



中国认可 国际互认 检测 TESTING CNAS L6791

TEST REPORT

Applicant:	Ugreen Group Limited				
Address:	URGEEN Building, Longcheng Industrial Park, Longguanxi Road, Longhua, ShenZhen, China				
Equipment Type:	UGREEN Studio Max2				
Model Name:	HP205				
Brand Name:	UGREEN				
FCC ID:	2AQI5-HP205				
Test Standard:	47 CFR Part 15 Subpart C (refer to section 3.1)				
Sample Arrival Date:	Nov. 06, 2024				
Test Date:	Nov. 13, 2024 - Dec. 02, 2024				
Date of Issue:	Dec. 05, 2024				

ISSUED BY:

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	Revision History						
	١	/ersion	Issue Date	Revisions			
	F	Rev. 01	<u>Dec. 05, 2024</u>	Initial Issue			
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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.				
Addroop	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road,				
Audress	Nanshan District, Shenzhen, Guangdong Province, P. R. China				
Phone Number	+86 755 6685 0100				

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.				
	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi				
	Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China				
Location	□ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park,				
	No. 1008, Songbai Road, Yangguang Community, Xili Sub-district,				
	Nanshan District, Shenzhen, Guangdong Province, P. R. China				
Appreditation Cartificate	The laboratory is a testing organization accredited by FCC as a				
Accreditation Certificate	accredited testing laboratory. The designation number is CN1196.				



2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Ugreen Group Limited
Address	UGREEN Building, Longcheng Industrial Park Longguanxi Road,
Address	Longhua, ShenZhen, China

2.2 Manufacturer Information

Manufacturer	Ugreen Group Limited
Addross	UGREEN Building, Longcheng Industrial Park Longguanxi Road,
Address	Longhua, ShenZhen, China

2.3 Factory Information

Factory	Aoni Intelligent Technology (Zhongshan) Co., LTD				
	Floor 4, 5, 6, 7, 8, 9, Building 2, NO. 138, Lefeng South Road,				
Address	Lianfeng, Xiaolan Town, Zhongshan City, Guangdong Province,				
	China				

2.4 General Description for Equipment under Test (EUT)

EUT Name	UGREEN Studio Max2
Model Name Under Test	HP205
Series Model Name	N/A
Description of Model	
name differentiation	
Hardware Version	V1.2
Software Version	V0.0.3
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

Remark:

- Product Number (P/N) code in the below table, for marketing purpose, will be marked on the marking plate.

45017	45017A	45017B	45017C	45017U	45017P	45017X	45017JP	45017EU	45017UK	45017US
45018	45018A	45018B	45018C	45018U	45018P	45018X	45018JP	45018EU	45018UK	45018US



2.5 Technical Information

	Network and Wireless connectivity	Bluetooth (BR+EDR+BLE)				
The	requirement for the followi	ng technical information of the EUT was tested in this report:				
	Modulation Technology	DTS				
Modulation Type GFSK						
	Product Type	⊠ Portable				
		Fix Location				
	Transfer Rate	1 Mbps, 2 Mbps				
	Frequency Range	The frequency range used is 2400 MHz to 2483.5 MHz.				
	Number of Channel	40 (at intervals of 2 MHz) ^{Note 1}				
	Tested Channel	1 Mbps: 0 (2402 MHz), 19 (2440 MHz), 39 (2480 MHz)				
	Tested Channel	2 Mbps: 1 (2404 MHz), 19 (2440 MHz), 38 (2478 MHz)				
	Antenna Type	PCB Antenna				
	Antenna Gain	1.32 dBi				
	Antenna Impedance	50Ω				
	Antenna System					
(MIMO Smart Antenna)						
	Note 1: 2 Mbps does not support Channel 0, Channel 12, and Channel 39.					

