

EMISSIONS TEST REPORT**Report Number: 3123708BOX-001****Project Number: 3123708****Testing performed on the****US Portable****Model: VT5****To****FCC Part 90****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

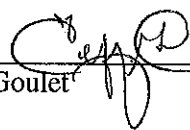
Prepared by:



Nicholas Abbondante

Date: 06/29/2007

Reviewed by:



Jeff Goulet

Date: 6-29-07

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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. Robert White
Telephone: 781-302-7128
Fax: 781-302-7199
Email: rwhite@lojack.com

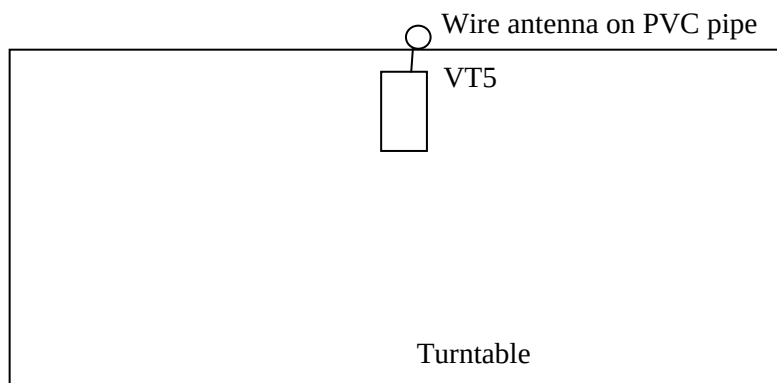
1.2 Equipment Under Test

Equipment Type: US Portable
Model Number(s): VT5
Serial number(s): 000AC, 000AA
Manufacturer: LoJack Corporation
EUT receive date: 06/27/2007
EUT received condition: Prototype in Good Condition
Test start date: 06/27/2007
Test end date: 06/29/2007

1.3 Test Plan Reference: Tested according to the standards listed.

1.4 Test Configuration

1.4.1 Block Diagram



1.4.2. Cables:

Cable	Shielding	Connector	Length (m)	Qty.
Antenna Wire	None	Wire	1.07	1
'Ground' Wire	None	Wire	0.63	1

1.4.3. Support Equipment:

Name: Dell Latitude Laptop
Model No.: PPL
Serial No.: ZZLP5

1.5 Mode(s) of Operation:

Both samples were activated from fresh 6V and 3.6V batteries throughout testing, except for frequency stability during which the EUT was powered from a DC power supply. Sample 000AC was configured in Police Training mode, transmitting a modulated carrier every 5 seconds. Sample 000AA was transmitting an unmodulated carrier for the frequency stability testing.

2.0 Test Summary

TEST STANDARD	RESULTS	
FCC Part 90		
SUB-TEST	TEST PARAMETER	COMMENT
RF Output Power and Spurious Emissions FCC 2.1046, 2.1053, 90.20(e)(6), 90.210(c)	RF Output Power must not exceed 2.5 Watts. Spurious emissions must not exceed -13 dBm.	Pass
Occupied Bandwidth FCC 2.1049, 90.20(e)(6)	Occupied bandwidth must not exceed 20 kHz.	Pass
Emissions Mask FCC 90.210(c)	The transmit waveform must meet the requirements of Emissions Mask C.	Pass
On-Time FCC 90.20(e)(6)	On time must not exceed 200 ms over the period of 1 second when the transmitter is in active mode. On time must not exceed 200 ms over the period of 10 seconds when the transmitter is not in active mode.	Pass
Transient Frequency Behavior FCC 90.214	The transmit frequency must stay within 12.5 kHz of the nominal frequency for the 20 ms after the first 5 ms that follow the transmitter being keyed on.	Pass
Frequency Stability FCC 2.1055, 90.213	Frequency drift must not exceed 50 PPM	Pass

Notes: The EUT transmits at 173.075 MHz.

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

<u>Date</u>	<u>Project</u>	<u>Project</u>	<u>Page(s)</u>	<u>Item</u>	<u>Description of Change</u>
	<u>No.</u>	<u>Handler</u>			

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

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.

