ELECTROMAGNETIC EMISSIONS TEST REPORT

Apple, Inc.

Apple Watch Magnetic Charging Cable
Model No A1598

12 February 2015

Engineering Contact: Apple, Inc
1 Infinite Loop M/S 91-1EMC
Cupertino, CA 95014
USA

Date FEBRUARY 13, 2015

Robert Steinfeld
EMC Design Engineering Manager

Date february 13, 2015

John Mosy
EMC Design Engineer

1. General EUT Information 3
1.1. Introduction 3
1.2. Test Information 3
1.3. Product Photographs 4
See Appendix C 4
1.4. Product Label 5
2. Electromagnetic Emissions 6
2.1. Test Facilities Used for Emissions Testing 6
2.2. Measurement Equipment Used for Emissions 7
2.2.1. Measurement Equipment Used for Conducted Emissions 7
2.2.2. Measurement Equipment Used for Radiated Emissions 7
2.3. Measurement Procedures Utilized for Emissions Testing 8
2.3.1. Pre-Testing 8
2.3.2. Measurement Procedures Utilized for Conducted Emissions 8
2.3.3. Measurement Procedures Utilized for Radiated Emissions 8
2.4. Radiated Emissions Measurement Distance 9
2.5. Emissions Measurement Uncertainty 9
2.6. Related Submittals and Grants of Certification 9
2.7. EUT Exercise Software 9
2.8. Special Accessories 9
2.9. Equipment Modifications and Deviations 9
2.10. EUT Test Configuration 10
2.11. Test Setup Photos 11
2.11.1. Conducted and Radiated Emissions Test Setup Photos 11
2.12. Emissions Data 12
2.12.1. Conducted Emissions Data 12
2.12.2. FCC Radiated Emissions Test Data 14
2.12.3. FCC Compliance Summary 14
2.12.4. NVLAP Note 15
3. Appendix A 16
4. Appendix B 17
5. Appendix C 18
6. Appendix D 19
7. Appendix E 21

1. General EUT Information

1.1. Introduction

This report documents the Class B conducted and radiated emissions test results for the Apple Watch Magnetic Charging Cable, model no A1598.

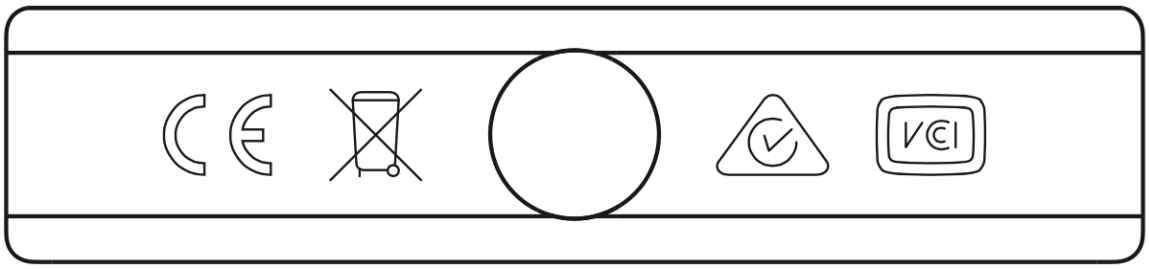
1.2. Test Information

Both emissions and immunity testing were performed using NVLAP accredited processes according to the procedures described in Apple, Inc. procedure number 080-0811 and the relevant standards listed in sections 2 and 3. All testing is NVLAP accredited - NVLAP Accredited Lab # 200071-0.

1.3. Product Photographs

See Appendix C

1.4. Product Label



2. Electromagnetic Emissions

All references to standards in Section 2 of this report are to the dated versions in the following list:
FCC CFR 47, Part 15
ICES-003, Issue 5, CAN/CSA-CEI/IEC CISPR 22-10
CISPR 22:2008

2.1. Test Facilities Used for Emissions Testing

Conducted Emissions Facilities

Apple, Inc. EMC Compliance Laboratory
18920 Forge Drive, Cupertino, California 95014
NVLAP Accredited Lab # 200071-0
VCCI Registration No. A-0016

Radiated Emissions Facilities

Apple, Inc. Test Site ALTS #1 OR #2
123 East Evelyn Ave., Mountain View, California 94041.
NVLAP Accredited Lab # 200071-0
VCCI Registration No. A-0016

Note: The emissions data in this report was recorded at the Apple, Inc. EMC facilities listed above. If data were recorded at a subcontracted test laboratory it would be noted in this test report with the name, contact information, and location of the subcontracted test facility.

