Zhiwei YANG, Xu WU, Deqin OUYANG, Encheng ZHANG, Huibin SUN, Shuangchen RUAN, 2021. Pulse control of frequency and width for a real-time independently adjustable laser source. *Frontiers of Information Technology & Electronic Engineering*, 22(10):1379-1389.
https://doi.org/10.1631/FITEE.2000294

Pulse control of frequency and width for a real-time independently adjustable laser source

Key words: Electric variable control; Electronic design automation and methodology; Optical pulse generation; Optical control

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Motivation

1. Picosecond laser pulses have important applications in various fields, such as quantum communication, optical measurement, and nonlinear optics.

2. For a sinusoidal signal, frequency is directly related to the pulse width, and the changes in the frequency and pulse width are observed simultaneously.

3. Using embedded technology, the frequency and pulse width of the laser pulse source can be separately modulated.

Main idea

1. Rate equations can be employed to analyze the relationship between the dynamic characteristics of semiconductor lasers and various device parameters.

2. The initial pulse is generated using an STM32F4 microcontroller based on the pulse width modulation (PWM) principle, which is a digital coding method for analog signals.

Method

1. A rate equation model has been established and analyzed for a semiconductor laser.

2. A set of semiconductor laser pulse seed sources based on an embedded chip (STM32F4) is proposed, and the semiconductor lasers are modulated using analog control and internal pulse generators.

Major results

Block diagram of the driving circuit

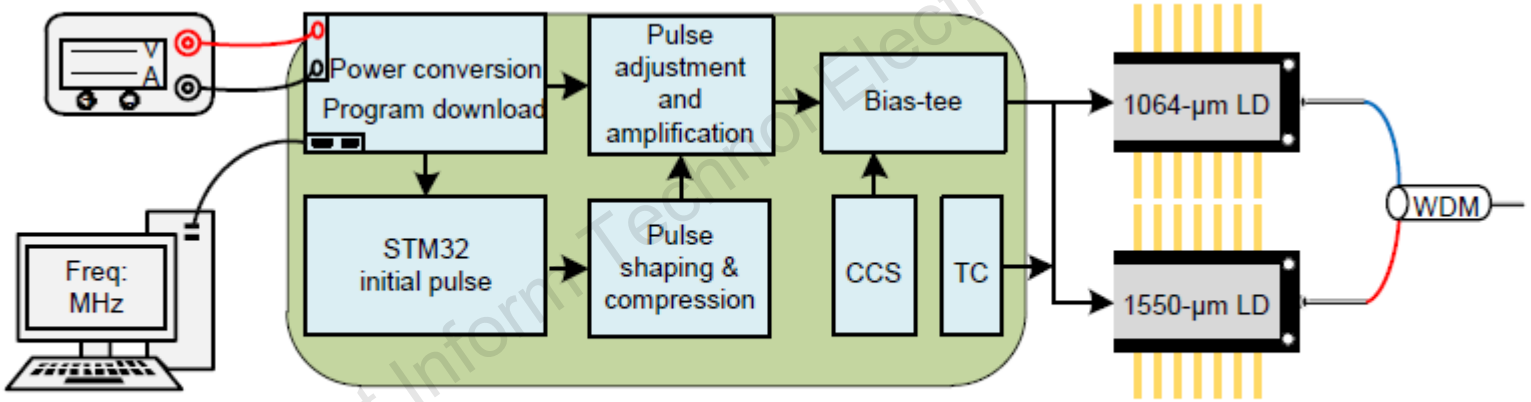

Fig. 4 A block diagram of the driving circuit

CCS: constant-current source; TC: temperature control; LD: laser diode; WDM: wavelength division multiplexing

Major results (Cont'd)

