



Report Number:	14116837-E2V2FCCIC- Report
Issue Date:	2022-05-20
Revision Date:	2022-06-07
Model Number:	M2004000
FCC ID:	2AM5N-ML2M2
IC ID:	23045-ML2M2

Electromagnetic Compatibility Test Report

For

Magic Leap Inc
7500 West Sunrise Blvd
Plantation, FL 33322 USA



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Test Report Details

Tests Performed By: UL LLC
12 LABORATORY DR.
RESEARCH TRIANGLE PARK, NC 27709, U.S.A.

Tests Performed For: **Magic Leap Inc**
7500 West Sunrise Blvd
Plantation, FL 33322 USA

Issue Date: 2022-05-20
Revision Date: 2022-06-07

Model Number Tested: M2004000

Sample Serial Number: **G65344G0000E**
G65344G0000R

Applicable Standards: FCC 47 CFR PART 15 SUBPART B:2022
ICES-003 ISSUE 7:2020-10
ICES-Gen Issue 1:2021-02

Date Test Item Received: **2021-08-24**

Testing Start Date: **2021-08-25**

Date Testing Complete: **2021-10-26**

Overall Results: Compliant

UL LLC 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.

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Report Revision History

Revision Date	Revision Version	Description	Revised By	Revision Reviewed By
2022-05-20	V1	Initial Issue		
2022-06-07	V2	Update model number from wildcard M2004XXX to singular model number M2004000.	Sarah Thomson	Michael Ferrer

1.0 TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4:2014, FCC 47 CFR PART 15 SUBPART B:2022, ICES-003 ISSUE 7:2020-10, ICES-Gen Issue 1:2021-02.

1.1 Deviations from standard test methods

None

1.2 Device Modifications Necessary for Compliance

None

1.3 TEST RESULTS SUMMARY

This product is considered Class B

Requirement – Test	Result
CONDUCTED EMISSIONS	Compliant
RADIATED EMISSIONS	Compliant

Approved & Released For

UL LLC. By:



Michael Ferrer
Operations Leader
Consumer Technology Division
UL LLC.

Prepared By:



Sarah Thomson
Engineer
Consumer Technology Division
UL LLC.

2.0 DECISION RULES AND MEASUREMENT UNCERTAINTY

2.1 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

2.2 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).

2.3 Measurement Uncertainty

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

PARAMETER	U _{lab}	U _{Cispr}
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB	3.4 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB	6.3 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB	5.5 dB

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

2.4 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

3.0 GENERAL - Product Description

3.1 Equipment Description

The EUT is an optical handheld operated input device includes BLE radio transceiver. It is intended for use with the Magic Leap compute pack and headset as part of a complete augmented reality system.

3.2 Device Configuration During Test

3.2.1 Equipment Used During Test:

Use	Product Type	Manufacturer	Model	Comments
EUT	Controller	Magic Leap	M2004000	FCC ID: 2AM5N-ML2M2; IC: 23045-ML2M2
EUT	Power Supply	Magic Leap	M3013	Used to charge the controller
AE	Laptop	HP	Ebook MLLW6525	Used to set the EUT into the test mode

Note: EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment, or SIM - Simulator (Not Subjected to Test)

3.2.2 Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
0	Enclosure	N/E	—	—	None
1	Mains	AC	N	N	AC mains to Power Supply
2	USB Type C	DC	N	N	Used for charging device

*Note:
 AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
 I/O = Signal Input or Output Port (Not Involved in Process Control)
 TP = Telecommunication Ports

