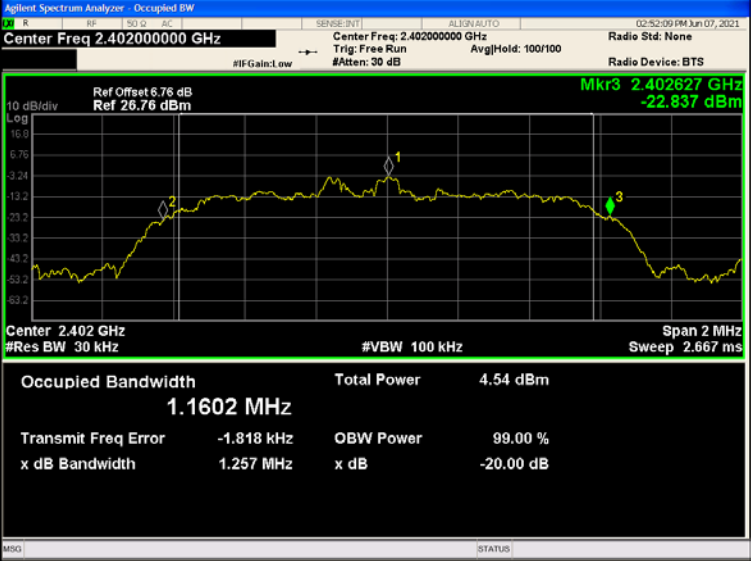
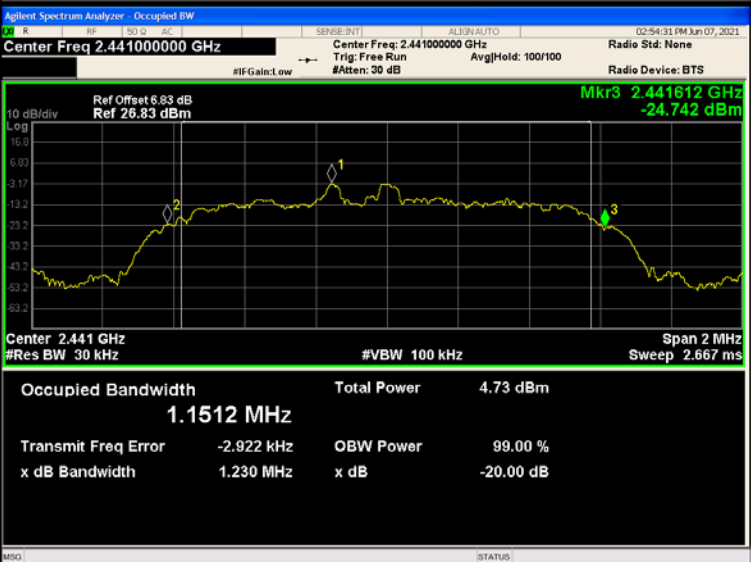
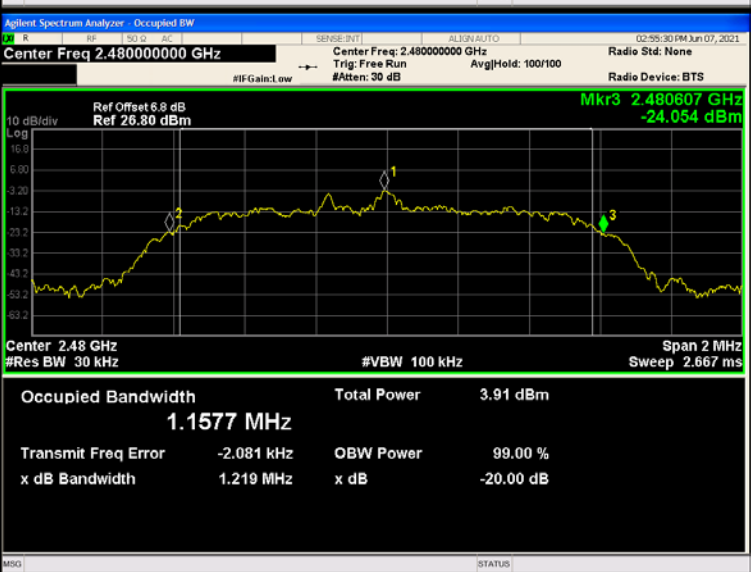
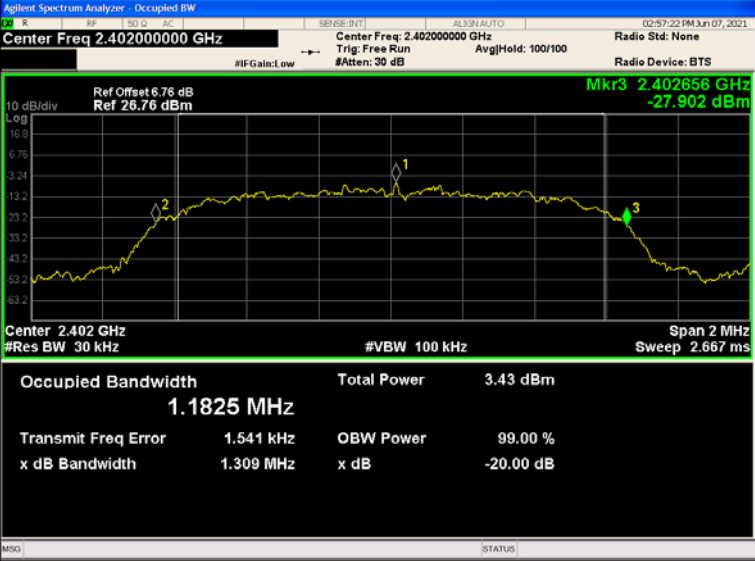
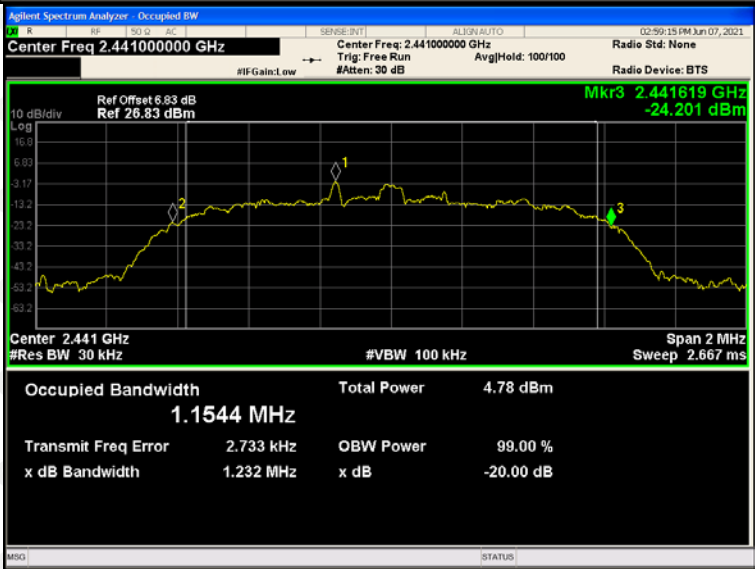
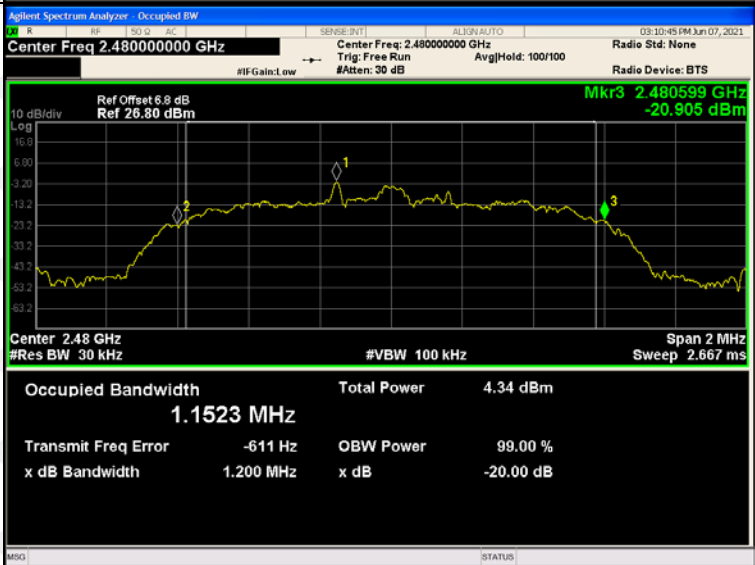
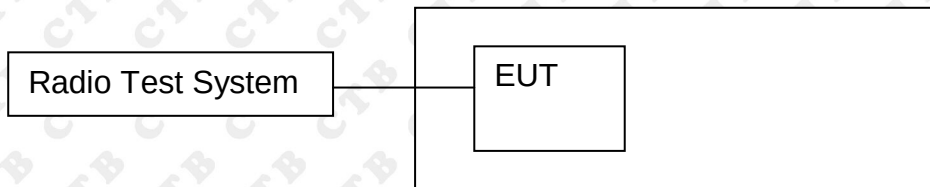


