

GFSK Modulation

 $\pi/4$ DQPSK Modulation

CH00



CH39



CH78

8DPSK Modulation



CH00



CH39



CH78

5.5 Frequency Separation

LIMIT

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the $2/3 \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW.

TEST CONFIGURATION



TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz) ($2/3 \times 20\text{dB}$ bandwidth)	Limit	Result
GFSK	CH00	0.966	0.68	25KHz	Pass
	CH39	1.005	0.69		
	CH78	0.999	0.68		
$\pi/4$ DQPSK	CH00	0.999	0.91	25KHz	Pass
	CH39	0.991	0.91		
	CH78	1.011	0.91		
8DPSK	CH00	0.993	0.90	25KHz	Pass
	CH39	0.996	0.90		
	CH78	0.999	0.90		

Note:

We have tested all mode at high, middle and low g..channel, and recorded worst case at middle

Test plot as follows:

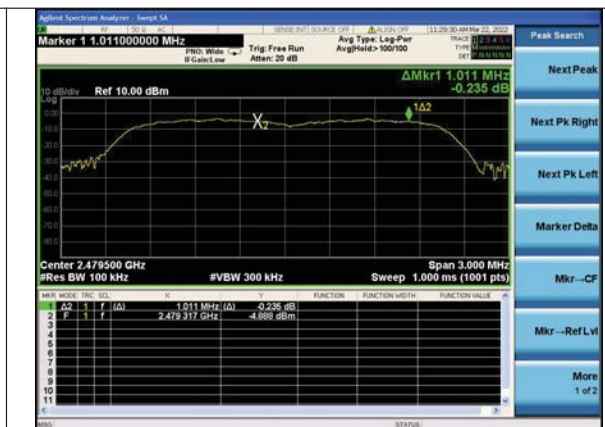
GFSK Modulation

 $\pi/4$ DQPSK Modulation

CH00

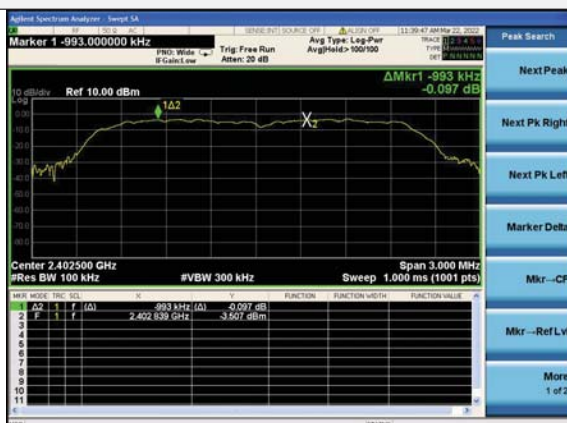


CH39



CH78

8DPSK Modulation

8DPSK Modulation																																		
 <table><tr><th>MARK</th><th>MODE</th><th>TRIG</th><th>SQL</th><th>SI</th><th>F</th><th>F (Δ)</th><th>V</th><th>FUNCTION</th><th>FUNCTION WIDTH</th><th>FUNCTION VALUE</th></tr><tr><td>1</td><td>Δ</td><td>1</td><td>F</td><td>(Δ)</td><td></td><td>2.402500 GHz</td><td>-0.097 dB</td><td></td><td></td><td></td></tr><tr><td>2</td><td>F</td><td>1</td><td>F</td><td></td><td></td><td>2.402500 GHz</td><td>-0.097 dB</td><td></td><td></td><td></td></tr></table>	MARK	MODE	TRIG	SQL	SI	F	F (Δ)	V	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	1	Δ	1	F	(Δ)		2.402500 GHz	-0.097 dB				2	F	1	F			2.402500 GHz	-0.097 dB				Peak Search NextPeak Next Pk Right Next Pk Left Marker Delta Mkr-CF Mkr-RefLvl More 1 of 2
MARK	MODE	TRIG	SQL	SI	F	F (Δ)	V	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE																								
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CH39																																		
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2	F	1	F			2.479149 GHz	-7.868 dB																											
CH78																																		

5.6 Number of hopping frequency

Limit

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with 100 KHz RBW and 300 KHz VBW.

