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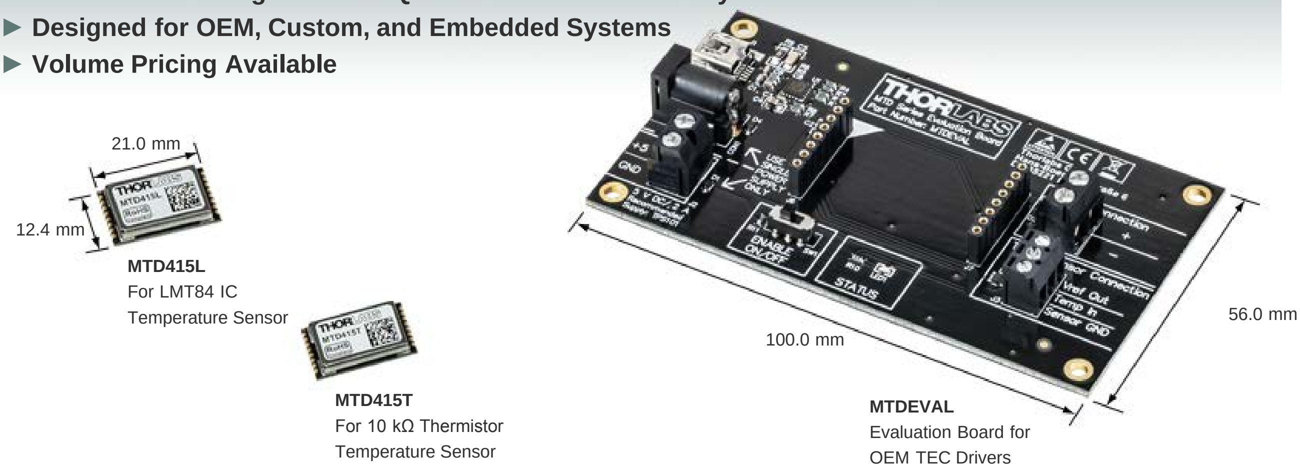
THORLABS

MTDEVAL - June 1, 2017

Item # MTDEVAL was discontinued on June 1, 2017. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

OEM TEMPERATURE CONTROLLERS IN SMT PACKAGES

- ▶ **Compact, Highly Integrated TEC Drivers**
- ▶ **16-Pin SMT Package Enables Quick Automated Assembly**
- ▶ **Designed for OEM, Custom, and Embedded Systems**
- ▶ **Volume Pricing Available**



Hide Overview

OVERVIEW

Features

- Up to ±1.5 A TEC Current
- High-Speed, Ultra-Stable PID Loop
- Very Low Output Current Noise: <10 mA
- Compact 21.0 mm x 12.4 mm x 3.1 mm Package Aids System Integration
- Ideal for Small Assemblies that Use Thermoelectric Coolers
- Units can be Controlled via a PC
  - Accepts Serial Commands Entered through a Command Line Interface
  - GUI to Adjust Settings and Monitor Driver Performance (See *Software* Tab)
- Evaluation Board Available for Test Applications
- Active Cooling and Temperature Stabilization for
  - Laser Modules and Diodes
  - WDM and DWDM Laser Diodes
  - EDFA Optical Amplifiers
  - Photodetectors and Photodiodes
  - ATE

Item #	MTD415L(E)	MTD415T(E)
Key Features[a]	Supports LMT84 IC Temperature Sensor	Supports 10 kΩ Thermistor Temperature Sensor
Output Current	Up to ±1.5 A (See Graphs on *Specs* Tab)	
Noise and Ripple (Typical)	<10 mA (TEC Element with 4 Ω Resistance)	
TEC Compliance Voltage	4.0 V	
Maximum Output Power	Up to 6.0 W (See Graphs on *Specs* Tab)	
Power Dissipation	1.5 W	
Data Sheet (Click for PDF)	PDF	PDF

- See the *Specs* and *Pin Diagram* tabs above for additional information.

