

FCC Test Report

Report No.: AGC05031200501FE03

FCC ID	:	2AV3Z-ONYXFREE
APPLICATION PURPOSE	:	Original Equipment
PRODUCT DESIGNATION	:	True Wireless Earbuds
BRAND NAME	÷	Tronsmart
MODEL NAME	-	Onyx Free
APPLICANT	•	Shenzhen Geekbuy E-commerce Co., LTD.
DATE OF ISSUE	:	Jun. 28, 2020
STANDARD(S)	:	FCC Part 15.247
REPORT VERSION	:	V1.0

Attestation of Global Compliance (Shenzhen) Co., Ltd

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REPORT REVISE RECORD

Report Version	Revise Time	Issued Date	Valid Version	Notes	
V1.0		Jun. 28, 2020	Valid	Initial Release	(S) A





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1. VERIFICATION OF CONFORMITY

Applicant	Shenzhen Geekbuy E-commerce Co., LTD.		
Address	19th Floor, Galaxy World Tower B, #1 YaBao Rd., LongGang District, Shenzhen, China		
Manufacturer	Shenzhen Geekbuy E-commerce Co., LTD.		
Address	19th Floor, Galaxy World Tower B, #1 YaBao Rd., LongGang District, Shenzhen, China		
Factory	Shenzhen Geekbuy E-commerce Co., LTD.		
Address	19th Floor, Galaxy World Tower B, #1 YaBao Rd., LongGang District, Shenzhen, China		
Product Designation	True Wireless Earbuds		
Brand Name	Tronsmart		
Test Model	Onyx Free		
Date of test	Jun. 08, 2020 to Jun. 28, 2020		
Deviation	No any deviation from the test method		
Condition of Test Sample	Normal		
Test Result	Pass		
Report Template	AGCRT-US-BR/RF		

We hereby certify that:

The above equipment was tested by Attestation of Global Compliance (Shenzhen) Co., Ltd. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 (2013) and the energy emitted by the sample EUT tested as described in this report is in compliance with radiated emission limits of FCC PART 15.247.

Prepared By

Reviewed By

Then Hunny

Thea Huang Project Engineer

Jun. 28, 2020

Max Zhans

Max Zhang Reviewer

Jun. 28, 2020

Approved By

Forrest Lei Authorized Officer

Jun. 28, 2020





2. GENERAL INFORMATION

2.1. PRODUCT DESCRIPTION

The EUT is designed as "True Wireless Earbuds". It is designed by way of utilizing the GFSK, Pi/4 DQPSK and 8DPSK technology to achieve the system operation.

A major technical description of EUT is described as following

Operation Frequency	2.402 GHz to 2.480GHz
RF Output Power	8.360dBm(Max)
Bluetooth Version	V5.0
Modulation	BR ⊠GFSK, EDR ⊠π /4-DQPSK, ⊠8DPSK BLE □GFSK 1Mbps □GFSK 2Mbps
Number of channels	79 Channels
Hardware Version	V1
Software Version	MCT_011_Tronsmart Onyx Free_0511.xuv
Antenna Designation	Ceramic Antenna(Comply with requirements of the FCC part 15.203)
Antenna Gain	1.5dBi
Power Supply	DC 3.7V by battery
Note: 1 The FUT descrites	

Note: 1. The EUT doesn't support BLE.

2. The EUT comprises left and right channel earphone, both are the same and have been tested and only the test data of left earphone recorded in this report.

2.2. TABLE OF CARRIER FREQUENCYS

Frequency Band	Channel Number	Frequency
	0	2402MHZ
	1	2403MHZ
	38	2440 MHZ
2402~2480MHZ	39	2441 MHZ
	40	2442 MHZ
	77	2479 MHZ
	78	2480 MHZ





2.3. RECEIVER INPUT BANDWIDTH

The input bandwidth of the receiver is 1.3MHZ, In every connection one Bluetooth device is the master and the other one is slave. The master determines the hopping sequence. The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master. Additionally the type of connection(e.g. single of multislot packet) is set up at the beginning of the

connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also the slave of the connection will use these settings.

Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

2.4. EXAMPLE OF A HOPPING SEQUENCY IN DATA MODE

Example of a 79 hopping sequence in data mode: 40,21,44,23,42,53,46,55,48,33,52,35,50,65,54,67 56,37,60,39,58,69,62,71,64,25,68,27,66,57,70,59 72,29,76,31,74,61,78,63,01,41,05,43,03,73,07,75 09,45,13,47,11,77,15,00,64,49,66,53,68,02,70,06 01, 51, 03, 55, 05, 04

2.5. EQUALLY AVERAGE USE OF FREQUENCIES AND BEHAVIOUR

The generation of the hopping sequence in connection mode depends essentially on two input values: 1. LAP/UAP of the master of the connection.

2. Internal master clock

The LAP(lower address part) are the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP(upper address part) are the 24MSB's of the 48BD_ADDRESS

The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For ehavior zation with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5us.The clock has a cycle of about one day(23h30).In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire. LAP(24 bits),4LSB's(4bits)(Input 1) and the 27MSB's of the clock(Input 2) are used. With this input values different mathematical procedures(permutations, additions, XOR-operations)are performed to generate te Sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following ehavior:

The first connection between the two devices is established, a hopping sequence was generated. For Transmitting the wanted data the complete hopping sequence was not used. The connection ended. The second connection will be established. A new hopping sequence is generated. Due to the fact the Bluetooth clock has a different value, because the period between the two transmission is longer(and it Cannot be shorter) than the minimum resolution of the clock(312.5us). The hopping sequence will always Differ from the first one.





