On your side

고 객 비 밀
CUSTOMER SECRET

TEST REPORT

FCC/ISED BT Test for VT250TWAN&VT250GYKN
Certification

APPLICANT
HYUNDAI MOBIS CO., LTD.

REPORT NO.
HCT-RF-2103-FC002

DATE OF ISSUE
March 4, 2021

Tested by
Sang Hoon Lee

Technical Manager
Jong Seok Lee

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

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

고 객 비 밀
CUSTOMER SECRET

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

TEST REPORT

FCC/ISED BT Test for VT250TWAN& VT250GYKN

REPORT NO.
HCT-RF-2103-FC002
DATE OF ISSUE
March 04, 2021
Additional Model
FCC : VT250JWAN, VT251JWAN, VT260TWAN, VT260JWAN, VT261JWAN, VT261TWAN, VT262JWAN, VT263JWAN
ISED: VT250JWKN, VT251JWKN, VT260GYKN, VT260JWKN, VT261JWKN, VT261GYKN, VT262JWKN, VT263JWKN

Applicant	**HYUNDAI MOBIS CO., LTD.** 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, South Korea
Eut Type	Car Audio System
FCC Model Name	VT250TWAN
ISED Model Name	VT250GYKN
FCC ID	TQ8-VT250TWAN
IC	5074A-VT250GYKN
Max. RF Output Power	2.550 dBm (1.80 mW)
FCC Classification	FCC Part 15 Spread Spectrum Transmitter
FCC Rule Part(s)	Part 15 subpart C 15.247
ISED Rule Part(s)	RSS-247 Issue 2 (February 2017) RSS-Gen Issue 5_Amendment 1 (March 2019)

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	March 04, 2021	Initial Release

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

CONTENTS

1. EUT DESCRIPTION

FCC Model	VT250TWAN
ISED Model	VT250GYKN
FCC Additional Model	VT250JWAN, VT251JWAN, VT260TWAN, VT260JWAN, VT261JWAN, VT261TWAN, VT262JWAN, VT263JWAN
ISED Additional Model	VT250JWKN, VT251JWKN, VT260GYKN, VT260JWKN, VT261JWKN, VT261GYKN, VT262JWKN, VT263JWKN
EUT Type	Car Audio System
Power Supply	DC 14.4 V
Frequency Range	2 402 MHz – 2 480 MHz
Max. RF Output Power	2.550 dBm (1.80 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: Single Bands Bluetooth ANT Peak Gain : -0.38 dBi
Date(s) of Tests	February 01, 2021 ~ February 28, 2021
PMN (Product Marketing Number)	VT250GYKN, VT250JWKN, VT251JWKN, VT260GYKN, VT260JWKN, VT261JWKN, VT261GYKN, VT262JWKN, VT263JWKN
HVIN (Hardware Version Identification Number)	VT250GYKN, VT250JWKN, VT251JWKN, VT260GYKN, VT260JWKN, VT261JWKN, VT261GYKN, VT262JWKN, VT263JWKN
FVIN (Firmware Version Identification Number)	NQ5.USA.0000.V038.001.201222
HMN (Host Marketing Name)	N/A
EUT serial numbers	Conducted : 96560-DW000 (FCC), 96560-P1030 (ISED) Radiated : 96560-DW000 (FCC), 96560-P1030 (ISED)

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 sh
  all 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 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

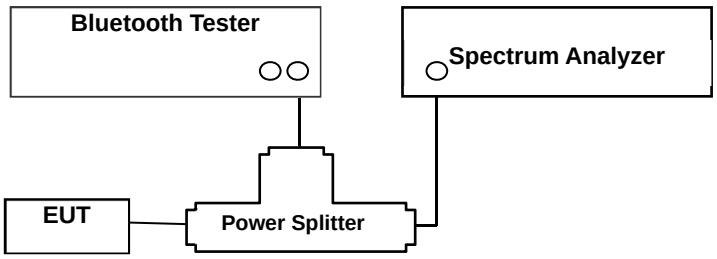
8.1. Conducted Maximum Peak Output Power

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)

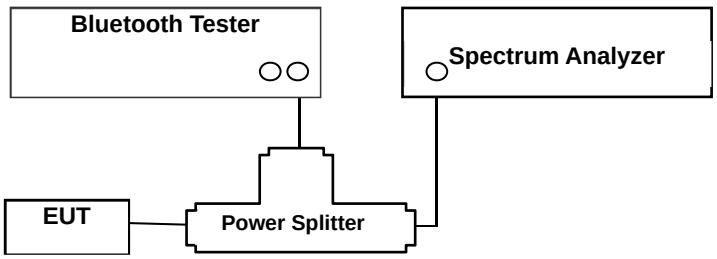
= 10 dBm + 6 dB + 1.5 dB = 17.5 dBm

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)

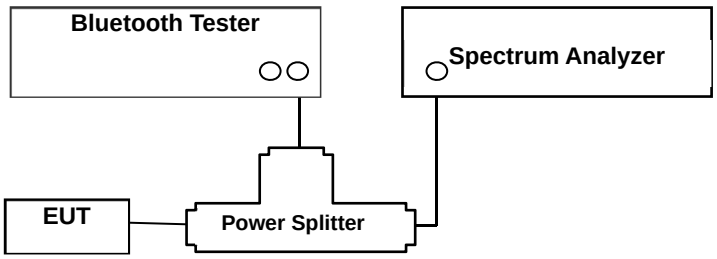
1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer 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)

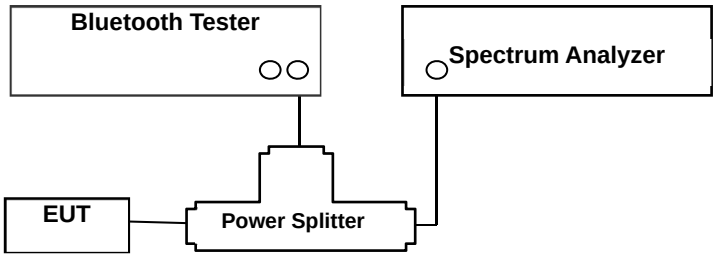
1) Span: Set between two times and five times the OBW
2) RBW: 1% to 5% of the OBW.
3) VBW ≥ 3 x RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) All the trace to stabilize.

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)

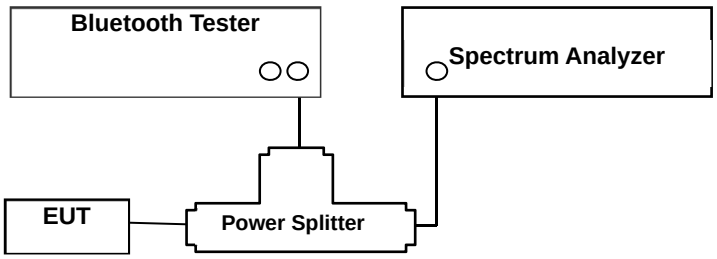
1) Span: the frequency band of operation
2) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3) VBW ≥ RBW
4) Sweep: Auto
5) Detector: Peak
6) Trace: Max hold
7) Allow the trace to stabilize.

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)

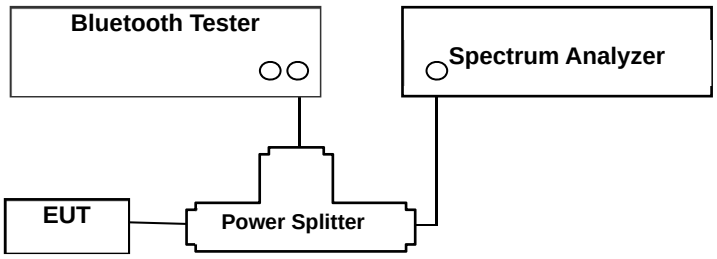
Note :
DH5 Packet need 5 time slot for transmitting and 1 time slot for receiving.
Then the system makes worst case 1600/6 hops per second with 79 channels. So the system have each channel 3.3755 times per second and so for 31.6 seconds the system have 106.667 times of appearance.
Each tx-time per appearance 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	26.63
100	26.71
200	26.80
300	26.91
400	26.97
500	26.99
600	26.99
700	27.03
800	27.06
900	27.10
1000	27.13
2000	27.42
2400	27.52
2480	27.54
2500	27.54
3000	27.64
4000	27.82
5000	28.01
5150	28.03
5850	28.10
6000	28.10
7000	28.26
8000	28.38
9000	28.51
10000	28.64
11000	28.73
12000	28.89
13000	29.06
14000	29.01
15000	29.08
16000	29.14
17000	29.21
18000	29.32
19000	29.37
20000	29.47
21000	29.80
22000	29.84
23000	30.04
24000	29.91
25000	30.03
26000	30.04

Note :
1. 2400 ~ 2500 MHz is fundamental frequency range.
2. Factor = Attenuator loss(20 dB) + 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

ISED

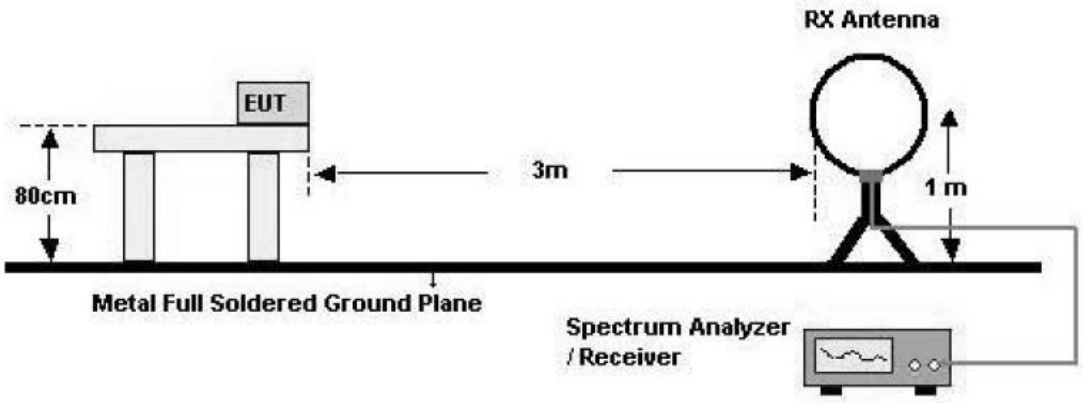
Frequency (MHz)	Field Strength (uA/m)	Measurement Distance (m)
0.009 – 0.490	6.37/F(kHz)	300
0.490 – 1.705	63.7/F(kHz)	30
1.705 – 30	0.08	30

FCC&ISED

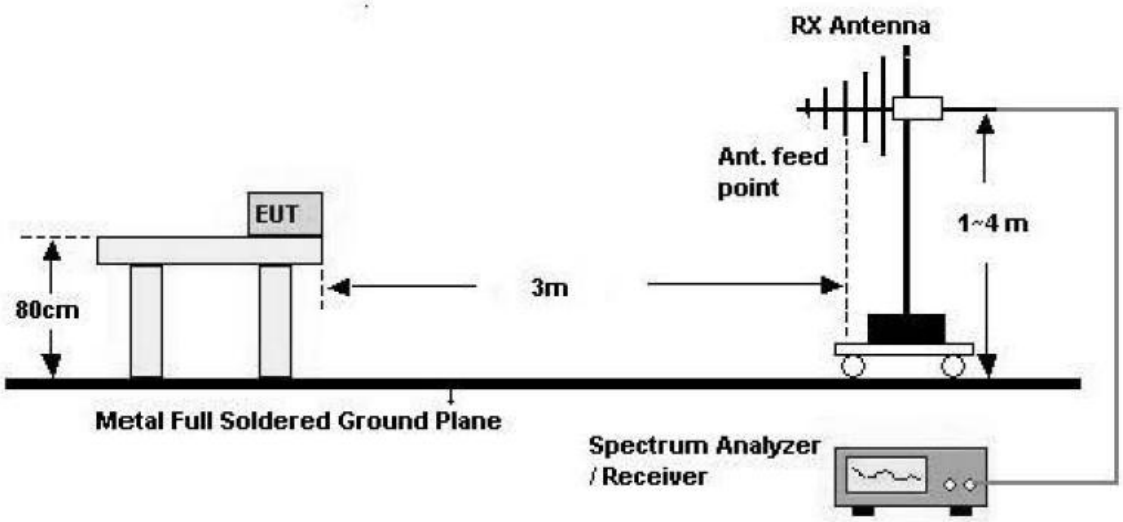
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