3.2.3 EUT Highest Frequencies:

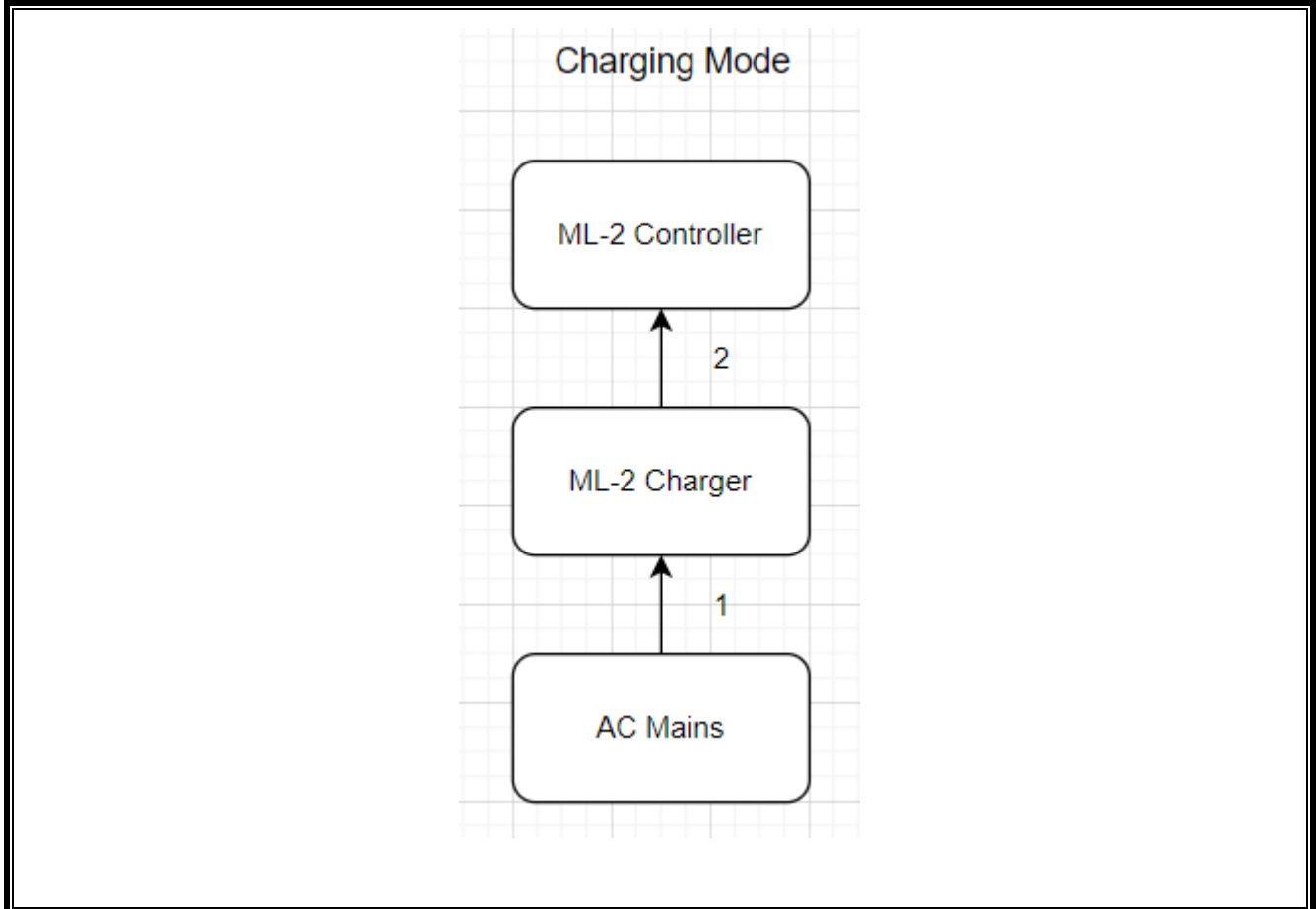
Frequency (MHz)	Description
2400-2480	BLE radio

3.2.4 Power Interface:

Mode # /Rated	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	100-240	-	-	AC-50/60Hz	Single	None
1	120	-	-	AC-60Hz	Single	FCC/ICES testing

3.3 Block Diagram:

The diagram below illustrates the configuration of the equipment above.



3.4 EUT Configurations

Configuration #	Description
1	The controller configured as table top equipment and was connected to the Magic Leap branded charger.

3.5 EUT Operation Modes

Mode of Operation#	Description
1	The ML-2 controller was operating with all electronics active in the worst case mode per the manufacturer. The BLE radio was idle.

3.6 Rationale for EUT Configurations and Modes of Operation

Configuration #	Description
1	EUT configurations and modes of operation were selected to maximize emissions. Charging mode was determined to be worst case as all the same electronics are active as in battery mode with the addition of the charging circuit, therefore it was determined by the manufacturer that investigation in battery mode was not necessary.

