



3.4. 20db Bandwidth

Limit

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

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 30 KHz RBW and 100 KHz VBW.

The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

RBW=1% to 5% of the OBW

VBW=approximately 3 X RBW

Detector=Peak

Trace Mode: Max Hold

Use the 99% power bandwidth function of the instrument to measure the Occupied Bandwidth and recorded.

Test Configuration



Test Results

Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	CH00	0.948	Pass
	CH39	0.939	
	CH78	0.957	
$\pi/4$ DQPSK	CH00	1.350	
	CH39	1.284	
	CH78	1.341	
8DPSK	CH00	1.353	
	CH39	1.296	
	CH78	1.317	

Test plot as follows:

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20dB bandwidth

GFSK Modulation



CH00



CH39



CH78

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 $\pi/4$ DQPSK Modulation

CH00



CH39



CH78

8DPSK Modulation



CH00



CH39



CH78

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3.5. Frequency Separation

LIMIT

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 KHz 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 300 KHz RBW and 1000 KHz VBW.

TEST CONFIGURATION



TEST RESULTS

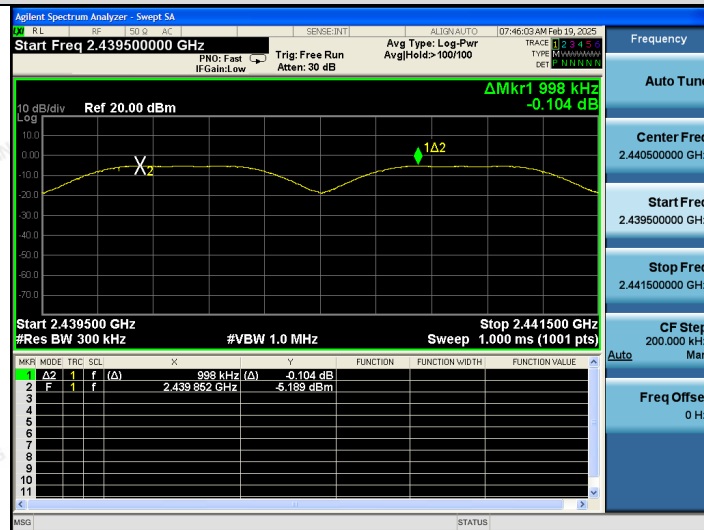
Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	Middle Channel	0.998	0.638	Pass
$\pi/4$ DQPSK	Middle Channel	1.000	0.900	Pass
8DPSK	Middle Channel	1.000	0.902	Pass

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

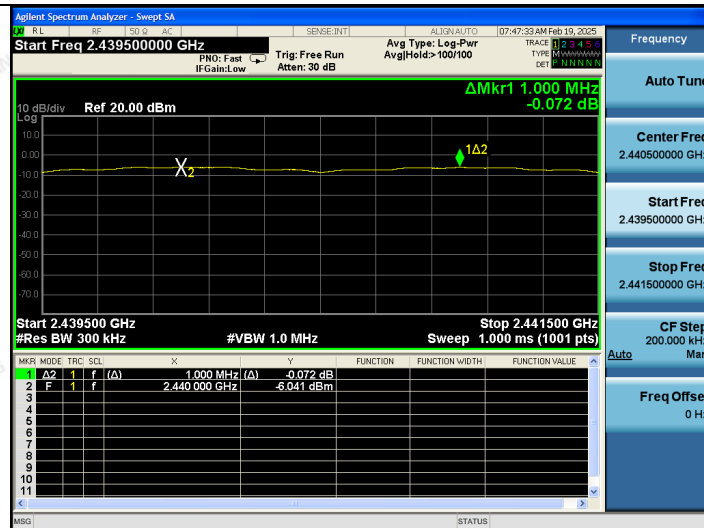
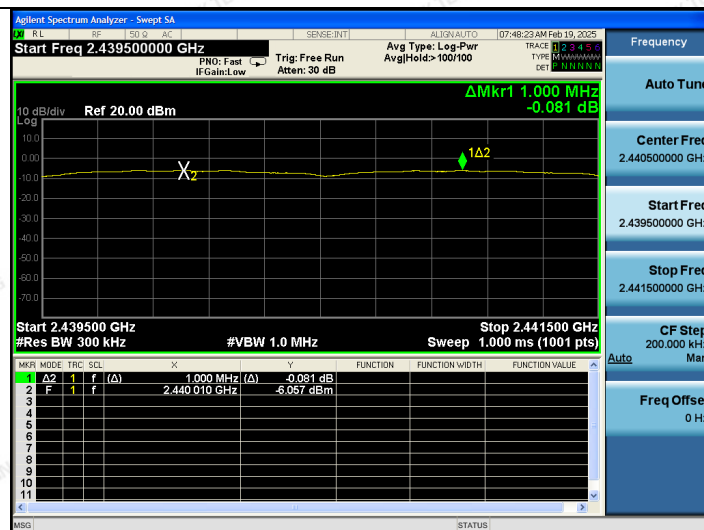
Test plot as follows:



Frequency Separation



GFSK

 $\pi/4$ DQPSK

8DPSK



3.6. 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.

Test Configuration



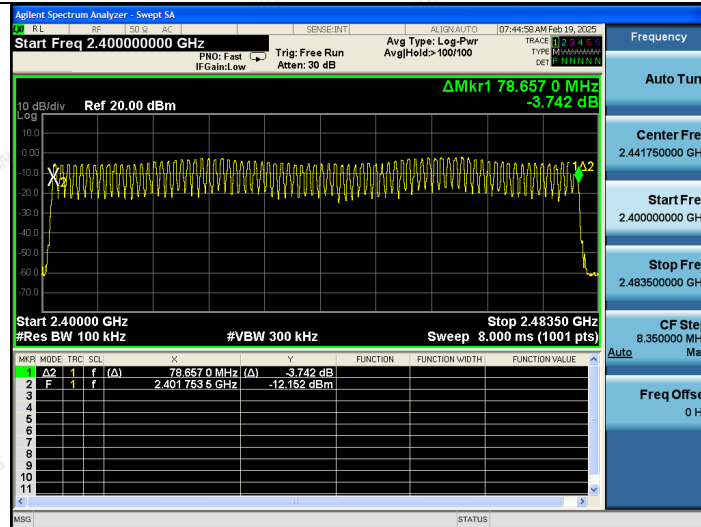
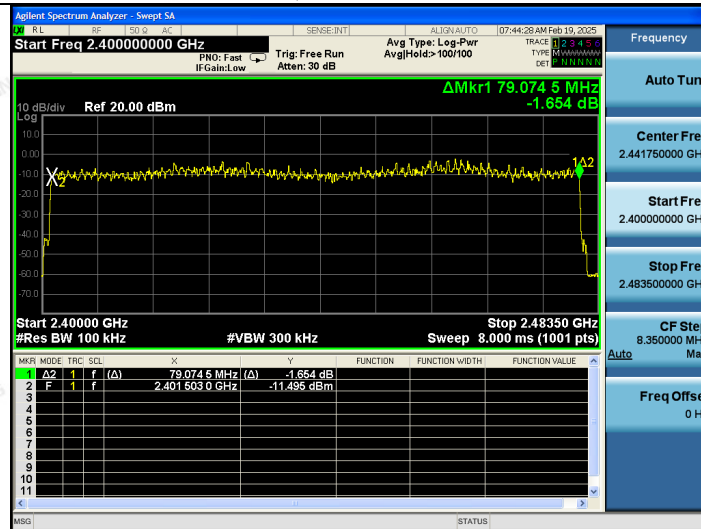
Test Results

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

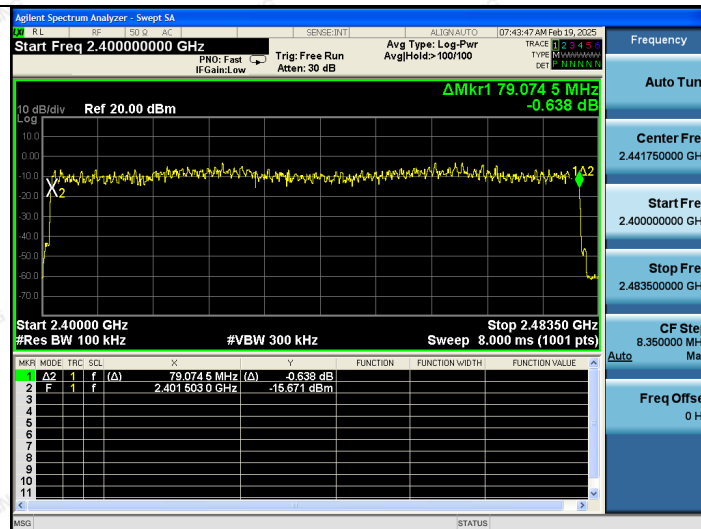
Test plot as follows:



GFSK Modulation

 $\pi/4$ DQPSK Modulation

8DPSK Modulation





3.7. 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 3MHz VBW, Span 0Hz.