The expanded uncertainty ($k = 2$) for radiated emissions from 30 to 1000 MHz has been determined to be:
 ± 3.5 dB at 10m, ± 3.8 dB at 3m

The expanded uncertainty ($k = 2$) for mains conducted emissions from 150 kHz to 30 MHz has been determined to be:

± 2.6 dB

The expanded uncertainty ($k = 2$) for telecom port conducted emissions from 150 kHz to 30 MHz has been determined to be:

± 3.2 for ISN and voltage probe measurements

± 3.1 for current probe measurements

3.2 Site Description

Test Site(s): 2

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.

The EMC Lab has two Semi-anechoic Chambers and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference groundplanes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Test Results: Pass

Test Standard: FCC 2.1046, 2.1053, 90.20(e)(6), 90.210(c)

Test: RF Output Power and Spurious Emissions

Performance Criterion: RF output power must not exceed 2.5 Watts. Spurious emissions must not exceed -13 dBm.

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	22	Humidity (%):	74	Pressure (hPa):	1000
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AC		

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	ANTENNA	EMCO	3142	9701-1116	12/04/2007
3	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	10/23/2007
4	10 Meter in floor cable for site 2	ITS	RG214B/U	S2 10M FLR	09/26/2007
5	BROADBAND ANTENNA	Compliance Design	B100	1852	09/08/2007
6	BROADBAND ANTENNA	Compliance Design	B200	1850	09/08/2007
7	BROADBAND ANTENNA	Compliance Design	B300	00674	09/08/2007
8	Synthesized Sweep Generator	Hewlett Packard	83620A	3213A01244	02/06/2009
9	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL029	12/04/2007
10	EMI Receiver, 9kHz to 6.5GHz	Hewlett Packard	8546A	3410A00173	07/26/2007
11	EMI Filter	Hewlett Packard	85460A	344800203	07/26/2007
12	FILTER, HIGH PASS 250 MHz	Mini-Circuits	NHP-250	882414	Verified
13	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 197	CBL027	12/04/2007
14	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 197	CBL028	12/04/2007
15	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/11/2007
16	HORN ANTENNA	EMCO	3115	9602-4675	09/11/2007

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3
EMI BOXBOROUGH	Intertek	3/07/07 Revision

Test Details:

Radiated Emissions, Substitution

Company: LoJack Corporation
 Model #: VT5
 Serial #: 000AC
 Engineer(s): Nicholas Abbondante
 Project #: 3123708
 Standard: FCC Part 90
 Barometer: BAR2 Temp/Humidity/Pressure: 22c 49% 1003 mB
 Test Distance (m): 10 Voltage/Frequency: Fresh Battery Frequency Range: 30-1800 MHz
 Net = Generator Level (0.00 dBm) + (EUT reading - Generator reading) - Cable Loss + Antenna Gain (dBi or dBd)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor RB = Restricted Band; Bandwidth denoted as RBW/VBW

Rx Antenna: LOG1 HORN2
 Rx Cable(s): S2 10M FLR CBL027 CBL028
 Rx Preamp: NONE Receiver: Atlanta5
 Tx Antenna: ANT2 EMC02 Atlanta6
 Tx Cable(s): CBL029 ROS001

Tx Signal Generator: HEW62

ERP or EIRP?: ERP

Detector Type	Ant. Pol. (V/H)	Frequency MHz	EUT Reading dB(uV)	Generator Reading dB(uV)	Transmit Cable Loss dB	Transmit Antenna dBi	Generator Level dBm	Net dBm	Limit dBm	Margin dB	Bandwidth
PK	V	173.075	104.7	55.2	0.3	-1.5	-20.0	25.5	34.0	-8.5	120/300 kHz
PK	V	346.150	24.8	47.1	0.4	-1.1	-20.0	-46.0	-13.0	-33.0	120/300 kHz
PK	V	519.225	18.3	48.6	0.5	2.2	-20.0	-50.8	-13.0	-37.8	120/300 kHz
PK	V	692.300	19.8	44.2	0.6	2.1	-20.0	-45.1	-13.0	-32.1	120/300 kHz
PK	V	865.375	19.7	40.9	0.7	0.5	-20.0	-43.6	-13.0	-30.6	120/300 kHz
Note: 3m test distance											
PK	V	1038.450	26.6	55.3	0.8	6.0	-20.0	-45.7	-13.0	-32.7	1/3 MHz
PK	V	1211.525	26.2	55.0	0.9	7.0	-20.0	-44.9	-13.0	-31.9	1/3 MHz
PK	V	1384.600	26.2	51.4	0.9	7.8	-20.0	-40.5	-13.0	-27.5	1/3 MHz
PK	V	1557.675	27.2	53.8	1.0	8.7	-20.0	-41.0	-13.0	-28.0	1/3 MHz
PK	V	1730.750	27.7	50.9	1.0	8.8	-20.0	-37.7	-13.0	-24.7	1/3 MHz

Setup Photos



Setup Photos



Test Results: Pass

Test Standard: FCC 2.1049, 90.20(e)(6)

Test: Occupied Bandwidth

Performance Criterion: The 20 dB bandwidth of the emission must not exceed 20 kHz.

