EXOflex Manual

January 2008

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Brief Contents

Part I Introduction and System Overview

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Part I **Introduction and System Overview**

Chapter 1 Using This Manual

This manual presents guidelines for system designers and project engineers on how to structure and connect EXOflex-units and other equipment into reliable systems.

This manual is intended as a guide. The final responsibility for the function of any particular installation rests solely upon the system designer, who should, by extensive testing, ensure that all the specifications are met.

If you should find errors or unclear information in this manual, kindly contact Regin so that future editions can be corrected and improved.

This manual will be revised without prior notice, as and when deemed necessary. Please check regularly that you have the latest revision.

Conventions Used in This Manual

This manual uses the following conventions:

This box and symbol will provide general information, not necessarily concerned directly with EXOflex.

This box and symbol will provide useful tips and tricks.

This type of box will give important information about avoiding common mistakes, dangerous practices, etc.

This box and symbol will be used to guide you through a procedure.

Chapter 2 **Introduction to EXOflex**

EXOflex

EXOflex is a general system for control, regulation, supervision and communication in general automation installations. The system offers great possibilities when constructing many different types of control and regulation systems: outstations in distributed systems, DUC’s in building automation systems, service gateways in LAN’s and on the Internet, etc.

The system is of a modular design and provides unique opportunities for adapting the number and type of inputs and outputs required, as well as the type of communication needed by the individual client.

An EXOflex unit is a process computer that can run completely independently or linked to other EXOflex-units and other types of computers and equipment, in small or large systems.

EXOflex consists of a range of hardware components, and of comprehensive software in the form of an operating system, standardized applications and add-ons. EXOflex is to a large extent compatible with other EXO products, including older process stations (controllers) and software.

Software applications such as EXOdesigner (development tools), EXO4 (operator program/SCADA), EXOreport etc, can be used to their full extent with EXOflex, and have in some cases been supplemented to fully integrate EXOflex with earlier products.

The software for EXOflex is described in Part III of this book. The system’s hardware is described below.

EPU – EXO Process Unit

EXOflex makes it possible to construct process stations with varying types and numbers of I/Os, communication ports and processors. The concept **EPU = EXO Process Unit** is used to designate an EXOflex process station, and is often equivalent to a *Module* in the earlier product range (strictly speaking, there are a few differences, which will be described later). The EPU is programmed in the same way, with EXOdesigner and ready-made objects and blocks, or alternatively, in free EXOL-code. The same program can often be used with few or no changes. The processor running the EXOL-code is called the main processor or EXOL processor. In contrast to earlier systems, an EPU can contain several EXOL processors.

An EPU usually consists of a mechanical unit mounted in a house. All the external connections are found on the **PIFA = Process Interface Adapter**. To increase the number of I/Os, an EPU can be extended with one or more houses, each containing further PIFA-units. These are known as “**Expansion Units**”.

Most of the PIFA-units have their own microprocessors, which provide specific configurable function for that model. This facilitates programming and reduces the load on the EXOL-processor. This configuration is done in EXOdesigner, in easy-to-use windows.

The EXOflex Housing

The EPU hardware consists of a housing and a selection of PIFA-units. The housings are supplied ready assembled as Processor Housings with an EXOL processor or as Expansion Housings without processor.

The EXOflex housings are based on an extrusion-pressed, anodized aluminum chassis. This robust chassis, which is available in four different lengths, is then the base for constructing the various different sizes of casings (housings), by adding the base circuit boards, end walls, shell, dividers, etc, as shown in the following illustrations.

Figure 1. An EXOflex house with section width 2.

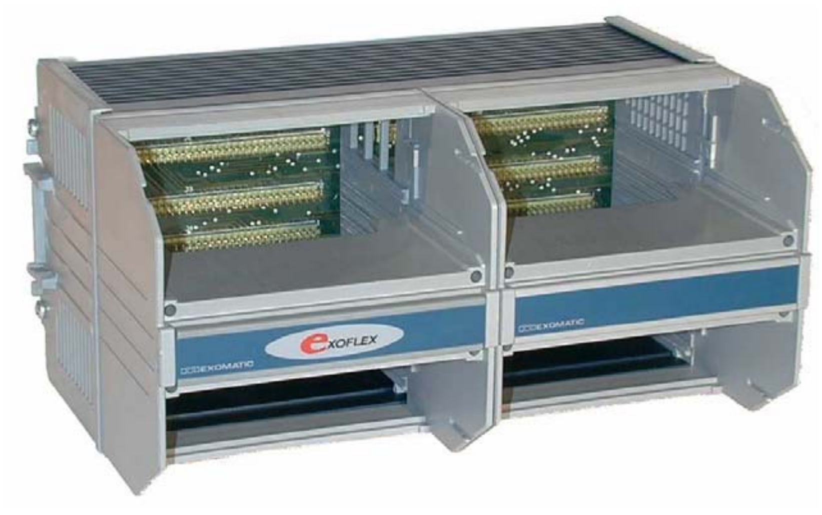


Figure 2. Side-view of an EXOflex house.

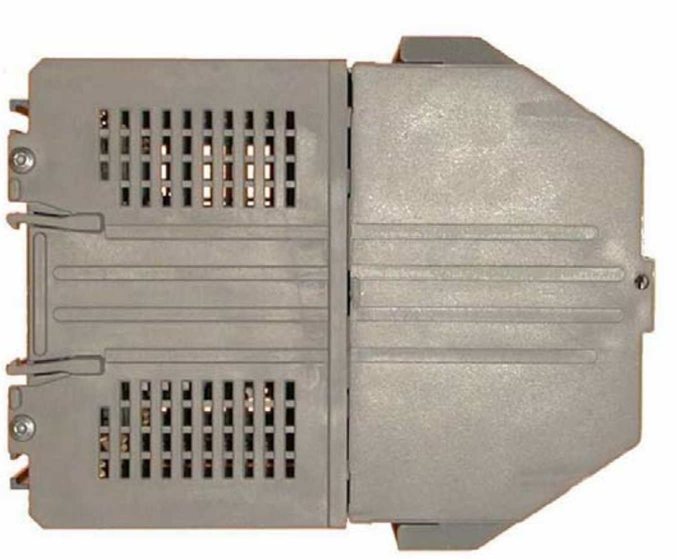
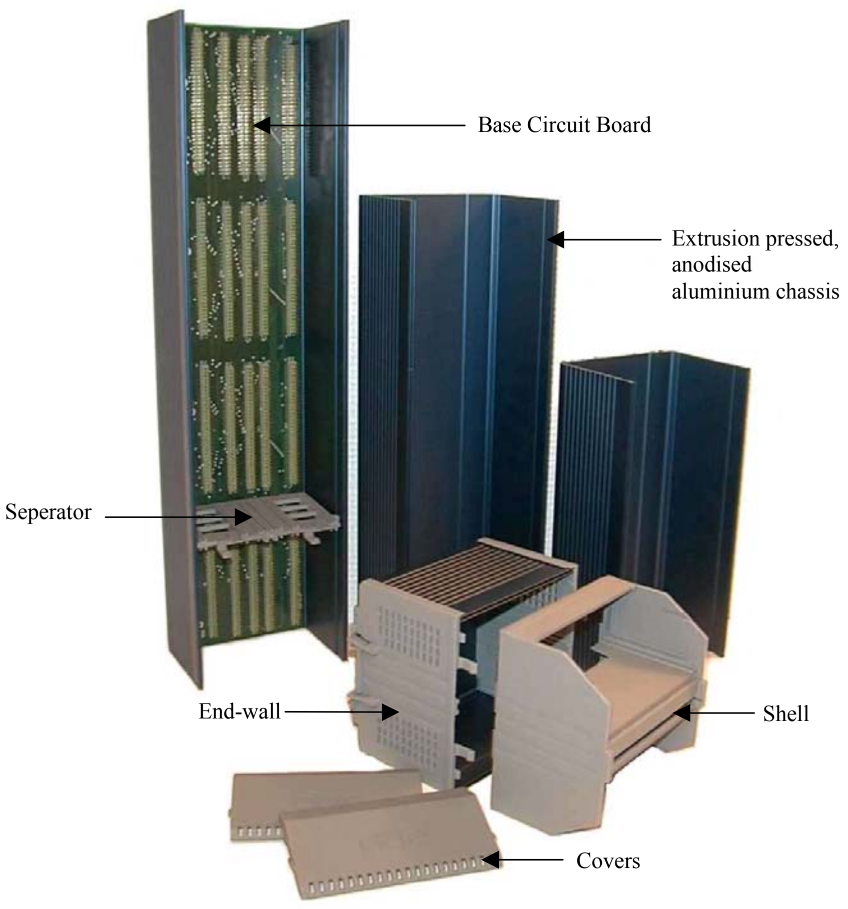
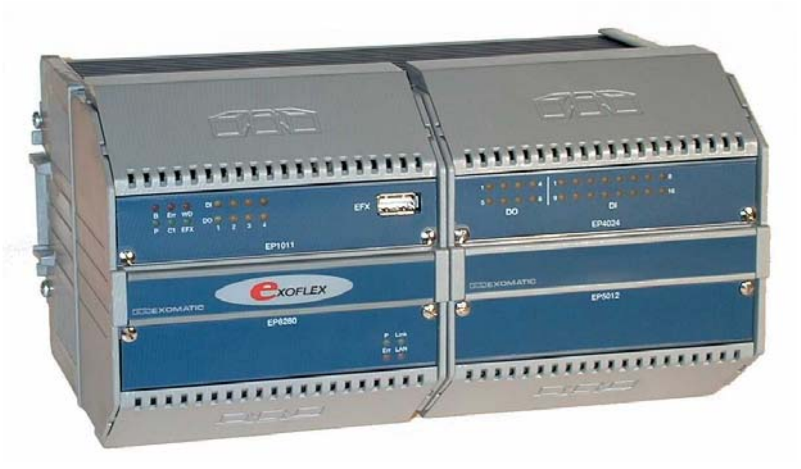


Figure 3. The basic components of an EXOflex house.



The basic system encompasses four different sizes of casing, with the section- widths 1, 2, 3 or 4. These are constructed from the components described above, all of which are also available as spare parts.

Figure 4. A complete EXOflex unit.



The EXOL Processor

The EXOL processor is located on two separate cards.

- CPU-card with a C515C micro-controller
- EFX-card with C515C micro-controller

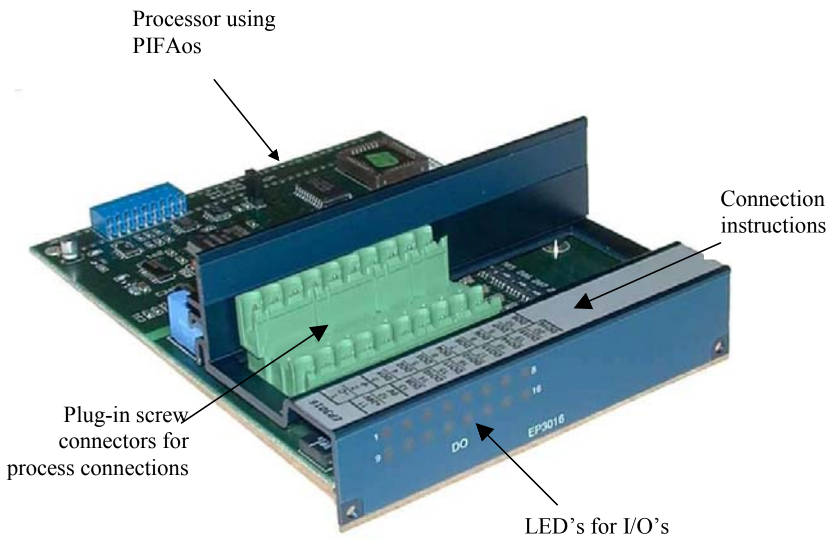
These two cards, known as ECX1, are **jointly** responsible for the processor function and will **together** be known as the **Processor** in the rest of this text.

It is also possible, at a later point, to connect the processor function in an expansion unit. See Chapter 25 ***Installing Processors and Option Cards***.

EXOflex PIFA-units

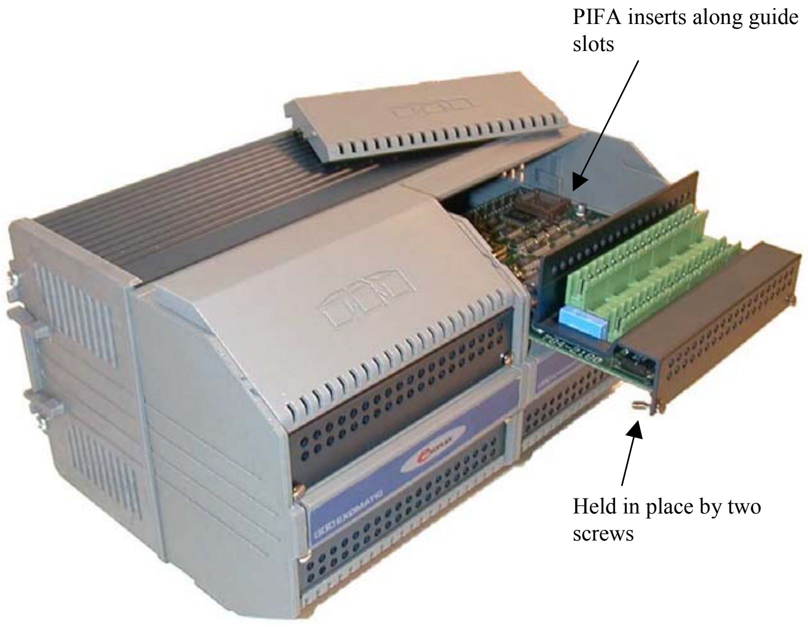
The true power of the EXOflex system lies in the range of PIFA-units available. All the cards are of a standard design and size and can be quickly and simply installed by slotting them into place.

Figure 5. An EXOflex PIFA-unit.



Mounting a PIFA-unit

Figure 6. The PIFA-unit slides easily into place and is held in place by two screws.

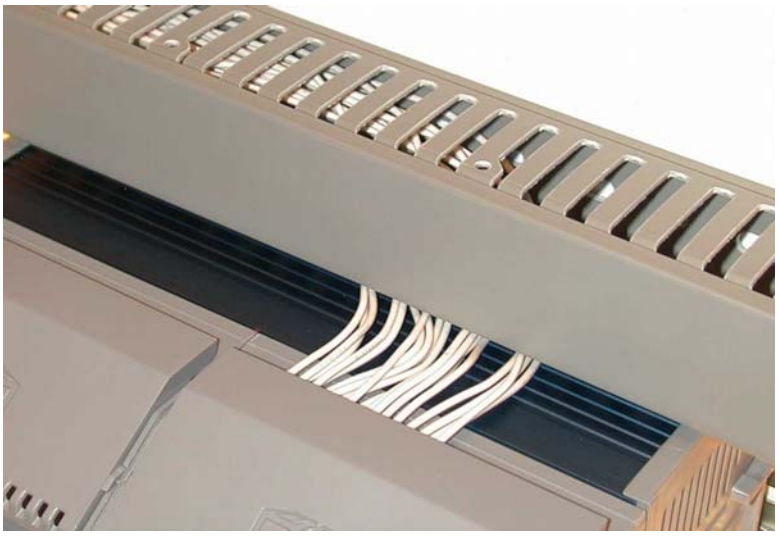


When a new PIFA-unit is mounted in an EPU, the signal description should also be fitted, as described below. The PIFA-unit must also be programmatically installed, according to the procedures in Part III .

