RF Test Report

As per

RSS-210 Annex B.6, Issue 9:2016 & FCC Part 15 Subpart 15.225:2017

Low Power Licence Exempt Radio Communication Devices Intentional Radiators

on the

SPC1-01 Wireless card reader

Issued by:

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Testing produced for

Square

See Appendix A for full client & EUT details.

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R-4023, G-506 C-4498, T-1246

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Report Scope

This report addresses the EMC verification testing and test results of the wireless card reader accepting NFC contactless payments and EMV chip card transactions unit from Square Inc, model: **SPC1-01**. This unit is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-210 Annex B.6, Issue 9:2016,

FCC Part 15 Subpart C 15.225:2017

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc, unless otherwise stated.

Summary

The results contained in this report relate only to the item(s) tested.

EUT Model:	SPC1-01
EUT FCC Certification #, FCC ID:	2AF3K-SPC1
EUT passed all tests performed	Yes
Tests conducted by	Raymond Lee Au

For testing dates, see "Testing Environmental Conditions and Dates".

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass [α]
FCC 15.225 (a), (b), (c) RSS-210 B.6	Operation within the band 13.110-14.010 MHz (Field Strength)	Quasi-Peak Average	Pass
FCC 15.225 (d) FCC 15.209 RSS-GEN (Tables 5 & 6)	Transmitter Spurious Radiated Emissions	Quasi-Peak Average	Pass
FCC 15.225 (e) RSS-Gen 6.11	Operation within the band 13.110-14.010 MHz (Frequency Stability at Extreme Temperatures)	±0.01% -20°C – +50°C	Pass
FCC 15.225 (e) RSS-Gen 6.11	Operation within the band 13.110-14.010 MHz (Frequency Stability at Extreme Voltages)	±0.01% 85% – 115%	Pass
FCC 15.205 RSS-GEN (Table 7)	Restricted Bands for Intentional Operation	QuasiPeak Average	Pass [α]
FCC 15.207 RSS-GEN (Table 4)	Power Line Conducted Emissions	QuasiPeak Average	Pass
Overall Result			**Pass**

[α] See *Notes, Justifications, or Deviations* section for more details.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a ‘PASS’ grade. If not ‘FAIL’ grade will be issued. Note that ‘PASS’ / ‘FAIL’ grade is independent of any measurement uncertainties. A ‘PASS’ / ‘FAIL’ grade within measurement uncertainty is marked with a ‘*’.

Notes, Justifications, or Deviations

The following notes, justifications for tests not performed or deviations from the above listed specifications apply:

The EUT is a portable credit card reader with BLE (2.402 – 2.480 MHz) and NFC RFID (13.56 MHz) capabilities. This report deals with the NFC RFID characteristics (tested to FCC 15.225). See report # 7169005271R-BLE-000 for the report regarding the BLE characteristics (tested to FCC 15.247).

For the antenna requirement specified in FCC 15.203, the NFC loop antenna is connected to the PCB which is sealed within the unit's enclosure. It is not meant to be replicable by the user, nor is it accessible.

The EUT is rated to be operated between 0°C – 40°C. The RFID transmitter does not operate or transmit at -20°C. Therefore, frequency stability test results are available down to -10°C only, as that is the lowest temperature at which the 13.56 MHz transmission is operational.

The EUT was tested positioned in the three orthogonal axis. Worst case results are presented, and occurs with the EUT positioned upright (broad side facing test antenna) during NFC testing. See *Appendix B* for test photos.

For the Restricted Bands of operation, the EUT is designed to only operate between 13.110-14.010 MHz.

The EUT's output is set to transmit continuously at 100% duty cycle at the maximum output power.

The EUT operates using an internal battery rechargeable by a USB port. It does not have the means to plug into mains directly. Power line conducted emissions is performed while it is recharging using a representative support device (S089 stand provided by the manufacturer). Other tests were performed with the battery fully charged.

See separate RF Exposure Exhibit for this unit regarding the permissible RF exposure levels.

SAR assessment is applied to the EUT. An assessment distance of ≤ 5 mm is applied. The device meets the SAR Test exemption criteria and no test is required. See RF Exposure exhibits for more details.

Sample Calculation(s)

Radiated Emission Test

Margin = Limit – (Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain)
Margin = 50.5dBµV/m – (50dBµV + 10dB + 2.5dB – 20dB)
Margin = 8.0 dB (pass)

Applicable Standards, Specifications and Methods

ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard For Testing Unlicensed Wireless Devices
CFR 47 FCC 15 Subpart C:2017	Code of Federal Regulations – Radio Frequency Devices, Intentional Radiators
RSS-Gen Issue 5 2018	General Requirements and Information for the Certification of Radio Apparatus
RSS 210:2016	Issue 9: Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
ISO 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories

Document Revision Status

Revision 000 December 27, 2018
- Initial Release

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiliary Equipment. A digital accessory that feeds data into or receives data from another device (host) that in turn, controls its operation.

BW – Bandwidth. Unless otherwise stated, this is refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line Impedance Stabilization Network

NCR – No Calibration Required

RF – Radio Frequency

Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada labs near Toronto, Ontario. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT that has a maximum width or length of up to 2m and a height of up to 3m. The chamber is equipped with a turntable that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120Vac and 240Vac single phase, or devices that are rated for a 208Vac 3 phase input. DC capability is also available for testing. The chamber is equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the Vertical Ground plane if applicable.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Industry Canada (IC, 6844A-3) and Voluntary Control Council for Interference (VCCI, R-4023, G-506, C-4498, and T-1246). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2555.01. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Testing Environmental Conditions and Dates

Following environmental conditions were recorded in the facility during time of testing

Date	Test	Initials	Temperature (ºC)	Humidity (%)	Pressure (kPa)
Nov. 30, 2018	Operation within the band 13.110-14.010 MHz (Field Strength)	RA	22.9	23.2	101.8
Nov. 30, 2018	Transmitter Spurious Radiated Emissions	RA	22.9	23.2	101.8
Nov. 30, 2018	20dB and 99% Occupied Bandwidth	RA	22.9	23.2	101.8
Dec. 6, 2018	Frequency Stability at Extreme Temperatures	RA	20.5 (Outside temperature chamber)	20.7	101.7
Dec. 10, 2018	Frequency Stability at Extreme Voltages	RA	20.1	20.5	102.2
Dec. 12, 2018	Power Line Conducted Emissions	RA	20.9	21.9	101.7

Detailed Test Results Section

Radiated Emission Field Strength

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect other devices which may be using the same spectrum allocations for similar or other purposes and also ensures the transmit range of the device is within the pre-determined suitable range. This also ensures public safety by not exceeding a level which has been deemed safe for human exposure.

Limits and Method

The method is as defined in ANSI C63.4.
The limits are defined in FCC Part 15.225 (a), (b), (c), and RSS-210 B.6.
The field strength of any emissions within the bands given in the table below shall not exceed the limits specified.
The testing is performed using a loop antenna.

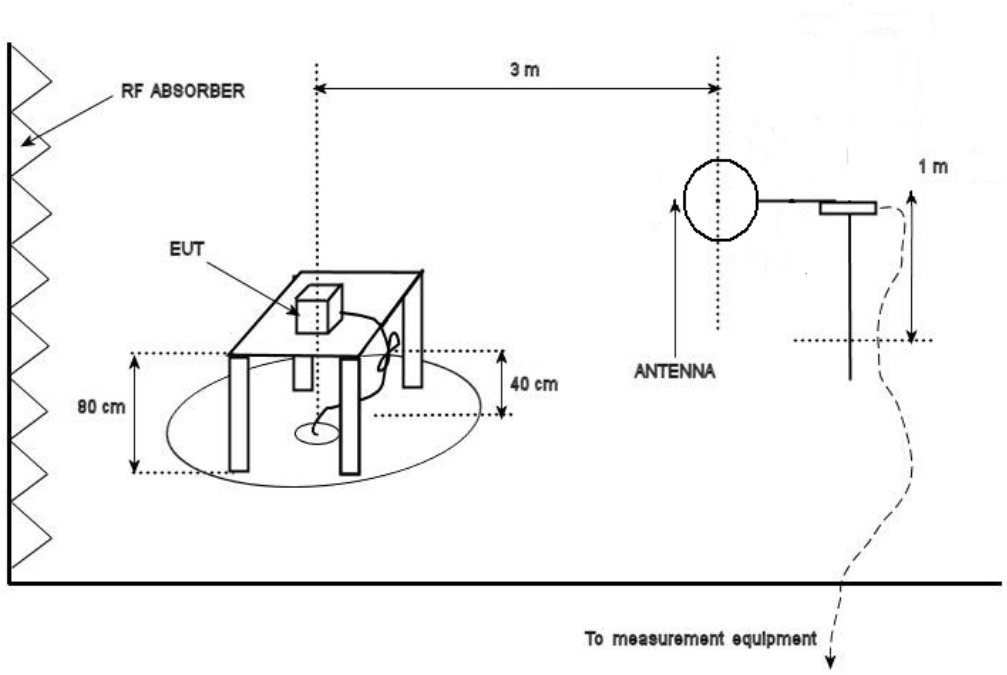
Frequency Range (MHz)	Limit (uV/m)[1] at 30m	Limit (dBuV/m)[1] at 3m
< 13.110	Emission limits of FCC 15.209 apply. See *Transmitter Spurious Radiated Emissions* section	
13.110 – 13.410	106	80.5
13.410 – 13.553	334	90.5
13.553 – 13.567	15,848	124.0
13.567 – 13.710	334	90.5
13.710 – 14.010	106	80.5
> 14.010	Emission limits of FCC 15.209 apply. See *Transmitter Spurious Radiated Emissions* section	

[1] Limit is with a Quasi-Peak detector with bandwidths as defined in CISPR-16-1-1

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

In accordance with FCC Part 15, section 15.31(f)(2), testing was performed at a 3 meter test distance and an extrapolation factor of 40 dB/decade was applied. For example, an extrapolation of 30m to 3m is 20Log(uV/m) + 40Log(30m/3m).

Typical Radiated Emissions Setup



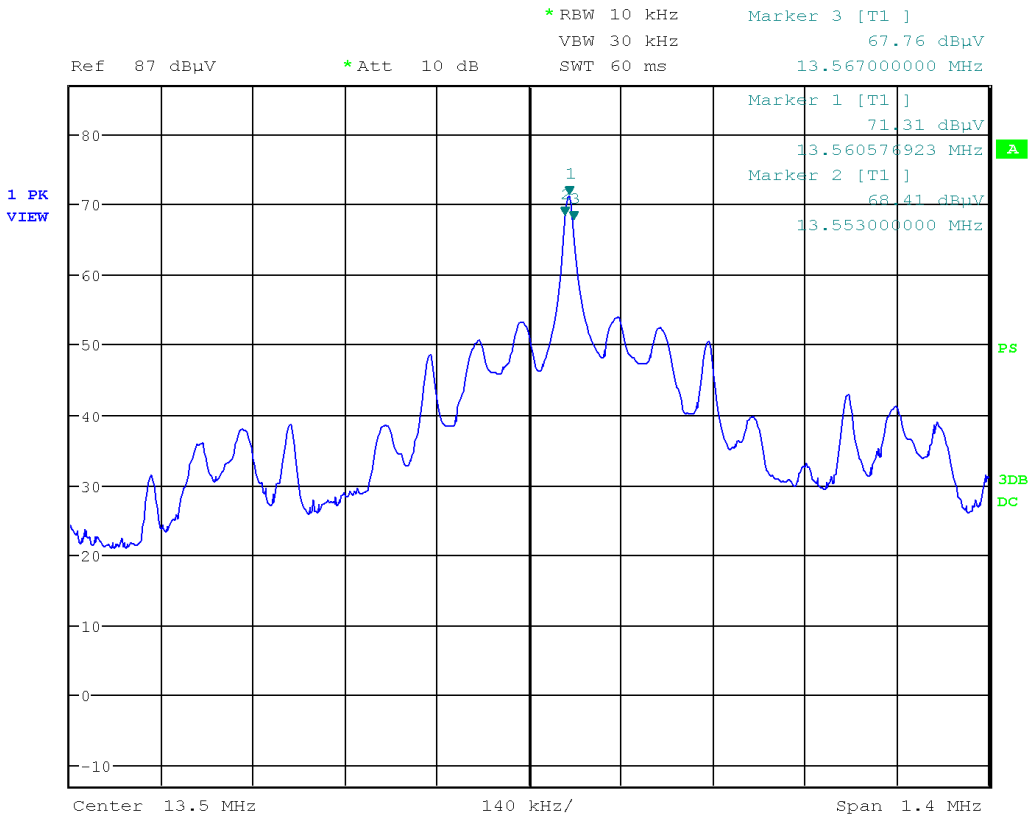
Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±4.25dB for 30MHz – 1GHz and ±4.93dB for 1GHz – 18GHz with a 'k=2' coverage factor and a 95% confidence level.

