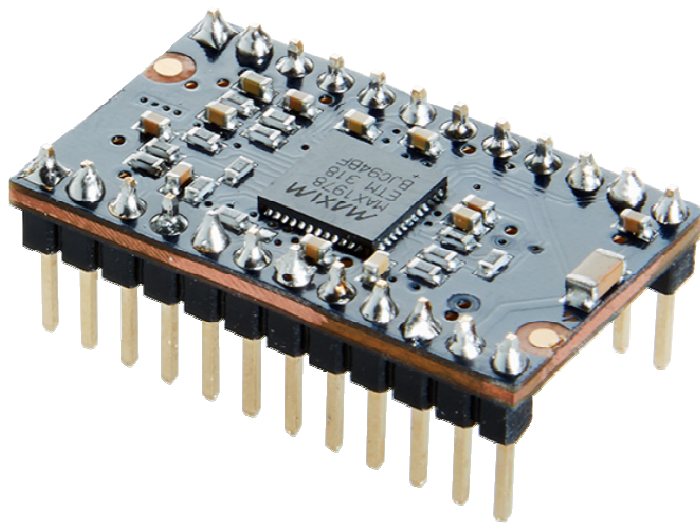# User Manual

## PL-TEC 1-0305

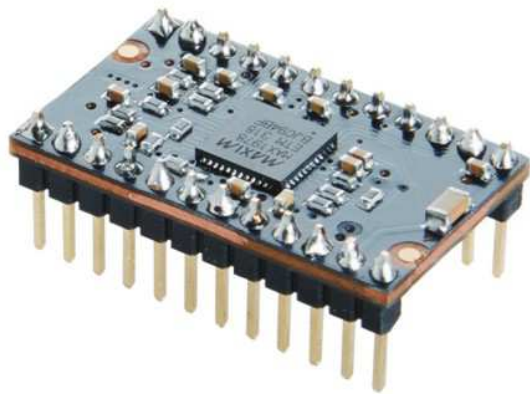

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# Table of Contents

Rev. 1905

# PL-TEC 1-0305
## Driver for TEC Modules



- Bipolar ±3 A output
- Temperature stability up to 0.001 K
- Adjustable TEC current and voltage limiting to protect TEC module
- Direct TEC temperature control
- No additional heat sink required
- Low ripple and low noise design
- Multiple monitoring outputs

## Product Description

The PL-TEC 1-0305 is a very small, safe and most accurate temperature controller for Peltier thermoelectric cooler (TEC) modules.
An ultra low drift chopper amplifier maintains ±0.001 K temperature stability. Output current, rather than voltage, is directly controlled to eliminate current surges. Individual heating and cooling current limits and voltage limits provide the highest level of TEC protection.
The PL-TEC 1-0305 operates from a single supply and provides bipolar ±3 A output by biasing the TEC between the outputs of two synchronous buck regulators. Therefore it is possible to keep the temperature constant even by low load currents without "dead zones" or other nonlinearities.
An analog control signal precisely sets the TEC temperature. The actual TEC temperature and current can be monitored via analog outputs. In addition, separate over- and undertemperature outputs indicate when the TEC temperature is out of range. An on-chip voltage reference provides bias for a thermistor bridge.
Through the new efficient design, the PL-TEC 1-0305 itself requires no heat sink or other cooling method to reach its full output power.
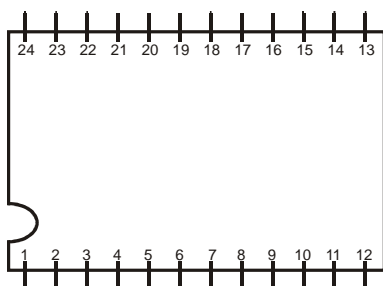
## Technical Data*

| | |
|---|---|
| Output current | Bipolar 2.5 A, 3 A peak** |
| Output current limiting range | Heating: 0 .. 3 A |
| | Cooling: 0 .. 3 A |
| | Independently limitable by external resistor |
| Max. output voltage (referred to the supply) | - 4.3 .. + 4.3 V (@ +5 V) |
| | - 2.3 .. + 2.3 V (@ +3 V) |
| Output voltage limiting range | 0 .. 4.3 V by external resistor |
| TEC temperature monitor | 0 .. 1.5 V** |
| Supply voltage | +3 .. +5 V single supply |
| Temperature stability | 0.001 K** |
| Monitor outputs | - TEC temperature monitor |
| | - Over- and undertemperature output (open collector) |
| | - TEC current monitor |
| Control inputs | - TEC temperature setpoint |
| | - enable (TTL level) |
| Power dissipation | < 2.5 W |
| Dimensions in mm | 30 x 18 x 7.5 |
| | DIP 24-6 package |
| Weight | 8 g |
| Operating temperature | -20 to +55 °C |

\* Technical data is subject to change without further notice.
\*\* See manual for detailed information.