|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><math>\pi/4</math>-DQPSK<br/>Low channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.40200000 GHz</p> <p>Ref Offset: 6.76 dB<br/>Ref: 26.76 dBm</p> <p>Mkr3: 2.402627 GHz<br/>-22.837 dBm</p> <p>Center: 2.402 GHz<br/>#Res BW: 30 kHz<br/>#VBW: 100 kHz<br/>Span: 2 MHz<br/>Sweep: 2.667 ms</p> <p>Occupied Bandwidth: 1.1602 MHz</p> <p>Total Power: 4.54 dBm</p> <p>Transmit Freq Error: -1.818 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.257 MHz</p> <p>x dB: -20.00 dB</p>  |
| <p><math>\pi/4</math>-DQPSK<br/>Mid channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.44100000 GHz</p> <p>Ref Offset: 6.83 dB<br/>Ref: 26.83 dBm</p> <p>Mkr3: 2.441612 GHz<br/>-24.742 dBm</p> <p>Center: 2.441 GHz<br/>#Res BW: 30 kHz<br/>#VBW: 100 kHz<br/>Span: 2 MHz<br/>Sweep: 2.667 ms</p> <p>Occupied Bandwidth: 1.1512 MHz</p> <p>Total Power: 4.73 dBm</p> <p>Transmit Freq Error: -2.922 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.230 MHz</p> <p>x dB: -20.00 dB</p> |
| <p><math>\pi/4</math>-DQPSK<br/>High channel</p> |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.48000000 GHz</p> <p>Ref Offset: 6.8 dB<br/>Ref: 26.80 dBm</p> <p>Mkr3: 2.480607 GHz<br/>-24.054 dBm</p> <p>Center: 2.48 GHz<br/>#Res BW: 30 kHz<br/>#VBW: 100 kHz<br/>Span: 2 MHz<br/>Sweep: 2.667 ms</p> <p>Occupied Bandwidth: 1.1577 MHz</p> <p>Total Power: 3.91 dBm</p> <p>Transmit Freq Error: -2.081 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.219 MHz</p> <p>x dB: -20.00 dB</p>  |

