



# 8-DPSK MODULATION IN HIGH CHANNEL

Hopping on



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# **10. RADIATED EMISSION**

### **10.1. MEASUREMENT PROCEDURE**

- 1. The EUT was placed on the top of the turntable 0.8 or 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
- 2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
- 3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
- 4. For each suspected emission, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
- 5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
- 6. For emissions above 1GHz, use 1MHz RBW and 3MHz VBW for peak reading. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
- 7. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum values.
- 8. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
- 9. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
- 10. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High Low scan is not required in this case.

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The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Start ~Stop Frequency	9KHz~150KHz/RB 200Hz for QP
Start ~Stop Frequency	150KHz~30MHz/RB 9KHz for QP
Start ~Stop Frequency	30MHz~1000MHz/RB 120KHz for QP
Start ~Stop Frequency	1GHz~26.5GHz 1MHz/3MHz for Peak, 1MHz/3MHz for Average

Receiver Parameter	Setting
Start ~Stop Frequency	9KHz~150KHz/RB 200Hz for QP
Start ~Stop Frequency	150KHz~30MHz/RB 9KHz for QP
Start ~Stop Frequency	30MHz~1000MHz/RB 120KHz for QP

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## 10.2. TEST SETUP

Radiated Emission Test-Setup Frequency Below 30MHz



# RADIATED EMISSION TEST SETUP 30MHz-1000MHz



# RADIATED EMISSION TEST SETUP ABOVE 1000MHz



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#### **10.3. LIMITS AND MEASUREMENT RESULT**

#### 15.209 Limit in the below table has to be followed

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)		
0.009~0.490	2400/F(kHz)	300		
0.490~1.705	24000/F(kHz)	30		
1.705~30.0	30	30		
30~88	100	3		
88~216	150	3		
216~960	200	3		
Above 960	500	3		

Note: All modes were tested for restricted band radiated emission, the test records reported below are the worst result compared to other modes.

#### **10.4. TEST RESULT**

## **RADIATED EMISSION BELOW 30MHz**

The amplitude of spurious emissions from 9kHz to 30MHz which are attenuated more than 20 dB below the permissible value need not be reported.

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#### Report No.: AGC02320201102FE03 Page 44 of 70

EUT	TWS True Wireless Headset	Vireless Headset Model Name	
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Horizontal

# **RADIATED EMISSION BELOW 1GHz**



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	52.3100	28.33	11.49	40.00	11.67	200	70	Horizontal
2	82.3800	21.56	7.17	40.00	18.44	200	359	Horizontal
3	128.940	28.02	14.08	43.50	15.48	200	173	Horizontal
4	258.920	24.34	14.57	46.00	21.66	100	343	Horizontal
5	437.400	33.64	20.69	46.00	12.36	100	90	Horizontal
6	582.900	30.48	23.97	46.00	15.52	200	359	Horizontal

## **RESULT: PASS**

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EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Vertical



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	52.3100	30.37	11.49	40.00	9.63	100	322	Vertical
2	114.390	28.17	12.89	43.50	15.33	100	258	Vertical
3	231.760	21.57	14.17	46.00	24.43	100	119	Vertical
4	349.130	25.22	17.82	46.00	20.78	100	82	Vertical
5	530.520	29.04	22.87	46.00	16.96	100	224	Vertical
6	904.940	37.81	30.15	46.00	8.19	100	295	Vertical

#### **RESULT: PASS**

Note: 1. Factor=Antenna Factor + Cable loss, Margin= Level -Limit.

2. All test modes had been pre-tested. The mode 1 is the worst case and recorded in the report.

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# **RADIATED EMISSION ABOVE 1GHz**

EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4804.000	46.58	0.08	46.66	74	-27.34	peak
4804.000	36.47	0.08	36.55	54	-17.45	AVG
7206.000	39.36	2.21	41.57	74	-32.43	peak
7206.000	32.41	2.21	34.62	54	-19.38	AVG
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			(R).			
Remark:						
Factor = Anter	na Factor + Cab	le Loss – Pre-	amplifier.	8		

EUT **TWS True Wireless Headset** IT Plus Model Name 25°C Temperature **Relative Humidity** 55.4% Pressure **Test Voltage** Normal Voltage 960hPa **Test Mode** Mode 1 Antenna Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Tree
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m) (dB)		
4804.000	45.68	0.08	45.76	74	-28.24	peak
4804.000	35.53	0.08	35.61	54	-18.39	AVG
7206.000	39.37	2.21	41.58	74	-32.42	peak
7206.000	31.23	2.21	33.44	54	-20.56	AVG
- 60	C				<u>.</u>	
emark:						

