



1 GHz ~ 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)
2384.98	V	Y	PK	45.45	1.69	N/A	N/A	47.14	74.00	26.86
2384.89	V	Y	AV	37.28	1.69	-24.79	N/A	14.18	54.00	39.82
3843.18	Н	Х	PK	45.52	3.96	N/A	N/A	49.48	74.00	24.52
3843.07	Н	Х	AV	36.89	3.96	-24.79	N/A	16.06	54.00	37.94
4803.25	V	Y	PK	45.88	5.45	N/A	N/A	51.33	74.00	22.67
4804.05	V	Y	AV	34.47	5.45	-24.79	N/A	15.13	54.00	38.87
7206.14	Н	Y	PK	44.36	7.86	N/A	N/A	52.22	74.00	21.78
7206.20	Н	Y	AV	33.64	7.86	-24.79	N/A	16.71	54.00	37.29

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)
4882.78	V	Y	PK	44.71	5.64	N/A	N/A	50.35	74.00	23.65
4881.76	V	Y	AV	34.45	5.64	-24.79	N/A	15.30	54.00	38.70
7322.22	Н	Y	PK	43.96	8.04	N/A	N/A	52.00	74.00	22.00
7322.76	Н	Y	AV	32.70	8.04	-24.79	N/A	15.95	54.00	38.05

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)
2487.73	V	Y	PK	53.91	1.82	N/A	N/A	55.73	74.00	18.27
2487.59	V	Y	AV	49.13	1.82	-24.79	N/A	26.16	54.00	27.84
4960.26	V	Y	PK	43.88	5.76	N/A	N/A	49.64	74.00	24.36
4959.66	V	Y	AV	33.43	5.76	-24.79	N/A	14.40	54.00	39.60
7440.25	Н	Y	PK	43.81	7.87	N/A	N/A	51.68	74.00	22.32
7439.80	Н	Y	AV	32.93	7.87	-24.79	N/A	16.01	54.00	37.99

Note.

1. The radiated emissions were investigated 1 GHz to 25 GHz. 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. Sample Calculation.

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

Refer to the original test report for D.C.F.

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

- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.88 X 20) = 1.74 = 2

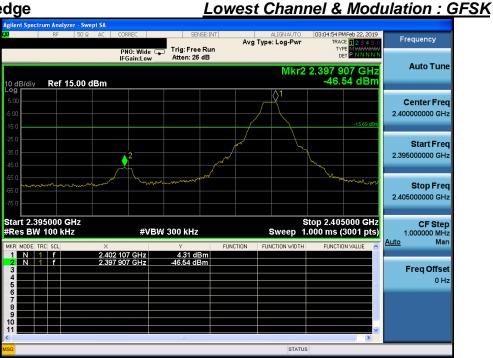
- The Worst Case Dwell Time = T [ms] x H' = 2.88 ms X 2 = 5.76 ms

