



## User Guide

TEC05-12, TEC05-24

TEC16-12, TEC16-24, TEC16-32

## Table of contents

Warranty .....	4
Safety Instructions.....	5
Kit Contents .....	6
TEC05-12, TEC05-24 .....	6
TEC16-12, TEC16-24, TEC16-32 .....	6
Connections TEC05-XX .....	7
Connections TEC16-XX .....	8
User Interfaces .....	9
USB Driver .....	9
RS485.....	9
TEC Config Utility.....	10
Getting Started .....	10
Connecting.....	10
Configuration.....	11
Factory Defaults .....	11
Firmware Update.....	11
Controller Config .....	12
Sensor Config.....	13
Supervision .....	14
Display .....	15
Fan Config.....	16
Aux I/O.....	17
Operation .....	18
AutoScript Function.....	19
Terminal.....	20
Annex I, Firmware Update.....	21
Annex II, User Interfaces .....	22
Parameter.....	22
TEC-Controller ASCII Command Set .....	23
Set Commands.....	23
Get Commands.....	25
Values Collective Commands .....	28
TEC-Controller Binary Command Set .....	31
Data Frames.....	31
Commands (Functions).....	32
Error messages .....	35

Version history ..... 36

## Warranty

head electronic warrants that these products are free from defects for a period of three (3) years from the date of delivery of material defects and labor.

Should a product prove to be defective within this warranty, head electronic will either repair or replace the product in accordance with the conditions stated in the full warranty.

To get the maintenance service, please contact head electronic.

NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IN NO EVENT SHALL HEAD ELECTRONIC BE LIABLE FOR ANY PARTICULAR PURPOSE. IN NO EVENT WILL HEAD ELECTRONIC BE LIABLE FOR INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES.

## Safety Instructions

Peltier elements can produce temperatures which lead to serious injuries to the skin. Use a thermometer to check temperatures and not your hand!

We would be pleased to support you with advice, please call our technical service at tel. +49 8051 6404512.

Our TEC controllers have been developed for research and industrial applications. Handling requires technical expertise and responsible action.

## Kit Contents

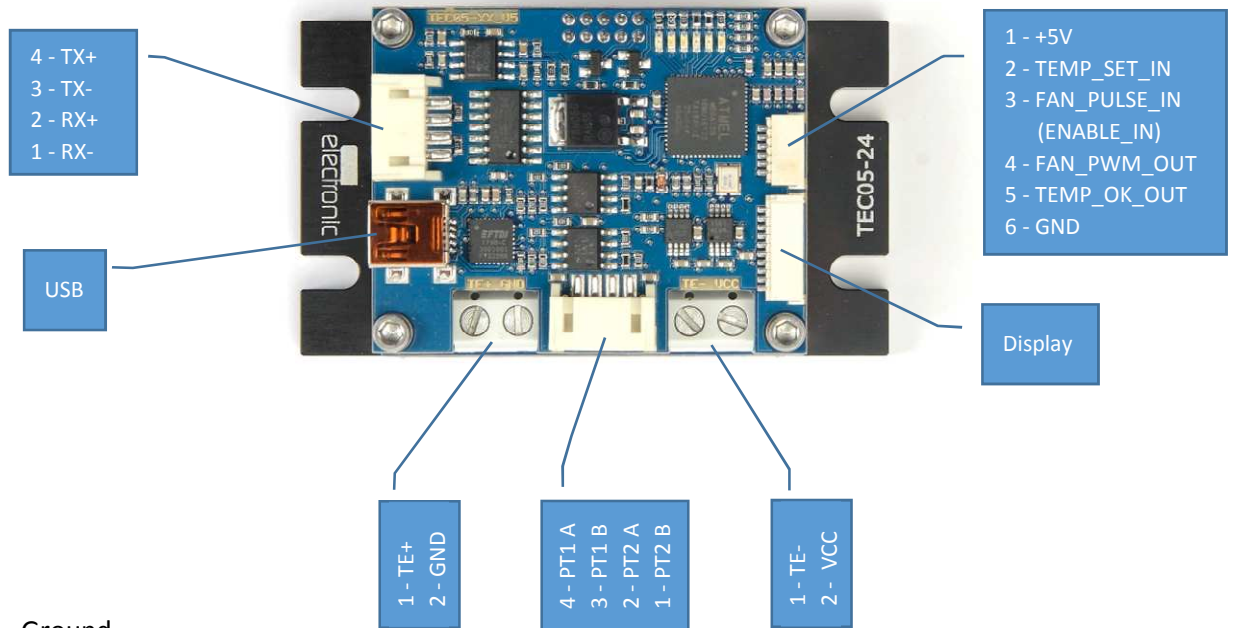
### TEC05-12, TEC05-24

- 1x TEC05-XX
- 2x temperature sensors Pt1000 (monitoring cold side and hot side)
- 1x Pt1000 cable 4 wires
- 2x connecting leads Power supply (red and black)
- 2x connecting leads Peltier element (gray and blue)
- 1x CD-ROM "TEC series"
- 1x USB connection cable
- 1x RS485 connection cable

### TEC16-12, TEC16-24, TEC16-32

- 1x TEC16-XX
- 2x temperature sensors Pt1000 (monitoring cold side and hot side)
- 1x Temperature sensor NTC10k (monitoring device temperature)
- 1x Pt1000 cable 4 wires
- 2x connecting leads Power supply (red and black)
- 2x connecting leads Peltier element (gray and blue)
- 4x screw M3x6
- 1x CD-ROM "TEC series"
- 1x USB connection cable
- 1x RS485 connection cable

## Connections TEC05-XX



GND Ground  
 VCC Supply  
 TE+ TEC +  
 TE- TEC -

PT1 A Sensor 1 (Pt1000) Terminal A  
 PT1 B Sensor 1 (Pt1000) Terminal B  
 PT2 A Sensor 2 (Pt1000) Terminal A  
 PT2 B Sensor 2 (Pt1000) Terminal B

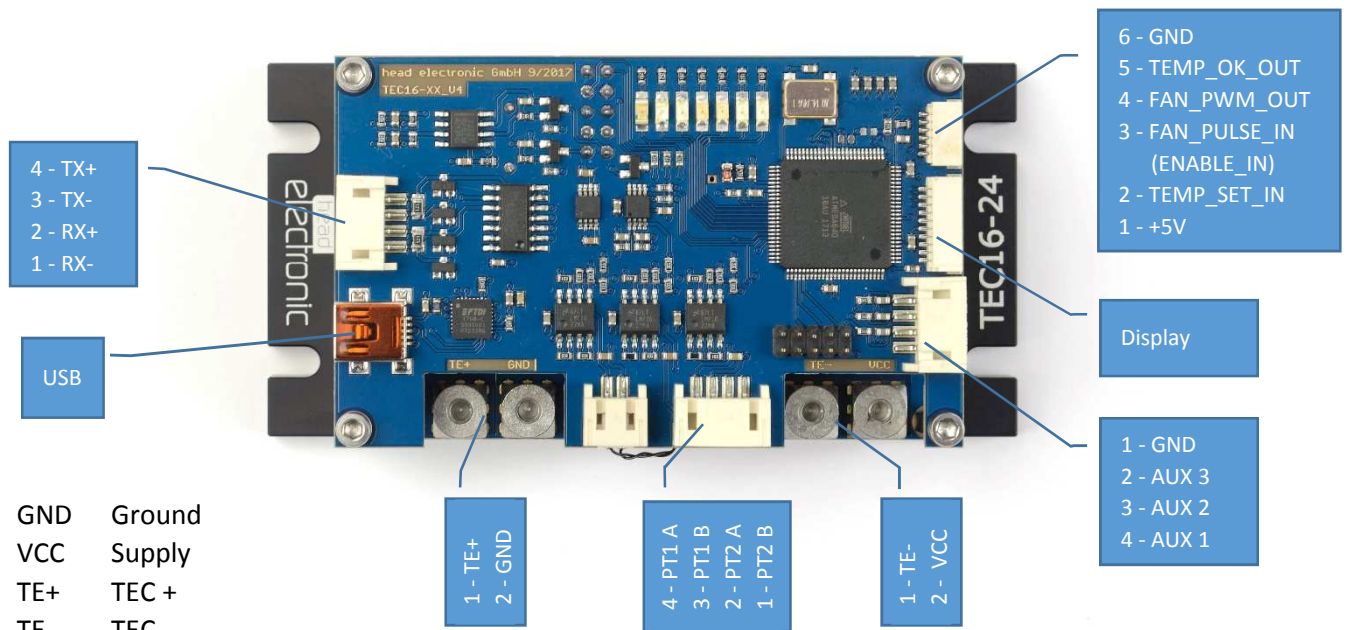
TX+ RS485 TX+  
 TX- RS485 TX-  
 RX+ RS485 RX+  
 RX- RS485 RX-

