TCP3500/4000 Series

3-Phase 3500/4000 W
Industrial AC-DC Power Supply

The TCP3500/4000 Series is a universal 3-phase AC-DC converter with adjustable DC output and universal 3-phase AC input. Conduction cooling (no fan) 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 for up to 16 units (57.6 kW).

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.

FEATURES

- World-Wide 3-phase Input Voltage Range (nom. 115 - 277 V / 200 - 480 V)
- Power Factor > 0.94
- High Power Density 16 W/in^3
- 94% Typical Efficiency
- Parallel Operation up to 16 Units (up to 57.6 kW)
- Cold-Plate Cooling System
- 0 to 50°C of Cold-Plate Surface, 0 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
- SEMI F47 Compliant

APPLICATIONS

- Laser cutting machines
- Industrial printers, welding
- Battery chargers, bulk power systems
- Cladding, surface treatment
- Rapid prototyping
- Other automated industrial applications

TCP3500/4000 Series

3500 / 4000 W AC-DC Converter

1. MODEL SELECTION

MODEL	INPUT VOLTAGE RANGE	NOMINAL OUTPUT VOLTAGE	OUTPUT VOLTAGE RANGE	MAX OUTPUT CURRENT	MAX OUTPUT POWER
TCP3500-1024G	180 – 528 Vrms, 50/60 Hz	28 V	Adjustable 10 – 32 VDC	125 ADC	3500 W
TCP3500-H048G	180 – 528 Vrms, 50/60 Hz	48 V	Adjustable 10 – 50 VDC	73 ADC or pulse [1]	3500 W
TCP3500-1048G	180 – 528 Vrms, 50/60 Hz	48 V	Adjustable 10 – 50 VDC	73 ADC	3500 W
TCP4000-H090 [2]	180 – 528 Vrms, 50/60 Hz	90 V	Adjustable 30 – 100 VDC	45 ADC or 39 A pulse [1]	3500 / 4000 W

[1] PSU model with pulse load operation capability 0 – 100 kHz, 0 – 100% Duty, 0 A/Iout_max.
[2] Output Power 4000W at Input Voltage range 340 – 528 Vrms (L-L)

2. INPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITIONS	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
Input Current THDi	Typical		30		%
Power Factor	Load above 40%	94			
Fuse	3 x 20 A, Fast acting				

3. OUTPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITIONS	MIN	NOM	MAX	UNIT
Output Voltage	Adjustable or fixed (see Model Selection table)				
Output Power Rating			3500		W
Output Current	Fixed or Adjustable (60 – 100%)				
Efficiency	Input Voltage 400 Vrms (L-L) and load above 40%		94		%
Voltage Setting Accuracy			± 0.5		%
Line Regulation	Io = 0.5 * Io_nom		±0.5		%
Load Regulation			±0.3		%
Thermal Drift			±0.02		%/°C
Transient Response	Load variation 10 - 100% / 100 - 10%:		±5		%
	Recovery time:			2	ms
	Load variation 50 - 100% / 100 – 50%:		±3		%
	Recovery time:			0.4	ms
Ripple	Vout_nom (BW 20 MHz)			1.5	%
Output Start Up				2	s
Rise Time				250	ms

4. PROTECTIONS

PARAMETER	DESCRIPTION / CONDITIONS	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 SW, based on Minimal Output Voltage	50		85	%
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 operating as a 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 & over voltage, Output under & over voltage, Output overload, Over temperature				

