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MEASUREMENT REPORT FCC PART 15.225 / ISED RSS-210 NFC

Applicant Name:

Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:

07/19/2019 - 07/26/2019

Test Site/Location:

PCTEST Lab. Morgan Hill, CA, USA

Test Report Serial No.:

1C1907170019.BCG

| | |
|-------------------|-------------------|
| FCC ID: | BCG-A2207 |
| IC: | 579C-A2207 |
| APPLICANT: | Apple Inc. |

Application Type:

Certification

Model/HVIN:

A2207

EUT Type:

Security Switch for Retail Security

Frequency:

13.56MHz

FCC Classification:

Low Power Communications Device Transmitter (DXX)

FCC Rule Part(s):

Part 15 Subpart C (15.225)

ISED Specification:

RSS-210 Issue 9

Test Procedure(s):

ANSI C63.10-2013

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President



| | | | |
|---|---|---|--|
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1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.1 PCTEST Test Location

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.2 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Morgan Hill, CA 95037, U.S.A.

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Security Switch for Retail Security FCC ID: BCG-A2207**. The test data contained in this report pertains only to the emissions due to the NFC transmitter of the EUT.

Test Device Serial No.: FV4R027MTL3

2.2 Device Capabilities

This device contains the following capabilities:

NFC

2.3 Test Support Equipment

| | | | | |
|---|---------------------|--------------|------|--------------|
| | | | | |
| 1 | Central Module | Model: A2206 | S/N: | FV4YP064MTL6 |
| | | | | |
| 2 | Apple CAN Bus Cable | Model: X2004 | S/N: | N/A |

Table 2-1. Test Support Equipment Used

2.4 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

2.5 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

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3.0 DESCRIPTION OF TEST

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) was used in the measurement of the EUT.

Deviation from measurement procedure.....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is EPCOS 2X60A Power Line Filter (100dB Attenuation, 14kHz-18GHz) and the two EPCOs 2X48A filters (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.6. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.35.1.

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3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

Per KDB 414788, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was rotated about its vertical axis while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

| | | | |
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4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

- The antenna of the EUT are **permanently attached**.
- This unit was tested while powered by a DC power source.

Conclusion:

The EUT complies with the requirement of §15.203.

| | | | |
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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

| Contribution | Expanded Uncertainty (\pm dB) |
|------------------------------|----------------------------------|
| Line Conducted Disturbance | 2.48 |
| Radiated Disturbance (<1GHz) | 4.15 |

| | | | |
|--------------------------------------|---|--|---------------------------------|
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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|----------------------|----------|----------------------------------|------------|--------------|------------|---------------|
| Agilent Technologies | N9030A | 3Hz-44GHz PXA Signal Analyzer | 3/13/2019 | Annual | 3/13/2020 | MY49430244 |
| COM-POWER | LIN-120A | LISN | 3/13/2019 | Annual | 3/13/2020 | 241297 |
| ESPEC | SU-241 | Table Top Temperature Chamber | 8/10/2018 | Annual | 8/10/2019 | 92009574 |
| ETS-Lindgren | 118490 | Pre-Amplifier (30MHz - 6GHz) | 8/31/2018 | Annual | 8/31/2019 | 213236 |
| ETS-Lindgren | 3142E | BiConiLog Antenna (30MHz - 6GHz) | 12/11/2018 | Annual | 12/11/2019 | 224569 |
| Rohde & Schwarz | ESW44 | EMI Test Receiver | 11/20/2018 | Annual | 11/20/2019 | 101570 |
| Rohde & Schwarz | HFH2-Z2 | Loop Antenna | 3/21/2019 | Annual | 3/21/2020 | 100519 |

Table 6-1. Annual Test Equipment Calibration Schedule

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.0 TEST DATA

7.1 Summary

Company Name: Apple Inc.
 FCC ID: BCG-A2207
 FCC Classification: Low Power Communications Device Transmitter (DXX)
 Frequencies Examined: 13.56MHz

| FCC Part Section(s) | RSS Section(s) | Test Description | Test Limit | Test Condition | Test Result | Reference |
|----------------------|----------------|--|---|---------------------|-------------|-------------|
| 2.1049 | RSS-Gen [6.6] | Occupied Bandwidth | N/A | RADIATED | PASS | Section 7.2 |
| 15.225 (a)(b)(c) | RSS-210 [B.6] | In-Band Emissions | 15,848µV/m @ 30m 13.553 – 13.567 MHz 334µV/m @ 30m 13.410 – 13.553 MHz 13.567 – 13.710 MHz 106µV/m @ 30m 13.110 – 13.410 MHz 13.710 – 14.010 MHz | | PASS | Section 7.4 |
| 15.225 (d) 15.209 | RSS-Gen [8.9] | Out-of-Band Emissions | Emissions outside of the specified band (13.110 – 14.010 MHz) must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9]) | | PASS | Section 7.5 |
| 15.225 (e) | RSS-210 [B.6] | Frequency Stability Tolerance | ± 0.01% of Operating Frequency | Temperature Chamber | PASS | Section 7.3 |
| 15.207 | RSS-Gen [8.8] | AC Conducted Emissions 150kHz – 30MHz | < FCC 15.207 limits (RSS-Gen) | LINE CONDUCTED | PASS | Section 7.6 |

Table 7-1. Summary of Test Results

Note:

This unit was tested while powered by a DC power source.

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.2 20dB Bandwidth Measurement

§2.1049; RSS-Gen (6.7)

Test Overview and Limit

The occupied bandwidth is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequency.

