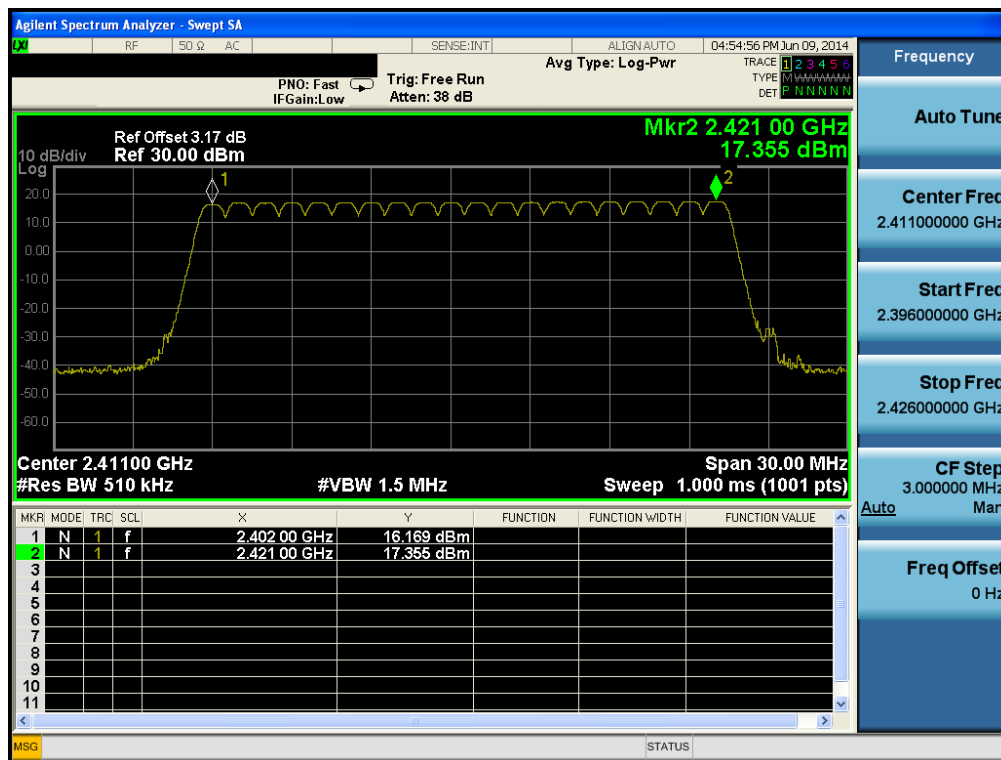


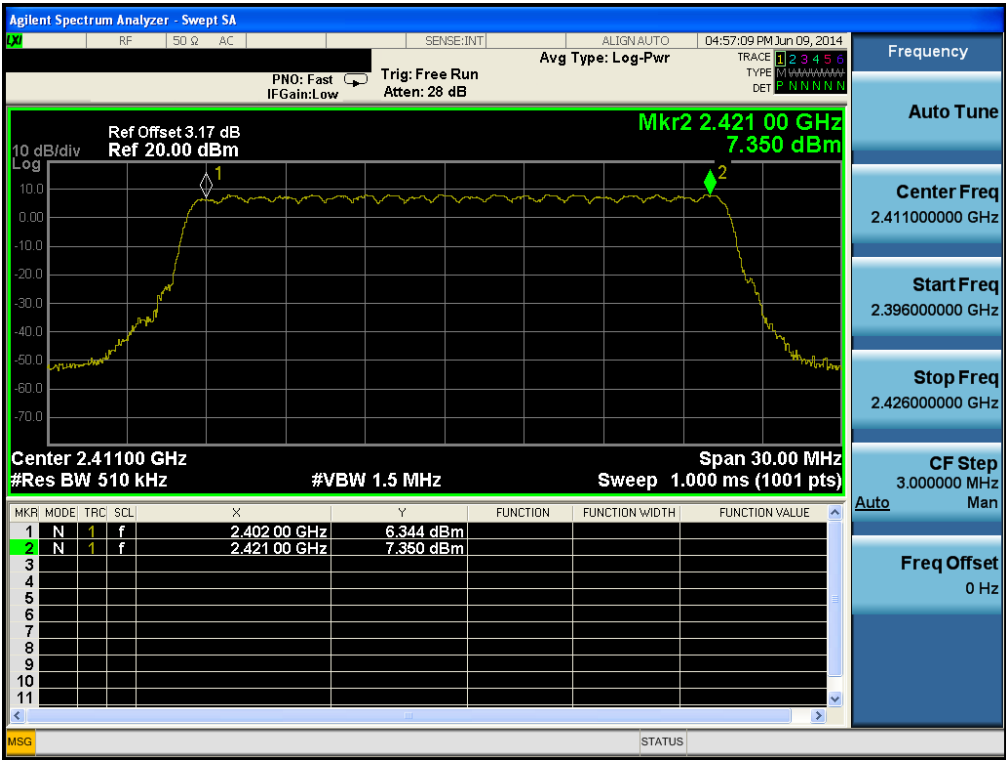
Number of Hopping Frequencies 1(AFH) *Hopping mode: Enable & GFSK Module 1*



Number of Hopping Frequencies 1(AFH) *Hopping mode: Enable & $\pi/4$ -DQPSK Module 1*



Number of Hopping Frequencies 1(AFH) Hopping mode: Enable & 8DPSK Module 1



5. 20dBc BW

5.1. Test Setup

Refer to the APPENDIX I.

5.2. Limit

Limit: Not Applicable

5.3. Test Procedure

1. The 20dBc bandwidth were measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using $RBW \geq 1\%$ of the 20 dB bandwidth, $VBW \geq RBW$, Span = 3MHz.

5.4. Test Results

Ambient temperature : 26 °C
Relative humidity : 47 %

Modulation	Tested Channel	20dBc BW (MHz)	
		Module 1	Module 2
<u>GFSK</u>	Lowest	0.948	0.939
	Middle	0.942	0.918
	Highest	0.936	0.945
<u>$\pi/4$DQPSK</u>	Lowest	1.233	1.269
	Middle	1.272	1.263
	Highest	1.260	1.269
<u>8DPSK</u>	Lowest	1.257	1.266
	Middle	1.257	1.266
	Highest	1.269	1.248

Note 1: See next pages for actual measured spectrum plots.

20dBc Bandwidth

Lowest Channel & Modulation: GFSK Module 1



20dBc Bandwidth

Middle Channel & Modulation: GFSK Module 1



20dBc Bandwidth

Highest Channel & Modulation: GFSK Module 1



20dBc Bandwidth

Lowest Channel & Modulation: $\pi/4$ DQPSK Module 1



20dBc Bandwidth

Middle Channel & Modulation: $\pi/4$ DQPSK Module 1



20dBc Bandwidth

Highest Channel & Modulation: $\pi/4$ DQPSK Module 1



20dBc Bandwidth

Lowest Channel & Modulation: 8DPSK Module 1

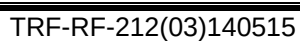


20dBc Bandwidth

Middle Channel & Modulation: 8DPSK Module 1



Highest Channel & Modulation: 8DPSK Module 1



20dBc Bandwidth

Lowest Channel & Modulation: GFSK Module 2



20dBc Bandwidth

Middle Channel & Modulation: GFSK Module 2



20dBc Bandwidth

Highest Channel & Modulation: GFSK Module 2



20dBc Bandwidth

Lowest Channel & Modulation: $\pi/4$ DQPSK Module 2



Middle Channel & Modulation: $\pi/4$ DQPSK Module 2

Highest Channel & Modulation: $\pi/4$ DQPSK Module 2

20dBc Bandwidth

Lowest Channel & Modulation: 8DPSK Module 2



20dBc Bandwidth

Middle Channel & Modulation: 8DPSK Module 2



20dBc Bandwidth

Highest Channel & Modulation: 8DPSK Module 2



6. Time of Occupancy (Dwell Time)

6.1. Test Setup

Refer to the APPENDIX I.

6.2. Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

6.3. Test Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

Center frequency = 2441 MHz

RBW = 1 MHz

Trace = max hold

Span = zero

VBW = $\geq$ RBW

Detector function = peak

6.4. Test Results

Ambient temperature : 26 °C
Relative humidity : 47 %

- Module 1 & Module 2 - FH mode

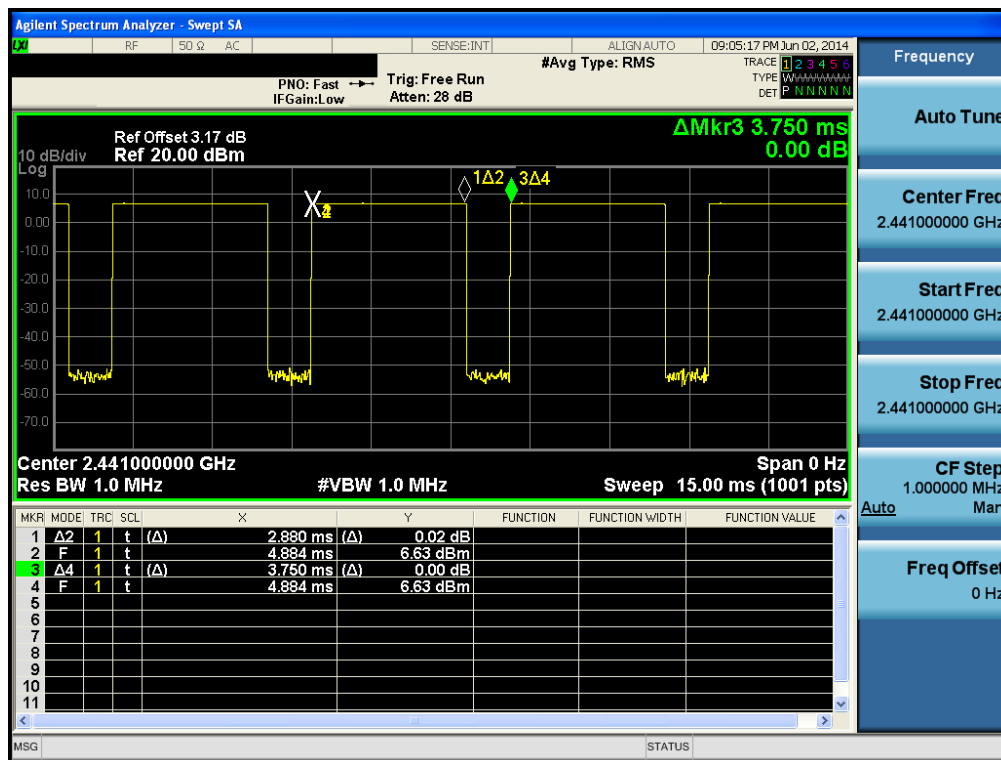
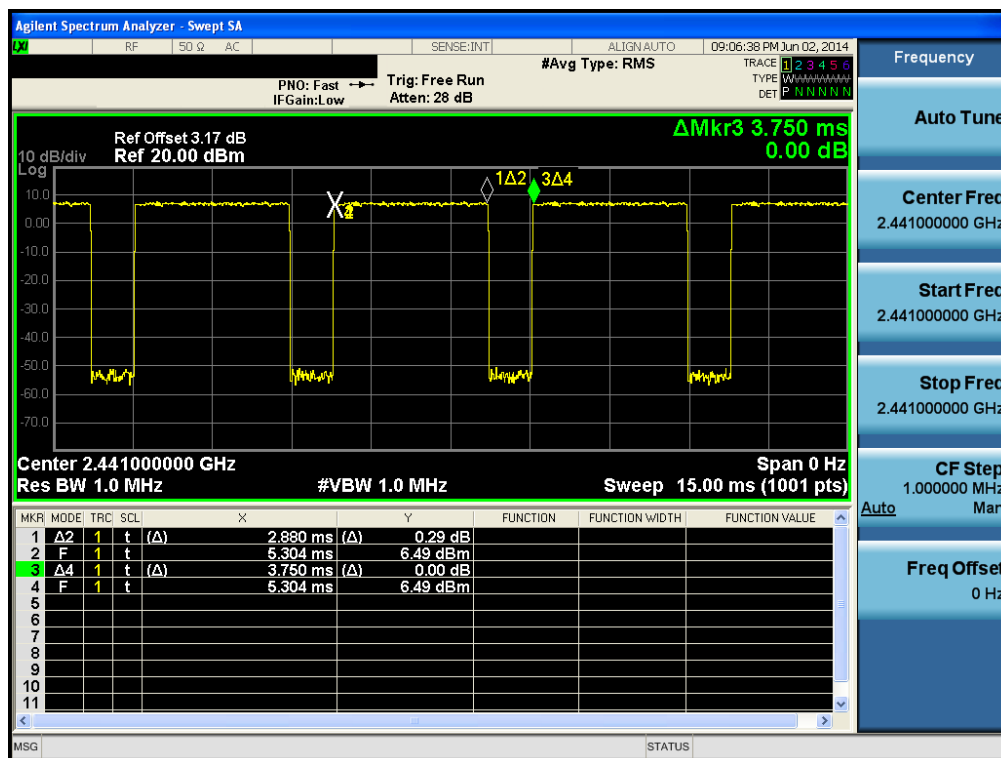
Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	79	2.880	3.750	0.307
	2 DH 5	79	2.880	3.750	0.307
	3 DH 5	79	2.880	3.750	0.307

