

This step by step guide will help you setting up a Meerstetter Engineering TEC controller for the first time.

Goal:

- Avoid difficulties and save time at first use
- Get familiar with the TEC service software

As an example application we set up a system to keep an object at a constant temperature. This means that the TEC controller will supply a Peltier element, to heat and cool depending on the measured temperature at the object.

During the setup we will perform the following steps:

1. [Software Installation](#)
2. [Hardware Setup](#)
3. [Default Configuration](#)
4. [Temperature Measurement](#)
5. [Peltier Element Characteristics](#)
6. [Temperature Controller](#)
7. [Auto Tuning](#)

Components used for this example:

- TEC-1089-SV-NTC39K controller
- Peltier element (CUI Inc. CP40236)
- Heat sink
- PC with Microsoft Windows 8
- Cable with mini USB-B connector
- Object temperature sensor (NTC 10K, B value = 3988K)
- Sink temperature sensor: none (fixed temperature selected)
- Power supply (24 V, 6 A output)
- Soldering station

This is a general TEC setup guide. So you can follow the steps even if you don't use exactly the same material and controller for your setup.

Red boxes are actions to be performed by yourself.



Yellow boxes show reactions from the soft- or hardware and are an indicator if an action was successful.



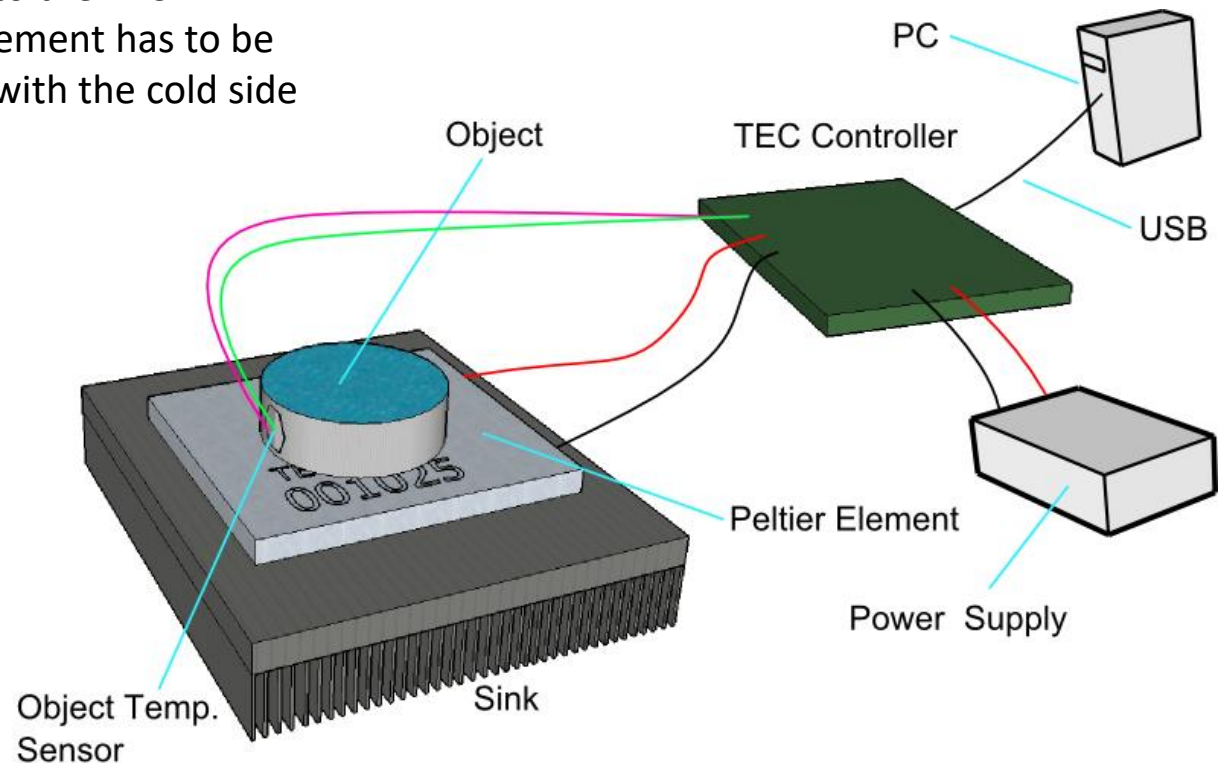
Blue boxes provide additional background information to the step to be performed.



