

EMI TEST REPORT for CERTIFICATION of FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

FCC ID: MOQ-LF700
Manufacturer: Laser Force International Pty Ltd
Test Sample: Laser Force Laser Tag Amusement System
Model Number: LF7 (Battlesuit)
Serial Number: 03221

Date: 14th April 2011

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**EMI TEST REPORT FOR CERTIFICATION
FOR
CERTIFICATION OF FCC Part 15.249 & FCC PART 15.207 TRANSMITTER**

**FCC ID: MOQ-LF700
EMC Technologies Report No. T101210A_F
Date: 12th April 2011**

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EMI TEST REPORT FOR CERTIFICATION OF FCC PART 15.249 & FCC PART 15.207 TRANSMITTER

Report Number: T101210A_F

Test Sample Name: Laser Force Laser Tag Amusement System

Model Number: LF7 (Battlesuit)

Serial Numbers: 03221 (Battle Suit)

FCC ID: MOQ-LF700

Manufacturer: Laser Force International Pty Ltd

Tested For: Laser Force International Pty Ltd
Address: 55 Ipswich Road
Woolloongabba QLD 4102

Phone Number: (07) 3391 0155
Fax Number: (07) 3891 6337
Responsible Party: Mr Len Kelly

Test Standards: **FCC Part 15.249 Intentional Radiators**
FCC Part 15.207 Conducted Limits
ANSI C63.4:2009

Test Dates: 28/01/2011 – 11/04/2011

Testing Officers:



Dale Matthews



Joel Mulig

Attestation:

I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.

Authorised Signature:



Christian Kai
Facility Manager
EMC Technologies Pty Ltd

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EMI TEST REPORT FOR CERTIFICATION
of
FCC PART 15.249 & FCC PART 15.207 TRANSMITTER
on the
Laser Force Laser Tag Amusement System

1.0 SUMMARY of RESULTS

This report details the results of EMI tests and measurements performed on the Laser Force Laser Tag Amusement System, Model: LF7 (Battlesuit), in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Rules for intentional radiators.

Part 15.31e

Amplitude stability with supply variation: Complied

Part 15.207

Conducted Emissions: Not applicable

Part 15.249 a & e

Carrier Signal Field Strength 2400 – 2483.5MHz: Complied

Part 15.249 d (15.209)

Field Strength Outside 2400 – 2483.5MHz: Complied

Part 15.249 e

Frequency Tolerance: Not applicable

1.1 EUT – Voltage Power Conditions

Testing with internal batteries were performed with a fully charged battery.

2.0 GENERAL INFORMATION

2.1 General Description of Test Sample

Manufacturer	:	Laserforce International Pty Ltd
Test Sample	:	Laserforce Laser Tag Amusement System
Model Number	:	LF7 (Battlesuit)
Serial Numbers	:	03221 (Battlesuit)

FCC ID	:	MOQ-LF700
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Equipment Type	:	Intentional Radiator
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Auxiliary Equipment

Laptop

2.2 Test Sample Description

The Laser Force Laser Vest Unit with Wireless Controller is a laser-tag system. The equipment used in this system consists of a Battlesuit (player worn vest) with attached Phaser (laser-tag gun) and a radio base-station.

2.3 Technical Specifications and System Overview

The EUT operates in the frequency range 2400 to 2483.5 MHz. For more details refer to Appendix I Installation Manual.

2.4 EUT Configurations

Refer to Appendix J for configuration of Battlesuit and Base Station.

2.5 Test Sample Support Equipment

The test sample support equipment used was a laptop to set up the Base Station and Battle Suit for transmit-mode.

2.6 Test Sample Block Diagram

Refer to Appendix E for Block Diagram.

2.7 EUT Operation Conditions

The EUT was operated in accordance with the standards and the Customers requirements.

2.8 Modifications

No modifications were performed on the EUT in order to comply with the standards.

2.9 Test Procedure

Radiated Emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009. The measurement distance for radiated emissions was 3 metres from the EUT for the frequency range 30MHz-25000MHz.

2.10 Test Facility

2.10.1 General

Conducted Emission measurements were performed at EMC Technologies Laboratory in Seven Hills, New South Wales, Australia. Radiated Emission measurements in the ranges 30MHz-25000MHz were performed at EMC Technologies' open area test site (OATS) situated at Upper Colo, NSW, Australia.

EMC Technologies Pty Ltd has FCC registration number 507687 and we have been designated by the Australian Communications and Media Authority under the APAC TELMRA and our designation number is AU0002 which will expire on the 1st March 2012.

2.10.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

“FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E).”

The current full scope of accreditation can be found on the NATA website:

www.nata.asn.au

It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A²LA).

2.11 Units of Measurements

2.11.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt ($\text{dB}\mu\text{V}$).

2.11.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre ($\text{dB}\mu\text{V/m}$). The measurement distance was 3 metres from the EUT for ranges 30MHz-25000MHz.

2.12 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurement Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A of this report.

