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THORLABS

# LTC100-C - November 13, 2017

Item # LTC100-C was discontinued on November 13, 2017. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

# COMPLETE LASER DIODE OPERATION STARTER SET

- ▶ Bundles LD Controller, TEC Controller, LD Mount, Collimation Optic, and Accessories
- ▶ Ideal for Stable and Safe Operation of Standard Laser Diodes

All Controller Cables Included

**LTC100-B**
LD Controller Kit

**Included Accessories**


Hide Overview

## OVERVIEW

### Included Items:

- Benchtop LD Current Controller ±500 mA HV: LDC205C
- Benchtop Temperature Controller, ±2 A / 12 W: TED200C
- TEC LD Mount: TCLDM9
- All Connection Cables
- Spanner Wrench for M9 x 0.5 Housing: SPW301
- Spanner Wrench for SM1 Adapters: SPW909
- TR Series Post: TR3
- Post Holder for TR Series Post: PH3
- Mounting Base: BA2
- Optic Adapter: S1TM09
- Locking Nut: SM1NT
- Grounding Wrist Strap: WS02
- AR-Coated Collimation Optic
  - For 350 - 700 nm: C230TMD-A
  - For 600 - 1050 nm: C230TMD-B
  - For 1050 - 1700 nm: C230TMD-C

| Item # | LDC205C |
|---|---|
| LD Current Control Range | 0 to ±500 mA |
| Compliance Voltage | >10 V |
| Photocurrent Control Range | 25 µA to 10 mA |
| Small Signal 3 dB Bandwidth, CC Mode | DC to 150 kHz |
| **Item #** | **TED200C** |
| TEC Current Control Range | -2 A to +2 A |
| Compliance Voltage | >6 V |
| Maximum Output Power | 12 W |
| Thermistor Control Range | 10 Ω to 20 kΩ / 100 Ω to 200 kΩ (2 Ranges) |
| Supported IC Sensors | AD590, AD592, LM135, LM335 |

The LTC100 Series is a complete laser diode and temperature controller set including mount, optic and accessories. It combines the benchtop LD Current Controller LDC205C and the benchtop Temperature Controller TED200C and other required items for a stable and safe operation of standard laser diodes.

The kit is offered in three versions depending of the anti-reflection coating of the collimation optic: LTC100-A for 350 - 700 nm, LTC100-B for 600 - 1050 nm, and LTC100-C for 1050 - 1700 nm. For detailed information about the components, please see the links to the product pages of the components list above. Each unit ships with two cables, one for the temperature controller (CAB420-15) and one for the laser diode controller (CAB400). Although all necessary cables are packaged with the purchase of the controllers and starter sets presented above, replacements can be purchased separately. A mounting flange for use with DPSS laser diodes is also available separately below (item # TCLDM9DJ).

The TED200C and LDC205C operate with a line voltage of 100, 115, or 230 VAC. These sets are shipped with imperial mounting posts and holders. The mounting base is compatible with both imperial and metric systems. If you prefer metric posts and holders please contact our Tech Support Team.

| Laser Diode Accessory Selection Guide | | | | | |
|---|---|---|---|---|---|
| Other Temperature Controlled Mounts | Passive Mounts | Passive Mounts with Collimation Package | Strain Relief Cables | Diode Sockets | Other Controllers |
|  |  |  |  |  |  |

Hide Controller Specs

## CONTROLLER SPECS

| Item # | LDC205C |
|---|---|
| **Current Control (Constant Current Mode)** | |
| Control Range | 0 to ±500 mA |
| Compliance Voltage | >10 V |
| Resolution | 10 µA |
| Accuracy | ±0.5 mA |
| Noise Without Ripple (10 Hz to 10 MHz, rms, typ.) | < 3 µA |
| Ripple (50/60 Hz, rms, typ.) | < 2 µA |
| Transients (Typ.) | < 0.5 mA |
| Drift, 24 hours (typ., 0-10Hz, at constant ambient temperature) | <10 µA |
| Temperature Coefficient | <50 ppm/ °C |
| **Current Limit** | |
| Setting Range | 0 to >500 mA |
| Resolution | 10 µA |
| Accuracy | ±1.5 mA |
| **Power Control (Constant Power Mode)** | |
| Photocurrent Control Range | 25 µA to 10 mA |
| Photocurrent Resolution | 1 µA |
| Photocurrent | ±10 µA |

