

### 8. Transmitter AC Power Line Conducted Emission

#### 8.1 Test Setup

Refer to test setup photo.

#### 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.

Frequency Range (MHz)	Conducted Limit (dBuV)						
Trequency hange (wriz)	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

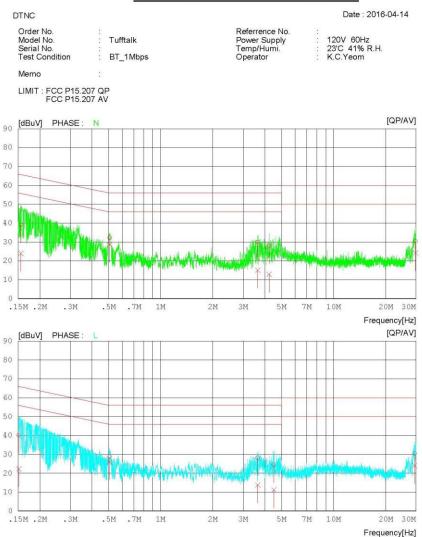
#### 8.3 Test Procedures

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

- 1. 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) = Modulation : <u>GFSK</u>



**Results of Conducted Emission** 

DTNC



### AC Line Conducted Emissions (List) = Modulation : <u>GFSK</u>

### **Results of Conducted Emission**

Date : 2016-04-19

Order No. Model No. Serial No. Test Condition	Tufftalk BT_1Mbps	Referrence No. Power Supply Temp/Humi. Operator	: 120V 60Hz 23'C 41% R.H. K.C.Yeom
Memo	:		
LIMIT : FCC P15.2 FCC P15.2			
NO FREQ	READING C.FACTOR	RESULT LIMIT	MARGIN PHAS

NC	) FREQ [MHz]	READ QP [dBuV]	AV	C.FACTOR [dB]	QP	ULT AV [dBuV]	QP	MIT AV ][dBuV]	QP	RGIN AV ][dBuV]	PHASE
1	0.15535	29.0	13.9	10.1	39.1	24.0	65.7	55.7	26.6	31.7	N
2	0.50726	22.2	18.6	10.1	32.3	28.7	56.0	46.0	23.7	17.3	Ν
3	3.64480	19.8	4.9	10.2	30.0	15.1	56.0	46.0	26.0	30.9	Ν
4	4.24460	17.9	2.7	10.2	28.1	12.9	56.0	46.0	27.9	33.1	Ν
5	29.77380	19.5	13.5	10.8	30.3	24.3	60.0	50.0	29.7	25.7	Ν
6	0.15137	29.9	12.2	10.1	40.0	22.3	65.9	55.9	25.9	33.6	L
7	0.50670	18.6	15.9	10.1	28.7	26.0	56.0	46.0	27.3	20.0	L
8	3.64760	17.9	3.6	10.2	28.1	13.8	56.0	46.0	27.9	32.2	L
9	4.51560	14.3	0.9	10.2	24.5	11.1	56.0	46.0	31.5	34.9	L
10	29.40000	19.2	12.8	11.2	30.4	24.0	60.0	50.0	29.6	26.0	L



### 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 employs a unique antenna connector.(Refer to Internal Photo file.)

#### - 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.



#### 10.1 Test Setup

Refer to the APPENDIX I.

#### 10.2 Limit

Limit : Not Applicable

#### **10.3 Test Procedure**

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately  $3 \times RBW$ .

Spectrum analyzer plots are included on the following pages.

#### **10.4 Test Results**

Test Mode	Tested Channel	Test Results (MHz)
	Lowest	0.869
<u>GFSK</u>	Middle	0.875
	Highest	0.862
	Lowest	1.233
<u>π/4DQPSK</u>	Middle	1.240
	Highest	1.223
	Lowest	1.196
<u>8DPSK</u>	Middle	1.204
	Highest	1.192





### Occupied Bandwidth (99 %)



Middle Frequency & GFSK

Lowest Frequency & GFSK

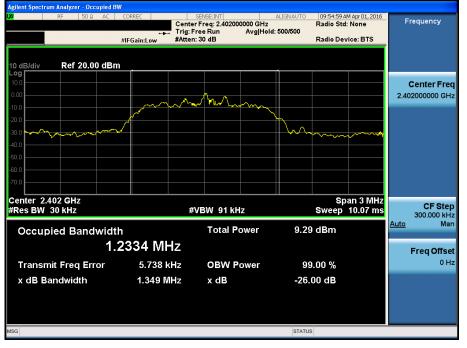








### Lowest Frequency & π/4 DQPSK



#### Occupied Bandwidth (99 %)

#### Middle Frequency & π/4 DQPSK d BW 09:55:32 AM Apr 01, 2016 Radio Std: None SENSE:INT ALIGNAUT Center Freq: 2.441000000 GHz Trig: Free Run Avg|Hold: 500/500 #Atten: 30 dB Frequency Radio Device: BTS #IFGain:Low Ref 20.00 dBm B/div **Center Freq** 2.441000000 GHz $\sim$ Center 2.441 GHz #Res BW 30 kHz Span 3 MHz Sweep 10.07 ms CF Step 300.000 kHz Man #VBW 91 kHz Auto **Occupied Bandwidth** Total Power 10.1 dBm 1.2404 MHz **Freq Offset** 0 Hz 4.743 kHz 99.00 % **OBW Power Transmit Freq Error** x dB Bandwidth 1.353 MHz -26.00 dB x dB STATUS



