

Two Channel OEM TEC Controller



Description:

The TEC-1166 is a specialized dual channel TEC Controller/power supply able to precision-drive two Peltier elements.

- Each channel features a true bipolar DC current source for cooling / heating, three temperature monitoring inputs (1x high resolution, 2x low resolution) and intelligent PID control with auto tuning. The TEC-1166 is fully digitally controlled, it's hard- and firmware offer numerous communication and safety options.
- The included PC-Software allows configuration, control, monitoring and live diagnosis of the TEC Controller via USB, RS232 TTL and RS485. All parameters are saved to non-volatile memory. Saving can be disabled for bus operation.
- For the most straightforward applications, only a power supply, a Peltier element and at least one temperature sensor need to be connected to the TEC-1166. After power-up the unit will operate according to pre-configured values. (In stand-alone mode no control interface is needed.)
- The TEC-1166 can handle either Pt100, Pt1000, NTC or Voltage temperature probes. For highest precision and stability applications a Pt100 / 4-wire input configuration is recommended. Analog measurement circuit is factory calibrated.
- Auxiliary temperature inputs allow the connection of NTC probes that are located on the heat sinks of the Peltier elements. This additional data is used to compensate for parasitic thermal conduction of Peltier elements. Also, it allows the control of external heat sink cooling fans.

- The heating and cooling power is optimized by proprietary thermal management routines based on power balance models (for Peltier elements and resistive heaters).
- Further functionality includes: Smooth temperature ramping, thermal stability indication and auto gain (NTC probes). The PC-Software allows data logging and configuration import/export.

Features

Input Characteristics:

- DC Input Voltage: 11.5 to 63 V

Output Characteristics (per channel):

- Voltage: up to ± 56 V
- Current: up to ± 5 A

Main Features:

- Temperature Sensor Types: Pt100, Pt1000, NTC, Voltage
- Temperature Precision / Stability: < 0.01 °C
- Temperature Control & Measurement Frequency: 1 Hz, 10 Hz, 90 Hz
- Communication bus compatible
- Configuration and monitoring with Service Software

Operation Modes:

- Stand-alone operation
- Remote-controlled over USB, RS485, RS232 TTL, CANopen CiA 301, I/O
- Script-controlled over lookup table (thermal cycling)

Driver Modes:

- DC power supply (bipolar)
- Temperature control: PID settings, auto tuning, optional cool/heat-only or resistor heating modes

Important Note:

The following features will be activated with an incoming firmware update, but are not yet useable:

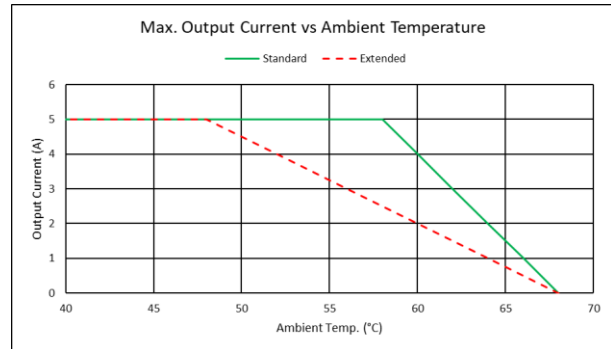
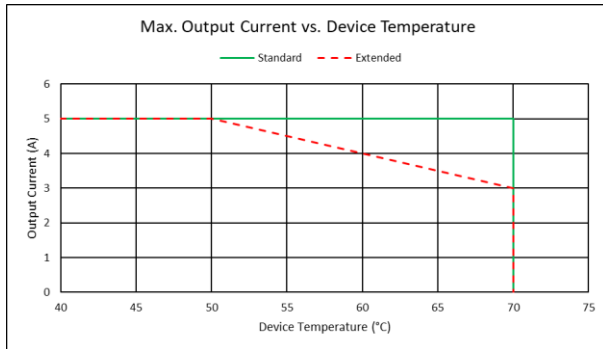
- GPIO9 and GPIO10
- Low Resolution temp. measurement input 3 and 4

