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

CERTIFICATION TEST REPORT

FOR

433 MHz TRANSMITTER

MODEL NUMBER: MB-TX433

FCC ID: 2AATU-MB-TX433
IC: 11336A-MBTX433

REPORT NUMBER: R10063313-RF

ISSUE DATE: 2013-10-31

Prepared for
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Revision History

Rev.	Issue Date	Revisions	Revised By
--	2013-10-31	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 MHz Transmitter

MODEL: MB-TX433

SERIAL NUMBER: 002D6 (standard unit); 0003BB (continuous transmit unit)

DATE TESTED: 2013-10-11 through 2013-10-15, and 2013-10-24

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.

Approved & Released
For UL LLC By:

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UL - WiSE
Wireless, **I**nteroperability, **S**ecurity/Payments & **E**MC

Prepared By:

Jeff Moser
EMC Program Manager
UL - WiSE

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 433.94 MHz transmitter intended for notifying customers that they have a package to pick up. (either mail or parcel in this case).

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 MB-TX, rev. A.

The test software used during testing was FCC-MB-TX, rev. A.

5.4. WORST-CASE CONFIGURATION AND MODE

The device was oriented to produce the highest emission at the device's fundamental operating frequency (Y-Axis). In addition, since there were two buttons available on the device (one button with an envelope icon, another with a block icon), the button that produced the highest emission at the device's fundamental operating frequency was used throughout radiated-emissions testing. The "worst-case" button proved to be the one with the envelope icon, but only by 0.2dB. (Basically, the two buttons were identical in E-field output at the fundamental operating frequency.)

5.5. MODIFICATIONS

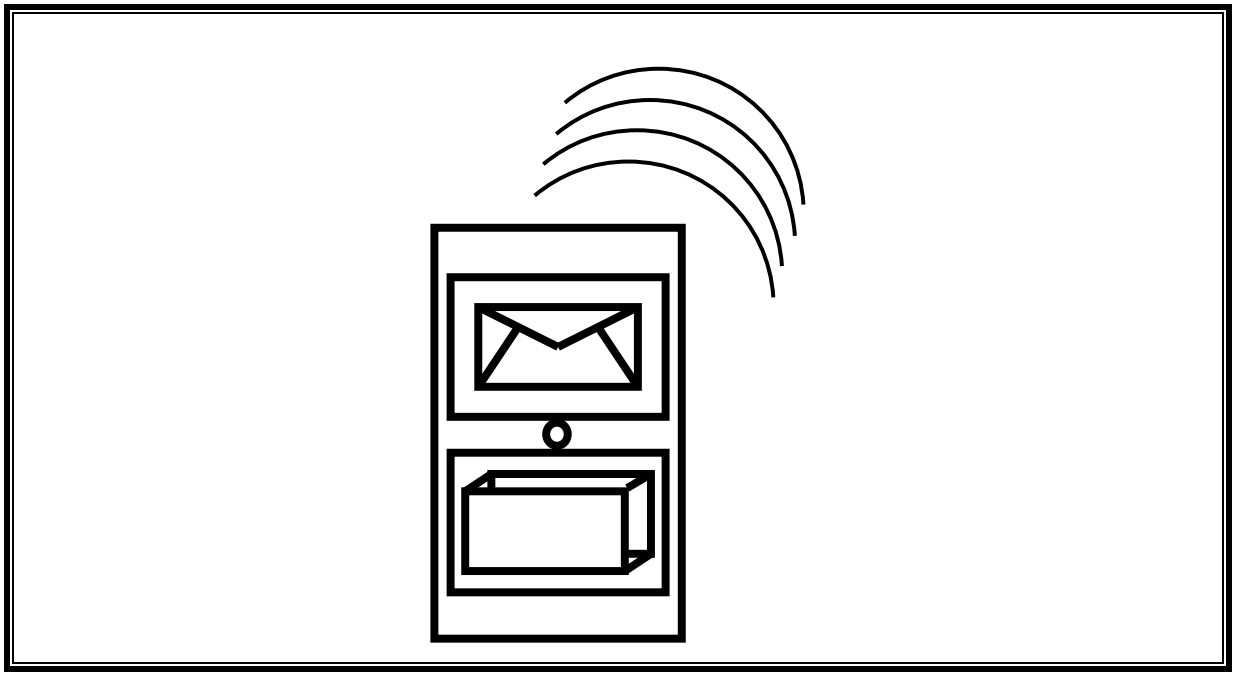
No modifications were made during testing.