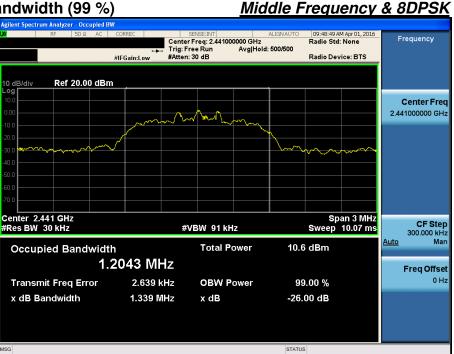
### Highest Frequency & π/4 DQPSK







### Occupied Bandwidth (99 %)





#### Highest Frequency & 8DPSK

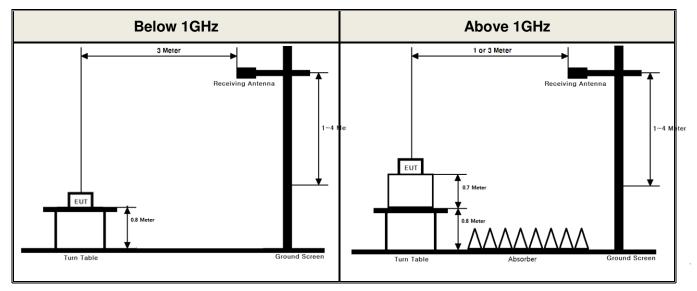




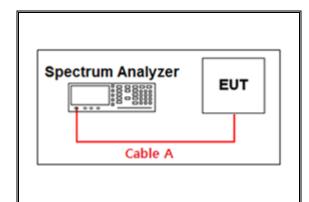
### **APPENDIX I**

#### Test set up diagrams

Radiated Measurement



#### Conducted Measurement



#### Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	0.22	15	4.76
1	1.39	20	5.84
2402 & 2441 & 2480	2.13	25	6.54
5	2.72	-	-
10	3.92	-	-

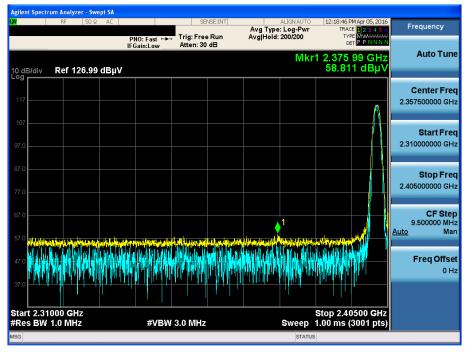
Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test. Path loss (S/A's Correction factor) = Cable A + Power splitter