Screenshots and photos will help you to better understand the actions you have to perform.

The TEC controller is configured by the service software on the PC. The temperature sensor and the Peltier element are connected to the TEC controller. The Peltier element has to be placed on the heat sink with the cold side (marked side) upward.

The connections are described later, step by step.



1. Software Installation

1.1 USB Driver Installation

Connect TEC controller on X4 to your PC using a mini USB-B cable.



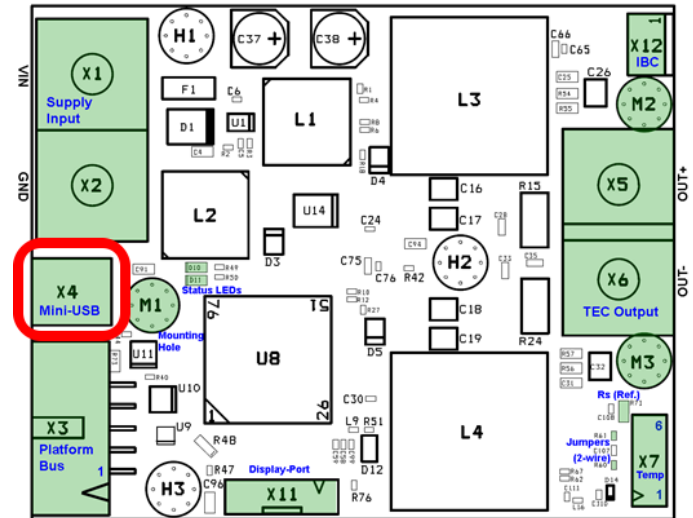
Windows will prompt you to install a USB (serial interface) driver – if not yet installed.



Follow the steps for the installation as shown by Windows.



If Windows cannot recognize a new device you can install the driver from FTDI directly.
(<http://www.ftdichip.com/Drivers/D2XX.htm>)



There are some minimum requirements for the service software:

- Microsoft .NET Framework 4.6.x
- Microsoft Visual C++ 2015 Redistributable Package



1.2 Microsoft .NET Installation

Install Microsoft .NET Framework if necessary:

<http://dotnetsocial.cloudapp.net/GetDotnet?tfm=.NETFramework,Version=v4.6>



1.3 Microsoft Visual C++ 2015 Redistributable (x86) Installation

Install Microsoft Visual C++ 2015 Redistributable (**x86**) if necessary:

<https://www.microsoft.com/en-us/download/details.aspx?id=48145>

(Use Microsoft Visual C++ 2010 Redistributable (x86) for Service Software Versions < 2.70)



1.4 TEC Service Software Installation

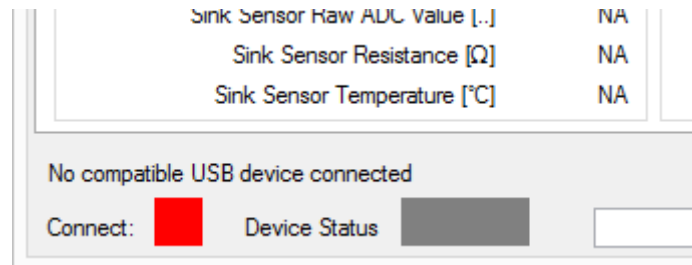
- Download TEC controllers software package to a folder on your PC (<http://meerstetter.ch/category/31-latest-software?download=331>)
- Right-click on the ZIP-file, click «Properties», click on «Unblock» on the bottom right



- Extract the files
- Open TEC service software (TEC Service vx.xx.exe)
- Get familiar with the 8 tabs of the TEC service software and their names on top.



