# FCC Test Report

**Report No.:** RF191023C07-2

**FCC ID:** BABTN0002A

**Test Model:** TN0002A

**Received Date:** Oct. 23, 2019

**Test Date:** Dec. 18, 2019 ~ Dec. 24, 2019

**Issued Date:** Jan. 06, 2020

**Applicant:** DENSO TEN Limited

**Address:** 2-28, GOSHO-DORI 1-CHOME, HYOGO-KU, KOBE 652-8510 JAPAN

**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
Lin Kou Laboratories

**Lab Address:** No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan

**Test Location:** No.19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, Taiwan

**FCC Registration / Designation Number:** 788550 / TW0003

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## Release Control Record

| Issue No. | Description | Date Issued |
|---|---|---|
| RF191023C07-2 | Original Release | Jan. 06, 2020 |

## 1 Certificate of Conformity

**Product:** Car Audio

**Brand:** ISUZU

**Test Model:** TN0002A

**Sample Status:** Engineering Sample

**Applicant:** DENSO TEN Limited

**Test Date:** Dec. 18, 2019 ~ Dec. 24, 2019

**Standards:** 47 CFR FCC Part 15, Subpart C (Section 15.247)
ANSI C63.10:2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

**Prepared by :** _____ , **Date:** Jan. 06, 2020
Shelly Hsueh / Specialist

**Approved by :** _____ , **Date:** Jan. 06, 2020
Dylan Chiou / Senior Project Engineer

## 2 Summary of Test Results

| 47 CFR FCC Part 15, Subpart C (Section 15.247) | | | |
|---|---|---|---|
| **FCC Clause** | **Test Item** | **Result** | **Remarks** |
| 15.207 | AC Power Conducted Emission | Pass | Meet the requirement of limit. Minimum passing margin is -25.73 dB at 0.15225 MHz. |
| 15.247(a)(1)(iii) | Number of Hopping Frequency Used | Pass | Meet the requirement of limit. |
| 15.247(a)(1)(iii) | Dwell Time on Each Channel | Pass | Meet the requirement of limit. |
| 15.247(a)(1) | 1. Hopping Channel Separation<br>2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System | Pass | Meet the requirement of limit. |
| 15.247(a)(1) | Maximum Peak Output Power | Pass | Meet the requirement of limit. |
| --- | Occupied Bandwidth Measurement | Pass | Reference only |
| 15.205 & 209 | Radiated Emissions | Pass | Meet the requirement of limit. Minimum passing margin is -9.2 dB at 2483.50 MHz. |
| 15.247(d) | Band Edge Measurement | Pass | Meet the requirement of limit. |
| 15.247(d) | Antenna Port Emission | Pass | Meet the requirement of limit. |
| 15.203 | Antenna Requirement | Pass | No antenna connector is used. |

**Note:**

1. If the Frequency Hopping System operating in 2400-2483.5 MHz band and the output power less than 125 mW. The hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of hopping channel whichever is greater.
2. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

### 2.1 Measurement Uncertainty

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

| Measurement | Frequency | Expanded Uncertainty (k=2) (±) |
|---|---|---|
| Conducted Emissions at mains ports | 150 kHz ~ 30 MHz | 2.79 dB |
| Radiated Emissions up to 1 GHz | 9 kHz ~ 30 MHz | 3.04 dB |
| | 30 MHz ~ 200 MHz | 2.93 dB |
| | 200 MHz ~ 1000 MHz | 2.95 dB |
| Radiated Emissions above 1 GHz | 1 GHz ~ 18 GHz | 2.26 dB |
| | 18 GHz ~ 40 GHz | 1.94 dB |

### 2.2 Modification Record

There were no modifications required for compliance.

# 3 General Information

## 3.1 General Description of EUT

| | |
|---|---|
| **Product** | Car Audio |
| **Brand** | ISUZU |
| **Test Model** | TN0002A |
| **Status of EUT** | Engineering Sample |
| **Power Supply Rating** | 12 Vdc (from car battery) |
| **Modulation Type** | GFSK, π/4-DQPSK, 8DPSK |
| **Transfer Rate** | 1/2/3 Mbps |
| **Operating Frequency** | 2402 ~ 2480 MHz |
| **Number of Channel** | 79 |
| **Output Power** | 7.295 mW |
| **Antenna Type** | Inverted F antenna with 2.14 dBi gain |
| **Antenna Connector** | N/A |
| **Accessory Device** | N/A |
| **Data Cable Supplied** | N/A |

Note:

1. WLAN 2.4GHz & WLAN 5GHz & BT technology cannot transmit at same time.
2. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or User's Manual.

## 3.2 Description of Test Modes

79 channels are provided to this EUT:

| Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|---|---|---|---|---|---|---|---|
| 0 | 2402 | 20 | 2422 | 40 | 2442 | 60 | 2462 |
| 1 | 2403 | 21 | 2423 | 41 | 2443 | 61 | 2463 |
| 2 | 2404 | 22 | 2424 | 42 | 2444 | 62 | 2464 |
| 3 | 2405 | 23 | 2425 | 43 | 2445 | 63 | 2465 |
| 4 | 2406 | 24 | 2426 | 44 | 2446 | 64 | 2466 |
| 5 | 2407 | 25 | 2427 | 45 | 2447 | 65 | 2467 |
| 6 | 2408 | 26 | 2428 | 46 | 2448 | 66 | 2468 |
| 7 | 2409 | 27 | 2429 | 47 | 2449 | 67 | 2469 |
| 8 | 2410 | 28 | 2430 | 48 | 2450 | 68 | 2470 |
| 9 | 2411 | 29 | 2431 | 49 | 2451 | 69 | 2471 |
| 10 | 2412 | 30 | 2432 | 50 | 2452 | 70 | 2472 |
| 11 | 2413 | 31 | 2433 | 51 | 2453 | 71 | 2473 |
| 12 | 2414 | 32 | 2434 | 52 | 2454 | 72 | 2474 |
| 13 | 2415 | 33 | 2435 | 53 | 2455 | 73 | 2475 |
| 14 | 2416 | 34 | 2436 | 54 | 2456 | 74 | 2476 |
| 15 | 2417 | 35 | 2437 | 55 | 2457 | 75 | 2477 |
| 16 | 2418 | 36 | 2438 | 56 | 2458 | 76 | 2478 |
| 17 | 2419 | 37 | 2439 | 57 | 2459 | 77 | 2479 |
| 18 | 2420 | 38 | 2440 | 58 | 2460 | 78 | 2480 |
| 19 | 2421 | 39 | 2441 | 59 | 2461 | | |

### 3.2.1 Test Mode Applicability and Tested Channel Detail

| EUT Configure Mode | Applicable To | | | | Description |
|---|---|---|---|---|---|
| | RE≥1G | RE<1G | PLC | APCM | |
| - | √ | √ | √ | √ | X-plane |

Where **RE≥1G:** Radiated Emission above 1 GHz **RE<1G:** Radiated Emission below 1 GHz

**PLC:** Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

**Note:**

1. "-" means no effect.

**Radiated Emission Test (Above 1 GHz):**

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|---|---|---|---|---|---|
| - | 0 to 78 | 0, 39, 78 | FHSS | GFSK | DH5 |
| | 0 to 78 | 0, 39, 78 | FHSS | 8DPSK | 3DH5 |

**Radiated Emission Test (Below 1 GHz):**

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|---|---|---|---|---|---|
| - | 0 to 78 | 78 | FHSS | GFSK | DH5 |

**Power Line Conducted Emission Test:**

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|---|---|---|---|---|---|
| - | 0 to 78 | 78 | FHSS | GFSK | DH5 |

**Antenna Port Conducted Measurement:**

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|---|---|---|---|---|---|
| - | 0 to 78 | 0, 39, 78 | FHSS | GFSK | DH5 |
| - | 0 to 78 | 0, 39, 78 | FHSS | 8DPSK | 3DH5 |

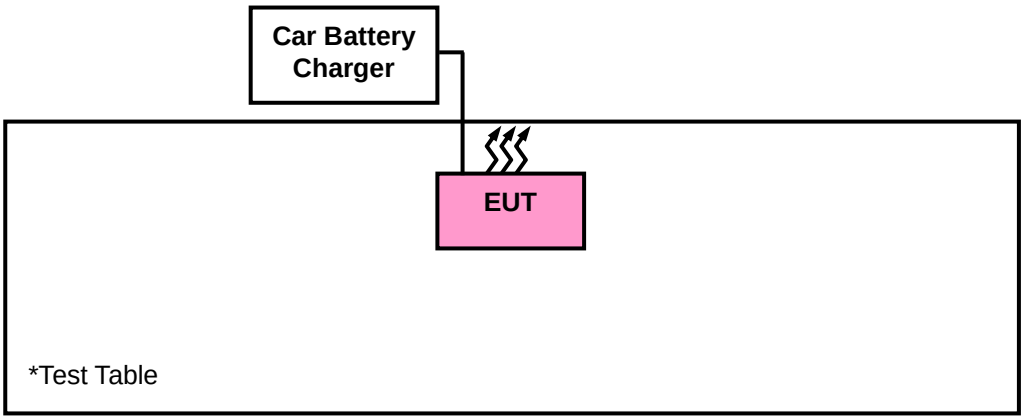
**Test Condition:**

| Applicable To | Environmental Conditions | Input Power | Tested by |
|---|---|---|---|
| RE≥1G | 25 deg. C, 65 % RH | 12 Vdc | Han Wu |
| RE<1G | 25 deg. C, 65 % RH | 12 Vdc | Han Wu |
| PLC | 25 deg. C, 65 % RH | 12 Vdc | Jones Chang |
| APCM | 25 deg. C, 65 % RH | 12 Vdc | Jisyong Wang |

## 3.3 Description of Support Units

The EUT has been tested as an independent unit.

### 3.3.1 Configuration of System under Test




## 3.4 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and references:

**Test Standard:**

**FCC Part 15, Subpart C (15.247)**
ANSI C63.10-2013

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

**References Test Guidance:**

**KDB 558074 D01 15.247 Meas Guidance v05r02**

All test items have been performed as a reference to the above KDB test guidance.

