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# TEST REPORT

## FCC/IC BT Test for ATB41HSAN&ATB41HSKN

## Certification

APPLICANT
HYUNDAI MOBIS CO., LTD.

REPORT NO.
HCT-RF-2003-FI006

DATE OF ISSUE
March 20, 2020

**HCT Co., Ltd.**
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# TEST REPORT

FCC/IC BT Test for ATB41HSAN& ATB41HSKN

REPORT NO.
HCT-RF-2003-FI006

DATE OF ISSUE
March 20, 2020

Additional Model
FCC: ATB40HSAN
IC: ATB40HSKN

| | |
|---|---|
| Applicant | **HYUNDAI MOBIS CO., LTD.**<br>203, Teheran-ro, Gangnam-gu, Seoul, 135-977, South Korea |
| Eut Type | Car Audio System |
| FCC Model Name | ATB41HSAN |
| IC Model Name | ATB41HSKN |
| FCC ID | TQ8-ATB41HSAN |
| IC | 5074A-ATB41HSKN |
| Max. RF Output Power | 4.129 dBm (2.59 mW) |
| Modulation type | GFSK(Normal), π/4DQPSK and 8DPSK(EDR) |
| FCC Classification | FCC Part 15 Spread Spectrum Transmitter |
| FCC Rule Part(s) | Part 15 subpart C 15.247 |
| IC Rule Part(s) | RSS-247 Issue 2 (February 2017)<br>RSS-Gen Issue 5_Amendment 1 (March 2019) |

This test results were applied only to the test methods required by the standard.

Tested by
Jeong Ho Kim (signature)

Technical Manager
Jong Seok Lee (signature)

HCT CO., LTD.
Soo Chan Lee
SooChan Lee / CEO

## REVISION HISTORY

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

| Revision No. | Date of Issue | Description |
|---|---|---|
| 0 | March 20, 2020 | Initial Release |

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

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

## CONTENTS

## 1. EUT DESCRIPTION

| | |
|---|---|
| FCC Model | ATB41HSAN |
| IC Model | ATB41HSKN |
| FCC Additional Model | ATB40HSAN |
| IC Additional Model | ATB40HSKN |
| EUT Type | Car Audio System |
| Power Supply | DC 14.4 V |
| Frequency Range | 2402 MHz - 2480 MHz |
| Max. RF Output Power | 4.129 dBm (2.59 mW) |
| BT Operating Mode | Normal, EDR, AFH |
| Modulation Type | GFSK(Normal), π/4DQPSK and 8DPSK(EDR) |
| Modulation Technique | FHSS |
| Number of Channels | 79Channels, Minimum 20 Channels(AFH) |
| Antenna Specification | Antenna type: Bluetooth Single Band Antenna<br>Peak Gain : -0.38 dBi |
| Date(s) of Tests | February 25, 2020 ~ March 20, 2020 |
| PMN<br>(Product Marketing Number) | ATB41HSKN, ATB40HSKN |
| HVIN<br>(Hardware Version Identification Number) | ATB41HSKN, ATB40HSKN |
| FVIN<br>(Firmware Version Identification Number) | N/A |
| HMN<br>(Host Marketing Name) | N/A |

## 2. Requirements for Bluetooth transmitter(15.247)

This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:

1) This system is hopping pseudo-randomly.
2) Each frequency is used equally on the average by each transmitter.
3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
4) The receiver shifts frequencies in synchronization with the transmitted signals.

- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

- RSS-247 5.1 (a): The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

# 3. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device (ANSI C63.10-2013, KDB 558074) is used in the measurement of the test device.

## EUT CONFIGURATION

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

## EUT EXERCISE

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

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the RSS-GEN issue 5, RSS-247 issue 2.

## GENERAL TEST PROCEDURES

**Conducted Emissions**

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

**Radiated Emissions**

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 6.6.5 of ANSI C63.10. (Version: 2013). To record the final measurements, the analyzer detector function was set to CISPR quasi-peak mode and the bandwidth of the spectrum analyzer was set to 120 kHz for frequencies below 1 GHz or 1 MHz for frequencies above 1 GHz. For average measurements above 1 GHz, the analyzer was set to peak detector with a reduced VBW setting(RBW = 1 MHz, VBW = 1/T Hz, where T = Pulse width).

### DESCRIPTION OF TEST MODES

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

## 4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

## 5. FACILITIES AND ACCREDITATIONS

### FACILITIES

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

### EQUIPMENT

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

## 6. ANTENNA REQUIREMENTS

**According to FCC 47 CFR § 15.203:**

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

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

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

**According to RSS-GEN(Issue 5) Section 6.8:**

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested..

## 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of
ANSI C63.10-2013.
All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.
The measurement data shown herein meets or exceeds the $U_{CISPR}$ measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

| Parameter | Expanded Uncertainty (±dB) |
|---|---|
| Conducted Disturbance (150 kHz ~ 30 MHz) | 1.82 |
| Radiated Disturbance (9 kHz ~ 30 MHz) | 3.40 |
| Radiated Disturbance (30 MHz ~ 1 GHz) | 4.80 |
| Radiated Disturbance (1 GHz ~ 18 GHz) | 5.70 |
| Radiated Disturbance (18 GHz ~ 40 GHz) | 5.05 |

# 8. DESCRIPTION OF TESTS

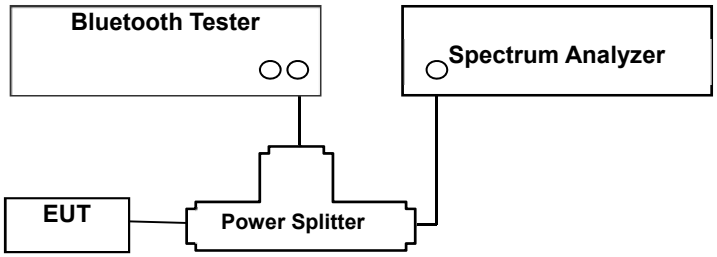
## 8.1. Conducted Maximum Peak Output Power

**Limit**

The maximum peak output power of the intentional radiator shall not exceed the following:

1. For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 W. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 W.
2. The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

**Test Configuration**




**Test Procedure**

The transmitter output is connected to the Spectrum Analyzer. The Spectrum Analyzer is set to the peak detector mode. This test is performed with hopping off.

The Spectrum Analyzer is set to (7.8.5 in ANSI 63.10-2013 & Procedure 10(b)(6)(i) in KDB 558074 v05r02)

1) Span: approximately 5 times the 20 dB bandwidth, centered on a hopping channel
2) RBW > the 20 dB bandwidth of the emission being measured
3) VBW ≥ RBW
4) Sweep = Auto
5) Detector = Peak
6) Trace = Max hold

**Sample Calculation**

Output Power = Spectrum Reading Power + Power Splitter loss + Cable loss(2 ea)

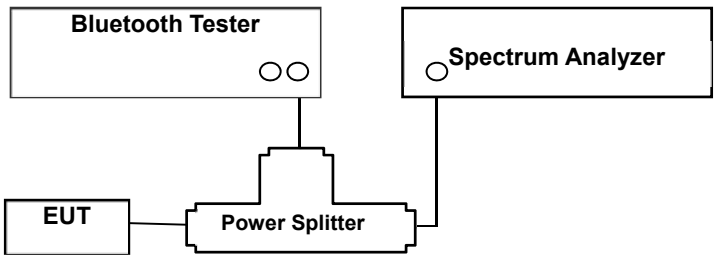
= 10 dBm + 6 dB + 1.5 dB = 17.5 dBm

## 8.2. Conducted Band Edge(Out of Band Emissions)

### Limit

According to § 15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

### Test Configuration




### Test Procedure

This test is performed with hopping off and hopping on.

The Spectrum Analyzer is set to (6.10.4 in ANSI 63.10-2013 & Procedure 8.5 and 8.6 in KDB 558074 v05r02)

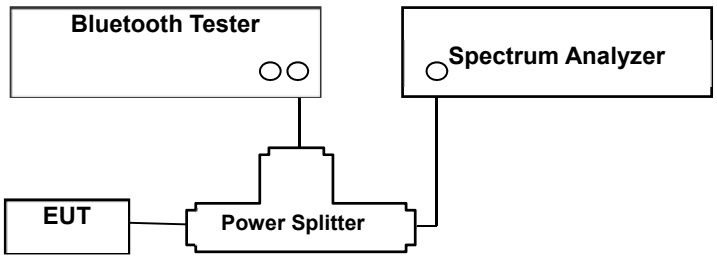
1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
3) Attenuation: Auto (at least 10 dB preferred).
4) Sweep time: Coupled.
5) RBW: 100 kHz
6) VBW: 300 kHz
7) Detector: Peak
8) Trace: Max hold

## 8.3. Frequency Separation & 20 dB Bandwidth

### Limit

According to § 15.247(a)(1), Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

### Test Configuration




### Test Procedure(Frequency Separation)

The Channel Separation test is performed with hopping on.
And the 20 dB Bandwidth test is performed with hopping off.

The Spectrum Analyzer is set to (7.8.2 in ANSI 63.10-2013 & Procedure 10(b)(6)(iii) in KDB 558074 v05r02)

1) Span: Wide enough to capture the peaks of two adjacent channels
2) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
3) VBW ≥ RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) All the trace to stabilize.
8) Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

**Test Procedure (20 dB Bandwidth)**

And the 20 dB Bandwidth test is performed with hopping off.

The Spectrum Analyzer is set to (6.9.2 in ANSI 63.10-2013)

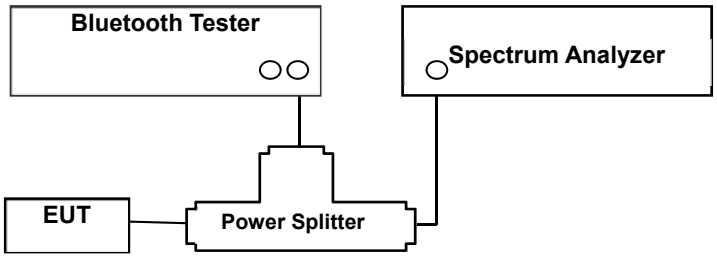
1) Span: Set between two times and five times the OBW
2) RBW: 1% to 5% of the OBW.
3) VBW ≥ 3 x RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) All the trace to stabilize.

## 8.4. Number of Hopping Frequencies

### Limit

According to § 15.247(a)(1)(iii), Frequency hopping systems operating in the 2400 MHz ~ 2483.5 MHz bands shall use at least 15 hopping frequencies.

### Test Configuration




### Test Procedure

The Bluetooth frequency hopping function of the EUT was enabled.

The Spectrum Analyzer is set to (7.8.3 in ANSI 63.10-2013 & Procedure 10(b)(4) in KDB 558074 v05r02)

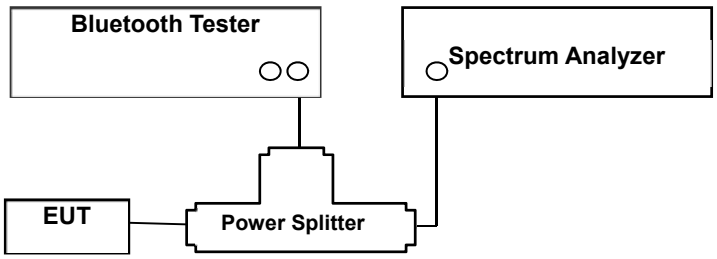
1) Span: the frequency band of operation
2) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3) VBW ≥ RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) Allow the trace to stabilize.

## 8.5. Time of Occupancy

### Limit

According to § 15.247(a)(1)(iii), Frequency hopping systems operating in the 2400 MHz ~ 2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

### Test Configuration




### Test Procedure

This test is performed with hopping off.

The Spectrum Analyzer is set to (7.8.4 in ANSI 63.10-2013 & Procedure 10(b)(6)(iv) in KDB 558074 v05r02)

1) Span: Zero span, centered on a hopping channel
2) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
3) Sweep = as necessary to capture the entire dwell time per hopping channel
4) Detector: Peak
5) Trace: Max hold

The marker-delta function was used to determine the dwell time.

**Sample Calculation**

The following calculation process is not relevant to our measurement results. It is just an example.

(1) Non-AFH Mode

- DH 5 (GFSK) : 2.890 x (1600/6)/79 x 31.6 = 308.27 (ms)
- 2-DH 5 (π/4DQPSK) : 2.890 x (1600/6)/79 x 31.6 = 308.27 (ms)
- 3-DH 5 (8DPSK) : 2.890 x (1600/6)/79 x 31.6 = 308.27 (ms)

(2) AFH Mode

- DH 5 (GFSK) : 2.890 x (800/6)/20 x 8.0 = 154.13 (ms)
- 2-DH 5 (π/4DQPSK) : 2.890 x (800/6)/20 x 8.0 = 154.13 (ms)
- 3-DH 5 (8DPSK) : 2.890 x (800/6)/20 x 8.0 = 154.13 (ms)

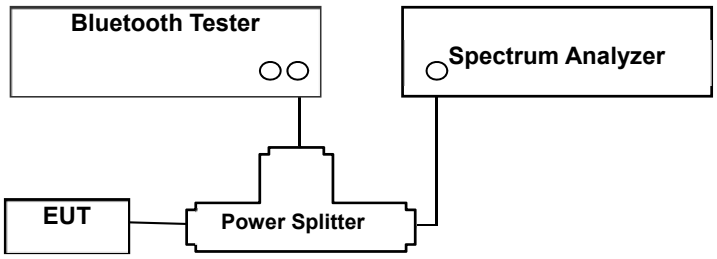
Note :
DH5 Packet need 5 time slot for transmitting and 1 time slot for receiving.
Then the system makes worst case 1600/6 hops per second with 79 channels. So the system have each channel 3.3755 times per second and so for 31.6 seconds the system have 106.667 times of appearance.
Each tx-time per appearance of DH5 is 2.890 ms.
Dwell time = Tx-time x 106.667 = 308.27 (ms)

## 8.6. Conducted Spurious Emissions

### Limit

Conducted > 20 dBc

### Test Configuration




### Test Procedure

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

The transmitter output is connected to the spectrum analyzer.
The Spectrum Analyzer is set to (7.8.8 in ANSI 63.10-2013 & Procedure 8.5 and 8.6 in KDB 558074 v05r02)

1) Span: 30 MHz to 10 times the operating frequency in GHz.
2) RBW: 100 kHz
3) VBW: 300 kHz
4) Sweep: Coupled
5) Detector: Peak

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.
This test is performed with hopping off.

Factors for frequency

| Freq(MHz) | Factor(dB) |
|---|---|
| 30 | 6.93 |
| 100 | 7.01 |
| 200 | 7.19 |
| 300 | 7.19 |
| 400 | 7.25 |
| 500 | 7.28 |
| 600 | 7.28 |
| 700 | 7.32 |
| 800 | 7.34 |
| 900 | 7.38 |
| 1000 | 7.40 |
| 2000 | 7.67 |
| 2400 | 7.76 |
| 2500 | 7.78 |
| 3000 | 7.88 |
| 4000 | 8.04 |
| 5000 | 8.23 |
| 6000 | 8.30 |
| 7000 | 8.45 |
| 8000 | 8.57 |
| 9000 | 8.69 |
| 10000 | 8.83 |
| 11000 | 8.91 |
| 12000 | 9.07 |
| 13000 | 9.26 |
| 14000 | 9.20 |
| 15000 | 9.30 |
| 16000 | 9.35 |
| 17000 | 9.42 |
| 18000 | 9.54 |
| 19000 | 9.60 |
| 20000 | 9.78 |
| 21000 | 9.97 |
| 22000 | 10.03 |
| 23000 | 10.06 |
| 24000 | 10.14 |
| 25000 | 10.27 |
| 26000 | 10.37 |

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

2. Factor = Cable loss(2 EA) + Splitter loss(6 dB) + EUT Cable(For Conducted)

## 8.7. Radiated Test

**Limit**

**FCC**

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

**IC**

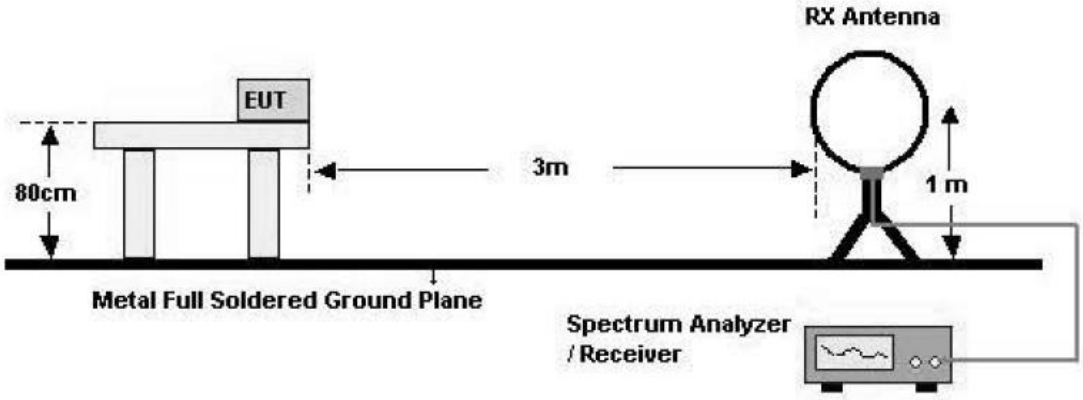
| Frequency (MHz) | Field Strength (uA/m) | Measurement Distance (m) |
|---|---|---|
| 0.009 – 0.490 | 6.37/F(kHz) | 300 |
| 0.490 – 1.705 | 63.7/F(kHz) | 30 |
| 1.705 – 30 | 0.08 | 30 |