- AFH mode

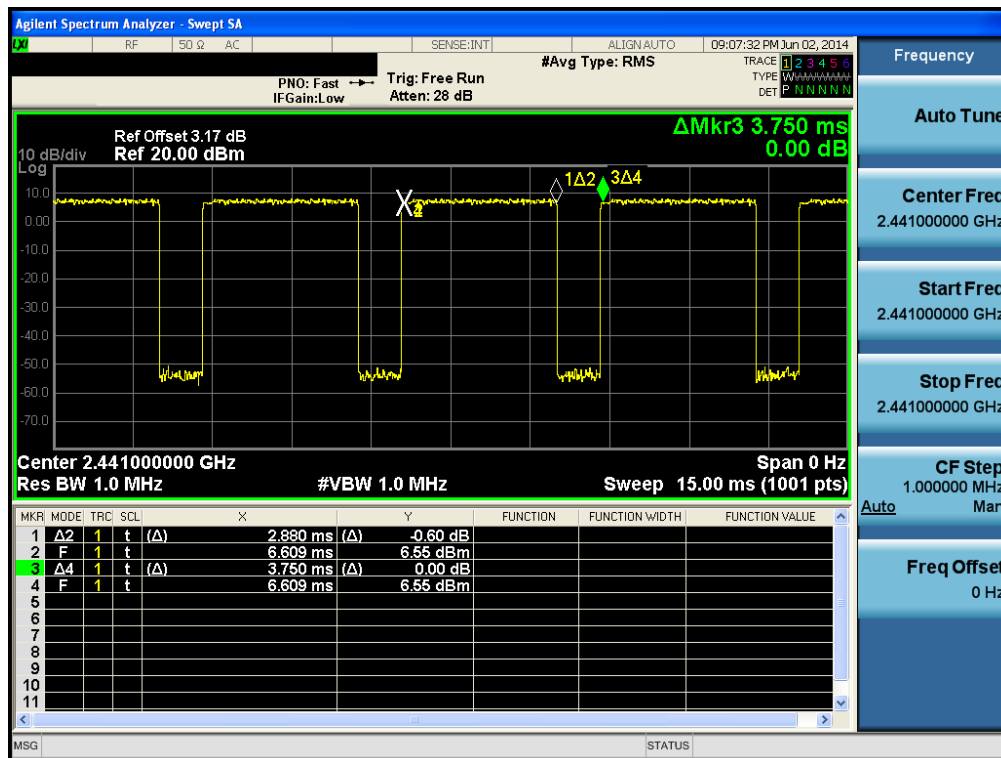
Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	20	2.880	3.750	0.154
	2 DH 5	20	2.880	3.750	0.154
	3 DH 5	20	2.880	3.750	0.154

Note 1: Dwell Time = $0.4 \times \text{Hopping channel} \times \text{Burst ON time} \times ((\text{Hopping rate} \div \text{Time slots}) \div \text{Hopping channel})$
 - Time slots for DH5 = 6 slots(TX = 5 slot / RX = 1 slot)
 - Hopping Rate = 1600 for FH mode & 800 for AFH mode

Note 2: See next pages for actual measured spectrum plots.

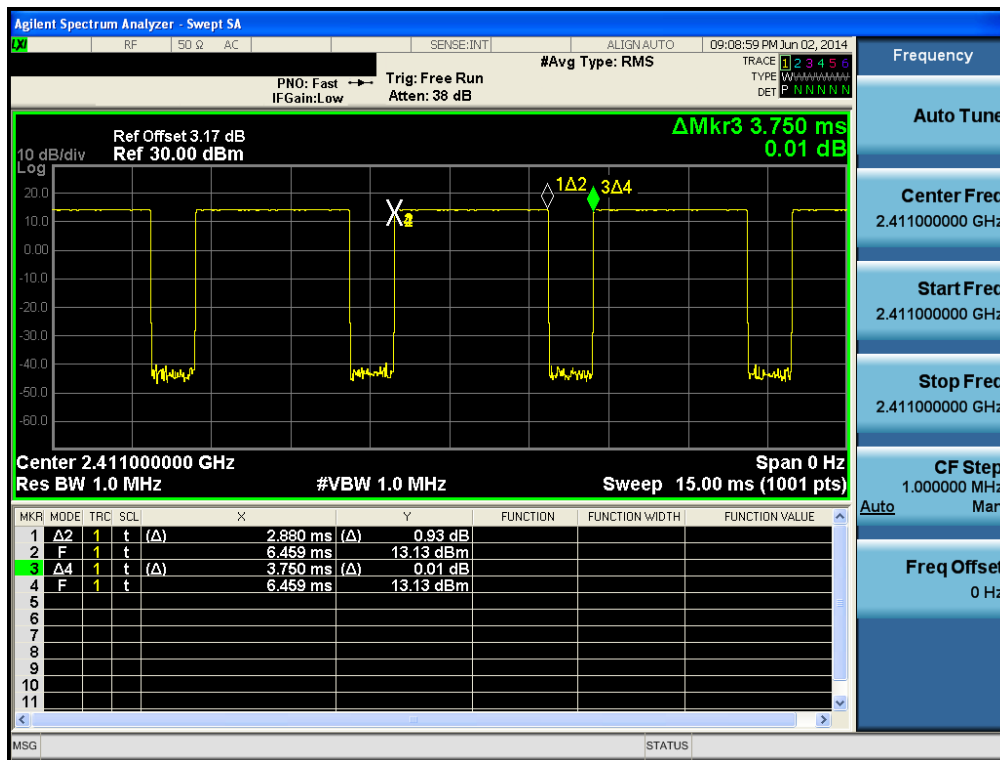
Time of Occupancy (FH)***Hopping mode: Enable & GFSK Module 1*****Time of Occupancy (FH)*****Hopping mode: Enable & $\pi/4$ -DQPSK Module 1***

Hopping mode: Enable & 8DPSK Module 1



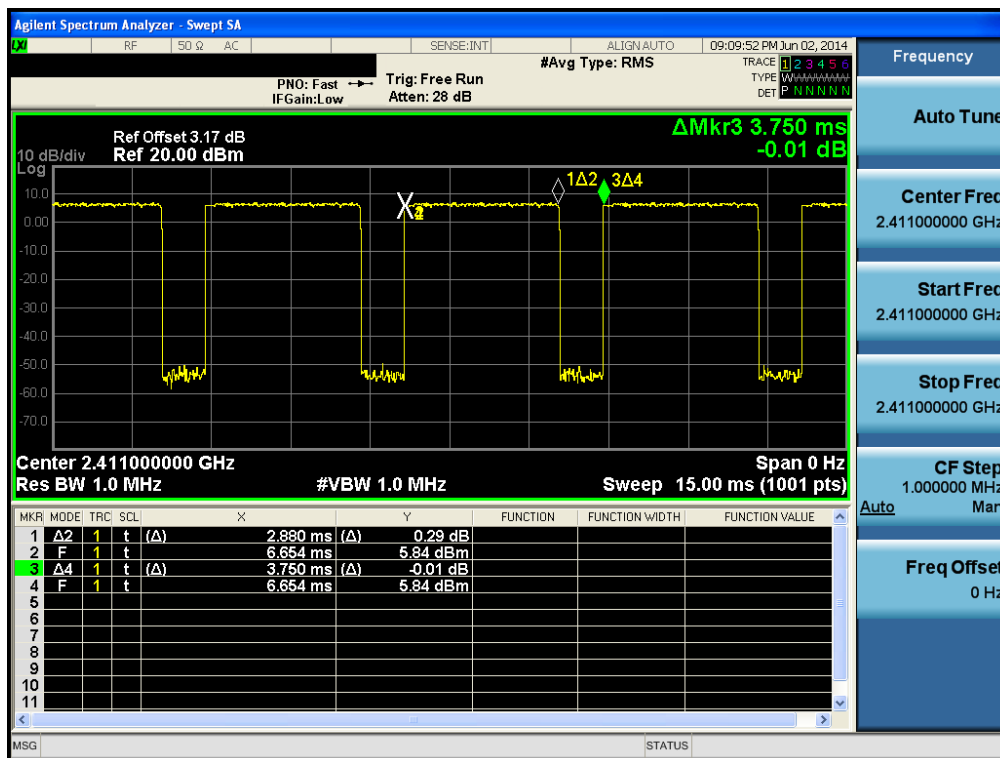
Time of Occupancy (AFH)

