

CERTIFICATION TEST REPORT

Report Number. : 13685813-E2V2

- Applicant : APPLE INC. **1 APPLE PARK WAY** CUPERTINO, CA 95014, U.S.A
 - Model : A2564
 - Brand : Apple
 - FCC ID : BCG-A2564
 - IC : 579C-A2564
- EUT Description : Bluetooth Earbud
- Test Standard(s) : FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5 + A1+A2

Date Of Issue: September 29, 2021

Prepared by: **UL VERIFICATION SERVICES** 47173 Benicia Street Fremont, CA 94538 U.S.A. TEL: (510) 319-4000 FAX: (510) 661-0888



NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	9/2/2021	Initial Issue	Tri Pham
V2	9/29/2021	Updated Power	Tri Pham

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A					
EUT DESCRIPTION:	BLUETOOTH EARBUD				
MODEL:	MODEL: A2564				
BRAND:	3RAND: Apple				
SERIAL NUMBER: H5R1262005N035Y3S; H5R1237002S035Y31					
SAMPLE RECEIPT DATE:	SAMPLE RECEIPT DATE: 6/26/2021				
DATE TESTED:	7/23/2021 – 8/11/2021				
	APPLICABLE STANDARDS	3			
ST	ANDARD	TEST RESULTS			
CFR 47 F	Part 15 Subpart C	Complies			
ISED R	SS-247 Issue 2	Complies			
ISED RSS-C	GEN Issue 5 +A1+A2	Complies			

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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Project Engineer/Operations Leader Consumer Technology Division UL Verification Services Inc.

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2. TEST RESULTS SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for the validity of results after the integration of the data provided by the customer.

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting	Per ANSI C63.10,
See Comment		Duty Cycle	purposes only	Section 11.6.
Soo Commont	RSS-GEN 6.7		Reporting	ANSI C63.10 Sections
See Comment		2008 800/99/0 0800	purposes only	6.9.2 and 6.9.3
15.247 (a)(1)	RSS-247 (5.1) (b)	Hopping Frequency Separation	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Number of Hopping Channels	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Average Time of Occupancy	Complies	None.
15.247 (b)(1)	RSS-247 (5.4) (b)	Output Power	Complies	None.
Soo Commont		Average Bower	Reporting	Per ANSI C63.10,
See Comment		Average Fower	purposes only	Section 11.9.2.3.2.
15.247 (d)	RSS-247 (5.5)	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

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3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with:

- FCC CFR 47 Part 2
- FCC CFR 47 Part 15
- FCC KDB 662911 D01 v02r01
- KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013
- RSS-GEN Issue 5 + A1 + A2
- RSS-247 Issue 2
- KDB 414788 D01 Radiated Test Site v01r01

4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, certification #0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
	Building 1: 47173 Benicia Street, Fremont, CA 94538, USA	US0104	2324A	208313
\boxtimes	Building 2: 47266 Benicia Street, Fremont, CA 94538, USA	US0104	22541	208313
\boxtimes	Building 4: 47658 Kato Rd, Fremont, CA 94538, USA	US0104	2324B	208313

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5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U _{Lab}
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.78 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.29 dB

Uncertainty figures are valid to a confidence level of 95%.

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided: Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB) 36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided: Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss. 36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a Bluetooth earbud for left ear with an integral battery, microphone, and antenna.

6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range	Mode	Output Power	Output Power
(MHz)		(dBm)	(mW)
2402 - 2480	Basic GFSK	12.76	18.88
2402 - 2480	Enhanced DQPSK	12.53	17.91
2402 - 2480	Enhanced 8PSK	12.62	18.28

Note: GFSK, DQPSK, 8PSK average Power are all investigated, The GFSK & 8PSK Power are the worst case. Testing is based on these modes to showing compliance. For average power data please refer to section 9.7.

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an LDS antenna, with a maximum gain of -4.5 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was B4B20

6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle, and high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X, Y, Z, it was determined that Y (Landscape) orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y (Landscape) orientation.

Radiated emissions below 1GHz, 18-26GHz and AC power line conducted emissions were performed with the EUT transmitting at the channel with the highest output power as worst-case scenario.

For below 1GHz and above 1GHz tests were performed with EUT only. For AC power line conducted emission, tests were investigated with AC power adapter and with laptop. GFSK, DQPSK, 8PSK average power are all investigated, The GFSK & 8PSK power are the worst case.

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Worst-case data rates provided by the client were: GFSK mode, DH5 & 8PSK mode, 3-DH5.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT							
D	escription	Manufacturer	Model	Serial Number		FCC ID/ DoC	
	Laptop	Apple	Macbook Pro	C02YL3ZN	/JHC8	BCGA1989	
Laptop	AC/DC adapter	Liteon Technology	A1424	NSW25	679	DoC	
EUT /	AC/DC adapter	Apple	A1720	C3D8417A7R	93KVPA8	DoC	
		I/O CAE	BLES (RF CONDUC	TED TEST)			
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks	
1	AC	1	AC	Un-shielded	2	N/A	
2	USB-A	1	Lightning	Shielded	1.0	N/A	
3	Antenna	1	SMA	Un-shielded 0.2		To spectrum Analyzer	
I/O CABLES (RF RADIATED TEST)							
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks	
1	AC	1	AC	Un-shielded	2	N/A	
2	USB-A	1	Lightning	Un-shielded	1	N/A	

TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

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7. MEASUREMENT METHODS

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6

Occupied BW (20dB): ANSI C63.10-2013 Section 6.9.2

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Carrier Frequency Separation: ANSI C63.10-2013 Section 7.8.2

Number of Hopping Frequencies: ANSI C63.10-2013 Section 7.8.3

Time of Occupancy (Dwell Time): ANSI C63.10-2013 Section 7.8.4

Peak Output Power: ANSI C63.10-2013 Section 7.8.5

Conducted Spurious Emissions: ANSI C63.10-2013 Section 7.8.8

Conducted Band-Edge: ANSI C63.10-2013 Section 6.10.4

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4 & 13

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3, 6.5 & 13

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3, 6.6 & 13

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5 & 13

AC Power-line conducted emissions: ANSI C63.10-2013, Section 6.2.

