



# LoadSlammer™ Pro User Guide

User Guide for: LSP1000, LSP200, LSP40

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## 2 INTRODUCTION

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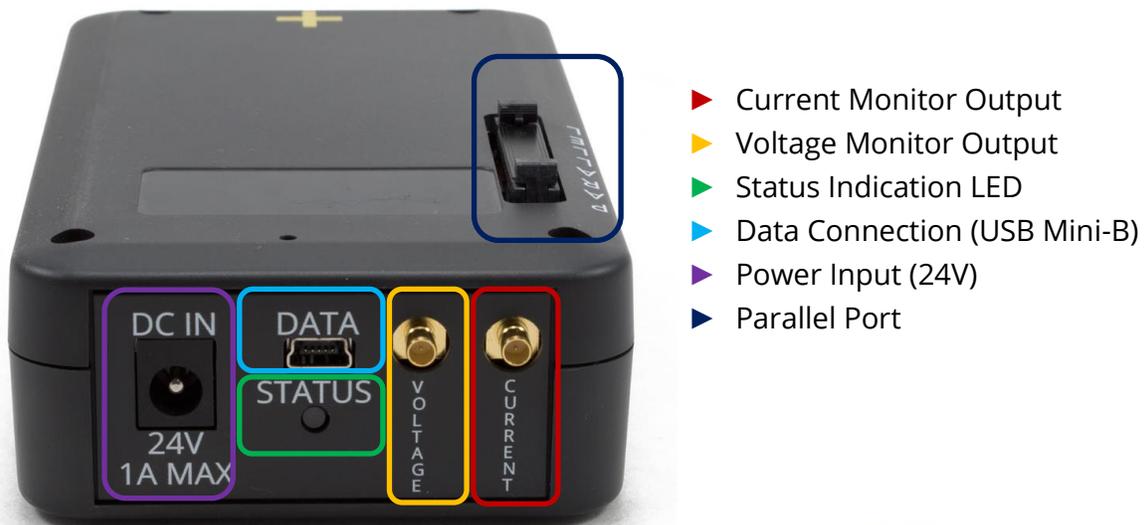
### 2.1 OVERVIEW

The LoadSlammer™ Pro is used to test fast, high current transient loads as seen in CPU, GPU, FPGA, and ASIC power profiles. It is designed to be easy to use with a simple GUI, voltage sense and current sense output. In addition to the sense outputs, the onboard sampling and analysis allows for pass/fail testing all in one device.

### 2.2 HARDWARE

Hardware overview of the LoadSlammer Pro family.