Hopping mode: Enable & GFSK Module 1



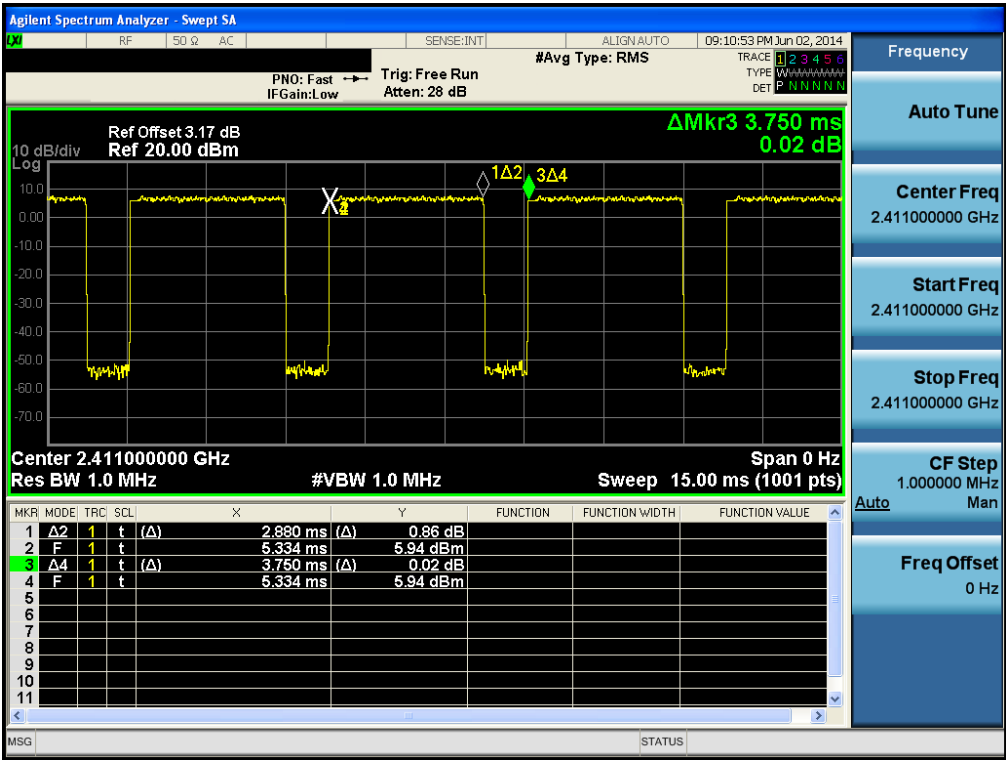
Time of Occupancy (AFH)

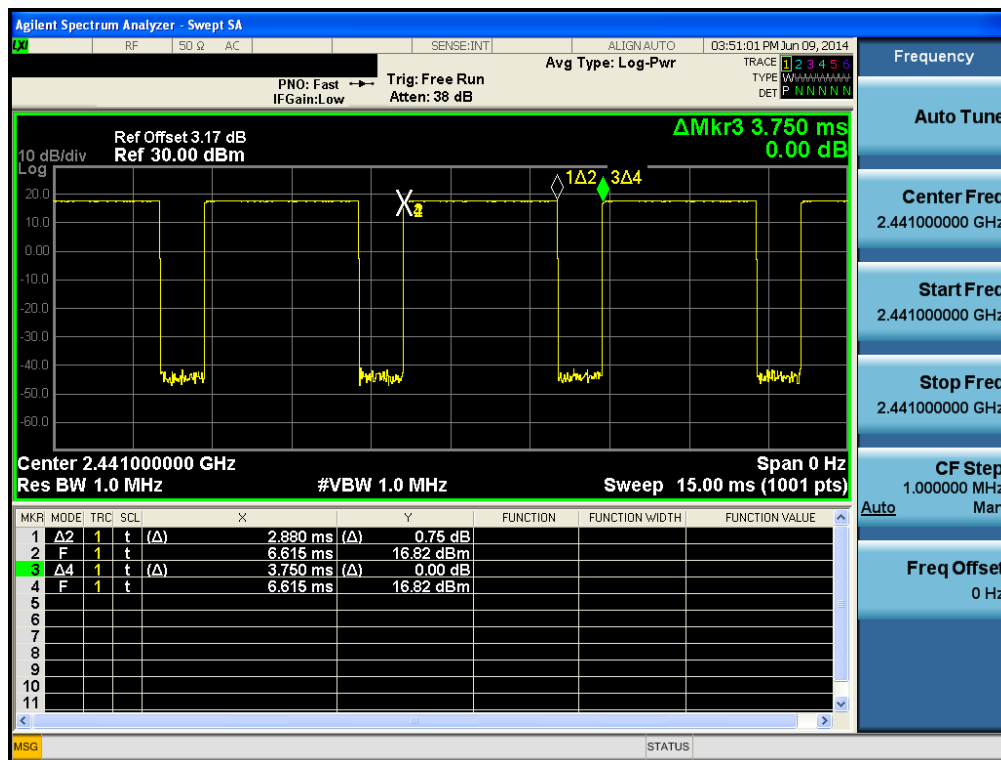
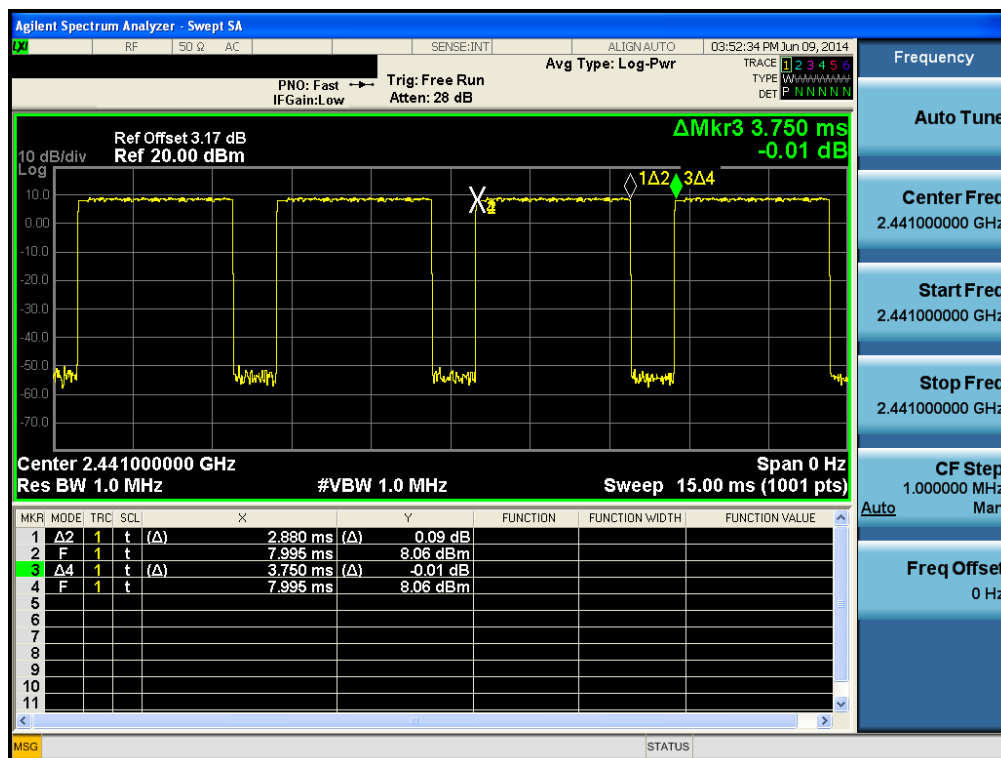
Hopping mode: Enable & π/4-DQPSK Module 1

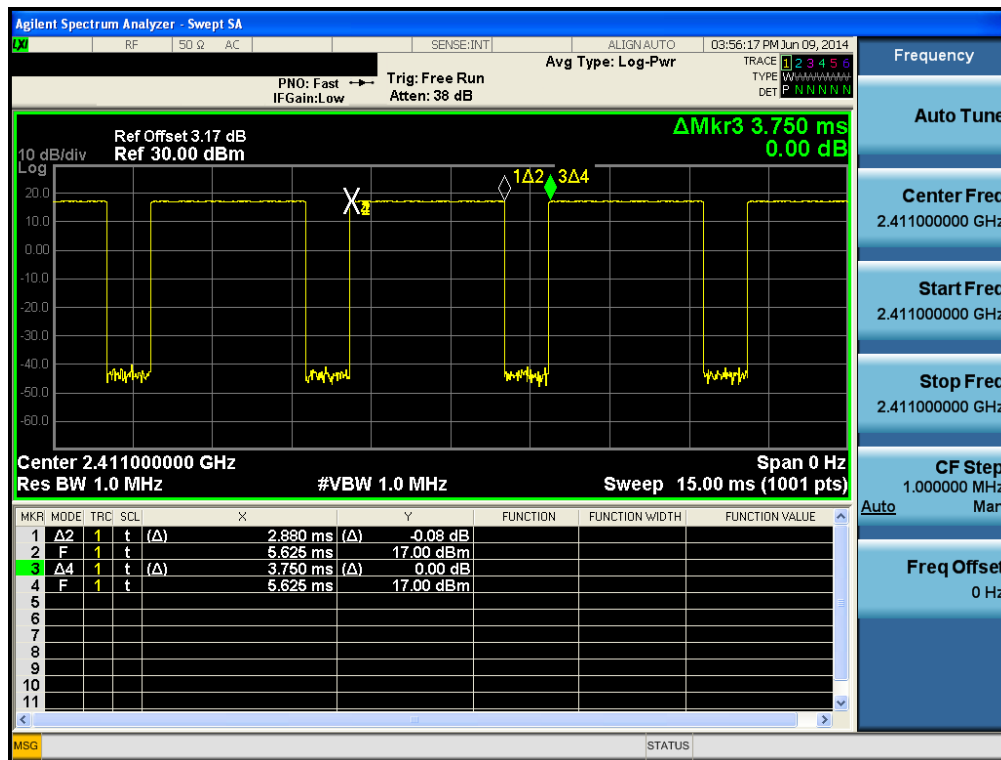
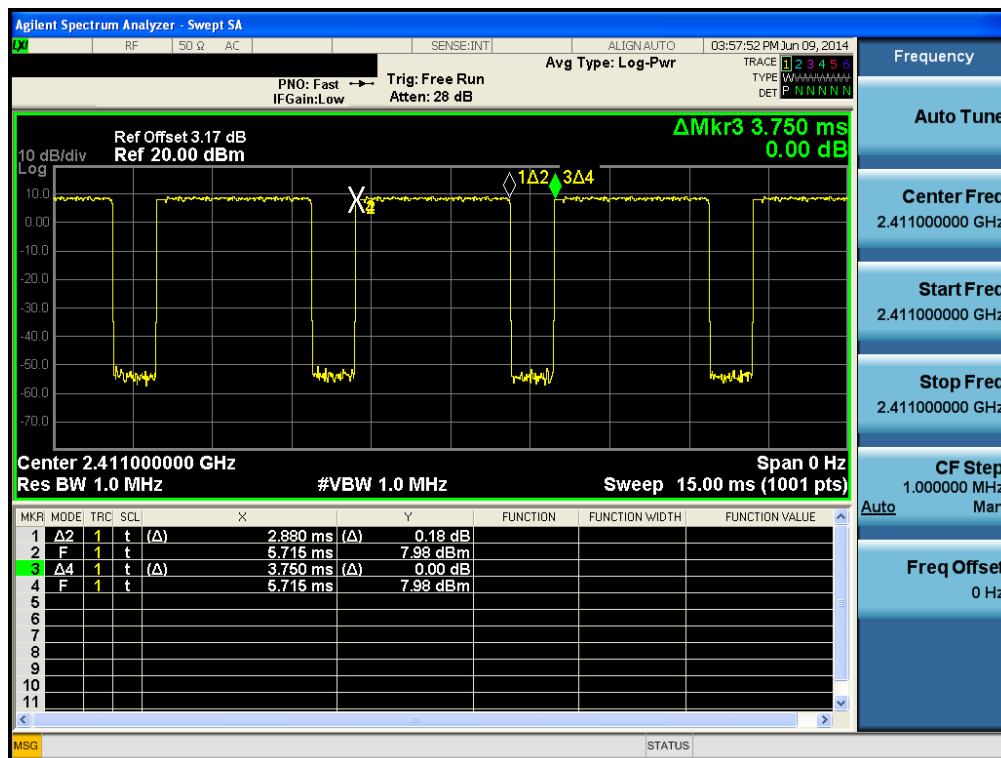


Time of Occupancy (AFH)

