

# 7. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

# 7.1 Test Setup

Refer to the APPENDIX I.

## 7.2 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.205(c))

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

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 ~ 0.490	2400/F (kHz)	300
0.490 ~ 1705	24000/F (kHz)	30
1705 ~ 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

\*\* Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 - 72 MHz, 76 - 88 MHz, 174 - 216 MHz or 470 - 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~ 12.52025	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.57675 ~ 12.57725	156.52475 ~ 156.52525	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	13.36 ~ 13.41	156.7 ~ 156.9	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	16.42 ~ 16.423	162.0125 ~ 167.17	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.69475 ~ 16.69525	167.72 ~ 173.2	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.80425 ~ 16.80475	240 ~ 285	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	25.5 ~ 25.67	322 ~ 335.4	2655 ~ 2900		
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3260 ~ 3267		
8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3332 ~ 3339		
8.37625 ~ 8.38675	74.8 ~ 75.2	960 ~ 1240	3345.8 ~ 3358		
			3600 ~ 4400		

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.



# 7.3. Test Procedures

#### 7.3.1. Test Procedures for Radiated Spurious Emissions

- 1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 1 or 3 meter away from the interference-receiving antenna.
- 3. For measurements above 1GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.
- 4. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 7. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Note: The radiated spurious emission was tested with below settings.

- Frequencies less than or equal to 1000 MHz The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
- Frequencies above 1000 MHz
  The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
   The result of Average measurement is calculated using PK result and duty correction factor



#### 7.3.2. Test Procedures for Conducted Spurious Emissions

- 1. The transmitter output was connected to the spectrum analyzer.
- 2. The **reference level** of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 kHz, VBW = 300 kHz.
- 3. The conducted spurious emission was tested each ranges were set as below.

Frequency range : 9 kHz ~ 30 MHz RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

Frequency range : 30 MHz ~ 10 GHz, 10 GHz ~ 26.5 GHz RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.



## 7.4. Test Results

#### 7.4.1. Radiated Emissions

#### 9 kHz ~ 25 GHz Data (Modulation : GFSK)

Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.43	Н	Х	PK	45.35	-3.69	N/A	N/A	41.66	74.00	32.34
2389.43	Н	Х	AV	45.35	-3.69	-24.79	N/A	16.87	54.00	37.13
4803.53	Н	Х	PK	46.29	2.79	N/A	N/A	49.08	74.00	24.92
4803.53	Н	Х	AV	46.29	2.79	-24.79	N/A	24.29	54.00	29.71

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.58	Н	Х	PK	46.50	2.98	N/A	N/A	49.48	74.00	24.52
4881.58	Н	Х	AV	46.50	2.98	-24.79	N/A	24.69	54.00	29.31

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2484.12	Н	Х	PK	48.06	-3.70	N/A	N/A	44.36	74.00	29.64
2484.12	Н	Х	AV	48.06	-3.70	-24.79	N/A	19.57	54.00	34.43
4959.60	Н	Х	PK	45.49	2.98	N/A	N/A	48.47	74.00	25.53
4959.60	Н	Х	AV	45.49	2.98	-24.79	N/A	23.68	54.00	30.32

Note.

1. The radiated emissions were investigated 9 kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.88 ms

- 100 ms /  $\Delta$ t [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / ( 2.88 X 20 ) = 1.74 = 2

- The Worst Case Dwell Time = T [ms] x H' = 2.88 ms X 2 = 5.76 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log( 5.76 / 100 ) = -24.79 dB

4. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.



#### 9 kHz ~ 25 GHz Data (Modulation : $\pi$ /4DQPSK)

#### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.67	Н	Х	PK	45.25	-3.69	N/A	N/A	41.56	74.00	32.44
2389.67	Н	Х	AV	45.25	-3.69	-24.79	N/A	16.77	54.00	37.23
4804.12	Н	Х	PK	46.83	2.79	N/A	N/A	49.62	74.00	24.38
4804.12	Н	Х	AV	46.83	2.79	-24.79	N/A	24.83	54.00	29.17

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.90	Н	Х	PK	45.83	2.98	N/A	N/A	48.81	74.00	25.19
4881.90	Н	Х	AV	45.83	2.98	-24.79	N/A	24.02	54.00	29.98

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2484.30	Н	Х	PK	47.82	-3.69	N/A	N/A	44.13	74.00	29.87
2484.30	Н	Х	AV	47.82	-3.69	-24.79	N/A	19.34	54.00	34.66
4959.70	Н	Х	PK	46.25	2.99	N/A	N/A	49.24	74.00	24.76
4959.70	Н	Х	AV	46.25	2.99	-24.79	N/A	24.45	54.00	29.55

#### <u>Note.</u>

1. The radiated emissions were investigated 9 kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.88 ms

- 100 ms /  $\Delta t$  [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.88 X 20) = 1.74 = 2

- The Worst Case Dwell Time = T [ms] x H' = 2.88 ms X 2 = 5.76 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log( 5.76 / 100 ) = -24.79 dB

4. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.



