

EMISSIONS TEST REPORT

Report Number: 3178382BOX-001a

Project Number: 3178382

Testing performed on the

2.4GHz EW3 Keyfob

Model: EW3

To

FCC Part 15 Subpart C Section 15.249

For

LoJack Corporation

Test Performed by:
Intertek – ETL SEMKO
70 Codman Hill Road
Boxborough, MA 01719

Test Authorized by:
LoJack Corporation
780 Dedham Street
Canton, Ma 02021

Prepared by:



Kouma Sinn

Date: 10/23/09

Reviewed by:



Jeff Goulet

Date: 10/26/09

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1.0 Job Description

1.1 Client Information

This EUT has been tested at the request of:

Company: LoJack Corporation
780 Dedham Street
Canton, Ma 02021
Contact: Mr. Bob White
Telephone: 781-302-7128
Fax: 781-302-7299
Email: rwhite@lojack.com

1.2 Equipment Under Test

Equipment Type: 2.4GHz EW3 Keyfob
Model Number(s): EW3
Serial number(s): CIREXX 1909
Manufacturer: LoJack Corporation
EUT receive date: June 18, 2009
EUT received condition: Production unit was received with no visible damage.
Test start date: June 19, 2009
Test end date: June 24, 2009

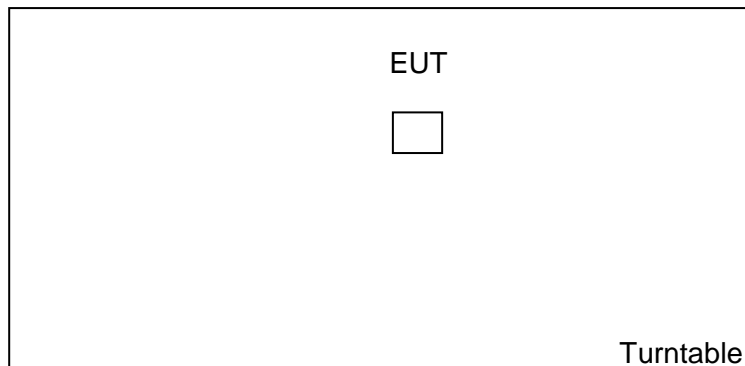
1.3 Test Plan Reference: FCC Part 15 Subpart C Section 15.249

1.4 Test Configuration:

1.4.1 EUT Voltage Range:

3Volts Lithium Battery

1.4.2 Block Diagram:



1.4.3 Cables:

None

1.4.4 Support Equipment:

None

1.5 Mode(s) of Operation:

The EUT was programmed to transmit with high repetition rate.

2.0 Test Summary

TEST STANDARD	RESULTS	
FCC Part 15 Subpart C Section 15.249		
SUB-TEST	TEST PARAMETER	COMMENT
15.249(a) – Fundamental Field Strength	2400–2483.5 MHz: The field strength of emission within this band shall not exceed 50 (millivolts/meter) or 94 (dBuV/m) at a distance of 3 meters	Pass
15.249(a) – Harmonics Field Strength	The field strength of harmonics shall not exceed 500 (microvolts/meter) or 54 (dBuV/m) at a distance of 3 meters	Pass
15.249(d) – Spurious Field Strength	Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209, whichever is the lesser attenuation.	Pass
15.207 – AC Line-Conducted Emissions	Not Applicable – Battery power	

REVISION SUMMARY – The following changes have been made to this Report:

<u>Date</u>	<u>Project No.</u>	<u>Project Handler</u>	<u>Page(s)</u>	<u>Item</u>	<u>Description of Change</u>
10/23/09	3178382	Kouma Sinn	1,2,8,9,12, 14-17	Model #	Changed model # from EW2 to EW3 (per client)

3.0 Sample Calculations

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

$$\text{Level in } \mu\text{V/m} = [10(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$$

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in dB μ V

- RF = Reading from receiver in dB μ V
- LF = LISN Correction Factor in dB
- CF = Cable Correction Factor in dB
- AF = Attenuator Loss Factor in dB

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where UF = Net Reading in } \mu\text{V}$$

Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 254 \mu\text{V/m}$$

3.1 Measurement Uncertainty

For radiated emissions, U_{lab} (4.9 dB at 3m and 4.2 dB at 10m) $< U_{CISPR}$ (5.2 dB), which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

For conducted emissions, U_{lab} (3.2 dB in worst case) $< U_{CISPR}$ (3.6 dB), which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

3.2 Site Description

Test Site(s): 1

Our OATS are 3m and 10m sheltered emissions measurement ranges located in a light commercial environment in Boxborough, Massachusetts. They meet the technical requirements of ANSI C63.4-2003 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal groundplane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity (12,000 lb. in Site 3) is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid. The copper strap is directly connected to the groundplane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical groundplane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical groundplane is electrically connected to the reference groundplane.



Test Results: Pass

Test Standard: FCC Part 15 Subpart C Section 15.249

Test: Fundamental Field Strength

Performance Criterion: Not Applicable

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	See data table	Humidity (%):	See data table	Pressure (hPa):	See data table
Pretest Verification Performed	Yes		Equipment under Test:	EW3		
Test Engineer(s):	Kouma Sinn		EUT Serial Number:	CIREXX 1909		

Maximum Test Disturbance Parameters: Emissions below 15.249(a)

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	HORN ANTENNA	EMCO	3115	9610-4980	02/25/2010
2	High Frequency Cable	Megaphase	TM40-K1K1-197	8148601-001	12/10/2009
3	Weather Station	Davis Instruments	7400	PE80519A61	06/10/2010
4	Spectrum Analyzer	Agilent	E7405A	US40240205	08/21/2009

Software Utilized:

Name	Manufacturer	Version
Excel 2003	Microsoft	(11.8231.8221) SP3
EMI Buxborough.xls	Intertek	4/17/09

Test Details:

Test Point	Standard Limit (as published)	Compliance Level	Pass/Fail	Comment
Around the EUT	Specified limits	Below specified limits	Pass	None

Test Results:

Fundamental Field Strength

Company: LoJack Corporation
 Model #: 2.4GHz EW3 Keyfob
 Serial #: CIREXX 1909
 Engineers: Kouma Sinn
 Project #: 3178382
 Standard: FCC Part 15 Subpart C 15.249
 Receiver: AGL001
 PreAmp: PRE9 04-03-10.txt
 Antenna & Cables: HF Bands: N, LF, HF, SHF
 Antenna: HORN3 V3m 02-25-10.txt HORN3 H3m 02-25-10.txt
 Cable(s): MEG005 12-10-2009.txt NONE.
 Barometer: DAV001
 Filter: NONE
 Location: 1
 Date(s): 06/22/09
 Temp/Humidity/Pressure: 67F 85% 29.32 IN
 Limit Distance (m): 3
 Test Distance (m): 3
 PreAmp Used? (Y or N): N Voltage/Frequency: 3V Battery Frequency Range: Fundamental
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Average Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
MaxH PK	H	2401.475	58.38	28.42	3.05	20.00	0.00	69.85	93.98	-24.13	1/3MHz
MaxH PK	V	2401.475	65.79	28.37	3.05	20.00	0.00	77.21	93.98	-16.77	1/3MHz

