





### 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



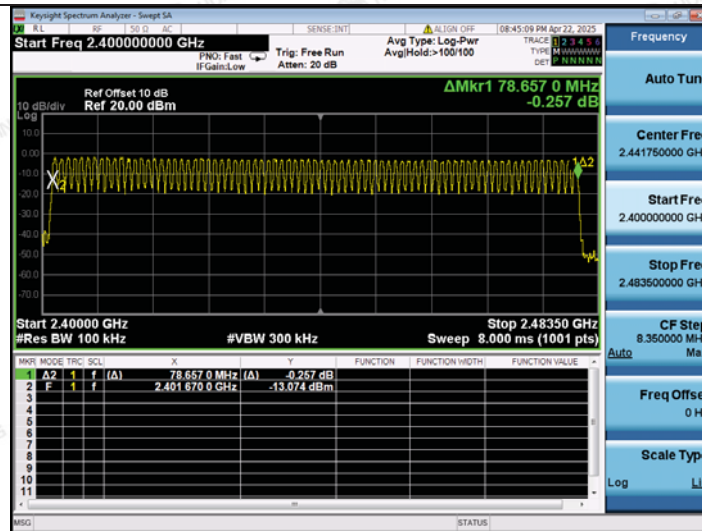
#### Test Results

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

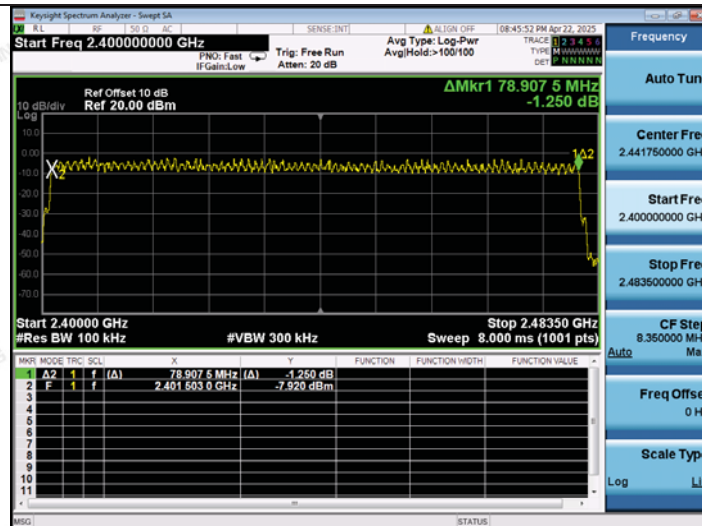
Test plot as follows:



## GFSK Modulation



## $\pi/4$ QPSK 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	0.381	0.122	0.40	Pass
	DH3	1.637	0.262		
	DH5	2.885	0.308		
π/4DQPSK	2-DH1	0.390	0.125	0.40	Pass
	2-DH3	1.642	0.263		
	2-DH5	2.891	0.308		

Note:

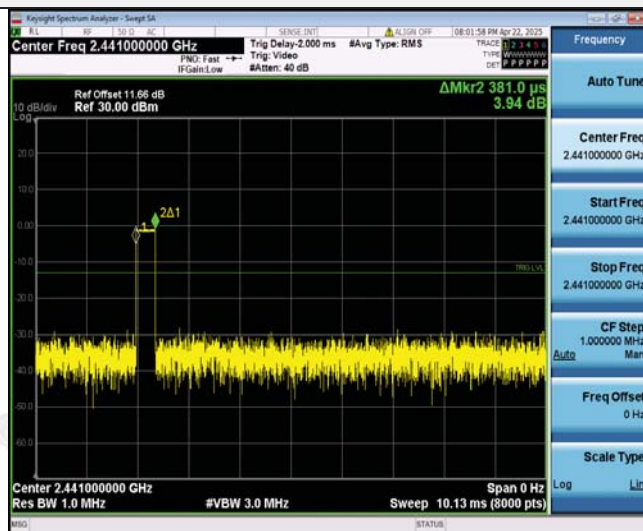
- We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
- $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 2 \div 79) \times 31.6$  Second for DH1, 2-DH1  
 $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 4 \div 79) \times 31.6$  Second for DH3, 2-DH3  
 $\text{Dwell time} = \text{Pulse time (ms)} \times (1600 \div 6 \div 79) \times 31.6$  Second for DH5, 2-DH5

Test plot as follows:

