FLASH *PHOTONICS*

The TCW is a current driver designed to drive and control the temperature of Peltier driven thermal systems. Includes a user interface with tools for controlling, monitoring and calibration. It is fully controllable and configurable through a USB to Serial digital interface and has analog I/O for monitoring and control.

Features:

- Bipolar output current up to ±15A
- Temperature stability up to ±0.01°C
- Adjustable current limits
- USB C or Micro USB, and RS232 digital communication
- Pass-through support for up to 8 controllers on a single USB line
- Intuitive GUI with auto-calibration
- Compatible with NTC and RTD temperature sensors
- Standalone, remote, and script-based operation

Specifications:

Output Current	± 15A
Output Voltage	± 24V
Ripple Frequency	> 300 kHz
Control	Digital For Analog Options Contact Supplier
Dimensions	115mm x 64mm x 15mm
Operating Temperature	10 to 55 ºC
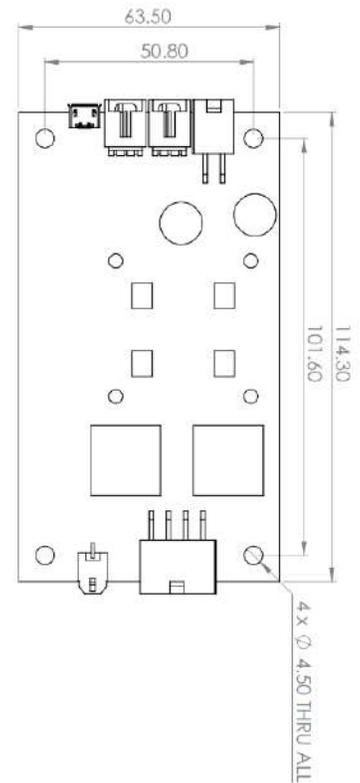
1 Product Description

The TCW is a bipolar temperature controller designed for real-time thermal stability in Peltier-driven systems. It delivers up to ±15A of low-noise current at up to 24V and can be controlled via analog signals or digitally over USB or RS232. An onboard microcontroller enables advanced PID control and auto-calibration. The pass-through feature allows up to 8 compatible controllers to share a single USB command line. Fan cooling is recommended for sustained operation above 5A.

2 Electrical Specifications

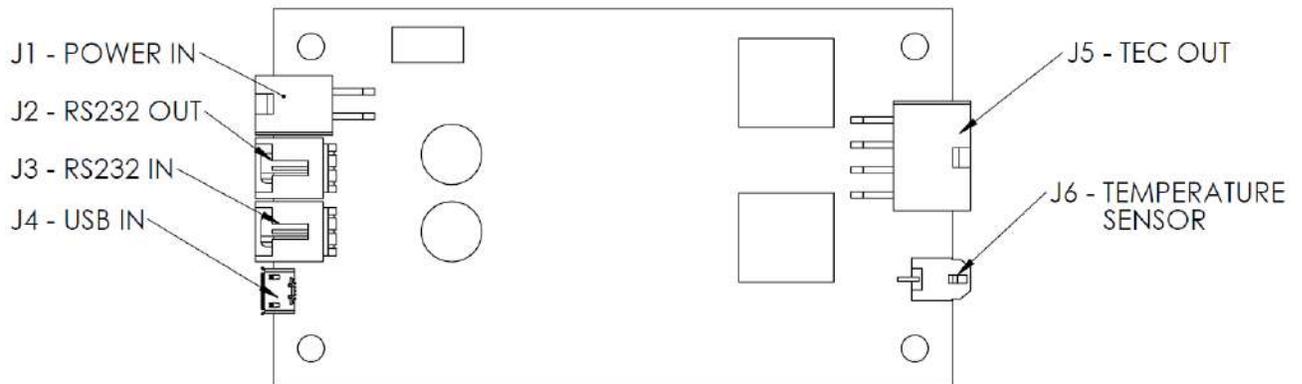| Specifications	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	V_{in}	12		25	VDC	
Output Voltage				$\pm(V_{in}-1)$	V	
Output Current				±15	A	
Short Term Stability, 1 hour			0.1		ºC	
Long Term Stability, 24 hours			0.1		ºC	
Operation Temperature		10		55	ºC	