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:

Radiated Disturbance Emissions (E-field)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AMP011	RF Amp, 1-20GHz	Miteq	AMF-6D-01002000-22-10P	2013-09-04	2014-09-30
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
SA0016	Spectrum Analyzer	Agilent	N9030A	2013-09-04	2014-09-30
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
HI0034	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2013-01-25	2014-01-31
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA

7. ANTENNA PORT TEST RESULTS

Note: Given that the EUT had an imbedded antenna with no 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 3 times the RBW. 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 3 times the RBW. 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)
433.94	71.6	1084.841	-1013.241

99% Bandwidth

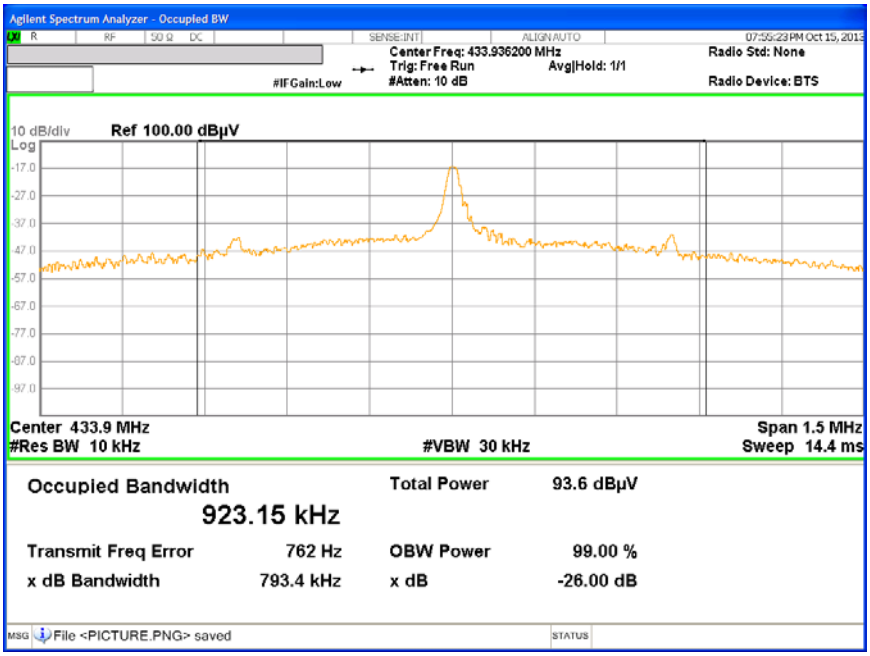
Frequency (MHz)	99% Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
433.94	923.15	1084.841	-161.691

20dB BANDWIDTH

20dB BANDWIDTH

99% BANDWIDTH

99% BANDWIDTH



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

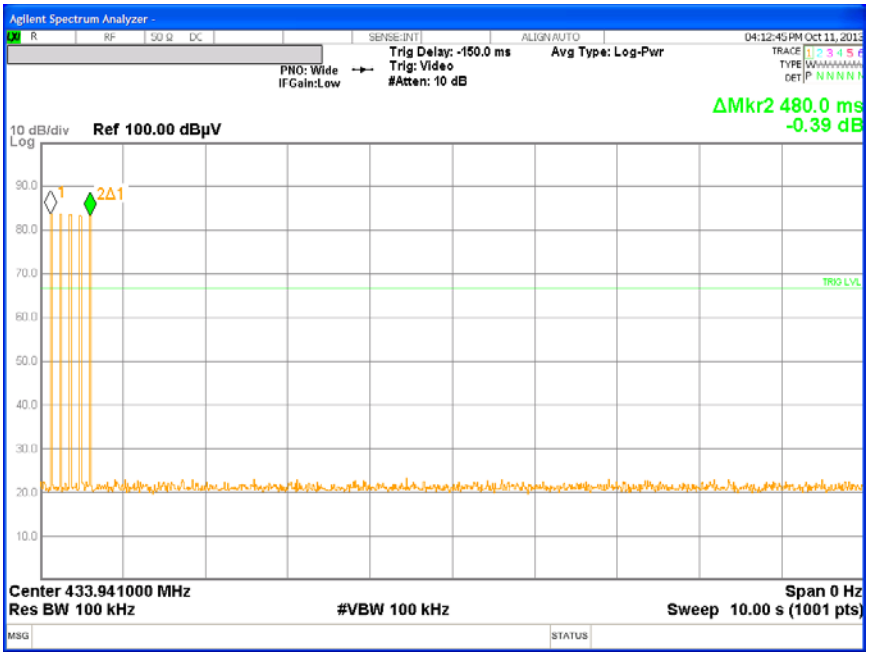
No non-compliance noted:

The EUT had two buttons: Envelope; Block. When either one was depressed momentarily, five bursts were transmitted. When either button was depressed continuously, sixteen bursts were transmitted. The burst durations were the same, roughly 14.1 ms, for both buttons and button-depression duration. For a given button, the pulse patterns were the same whether it was depressed momentarily or continuously. Additionally, the number of each pulse type within a burst was the same for the two buttons. The only difference noted was that the pulse sequence was different between the two buttons.

