

# FCC BT REPORT

## Certification

Applicant Name: SAMSUNG Electronics Co., Ltd.		Date of Issue: December 26, 2018 Location: HCT CO., LTD.,	
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Suwon-si, Gyeonggi-do, 16	677, Rep. of Korea	Report No.: HCT-RF-1812-FC041	
FCC ID:	A3LSMM105F		
APPLICANT:	SAMSUNG Electronics Co., Ltd.		
Model:	SM-M105F/DS		
EUT Type:	Smart Phone		
Max. RF Output Power:	10.091 dBm (10.212 mW)		
Frequency Range:	2402 MHz - 2480 MHz (Bluetooth)		
Modulation type	GFSK(Normal), π/4DQPSK and 8DPSK(EDR)		
FCC Classification:	FCC Part 15 Spread Spectrum Transmitter		

The measurements shown in this report were made in accordance with the procedures specified in §2.947. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

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# **Version**

TEST REPORT NO.	DATE	DESCRIPTION	
HCT-RF-1812-FC041	December 26, 2018	- First Approval Report	



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# 1. EUT DESCRIPTION

Model	SM-M105F/DS
EUT Type	Smart Phone
Power Supply	DC 3.85 V
Battery Information	Model: GH43-04898-A Type: Li-ion Battery
Travel Adapter Information	Model: GH44-02878A Manufacture: SALCOMP
Frequency Range	2402 MHz - 2480 MHz
Max. RF Output Power	10.091 dBm (10.212 mW)
BT Operating Mode	Normal, EDR, AFH
Modulation Type	GFSK(Normal), $\pi/4DQPSK$ and $8DPSK(EDR)$
Modulation Technique	FHSS
Number of Channels	79Channels, Minimum 20 Channels(AFH)
Antenna Specification	Antenna type: LDS Antenna Peak Gain : -0.51 dBi
Date(s) of Tests	December 10, 2018 ~ December 20, 2018



# 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.



# 3. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05 dated August 24, 2018 entitled "guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

## **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.

## **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 8 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).

#### Conducted Antenna Terminal

See Section from 7.8.2 to 7.8.8.(ANSI 63.10-2013)

## **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.

Espectially, 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).

## 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."

- \* The antennas of this E.U.T are permanently attached.
- \* The E.U.T Complies with the requirement of §15.203



# 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)	5.71



# 8. DESCRIPTION OF TESTS

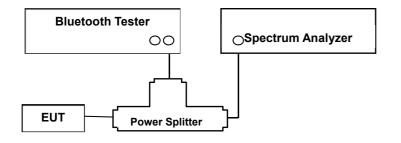
#### 8.1. Conducted Maximum Peak Output Power

#### <u>Limit</u>

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 nonoverlapping 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)

- 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

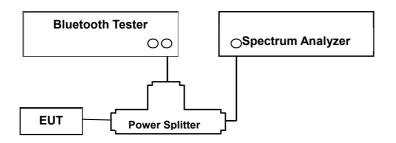


#### 8.2. Conducted Band Edge(Out of Band Emissions)

#### <u>Limit</u>

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)

- 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
- 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

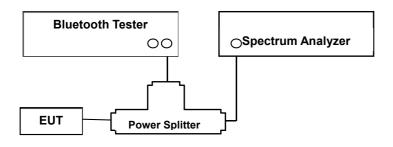


#### 8.3. Frequency Separation & 20 dB Bandwidth

#### <u>Limit</u>

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**

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)

- 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.

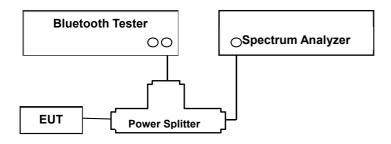


#### 8.4. Number of Hopping Frequencies

#### <u>Limit</u>

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)

- 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.

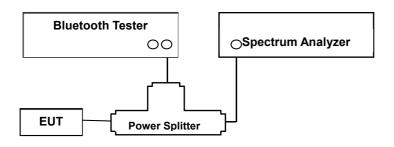


#### 8.5. Time of Occupancy

#### <u>Limit</u>

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)

- 1) Span: Zero span, centered on a hopping channel
- 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.