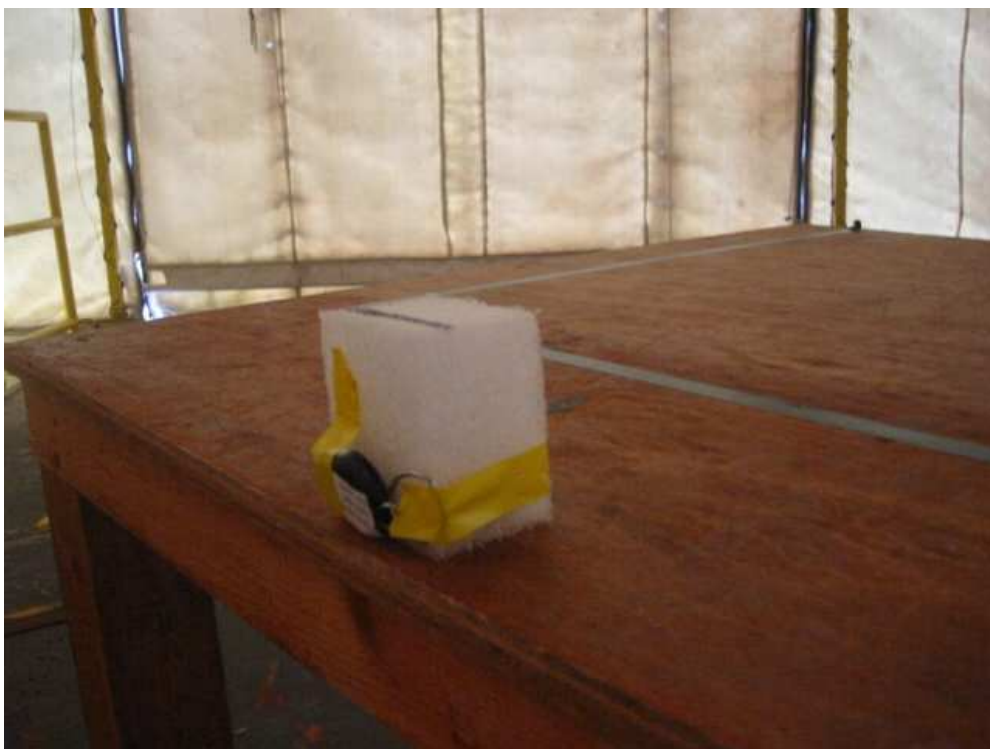
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Notes: Used 20dB average factor

Radiated Emissions Setup Photos – Horn Antenna In Horizontal Polarity Position



Radiated Emissions Setup Photos – Horn Antenna In Vertical Polarity Position



Test Results: Pass

Test Standard: FCC Part 15 Subpart C Section 15.249

Test: Harmonics/Spurious Field Strength

Performance Criterion: Not Applicable

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	See data table	Humidity (%):	See data table	Pressure (hPa):	See data table
Pretest Verification Performed	Yes		Equipment under Test:	EW3		
Test Engineer(s):	Kouma Sinn		EUT Serial Number:	CIREXX 1909		

Maximum Test Disturbance Parameters: Emissions below 15.249(a) and 15.249(d)

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	01/27/2010
2	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2009
3	40 GHz Cable	Megaphase	TM40-K1K1-80	58013901001	05/26/2010
4	100MHz-40GHz Preamp	MITEQ	NSP4000-NFG	1260417	04/03/2010
5	Weather Station	Davis Instruments	7400	PE80519A61	06/10/2010
6	HORN ANTENNA	EMCO	3115	9610-4980	02/25/2010
7	High Frequency Cable	Megaphase	TM40-K1K1-197	8148601-001	12/10/2009
8	3GHz High Pass Filter	Reactel, Inc	7HSX-3G/18G-S11	06-1	10/15/2009
9	ANTENNA	EMCO	3142	9701-1116	12/02/2009
10	30 ft 50 ohm coax, BNC - BNC	ITT Pomona	RG 58 C/U	CBLBNC7	02/25/2010

**Software Utilized:**

Name	Manufacturer	Version
Excel 2003	Microsoft	(11.8231.8221) SP3
EMI Boxborough.xls	Intertek	4/17/09

Test Details:

Test Point	Standard Limit (as published)	Compliance Level	Pass/Fail	Comment
Around the EUT	Specified limits	Below specified limits	Pass	None

Test Results:

Radiated Emissions From 30-1000MHz

Company: LoJack Corporation
 Model #: 2.4GHz EW3 Keyfob
 Serial #: CIREXX 1909
 Engineers: Kouma Sinn
 Project #: 3178382
 Standard: FCC Part 15 Subpart B Class B
 Receiver: AGL001
 PreAmp: PRE9 04-03-10.txt
 Antenna & Cables: N Bands: N, LF, HF, SHF
 Antenna: LOG1 12-02-2009 V10.txt LOG1 12-02-2009 H10.txt
 Cable(s): CBLBNC7 02-25-10.txt NONE.
 Barometer: DAV001
 Filter: None
 Location: 1
 Date(s): 06/19/09
 Temp/Humidity/Pressure: 20C 80% 998mbar
 Limit Distance (m): 3
 Test Distance (m): 3
 PreAmp Used? (Y or N): N Voltage/Frequency: 3V battery
 Frequency Range: 30-1000MHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC
No emissions were detected. Data below are noise floor readings												
QP	V	30.000	-3.00	16.80	1.29	0.00	0.00	15.09	40.00	-24.92	120/300 kHz	NF
QP	V	60.355	10.51	6.68	1.70	0.00	0.00	18.90	40.00	-21.10	120/300 kHz	NF
QP	V	120.000	2.97	6.90	2.23	0.00	0.00	12.10	43.50	-31.40	120/300 kHz	NF
QP	V	200.000	4.50	10.60	2.80	0.00	0.00	17.90	43.50	-25.60	120/300 kHz	NF
QP	V	300.000	-2.70	14.10	3.33	0.00	0.00	14.73	46.00	-31.28	120/300 kHz	NF
QP	V	500.000	1.00	18.20	4.42	0.00	0.00	23.62	46.00	-22.38	120/300 kHz	NF
QP	V	700.000	-6.50	21.50	5.52	0.00	0.00	20.52	46.00	-25.49	120/300 kHz	NF
QP	V	900.000	6.60	23.30	6.32	0.00	0.00	36.22	46.00	-9.78	120/300 kHz	NF

Test Results Continued:

Radiated Emissions From 1-18GHz

Company: LoJack Corporation Antenna & Cables: If Bands: N, LF, HF, SHF
 Model #: 2.4GHz EW3 Keyfob Antenna: HORN3 V3m 02-25-10.txt HORN3 V3m 02-25-10.txt
 Serial #: CIREXX 1909 Cable(s): MEG005 12-10-2009.txt MEG003 05-26-10.txt
 Engineers: Kouma Sinn Location: 1 Barometer: DAV001 Filter: REA004 (3-18GHz only)
 Project #: 3178382 Date(s): 06/22/09
 Standard: FCC Part 15 Subpart C 15.249 Temp/Humidity/Pressure: 69F 79% 29.34IN
 Receiver: AGL001 Limit Distance (m): 3
 PreAmp: PRE9 04-03-10.txt Test Distance (m): 3
 PreAmp Used? (Y or N): Y Voltage/Frequency: 3V Battery Frequency Range: 3-18GHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Average Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	
MaxH PK	V	1000.000	34.80	24.05	1.88	0.00	0.00	60.73	74.00	-13.27	1/3MHz	FCC
AVG	V	1000.000	14.00	24.05	1.88	0.00	0.00	39.93	54.00	-14.07	1/3MHz	NF
MaxH PK	V	2000.000	36.40	27.52	2.76	0.00	0.00	66.68	74.00	-7.32	1/3MHz	NF
AVG	V	2000.000	14.50	27.52	2.76	0.00	0.00	44.78	54.00	-9.22	1/3MHz	NF
MaxH PK	V	3000.000	35.40	29.97	3.46	0.00	0.00	68.83	74.00	-5.17	1/3MHz	NF
AVG	V	3000.000	15.30	29.97	3.46	0.00	0.00	48.73	54.00	-5.27	1/3MHz	NF
MaxH PK	V	4802.963	49.15	33.38	6.41	28.09	20.00	40.86	54.00	-13.14	1/3MHz	RB
MaxH PK	V	7204.425	36.80	35.95	8.13	27.31	0.00	53.57	74.00	-20.43	1/3MHz	NF
AVG	V	7204.425	22.70	35.95	8.13	27.31	0.00	39.47	54.00	-14.53	1/3MHz	NF
MaxH PK	V	9605.900	35.70	39.34	9.97	26.44	0.00	58.57	74.00	-15.43	1/3MHz	NF
AVG	V	9605.900	20.20	39.34	9.97	26.44	0.00	43.07	54.00	-10.93	1/3MHz	NF
MaxH PK	V	12007.380	35.60	39.17	10.98	26.34	0.00	59.41	74.00	-14.59	1/3MHz	NF
AVG	V	12007.380	19.30	39.17	10.98	26.34	0.00	43.11	54.00	-10.89	1/3MHz	NF
MaxH PK	V	14408.850	36.30	42.72	12.40	26.39	0.00	65.03	74.00	-8.97	1/3MHz	NF
AVG	V	14408.850	21.50	42.72	12.40	26.39	0.00	50.23	54.00	-3.77	1/3MHz	NF
MaxH PK	V	16810.325	36.40	40.12	13.73	27.23	0.00	63.01	74.00	-10.99	1/3MHz	NF
AVG	V	16810.325	21.90	40.12	13.73	27.23	0.00	48.51	54.00	-5.49	1/3MHz	NF