5. SAFETY, REGULATORY & EMI SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITIONS	CLASS / LEVEL / CRITERION
SAFETY		**APPROVAL**
Safety Standards	UL/CSA 62368-1, IEC 62368-1	
Insulation (Factory tested)	Input to output: Input to chassis: Output to chassis: Signals to chassis:	2122 VDC 2122 VDC 500 VDC 500 VDC
EMISSION REQUIREMENTS		**CLASS**
Radiated Emission	EN 55011	Class A
Conducted Emissions	EN 55011	Class A
IMMUNITY REQUIREMENTS		**CRITERION**
Electrostatic Discharge (ESD)	EN IEC 61204-3 ±8 kV contact, ±15 kV air	Criterion A
Radiated Electromagnetic Field	EN IEC 61204-3	Criterion A
Electrical Fast Transients (EFT)/Burst	EN IEC 61204-3	Criterion A
Surge Immunity	EN IEC 61204-3	Criterion A
RF Conducted Immunity	EN IEC 61204-3	Criterion A
Useful Life Assessment	>5 years life at ambient temperature of +70°C and case temperature 55°C >10 years of predicted electrolytic capacitor life at 55°C of case temperature and 100% load.	
Voltage Sag	SEMI F47 (Nominal output voltage and current (up to max. 3.5 kW), input voltage 200/208 VAC L-L and 400/480 VAC L-L)	Criterion A

6. ENVIRONMENTAL & RELIABILITY SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITIONS	MIN	NOM	MAX	UNIT
Humidity	Operating range according to IEC 60068-2-78	10		90	RH
Operating Temperature	Cold-plate cooling: of base plate (Tc - ref. point) of ambient air temperature	0 0		+55 +70	°C
Storage Temperature		-40		+85	°C
Demonstrated MTBF	Confidence Level 80%	260 000			hours

WARNING
In order to ensure maximal useful lifetime of the power supply, minimal time between SWITCH-OFF and SWITCH-ON of the input AC power is 30 seconds and it is not allowed more than 100 cycles within 120 minutes otherwise damage of power supply can occur.

7. MONITORING & CONTROL

7.1 GRAPHICAL USER INTERFACE (GUI) & RS485 COMMUNICATION PROTOCOL

Bel Power Solutions provides Windows 7, 10, and 11 (64 bit only) compatible Graphical User Interface (GUI) software, used for control, programming and monitoring of TCP/TXP 3500/4000 power supplies via Serial Communication Interface – RS485. The SW can be downloaded here: Bel SC Utility Setup.

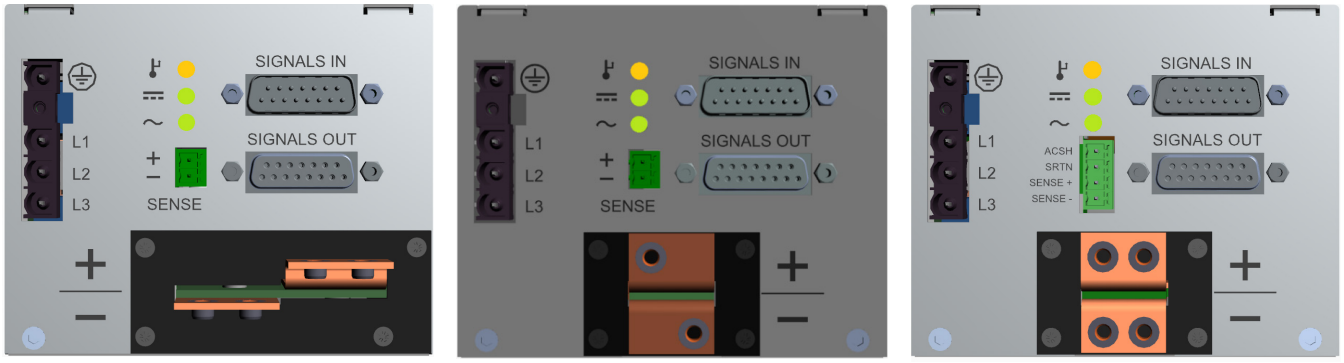
For detailed information please see Communication Manual (BCA.00140) or contact Bel Power Solutions sales representative.