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	22	Humidity (%):	74	Pressure (hPa):	1000
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AC		

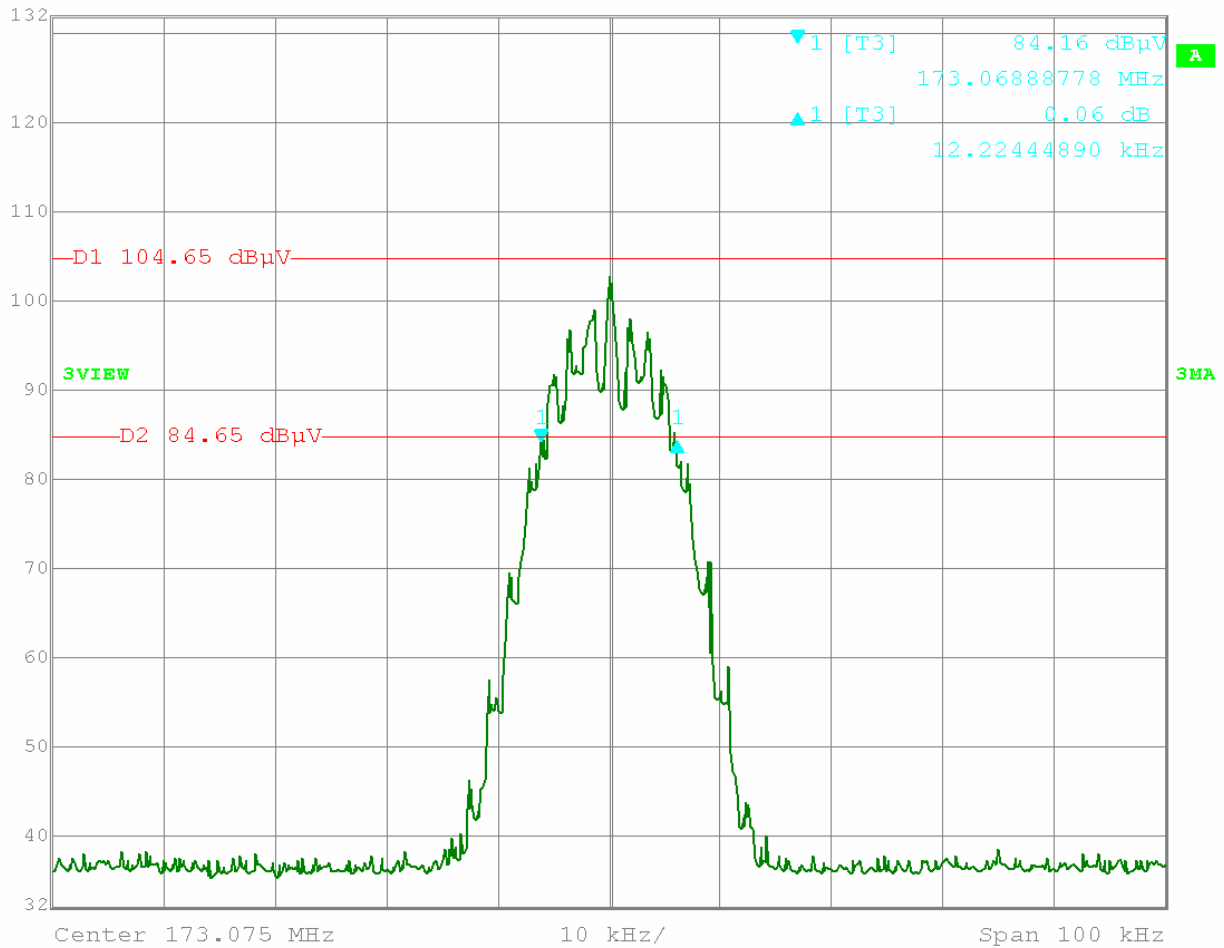
Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	10/23/2007
3	ANTENNA	EMCO	3142	9701-1116	12/04/2007
4	10 Meter in floor cable for site 2	ITS	RG214B/U	S2 10M FLR	09/26/2007

