RF Test Report

As per

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

Low Power Licence Exempt Radio Communication Devices Intentional Radiators

on the

UNT1422 RFID Module
13.56 MHz

Issued by:

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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

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Report Scope

This report addresses the EMC verification testing and test results of the **UNT1422 RFID Module (13.56 MHz)**, 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, Annex B

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.

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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".

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Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.225 (a), (b), (c) RSS-210 B.6	Operation within the band 13.110-14.010 MHz (Field Strength)	--	Pass
FCC 15.225 (d) FCC 15.209 RSS-GEN (Table 4)	Transmitter Spurious 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.

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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 13.56 MHz characteristics. See report # 7169006767R-125-000 for the 125 kHz characteristics (tested to FCC 15.209).

For the Restricted Bands of operation, the EUT is designed to 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.

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

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

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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

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Document Revision Status

Revision 000 November 18, 2019
- Initial Release

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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

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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.

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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)
Oct. 23, 2019	All	RA	23.2	34.2	101.0

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Detailed Test Results Section

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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).

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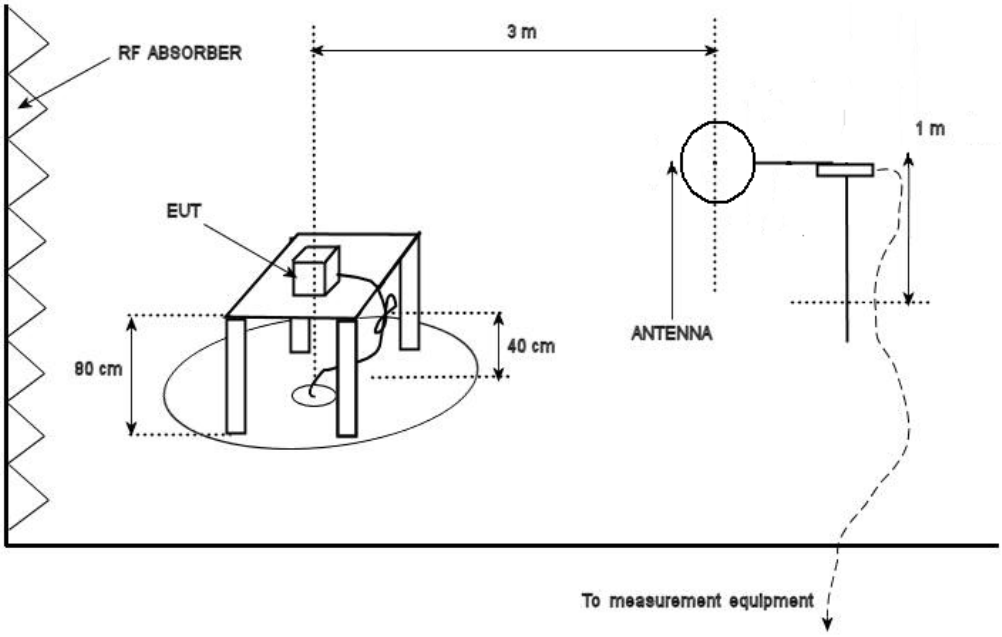
Typical Radiated Emissions Setup



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.

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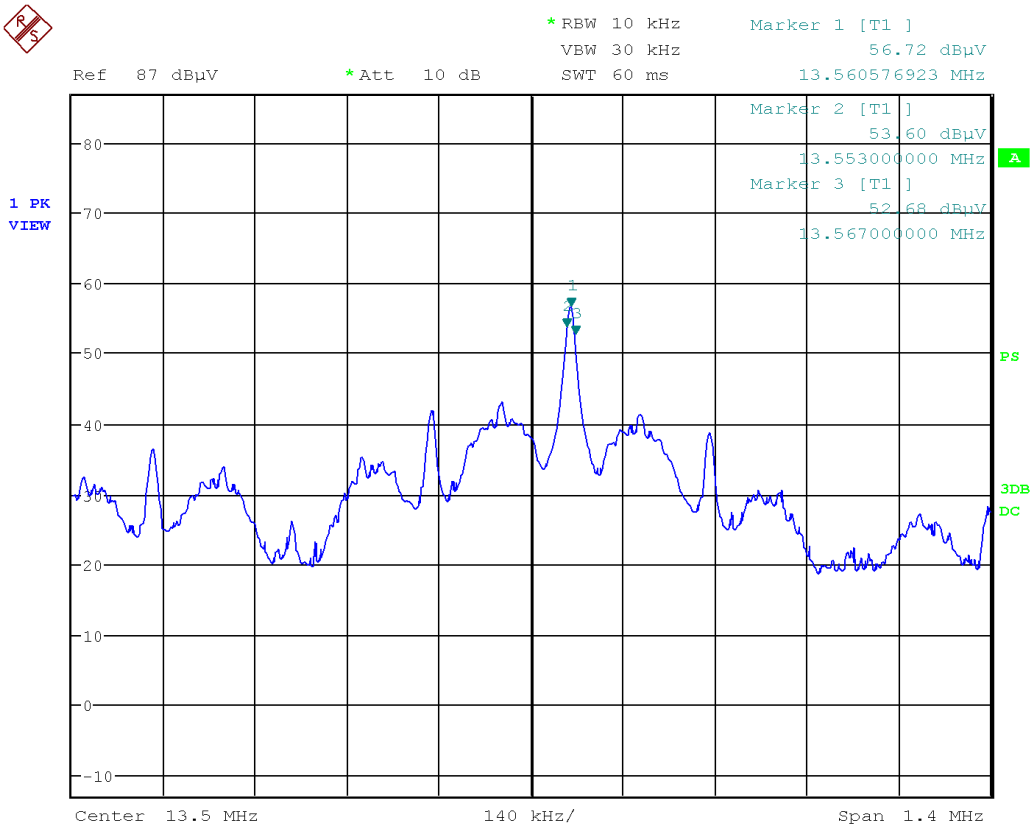
Peak Emission
Max Fundamental Emission & Band Edges
13.553-13.567 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



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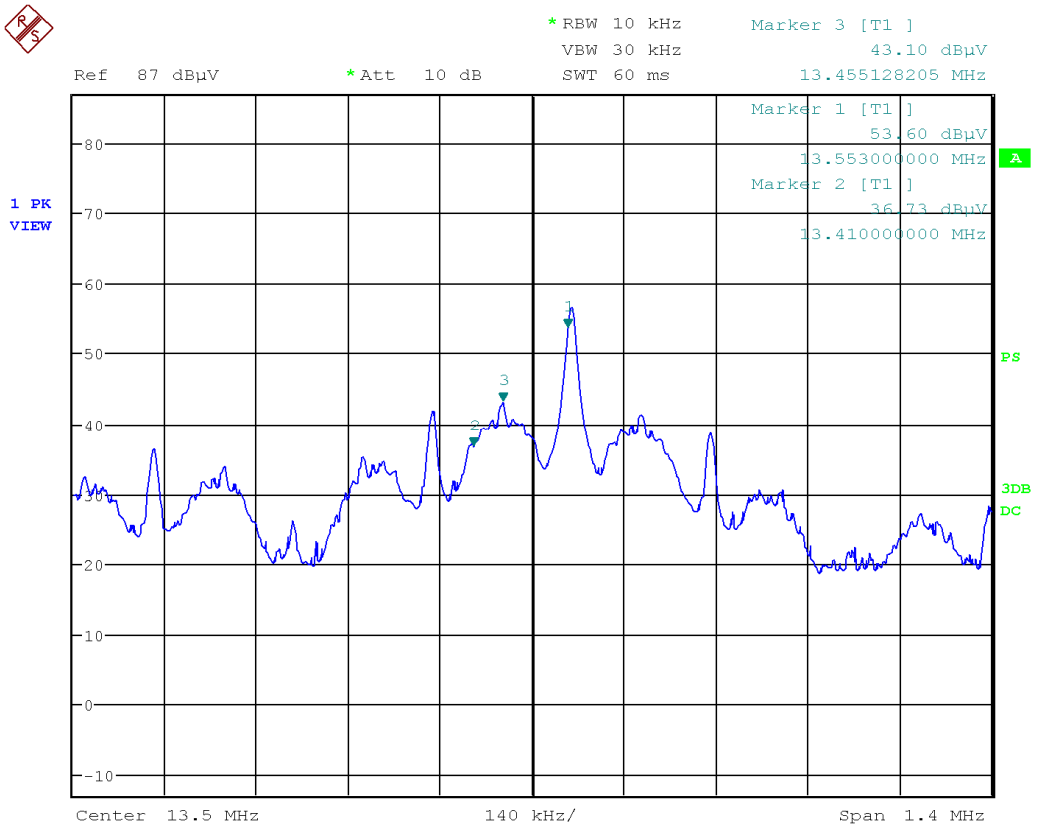
Peak Emission
Band Edges
13.410-13.553 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