| Item # | TED200C |
|---|---|
| **TEC Current Output** | |
| Control Range | -2 A to +2 A |
| Compliance Voltage | >6 V |
| Maximum Output Power | 12 W |
| Measurement Resolution | 1 mA |
| Measurement Accuracy | ±10 mA |
| Noise and Ripple (typ.) | <1 mA |
| **TEC Current Limit** | |
| Setting Range | 0 to >2 A |
| Resolution | 1 mA |
| Setting Accuracy | ±20 mA |
| **Thermistor Sensors[a])** | |
| Control Range | 10 Ω to 20 kΩ / 100 Ω to 200 kΩ (2 Ranges) |
| Resolution (20kΩ / 200 kΩ Range) | 1 Ω / 10 Ω |
| Accuracy (20 kΩ / 200 kΩ Range) | ±10 Ω / ±100 Ω |
| Temperature Stability 24 hours[b]) (20 kΩ / 200 kΩ Range) | <0.5 Ω / <5 Ω |
| **IC Sensors** | |
| Supported | |

| | |
|---|---|
| Accuracy | |
| **Analog Modulation Input** | |
| Input Resistance | 10 kΩ |
| Small Signal 3 dB Bandwidth, CC Mode | DC to 150 kHz |
| Modulation Coefficient, CC Mode | 50 mA/V ±5% |
| Modulation Coefficient, CP Mode | 1 mA/V ±5% |
| **Laser Current Monitor Output** | |
| Load Resistance | >10 kΩ |
| Transmission Coefficient | 20 V/A ±5% |
| **General Data** | |
| Safety Features | Interlock, Laser Current Limit, Soft Start, Short Circuit when Laser off, Open Circuit Detection, Over Temperature Protection |
| Display | LED, 5 Digits |
| Connector for Laser, Photodiode, Interlock & Laser On Signal | 9-pin D-Sub Jack |
| Connectors for Control Input / Output | BNC |
| Chassis Ground Connector | 4 mm Banana Jack |
| Line Voltage / Frequency | 100 V, 115 V, 230 V +15% –10% each / 50 to 60 Hz |
| Maximum Power Consumption | 30 VA |
| Mains Supply Overvoltage | Category II (Cat II) |
| Operating Temperature | 0 to +40 °C |
| Storage Temperature | -40 to +70 °C |
| Relative Humidity | Max. 80% UP to 30 °C, Decreasing to 50% at 40 °C |
| Pollution Degree (Indoor Use Only) | 2 |
| Operation Altitude | <2000 m |
| Warm-up Time for Rated Accuracy | 10 min |

| | |
|---|---|
| Sensors | AD590, AD592, LM135, LM335 |
| Control Range with AD590, LM135 | -45 °C to +145 °C |
| Control Range with AD592 | -25 °C to +105 °C |
| Control Range with LM335 | -40 °C to +100 °C |
| Resolution | 0.01 °C |
| Accuracy | ±0.1 °C |
| Temperature Stability 24 Hours | <0.002 °C |
| **Temperature Control Input** | |
| Input Resistance | 10 kΩ |
| Control Voltage | -10V to +10V |
| Transmission Coefficient Thermistor (20 kΩ / 200 kΩ Range) | 2 kΩ/V / 20 kΩ/V ±5% |
| Transmission Coefficient IC-Sensors | 20 °C/V ±5% |
| **Temperature Control Output** | |
| Load Resistance | >10 kΩ |
| Transmission Coefficient Thermistor (20 kΩ / 200 kΩ Range) | 500 mV/kΩ / 50 mV/kΩ ±5% |
| Transmission Coefficient IC-Sensors | 50 mV/ °C ±5% |
| **General Data** | |
| Safety Features | TEC Current Limit, Short Circuit when TEC off, Missing Sensor Protection, Open Circuit Detection, Over Temperature Protection |
| Display | LED, 5 Digits |
| Connector for Sensor, TE Cooler, TEC On Signal | 15-pin D-sub Jack |
| Connectors for Control Input / Output | BNC |
| Chassis Ground Connector | 4mm Banana Jack |
| Line Voltage / Frequency | 100 V, 115 V, 230 V +15% -10% each / 50 to 60Hz |
| Maximum Power | 60 VA |

| | |
|---|---|
| Weight | <3.1 kg |
| Dimensions (W X H X D) without Operating Elements | 146 x 66 x 290 mm³ |
| Dimensions (W X H X D) with Operating Elements | 146 x 77 x 320 mm³ |