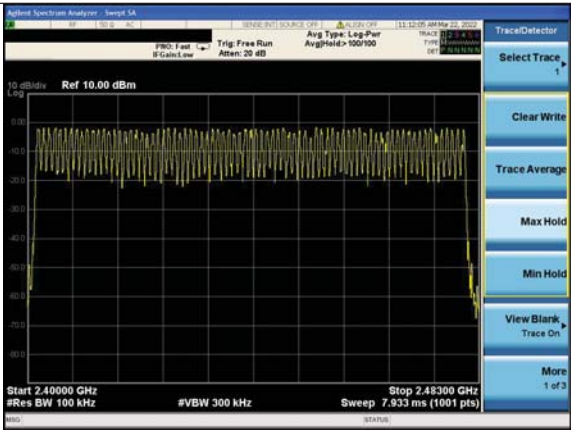
Test Configuration



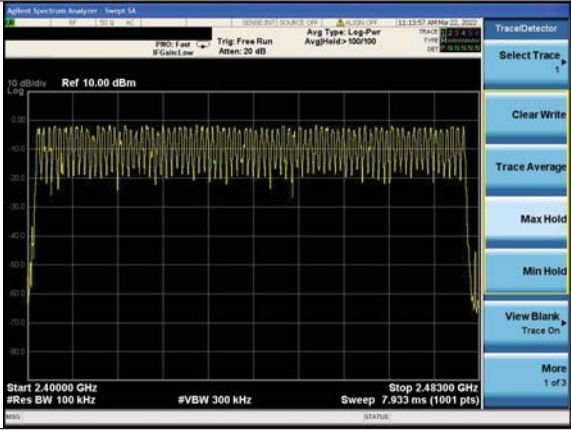
Test Results

Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
$\pi/4$ DQPSK	79		
8DPSK	79		

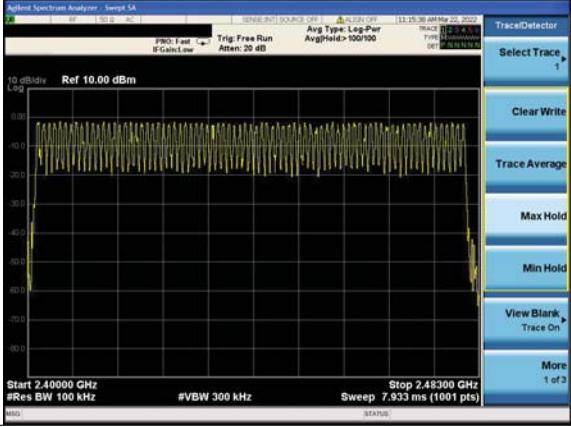
Test plot as follows:



GFSK Modulation



$\pi/4$ DQPSK Modulation



8DPSK Modulation

5.7 Time of Occupancy (Dwell Time)

Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 1MHz VBW, Span 0Hz.

Test Configuration



Test Results

Modulation	Packet	Burst time (ms)	Dwell time (s)	Limit (s)	Result
GFSK	DH1	0.390	0.12	0.40	Pass
	DH3	1.670	0.27		
	DH5	2.920	0.31		
π/4DQPSK	2-DH1	0.380	0.12	0.40	Pass
	2-DH3	1.655	0.26		
	2-DH5	2.930	0.31		
8DPSK	3-DH1	0.410	0.13	0.40	Pass
	3-DH3	1.670	0.27		
	3-DH5	2.925	0.31		