USB Mini-USB (PC connection)

TEMP\_SET\_IN Input: Analog temperature set (0 - 4096mV)  
 FAN\_PULSE\_IN Input: Fan speed (5V, 500Hz max)  
 ENABLE\_IN Input: TEC Driver en-/disable  
 FAN\_PWM\_OUT Output: 5V / 25kHz fan control pwm signal  
 TEMP\_OK\_OUT Output: 5V if temperature is in set point window

Display LCD / Keys connection

## Connections TEC16-XX



GND Ground  
 VCC Supply  
 TE+ TEC +  
 TE- TEC -

NTC A Sensor 3 (NTC 10k) Terminal A  
 NTC B Sensor 3 (NTC 10k) Terminal B  
 PT1 A Sensor 1 (Pt1000) Terminal A  
 PT1 B Sensor 1 (Pt1000) Terminal B  
 PT2 A Sensor 2 (Pt1000) Terminal A  
 PT2 B Sensor 2 (Pt1000) Terminal B

TX+ RS485 TX+  
 TX- RS485 TX-  
 RX+ RS485 RX+  
 RX- RS485 RX-

USB Mini-USB (PC connection)

TEMP\_SET\_IN Input: Analog temperature set (0 - 4096mV)  
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 ENABLE\_IN Input: TEC Driver en-/disable  
 FAN\_PWM\_OUT Output: 5V / 25kHz fan control pwm signal  
 TEMP\_OK\_OUT Output: 5V if temperature is in set point window

AUX 1 Output: 5V, Signal depends on configuration  
 AUX 2 Output: 5V, Signal depends on configuration  
 AUX 3 Output: 5V, Signal depends on configuration



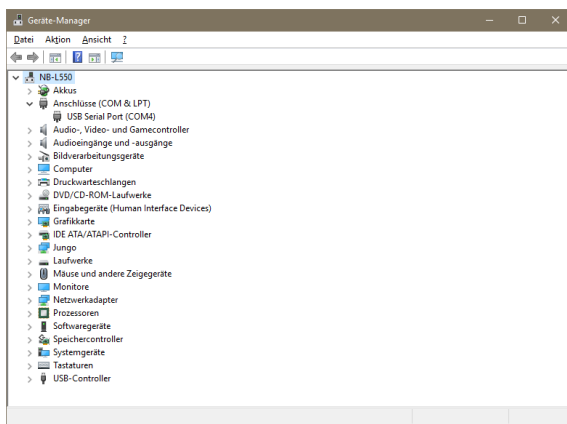
## User Interfaces

The TEC controller has a USB and an RS485 interface with which it can be configured and controlled. The corresponding communication protocol is described in detail in Annex I.

### USB Driver

The TEC controller is equipped with an FTDI FT232R USB chip. If you connect the TEC controller to your PC for the first time, the driver installation is started automatically. Depending on your operating system, you may need to specify the location of the driver files and the appropriate driver will be installed automatically. The driver files can be found at <http://www.ftdichip.com/Drivers/VCP.htm>.

Each connected TEC controller generates a separate virtual COM port in your PC (E.g. COM4).



### RS485

The RS485 interface conforms to the EIA-485 standard and has a 4-wire design. The levels on all four connections must be between GND and +5V. Because some RS485 hardware is inverted an interchange of the + and - signals may be necessary.

TX+ > TX- => 5V TTL => binary 1 = bus idle

TX+ < TX- => 0V TTL => binary 0

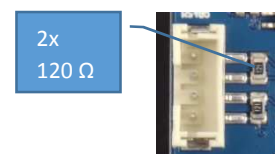
If necessary, the pair of transmitter wires can be connected to the pair of receive wires to connect the TEC-Driver to a 2-wire host terminal:

A = TX+ / RX+

B = TX- / RX-

C = GND

120Ω terminating resistors are assembled on the TEC controller. These should be removed if there are other bus nodes behind the TEC controller.

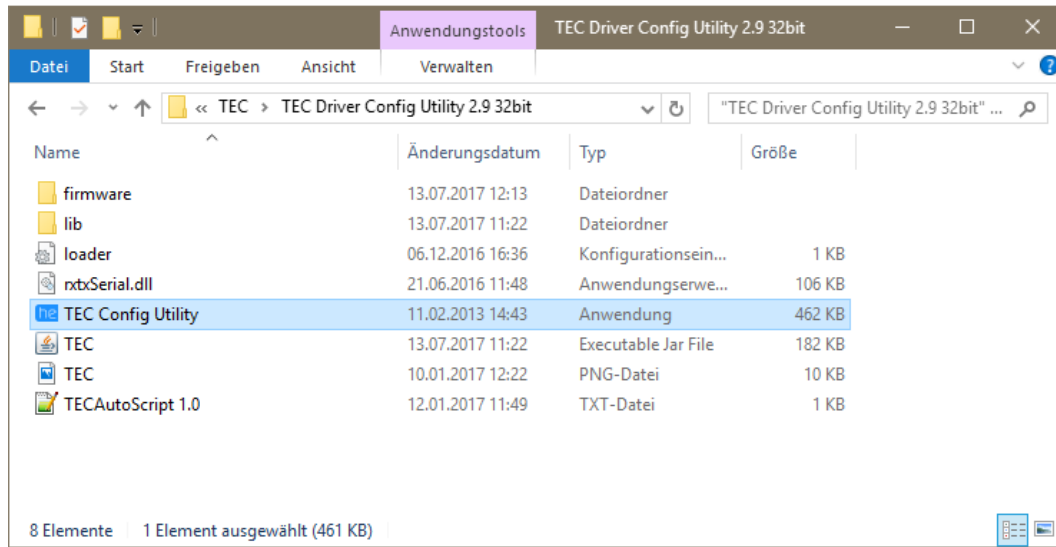


# TEC Config Utility

## Getting Started

The Java-based application "TEC Config Utility" is available for the comfortable operation of the TEC controller. This requires the Java Runtime Environment, which can be downloaded in the latest version at <http://www.java.com>.

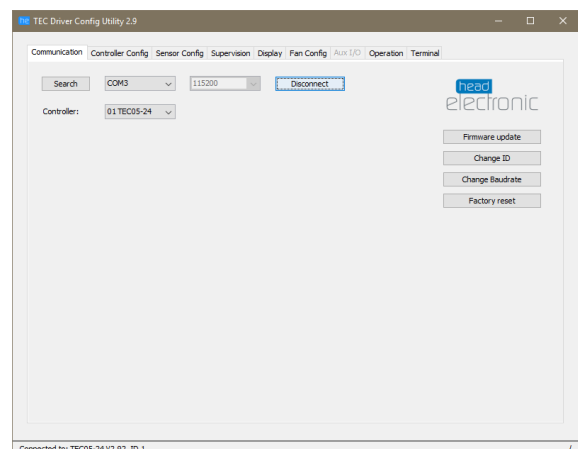
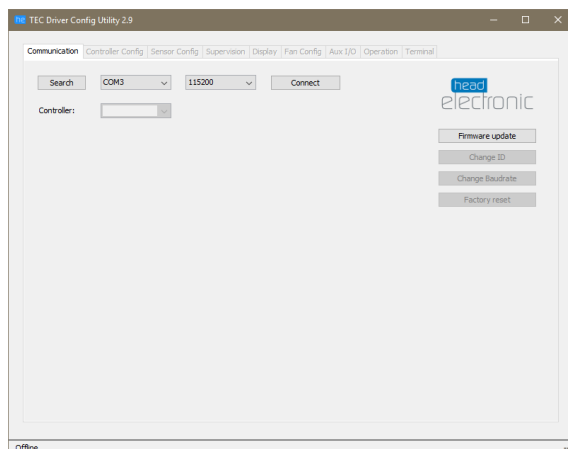
Start the TEC Config Utility:



## Connecting

Select the COM port that was created by your TEC controller and set the baud rate which is set in the TEC controller. By default, the baud rate is set to 115200. Start the connection with the "Connect" button. After a successful connection setup, the connected TEC controller and its firmware version are displayed in the status bar.

If the corresponding COM port is not listed, check whether TEC controller and PC are connected by the USB connection cable. Click the "Search" button to search for recently installed COM ports.