| | |
|---|---|
| Consumption | |
| Mains Supply Overvoltage | Category II (Cat II) |
| Operating Temperature | 0 to +40 °C |
| Storage Temperature | -40 to +70 °C |
| Relative Humidity | Max. 80% Up to 30 °C, Decreasing to 50% at 40 °C |
| Pollution Degree (Indoor Use Only) | 2 |
| Operation Altitude | <2000 m |
| Warm-up Time for Rated Accuracy | 10 min |
| Weight | <3.1 kg |
| Dimensions (W x H x D) without Operating Elements | 146 x 66 x 290 mm³ |
| Dimensions (W x H x D) with Operating Elements | 146 x 77 x 320 mm³ |

- Temperature Control data for thermistors are given in Ω since the controlled parameter is the resistance, not the temperature
- Due to the nonlinear conversion from Ω to °C the stability in °C depends on the operating conditions and the characteristics of the thermistor. E.g. for a typical thermistor at a set point of 10kΩ (25°C), a 0.5Ω stability translates into about 1mK temperature stability. At a set point of 5kΩ (38°C), the stability is about 2mK.

All technical data valid at 23 ± 5 °C and 45 ± 15% rel. humidity

Hide Diode Mount Specs

## DIODE MOUNT SPECS

| Item # | TCLDM9 |
|---|---|
| Laser Diode Package | Ø5.6 mm & Ø9 mm |
| Supported Pin Configurations | A, B, C, D, E, H<br>(G with Modification,<br>See *Pin Configurations* Tab of TCLDM9 Page) |
| Laser Current (Max) | 2 A |
| Polarity of Laser Diode | Selectable |
| Polarity of Monitor Diode | Selectable |
| RF Power (Max) | 200 mW, RMS |
| RF Input Impedence | 50 Ω |
| Modulation Frequency (Bias-T) | 0.2 to 500 MHz |
| TEC Current (Max) | 5 A |
| | |

| | |
|---|---|
| TEC Voltage (Max) | 4 V |
| TEC Heating/ Cooling Capacity | 20 W |
| TEC Interface | DB9, Male |
| Temperature Sensor | AD592, 10 kΩ Thermistor |
| Temperature Range (@25 °C with 2 A TEC Current) | 5 to 70 °C |

Hide Front & Back Panel

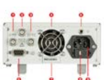
## FRONT & BACK PANEL

### LDC Front Panel


Click to Enlarge

| Callout | Connection | Callout | Connection |
|---|---|---|---|
| 1 | 5-Digit LED Display | 9 | Display Indicators |
| 2 | Display Units | 10 | Up/Down Display Select |
| 3 | Interlock Indicators | 11 | Diode Polarization Indicator |
| 4 | Laser Status Indicator | | |
| 5 | Laser Current On/Off Switch | 12 | Output Mode Indicator |
| 6 | Display Adjustment Knob | 13 | Diode Polarization Select |
| 7 | Supply Power Switch | 14 | Output Mode Select |
| 8 | Current Limit and Power Calibration Pots | 15 | Photodiode Current Range Pot |

### LDC Back Panel


Click to Enlarge

| Callout | Connection | Callout | Connection |
|---|---|---|---|
| 1 | TTL Input "LD REM" 0 to 5 V | 6 | Connector "LD OUT" for LD, PD, Interlock, & Status LED |
| 2 | Modulation Input / Analog Control Input "MOD IN", -10 to +10 V | 7 | Serial Number of the Unit |
| 3 | Analog Control Output "CTL OUT", -10 to +10 V | 8 | Indicator / Switch for Line Voltage (Included in Fuse Holder) |
| 4 | Cooling Fan | | |
| 5 | 4 mm Banana Jack for Chassis Ground | 9 | Power Connector and Fuse Holder |