# 4 Test Types and Results

## 4.1 Radiated Emission and Bandedge Measurement

### 4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009 ~ 0.490 | 2400/F (kHz) | 300 |
| 0.490 ~ 1.705 | 24000/F (kHz) | 30 |
| 1.705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 100 | 3 |
| 88 ~ 216 | 150 | 3 |
| 216 ~ 960 | 200 | 3 |
| Above 960 | 500 | 3 |

**Note**:

a. The lower limit shall apply at the transition frequencies.

b. Emission level (dBuV/m) = 20 log Emission level (uV/m).

c. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

4.1.2 Test Instruments

| Description & Manufacturer | Model No. | Serial No. | Cal. Date | Cal. Due |
|---|---|---|---|---|
| Test Receiver KEYSIGHT | N9038A | MY55420137 | Apr. 15, 2019 | Apr. 14, 2020 |
| Spectrum Analyzer ROHDE & SCHWARZ | FSP40 | 100039 | Jun. 12, 2019 | Jun. 11, 2020 |
| BILOG Antenna SCHWARZBECK | VULB9168 | 9168-160 | Nov. 07, 2019 | Nov. 06, 2020 |
| HORN Antenna SCHWARZBECK | BBHA 9120 D | 9120D-1169 | Nov. 24, 2019 | Nov. 23, 2020 |
| HORN Antenna SCHWARZBECK | BBHA 9170 | BBHA9170241 | Nov. 24, 2019 | Nov. 23, 2020 |
| Loop Antenna TESEQ | HLA 6121 | 45745 | Jul. 01, 2019 | Jun. 30, 2020 |
| Preamplifier Agilent (Below 1GHz) | 8447D | 2944A10638 | Jul. 11, 2019 | Jul. 10, 2020 |
| Preamplifier Agilent (Above 1GHz) | 8449B | 3008A02367 | Feb. 19, 2019 | Feb. 18, 2020 |
| RF signal cable HUBER+SUHNER&EMCI | SUCOFLEX 104 & EMC104-SM-SM8000 | CABLE-CH9-02 (248780+171006) | Jan. 19, 2019 | Jan. 18, 2020 |
| RF signal cable HUBER+SUHNER | SUCOFLEX 104 | CABLE-CH9-(250795/4) | Jul. 11, 2019 | Jul. 10, 2020 |
| RF signal cable Woken | 8D-FB | Cable-CH9-01 | Jul. 30, 2019 | Jul. 29, 2020 |
| Software BV ADT | ADT_Radiated_ V7.6.15.9.5 | NA | NA | NA |
| Antenna Tower EMCO | 2070/2080 | 512.835.4684 | NA | NA |
| Turn Table EMCO | 2087-2.03 | NA | NA | NA |
| Antenna Tower &Turn BV ADT | AT100 | AT93021705 | NA | NA |
| Turn Table BV ADT | TT100 | TT93021705 | NA | NA |
| Turn Table Controller BV ADT | SC100 | SC93021705 | NA | NA |
| Boresight Antenna Fixture | FBA-01 | FBA-SIP01 | NA | NA |
| USB Wideband Power Sensor KEYSIGHT | U2021XA | MY55050005/MY55190004/MY55190007/MY55210005 | Jul. 15, 2019 | Jul. 14, 2020 |

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa Chamber 9.

4.1.3 Test Procedures

**For Radiated Emission below 30 MHz**

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

**Note:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30 MHz.

**For Radiated Emission above 30 MHz**

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30 MHz ~ 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
f. The test-receiver system was set to peak and average detected 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:**

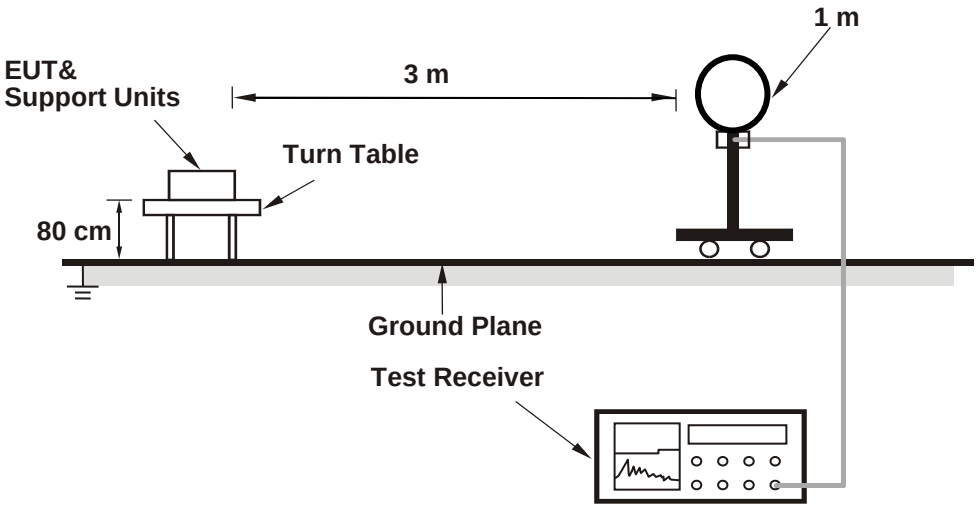
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) or Peak detection (PK) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98 %) or 10 Hz (Duty cycle ≥ 98 %) for Average detection (AV) at frequency above 1 GHz. (RBW = 1 MHz, VBW = 1 kHz)
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

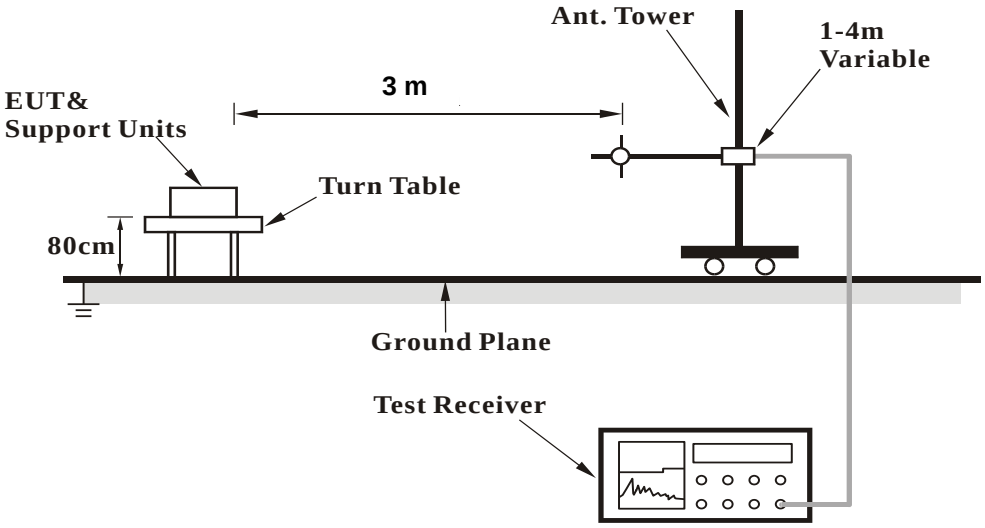
No deviation.

4.1.5 Test Set Up

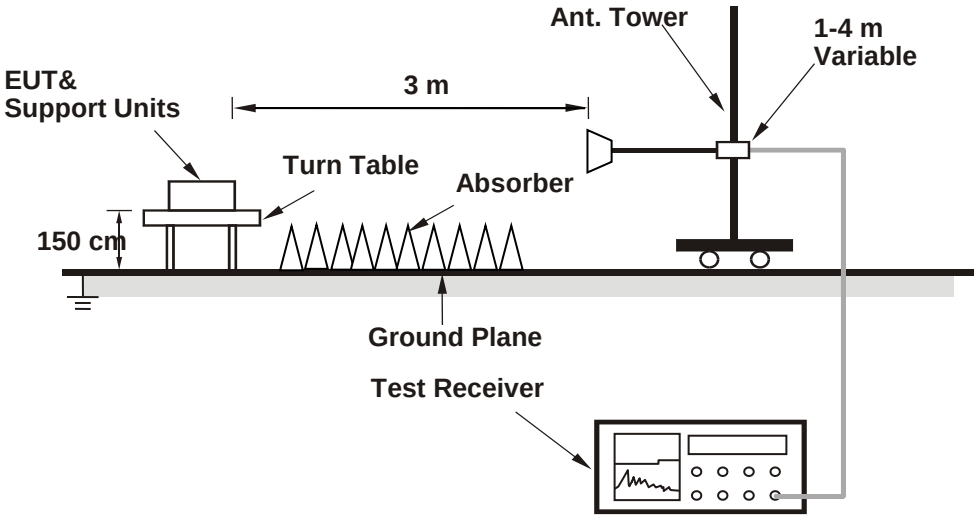
**<Radiated Emission below 30 MHz>**




**<Radiated Emission 30 MHz to 1 GHz>**



**<Radiated Emission above 1 GHz>**




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

4.1.6 EUT Operating Conditions

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

4.1.7 Test Results

**Above 1 GHz Data:**

**GFSK**

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 0 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| 2390.00 | 55.5 PK | 74.0 | -18.5 | 3.70 H | 255 | 23.6 | 31.9 |
| 2390.00 | 43.9 AV | 54.0 | -10.1 | 3.70 H | 255 | 12.0 | 31.9 |
| *2402.00 | 92.2 PK | | | 3.71 H | 250 | 60.4 | 31.8 |
| *2402.00 | 90.9 AV | | | 3.71 H | 250 | 59.1 | 31.8 |
| 4804.00 | 45.2 PK | 74.0 | -28.8 | 3.48 H | 81 | 41.3 | 3.9 |
| 4804.00 | 31.9 AV | 54.0 | -22.1 | 3.48 H | 81 | 28.0 | 3.9 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| 2390.00 | 55.9 PK | 74.0 | -18.1 | 2.46 V | 348 | 24.0 | 31.9 |
| 2390.00 | 44.0 AV | 54.0 | -10.0 | 2.46 V | 348 | 12.1 | 31.9 |
| *2402.00 | 97.0 PK | | | 2.44 V | 350 | 65.2 | 31.8 |
| *2402.00 | 95.8 AV | | | 2.44 V | 350 | 64.0 | 31.8 |
| 4804.00 | 45.7 PK | 74.0 | -28.3 | 3.46 V | 65 | 41.8 | 3.9 |
| 4804.00 | 34.0 AV | 54.0 | -20.0 | 3.46 V | 65 | 30.1 | 3.9 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 39 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2441.00 | 94.2 PK | | | 3.67 H | 253 | 62.3 | 31.9 |
| *2441.00 | 93.1 AV | | | 3.67 H | 253 | 61.2 | 31.9 |
| 4882.00 | 45.5 PK | 74.0 | -28.5 | 3.47 H | 86 | 41.7 | 3.8 |
| 4882.00 | 31.9 AV | 54.0 | -22.1 | 3.47 H | 86 | 28.1 | 3.8 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2441.00 | 99.1 PK | | | 2.58 V | 350 | 67.2 | 31.9 |
| *2441.00 | 98.0 AV | | | 2.58 V | 350 | 66.1 | 31.9 |
| 4882.00 | 45.4 PK | 74.0 | -28.6 | 3.52 V | 66 | 41.6 | 3.8 |
| 4882.00 | 33.7 AV | 54.0 | -20.3 | 3.52 V | 66 | 29.9 | 3.8 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 78 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2480.00 | 92.8 PK | | | 3.70 H | 252 | 60.9 | 31.9 |
| *2480.00 | 91.6 AV | | | 3.70 H | 252 | 59.7 | 31.9 |
| 2483.50 | 56.5 PK | 74.0 | -17.5 | 3.65 H | 253 | 24.5 | 32.0 |
| 2483.50 | 44.2 AV | 54.0 | -9.8 | 3.65 H | 253 | 12.2 | 32.0 |
| 4960.00 | 45.8 PK | 74.0 | -28.2 | 3.43 H | 75 | 41.7 | 4.1 |
| 4960.00 | 32.1 AV | 54.0 | -21.9 | 3.43 H | 75 | 28.0 | 4.1 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2480.00 | 97.5 PK | | | 2.70 V | 350 | 65.6 | 31.9 |
| *2480.00 | 96.3 AV | | | 2.70 V | 350 | 64.4 | 31.9 |
| 2483.50 | 56.8 PK | 74.0 | -17.2 | 2.69 V | 349 | 24.8 | 32.0 |
| 2483.50 | 44.8 AV | 54.0 | -9.2 | 2.69 V | 349 | 12.8 | 32.0 |
| 4960.00 | 45.3 PK | 74.0 | -28.7 | 3.40 V | 62 | 41.2 | 4.1 |
| 4960.00 | 34.2 AV | 54.0 | -19.8 | 3.40 V | 62 | 30.1 | 4.1 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

