ITS Intertek Testing Services
ETL SEMKO

TEST REPORT

Report Number: 3053195.012
Project Number: 3053195
January 30, 2004

Testing performed on the
VTU3

to
47 CFR:2003, §15.109 and §15.111
Class A

For
LoJack Corporation

Test Performed by:
Intertek
7250 Hudson Blvd. Suite 100
Oakdale, MN 55128

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

Prepared by: _____ Date: January 30, 2004
Norman Shpilsher

Reviewed by: _____ Date: January 30, 2004
Yuriy Litvinov

CONTENTS

1.0 JOB DESCRIPTION

Equipment:	VTU3, Vehicle Receiver with VTU3 Display Unit
Equipment Serial No:	0001 (VTU3) 0302 (Display)
Voltage/Phase:	12VDC from external battery
Customer:	Mr. Jesse Rhodes LoJack Corporation 780 Dedham Street Canton, MA 02021 Phone: 781-302-7107, Fax: 781-302-7299
Test Standard:	**47 CFR:2003**, §15.109 and §15.111 Class A
Date Sample Submitted:	January 22, 2004
Test Work Started:	January 26, 2004
Test Work Completed:	January 29, 2004

2.0 TEST SUMMARY

Referring to the performance criteria and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards.

TEST STANDARD	TEST	COMMENTS
Subpart B – 15.109	Radiated Emissions	Pass
Subpart B – 15.111	Antenna Conducted Emissions	Pass

Where comments other than "pass" are entered in the "comments" column, further details may be found in the TEST RESULTS section.

Note 1: The measured result in this report is within the specification limits by a more than the measurement uncertainty; the measured result indicates that the product tested complies with the specification limit.

2.1 Limits for Conducted and Radiated Disturbances for FCC parts 15.107 and 15.109

Conducted Emissions Limits

Frequency range (MHz)	Class A		Class B	
	QP Limits (dBμV)	AVG Limits (dBμV)	QP Limits (dBμV)	AVG Limits (dBμV)
0.15 to 0.50	79	66	66 to 56	56 to 46
0.50 to 5	73	60	56	46
5 to 30	73	60	60	50

NOTES 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

Radiated Emissions Limits

Frequency of Emissions (MHz)	CLASS A at 10 m		CLASS B at 3 m	
	μV/m	dBμV/m	μV/m	dBμV/m
30 to 88	90	39	100	40
88 to 216	150	44	150	44
216-960	210	46	200	46
Above 960	300	50	500	54

NOTE: In the emission tables above, the tighter limit applies at the band edges.

2.2 Emissions Test Results (see Appendix I)

No modifications were installed on the unit(s) during the emissions testing.

The Radiated Emissions testing was performed in Anechoic Chamber at 3m-measurement distance in frequency range from 30MHz to 2GHz (see Table 1 and Graph1).

The Antennas Conducted Emissions testing was performed for all four antenna ports in frequency range from 30MHz to 2GHz (see Graphs 2 to 5).

Line Conducted Emissions testing is inappropriate and therefore unnecessary as external battery power the equipment.

3.0 TEST EQUIPMENT

Receivers/Spectrum Analyzers

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
HP85462A Receiver RF Section	3325A00106	08/03	08/04	X
HP85460A RF Filter Section	3330A00109	08/03	08/04	X
HP85462A Receiver RF Section	3549A00306	12/03	12/04	
HP85460A RF Filter Section	3448A00276	12/03	12/04	
Advantest Spectrum Analyzer R3271A	55050084	06/03	06/04	

Antennas

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
Schaffner-Chase Bicono-Log Antenna	2468	01/04	01/05	X
Schaffner-Chase Bicono-Log Antenna	2630	06/03	06/04	
EMCO Horn Antenna 3115	9507-4513	12/03	12/04	
EMCO Horn Antenna 3115	6579	01/12/04	01/12/05	

4.0 TEST CONFIGURATION (see Appendix II)

4.1 Support Equipment/Services

Motorola PTU Transmitter, p/n REPLY 000DF, s/n 0000DF
12VDC Car Battery
Four 16” Array Antennas

4.2 Sample Set-Up

The EUT was setup as tabletop equipment and powered at 12.6VDC from the external Car Battery via DC cable. The Display and four Antennas were connected to the EUT via Display and Antenna Array cables. Non-terminated USB and three COM Port cables were connected to the EUT also. The transmitter was placed in close proximity to the EUT in order to activate Receiver.

Cables

DC cable, unshielded, 1.5m length
USB cable, unshielded, 1.5m length
Display cable, unshielded, 5m length
Three COM Port cables, unshielded CAT 5 cables, 1.5m length
Four Antenna Array cables, unshielded, 5m length

4.3 Mode of Operation

For the Radiated Emissions testing the EUT was run continuously in receiving mode of operation to receive signal from the Transmitter and display information on the display.
For Antenna Conducted Emissions testing the EUT was powered and run in standby mode. Each antenna port was connected to the Spectrum Analyzer and other antenna ports were terminated.