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>8DPSK<br/>Low channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.402000000 GHz</p> <p>Ref Offset 6.76 dB<br/>Ref 26.76 dBm</p> <p>Mkr3 2.402656 GHz<br/>-27.902 dBm</p> <p>Center 2.402 GHz<br/>#Res BW 30 kHz</p> <p>#VBW 100 kHz</p> <p>Span 2 MHz<br/>Sweep 2.667 ms</p> <p>Occupied Bandwidth<br/>1.1825 MHz</p> <p>Total Power<br/>3.43 dBm</p> <p>Transmit Freq Error<br/>1.541 kHz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>1.309 MHz</p> <p>x dB<br/>-20.00 dB</p>  |
| <p>8DPSK<br/>Mid channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.441000000 GHz</p> <p>Ref Offset 6.83 dB<br/>Ref 26.83 dBm</p> <p>Mkr3 2.441619 GHz<br/>-24.201 dBm</p> <p>Center 2.441 GHz<br/>#Res BW 30 kHz</p> <p>#VBW 100 kHz</p> <p>Span 2 MHz<br/>Sweep 2.667 ms</p> <p>Occupied Bandwidth<br/>1.1544 MHz</p> <p>Total Power<br/>4.78 dBm</p> <p>Transmit Freq Error<br/>2.733 kHz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>1.232 MHz</p> <p>x dB<br/>-20.00 dB</p> |
| <p>8DPSK<br/>High channel</p> |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.480000000 GHz</p> <p>Ref Offset 6.8 dB<br/>Ref 26.80 dBm</p> <p>Mkr3 2.480599 GHz<br/>-20.905 dBm</p> <p>Center 2.48 GHz<br/>#Res BW 30 kHz</p> <p>#VBW 100 kHz</p> <p>Span 2 MHz<br/>Sweep 2.667 ms</p> <p>Occupied Bandwidth<br/>1.1523 MHz</p> <p>Total Power<br/>4.34 dBm</p> <p>Transmit Freq Error<br/>-611 Hz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>1.200 MHz</p> <p>x dB<br/>-20.00 dB</p>    |

## 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 = 30kHz. VBW = 100kHz , Span = 3.0MHz. 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] | Verdict |
|---------------|----------|------------------------------------|---------|
| GFSK          | LCH      | 0.999                              | PASS    |
| GFSK          | MCH      | 0.999                              | PASS    |
| GFSK          | HCH      | 0.996                              | PASS    |
| $\pi/4$ DQPSK | LCH      | 0.999                              | PASS    |
| $\pi/4$ DQPSK | MCH      | 0.999                              | PASS    |
| $\pi/4$ DQPSK | HCH      | 0.999                              | PASS    |
| 8DPSK         | LCH      | 0.999                              | PASS    |
| 8DPSK         | MCH      | 0.999                              | PASS    |
| 8DPSK         | HCH      | 0.999                              | PASS    |