All channel was listed on the following table:

BLE 1M:

Channel	Freq.	Channel	Freq.	Channel	Freq.	Channel	Freq.
number	(MHz)	number	(MHz)	number	(MHz)	number	(MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

BLE 2M:

Channel	Freq.	Channel	Freq.	Channel	Freq.	Channel	Freq.
number	(MHz)	number	(MHz)	number	(MHz)	number	(MHz)
١	١	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	\	\	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	١	١





3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3	KDB 558074 D01 15 247	Guidance for compliance measurements on digital transmission
	Moas Guidance v05r02	system, frequency hopping spread spectrum system, and hybrid
X	Meas Guidance V00102	system devices operating under section 15.247 of the FCC rules

3.2 Test Verdict

No.	Description	FCC Part No.	Channel	Test Result	Verdict
1	Antenna Requirement	15.203	N/A		Pass ^{Note}
2	Output Power	15.247(b)	Low/Middle/High	5.2.4	Pass
3	Occupied Bandwidth	15.247(a)	Low/Middle/High	5.3.4	Pass
4	Conducted Spurious Emission	15.247(d)	Low/Middle/High	5.4.4	Pass
5	Band Edge(Authorized-band band-edge)	15.247(d)	Low/High	5.5.4	Pass
6	Conducted Emission	15.207	Low/Middle/High	5.6.4	Pass
7	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	5.7.4	Pass
8	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Low/High	5.8.4	Pass
9	Power spectral density (PSD)	15.247(e)	Low/Middle/High	5.9.4	Pass
Note	: The EUT has a permanently and irre	eplaceable attached	l antenna, which cor	nplies with the)

requirement FCC 15.203.



4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	44% to 64%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+21.3℃ to +24.4℃
Working Voltage of the EUT	NV (Normal Voltage)	3.7 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY50330200	2024.05.08	2025.05.07
Spectrum Analyzer	KEYSIGHT	N9020A	MY52510065	2024.08.01	2025.07.31
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	01631	2022.02.23	2025.02.22
Test Antenna-Horn	A-INFO	LB-180400KF	J211060273	2024.06.15	2027.06.14
Anechoic Chamber	RAINFORD	9m*6m*6m	144	2022.02.19	2025.09.03
Amplifier	COM-MV	LSCX_LNA1- 12G-01	180602	2024.08.01	2025.07.31
Amplifier	COM-MV	XKu_LNA7- 18G-01	180601	2024.08.01	2025.07.31
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2024.08.01	2025.07.31
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-01162	2023.08.04	2026.08.03
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2024.01.23	2025.01.22
Amplifier	COM-MV	ZT30-1000M	B2018054558	2023.12.05	2024.12.04
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7 .35m	130	2024.07.13	2027.07.12
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2024.08.01	2025.07.31
LISN	SCHWARZBECK	NSLK 8127	8127-687	2024.05.09	2025.05.08
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m*2. 8m	112	2022.02.19	2025.02.18

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V22.930	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5



4.4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	3 8.0
Humidity	4%

4.5 Description of Test Setup

4.5.1 For Antenna Port Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT: Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm



(Diagram 1)



4.5.2 For AC Power Supply Port Test



4.5.3For Radiated Test (Below 30 MHz)



(Diagram 3)



4.5.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5 For Radiated Test (Above 1 GHz)





4.6 Measurement Results Explanation Example

4.6.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

4.6.2For radiated band edges and spurious emission test:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in $dB\mu V/m$,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.



5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b)

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 shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

	<u> </u>
Protected Method	Description
The antenna is embedded in the	An embedded-in antenna design is used.
product.	

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

5.1.3Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



5.2 Output Power

5.2.1 Test Limit

FCC § 15.247(b)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements.

5.2.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.2.3 Test Procedure

a) Maximum peak conducted output power

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

Set the RBW \geq DTS bandwidth.

Set VBW ≥ 3 x RBW.

Set span ≥ 3 x RBW

Sweep time = auto couple.

Detector = peak.

Trace mode = max hold.

Allow trace to fully stabilize.

Use peak marker function to determine the peak amplitude level.

b) Measurements of duty cycle

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

Set the center frequency of the instrument to the center frequency of the transmission.

Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.

Set VBW ≥ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T \leq 16.7 microseconds.)