## 8DPSK

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 0 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| 2390.00 | 55.6 PK | 74.0 | -18.4 | 3.63 H | 252 | 23.7 | 31.9 |
| 2390.00 | 33.8 AV | 54.0 | -20.2 | 3.63 H | 252 | 1.9 | 31.9 |
| *2402.00 | 91.0 PK | | | 3.72 H | 251 | 59.2 | 31.8 |
| *2402.00 | 85.7 AV | | | 3.72 H | 251 | 53.9 | 31.8 |
| 4804.00 | 45.0 PK | 74.0 | -29.0 | 3.56 H | 75 | 41.1 | 3.9 |
| 4804.00 | 31.9 AV | 54.0 | -22.1 | 3.56 H | 75 | 28.0 | 3.9 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| 2390.00 | 55.8 PK | 74.0 | -18.2 | 2.48 V | 354 | 23.9 | 31.9 |
| 2390.00 | 44.0 AV | 54.0 | -10.0 | 2.48 V | 354 | 12.1 | 31.9 |
| *2402.00 | 95.9 PK | | | 2.42 V | 350 | 64.1 | 31.8 |
| *2402.00 | 90.5 AV | | | 2.42 V | 350 | 58.7 | 31.8 |
| 4804.00 | 45.5 PK | 74.0 | -28.5 | 3.38 V | 67 | 41.6 | 3.9 |
| 4804.00 | 33.8 AV | 54.0 | -20.2 | 3.38 V | 67 | 29.9 | 3.9 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 39 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2441.00 | 93.7 PK | | | 3.81 H | 248 | 61.8 | 31.9 |
| *2441.00 | 88.6 AV | | | 3.81 H | 248 | 56.7 | 31.9 |
| 4882.00 | 45.7 PK | 74.0 | -28.3 | 3.58 H | 75 | 41.9 | 3.8 |
| 4882.00 | 31.8 AV | 54.0 | -22.2 | 3.58 H | 75 | 28.0 | 3.8 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2441.00 | 98.6 PK | | | 2.64 V | 349 | 66.7 | 31.9 |
| *2441.00 | 93.5 AV | | | 2.64 V | 349 | 61.6 | 31.9 |
| 4882.00 | 45.7 PK | 74.0 | -28.3 | 3.53 V | 68 | 41.9 | 3.8 |
| 4882.00 | 34.1 AV | 54.0 | -19.9 | 3.53 V | 68 | 30.3 | 3.8 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 78 | **Frequency Range** | 1 GHz ~ 25 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Peak (PK)<br>Average (AV) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2480.00 | 91.8 PK | | | 3.80 H | 250 | 59.9 | 31.9 |
| *2480.00 | 86.5 AV | | | 3.80 H | 250 | 54.6 | 31.9 |
| 2483.50 | 56.2 PK | 74.0 | -17.8 | 3.69 H | 254 | 24.2 | 32.0 |
| 2483.50 | 44.1 AV | 54.0 | -9.9 | 3.69 H | 254 | 12.1 | 32.0 |
| 4960.00 | 45.1 PK | 74.0 | -28.9 | 3.41 H | 89 | 41.0 | 4.1 |
| 4960.00 | 32.0 AV | 54.0 | -22.0 | 3.41 H | 89 | 27.9 | 4.1 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| *2480.00 | 96.7 PK | | | 2.73 V | 350 | 64.8 | 31.9 |
| *2480.00 | 91.5 AV | | | 2.73 V | 350 | 59.6 | 31.9 |
| 2483.50 | 56.1 PK | 74.0 | -17.9 | 2.74 V | 349 | 24.1 | 32.0 |
| 2483.50 | 44.5 AV | 54.0 | -9.5 | 2.74 V | 349 | 12.5 | 32.0 |
| 4960.00 | 45.2 PK | 74.0 | -28.8 | 3.51 V | 71 | 41.1 | 4.1 |
| 4960.00 | 34.0 AV | 54.0 | -20.0 | 3.51 V | 71 | 29.9 | 4.1 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

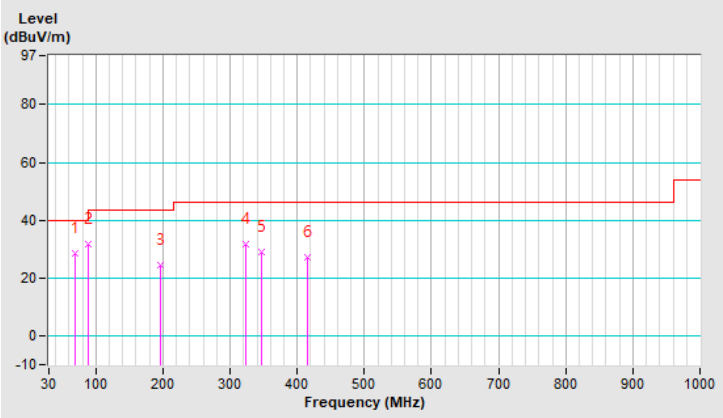
### 9 kHz ~ 30 MHz Data:

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

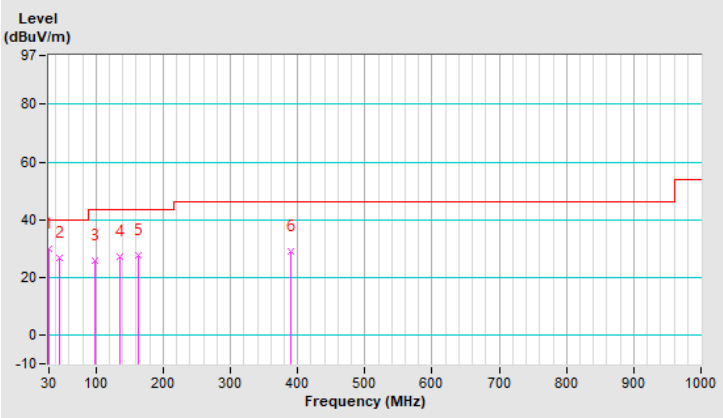
### 30 MHz ~ 1 GHz Worst-Case Data:

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 78 | **Frequency Range** | 30 MHz ~ 1 GHz |
| **Input Power** | 120 Vac, 60 Hz | **Detector Function** | Quasi-peak (QP) |
| **Environmental Conditions** | 25 deg. C, 65 % RH | **Tested By** | Han Wu |

**Horizontal**




**Vertical**



| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| 69.77 | 28.7 QP | 40.0 | -11.3 | 1.00 H | 58 | 40.2 | -11.5 |
| 88.20 | 31.9 QP | 43.5 | -11.6 | 1.00 H | 212 | 46.8 | -14.9 |
| 196.84 | 24.5 QP | 43.5 | -19.0 | 1.00 H | 193 | 36.6 | -12.1 |
| 322.94 | 31.8 QP | 46.0 | -14.2 | 1.00 H | 221 | 39.3 | -7.5 |
| 346.22 | 29.2 QP | 46.0 | -16.8 | 1.00 H | 60 | 36.3 | -7.1 |
| 415.09 | 27.3 QP | 46.0 | -18.7 | 1.00 H | 205 | 32.8 | -5.5 |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Frequency (MHz)** | **Emission Level (dBuV/m)** | **Limit (dBuV/m)** | **Margin (dB)** | **Antenna Height (cm)** | **Table Angle (Degree)** | **Read Level (dBuV)** | **Factor (dB/m)** |
| **30.97** | **29.8 QP** | **40.0** | **-10.2** | **1.00 V** | **205** | **41.6** | **-11.8** |
| 46.49 | 26.9 QP | 40.0 | -13.1 | 1.00 V | 133 | 36.7 | -9.8 |
| 97.90 | 26.0 QP | 43.5 | -17.5 | 1.00 V | 130 | 40.2 | -14.2 |
| 134.76 | 27.0 QP | 43.5 | -16.5 | 1.00 V | 181 | 37.3 | -10.3 |
| 162.89 | 27.5 QP | 43.5 | -16.0 | 1.00 V | 233 | 36.6 | -9.1 |
| 389.87 | 28.8 QP | 46.0 | -17.2 | 1.00 V | 107 | 34.8 | -6.0 |

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.

## 4.2 Conducted Emission Measurement

### 4.2.1 Limits of Conducted Emission Measurement

| Frequency (MHz) | Conducted Limit (dBuV) | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15 - 0.5 | 66 - 56 | 56 - 46 |
| 0.50 - 5.0 | 56 | 46 |
| 5.0 - 30.0 | 60 | 50 |

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.