2.6. RELATED SUBMITTAL(S) / GRANT (S)

This submittal(s) (test report) is intended for **FCC ID: 2AV3Z-ONYXFREE** filing to comply with the FCC PART 15.247 requirements.

2.7. TEST METHODOLOGY

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10 (2013). Radiated testing was performed at an antenna to EUT distance 3 meters.

2.8. SPECIAL ACCESSORIES

Refer to section 5.2.

2.9. EQUIPMENT MODIFICATIONS

Not available for this EUT intended for grant.





3. MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ±U, where expended uncertainty U is based on a standard

uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

- Uncertainty of Conducted Emission, Uc = ±3.1 dB
- Uncertainty of Radiated Emission below 1GHz, Uc = ±4.0 dB
- Uncertainty of Radiated Emission above 1GHz, Uc = ±4.8 dB
- Uncertainty of total RF power, conducted, $Uc = \pm 0.8$ dB
- Uncertainty of spurious emissions, conducted, Uc = ±2.7dB
- Uncertainty of Occupied Channel Bandwidth: Uc = ±2 %
- Uncertainty of Dwell Time: Uc = ± 2 %
- Uncertainty of Frequency: $Uc = \pm 2 \%$





4. DESCRIPTION OF TEST MODES

NO.	TEST MODE DESCRIPTION
1	Low channel GFSK
2	Middle channel GFSK
3	High channel GFSK
4	Low channel π/4-DQPSK
5	Middle channel π/4-DQPSK
6	High channel π/4-DQPSK
7	Low channel 8DPSK
8	Middle channel 8DPSK
9	High channel 8DPSK
10	Hopping mode GFSK
11	Hopping mode π/4-DQPSK
12	Hopping mode 8DPSK

Note: 1. Only the result of the worst case was recorded in the report, if no other cases.

2. For Conducted Test method, a temporary antenna connector is provided by the manufacture.

3. For Radiated Emission, 3axis were chosen for testing for each applicable mode.

Software Setting

Test Commands		-Test Arguments -			7
RADIO STATUS FULL	^	LO Freq. (NDHz)	2402		Close
TXSTART		Power	2 5	0	-
TXDATA1 TXDATA2		(Atn. Mag. Exp)	r r	P	Help
TXDATA3					
TXDATA4	2 19 1				Execute
RXSTART1					Reset
RXSTART2					Aeset
RXDATA1	~				
Test Results 「 Save to file C:\Users\高字环\Ap	-		play : @ S 3\testapple	ANOTORICALED.	C BER
☐ Save to file _	-			ANOTORICALED.	C BER
「 Save to file C:\Users\高字环\Ap	-			ANOTORICALED.	C BER
□ Save to file C:\Users\查字环\Ap SSI: 0. SSI: 0. SSI: 0. SSI: 0.	-			ANOTORICALED.	C BER
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C:\Users\APFW\Ap SSI: 0. SSI: 0. SSI: 0. SSI: 0. SSI: 1. SSI: 1. SSI: 1. SSI: 1. SSI: 1. SSI: 1. SSI: 2. adio Test CFG PKT su	pData\Lo	cal\QTIL\BlueTest		ANOTORICALED.	C BER
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5. SYSTEM TEST CONFIGURATION

5.1. CONFIGURATION OF EUT SYSTEM

Radiated Emission Configure :

EUT

5.2. EQUIPMENT USED IN TESTED SYSTEM

ltem	Equipment	Model No.	ID or Specification	Remark
1	True Wireless Earbuds	Onyx Free	2AV3Z-ONYXFREE	EUT
2	Control Box	N/A	USB-TTL	AE

5.3. SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT
15.247 (b)(1)	Peak Output Power	Compliant
15.247 (a)(1)	20 dB Bandwidth	Compliant
15.247 (d)	Conducted Spurious Emission	Compliant
15.209	Radiated Emission	Compliant
15.247 (a)(1)(iii)	Number of Hopping Frequency	Compliant
15.247 (a)(1)(iii)	Time of Occupancy	Compliant
15.247 (a)(1)	Frequency Separation	Compliant
15.207	Conducted Emission	N/A

Note: The EUT is powered by battery.





6. TEST FACILITY

Test Site	Attestation of Global Compliance (Shenzhen) Co., Ltd	
Location	1-2/F, Building 19, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China	
Designation Number	CN1259	
FCC Test Firm Registration Number	975832	
A2LA Cert. No.	5054.02	
Description	Attestation of Global Compliance(Shenzhen) Co., Ltd is accredited by A2LA	