5.2.4 Test Result

Peak Power Test Data

	Measured Output Peak Power		Lir		
Channel	GFSK (BLE 1Mbps)		dDm	ma\\/	Verdict
	dBm	mW	UDIII	TITVV	
Low Channel	1.48	1.41			Pass
Middle Channel	1.69	1.48	30	1000	Pass
High Channel	1.64	1.46			Pass

	Measured Output Peak Power		Lir		
Channel	GFSK (BLE 2Mbps)		dDura		Verdict
	dBm	mW	UDITI	mvv	
Low Channel	0.20	1.05			Pass
Middle Channel	0.32	1.08	30	1000	Pass
High Channel	-0.11	0.98			Pass



Test Plots

GFSK (BLE 1Mbps) LOW CHANNEL



GFSK (BLE 1Mbps) MIDDLE CHANNEL



GFSK (BLE 1Mbps) HIGH CHANNEL

RLT RF 500 40	CORRECT ADVIT REFL	A REIGN OFF	06:09:27 PM Nov 13, 2024	Concession of the local division of the loca
Center Freq 2.48000000	PNO: Fast Trig: Free Run IFGain:Low #Atten: 30 dB	Avg Type: Log-Pwr Avg Hold:>1/1	TRACE 2 3 4 5 TYPE DET PRIMININ	Frequency
lo dB/div Ref 20.00 dBm	Mkr1	2.479 775 GHz 1.635 dBm	Auto Tune	
10.00				Center Free 2.480000000 GH
000				Start Free 2.478500000 GH
00				Stop Fre 2.481500000 GH
80 E				CF Ste 300.000 kH Auto Ma
00				Freq Offse 0 F
Center 2.480000 GHz Res BW 1.0 MHz	#VBW 3.0 MHz	Sweep	Span 3.000 MHz 1.000 ms (601 pts)	
and Diversion all traces	s cleared	STATU	1.000 ma (oo r pray	



GFSK (BLE 2Mbps) LOW CHANNEL



GFSK (BLE 2Mbps) MIDDLE CHANNEL



GFSK (BLE 2Mbps) HIGH CHANNEL

Center Freq 2.47800000	CORREC INT REF GHZ PNO: Fast Trig: Free Run	Avg Type: Log-Pwr Avg Hold:>1/1	08:59:52 PM Nov 29, 2024 TRACE 2 3 4 5 TYPE N	Frequency
o dB/div Ref 20.00 dBm	IFGain:Low #Atten: 30 dB	Mkr1	2.477 53 GHz -0.105 dBm	Auto Tune
10.0	.1			Center Free 2.478000000 GH
9 W				Start Fre 2,475000000 GH
90				Stop Fre 2,48100000 GH
				CF Ste 600.000 kH Auto Ma
00				Freq Offs 0 F
Center 2.478000 GHz	#1/RIM 9.0 MIL	Swaan 1	Span 6.000 MHz	



Duty Cycle Test Data

Dand	On Time	On+Off Time	Duty Cycle
Danu	(ms)	(ms)	(%)
GFSK (BLE 1Mbps)	0.388	0.624	62.18%
GFSK (BLE 2Mbps)	0.209	0.624	33.49%

Test Plots

GFSK (BLE 1Mbps)

PNO: Fast	rig: Free Run Atten: 8 dB	wall type: collic at	DET P NINN N	
7.69 dB dBm			ΔMkr5 624.0 μs -0.01 dB	Auto Tune
χ ^{1Δ2}	546			Center Fred 2.440000000 GH:
				Start Free 2.440000000 GH
human		Unapplych	hlu	Stop Free 2.440000000 GH
GHz #VBW 3.	0 MHz	Sweep	Span 0 Hz 1.600 ms (401 pts)	CF Step 1.000000 MH
X 399 0 He (A)	Y FU	NCTION FUNCTION WOTH	FUNCTION VALUE	
52.00 μs 236.0 μs 440.0 μs 624.0 μs 52.00 μs	1.36 dBm 0.57 dB 0.78 dBm -0.01 dB 1.36 dBm		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Freq Offset 0 Ha
	7.69 dB dBm 42.00 μ5 64.00 μ5 64.00 μ5 62.00 μ5 62	CHILES PARTICUE To dB dBm	Formula Formula dBm 5.6.6	Totality Main You AMIK'S 624.0 µs dBm -0.01 dB -0.01 dB dBm -0.01 dB -0.01 dB ide -0.01 dB -0.01 dB <tr< td=""></tr<>

GFSK (BLE 2Mbps)





5.3 Occupied Bandwidth

5.3.1Limit

FCC §15.247(a)

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW. The 6 dB bandwidth must be greater than 500 kHz.

