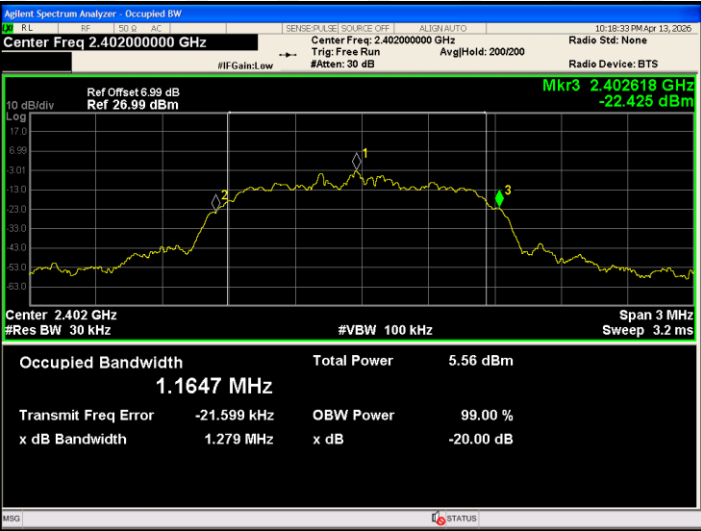
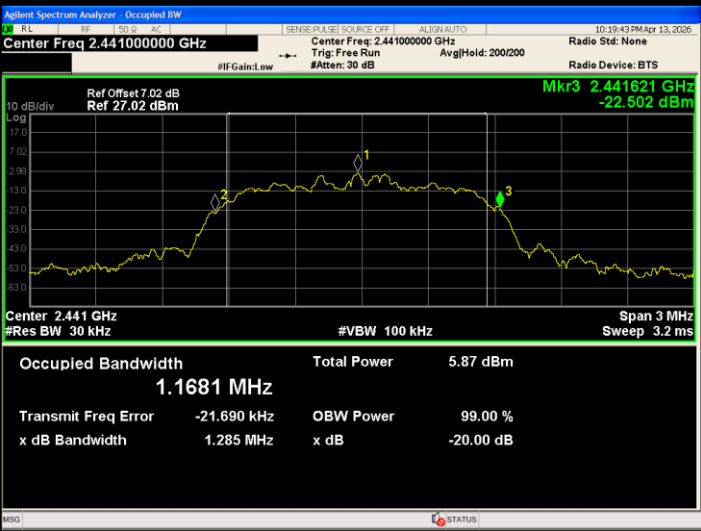
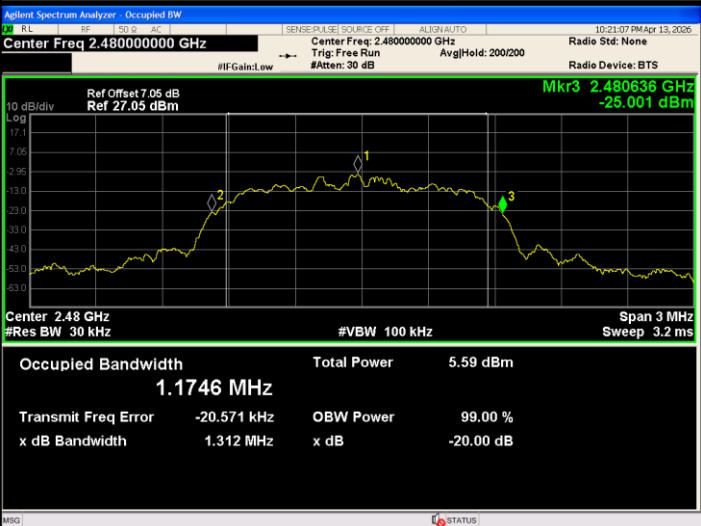
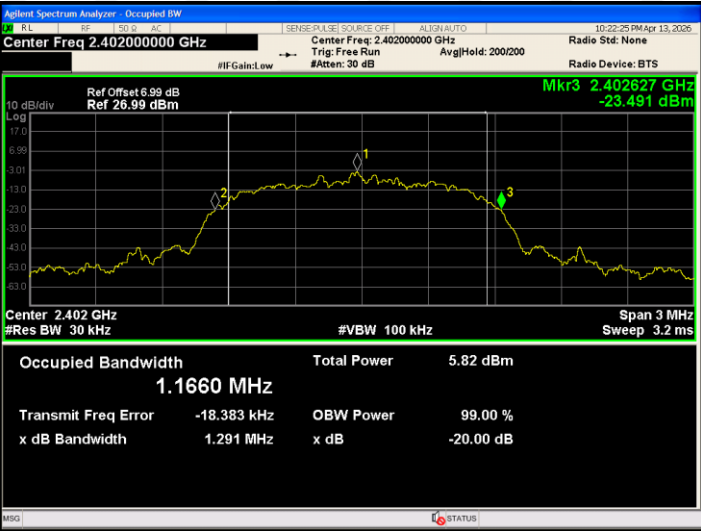
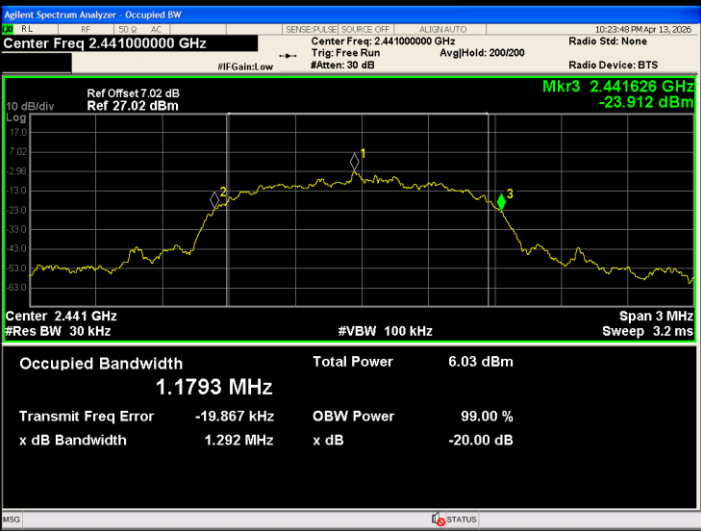
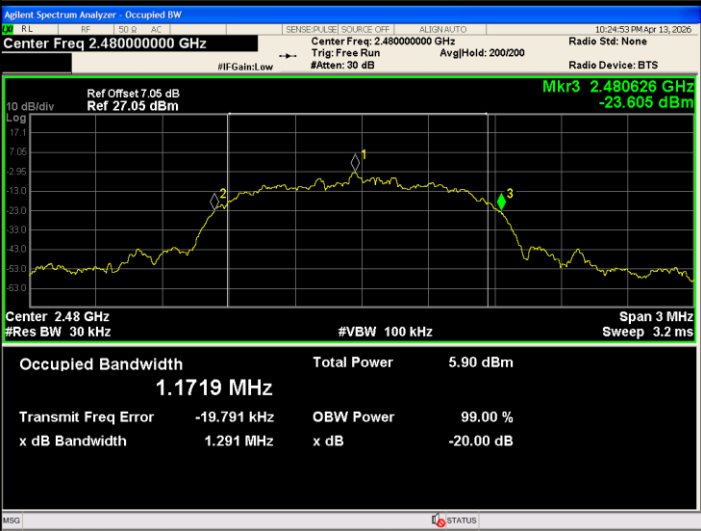
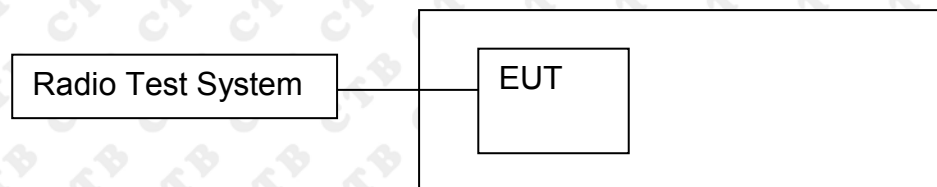


