E-T-A®
Circuit Protection & Control

PowerPlex® User Manual

Volume 1: System Description

Edition

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Qualified Personnel

The system may only be installed, connected and set up in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by qualified personnel. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Safety Instructions

Please follow the installation and adjustment instructions outlined in this manuall carefully. Nonobservance may result in serious damage to the product or your system. E-T-A will not accept liability or warranty claims for issues caused by incorrect installation or handling by the customer or a third party.

About This Manual

The PowerPlex manual is intended for the professional boat electrician who wants to install and configure the E-T-A PowerPlex system for controlling the boat's electrical equipment.

We have divided the PowerPlex manual into three volumes to make handbook reading easy for you. You don't need to carry a bulky handbook around with you when working on the PowerPlex system. Depending on what you set out to do, whether you want to install the Powerplex hardware or rather define the system parameters using the Configuration Software, just consult the volume that describes the particular issue you are interested in.

Volume 1 **PowerPlex: System Description**

Here you find a general system overview, a description of the PowerPlex system architecture and a detailed explanation about the function of each PowerPlex system component. The Appendix contains background information which you may be interested in in connection with the principles of the PowerPlex system. It gives you a short introduction into CAN networking, and provides the technical data sheets of the main components, such as PowerPlex modules and circuit breakers.

Volume 2 **PowerPlex: Hardware Installation and Maintenance**

Volume 2 of the PowerPlex Manual Box gives you step-by-step instructions on how to install the system. Here you find out where and how to mount the DC Power Modules and the Panel Modules, how to wire them up, and how to connect the appliances and equipment you wish to control. The final chapter summarizes the installation instructions and provides you with a Quick Installation Guide.

Volume 3 **PowerPlex: System Setup and Configuration**

Volume 3 describes the PowerPlex Configuration Software and gives you step-by-step instructions on how to set up your PowerPlex system once the hardware has been properly installed. We take you through all the dialog boxes and menus of the software and create a configuration exaple. This example configuration shall be loaded into the PowerPlex hardware and tested. A separate chapter is dedicated to special PowerPlex functions that allow you to create a highly sophisticated CAN bus based control system for the boat's entire electrical equipment.

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Conventions and Symbols Used in This Manual

Bold	Menu names and items, text you must select in the PowerPlex configu-ration software, such as menu items, buttons, and commands.
Italics	Words and characters you see on the screen when you are working with the PowerPlex configuration software. In some cases, italics are used to emphasize a new term or an important fact.
Numbered lists	indicate sequential steps for completing a procedure.
Note	Notes are displayed on a grey background.
Important	Information that is critical for successful application and understanding of the product is displayed on a pale blue background.
→	indicates the progression of menu choices you should select in the graphical user interface (GUI), such as File→Print

The symbols used throughout this manual have the following meaning:

Caution
In this situation, you might do something that could result in equipment damage or loss of data.

Warning
You are in a situation that could cause bodily injury. Before you work on any equipment, you must be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.

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1. What is PowerPlex?

PowerPlex is an innovative distributed technology for electrical marine applications.

Benefits for the Boat Owner

Combining power distribution with monitoring and switching functions, PowerPlex allows boat owners to monitor and operate the boat‘s entire range of electrics from a central point in the helm area or from any position around the boat. All important control features expected by a boat owner - power management, fault diagnostics, alarm system and supervision - are merged into one system and thus become very easy to handle. Particularly in combination with a connected Touch Panel PC, PowerPlex provides easy and fast access to alarm information and operation hours counts which facilitates service and maintenance jobs.

Benefits for the Boat Builder

The E-T-A PowerPlex system provides switching and controlling, timer functions, real load status indication, overcurrent protection and wire break detection. Each function is individually programmable to fit the requirements of the different loads.

Based on CAN network communication, the PowerPlex control system makes individual wiring between loads and switching equipment a thing of the past. As the transmission of switching commands and status information is based on peer-to-peer CAN bus communication, there is no need to have direct cabling between the operating element, say a light switch, and the load to be switched, say a lamp. The obvious advantage to the ship builder lies in the reduced cabling and build costs, and in the convenient system setup using Windows based configuration software. As the system's control functions are freely configurable with respect to complexity and system size, modification and expansion at a later stage is extremely easy.

PowerPlex Functional Range

On the boat, PowerPlex takes charge of the following tasks:

- **Distribute the 12 V DC or 24 V DC supply**
  to all points of the boat where loads are installed, such as lighting and heater control, bilge pumps, water pumps, windscreen wiper motors, etc.
- **Collect status information**
  from all sensors and operating elements around the boat, such as temperature and tank level measurement points, ON/OFF status signals of actuators.
- **Switch appliances and equipment ON and OFF,**
  according to selectable, predefined scenarios, at the touch of a button.
- **Monitor appliances and equipment**
  for out-of-range conditions, indicate such faults and respond to them by switching the associated control device, such as switching ON a pump if the potable water tank level is too low.
- **Protect appliances and equipment**
  against dangerous overloads and short circuits by isolating the faulty load from the system and indicating its failure.
- **Provide backup protection and switching**
  in the unlikely event of PowerPlex system or component failure.

1.1 System Components: Overview

PowerPlex communication is based on the CAN bus principle using "nodes" that talk to each other over 2-wire serial connections (→ Appendix, "CAN Bus Principles"). Therefore, the core components of the PowerPlex system are such nodes distributed over the boat. The PowerPlex term for these interconnected nodes is "module".

You will connect these PowerPlex modules to sensors, switches, indicators, lamps and so on. PowerPlex modules have inputs, such as the sensor value "Water tank level too low" and outputs, such as the command "Water pump ON".

Figure 1 shows a typical PowerPlex arrangement comprising a number of distributed PowerPlex modules installed in different locations of the boat.

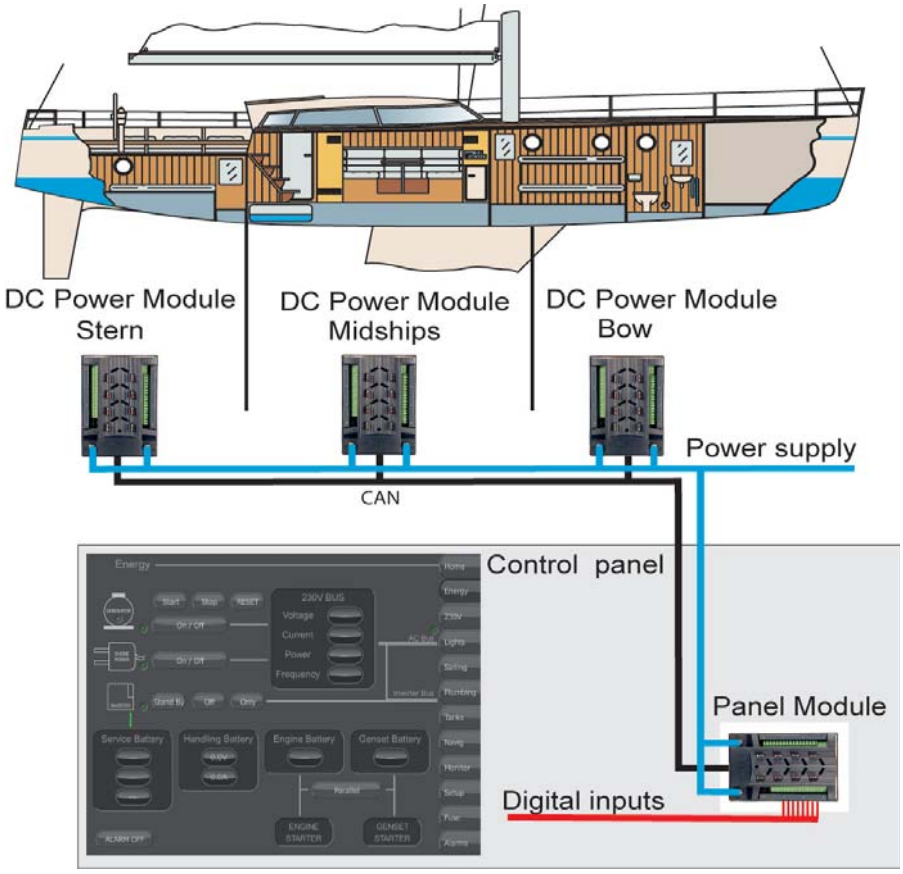


Figure 1: Distributed PowerPlex modules communicating over the CAN bus

Technical Characteristics	
Operating temperature	-40 °C ... +85 °C
Operating voltage	9 V ... 32 V DC
Protection class	IP22
Data and control network	CAN bus, compatible with SAE J1939
Load rating, switchable	Selectable power outputs 1 A, 8 A, 25 A
Load protection	Thermal circuit breakers type 1610

Table 1: General system characteristics

A complete PowerPlex system comprises the following components:

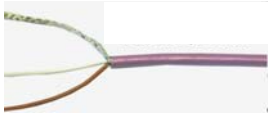
Component (Example)	Designation	E-T-A Delivery	Description
	**PowerPlex module** Two types are available: the DC Power Module and the Panel Module Minimum configuration: 2 modules that are connected to each other by means of a CAN bus cable.	yes	→ 2.1 → 3 → 4
	**Miniature thermal circuit breakers** 10 A or 30 A thermal circuit breakers type 1610-21 are integrated in the PowerPlex modules. They provide enhanced load protection for the 8 A and 10 A loads.	yes	→ 2.6
	**CAN bus cable** A standard twisted-pair CAN bus cable comprising two wires (CAN-H and CAN-L) and the shield (SHLD) connects two PowerPlex modules to each other.	no	→ 7 → Vol. 2
	**Terminating resistors** Two 120 Ω resistors terminate the CAN bus network, one at each end of the bus structure.	no	→ 7 → Vol. 2
	**PowerPlex Configuration Software** Windows based configuration software for defining the addresses, characteristics and functions of the Powerplex modules, assigning inputs and outputs to them, and carrying out system tests and analysis.	yes	→ Vol. 3
	**Touch Panel PC** Touch Panel(s) for convenient system control and display. Within the PowerPlex system, a Touch Panel PC is processed exactly like any other PowerPlex module.	yes (option)	
	**CAN-USB converter plus software / RJ-45 adapter** Converter connector cable, inclusive of RJ-45 adapter if required, to connect the CAN bus hardware to the USB interface of the computer running the PowerPlex configuration software and/or to the USB interface of a touch panel that might be connected to the system.	yes	→ 6 → Vol. 2
	**Voltage supply** 12 V DC or 24 V DC battery voltage supply	no	→ Vol. 2
	**Line protection** Protection of the L (+) connection from the PowerPlex module to the battery or the bus. Recommended: E-T-A thermo-magnetic circuit breaker type 8345	option (to be ordered separately)	→ Vol. 2

Table 2: PowerPlex system components: Overview

The following chapters will give you detailed descriptions of the individual components.

2. PowerPlex Modules: General Characteristics

PowerPlex modules are the key components of the PowerPlex control network. According to CAN bus termoinology, they are the "nodes" in the network and form the switching, relaying and control points. These module boxes are about 260 mm high and 170 mm wide and are typically distributed over the boat.

One PowerPlex control network may comprise up to 30 PowerPlex modules of any type. The smallest PowerPlex network would be made up of two such modules interconnected by a CAN bus cable.

You can choose between two types of PowerPlex modules:

- DC Power Module
- Panel Module

Figure 2: PowerPlex modules:
left: DC Power Module with a total of 8 mcbs: 6 x 10 A for 8 A loads, 2 x 30 A for 25 A loads
right: Panel Module with two 10 A miniature circuit breakers for the protection of 8 A loads

Your PowerPlex system will most probably comprise a certain number of each module type, depen-ding on the size of the electrical system you wish to monitor and control, and on the current rating of the loads you wish to switch.

The following table shows which principal features these two module types have in common and where they differ.

Features	Panel Module	DC Power Module
Voltage rating V_N	DC 12 V / DC 24 V	DC 12 V / DC 24 V
Total load current per module	20 A max.	102 A max.
Inputs, digital (switch inputs)	32	8
Inputs, analog	4	4
Power outputs, high-side MOSFET switching for load control	Total: 6 digital outputs 4 at 1 A max. 2 at 8 A max. with circuit breaker protection for 8 A loads	Total: 12 digital outputs 4 at 1 A max. 6 at 8 A max. 2 at 25 A max. with circuit breaker protection for 8 A and 25 A loads
Signal outputs, for load status indication using LEDs	32	8
Integrated load protection	2 single-pole thermal circuit breakers type 1610, 10 A (red) for 8 A load	8 single-pole thermal circuit breakers type 1610 10 A (red) for 8 A loads 30 A (green) for 25 A loads
Module status indication	Green LED: Power ON Orange LED: CAN bus active	Green LED: Power ON Orange LED: CAN bus active
Module labelling	Module bus address	Module bus address

Table 3: Principal features of Panel Modules and DC Power Modules

Chapters 3 and 4 describe both types of PowerPlex modules in more detail. For a complete list of the modules' technical characteristics, please refer to the module data sheets in the Appendix.

2.1 Which PowerPlex Module for Which Purpose?

In their looks and in their principal functions, the Panel and the Power Module are very similar.

Panel Module

The **Panel Module** offers the added advantage of providing a larger number of digital inputs, i.e. 32 compared to the 8 digital inputs of the DC Power Module. In line with the 32 digital inputs, it offers 32 signal outputs for LED indication.

So, you would typically use the **Panel Module** in situations where you want to monitor the switching activities (ON / OFF) of 32 loads. While this status information can be indicated on the same Panel Module by means of the LED signal outputs, it can also be sent to any other PowerPlex module connected to the CAN bus to be indicated or further processed.

As its name suggests, the **Panel Module** with its extended status monitoring and LED indication facilities would most probably be installed on the bridge console in the helm area.

DC Power Module

The **DC Power Module** offers fewer digital inputs and - in line with this - fewer LED signal outputs, but it allows you to connect and control more loads than the Panel Module. It offers a total of 12 power switching outputs, two of which are rated as high as 25 A.

So, you would typically use the DC **Power Module** where loads need to be switched ON and OFF, and powerful devices, such as anchor winch and pumps, need to be controlled. The typical PowerPlex control network on a boat will comprise a lot more DC Power Modules than Panel Modules.

2.2 How to Distinguish One from the Other?

Both module types allow you to protect the higher-rated loads with single-pole miniature circuit breakers which you insert into the slots provided for this purpose. With the module snap-on cover closed, you can distinguish one module type from the other by the number and colour of circuit breakers you can see shining through the transparent cover.

DC Power Module

A total of 8 mcbs:

6x 10 A (red) for 8 A loads,
2x 30 A (green) for 25 A loads

Panel Module

A total of 2 mcbs:
2x 10 A (red) for 8 A loads

Figure 3: DC Power and Panel Modules: How to distinguish one from the other

For a detailed description of the different interfaces and connection terminals of the Panel and DC Power Modules, please refer to chapters 3.2 and 4.2.

2.3 How PowerPlex Modules Communicate with Each Other

Figure 4 shows the connection and communication scheme of the smallest PowerPlex system possible: two PowerPlex modules connected to each other by means of a CAN bus cable.

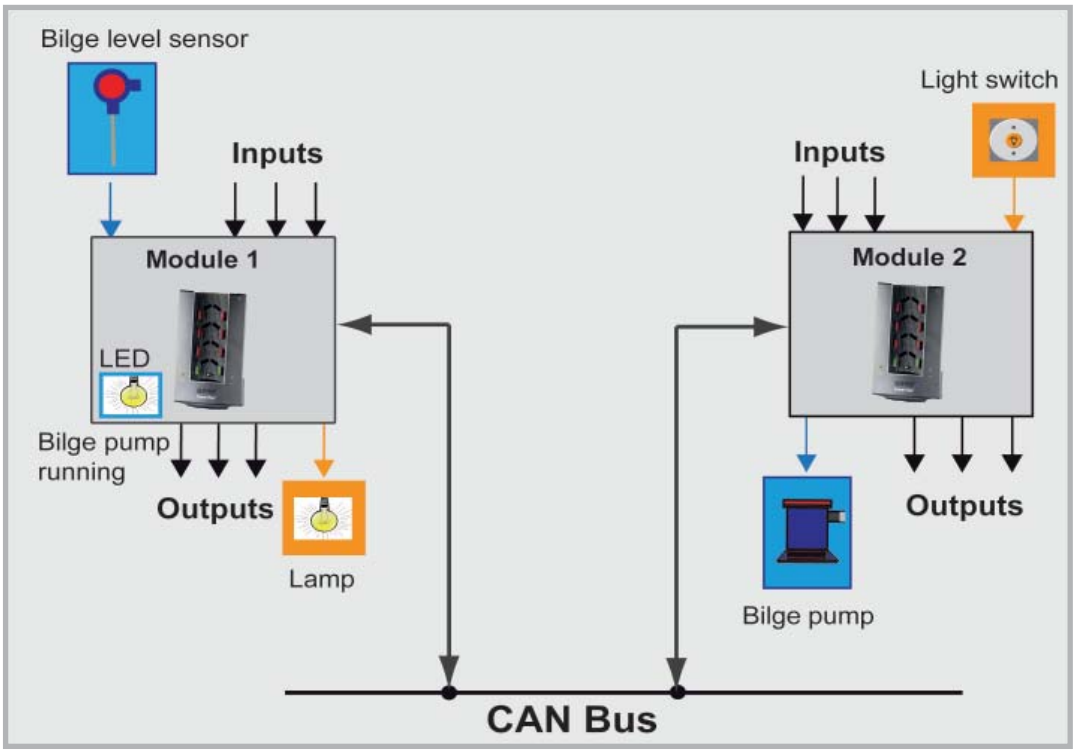


Figure 4: Minimum PowerPlex configuration: Two PowerPlex modules connected by a CAN bus cable

The example illustrates the principle of applying sensor and switch signal information to the module inputs and sending switching or indicating commands to the outputs of the same or another module.