Test Configuration



Test Results

Modulation	Packet	Pulse time (ms)	Dwell time (second)	Limit (second)	Result
GFSK	DH1	0.380	0.122	0.40	PASS
	DH3	1.635	0.262		
	DH5	2.884	0.308		
π/4DQPSK	2-DH1	0.386	0.124	0.40	PASS
	2-DH3	1.638	0.262		
	2-DH5	2.885	0.308		
8DPSK	3-DH1	0.386	0.124	0.40	PASS
	3-DH3	1.638	0.262		
	3-DH5	2.888	0.308		

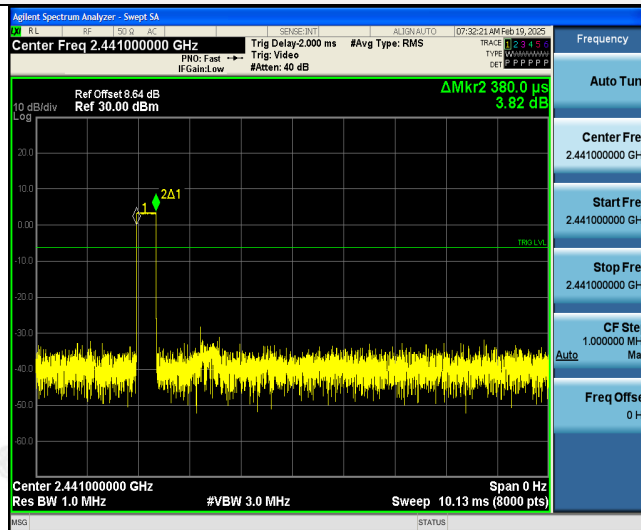
Note:

1. We have tested all mode at high, middle and low channel, and recorded worst case at middle channel.
2. 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

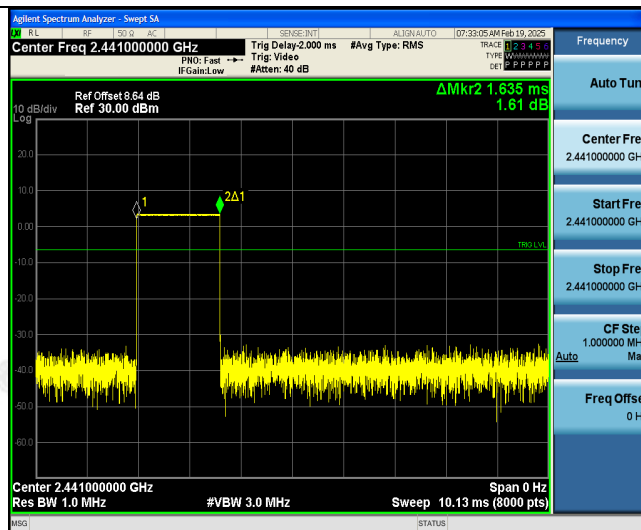
Test plot as follows:



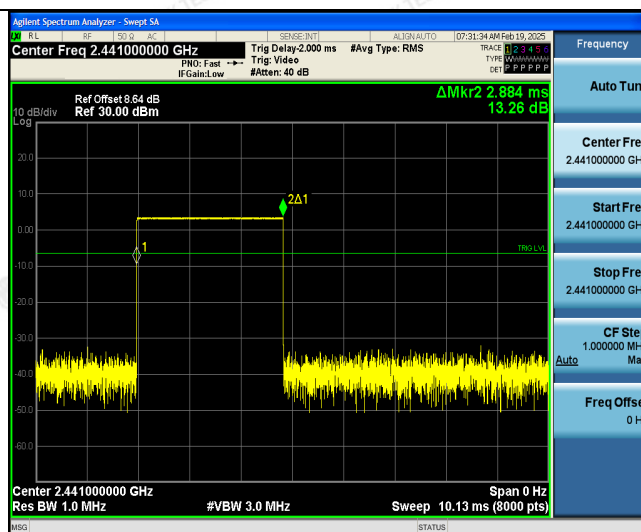
GFSK Modulation



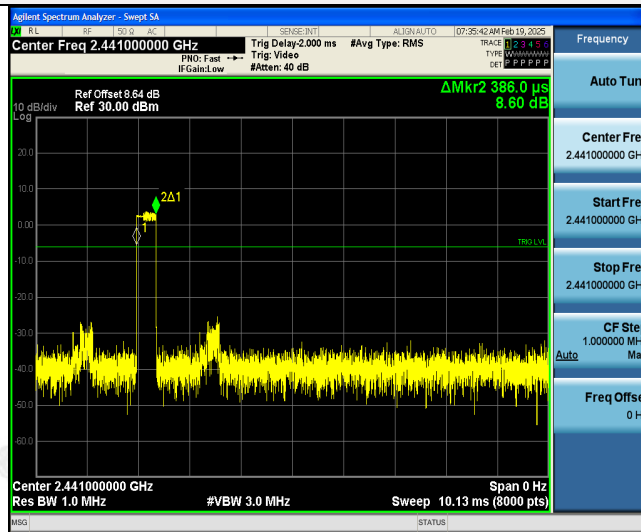
DH1



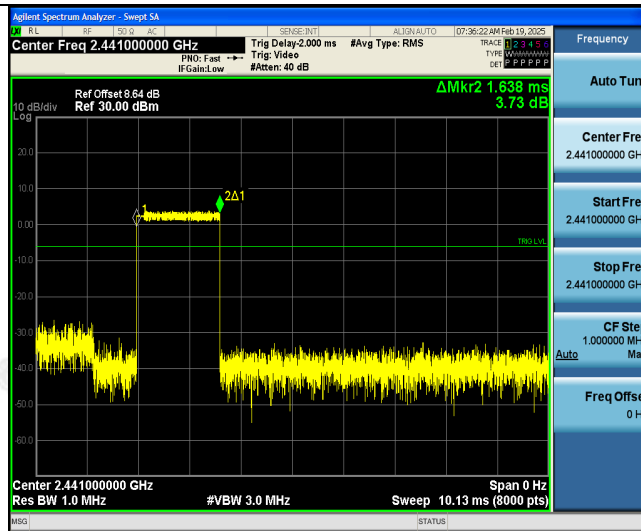
DH3



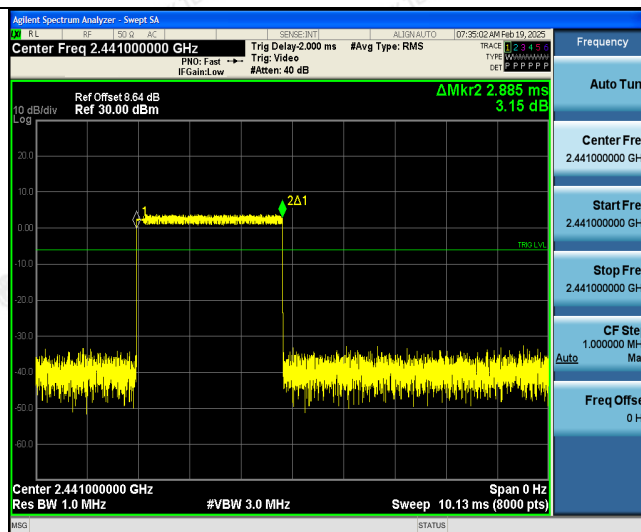
DH5

 $\pi/4$ DQPSK Modulation

2-DH1



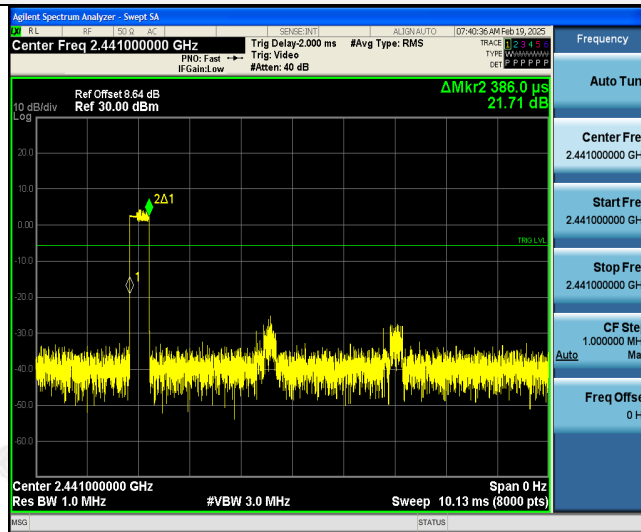
2-DH3



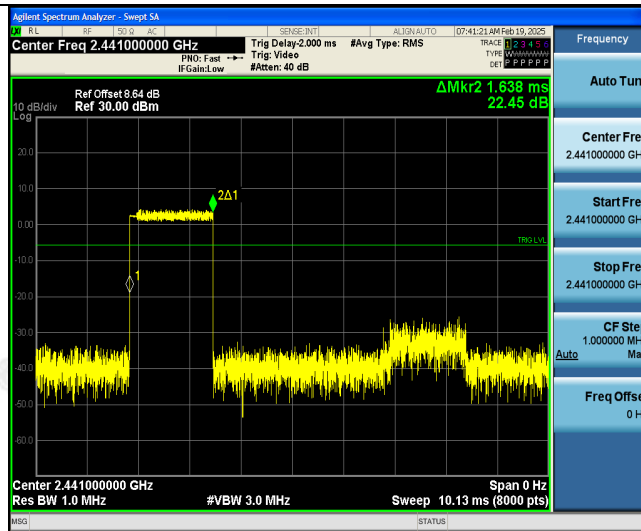
2-DH5



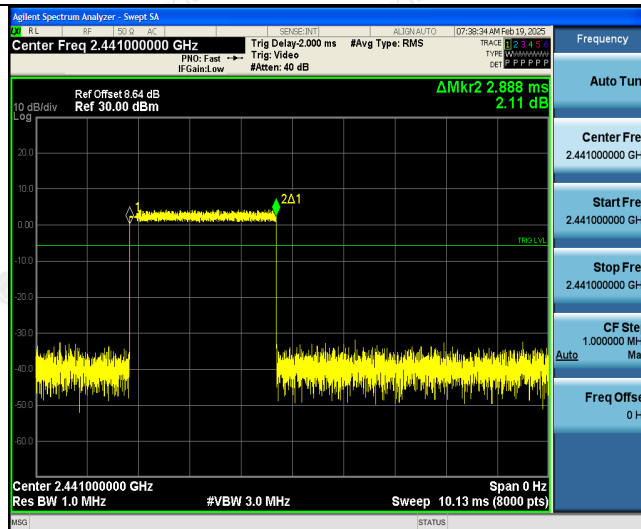
8DPSK Modulation



3-DH1



3-DH3



3-DH5



3.8. Out-of-Band Emissions

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, band edge and out-of-band emissions.

Test Configuration



Test Results

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and band edge measurement data.

We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5, 2DH5 and 3DH5.

Test plot as follows:

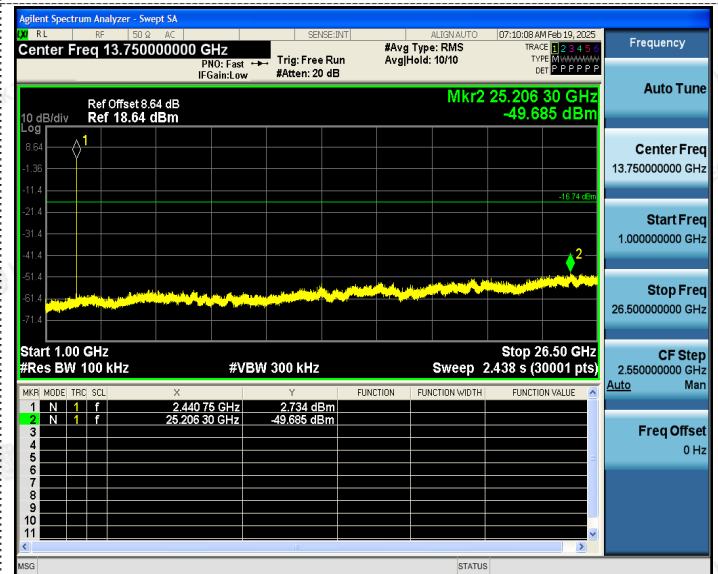
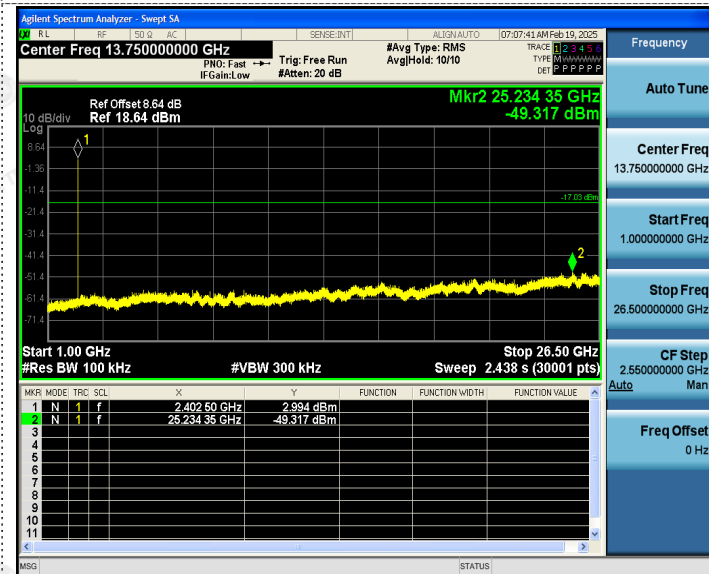
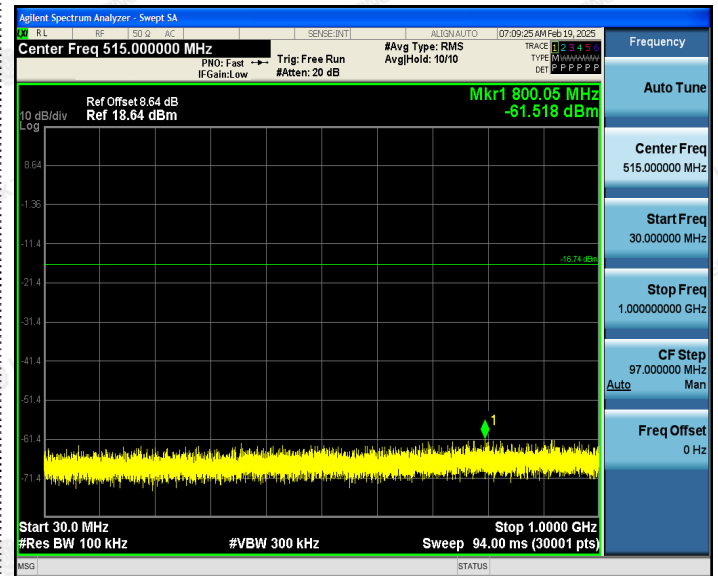
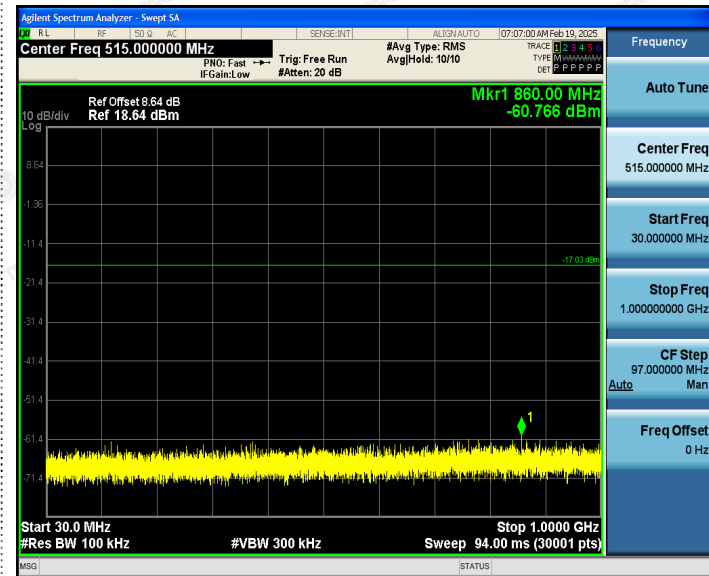
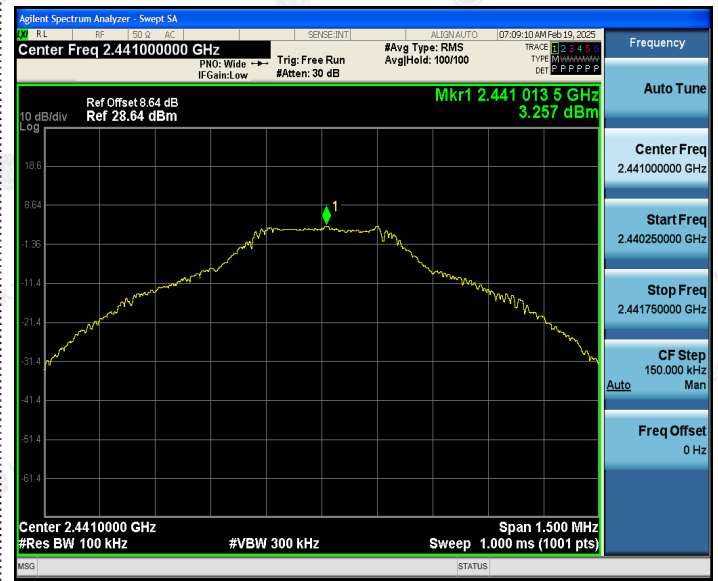


