Cool*Tronic*

Peltier-Controller TC0806-RS232

User Manual

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Contents

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1. Overview

1.1. Application

The **Peltier-Controller TC0806-RS232** is a temperature indicator with controlling function and DC voltage output for driving thermoelectric (Peltier) elements. It has a housing for panel mount according to DIN 43700.

It requires an external DC power supply in the range from 12 to 13.8V and is solely intended for use with a low voltage power supply.

1.2. About the documentation

This documentation is valid for **Peltier-Controller TC0806-RS232**, FW-Version V100.70 as of 26.11.2012. TCCOM for Windows is documented in its own manual, supplied with the program. Version V100.70 of the firmware requires TCCOM for Windows V1.82 Build 120 or above. (C) 2006 - 2016 jagdt engineering, all rights reserved.

1.3. Items supplied

Supplied items are:
- Peltier Controller TC0806-RS232
- 2 pcs. mounting clamps
- 1 connector Sauro CIF, spacing 5.08mm, 4-pole
- 2 connectors Sauro CTF, spacing 3.81mm, 8-pole
- this manual as PDF file on CD
- TCCOM for Windows™ on CD
- User manual TCCOM for Windows™ as PDF-document on CD

As an option:
- Interface cable with 9-pole DSUB receptacle and connector Sauro CTF, spacing 3.81mm, 8-pole
  lengths available: 2m or 5m

2. Operation and Installation

2.1. Overview

The keys are positioned on the visible front of the TC0806-RS232 Peltier-Controller.. The connections of the instrument are done via three connectors on the rear of the controller and are not accessible after installation. The instrument will be installed via two snap clamps with fastening screws.

2.2. Display and operating elements
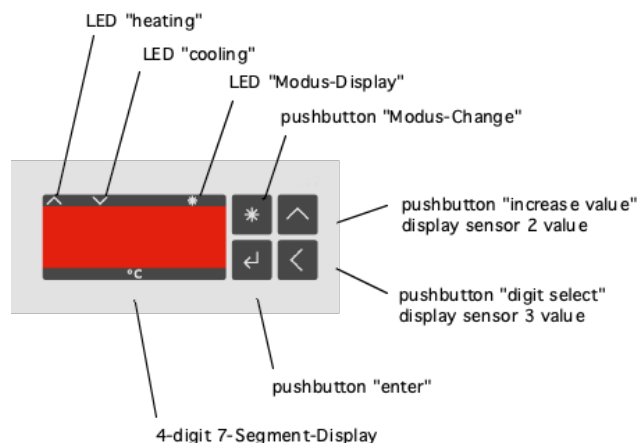
view of the front panel

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The instrument has a 4-digits 7-segment-display. The temperature indication range is -75.0 ... + 175.0. The nominal temperature range is -50.0 ... + 150.0. The unused decimal points are used for displaying the operation modes.

<u>Function of the 3 LEDs:</u>

LED "Heating"	Controller heats
LED "Cooling"	Power output shut off
LED "Mode-Display"	Programming mode and other special displays

The 4 Keys have the following functions:

Key "Mode-Switch"	changes the operation mode
Key "increase value"	increases the value of the selected digit
	temporarily display value of sensor 2 (if present)
Key "Digit selection"	changes the activated digit
	temporarily display value of sensor 2 (if present)
Key "Enter"	stores the value or the item changed

For details see chapter „Firmware".

2.3. Inputs and outputs

2.3.1. Overview

The connection is made with three connectors on the rear side of the controller.
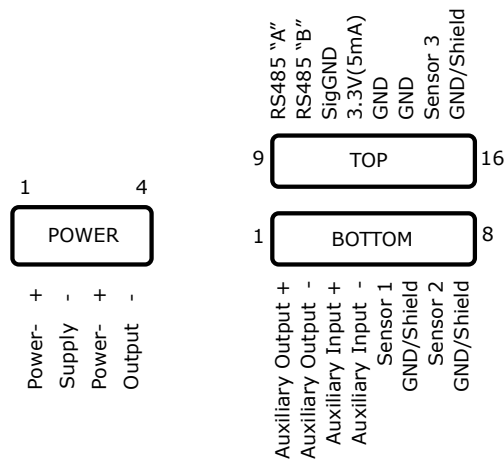
view at the connectors

The connection is made via a 4-pole plug for power supply and power output and two 8-pole plugs for signals and sensors.

Voltage supply and power output

Pin configuration	1	power supply (plus)
	2	power supply (minus)
	3	power output (plus)
	4	power output (minus)

Pin configuration	1	Signal output (plus)
	2	Signal output (minus)
	3	Control input (plus)
	4	Control input (minus)
	5	input (Sensor 1)
	6	GND (Sensor 1)
	7	input (Sensor 2)
	8	GND (Sensor 3)

9   RS232, RX-data to personal computer
10 RS232, TX-data from personal computer
11 RS232, signal ground
12 not connected, do not use
13 GND
14 GND
15 input (Sensor 3)
16 GND (Sensor 3)

2.3.2. Sensor inputs

The sensor inputs accept Pt1000 resistive sensors only. A special version to use with Pt100 resistive sensors is available on request.

Input voltage range	400..1100mV nominal
sensor current range	0.6 to 0.9 mA, depending on actual temperature value
resistance range	apr. 700 .. 1670 Ohm (for - 75.0 ... 175.0 °C)
connection	2-wire mode
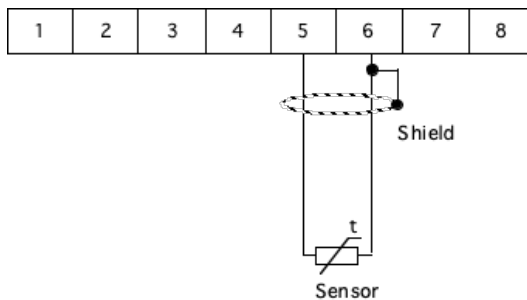
connection of Sensors 1 as an example

The use of 2-wire sensors implies that the wire resistance will not be compensated, this leads to the following errors:

- permanent offset as a function of the wire resistance resulting in a higher temperature reading
- variable error as a function of the temperature change of the cable according to its temperature coefficient

Sensor leads with larger cross section of 0.5 mm2 or 0.75 mm2 will reduce the error effects.

Shielding of the sensor cable is recommended.