The loads controlled by the module outputs - here: one lamp and one bilge pump - will typically be installed somewhere on the boat, not necessarily close to the input signal. The distributed control architecture of PowerPlex therefore allows you to monitor and switch appliances anywhere on the boat from any point you wish.

In Figure 4, a level sensor monitors the bilge area and feeds this analog information to Module 1. From there, the information is transmitted to Module 2 over the CAN bus. As soon as the measured bilge level (i.e., the analog input value) exceeds a predefined limit value, Module 2 sends a switching command to the load, i.e. the "Bilge pump", to switch on the pump and empty the bilge to an acceptable level. Information on the bilge pump status can be sent back to Module 1 to light up the visual "Bilge pump running" indicator.

Module 2 monitors the position of a light switch - ON or OFF - at one of its digital inputs, sends this switch signal to Module 1 which switches the light ON or OFF depending on the switch position.

A typical PowerPlex control system will of course interconnect a much larger number of modules, and their inputs and outputs, which are distributed over the entire vessel.

For detailed instructions on how to install and connect the modules of your PowerPlex system, please refer to PowerPlex Manual, Volume 2, "PowerPlex: Hardware Installation and Maintenance".

A typical PowerPlex system will of course comprise more than just two modules. Figure 5 illustrates the electrical connection of several PowerPlex modules in a serial CAN bus topology. Each module must be connected to the DC power supply and to the CAN bus.

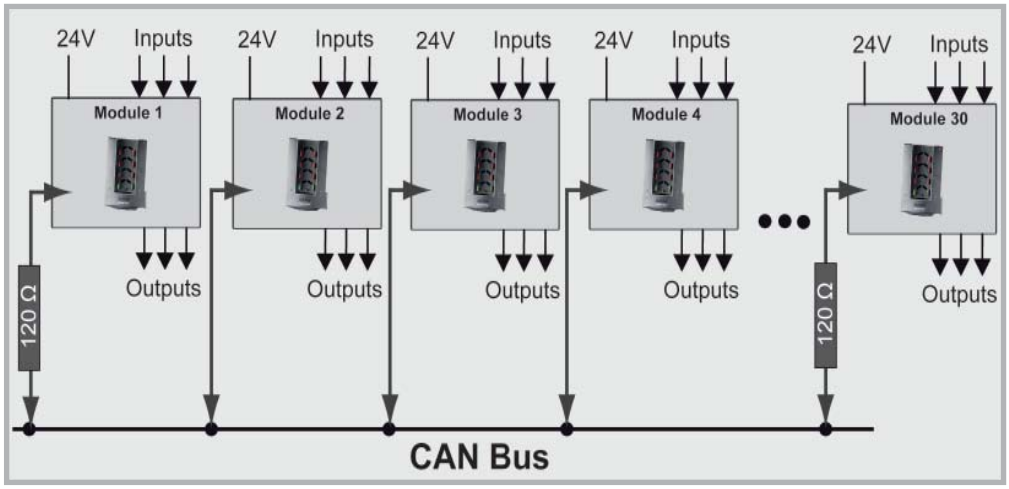


Figure 5: Several PowerPlex modules connected in a serial CAN bus topology

The first and the last module of the CAN bus topology have to have a 120 Ω terminating resistor connected between the CAN-High and the CAN-Low signals to prevent interferences on the bus.

For detailed instructions on how to install and connect the modules of your PowerPlex system, please refer to PowerPlex Manual, Volume 2, "PowerPlex: Hardware Installation and Maintenance".

Table 4 gives you an overview of the modules' interfaces and their principal characteristics. Later on, in chapters 3.2 and 4.2, we will have a closer look at every individual terminal connection and pin assignment.

2.4 Inputs, Outputs and Interfaces of the PowerPlex Modules: Overview

Input / Output / Interface	What to Connect	Terminals	Cable Connection	Protection & Status Indication / Comments
CAN bus	CAN bus cable	CAN-H CAN-L, Shield	1.5 mm², screwless cage-clamp	SAE J1939 protocol
Input: Switch	Switch, puhbutton, ...	Control, GND	1.5 mm², screwless cage-clamp	
Input: Analog	0 to 10 V for sensors, potentiometers, ..	Control, GND	1.5 mm², screwless cage-clamp	
Output: Power 1 A	Loads, 1 A max.	Load, GND	1.5 mm², screwless cage-clamp	Short-circuit and overload proof: Current-limiting and electronic safety disconnection ensured by semiconductor components used in modules
Output: Power 8 A	Loads, 8 A max.	Load, GND	4.0 mm², screwless cage-clamp	Short-circuit proof, Overcurrent protection (programmable) Added overload protection: E-T-A thermal mcb 1610-21- 10 A LED indication: Load ON/OFF, wire break, short circuit, overload (connect LED to status output)
Output: Power 25 A	Loads, 25 A max.	Load, GND	4.0 mm², screwless cage-clamp	Short-circuit and overcurrent protection (programmable) Added overload protection: E-T-A thermal mcb 1610-21- 30 A LED indication: Load ON/OFF, wire break, short circuit, overload (connect LED to status output)
Output: Signal	Status LEDs Integrated LED driver: 5 V, 150 Ω	Status, GND	1.5 mm², screwless cage-clamp	Load OFF: LED OFF Load ON: LED ON Short circuit: LED flashing quickly Overcurrent: LED flashing quickly Wire break: LED flashing slowly
Supply: Voltage	12 V or 24 V DC 9 V DC min., 32 V DC max.	LINE +, 0 V	M8 stud screw	

Table 4: Inputs, outputs and interfaces of PowerPlex modules: Overview

2.5 Display Elements on the Snap-On Module Cover

The semi-transparent snap-on covers for both types of modules are provided with the same LED displays and labelling:

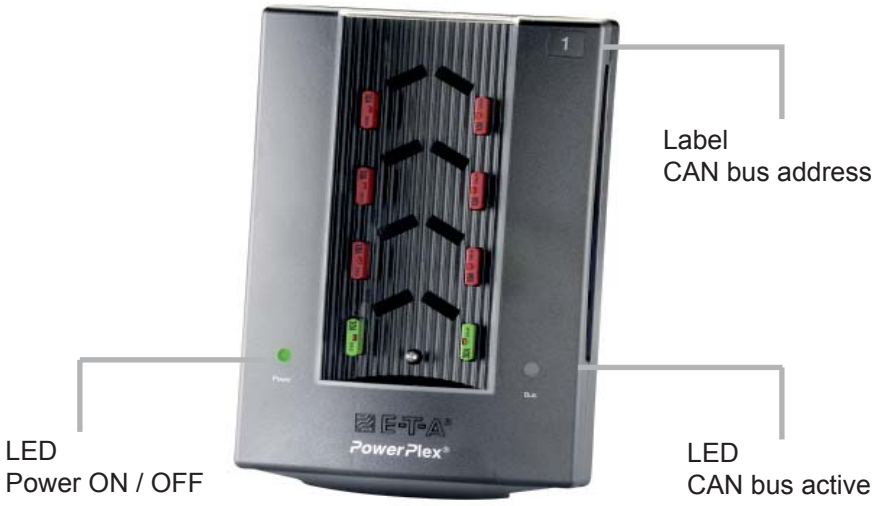


Figure 6: Display elements on the module cover

Display Element	Indication	Meaning	Comment
LED Power ON / OFF	Green slow flashing light LED extinguished	Module is powered up Module is without power	The Power LED blinks at a slower pace than the other indicators in the system. This is normal.
LED CAN bus active	Orange quick flashing light LED extinguished	CAN bus communication in progress No CAN bus communication	
Label CAN bus address	Adhesive label, to be fixed during installation	Module's CAN bus address in the range from 1 to 30	

Table 5: Display elements on the module snap-on cover

Note:

If the flashing frequency of the Power LED is as slow as 3 times per second, or if the Power LED and the BUS LED flash alternately, then the module is in an error state. Try to reconfigure the module by uploading its configuration. If this fails, the module needs to be replaced.

2.6 Load Protection against Overload and Short Circuit

2.6.1 Four Level Protection Concept FLPC

PowerPlex offers a multilevel protection facility to ensure that loads, cables and system components are at all times protected against overload and short circuit.

The integrated **F**our **L**evel **P**rotection **C**oncept FLPC comprises the following protection measures:

- Controller driven, progammable overcurrent protection. Electronic disconnection of loads drawing currents that are 1.3 times higher than the programmed limit value.
- Watchdog function for outputs
- Current-limiting and disconnection at overtemperature caused by overcurrent.
  Protection inherent in the semiconductor components used in the PowerPlex modules.
- Short-circuit and overload protection and genuine galvanic isolation of 8 A and 25 A loads provided by plug-in circuit breakers (→ 2.6.2 and data sheets in Appendix).