GFSK

CH00



CH39



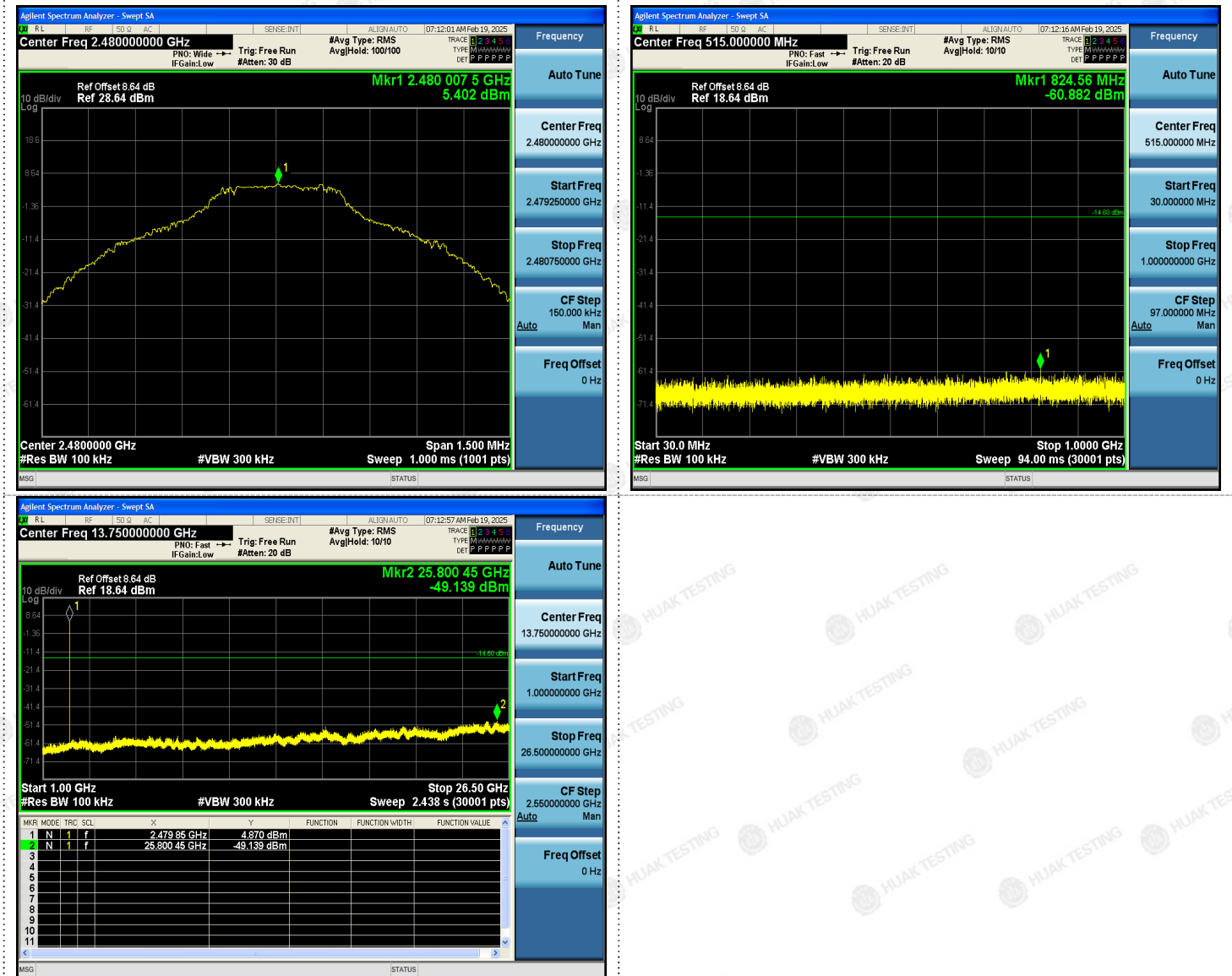
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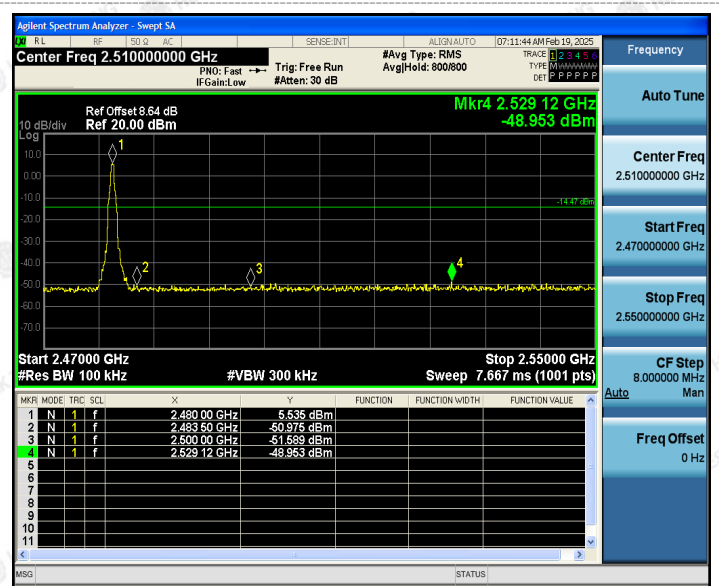
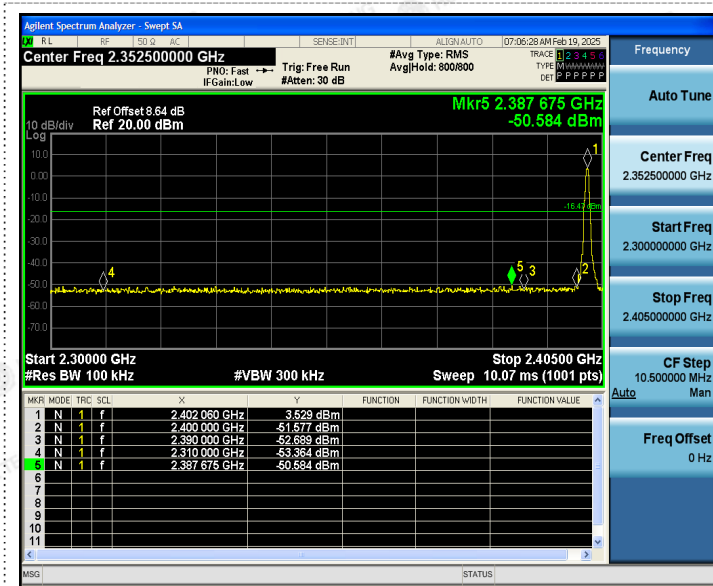
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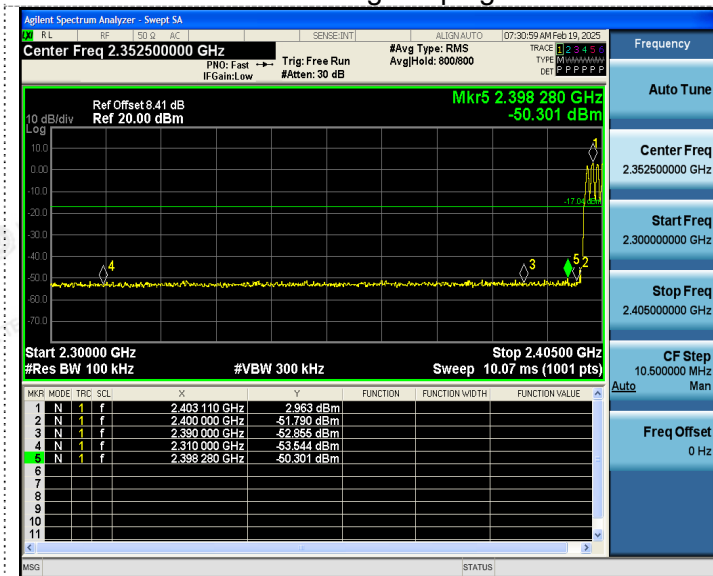