Test Procedure Used

ANSI C63.10-2013 – Section 6.9.2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 20dB bandwidth measurement. The "X" dB bandwidth parameter was set to $X = 20$. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission
2. $RBW = 1 - 5\% \text{ OBW}$
3. $VBW \geq 3 \times RBW$
4. Reference level set to keep signal from exceeding maximum input mixer level for linear operation.
5. Detector = Peak
6. Trace mode = max hold
7. Sweep = auto couple
8. The trace was allowed to stabilize

Test Notes

None.

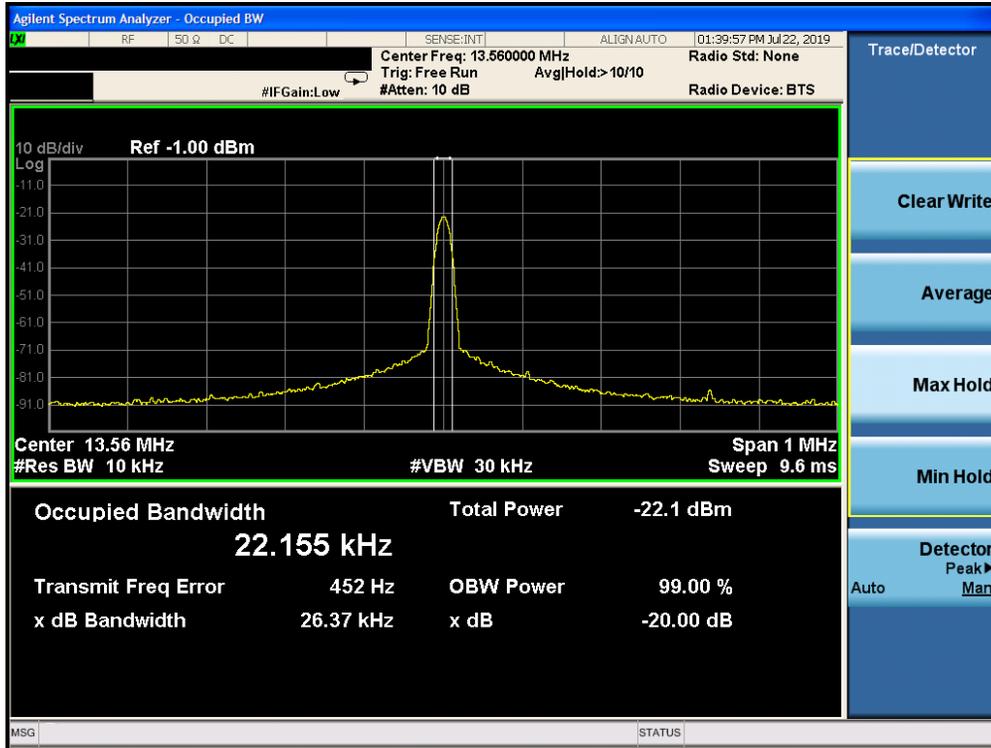


Figure 7-1. Test Instrument & Measurement Setup

| | | | |
|--------------------------------------|---|--|---------------------------------|
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| Frequency | 20dB Bandwidth |
|-----------|----------------|
| 13.56MHz | 26.37kHz |

Table 7-2. 20dB Bandwidth Measurement



Plot 7-1. 20dB Bandwidth Plot

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.3 Frequency Stability Test Data

§15.225; RSS-210 (B.6)

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.10-2013. The frequency stability of the transmitter is measured by:

- a.) **Temperature:** The temperature is varied from -20°C to +50°C in 10°C increments using an environmental chamber.
- b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

For Part 15.225, the frequency stability of the transmitter shall be maintained within ±0.01% of the center frequency.

Test Procedure Used

ANSI C63.10-2013 – Section 6.8

Test Settings

1. The carrier frequency of the transmitter is measured at room temperature (20°C to provide a reference).
2. The equipment is turned on in a “standby” condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3. Frequency measurements are made at 10°C intervals ranging from -20°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Test Setup



Figure 7-2. Test Instrument & Measurement Setup

Test Notes

None.

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Frequency Stability Test Data

§15.225; RSS-210 (B.6)

OPERATING FREQUENCY: 13,560,000 Hz
 REFERENCE VOLTAGE: 5.00 VDC
 DEVIATION LIMIT: ± 0.01 % = 1356Hz

| VOLTAGE (%) | POWER (VDC) | TEMP (°C) | FREQUENCY (Hz) | Freq. Dev. (Hz) | Deviation (%) |
|----------------|-------------|-----------|----------------|-----------------|---------------|
| 100 % | 5.00 | - 20 | 13,560,189 | 189 | 0.0013939 |
| 100 % | | - 10 | 13,559,609 | -391 | -0.0028836 |
| 100 % | | 0 | 13,559,609 | -391 | -0.0028836 |
| 100 % | | + 10 | 13,559,609 | -391 | -0.0028836 |
| 100 % | | + 20 | 13,559,899 | -101 | -0.0007449 |
| 100 % | | + 30 | 13,559,899 | -101 | -0.0007449 |
| 100 % | | + 40 | 13,560,101 | 101 | 0.0007449 |
| 100 % | | + 50 | 13,560,101 | 101 | 0.0007449 |
| BATT. ENDPOINT | 4.50 | + 20 | 13,560,391 | 391 | 0.0028836 |

Table 7-3. Frequency Stability Test Data

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Frequency Stability Test Data
§15.225; RSS-210 (B.6)