Optional Accessories: PL-TEC BOB

# Pin Assignments and Description



| Pin | Short Desc. | Description |
|---|---|---|
| 1, 2 | GND | GND |
| 3 | FB+ | Feedback voltage input (thermal setpoint, analog voltage 0 .. 1.5 V in). See page 6 for details |
| 4 | REF | 1.5 V reference voltage output. Max. load 50 µA (>36 k to GND) |
| 5 | Itec | TEC current monitor output. The output voltage corresponds to the current by: Itec = (Ua -1.5 V)/0.4. A readout of 1.5 V means zero current, 1.9 V = 1.0 A pos, 0.7 V = 2 A neg. Accuracy +/- 10 % |
| 6 | MaxIP | Maximum positive TEC current. Connect MAXIP to REF to set default positive current limit +150 mV / 0.05 R = 3 A. This pin is tied to 1.5 V ref by an 47 k resistor. So use any resistor to GND to reduce maximum positive current. See page 7 for details. |
| 7 | MaxIN | Maximum negative TEC current. Connect MAXIN to REF to set default negative current limit -150 mV / 0.05 R = 3 A. This pin is tied to 1.5 V ref by an 47 k resistor. So use any resistor to GND to reduce maximum negative current. See page 7 for details. |
| 8 | Rth+ | Connect the NTC between Rth+ and Rth-. NTC value must be around 10 k. |
| 9 | Rth- | NTC return |
| 10 | GND | GND |
| 11, 12 | Tec + | Power outlet for the TEC. Connect both pins together. |
| 13, 14 | Tec - | Power return for the TEC. Connect both pins together. |
| 15 | GND | GND |
| 16 | n.c. | |
| 17 | MaxV | Maximum bipolar TEC voltage. Internal resistor divider (47 k to 1.5 V and 150 k to GND) provides the maximum voltage across the TEC. The maximum TEC voltage is four times the voltage on this pin. Connect any resistor to GND to reduce MaxV-TEC-Voltage. See page 7 for details. |
| 18 | /Shdn | Enable Input. Tie to VCC to enable unit, a connection to GND will disable the unit. No internal pullup resistor. |
| 19 | /OT | Overtemperature alarm. Open drain output pulls low if temperature feedback rises 20 mV (typically +1.5 °C) above the setpoint voltage. Typ. sinking current 4 mA. |
| 20 | /UT | Undertemperature alarm. Open drain output pulls low if temperature feedback falls 20 mV (typically +1.5 °C) below the setpoint voltage. Typ. sinking current 4 mA. |
| 21 | Tntc | NTC temperature monitor output: 0 .. 3 V. See page 6 for details. |
| 22, 23, 24 | VCC | Supply voltage input (single supply +3 to +5 V). |

# Minimal Operating Environment

For correct operation at least one additional 100 k poti for the temperature setpoint is necessary:
Connect the +5 V to pins 22, 23, 24, and 18; GND to 1, 2, 10 and 15; the poti to the pins 2, 3 and 4; the NTC to the pins 8 and 9 and finally the TEC to the pins 11 and 12 vs. 13 and 14. The TEC and NTC are part of the common butterfly package of laser diodes.
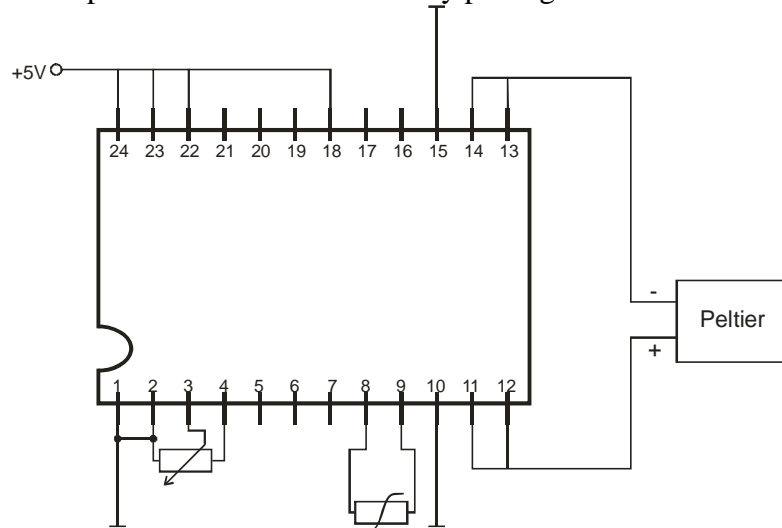