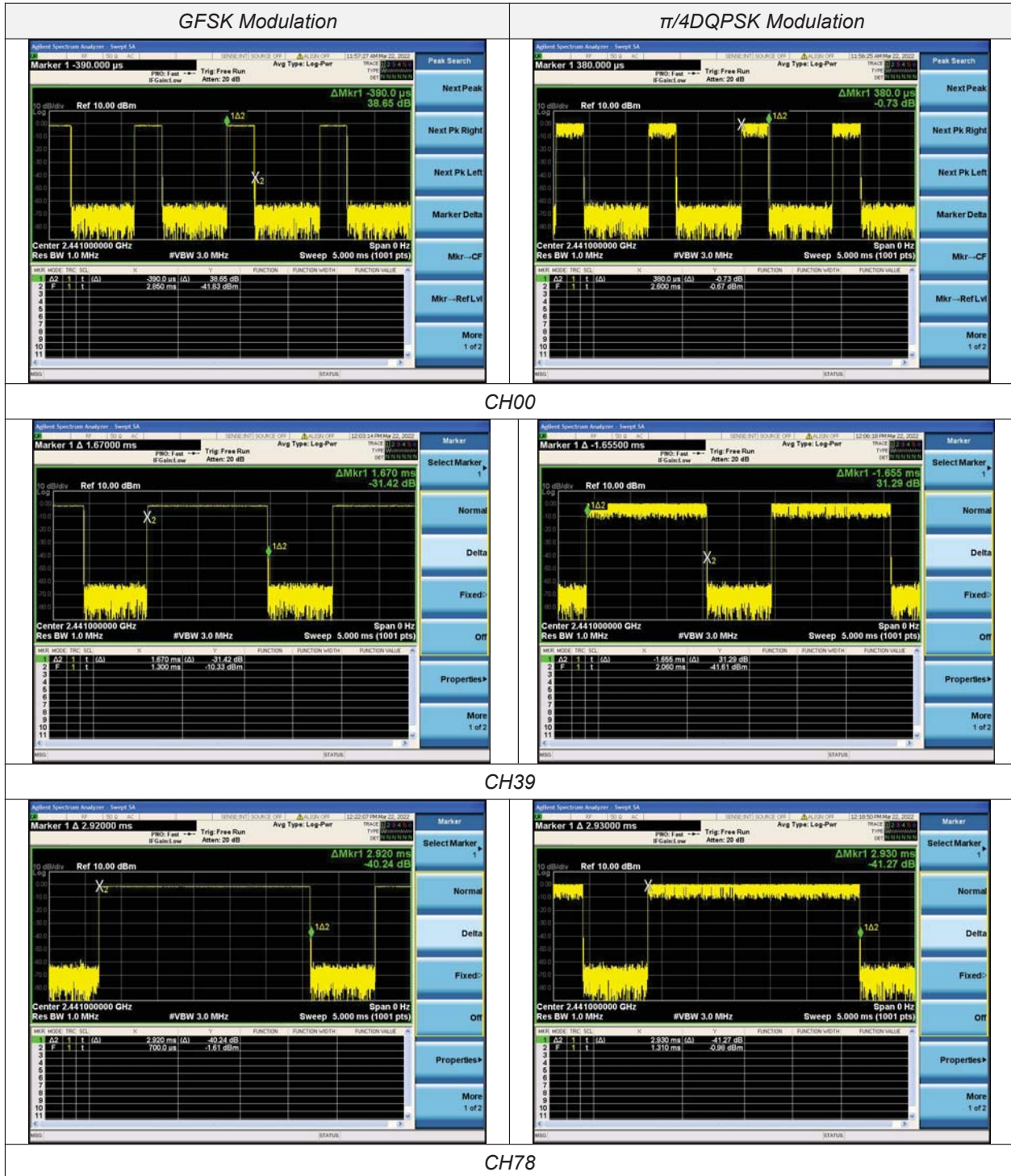
Note: We have tested all mode at high, middle and low channel, and recorded worst case at middle channel.