#### \* Mon-AFH Mode

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

#### \* AFH Mode

- DH 5 (GFSK) : 2.890 \* (800/6)/20 \* 8.0 = 154.13 (ms)
- 2-DH 5 (π/4DQPSK) : 2.890 \* (800/6)/20 \* 8.0 = 154.13 (ms)
- 3-DH 5 (8DPSK) : 2.890 \* (800/6)/20 \* 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 \* 106.667 = 308.27 (ms)

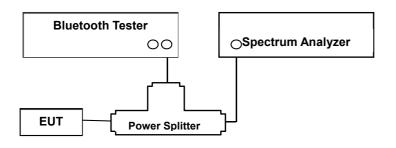


#### 8.6. Conducted Spurious Emissions

#### <u>Limit</u>

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)

- 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.



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#### Factors for frequency

Freq(MHz)	Factor(dB)
30	6.51
100	6.06
200	6.75
300	6.29
400	5.97
500	5.66
600	5.88
700	6.05
800	6.43
900	6.79
1000	7.09
2000	6.92
2400*	7.11
2500*	7.15
3000	7.59
4000	8.66
5000	9.28
6000	6.39
7000	9.70
8000	8.05
9000	9.32
10000	10.18
11000	8.67
12000	9.44
13000	8.55
14000	9.21
15000	11.25
16000	7.85
17000	11.44
18000	9.42
19000	10.11
20000	11.40
21000	10.43
22000	12.02
23000	9.56
24000	12.23
25000	10.78
26000	10.21

Note : 1. '\*' is fundamental frequency range.

2. Factor = Cable loss(2 ea) + Splitter loss



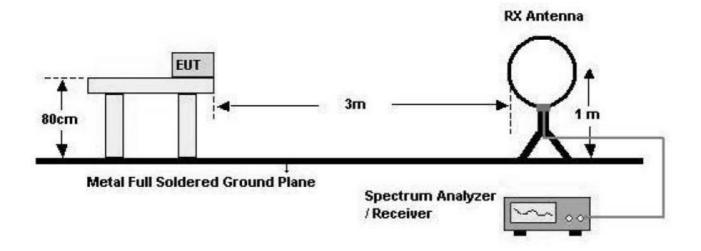
#### 8.7. Radiated Test

L	ir	n	it	

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
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### **Test Configuration**

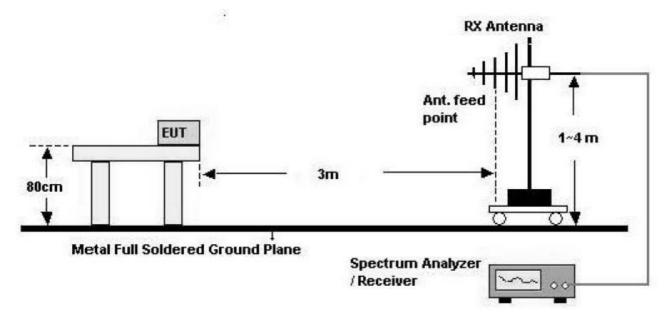
Below 30 MHz



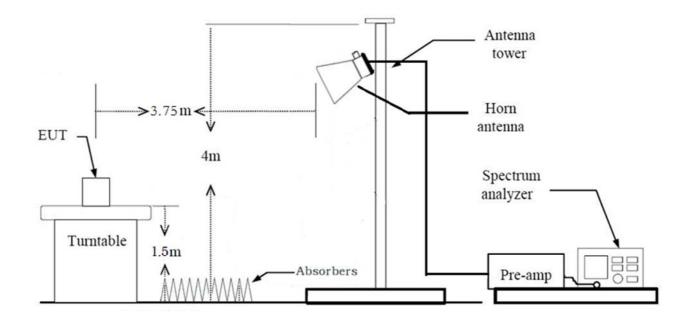


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30 MHz - 1 GHz



Above 1 GHz





#### 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 = 20\*log (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\*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  $\ge$  1/T Hz, where T = pulse width in seconds
      - The actual setting value of VBW = 1 kHz
- 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 = 20\*log (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\*RBW
  - (2) Measurement Type(Average):
    - We performed using a reduced video BW method was done with the analyzer in linear mode
    - Detector = Peak
    - Trace = Maxhold
    - RBW = 1 MHz
    - VBW  $\ge$  1/T Hz, where T = pulse width in seconds