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EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 2	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	- value Type
4882.000	47.89	0.14	48.03	74	-25.97	peak
4882.000	36.65	0.14	36.79	54	-17.21	AVG
7323.000	40.74	2.36	43.1	74	-30.9	peak
7323.000	33.53	2.36	35.89	54	-18.11	AVG
®				S		
C.	8				®	
Remark:	- 6	8			- 6	8
Factor = Anter	nna Factor + Cable	e Loss – Pre-	amplifier.			- 6

EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 2	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4882.000	47.69	0.14	47.83	74	-26.17	peak
4882.000	39.45	0.14	39.59	54	-14.41	AVG
7323.000	41.51	2.36	43.87	74	-30.13	peak
7323.000	33.38	2.36	35.74	54	-18.26	AVG
8						
					C	
Remark:		3				C

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

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WS True Wireless Headset	Model Name	IT Plus
25°C	Relative Humidity	55.4%
)60hPa	Test Voltage	Normal Voltage
Mode 3	Antenna	Horizontal
	WS True Wireless Headset 5°C 60hPa Iode 3	WS True Wireless HeadsetModel Name5°CRelative Humidity60hPaTest VoltageIode 3Antenna

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4960.000	45.78	0.22	46	74	-28	peak
4960.000	36.64	0.22	36.86	54	-17.14	AVG
7440.000	39.54	2.64	42.18	74	-31.82	peak
7440.000	30.31	2.64	32.95	54	-21.05	AVG
8				®		
	8				®	
Remark:	- 6	8			- 6	8
Factor = Anter	nna Factor + Cable	Loss – Pre-	-amplifier.			a G

EUT IT Plus **TWS True Wireless Headset** Model Name 25°C 55.4% Temperature **Relative Humidity** 960hPa Pressure **Test Voltage** Normal Voltage **Test Mode** Mode 3 Antenna Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4960.000	45.86	0.22	46.08	74	-27.92	peak
4960.000	35.32	0.22	35.54	54	-18.46	AVG
7440.000	39.45	2.64	42.09	74	-31.91	peak
7440.000	30.49	2.64	33.13	54	-20.87	AVG
			0			6
omorki				6		
entark.	R					

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

# **RESULT: PASS**

Note:

The amplitude of other spurious emissions from 1G to 25 GHz which are attenuated more than 20 dB below the permissible value need not be reported.

Factor = Antenna Factor + Cable loss - Amplifier gain, Margin= Level -Limit.

The "Factor" value can be calculated automatically by software of measurement system.

All test modes had been tested. The GFSK modulation is the worst case and recorded in the report.

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# TEST RESULT FOR RESTRICTED BANDS REQUIREMENTS

EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Horizontal

PK



AV



## **RESULT: PASS**

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EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Vertical

PK



AV



**RESULT: PASS** 

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EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 3	Antenna	Horizontal

PK



AV



**RESULT: PASS** 

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EUT	TWS True Wireless Headset	Model Name	IT Plus
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 3	Antenna	Vertical



PK



# **RESULT: PASS**

**Note**: The factor had been edited in the "Input Correction" of the Spectrum Analyzer. The GFSK modulation is the worst case and recorded in the report.

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# **11. NUMBER OF HOPPING FREQUENCY**

### **11.1. MEASUREMENT PROCEDURE**

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

2. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

3. VBW  $\geq$  RBW. Sweep: Auto. Detector function: Peak. Trace: Max hold.

4. Allow the trace to stabilize.

## 11.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

#### **11.3. MEASUREMENT EQUIPMENT USED**

The same as described in section 6

#### **11.4. LIMITS AND MEASUREMENT RESULT**

TOTAL NO. OF HOPPING CHANNEL	LIMIT (NO. OF CH)	MEASUREMENT (NO. OF CH)	RESULT
	>=15	79	PASS



## TEST PLOT FOR NO. OF TOTAL CHANNELS

Note: The GFSK modulation is the worst case and recorded in the report.

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# 12. TIME OF OCCUPANCY (DWELL TIME)

# **12.1. MEASUREMENT PROCEDURE**

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span: Zero span, centered on a hopping channel.

