

# 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**

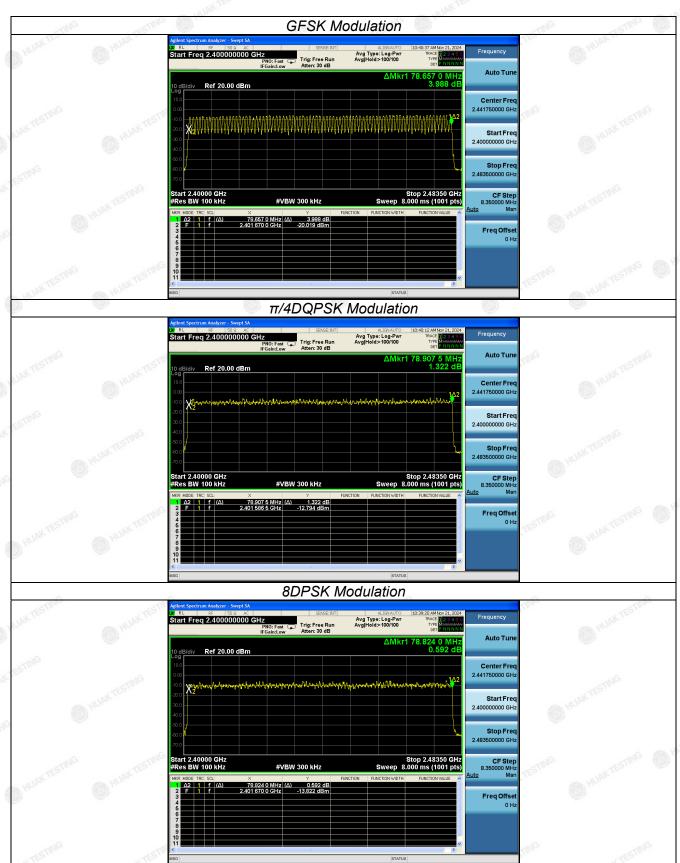


### **Test Results**

Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	0,	0,,
π/4DQPSK	79	≥15	Pass
8DPSK	79 THE TEST TO THE	₩IAN*	- WAKTESTING

Test plot as follows:

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# 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.

Report No.: HK2411196940-1E

## **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**

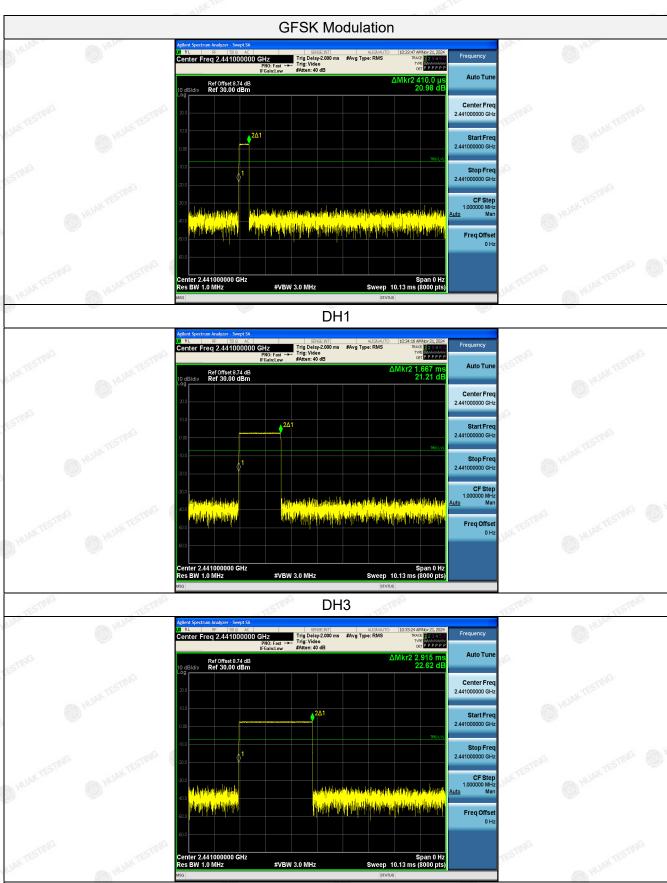
Modulation	Packet	Pulse time (ms)	Dwell time (second)	Limit (second)	Result
GFSK	DH1	0.410	0.131	0.40	PASS
	DH3	1.667	0.267		
	DH5	2.915	0.311		
π/4DQPSK	2-DH1	0.419	0.134	K TESTING	
	2-DH3	1.672	0.268	0.40	PASS
	2-DH5	2.920	0.311	HUAKTEL	
8DPSK	3-DH1	0.421	0.135		
	3-DH3	1.671	0.267	0.40	PASS
	3-DH5	2.922	0.312	HUAKTEST	HUAKTES