TEC service software displays: «No compatible USB device connected» because the TEC controller is not yet powered by the external power supply



2. Hardware Setup

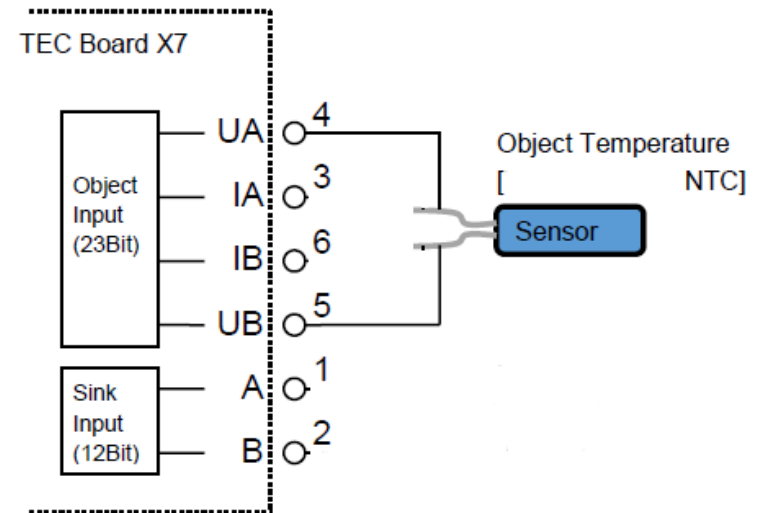
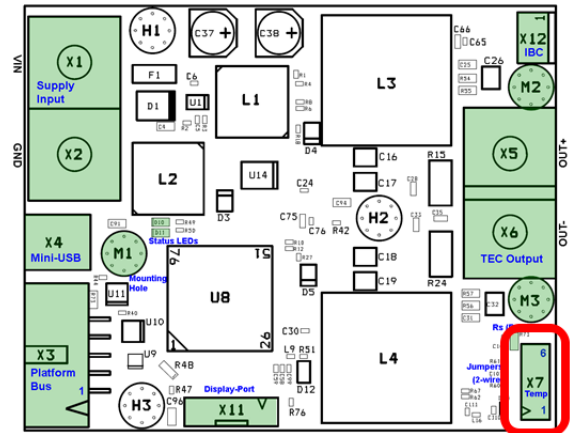
TEC Controller Setup Guide

2.1 Connect Temperature Sensors

- Consult the pinout in the CAB-6154 specifications to learn how to connect the sensor:
<http://meerstetter.ch/category/46-cables?download=176>
- Solder the NTC temperature sensor to the pre-assembled cable (Pin 4 & 5 of CAB-6154)
- Connect the sensor at X7 of the controller.



A sink temperature sensor is not used in this case. (Pin 1 & 2 of X7)



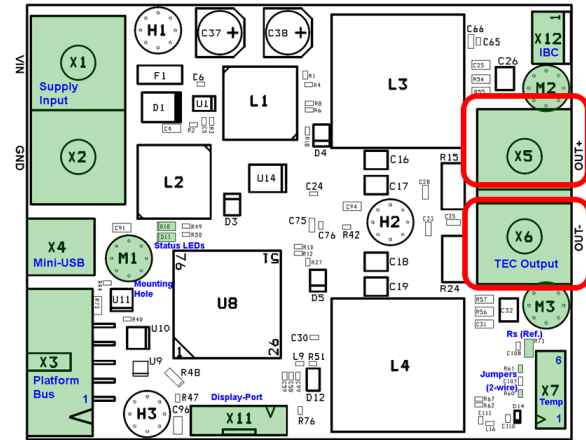
2. Hardware Setup

2.2 Connect Peltier Element

- Connect the red cable of the Peltier element to X5 (OUT+)
- Connect the black cable of the Peltier element to X6 (OUT-)

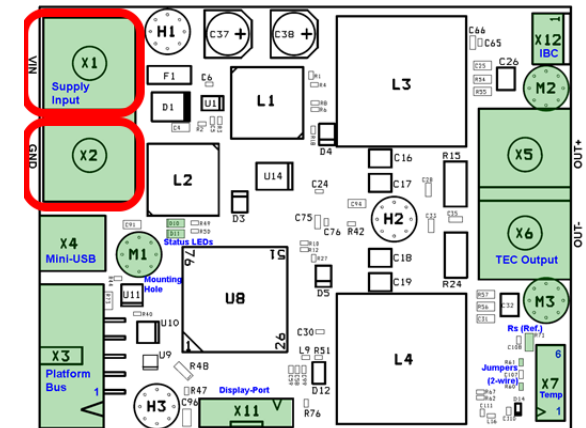


The cold side of the Peltier element will be the one with the identification marking.