#### 9 kHz ~ 25 GHz Data (Modulation : <u>8DPSK</u>)

#### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.53	Н	Х	PK	45.68	-3.69	N/A	N/A	41.99	74.00	32.01
2389.53	Н	Х	AV	45.68	-3.69	-24.79	N/A	17.20	54.00	36.80
4803.73	Н	Х	PK	45.61	2.79	N/A	N/A	48.40	74.00	25.60
4803.73	Н	Х	AV	45.61	2.79	-24.79	N/A	23.61	54.00	30.39

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4882.10	Н	Х	PK	47.24	2.98	N/A	N/A	50.22	74.00	23.78
4882.10	Н	Х	AV	47.24	2.98	-24.79	N/A	25.43	54.00	28.57

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2484.46	Н	Х	PK	47.56	-3.69	N/A	N/A	43.87	74.00	30.13
2484.46	Н	Х	AV	47.56	-3.69	-24.79	N/A	19.08	54.00	34.92
4959.93	Н	Х	PK	46.03	2.99	N/A	N/A	49.02	74.00	24.98
4959.93	Н	Х	AV	46.03	2.99	-24.79	N/A	24.23	54.00	29.77

#### <u>Note.</u>

1. The radiated emissions were investigated 9 kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.88 ms

- 100 ms /  $\Delta$ t [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / ( 2.88 X 20 ) = 1.74  $\rightleftharpoons$  2

- The Worst Case Dwell Time = T [ms] x H' = 2.88 ms X 2 = 5.76 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log( 5.76 / 100 ) = -24.79 dB

4. Sample Calculation.

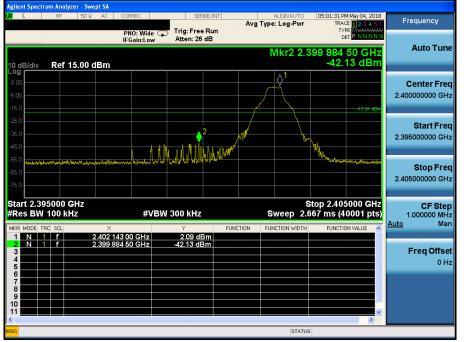
Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.

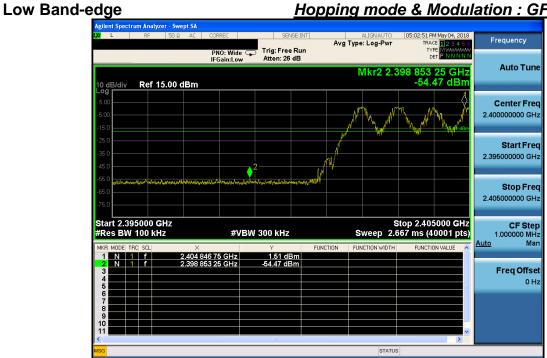


## Low Band-edge

**Dt&C** 



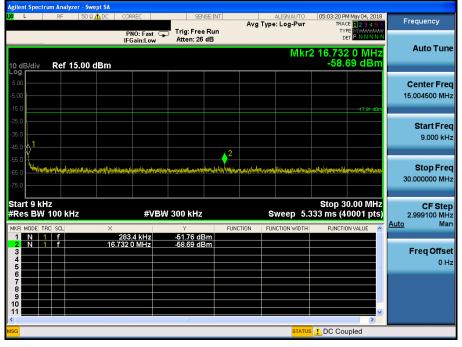
#### Lowest Channel & Modulation : GFSK



## Hopping mode & Modulation : GFSK



# Lowest Channel & Modulation : GFSK



Agilent Spectrum												
LXI L	RF 50 Ω	AC C	IORREC		SEN	ISE:INT	Ava		LIGNAUTO		M May 04, 2018 CE <b>1 2 3 4 5 6</b>	Frequency
			PNO: Fa		Trig: Free Atten: 26			. ,, .		TY	PE MWWWWWW ET P N N N N N	
			IFGain:L	0W	Atten: 26	dB			D.41			Auto Tune
10 dB/div	Ref 15.00 d	IBm							WK		66 GHz 55 dBm	
5.00												Center Freq
-5.00												5.015000000 GHz
-15.0											-17.91 dDm	
-25.0												Otort From
-35.0			۸ <mark>3</mark>		5		2				4	Start Freq 30.00000 MHz
-45.0	and the second		Lunder .	-		Y			Mangapan Rawaya	and the second second		30.000000 MH2
-55.0												
-65.0												Stop Freq
-75.0												10.00000000 GHz
Start 30 MH	-									Stop 10	.000 GHz	
#Res BW 1.			#	¢VBW	3.0 MHz			Sv	veep 18	.67 ms (4	.000 GH2 0001 pts)	CF Step 997.000000 MHz
MKR MODE TRC		Х			Y		ICTION	FUN	CTION WIDTH	FUNCTI	DN VALUE	<u>Auto</u> Man
	f f	5.846	2 <u>11 GH</u> 5 75 GH	z	2.37 dE -40.53 dE							
3 N 1 4 N 1	f	2.801	16 GH	z	-42.33 dE -42.41 dE							Freq Offset
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MSG									STATUS			