### TED200C Front Panel


Click to Enlarge

| Callout | Connection | Callout | Connection |
|---|---|---|---|
| 1 | 5-Digit LED Display | 8 | Display Indicators |
| 2 | Display Units | 9 | Up/Down Display Select |
| 3 | Interlock Indicators | 10 | Selected Sensor Inticators |
| 4 | TEC Status Indicator | 11 | Sensor Select Key |
| 5 | TEC Current On/Off Switch | 12 | Potentiometers for PID Gain Settings |
| 6 | Supply Power Switch | | |
| 7 | Potentiometer for Current | 13 | Display Adjustment |

| | | | |
|---|---|---|---|
| | Limit Setting | | Knob |

### TED200C Back Panel

Click to Enlarge

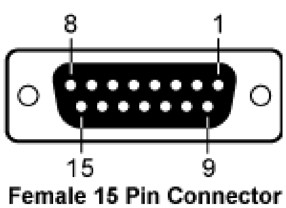
| Callout | Connection | Callout | Connection |
|---|---|---|---|
| 1 | Analog Temperature Control Input "Tune In", -10 to 10 V | 5 | 15-pin D-sub Jack for the TEC Element and the Temperature Sensor "TE OUTPUT" |
| 2 | Analog Temperature Control Output "CTL Out", -10 to 10 V | 6 | Serial Number of the Unit |
| 3 | Cooling Fan | 7 | Indicator / Switch for Line Voltage (Included in Fuse Holder) |
| 4 | 4 mm Banana Jack for Chassis Ground | 8 | Power Connector and Fuse Holder |

Hide Pin Diagrams

## PIN DIAGRAMS

### TED200C - Benchtop Temperature Controller

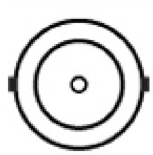
#### Temperature Sensor and Controller




| Pin | Connection | Pin | Connection |
|---|---|---|---|
| 1 | Status LED (+) TEC ON/OFF | 9 | Not Connected |
| 2 | Not Connected | 10 | Transducer AD 590/592 (-), LM 135/335 (+) |
| 3 | Thermistor (-), Ground | 11 | Transducer AD 590/592 (+), LM 135/335 (+) |
| 4 | Thermistor (+) | | |
| 5 | TEC (+) | 12 | Not Connected |
| 6 | TEC (+) | 13 | TEC (-), Status-LED (-) |
| 7 | TEC (+) | 14 | TEC (-), Status-LED (-) |
| 8 | AGND LM 135/335 (-) | 15 | TEC (-), Status-LED (-) |

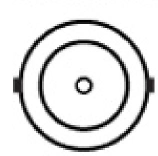
#### Analog Temperature Control Input

BNC Female



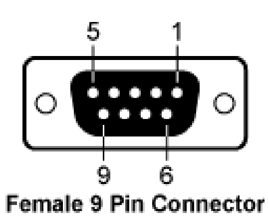
#### Analog Temperature Control Output

BNC Female



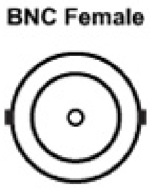
### LDC205C - Benchtop LD Current Controller

#### Laser Diode Connector



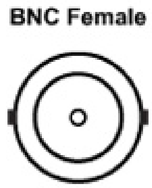

| Pin | Connection | Pin | Connection |
|---|---|---|---|
| 1 | Interlock and Status LASER ON/OFF | 6 | Not Connected |
| 2 | Photodiode Cathode | 7 | Laser Diode Cathode (with Polarity Anode Grounded - AG) |
| 3 | Laser Diode Ground | 8 | Laser Diode Anode (with Polarity Cathode Grounded - CG) |
| 4 | Photodiode Anode | | |
| 5 | Ground for Pin 1 | 9 | Not Connected |

**Laser Diode Remote***



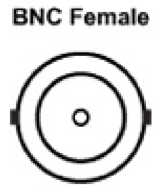

*TTL Input (0...+5 V)

**Modulation Input****




**Analog Control Input (-10 V ...10V)

**Control Output*****




***Analog Control Output (0 ...±10 V)

**Chassis Ground**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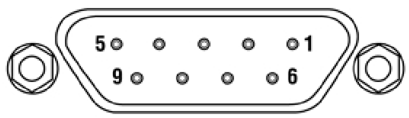
## TCLDM9 Laser Diode Mount

