FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CERTIFICATION TEST REPORT

FOR

433 MHz TRANSMITTER

MODEL NUMBER: MAP.013.1

FCC ID: 2AATU-AG-TX433
IC: 11336A-AGTX433

REPORT NUMBER: R10092698-RF

ISSUE DATE: 2013-12-05

Prepared for

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NVLAP LAB CODE 200246-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	2013-12-05	Initial Issue	Jeff Moser

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: INNOVATIVE INDUSTRIAL DESIGN, LLC
PO BOX 189
NOLENSVILLE, TN 37135 USA

EUT DESCRIPTION: 433.93 MHz Transmitter

MODEL: MAP.013.1

SERIAL NUMBER: 00014F (standard unit); 0001CC (continuous transmit unit); 0001CD (worst-case on-time unit)

DATE TESTED: 2013-10-11, 2013-11-11, 2013-11-13, and 2013-11-26

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC PART 15 SUBPART C	Pass
INDUSTRY CANADA RSS-210 Issue 8, Annex 1	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2002460.htm.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	+/- 2.5 dB
Radiated Disturbance, 30 to 1000 MHz	+/- 3.4 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a 433.93 MHz transmitter intended for notifying customers when an asset has been removed.

5.2. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PCB antenna, with a maximum gain of 0 dBi.

5.3. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was AG, rev. X42.

The test utility software used during testing was AG-TEST, rev. X42.

5.4. WORST-CASE CONFIGURATION AND MODE

The device was oriented to produce the highest emission at the device's fundamental operating frequency. The worst-case orientation was investigated over three orthogonal orientations of the device. The upright orientation (Y orientation presented in the SETUP PHOTOS section of this report) proved to be the worst-case orientation.

5.5. MODIFICATIONS

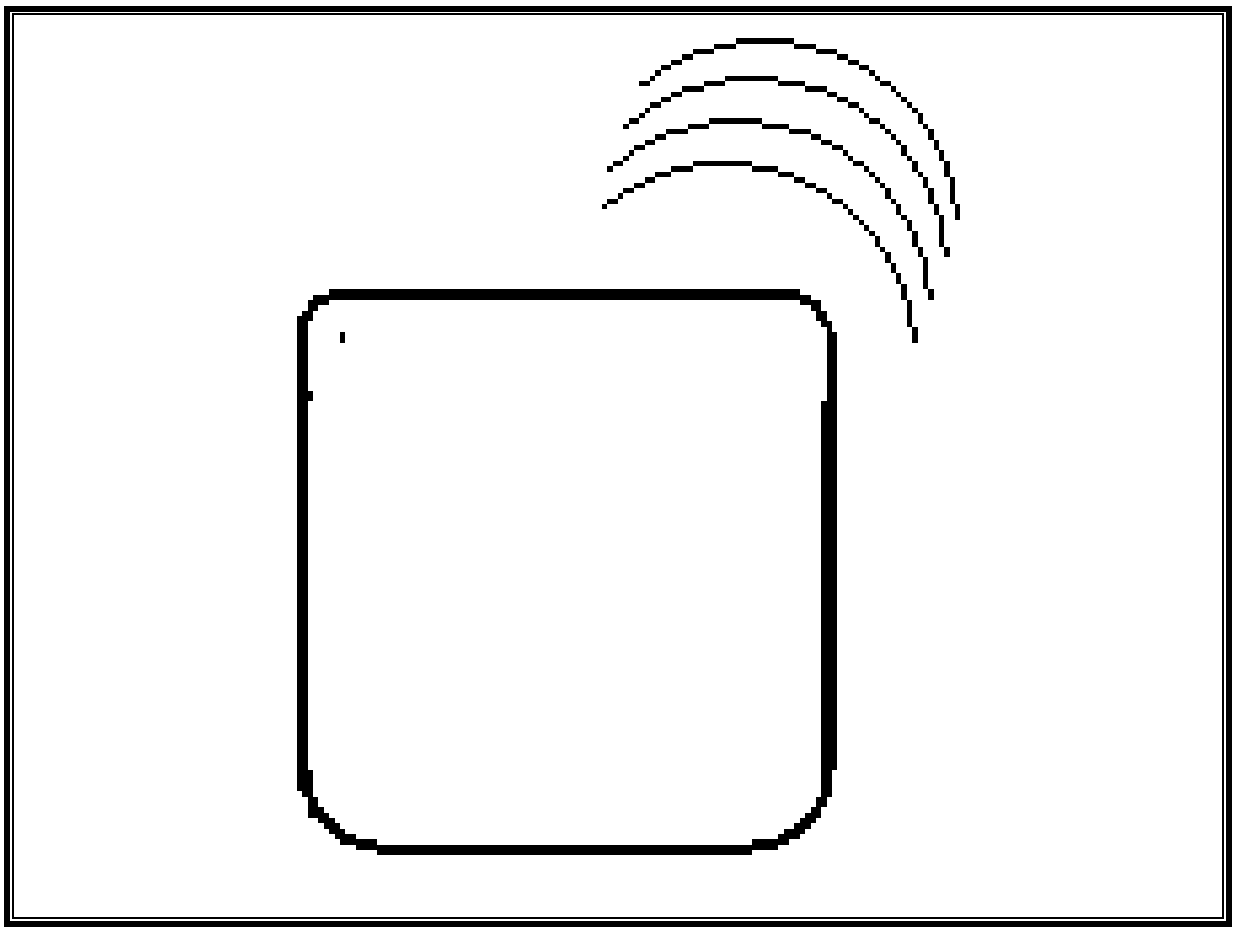
No modifications were made during testing.