7.2 LED SIGNALING

LED NAME	COLOR	STATUS	OPERATING CONDITIONS
AC-OK	Green	ON	AC input voltage is within operation range
DC-OK	Green	ON	Output is enabled and operational
OT/FAIL	Orange	ON Blinking	Over Temperature conditions inside the unit or FAIL appeared (e.g. Overload) FW upgrade via RS485-1

8. CONNECTORS

PARAMETER	DESCRIPTION / CONDITIONS
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)



TCP3500-1024G *TCP3500-1048G* *TCP4000-H090*

Figure 1. Rear View - Connectors Position

8.1 INPUT POWER CONNECTOR: PINOUT

SIGNAL NAME	PIN #	TYPE	RECOMMENDED WIRES	V MAX I MAX
Earth	⏚	Protective Earth/Chassis	Min. 2.5 mm²	
AC Line 1	L1	Input Power AC Fused	Min. 2.5 mm²	528 Vrms (line to line) 16 Arms (per line)
AC Line 2	L2	Input Power AC Fused	Min. 2.5 mm²	
AC Line 3	L3	Input Power AC Fused	Min. 2.5 mm²	

Connector type: *Weidmüller 1081850000*
Mating part: *Weidmüller 1173520000*

8.2 POWER OUTPUTS CONNECTOR: +/- BUSBARS

SIGNAL NAME	PIN #	TYPE	SIGNAL REFERENCE	LOW LEVEL HIGH LEVEL	V MAX I MAX
Vout+	+	Output Power DC	Vout-	see Model Selection table	
Vout-	-	Output Power DC	-	see Model Selection table	

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

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

[1] *SRTN and Vout- are connected together inside the power supply (not valid for TCP4000-H090). The power supplies with maximal output voltage >60V have all signals on 15-pin DSUB connector galvanically isolated from main output (including SENSE +/- and ACSH).*
[2] *120Ω resistors connection required between RS485-xA and RS485-xB on both sides externally.*
[3] *The pin 14 on TCP4000-H090 is not internally connected to ACSH signal (see section 8.6).*

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8.4 SIGNAL OUTPUT CONNECTOR: PINOUT

SIGNAL NAME	PIN #	TYPE	SIGNAL REFERENCE	LOW LEVEL HIGH LEVEL	V MAX I MAX
RS485-1A	1	RS485 Half Duplex, Differential pair 1	RS485-1B	±60 mA @ 60 Ω, 50 pF [2]	-7 to 12 VDC 8 mA
RS485-2A	2	RS485 Simplex, Differential pair 2	RS485-2B	±60 mA @ 60 Ω, 50 pF [2]	-7 to 12 VDC 8 mA
ADDR-INIT OUT	3	The unit's address change accepted	SRTN	<0.4 VDC Pull up	7 VDC 20 mA
IN OK	4	AC Power Fail Warning - open collector, external pull-up needed to max. 7 V	SRTN	<0.4 VDC Pull up	7 VDC 20 mA
OUT OK	5	Output Voltage Fault - open collector, external pull-up needed to max. 7 V	SRTN	<0.4 VDC Pull up	7 VDC 20 mA
INHIBIT	6	Output Inhibit - Open circuit or "High" to SRTN shuts OFF Vout	SRTN	<0.4 VDC >2.5 VDC	3.6 VDC 0.2 mA
ENABLE	7	Power Supply Enable pin – for unit enable short this pin to SRTN	SRTN	<0.4 VDC >2.5 VDC	3.6 VDC 0.2 mA
SRTN [1]	8	Signal Return	—	—	—
RS485-1B	9	RS485 Half Duplex, Differential pair 1	RS485-1B	±60 mA @ 60 Ω, 50 pF [2]	-7 to 12 VDC 8 mA
RS485-2B	10	RS485 Simplex, Differential pair 2	RS485-2B	±60 mA @ 60 Ω, 50 pF [2]	-7 to 12 VDC 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 Pull up	7 VDC 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 >2.5 VDC	3.6 VDC 0.2 mA
ACSH	14 [3]	Active Current Share	SRTN	0.2 VDC 5.0 VDC	7 VDC 0.7 mA
Margin	15	Optional – analog signal for Output Voltage adjustment – Not connected	SRTN	—	—