5.0 TEST PROCEDURES

5.1 Emissions Testing

Radiated emission measurements are performed according to the procedures in ANSI C63.4 (1992). Measurements are performed in Open Area Test Sites or the 3-meter Anechoic chamber. Preliminary scans are normally performed in the 3-meter Anechoic chamber only to determine worst case modes. For each scan, the procedure for maximizing emissions in Appendices D and E were followed.

The Open Area Test Site facility is a specially designed and constructed building measuring 30 meters by 50 meters. Two test sites are used (Distances: 3 meters, 10 meters, 30 meters) for CISPR testing.

All test sites include a metal ground plane constructed of 22-gauge sheet metal. Each site contains a 2.5 meter diameter turntable for floor standing equipment, and a wooden table measuring 1.5 x 1.5 x 0.8 meters for table top equipment to facilitate testing, also it has heat and air conditioning systems to control environmental test conditions.

Measurements from 30 MHz to 2000 MHz are taken with log-periodic antennas. A horn antenna is used above 2000 MHz. The mast to support the antennas is capable of a 1 to 4 meter height range, which meets CISPR requirements. The antenna mast is non-conductive and remotely controllable.

Since radiated emissions, and to a lesser extent, conducted emissions, are a function of cable placement, the cable placement is varied to encompass all configurations that an end user would encounter to determine the configuration resulting in maximum emissions. At least one cable for each I/O port type is attached to the EUT. If peripherals or modules are available, at least one of each available type is installed and noted in the report. Generally, only one of each type is used unless good engineering judgment dictates that the use of more will affect emission levels. Excess cable lengths are arranged into a 30 x 40-cm bundle. Cables requiring non-standard lead dress are recorded in the report.

For the antenna conducted emissions testing, the antenna port of the EUT was directly connected to the spectrum analyzer.

For conducted emissions testing, the equipment is moved to an insulating platform over the ground plane, and the EUT is powered from a LISN. Both sides of the AC line are measured and the results are compared to the applicable limits. Measurements are taken using CISPR quasi-peak and average detectors when the peak readings approach or exceed the average limit. Only quasi-peak readings are taken when the emissions from the EUT meet the average limit as measured with the quasi-peak detector.

5.2 Field Strength Calculation

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

FS = RA + AF + CF - AG

Where: FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude in dB(μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(m^{-1})
AG = Amplifier Gain in dB

Assume a receiver reading of 48.1 dB(μV) is obtained. The antenna factor of 7.4 dB(m^{-1}) and cable factor of 1.6 dB is added and amplifier gain of 16.0 dB is subtracted giving field strength of 41.1 dB(μV/m).

RA = 48.1 dB(μV)
AF = 7.4 dB(m^{-1})
CF = 1.6 dB
AG = 16.0 dB
FS = RA + AF + CF - AG
FS = 48.1 + 7.4 + 1.6 – 16.0
FS = 41.1 dB(μV/m)

In the Tables of the Appendix I Total Correction Factor includes the Cable Attenuation Factor and the Antenna Factor.

5.3 Measurement Uncertainty

The expanded uncertainty (k = 2) for radiated emissions from 30 to 1000 MHz has been determined to be:
±4 dB at 10m, ±5.4 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

APPENDIX I

EMISSIONS TEST DATA

Radiated Emissions, Vertical Antenna Polarization **Date:** 01-26-2004

Company: LoJack Corporation
Model: VTU3
Test Engineer: Norman Shpilsher
Special Info: Emissions at fundamental frequency at 172.8MHz was excluded from the Table
Standard: FCC Part 15.109, Class A
Test Site: 3m Anechoic Chamber, 3m measurement distance
Note: The table shows the worst case radiated emissions
All measurements were taken using a Peak detector with RBW=100kHz in frequency range below 1GHz and RBW=1MHz in frequency range above 1GHz