## Configuration

You can set all the control parameters and limits according to your requirements. The entered values are stored in the TEC controller and are retained even after switching off the power supply. The configuration is divided into the following six categories: Controller, Sensor, Supervision, Display, Fan and Aux (TEC16-XX only).

### Factory Defaults

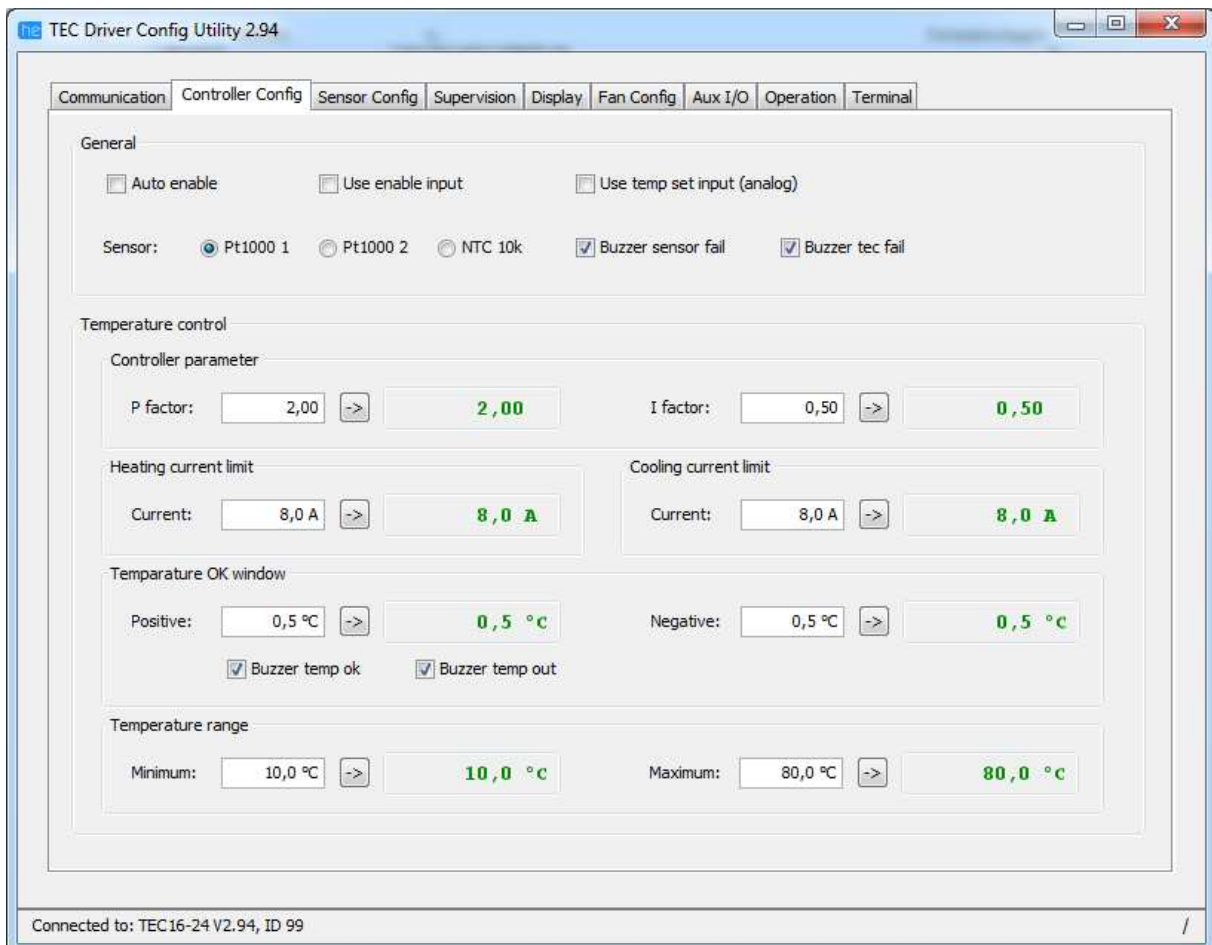
Press the "Factory reset" button on the Communication page to reset the TEC controller to factory defaults.

### Firmware Update

Please refer to annex I.

## Controller Config

Field	Description
Auto enable	Automatically enable the TEC controller after switching on the power supply
Use enable input	Use digital input for TEC controller en-/disabling
Use temp set input	Use analog input for temperature set point
Sensor	Set the sensor for temperature control
Buzzer sensor fail	Alarm on sensor fail (TEC16-XX only)
Buzzer tec fail	Alarm on TEC fail (TEC16-XX only)
P factor	P portion of the controller
I factor	I portion of the controller
Heating current limit	Current limit for positive current
Cooling current limit	Current limit for negative current
Temperature OK window	Maximum positive / negative deviation of temperature for control LED and output
Temperature range	Absolute maximum temperature range



## Sensor Config

Field	Description
Factor	Temperature calculation factor
Offset	Temperature calculation offset
Auto calibration	Automatic calculation of factor and offset using three measuring points with input of the reference values (The calculated values are not automatically transferred to the TEC controller!)

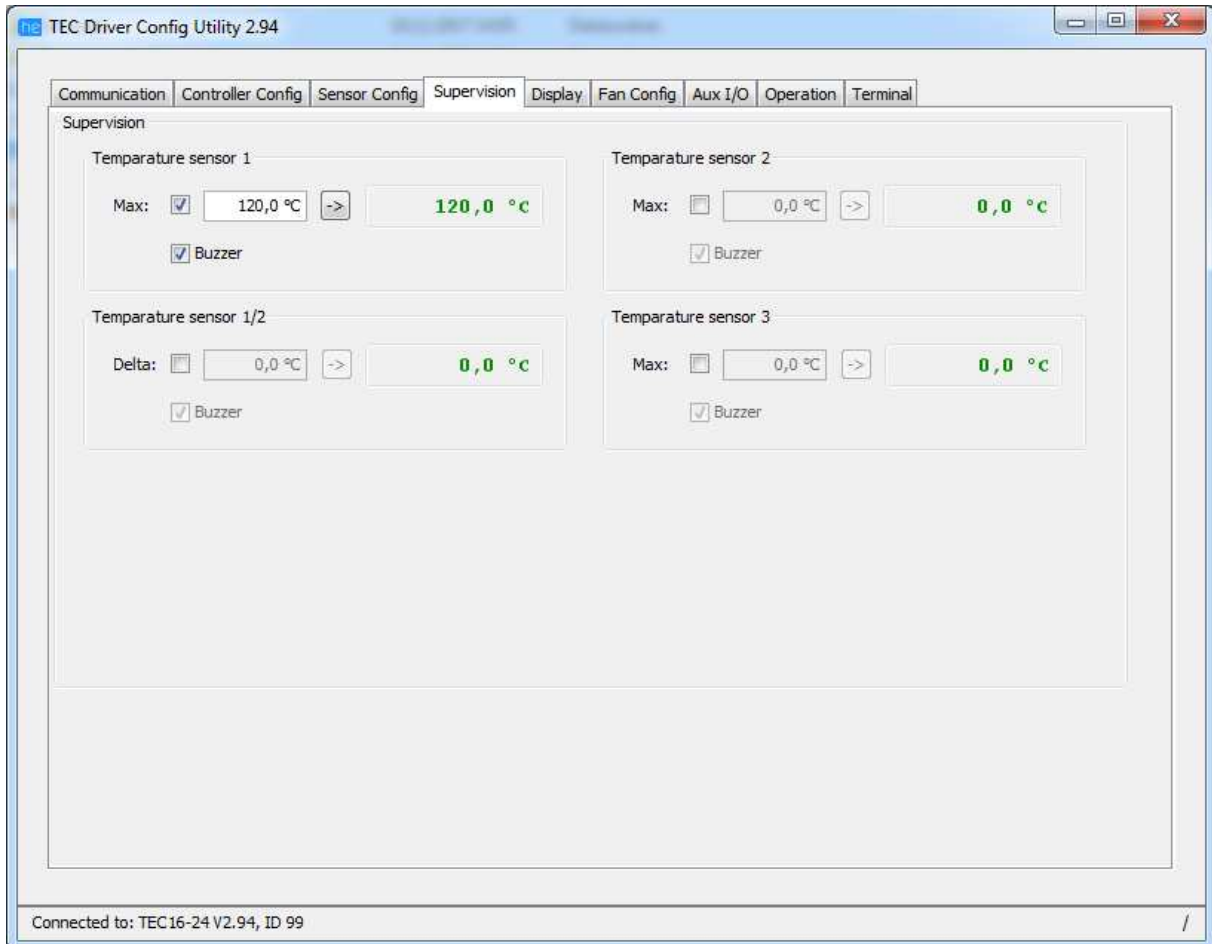
The screenshot shows the 'TEC Driver Config Utility 2.9' window with the 'Sensor Config' tab selected. The interface is divided into several sections:

- Sensor 1 (PT1000):** Factor: 4,13 (displayed as 4,13 in green); Offset: 8494 (displayed as 8494 in green).
- Sensor 2 (PT1000):** Factor: 4,13 (displayed as 4,13 in green); Offset: 8494 (displayed as 8494 in green).
- Auto calibration:** Sensor:  Pt1000 1  Pt1000 2; Temperature min.: 20,0 °C; Temperature max.: 40,0 °C; Start button.
- Measurement points:** A table with columns for Set, Controller, and Reference, and rows for Measurement 1, 2, and 3. Each row has an 'Ok' button.
- Measure accuracy:** A text input field.

