Data Sheet
Miniature Temperature Controller MTD415L

Features

- Small, safe and very high accuracy complete single-module controller
- High speed, ultra stable digital PID Loop
- Up to ± 1.5 A TEC current
- Very low output current noise
- Very small footprint (21.0 x 12.4 mm)
- Circuit Height 3.1 mm
- Supports LMT84 IC or similar temperature sensor
- Single power supply operation
- Multiple safety features
- Digital controllable via UART interface

Applications

- Active cooling and temperature stabilization for a wide range of laser modules and diodes
- WDM, DWDM Laser-Diode Temperature Control
- EDFA Optical Amplifiers
- Temperature stabilization of photo detectors and photodiodes
- ATE

Short Description and Typical Application Circuit

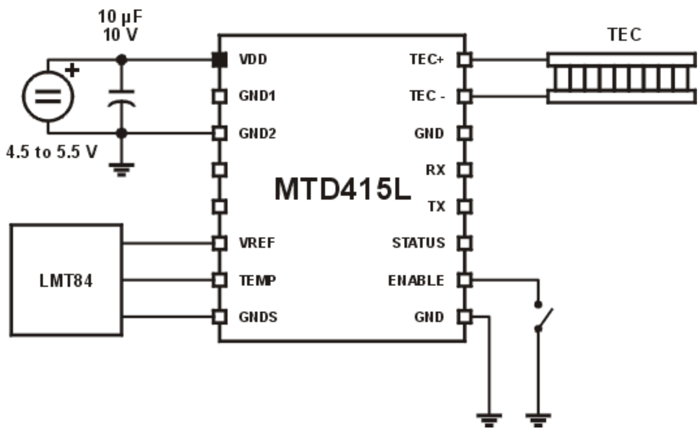
The MTD415L is a compact and highly integrated temperature controller optimized for use in high performance thermoelectric temperature control applications.

The on-chip power stage and the thermal control loop circuitry minimize external components while maintaining high efficiency.

The output current is directly controlled to eliminate current surges. An adjustable TEC current limit provides the highest level of TEC protection.

The MTD415L is operated from a single power supply and provides a bipolar ±1.5 A output by connecting the TEC to the output of a bipolar power stage. True bipolar operation ensures temperature control without "dead zones" or other nonlinearities at low TEC current values.

The digital control interface allows quick access to all system parameters as well as to digital measurement data, this way enabling a simple integration into different systems.



Revision History

Revision	Changes with respect to previous revision
1.0	Initial Release
1.1	Programmers Reference: Command Description: Several value ranges corrected • Wx Range: 1 to 32000 • dx Range: 1 to 3200 Factory Default Settings: Parameter d changed: 6 sec Error Register and Safety Bitmask: Value Sx range: 0 to 255 PID Tutorial updated
1.2	• Polarity of TEC connection. Please see the section "Pin Configuration and Functions" • Section Electrical Characteristics: Noise and Ripple (typ.): changed from < 10mA to 150 mA (PeakPeak) or 87 mA RMS • Section Electrical Characteristics: Temperature Stability: short term: 100 mK • Section Tec Commands "Lx": Value range x: 200 to 1500 [mA]

Contents

1 Pin Configuration and Functions

MTD415L Pin Configuration

Pin	Name	Description
1	VDD	**Supply Voltage Input** Connect a + 4.5 V to 5.5 V power supply to VDD.
2	GND	**Supply Voltage Ground** Connect the power supply ground connections to GND.
3	GND	**Supply Voltage Ground** Connect the power supply ground connections to GND.
4	DNC	**Do Not Connect** Do not connect this pin to any signal or potential. This pin is used for manufacturing and test purposes.
5	DNC	**Do Not Connect** Do not connect this pin to any signal or potential. This pin is used for manufacturing and test purposes.
6	VREF	**Reference Output Voltage for LMT84 Temperature Sensor** Connect this reference voltage output (1.8 V) to the LMT84 temperature sensor supply pin.
7	TEMP	**LMT84 Temperature Sensor Input** Connect this pin to the voltage output pin of the LMT84 temperature sensor.
8	GNDS	**Temperature Sensor Ground** Connect this pin to the LMT84 temperature sensor ground. This ground connection should be wired separately and not be shared with other Ground pins.
9	GND	**Supply Voltage Ground** Connect the power supply ground connections to GND.
10	ENABLE	**Enable Signal Input (Low-Active)** Enable Input (Low = enabled, High = Disabled), can be connected directly to GND.
11	STATUS	**Status Signal Output (Can be left floating)** Status Signal (High = temperature within defined temperature window, Low = Temperature outside programmed temperature window or an error occurred).

Pin	Name	Description
12	TX	**Digital Interface Transmit Signal** UART Transmit Asynchronous Data Output. Connect this pin to the RX pin of your application.
13	RX	**Digital Interface Receive Signal** UART Transmit Asynchronous Data Input. Connect this pin to the TX pin of your application.
14	GND	**Supply Voltage Ground** Connect the power supply ground connections to GND.
15	TEC -	**TEC Element negative connection** Connect this pin to the **positive** terminal of the TEC element. [1])
16	TEC +	**TEC Element positive connection** Connect this pin to the **negative** terminal of the TEC element. [1])

[1]) Please remember that the TEC element has a (+) and a (-) terminal corresponding to the cold and hot side of the TEC element respectively. Please ensure to mount the TEC element cold side to the device of interest and connect the negative MTD415 pin (15) to the positive TEC terminal and the positive MTD415 pin (16) to the negative TEC terminal.