4.0 APPLICABLE EMISSIONS LIMITS AND TEST RESULTS

4.1 Test Conditions and Results - MAINS TERMINAL - CONDUCTED EMISSIONS

Test Engineer	Phil Foote,11775	
Test Date	2021-08-30	
Laboratory Parameters	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	23.3 °C
Humidity	10 % to 90 %	57.4 %
	Frequency range on each side of line	Measurement Point
Fully configured sample scanned over the following frequency range	150kHz to 30MHz	Mains
Limits - Class B		
Frequency (MHz)	Limit (dBµV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50
Supplementary information: Please see the attached document 13757234-E1V1FCCIC-Photos for all test setup photos.		

Conducted Emissions EUT Configuration Settings

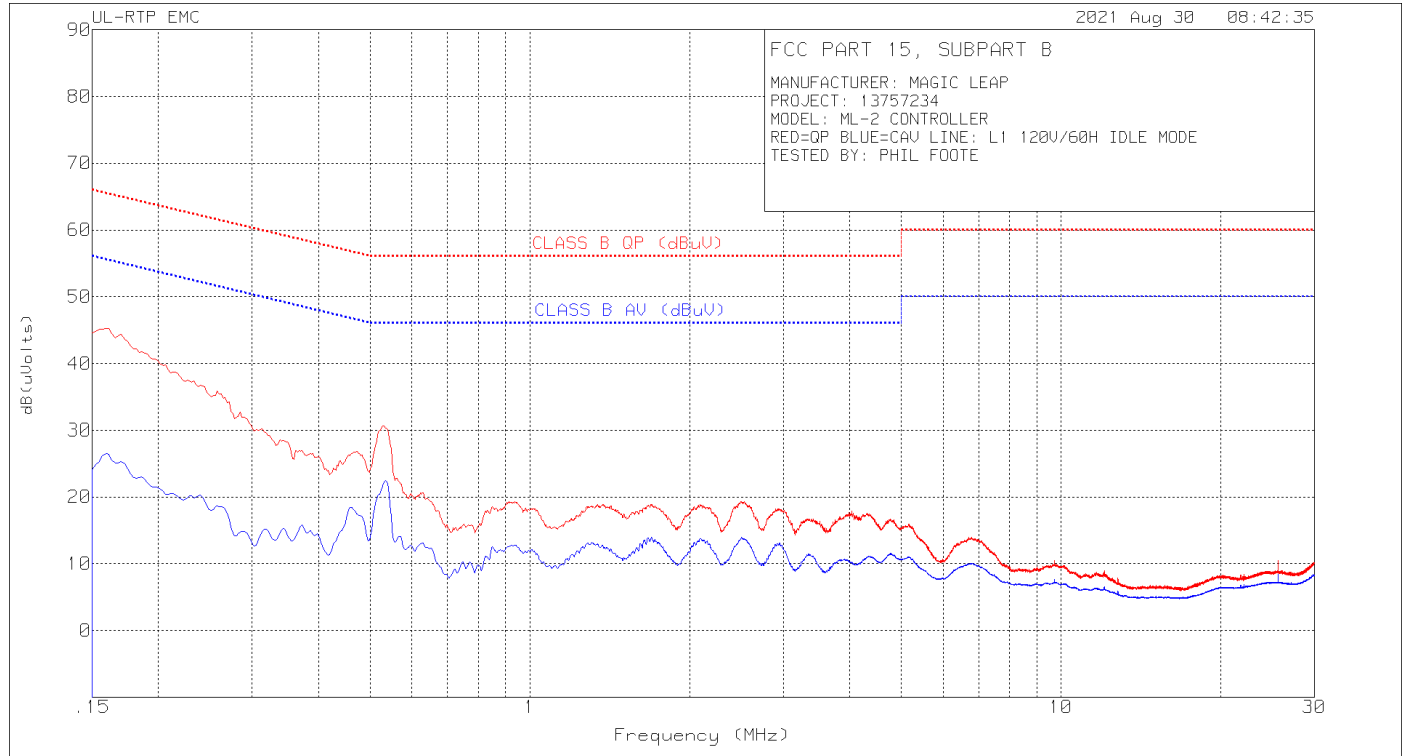
Power Interface #	EUT Configurations #	EUT Mode of Operation#
1 (120V/60Hz)	1	1 (radio idle)
Supplementary information: None		