#### Note:

- 1. We have tested all mode at high, middle and low channel, and recoreded 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

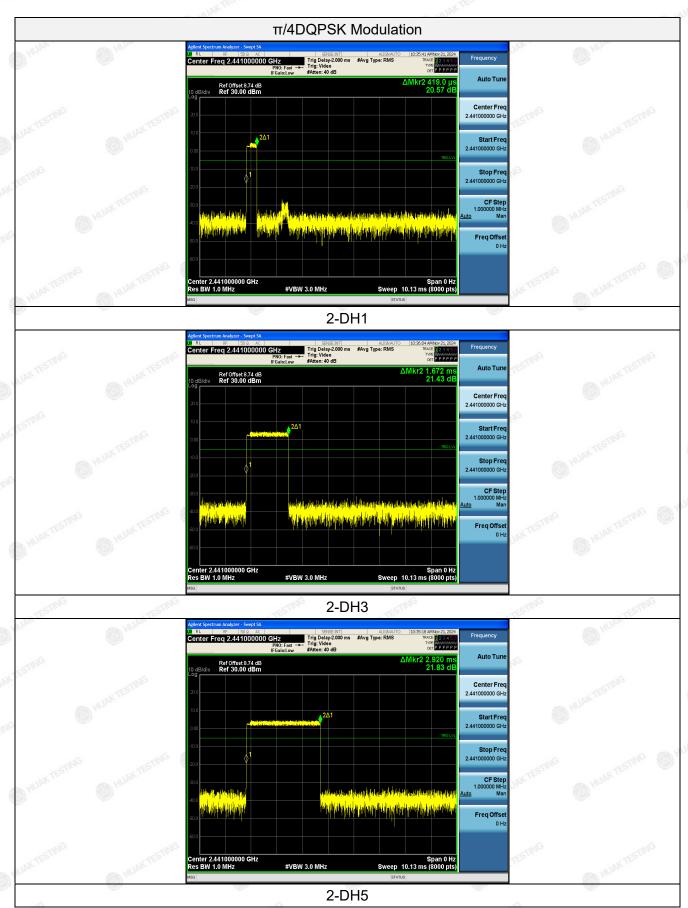
Test plot as follows:

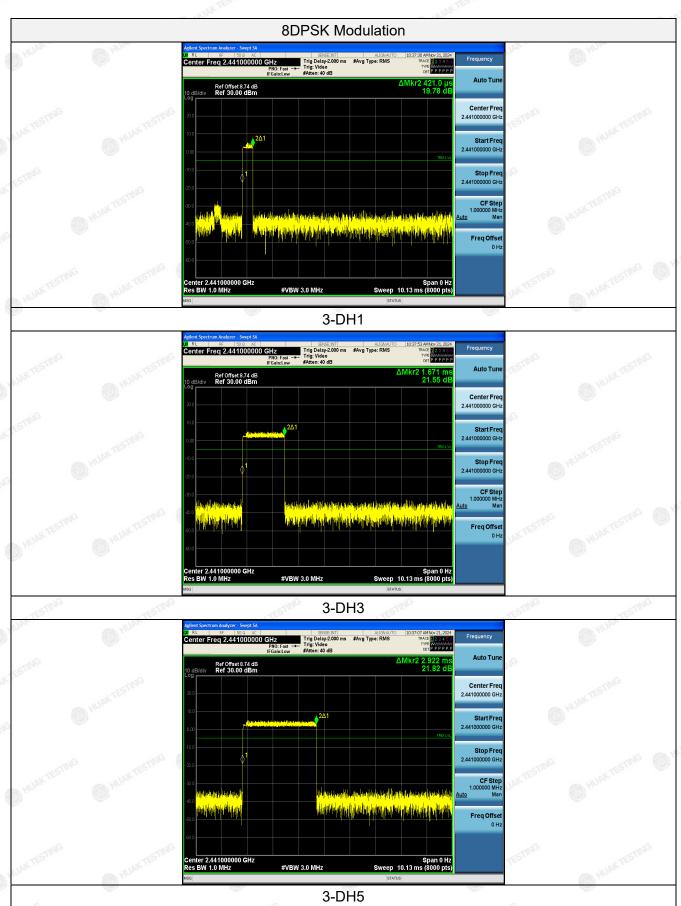
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DH<sub>5</sub>





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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 con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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 bandage measurement data.

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

Test plot as follows:

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**GFSK CH00 CH39** #Avg Type: RMS Avg|Hold: 100/100 #Avg Type: RMS Avg|Hold: 100/100 Auto Tun Auto Tun 1 839 5 GH 2.146 dBn 064 5 GH 2.023 dBr Ref Offset 8.74 dB Ref 28.74 dBm Ref Offset 8.74 dB Ref 28.74 dBm Center Free Center Free **♦**¹ 2.401250000 GH Stop Free 2.402750000 GH CF Step 150.000 kH Freq Offse Freq Offse Center 2.4020000 GHz Res BW 100 kHz Span 1.500 MHz 1.000 ms (1001 pts Center 2.4410000 GHz #Res BW 100 kHz #VBW 300 kHz #VBW 300 kHz RF 50.0 AC

PRO: Freq 515.000000 MHz

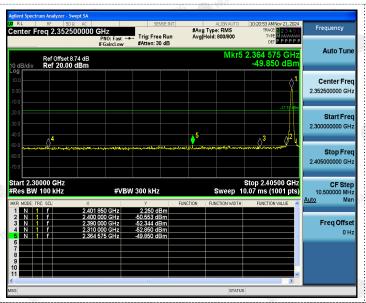
PRO: Fast 

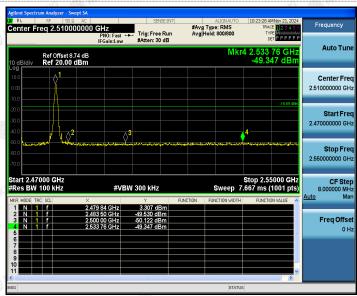
PRO: Fast 

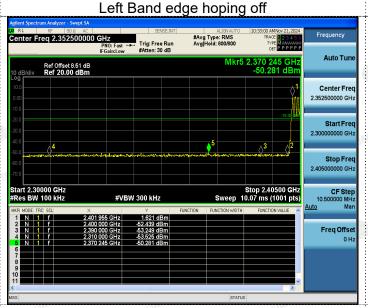
#Atten: 20 dB Frequency enter Freq 515.000000 MHz
PN0: Fast Free Run
IFGain:Low #Atten: 20 dB #Avg Type: RMS Avg|Hold: 10/10 #Avg Type: RMS Avg|Hold: 10/10 Auto Tune r1 803.54 MF -61.715 dB Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Free Center Freq 515.000000 MH 30.000000 MH Stop Free 1.000000000 GH 1.000000000 GH CF Step 97.000000 MI CF St 97.000000 M Freq Offse Freq Offse Frequency #Avg Type: RMS Avg|Hold: 10/10 Center Freq 13.750000000 GHz enter Freq 13.750000000 GHz #Avg Type: RMS Avg|Hold: 10/10 Trig: Free Run #Atten: 20 dB Trig: Free Run #Atten: 20 dB Auto Tun Auto Tun Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Freq 13.750000000 GHz Center Free Start Fred 1.000000000 GH Stop Free 26.500000000 GH Stop Fred 26.500000000 GH CF Step 2.550000000 GHz CF Ste 2.401 65 GHz 4.803 75 GHz 1.244 dBm -33.502 dBm 2.440 75 GHz 4.881 95 GHz 2.026 dBn -31.748 dBn Freq Offset Frea Offse