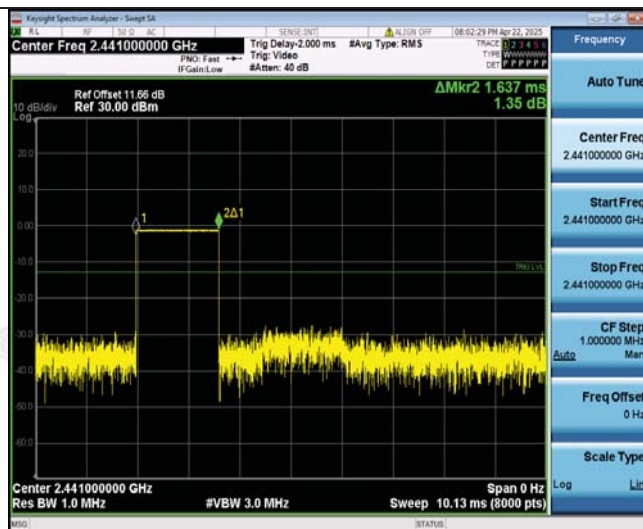




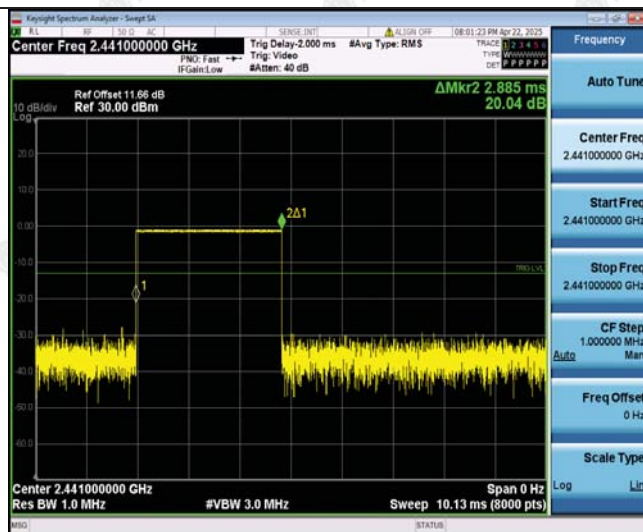
## GFSK Modulation



## DH1



## DH3



## DH5

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Keysight Spectrum Analyzer - Source SA

SENSE [INT] ALIGN CHS 08:04:22 PM Apr 22, 2025

Center Freq 2.441000000 GHz Trig Delay: 2.000 ms #Avg Type: RMS

PMW Fast → PNO: Fast TYPE WWWWWW DET ZZZZZZ

IF Gain: Low #Atten: 40 dB

Ref Offset 11.66 dB Ref 30.00 dBm

ΔMkr2 390.0 μs 7.35 dB

2d1

10 dB/div Log

Center 2.441000000 GHz Span 0 Hz

Res BW 1.0 MHz #VBW 3.0 MHz Sweep 10.13 ms (8000 pts)

Log Lin

Frequency

Auto Tune

Center Freq 2.441000000 GHz

Start Freq 2.441000000 GHz

Stop Freq 2.441000000 GHz

CF Step 1.000000 MHz

Auto

Freq Offset 0 Hz

Scale Type

Keysight Spectrum Analyzer - Swept SA

SENSE INT

08:04:53 PM Apr 22, 2025

Center Freq 2.441000000 GHz

Trig Delay: 2000 ms

Avg Type: RMS

Trace 1: 1, 4, 5, 6

PHO Fast

IF Gain: Low

Trig: Video

#Atten: 40 dB

TYPE WWWWWWWW

DET AVERAGE

Ref Offset: 11.66 dB

Ref 30.00 dBm

$\Delta$ Mkr2 1.642 ms

0.93 dB

10 dB/div

Log

1

2Δ1

INDIVIDUAL

Center 2.441000000 GHz

Res BW 1.0 MHz

#VBW 3.0 MHz

Sweep 10.13 ms (8000 pts)

Span 0 Hz

Log

Auto Tune

Center Freq 2.441000000 GHz

Start Freq 2.441000000 GHz

Stop Freq 2.441000000 GHz

CF Step 1.000000 MHz

Auto

Man

Freq Offset 0 Hz

Scale Type

Log

Lin

STATUS

[illegible]

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### 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 settings 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 and 2DH5

Test plot as follows:

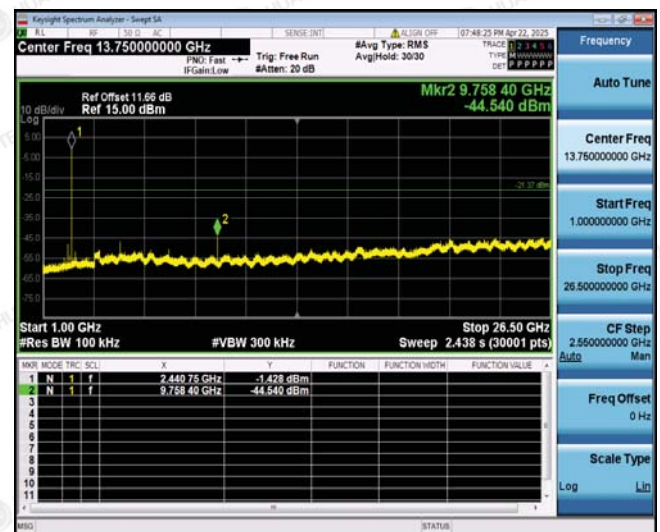
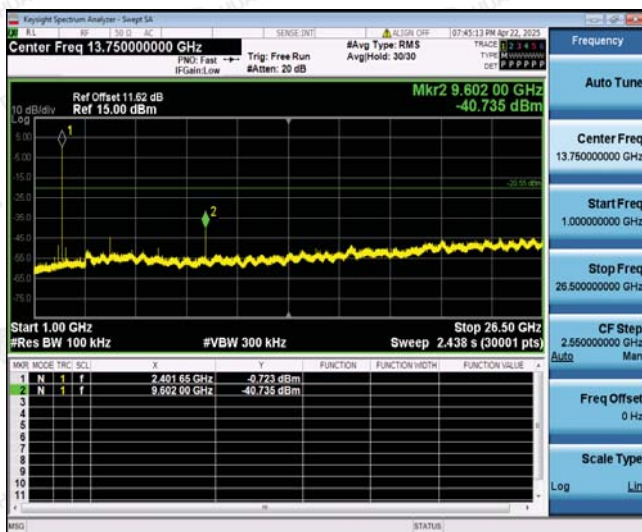
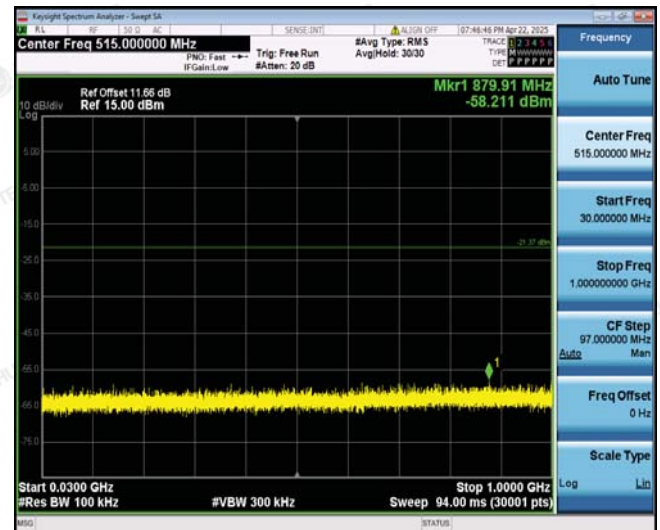
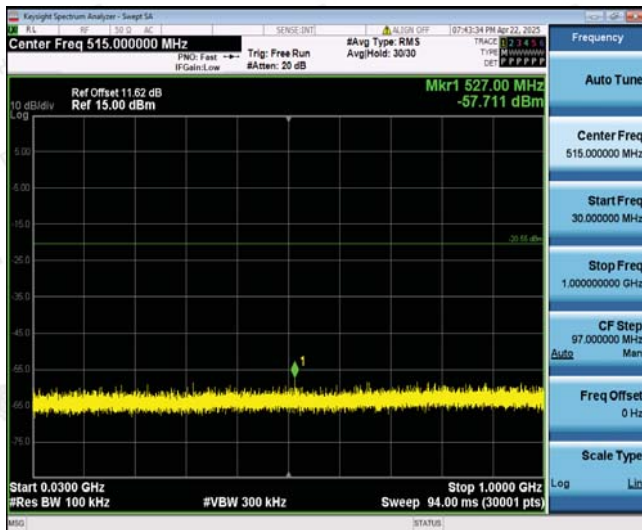