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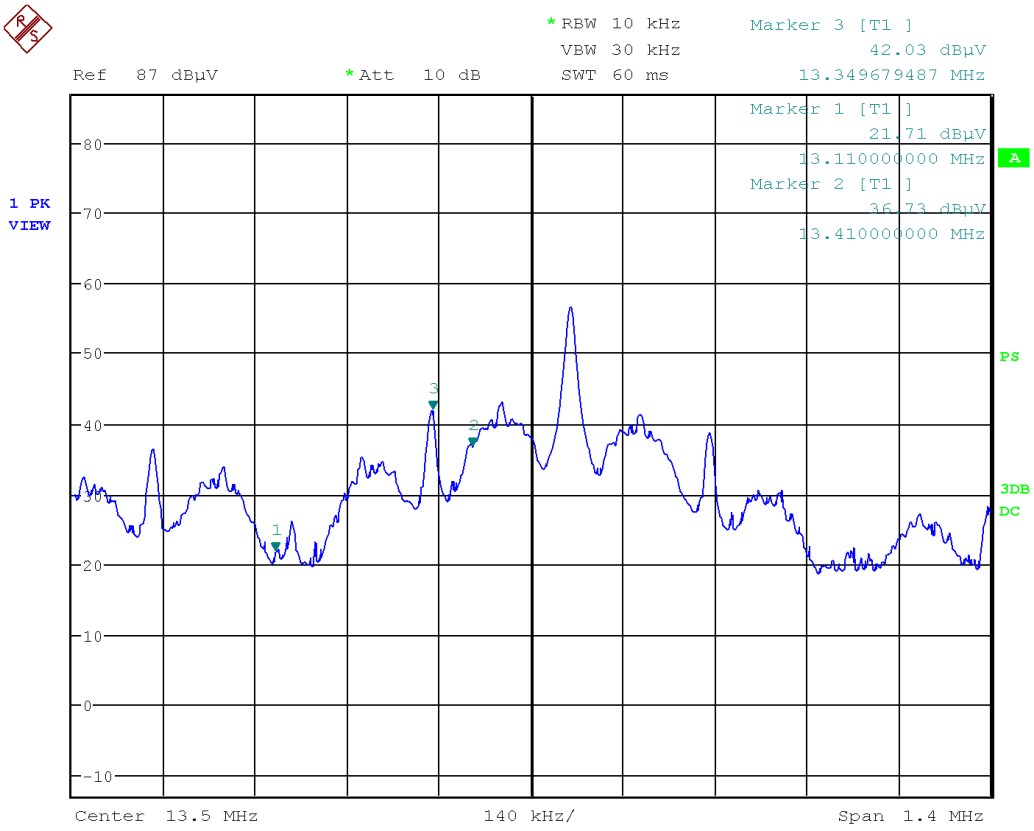
Peak Emission
Band Edges
13.110-13.410 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



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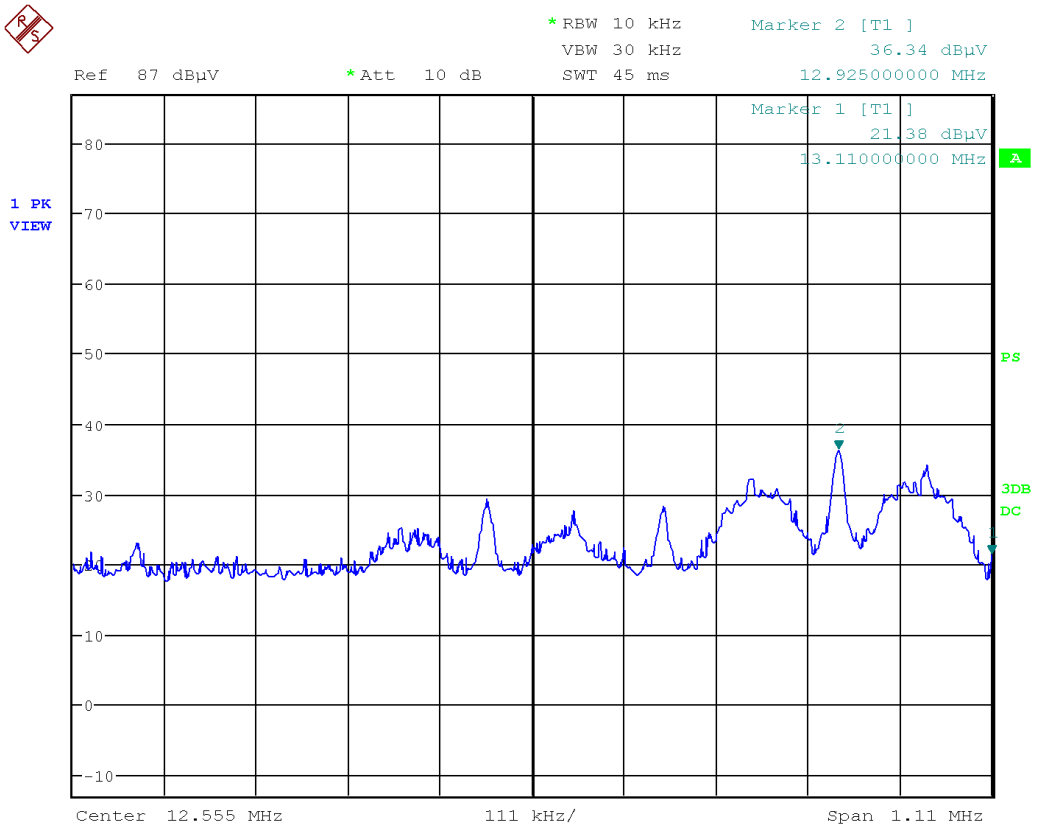
Peak Emission
Band Edges
< 13.110 MHz
3m test distance
(Factors not incorporated. See *Final Measurements*.)



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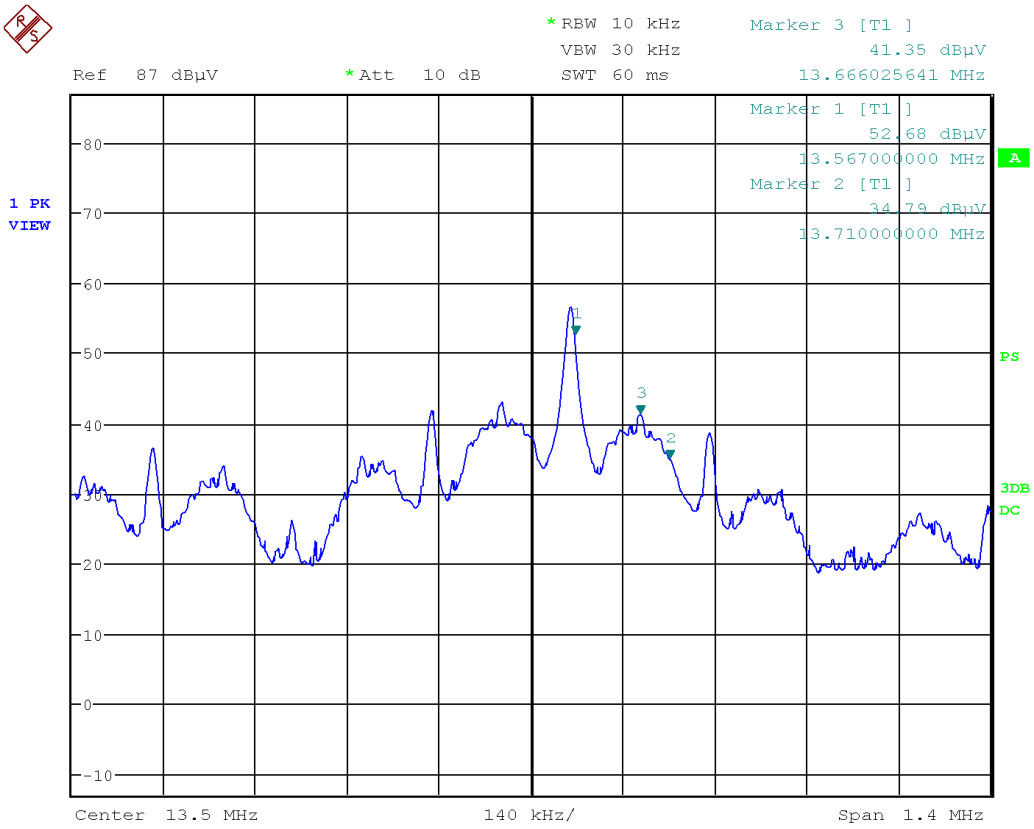
Peak Emission
Band Edges
13.567-13.710 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