## Lowest Channel & Modulation : GFSK



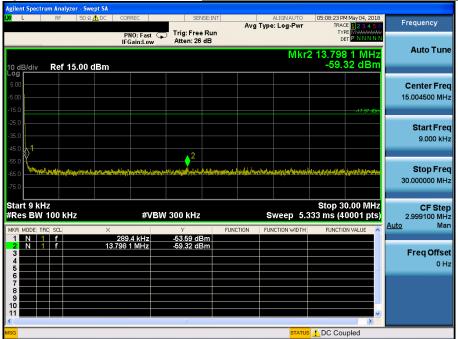


**Reference for limit** 

## Middle Channel & Modulation : GFSK



## Conducted Spurious Emissions <u>Middle Channel & Modulation : GFSK</u>





## Middle Channel & Modulation : GFSK

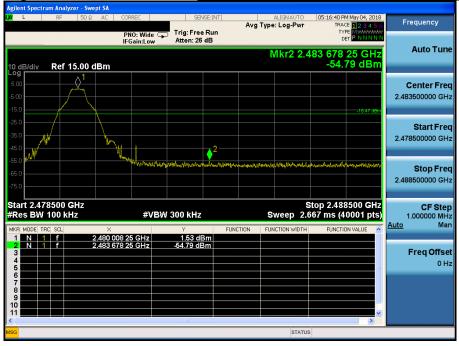






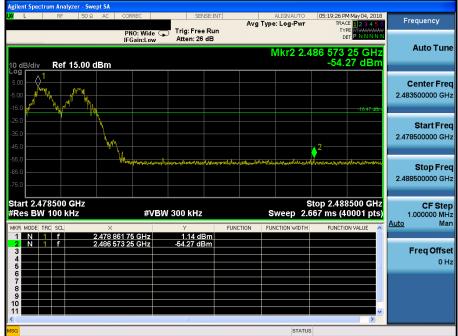
## **High Band-edge**

## Highest Channel & Modulation : GFSK



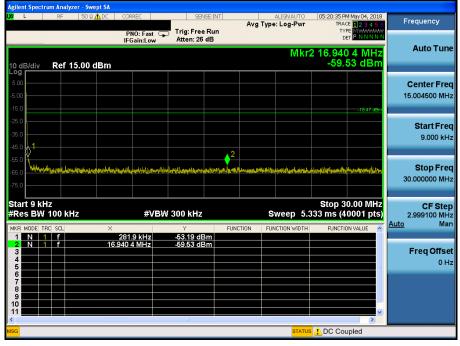
## High Band-edge

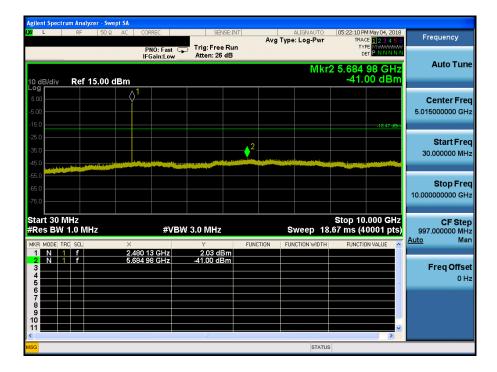
## Hopping mode & Modulation : GFSK





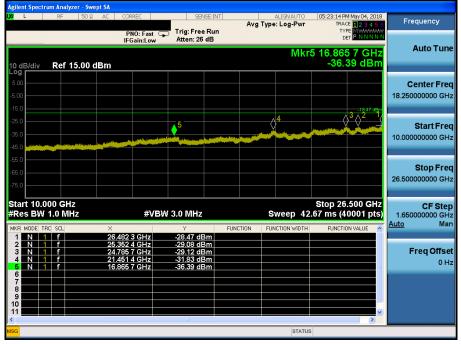
## Highest Channel & Modulation : GFSK







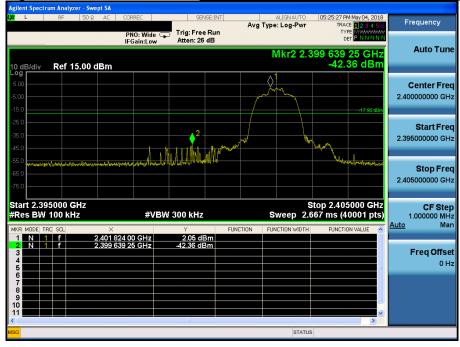
# Highest Channel & Modulation : GFSK





## Low Band-edge

# Lowest Channel & Modulation : π/4DQPSK



## Low Band-edge

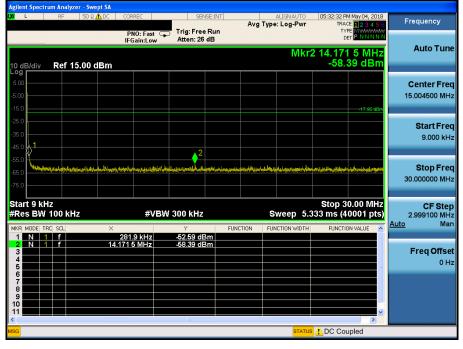
## Hopping mode & Modulation : π/4DQPSK







## Lowest Channel & Modulation : π/4DQPSK



Agilent Spectrum Analyzer - S						
L RF 50	Ω AC CORREC	SENSE:INT		ALIGNAUTO ype: Log-Pwr	05:33:54 PM May 04, 2018 TRACE 123456	Frequency
