

## 3.5. Frequency Separation

## **LIMIT**

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 KHz or the 2/3\*20dB 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	1.000	0.642	Pass
π/4DQPSK	Middle Channel	1.016	0.878	Pass
8DPSK	Middle Channel	1.006	0.890	Pass

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

#### Test plot as follows:

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## 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 TESTING	MIAN TO HUAN	- WAX TESTING

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.

## **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
"NG	DH1	0.381	0.122	, nic	
WEST.	DH3	1.643	0.263	0.40	PASS
	DH5	2.885	0.308	- N	
π/4DQPSK	2-DH1	0.391	0.125	ESTING	
	2-DH3	1.643	0.263	0.40	PASS
	2-DH5	2.892	0.308	HUAKTES	
8DPSK	3-DH1	0.391	0.125		
	3-DH3	1.643	0.263	0.40	PASS
	3-DH5	2.894	0.309	HUAKTEST	

#### 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

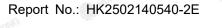
Test plot as follows:

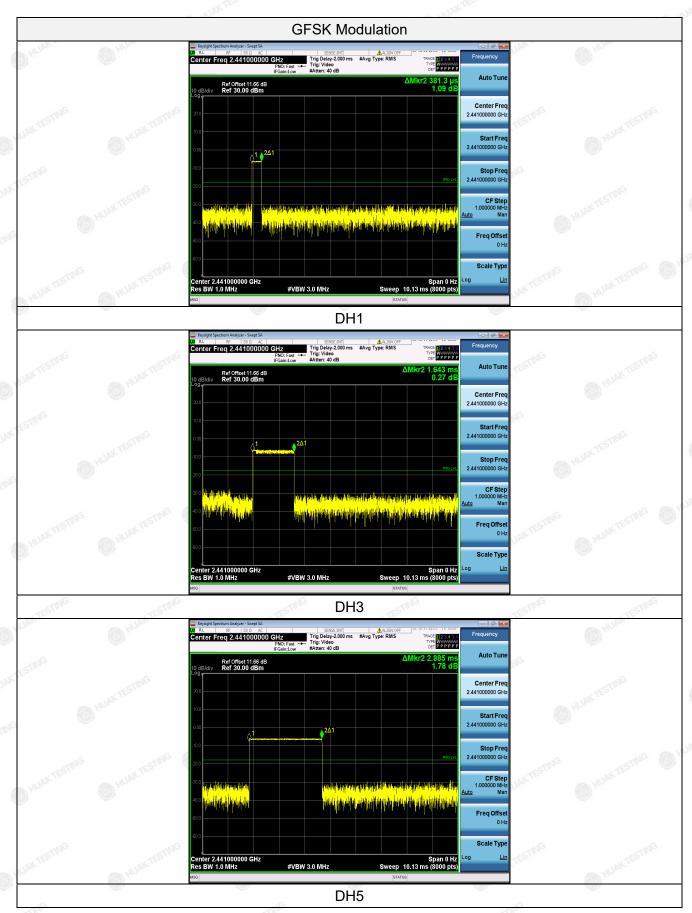
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Report No.: HK2502140540-2E

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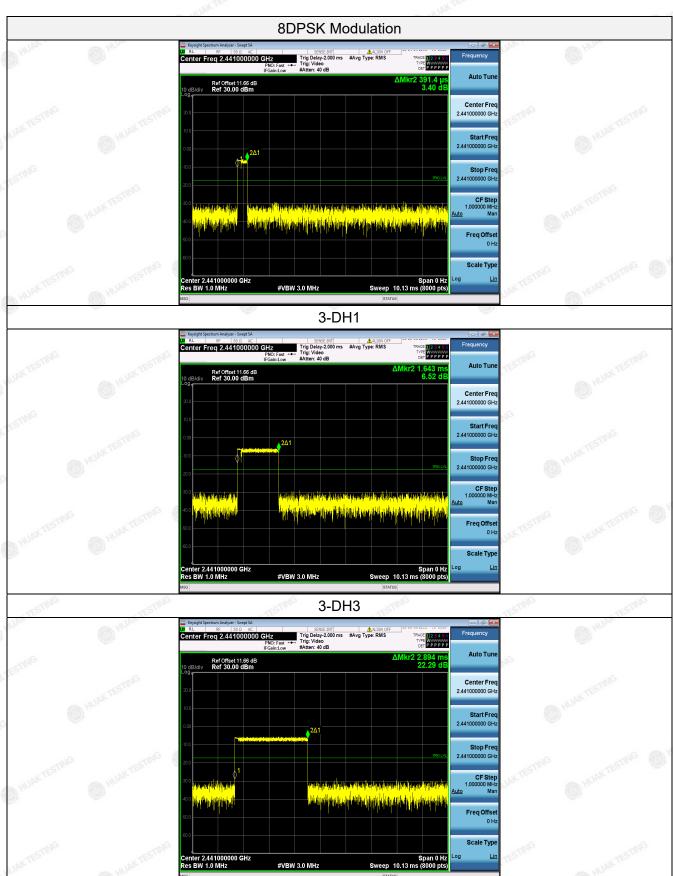