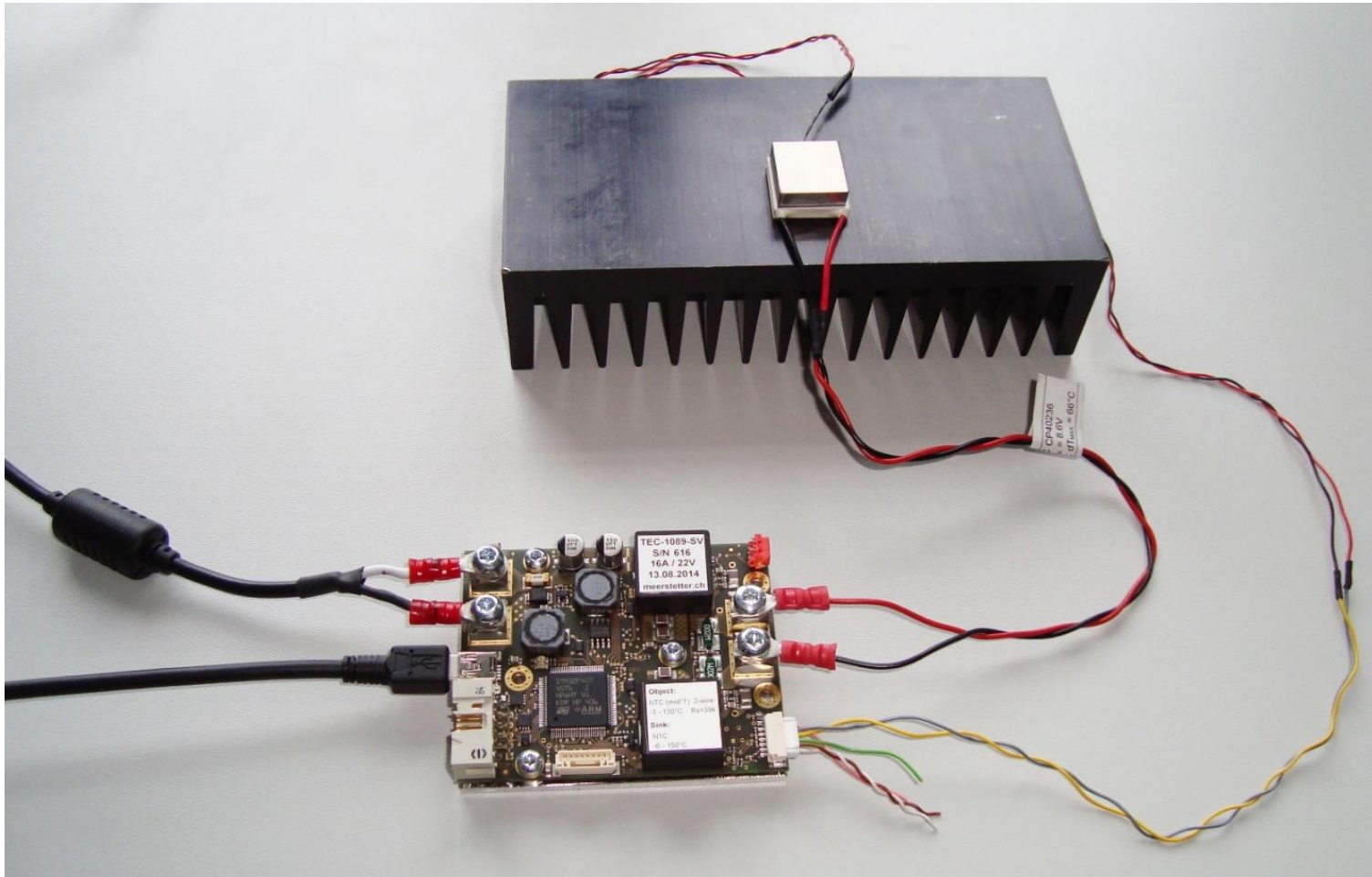


2.3 Connect Power Supply

- Set the power supply to 24 V
- Switch off the power supply
- Connect the TEC controller to the power supply at X1 (24 V) and X2 (Ground)
- Switch on the power supply



Since we have everything connected and prepared, our setup now looks like this.