CH78



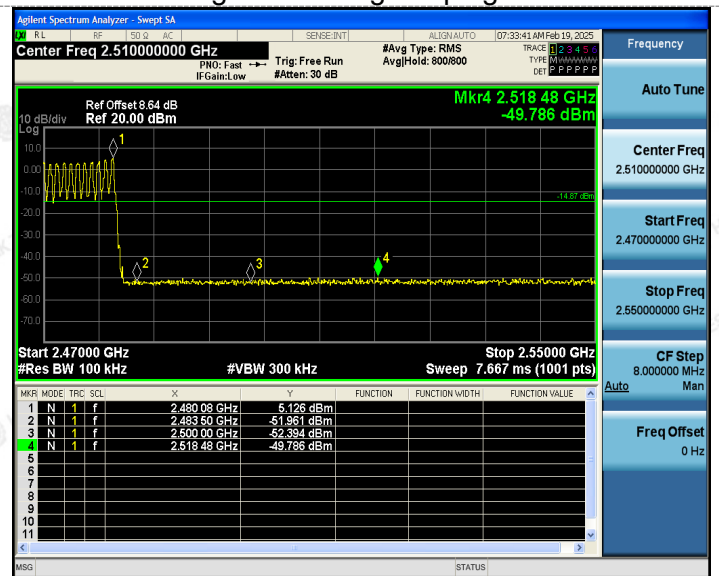


Left Band edge hopping off



Left Band edge hopping on

Right Band edge hopping off



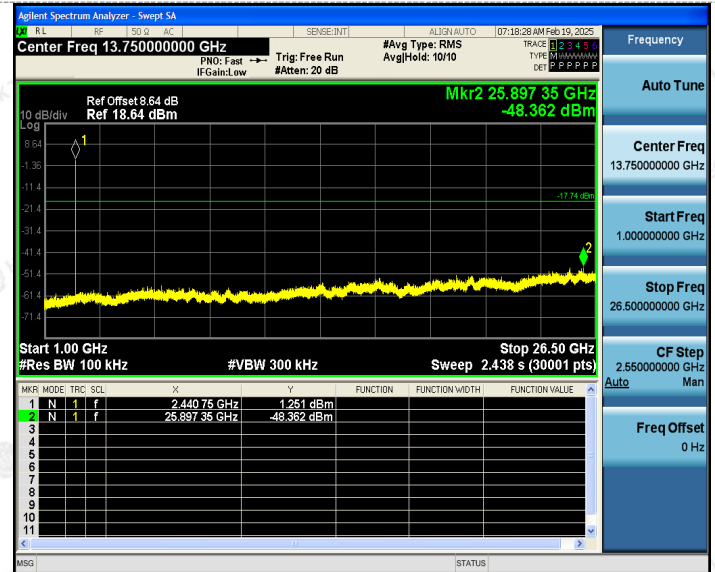
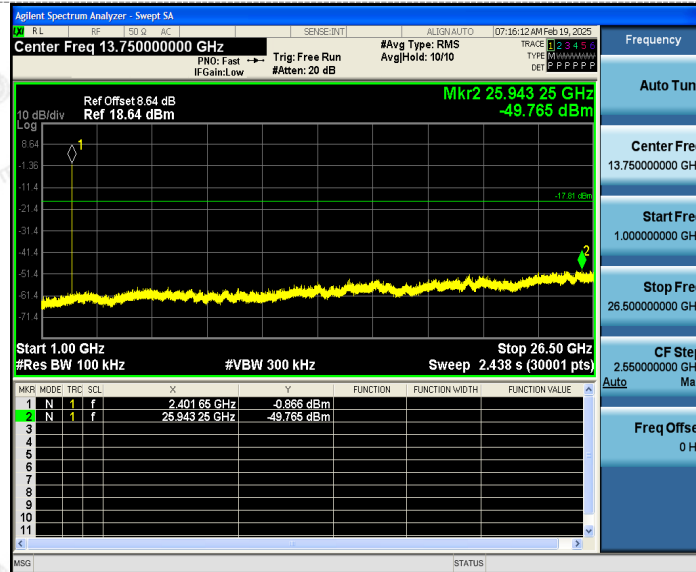
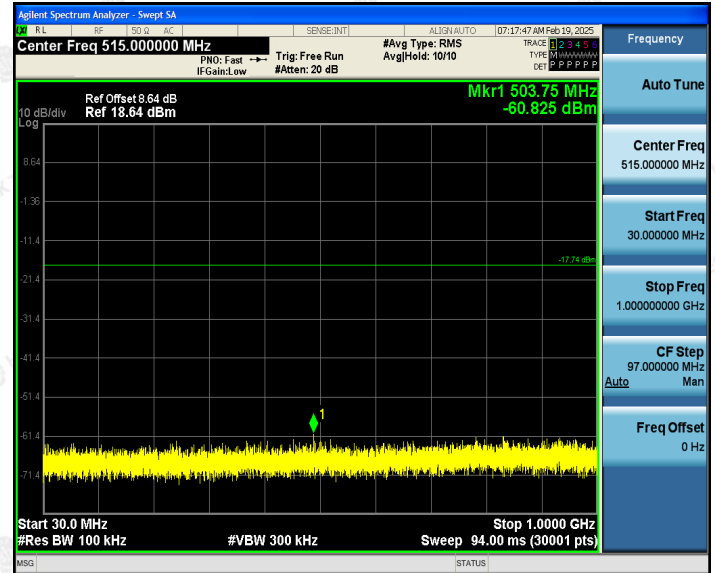
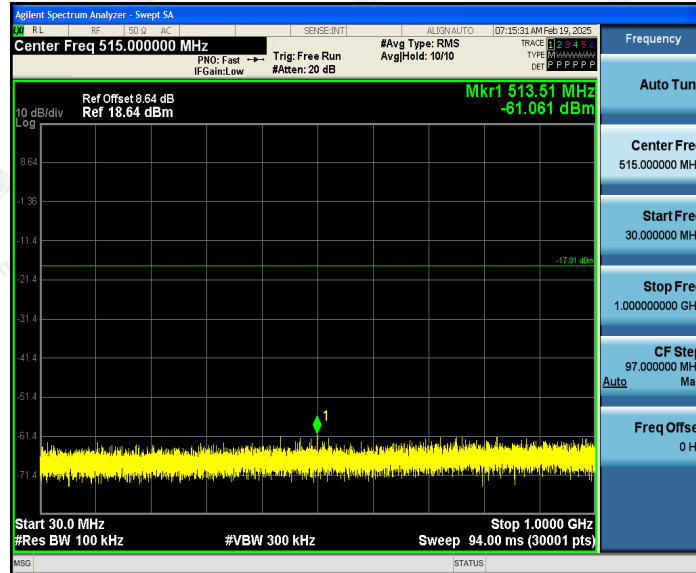
Right Band edge hopping on

 $\pi/4$ DQPSK

CH00



CH39



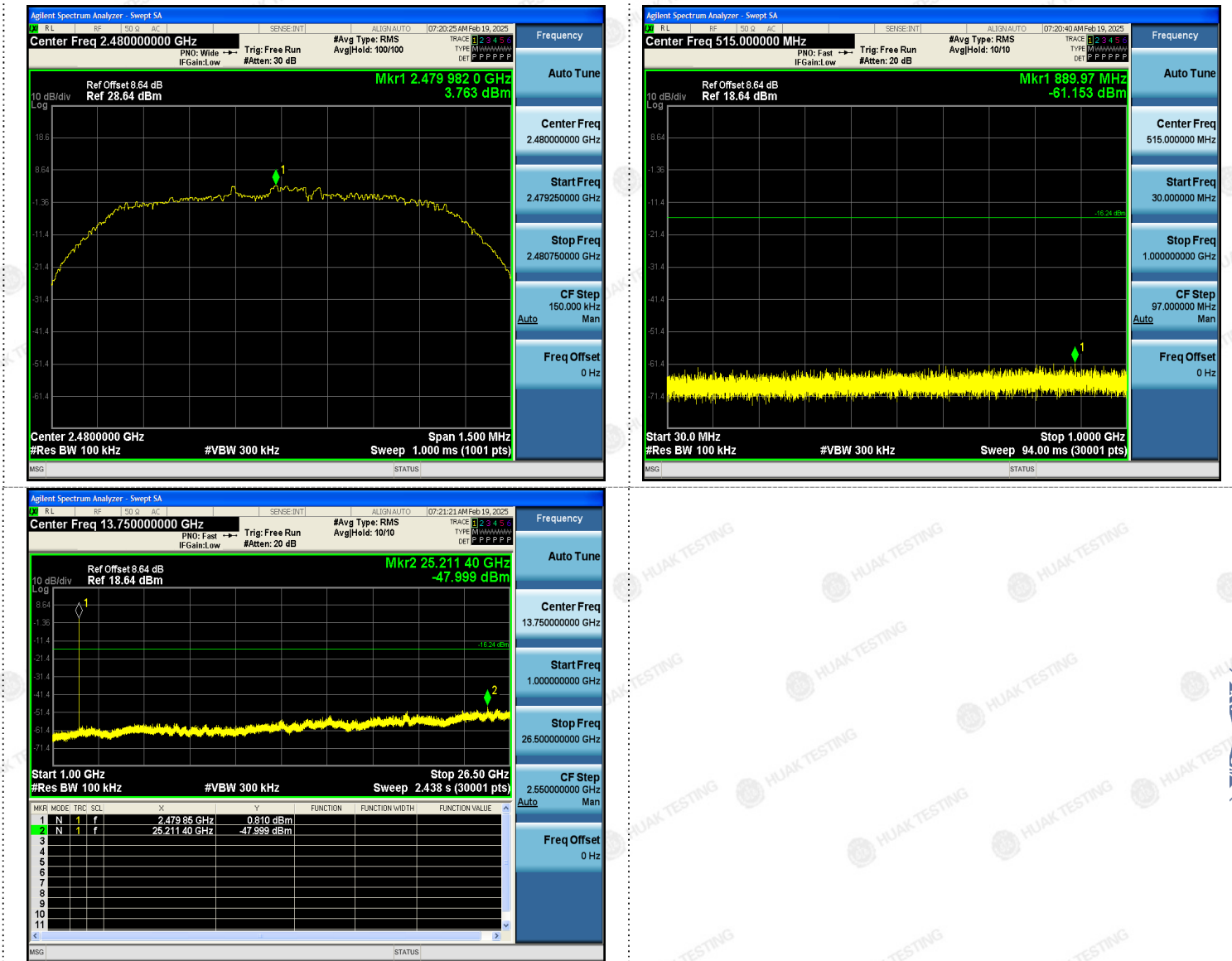
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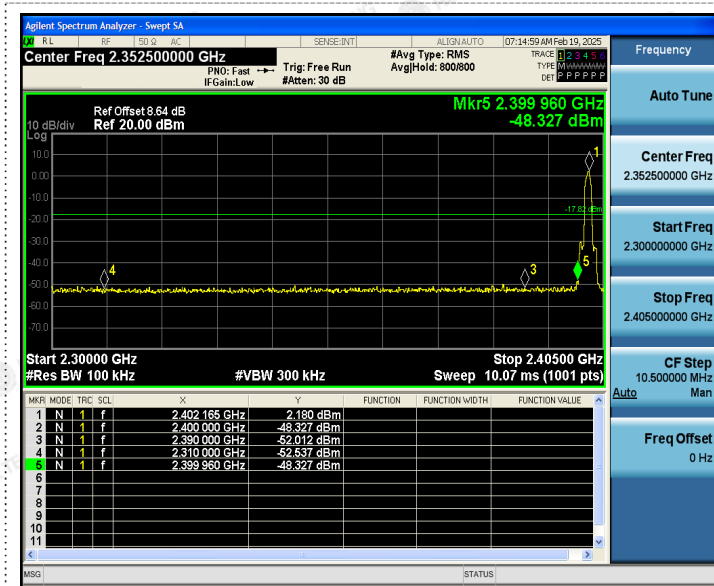
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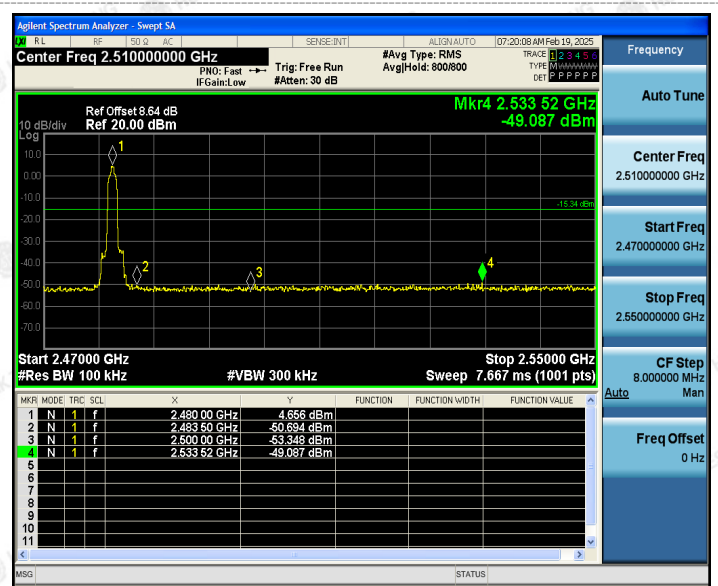