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3-DH5



## 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 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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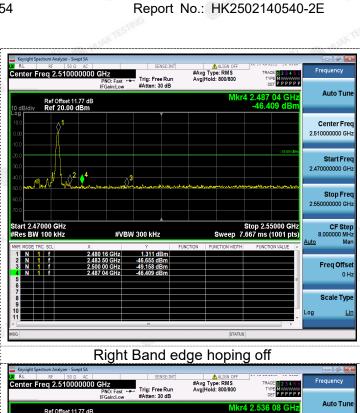
**GFSK** CH00 **CH39** #Avg Type: RMS Avg|Hold: 100/100 #Avg Type: RMS Avg|Hold: 100/100 Center Freq 2.402000000 GHz Center Freq 2.441000000 GHz Trig: Free Run 1 832 0 GF 2.180 dB 988 0 GF 1.721 dB Ref Offset 11.62 dB Ref 30.00 dBm Ref Offset 11.66 dB Ref 30.00 dBm Center Fred Center Freq 2.402000000 GH: 2.441000000 GH Start Fred 2.401250000 GH: Start Fred 2.440250000 GHz Stop Fred Stop Free 2.441750000 GH 2.402750000 GH CF Step 150.000 kH: CF Ste 150.000 kH Freq Offset Freq Offse 0 H: Scale Type Scale Type Span 1.500 MHz Sweep 1.000 ms (1001 pts) Center 2.4410000 GHz #Res BW 100 kHz Span 1.500 MHz Sweep 1.000 ms (1001 pts) #VBW 300 kHz #VBW 300 kHz #Avg Type: RMS Avg|Hold: 30/30 #Avg Type: RMS Avg|Hold: 30/30 Frequency Center Freq 515.000000 MHz Trig: Free Run #Atten: 20 dB PNO: Fast +> Trig: Free Run FGain:Low #Atten: 20 dB 1 2 3 4 5 6 MWWWWW PPPPPP TYPE MWWWWW Auto Tune Auto Tun | 767.69 MH -58.692 dB Ref Offset 11.62 dB Ref 15.00 dBm Ref Offset 11.66 dB Ref 15.00 dBm Center Fred Center Fred 515.000000 MH 515.000000 MH Start Fred 30.000000 MH 30.000000 MH Stop Free Stop Fre CF Ste 97.000000 M Freq Offset Freq Offse Scale Type Start 0.0300 GHz Res BW 100 kHz #VBW 300 kHz #VBW 300 kHz #Avg Type: RMS Avg|Hold: 30/30 #Avg Type: RMS AvalHold: 30/30 Center Freq 13.750000000 GHz Trig: Free Run Auto Tun Auto Tun (r2 9.758 40 G -38.811 d Ref Offset 11.66 dB Ref 15.00 dBm Ref Offset 11.62 dB Ref 15.00 dBm 13.750000000 GH 13.750000000 GH Start Fred Start Fred Stop Fred 26.500000000 GH Stop 26.50 GHz Sweep 2.438 s (30001 pts) Stop 26.50 GHz Sweep 2.438 s (30001 pts) **CF Step** 2.550000000 GHz <u>Auto</u> Man CF Ste #VBW 300 kHz #VBW 300 kHz 1.319 d -38.811 d 2.200 dBr -37.600 dBn Freq Offset Freq Offse Scale Type Scale Typ