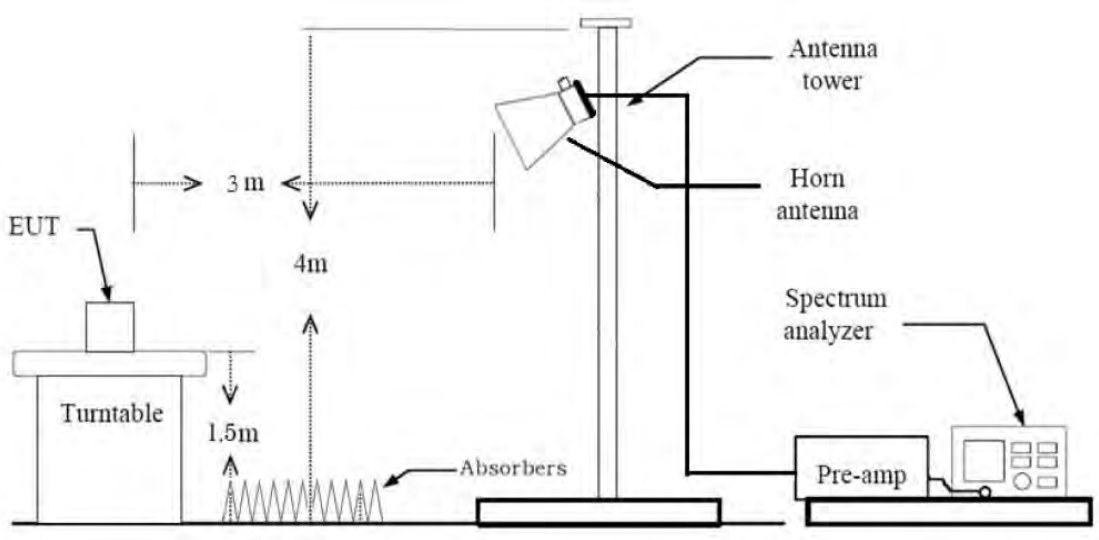
Below 30 MHz



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. The Hybrid antenna was placed at a location 3m from the EUT, which is varied from 1m to 4m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = 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
7. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)
8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. 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 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
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):
      - 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. 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. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
12. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(A.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 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. Spectrum Setting
   (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
9. Distance extrapolation factor = 20log (test distance / specific distance) (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

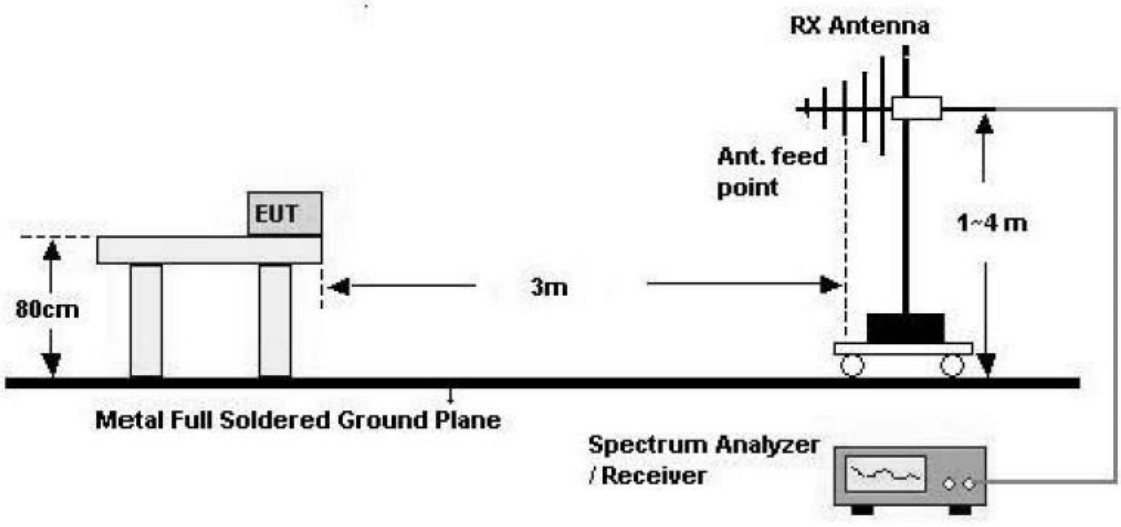
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

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

Test Configuration

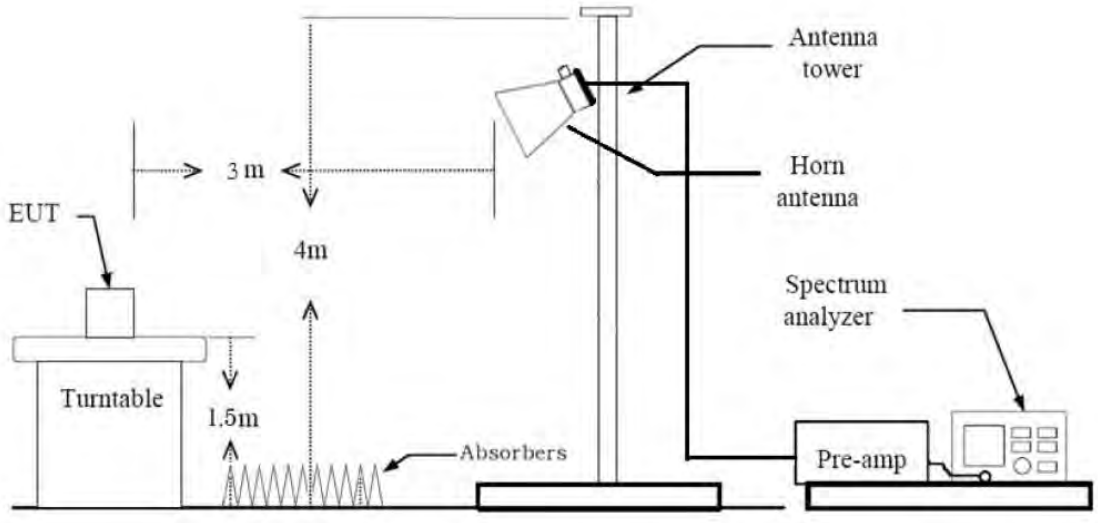
30 MHz - 1 GHz



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. The Hybrid antenna was placed at a location 3m from the EUT, which is varied from 1m to 4m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = 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
7. 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 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. Spectrum Setting
   (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

9. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
10. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)
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. VT250TWAN(FCC)& VT250GYKN(ISED), Additional Model were tested and the worst case results are reported.

(Worst case : VT250TWAN(FCC)& VT250GYKN(ISED))

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. VT250TWAN(FCC)& VT250GYKN(ISED), Additional Model were tested and the worst case results are reported.

(Worst case : VT250TWAN(FCC)& VT250GYKN(ISED))

9. SUMMARY OF TEST RESULTS

Test Description	FCC Part Section(s)	ISED 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	2.065	1.61	125
Mid	2441	2.550	1.80	
High	2480	2.148	1.64	

Channel	Frequency (MHz)	Output Power (8DPSK)		Limit (mW)
		(dBm)	(mW)	
Low	2402	-0.596	0.87	125
Mid	2441	0.359	1.09	
High	2480	0.237	1.06	

Channel	Frequency (MHz)	Output Power (π/4DQPSK)		Limit (mW)
		(dBm)	(mW)	
Low	2402	-1.023	0.79	125
Mid	2441	-0.103	0.98	
High	2480	-0.198	0.96	

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 27.52 dB at 2400 MHz
   and is 27.54 dB at 2500 MHz.
   So, 27.54 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)

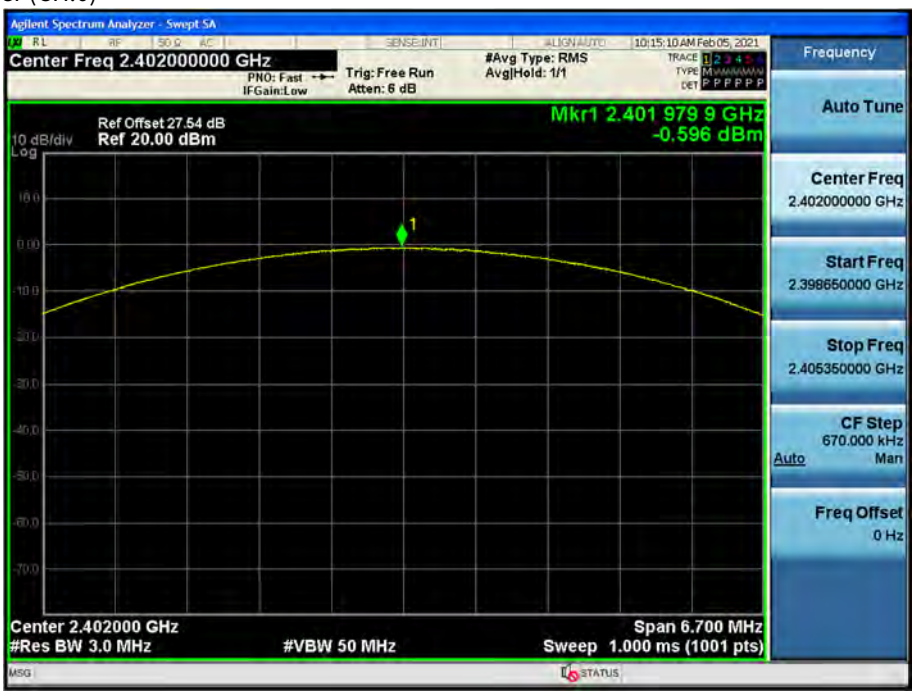
Peak Power (CH.39)

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	57.956	54.500	53.967	20
Upper	60.251	55.357	54.963	

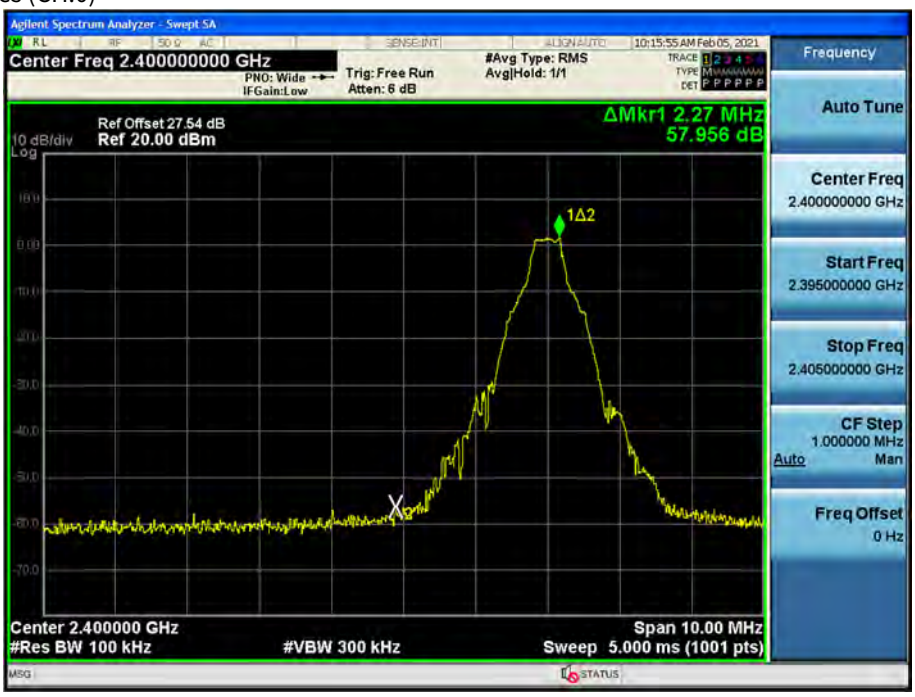
With hopping

Outside Frequency Band	GFSK (dB)	8DPSK (dB)	π/4DQPSK (dB)	Limit (dBc)
Lower	59.005	53.998	54.062	20
Upper	56.370	52.724	55.335	

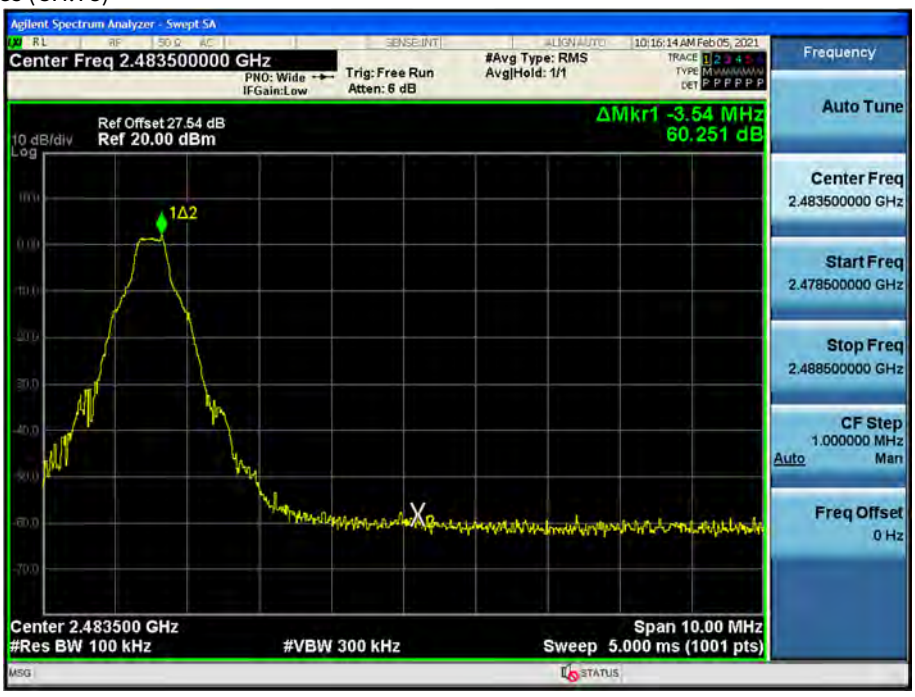
Note :

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 27.52 dB at 2400 MHz
   and is 27.54 dB at 2500 MHz.
   So, 27.54 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result.