CH78

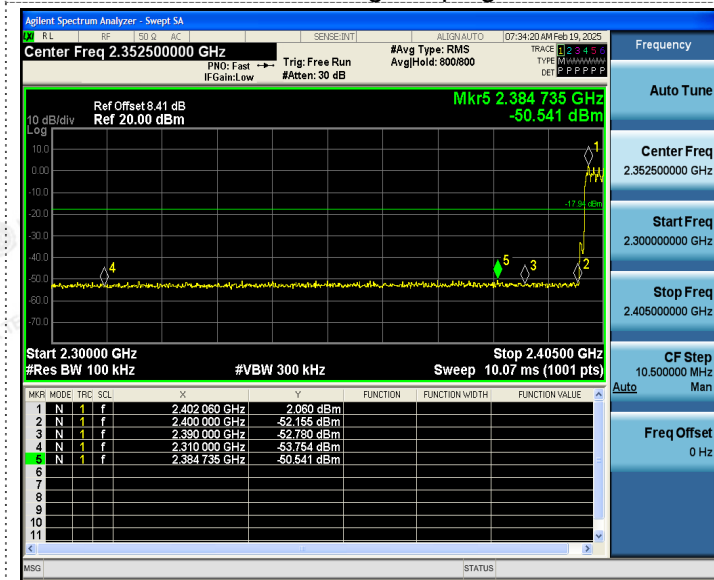




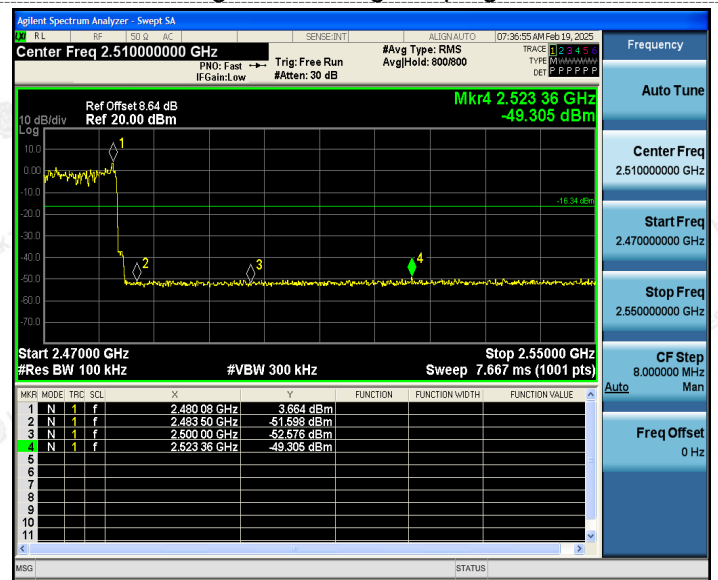
Left Band edge hopping off



Right Band edge hopping off



Left Band edge hopping on



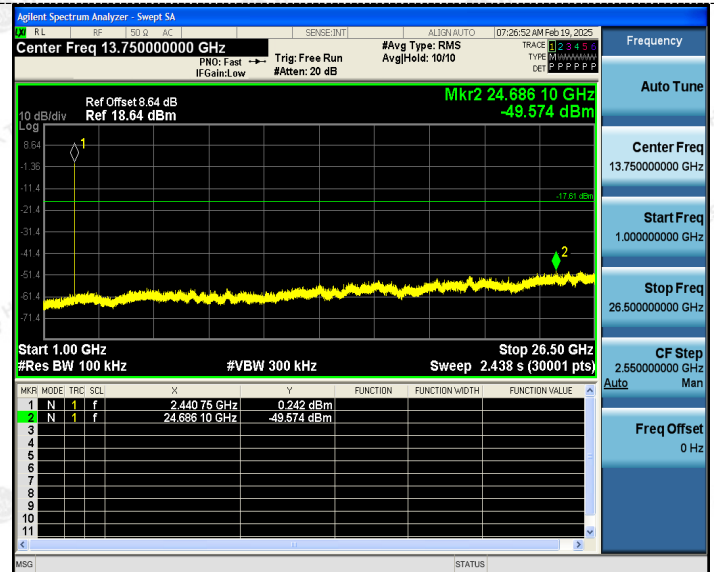
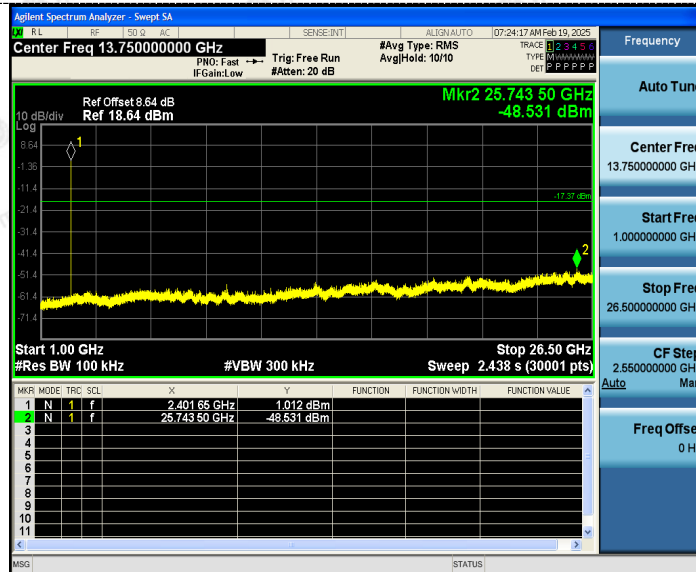
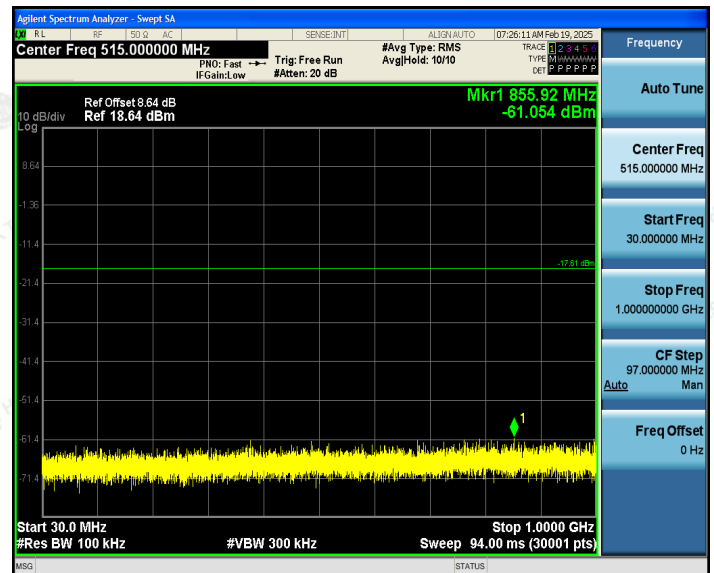
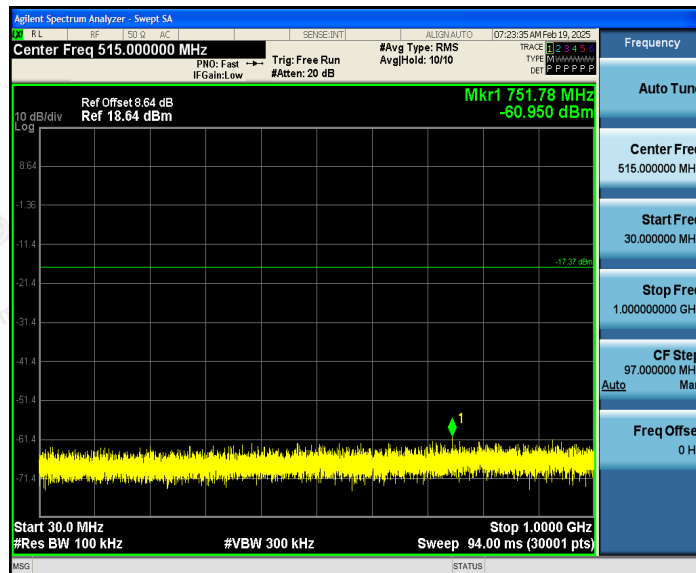
Right Band edge hopping on