Volume Pricing and OEM Support

Contact Us

Thorlabs' production facilities are capable of manufacturing TEC controllers in high volumes, and we pass the savings associated with planned production on to our customers. To learn more, please contact our OEM team. An OEM specialist will contact you within 24 hours or the next business day.

These OEM-grade TEC drivers are surface-mount devices (SMDs) that regulate the current through a thermoelectric cooler (TEC) to provide stable temperature control. They can provide a maximum operating current of ±1.5 A and support a maximum compliance voltage of 4 V (see the table to the right). Each driver is contained within a 16-pin surface-mount technology (SMT) package that uses a 5 V supply voltage for operation. The compact 21.0 mm × 12.4 mm × 3.1 mm form factor uses plated half-hole connectors to allow easy surface mounting and electrical connections.

Each chip features an on-chip power stage that supplies a ±1.5 A output to drive a TEC. The power supply provides true bipolar operation, allowing the current to reach zero current; this ensures temperature control without "dead zones" or other nonlinearities at low TEC current values. The complete on-chip power stage and thermal control loop circuitry are designed to

Click to Enlarge
Application Example
MTD415L TEC drivers are used for temperature regulation in Thorlabs' Nanosecond Pulsed Laser Systems, as shown in this

require low thermal dissipation, minimizing the need for external components such as a heat sink. The output current is directly controlled to eliminate current surges to the TEC, while an adjustable TEC current limit provides protection against overdriving the cooler.

cutaway view of the NPL64A.

These drivers use a UART digital control interface that allows quick access to PID settings, all other system parameters, and digital measurement data, enabling easy integration into a variety of systems. They can be controlled by a PC using a UART-to-USB adapter, at which point they can be programmed through a command line interface. See Chapter 6 of the Data Sheet for each item (linked to in the table above) for details.

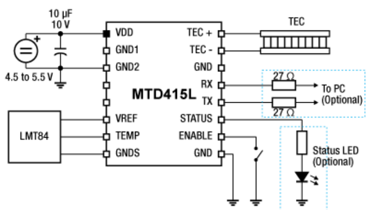
Evaluation Board

For customers interested in testing the performance characteristics of our drivers, we offer an evaluation board. As the TEC driver parameters are set using a UART interface, the evaluation board incorporates a UART-to-USB adapter that allows the board to be controlled through a USB 2.0 connection to a PC. This allows the unit to be controlled through the command line following the programming reference in the TEC driver data sheets or using Thorlabs' MTD GUI for Windows® operating systems, available on the *Software* tab. Two screw terminals near the edge of the board accept wires from a temperature sensor and TEC module. Each of our drivers is available pre-mounted on a daughterboard that converts the 16-pin SMT layout of the driver to the mating sockets on the evaluation board.

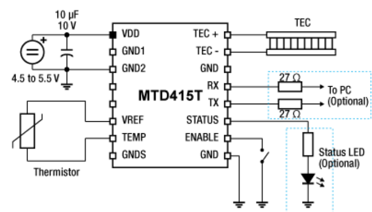
Computer Control

The TEC drivers available below can be controlled by a PC using either the programming commands outlined in the TEC driver data sheets or a GUI for Windows® operating systems (see the *Software* tab). This GUI provides a simple means of optimizing the TEC driver settings to a specific thermal load, as well as graphical output that tracks the TEC performance. See the *PID Oscillation Test* tab for an example of how to set the PID parameters using the GUI.

