# RF Test Report

As per

# RSS-210 Issue 9:2016
# &
# FCC Part 15 Subpart 15.209:2017

**Low Power Licence Exempt Radio Communication Devices Intentional Radiators**

on the

# UNT1422 RFID Module
# 125 kHz

Issued by:

**TÜV SÜD Canada Inc.**
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Raymond Lee Au,
Project Engineer

Testing produced for

See Appendix A for full client & EUT details.

Industry Canada
**Registration # 6844A-3**

Testing Laboratory
Certificate #2955.02

**R-14023, G-20072**
**C-14498, T-20060**

**Registration # CA6844**

# Table of Contents

# Report Scope

This report addresses the EMC verification testing and test results of the **UNT1422 RFID Module (125 kHz)**, and is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-210 Issue 9:2016

FCC Part 15 Subpart C 15.209:2017

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 | UNT1422 |
| FCC Certification #, FCC ID: | 2AJLM-UNT1422 |
| Industry Canada Certification #, IC: | 21879-UNT1422 |
| 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<br>See<br>Justification |
| FCC 15.209<br>RSS-GEN (Table 4) | Transmitter Spurious<br>Radiated Emissions | Quasi-Peak | Pass |
| **Overall Result** | | | **Pass** |

If the product as tested complies with the specification or requirement, the EUT is deemed to comply and is issued a 'PASS' grade. If not, 'FAIL' grade is issued.

## *Notes, Justifications, or Deviations*

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

This report incorporates test results performed after changes to the EUT were made by the manufacturer. The antenna was changed, the shield over non-RF portions of the module is removed (the shield over the RF circuitry remains), and minor changes were made to the PCB shape to allow it to fit within other dimensions. As per the manufacturer, the updated unit is otherwise unchanged, and electrically equivalent to the previously certified unit.

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), with its long edge resting on the test surface. See *Appendix B* for test photos.

The EUT is a wireless NFC RFID module capable of operating at 13.56 MHz and 125 kHz. This report deals with the 125 kHz characteristics. See report # 7169006767R-1356-000 for the 13.56 MHz characteristics (tested to FCC 15.225).

For the antenna requirement specified in FCC 15.203, the unit used a custom loop antenna which is also not meant to be replaceable by the user. See EUT photos for reference.

For the Restricted Bands of operation, the EUT is designed to operate at 125 kHz.

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

The EUT is a module that is powered at 5VDC from the host device it will be installed in. It does not connect to any AC mains directly.

### *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 Issue 9:2016 | Licence-Exempt Radio Apparatus: Category I Equipment |
| ISO 17025:2017 | General Requirements for the Competence of Testing and Calibration Laboratories |

# Document Revision Status

Revision 000 November 18, 2019
- 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 20 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-14023, G-20072, C-14498, and T-20060). 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 biennial 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 (°C) | Humidity (%) | Pressure (kPa) |
|---|---|---|---|---|---|
| Oct. 23, 2019 | All | RA | 23.2 | 34.2 | 101.0 |

# 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 limits are defined in FCC Part 15.209(a) and RSS- Gen (Table 5 and Table 6). Method is using a loop antenna and converting to voltage based on the impedance of free space.

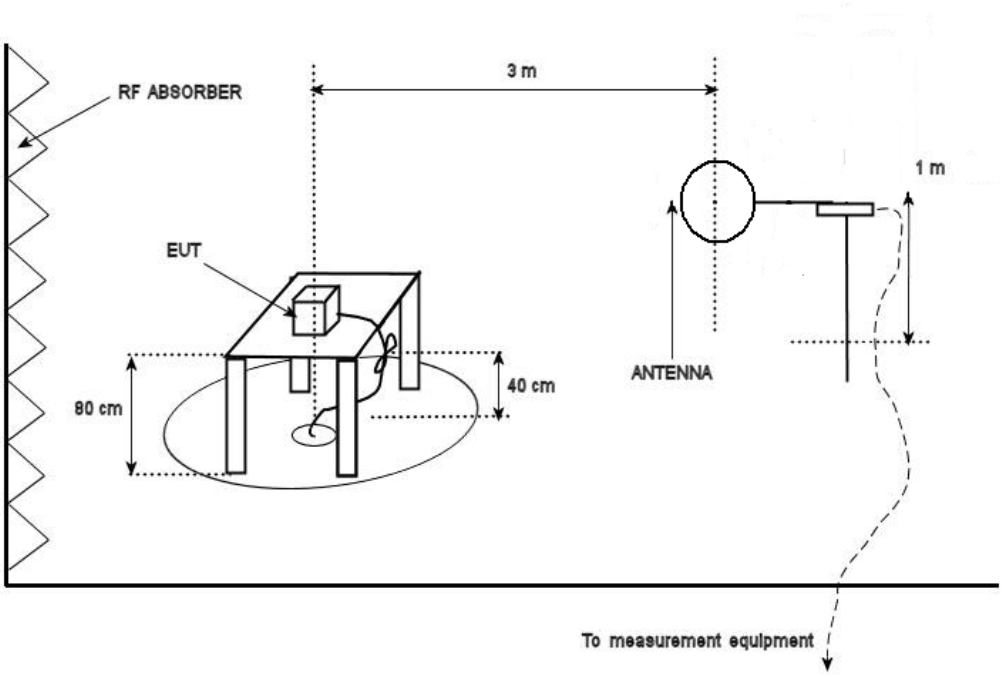
| Fundamental Frequency (kHz) | Field Strength Limit (uV/m) at 300m | Limit (dBuV/m)[1] at 3m |
|---|---|---|
| 125 kHz | 2400/F (kHz) | 105.6 |

[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 300m to 3m is 20Log(uV/m) + 40Log(300m/3m).