Conducted Emissions Test Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Equipment – Ground Plane E				
85496	EMI Test Receiver 9kHz-3.6GHz	Rohde & Schwarz	ESR3	2021-08-17	2022-08-17
CBL004	Coaxial cable, 20 ft., BNC -male to BNC-male	UL	RG-223	2021-08-02	2022-08-02
207229	Temp/Humid/Pressure Meter	Extech	SD700	2021-04-20	2022-04-20
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Transient Limiter				
206212	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM 7600	2021-08-02	2022-08-02
	LISN (FCC & CISPR testing)				
LISN002	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2021-08-16	2022-08-16
	Artificial hand				
TN00135	Artificial Hand	UL	N/A	2020-08-20	2022-08-30

Results – 120V/60Hz, Controller + ML-2 Charger, Radios Idle – Line 1

Conducted Emissions Graph



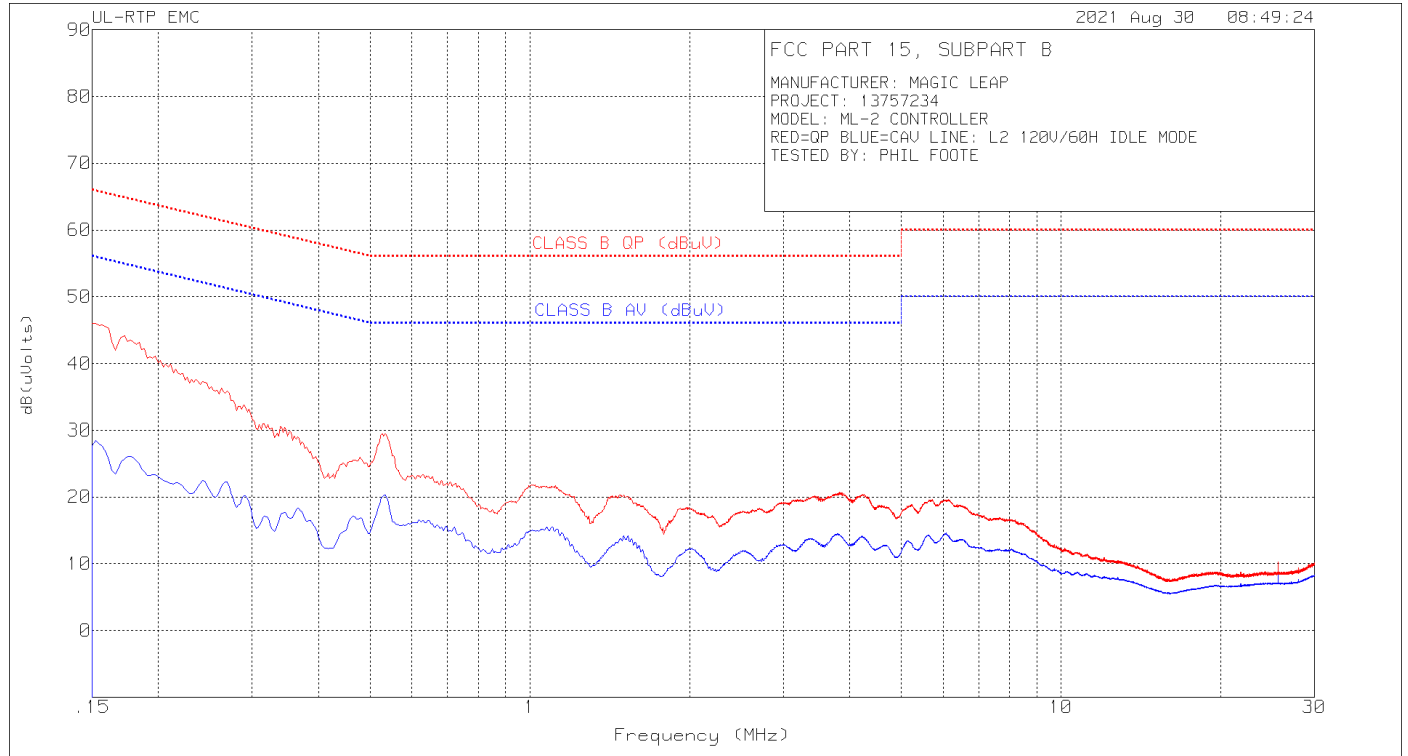
Conducted Emissions Data Points

Frequency (MHz)	Meter Reading (dBuV)	Det	LISN002 (dB)	CBL004_206212 (dB)	Corrected Reading dB(uVolts)	CLASS B QP (dBuV)	Margin (dB)	CLASS B AV (dBuV)	Margin (dB)
.159	16.46	Ca	.3	9.8	26.56	-	-	55.52	-28.96
.20175	11.15	Ca	.2	9.8	21.15	-	-	53.54	-32.39
.258	8.71	Ca	.2	9.8	18.71	-	-	51.5	-32.79
.4605	8.58	Ca	.1	9.8	18.48	-	-	46.68	-28.2
.53475	12.6	Ca	.1	9.8	22.5	-	-	46	-23.5
2.53275	3.84	Ca	0	9.9	13.74	-	-	46	-32.26
.16125	35.2	Qp	.3	9.8	45.3	65.4	-20.1	-	-
.20175	29.91	Qp	.2	9.8	39.91	63.54	-23.63	-	-
.258	25.9	Qp	.2	9.8	35.9	61.5	-25.6	-	-
.47175	16.9	Qp	.1	9.8	26.8	56.48	-29.68	-	-
.528	20.77	Qp	.1	9.8	30.67	56	-25.33	-	-
2.53275	9.41	Qp	0	9.9	19.31	56	-36.69	-	-

Qp - Quasi-Peak detector
 Ca - CISPR average detection

Results – 120V/60Hz, Controller + ML-2 Charger, Radios Idle – Line 2

Conducted Emissions Graph



Conducted Emissions Data Points

Frequency (MHz)	Meter Reading (dBuV)	Det	LISN002 (dB)	CBL004_206212 (dB)	Corrected Reading dB(uVolts)	CLASS B QP (dBuV)	Margin (dB)	CLASS B AV (dBuV)	Margin (dB)
.15225	18.25	Ca	.4	9.8	28.45	-	-	55.88	-27.43
.17475	15.99	Ca	.3	9.8	26.09	-	-	54.73	-28.64
.267	12.37	Ca	.1	9.8	22.27	-	-	51.21	-28.94
.34575	7.83	Ca	.1	9.8	17.73	-	-	49.06	-31.33
.5325	10.41	Ca	.1	9.8	20.31	-	-	46	-25.69
1.077	5.67	Ca	0	9.8	15.47	-	-	46	-30.53
.15225	35.86	Qp	.4	9.8	46.06	65.88	-19.82	-	-
.1725	34.04	Qp	.3	9.8	44.14	64.84	-20.7	-	-
.2625	26.34	Qp	.2	9.8	36.34	61.35	-25.01	-	-
.339	20.65	Qp	.1	9.8	30.55	59.23	-28.68	-	-
.5325	19.57	Qp	.1	9.8	29.47	56	-26.53	-	-
1.0725	11.84	Qp	0	9.8	21.64	56	-34.36	-	-

Qp - Quasi-Peak detector
 Ca - CISPR average detection

4.2 Test Conditions and Results - RADIATED EMISSIONS

Test Engineer	Frank Lewis	
Test Date	2021-08-25 2021-08-26 2021-10-26	
Laboratory Parameters	Required prior to the test	During the test
Ambient Temperature	10 to 40 °C	22.6 °C 23.2 °C 22.4 °C
Humidity	10 % to 90 %	62.7 % 59.8 % 37.8 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30-1000 MHz	3 m
	1-13 GHz	3 m
Limits - Class B		
Frequency (MHz)	Limit (dBµV/m)	
FCC/ICES Limits for radiated disturbance of Class B ITE at measuring distance of 3 m		
	Quasi-Peak	Average
30-88	40	NA
88-216	43.5	NA
216-230	46	NA
230-960	46/47	NA
Above 960	54	NA
	Peak	Average
Above 1 GHz	74	54
<p>Supplementary information: The peak scan is taken and then any points above or sufficiently close (within 6 dB) of the Quasi-peak limit are remeasured using the Qp detector. If no points on the plot are within 6dB of the limit then only peak data is shown as no Qp measurements are required to be taken.</p> <p>Only charging mode was evaluated as it is the worst case mode per the manufacturer, all of the same electronics are active as in battery mode with the addition of the charger electronics.</p> <p>Please see the attached document 14116837-E2V1FCCIC-Photos for all test setup photos.</p>		