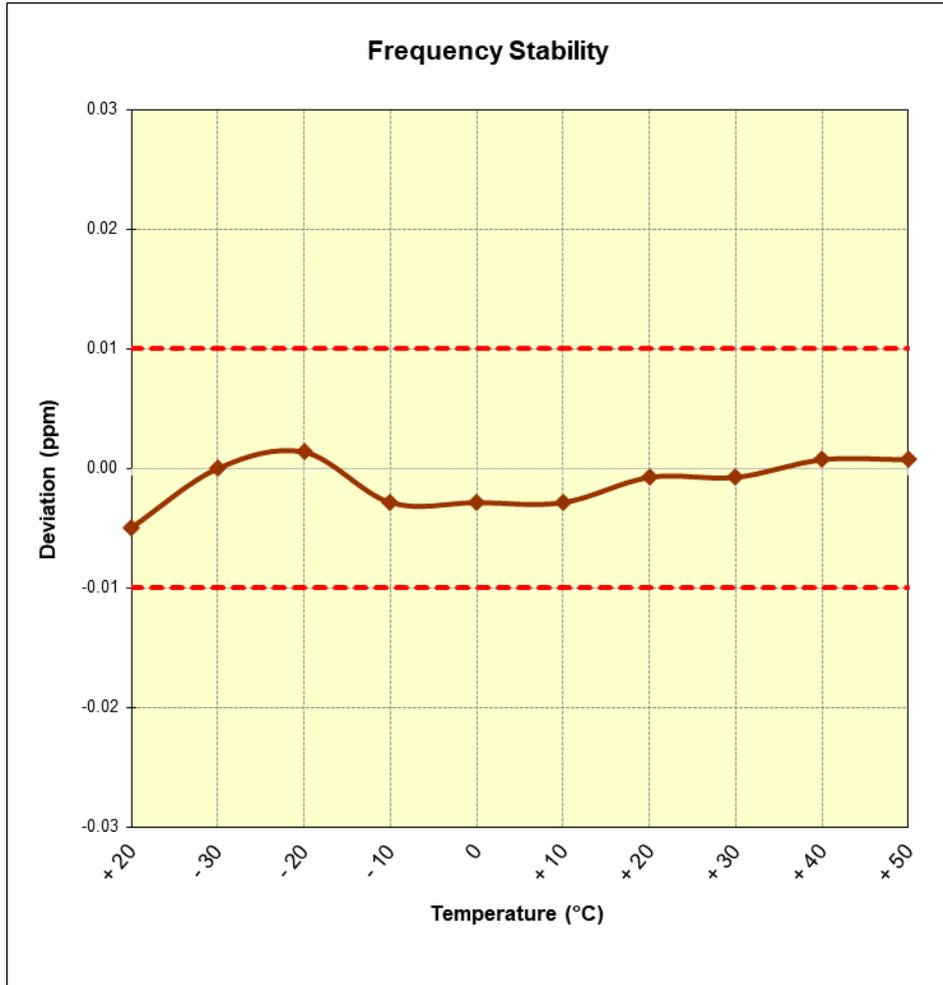


Figure 7-3. Frequency Stability Plot

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.4 In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c); RSS-210 (B.6)

Test Overview and Limit

The EUT was tested from 13.110 – 14.010 MHz. All in-band radiated spurious emissions are measured with a spectrum analyzer connected to a loop antenna while the EUT is operating at appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All in-band emissions appearing in a restricted band as specified in Section 15.225 of the Title 47 CFR must not exceed the limits shown in Table 7-4.

| Frequency [MHz] | Field Strength [$\mu\text{V/m}$] | Measured Distance [Meters] |
|--|------------------------------------|----------------------------|
| 13.553-13.567 MHz | 15,848 | 30 |
| 13.410-13.553 MHz and 13.567-13.710 MHz | 334 | 30 |
| 13.110-13.410 MHz and 13.710-14.010 MHz | 106 | 30 |

Table 7-4. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Section 6.4.7

Test Settings

1. RBW = 9kHz
2. VBW $\geq 3 \times$ RBW
3. Detector = peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

| | | | |
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Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

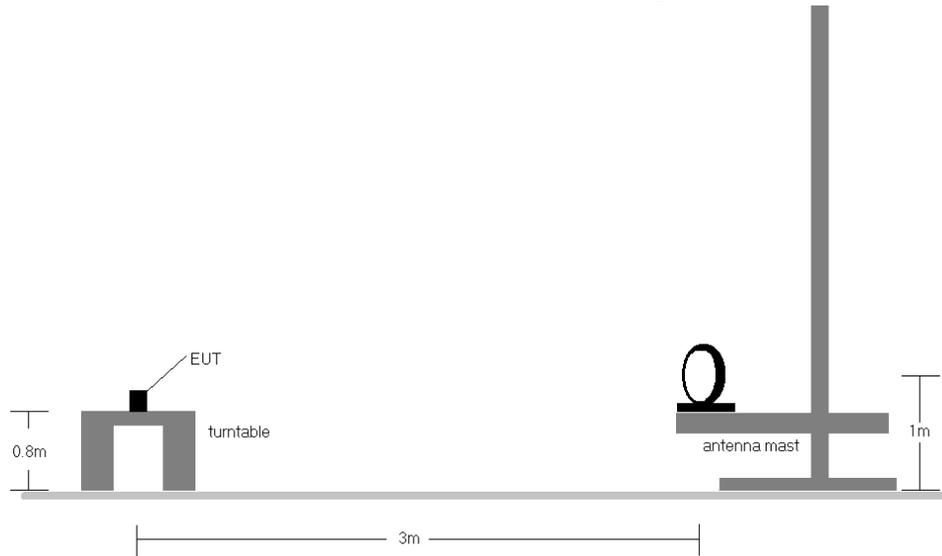


Figure 7-4. Radiated Test Setup

Test Notes:

1. All emissions lying in restricted bands specified in §15.225 and RSS-210 are below the limit shown in Table 7-4.
2. All measurements were performed using a loop antenna. The antenna was positioned in three orthogonal positions (X front, Y side, Z top) and the position with the highest emission level was recorded.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2). Extrapolation Factor = $20 \log_{10}(30/3)^2 = 40\text{dB}$.
5. The spectrum was investigated from 9kHz up to 30MHz using the loop antenna. Only the emissions shown in the table below were found to be significant.
6. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector.
7. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

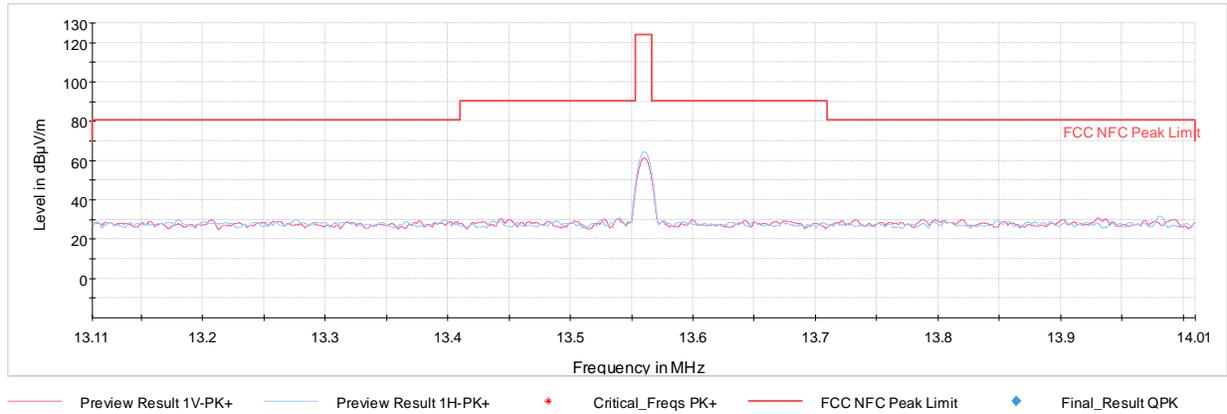
Sample Calculation

- Field Strength Level $[\text{dB}\mu\text{V}/\text{m}] = \text{Analyzer Level} [\text{dBm}] + 107 + \text{AFCL} [\text{dB}/\text{m}]$
- $\text{AFCL} [\text{dB}/\text{m}] = \text{Antenna Factor} [\text{dB}/\text{m}] + \text{Cable Loss} [\text{dB}]$
- $\text{Margin} [\text{dB}] = \text{Field Strength Level} [\text{dB}\mu\text{V}/\text{m}] - \text{Limit} [\text{dB}\mu\text{V}/\text{m}]$

| | | | |
|--------------------------------------|---|--|---------------------------------|
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In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c); RSS-210 (B.6)



Plot 7-2. In Band Radiated Spurious Plot

Frequency: 13.56MHz

Measurement Distance: 3 Meters

| Frequency [MHz] | Detector | Ant. Pol. [X/Y/Z] | Antenna Height [cm] | Turntable Azimuth [degree] | Level [dBm] | AFCL [dB/m] | 3m Field Strength [dBµV/m] | 30m Field Strength [dBµV/m] | Limit [µV/m] | Limit [dBµV/m] | Margin [dB] |
|-----------------|----------|-------------------|---------------------|----------------------------|-------------|-------------|----------------------------|-----------------------------|--------------|----------------|-------------|
| 13.180 | Max Peak | X | 100 | 182 | -98.04 | 20.93 | 29.89 | -10.11 | 106.00 | 40.51 | -50.62 |
| 13.443 | Max Peak | X | 100 | 291 | -97.62 | 20.94 | 30.32 | -9.68 | 334.00 | 50.47 | -60.15 |
| 13.560 | Max Peak | X | 100 | 303 | -63.32 | 20.94 | 64.62 | 24.62 | 15848.00 | 84.00 | -59.38 |
| 13.600 | Max Peak | X | 100 | 75 | -98.35 | 20.95 | 29.60 | -10.40 | 334.00 | 50.47 | -60.87 |
| 13.981 | Max Peak | X | 100 | 79 | -96.16 | 20.96 | 31.80 | -8.20 | 106.00 | 40.51 | -48.71 |

Table 7-5. In-Band Radiated Measurements

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.5 Radiated Spurious Emission Measurements, Out-of-Band

§15.209 §15.225(d); RSS-Gen (8.9)

Test Overview and Limit

The EUT was tested from 9kHz up to the 1GHz excluding the band 13.110 – 14.010 MHz. All measurements up to 960MHz were recorded with a spectrum analyzer employing a quasi-peak detector.