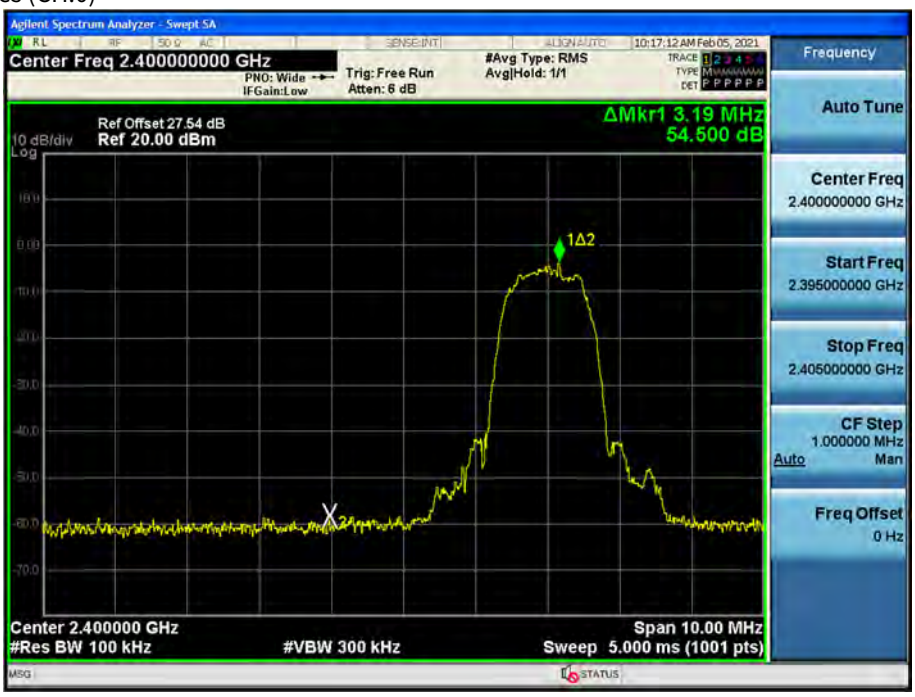
Test Plots without hopping (GFSK)
Band Edges (CH.0)



Test Plots without hopping (GFSK)
Band Edges (CH.78)



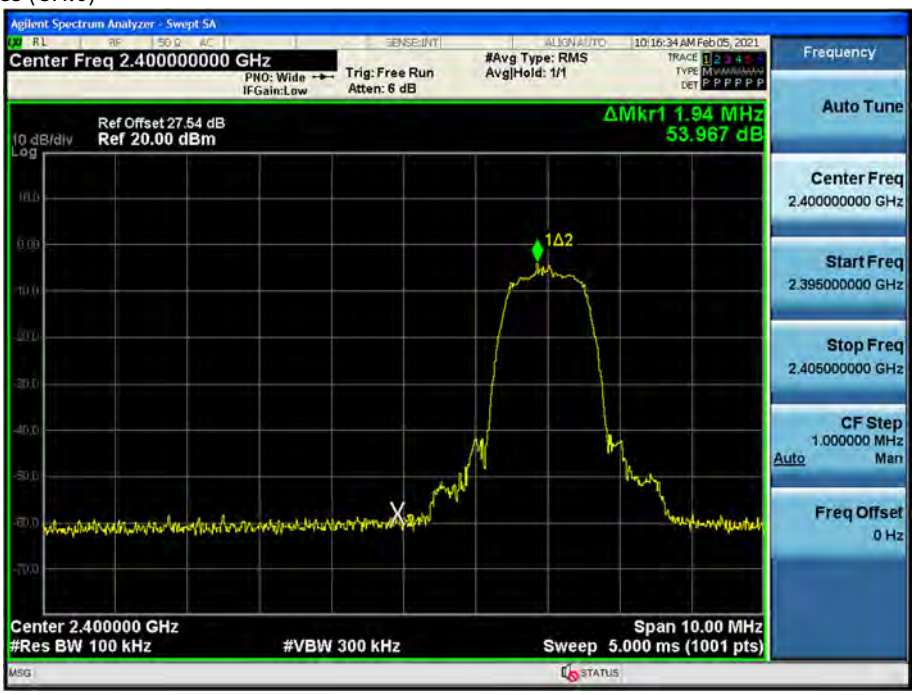
Test Plots without hopping (8DPSK)
Band Edges (CH.0)



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	901.13	1216.2	1210.9
CH.39	902.01	1215.4	1209.1
CH.78	898.66	1215.4	1206.8

20dB BW (kHz)			
Channel	GFSK	8DPSK	π/4DQPSK
CH.0	992.8	1340	1354
CH.39	1001.0	1339	1354
CH.78	1001.0	1342	1355

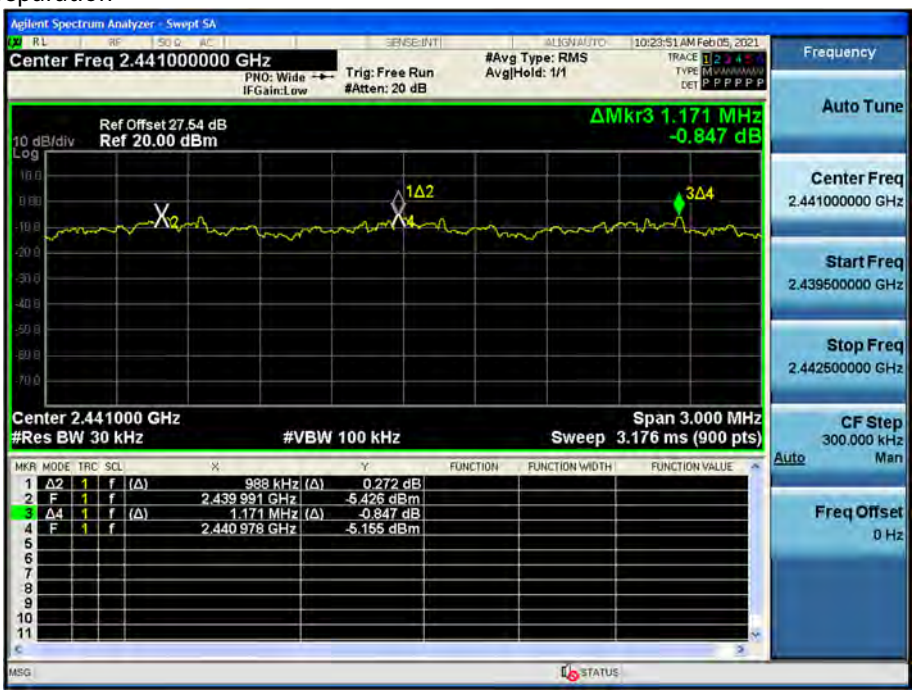
Channel Separation(kHz)			Limit
GFSK	8DPSK	π/4DQPSK	(kHz)
1004	988	991	>25 kHz or >2/3 of the 20dB BW

Test Plots (GFSK)

Channel Separation

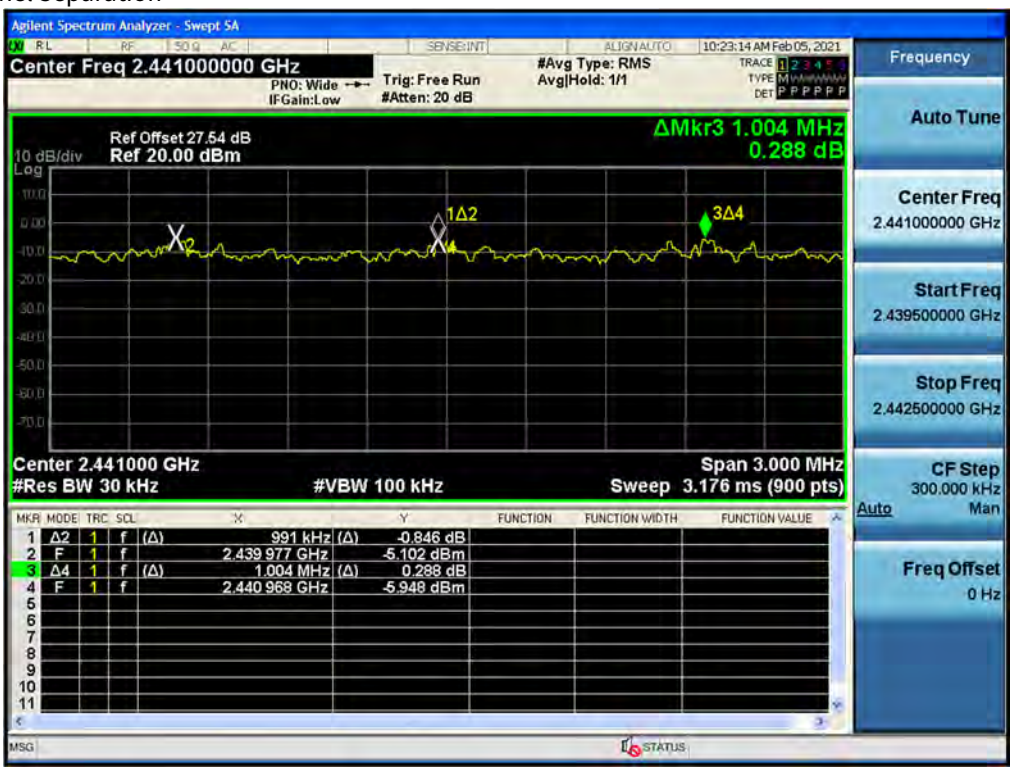
Test Plots (8DPSK)

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

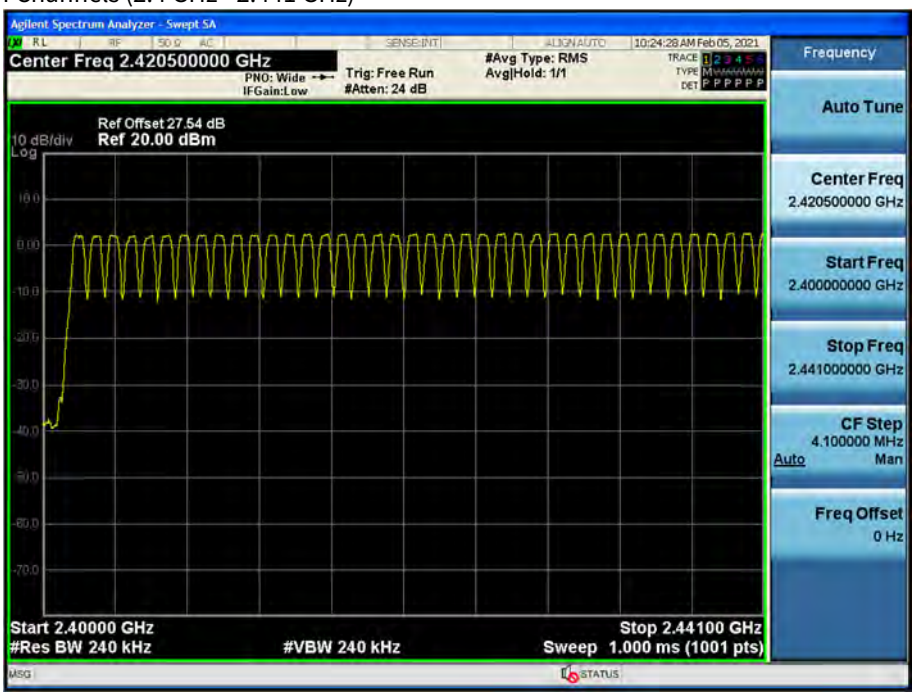
Result (No. of CH)			Limit
GFSK	8DPSK	π/4DQPSK	
79	79	79	>15

Note :

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

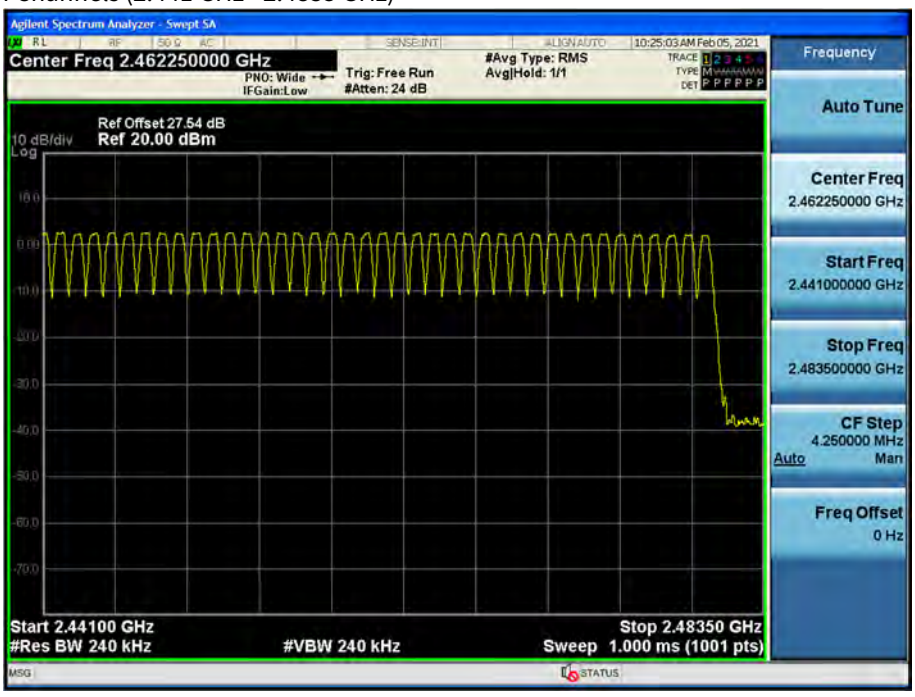
Test Plots (GFSK)