$\pi/4$-DQPSK Low channel	
$\pi/4$-DQPSK Mid channel	
$\pi/4$-DQPSK High channel	

8DPSK Low channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.40200000 GHz Ref Offset: 6.99 dB Ref: 26.99 dBm Occupied Bandwidth: 1.1660 MHz Total Power: 5.82 dBm Transmit Freq Error: -18.383 kHz OBW Power: 99.00 % x dB Bandwidth: 1.291 MHz x dB: -20.00 dB
8DPSK Mid channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.44100000 GHz Ref Offset: 7.02 dB Ref: 27.02 dBm Occupied Bandwidth: 1.1793 MHz Total Power: 6.03 dBm Transmit Freq Error: -19.867 kHz OBW Power: 99.00 % x dB Bandwidth: 1.292 MHz x dB: -20.00 dB
8DPSK High channel	 Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.48000000 GHz Ref Offset: 7.05 dB Ref: 27.05 dBm Occupied Bandwidth: 1.1719 MHz Total Power: 5.90 dBm Transmit Freq Error: -19.791 kHz OBW Power: 99.00 % x dB Bandwidth: 1.291 MHz x dB: -20.00 dB

11. CARRIER FREQUENCIES SEPARATION

11.1 Block Diagram Of Test Setup



11.2 Limit

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. 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 0.125W.

11.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 20kHz. VBW = 60kHz , Span = 2MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

11.4 Test Result

Mode	Channel.	Carrier Frequency Separation [MHz]	Limit(2/3 of the 20dB bandwidth MHz)	Verdict
GFSK	LCH	0.998	0.584	PASS
GFSK	MCH	0.996	0.588	PASS
GFSK	HCH	0.996	0.590	PASS
$\pi/4$ DQPSK	LCH	0.998	0.853	PASS
$\pi/4$ DQPSK	MCH	1.000	0.857	PASS
$\pi/4$ DQPSK	HCH	0.998	0.875	PASS
8DPSK	LCH	0.998	0.861	PASS
8DPSK	MCH	1.000	0.861	PASS
8DPSK	HCH	0.996	0.861	PASS

Test Graph

Graphs

GFSK/LCH



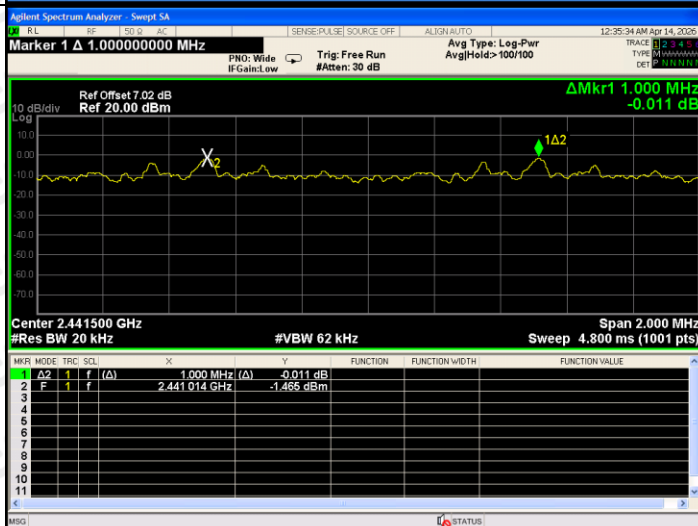
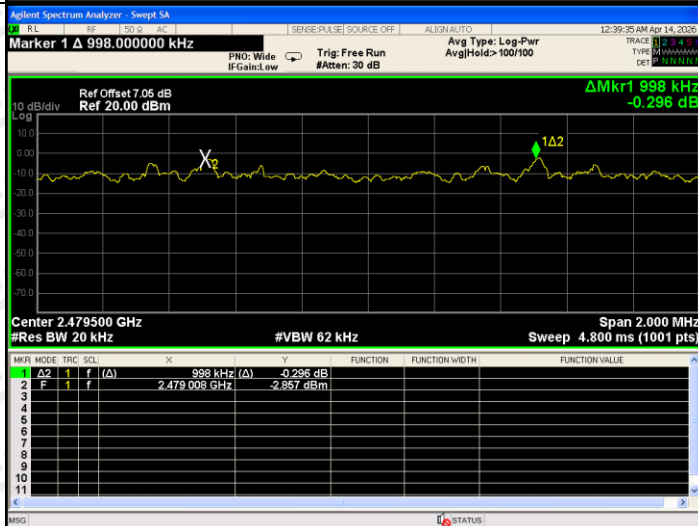
GFSK/MCH