	PNO: Fast ( IFGain:Low	Trig: Free Run Atten: 26 dB			TYPE MWWWWWW DET P N N N N N	
10 dB/div Ref 15.00	) dBm			Mkr	5 9.763 71 GHz -41.91 dBm	Auto Tune
5.00 -5.00	↓ ↓ 1 ↓ ↓ ↓				-17.95 dDm	Center Freq 5.015000000 GHz
-25.0 -35.0 -45.0				<u>3</u>	5	Start Freq 30.000000 MHz
-65.0 -65.0 -75.0						<b>Stop Freq</b> 10.000000000 GHz
Start 30 MHz #Res BW 1.0 MHz	#VB	W 3.0 MHz		Sweep 18	Stop 10.000 GHz .67 ms (40001 pts)	CF Step 997.000000 MHz
MKR MODE TRC SCL	× 2.402 11 GHz	Y 2.63 dBm	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Man
2 N 1 f 3 N 1 f 4 N 1 f 5 N 1 f	5.724 37 GHz 7.093 25 GHz 6.392 36 GHz 9.763 71 GHz	-41.13 dBm -41.41 dBm -41.46 dBm -41.91 dBm				<b>Freq Offset</b> 0 Hz
7 8 9 10 11					~	
K MSG		III	_	STATUS		
				STATUS		



## Lowest Channel & Modulation : π/4DQPSK



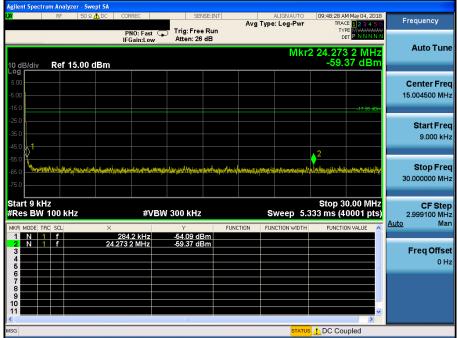


## Reference for limit

# Middle Channel & Modulation : π/4DQPSK



## Conducted Spurious Emissions <u>Middle Channel & Modulation : π/4DQPSK</u>





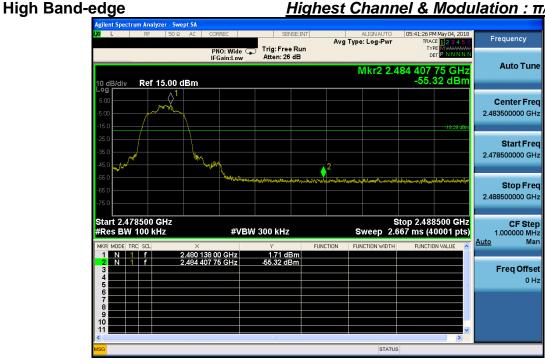
## Middle Channel & Modulation : π/4DQPSK