**Typical Radiated Emissions Setup**



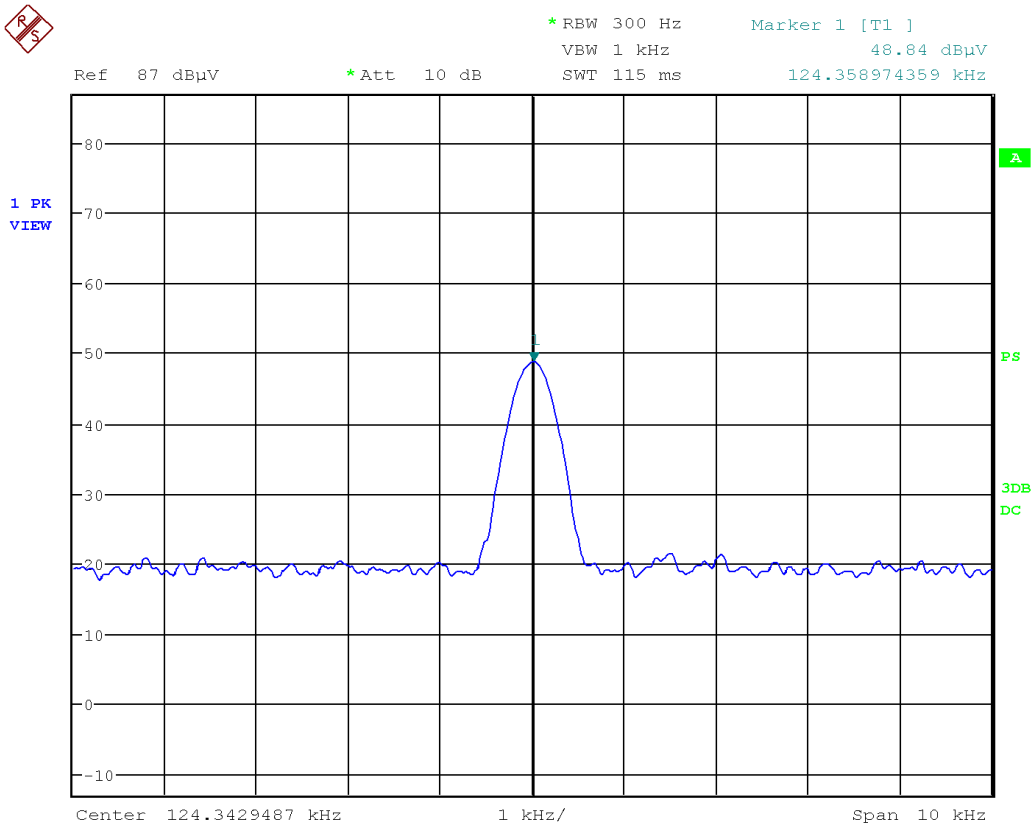

## Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±5.67dB for 30MHz – 1GHz and ±4.58dB 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
125 kHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



## Final Measurements

Radiated Emissions Table - 15.209
Fundamental

| Test Frequency (MHz) | Detection mode | EUT Axis | Received signal (dBµA) | Cable loss + Pre-selector (dB) | dBµA to dBµV conversion factor (dB) | Antenna factor (dB) | Pre-Amp Gain (dB) | Received signal (dBµV/m) | Emission limit (dBµV/m) | Margin (dBµV) | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.1244** | **Peak** | **X** | **48.84** | **0** | **51.5** | **4.2** | **-28.8** | **75.74** | **105.6** | **29.86** | **Pass** |
| 0.1244 | Peak | Y | 48.64 | 0 | 51.5 | 4.2 | -28.8 | 75.54 | 105.6 | 30.06 | Pass |
| 0.1244 | Peak | X | 36.15 | 0 | 51.5 | 4.2 | -28.8 | 63.05 | 105.6 | 42.55 | Pass |

Notes:

See 'Appendix B – EUT 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 | ESU 40 | Rohde & Schwarz | Jan. 12, 2018 | Jan. 12, 2020 | GEMC 233 |
| Loop Antenna 9 – 150 kHz | EM 6871 | Electro-Metrics | Feb 15, 2019 | Feb 15, 2021 | GEMC 70 |
| Pre-Amp 9 kHz – 1 GHz | LNA 6901 | Teseq | Feb. 25, 2019 | Feb. 25, 2021 | GEMC 168 |
| 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.

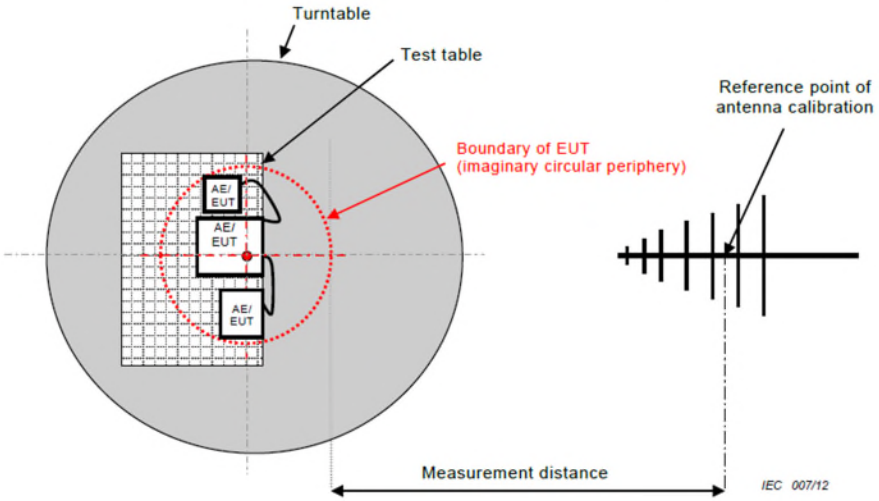
These limits are as follows:

| 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, except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz where an Average detector is used.
[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 ±5.67dB for 30MHz – 1GHz and ±4.58dB 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.