Dwell time = Pulse time (ms) × (1600 ÷ 2 ÷ 79) × 31.6 Second for DH1, 2-DH1, 3-DH1

Dwell time = Pulse time (ms) × (1600 ÷ 4 ÷ 79) × 31.6 Second for DH3, 2-DH3, 3-DH3

Dwell time = Pulse time (ms) × (1600 ÷ 6 ÷ 79) × 31.6 Second for DH5, 2-DH5, 3-DH5

Test plot as follows:



8DPSK Modulation

8DPSK Modulation

Agilent Spectrum Analyzer - Sweep SA

Marker 1 Δ 410.000 μs

Ref 10.00 dBm

ΔMkr1 410.0 μs -52.20 dB

Center 2.441000000 GHz #VBW 3.0 MHz Sweep 5.000 ms (1001 pts)

Res BW 1.0 MHz

MSR MODE TRIG SEC SI SI FUNCTION FUNCTION WIDTH FUNCTION VALUE

1	Δ	1	1	(Δ)	410.0 μs	(Δ)	-52.20 dB	
2	F	1	1	t	2.200 ms		-52.20 dBm	

Properties>

More 1 of 2

CH00

Agilent Spectrum Analyzer - Sweep SA

Marker 1 Δ 1.67000 ms

Ref 10.00 dBm

ΔMkr1 1.670 ms -42.12 dB

Center 2.441000000 GHz #VBW 3.0 MHz Sweep 5.000 ms (1001 pts)

Res BW 1.0 MHz

MSR MODE TRIG SEC SI SI FUNCTION FUNCTION WIDTH FUNCTION VALUE

1	Δ	1	1	(Δ)	1.670 ms	(Δ)	-42.12 dB	
2	F	1	1	t	2.630 ms		0.03 dBm	

Properties>

More 1 of 2

CH39

Agilent Spectrum Analyzer - Sweep SA

Marker 1 Δ -2.92500 ms

Ref 10.00 dBm

ΔMkr1 -2.925 ms 32.42 dB

Center 2.441000000 GHz #VBW 3.0 MHz Sweep 5.000 ms (1001 pts)

Res BW 1.0 MHz

MSR MODE TRIG SEC SI SI FUNCTION FUNCTION WIDTH FUNCTION VALUE

1	Δ	1	1	(Δ)	-2.925 ms	(Δ)	32.42 dB	
2	F	1	1	t	3.155 ms		66.67 dBm	

Properties>

More 1 of 2

CH78

5.8 Spurious RF Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

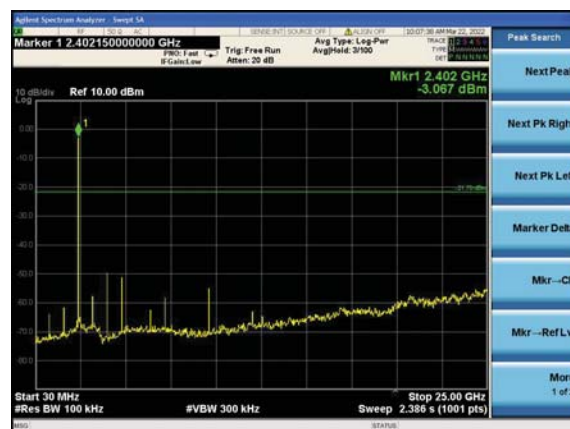
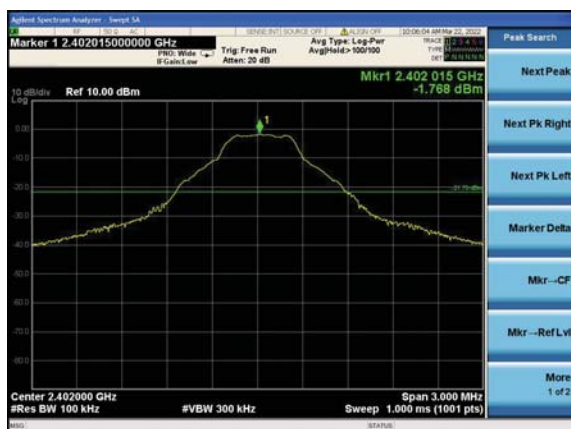
The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100kHz and VBW= 300KHz to measure the peak field strength, and measure frequency range from 9KHz to 25GHz.