Table # 1

Frequency	Antenna		Peak reading $dB_\mu V$	Total Peak $dB_\mu V/m$	Limit $dB_\mu V/m$	Margin dB
	Polarity	Factor(dB1/m)				
61.525 MHz	V	7.0	21.5	28.5	49.5	-21.0
62.495 MHz	V	7.0	21.8	28.8	49.5	-20.7
73.65 MHz	V	7.6	18.2	25.7	49.5	-23.8
77.53 MHz	V	8.0	18.6	26.5	49.5	-23.0
80.44 MHz	V	8.3	17.9	26.2	49.5	-23.3
82.622 MHz	V	8.5	22.7	31.3	49.5	-18.2
83.592 MHz	V	8.7	21.5	30.2	49.5	-19.3
84.562 MHz	V	8.8	22.0	30.7	49.5	-18.8
111.96 MHz	V	13.1	15.0	28.1	54.0	-25.9
172.83 MHz	V	11.0	64.5	75.5	54.0	21.5
177.92 MHz	V	10.8	16.8	27.5	54.0	-26.5
519.36 MHz	V	20.6	24.6	45.2	56.9	-11.7
692.51 MHz	V	22.5	16.2	38.7	56.9	-18.2
966.53 MHz	V	26.0	13.8	39.8	60.0	-20.2
1037.50 MHz	V	26.7	14.7	41.4	60.0	-18.6
1211.01 MHz	V	28.3	16.8	45.1	60.0	-14.9
1904.24 MHz	V	33.6	16.0	49.6	60.0	-10.4

Radiated Emissions, Horizontal Antenna Polarization **Date:** 01-26-2004

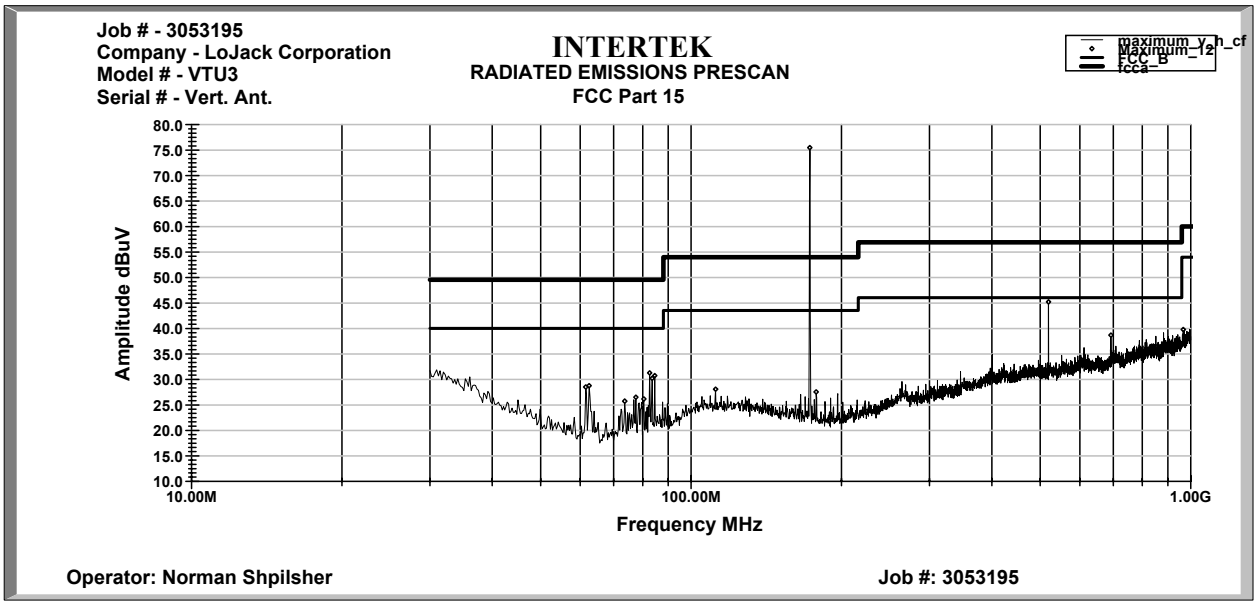
Company: LoJack Corporation
Model: VTU3
Test Engineer: Norman Shpilsher
Special Info: Emissions at fundamental frequency at 172.8MHz was excluded from the Table
Standard: FCC Part 15.109, Class A
Test Site: 3m Anechoic Chamber, 3m measurement distance
Note: The table shows the worst case radiated emissions
All measurements were taken using a Peak detector with RBW=100kHz in frequency range below 1GHz and RBW=1MHz in frequency range above 1GHz