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





Low Band-edge



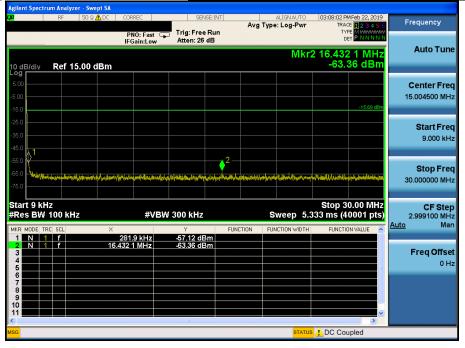
Low Band-edge

Hopping mode & Modulation : GFSK





Lowest Channel & Modulation : GFSK





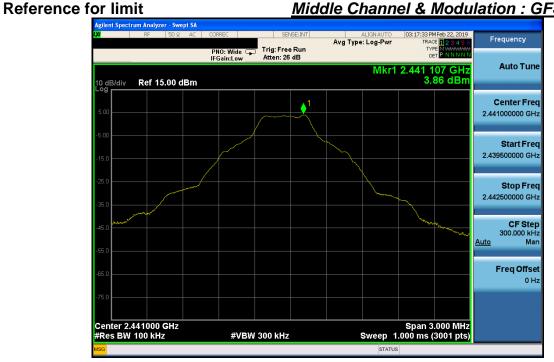


Lowest Channel & Modulation : GFSK

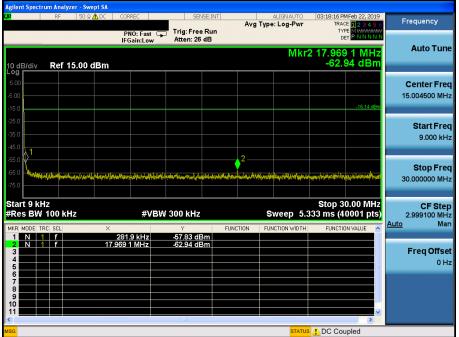




Middle Channel & Modulation : GFSK

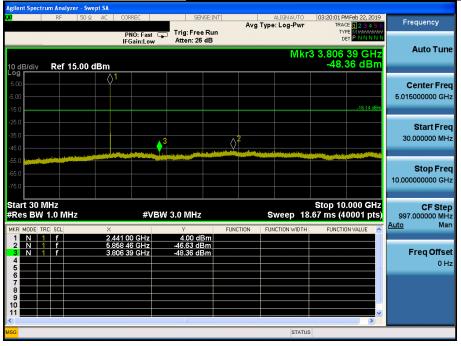


Conducted Spurious Emissions Middle Channel & Modulation : GFSK





Middle Channel & Modulation : GFSK







High Band-edge

Highest Channel & Modulation : GFSK



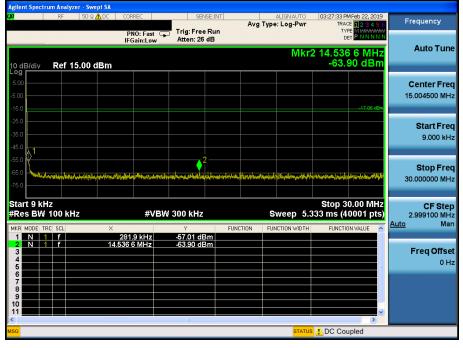
High Band-edge

Hopping mode & Modulation : GFSK





Highest Channel & Modulation : GFSK



Agilent Spectrum Analyzer - Swe						
LX RF 50 Ω	AC CORREC	SENSE:I		ALIGNAUTO	03:29:32 PM Feb 22, 2019 TRACE 1 2 3 4 5	Frequency
	PNO: Fast IFGain:Low	Trig: Free Ru Atten: 26 dB		,,	TYPE MUMUMUM DET P N N N N	
	IFGain:Low	Atten. 20 dB		Mice		
10 dB/div Ref 15.00 d	IBm				2 6.344 50 GHz -46.53 dBm	
5.00						Center Freq
-5.00						5.015000000 GHz
-15.0					-17.06 dBn	
-25.0						
-35.0			2			Start Freq 30.000000 MHz
-45.0			¢ ²			30.000000 WHZ
-55.0 automatication devices and						
-65.0						Stop Freq
-75.0						10.00000000 GHz
Start 20 Mills					Stop 10 000 CH-	
Start 30 MHz #Res BW 1.0 MHz	#VE	3W 3.0 MHz		Sweep 18	Stop 10.000 GHz .67 ms (40001 pts	997.000000 MHz
MKR MODE TRC SCL	×	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Man
1 N 1 f 2 N 1 f	2.480 13 GHz 6.344 50 GHz	2.93 dBm -46.53 dBm				
3						Freq Offset
5						0 Hz
6 7						
9						
10						
<		mii				
MSG				STATUS		