LIMIT

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

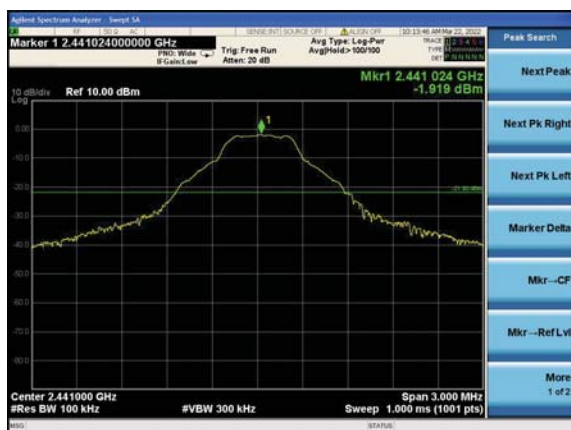
Test plot as follows:

GFSK CH00



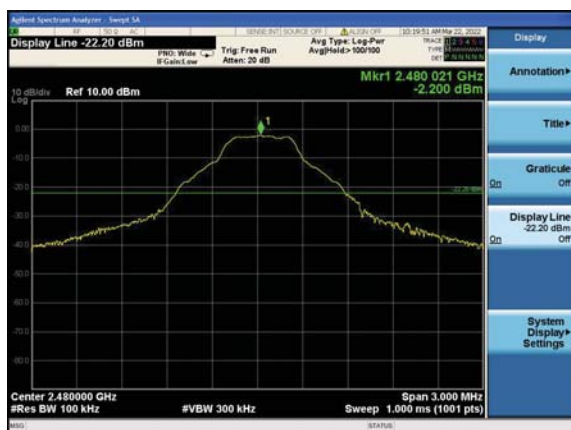
30MHz -25GHz

GFSK CH39



30MHz -25GHz

GFSK CH78



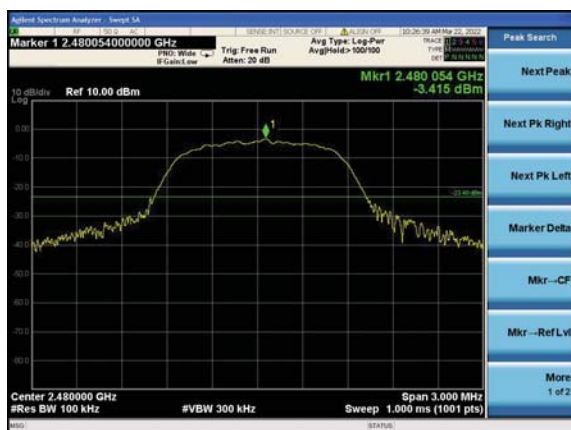
30MHz -25GHz

$\pi/4$ DQPSK CH00

30MHz -25GHz

 $\pi/4$ DQPSK CH39

30MHz -25GHz

 $\pi/4$ DQPSK CH78

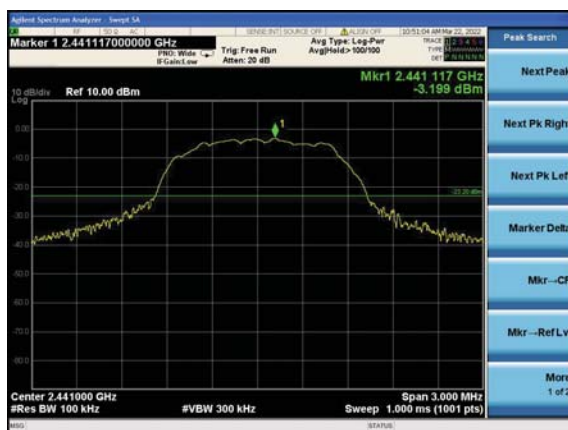
30MHz -25GHz

8DPSK CH00



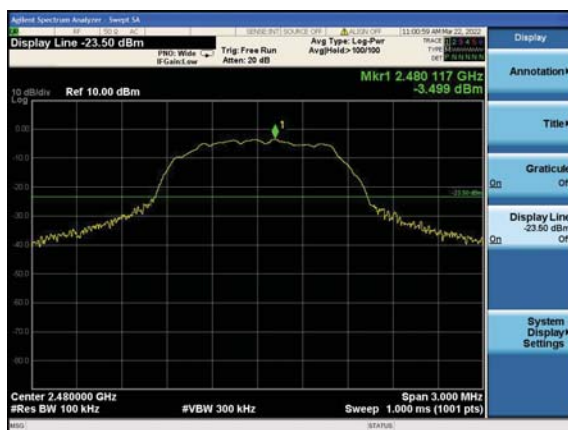
30MHz -25GHz

8DPSK CH39

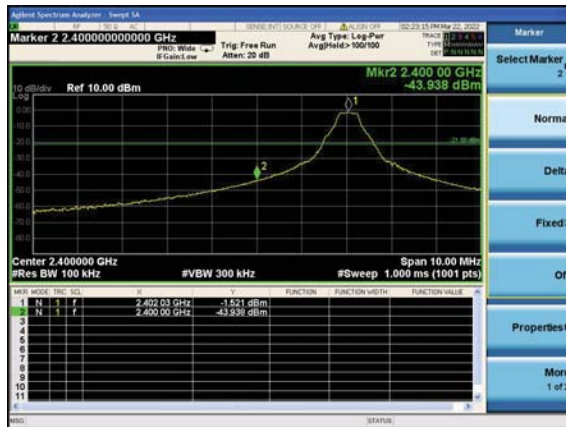


30MHz -25GHz

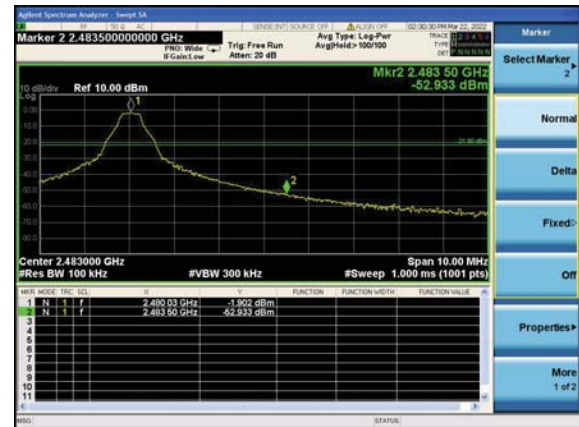
8DPSK CH78



30MHz -25GHz

Band-edge Measurements for RF Conducted Emissions:**GFSK**