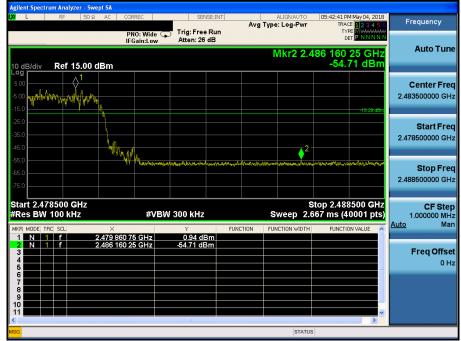


# Highest Channel & Modulation : π/4DQPSK



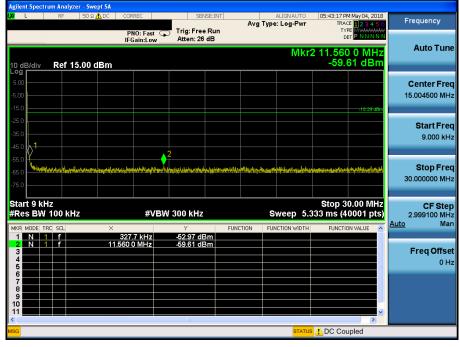
## High Band-edge

## Hopping mode & Modulation : π/4DQPSK





## Highest Channel & Modulation : π/4DQPSK



Agilent Spectrum Analyzer - Sw	ept SA				
<mark>LX L</mark> RF 50 Ω	AC CORREC	SENSE:INT	ALIGNAUTO Avg Type: Log-Pwr	05:44:31 PM May 04, 2018 TRACE 1 2 3 4 5 6	Frequency
	PNO: Fast ⊂ IFGain:Low	Trig: Free Run Atten: 26 dB		DET P N N N N	
But the second			Mkr	2 5.815 59 GHz -40.65 dBm	Auto Tune
10 dB/div Ref 15.00				-40.00 dBill	
5.00	+ <u> </u>				Center Freq
-5.00					5.015000000 GHz
-15.0				-18.29 dBm	
-25.0			2		Start Freq
-35.0		وأسانحا تلذ و وو بسطور		- administration of a little and admitted of	30.000000 MHz
-55.0					
-65.0					Stop Freq
-75.0					10.00000000 GHz
Start 30 MHz #Res BW 1.0 MHz	#VB	N 3.0 MHz	Sweep 18	Stop 10.000 GHz .67 ms (40001 pts)	CF Step 997.000000 MHz
MKR MODE TRC SCL	×		INCTION FUNCTION WIDTH	FUNCTION VALUE	Auto Man
1 N 1 f	2.480 38 GHz 5.815 59 GHz	2.18 dBm -40.65 dBm			
3	5.015 59 GHZ	-40.05 dBm			Freq Offset
5					0 Hz
6 7					
8					
10					
<				>	
MSG			STATUS	3	



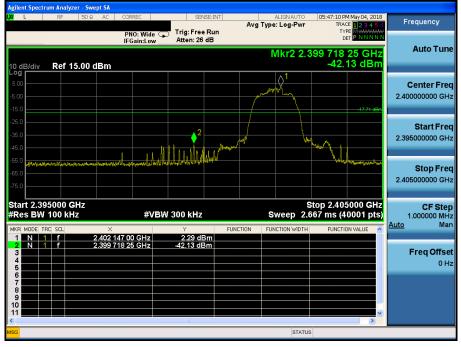
## Highest Channel & Modulation : π/4DQPSK