At the bottom, the status bar indicates 'Connected to: TEC05-24 V2.92, ID 1'.

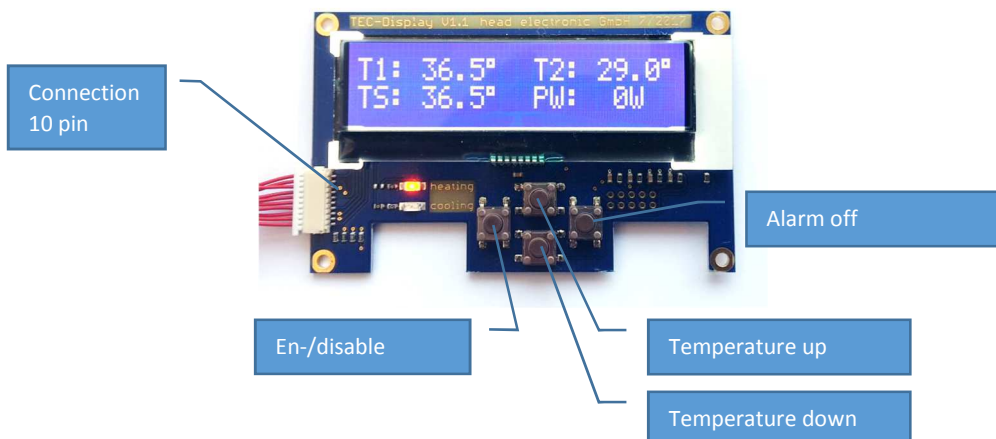
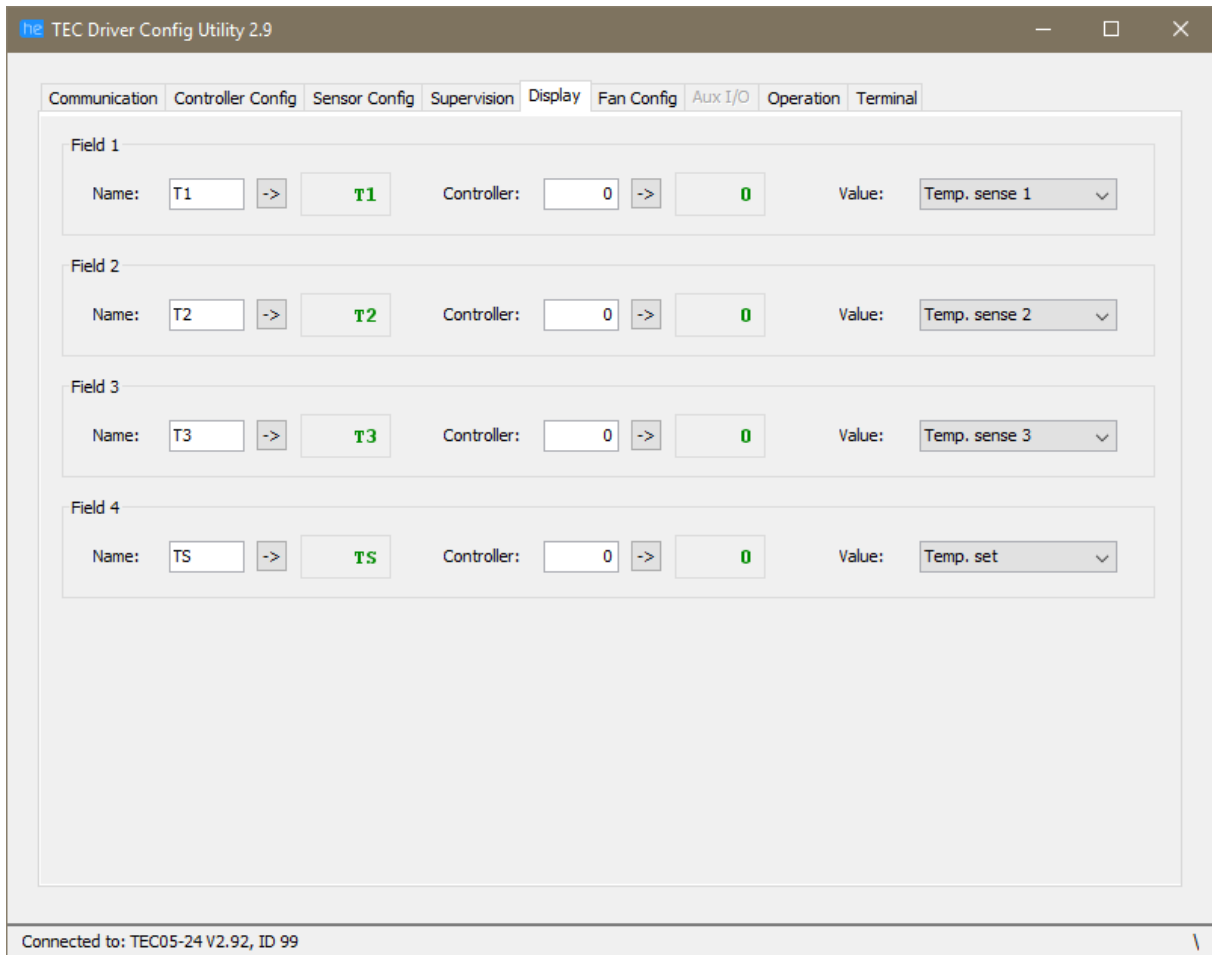
## Supervision

Field	Description
Temperature max	Switch-off temperature
Temperature delta	Switch-off difference sensor 1 and 2
Buzzer	Alarm (TEC16-XX only)



