The following table shows the highest levels of radiated emissions on the worst polarization.

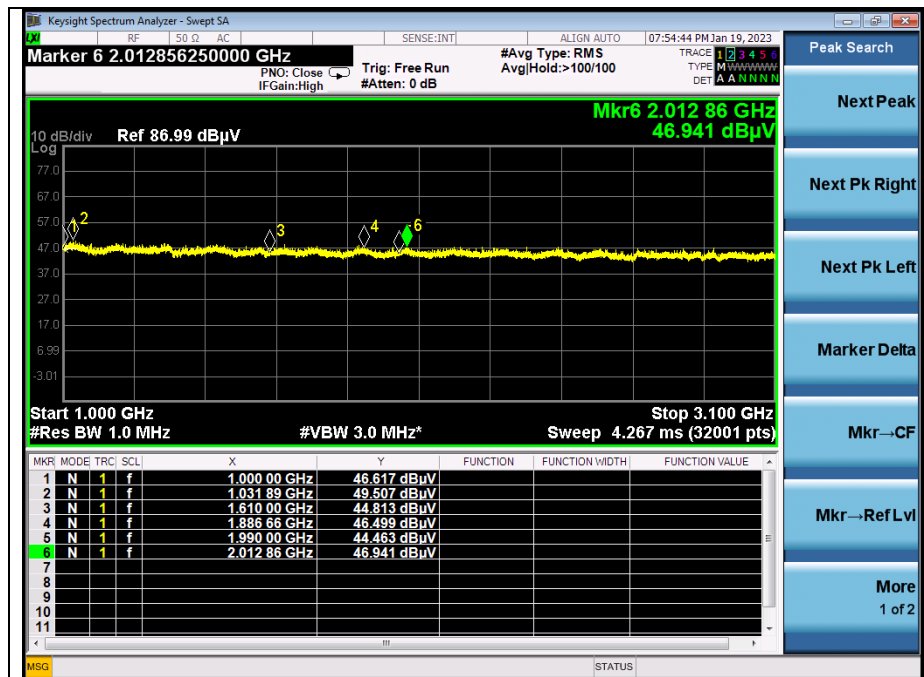
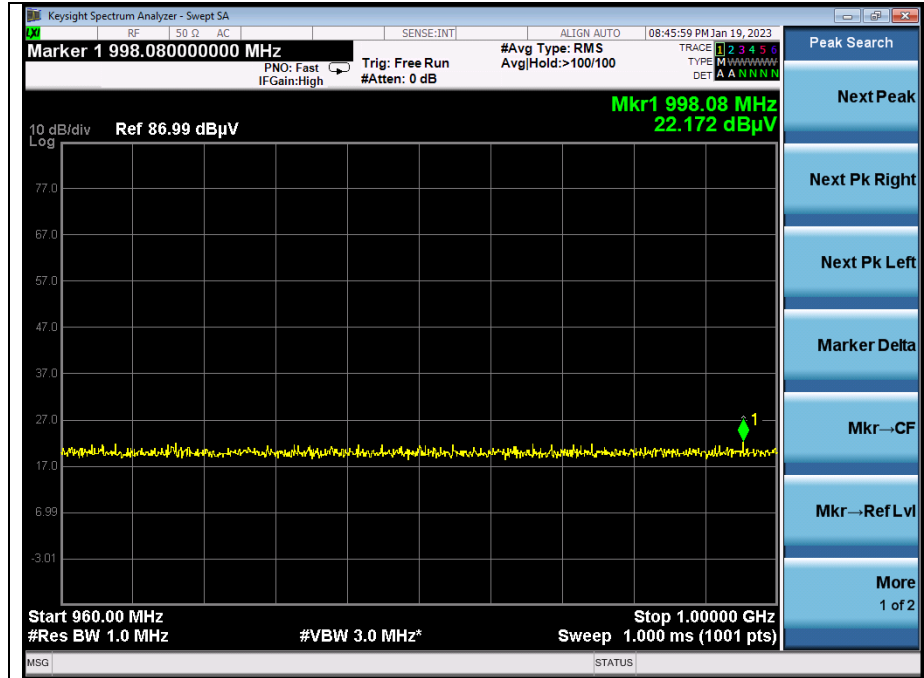
| Frequency<br>(MHz) | Reading<br>(dBμV) | Ant.<br>Pol. | AF<br>(dB/m) | AMP+CL<br>(dB) | E<br>(dBμV/m) | CF<br>(dB) | E.I.R.P.<br>(dB m) | Limit<br>(dB m) |     | Margin<br>(dB) |      |
|--------------------|-------------------|--------------|--------------|----------------|---------------|------------|--------------------|-----------------|-----|----------------|------|
|                    |                   |              |              |                |               |            |                    | FCC             | IC  | FCC            | IC   |
| 998.08             | 22.17             | H            | 25.53        | -40.75         | 6.95          | -110.82    | -103.87            | -75.30          |     | 28.57          |      |
| 1 000.00           | 46.62             | H            | 23.80        | -40.74         | 29.68         | -110.82    | -81.14             | -75.30          |     | 5.84           |      |
| 1 031.89           | 49.51             | H            | 24.18        | -40.41         | 33.28         | -110.82    | <b>-77.54</b>      | -75.30          |     | 2.24           |      |
| *1 178.04          | 8.85              | H            | 24.94        | -39.90         | -6.11         | -110.82    | -116.93            | -85.30          |     | 31.63          |      |
| *1 580.90          | 8.18              | H            | 25.42        | -38.68         | -5.08         | -110.82    | -115.90            | -85.30          |     | 30.60          |      |
| 1 610.00           | 44.81             | H            | 25.52        | -38.60         | 31.73         | -110.82    | -79.09             | -75.30          |     | 3.79           |      |
| 1 886.66           | 46.50             | H            | 27.43        | -38.00         | 35.93         | -110.82    | -74.89             | -63.30          | -70 | 11.59          | 4.89 |
| 1 990.00           | 44.46             | H            | 27.66        | -37.69         | 34.43         | -110.82    | -76.39             | -63.30          | -70 | 13.09          | 6.39 |
| 2 012.86           | 46.94             | H            | 27.67        | -37.62         | 36.99         | -110.82    | -73.83             | -61.30          | -70 | 12.53          | 3.83 |
| 3 292.19           | 44.93             | H            | 30.65        | -37.11         | 38.47         | -110.82    | -72.35             | -61.30          | -70 | 11.05          | 2.35 |
| Above<br>3 300.00  | Not<br>detected   | -            | -            | -              | -             | -          | -                  | -               |     | -              |      |