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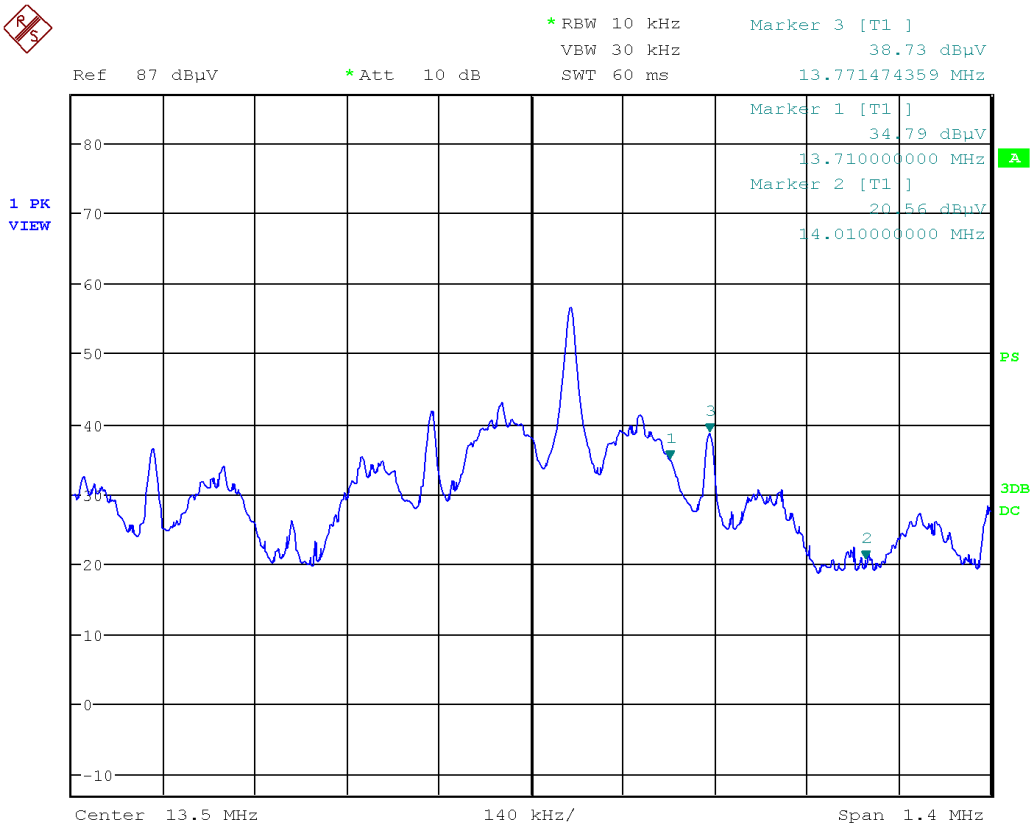
Peak Emission
Band Edges
13.710-14.010 MHz
3m test distance
(Factors not incorporated. See *Final Measurements*.)



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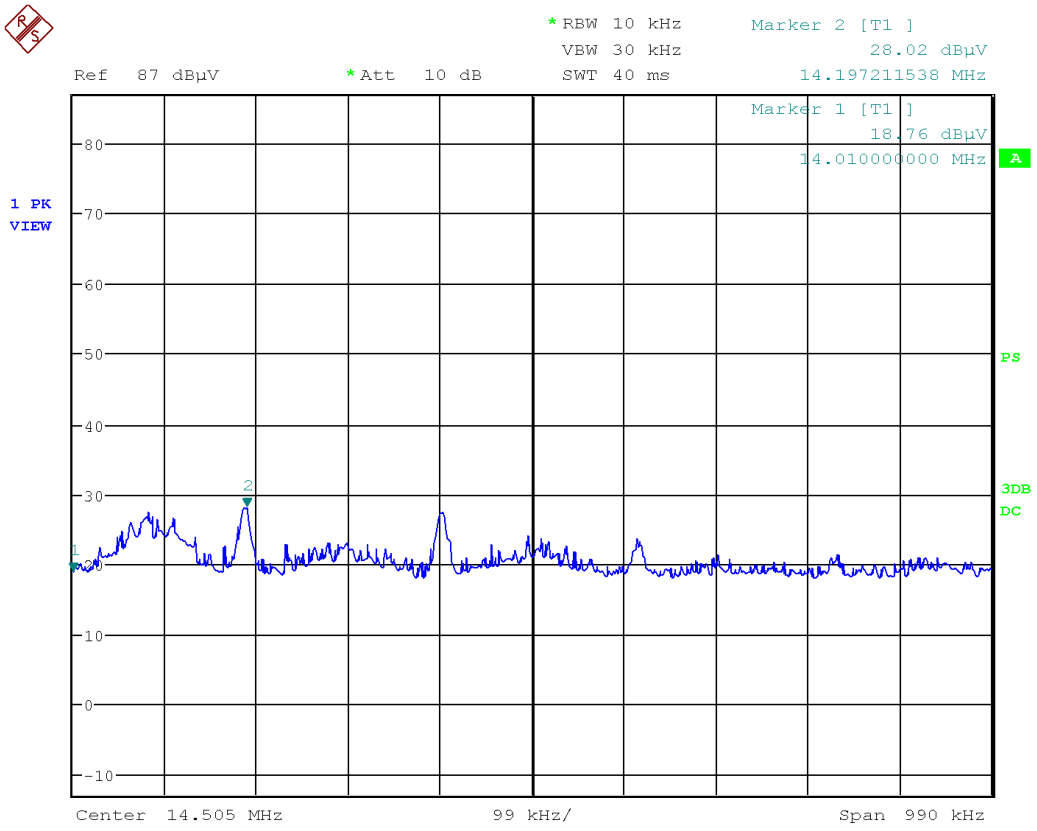
Peak Emission
Band Edges
> 14.010 MHz
3m test distance
(Factors not incorporated. See *Final Measurements.*)



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Final Measurements

Radiated Emissions Table - 15.225
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
13.5606	**Peak**	**X**	**56.72**	**0.4**	**51.5**	**-16.7**	**-28.5**	**63.42**	**124.0**	**60.58**	**Pass**
13.5606	Peak	Y	56.6	0.4	51.5	-16.7	-28.5	63.3	124.0	60.7	Pass
13.5606	Peak	Z	44.04	0.4	51.5	-16.7	-28.5	50.74	124.0	73.26	Pass

Radiated Emissions Table - 15.225
Band Edges

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
12.925	Peak	X	36.34	0.4	51.5	-16.8	-28.5	42.94	69.5	26.56	Pass
13.110	Peak	X	21.71	0.4	51.5	-16.8	-28.5	28.31	69.5	41.19	Pass
13.350	Peak	X	42.03	0.4	51.5	-16.8	-28.5	48.63	80.5	31.87	Pass
13.410	Peak	X	36.73	0.4	51.5	-16.8	-28.5	43.33	80.5	37.17	Pass
13.455	Peak	X	43.1	0.4	51.5	-16.8	-28.5	49.7	90.5	40.8	Pass
13.553	Peak	X	53.6	0.4	51.5	-16.7	-28.5	60.3	90.5	30.2	Pass
13.567	Peak	X	52.68	0.4	51.5	-16.7	-28.5	59.38	90.5	31.12	Pass
13.666	Peak	X	41.35	0.4	51.5	-16.7	-28.5	48.05	90.5	42.45	Pass
13.710	Peak	X	34.79	0.4	51.5	-16.7	-28.5	41.49	80.5	39.01	Pass
13.771	Peak	X	38.73	0.4	51.5	-16.7	-28.5	45.43	80.5	35.07	Pass
14.010	Peak	X	20.56	0.4	51.5	-16.7	-28.5	27.26	69.5	42.24	Pass
14.197	Peak	X	28.02	0.4	51.5	-16.7	-28.5	34.72	69.5	34.78	Pass

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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 15, 2019	Feb 15, 2021	GEMC 71
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

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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.