2.3.3. Auxiliary Output

The instrument has a digital output which serves the signalization of the process status. According to the configuration the output becomes active at:

- "OK"-function, the auxiliary output will be activated if the actual temperature of sensor 1 is in a range +/- tolerance range around the set-value
- "Alarm"-function, the auxiliary output will be activated if the actual temperature of sensor 1 is outside +/- alarm range around the set-value

Applicable voltage	max. 30V
Output current	max. 100 mA
Overload protection	limited protection against voltage spikes
Type	NPN-Transistor
Minimum Voltage	< 2V in switched-state

The following diagram shows the connection to a SPS input. A voltage lower than 2 Volts at the SPS-input corresponds to an activated auxiliary output.
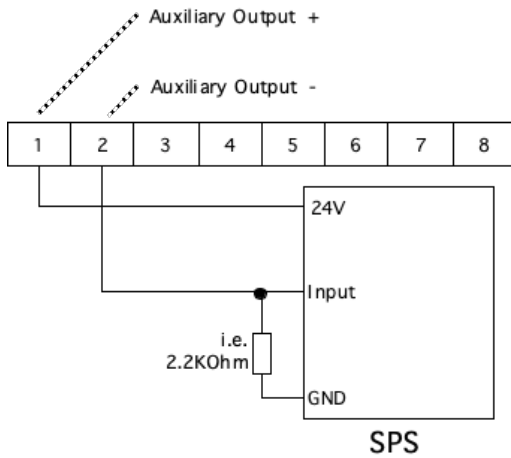
Wiring of a SPS to the auxiliary output (LOW-active)

The following diagram shows the wiring to the a SPS input. A voltage higher than > 22 V at the SPS input corresponds to an activated auxiliary output.
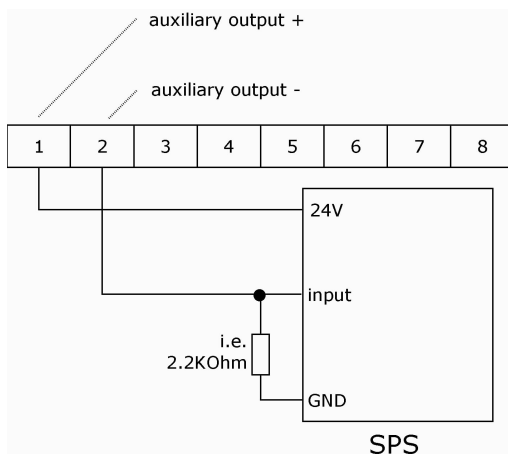
Wiring of a SPS to the auxiliary output (HIGH-active)

2.3.4. Auxiliary Input

The instrument has a digital input, which can be used to switch the power output on or off, start the Sine function or select the set-value. Depending on the configuration:

- "OFF"-function, in case of activated input the power output is off
  (this option is set as default in order to have the device functional without wiring the auxiliary input)
- "ON"-function, the power output is on with input activated
- "Sine off"-function, the Sine function is inhibited when the input is active
- "DUAL-Mode"-function, the instrument uses set-value 2 with activated input and set-value 1 if inactive or not connected

Maximum input voltage   30V
Input resistance   approx. 1 KOhms
Voltage for „ON"   > 5V
Voltage for "OFF"   < 1V

The input works independently of the polarity. Operation with alternating current is not possible, since the power output would be modulated.

Following diagram shows the driving by a NPN-output of a SPS. When the NPN output is on (= LOW) the auxiliary input will be activated.
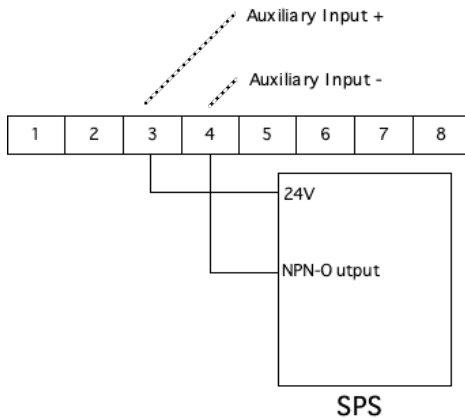
Wiring of a SPS to the auxiliary Input

2.3.5. Power output

The power output provides a DC-voltage to drive the peltier modules. The polarity is changed automatically to switch from heating to cooling or vice versa.

Output voltage	configurable in the range +/- 1.0V to +/- 8.0V
Output current	6 A max.
Overload protection	Over current shut off with automatic retry
Connecting cable	recommended cross section 0.75 …1.5 mm2 depending on the Peltier current and lead length

The marking "Output +" and "Output -" refer to the polarity when cooling down. If the system cools when it should heat and vice versa, please exchange the connections

Regarding the EMV compatibility (radiated interference) it is recommended to use twisted wires, especially in case of long cable length.

2.3.6. Voltage supply

Voltage supply	12.. 13.8V Direct Current
Current consumption	max. 6A, depends on output current and voltage supply value
Protection	6.3A fast acting fuse (may only be replaced by the manufacturer – the warranty is cancelled after opening of the case)
Supply cable	recommended cross section 0.75… 1.5 mm2 depending on the peltier current and lead length

Regarding the EMV compatibility (radiation influence) it is recommended to use twisted leads, especially in case of long lead length.

2.3.7. Serial Interface according to RS232C

The optional serial interface supports a simple protocol with software handshake, using the signals RXD and TXD only.

The interface is used for factory internal adjustments and diagnostics.

It can be used by the customers for remote control e.g. by a master process control unit. In this case CoolTronic can not be made liable for correct function of the device and the resulting accuracy.

The interface has the following data configuration

Data configuration	8 Data-, 2 Stop-Bits
Parity	none
Baud rate	9600 Baud

The interface signals are connected to one of the 8-pole connectors.

9	RS232, RX-data to personal computer
10	RS232, TX-data from personal computer
11	RS232, signal ground

The calibration of the instrument is part of the configuration data. Therefore it is not allowed to exchange the configuration data between individual instruments.

3.   Functional description

3.1.   Overview

The device has two basic modes, the normal mode and the configuration mode. After power on the controller starts in the normal mode.

Pressing the „Mode Switch" button shortly displays the actual set value. In dual mode this is the active set-value, i.e. the value selected with the auxiliary input.

Pressing the „Mode Switch" button for long will switch the controller into the configuration mode.

3.2.   Power on

Immediately after power on the controller shows a test display (all segments and decimal points are illuminated). The device tries to read out a valid configuration from the EEPROM. If this fails, the device shows the error message E100   and it is not operational. In case of an E100 error please contact the factory.

The outputs are inactive during the initialization process of the device and if errors are detected.

3.3.   Normal Mode

In the normal mode the temperature will be measured   and displayed continuously. The "mode select" button is continuously checked. The controller processes the actual temperature and the set temperature and calculates the power output setting.

The LED "heating" and LED "cooling" are flashing, if the temperature is outside the alarm range.

The LED "heating" and LED "cooling" are on, if the temperature is between the tolerance- and alarm range.

The LED "heating" and LED "cooling" are off, if the temperature is within the tolerance range.

3.4.   Set Point Display

To display the set point value press the „mode select" button, until the "mode display"-LED starts to flash. Now release the button. The controller will show the set value for 3 seconds. After that the instrument automatically returns to display the actual temperature of sensor 1.

3.5.   Display temperature value of sensor 2

To display the temperature value of Sensor 2 press the „increase value" button. The controller will show the value for 3 seconds. After that the instrument automatically returns to display the actual temperature of sensor 1.

If Sensor 2 is not enabled, this function is inhibited, the button does not react at all.

3.6. Display temperature value of sensor 2

To display the temperature value of Sensor 3 press the „digit select" button. The controller will show the value for 3 seconds. After that the instrument automatically returns to display the actual temperature of sensor 1.

If Sensor 3 is not enabled, this function is inhibited, the button does not react at all.

3.7. Programming the configuration values

To program the configuration values press the „mode select" button, until the "mode display" starts to flash and continue to hold it down until the controller changes to configuration mode.

Please note, that not all internal values can be programmed using the buttons. Certain values can only be adjusted via the serial interface. In this chapter only the values changeable via the buttons are described.