5.6. DESCRIPTION OF TEST SETUP

TEST SETUP

The EUT was placed on a standard test table.

SETUP DIAGRAM FOR TESTS



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0037	Loop Antenna (Low Range)	Electro-Metrics	EM-6871	2013-06-19	2014-06-30
AT0036	Loop Antenna (High Range)	Electro-Metrics	EM-6872	2013-06-20	2014-06-30
AT0022	Log-periodic Antenna, 200 MHz to 1000 MHz	Chase	UPA6109	2013-01-29	2014-01-31
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner-Chase EMC Ltd.	VBA6106A	2013-06-14	2014-06-30
AT0062	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2013-08-27	2014-08-31
SAC_C (Biconical 3m location)	Gain-Loss string for biconical antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAC_D (Log-Periodic 3m location)	Gain-Loss string for log-periodic antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAC_E_LR (Loop & Rod 3m location)	Gain-Loss string for loop/rod antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	ESIB40 (1088.7490.40)	2013-09-03	2014-09-30
SA0016	Spectrum Analyzer	Agilent	N9030A	2013-09-04	2014-09-30
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
AMP011	RF Amp, 1-20GHz	Miteq	AMF-6D-01002000-22-10P	2013-09-04	2014-09-30
HI0040	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2013-01-25	2014-01-31

7. ANTENNA PORT TEST RESULTS

Note: Given that the EUT had an imbedded antenna with not accessible antenna port, the following tests were performed over the air via a receive antenna.

7.1. 20 dB AND 99% BW

LIMITS

FCC §15.231 (c)
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

IC A1.1.3
For the purpose of Section A1.1, the 99% Bandwidth shall be no wider than 0.25% of the center frequency for devices operating between 70-900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency.

TEST PROCEDURE

ANSI C63.4

The transmitter output is connected to the spectrum analyzer.

20dB Bandwidth: The RBW is set to 10 KHz. The VBW is set to 30 KHz. The sweep time is coupled. Bandwidth is determined at the points 20 dB down from the modulated carrier.

99% Bandwidth: The RBW is set to 10 KHz. The VBW is set to 30 KHz. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

No non-compliance noted:

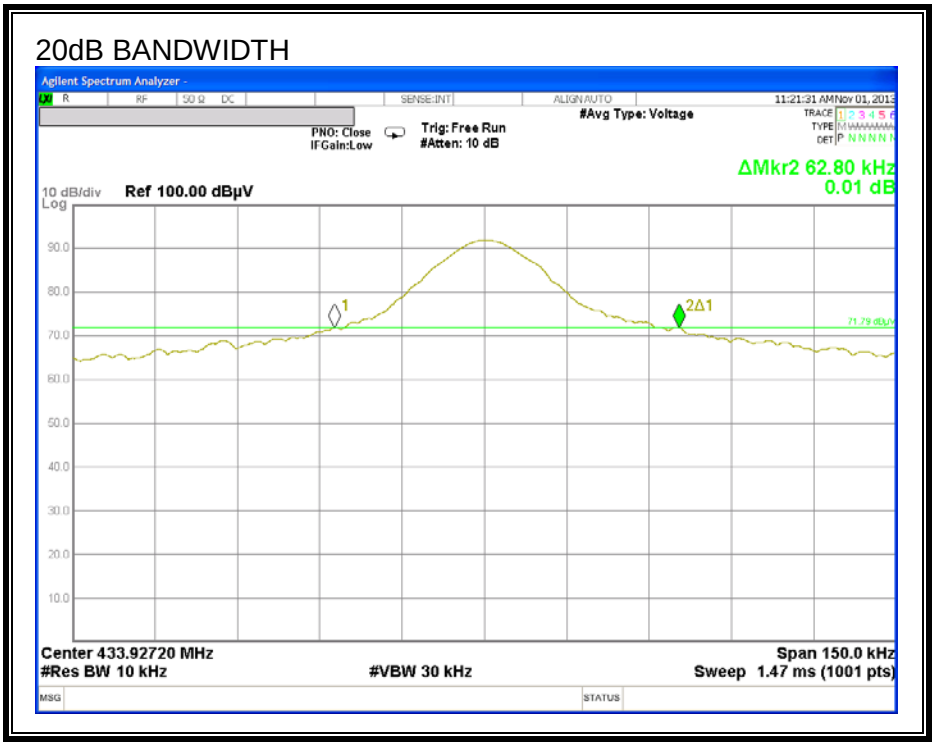
20dB Bandwidth

Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
433.93	62.8	1084.825	-1022.025