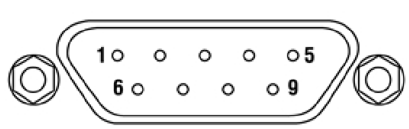
### LD Driver: D-Type Female




| Pin | Signal | Description |
|---|---|---|
| 1 | Interlock and Status Pin (LDC Specific) | LD Status Indicator and Interlock Circuits input. |
| 2 | Photodiode Cathode | This pin is connected to the 9 o'clock pin on the laser socket when the PD Polarity Switch is set to AG*. It is attached to ground and the 12 o'clock and 6 o'clock pins on the laser socket when the PD Polarity Switch is set to CG**. |
| 3 | Laser Ground (Case) | This pin is connected to the 12 o'clock and 6 o'clock pins on the laser socket and corresponds to the settings of the LD and PD polarity switches. i.e. If the LD and PD switches are set to AG then this pin grounds the Anodes of the laser and photo diodes. |
| 4 | Photodiode Anode | This pin is connected to the 9 o'clock pin on the laser socket when the PD Polarity Switch is set to CG. It is attached to ground and the 12 o'clock and 6 o'clock pins on the laser socket when the PD Polarity Switch is set to AG. |
| 5 | Interlock and Status Return | Status and Interlock circuitry return. |
| 6 | Laser Diode Voltage (Cathode) | This pin is connected to LD Interface Pin 7, thru a 499 Ω resistor, when the LD Polarity Switch is set to AG. It is attached directly to LD Interface Pin 3 when the LD Polarity Switch is set to CG. |
| 7 | Laser Diode Cathode | This pin is connected to the 3 o'clock pin on the laser socket when the LD Polarity Switch is set to AG . Otherwise it is floating. |
| 8 | Laser Diode Anode | This pin is connected to the 3 o'clock pin on the laser socket when the LD Polarity Switch is set to CG . Otherwise it is floating. |
| 9 | Laser Diode Voltage (Anode) | This pin is connected to LD Interface Pin 8, thru a 499 Ω resistor, when the LD Polarity Switch is set to CG. It is attached directly to LD Interface Pin 3 when the LD Polarity Switch is set to AG. |

*AG stands for Anode Ground
**CG stands for Cathode Ground

### TEC Controller: D-Type Male

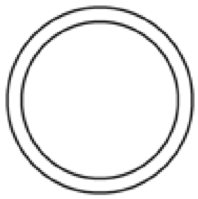



| Pin | Signal | Description |
|---|---|---|
| 1 | TEC Lockout (+) | This pin is connected to the anode of the photo-relay side of the TEC Lockout circuit. When using Thorlabs TEDs no external circuitry is required. To use these features with third-party controllers please refer to the Status and Interlock section of this manual. |

| | | |
|---|---|---|
| 2 | +Thermistor | The 10 kΩ at 25 °C NTC thermistor (provided for temperature feedback). |
| 3 | -Thermistor | The thermistor return pin. |
| 4 | +TEC | This pin is connected to the positive terminal of the TEC element. |
| 5 | -TEC and TEC Lockout (-) | This pin is connected to the negative terminal of the TEC element, and also is common to the cathode of the photo-relay of the TEC Lockout circuit - refer to the Status and Interlock section of this manual. |
| 6 | N.C. | Not Used. |
| 7 | AD592(-) | The negative terminal of the AD592 temperature transducer. When using Thorlabs TEDs no external circuitry is required. To use this device with third party controllers it must be properly biased. Refer to Analog Devices AD592 Data for application information. |
| 8 | N.C. | Not Used. |
| 9 | AD592(+) | The positive terminal of the AD592 |

**Optional Remote Interlock**

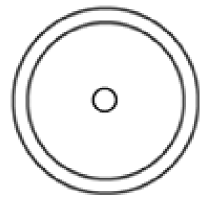
**2.5 mm Female Mono Phono Jack**



| Specifications | Value |
|---|---|
| Type of Mating Connector | 2.5 mm mono phono jack |
| Open Circuit Voltage | +5 VDC with respect to system ground (when used in conjunction with Thorlabs drivers) |
| Short Circuit Current | 10 mA DC Typical |
| Connector Polarity | Tip is positive, Barrel is ground |
| Interlock Switch Requirements | Must be N.O. dry contacts (under no circumstances should any external voltages be applied to the Interlock input) |