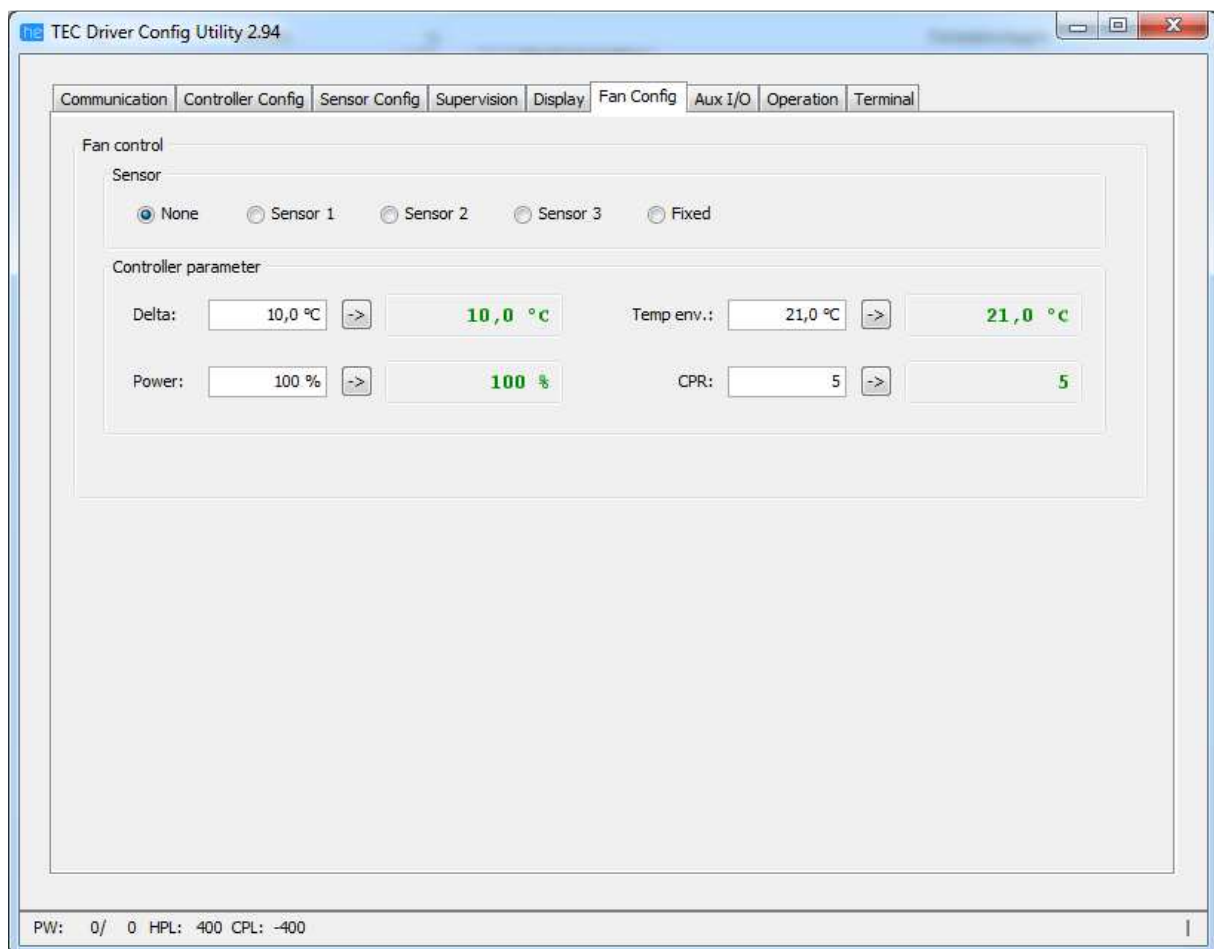
## Display

Field	Description
Name	Two digit label
Controller	TEC controller ID of value source. (0-> self)
Value	Value to be shown



## Fan Config

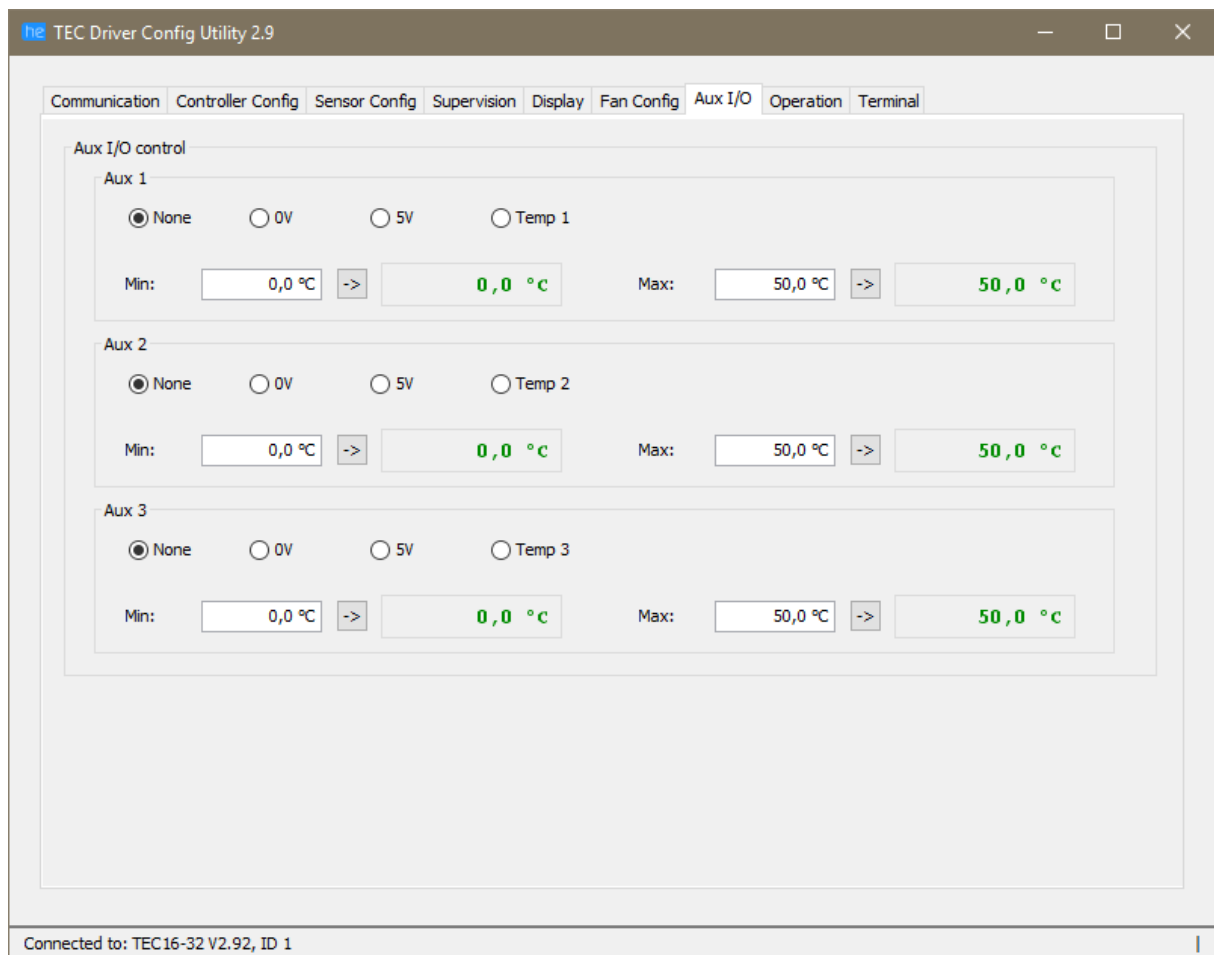
Field	Description
Sensor	Selection of temperature sensor for fan control Fixed -> Fixed fan speed
Delta	Temperature delta for maximum fan speed
Temp env.	Ambient air temperature
Power	Maximum power in sensor modes; Power in fixed mode
CPR	Counts per round on fan pulse input





## Aux I/O

Field	Description
Aux	No output; fixed (0V/5V); analog temperature (PWM)
Min	Lowest temperature for analog output
Max	Highest temperature for analog output



## Operation

The current values of the TEC-Controller are displayed on the "Operation" page. The TEC-Controller is switched on or off with the "Enable" button.

The measurement data can be stored in a CSV file if required. To start and stop logging, press the "Log to file" button. For each recording, a separate file is created in the main directory of the software.

Field	Description
Enable	En-/disable TEC controller
Temp. Setpoint	Temperature set value
Temp. slope	Temperature slope
Log to file	Save measured data to logfile
AutoScript	Auto control by script
Alarm on	Alarm on/off

The screenshot shows the 'TEC Driver Config Utility 2.93' software window. The 'Operation' tab is active, displaying the following controls and data:

- TEC Driver Controls:**
  - TEC driver:
  - Temp. setpoint:
  - Temp. slope:
- TEC Driver data:**
  - Temp. setpoint: **20,0 °C**
  - Temp. slope: **0,00 °C/s**
  - Temp. sensor 1: **24,3 °C**
  - Temp. sensor 2: **24,4 °C**
  - Temp. sensor 3: **no sensor**
  - Driver status: **disabled**
  - TEC voltage: **0,0 V**
  - TEC current: **0,0 A**
  - TEC power: **0,0 W**
  - Fan speed: **0 rpm**
- Buttons:** Log to file, AutoScript, Alarm on
- Logos:** head electronic
- Status Bar:** Connected to: TEC16-24 V2.93, ID 99

## AutoScript Function

With the AutoScript function a command sequence can be programmed by script. To do this, create a text file in which you enter one command in each line.

In addition to the known TEC-Controller commands, the following statements are possible:

"PAUSE": Stop the execution of the script.

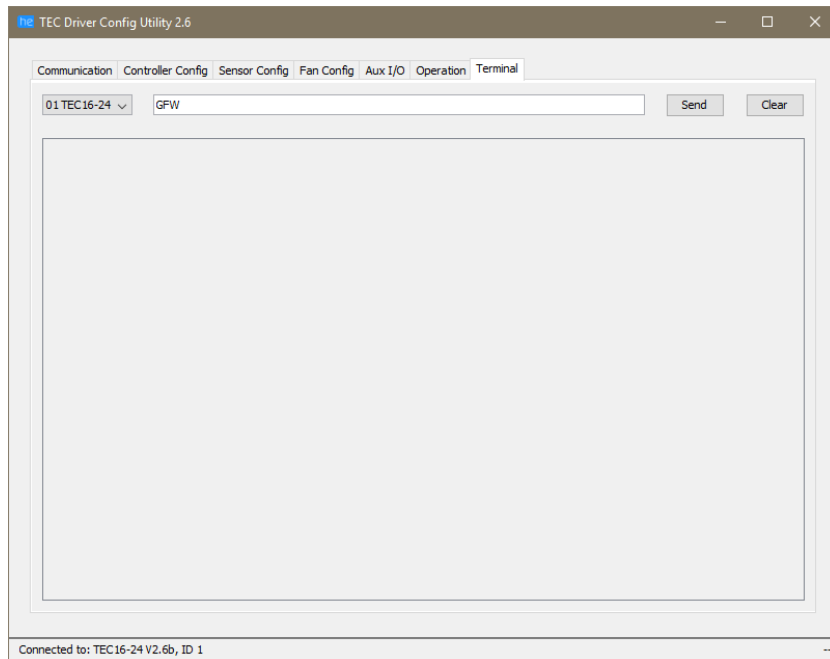
"BEEP": Output a note.