Highest Channel & Modulation : GFSK





Low Band-edge

Lowest Channel & Modulation : π/4DQPSK



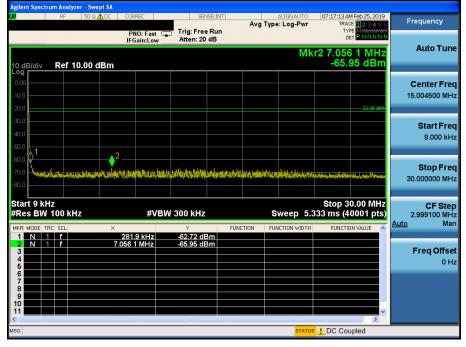
Low Band-edge

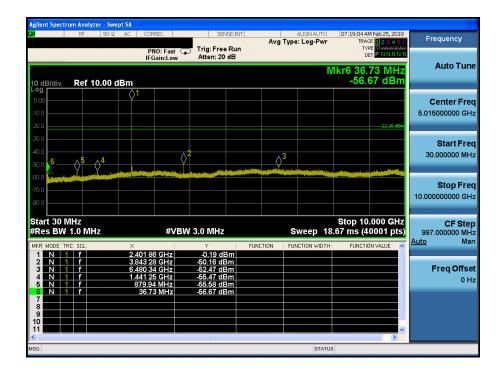
Hopping mode & Modulation : π/4DQPSK





Lowest Channel & Modulation : π/4DQPSK







Lowest Channel & Modulation : π/4DQPSK

Conducted Spurious Emissions

47 AM Feb 25, 2019 Avg Type: Log-Pwr Frequency TRACE Trig: Free Run Atten: 20 dB PNO: Fast 🖵 IFGain:Low Auto Tune Mkr3 16.762 000 GHz -47.64 dBm Ref 10.00 dBm dB/div Center Freq 17.50000000 GHz Start Freq ¢³ 10.000000000 GHz Stop Freq 25.00000000 GHz CF Step 1.50000000 GHz uto Man Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.00 ms (40001 pts) #VBW 3.0 MHz Auto -40.16 dBm -43.16 dBm -47.64 dBm 24.799 000 21.413 125 16.762 000 GHZ Freq Offset 0 Hz



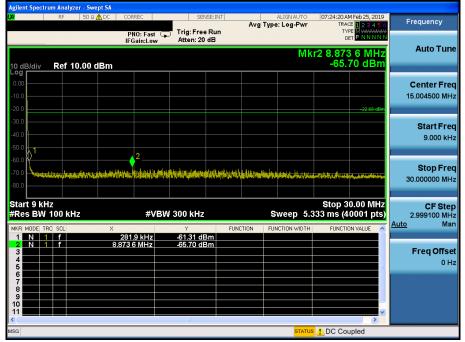
Reference for limit

Middle Channel & Modulation : π/4DQPSK



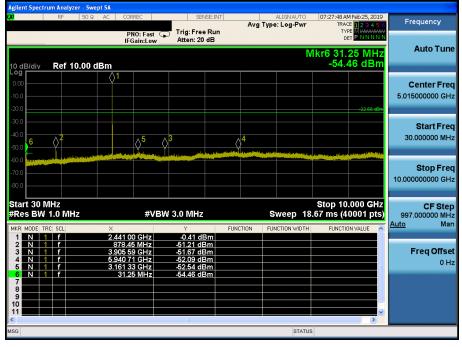
Conducted Spurious Emissions <u>Middle C</u>