General Characteristics

Absolute Maximum Ratings	
Supply voltage (DC)	70 V

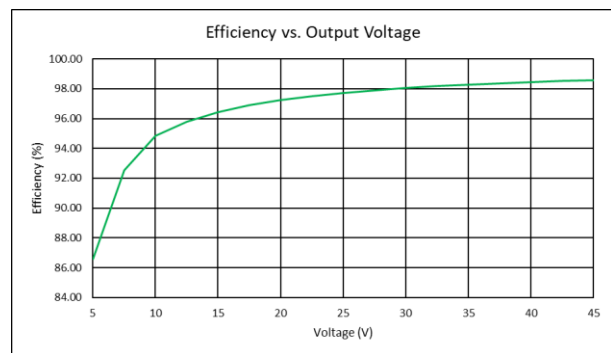
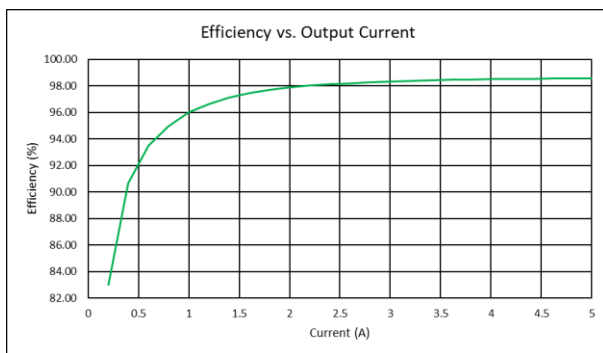
Operating Ratings	
Temperature	-40 – 70 °C
Humidity	5 – 95 % non-condensing

Operating Characteristics



Note:
Standard or Extended Device Temperature Mode can be set as software setting.
No forced air flow was present.

Efficiency



Note:
The Efficiency measurements were done at 48 V input voltage, an output voltage of 44 V, an output current of 5 A and a device temperature of 60°C unless otherwise noted. The ambient temperature was 23°C, no forced air flow was present.

Electrical Characteristics

Unless otherwise noted: $T_A = 25$ °C, $U_{IN} = 48$ V

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
DC Power Supply Input:						
U_{IN}	Supply voltage		11.5		63	V
U_{IN} Ripple	Ripple tolerance	U_{IN} never below $U_{IN\ min}$ or above $U_{IN\ max}$			300	mVPP
Output:						
I_{OUT}	Bipolar current swing				± 5	A
U_{OUT}	Bipolar voltage swing	U_{OUT} is maximum $\sim 0.90 U_{IN}$			± 56	V
U_{OUT} Ripple	Voltage ripple	@ 5 A			30	mVPP
System Characteristics:						
$\eta_{50\%}$	Power efficiency	@ 50 % load (28 V, 5 A)		96		%
$\eta_{100\%}$	Power efficiency	@ 100 % load (56 V, 5 A)		98		%
Output Monitoring (I_{OUT} Resolution is 3.7 mA; U_{OUT} Resolution is 17.6 mV):						
I_{OUT} Read	Precision	@ 4.8 A		1	5	%
U_{OUT} Read	Precision	@ 30.0 V		1	3	%

Output Safety Characteristics

Unless otherwise noted: $T_A = 25$ °C, $U_{IN} = 48$ V

Symbol	Parameter	Test Conditions / Hints	Min	Typ	Max	Units
Output Stage Protection Delays:						
t_{OFF} short circuit		Full load condition		10	30	μ s
t_{OFF} power system limits		Current and voltage limits			200	μ s
Output Stage Current Supervision:						
(If the OUT+ and OUT- currents differ too much, an error is generated)						
I_{OUT_DIFF}	Error threshold			500		mA

High Resolution Temperature Measurement Characteristics (NTC Probes)

NTC thermistor resistive input characteristics translate into temperature ranges valid for only one type of NTC probe. Below example is given in the case of an NTC B25/100 3988K R25 10k temperature sensor.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$R_{HR, RANGE}$	ADC auto gain		73		1 M	Ω
	PGA = 1 or 8 or 32		194.3 to -55.5			°C

$R_{OBJ, RANGE}$ is resistance range of the NTC sensor.