Compact Mounting

Process connections are made on the PIFA-unit’s connector blocks. Most of the wiring is neatly hidden under the cover.

Figure 7. The unit can be mounted adjacent to a cable duct.



Signal Descriptions

Cardholders

Each section of an EPU is fitted with a plastic cardholder for special cards showing signal descriptions. The cardholder is an integral part of the handle located at the center of each section. This is pulled out to show the descriptions. See the illustrations below.

The innermost part of the cardholder is a hinge. The cardholder must be pulled out all the way before it is raised or lowered.

Figure 8. The inlay card in the lower position shows the signal descriptions for the PIFA-unit in the upper position.

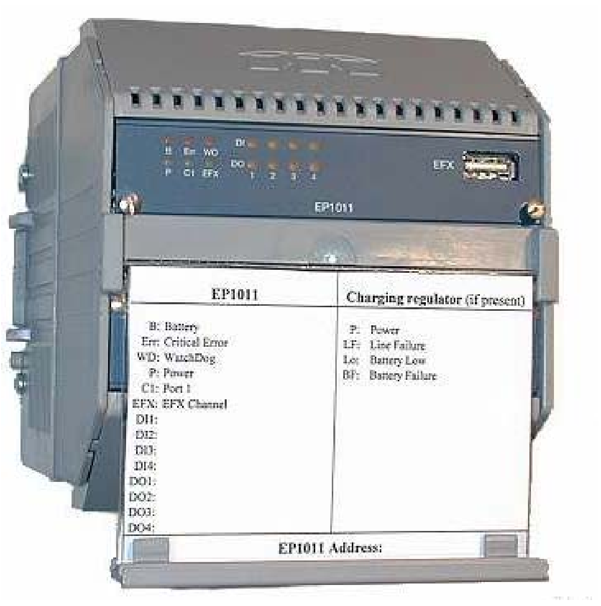
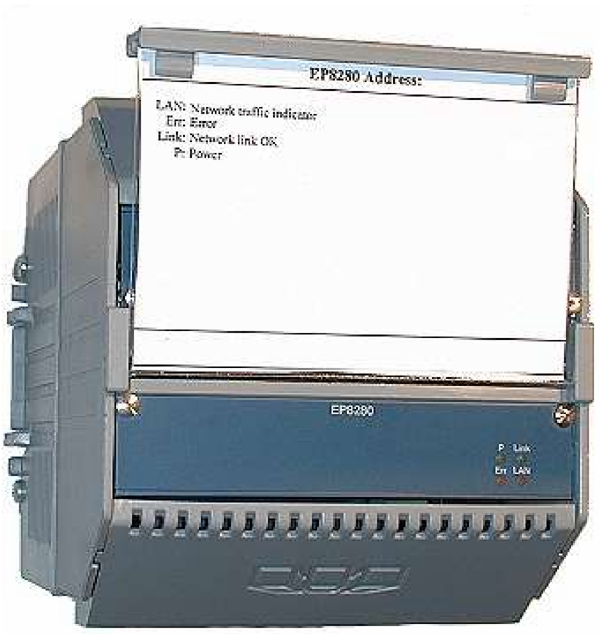


Figure 9. The inlay card in the upper position shows the signal descriptions for the PIFA-unit in the lower position.

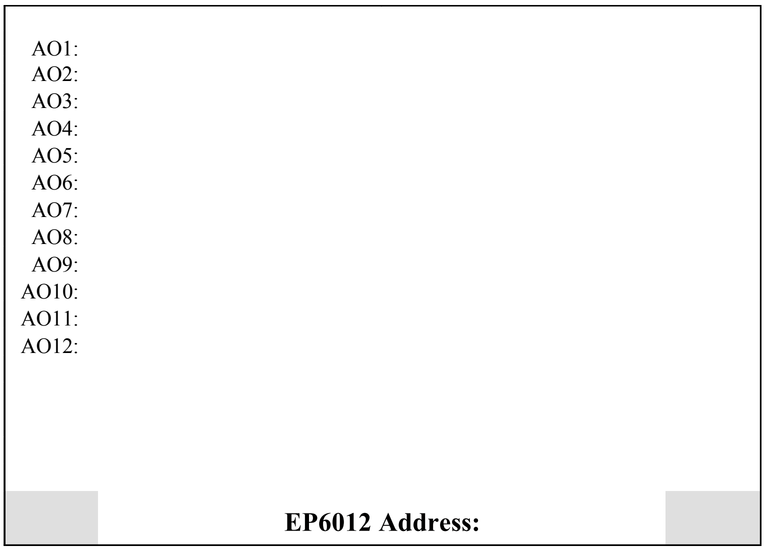


There are also description cards for vertically mounted units. See Figure 15.

Inlay Cards for PIFA-units

All PIFA-units are supplied with templates intended for signal descriptions for the inlays. The templates are supplied in MS-Word 97 format and can be edited. The files are supplied as read-only and must be saved under a new name each time they are used. The following examples are for model EP6012, which has 4 different inlays. Other PIFA-units may have fewer inlay cards if they have limitations on their mounting.

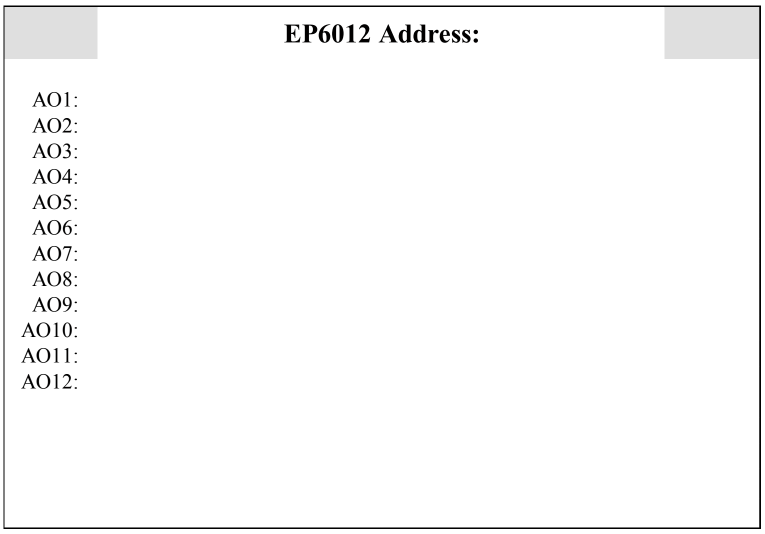
Example 1 – PIFA-unit mounted horizontally **above** the cardholder.
The cardholder is then pulled out and shown below the PIFA-unit.


AO1:
AO2:
AO3:
AO4:
AO5:
AO6:
AO7:
AO8:
AO9:
AO10:
AO11:
AO12:

EP6012 Address:

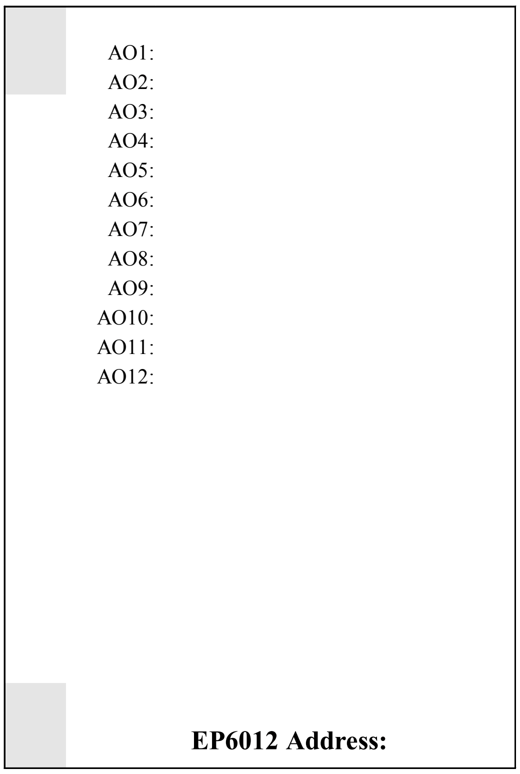
.

Example 2 – PIFA-unit mounted horizontally **below** the cardholder.

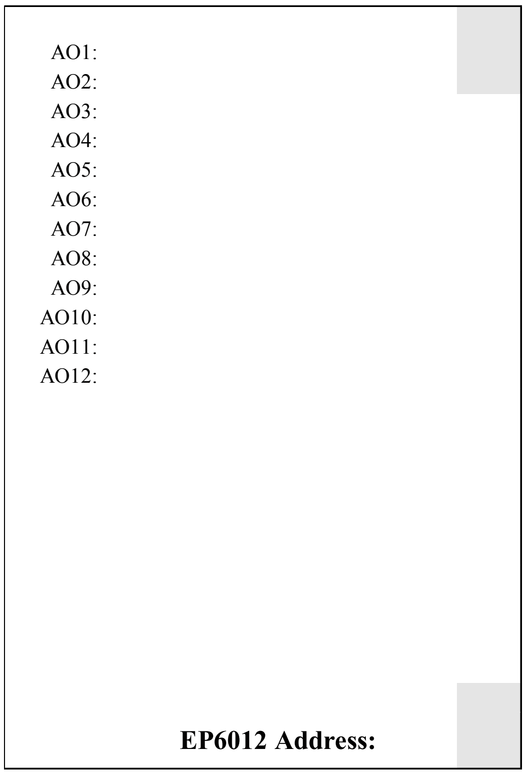

EP6012 Address:

AO1:
AO2:
AO3:
AO4:
AO5:
AO6:
AO7:
AO8:
AO9:
AO10:
AO11:
AO12:

Example 3 – PIFA-unit mounted vertically to the **right** of the cardholder.



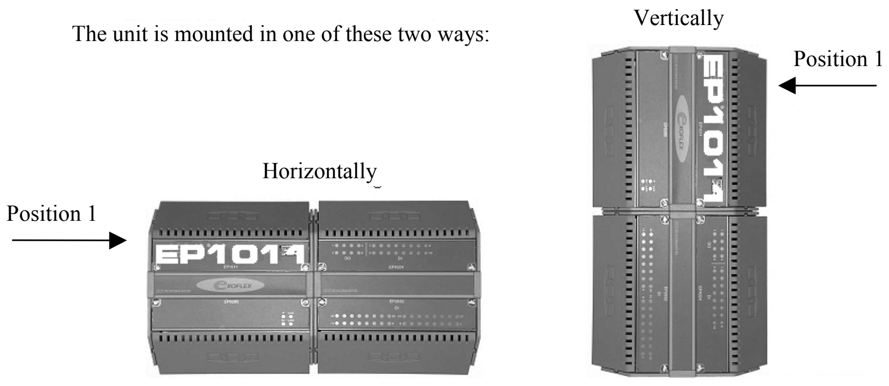
Example 4 – PIFA-unit mounted vertically to the **left** of the cardholder.



Mounting

EXOflex-units can be mounted horizontally or vertically. If mounted vertically, the use of fasteners is recommended.

Figure 10. Mounting the EXOflex house.



Note that **one** power-PIFA must always be present in each house and is always mounted in position 1. In the event of damage as a result of the power-PIFA being incorrectly mounted, your guarantee will not be valid.

Horizontal Rail-mounting

When mounted horizontally, the unit will hang on the integrated track in the aluminum chassis.

Figure 11. The EXOflex unit snaps quickly onto a TS 35 DIN-rail.

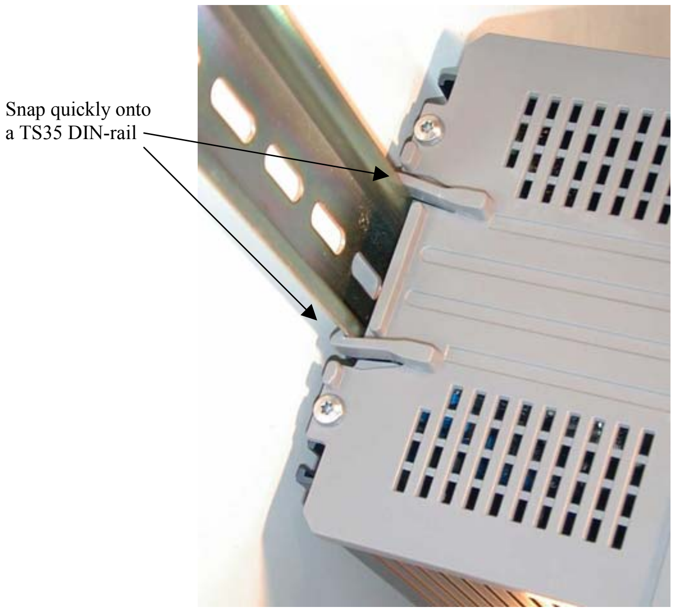
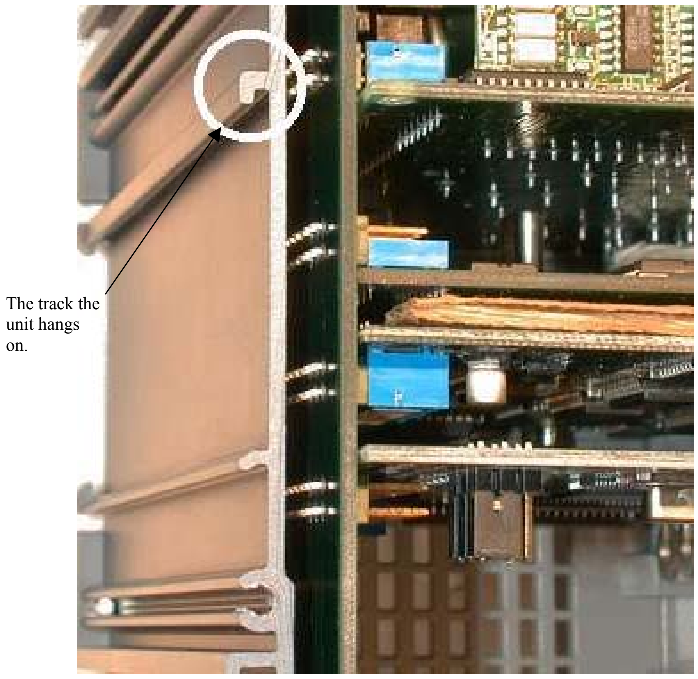
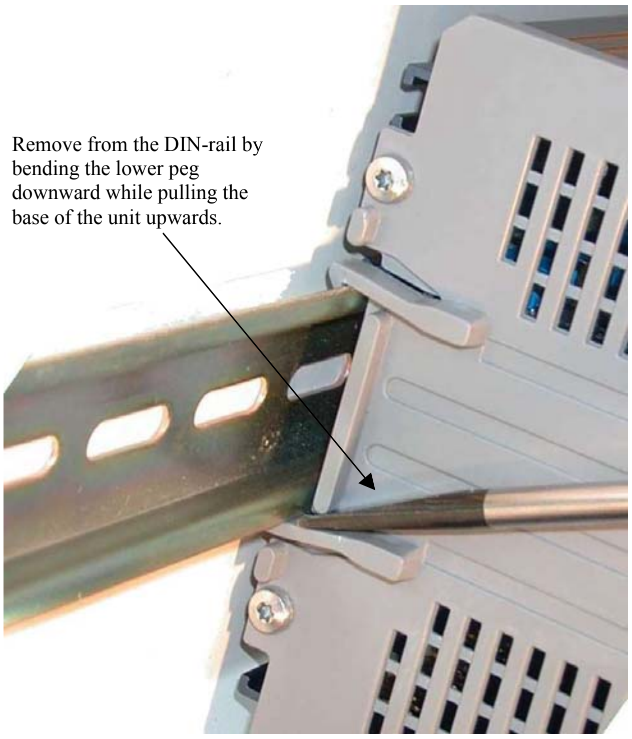


Figure 12. The track at the rear the unit hangs on.