Number of Channels (2.4 GHz - 2.441 GHz)



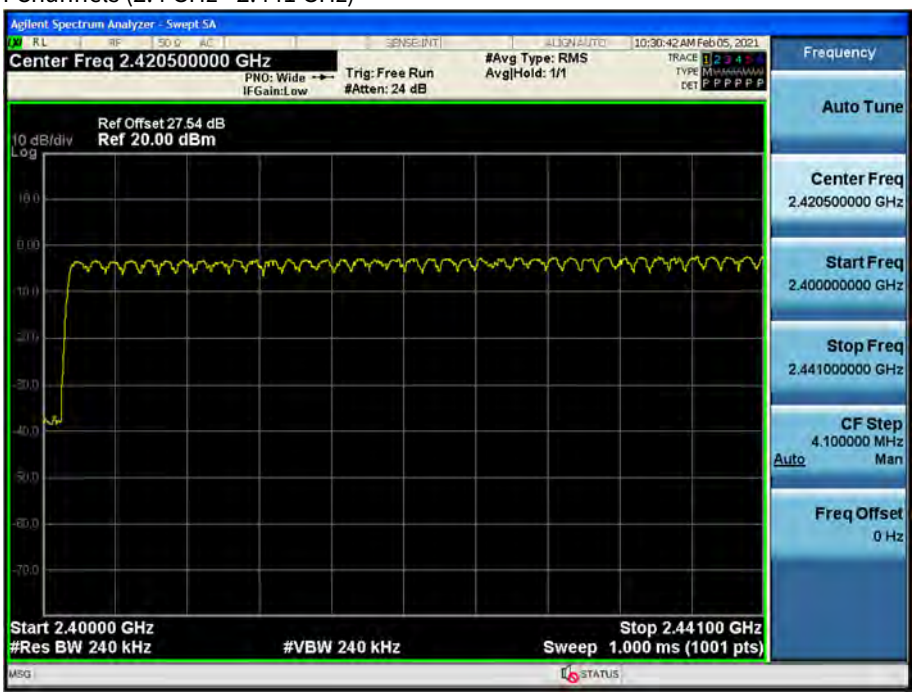
Test Plots (GFSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



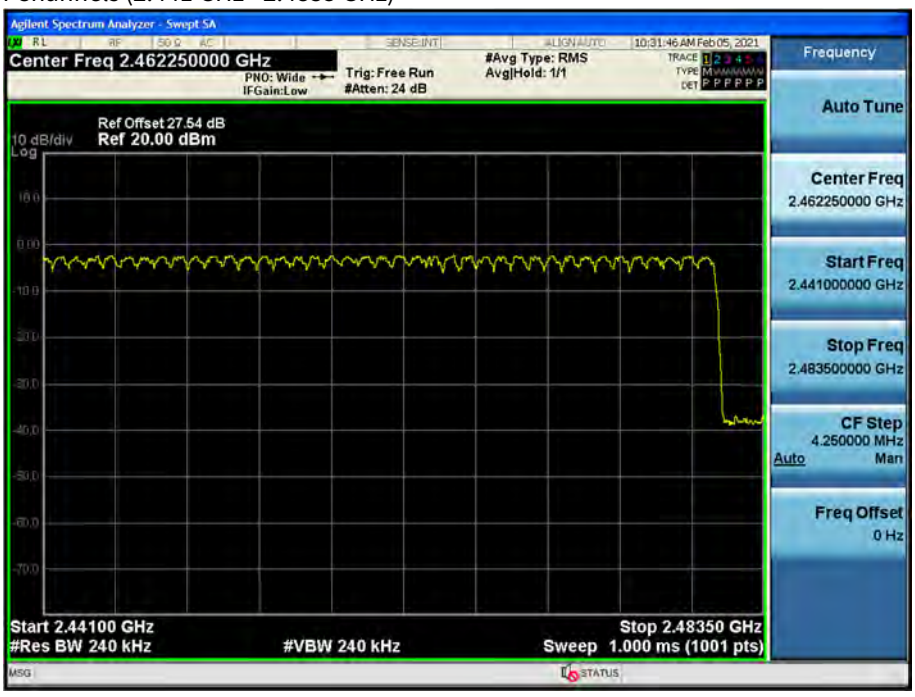
Test Plots (8DPSK)

Number of Channels (2.4 GHz - 2.441 GHz)



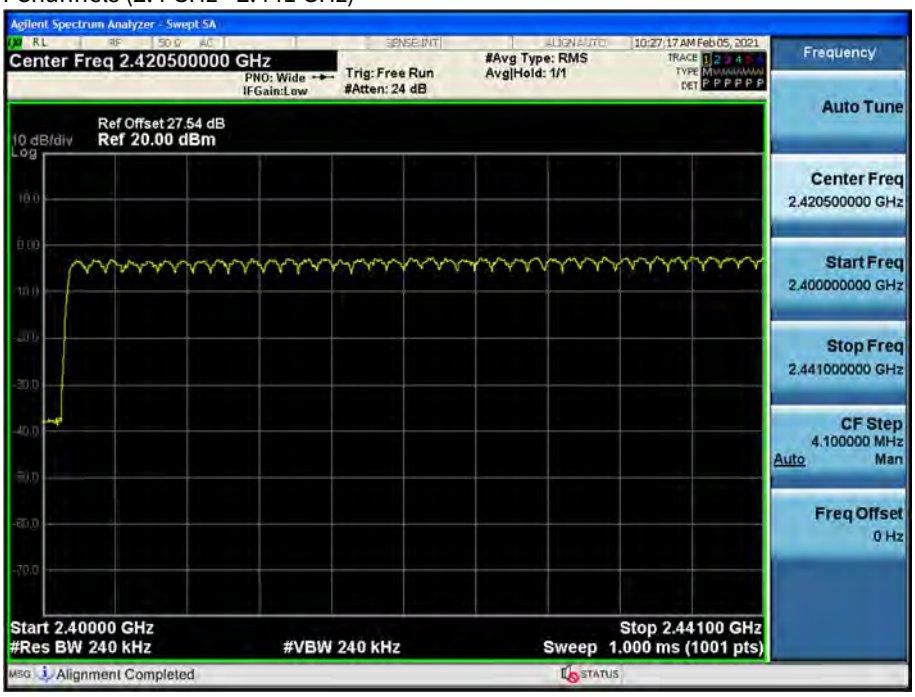
Test Plots (8DPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)



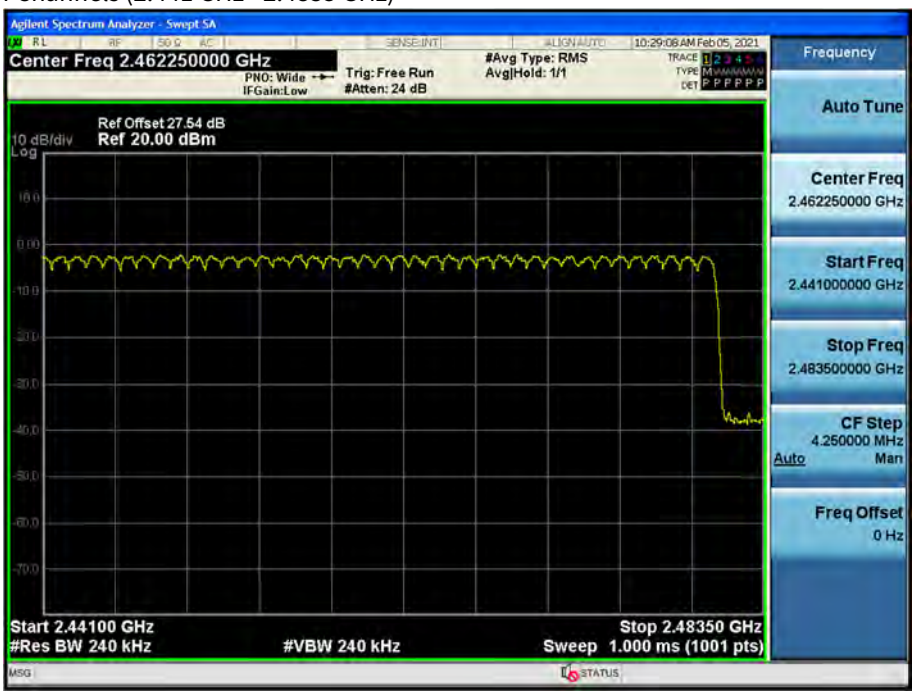
Test Plots (π/4DQPSK)

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	2.885	2.890	2.890
	Mid	2.885	2.895	2.890
	High	2.890	2.890	2.890

Non-AFH Mode

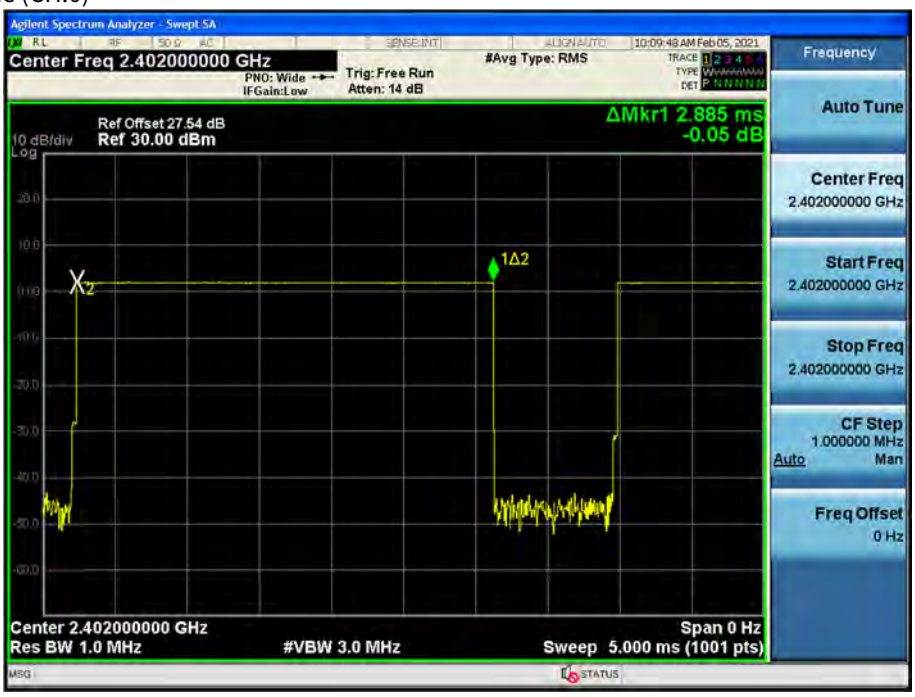
	Channel	GFSK	8DPSK	π/4DQPSK	Period Time (s)	Limit (ms)
Total of Dwell (ms)	Low	307.73	308.27	308.27	31.60	400
	Mid	307.73	308.80	308.27	31.60	
	High	308.27	308.27	308.27	31.60	

AFH Mode

	Channel	GFSK	8DPSK	π/4DQPSK	Period Time (s)	Limit (ms)
Total of Dwell (ms)	Low	153.87	154.13	154.13	8.0	400
	Mid	153.87	154.40	154.13	8.0	
	High	154.13	154.13	154.13	8.0	

Test Plots (GFSK)

Dwell Time (CH.0)



Test Plots (GFSK)

Dwell Time (CH.39)

Test Plots (GFSK)

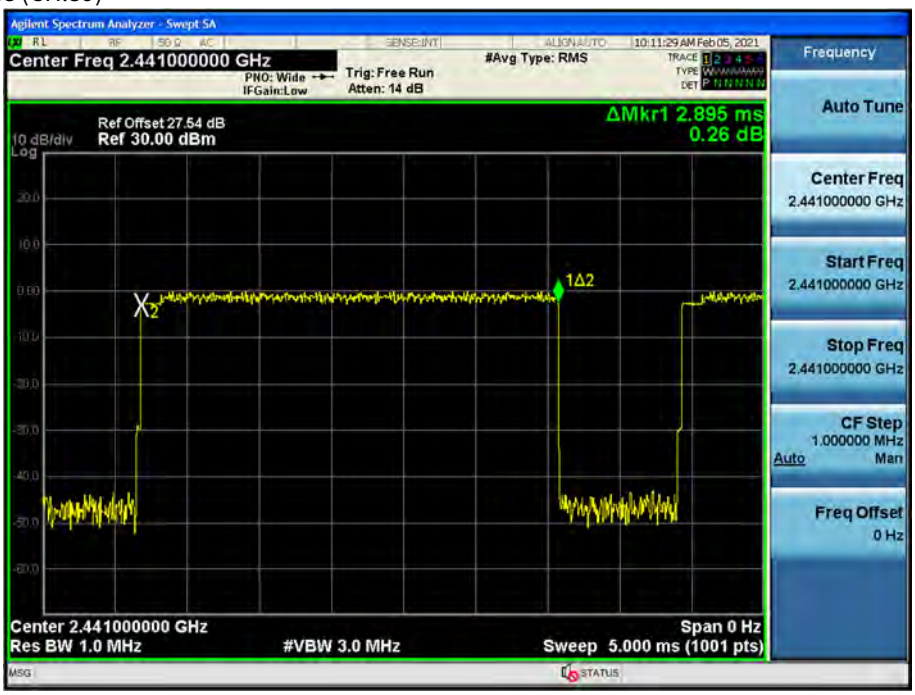
Dwell Time (CH.78)

