

# TCP3500 Series

## 3-phase 3500 W AC-DC Industrial PSU

The TCP3500 series is a universal 3-phase AC-DC converter with adjustable DC output and universal 3-phase AC input. Conduction cooling (no fans) makes this power supply series suitable for a wide variety of Industrial Applications that can utilize conduction or liquid cooling, negating the use of fans.

Emphasis is given on reliability and long life. Parallel operation is possible up to 16 units (50.4 kW). Passive or active current share system can be selected.

The PSU includes DSP which enables monitoring of electrical parameters (including input voltage of all 3 phases) and controlling the PSU from system controller.

An RS485 bus is used for command, monitoring and diagnostic information that can be supplied to a system controller.



### Key Features & Benefits

- World-Wide 3-phase Input Voltage Range (nom. 115 - 277 V / 200 - 480 V)
- Power Factor > 0.94
- High Power Density 16 W/in<sup>3</sup>
- 94% Typical Efficiency
- Parallel Operation up to 16 Units (50.4 kW)
- Cold-Plate Cooling System
- -25 to 50°C of Cold-Plate Surface, -25 to 70°C of Ambient Air Temperature
- Possibility to Install 4 Units in 2U 19" Rack
- Advanced Performance for Fast Dynamic and Pulsed Load – up to 100 kHz (Optional)
- RS485 Interfaces
- Wide Adjustable Output Voltage Range
- Fast Output Voltage Set Response (5 ms)
- Active Current Sharing



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## 1. MODEL SELECTION

| MODEL         | INPUT VOLTAGE RANGE         | NOMINAL OUTPUT VOLTAGE | OUTPUT VOLTAGE RANGE      | MAX OUTPUT CURRENT           | MAX OUTPUT POWER | AVAILABILITY    |
|---------------|-----------------------------|------------------------|---------------------------|------------------------------|------------------|-----------------|
| TCP3500-H048G | 180 – 528 Vrms,<br>50/60 Hz | 48 V                   | Adjustable<br>10 – 50 VDC | 73 ADC or pulse <sup>1</sup> | 3500 W           | Mass production |
| TCP3500-1048G | 180 – 528 Vrms,<br>50/60 Hz | 48 V                   | Adjustable<br>10 – 50 VDC | 73 ADC                       | 3500 W           | Mass production |
| TCP3500-H060G | 180 – 528 Vrms,<br>50/60 Hz | 60 V                   | Adjustable<br>20 – 60 VDC | 65 ADC or pulse <sup>1</sup> | 3500 W           | Consult factory |
| TCP3500-1024G | 180 – 528 Vrms,<br>50/60 Hz | 24 V                   | Adjustable<br>10 – 30 VDC | 145 ADC                      | 3500 W           | Consult factory |

<sup>1</sup> PSU model with pulse load operation capability 0 – 100 kHz, 0 – 100% Duty, 0 A/Iout\_max.

## 2. INPUT SPECIFICATIONS

| PARAMETER       | DESCRIPTION / CONDITION              | MIN                   | NOM | MAX | UNIT |
|-----------------|--------------------------------------|-----------------------|-----|-----|------|
| Input Voltage   | 3-phase (L-N / L-L), 3 wires + PE    | 115 - 277 / 200 - 480 |     |     | V    |
|                 | Permitted variation (L-N / L-L)      | 104 - 305 / 180 - 528 |     |     | V    |
| Input Frequency |                                      | 50/60                 |     |     | Hz   |
|                 | Permitted variation                  | 47                    |     | 63  | Hz   |
| Input Current   | per Line at 3 x 180 V (line to line) |                       |     | 14  | Arms |
| Fuse            | 3 x 20 A, Fast acting                |                       |     |     |      |