Typical Applications



Sample External Circuit for MTD415L TEC Driver

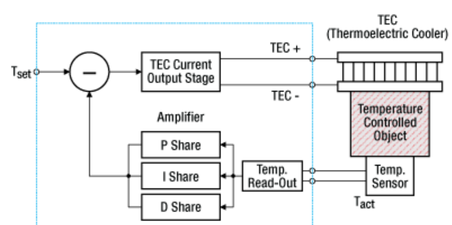


Sample External Circuit for MTD415T TEC Driver

[Hide Specs]

SPECS

Basic TEC Driver Operating Principle



TEC Driver Integrated into a Circuit with a TEC and Temperature Sensor

Maximum and Recommended Ratings (All Drivers)

Absolute Maximum Ratings		
Supply Input Voltage		4.5 V to 6 V
Supply Input Current		1.6 A
TEC Output Current		-1.5 A to +1.5 A
TEC Compliance Voltage		4.0 V
Maximum Output Power		6.0 W
Power Dissipation		1.5 W
Pin Voltage Range[a] (With Respect to Ground Terminal)	**VDD**	-0.3 V to +6 V
	ENABLE, RX, TEC-, TEC+	-0.3 V to (VDD + 0.3 V)
	TEMP	-0.3 V to +3.3 V
Maximum Output Current (STATUS, TX)		10 mA

Maximum Input Current (ENABLE, RX)	10 mA
Operating Temperature	-40 °C to 70 °C

a. See the *Pin Diagrams* tab for pin assignments.

The above specifications are given for the free-air operating temperature range unless otherwise noted. Operating these drivers outside of the maximum rated conditions listed above may affect product reliability and/or cause permanent damage to the product. These are stress ratings only; functional operation at these or any other conditions beyond the specifications listed below is not implied.

Evaluation Board

Specifications	
Supply Input Voltage	5 VDC ± 5%
Supply Input Current	1.6 A (Min) 2 A (Recommended)
USB Connection	USB Mini B
Operating Temperature Range	0 °C to 40 °C
Storage Temperature Range	-40 °C to 70 °C
Dimensions	100.0 mm x 56.0 mm x 16.8 mm (3.94" x 2.20" x 0.66")
Weight	0.04 kg

All technical data are valid at 23 ± 5 °C and 45 ± 15% relative humidity (non condensing).

Recommended Operating Conditions	
Supply Voltage	4.5 V to 5.5 V
Operating Temperature	-20 °C to 60 °C

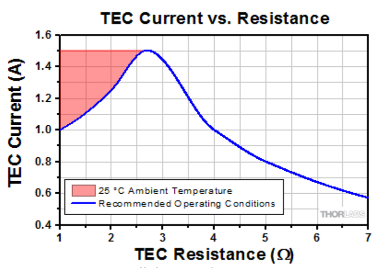
TEC Drivers

Item #	MTD415L(E)	MTD415T(E)	Notes
TEC Current Output			
Maximum Output Current	Up to ±1.5 A (See Graphs Below)		See the *Pin Diagrams* Tab
TEC Compliance Voltage	4.0 V		-
Maximum Output Power	Up to 6.0 W		-
Measurement Resolution	3 mA (Typical) / 8 mA (Max)		-
Measurement Accuracy	±50 mA		-
Noise and Ripple (Typical)	<10 mA		Measured with a TEC element with an equivalent resistance of 4 Ω.
TEC Current Limit			
Setting Range	0 to 1.5 A		-
Setting Resolution	1 mA		-
Setting Accuracy	±50 mA		-
Temperature Sensor			
Supported Sensor	LMT84 IC Sensor or Similar	10 kΩ Thermistor	For MTD415T, thermistor resistance given at 25 °C. Thermistor resistance measurement range should be 4.2 to 29 kΩ.
Maximum Temperature Control Range	+5 °C to +45 °C		Control range and thermal stability depend on IC or thermistor temperature sensor parameters.
Temperature Setting Resolution	1 mK		-
Temperature Measurement Resolution	2 mK (Typical) / 10 mK (Max)		Maximum measurement resolution depends on cycle time settings.
Absolute Temperature Accuracy	±0.5 °C		Control range and thermal stability depend on IC or thermistor temperature sensor parameters.
Temperature Stability over 8 Hours (Typical)	Better than 20 mK		-
Temperature Coefficient	<20 mK/°C		-
Programming Interface			
Type	UART		-
Voltage Level	3.3 V Logic Level; Input 5 V Tolerant		-
Data Rate	115,200 bps; 8 Data Bits, 1 Stop Bit		-