All out-of-band emissions appearing in a restricted band as specified in Section 15.225 of the Title 47 CFR must not exceed the limits shown in Table 7-6 per Section 15.209.

| Frequency | Field Strength [$\mu\text{V/m}$] | Measured Distance [Meters] |
|-------------------|---------------------------------------|-------------------------------|
| 0.009 – 0.490 MHz | 2400/F (kHz) | 300 |
| 0.490 – 1.705 MHz | 24000/F (kHz) | 30 |
| 1.705 – 30.00 MHz | 30 | 30 |
| 30.00 – 88.00 MHz | 100 | 3 |
| 88.00 – 216.0 MHz | 150 | 3 |
| 216.0 – 960.0 MHz | 200 | 3 |
| Above 960.0 MHz | 500 | 3 |

Table 7-6. Radiated Limits – Out of band

Test Procedures Used

ANSI C63.10-2013 – Section 6.5.4

Test Settings

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 9kHz for emissions below 30MHz and 100kHz for emissions between 30MHz and 1GHz
3. VBW $\geq 3 \times$ RBW
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

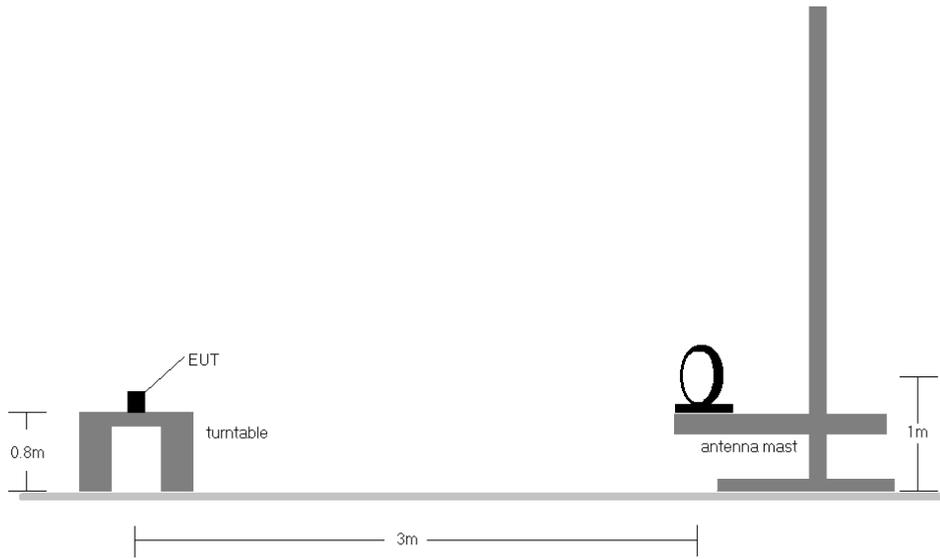


Figure 7-5. Radiated Test Setup < 30MHz

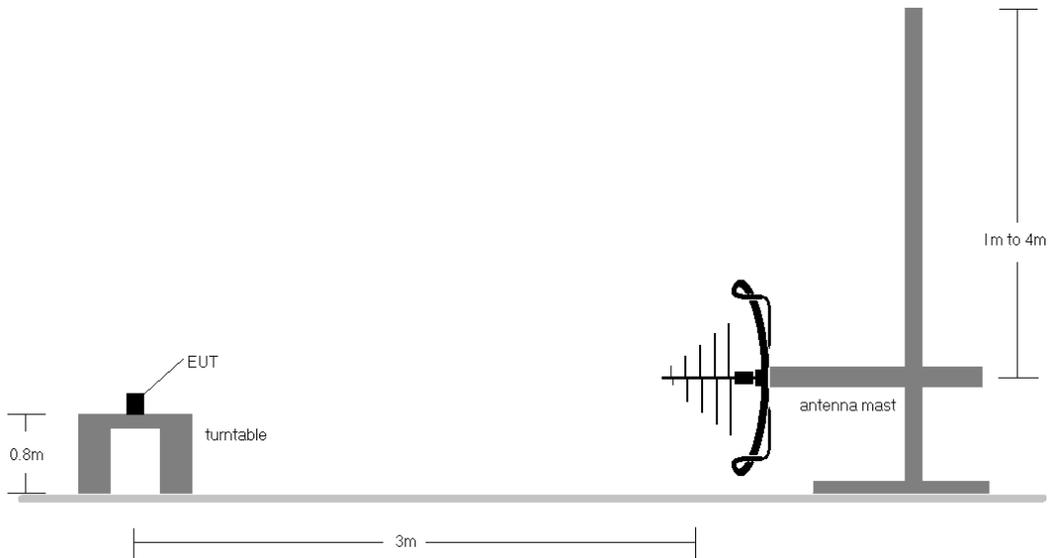


Figure 7-6. Radiated Test Setup > 30MHz

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Test Notes:

1. A loop antenna was used to investigate emissions below 30MHz.
2. Both Vertical and Horizontal polarities of the receive antenna were evaluated with the worst case emissions being reported. Below 30MHz the loop antenna was positioned in 3 orthogonal planes (X front, Y side, Z top) to determine the orientation resulting in the worst case emissions.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
5. No spurious emissions levels were found to be greater than the level of the fundamental.
6. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