## GFSK

CH00

CH39



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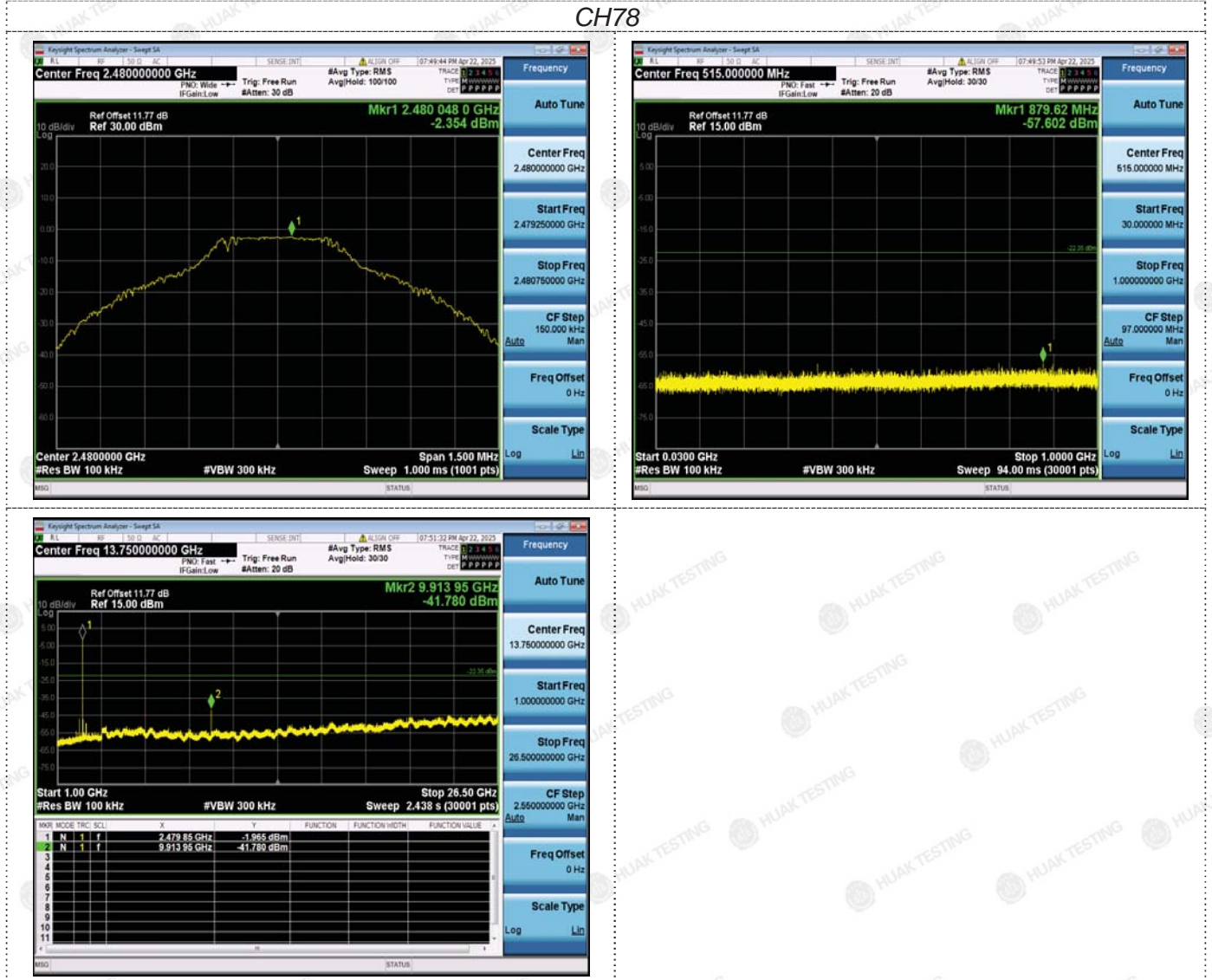
TEL : +86-755 2302 9901 FAX : +86-755 2302 9901 E-mail : [service@cer-mark.com](mailto:service@cer-mark.com)

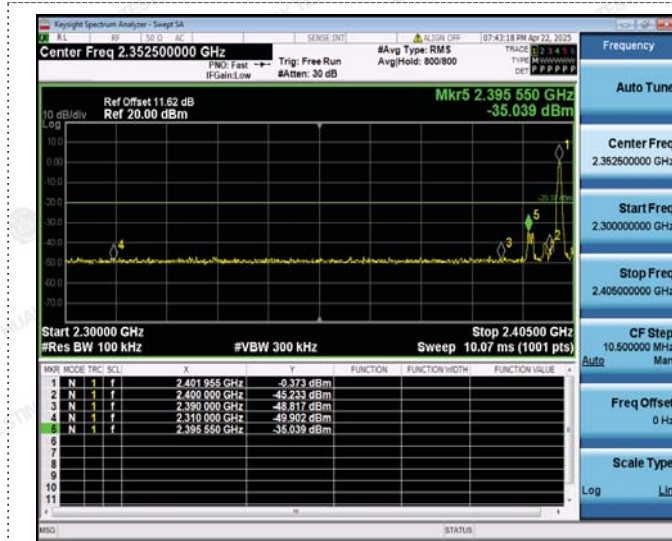
Add: 1-2F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China