8DPSK

CH00

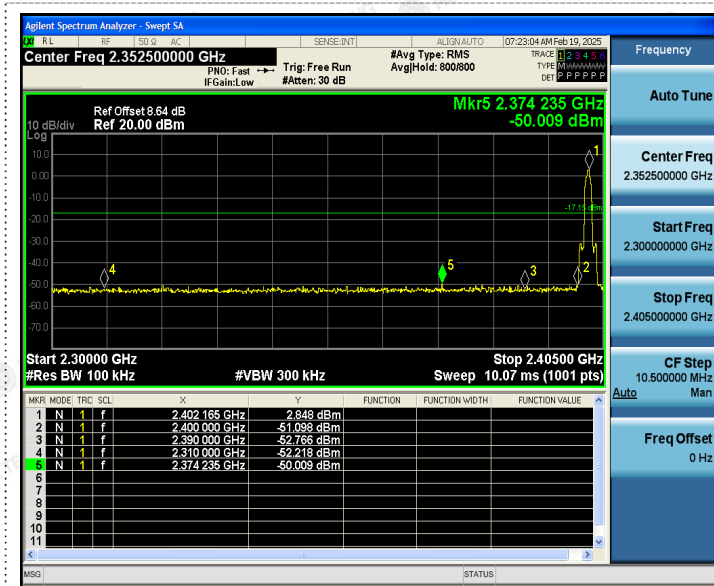
CH39



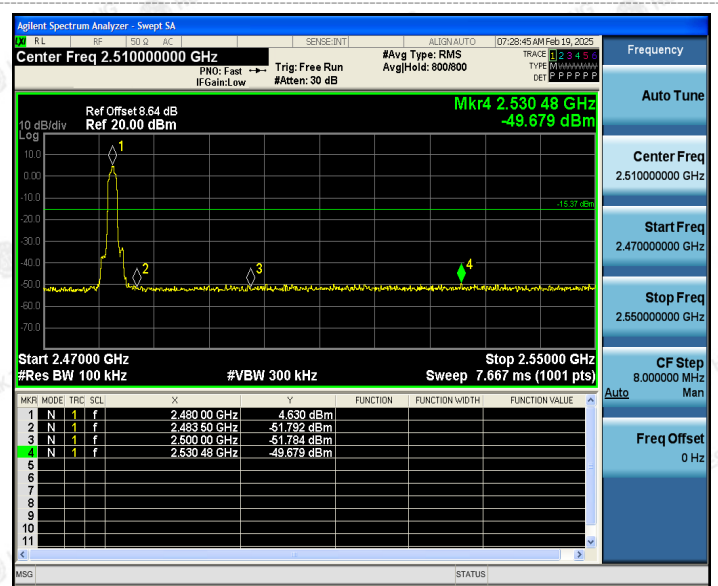


CH78

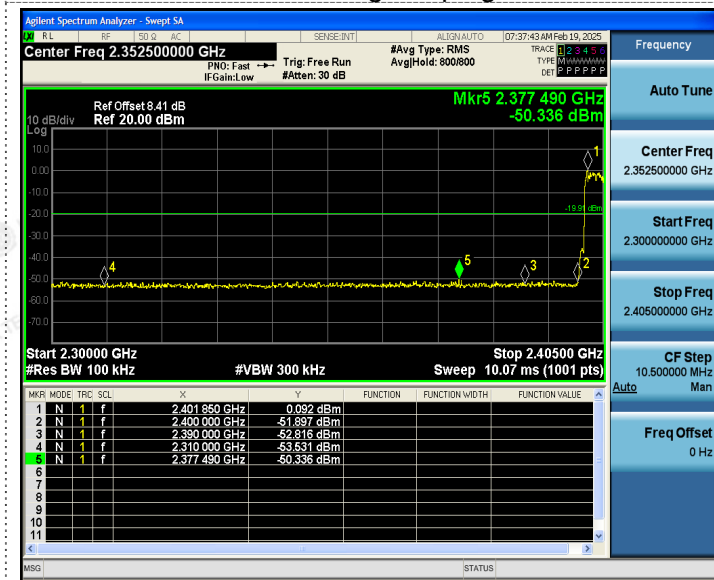




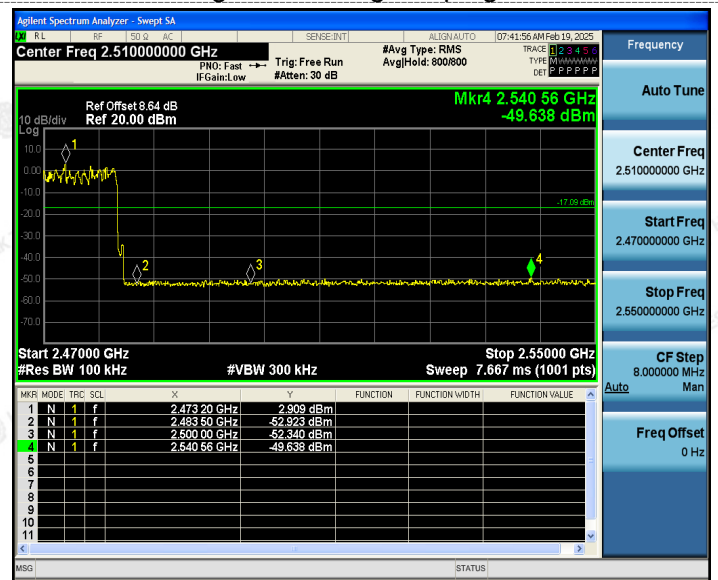
Left Band edge hopping off



Right Band edge hopping off



Left Band edge hopping on



Right Band edge hopping on



3.9. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

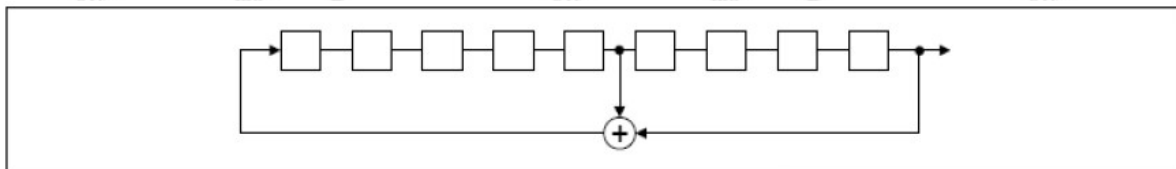
For 47 CFR Part 15C section 15.247 (a) (1):

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

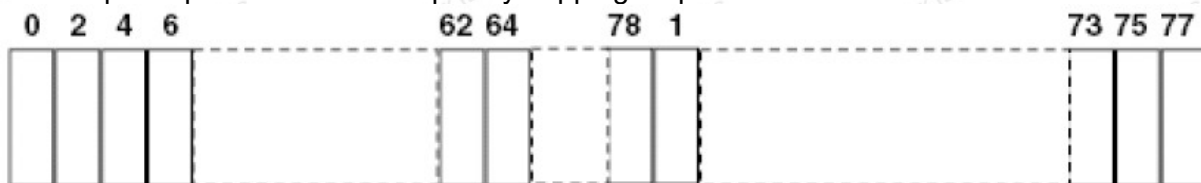
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: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



3.10. 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, 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.