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)

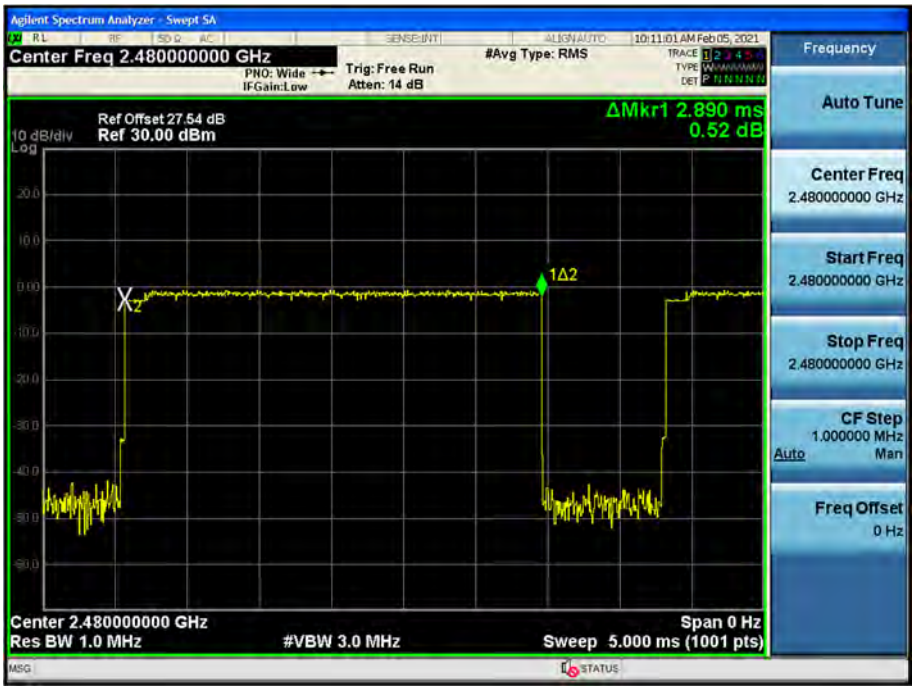
Dwell Time (CH.0)

Test Plots (π/4DQPSK)

Dwell Time (CH.39)

Test Plots (π/4DQPSK)

Dwell Time (CH.78)



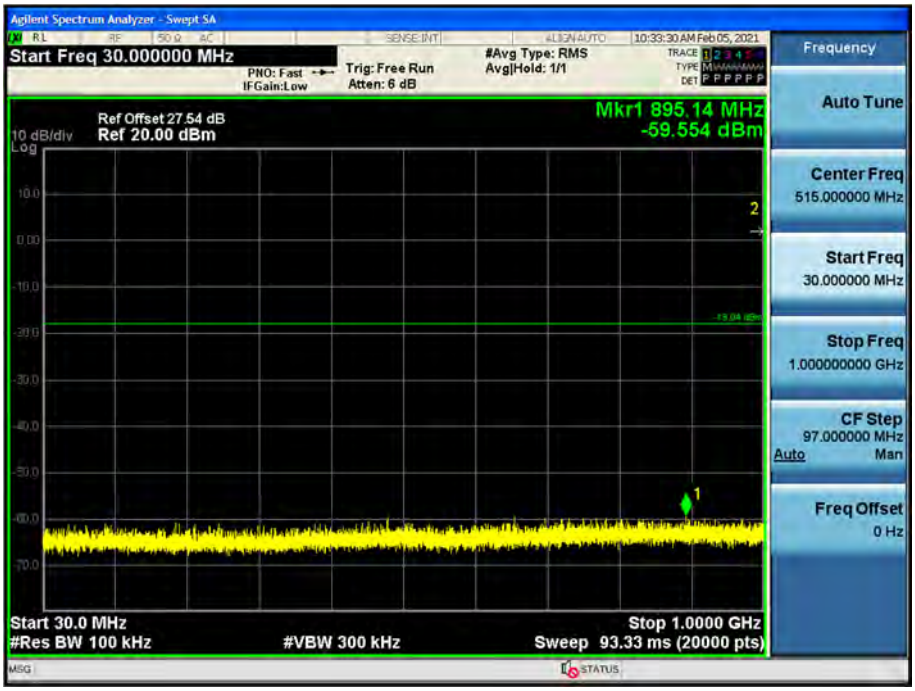
10.6 SPURIOUS EMISSIONS

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.

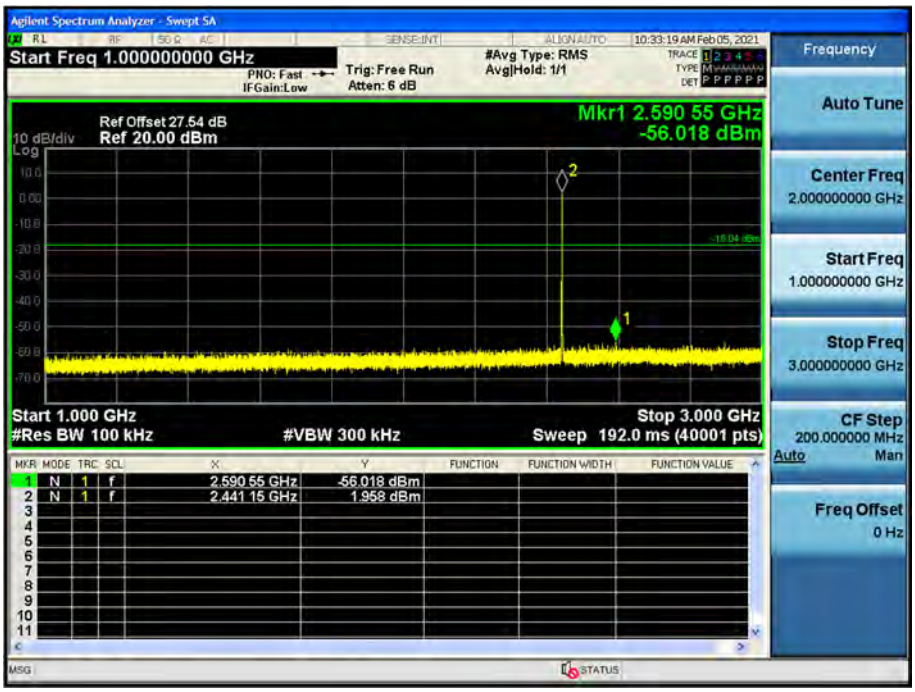
Test Plots (GFSK)- 30 MHz - 1 GHz

Spurious Emission (CH.39)



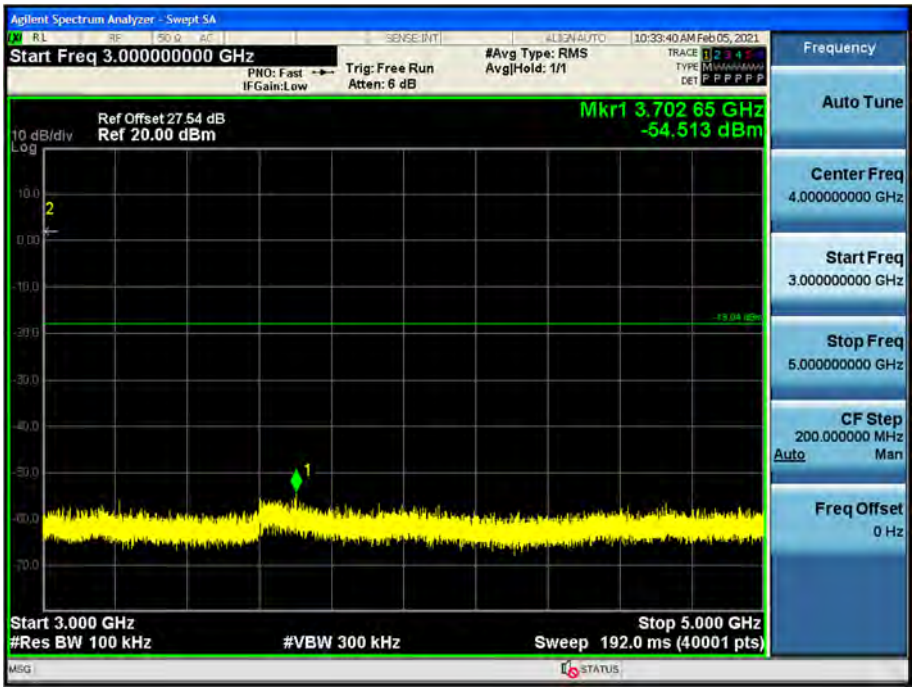
Test Plots (GFSK)- 1 GHz – 3 GHz

Spurious Emission (CH.39)



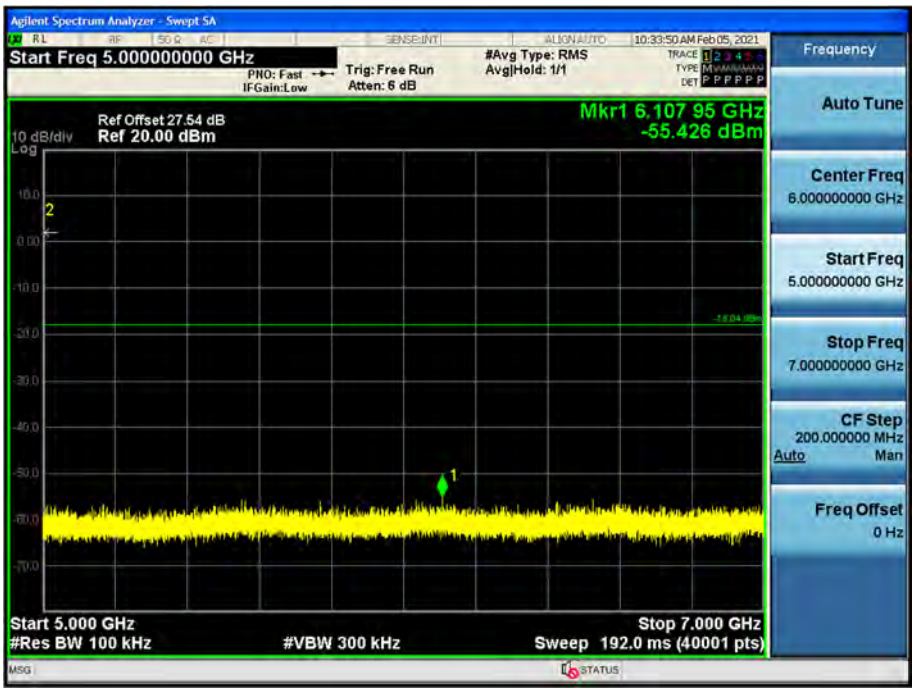
Test Plots(GFSK)- 3 GHz - 5 GHz

Spurious Emission (CH.39)



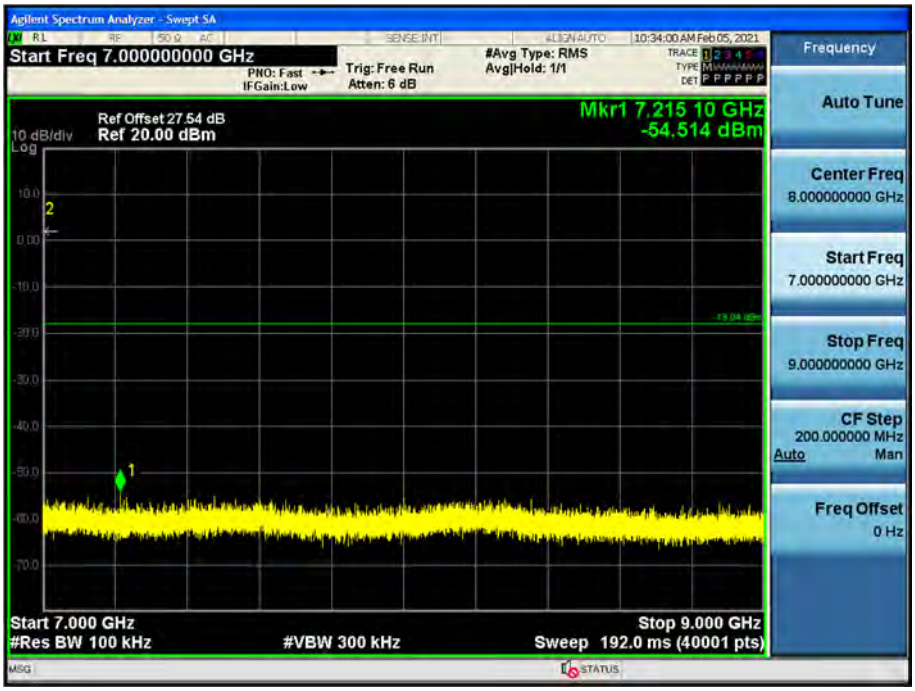
Test Plots (GFSK)- 5 GHz - 7 GHz

Spurious Emission (CH.39)