2 Technical Data

2.1 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 [1]) VDD ENABLE, RX, TEC-, TEC+ TEMP	 -0.3 V to 6 V -0.3 V to (VDD + 0.3 V) -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

[1]) All voltages with respect to network ground terminal.

Notes

(1) Above specifications are given for the free-air operating temperature range unless otherwise noted.

(2) Stresses beyond those listed above may cause permanent damage to the product. These are stress ratings only; functional operation of the MTD415L at these or any other conditions beyond those indicated under *Recommended Operating Conditions* and *Electrical Characteristics* is not implied.

(3) Operation beyond the maximum rated conditions for extended periods may affect product reliability.

2.2 Recommended Operating Conditions

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

2.3 Electrical Characteristics

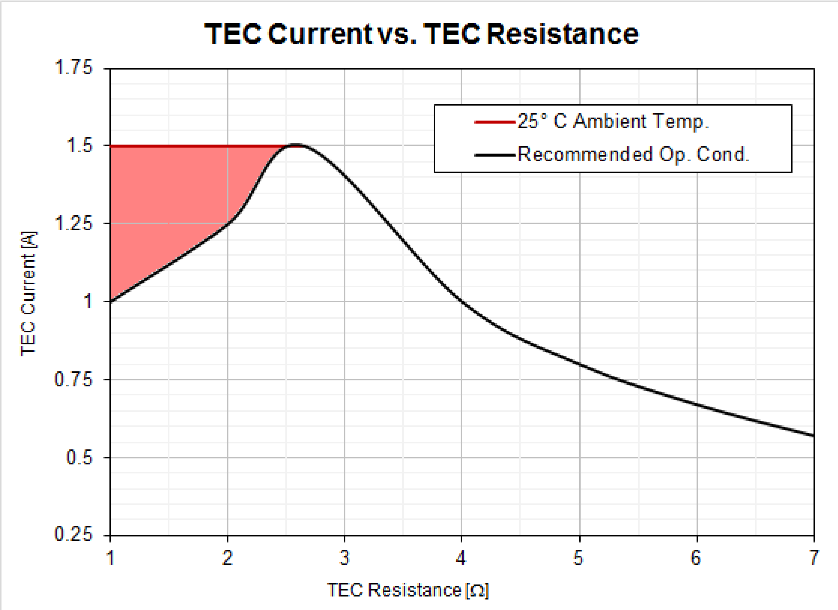
TEC Current Output	
Output Current	up to ±1.5 A into 2.66 Ω TEC - see diagram on page.
Compliance Voltage	4.0 V
Output Power	up to 6.0 W
Measurement Resolution	better than 8 mA, typ. 3 mA
Measurement Accuracy	± 50 mA
Noise and Ripple (typ.)	150 mA (PeakPeak) or 87 mA RMS
TEC Current Limit	
Setting Range	0 to 1.5 A
Setting Resolution	1 mA
Setting Accuracy	± 50 mA
Temperature Sensor	
Supported Sensor	IC Sensor LMT84 or similar
Maximum Temperature Control Range [1])	+ 5 °C to + 45 °C
Temperature Setting Resolution	1 mK
Temperature Measurement Resolution [2])	better than 10 mK; typ. 2 mK
Absolute Temperature Accuracy [1])	± 0.5 °C
Temperature Stability, typ.[3])	100 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 [4])
Storage Temperature	-40 °C to +100 °C [4])
Warm-Up Time for Rated Accuracy	10 min
Dimensions (W x H x D)	21 x 12.4 x 3.1 mm³
Approx. Weight	2 g

[1]) Control range and thermal stability depend on temperature sensor IC parameters.
[2]) Maximum measurement resolution depends on cycle time settings. Please refer to Programmers Reference.

[3]) Better temperature stability can be achieved with optimization. Please contact OEM sales.
[4]) non-condensing

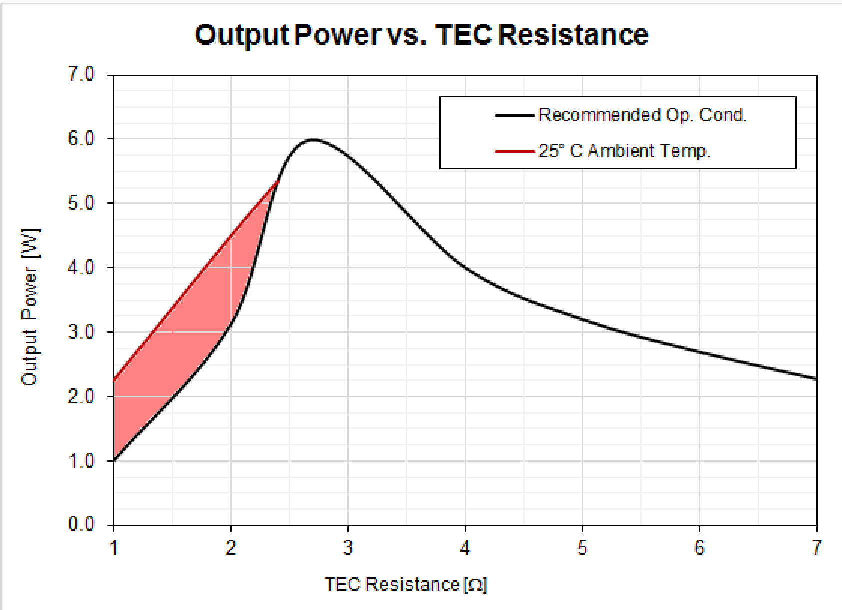
All technical data are valid at 23 ±5 °C and 45 ±15% rel. humidity (non condensing)