Left Band edge hopping off



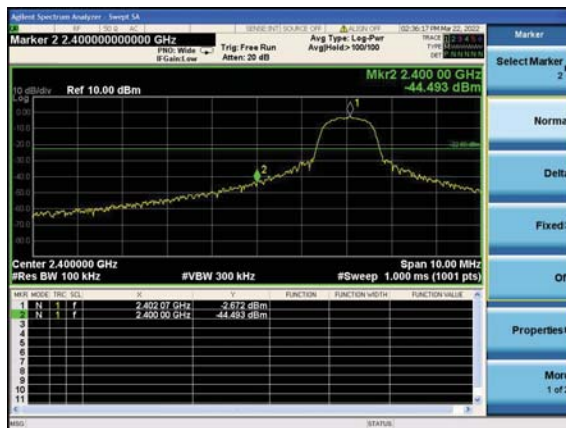
Right Band edge hopping off



Left Band edge hopping on



Right Band edge hopping on

 $\pi/4$ DQPSK

Left Band edge hopping off



Right Band edge hopping off



Left Band edge hoping on

Right Band edge hoping on

8DPSK



Left Band edge hoping off

Right Band edge hoping off



Left Band edge hoping on

Right Band edge hoping on

5.9 Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

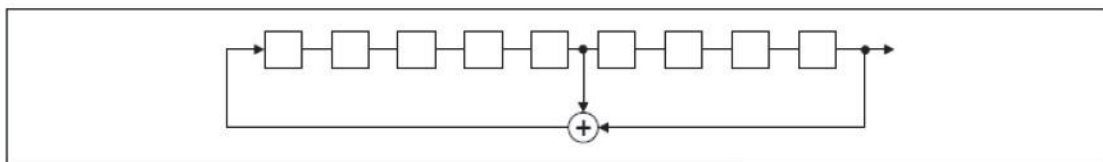
For 47 CFR Part 15C section 15.247 (a) (1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence Requirement

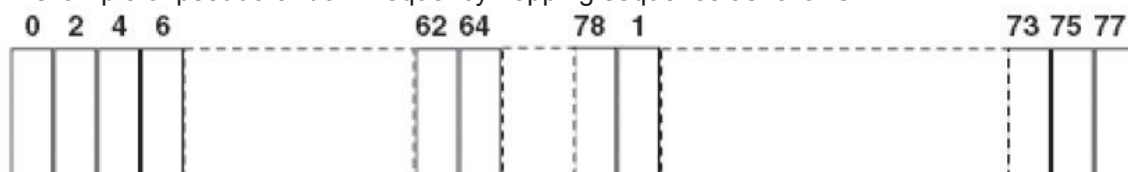
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