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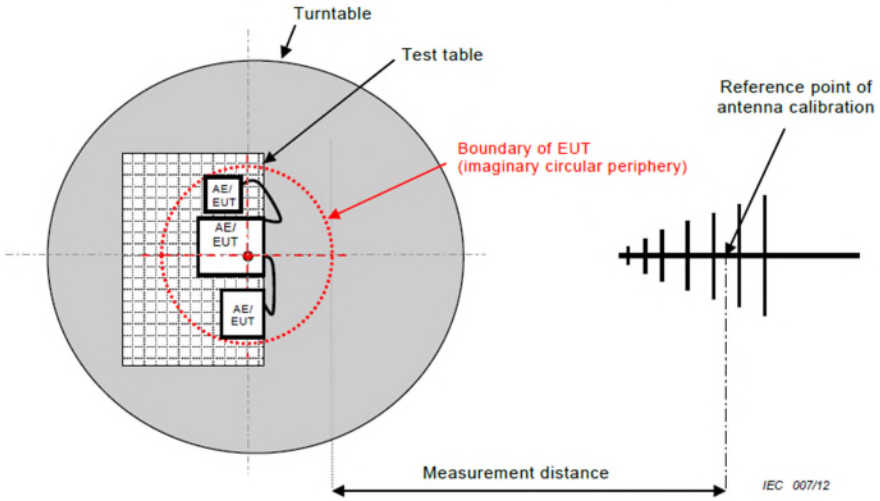
Typical Radiated Emissions Setup



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 10th 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*.

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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.

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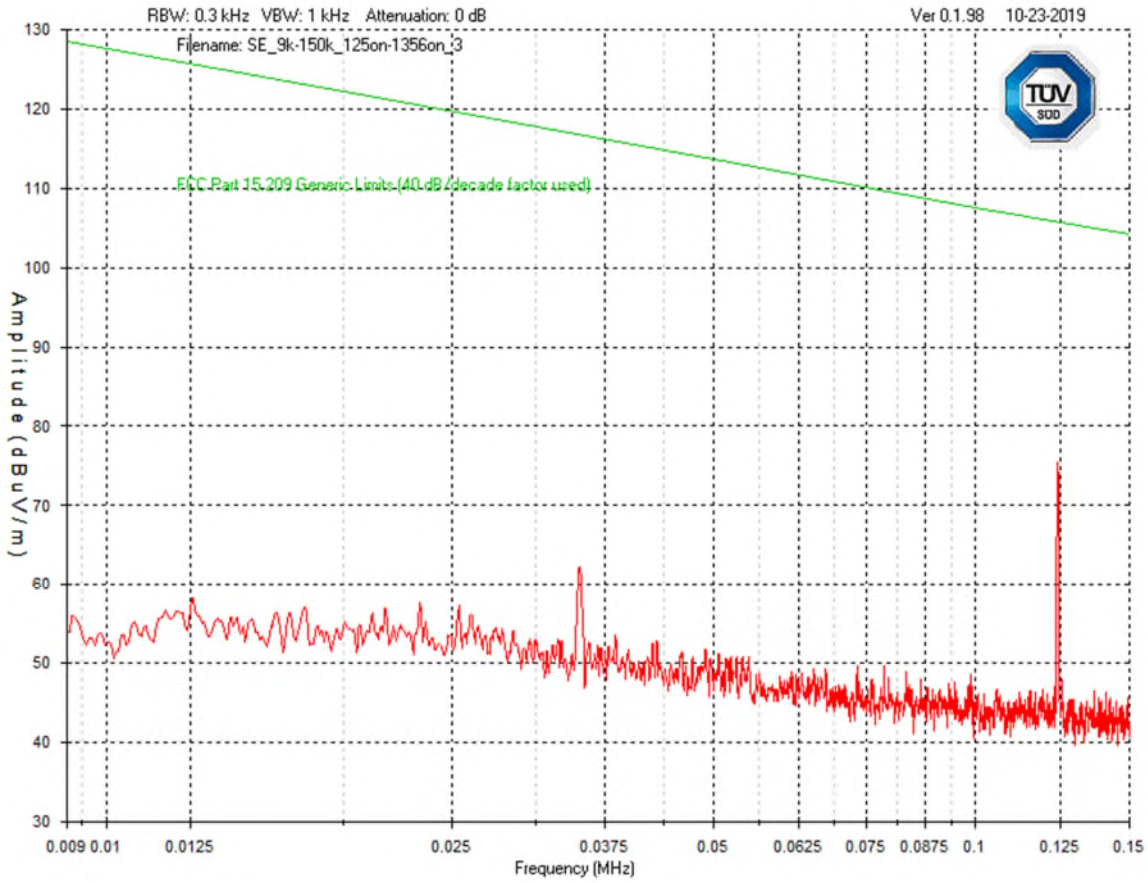
9 kHz – 150 kHz
Peak Emission Graph



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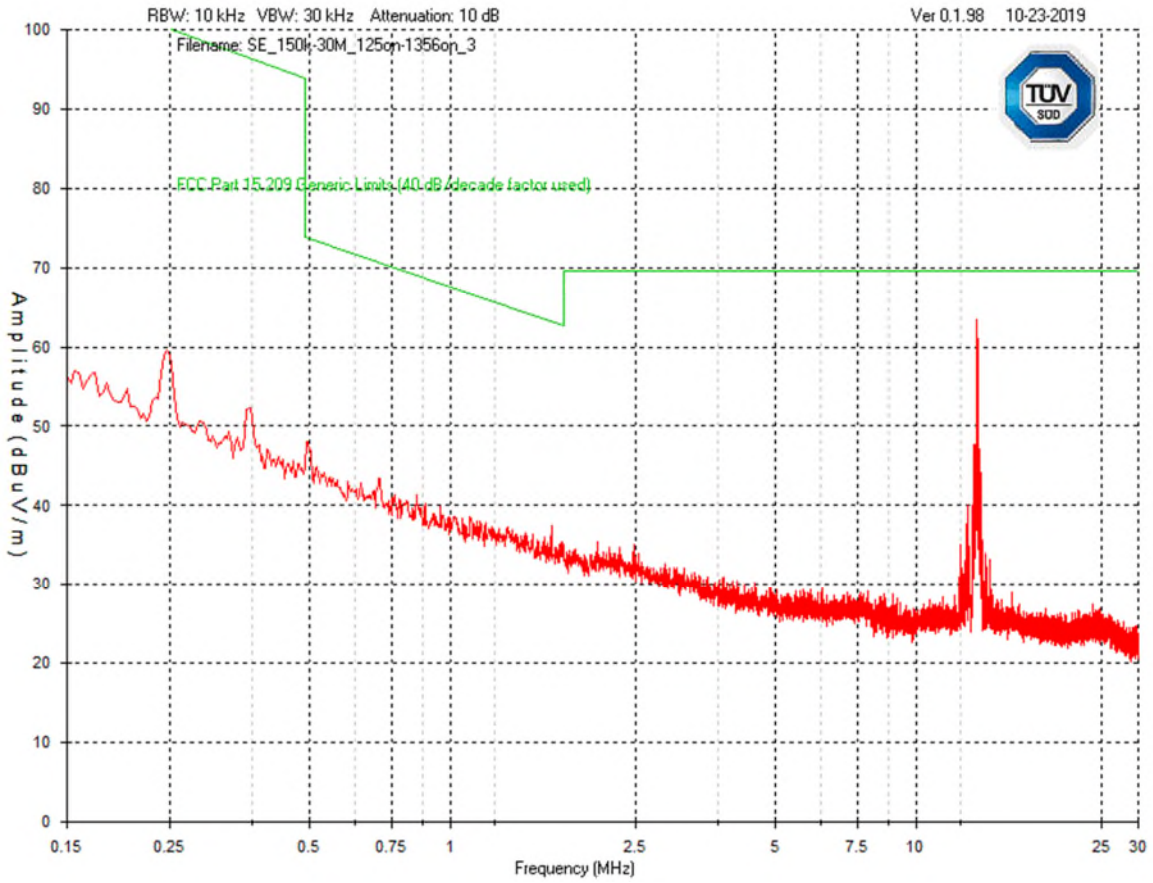
150 kHz – 30 MHz
Peak Emission Graph