3 Typical Output Characteristics



Notes

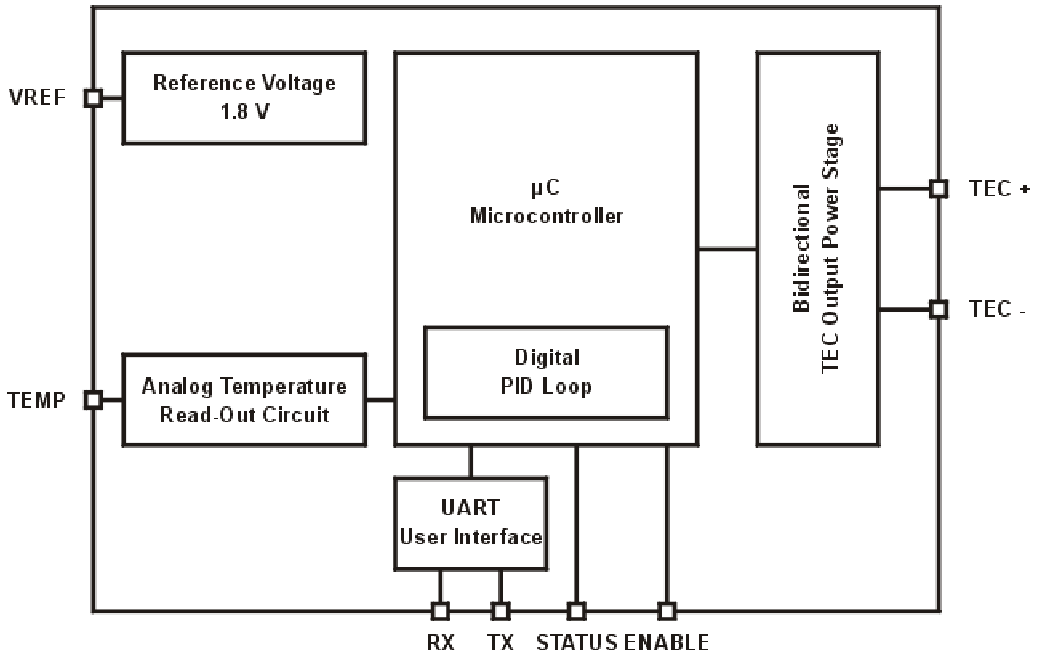
1. The maximum TEC current of 1.5 A can be delivered into a load resistance of 2.66 Ω at recommended operating conditions.
2. At higher load resistance, the maximum output current drops due to compliance voltage limitation.
3. The maximum output current at lower than 2.66 Ω load resistance (colored range)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



Notes

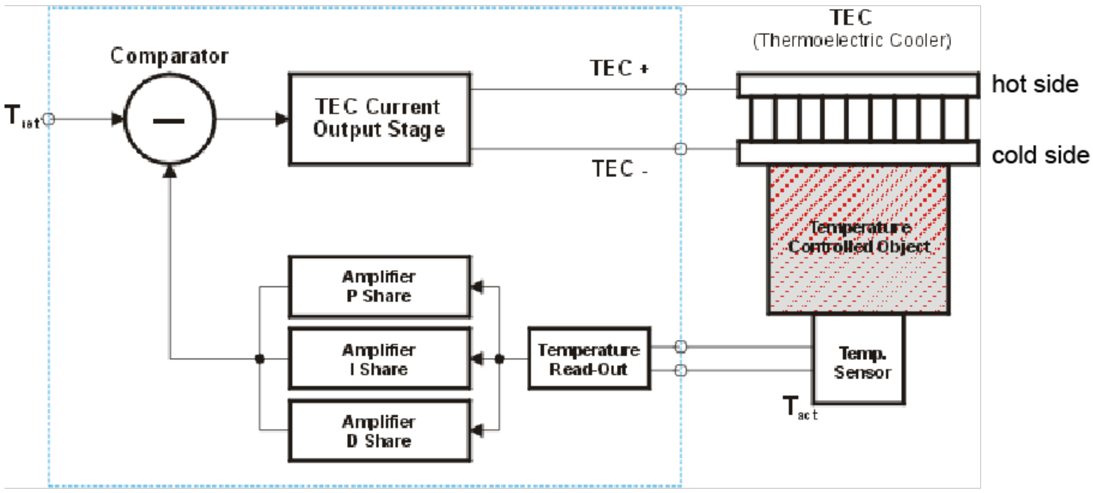
1. The maximum output power of 6 W can be delivered into a load resistance of 2.66 Ω at recommended operating conditions.
2. The maximum output power at lower than 2.66 Ω load resistance (colored range) depends on environmental conditions.