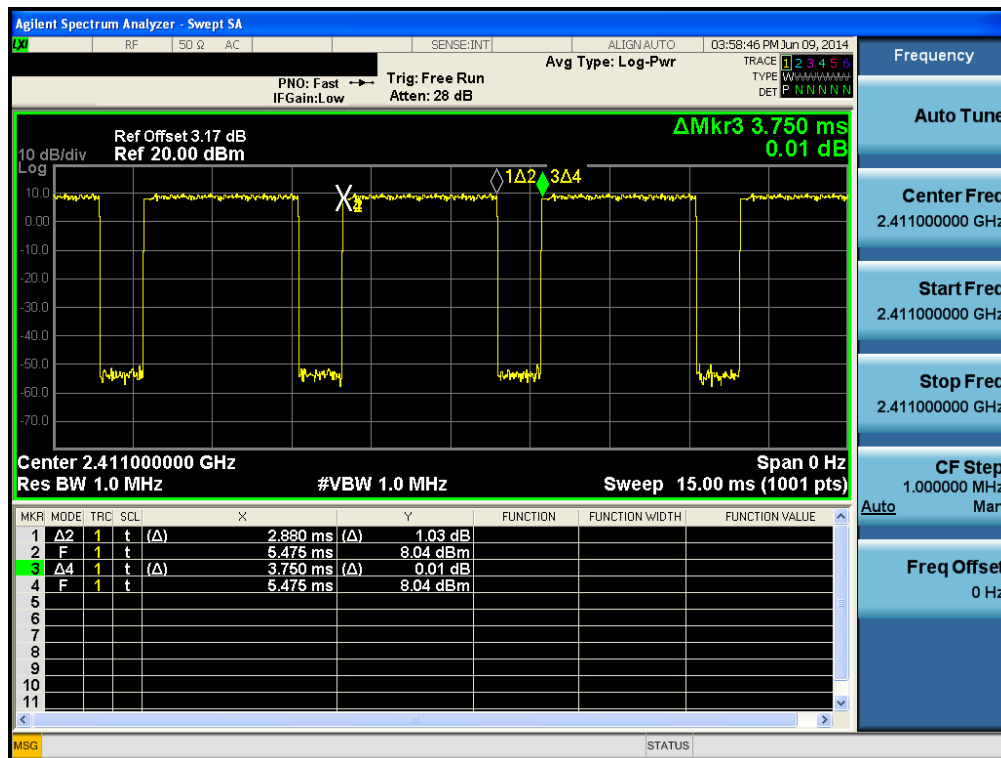
Hopping mode: Enable & 8DPSK Module 1



Time of Occupancy (FH)***Hopping mode: Enable & GFSK Module 2*****Time of Occupancy (FH)*****Hopping mode: Enable & π/4-DQPSK Module 2***

Time of Occupancy (AFH)***Hopping mode: Enable & GFSK Module 2*****Time of Occupancy (AFH)*****Hopping mode: Enable & $\pi/4$ -DQPSK Module 2***

Hopping mode: Enable & 8DPSK Module 2



7. Maximum Peak Output Power Measurement

7.1. Test Setup

Refer to the APPENDIX I.

7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band: 1 Watt.

7.3. Test Procedure

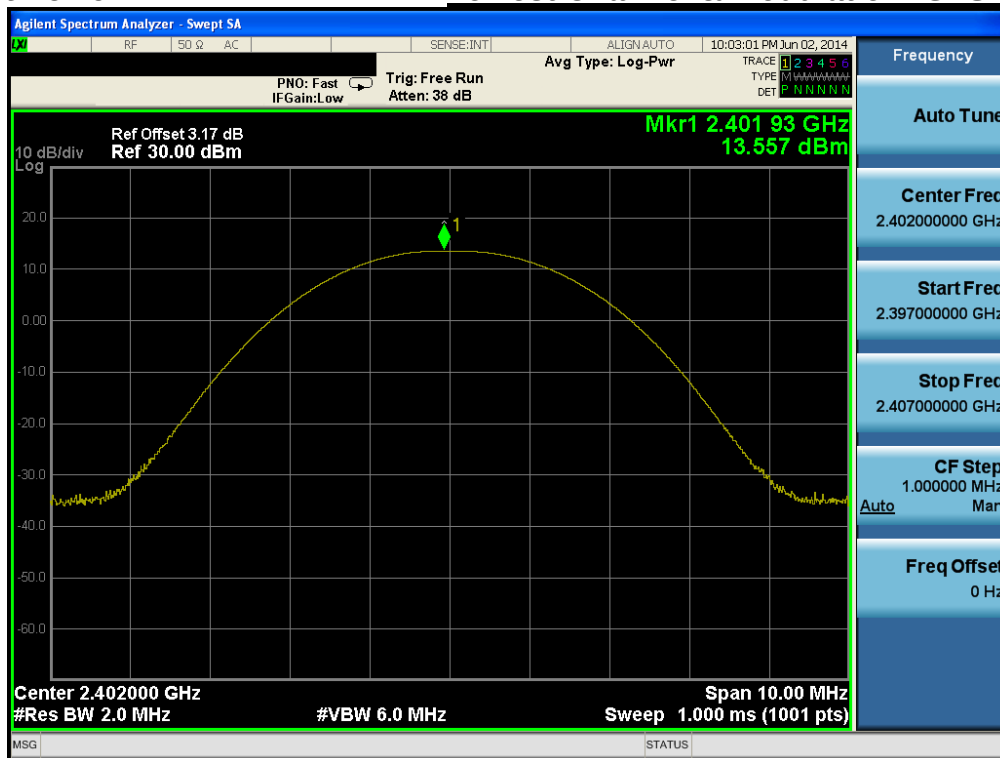
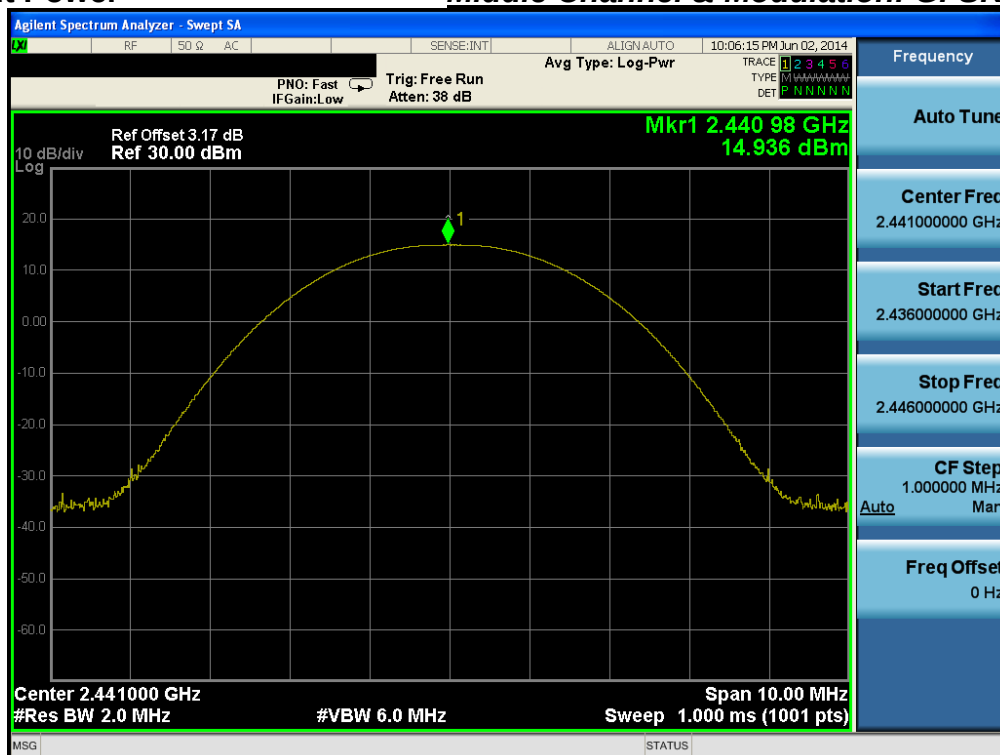
1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;
Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel
RBW $\geq$ 20dB BW
VBW $\geq$ RBW
Sweep = auto
Detector function = peak
Trace = max hold