Use an end-stop on the DIN-rail so that the unit cannot move sideways.

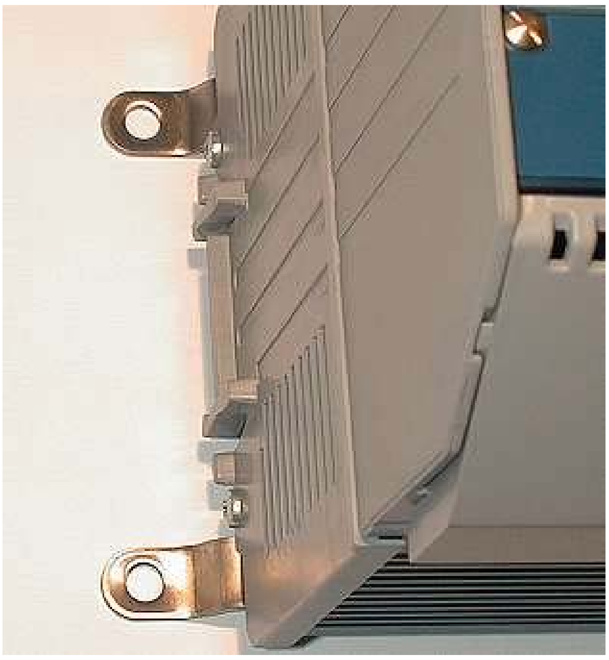
Figure 13. Removing the unit.


Remove from the DIN-rail by bending the lower peg downward while pulling the base of the unit upwards.

Wall Mounting

The unit is mounted on a wall using fasteners. These slide into the runners at the rear of the aluminum chassis.

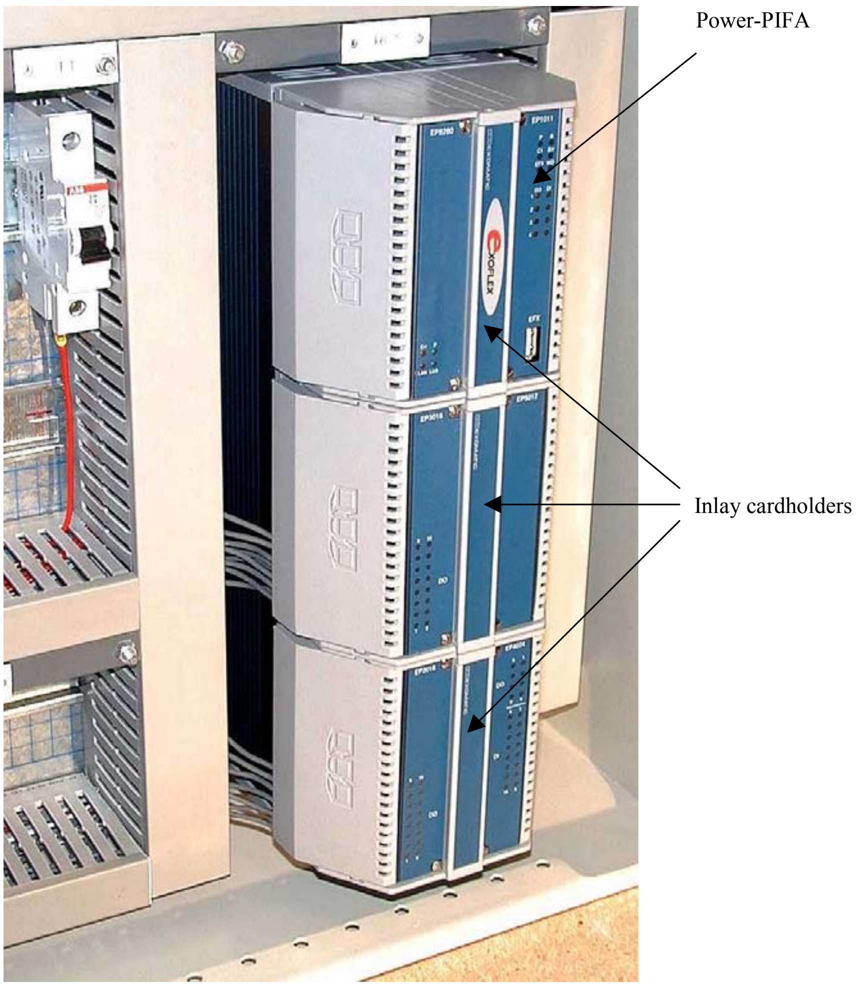
Figure 14. Wall mounting with fasteners.



Vertical Mounting

When mounted vertically, the unit is rotated 90^o clockwise, so that it stands on end, as in Figure 15. In this way, the power-PIFA will be located in the upper right position.

Figure 15. Vertical mounting of the EPU.



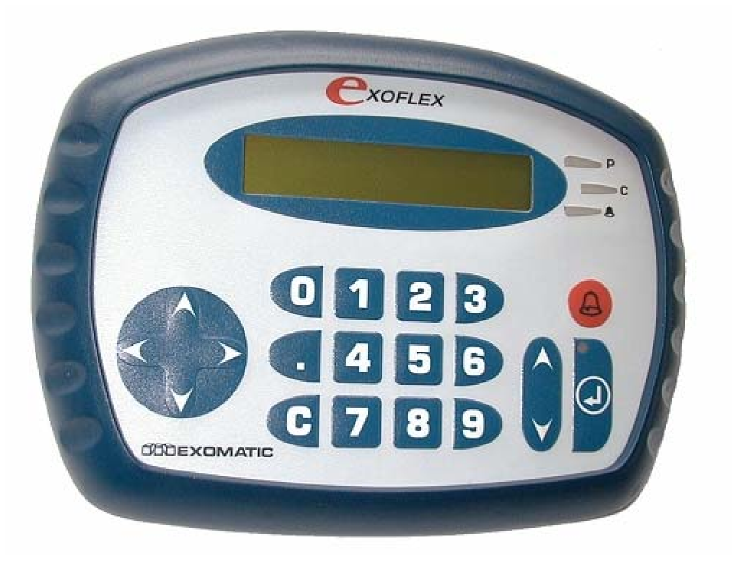
In vertical mounting, the power PIFA is always located in the upper right position.

External Display

The EXOflex range includes a freestanding external display. See the figure below.

The external display is used for local display of alarms, changes to set-point values, etc. It is an independent PIFA that connects to a processor house via the EFX channel. See also Part III for software handling and Part IV for specifications.

Figure 16. The external display ED9200.



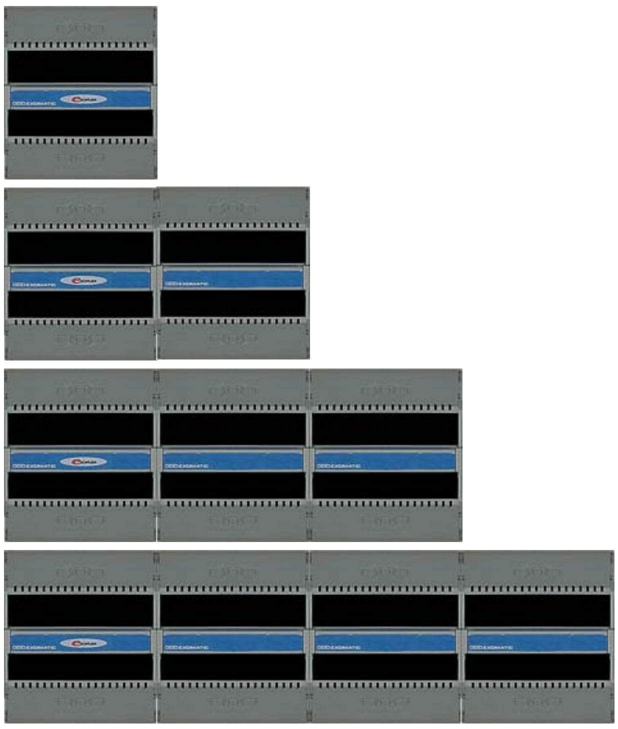
Summary

EXOflex-installations are made up of one or more of the following components:

- ❑ Processor unit – unit/house **with** processor, section width 1, 2, 3 or 4.
- ❑ Expansion unit – unit/house **without** processor, section width 1, 2, 3 or 4.

Processor units and expansion units are available in four different section widths. These and the wide range of PIFA-units makes it possible to adapt the number and type of I/Os as desired – for very small installations or for ones with thousands of I/Os.

Figure 17. Four section widths.



- ❑ PIFA-units – power, I/O, communication, fieldbus adapters, external display, etc.
- ❑ Extra processor cards – can be fitted in all sections.

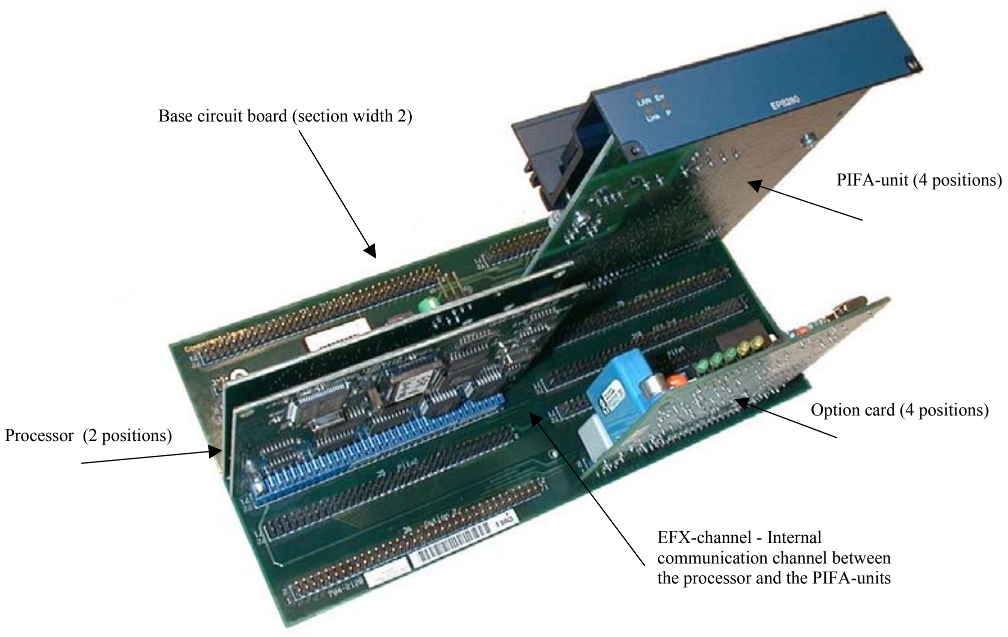
The complete range of EXOflex-components and auxiliary equipment can be found in the latest price list from Regin.

Chapter 3 **EPU Internal System Design**

An EXOflex base circuit board contains contacts for the processor, PIFA-units and option cards. Each section has space for one processor, two PIFA-units and two option cards. The baseboard links all of the internal electronics together.

The various option cards always have their physical inputs and outputs on PIFA-units.

Figure 18. An example of a Processor Unit with section width 2.

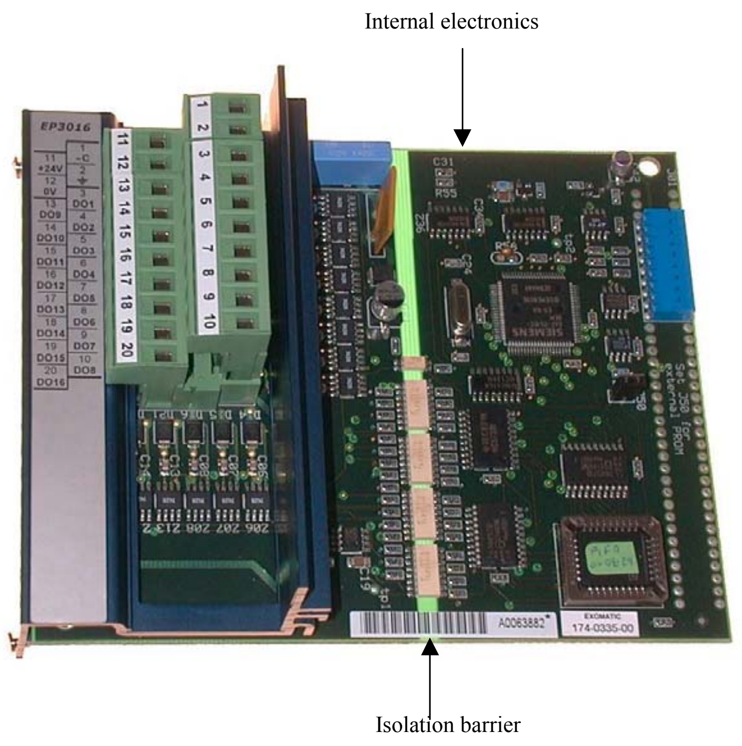

Base circuit board (section width 2)
PIFA-unit (4 positions)
Option card (4 positions)
Processor (2 positions)
EFX-channel - Internal communication channel between the processor and the PIFA-units

Isolation Barrier

The parts of the PIFA-units close to the process are separated from the internal electronics by an isolation barrier, which is bridged by the use of an optocoupler. This provides for optimum handling of difficult electrical environments.

This also means that the parts of the PIFA-units close to the process must get their power from an external source, which could well be the same as the source supplying the whole EXOflex-unit.

Figure 19. The isolation barrier.