2.2. Measurement Equipment Used for Emissions

2.2.1. Measurement Equipment Used for Conducted Emissions

Description	Manufacturer	Model No	Identification No	Last Cal	Next Cal
Spectrum Analyzer	R&S	ESR	101665	5/2014	5/2015
EMI Receiver	R&S	ESR	101665	5/2014	5/2015
AC Voltmeter	HP	34401-A	MY47012468	5/2014	5/2015
LISN	Fischer	50/250-16-2-07	4003	5/2014	5/2015
Cable	Pasternack/Fischer	RG223	FG3-CE	1/2014	1/2015

2.2.2. Measurement Equipment Used for Radiated Emissions

Description	Manufacturer	Model No	Identification No	Last Cal	Next Cal
Spectrum Analyzer	R&S	ESU	100374	5/2014	5/2015
Receiver	R&S	ESU	100374	5/2014	5/2015
Spectrum Analyzer	R&S	ESU	100354	5/2014	5/2015
Antenna	Sunol	JB1	A122302-1	2/2014	2/2015
Antenna	Sunol	JB1	A122302-2	2/2014	2/2015
Amplifier	AR	LN1000B	306955	4/2014	4/2015
Amplifier	AR	LN1000B	306954	4/2014	4/2015
Cable	RU	214-N	E1T2	12/2014	12/2015

Notes: HP is an abbreviation for Hewlett Packard.
AR is an abbreviation for Amplifier Research.
R&S is an abbreviation for Rohde & Schwarz.
Ca. Inst. is and abbreviation for California Instruments
N/A is an abbreviation for Not Applicable.
The above equipment is traceable to NVLAP calibration standards.

2.3. Measurement Procedures Utilized for Emissions Testing

2.3.1. Pre-Testing

Prior to taking the formal emissions data comprehensive pre-testing has been performed. The selection of the worst case system documented in this report was based upon this pre-testing.

Pre-Testing Component List

Component Type	Vendor	Part No
Apple Watch Magnetic Charging Cable (EUT)	Apple, Inc.	A1598
Apple Watch 42MM	Apple, Inc.	A1554
Apple Watch 38MM	Apple, Inc.	A1553
Stainless Steel Link Bracelet	Apple, Inc.	N/A
Stainless Steel Milanese Loop	Apple, Inc.	N/A
Fluoroelastomer Sport Band	Apple, Inc.	N/A
Classic Buckle Leather Band	Apple, Inc.	N/A
Modern Buckle Leather Band	Apple, Inc.	N/A
Leather Loop	Apple, Inc.	N/A
Apple MacBook Pro 15”	Apple, Inc.	A1286
Apple MagSafe Power Adapter	Apple, Inc.	A1343
Apple ac Power Adapter (US)	Apple, Inc.	A1385

2.3.2. Measurement Procedures Utilized for Conducted Emissions

The EUT was placed on a non-metallic table, 80 cm above the floor. Power to the EUT was supplied through 50 μH LISNs bonded to the ground-plane 80 centimeters from the EUT. The ground-plane was electrically bonded to the shield room ground system and all power-lines entering the shielded room were filtered. Mains power was supplied for various voltage levels and power-line frequencies. A more detailed description can be found in procedure document 080-0811 on file at Apple, Inc.

2.3.3. Measurement Procedures Utilized for Radiated Emissions

The EUT was placed on a non-metallic table, 80 cm above the metallic ground-plane. The EUT and peripherals were powered from a filtered main supply.

The frequency spectrum from 30 MHz to ≤ 1000 MHz was scanned and the emission levels maximized at each frequency recorded. The antenna was varied in height between 1.0 and 4.0 meters and the system was rotated 360 degrees while scanning for maximum emission amplitudes. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

During maximization the position of the cables was varied and the scanning repeated until the worst-case emission was found. The data recorded in this report are the maximum emission levels measured. A more detailed description can be found in procedure document 080-0811 on file at Apple, Inc.

2.4. Radiated Emissions Measurement Distance

FCC Part 15 measurements were performed at an EUT to antenna distance of 3 meters. Optionally as may be indicated in the report the FCC data may be taken at 10 meters as allowed by the FCC. CISPR 22 measurements were performed at an EUT to antenna distance of 10 meters.

2.5. Emissions Measurement Uncertainty

The measurement uncertainty (see Apple procedure 080-0835) has been determined to be the following:

Emissions Tests	Frequency Range	Polarization	Measurement Uncertainties
Conducted	150 kHz – 30 MHz		3.50 dB
Radiated	30 – 200MHz	Horizontal	4.48 dB
Radiated	30 – 200MHz	Vertical	4.60 dB
Radiated	0.2 – 1 GHz	Horizontal	4.60 dB
Radiated	0.2 – 1 GHz	Vertical	4.60 dB

In Apple procedure 080-0835 the uncertainty has been calculated in accordance with CISPR 16-4-2:2003. Measurement uncertainty is not used in determining pass / fail criteria of the EUT.