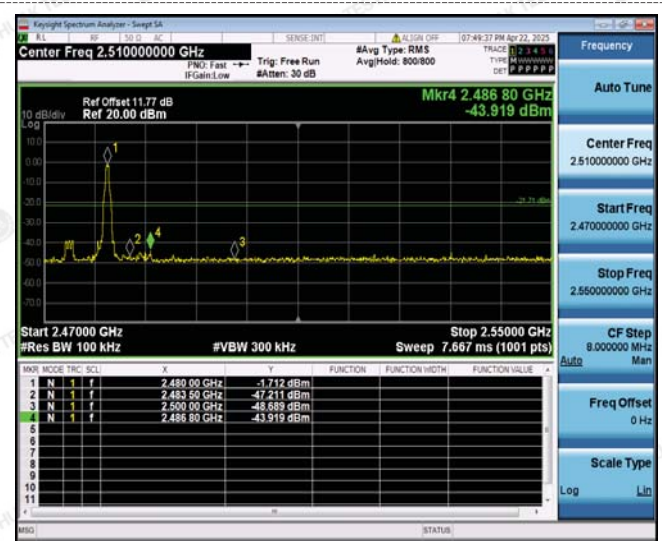


CH78

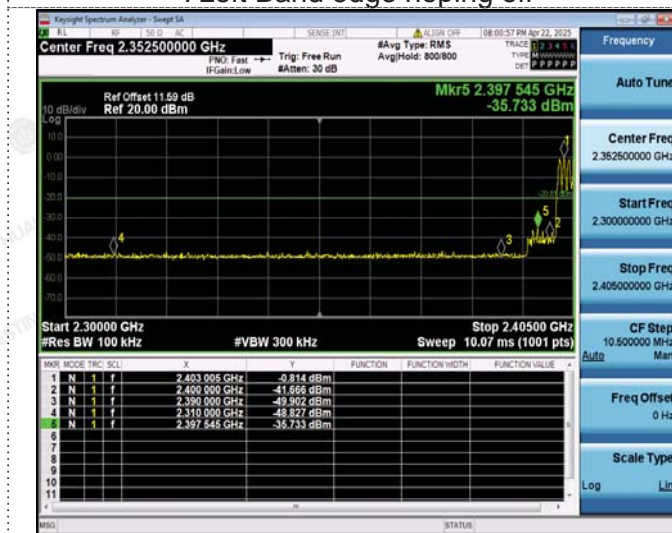




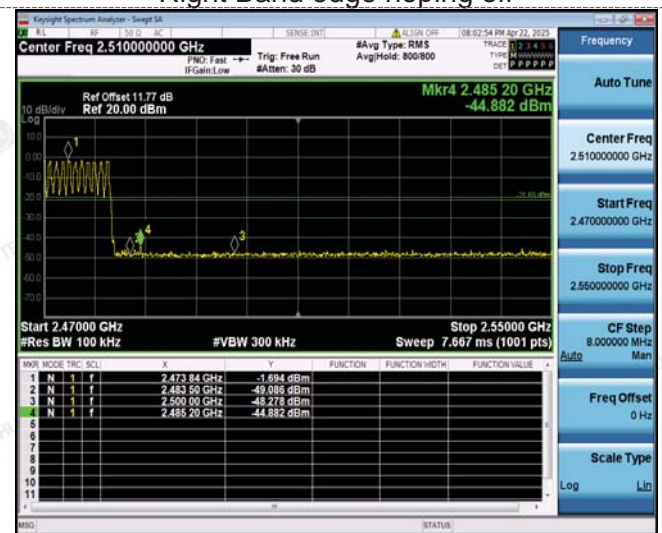
7Left Band edge hopping off



Right Band edge hopping off



Left Band edge hopping on



Right Band edge hopping on



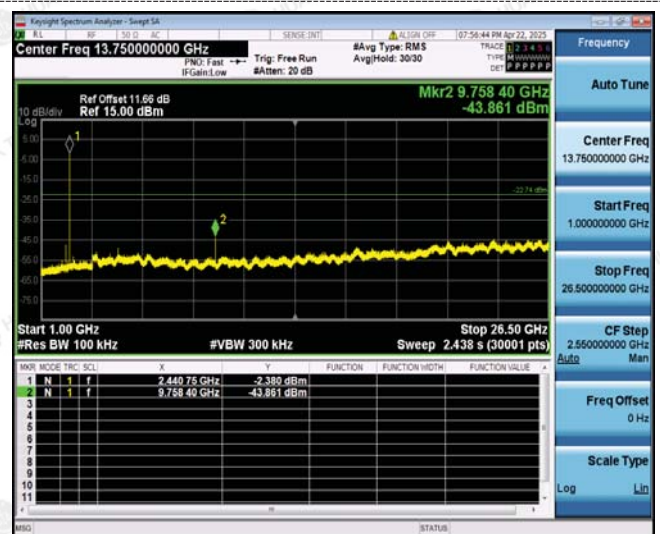
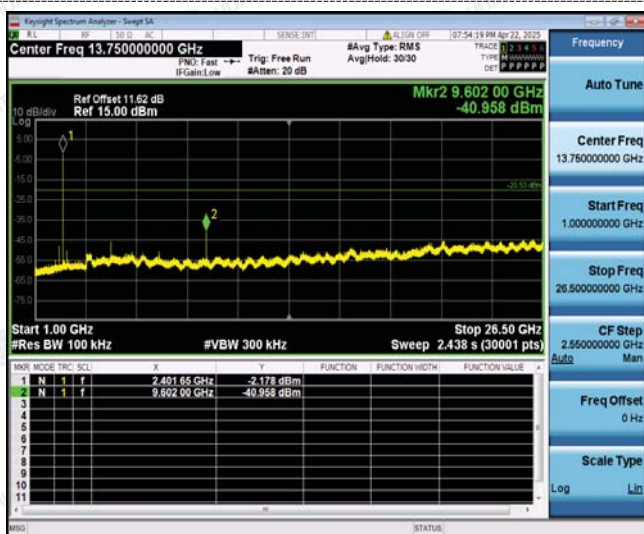
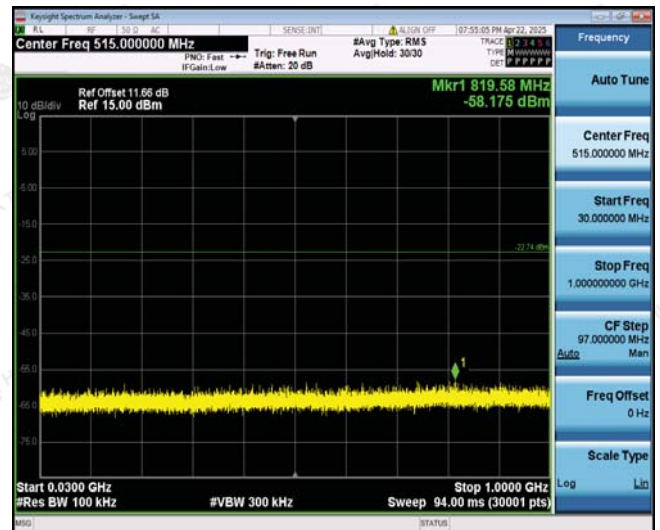
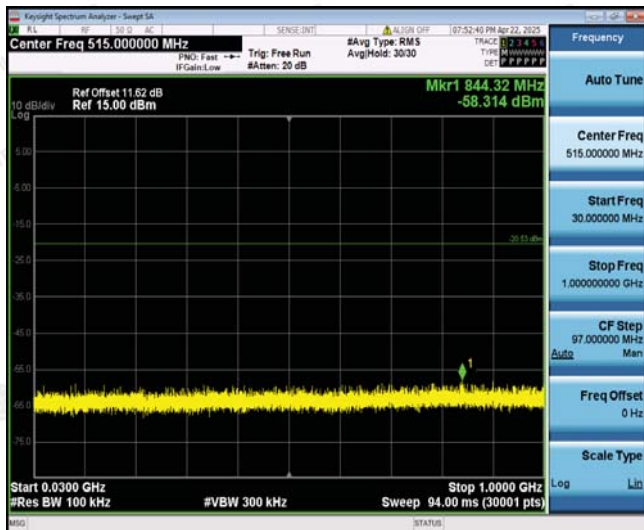
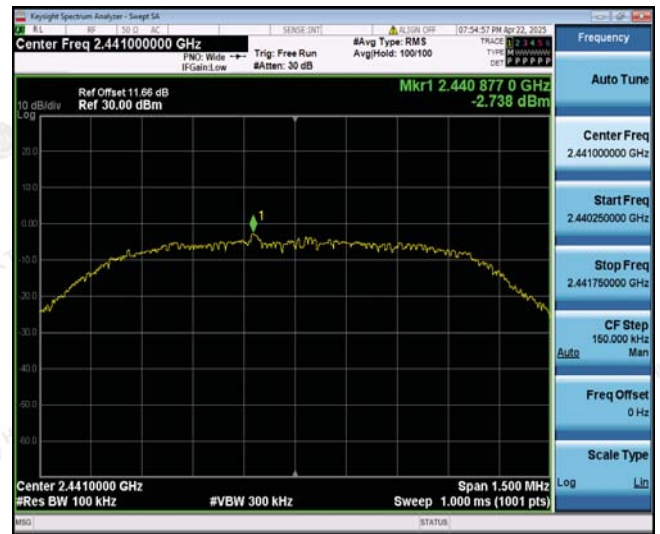