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

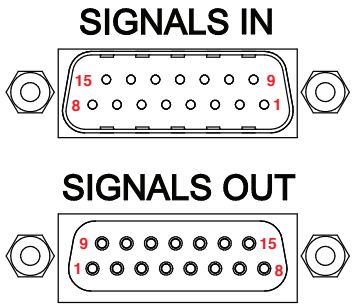


Figure 2. – Detail of Signal Connector Pin Positions

8.5 SENSE CONNECTOR: PINOUT

SIGNAL NAME	PIN #	TYPE	SIGNAL REFERENCE	LOW LEVEL HIGH LEVEL	V MAX I MAX
SENSE+	1	Sense line for Vout+ – voltage drop compensation for positive pole	Vout+	—	—
SENSE-	2	Sense line for Vout- – voltage drop compensation for negative pole	Vout-	—	—

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

8.6 SENSE / ACSH CONNECTOR: PINOUT (TCP4000-H090)

SIGNAL NAME	PIN #	TYPE	SIGNAL REFERENCE	LOW LEVEL HIGH LEVEL	V MAX I MAX
ACSH	1	Active Current Share	SRTN	—	—
SRTN	2	Signal Return	—	—	—
SENSE+	3	Sense line for Vout+ – voltage drop compensation for positive pole	Vout+	—	—
SENSE-	4	Sense line for Vout- – voltage drop compensation for negative pole	Vout-	—	—

Connector type: *Phoenix Contact, MC 1.5/ 4-G-3.81*
Mating part: *Phoenix Contact, MC 1.5/ 4-ST-3.81*

9. MECHANICAL SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITIONS	MIN	NOM	MAX	UNIT
Dimensions (W x D x H)	See Figure 2		400.6 x 103 x 84.6 15.7 x 4 x 3.3		mm in
Weight	Single PSU		6.5		kg
Cooling	Liquid cooled cold-plate, power dissipation ~300 W/PSU Recommended water flow rate: 2 – 4 liters/min. (depending on the cooling plate design)				
Insulation	Input to Output: Input to Chassis:	3000 1768			VAC
Enclosure	IP20				