2.13 Ambients at OATS

The Open Area Test Site (OATS) is an area of low background ambient signals. No significant broadband ambients are present however commercial radio and TV signals exceed the limit in the FM radio, VHF and UHF television bands. Radiated prescan measurements were performed in the shielded enclosure to check for possible radiated emissions at the frequencies where the OATS ambient signals exceeded the test limit.

3.0 CONDUCTED EMISSION MEASUREMENTS

3.1 Test Procedure

The arrangement specified in ANSI C63.4:2009 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1987 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all duration peaks were captured.

3.2 Peak Maximizing Procedure

For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector was then invoked to measure the actual Quasi-Peak level of the most significant peaks which were detected.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. Peaks that were greater than 20dB below the limit were not measured. For each numbered peak the frequency, peak field strength, Quasi-peak field strength, Average field strength and the margin relative to the limit in dB is listed. A negative margin is the level below the limit.

3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$$V_{EMI} = V_{Rx} + L_{BPF}$$

Where:

V_{EMI}	=	The Measured EMI voltage in dB μ V to be compared to the limit.
V_{Rx}	=	The Voltage in dB μ V read directly at the EMI receiver.
L_{BPF}	=	The insertion loss in dB of the cables and the Limiter and Pass Filter.

3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graphs.

3.5 Conducted EMI Results

3.5.1 Mains Terminals

Conducted emissions was not applicable because the Battlesuit is powered by an internal battery.

4.0 RADIATED EMISSION MEASUREMENTS – 30 MHz to 25 GHz

4.1 Frequency Range of Radiated Measurements

The highest frequency of the EUT is greater than 1GHz (refer to section 2.3 of this report).

Highest frequency generated or used in the device or on which the device operates or tunes [MHz]	Upper frequency of measurement range [MHz]
1.705 - 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	10 th harmonic of the highest frequency or 40 GHz, whichever is lower

Testing above 1GHz was performed in average mode.

According to the table in FCC Part 15, Section 15.33 and the highest radio frequency signal generated or used in the EUT is greater than 1GHz, the radiated emissions measurement were performed from 30MHz to 25GHz.

4.2 Test Procedure

Radiated emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009 Radiated emission tests from 30 MHz to 1GHz were performed at the Open Area Test Site (OATS) an EUT distance of 3 metres.

The EUT was placed on a plastic table 0.8m above an inground and operated in accordance with section 2 of this report. The EMI Receiver was operated under software control via the PC Controller.

4.2.1 30 – 1000 MHz Range

The 30 MHz to 1000 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.2.2 1 GHz - 25 GHz

The 1 GHz to 25 GHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the average detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Average detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.3 Plotting of Measurement Data for Radiated Emissions

4.3.1 30 – 1000 MHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 30 – 1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the “#” symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with “#” symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

4.3.2 1 GHz– 25GHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 1 GHz – 25 GHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the “#” symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with “#” symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Average field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the average level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the Average detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the average level higher than the peak level.

4.4 Calculation of Field Strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

$$E = V + AF - G + L$$

Where: **E** = Radiated Field Strength in dB μ V/m.
V = EMI Receiver Voltage in dB μ V. (measured value)
AF = Antenna Factor in dB/m (stored as a data array)
G = Preamplifier Gain in dB. (stored as a data array)
L = Cable insertion loss in dB. (stored as a data array)

Example Field Strength Calculation

Assuming a receiver reading of 34.0 dB μ V is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9dB while the preamplifier gain is 20dB.

$$34.0 + 9.2 + 1.9 - 20 = 25.1 \text{ dB}\mu\text{V/m}$$

4.5 Radiated Field Strength Measurement Results – Section 15.249

The EUT was set to the lowest channel, the highest channel and to one channel in the middle range. Testing was performed from 30MHz up to 25GHz. The results with the highest emissions were recorded in this report.

4.5.1 Radiated Field Strength Measurements

4.5.1.1 30MHz to 1GHz

Frequency (MHz)	Polarisation	Quasi Peak (dB μ V/m)	Limit (dB μ V/m)	Δ Limit (dB)
54.04	Horizontal	33.3	40.0	-6.7
54.04	Horizontal	33.2	40.0	-6.8
835.75	Horizontal	39.1	46.0	-6.9
52.49	Horizontal	32.9	40.0	-7.1
56.04	Horizontal	32.4	40.0	-7.6
52.53	Horizontal	32.2	40.0	-7.8
934.06	Horizontal	38.2	46.0	-7.8
53.23	Horizontal	31.6	40.0	-8.4
52.16	Horizontal	31.4	40.0	-8.6
53.76	Horizontal	31.1	40.0	-8.9
52.46	Vertical	31.0	40.0	-9.0
52.87	Vertical	30.5	40.0	-9.5
53.23	Vertical	30.2	40.0	-9.8
188.57	Horizontal	33.6	43.5	-9.9

