Finalmouse

TEST REPORT FOR

Wireless Gaming Mouse
Models: ULXM (Ultralight X – Lion) and ULXL (Ultralight X – Tiger)

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.247
(DTS 2400-2483.5 MHz)

Report No.: 109545-4

Date of issue: April 2, 2024

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Test Certificate # 803.01

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Administrative Information

Test Report Information

REPORT PREPARED FOR:

Finalmouse
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Project Number: 109545

DATE OF EQUIPMENT RECEIPT: March 14, 2024
DATE(S) OF TESTING: March 14, 2024

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable, and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
Canyon Park
22116 23rd Drive S.E., Suite A
Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.20

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

Summary of Results

Standard / Specification: FCC Part 15 Subpart C - 15.247 (DTS)

Test Procedure	Description	Modifications	Results
15.247(a)(2)	6dB Bandwidth	NA	NP
15.247(b)(3)	Output Power	NA	NP
15.247(d)	RF Conducted Emissions & Band Edge	NA	NP
15.247(d)	Radiated Emissions	NA	Pass
15.247(d)	Radiated Band Edge	NA	NP
15.247(e)	Power Spectral Density	NA	NP
15.207	AC Conducted Emissions	NA	NP

NA = Not Applicable
NP = CKC Laboratories was not contracted to perform test.

ISO/IEC 17025 Decision Rule
The equipment sample utilized for testing is selected by the manufacturer. The declaration of pass or fail herein is a binary statement for simple acceptance rule (ILAC G8) based upon assessment to the specification(s) listed above, without consideration of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

Equipment Under Test (EUT)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
Wireless Gaming Mouse	Finalmouse	ULXM (Ultralight X – Lion)	None
Wireless Gaming Mouse	Finalmouse	ULXL (Ultralight X – Tiger)	None

Support Equipment:

Device	Manufacturer	Model #	S/N
Laptop	HP	ProtectSmart	CKCAN3512
Laptop PSU	HP	PPP009A	WFTLK0FGM961LE

General Product Information:

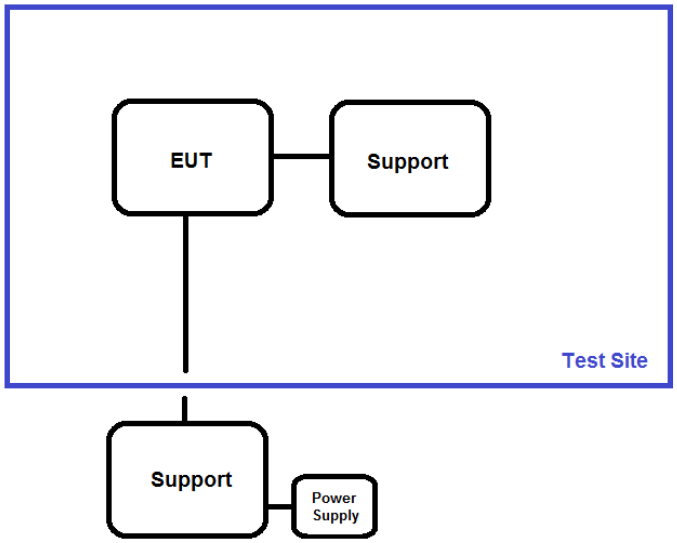
Description of EUT
Wireless Gaming Mouse