5.10 Antenna Requirement

Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203, 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.

And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Refer to statement below for compliance

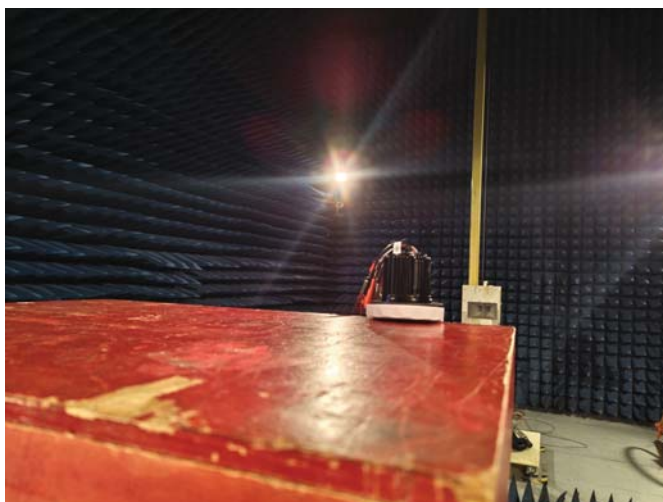
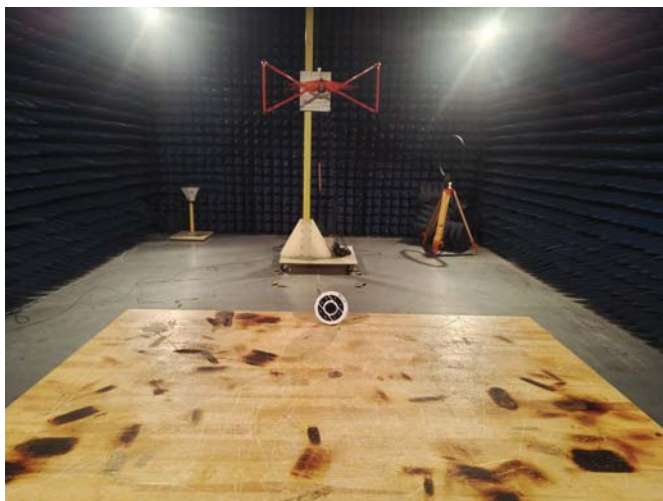
The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

Antenna Connected Construction

The directional gains of antenna used for transmitting is -2dBi, and the antenna is an PCB antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

Results: Compliance.

6 Test Setup Photos of the EUT



7 Photos of the EUT

See related photo report.

***** End of Report *****