The following description uses the these conventions:

bold:	Segment flashing
normal	Segment consistent on
grey	Segment off

Step 1 – Switch to the configuration mode

Press button „mode select"
The LED „mode-display" starts to flash
Keep pressing till the display changes to:
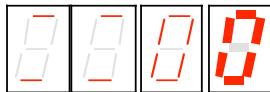
- the 2 most left digits show 2 horizontal lines to indicate that the kind of value can be selected
- the left most digit is blinking an can be changed
- the LED "heating" and LED "cooling" furthermore indicate the state of the controller
- a timeout is running, which returns to the normal mode, if no button is pressed

Step 2 – Selection of the value to be changed
There are the following options:

- press button „enter" to display the selected parameter
- press button "increase value" or button „digit selection" to select a different parameter
- press button "mode select" to exit the configuration mode immediately

Step 3 – adjust value
- You have selected the kind of value with the button „increase value", "digit select" and the button " enter"
- the display jumped to display the value selected, in this example the set temperature:
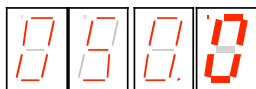
- the set temperature is displayed (here for instance 50.0°C)
- the last digit flashes

there are the following options:
- press button „increase value" to change the flashing digit (0..9, 0…)
- press button "digit select" to choose another digit
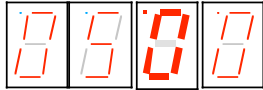
- adjust the desired value using the buttons „increase value" and „digit select"

Step 4 – confirm or reject value
- press button „enter" to confirm the adjusted value
- all digits flash
- after releasing the „enter" button the value has been transferred to the non volatile memory
- the display indicates again, which value can be changed, see step 2

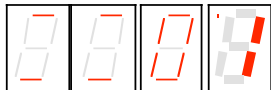

- to reject the value - press button „mode select" to exit immediately the configuration mode without changing the actual value

Please note, that changed values get effective by leaving the setup mode.

During setup mode all outputs are inhibited to avoid undesirable effects, which may be caused by uncompleted new settings.

Display of the 2 leftmost digits and their meaning

Display	Meaning
00	Set value 1
01	Set value 2
02	tolerance range
03	alarm range
04	filter-time constant
05	function of auxiliary input
06	function of auxiliary output
07	P
08	I
09	D
10	IL
11	output voltage setting
12	temperature correction, sensor 1
13	temperature ramp of the set value
14	Sine function: amplitude
15	Sine function: cycle time
16	temperature correction, sensor 2
17	temperature correction, sensor 3

All values are checked for an internally defined value range. If the range is exceeded the value is reset to a start value and must be adjusted again.

If some value was out of range the value will be reset to a default value when selected.

Value range, start value and default value are documented in chapter "Configuration vales".

3.8. Display of specific configuration values

3.8.1. Set value 1 and 2

The adjustable range is -75.0 … 175.0, whereas the nominal range is -50.0 … 150.0. Hence the highest digit changes only 0 .. 1 .. - (negative sign).

3.8.2. Tolerance and alarm range

- the range is 0.0 .. 9.9
- the display is in 1/10°

3.8.3. Filter

- visualized by „F" for Filter in the left most digit

  ...

- Digit 0 und 1 show the time constants in seconds 1 - 2 - 5 - 10 - 20 - 50

3.8.4. Auxiliary input

The auxiliary input can optionally be used for switching the power output ON or OFF. Switching OFF is standard, to have the device functional without external wiring. In addition the input may be configured to select the set value or to start / stop the Sine function.
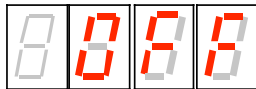
Display „OFF" corresponds to the switch OFF Function, where the the controller output will be switched off when activated.
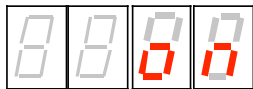
Display „on" corresponds to the switch ON Function, where the the controller output will be switched on when activated.
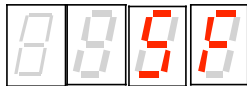
Display "SF" stands for "stop Sine function", which means the instrument will regulate the temperature according to the nominal set value, and ignore the Sine function settings. When the auxiliary input is deactivated the Sine function will start at the set value.
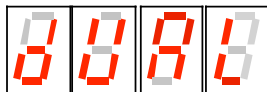
Display "dUAL" enables the "Dual mode". With the auxiliary input activated set value 2 is effective, else set value 1.

3.8.5. Auxiliary output

The auxiliary output has two operation modes:
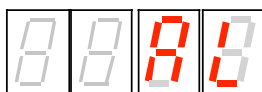
- "AL" corresponds to the Alarm-Function: the output is activated, if the temperature is outside the alarm range
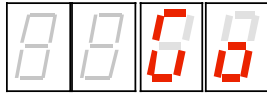
- "Go" corresponds to the Good-Function: the output is activated, if the temperature is inside the tolerance range

3.8.6.   Control parameter

The Parameter adjustment shows an identification letter in the first digit: (in the example a "P" for the proportional coefficient KP:

Meaning of the identification letter:

P: Control Parameter KP
I: Control Parameter KI
d: Control Parameter KD

The maximum value is 63, in case of exceeding the value the display returns to Zero and it must be set again from start. A value of 0 inhibits the corresponding part of the control algorithm

L: Control Parameter IL (Integration limit), maximum value 999, a value of 0 inhibits the integral part, the value is multiplied internally by ten

U: Maximum value of the output voltage, value range 1.0 .. 8.0 [V], in case of exceeding the value the display returns to Zero and it must be set again from start. A value of 0 inhibits the output stage. Values between 0.0 and 1.0 are not allowed.

3.8.7.   Temperature offset setting

The left most digit shows the identification letter „o":
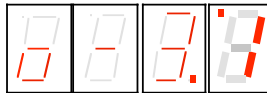
To correct errors caused by temperature sensor or wiring, an offset of -9.90 to 9.9 can be input. Use a reference thermometer or an ice bath for calibration.

3.8.8.   Temperature set-value ramp

The left most digit shows the identification letter „r":

The ramp value in 0.1°C is displayed, in our example 3.0°C. The value range is 0.0 to 9.9.

A value of 3.0 means, that the internal set point value will be increased linearly with a rate of 3.0°C per minute

A selected value of 0.0 inhibits the ramp function, any change of the setpoint will become effective immediately.

The „nominal set point value" is the value, which appears after short pressing the mode button.

The "actual set point value" is an internal value, which will be evaluated based on the ramp adjustment and nominal set point value, as well as on the prehistory.

When you turn on the controller the ramp starts at the actual temperature, the actual set point temperature is set to that value. In all other cases the starting point is the actual (internal) set point temperature.

Please note - the temperature ramp is disabled with Sine function activated. The Sine function has priority !

3.8.9. Sine-Function

The Sine function changes the actual set-value periodically around the configured nominal set-value according to a sine curve. Amplitude and cycle time can be configured.

Amplitude-Setting
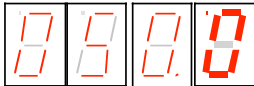
In our example the amplitude is set to 50.0°, this means that the peak values will be +50° above and -50° below the nominal set value.

A value of 0.0 will inhibit the Sine function. The actual set-value will be equal to the nominal set-value.

The value range is -99.9 to 99.9°. With negative values the Sine will start with the negative half wave.

Cycle time setting
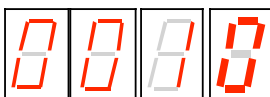
The unit of the cycle time is in minutes. in our example 10 minutes. The alue range is 0 to 9999 minutes. This allows to configure up to 166.65 hours or nearly 7 days.

For longer time settings ther may be a certain deviation, in the range of some percent compared with a precision timer.