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8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List						
Description	Manufacturer	Model	Local ID	Cal Date	Cal Due	
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0203383	2/24/2021	2/24/2022	
Horn Antenna, 1-18 GHz	ETS Lindgren	3117	T120	4/7/2021	4/7/2022	
Preamp, 1-18 GHz	Miteq	AFS42-00101800-25-S-42	PRE0183207	4/27/2021	4/27/2022	
PXA Signal Analyzer	Agilent	N9030A	T906	1/27/2021	1/27/2022	
Hybrid Antenna, 30-2000 MHz	SunAR	JB3	T900	2/24/2021	2/24/2022	
Preamp, 0.1-1300 MHz	Sonoma Inst.	310	T173	7/22/2021	7/22/2022	
Horn Antenna, 1-18 GHz	ETS Lindgren	3117	T712	3/22/2021	3/22/2022	
*Preamp, 1-18 GHz	Miteq	AFS42-00101800-25-S-42	PRE0183530	8/27/2020	8/27/2021	
Antenna, Active Loop 9kHz-30MHz	ETS Lindgren	6502	T1616	12/2/2020	12/2/2021	
PXA Signal Analyzer	Aglilent	N9030A	T1454	1/27/2021	1/27/2022	
Preamplifier, 1-26.5GHz	Agilent	8449B	T404	4/19/2021	4/19/2022	
Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	T449	4/22/2021	4/22/2022	
Preamplifier, 26-40 GHz	Miteq	NSTTA2640-35-HG	T1864	4/19/2021	4/19/2022	
PXA Signal Analyzer	Agilent	N9030A	206415	3/12/2021	3/12/2022	
Horn Antenna, 26-40 GHz	ARA	MWH-2640/B	PRE0183142	4/22/2021	4/22/2022	
PXA Signal Analyzer	Agilent	N9030A	T908	1/28/2021	1/28/2022	
Power Meter, P-series single channel	Keysight	N1912A	T1245	1/21/2021	1/21/2022	
Power Sensor	Keysight	N1912A	90392	1/28/2021	1/28/2022	
PXA Signal Analyzer	Agilent	N9030A	T341	1/28/2021	1/28/2022	
Power Meter, P-series single channel	Keysight	N1911A	PRE0177682	1/21/2021	1/21/2022	
Power Meter, P-series single channel	Keysight	N1911A	T1264	1/26/2021	1/26/2022	
Power Sensor	Keysight	N1921A	T1226	2/19/2021	2/19/2022	
Power Sensor	Keysight	N1921A	T1227	3/16/2021	3/16/2022	
EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	T1436	2/19/2021	2/19/2022	
Power Cable, Line Conducted Emissions	Pasternack Enterprises	RG233/U	202327	10/16/2020	10/16/2021	
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN-50/250-25-2-01	PRE0186446	1/20/2021	1/20/2022	
Radiated Software	UL	UL EMC	Ve	r 9.5.07, July 20	20	
AC Line Conducted Software	UL	UL EMC	Ve	r 9.5.07, Jul <mark>y</mark> 20	20	

Test Software List							
Description Manufacturer Model Version							
Radiated Software	UL	UL EMC	Ver 9.5.07, July 2020				
AC Line Conducted Software	UL	UL RF	Ver 9.5.07, July 2020				
Antenna Port Software	UL	UL RF	Ver 2021.5.13				

Note: *Testing is completed before equipment expiration date

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9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time	Period	Duty Cycle	Duty	Duty Cycle	1/T
	В		х	Cycle	Correction Factor	Minimum VBW
	(msec)	(msec)	(linear)	(%)	(dB)	(kHz)
Bluetooth GFSK	2.000	2.000	1.000	100.0%	0.00	0.010
Bluetooth 8PSK	2.000	2.000	1.000	100.0%	0.00	0.010





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9.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to $\ge 1\%$ of the 20 dB bandwidth. The VBW is set to $\ge 3x$ RBW. The sweep time is coupled.

RESULTS

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9.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	0.9568	0.89550
Mid	2441	0.9580	0.98936
High	2480	0.9568	0.89656





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9.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	1.355	1.2130
Mid	2441	1.356	1.2150
High	2480	1.359	1.2129



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9.3. HOPPING FREQUENCY SEPARATION

<u>LIMITS</u>

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping 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.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to VBW >= 3xRBW. The sweep time is coupled.