Radiated Emissions EUT Configuration Settings

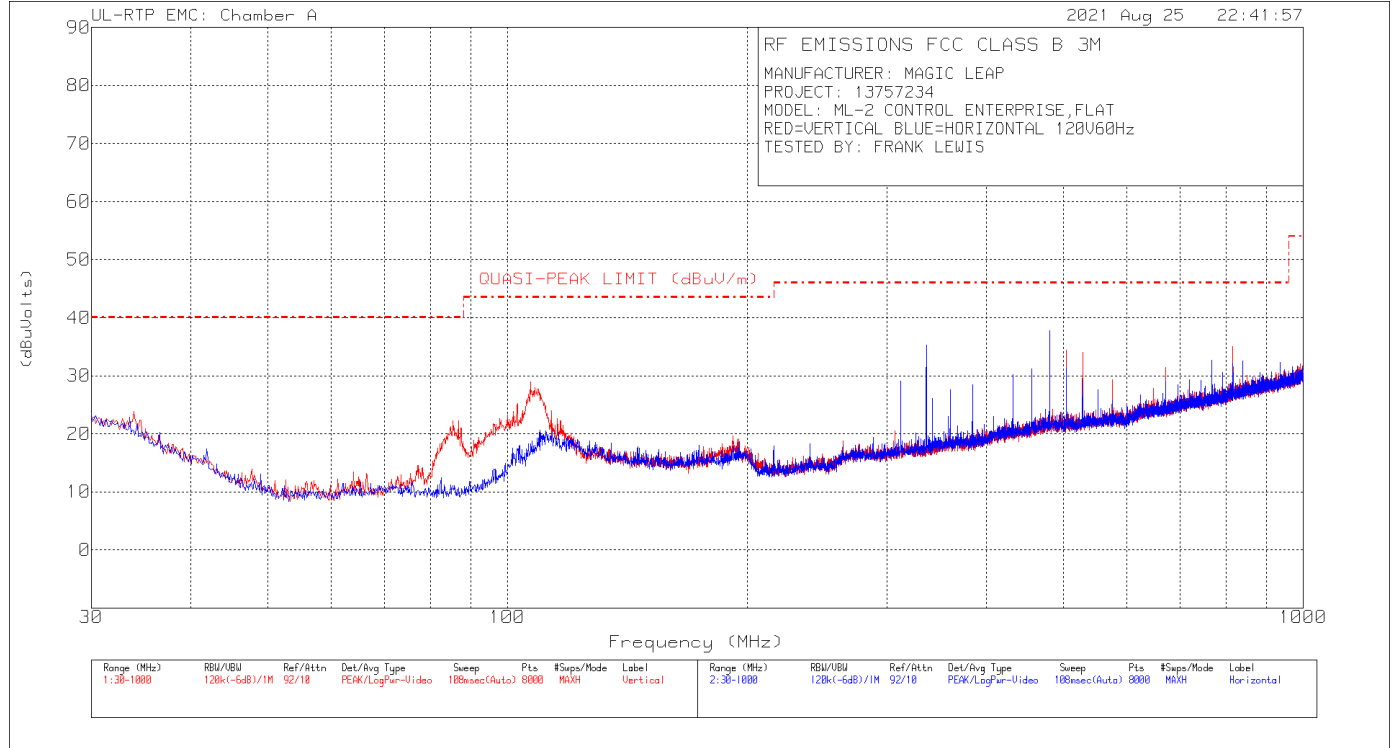
Power Interface #	EUT Configurations #	EUT Mode of Operation#
1 (120V/ 60Hz)	1	1 (radio idle)
Supplementary information: None		

Radiated Emissions Test Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz Range				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2021-08-10	2022-08-10
	Gain-Loss Chains				
SAC C (Hybrid 3m location)	Gain-Loss string for Hybrid antenna at 3m	Various	Various	2021-08-03	2022-08-03
	1-18GHz Range				
AT0062	1-18GHz	ETS-Lindgren	3117	2021-02-03	2022-02-03
SAC F Gain/Loss	1-18GHz	Various	Various	2021-08-24	2022-08-24
	Receiver & Software				
SA0016	Spectrum Analyzer	Agilent	PXA N9030A	2020-11-25	2021-11-25
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
207229	Temp/Humid/Pressure Meter	Extech	SD700	2021-04-20	2022-04-20

RADIATED EMISSIONS 30 TO 1000 MHz, 120V/60Hz (FCC/ICES Limits @ 3m) – Controller + ML-2 Charger, Horizontal Orientation