## 3. OUTPUT SPECIFICATIONS

| PARAMETER                | DESCRIPTION / CONDITION                         | MIN | NOM   | MAX | UNIT |
|--------------------------|---|-----|-------|-----|------|
| Output Voltage           | Adjustable or fixed (see Model Selection table) |     |       |     |      |
| Output Power Rating      | High Line and Low Line                          |     | 3500  |     | W    |
| Output Current           | Fixed or Adjustable (60 – 100%)                 |     |       |     |      |
| Efficiency               | Typical, High Line and load above 40%           |     | 94    |     | %    |
| Voltage Setting Accuracy |   |     | ± 0.5 |     | %    |
| Line Regulation          | $I_o = 0.5 * I_{o\_nom}$                        |     | ±0.5  |     | %    |
| Load Regulation          |   |     | ±0.3  |     | %    |
| Thermal Drift            |   |     | ±0.02 |     | %/°C |
| Transient Response       | load variation 10-100% and back:                |     | ±5    |     | %    |
|                          | Recovery time:                                  |     |       | 2   | ms   |
|                          | load variation 50-100% and back:                |     | ±3    |     | %    |
| Recovery time:           |   |     |       | 0.4 | ms   |
| Ripple                   | Vout_nom (BW 20 MHz)                            |     |       | 1.5 | %    |
| Output Start Up          |   |     |       | 2   | s    |
| Rise Time                |   |     |       | 250 | ms   |

#### 4. PROTECTION SPECIFICATIONS

| PARAMETER                        | DESCRIPTION / CONDITION  | MIN       | NOM | MAX       | UNIT |
|----------------------------------|--|-----------|-----|-----------|------|
| Over Temperature Protection      | Cooling Plate surface (PSU bottom side)  | 55        |     |           | °C   |
| Input Under Voltage Protection   | 3-phase (L-N / L-L)  |           |     | 104 / 180 | V    |
| Input Over Voltage Protection    | 3-phase (L-N / L-L)  | 305 / 528 |     |           | V    |
| Reversed Sense Output Protection | Latch type   |           |     |           |      |
| Output Under Voltage Protection  | Latch type – Fixed HW, based on Nominal Output Voltage   | 10        |     | 18        | %    |
| Output Over Voltage Protection   | Latch type – Fixed HW, based on Nominal Output Voltage   | 115       |     | 125       | %    |
|                                  | Resettable – Floating SW, based on Output Voltage Set Point (configurable)                           | +4        |     | +6        | V    |
| Output Over Current              | PSU starts operate as current source, based on Maximal Output Current                                | 104       |     | 112       | %    |
|                                  | Latch type – Fixed SW, based on Maximal Measured Output Current                                      | 114       |     | 122       | %    |
| Short Circuit Protection         | Fast Acting Fuse for min. 120% of Rated Output Current   |           |     |           |      |
| Alarms                           | Input under and over voltage<br>Output under and over voltage<br>Output overload<br>Over temperature |           |     |           |      |

#### 5. SAFETY, REGULATORY AND EMC SPECIFICATIONS

| PARAMETER                             | DESCRIPTION / CONDITION  | SPECIFICATION                      |
|---------------------------------------|--|------------------------------------|
| <i>Emission Requirements</i>          |  |                                    |
| Radiated Emission                     | EN55011  | Class A                            |
| Conducted Emissions                   | EN55011  | Class A                            |
| <i>Immunity Requirements</i>          |  |                                    |
| Electrostatic Discharge               | IEC 61000-4-2  | Level 4: ±8 kV contact, ±15 kV air |
| Radiated Electromagnetic Field        | IEC 61000-4-3  | 10 V/m                             |
| Electrical Fast Transient (EFT)/Burst | IEC 61000-4-4  | Level 3: ±2/1 kV                   |
| Surge Immunity                        |  | Level 3: ±1 kV DM, ±2 kV CM        |
| RF Conducted Immunity                 | Level 3: 10 V  | Criterion A                        |
| Useful Life Assessment                | >5 years life at ambient temperature of +70°C and case temperature 55°C<br>>10 years of predicted electrolytic capacitor life at 55°C of case temperature and 100% load. |                                    |

#### 6. ENVIRONMENTAL SPECIFICATIONS

| PARAMETER             | DESCRIPTION / CONDITION                  | MIN | NOM | MAX | UNIT |
|-----------------------|--|-----|-----|-----|------|
| Humidity              | Operating range according IEC 60068-2-78 | 10  |     | 90  | RH   |
| Operating Temperature | Cold-plate cooling: of base plate        | -25 |     | +55 | °C   |
|                       | of ambient air temperature               | -25 |     | +70 |      |
| Storage Temperature   |  | -40 |     | +85 | °C   |



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## 7. MONITORING AND CONTROL

### 7.1 GUI (GRAPHIC USER INTERFACE) AND RS485 COMMUNICATION PROTOCOL

Bel Power Solutions provides a Windows® XP/Vista/Win7 compatible Bel Power Solutions I<sup>2</sup>C User Interface allowing the programming and monitoring of the TCP3500 power supply. The I<sup>2</sup>C Utility can be downloaded from: [belpowersolutions.com](http://belpowersolutions.com).

