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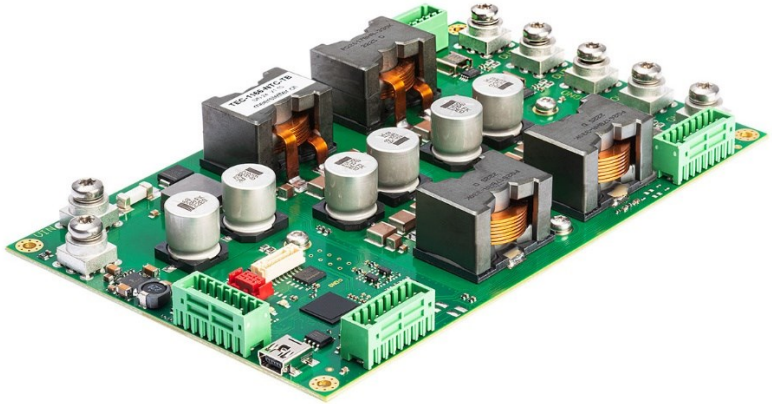
Datasheet –
TEC Controller TEC-1166 (2x (±5 A / ±56 V))



Support / First Steps

Meerstetter Engineering provides technical support for all products and helps you to integrate a product into your solution. Most of your questions should be solved by reading the provided user manuals of the corresponding product or the FAQ (frequently asked questions).
For further help or if you have any other questions, please do not hesitate to contact us. We are happy to help you. You can contact us by email support@meerstetter.ch.

Meerstetter's Product Family Compatibility

The Meerstetter LDD- and TEC-Families have been developed to work along with each other. They share the same platform bus, communication protocol and hardware architecture. See the following table for an overview of the LDD- and TEC-Families.

LDD-Family		
LDD-1321	0-1.5 A / 0-14 V	CW, Add on TEC Controller available
LDD-1301	0-20 A / 0.5-45 V	1 ms - CW
LDD-1303	0-20 A / 1-120 V	1 ms - CW
LDD-1137	0-75 A / 0-70 V	0.5 µs - CW, modulated, QCW and pulsed modes
LDD-1124-SV	0-1.5 A / 0-15 V	1 µs - CW, modulated, QCW and pulsed modes
LDD-1121-SV	0-15 A / 0-15 V	1 µs - CW, modulated, QCW and pulsed modes
LDD-1125-HV	0-30 A / 0-27 V	1 µs - CW, modulated, QCW and pulsed modes
TEC-Family		
TEC-1092	±1.2 A / ±9.6 V	Micro, single channel
TEC-1091	±4 A / ±21 V	Small, single channel
TEC-1089-SV	±10 A / ±21 V	Medium, single channel
TEC-1162	±5 A / ±56 V	Medium-high, single channel
TEC-1090-HV	±16 A / ±30 V	Large, single channel
TEC-1163	±25 A / ±56 V	Extra-large, single channel
TEC-1161-4A	2 x (±4 A / ±21 V)	Small, dual channel
TEC-1161-10A	2 x (±10 A / ±21 V)	Medium, dual channel
TEC-1122-SV	2 x (±10 A / ±21 V)	Medium, dual channel
TEC-1166	2 x (±5 A / ±56 V)	Medium-high, dual channel
TEC-1123-HV	2 x (±16 A / ±30 V)	Large, dual channel
TEC-1167	2 x (±25 A / ±56 V)	Extra-large, dual channel

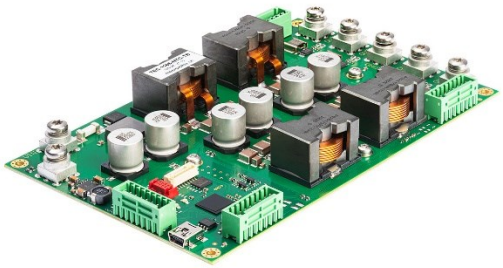
Thermoelectric Cooling Temperature Controller

TEC Controller / Peltier Driver up to ±5 A / up to ±56 V

TEC-1166

HW v1.20

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 can be saved to non-volatile memory.
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.
Low resolution 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 / Diagnosis over all communication interfaces with PC Software
- Measurement Inputs freely assignable to any Output Channel
- Bipolar output channels can be split into unipolar channels

Operation Modes:

- Stand-alone operation
- Remote-controlled over USB, RS485 (Half-Duplex), 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

Special Requirements / More Information:

- Please contact us for additional information or customization.