#### 2.2.1 LoadSlammer Pro 1000



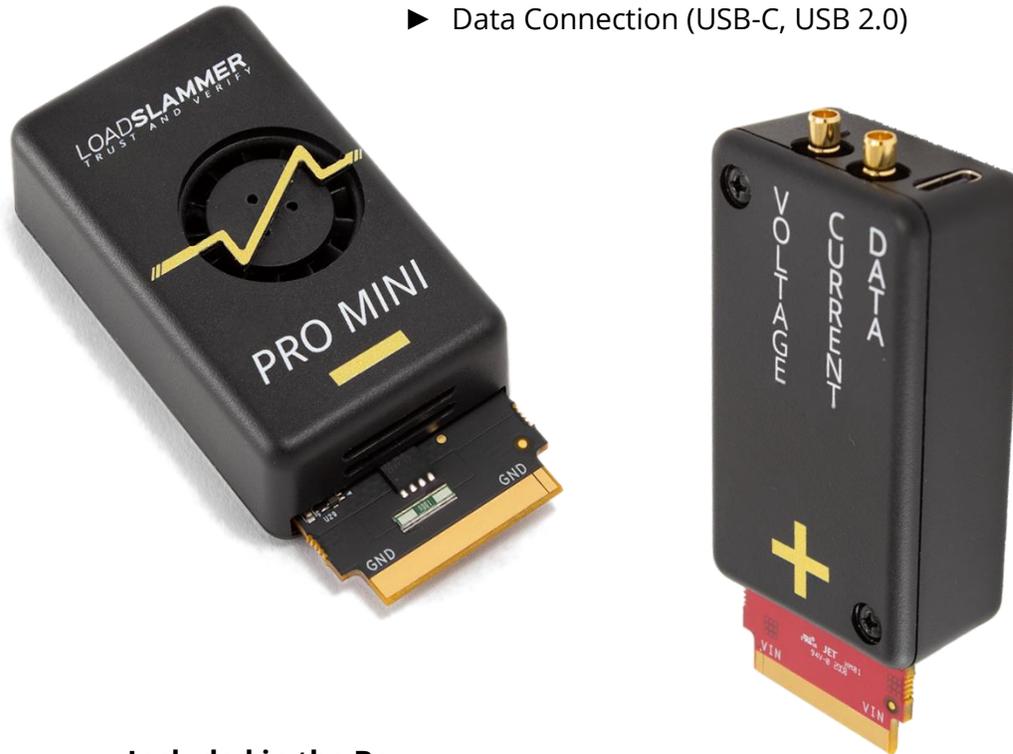
#### Included in the Box

- LSP1000 Device
- USB Mini-B Cable
- 24V Power Adapter
- North American Power Cord



## 2.2.2 LoadSlammer Pro Mini (200 & 40)

- ▶ Current Monitor Output
- ▶ Voltage Monitor Output
- ▶ Status Indication LED
- ▶ Data Connection (USB-C, USB 2.0)



### Included in the Box

- LoadSlammer Pro Mini
- USB 2.0 type-A to type-C cable

## 2.3 OPERATING SPECIFICATIONS

### 2.3.1 LoadSlammer Pro Mini 40

Parameter	Min	Typ.	Max	Unit
<b>Timing Characteristics</b>				
Rise Time	180	200	89,000	nS
On Time Range	7.5 $\mu$		100m	Sec
Off Time Range	7.5 $\mu$		10	Sec
<b>Load Characteristics</b>				
Current Range	1		20	A
Current Resolution		200		mA
Current Output Accuracy		5		%
Input Voltage Rating	0.6		2.0	V
<b>Current Sense Output</b>				
Conversion Ratio		10		A/V
Max Current		20		A
Current Readout Accuracy		5		%
<b>Sampling System</b>				
Sampling Rate			10	MSPS
Bandwidth		5		MHz
Capture Depth		24		kPoints
<b>Power Dissipation Characteristics</b>				
Continuous Power Dissipation			5	W
Instantaneous Power Dissipation			100	W
<b>Device Connection</b>				
<b>DUT Connector</b>	Preferred	Samtec HSEC8-130-01-L-DV-A-WT-K-TR		
	Surface Mount Only	Samtec HSEC8-130-01-L-DV-K-TR		
	Keepout Drawing and Pinout	<a href="https://loadslammer.com/connector/">https://loadslammer.com/connector/</a>		
<b>Non-Isolated</b>	LoadSlammer Pro must be used with a regulator that has a positive voltage. The USB data connection is non-isolated, this effectively grounds the DUT's ground.			

Table 1 – LSP40 Operating Characteristics



### 2.3.2 LoadSlammer Pro Mini 200

Parameter		Min	Typ.	Max	Unit
<b>Timing Characteristics</b>					
Rise Time		180	200	89,000	nS
On Time Range		7.5 $\mu$		100m	Sec
Off Time Range		7.5 $\mu$		10	Sec
<b>Load Characteristics</b>					
Current Range		5		100	A
Current Resolution			1		A
Current Output Accuracy			5		%
Input Voltage Rating		0.6		2.0	V
<b>Current Sense Output</b>					
Conversion Ratio			50		A/V
Max Current			100		A
Current Readout			5		%
<b>Sampling System</b>					
Sampling Rate				10	MSPS
Bandwidth			5		MHz
Capture Depth			24		kPoints
<b>Power Dissipation Characteristics</b>					
Continuous Power Dissipation				5	W
Instantaneous Power Dissipation				100	W
<b>Device Connection</b>					
<b>DUT Connector</b>	Preferred	Samtec HSEC8-130-01-L-DV-A-WT-K-TR			
	Surface Mount Only	Samtec HSEC8-130-01-L-DV-K-TR			
	Keepout Drawing and Pinout	<a href="https://loadslammer.com/connector/">https://loadslammer.com/connector/</a>			
<b>Non-Isolated</b>	LoadSlammer Pro must be used with a regulator that has a positive voltage. The USB data connection is non-isolated, this effectively grounds the DUT's ground.				