TEST EQUIPMENT OF RADIATED EMISSION TEST

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
TEST RECEIVER	R&S	ESCI	10096	May 15, 2020	May 14, 2022
EXA Signal Analyzer	Aglient	N9010A	MY53470504	Dec. 12, 2019	Dec. 11, 2020
2.4GHz Fliter	EM Electronics	2400-2500MHz	N/A	Mar. 23, 2020	Mar. 22, 2022
Attenuator	ZHINAN	E-002	N/A	Sep. 09, 2019	Sep. 08, 2020
Horn antenna	SCHWARZBECK	BBHA 9170	#768	Sep. 21, 2019	Sep. 20, 2021
Active loop antenna (9K-30MHz)	ZHINAN	ZN30900C	18051	May 22, 2020	May 21, 2022
Double-Ridged Waveguide Horn	ETS LINDGREN	3117	00154520	Oct. 25, 2019	Oct. 26, 2021
Broadband Preamplifier	ETS LINDGREN	3117PA	00225134	Oct. 15, 2019	Oct. 16, 2020
ANTENNA	SCHWARZBECK	VULB9168	494	Sep. 20, 2019	Sep. 19, 2021
Test software	FARA	EZ-EMC (Ver RA-03A)	N/A	N/A	N/A





7. PEAK OUTPUT POWER

7.1. MEASUREMENT PROCEDURE

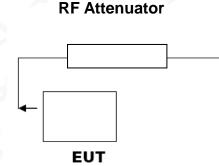
For peak power test:

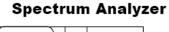
- 1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
- 2. Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
- 3. RBW > 20 dB bandwidth of the emission being measured.
- 4. VBW \geq RBW.
- 5. Sweep: Auto.
- 6. Detector function: Peak.
- 7. Trace: Max hold.

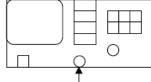
Allow trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power, after any corrections for external attenuators and cables.

7.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

PEAK POWER TEST SETUP













7.3. LIMITS AND MEASUREMENT RESULT

PEAK OUTPUT POWER MEASUREMENT RESULT FOR GFSK MOUDULATION						
FrequencyPeak Power(GHz)(dBm)		Applicable Limits (dBm)	Pass or Fail			
2.402	7.085	30	Pass			
2.441	7.219	30	Pass			
2.480	7.497	30	Pass			

Avg Type: Log-Pwi Avg|Hold:>100/100 Peak Search GHz PNO: Fast IFGain:Low Trig: Free Run Atten: 30 dB Ð Next Peak Mkr1 2.401 995 GHz 7.085 dBm Ref 20.00 dBm 10 dB/div Next Pk Right Next Pk Left Marker Delta Mkr→CF Mkr→RefLv More 1 of 2 Center 2.402000 GHz #Res BW 1.5 MHz Span 5.000 MHz Sweep 1.000 ms (1001 pts) #VBW 5.0 MHz



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RF 50 Ω AC arker 1 2.479980000000	GHz PNO: Fast Trig: Free		r TRACE 1 2 3 4 5 6	Peak Search
dB/div Ref 20.00 dBm	IFGain:Low Atten: 30		r1 2.479 980 GHz 7.497 dBm	Next Pe
0.0		1		Next Pk Rig
1.00				Next Pk L
0.0				Marker Do
				Mkr⊸
.0				Mkr→Ref
0.0				M
enter 2.480000 GHz Res BW 1.5 MHz	#VBW 5.0 MHz	Sweep	Span 5.000 MHz 1.000 ms (1001 pts)	1



More 1 of 2

	PEAK OUTPUT POWER MEA FOR II /4-DQPSK N		
Frequency (GHz)	Peak Power (dBm)	Applicable Limits (dBm)	Pass or Fail
2.402	7.620	21	Pass
2.441	7.853	21	Pass
2.480	8.360	21	Pass



#VBW 5.0 MHz

CH0



Center 2.402000 GHz #Res BW 1.5 MHz Span 5.000 MHz Sweep 1.000 ms (1001 pts)

STATUS

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1	Im Analyzer - Swept SA RF 50 Ω AC 48016000000	0 GHz PNO: Fast			ALIGN AUTO : Log-Pwr :>100/100	TRAC	MJun 10, 2020 E 1 2 3 4 5 6 E MWWWW T P N N N N N	Peak Search
0 dB/div	Ref 20.00 dBm				Mkr1	2.480 1 8.3	60 GHz 60 dBm	NextPea
10.0				∮ ¹	 			Next Pk Rig
10.0								Next Pk L
80.0								Marker De
0.0								Mkr→
60.0								Mkr→Refl
center 2.48		#VB	SW 5.0 MHz		Sweep_1	Span 5 .000 ms (.000 MHz 1001 pts)	М а 1 о
SG					STATUS			



PEAK OUTPUT POWER MEASUREMENT RESULT FOR 8DPSK MODULATION						
Frequency (GHz)	Peak Power (dBm)	Applicable Limits (dBm)	Pass or Fail			
2.402	7.615	21	Pass			
2.441	7.857	21	Pass			
2.480	8.359	21	Pass			



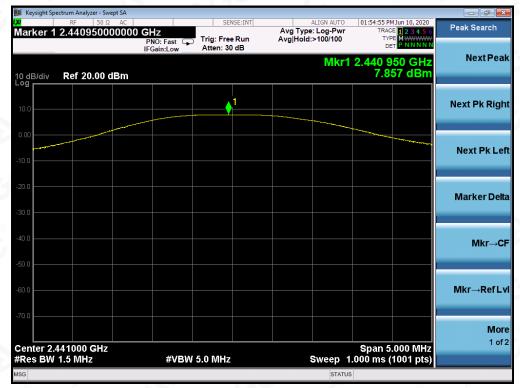
Keysight Spectrum Analyzer - Swept SA	S	ENSE:INT	ALIGN AUTO 01:53	:46 PM Jun 10, 2020	
Marker 1 2.40176000000		Avg Tyj ee Run Avg Hol		TRACE 1 2 3 4 5 6 TYPE MWWWW DET P NNNNN	Peak Search
10 dB/div Ref 20.00 dBm			Mkr1 2.40	1 760 GHz 7.615 dBm	NextPeal
10.0	↓ 1				Next Pk Righ
0.00					Next Pk Let
-20.0					Marker Delt
-30.0					Mire O
50.0					Mkr→C
60.0					Mkr→RefLv
Center 2.402000 GHz #Res BW 1.5 MHz	#\/D\\\ 6 0 BAL		Spa	n 5.000 MHz	Mor 1 of
#Res BW 1.5 WHZ	#VBW 5.0 MH		Sweep 1.000 r	ns (1001 pts)	