The actual setting value of VBW = 1 kHz

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



#### 8.8. AC Power line Conducted Emissions

#### <u>Limit</u>

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  $\mu$ H/50 ohms line impedance stabilization network (LISN).

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

\*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.

#### Sample Calculation

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



#### 8.9. 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, Stand alone + external accessories(earphone, etc)
  - Worstcase : Stand alone
- 2. EUT Axis
  - Radiated Spurious Emissions : Y
  - Radiated Restricted Band Edge : Z
- 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

#### **AC Power line Conducted Emissions**

- 1. All modes of operation were investigated and the worst case configuration results are reported.
  - Mode : Stand alone+Earphone+Travel Adapter, Stand alone+Travel Adapter
  - Worstcase : Stand alone+Travel Adapter

#### **Conducted test**

- 1. The EUT was configured with data rate of highest power.
  - GFSK : DH5
  - $\pi/4DQPSK$  : 2-DH5
  - 8DPSK : 3-DH5
- 2. AFH & Non-AFH were tested and the worst case results are reported.

(Worst case : Non-AFH)



# 9. SUMMARY OF TEST RESULTS

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



# **10. TEST RESULT**

## 10.1 PEAK POWER

Channel	Frequency	Output Power (GFSK)		Limit
	(MHz)	(dBm)	(mW)	(mW)
Low	2402	9.672	9.273	
Mid	2441	10.091	10.212	125
High	2480	9.271	8.455	

Channel	Frequency (8DPSK)		Limit	
	(MHz)	(dBm)	(mW)	(mW)
Low	2402	7.160	5.200	
Mid	2441	7.855	6.102	125
High	2480	7.618	5.778	

Channel	Channel Frequency (MHz)		Output Power (π/4DQPSK)		
	(MHZ)	(dBm)	(mW)		
Low	2402	6.623	4.595		
Mid	2441	7.353	5.436	125	
High	2480	7.173	5.216		

#### 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 7.02 dB at 2402 MHz and is 7.11 dB at 2480 MHz.

So, 7.11 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result.



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# Test Plots (GFSK)

## Peak Power (CH.0)

Agilent Spectrum Analyzer - Swept SA W RL RF 50 Ω AC		ALIGN AUTO	01:23:44 PMDec 13, 2018	
Center Freq 2.4020000		#Avg Type: RMS Avg Hold: 1/1	TRACE 1 2 3 4 5 6 TYPE M M TYPE DET P P P P P P	Frequency
Ref Offset 7.11 dE Ref 20.00 dBm	n oumeon	Mkr1	2.401 901 GHz 9.672 dBm	Auto Tun
10.0		~~~~~		Center Fre 2.402000000 G⊦
0.0				<b>Start Fre</b> 2.399389447 GF
30.0				<b>Stop Fre</b> 2.404610553 Gi
				<b>CF Ste</b> 522.111 kl <u>Auto</u> M
0.0				Freq Offs 0
			0	
Center 2.402000 GHz #Res BW 3.0 MHz	#VBW 50 MHz	Sweep 1	Span 5.221 MHz 1.000 ms (1001 pts)	
SG		<b>L</b> STATU:	S	