3 Electrical Connections

Figure 3-1 Top view of driver, highlighting electrical connections
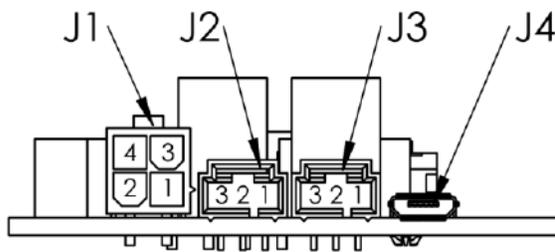
Figure 3-2 Side view 1 of driver, highlighting connector pins

Pin	Name	Description
J1 – Power In – TE 4.2mm - Part No. 1586041-4		
1 & 3	GND	Ground, use both pins for currents > 9A
2 & 4	Vin	Power Input, voltages 12 – 25 V, Use both pins for currents > 9A
J2 – RS232 Out - Molex 2.54mm – Part No. 0705530037		
1	GND	Ground
2	TX-Out	RS232 Transmit, for pass-through chaining with other controllers
3	RX-Out	RS232 Receive, for pass-through chaining with other controllers
J3 – RS232 In - Molex 2.54mm – Part No. 0705530037		
1	GND	Ground
2	RX-In	RS232 Receive
3	TX-In	RS232 Transmit
J4 – USB In – USB C or Micro USB Port		
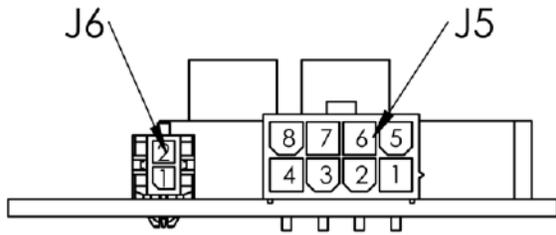
Figure 3-3 Side view 2 of driver, highlighting connector pins

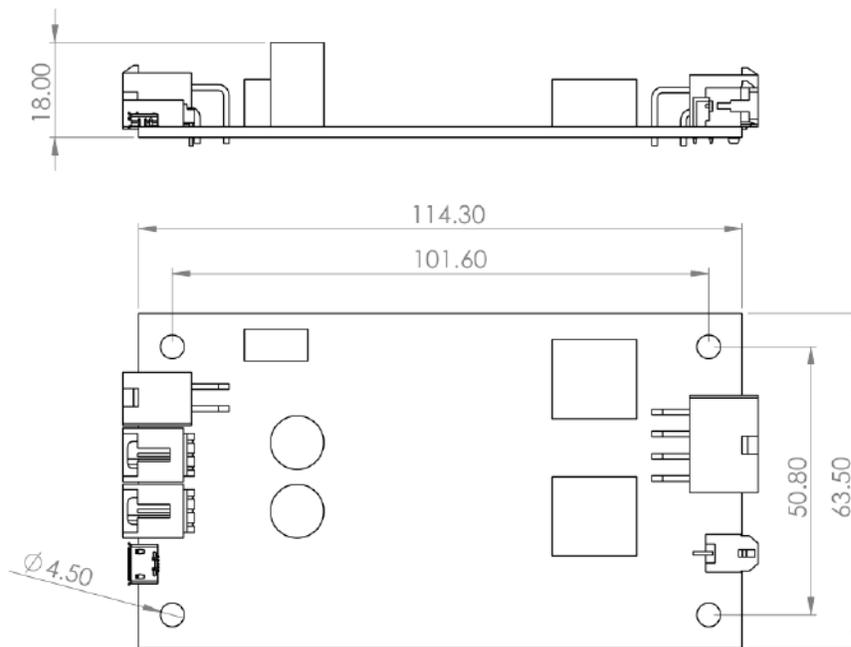| Pin	Name	Description
J5 – TEC Out – TE 4.2mm – Part No. 1586041-8		
1 & 4	GND	Ground
5 & 6	TEC-	Negative pole of TEC, use both pins for currents > 9A
7 & 8	TEC+	Positive pole of TEC, use both pins for currents > 9A
J6 – Temperature Sensor – Molex 3mm – Part No. 0430450200		
1	SEN-	Temperature sensor negative input
2	SEN+	Temperature sensor positive input

4 Mechanical Layout

Figure 4-1 Top and side view of open frame driver, highlighting mechanical dimensions

5 Serial Communication

Communication Overview

The TCW can be controlled digitally via USB or RS232. When a USB connection to a PC is active, the device defaults to USB communication and the RS232 port is disabled.