Table 2 – LSP200 Operating Characteristics



### 2.3.3 LoadSlammer Pro 1000

Parameter		Min	Typ.	Max	Unit
<b>Timing Characteristics</b>					
Rise Time		180	200		nS
On Time Range		7.5 $\mu$		100m	Sec
Off Time Range		7.5 $\mu$		10	Sec
<b>Load Characteristics</b>					
Current Range		5		500	A
Current Resolution			1		A
Current Output			5		%
Input Voltage Rating		0.6		2.0	V
<b>Current Sense Output</b>					
Conversion Ratio		50		250	A/V
Max Current	single device		500		A
Current Readout			5		%
<b>Sampling System</b>					
Sampling Rate				10	MSPS
Bandwidth			5		MHz
Capture Depth			24		kPoints
<b>Power Dissipation Characteristics</b>					
Continuous Power				25	W
Instantaneous				500	W
<b>Device Connection</b>					
<b>DUT Connector</b>	Preferred	Samtec HSEC8-130-01-L-DV-A-WT-K-TR			
	Surface Mount	Samtec HSEC8-130-01-L-DV-K-TR			
	Keepout Drawing and Pinout	<a href="https://loadslammer.com/connector/">https://loadslammer.com/connector/</a>			
<b>Non-Isolated</b>	LoadSlammer Pro must be used with a regulator that has a positive voltage. The USB data connection is non-isolated, this effectively grounds the DUT's ground.				

Table 2 - LSP1000 Operating Characteristics



## 2.4 TERMINOLOGY

**Slew Rate** – The change in current per unit of time (di/dt). Usually discussed in amps per microsecond.  $SR = \frac{I_{step}}{t_{rise}}$

**Rise Time** – The time required for a signal to rise from 10% to 90% of the steady state values.

**Load Transient** – A sudden change in load current.

**Output Impedance** – How well the DUT can maintain voltage regulation over frequency.

**DUT (Device Under Test)** – The DC-DC solution.

## 3 OPERATING THE LOADSLAMMER PRO

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### 3.1 PHYSICAL CONNECTION TO DUT

#### 3.1.1 Placement Location

Placement of the LoadSlammer Pro on the DUT (Device Under Test) is crucial. For best results, place the LoadSlammer Pro as close to the load as possible to include all the effects of the PDN. Placing the LoadSlammer Pro directly at the output of the regulator does not adequately test the real-world application.

**Do not connect the LoadSlammer Pro using wires. Wires increase the inductance of the system which prevents high slew rates. The results will not be valid.**

#### 3.1.2 Connection Options

There are several ways to connect to a DUT. Using a connector provides ease of use and reduces wear on the PCB but adds inductance and resistance to the power path. These factors may limit your maximum slew rate. Soldering directly to the PCB helps minimize inductance which can provide a cleaner signal and a faster slew rate. Additionally, LoadSlammer offers custom passive adapter design services to provide a higher level of confidence in the test results.

##### 3.1.2.1 Design in Connector

The connector provides ease of use for quickly testing different DUTs.

Drawings are available on our [website](#) detailing pinout and keepout regions.

The preferred connector is the Samtec HSEC8-130-01-L-DV-A-WT-K-TR, however it does require through holes. If design requirements prohibit through holes, there is a surface mount only variant: Samtec HSEC8-130-01-L-DV-K-TR.

Due to the design of card edge connectors, the socket does not support the card rigidly. There is a stabilizer accessory that prevents the device from tilting in the connector.

**Note:** For optimal performance when using a connector, ensure that the LoadSlammer is firmly seated and that the connector socket is clean. Failure to ensure a good connection can impact your test results.

##### 3.1.2.2 Solder Down

To solder the slammer to the DUT, find a large ground and power plane butting up to each other, scrape some solder mask off, then solder it down with copper braid. Alternatively, if your PCB has many ceramic capacitors in a row, it is possible to solder directly on top of them.

### **3.1.2.3 Passive Adapter**

Passive adapters are the best way to connect the LoadSlammer to a DUT. The adapter sits in place of a large BGA package to allow connection of the LoadSlammer on an application board. LoadSlammer offers custom passive adapter design services to provide a higher level of confidence in the test results, from design reviews to turnkey development for your application.

### **3.1.3 Test Equipment Setup**

Use the following steps to get started with the LoadSlammer Pro:

1. Make sure DUT (Device Under Test) and LoadSlammer are both powered off
2. Install LoadSlammer unit onto DUT

**Note: Make sure you observe proper polarity. The case has polarity marked with "+" and "-"**

3. Connect the USB cable from LoadSlammer to PC
4. (optional) Attach current & voltage monitoring of LoadSlammer to oscilloscope using an SMB cable. Make sure the oscilloscope channels are set to high input impedance
5. (LSP1000 only) Power on the LoadSlammer by plugging in the 24V power adapter provided
6. Connect to the LoadSlammer through the GUI

**Download the GUI from: <https://loadslammer.com/downloads/>**

7. Adjust test parameters to desired values
8. Hit the "Run" button to start slamming

#### **3.1.3.1 Oscilloscope Connection**

The current sense output on the LSP1000 has a gain that depends on the maximum amount of current and power dissipation. The other LoadSlammer Pro devices have a fixed current sense output gain.