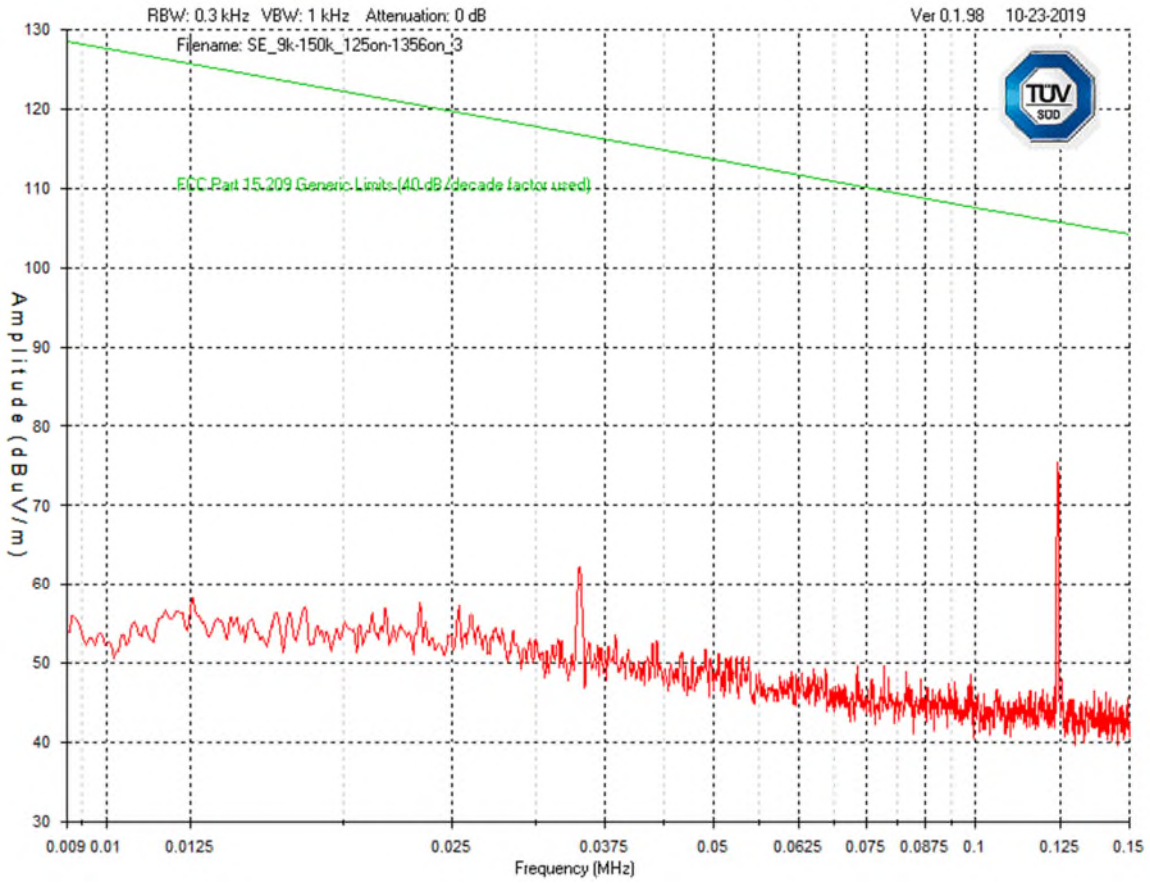
The worst case emissions are found with the EUT in the X-axis, (meaning the EUT is upright, with its long edge resting on the test table). See photos in *Appendix A*.

During testing, both transmitters in the EUT are on and transmitting continuous modulated data at the maximum power setting used by the manufacturer. This presents the worst case spurious emissions scenario.

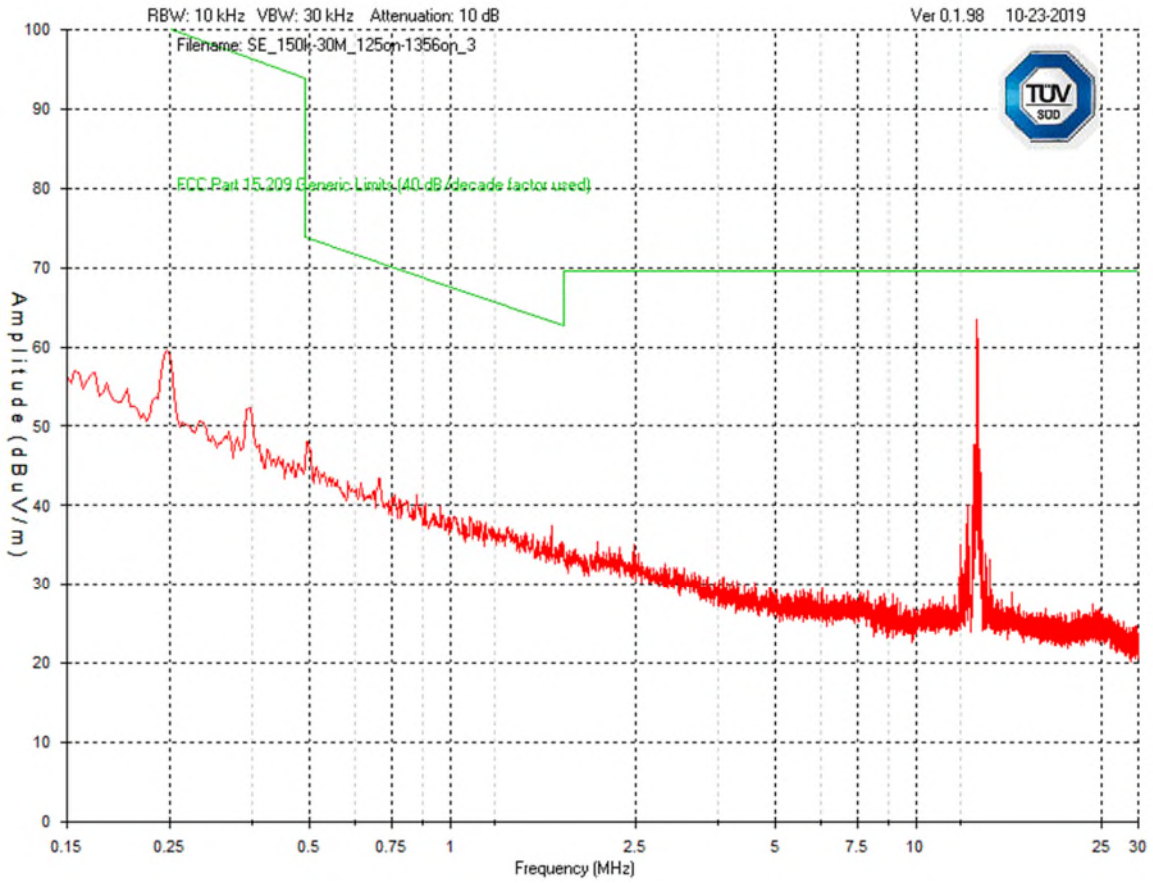
Plots and measurements are made at a 3 meter distance.