For detailed information please see Communication Manual (BCA.00129) or contact Bel Power Solutions sales representative.

### 7.2 LED SIGNALING

| LED NAME | COLOR  | STATUS         | OPERATING CONDITIONS   |
|----------|--------|----------------|--|
| AC-OK    | Green  | ON<br>Blinking | AC Input Voltage is within operation range<br>FW upgrade via RS485-1         |
| DC-OK    | Green  | ON             | Output is Enabled and Operational  |
| OT/FAIL  | Orange | ON             | Over Temperature conditions inside the unit or FAIL appeared (e.g. Overload) |

## 8. CONNECTORS

| PARAMETER               | DESCRIPTION / CONDITION   |
|-------------------------|---|
| Input Connector         | 4-pin, Pitch 7.62 mm (Weidmüller 1081850000, see Figure 1)        |
| Output Connector        | Bus bars, screw size M4, see Fig.1                                |
| Signal Input Connector  | 15-pin D-SUB Male (Würth Elektronik, 61801529221, see Figure 1)   |
| Signal Output Connector | 15-pin D-SUB Female (Würth Elektronik, 61801529321, see Figure 1) |

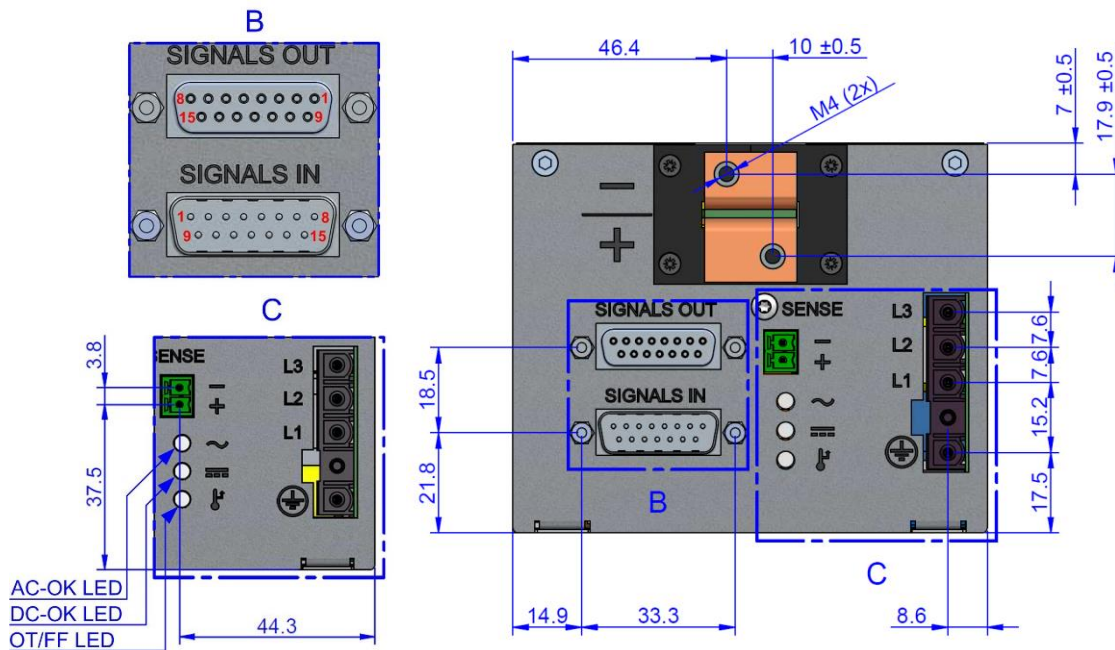



Figure 1. Rear View - Connectors Position

### 8.1 INPUT POWER CONNECTOR: PINOUT

| SIGNAL NAME | PIN #   | TYPE                 | RECOMMENDED WIRES        | V MAX<br>I MAX                                |
|-------------|---|----------------------|--------------------------|---|
| Earth       |  | Earth / Chassis      | Min. 2.5 mm <sup>2</sup> |   |
| AC Line 1   | L1  | Input Power AC Fused | Min. 2.5 mm <sup>2</sup> | 528 Vrms (line to line)<br>16 Arms (per line) |
| AC Line 2   | L2  | Input Power AC Fused | Min. 2.5 mm <sup>2</sup> |   |
| AC Line 3   | L3  | Input Power AC Fused | Min. 2.5 mm <sup>2</sup> |   |