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	1.008	1	0.231	7	0.111	40	0.071	-23.0

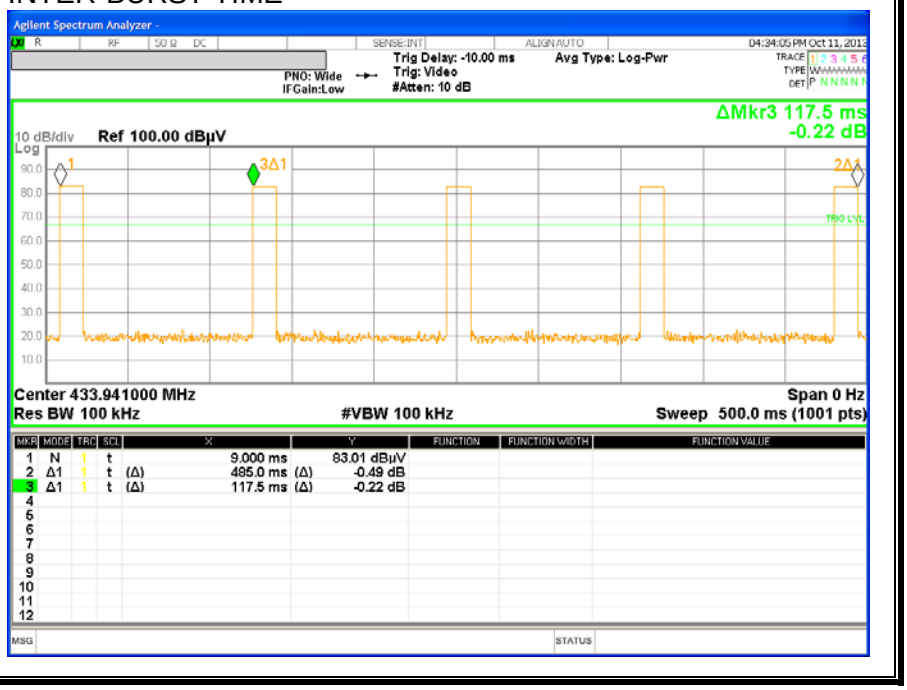
ENVELOPE BUTTON: Momentary Contact

FIVE BURSTS



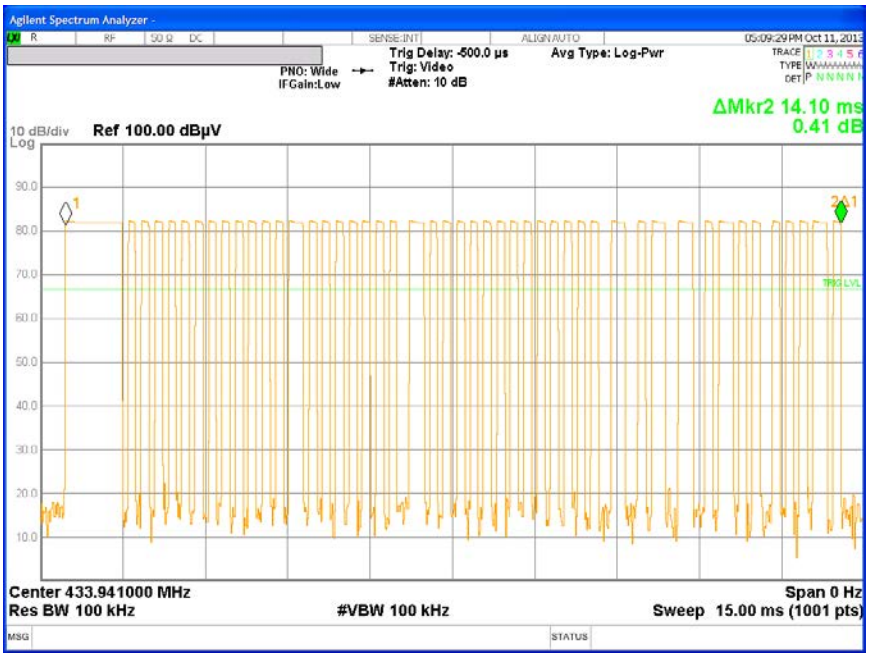
Note: Contents within each burst were verified to be the same in pulse pattern.

INTER-BURST TIME



Time between bursts > 100ms.

SINGLE BURST



Each burst consists of pulses with three different durations: large, medium, small.

LARGE PULSE & SMALL PULSE

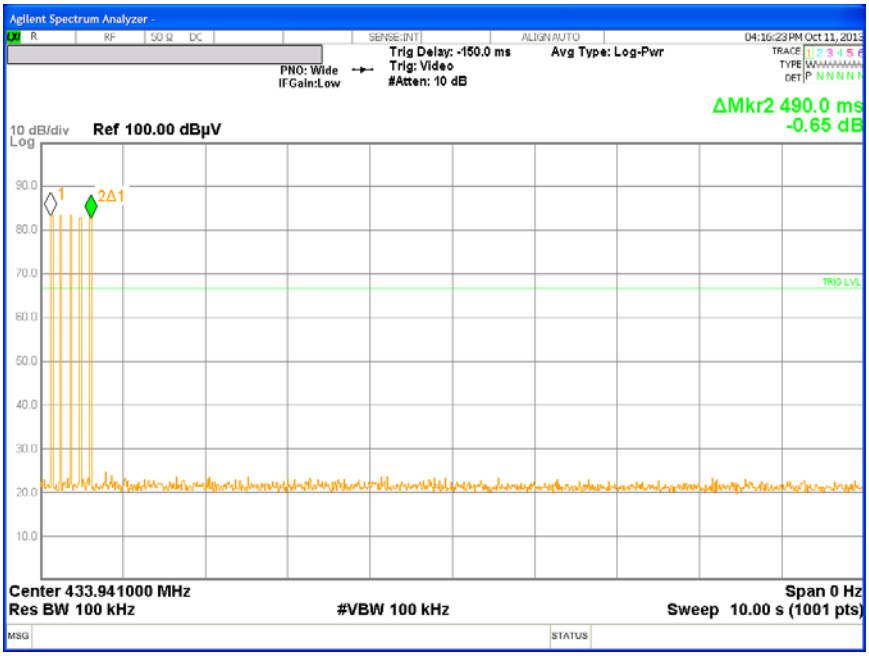
Large-pulse duration: 1.008ms
Small-pulse duration: 111.0us