### **APPENDIX II**

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

#### GFSK & Lowest & X & Hor & TM 1

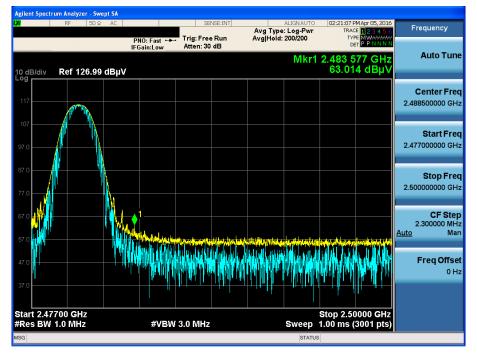


#### GFSK & Lowest & X & Hor & TM 1

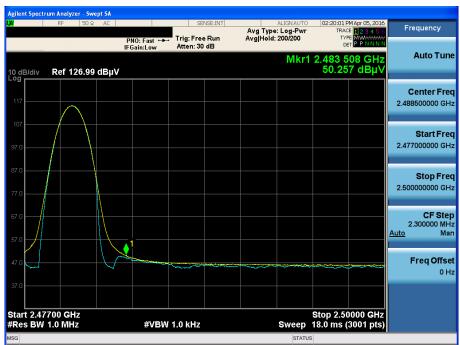




#### GFSK & Highest & X & Hor & TM 1

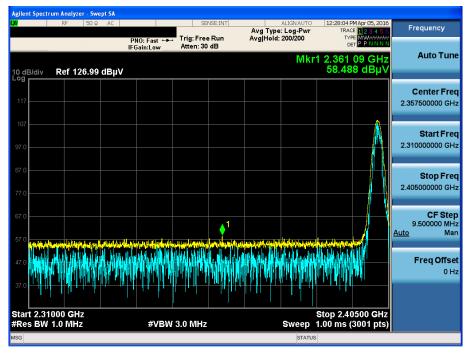


#### GFSK & Highest & X & Hor & TM 1





#### $\pi/4DQPSK$ & Lowest & X & Hor & TM 1

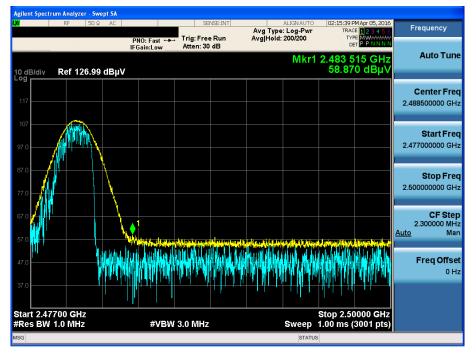


#### $\pi$ /4DQPSK & Lowest & X & Hor & TM 1

#### zer - Swent SA 1 Apr 05, 2 Frequency PNO: Fast $\rightarrow$ Trig: Free Run IFGain:Low Atten: 30 dB TRACE 1 2 3 4 5 TYPE MWWWW DET P P N N N Avg Type: Log-Pwr Avg|Hold: 200/200 Auto Tune Mkr1 2.361 28 GHz 45.437 dBµV Ref 126.99 dBµV 10 dB/div **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz Stop Freq 2.405000000 GHz CF Step 9.500000 MHz Man Auto **≜**<sup>1</sup> Freq Offset 0 Hz Start 2.31000 GHz #Res BW 1.0 MHz Stop 2.40500 GHz Sweep 74.2 ms (3001 pts) #VBW 1.0 kHz



#### $\pi/4DQPSK$ & Highest & X & Hor & TM 1

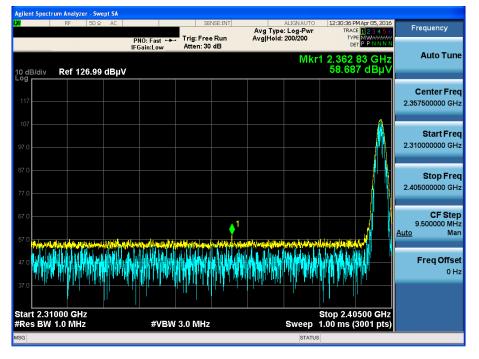


#### $\pi$ /4DQPSK & Highest & X & Hor & TM 1

#### ent SA Frequency PNO: Fast +++ IFGain:Low Atten: 30 dB TRACE 12345 TYPE MWWWW DET PPNNN Avg Type: Log-Pwr Avg|Hold: 200/200 Auto Tune Mkr1 2.483 531 GHz 47.457 dBµV Ref 126.99 dBµV 10 dB/div **Center Freq** 2.488500000 GHz Start Freq 2.477000000 GHz Stop Freq 2.50000000 GHz CF Step 2.300000 MHz Man Auto Freq Offset 0 Hz Start 2.47700 GHz #Res BW 1.0 MHz Stop 2.50000 GHz Sweep 18.0 ms (3001 pts) #VBW 1.0 kHz



#### 8DPSK & Lowest & X & Hor & TM 1

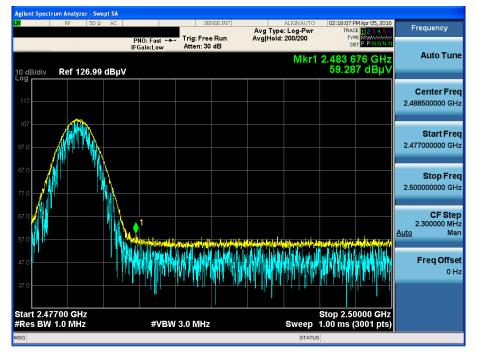


#### 8DPSK & Lowest & X & Hor & TM 1

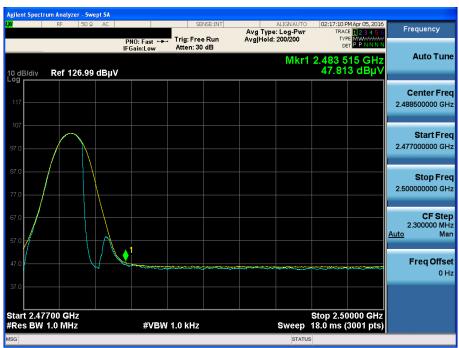
#### 4:10 PM Apr 05, 20 TRACE 1 2 3 4 5 TYPE MWWWW DET P P N N N Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 PNO: Fast ↔→ IFGain:Low Trig: Free Run Atten: 30 dB Auto Tune Mkr1 2.363 75 GHz 45.611 dBµV Ref 126.99 dBµV 10 dB/div **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz Stop Freq 2.40500000 GHz CF Step 9.500000 MHz Man <u>Auto</u> Ø Freq Offset 0 Hz Stop 2.40500 GHz Sweep 74.2 ms (3001 pts) Start 2.31000 GHz #Res BW 1.0 MHz #VBW 1.0 kHz