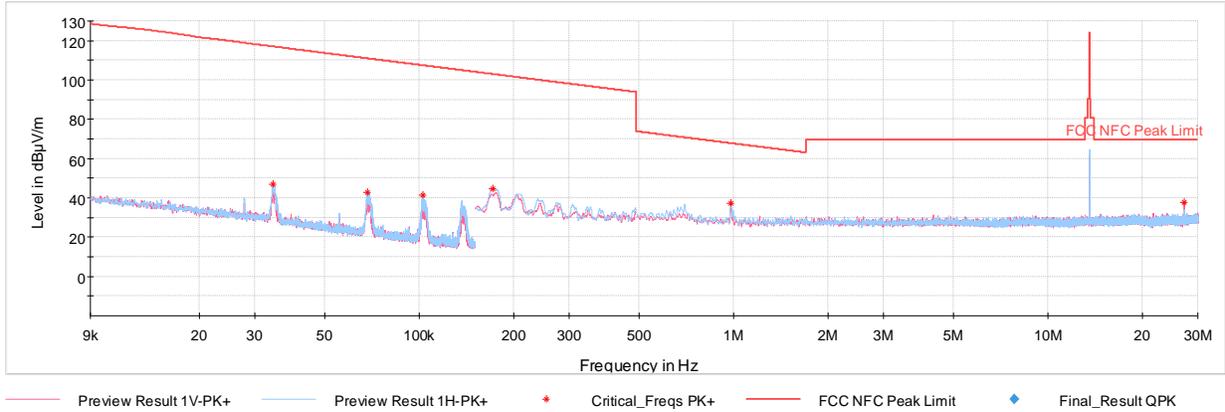
Sample Calculation

- Field Strength Level [dB μ V/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
- Margin [dB] = Field Strength Level [dB μ V/m] – Limit [dB μ V/m]

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Radiated Spurious Emission Measurements, Out-of-Band

§15.209 §15.225(d); RSS-Gen (8.9)



Plot 7-3. Radiated Spurious Plot 9kHz – 30MHz

Tx Frequency 13.56MHz

Measurement Distance: 3 Meters

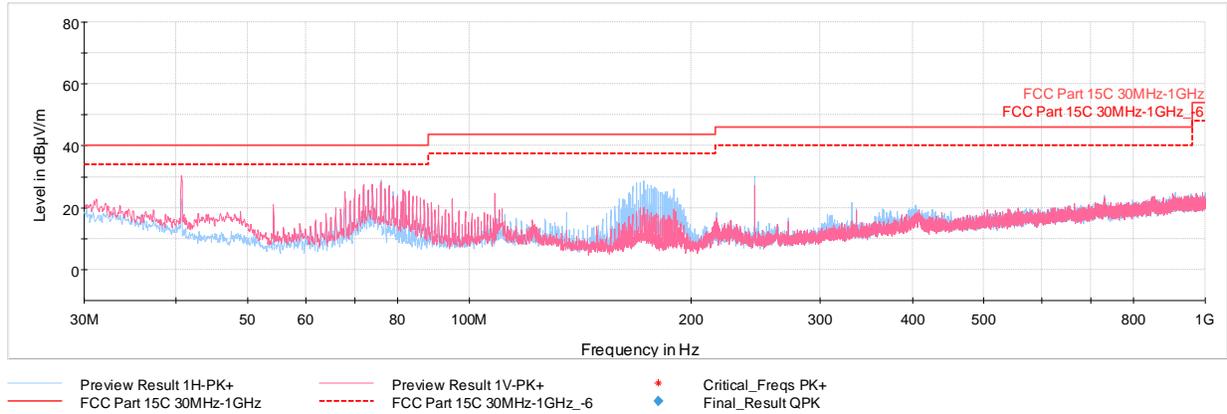
| Frequency [MHz] | Detector | Ant. Pol. [X/Y/Z] | Antenna Height [cm] | Turntable Azimuth [degree] | Level [dBm] | AFCL [dB/m] | 3m Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|-----------------|----------|-------------------|---------------------|----------------------------|-------------|-------------|----------------------------|----------------|-------------|
| 0.03 | Max Peak | X | 100 | 275 | -80.12 | 20.00 | 46.88 | 117.00 | -70.12 |
| 0.07 | Max Peak | X | 100 | 162 | -83.33 | 19.00 | 42.67 | 110.88 | -68.21 |
| 0.10 | Max Peak | X | 100 | 275 | -84.57 | 19.00 | 41.43 | 107.39 | -65.96 |
| 0.17 | Max Peak | X | 100 | 164 | -81.39 | 19.00 | 44.61 | 102.94 | -58.33 |
| 0.98 | Max Peak | X | 100 | 251 | -89.85 | 20.00 | 37.15 | 67.78 | -30.63 |
| 27.12 | Max Peak | X | 100 | 82 | -92.51 | 23.00 | 37.49 | 69.54 | -32.05 |

Table 7-7. Radiated Measurements 9kHz – 30MHz

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Radiated Spurious Emission Measurements, Out-of-Band

§15.209 §15.225(d); RSS-Gen (8.9)



Plot 7-4. Radiated Spurious Plot 30MHz – 1GHz

Tx Frequency 13.56MHz

Measurement Distance: 3 Meters

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Level [dBm] | AFCL [dB/m] | 3m Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|-----------------|----------|-----------------|---------------------|----------------------------|-------------|-------------|----------------------------|----------------|-------------|
| 40.67 | Max Peak | V | 100 | 201 | -61.75 | -14.72 | 30.53 | 40.00 | -9.47 |
| 75.93 | Max Peak | H | 250 | 129 | -59.14 | -19.11 | 28.75 | 40.00 | -11.25 |
| 108.47 | Max Peak | V | 100 | 303 | -65.16 | -17.30 | 24.54 | 43.52 | -18.98 |
| 172.78 | Max Peak | H | 100 | 269 | -62.39 | -16.10 | 28.51 | 43.52 | -15.01 |
| 244.08 | Max Peak | H | 100 | 251 | -59.48 | -17.33 | 30.19 | 46.02 | -15.83 |
| 330.80 | Max Peak | H | 250 | 306 | -70.87 | -14.60 | 21.53 | 46.02 | -24.49 |

Table 7-8. Radiated Measurements 30MHz – 1GHz

| | | | |
|--------------------------------------|---|--|---------------------------------|
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7.6 AC Line Conducted Measurement Data