4 Functional Block Diagram



Functional Block Diagram MTD415L

Principle of Operation



In general, a temperature controller (within the blue frame) is a closed loop system. A temperature sensor measures the temperature of the controlled object (e.g., a laser diode). This **actual temperature** signal is amplified and compared with the **temperature set value**. The differential signal out of the **comparator** controls then the current of the **thermoelectric cooler** in order to maintain the temperature of the object constant. Ideally, the temperature settling is carried out in the shortest times, with minimum settling error and without temperature overshoots.

A thermoelectric cooler is a Peltier element that produces a positive or negative temperature gradient depending on the current direction trough the TEC. To enable heating and cooling, the TEC current must be capable of bidirectional flow.
In order to adapt the control loop to different thermal loads, and to optimize the temperature controller's response characteristics, a PID amplifier is used. For detailed information please, see the PID Tutorial (page).

Functional Description

The MTD415L is a miniature, closed-loop temperature controller module. It is compatible with a LMT84 or similar temperature sensor and its output is designed for control of thermoelectric coolers (TEC).

The MTD415L delivers a TEC current up to 1500 mA at 4.0 V compliance voltage.

Power Supply

The supply voltage ranges from 4.5 V to 5,5 V. From the supply voltage, the internal supply voltage for the microcontroller is derived. Further, a reference voltage for the temperature sensor is generated (**VREF**; 1.8 V).

TEC Current Control

The TEC element is connected between **TEC+** and **TEC-**. A correct connection is essential to avoid wrong temperature correction.

Note Please connect PIN 15 (Tec-) to the positive terminal of the TEC element and Pin16 (Tec+) to the negative terminal of the TEC element.

The MTD415L allows to limit the maximum TEC current. Lowering the TEC current limit might be helpful for control loop optimization in the case of low thermal loads, as it lowers the maximum rate of temperature change driven by the MTD415L.

Micro-controller

The functions of the microcontroller are:

- Comparison of the actual temperature with the set temperature;
- Generation of the control signal for the TEC output stage with respect to the comparator signal;
- PID loop control for optimization of the temperature settling time and for minimizing the final temperature error.

All parameters (TEC current limit, set temperature, temperature window, PID share settings etc.) are programmed via the **UART** user interface. Detailed information about how to program the MTD415L can be found in the section Programmers Reference on page .

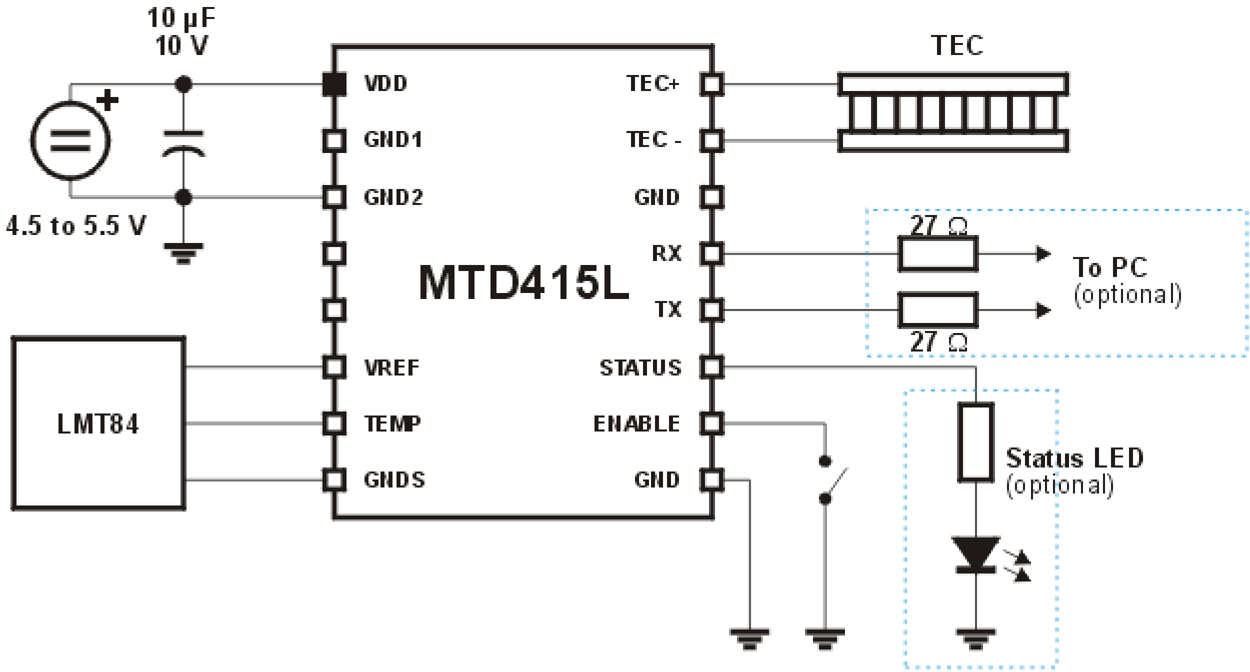
Note

The **UART** interface uses 3.3 V logic level. Connect the **UART** to a PC only using an appropriate converter, e.g., a commercially available UART-to-USB cable.