## Test Plots (GFSK)

# Peak Power (CH.39)

Agilent Spectrum Analyzer - Swept SA					
00 RL RF 50 Ω AC Center Freq 2.441000000	PNO: Fast +++ Trig: Free Ru	#Avg Type: RMS	01:23:56 PMDec 13, 2018 TRACE 1 2 3 4 5 6 TYPE M DET P P P P P P	Frequency	
Ref Offset 7.11 dB 10 dB/div Ref 20.00 dBm	IFGain:Low Atten: 24 dB	Mkr	1 2.440 881 GHz 10.091 dBm	Auto Tune	
10.0	<sup>1</sup>	man		Center Freq 2.441000000 GHz	
.10.0				Start Freq 2.438517253 GHz	
-20.0				Stop Fred 2.443482747 GH	
-40.0				CF Step 496.549 kH Auto Mar	
-60.0				Freq Offse 0 H	
Center 2.441000 GHz #Res BW 3.0 MHz	#VBW 50 MHz	Sweep	Span 4.965 MHz 1.000 ms (1001 pts)		
NSG					



## Test Plots (GFSK)

Peak Power (CH.78)



#### Test Plots (8DPSK) Peak Power (CH.0)





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#### Test Plots (8DPSK)

#### Peak Power (CH.39)

enter F	RF 50 Ω AC req 2.441000000	) GHz PNO: Fast ↔ IFGain:Low	SENSE:INT Trig: Free Run Atten: 24 dB	ALIGNAUTO #Avg Type: RMS Avg Hold: 1/1	01:25:06 PMDec 13, 2018 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P P P P P P	Frequency
0 dB/div	Ref Offset 7.11 dB Ref 20.00 dBm	IF Gall.Low	TRUME T	Mkr1 2.	440 805 99 GHz 7.855 dBm	Auto Tun
10.0			<b>↓</b> 1			Center Fre 2.441000000 GF
0.00						<b>Start Fr</b> 2.437655000 Gi
8.0						<b>Stop Fr</b> 2.444345000 G
0.0						CF St 669.000 k Auto M
0.0						Freq Offs 0
	441000 GHz				Span 6.690 MHz	
Res BW	3.0 MHz	#VBW	50 MHz	Sweep 1	.000 ms (1001 pts)	

#### Test Plots (8DPSK) Peak Power (CH.78)



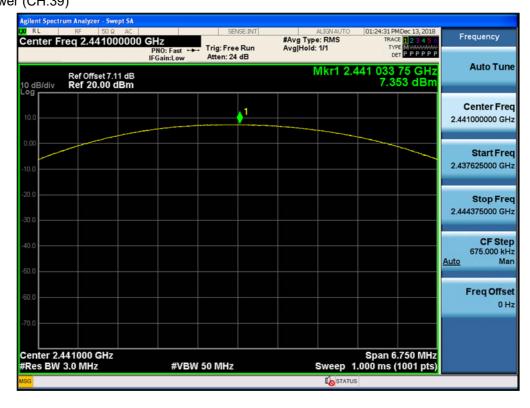


Test Plots (π/4DQPSK)

## Peak Power (CH.0)



#### Test Plots (π/4DQPSK) Peak Power (CH.39)





#### Report No.: HCT-RF-1812-FC041

# Test Plots ( $\pi$ /4DQPSK)

## Peak Power (CH.78)

RL RF 50 Ω AC Center Freq 2.480000000	CHz PN0: Fast →→ IFGain:Low Atten: 24 dB	#Avg Type: RMS Avg Hold: 1/1	01:24:42 PMDec 13, 2018 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P P P P P	Frequency
Ref Offset 7.11 dB 0 dB/div Ref 20.00 dBm		Mkr1	2.479 782 GHz 7.173 dBm	Auto Tun
10.0	<b>↓</b> 1			Center Fre 2.480000000 GF
0.00				Start Fre 2.476592500 GF
80.0				Stop Fre 2.483407500 GH
0.0				CF Ste 681.500 kl Auto Ma
0.0				Freq Offs 01
roo Center 2.480000 GHz Res BW 3.0 MHz	#VBW 50 MHz		Span 6.815 MHz .000 ms (1001 pts)	



## 10.2 BAND EDGES

#### Without hopping

Outside Frequency Band	GFSK	8DPSK	π/4DQPSK	Limit
Outside Frequency Band	(dB) (dB)		(dB)	(dBc)
Lower	57.471	59.207	59.702	20
Upper	62.911	61.376	61.724	20