§15.207; RSS-Gen (8.8)

Test Overview and Limit

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207 and RSS-Gen (8.8).

| Frequency of emission (MHz) | Conducted Limit (dB μ V) | |
|-----------------------------|------------------------------|-----------|
| | Quasi-peak | Average |
| 0.15 – 0.5 | 66 to 56* | 56 to 46* |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

Table 7-9. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

| | | | |
|---|---|---|--|
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Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

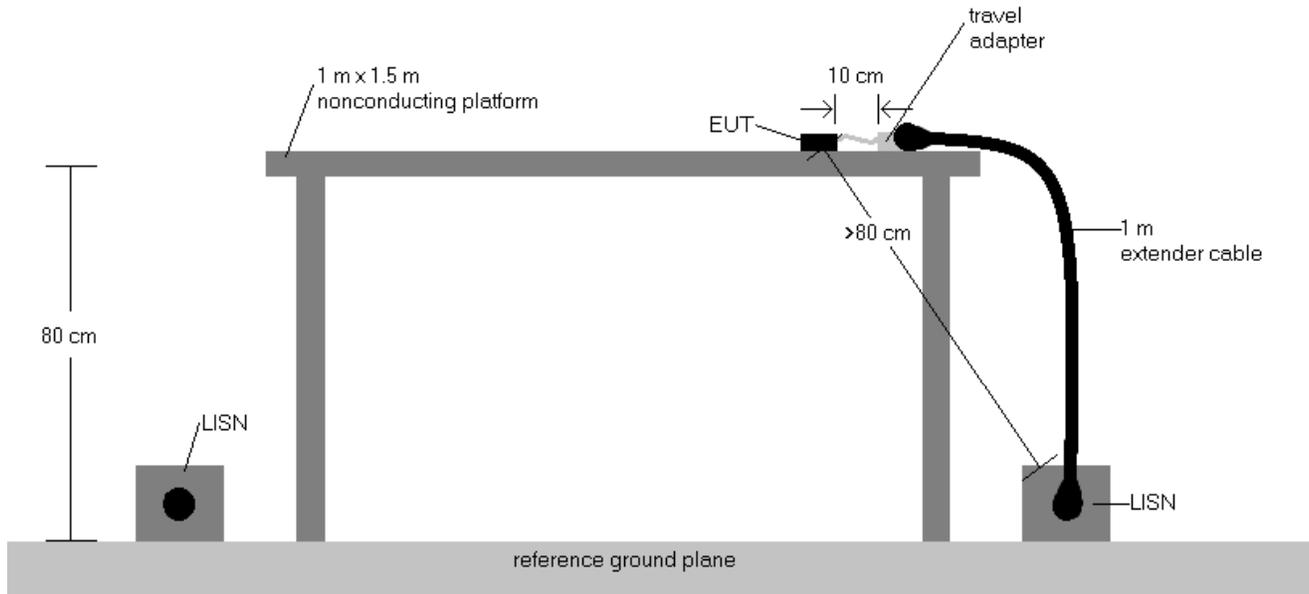
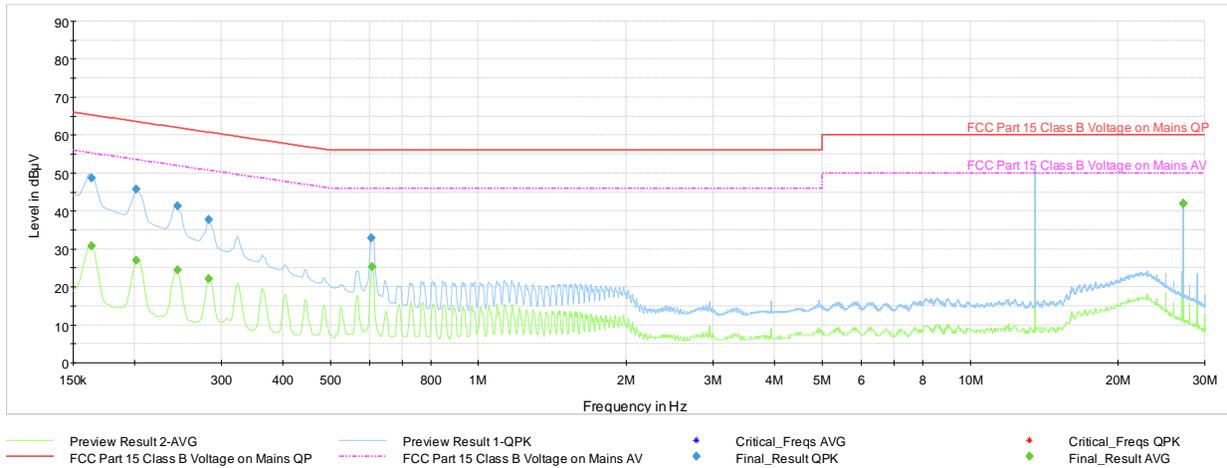


Figure 7-7. Test Instrument & Measurement Setup

Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207 and RSS-Gen (8.8).
3. $\text{Corr. (dB)} = \text{Cable loss (dB)} + \text{LISN insertion factor (dB)}$
4. $\text{QP/AV Level (dB}\mu\text{V)} = \text{QP/AV Analyzer/Receiver Level (dB}\mu\text{V)} + \text{Corr. (dB)}$
5. $\text{Margin (dB)} = \text{QP/AV Limit (dB}\mu\text{V)} - \text{QP/AV Level (dB}\mu\text{V)}$
6. Traces shown in plot are made using Quasi Peak and Average detectors.
7. Deviations to the Specifications: None.