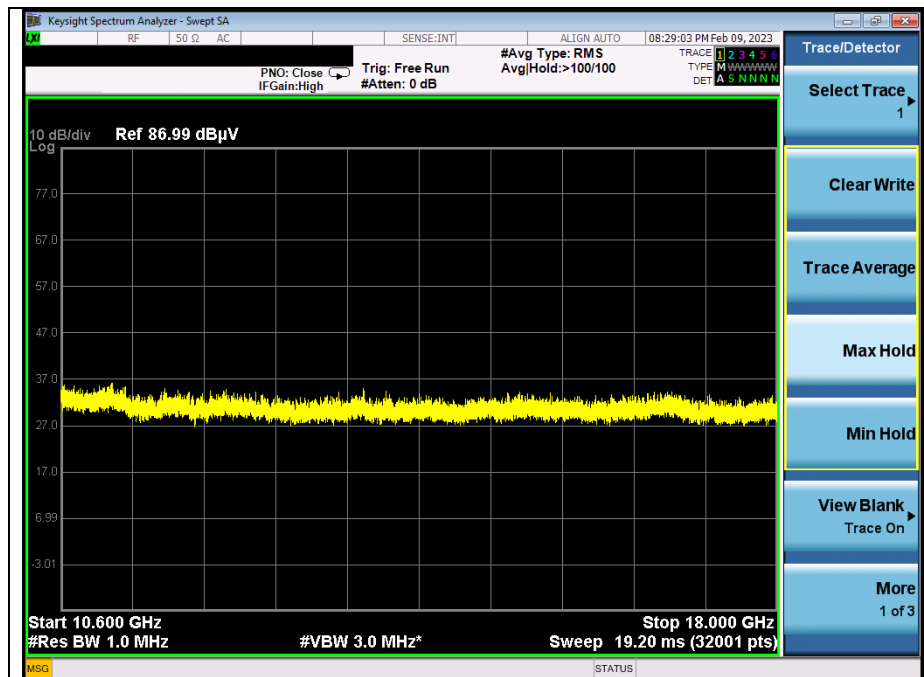
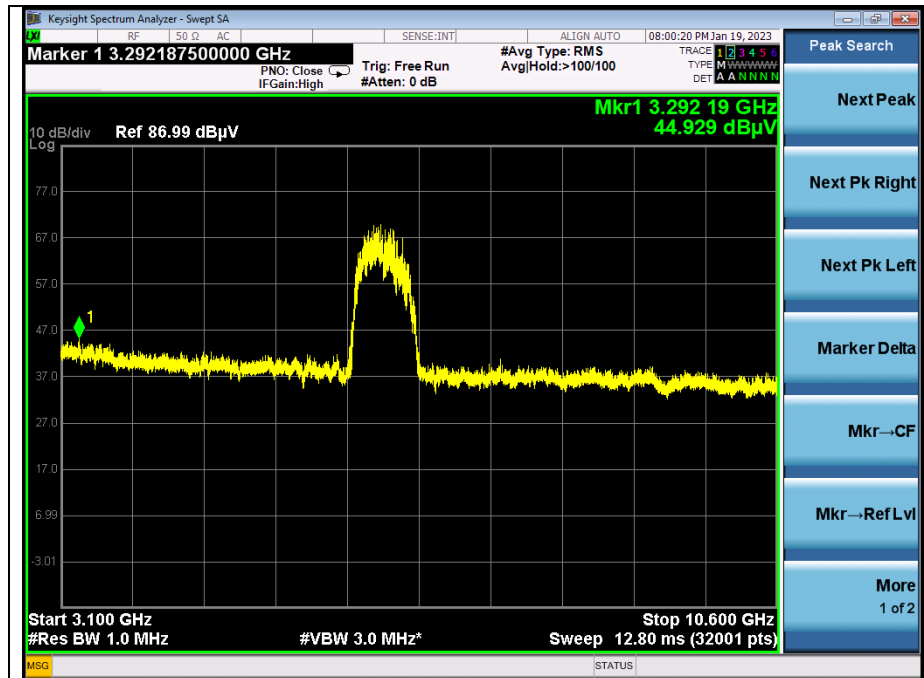
#### Remark;