High Resolution Temperature Measurement Characteristics (Pt100 and Pt1000 Probes)

Measurement configuration = 23 bit / 4-wire / unshielded cable <50 mm

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
T _{OBJ, RANGE}	Range	Range is extendable upon request. Extended measurement range is -193 °C ... +787 °C	-220		+200	°C
T _{OBJ, PREC}	Precision	(EN 60751 / IEC 751)		5		mK
T _{OBJ, COEFF}	Temp. coefficient	Relative to device temperature			1.6	mK/K
T _{OBJ, NOISE}	Value noise	Reference measurement fluctuations while output stage operating @ 70 % load		5		mK
T _{OBJ, REP}	Repeatability	Repeated measurements of refer- ence resistors after up to 3 days		8		mK

High Resolution Temperature Measurement Configuration (Voltage Measurement VIN1/2)

Sensors with linear Voltage/Temperature output.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
V _{SENS, DIFF}	Range	Differential Input voltage Temperature range depends on sensor used	-2.039		2.039	V
T _{OBJ, RANGE}	Range	Absolute Input voltage	-0.1		5.1	V

Low Resolution Temperature Measurement Characteristics (NTC only)

T_A = 25 °C, measurement configuration = 12 bit / 2-wire / unshielded cable <50 mm, °T probe = NTC B25/100 3988K R25 10k

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
R _{LR, RANGE}	Range	Corresponding temperature range	83		182413	Ω
				-30 to 187		°C

General Purpose Digital I/O Characteristics (GPIO1 ... GPIO10)