2.6.2 Load Protection Provided by E-T-A Circuit Breakers

In addition to the software-controlled current limiting and overload protection features which you set up in the PowerPlex Configuration Software, E-T-A miniature thermal circuit breakers (mcbs) type 1610 protect the higher rated loads of 8 A and 25 A.

Not only do these circuit breakers isolate a faulty load safely from the PowerPlex system and the power supply in the event of a short circuit or overload, they also serve as manual switches to bypass the PowerPlex system, and to activate and deactivate a load in the unlikely event of a module failure.

2.7 Manual Load OFF / RESET / ON Using Circuit Breakers

With the PowerPlex module in proper functioning mode, i.e. loads are being switched ON and OFF over the CAN bus by means of the transistor-driven module outputs, you can still control loads manually by removing and re-inserting the associated circuit breaker.

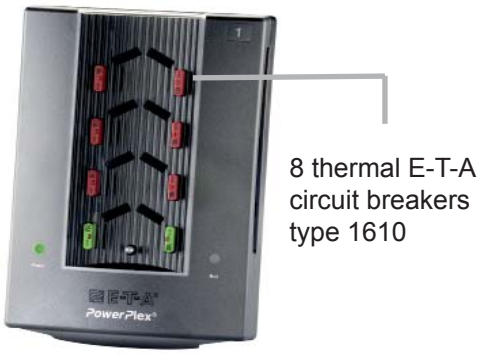


Figure 7: DC Power Module with 8 inserted circuit breakers

Manual Load	Control ON / OFF / RESET
Manual Load OFF	Unplug circuit breaker → load is isolated from power
Manual Load ON	Re-insert circuit breaker into its vertical plug-in slot → load is reconnected to power.
RESET after mcb trip	If the mcb has tripped to protect against short circuit or overload, reset the device by pressing its red reset button.

Table 6: Manual load OFF / ON / RESET using integrated circuit breakers

2.8 Manual Override of Automatic Load OFF / RESET / ON Using Circuit Breakers

In the unlikely event that a module is faulty and one of its transistor-driven outputs is not functioning properly due to a faulty semiconductor component, you can override the CAN-driven switching function by moving the associated circuit breaker from the normal vertical plug-in slot to the diagonal plug-in slot. This overrides the faulty load output and re-establishes power to the load.

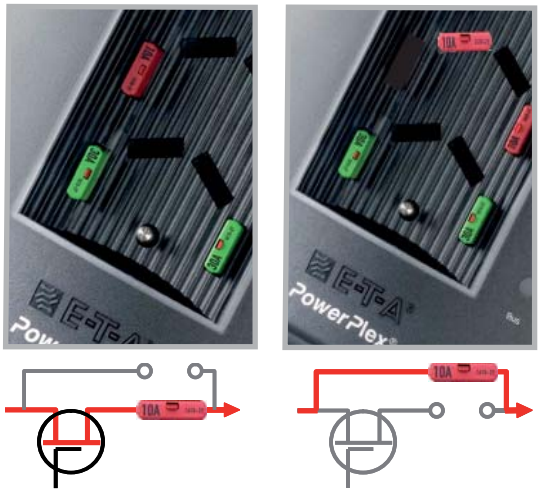


Figure 8: DC Power Module with one mcb in override position

Manual	System Override
Faulty Load OFF due to transistor failure	Unplug circuit breaker
Manual override of faulty transistor output	Re-insert circuit breaker into the associated diagonal plug-in slot → load is manually reset and reconnected to power

Table 7: Manual system override using integrated circuit breakers

For a detailed description of the E-T-A thermal circuit breakers type 1610-21, please consult the data sheets in the Appendix.

2.9 The Module Serial Number

Every PowerPlex module has a unique serial number. You find the serial number label on the module housing, underneath the bottom face. So, to see the serial number, remove the module's snap-on cover by clicking the cover's bottom handle towards you and then pulling the cover off.

The serial number comprises 7 digits preceded by the letter D or P indicating the module type.

Serial Number	Module Type
P xxxxxxx	Panel Module
D xxxxxxx	DC Power Module

Table 8: Module serial numbers indicating the module type

The serial number serves as an identifier for new, unconfigured modules which initially have the CAN bus address 0. You will come across the module serial number when you set up your PowerPlex system and assign CAN bus addresses using the PowerPlex Configuration Software.

2.10 The Module CAN Bus Address

Every PowerPlex module connected to the CAN bus must have its own unique CAN bus address in the range from 1 to 30 for unambiguous identification within the network. You assign the address when you set up your PowerPlex system using the PowerPlex Configuration software (see PowerPlex Manual, Volume 3).

We recommend using the adhesive CAN bus address labels 1 to 30 provided and fix them to the upper right corner of the module covers to keep track of module identification. For details on the recommended circuit and address labels, please consult the module data sheets in the Appendix.

Figure 9: Labelling the CAN bus address on the module

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3. The DC Power Module

The DC Power Module offers a lot more power outputs than the Panel Module, some of which have a current rating as high as 25 A. So, you will therefore use DC Power Modules primarily for switching power devices. However, you may of course also connect switches, pushbuttons, lamps and appliances to a DC Power Module.

3.1 Where to Install the DC Power Module?

As you will most likely choose a DC Power Module for those locations on the boat where you have to switch the more powerful loads that draw higher currents and require larger cables, such as pumps, motors, and other actuators, we recommend installing these power modules in the vicinity of the load to be controlled.

Figure 10 illustrates a typical distribution of DC Power and Panel Modules. Here, the higher switching capacity of the DC Power Modules is applied in the anchor winch area, for bilge pumps and the shower/WC area of the accommodation rooms, just to give you an example.

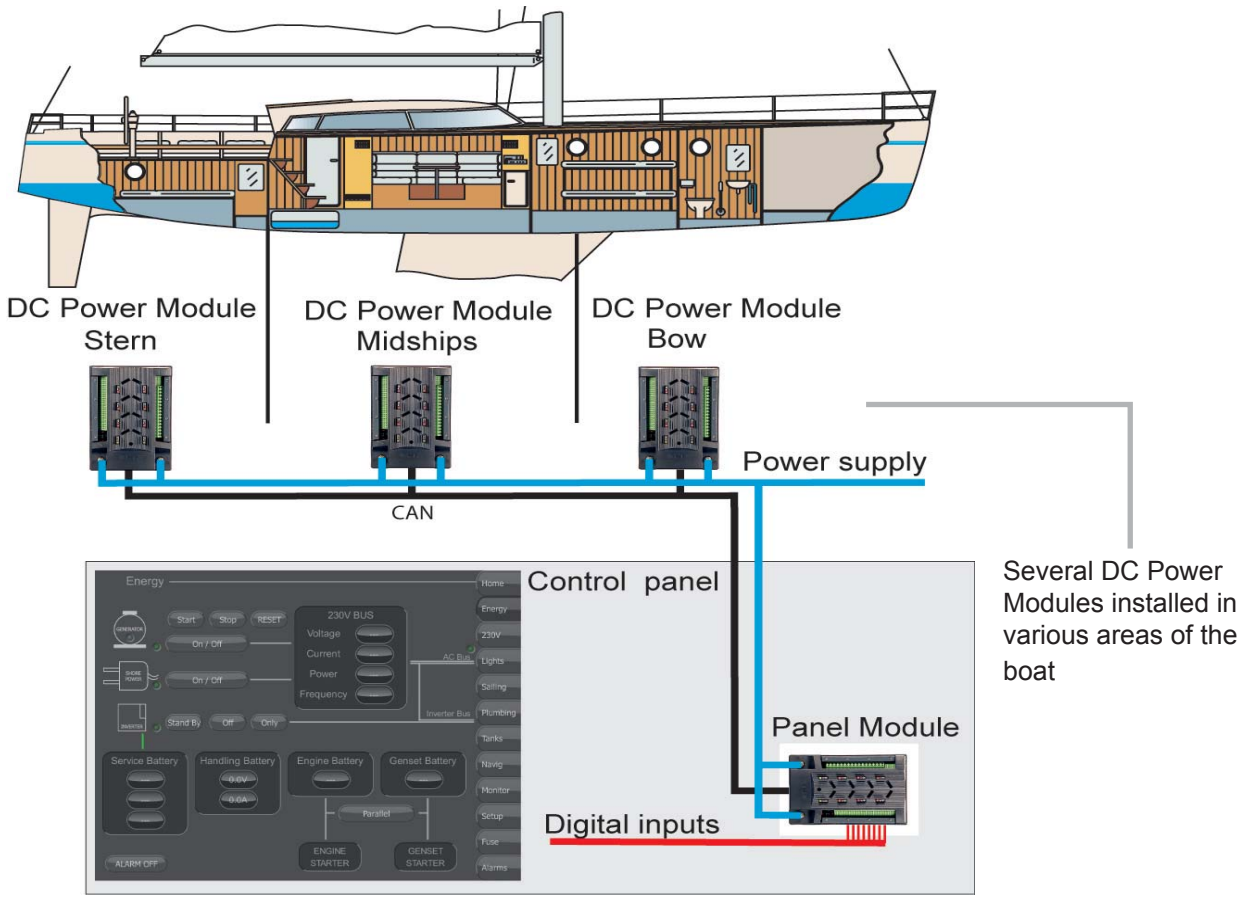

Figure 10: Typical distribution of DC Power Modules on a boat

Note:

Use DC Power Modules for switching high current rating loads of up to 25 A and install them in the vicinity of the loads to be controlled.