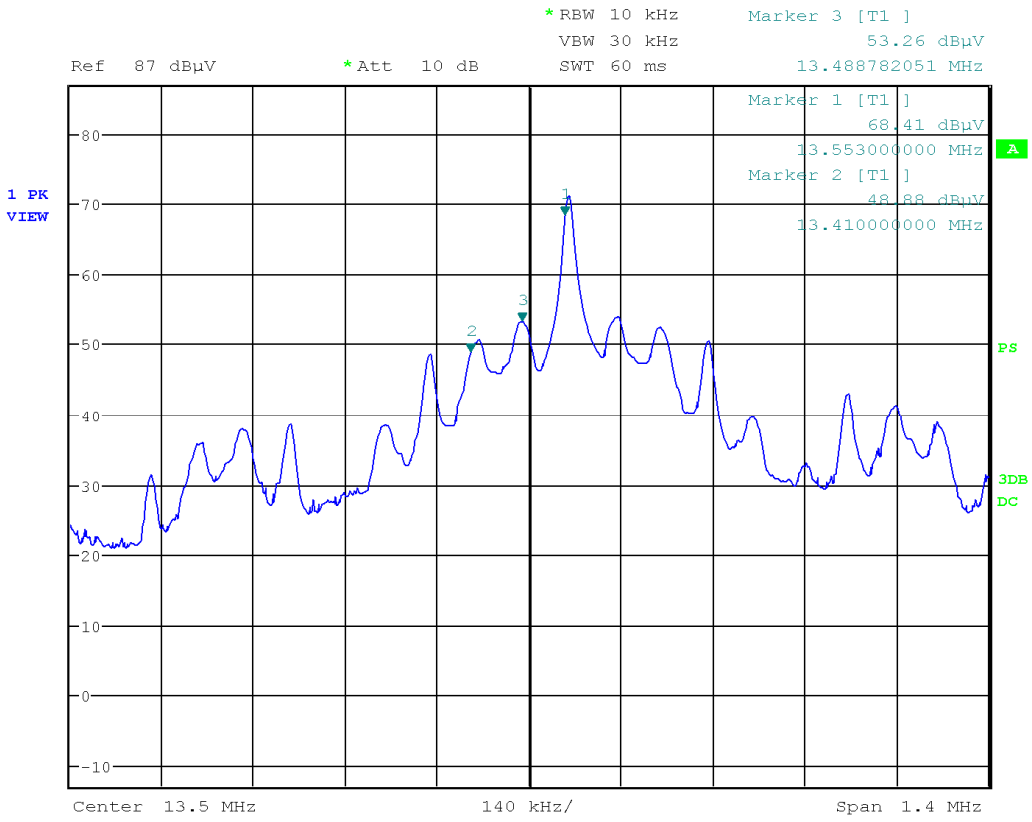
Preliminary Graphs

The graphs shown below are maximized peak measurement graphs over a full 0-360° rotation. The loop was orientated at 0 degrees and 90 degrees and a maximized reading is shown. The marker shows the value before factors are applied. See the *Final Measurements* section following for factor corrected values.

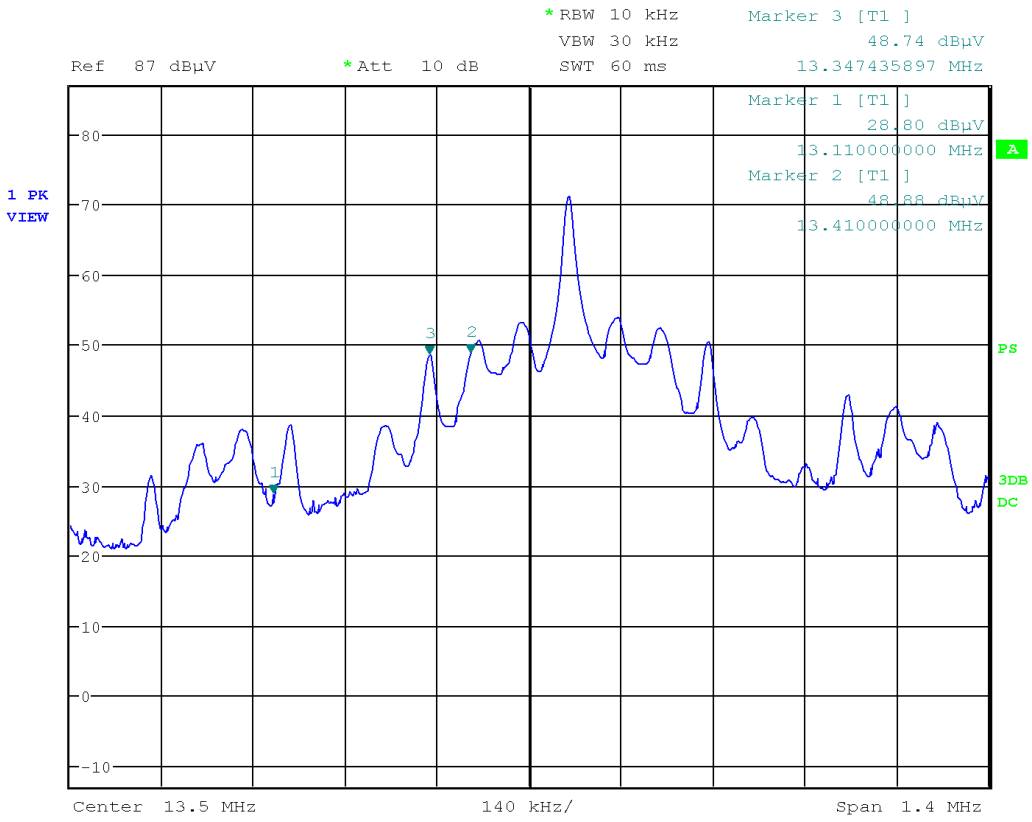
Peak Emission
Max Fundamental Emission & Band Edges
13.553-13.567 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



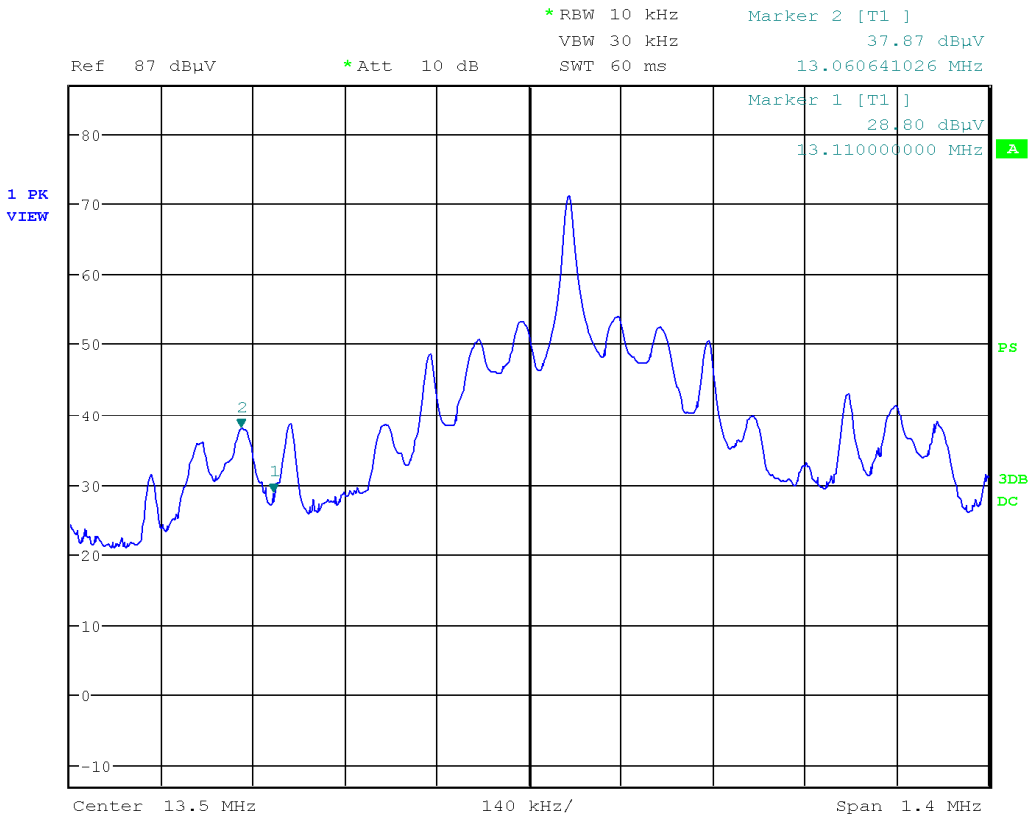
Peak Emission
Band Edges
13.410-13.553 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



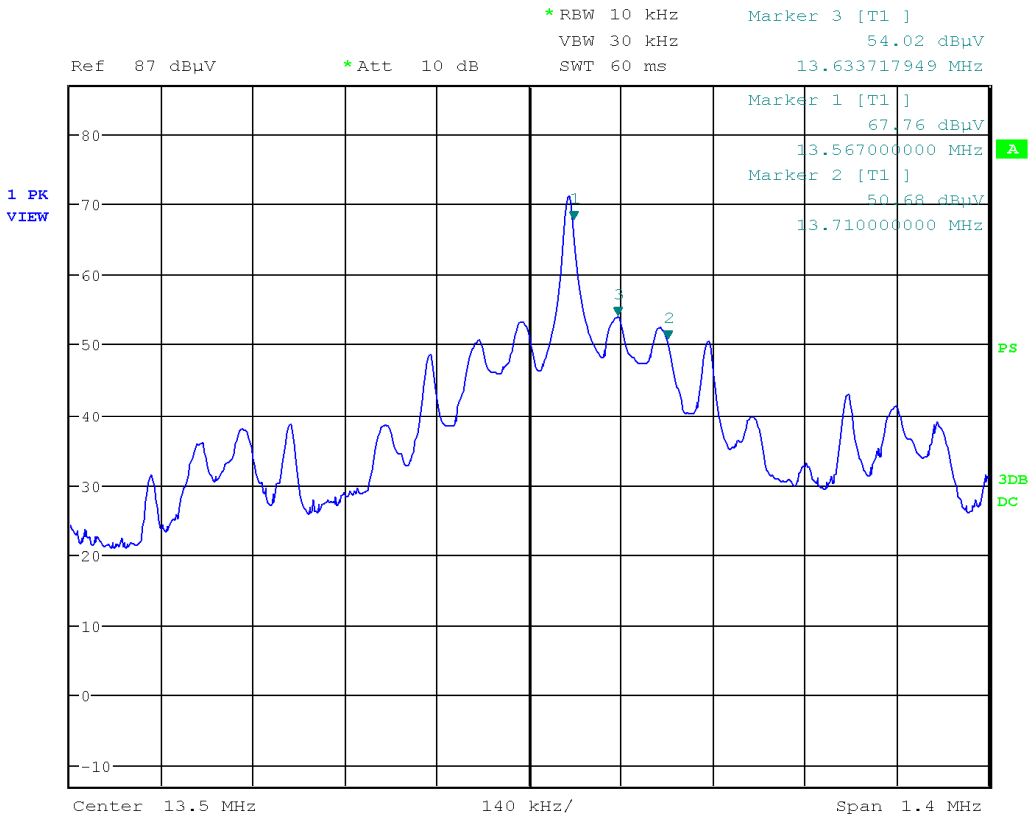
Peak Emission
Band Edges
13.110-13.410 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



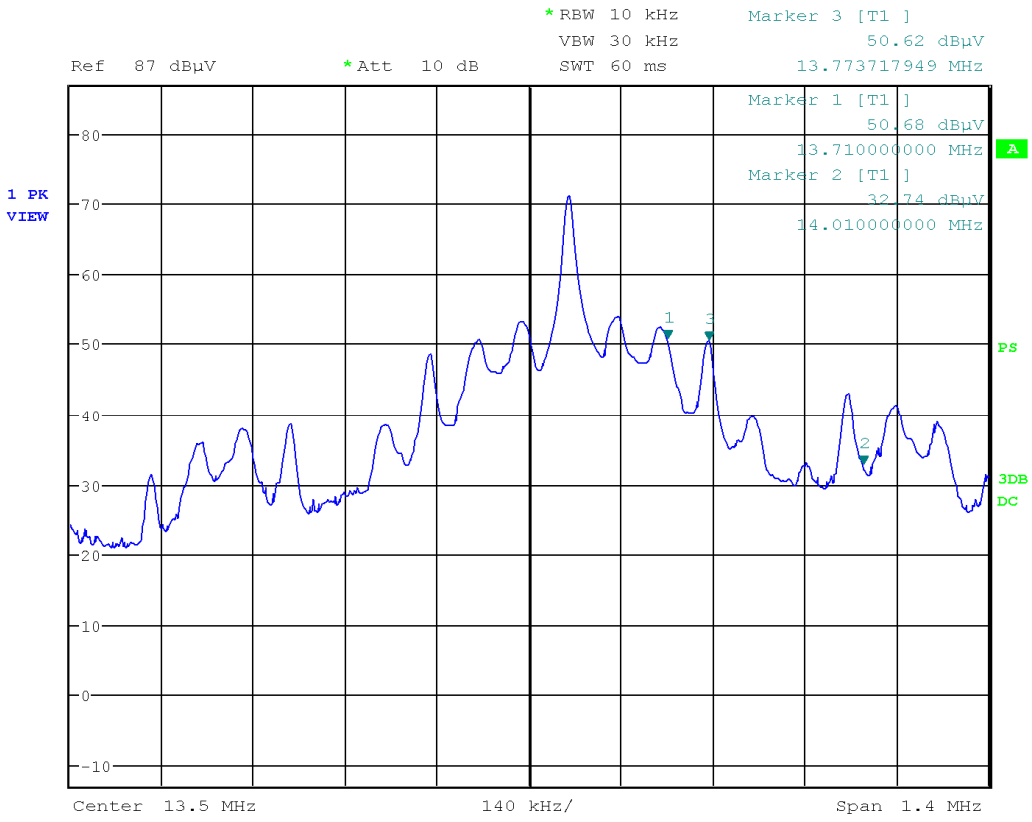
Peak Emission
Band Edges
< 13.110 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