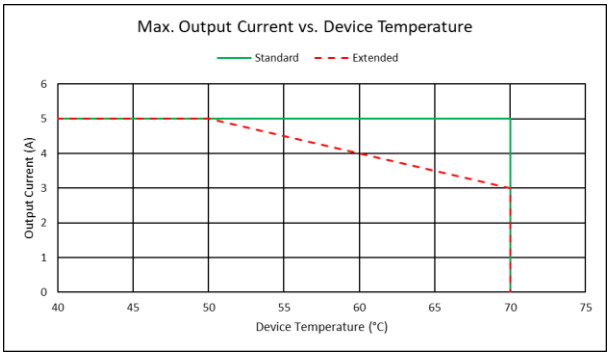
Document Number: 5286C (18 October 2024)

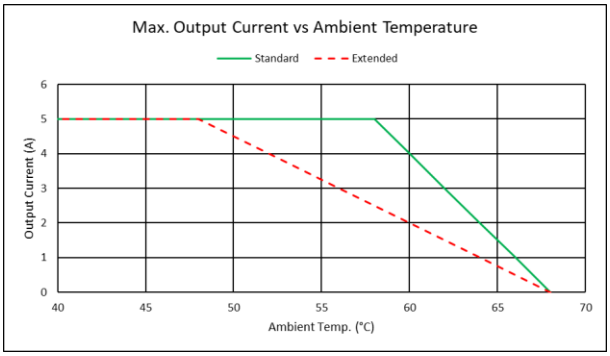
General Characteristics

Absolute Maximum Ratings	
Supply voltage (DC)	70 V

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

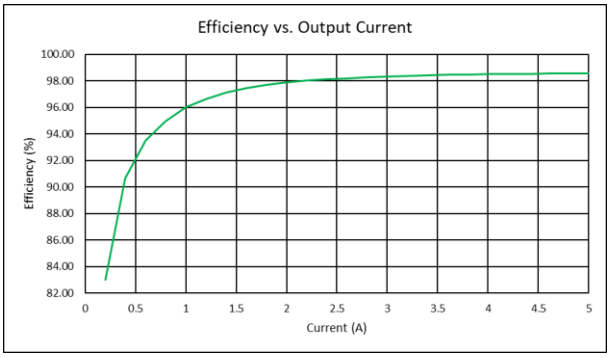
Operating Characteristics

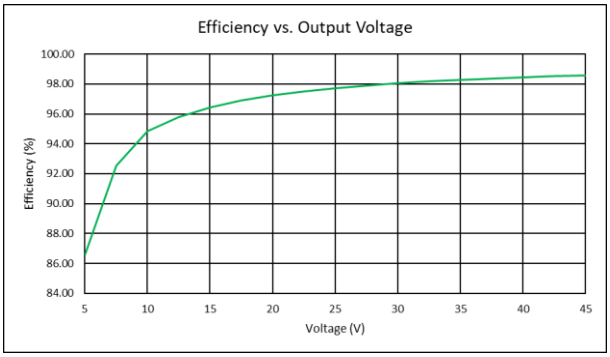




Note:
Standard or Extended Device Temperature Mode can be set as software setting.
No forced air flow was present.

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 / Hints	Min	Typ	Max	Units
DC Power Supply Input:						
U_{IN}	Supply voltage	Measured directly on power input terminals	11.5		63	V
$U_{IN\ Ripple}$	Ripple tolerance	U_{IN} never below $U_{IN\ min}$ or above $U_{IN\ max}$			300	mV_{PP}
I_{IN}	Max input current	Hint: Software limitation			13	A
Output (per Channel):						
I_{OUT}	Bipolar current				±5	A
U_{OUT}	Bipolar voltage	U_{OUT} is maximum ~0.90 * U_{IN}			±56	V
I_{OUT}	Unipolar current [1]				5	A
U_{OUT}	Unipolar voltage [1]	U_{OUT} is maximum ~ 0.90 * U_{IN}			56	V
$U_{OUT\ Ripple}$	Voltage ripple	@ 5 A			30	mV_{PP}
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	%

[1] In unipolar mode, the total output power is doubled in comparison to the bipolar mode, but the controller input current is limited to I_{IN}, which limits the total available output power. The controller limits the output current for each channel dynamically if the max input current limit is reached.