Fig. 1: Minimal operating environment

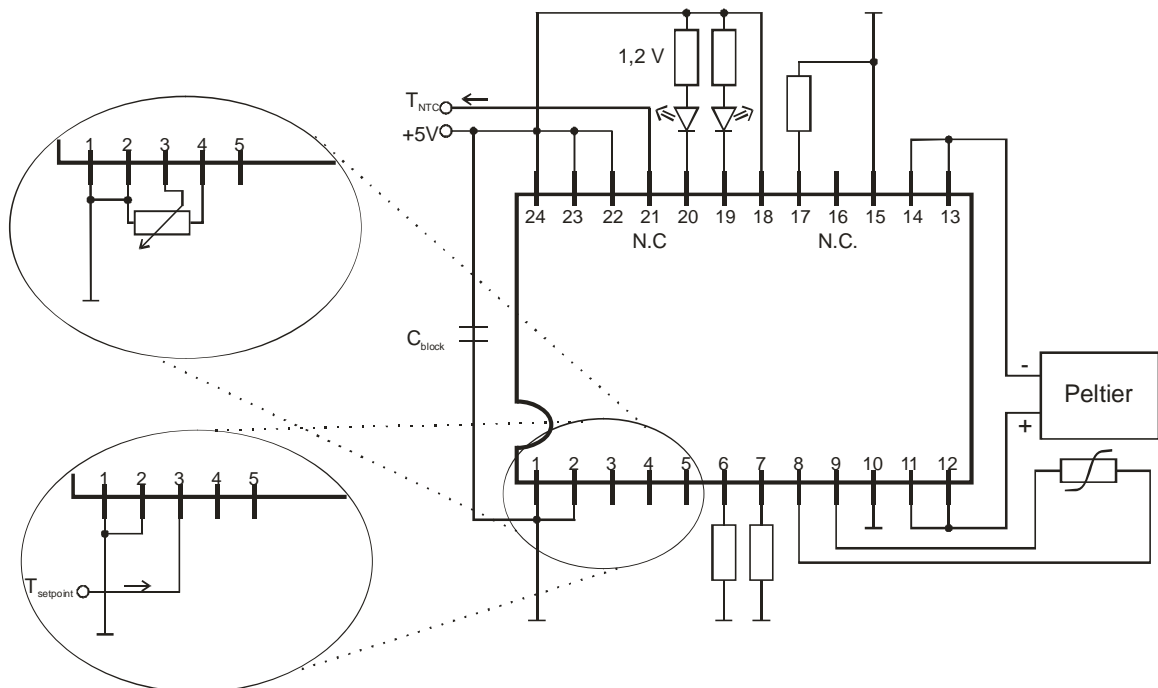# Typical Operating Environment



Fig. 2: Typical operating environment

Typically, the PL-TEC 1-0305 driver can be operated using the above environment. The two resistors connected to pins 6 and 7 adjust the maximum TEC current and a resistor connected to pin 17 adjusts the maximum TEC voltage corresponding to table 1 (page 7). Pins 20 and 19 are open collector outputs which can be used to drive LEDs to signal a critical over- or undertemperature condition, respectively. These diodes have to be an ultra low current type. The series resistors limit the current which flows into the pins to a maximum of 4 mA. The voltage applied to pin 3 is adjusting the temperature setpoint. However, the signal from the NTC is not linear. See figure 4 for details. The current through the TEC can be monitored at pin 5. Depending on the power supply an additional blocking capacitor ($C_{Block}$) may be necessary.

## Wheatstone Bridge

For improved temperature stability the reference network and the feedback network are linked to the same reference voltage. However, this yields in a full Wheatstone bridge. Any influence on the reference voltage will have the same effect on the measured temperature and the setpoint.
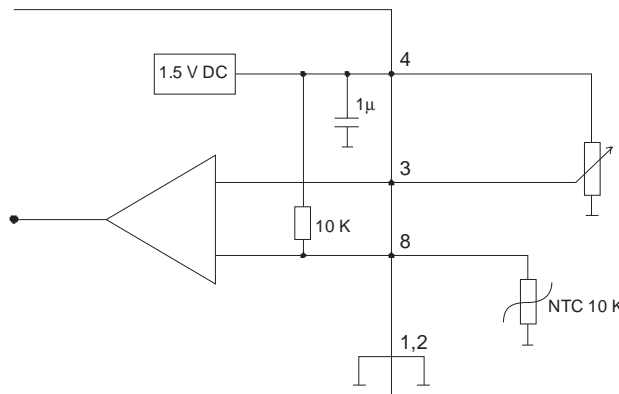


Fig. 3: Part of Fig 1.