**FCC&IC**

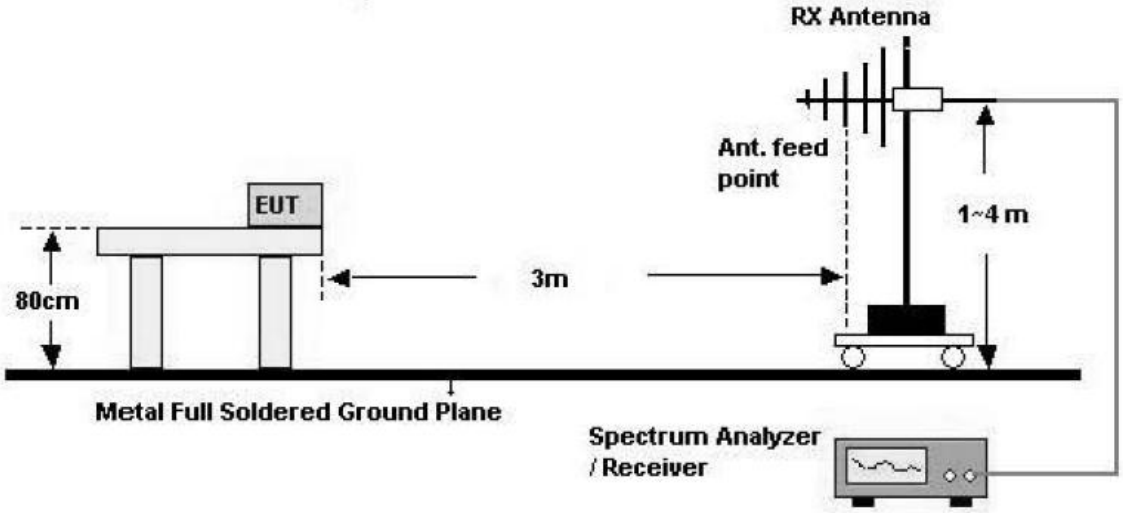
| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
|---|---|---|
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

## Test Configuration

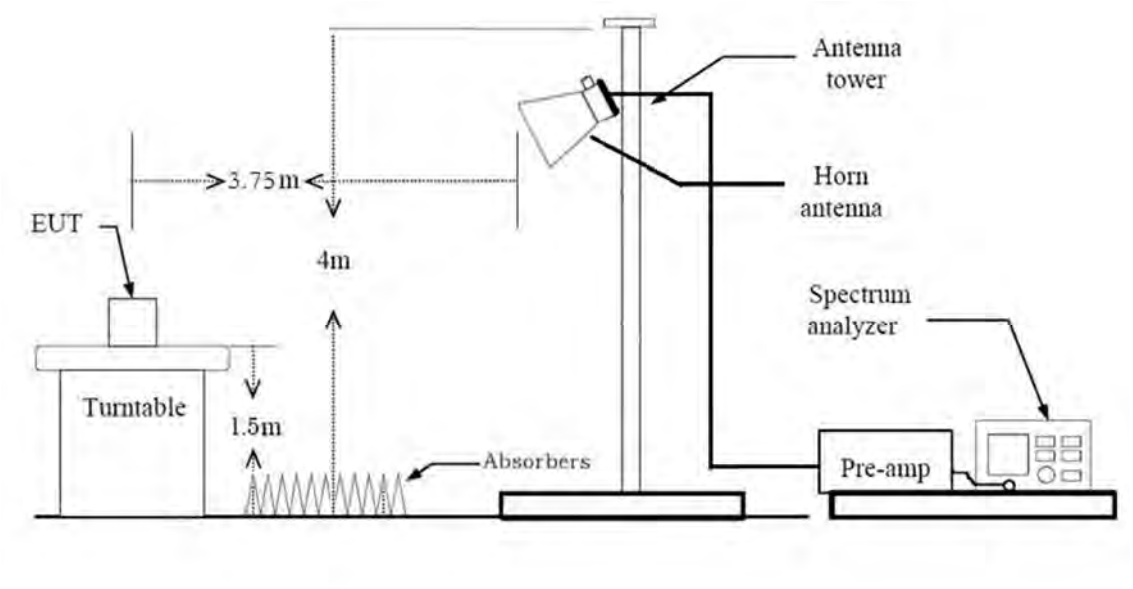
Below 30 MHz




30 MHz - 1 GHz



Above 1 GHz




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

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

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

**KDB 414788 OFS and Chamber Correlation Justification**

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

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

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

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 100 kHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz

   In general, (1) is used mainly
6. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)
7. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

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

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor( reference distance : 3 m).
   - ◆ Distance extrapolation factor = 20log (test distance / specific distance) (dB)
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. The unit was tested with its standard battery.
10. Spectrum Setting
    (1) Measurement Type(Peak):
    - Measured Frequency Range : 1 GHz – 25 GHz
    - Detector = Peak
    - Trace = Maxhold
    - RBW = 1 MHz
    - VBW ≥ 3 x RBW

    (2) Measurement Type(Average):
    - Average value of pulsed emissions
    - Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in Number.13 (On Page. 25)
    - ◆ Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB
11. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
12. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

**Test Procedure of Radiated Restricted Band Edge**

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor( reference distance : 3 m).
   - ◆ Distance extrapolation factor = 20log (test distance / specific distance) (dB)
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.

9. Spectrum Setting
   (1) Measurement Type(Peak):
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 3 x RBW

   (2) Measurement Type(Average):
   - Average value of pulsed emissions
   - Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in Number.13 (On Page. 25)
   - ◆ Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB

10. Total
    = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

11. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

12. Duty Cycle Correction Factor (79 channel hopping)

a. Time to cycle through all channels= Δ t= τ [ms] x 79 channels = 229.100 ms, where τ = pulse width

b. 100 ms/ Δt [ms] = H → Round up to next highest integer, H ' =1

c. Worst Case Dwell Time = τ [ms] x H ' = 2.9 ms

d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100ms) dB = -30.752 dB

13. Duty Cycle Correction Factor(AFH mode – minimum channel number case - 20 channels)

a. Time to cycle through all channels= Δ t= τ [ms] x 20 channels = 58.00 ms, where τ = pulse width

b. 100 ms/ Δt [ms] = H → Round up to next highest integer, H ' = 2

c. Worst Case Dwell Time = τ [ms] x H ' = 5.800 ms

d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100ms) dB = -24.7314 dB

## 8.8. AC Power line Conducted Emissions

### Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).

| Frequency Range (MHz) | Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56[a] | 56 to 46[a] |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

[a]Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

### Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

### Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.
5. The EUT is the device operating below 30 MHz.
   - For unterminated the Antenna, the AC line conducted tests are performed with the antenna connected
   - For terminated the Antenna, the AC line conducted tests are performed with a dummy load connected to the EUT antenna output terminal.

### Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

## 8.9. Receiver Spurious Emissions

**Limit**

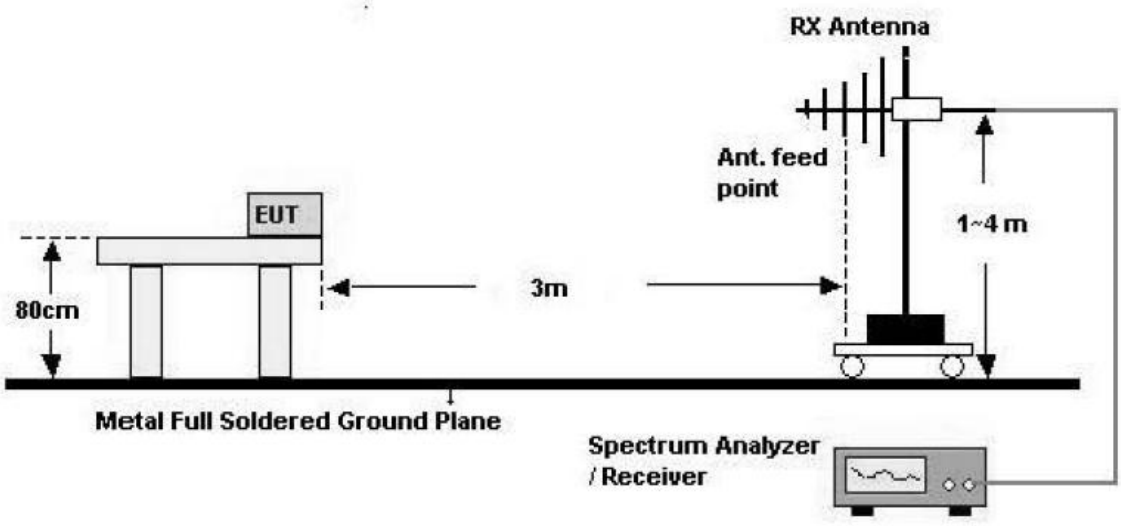
| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
|---|---|---|
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

Note:

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

**Test Configuration**

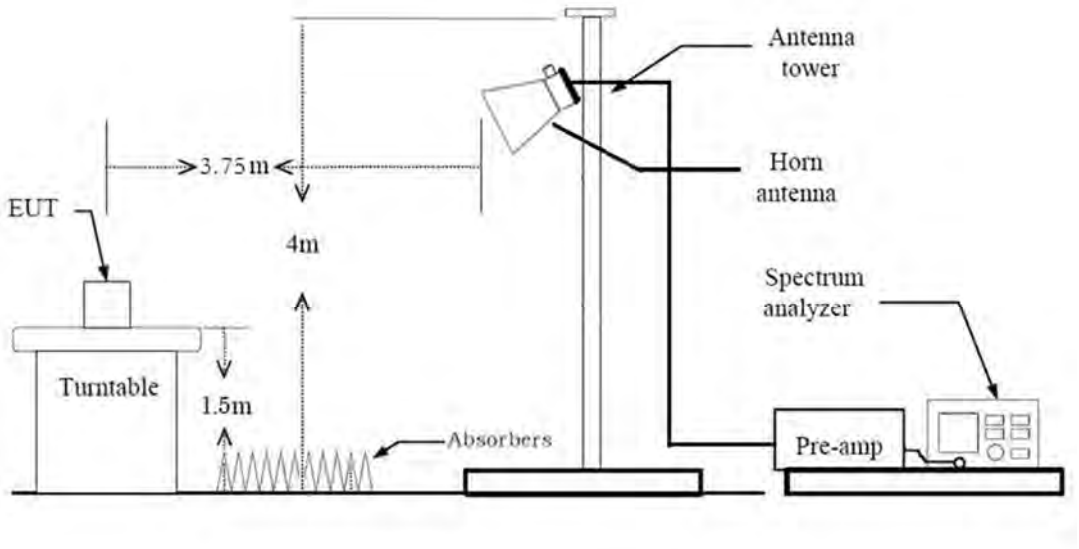
30 MHz - 1 GHz



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

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 100 kHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz
6. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)

Above 1 GHz




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

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor( reference distance : 3 m).
   ◆ Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 1 GHz – 25 GHz
      - Detector = Peak

- Trace = Maxhold
- RBW = 1 MHz
- VBW ≥ 3 x RBW

(2) Measurement Type(Average):

- We performed using a reduced video BW method was done with the analyzer in linear mode
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Maxhold
- RBW = 1 MHz
- VBW ≥ 1/τ Hz, where τ = pulse width in seconds

The actual setting value of VBW = 1 kHz

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
11. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

### 8.10. Worst case configuration and mode

**Radiated test**

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Stand alone
   - Worstcase : Stand alone
2. EUT Axis
   - Radiated Spurious Emissions : X
   - Radiated Restricted Band Edge : X
3. All data rate of operation were investigated and the test results are worst case in highest datarate of each mode.
   - GFSK : DH5
   - π/4DQPSK : 2-DH5
   - 8DPSK : 3-DH5
4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.
   - Position : Horizontal, Vertical, Parallel to the ground plane
5. ATB41HSAN(FCC)&ATB41HSKN(IC), ATB40HSAN(FCC)&ATB40HSKN(IC) were tested and the worst case results are reported.

(Worst case : ATB41HSAN(FCC)&ATB41HSKN(IC))

**AC Power line Conducted Emissions**

1. We don't perform powerline conducted emission test. Because this EUT is used with vehicle.

**Conducted test**

1. The EUT was configured with data rate of highest power.
   - GFSK : DH5
   - π/4DQPSK : 2-DH5
   - 8DPSK : 3-DH5
2. AFH & Non-AFH were tested and the worst case results are reported.
   (Worst case : Non-AFH)
3. ATB41HSAN(FCC)&ATB41HSKN(IC), ATB40HSAN(FCC)&ATB40HSKN(IC) were tested and the worst case results are reported.

(Worst case : ATB41HSAN(FCC)&ATB41HSKN(IC))

## 9. SUMMARY OF TEST RESULTS

| Test Description | FCC Part Section(s) | IC Part Section(s) | Test Limit | Test Condition | Test Result |
|---|---|---|---|---|---|
| 20 dB Bandwidth | § 15.247(a)(1) | RSS-247, 5.1 | N/A | Conducted | PASS |
| Occupied Bandwidth | N/A | RSS-GEN, 6.7 | N/A | | N/A |
| Conducted Maximum Peak Output Power | § 15.247(b)(1) | RSS-247, 5.1 b) | < 0.125 W | | PASS |
| Carrier Frequency Separation | § 15.247(a)(1) | RSS-247, 5.1 b) | > 25 kHz or >2/3 of the 20dB BW | | PASS |
| Number of Hopping Frequencies | § 15.247(a)(1)(iii) | RSS-247, 5.1 d) | ≥ 15 | | PASS |
| Time of Occupancy | § 15.247(a)(1)(iii) | RSS-247, 5.1 d) | < 400 ms | | PASS |
| Conducted Spurious Emissions | § 15.247(d) | RSS-247, 5.5 | > 20 dB for all out-of band emissions | | PASS |
| Band Edge (Out of Band Emissions) | § 15.247(d) | RSS-247, 5.5 | > 20 dB for all out-of band emissions | | PASS |
| AC Power line Conducted Emissions | § 15.207(a) | RSS-GEN, 8.8 | cf. Section 8.8 | | N/A (Note1) |
| Radiated Spurious Emissions | § 15.247(d), 15.205, 15.209 | RSS-GEN, 8.9 | cf. Section 8.7 | Radiated | PASS |
| Radiated Restricted Band Edge | § 15.247(d), 15.205, 15.209 | RSS-GEN, 8.9 RSS-GEN, 8.10 | cf. Section 8.7 | | PASS |
| Receiver Spurious Emissions | N/A | RSS-GEN, 7 | cf. Section 8.9 | | PASS |

# 10. TEST RESULT

## 10.1 PEAK POWER

| Channel | Frequency (MHz) | Output Power (GFSK) | | Limit (mW) |
|---|---|---|---|---|
| | | (dBm) | (mW) | |
| Low | 2402 | 3.636 | 2.31 | 125 |
| Mid | 2441 | 4.129 | 2.59 | |
| High | 2480 | 3.729 | 2.36 | |

| Channel | Frequency (MHz) | Output Power (8DPSK) | | Limit (mW) |
|---|---|---|---|---|
| | | (dBm) | (mW) | |
| Low | 2402 | 0.827 | 1.21 | 125 |
| Mid | 2441 | 1.765 | 1.50 | |
| High | 2480 | 1.853 | 1.53 | |

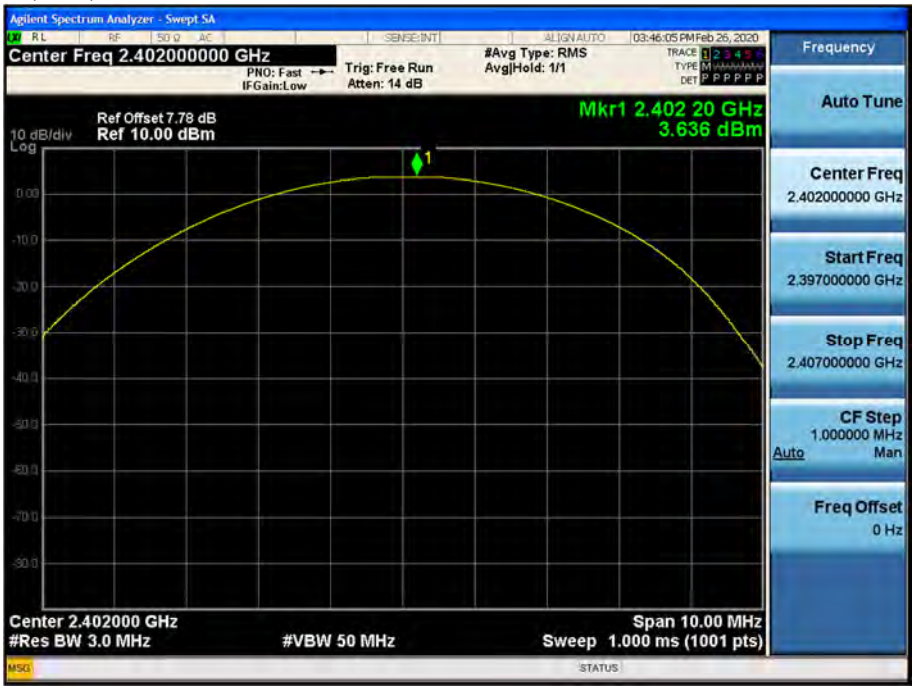
| Channel | Frequency (MHz) | Output Power (π/4DQPSK) | | Limit (mW) |
|---|---|---|---|---|
| | | (dBm) | (mW) | |
| Low | 2402 | 0.420 | 1.10 | 125 |
| Mid | 2441 | 1.406 | 1.38 | |
| High | 2480 | 1.503 | 1.41 | |

Note:

1. Spectrum reading values are not plot data.
   The power results in plot is already including the actual values of loss for the splitter and cable combination.
2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.
   Actual value of loss for the splitter and cable combination is 7.76 dB at 2400 MHz
   and is 7.78 dB at 2500 MHz.
   So, 7.78 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result.

