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Product Description

TEC-8A-24V-PID-HC is an improved digital temperature controller. The present version can heat and cool without changing any jumpers. The controller is available in two versions of the program: Basic and Advanced. Beyond the basic functionality, Advanced version offers the possibility to set various parameters of the controller using [UART](#).

TEC-8A-24V-PID-HC has an open collector output which allows it to use it as a signal for other devices. Open collector will indicate when the measured temperature is out of the Tmin/Tmax range. In addition to the open collector, warning LED will indicate this also. The indication LEDs show heating or cooling activity. Also, the dimensions of the PCB are smaller and mounting holes were added.

You can use UART to read the temperature setpoint, actual temperature and PID parameters values. To accurately read the value of the temperature use a thermistor with BETA value of 3950 for basic and advanced versions and for advanced $\pm 100^{\circ}\text{C}$ version you need a P0K1.202.3FW.B.007 thermistor.

Its small size, simplicity of regulation and versatility make it widely used in many areas. It is dedicated to work with 12 V thermocouples (Peltier modules) yet it does well with all modules whose supply voltage falls in the range of 5 to 24 V.

With the use of four trimmers, the temperature setpoint as well as values of the PID controller parameters can be set. The controller operates in PWM mode (Pulse Width Modulation) and can control currents of up to 8 A. For the temperature sensor, it uses a standard 10k NTC B=3950 thermistor for basic and advanced version and for advanced $\pm 100^{\circ}\text{C}$ version it uses a P0K1.202.3FW.B.007 thermistor. By default, the temperature setpoint is set to 25 degrees Celsius.

Due to the possibility to set the parameters of a PID controller, the driver can be adapted to almost any system. Depending on the inertia of the system, properly adjusted drivers are able to maintain the desired temperature with an accuracy better than $\pm 0.05^{\circ}\text{C}$.

The current flowing through the Peltier cell depends on the supply voltage used. Most of the common modules should be supplied with the voltage of 5 to 24V, and the maximum current that flows through them is defined by a cell symbol.

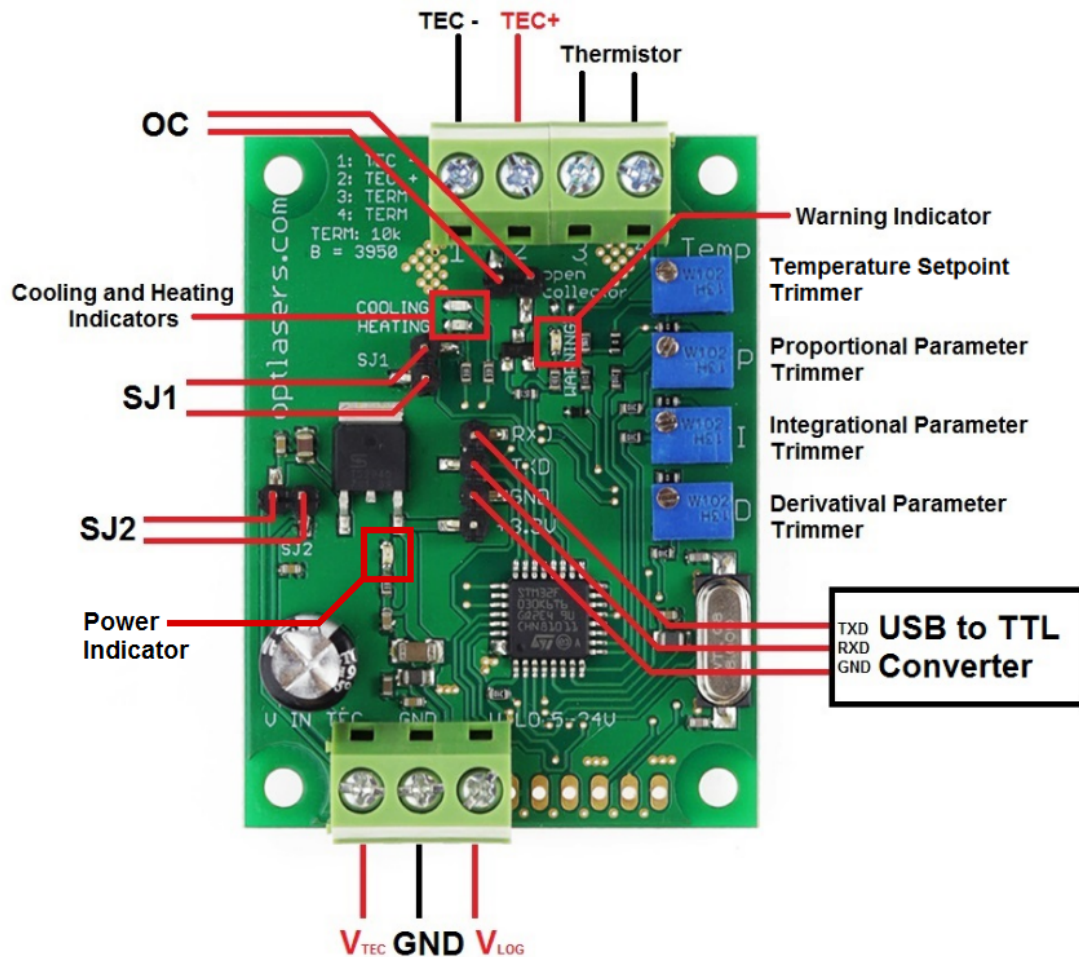
The driver is working in TTL 3.3V standard.