Table # 2

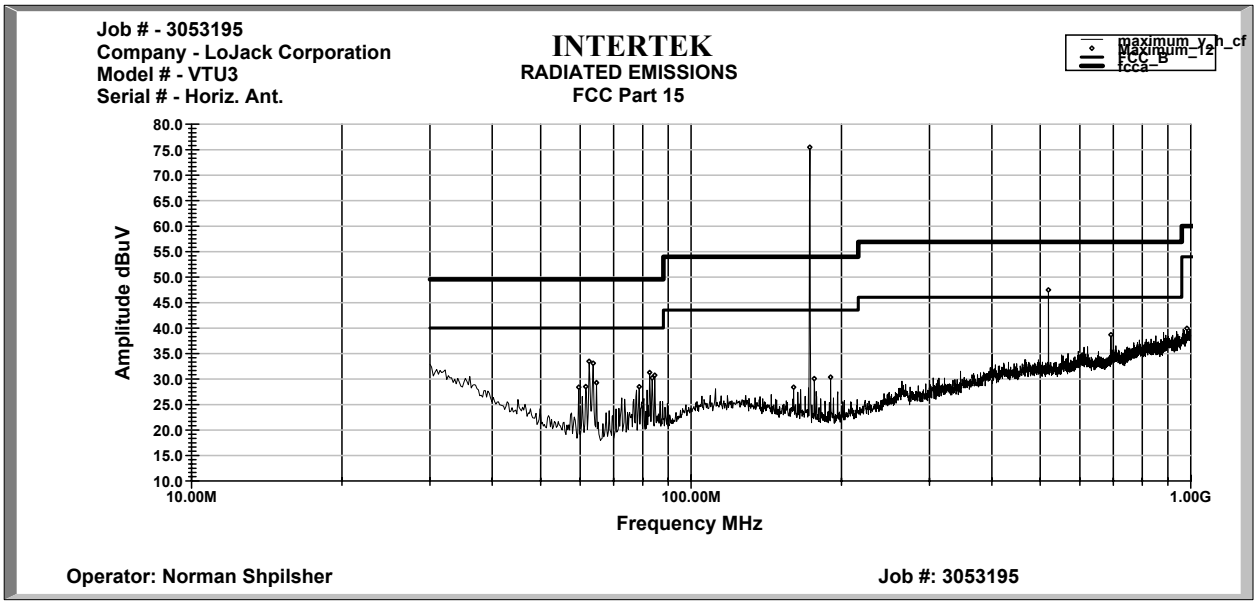
Frequency	Antenna		Peak reading $dB_\mu V$	Total Peak $dB_\mu V/m$	Limit $dB_\mu V/m$	Margin dB
	Polarity	Factor(dB1/m)				
59.585 MHz	H	7.1	21.3	28.4	49.5	-21.1
61.525 MHz	H	7.0	21.5	28.5	49.5	-21.0
62.495 MHz	H	7.0	26.5	33.5	49.5	-16.0
63.708 MHz	H	7.0	26.1	33.1	49.5	-16.4
64.677 MHz	H	7.0	22.3	29.3	49.5	-20.2
78.742 MHz	H	8.1	20.4	28.5	49.5	-21.0
82.622 MHz	H	8.5	22.7	31.3	49.5	-18.2
83.592 MHz	H	8.7	21.5	30.2	49.5	-19.3
84.562 MHz	H	8.8	22.0	30.7	49.5	-18.8
160.46 MHz	H	11.5	16.9	28.4	54.0	-25.6
172.83 MHz	H	11.0	64.5	75.5	54.0	21.5
176.47 MHz	H	10.8	19.2	30.1	54.0	-23.9
190.29 MHz	H	10.7	19.7	30.4	54.0	-23.7
519.12 MHz	H	20.6	26.9	47.5	56.9	-9.4
692.51 MHz	H	22.5	16.2	38.7	56.9	-18.2
983.03 MHz	H	26.2	13.8	40.0	60.0	-20.1
1037.50 MHz	H	26.7	14.4	41.1	60.0	-18.9
1211.03 MHz	H	28.3	14.3	42.6	60.0	-17.4
1904.89 MHz	H	33.6	14.2	47.8	60.0	-12.2