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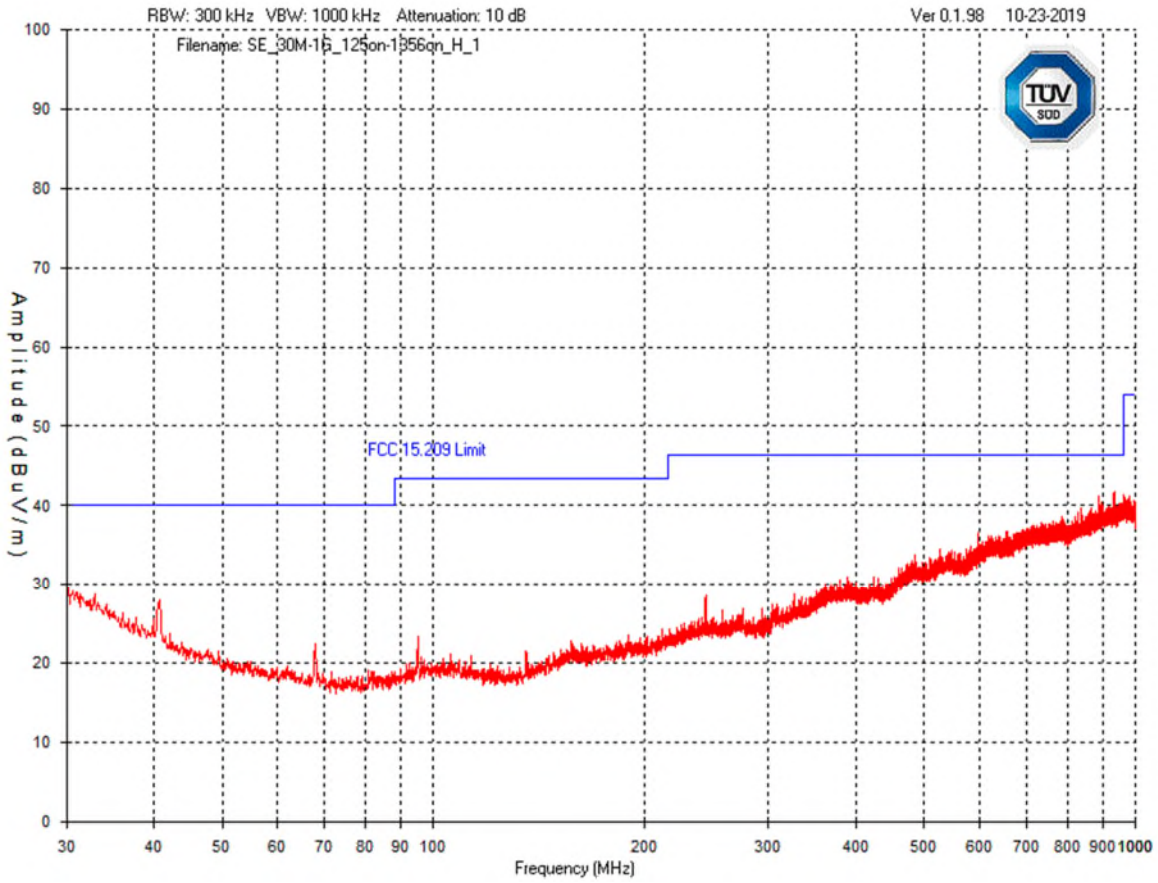
30 MHz – 1 GHz
Horizontal - Peak Emission Graph



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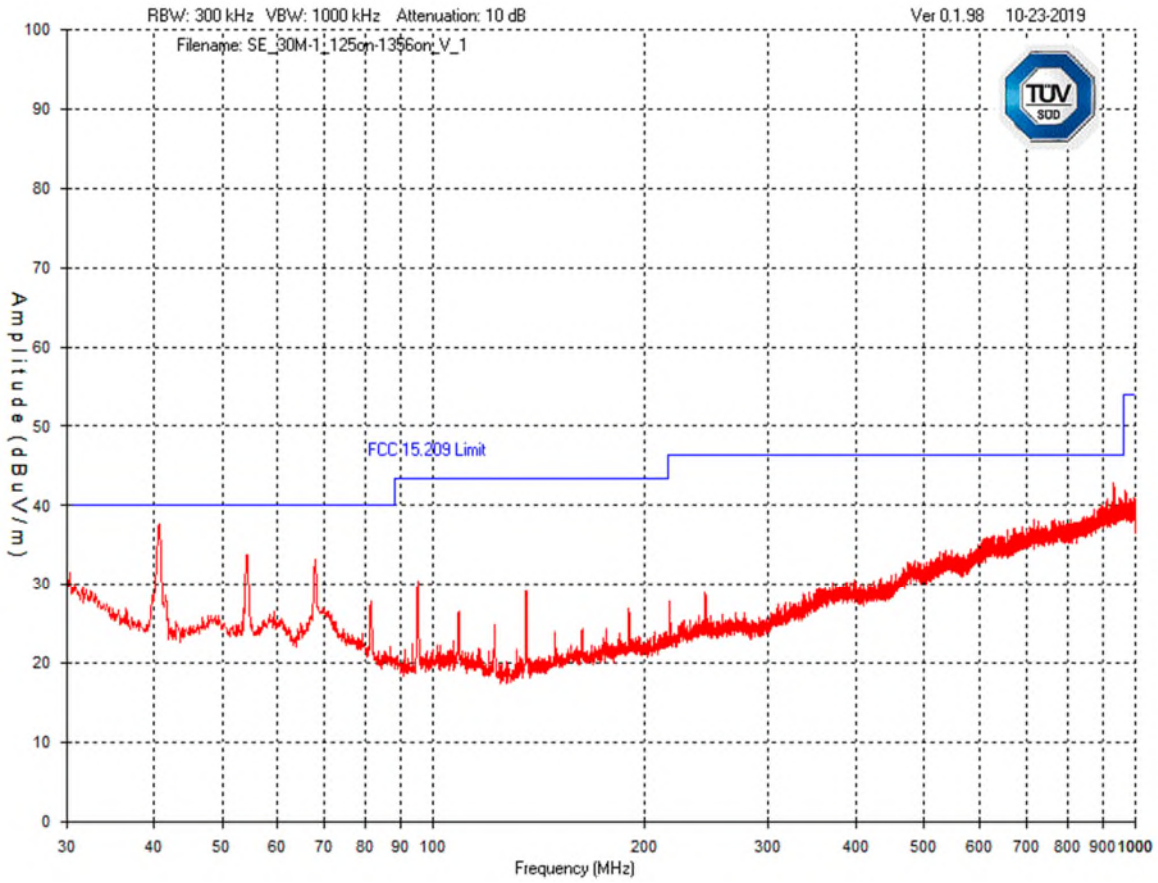
30 MHz – 1 GHz
Vertical - Peak Emission Graph



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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.

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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

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Appendix A – EUT Summary

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

General EUT Description

Client	
Organization / Address	ARCX Inc. 151 Amber Street, Unit 16 Markham, Ontario 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 (Tested with an AC/DC USB adaptor powered at 120Vac/60Hz)
Connectors available on EUT	None
Peripherals Required for Test	13.56MHz 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’.

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Appendix B – EUT and Test Setup Photos