Technical Data

	RS232 Programmable Temperature Controller $\pm 100^{\circ}\text{C}$ (Advanced)	RS232 Programmable Temperature Controller (Advanced)	Temperature Controller (Basic)
Maximum current	8A		
Input Voltage (V LOG)	5 – 24 V		
Input Voltage (V TEC)	5 – 24 V		
Serial Interface	3.3V Logic, 1 start bit = 0, 8 data bits, no parity, 1 stop bit = 1		
Serial Transmission	Yes		
Serial Reception	Yes		No
Temperature Stabilization Accuracy	$\pm 0,05^{\circ}\text{C}^*$	$\pm 0,05^{\circ}\text{C}$	$\pm 0,05^{\circ}\text{C}$
Temperature Tracing Accuracy	$\pm 2^{\circ}\text{C}$		
Cooling or heating work	Yes		
Temperature sensor	P0K1.202.3FW.B.007	10k NTC B=3950	
Temperature range $T_{\min}$ and $T_{\max}$	-100 to $+100^{\circ}\text{C}$	0 to $+50^{\circ}\text{C}$	0 to $+50^{\circ}\text{C}$
Heat sink required	No		
Dimensions	45 x 60 mm		
Mounting holes	37 x 52 mm		
Mounting holes diameter	3.2 mm		

* Applicable for the range $\pm 50^{\circ}\text{C}$. For the range $\pm 100^{\circ}\text{C}$ accuracy is $\pm 3^{\circ}\text{C}$

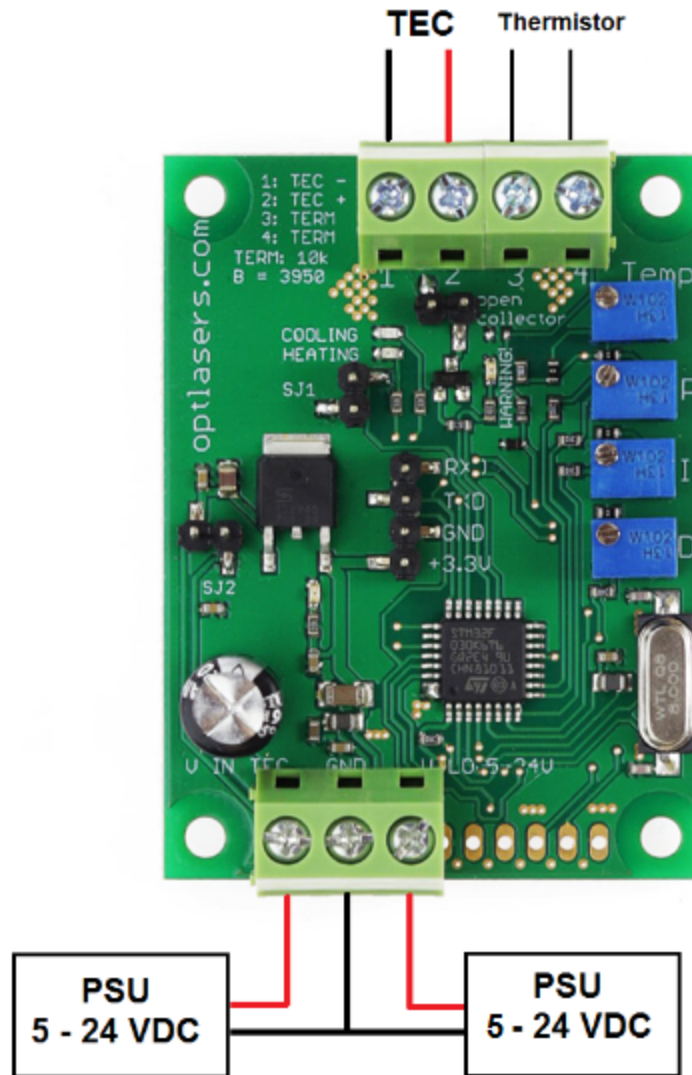
Pinout



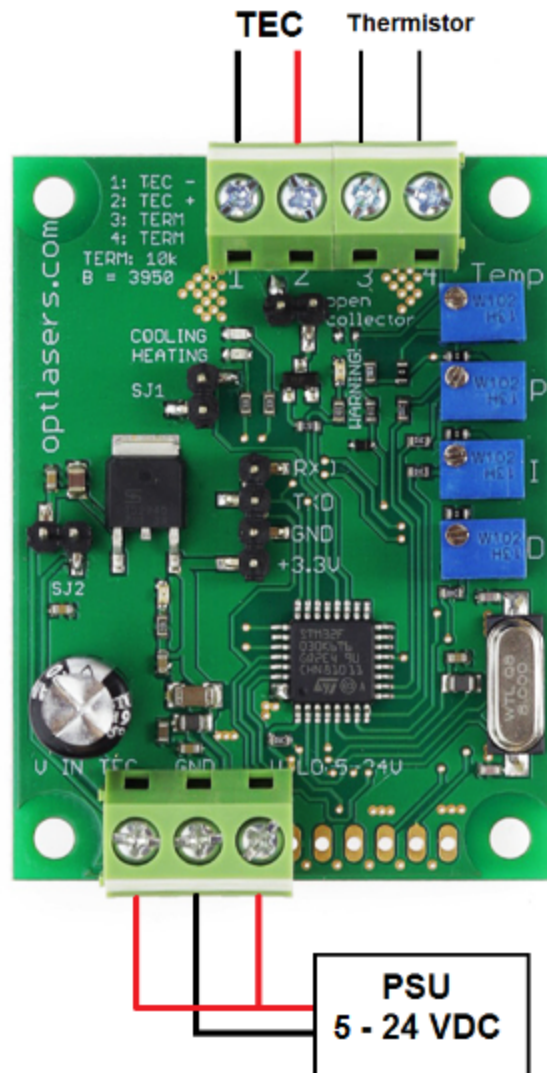
Electrical Wiring

The TEC-8A-24V-PID-HC driver can be power supplied in three different ways.