Test Details:



Ref Lvl	Delta 1 [T3]	RBW	300 Hz	RF Att	40 dB
132 dBμV	0.06 dB	VBW	5 kHz		
	12.22444890 kHz	SWT	2500 s	Unit	dBμV



Date: 28.JUN.2007 13:12:55

Notes: The 20 dB bandwidth is 12.22 kHz. Since the EUT operates with an integral antenna, this is a relative measurement and is referenced to the full field strength when observed with a 100 kHz bandwidth.

Test Results: Pass

Test Standard: 90.210(c)

Test: Emissions Mask

Performance Criterion: The transmit waveform must meet the requirements of Emissions Mask C. The fundamental emission waveform must be attenuated below the measured fundamental power P in watts by zero dB for frequencies within 5 kHz of the fundamental center frequency and by $83 \cdot \log(f/5)$ dB (f in kHz) in the bands between 5 and 10 kHz offset from the fundamental center frequency. Emissions offset by 10 kHz to 50 kHz must be attenuated below the measured fundamental power by at either 50 dB or $29 \cdot \log(f/11)$, whichever is the lesser attenuation.

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	22	Humidity (%):	74	Pressure (hPa):	1000
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AC		

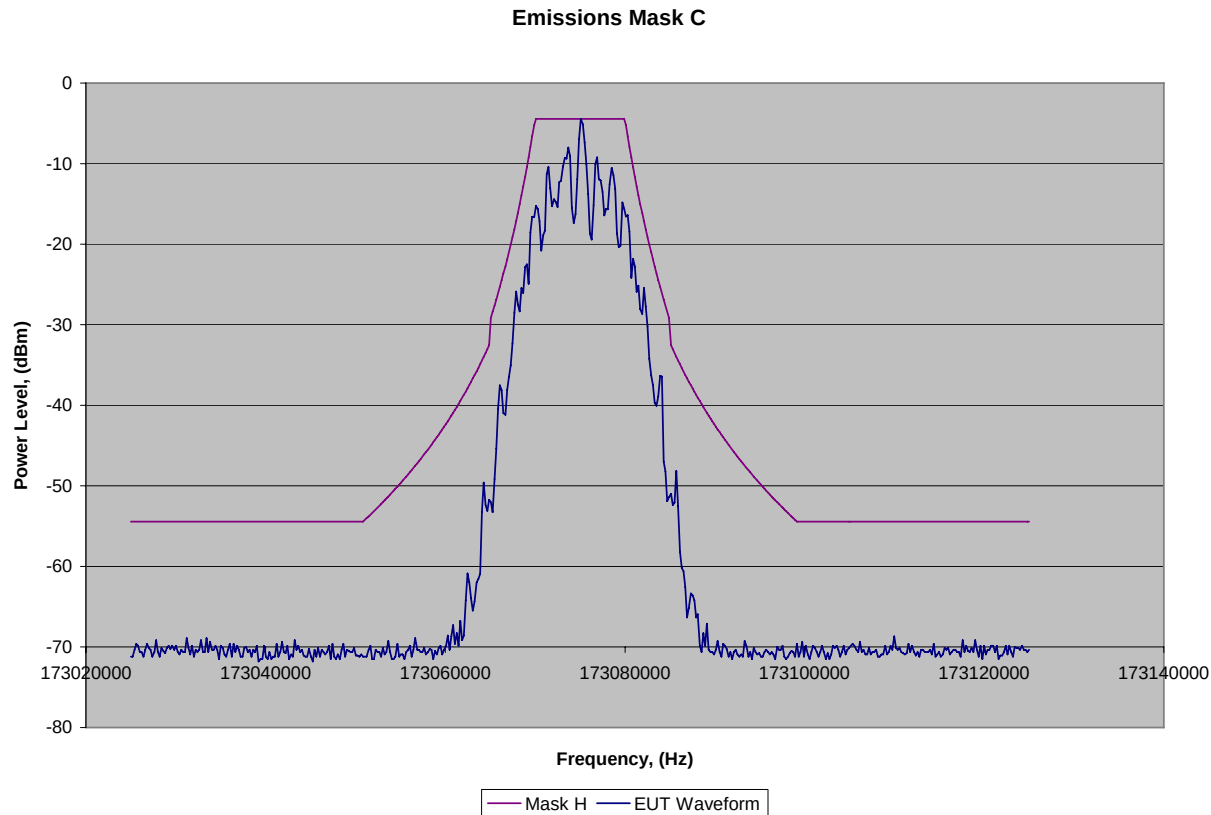
Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	10/23/2007
3	ANTENNA	EMCO	3142	9701-1116	12/04/2007
4	10 Meter in floor cable for site 2	ITS	RG214B/U	S2 10M FLR	09/26/2007