Connector type: Weidmüller 1081850000  
Mating part: Weidmüller 1173520000

### 8.2 POWER OUTPUTS CONNECTOR: +/- BUSBARS

| SIGNAL NAME | PIN # | TYPE            | SIGNAL REFERENCE | LOW LEVEL<br>HIGH LEVEL | V MAX<br>I MAX |
|-------------|-------|-----------------|------------------|-------------------------|----------------|
| Vout+       | +     | Output Power DC | Vout-            | -                       | 50 VDC<br>8 mA |
| Vout-       | -     | Output Power DC | -                | -                       | 73 ADC         |

Connector type: Busbar see Figure 1  
Mating part: Ring terminal for M4 screw, with appropriate cross section for wire.

### 8.3 SIGNAL INPUT CONNECTOR: PINOUT

| SIGNAL NAME       | PIN # | TYPE  | SIGNAL REFERENCE | LOW LEVEL<br>HIGH LEVEL                | V MAX<br>I MAX       |
|-------------------|-------|---|------------------|--|----------------------|
| RS485-1A          | 1     | RS485 Half Duplex, Differential pair 1  | RS485-1B         | +/-60 mA<br>@ 60 Ω, 0 pF <sup>2</sup>  | -7 to 12 VDC<br>8 mA |
| RS485-2A          | 2     | RS485 Half Duplex, Differential pair 2  | RS485-2B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| ADDR-INIT IN      | 3     | The unit's address change required  | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| IN OK             | 4     | AC Power Fail Warning - open collector, external pull-up needed to max. 7 V       | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| OUT OK            | 5     | Output Voltage Fault - open collector, external pull-up needed to max. 7 V        | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| INHIBIT           | 6     | Output Inhibit - Open circuit or "High" to SRTN shuts OFF Vout                    | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| ENABLE            | 7     | Power Supply Enable pin – for unit enable short this pin to SRTN                  | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| SRTN <sup>1</sup> | 8     | Signal Return   | -                | -                                      | -                    |
| RS485-1B          | 9     | RS485 Half Duplex, Differential pair 1  | RS485-1B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| RS485-2B          | 10    | RS485 Half Duplex, Differential pair 2  | RS485-2B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| Not Connected     | 11    | -   | -                | -                                      | -                    |
| OT/FAIL           | 12    | Over Temperature /PSU Fail, open collector, external pull-up needed to max. 7 VDC | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| PS-PRESENT        | 13    | Power Supply Seated – signal internally connected through 10 Ohm resistor to SRTN | SRTN             | -                                      | 1 VDC<br>100 mA      |
| ACSH              | 14    | Active Current Share  | SRTN             | 0.2 VDC<br>5.0 VDC                     | 7 VDC<br>0.7 mA      |
| Margin            | 15    | Optional – analog signal for Output Voltage adjustment – Not connected            | -                | -                                      | -                    |

<sup>1</sup> SRTN and Vout- are connected together inside the power supply

<sup>2</sup> 120Ω resistors connection required between RS485-xA and RS485-xB on both sides externally

Connector type: Würth Elektronik, 61801529221  
Mating part: Würth Elektronik, 61801529321