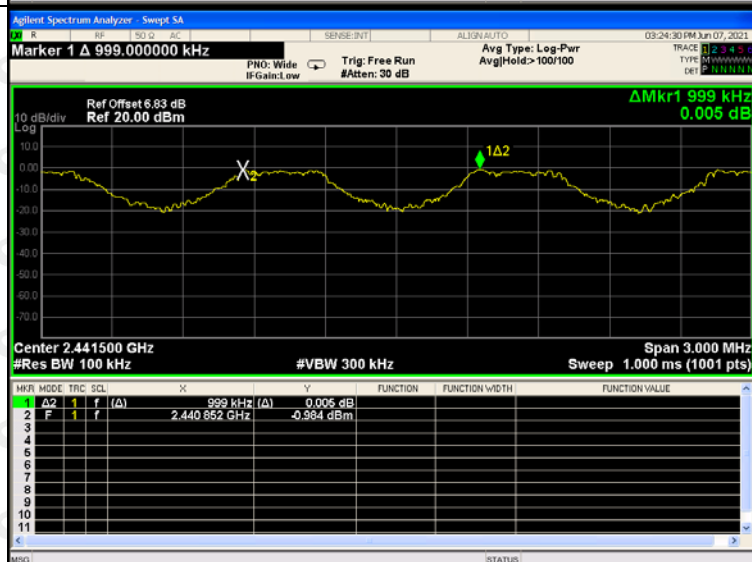
# Test Graph

## Graphs

GFSK/LCH



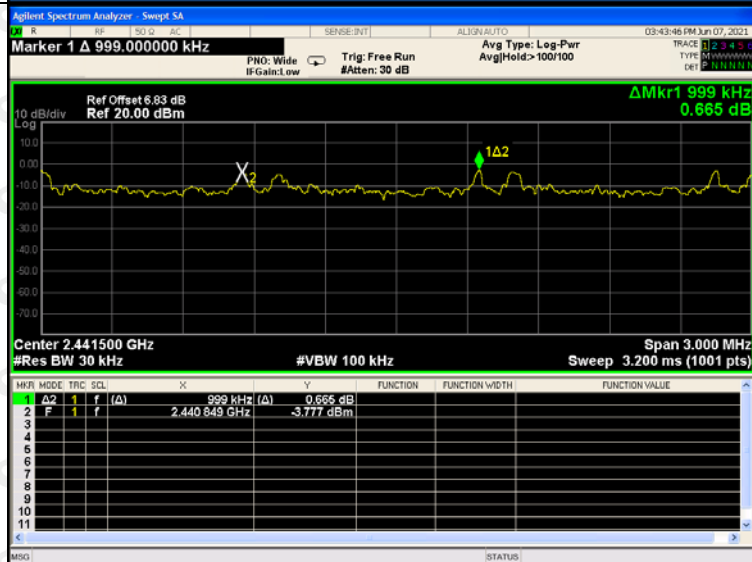
GFSK/MCH



GFSK/HCH



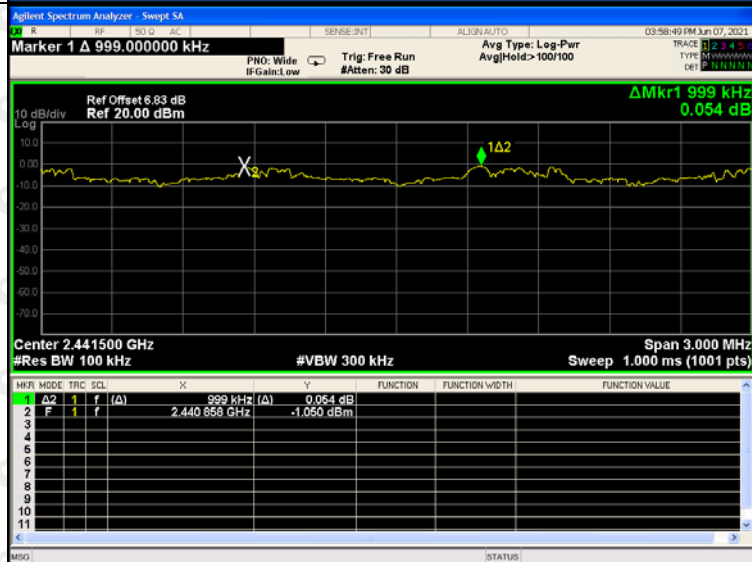
$\pi/4$ DQPSK/LCH

 $\pi/4$ DQPSK/MCH

 $\pi/4$ DQPSK/HCH


8DPSK/LCH



8DPSK /MCH

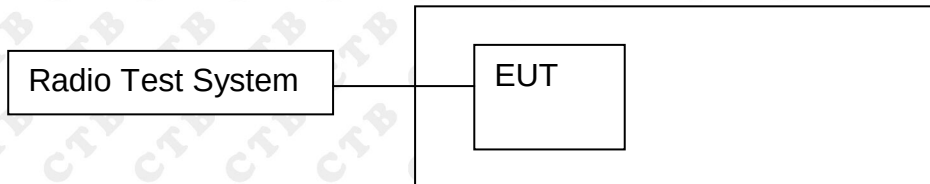


8DPSK /HCH



## 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;

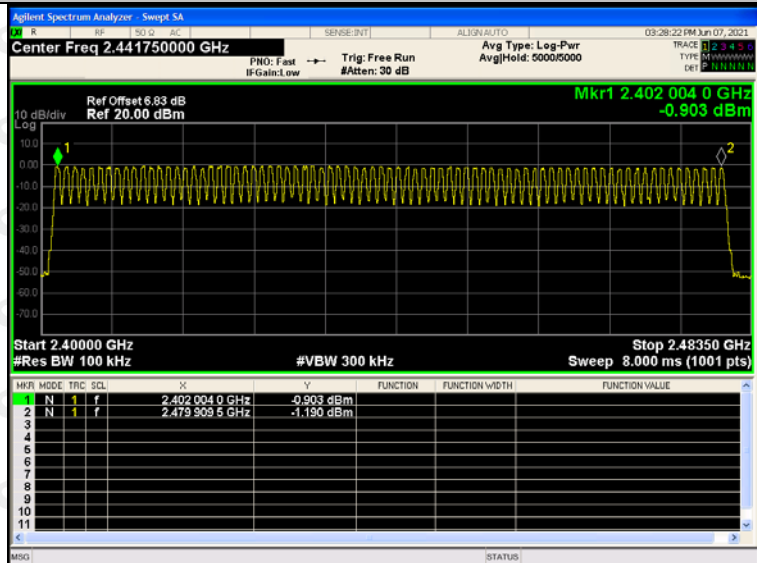
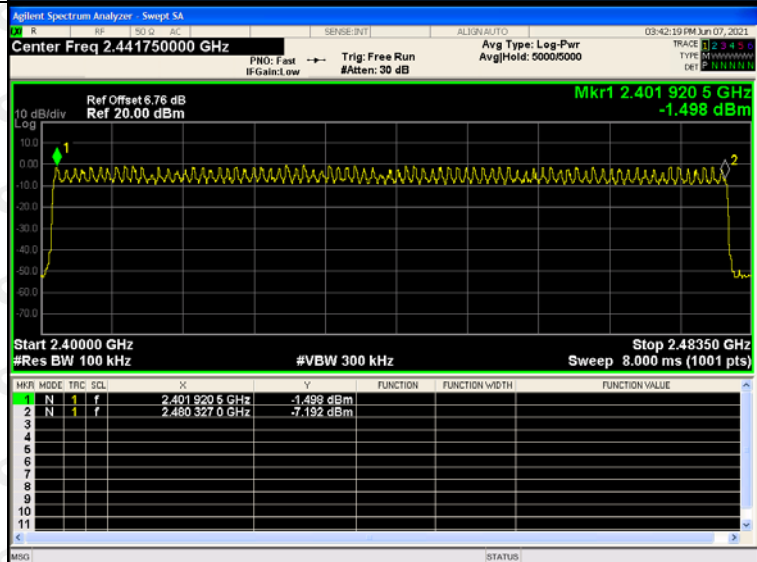
### 12.4 Test Result