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

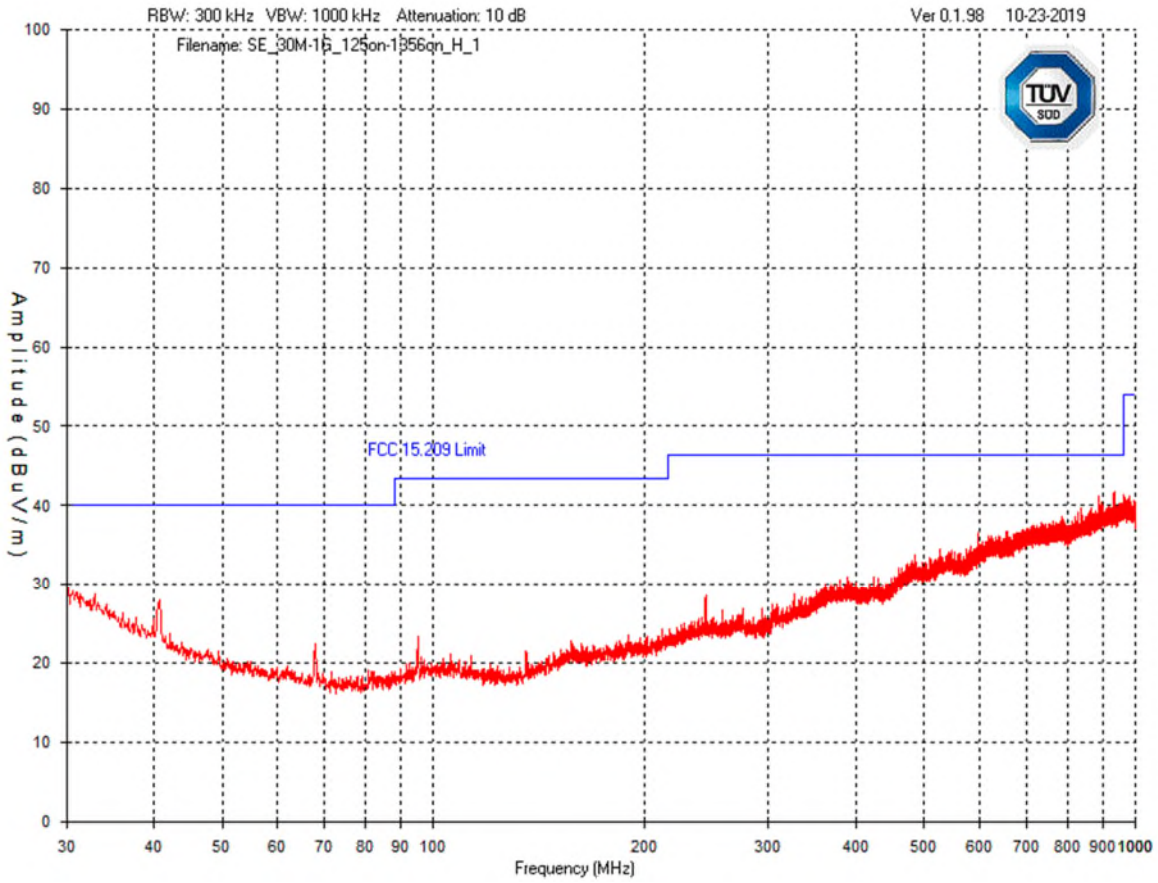
9 kHz – 150 kHz
Peak Emission Graph



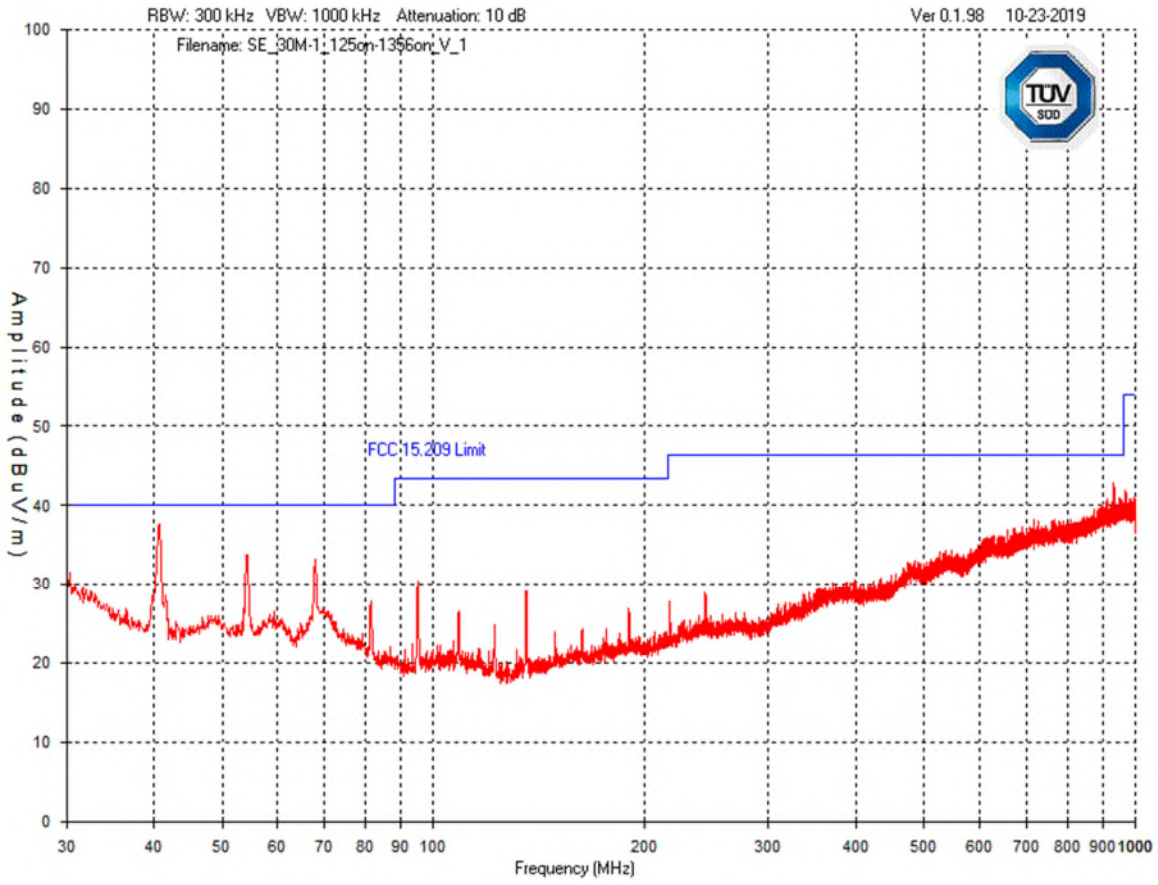
150 kHz – 30 MHz
Peak Emission Graph



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) | Test Result |
|---|---|---|---|---|---|---|---|---|---|---|
| Horizontal Antenna Polarization | | | | | | | | | | |
| 931.64 | PEAK | 35.3 | 29.7 | 0 | 4.8 | -28.1 | 41.7 | 46.4 | 4.7 | Pass |
| 30.19 | PEAK | 34.6 | 23.0 | 0 | 0.5 | -28.5 | 29.6 | 40.0 | 10.4 | Pass |
| 40.68 | PEAK | 38.2 | 17.7 | 0 | 0.6 | -28.5 | 28.0 | 40.0 | 12.0 | Pass |
| 67.77 | PEAK | 37.7 | 12.5 | 0 | 0.8 | -28.5 | 22.5 | 40.0 | 17.5 | Pass |
| 244.10 | PEAK | 36.7 | 18.6 | 0 | 1.8 | -28.5 | 28.6 | 46.4 | 17.8 | Pass |
| 95.06 | PEAK | 37.2 | 13.7 | 0 | 0.9 | -28.5 | 23.3 | 43.5 | 20.2 | Pass |
| Vertical Antenna Polarization | | | | | | | | | | |
| 40.68 | QP | 47.0 | 17.7 | 0 | 0.6 | -28.5 | 36.8 | 40.0 | 3.2 | Pass |
| 931.45 | PEAK | 36.5 | 29.7 | 0 | 4.8 | -28.1 | 42.9 | 46.4 | 3.5 | Pass |
| 54.27 | PEAK | 47.8 | 13.8 | 0 | 0.7 | -28.5 | 33.8 | 40.0 | 6.2 | Pass |
| 67.77 | PEAK | 48.3 | 12.5 | 0 | 0.8 | -28.5 | 33.1 | 40.0 | 6.9 | Pass |
| 30.29 | PEAK | 36.6 | 23.0 | 0 | 0.5 | -28.5 | 31.6 | 40.0 | 8.4 | Pass |
| 81.46 | PEAK | 43.1 | 12.3 | 0 | 0.9 | -28.5 | 27.8 | 40.0 | 12.2 | Pass |