2.6. Related Submittals and Grants of Certification

None.

2.7. EUT Exercise Software

The Apple Watch Magnetic Charging Cable was tested using the preloaded firmware, which charges the Apple Watch after authentication. The radiated and conducted emissions measurements were made while the system was exercised in this manner.

2.8. Special Accessories

There were no special accessories used during these tests.

2.9. Equipment Modifications and Deviations

The Apple Watch Magnetic Charging Cable achieved compliance with the FCC CFR47 Part 15, ICES-003, CAN/CSA-CEI/IEC CISPR 22, CISPR 22, with no modifications.

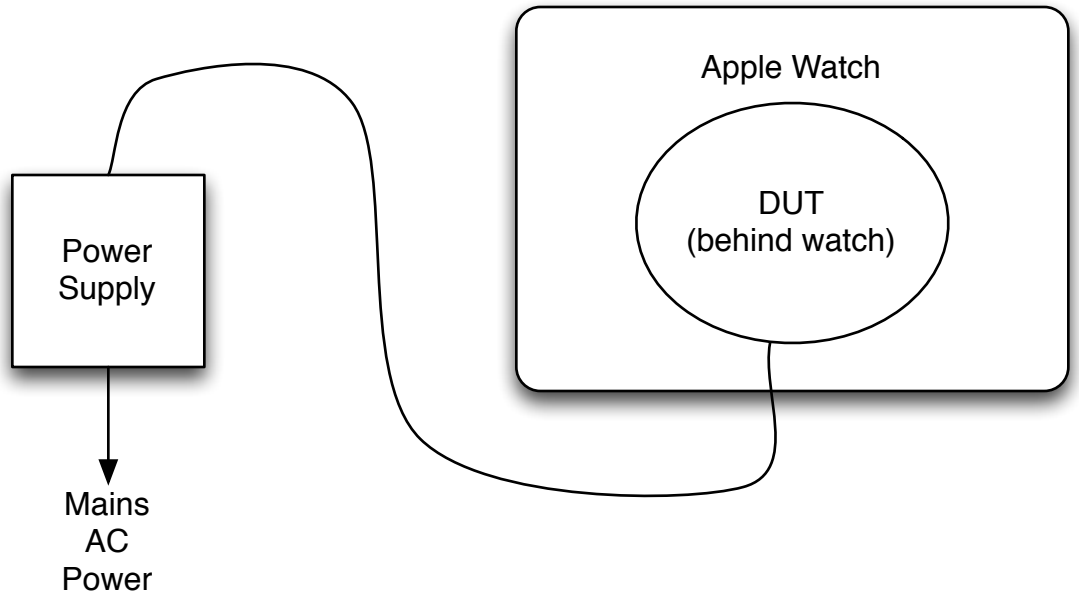
2.10. EUT Test Configuration

The EUT was tested in the worst-case mode as determined from the pre-testing described in section 2.3.1.

Final Testing (worst case) EUT Description

Component	Vendor	Part Number
Apple Watch Magnetic Charging Cable	Apple	A1598
Apple Watch 42MM	Apple	A1554
Stainless Steel Link Bracelet	Apple	N/A
Apple ac Power Adapter (Int.)	Apple, Inc.	A1400

Diagram of Test Configuration



Equipment Key

	Description	Model No
1	Apple Watch Magnetic Charging Cable (DUT)	A1598
2	Apple Watch	A1554
3	Apple AC Adapter (Int.)	A1400

2.11. Test Setup Photos

2.11.1. Conducted and Radiated Emissions Test Setup Photos

See Appendix D

2.12. Emissions Data

2.12.1. Conducted Emissions Data

The following data was collected with a spectrum analyzer in Peak detection mode, unless otherwise noted. Test Date: 12 February 2015.

CISPR 110VAC 60Hz Mains

Frequency (MHz)	Measured Line 1 (dBμV)	Agency Limit (dBμV)	Frequency (MHz)	Measured Line 2 (dBμV)	Agency Limit (dBμV)
0.654	27.4 QP	56.0	0.548	37.3 QP	56.0
0.654	27.3 Av	46.0	0.548	28.9 Av	46.0
0.978	31.3 QP	56.0	0.978	36.3 QP	56.0
0.978	25.3 Av	46.0	0.978	28.5 Av	46.0
2.285	24.7 QP	56.0	2.285	21.6 QP	56.0
2.285	23.7 Av	46.0	2.611	20.1 Av	46.0

Note: Conducted emissions data was also taken at 100VAC, 60Hz. This data was found to be equivalent or lower than the data listed above.