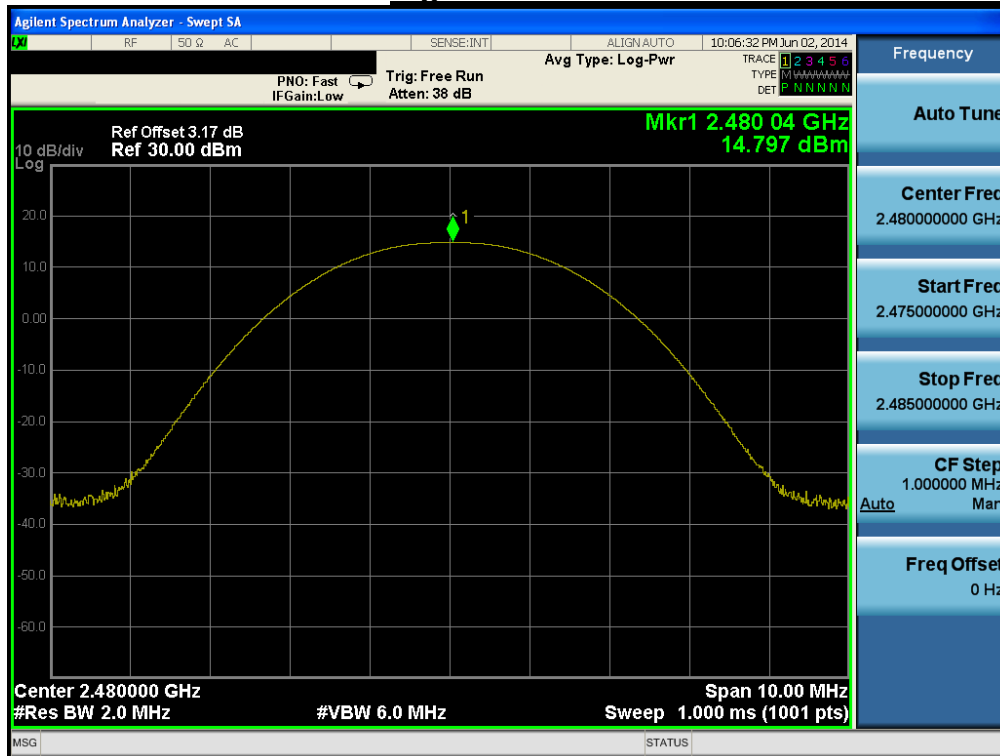
7.4. Test Results

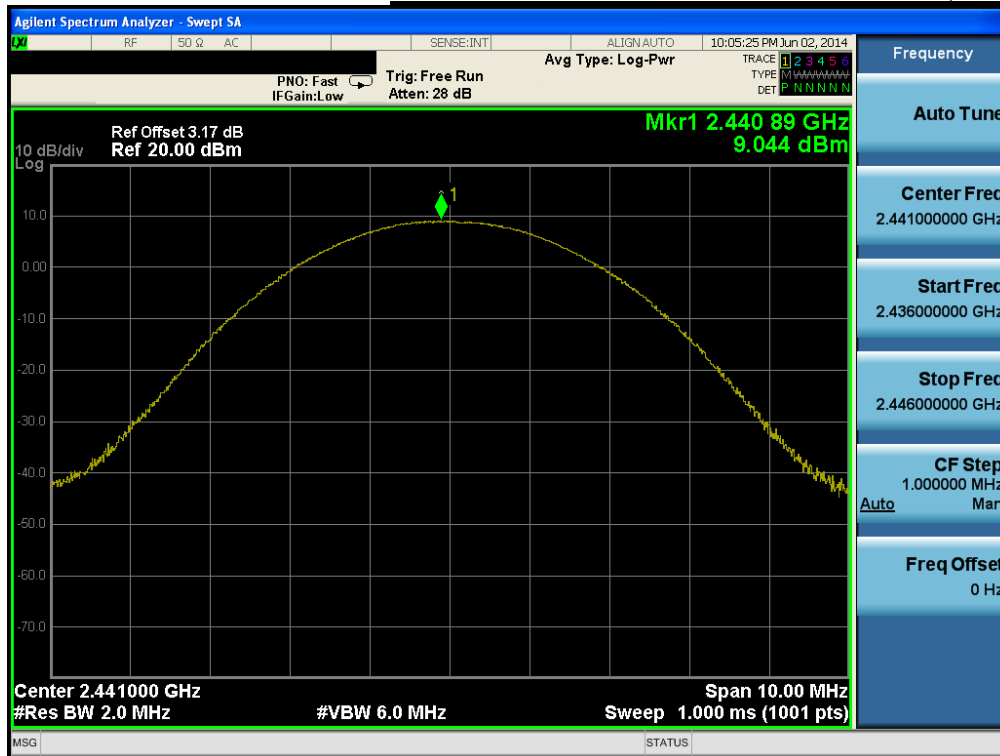
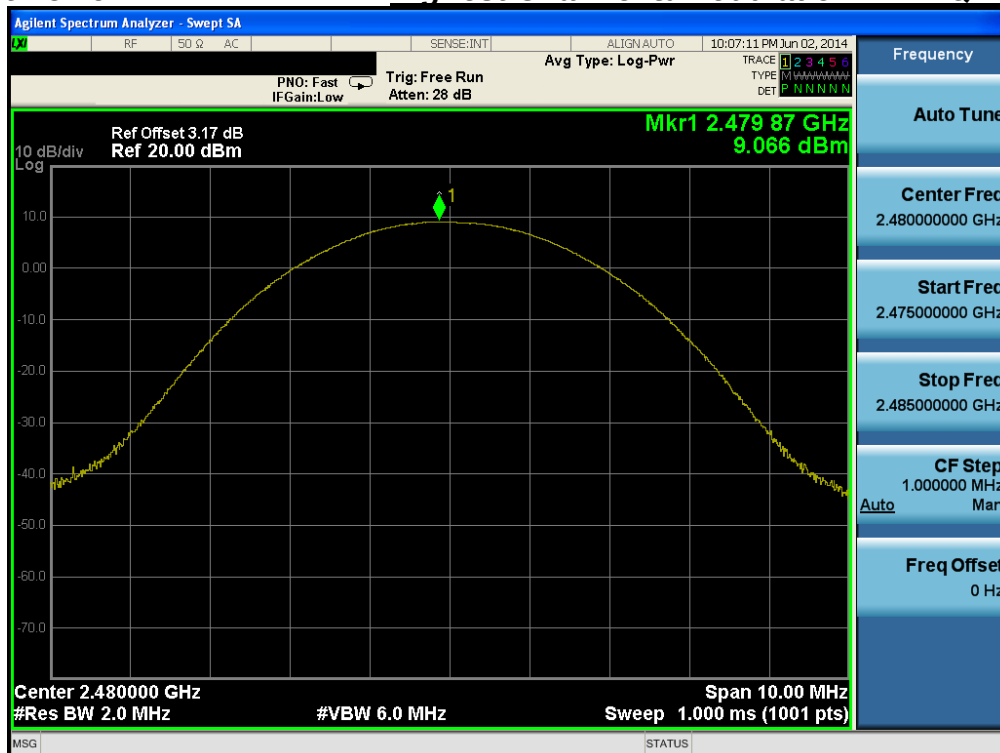
Ambient temperature : 26 °C
Relative humidity : 47 %

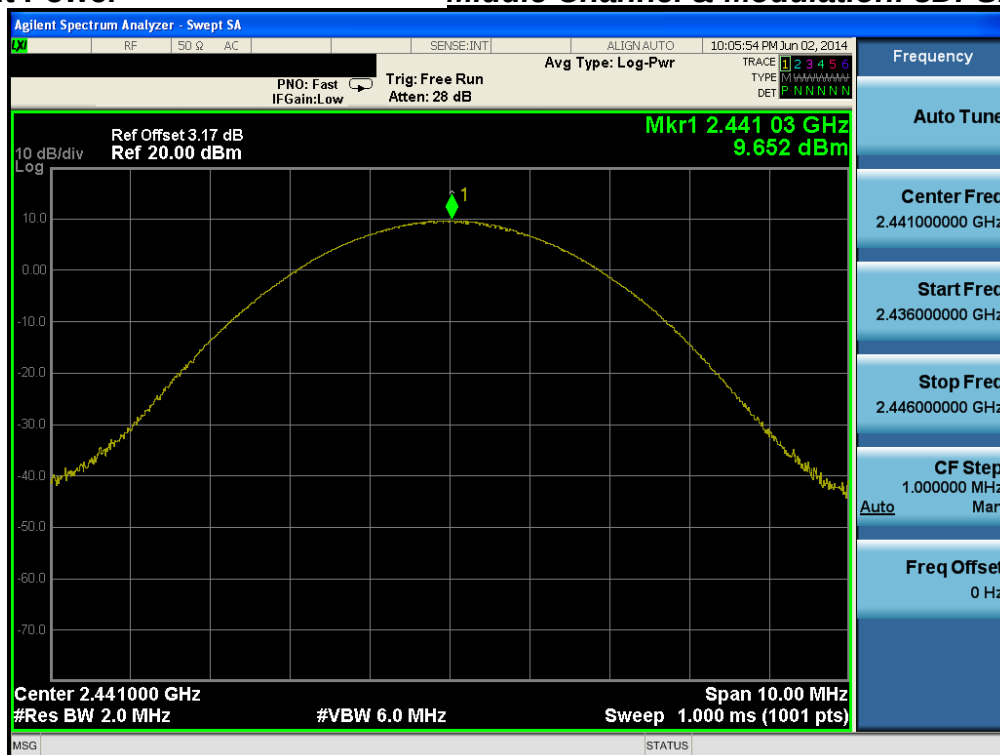
Modulation	Tested Channel	Peak Output Power			
		Module 1		Module 2	
		dBm	mW	dBm	mW
<u>GFSK</u>	Lowest	13.56	22.683	16.032	40.105
	Middle	14.94	31.160	17.508	56.338
	Highest	14.80	30.179	18.124	64.923
<u>$\pi/4$DQPSK</u>	Lowest	6.96	4.966	9.165	8.251
	Middle	9.04	8.024	9.614	9.150
	Highest	9.07	8.065	10.024	10.055
<u>8DPSK</u>	Lowest	7.52	5.644	8.980	7.907
	Middle	9.65	9.230	10.313	10.747
	Highest	9.62	9.162	10.605	11.495

Note 1: See next pages for actual measured spectrum plots.

Peak Output Power***Lowest Channel & Modulation: GFSK Module 1*****Peak Output Power*****Middle Channel & Modulation: GFSK Module 1***

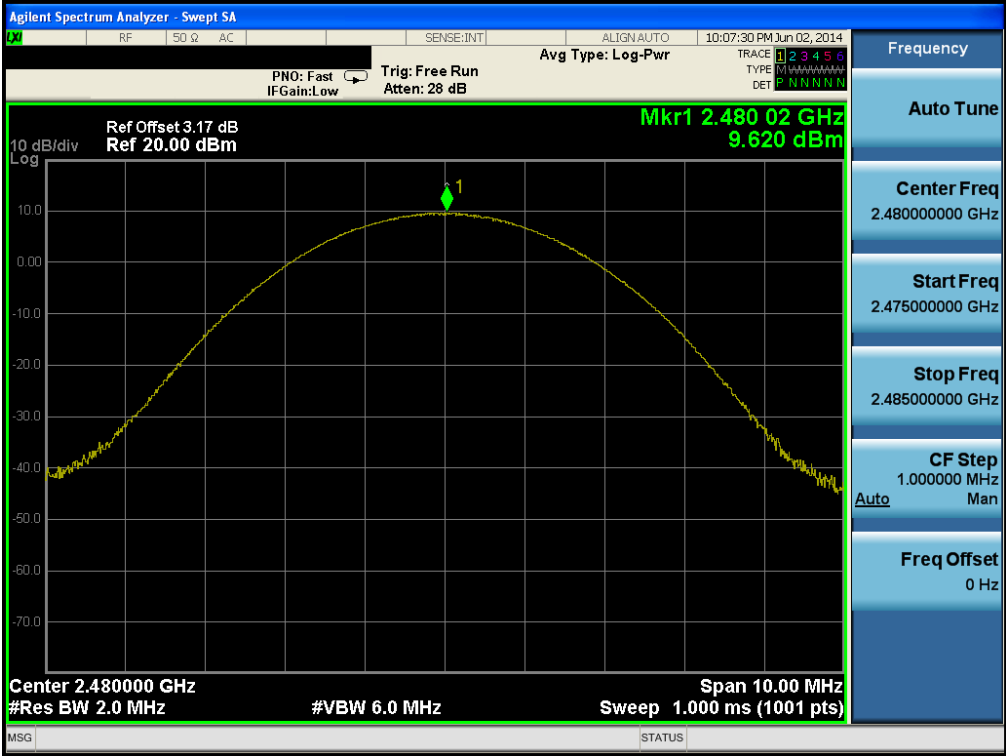
Peak Output Power***Highest Channel & Modulation: GFSK Module 1*****Peak Output Power*****Lowest Channel & Modulation: $\pi/4$ DQPSK Module 1***

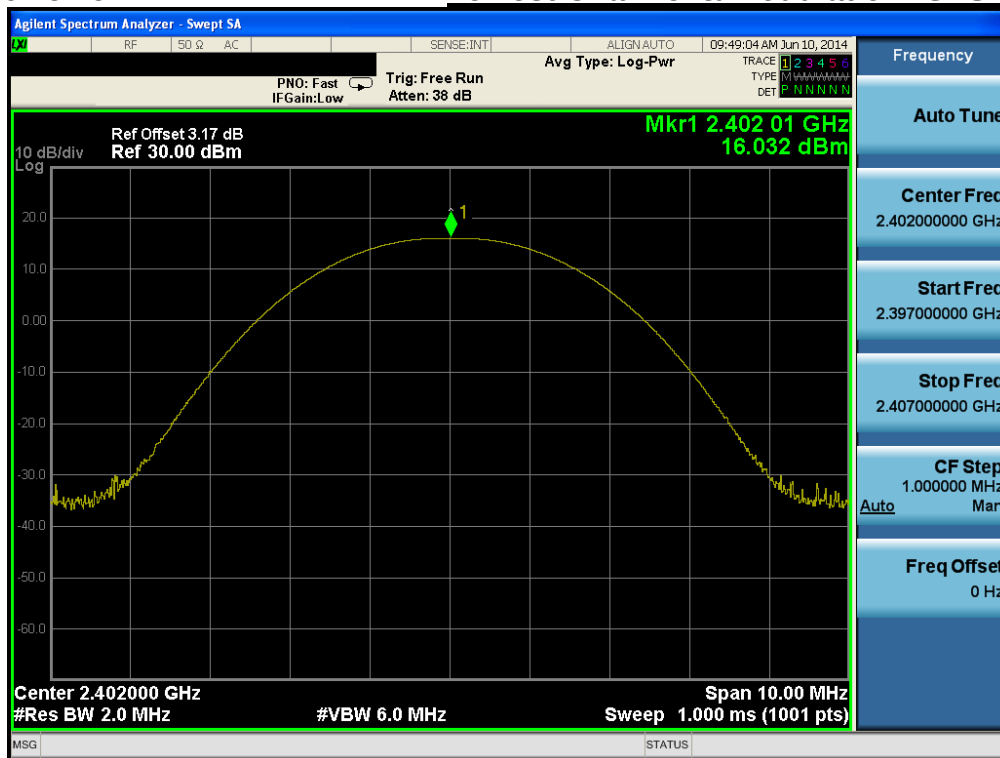
Peak Output Power***Middle Channel & Modulation: $\pi/4$ DQPSK Module 1*****Peak Output Power*****Highest Channel & Modulation: $\pi/4$ DQPSK Module 1***