### 4.2.2 Test Instruments

| Description & Manufacturer | Model No. | Serial No. | Date of Calibration | Due Date of Calibration |
|---|---|---|---|---|
| Test Receiver<br>ROHDE & SCHWARZ | ESCI | 100613 | Dec. 11, 2019 | Dec. 10, 2020 |
| RF signal cable<br>Woken | 5D-FB | Cable-cond1-01 | Sep. 05, 2019 | Sep. 04, 2020 |
| LISN/AMN<br>ROHDE & SCHWARZ<br>(EUT) | ENV216 | 101826 | Feb. 21, 2019 | Feb. 20, 2020 |
| LISN/AMN<br>ROHDE & SCHWARZ<br>(Peripheral) | ESH3-Z5 | 100311 | Aug. 22, 2019 | Aug. 21, 2020 |
| Software<br>ADT | BV ADT_Cond_<br>V7.3.7.4 | NA | NA | NA |

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in HwaYa Shielded Room 1.
3. The VCCI Site Registration No. is C-12040.

4.2.3 Test Procedures

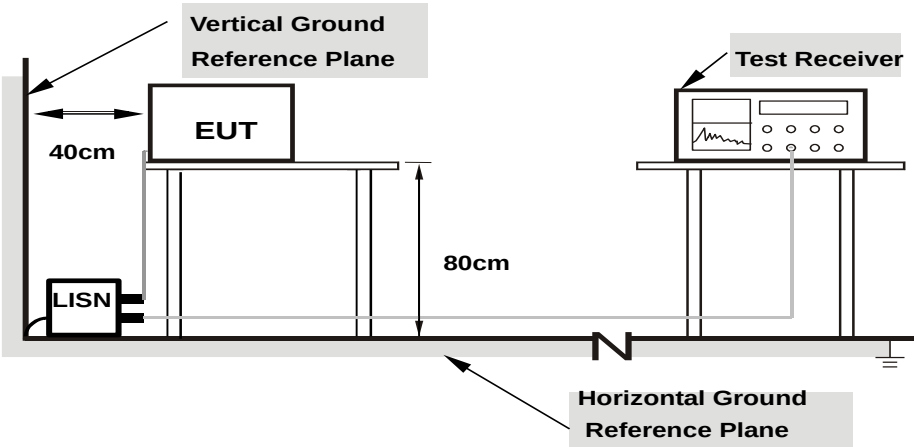
a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50 uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20 dB) was not recorded.

**Note:** The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15 MHz - 30 MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup




**Note: 1.Support units were connected to second LISN.**
**2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes**

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

4.2.6 EUT Operating Condition

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

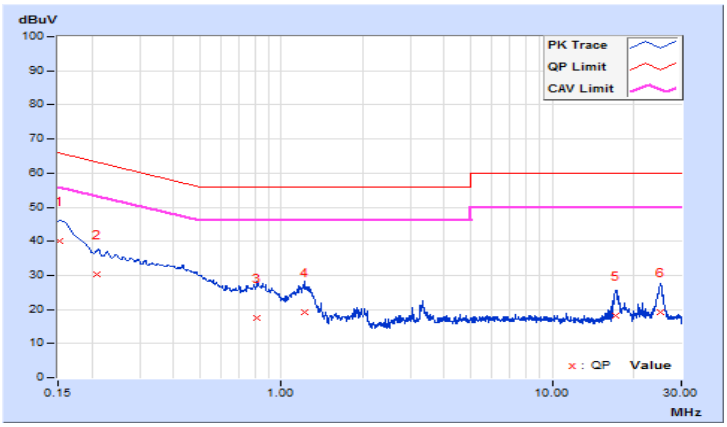
4.2.7 Test Results

| Phase | Line (L) | Detector Function & Resolution Bandwidth | Quasi-Peak (QP) / Average (AV), 9kHz |
|---|---|---|---|

| No | Freq. | Corr. Factor | Reading Value [dB (uV)] | | Emission Level [dB (uV)] | | Limit [dB (uV)] | | Margin (dB) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [MHz] | (dB) | Q.P. | AV. | Q.P. | AV. | Q.P. | AV. | Q.P. | AV. |
| 1 | 0.15225 | 10.15 | 30.00 | 6.88 | 40.15 | 17.03 | 65.88 | 55.88 | -25.73 | -38.85 |
| 2 | 0.20846 | 10.17 | 19.98 | 0.47 | 30.15 | 10.64 | 63.27 | 53.27 | -33.12 | -42.63 |
| 3 | 0.81375 | 10.24 | 7.21 | 0.97 | 17.45 | 11.21 | 56.00 | 46.00 | -38.55 | -34.79 |
| 4 | 1.21617 | 10.27 | 8.88 | 1.52 | 19.15 | 11.79 | 56.00 | 46.00 | -36.85 | -34.21 |
| 5 | 17.08125 | 10.56 | 7.74 | 3.02 | 18.30 | 13.58 | 60.00 | 50.00 | -41.70 | -36.42 |
| 6 | 25.14525 | 10.48 | 8.79 | 0.94 | 19.27 | 11.42 | 60.00 | 50.00 | -40.73 | -38.58 |

**REMARKS:**

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

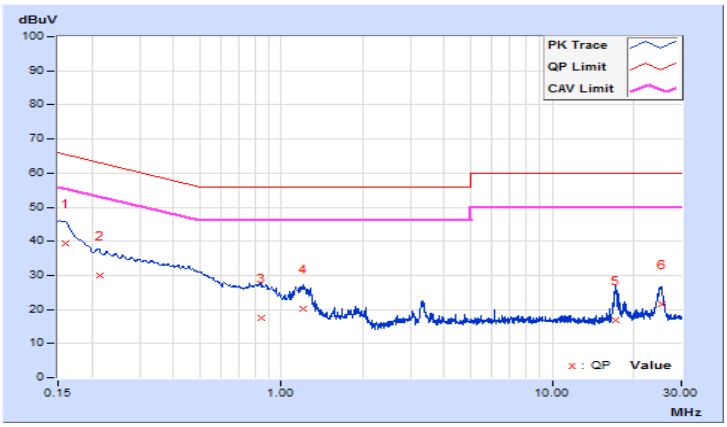


| Phase | Neutral (N) | Detector Function & Resolution Bandwidth | Quasi-Peak (QP) / Average (AV), 9kHz |
|---|---|---|---|

| No | Freq. | Corr. Factor | Reading Value [dB (uV)] | | Emission Level [dB (uV)] | | Limit [dB (uV)] | | Margin (dB) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [MHz] | (dB) | Q.P. | AV. | Q.P. | AV. | Q.P. | AV. | Q.P. | AV. |
| 1 | 0.15900 | 10.12 | 29.29 | 5.24 | 39.41 | 15.36 | 65.52 | 55.52 | -26.11 | -40.16 |
| 2 | 0.21300 | 10.13 | 19.80 | 0.04 | 29.93 | 10.17 | 63.09 | 53.09 | -33.16 | -42.92 |
| 3 | 0.84257 | 10.22 | 7.15 | 1.00 | 17.37 | 11.22 | 56.00 | 46.00 | -38.63 | -34.78 |
| 4 | 1.21200 | 10.25 | 9.82 | 1.97 | 20.07 | 12.22 | 56.00 | 46.00 | -35.93 | -33.78 |
| 5 | 17.25450 | 10.74 | 6.22 | 0.58 | 16.96 | 11.32 | 60.00 | 50.00 | -43.04 | -38.68 |
| 6 | 25.30950 | 10.65 | 10.81 | 2.82 | 21.46 | 13.47 | 60.00 | 50.00 | -38.54 | -36.53 |

**REMARKS:**

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

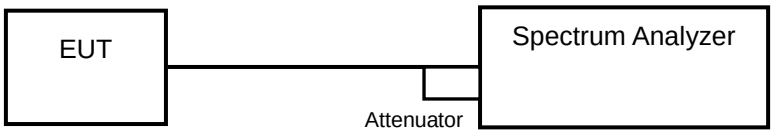


## 4.3 Number of Hopping Frequency Used

### 4.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

### 4.3.2 Test Setup




### 4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.3.4 Test Procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
d. Set the SA on View mode and then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

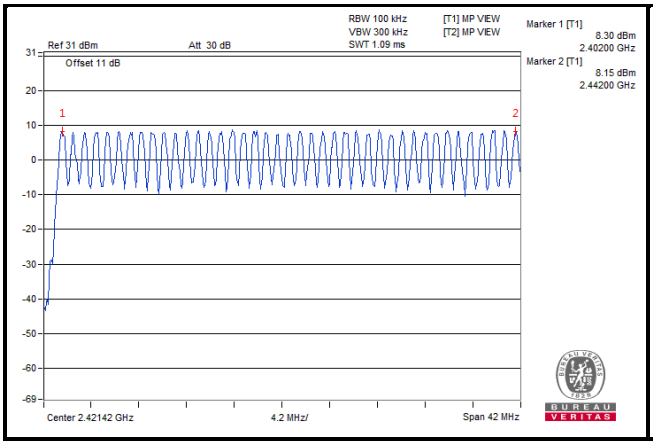
### 4.3.5 Deviation from Test Standard

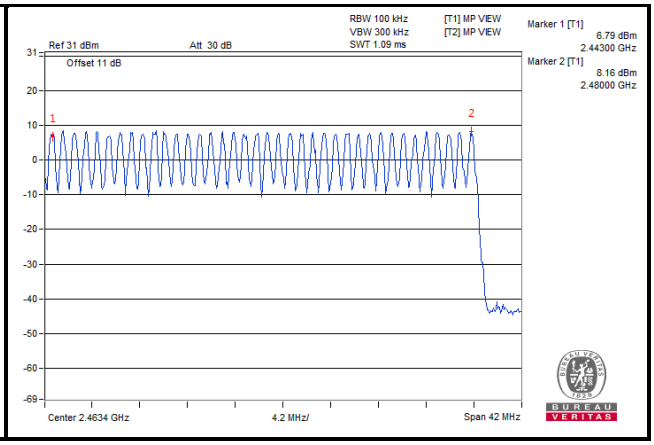
No deviation.