Notes: From 1-3GHz, no preamp or filter were used and only MEG005 cable was used

Notes: 20dB average factor was used on 4802.963MHz only

Test Results Continued:

Radiated Emissions From 18-24GHz

Company: LoJack Corporation
 Model #: 2.4GHz EW3 Keyfob
 Serial #: CIREXX 1909
 Engineers: Kouma Sinn
 Project #: 3178382
 Standard: FCC Part 15 Subpart C 15.249
 Receiver: R&S ESCI (ROS002) 02-17-2010
 PreAmp: PRE9 04-03-10.txt
 Antenna & Cables: SHF
 Antenna: EMC04 V1m 01-27-2010.txt
 Cable(s): CBL030 12-10-09.txt
 Barometer: DAV001
 Bands: N, LF, HF, SHF
 EMC04 H1m 01-27-2010.txt
 MEG003 05-26-10.txt
 Filter: NONE
 Location: 1
 Date(s): 06/22/09
 Temp/Humidity/Pressure: 69F 79% 29.34IN
 Limit Distance (m): 1
 Test Distance (m): 1
 PreAmp Used? (Y or N): Y
 Voltage/Frequency: 3V battery
 Frequency Range: 18-24GHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
No emissions were detected at 1, 0.5 or 0.3 meter											



Test Results: Not Applicable

Test Standard: FCC Part 15 Subpart C Section 15.249

Test: Average Factor

Performance Criterion: Not Applicable

Test Environment:

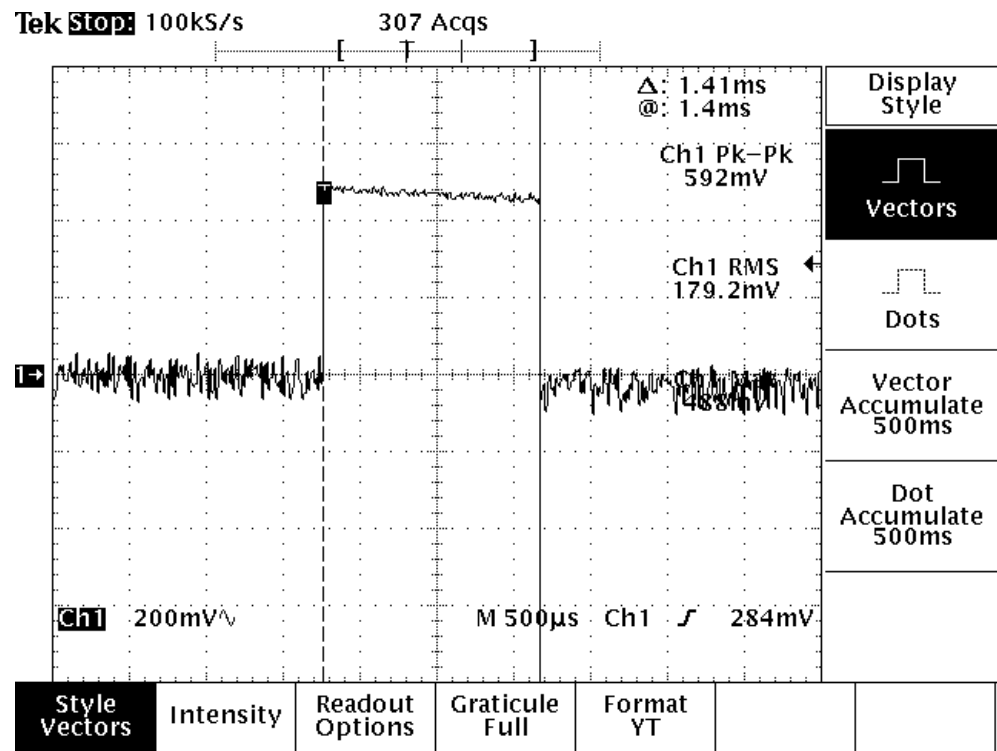
Environmental Conditions During Testing:	Ambient (°F):	69	Humidity (%):	79	Pressure (IN):	29.34
Pretest Verification Performed	Yes		Equipment under Test:	EW3		
Test Engineer(s):	Kouma Sinn		EUT Serial Number:	CIREXX 1909		