MEDIUM PULSE

Medium-pulse duration: 231.0us

BLOCK BUTTON: Momentary Contact

FIVE BURSTS



Note: Contents within each burst were verified to be the same in pulse pattern.

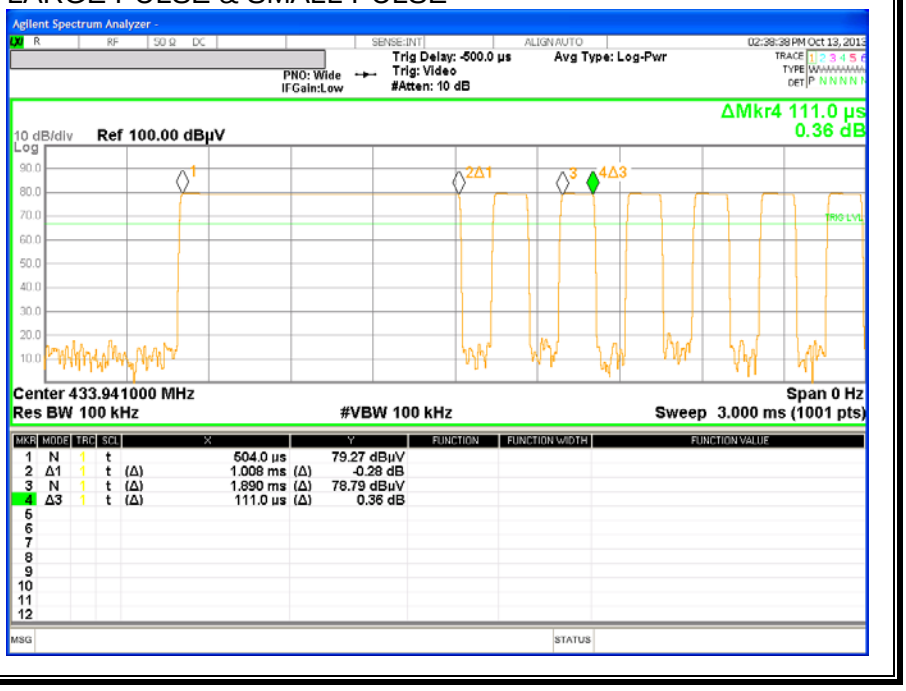
INTER-BURST TIME

Time between bursts > 100ms.

SINGLE BURST

Each burst consists of pulses with three different durations: large, medium, small.

LARGE PULSE & SMALL PULSE



Large-pulse duration: 1.008ms
Small-pulse duration: 111.0us

MEDIUM PULSE

Medium-pulse duration: 231.0us

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

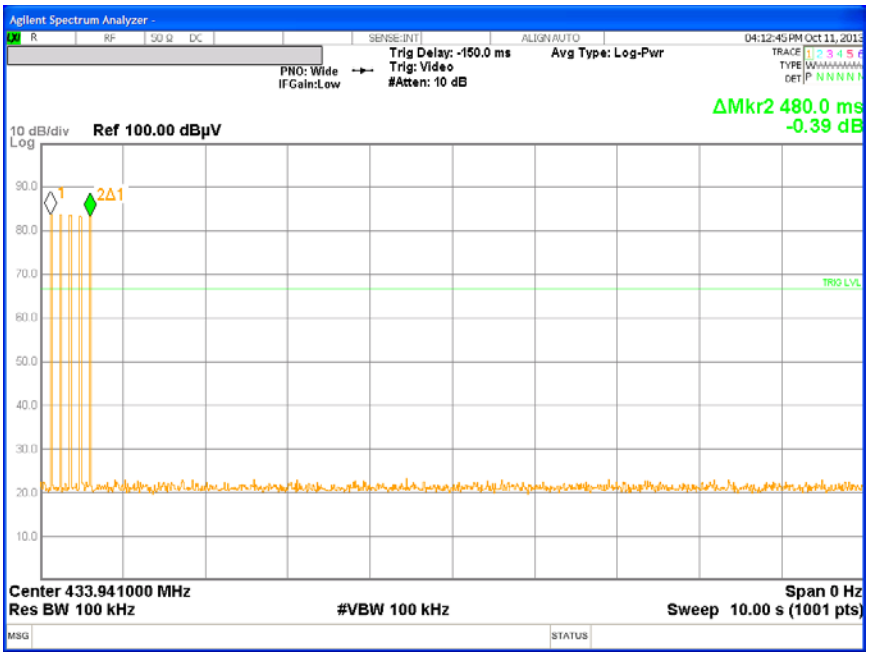
The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is set to 10 seconds and the span is set to 0 Hz.