#### 8DPSK & Highest & X & Hor & TM 1



#### 8DPSK & Highest & X & Hor & TM 1





#### GFSK & Middle & X & Hor & TM 1

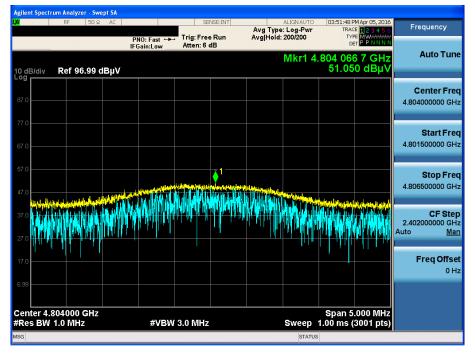


#### GFSK & Middle & X & Hor & TM 1









#### $\pi$ /4DQPSK & Lowest & X & Hor & TM 1





#### 8DPSK & Lowest & X & Hor & TM 1



#### 8DPSK & Lowest & X & Hor & TM 1



Trig: Free Ru Atten: 30 dB

PNO: Fast 🔸

Avg Type: Log-Pwr Avg|Hold: 1000/1000

Mkr1

L. D.L.

Stop 2.40500 GHz 1.00 ms (3001 pts)

# GFSK & Hopping mode & X & Hor & TM 1 Aglent Spectrum Analyzer - Swept SA

10 d

Ref 126.99 dBµV

#### 77.0 1 67.0 47.0 47.0 57.0 47.0 57.0 47.0 57.

### GFSK & Hopping mode & X & Hor & TM 1

TRF-RF-237(02)160407



#### **Detector Mode : AV**

### Detector Mode : PK

Frequency

Auto Tune

Center Freq 2.357500000 GHz

Start Freq 2.31000000 GHz

Stop Freq 2.40500000 GHz

> CF Step 9.500000 MHz Man

Freq Offset

Auto

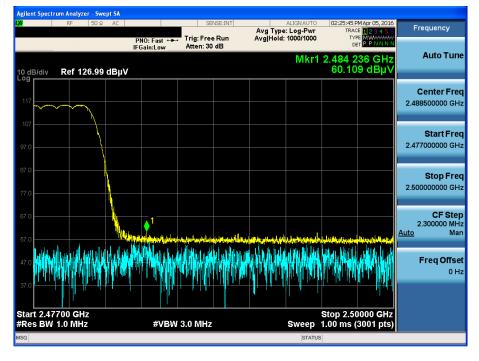
TYPE MWAW DET P P N N

2.319 12 GHz 65.051 dBµV





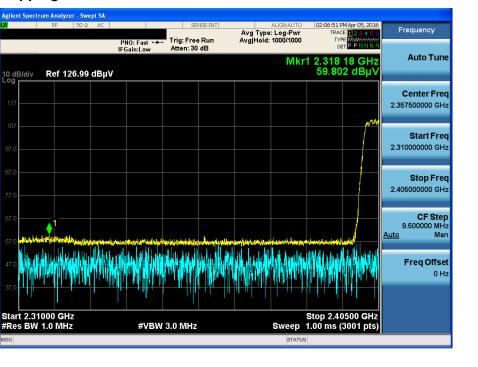
GFSK & Hopping mode & X & Hor & TM 1



#### GFSK & Hopping mode & X & Hor & TM 1

#### Frequency TRACE TYPE DET PNO: Fast +++ IFGain:Low Atten: 30 dB Avg Type: Log-Pwr Avg|Hold: 1000/1000 Auto Tune Mkr1 2.484 052 GHz 51.067 dBµV Ref 126.99 dBµV 10 dB/div **Center Freq** 2.488500000 GHz Start Freq 2.477000000 GHz Stop Freq 2.50000000 GHz CF Step 2.300000 MHz Man Auto Freq Offset 0 Hz Start 2.47700 GHz #Res BW 1.0 MHz Stop 2.50000 GHz Sweep 18.0 ms (3001 pts) #VBW 1.0 kHz

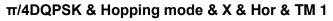
 $\pi$ /4DQPSK & Hopping mode & X & Hor & TM 1