#### With hopping

Outside Frequency Band	GFSK	8DPSK	π/4DQPSK	Limit
Outside Frequency Band	(dB) (dB)		(dB)	(dBc)
Lower	61.896	61.442	61.592	20
Upper	65.579	61.670	62.264	20

#### 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 7.02 dB at 2402 MHz

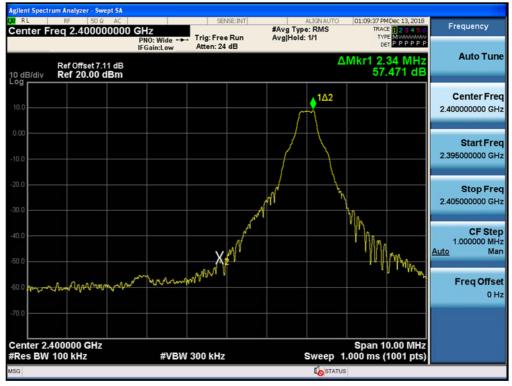
and is 7.11 dB at 2480 MHz.

So, 7.11 dB is offset. And the offset gap in the 2.4 GHz range do not affect the conducted peak power final result.

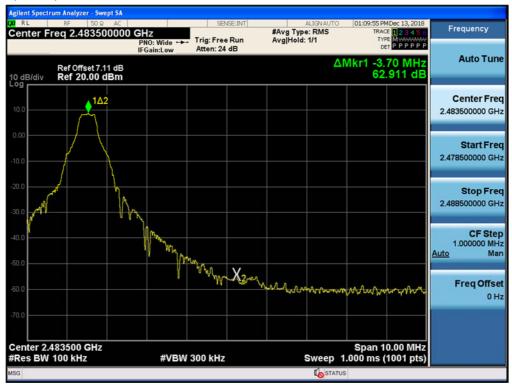


#### Test Plots without hopping (GFSK)

#### Band Edges (CH.0)



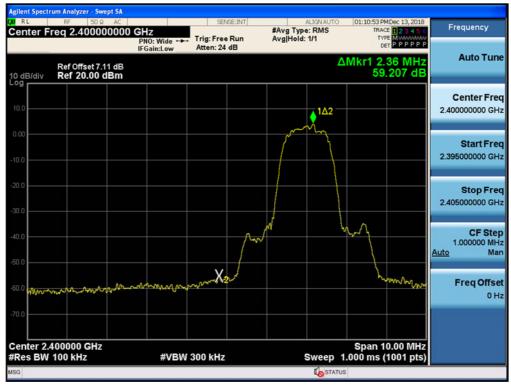
#### Test Plots without hopping (GFSK)





#### Test Plots without hopping (8DPSK)

#### Band Edges (CH.0)



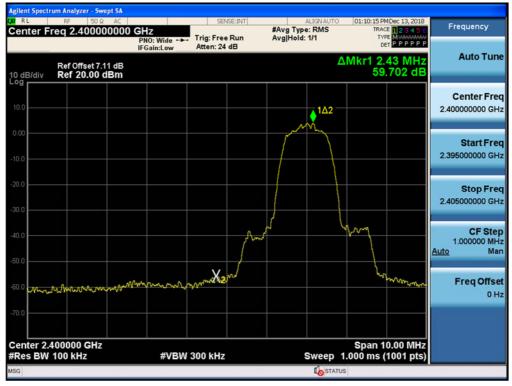
## Test Plots without hopping (8DPSK)





#### Test Plots without hopping ( $\pi$ /4DQPSK)

#### Band Edges (CH.0)



Test Plots without hopping ( $\pi$ /4DQPSK)