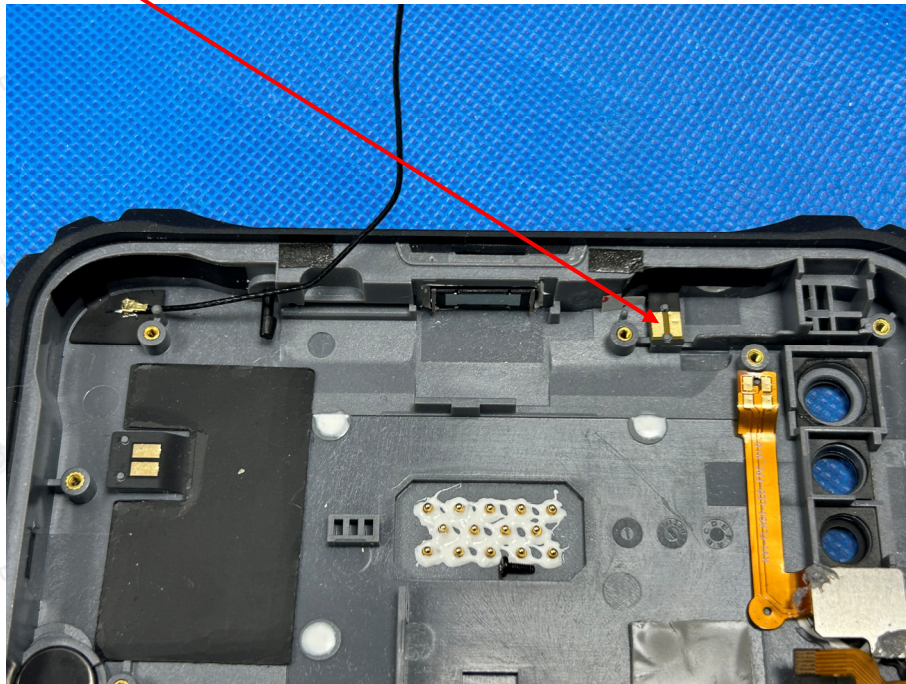
Refer to statement below for compliance.

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 antenna used in this product is a FPC Antenna, need professional installation, not easy to remove. It conforms to the standard requirements. The directional gains of antenna used for transmitting is 2.67dBi.

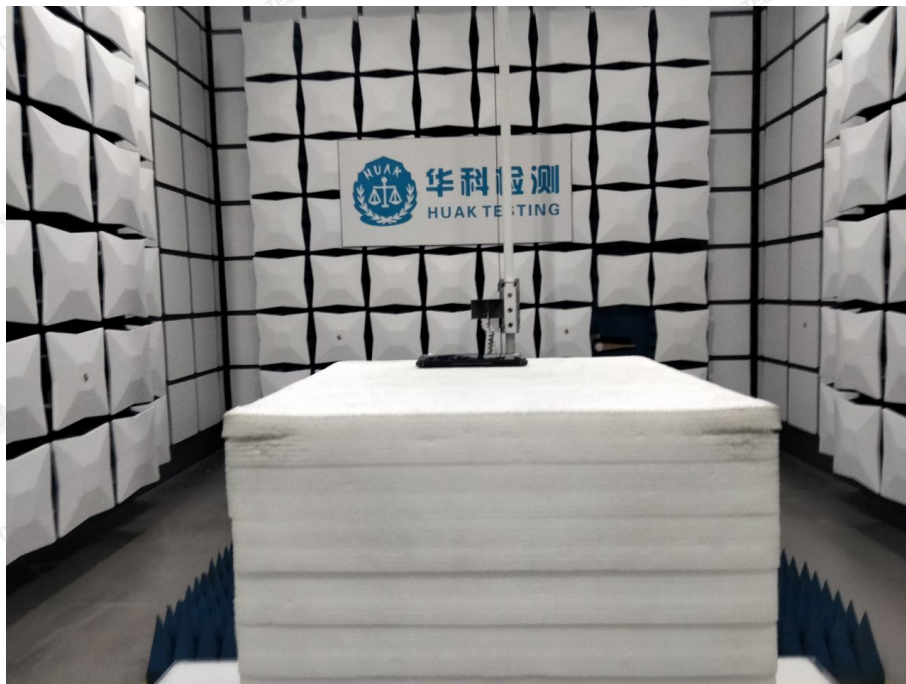
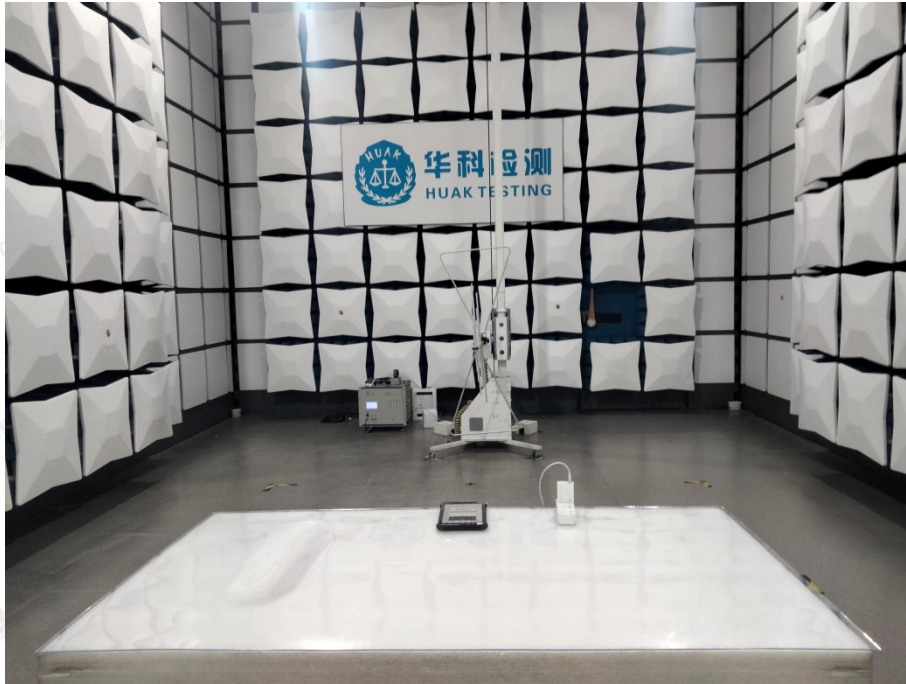
Antenna





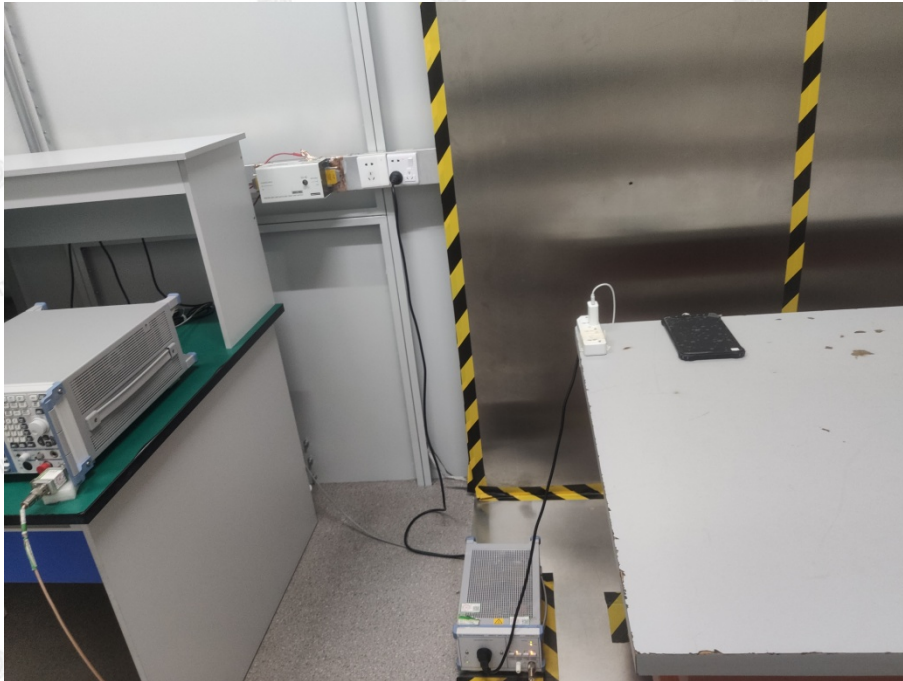
4. Test Setup Photos of the EUT

Radiated Emissions





Conducted Emission



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5. Photos of the EUT

Reference to the report: ANNEX A of external photos and ANNEX B of internal photos.

-----End of test report-----