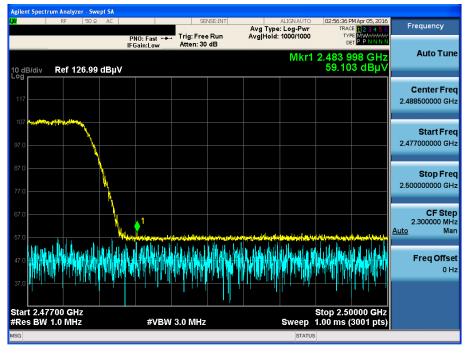


#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 1

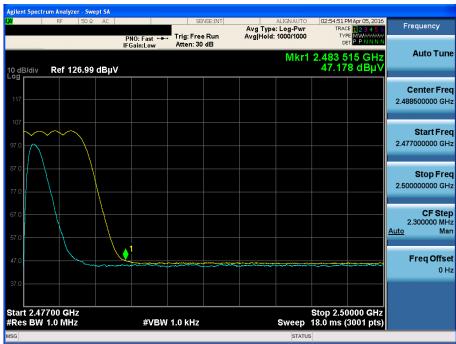






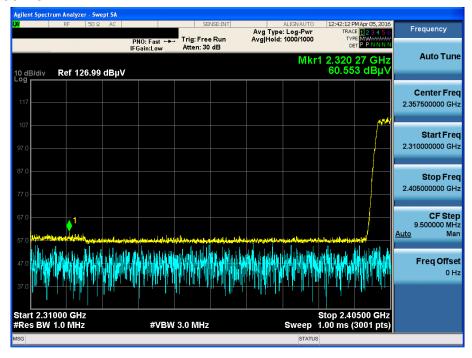


#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 1



### 8DPSK & Hopping mode & X & Hor & TM 1

**Detector Mode : PK** 



#### 8DPSK & Hopping mode & X & Hor & TM 1



### 8DPSK & Hopping mode & X & Hor & TM 1

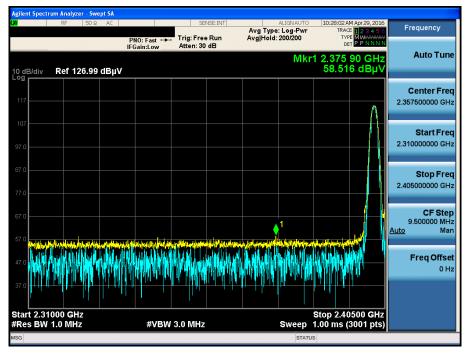


#### 8DPSK & Hopping mode & X & Hor & TM 1

#### Frequency TRACE Avg Type: Log-Pwr Avg|Hold: 1000/1000 PNO: Fast ↔→ IFGain:Low Trig: Free Run Atten: 30 dB DET P P N N Auto Tune Mkr1 2.483 531 GHz 47.100 dBµV 0 dB/div Ref 126.99 dBµV **Center Freq** 2.488500000 GHz Start Freq 2.477000000 GHz Stop Freq 2.50000000 GHz CF Step 2.300000 MHz Mar Auto ٠ Freq Offset 0 Hz Stop 2.50000 GHz Sweep 18.0 ms (3001 pts) Start 2.47700 GHz #Res BW 1.0 MHz #VBW 1.0 kHz



#### GFSK & Lowest & X & Hor & TM 2

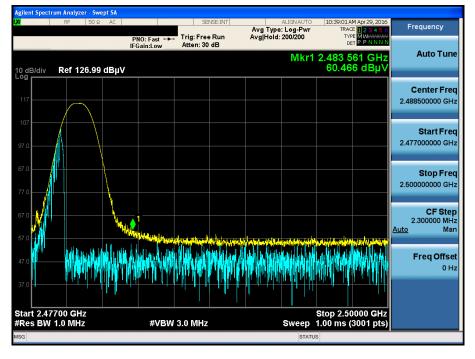


#### GFSK & Lowest & X & Hor & TM 2

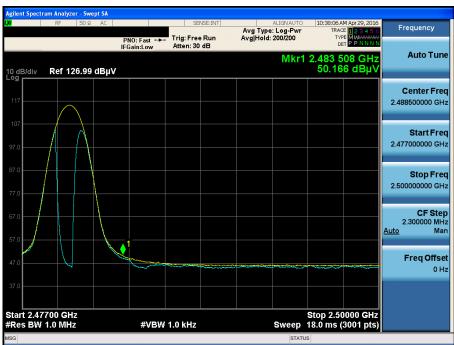
#### Frequency TYPE MWARAA DET P P N N N Avg Type: Log-Pwr Avg|Hold: 200/200 PNO: Fast ↔→ IFGain:Low Trig: Free Run Atten: 30 dB Auto Tune Mkr1 2.376 15 GHz 46.514 dBµ\ Ref 126.99 dBµV 10 dB/div **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz Stop Freq 2.405000000 GHz CF Step 9.500000 MHz Man <u>Auto</u> Freq Offset 0 Hz Start 2.31000 GHz #Res BW 1.0 MHz Stop 2.40500 GHz Sweep 74.2 ms (3001 pts) #VBW 1.0 kHz