RESULTS

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9.3.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



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9.3.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



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9.4. NUMBER OF HOPPING CHANNELS

<u>LIMITS</u>

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 nonoverlapping channels.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

Normal Mode: 79 Channels Observed

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9.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



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× ∟ Cent	er F	req	2.4	50 g	DC	00 0	Hz			٦.		SENSE	:INT	-	#,	Avg	Тур	e: R	MS		10	:43:3 T	5 PM RACE	Aug 06, 2	2021	F	requency
10 dB	/div	Re	of Off	set 10).00 (NFE .7 dE	3	PNO IFGa	: Wid in:Lo	le ⊂ _∎ w	J Tr A	ig: Fi tten:	ree R 30 d	un B		A	vg H	lold	:>10	0/10	0			DET		VWW V N N		Auto Tur
20.0																									_	2.41	Center Fre
10.0 - 0.00 -		M	V	Ŵ	V	Y	Ŵ	Λ	Ŵ	V	Y	M	Ŋ	Ŋ	V	Y	V	V	Y	V	Y	Y	V	VV	Y	2.40	Start Fre 10000000 GF
10.0 20.0 -																										2.43	Stop Fre 10000000 GH
30.0 -																									_	Auto	CF Ste 3.000000 MH Ma
50.0 -																									_		Freq Offs 0 H
60.0 -															T												Scale Typ
start /Res	2.40 BW	0000 ' 300	GH KH	z z				#\	∕ви	/ 91	0 kH	İz						Sw	eep	o 1	Sto .001	р2) m	.43 s (1	000 G 1001 p	iHz ots)	Log	<u>L</u>
SG																			ST	ATUS							

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- Ke	ysight	Spect	rum	Analy	/zer -	AP2	021.4	1.1,23	560,C	ond I	-3																					
N Cen	L	Fre	R	24	5	0Ω 			GF	17		_	1		SE	NSE:I	NT	_	#/	٩vg	Тур	e: R	MS		_	10:4	7:16 F TRA	OF 1 2	3 4 5 6		Frequ	lency
			Ref	Off	set	10.	NFE	в	PI	NO: N Gain	Vide :Low	, G		rig: \tter	Fre n: 3(e Ru) dB	n		A	vgĬ⊦	łold	:>10	00/1	00			T) E	PE M ₩ ET P N			Aı	uto Tun
l0 dl _og	B/div	r	Re	f 3(0.0	0 d	Bn	n								-									_					F		
20.0																														2	Cer .44500	n ter Fre 0000 GH
10.0 0.00	Y	V	V	V	Y	Y	Y	Y	V	V	V	V	V	Y	V	V	Y	V	V	V	V	V		7	Λ	\cap	N	r V	VV	2	S .43000	tart Fre 0000 GH
10.0																														2	S .46000	top Fre 0000 GH
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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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9.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



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	L é a n	Fra a	RF	50 Ω	DC		1		_		SENS	E:INT		#	Ava	Typ	DA	45		10:	43:35 TR	PM Au	g 06, 2021		Frequency
cen	ler	riec	Z. 4	1900	NFE	P P	NO: W Gain:	/ide ⊂ Low	7	rig: F Atten:	ree 30 d	Run dB		Â	vg H	old:	>100	0/100			T	YPE M DET P		¥ N	
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Stari #Res	t 2.4 s BV	0000 V 300) GH:) kHz	2	1			#VB	N 91	10 ki	-iz						Swe	ер	1.	Stoj 000	o 2.4 ms	1300 (10	00 GHz 01 pts	Log	Lir
MSG																		STA	TUS						

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

d L	R	F 50 Ω	DC			SE	NSE:INT			11:24:21	M Aug 06, 2021	Frequency
Center	Freq	2.44500	0000 IFE	GHz PNO: Wid IFGain:Lo	e 🖵 w	Trig: Fre Atten: 3	e Run 0 dB	#Avg Ty Avg Hol	pe: RMS d:>100/100		CE 1 2 3 4 5 6 PE M WWWWW ET P N N N N N	Frequency
I0 dB/di	Rei v R e	f Offset 10.7 f 30.00 d	′dB Bm									Auto Tu
20.0												Center Fr 2.445000000 0
10.0 V	VV.	VVV	VV		mvr —	$\vee \vee \vee$				VVV		Start Fi 2.430000000 0
20.0												Stop Fi 2.460000000 0
30.0												CF S1 3.000000 M Auto M
0.0												Freq Off
50.0												Scale Ty
tart 2. Res B	43000 W 300	GHz kHz		#\	/BW	910 kHz	:		Sweep 1	Stop 2.4 .000 ms	6000 GHz (1001 pts)	Log
SG									STATUS	5		

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Keysight Sp	ectrum Analyzer - AP2021.4	1,23560,Cond F3					
d L	RF 50 Ω D0		SENSE:INT		11:30:53 PM	Aug 06, 2021	Frequency
Center F	req 2.4750000	PNO: Wide	Trig: Free Run	#Avg Type: Rf Avg Hold:>10	NS TRACE	1 2 3 4 5 6 MWWWW P N N N N N	riequency
0 dB/div	Ref Offset 10.7 dl Ref 30.00 dBn	IFGain:Low	Atten: 30 dB		DEI		Auto Tur
20.0		-					Center Fre 2.475000000 GH
0.00 VVV		VVVVV	VVVVV				Start Fre 2.46000000 Gi
0.0							Stop Fr 2.49000000 Gi
0.0							CF Ste 3.000000 Mi <u>Auto</u> Mi
50.0				}	h Inn will water	lp-4/2/p-4-1000	Freq Offs 0 H
0.0							Scale Typ
tart 2.46 Res BW	6000 GH z 300 kHz	#VBW	910 kHz	Swe	Stop 2.490 eep 1.000 ms (1	000 GHz 001 pts)	.og <u>L</u>

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9.5. AVERAGE TIME OF OCCUPANCY

<u>LIMITS</u>

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 3.16 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to 10 * (# of pulses in 0.8 s) * pulse width.