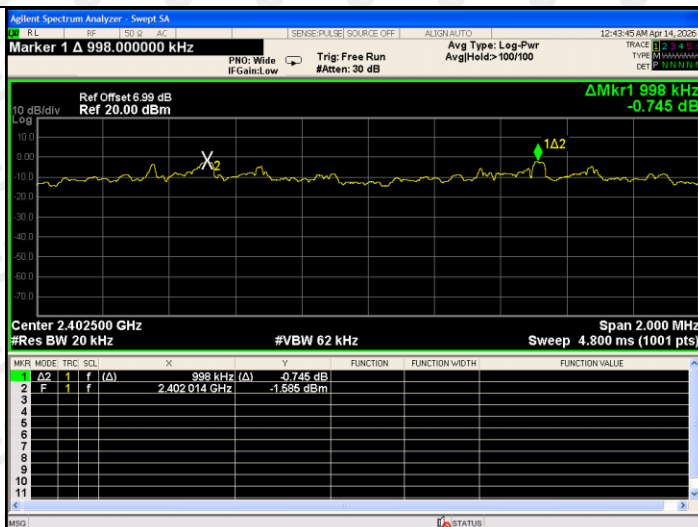
GFSK/HCH



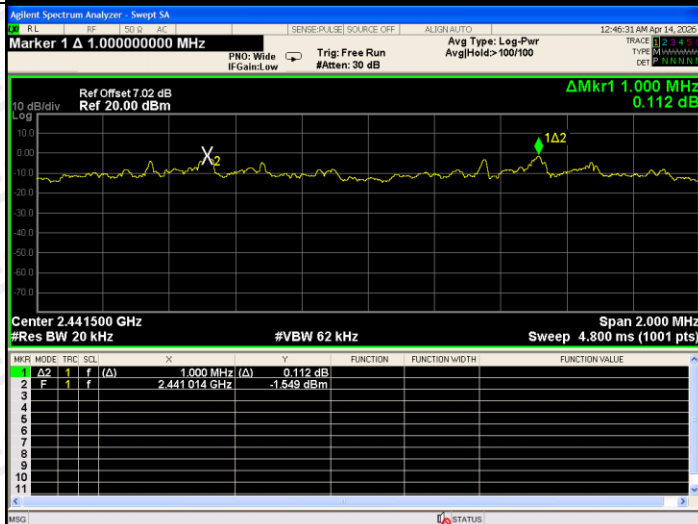
$\pi/4$ DQPSK/LCH

 $\pi/4$ DQPSK/MCH

 $\pi/4$ DQPSK/HCH


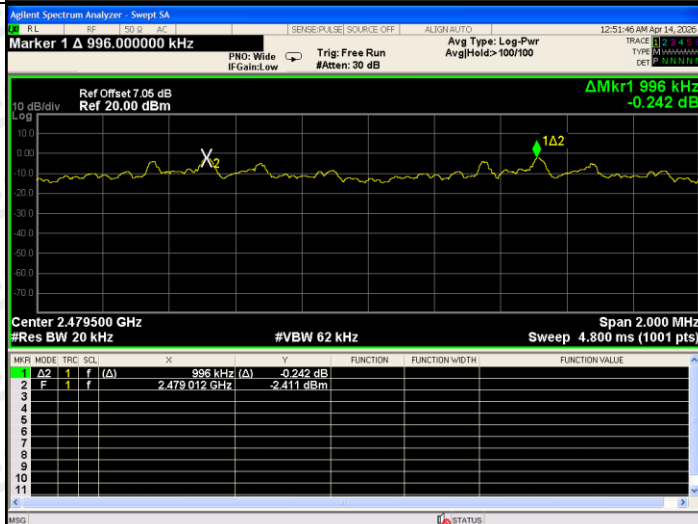
8DPSK/LCH



8DPSK /MCH

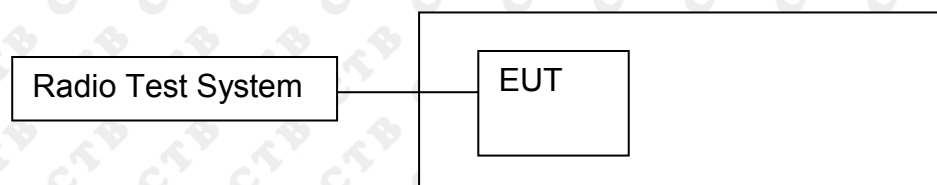


8DPSK /HCH



12. HOPPING CHANNEL NUMBER

12.1 Block Diagram Of Test Setup



12.2 Limit

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

12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

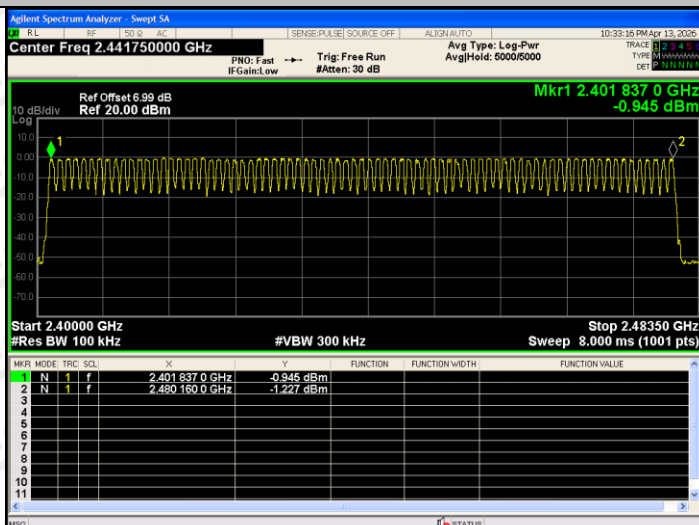
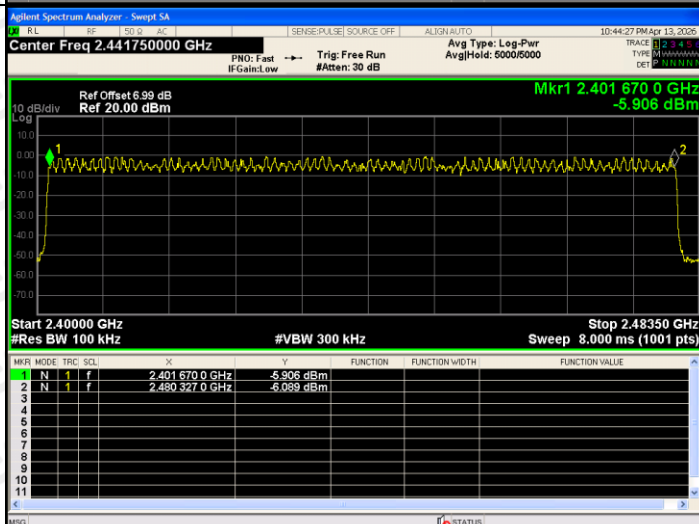
12.4 Test Result