Notes:

PEAK = Peak measurement
QP = Quasi-Peak measurement

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 9 – 150 kHz | EM 6871 | Electro-Metrics | Feb 15, 2019 | Feb 15, 2021 | GEMC 70 |
| Loop Antenna 150 kHz – 30 MHz | EM 6872 | Electro-Metrics | Feb 15, 2019 | Feb 15, 2021 | GEMC 71 |
| BiLog Antenna 30 – 1000 MHz | 3142-C | ETS | Oct. 19, 2018 | Oct. 19, 2020 | GEMC 8 |
| Pre-Amp 9 kHz – 1 GHz | LNA 6901 | Teseq | Feb. 25, 2019 | Feb. 25, 2021 | GEMC 168 |
| 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 |

FCC - 15.209 -Radiated Emissions_Rev1

# Appendix A – EUT Summary

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

## General EUT Description

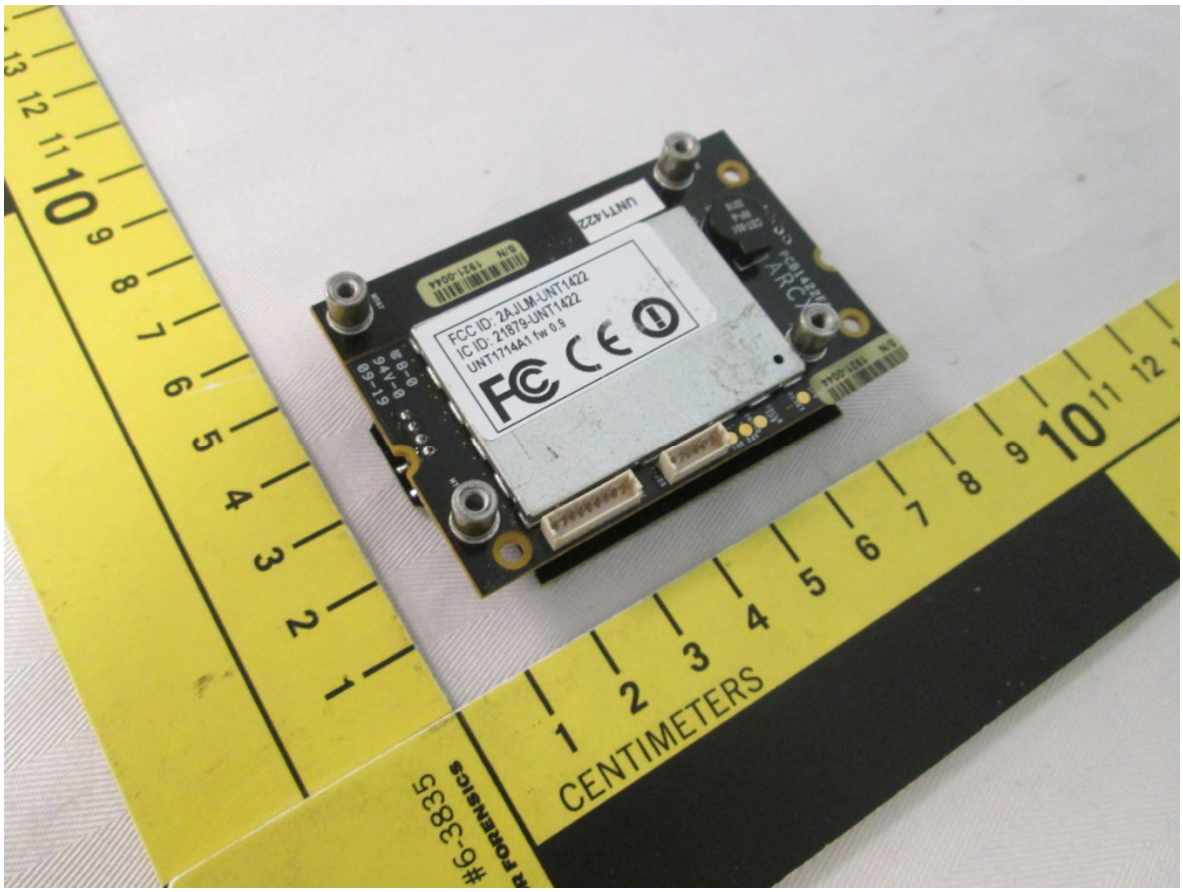
| **Client** | |
|---|---|
| Organization / Address | ARCX Inc.<br>151 Amber Street, Unit 16<br>Markham, Ontario<br>L3R 3B3, Canada |
| Phone | 905-513-9160 |
| **EUT Details** | |
| EUT Name | UNT1422 |
| Equipment Category | RFID Module |
| Basic EUT Functionality | RFID Module to allow contactless communication with RFID cards and tags. |
| Input Voltage and Frequency | 5VDC<br>(Tested with an AC/DC USB adaptor powered at 120Vac/60Hz) |
| Connectors available on EUT | None |
| Peripherals Required for Test | 125kHz RFID card |
| Release type | Final |
| Intentional Radiator Frequency | 125kHz and 13.56MHz for RFID applications |
| EUT Configuration | Wireless configured to transmit continuously at 100% duty cycle |

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see 'Appendix B – EUT and Test Setup Photos'.