3.2 Inputs, Outputs and Interfaces of the DC Power Module

Table 9 summarizes the I/O and interfaces the DC Power Module has to offer.

I / O, Interfaces	Quantity	Purpose
8 Inputs: Switch	8 sets of 2 terminals: S1 to S8 with one SR*) each	These digital **S**witch inputs S1 to S8, typically coming from switches or pushbuttons, are assigned to load outputs of the same or another PowerPlex module in order to switch the load connected to these outputs.
4 Inputs: Analog	4 sets of 2 terminals: A1 to A4 with one AR*) each	Here you connect sensors and other devices providing analog measurement values, such as water levels, temperatures, pressures etc. In the Configuration Software, you may define limit values that trigger a switching action when violated, such as PUMP ON.
8 Outputs: Signal	8 sets of 2 terminals: L1 to L8 with one LR*) each	These signal outputs L1 to L8 are assigned to the integrated LED drivers to indicate the status of loads. In the Configuration Software, you assign the load output whose status you wish to monitor and indicate, to a signal output L1 to L8 of the same or another module of your PowerPlex system.
12 Outputs: Power	4 sets of 2 terminals: 1 A load: 11 to 14 with one 1R*) each 6 sets of 2 terminals: 8 A load: 81 to 88 with one 8R*) each 2 sets of 2 terminals: 25A load: 251 to 252 with one 25R*) each	High-side MOSFET switching power outputs for energizing and de-energizing connected loads, such as lights, pumps, motors, ventilators, and so on.
2 Interfaces: CAN	2 sets of 3 terminals: CH CAN High CL CAN Low CS CAN Shield	CAN bus cable connection to connect one PowerPlex module to the other to build a CAN network of bus topology.

Table 9: DC Power Module: I/O and interfaces (Overview)

*) GND return cable

Note:

For detailed technical data of the inputs, outputs and interfaces as well as for all information on approvals, ambient conditions, protection degrees and dimensional drawings, please consult the module data sheet in the Appendix.

3.3 Terminal Designations

Figure 11 shows the DC Power Module, complete with its terminals covered and protected by the snap-on cover, and with the snap-on cover removed.

Figure 11: *left:* *DC Power Module, complete with transparent snap-on cover*
right: *DC Power Module with snap-on cover removed*

3.3.1 Terminal Block on the Left

The terminal block on the module's left comprises 25 double-level terminals for cage clamp connection for 1.5 mm² cables. They are labelled as follows:

Pin	Bottom Terminal Row 1.5 mm²	Top Terminal Row 1.5 mm²
	8 **S**ignal outputs 24V (Lx) + 0V return (LR)	8 **S**witch inputs 24V (Sx) + 0V return (SR)
1 2 3 3 . . . 16	L1 LR L2 LR L3 LR ... L8 LR	S1 SR S2 SR S3 SR ... S8 SR
	2 Analog inputs: 0...10V (Ax) + 0V return (AR)	2 Analog inputs: 0...10V (Ax) + 0V return (AR)
17 18 19 20	A1 AR A2 AR	A3 AR A4 AR
	RS232 serial interface (currently not used)	RS232 serial interface (currently not used)
21 22	GND	TX RX
	3 CAN Bus cable terminals (Low, High, Shield) to previous module	3 CAN Bus cable terminals (Low, High, Shield) to next module
23 24 25	CL CH CS	CL CH CS

Table 10: DC Power Module: Terminal designation of left-hand terminal block

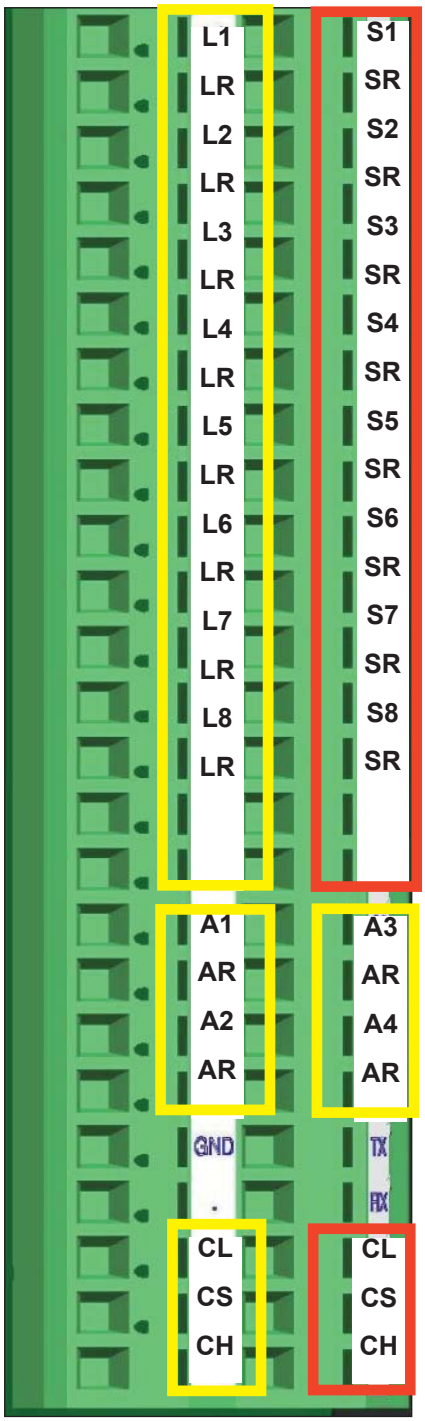

Figure 12: DC Power Module: Terminal block on the left, without snap-on cover

3.3.2 Terminal Block on the Right

The terminal block on the module's right comprises 4 double-level terminals for 1.5 mm² cables and 16 single-level terminals for 4 mm² cables, both for cage clamp connection. They are labelled as follows:

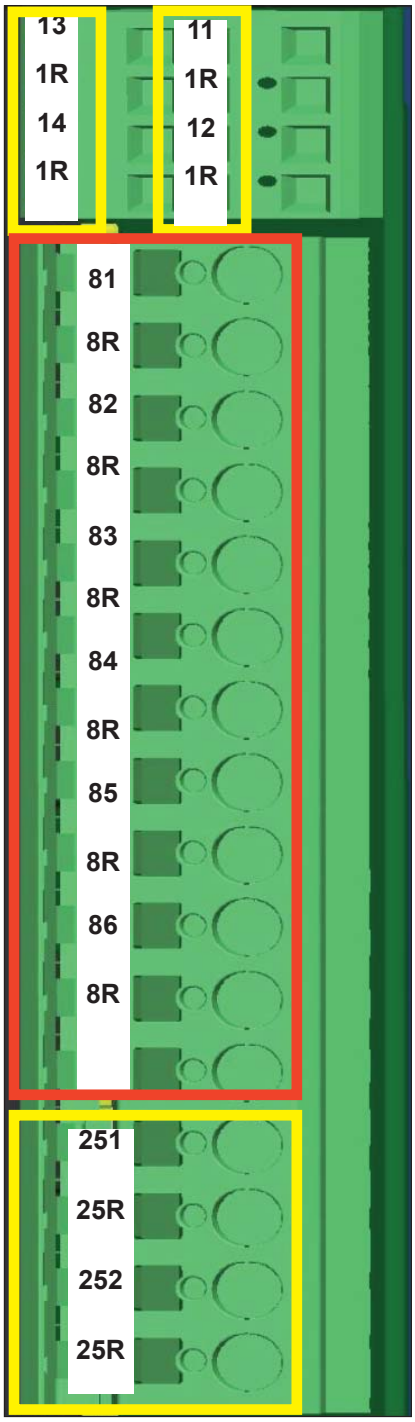

Figure 13: DC Power Module: Terminal block on the right, without snap-on cover

Pin	Top Terminal Row 1.5 mm²	Bottom Terminal Row 1.5 mm²
	2 Power outputs 1 A 24V (1x) + 0V return (1R)	2 Power outputs 1 A 24V (1x) + 0V return (1R)
1 2 3 4	13 1R 14 1R	11 1R 12 1R

Pin	Single Terminal Row 4 mm²
	6 Power outputs 8 A 24 V (8x) + 0 V return (8R)
5	81
6	8R
7	82
8	8R
9	83
10	8R
11	84.
12	8R
13	85
14	8R
15	86
16	8R
	2 Power outputs 25 A 24 V (2x) + 0 V return (25R)
17	251
18	25R
19	252
20	25R