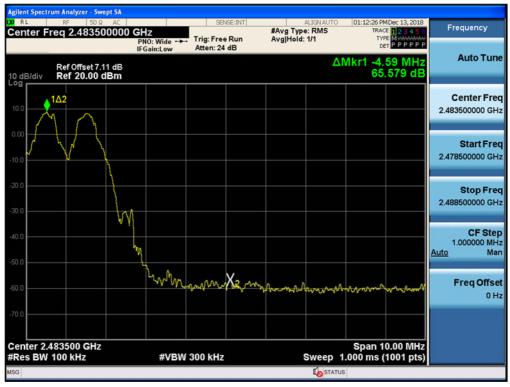




## Test Plots with hopping (GFSK) Band Edges (CH.0)

Agilent Spectru	m Analyzer - Swept SA		000.000				01.11.10.01	10 0010	
	RF 50 Ω AC eq 2.400000000	GHz	SENSE		#Avg Type Avg Hold:		TRAC	MDec 13, 2018 25 1 2 3 4 5 6 26 M 4444444	Frequency
		PNO: Wide +++ IFGain:Low	Atten: 24 di		Avginoid.		D	TPPPPP	Auto Tuno
	Ref Offset 7.11 dB Ref 20.00 dBm					Δ	Mkr1 3. 61	43 MHz .896 dB	Auto Tune
10.0							1Δ2		Center Freq 2.40000000 GHz
0.00						$\gamma$	$\gamma$		
-10.0					/	$\checkmark$	$\bigvee$	$\bigvee$	Start Freq 2.395000000 GHz
-20.0									Stop Freq
-30.0				Ŵ	W				2.405000000 GHz
-40.0									CF Step 1.000000 MHz
-50.0			X <sub>2</sub>						<u>Auto</u> Man
-60.0 mm	manne	warman	windhing	¥					Freq Offset 0 Hz
-70.0									
Center 2.40 #Res BW 1		#VBW	300 kHz			Sweep 1	Span 1 .000 ms (	0.00 MHz 1001 pts)	
MSG						<b>STATUS</b>	5		

Test Plots with hopping (GFSK)





#### Test Plots with hopping (8DPSK)

#### Band Edges (CH.0)



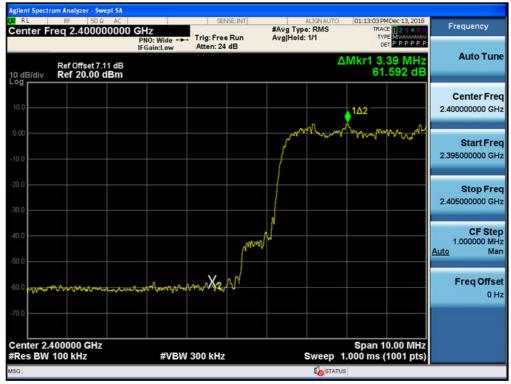
# Test Plots with hopping (8DPSK)





#### Test Plots with hopping ( $\pi$ /4DQPSK)

#### Band Edges (CH.0)



## Test Plots with hopping ( $\pi$ /4DQPSK)





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

99% BW (kHz)							
Channel	GFSK	8DPSK	π/4DQPSK				
CH.0	900.54	1206.0	1201.9				
CH.39	899.15	1209.1	1200.1				
CH.78	900.07	1209.5	1203.4				

20dB BW (kHz)							
Channel	GFSK	8DPSK	π/4DQPSK				
CH.0	1044	1330	1360				
CH.39	993.1	1338	1350				
CH.78	1036	1334	1363				