Graph #1
Radiated Emissions from 30MHz to 1GHz

Vertical Antenna Polarization

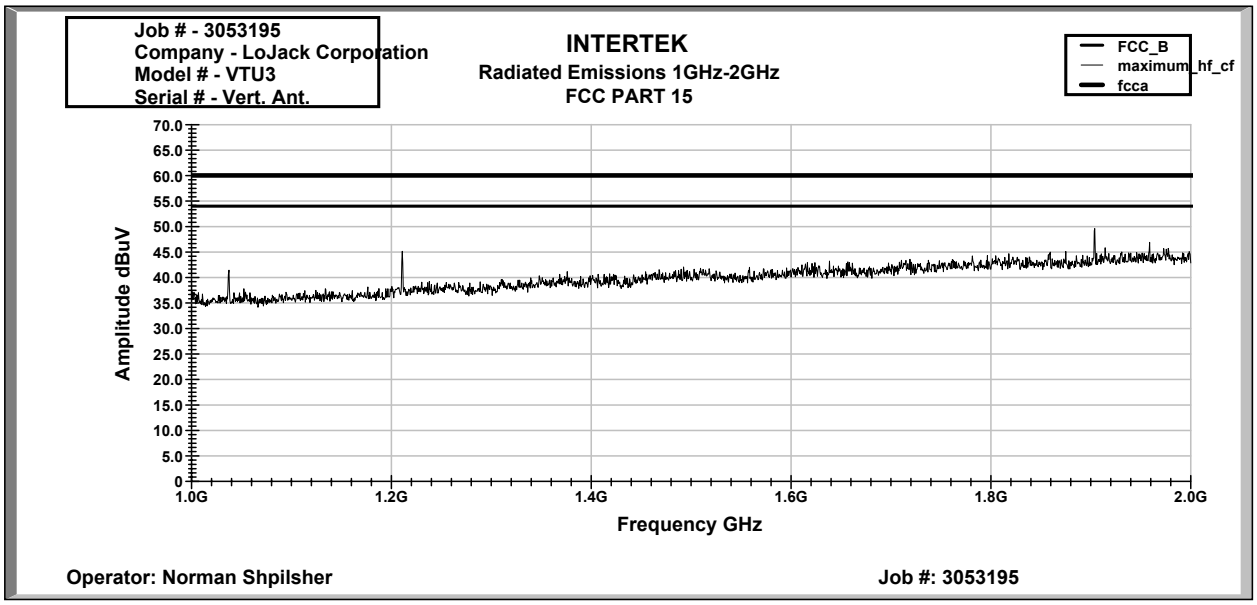


Horizontal Antenna Polarization

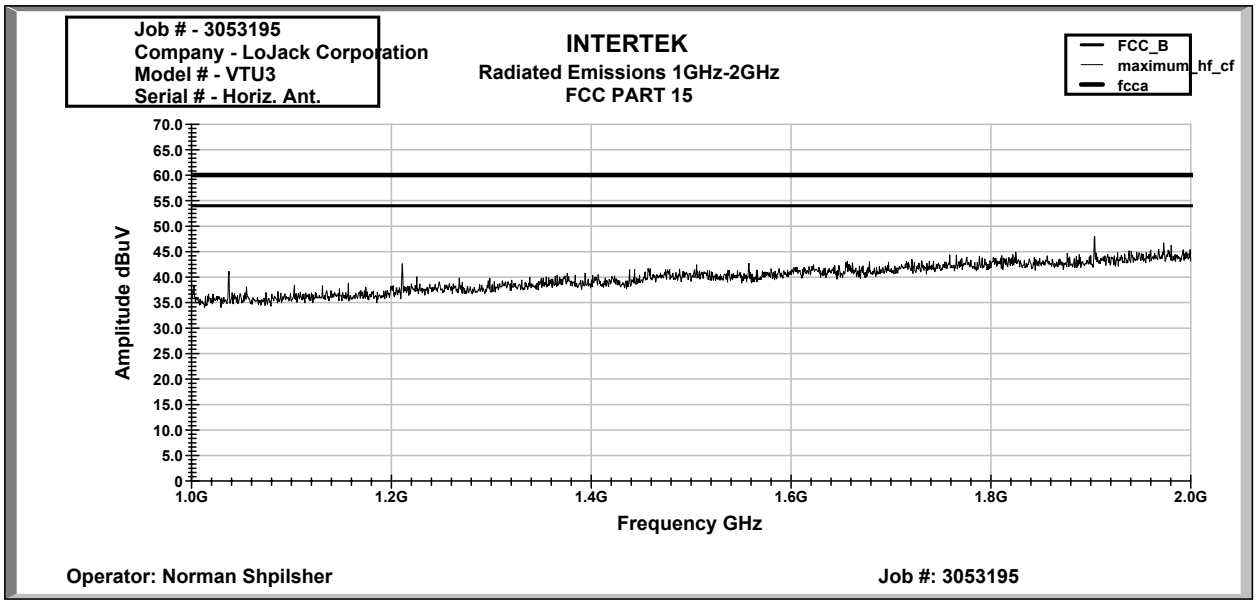


Graph #2
Radiated Emissions from 1GHz to 2GHz