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	µs
t_{OFF}	Power system limits	Current and voltage limits			200	µs
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 / Hints	Min	Typ	Max	Units
$R_{HR,\ RANGE}$	ADC auto gain PGA = 1 or 8 or 32	 Corresponding temperature range	73 194.3 to -55.5		1 M	Ω °C

$R_{HR,\ RANGE}$ is the 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 / Hints	Min	Typ	Max	Units
$T_{HR,\ RANGE}$	Range	Range is extendable upon request. Extended measurement range is -193 °C … +787 °C	-220		+200	°C
$T_{HR,\ PREC}$	Precision	(EN 60751 / IEC 751)		5		mK
$T_{HR,\ COEFF}$	Temp. coefficient	Relative to device temperature			1.6	mK/K
$T_{HR,\ NOISE}$	Value noise	Reference measurement fluctuations while output stage operating @ 70 % load		5		mK
$T_{HR,\ REP}$	Repeatability	Repeated measurements of reference resistors after up to 3 days		8		mK

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

Sensors with linear Voltage/Temperature output

Symbol	Parameter	Test Conditions / Hints	Min	Typ	Max	Units
$V_{SENS, DIFF}$	Range	Differential input voltage Temperature range depends on sensor used	-2.039		2.039	V
$V_{HRUx, ABS}$	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 / Hints	Min	Typ	Max	Units
$R_{LR, RANGE}$	Range		83		182413	Ω
		Corresponding temperature range	-30 to 187			°C