**RF Laser Modulation Input***

**SMA Female**



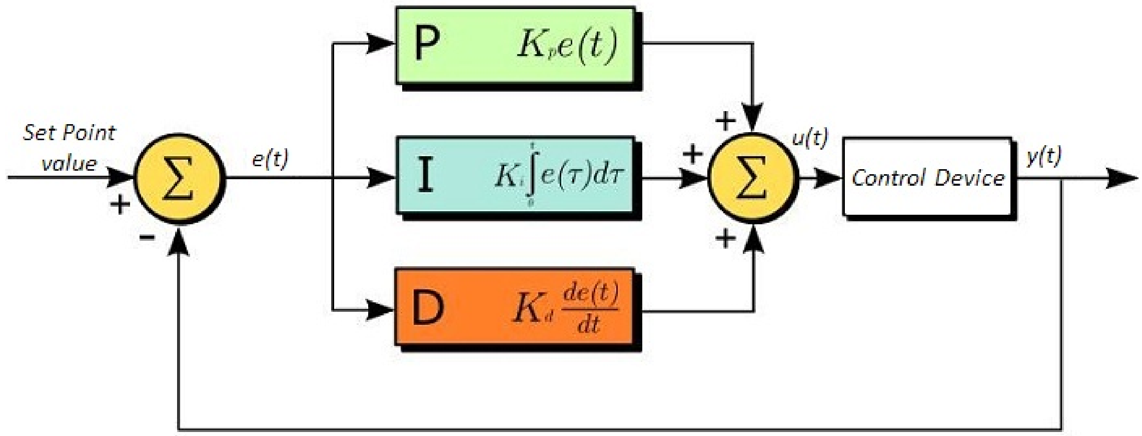
*RF input for modulation with an external source up to 500 MHz. This is a 50 Ω input that is AC-couples directly to the laser through a Bias-Tee network.

Hide PID Tutorial

PID TUTORIAL

## PID Basics

The PID circuit is often utilized as a control loop feedback controller and is very commonly used for many forms of servo circuits. The letters making up the acronym PID correspond to Proportional (P), Integral (I), and Derivative (D), which represents the three control settings of a PID circuit. The purpose of any servo circuit is to hold the system at a predetermined value (set point) for long periods of time. The PID circuit actively controls the system so as to hold it at the set point by generating an error signal that is essentially the difference between the set point and the current value. The three controls relate to the time-dependent error signal; at its simplest, this can be thought of as follows: Proportional is dependent upon the present error, Integral is dependent upon the accumulation of past error, and Derivative is the prediction of future error. The results of each of the controls are then fed into a weighted sum, which then adjusts the output of the circuit, u(t). This output is fed into a control device, its value is fed back into the circuit, and the process is allowed to actively stabilize the circuit's output to reach and hold at the set point value. The block diagram below illustrates very simply the action of a PID circuit. One or more of the controls can be utilized in any servo circuit depending on system demand and requirement (i.e., P, I, PI, PD, or PID).




Through proper setting of the controls in a PID circuit, relatively quick response with minimal overshoot (passing the set point value) and ringing (oscillation about the set point value) can be achieved. Let's take as an example a temperature servo, such as that for temperature stabilization of a laser diode. The PID circuit will ultimately servo the current to a Thermo Electric Cooler (TEC) (often times through control of the gate voltage on an FET). Under this example, the current is referred to as the Manipulated Variable (MV). A thermistor is used to monitor the temperature of the laser diode, and the voltage over the thermistor is used as the Process Variable (PV). The Set Point (SP) voltage is set to correspond to the desired temperature. The error signal, e(t), is then just the difference between the SP and PV. A PID controller will generate the error signal and then change the MV to reach the desired result. If, for instance, e(t) states that the laser diode is too hot, the circuit will allow more current to flow through the TEC (proportional control). Since proportional control is proportional to e(t), it may not cool the laser diode quickly enough. In that event, the circuit will further increase the amount of current through the TEC (integral control) by looking at the previous errors and adjusting the output in order to reach the desired value. As the SP is reached [e(t) approaches zero], the circuit will decrease the current through the TEC in anticipation of reaching the SP (derivative control).

Please note that a PID circuit will not guarantee optimal control. Improper setting of the PID controls can cause the circuit to oscillate significantly and lead to instability in control. It is up to the user to properly adjust the PID gains to ensure proper performance.

### PID Theory

The output of the PID control circuit, u(t), is given as

$$u(t) = MV(t) = K_p e(t) + K_i \int_0^t e(\tau)d\tau + K_d \frac{d}{dt} e(t)$$

where
$K_p$= Proportional Gain
$K_i$ = Integral Gain
$K_d$ = Derivative Gain
e(t) = SP - PV(t)

From here we can define the control units through their mathematical definition and discuss each in a little more detail. Proportional control is proportional to the error signal; as such, it is a direct response to the error signal generated by the circuit:

$$P = K_p e(t)$$

Larger proportional gain results is larger changes in response to the error, and thus affects the speed at which the controller can respond to changes in the system. While a high proportional gain can cause a circuit to respond swiftly, too high a value can cause oscillations about the SP value. Too low a value and the circuit cannot efficiently respond to changes in the system.