## Temperature Setpoint and Monitor

The temperature setpoint input voltage corresponds to the TEC temperature through the voltage of the NTC. The voltage of the NTC depends on its B-value and the temperature. Figure 4 shows the correlation between TEC temperature and setpoint voltage for different B-values of 10 kΩ-NTCs.
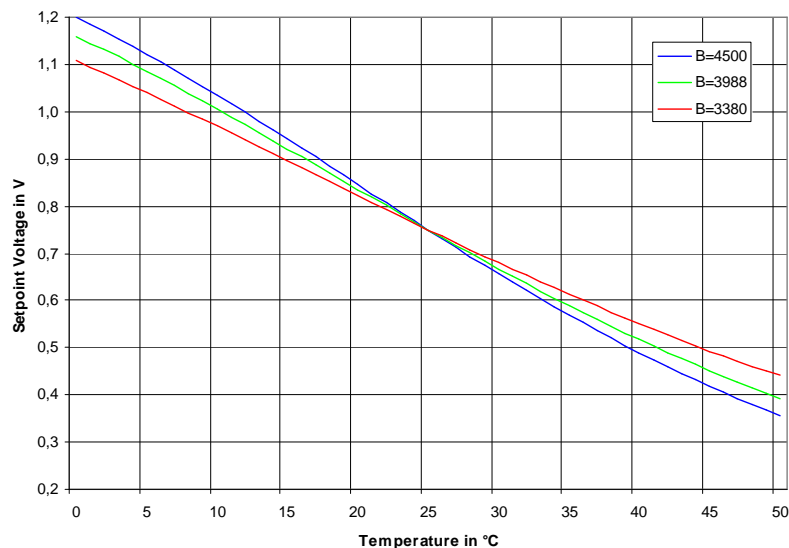


Fig. 4: Setpoint voltage for different B-values of 10 kR NTC resistors

The temperature monitor is equal to the voltage of the NTC, but for a better readability the NTC voltage is inverted and amplified. The following graph shows the relation between the NTC temperature and the monitor output voltage.
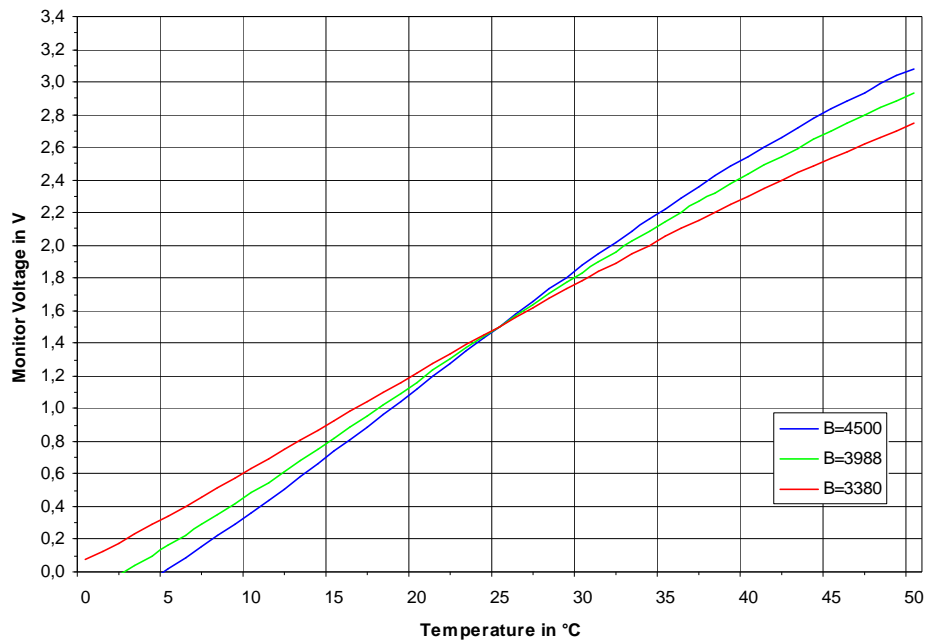