Mode	Channel.	Number of Hopping Channel	Limit	Verdict
GFSK	Hop	79	≥ 15	PASS
$\pi/4$ DQPSK	Hop	79	≥ 15	PASS
8DPSK	Hop	79	≥ 15	PASS

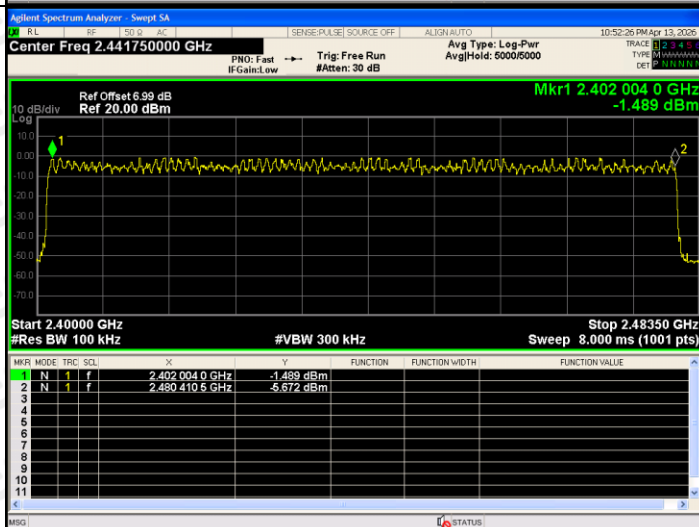
Test Graph

Graphs

GFSK/Hop

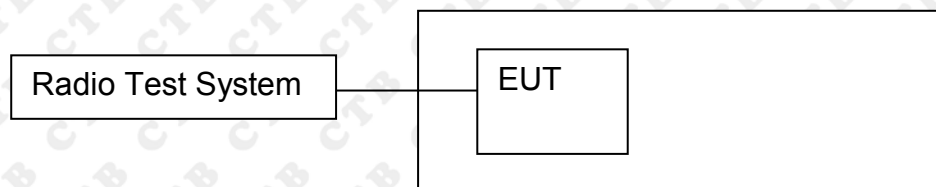

 $\pi/4$ DQPSK/Hop


8DPSK/Hop



13. DWELL TIME

13.1 Block Diagram Of Test Setup



13.2 Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

13.3 Test procedure

According to ANSI C63.10-2020 sub-clause 7.8.4

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- Span: Zero span, centered on a hopping channel.
- RBW shall be $\leq$ channel spacing and where possible RBW should be set $\geq 1/T$, where T is the expected dwell time per channel.
- Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- Detector function: Peak.
- Trace: Max hold.
- Trace: Clear-write, single sweep.
- Place markers at the start of the first transmission on the channel and at the end of the last transmission. The dwell time per hop is the time between these two markers.