	Limit		
GFSK	8DPSK	(kHz)	
			>25 kHz
991	998	998	or
			>2/3 of the 20dB BW



# Test Plots (GFSK)

#### **Channel Separation**

Agilent Spectr Center Fi	RF	50 Ω A	AC		SENS		#Avg T Avg Ho	ALIGNAUTO ype: RMS	TRAC	1Dec 13, 2018 E <b>1 2 3 4 5</b> 6 E Maardaa	Frequency
10 dB/div		Offset 7.11	IFGain:L		#Atten: 20 d		- Angline		ΔMkr3 9 0.	91 kHz 010 dB	Auto Tur
2.89 -12.9	$\sim$	~~X <sub>2</sub> ~	Landon and a second	ممہر	$\sim$	1∆2 ⊶	~~		<u>3∆4</u>	Lange and the second se	Center Fre 2.441000000 G⊦
-22.9 -32.9 -42.9											Start Fre 2.439500000 GF
-52.9 -62.9 -72.9											Stop Fre 2.442500000 GH
Center 2.4 #Res BW			#	¢VB₩	100 kHz			Sweep	Span 3. 3.176 ms	000 MHz (900 pts)	CF Ste 300.000 kH Auto Ma
MKR MODE TR		(Δ)	× 1.004 MH		∀ 0.040 d	в	CTION	FUNCTION WIDTH	FUNCTIO	N VALUE	<u>Auto</u> Ma
2 F 1 3 Δ4 1 4 F 1 5 6	f f f	(Δ)	2.440 021 GH 991 kH 2.441 025 GH	z (Δ)	6.872 dBr 0.010 d 6.912 dBr	в					Freq Offso 0 F
7 8 9 10 11											
MSG Doint	s cha	nged; all tra	ces cleared					STATUS	6	2	

# Test Plots (8DPSK)

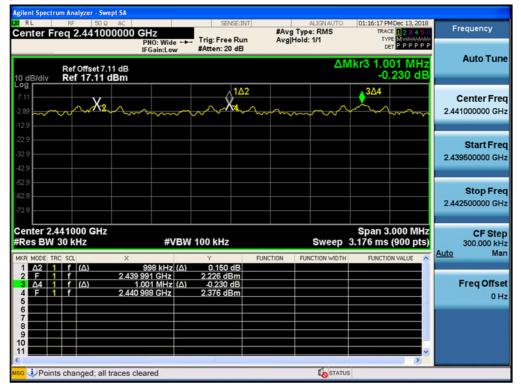
**Channel Separation** 





#### 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)





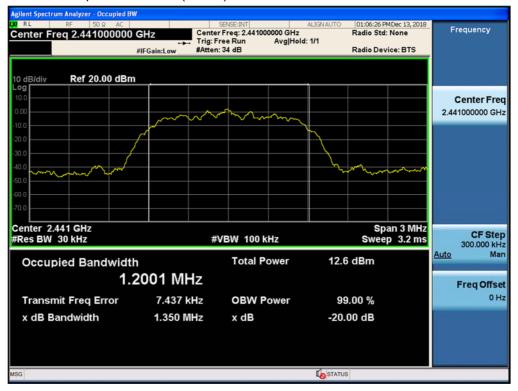
# Test Plots ( $\pi$ /4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.0)



#### Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.39)





#### FCC ID: A3LSMM105F

# Test Plots (π/4DQPSK)

20 dB Bandwidth & Occupied Bandwidth (CH.78)





# 10.4 NUMBER OF HOPPING FREQUENCY

	Limit					
GFSK	GFSK 8DPSK π/4DQPSK					
79	79	79	>15			

## Note :

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



#### Report No.: HCT-RF-1812-FC041

Test Plots (GFSK)

Number of Channels (2.4 GHz - 2.441 GHz)



## Test Plots (GFSK)

Number of Channels (2.441 GHz - 2.4835 GHz)





#### Report No.: HCT-RF-1812-FC041

# Test Plots (8DPSK)

Number of Channels (2.4 GHz - 2.441 GHz)

gilent Spectrum Analyzer - Swept S/ RL RF 50 Ω AG		SENSE:INT	ALIGNAUTO	01:19:55 PMDec 13, 2018	_
enter Freq 2.4205000	00 GHz PNO: Fast ↔ IFGain:Low	Trig: Free Run #Atten: 24 dB	#Avg Type: RMS Avg Hold: 1/1	TRACE 123456 TYPE M	Frequency
Ref Offset 7.11 df 0 dB/div Ref 20.00 dBn	3	MALEN. 24 GD			Auto Tun
од 10.0 м. м. м. м. Л. Полями		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	ኯቍ፞፞ጚዻቚ፞፟፞፞፞፞፞፞፞፞፞፞፞፞ቚ	Center Fre 2.420500000 G⊦
					<b>Start Fre</b> 2.400000000 GF
0.0					Stop Fre 2.441000000 GF
0.0					CF Ste 4.100000 Mi <u>Auto</u> M
0.0					Freq Offs 01
tart 2.40000 GHz				Stop 2 44100 CH7	
Res BW 240 kHz	#VBW	240 kHz	Sweep 1	Stop 2.44100 GHz .000 ms (1001 pts)	
SG			Lo STATUS		