5.3.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.3.3 Test Procedure

Use the following spectrum analyzer settings:

Set RBW = 100 kHz.

Set the video bandwidth (VBW) \geq 3 RBW.

Detector = Peak.

Trace mode = max hold.

Sweep = auto couple.

Allow the trace to stabilize.

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.3.4 Test Result

<u>Test Data</u>

Test Mode	GFSK (BLE 1Mbps)				
Channal	6 dB Bandwidth	99% Bandwidth	6 dB Bandwidth		
Channel	(kHz)	(kHz)	Limits (kHz)		
Low Channel	682.600	1035.200	≥500		
Middle Channel	682.600	1031.100	≥500		
High Channel	682.600	1014.800	≥500		

Test Mode	GFSK (BLE 2Mbps)				
Channel	6 dB Bandwidth	99% Bandwidth	6 dB Bandwidth		
	(kHz)	(kHz)	Limits (kHz)		
Low Channel	1199.951	2035.427	≥500		
Middle Channel	1199.951	2033.642	≥500		
High Channel	1185.059	2038.299	≥500		



Test Plots

6 dB Bandwidth

GFSK (BLE 1Mbps) LOW CHANNEL



GFSK (BLE 1Mbps) HIGH CHANNEL

nter Freq 2.48000000	PNO: Wide - Trig: Free Run	Avg Type: Log-Pwr Avg Hold: 1000/1000	TRACE 2345 TYPE M DET PRINNIN	Frequency
Ref Offset 17.55 dB Blidiv Ref 15.00 dBm	a dameow	ΔΝ	kr2 682.6 kHz -0.161 dB	Auto T
	X3	243	4.0-00	Center F 2.480000000
				Start F 2.478500000
				Stop F 2.481500000
nter 2.480000 GHz es BW 100 kHz	#VBW 300 kHz	Sweep 1	Span 3.000 MHz .013 ms (401 pts)	CF S 300.000 Auto
N 1 f 2.480 Δ3 1 f (Δ) F 1 f 2.479	037 5 GHz 1.173 dBm 682.6 kHz (Δ) -0.161 dB 677 5 GHz -5.037 dBm		8	Freq Of

GFSK (BLE 1Mbps) MIDDLE CHANNEL





GFSK (BLE 2Mbps) LOW CHANNEL



GFSK (BLE 2Mbps) HIGH CHANNEL



GFSK (BLE 2Mbps) MIDDLE CHANNEL





99% Bandwidth

GFSK (BLE 1Mbps) LOW CHANNEL



GFSK (BLE 1Mbps) HIGH CHANNEL



Tel: +86-755-66850100E-mail: qc@baluntek.comPage No. 23 / 74Web: www.titcgroup.comTemplate No.: TRP-FCC Part 15.247 (2022-01-12)Add: Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China

GFSK (BLE 1Mbps) MIDDLE CHANNEL





GFSK (BLE 2Mbps) LOW CHANNEL



GFSK (BLE 2Mbps) HIGH CHANNEL

Center Freq 2.478000	000 GHz	Center F Trig: Fre #Atten: 0	INT REF Freq: 2.47800 Re Run 5 dB	0000 GHz Avg Hol	1: 50/50	Radio De	Nov 29, 2824 I: None vice: BTS	Frequency
Ref Offset 17 15 dB/div Ref 0.00 d	56 dB Bm							
Log 	~~~~~	ano a	- Annes		~~~	-	· ······	Center Freq 2.47800000 GHz
103 123 133 Center 2.478 GHz #Res BW 30 kHz		VB	W 300 KI	łz		Sp	pan 6 MHz p 6.2 ms	CF Step 600.000 kHz
Occupied Bandwidth 2.0383 MHz			Total Power 5.19			9 dBm		Auto Man Freq Offset
Transmit Freq Erro x dB Bandwidth	45.038 2.443	kHz MHz	% of O x dB	BW Pow	rer 9 -26	9.00 % 5.00 dB		0 Hz
MSO					STAT	148		

GFSK (BLE 2Mbps) MIDDLE CHANNEL





5.4 Conducted Spurious Emission

5.4.1 Limit

FCC §15.247(d)

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 conducted or a radiated measurement.