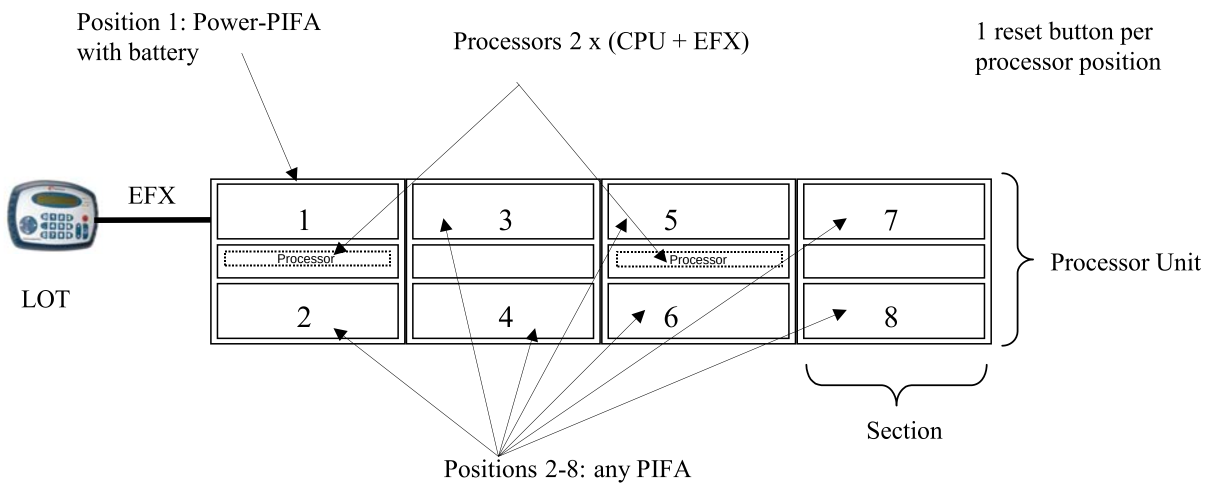


Addressing PIFA-units

The processor in the position furthest to the left in Figure 20 (the main processor) normally communicates with all of the houses' PIFA-units. In certain cases however, you will want to use one or more extra processors, and in this case, these slave processors will take over the PIFA-units in their own sections and in the following ones. In the example below, the main processor addresses the PIFA-units in positions 2,3 and 4. The slave processor in section 3 addresses the PIFA-units in positions 5,6,7 and 8. Communication from processor to PIFA-unit is via the EFX-channel, which runs along the baseboard. In the example, the EFX-channel is divided into two separate channels, one for each processor.

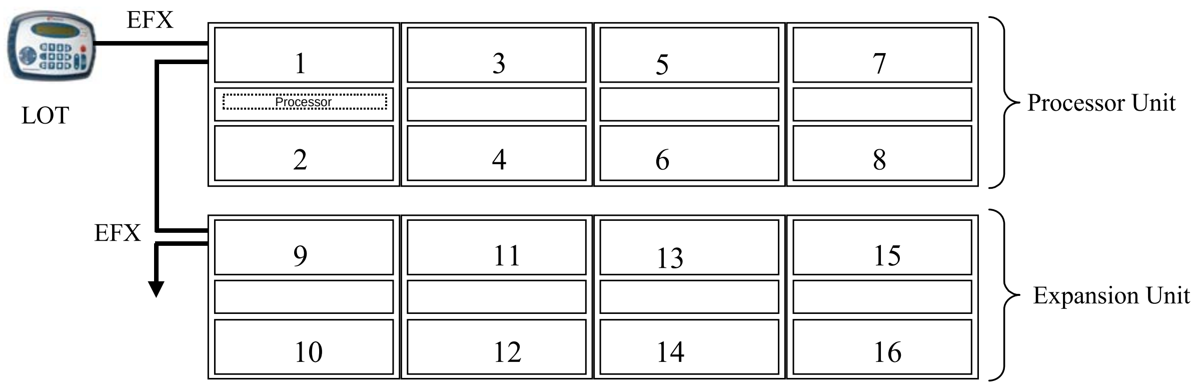
An external display is always addressed from the main processor and via its EFX-channel.

Figure 20. A schematic view of the internal design of a 4-section Processor Unit.


Position 1: Power-PIFA with battery
Processors 2 x (CPU + EFX)
1 reset button per processor position
EFX
LOT
1
3
5
7
Processor
Processor
2
4
6
8
Processor Unit
Section
Positions 2-8: any PIFA

PIFA-units in expansion houses are also handled via the main processor's EFX channel. To give all the PIFA-units in expansion houses a unique identity, a base address must be set for the expansion unit. This setting is made with the address jumper switches on the power-PIFA in the expansion house.

Figure 21. An example of a multi-unit installation.



A maximum of 32 PIFA's can be addressed

Distributed Processor Power

The Processor Card

The processor card uses a double-processor set-up, with two 8-bit 8051 compatible processors. The first of these handles processor Tasks (the EXOreal-processor) and the other handles the PIFA-units via the EFX-channel.

The PIFA-unit

Each PIFA-unit in turn contains an 8-bit processor, connected to the EFX-channel. This handles the I/Os, filtering, scaling, frequency generation etc, all depending on which PIFA is being used.

The Built-In Battery

All units have an in-built battery for data memory. The battery on the power-PIFA must be changed regularly. The recommended replacement period is five years.

The old battery can be replaced with no loss of memory, but the procedure should not take longer than 30 minutes. See Chapter 22 ***Changing the Battery***.

Serial Ports

An EXOflex processor can have a maximum of 3 serial ports, just as all other EXO controllers. The ports are called Port 1, Port 2 and Port 3, or P1, P2 and P3 for short. Serial ports are **not** handled by independent PIFA's via EFX (as for e.g. digital inputs), but by EXOreal directly.

There are also other types of communication ports that are handled by independent PIFA-units, e.g. the EXOlon PIFA and the TCP/IP PIFA-units that are used as gateway in Lon and TCP/IP networks.

To use Ports 1-3, special connection-PIFA's must be used.

This means that the 3 ports have the same properties, possibilities and limitations as other models. All of the software-based configuration, interfaces etc, is identical to that in other models.

Ports 1-3 can be used for RS232 or RS485 (EXOline) and are galvanically separated from each other and from the internal electronics. Selection of RS232 or RS485 interface is hardware-based. In some applications with long communication distances, there is a further option available for the RS485 interface, i.e. to transmit at higher power, so-called hlEXOline.

When using RS232 on Port 1, this is always limited to the signals RxD, TxD and RTS, whilst on Port 2 you will have RxD, TxD, RTS, CTS, and on Port 3, a complete set of signals for RS232, i.e. RxD, TxD, RTS, CTS, DTR, DSR, RI and DCD. EXOreal's support for dial-up modems for **EXOline**-communication is thus limited to Port 3.

To use the serial ports, you must use the PIFA's port-connections. These are **not** configured in EXOflex Tool, but are simply installed physically in the intended positions.

Examples of PIFA units with port connections are the power-PIFA EP1011 and the double port PIFA EP8102.

The power PIFA must be used on position 1 (in the processor house) The double port PIFA can be used in other positions. Port connections cannot be used in expansion houses at all.

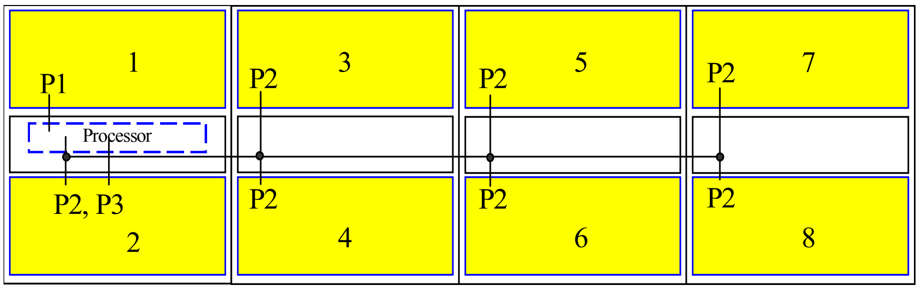
This means that Port 1 (from the main processor) can be obtained via the power-PIFA and, as mentioned earlier, in the form of an RS232 interface and an RS485 interface.

The double port PIFA contains, as the name implies, two port connections (P2 and P3), and it can be used in all other positions in the processor house. The port connections go to different serial ports, depending on the position in the processor house. Furthermore, there is space for an *option card*, which can be connected to P2 or P3 on the PIFA.

If the double port PIFA is used in position 2 in the processor house, port 2 and 3 (from the main processor) are obtained via the PIFA. If the double port PIFA is used in another position, you will only get P2 (from the main processor).

See below:

Figure 22. Schematic showing the principles for a processor house.



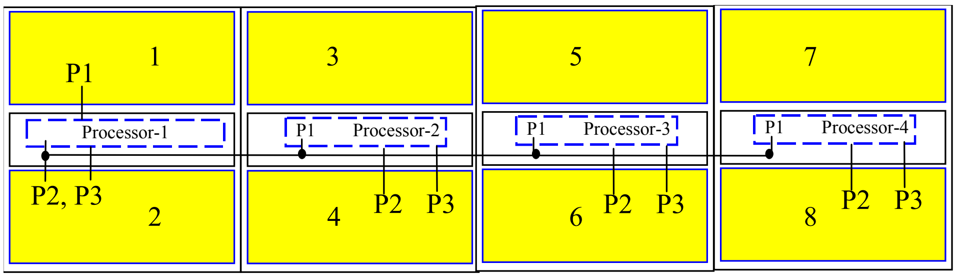
When using more than one double port PIFA in a processor house, P2 (from the main processor) will be available in all positions, but not at the same time. One position at a time can be selected with the system variable **`Control_Port_2`**.

When using an option card, software is used to connect a port to the card.

Multi-Processor House

In houses with several processors (controllers), the main processor's port 2 is connected to the other processors' port 1. The connection is entirely internal. See below:

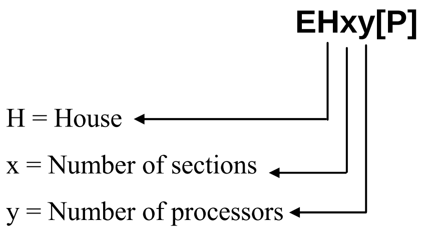
Figure 23. Schematic showing the principles for a multi-processor house.



Support for multi-processor houses requires a base circuit board with revision 784-21x1or higher, which was included in deliveries starting in August 2000. The revision can be found in position 2, down and to the left.

Chapter 4 Naming System for EXOflex Components

Houses (process houses/expansion houses)

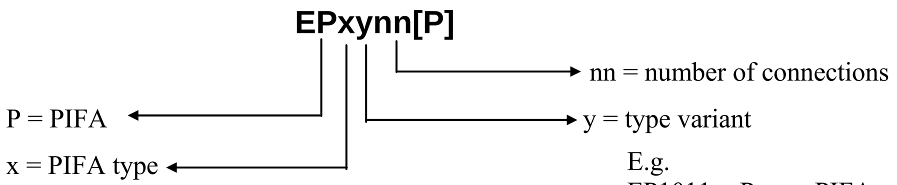


Examples:

EH10 – one section, no processor

EH41 – four sections, one processor

PIFA-units



x = PIFA type

1 = Power
2 = DI
3 = DO
4 = Mixed DI/DO
5 = AI
6 = AO
7 = Mixed I/O
8 = Special
9 = External Display

y = type variant

E.g.
EP1011 = Power PIFA
EP2032 = 32 DI
EP6012 = 12 AI
EP8102 = Dual Basic Serial
EP9040 = LOT

Part II Installation and Commissioning

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Part II **Installation and Commissioning**

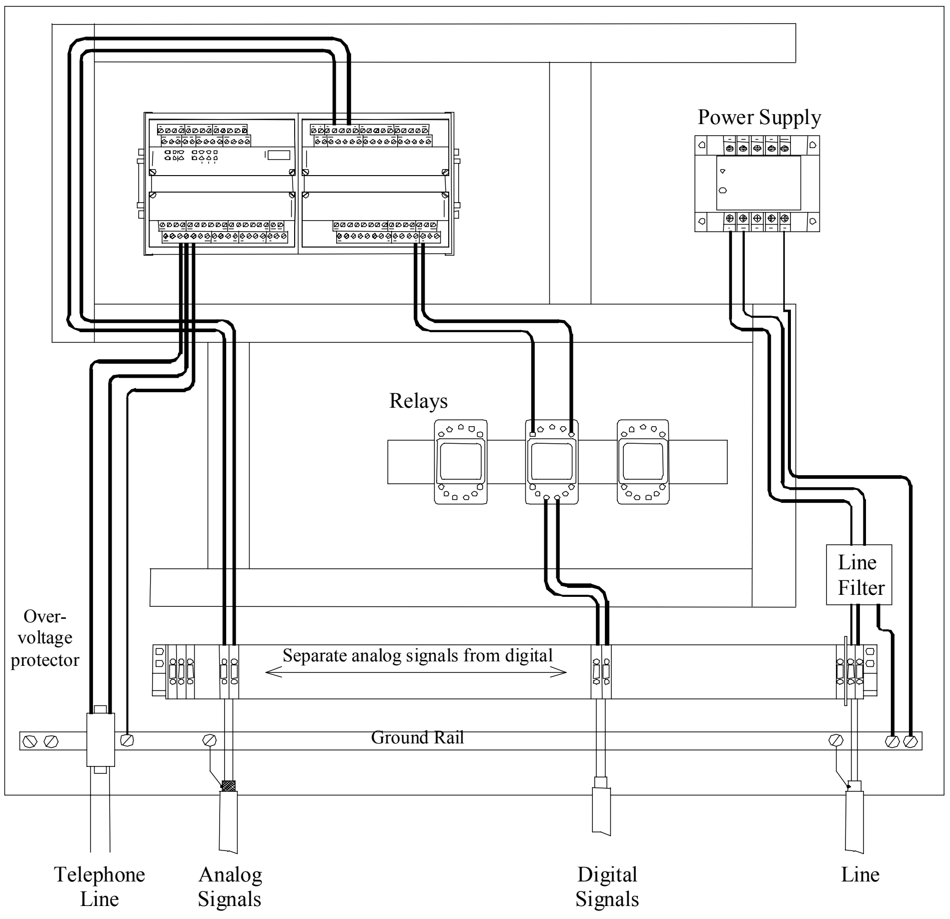
Chapter 5 **Cabinet Installations**

A correct cabinet installation entails, amongst other things, not mixing cables for sensitive analog measurements with disruptive power cables. It is therefore very important that the cabinet area is used properly. As you can choose which position in the EXOflex-unit to mount a particular PIFA-unit, you can then e.g. put analog PIFA-units on the one side and digital PIFA-units on the other. This will result in a natural separation of sensitive and disruptive cables.

The following section provides further tips for creating an installation that complies with EMC requirements.

Cabinet Layout

Figure 24. A typical cabinet layout.



A Few Rules

- ❑ Use a heavy ground rail close to where external cables enter the cabinet. The rail should be connected to local ground with a heavy wire.
- ❑ If using a steel cabinet, it and its door should be connected to the ground rail for safety.

- ❑ The output contacts of power relays should be connected to wires that are separated from other wiring as much as possible.
- ❑ Contactors switching heavy loads can be prevented from causing interference in other parts of an installation by using a transient protection device on the contactor output. This RC network is sometimes an integrated part of the contactor.
- ❑ If a power-supply filter is used, it should be mounted close to the rail and grounded at the rail.
- ❑ If lightning protection is used on the communications line, it should be mounted directly on the rail.
- ❑ Use separate ground wires for each ground connector on each controller and each power supply. Always connect grounds to the rail.
- ❑ Conductors connecting modems to controllers are more sensitive than other connections. These should be kept together and not be mixed with other cables unless absolutely necessary.
- ❑ If shielded wires are used outside the cabinet, the shield should be properly connected to the ground rail.
- ❑ If shielded cables are used inside the cabinet, the shield should be connected to the rail. Internal shielding is an excellent way of improving interference protection from external cables that are being exposed to heavy disturbances.
- ❑ Do not install frequency converters in the same cabinet as regulation equipment. It is our experience that frequency converters, even CE-marked ones, generate extremely heavy interference, often far beyond the allowed limits.