Middle Channel & Modulation : π/4DQPSK





Middle Channel & Modulation : π/4DQPSK







High Band-edge

Highest Channel & Modulation : π/4DQPSK

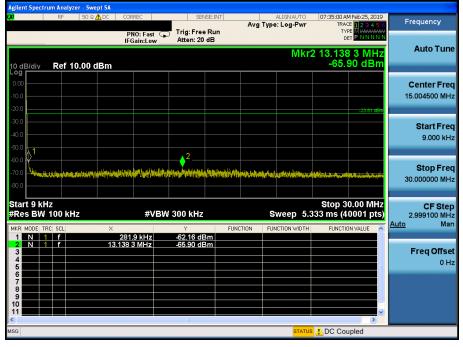


High Band-edgeHopping mode & Modulation : π/4DQPSK





Highest Channel & Modulation : π/4DQPSK



Agilent Spectrum Analyzer - Swe						
LXI RF 50 Ω	AC CORREC	SENSE:INT	Avg T	ALIGNAUTO ype: Log-Pwr	07:37:39 AM Feb 25, 2019 TRACE 1 2 3 4 5 6	Frequency
	PNO: Fast G IFGain:Low	Trig: Free Run Atten: 20 dB		N	Ikr6 36.48 MHz -56.66 dBm	Auto Tune
10 dB/div Ref 10.00 c Log 0.00 -10.0 -20.0	iBm ↓1				-30.00 GBM	Center Freq 5.015000000 GHz
-30.0 -40.0 -50.0 -50.0	Ç	A2				Start Freq 30.000000 MHz
-60.0						Stop Freq 10.000000000 GHz
Start 30 MHz #Res BW 1.0 MHz	#VBI	₩ 3.0 MHz	FUNCTION	Sweep 18	Stop 10.000 GHz 67 ms (40001 pts)	CF Step 997.000000 MHz <u>Auto</u> Man
1 N 1 f 2 N 1 f 3 N 1 f 4 N 1 f 5 N 1 f	2.479 88 GHz 3.968 15 GHz 5.802 88 GHz 3.834 30 GHz 878 95 MHz	-1.49 dBm -51.75 dBm -51.88 dBm -53.19 dBm -55.72 dBm				Freq Offset 0 Hz
6 N 1 f 7 - - - 8 - - - 9 - - - 10 - - - 11 - - -	36.48 MHz	-56.66 dBm			_	
MSG				STATUS	>	



Highest Channel & Modulation : π/4DQPSK





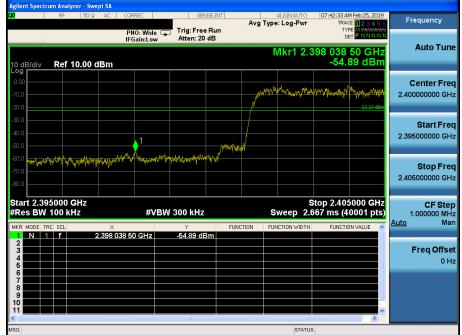
Low Band-edge

Lowest Channel & Modulation : 8DPSK



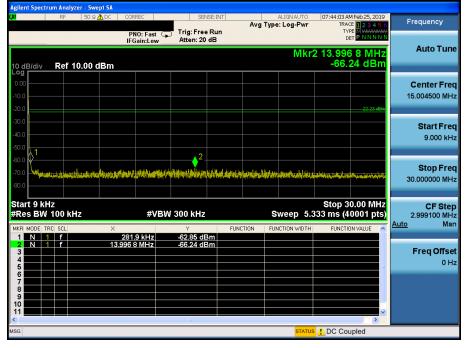
Low Band-edge

Hopping mode & Modulation : 8DPSK





Lowest Channel & Modulation : 8DPSK



Agilent Spectrum	Analyzer - Swe RF 50 Ω		REC	SEN	SE:INT		ALIGNAUTO	07:46:05 4	4 Feb 25, 2019	
	00 2						: Log-Pwr	TRAC		Frequency
			NO: Fast G Gain:Low	Atten: 20				D		Auto Tune
10 dB/div	D dB/div Ref 10.00 dBm -56.40 dBm									
0.00		1								Center Freq
-10.0										5.015000000 GHz
-20.0									22.23 dBm	
-30.0										Start Freq
-40.0	3			25						30.000000 MHz
-50.0	a provide the second of the	alitatis and it where		Y						
-70.0										Stop Freq
-80.0										10.00000000 GHz
Start 30 MH	7							Stop 10	.000 GHz	
#Res BW 1.			#VBV	V 3.0 MHz		s	weep 18	.67 ms (4	0001 pts)	CF Step 997.000000 MHz
MKR MODE TRC	SCL	×		Y	FUNC	TION FUN	NCTION WIDTH	FUNCTIO	IN VALUE	<u>Auto</u> Man
1 N 1	f	2.401 8 3.843 2		0.04 dE -50.14 dE						
3 N 1	f	878.4	5 MHz	-50.63 dE	m					Freq Offset
4 N 1 5 N 1	f	<u>5.710 9</u> 3.975 8		<u>-52.59 dE</u> -53.67 dE						0 Hz
6 N 1	f		8 GHZ 8 MHZ	-55.67 dE -56.40 dE	m				=	
7										
8										
10										
11									~	
MSG							STATUS	5		
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Lowest Channel & Modulation : 8DPSK