Vertical Antenna Polarization

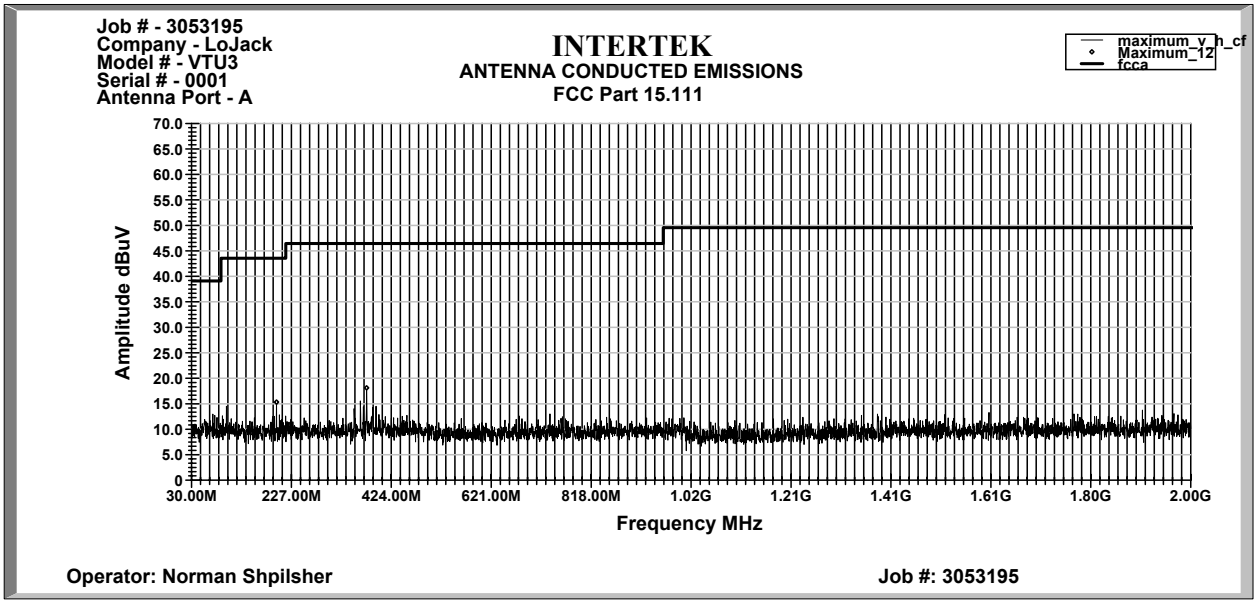


Horizontal Antenna Polarization



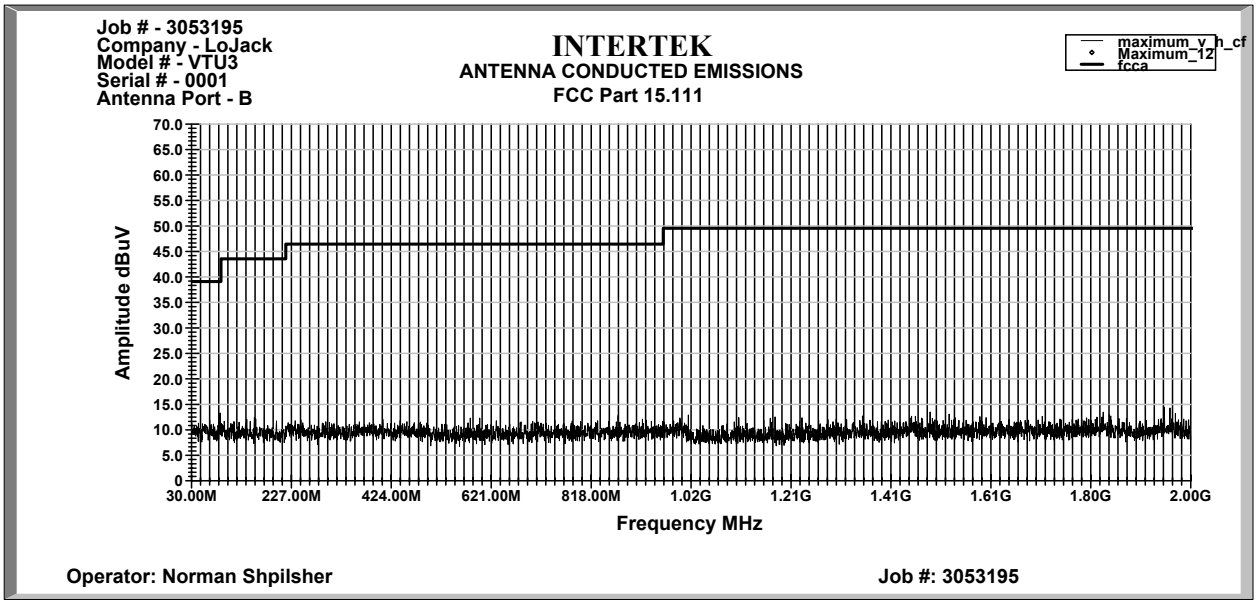
Graph #3

Antenna Conducted Emissions from 30MHz to 2GHz, Antenna Port A