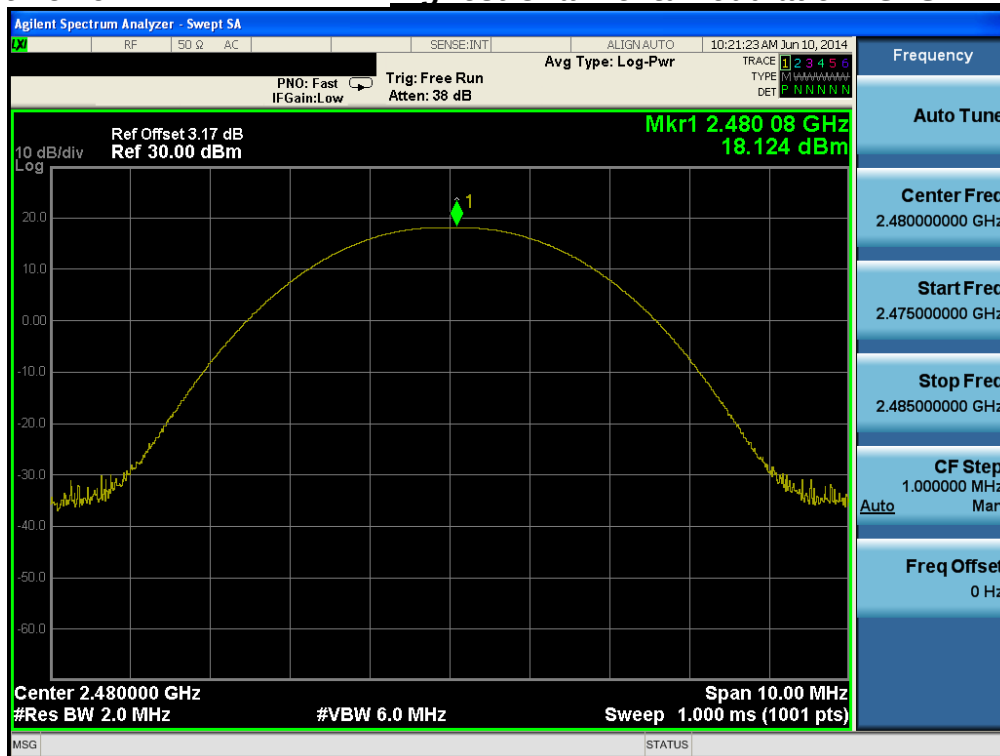
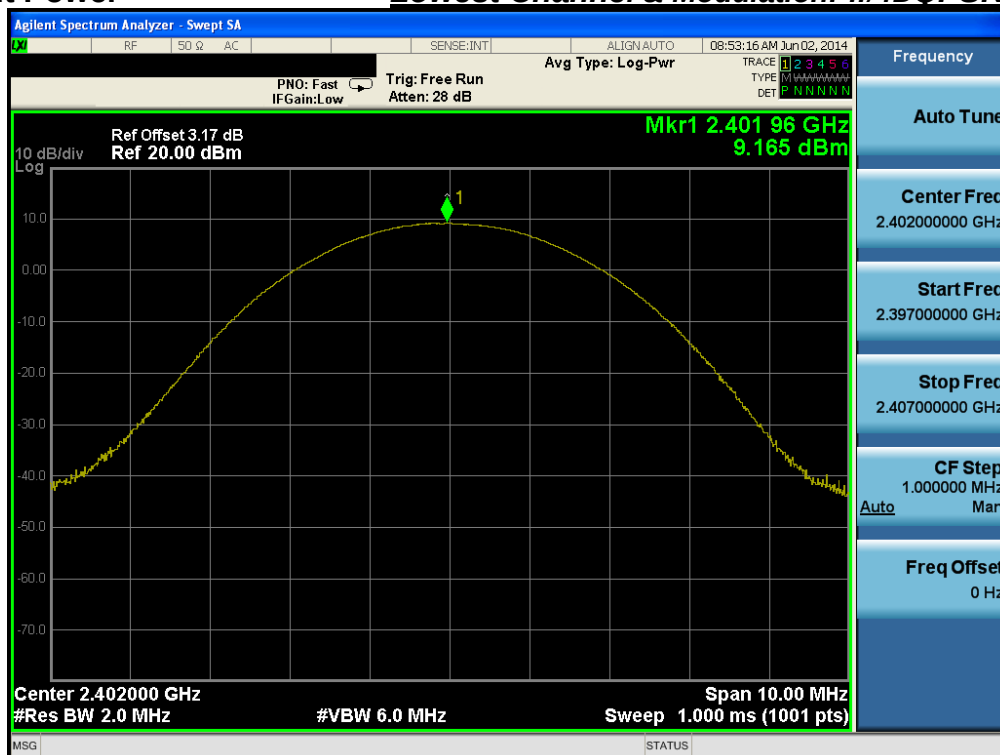
Peak Output Power**Lowest Channel & Modulation: 8DPSK Module 1****Peak Output Power****Middle Channel & Modulation: 8DPSK Module 1**

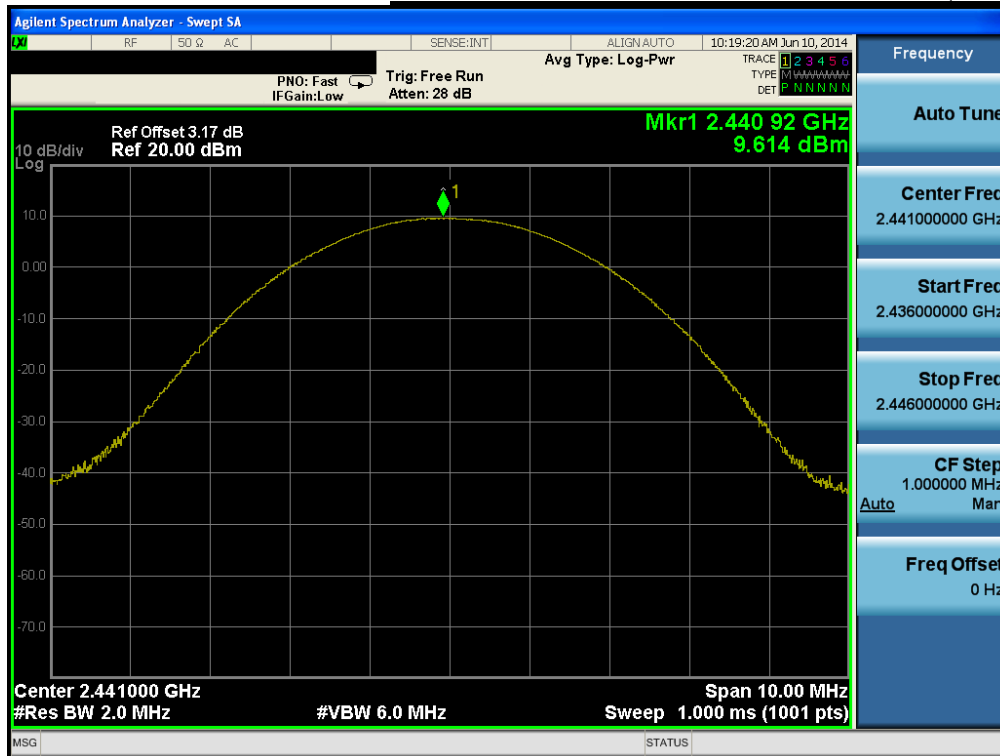
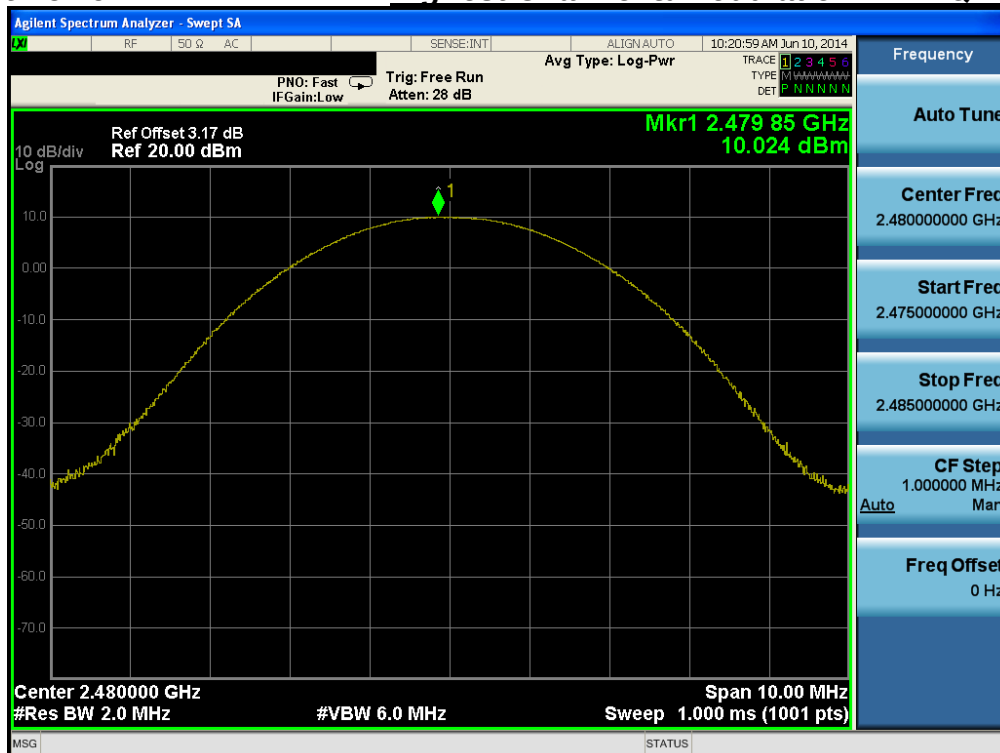
Peak Output Power