RESULTS

No non-compliance noted:

Envelope Button: Momentary Contact

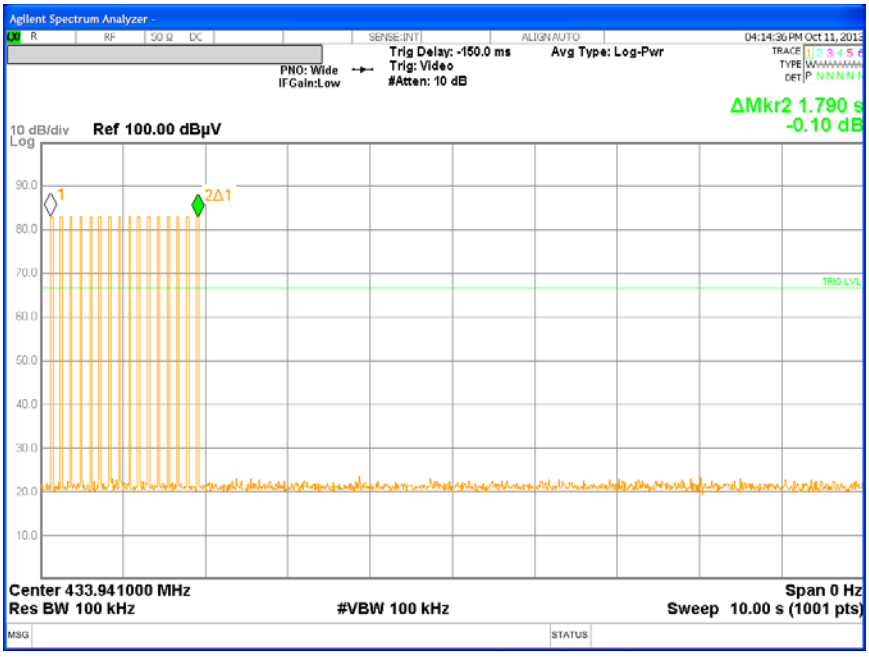
LESS THAN 5 SECONDS



EUT automatically shuts off within 0.5s.

Envelope Button: Continuous Contact

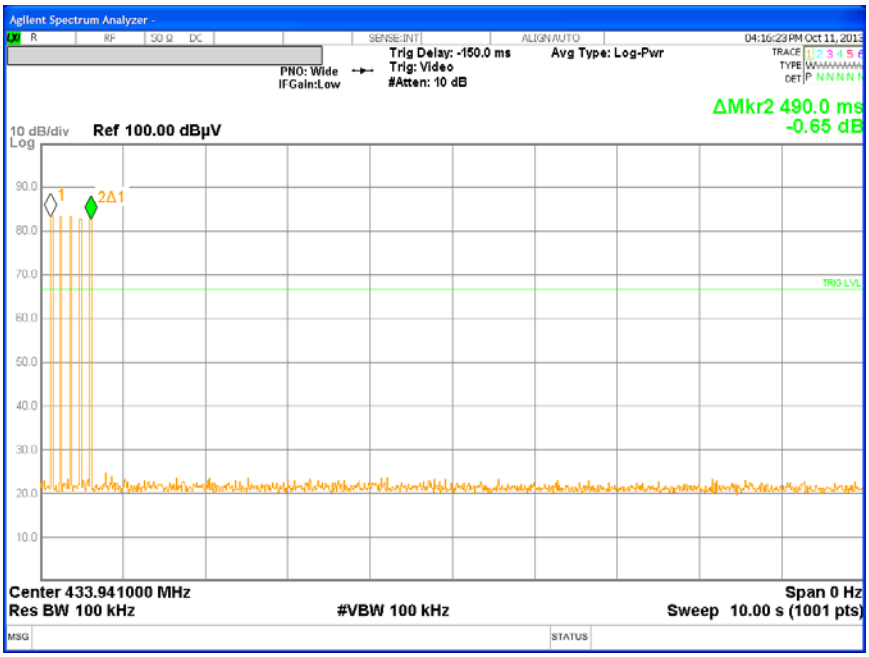
LESS THAN 5 SECONDS



EUT automatically shuts off within 2s.

Block Button: Momentary Contact

LESS THAN 5 SECONDS



EUT automatically shuts off within 0.5s.

Block Button: Continuous Contact

LESS THAN 5 SECONDS

EUT automatically shuts off within 2s.

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[1]	125 to 375[1]
174 - 260	3,750	375
260 - 470	3,750 to 12,500[1]	375 to 1,250[1]
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 between 30 MHz and 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

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

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.