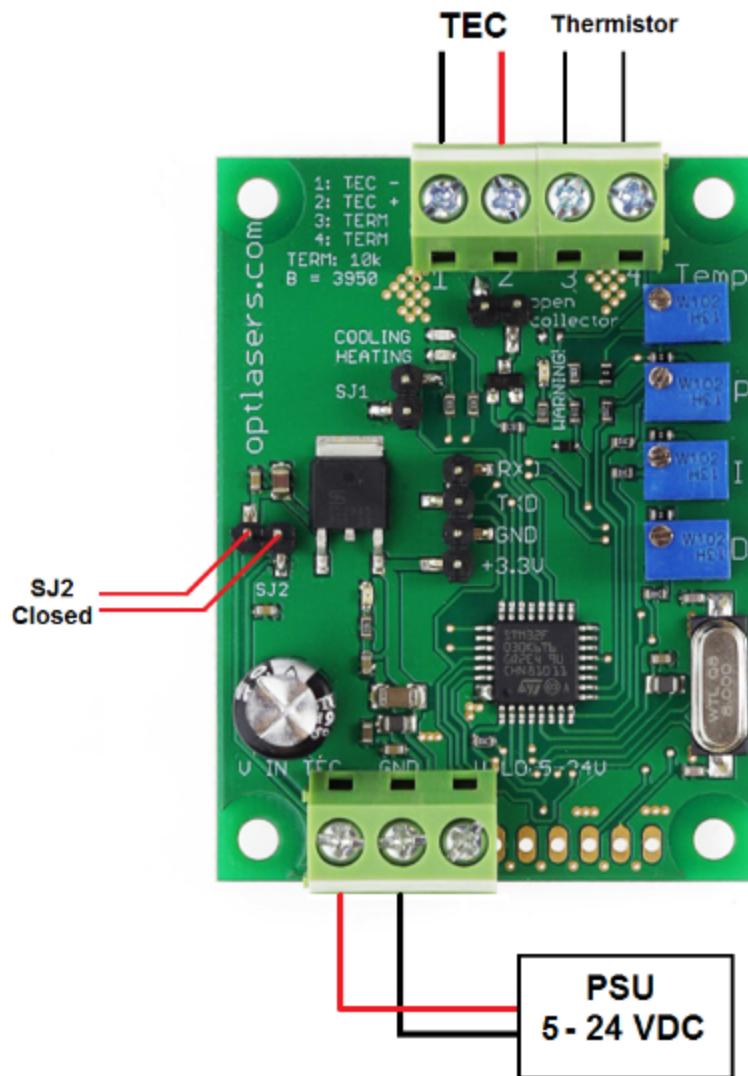
1. Using two PSUs:



2. Using one PSU:



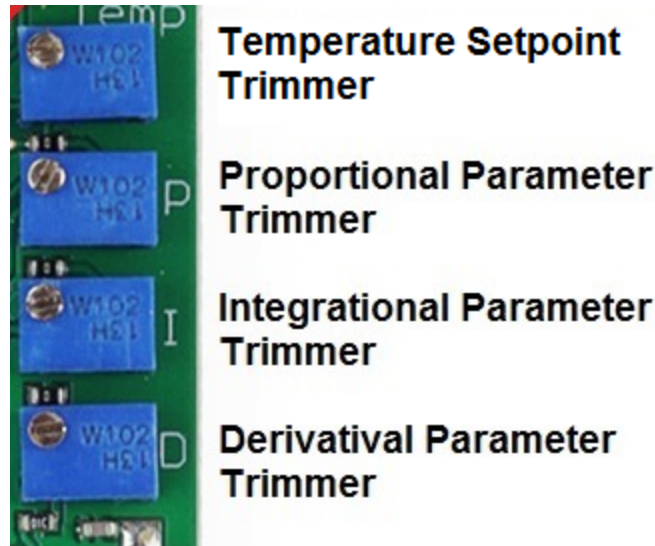
3. Using one PSU with **closed SJ2**:



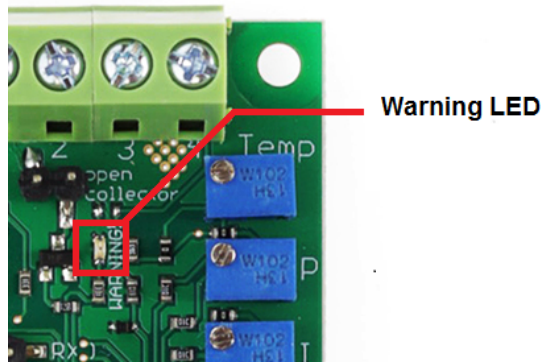
Advanced Program

Opened/Not connected SJ1 jumper mode

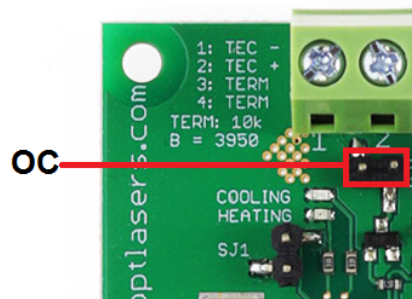
1. Adjustment with the use of four trimmers. Trimmers allow you to set PID parameters, as well as the temperature setpoint.