RESULTS

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9.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal	Mode				
DH5	2.86	11	0.3146	0.4	-0.0854
		-			-
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH M	ode				
DH5	2.86	2.75	0.07865	0.4	-0.3214



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA
9.5.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

DH Packet	Pulse	Number of	Average Time	Limit	Margin
	Width	Pulses in	of Occupancy		
	(msec)	3.16	(sec)	(sec)	(sec)
		seconds			
8PSK Normal Mode					
3DH5	2.86	11	0.3146	0.4	-0.0854

Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

9.6. OUTPUT POWER

<u>LIMITS</u>

§15.247 (b) (1)

RSS-247 (5.4) (b)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. 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.

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

TEST PROCEDURE

Measurements was perform using a power meter with wideband peak power sensor.

RESULTS

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9.6.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	19232
Date:	7/23/2021

Channel	Frequency	Output Power	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2402	12.76	21	-8.24
Middle	2441	12.67	21	-8.33
High	2480	12.74	21	-8.26

9.6.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	19232
Date:	7/23/2021

Channel	Frequency	Output Power	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2402	12.53	21	-8.47
Middle	2441	12.46	21	-8.54
High	2480	12.44	21	-8.56

9.6.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	19232
Date:	7/23/2021

Channel	Frequency	Output Power	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
Low	2402	12.62	21	-8.38
Middle	2441	12.52	21	-8.48
High	2480	12.61	21	-8.39

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9.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements was performed using a power meter with wideband average power sensor.

RESULTS

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

9.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	19232
Date	7/23/2021

Channel	Frequency	Average Power
	(MHz)	(dBm)
Low	2402	12.43
Middle	2441	12.39
High	2480	12.45

9.7.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	19232	
Date	7/23/2021	

Channel	Frequency	Average Power
	(MHz)	(dBm)
Low	2402	9.32
Middle	2441	9.27
High	2480	9.34

9.7.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	19232
Date	7/23/2021

Channel	Frequency	Average Power
	(MHz)	(dBm)
Low	2402	9.38
Middle	2441	9.33
High	2480	9.42

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9.8. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

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9.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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9.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



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Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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10. RADIATED TEST RESULTS

LIMITS

FCC §15.205 and §15.209

RSS-GEN, Section 8.9 and 8.10.

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.

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Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

KDB 558074 D01 15.247 Meas Guidance v05r02

Use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period.

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10.1. TRANSMITTER ABOVE 1 GHz

10.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)



HORIZONTAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	38.48	Pk	32.1	-20.3	50.28	-	-	74	-23.72	13	139	н
2	* 2.32928	41.41	Pk	31.8	-20.5	52.71	-	-	74	-21.29	13	139	Н
3	* 2.39	26.29	VA1T	32.1	-20.3	38.09	54	-15.91	-	-	13	139	Н
4	* 2.38306	26.37	VA1T	32.2	-20.4	38.17	54	-15.83	-	-	13	139	Н

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	37.97	Pk	32.1	-20.3	49.77	-	-	74	-24.23	160	397	V
2	* 2.33587	41.31	Pk	31.9	-20.4	52.81	-	-	74	-21.19	160	397	V
3	* 2.39	26.17	VA1T	32.1	-20.3	37.97	54	-16.03	-	-	160	396	V
4	* 2.38384	26.36	VA1T	32.1	-20.4	38.06	54	-15.94	-	_	160	396	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

REPORT NO: 13685813-E1V2 FCC ID: BCG-A2564 BANDEDGE (HIGH CHANNEL)

125<mark>UL Fremont - Chamber D</mark> 2021 Jul 25 00:00:52 Restricted Bandedge Config:EUT Only Mode:BDR 2480MHz Tested by:12471 11! 105 95 zontal 85 Peak Limit (dBuV/ Ч 75 (dBuU/m) 65 Average Limit (dBuV/m) 55 45 ą 35 2.46 10.3MHz/ 2.563 Frequency (GHz) RBU/VBU RBU/VBU Ref/Attn Det/Avg Mode Sweep Pts #Swps/Made Position Ronge (GHz) 1M(-3dB)/3M 187/10 PEAK/Pur Avg(RMS) Bissec(Auto) 8008 MXH 7 degs 153 cn H 2:2:46-2:563 Ref/Attn Det/Avg Mode Pts #Swps/Mode Position Range (GHz) 1:2.46-2.563 Ѕиеер High CH BE - H.TST 30915 11 May 2016 Rev 9.5 06 Mar 2020

HORIZONTAL RESULT

1 * 2.4835 38.78 Pk 32.7 -20	20.3 51.18	-	-	74	-22.82	7	153	Н
3 * 2.4835 26.9 VA1T 32.7 -20	20.3 39.3	54	-14.7	-	-	7	153	Н
4 * 2.48353 26.89 VA1T 32.7 -20	20.3 39.29	54	-14.71	-	-	7	153	Н
2 2.51036 40.95 Pk 32.7 -20	20.3 53.35	-	-	74	-20.65	7	153	Н

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	38.16	Pk	32.7	-20.3	50.56	-	-	74	-23.44	250	364	V
2	* 2.49181	40.94	Pk	32.8	-20.2	53.54	-	-	74	-20.46	250	364	V
3	* 2.4835	26.28	VA1T	32.7	-20.3	38.68	54	-15.32	-	-	250	364	V
4	* 2.48351	26.28	VA1T	32.7	-20.3	38.68	54	-15.32	-	-	250	364	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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HARMONICS AND SPURIOUS EMISSIONS