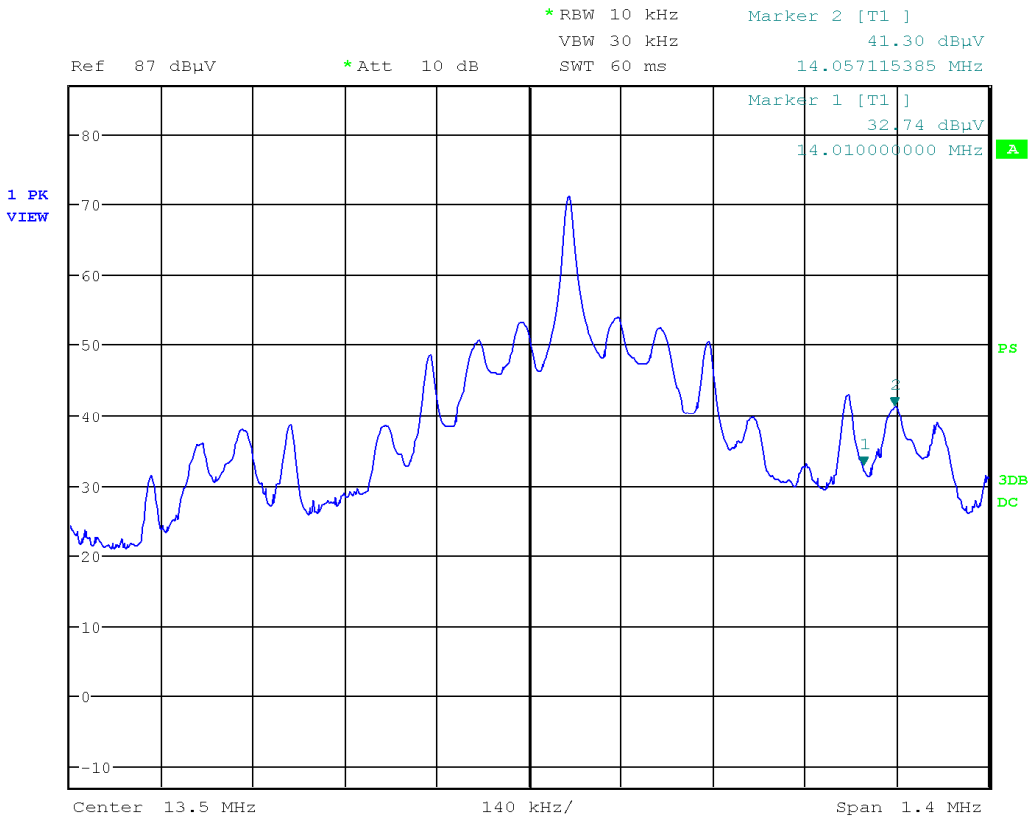
Peak Emission
Band Edges
13.567-13.710 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



Peak Emission
Band Edges
13.710-14.010 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



Peak Emission
Band Edges
> 14.010 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



Final Measurements

Radiated Emissions Table - 15.225
Fundamental

Test Frequency (MHz)	Detection mode	Raw signal dB(µA)	Cable loss + Pre-selector dB	dBµA to dBµV conversion factor	Antenna factor dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
13.56	Peak	71.31	0.3	51.5	-16.3	-32.1	74.71	123.9	49.19	Pass

Radiated Emissions Table - 15.225
Band Edges

Test Frequency (MHz)	Detection mode	Raw signal dB(µA)	Cable loss + Pre-selector dB	dBµA to dBµV conversion factor	Antenna factor dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
13.061	Peak	37.87	0.3	51.5	-16.3	-32.1	41.27	69.5	28.23	Pass
13.110	Peak	28.8	0.3	51.5	-16.3	-32.1	32.2	69.5	37.3	Pass
13.347	Peak	48.74	0.3	51.5	-16.3	-32.1	52.14	80.5	28.36	Pass
13.410	Peak	48.88	0.3	51.5	-16.3	-32.1	52.28	80.5	28.22	Pass
13.489	Peak	53.26	0.3	51.5	-16.3	-32.1	56.66	90.47	33.81	Pass
13.553	Peak	68.41	0.3	51.5	-16.3	-32.1	71.81	90.47	18.66	Pass
13.567	Peak	67.76	0.3	51.5	-16.3	-32.1	71.16	90.47	19.31	Pass
13.634	Peak	54.02	0.3	51.5	-16.3	-32.1	57.42	90.47	33.05	Pass
13.710	Peak	50.68	0.3	51.5	-16.3	-32.1	54.08	80.5	26.42	Pass
13.774	Peak	50.62	0.3	51.5	-16.3	-32.1	54.02	80.5	26.48	Pass
14.010	Peak	32.74	0.3	51.5	-16.3	-32.1	36.14	69.5	33.36	Pass
14.057	Peak	41.3	0.3	51.5	-16.3	-32.1	44.7	69.5	24.8	Pass

Notes:

See *Transmitter Spurious Radiated Emissions* section in this report for spurious emissions test results outside of the FCC 15.225 bands.

See 'Appendix B – EUT and Test Setup Photos' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration / Verification Date	Next Calibration / Verification Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 12, 2018	Jan. 12, 2020	GEMC 233
Loop Antenna 150 kHz – 30 MHz	EM 6872	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 71
Pre-Amp 9 kHz – 1 GHz	CPA9230	Chase	Feb. 28, 2018	Feb. 28, 2020	GEMC 301
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 274
RF Cable 2m	Sucoflex 104A	Huber+Suhner	NCR	NCR	GEMC 271

Transmitter Spurious Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limits and Method

The method is defined in ANSI C63.10.
The requirement is stated in FCC 15.225(d), and RSS-210 B.6(d.)
The limits are as defined in 47 CFR FCC Part 15.209 and RSS- Gen (Table 5 and Table 6).
The limits apply for emissions that fall outside the 13.110‑14.010 MHz band.

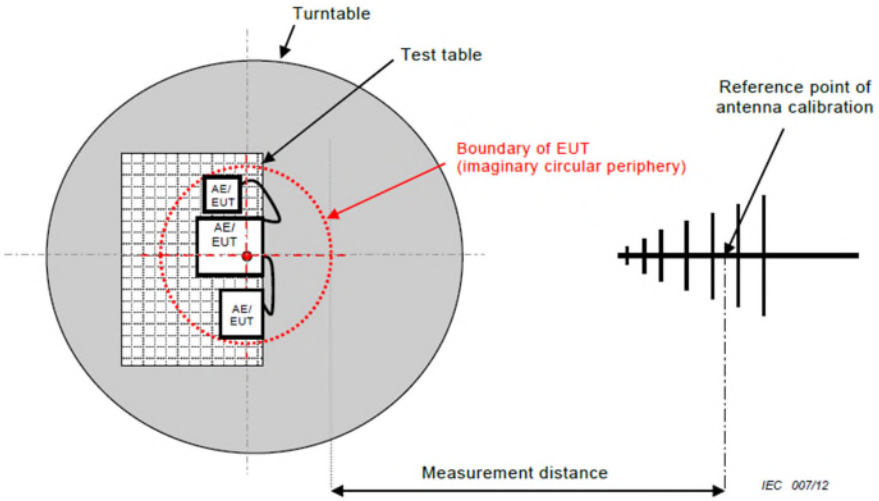
These limits are as follows:

Frequency	Limit
0.009 MHz – 0.490 MHz	2400/F(kHz) uV/m at 300m[1]
0.490 MHz – 1.705 MHz	24000/F(kHz) uV/m at 30m[1]
1.705 MHz – 30 MHz	30 uV/m at 30m[1]
30 MHz – 88 MHz	100 uV/m (40.0 dBuV/m[1]) at 3m
88 MHz – 216 MHz	150 uV/m (43.5 dBuV/m[1]) at 3m
216 MHz – 960 MHz	200 uV/m (46.0 dBuV/m[1]) at 3m
Above 960 MHz	500 uV/m (54.0 dBuV/m[1]) at 3m
Above 1000 MHz	500 uV/m (54 dBuV/m[2]) at 3m
Above 1000 MHz	500 uV/m (74 dBuV/m[3]) at 3m

[1]Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector
[3]Limit is with 1 MHz measurement bandwidth and using a Peak detector

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±4.25dB for 30MHz – 1GHz and ±4.93dB for 1GHz – 18GHz with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under *Final Measurements*.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10^{th} harmonic.

Devices scanned may be scanned at alternate test distances and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz.

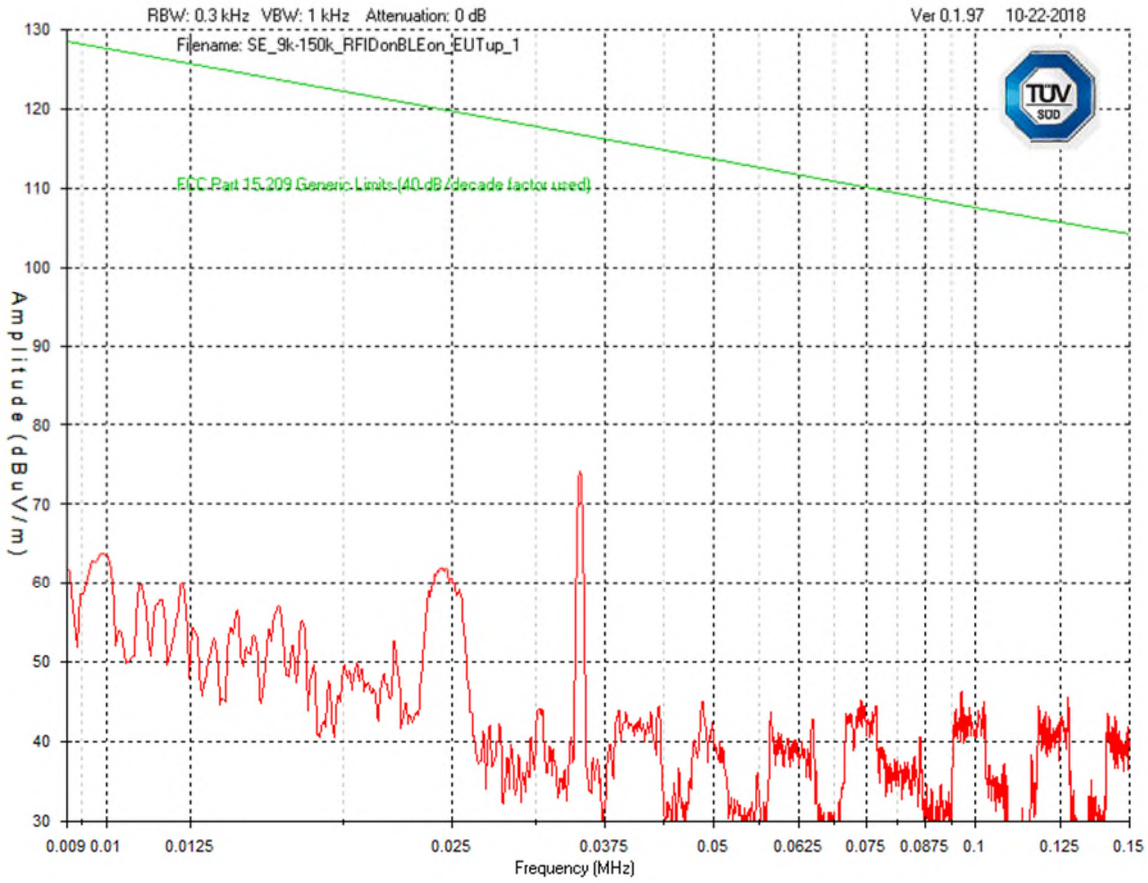
The three orthogonal axis were investigated. Worst case graphs are presented.

All transmitters in the EUT are on and transmitting continuous modulated data at the maximum power setting used by the manufacturer.