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

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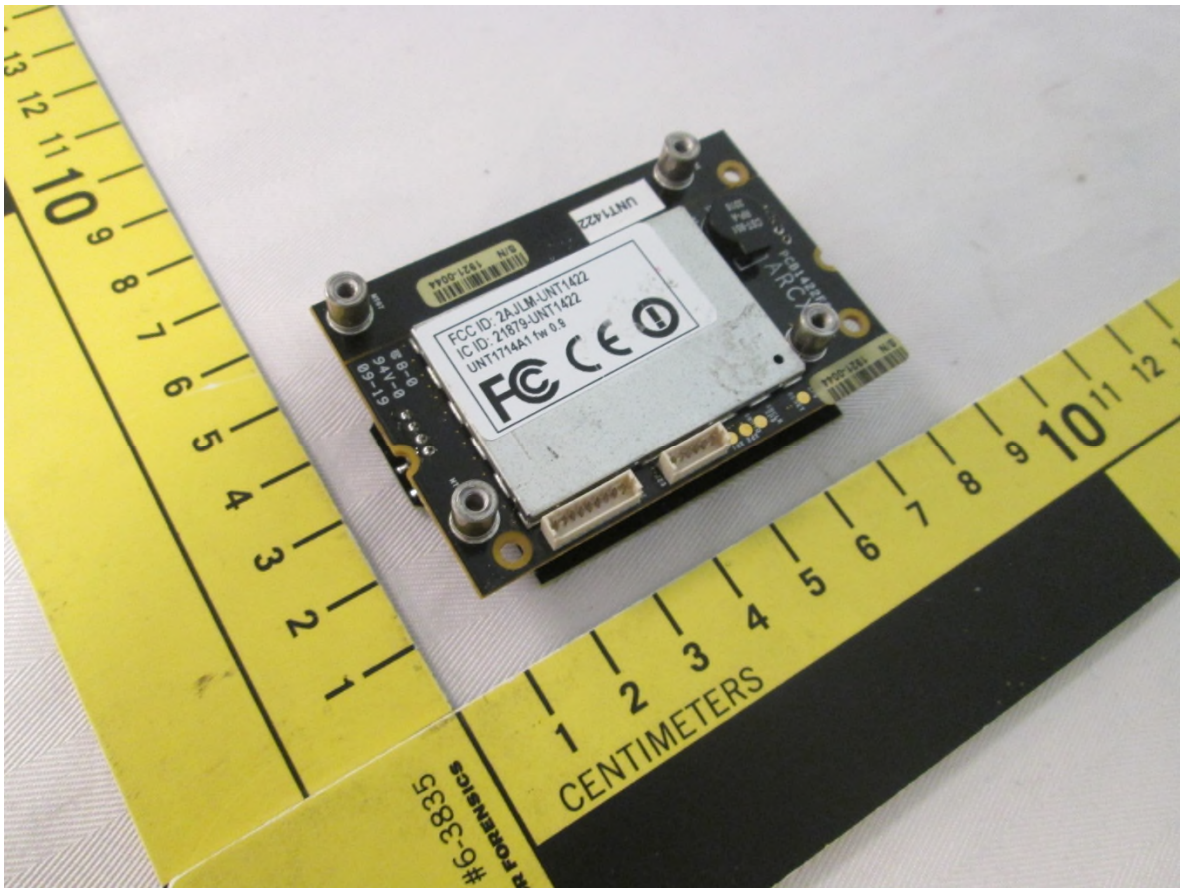
EUT – External view 1



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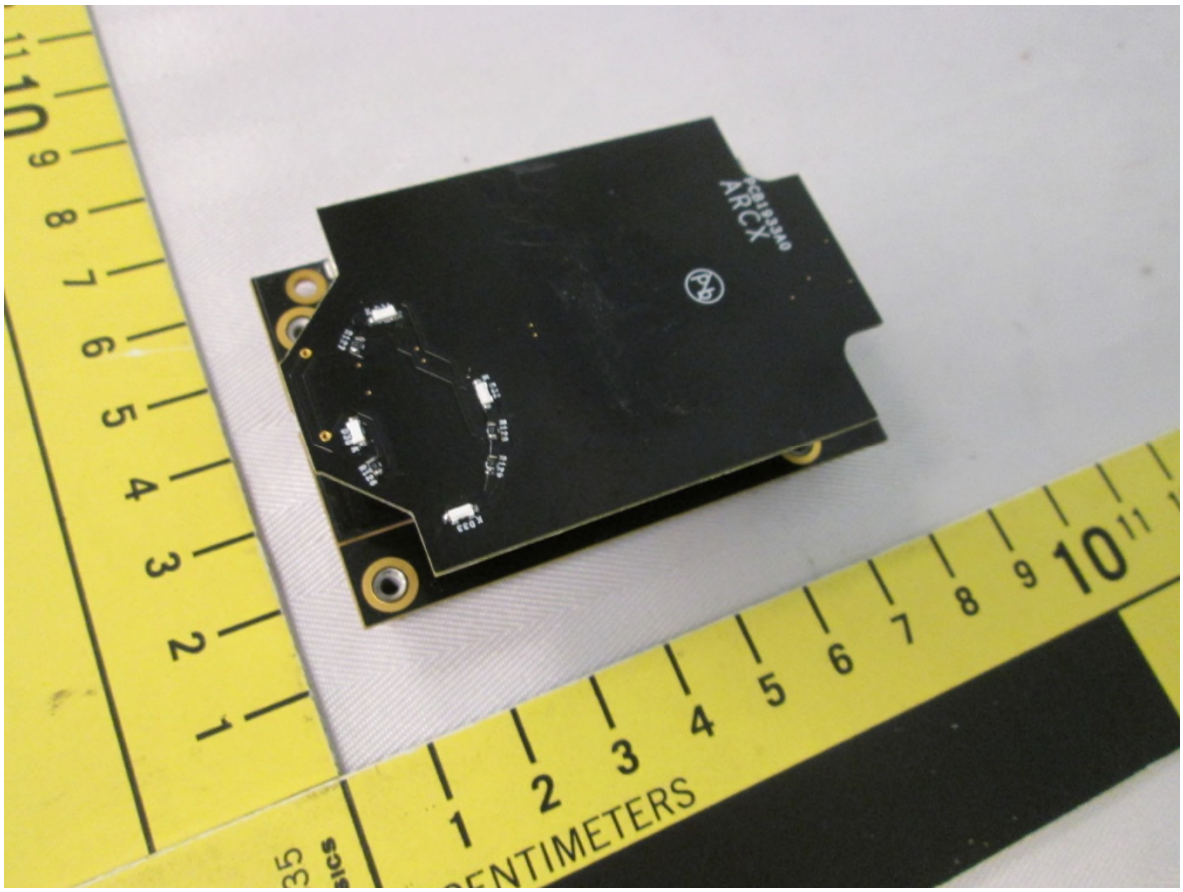
EUT – External view 2



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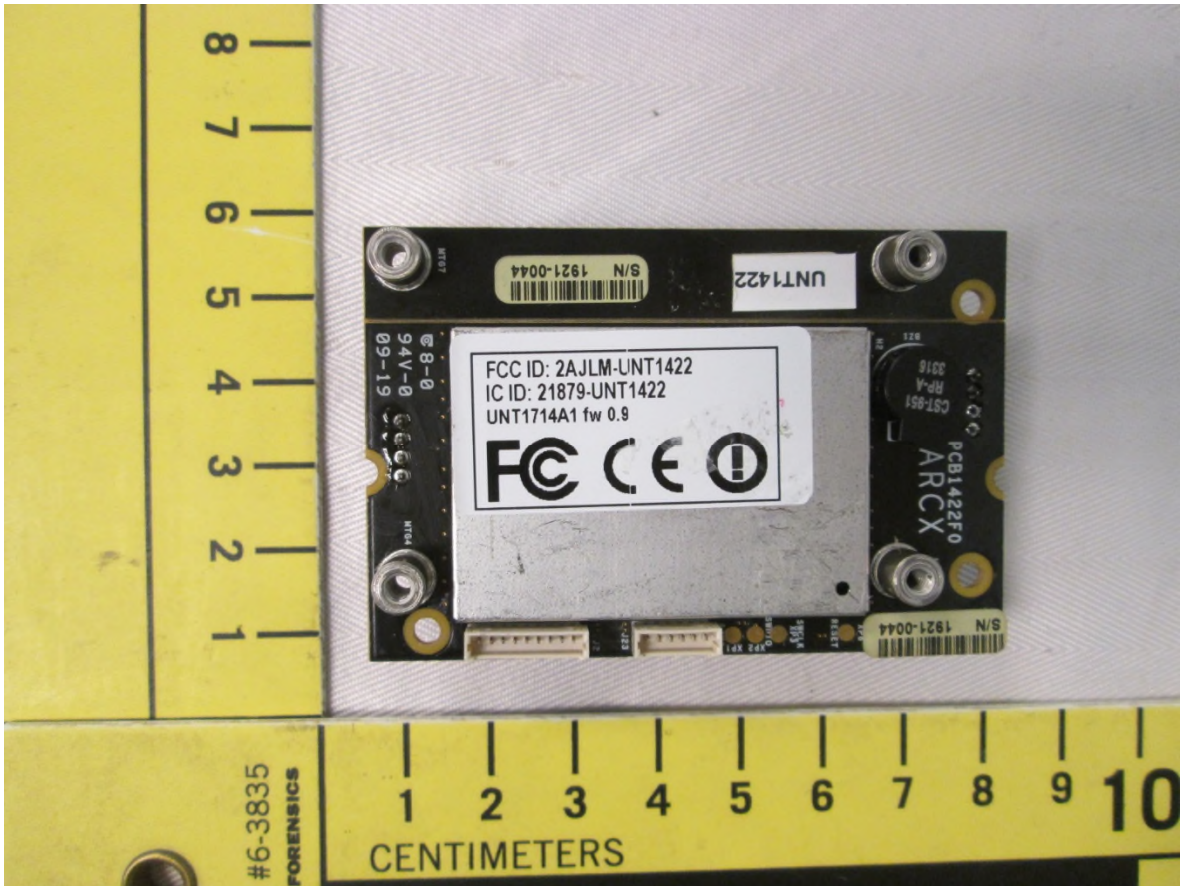
EUT – External view 3
PCB 1, main board, side 1