## Low Band-edge

## Lowest Channel & Modulation : 8DPSK



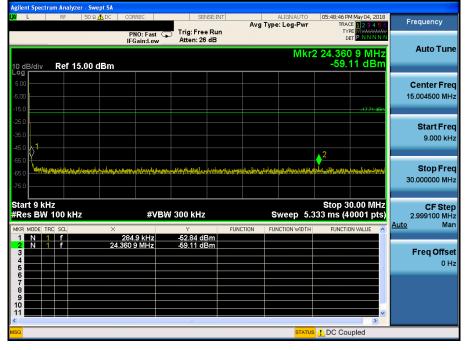
## Low Band-edge

## Hopping mode & Modulation : 8DPSK





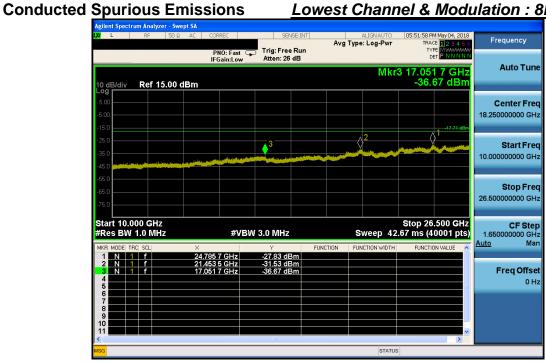
## Lowest Channel & Modulation : 8DPSK



Agilent Spectrum An									
LXI L RF	50 Ω AC	CORREC	SENS	EINT		ALIGNAUTO		4 May 04, 2018 E <mark>1 2 3 4 5 6</mark>	Frequency
		PNO: Fast G	Trig: Free F				TYF		
		IFGain:Low	Atten: 26 d	8					Auto Tune
_						IVIKI	3 9.715	86 GHZ 78 dBm	
10 dB/div Re Log	f 15.00 dBm	4					-41.	o ubili	
5.00	🔷								Center Fred
-5.00									5.015000000 GH:
-15.0								-17.71 dBm	
-25.0									
-35.0				<mark>2</mark>				3	Start Fred
-45.0		deland in a street of the	and the second second	and the second	lage of the second s	Read of Dispersion - A		In the set of the set	30.000000 MHz
-55.0					44 ATT 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				
-65.0									Stop Free
-75.0									10.00000000 GH:
-75.0									
Start 30 MHz							Stop 10	.000 GHz	CF Step
#Res BW 1.0 I	MHz	#VB\	V 3.0 MHz		S	weep 18	.67 ms (4	0001 pts)	997.000000 MHz
MKR MODE TRC SCL			Y	FUNC	FION FUN	ICTION WIDTH	FUNCTIO	IN VALUE	<u>Auto</u> Man
1 N 1 f 2 N 1 f		402 11 GHz 551 88 GHz	2.84 dBr -41.43 dBr						
3 N 1 f	9.	715 86 GHz	-41.78 dBr						Freq Offset
4 5								=	0 Hz
6									
8									
9									
11								~	
K MSG						STATUS			
mod						STATUS			



# Lowest Channel & Modulation : 8DPSK



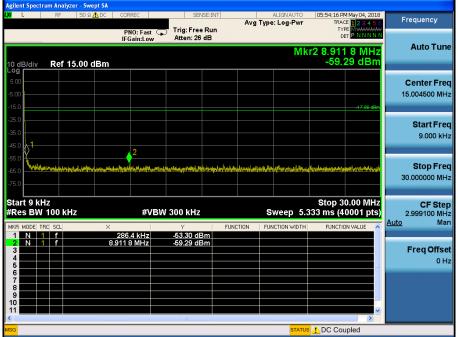


## **Reference for limit**

Middle Channel & Modulation : 8DPSK



# Conducted Spurious Emissions <u>Middle Channel & Modulation : 8DPSK</u>





## Middle Channel & Modulation : 8DPSK

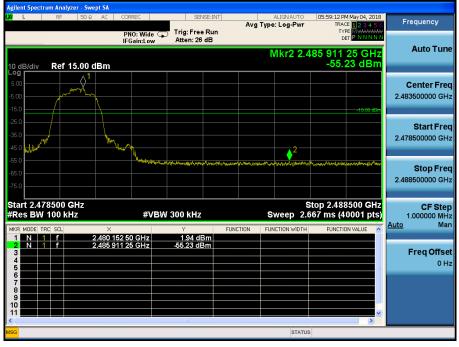




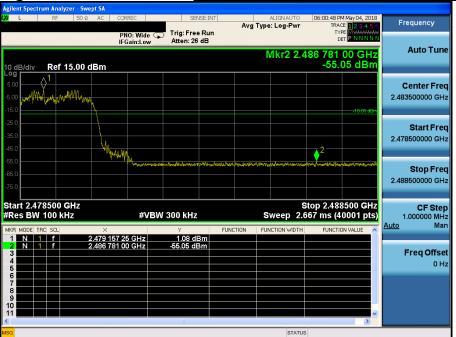


## **High Band-edge**

## Highest Channel & Modulation : 8DPSK

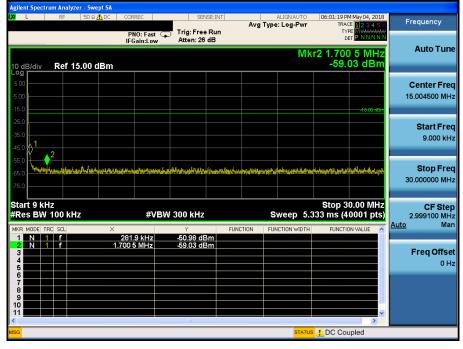


# High Band-edgeHopping mode & Modulation : 8DPSK





# Highest Channel & Modulation : 8DPSK



	ım Analyzer - Sı						
L <mark>XI</mark> L	RF 50	Ω AC CORREC	SENSE	Avg	ALIGNAUTO Type: Log-Pwr	06:02:19 PM May 04, 2018 TRACE 2 3 4 5 6	Frequency
		PNO: Fast IFGain:Lov	Trig: Free R Atten: 26 dB			DET P N N N N	
		il Guilleon			Mkr	4 8.240 05 GHz	Auto Tune
10 dB/div	Ref 15.00	dBm				-42.96 dBm	
Log 5.00							Center Freq
-5.00							5.015000000 GHz
-15.0						-10.06 dBm	
-25.0							
-35.0						4	Start Freq 30.000000 MHz
-45.0		Y.	a state of the second se		akaya ana dani maya na kana kana kana kana kana kana kan		30.00000 WH2
-55.0		استكار ويتكتركيهم				فتأكأن فالبر محصوبالثان	
-65.0							Stop Free
-75.0							10.00000000 GHz
Start 30 N	111-7					Stop 10.000 GHz	
#Res BW		#V	'BW 3.0 MHz		Sweep 18	.67 ms (40001 pts)	CF Step 997.000000 MHz
MKR MODE TR	C SCL	×	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Mar
1 N 1 2 N 1	f	2.480 38 GHz 5.795 65 GHz	2.59 dBm -41.77 dBm				
3 N 1	f	3.082 56 GHz 8.240 05 GHz	-42.70 dBm -42.96 dBm				Freq Offset
5		8.240 05 GHZ	-42.96 dBm				0 Hz
6							
8							
10							
11			ш			>	
MSG					STATUS		