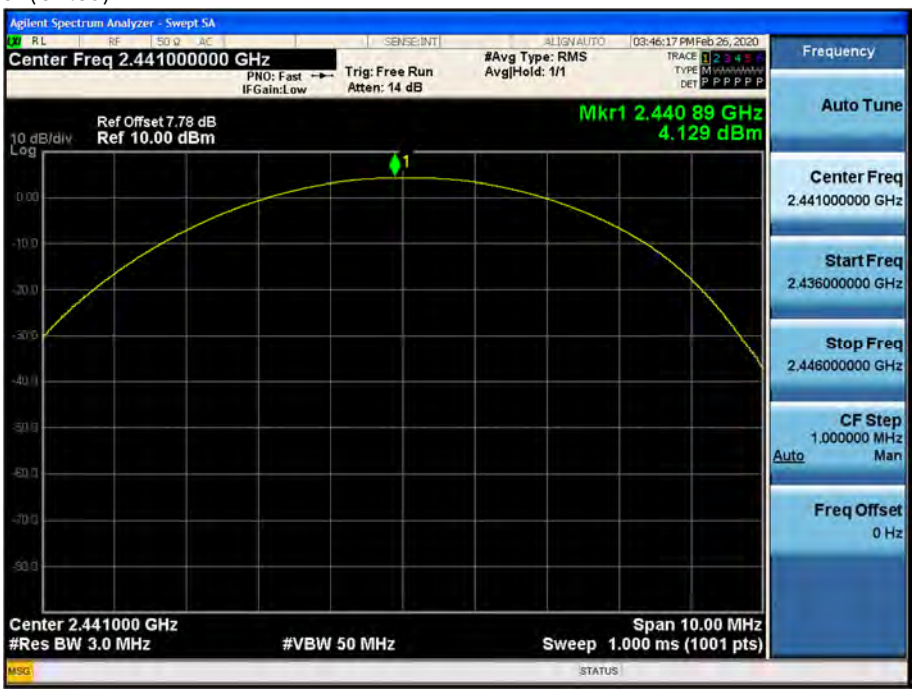
Test Plots (GFSK)

Peak Power (CH.0)



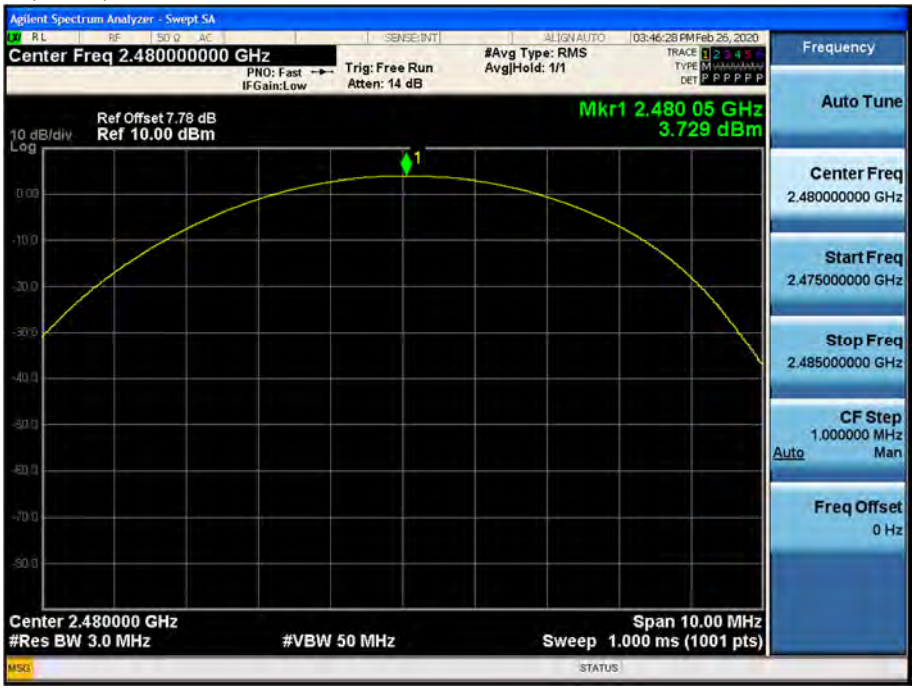

Test Plots (GFSK)

Peak Power (CH.39)



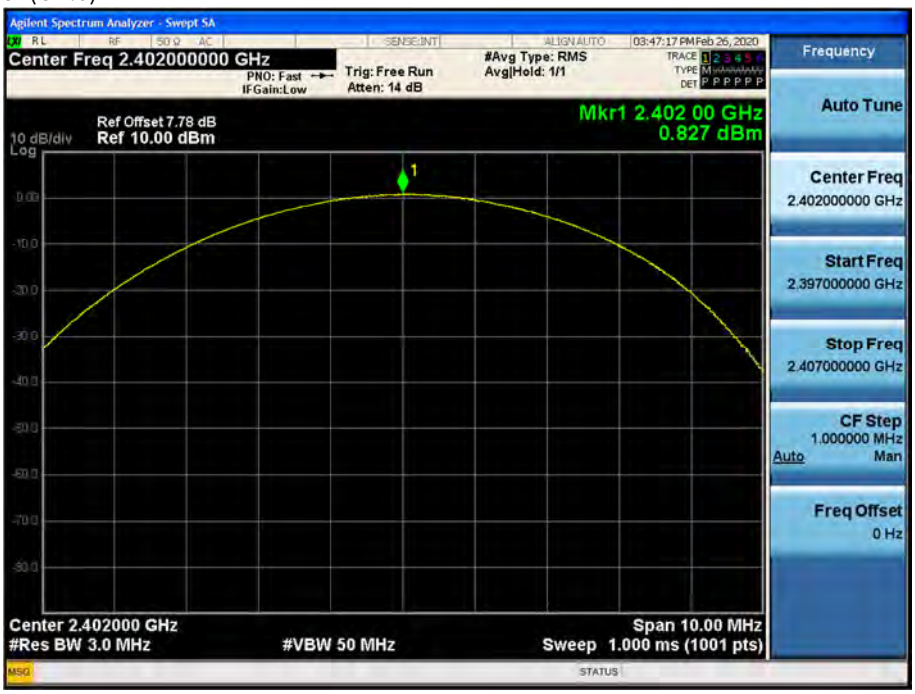
Test Plots (GFSK)

Peak Power (CH.78)



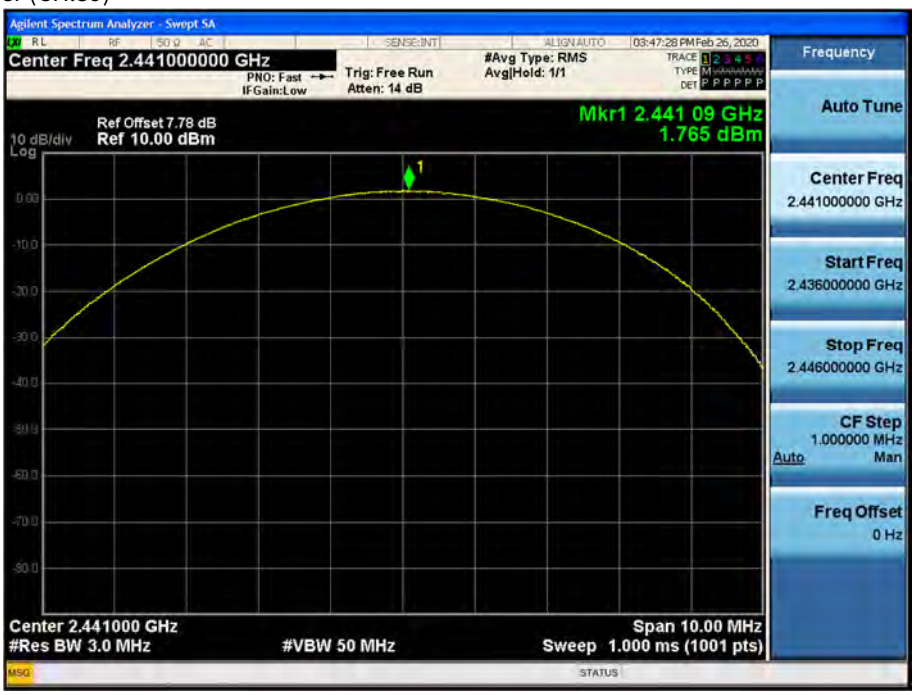

Test Plots (8DPSK)

Peak Power (CH.0)



Test Plots (8DPSK)

Peak Power (CH.39)

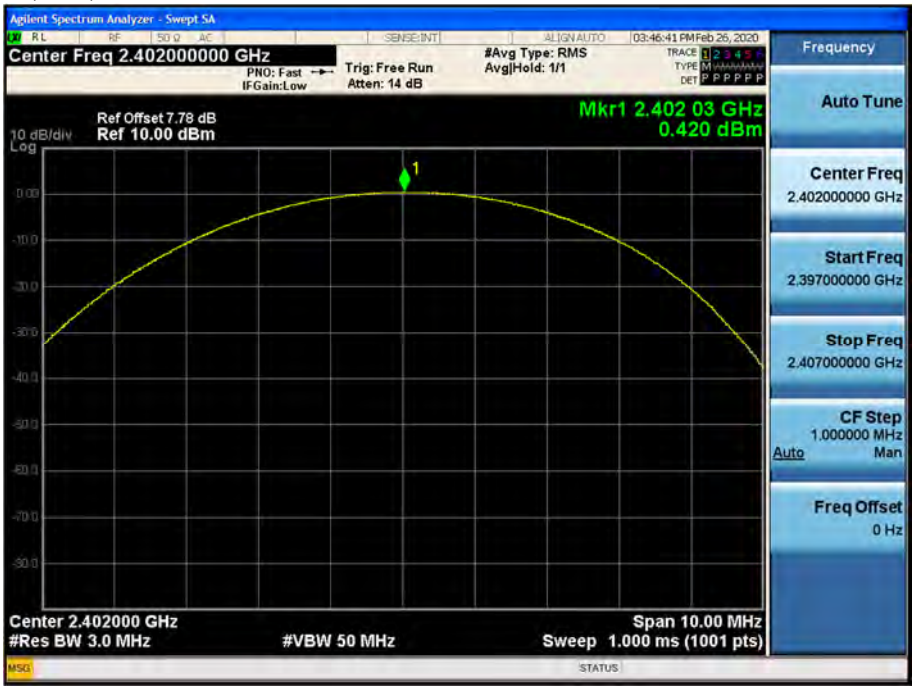



Test Plots (8DPSK)

Peak Power (CH.78)

Test Plots (π/4DQPSK)

Peak Power (CH.0)

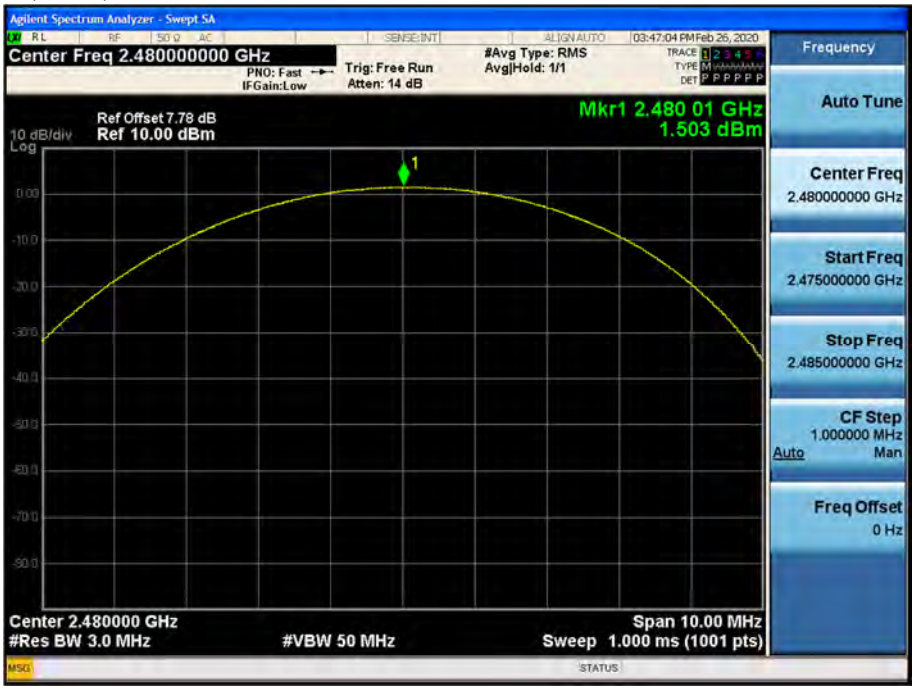



Test Plots (π/4DQPSK)

Peak Power (CH.39)

Test Plots (π/4DQPSK)

Peak Power (CH.78)



## 10.2 BAND EDGES

**Without hopping**

| Outside Frequency Band | GFSK (dB) | 8DPSK (dB) | π/4DQPSK (dB) | Limit (dBc) |
|---|---|---|---|---|
| Lower | 61.116 | 58.638 | 59.444 | 20 |
| Upper | 63.540 | 62.876 | 62.913 | |

**With hopping**

| Outside Frequency Band | GFSK (dB) | 8DPSK (dB) | π/4DQPSK (dB) | Limit (dBc) |
|---|---|---|---|---|
| Lower | 63.363 | 60.644 | 57.221 | 20 |
| Upper | 60.351 | 58.298 | 58.352 | |

**Note :**

1. Spectrum reading values are not plot data.
   The power results in plot is already including the actual values of loss for the splitter and cable combination.
2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.
   Actual value of loss for the splitter and cable combination is 7.76 dB at 2400 MHz
   and is 7.78 dB at 2500 MHz.
   So, 7.78 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result.

Test Plots without hopping (GFSK)

Band Edges (CH.0)


Test Plots without hopping (GFSK)

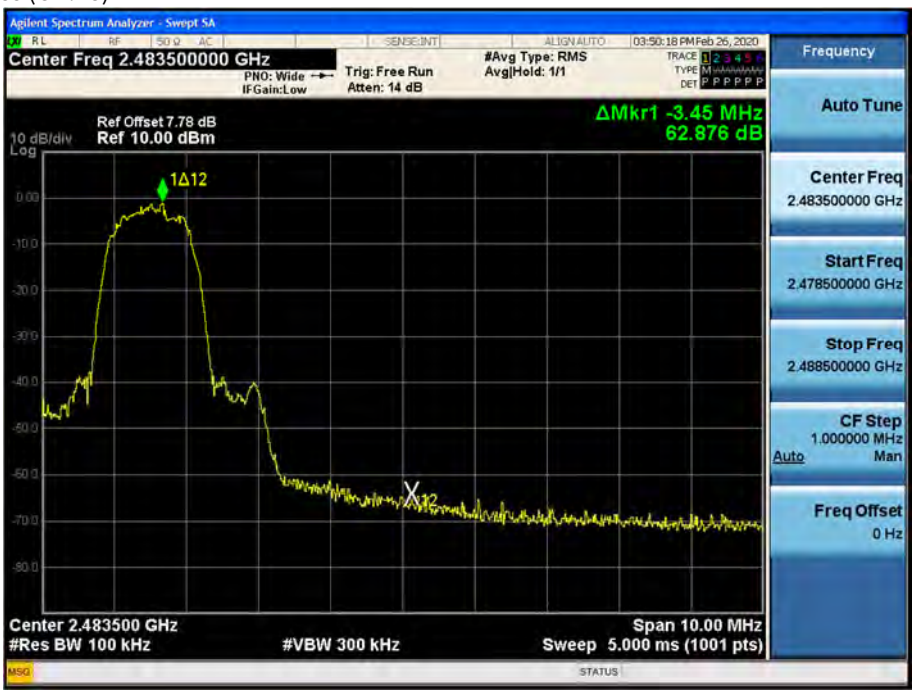
Band Edges (CH.78)

Test Plots without hopping (8DPSK)

Band Edges (CH.0)

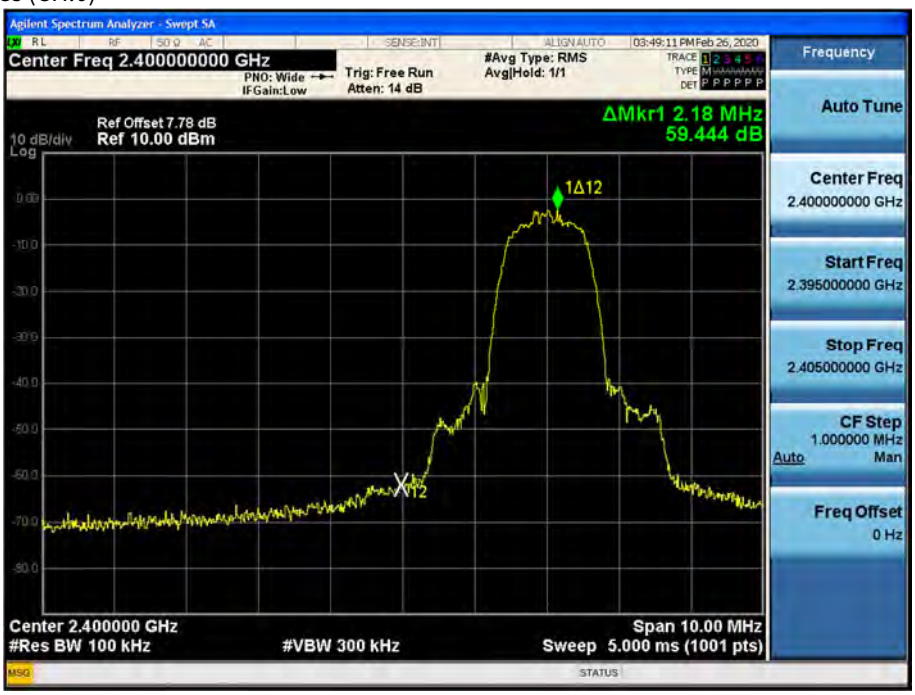

Test Plots without hopping (8DPSK)

Band Edges (CH.78)



Test Plots without hopping (π/4DQPSK)

Band Edges (CH.0)




Test Plots without hopping (π/4DQPSK)

Band Edges (CH.78)

Test Plots with hopping (GFSK)

Band Edges (CH.0)


Test Plots with hopping (GFSK)

Band Edges (CH.78)

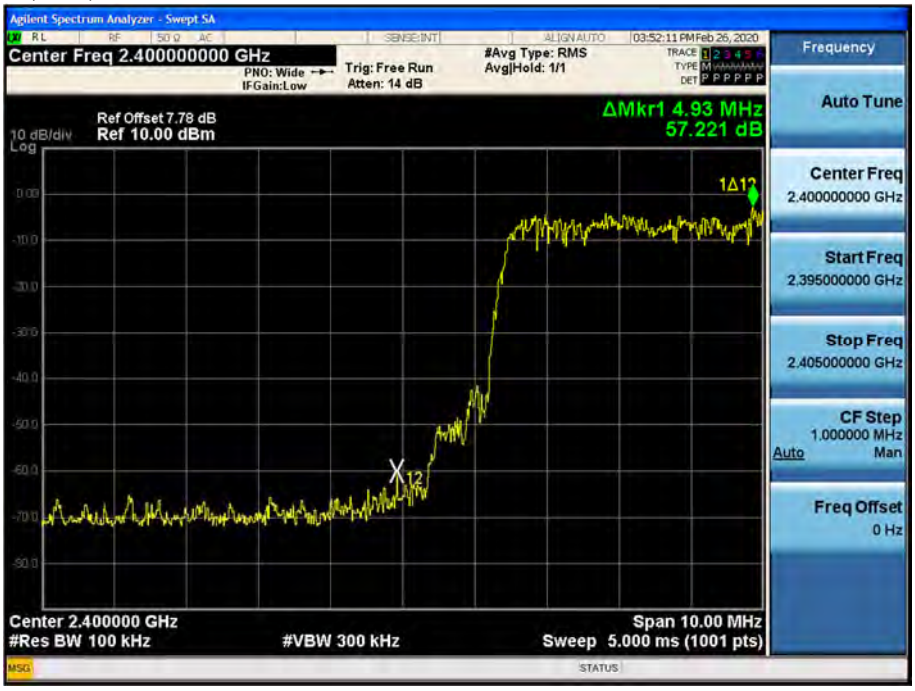
Test Plots with hopping (8DPSK)