2. The system detects a lack of connection with the thermistor and then switches WARNING LED on. As long as the connection is lost, the driver will not take any action and the open collector output is grounded.
3. If the measured temperature exceeds an overriding limit of +70°C in the NTC 10k versions (+120°C in the Advanced -100/+100 version), the Peltier module is switched off.
4. If the measured temperature is out of Tmin...Tmax range, the WARNING LED is ON and the open collector output (OC) is connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded). In the Advanced versions, when the SJ1 jumper is open, Tmin and Tmax have fixed values: 0°C and 70°C respectively in the Advanced NTC 10k version, and -120°C and +120°C respectively in the Advanced -100/+100 version. In the Advanced versions, Tmin and Tmax can be set by the user (through the serial connection) and the settings become valid when the SJ1 jumper is closed.



5. If the measured temperature lies between $+45^{\circ}\text{C}$ and T_{max} , the WARNING LED is flashing. The open collector output (OC) is not connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded).



Closed/Connected SJ1 jumper mode

1. Adjustment with use of UART port

Using PC and [USB to UART converter](#) it is possible to send (valid only for advanced version) and read parameters to/from the regulator. While using this mode, trimmers are not working, and users get control via USB to UART communications which allows the automation of cooling and heating processes. Additionally, it is possible to set T_{max} and T_{min} values which are checked by the driver (OC and Warning LED).

Connectivity

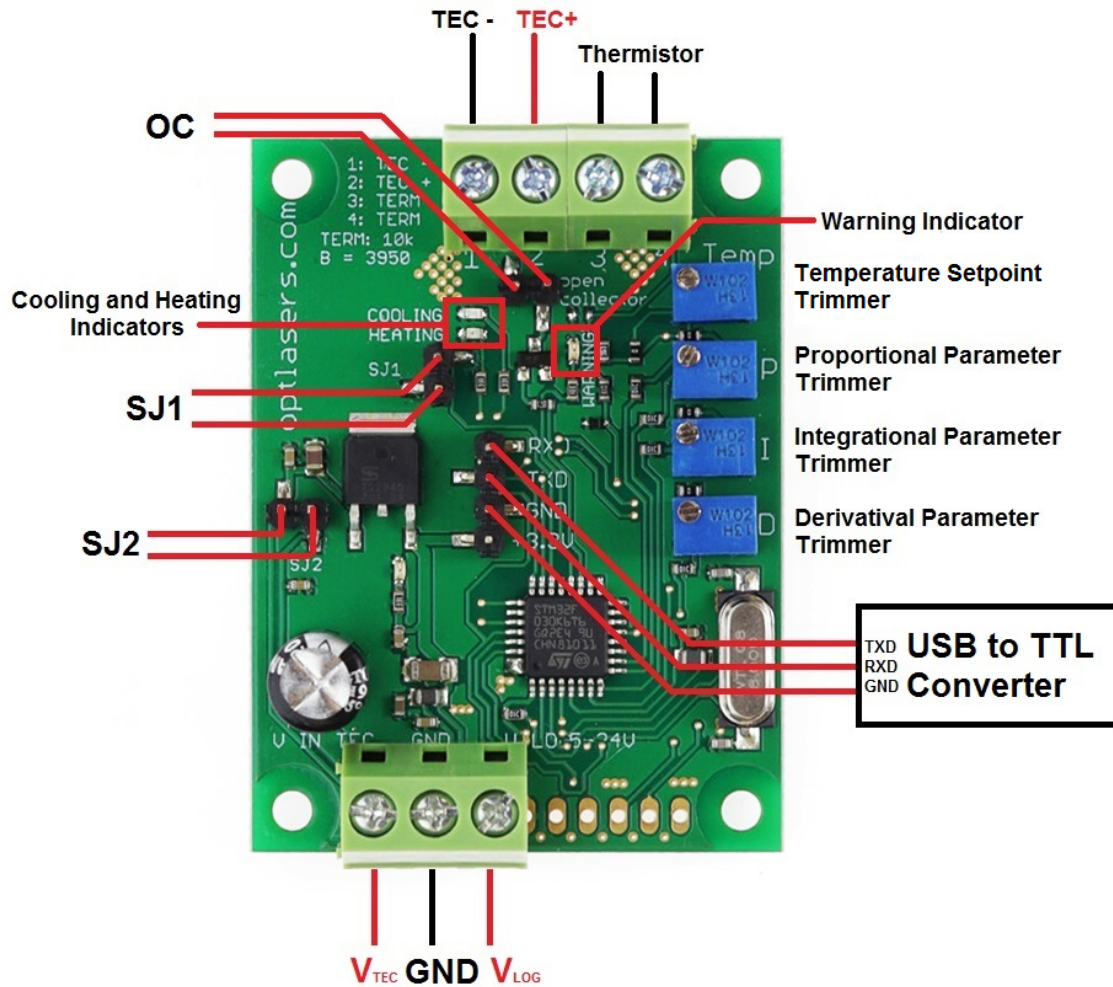


Figure 1. TEC 8A-24V-PID Connection scheme

UART parameters:

- 38400 bits / second
- 8 data bits
- even parity: No parity
- stop bits: 1
- flow control: No

Communication with the device requires terminal software installed on the PC. Users can use their favourite terminal software. This guide contains an example how to set up a connection with the device using PuTTY software with Windows 7 operating system.

Serial Protocol

Protocol allows users to set configuration parameters of the device or acquire measured data using commands specified below. Each command is a set of ASCII characters which may be followed by <CR> and/or <LF>.

Configuration command

Command template: **<T_{setpoint} P I D T_{min} T_{max}>**

T_{setpoint} [°C] – target temperature value. The device checks output temperature via thermistor and manages output current to reach temperature setpoint.