#### Test Plots (8DPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)

Agilent Spectrum Analyzer - Swept SA				
RL RF 50 Ω AC Center Freg 2.462250000	GHz	EE:INT ALIGNAUTO	TRACE 1 2 3 4 5 6	Frequency
Ref Offset 7.11 dB 10 dB/div Ref 20.00 dBm	PNO: Fast +++ Trig: Free IFGain:Low #Atten: 24		TYPE MUMUMUM DET PPPPP	Auto Tune
	$\mathcal{M}$	ጞኊራኊኯዾ፟፟፟፟ኯኯ	Vhrunn	Center Freq 2.462250000 GHz
-10.0				Start Freq 2.441000000 GHz
-20.0				Stop Freq 2.483500000 GHz
-40.0				CF Step 4.250000 MHz Auto Man
-60.0			"lu	Freq Offset 0 Hz
-70.0 Start 2.44100 GHz #Res BW 240 kHz	#VBW 240 kHz	Sweep	Stop 2.48350 GHz 1.000 ms (1001 pts)	
MSG		<b>Ko</b> stat	านร	



#### Report No.: HCT-RF-1812-FC041

# Test Plots ( $\pi$ /4DQPSK)

Number of Channels (2.4 GHz - 2.441 GHz)

RL RF 50 Q AC		ENSE:INT	ALIGN AUTO	01:18:44 PMDec 13, 2018	Frequency
enter Freq 2.420500000	CHZ PNO: Fast ↔ Trig: Fre IFGain:Low #Atten: 2	e Run Avg	g Type: RMS  Hold: 1/1	TRACE 1 2 3 4 5 6 TYPE MUMMUM DET P P P P P P	Frequency
Ref Offset 7.11 dB 0 dB/div Ref 20.00 dBm	I Galil. Low In Action				Auto Tur
	*m~~~~~m~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			~~~~~	Center Fr 2.420500000 G
					<b>Start Fr</b> 2.400000000 G
1.0					<b>Stop Fr</b> 2.441000000 G
					CF St 4.100000 M <u>Auto</u> M
.0					Freq Offs 0
art 2.40000 GHz				Stop 2.44100 GHz	
Res BW 240 kHz	#VBW 240 kH	Z	Sweep 1	.000 ms (1001 pts)	

#### Test Plots (π/4DQPSK)

Number of Channels (2.441 GHz - 2.4835 GHz)

Agilent Spectrum Analyzer - Swe				
Center Freq 2.46225	50000 GHz	SE:INT ALIGN AU #Avg Type: RMS Run Avg[Hold: 1/1	TRACE 123456	Frequency
Ref Offset 7.1 10 dB/div Ref 20.00 d	IFGain:Low #Atten: 24		DET PPPPP	Auto Tune
Log 10.0	ᢣ᠊ᢉᡢᠰᠬᡨᡘ᠇ᠬᢣᠰᢘᡀ᠆ᡥ᠆ᠬᠬ	$\sim$	ᡃᢊᠡᢩᠰ᠇ᢧᠰ᠇ᢇᠰᢩ	Center Freq 2.462250000 GHz
-10.0				Start Freq 2.441000000 GHz
-20.0				Stop Freq 2.483500000 GHz
-40.0			۷ 	CF Step 4.250000 MHz Auto Man
-60.0			,	Freq Offset 0 Hz
Start 2.44100 GHz			Stop 2.48350 GHz	
#Res BW 240 kHz <sup>MSG</sup>	#VBW 240 kHz	Sweep Kost	p 1.000 ms (1001 pts)	