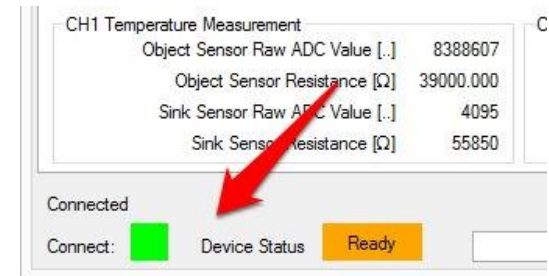
2. Hardware Setup

TEC Controller Setup Guide

- Green LED starts flashing continuously on the TEC Controller
- Service software displays «Connected» and connect status indicator is green
- «Device Status» is amber and ready



- Information about your TEC controller is displayed on the top right corner of the first tab
- If an error occurs, the description is displayed in the «Monitor» tab



Important: We assume that you set up a new TEC controller with default settings.



If not please load the default configuration from the TEC controllers software package you have downloaded from our website.
(5134x TEC Default Config.ini)

- Load the default configuration by clicking on «Import Config» in the bottom right corner of the window



The loaded values appear in the text fields. They are not yet active on the TEC controller.



Save the changed settings to the TEC controller by clicking «Write Config» in the bottom right corner of the window.



In general you have to set values by typing them to the corresponding field and click on «Write Config» to save them to the controller.



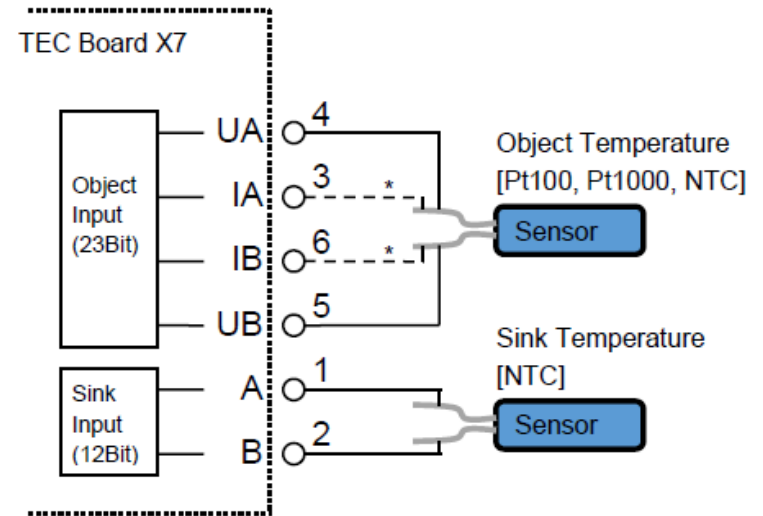
4. Temperature Measurement

TEC Controller Setup Guide

- We use a 10K NTC sensor with a B value of 3988K (beta value). The values for the sensor already correspond to the default settings. If you use another NTC sensor, you will have to set the values given by the datasheet of the sensor.
- For Pt100 or Pt1000 sensors the TEC will use internally stored settings.
- If a Pt100/1000 sensor is used, we use 4-wire sensing for higher precision. In this case the assembly is done according to the schematic on the right side. (Thus on each pin of the sensor, two cables are soldered to.)



Set «CH1 Object NTC Sensor Characteristics» in Tab 7 if you are not using a NTC 10K B = 3988K sensor, by defining the resistances for the corresponding temperature points, given by the datasheet of the sensor.



