Application Brief
Space Grade 12A Laser Diode Driver

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Introduction

This application brief describes a digitally controlled, high-current laser diode driver intended for precision alignment and tracking in space based optical communications terminals (OCT). The design provides an adjustable constant-current output from 0A to 12A using space-rated components and closed-loop current regulation. Output current level is programmed through a SPI-controlled digital-to-analog converter (DAC), enabling precise control required for the laser diode. The design occupies approximately 1.5in × 2in.

Application

Laser-based optical communication terminals rely on highly stable and accurate alignment lasers to enable reliable data transfer over extreme distances. The pointing, acquisition, and tracking (PAT) lasers in these systems must be driven with precise constant current rather than constant voltage to verify safe operation, optical stability, and long device lifetime.

System Overview

Laser diodes require precise constant-current sources, not constant-voltage sources, to operate safely and effectively. Variations in voltage or temperature can cause destructive current runaway if not properly controlled. This design implements a buck converter–based current source, where output current is regulated using feedback across a precision shunt resistor. The control loop adjusts the buck switch duty cycle to maintain the commanded current level. Output current is digitally programmed using a space-rated digital-to-analog converter (DAC) over an SPI interface, enabling fine resolution adjustment and remote control.

Key Features
- Adjustable output current: 0A to 12A
- Digitally programmable: SPI-controlled DAC
- SP or SEP Space-rated components accommodating GEO and LEO mission profiles\
- High precision constant-current regulation
- Compact design size: approximately 1.5" × 2"

Circuit Description and Block Diagram

The design uses a buck converter configured as a current source. A low-value shunt resistor placed in series with the laser diode senses output current. The voltage across the shunt is fed back to the controller to close the control loop. To set the level of the current output, a DAC121S101SEP space-grade DAC provides the programmable reference for the current loop. The DAC is controlled through an SPI bus, allowing current adjustments during system operation.

Testing

Circuit was tested by connecting DAC121S101SEP, TPS7H4011-SEP EVMs according to the block diagram in Figure 1. During verification, the DAC value was updated using a PHI interface board connected to a PC over USB. This configuration allowed rapid evaluation of current steps, stability, and transient response.
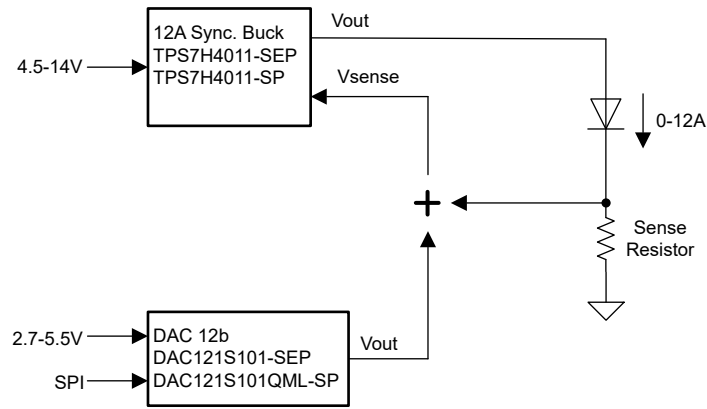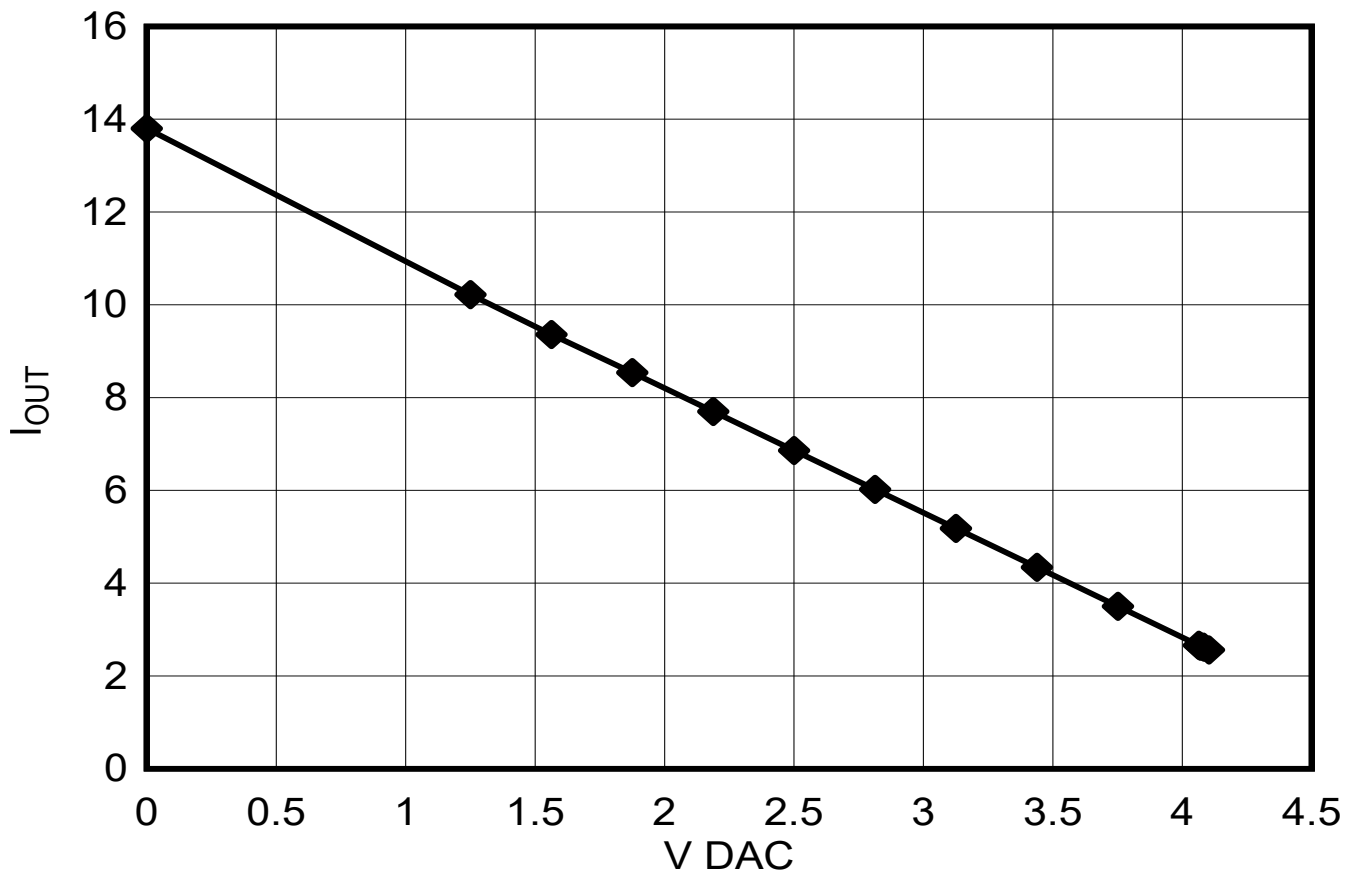
Figure 1. Simplified Block Diagram

Figure 2. Test Data

Additional Resources

- ADC Adapter Card
- Radiation Handbook for Electronics
- Space Products Selection Guide
- Support TI E2E Forums

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