Table 11: DC Power Module: Terminal designation of right-hand terminal block

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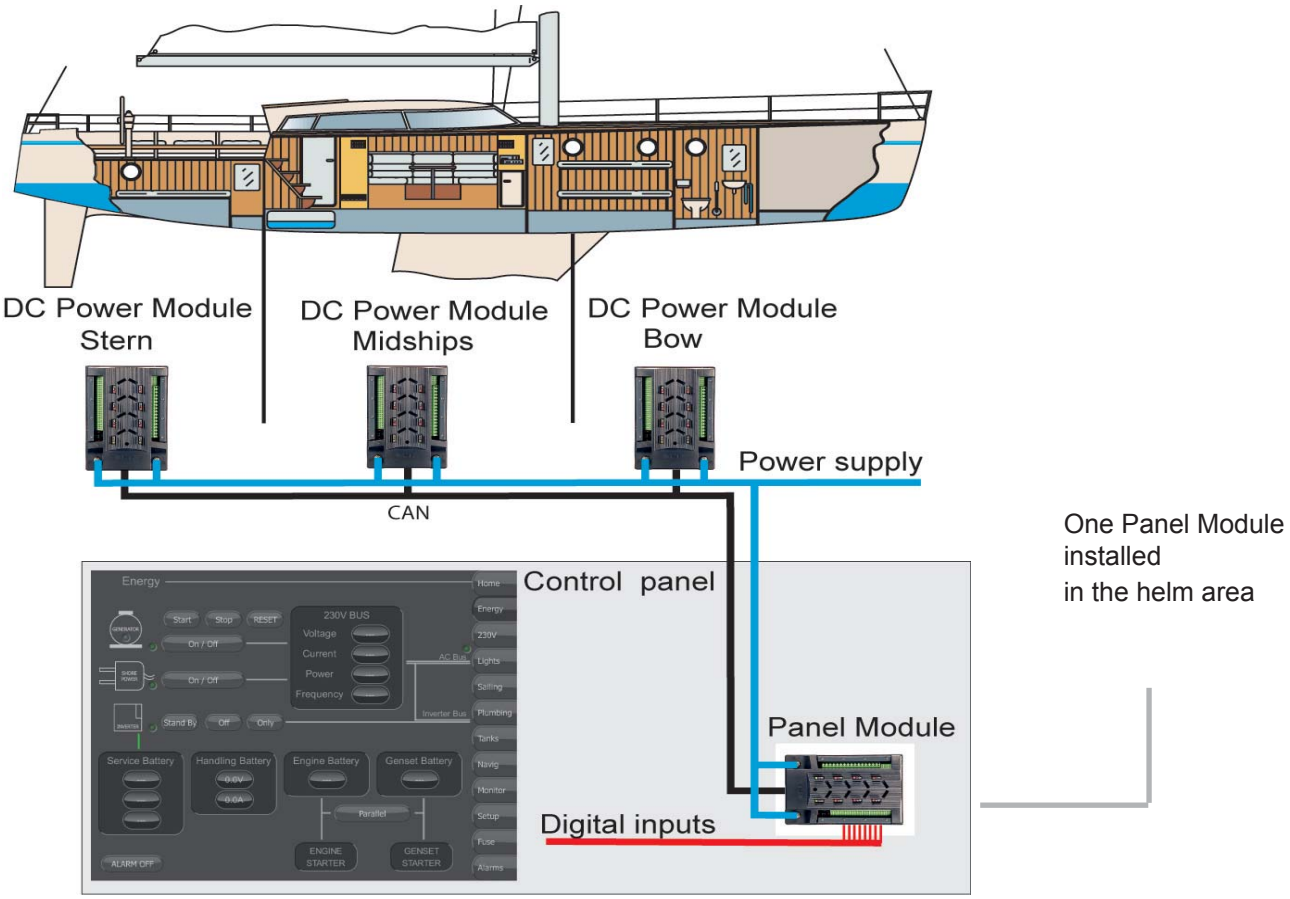
4. The Panel Module

The Panel Module offers more digital switch inputs and signal outputs and fewer power outputs than the DC Power Module. The 32 digital switch input signals can be assigned to switchable loads or LED status outputs of the same or of any other PowerPlex module connected to the system. Hence, you would typically use the Panel Module to transmit status information of switching activities to LED outputs in order to indicate the ON or OFF status of a load. So, unlike the DC Power Modules, the Panel Module is primarily used for status indication rather than for switching a larger number of loads. However, Panel Modules can also be connected to small switchable loads of 1 A. In addition, the Panel Module provides 2 power outputs for the control of loads drawing currents not higher than 8 A.

4.1 Where to Install the Panel Module?

Figure 14 illustrates a typical distribution of DC Power and Panel Modules. Here, the higher switching capacity of the DC Power Modules is applied in the anchor winch area, for bilge pumps and the shower/WC area of the accommodation rooms, just to give you an example.



Note:
Use Panel Modules to indicate the ON / OFF states of a large number of loads that are distributed all over the boat. Install the Panel Module at a central point where you wish to have an overview of the electrical system on the boat. This will typically be the control console in the helm area.

4.2 Inputs, Outputs and Interfaces of the Panel Module

Table 12 summarizes the I/O and interfaces the Panel Module has to offer.

I / O, Interfaces	Quantity	Purpose
32 Inputs: Switch	32 terminals S1 to S32 with a total of two return lines SR	These digital **S**witch inputs S1 to S32, typically coming from switches or pushbuttons, are assigned to load outputs of the same or another PowerPlex module in order to switch the load connected to these outputs.
4 Inputs: Analog	4 sets of 2 terminals: A1 to A4 with one AR*) each	Here you connect sensors and other devices providing analog measurement values, such as water levels, temperatures, pressures etc. In the Configuration Software, you may define limit values that trigger a switching action when violated, such as PUMP ON.
32 Outputs: Signal	32 terminals L1 to L32 with a total of two return line LR	These signal outputs L1 to L32 can be connected to the integrated LED drivers to indicate the status of loads. In the Configuration Software, you assign the load output whose status you wish to monitor and indicate, to an LED output L1 to L8 of the same or another module of your PowerPlex system.
6 Outputs: Power	4 sets of 2 terminals: 1 A load: 11 to 14 with one 1R*) each 2 sets of 2 terminals: 8 A load: 81 to 82 with one 8R*) each	High-side MOSFET switching power outputs for energizing and de-energizing connected loads, such as lights, ventilators, and so on.
2 Interfaces: CAN	2 sets of 3 terminals: CH CAN High CL CAN Low CS CAN Shield	CAN bus cable connection to connect one PowerPlex module to the other to build an open ring CAN network.

Table 12: Panel Module: I/O and interfaces (Overview)

*) GND return cable

Note:
For detailed technical data of the inputs, outputs and interfaces as well as for all information on approvals, ambient conditions, protection degrees and dimensional drawings, please consult the module data sheet in the Appendix.

4.3 Terminal Designations

Figure 15 shows the Panel Module complete with its terminals covered and protected by the snap-on cover, and with the snap-on cover removed.

Figure 15: *left:* *Panel Module with semi-transparent snap-on cover*
right: *Panel Module with snap-on cover removed*

4.3.1 Terminal Block on the Left

The terminal block on the module's left comprises 26 double-level terminals for cage clamp connection for 1.5 mm² cables. They are labelled as follows:

Pin	Bottom Terminal Row 1.5 mm²	Top Terminal Row 1.5 mm²
	1 0V return line SR + 16 Switch inputs Sx	1 0V return line SR + 16 Switch inputs Sx
1 2 3 4 5 6. . 17	SR S1 S2 S3 S4 S5 ... S15 S16	SR S17 S18 S19 S20 S21 ... S31 S32
	2 Analog inputs: 0...10V (Ax) + 0V return (AR)	2 Analog inputs: 0...10V (Ax) + 0V return (AR)
18 19 20 21	A1 AR A2 AR	A3 AR A4 AR
	RS232 serial interface (currently not used)	RS232 serial interface (currently not used)
22 23	GND	TX RX
	3 CAN Bus cable terminals (Low, High, Shield) to previous module	3 CAN bus cable terminals (Low, High, Shield) to next module
24 25 26	CL CH CS	CL CH CS