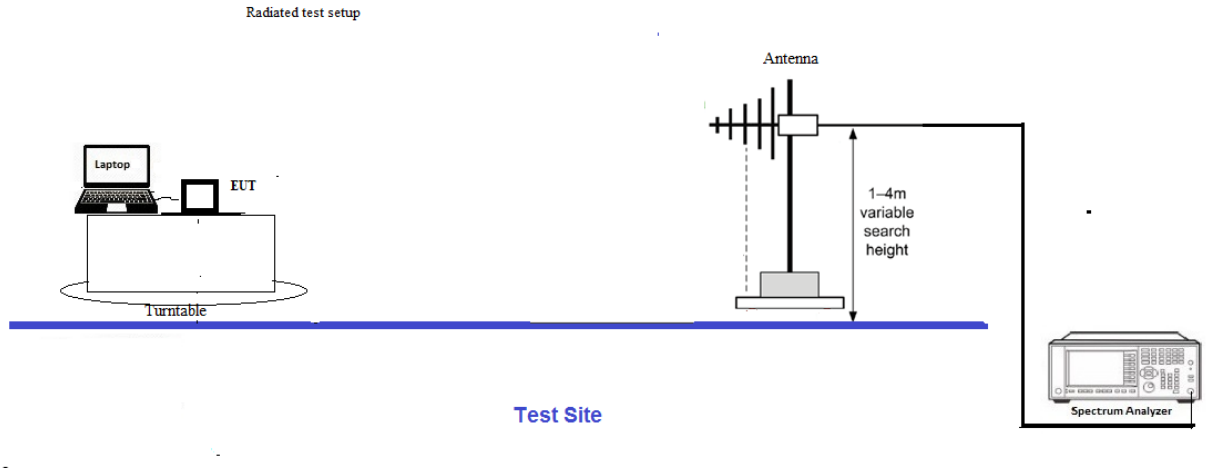
Product Information	Manufacturer-Provided Details
Operating Frequencies Tested:	2402-2480 MHz
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	DTS
Maximum Duty Cycle:	100% (Tested worst-case)
Modulation Type(s):	GFSK
Number of TX Chains:	1
Beamforming Type:	NA
Antenna Type(s) and Gain:	inverted F PCB trace antenna Medium Mouse: Average Gain: -7.73 dBi Max Gain: 1.32 dBi Large Mouse: Average Gain: -7.39 dBi Max Gain: 1.80 dBi
Antenna Connection Type:	Integral
Nominal Input Voltage:	120VAC (Host) EUT 5VDC
Firmware / Software Version(s):	v2.1.0
Firmware / Software Description:	Production release software
Firmware / Software Setting(s):	Default or Radio Test mode, depending on tests
Tune-up or Adjustment(s):	None
The validity of results is dependent on the stated product details, the accuracy of which the manufacturer assumes full responsibility.	

Block Diagram of Test Setup(s)

Config#	Setup Description of Block Diagram
1	EUT is setup in a tabletop configuration. It is connected to a Laptop via USB cable. Laptop is sitting on turntable. X, Y, and Z axis were investigated and worst-case data provided.

Test Setup Block Diagram





FCC Part 15 Subpart C

15.247(d) Radiated Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Finalmouse**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**109545**	Date:	3/14/2024
Test Type:	**Radiated Scan**	Time:	15:23:35
Tested By:	Matt Harrison	Sequence#:	4
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Test Environment Conditions:
Temperature: 21°C
Humidity: 35%
Pressure: 103.0kPa