P – PID proportional coefficient (in range from 0.0 to 20.0)

I – PID integral coefficient (in range from 0.0 to 20.0)

D – PID derivative coefficient (in range from 0.0 to 20.0)

T_{min} [°C] – lower threshold which is checked by the driver (OC)

T_{max} [°C] – upper threshold which is checked by the driver (OC)

Example: **<10 4.5 1 30.6 0 60.7>**

Single byte commands

These are single character commands without additional parameters:

o – print single readout

R – turn ON cyclic print (print every second).

r – turn OFF cyclic print

A - switch ON TEC supply

a - switch OFF TEC supply

Template of readout: **<T_{setpoint} P I D T_{min} T_{max} T_{measured} OC PWM>**

T_{setpoint} [°C] – target temperature value set by user

P – set PID proportional coefficient (in range from 0.0 to 20.0)

I – set PID integral coefficient (in range from 0.0 to 20.0)

D – set PID derivative coefficient (in range from 0.0 to 20.0)

T_{min} [°C] - lower threshold which is checked by the driver (OC)

T_{max} [°C] - upper threshold which is checked by the driver (OC)

T_{measured} [°C] - instantaneous value of measured temperature

OC - status of the open collector (0 – disconnected from GND or 1 – connected to GND)

PWM [%] - Negative values indicate cooling phase and positive ones indicate heating phase. The absolute value of the parameter informs about intensity.

How to connect PC to TEC 8A-24V-PID

After setting up connections (Figure 1) and powering up the TEC 8A-24V-PID we should check if the converter has been recognized and installed in system (Figure 2). In our case USB to UART converter driver has been installed without problems.

If you experience any problems with driver installation you should check the official website of the manufacturer of the converter device you use.

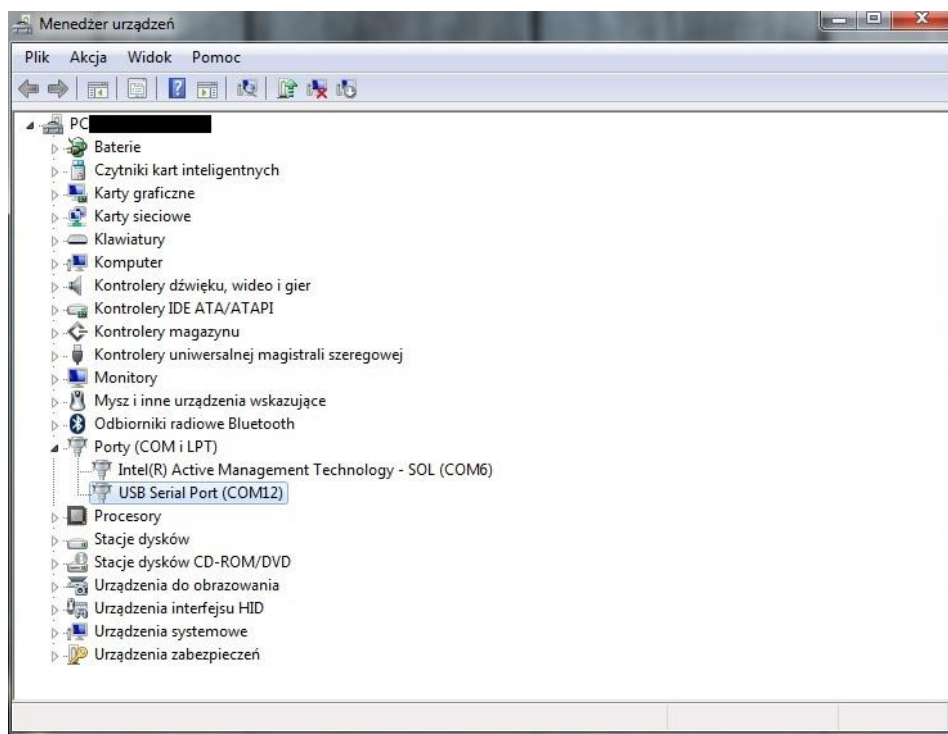
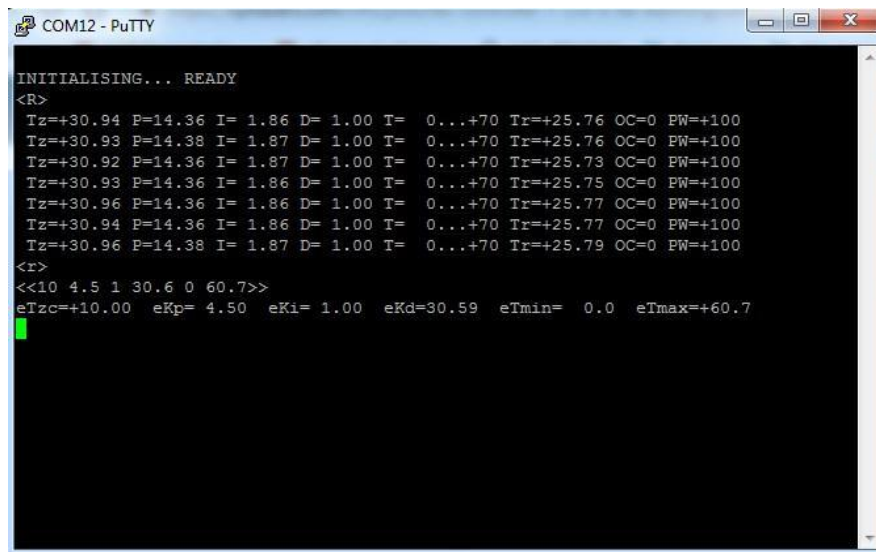
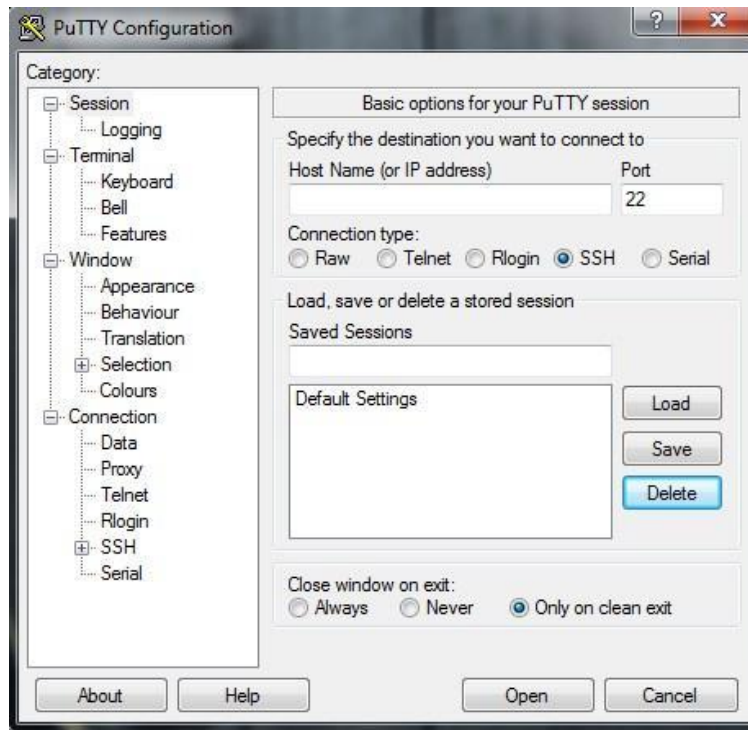