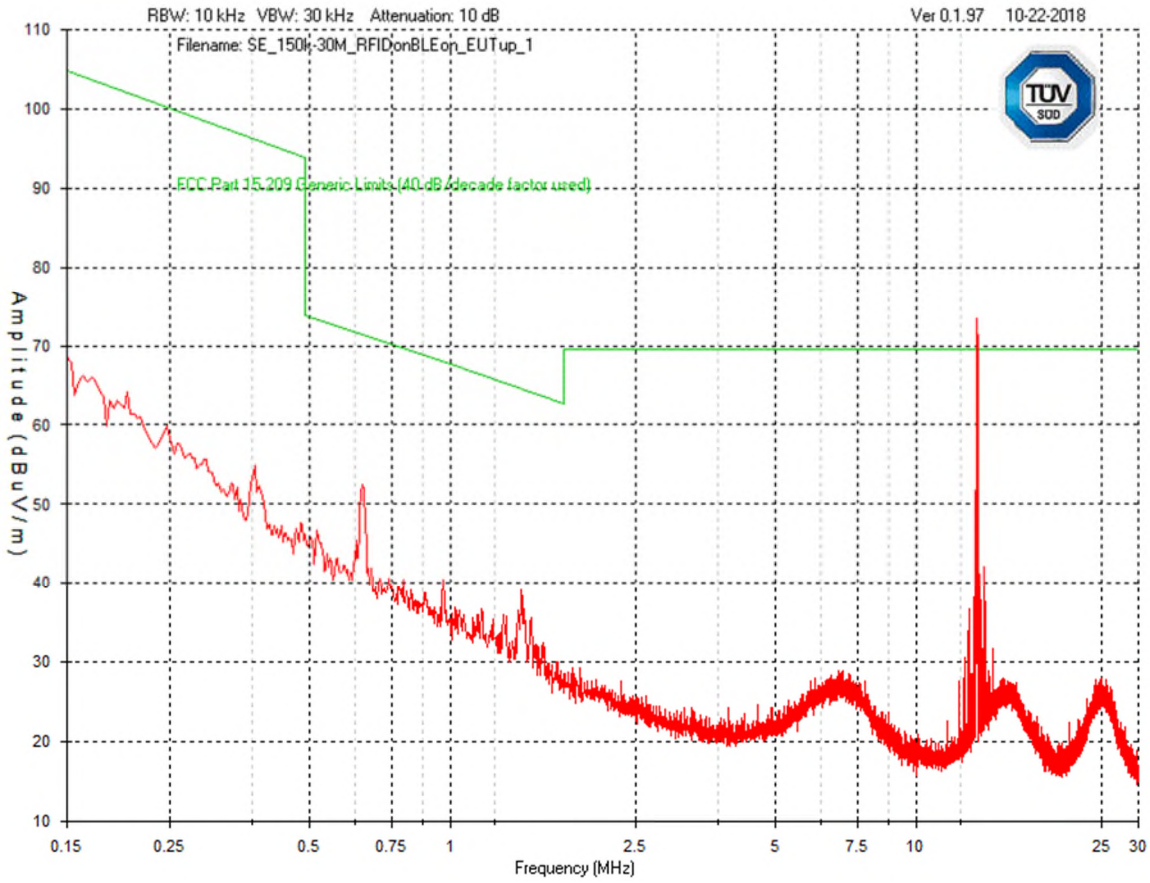
Plots and measurements are made at a 3 meter distance.

See *Radiated Emission Field Strength* section for measurements at the band-edges.

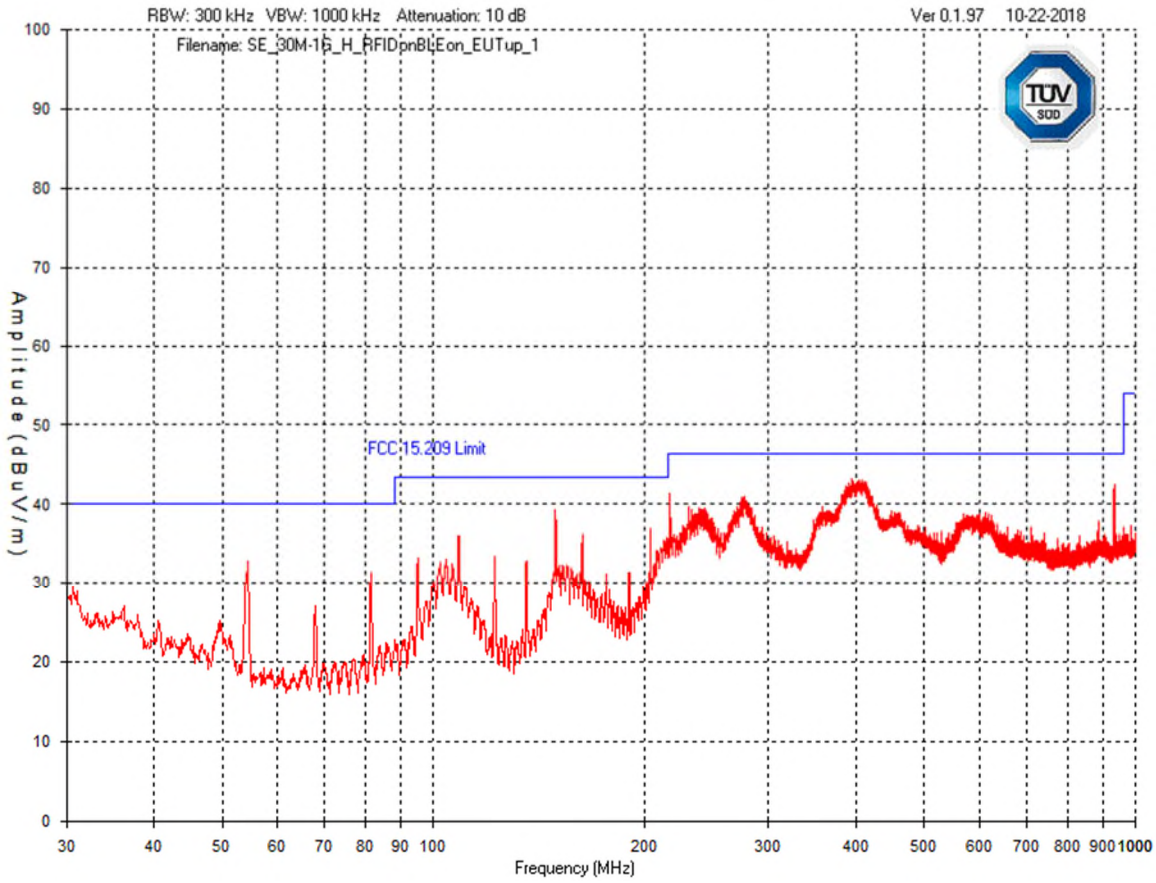
9 kHz – 150 kHz
Peak Emission Graph



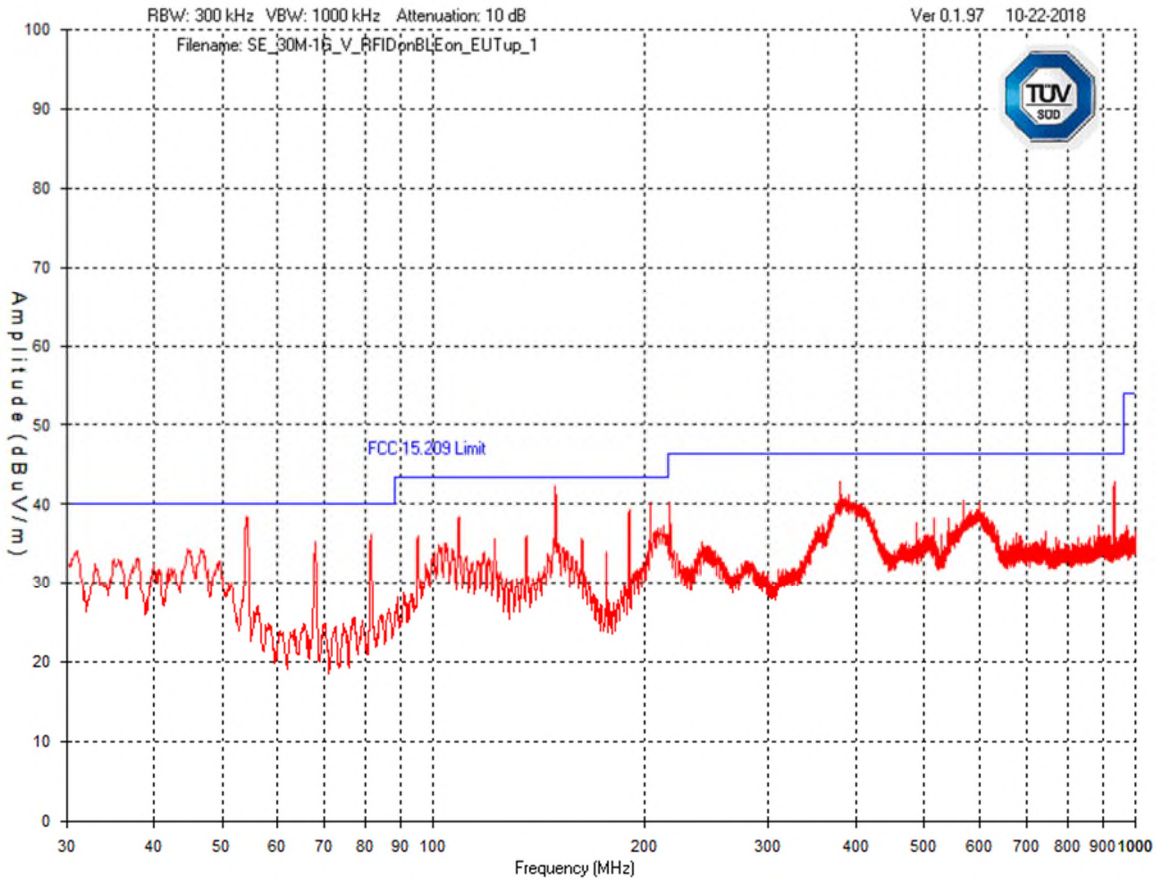
150 kHz – 30 MHz
Peak Emission Graph



30 MHz – 1 GHz
Horizontal - Peak Emission Graph



30 MHz – 1 GHz
Vertical - Peak Emission Graph



Final Measurements and Results

The measurements were maximized by rotating the turn table over a full 0-360º rotation and the antenna height was varied from 1 m to 4 m.

Spurious Radiated Emissions Table

Frequency (MHz)	Detector	Received Signal (dBµV)	Antenna Factor (dB/m)	Atten Factor (dB)	Cable Factor (dB)	Pre-Amp (dB)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pass/ Fail
Horizontal Antenna Polarization										
393.63	QP	43.3	16.6	6	1.6	-31.9	35.6	46.4	10.8	Pass
931.64	QP	38.6	23.4	6	2.6	-30.7	39.9	46.4	6.5	Pass
149.14	PEAK	55.9	8.4	6	0.9	-32.0	39.2	43.5	4.3	Pass
217.11	PEAK	55.5	10.7	6	1.0	-31.9	41.3	46.4	5.1	Pass
277.31	PEAK	53.3	12.6	6	1.2	-32.0	41.1	46.4	5.3	Pass
203.51	PEAK	51.9	10.0	6	1.0	-31.9	37.0	43.5	6.5	Pass
Vertical Antenna Polarization										
149.14	QP	56.6	8.4	6	0.9	-32.0	39.9	43.5	3.6	Pass
54.37	QP	53.8	7.8	6	0.5	-32.0	36.1	40.0	3.9	Pass
203.51	QP	51.6	10.0	6	1.0	-31.9	36.7	43.5	6.8	Pass
379.94	QP	43.8	16.8	6	1.6	-32.0	36.2	46.4	10.2	Pass
931.64	PEAK	41.6	23.4	6	2.6	-30.7	42.9	46.4	3.5	Pass
81.36	PEAK	55.4	6.0	6	0.7	-32.0	36.1	40.0	3.9	Pass

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration / Verification Date	Next Calibration / Verification Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 12, 2018	Jan. 12, 2020	GEMC 233
Loop Antenna 9 – 150 kHz	EM 6871	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 70
Loop Antenna 150 kHz – 30 MHz	EM 6872	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 71
BiLog Antenna	3142-C	ETS	Oct. 19, 2018	Oct. 19, 2020	GEMC 8
Pre-Amp 9 kHz – 1 GHz	CPA9230	Chase	Feb. 28, 2018	Feb. 28, 2020	GEMC 301
Attenuator 6 dB	612-6-1	Meca Electronics, Inc	NCR	NCR	GEMC 286
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 274
RF Cable 2m	Sucoflex 104A	Huber+Suhner	NCR	NCR	GEMC 271
Emissions Software	0.1.97	Global EMC	NCR	NCR	GEMC 58

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Carrier Frequency Stability

Purpose

The purpose of this test is to ensure that the frequency tolerance of the carrier signal is maintained within the required limits during extreme temperature and voltage variations. This helps protect radio broadcasts and receivers with spectrum nearby to the equipment under test from unwanted interference. This also helps ensure proper reception of the intended signal by ensuring the transmit frequency is correct over the expected temperature and voltage range.

Limits and Method

The limits are as defined in FCC Part 15, Section 15.225 (e). The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency (i.e. 13.558644 – 13.561356 MHz) over a temperature variation of −20°C to +50°C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20˚C.

Results (Temperature Variation)

There is no deviation in the fundamental frequency during the tests which would cause it to be non-compliant with the requirements. The results are presented in the charts below.

The EUT is only rated to be used within 0°C - 40°C. The lowest temperature at which the RFID's fundamental transmission was detected is -10°C. The RFID is not operational at -20°C, and no transmission is detected at this temperature.

Frequency Tolerance Table

	Frequency Recorded After EUT is Turned On (MHz)			
Temperature	**Immediately**	**2 mins**	**5 mins**	**10 mins**
+50°C	13.560416667	13.560432692	13.560432692	13.560432692
+40 °C	13.560410256	13.560410256	13.560410256	13.560410256
+30 °C	13.560413462	13.560410256	13.560410256	13.560410256
+20 °C	13.560413462	13.560413462	13.560413462	13.560413462
+10°C	13.560429487	13.560429487	13.560429487	13.560432692
0 °C	13.560445513	13.560445513	13.560439103	13.560442308
-10 °C	13.560439103	13.560435897	13.560442308	13.560442308
-20 °C	13.56 MHz circuit on EUT fails to operate at this temperature. No transmission.			

Results (Temperature Variation)

There is no deviation in the fundamental frequency during the tests which would cause it to be non-compliant with the requirements. The results are presented in the charts below.

The 13.56 MHz transmitter is powered by the EUT's rechargeable battery. The battery has a nominal voltage of 3.7 Vdc. The battery is disconnected from the EUT and powered with a variable power supply. The voltage is varied between 3.145 Vdc – 4.255 Vdc, however, voltage regulation stops operation of the EUT if the primary voltage source is below ~3.3Vdc. The RFID is not operational below this voltage, and no transmission is detected.

