TECH NOTE

LDP-3830 Independent Current Limit

OVERVIEW

The LDP-3830 Precision Pulsed Current Source was designed to provide safe current up to 5 A with a maximum compliance voltage of 20 V. This technical note discusses the performance of the independent current limit of the LDP-3830, and the compromise that inductive loads have on the difference between the setpoint current and current limit.

CURRENT LIMIT THEORY OF OPERATION

There are two independent current limits in the LDP-3830. The primary current limit setpoint is adjusted by the front panel CURRENT button and displayed in the large seven segment area of the display. The secondary current limit setpoint is adjusted by the "Current Limit:" parameter available under the setup menu.

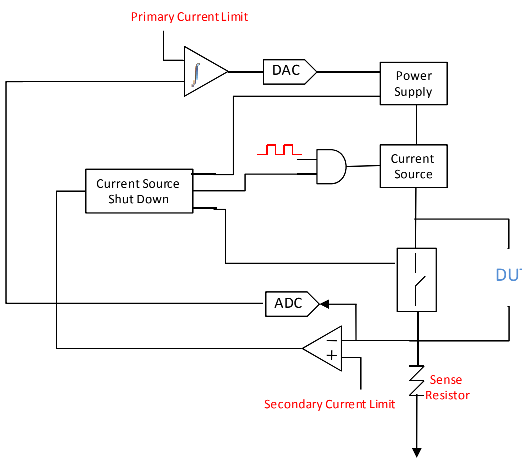

Figure 1: Current Limit Circuit Diagram

The primary current limit measures the current on the output approximately every 8 ns using a high speed analog to digital converter (ADC). This signal is used to control a DC voltage and was designed to regulate the average current across 80% of the pulse shape to the setpoint value. This method provides the most repeatable current accuracy since it alleviates errors due to overshoots, sampling jitter, or ADC noise on the current measurement.

The secondary current limit also monitors the current, but with an ultrafast comparator instead of an ADC. The secondary current limit sets a threshold level on the comparator, which when exceeded by the actual current immediately shuts off the current source.

CURRENT LIMIT ACCURACY

The primary current limit accuracy is limited by the sampling interval and the length of the pulse. As noted before, the signal is sampled every 8 ns and uses the average amplitude over 80% of the pulse. For the shortest pulse width, 25 ns, it will take two to three samples to get the average current. When combined with an inductive load, that slows the rise time, the current could still be on the rising edge for the first sample. Therefore ADC jitter has a strong affect of where the current is sampled on this rising edge. Also, since it is sampled and processed, it can't respond to laser related transients.

The secondary current limit has a much faster response that provides protection by limiting the absolute current into the laser. The error in this circuit is primarily due to propagation delay. The largest propagation delay is the delay from the cable, which can be about 8 ns in each direction; the next largest delay is the logic circuit delay which accounts for about 6.5 ns. This will allow a signal that once it has exceeded the limit, to continue to increase current for another 22 ns before it is shut down. Given the fast rise times of the LDP-3830 the 22 ns delay could be an issue, however the LDP-3830 uses a slow ramp when changing the current setpoint. This slow ramp allows the secondary current limit to detect any potential damaging transients, see ILX Lightwave Technical Note LDP-3830 Laser Protection (TN#3830-3) for additional information on the slow ramp.

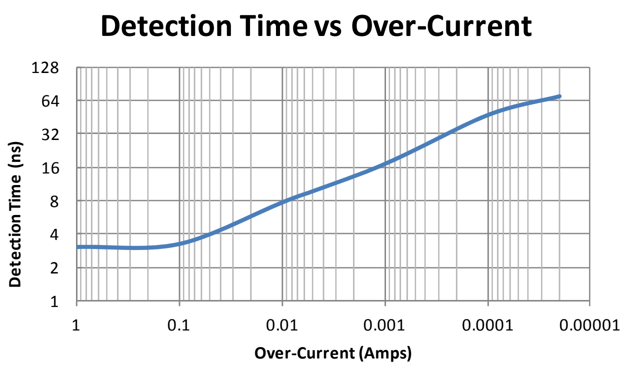

Figure 2: Secondary current limit Detection Time vs Over Current condition

Another source of error is in the detection time. Due to the gain of the comparator in the secondary current limit the time to shut down the pulse is dependent on the amount of current over the limit. As seen in *Figure 2*, for 20 µA of current over the limit, it can take as long as 80 ns to detect the over current. However this time quickly decreases with the amount of current over the setpoint. For currents greater than 100 mA it takes about 3 ns for the over current condition to be detected.

OPERATIONAL AFFECTS OF INDEPENDENT CURRENT LIMITS

The LDP-3830 current limit has a range of 0 to 5.5 A. This is to allow pulsing at 5 A with low inductance loads. In a case of a high inductance load with a pulse width of 25 ns with a primary current limit set to 5 A and secondary current limit set to 5.5 A the output may be disabled due to an overshoot caused by the high inductance. To achieve 5 A the user may increase the pulse width above 30 ns or decrease the inductance.

As an example, the waveform in *Figure 3* shows a 25 ns pulse with a primary current limit of 2.5 A, and the secondary current limit initially set to 3.0 A, the red line shows the 2.5 A setpoint. The primary current limit did not detect the overshoot since the average power was not over 2.5A. With the output enabled the secondary current limit was reduced until 2.83 A where it detected the over current condition of this pulse.

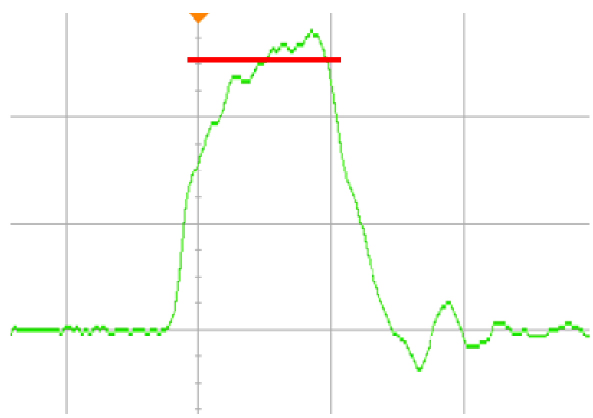

Figure 3: Waveform of 2.5 A, 25ns pulse, inductive load with the scope configured to 20 ns/division and 1 A/division

CONCLUSION

The LDP-3830 provides two independent methods for current limit protection. The primary current limit is used to adjust the current setpoint and is not affected by high inductance loads. The secondary current limit is a fast detection limit that will detect overshoot conditions common with high inductance loads. To achieve 5 A peak pulse the user must limit the inductance of the load or increase the pulse width.