A value of 0.0 will inhibit the Sine function. The actual set-value will be equal to the nominal set-value.
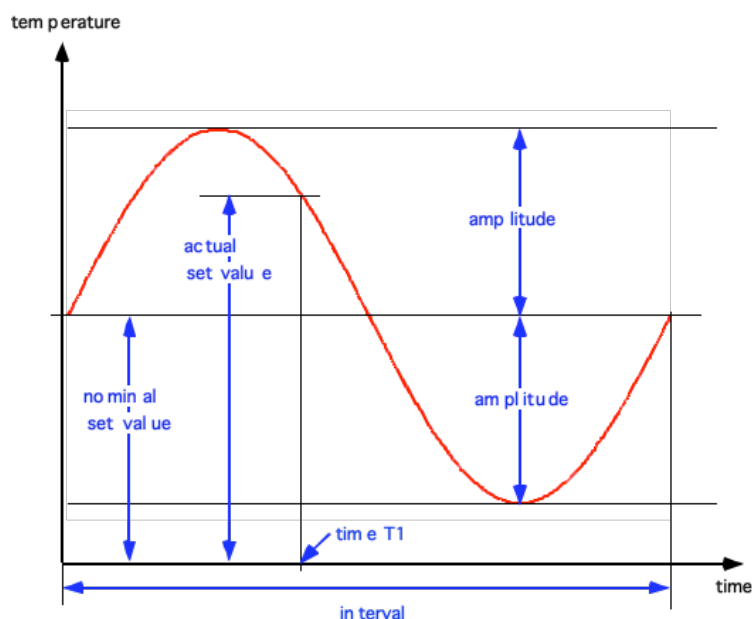
Definition of the values used in the Sine function

The nominal set value is the zero point of the Sine curve. This value will be displayed by pressing the mode button shortly.

The actual set value is an internal value calculated from nominal set value, amplitude and cycle time according to the position of time moment (example time T1) within the cycle time value.

When activated the sine function will start at the nominal set value. If the actual temperature differs, the controller will regulate to the actual set value and reach the sine curve some time later. After that the actual temperature will follow the sine curve.

To avoid this effect first regulate to the nominal set value and then start the sine function. Tis can be achieved by configuring the auxiliary input to "stop sine function".

The amplitude resolution is limited, the following table shows the size of the steps of the actual set value depending on the amplitude value:

Amplitude [°C]	steps [°C]
0 .. 19	0.1
20 .. 38	0.2
39 .. 56	0.3
57.. 75	0.4
76 ..94	0.5
95..99.9	0.6

The controller will regulate to the actual set value within +/- 0.1°C, provided the control loop and the controller setup allow this.

3.8.10. Limits for sensor 2 and sensor 3

The adjustable range is -75.0 … 175.0, whereas the nominal range is -50.0 … 150.0. Hence the highest digit changes only 0 .. 1 .. - (negative sign).

A value of -99.9 disables the corresponding sensor. Adjust to -99.9, if no sensor is connected to avoid an error message caused by an open input.

The range -99.8 .. -75.0 is not allowed !

3.8.11. Offset for sensor 2 and sensor 3

The left most digit will show "C" (Cool-side) for sensor 2 and „H" (Hot-side) for sensor 3:
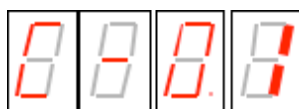
Sensor 2, -0.1°C

Sensor 3, + 1.0°C

To correct errors caused by temperature sensor or wiring, an offset of -9.9 to 9.9 can be input. Use a reference thermometer or an ice bath for calibration.

If starting from 00.0 the negative sign is set, the value jumps to -0.1, because -0.0 is a useless value.

The values set as delivery status are derived from a calibration using a 1000 ohms precision resistor directly connected to the sensor inputs. The values should be written down to preserve them.

3.9. Host mode

When the controller receives characters via the serial interface, they are decoded and if a valid command is recognized, it is executed immediately. The device in parallel processes and displays the sensor values and performs the control algorithm.

There is no visualization on the display during the interface access. Values changed in the internal data-structure will be used immediately. Values changed in the EEPROM will only become effective, when the command u_0_0 is sent. This happens automatically by using the program TCCOM for Windows. In case of using your own control program the procedure described above has to be implemented.

In case of uncertainty whether all values have been updated, it is recommended to turn off and on the controller, after altering the configuration !

The calibration is part of the configuration data and unique for each controller. Therefore it is not allowed to exchange data sets between different controllers.

3.10. Range error

If the actual value falls below -75.0°C or exceeds +175°C, the controller will enter a temporary error status. The display shows a flashing "9999". The power output is switched off. The instrument checks continuously the measuring value. If the value returns within the allowed limits, the controller returns automatically to normal operation.

Please note, that only in the range of -50.0 … + 150.0°C the accuracy of the measurement is guaranteed.

3.11. Error messages

A non fatal error will be displayed as „Ennn" for 5 Seconds after its detection, then the controller returns to normal operation. If the error is still present, it is displayed again immediately.

Fatal errors will be displayed permanently. They can only be reset by switching the device off and on.

Error Number	Meaning	Error cause – and removal
Non fatal error		
E001	General error	several causes > contact factory
E002	Error of writing the EEPROM	The writing of the configuration value has failed > repeat configuration-step > contact factory
E003	over-current error	Short circuit at the output, Peltier module defect > check wiring / correction > check Peltier module / replace > if permanent contact factory
E004	controller overheated	temperature inside of the controller is too high, ambient temperature too high, Instrument exposed directly to the sun, output overloaded > avoid excessive external warming > eliminate overload > try to reduce PWM-Limit
E005	sensor 2 value beyond limit	temperature of sensor 2 higher than configured limit
E006	sensor 3 value beyond limit	temperature of sensor 3 higher than configured limit

Error Number	Meaning	Error cause – and removal
E007	sensor 2 value out of range	temperature of sensor 2 < -75.0 or > 175.0ºC no sensor present or wiring incorrect if sensor 2 is not present, disable input by setting the limit to -99.9 to avoid this error
E008	sensor 3 value out of range	temperature of sensor 3 < -75.0 or > 175.0ºC no sensor present or wiring incorrect if sensor 3 is not present, disable input by setting the limit to -99.9 to avoid this error
E009	Watchdog error	interference or software error > one time appearance may be ignored > else contact factory

Fatal error

E100	EEPROM contains no valid configuration	power supply failure during prior configuration change, unsuitable TCCOM version, invalid commands or parameter values used > Switch off / switch on > re-configure > contact factory
E200	Stack error	excessive electronic noise or program failure > one time appearance to be ignored > else contact factory

3.12. Communication

3.12.1. Overview

The below mentioned information will be required for the implementation of own Control-Software. Otherwise you can ignore them.

Warning: wrong usage of the commands shown here can render the controller useless, can destroy the controller and the system attached. High temperature and high currents can occur. Danger of injuries and fire hazard.

3.12.2. Block format

Communication uses a simple ASCII-Protocol. To simplify the use of the serial communication the program "TCCOM.EXE" has been developed. It is included with the RS232 option.

It is also possible to use a simple Terminal-Program even it's less comfortable.