1. Design of the semiconductor laser seed source

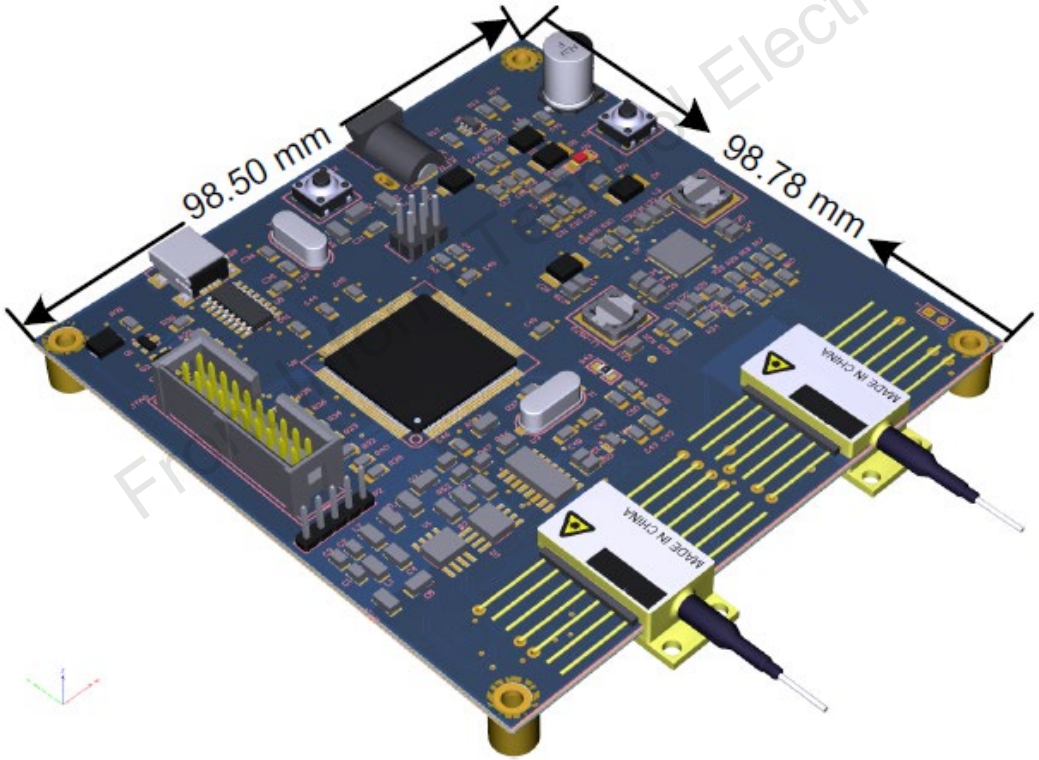

Fig. 5 Design of the semiconductor laser seed source

Major results (Cont'd)

2. Optical pulse output with spectral widths of 80 ps (a) and 980 ns (b)

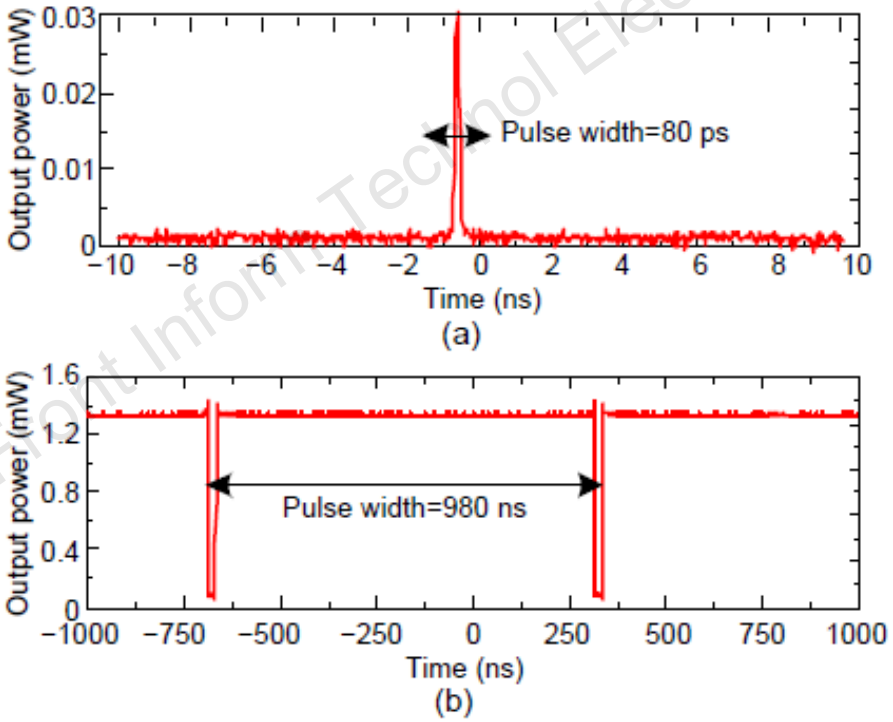

Fig. 7 Optical pulse output with spectral widths of 80 ps (a) and 980 ns (b)

Major results (Cont'd)

3. Optical pulse output with frequencies of 250 Hz (a) and 42 MHz (b)

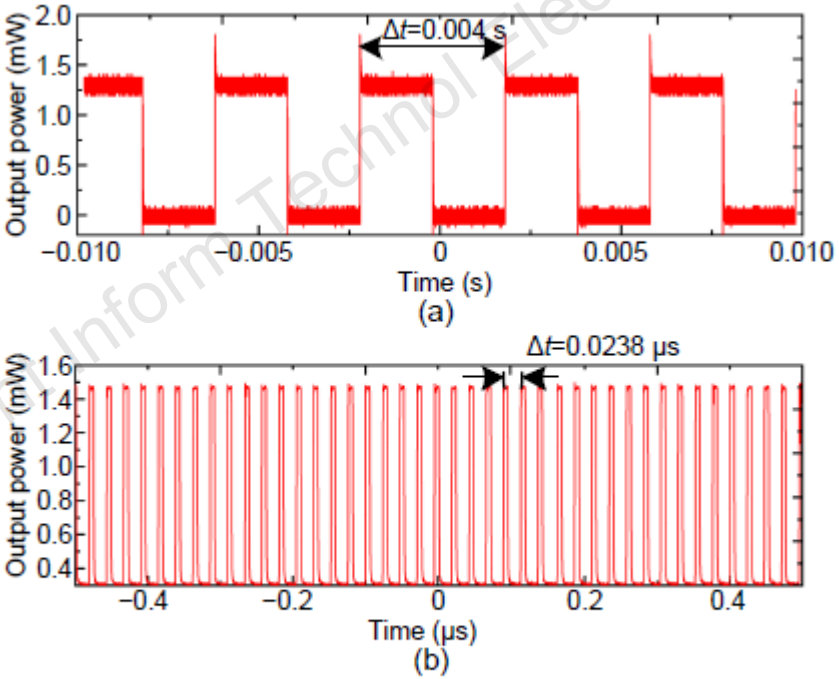

Fig. 8 Optical pulse output with frequencies of 250 Hz (a) and 42 MHz (b)

Conclusions

1. A set of fiber laser pulse sources with adjustable optical signal parameters has been obtained using an embedded technology design.

2. A rate equation model has been established and analyzed for a semiconductor laser, and the accuracy of the model has been experimentally verified.

3. The designed drive circuit exhibits a compact structure, adjustable pulse width and frequency, and high stability.

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