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<mark>»</mark> Marker 1 2	RF 50 Ω AC 2.480135000000	GHz PNO: Fast	Trig: Free Run Atten: 30 dB	Avg Type: Avg Hold:>		01:56:10 PM Jun 10, 2 TRACE 1 2 3 TYPE MWW DET P NN	4 5 6 Peak Search
10 dB/div	Ref 20.00 dBm				Mkr1	2.480 135 G 8.359 dB	Hz NextPe Bm
10.0			• ¹				Next Pk Rig
0.00							Next Pk L
0.0							Marker De
0.0							Mkr→
0.0							Mkr→Refi
	80000 GHz	#\/B\				Span 5.000 M	Mc 1 d
Center 2.43 #Res BW 1		#VBV	V 5.0 MHz	S	weep 1.	Span 5.000 M 000 ms (1001 p	1Hz



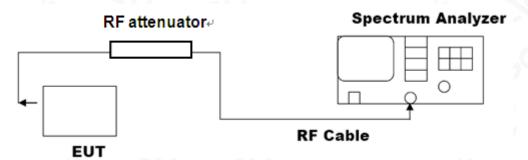


8. 20DB BANDWIDTH

8.1. MEASUREMENT PROCEDURE

- 1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
- 2, Set the EUT Work on the top, the middle and the bottom operation frequency individually.
- 3. Set Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hoping channel The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW; Sweep = auto; Detector function = peak
- 4. Set SPA Trace 1 Max hold, then View.

8.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)



8.3. LIMITS AND MEASUREMENT RESULTS

MEASUREMENT RESULT FOR GFSK MOUDULATION						
Appliachta Limita	Measurement Result					
Applicable Limits	Test Data	Criteria				
	Low Channel	0.9590	PASS			
N/A	Middle Channel	0.9589	PASS			
	High Channel	0.960	PASS			







TEST PLOT OF BANDWIDTH FOR LOW CHANNEL

TEST PLOT OF BANDWIDTH FOR MIDDLE CHANNEL







TEST PLOT OF BANDWIDTH FOR HIGH CHANNEL



MEASUREMENT RESULT FOR II /4-DQPSK MODULATION							
Angliachte Limite	Measurement Result						
Applicable Limits	Test Data	Criteria					
	Low Channel	1.347	PASS				
N/A	Middle Channel	1.349	PASS				
	High Channel	1.349	PASS				

TEST PLOT OF BANDWIDTH FOR LOW CHANNEL







TEST PLOT OF BANDWIDTH FOR MIDDLE CHANNEL

TEST PLOT OF BANDWIDTH FOR HIGH CHANNEL

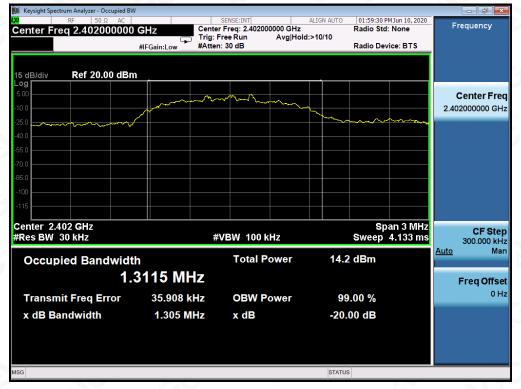
Keysight Spectrum Analyzer - Occupied BW						- 7
enter Freq 2.480000000	Trig: I	SENSE:INT r Freq: 2.480000000 GHz Free Run Avg Hol n: 30 dB	ALIGN AUTO	02:04:11 PM Radio Std: Radio Devi		Frequency
5 dB/div Ref 20.00 dBm						
10.0	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				\sim	Center Fre 2.480000000 GH
5.0						
100						
enter 2.48 GHz					ın 3 MHz	CF Ste
Res BW 30 kHz	#	VBW 100 kHz		Sweep 4		300.000 kł Auto Ma
Occupied Bandwidth	ո 1871 MHz	Total Power	14.5	dBm		Freq Offs
Transmit Freq Error	130.15 kHz	OBW Power	99	.00 %		0 H
x dB Bandwidth	1.349 MHz	x dB	-20.	00 dB		
G			STATUS			





MEASUREMENT RESULT FOR 8DPSK MODULATION							
Appliachta Limita		Measurement Result					
Applicable Limits	Test Data	Criteria					
	Low Channel	1.305	PASS				
N/A	Middle Channel	1.308	PASS				
	High Channel	1.310	PASS				