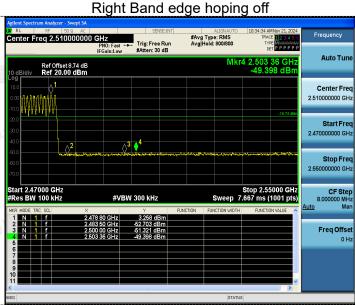
2.479 85 GHz 4.960 15 GHz 2.681 dBm -31.601 dBm











Left Band edge hoping on

Right Band edge hoping on

Report No.: HK2411196940-1E π/4DQPSK **CH00 CH39** #Avg Type: RMS Avg|Hold: 100/100 #Avg Type: RMS Avg|Hold: 100/100 Auto Tun Auto Tun 817 0 GH 1.371 dBn 833 5 GF 2.562 dBı Ref Offset 8.74 dB Ref 28.74 dBm Ref Offset 8.74 dB Ref 28.74 dBm Center Fred Center Free 2.401250000 GH 2.440250000 GH Stop Freq 2.402750000 GHz Stop Free 2.441750000 GH Freq Offse Freq Offse Center 2.4020000 GHz Res BW 100 kHz Span 1.500 MHz Sweep 1.000 ms (1001 pts Center 2.4410000 GHz #Res BW 100 kHz #VBW 300 kHz #VBW 300 kHz Frequency #Avg Type: RMS Avg|Hold: 10/10 #Avg Type: RMS Avg|Hold: 10/10 PNO: Fast --- Trig: Free Run IFGain:Low #Atten: 20 dB r1 820.49 MF -60.148 dB 1 861.81 M -60.844 dE Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Fred Center Free 515.000000 MH 30.000000 MH: Stop Free 1.000000000 GH 27.000000 MH CF Ste 97.000000 MH Freq Offse Freq Offse Frequency Frequency Center Freq 13.750000000 GHz #Avg Type: RMS Avg|Hold: 10/10 enter Freg 13.750000000 GHz #Avg Type: RMS Avg|Hold: 10/10 Trig: Free Run #Atten: 20 dB Auto Tun Auto Tun Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Free Center Free 13.750000000 GH Start Fred Start Freq 1.000000000 GH Stop Free Stop Fred 26.500000000 GH: CF Ste CF Step 2.550000000 GH: 2.402 50 GHz 4.803 75 GHz 1.947 dBm -33.194 dBm 2.440 75 GHz 4.881 95 GHz 0.869 dBn -32.114 dBn Frea Offse Frea Offse