Unless otherwise noted: T_A = 25 °C

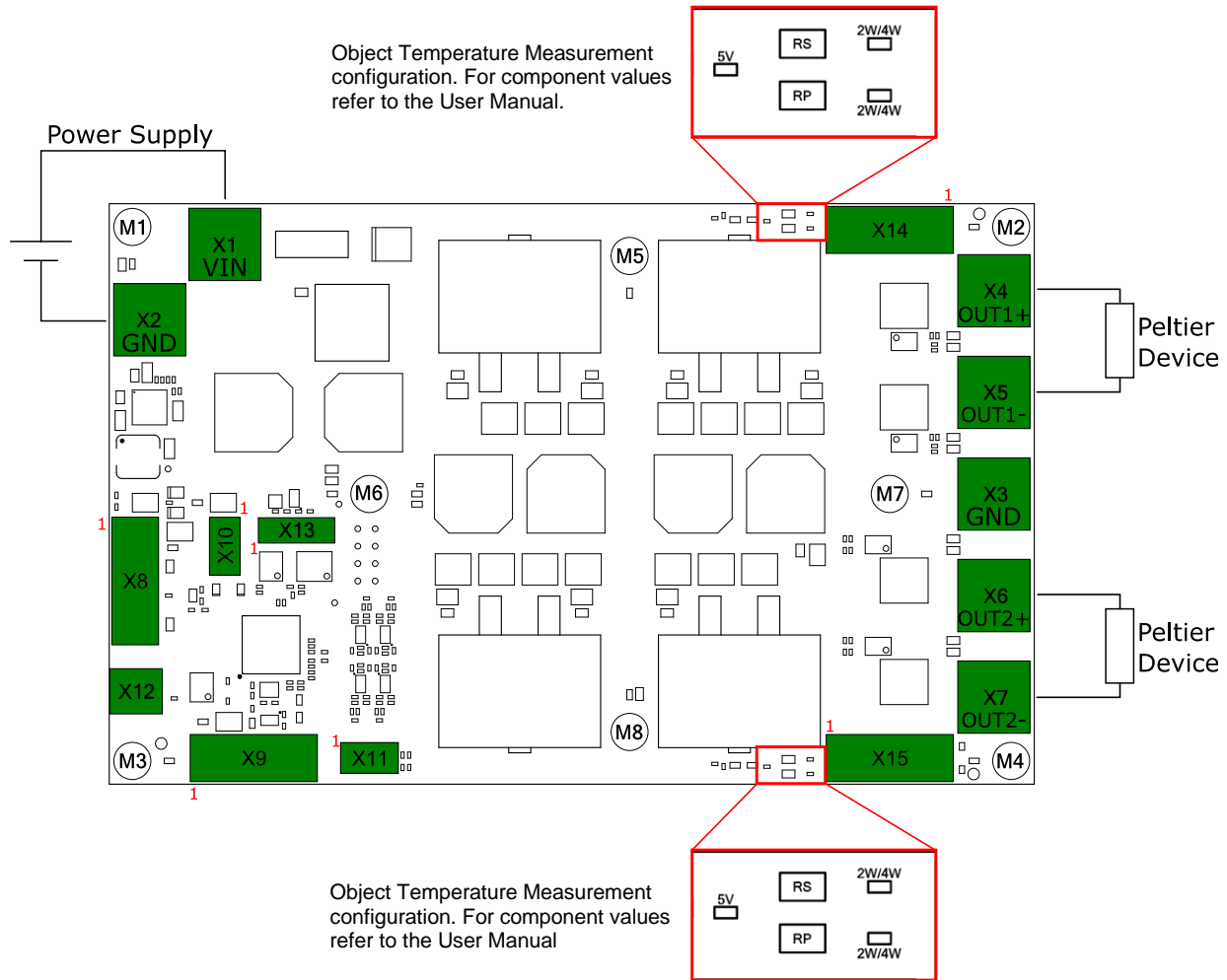
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
Input Characteristics:						
(Microprocessor)						
U _{IH}	Logic high input threshold		2.38			V
U _{IL}	Logic low input threshold				0.93	V
U _{IMAX}	Maximum input voltage		-0.5		5.5	V
Output Characteristics:						
(Microprocessor)						
U _{OH}	Logic high output voltage	Output current 8 mA	2.8		3.3	V
U _{OL}	Logic low output voltage	Input current 8 mA			0.4	V
Z _{OUT}	Output impedance			50		Ω
I _{OUT}	Output Sink or Source Current			± 8	± 20	mA
ESD Protection:						
(Between Processor and Connector)						
U _{PP}	ESD discharge	IEC61000-4-2		18		kV
	Series resistance		85	100	115	Ω

Auxiliary Connector X8, X9, X10 Power Supply Output Characteristics

Unless otherwise noted: $T_A = 25$ °C

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
Input Characteristics:						
U_{OUT}	Output voltage	Output current 50 mA	4.4	4.5	5	V
I_{OUT}	Output current	Sum of output currents of X8, X9 and X10	0	150	200	mA
U_{MAX}	Maximum input voltage		-0.5		5.5	V

PCB-Overview



Connector X1 – X7

Parameter	Min	Typ	Max	Units
Matching screw		M4x6		
Tightening torque		2.2		Nm

Connector X8, X9, X14, X15 TB (Terminal Block) version

Matching Receptacle: Würth WR-TBL Series 382. Würth Part Number 691381000008. Pin 1 is marked in red.

Parameter	Min	Typ	Max	Units
Wire thickness	0.2		1.5	mm ²

For pinout description: see next paragraph.

Connector X8, X9, X14, X15 CON version

Matching Receptacle: Molex Nano-Fit. Molex Part Number 1053071208. Pin 1 is marked in red.