Synchronization	*
Command (Master only)	<address> _ <command> _ <parameter> _ <value>§
Acknowledge (Slave only)	. / ? / #
Response (Slave only)	<value> §

The several components are defined as follows:

address	A..Z (at present only A)
command	a..z (used: d, r, u, w)

parameter	0..65535
	(no leading zeros, negative figures will be transferred as positive figures, and then accordingly interpreted "typecasted")
value	0..65535
	(no leading zeros, negative figures will be transferred as positive figures, and then interpreted accordingly "typecast")

3.12.3. Character set

*	Reset communication (from Master to re-synchronize)
A..Z	Address
a..z	commands
_	(underline) is separation character between values
§	End of the message (hex 0x15 or decimal 21 !)
.	acknowledge "OK"
?	acknowledge "unknown / incomplete command sequence"
#	Internal fault

3.12.4. Data flow

Each communication is initiated by the Master (PC), by sending a „*" as Synchronisation. Hence the Slave (TC0806-RS232) changes to the basic communication state.

Now the Master sends address and command (in our example „A_r_0_0"). After each character, the received character is returned by the Slave (echo). It is very important to check for the echo before sending the next character by the master. Sending the whole command as a string at once will fail !

Finally [15] (hex value) represents the end of the message "§".

Now the Slave executes the command. In case of success it sends a ".". In case of a command the communication is finished. If it was a request, the answer (in our example "65394§") is appended. [15] represents the end of the answer string "§".

Excerpt from a Log file (bold font corresponds to   data traffic, normal "High level"-Information, special character are given as hex value in [ ]):

15:46 29.07.02001 15:46 TCCOM for Windows
15:46 --------------> r_50_0
15:46 > A_r_50_0
15:46 > *A
15:46 < A
15:46 > _
15:46 < _
15:46 > r
15:46 < r
15:46 > _
15:46 < _
15:46 > 5
15:46 < 5
15:46 > 0
15:46 < 0
15:46 > _
15:46 < _
15:46 > 0
15:46 < 0
15:46 > [15]
15:46 < [15]
15:46 < .
15:46 < . (OK)
15:46 < 65394[15]
15:46 < 65394
15:46 --------------< -142

3.12.5. Debug mode

Initiated with the command d_1_0 the TC2812HT. Then the module starts to send internal values continuously until the reception of the command d_0_0.

The values sent are recorded by the program TCCOM and can be display in graphical form using the function "Recorder".

4. Usage with TCCOM for Windows

4.1. Warning

The program allows extensive changes of internal parameters. Misuse of the program may render the attached controller unusable.

Components attached to the controller or the controller itself may be destroyed. Risk of excessive currents and temperature. Risk of Fire hazard and Injuries !

Therefore it is mandatory to read and understand the manual prior to using the program. Please also consult the manual accompanying the controller and other components of the system. Be sure to understand what you are doing, before using the program

In case of unexpected effects or any uncertainty disconnect the system from power supply and consult the manufacturer or his sales representative.

CoolTronic GmbH cannot be made liable for any damages caused by the use of the program.

4.2. Overview

This documentation applies for TCCOM for Windows version V1.8.1 Build 101 as of 06.05.2010 or higher. Only the function specific for TC0806-RS232 are described here.

Concerning all other functions of the program refer to the software manual.

General knowledge and experience with Windows™ programs is required.

The Menu "TC0806" provides the standard operation options for the controller TC0806 and allows the configuration of most internal values. The factory defined linearization table and other factory setup values are not accessible, therefore are not allowed to be changed.
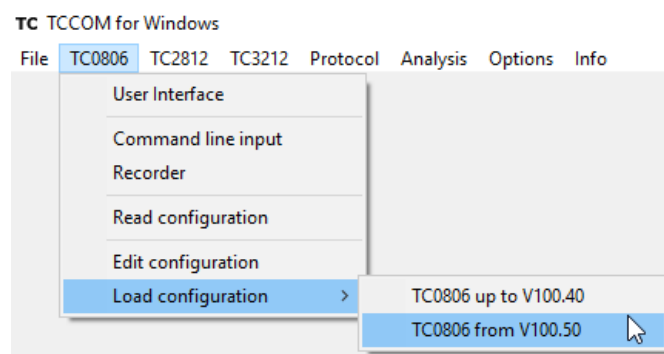
Menu TC0806 with expert mode activated

The above picture shows the available commands with expert mode activated. In normal mode some commands are not available.
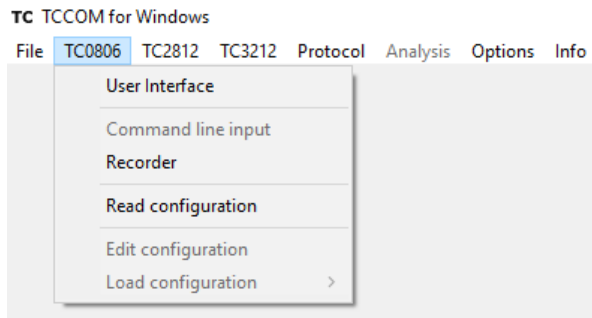
Menu TC0806 in normal mode

4.3. User Interface

The user Interface allows the setting of all parameters of the TC0806 needed for normal operation.

Observe warnings given in chapter 4.1
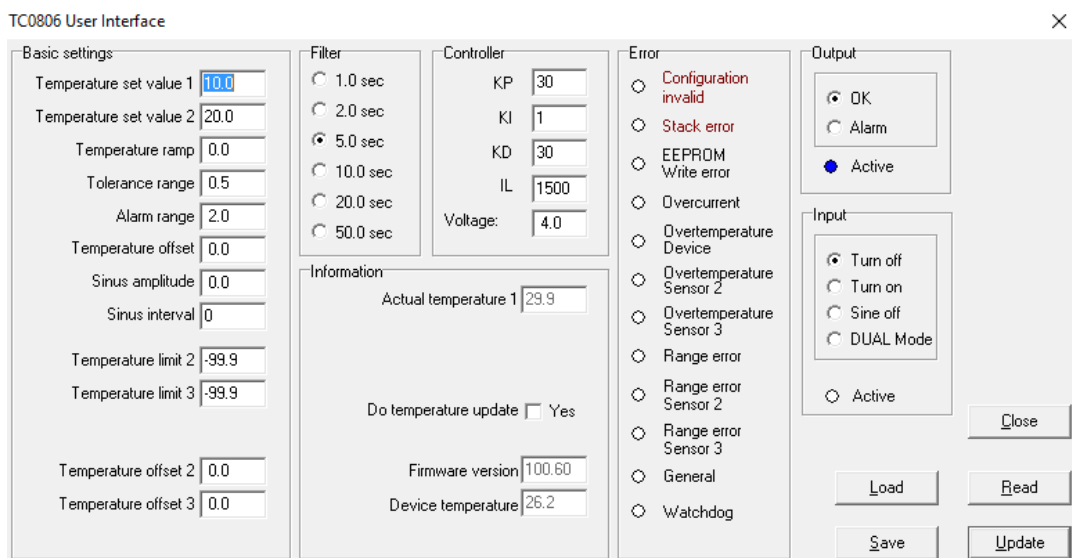
User interface of firmware V100.60 and above

Item	Description

Basic settings

Temperature set value **Firmware V10040 and below**	temperature set point for the controller, range -50.0 ... + 150.0°C, sensor 1 is used for the control loop !
Temperature set value 1 / 2 **Firmware V10060 and above**	temperature set points for the controller, range -50.0 ... + 150.0°C, sensor 1 is used for the control loop ! selected by auxiliary input in "DUAL Mode"
Temperature ramp	speed of change of the temperature set value, range 0.0 .. 9.9°C / Minute. a setting of 0.0 disables the linear ramp function