USB communication is handled by an FTDI USB-to-Serial converter. VCP drivers for Windows and macOS are available at: https://ftdichip.com/drivers/vcp-drivers/

Pass-Through Chaining

Up to 8 compatible controllers can share a single USB line using pass-through chaining. To chain controllers, connect the **J2 – RS232 Out** pin of each controller to the **J3 – RS232 In** pin of the next.

Serial Parameters

Parameter	Value
Baudrate	115200
Data Bits	8
Stop Bits	1
Flow Control:	None

Command Syntax

The TCW communicates using ASCII commands, each terminated with a newline character `\n`.
- **Set a parameter:** Send the command, followed by a space, the desired value, and `\n`
- **Queries:** End with `?\n` and return the query name followed by the value
- **Success/failure:** Commands return `ok\n` or `error\n`

Addressing

Each command must begin with one or more characters that route the message to the intended driver in the chain.
- `'` (Single quote; 0x27) passes the command **one step forward** to the next driver. Chain multiple `'` characters to route further down the line. For example, `''` passes through two drivers to reach the third.
- `"` (Double quote; 0x22) instructs the **current driver** (at the end of the routing path) to execute the command.

These can be combined: prefix the command with the appropriate number of `'` characters to reach the target driver, followed by `"` to address it. For example, to send a command to the **third** driver in the chain, use `''"`. Alternatively, once a driver has been assigned an address, it can be targeted directly using its address character, without needing to count hops.

Example — Set the third driver's address to 5, then query its firmware version:

```
''"addr 5\n
> ok\n
5ver?\n
> ver? TCW 1.0.0
```

| Character	Behavior
" (0x22)	Communicate directly with the addressed driver
' (0x27)	Pass through to the next driver in the chain
Address Char	Communicate with a specific driver by its assigned address

Serial Commands

Command	Arg Type	Description
ver?	Queries Only	Returns the software version of the controller
addr x	0 − 9	Character for addressing the device
sern?	Queries Only	Returns the serial number of the controller
temp?	Queries Only	Returns the temperature of the sensor in ºC
vs1?	Queries Only	Returns the voltage across the Peltier device in volts
is1?	Queries Only	Returns the current through the Peltier device in amps
btemp?	Queries Only	Returns the temperature of the board
enable x	Boolean	Enables (1) or disables (0) the control output
ge?	Queries Only	Returns any errors
clerr	None	Attempts to clear any errors
ctler	None	Puts the controller in an error state
tset x	Float	Sets the setpoint of the controller temperature in ºC
maxi x	Float	Sets the max current of the controller in amps
lock x	Float	Sets the locked temperature threshold in ºC
kp x	Float	Sets the proportional term of the PID loop
ki x	Float	Sets the integral term of the PID loop
kd x	Float	Sets the derivative term of the PID loop
autos x	Boolean	Enables (1) or disables (0) enabling the controller at boot
thrmt x	Int	Thermistor type: 1 - NTC 3 - RTD
th**b**ta x	Float	Beta parameter for thermistor
thrro x	Float	Ro parameter for thermistor
thalp x	Float	Alpha parameter for thermistor

6 User Interface

The TCW provides a graphical user interface for streamlined control and monitoring of the device.