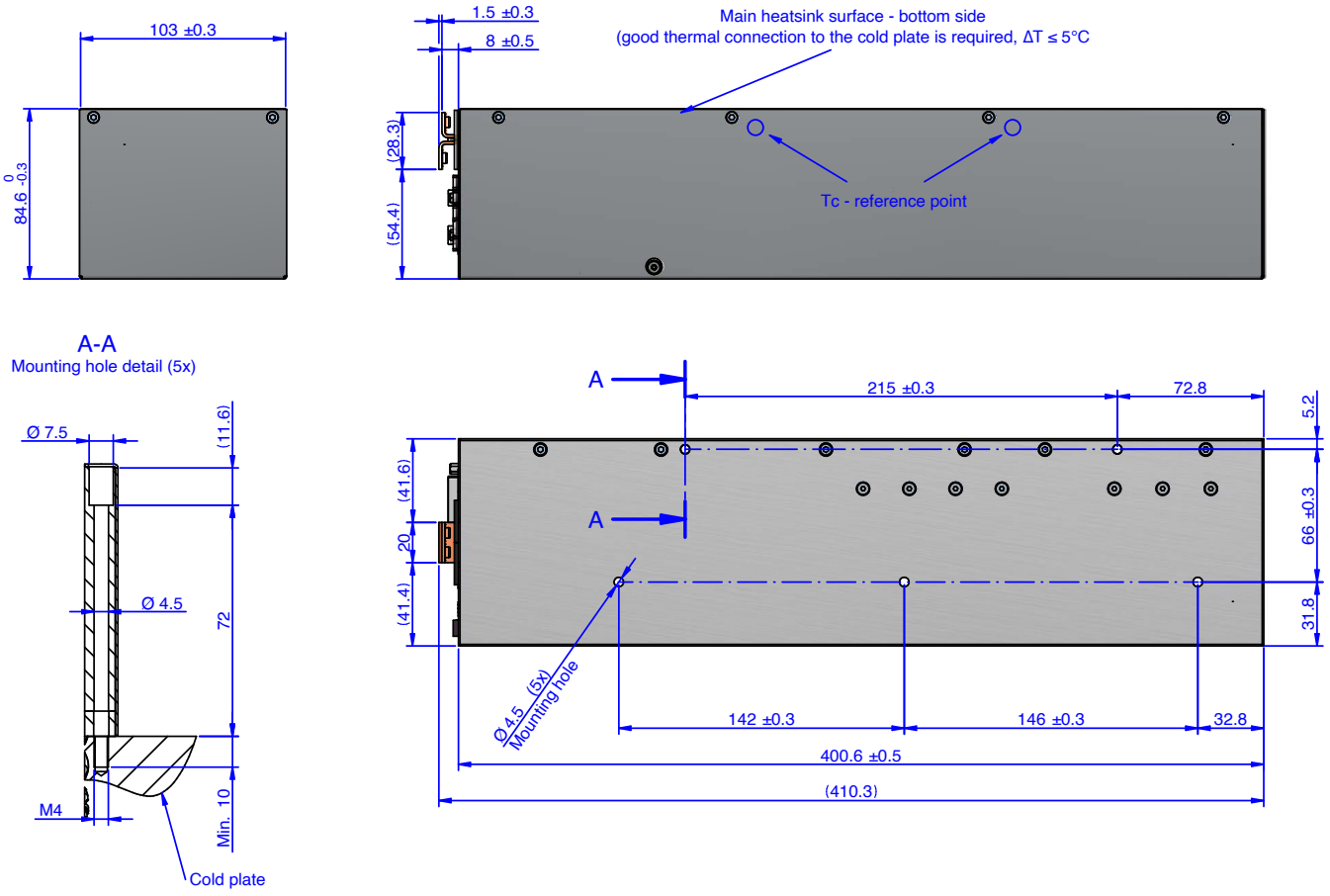
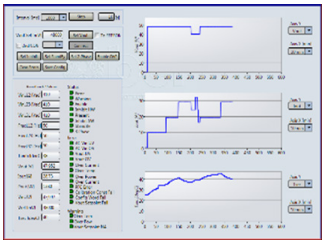
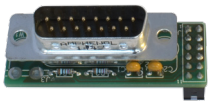


Figure 3. Mechanical Drawing

TCP3500/4000 Series
3500 / 4000 W AC-DC Converter

10. ACCESSORIES

ITEM	DESCRIPTION	ORDERING PART NUMBER	SOURCE
SW GUI 	Bel Power Solutions Graphical User Interface Windows 7 / 10 / 11 compatible GUI to program, control and monitor TCP3500/4000 PSU (and other Serial Communication units)	N/A	Bel SC Utility Setup
Mounting Screws 	M4 x 80 mm, Hex socket	XFM.00183.0	Bossard: 3186737
AC Input connector 	4-pin Straight Cable Receptacle (Female)	ZES.00962	Weidmüller: 1173520000
Signal Connector 	2-pin Straight Cable Receptacle, pitch 3.81 mm (SENSE+/-)	1-111890-G	Phoenix Contact: 1803578
	* 4-pin Straight Cable Receptacle, pitch 3.81 mm (SENSE+/- and ACSH)	1-114261-G	Phoenix Contact: 1803594
Signal End Board 	PCB (ZGN.00383) with 15-pin DSUB connector and 6 jumpers: two for setting-up of 120Ω resistors for RS485-1 and -2, and signals ADDR-INIT_OUT, ENABLE, INHIBIT, PS PRESENT OUT	VKA.00488.0	Bel Power Solutions
Signal Connection Board 	PCB (ZGN.00382) with two 15-pin DSUB connectors. This PCB makes practical and space saving solution for parallel signals connection.	VKA.00487.0	Bel Power Solutions

** For TCP4000-H090 only*