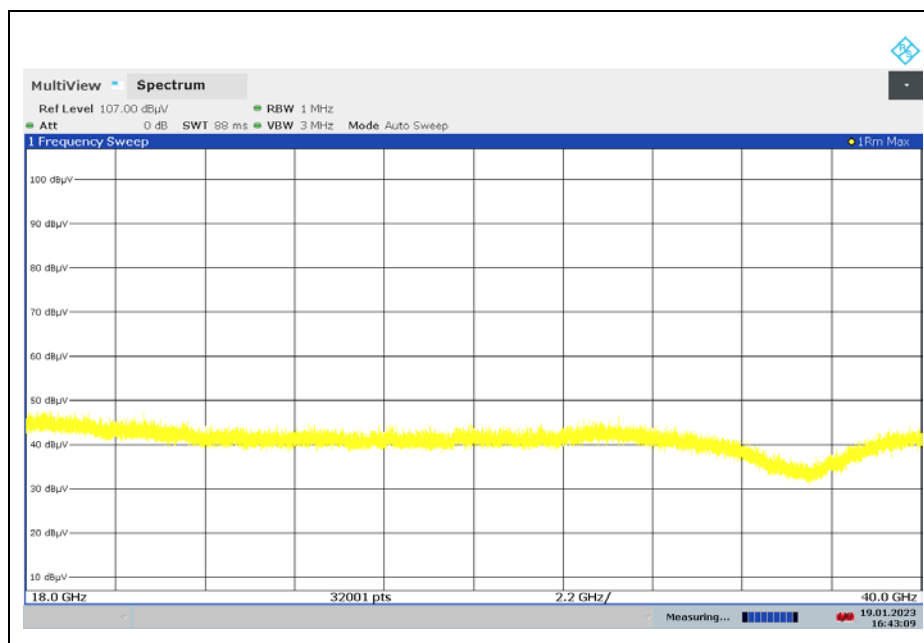
1.  $E \text{ (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Amp (dB)} + \text{Cable Loss (dB)}$ .
2.  $E.I.R.P. \text{ (dB m)} = E \text{ (dB}\mu\text{V/m)} + 20 \log D - 104.8$ ; where D is the measurement distance in meters.
3.  $CF \text{ (dB)} (E.I.R.P.) = 20 \log D - 104.8$
4. All the emissions above 960 MHz were measured at a 0.5 meter test distance.
5. "\*" means the GPS band.
6. Measurement In frequency 1 162-1 240 MHz and 1 559-1 610 MHz, RBW is set to 1 kHz.
7. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 dB.
8. AF = Antenna Factor, AMP = Amplifier, CL = Cable Loss.