General Data		
Safety Features	TEC Current Limit Sensor Fault Protection TEC Open Circuit Protection Temperature Setpoint Limit Temperature Window Protection Delay Over Temperature Protection	-
Operating Temperature	-20 °C to 60 °C	Non-Condensing
Storage Temperature	-40 °C to 100 °C	Non-Condensing
Warm-Up Time for Rated Accuracy	10 Minutes	-
Dimensions of SMT Package (W x H x D)	21.0 mm x 12.4 mm x 3.1 mm (0.83" x 0.49" x 0.12")	-
Dimensions of Daughterboard with SMT Package (W x H x D)	39.6 mm x 21.5 mm x 14.1 mm (1.56" x 0.85" x 0.55")	MTD415LE and MTD415TE Only
Approximate Weight	2 g	-

All technical data are valid at 23 ± 5 °C and 45 ± 15% relative humidity (non-condensing).

TEC Driver Typical Output Characteristics



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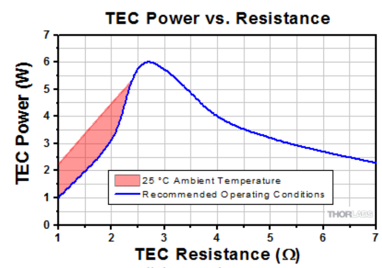
The maximum TEC current of 1.5 A can be delivered into a load resistance of 2.66 Ω under the recommended operating conditions. At a higher load resistance, the maximum output current drops due to the limit of the compliance voltage. The maximum output current at lower than 2.66 Ω load resistance (shaded range) depends on environmental conditions.



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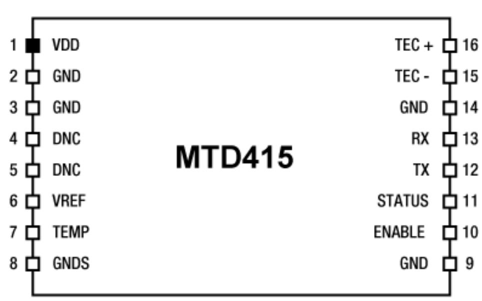
The maximum output power of 6 W can be delivered into a load resistance of 2.66 Ω under the recommended operating conditions. The maximum output power at lower than 2.66 Ω load resistance (shaded range) depends on environmental conditions.

Hide Pin Diagrams

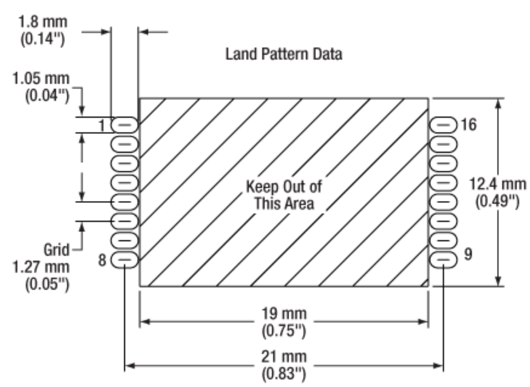
PIN DIAGRAMS

Pin Layout



These pin assignments correspond to viewing the driver from the top when the engraving on the driver is right-side up.

Land Pattern Data



MTD415L(E) TEC Driver		
Pin	**Name**	**Description**
1	VDD	Supply Voltage Input (+4.5 V to +5.5 V)
2	GND	Supply Voltage Ground
3	GND	Supply Voltage Ground
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	VREF	Reference Output Voltage for LMT84 Temperature Sensor (1.8 V)
7	TEMP	LMT84 Temperature Sensor Input
8	GNDS	Temperature Sensor Ground This ground connection should be wired separately and not be shared with other Ground pins.
9	GND	Supply Voltage Ground
10	ENABLE	Enable Signal Input (Low-Active) Low = Enabled, High = Disabled Can be Connected Directly to GND
11	STATUS	Status Signal Output (Can be Left Floating) High = Temperature within Defined Temperature Window Low = Temperature outside Programmed Temperature Window or an Error Occurred
12	TX	Digital Interface Transmit Signal
13	RX	Digital Interface Receive Signal
14	GND	Supply Voltage Ground
15	TEC -	TEC Element Negative Connection
16	TEC +	TEC Element Positive Connection