TEST PLOT OF BANDWIDTH FOR LOW CHANNEL







TEST PLOT OF BANDWIDTH FOR MIDDLE CHANNEL

TEST PLOT OF BANDWIDTH FOR HIGH CHANNEL

Keysight Spectrum Analyzer - Occupied BW					
RF 50 Ω AC enter Freq 2.480000000 GHz		SENSE:INT ALIGN AUTO Center Freq: 2.480000000 GHz Trig: Free Run Avg Hold:>10/10 #Atten: 30 dB		02:04:49 PM Jun 10, 2020 Radio Std: None Radio Device: BTS	Frequency
5 dB/div Ref 20.00 dBm		~~~~~			Center Fre
				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	2.480000000 GH
.0 .0					
10 15					
enter 2.48 GHz Res BW 30 kHz	#	VBW 100 kHz		Span 3 MHz Sweep 4.133 ms	CF Ste 300.000 ki
Occupied Bandwidth 1.3	322 MHz	Total Power	15.2 c	IBm	Auto Ma Freg Offs
Transmit Freq Error	50.122 kHz			0 %	01
x dB Bandwidth	1.310 MHz	x dB	-20.00	) dB	
à			STATUS		





#### 9. CONDUCTED SPURIOUS EMISSION

#### 9.1. MEASUREMENT PROCEDURE

- 1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
- 2. Set the EUT Work on the top, the Middle and the bottom operation frequency individually.
- 3. Set the Span = wide enough to capture the peak level of the in-band emission and all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonic.
  RBW = 100 kHz; VBW= 300 kHz; Sweep = auto; Detector function = peak.
- 4. Set SPA Trace 1 Max hold, then View.

#### 9.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

The same as described in section 8.2

#### 9.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6

#### 9.4. LIMITS AND MEASUREMENT RESULT

LIMITS AND MEASUREMENT RESULT							
Applieghte Limite	Measurement Result						
Applicable Limits	Test Data	Criteria					
In any 100 KHz Bandwidth Outside the frequency band in which the spread spectrum	At least -20dBc than the limit Specified on the BOTTOM Channel	PASS					
intentional radiator is operating, the radio frequency power that is produce by the intentional radiator shall be at least 20 dB below that in 100KHz bandwidth within the band that contains the highest level of the desired power. In addition, radiation emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in§15.209(a))	At least -20dBc than the limit Specified on the TOP Channel	PASS					





# TEST RESULT FOR ENTIRE FREQUENCY RANGE TEST PLOT OF OUT OF BAND EMISSIONS WITH THE WORST CASE OF $\pi$ /4-DQPSK MODULATION IN LOW CHANNEL

:55 PM Jun 10, 2020 RF 50 Ω AC 402161422047 GHz PNO: Wide IFGain:Low Peak Search Avg Type: Log-Pwi Avg|Hold:>100/100 Trig: Free Run Atten: 30 dB Next Peak Mkr1 2.402 161 42 GHz 7.004 dBm 10 dB/div Log Ref 20.00 dBm Next Pk Right Next Pk Left Marker Delta Mkr→CF Mkr→RefLv More 1 of 2 Center 2.402000 GHz #Res BW 100 kHz Span 5.000 MHz Sweep 2.000 ms (30000 pts) #VBW 300 kHz Avg Type: Log-Pwr Avg|Hold:>100/100 Peak Search 22.482940098003 GHz Trig: Free Run Atten: 30 dB PNO: Fast IFGain:Low **Next Peak** Mkr3 22.482 9 GHz -50.543 dBm 0 dB/div Ref 20.00 dBm Next Pk Right Next Pk Left 7 Marker Delta Start 30 MHz #Res BW 100 kHz Stop 25.00 GHz Sweep 2.388 s (30000 pts) #VBW 300 kHz Mkr→CF -48.978 dBn -50.543 dBn Mkr→RefLvl More 1 of 2 STATUS







## TEST PLOT OF OUT OF BAND EMISSIONS OF $\pi$ /4-DQPSK MODULATION IN MIDDLE CHANNEL

Keysight Spectrum Analyzer - Swept SA	149 GHz	SENSE:IN	Avg	ALIGN AUTO	TRAC	1 Jun 10, 2020 E 1 2 3 4 5 6	Peak Search
0 dB/div Ref 20.00 dBn	IFGain:Low Atten: 30 dB DET PINNINN Mkr3 21.003 8 GHz						
• <b>g</b> 10.0 0.00						-12.78 dBm	Next Pk Righ
20.0 					3	<u>\</u> 2\1_	Next Pk Le
50.0 (10110000000000000000000000000			a sa ila sa sa ila				Marker Del
	X	V 300 kHz Y	FUNCTION	Sweep 2	Stop 2: 2.388 s (30 FUNCTIC		Mkr→C
2 N 1 f	24.245 9 GHz 23.555 9 GHz 21.003 8 GHz	-48.099 dBm -48.248 dBm -50.824 dBm				E	Mkr→RefL
7 8 8 9 9 0 1 0							<b>Mo</b> 1 of
G		III		STATUS		•	





## TEST PLOT OF OUT OF BAND EMISSIONS OF $\pi$ /4-DQPSK MODULATION IN HIGH CHANNEL

Note: The peak emissions without marker on the above plots are fundamental wave and need not to compare with the limit. The  $\pi$  /4-DQPSK modulation is the worst case and only those data recorded in the report.