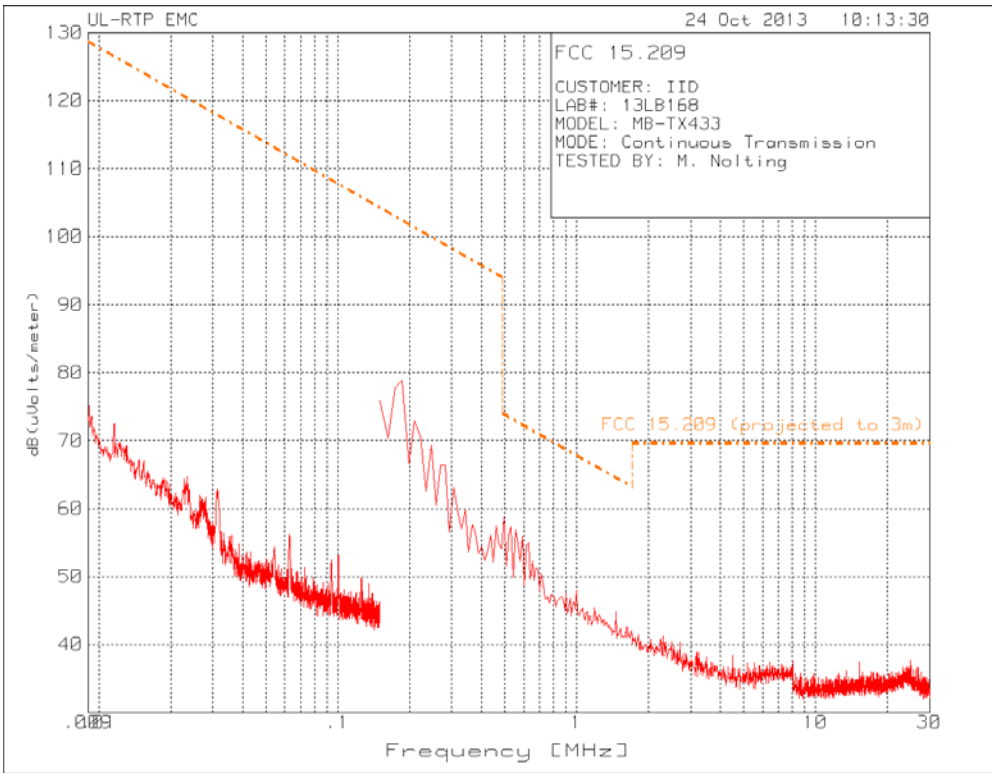
RESULTS

No non-compliance noted:

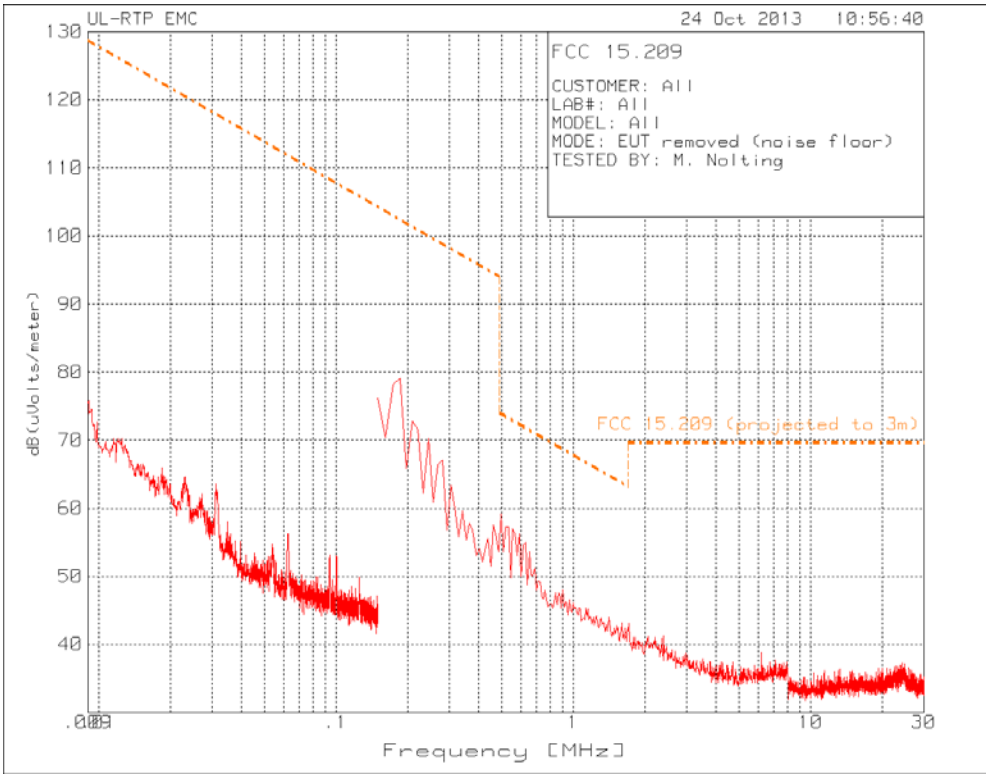
TX SPURIOUS EMISSIONS (BELOW 30 MHz)