The **Status** signal indicates whether the MTD415L is operating correctly.

The temperature control is activated by setting the **Enable** pin to low.

5 Typical Application



6 Programmers Reference

6.1 Nomenclature

Program messages are written in straight quotation marks:	**"A?"** **"Lx"** (**x** - Parameter)
Response messages are written in brackets:	**[-800 <LF>]**
Data Format	Numerical value with sign in integer notation: **-220** or **16789432**.
Command /response Terminator:	Line Feed (**<LF>**)

6.2 Command Description

6.2.1 General Commands

Command	Explanation Response Example
"m?"	Reads the version of hardware and software [MTD415L FW0.6.8]

Command	Explanation Response Example
"u?"	Reads the UUID (Universal Unique Identifier) of the MTD415L [045F778655FDE5118ED499C9B4521485]

Command	Explanation Response Example
"E?"	Reads the Error Register. For responses see section Error Register and Safety Bitmask
"c"	Resets the Error register

Note

The MTD415L has a non-volatile memory (flash) that stores the setting parameters. This memory has a limited number of erase / write cycles. In order to protect the flash memory, changes to setting parameters are not stored automatically. If you want to keep parameter changes after power-down of the MTD415L, save them to the flash memory using the "**M**" command. This command saves the T, W, L, d, G, O, P, I, D, C and S parameters at a time.

6.2.2 TEC Commands

Command	Explanation **Response Example**
Programming	
"Lx"	Sets the TEC current limit to **x** *) Value range **x**: **200** to 1500 [mA]
Reading	
"L?"	Reads the TEC current limit **[x<LF>]**[mA]
"A?"	Reads the actual TEC current **[x<LF>]**[mA] x < 0: Heating; x > 0: Cooling
"U?"	Reads the actual TEC voltage **[x<LF>]**[mV]

*) This set value remains during the actual power-on cycle. Use the "**M**" command to save it to the non-volatile memory.

6.2.3 Temperature

Command	**Explanation** **Response Example**
Programming	
"Tx"	Sets the set temperature to **x** *) Value range **x**: **5000** to **45000** [10^{-3} °C]
Reading	
"T?"	Reads the set temperature **[x<LF>]** Value range **x**: **5000** to **45000** [10^{-3} °C]
"Te?"	Reads the actual temperature **[x<LF>]**

Command	**Explanation** **Response Example**
Programming	
"Wx"	Sets the set temperature window to **x** *) Value range **x**: **1** to **32000** [mK]
Reading	
"W?"	Reads the temperature window **[x<LF>]**[mK]

Command	**Explanation** **Response Example**
Programming	
"dx"	Sets the delay time between reaching the temperature window and activating the **Status** output pin to **x** *) Value range **x**: **1** to **32000** [sec]
Reading	
"d?"	Reads the delay time between reaching the temperature window and activating the **Status** output pin **[x<LF>]**[sec]

*) This set value remains during the actual power-on cycle. Use the "**M**" command to save it to the non-volatile memory.

6.2.4 Control Loop

Loop Test

Command	Explanation Response Example
Programming	
"Gx"	Sets the critical gain to **x** *) Value range **x**: **10** to **100000** [mA/K]
Reading	
"G?"	Reads the critical gain **[x<LF>]**[mA/K]

Command	Explanation Response Example
Programming	
"Ox"	Sets the critical period to **x** *) Value range **x**: **100** to **100000** [msec]
Reading	
"O?"	Reads the critical period **[x<LF>]**[msec]

PID Settings

Command	Explanation Response Example
Programming	
"Cx"	Sets the cycling time to **x** *) Value range **x**: **1** to **1000** [msec]
Reading	
"C?"	Reads the cycling time **[x<LF>]**[msec]

Command	Explanation Response Example
Programming	
"Px"	Sets the P Share to **x** *) Value range **x**: **0** to **100000** [mA/K]
Reading	
"P?"	Reads the P Share **[x<LF>]**[mA/K]

*) This set value remains during the actual power-on cycle. Use the "**M**" command to save it to the non-volatile memory.

Command	**Explanation** **Response Example**
Programming	
"Ix"	Sets the I Share to **x** *) Value range **x**: **0** to **100000** [mA/(K*sec)]
Reading	
"I?"	Reads the I Share **[x<LF>]**[mA/(K*sec)]

Command	**Explanation** **Response Example**
Programming	
"Dx"	Sets the D Share to **x** *) Value range **x**: **0** to **100000** [(mA*sec)/K]
Reading	
"D?"	Reads the D Share **[x<LF>]**[(mA*sec)/K]

*) This set value remains during the actual power-on cycle. Use the "**M**" command to save it to the non-volatile memory.