## - Test plots

Above 960 MHz

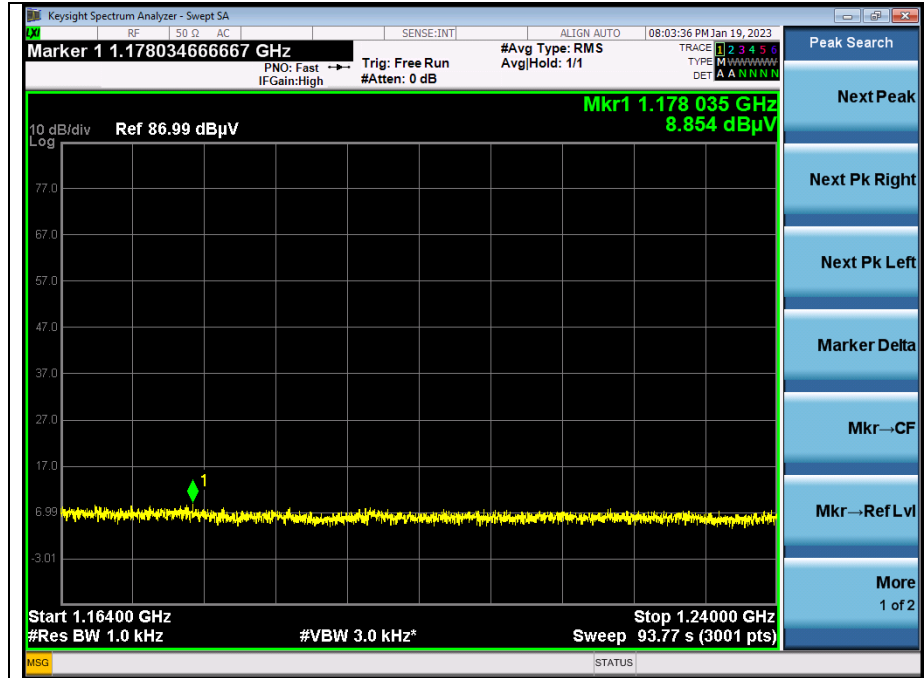




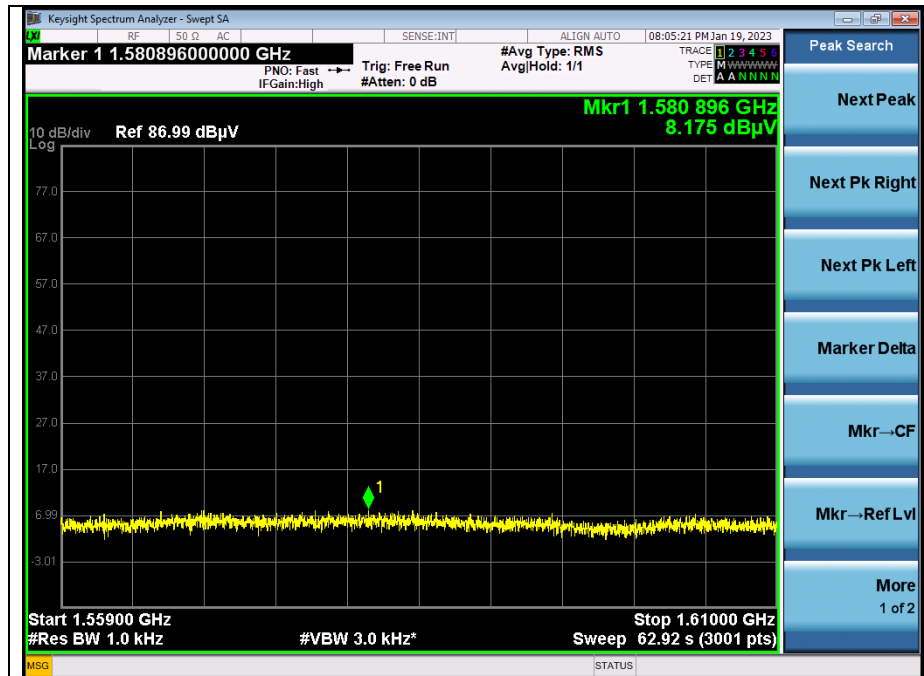


## - GPS Band

1 164 - 1 240 MHz

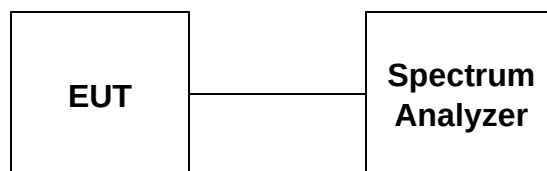


1 559 - 1 610 MHz



### 3. 10 dB Bandwidth

#### 3.1. Test Setup



#### 3.2. Limit

##### 3.2.1. FCC

According to §15.503(a), for the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna.

According to §15.519(b), the UWB bandwidth of a device operating under the provisions of this section must be contained between 3 100 MHz and 10,600 MHz.

##### 3.2.2. IC

According to 2 of RSS-220 Issue 1, a UWB device is an intentional radiator that has either a -10 dB bandwidth of at least 500 MHz or a -10 dB fractional bandwidth greater than 0.2. There are eight distinct subclasses of UWB device.

#### 3.3. Test Procedure

##### 10 dB Bandwidth

The test follows section 10.1 of ANSI C63.10-2013.

The frequency at which the maximum power level is measured with the peak detector is designated  $f_M$ . The peak power measurements shall be made using a spectrum analyzer or EMI receiver with a 1 MHz resolution bandwidth and a video bandwidth of 1 MHz or greater. The instrument shall be set to peak detection using the maximum-hold trace mode. The outermost 1 MHz segments above and below  $f_M$ , where the peak power falls by 10 dB relative to the level at  $f_M$ , are designated as  $f_H$  and  $f_L$ , respectively:

- For the lowest frequency bound  $f_L$ , the emission is searched from a frequency lower than  $f_M$  that has, by inspection, a peak power much lower than 10 dB less than the power at  $f_M$  and increased toward  $f_M$  until the peak power indicates 10 dB less than the power at  $f_M$ . The frequency of that segment is recorded.
- This process is repeated for the highest frequency bound  $f_H$ , beginning at a frequency higher than  $f_M$  that has, by inspection, a peak power much lower than 10 dB below the power at  $f_M$ . The frequency of that segment is recorded.
- The two recorded frequencies represent the highest  $f_H$  and lowest  $f_L$  bounds of the UWB transmission, and the -10 dB bandwidth ( $B - 10$ ) is defined as  $(f_H - f_L)$ . The center frequency ( $f_c$ ) is mathematically determined from  $(f_H - f_L) / 2$ .