# Highest Channel & Modulation : 8DPSK



# 8. Transmitter AC Power Line Conducted Emission

## 8.1 Test Setup

NA

## 8.2 Limit

According to §15.207(a) 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 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

	Conducted Limit (dBuV)				
Frequency Range (MHz)	Quasi-Peak	Average			
0.15 ~ 0.5	66 to 56 *	56 to 46 *			
0.5 ~ 5	56	46			
5 ~ 30	60	50			

\* Decreases with the logarithm of the frequency

## 8.3 Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10.

- The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
- 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
- 3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
- 4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

## 8.4 Test Results

NA



# 9. Antenna Requirement

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that

it employs a unique antenna connector, for every antenna proposed for use with the EUT.

#### Conclusion: Comply

The antenna is printed to the internal PCB (Refer to Internal Photo file.) Therefore this E.U.T Complies with the requirement of §15.203

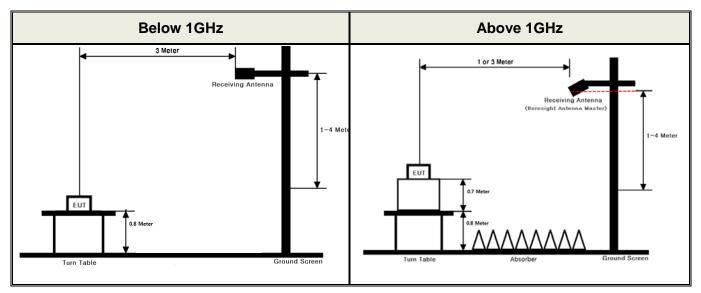
#### - Minimum Standard :

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. 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.

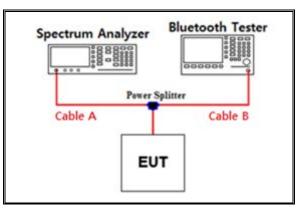
# **APPENDIX I**

#### Test set up diagrams

#### Radiated Measurement



#### Conducted Measurement



#### Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	6.52	15	9.50
1	6.62	20	10.31
2.402 & 2.441 & 2480	7.30	25	10.80
5	8.05	-	-
10	8.66	-	-

Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test.

Path loss (S/A's Correction factor) = Power Splitter + Cable A

**Detector Mode : PK** 

# **APPENDIX II**

## **Unwanted Emissions (Radiated) Test Plot**

#### GFSK & Lowest & X & Hor

Frequency Avg Type: Log-Pwr TRACE PNO: Fast Trig: Free Run IFGain:Low Atten: 10 dB TYP! DE Auto Tune Mkr3 2.389 43 GH 45.35 dBµ Ref 106.99 dBµV **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz  $\mathbf{0}^{3}$ Stop Freq 2.40500000 GHz Stop 2.40500 GHz 1.00 ms (3001 pts) Start 2.31000 GHz #Res BW 1.0 MHz CF Step 2.40200000 GHz VBW 3.0 MHz Sweep Auto Man 88.89 dBµ 43.47 dBµ 45.35 dBµ Freq Offset 0 Hz

## GFSK & Highest & X & Hor

#### Analyzer - Swept Si Frequency Avg Type: Log-Pwr PNO: Fast Trig: Free Run IFGain:Low Atten: 10 dB Auto Tune Mkr3 2.484 117 GH 48.06 dBµ Ref 106.99 dBµV **Center Freq** 2.487500000 GHz Start Freq 2.475000000 GHz $\Diamond^2$ A WAR WARAN when the first of the of Stop Freq 2.50000000 GHz Stop 2.50000 GHz Start 2.47500 GHz #Res BW 1.0 MHz CF Step 2.40200000 GHz VBW 3.0 MHz Sweep 1.00 ms (3001 pts) FUNCTION Mar Auto <u>84.09</u> 44.63 48.06 dBµ\ Freq Offset 0 Hz STATUS