* In case of Pt100 or Pt1000, use 4 wires to connect the Object Temperature Sensor

CH1 Object NTC Sensor Characteristics		Actual	New
Upper Point	Temperature [°C]	60	<input type="text"/>
	Resistance [Ω]	2488	<input type="text"/>
Middle Point	Temperature [°C]	25	<input type="text"/>
	Resistance [Ω]	10000	<input type="text"/>
Lower Point	Temperature [°C]	0	<input type="text"/>
	Resistance [Ω]	32650	<input type="text"/>

4. Temperature Measurement

TEC Controller Setup Guide

Check if the temperature measurement in Tab 1 shows realistic values. The value of «Object Temperature» should be approx. ambient temperature.



Monitor	Chart	Operation	Temperature Control	Object Te
CH1 Temperature Measurement				
			Object Temperature [°C]	23.436
			Sink Temperature [°C]	25.000
CH1 Temperature Control				
			Target Object Temperature [°C]	25.000
			(Ramp) Nominal Object Temperature [°C]	25.000
			Thermal Power Model Current [A]	0.00
CH1 Output Stage Monitoring				
			Actual Output Current [A]	0.01
			Actual Output Voltage [V]	0.02

5. Peltier Element Characteristics

TEC Controller Setup Guide

Important: «CH1 Peltier Characteristics» in Tab 5 are values given by the datasheet of the Peltier element. These values can not be used to limit the output. Limits are set in Tab 4 Operation.



- Search the two parameters in the datasheet of your Peltier element:
 I_{\max} and dT_{\max}
In this example 4 A and 66 °C
- «CH1 Peltier Characteristics»: Put the two parameters into the corresponding fields
- Choose the option «Cooling» in «Positive Current is»



Monitor	Chart	Fast Chart	Operation	Temperature Control
CH1 Nominal Temperature				
	Actual	New		
Target Object Temp [°C]	25	<input type="text"/>		
Coarse Temp Ramp [°C/s]	1	<input type="text"/>		
Proximity Width [°C]	1	<input type="text"/>		
CH1 Temperature Controller PID Values				
	Actual	New		
Kp [%/°C]	10	<input type="text"/>		
Ti [s]	300	<input type="text"/>		
Td [s]	0	<input type="text"/>		
D Part Damping PT1 [..]	0.3	<input type="text"/>		
CH1 Modelization for Thermal Power Control				
Actual	Peltier, Full Control			
New	<input type="text" value="Peltier, Full Control"/>			
CH1 Peltier Characteristics				
	Actual	New		
Maximal Current Imax [A]	15	<input type="text" value="4"/>		
Delta Temp dTmax [°C]	68	<input type="text" value="66"/>		
Positive Current is	Heating	<input type="text" value="Cooling"/>		
CH1 Resistor Characteristics				
	Actual	New		
Resistance [Ω]	1.65	<input type="text"/>		

6.1 Target Object Temperature

Our goal is now to keep an object at a constant temperature. First we set the control parameters. Then we have to limit the output of the TEC controller.



Set «Target Object Temp [°C]» at «CH1 Nominal Temperature» to 15



In «CH1 Modelization for Thermal Power Regulation» the option «Peltier, Full Control» is chosen. That means that the controller can heat and cool the object using the Peltier element.



	Actual	New
CH1 Nominal Temperature		
Target Object Temp [°C]	25	<input type="text" value="15"/>
Coarse Temp Ramp [°C/s]	1	<input type="text"/>
Proximity Width [°C]	1	<input type="text"/>

	Actual	New
CH1 Modelization for Thermal Power Control		
Actual		
New		<input type="text" value="Peltier, Full Control"/>

	Actual	New
CH1 Peltier Characteristics		
Maximal Current I _{max} [A]	4	<input type="text"/>
Delta Temp dT _{max} [°C]	66	<input type="text"/>
Positive Current is	Cooling	<input type="text"/>

6.2 Operation Limits

Now we need to set the output limits for the operation of the Peltier element.

Limits are set depending on the application. However, usually the voltage limitation should be set approx. 1 V over U_{\max} of the Peltier element.



- Set «CH1 Output Stage Control Input Selection» to «Temperature Controller»
- Set «CH1 Output Stage Limits» & Error thresholds for this example:
 - «Current Limitation [A]»: 4
 - «Voltage Limitation [V]»: 9.6
 - «Current Error Threshold [A]»: 4.8
 - «Voltage Error Threshold [V]»: 12



Error thresholds should be set approx. 20% over the corresponding limits. An error is generated if a value reaches the threshold.