| Mode          | Channel. | Number of Hopping Channel | Verdict |
|---------------|----------|---------------------------|---------|
| GFSK          | Hop      | 79                        | PASS    |
| $\pi/4$ DQPSK | Hop      | 79                        | PASS    |
| 8DPSK         | Hop      | 79                        | PASS    |

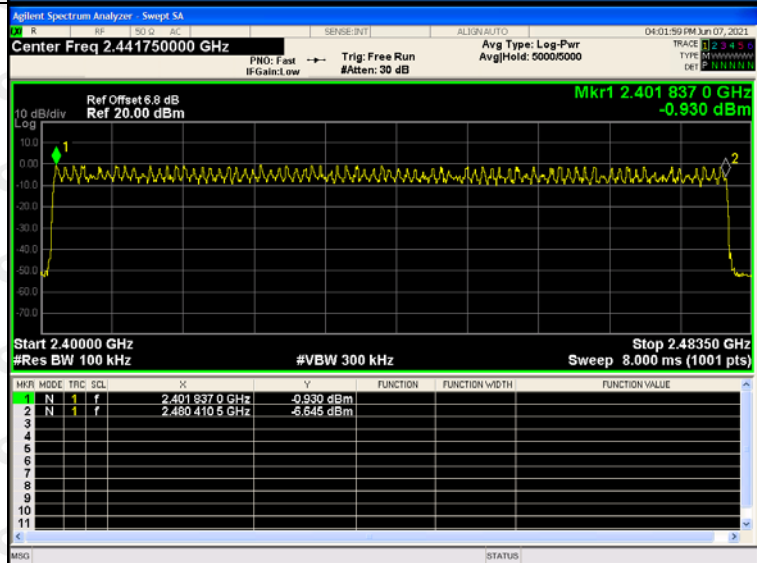
## Test Graph

## Graphs

GFSK/Hop

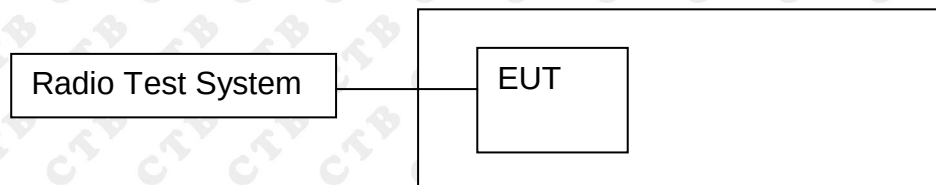
 $\pi/4$ DQPSK/Hop

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

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

### 13.4 Test Result

| Mode | Packet | Channel | Pulse Time (ms) | Total Dwell Time (ms) | Limit (ms) | Verdict |
|------|--------|---------|-----------------|-----------------------|------------|---------|
| GFSK | DH1    | LCH     | 0.372           | 119.04                | 400        | PASS    |
|      | DH1    | MCH     | 0.372           | 119.04                | 400        | PASS    |
|      | DH1    | HCH     | 0.372           | 119.04                | 400        | PASS    |
|      | DH3    | LCH     | 1.637           | 261.92                | 400        | PASS    |
|      | DH3    | MCH     | 1.632           | 261.12                | 400        | PASS    |
|      | DH3    | HCH     | 1.632           | 261.12                | 400        | PASS    |
|      | DH5    | LCH     | 2.888           | 308.063               | 400        | PASS    |
|      | DH5    | MCH     | 2.882           | 307.413               | 400        | PASS    |
|      | DH5    | HCH     | 2.882           | 307.413               | 400        | PASS    |

Remark: DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

DH5:  $1600/79/6 \times 0.4 \times 79 \times (\text{MkrDelta ms})$

DH3:  $1600/79/4 \times 0.4 \times 79 \times (\text{MkrDelta ms})$

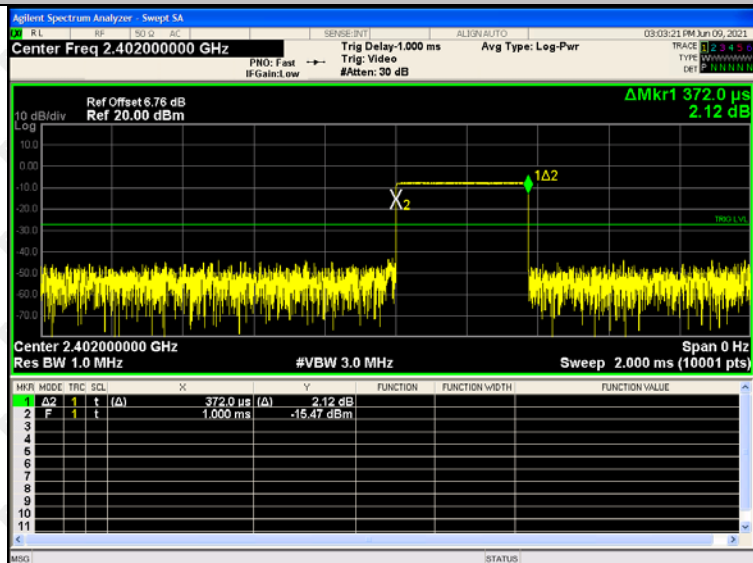
DH1:  $1600/79/2 \times 0.4 \times 79 \times (\text{MkrDelta ms})$

Remark: Mkr Delta is once pulse time.