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#### 8.4 SIGNAL OUTPUT CONNECTOR: PINOUT

| SIGNAL NAME       | PIN # | TYPE  | SIGNAL REFERENCE | LOW LEVEL<br>HIGH LEVEL                | V MAX<br>I MAX       |
|-------------------|-------|---|------------------|--|----------------------|
| RS485-1A          | 1     | RS485 Half Duplex, Differential pair 1  | RS485-1B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| RS485-2A          | 2     | RS485 Half Duplex, Differential pair 2  | RS485-2B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| ADDR-INIT OUT     | 3     | The unit's address change accepted  | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| IN OK             | 4     | AC Power Fail Warning - open collector, external pull-up needed to max. 7 V   | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| OUT OK            | 5     | Output Voltage Fault - open collector, external pull-up needed to max. 7 V  | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| INHIBIT           | 6     | Output Inhibit - Open circuit or "High" to SRTN shuts OFF Vout  | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| ENABLE            | 7     | Power Supply Enable pin – for unit enable short this pin to SRTN  | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| SRTN <sup>1</sup> | 8     | Signal Return   | -                | -                                      | -                    |
| RS485-1B          | 9     | RS485 Half Duplex, Differential pair 1  | RS485-1B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| RS485-2B          | 10    | RS485 Half Duplex, Differential pair 2  | RS485-2B         | +/-60 mA<br>@ 60 Ω, 50 pF <sup>2</sup> | -7 to 12 VDC<br>8 mA |
| NC                | 11    | -   | -                | -                                      | -                    |
| OT/FAIL           | 12    | Over Temperature /PSU Fail, open collector, external pull-up needed to max. 7 VDC   | SRTN             | <0.4 VDC<br>Pull up                    | 7 VDC<br>20 mA       |
| PS-PRESENT OUT    | 13    | Power Supply Seated – last unit in string will pull down this signal (external short to SRTN) and informs Master Controller that all units in string are seated and connected | SRTN             | <0.4 VDC<br>>2.5 VDC                   | 3.6 VDC<br>0.2 mA    |
| ACSH              | 14    | Active Current Share  | SRTN             | 0.2 VDC<br>5.0 VDC                     | 7 VDC<br>0.7 mA      |
| Margin            | 15    | Optional – analog signal for Output Voltage adjustment - Not Connected  | SRTN             | -                                      | -                    |

<sup>1</sup> SRTN and Vout- are connected together inside the power supply

Connector type: Würth Elektronik, 61801529321  
Mating part: Würth Elektronik, 61801529221

#### 8.5 SIGNAL OUTPUT CONNECTOR: PINOUT

| SIGNAL NAME | PIN # | TYPE   | SIGNAL REFERENCE | LOW LEVEL<br>HIGH LEVEL | V MAX<br>I MAX |
|-------------|-------|--|------------------|-------------------------|----------------|
| SENSE+      | +     | Sense line for Vout+ – voltage drop compensation for positive pole | Vout+            | -                       | -              |
| SENSE-      | -     | Sense line for Vout- – voltage drop compensation for positive pole | Vout-            | -                       | -              |

Connector type: Phoenix Contact, MC 1.5/ 2-G-3.81  
Mating part: Phoenix Contact, MC 1.5/ 2-ST-3.81

## 9. MECHANICAL SPECIFICATIONS

| PARAMETER              | DESCRIPTION / CONDITION   | MIN        | NOM                              | MAX | UNIT     |
|------------------------|---|------------|----------------------------------|-----|----------|
| Dimensions (W x D x H) | See Figure 2  |            | 400 x 103 x 85<br>15.7 x 4 x 3.3 |     | mm<br>in |
| Weight                 | Single PSU  |            | 6.5                              |     | kg       |
| Cooling                | Liquid cooled cold-plate, power dissipation ~300 W/PSU<br>Recommended water flow rate: 2 – 4 liters/min.<br>(depends on the cooling plate design) |            |                                  |     |          |
| Insulation             | Input to Output:<br>Input to Chassis:   | 3.0<br>1.5 |                                  |     | kVAC     |
| Enclosure              | IP20  |            |                                  |     |          |