5.4.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.4.3 Test Procedure

The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).

c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

The following procedures shall be used to demonstrate compliance to these limits. Note that these procedures can be used in either an antenna-port conducted or radiated test set-up. Radiated tests must conform to the test site requirements and utilize maximization procedures defined herein.

Reference level measurement:

Establish a reference level by using the following procedure:

Set instrument center frequency to DTS channel center frequency.

Set the span to \geq 1.5 times the DTS bandwidth.

Set the RBW = 100 kHz.

Set the VBW \geq 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.



Use the peak marker function to determine the maximum PSD level.

Emission level measurement:

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

Set the RBW = 100 kHz.

Set the VBW \geq 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

5.4.4 Test Result

<u>Test Data</u>

GFSK (BLE 1Mbps)								
	Measured Max.	Limit	Limit (dBm)					
Channel	Out of Band	Corrier Lovel	Calculated	Verdict				
	Emission (dBm)		20 dBc Limit					
Low Channel	-27.64	1.05	-18.95	Pass				
Middle Channel	-27.61	1.29	-18.71	Pass				
High Channel	-26.87	1.26	-18.74	Pass				

GFSK (BLE 2Mbps)								
	Measured Max.	Limit (dBm)						
Channel	Out of Band	Corrier Lovel	Calculated	Verdict				
	Emission (dBm)	Carrier Level	20 dBc Limit					
Low Channel	-28.13	-0.60	-20.60	Pass				
Middle Channel	-27.23	-0.46	-20.46	Pass				
High Channel	-27.81	-1.00	-21.00	Pass				



Test Plots

GFSK (BLE 1Mbps) LOW CHANNEL, CARRIER LEVEL



GFSK (BLE 1Mbps) LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 1Mbps) LOW CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



GFSK (BLE 1Mbps) MIDDLE CHANNEL, CARRIER LEVEL





GFSK (BLE 1Mbps) MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 1Mbps) HIGH CHANNEL, CARRIER LEVEL



GFSK (BLE 1Mbps) HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 1Mbps) MIDDLE CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



GFSK (BLE 1Mbps) HIGH CHANNEL, SPURIOUS 2 GHz ~ 25 GHz





GFSK (BLE 2Mbps) LOW CHANNEL, CARRIER LEVEL



GFSK (BLE 2Mbps) LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 2Mbps) LOW CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



GFSK (BLE 2Mbps) MIDDLE CHANNEL, CARRIER LEVEL





GFSK (BLE 2Mbps) MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 2Mbps) MIDDLE CHANNEL, SPURIOUS 2 GHz ~ 25 GHz

Peak Search	MNov 29, 2024	08:57:06 P	Type: Log-Pwr	Avs	Int se) GHz	5000000	8.0137	ker 1	ark
	PINNISHI	Di	1010.21/1	Avg	#Atten: 30 dB	PNO: Fast 0 IFGain:Low	-			
NextPea	75 GHz 57 dBm	18.013 -30.6	Mkr1				00 dBm	Ref 20.	3/div	0 dE
Next Pk Righ										9 9 10.0
Next Pk Le	_0.45 effer	, James	المرجود المساحي			A December 201				0.0 0.0 0.0 0.0
Marker Delt										000 8 0 8 0
Mkr→C	5.00 GHz 4001 pts)	Stop 2 2.198 s (Sweep		W 300 kHz	#VB		GHz 00 kHz	t 2.00 s BW	tari Res
Mkr. Poll	ON VALUE	FUNCTI	FUNCTION WIDTH	FUNCTION	-30.657 dBm -27.227 dBm	3 75 GHz 5 75 GHz	X 18.01 21.09	SGL) 1 1	N 1 N 1	2 3
tini Rei Li										4567
Mor 1 of										9
	- / -	-	STATUS					_		a