Band Edges (CH.0)


Test Plots with hopping (8DPSK)

Band Edges (CH.78)

Test Plots with hopping (π/4DQPSK)
Band Edges (CH.0)




Test Plots with hopping (π/4DQPSK)
Band Edges (CH.78)

## 10.3 FREQUENCY SEPARATION / OCCUPIED BANDWIDTH (99% BW)

| 99% BW (kHz) | | | |
|---|---|---|---|
| Channel | GFSK | 8DPSK | π/4DQPSK |
| CH.0 | 898.42 | 1216.7 | 1212.9 |
| CH.39 | 900.97 | 1218.5 | 1209.0 |
| CH.78 | 899.20 | 1215.7 | 1210.2 |

| 20dB BW (kHz) | | | |
|---|---|---|---|
| Channel | GFSK | 8DPSK | π/4DQPSK |
| CH.0 | 992.7 | 1341 | 1356 |
| CH.39 | 1001.0 | 1343 | 1356 |
| CH.78 | 997.6 | 1341 | 1365 |

| Channel Separation(kHz) | | | Limit (kHz) |
|---|---|---|---|
| GFSK | 8DPSK | π/4DQPSK | |
| 998 | 991 | 991 | >25 kHz or >2/3 of the 20dB BW |

Test Plots (GFSK)

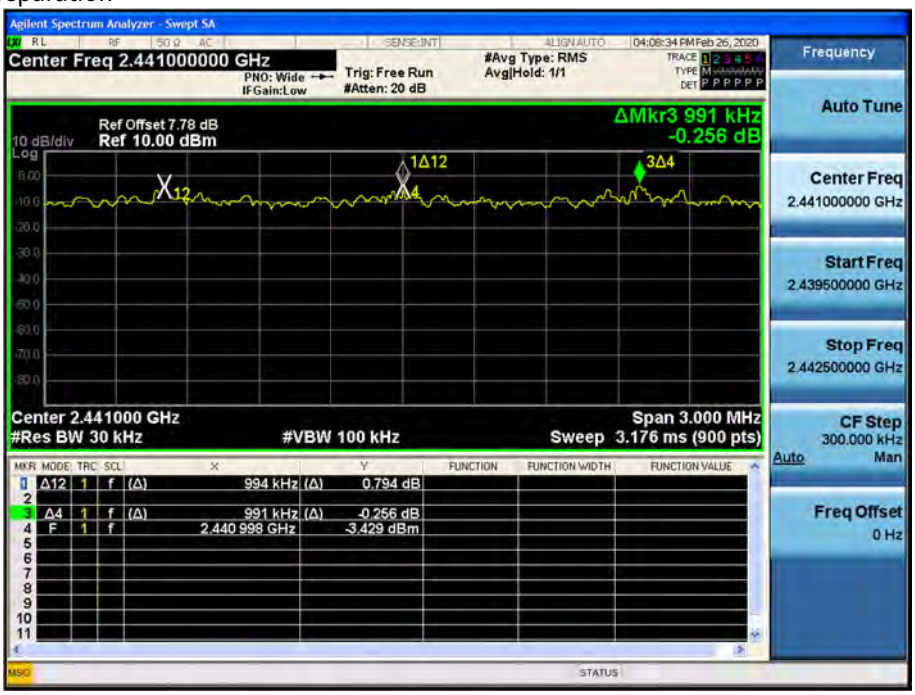
Channel Separation


Test Plots (8DPSK)

Channel Separation

Test Plots (π/4DQPSK)

Channel Separation



Test Plots (GFSK)

20 dB Bandwidth & Occupied Bandwidth (CH.0)


Test Plots (GFSK)

20 dB Bandwidth & Occupied Bandwidth (CH.39)

Test Plots (GFSK)

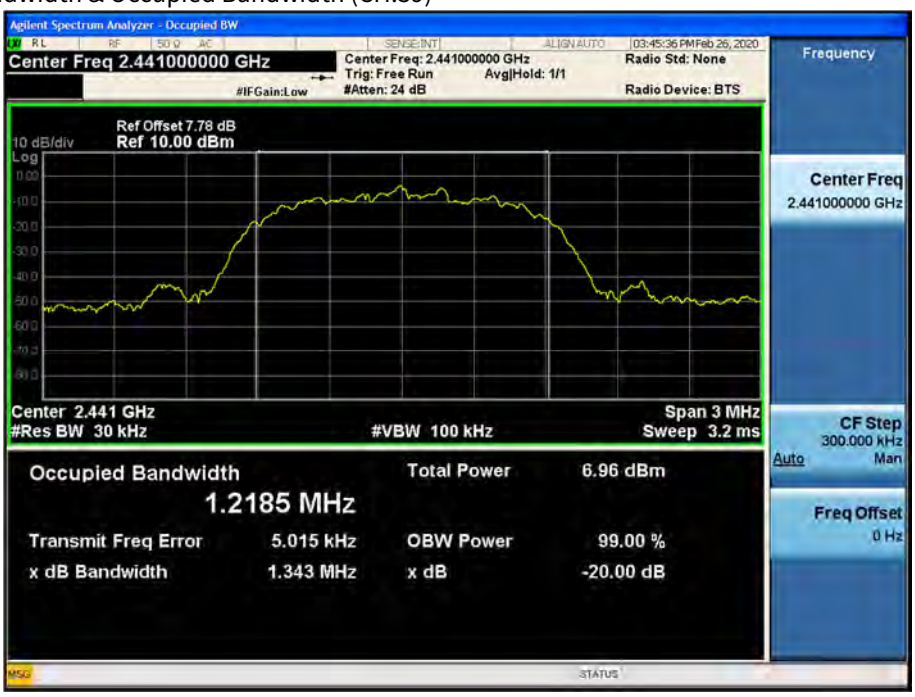
20 dB Bandwidth & Occupied Bandwidth (CH.78)


Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.0)

Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.39)




Test Plots (8DPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.78)

Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.0)


Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.39)

Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.78)

## 10.4 NUMBER OF HOPPING FREQUENCY

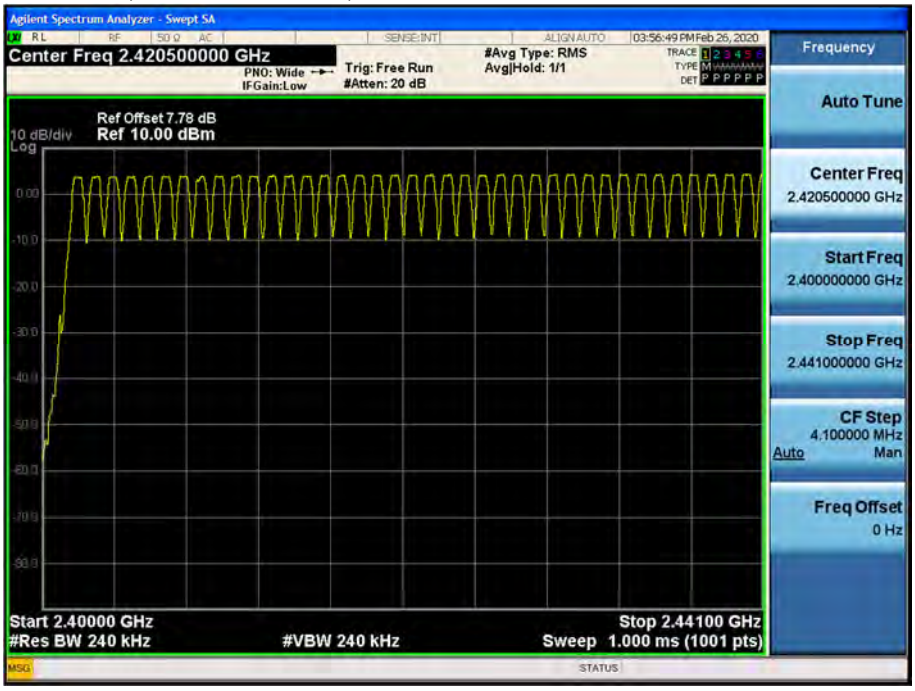
| Result (No. of CH) | | | Limit |
|---|---|---|---|
| GFSK | 8DPSK | π/4DQPSK | |
| 79 | 79 | 79 | >15 |

**Note :**

In case of AFH mode, minimum number of hopping channels is 20.

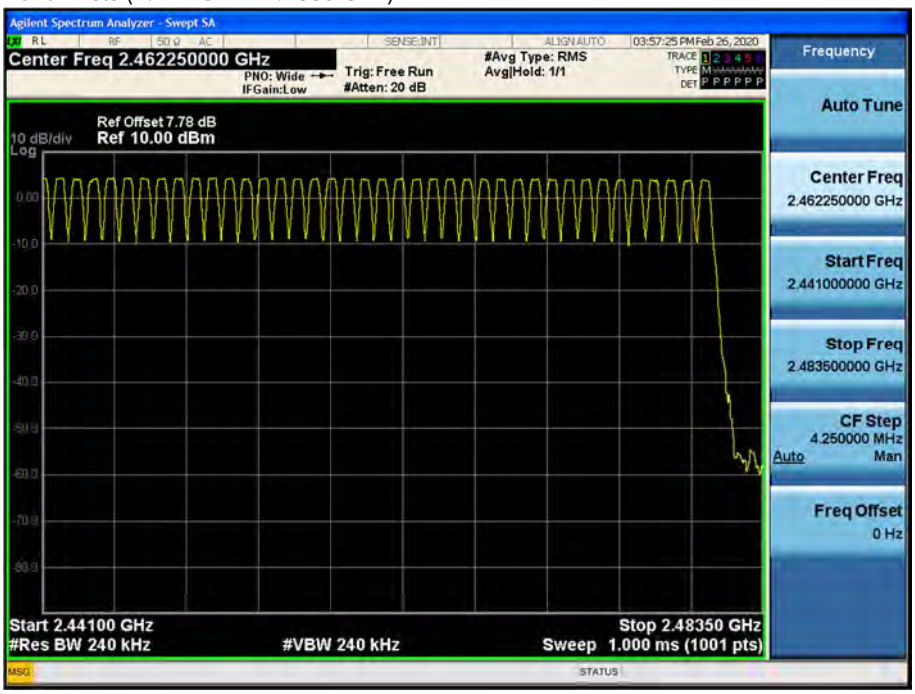
Test Plots (GFSK)

Number of Channels (2.4 GHz - 2.441 GHz)



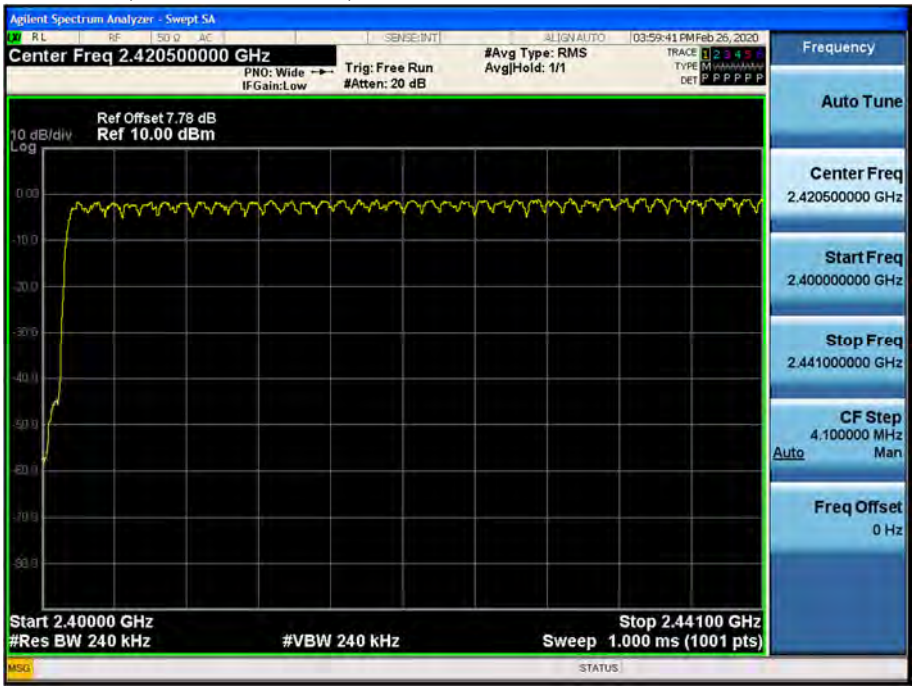

Test Plots (GFSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



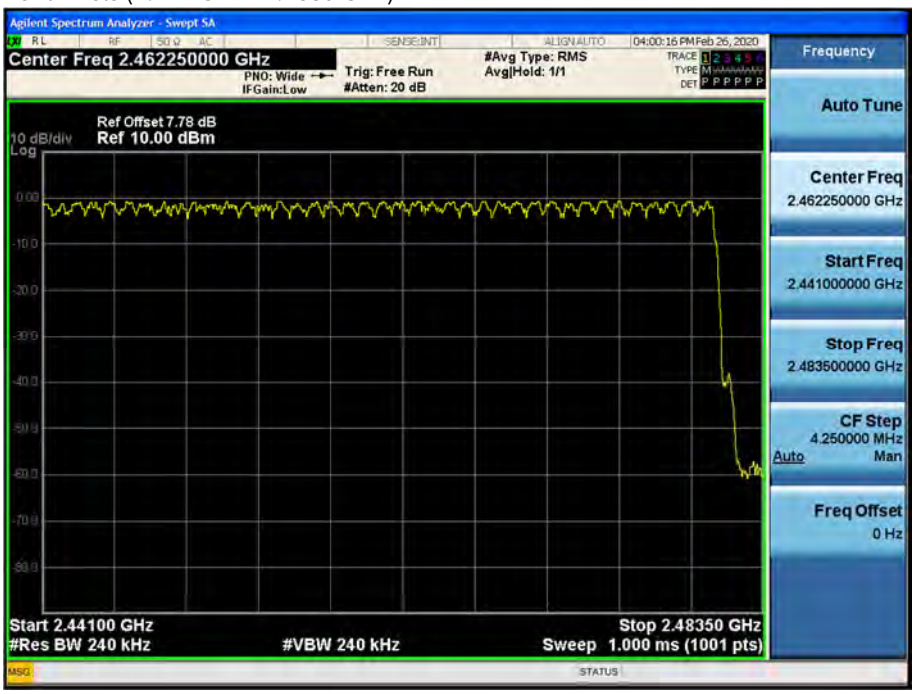
Test Plots (8DPSK)

Number of Channels (2.4 GHz - 2.441 GHz)



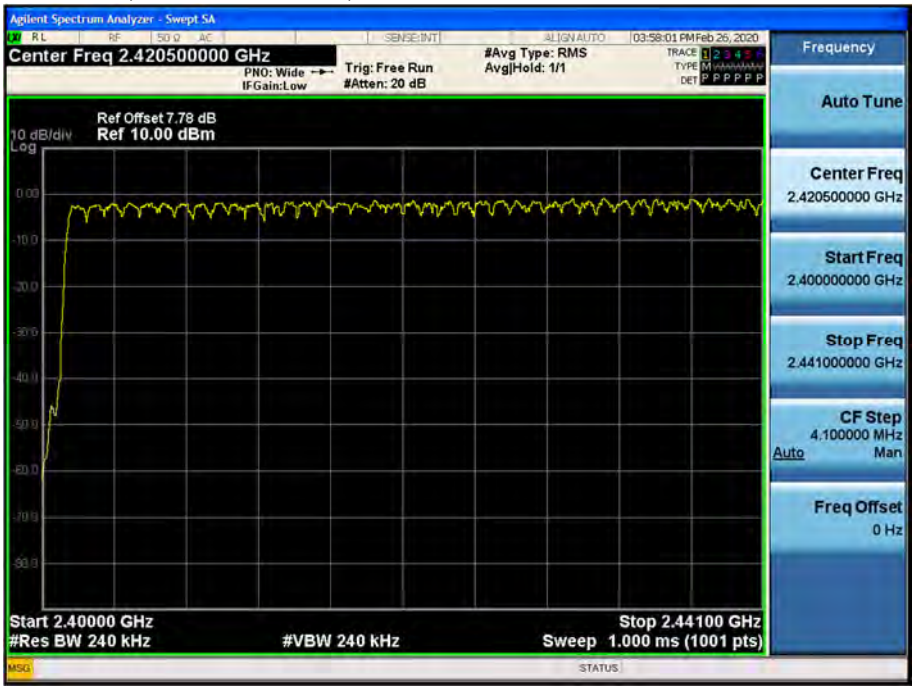

Test Plots (8DPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



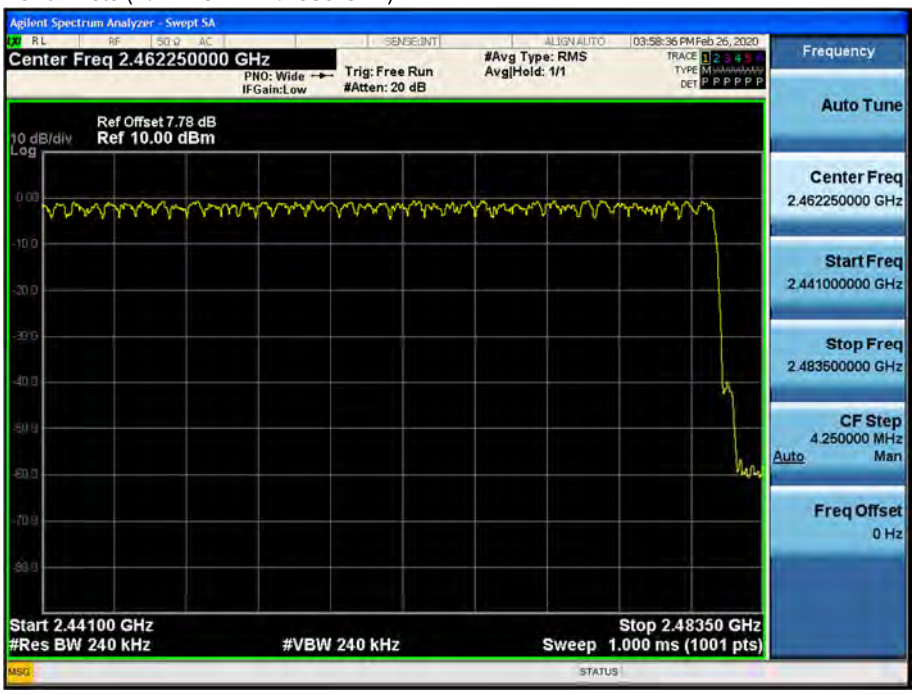
Test Plots (π/4DQPSK)