## $\pi/4$ DQPSK

CH00



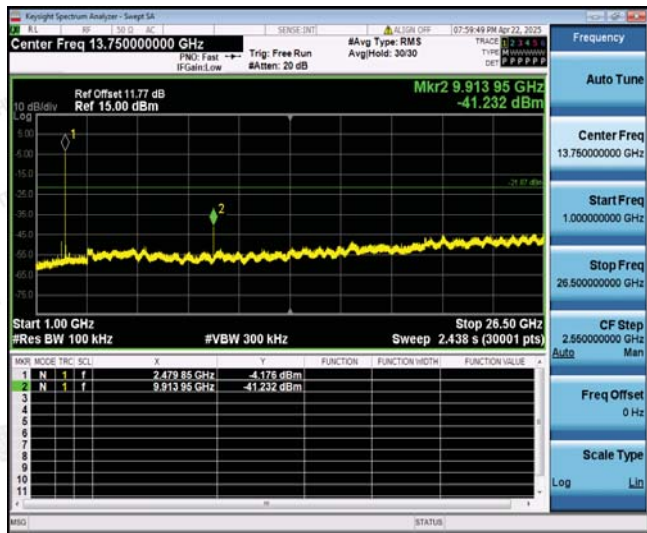
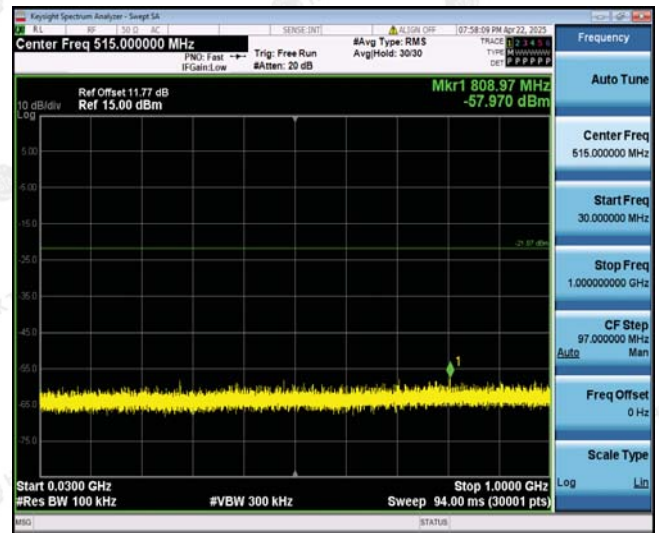
CH39