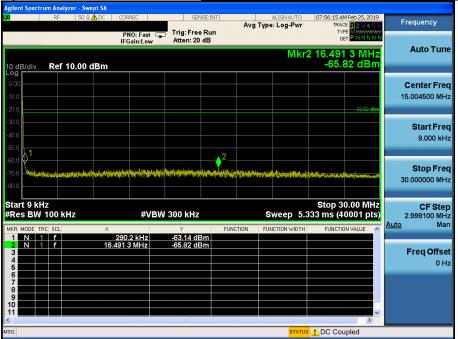


Reference for limit



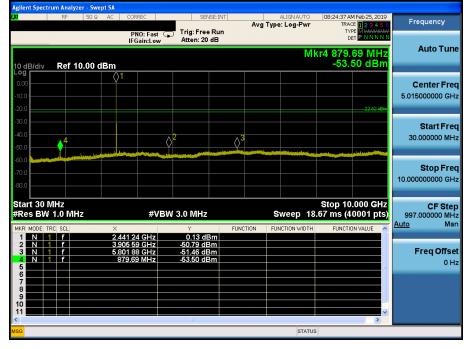


Conducted Spurious Emissions <u>Middle Channel & Modulation : 8DPSK</u>





Middle Channel & Modulation : 8DPSK







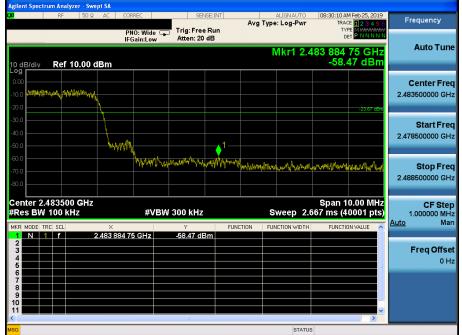
High Band-edge

Highest Channel & Modulation : 8DPSK



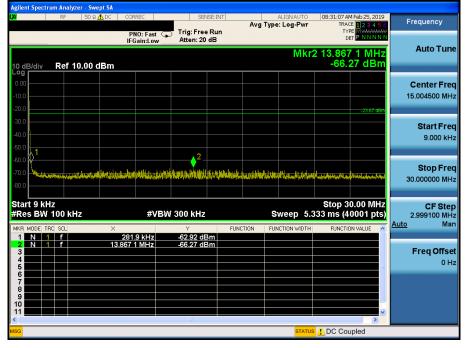
High Band-edge

Hopping mode & Modulation : 8DPSK





Highest Channel & Modulation : 8DPSK



Agilent Spe		Analyze RE	e <mark>r - Swe</mark> j 50 Ω		CORI	250			SENSE:	TA IT			ALIGN AU	TO	08:35:14/	MEeb OF 1	010	
1		RF .	1 20 2	AC							Avg		: Log-P		TRA	CE 1 2 3 4	5.6	Frequency
10 dB/div	/	lef 10	0.00 d	Bm		lO: Fas ain:Lo		Atten:						Μ	، kr6 31	et <mark>P N N I</mark>	Hz	Auto Tune
Log 0.00 -10.0 -20.0					<u>}</u> 1											-23.67	dBm	Center Freq 5.015000000 GHz
-30.0 -40.0 -50.0 ⁶	(4	5				Ŷ	3		^2	2	il essent est			gentlen gestleden			Start Freq 30.000000 MHz
-60.0 -70.0 -80.0																		Stop Freq 10.000000000 GHz
Start 30 #Res B			z			#\	/BW	3.0 MH	lz			S	weep	18.	Stop 10 67 ms (4	1.000 G 10001 p	Hz ots)	CF Step 997.000000 MHz
MKR MODE	TRC	SCL		Х				Y		FUN	CTION	FUN	ICTION WI	DTH	FUNCT	ON VALUE	^	<u>Auto</u> Man
1 N 2 N 3 N 4 N 5 N	1 1 1	f f f		5. 3.	480 13 785 18 968 40 379.44 812 14	GHz GHz MHz		-1.12 -52.19 -52.77 -54.11 -54.53	dBm dBm dBm									Freq Offset
6 N 7 8 9 10		f			31.00			-54.53 -55.50	dBm									
11													_				>	
MSG													ST	ATUS				