Radiated Emissions Graph



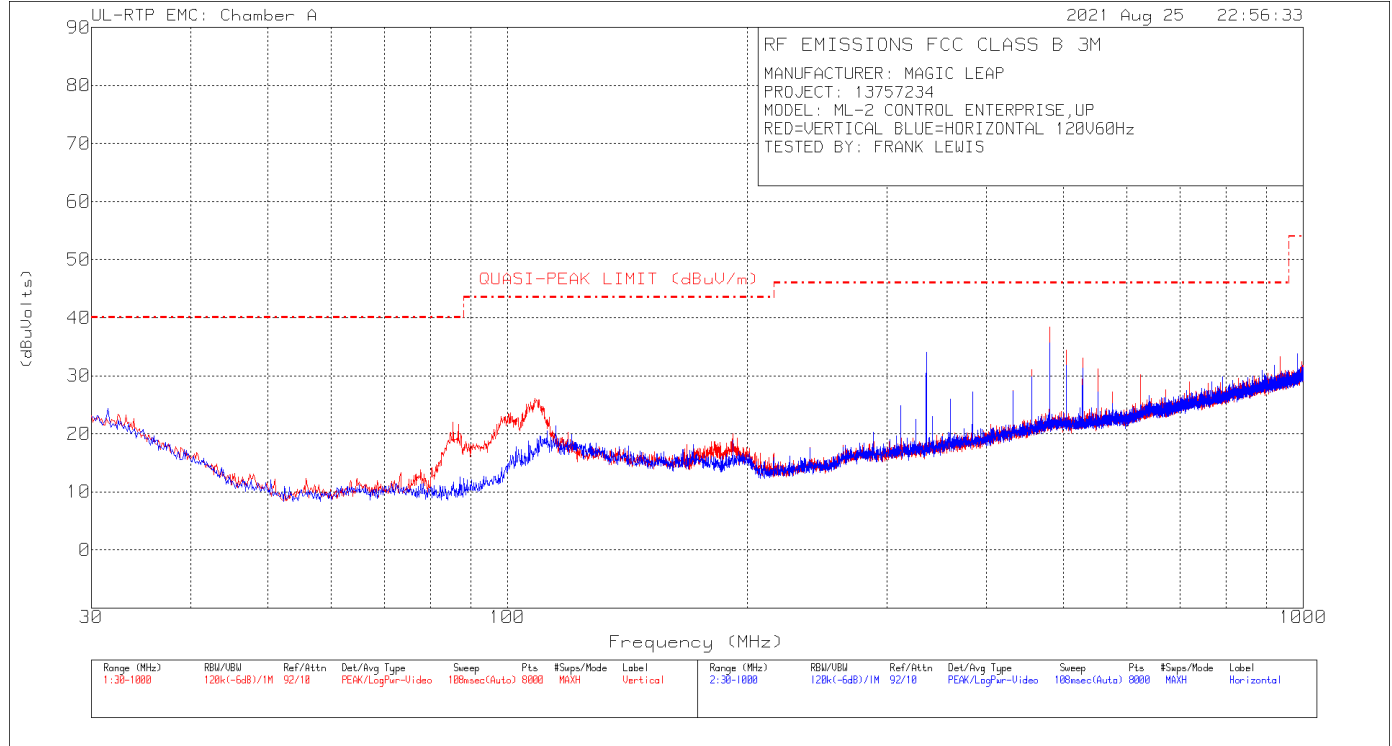
Radiated Emissions Data Points

Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 (dB)	SAC C (dB)	Corrected Reading (dBuVolts)	QUASI-PEAK LIMIT (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
106.882	41.82	Pk	18.3	-31.2	28.92	43.52	-14.6	0-360	98	V
335.9516	44.84	Pk	20	-29.5	35.34	46.02	-10.68	0-360	102	H
480.0144	42.92	Pk	23.7	-28.8	37.82	46.02	-8.2	0-360	248	H
503.9036	39.4	Pk	23.7	-28.7	34.4	46.02	-11.62	0-360	98	V
528.0354	38.52	Pk	24	-28.5	34.02	46.02	-12	0-360	98	V
816.0397	34.25	Pk	27.8	-27	35.05	46.02	-10.97	0-360	98	V

Pk - Peak Detector

RADIATED EMISSIONS 30 TO 1000 MHz, 120V/60Hz (FCC/ICES Limits @ 3m) – Controller + ML-2 Charger, Vertical Orientation