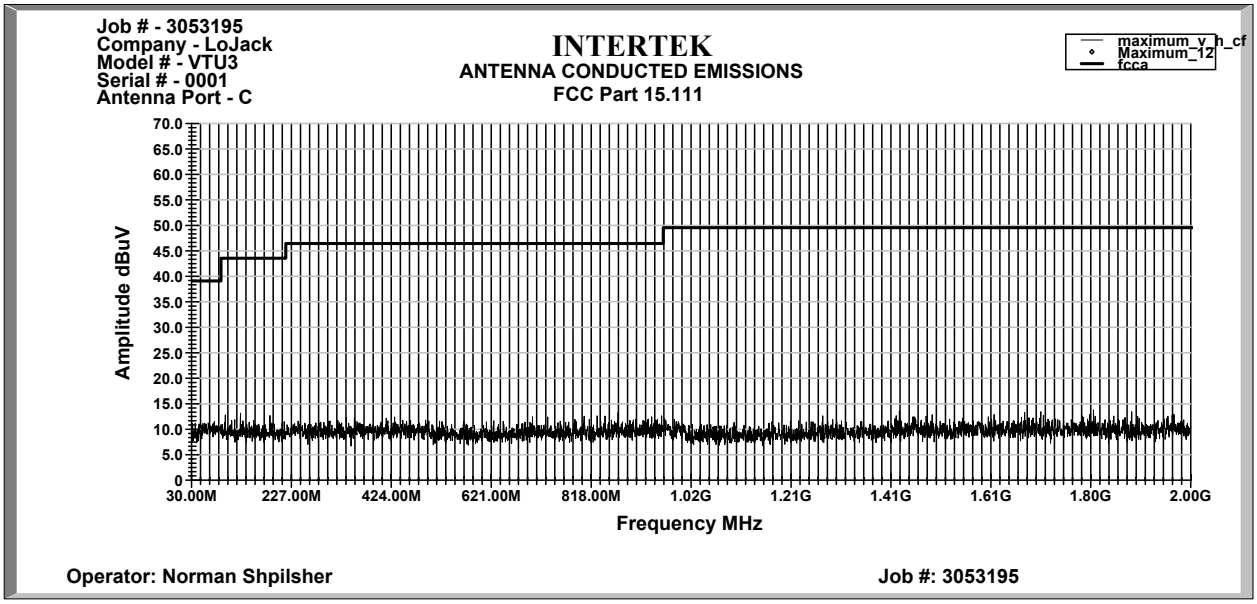
Graph #4

Antenna Conducted Emissions from 30MHz to 2GHz, Antenna Port B



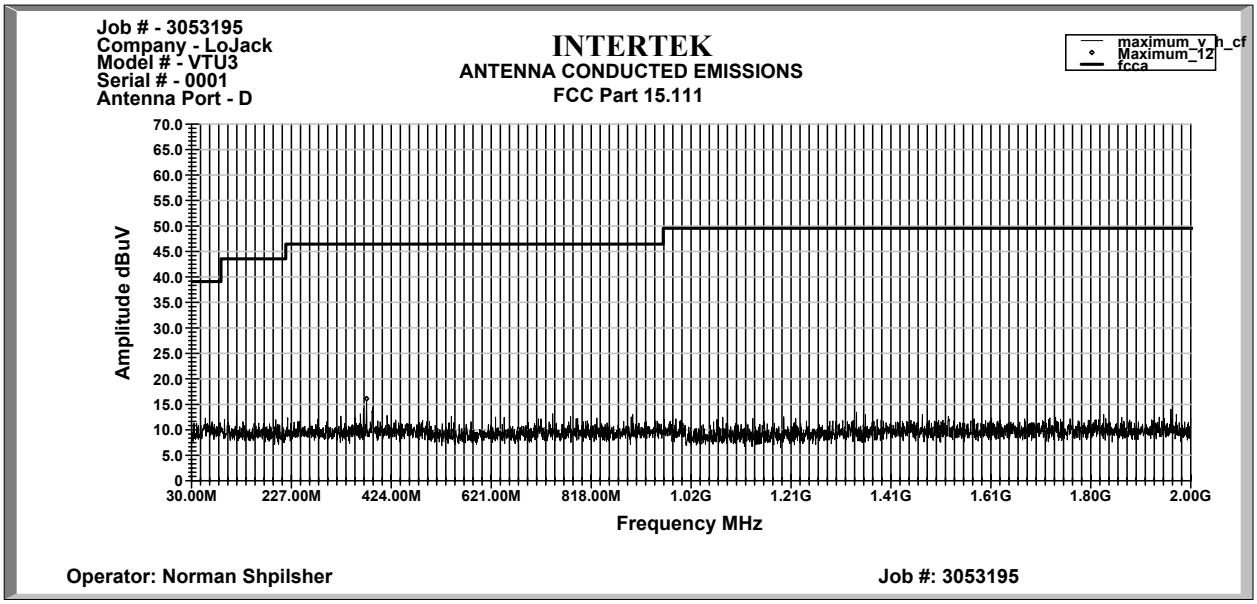
Graph #5

Antenna Conducted Emissions from 30MHz to 2GHz, Antenna Port C



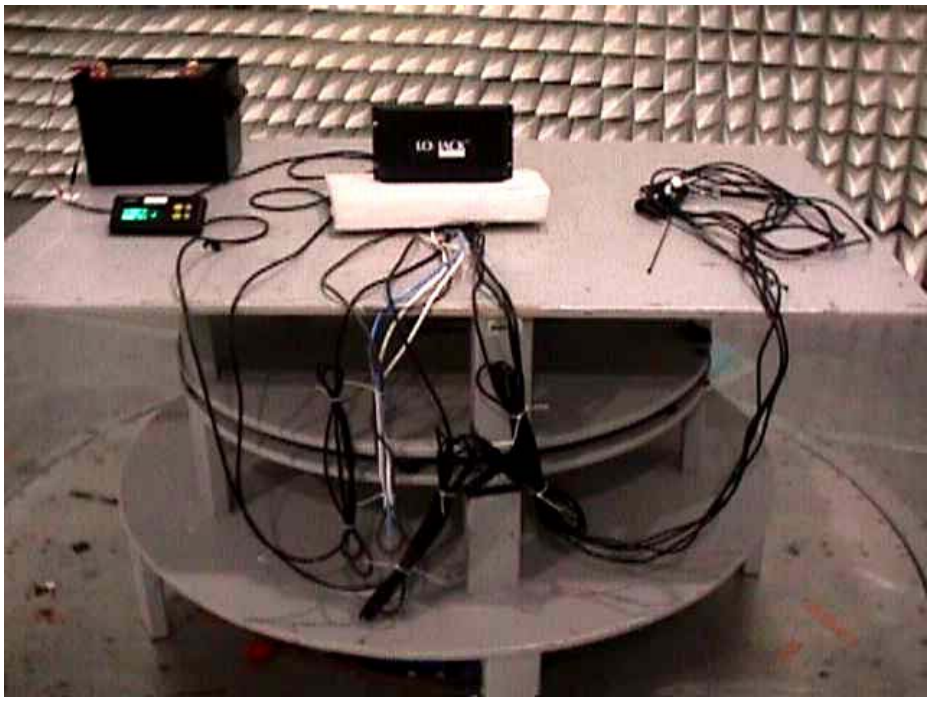