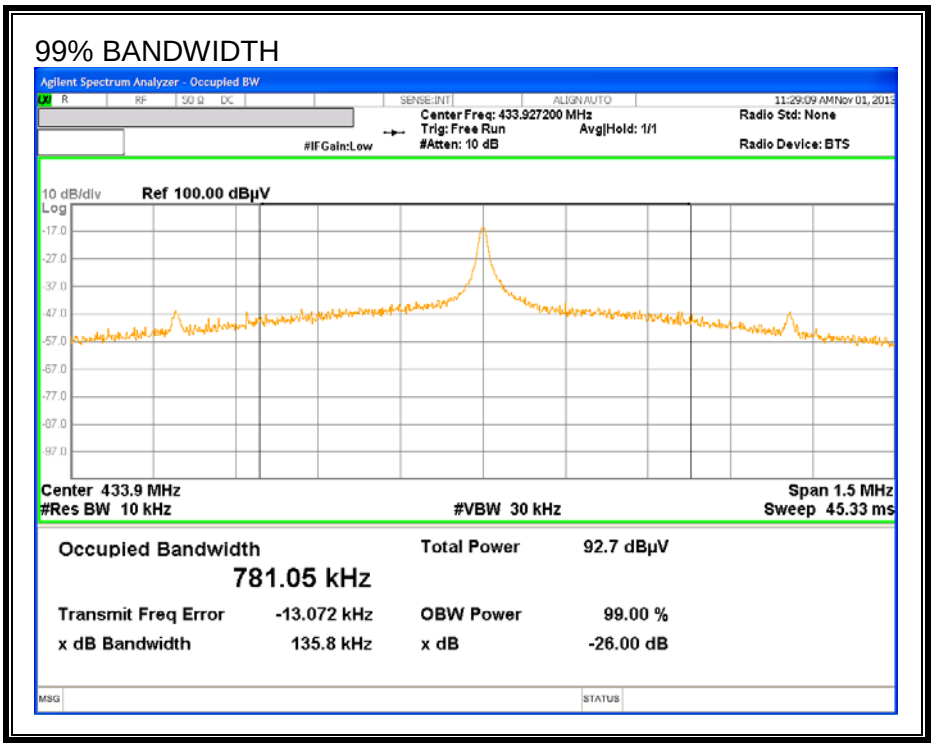
99% Bandwidth

Frequency (MHz)	99% Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
433.93	781.05	1084.825	-303.775

20dB BANDWIDTH



99% BANDWIDTH



Detector Type: Sample

7.2. DUTY CYCLE

LIMITS

FCC §15.35 (c)
The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled and the span is set to 0 Hz. The number of pulses is measured and calculated in a 100 ms scan.

CALCULATION

Average Reading = Peak Reading (dBuV/m) + 20log (Duty Cycle), Where Duty Cycle is
(# of long pulses * long pulse width) + (# of short pulses * short pulse width) / 100 or T

RESULTS

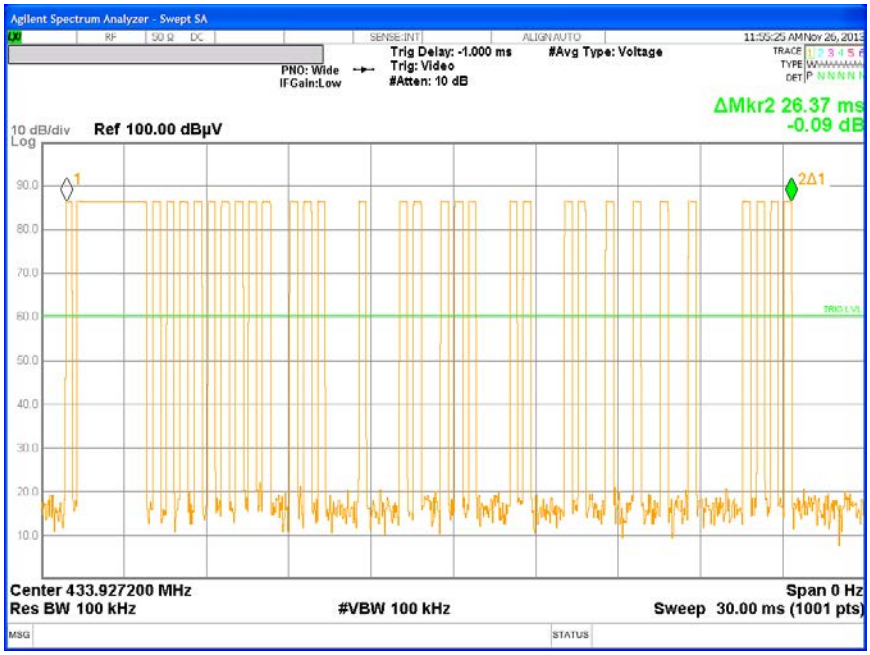
No non-compliance noted:

One Period (ms)	Long Width (ms)	# of Long Pulses	Medium Width (ms)	# of Medium Pulses	Short Width (ms)	# of Short Pulses	Duty Cycle	20*Log Duty (dB)
100.0	2.505	1	0.245	30	0.195	1	0.101	-19.95

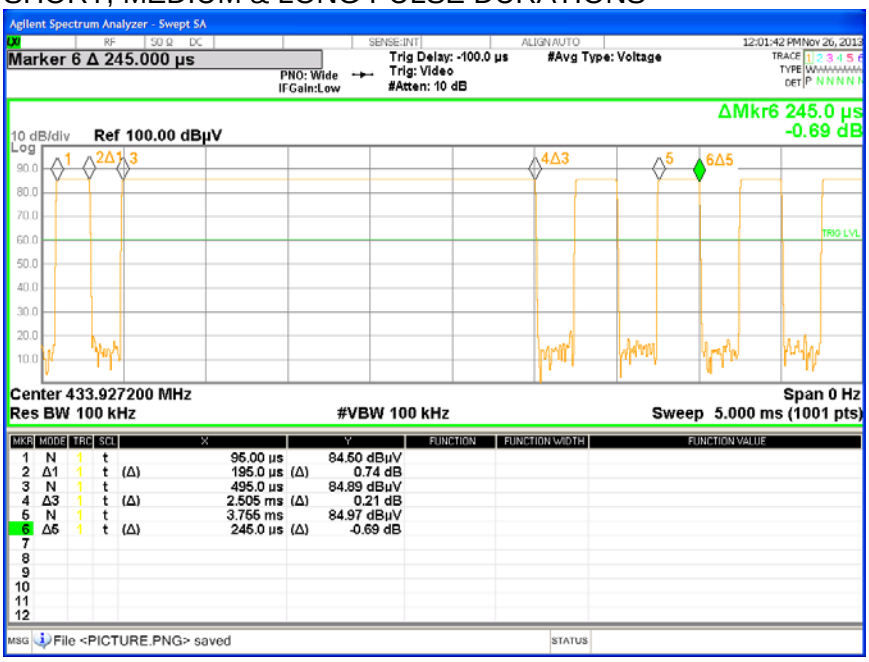
Worst-Case Packet Content

The burst-packet content is dependent upon the event that triggers a transmission. The following packet was deemed worst-case by the client in terms of total on time within a burst packet. (This transmission represents the following conditions: door open; tamper open; low battery.)

WORST-CASE PACKET

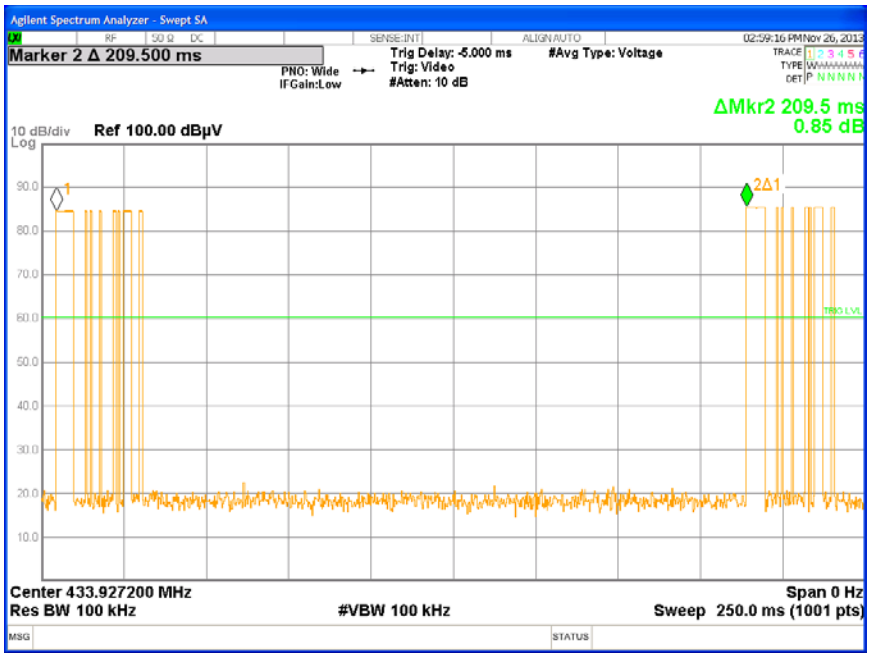


SHORT, MEDIUM & LONG PULSE DURATIONS



Long-pulse duration: 2.505ms
Medium-pulse duration: 245.0us
Short-pulse duration: 195.0us

INTER-BURST TIME



The above plot is the shortest inter-burst packet observed during test. The client stated that the shortest inter-packet duration is 120ms. Therefore, the averaging period was set at 100ms.