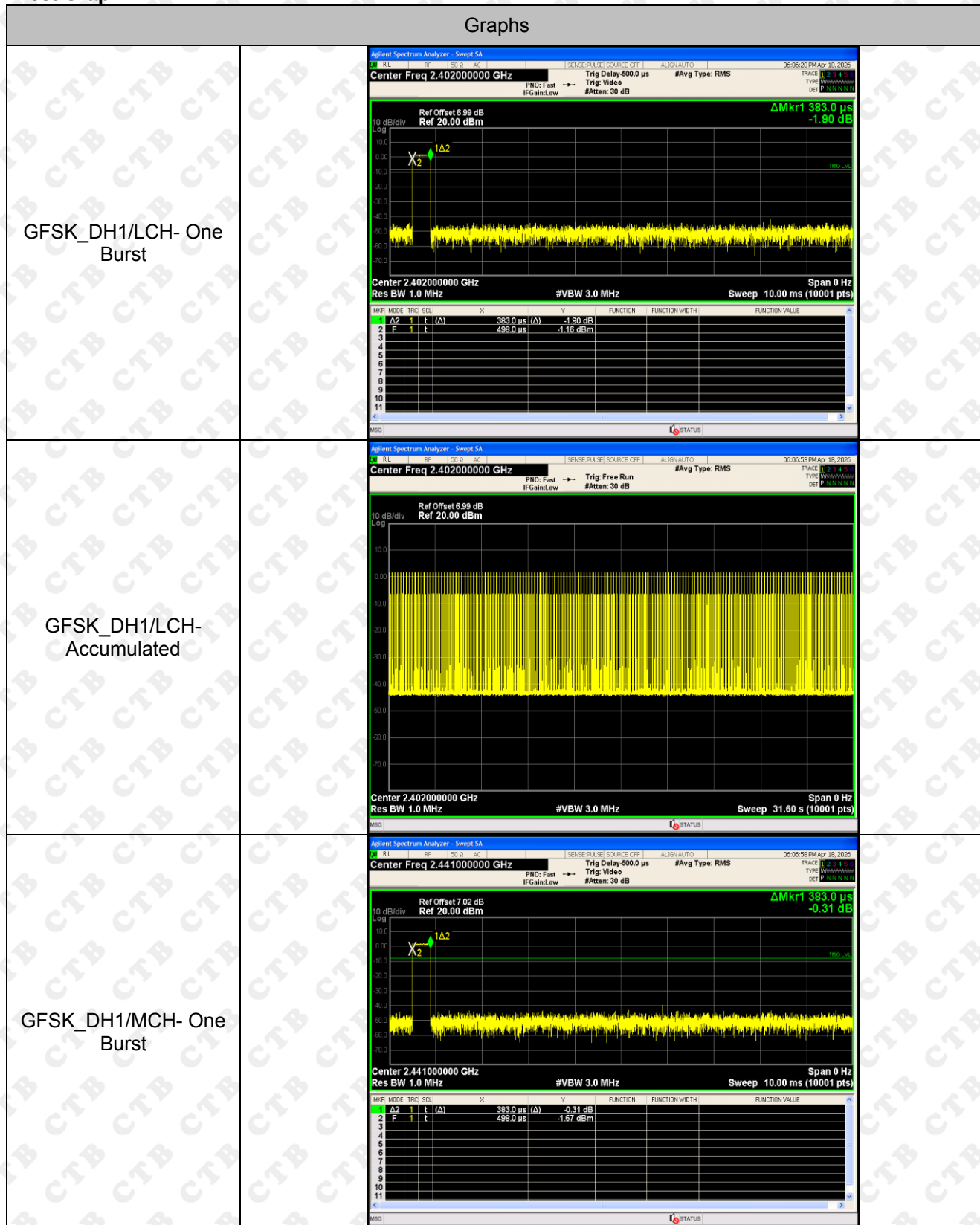
13.4 Test Result

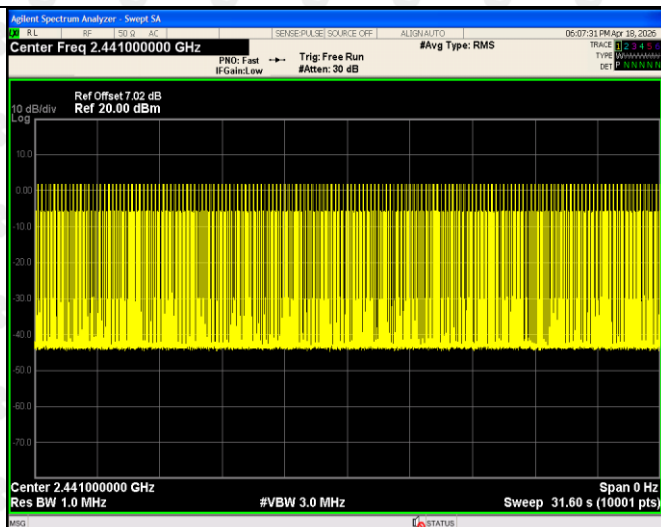
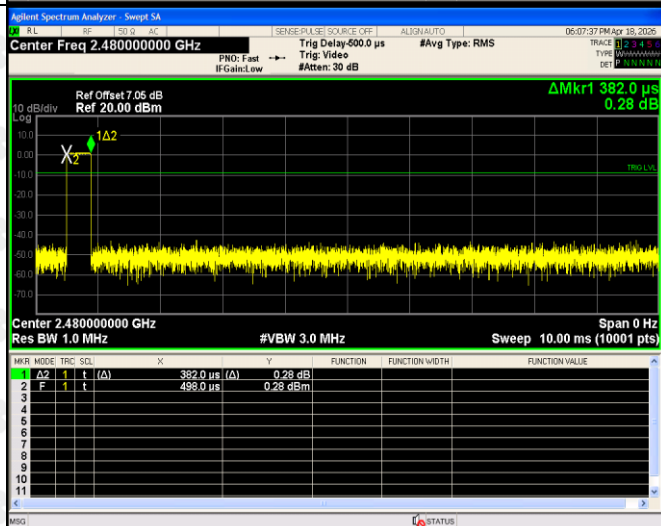
Mode	Packet	Channel	Pulse Time (ms)	Burst Count (Num)	Total Dwell Time (ms)	Limit (ms)	Verdict
GFSK	DH1	LCH	0.383	318	121.794	400	PASS
	DH1	MCH	0.383	318	121.794	400	PASS
	DH1	HCH	0.382	318	121.476	400	PASS
	DH3	LCH	1.644	161	264.684	400	PASS
	DH3	MCH	1.644	145	238.38	400	PASS
	DH3	HCH	1.643	158	259.594	400	PASS
	DH5	LCH	2.893	106	306.658	400	PASS
	DH5	MCH	2.893	118	341.374	400	PASS
	DH5	HCH	2.893	105	303.765	400	PASS

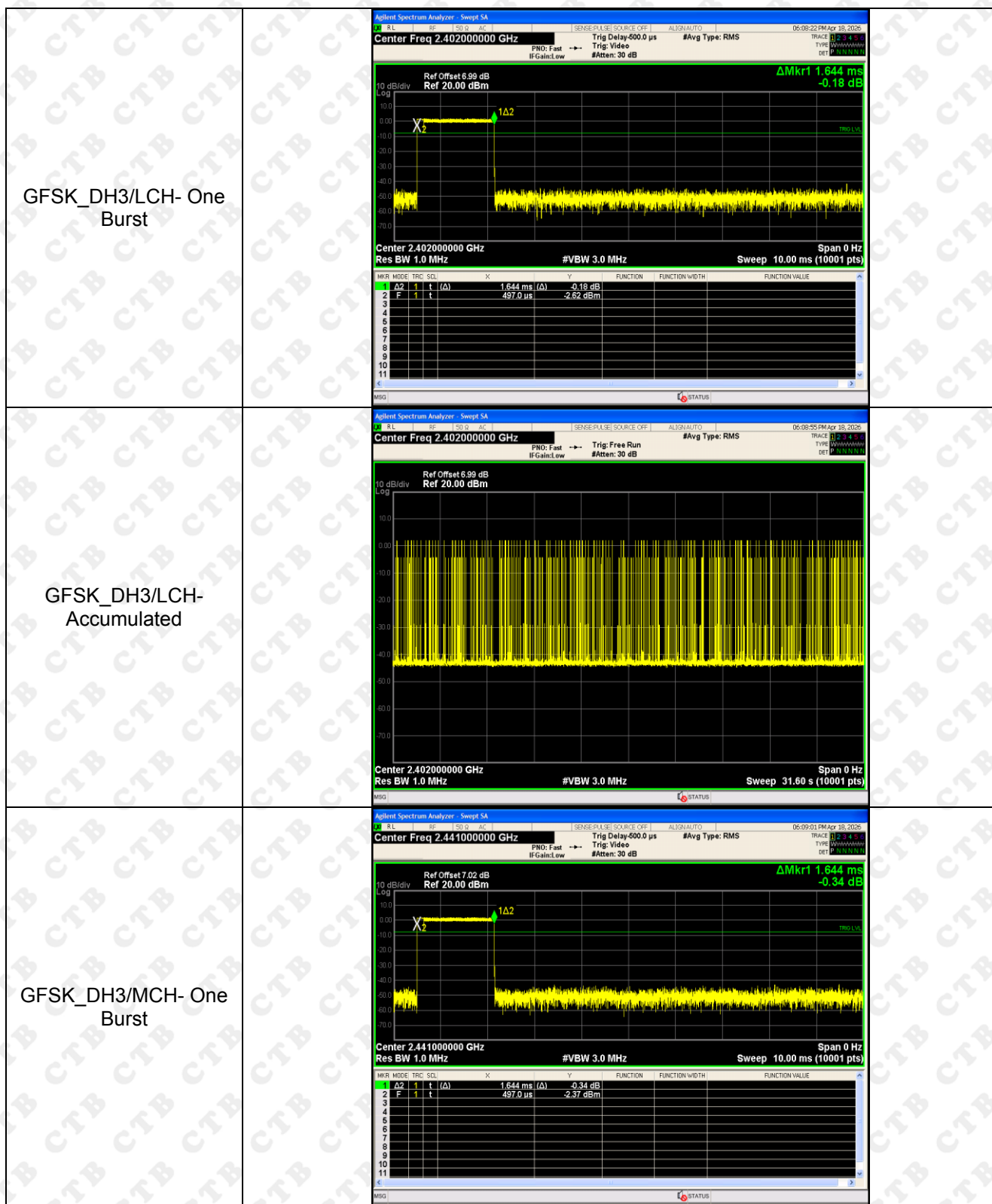
Remark: Dwell time = Pulse time * Total Hops