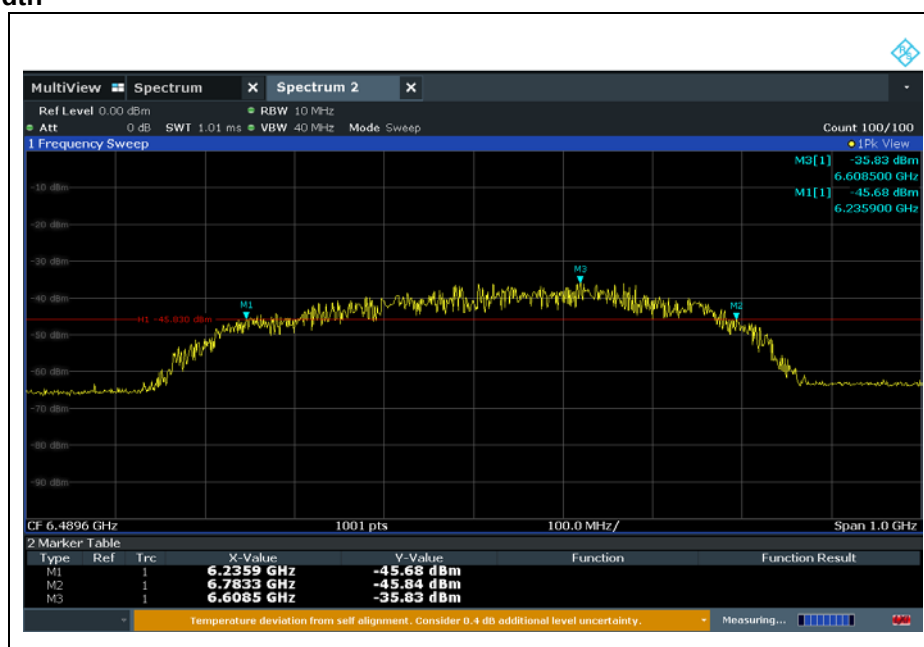
### 3.4. Test Result

Ambient temperature : (23 ± 1) °C  
Relative humidity : 47 % R.H.

| Frequency (MHz) | f <sub>M</sub> (MHz) | f <sub>L</sub> (MHz) | f <sub>H</sub> (MHz) | f <sub>C</sub> (MHz) | 10 dB Bandwidth (MHz) | Minimum Bandwidth (MHz) | Remark |
|-----------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-------------------------|--------|
| 6 489.6         | 6 608.5              | 6 235.9              | 6 783.3              | 6 509.6              | 547.4                 | 500                     | Pass   |

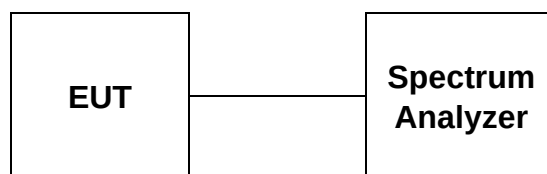
#### - Test plot

#### 10 dB Bandwidth



## 4. 99 % Bandwidth

### 4.1. Test Setup



### 4.2. Limit

Limit: Not Applicable

### 4.3. Test Procedure

#### 99 % Bandwidth

- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99 % emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99 % emission bandwidth).

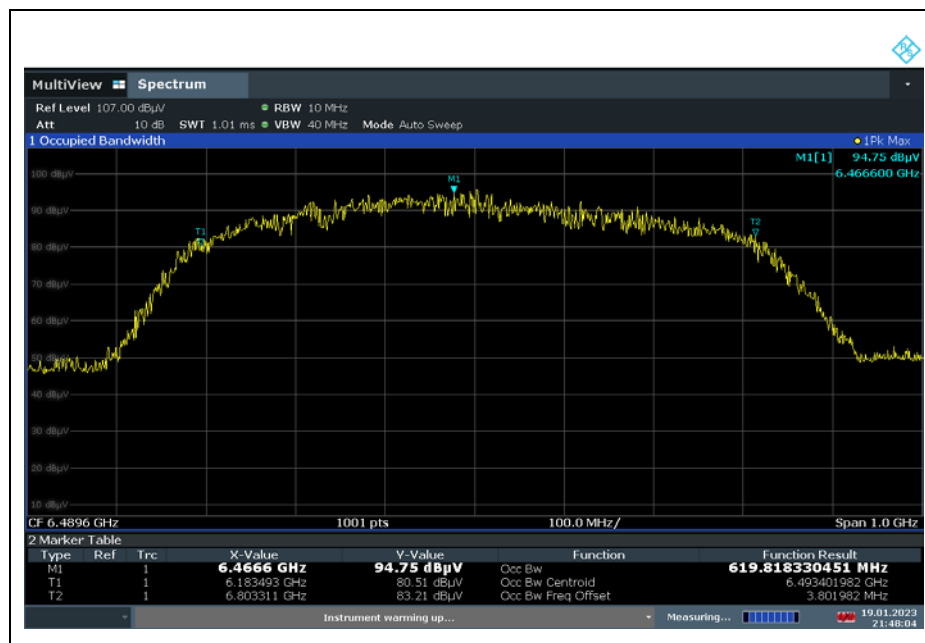


#### 4.4. Test Result

Ambient temperature : (23 ± 1) °C  
 Relative humidity : 47 % R.H.