Highest Channel & Modulation : 8DPSK



8. Transmitter AC Power Line Conducted Emission

8.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

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

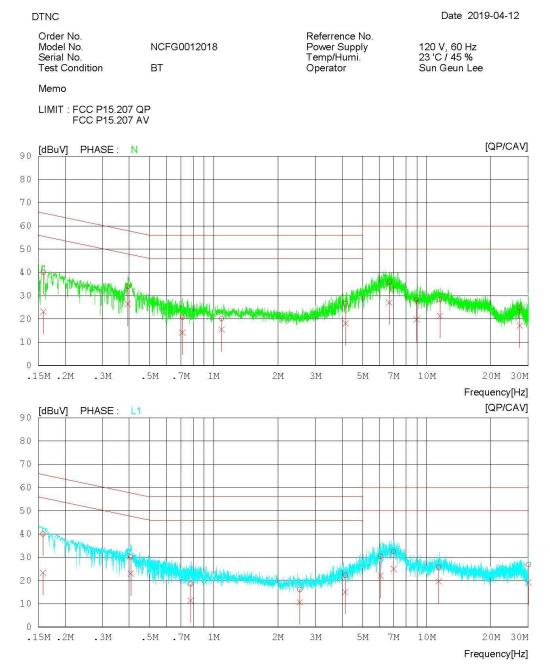
8.3 Test Procedures

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 AC Line Conducted Emissions (Graph)

Results of Conducted Emission



AC Line Conducted Emissions (List)

Results of Conducted Emission

DTNC			Date 2019-04-12
Order No. Model No. NCFG Serial No. Test Condition BT	0012018	Referrence No. Power Supply Temp/Humi. Operator	120 V, 60 Hz 23 'C / 45 % Sun Geun Lee
Memo			
LIMIT : FCC P15.207 QP FCC P15.207 AV			
NO FREQ READING QP CAV [MHz] [dBuV][dBu	C.FACTOR RESULT QP CAV V] [dB] [dBuV][dBu		MARGIN PHASE QP CAV] [dBuV] [dBuV]
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	25.45 32.38 N 24.14 21.50 N 35.34 31.89 N 35.81 30.48 N 29.48 27.86 N 24.23 22.96 N 31.81 30.14 N 31.63 28.65 N 35.35 32.81 N 25.58 32.22 L1 27.60 24.69 L1 37.57 34.65 L1 39.77 35.43 L1 33.79 31.03 L1 29.53 27.96 L1 27.57 25.00 L1 34.23 30.38 L1 33.12 30.94 L1



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 permanently printed on the PCB. Therefore this E.U.T Complies with the requirement of §15.203

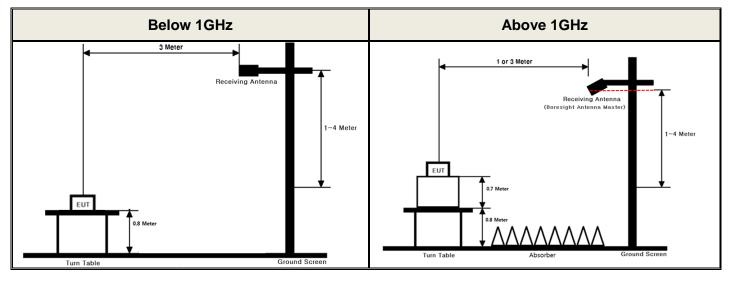
- Minimum Standard :

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.

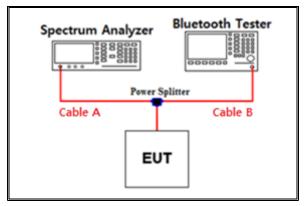
APPENDIX I

Test set up diagrams

Radiated Measurement



Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	6.13	15	9.72
1	6.88	20	10.81
2.402 & 2.441 & 2.480	7.36	25	11.52
5	8.06	-	-
10	9.29	-	-

Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test. Path loss (S/A's Correction factor) = Cable A + Power splitter