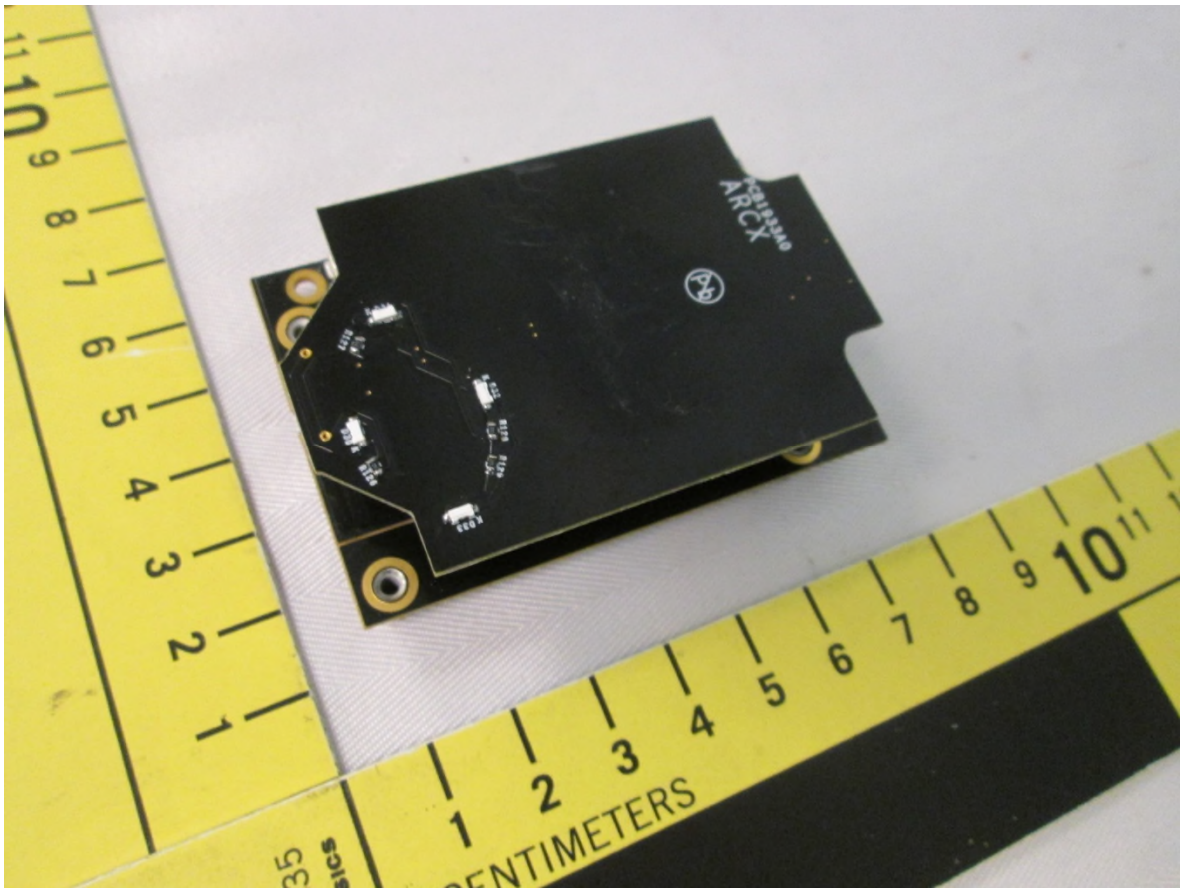
# Appendix B – EUT and Test Setup Photos

Note: Also refer to photo documentation files separate from this test report.