Item	Description
Tolerance range	defines a range around the set value in between the set value is regarded as reached. If in range: - both LED's „heating" and „cooling" will be shut off - the auxiliary output will be active if option „OK" is configured
Alarm-range	defines a range around the set value outside which the temperature is regarded as critical. If out of range: - LED „heating" or „cooling" will blink - the auxiliary output will be active if option „ALARM" is configured
Temperature offset	value to compensate errors caused by sensor 1 itself or the system setup
Sine amplitude	the controller TC0806 has a function to modulate the set value according to a sineodial curve. The amplitude may be set in the range -99.9 .. 0 .. 99.9 °C. Setting amplitude to 0 disables the function. With a negative value the sinus curve will start with the negative half wave of the sinus curve.
Sine interval	time interval for a full sine wave, range allowed is 0..9999. Setting interval to 0 disables the function
Temperature limit 2 / 3	Temperature limit for sensor 2 and 3, range allowed: -99.0, -75.0 ... 175.0, nominal range: -50.0 ... 150.0 A value of -99.9 disables the sensor and therefore has to be set if the sensor is absent if the actual temperature value exceeds the limit value the controller output stage will be shut off
Temperature offset 2 / 3	value to compensate errors caused by sensor 1 itself or the system setup The factory setting refers to a resistor 1000 Ohm +/- 0.1% directly connected to the connector
<u>Filter</u>	time constant of the digital filter, also defines the sampling rate of the controller. Can be used to adapt to the timing of the open loop control system Note: control systems with dead time require a larger filter time constant
<u>Controller</u>	
KP	Proportional coefficient of the controller, value range 0..63, typical values: 5..30
KI	Integral coefficient of the controller, value range 0..63, typical values: 1..5
KD	Derivative coefficient of the controller, value range 0..63, typical values: 5..30
IL	limit for the integration sum, value range 0..9999, typical values: 500 .. 2500

Item	Description
Voltage	controller output voltage in 0.1 V - value range 0, 1.0 .. 8.0V - has to be adapted to the nominal values of the attached peltier module. A good approach is to use 70 .. 80% of the peltier module's maximum voltage - a value of 0 shuts down the power stage

Information

Actual temperature 1	actual value of temperature in 1/10 °C of sensor 1 will be updated only, if the option "Do temperature update- Yes" is activated, if not, the value is displayed which was valid at the last time the user clicked on the „Read" or „Update" button
Actual temperature 2	actual value of temperature in 1/10 °C of sensor 2, if sensor 2 is not configured (limit = -99.9) the field is suppressed
Actual temperature 3	actual value of temperature in 1/10 °C of sensor 3, if sensor 3 is not configured (limit = -99.9) the field is suppressed
Do temperature update	see above Note: if using the „Recorder" function, this option must be OFF !
Firmware version	displays the firmware-version of TC0806 in format: nnn.mm nnn main version mm sub version
Chip temperature	temperature measured in the controller-chip in °C. Note: This value may differ a few degrees celsius from the real temperature inside the TC0806-housing

Error

Configuration invalid	configuration memory does not contain valid data
Stack error	internal firmware error or interference problem
EEPROM Write Error	failure while writing the configuration to the EEPROM
Over current	overload or short circuit at the output of the TC0806
Over temperature Device	the TC0806 is overheated, temperature of the environment too high or overload
Over temperature Sensor 2	the actual value of sensor 2 is above the configured limit
Over temperature Sensor 3	the actual value of sensor 3 is above the configured limit
Range error	the actual value of sensor 1 is outside the allowed range (< -75.0 oder > 175.0°C)
Range error Sensor 2	the actual value of sensor 2 is outside the allowed range (< -75.0 oder > 175.0°C)
Range error Sensor 3	(range error) the actual value of sensor 3 is outside the allowed range (< -75.0 oder > 175.0°C)

Item	Description
General	different internal failures of the TC0806
Watchdog	the program flow has been interfered, the monitoring function was activated
Output	
OK	the auxiliary output will be activated if the actual temperature of sensor 1 is in a range +/- Tolerance range around the set value
Alarm	the auxiliary output will be activated if the actual temperature of sensor 1 is outside +/- Alarm range around the set value
Input	
Turn off	the output stage will be shut off, when the auxiliary input is activated (Standard value, to make the controller functional without wiring the input)
Turn on	the output stage will be turned on, when the auxiliary input is activated
Sine off	the sine function is disabled, when the auxiliary input is activated very useful to synchronize the start of the sinus function with some external event
DUAL Mode	select set temperature value 1 (inactive) or 2 (active)

4.4. Command Line interface
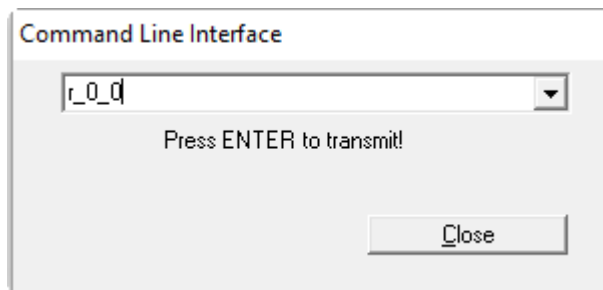
Command line interface

With this dialog „Low-Level" commands in the form r_0_0 may be sent to the controller. The answer will be displayed in the log window if the necessary options are set. Requires in depth knowledge of the command set.

Observe Warnings given in chapter 4.1 !

4.5. Recorder

The „Recorder" function uses a special debug mode of the TC0806. After activated, the controller sends internal values continuously until stopped. This function is a „mighty" tool for optimizing the control loop settings.

The scale of the display will be adapted automatically. Minimum, maximum and mean value are displayed as numerical value (see vertical axes)
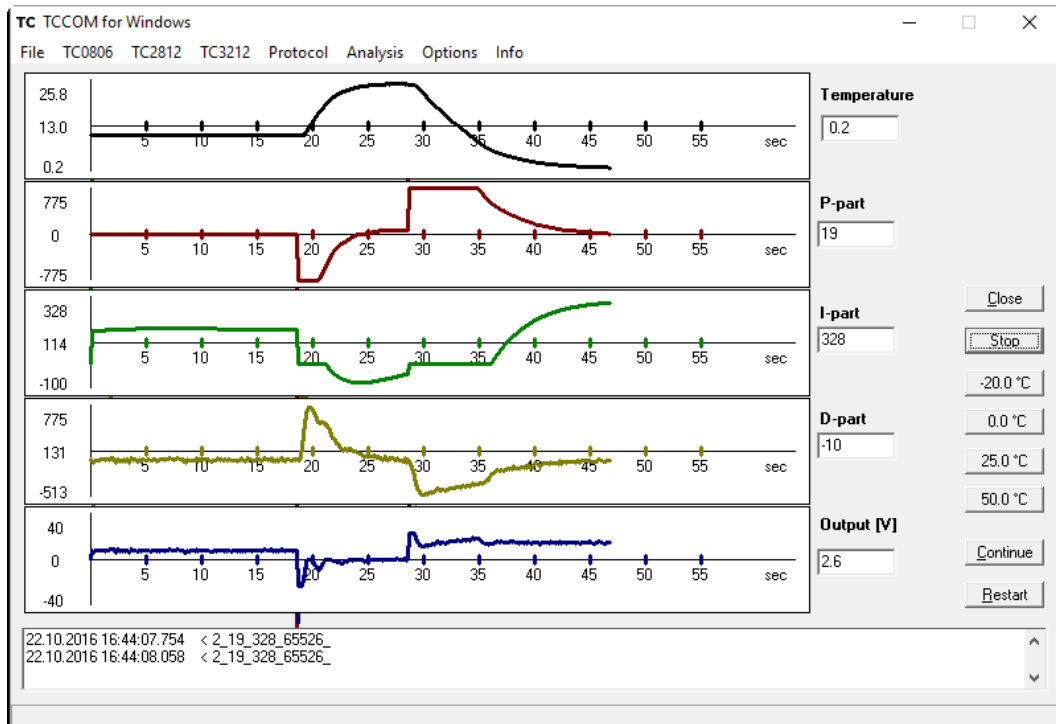
Recorder-Display