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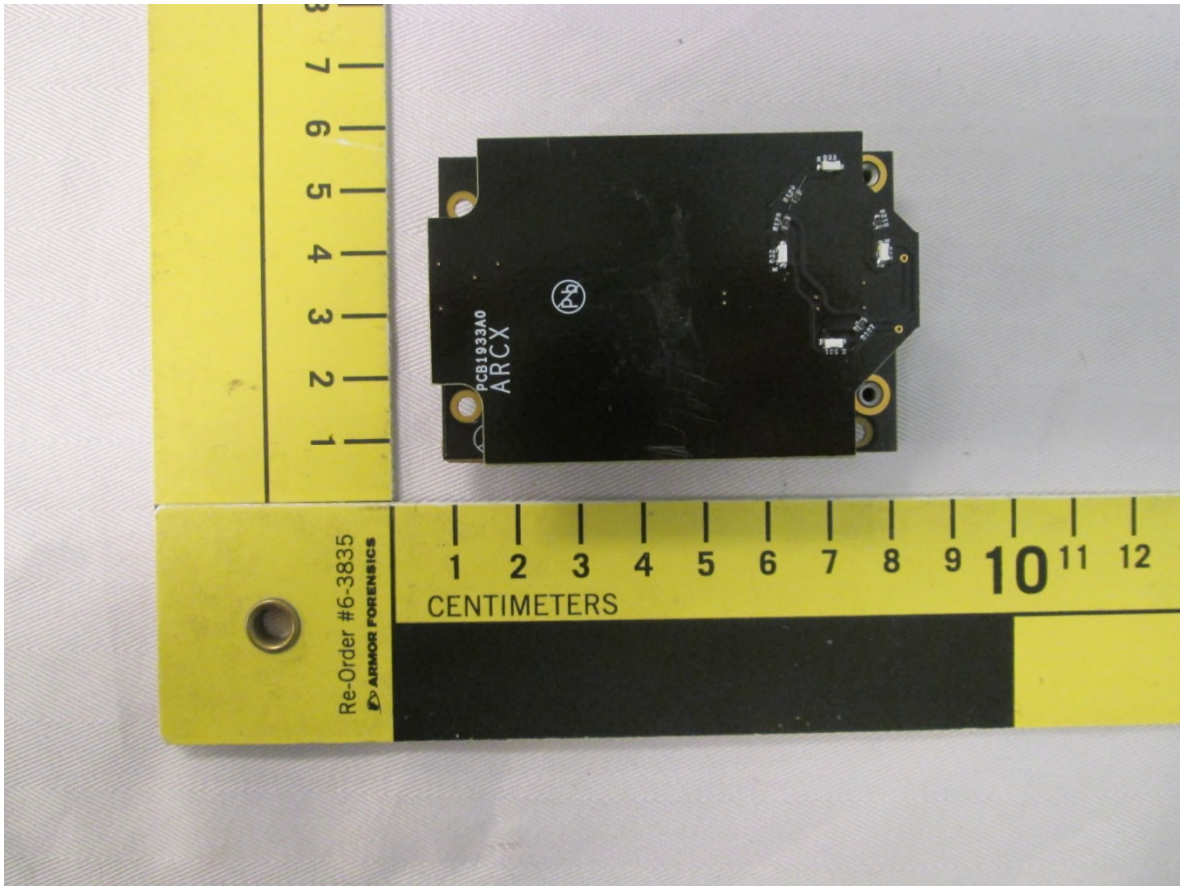
EUT – External view 4
PCB 2, antenna board side 1



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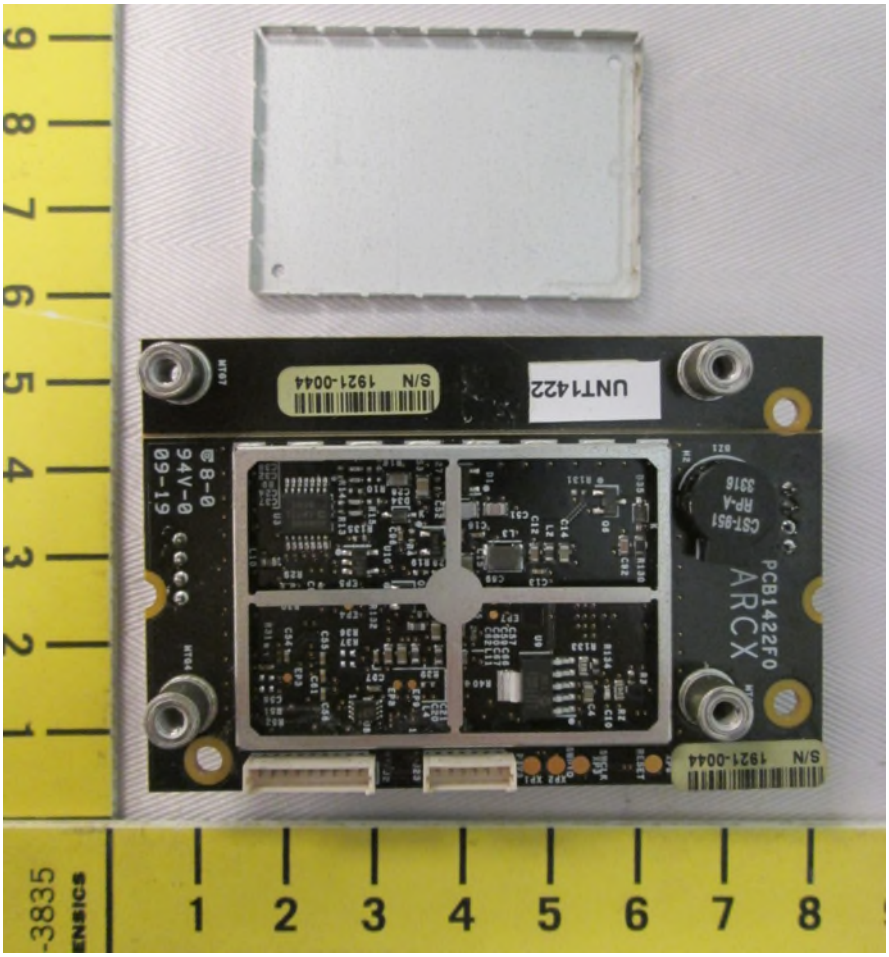
EUT – Internal view 1
PCB 1, main board, side 1, shield removed



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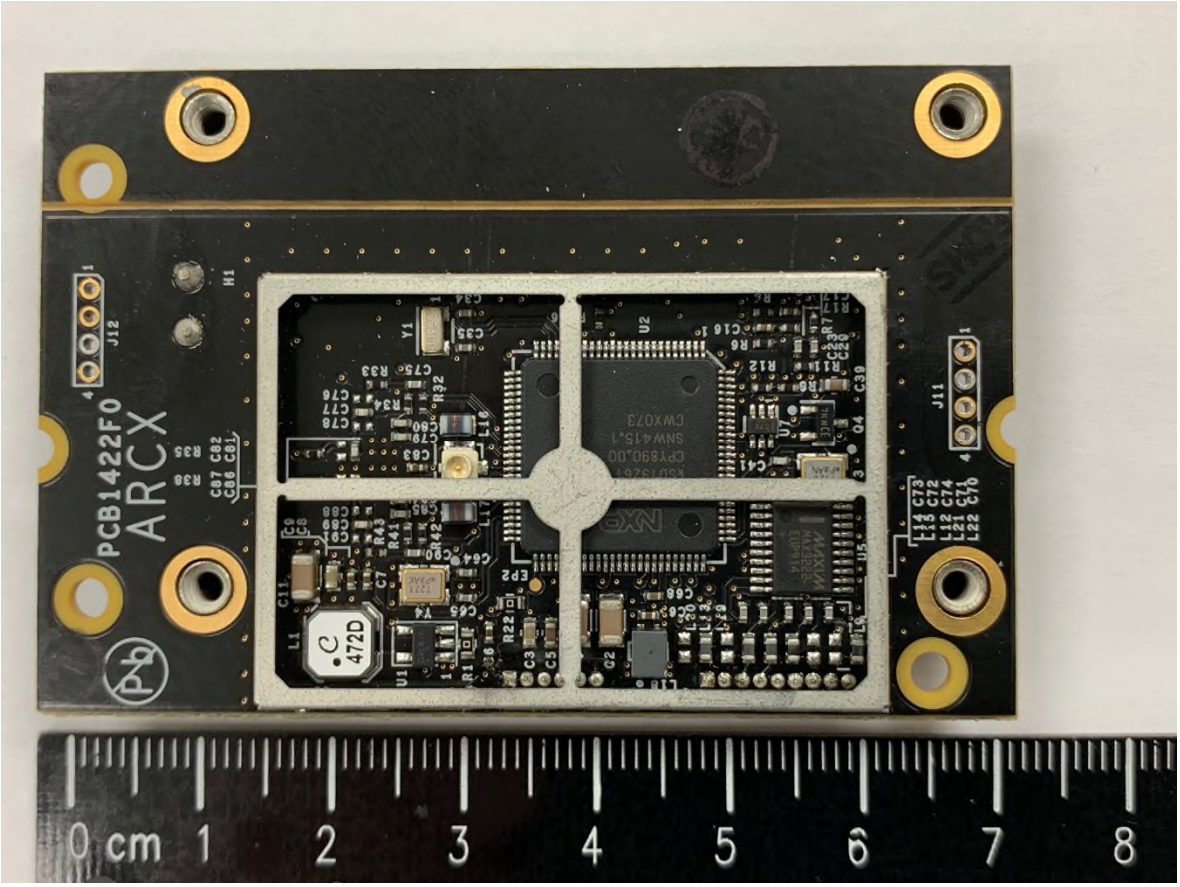
EUT – Internal view 2
PCB 1, main board, side 2