MTD415T(E) TEC Driver		
Pin	**Name**	**Description**
1	VDD	Supply Voltage Input (+4.5 V to +5.5 V)
2	GND	Supply Voltage Ground
3	GND	Supply Voltage Ground
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	VREF	Reference Output Voltage for Thermistor Temperature Sensor (1.8 V)
7	TEMP	Thermistor Temperature Sensor Input
8	GNDS	Temperature Sensor Ground Can be used for Shielding Purposes or Left Open
9	GND	Supply Voltage Ground
10	ENABLE	Enable Signal Input (Low-Active) Low = Enabled, High = Disabled Can be Connected Directly to GND
11	STATUS	Status Signal Output (Can be Left Floating) High = Temperature within Defined Temperature Window, Low = Temperature Outside Programmed Temperature Window or an Error Occurred
12	TX	Digital Interface Transmit Signal
13	RX	Digital Interface Receive Signal
14	GND	Supply Voltage Ground

15	TEC -	TEC Element Negative Connection
16	TEC +	TEC Element Positive Connection

Hide Software

SOFTWARE

GUI and Drivers for OEM Temperature Controllers and Evaluation Board

The download button below provides a link to the GUI and drivers that allow these TEC drivers to be controlled via a PC with a Windows® operating system. The software can be used to perform an oscillation test and can automatically calculate the optimal P, I, and D parameters for a setup using the results. For details on the oscillation test procedure and an introduction to PID circuits, see the *PID Oscillation Test* tab.

Click to Enlarge
The OEM Temperature Controller GUI Interface

Software

Version 1.1

This is a software package with a GUI and drivers for Thorlabs' OEM TEC drivers in SMT packages.

Software

Hide PID Oscillation Test

PID OSCILLATION TEST

Oscillation Test to Set PID Parameters

Each MTD415 module incorporates a digital PID controller. The P, I, and D shares can be programmed manually or calculated automatically by the firmware by entering the results of a loop oscillation test. This test can be performed using the GUI available on the *Software* tab, and provides a convenient method for optimizing the PID parameters.

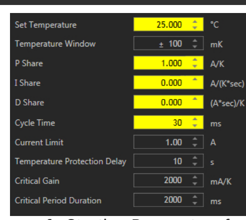


Figure 1: Starting Parameters for the Oscillation Test

Oscillation Test Starting Parameters	
Set Temperature	25.000 °C
P Share	1000 mA/K
I Share	0 A/Ks
D Share	0 As/K
Cycle Time	30 ms

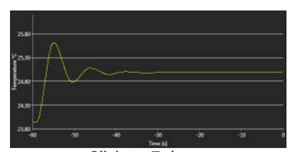


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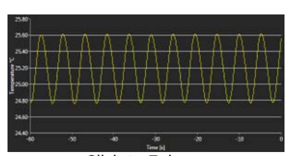
Figure 2: Initial Settling Behavior after TEC is Enabled

Before running the test, the following preconditions must be met:

- TEC Current Limit is Set to 1 A
- All Connections are Made Properly
- Temperature Window Settings in the GUI's Software Settings
  - Set the Temperature Window to ±100 mK
  - Display only the Actual Temperature
  - Set the X-Axis of the Temperature Graph to a Max Time of 60 s

First, enter the PID loop settings shown in the table to the upper right. These initial settings allow the user to observe the temperature settling process, as typically no oscillations will appear when the driver is operated with these settings. Then, enable the TEC. The actual temperature, measured by the unit and recorded on the graph in the GUI, will approximate the set value.