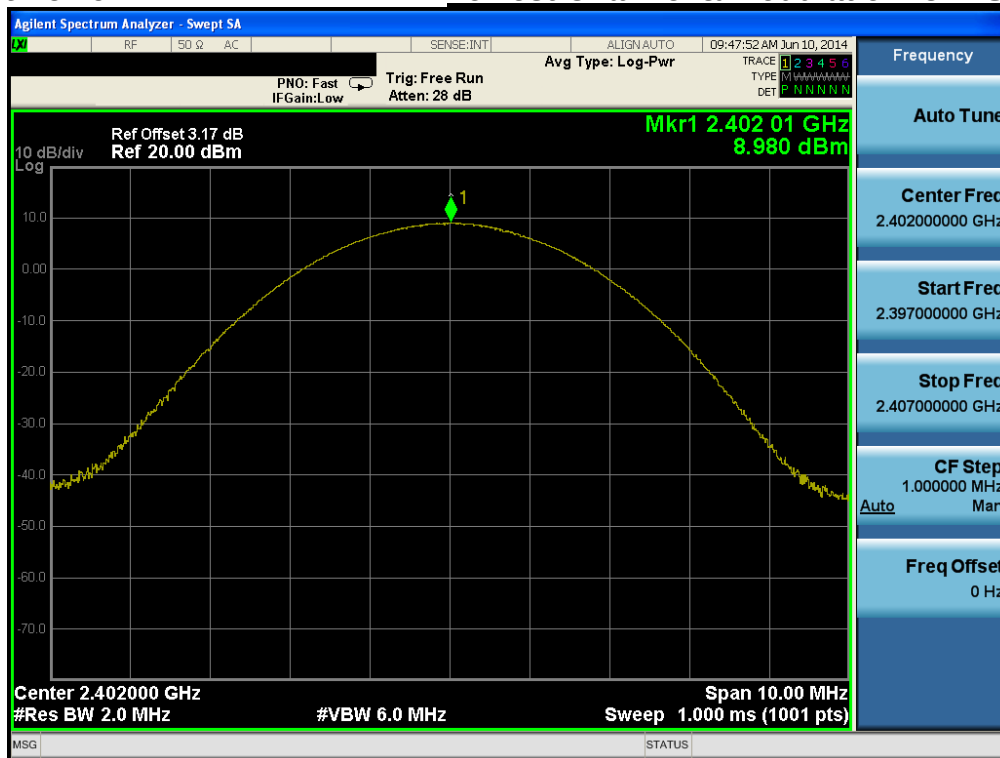
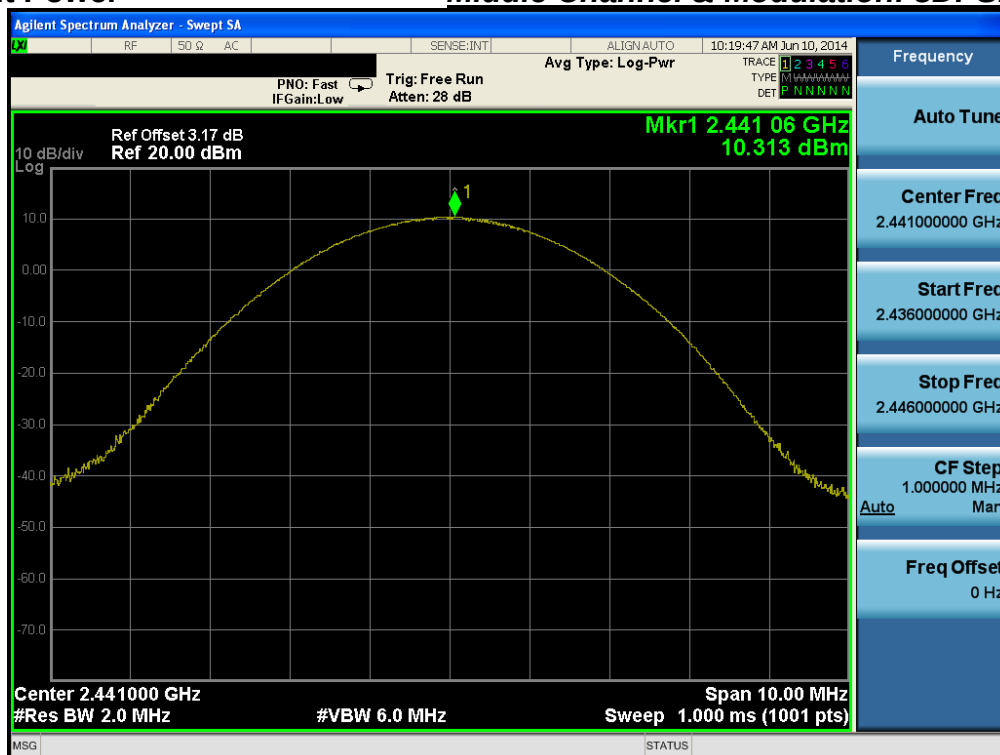
Highest Channel & Modulation: 8DPSK Module 1



Peak Output Power***Lowest Channel & Modulation: GFSK Module 2*****Peak Output Power*****Middle Channel & Modulation: GFSK Module 2***

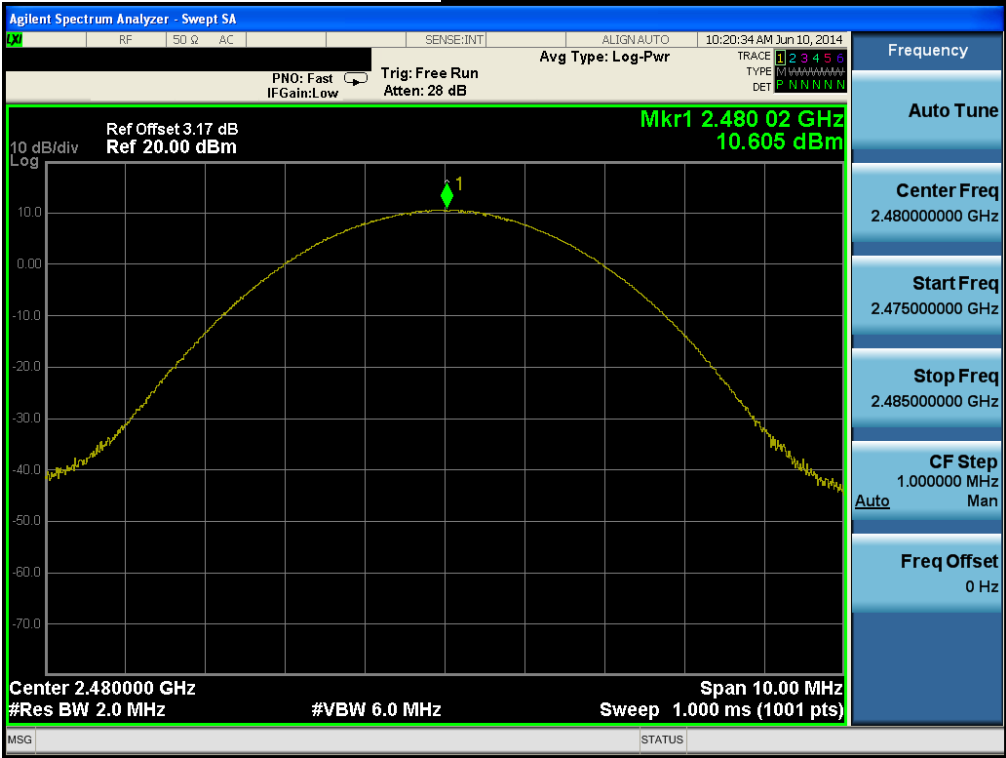
Peak Output Power***Highest Channel & Modulation: GFSK Module 2*****Peak Output Power*****Lowest Channel & Modulation: $\pi/4$ DQPSK Module 2***

Peak Output Power***Middle Channel & Modulation: $\pi/4$ DQPSK Module 2*****Peak Output Power*****Highest Channel & Modulation: $\pi/4$ DQPSK Module 2***

Peak Output Power***Lowest Channel & Modulation: 8DPSK Module 2*****Peak Output Power*****Middle Channel & Modulation: 8DPSK Module 2***

Peak Output Power

Highest Channel & Modulation: 8DPSK Module 2



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)	
	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 C63.10-2009

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: GFSK & Module 1



Results of Conducted Emission

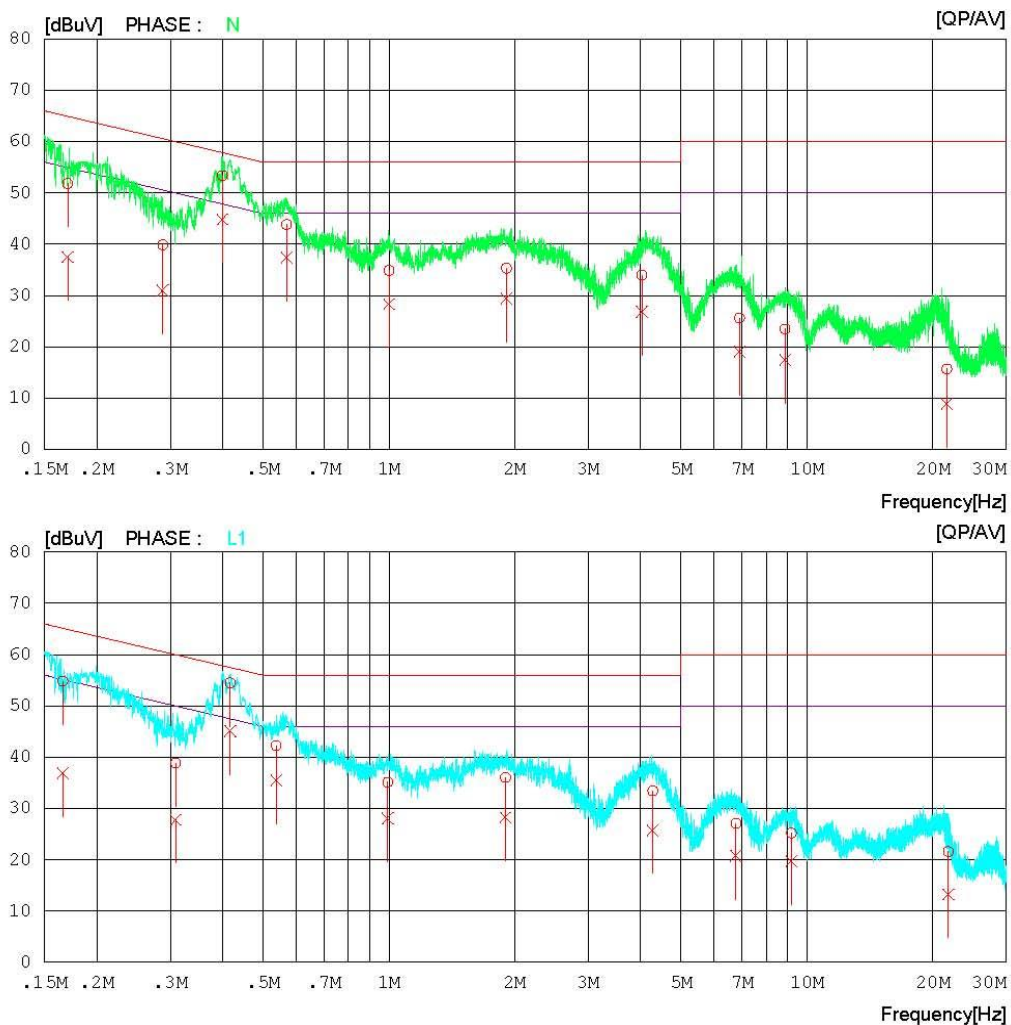
Digital EMC
Date : 2014-06-11

Model No. : 20S
Type :
Serial No. : Identical prototype
Test Condition : BT

Reference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 24 °C 35 % R.H.
Operator : H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV



AC Line Conducted Emissions (List)& Modulation: GFSK & Module 1**Results of Conducted Emission**Digital EMC
Date : 2014-06-11Model No. : 20S
Type :
Serial No. : Identical prototype
Test Condition : BTReference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 23 °C 35 % R.H.
Operator : H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15800	55.8	37.5	0.1	55.9	37.6	65.6	55.6	9.7	18.0	N
2	0.17113	53.2	37.7	0.1	53.3	37.8	64.9	54.9	11.6	17.1	N
3	0.21536	49.0	36.5	0.1	49.1	36.6	63.0	53.0	13.9	16.4	N
4	0.40170	54.5	44.8	0.1	54.6	44.9	57.8	47.8	3.2	2.9	N
5	0.55143	43.1	36.6	0.1	43.2	36.7	56.0	46.0	12.8	9.3	N
6	0.90116	33.0	26.3	0.1	33.1	26.4	56.0	46.0	22.9	19.6	N
7	1.85560	35.3	29.0	0.2	35.5	29.2	56.0	46.0	20.5	16.8	N
8	4.14420	34.2	26.9	0.3	34.5	27.2	56.0	46.0	21.5	18.8	N
9	6.45400	28.7	23.2	0.3	29.0	23.5	60.0	50.0	31.0	26.5	N
10	20.86560	18.4	10.4	0.3	18.7	10.7	60.0	50.0	41.3	39.3	N
11	0.15540	54.4	38.5	0.1	54.5	38.6	65.7	55.7	11.2	17.1	L1
12	0.18361	51.1	36.6	0.1	51.2	36.7	64.3	54.3	13.1	17.6	L1
13	0.22450	47.1	34.6	0.1	47.2	34.7	62.7	52.7	15.5	18.0	L1
14	0.41815	54.1	44.8	0.2	54.3	45.0	57.5	47.5	3.2	2.5	L1
15	0.55508	41.2	35.4	0.2	41.4	35.6	56.0	46.0	14.6	10.4	L1
16	0.99800	33.7	27.5	0.2	33.9	27.7	56.0	46.0	22.1	18.3	L1
17	1.82300	32.7	26.7	0.2	32.9	26.9	56.0	46.0	23.1	19.1	L1
18	4.27440	31.0	23.5	0.3	31.3	23.8	56.0	46.0	24.7	22.2	L1
19	6.82640	23.9	17.5	0.3	24.2	17.8	60.0	50.0	35.8	32.2	L1
20	21.51640	17.4	10.9	0.5	17.9	11.4	60.0	50.0	42.1	38.6	L1

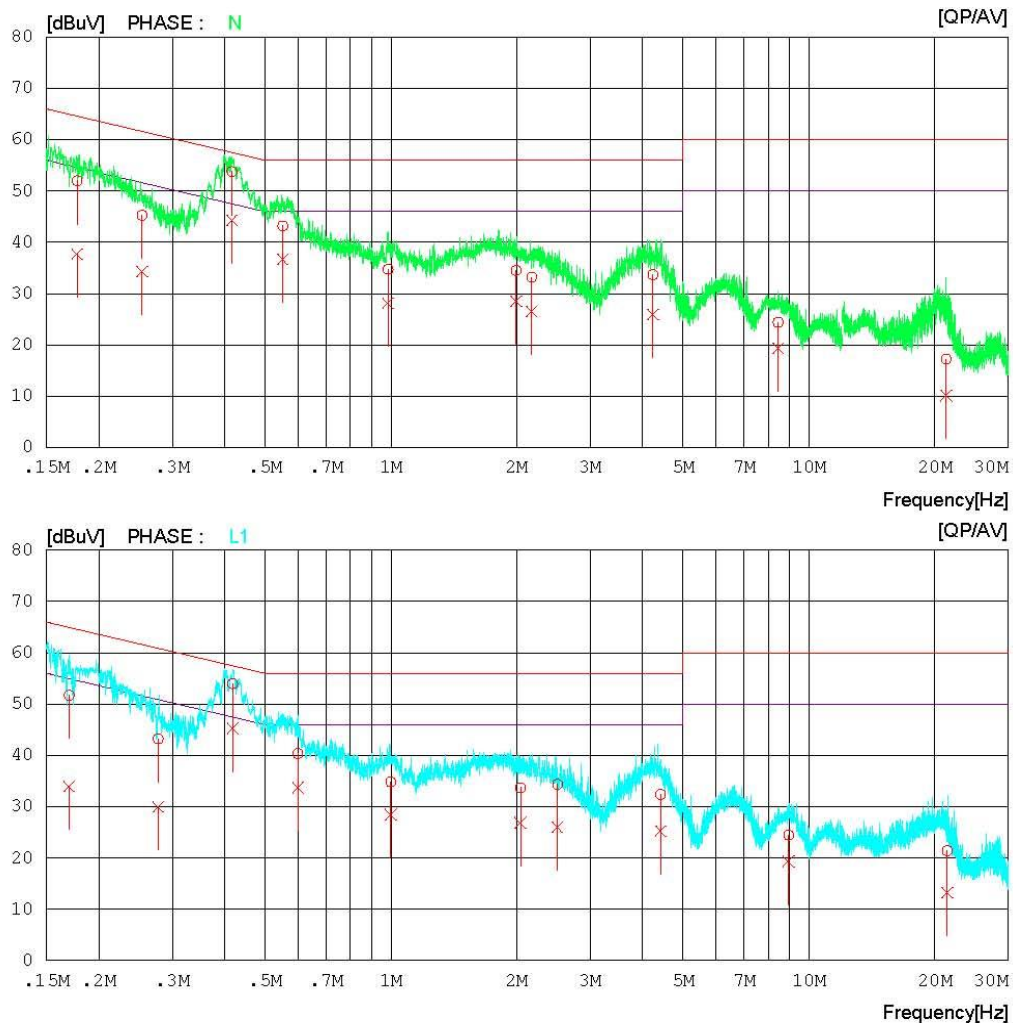
AC Line Conducted Emissions (Graph)& Modulation: GFSK & Module 2**Results of Conducted Emission**Digital EMC
Date : 2014-06-11

Model No. : 20S
Type :
Serial No. : Identical prototype
Test Condition : BT

Reference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 24 'C 35 % R.H.
Operator : H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV



AC Line Conducted Emissions (List)& Modulation: GFSK & Module 2**Results of Conducted Emission**Digital EMC
Date : 2014-06-11Model No. : 20S
Type :
Serial No. : Identical prototype
Test Condition : BTReference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 24 °C 35 % R.H.
Operator : H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.17760	51.9	37.6	0.1	52.0	37.7	64.6	54.6	12.6	16.9	N
2	0.25391	45.2	34.2	0.1	45.3	34.3	61.6	51.6	16.3	17.3	N
3	0.41676	53.7	44.2	0.1	53.8	44.3	57.5	47.5	3.7	3.2	N
4	0.55127	43.1	36.6	0.1	43.2	36.7	56.0	46.0	12.8	9.3	N
5	0.98510	34.6	28.0	0.1	34.7	28.1	56.0	46.0	21.3	17.9	N
6	1.99380	34.3	28.3	0.2	34.5	28.5	56.0	46.0	21.5	17.5	N
7	2.17160	33.0	26.3	0.2	33.2	26.5	56.0	46.0	22.8	19.5	N
8	4.23680	33.4	25.6	0.3	33.7	25.9	56.0	46.0	22.3	20.1	N
9	8.44180	24.2	19.1	0.2	24.4	19.3	60.0	50.0	35.6	30.7	N
10	21.29320	16.9	9.8	0.3	17.2	10.1	60.0	50.0	42.8	39.9	N
11	0.17000	51.6	33.9	0.1	51.7	34.0	65.0	55.0	13.3	21.0	L1
12	0.27749	43.1	29.9	0.1	43.2	30.0	60.9	50.9	17.7	20.9	L1
13	0.41837	53.8	45.1	0.2	54.0	45.3	57.5	47.5	3.5	2.2	L1
14	0.59913	40.1	33.5	0.2	40.3	33.7	56.0	46.0	15.7	12.3	L1
15	0.99929	34.6	28.3	0.2	34.8	28.5	56.0	46.0	21.2	17.5	L1
16	2.04240	33.4	26.6	0.3	33.7	26.9	56.0	46.0	22.3	19.1	L1
17	2.50320	34.1	25.7	0.3	34.4	26.0	56.0	46.0	21.6	20.0	L1
18	4.41980	32.1	24.9	0.3	32.4	25.2	56.0	46.0	23.6	20.8	L1
19	8.94840	24.2	19.0	0.3	24.5	19.3	60.0	50.0	35.5	30.7	L1
20	21.43440	20.9	12.8	0.5	21.4	13.3	60.0	50.0	38.6	36.7	L1

9. Antenna Requirement

■ **Procedure:**

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 internal antenna of this E.U.T is permanently attached using the soldering.

The external antenna is attached on the main PCB using the special spring tension. (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. Occupied Bandwidth(99 %)

- **Procedure: (RSS-Gen Issue 3)**

- The 99 % power bandwidth was measured with a calibrated spectrum analyzer.
- Spectrum analyzer plots are included on the following pages.

- **Measurement Data:** **NA**

- **Minimum Standard:**

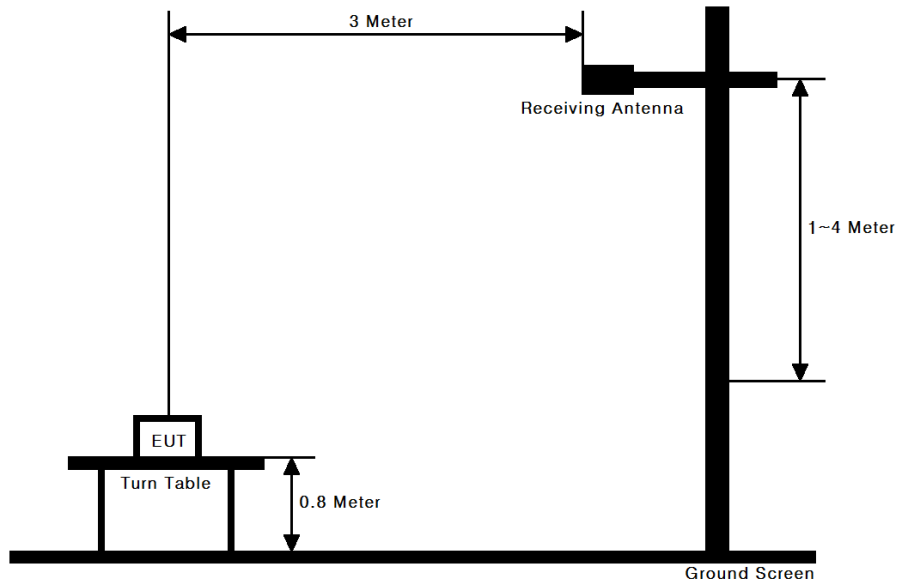
N/A

APPENDIX I

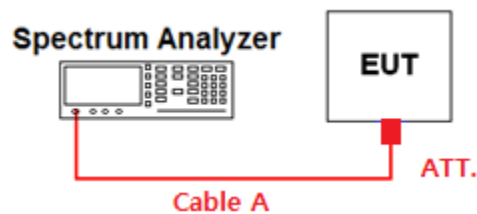
Test set up Diagrams & Path loss Information

▪ Radiated Measurement

The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 25 GHz Emissions.



▪ Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	2.69	15	3.11
1	3.00	20	4.31
2.402 & 2.441 & 2.480	3.17	25	5.21
5	3.33	-	-
10	3.33	-	-

Note. 1: The path loss from EUT to Spectrum analyzer were measured and used for test.
Path loss = Cable A + Attenuator