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

Unless otherwise noted: T_A = 25 °C

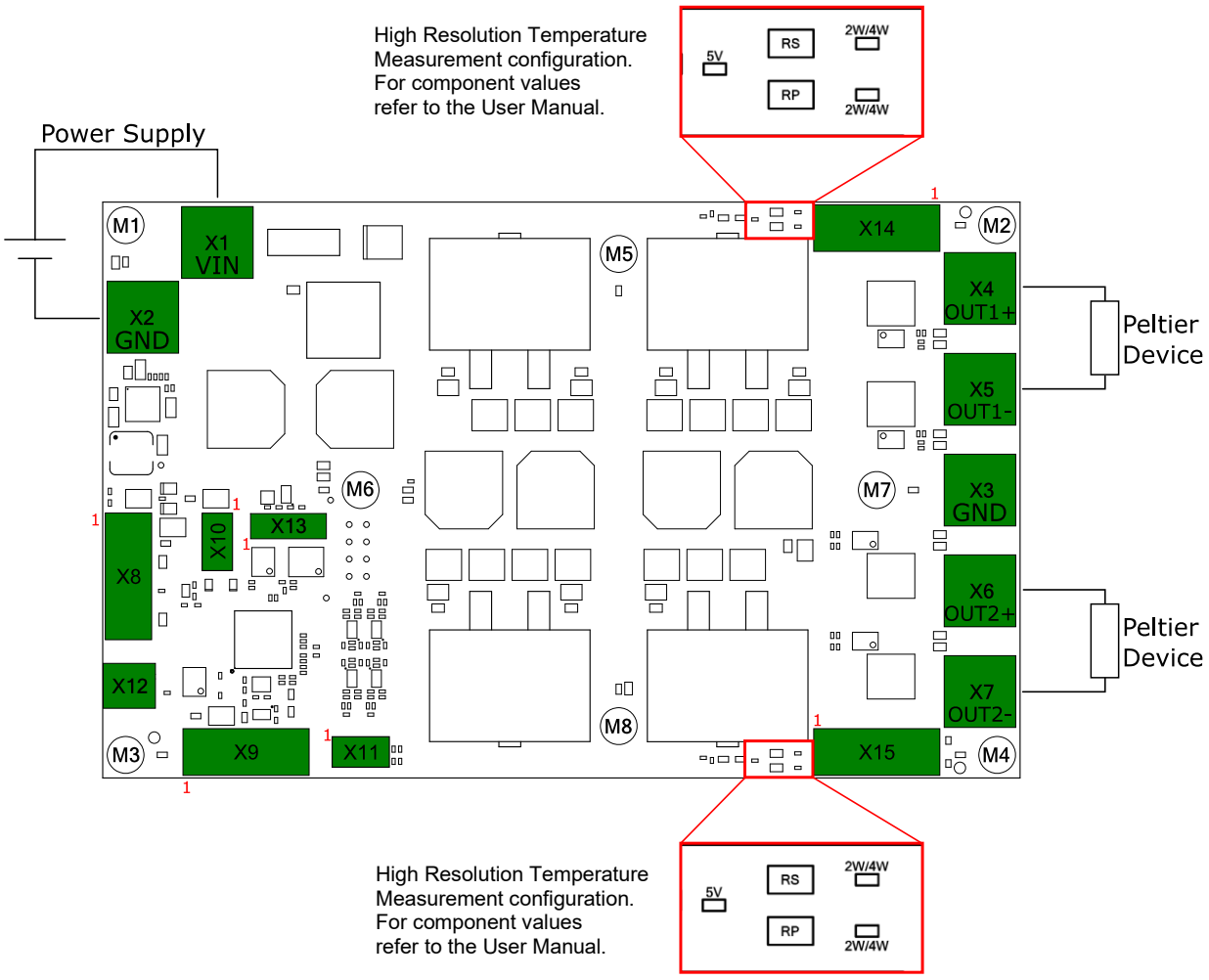
Symbol	Parameter	Test Conditions / Hints	Min	Typ	Max	Units
Input Characteristics: (Microprocessor)						
U_{IH}	Logic high input threshold		2.38			V
U_{IL}	Logic low input threshold				0.93	V
U_{IMAX}	Maximum input voltage		-0.5		5.5	V
Output Characteristics: (Microprocessor)						
U_{OH}	Logic high 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)						
V_{PP}	ESD discharge	IEC61000-4-2		18		kV
R_A	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 / Hints	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_{IMAX}	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 1 IA	PIN 5	LR Temp 1 A
PIN 2	HR Temp 1 IB	PIN 6	LR Temp 1 B
PIN 3	HR Temp 1 UA	PIN 7	LR Temp 3 A
PIN 4	HR Temp 1 UB	PIN 8	LR Temp 3 B