Controllers are often mounted in cabinets containing relays, actuators, transformers and other equipment. This should normally not be of any concern. However, actuators handling heavy currents (>10A) must always be mounted in separate cabinets.

Chapter 6 Power Supply

The EXOflex system with its separate PIFA-units can be viewed as galvanically isolated "processing islands", where each island normally requires an external power supply. This design provides a number of possibilities and advantages:

- ❑ Each PIFA-unit (processing island) can be powered by separate, isolated power units. This means the galvanic insulation from other processes can be retained, if this is desired.
- ❑ Very accurate analog measurements can be made.
- ❑ Battery backup of selected processes.
- ❑ Separately fused processes, and thus better error handling.

When the advantages above are not required, some, or all, of the PIFA-units can be powered by the same source, which may also be used for active two-wire sensors and output relays, etc. Note that the maximum load of the supply must not be exceeded.

Note also that long cables will introduce a voltage drop that may impair correct operation of the units. A 1.5mm^2 conductor typically has a resistance of 11 Ω/1000 m. If carrying 1 A, the drop will be 2.2 V per 100 meters of cable (two conductors). It is therefore recommended that a separate power supply be used at each location where units are mounted.

To avoid high, ground relative voltages, it is recommended that the power supply is grounded. The best point is at the negative pole of the power supply.

24V DC Units

Although a stabilized power supply is **highly recommended,** you may use a rectified AC supply with a filter capacitor, with a value depending on the load and permissible tolerance on the input voltage.

Note that external power supplies generating 24V DC for EXO controllers must be CE marked as SELV, safety extra low voltage, or PELV, protected extra low voltage, power supplies.

Observe that the peak and lowest momentary value of the filtered supply voltage *must be within the supply tolerance specified for the model.* If you are using a rectified AC supply, momentary values cannot normally be measured with a standard voltmeter, but instead require an oscilloscope.

Power PIFA-units

- ❑ **Connection to power supply**

  All power PIFA-units have a galvanically insulated DC/DC converter that generates the internal supply for the logic circuits and, in some cases, galvanically insulated voltages for external equipment (see Part IV ***Specifications***). The 0 V circuit is the terminal marked **0 V** and the positive **+24 V**.

The 0 V circuit should be grounded at the power supply, to define the potential with reference to ground and to compensate for disturbances and transients from I/O signals.

- **The Protective Ground Circuit, EMI ground**

  This terminal is located close to the power terminals and labeled ⏚. It is connected internally to the PIFA frame and to internal protective circuits. It should be connected with a separate, heavy wire to the ground rail.

Other PIFA-units

- **Connection to power supply**

  All processing PIFA units must be connected to an external power supply, which may be the same supply as for the Power PIFA. The 0 V-circuit is the terminal marked **0 V**, and the positive+**24 V**.

The 0 V-connection is normally grounded at the supply source, so as to define the potential to earth reference and to compensate for disturbances and transients from I/O signals.

- **The Protective Ground Circuit, EMI ground**

  This terminal is located close to the current terminals and is marked ⏚ . It is connected internally to the PIFA's frame and to internal protective circuits. It should be tied with a separate, heavy wire to the ground rail.

- **The RS232 connections (Port 1, 2 or 3)**

  These connections are galvanically isolated from the internal circuits. The signal zero is marked **Gnd**. Use screened cable and earth it at one point.

- **The EXOline-connection (Port 1, 2 or 3)**

  Galvanically insulated from all other circuits. The 0V reference is labeled **N** and should be tied to the screen of the communication cable, which in turn should be grounded at least one point.

- **Digital input and output connections.**

  Inputs should be referenced to **+C** (+24 V) and outputs to **–C** (0 V)

- **Analog input connections**

  Voltage and resistance measuring (PT100 etc.) is relative to **Agnd**.

  Screened cables must be used and the screens connected to the **SCR**–connector next to the input connection. Alternatively, the screen can be connected to the ground rail according to Figure 24 on page 31. In most cases, this alternative connection will give a measurement result that is accurate enough. However, in harsh electrical environments we recommend that the screen is connected to **SCR.** Power supply for transmitters etc. is from the fused **+C** output on the AI PIFA-unit.

- **Analog output connections**

  Analog output voltages are referenced relative to **Agnd**.

  Certain PIFA-units have a connection for screened cables for analog outputs. The connection is **SCR**.

Check the Power Requirements

The PIFA-unit’s internal circuits and option cards get their power supply from the power-PIFA. This internal voltage is mostly 5 V, but other voltages can also apply, e.g. ±12 V.

So as to not exceed the maximum power output from the power-PIFA, you must ensure that the total internal power requirements of all the individual PIFA-units and options do not exceed the power-PIFA’s maximum current supply on the internal voltages.

More information can be found under the information for each PIFA in Part IV

Maximum Limits

Care must be taken during installation and commissioning that inputs, outputs, ports and supply terminals are not subject to excessive voltages due to incorrect external connections.

A safe routine during installation is to connect the plug-in contacts to the PIFA-units only when all external cables have been connected and tested.

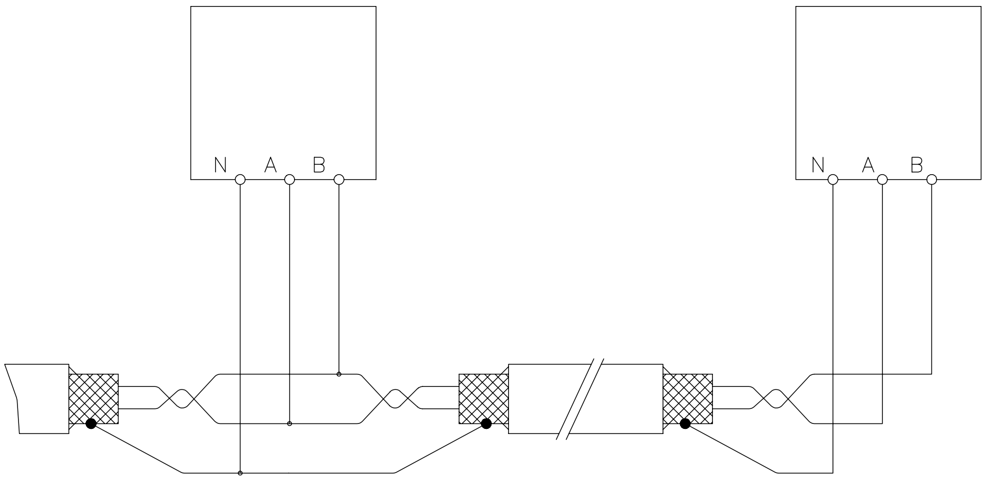
Chapter 7 **Communication Buses & Interfaces**

EXOline

EXOline is the standard means for communication via fixed cables.

The EPUs are connected in parallel on the line, as shown in Figure 25.

Figure 25. EXOline - Parallel Connected EPUs.



Screened and twisted cables should be used. The area should be 0,25 mm^2 or more, as dictated by mechanical considerations, and the capacitance should be less than 100 pF/m. The line should normally be terminated at both ends (last controller at each end) with a resistor value of 100 Ω/0.5 W

The line may be branched into several lines in a tree structure. If one of the branches should exceed 200m, it is recommended that the line be terminated with an *n*x100 Ω resistor at the last controller in each branch (*n* = No of branches). Up to 50 controllers may be connected on the same line without amplification. The screen should normally be grounded at least at one point, normally the **N** terminal on the master unit.

The E-signal

EXOline carries messages in both directions on the same pair of conductors. A special signal is used to control the communication direction when converting to RS232 and EXOloop. This signal is called the **E-**signal.

hlEXOline

hlEXOline is an enhanced EXOline port capable of supplying more power to the line and handling line receivers with higher sensitivity than the standard EXOline port. Extended communication distances may thus be achieved by using hlEXOline. The cable area should be 0.5 mm^2 or more, as dictated by mechanical considerations and with terminations as for EXOline**,** but the resistor should be able to dissipate 2 Watts (100Ω/2W), due to higher line power**.**

hlEXOline is obtained by moving a jumper switch on the power-PIFA (Port 1) or on the communication-PIFA (Port 2–3). See the descriptions for each PIFA-unit in Part IV ***Specifications***.

Note that hlEXOline and EXOline must not be mixed on the same communication loop.

SIOX Bus

The **SIOX** bus is a two wire asynchronous bus with a level of 24 V DC. The wire should normally be a twisted pair and the recommended cable area is 1.5 mm^2. The bus should not normally be terminated.

See also documentation from **Telefrang AB** for more information regarding the properties of the **SIOX** bus.

M-Bus

The M-Bus, or Meter Bus, is a two wire asynchronous bus and 42 V DC power supply for connected meters. The wire should normally be a twisted pair and the recommended cable area is 1.5 mm^2. The cable should not be longer than 3 km for 2400 bps communication speed. The bus should not normally be terminated.

The RS232 Interface

RS232 is used for communication between two devices, port to port, on normally fixed cables.

A screened cable must be used. The area should be 0.25 mm^2 or more, as dictated by mechanical considerations, and the length should not exceed 15 meters, unless otherwise specified in the data sheet. The RS232 port on EXOflex-units is normally insulated from the internal circuits, but the RS232 cable should nonetheless be separated from heavy disturbances.

The Ethernet Interface

Ethernet is an interface used for constructing computer networks. Ethernet is not specific for any particular media or communication speed and it is used often for creating local area networks (LANs), radio networks and fiber optic networks using very high speeds.

One of the most common standards for Ethernet in a LAN is IEEE 802.3, which is Ethernet with a transfer speed of 10 Mbits. The usual way to connect to a 10Mbit Ethernet network is via 10Base-T, which is the technical term for twisted-pair Ethernet. Other connection methods used for 10 Mbit Ethernet are 10Base-2/BNC (thin-wire Ethernet) and AUI (thick-wire Ethernet).

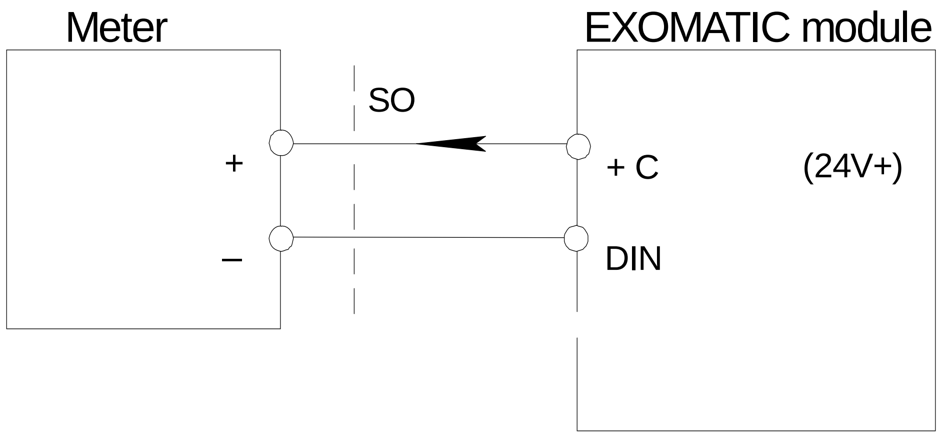
When connecting equipment to a twisted pair Ethernet network, a so-called TP cable is used. The TP cable is an 8-pole twisted pair cable with an impedance of 100 Ohms impedance and RJ45 connectors at both ends. The TP cable is either screened (STP) or unscreened (UTP). EXOflex-units that are connected to Ethernet have a screened RJ45 connector and should therefore be connected by screened TP cable (STP). To avoid disturbances to network traffic, the cable should not be spliced or pass a plinth.

The SO Interface

The SO interface is a commonly used interface for energy meters. Some digital inputs can handle SO signals directly, by selecting SO logic levels via jumpers on the PIFA-unit.

The connection diagram in the figure below shows a meter with SO interface with open collector output and a common + pole.

Figure 26. The SO interface.



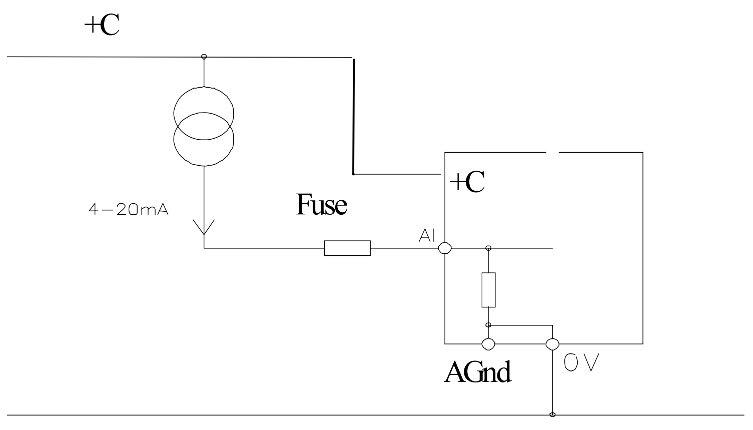
Chapter 8 Connecting Active Transmitters to Inputs

Active transmitters supplying 0–20 mA or 4–20 mA are frequently used for flow, pressure, differential pressure, etc. There are three basic categories available.

The Two-Wire Transmitter

This type is typically powered by 12–24 V DC and varies its current consumption proportionally to the input in the range 4-20 mA. This type is connected with the positive terminal to +C (+24 V), or better still, to 12 V DC if available and is sufficient for the transmitter. The negative pole is connected to the analog input with the current shunt activated. If the transmitter is short circuited, excessive current will be fed into the controller, which will be damaged. To protect the controller, use a fast fuse in the circuit or a separate, current limited supply. Note that **Agnd** must not be connected. Instead the current through the shunt must be re-routed via the PIFA-unit's **0 V**-connection. The fuse can be omitted if the transmitter is supplied by 12 V instead of **+C** (24 V).

Figure 27. Connection of Two-Wire Transmitter.



The Three-Wire Transmitter (PNP-type)

This type feeds current to the load, which should be connected to the signal ground.

Figure 28. Current Source Active Transmitter.