Graph #6

Antenna Conducted Emissions from 30MHz to 2GHz, Antenna Port D

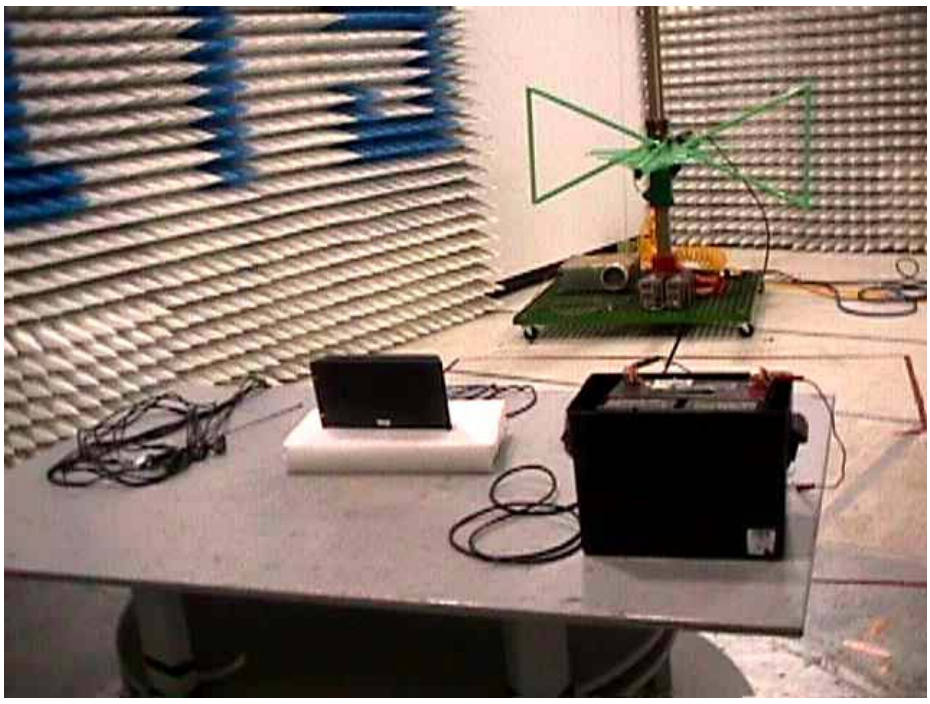


APPENDIX II

CONFIGURATION PHOTOGRAPHS



Radiated Emissions Test Configuration



Radiated Emissions Test Configuration