### 4.3.6 Test Results

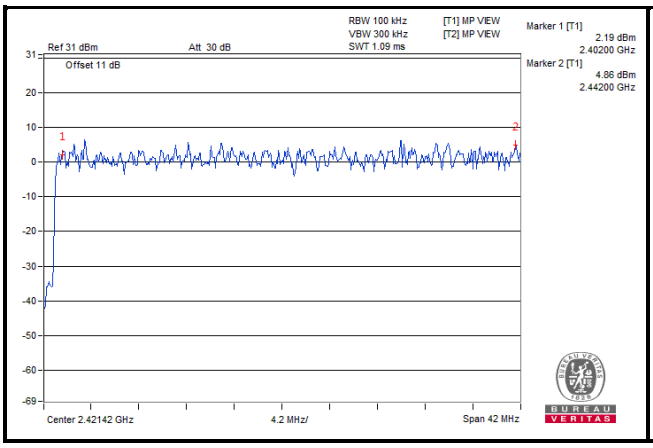
There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

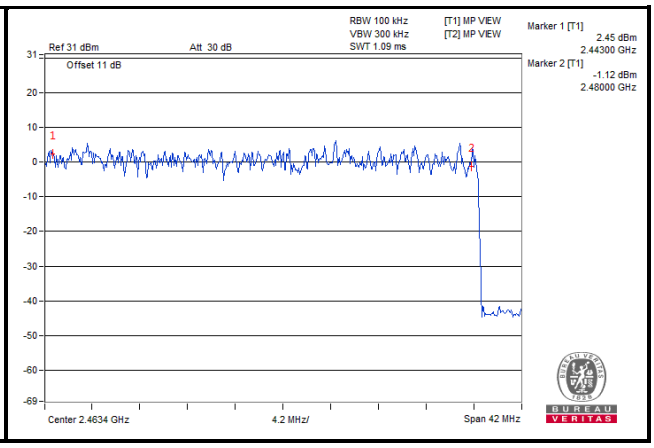
**<GFSK>**




**<8DPSK>**



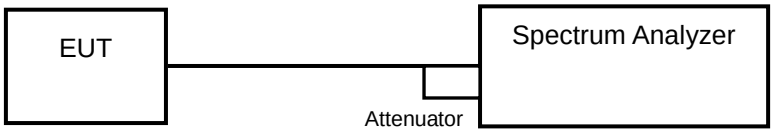



## 4.4 Dwell Time on Each Channel

### 4.4.1 Limits of Dwell Time on Each Channel Measurement

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### 4.4.2 Test Setup




### 4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.4.4 Test Procedures

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.

.

### 4.4.5 Deviation from Test Standard

No deviation.

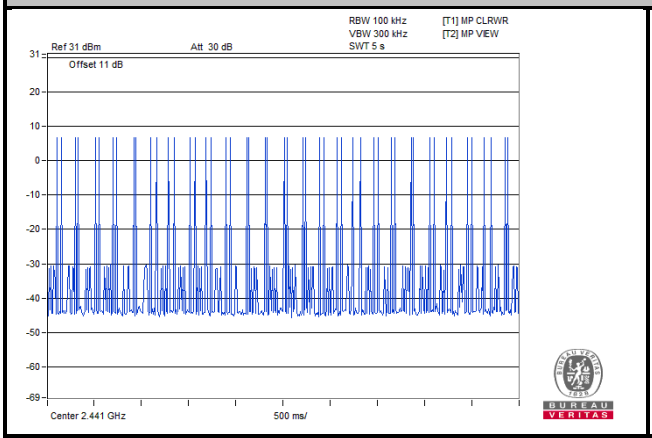
### 4.4.6 Test Results

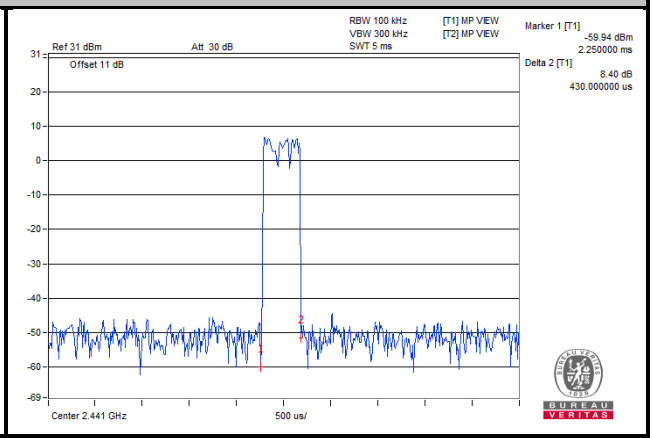
**GFSK**

| Mode | Number of Transmission in a 31.6 (79 Hopping*0.4) | Length of Transmission Time (msec) | Result (msec) | Limit (msec) |
|---|---|---|---|---|
| DH1 | 50 (times / 5 sec) * 6.32 = 316 times | 0.43 | 135.88 | 400 |
| DH3 | 27 (times / 5 sec) * 6.32 = 170.64 times | 1.69 | 288.38 | 400 |
| DH5 | 20 (times / 5 sec) * 6.32 = 126.4 times | 3.01 | 380.46 | 400 |

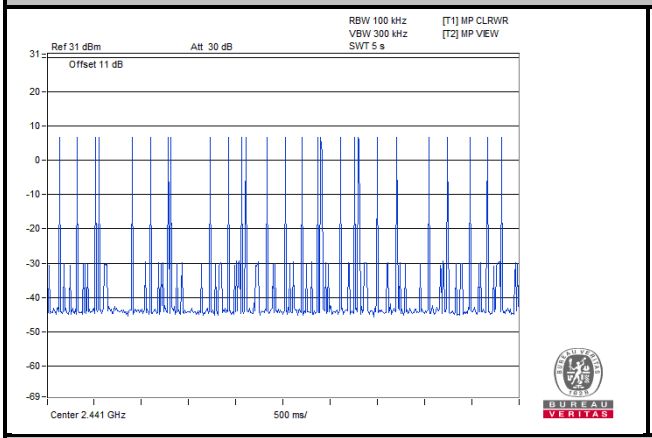
**Note:** Test plots of the transmitting time slot are shown as below.

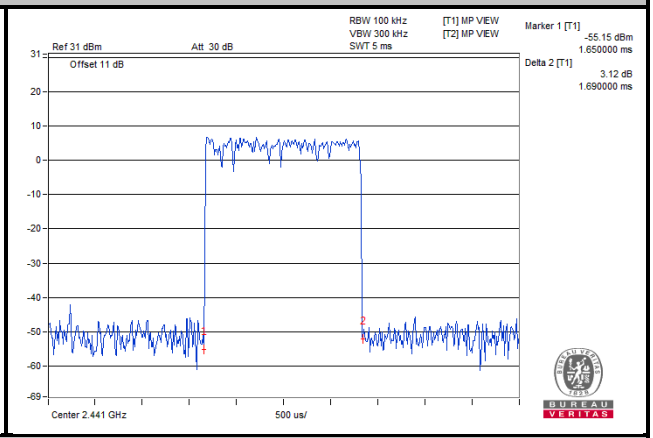
**DH1**



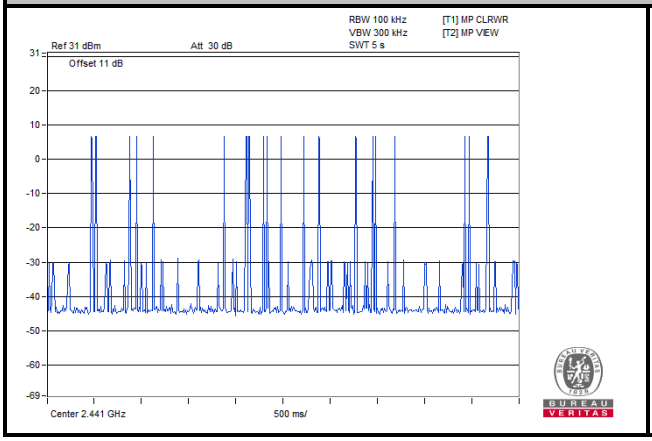



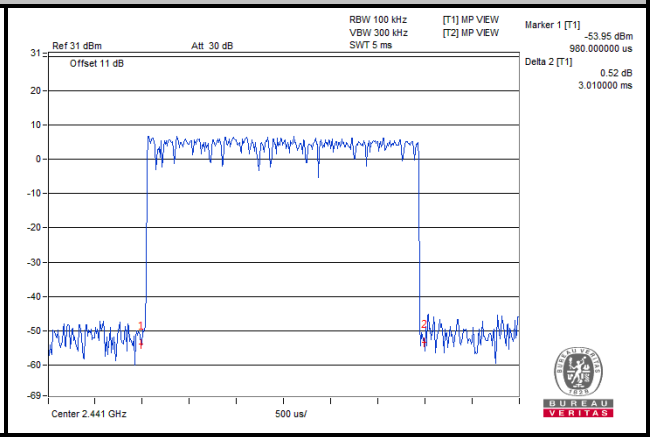

**DH3**




**DH5**



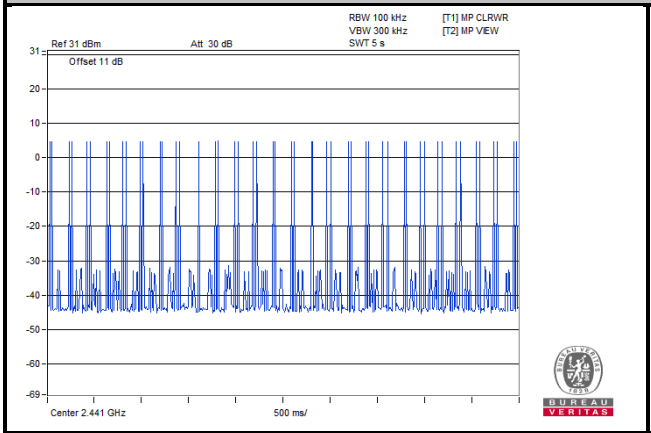



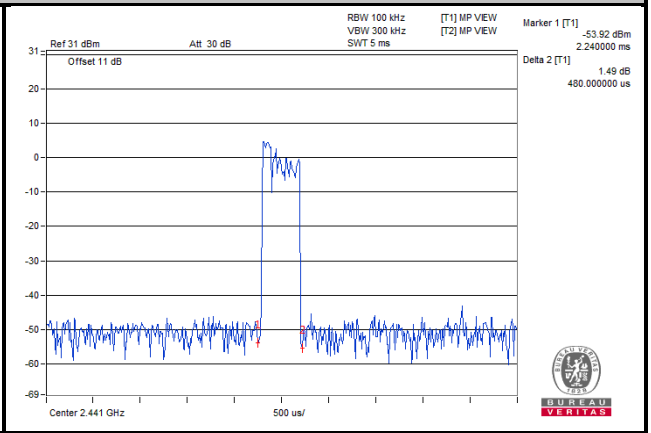
## 8DPSK

| Mode | Number of Transmission in a 31.6 (79 Hopping*0.4) | Length of Transmission Time (msec) | Result (msec) | Limit (msec) |
|---|---|---|---|---|
| 3DH1 | 50 (times / 5 sec) * 6.32 = 316 times | 0.48 | 151.68 | 400 |
| 3DH3 | 26 (times / 5 sec) * 6.32 = 164.32 times | 1.68 | 276.06 | 400 |
| 3DH5 | 16 (times / 5 sec) * 6.32 = 101.12 times | 2.99 | 302.35 | 400 |

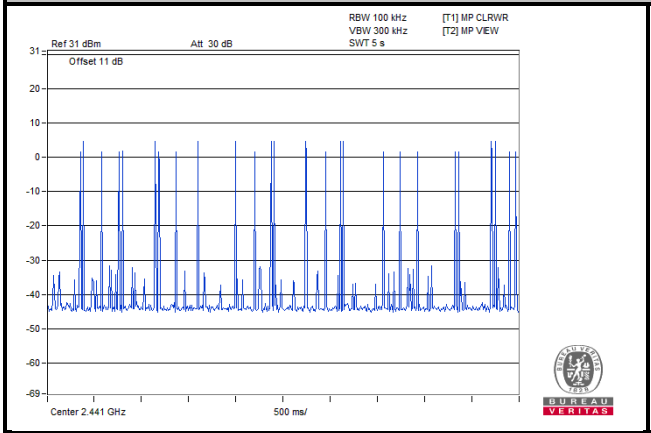
**Note:** Test plots of the transmitting time slot are shown as below.