Voltage Variation Table

Voltage (Vdc)	Frequency (MHz)
4.255	13.560410256
3.7	13.560407051
3.3	13.560413462
3.145	13.56MHz circuit on EUT fails to operate at this voltage. No transmission.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration / Verification Date	Next Calibration / Verification Date	Asset #
Spectrum Analyzer	FSQ 26	Rohde & Schwarz	Feb 28, 2017	Feb 28, 2019	GEMC 234
Loop Antenna 150 kHz – 30 MHz	EM 6872	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 71
Temperature & Humidity Monitor	iTHX-SD	Omega	Apr. 27, 2017	Apr. 27, 2019	GEMC 282
Digital Multimeter	287	Fluke	Jul. 13, 2018	Jul. 13, 2019	CANE 00151

Power Line Conducted Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio operators, maritime radio, CB radio, and so on, from unwanted interference.

Limits and Method

The limits are defined in FCC 15.207 and RSS-Gen Table 4.
Method is as defined in ANSI C63.4:2014

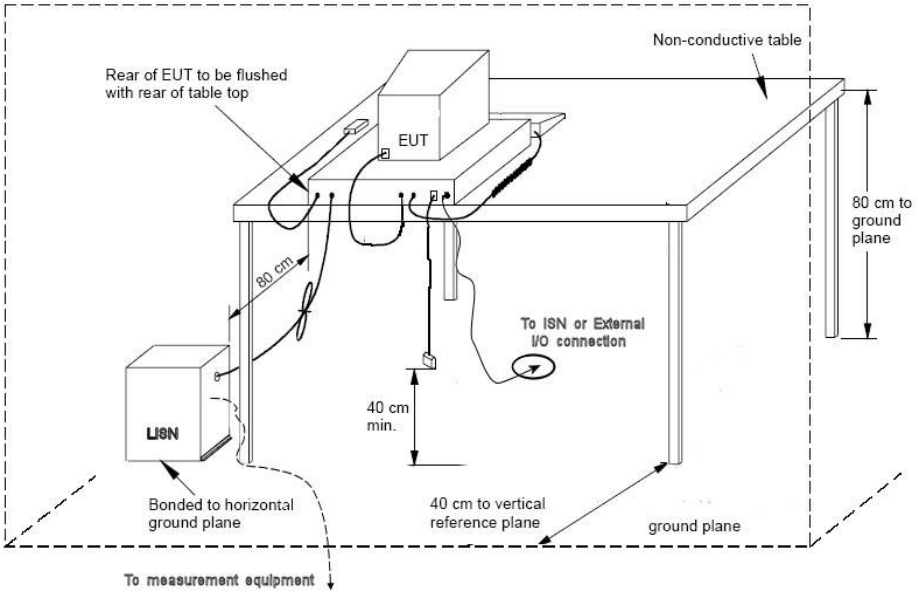
Average Limits		Quasi-Peak Limits	
150 kHz – 500 kHz	56 to 46* dBµV	150 kHz – 500 kHz	66 to 56* dBµV
500 kHz – 5 MHz	46 dBµV	500 kHz – 5 MHz	56 dBµV
5 MHz – 30 MHz	50 dBµV	5 MHz – 30 MHz	60 dBµV

* Decreases linearly with the logarithm of the frequency

Both Quasi-Peak and Average limits are applicable and each is specified as being measured with a resolution bandwidth of 9 kHz. For Quasi-Peak, a video bandwidth at least three times greater than the resolution bandwidth is used.

Based on ANSI C63.4 Section 4.2, if the Peak or Quasi-Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Typical Setup Diagram



Measurement Uncertainty

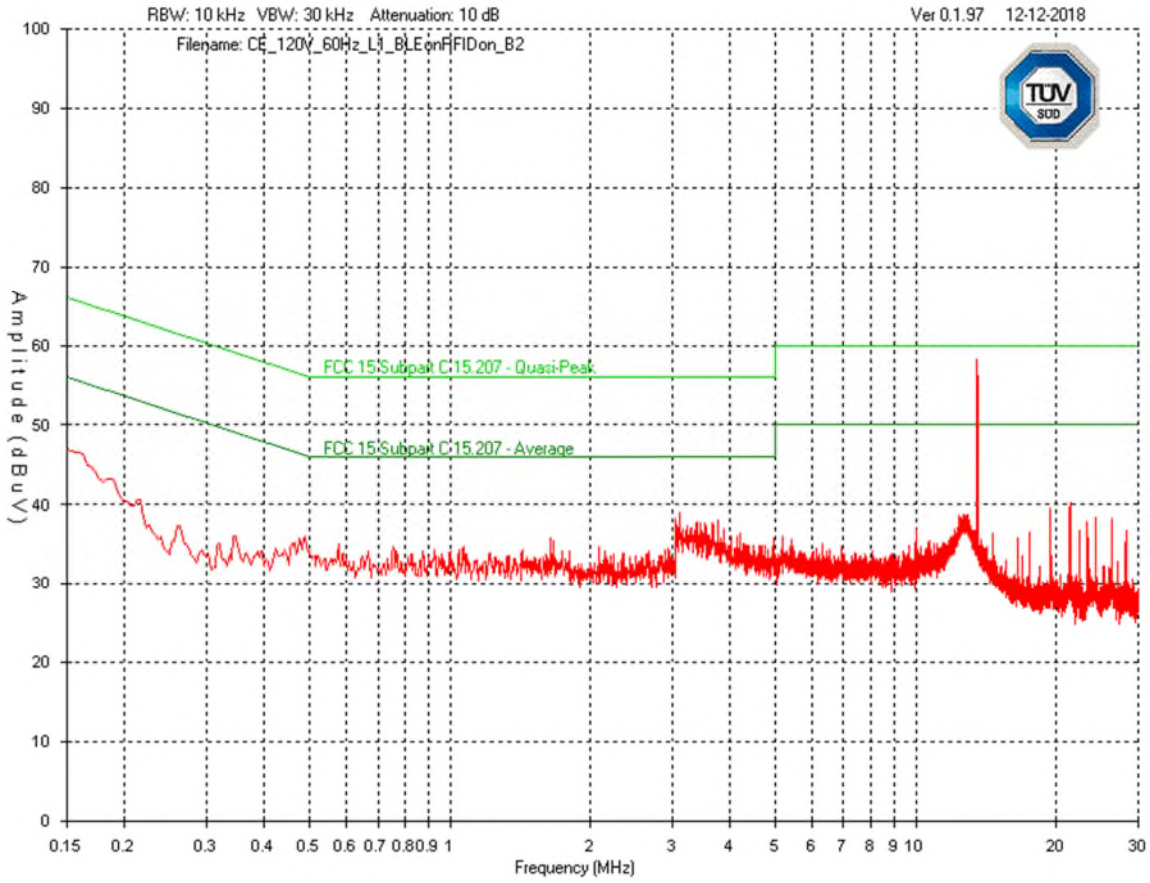
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±2.73dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

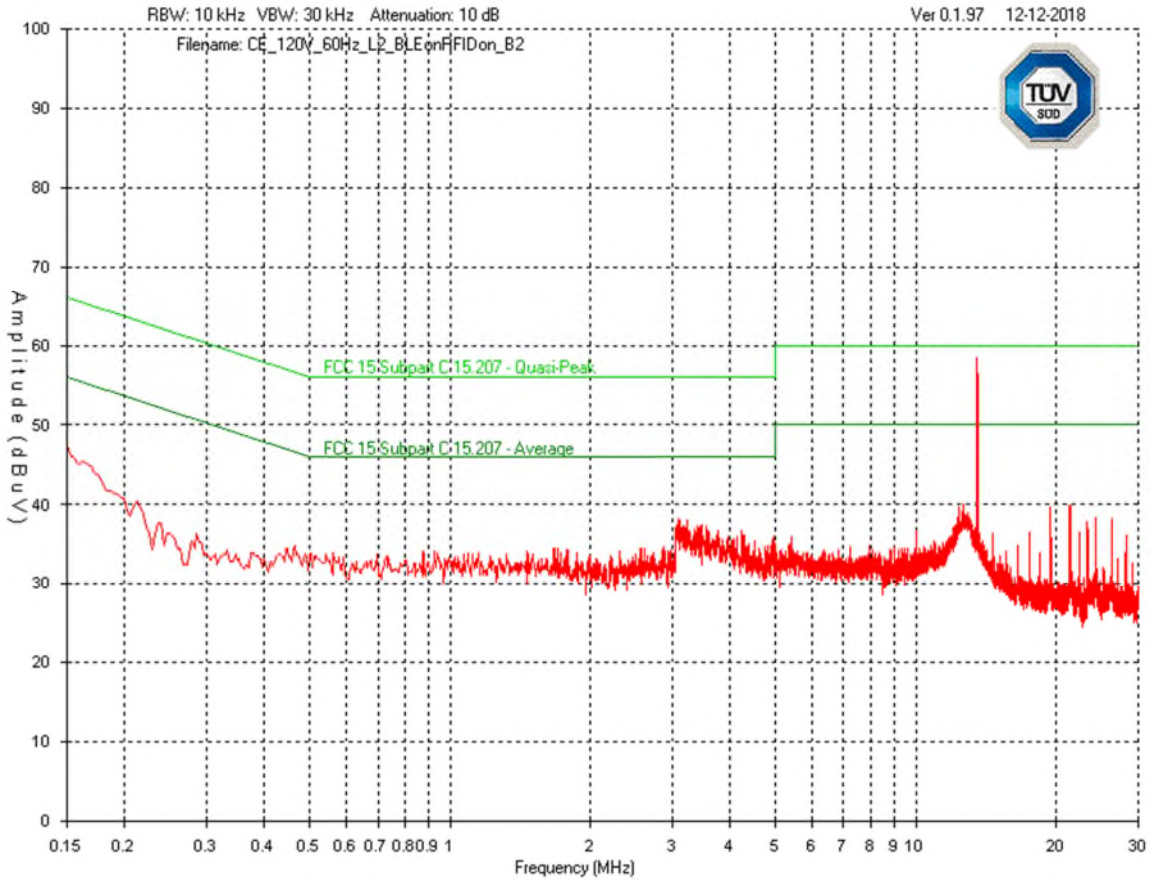
The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector. This peaking process is done as a worst case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

The EUT is a battery operated device with a battery rechargeable via a USB port. Power line conducted emissions is performed while it is recharging using a representative support device (S089 stand provided by the manufacturer).

Line 1 (L1) – 120Vac 60Hz



Line 2 (L2) – 120Vac 60Hz



Final Measurements

Power Line Conducted Emissions Table
120V, 60Hz

Frequency (MHz)	Detector	Received Signal (dBµV)	Atten Factor (dB)	Cable Factor (dB)	LISN Factor (dB)	Level (dBµV)	QP Limit (dBµV)	AVG Limit (dBµV)	QP Margin (dB)	AVG Margin (dB)	Pass/ Fail
Line											
13.560	QP	34.9	20	0.1	0.1	55.1	60.0	--	4.9	--	Pass
13.560	AVG	25.8	20	0.1	0.1	46.0	--	50.0	--	4.1	Pass
3.114	PEAK	18.9	20	0.1	0.0	39.0	56.0	46.0	17.0	7.0	Pass
0.153	PEAK	26.7	20	0.0	0.1	46.8	65.8	55.8	19.0	9.0	Pass
21.443	PEAK	20.1	20	0.1	0.1	40.3	60.0	50.0	19.7	9.7	Pass
19.492	PEAK	19.4	20	0.1	0.1	39.6	60.0	50.0	20.4	10.4	Pass
24.364	PEAK	18.3	20	0.1	0.1	38.5	60.0	50.0	21.5	11.5	Pass
Neutral											
13.560	QP	34.9	20	0.1	0.1	55.1	60.0	--	4.9	--	Pass
13.560	AVG	26.1	20	0.1	0.1	46.3	--	50.0	--	3.7	Pass
3.095	PEAK	18.0	20	0.1	0.0	38.1	56.0	46.0	17.9	7.9	Pass
0.153	PEAK	26.0	20	0.0	0.1	46.1	65.8	55.8	19.7	9.7	Pass
21.446	PEAK	19.8	20	0.1	0.0	39.9	60.0	50.0	20.1	10.1	Pass
19.495	PEAK	19.6	20	0.1	0.0	39.7	60.0	50.0	20.3	10.3	Pass
24.360	PEAK	18.2	20	0.1	0.0	38.3	60.0	50.0	21.7	11.7	Pass

Notes:

PEAK = Peak measurement
AVG = Average measurement

See 'Appendix B – EUT, Peripherals and Test Setup Photos' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	Dec. 27, 2017	Dec. 27, 2019	GEMC 160
LISN	FCC-LISN-50/250-16-2-01	FCC	Jan. 10, 2018	Jan. 10, 2020	GEMC 302
RF Cable 3m	LMR-400-3M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 276
Attenuator 10 dB	612-10-1	Meca Electronics, Inc.	NCR	NCR	GEMC 223
Emissions Software	0.1.97	TUV SUD Canada, Inc.	NCR	NCR	GEMC 58

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20dB and 99% Occupied Bandwidth

Purpose

The purpose of this test is to find the 20 dB and 99% occupied bandwidths of the 13.56 MHz emission. This is the bandwidth which is attenuated 20 dB from the peak of the intentional transmission, and the bandwidth which contains 99% transmitted power, respectively.