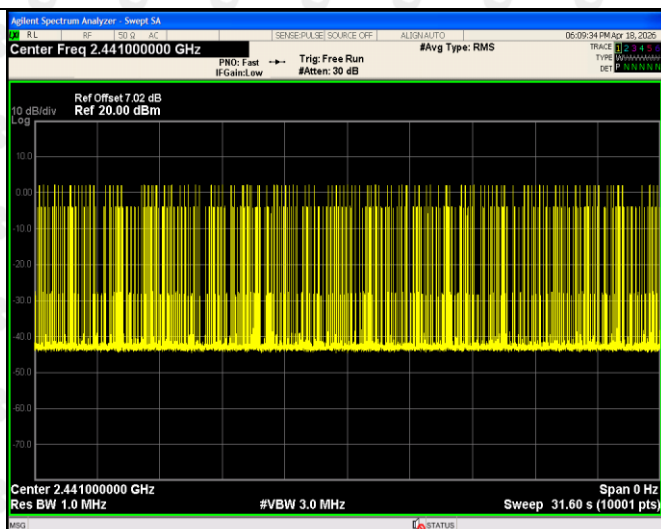
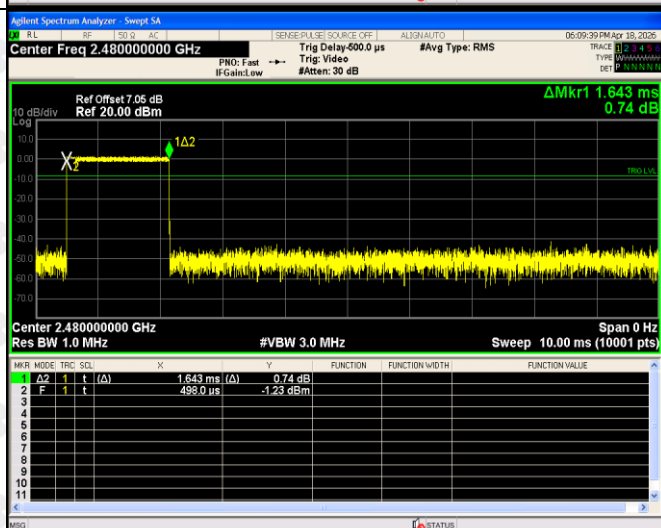
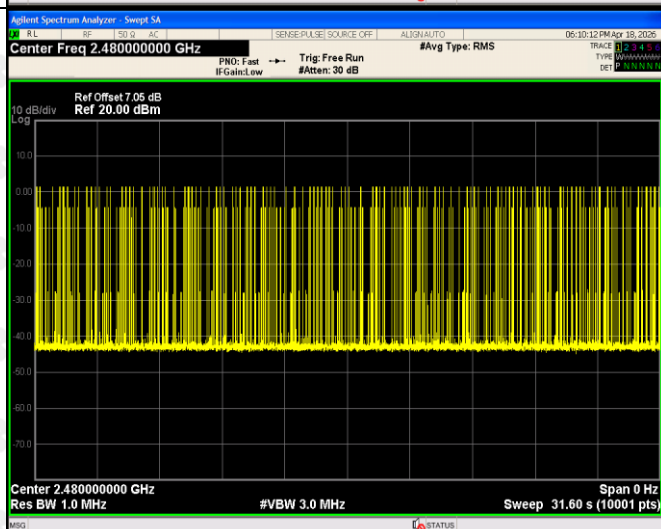
Remark: Mkr Delta is once pulse time.