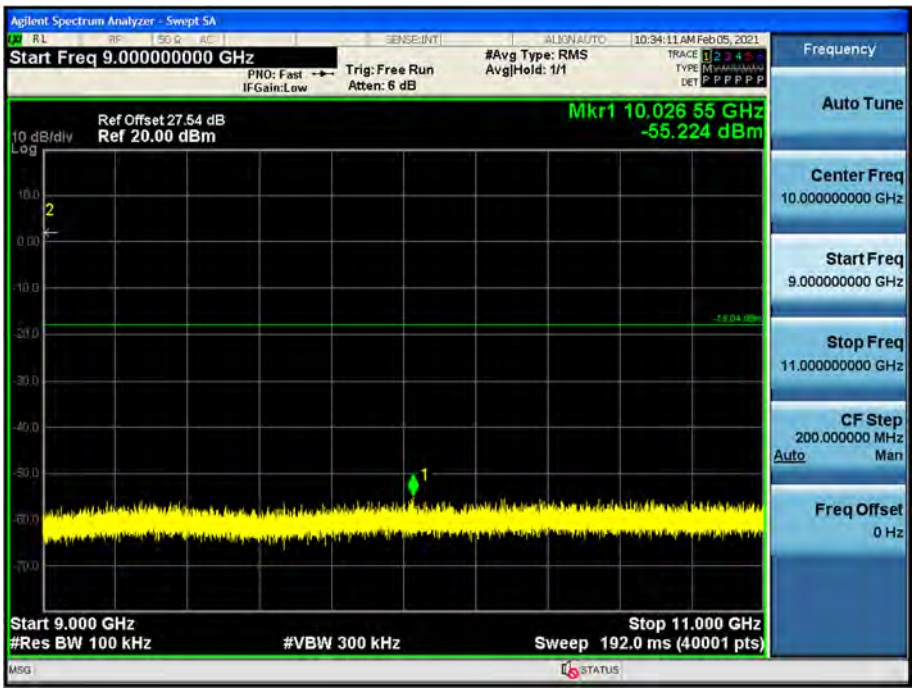
Test Plots(GFSK)- 7 GHz - 9 GHz

Spurious Emission (CH.39)



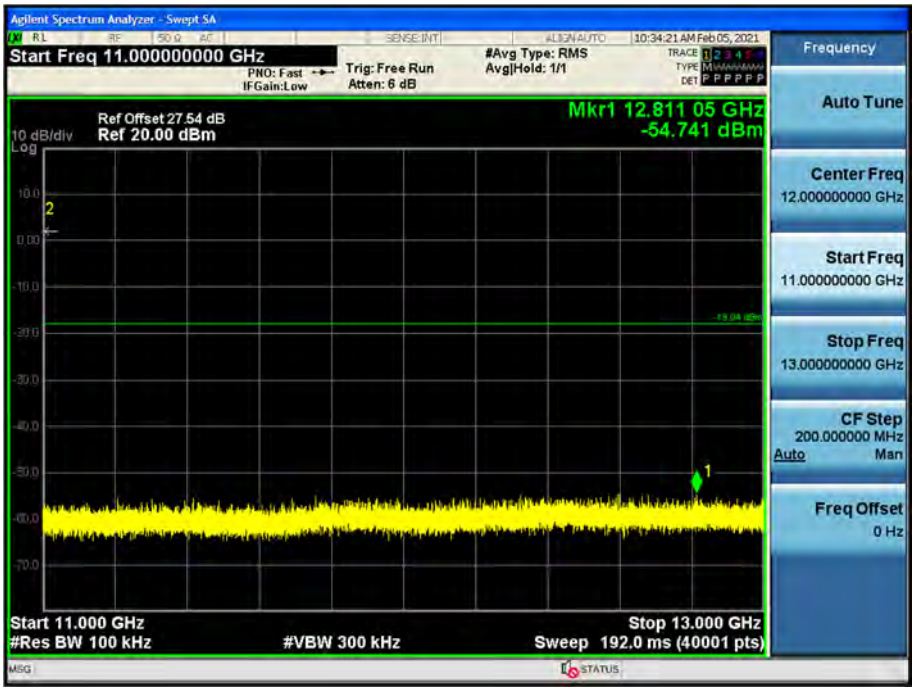
Test Plots(GFSK)- 9 GHz - 11 GHz

Spurious Emission (CH.39)



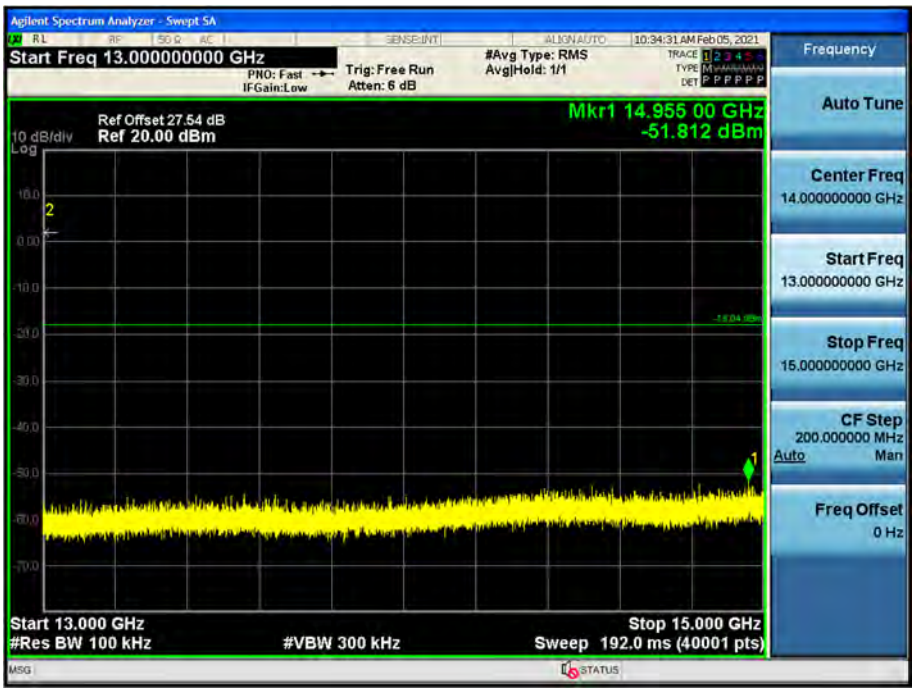
Test Plots(GFSK) 11 GHz - 13 GHz

Spurious Emission (CH.39)



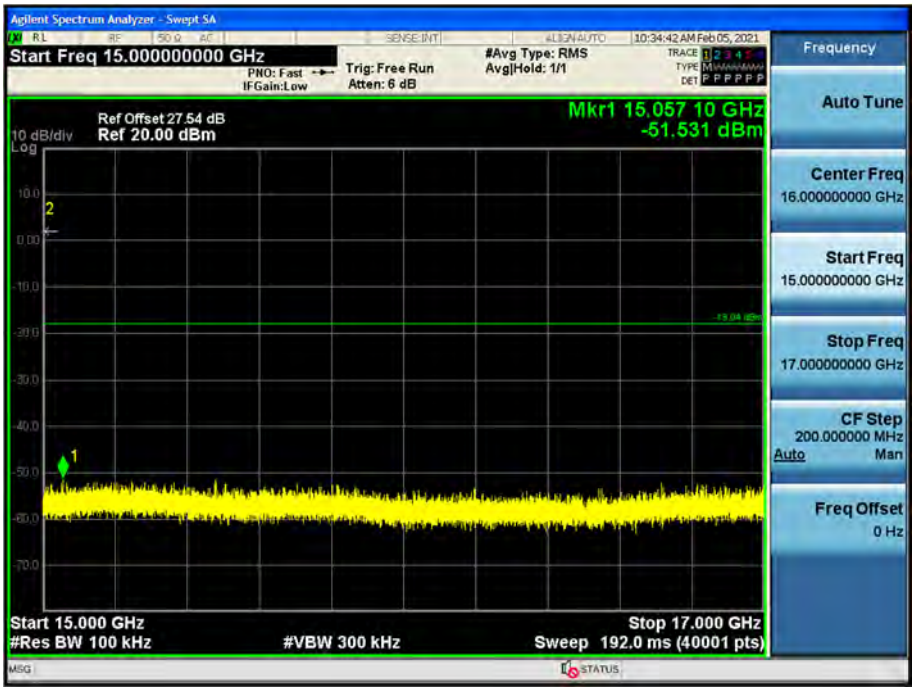
Test Plots (GFSK)- 13 GHz – 15 GHz

Spurious Emission (CH.39)



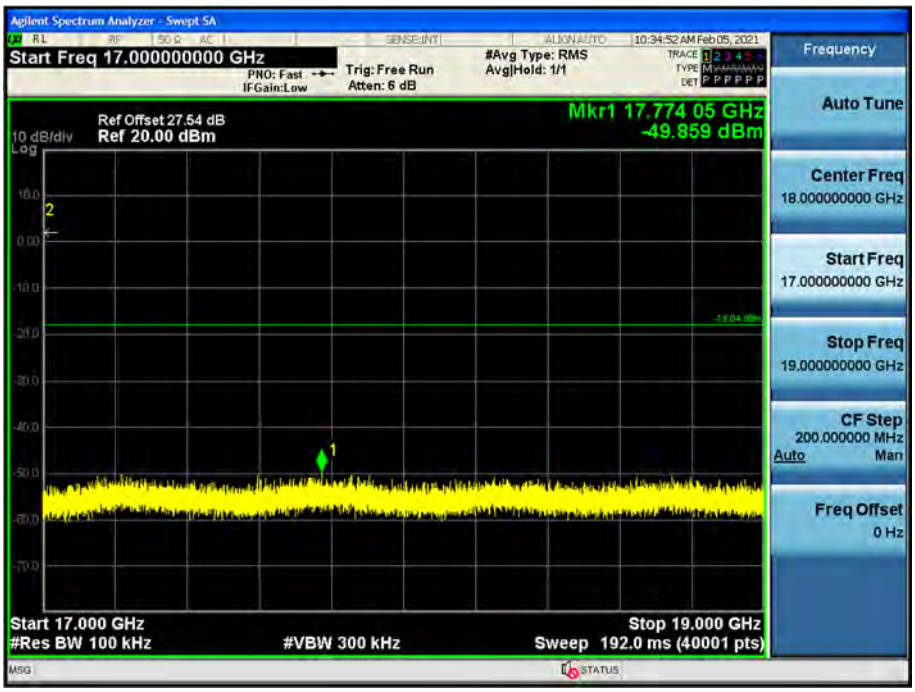
Test Plots(GFSK)– 15 GHz - 17 GHz

Spurious Emission (CH.39)



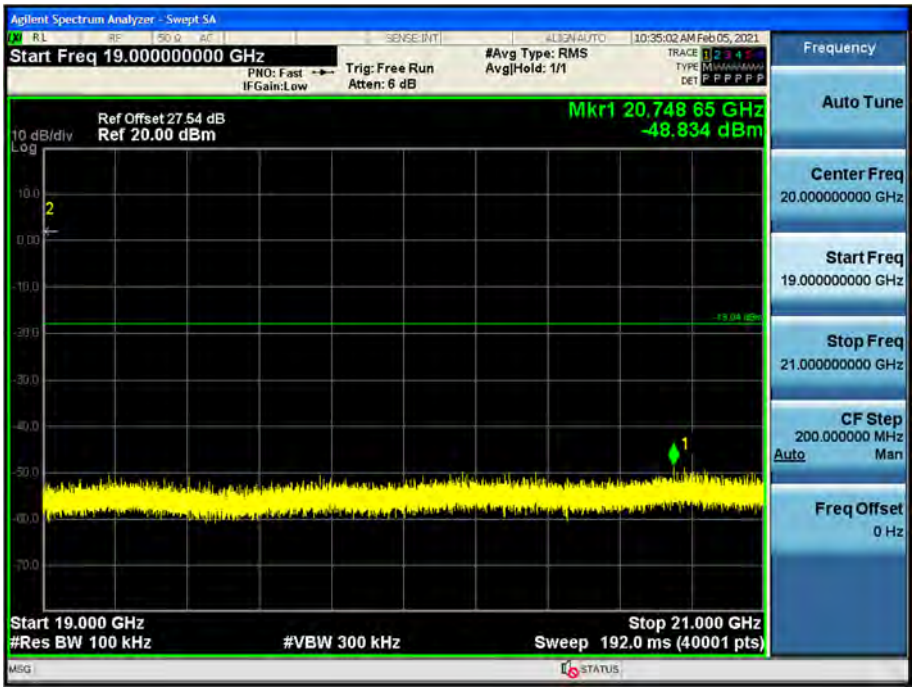
Test Plots(GFSK)- 17 GHz - 19 GHz

Spurious Emission (CH.39)