Limits and Method

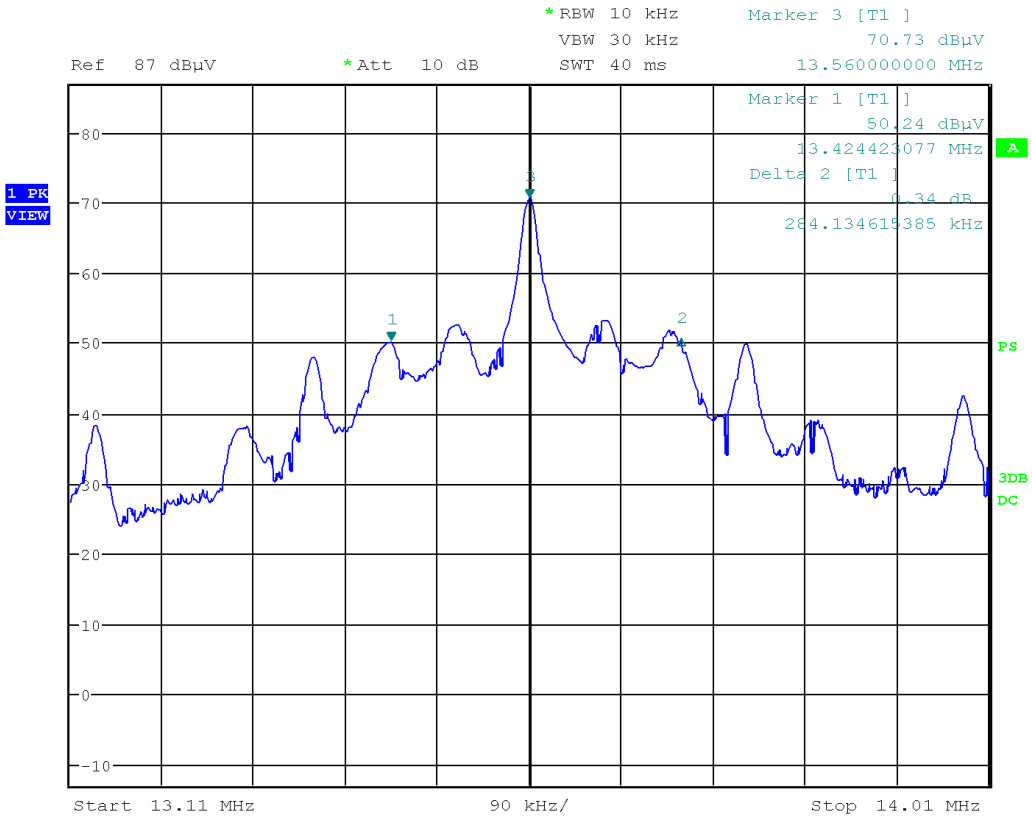
The method is as defined in ANSI C63.10.
There are no applicable limits for the 13.56 MHz emission. Its results are for informational purposes only.

Results

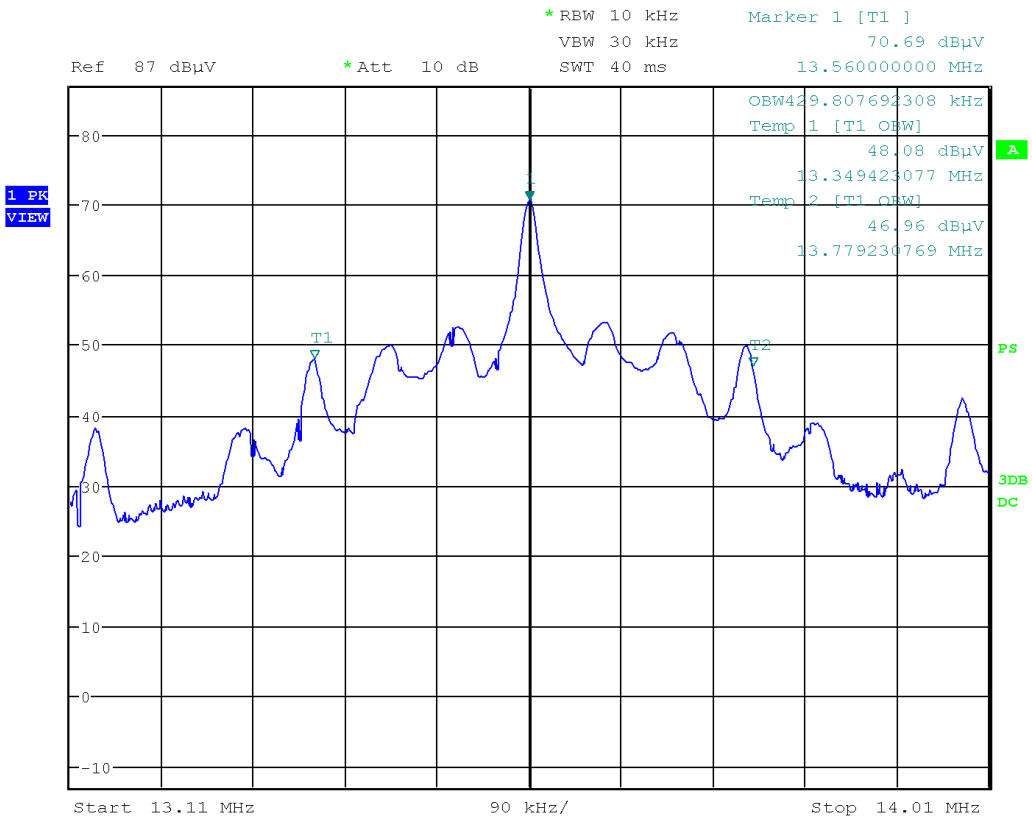
The 20dB BW measured is: 284 kHz
The 99% BW measured is: 430 kHz

Graphs

20dB Bandwidth



99% Bandwidth



Note: See ‘Appendix B – EUT & Test Setup Photos’ for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration / Verification Date	Next Calibration / Verification Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 12, 2018	Jan. 12, 2020	GEMC 233
Loop Antenna 150 kHz – 30 MHz	EM 6872	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 71
Pre-Amp 9 kHz – 1 GHz	CPA9230	Chase	Feb. 28, 2018	Feb. 28, 2020	GEMC 301
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 274
RF Cable 2m	Sucoflex 104A	Huber+Suhner	NCR	NCR	GEMC 271

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.

General EUT Description

Client Details	
Organization / Address	Square Inc. 1455 Market St. Suite 600 San Francisco, CA USA 95014
Contact	Gavin Demonte
Phone	416-319-7479
Email	gavin@squareup.com
EUT (Equipment Under Test) Details	
EUT Name	Wireless card reader
EUT Model	SPC1-01
EUT is powered using	Internal rechargeable battery charged using USB cable.
Input voltage (V)	USB: 5 VDC Internal rechargeable battery: 3.7 VDC (nominal)
Rated input current (A)	0.5 A
Frequency range(s) (Hz)	BLE: 2402-2480 MHz NFC: 13.56 MHz
Nominal power consumption (W)	2.5 W (max for USB)
Transmits RF energy? (describe)	Bluetooth LE transceiver NFC transceiver
Basic EUT functionality description	Wireless card reader accepting NFC contactless payments and EMV chip card transactions
Modes of operation	Bluetooth LE: 2402-2480 MHz, GFSK modulation. NFC: 13.56 MHz, ASK modulation.
Frequency of all clocks present in EUT	32.768 kHz, 24 MHz, 27.12 MHz
I/O cable description	30 cm micro-USB-to-Type-A cable
Available connectors on EUT	Micro-USB
Peripherals required to exercise EUT	S089 stand (provided by manufacturer)
Dimensions of product	L: 67mm, W: 67mm, H: 11mm

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated.

For close-up pictures of the EUT, see ‘Appendix B – EUT and Test Setup Photos’.

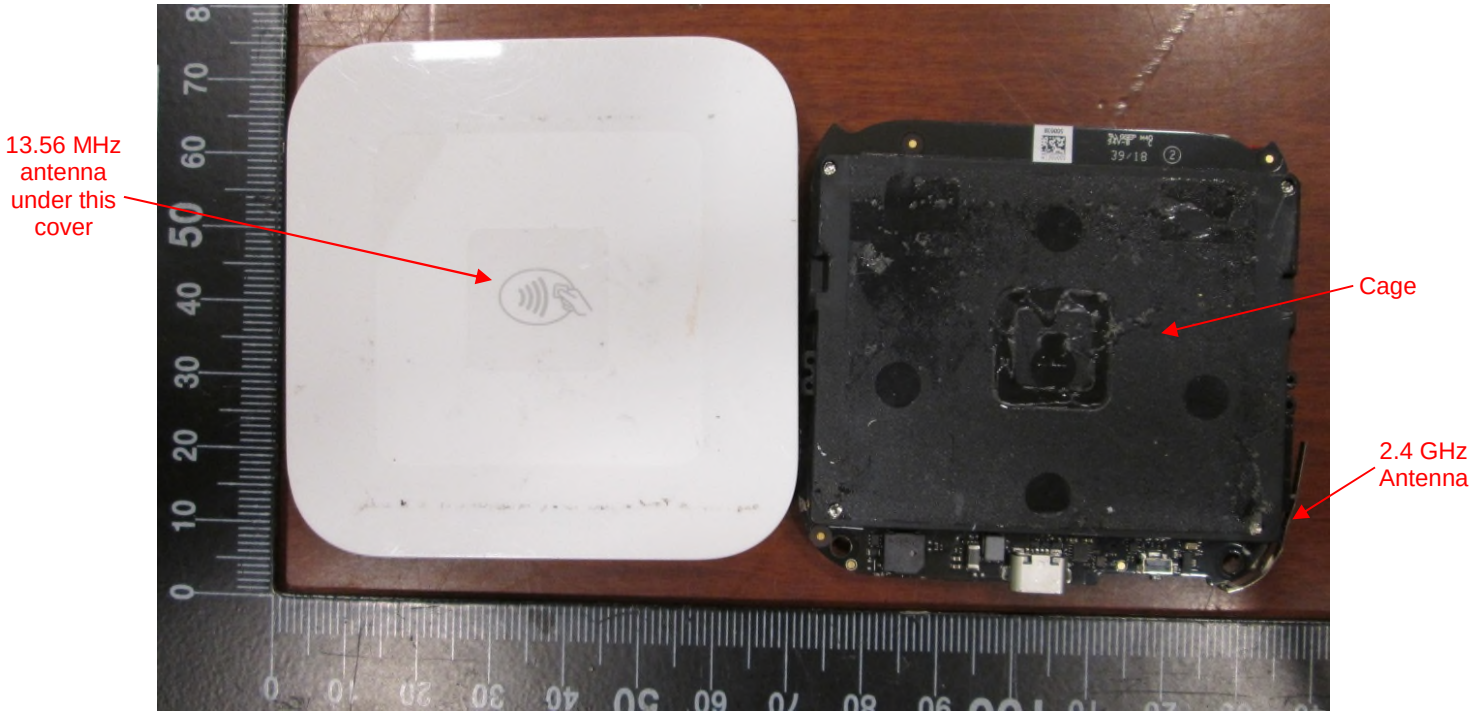
Appendix B – EUT and Test Setup Photos

Note: These photos are for information purposes only.
Also refer to submitted files that are separate from this test report.