Number of Channels (2.4 GHz - 2.441 GHz)




Test Plots (π/4DQPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



## 10.5 TIME OF OCCUPANCY (DWELL TIME)

| | Channel | GFSK | 8DPSK | π/4DQPSK |
|---|---|---|---|---|
| Pulse Time (ms) | Low | 2.890 | 2.890 | 2.890 |
| | Mid | 2.885 | 2.890 | 2.890 |
| | High | 2.885 | 2.890 | 2.890 |

Non-AFH Mode

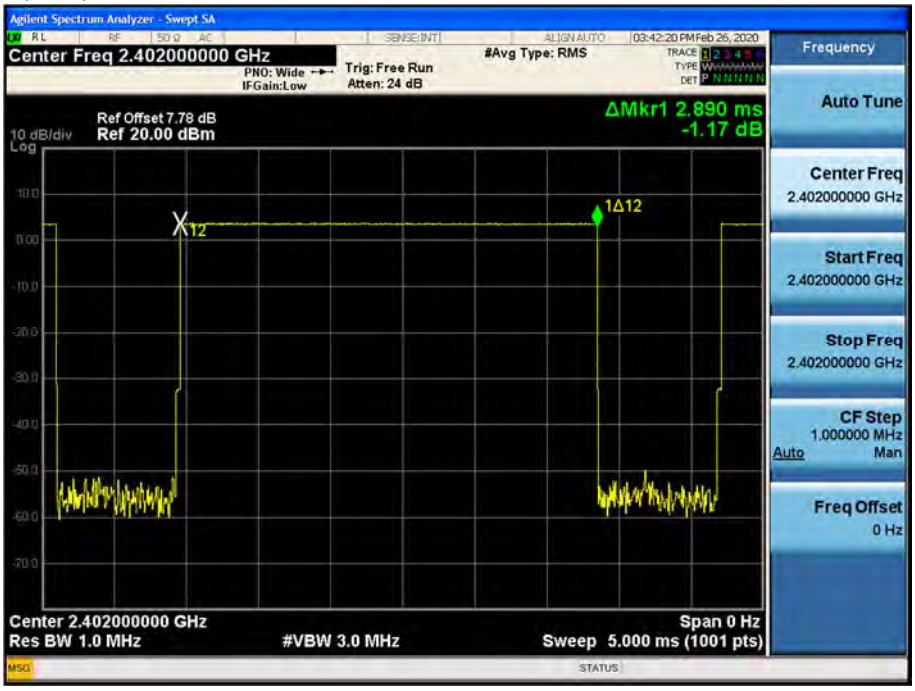
| | Channel | GFSK | 8DPSK | π/4DQPSK | Period Time (s) | Limit (ms) |
|---|---|---|---|---|---|---|
| Total of Dwell (ms) | Low | 308.27 | 308.27 | 308.27 | 31.6 | 400 |
| | Mid | 307.73 | 308.27 | 308.27 | 31.6 | |
| | High | 307.73 | 308.27 | 308.27 | 31.6 | |

AFH Mode

| | Channel | GFSK | 8DPSK | π/4DQPSK | Period Time (s) | Limit (ms) |
|---|---|---|---|---|---|---|
| Total of Dwell (ms) | Low | 154.13 | 154.13 | 154.13 | 8.0 | 400 |
| | Mid | 153.87 | 154.13 | 154.13 | 8.0 | |
| | High | 153.87 | 154.13 | 154.13 | 8.0 | |

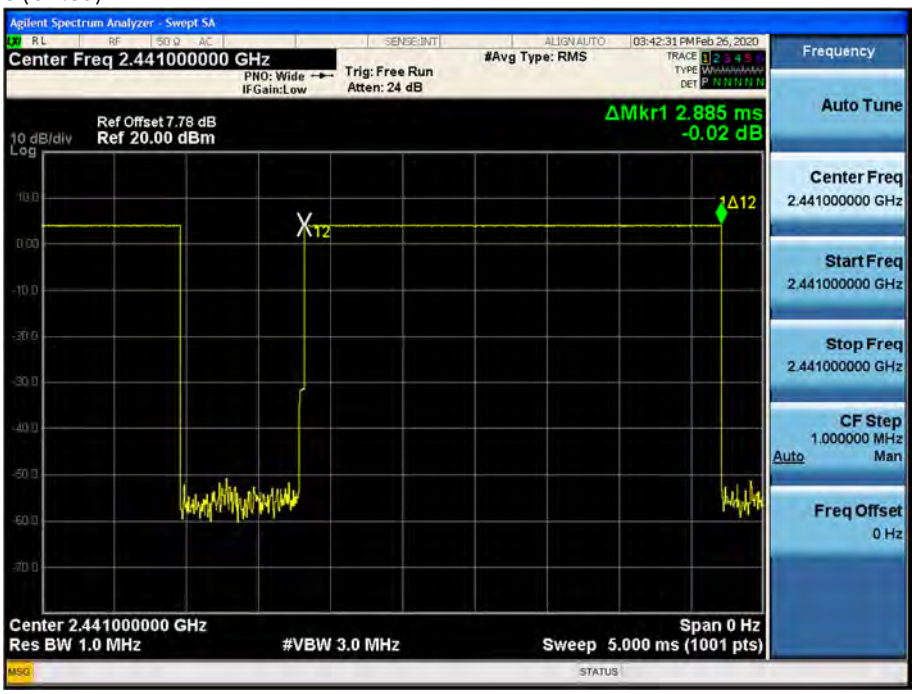
Test Plots (GFSK)

Dwell Time (CH.0)



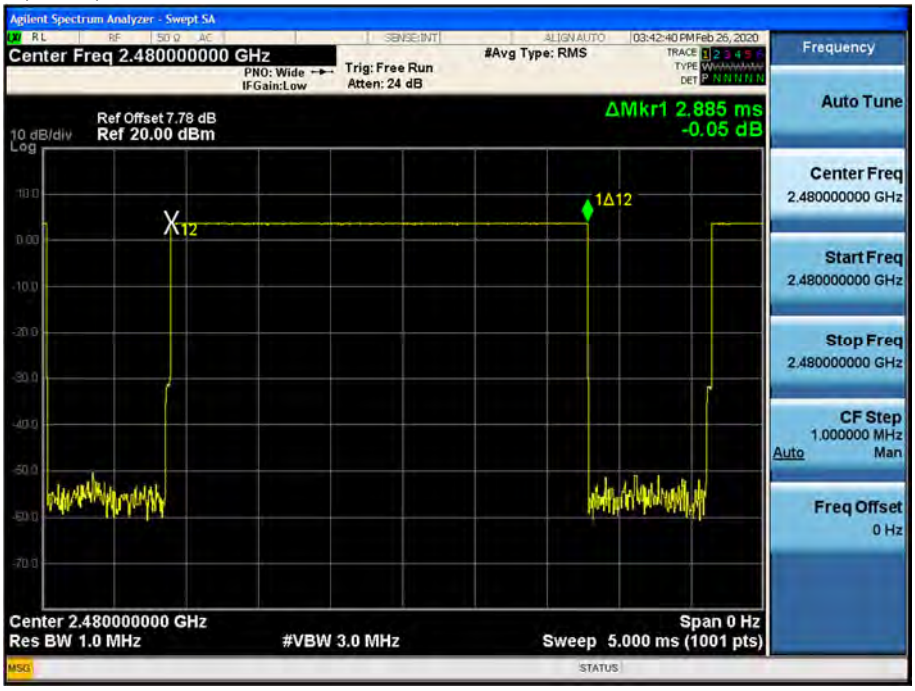

Test Plots (GFSK)

Dwell Time (CH.39)



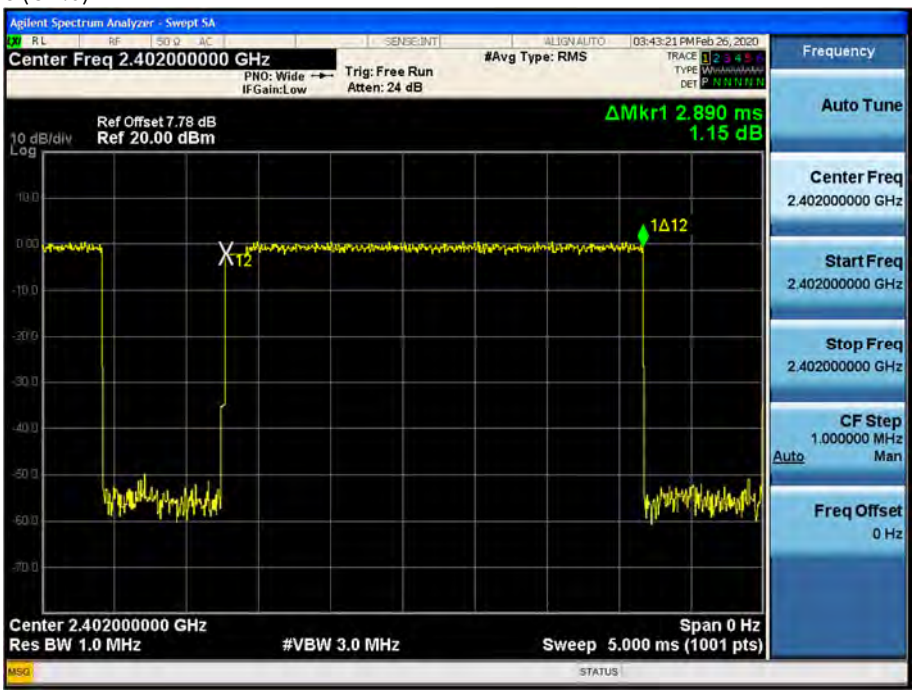
Test Plots (GFSK)

Dwell Time (CH.78)



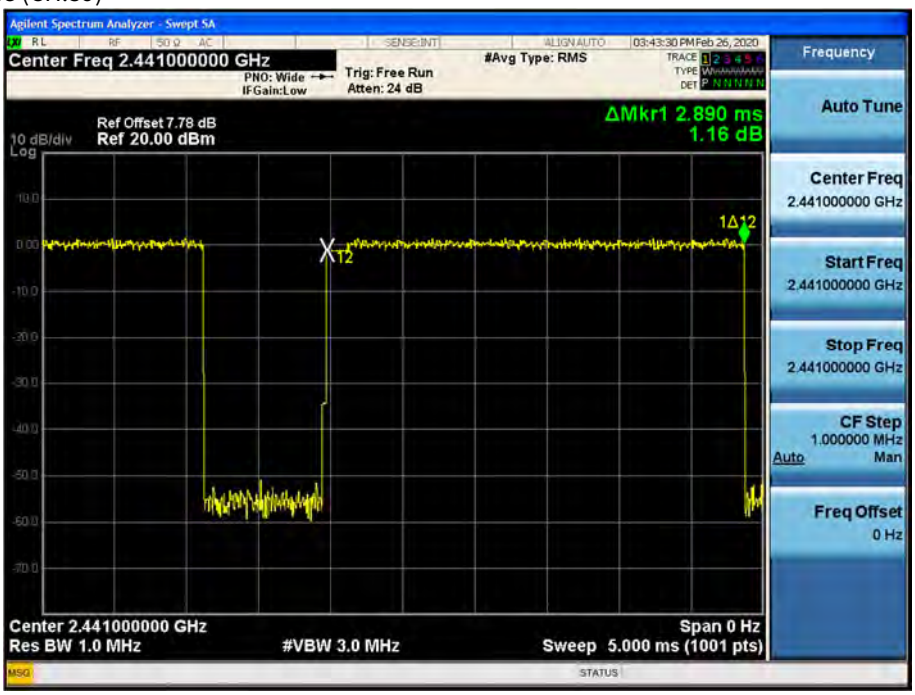

Test Plots (8DPSK)

Dwell Time (CH.0)



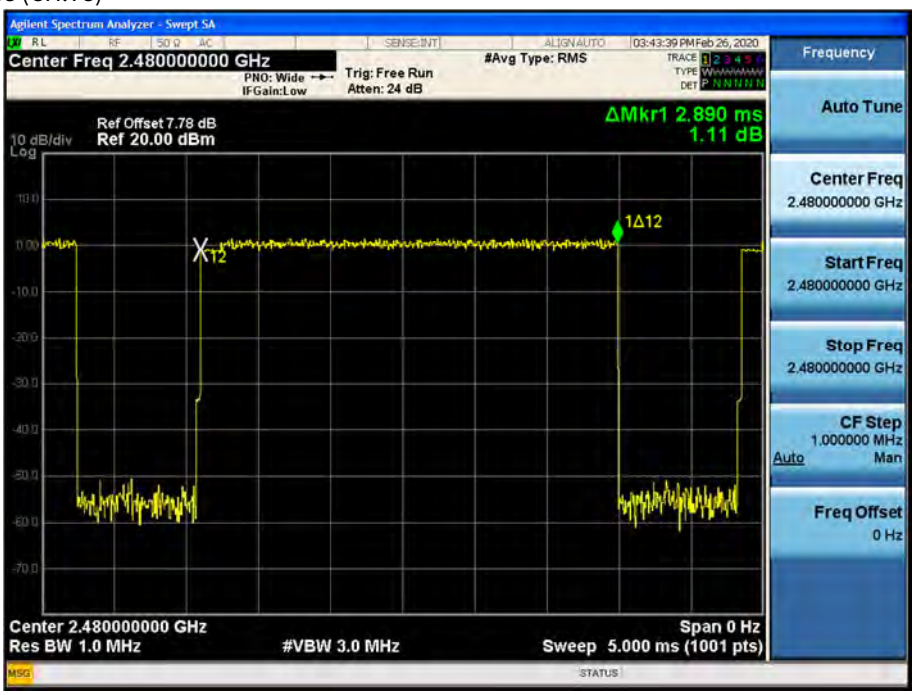
Test Plots (8DPSK)

Dwell Time (CH.39)



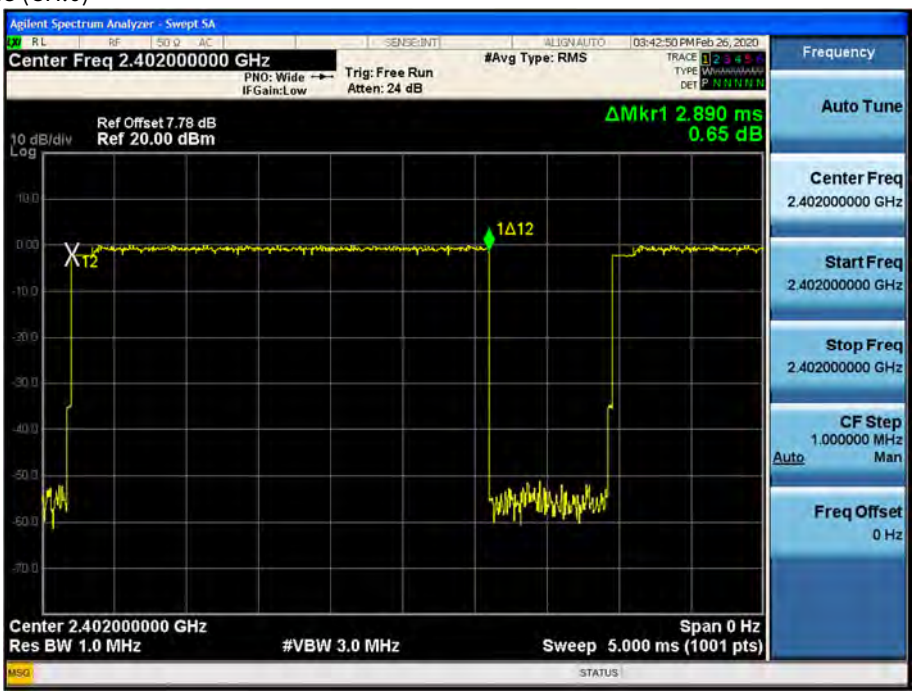

Test Plots (8DPSK)

Dwell Time (CH.78)



Test Plots (π/4DQPSK)

Dwell Time (CH.0)

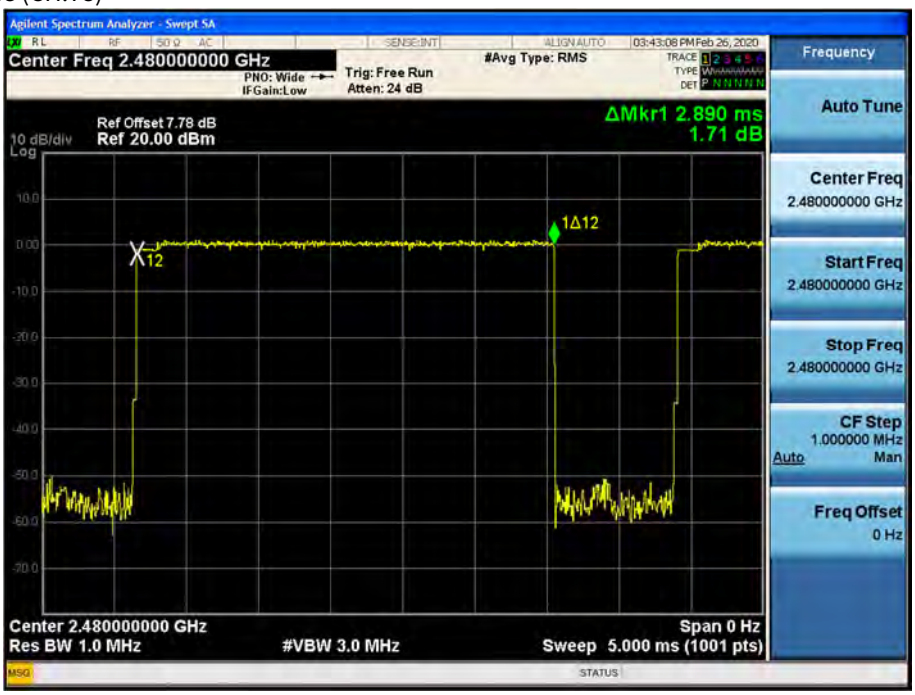



Test Plots (π/4DQPSK)