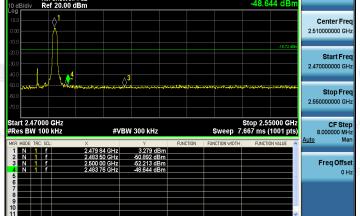
#VBW 300 kHz

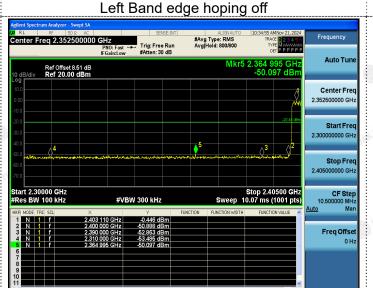
Y
Hz -0.249 dBm
Hz -31.767 dBm

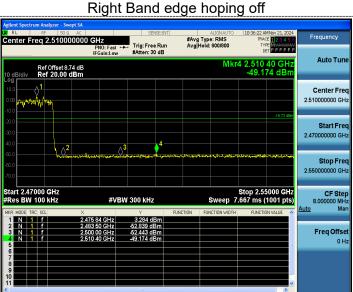












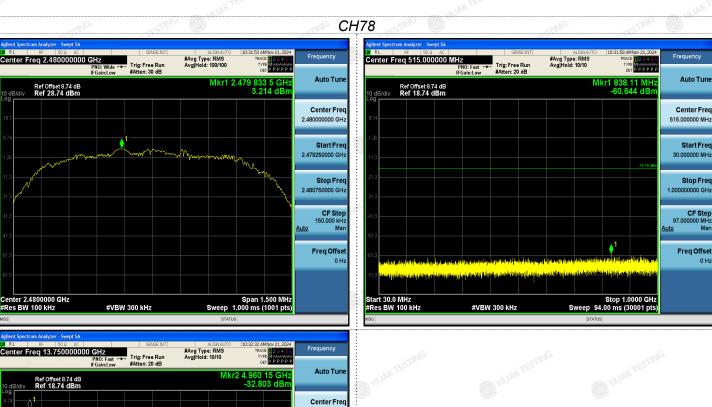
Left Band edge hoping on

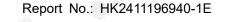
Right Band edge hoping on

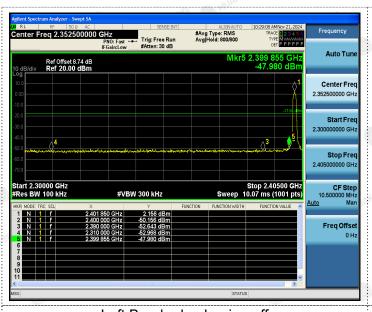
Report No.: HK2411196940-1E 8DPSK **CH00 CH39** RL RF 50 \( \text{RL} \) AC | enter Freq 2.402000000 GHz PNO: Wide RL RF 50.2 AC CHZ
enter Freq 2.441000000 GHZ
PN0: Wide → PN0: Wide → RAtten: 30 dB #Avg Type: RMS AvaiHold: 100/100 #Avg Type: RMS AvalHold: 100/100 Auto Tun 835 0 GF 2.548 dB Ref Offset 8.74 dB Ref 28.74 dBm Ref Offset 8.74 dB Ref 28.74 dBm Center Fred Center Free 2.402000000 GHz 2.441000000 GH Start Freq CF Step 150.000 kHz CF Step 150.000 kH Freq Offse Freq Offse Center 2.4020000 GHz #VBW 300 kHz #VBW 300 kHz #Avg Type: RMS Avg|Hold: 10/10 #Avg Type: RMS Avg|Hold: 10/10 PNO: Fast --- Trig: Free Run PNO: Fast --- Trig: Free Run Auto Tun Auto Tun 940.28 MF -61.499 dB Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Fred Center Fred 515.000000 MH 30.000000 MH Stop Free 1.000000000 GH Freq Offse Freq Offse #VBW 300 kHz #Avg Type: RMS Avg|Hold: 10/10 nter Freq 13.750000000 GHz #Avg Type: RMS Avg|Hold: 10/10 er Freq 13.750000000 GHz Auto Tun Auto Tun Ref Offset 8.74 dB Ref 18.74 dBm Ref Offset 8.74 dB Ref 18.74 dBm Center Free Center Fred 13.750000000 GH Start Fre Start Fred 1.000000000 GH 1.000000000 GH **Stop Fre** 26.500000000 GH Stop Fre CF Step 2.550000000 GHz CF Ste 2.401 65 GHz 4.803 75 GHz 0.605 dBn -36.879 dBn 2.440 75 GHz 4.881 95 GHz 0.207 dB -33.103 dB Freq Offse Freq Offse