Item	Description
Temperature	actual value of the temperature in 1/10°C
P-part	Proportional part of the controller
	Note: this is a raw value which is normalized to form the control output value
I-part	Integration sum of the controller
	Note: this is a raw value which is normalized to form the control output value
D-part	Derivative part of the controller
	Note: this is a raw value which is normalized to form the control output value
Output [V]	voltage value of the output stage in 0.1 Volt

Button	Description
Close	ends (closes) the recorder display
-20.0 °C	set the temperature set value of the TC0806 to -20.0°C
0.0 °C	set the temperature set value of the TC0806 to 0.0°C
25.0 °C, 50.0°C	same as above

Note: the actuals values of the 4 buttons may be changed using the program settings

Button	Description
Restart	clears all values and restarts the recorder
	Note: the scale will be reset and recalculated
Stop	stops the Recorder
Continue	restarts the recorder preserving the recorded values
	Note: when stopped the values are not recorded, therefore there may be a „jump" of the values

4.6.   Readout configuration

Configuration dialog (shown for firmware version V100.60 and above)

Only functional with a controller attached to the serial communication line.

Reads the actual configuration and displays the values in the dialog, which allows saving but not changing the values.
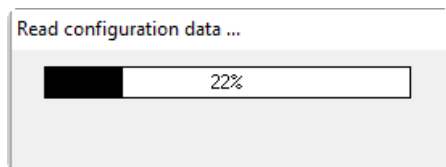
Time bar during read out

The purpose of the different values will be explained in detail below.

Button	Description
Close	closes the dialog
Save	saves the configuration data to disk

4.7. Edit configuration

Only functional with a controller attached to the serial communication line.

Reads the actual configuration and displays the values in the dialog.

Except the basic factory setting all values are editable. The values may be read from and saved to disk. The edited values may be sent to the controller.

This menu option is only available with expert mode activated. (See Options / General Options)

Observe Warnings given in chapter 4.1 !

Configuration dialog (for firmware version V100.60 and above)

| Value	Description
Adjustment	linearization table with values of the AD-converter for temperature steps -75.0°C bis +175.0°C Note: Factory setting, not editable
Temperature set value **Firmware V10040 and below**	temperature set point for the controller, range -50.0 … + 150.0°C, sensor 1 is used for the control loop !
Temperature set value 1 / 2 **Firmware V10060 and above**	temperature set points for the controller, range -50.0 … + 150.0°C, sensor 1 is used for the control loop ! selected by auxiliary input in "DUAL Mode"
Temperature ramp	speed of change of the temperature set value, range 0.0 .. 9.9°C / Minute. a setting of 0.0 disables the linear ramp function
Tolerance range	defines a range around the set value in between the set value is regarded as reached. If in range: - both LED's „heating" and „cooling" will be shut off - the auxiliary output will be active if option „OK" is configured

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Value	Description
Alarm-range	defines a range around the set value outside which the temperature is regarded as critical. If out of range: - LED „heating" or „cooling" will blink - the auxiliary output will be active if option „ALARM" is configured
Temperature offset	value to compensate errors caused by sensor 1 itself or the system setup
Sine amplitude	the controller TC0806 has a function to modulate the set value according to a sineodial curve. The amplitude may be set in the range -99.9 .. 0 .. 99.9 °C. Setting amplitude to 0 disables the function. With a negative value the sinus curve will start with the negative half wave of the sine curve.
Sine interval	time interval for a full sine wave, range allowed is 0..9999. Setting interval to 0 disables the function
Temperature limit 2 / 3	Temperature limit for sensor 2 and 3, range allowed: -99.0, -75.0 … 175.0, nominal range: -50.0 … 150.0 A value of -99.9 disables the sensor and therefore has to be set if the sensor is absent if the actual temperature value exceeds the limit value the controller output stage will be shut off
Temperature offset 2 / 3	value to compensate errors caused by sensor 1 itself or the system setup The factory setting refers to a resistor 1000 Ohm +/- 0.1% directly connected to the connector
<u>Filter</u>	time constant of the digital filter, also defines the sampling rate of the controller. Can be used to adapt to the timing of the open loop control system Note: control systems with dead time require a larger filter time constant
<u>Controller</u>	
KP	Proportional coefficient of the controller, value range 0..63, typical values: 5..30
KI	Integral coefficient of the controller, value range 0..63, typical values: 1..5
KD	Derivative coefficient of the controller, value range 0..63, typical values: 5..30
IL	limit for the integration sum, value range 0..9999, typical values: 500 .. 2500
Voltage	controller output voltage in 0.1 V - value range 0, 1.0 .. 8.0V - has to be adapted to the nominal values of the attached peltier module. A good approach is to use 70 .. 80% of the peltier module's maximum voltage - a value of 0 shuts down the power stage
<u>Output</u>	
OK	the auxiliary output will be activated if the actual temperature of sensor 1 is in a range +/- Tolerance range around the set value

Value	Description
Alarm	the auxiliary output will be activated if the actual temperature of sensor 1 is outside +/- Alarm range around the set value

Input

Value	Description
Turn off	the output stage will be shut off, when the auxiliary input is activated (Standard value, to make the controller functional without wiring the input)
Turn on	the output stage will be turned on, when the auxiliary input is activated
Sine off	the sine function is disabled, when the auxiliary input is activated very useful to synchronize the start of the sinus function with some external event
DUAL Mode	select set temperature value 1 (inactive) or 2 (active)
Factory settings	not editable, changing these values would render the controller unusable

Button	Description
Close	close the dialog
Save	save configuration data to disk
Load	load configuration data from disk
Read	read configuration data from controller
Update	update configuration data of the TC0806

4.8.   Load Configuration

Open a dialog to select the file to load the data from. In the sub menu the correct firmware version must be selected. After loading, the configuration data is displayed.