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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/P ad (dB)	Corrected Reading	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
		(dBuV)				(dBuV/m)							
1	* 3.65826	37.37	PKFH	33.1	-28.5	41.97	-	-	74	-32.03	283	205	Н
	* 3.65738	24.44	VA1T	33.1	-28.5	29.04	54	-24.96	-	-	283	205	Н
3	* 11.90557	32.53	PKFH	38.6	-20.3	50.83	-	-	74	-23.17	354	143	Н
	* 11.90779	19.78	VA1T	38.6	-20.3	38.08	54	-15.92	-	-	354	143	Н
4	* 4.18116	36.87	PKFH	33.5	-27.3	43.07	-	-	74	-30.93	203	148	V
	* 4.18024	23.39	VA1T	33.5	-27.3	29.59	54	-24.41	-	-	203	148	V
6	* 12.52143	34.41	PKFH	39	-21	52.41	-	-	74	-21.59	241	339	V
	* 12.5239	20.72	VA1T	39	-21	38.72	54	-15.28	-	-	241	339	V
2	7.20595	40.37	PKFH	35.6	-24.7	51.27	-	-	-	-	47	104	Н
5	7.20597	26.72	VA1T	35.6	-24.7	37.62	-	-	-	-	250	104	V
2	7.20598	33.95	VA1T	35.6	-24.7	44.85	-	-	-	-	47	104	Н
5	7.20666	37.14	PKFH	35.6	-24.7	48.04	-	-	-	-	250	104	V

 * - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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MID CHANNEL RESULTS





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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.42042	39.38	PKFH	29.4	-21.6	47.18	-	-	74	-26.82	0	200	Н
	* 1.41798	26.42	VA1T	29.4	-21.6	34.22	54	-19.78	-	-	0	200	н
4	* 1.45587	40.51	PKFH	29.1	-21.5	48.11	-	-	74	-25.89	0	200	V
	* 1.45916	26.42	VA1T	29	-21.6	33.82	54	-20.18	-	-	0	200	V
2	* 7.3224	40.02	PKFH	35.6	-24.8	50.82	-	-	74	-23.18	232	118	Н
	* 7.32299	33.76	VA1T	35.6	-24.8	44.56	54	-9.44	-	-	232	118	н
3	* 10.76459	32.98	PKFH	37.8	-20.1	50.68	-	-	74	-23.32	0	200	Н
	* 10.76584	19.65	VA1T	37.8	-20.1	37.35	54	-16.65	-	-	0	200	Н
5	* 7.32207	36.82	PKFH	35.7	-24.8	47.72	-	-	74	-26.28	186	104	V
	* 7.32299	26.17	VA1T	35.6	-24.8	36.97	54	-17.03	-	-	186	104	V
6	* 10.74278	33.05	PKFH	37.9	-20.1	50.85	-	-	74	-23.15	0	200	V
	* 10.74279	19.9	VA1T	37.9	-20.1	37.7	54	-16.3	-	-	0	200	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

HIGH CHANNEL RESULTS





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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.38441	39.53	PKFH	29.4	-21.7	47.23	-	-	74	-26.77	360	101	Н
	* 1.38323	26.32	VA1T	29.4	-21.7	34.02	54	-19.98	-	-	360	101	н
4	* 2.32358	39.75	PKFH	31.8	-20.4	51.15	-	-	74	-22.85	360	101	V
	* 2.32555	25.86	VA1T	31.8	-20.4	37.26	54	-16.74	-	-	360	101	V
2	* 7.44069	40.6	PKFH	35.7	-24.4	51.9	-	-	74	-22.1	47	102	Н
	* 7.43999	32.82	VA1T	35.7	-24.4	44.12	54	-9.88	-	-	47	102	н
3	* 15.78385	33	PKFH	40.3	-19.5	53.8	-	-	74	-20.2	0	102	Н
	* 15.78289	19.7	VA1T	40.3	-19.5	40.5	54	-13.5	-	-	0	102	Н
5	* 7.43941	36.57	PKFH	35.7	-24.4	47.87	-	-	74	-26.13	47	110	V
	* 7.43997	26.83	VA1T	35.7	-24.4	38.13	54	-15.87	-	-	47	110	V
6	* 12.48148	33.35	PKFH	39	-20.8	51.55	-	-	74	-22.45	0	200	V
	* 12.48306	20.25	VA1T	39	-20.7	38.55	54	-15.45	-	-	0	200	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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10.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)



HORIZONTAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	39.19	Pk	32.1	-20.3	50.99	-	-	74	-23.01	4	159	Н
2	* 2.31297	41.45	Pk	31.8	-20.5	52.75	-	-	74	-21.25	4	159	Н
3	* 2.39	26.37	VA1T	32.1	-20.3	38.17	54	-15.83	-	-	4	159	Н
4	* 2.38423	26.59	VA1T	32.1	-20.4	38.29	54	-15.71	-	-	4	159	Н

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	38.28	Pk	32.1	-20.3	50.08	-	-	74	-23.92	159	397	V
2	* 2.37233	40.78	Pk	32	-20.4	52.38	-	-	74	-21.62	159	397	V
3	* 2.39	26.26	VA1T	32.1	-20.3	38.06	54	-15.94	-	-	159	397	V
4	* 2.38755	26.47	VA1T	32.1	-20.4	38.17	54	-15.83	-	_	159	397	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

BANDEDGE (HIGH CHANNEL)



HORIZONTAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	40.82	Pk	32.7	-20.3	53.22	-	-	74	-20.78	4	174	Н
2	* 2.48384	41.12	Pk	32.7	-20.3	53.52	-	-	74	-20.48	4	174	Н
3	* 2.4835	26.94	VA1T	32.7	-20.3	39.34	54	-14.66	-	-	4	174	Н
4	* 2.48355	26.9	VA1T	32.7	-20.3	39.3	54	-14.7	-	-	4	174	Н