The critical P share (critical gain) is the value at which the system starts to oscillate for a minimum of 20 cycles without a drop in amplitude as a reaction to a change in the temperature setpoint. The procedure for the oscillation loop test used to find the critical P share is described as follows: with I and D set at zero, the P share value is set high enough that the loop oscillates without damping. Then, smaller P share values are tested until the oscillations are damped. The P share is increased again by a smaller amount until the loop begins to oscillate continuously again, and then decreased to find the threshold where the oscillations become damped again. After each change in the P share value, the temperature setpoint must be changed slightly to trigger the loop with the new P share setting. The process is repeated until the minimum P share value for the loop to oscillate without damping is found; this is the critical P share value.



Click to Enlarge
Figure 3: P Share = 10,000 mA/K

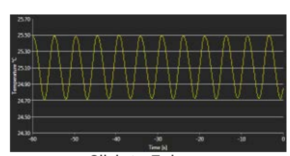


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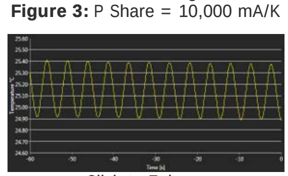
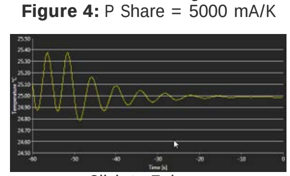
Figure 4: P Share = 5000 mA/K

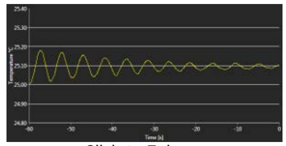


Click to Enlarge
Figure 5: P Share = 3000 mA/K



Click to Enlarge
Figure 6: P Share = 2000 mA/K

The following example illustrates how the oscillation loop test procedure is carried out. For this case, a passive thermal load consisting of a 60 mm x 60 mm x 25 mm radiator was connected to a TEC and a temperature sensor.



Click to Enlarge
Figure 7: P Share = 2600 mA/K

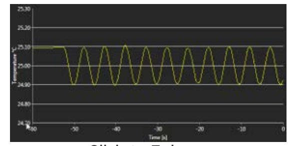


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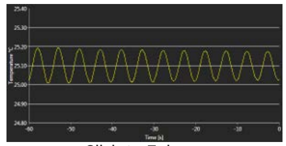
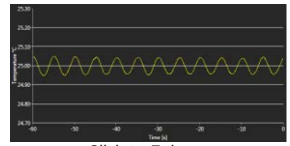
Figure 8: P Share = 2800 mA/K



Click to Enlarge
Figure 9: P Share = 2700 mA/K



Click to Enlarge
Figure 10: P Share = 2650 mA/K

1. After entering the initial settings and enabling the TEC (Figure 1), the temperature begins to settle (Figure 2).
2. The P share is set to 10,000 mA/K, since this value is high enough that it will trigger the loop to oscillate for almost any thermal load. Then, the set temperature is increased by 0.1 K to 25.1 °C. The loop begins to show strong oscillations (Figure 3).
3. The P share is lowered to 5000 mA/K and the set temperature is decreased to 25.0 °C again. The loop continues to oscillate (Figure 4).
4. The P share is lowered again to 3000 mA/K and the set temperature increased to 25.1 °C. The loop continues to oscillate (Figure 5).
5. The P share is lowered to 2000 mA/K and the set temperature is decreased to 25.0 °C. The oscillations are now damped (Figure 6).
6. The P share is increased to 2600 mA/K and the set temperature to 25.1 °C. The oscillations are still damped (Figure 7).
7. The P share is increased again to 2800 mA/K and the set temperature decreased to 25.0 °C. The loop begins to oscillate again (Figure 8).
8. The P share is lowered to 2700 mA/K and the set temperature increased to 25.1 °C. The loop continues to oscillate (Figure 9).
9. The P share is lowered to 2650 mA/K and the set temperature decreased to 25.0 °C. The loop still oscillates (Figure 10).
10. At this point, we know that at 2600 mA/K, the oscillations were damped (step 6), so 2650 mA/K is the lowest P share value for which the loop will oscillate continuously. This value will be used for the critical gain.
11. Use the diagram from step 9 (Figure 10) to calculate the critical period (i.e., the time of one oscillation). Count the number of oscillations across the 60 s observation window and divide 60 by this number. In this case, there are 11.8 periods, so each period has a duration of approximately 5.085 s.
12. Enter the critical gain (step 10) and critical period duration (step 11) into the GUI (Figure 11). Press enter to trigger the calculation of the PID shared and cycle time by the firmware. The calculated loop parameters will be displayed immediately (Figure 12).