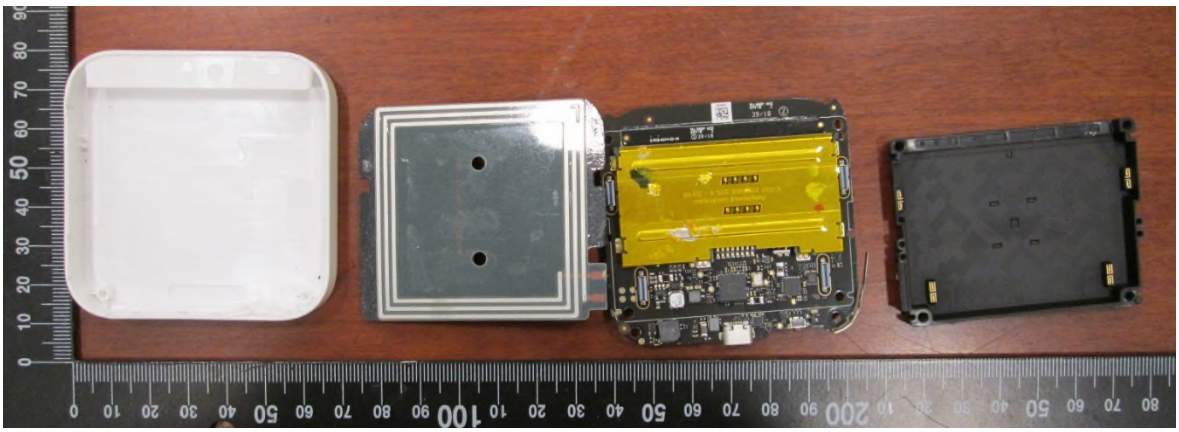
EUT – External view 1

EUT – External view 2

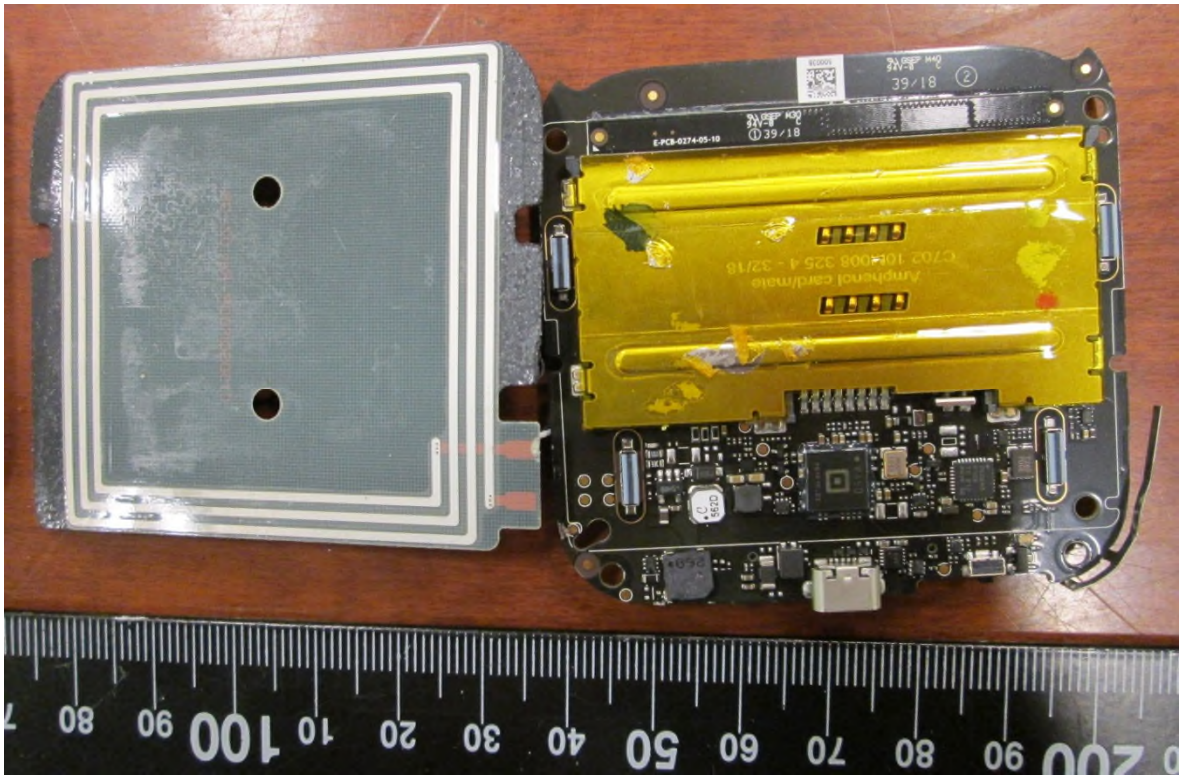
EUT – Internal view 1
Back cover removed.



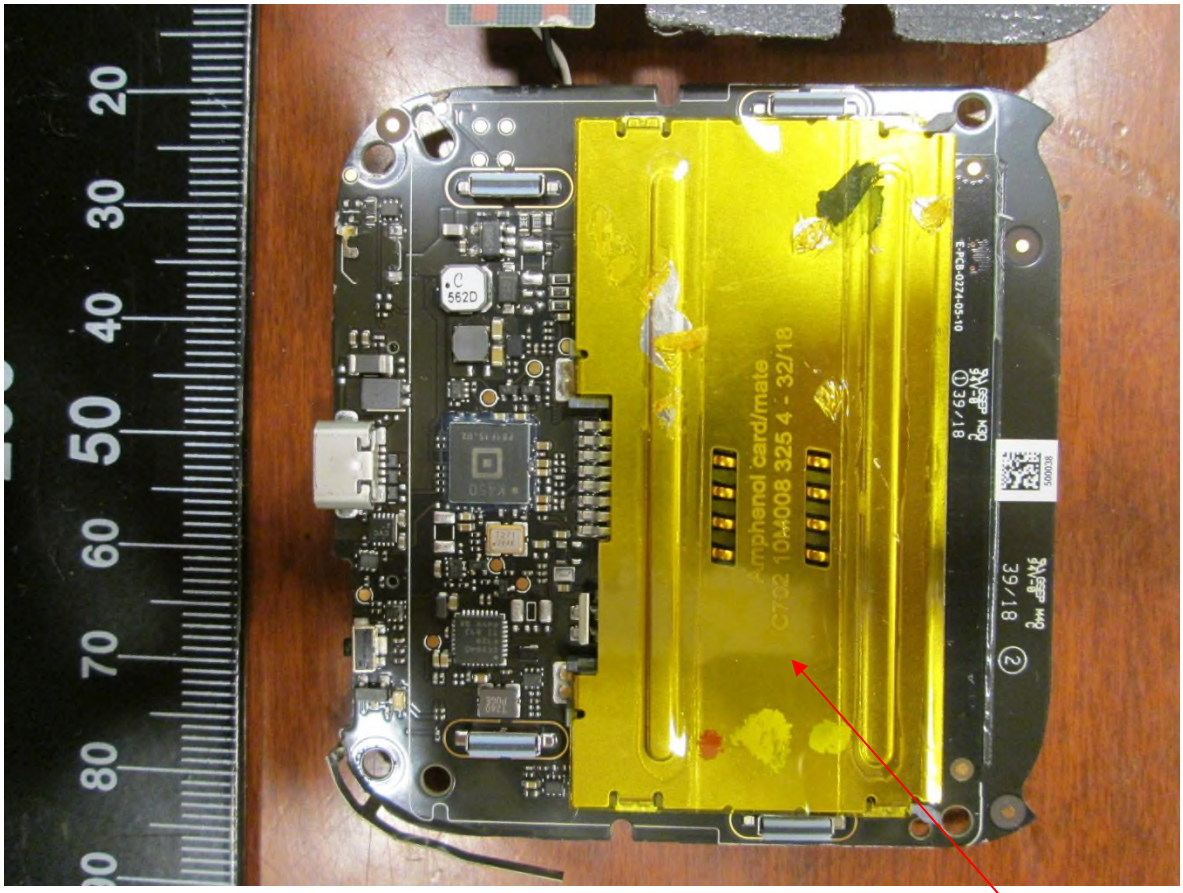
EUT – Internal view 2
PCB removed from enclosure



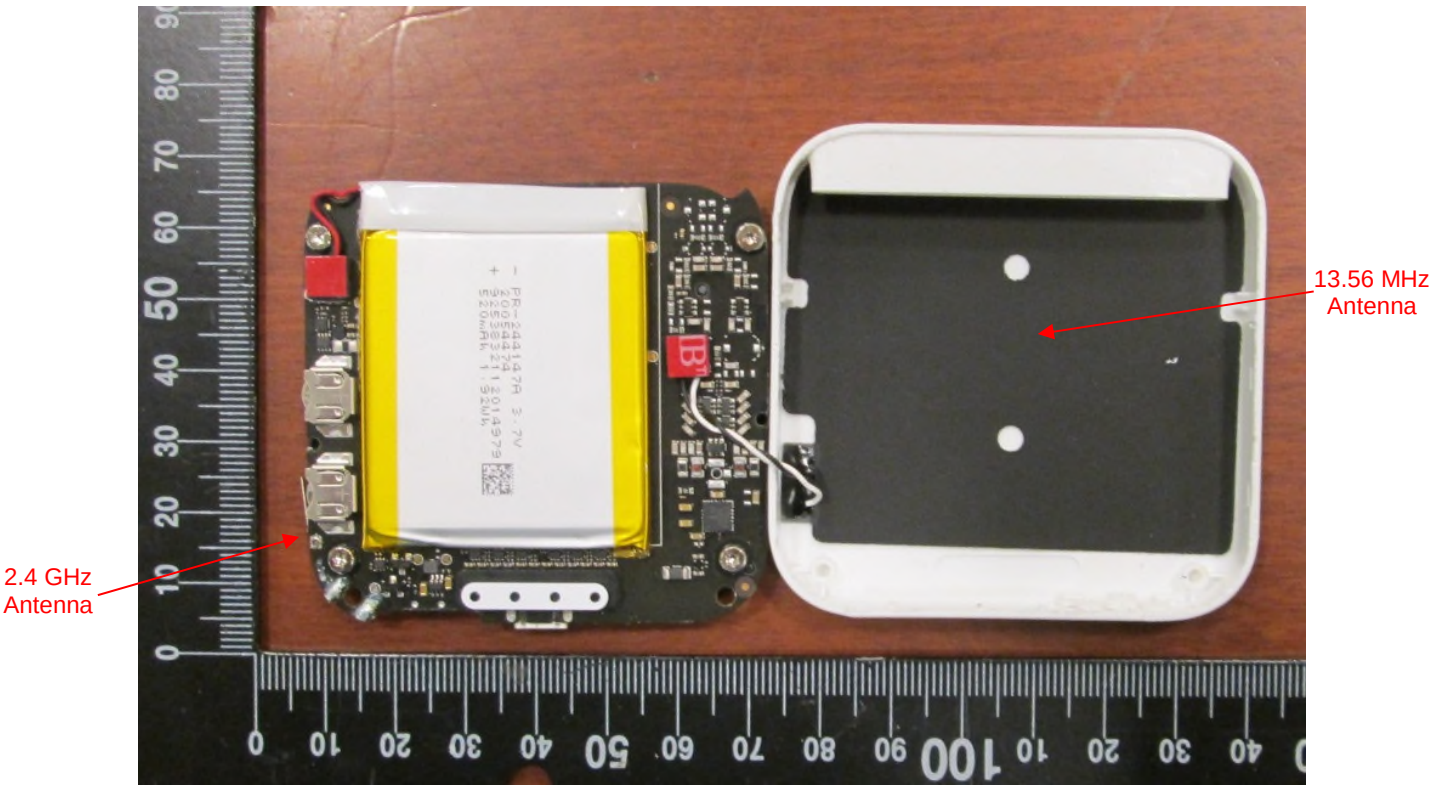
EUT – Internal view 3
Cage removed.
Cover removed over 13.56 MHz antenna.



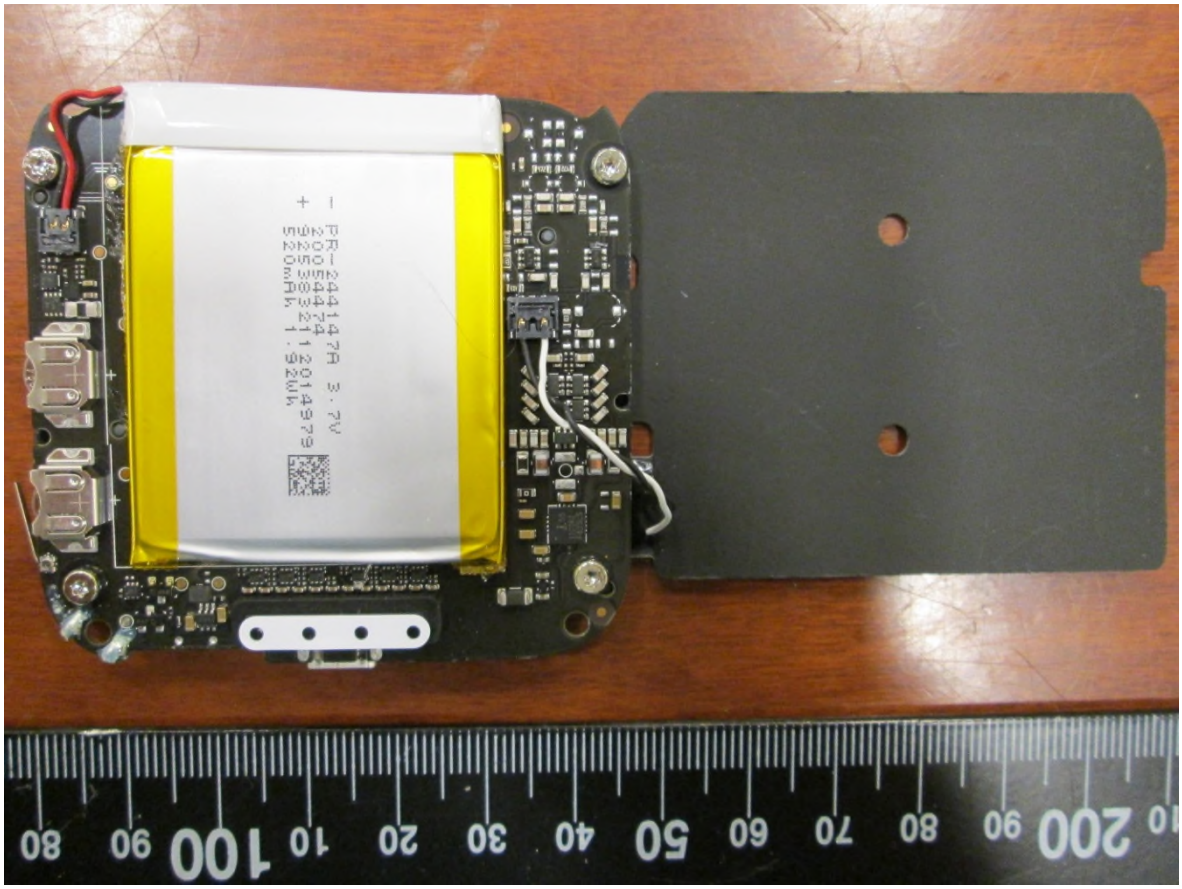
EUT – Internal view 4
Close-up of PCB, side 1