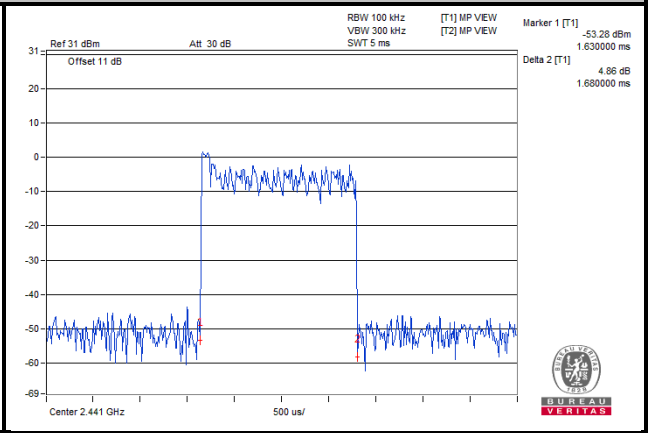
**3DH1**



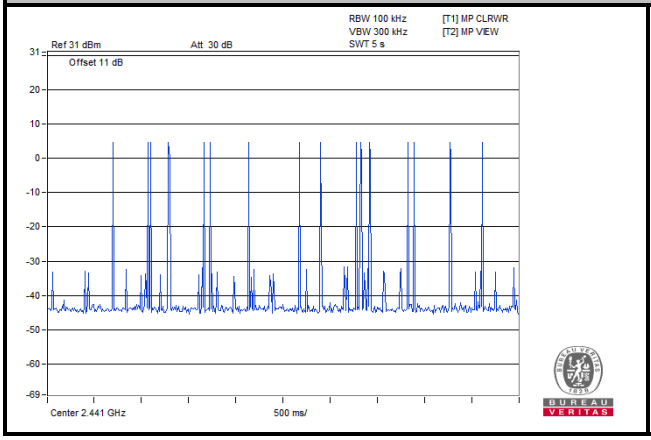



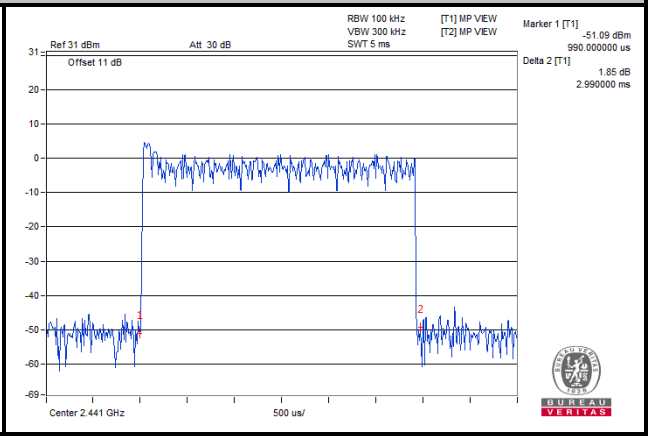

**3DH3**




**3DH5**



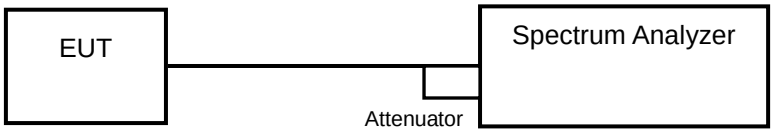



## 4.5 Channel Bandwidth

### 4.5.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5 MHz, if the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

### 4.5.2 Test Setup




### 4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.5.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
c. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

### 4.5.5 Deviation from Test Standard

No deviation.

### 4.5.6 EUT Operating Condition

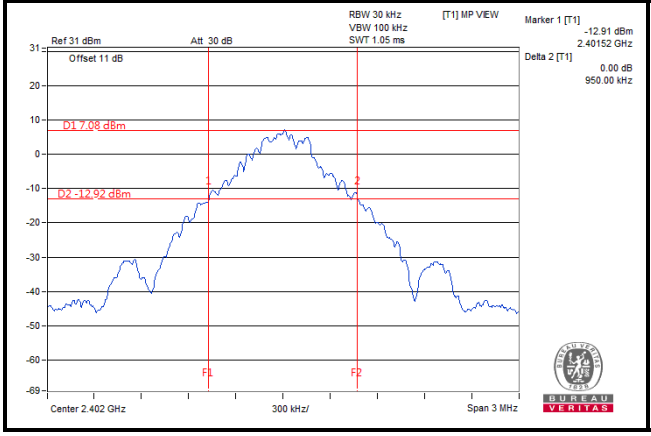
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

### 4.5.7 Test Results

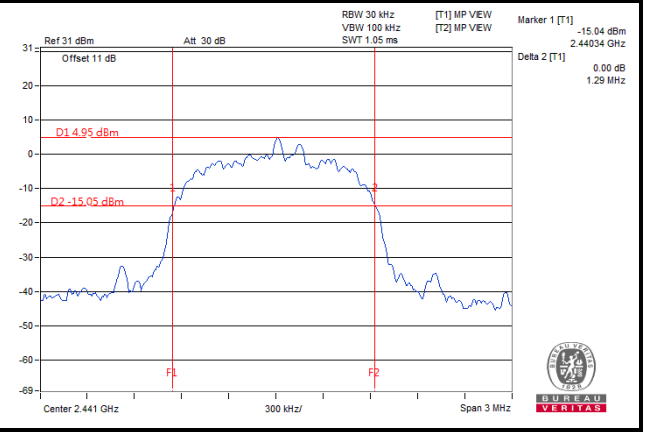
| Channel | Frequency (MHz) | 20 dB Bandwidth (MHz) | |
|---|---|---|---|
| | | GFSK | 8DPSK |
| 0 | 2402 | 0.95 | 1.28 |
| 39 | 2441 | 0.95 | 1.29 |
| 78 | 2480 | 0.95 | 1.29 |

**Spectrum Plot of Worst Value**

**GFSK**

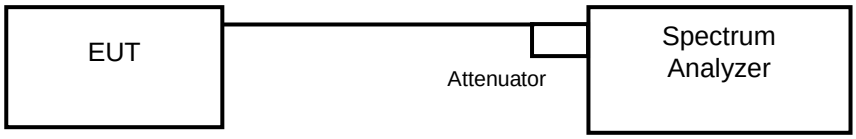



**8DPSK**



## 4.6 Occupied Bandwidth Measurement

### 4.6.1 Test Setup




### 4.6.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument

### 4.6.3 Test Procedure

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

### 4.6.4 Deviation from Test Standard

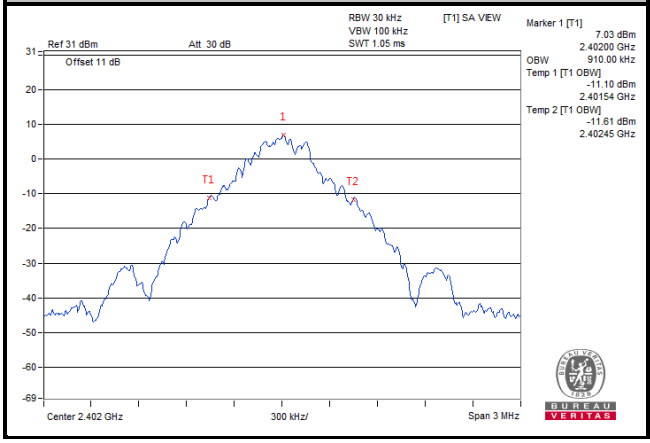
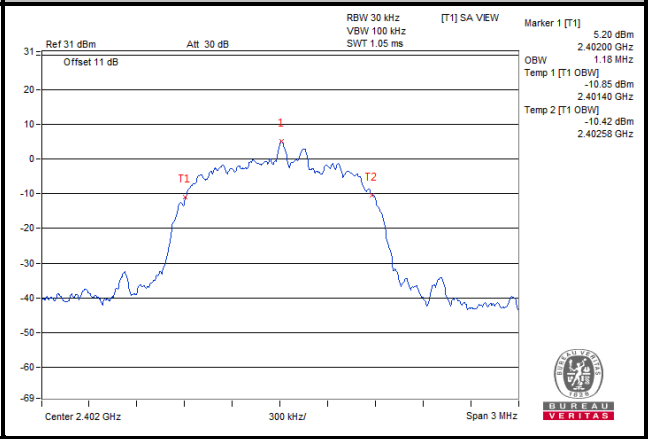
No deviation.

### 4.6.5 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

### 4.6.6 Test Results

| Channel | Frequency (MHz) | Occupied Bandwidth (MHz) | |
|---|---|---|---|
| | | GFSK | 8DPSK |
| 0 | 2402 | 0.91 | 1.18 |
| 39 | 2441 | 0.91 | 1.17 |
| 78 | 2480 | 0.91 | 1.17 |

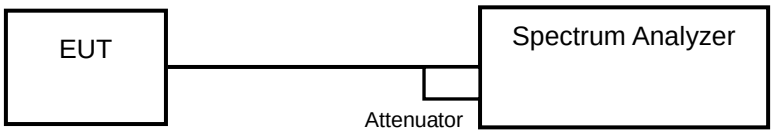
| Spectrum Plot of Worst Value | |
|---|---|
| GFSK | 8DPSK |
|  |  |

## 4.7 Hopping Channel Separation

### 4.7.1 Limits of Hopping Channel Separation Measurement

At least 25 kHz or two-third of 20 dB hopping channel bandwidth (whichever is greater).

