MODULAR CLOSED-LOOP CONTROL BOARD FOR INFRARED LASER SYSTEMS

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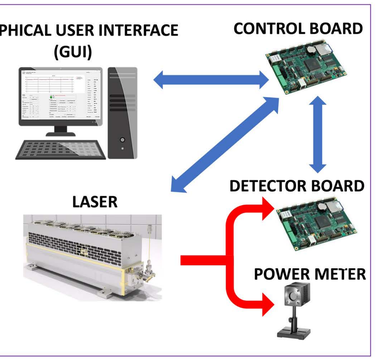
TRUMPF

CONTROL OF APPLICATION SPECIFIC LASER SYSTEMS

Overview

- **This work aims to design a modular closed-loop control system with a user-friendly interface for customizable infrared laser systems.**
- End users will easily customize the beam parameters to desired specifications using the GUI, and the GUI will include plots and recordings of the resulting beam.



GRAPHICAL USER INTERFACE (GUI)

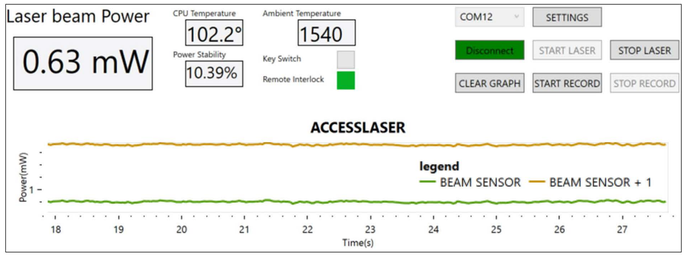
Design and Features

(1) The GUI provides easily tunable laser parameters to the control board
- Including frequency, duty cycle, pulse width, phase difference and target power of two PWM signals.

(2) It can control the PWM signals with high accuracy.
- 0.01% or 1µs adjustable step in duty cycle
- 10Hz adjustable step in frequency
- 10µs steps in phase difference

(3) The GUI receives data from the control board. Data visualization is easy to understand.
- The GUI includes dynamic graphs of power measured from a beam sampler and beam sensor
- display the board and ambient temperature, and power stability updating every 0.1 seconds.
- ON/OFF display of key switch and remote interlock

(4) It can record the data in an excel file.



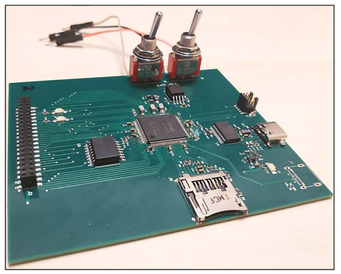
CONTROL BOARD MODULE

Design and Features

(1) The control board is centered around a 120 MHz SAM E54 microcontroller. This microcontroller takes inputs from the GUI and generates signals that will drive the laser.
(2) The microcontroller is also responsible for converting all the recorded sensor board data into digital signals that will be displayed on the GUI.
(3) A micro SD card slot is integrated into the design, and any events triggered in the laser are logged and time stamped.
(4) Safety is critical in the laser industry. A key switch and remote interlock apparatus are included on the board.

Milestones

(1) Successful fabrication of the first control board.
(2) Control board has been successfully powered on, with the correct voltage conversions taking place where necessary.
(3) Successfully established UART communication between control board and user PC.

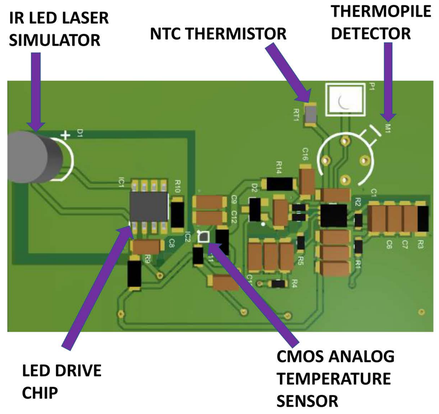


Control Board

SENSOR/DETECTOR BOARD MODULE

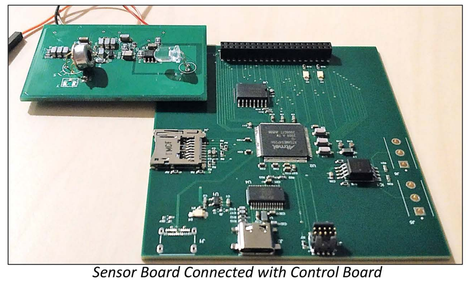
Design and Features

- The detector board has four sensor conditioning circuits:
  (1) A thermopile detector circuit (ST150) for radiation sensing of laser beam.
  (2) A 30 kΩ 5% NTC (Negative Temperature Coefficient) thermistor circuit for laser beam temperature sensing.
  (3) A CMOS analog temperature sensor for ambient temperature measuring and compensation.
  (4) Laser simulation circuit for testing using a PWM controlled IR LED drive circuit.



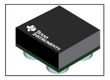
SENSOR/DETECTOR BOARD MODULE CONT'D

Integration



Sensor Board Connected with Control Board

Thermopile Laser Beam Sensor



CMOS Analog Temperature Sensor

- The sensor board has been successfully integrated with the Control Board
- Our CMOS analog temperature sensor is a small 0.924 x 0.924 mm^2 device and is currently experiencing issues in the assembly phase.

ONGOING WORK

Looking Forward

(1) Next steps are to perform more robust module testing and complete a full system integration and testing.
(2) The next version of the control board will integrate an FPGA into the design, which will generate PWM signals with greater precision than the microcontroller can provide.
(3) Many I/O pins have been assigned on the control board but do not currently serve a purpose, future designs will look to utilize these pins.
(4) Future designs look to integrate USB 3.0 into the control board layout, allowing faster communications between the control board and the user's PC.

ACKNOWLEDGMENTS

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