Settings Tab
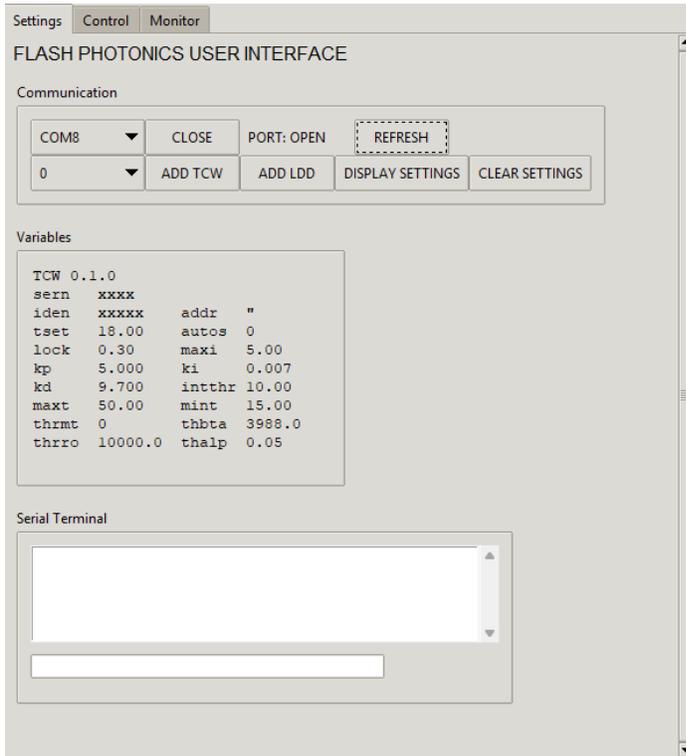
The Settings tab manages communication setup and driver initialization. Ensure the TCW driver is powered on and connected, then select the appropriate COM port from the **PORT** drop-down menu. Click **OPEN** to establish communication.

To operate multiple drivers on the same communication line, click **ADD TCW** once for each additional driver. For example, if two TCW drivers are in use, click **ADD TCW** twice. All added drivers will appear in the **DRIVER** drop-down menu. Select the desired driver from this menu before issuing any commands. For example, to communicate with the first driver, select **0** and click **DISPLAY SETTINGS**, the driver's settings will populate on screen. A Serial Terminal at the bottom of the tab is available for direct command entry.

Control Tab
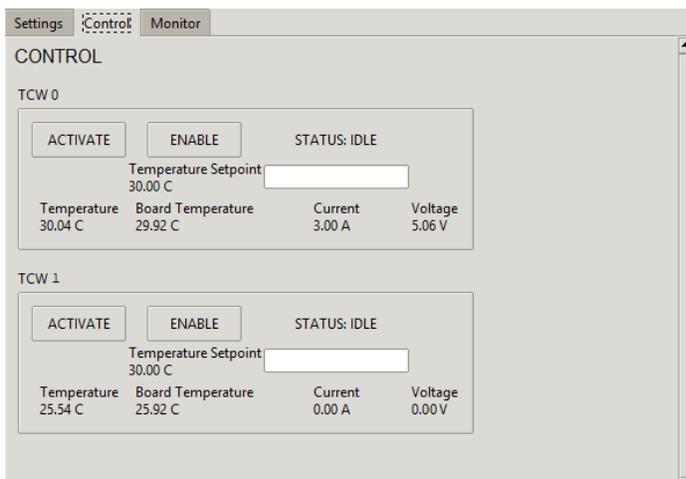
The Control tab provides quick access to essential driver controls. Click **ACTIVATE** on each driver panel to enable continuous live updates for that driver. From this tab, drivers can be individually enabled or disabled and the temperature set point can be adjusted.