"WAIT": Wait for given seconds, eg. WAIT 10

"CHECK TEMP": Check "Temp OK", if not set stop script and deactivate the TEC-Controller.

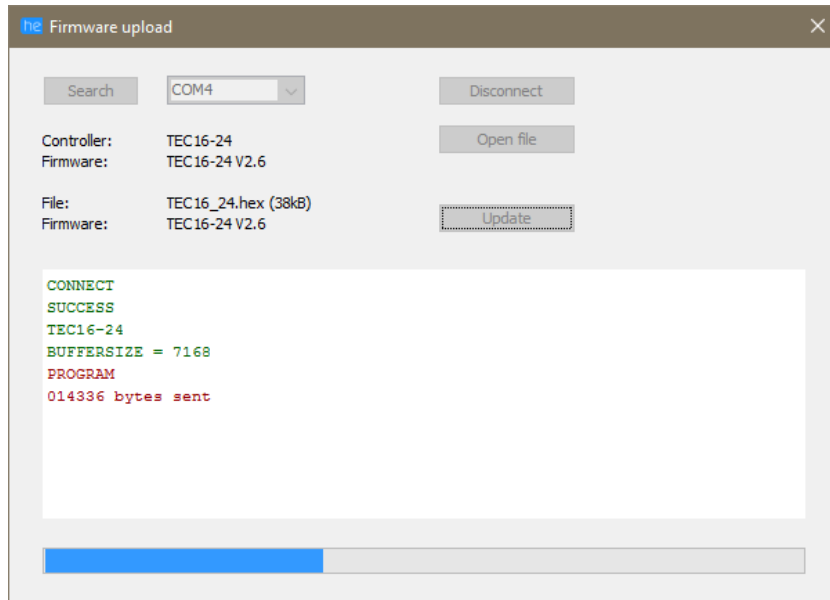
## Terminal

The terminal is used for the manual operation of the TEC-controller by means of the general ASCII commands (see Annex I).



## Annex I, Firmware Update

The software update is started by pressing the "Firmware update" button on the Communication page. Note that the TEC-Controller must be in ASCII data mode and will be disabled during the update process. Under certain circumstances, the TEC-Controller must also be reset to the factory defaults.



## Annex II, User Interfaces

### Parameter

USB Chip:	FTDI FT232R
RS485:	2-wire or 4-wire
Baud rate USB:	115200
Baud rate RS485:	9600, 14400, 19200, 28800, 38400, 57600, 115200
Mode:	8N1

On the RS485 bus all commands must start with the two-digit ID followed by a space (, \ s').

If all TEC-Controllers on the RS485 bus are to be addressed, use the broadcast address 00. In this case the TEC-Controllers respond with a delay according to their ID:  $(ID - 1) * 128 \text{ symbols} + 1\text{ms}$ .

For a USB connection, the ID is optional.

## TEC-Controller ASCII Command Set

### Set Commands

Command followed, if necessary, by a space character and the parameter, and completed by a newline character (\n), zB.:

01 SEN\n

01 STV 2000\n

If the command is not correct/implemented the TEC-Controller will reply: „COMMAND ERR“.

If the parameter is incorrect the TEC-Controller will reply: „FORMAT ERR“.

If the value of the parameter is out of range the TEC-Controller will reply: „NUMBER ERR“.

Each reply will start with the two-digit ID.

Command	Parameter	Description	Answer
RST		Controller reset	reboot
RST	1	Controller reset (Set factory defaults)	factory reset
SA1	MIN+100..15000	Top temperature limit Aux 1 (x 10m°C) (TEC16-XX only)	TEMP_OUT_1_MAX=xxx.xx C
SA2	MIN+100..15000	Top temperature limit Aux 2 (x 10m°C) (TEC16-XX only)	TEMP_OUT_2_MAX=xxx.xx C
SA3	MIN+100..15000	Top temperature limit Aux 3 (x 10m°C) (TEC16-XX only)	TEMP_OUT_3_MAX=xxx.xx C
SAE	0;1	Set auto enable	AUTOENAB=x
SAS	0;1;2	Set periodical (175ms) value send (see command ,GSV‘)	AUTOSEND=x
SBE	0;1	Buzzer enable (TEC16-XX only)	BUZZER_ENABLE=x
SBR	96..1152	Baud rate (x 0,1 kBd)	BAUDRATE=x.x kBd
SBT	0;1..4	Alarm playback (TEC16-XX only)	BUZZER=x
SC1	0..1000	Coefficient Sensor 1 (x 0,01)	TEMP_1_COEFF=xx.xx
SC2	0..1000	Coefficient Sensor 2 (x 0,01)	TEMP_2_COEFF=xx.xx
SCC	0..1600	Negative (cool) current limit (x 10mA)	COOL_C_LIMIT=xx.xx A
SCL	1	Reset hi/low temperature memory	OK
SDI	-	Disable TEC-Controller	STATUS=0
SEI	0;1	Use TEC controller enable input	ENABLE_INPUT=x

SEN	-	Enable TEC-Controller	STATUS=x
SFC	1..8	Fan speed input counts per round	FAN_CPR=x
SFD	0..15000	Temperature delta fan control (x 10m°C)	FAN_DELTA=x
SFP	0..100	Fan power limit (%)	FAN_POWER=x %
SFS	0;1;2;3;4	Sensor fan control (0=Fan off; 4=Fan at power limit)	FAN_SENS=x
SFT	-5000..15000	Ambient temperature fan control (x 10m°C)	FAN_TEMP=x
SHC	0..1600	Positive (heat) current limit (x 10mA)	HEAT_C_LIMIT=xx.xx A
SI1	-5000..MAX-100	Bottom temperature limit Aux 1 (x 10m°C) (TEC16-XX only)	TEMP_OUT_1_MIN=xxx.xx C
SI2	-5000..MAX-100	Bottom temperature limit Aux 2 (x 10m°C) (TEC16-XX only)	TEMP_OUT_2_MIN=xxx.xx C
SI3	-5000..MAX-100	Bottom temperature limit Aux 3 (x 10m°C) (TEC16-XX only)	TEMP_OUT_3_MIN=xxx.xx C
SID	01..99	Set TEC-Controller ID	ID=xx
SIF	0..1000	Factor of the integral portion	I_FACTOR=xx.xx
SIM	0;1	Interface mode (0=ASCII; 1=Binary)	IF_MODE=x
SMA	MIN+100..15000	Maximum temperature (set value) (x 10m°C)	TEMP_MAX=xxx.xx C
SMI	-5000..MAX-100	Minimum temperature (set value) (x 10m°C)	TEMP_MIN=xxx.xx C
SM1	0;1..15000	High temperature limit sensor 1 (x 10m°C) (0=inactive)	TEMP_1_MAX=xxx.xx C
SM2	0;1..15000	High temperature limit sensor 2 (x 10m°C) (0=inactive)	TEMP_2_MAX=xxx.xx C
SM3	0;1..15000	High temperature limit sensor 3 (x 10m°C) (0=inactive) (TEC16-XX only)	TEMP_3_MAX=xxx.xx C
SN1	ASCII [2]	Name LCD field 1	SN1=xx
SN2	ASCII [2]	Name LCD field 2	SN2=xx
SN3	ASCII [2]	Name LCD field 3	SN3=xx
SN4	ASCII [2]	Name LCD field 4	SN4=xx
SNT	0..1000	Negative limit „Temperature OK“ (x 10m°C)	TEMP_OK_NEG=xx.xx C
SO1	-10000..10000	Offset sensor 1 (x 10m°C)	TEMP_1_OFFSET=x
SO2	-10000..10000	Offset sensor 2 (x 10m°C)	TEMP_2_OFFSET=x
SPF	0..1000	Factor of the proportional portion	P_FACTOR=xx.xx
SPT	0..1000	Positive limit „Temperature OK“ (x 10m°C)	TEMP_OK_POS=xx.xx C
SPW	0;-4095..4095	Set TEC voltage (0=inactive, normal control) !For test purposes only, no current limitation, etc.	POWER=x
SS1	0..99	LCD field 1 TEC-Controller ID (0=self)	SS1=x