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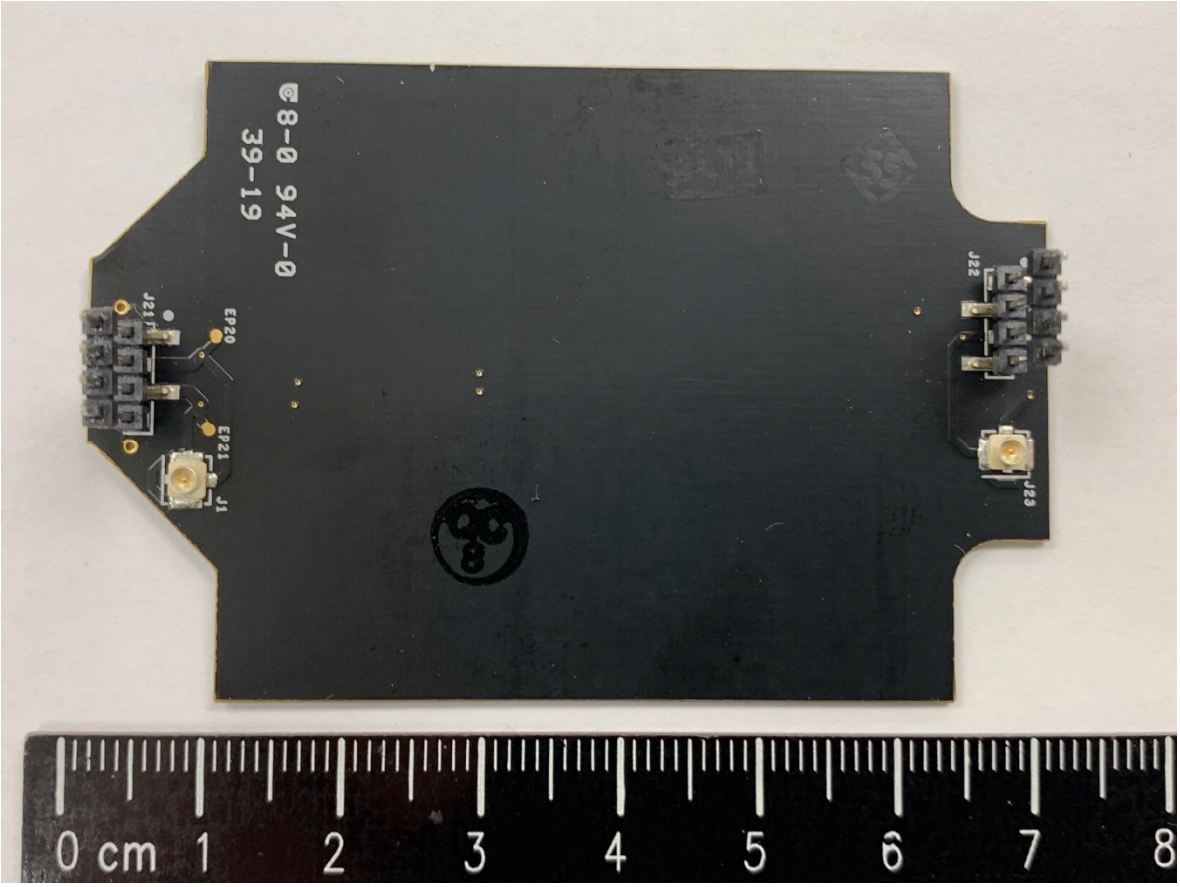
EUT – Internal view 3
PCB 2, antenna board, side 2



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

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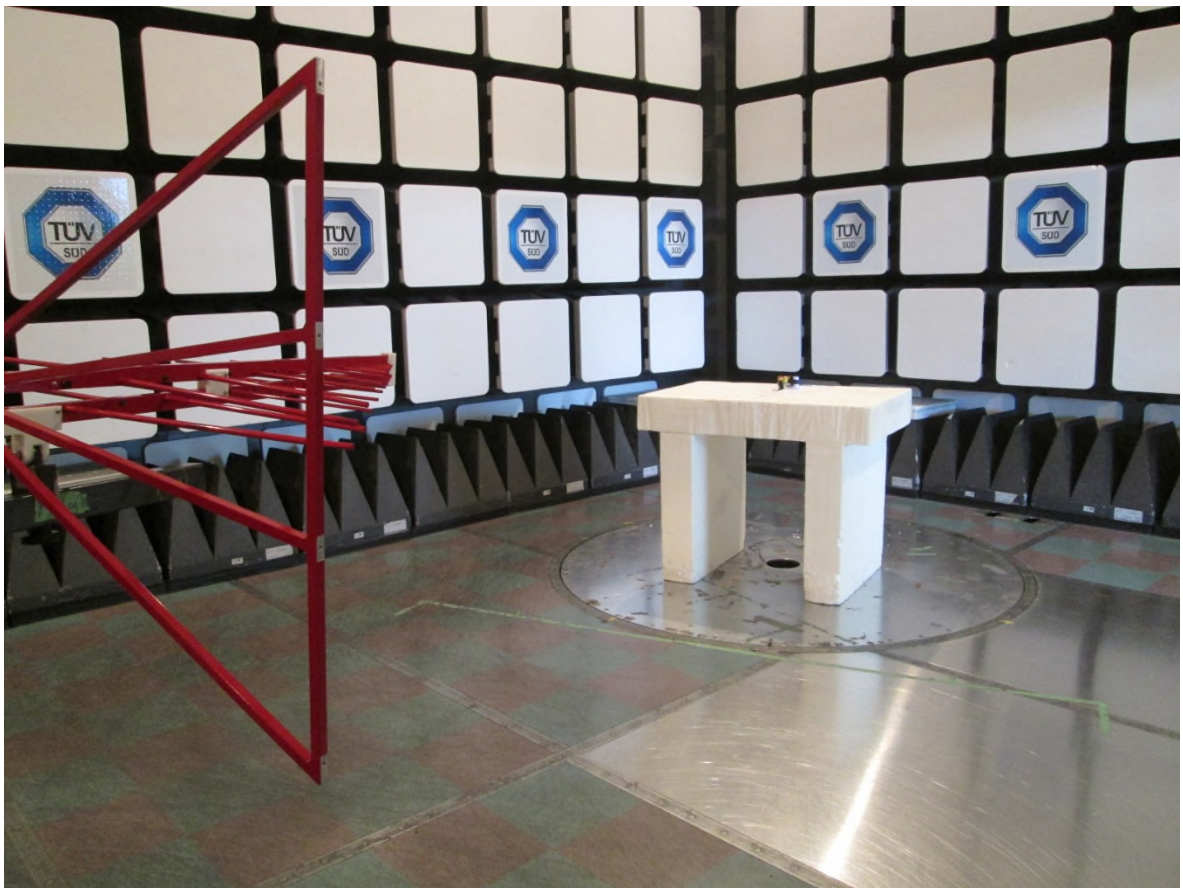
Test setup photo 2
Radiated measurements, 30 MHz – 1 GHz



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