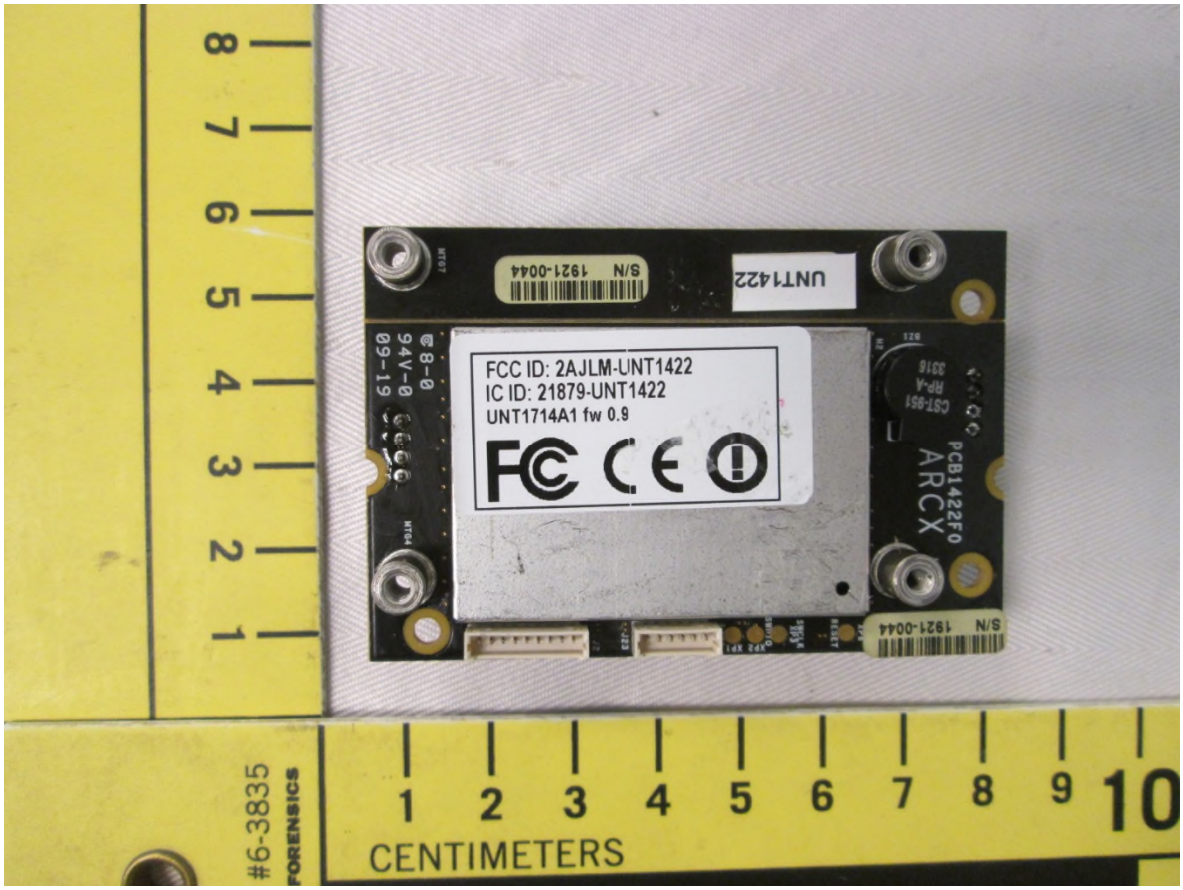
EUT – External view 1



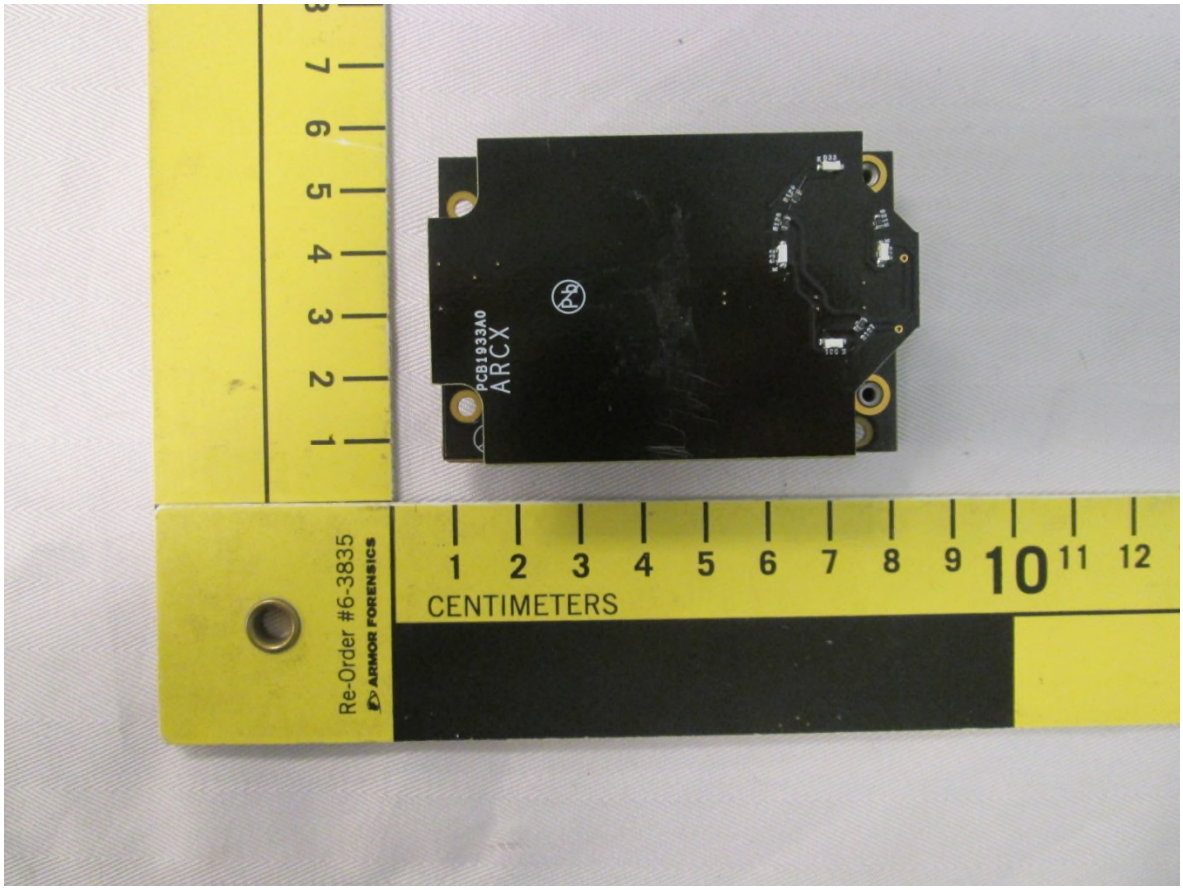
EUT – External view 2



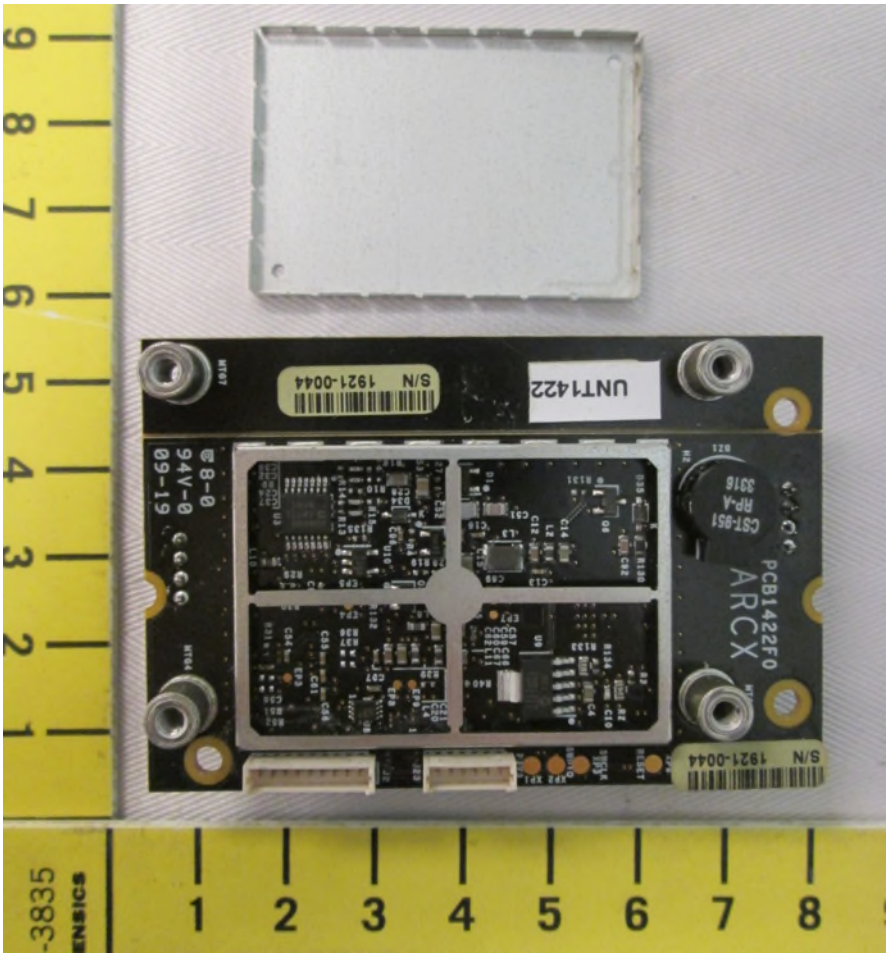
EUT – External view 3
PCB 1, main board, side 1