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



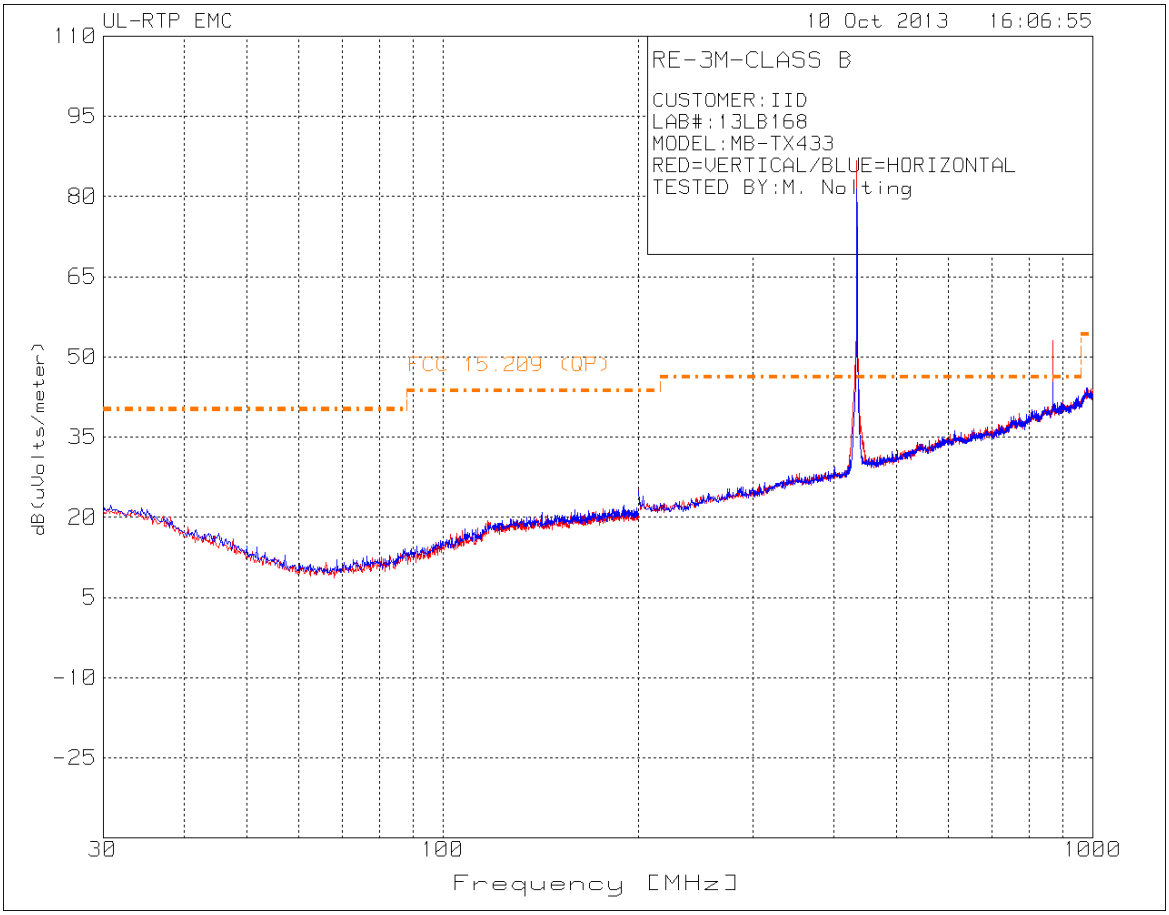
NOISE-FLOOR PLOT



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 EMISSIONS (30 – 1000 MHz)