Fig. 5: Monitor voltage for different B-values of 10 kR NTC resistors

## Setting TEC Voltage and Current Limits

TEC voltage and current limits are adjusted by connecting a resistor between ground and the corresponding pin of the PL-TEC 1-0305. The following table shows the relation between the resistor value and the voltage/current limit:

| $R_{ext}$ in kΩ | $V_{tec,max}$ in V | $R_{ext}$ in kΩ | $I_{tec,max}$ in A |
|---|---|---|---|
| 10 | 1.05 | 10 | 0.53 |
| 12 | 1.22 | 15 | 0.73 |
| 15 | 1.45 | 22 | 0.96 |
| 18 | 1.66 | 33 | 1.24 |
| 22 | 1.91 | 47 | 1.50 |
| 27 | 2.19 | 68 | 1.77 |
| 33 | 2.48 | 100 | 2.04 |
| 39 | 2.72 | 150 | 2.28 |
| 47 | 3.00 | 220 | 2.47 |
| 56 | 3.26 | 330 | 2.63 |
| 68 | 3.55 | 470 | 2.73 |
| 82 | 3.81 | 680 | 2.81 |
| 100 | 4.08 | 1000 | 2.87 |
| Open | 4.3 | Open | 3.00 |

Table 1: Resistor values for TEC current and voltage limits

# TEC Current Monitor

The current which is driven through the TEC module can be monitored at pin 5 (Itec). The output voltage corresponds to the current by: $I_{tec} = (Ua - 1,5 \text{ V})/0,4$. A readout of 1.5 V means zero current, 1.9 V = 1.0 A pos, 0.7 V = 2 A neg. Accuracy +/-10 %. The diagram shows the full trace including the internal offset.
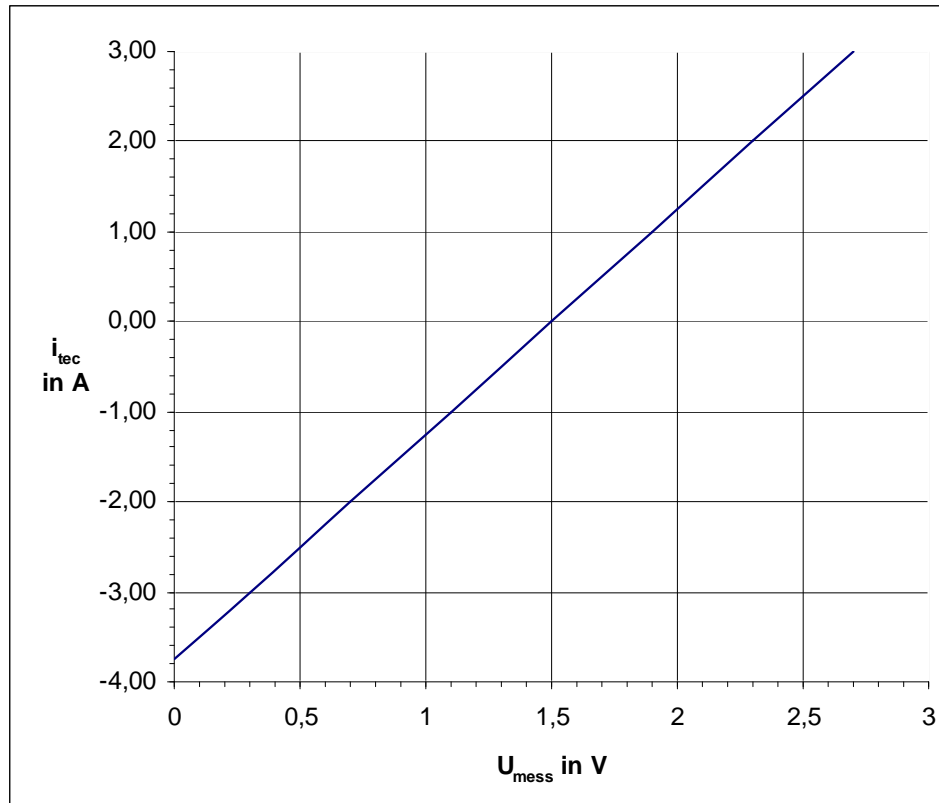


Fig. 6: TEC current monitor output voltage vs. TEC current

# Absolute maximum Ratings (destroying limits)

- All input pins must not exceed the voltage range below zero (GND) and beyond VCC
- VCC Limit: +6 V
- Peak TEC current: +/- 4.5 A
- Max /UT /OT current: 10 mA
- Ref-Voltage: Current sink (into pin) 100 µA, source 800 µA