Monitor Tab
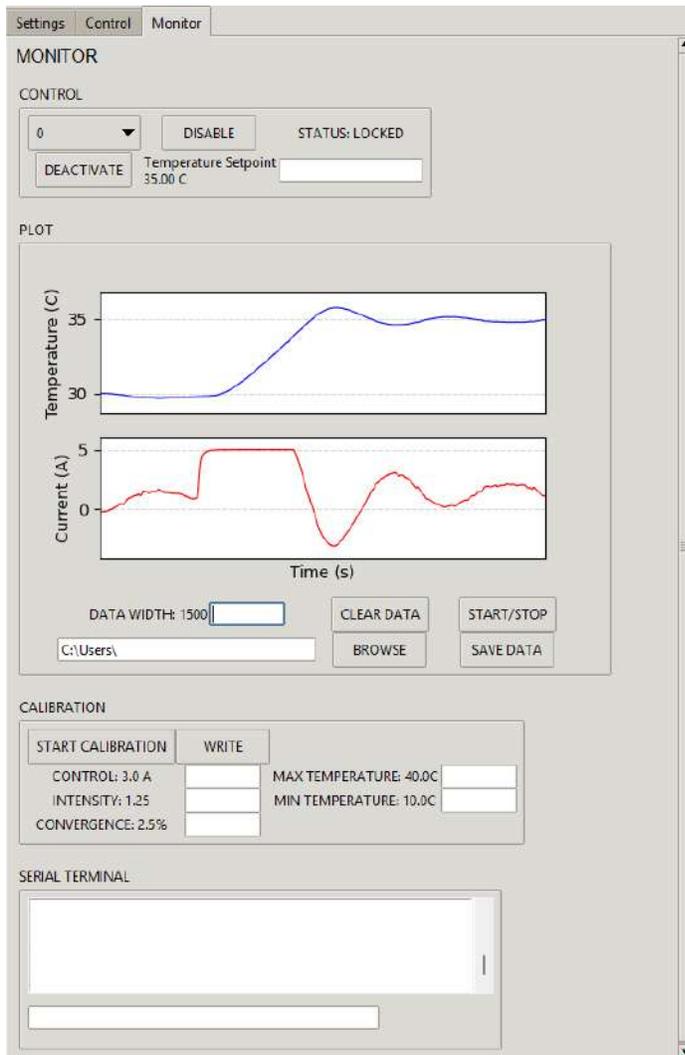
The Monitor tab displays detailed driver information and provides access to calibration functionality. Select a driver from the drop-down menu at the top of the tab.

In addition to standard temperature controls, a real-time graph is available and can be toggled using the **START/STOP** button. Data can be saved to a user-specified location on the computer by clicking **Browse** to select a destination folder.

The control loop for the selected driver can also be calibrated from this tab. During the calibration routine, the driver waits for thermal stability, then applies a constant current through the load. The resulting temperature response is recorded, and the loop parameters are calculated accordingly.

⚠ **Caution:** A constant current will be applied to your system during calibration. It is the user's responsibility to set a current appropriate for their specific hardware and thermal setup.

The following calibration parameters are user-configurable:

- **Max/Min Temperature Limits** — Define safe operating boundaries for connected devices. Note that these limits are not a substitute for proper thermal system design and do not guarantee system safety.
- **Intensity** — Adjusts the gain applied during parameter calculation. Increase or decrease this value to tune the responsiveness of the calibration.
- **Convergence** — Determines how long the calibration routine waits before settling on final parameters. A lower value allows more time for stabilization.

7 Error Codes

The TCW features error conditions. To read errors write the command `ge?`. If there are any errors they will be listed in return. It is possible to read more information from the error by writing the error number after ge?. It is possible to attempt to clear the errors with the command `clerr`. For example:

```
ge?\n
> ge? 1 3\n
ge? 1\n
> TEC Error\n
clerr\n
> ok\n
ge?\n
> ge?\n
```

More information on the errors are provided below.

Error Number	Description	Recommended Solution
0	**Thermistor Error** The controller's reading of temperature is out of an acceptable range.	Ensure that the temperature sensor is properly connected and the temperature sensor settings are properly set on the controller
1	**Load Error** The controller has detected an open circuit on output	Ensure that the Peltier device is properly connected and is in working condition
3	**Initialization Error** The controller did not initialize properly	Unplug the controller, wait a few seconds and then plug it back in
4	**Fatal Error** The controller has detected a short circuit on the output	Unplug the controller, inspect the output and ensure that the Peltier device is properly connected and is in working condition
6	**Board Temperature Error** The temperature of the controller has exceeded its rated limit	Use a fan to cool down the board when in operation
7	**Control Error** Error state when the command `ctler` is sent	Clear the error with `clerr`