### 4.7.2 Test Setup




### 4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.7.4 Test Procedure

Measurement Procedure REF

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
c. By using the MaxHold function record the separation of two adjacent channels.
d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

### 4.7.5 Deviation from Test Standard

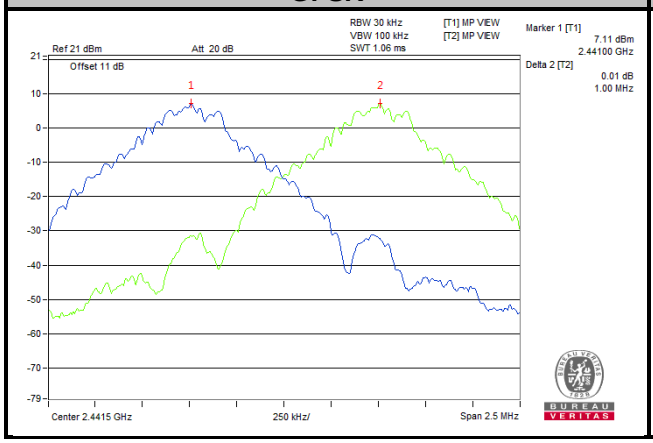
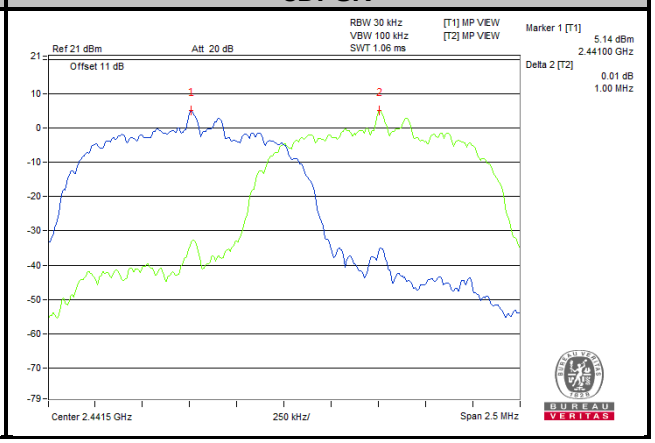
No deviation.

4.7.6 Test Results

| Channel | Freq. (MHz) | Adjacent Channel Separation (MHz) | | 20 dB Bandwidth (MHz) | | Minimum Limit (MHz) | | Pass / Fail |
|---|---|---|---|---|---|---|---|---|
| | | GFSK | 8DPSK | GFSK | 8DPSK | GFSK | 8DPSK | |
| 0 | 2402 | 1.00 | 1.00 | 0.95 | 1.28 | 0.64 | 0.86 | Pass |
| 39 | 2441 | 1.00 | 1.00 | 0.95 | 1.29 | 0.64 | 0.86 | Pass |
| 78 | 2480 | 1.00 | 1.00 | 0.95 | 1.29 | 0.64 | 0.86 | Pass |

**Note:**

1. The minimum limit is two-third 20 dB bandwidth.

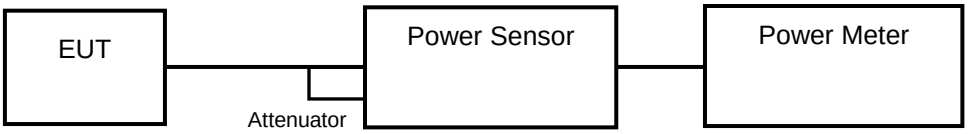
| Spectrum Plot of Worst Value | |
|---|---|
| GFSK | 8DPSK |
|  |  |

## 4.8 Maximum Output Power

### 4.8.1 Limits of Maximum Output Power Measurement

Refer to Regulation 15.247 (a)(1), the Maximum Output Power Measurement is 125 mW.

### 4.8.2 Test Setup




### 4.8.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.8.4 Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

### 4.8.5 Deviation from Test Standard

No deviation.

### 4.8.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.7 Test Results

<GFSK>

| Channel | Freq. (MHz) | Peak Power (mW) | Peak Power (dBm) | Power Limit (mW) | Pass / Fail |
|---|---|---|---|---|---|
| 0 | 2402 | 6.966 | 8.43 | 125 | Pass |
| 39 | 2441 | 6.745 | 8.29 | 125 | Pass |
| 78 | 2480 | 6.18 | 7.91 | 125 | Pass |

<8DPSK>

| Channel | Freq. (MHz) | Peak Power (mW) | Peak Power (dBm) | Power Limit (mW) | Pass / Fail |
|---|---|---|---|---|---|
| 0 | 2402 | 6.383 | 8.05 | 125 | Pass |
| 39 | 2441 | 7.295 | 8.63 | 125 | Pass |
| 78 | 2480 | 6.855 | 8.36 | 125 | Pass |

## 4.9 Conducted Out of Band Emission Measurement

### 4.9.1 Limits Of Conducted Out of Band Emission Measurement

Below –20 dB of the highest emission level of operating band (in 100 kHz RBW).

### 4.9.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.9.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

### 4.9.4 Deviation from Test Standard

No deviation.

### 4.9.5 EUT Operating Condition

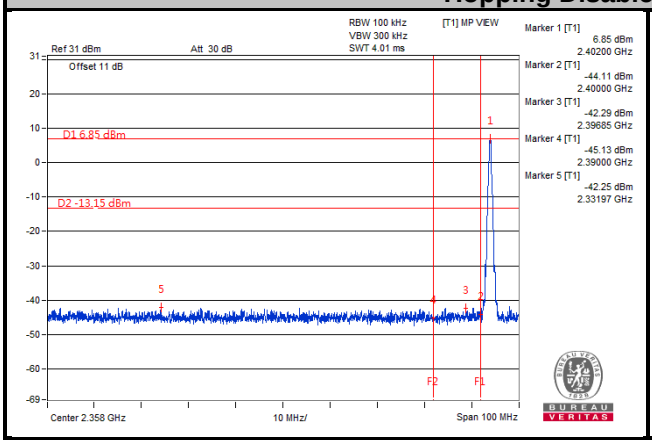
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

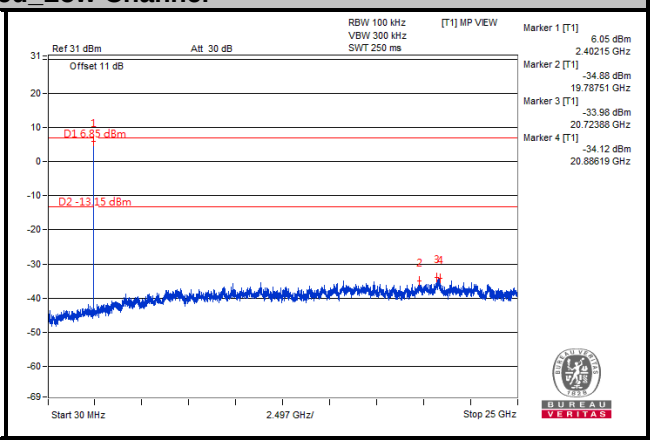
### 4.9.6 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20 dB offset below D1. It shows compliance with the requirement.