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	38.8	Pk	32.7	-20.3	51.2	-	-	74	-22.8	222	363	V
2	* 2.49429	40.85	Pk	32.8	-20.2	53.45	-	-	74	-20.55	222	363	V
3	* 2.4835	26.4	VA1T	32.7	-20.3	38.8	54	-15.2	-	-	222	363	V
4	* 2.49146	26.24	VA1T	32.8	-20.2	38.84	54	-15.16	-	_	222	363	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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HARMONICS AND SPURIOUS EMISSIONS



LOW CHANNEL RESULTS



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin	Azimuth (Degs)	Height (cm)	Polarity
1	* 1 42044	39.83	PKEH	29.4	-21.6	47.63	-	_	74	-26.37	356	200	н
	* 1.41929	26.45	VA1T	29.4	-21.6	34.25	54	-19.75	-	-20.01	356	200	H
4	* 1.52641	40.68	PKFH	27.9	-21.5	47.08	-	-	74	-26.92	360	200	V
	* 1.52474	26.32	VA1T	27.9	-21.5	32.72	54	-21.28	-	-	360	200	V
3	* 10.70202	33.82	PKFH	37.9	-20.6	51.12	-	-	74	-22.88	0	101	Н
	* 10.70465	20.08	VA1T	37.9	-20.5	37.48	54	-16.52	-	-	0	101	Н
6	* 12.56199	34.99	PKFH	39	-21.5	52.49	-	-	74	-21.51	0	101	V
	* 12.56503	21.1	VA1T	39	-21.5	38.6	54	-15.4	-	-	0	101	V
2	7.20565	39.34	PKFH	35.6	-24.7	50.24	-	-	-	-	224	104	Н
5	7.20632	37.52	PKFH	35.6	-24.7	48.42	-	-	-	-	195	103	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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MID CHANNEL RESULTS





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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.35361	39.8	PKFH	29.6	-21.7	47.7	-	-	74	-26.3	0	200	Н
	* 1.35462	26.5	VA1T	29.6	-21.8	34.3	54	-19.7	-	-	0	200	н
4	* 1.28601	40.52	PKFH	29.5	-21.9	48.12	-	-	74	-25.88	0	101	V
	* 1.28659	26.52	VA1T	29.5	-21.9	34.12	54	-19.88	-	-	0	101	V
2	* 7.32335	39.04	PKFH	35.6	-24.8	49.84	-	-	74	-24.16	230	117	н
	* 7.32303	28.59	VA1T	35.6	-24.8	39.39	54	-14.61	-	-	230	117	Н
3	* 11.52732	32.9	PKFH	38.2	-20.1	51	-	-	74	-23	0	200	Н
	* 11.52886	19.59	VA1T	38.2	-20	37.79	54	-16.21	-	-	0	200	н
5	* 11.36731	32.93	PKFH	38	-20.8	50.13	-	-	74	-23.87	0	200	V
	* 11.36744	19.78	VA1T	38	-20.8	36.98	54	-17.02	-	-	0	200	V
6	* 17.85486	31.37	PKFH	41.3	-17	55.67	-	-	74	-18.33	0	200	V
	* 17.85523	18.1	VA1T	41.3	-17	42.4	54	-11.6	-	-	0	200	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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HIGH CHANNEL RESULTS





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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.33942	40.02	PKFH	29.4	-21.8	47.62	-	-	74	-26.38	0	101	Н
	* 1.3403	26.44	VA1T	29.4	-21.8	34.04	54	-19.96	-	-	0	101	Н
4	* 1.16865	40.14	PKFH	27.8	-22	45.94	-	-	74	-28.06	0	101	V
	* 1.16756	26.49	VA1T	27.8	-22	32.29	54	-21.71	-	-	0	101	V
2	* 7.44053	38.74	PKFH	35.7	-24.4	50.04	-	-	74	-23.96	231	117	Н
	* 7.44002	27.58	VA1T	35.7	-24.4	38.88	54	-15.12	-	-	231	117	н
3	* 11.42223	33.43	PKFH	38	-20.6	50.83	-	-	74	-23.17	0	200	Н
	* 11.4233	19.67	VA1T	38	-20.7	36.97	54	-17.03	-	-	0	200	Н
5	* 11.93514	34.85	PKFH	38.7	-20.8	52.75	-	-	74	-21.25	0	101	V
	* 11.93823	20.16	VA1T	38.7	-20.8	38.06	54	-15.94	-	-	0	101	V
6	* 15.749	33	PKFH	40.2	-19.7	53.5	-	-	74	-20.5	0	101	V
	* 15.74648	19.79	VA1T	40.2	-19.6	40.39	54	-13.61	-	-	0	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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10.2. WORST CASE BELOW 1 GHZ

95 UL Fremont - Chamber F 2021 Aug 4 18:49:41 Radiated Emissions - 3 Meters Config:EUT Dnly Mode:BDR Worst Case Tested by:23560 85 75 65 zantal 55 Har 45 @Pk Limit (dBuU/m) (dBuU/m) 35 25 2 15 100 1000 Frequency (MHz) RBM/VBM Ref/Attn Det/Avg Type Sweep 128k(-6dB)/1M 97/18 PEAK/LooPw--Video 1ms/MHz Pts #Sups/Nade 4000 MAXH RBU/UBU Ref/Attn Det/Avg Type Sweep 128k(-6d8)/IM 97/18 PEAK/LooPar-Video Ins/MHz Range (MHz) 1:30-200 Position 8-368deas H Ronge (MHz) 3:208-1000 Pts #Swps/Mode Position 8088 MAXH 8-368degs H *.TST 30915 15 Jul 2014 Rev 9.5 30 Apr 2020 HORIZONTAL