7.3. TRANSMISSION TIME

LIMITS

FCC §15.231 (a) (2)

IC A1.1.1 (b)

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is set to 10 seconds and the span is set to 0 Hz.

RESULTS

No non-compliance noted:

LESS THAN 5 SECONDS

The above represents a magnet moved quickly away from the EUT. (e.g., opening a window.)

LESS THAN 5 SECONDS

The above represents a magnet moved quickly towards the EUT. (e.g., closing a window.)

8. RADIATED EMISSION TEST RESULTS

8.1. TX RADIATED SPURIOUS EMISSION

LIMITS

FCC §15.231 (b)
IC A1.1.2
In addition to the provisions of § 15.205, the field strength of emissions from Intentional radiators operated under this section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental Frequency (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750	125 to 375
174 - 260	3,750	375
260 - 470	3,750 to 12,500	375 to 1,250
Above 470	12,500	1,250

1 Linear interpolation

§15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	([2])
13.36 – 13.41	322 - 335.4		

1 Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
2 Above 38.6

§15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 88	100 **	3
88 216	150 **	3
216 960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 72 MHz, 76 88 MHz, 174 216 MHz or 470 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 120 kHz for peak and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For peak measurements above 1 GHz, the resolution bandwidth is set to 1 MHz and the video to 3 MHz. For spurious harmonics of pulsed signals, the average value is computed by adding the duty-cycle correction factor to the peak measurement. For non-pulsed signals either a CISPR-compliant average detector or a 10Hz video bandwidth measurement is used for average measurements.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For measurements below 30 MHz loop antennas were used per FCC requirements, and measurement equipment settings test method were consistent with ANSI C63.4.

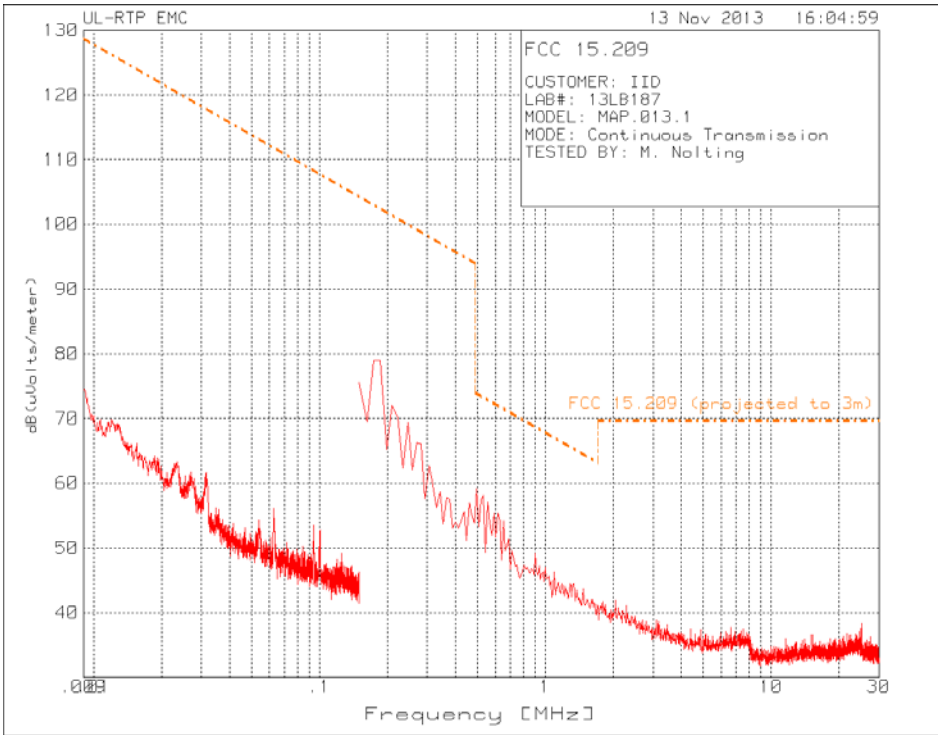
RESULTS

No non-compliance noted.