Dwell Time (CH.39)

Test Plots (π/4DQPSK)

Dwell Time (CH.78)



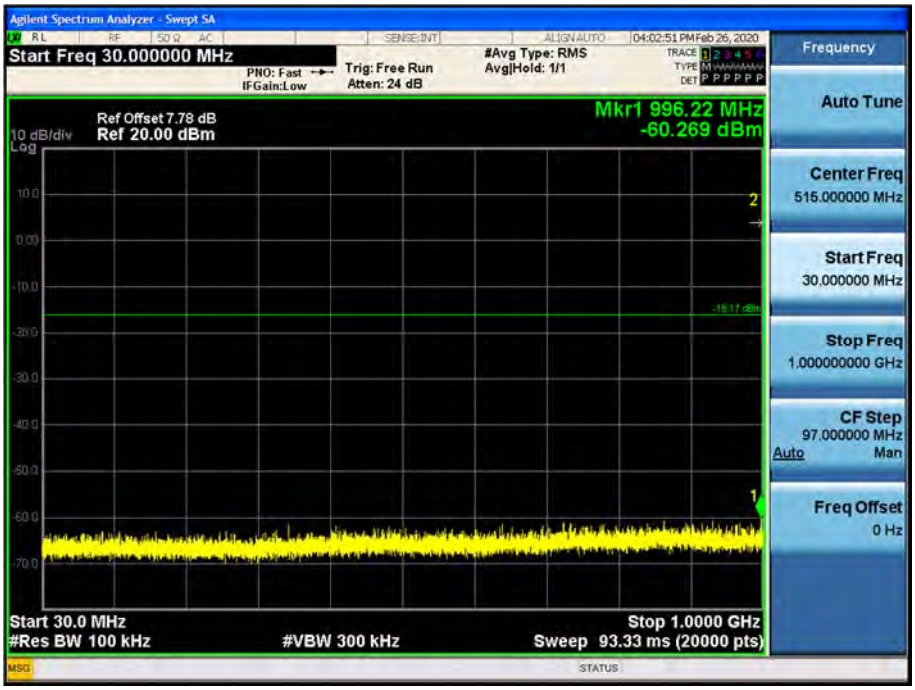
## 10.6 SPURIOUS EMISSIONS

### 10.6.1 CONDUCTED SPURIOUS EMISSIONS

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

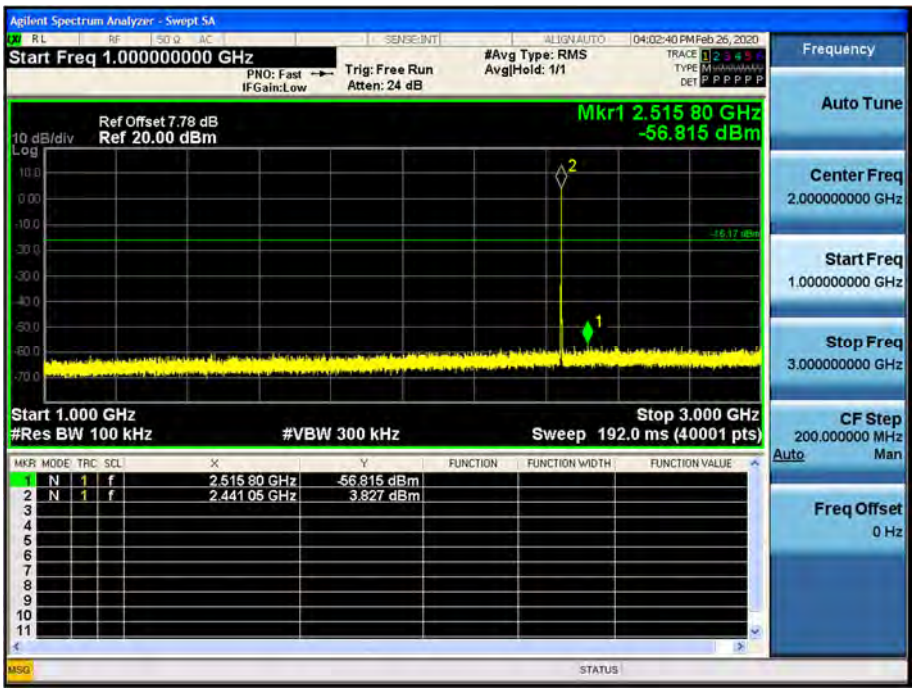
Test Plots (GFSK)- 30 MHz - 1 GHz

Spurious Emission (CH.39)



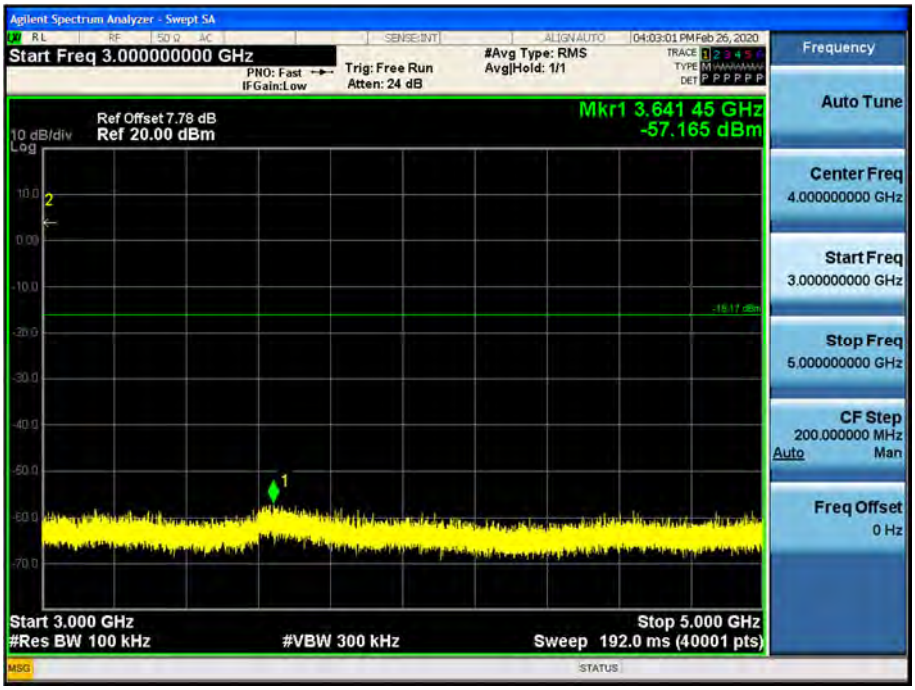

Test Plots (GFSK)- 1 GHz – 3 GHz

Spurious Emission (CH.39)



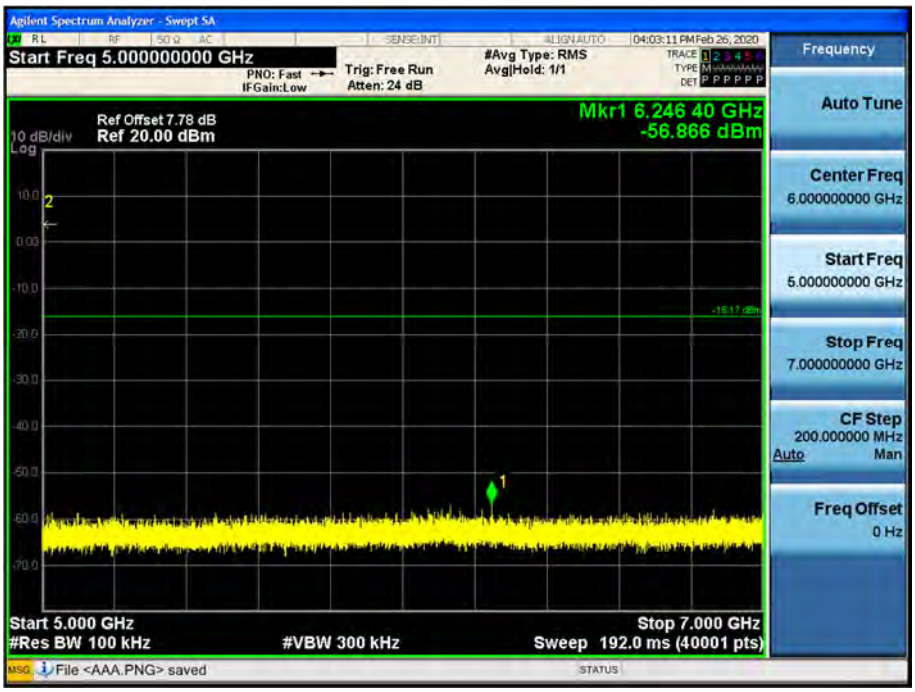
Test Plots(GFSK)- 3 GHz - 5 GHz

Spurious Emission (CH.39)



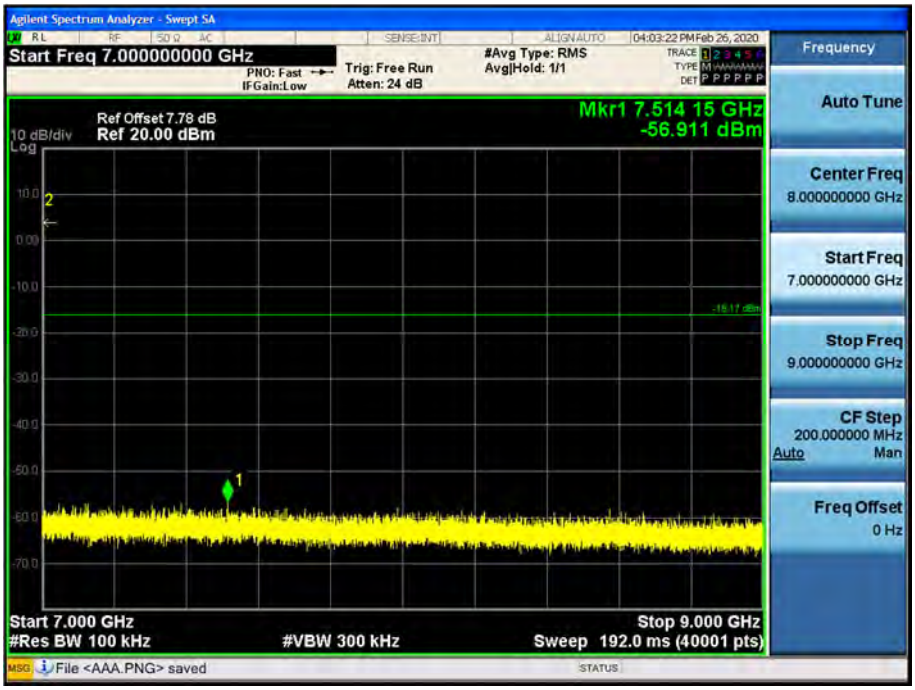

Test Plots (GFSK)- 5 GHz - 7 GHz

Spurious Emission (CH.39)



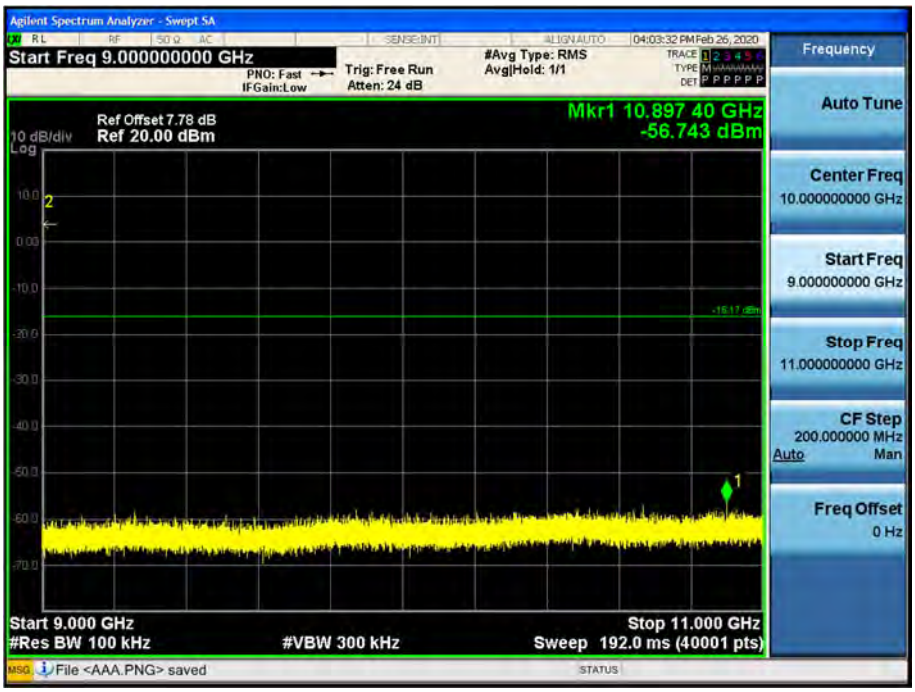
Test Plots(GFSK)- 7 GHz - 9 GHz

Spurious Emission (CH.39)



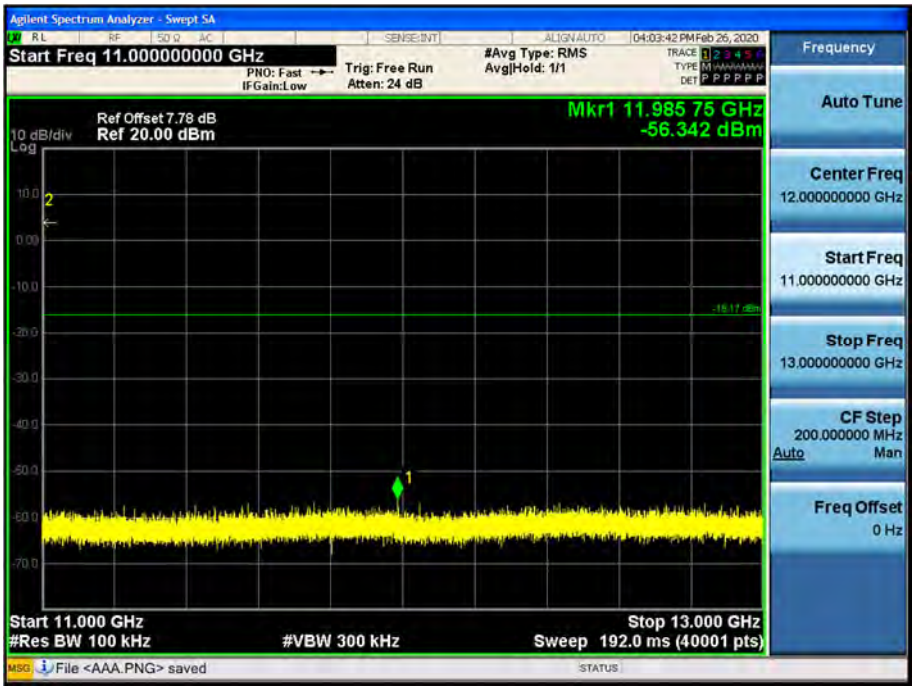

Test Plots(GFSK)- 9 GHz - 11 GHz

Spurious Emission (CH.39)



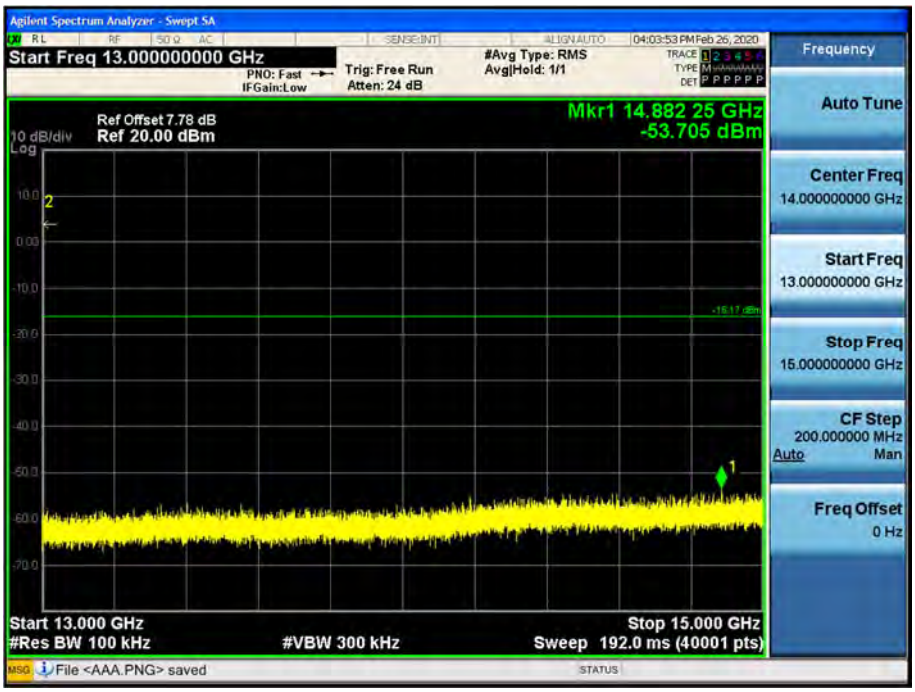
Test Plots(GFSK) 11 GHz - 13 GHz

Spurious Emission (CH.39)