GFSK & Highest & X & Hor & TM 2

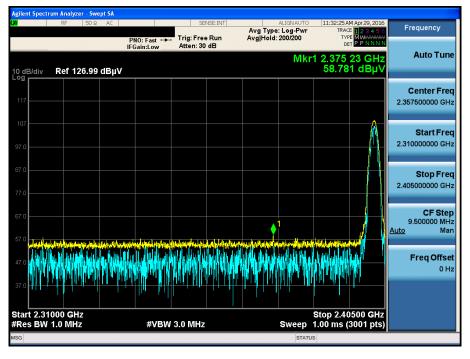


#### GFSK & Highest & X & Hor & TM 2





#### $\pi/4DQPSK$ & Lowest & X & Hor & TM 2



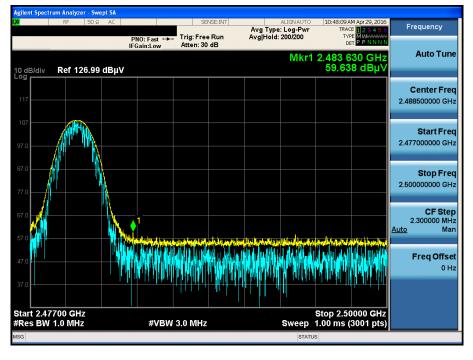
### Detector Mode : AV

#### $\pi$ /4DQPSK & Lowest & X & Hor & TM 2

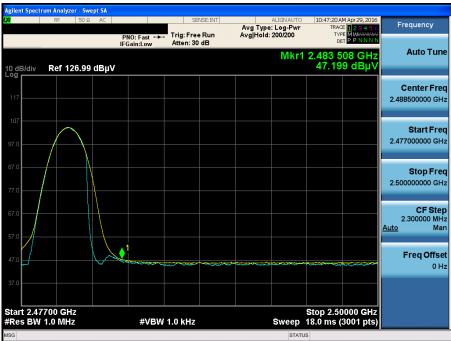
	RF 5	iOΩ AC		SE	NSE:INT		ALIGNAUTO	11:29:58 AM		Francisco
			PNO: Fast 🔸 IFGain:Low	Trig: Free Atten: 30		Avg Type Avg Hold:	: Log-Pwr 200/200	TYPE	123456 MWWWWW PPNNNN	Frequency
dB/div	Ref 126.	99 dBµV					Mkr	1 2.375 4 45.775	9 GHz dBµV	Auto Tun
17										<b>Center Fre</b> 2.357500000 GH
7.0										<b>Start Fre</b> 2.310000000 G⊦
										Stop Fre 2.405000000 G⊦
										CF Ste 9.500000 MH <u>Auto</u> Ma
.0	<del></del>	w	-				1	and the second	Д	Freq Offs 0 H
art 2.31	000 GHz							Stop 2.405	i00 GHz	



#### $\pi/4DQPSK$ & Highest & X & Hor & TM 2

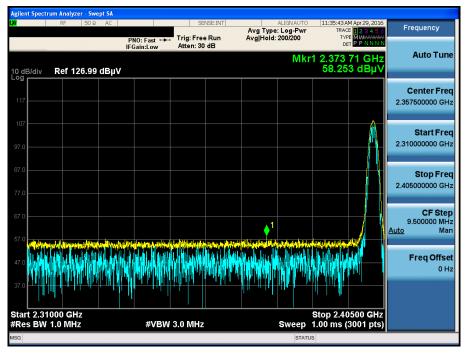


#### $\pi$ /4DQPSK & Highest & X & Hor & TM 2





#### 8DPSK & Lowest & X & Hor & TM 2

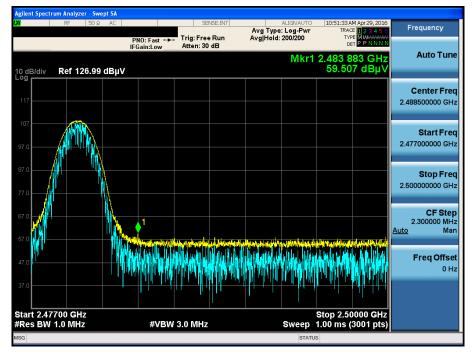


#### 8DPSK & Lowest & X & Hor & TM 2

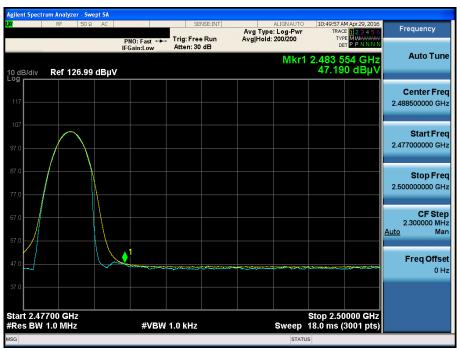
#### Frequency TRACE 12345 TYPE MWWWW DET PPNNN Avg Type: Log-Pwr Avg|Hold: 200/200 PNO: Fast ↔→ IFGain:Low Trig: Free Run Atten: 30 dB Auto Tune Mkr1 2.375 80 GHz 45.970 dBµ\ Ref 126.99 dBµV 10 dB/div **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz Stop Freq 2.405000000 GHz CF Step 9.500000 MHz Man <u>Auto</u> Freq Offset 0 Hz Start 2.31000 GHz #Res BW 1.0 MHz Stop 2.40500 GHz Sweep 74.2 ms (3001 pts) #VBW 1.0 kHz