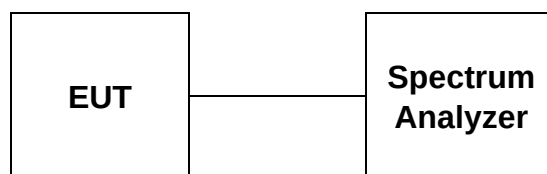
| Frequency<br>(MHz) | 99 % Bandwidth<br>(MHz) | Remark                  |
|--------------------|-------------------------|-------------------------|
| 6 489.6            | 619.82                  | 99 % Occupied bandwidth |

#### - Test plot



## 5. Cease Transmission Time

### 5.1. Test Setup



### 5.2. Limit

#### 5.2.1. FCC

According to §15.519(a)(1), a UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

#### 5.2.2. IC

According to 5.3.1(b) of RSS-220 Issue 1, the device is to transmit only when it is sending information to an associated receiver. The device shall cease transmission of information within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received.

An acknowledgment of reception must continue to be received by the UWB device at least every 10 seconds or the UWB device shall cease transmitting any information other than periodic signals used for the establishment or re-establishment of a communication link with an associated receiver.

### 5.3. Test Procedure

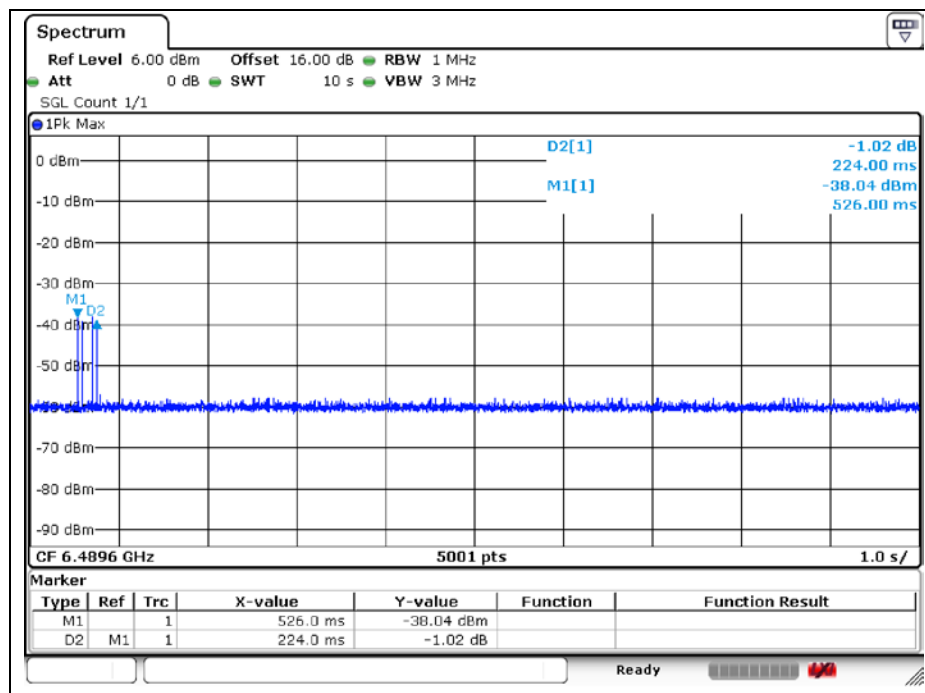
1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 MHz, VBW = 3 MHz, Span = 0 Hz.

## 5.4. Test Result

Ambient temperature : (23 ± 1) °C  
 Relative humidity : 47 % R.H.

| Frequency<br>(MHz) | Transmission Time<br>(ms) | Limit<br>(sec) | Remark |
|--------------------|---------------------------|----------------|--------|
| 6 489.6            | 224                       | 10             | Pass   |

### - Test plot



### Remark;

The EUT transmit only 224 ms when sending information to an associated receiver.

## **6. Antenna Requirement**

### **6.1. Standard Applicable**

For intentional device, according to FCC 47 CFR 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. And according to FCC 47 CFR Section §15.519 (a)(2), the use of antennas mounted on outdoor structures, e.g., antenna mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.

### **6.2. Antenna Connected Construction**

Antenna used in this product is PCB Pattern Antenna with gain of 0.78 dB i.

**- End of the Test Report -**