There must not be any controller attached to the computer to use this menu item, but of course the other functions „Read" and „update" only work with a TC0806 attached.
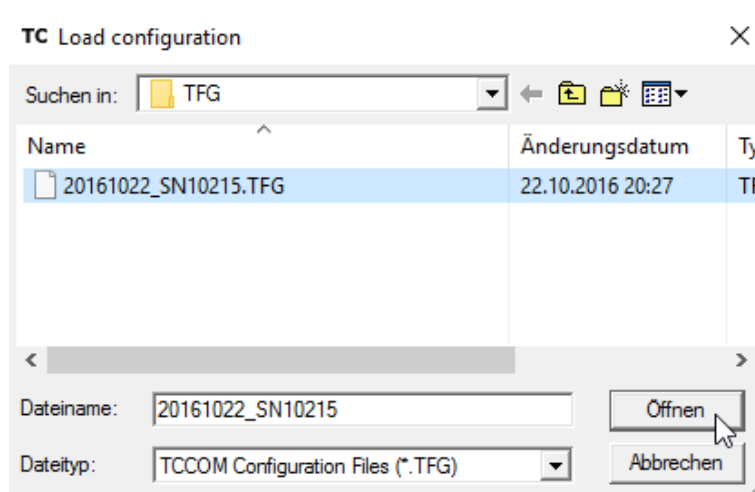
Dialog for loading configuration files

5. Command set

Warning: wrong usage of the commands shown here can render the controller useless, can destroy the controller and the system attached. High temperature and high currents can occur. Danger of injuries and fire hazard.

read/write command r_ .. _ / w_ .. _	Parameter	structure	Datum	Description
General settings - cfgTable				
0	0	cfgTable	setValue_1	set temperature value 1
1	0	cfgTable	setValue_2	set temperature value 2
2	0	cfgTable	tolRange	Tolerance range
3	0	cfgTable	alarmRange	Alarm range
4	0	cfgTable	filter	Filter setting
5	0	cfgTable	cfg	0x00: Off mode (0) 0x40: On mode (64) 0x80: Sine stop (128) 0xC0: DUAL Mode (192) add to the above values: 0x00: Good output 0x10: Alarm output (16) Values in brace: decimal
6	0	cfgTable	KP	Control parameters
7	0	cfgTable	KI	
8	0	cfgTable	KD	
9	0	cfgTable	IL	
10	0	cfgTable	Voltage limit	Output voltage limit
11	0	cfgTable	offset	Temperature offset
12	0	cfgTable	setValRamp	Set temperature ramp
13	0	cfgTable	sinAmplitude	Sine amplitude
14	0	cfgTable	sinInterval	Sine Interval
15	0	cfgTable	tempLimit2	Temperature limit 2
16	0	cfgTable	tempLimit3	Temperature limit 3
18	0	cfgTable	Temperature Offset 2	factory setting, read manual !
19	0	cfgTable	Temperature Offset 3	factory setting, read manual !

read/write command r_ .. _ / w_ .. _	Parameter	structure	Datum	Description
General settings - EEData				
43	0	EEData	setValue_1	set temperature value 1
44	0	EEData	setValue_2	set temperature value 2
45	0	EEData	tolRange	Tolerance range
46	0	EEData	alarmRange	Alarm range
47	0	EEData	filter	Filter setting
48	0	EEData	cfg	0x00: Off mode (0) 0x40: On mode (64) 0x80: Sine stop (128) 0xC0: DUAL Mode (192) add to the above values: 0x00: Good output 0x10: Alarm output (16) Values in brace: decimal
49	0	EEData	KP	Control parameters
50	0	EEData	KI	
51	0	EEData	KD	
52	0	EEData	IL	

read/write command r_ .. _ / w_ .. _	Parameter	structure	Datum	Description
53	0	EEData	Voltage limit	Output voltage limit
54	0	EEData	offset	Temperature offset
55	0	EEData	setValRamp	Set temperature ramp
56	0	EEData	sinAmplitude	Sine amplitude
57	0	EEData	sinInterval	Sine Interval
58	0	EEData	tempLimit2	Temperature limit 2
59	0	EEData	tempLimit3	Temperature limit3
61	0	EEData	Temperature Offset 2	factory setting, read manual !
62	0	EEData	Temperature Offset 3	factory setting, read manual !

Requests and maintenance commands

102	0	intData	Value Sensor 1	read only
103	0	intData	actP	read only
104	0	intData	actI	read only
105	0	intData	actD	read only
106	0	--	FWVersion	read only
121	0	--	Value Sensor 2	read only
122	0	--	Value Sensor 3	read only
150	0	--	Test-voltage	inhibits control algorithm and set output to constant voltage (+/- 0..127 refers to +/- 0..100% of the maximum output voltage configured)
151	0	--	Test-Minimal temperature	lower limit for temperature, below power is off (only test mode)
151	0	--	Test-Maximal temperature	upper limit for temperature, above power is off (only test mode)
200	0	--	Device type	0: unknown 1: TC0806
201	0	--	Device state	b0 auxIn b1 auxOut
202	0	--	error state	error flags

<u>WARNING:</u> Only the commands released for end users are documented. Using other command codes may damage the controller and is strictly forbidden !

Attention: wrong use of commands 150..152 will destroy controller and system and may cause overheating and fire hazard. Use solely at users own risk !

Read commands have a parameter value of 0, for write commands the desired value has to be appended.

Meaning of the structure information

cfgTable   internal configuration data structure, only valid until next power off

EEData   same values a cfgTable, but stored permanently in nonvolatile memory. These values will be reloaded at next power on.

Attention:
Excessive writing to the EEData can cause a wear out of the component and result in data loss.

Values from EEData must be transferred to cfgTable with the command u_0_0 to be effective !

intData   internal data structure for variables

6.   Configuration values

minimum value	maximum value	reset value	default value	description
-75.0	175.0	0.0	0.0	set value 1
-75.0	175.0	0.0	0.0	set value 2
0.0	9.9	0.0	0.5	tolerance range
0.0	9.9	0.0	2.0	alarm range
1	50	1	2	filter time constant
0	63	0	30	KP
0	63	0	1	KI
0	63	0	30	KD
0	999	0	26	IL (internal value *10, default 26 yields 260)
0.0	8.0	0	1.0	voltage limit
-9.9	9.9	0.0	0.0	Offset, Sensor1
0.0	9.9	0.0	0.0	Ramp
-99.9	99.9	0	0	Sine-Amplitude
0	9999	0	0	Sine-Interval
-99.9	175.0	0.0	-99.9	TempLimit2 (cold side)
-99.9	175.0	0.0	-99.9	TempLimit3 (warm side)
-9.9	9.9	0.0	0.0	Offset, Sensor2
-9.9	9.9	0.0	0.0	Offset, Sensor3

values allowed	description
On / Off / SF / DUAL	AuxIn
Alarm / Good	AuxOut

7.   State codes

answer to request CmdGetDeviceState (r_202_0), shown as binary values

State value	Meaning
0000 0000 0000 000X	0: auxiliary output active 1: auxiliary output not active
0000 0000 0000 00X0	0: auxiliary input active 1: auxiliary input inactive

8. Error codes

answer to request CmdGetErrorState (r_203_0), shown as binary values

State value	Meaning
0000 0000 0000 0001	range error, Sensor 1
0000 0000 0000 0010	general error
0000 0000 0000 0100	EEPROM write error
0000 0000 0000 1000	over current
0000 0000 0001 0000	over temperature, controller
0000 0000 0010 0000	over temperature,, Sensor 2
0000 0000 0100 0000	over temperature,, Sensor 3
0000 0000 1000 0000	range error, Sensor 2
0000 0001 0000 0000	range error, Sensor 3
0000 0010 0000 0000	Watchdog
0000 0100 0000 0000	configuration invalid
0000 1000 0000 0000	Stack error
0001 0000 0000 0000	not implemented
0010 0000 0000 0000	not implemented
0100 0000 0000 0000	not implemented
1000 0000 0000 0000	not implemented