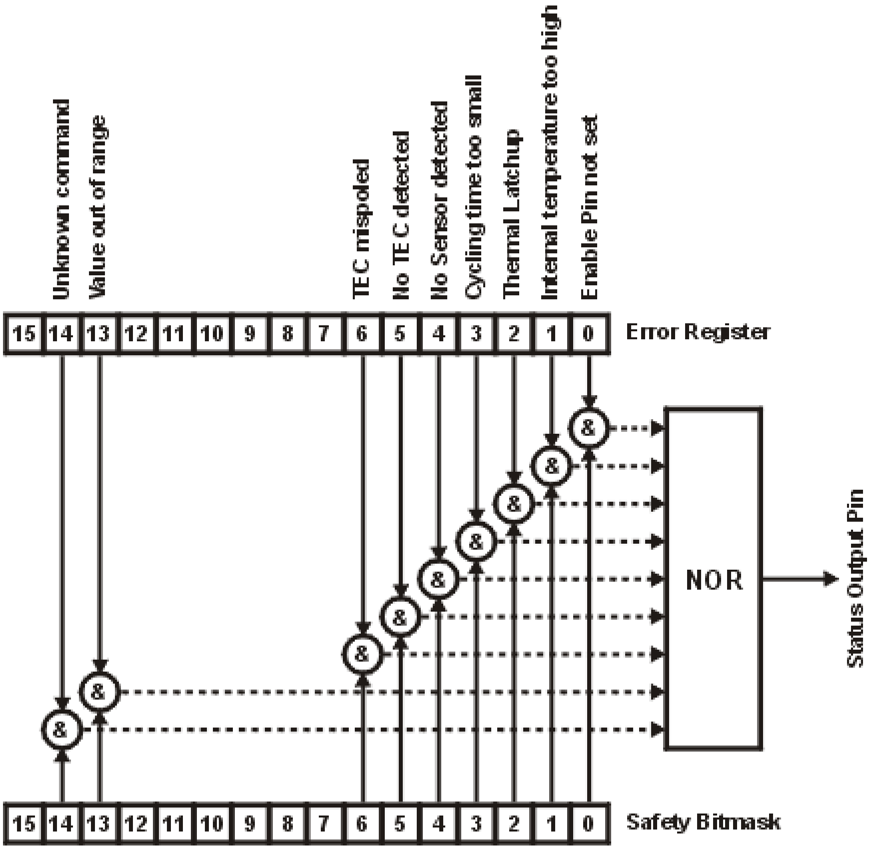
6.2.5 Save Settings

Command	Explanation Response Example
"M"	Saves the setup. The actual parameters that have been set using the commands T, W, L, d, G, O, P, I, D, C and S, are saved to the nonvolatile memory.

6.2.6 Factory Default Settings

Parameter	Explanation	Factory Default
L	TEC current limit	1000 mA
T	Temperature set value	25 °C
W	Temperature window	1000 mK
d	Temperature window delay	6 sec
C	Cycle time PID loop	50 msec
P	P share PID loop	1000 mA/K
I	I share PID loop	200 mA/(K*sec)
D	D share PID loop	100 (mA*sec)/K
G	Critical PID loop gain (Loop test)	2000 mA/K
O	Critical PID loop oscillation period (Loop test)	2000 msec
S	Value of the Safety Bitmask	255

6.3 Error Register and Safety Bitmask



The MTD415L has an internal 16 bit error register:

Bit Number	Event
0	Enable pin not set to L (GND)
1	Internal temperature too high
2	Thermal Latch-Up (TEC current at limit without temperature improvement)
3	Cycling time too small
4	No Sensor detected
5	No TEC detected (connection open)
6	TEC mispoled
7	(not used)
8	(not used)
9	(not used)
10	(not used)
11	(not used)
12	(not used)
13	Value out of range
14	Invalid command
15	(not used)

The error register can be read out using the **"E?"** command. The error register can be reset using the **"c"** command or by setting the **Enable** pin to Off and On again.

Further, with default setting of the Safety Bitmask (value = 255), the states of bits 0 to 7 are handed over to the **Status** output pin - if any of the bits 0 to 7 is H, the **Status** level is "LOW" and the TEC Current Output is switched off.

The Safety Bitmask can be used to mask any desired error at the **Status** output pin.

Attention

Masking an error may lead to damage of the MTD415L. For example, if bit 1 is masked, exceeding the internal temperature will **not be reflected** on the status pin as an error and the TEC output will not be disabled!

The safety bitmask can be programmed:

Command	**Explanation** **Response Example**
Programming	
"Sx"	Sets the Safety Bitmask to **x** Value range **x**: **0** to **255**
Reading	
"S?"	Reads the Safety Bitmask value. **[x<LF>]**

Note

If the safety bitmask should be saved for future use, it needs to be stored using the "**M**" command.

7 PID Tutorial

The general requirements of a temperature control loop are:

- fastest settling time after power on or changing the set temperature
- minimum residual temperature error
- settling without temperature overshoot
- fastest response to changes of the thermal load

PID amplifiers can fulfill these requirements. Temperature control loops are comparatively slow; control oscillations appear with a frequency in the range of several Hz or parts of Hz. The PID adjustment adjustment can be used to optimize the dynamic behavior of the control loop.

The **P share** is the proportional share, or the gain of the amplifier, that defines the settling time. The higher the P share, the faster the settling and the less residual temperature error. The downside is that high P shares lead to oscillations.

The **I share** is the integrating share of the amplification, or the gain at low frequencies. It allows to minimize the residual temperature error.

Optimal settings of the P and I shares result in a fast approach to the set temperature, without oscillations and with a minimum residual temperature error. However, such a loop is not able to quickly react to sudden changes of the thermal load, for example, if a thermally stabilized laser diode is set to a higher or lower output power that changes the laser's heat dissipation. The **D share** (differential share, or the gain at high frequencies) allows the system to quickly react to temperature changes, without generating oscillation of the temperature around the set point.