2.479 85 GHz 1.262 dBm 9.913 95 GHz -36.579 dBm



1 2 3 4 5 0 MWWWWW PPPPP

Ref Offset 11.62 dB Ref 20.00 dBm





Left Band edge hoping on

Right Band edge hoping on

2.401 65 GHz 9.602 00 GHz

1.357 dBr -36.464 dBr

Report No.: HK2502140540-2E Page 44 of 54 π/4DQPSK **CH00 CH39** #Avg Type: RMS Avg|Hold: 100/100 #Avg Type: RMS Avg|Hold: 100/100 Center Freq 2.441000000 GHz 1 848 5 G 2.348 dE 11 153 0 G 1.454 dE Ref Offset 11.62 dB Ref 30.00 dBm Ref Offset 11.66 dB Ref 30.00 dBm 2.402000000 GH: 2.441000000 GH Start Free 2.440250000 GH Start Free Stop Free Stop Fre 2.441750000 GH 2.402750000 GH CF Step 150.000 kH: CF Ste 150.000 kF Freq Offset Freq Offse 0 H: Scale Type Scale Typ Center 2.4410000 GHz #Res BW 100 kHz Center 2.4020000 GHz #Res BW 100 kHz Span 1.500 MHz Sweep 1.000 ms (1001 pts) Span 1.500 MHz Sweep 1.000 ms (1001 pts) #VBW 300 kHz #VBW 300 kHz RL RF 50 Q AC

Center Freq 515.000000 MHz

PNO: Fast
| FGain-Low #Avg Type: RMS Avg|Hold: 30/30 #Avg Type: RMS Avg|Hold: 30/30 Center Freq 515.000000 MHz Frequency Trig: Free Run #Atten: 20 dB Trig: Free Run #Atten: 20 dB TYPE MWWWWW 1 2 3 4 5 6 E M WWW WW P P P P P P Auto Tune Auto Tun Ref Offset 11.62 dB Ref 15.00 dBm -57.713 dB Ref Offset 11.66 dB Ref 15.00 dBm Center Fred Center Fre 515.000000 MH 515.000000 MH 30.000000 MH 30.000000 M Stop Fre 1.000000000 G Freq Offset Freq Offse Scale Type Start 0.0300 GHz #Res BW 100 kHz #VBW 300 kHz #VBW 300 kHz #Avg Type: RMS Avg|Hold: 30/30 #Avg Type: RMS Avg|Hold: 30/30 r Freq 13.750000000 GHz Center Freq 13.750000000 GHz 1 2 3 4 5 MWWW PPPPPI Auto Tun Auto Tun 9.602 00 Gr -36.464 dB Ref Offset 11.62 dB Ref 15.00 dBm Ref Offset 11.66 dB Ref 15.00 dBm Center Fre 13.750000000 GH Start Fred 1.000000000 GH Stop Fre 26.500000000 GH Stop Fre Stop 26.50 GHz Sweep 2.438 s (30001 pts Stop 26.50 GHz Sweep 2.438 s (30001 pts CF Step Start 1.00 GHz Res BW 100 kH tart 1.00 GHz Res BW 100 kH CF Step 2.550000000 GH 2.5500

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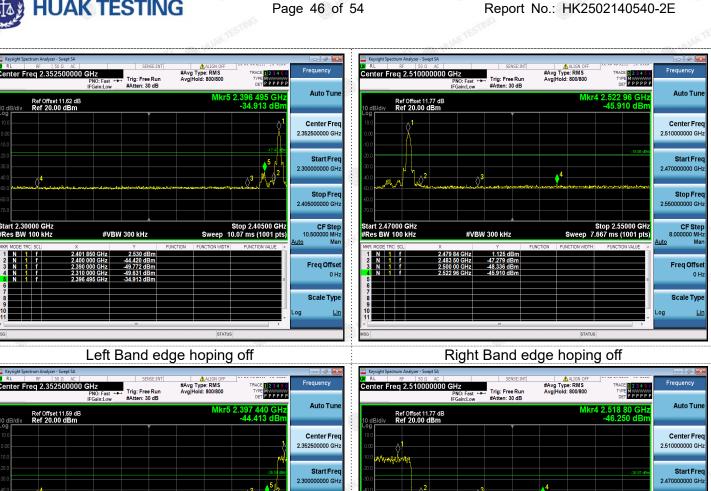
Freq Offse

Scale Type

0.109 dB: -38.057 dB:

Freq Offs



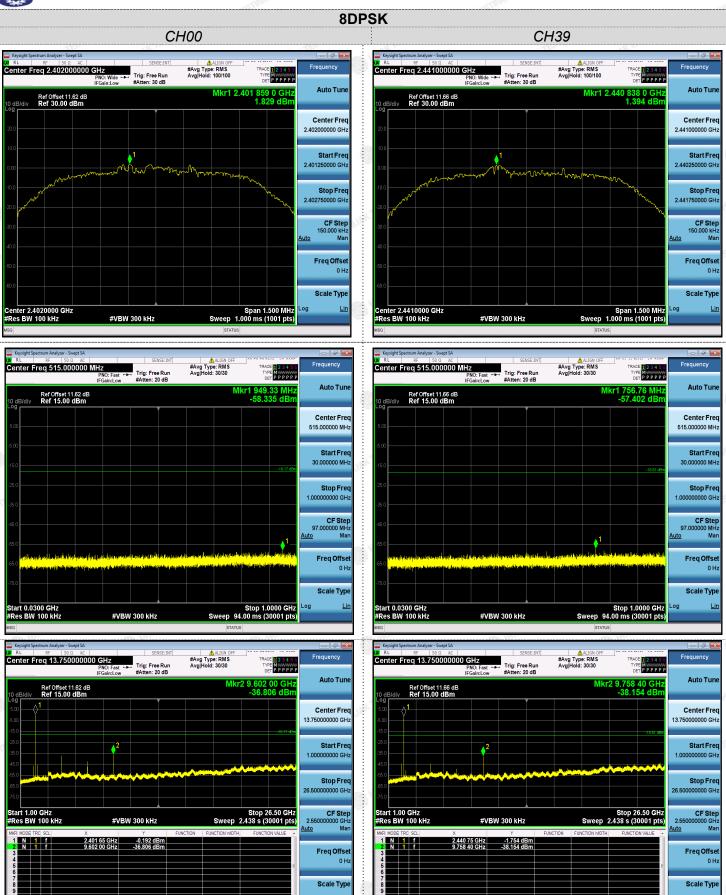


Freq Offse

Left Band edge hoping on

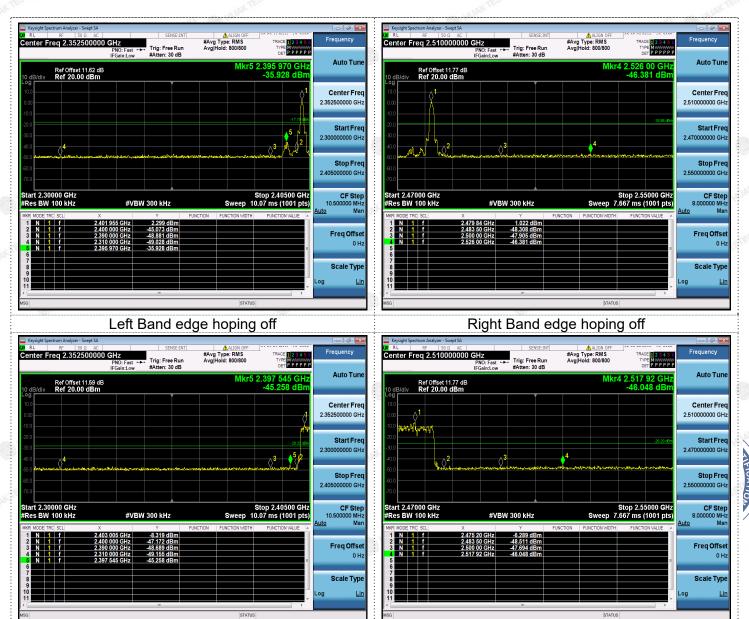
Right Band edge hoping on

Freq Offs





of 54 Report No.: HK2502140540-2E



Left Band edge hoping on Right Band edge hoping on



## 3.9. Pseudorandom Frequency Hopping Sequence

### **TEST APPLICABLE**

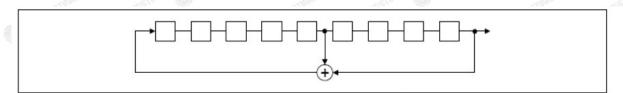
## For 47 CFR Part 15C section 15.247 (a) (1):

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**

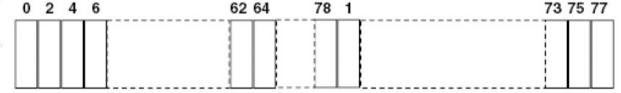
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive 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 FPC Antenna, need professional installation, not easy to remove. It conforms to the standard requirements. The directional gains of antenna used for transmitting is 0.11dBi.

#### Antenna

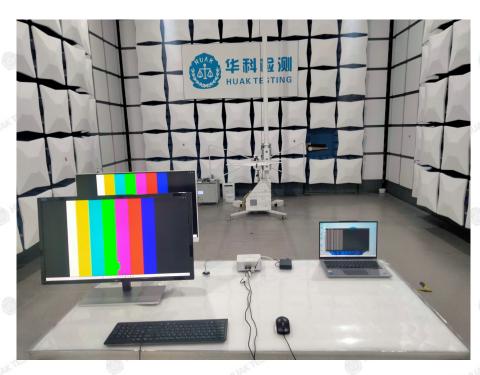


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# 4. Test Setup Photos of the EUT

#### **Radiated Emissions**





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Conducted Emission



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5. Photos of the EUT



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