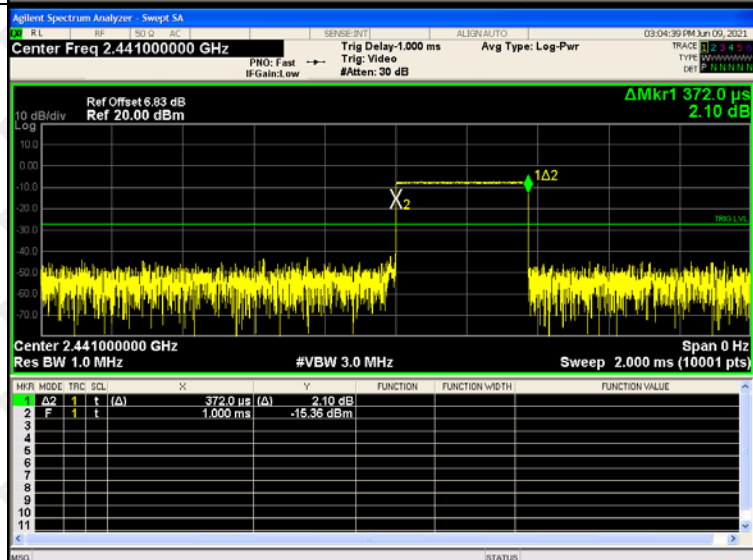
# Test Graph

## Graphs

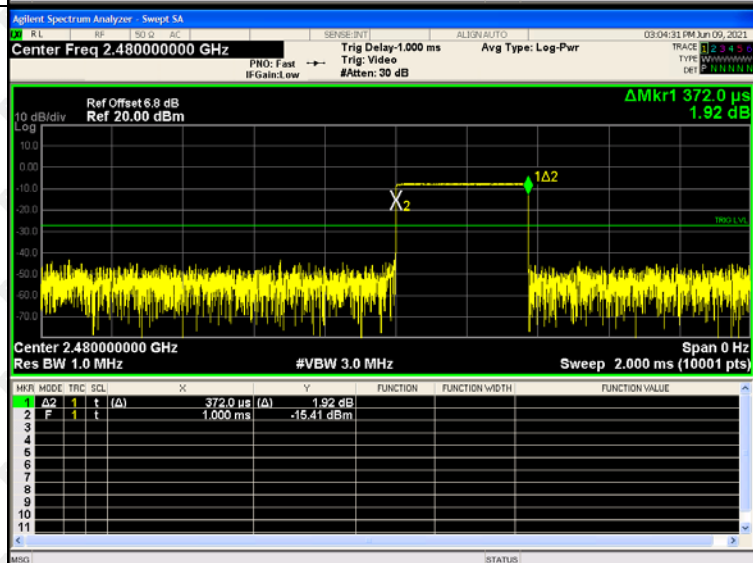
GFSK\_DH1/LCH



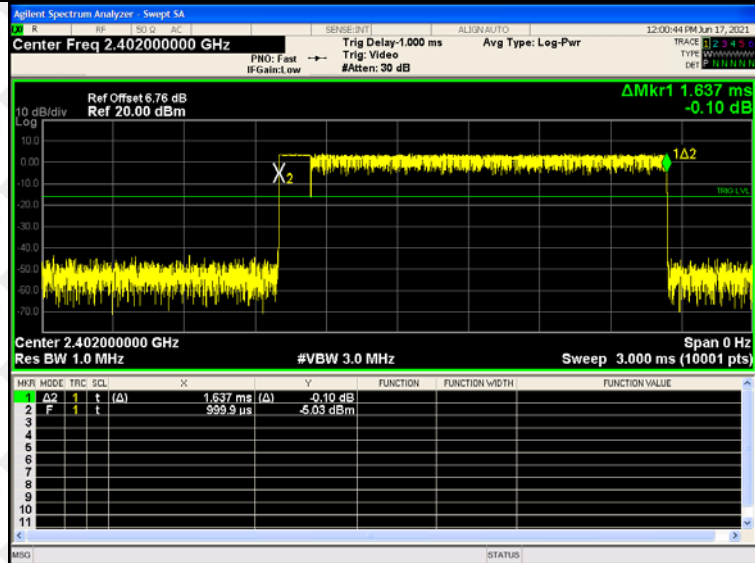
GFSK\_DH1/MCH



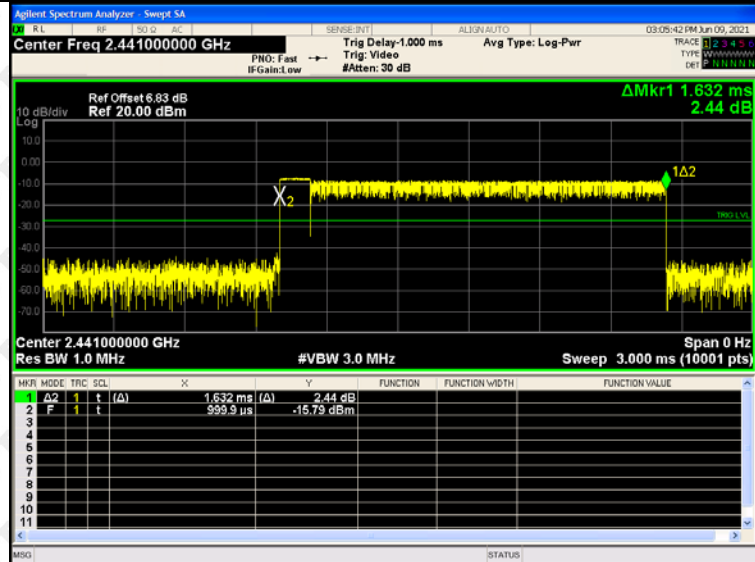
GFSK\_DH1/HCH



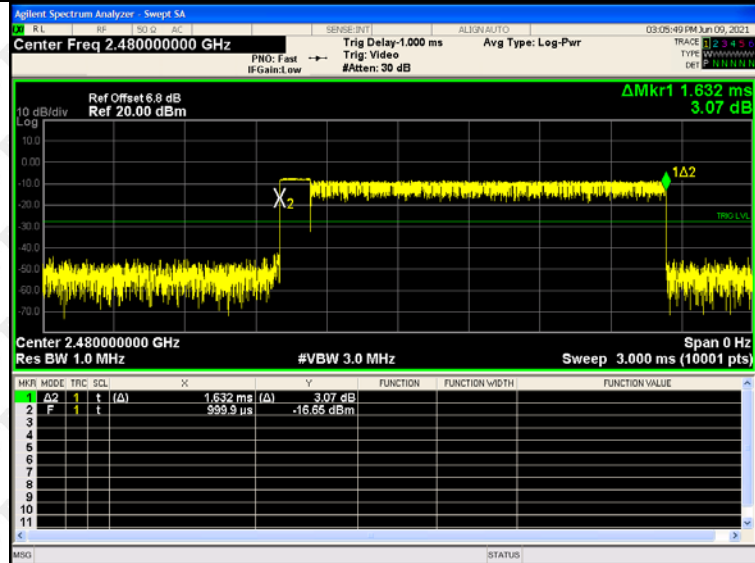
GFSK\_DH3/LCH



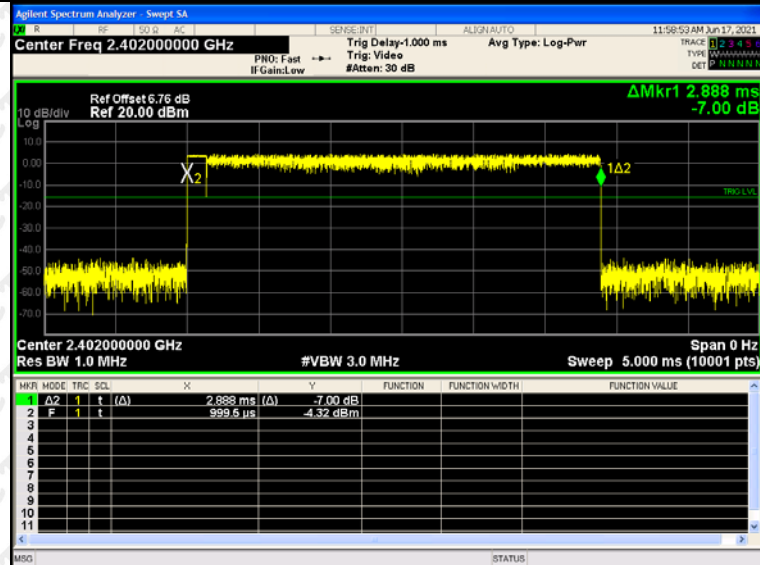
GFSK\_DH3/MCH