Test Graph

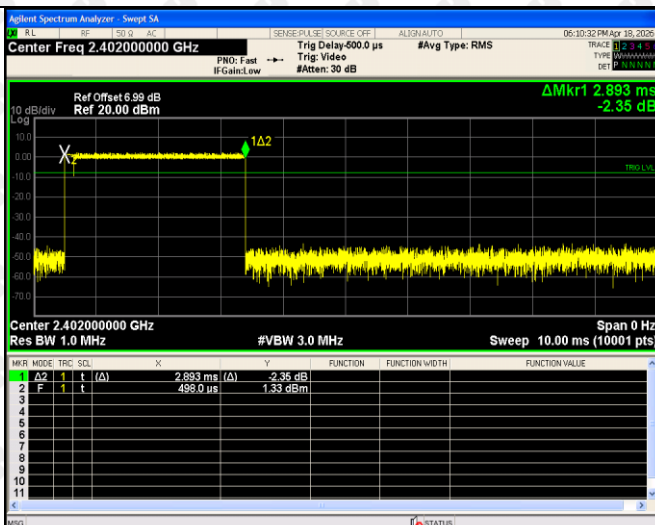


GFSK_DH1/MCH-
Accumulated

GFSK_DH1/HCH- One
Burst

GFSK_DH1/HCH-
Accumulated

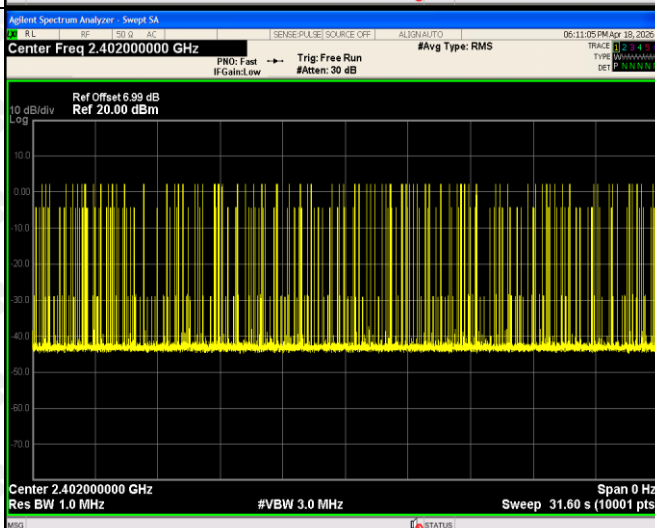



GFSK_DH3/MCH-
Accumulated

GFSK_DH3/HCH- One
Burst

GFSK_DH3/HCH-
Accumulated


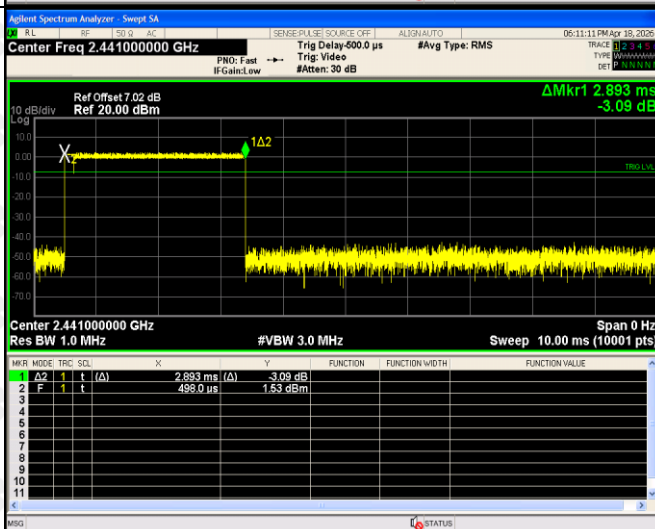
GFSK_DH5/LCH- One Burst

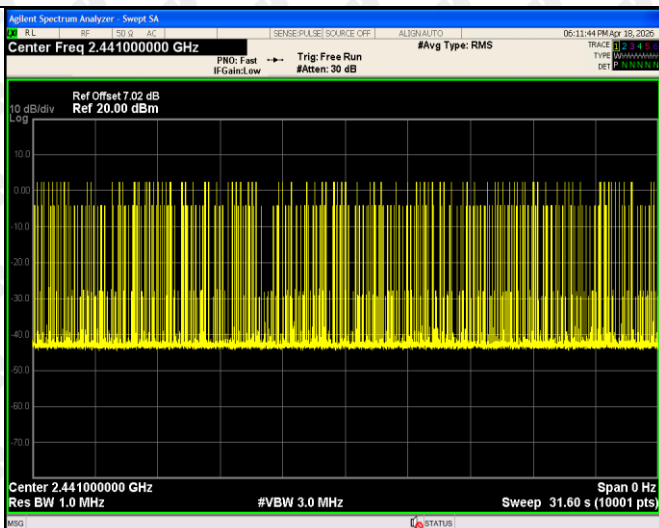
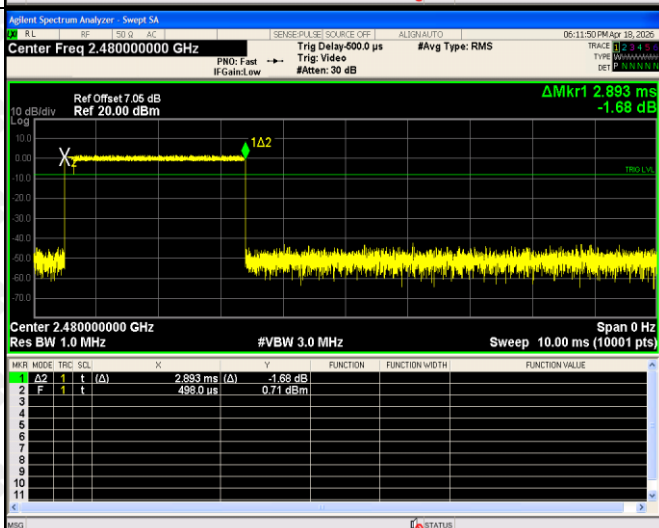
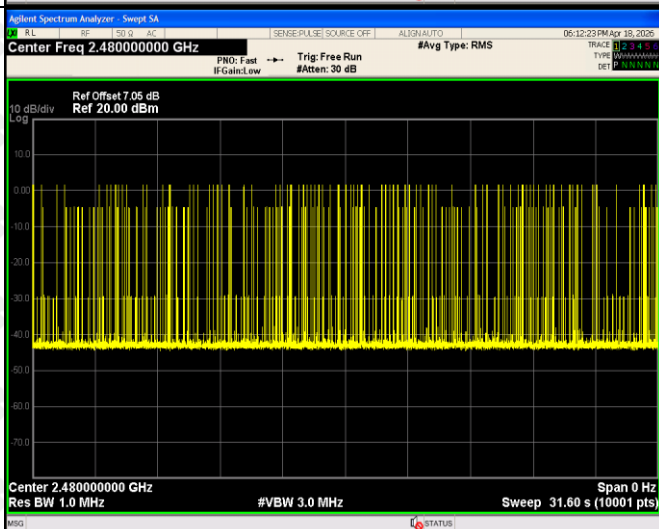


GFSK_DH5/LCH- Accumulated



GFSK_DH5/MCH- One Burst



GFSK_DH5/MCH-
Accumulated

GFSK_DH5/HCH- One
Burst

GFSK_DH5/HCH-
Accumulated


14. PSEUDORANDOM FREQUENCY

14.1 Limit

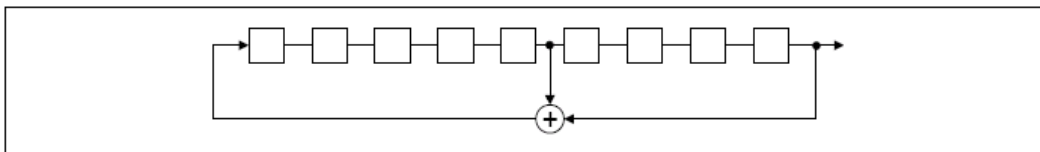
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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 Pseudorandom 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 hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

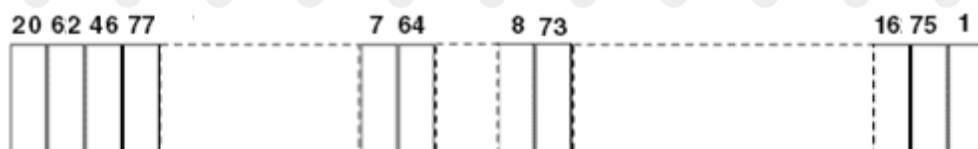
14.2 Test procedure

The pseudorandom 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; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.