Radiated Emissions Graph



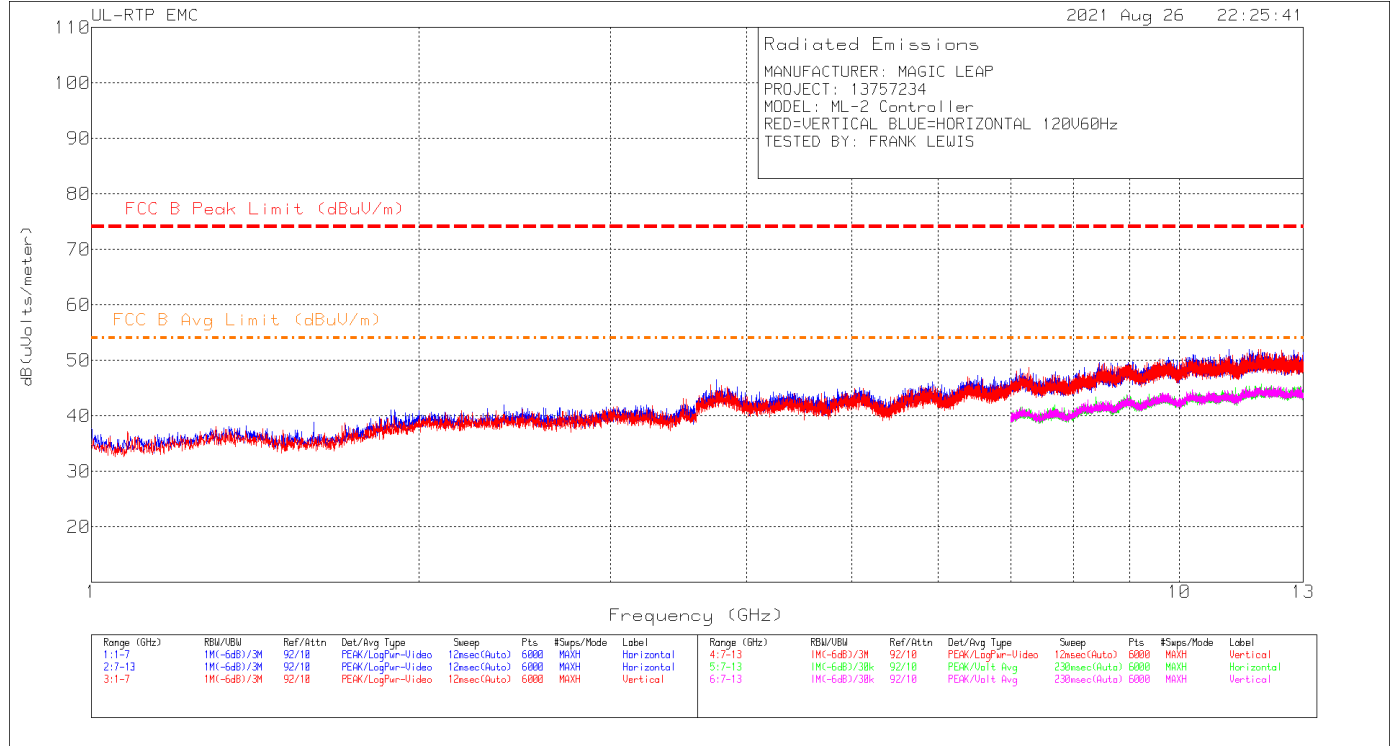
Radiated Emissions Data Points

Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 (dB)	SAC C (dB)	Corrected Reading (dBuVolts)	QUASI-PEAK LIMIT (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
335.9516	43.48	Pk	20	-29.5	33.98	46.02	-12.04	0-360	102	H
479.9538	43.48	Pk	23.7	-28.8	38.38	46.02	-7.64	0-360	99	V
480.0144	40.7	Pk	23.7	-28.8	35.6	46.02	-10.42	0-360	102	H
503.9036	39.44	Pk	23.7	-28.7	34.44	46.02	-11.58	0-360	99	V
528.0354	37.56	Pk	24	-28.5	33.06	46.02	-12.96	0-360	99	V
935.9708	30.04	Pk	28.9	-25.6	33.34	46.02	-12.68	0-360	99	V
984.0524	29.38	Pk	29.3	-24.9	33.78	53.97	-20.19	0-360	102	H

Pk - Peak Detector

RADIATED EMISSIONS 1000 TO 13,000 MHz (FCC), 120V/60Hz – Controller + ML-2 Charger, Horizontal Orientation