Pinout Com Connector X8 (TB and CON version)			
PIN 1	+5V	PIN 5	RS232 TTL TX
PIN 2	GND	PIN 6	RS232 TTL RX
PIN 3	RS485 1 A/D+	PIN 7	CAN1 H
PIN 4	RS485 1 B/D-	PIN 8	CAN1 L

Pinout GPIO Connector X9 (TB and CON version)			
PIN 1	+5V	PIN 5	GPIO 3
PIN 2	GND	PIN 6	GPIO 4
PIN 3	GPIO 1	PIN 7	GPIO 5
PIN 4	GPIO 2	PIN 8	GPIO 6

Pinout Temp Measurement Connector X14 (TB and CON version)			
PIN 1	HR Temp IA	PIN 5	LR Temp 1 A
PIN 2	HR Temp IB	PIN 6	LR Temp 1 B
PIN 3	HR Temp UA	PIN 7	LR Temp 3 A
PIN 4	HR Temp UB	PIN 8	LR Temp 3 B

Pinout Temp Measurement Connector X15 (TB and CON version)			
PIN 1	HR Temp 2IA	PIN 5	LR Temp 2 A
PIN 2	HR Temp 2IB	PIN 6	LR Temp 2 B
PIN 3	HR Temp 2UA	PIN 7	LR Temp 4 A
PIN 4	HR Temp 2UB	PIN 8	LR Temp 4 B

Connector X10, X11

Matching Receptacle: Würth Mini Module. Würth Part Number 690157000472. Pin 1 is marked in red.

Pinout Aux Com Connector X10			
PIN 1	+5V	PIN 3	CAN2 H (CAN2 is not available)
PIN 2	GND	PIN 4	CAN2 L (CAN2 is not available)

Pinout Aux GPIO Connector X11			
PIN 1	GPIO 7	PIN 3	GPIO 9
PIN 2	GPIO 8	PIN 4	GPIO 10

Connector Specifications X12

The Mini USB Connector X12 can be used to communicate with the TEC Controller using the meCom communications protocol or the Service Software. It is electrically isolated.

Connector Specifications X13

The Connector X13 can be used to connect one of the OLED Displays available from Meerstetter (DPY-1113, DPY-1114 or DPY-1115)

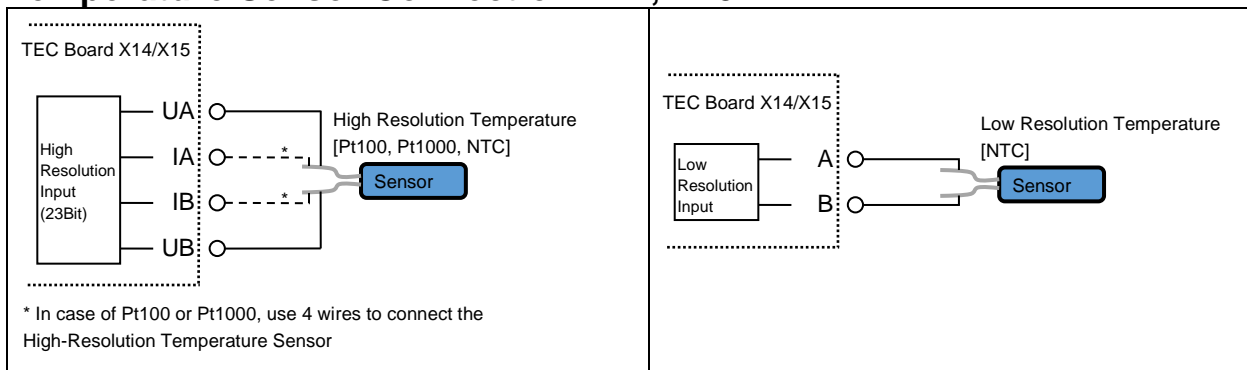
Temperature Measurement Configuration

The Jumpers "2W/4W" are used for the 2 Wire / 4 Wire configuration. For the values of R_S and R_P please refer to the TEC Controller User Manual.