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

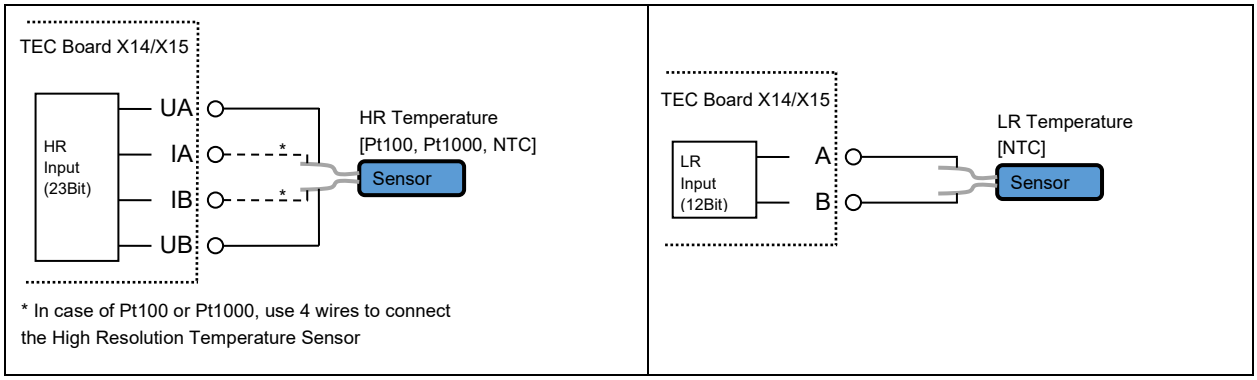
Temperature Measurement Configuration

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

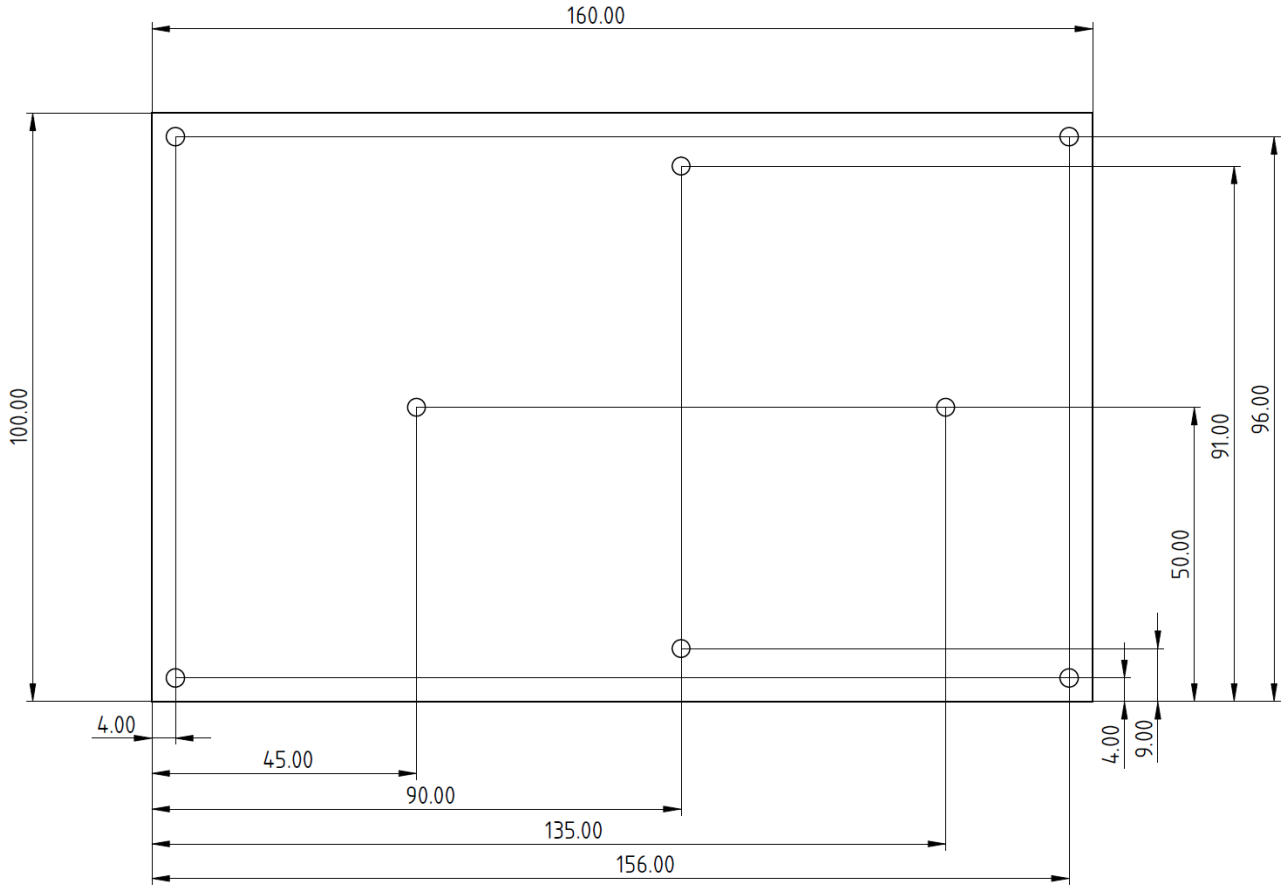
All Mounting holes have a Diameter of 3.05 mm.