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3

Test Details:



Notes: Since the EUT operates with an integral antenna, this is a relative measurement, and is referenced to the highest signal strength observed in the trace which was -4.43 dBm.

Test Results: Pass

Test Standard: FCC 90.20(e)(6)

Test: On-Time

Performance Criterion: On time must not exceed 200 ms over the period of 1 second when the transmitter is in active mode. On time must not exceed 200 ms over the period of 10 seconds when the transmitter is not in active mode.

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	22	Humidity (%):	74	Pressure (hPa):	1000
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AC		

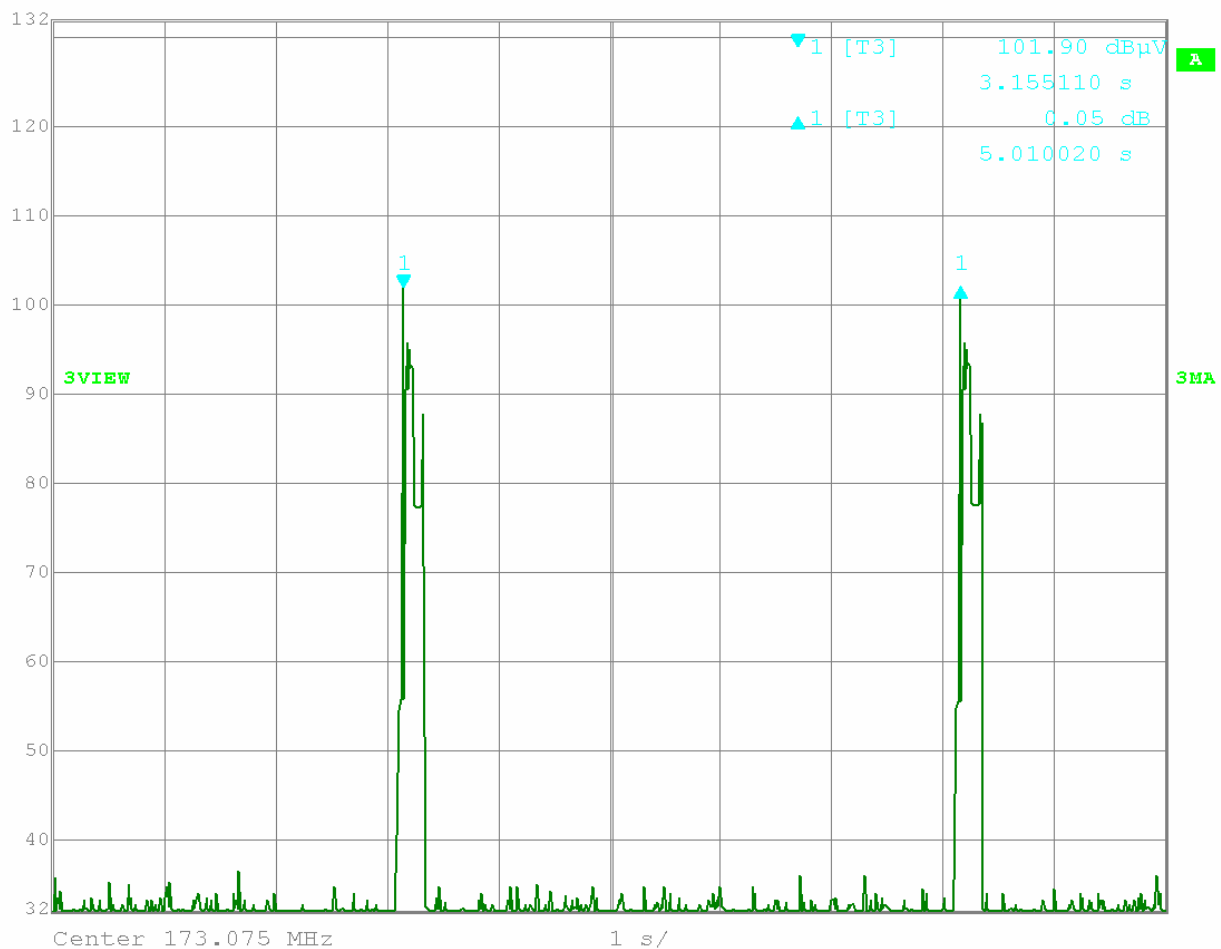
Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	10/23/2007
3	ANTENNA	EMCO	3142	9701-1116	12/04/2007
4	10 Meter in floor cable for site 2	ITS	RG214B/U	S2 10M FLR	09/26/2007