Mounting Holes M1 – M8

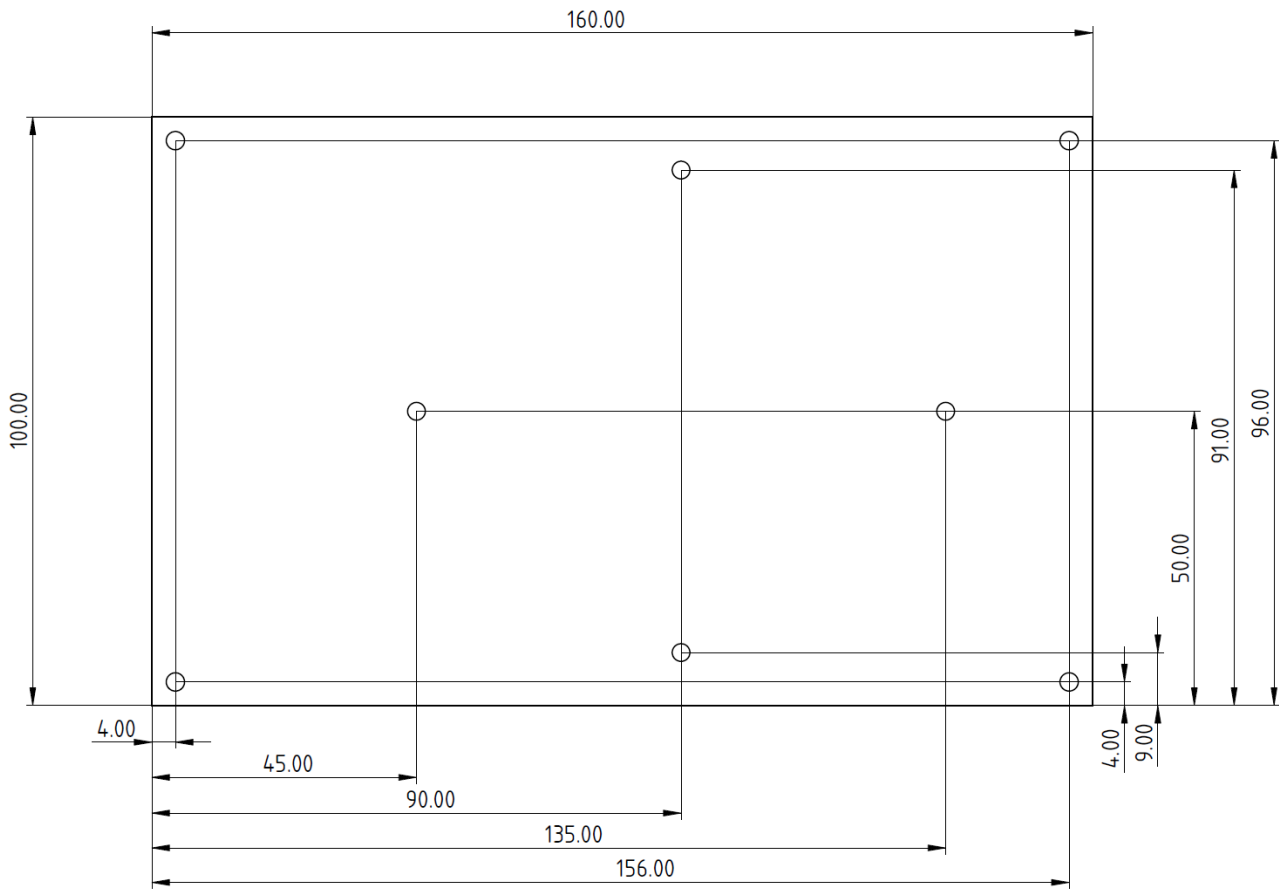
All Mounting holes have a Diameter of 3.05 mm.