The MTD415L microcontroller 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. Below an example procedure is explained in detail.

Example of a PID adjustment

Pre-conditions:

- TEC current limit is set correctly
- all connections are made properly

In order to observe the temperature change, connect an appropriate instrument that can display the temperature change vs. time signal that is sent to the **TEMP** input of the MTD415L.

1. Configure the PID loop:
   Set temperature = 25°C: "**`T25000`**"
   P share = 1000 mA/K: "**`P1000`**"
   I share = 0: "**`I0`**"
   D share = 0: "**`D0`**"
   Cycle time = 30 ms: "**`C30`**"
2. Enable the TEC. The actual temperature **`Te`** approximates the set value.
3. Now, find the critical P share (critical gain) value at which the system starts to oscillate for a minimum of 20 cycles without amplitude drop as a reaction to a changed set temperature. An example procedure is described below:
   - Set P to 10.000 mA/K: "**`P10000`**".
     In order to trigger loop oscillation, increase the set temperature for 0.1 K: "**`T25100`**"
   - Lower P to 5.000 mA/K: "**`P5000`**", decrease the set temperature for 0.1 K: "**`T25000`**" and observe the loop behavior.
   - If the loop still oscillates, lower the P share again, change the set set temperature for 0.1K and observe the loop behavior.

Example:
"**P3000**"; "**T25100**" -> the loop still oscillates
"**P2000**"; "**T25000**" -> the loop stopped oscillating

- If the loop stopped oscillating, increase the P share, change the set set temperature for 0.1K and observe the loop behavior.
  Example:
  "**P2500**"; "**T25100**" -> the loop oscillates again
- Repeat above steps.
  Example:
  "**P2200**"; "**T25100**" -> the loop stopped oscillating.
  "**P2300**"; "**T25000**" -> the loop oscillates again
  "**P2250**"; "**T25100**" -> the loop still oscillates
  "**P2200**"; "**T25000**" -> the loop stopped oscillating
- By this approximation of the P share, a value can be found at which the loop starts to oscillate.
  In our example, this happened at P = 2250 mA/K.
  Read the oscillation period at this value - for example, 5.58 sec.
  The critical gain and the critical oscillation period are found.

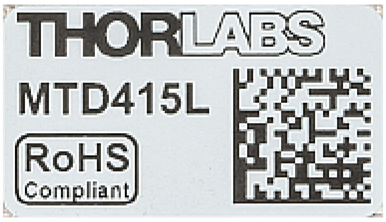
4. Program the MTD415L with these values in order to trigger the calculation of the PID shares and the cycle time by the firmware:
   Program the critical gain to the found above value: "**G2250**"
   Program the critical oscillation period: "**O5580**"
5. The firmware calculates the parameters of the digital PID loop and applies them instantly. The calculated parameters can be read out using the following commands:
   "**P?**" "**[1350<LF>]**" -> P share = 1350 mA/K
   "**I?**" "**[483<LF>]**" -> I share = 483 mA/(K*sec)
   "**D?**" "**[941<LF>]**" -> D share = 941 (mA*sec)/K
   "**C?**" "**[88<LF>]**" -> Cycle time = 88 msec
6. Usually, at this point the PID optimization for the settling behavior is finished. 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.
7. As a final step, save the settings to the non-volatile memory: "**M**"

Notes

- The cycling time is the time base of the internal digital control loop and is calculated automatically by entering G (critical gain) and O (critical oscillation period).
- The optimized PID parameters are valid for a steady state that depends on the set temperature as well as on the ambient conditions (ambient temperature, temperature of the thermal drain side of the TEC). Any changes of the operating and/or environmental conditions may require a re-adjustment of the PID parameters.

8 Troubleshooting

The MTD415L has an imprinted Data Matrix code, that contains manufacturing information:



Please scan this code with your smartphone, and submit the DataMatrix code information to Thorlabs.

Compatible Android apps are:

QR & Barcode Scanner **QRbot** by TeaCapps. This scanner allows to share the scanned code directly by email.
(https://play.google.com/store/apps/details?id=net.qrbot&hl=de)