Test Details:

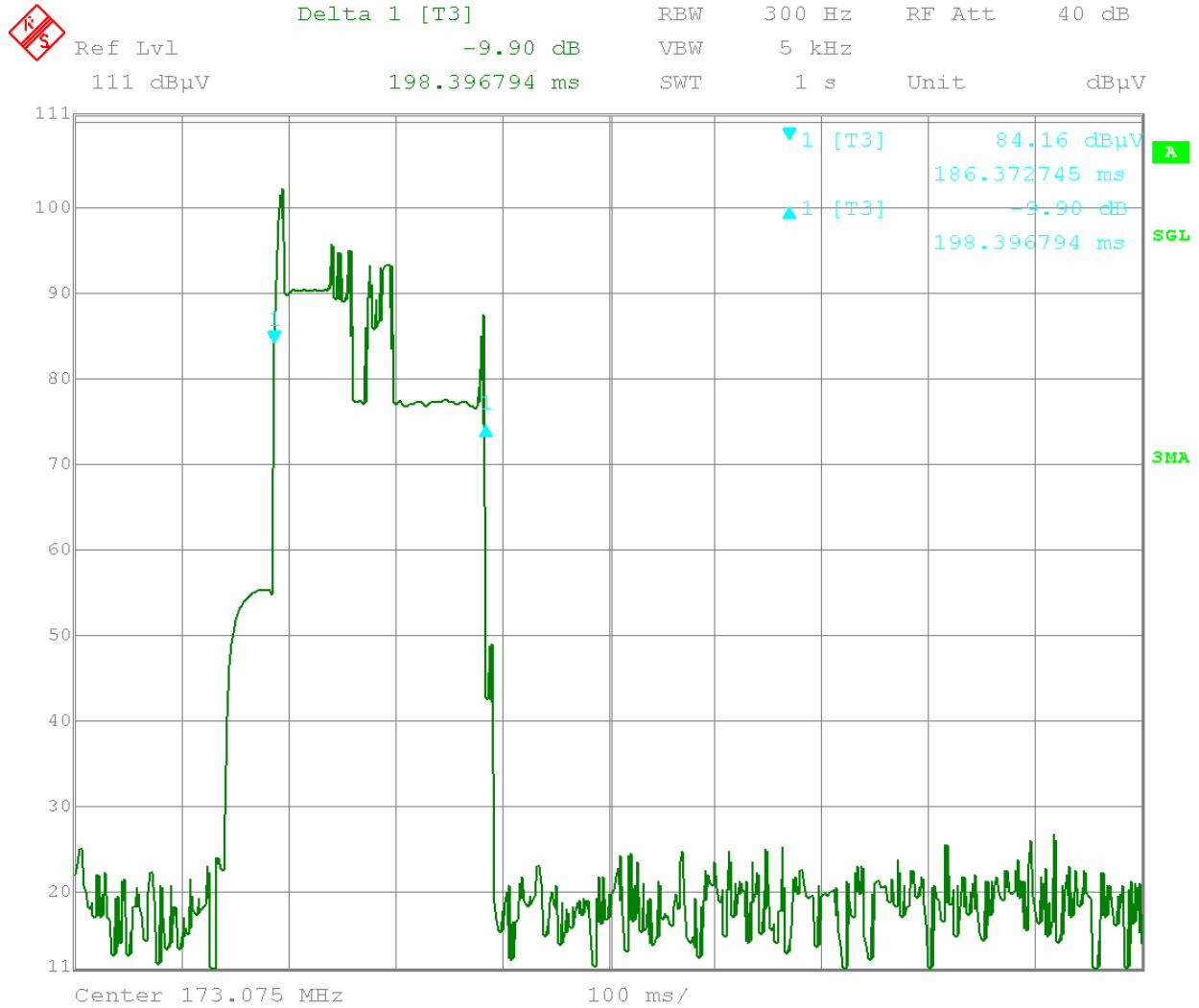


Ref Lvl	Delta 1 [T3]	RBW	300 Hz	RF Att	40 dB
132 dBμV	0.05 dB	VBW	5 kHz		
	5.010020 s	SWT	10 s	Unit	dBμV



Date: 28.JUN.2007 13:40:00

Pulse Interval, 5 seconds



Date: 28.JUN.2007 13:43:01

Pulse Duration, 198.4 ms

Notes: The transmitter only transmits when instructed to go into active mode.

Test Results: Pass

Test Standard: FCC 90.214

Test: Transient Frequency Behavior

Performance Criterion: The EUT operates at 173.075 MHz at not more than 2.5 Watts of output power, therefore only the time interval t₂ (5-25 ms after turning the EUT on) is subject to the limits below.

equipment designed to operate on 25 kHz channels			
time intervals ¹	maximum frequency difference, kHz	frequency range, MHz	
		IC: 138-174 FCC: 150-174	IC: 406.1-470 FCC: 421-512