Temperature Sensor Connection X14, X15



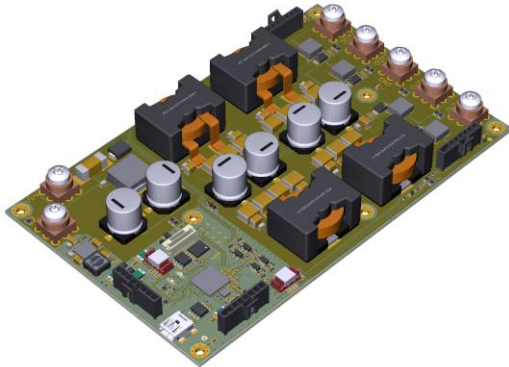
Dimensions and Mounting Hole Positions

Top View, all measurements in mm.

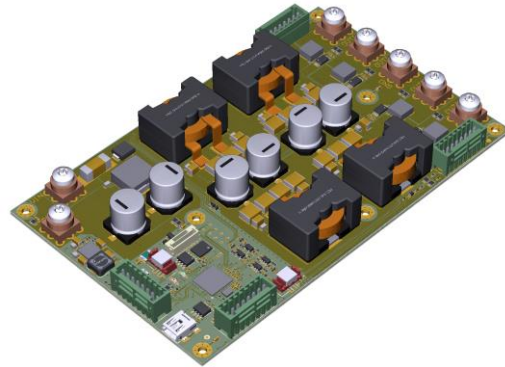


Operation-Modes / Theory of Operation

The TEC-1166 is an OEM precision TEC Controller that is available with Terminal Blocks and with connectors. Its basic operation status is visually indicated by on-board green and red LEDs and their blinking pattern.



CON locking Connector equipped version
(Best suited for series production)



TB Terminal Block equipped version
(Best suited for prototyping, commissioning and small series.
Attention: Counter parts for Terminal Blocks will not be shipped with the device!)

Status information can be polled at any time by industry standard connections RS485, RS232 TTL, CANopen or by USB. The TEC-1166 can also operate in a remotely controlled manner, with parameters adjusted on the fly. The TEC Controller has Scripting capability by sequential lookup table read-out.

Configured as a DC power-supply, the TEC-1166 can handle current and voltage settings. In the remote-control case, temperature data may be passed on to be processed by the host.

Configurable parameters further include sensor linearization (Pt100 / Pt1000) and Steinhart-Hart modeling (NTC), temperature acquisition hardware calibration, Peltier element modeling, PID controller auto tuning, nominal temperature ramping, current, voltage and temperature limits, error thresholds, etc. Please refer to the TEC Controller User Manual (Document 5216) for further information.

TEC-1166 Ordering Information, Hardware Configuration

Example Configuration: **TEC-1166-PT100-TB-CSX**

TEC Model:
-TEC-1166

High Resolution Sensor Type:
- PT100 (4 Wire)
- PT1000 (4 Wire)
- NTC (2 Wire)
- VIN1 or VIN2

Terminal Configuration:
-TB (Terminal Block)
-CON (Connector)

Customer Specific Hardware:
- Indicates a Customer Specific Hardware Configuration
Normally left blank

High Resolution Sensor Type:

Thermocouple: To use our TEC Controller with thermocouples type K, you need a TCI-1181 in addition to the TEC Controller with a VIN1 Object Sensor Type configuration.

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Meerstetter Engineering GmbH (ME) reserves the right to make changes without further notice to the product described herein. Information furnished by ME is believed to be accurate and reliable. However typical parameters can vary depending on the application and actual performance may vary over time. All operating parameters must be validated by the customer under actual application conditions.

Annex A. Change history

Date of change	Doc/Version	Changed/Approved	Change / Reason
6 July 2023	A	HS / ML	Document Created