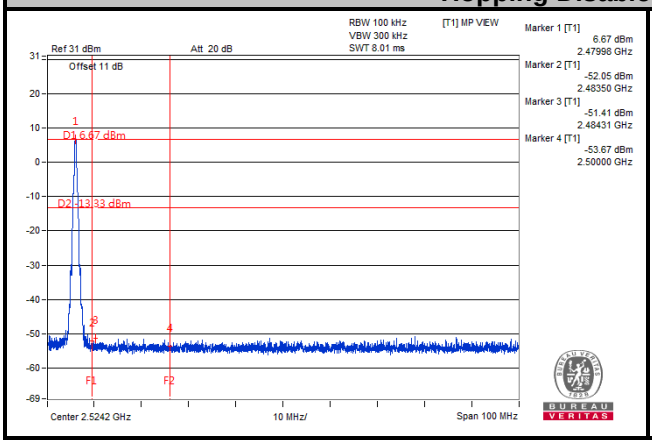
## GFSK

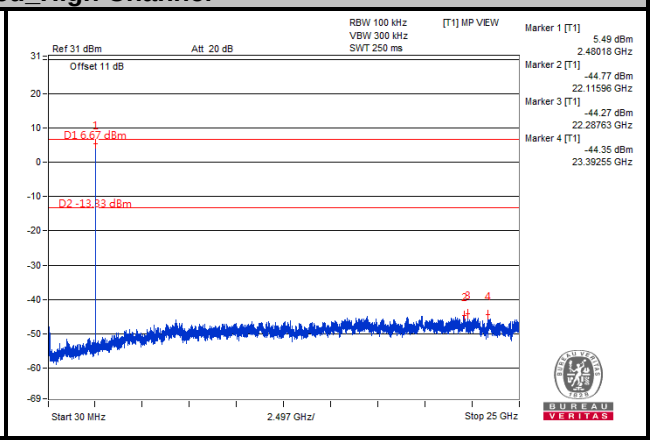
### Hopping Disabled_Low Channel



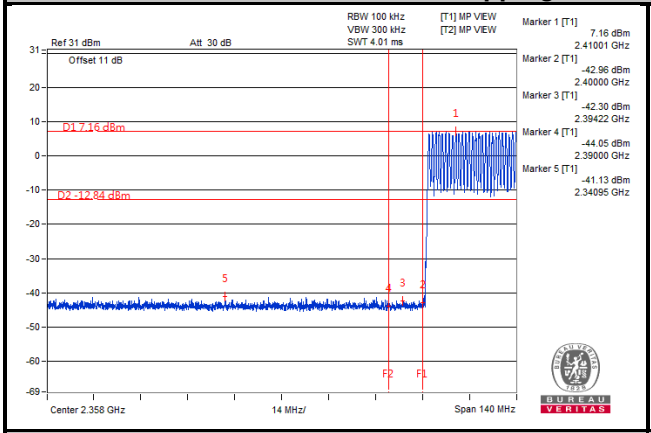



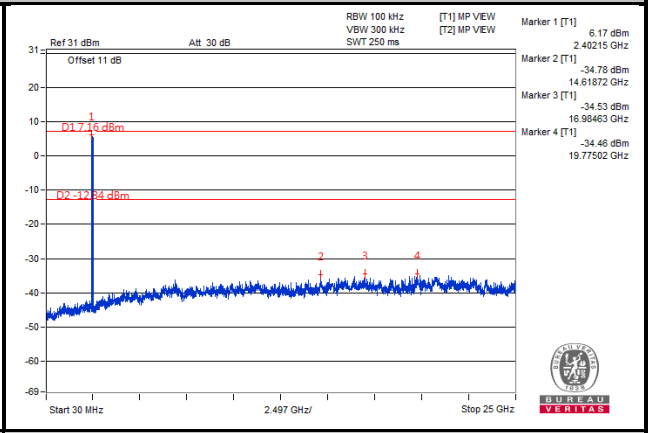

### Hopping Disabled_High Channel



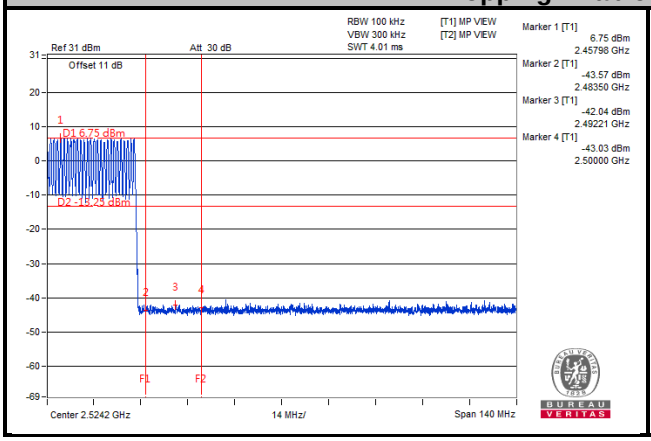



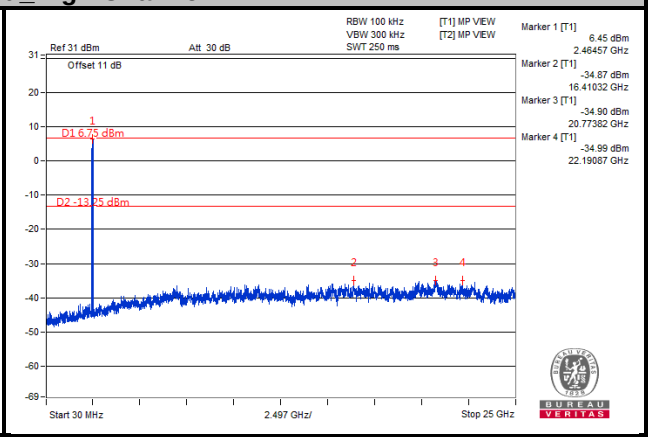
## Hopping Enabled_Low Channel



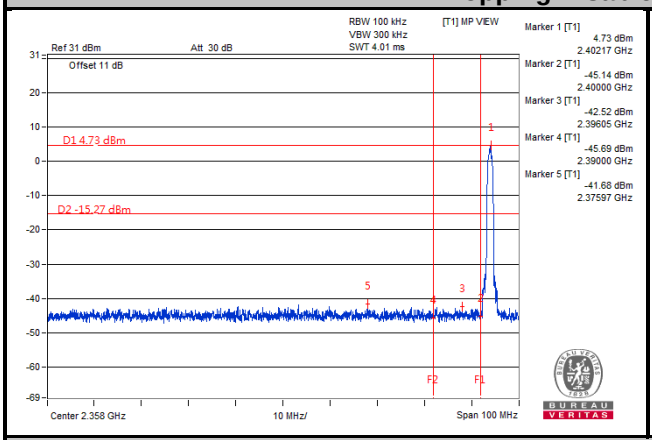

## Hopping Enabled_High Channel

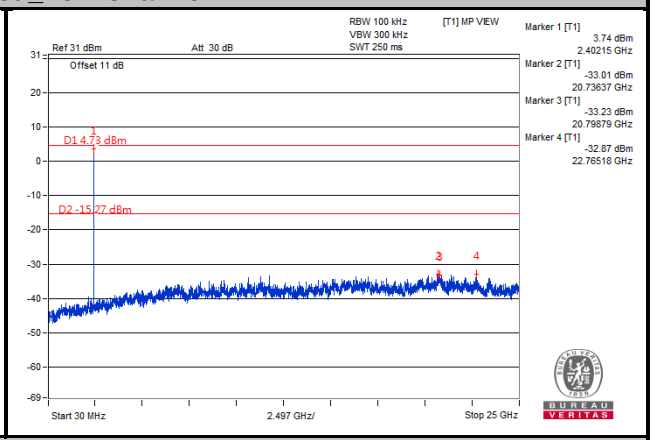


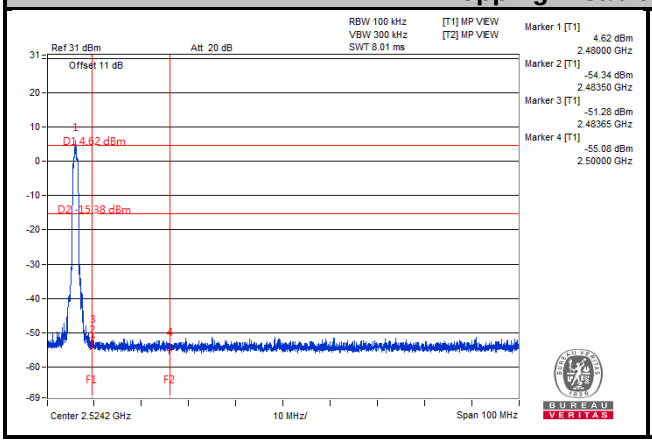
## 8DPSK

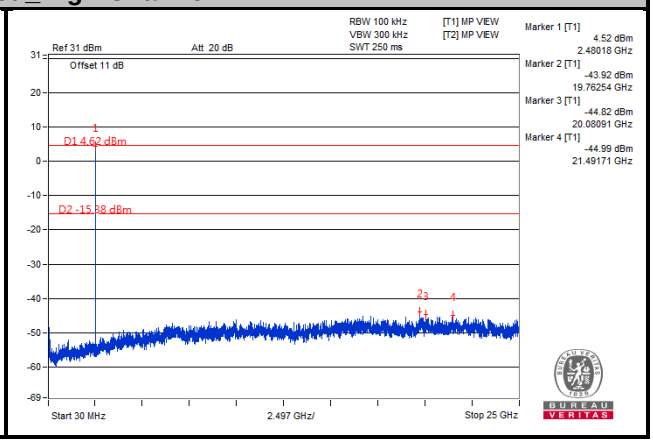
### Hopping Disabled_Low Channel



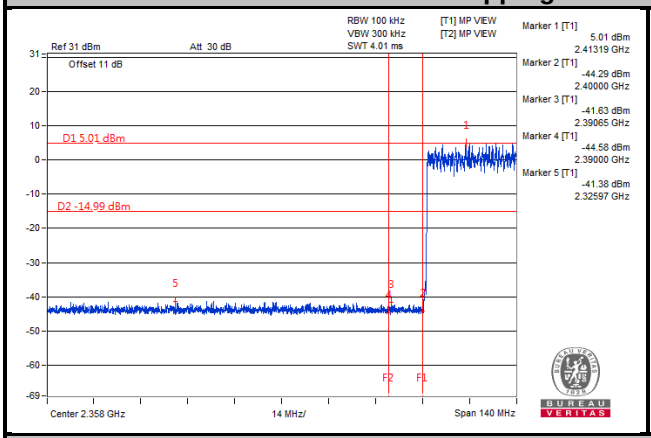



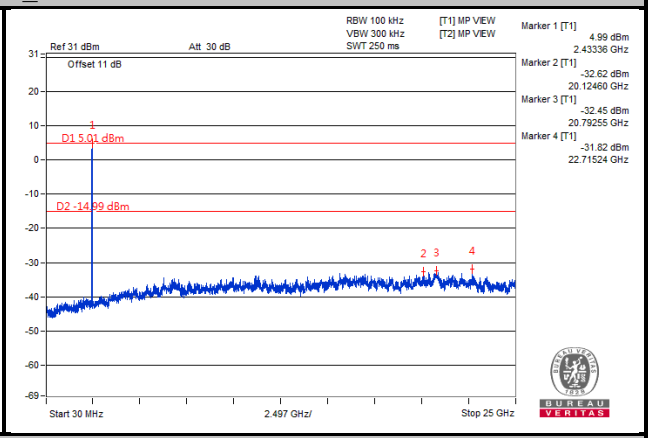

### Hopping Disabled_High Channel



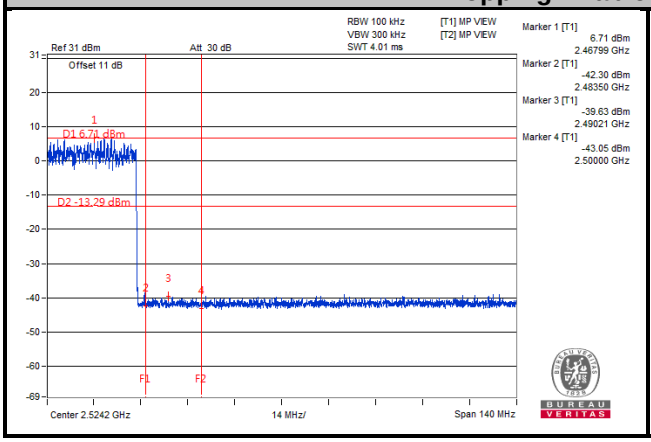



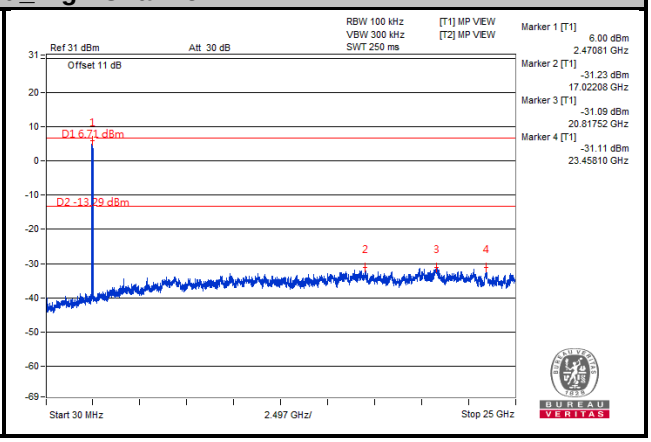
## Hopping Enabled_Low Channel




## Hopping Enabled_High Channel



## 5 Pictures of Test Arrangements

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

**Appendix – Information of the Testing Laboratories**

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following: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The address and road map of all our labs can be found in our web site also.

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