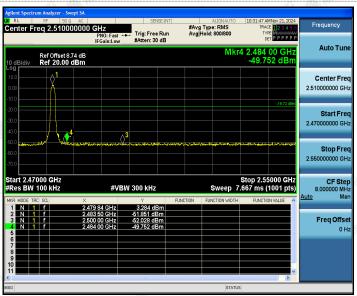
#VBW 300 kHz

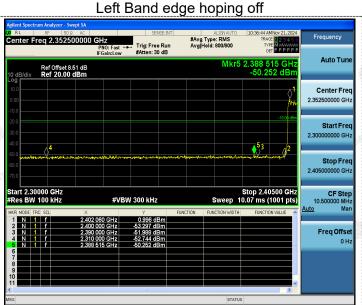
Y
Hz 0.904 dBm
Hz -32.803 dBm













Left Band edge hoping on

Right Band edge hoping on



# 3.9. Pseudorandom Frequency Hopping Sequence

#### **TEST APPLICABLE**

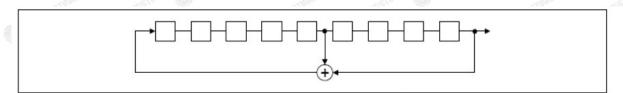
## For 47 CFR Part 15C section 15.247 (a) (1):

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**

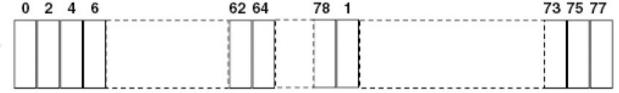
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive 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.

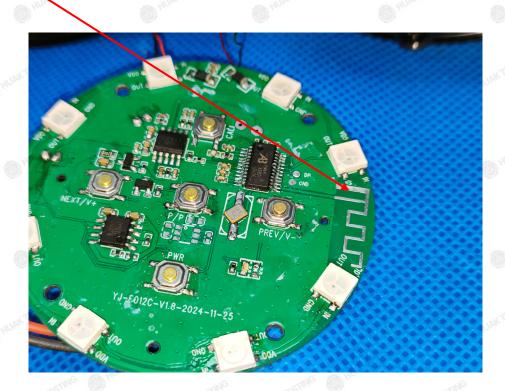
#### Refer to statement below for compliance.

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 PCB Antenna, which permanently attached. It conforms to the standard requirements. The directional gains of antenna used for transmitting is -0.68dBi.

#### Antenna

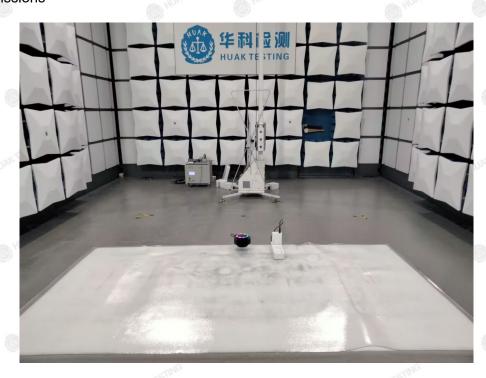


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# 4. Test Setup Photos of the EUT

**Radiated Emissions** 

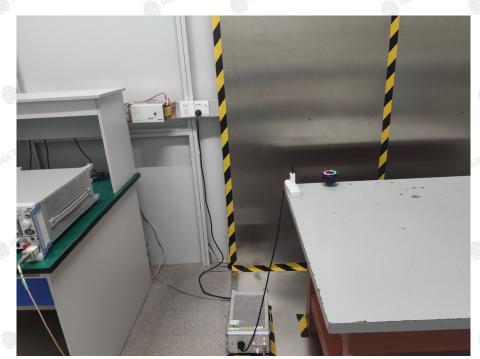




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**Conducted Emission** 





5. Photos of the EUT

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

End of test report

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