t ₁	± 25	5 ms	10 ms
t ₂	± 12.5	20 ms	25 ms
t ₃	± 25	5 ms	10 ms

- NOTES: 1. t_{on} is the instant when the EUT starts transmitting.
t₁ is the time period immediately following t_{on}.
t₂ is the time period immediately following t₁.
t₃ is the time period from the instant when the transmitter is turned off until t_{off}.
t_{off} is the instant when the transmitter stops transmitting.
2. If the transmitter carrier output power is 6 W or less, the frequency difference during the time periods t₁ and t₃ may exceed the maximum frequency difference limit for those periods.

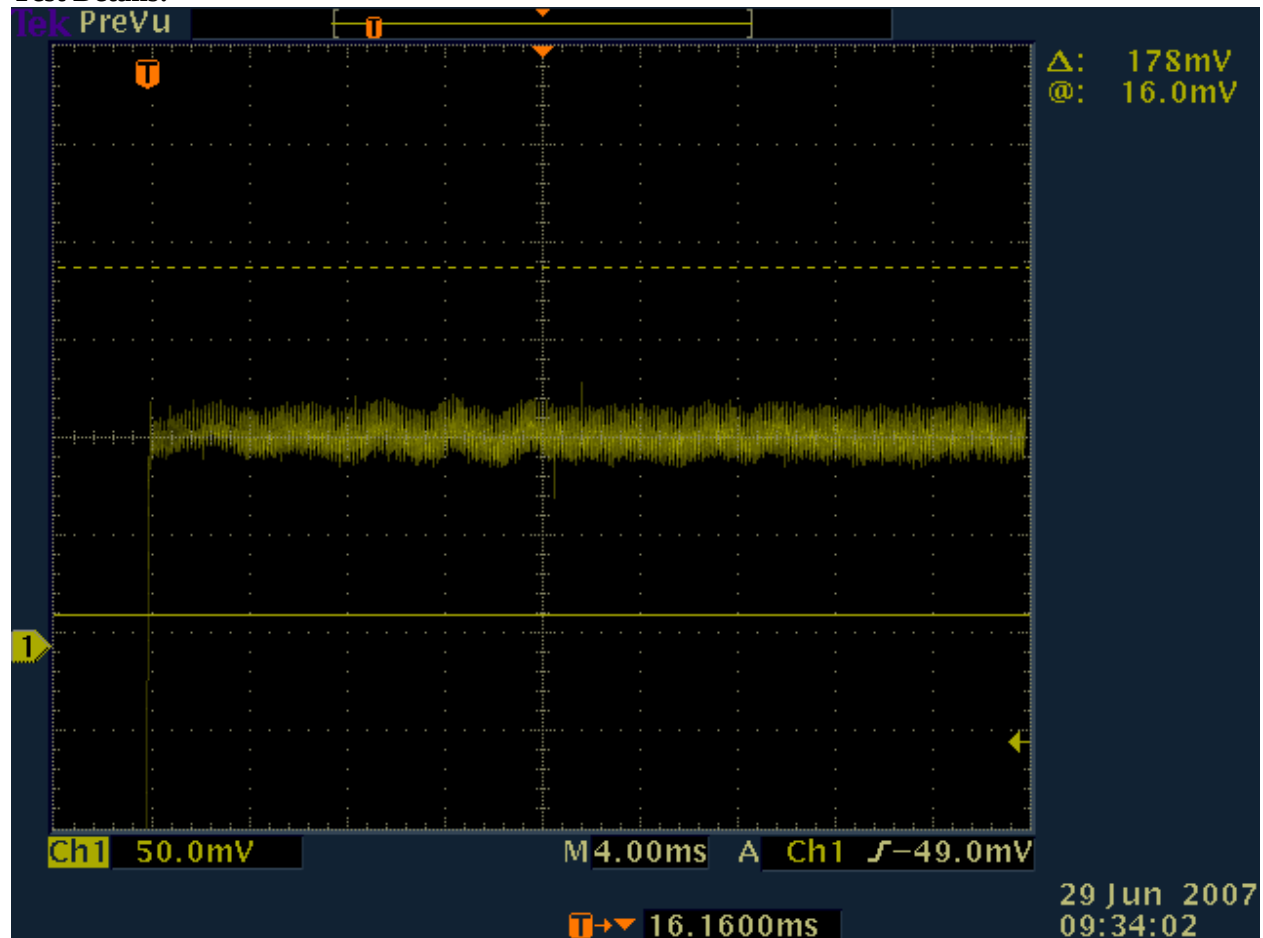
Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	21	Humidity (%):	51	Pressure (hPa):	1006
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AA		