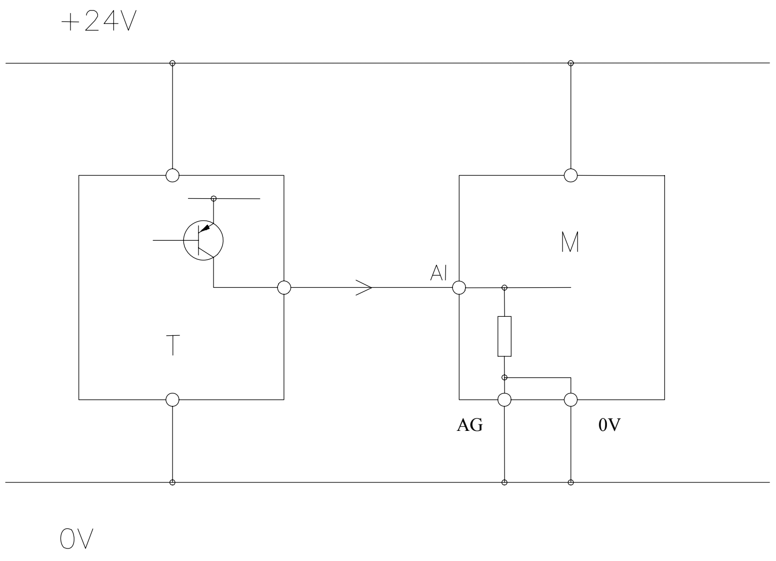
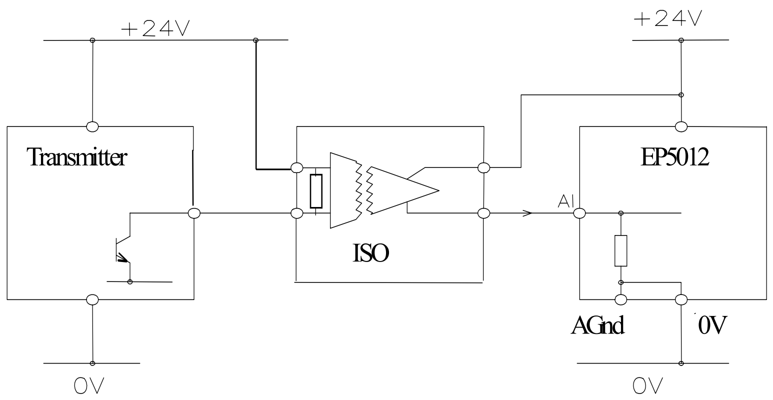


Figure 28 shows a suitable connection. Note that Agnd should not be connected to the PIFA-unit. Instead the current through the shunt goes via the 0V-connection The same connection may be used with an internally powered transmitter, provided the internal power supply is insulated.

The Three-Wire Current Sink Transmitter (NPN-type)

This type requires an insulation amplifier as shown in Figure 29. Note that Agnd should not be connected to the PIFA-unit. Instead the current through the shunt goes via the 0V-connection. Power supplies can be common or separate, as in the figure.

Figure 29. Current Sink Active Transmitter.



Other Considerations

Many transmitter types have internal ground connection via the sensor or power supply. An insulation amplifier is required in most cases.

Chapter 9 **Commissioning**

Setting Addresses

Each PIFA must have a unique address in the interval 0 to 31.

PIFA-units mounted in an EXOflex-house will receive an address depending on their position in the house. The position at the uppermost left has the address 1, the position under that has address 2, the position to the right of position 1 has the address 3 and so on. See the figure below.

1	3	5	7
2	4	6	8

In a processor house, with one or more processors, the PIFA-units will have these addresses as standard upon delivery, i.e. the power-PIFA's address jumpers are set to the base address 0.

In expansion houses, base addresses can be set using a group of jumper switches. The base addresses are selected as follows:

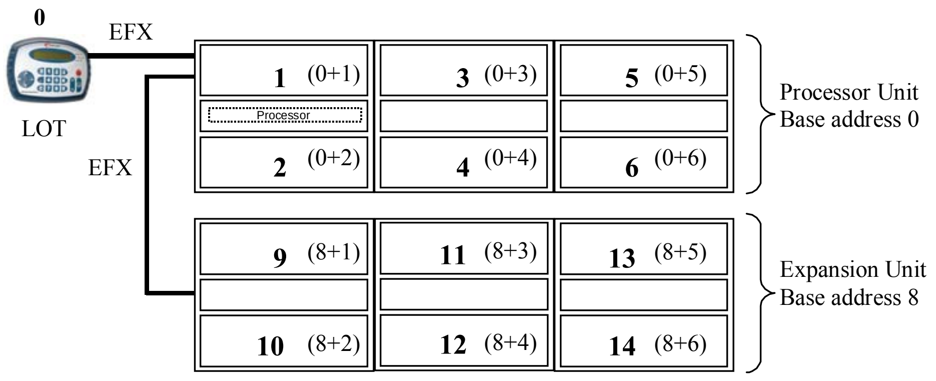
Base address	**Jumpers** **3 2 1**
28	⁚ ⁚ ⁚
24	⁚ ⁚ [⁚]
20	⁚ [⁚] ⁚
16	⁚ [⁚][⁚]
12	[⁚] ⁚ ⁚
8	[⁚] ⁚ [⁚]
4	[⁚][⁚] ⁚
0	[⁚][⁚][⁚] (Standard setting for processor house)

3, 2 and 1 in the table refer to Figure 31.

The PIFA-unit's address is then obtained by adding the base address to the PIFA-position's address. The external display PIFA always has the address 0.

Example

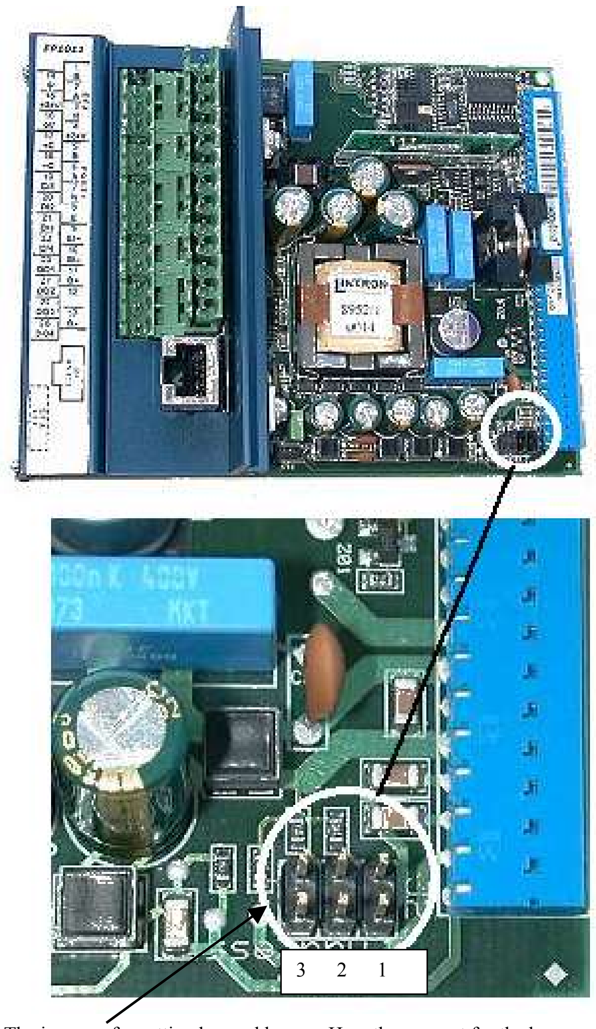
Figure 30. Addressing in a system with one processor unit and one expansion unit.



Add the base address to the position address to get the PIFA-unit's address

To avoid ESD damage to the electronics, you must use a wristband connected to earth for this procedure.

Figure 31. The jumper switches for setting base addresses on the EPU's power PIFA.



The jumpers for setting base addresses. Here they are set for the base address 28, i.e. no jumpers have been set.

Part III **EXOflex Software**

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Part III **EXOflex Software**

Chapter 10 **Overview**

EXOflex' mechanical design, which uses different types of houses, has little meaning when programming. Instead we use the logical concept of *controllers*.

In earlier EXO systems, the term module was used to describe both hardware and software. In the EXOflex system, however, we define a module (controller) as:

A processor (using EXOreal) and its PIFA-units.

A processor house can thus contain one or more controllers and it is also possible to connect one or more expansion houses to the processor house. These together then make up a controller. This definition of a controller is used exclusively in EXOdesigner, EXO4, etc.

Each EXOflex-controller can handle a maximum of 32 PIFA-units. There are two basic types of PIFA-units: EFX-units and non-EFX-units.

EFX PIFA Units

EFX PIFA units communicate with EXOreal in the processor house via the so-called EFX channel. EFX is RS485 based communication, which is only intended for use between PIFA units and EXOreal. The EFX channel runs between all the PIFA units in a house, but can also be run via a cable from one house to another.

This type of PIFA can be placed in any position in processor or expansion houses, with identical functionality.

EFX PIFA units have their own CPU, which uses the operating system PIFAos. The operating system in the PIFAs and EXOreal handle all communication between each other completely automatically and invisibly. The result of this is that the PIFA units' functionality is exposed via ordinary EXOL variables in VPacs.

Non EFX PIFA Units

Non EFX PIFA units **do not** communicate with EXOreal in the processor house via the EFX-channel, but by special connections inside the processor house. This is used by power and communication PIFAs, which **cannot** be used in expansion houses. Furthermore, there are special rules for which positions they may occupy in the processor house.

EXOreal handles non EFX PIFA units directly, as if they were built into the processor, in the same way as in earlier EXO systems. Non EFX PIFA units can have their own CPU, but do not have to.

Configuration

EXOflex-controllers are created and programmed in the usual way, using Project Builder, Controller Functions, EXOL files, etc.

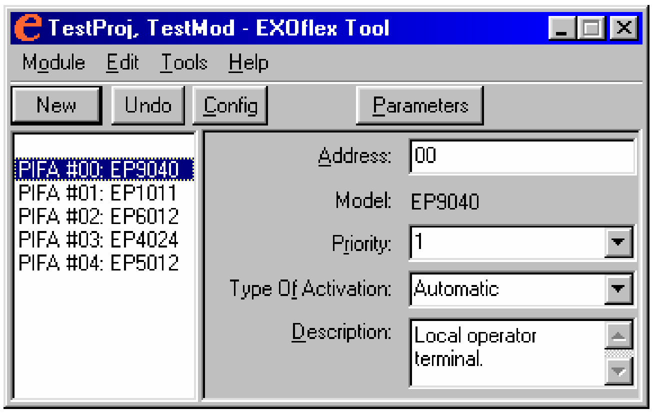
To configure the functions in an EXOflex controller, you use the controller function **EXOflex I/O**, which is added with Controller Functions in the usual way.

Configuration does not take place on-line, but instead in EXOL files on the hard drive (exactly as for all other controller functions). The configuration is loaded to the controller together with the application programs.

The configuration of EXOflex and the PIFA units is the only difference as concerns application programming of the controllers, everything else is the same as usual. All the existing programs in EXOdesigner (and other, third-party programs) can be used as they are.

During configuration you must specify which PIFAs are being used. This is done with EXOflex I/O Tool:

Figure 32. EXOflex Tool.

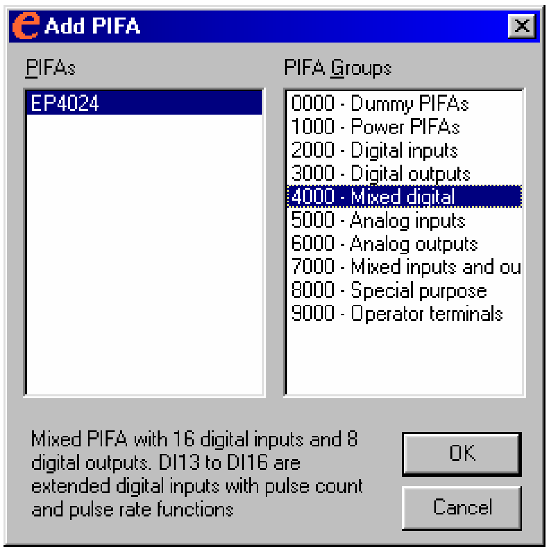


PIFA #00: EP9040
PIFA #01: EP1011
PIFA #02: EP6012
PIFA #03: EP4024
PIFA #04: EP5012

Address: 00
Model: EP9040
Priority: 1
Type Of Activation: Automatic
Description: Local operator terminal.

Add a PIFA by clicking **New** and selecting the model in the dialog **Add PIFA**:

Figure 33. Add a PIFA-unit.



EP4024

0000 - Dummy PIFAs
1000 - Power PIFAs
2000 - Digital inputs
3000 - Digital outputs
4000 - Mixed digital
5000 - Analog inputs
6000 - Analog outputs
7000 - Mixed inputs and ou
8000 - Special purpose
9000 - Operator terminals

Mixed PIFA with 16 digital inputs and 8 digital outputs. DI13 to DI16 are extended digital inputs with pulse count and pulse rate functions

A new PIFA unit is assigned the first available address. This is then changed to the actual address in the attribute **Address**.

Both EFX and non EFX PIFA units must be defined in EXOflex I/O Tool. The individual functions for each PIFA are configured separately in a special tool. Most PIFA units are configured with PIFA I/O Tool.

You can also provide a description for each PIFA. All other configuration is described in Chapter 11 ***EFX PIFA Units.***

Chapter 11 EFX PIFA Units

EFX PIFA units are in many cases advanced, with many possible settings. Configuration is done (in most cases) with PIFA I/O Tool.

Resources

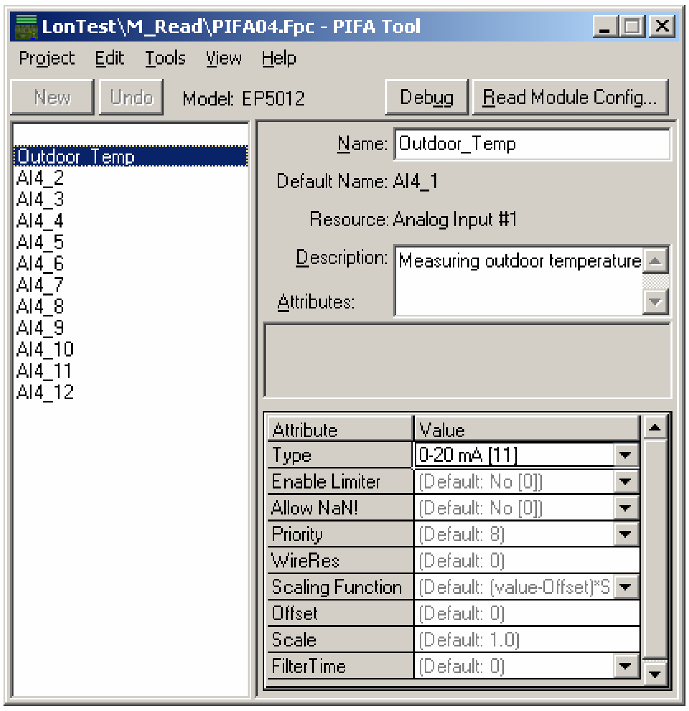
A PIFA often contains a number of separate units, e.g. analog inputs or digital outputs. Each such unit is called a *resource*. Both the hardware and software are organized by resources.

In the case of software, a resource is roughly equivalent to an object. There are a number of standardized software resource types, which are to be found in many different PIFA units in various combinations.

Configuration

Most types of PIFA units are configured with PIFA I/O Tool. There are, however, certain advanced types of PIFA units that have their own tools. You start a PIFA unit's configuration tool from EXOflex I/O Tool.