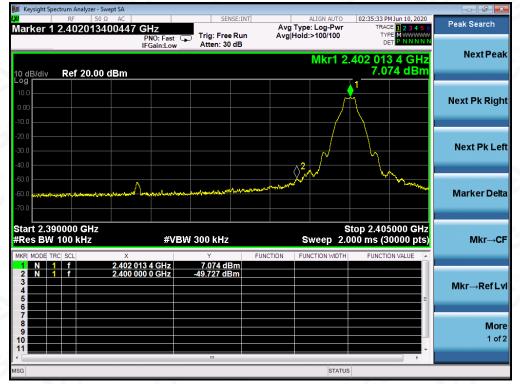




#### TEST RESULT FOR BAND EDGE

#### GFSK MODULATION IN LOW CHANNEL

Hopping off

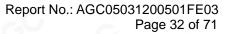


Hopping on

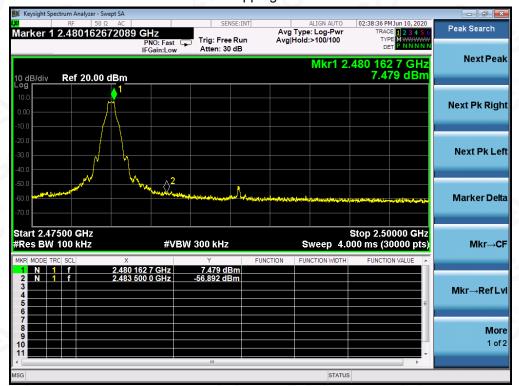




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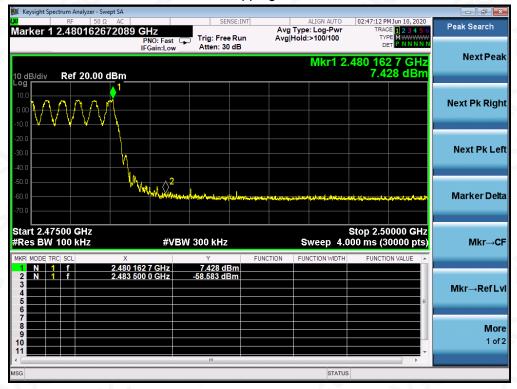






#### GFSK MODULATION IN HIGH CHANNEL Hopping off

Hopping on









#### $\pi$ /4-DQPSK MODULATION IN LOW CHANNEL Hopping off

Hopping on











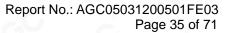
### $\pi$ /4-DQPSK MODULATION IN HIGH CHANNEL Hopping off

Hopping on





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#### 8DPSK MODULATION IN LOW CHANNEL Hopping off

Hopping on



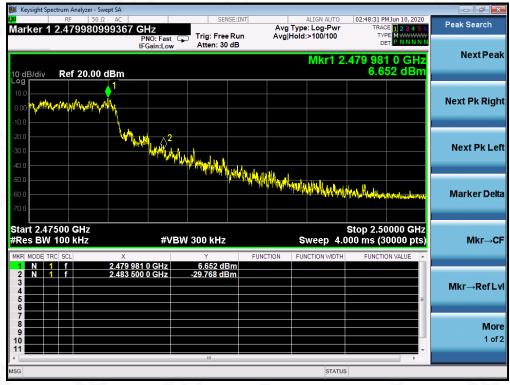






#### 8DPSK MODULATION IN HIGH CHANNEL Hopping off

Hopping on







## **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 emissions, 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.





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

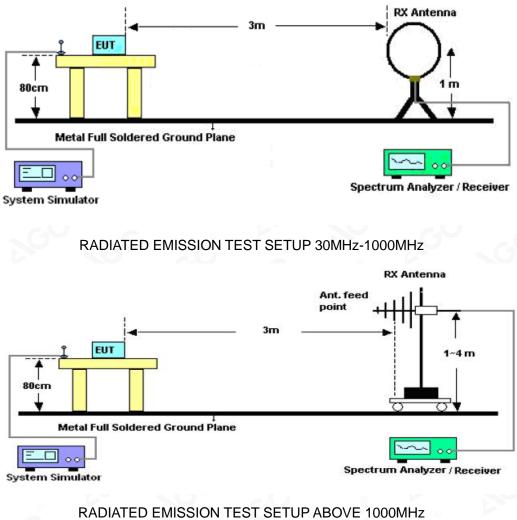
Receiver Parameter	Setting
Start ~Stop Frequency	9KHz~150KHz/RB 200Hz for QP
Start ~Stop Frequency	150KHz~30MHz/RB 9KHz for QP
Start ~Stop Frequency	30MHz~1000MHz/RB 120KHz for QP

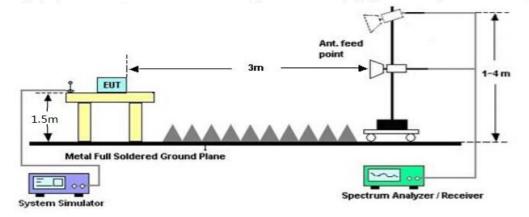




## **10.2. TEST SETUP**

Radiated Emission Test-Setup Frequency Below 30MHz







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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 (micorvolts/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**

No emission found between lowest internal used/generated frequencies to 30MHz.