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	Measuring Receiver	Hewlett Packard	8902A	3749A04397	03/07/2008
3	Synthesized Sweep Generator	Hewlett Packard	83620A	3213A01244	02/06/2009
4	Oscilloscope, Digital Storage	Tektronix	TDS3052	B014809	03/14/2008

Test Details:



Test Results: Pass

Test Standard: FCC 2.1055, 90.213

Test: Frequency Stability

Performance Criterion: The frequency drift must not exceed 50 PPM.

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	As Shown	Humidity (%):	21	Pressure (hPa):	1008
Pretest Verification Performed	Yes		Equipment under Test:	VT5		
Test Engineer(s):	Nicholas Abbondante		EUT Serial Number:	000AA		

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Receiver	Hewlett Packard	HP 8542E	145-092	02/16/2008
2	RF Filter	Hewlett Packard	HP 85420E	145-092	02/12/2008
3	DC Power Supply	Kepco	ATE25-10M	148-007	Verified
4	Digital Multimeter	Fluke	187	147-238	12/12/2007
5	Agree Chamber	Cincinnati Sub-Zero	AVH-61-22-22-SRPP\RAC	148-035	02/12/2008

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3
EMI BOXBOROUGH	Intertek	3/07/07 Revision

Test Details:

Frequency Stability

Company: LoJack Corporation

Model #: VT5

Serial #: 000AA

Engineer(s): Nicholas Abbondante

Project #: 3123708

Standard: FCC Part 90

Test Equipment Used:

145-092 148-035 148-007 147-238

Location: Littleton

Date(s): 06/29/07

Limit: 50 PPM

Nominal f: 173.075 MHz

Voltage: 6 VDC

%	Voltage Volts	Frequency MHz	Deviation kHz	Limit kHz
-15%	5.1	173.07520	0.2	8.65
-10%	5.4	173.07520	0.2	8.65
-5%	5.7	173.07510	0.1	8.65
+0%	6	173.07530	0.3	8.65
+5%	6.3	173.07510	0.1	8.65
+10%	6.6	173.07520	0.2	8.65
+15%	6.9	173.07510	0.1	8.65

Temp Celsius	Frequency MHz	Deviation kHz	Limit kHz
-30	173.07610	1.1	8.65
-20	173.07670	1.7	8.65
-10	173.07690	1.9	8.65
0	173.07680	1.8	8.65
10	173.07630	1.3	8.65
20	173.07580	0.8	8.65
30	173.07500	0	8.65
40	173.07450	-0.5	8.65
50	173.07410	-0.9	8.65