Maximum Test Disturbance Parameters: N/A

Test Equipment Used:

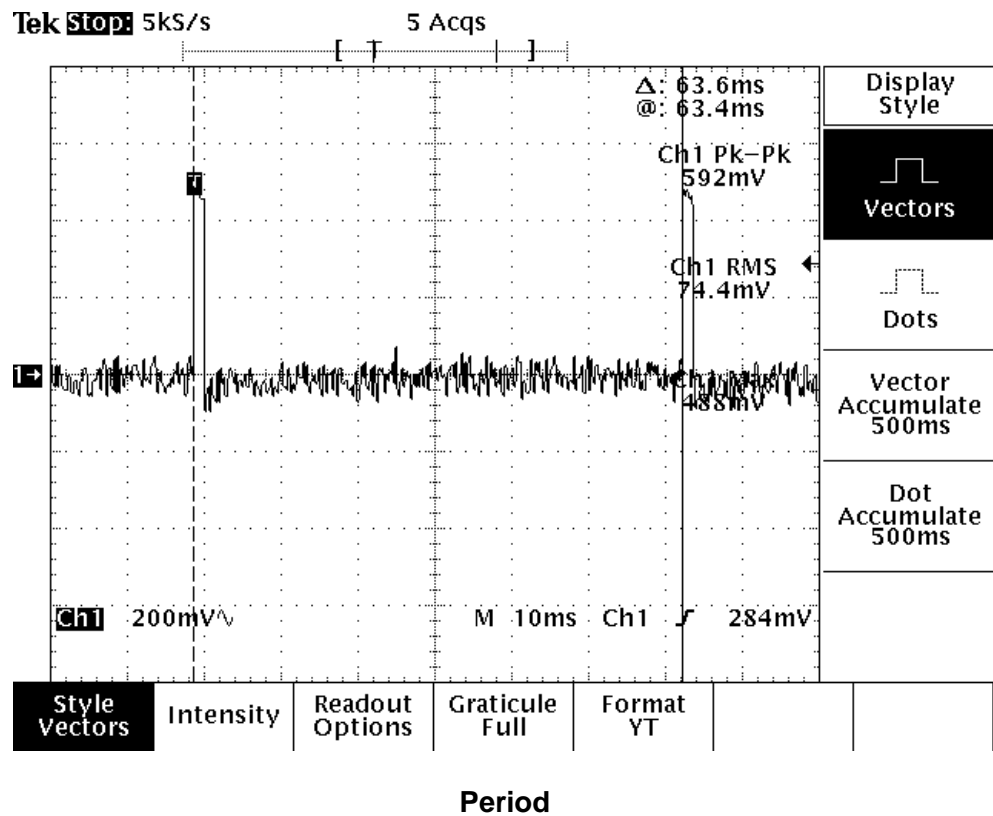
TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	HORN ANTENNA	EMCO	3115	9610-4980	02/25/2010
2	High Frequency Cable	Megaphase	TM40-K1K1-197	8148601-001	12/10/2009
3	Weather Station	Davis Instruments	7400	PE80519A61	06/10/2010
4	Spectrum Analyzer	Agilent	E7405A	US40240205	08/21/2009
5	OSCILLOSCOPE	Tektronix	TDS380	B011379	03/17/2010

Average Factor Calculation:



Total On-Time

Average Factor Calculation Continued:



$\text{Average Factor} = 20 * \log (\text{On-Time}/\text{Period})$

$\text{Average Factor} = 20 * \log (1.41/63.6)$

$\text{Average Factor} = -33.0848 \text{ dB}$

The maximum allowed average factor of 20dB was used instead of the calculated value.