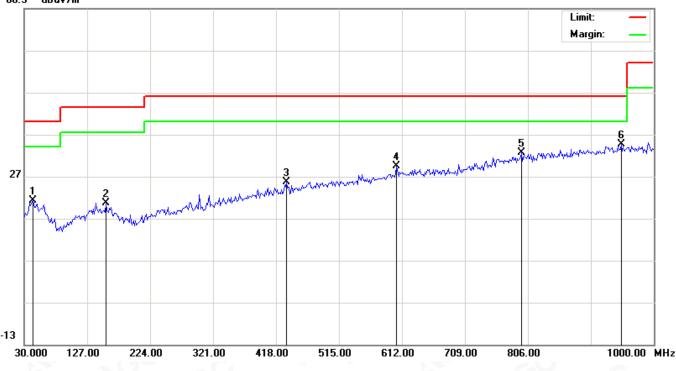




# **RADIATED EMISSION BELOW 1GHZ**

EUT	True Wireless Earbuds	eless Earbuds Model Name	
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Horizontal

#### 66.9 dBuV/m



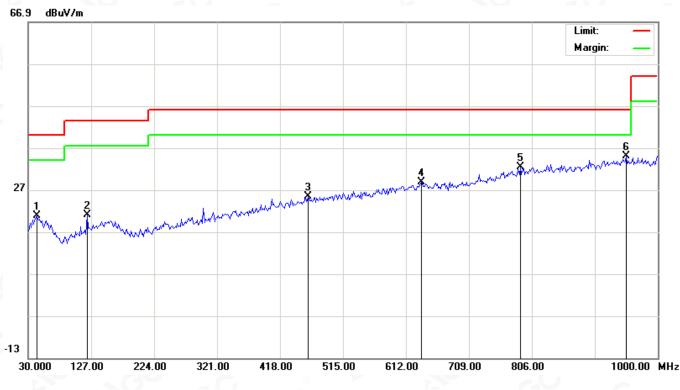
No.	Mk	Freq.	Reading	Factor	Measurement	Limit	Over	Detector
	•	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1		42.9333	1.15	19.98	21.13	40.00	-18.87	peak
2		156.1000	1.38	19.20	20.58	43.50	-22.92	peak
3		434.1667	1.84	23.67	25.51	46.00	-20.49	peak
4		603.9167	2.36	27.00	29.36	46.00	-16. <mark>64</mark>	peak
5		796.3000	2.37	30.33	32.70	46.00	-13.30	peak
6	*	949.8833	2.45	32.13	34.58	46.00	-11.42	peak

## **RESULT: PASS**





A			
EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical



		and the second sec					
No.	Mk	Freq.	Reading	Factor	Measurement	Limit	Over
	•	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB
1		42.9333	0.92	19.98	20.90	40.00	-19.10
2		120.5333	2.91	18.00	20.91	43.50	-22.59
3		461.6500	1.11	24.22	25.33	46.00	-20.67
4		636.2500	1.52	27.38	28.90	46.00	-17.10
5		788.2167	2.30	30.14	32.44	46.00	-13.56
6	*	951.5000	2.93	32.14	35.07	46.00	-10.93

## **RESULT: PASS**

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

2. All test modes had been pre-tested. The mode 4 is the worst case and recorded in the report.





# **RADIATED EMISSION ABOVE 1GHZ**

EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Horizontal

(dBµV) 55.36	(dB) 0.08	(dBµV/m)	(dBµV/m)	(dB)	- Value Type
55.36	0.08				
	0.00	55.44	74	-18.56	peak
46.34	0.08	46.42	54	-7.58	AVG
53.91	2.21	56.12	74 💿	-17.88	peak
45.85	2.21	48.06	54	-5.94	AVG
	5			<u> </u>	-0
	53.91 45.85	53.91      2.21        45.85      2.21	53.91 2.21 56.12	53.91      2.21      56.12      74        45.85      2.21      48.06      54	53.91      2.21      56.12      74      -17.88        45.85      2.21      48.06      54      -5.94

EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin		
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	Value Type	
4804.000	53.13	0.08	53.21	74	-20.79	peak	
4804.000	44.86	0.08	44.94	54	-9.06	AVG	
7206.000	52.72	2.21	54.93	74	-19.07	peak	
7206.000	43.95	2.21	46.16	54	-7.84	AVG	
<u>,</u>			- C				
	8			0			
emark:							





EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 5	Antenna	Horizontal

Frequency Met (MHz)	ter Reading (dBµV)	Factor (dB)	Emission Level	Limits	Margin	Malus Tar
(MHz)	(dBµV)	(dB)				
			(dBµV/m)	(dBµV/m)	(dB)	- Value Type
4882.000	52.02	0.14	52.16	74	-21.84	peak
4882.000	42.87	0.14	43.01	54	-10.99	AVG
7323.000	51.26	2.36	53.62	74	-20.38	peak
7323.000	41.88	2.36	44.24	54	-9.76	AVG
	0			NO	60	
Remark:	- 64	0	6			CAV .
actor = Antenna Fa	actor + Cable	Loss – Pre-a	amplifier.	0		

EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 5	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4882.000	50.69	0.14	50.83	74	-23.17	peak
4882.000	41.11	0.14	41.25	54	-12.75	AVG
7323.000	49.87	2.36	52.23	74	-21.77	peak
7323.000	40.53	2.36	42.89	54	-11.11	AVG
		- C	0			
				8		

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





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EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4960.000	49.23	0.22	49.45	74	-24.55	peak
4960.000	39.65	0.22	39.87	54	-14.13	AVG
7440.000	48.72	2.64	51.36	74	-22.64	peak
7440.000	38.49	2.64	41.13	54	-12.87	AVG
	© I		9 60		8	
emark:	- C1	8			- 61	®
ctor = Anter	na Factor + Cable	Loss – Pre-	amplifier.			