| | | | |
|--------------------------------------|---|--|---------------------------------|
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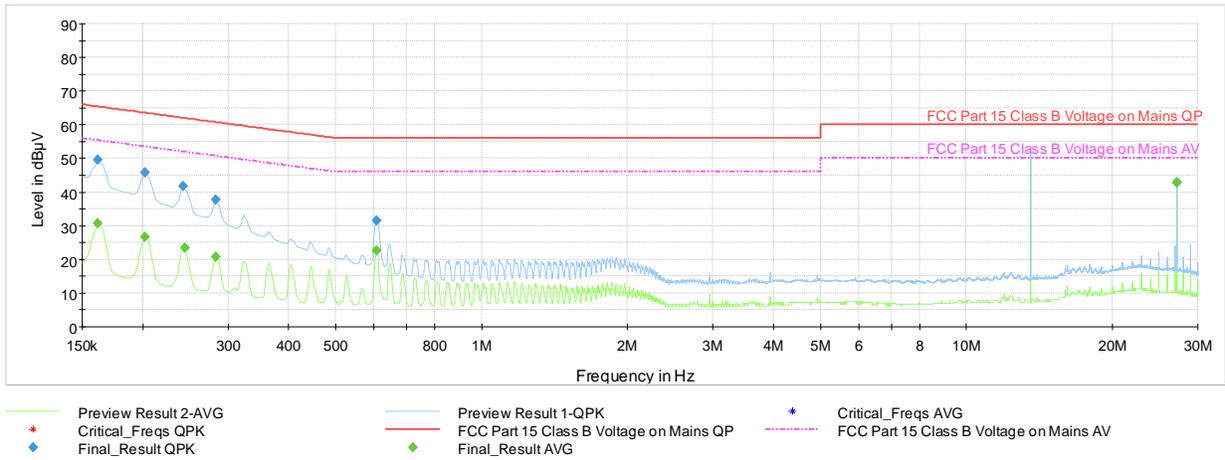


Plot 7-5. Line-Conducted Test Plot (L1)

| Frequency [MHz] | Process State | QuasiPeak [dBµV] | Average [dBµV] | Limit [dBµV] | Margin [dB] | Line | PE |
|-----------------|---------------|------------------|----------------|--------------|-------------|------|-----|
| 0.164 | FINAL | — | 30.77 | 55.28 | -24.51 | L1 | GND |
| 0.164 | FINAL | 48.8 | — | 65.28 | -16.51 | L1 | GND |
| 0.202 | FINAL | — | 26.96 | 53.54 | -26.58 | L1 | GND |
| 0.202 | FINAL | 45.7 | — | 63.54 | -17.84 | L1 | GND |
| 0.245 | FINAL | — | 24.50 | 51.94 | -27.44 | L1 | GND |
| 0.245 | FINAL | 41.2 | — | 61.94 | -20.73 | L1 | GND |
| 0.283 | FINAL | 37.8 | — | 60.74 | -22.93 | L1 | GND |
| 0.283 | FINAL | — | 22.16 | 50.74 | -28.58 | L1 | GND |
| 0.605 | FINAL | 32.9 | — | 56.00 | -23.11 | L1 | GND |
| 0.607 | FINAL | — | 25.25 | 46.00 | -20.75 | L1 | GND |
| 27.121 | FINAL | — | 41.91 | 50.00 | -8.09 | L1 | GND |
| 27.121 | FINAL | 42.0 | — | 60.00 | -17.98 | L1 | GND |

Table 7-10. Line-Conducted Test Data (L1)

| | | | |
|--------------------------------------|---|--|---------------------------------|
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Plot 7-6. Line-Conducted Test Plot (N)

| Frequency [MHz] | Process State | QuasiPeak [dBµV] | Average [dBµV] | Limit [dBµV] | Margin [dB] | Line | PE |
|-----------------|---------------|------------------|----------------|--------------|-------------|------|-----|
| 0.161 | FINAL | — | 30.76 | 55.40 | -24.64 | N | GND |
| 0.161 | FINAL | 49.6 | — | 65.40 | -15.76 | N | GND |
| 0.202 | FINAL | — | 26.60 | 53.54 | -26.94 | N | GND |
| 0.202 | FINAL | 45.7 | — | 63.54 | -17.85 | N | GND |
| 0.242 | FINAL | 41.9 | — | 62.02 | -20.13 | N | GND |
| 0.245 | FINAL | — | 23.39 | 51.94 | -28.55 | N | GND |
| 0.283 | FINAL | 37.6 | — | 60.74 | -23.13 | N | GND |
| 0.283 | FINAL | — | 20.68 | 50.74 | -30.06 | N | GND |
| 0.607 | FINAL | 31.6 | — | 56.00 | -24.40 | N | GND |
| 0.607 | FINAL | — | 22.66 | 46.00 | -23.34 | N | GND |
| 27.121 | FINAL | — | 42.88 | 50.00 | -7.12 | N | GND |
| 27.121 | FINAL | 43.0 | — | 60.00 | -17.03 | N | GND |

Table 7-11. Line-Conducted Test Data (N)

| | | | | |
|--------------------------------------|---|--|---------------------------------------|---------------------------------|
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8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Security Switch for Retail Security FCC ID: BCG-A2207** has been tested to show compliance with Part 15 Subpart C (15.225) of the FCC Rules and RSS-210 of the Innovation, Science and Economic Development Canada Rules.

| | | | |
|--------------------------------------|---|--|---------------------------------|
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