GFSK (BLE 2Mbps) HIGH CHANNEL, CARRIER LEVEL

nter Freq 2.47800000	0 GHz	A Dun A	Avg Type: Log-Pwr	TRACE	Frequency
All reserves a	IFGain:Low #Atten:	: 30 dB	vginoid:>1/1	DET P N NNN N	
Bidiv Ref 20.00 dBm			Mkr1 2	.478 055 GHz -0.998 dBm	Auto Tune
u					Center Freq 2.478000000 GHz
women				- mark	Start Freq 2.476500000 GHz
					Stop Freq 2.479500000 GHz
nter 2.478000 GHz es BW 100 kHz	#VBW 300 kH	1Z	Sweep 1.	Span 3.000 MHz 000 ms (601 pts)	CF Step 300.000 kHz Auto Man
N 1 1 2.4	78 055 GHz -0.998	dBm		Policificiti concerni	Freq Offse
				-	UH:
<u>م م</u>					

GFSK (BLE 2Mbps) HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 2Mbps) HIGH CHANNEL, SPURIOUS 2 GHz ~ 25 GHz





5.5 Band Edge (Authorized-band band-edge)

5.5.1 Limit

FCC §15.247(d)

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 conducted or a radiated measurement.

5.5.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.5.3 Test Procedure

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is utilized, use the procedure described in 13.2.1. Use the procedure described in 13.2.2 when using an average detector and the EUT can be configured to transmit continuously (i.e., duty cycle \geq 98%). Use the procedure described in 13.2.3 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent). Use the procedure described in 13.2.4 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2 percent).

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used.

Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).

Set span to 2 MHz

RBW = 100 kHz.

VBW \geq 3 x RBW.

Detector = peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)

Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency (femission) \pm 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by femission \pm 0.5 MHz.

5.5.4 Test Result

Note: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

<u>Test Data</u>

GFSK (BLE 1Mbps)								
	Measured Max.	Limit						
Channel	Band Edge	Carrier Lovel	Calculated	Verdict				
	Emission (dBm)	Carrier Lever	20 dBc Limit					
Low Channel	-39.64	1.05	-18.95	Pass				
High Channel	-46.40	1.26	-18.74	Pass				

GFSK (BLE 2Mbps)							
	Measured Max. Limit (dBm)		(dBm)				
Channel	Band Edge	Corrier Lovel	Calculated	Verdict			
	Emission (dBm)	Emission (dBm)					
Low Channel	-38.91	-0.60	-20.60	Pass			
High Channel	-46.85	-1.00	-21.00	Pass			



Marke

Marker

Marker

Marker

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Marker

More 1 of 2

317

Span 10.00 M

Test Plots

GFSK (BLE 1Mbps) LOW CHANNEL, CARRIER LEVEL



GFSK (BLE 1Mbps) LOW CHANNEL, BAND EDGE

Trig: Free Run

¢²

41 250 0

Avg Type: Log Avg Hold:>1/1

rker 2 2.3993166666667 GHz

Ref 20.00 dBn

2.400000 GH

2,400,000

GFSK (BLE 1Mbps) HIGH CHANNEL, CARRIER LEVEL



GFSK (BLE 1Mbps) HIGH CHANNEL, BAND EDGE





GFSK (BLE 2Mbps) LOW CHANNEL, CARRIER LEVEL



GFSK (BLE 2Mbps) HIGH CHANNEL, CARRIER LEVEL

Center Freq 2 478000000	GHZ	DINT REF	Avg Type: Log-Pwr	09:00:45 PM Nov 29, 2024 TRACE	Frequency
	PNO: Wide	Trig: Free Run #Atten: 30 dB	Avg[Hold:>1/1	DET P IN PLATER FO	
o dB/div Ref 20.00 dBm			Mkr1 :	2.478 055 GHz -0.998 dBm	Auto Tune
100	m	mon			Center Free 2.478000000 GH
20 b 30.0 40 c				www	Start Free 2.476500000 GH:
auri) auri) 70.0					Stop Free 2.479500000 GH
Center 2.478000 GHz #Res BW 100 kHz	#VBW	300 kHz	Sweep 1	Span 3.000 MHz .000 ms (601 pts)	CF Step 300,000 kH Auto Mar
N 1 f 2.47	8 055 GHz	-0.998 dBm			Freq Offse 0 H
7 8 9 10					
nsal			STATUS		