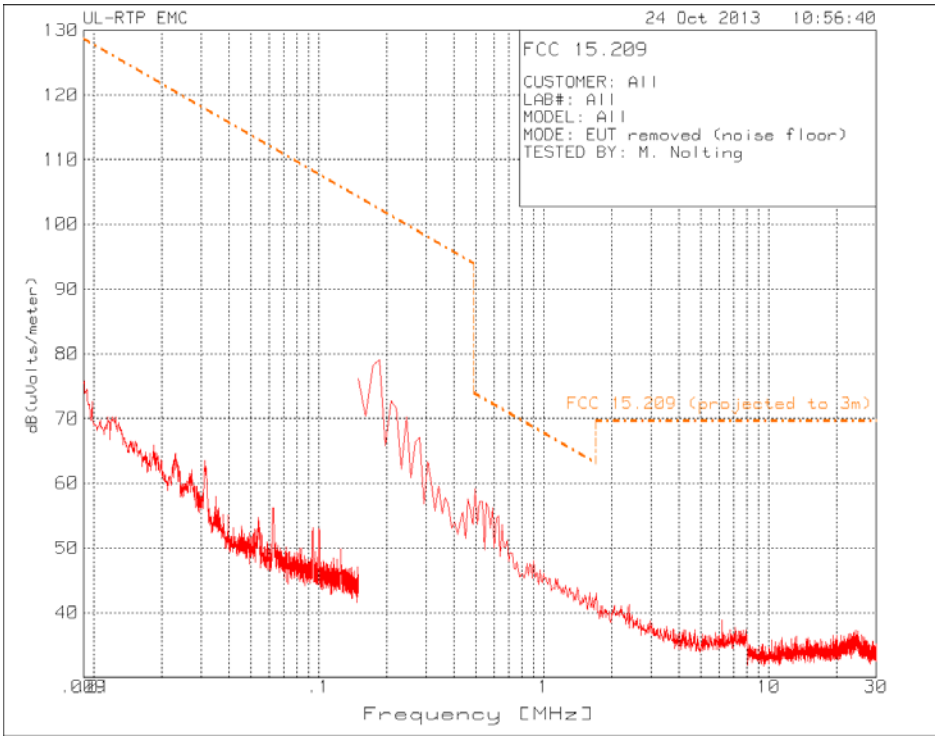
TX SPURIOUS EMISSIONS (BELOW 30 MHz)

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz-30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were
40*Log (specification distance / test distance).