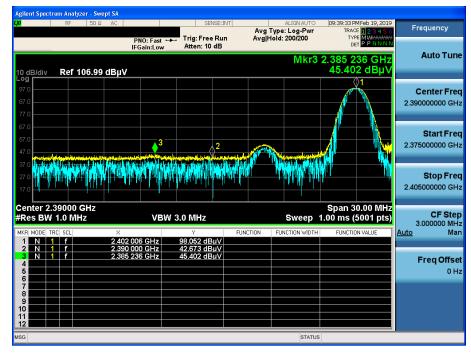


APPENDIX II

Unwanted Emissions (Radiated) Test Plot

GFSK & Lowest & Y & Ver



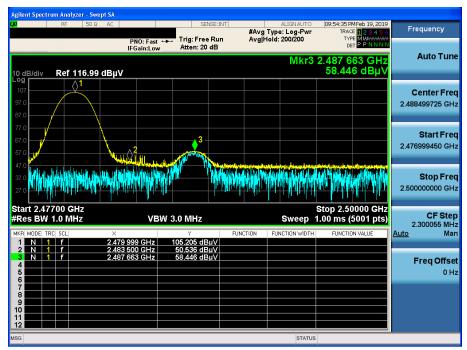


GFSK & Lowest & Y & Ver

ent Spectrum Analyzer - Swept SA Frequency #Avg Type: Voltage Avg|Hold: 200/200 Trig: Free Run Atten: 10 dB MWH TYPE DET PNO: Fast ↔→ IFGain:Low Auto Tune Mkr3 2.385 038 GHz 36.984 dBµV Ref 106.99 dBµV dB/div **Center Freq** 2.39000000 GHz Start Freq 2.375000000 GHz **♦**³ 02 Stop Freq 2.405000000 GHz Center 2.39000 GHz #Res BW 1.0 MHz Span 30.00 MHz Sweep 23.7 ms (5001 pts) CF Step 3.000000 MHz #VBW 1.0 kHz Auto Mar 2.390 000 GHz 34.347 dBµ∖ 36.984 dBµ∖ Freq Offset 0 Hz



GFSK & Highest & Y & Ver



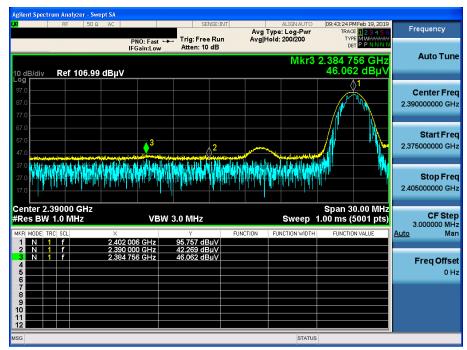
GFSK & Highest & Y & Ver

ar - Swept S/ Frequency #Avg Type: Voltage Avg|Hold: 200/200 Trig: Free Run Atten: 20 dB DET P P N PNO: Fast • IFGain:Low Auto Tune Mkr3 2.487 557 GH: 56.460 dBµ\ Ref 116.99 dBµV dB/div **Center Freq** 2.488499725 GHz Start Freq **♦**³ 2.476999450 GHz Stop Freq 2.50000000 GHz Stop 2.50000 GHz 18.0 ms (5001 pts) Start 2.47700 GHz #Res BW 1.0 MHz CF Step 2.300055 MHz #VBW 1.0 kHz Sweep Man Auto 41.974 dBµ\ 56.460 dBµ\ 2.483 500 GHz 2.487 <u>557 GH</u>z Freq Offset 0 Hz STATUS



π /4DQPSK & Lowest & Y & Ver

Detector Mode : PK

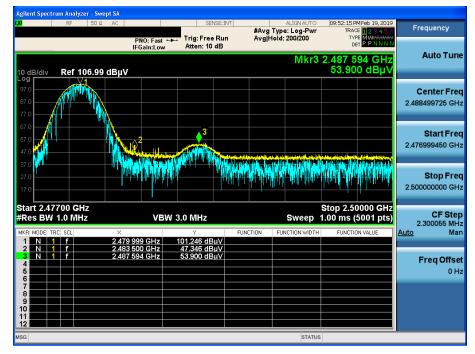


$\pi/4DQPSK$ & Lowest & Y & Ver

ent Spectrum Analyzer - Swept SA Frequency #Avg Type: Voltage Avg|Hold: 200/200 Trig: Free Run Atten: 10 dB DET P P N PNO: Fast IFGain:Low Auto Tune Mkr3 2.385 038 GHz 37.314 dBµV Ref 106.99 dBµV lB/div **Center Freq** 2.39000000 GHz Start Freq 2.375000000 GHz 73 .2 Stop Freq 2.405000000 GHz Center 2.39000 GHz #Res BW 1.0 MHz Span 30.00 MHz 23.7 ms (5001 pts) CF Step 3.000000 MHz Man #VBW 1.0 kHz Sweep <u>Auto</u> 34.341 dBµ 37.314 dBµ Freq Offset 0 Hz STATUS