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

Below 1GHz Data

	Marker	Frequency (MHz)	Meter Reading	Det	AF T900 (dB/m)	Amp/Cbl (dB)	Corrected Reading	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
		((dBuV)		(ub/iii)		(dBuV/m)	(abuv/iii)	(42)	(2090)	(011)	
	1	33.104	22.2	Qp	25.9	-31.9	16.2	40	-23.8	312	302	Н
Γ	2	* 134.5777	21.71	Qp	19.6	-30.9	10.41	43.52	-33.11	338	201	Н
	4	32.6252	22.01	Qp	26.3	-31.9	16.41	40	-23.59	170	161	V
	5	* 116.5147	21.88	Qp	19.1	-31	9.98	43.52	-33.54	9	313	V
	3	* 960.3739	19.62	Qp	28.8	-26.1	22.32	53.97	-31.65	279	115	Н
Γ	6	826.1212	20.45	Qp	27.5	-27.5	20.45	46.02	-25.57	192	275	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band Qp - Quasi-Peak detector

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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10.3. WORST CASE 18-26 GHZ

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

REPORT NO: 13685813-E1V2 FCC ID: BCG-A2564

18 – 26GHz DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T449 AF	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Polarity
1	19.35733	35.85	Pk	32.7	-18.2	-9.5	40.85	54	-13.15	74	-33.15	Н
2	22.608	36.55	Pk	33.4	-18.8	-9.5	41.65	54	-12.35	74	-32.35	Н
3	25.31822	37.35	Pk	34.1	-17.9	-9.5	44.05	54	-9.95	74	-29.95	Н
4	19.51111	35.96	Pk	32.6	-18.1	-9.5	40.96	54	-13.04	74	-33.04	V
5	22.13867	37.11	Pk	33.3	-18.7	-9.5	42.21	54	-11.79	74	-31.79	V
6	25.22311	38.28	Pk	34.2	-17.7	-9.5	45.28	54	-8.72	74	-28.72	V

Pk - Peak detector

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888
REPORT NO: 13685813-E1V2 FCC ID: BCG-A2564

10.4. WORST CASE BELOW 30MHz

Parallel and Perpendicular



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

Trace Markers

ſ	Marke	Frequenc	Meter	De	Loop	Cable	Dist	Corrected	Peak	Margi	Avg	Margi	Azimut	Antenna
	r	y (MHz)	Readin g	t	Antenn a (dBm)	s (dB)	Corr 300	Reading (dBuVolts	Limit (dBuV/m	n (dB)	Limit (dBuV/m	n (dB)	h (Degs)	Orientatio n
			(dBuV)				m)))			
I	1	.24368	44.16	Pk	11.4	.1	-80	-24.34	39.88	-64.22	19.88	-44.22	0-360	Face off

Marker	Frequency	Meter	Det	Loop	Cables	Dist Corr	Corrected	QP Limit	Margin	Azimuth	Antenna
	(MHz)	Reading		Antenna	(dB)	(dB) 40Log	Reading	(dBuV/m)	(dB)	(Degs)	Orientation
		(dBuV)		(dBm)			(dBuVolts)				
4	.53127	37.28	Pk	11.2	.1	-40	8.58	33.1	-24.52	0-360	Face on
5	1.92718	24.03	Pk	11.4	.2	-40	-4.37	29.5	-33.87	0-360	Face on
6	8.68887	14.15	Pk	10.9	.3	-40	-14.65	29.5	-44.15	0-360	Face on
2	.55734	36.89	Pk	11.2	.1	-40	8.19	32.68	-24.49	0-360	Face off
3	3.56206	20.37	Pk	11.5	.2	-40	-7.93	29.5	-37.43	0-360	Face off

Pk - Peak detector

FCC 15.209 Below 30MHz.TST 30915 28 Apr 2017 Rev 9.5 30 Apr 2020

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

11. AC POWER LINE CONDUCTED EMISSIONS

<u>LIMITS</u>

FCC §15.207 (a)

RSS-Gen 8.8

Frequency of Emission (MHz)	Conducted Limit (dBuV)				
	Quasi-peak	Average			
0.15-0.5	66 to 56 *	56 to 46 "			
0.5-5	56	46			
5-30	60	50			

Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

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11.1. AC Power Line With Laptop