EUT PLOT



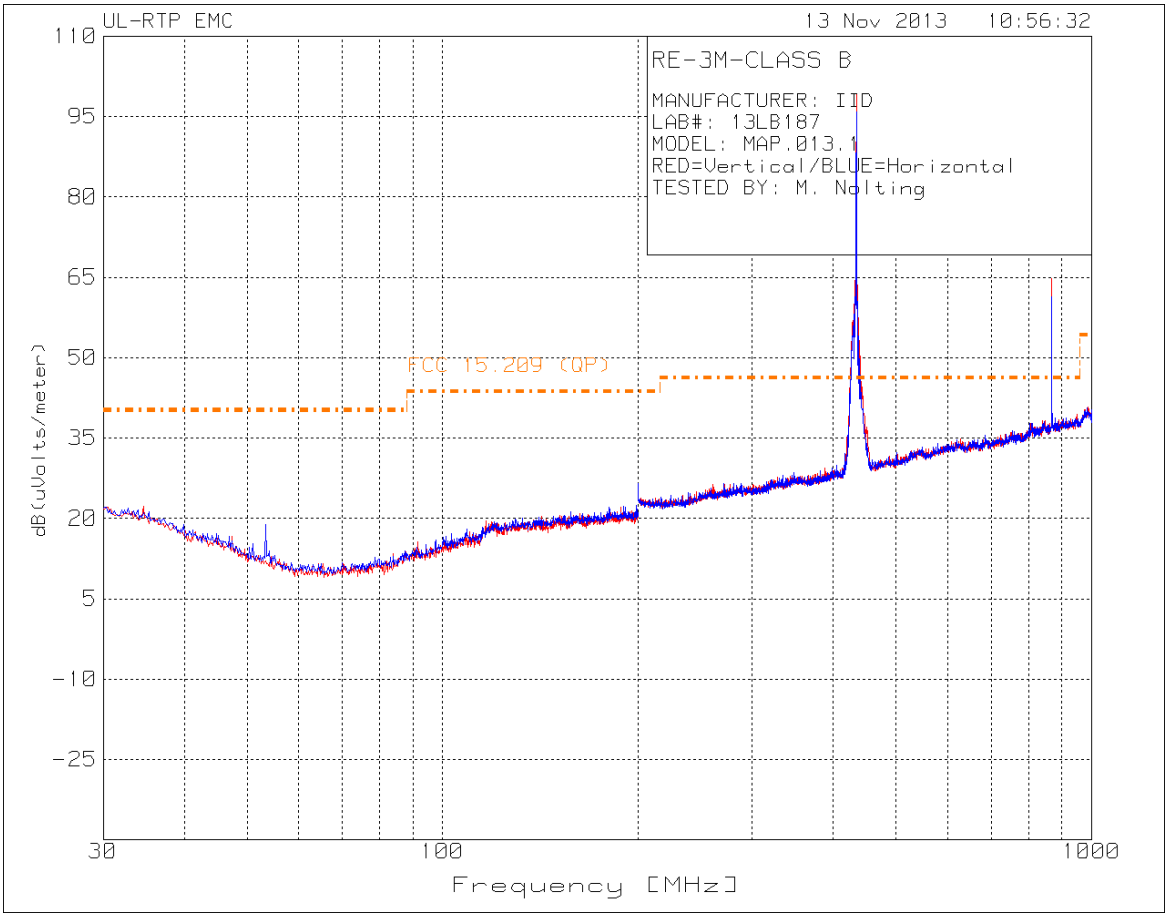
NOISE-FLOOR PLOT



The above plots demonstrate there were no EUT-related emissions of interest relative to the FCC 15.209 limit below 30MHz.

FUNDAMENTAL, HARMONICS AND TX SPURIOUS EMISSION (30 – 1000 MHz)

VERTICAL/HORIZONTAL PLOT



TABULAR DATA

MANUFACTURER: IID
LAB#: 13LB187
MODEL: MAP.013.1
RED=VERTICAL/BLUE=HORIZONTAL
TESTED BY: M. Nolting

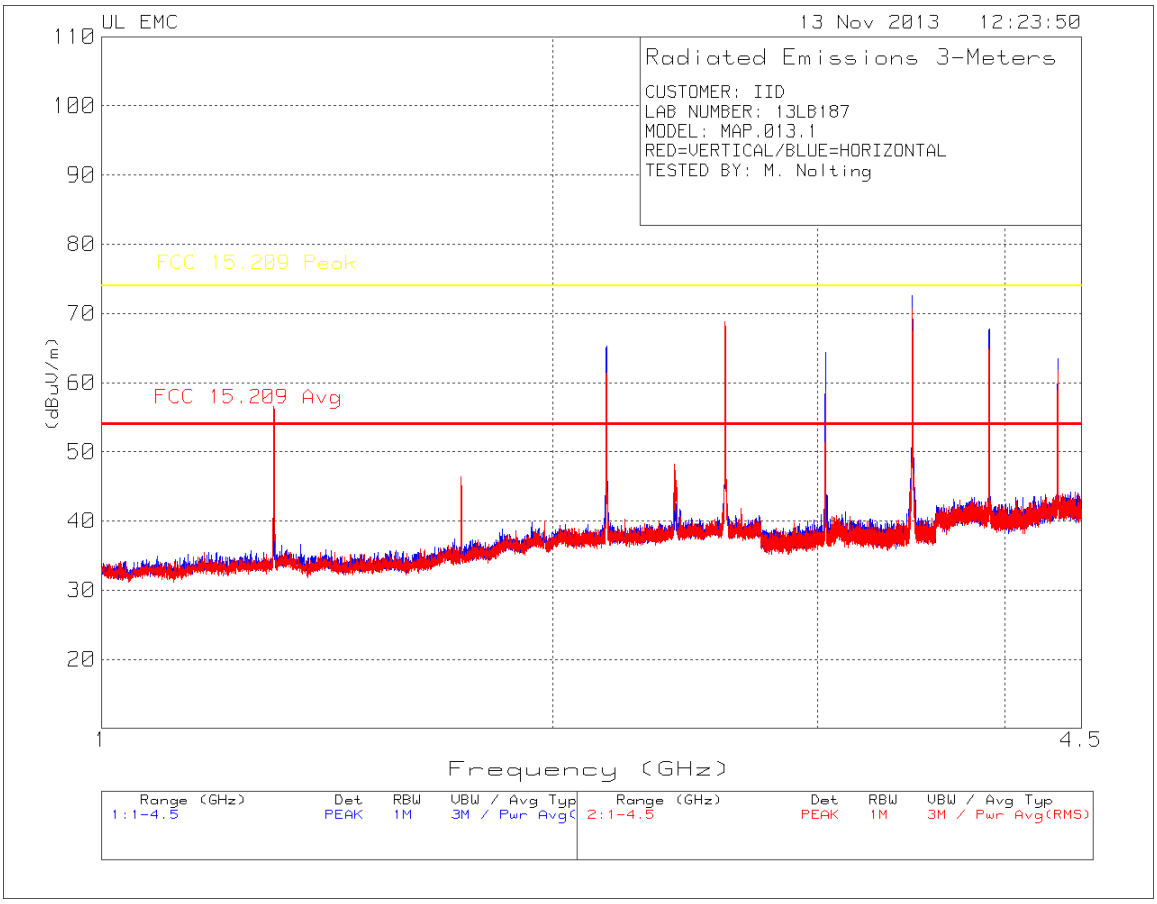
Freq (MHz)	Meter Reading [dBuV]	Detector*	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	FCC 15.231 Peak Limit [dBuV/m]	Margin [dB]	DCF (dB)	Average Field Strength [dBuV/m]	FCC 15.231 Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
433.93	95.68	PK	16.40	-16.90	95.2	100.8	-5.6	-19.95	75.2	80.8	-5.6	H	N
867.86	61.89	PK	22.60	-16.70	67.8	80.8	-13.0	-19.95	47.8	60.8	-13.0	H	N
433.93	99.86	PK	16.40	-16.90	99.4	100.8	-1.5	-19.95	79.4	80.8	-1.4	V	N
867.86	55.87	PK	22.60	-16.70	61.8	80.8	-19.1	-19.95	41.8	60.8	-19.0	V	N