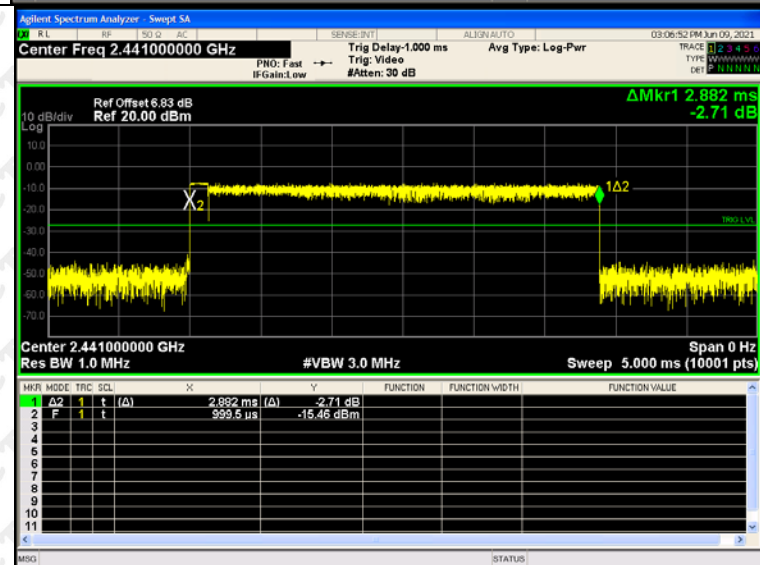
GFSK\_DH3/HCH



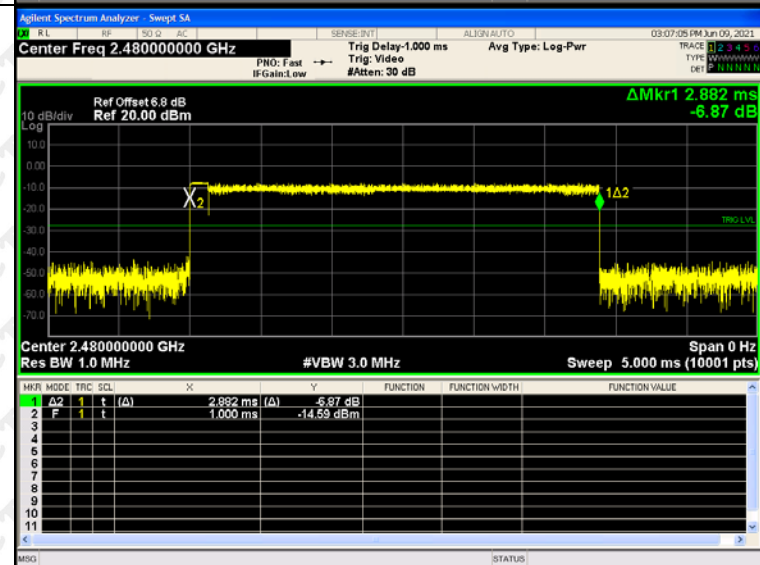
GFSK\_DH5/LCH



GFSK\_DH5/MCH



GFSK\_DH5/HCH



## 14. PSEUDORANDOM FREQUENCY

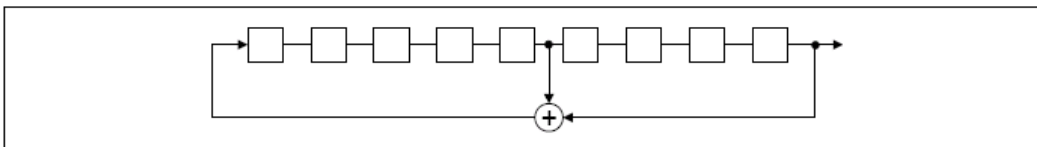
### 14.1 Limit

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.

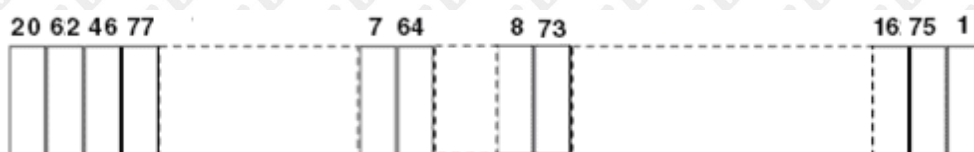