LINE 1 RESULTS





LINE 2 RESULTS

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

REPORT NO: 13685813-E1V2 FCC ID: BCG-A2564

AC LINE DATA

Range	e 1: Line-L1	1.15 - 30)MHz								
Marker	Frequency	Meter	Det	PRE018644	LC Cables	TekBox	Corrected	CFR 47 Part	QP Margin	CFR 47 Part	Av(CISPR)M
	(MHz)	Reading		6 L1	C1&C3 dB	Limiter	Reading	15 Class B	(dB)	15 Class B	argin
		(dBuV)				TBFL1	dBuV	QP		Avg	(dB)
						Model 207					
2	.20175	9.74	Ca	0	0	9.3	19.04	-	-	53.54	-34.5
4	.25125	.6	Ca	0	0	9.3	9.9	-	-	51.72	-41.82
6	.34125	-3.74	Ca	0	0	9.3	5.56	-	-	49.17	-43.61
8	.68325	-8.42	Ca	0	0	9.3	.88	-	-	46	-45.12
10	1.84875	-3.7	Ca	0	.1	9.3	5.7	-	-	46	-40.3
12	27.82275	2.67	Ca	0	.3	9.4	12.37	-	-	50	-37.63
1	.18825	27.16	Qp	0	0	9.4	36.56	64.11	-27.55	-	-
3	.25125	18.28	Qp	0	0	9.3	27.58	61.72	-34.14	-	-
5	.32775	12.98	Qp	0	0	9.3	22.28	59.51	-37.23	-	-
7	.69	.74	Qp	0	0	9.3	10.04	56	-45.96	-	-
9	1.851	6.76	Qp	0	.1	9.3	16.16	56	-39.84	-	-
11	27.8205	8.13	Qp	0	.3	9.4	17.83	60	-42.17	-	-

Range	Range 2: Line-L2 .15 - 30MHz												
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	PRE018644 6 L2	LC Cables C2&C3 dB	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)M argin (dB)		
14	.20175	9.44	Ca	0	0	9.3	18.74	-	-	53.54	-34.8		
16	.25125	.84	Ca	0	0	9.3	10.14	-	-	51.72	-41.58		
18	.34125	-3.35	Ca	0	0	9.3	5.95	-	-	49.17	-43.22		
20	.6855	-6.1	Ca	0	0	9.3	3.2	-	-	46	-42.8		
22	1.8555	-2.66	Ca	0	.1	9.3	6.74	-	-	46	-39.26		
24	27.7935	3.29	Ca	.1	.3	9.4	13.09	-	-	50	-36.91		
13	.18825	27.17	Qp	0	0	9.4	36.57	64.11	-27.54	-	-		
15	.222	18.53	Qp	0	0	9.3	27.83	62.74	-34.91	-	-		
17	.33	13.1	Qp	0	0	9.3	22.4	59.45	-37.05	-	-		
19	.6855	1.64	Qp	0	0	9.3	10.94	56	-45.06	-	-		
21	1.85325	8.1	Qp	0	.1	9.3	17.5	56	-38.5	-	-		
23	27.79125	8.91	Qp	.1	.3	9.4	18.71	60	-41.29	-	-		

Qp - Quasi-Peak detector

Ca - CISPR average detection

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

11.2. AC Power Line with AC/DC Adapter



LINE 2 RESULTS



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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

TEL:(510) 319-4000

FAX:(510) 661-0888

REPORT NO: 13685813-E1V2 FCC ID: BCG-A2564

AC LINE DATA

Range	Range 1: Line-L1 .15 - 30MHz												
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	PRE018644 6 L1	LC Cables C1&C3 dB	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)M argin (dB)		
2	.17025	13.12	Ca	0	0	9.4	22.52	-	-	54.95	-32.43		
4	.25575	9.59	Са	0	0	9.3	18.89	-	-	51.57	-32.68		
6	.339	5.83	Ca	0	0	9.3	15.13	-	-	49.23	-34.1		
8	.77325	9.98	Ca	0	.1	9.3	19.38	-	-	46	-26.62		
10	1.2885	.05	Ca	0	.1	9.3	9.45	-	-	46	-36.55		
12	6.37575	1.19	Ca	0	.1	9.3	10.59	-	-	50	-39.41		
1	.17025	31.35	Qp	0	0	9.4	40.75	64.95	-24.2	-	-		
3	.2535	27.4	Qp	0	0	9.3	36.7	61.64	-24.94	-	-		
5	.33675	22.86	Qp	0	0	9.3	32.16	59.28	-27.12	-	-		
7	.77325	20.47	Qp	0	.1	9.3	29.87	56	-26.13	-	-		
9	1.2885	10.15	Qp	0	.1	9.3	19.55	56	-36.45	-	-		
11	6.37575	8.12	Qp	0	.1	9.3	17.52	60	-42.48	-	-		

Range	e 2: Line-L	2 .15 - 30	OMHz								
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	PRE018644 6 L2	LC Cables C2&C3 dB	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)M argin (dB)
14	.17025	12.39	Ca	0	0	9.4	21.79	-	-	54.95	-33.16
16	.25575	8.19	Ca	0	0	9.3	17.49	-	-	51.57	-34.08
18	.339	4.07	Ca	0	0	9.3	13.37	-	-	49.23	-35.86
20	.771	8.14	Ca	0	0	9.3	17.44	-	-	46	-28.56
22	1.28625	-1.31	Ca	0	.1	9.3	8.09	-	-	46	-37.91
24	6.3555	1.2	Ca	0	.1	9.3	10.6	-	-	50	-39.4
13	.17025	30.96	Qp	0	0	9.4	40.36	64.95	-24.59	-	-
15	.2535	27.01	Qp	0	0	9.3	36.31	61.64	-25.33	-	-
17	.33675	22.5	Qp	0	0	9.3	31.8	59.28	-27.48	-	-
19	.789	20.78	Qp	0	0	9.3	30.08	56	-25.92	-	-
21	1.28625	10.24	Qp	0	.1	9.3	19.64	56	-36.36	-	-
23	6.35325	8.26	Qp	0	.1	9.3	17.66	60	-42.34	-	-

Qp - Quasi-Peak detector

Ca - CISPR average detection

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12. SETUP PHOTOS

Please refer to 13685813-EP1V1 for setup photos

END OF TEST REPORT

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UL VERIFICATION SERVICES INC. 47173 Benicia Street, Fremont, CA 94538; USA

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DATE: 9/29/2021 IC: 579C-A2564