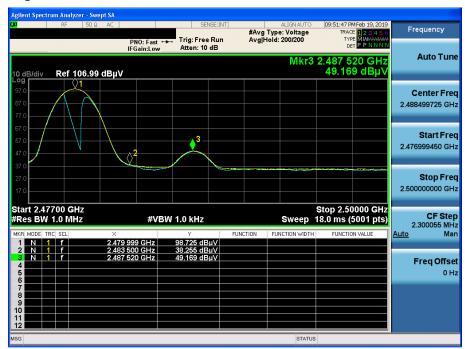


$\pi/4DQPSK$ & Highest & Y & Ver



Detector Mode : AV

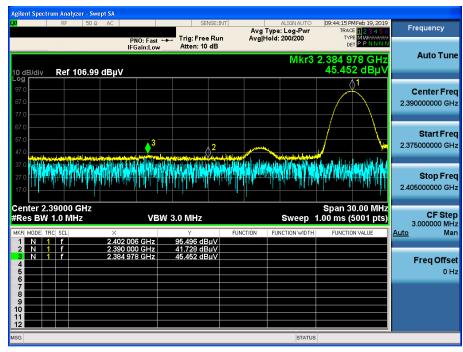
π/4DQPSK & Highest & Y & Ver





8DPSK & Lowest & Y & Ver

Detector Mode : PK

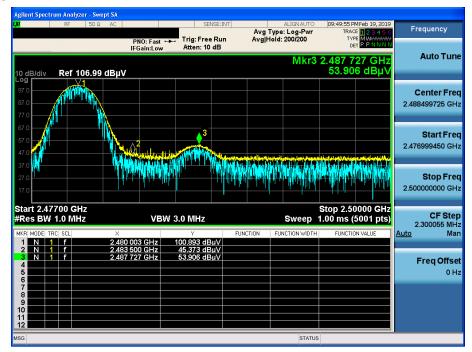


8DPSK & Lowest & Y & Ver

gilent Spectrum Analyzer - Swept SA Frequency #Avg Type: Voltage Avg|Hold: 200/200 Trig: Free Run Atten: 10 dB MWA PPN PNO: Fast ↔→ IFGain:Low DET Auto Tune Mkr3 2.384 888 GH: 37.277 dBµ Ref 106.99 dBµV 3/div 0 d .og **Center Freq** 2.390000000 GHz Start Freq 2.375000000 GHz **3** <mark>ہ د</mark> Stop Freq 2.405000000 GHz Center 2.39000 GHz #Res BW 1.0 MHz Span 30.00 MHz 23.7 ms (5001 pts) CF Step 3.000000 MHz Man #VBW 1.0 kHz Sweep Auto 92.990 dBµV 34.253 dBµV 37.277 dBµV Freq Offset 0 Hz STATUS



8DPSK & Highest & Y & Ver



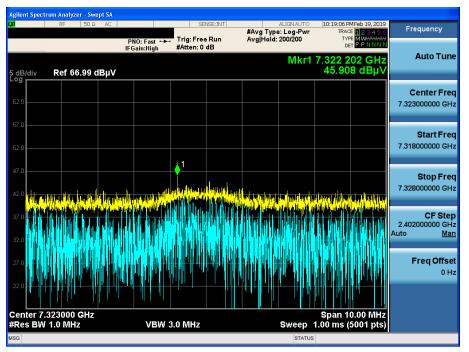
Detector Mode : AV

8DPSK & Highest & Y & Ver



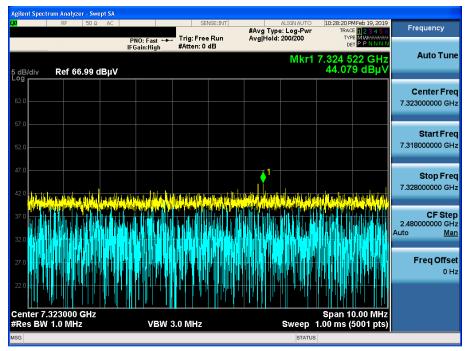


GFSK & Middle & Y & Hor



$\pi/4DQPSK$ & Middle & Y & Hor

Detector Mode : PK





8DPSK & Lowest & Y & Hor