	- w		
EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Vertical

Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
48.31	0.22	48.53	74	-25.47	peak
37.84	0.22	38.06	54	-15.94	AVG
47.95	2.64	50.59	74	-23.41	peak
36.49	2.64	39.13	54	-14.87	AVG
	0		6	- 6	8
				0	- 6
	- 69				5 2
	(dBµV) 48.31 37.84 47.95	(dBµV)      (dB)        48.31      0.22        37.84      0.22        47.95      2.64	(dBµV)      (dB)      (dBµV/m)        48.31      0.22      48.53        37.84      0.22      38.06        47.95      2.64      50.59	(dBµV)      (dB)      (dBµV/m)      (dBµV/m)        48.31      0.22      48.53      74        37.84      0.22      38.06      54        47.95      2.64      50.59      74	(dBµV)(dB)(dBµV/m)(dBµV/m)(dB)48.310.2248.5374-25.4737.840.2238.0654-15.9447.952.6450.5974-23.41

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

## **RESULT: PASS**

**Note:** Other emissions from 1G to 25 GHz are considered as ambient noise. No recording in the test report. Factor = Antenna Factor + Cable loss - Amplifier gain, Over=Measure-Limit.

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

All test modes had been tested. The  $\pi$  /4-DQPSK modulation is the worst case and recorded in the report.

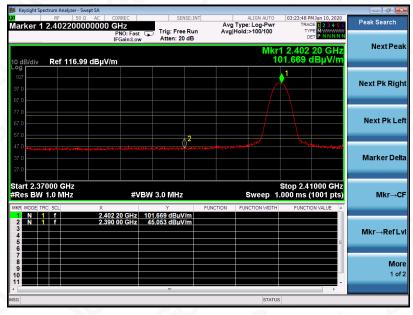


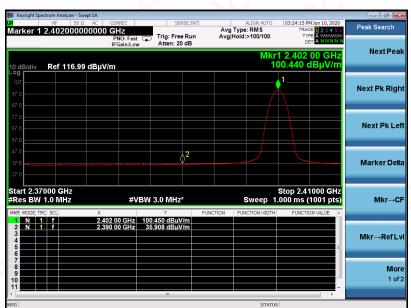


EUT	True Wireless Earbuds	Model Name	Onyx Free	
Temperature	25°C	Relative Humidity	55.4%	
Pressure	960hPa	Test Voltage	Normal Voltage	
Test Mode	Mode 4	Antenna	Horizontal	

#### TEST RESULT FOR RESTRICTED BANDS REQUIREMENTS

PK





**RESULT: PASS** 



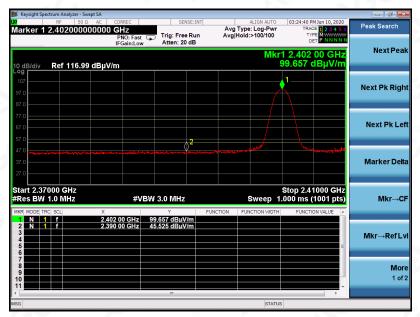
AV



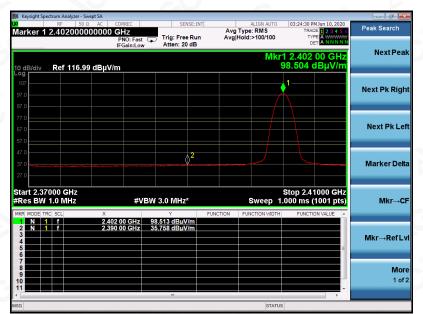
#### Report No.: AGC05031200501FE03 Page 47 of 71

EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical

PK



AV



**RESULT: PASS** 



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EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Horizontal

PK



#### AV



**RESULT: PASS** 



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#### Report No.: AGC05031200501FE03 Page 49 of 71

EUT	True Wireless Earbuds	Model Name	Onyx Free
Temperature	25°C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Vertical

PK



AV



#### **RESULT: PASS**

**Note**: The factor had been edited in the "Input Correction" of the Spectrum Analyzer. So the Amplitude of test plots is equal to Reading level plus the Factor in dB. Use the A dB( $\mu$ V) to represent the Amplitude. Use the F dB( $\mu$ V/m) to represent the Field Strength. So A=F. All test modes had been pre-tested. The  $\pi$  /4-DQPSK modulation is the worst case and recorded in the report.





# **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)**

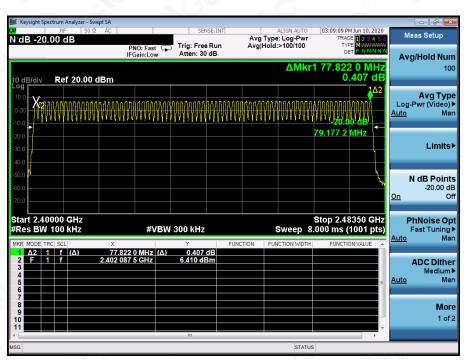
Same as described in section 8.2

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

The same as described in section 6

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

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



# TEST PLOT FOR NO. OF TOTAL CHANNELS

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