2. RBW shall be  $\leq$  channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.

3. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.

4. Detector function: Peak. Trace: Max hold.

5. Use the marker-delta function to determine the transmit time per hop.

6. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer)  $\times$  (period specified in the requirements / analyzer sweep time)

7. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

# 12.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

# 12.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6

# **12.4. LIMITS AND MEASUREMENT RESULT**

Channel	Time of Pulse for DH5 (ms)	Number of hops in the period specified in the requirements	Sweep Time (ms)	Limit (ms)
Low	2.901	27*4	313.308	400
Middle	2.901	27*4	313.308	400
High	2.901	26*4	301.704	400

Note: The GFSK modulation is the worst case and recorded in the report.

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#### Keysight Spectrum Analyze 01:48:02 PM Dec 16, 202 Trig Delay-2.000 ms Trig: Video Atten: 30 dB Frequency Center Freq 2.402000000 GHz Avg Type: Log-Pwr PNO: Fast IFGain:Low Auto Tune Mkr1 2.028 m 2.72 dBm Ref 20.00 dBm 10 dB/div Center Frea 2.402000000 GHz -3.00 dB 2.901 ms Start Freq 2.402000000 GHz Stop Freq 2.402000000 GHz CF Step 1.000000 MHz <u>Auto</u> Man a bhailt ballach an Dhalabhainn a th Freq Offset 0 Hz Center 2.402000000 GHz Res BW 1.0 MHz Span 0 Hz Sweep 8.000 ms (30000 pts) #VBW 3.0 MHz G 😳 Points changed; all traces cleared STATUS 01:48:12 PM Dec 16, 2020 Frequency Avg Type: Log-Pwr Center Freq 2.402000000 GHz TYF DE Trig: Free Run PNO: Fast IFGain:Low Atten: 30 dB Auto Tune 10 dB/div Ref 20.00 dBm **Center Freq** 2.402000000 GHz Start Freq 2.402000000 GHz Stop Freq 2.402000000 GHz CF Step 1.000000 MHz <u>Auto</u> Mar Freq Offset 0 Hz Center 2.402000000 GHz Res BW 1.0 MHz Span 0 Hz Sweep 7.902 s (30000 pts) #VBW 3.0 MHz File <image.png> saved

# TEST PLOT OF LOW CHANNEL

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## TEST PLOT OF MIDDLE CHANNEL

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# TEST PLOT OF HIGH CHANNEL

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# **13. FREQUENCY SEPARATION**

### **13.1. MEASUREMENT PROCEDURE**

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span: Wide enough to capture the peaks of two adjacent channels.

2. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

3. Video (or average) bandwidth (VBW)  $\geq$  RBW.

4. Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

#### **13.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)**

Same as described in section 6.2

#### 13.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6.3

#### **13.4. LIMITS AND MEASUREMENT RESULT**

CHANNEL CHANNEL SEPARATION		LIMIT	RESULT	
	MHz			
Hopping mode	1.001	20 dB BW	Pass	

#### 50:03 PM Dec 16, 202 Marker Avg Type: Log-Pwr Avg Hold: 100/100 Marker 1 2.439996996997 GHz Trig: Free Run PNO: Wid IFGain:Lo Atten: 30 dB Select Marker Mkr1 2.439 997 GHz 2.440 dBm Ref 20.00 dBm ) dB/div Normal Delta Fixed Center 2.441000 GHz #Res BW 30 kHz Span 4.000 MHz 4.262 ms (1000 pts) #VBW 100 kHz Off Sweep 2.439 997 GHz 2.440 998 GHz 2.440 dBn 2.491 dBn Properties) More 1 of 2

## TEST PLOT FOR FREQUENCY SEPARATION

Note: The GFSK modulation is the worst case and recorded in the report.

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# APPENDIX A: PHOTOGRAPHS OF TEST SETUP

RADIATED EMISSION TEST SETUP BELOW 1GHz



RADIATED EMISSION TEST SETUP ABOVE 1GHz



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## CONDUCTED TEST SETUP



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# APPENDIX B: PHOTOGRAPHS OF EUT

TOP VIEW OF EUT



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#### BOTTOM VIEW OF EUT



#### FRONT VIEW OF EUT



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#### BACK VIEW OF EUT



LEFT VIEW OF EUT



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