Figure 34. An example of a PIFA I/O Tool window:



Model: EP5012

Outdoor_Temp
AI4_2
AI4_3
AI4_4
AI4_5
AI4_6
AI4_7
AI4_8
AI4_9
AI4_10
AI4_11
AI4_12

Name: Outdoor_Temp
Default Name: AI4_1
Resource: Analog Input #1
Description: Measuring outdoor temperature
Attributes:

Attribute	Value
Type	0-20 mA [11]
Enable Limiter	(Default: No [0])
Allow NaN!	(Default: No [0])
Priority	(Default: 8)
WireRes	(Default: 0)
Scaling Function	(Default: (value-Offset)*S
Offset	(Default: 0)
Scale	(Default: 1.0)
FilterTime	(Default: 0)

In PIFA I/O, each resource is configured as a separate object. The configuration attributes vary, depending on the resource type. See the description for each resource type.

There are, however, certain attributes that are always available for all resource types: **Description** and **Name**.

Description is intended for describing the resource in the application.

Name is intended for giving the resource another programmatic name than the default. See also ***Application Interface*** below.

During configuration, a number of VPacs with variables equivalent to the PIFA-units' interface variables are created. A BPac is also created, which has pointers to all these data structures, as well as a few other settings.

Commands

Debug

Teh command **Debug** starts EXOtest in order to inspect the attribute variables of the selected resources. An `.ete` file is created for each resource. You start a debug session either by pressing the button or with the key combination **Alt+U**.

Synchronize Parameters

The command **Syncrhonize Parameters** is used to read the configuration parameters from the controller. In this way you can synchronize the project's configuration in the software with the actual configuration in the controller. To execute a synchronization you press the button or use the key combination **Alt+R**.

Changing the Configuration

As mentioned above, configuration is done in EXOL files on the hard drive, in the files **`PIFAConf.Dpe`**, **`PIFA.Dpe`** and **`PIFACtrl.Dpe`**.

The EXOL-files are loaded to the controller with the command **Load Controller**, just as other EXOL files. However, when changes have been made, you **cannot** simply reload the files, but must instead reload the entire controller, i.e. cold or cool start it.

Note that the application can change the value of a parameter variable during run time without changing the configuration. When the PIFA is reloaded however, all the variables will receive the values stored in the configuration.

Application Interface

The EXOflex controller's application is programmed as usual in EXOL files, which can interact with other controllers and operator programs (e.g. EXO4) in the usual way.

This is possible due to the fact that the interface between the PIFA units and the application programs goes via ordinary EXOL variables in VPacs. The VPacs are created on the hard drive during configuration and loaded to the controller with the command **Load Controller**. The operating system in the EXOflex controller and the PIFA units automatically and invisibly takes care of the transfer between the PIFA units and the variables in the VPacs.

The VPacs with variables are called **`PIFA.Dpe`** etc. The function EXOflex I/O automatically declares these in the process Tasks (**`Normal`**, **`Slow`**, **`Fast`** and **`VeryFast`**).

The variables are divided into four different data classes, according to how data is transferred, according to the below:

Data class	Description
Read variables	Transferred automatically from the PIFA units to the controller upon changes. Will be read by the application programs. See however, ***Counter Variables*** below.

Write variables	Can be written or read by the application programs. Transferred automatically from the controller to the PIFA units upon changes.
Parameter variables	Can be written or read by the application programs. Transferred automatically from the controller to the PIFA units upon changes, i.e. as for write variables, but at a lower priority.
Control variables	Special variables, valid for the whole PIFA, irrespective of the PIFA'smodel. The variables have various meanings. There are variables for e.g. indicating status, serial number, PIFAos revision etc. These variables are stored in **`PIFACtrl.Dpe`** (which is not declared automatically in the process Task).

Read, Write and Parameter Variables

Each PIFA has its own set of read, write and parameter variables. Normally all PIFA units of a particular model have a fixed set of variables. This means that for each PIFA model you install, you will get the same set of variables. There can however, be PIFA units with a *dynamic* set of variables, where even the variable set itself depends on the configuration.

The variables are usually organized and named according to their resources, so that all the variables belonging to a particular resource start in the same way, i.e. with the resource name. The name of the attribute follows directly after the resource name.

Each resource has a default name. This name is normally constructed from information about the resource type, the PIFA-address and the resource number. Examples of default resource names are **`AI1_2`** and **`DI3_7`**, for analog input 2 in PIFA 1 and digital input 7 in PIFA 3 respectively. You can however, during configuration give each resource any name, e.g. **`OutTemp, FanGuard, Pump`**, etc.

Example:

A normal digital input has a variable that registers the input's value. This variable is special, as its name is equivalent to the resource's name, e.g. **`DI3_7`** or **`Fanguard`**. A digital input also has variables for selecting on/off delays. These are called **`OnDelay`** and **`OffDelay`** respectively. The variable names for these will then be **`DI3_7OnDelay, DI3_7OffDelay, FanGuardOnDelay`** and **`FanGuardOffDelay`**.

Indexing

In most cases, an attribute for all the resources in a PIFA is also available for indexing, which can be exploited in loops in application programs. In this case, the default name in the variable name is always used. The resource numbers are used as an index, instead of the actual variable name.

Example:

On/off delays for the digital inputs in PIFA 3 are available in the indexed variables **`DI3OnDelay(`***`x`***`)`** and **`DI3OffDelay(`***`x`***`)`** respectively, where *`x`* is the resource number.

Counter Variables

Read variables can normally only be read by application programs. If you write something in such a variable, this value will be overwritten as soon as a new value is generated by the PIFA. An exception to this is counter variables, which e.g. count pulses or track run time for a digital input. This type of variable can be both read and written. If you enter something into a variable of this type, it will proceed to count from the value you entered.

Transient Flags

All read variables have transient flags that are set when the value is changed. Especially for digital inputs, there are flags that are set also for very short pulses. See ***Chapter 14 Digital Inputs*** on page 62.

You cannot use the transient flags for write and parameter variables in application programs in EXOflex, since they are used internally by EXOreal.

Control Variables

The control variables apply to the whole PIFA and are therefore **not** organized by resource. The names of these variables can not be configured. They always start with **`PIFA`***`x`*, where *`x`* is the PIFA address, followed directly by the name of the attribute.

Example:

The serial number for the PIFA in position 3 can be read in the variable **`PIFA3_SerialNumber`**.

The control variables are placed in their own VPac, named **`PIFACtrl.Dpe`** (which is not declared automatically in the process Task).

Run Modes

A PIFA can run in a number of different modes, as described below.

Normal Run

When a PIFA is in normal run mode, it is said to be in its *active mode*. Values are then automatically transferred between the PIFA and the EXOL-variables in the controller. The transfer is event-driven, i.e. values are only transferred when they change. Although the process is event-driven it is not immediate. There are certain delays in the system.

The delays are dependent on the variable's data class, the number of PIFA units and the PIFA's priority. If all the PIFA units have the same priority, the maximum delays can be calculated in the following way:

Read variables: 20 + (*NumberOfPIFA-units* * 1.4) milliseconds.

Write variables: 20 * *NumberOfPIFA-units* milliseconds.

Parameter variables: 400 * *NumberOfPIFA-units* milliseconds.

In EXOflex I/O Tool, you can configure the priority for each PIFA. This can be exploited if you have a limited number of PIFAs that need much faster transfer than the other ones. The priority is specified numerically, the value 1 is the highest priority. It can be fairly complicated to calculate the maximum delay when priorities are stated in this way. However, the maximum delay between two PIFA units is inversely proportional to the relationship between their respective priorities, i.e. a PIFA with priority 1 is 3 times as fast as a PIFA with priority 3, which in turn is twice as fast as a PIFA with priority 6, and so on.

You can also change the priority of parameter variables in relationship to write variables. Normally write variables are 20 times faster, but this can be configured in the parameter **Priority for scanning for changes in the parameter variables** in PIFA I/O Tool.

No Power

When a PIFA has no power, then naturally nothing happens. All outputs are "low", even digital outputs with relays. This is always equivalent to the value **0** during normal operation in the corresponding write variable for the application programs.

Power-up

A PIFA usually has no battery and will therefore not "remember" anything of its configuration, settings or values for outputs, etc. All outputs will therefore be "low".

The EXOflex controller however, contains all the variables and their configurations, values, etc. When both the PIFA and the controller are powered up and have made contact, the controller will automatically update the PIFA with this information. Once this is done, the PIFA's continued behavior will depend on its configuration for **Type Of Activation** in EXOflex I/O. Automatic or manual activation can be selected.

If automatic activation is selected, the PIFA will automatically go to active mode (i.e. normal operation) as soon as the PIFA and the controller have been updated.

If manual activation is selected, the PIFA will instead go to passive mode as soon as the PIFA and the controller have been updated. In passive mode, values are automatically transferred between the PIFA units and the EXOL variables in the controller, just as in active mode, but all outputs will remain "low". Inputs and other resources function exactly as in active mode.

The PIFA will remain in passive mode until it is activated manually, usually by the application program. Manual activation is intended for use in sensitive installations, where various equipments need to be started in very special ways after power-up.

Apart from this advanced function, output resources usually also have other, simple functions for start-up, e.g. **`PowerUpDelay`**. See the description for each resource type.

A PIFA's mode can be read in the control variable **`PIFA`*`x`*`_Status`**, where *x* is the PIFA's address. The variable can have one of the following values:

Mode	**Value**	**Description**
No contact	0	The controller has no contact with the PIFA. This could mean that it does not exist, that it is defective, that it is not powered or that a communication cable is missing or is defective.
Start-up	1	The PIFA is in start-up mode. The PIFA and the controller are updating each other.
Passive	2	The PIFA is in passive mode and functions as usual, except that all outputs are "low".
Active	3	The PIFA is in active mode, i.e. normal operation.
Configuration error	4	The PIFA is not of the model specified in the configuration. The PIFA behaves as if in off-line mode. See ***Off-line Mode*** below.

A PIFA in passive mode can be activated manually by setting the variable **`PIFA`*`x`*`_Active`**, where *x* is the PIFA's address. This can be done by the application program in the controller.

Off-line Mode

Off-line mode means that the PIFA has power, but no contact with the controller. This mostly happens for a PIFA in an expansion house or in an external display PIFA if the cable between the units is missing or defective, or if the processor house has no power.

As the PIFA has power it can continue to operate, but it must work entirely without instructions from the application program. The only point of interest (for normal PIFA-units) is the mode for the outputs.

A PIFA that goes into off-line mode directly after power-up cannot do anything, as it has no battery and will behave as if in a powerless state, i.e. the outputs will remain "low".

A PIFA that goes into off-line mode directly from normal operation will remember all of its settings and values, as long as it has power itself. The behavior for each output in this case can be configured. You can either let the output retain the value it had when it entered off-line mode, or you can let it go "low" directly.

When the PIFA regains contact with the controller, they will first of all update each other. Once this is done, the PIFA's continued behavior will depend on the configuration for the type of activation, in exactly the same way as for power-up.

Communication Disturbance

Communication between a controller and its PIFA units is via the EFX-channel. Communication within the processor house cannot, in principle, be disturbed.

Communication with PIFA units in an expansion house or with an external display PIFA however, is via a cable. This communication can be disturbed. Naturally, the protocol used in the EFX channel contains mechanisms that ensure that disturbance is detected and that the query is automatically sent again. If there is severe disturbance however, communication can sometimes be knocked out in all retries.

If there is long-term communication disturbance (several seconds), the PIFA will go to off-line mode.

Whatever happens, the controller and the PIFA will continue to update each other as soon as communication is re-established. The continued behavior will depend on the configuration for the type of activation, in the usual way.

Spontaneous Warm-start

All the operating systems involved contain security systems, both in the software and hardware, which monitor their function. If something serious occurs, e.g. because of an error in an operating system, there will be an automatic re-start, i.e. a *spontaneous warm-start*.

When this occurs, the controller and the PIFA will immediately update each other again. Continued behavior will depend on the configuration for the type of activation, in the usual way.

Other Considerations

PIFAos

Each EFX-PIFA has its own CPU with the operating system PIFAos. The revision of PIFAos for each PIFA can be read from a number of EXOL-variables, as below:

Type	Variable	Description
X	**PIFA*x*_RevisionMajor**	Integer part of the PIFAos revision.
X	**PIFA*x*_RevisionMinor**	Decimal part of the PIFAos revision.
X	**PIFA*x*_RevisionBranch**	Branch part of the PIFAos revision.
I	**PIFA*x*_RevisionNumber**	Incremental part of the PIFAos revision.

x is the PIFA's address.

Example: 1.3-1-17

Serial Number

The serial number for each PIFA can be read in the variable **PIFA*x*_SerialNumber**, where *x* is the PIFA's address.

Chapter 12 **The Processor and the Power-PIFA**

Each processor unit has one or more processors. The processor furthest to the left in the house is called the main processor. This handles the resources in the power-PIFA and also has a special role in handling the serial ports.

EXOreal

Each processor has a CPU with the real-time operating system EXOreal, which is the heart of the controller. EXOreal runs all the application programs etc. The EXOreal CPU is of the type C515C, which is a variant of Intel's 8051 core. This CPU is 100% software compatible with the processors used in other EXO controllers: the 8032 and the 80522. It also has the same performance, i.e. equivalent to 22 MHz clock frequency.

The EXOreal revision can be read from a number of system variables in the usual way. See the document *EXOreal*.

The EXOreal CPU has 480 kByte expanded memory and 32 kByte conventional memory for application programs. The amount of free memory can be read with e.g. EXOtest in the usual way. See also the document *Troubleshooting controllers with EXOtest*.

The EFX Channel

Each processor also has an EFX channel, which is handled by another CPU, using the real-time operating system EFXos.

In a house with only one processor, the EFX channel runs to all the PIFA units in the house and to contacts on the power-PIFA, where the EFX channel can be connected via a cable to an expansion house or an external display PIFA.

In houses with several processors, the EFX channel runs from each processor to the PIFA units in the same section as the processor and to sections to the right of that, up to the next processor.

The EFXos revision can be read from the system variables **`EFXosRevMajor`**, **`EFXosRevMinor`**, **`EFXosRevBranch`** and **`EFXosRevNumber`**.

Type	Name	QPac	QLN	Cell	Nor	Ver	T	Description
X	**`EFXosRevMajor`**	**`QEXOflex`**	239	10	-	2.8	-	Integer part of EFXos version.
X	**`EFXosRevMinor`**	**`QEXOflex`**	239	11	-	2.8	-	Decimal part of EFXos version (multiplied by 10).
X	**`EFXosRevBranch`**	**`QEXOflex`**	239	12	-	2.8	-	Branch part of EFXos revision.
I	**`EFXosRevNumber`**	**`QEXOflex`**	239	13	-	2.8	-	Incremental part of EFXos revision.

Hardware Clock

Each processor has a hardware clock that ensures that the real-time clock runs with high accuracy, even when the processor house has no power. Transfer between the hardware clock and the software clock in EXOreal occurs completely automatically.

Built-in Battery

The power-PIFA contains a battery that preserves the contents of the processors' memory and keeps the hardware clock running when the house has no power.