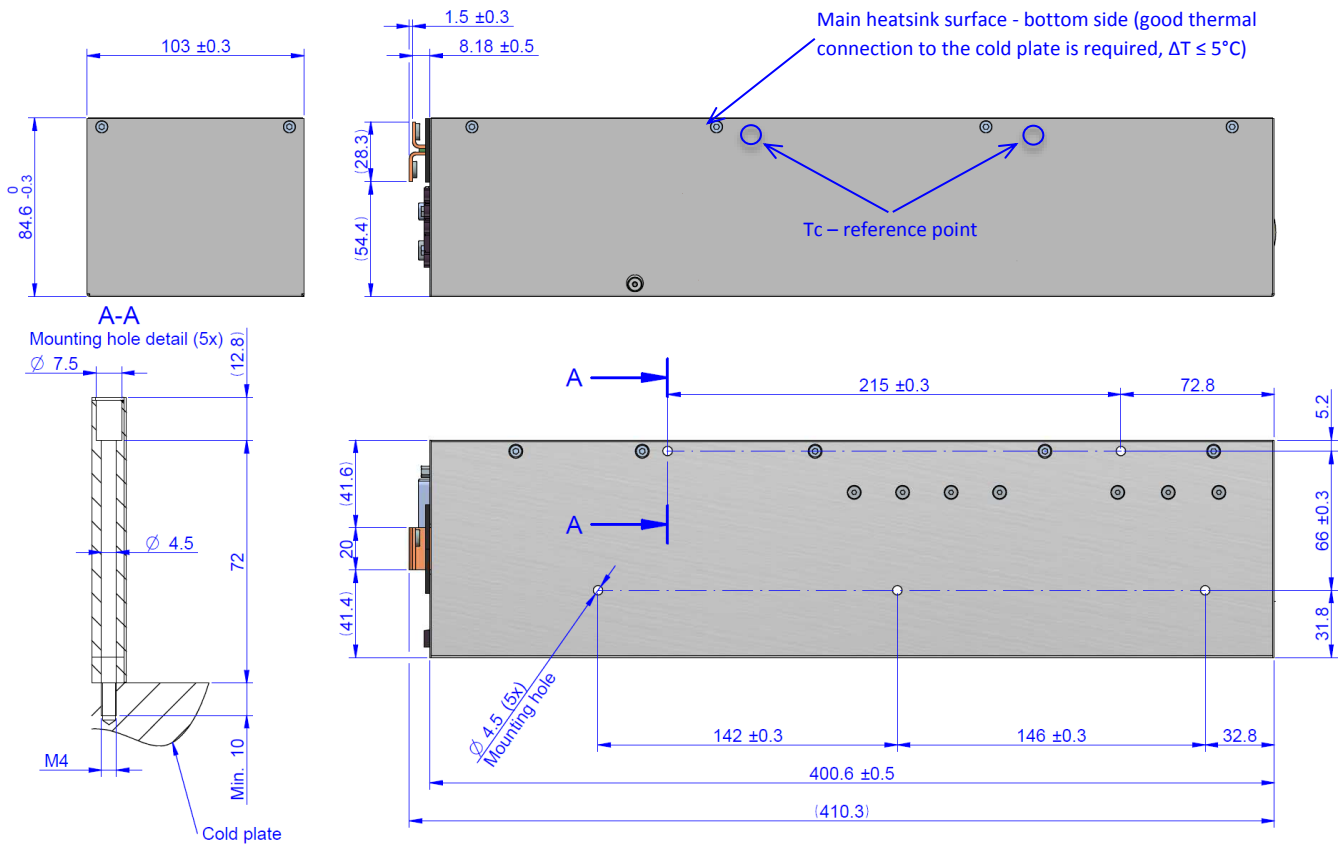
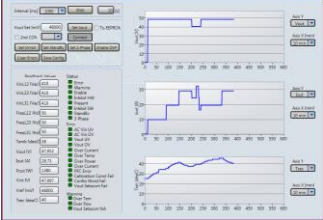


Figure 2. Mechanical Dimensions

10. ACCESSORIES

| ITEM  | DESCRIPTION  | ORDERING PART NUMBER | SOURCE  |
|---|--|----------------------|---|
|  | <p><b>Bel Power Solutions I²C User Interface</b> Windows XP/Vista/7 compatible GUI to program, control and monitor TCP3500 PSU (and other I²C units)</p> | <p>N/A</p>           | <p><a href="http://belpowersolutions.com">belpowersolutions.com</a></p> |
| <p><b>RS485/USB Connector</b></p>   |  |                      |   |
| <p><b>Single Signal Connector</b><br/>(with hardware links for signals)</p>       |  |                      |   |
| <p><b>Parallel Signal Connector</b></p>   |  |                      |   |

**For more information on these products consult: [tech.support@psbel.com](mailto:tech.support@psbel.com)**

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