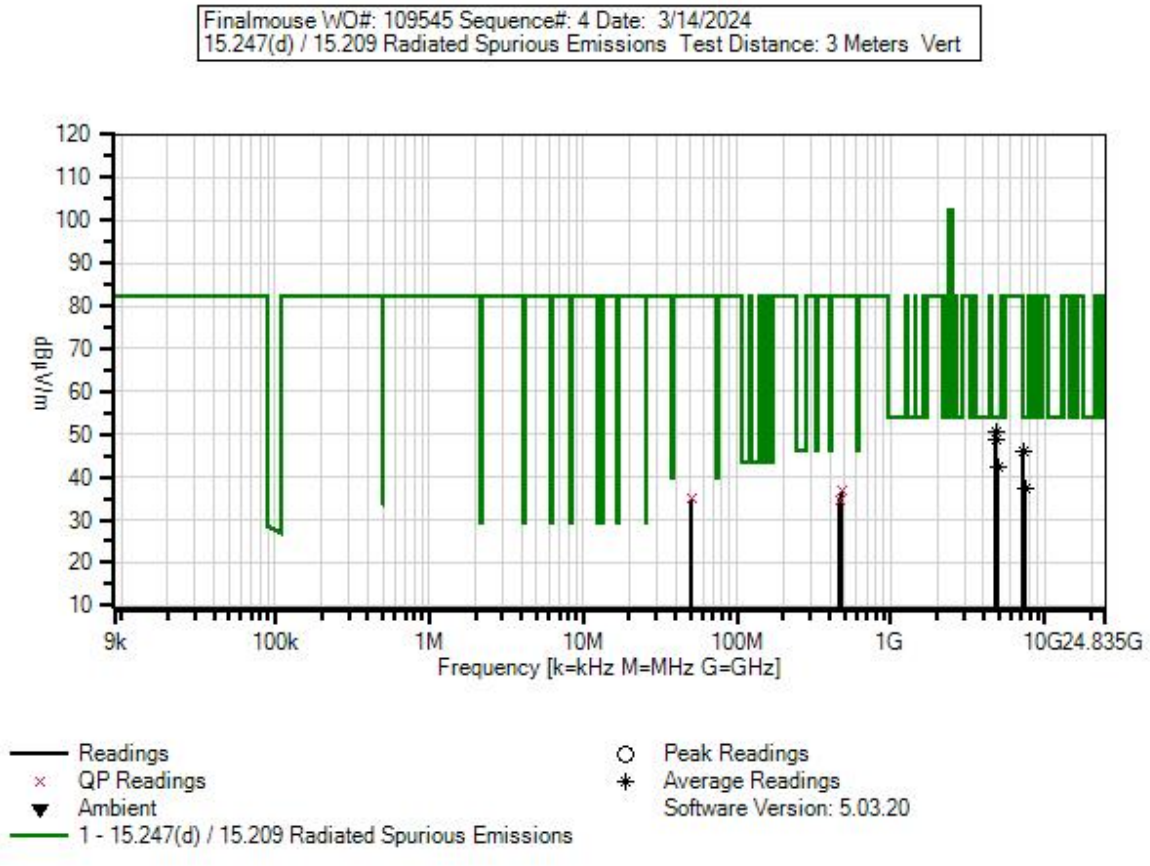
Test Method: ANSI C63.10

Frequency Range: 9k-25GHz

Test Setup: EUT is set up in a Tabletop configuration. It is 150cm high above 1GHz and 0.8m high below 1GHz on a Styrofoam table. It is connected to a support laptop via USB Cable. Laptop is sitting 20cm above ground plane. Horizontal and Vertical Polarities along with X, Y, and Z axis investigated, worst-case data provided.

Notes:
Large and Medium Mice
Transmitting on 2402 & 2480MHz
Output Power: 8dBm

No EUT Emissions found within 20dB of the limit above 10GHz or below 30MHz.



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02374ANSI	Horn Antenna	RGA-60	5/26/2023	5/26/2025
T2	ANP07504	Cable	CLU40-KMKM-02.00F	1/24/2023	1/24/2025
T3	ANP06011	Cable	Heliax	11/16/2023	11/16/2025
T4	ANP06515	Cable	Heliax	2/28/2024	2/28/2026
T5	AN03834	Spectrum Analyzer	E4448A	11/8/2023	11/8/2025
T6	AN03540	Preamp	83017A	3/24/2023	3/24/2025
T7	AN02741	Active Horn Antenna	AMFW-5F-12001800-20-10P	5/26/2023	5/26/2025
T8	AN02742	Active Horn Antenna	AMFW-5F-18002650-20-10P	11/18/2022	11/18/2024
T9	AN02763-69	Waveguide	Multiple	1/9/2024	1/9/2026
	AN02307	Preamp	8447D	8/9/2023	8/9/2025
	AN03824	Biconilog Antenna	3142E	5/9/2023	5/9/2025
	ANP05333	Cable	Heliax	8/8/2023	8/8/2025
	ANP05360	Cable	RG214	8/8/2023	8/8/2025
	AN00052	Loop Antenna	6502	5/11/2022	5/11/2024