Typically, the PID optimization for settling behavior is finished at this point. If required, the PID values and the cycle time can be manually fine-tuned in order to optimize the loop response to changes of the thermal load.

Saving the PID Parameters for Later Use
These TEC drivers are designed with a temporary volatile memory and a non-volatile flash memory. As the flash memory has a limited number of erase-write cycles, parameters entered into the GUI will be saved in the volatile memory only, unless otherwise directed by the user. This means that these parameters will be immediately applied to the driver operation, but will not be saved when the unit is powered down. All parameters can be saved to both the non-volatile flash memory and volatile memory by pressing the Save Settings in MTD Flash button in the GUI; parameters saved to the non-volatile memory will be applied the next time that the unit is powered on.

Alternatively, the PID parameters can be saved to the computer running the GUI. The next time that the GUI is used to operate the TEC driver, the saved parameters can be loaded into the GUI and will automatically populate all of the fields; the user can then select whether to save these parameters to the volatile memory only (meaning that the driver will immediately use the parameters), or to save the parameters to both the volatile and non-volatile memory.

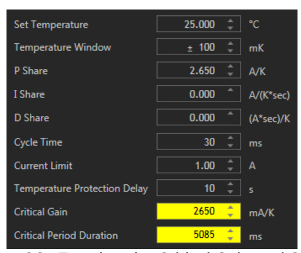


Figure 11: Entering the Critical Gain and Critical Period Duration

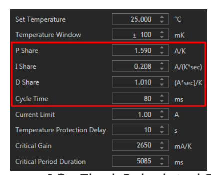


Figure 12: Final Calculated PID Parameters

Notes
The cycling time is the time basis of the internal digital control loop and is calculated automatically by entering the critical gain and the critical oscillation period. If the cycling time is manually reset, the firmware recalculates the I and the D shares.

The optimized PID parameters are valid for a steady state that is dependent on the set temperature as well as on the ambient conditions (ambient temperature, temperature of the thermally controlled object). Any changes in the operating and/or environmental conditions may require a re-adjustment of the PID parameters.

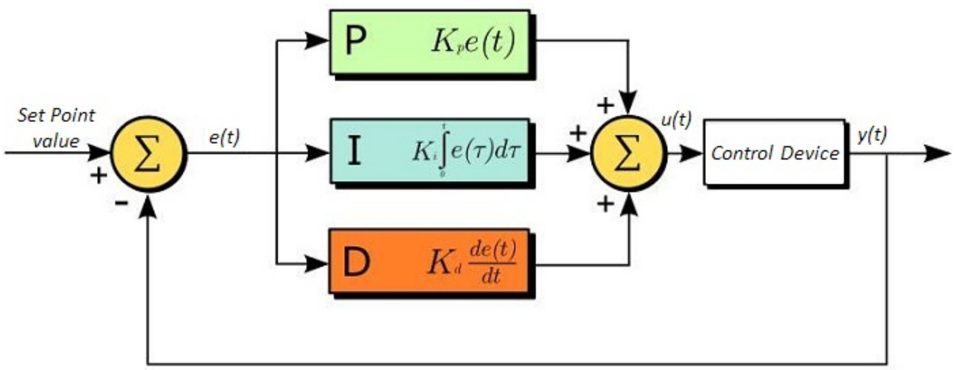
For more information on the basics of PID circuits, see the *PID Tutorial* tab.