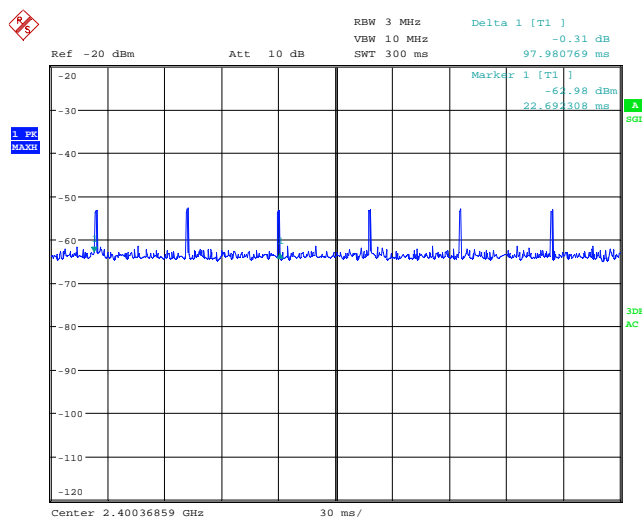
All measured frequencies complied with the quasi peak limits by a margin of at least 6.7dB.

Refer to Appendix H, Graphs 1 and 2

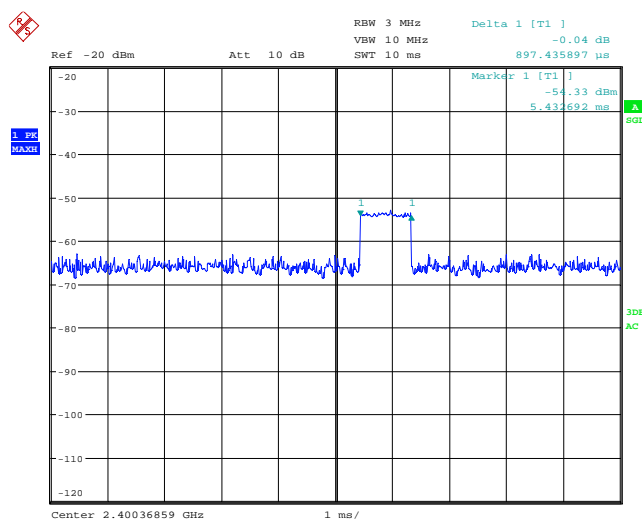
4.5.1.2 1000MHz to 25000MHz

The measurements were taken with the EUT transmitting continuously. To account for the duty cycle, the measured harmonics emissions levels have to be corrected.

Measured Duty Cycle within any 100ms



Date: 14.FEB.2011 16:52:56



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Three On cycles in any 100ms = $3 \times 0.897\text{ms} = 2.691\text{ms}$
 Duty Cycle: $2.691\text{ms}/100\text{ms} = 0.02691$

Correction Factor for Duty Cycle 0.02691 (2.691%):

$$\text{CorrectionFactor} = 20 * \log(\text{DutyCycle}) = 20 * \log(0.02691) = \underline{\underline{-31.40\text{dB}}}$$

No peaks are allowed to be 20dB above the limits (according section 15.35b), therefore the maximum allowable correction factor is: -20dB.

1000MHz to 25000MHz with Correction Factor

Frequency (MHz)	Polarisation	Average (dB μ V/m)	Corr. Factor	Corrected Peak (dB)	Limit (dB μ V/m)	Result [dB]
4878.84	Horizontal	65.3	-20dB	45.3	54.0	-8.7
4878.84	Vertical	57.5	-20 dB	37.5	54.0	-16.5

All measured frequencies complied with the average limits by a margin of at least 8.7 dB.

Refer to Appendix H, Graphs 3 to 6.

4.5.2 2400MHz Carrier Field Strength Measurement at 3m Antenna Distance**4.5.2.1 Tested on Battle Suit**

Frequency MHz	Average Level dB μ V/m	Limit @ 3m dB μ V/m	Result \pm dB
2480.49	89.4	94.0	-4.6
2400.47	88.6	94.0	-5.4
2440.48	88.5	94.0	-5.5

Complied with a margin of at least 4.6dB with Section 15.249 Subpart a, b & c.

Refer to Appendix H, Graph 7 to 9.

To confirm compliance to the amplitude stability tests according part 15.31e, testing was performed with a fully charged battery.

5.0 UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions

9kHz to 30 MHz ± 3.2 dB

Radiated Emissions

9kHz to 30MHz ± 4.1 dB

30MHz to 300MHz ± 5.1 dB

300MHz to 1000MHz ± 4.7 dB

1GHz to 18GHz ± 4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

6.0 FREQUENCY TOLERANCE (FCC Part 15 Sections 15.249b)

The frequency tolerance is only applicable for fixed point-to-point operation devices.

7.0 CONCLUSION

The Laser Force Laser Tag Amusement System with Model: LF7 (Battlesuit), FCC ID: MOQ-LF700 complied with the requirements of FCC Part 15 Rules for internal radiator when tested in accordance with FCC Part 15.31e, 15.207 and 15.249.

Part 15.31e

Amplitude stability with supply variation: Complied

Part 15.207

Conducted Emissions: Complied

Part 15.249 a, b & c

Carrier Signal Field Strength 2400 – 2483.5MHz: Complied

Part 15.249 d (15.209)

Field Strength Outside 2400 – 2483.5MHz: Complied

Part 15.249 e

Frequency Tolerance: Not applicable

APPENDIXES

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