Table 13: Panel Module: Terminal designation of left-hand terminal block

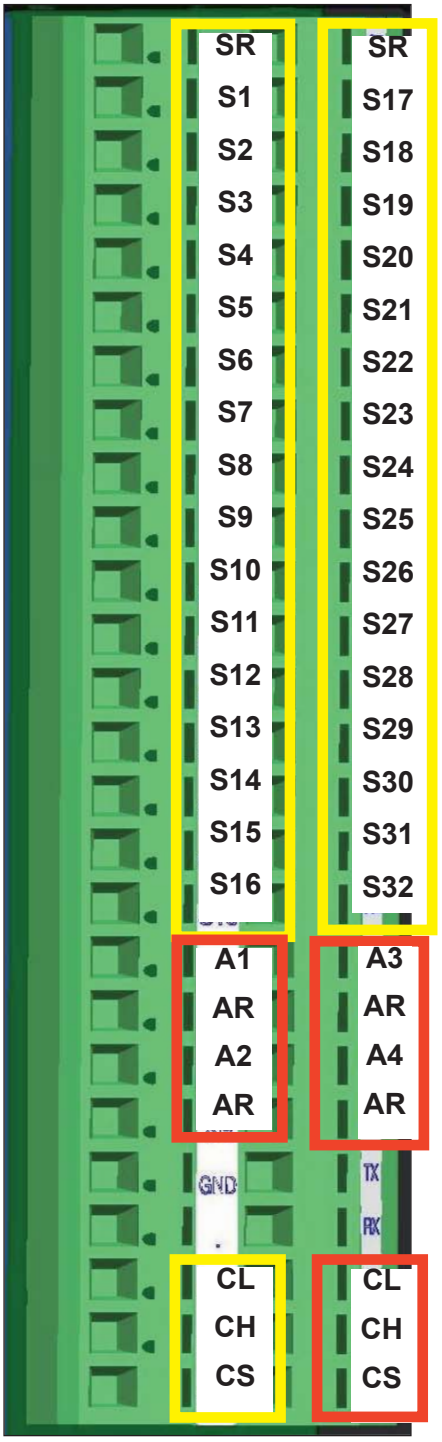
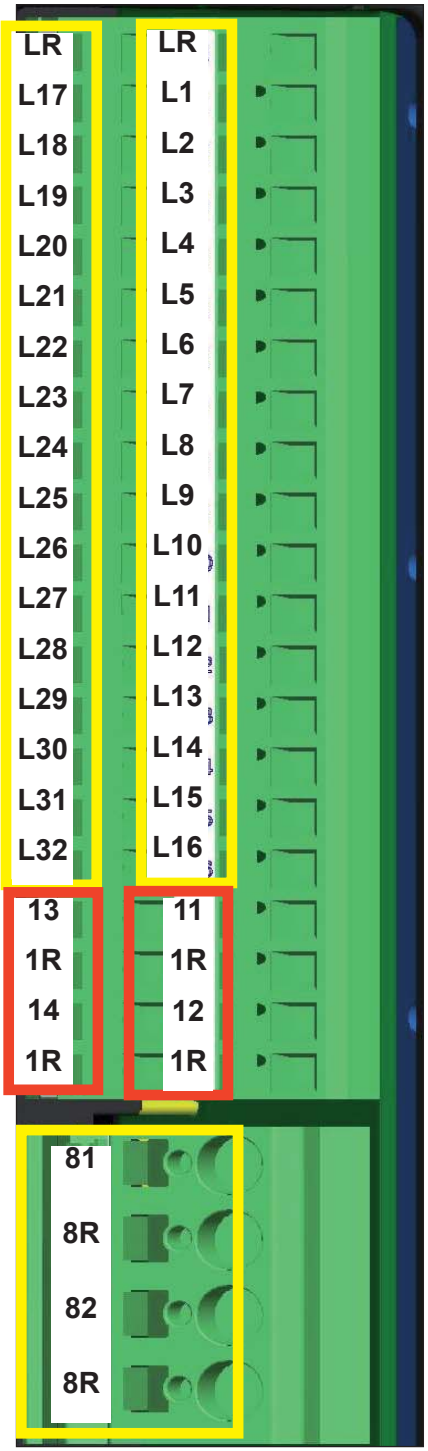


Figure 16: Panel Module: Terminal block on the left, without snap-on cover

4.3.2 Terminal Block on the Right

The terminal block on the module's right comprises 21 double-level terminals for 1.5 mm² cables, and 4 single-level terminals for 4.0 mm² cables, both for cage clamp connection. They are labelled as follows:



Pin	Top Terminal Row 1.5 mm²	Bottom Terminal Row 1.5 mm²
	1 0V return line LR + 16 signal outputs Lx	1 0V return line LR + 16 signal outputs
1 2 3 4 5 6 . . 17	LR L17 L18 L19 L20 L21 ... L31 L32	LR L1 L2 L3 L4 L5 ... L15 L16
	2 Power outputs 1 A 24V (1x) + 0V return (1R)	2 Power outputs 1 A 24V (1x) + 0V return (1R)
18 19 20 21	13 1R 14 1R	11 1R 12 1R

Pin	Single Terminal Row 4 mm²
	2 Power outputs 8 A 24 V (8x) + 0 V return (8R)
22	81
23	8R
24	82
25	8R

Figure 17: Panel Module: Terminal block on the right, without snap-on cover

Table 14: Panel Module: Terminal designation of right-hand terminal block

5. The PowerPlex Configuration Software

The PowerPlex Configuration Software is a Windows based software running on your computer or laptop. You are going to use this software to allocate CAN bus addresses to the PowerPlex modules of your system, to set up the system parameters, and to configure the role of the modules' inputs and outputs.

The PowerPlex software tool allows you

- to create and save different PowerPlex projects and configurations
- to modify existing PowerPlex configurations and upload them again into the PowerPlex hardware
- to print out configuration documentation, parts lists, connection diagrams
- simulate, analyse and debug PowerPlex configurations.

The PowerPlex Configuration Software is provided on a USB stick. For a detailed description of the software tool and step-by-step configuration instructions, please consult Volume 3 of the PowerPlex Manual, "PowerPlex: System Setup and Configuration".

6. The CAN-USB Converter

To connect your computer running the PowerPlex Configuration Software to the hardware of the PowerPlex system and the CAN bus, you require the CAN-USB converter. It establishes a connection between the computer's USB interface and the CAN bus socket of your PowerPlex system hardware.

Figure 18: CAN-USB converter cable (example: PEAK)

The CAN-USB converter cable has a USB connector at one end and a 9-pin D-SUB plug connector (male) at the other. A corresponding 9-pin D-SUB socket (female) connector cable must be connected to the PowerPlex module.

Both, the CAN-BUS converter and the socket cable, inclusive of the driver software, are part of the E-T-A PowerPlex delivery scope. For more details on these accessory items, please consult the module data sheets in the Appendix.

For the pin assignments of the CAN bus plug connector and detailed instructions on how to connect and use the CAN-USB converter, please refer to Volume 2 of this manual, "PowerPlex: Hardware Installation and Maintenance".

You may also use an RJ-45 adapter cable which connects the 9-pin SUB-D male connector of the CAN-USB converter cable directly to the RJ-45 socket of the PowerPlex module.

7. CAN Bus Cabling

A typical CAN bus cable is a twisted-pair cable comprising two wires CAN-H and CAN-L and the shield wire SHLD.

Table 15 lists the principal characteristics of the type of CAN bus cable to be used. The following specifications are those of a typical CAN bus cable, type CAN.BUS 1X2X0.50 HOC, as supplied by HELUKABEL (www.helukabel.de).

Mechanical Properties	
Inner conductor diameter	0.97 mm
Conductor nominal cross-sectional area	0.50 mm^2
Conductor material	copper, bare
Conductor class	class 2: stranded
Number of cores	2
Total shielding	CU braid, tinned
Core colours	CAN-High: white (wh) CAN-Low: brown (bn)
Cable external diameter	7.0 mm
Outer sheath colour	violet
Weight	69 kg /km
Minimum bending radius	laying: 90 mm static: 48 mm
Operation temperature	-40 °C ... +70 °C
Electrical Properties	
Characteristic impedance	120 Ω
Conductor resistance	37 Ω / km max.
Insulation resistance	1 GΩ / km
Test voltage	1.5 kV
Other General Properties	
Resistance to ambient influences	UV, weather, oil, coolant and microbe resistant
Mechanical resistance	Abrasion and notch resistant, low adhesion
Chemical resistance	Acid and alkali resistant
Thermal resistance	Caloric load: 1.09 MJ / m

Table 15: Characteristics of recommended CAN bus cabling (example: HELUKABEL)

Note:

CAN bus cables are not part of the E-T-A PowerPlex delivery scope.

8. Appendix

8.1 CAN Bus Principles

CAN (Controller Area Network) is a serial bus system for transmission rates up to 1 MBit/s, which was originally developed for in-car use in the 1986 by Robert Bosch. In 1993, the CAN bus protocol was internationally standardized as ISO-11898 and comprises the data link layer of the seven ISO/OSI reference model.

Today, most major car manufacturers offer power engine systems based on CAN networks as CAN greatly reduces wiring volume, weight and complexity which in turn facilitates installation and fault diagnosis.

The fact that CAN is also widely used in medical equipment is testimony to the systems inherent reliability. Particularly CANs high noise immunity and fault tolerance and its real-time capabilities combined with cost-effective installation make it today the ideal communication network in industrial automation as well as in car and utility vehicle control systems.