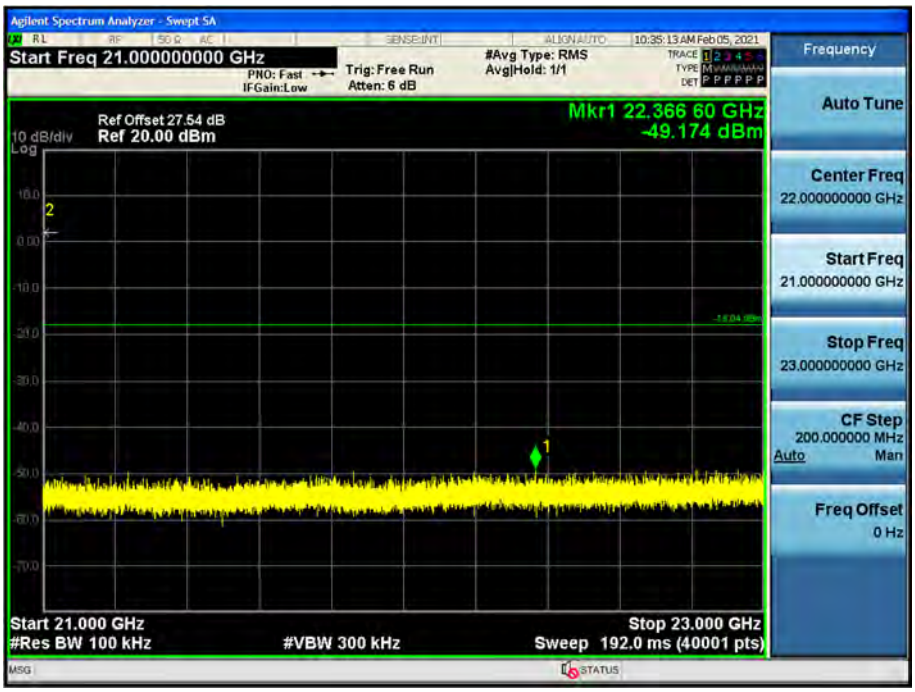
Test Plots (GFSK)- 19 GHz - 21 GHz

Spurious Emission (CH.39)



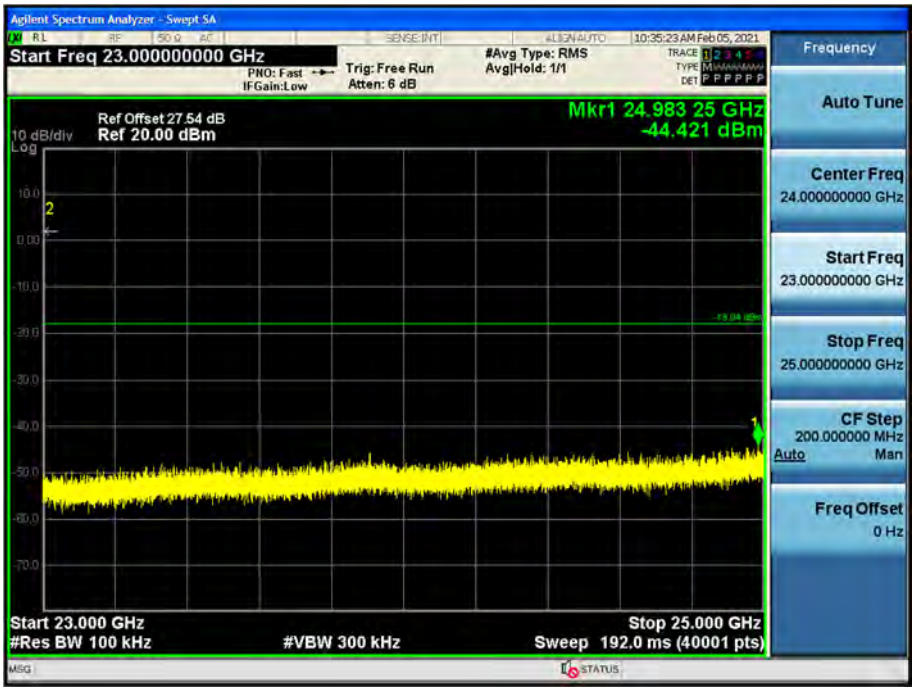
Test Plots (GFSK)- 21 GHz - 23 GHz

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	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4804	43.68	4.08	V	0.00	47.76	73.98	26.22	PK
4804	43.68	4.08	V	-24.73	23.03	53.98	30.95	AV
7206	38.02	12.05	V	0.00	50.07	73.98	23.91	PK
7206	38.02	12.05	V	-24.73	25.34	53.98	28.64	AV
4804	42.06	4.08	H	0.00	46.14	73.98	27.84	PK
4804	42.06	4.08	H	-24.73	21.41	53.98	32.57	AV
7206	37.91	12.05	H	0.00	49.96	73.98	24.02	PK
7206	37.91	12.05	H	-24.73	25.23	53.98	28.75	AV

Operation Mode: CH Mid(GFSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4882	40.92	4.01	V	0.00	44.93	73.98	29.05	PK
4882	40.92	4.01	V	-24.73	20.20	53.98	33.78	AV
7323	38.10	12.49	V	0.00	50.59	73.98	23.39	PK
7323	38.10	12.49	V	-24.73	25.86	53.98	28.12	AV
4882	40.48	4.01	H	0.00	44.49	73.98	29.49	PK
4882	40.48	4.01	H	-24.73	19.76	53.98	34.22	AV
7323	38.22	12.49	H	0.00	50.71	73.98	23.27	PK
7323	38.22	12.49	H	-24.73	25.98	53.98	28.00	AV

Operation Mode: CH High(GFSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4960	41.15	4.55	V	0.00	45.70	73.98	28.28	PK
4960	41.15	4.55	V	-24.73	20.97	53.98	33.01	AV
7440	38.79	12.60	V	0.00	51.39	73.98	22.59	PK
7440	38.79	12.60	V	-24.73	26.66	53.98	27.32	AV
4960	40.81	4.55	H	0.00	45.36	73.98	28.62	PK
4960	40.81	4.55	H	-24.73	20.63	53.98	33.35	AV
7440	38.63	12.60	H	0.00	51.23	73.98	22.75	PK
7440	38.63	12.60	H	-24.73	26.50	53.98	27.48	AV

Operation Mode: CH Low(π/4DQPSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4804	43.17	4.08	V	0.00	47.25	73.98	26.73	PK
4804	43.17	4.08	V	-24.73	22.52	53.98	31.46	AV
7206	38.59	12.05	V	0.00	50.64	73.98	23.34	PK
7206	38.59	12.05	V	-24.73	25.91	53.98	28.07	AV
4804	41.84	4.08	H	0.00	45.92	73.98	28.06	PK
4804	41.84	4.08	H	-24.73	21.19	53.98	32.79	AV
7206	38.34	12.05	H	0.00	50.39	73.98	23.59	PK
7206	38.34	12.05	H	-24.73	25.66	53.98	28.32	AV

Operation Mode: CH Mid(π/4DQPSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4882	41.06	4.01	V	0.00	45.07	73.98	28.91	PK
4882	41.06	4.01	V	-24.73	20.34	53.98	33.64	AV
7323	38.11	12.49	V	0.00	50.60	73.98	23.38	PK
7323	38.11	12.49	V	-24.73	25.87	53.98	28.11	AV
4882	40.66	4.01	H	0.00	44.67	73.98	29.31	PK
4882	40.66	4.01	H	-24.73	19.94	53.98	34.04	AV
7323	38.15	12.49	H	0.00	50.64	73.98	23.34	PK
7323	38.15	12.49	H	-24.73	25.91	53.98	28.07	AV

Operation Mode: CH High (π/4DQPSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4960	41.42	4.55	V	0.00	45.97	73.98	28.01	PK
4960	41.42	4.55	V	-24.73	21.24	53.98	32.74	AV
7440	38.66	12.60	V	0.00	51.26	73.98	22.72	PK
7440	38.66	12.60	V	-24.73	26.53	53.98	27.45	AV
4960	41.03	4.55	H	0.00	45.58	73.98	28.40	PK
4960	41.03	4.55	H	-24.73	20.85	53.98	33.13	AV
7440	38.52	12.60	H	0.00	51.12	73.98	22.86	PK
7440	38.52	12.60	H	-24.73	26.39	53.98	27.59	AV

Operation Mode: CH Low(8DPSK)

Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4804	42.84	4.08	V	0.00	46.92	73.98	27.06	PK
4804	42.84	4.08	V	-24.73	22.19	53.98	31.79	AV
7206	38.48	12.05	V	0.00	50.53	73.98	23.45	PK
7206	38.48	12.05	V	-24.73	25.80	53.98	28.18	AV
4804	42.01	4.08	H	0.00	46.09	73.98	27.89	PK
4804	42.01	4.08	H	-24.73	21.36	53.98	32.62	AV
7206	38.31	12.05	H	0.00	50.36	73.98	23.62	PK
7206	38.31	12.05	H	-24.73	25.63	53.98	28.35	AV

Operation Mode: CH Mid(8DPSK)

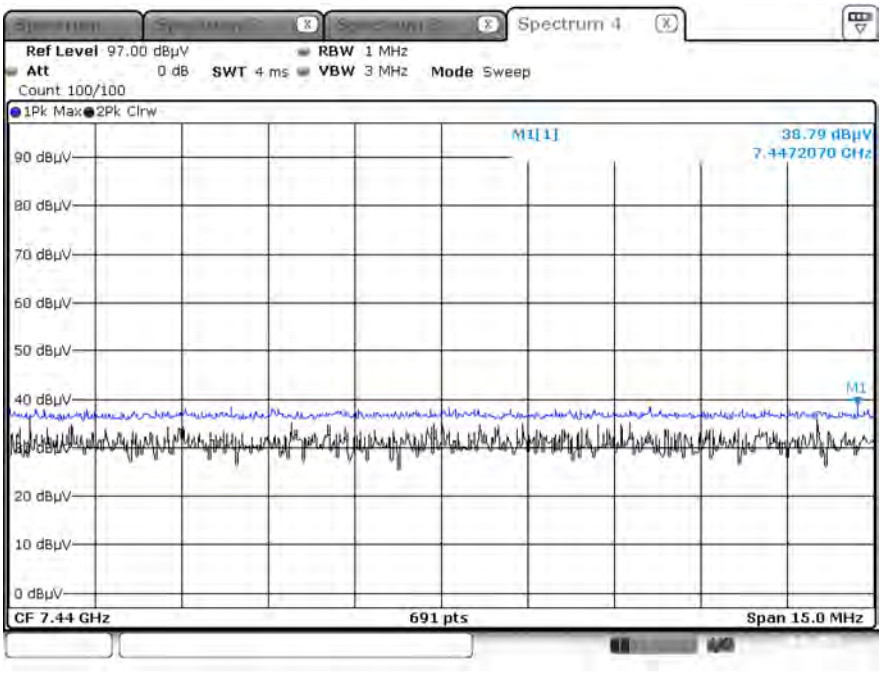
Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4882	40.97	4.01	V	0.00	44.98	73.98	29.00	PK
4882	40.97	4.01	V	-24.73	20.25	53.98	33.73	AV
7323	38.13	12.49	V	0.00	50.62	73.98	23.36	PK
7323	38.13	12.49	V	-24.73	25.89	53.98	28.09	AV
4882	40.35	4.01	H	0.00	44.36	73.98	29.62	PK
4882	40.35	4.01	H	-24.73	19.63	53.98	34.35	AV
7323	38.84	12.49	H	0.00	51.33	73.98	22.65	PK
7323	38.84	12.49	H	-24.73	26.60	53.98	27.38	AV

Operation Mode: CH High(8DPSK)

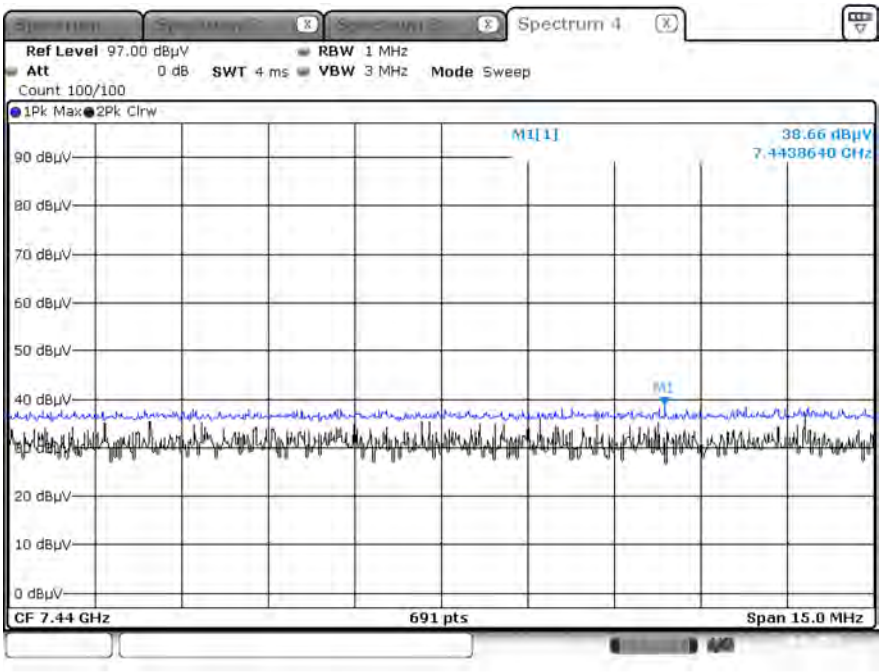
Frequency	Reading	A.F+C.L-A.G+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
4960	40.98	4.55	V	0.00	45.53	73.98	28.45	PK
4960	40.98	4.55	V	-24.73	20.80	53.98	33.18	AV
7440	38.74	12.60	V	0.00	51.34	73.98	22.64	PK
7440	38.74	12.60	V	-24.73	26.61	53.98	27.37	AV
4960	40.93	4.55	H	0.00	45.48	73.98	28.50	PK
4960	40.93	4.55	H	-24.73	20.75	53.98	33.23	AV
7440	38.65	12.60	H	0.00	51.25	73.98	22.73	PK
7440	38.65	12.60	H	-24.73	26.52	53.98	27.46	AV