Monitor	Chart	Fast Chart	Operation	Temperature Control
CH1 Output Stage Control Input Selection				
Actual	Static Current/Voltage			
New	Temperature Controller			
CH1 Output Stage Enable				
Actual	New			
Output Enable	Static OFF			
CH1 Output Stage 'Static Current/Voltage' Control Values				
Actual	New			
Set Current** [A]	10			
Set Voltage [V]	8			
CH1 Output Stage Limits				
Actual	New			
Current Limitation [A]	10	4		
Voltage Limitation [V]	19	9.6		
Current Error Threshold [A]	12	4.8		
Voltage Error Threshold [V]	22.8	12		

6. Temperature Controller

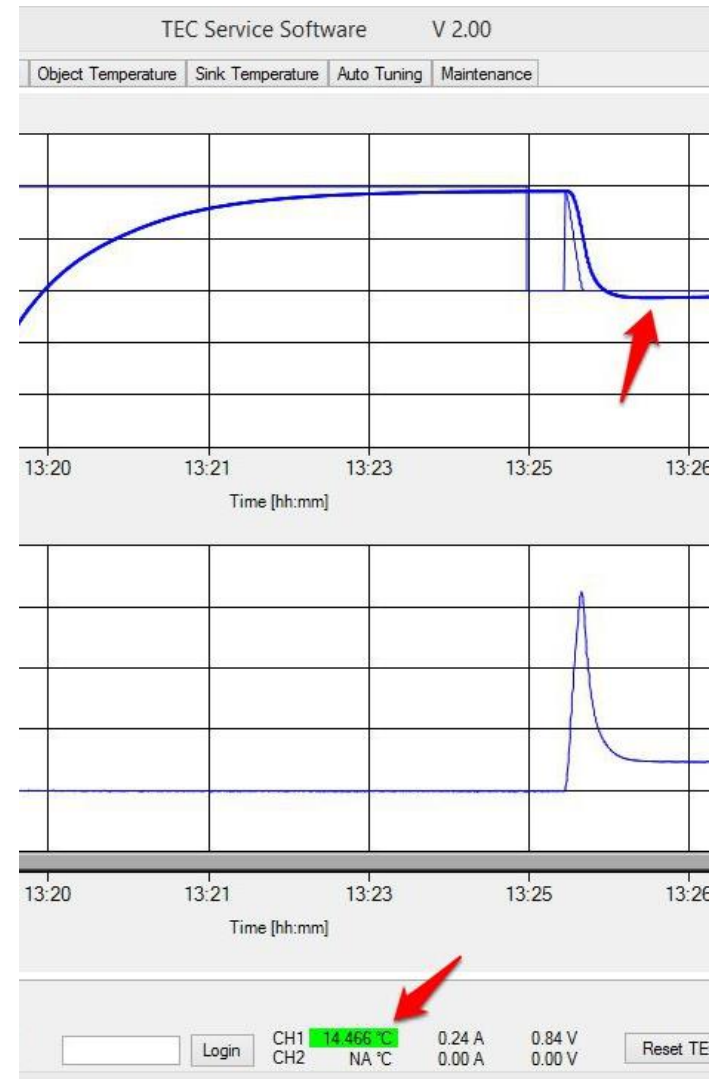
TEC Controller Setup Guide

6.3 Functionality Check

Set «CH1 Output Stage Enable» to «Static ON» in Tab 4



- Check the temperature chart in Tab 2
- The temperature will converge to 15°C
- In the status bar at the bottom the «Object Temperature» is amber if it has not yet reached the target temperature
- If the «Object Temperature» equals the target temperature the indicator is green
- There can be a small difference between the desired target temperature and the measured object temperature



- If the temperature is changing in the wrong direction, the Peltier element is connected the wrong way. Switch the wires at X5 and X6 and test your setup again.
- See step 2.2 for more information about how to connect the Peltier element.



7. Auto Tuning

TEC Controller Setup Guide

To be able to precisely control the object temperature we have to optimize the control system of the TEC controller. This can be done using the integrated PID Auto Tuning function to optimize the values of the PID controller.