SS2	0..99	LCD field 2 TEC-Controller ID (0=self)	SS2=x
SS3	0..99	LCD field 3 TEC-Controller ID (0=self)	SS3=x
SS4	0..99	LCD field 4 TEC-Controller ID (0=self)	SS4=x
STI	0;1	Use analog temperature set value input	TEMP_INPUT=x
STD	0;1..15000	Maximum temperature delta sensor 1 and 2 (x 10m°C) (0=inactive)	TEMP_DELTA=xxx.xx C
STS	0;1..1000	Temperature setpoint slope (x 10m°C/s) (0=inactive)	TEMP_SLOPE=xx.xx C/s
STV	MIN..MAX	Temperature set value (x 10m°C)	TEMP_SET=xxx.xx C
SUS	1;2;3	Temperature sensor for TEC control	USE_SENSOR=x
SV1	0..5	LCD value 1 (0=none; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)	SV1=xx
SV2	0..5	LCD value 2 (0=none; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)	SV2=xx
SV3	0..5	LCD value 3 (0=none; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)	SV3=xx
SV4	0..5	LCD value 4 (0=none; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)	SV4=xx
SX1	0;1;2	Set Aux I/O 1 (0=inactive; 1=0V; 2=5V; 3=Temp 1) (TEC16-XX only)	AUX_1=x
SX2	0;1;2	Set Aux I/O 2 (0=inactive; 1=0V; 2=5V; 3=Temp 2) (TEC16-XX only)	AUX_2=x
SX3	0;1;2	Set Aux I/O 3 (0=inactive; 1=0V; 2=5V; 3=Temp 3) (TEC16-XX only)	AUX_3=x

### Get Commands

Command followed by a newline character (\n), zB.:

01 GST\n

01 GTP\n

If the command is not correct/implemented the TEC-Controller will reply: „COMMAND ERR“.

Each reply will start with the two-digit ID.

Command	Description	Answer	Value range
GBR	Baud rate (x 0,1 kBd)	BAUDRATE=x.x kBd	9.6 .. 115.2
GBE	Buzzer enabled (TEC16-XX only)	BUZZER_ENABLE=x	0;1
GC1	Coefficient sensor 1	TEMP_1_COEFF=xx.xx	0.00 .. 10.00

GC2	Coefficient sensor 2	TEMP_2_COEFF=xx.xx	0.00 .. 10.00
GCS	TEC state	CONV=x	0=idle; 1=heat; 2=cool
GCU	TEC current	CURRENT=x.xx A	-99.99 .. 99.99
GEI	Use TEC controller enable input	ENABLE_INPUT=x	0;1
GEN	TEC-Controller state	STATUS=x	0;1
GFC	Fan speed input counts per round	FAN_CPR=x	1..8
GFV	Fan speed	FAN_SPEED=x rpm	0..15000
GFW	Firmware version	FW=x	Text
GID	TEC-Controller ID	ID=xx	01 .. 99
GLC	Display configuration	LCD_SET=x	Text
GMA	Maximum temperature (set value)	TEMP_MAX=x.xx C	-99.99 .. 999.99
GMI	Minimum temperature (set value)	TEMP_MIN=x.xx C	-99.99 .. 999.99
GM1	High temperature limit sensor 1	TEMP_1_MAX=xxx.xx C	0;1..15000
GM2	High temperature limit sensor 2	TEMP_2_MAX=xxx.xx C	0;1..15000
GM3	High temperature limit sensor 3 (TEC16-XX only)	TEMP_3_MAX=xxx.xx C	0;1..15000
GO1	Offset sensor 1	TEMP_1_OFFSET=x	-30000 .. 30000
GO2	Offset sensor 2	TEMP_2_OFFSET=x	-30000 .. 30000
GOK	Temperature OK	TEMP_OK=x	0;1
GPA	Get main parameters (see below)	PARAMS=x	Text
GPW	TEC power	POWER=x W	0..999
GR1	Raw value sensor 1	TR1=x	0..10000
GR2	Raw value sensor 2	TR2=x	0..10000
GR3	Raw value sensor 3 (TEC16-XX only)	TR3=x	0..1000
GS1	Sensor 1 error state	SENSOR_1_ERR=x	0=ok; 1=low; 2=high; 3=fail; 4=Over limit
GS2	Sensor 2 error state	SENSOR_2_ERR=x	0=ok; 1=low; 2=high; 3=fail; 4=Over limit
GS3	Sensor 3 error state (TEC16-XX only)	SENSOR_3_ERR=x	0=ok; 1=low; 2=high; 3=fail; 4=Over limit
GST	TEC-Controller model	ST=x	Text
GSV	Current operation values	ALL=x	Text
GT1	Temperature value sensor 1	TEMP1=x.xx C	-99.99 .. 999.99
GT2	Temperature value sensor 2	TEMP2=x.xx C	-99.99 .. 999.99

GT3	Temperature value sensor 3 (TEC16-XX only)	TEMP3=x.xx C	-99.99 .. 999.99
GTD	Maximum temperature delta Sensor 1 and 2	TEMP_DELTA=xxx.xx C	0;1..15000
GTI	Raw value temperature set input	GTI=x	0..1023
GTS	Temperature setpoint slope (x 10m°C/s) (0=inactive)	TEMP_SLOPE=xx.xx C/s	0;1..1000
GTV	Temperature set value (x 10m°C)	TEMP_SET=xxx.xx C	MIN..MAX
GTE	TEC error	TEC_ERR=x	0;1
GUS	Temperature control sensor	USE_SENSOR=x	1;2;3
GV1	Voltage TEC+	U_HEAT=x.xx V	0.00 .. 99.99
GV2	Voltage TEC-	U_COOL=x.xx V	0.00 .. 99.99

## Values Collective Commands

<b>GPA</b>
Set temperatur value
100
100
Positive current limit
Negative current limit
Factor of the proportional portion
Factor of the integral portion
Positive limit „Temperature OK“
Negative limit „Temperature OK“
Maximum temperature (set value)
Minimum temperature (set value)
Auto enable active
Use analog temperature set input
High temperature limit sensor 1
Maximum temperature delta Sensor 1 and 2
Temperature sensor for TEC control
High temperature limit sensor 2
High temperature limit sensor 3
Sensor fan control
Temperature delta fan control
Ambient temperature fan control
Fan power limit
Coefficient sensor 1
Offset sensor 1
Coefficient sensor 2
Offset sensor 2
Aux I/O 1
Aux I/O 2

Aux I/O 3
Bottom temperature limit Aux 1
Top temperature limit Aux 1
Bottom temperature limit Aux 2
Top temperature Aux 2
Bottom temperature limit Aux 3
Top temperature Aux 3
Temperature setpoint slope
Use TEC controller enable input
Buzzer enable
Fan speed input counts per round

<b>GLC</b>
Feld 1 Bezeichnung
Feld 1 Slave ID
Feld 1 Typ Anzeigewert
Feld 2 Bezeichnung
Feld 2 Slave ID
Feld 2 Typ Anzeigewert
Feld 3 Bezeichnung
Feld 3 Slave ID
Feld 3 Typ Anzeigewert
Feld 4 Bezeichnung
Feld 4 Slave ID
Feld 4 Typ Anzeigewert

<b>GSV</b>
TEC-Controller state
Set temperatur value
Sensor 1 error state
Temperature value sensor 1
Sensor 2 error state
Temperature value sensor 2
Sensor 3 error state
Temperature value sensor 3
TEC current
Voltage TEC+
Voltage TEC-
LED "heat"
LED "cool"
LED "temp_ok"
LED "tec_fail"
LED "sensor_fail"
High temperature limit sensor 1-3 exceeded
Maximum temperature delta sensor 1 and 2 exceeded
Fan speed
Temperature slope

## TEC-Controller Binary Command Set

### Data Frames

Data frames are only processed if they meet the following specification. There is always a confirmation frame with the repeated command or an error message. After the confirmation frame has been returned, another frame can be transmitted.