Temperature Sensor Connection X14, X15



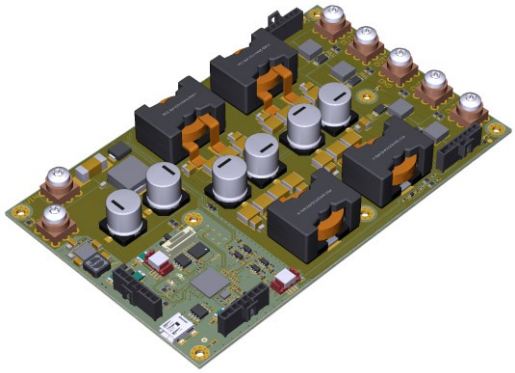
Dimensions and Mounting Hole Positions

Top View, all measurements in mm.



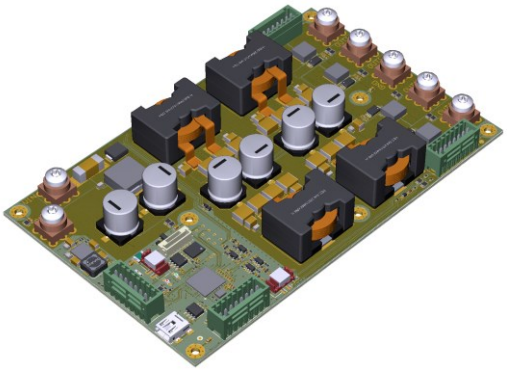
Operation Modes / Theory of Operation

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!)

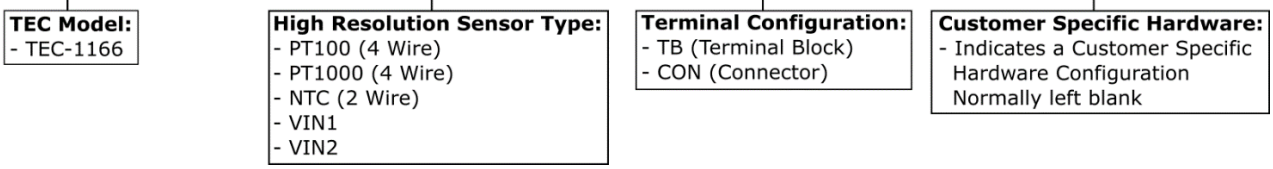
Status information can be polled at any time by industry standard connections RS485, RS232 TTL, CANopen or by USB. The TEC-1166 can also operate in a remotely controlled manner, with parameters adjusted on the fly. Scripting capability by sequential lookup table read-out is supported.

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**



High Resolution Sensor Type:
NTC: By default, we mount an NTC1M. If you require an older version (NTC56K), please write which one you need in the comment section of your order or contact us: contact@meerstetter.ch.

Thermocouple:
To use our TEC Controllers with thermocouples type K, you need a TCI-1181 in addition to the TEC Controller with a VIN1 or VIN2 High Resolution Sensor Type configuration.

Display Unit:
It is possible to connect a small or big OLED 2x16 / 4x20 character display directly to the X11 connector of the device. Please visit the DPY-111x product pages on our website for further information.

Customization:
Many hardware and software features of the TEC-1166 are customizable upon request. Please contact Meerstetter Engineering with your enquiry.

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Change History

Date of change	Version	Changed/ Approved	HW-Version	Change / Reason
6 July 2023	A	HS / ML	v1.10	• Document Created
13 December 2023	B	LS / MR	v1.20	• Add: Front Page
18 October 2024	C	XF / ML	v1.20	• Fix: Pictures of the device on the first two pages incorrectly showed the TEC-1167 instead of the TEC-1166 • Add: New Main Feature: Measurement Inputs are freely assignable to any Output Channel • Add: New Main Feature: Bipolar output channels can be split into unipolar channels • Add: "Unipolar current per channel" and "Unipolar voltage per channel" specifications in "Electrical Characteristics" section • Add: "Max Input Current (I_{IN})" specification in "Electrical Characteristics" section • Mod: Specified that the RS485 Data Interface only supports Half-Duplex communication • Del: "Important note" regarding GPIO 9/10 and Low resolution temp. measurement 3/4 not being available removed as they are available as of firmware v6.00