#### **Detector Mode : PK**



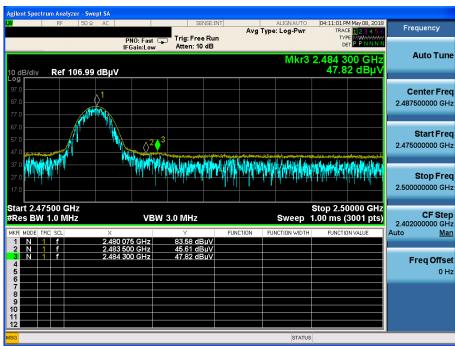
## $\pi/4DQPSK$ & Lowest & X & Hor

## **Detector Mode : PK**

Agilent Spectrum Analyzer - Swept SA				
RF 50Ω AC	SENSE:INT	ALIGN AUTO Avg Type: Log-Pwr	04:22:02 PM May 08, 2018 TRACE 123456	Frequency
10 dB/div Ref 106.99 dBµV	PNO: Fast Trig: Free Run IFGain:Low Atten: 10 dB	Mkr	түре Минилин Det P P NNNN 3 2.389 67 GHz 45.25 dBµV	Auto Tune
og				Center Free 2.357500000 GH
67.0 47.0	naturi danatina di nati nati nati na di nati na di nati na	Maganiak Negarat, an ing ali ya biyaka na	3 martingenerativet	<b>Start Free</b> 2.310000000 GH
37.0 27.0 17.0	uudunda hadaa hada	a maa da jir faalaa ka mila ka ku ka	<b>Murium a</b>	Stop Free 2.405000000 GH:
Start 2.31000 GHz #Res BW 1.0 MHz	VBW 3.0 MHz	Sweep	Stop 2.40500 GHz 1.00 ms (3001 pts)	CF Step 2.402000000 GH
MKR MODE TRC SCL X	Y 02 06 GHz 89.37 dBµV	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	Auto <u>Mar</u>
2 N 1 f 2.39	90 00 GHz 44.38 dBµV 99 67 GHz 45.25 dBµV			Freq Offse 0 H
7 8 9 10				
		STATUS		

#### **Detector Mode : PK**

# $\pi/4DQPSK$ & Highest & X & Hor



**Detector Mode : PK** 



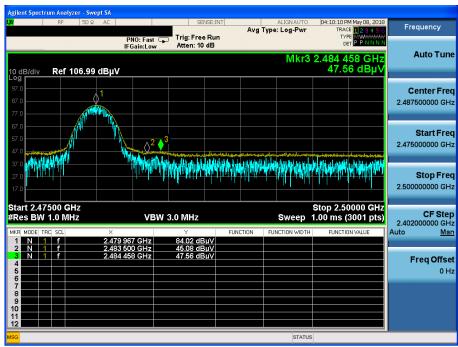
#### 8DPSK & Lowest & X & Hor

.00

#### Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 10 dB PNO: Fast 😱 IFGain:Low Auto Tune Mkr3 45.68 dBµ\ Ref 106.99 dBµV **Center Freq** 2.357500000 GHz Start Freq 63 2.310000000 GHz un han period bet an an in the set of the set Stop Freq 2.405000000 GHz Start 2.31000 GHz #Res BW 1.0 MHz Stop 2.40500 GHz 1.00 ms (3001 pts) CF Step 2.40200000 GHz VBW 3.0 MHz Sweep Auto Mar FUN 89.76 dBµV 44.69 dBµV 45 68 dBµV Freq Offset 0 Hz

#### **Detector Mode : PK**

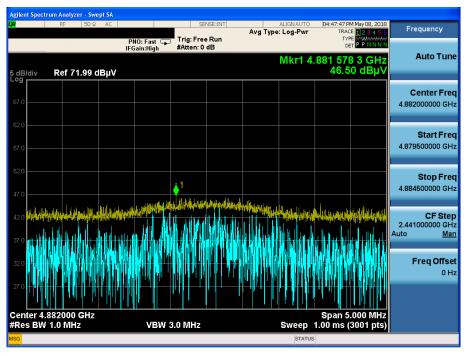
## 8DPSK & Highest & X & Hor





#### GFSK & Middle & X & Hor

# **Detector Mode : PK**



#### $\pi$ /4DQPSK & Lowest & X & Hor

#### Swept SA Avg Type: Log-Pwr Frequency TRACE 1 2 3 4 5 TYPE MWWWW DET P P N N I PNO: Fast Trig: Free Run IFGain:High #Atten: 0 dB Auto Tune Mkr1 4.804 115 0 GHz 46.83 dBµV Ref 71.99 dBµV dB/div **Center Freq** 4.804000000 GHz Start Freq 4.801500000 GHz Stop Freq 4.806500000 GHz CF Step 2.40200000 GHz Auto Man Freq Offset 0 Hz Center 4.804000 GHz #Res BW 1.0 MHz Span 5.000 MHz Sweep 1.00 ms (3001 pts) VBW 3.0 MHz

#### **Detector Mode : PK**

**Detector Mode : PK** 



#### 8DPSK & Middle & X & Hor