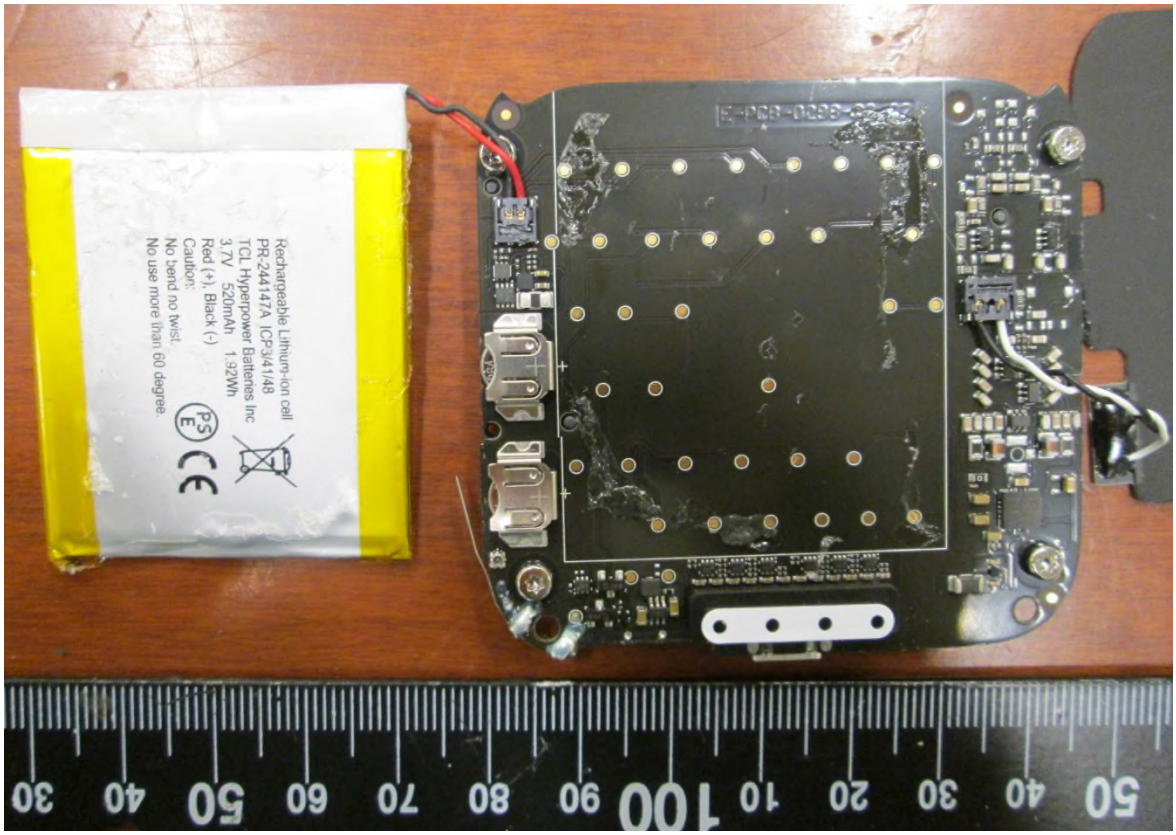
EUT – Internal view 5
Close-up of PCB side 1, alternate view



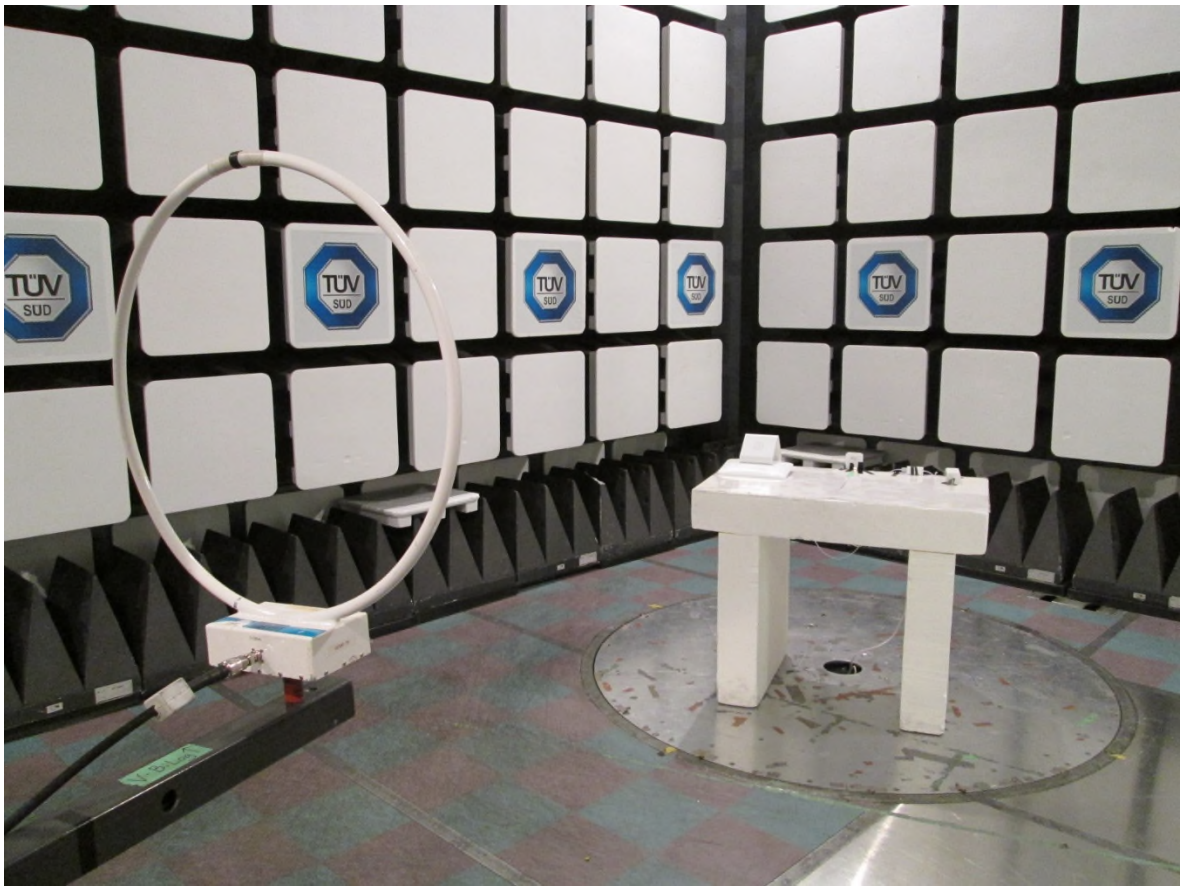
EUT – Internal view 6
PCB removed from enclosure and inverted
PCB side 2 shown.



EUT – Internal view 7
Close-up of PCB side 2.



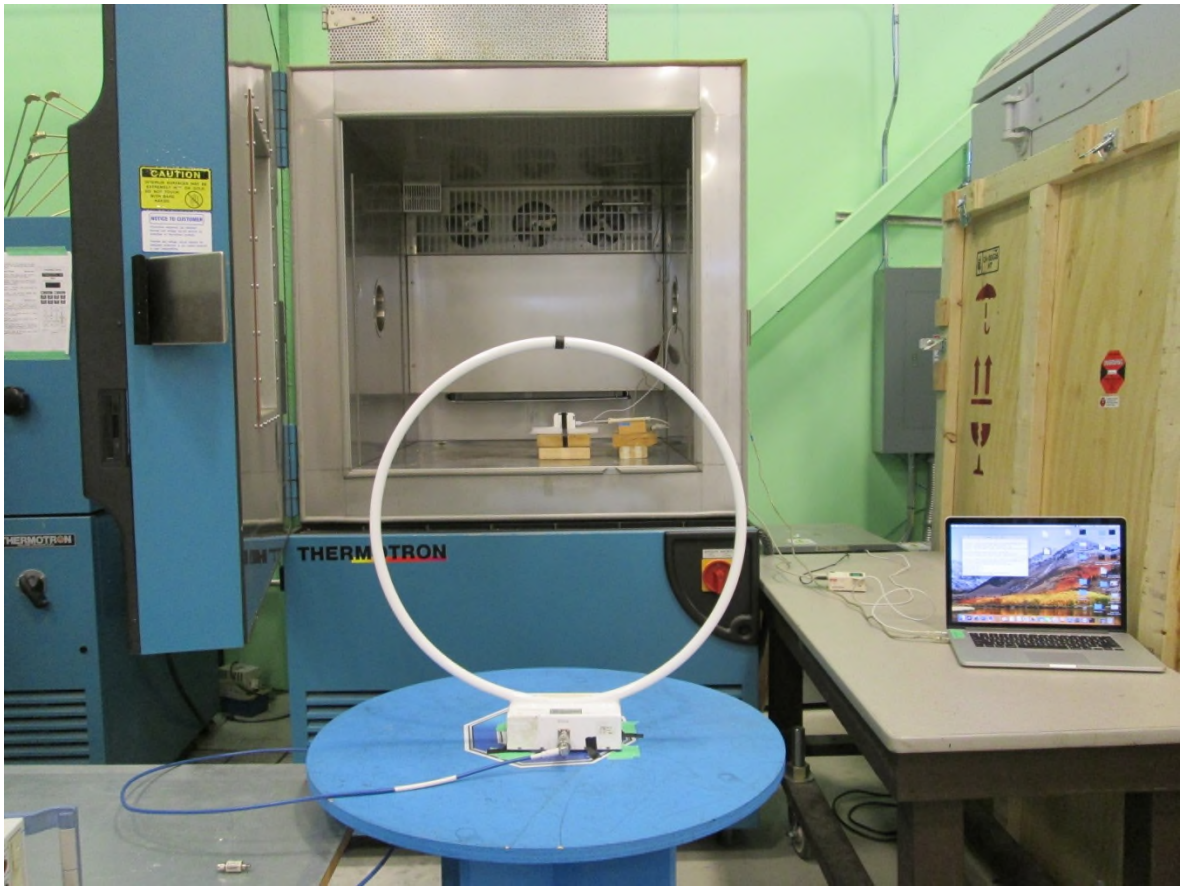
EUT – Internal view 8
Close-up of PCB side 2, with battery moved aside.



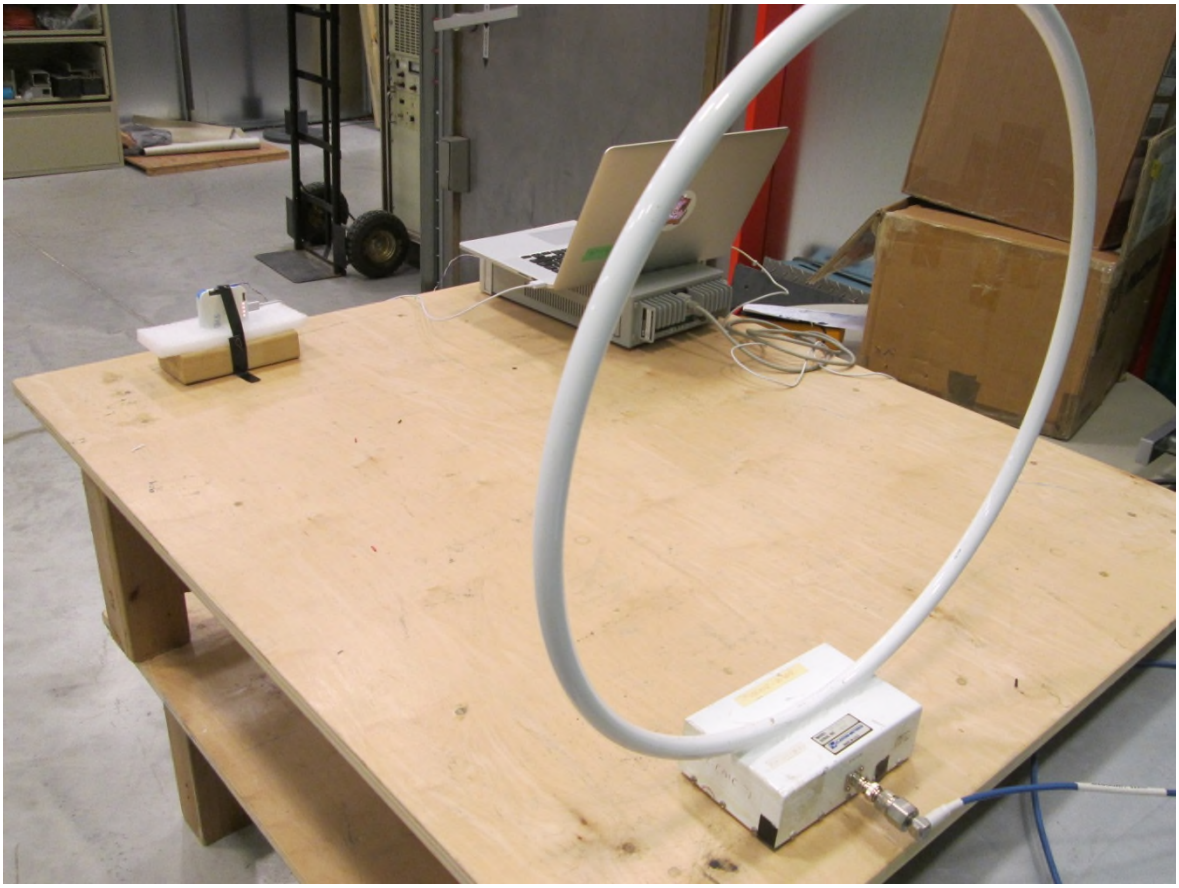
Test setup photo 1
Radiated measurements, 9 kHz – 30 MHz

Test setup photo 2
Radiated measurements, 30 MHz – 1 GHz

Test setup photo 3
Power line conducted emissions measurements



Test setup photo 4
Frequency Stability at Extreme Temperatures



Test setup photo 5
Frequency Stability at Extreme Voltages