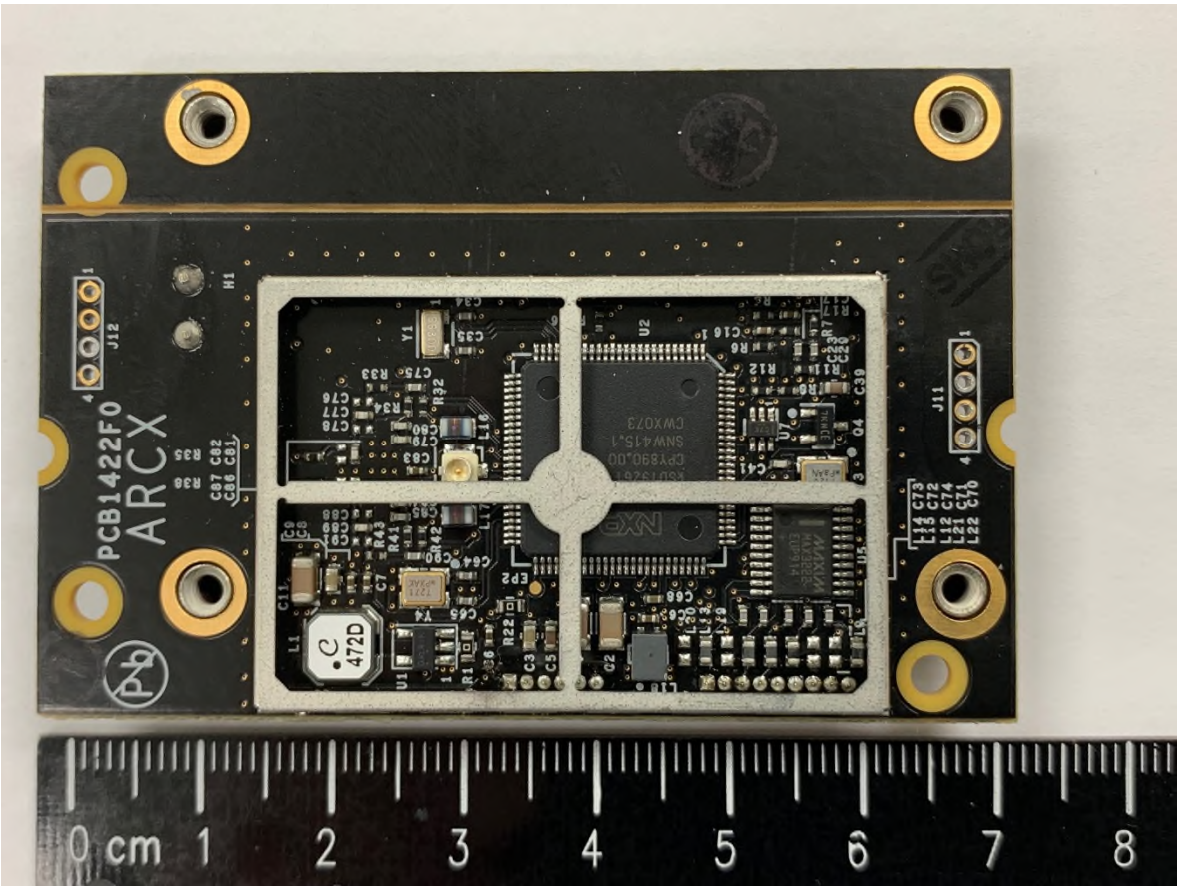
EUT – External view 4
PCB 2, antenna board side 1



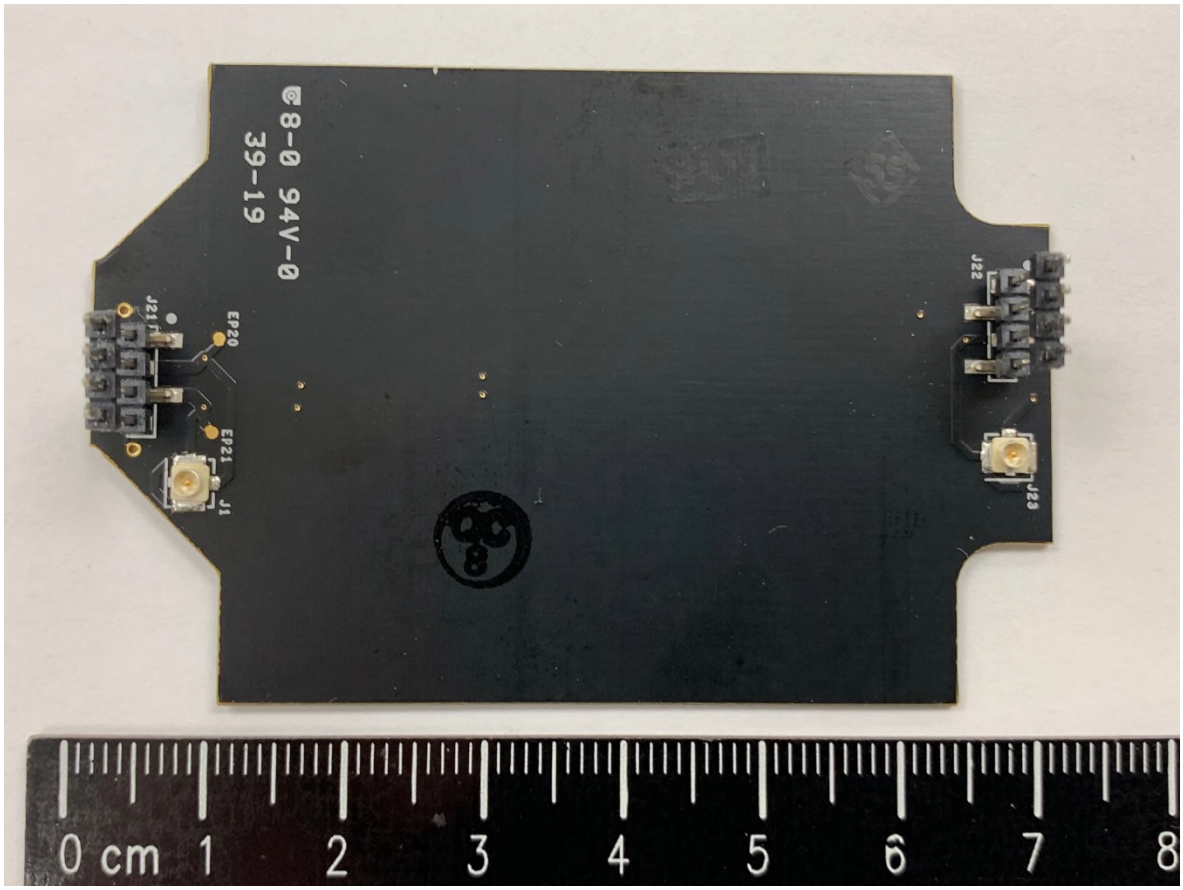
EUT – Internal view 1
PCB 1, main board, side 1, shield removed



EUT – Internal view 2
PCB 1, main board, side 2



EUT – Internal view 3
PCB 2, antenna board, side 2



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

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