*PK = Peak, QP = Quasi-Peak

Average Field Strength computed as follows for the above fundamental and harmonics: PK + DCF, where DCF = 20*log(T_on/100ms)

HARMONICS AND TX SPURIOUS EMISSIONS ABOVE 1GHz

VERTICAL/HORIZONTAL PLOT



TABULAR DATA

MANUFACTURER: IID
LAB#: 13LB187
MODEL: MAP.013.1
RED=VERTICAL/BLUE=HORIZONTAL
TESTED BY: M. Nolting

Freq (GHz)	Meter Reading [dBuV]	Detector*	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	15.231 Peak Limit [dBuV/m]	Margin [dB]	DCF (dB)	Average Field Strength [dBuV/m]	FCC 15.231 Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
1.302	62.62	PK	28.80	-40.70	50.7	74.0	-23.3	-19.95	30.8	54.0	-23.2	H	Y
1.736	52.07	PK	29.40	-39.90	41.6	80.8	-39.3	-19.95	21.6	60.8	-39.2	H	N
2.170	71.90	PK	31.60	-39.10	64.4	80.8	-16.4	-19.95	44.5	60.8	-16.4	H	N
2.604	75.23	PK	32.00	-38.30	68.9	80.8	-11.9	-19.95	49.0	60.8	-11.8	H	N
3.038	70.93	PK	32.90	-38.10	65.7	80.8	-15.1	-19.95	45.8	60.8	-15.0	H	N
3.471	76.71	PK	33.00	-37.70	72.0	80.8	-8.8	-19.95	52.1	60.8	-8.8	H	N
3.905	72.01	PK	33.40	-37.40	68.0	74.0	-6.0	-19.95	48.1	54.0	-5.9	H	Y
4.339	69.13	PK	33.70	-37.10	65.7	74.0	-8.2	-19.95	45.8	54.0	-8.2	H	Y
Note: The followig frequency was not a harmonic of the EUT's fundamental frequency and it did not exhibit pulse modulation.													
2.410	50.21	PK	32.20	-38.60	43.8	74.0	-30.2	-	-	54.0	-10.2	H	N
1.302	68.80	PK	28.80	-40.70	56.9	74.0	-17.1	-19.95	37.0	54.0	-17.0	V	Y
1.736	57.60	PK	29.40	-39.90	47.1	80.8	-33.7	-19.95	27.2	60.8	-33.7	V	N
2.170	74.50	PK	31.60	-39.10	67.0	80.8	-13.8	-19.95	47.1	60.8	-13.8	V	N
2.604	76.36	PK	32.00	-38.30	70.1	80.8	-10.8	-19.95	50.1	60.8	-10.7	V	N
3.038	63.84	PK	32.90	-38.10	58.6	80.8	-22.2	-19.95	38.7	60.8	-22.1	V	N
3.471	75.44	PK	33.00	-37.70	70.7	80.8	-10.1	-19.95	50.8	60.8	-10.0	V	N
3.905	69.05	PK	33.40	-37.40	65.1	74.0	-8.9	-19.95	45.1	54.0	-8.9	V	Y
4.339	65.80	PK	33.70	-37.10	62.4	74.0	-11.6	-19.95	42.5	54.0	-11.5	V	Y
Note: The followig frequency was not a harmonic of the EUT's fundamental frequency and it did not exhibit pulse modulation. Therefore, an avergage-detector measurement was used to obtain it average value.													
2.409	54.64	PK	32.20	-38.60	48.2	74.0	-25.7	-	-	54.0	-5.7	V	N
2.414	33.17	Av	32.20	-38.60	-	-	-	-	26.8	54.0	-27.2	V	N
*PK = Peak, Av = Average													
Average Field Strength computed as follows for the above harmonics: PK + DCF, where DCF = 20*log(T_on/100ms)													

END OF REPORT