Figure 2. Device Manager – USB to UART converter driver is installed (COM12)

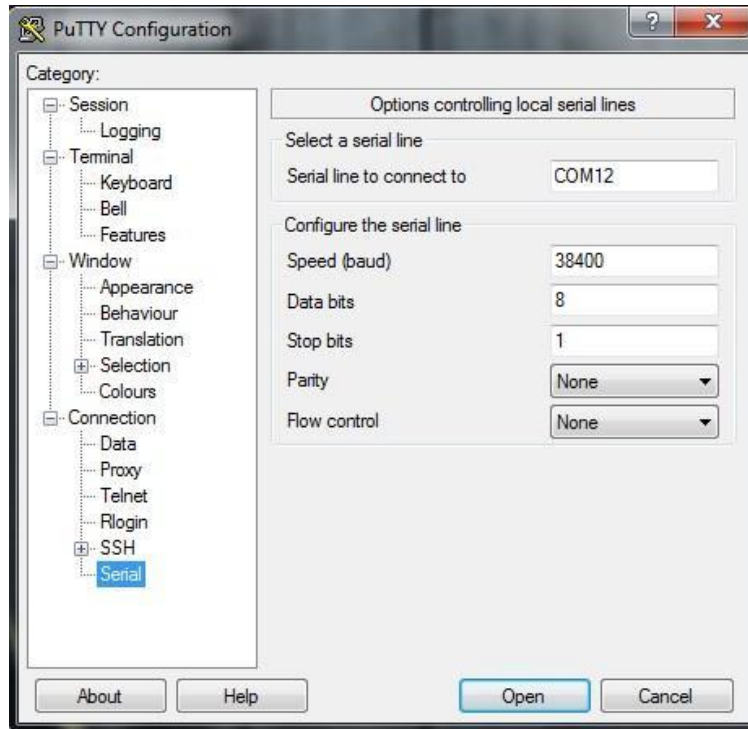


Communication via PuTTY:

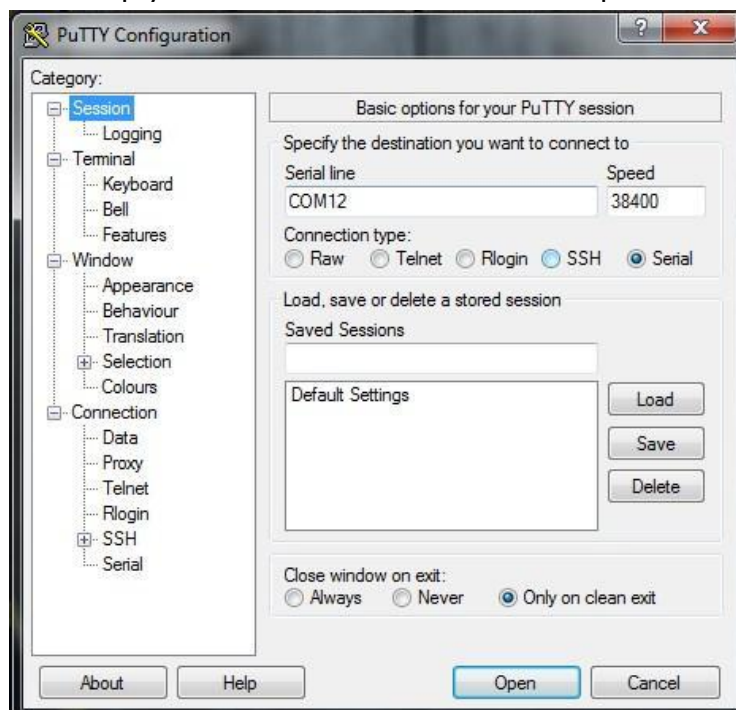
1. Download and open PuTTY. (Visit <https://www.putty.org/> for details)



2. Open category Connection->Serial. Make sure transmission parameters are set properly (look for chapter *TEC 8A-24V-PID Connectivity* and check parameter values). In field **Serial line to connect to** write the name (COM) of the USB to UART converter shown in the device manager operating system (Figure 2.)