8DPSK & Highest & X & Hor & TM 2

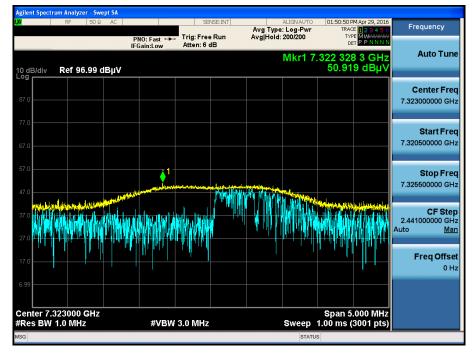


#### 8DPSK & Highest & X & Hor & TM 2





#### GFSK & Middle & X & Hor & TM 2

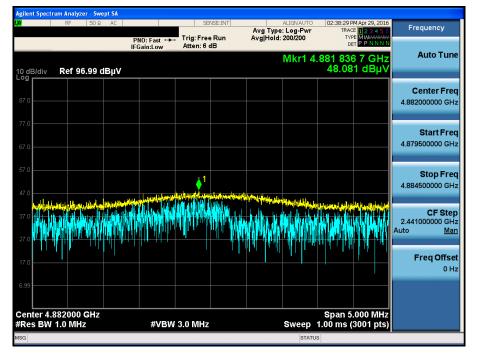


#### GFSK & Middle & X & Hor & TM 2

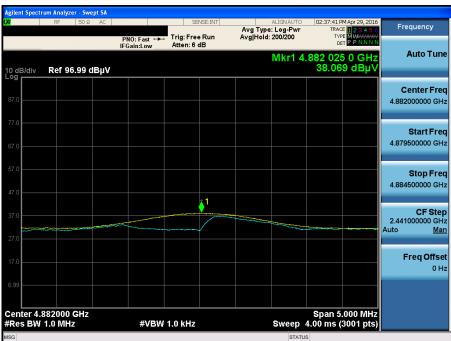
#### eilent Spectrum Analyzer - Swept SA Frequency PNO: Fast ↔ IFGain:Low Avg Type: Log-Pwr Avg|Hold: 200/200 TRACE 12345 TYPE MWAMA DET PPNNN Trig: Free Run Atten: 6 dB Auto Tune Mkr1 7. 323 116 7 GH 45.166 dBµ\ 10 dB/div Ref 96.99 dBµV **Center Freq** 7.323000000 GHz Start Freq 7.320500000 GHz Stop Freq 7.325500000 GHz 1 CF Step 2.441000000 GHz Auto Man Freq Offset 0 Hz Center 7.323000 GHz #Res BW 1.0 MHz Span 5.000 MHz Sweep 4.00 ms (3001 pts) #VBW 1.0 kHz



 $\pi/4DQPSK$  & Middle & X & Hor & TM 2

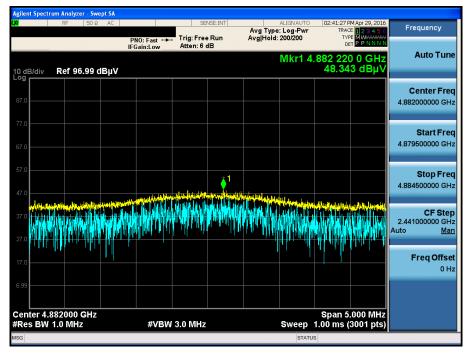


#### $\pi$ /4DQPSK & Middle & X & Hor & TM 2





#### 8DPSK & Middle & X & Hor & TM 2



#### 8DPSK & Middle & X & Hor & TM 2

	RF 50	ΩAC			ISE:INT		ALIGNAUTO	02:40:43 PM Apr 29, 201 TRACE 1 2 3 4 5	Frequency
			PNO: Fast ++ IFGain:Low	Trig: Free Atten: 6 d		Avg Hold:		TYPE MWAAAAA DET PPNNN	
dB/div	Ref 96.99	dBµV					Mkr1 4.	882 016 7 GH 38.016 dBµ\	Auto Tu
9									Center Fr
7.0									4.882000000 G
									-
									Start Fr 4.879500000 G
7.0									4.879500000 G
									Stop Fr
									4.884500000 G
					1				
									CF St 2.441000000 G
7.0									Auto <u>N</u>
7.0									Freq Offs 0
99									
enter 4.	882000 GH	 Z						Span 5.000 MH	

PNO: Fast +++ Trig: Free Run IFGain:Low Atten: 30 dB Avg Type: Log-Pwr Avg|Hold: 1000/1000

Mkr1

# GFSK & Hopping mode & X & Hor & TM 2 Agilent Spectrum Analyzer - Swept SA

Ref 126.99 dBµV

Bidis

### 57.0 47.0 37.0 Start 2.31000 GHz #Res BW 1.0 MHz MSG

#### GFSK & Hopping mode & X & Hor & TM 2



TRF-RF-237(02)160407

Frequency

Auto Tune

Center Freq 2.357500000 GHz

Start Freq 2.31000000 GHz

Stop Freq 2.40500000 GHz

> CF Step 9.500000 MHz Man

Freq Offset

**Detector Mode : AV** 

<u>Auto</u>

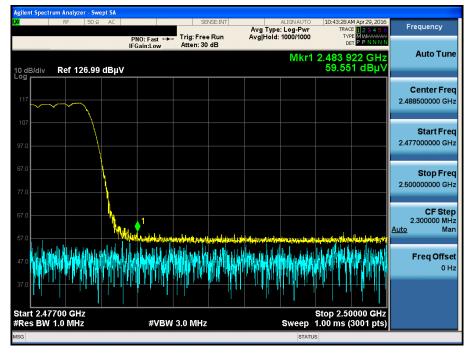
DET PPN

2.322 26 GH: 59.631 dBµ

Stop 2.40500 GHz Sweep 1.00 ms (3001 pts)