CAN has become a de facto standard for automotive communications and also has considerable impact in other industries and applications where noise immunity and fault tolerance are more important than raw speed. Used in numerous types of vehicles, from trains to ships, CAN is one of the most dominating bus protocols.

CAN Bus Topology

The Controller Area Network connects several nodes of same priority to a common data line. In a CAN network, this data line is a twisted pair 2-wire multidrop cable.

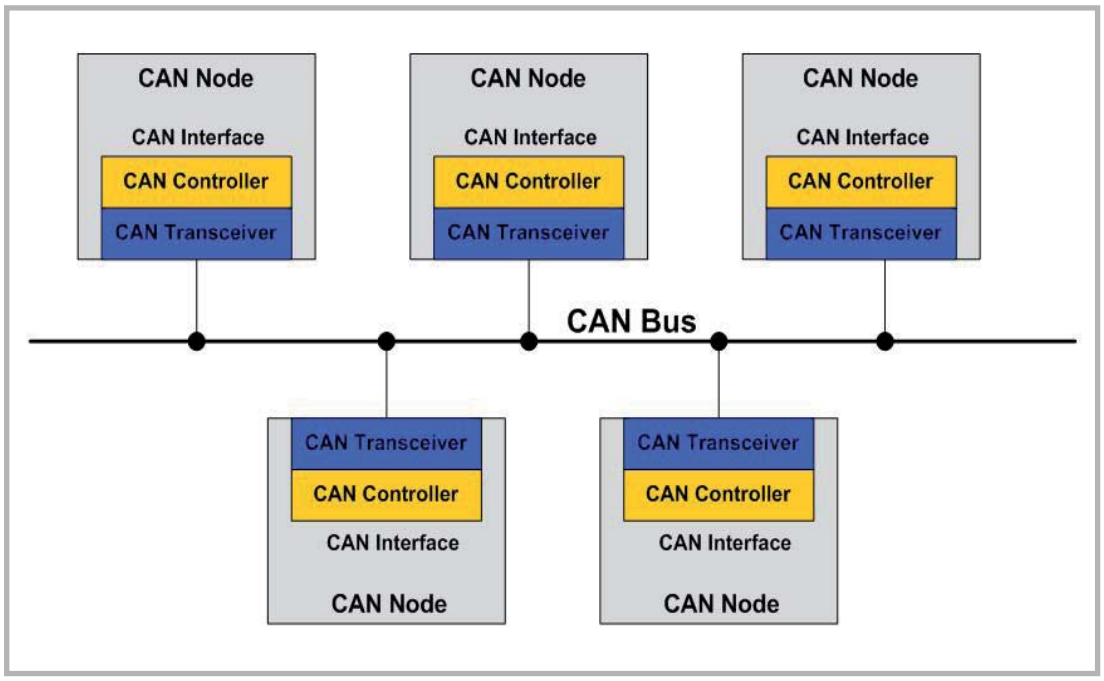


Figure 19: Open CAN bus topology

Short stub lines connect the components that are to "talk to each other" to the bus. CAN interfaces comprising a controller and a transceiver control the data exchange between the nodes which is based on the CAN communication protocol.

The CAN Interface

The CAN interface comprises the CAN controller and the CAN transceiver. The CAN contro-ller handles the CAN protocol, and the CAN transceiver establishes the physical connection between the node and the CAN bus.

Information is carried on the bus as a voltage difference; the signal is mapped onto two lines, one signal having the opposite polarity of the original signal. So, the CAN-High and the CAN-Low signals contain the inverted and the non-inverted serial data signal, respectively.

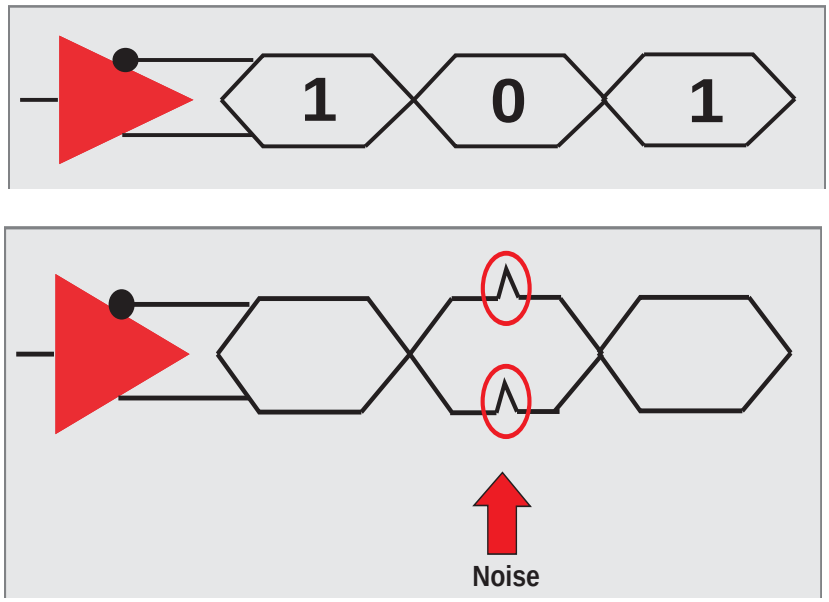


Figure 20: Differential signal CAN-H and CAN-L on the 2-wire CAN bus, with noise signal

Noise Immunity

There is no independent ground reference point for these two lines. The bus is therefore immune to any ground noise, which in vehicles or ships can be considerable.

The signals on the two CAN lines will both be subject to the same electromagnetic influences. As these interferences on both lines always act in the same direction (→ Figure 20), and the differential lines are always at exactly opposite levels, noise signals are levelled out and the potential difference remains unchanged. This "Common Mode Rejection Ratio" makes the CAN bus immune to electro-magnetic interferences.

CAN Connector and Pin Assignment

The 9-pin D shaped subminiature connector, in short SUB-D, has proved successful for the CAN bus. This allows easy integration of additional nodes into the bus line without interrupting the network.

Figure 21: 9-pin D-SUB plug connector (male)

PIN	Signal	Designation
1		Not connected
2	CAN-L	Inverted CAN signal (dominant low)
3	CAN-GND	Ground
4		Not connected
5	CAN-SHLD	Shielding (optional)
6	GND	Device ground (optional)
7	CAN-H	Non-inverted CAN signal (dominant high)
8		Not connected
9	VCC	Supply voltage (optional)

Table 16: D-SUB connector: pin assignment

To transmit the standard CAN bus signals CAN-High and CAN-Low you need a connector cable with at least two cores. Although the use of a shield is not mandatory, shielding as well as twisting the signal carrying pair is recommended for long-distance CAN bus lines. Therefore, a shielded twisted-pair cable is recommended for the PowerPlex system. A typical CAN bus cable is described in Chapter 7.

CAN Bus Termination

To avoid reflections on the bus make sure to terminate both ends of the CAN bus line with one 120 Ohm resistor each. A standard resistor or a plug with internal resistor can be used. Please note that this resistor is not part of the E-T-A PowerPlex delivery scope.

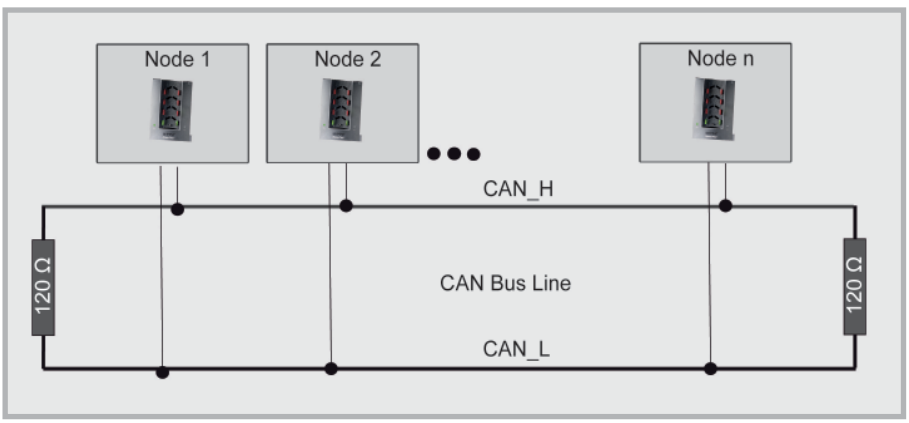


Figure 22: Line termination with 120 Ω resistors

Figure 23: Typical 120 Ω resistors

8.2 Technical Data Sheets

At the end of this manual, we have inserted the technical data sheets of the following Powerplex system components:

- DC Power Module
- Panel Module
- Touch Panel PC
- Thermal circuit breaker type 1610
- Thermo-magnetic circuit breaker type 8345

Please note that these data sheets are subject to modifications and extensions. For the most recent and up-to-date technical information on these components, we should like to ask you to consult our web site www.e-t-a.com where you can download updated technical data on all E-T-A components.

9. Index