- Open category **Session** and switch connection type to **Serial**. Value in the field **Serial line** and **Speed** should update. There is an option to save configuration. You can name configuration in field under **Saved sessions** then press the **Save** button. The list will update. To use one of saved configurations simply check one from the list then press **Load** button.

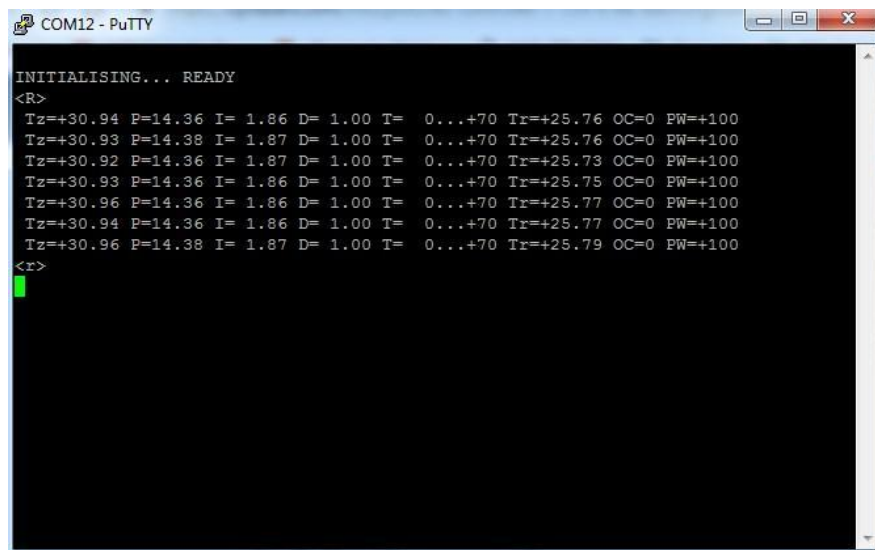


- After setting up the session parameters click the **Open** button. The terminal window will show up. If you want to make sure TEC 8A-24V-PID is connected properly you can reset the device. Simply disconnect it from the power supply and after couple seconds connect again. You will receive initialization info from the device (shown below).



```
COM12 - PuTTY
INITIALISING... READY
█
```

- Now we are able to send commands to the device. Single byte commands can be sent by hand. Type **R** and after a couple of seconds type **r**.



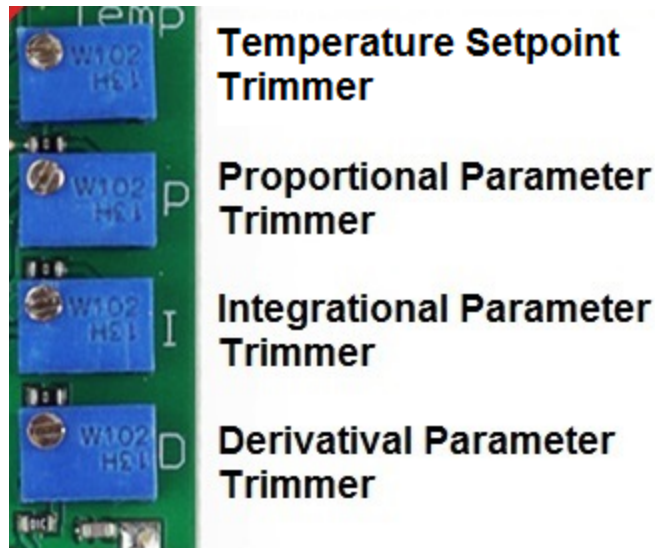
```
COM12 - PuTTY
INITIALISING... READY
<R>
Tz=+30.94 P=14.36 I= 1.86 D= 1.00 T= 0...+70 Tr=+25.76 OC=0 FW=+100
Tz=+30.93 P=14.38 I= 1.87 D= 1.00 T= 0...+70 Tr=+25.76 OC=0 FW=+100
Tz=+30.92 P=14.36 I= 1.87 D= 1.00 T= 0...+70 Tr=+25.73 OC=0 FW=+100
Tz=+30.93 P=14.36 I= 1.86 D= 1.00 T= 0...+70 Tr=+25.75 OC=0 FW=+100
Tz=+30.96 P=14.36 I= 1.86 D= 1.00 T= 0...+70 Tr=+25.77 OC=0 FW=+100
Tz=+30.94 P=14.36 I= 1.86 D= 1.00 T= 0...+70 Tr=+25.77 OC=0 FW=+100
Tz=+30.96 P=14.38 I= 1.87 D= 1.00 T= 0...+70 Tr=+25.79 OC=0 FW=+100
<r>
█
```

- To send a configuration command you should write it first in any text editor, copy it and press the right mouse button on the terminal window. This is an

inconvenience that is improved in other software (RealTerm, Hyper Terminal etc.).

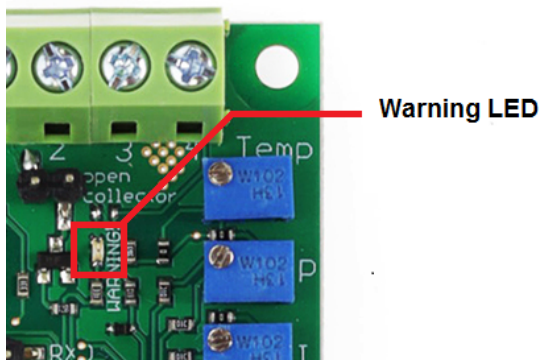
Basic Program

1. Adjustment with the use of four trimmers. Trimmers allow you to set PID parameters, as well as the temperature setpoint.