Radiated Emissions Graph



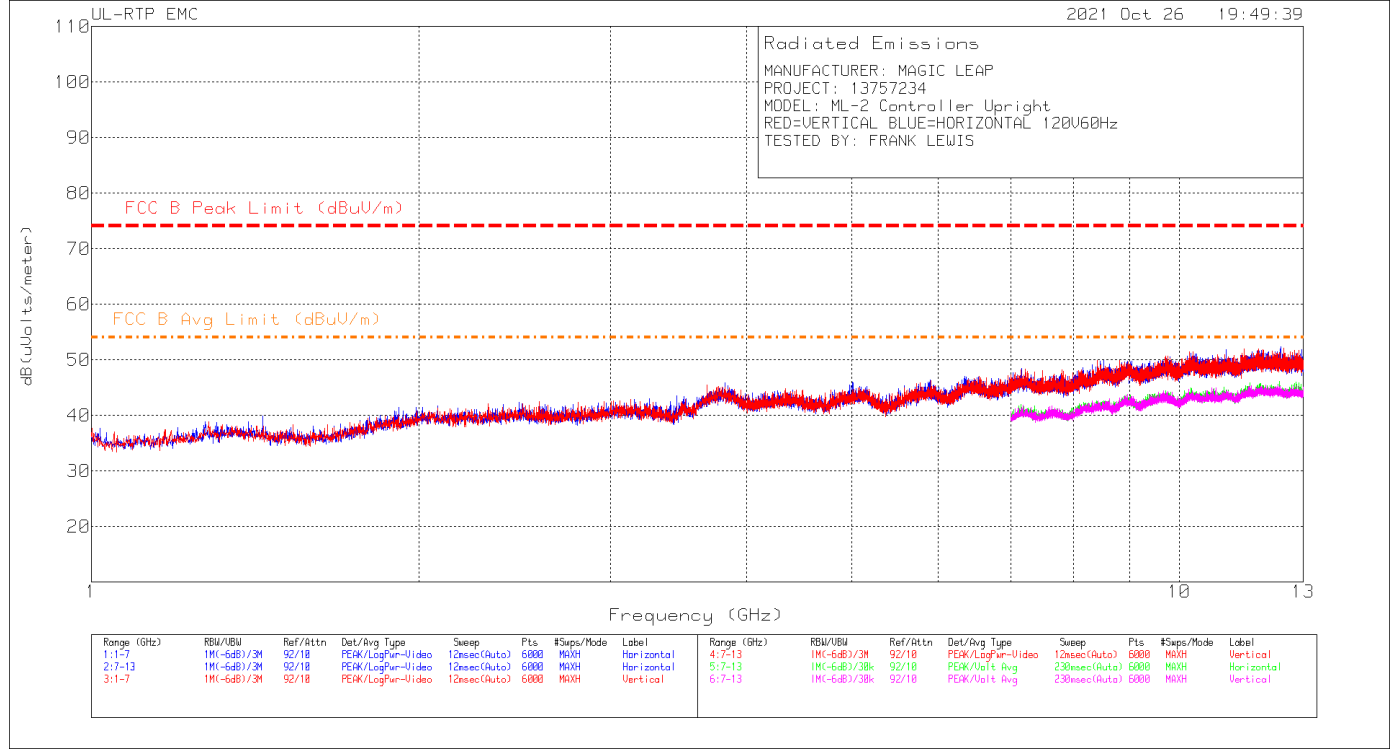
Radiated Emissions Data Points

Frequency (GHz)	Meter Reading (dBuV)	Det	AT0062 (dB/m)	SAC-F (dB)	Corrected Reading dB(µV/m)	FCC B Peak Limit (dBuV/m)	Margin (dB)	FCC B Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3.75346	44.89	Pk	33.5	-31.9	46.49	74	-27.51	54	-7.51	0-360	101	H
6.3939	40.16	Pk	35.8	-28.9	47.06	74	-26.94	54	-6.94	0-360	98	V
6.52392	40.3	Pk	35.8	-28.8	47.3	74	-26.7	54	-6.7	0-360	101	H
7.27405	40.44	Pk	35.9	-27.6	48.74	74	-25.26	54	-5.26	0-360	252	V
8.44324	40.27	Pk	35.9	-26.5	49.67	74	-24.33	54	-4.33	0-360	252	H
11.11169	40.17	Pk	38.1	-26.3	51.97	74	-22.03	54	-2.03	0-360	252	H
11.1907	39.11	Pk	38.1	-26.2	51.01	74	-22.99	54	-2.99	0-360	252	V
11.59177	39.35	Pk	38.5	-25.8	52.05	74	-21.95	54	-1.95	0-360	252	H
11.83081	38.59	Pk	38.8	-25.4	51.99	74	-22.01	54	-2.01	0-360	252	V
12.4129	39.01	Pk	39.1	-26.3	51.81	74	-22.19	54	-2.19	0-360	252	V
7.27582	27.09	Av	35.9	-27.6	35.39	74	-38.61	54	-18.61	194	293	V
8.44965	27.29	Av	35.9	-26.6	36.59	74	-37.41	54	-17.41	8	306	H
11.10885	26.67	Av	38.1	-26.3	38.47	74	-35.53	54	-15.53	236	295	H
11.18382	26.17	Av	38.1	-26.3	37.97	74	-36.03	54	-16.03	302	172	V
11.58698	26.43	Av	38.5	-25.8	39.13	74	-34.87	54	-14.87	106	240	H
11.8301	26.1	Av	38.8	-25.4	39.5	74	-34.5	54	-14.5	100	226	V
12.41446	26.17	Av	39.1	-26.3	38.97	74	-35.03	54	-15.03	212	114	V

PK - Peak Detector
Av - Average Detection

RADIATED EMISSIONS 1000 TO 13,000 MHz (FCC), 120V/60Hz – Controller + ML-2 Charger, Vertical Orientation

Radiated Emissions Graph



Radiated Emissions Data Points

Frequency (GHz)	Meter Reading (dBuV)	Det	AT0062 (dB/m)	SAC-F (dB)	Corrected Reading dB(uV/m)	FCC B Peak Limit (dBuV/m)	Margin (dB)	FCC B Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3.67845	44.41	Pk	33.3	-32.2	45.51	74	-28.49	54	-8.49	0-360	252	V
5.00967	43.35	Pk	34	-31.3	46.05	74	-27.95	54	-7.95	0-360	248	H
5.89882	41.27	Pk	35.2	-30.1	46.37	74	-27.63	54	-7.63	0-360	98	H
5.90982	40.99	Pk	35.3	-30	46.29	74	-27.71	54	-7.71	0-360	98	V
6.35389	40.36	Pk	35.7	-29	47.06	74	-26.94	54	-6.94	0-360	248	H
6.64394	39.4	PK	35.8	-28.4	46.8	74	-27.2	54	-7.2	0-360	98	V
8.40223	40.63	Pk	36	-26.7	49.93	74	-24.07	54	-4.07	0-360	252	V
8.52425	40.41	Pk	35.9	-26.4	49.91	74	-24.09	54	-4.09	0-360	102	H
10.30055	40.18	Pk	37.7	-26.4	51.48	74	-22.52	54	-2.52	0-360	252	V
11.03967	39.82	Pk	38.1	-26.1	51.82	74	-22.18	54	-2.18	0-360	102	H
11.47175	39.53	Pk	38.4	-25.9	52.03	74	-21.97	54	-1.97	0-360	252	V
12.3939	39.5	Pk	39.1	-26.2	52.4	74	-21.6	54	-1.6	0-360	102	H
12.77196	38.28	Pk	39.4	-26	51.68	74	-22.32	54	-2.32	0-360	252	V
8.39725	27.26	Av	36	-26.6	36.66	74	-37.34	54	-17.34	215	160	V
8.52665	27.28	Av	35.9	-26.4	36.78	74	-37.22	54	-17.22	227	192	H
10.30351	26.99	Av	37.7	-26.4	38.29	74	-35.71	54	-15.71	231	328	V
11.04164	26.67	Av	38.1	-26	38.77	74	-35.23	54	-15.23	354	382	H
11.47123	26.64	Av	38.4	-26	39.04	74	-34.96	54	-14.96	280	200	V
12.40017	26.4	Av	39.1	-26.1	39.4	74	-34.6	54	-14.6	354	303	H
12.77945	26.12	Av	39.4	-26.2	39.32	74	-34.68	54	-14.68	224	162	V

PK - Peak Detector

Av - Average Detection

5.0 Setup Photos

Refer to 14116837-E2V1FCCIC-Photos for setup photos.

Appendix A

Facilities, Accreditations and Authorizations

UL LLC is accredited by A2LA, Certificate Number 0751.06, 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
<input checked="" type="checkbox"/>	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	703469

BSMI Laboratory Code is SL2-IN-E-1033 (US0067).

The UL LLC, RTP VCCI laboratory facility registration number is A-0046.

END OF TEST REPORT