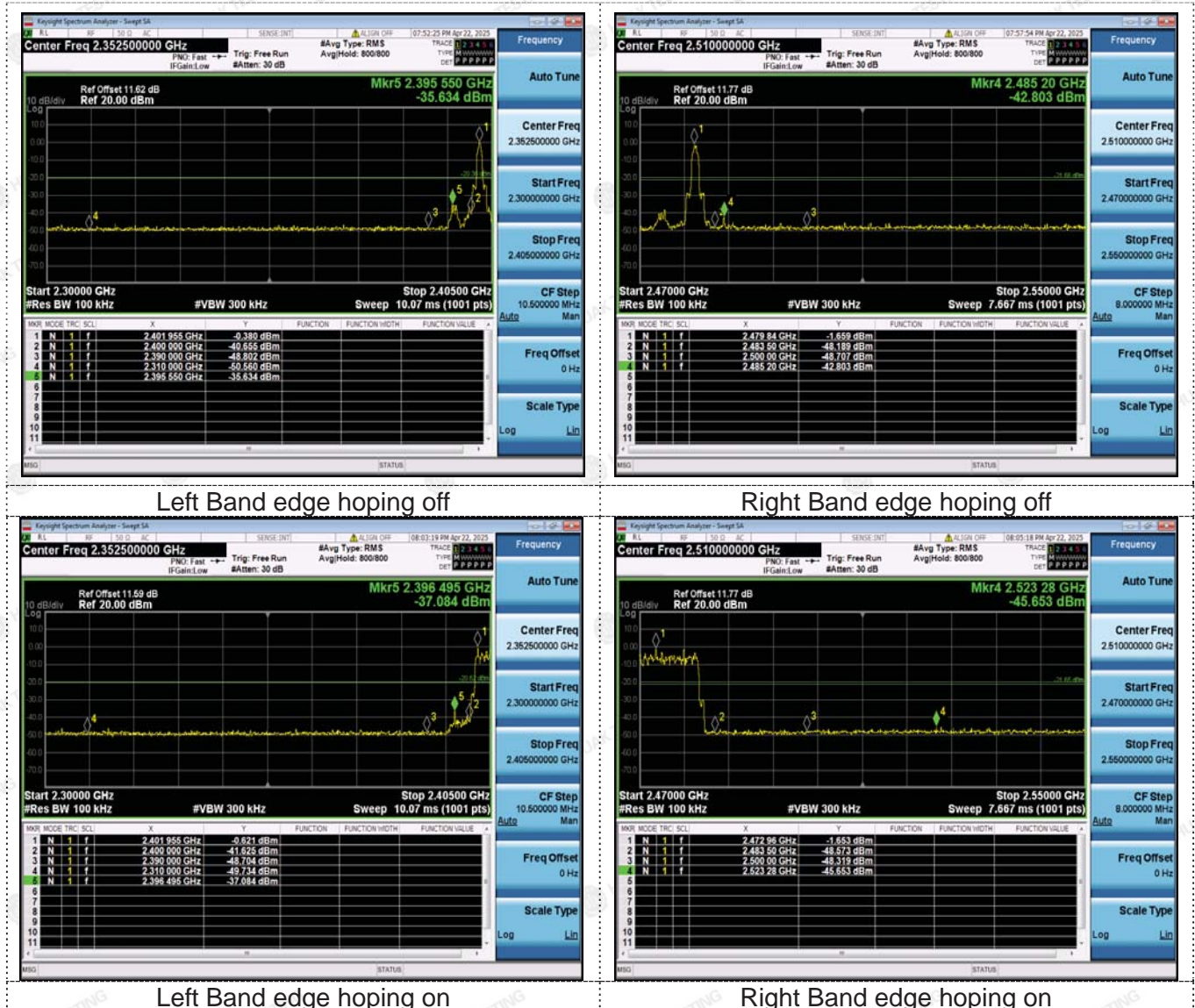






CH78







### 3.9. Pseudorandom Frequency Hopping Sequence

#### Test Applicable

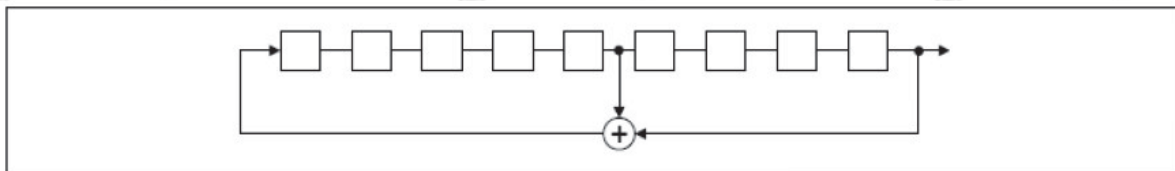
#### **For 47 CFR Part 15C section 15.247 (a) (1):**

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**

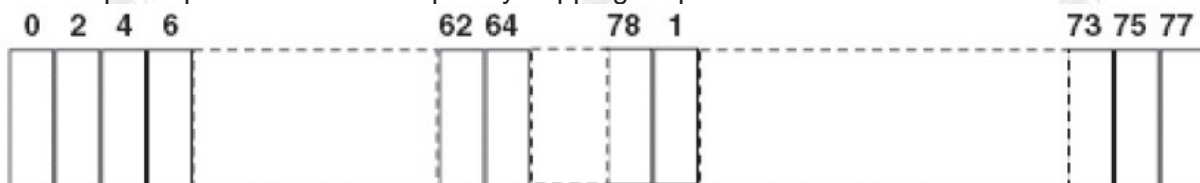
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive 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 Ceramic Antenna, need professional installation, not easy to remove. It conforms to the standard requirements. The directional gains of antenna used for transmitting is 2.7dBi.