The frames are structured as follows:

Frame Start	Destination Address	Origin Address	Frame Length	Function/Error (big-Endian)	Data (big-Endian)	CRC16 LByte	CRC16 HByte	Frame End
1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes	0 - 247 Bytes	1 Byte	1 Byte	1 Byte

#### *Frame Start*

Character: 0x7E

Escape: 0x7D + XOR 0x20 (0x7E -> 0x7D + 0x5E)

#### *Destination Address*

Address range: 1 - 99

Broadcast: 0

#### *Origin Address*

Address range: 1 – 99

#### *Frame Length*

Data bytes except frame start/frame end

#### *CRC16*

Initial value: 0xFFFF

Polynomial: 0xA001

#### *Frame End*

Character: Frame start

Not applicable for successive frames

## Commands (Functions)

The following commands are implemented. If a valid command including valid data is sent the answer contains the new value if accepted.  
If a command is sent without data, the current value is sent back.

Functions	Bytes	Value range	R	W	Description
0x1000	1	0;1;2	X		Controller state (0=idle; 1=heating; 2=cooling)
0x1001	1	0;1;2	X	X	En-/Disable TEC-Controller (0=Off; 1=On; 2=On + error reset)
0x1002	2	MIN..MAX	X	X	Temperature set value (x 10m°C)
0x1003	1	1		X	Reset hi/low temperature memory
0x1004	1	0;1	X	X	Set auto enable
0x1005	2	96..1152	X	X	Baud rate (x 0,1 kBd)
0x1006	1	0;1	X	X	Interface mode (0=ASCII; 1=Binary)
0x1007	1	0;1	X	X	Use TEC controller enable input
0x2001	2	0..1000	X	X	Coefficient Sensor 1 (x 0,01)
0x2002	2	0..1000	X	X	Coefficient Sensor 2 (x 0,01)
0x2004	2	-30000..30000	X	X	Offset sensor 1 (x 10m°C)
0x2005	2	-30000..30000	X	X	Offset sensor 2 (x 10m°C)
0x2007	2	MIN+100..15000	X	X	Maximum temperature (set value) (x 10m°C)
0x2008	2	-5000..MAX-100	X	X	Minimum temperature (set value) (x 10m°C)
0x2009	2	0..1000	X	X	Positive limit „Temperature OK“ (x 10m°C)
0x2010	2	0..1000	X	X	Negative limit „Temperature OK“ (x 10m°C)
0x2011	1	0;1	X	X	Use analog temperature set input
0x2012	2	0;1..15000	X	X	Maximum temperature delta sensor 1 and 2 (x 10m°C) (0=inactive)
0x2013	2	0,1..15000	X	X	High temperature limit sensor 1 (x 10m°C) (0=inactive)
0x2014	1	1;2;3	X	X	Temperature sensor for TEC control
0x2015	2	0..1000	X	X	Factor of the proportional portion
0x2016	2	0..1000	X	X	Factor of the integral portion
0x2017	2	0;1..15000	X	X	High temperature limit sensor 2 (x 10m°C) (0=inactive)
0x2018	2	0;1..15000	X	X	High temperature limit sensor 3 (x 10m°C) (0=inactive) (TEC16-XX only)
0x2020	2	-5000..15000	X		Temperature value sensor 1



Functions	Bytes	Value range	R	W	Description
0x2021	2	-5000..15000	X		Temperature value sensor 2
0x2022	2	-5000..15000	X		Temperature value sensor 3
0x2023	1	0;1;2;3	X		Sensor 1 error state (0=ok; 1=low; 2=high; 3=fail; 4=Over limit)
0x2024	1	0;1;2;3	X		Sensor 2 error state (0=ok; 1=low; 2=high; 3=fail; 4=Over limit)
0x2025	1	0;1;2;3	X		Sensor 3 error state (0=ok; 1=low; 2=high; 3=fail; 4=Over limit)
0x2026	1	0;1	X		Temperature OK
0x2027	2	0;1..1000	X	X	Temperature setpoint slope (x 10m°C/s) (0=inactive)
0x2028	2	0..4095	X		Raw value sensor 1
0x2029	2	0..4095	X		Raw value sensor 2
0x2030	2	0..1023	X		Raw value sensor 3 (TEC16-XX only)
0x2031	2	0..1023	X		Raw value temperature set input
0x2032	2	0..15000	X		Fan speed (rpm)
0x2101	2	0..1600	X	X	Positive (heat) current limit (x 10mA)
0x2102	2	0..1600	X	X	Negative (cool) current limit (x 10mA)
0x2103	2	-9999..9999	X		TEC current (x 10mA)
0x2104	1	0..9999	X		Voltage TEC+ (x 10mV)
0x2105	1	0..9999	X		Voltage TEC- (x 10mV)
0x2106	1	0;1	X		TEC error
0x2201	1	0;1;2;3;4	X	X	Sensor fan control (0=Fan off; 4=Fan at power limit)
0x2202	2	-5000..15000	X	X	Ambient temperature fan control (x 10m°C)
0x2203	2	0;1..15000	X	X	Temperature delta fan control (x 10m°C)
0x2204	1	0..100	X	X	Fan power limit (%)
0x2205	1	0;1;2;3	X	X	Set Aux I/O 1 (0=inactive; 1=0V; 2=5V; 3=Temp 1) (TEC16-XX only)
0x2206	1	0;1;2;3	X	X	Set Aux I/O 2 (0=inactive; 1=0V; 2=5V; 3=Temp 2) (TEC16-XX only)
0x2207	1	0;1;2;3	X	X	Set Aux I/O 3 (0=inactive; 1=0V; 2=5V; 3=Temp 3) (TEC16-XX only)
0x2208	2	MIN+100..15000	X	X	Top temperature limit Aux 1 (x 10m°C) (TEC16-XX only)
0x2209	2	MIN+100..15000	X	X	Top temperature limit Aux 2 (x 10m°C) (TEC16-XX only)
0x2210	2	MIN+100..15000	X	X	Top temperature limit Aux 3 (x 10m°C) (TEC16-XX only)
0x2211	2	-5000..MAX-100	X	X	Bottom temperature limit Aux 1 (x 10m°C) (TEC16-XX only)

Functions	Bytes	Value range	R	W	Description
0x2212	2	-5000..MAX-100	X	X	Bottom temperature limit Aux 2 (x 10m°C) (TEC16-XX only)
0x2213	2	-5000..MAX-100	X	X	Bottom temperature limit Aux 3 (x 10m°C) (TEC16-XX only)
0x2220	2	ASCII	X	X	Label LCD field 1
0x2221	2	ASCII	X	X	Label LCD field 2
0x2222	2	ASCII	X	X	Label LCD field 3
0x2223	2	ASCII	X	X	Label LCD field 4
0x2224	1	0..99	X	X	LCD field 1 TEC controller-ID (0=self)
0x2225	1	0..99	X	X	LCD field 2 TEC controller-ID (0=self)
0x2226	1	0..99	X	X	LCD field 3 TEC controller-ID (0=self)
0x2227	1	0..99	X	X	LCD field 4 TEC controller-ID (0=self)
0x2228	1	0..5	X	X	LCD value 1 (0=na; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)
0x2229	1	0..5	X	X	LCD value 2 (0=na; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)
0x2230	1	0..5	X	X	LCD value 3 (0=na; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)
0x2231	1	0..5	X	X	LCD value 4 (0=na; 1=Temp 1; 2=Temp 2; 3=Temp 3; 4=Temp set; 5=TEC power)
0x9001	2	0x0..0xFFFF	X		Firmware version (Code)
0x9002	<=32	text	X		Firmware version (Text)
0x9003	<=32	text	X		TEC-Controller model
0xAA01	1	01..99	X	X	Set TEC-Controller ID
0xAA02	2	0;-4095..4095	X	X	Set TEC voltage (0=inactive, normal control) !For test purposes only, no current limitation, etc.
0xA AFF	1	0;1		X	Controller reset (0=reset; 1=set factory defaults)

## Error messages

The following error messages are implemented.

<b>Error code</b>	<b>Bytes</b>	<b>Value range</b>	<b>Description</b>
0xFFA1	0		Function not implemented
0xFFA2	0		Data out of range
0xFFA3	2	CRC	CRC error (Output to the first correctly transmitted CRC only)
0xFFA4	2		Data length length not equal number of received bytes

## Version history

### V 2.94

- New command: „SFC“
- New command: „GFC“

### V 2.93

- New feature: Buzzer (TEC16-XX only)
- New command: „SBE“
- New command: „SBT“

### V 2.92

- New feature: Display keys

### V 2.9

- New command: „SNx“
- New command: „SSx“
- New command: „SVx“
- New command: „GPW“
- New command: „GTI“
- New command: „GUS“
- New command: „GLC“
- Extended command: „GSV“

### V 2.8

- New feature: Display connection
- New command: „SEI“