VERTICAL/HORIZONTAL PLOT



TABULAR DATA

CUSTOMER: IID
LAB NUMBER: 13LB168
MODEL: MB-TX433
RED=VERTICAL/BLUE=HORIZONTAL
TESTED BY: M. Nolting

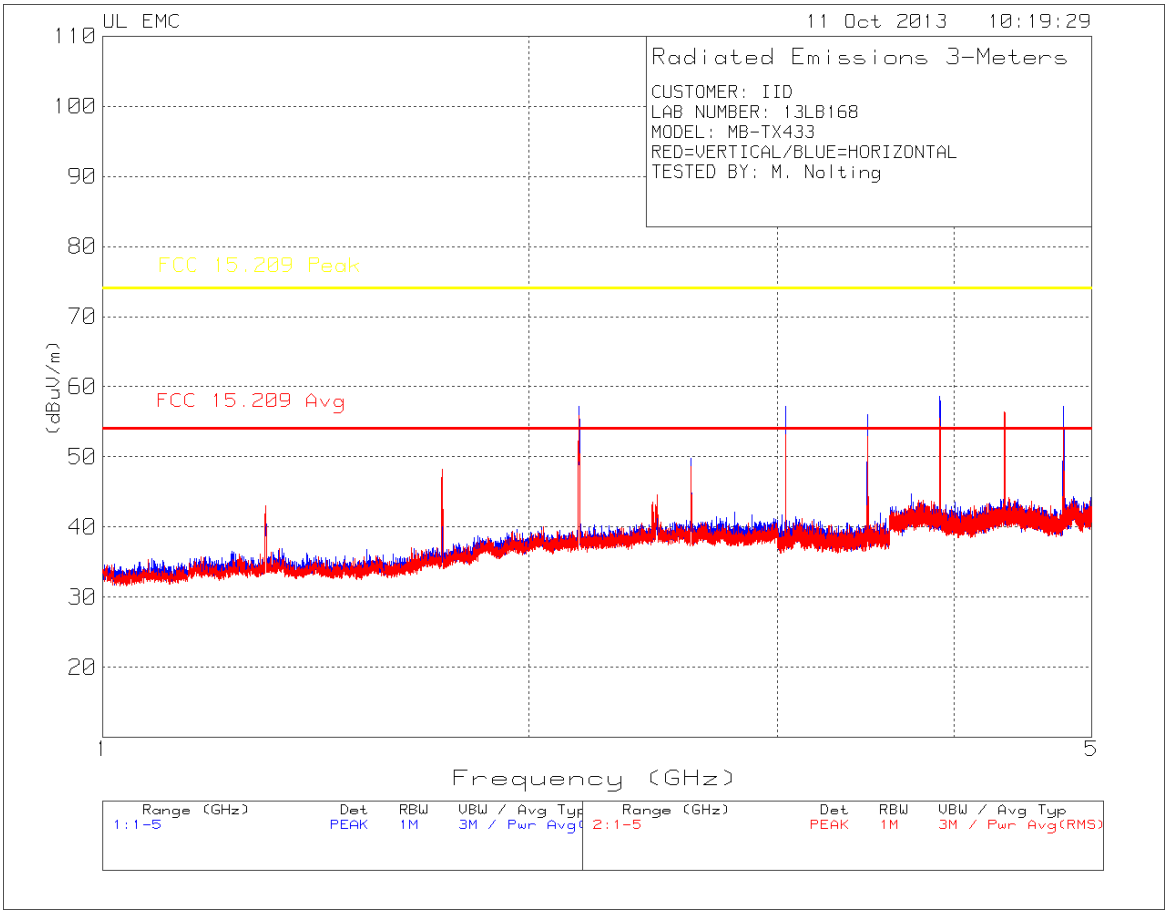
Freq (MHz)	Meter Reading [dBuV]	Detector	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Average Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
433.94	91.94	PK	16.40	-26.90	81.4	100.8	-19.4	58.4	80.8	-22.4	H	N
867.87	43.91	PK	22.60	-26.70	39.8	80.8	-41.0	16.8	60.8	-44.0	H	N
433.94	99.81	PK	16.40	-26.90	89.3	100.8	-11.5	66.3	80.8	-14.5	V	N
867.87	61.39	PK	22.60	-26.70	57.3	80.8	-23.5	34.3	60.8	-26.5	V	N

PK - Peak detector

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

HARMONICS AND TX SPURIOUS EMISSIONS ABOVE 1GHz

VERTICAL/HORIZONTAL PLOT



TABULAR DATA

CUSTOMER: IID
LAB NUMBER: 13LB168
MODEL: MB-TX433
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]	Peak Limit [dBuV/m]	Margin [dB]	Average Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
1.30	54.10	PK	28.80	-40.70	42.2	74.0	-31.8	19.2	54.0	-34.8	H	Y
1.74	56.07	PK	29.40	-39.90	45.6	80.8	-35.2	22.6	60.8	-38.2	H	N
2.17	64.66	PK	31.60	-39.10	57.2	80.8	-23.6	34.2	60.8	-26.6	H	N
2.61	56.08	PK	32.00	-38.30	49.8	80.8	-31.0	26.8	60.8	-34.0	H	N
3.04	62.38	PK	32.90	-38.10	57.2	80.8	-23.6	34.2	60.8	-26.6	H	N
3.47	60.73	PK	33.00	-37.70	56.0	80.8	-24.8	33.0	60.8	-27.8	H	N
3.91	62.61	PK	33.40	-37.40	58.6	74.0	-15.4	35.6	54.0	-18.4	H	Y
4.34	58.32	PK	33.70	-37.10	54.9	74.0	-19.1	31.9	54.0	-22.1	H	Y
4.77	59.90	PK	33.90	-36.60	57.2	74.0	-16.8	34.2	54.0	-19.8	H	Y
1.30	54.90	PK	28.80	-40.70	43.0	74.0	-31.0	20.0	54.0	-34.0	V	Y
1.74	58.80	PK	29.40	-39.90	48.3	80.8	-32.5	25.3	60.8	-35.5	V	N
2.17	63.42	PK	31.60	-39.10	55.9	80.8	-24.9	32.9	60.8	-27.9	V	N
2.60	54.87	PK	32.00	-38.30	48.6	80.8	-32.2	25.6	60.8	-35.2	V	N
3.04	58.38	PK	32.90	-38.10	53.2	80.8	-27.6	30.2	60.8	-30.6	V	N
3.47	57.60	PK	33.00	-37.70	52.9	80.8	-27.9	29.9	60.8	-30.9	V	N
3.91	59.45	PK	33.40	-37.40	55.5	74.0	-18.6	32.5	54.0	-21.6	V	Y
4.34	59.78	PK	33.70	-37.10	56.4	74.0	-17.6	33.4	54.0	-20.6	V	Y
4.77	56.60	PK	33.90	-36.60	53.9	74.0	-20.1	30.9	54.0	-23.1	V	Y

PK - Peak detector

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

END OF REPORT