Integral control goes a step further than proportional gain, as it is proportional to not just the magnitude of the error signal but also the duration of the error.

$$I = K_i \int_0^t e(\tau)d\tau$$

Integral control is highly effective at increasing the response time of a circuit along with eliminating the steady-state error associated with purely proportional control. In essence integral control sums over the previous error, which was not corrected, and then multiplies that error by $K_i$ to produce the integral response. Thus, for even small sustained error, a large aggregated integral response can be realized. However, due to the fast response of integral control, high gain values can cause significant overshoot of the SP value and lead to oscillation and instability. Too low and the circuit will be significantly slower in responding to changes in the system.

Derivative control attempts to reduce the overshoot and ringing potential from proportional and integral control. It determines how quickly the circuit is changing over time (by looking at the derivative of the error signal) and multiplies it by $K_d$ to produce the derivative response.

$$D = K_d \frac{d}{dt} e(t)$$

Unlike proportional and integral control, derivative control will slow the response of the circuit. In doing so, it is able to partially compensate for the overshoot as well as damp out any oscillations caused by integral and proportional control. High gain values cause the circuit to respond very slowly and can leave one susceptible to noise and high frequency oscillation (as the circuit becomes too slow to respond quickly). Too low and the circuit is prone to overshooting the SP value. However, in some cases overshooting the SP value by any significant amount must be avoided and thus a higher derivative gain (along with lower proportional gain) can be used. The chart below explains the effects of increasing the gain of any one of the parameters independently.

| Parameter Increased | Rise Time | Overshoot | Settling Time | Steady-State Error | Stability |
|---|---|---|---|---|---|
| $K_p$ | Decrease | Increase | Small Change | Decrease | Degrade |
| $K_i$ | Decrease | Increase | Increase | Decrease Significantly | Degrade |
| $K_d$ | Minor Decrease | Minor Decrease | Minor Decrease | No Effect | Improve (for small $K_d$) |

## Tuning

In general the gains of P, I, and D will need to be adjusted by the user in order to best servo the system. While there is not a static set of rules for what the values should be for any specific system, following the general procedures should help in tuning a circuit to match one's system and environment. In general a PID circuit will typically overshoot the SP value slightly and then quickly damp out to reach the SP value.

Manual tuning of the gain settings is the simplest method for setting the PID controls. However, this procedure is done actively (the PID controller turned on and properly attached to the system) and requires some amount of experience to fully integrate. To tune your PID controller manually, first the integral and derivative gains are set to zero. Increase the proportional gain until you observe oscillation in the output. Your proportional gain should then be set to roughly half this value. After the proportional gain is set, increase the integral gain until any offset is corrected for on a time scale appropriate for your system. If you increase this gain too much, you will observe significant overshoot of the SP value and instability in the circuit. Once the integral gain is set, the derivative gain can then be increased. Derivative gain will reduce overshoot and damp the system quickly to the SP value. If you increase the derivative gain too much, you will see large overshoot (due to the circuit being too slow to respond). By playing with the gain settings, you can maximize the performance of your PID circuit, resulting in a circuit that quickly responds to changes in the system and effectively damps out oscillation about the SP value.

While manual tuning can be very effective at setting a PID circuit for your specific system, it does require some amount of experience and understanding of PID circuits and response. The Ziegler-Nichols method for PID tuning offers a bit more structured guide to setting PID values. Again, you'll want to set the integral and derivative gain to zero. Increase the proportional gain until the circuit starts to oscillate. We will call this gain level $K_u$. The oscillation will have a period of $P_u$. Gains are for various control circuits are then given below in the chart.

| Control Type | $K_p$ | $K_i$ | $K_d$ |
|---|---|---|---|
| P | 0.50 $K_u$ | - | - |
| PI | 0.45 $K_u$ | 1.2 $K_p/P_u$ | - |
| PID | 0.60 $K_u$ | 2 $K_p/P_u$ | $K_pP_u/8$ |

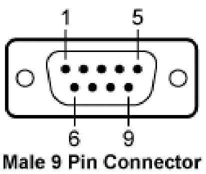
Hide Complete Laser Diode Operation Starter Set