- Make sure the Output Stage is «Static ON», the Target Temperature is approximately reached and the temperature has equalized
- Click on the «Start» button



The Auto Tuning tries to optimize the system and seeks optimum PID controller values



Monitor | Chart | Operation | Temperature Control | Object Temp

PID Auto Tuning

Select the TEC Instance: CH 1

1. Presettings

Thermal Model Speed: Fast Model

2. Status

Start | Cancel

Ramping to Target Temperature...

3. Tuning Results

Fast PID Values

Kp	0.000 %/°C
Ti	0.0 s
Td	0.0 s

Slow PI Values

Kp	0.000 %/°C
Ti	0.0 s

Use Slow PI Values

PID D Part Damping PT1 Recommendation

Recommended Value: 0.000

Use the Recommended Value

Nominal Temperature Ramping Recommendation

Coarse Temp Ramp: 0.000 °C/s

Proximity Width: 0.0 °C

Use the Recommended Value

Write Auto Tuning Results to TEC

7. Auto Tuning

TEC Controller Setup Guide

Tab 2 Chart:

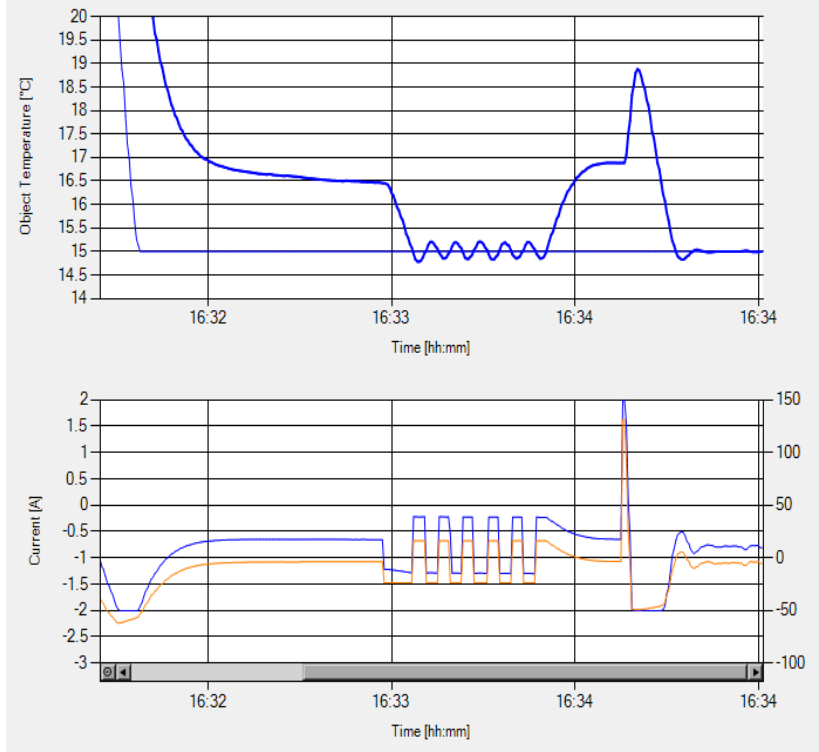
- 16:33:00 Auto Tuning started
- 16:33:50 Auto Tuning finished
- 16:34:30 New PID values applied



- If the tuning was successful, the found values can be saved by clicking on «Write Auto Tuning Results to TEC» in Tab 8
- If it was not successful, try the option «Slow Model» in «Thermal Model Speed»



The system will use the found PID parameters from now on to control the system if the tuning was successful.



Congratulations! Your TEC controller is working and you should be able to set up a simple application with your TEC controller.

- If you need more information about how to design a thermoelectric application including calculations, choosing Peltier elements, temperature sensors, heat sinks and power supplies, please refer to our «TEC / Peltier Element Design Guide» on our website:
<http://meerstetter.ch/compendium/tec-peltier-element-design-guide>
- If you need further or more detailed information about operating our TEC controllers, please refer to the TEC Family User Manual:
<http://meerstetter.ch/de/category/33-latest-user-manuals?download=4>
- For a general overview of our TEC controllers please visit our products page:
<http://meerstetter.ch/products/tec-controllers>