Ensure the input impedance is set to 1M $\Omega$  or high impedance for both sense inputs. There is a 50 ohm series termination resistor on the LoadSlammer. The current sense output has an offset, so it should be zeroed out before taking measurements.

### 3.1.3.2 DC Measurements

While the LoadSlammer Pro has limited power dissipation, preventing efficiency measurements, the LoadSlammer can create a 'shoulder' of current before each load transient. This allows the DUT to settle to a steady state before the load transient.

An external DC load unit can be connected to the DUT if additional continuous power is needed.

## 3.2 CONNECTIONS TO LOADSLAMMER

### 3.2.1 USB Data Connection

The LoadSlammer Pro Mini devices require only a USB 2.0 type-C connection; no external power is required. The LoadSlammer Pro 1000 requires external 24V power in addition to the USB 2.0 Mini-B connection.

### 3.2.2 Voltage Sense

The voltage sense output on the LoadSlammer Pro is a passive single ended, 50 Ohm transmission line. The transmission line is series terminated, so ensure oscilloscope input is setup as high-impedance input. Note the SMB monitor is not differential. The voltage sense to the LoadSlammer ADC is differential. If you wish to measure hi di/dt voltage excursions with an external oscilloscope you should measure directly.

### 3.2.3 Current Sense

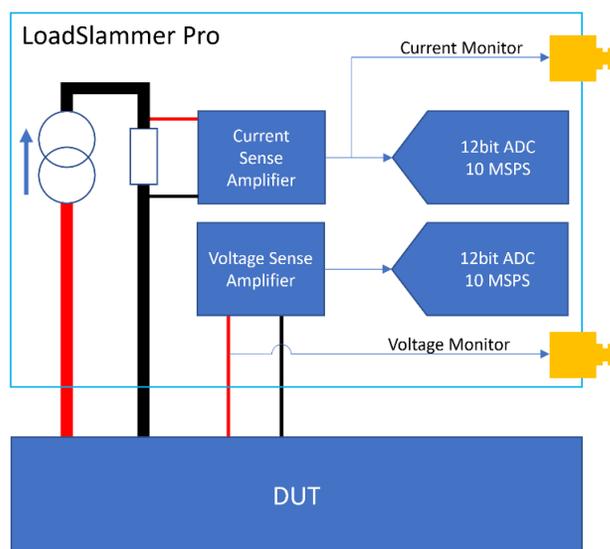
The current monitor output is derived from the current shunt. There is a fundamental L/R time constant that limits the maximum bandwidth. For the LSP1000 and LSP200, the maximum bandwidth is limited to approx. 750 kHz.

On the LSP1000, there are 5 parallel 'channels' with 5 current shunts summed together in the analog domain.

### 3.2.4 Parallel

The LoadSlammer Pro 1000 supports the ability to parallel multiple devices to support very high current requirements. A parallel cable is required to link the devices together.

To operate the devices in parallel, simply connected the parallel cable to each device. Power all the devices through their respective DC barrel jack, then connect only one device to USB (this will be referred to as the master device). With the GUI open, all the 'slave'



devices' status indicator light will turn green indicating the device is in slave mode and ready to test.

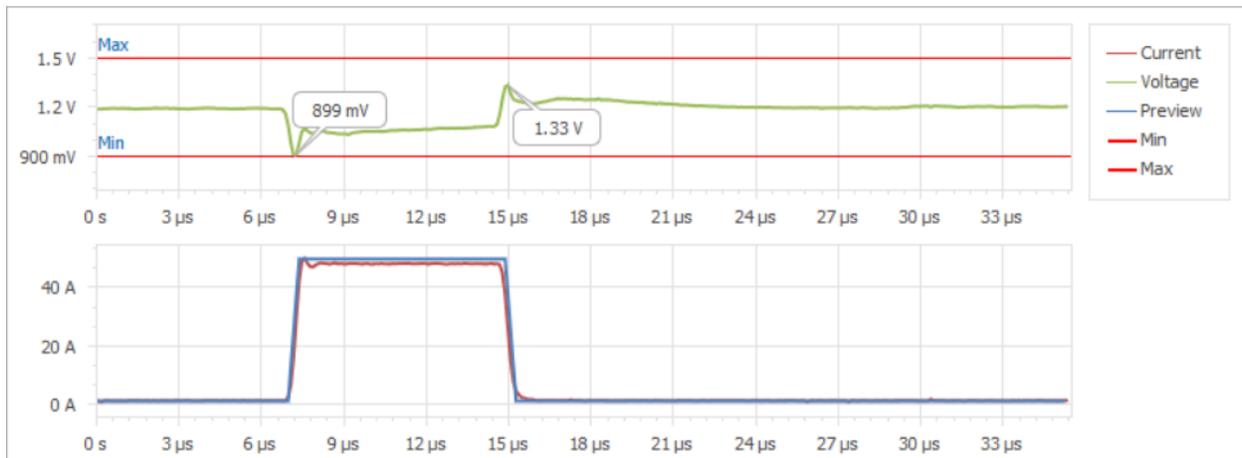
The voltage measurements are taken only from the master device.