Conducted Emissions Environmental Conditions

	EUT Location	Measurement Equipment Location
Temperature	26.1°C	26.1°C
Humidity	41%	41%

CISPR 240VAC 50Hz Mains

Frequency (MHz)	Measured Line 1 (dBμV)	Agency Limit (dBμV)	Frequency (MHz)	Measured Line 2 (dBμV)	Agency Limit (dBμV)
0.654	28.2 QP	56.0	0.276	33.3 QP	60.9
0.654	27.3 Av	46.0	0.325	23.5 Av	49.6
0.980	26.2 QP	56.0	0.697	31.1 QP	56.0
0.980	23.9 Av	46.0	0.654	27.8 Av	46.0
2.285	24.5 QP	56.0	1.093	28.9 QP	56.0
2.285	23.8 Av	46.0	1.095	23.9 Av	46.0

Note: Conducted emissions data was also taken at 220VAC, 60Hz. This data was found to be equivalent to or lower than the data listed above.

Conducted Emissions Environmental Conditions

	EUT Location	Measurement Equipment Location
Temperature	26.1°C	26.1°C
Humidity	41%	41%

2.12.2. FCC Radiated Emissions Test Data

The following data was collected at a 10 meter distance with a spectrum analyzer in peak detection mode, unless otherwise noted. Test Date: 12 February 2015.

FCC Radiated Emissions - 110VAC 60 Hz Mains
Vertical Polarization

Frequency	Corrected Level (dBμV/m)	Limit (dBμV)	Measured Value (dBμV)	Antenna Factor (dB/m)	Cable Factor	Amplifier Gain (dB)
37.76	20.6	30.0	36.16	15.22	2.01	32.78
100.49	17.2	30.0	36.46	10.15	2.93	32.36
146.72	16.3	30.0	32.48	12.53	3.50	32.19
185.85	14.7	30.0	31.76	11.20	3.86	32.14
501.10	20.8	37.0	28.40	17.72	7.03	32.30
547.98	21.2	37.0	28.32	17.78	7.46	32.41

Horizontal Polarization

Frequency	Corrected Level (dBμV/m)	Limit (dBμV)	Measured Value (dBμV)	Antenna Factor (dB/m)	Cable Factor	Amplifier Gain (dB)
31.94	16.8	30.0	27.45	20.58	1.47	32.74
127.00	12.0	30.0	35.04	7.53	2.02	32.62
512.09	19.1	37.0	36.17	11.37	3.59	31.99
555.74	18.1	37.0	35.39	11.16	3.77	32.18
597.45	18.9	37.0	36.67	10.57	3.90	32.21
646.92	20.8	37.0	37.53	11.33	4.06	32.07

Note: Radiated emissions data was also taken at 100VAC, 60Hz. This data was found to be equivalent to or lower than the data listed above.

Radiated Emissions Environmental Conditions

	EUT Location	Measurement Equipment Location
Temperature	20.6 °C	20.6 °C
Humidity	43%	43%

2.12.3. FCC Compliance Summary

The Apple Watch Magnetic Charging Cable has met the B requirements as specified in CFR47, Part 15, Subpart B for unintentional radiators.

2.12.4. NVLAP Note

Although the data in this report has been obtained at a NVLAP accredited facility, the United States Government does not certify, approve, or endorse the product described herein.

3. Appendix A

Revision History Sheet

Test Report No	2873
Model No	A1598
Model Name	Apple Watch Magnetic Charging Cable
Responsible Engineer	John Mosy
Original Signature Date	12 February 2015

Revision History

Test Report No	Revision Description	Date

Notes:

1. Appendix C documents the original test report and all amendments to the test report. The serial number of the report is the Apple File Number printed on each page of the report. Amended reports will show the Apple File Number and are denoted with a dash (-) followed by the revision letter designation.

2. Revisions or amendments to the Test Report will include the statement
" Supplement to the Test Report" in the Revision Description.

3. This report was generated using EMC Report Template 040414-ITE

4. Appendix B

EMC Control Components

Item	Location	Manufacturer	Part No	QTY
Ferrite Bead	MLB	Superworld Electronics	155S0699	1
Ferrite Bead	MLB	Taiyo Yuden Co	155S0824	1
Common Mode Choke	MLB	Taiyo Yuden Co	155S00007	1
Transient Suppressor	MLB	On Semiconductor	377S00016	1
Transient Suppressor	MLB	Texas Instruments	377S00005	2
Transient Suppressor	MLB	On Semiconductor	377S00022	2