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5 T9	T2 T6	T3 T7	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	4803.450M Ave	44.5	+33.1 +0.0 +0.0	+1.5 -33.8	+1.3 +0.0	+4.0 +0.0	+0.0	50.6	54.0	-3.4	Horiz
^	4803.450M	54.7	+33.1 +0.0 +0.0	+1.5 -33.8	+1.3 +0.0	+4.0 +0.0	+0.0	60.8	54.0	+6.8	Horiz
3	50.930M QP	49.3	+0.1 +0.3 +0.5	+0.0 +0.5	-27.7 +0.5	+12.4 +0.5	+0.0	34.9	40.0	-5.1	Vert
^	50.930M	53.3	+0.1 +0.3 +0.5	+0.0 +0.5	-27.7 +0.5	+12.4 +0.5	+0.0	38.9	40.0	-1.1	Vert
5	4804.840M Ave	42.8	+33.1 +0.0 +0.0	+1.5 -33.8	+1.3 +0.0	+4.0 +0.0	+0.0	48.9	54.0	-5.1	Vert
^	4804.840M	53.6	+33.1 +0.0 +0.0	+1.5 -33.8	+1.3 +0.0	+4.0 +0.0	+0.0	59.7	54.0	+5.7	Vert
7	479.990M QP	37.3	+0.3 +1.1 +1.9	+0.0 +1.9	-27.8 +1.9	+24.0 +1.9	+0.0	36.8	46.0	-9.2	Horiz
^	479.990M	40.4	+0.3 +1.1 +1.9	+0.0 +1.9	-27.8 +1.9	+24.0 +1.9	+0.0	39.9	46.0	-6.1	Horiz
9	467.996M QP	35.2	+0.3 +1.1 +1.8	+0.0 +1.8	-27.8 +1.8	+24.1 +1.8	+0.0	34.7	46.0	-11.3	Horiz
^	467.996M	41.6	+0.3 +1.1 +1.8	+0.0 +1.8	-27.8 +1.8	+24.1 +1.8	+0.0	41.1	46.0	-4.9	Horiz
11	4960.130M Ave	36.4	+33.7 +0.0 +0.0	+1.2 -33.8	+1.1 +0.0	+3.9 +0.0	+0.0	42.5	54.0	-11.5	Horiz
^	4960.130M	51.8	+33.7 +0.0 +0.0	+1.2 -33.8	+1.1 +0.0	+3.9 +0.0	+0.0	57.9	54.0	+3.9	Horiz

13	7439.320M Ave	27.4	+37.4 +0.0 +0.0	+1.2 -35.1	+1.5 +0.0	+5.1 +0.0	+0.0	37.5	54.0	-16.5	Horiz
^	7439.320M	44.1	+37.4 +0.0 +0.0	+1.2 -35.1	+1.5 +0.0	+5.1 +0.0	+0.0	54.2	54.0	+0.2	Horiz
15	7207.060M Ave	36.6	+36.7 +0.0 +0.0	+1.3 -35.0	+1.4 +0.0	+4.9 +0.0	+0.0	45.9	82.3	-36.4	Horiz
^	7207.060M	48.6	+36.7 +0.0 +0.0	+1.3 -35.0	+1.4 +0.0	+4.9 +0.0	+0.0	57.9	82.3	-24.4	Horiz

Test Setup Photo(s)

Below 1GHz, 0.8m; View 1

Below 1GHz, 0.8m; View 2

Above 1GHz with USB; View 1

Above 1GHz with USB; View 2

Medium + Large with USB; X-Axis

Medium + Large with USB; Y-Axis

Medium + Large with USB; Z-Axis

Supplemental Information

Measurement Uncertainty

Uncertainty Value	Parameter
5.77 dB	Radiated Emissions
0.673 dB	RF Conducted Measurements
5.77×10^{-10}	Frequency Deviation
0.00005 s	Time Deviation
3.18 dB	Mains Conducted Emissions

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point, the measuring device is set into the linear mode and the scan time is reduced.

End of Report