### 14.2 Test procedure

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 Internal Antenna. The best case gain of the antenna is 1dBi.

## 16. EUT PHOTOGRAPHS

EUT Photo 1



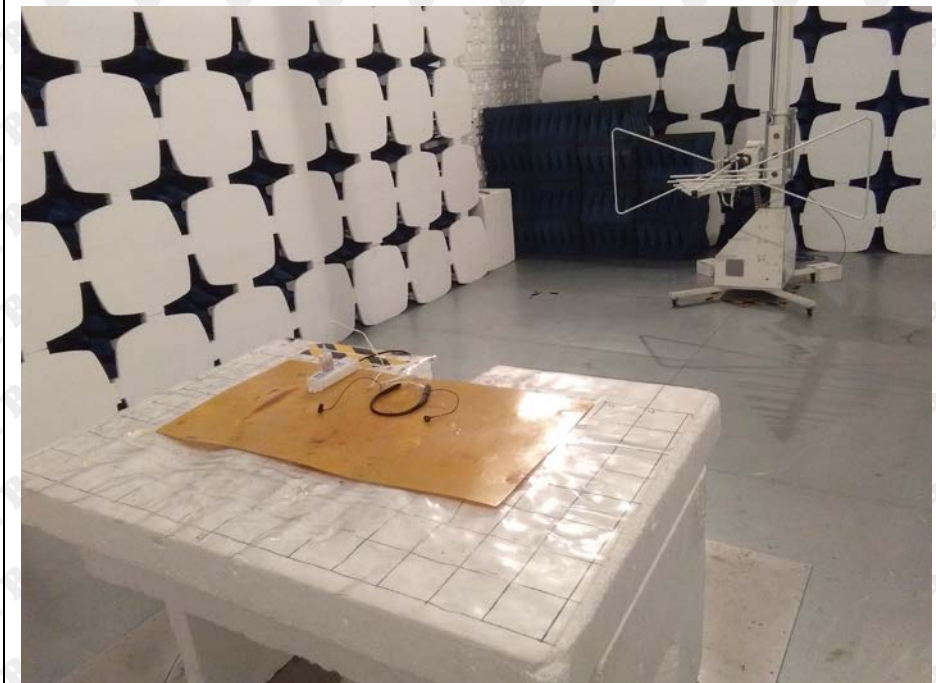
EUT Photo 2



## 17. EUT TEST SETUP PHOTOGRAPHS

### Radiated Emission

Below 1G



Above 1G



## Conducted emissions



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