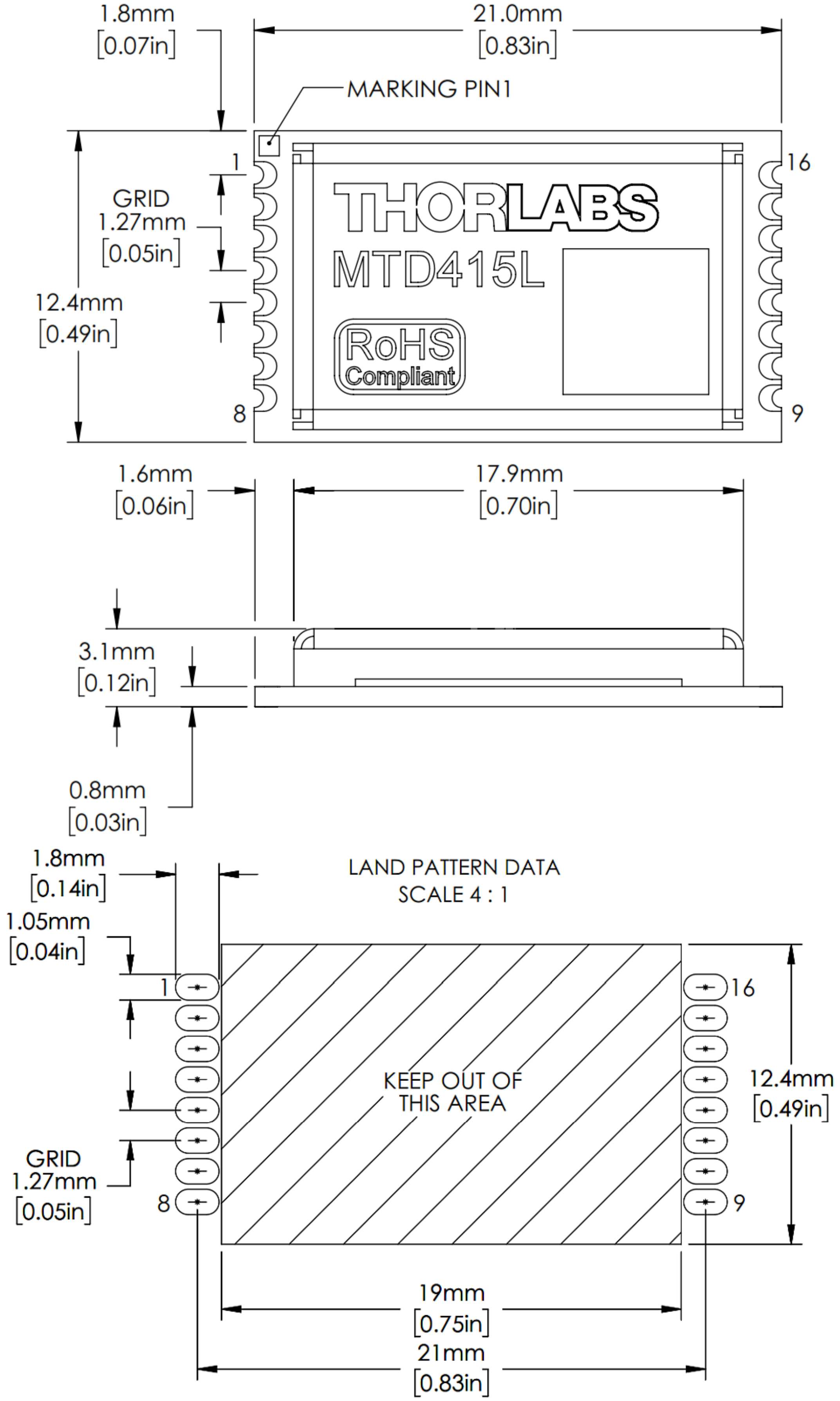
QR Droid Code Scanner QRDroid by DroidLa.
(https://play.google.com/store/apps/details?id=net.qrbot&hl=de)

Compatible iOS apps:

QR & Mobile Barcode Scanner **NeoReader®** by NeoMedia Technologies.
(https://itunes.apple.com/de/app/neoreader-qr-mobile-barcode/id284973754?mt=8)

- **Temperature adjusts to the wrong direction:**
  - ➢ Please ensure to connect PIN 15 (Tec-) to the positive terminal of the TEC element and Pin16 (Tec+) to the negative termial of the TEC element.

9 Drawing


1.8mm
[0.07in]
21.0mm
[0.83in]
MARKING PIN1
1
16
GRID
1.27mm
[0.05in]
12.4mm
[0.49in]
THORLABS
MTD415L
RoHS
Compliant
8
9
1.6mm
[0.06in]
17.9mm
[0.70in]
3.1mm
[0.12in]
0.8mm
[0.03in]
1.8mm
[0.14in]
LAND PATTERN DATA
SCALE 4 : 1
1.05mm
[0.04in]
1
16
KEEP OUT OF
THIS AREA
12.4mm
[0.49in]
GRID
1.27mm
[0.05in]
8
9
19mm
[0.75in]
21mm
[0.83in]

10 List of Acronyms

The following acronyms and abbreviations are used in this data sheet:

AC	Alternating Current
DC	Direct Current
GND	Ground
NTC	Negative Temperature Coefficient (thermistor)
PCB	Printed Circuit Board
SMT	Surface Mounted Technology
TEC	Thermoelectric cooler
UART	Universal AsychronousRT

11 Warranty

Thorlabs warrants material and production of the MTD415L for a period of 24 months starting with the date of shipment in accordance with and subject to the terms and conditions set forth in Thorlabs' General Terms and Conditions of Sale which can be found at:

General Terms and Conditions:

https://www.thorlabs.com/Images/PDF/LG-PO-001_Thorlabs_terms_and_%20agreements.pdf

and

https://www.thorlabs.com/images/PDF/Terms%20and%20Conditions%20of%20Sales_Thorlabs-GmbH_English.pdf

12 Copyright and Exclusion of Reliability

Thorlabs has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the product.

Please refer to the general terms and conditions linked under Warranty.

13 Thorlabs Worldwide Contacts and WEEE policy

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

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Japan
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China
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chinasales@thorlabs.com

Thorlabs 'End of Life' Policy (WEEE)

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

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