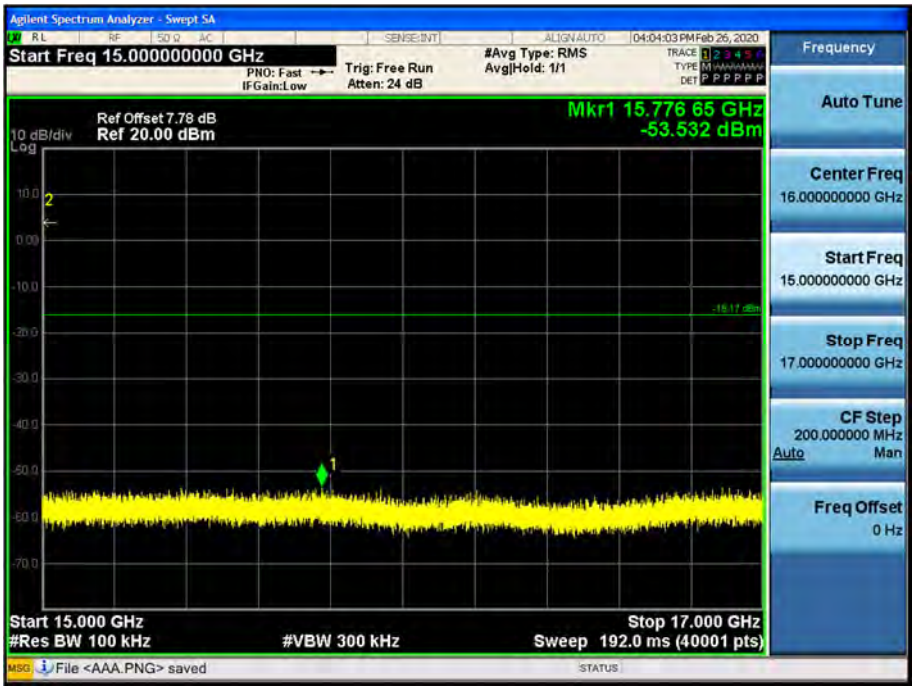

Test Plots (GFSK)- 13 GHz – 15 GHz

Spurious Emission (CH.39)



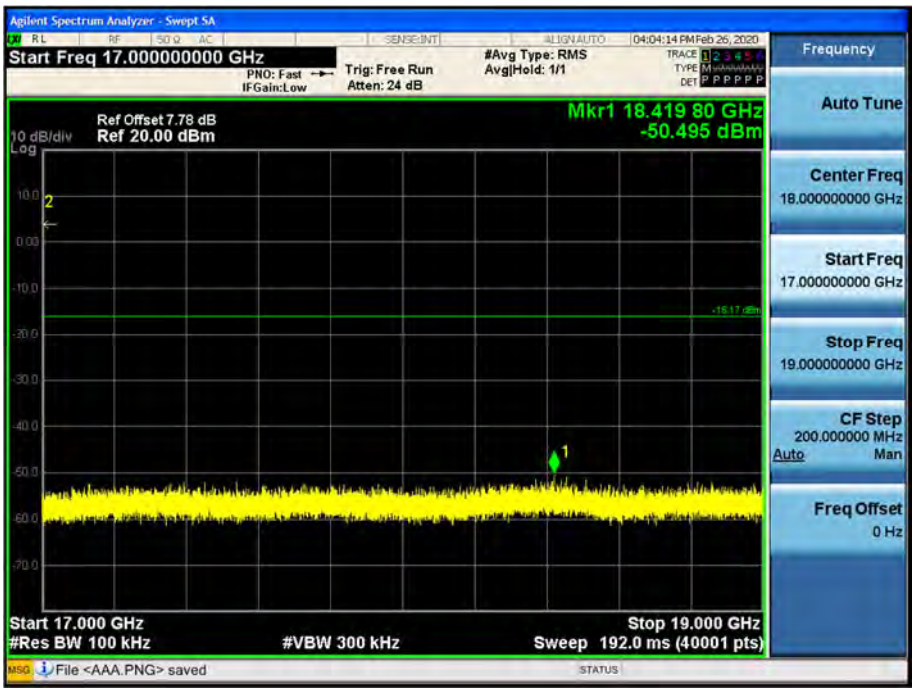
Test Plots(GFSK)– 15 GHz - 17 GHz

Spurious Emission (CH.39)



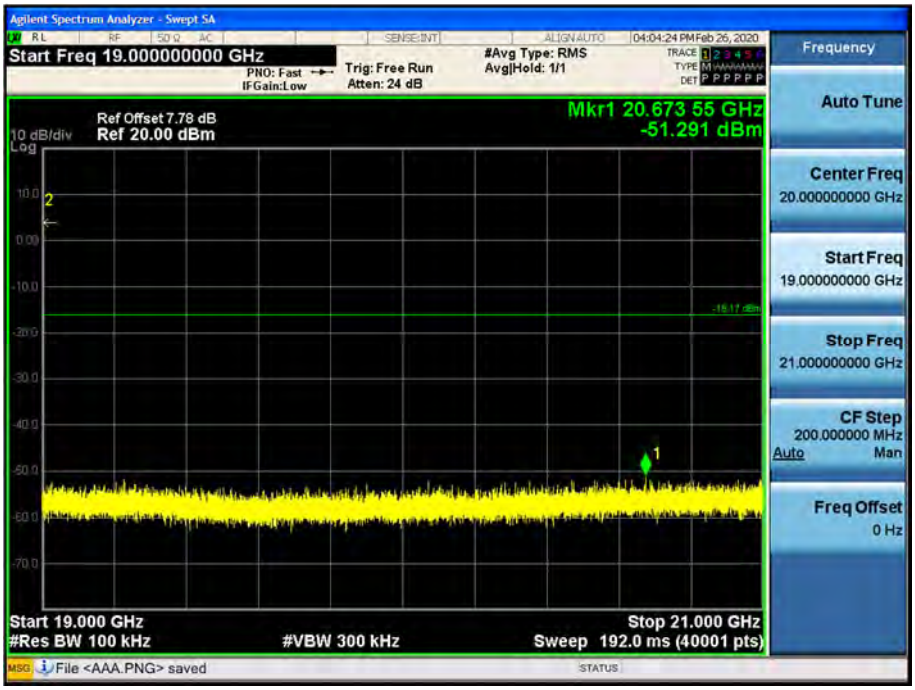

Test Plots(GFSK)- 17 GHz - 19 GHz

Spurious Emission (CH.39)



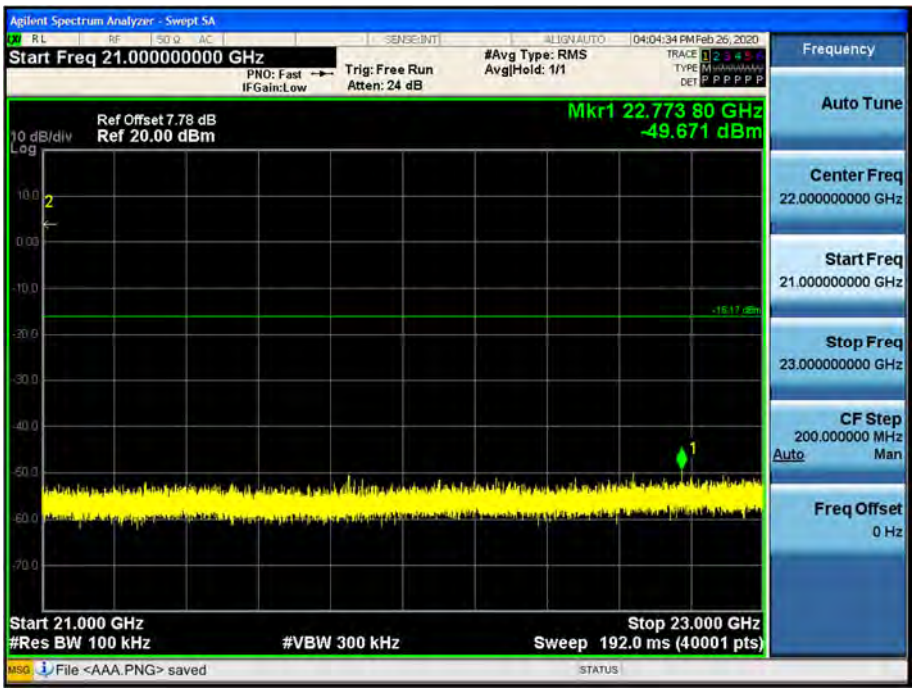
Test Plots (GFSK)- 19 GHz - 21 GHz

Spurious Emission (CH.39)



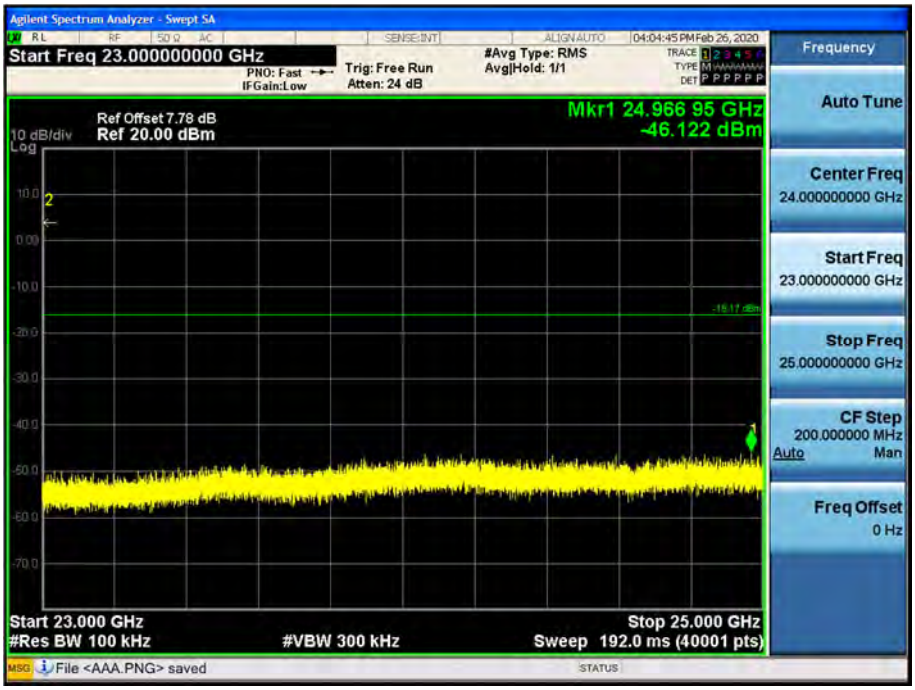

Test Plots (GFSK)- 21 GHz - 23 GHz

Spurious Emission (CH.39)



Test Plots (GFSK)- 23 GHz - 25 GHz

Spurious Emission (CH.39)



### 10.6.2 RADIATED SPURIOUS EMISSIONS

**Frequency Range : 9 kHz – 30MHz**

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

**Note:**

1. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
2. Distance extrapolation factor = 40log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. Radiated test is performed with hopping off.

**Frequency Range : Below 1 GHz**

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

**Note:**

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
2. Radiated test is performed with hopping off.

**Frequency Range : Above 1 GHz**

Operation Mode: CH Low(GFSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4804 | 42.64 | 1.83 | V | 0.00 | 44.47 | 73.98 | 29.51 | PK |
| 4804 | 42.64 | 1.83 | V | -24.76 | 19.71 | 53.98 | 34.27 | AV |
| 7206 | 39.78 | 9.65 | V | 0.00 | 49.43 | 73.98 | 24.55 | PK |
| 7206 | 39.78 | 9.65 | V | -24.76 | 24.67 | 53.98 | 29.31 | AV |
| 4804 | 42.61 | 1.83 | H | 0.00 | 44.44 | 73.98 | 29.54 | PK |
| 4804 | 42.61 | 1.83 | H | -24.76 | 19.68 | 53.98 | 34.30 | AV |
| 7206 | 40.15 | 9.65 | H | 0.00 | 49.80 | 73.98 | 24.18 | PK |
| 7206 | 40.15 | 9.65 | H | -24.76 | 25.04 | 53.98 | 28.94 | AV |

Operation Mode: CH Mid(GFSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4882 | 41.25 | 2.31 | V | 0.00 | 43.56 | 73.98 | 30.42 | PK |
| 4882 | 41.25 | 2.31 | V | -24.76 | 18.80 | 53.98 | 35.18 | AV |
| 7323 | 38.94 | 9.96 | V | 0.00 | 48.90 | 73.98 | 25.08 | PK |
| 7323 | 38.94 | 9.96 | V | -24.76 | 24.14 | 53.98 | 29.84 | AV |
| 4882 | 41.91 | 2.31 | H | 0.00 | 44.22 | 73.98 | 29.76 | PK |
| 4882 | 41.91 | 2.31 | H | -24.76 | 19.46 | 53.98 | 34.52 | AV |
| 7323 | 38.75 | 9.96 | H | 0.00 | 48.71 | 73.98 | 25.27 | PK |
| 7323 | 38.75 | 9.96 | H | -24.76 | 23.95 | 53.98 | 30.03 | AV |

Operation Mode: CH High(GFSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4960 | 41.21 | 2.26 | V | 0.00 | 43.47 | 73.98 | 30.51 | PK |
| 4960 | 41.21 | 2.26 | V | -24.76 | 18.71 | 53.98 | 35.27 | AV |
| 7440 | 38.63 | 9.78 | V | 0.00 | 48.41 | 73.98 | 25.57 | PK |
| 7440 | 38.63 | 9.78 | V | -24.76 | 23.65 | 53.98 | 30.33 | AV |
| 4960 | 41.36 | 2.26 | H | 0.00 | 43.62 | 73.98 | 30.36 | PK |
| 4960 | 41.36 | 2.26 | H | -24.76 | 18.86 | 53.98 | 35.12 | AV |
| 7440 | 38.71 | 9.78 | H | 0.00 | 48.49 | 73.98 | 25.49 | PK |
| 7440 | 38.71 | 9.78 | H | -24.76 | 23.73 | 53.98 | 30.25 | AV |

Operation Mode: CH Low(π/4DQPSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4804 | 42.45 | 1.83 | V | 0.00 | 44.28 | 73.98 | 29.70 | PK |
| 4804 | 42.45 | 1.83 | V | -24.76 | 19.52 | 53.98 | 34.46 | AV |
| 7206 | 39.55 | 9.65 | V | 0.00 | 49.20 | 73.98 | 24.78 | PK |
| 7206 | 39.55 | 9.65 | V | -24.76 | 24.44 | 53.98 | 29.54 | AV |
| 4804 | 42.53 | 1.83 | H | 0.00 | 44.36 | 73.98 | 29.62 | PK |
| 4804 | 42.53 | 1.83 | H | -24.76 | 19.60 | 53.98 | 34.38 | AV |
| 7206 | 39.24 | 9.65 | H | 0.00 | 48.89 | 73.98 | 25.09 | PK |
| 7206 | 39.24 | 9.65 | H | -24.76 | 24.13 | 53.98 | 29.85 | AV |

Operation Mode: CH Mid(π/4DQPSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4882 | 40.91 | 2.31 | V | 0.00 | 43.22 | 73.98 | 30.76 | PK |
| 4882 | 40.91 | 2.31 | V | -24.76 | 18.46 | 53.98 | 35.52 | AV |
| 7323 | 39.49 | 9.96 | V | 0.00 | 49.45 | 73.98 | 24.53 | PK |
| 7323 | 39.49 | 9.96 | V | -24.76 | 24.69 | 53.98 | 29.29 | AV |
| 4882 | 40.93 | 2.31 | H | 0.00 | 43.24 | 73.98 | 30.74 | PK |
| 4882 | 40.93 | 2.31 | H | -24.76 | 18.48 | 53.98 | 35.50 | AV |
| 7323 | 38.90 | 9.96 | H | 0.00 | 48.86 | 73.98 | 25.12 | PK |
| 7323 | 38.90 | 9.96 | H | -24.76 | 24.10 | 53.98 | 29.88 | AV |

Operation Mode: CH High (π/4DQPSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4960 | 40.96 | 2.26 | V | 0.00 | 43.22 | 73.98 | 30.76 | PK |
| 4960 | 40.96 | 2.26 | V | -24.76 | 18.46 | 53.98 | 35.52 | AV |
| 7440 | 38.70 | 9.78 | V | 0.00 | 48.48 | 73.98 | 25.50 | PK |
| 7440 | 38.70 | 9.78 | V | -24.76 | 23.72 | 53.98 | 30.26 | AV |
| 4960 | 41.30 | 2.26 | H | 0.00 | 43.56 | 73.98 | 30.42 | PK |
| 4960 | 41.30 | 2.26 | H | -24.76 | 18.80 | 53.98 | 35.18 | AV |
| 7440 | 38.87 | 9.78 | H | 0.00 | 48.65 | 73.98 | 25.33 | PK |
| 7440 | 38.87 | 9.78 | H | -24.76 | 23.89 | 53.98 | 30.09 | AV |

Operation Mode: CH Low(8DPSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4804 | 41.96 | 1.83 | V | 0.00 | 43.79 | 73.98 | 30.19 | PK |
| 4804 | 41.96 | 1.83 | V | -24.76 | 19.03 | 53.98 | 34.95 | AV |
| 7206 | 39.62 | 9.65 | V | 0.00 | 49.27 | 73.98 | 24.71 | PK |
| 7206 | 39.62 | 9.65 | V | -24.76 | 24.51 | 53.98 | 29.47 | AV |
| 4804 | 42.15 | 1.83 | H | 0.00 | 43.98 | 73.98 | 30.00 | PK |
| 4804 | 42.15 | 1.83 | H | -24.76 | 19.22 | 53.98 | 34.76 | AV |
| 7206 | 39.62 | 9.65 | H | 0.00 | 49.27 | 73.98 | 24.71 | PK |
| 7206 | 39.62 | 9.65 | H | -24.76 | 24.51 | 53.98 | 29.47 | AV |

Operation Mode: CH Mid(8DPSK)

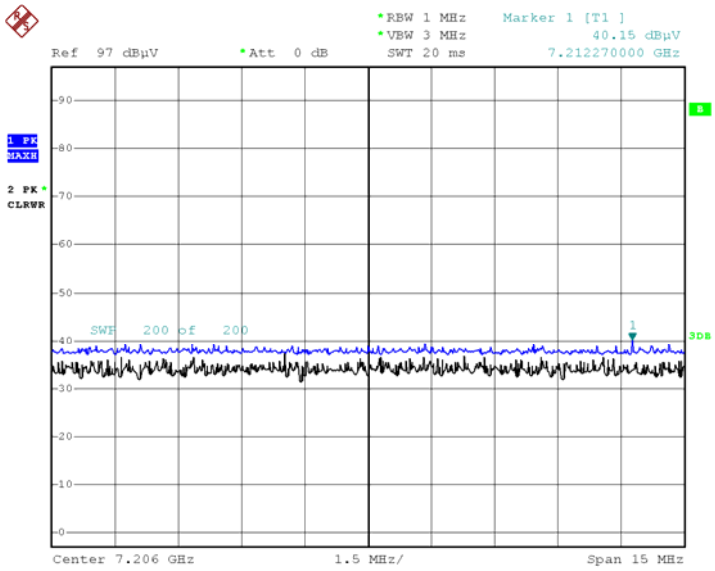
| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4882 | 40.91 | 2.31 | V | 0.00 | 43.22 | 73.98 | 30.76 | PK |
| 4882 | 40.91 | 2.31 | V | -24.76 | 18.46 | 53.98 | 35.52 | AV |
| 7323 | 39.25 | 9.96 | V | 0.00 | 49.21 | 73.98 | 24.77 | PK |
| 7323 | 39.25 | 9.96 | V | -24.76 | 24.45 | 53.98 | 29.53 | AV |
| 4882 | 41.36 | 2.31 | H | 0.00 | 43.67 | 73.98 | 30.31 | PK |
| 4882 | 41.36 | 2.31 | H | -24.76 | 18.91 | 53.98 | 35.07 | AV |
| 7323 | 39.36 | 9.96 | H | 0.00 | 49.32 | 73.98 | 24.66 | PK |
| 7323 | 39.36 | 9.96 | H | -24.76 | 24.56 | 53.98 | 29.42 | AV |