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 TEC Drivers for OEMs

TEC Drivers for OEMs

- TEC Drivers in 16-Pin SMT Packages
- MTD415L: Designed for LMT84 Temperature Sensor
- MTD415T: Designed for 10 kΩ Thermistor

Volume pricing is available for these TEC drivers. To view our current price schedules, please click the "Volume Pricing" links located below.

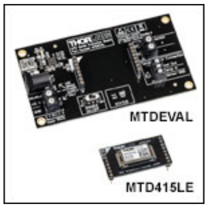
Drivers compatible with the sockets on the MTDEVAL Evaluation Board are sold separately below.

Click to Enlarge
Upon request, large-quantity orders of our drivers can be delivered in an IC tube for simplified integration with assembly equipment.

Part Number	Description	Price	Availability
MTD415L	TEC Driver, SMT Package, Compatible with LMT84 Temperature Sensor	$26.75 Volume Pricing Available	Today
MTD415T	TEC Driver, SMT Package, Compatible with 10 kΩ Thermistor	$26.75 Volume Pricing Available	Today

Hide Evaluation Board and TEC Drivers for Evaluation Board

Evaluation Board and TEC Drivers for Evaluation Board



- Evaluation Board for Test Applications with MTD415xE TEC Drivers
  - USB Connector for Control via GUI (See *Software* Tab)
  - 2.1 mm Jack and Screw Terminal for 5 VDC, 2 A Power Supply (Only Use One)
  - Screw Terminals for TEC and Temperature Sensor Connections
- TEC Drivers Designed to Mount onto Evaluation Board

Click for Details
Top View and Functional Elements of MTDEVAL Evaluation Board
The MTDEVAL is configured with two power input options: a screw terminal and a 2.1 mm jack. Do not use both power inputs at the same time.

Click to Enlarge
Evaluation Board with MTD415TE Driver Installed

Evaluation Board
The MTDEVAL Evaluation Board is a break-out board that interfaces our OEM-grade TEC drivers with several common connectors. The board includes a USB Mini B connector that allows the unit to be controlled by a PC, as well as screw terminals to wire the unit directly to a temperature sensor and a TEC. To operate the MTDEVAL, it must be connected to a PC with a USB 2.0 cable, such as the USB-AB-72 available below.

When connected to a computer, the settings of the TEC driver can be changed using either the text commands outlined in the data sheet for each driver or through the MTD GUI available on the *Software* tab. In additional to allowing users to manually set the parameters of the control loop, the GUI can calculate the optimal P, I, and D parameters using the results of an oscillation test (see the *PID Oscillation Test* tab for details). Be sure to install the driver software before connecting the MTDEVAL to a PC; installing the driver software after connection can cause errors in the installation.

The board includes a 2.1 mm jack and a screw terminal, either of which accepts a 5 VDC power supply that can provide at least 2 A of current. In addition to a power connection, a USB cable (such as the USB-AB-72 available separately below) is required to operate the MTDEVAL.

The board's overall dimensions are 100.0 mm × 56.0 mm × 16.8 mm. Four Ø3.2 mm through holes are located at the corners for use in custom mounting.

TEC Drivers for use with Evaluation Board
Our OEM-grade TEC drivers contain plated half-hole connectors that are intended for installation by automated assembly systems. For ease of installation with the MTDEVAL evaluation board, each driver is available pre-mounted on a daughterboard. This daughterboard is installed by inserting it into mating sockets on the evaluation board, allowing these drivers to be quickly deployed in laboratory and test environments.

Prior to installing the driver, the SW1 (ENABLE ON/OFF) switch must be set to the off position to avoid damaging the driver upon installation.

Part Number	Description	Price	Availability
MTDEVAL	Evaluation Board for MTD415xE TEC Drivers	$123.00	Lead Time
MTD415LE	TEC Driver, on Daughterboard, Compatible with LMT84 Temperature Sensor	$31.75	Today
MTD415TE	TEC Driver, on Daughterboard, Compatible with 10 kΩ Thermistor	$31.75	3-5 Days
USB-AB-72	USB 2.0 Type-A to Mini-B Cable, 72" (1.83 m) Long	$8.20	Today