GFSK (BLE 2Mbps) LOW CHANNEL, BAND EDGE



GFSK (BLE 2Mbps) HIGH CHANNEL, BAND EDGE

arker 2 2.486850000000 GHz PNO: Wide IFGain:Low	Trig: Free Run #Atten: 30 dB	Avg Type: Log-Pwr Avg Hold:>1/1		Select Marker
dBldiv Ref 20.00 dBm		Mkr2	2.486 850 GHz -46.854 dBm	Marker
				Marker
			21 03 albra	Marker
00		ng ng than the second	and the second	Marker
enter 2.483500 GHz Res BW 100 kHz #VE	300 kHz	Sweep	Span 10.00 MHz 1.000 ms (601 pts)	Marker
RR MODE TRC SCL X 1 N 1 f 2.483 500 GHz 2 N 1 f 2.486 850 GHz 3 4 5	-48.564 dBm -46.854 dBm	INCTION FUNCTION (HOTH)	FUNCTION VALUE	Marker
6 7 8 9 9				Mor 1 of



5.6 Conducted Emission

5.6.1 Limit

FCC §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μ H/50 Ω line impedance stabilization network (LISN).

Frequency range	Conducted Limit (dBµV)				
(MHz)	Quai-peak	Average			
0.15 - 0.50	66 to 56	56 to 46			
0.50 - 5	56	46			
0.50 - 30	60	50			

5.6.2 Test Setup

See section 4.5.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX A.

5.6.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.



5.6.4 Test Result

Note ¹: The EUT was tested in charging mode.

Note ²: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (120 VAC, 60 Hz) shown here.

Note ³: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)



No.	Frequency	Results	Factor	Limit	Margin	Detector	Line	Verdict
	(MHz)	(dBuV)	(dB)	(dBuV)	(dB)			
1	0.150	43.14	9.78	66.00	22.86	Peak	L	Pass
1**	0.150	30.99	9.78	56.00	25.01	AV	L	Pass
2	0.350	37.69	10.76	58.96	21.27	Peak	L	Pass
2**	0.350	27.60	10.76	48.96	21.36	AV	L	Pass
3	0.546	37.61	10.02	56.00	18.39	Peak	L	Pass
3**	0.546	29.63	10.02	46.00	16.37	AV	L	Pass
4	1.760	35.91	10.16	56.00	20.09	Peak	L	Pass
4**	1.760	24.09	10.16	46.00	21.91	AV	L	Pass
5	2.270	36.22	10.20	56.00	19.78	Peak	L	Pass
5**	2.270	24.95	10.20	46.00	21.05	AV	L	Pass
6	4.980	35.95	10.36	56.00	20.05	Peak	L	Pass
6**	4.980	25.44	10.36	46.00	20.56	AV	L	Pass



PHASE N



No.	Frequency	Results	Factor	Limit	Margin	Detector	Line	Verdict
	(MHz)	(dBuV)	(dB)	(dBuV)	(dB)			
1	0.350	38.24	10.76	58.96	20.72	Peak	Ν	Pass
1**	0.350	26.95	10.76	48.96	22.01	AV	Ν	Pass
2	0.528	40.14	10.01	56.00	15.86	Peak	Ν	Pass
2**	0.528	31.21	10.01	46.00	14.79	AV	Ν	Pass
3	0.790	36.85	10.46	56.00	19.15	Peak	Ν	Pass
3**	0.790	26.29	10.46	46.00	19.71	AV	Ν	Pass
4	1.642	35.84	9.91	56.00	20.16	Peak	Ν	Pass
4**	1.642	24.61	9.91	46.00	21.39	AV	Ν	Pass
5	4.314	36.46	10.26	56.00	19.54	Peak	Ν	Pass
5**	4.314	24.28	10.26	46.00	21.72	AV	Ν	Pass
6	10.520	37.13	10.19	60.00	22.87	Peak	Ν	Pass
6**	10.520	28.17	10.19	50.00	21.83	AV	Ν	Pass