GFSK & Hopping mode & X & Hor & TM 2

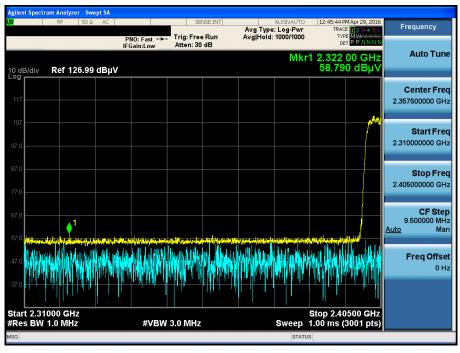


#### GFSK & Hopping mode & X & Hor & TM 2

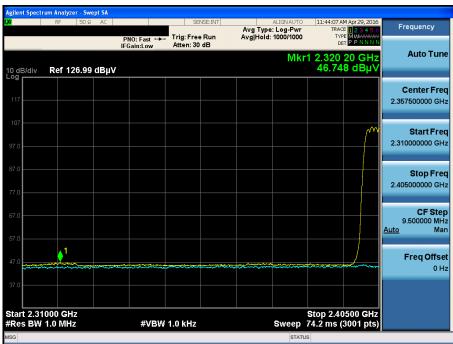
#### - Swent SA nt Spectrum Analy Frequency PNO: Fast Avg Type: Log-Pwr Avg|Hold: 1000/1000 TYPE MWARAAA DET P P N N N Trig: Free Run Atten: 30 dB Auto Tune Mkr1 2.483 937 GH2 50.003 dBµ\ Ref 126.99 dBµV 10 dB/div Log **Center Freq** 2.488500000 GHz Start Freq 2.477000000 GHz Stop Freq 2.500000000 GHz CF Step 2.300000 MHz Auto Ma Freq Offset 0 Hz Start 2.47700 GHz #Res BW 1.0 MHz Stop 2.50000 GHz 18.0 ms (3001 pts) #VBW 1.0 kHz Sweep



#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 2

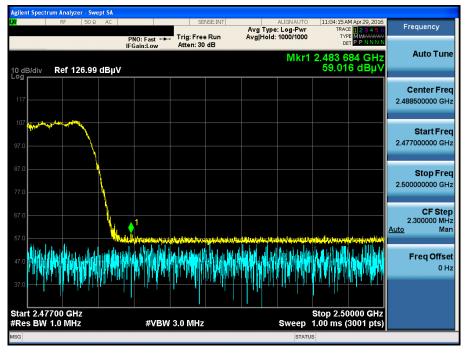


#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 2





#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 2

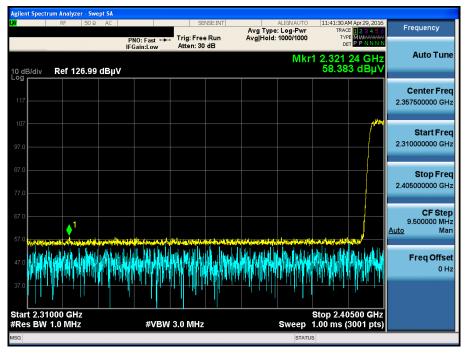


#### $\pi/4DQPSK$ & Hopping mode & X & Hor & TM 2

#### nt Spectrum Analyzer - Swept SA Frequency PNO: Fast Avg Type: Log-Pwr Avg|Hold: 1000/1000 TYPE MWATAA DET P P N N N Trig: Free Run Atten: 30 dB Auto Tune Mkr1 2.483 523 GHz 46.747 dBµ\ Ref 126.99 dBµV 10 dB/div Log **Center Freq** 2.488500000 GHz Start Freq 2.477000000 GHz Stop Freq 2.500000000 GHz CF Step 2.300000 MHz Auto Mai ١ Freq Offset 0 Hz Start 2.47700 GHz #Res BW 1.0 MHz Stop 2.50000 GHz Sweep 18.0 ms (3001 pts) #VBW 1.0 kHz



#### 8DPSK & Hopping mode & X & Hor & TM 2

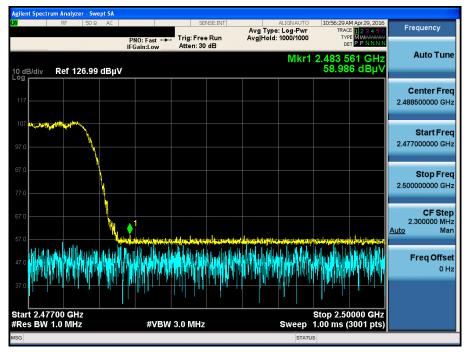


#### 8DPSK & Hopping mode & X & Hor & TM 2

#### Frequency TYPE MWARAA DET P P NNN Avg Type: Log-Pwr Avg|Hold: 1000/1000 PNO: Fast +++ Trig: Free Run IFGain:Low Atten: 30 dB Auto Tune Mkr1 2.320 80 GHz 46.706 dBµ\ 10 dB/div Ref 126.99 dBµV **Center Freq** 2.357500000 GHz Start Freq 2.310000000 GHz Stop Freq 2.405000000 GHz CF Step 9.500000 MHz Man <u>Auto</u> **≜**<sup>1</sup> Freq Offset 0 Hz Start 2.31000 GHz #Res BW 1.0 MHz Stop 2.40500 GHz Sweep 74.2 ms (3001 pts) #VBW 1.0 kHz



#### 8DPSK & Hopping mode & X & Hor & TM 2



#### 8DPSK & Hopping mode & X & Hor & TM 2

