

## Low-Noise Laser Current Driver

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Bulk Metal<sup>®</sup> Foil resistors from Vishay Foil Resistors (VFR) are used to construct a low-cost, low-noise current source to be used with diode lasers. With a tolerance of 0.01% and a power rating of 10 W, the VHP power resistor completely addresses the strict requirements for a sense resistor in this application, including resistance to internal and external temperature drifts, a high power rating, and low thermal EMF.

**Industry/Application Area:** Precision instruments

**Product Used:** VHP-4, 0.01%, 50  $\Omega$ , 10 W, TO-3 Package

### The Challenge

Diode lasers have come to play a fundamental role in experimental atomic physics. Their low cost and ease of use make them a standard tool in many experiments. Since the laser frequency and output power depend both on the diode laser current and temperature, a stable laser requires that both of these be precisely regulated. A high level of stability and low noise can be achieved through the use of commercial current controllers. Unfortunately, these current sources are costly, and often much more expensive than the sum cost of the individual components used in their construction. The objective here was to construct a low-cost, low-noise current source to be used with diode lasers.

### The Solution

This laser current controller design is based on the Hall-Libbrecht current driver, a precision current controller designed to be used with diode lasers. The critical element of the current source is the



sub-circuit responsible for current regulation. In this sub-circuit, a regulated voltage source,  $V_{reg}$ , is used to drive a current through a precision sense resistor,  $R_s$ . The amount of current coming out of the laser current driver is controlled by tuning a set voltage,  $V_{set}$ , on an adjustable voltage regulator:

$$I = (V_{reg} - V_{set}) / R_s$$

In order to generate a stable laser, the sense resistor in the current source must be resistant to internal and external temperature drifts, have a high power rating, and a low thermal EMF. With a tolerance of 0.01% and a power rating of 10 W, VFR's VHP Bulk Metal Foil power resistor (VHP) completely addresses these strict requirements for a sense resistor.

### The User Explains

The most critical element of the current driver is the sub-circuit responsible for current regulation since the stability of the laser must not exceed the stability of the sense resistor. Thus, great care must be taken when choosing a sense resistor. Here we chose the VHP-4 sense resistor with a total resistance of 50  $\Omega$  and a temperature coefficient of 5 ppm/ $^{\circ}\text{C}$ . This value for the total resistance ensures that the voltage drop is large enough for accurate current regulation, but small enough as to not affect the regulated supply voltage.

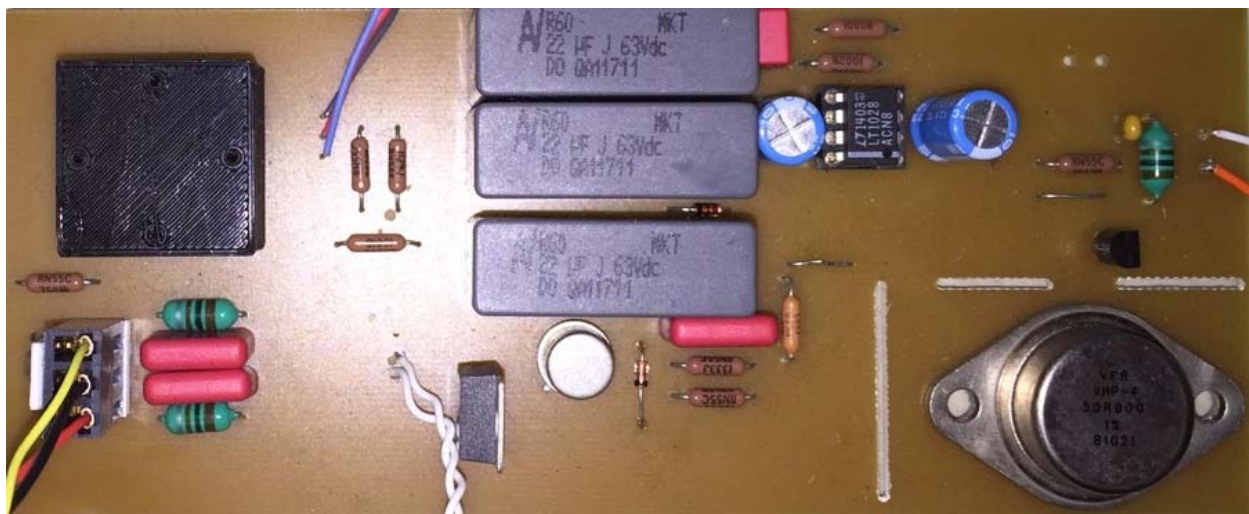


Figure 1: Photograph of front view of PCB prototype (VHP-4 bottom right hand side)

**“The combination of the long-term stability and low temperature coefficient make the Vishay Foil Resistors’ Bulk Metal<sup>®</sup> Foil power resistor the optimal tool for a precision current source.”**



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