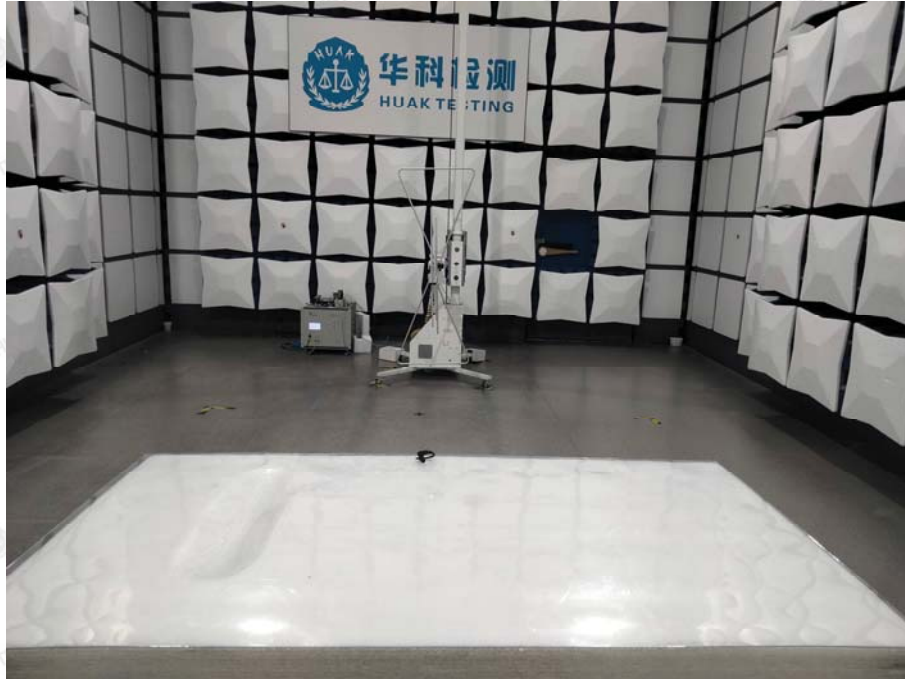
#### Antenna





## 4. Test Setup Photos of the EUT

### Radiated Emission



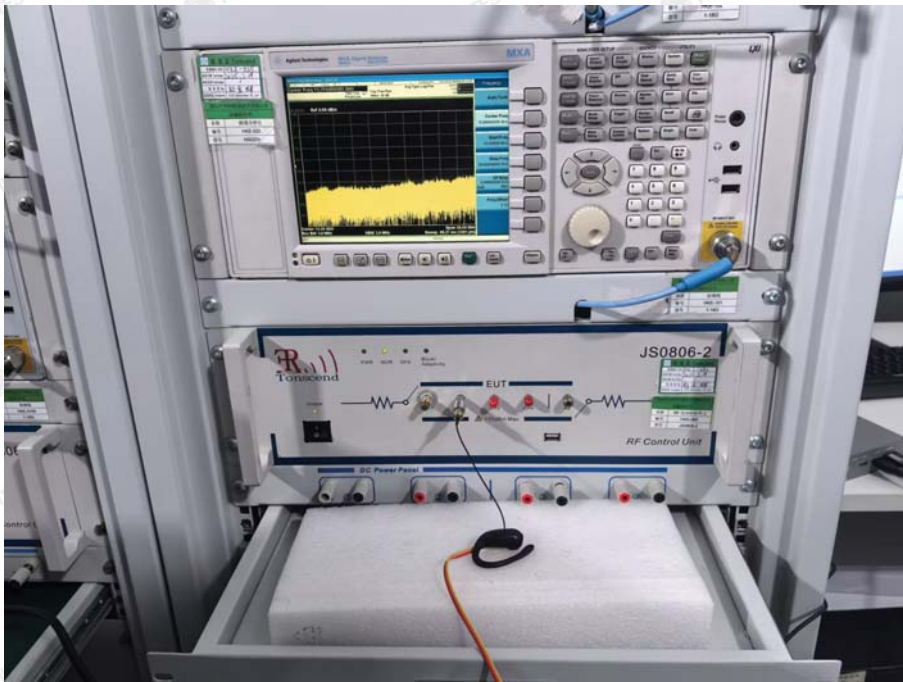




### AC Conducted Emission



### RF Conducted Emission







## 5. Photos of the EUT

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

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