Operation Mode: CH High(8DPSK)

| Frequency [MHz] | Reading dBuV | A.F+C.L-A.G+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect |
|---|---|---|---|---|---|---|---|---|
| 4960 | 41.51 | 2.26 | V | 0.00 | 43.77 | 73.98 | 30.21 | PK |
| 4960 | 41.51 | 2.26 | V | -24.76 | 19.01 | 53.98 | 34.97 | AV |
| 7440 | 38.52 | 9.78 | V | 0.00 | 48.30 | 73.98 | 25.68 | PK |
| 7440 | 38.52 | 9.78 | V | -24.76 | 23.54 | 53.98 | 30.44 | AV |
| 4960 | 41.43 | 2.26 | H | 0.00 | 43.69 | 73.98 | 30.29 | PK |
| 4960 | 41.43 | 2.26 | H | -24.76 | 18.93 | 53.98 | 35.05 | AV |
| 7440 | 38.62 | 9.78 | H | 0.00 | 48.40 | 73.98 | 25.58 | PK |
| 7440 | 38.62 | 9.78 | H | -24.76 | 23.64 | 53.98 | 30.34 | AV |

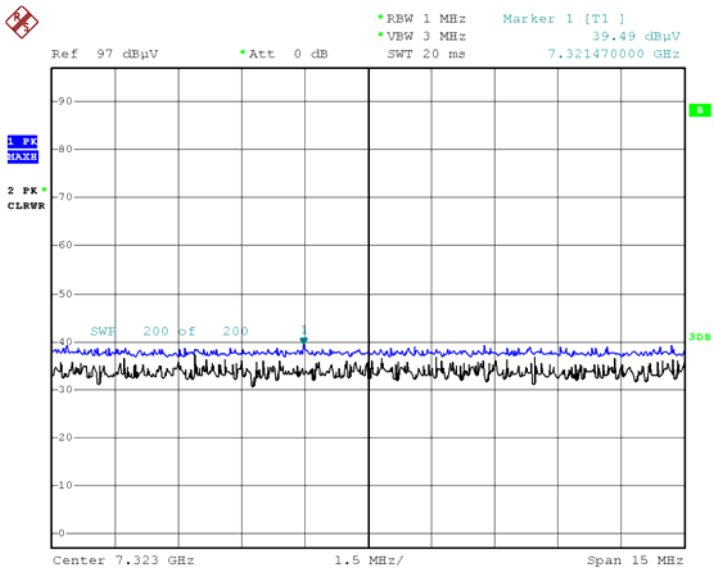
## RESULT PLOTS

Radiated Spurious Emissions plot – Peak Reading (GFSK, Ch.0 3rd Harmonic, X-H)



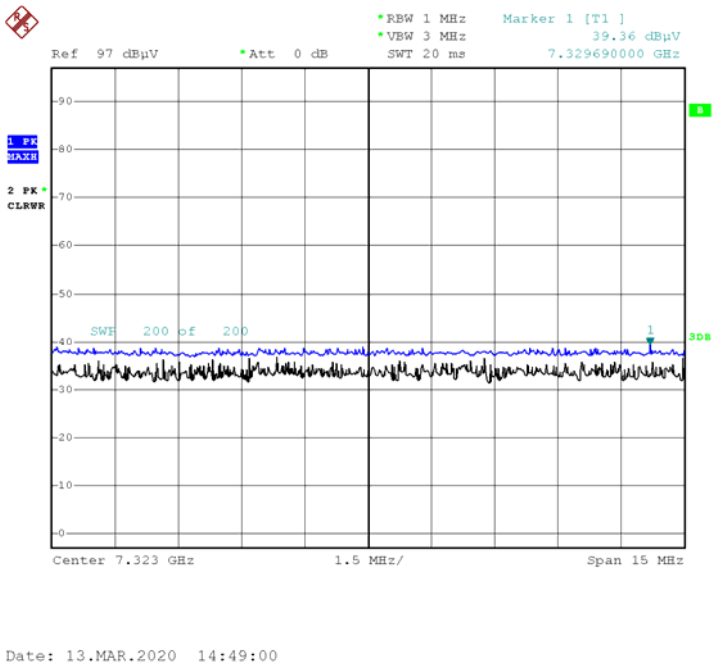

Date: 12.MAR.2020 17:28:26

Radiated Spurious Emissions plot – Peak Reading (π/4DQPSK, Ch.39 3rd Harmonic, X-V)




Date: 13.MAR.2020 14:54:58

Radiated Spurious Emissions plot – Peak Reading (8DPSK, Ch.39 3rd Harmonic, X-H)




**Note:**

Plot of worst case are only reported.

### 10.6.3 RADIATED RESTRICTED BAND EDGES

| | |
|---|---|
| Operation Mode | Normal(GFSK) |
| Operating Frequency | 2402 MHz, 2480 MHz |
| Channel No | CH 0, CH 78 |

| Frequency [MHz] | Reading dBuV | ※ A.F+C.L -AMP+ATT+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect [dB] |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 48.47 | 2.61 | H | 0 | 51.08 | 73.98 | 22.90 | PK |
| 2390.0 | 48.47 | 2.61 | H | -24.76 | 26.32 | 53.98 | 27.66 | AV |
| 2390.0 | 47.41 | 2.61 | V | 0 | 50.02 | 73.98 | 23.96 | PK |
| 2390.0 | 47.41 | 2.61 | V | -24.76 | 25.26 | 53.98 | 28.72 | AV |
| 2483.5 | 60.11 | 3.13 | H | 0 | 63.24 | 73.98 | 10.74 | PK |
| 2483.5 | 60.11 | 3.13 | H | -24.76 | 38.48 | 53.98 | 15.50 | AV |
| 2483.5 | 53.72 | 3.13 | V | 0 | 56.85 | 73.98 | 17.13 | PK |
| 2483.5 | 53.72 | 3.13 | V | -24.76 | 32.09 | 53.98 | 21.89 | AV |

| | |
|---|---|
| Operation Mode | EDR(π/4DQPSK) |
| Operating Frequency | 2402 MHz, 2480 MHz |
| Channel No | CH 0, CH 78 |

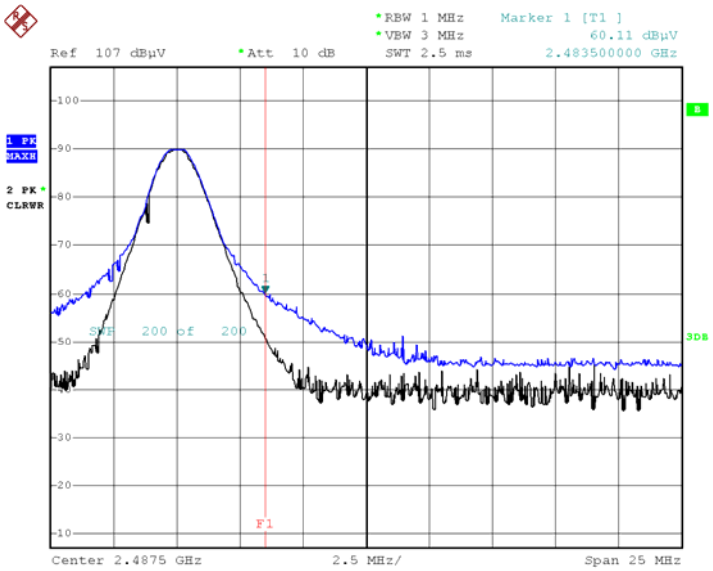
| Frequency [MHz] | Reading dBuV | ※ A.F+C.L -AMP+ATT+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect [dB] |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 47.63 | 2.61 | H | 0 | 50.24 | 73.98 | 23.74 | PK |
| 2390.0 | 47.63 | 2.61 | H | -24.76 | 25.48 | 53.98 | 28.50 | AV |
| 2390.0 | 47.65 | 2.61 | V | 0 | 50.26 | 73.98 | 23.72 | PK |
| 2390.0 | 47.65 | 2.61 | V | -24.76 | 25.50 | 53.98 | 28.48 | AV |
| 2483.5 | 59.63 | 3.13 | H | 0 | 62.76 | 73.98 | 11.22 | PK |
| 2483.5 | 59.63 | 3.13 | H | -24.76 | 38.00 | 53.98 | 15.98 | AV |
| 2483.5 | 53.18 | 3.13 | V | 0 | 56.31 | 73.98 | 17.67 | PK |
| 2483.5 | 53.18 | 3.13 | V | -24.76 | 31.55 | 53.98 | 22.43 | AV |

| | |
|---|---|
| Operation Mode | EDR(8DPSK) |
| Operating Frequency | 2402 MHz, 2480 MHz |
| Channel No | CH 0, CH 78 |

| Frequency [MHz] | Reading dBuV | ※ A.F+C.L -AMP+ATT+D.F [dB] | ANT. POL [H/V] | Duty Cycle Correction [dB] | Total [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Detect [dB] |
|---|---|---|---|---|---|---|---|---|
| 2390.0 | 47.84 | 2.61 | H | 0 | 50.45 | 73.98 | 23.53 | PK |
| 2390.0 | 47.84 | 2.61 | H | -24.76 | 25.69 | 53.98 | 28.29 | AV |
| 2390.0 | 47.45 | 2.61 | V | 0 | 50.06 | 73.98 | 23.92 | PK |
| 2390.0 | 47.45 | 2.61 | V | -24.76 | 25.30 | 53.98 | 28.68 | AV |
| 2483.5 | 59.86 | 3.13 | H | 0 | 62.99 | 73.98 | 10.99 | PK |
| 2483.5 | 59.86 | 3.13 | H | -24.76 | 38.23 | 53.98 | 15.75 | AV |
| 2483.5 | 53.63 | 3.13 | V | 0 | 56.76 | 73.98 | 17.22 | PK |
| 2483.5 | 53.63 | 3.13 | V | -24.76 | 32.00 | 53.98 | 21.98 | AV |

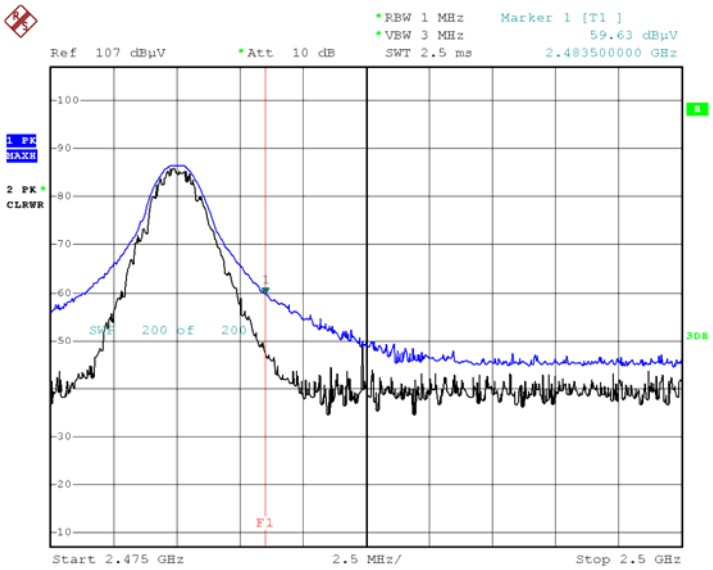
## RESULT PLOTS

Radiated Restricted Band Edges plot – Peak Reading (GFSK, Ch.78, X-H)



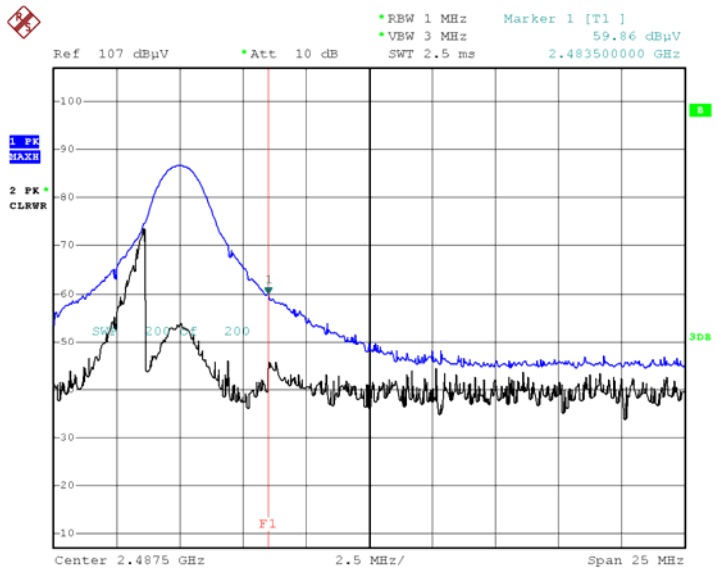

Date: 12.MAR.2020 15:03:32

Radiated Restricted Band Edges plot – Peak Reading (π/4DQPSK, Ch.78, X-H)




Date: 12.MAR.2020 15:12:44

Radiated Restricted Band Edges plot – Peak Reading (8DPSK, Ch.78, X-H)




**Note:**

Plot of worst case are only reported.

## 10.7 RECEIVER SPURIOUS EMISSIONS

**Frequency Range : Below 1 GHz**

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

**Note:**

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

**Frequency Range : Above 1 GHz**

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

## 11. LIST OF TEST EQUIPMENT

**Conducted Test**

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|---|---|---|---|---|
| Rohde & Schwarz | ENV216 / LISN | 09/11/2019 | Annual | 102245 |
| Rohde & Schwarz | ESCI / Test Receiver | 06/18/2019 | Annual | 100584 |
| ESPAC | SU-642 /Temperature Chamber | 08/14/2019 | Annual | 93000718 |
| Agilent | N9020A / Signal Analyzer | 05/23/2019 | Annual | MY51110085 |
| Agilent | N9030A / Signal Analyzer | 05/09/2019 | Annual | MY49432108 |
| Agilent | N1911A / Power Meter | 04/10/2019 | Annual | MY45100523 |
| Agilent | N1921A / Power Sensor | 04/10/2019 | Annual | MY52260025 |
| Agilent | 87300B / Directional Coupler | 11/11/2019 | Annual | 3116A03621 |
| Hewlett Packard | 11667B / Power Splitter | 05/24/2019 | Annual | 05001 |
| Hewlett Packard | E3632A / DC Power Supply | 06/18/2019 | Annual | KR75303960 |
| Agilent | 8493C / Attenuator(10 dB) | 07/02/2019 | Annual | 07560 |
| Rohde & Schwarz | EMC32 / Software | N/A | N/A | N/A |
| HCT CO., LTD. | FCC WLAN&BT&BLE Conducted Test Software v3.0 | N/A | N/A | N/A |
| Rohde & Schwarz | CBT / Bluetooth Tester | 05/16/2019 | Annual | 100422 |

**Note:**

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

**Radiated Test**

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|---|---|---|---|---|
| Innco system | CO3000 / Controller(Antenna mast) | N/A | N/A | CO3000-4p |
| Innco system | MA4640/800-XP-EP / Antenna Position Tower | N/A | N/A | N/A |
| Audix | EM1000 / Controller | N/A | N/A | 060520 |
| Audix | Turn Table | N/A | N/A | N/A |
| TNM system | FBSM-01B / Amp & Filter Bank Switch Controller | N/A | N/A | N/A |
| Rohde & Schwarz | Loop Antenna | 04/26/2019 | Biennial | 1513-175 |
| Schwarzbeck | VULB 9168 / Hybrid Antenna | 08/02/2019 | Biennial | 01039 |
| Schwarzbeck | BBHA 9120D / Horn Antenna | 06/28/2019 | Biennial | 1300 |
| Schwarzbeck | BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz) | 04/29/2019 | Biennial | BBHA9170342 |
| Rohde & Schwarz | FSP(9 kHz ~ 40 GHz) / Spectrum Analyzer | 07/16/2019 | Annual | 100843 |
| Wainwright Instruments | WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter | 01/21/2020 | Annual | 2 |
| Wainwright Instruments | WRCJV5100/5850-40/50-8EEK / Band Reject Filter | 02/10/2020 | Annual | 1 |
| CERNEX | CBL18265035 / Power Amplifier | 12/26/2019 | Annual | 22966 |
| CERNEX | CBL26405040 / Power Amplifier | 06/18/2019 | Annual | 25956 |
| TESCOM | TC-3000C / Bluetooth Tester | 03/26/2019 | Annual | 3000C000276 |
| TNM system | FBSM-05B / HPF(3~18GHz) + LNA1(1~18GHz) | 01/21/2020 | Annual | F6 |
| TNM system | FBSM-05B / ATT(10dB) + LNA1(1~18GHz) | 01/21/2020 | Annual | None |
| TNM system | FBSM-05B / ATT(3dB) + LNA1(1~18GHz) | 01/21/2020 | Annual | None |
| TNM system | FBSM-05B / LNA1(1~18GHz) | 01/21/2020 | Annual | 25540 |
| TNM system | FBSM-05B / HPF(7~18GHz) + LNA2(6~18GHz) | 01/21/2020 | Annual | 28550 |
| TNM system | FBSM-05B / Thru(30MHz ~ 18GHz) | 01/21/2020 | Annual | None |

**Note:**

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
3. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5(Version : 2017).

## 12. ANNEX A_ TEST SETUP PHOTO

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

| No. | Description |
|---|---|
| 1 | HCT-RF-2003-FI006-P |