RESULT PLOTS

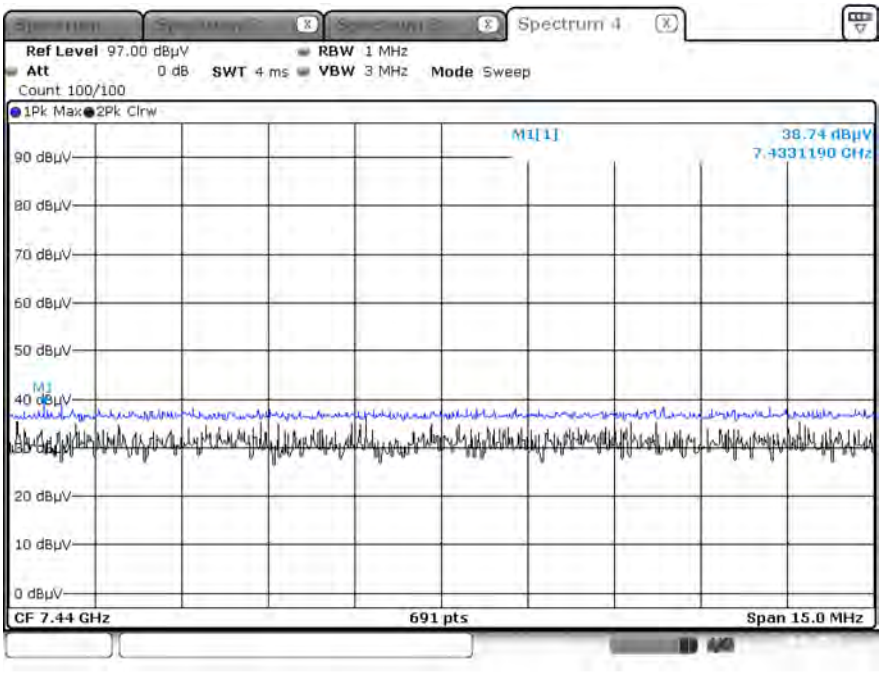
Radiated Spurious Emissions plot – Average & Peak Reading (GFSK, Ch.78 3rd Harmonic, X-V)



Radiated Spurious Emissions plot – Average & Peak Reading (π/4DQPSK, Ch.78 3rd Harmonic, X-V)



Radiated Spurious Emissions plot – Average & Peak Reading (8DPSK, Ch.78 3rd Harmonic, X-V)



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	Reading	※ A.F+C.L-AMP+ATT+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
2390.0	47.72	3.32	H	0	51.04	73.98	22.94	PK
2390.0	47.72	3.32	H	-24.73	26.31	53.98	27.67	AV
2390.0	48.44	3.32	V	0	51.76	73.98	22.22	PK
2390.0	48.44	3.32	V	-24.73	27.03	53.98	26.95	AV
2483.5	59.85	3.78	H	0	63.63	73.98	10.35	PK
2483.5	59.85	3.78	H	-24.73	38.90	53.98	15.08	AV
2483.5	61.50	3.78	V	0	65.28	73.98	8.70	PK
2483.5	61.50	3.78	V	-24.73	40.55	53.98	13.43	AV

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

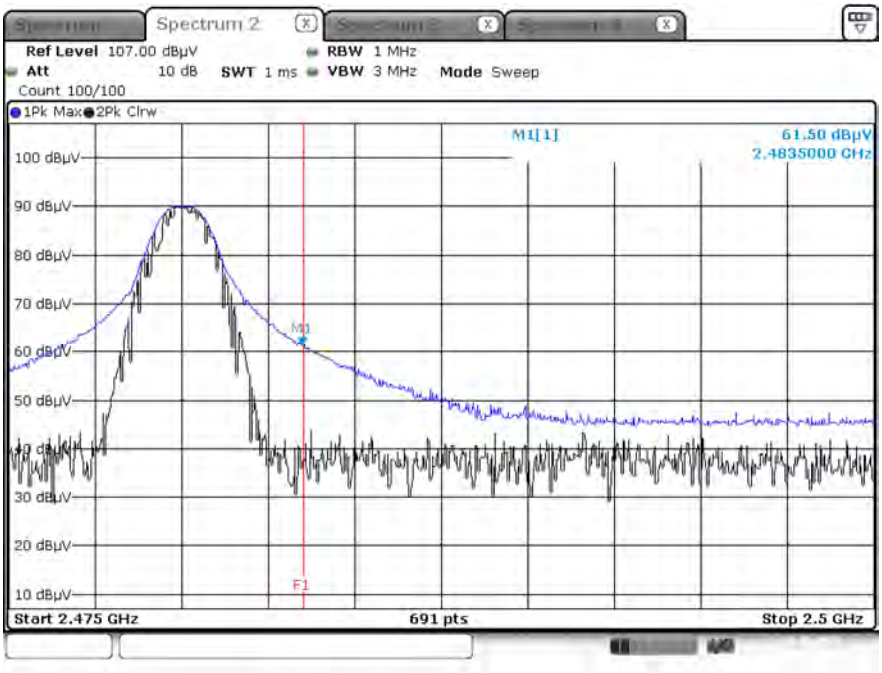
Frequency	Reading	※ A.F+C.L-AMP+ATT+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
2390.0	47.61	3.32	H	0	50.93	73.98	23.05	PK
2390.0	47.61	3.32	H	-24.73	26.20	53.98	27.78	AV
2390.0	47.94	3.32	V	0	51.26	73.98	22.72	PK
2390.0	47.94	3.32	V	-24.73	26.53	53.98	27.45	AV
2483.5	59.72	3.78	H	0	63.50	73.98	10.48	PK
2483.5	59.72	3.78	H	-24.73	38.77	53.98	15.21	AV
2483.5	61.46	3.78	V	0	65.24	73.98	8.74	PK
2483.5	61.46	3.78	V	-24.73	40.51	53.98	13.47	AV

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

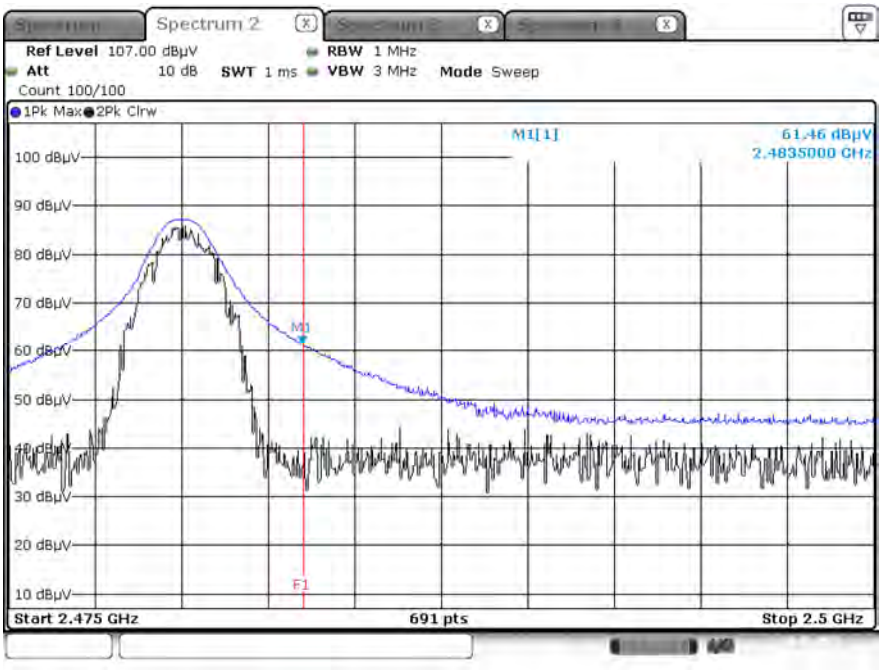
Frequency	Reading	※ A.F+C.L-AMP+ATT+D.F	ANT. POL	Duty Cycle Correction	Total	Limit	Margin	Detect
[MHz]	dBuV	[dB]	[H/V]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
2390.0	47.70	3.32	H	0	51.02	73.98	22.96	PK
2390.0	47.70	3.32	H	-24.73	26.29	53.98	27.69	AV
2390.0	47.97	3.32	V	0	51.29	73.98	22.69	PK
2390.0	47.97	3.32	V	-24.73	26.56	53.98	27.42	AV
2483.5	59.75	3.78	H	0	63.53	73.98	10.45	PK
2483.5	59.75	3.78	H	-24.73	38.80	53.98	15.18	AV
2483.5	61.38	3.78	V	0	65.16	73.98	8.82	PK
2483.5	61.38	3.78	V	-24.73	40.43	53.98	13.55	AV

RESULT PLOTS

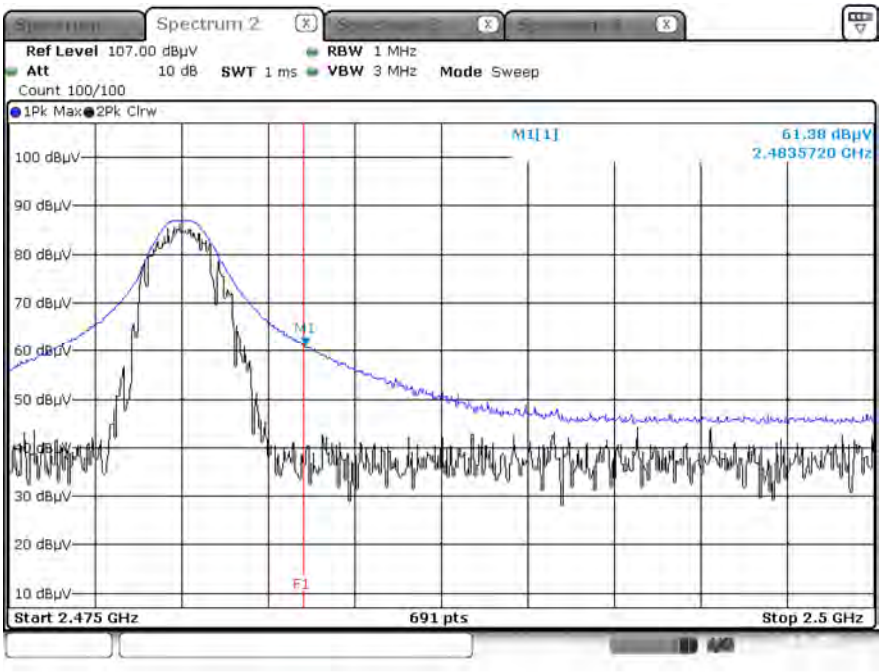
Radiated Restricted Band Edges plot – Average & Peak Reading (GFSK, Ch.78, X-V)



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



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



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	09/04/2020	Annual	102245
Rohde & Schwarz	ESR / EMI Test Receiver	09/16/2020	Annual	101910
ESPEC	SU-642 /Temperature Chamber	07/30/2020	Annual	0093000718
Agilent	N9020A / Signal Analyzer	05/11/2020	Annual	MY51110085
Agilent	N9030A / Signal Analyzer	03/23/2020	Annual	MY49432108
Agilent	N1911A / Power Meter	04/07/2020	Annual	MY45100523
Agilent	N1921A / Power Sensor	06/08/2020	Annual	MY57820067
Agilent	87300B / Directional Coupler	11/10/2020	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	04/27/2020	Annual	11275
HP	E3632A / DC Power Supply	09/16/2020	Annual	MY40004427
HP	8493C / Attenuator(10 dB)(DC-26.5 GHz)	06/26/2020	Annual	07560
HP	8493C / Attenuator(10 dB)(DC-26.5 GHz)	07/03/2020	Annual	08285
Rohde & Schwarz	18N-20dB / Attenuator(20 dB)	03/23/2020	Annual	8
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

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
Schwarzbeck	Loop Antenna	05/18/2020	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	08/02/2019	Biennial	01039
Schwarzbeck	BBHA 9120D / Horn Antenna	08/01/2019	Biennial	912D-1151
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	04/29/2019	Biennial	BBHA9170342
Rohde & Schwarz	FSP(10 Hz ~ 40 GHz) / Spectrum Analyzer	05/13/2020	Annual	101055
Wainwright Instruments	WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter	01/06/2021	Annual	2
Wainwright Instruments	WRCJV12-4900-5100-5900-6100-50SS	06/24/2020	Annual	5
Wainwright Instruments	WRCJV12-4900-5100-5900-6100-50SS	06/24/2020	Annual	6
CERNEX	CBL18265035 / Power Amplifier	12/04/2020	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	03/23/2020	Annual	25956
TESCOM	TC-3000C / Bluetooth Tester	03/18/2020	Annual	3000C000276
TNM system	FBSM-05B / HPF(3~18GHz) + LNA1(1~18GHz)	01/20/2021	Annual	F6
TNM system	FBSM-05B / ATT(10dB) + LNA1(1~18GHz)	01/20/2021	Annual	None
TNM system	FBSM-05B / ATT(3dB) + LNA1(1~18GHz)	01/20/2021	Annual	None
TNM system	FBSM-05B / LNA1(1~18GHz)	01/20/2021	Annual	25540
TNM system	FBSM-05B / HPF(7~18GHz) + LNA2(6~18GHz)	01/20/2021	Annual	28550
TNM system	FBSM-05B / Thru(30MHz ~ 18GHz)	01/20/2021	Annual	None
Weinschel	2-3 / Attenuator (3 dB)	10/07/2020	Annual	BR0617
H+S	5910-N-50-010 / Attenuator(10 dB)	10/28/2020	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-2103-FC002-P