The system receivers have input bandwidths that match the hopping channel bandwidths of their Corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

14.3 Test Result

The device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

15. ANTENNA REQUIREMENT

15.203 requirement:

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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

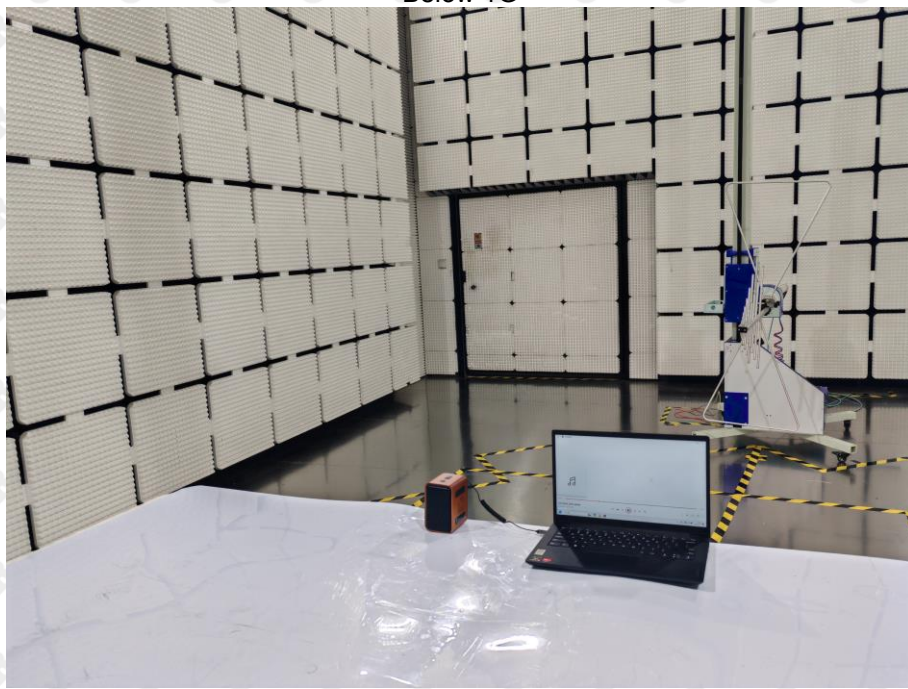
EUT Antenna:

The antenna is PCB antenna. The best case gain of the antenna is -0.76dBi.

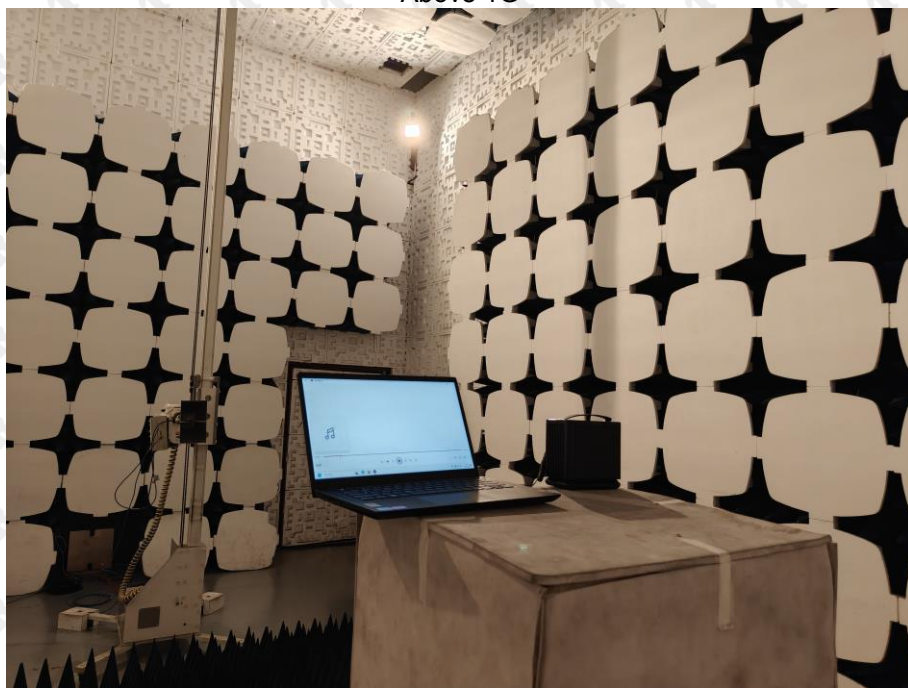
16. EUT TEST SETUP PHOTOGRAPHS

Radiated Emission

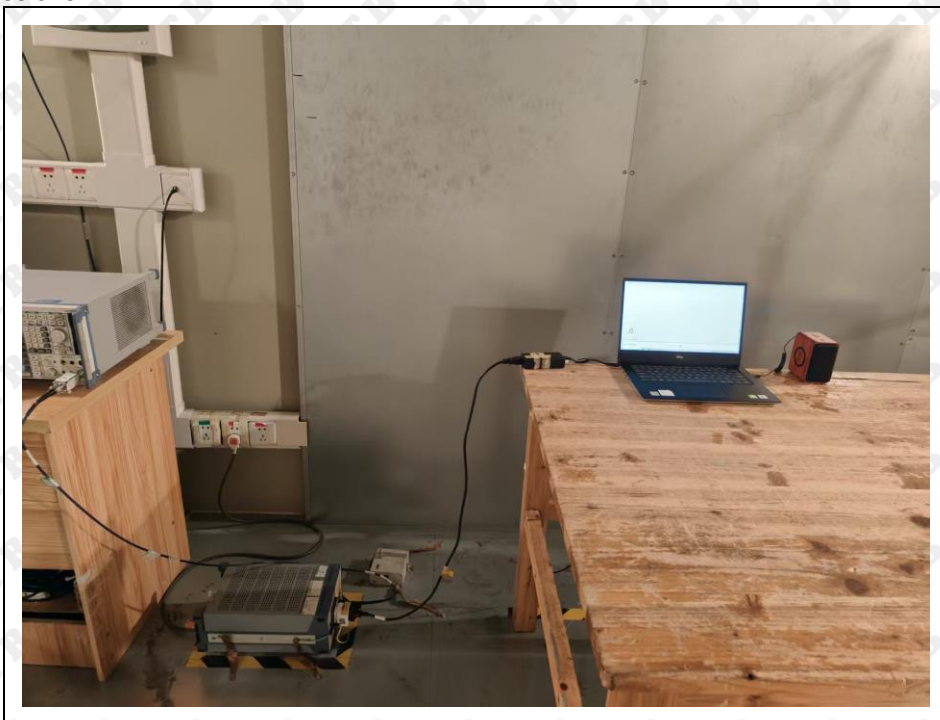
Below 1G



Above 1G



Conducted emissions



***** END OF REPORT *****