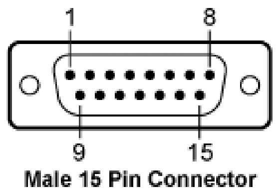
## Complete Laser Diode Operation Starter Set

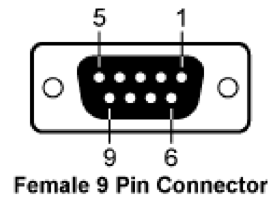
| Part Number | Description | Price | Availability |
|---|---|---|---|
| LTC100-A | Customer Inspired!Complete Laser Diode / Temperature Controller Set incl. Mount, Optic, & Accessories for 350-700 nm | $2,424.00 | Lead Time |
| LTC100-B | Complete Laser Diode / Temperature Controller Set incl. Mount, Optic, & Accessories for 600-1050 nm | $2,424.00 | 3-5 Days |
| LTC100-C | Complete Laser Diode / Temperature Controller Set incl. Mount, Optic, & Accessories 1050-1700 nm | $2,424.00 | Lead Time |

Hide Additional Connector Cables

## Additional Connector Cables

| Pin # | CAB 400 (9 Pin Male) |
|---|---|
| |   |
| 1 | Interlock and Status LASER ON/OFF |
| 2 | Photodiode Cathode |
| 3 | Laser Diode Ground |
| 4 | Photodiode Anode |
| 5 | Ground for Pin 1 |
| 6 | N.C. |
| 7 | Laser Diode Cathode (with Polarity Anode Grounded - AG) |
| 8 | Laser Diode Anode (with Polarity Cathode Grounded - CG) |
| 9 | N.C. |

| Pin # | CAB 420-15 (15 Pin Male) |
|---|---|
| |   |
| 1 | Status LED (+) (for TEC ON/OFF indication) |
| 2 | N.C. |
| 3 | Thermistor (-), Ground |
| 4 | Thermistor (+) |
| 5 | TEC (+) |
| 6 | TEC (+) |
| 7 | TEC (+) |
| 8 | LM 135/335 (-), Ground |
| 9 | N.C. |
| 10 | Transducer AD 590/592 (-), LM 135/335 (+) |
| 11 | Transducer AD 590/592 (+), LM 135/335 (+) |
| 12 | N.C. |
| 13 | TEC (-), Status LED (-) |
| 14 | TEC (-), Status LED (-) |
| 15 | TEC (-), Status LED (-) |

| CAB 420-15 (9 Pin Female) |
|---|
|   |
| Status LED (+) (for TEC ON/OFF indication) |
| Thermistor (+) |
| Thermistor (-), Ground |
| TEC (+) |
| TEC (-), Status LED (-) |
| N.C. |
| Transducer AD 590/592 (-), LM 135/335 (+) |
| LM 135/335 (-), Ground |
| Transducer AD 590/592 (+), LM 135/335 (+) |

| Part Number | Description | Price | Availability |
|---|---|---|---|
| CAB400 | Cable; Current Controller with 9-Pin D-Sub Connector, 1.5 m | $69.50 | Today |
| CAB420-15 | Temperature Controller Cable with 15-Pin D-Sub Connector, 1.5 m | $73.50 | Today |

Hide Mounting Flange for DPSS Laser Diode

## Mounting Flange for DPSS Laser Diode

The TCLDM9DJ mounting flange is used to secure a DPSS Laser Diode to the TCLDM9 laser diode temperature controlled mount. To use, remove the face plate of the TCLDM9 by removing the four corner-located 2-56 screws using a 5/64" hex driver. Remove the flange, either the one that comes already installed in the mount or one that has been installed later, by removing the two 2-56 x 3/8" cap screws and firmly pulling the flange out. Mount either the DJ532-10 or the DJ532-40 laser diode. Using the two 2-56 x 3/8" cap head screws provided with the flange, or with the mount itself, attach the flange to the mount. Replace the face plate, and the mount is ready for use (see photo to the right).

Click to Enlarge

Please Note: This flange does not come with the TCLDM9 Temperature Controlled Laser Diode Mount.

| Part Number | Description | Price | Availability |
|---|---|---|---|
| TCLDM9DJ | Customer Inspired!DPSS Laser Mounting Flange for TCLDM9 Laser Diode Mount | $20.40 | Today |