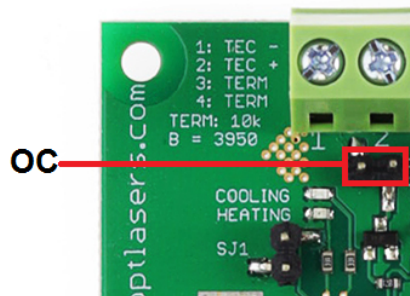


2. The system detects a lack of connection with the thermistor and then switches WARNING LED on. As long as the connection is lost, the driver will not take any action and the open collector output is grounded.
3. If the measured temperature exceeds an overriding limit of +70°C in the NTC 10k versions (+120°C in the Advanced -100/+100 version), the Peltier module is switched off.
4. If the measured temperature is out of Tmin...Tmax range, the WARNING LED is ON and the open collector output (OC) is connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded). In the Basic version, Tmin and Tmax are 0°C and 70°C

respectively. In the Basic versions, Tmin and Tmax cannot be set by the user (through the serial connection).



5. If the measured temperature lies between $+45^{\circ}\text{C}$ and Tmax, the WARNING LED is flashing. The open collector output (OC) is not connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded).



6. In the Basic version SJ1 is not working;
7. Open collector (OC) is grounded, Warning LED is ON and Peltier current is OFF at more than 70 degrees Celsius;
8. When temperature drops below 70 degrees, the driver goes back to normal work;
9. The parameters exchanged with UART:

Tz - Temperature setpoint
Tr - Temperature measured
P - proportional parameter 0.0 - 20.0
I - integral parameter 0.0 - 20.0
D - derivative parameter 0.0 - 20.0

Example:

```
COM8 - PuTTY
Tz=+27.02 P=13.09 I= 2.02 D= 1.01 T= 0...+70 Tr=+24.73 OC=0 PW=+100
Tz=+27.05 P=13.09 I= 2.03 D= 1.01 T= 0...+70 Tr=+24.72 OC=0 PW=+100
Tz=+27.03 P=13.10 I= 2.02 D= 1.01 T= 0...+70 Tr=+24.70 OC=0 PW=+100
Tz=+27.01 P=13.10 I= 2.03 D= 1.01 T= 0...+70 Tr=+24.68 OC=0 PW=+100
```

PID Regulator

The PID regulator is a part of the Controller's software. It controls the TEC module according to the current temperature error (the difference between the real and the preset temperature), trying to bring the error as close to zero as possible.

The output of the regulator consists of Proportional, Integral, and Differential parts. The user may adjust the amount of each part in the range of 0...20 (P, I, and D parameters respectively).

PROPORTIONAL PART

This part is proportional to the temperature error. The higher P, the less temperature error is required for the same output. At maximum P setting, an error of 0.5°C causes the maximum output (100%).

INTEGRAL PART

The temperature error is being integrated in this part. The output will rise or fall until the error reaches zero.

The I parameter sets the amount of integral part and also adjusts the integrator's time constant. The higher I, the longer the time constant.

The integrator saturates at -100% and +100%. The integrator does not clear itself on any timeout.

At I settings below 0.05, the integrator is turned off and cleared.

DIFFERENTIAL PART

This part acts as a high-pass filter. When the temperature error changes, the differential part brings some amount of energy to the output and therefore "speeds up" reaching the target temperature. In the frequency domain, adding some differential part increases the phase margin of the regulator and thus improves the regulation loop stability.

The D parameter sets the amount of differential part and also adjusts its time constant. The higher D, the longer the time constant.

At D settings below 0.05, the differential part is turned off and cleared.

Recommendations and Requirements

We recommend the use of power cables with a minimum cross-section of 0.5mm².

TEC-8A-24V-PID-HC uses serial port (COM) to communicate with PC. There are a lot of desktop applications which can be used to read out data, sending from the controller and to write in parameters (Advanced version). Below, there are only a few examples:

- RealTerm (Windows)
- Minicom (Linux)
- PuTTY

If you are able to program, you can also write your own application. There are a lot of libraries for serial communication in any programming language.

Protection

The system detects a lack of connection with the thermistor and then switches WARNING LED on. As long as the connection is lost, the driver will not take any action and the open collector output is grounded.

If the measured temperature exceeds an overriding limit of +70°C in the NTC 10k versions (+120°C in the Advanced -100/+100 version), the Peltier module is switched off.

If the measured temperature is out of Tmin...Tmax range, the WARNING LED is ON and the open collector output (OC) is connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded). In the Basic version, Tmin and Tmax are 0°C and 70°C respectively. In the Advanced versions, Tmin and Tmax have fixed values when the SJ1 jumper is open: 0°C and 70°C respectively in the Advanced NTC 10k version, and -120°C and +120°C respectively in the Advanced -100/+100 version. In the Advanced versions, Tmin and Tmax can be set by the user (through the serial connection) and the settings become valid when the SJ1 jumper is closed.

If the measured temperature lies between +45°C and Tmax, the WARNING LED is flashing. The open collector output (OC) is not connected to ground. The PID regulator works normally (unless the overriding limit mentioned before is exceeded).

Attention: This temperature controller has no reverse polarity protection. Reverse polarity at power supply will permanently damage the temperature controller.

Related products

- [TEC-8A-24V-PID-HC-RS232 Programmable Temperature Controller -100 +100°C](#)
- [TEC-8A-24V-PID-HC-RS232 Programmable Temperature Controller](#)
- [TEC-8A-24V-PID-HC Temperature Controller](#)