### 3.3 TEST MODES

The LoadSlammer Pro family has several modes of operation and is field upgradeable to offer additional functionality.

#### 3.3.1 Transient

Transient mode is the most basic mode of operation. In this mode, the main goal is to understand the step response of the DUT. A load transient is applied to the DUT to determine the output voltage response. Some of the primary measurements are the Droop and Liftoff amplitudes, and the recovery time of the regulator. Additionally, the load line can be calculated, and the recovery response gives an indication of phase margin.



#### 3.3.2 Pulse Train

Pulse Train mode is very similar to the transient mode. The main difference is the current step from the transient pulse is modulated with a square wave to give a specific frequency and duty cycle. This allows for the frequency and duty cycle to be swept over a range to generate a 3D graph or frequency alone to look for resonant modes.

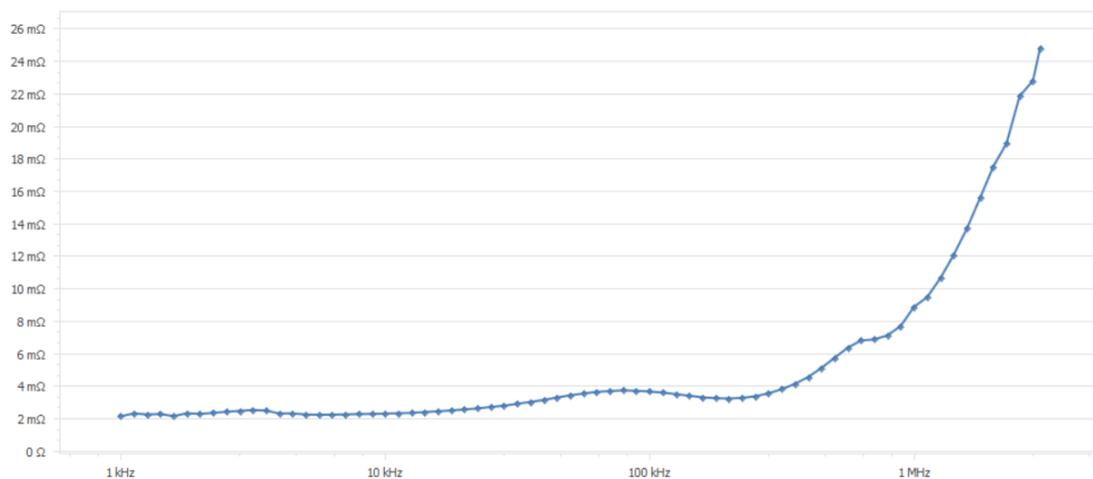
[Shot of Pulse Train]

### 3.3.3 Impedance

Impedance mode applies a sinusoidal load transient and measures voltage amplitude to determine the large signal impedance.

There are several ways to interpret this data. One way is to look at the amplitude response of the voltage over frequency, known as output impedance. Complementary, analyzing the spectral content at each applied frequency can inform on where the non-linearities of the system are located.

The amplitude of the sin wave and the offset are set via the GUI. Determine the values to sweep are based on target load currents, step sizes and PDN goals.



### 3.3.4 Arbitrary

Arbitrary mode lets the user configure a custom pattern. (Yet to be implemented).

### 3.3.5 Vender Specific

Vender specific tests are available upon request. Contact us at [support@loadslammer.com](mailto:support@loadslammer.com).

## 4 CHANGE HISTORY

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<b>Revision Number</b>	<b>Date</b>	<b>Reason for change</b>
0.1	May 27, 2020	Initial Release