The battery is easily replaced by pulling out the power-PIFA. Each processor has a small current reserve that can keep the memory and hardware clock running for approximately 30 minutes, without the power-PIFA.

The power-PIFA also monitors the battery voltage. When the voltage drops too low, a LED in the front panel is lit. Furthermore, the system variable **`BattFail`** is set in the house's main processor. See also the document *EXOreal*.

External Battery (Option 9035)

The main power PIFA EP1011 can be fitted with option 9035, which makes it possible to connect an external battery as an alternative power source for the controller. This battery is intended to complement the normal power supply to the controller, so that the controller can continue working as normal during a power failure.

The main power PIFA has certain indicators regarding the external battery and the power supply. These are found in the system variable **`ExtBattery`** and is shown with LEDs on the front panel of the main power PIFA.

Line Failure (**LF**), bit #0, indicates that the normal external power supply is not working, i.e. the controller is being powered by the external battery. When the bit is set to zero, the controller is powered as normal.

Battery Low (**Lo**), bit #1, indicates that the voltage from the external battery is running low. If this bit is set when the external battery is powering the controller, the battery can only continue to power the controller for a short while. You may however assume that the time is long enough for sending an alarm.

Battery Failure (**BF**), bit #2, indicates that the external battery is out of function, e.g. completely drained or erroneously connected. This can of course only be indicated while the normal power supply is working.

Type	Name	QPac	QLN	Cell	Nor	Ver	T	Description
X	**`ExtBattery`**	**`QSystem`**	241	29	-	2.8	-	Handling of external battery (Option 9035). Bit # 0 = Normal external power supply out of function. Bit #1 = External battery, low voltage. Bit #2 = External battery out of function.

Digital Inputs and Outputs (on the Main Power PIFA)

The main power PIFA has a few simple digital inputs and outputs.

The main power PIFA is not an EFX PIFA, which means that the inputs and outputs do not work in the same way as in other PIFA units. Instead these are handled directly by EXOreal, as in other, non-EXOflex-controllers, i.e. with the system variables **`DI`***`n`* and **`DQ`***`n`*. See also the document *EXOreal*.

Chapter 13 Communication

Serial ports are handled in the same way as in non EXOflex controllers, directly by EXOreal. In software respects, each EXOflex controller always has 3 ports. Communication is handled by the application program in the traditional way, which is described in detail in the document *EXOreal*.

The differences in EXOflex are mechanical and electrical, i.e. how the ports are connected in the house, both between the processors in the house and to the various PIFA units.

Electrical Formats

All ports can be used for RS232 or RS485.

RS485

All RS485 ports have a complete set of signals, i.e. N, A, B and E.

RS232

The ports have support for various sets of signal for RS232, according to the below:

Port 1: RxD, TxD and RTS.

Port 2: RxD, TxD, RTS and CTS.

Port 3: RxD, TxD, RTS, CTS, DTR, DSR, RI and DCD.

Connections

The Main Processor

The main processor is the one furthest to the left in a processor house. Descriptions of how to connect these ports follow below.

Port #1

Port #1 always connects to the power-PIFA in PIFA position 1. There is no configuration for the actual connection.

Port #2

The main processor's port #2 can be connected in several ways.

Internally, port #2 is connected to port #1 on the other processors in the house. In houses with several processors, this should be used for communication between the processors (i.e. the controllers). This connection is always present, irrespective of the configuration.

Port #2 can also be connected to a communication-PIFA in any position in the house. The position is selected with the system variable **`Control_Port_2`**, by assigning it the position address for the desired PIFA. Assigning it the value 0 will mean that it is not connected.

In houses with several processors, port #2 can be used for internal EXOline communication in the house and for external controllers via a communication PIFA, both at the same time.

It is possible to mount an option card alongside the communication PIFA in the same position. The port's connection is selected with bit #1 in the system variable **`Signal_Port_2`**. When the bit is reset, the port is connected directly to the external connector on the communication PIFA. When the bit is set, it is connected via the option card and onwards to its external connector on the communication PIFA.

Normally, the port's connection is configured statically, but for special applications it is possible to change the connection dynamically. This is not suitable for EXOline communication, but rather for communication using special protocols with low performance requirements, e.g. meter reading.

Port #3

Port #3 is always connected to PIFA position 2, if a communication PIFA is used in that position.

It is possible to mount an option card with the communication PIFA, in the same position. Select the port's connection with bit #1 in the system variable **`Signal_Port_3`**. When the bit is reset, the port is connected directly to the external connector on the communication PIFA. When the bit is set, it is connected via the option card and onwards to its external connector on the communication PIFA.

The application program can determine whether or not the external connector on the communication PIFA is connected via a cable to other equipment. This is indicated by bit #3 in **`Signal_Port_3.`** If there is a connection present, this will be set.

Other Processors

Port #1

Port #1 is always connected to port #2 in the main processor. The port cannot be connected externally.

Port #2

Port #2 can only be connected to a communication PIFA in one of the two PIFA positions in the same section as the processor. Select the position with the system variable **`Control_Port_2`**, by assigning it the position address for the desired PIFA. The value 0 will mean that it is not connected.

It is possible to mount an option card with the communication PIFA, in the same position. Select the port's connection with bit #1 in the system variable **`Signal_Port_2`**. When the bit is reset, the port is connected directly to the external connector on the communication PIFA. When the bit is set, it is connected via the option card and onwards to its external connector on the communication PIFA.

Port #3

Port 3 is always connected to the PIFA position closest to and "under" the processor, if using a communication PIFA in that position.

It is possible to mount an option card with the communication PIFA, in the same position. Select the port's connection with bit #1 in the system variable **`Signal_Port_3`**. When the bit is reset, the port is connected directly to the external connector on the communication PIFA. When the bit is set, it is connected via the option card and onwards to its external connector on the communication PIFA.

The application program can detect whether or not the external connector on the communication PIFA is connected via a cable to other equipment. This is indicated by bit #3 in **`Signal_Port_3`**. If there is a connection present, this will be set.

System Variables

Type	Name	QPac	QLN	Cell	Nor	Ver	T	Description
X	**`Signal_Port_2`**	**`QCom`**	248	45	0	2.4	-	Control signals in port #2.
X	**`Signal_Port_3`**	**`QCom`**	248	46	0	2.4	-	Control signals in port #3.
X	**`Control_Port_2`**	**`QCom`**	248	55	2	2.8	-	Determines which PIFA position port #2 will connect to.

Chapter 14 Digital Inputs

General

There are two standardized types of digital inputs, in software respect *normal* and *advanced*. They have the following functions:

Normal Inputs

A normal digital input has the following functions:

- ❑ A digital filter, which always filters out pulses shorter than 4.5 ms and always registers pulses longer than 9 ms.
- ❑ The signal can be inverted.
- ❑ Configurable on/off delays, in the interval 0.1 to 3000 seconds, with separate variables for filtered values and raw values.
- ❑ Run time logging with the resolution 1 second. The function has double counters (with normal or very high resolution respectively). The counters can be set independently of each other by the application program.
- ❑ A transient flag that is set each time a changed value is registered that can be used to register short pulses in a Task.

Advanced Inputs

An advanced digital input has the following functions:

- ❑ All the functions found in a normal input, but with a faster digital filter, which always filters out pulses shorter than 2.25 ms and always registers pulses longer than 4.5 ms.
- ❑ Pulse counting up to 110 pulses per second. The function has double counters (with normal and very high resolution respectively). The counters can be set independently of each other by the application program.
- ❑ Pulse speed measuring up to 110 pulses per second.
- ❑ Option to automatically convert pulse counting and pulse speed measuring to application units (scaling).

Function

Using the configuration attribute **Type,** the digital input's function is selected.

With the type **Normal,** the input's level is continuously indicated by the variable *DI*. The indication can be delayed by using the attributes **OnDelay** and **OffDelay** respectively, which specify the on and off delays in seconds, in the interval 0.1 to 3000 seconds.

It is also possible to invert the signal, i.e. a low signal to the hardware will be seen as high in the software and vice versa. The inversion is not absolute until the first reading of the level in the hardware. The function is activated with the attribute **Invert Signal**.

For troubleshooting (or other purposes), the input's momentary value (raw value) is indicated in the variable ***DI*Raw**.

Run-time Logging

Digital inputs have a built-in function for run time logging. The function is active if **Type = Runtime Counter**.

The function logs the time the input is high. The desired unit can be configured in the variable **TimeUnit** and is given in seconds. By default, run time is calculated in hours (3600 seconds), but always uses the resolution 1 second.

The time logged is counted up automatically in the variable ***DI*Count**. The application program can, at any time, set the value of ***DI*Count** to some other value. The input continues to count from the entered value.

By configuring **Two Counters = Yes** there will be two separate variables for run time logging: ***DI*Count** and ***DI*Count2**. These are intended for logging run time at different time periods. Both can be set (or reset) independently of each other by the application program.

***DI*Count** has high resolution, with approximately 12 figure accuracy, which is equivalent to >30 000 years. ***DI*Count2** has a more moderate resolution, with approximately 6 figure accuracy, which is equivalent to 11 days (24h periods). ***DI*Count2** can advantageously be used for data assimilation to Logging, for e.g. logging run time per 24h. Logging can be configured to log ***DI*Count2** directly to achieve this.

When run time logging is active, the input's value is indicated simultaneously in ***DI*** and ***DI*Raw**, just as during normal function.

Pulse Counting

Normal Inputs

Pulse counting on normal digital inputs can be done with an application program, if the pulses are not coming too quickly. It is then possible to catch very short pulses (> 9 ms) in a relatively slow program, with the help of the transient flag.

Each time the input's value changes, this is indicated in the variables ***DI*** and ***DI*Raw.** The input's transient flags are also set each time the value changes. By reading the transient flag in the program, even very short pulses can be counted. EXOdesigner provides a ready-made controller object **Pulse Counting**, which is suitable for this purpose.

The shortest time allowed between pulses is determined by the transfer between the PIFA and EXOreal, as well as by the application program's scan cycle.

Example: With 7 PIFA units and a program with the scan cycle 500 ms, the shortest period allowed between the pulses is: 20 + 7*1.4 ms + 500 ms = 530 ms. This applies if all the PIFA units have the same priority. If this is too slow, you can increase the priority for some of the PIFA units and decrease it for others.

Advanced Inputs

Advanced digital inputs have a built-in function for pulse counting. The function is active if **Type = Pulse Counter** or **Pulse Counter+Rate**.

The function counts all pulses (> 4.5 ms) and automatically counts up the variable ***DI*Count** at regular intervals. Pulses arriving at speeds of up to 9 ms can be counted. The function can also automatically convert the value to application units. The number of pulses is multiplied with the value **Scale** before ***DI*Count** is updated.

The application program can, at any time, set the value of ***DI*Count** to a desired value. The input will then continue to count from the entered value.

By configuring **Two Counters = Yes** you will get two separate variables with pulse counting: ***DI*Count** and ***DI*Count2**. These are intended for pulse counting at different resolutions. Both can be set (or reset) independently of each other by the application program.

***DI*Count** has high resolution, with approx. 12 numbers accuracy, i.e. 1 billion pulses. ***DI*Count2** has a more moderate resolution, with approx. 6 numbers accuracy, i.e. 1 million pulses. ***DI*Count2** can advantageously be used for data assimilation to Logging, for e.g. logging the number of pulses per day (24h). Logging can be configured to log ***DI*Count2** directly to achieve this function.

When pulse counting is active, the input's status is **not** indicated in *DI* and ***DI*Raw**. If this is required, you must configure **Type** with a numerical value that activates the function. Note however, that if the pulse speed is high, this will put a great load on the EXOreal processor.

Pulse Rate Measuring

Normal Inputs

Pulse rate measuring (i.e. frequency measuring) on normal digital inputs can be done with an application program, if pulses are not coming too quickly. It is then possible to capture very short pulses (> 9 ms) in a relatively slow program, with the help of the transient flags for *DI* or ***DI*Raw**, in the same way as for pulse counting.

EXOdesigner has a ready-made controller object for pulse rate measuring, **Pulse Counting**, which is suitable for this purpose.

Advanced Inputs

Advanced digital inputs have a built-in function for pulse rate measuring (i.e. frequency measuring). The function is active if **Type = Pulse Counter+Rate**.

Pulse rate is indicated continuously in the variable ***DI*Rate**.

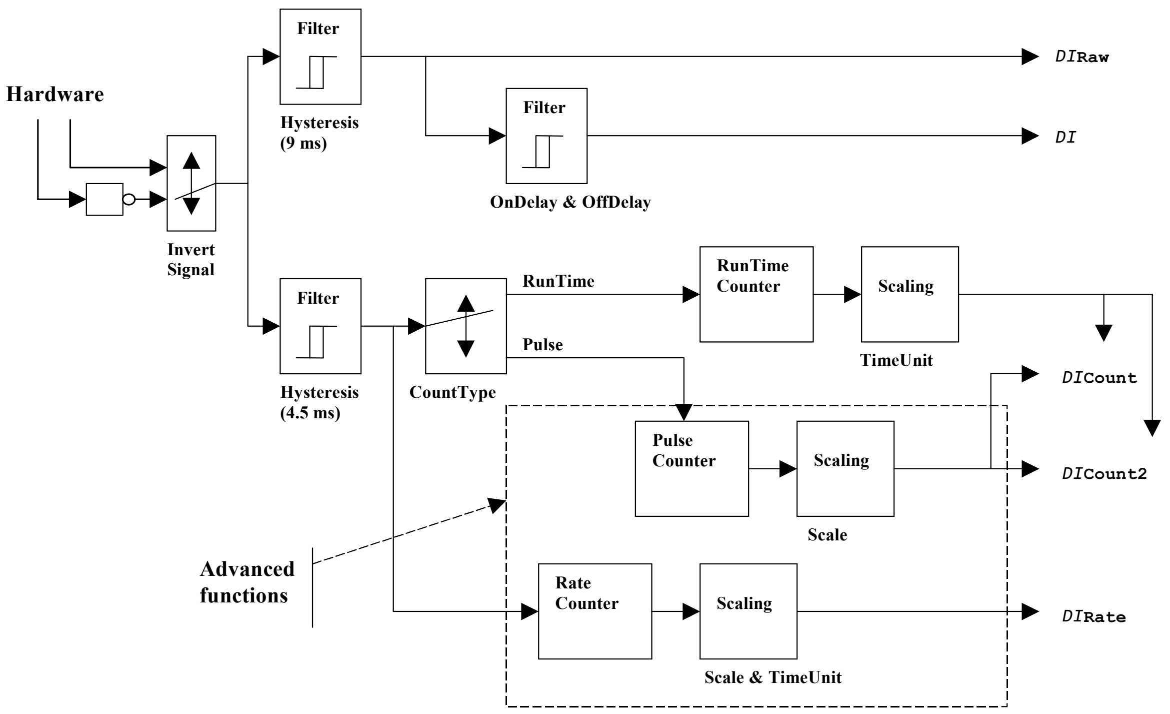
The function counts all pulses (> 4.5 ms), even if they are coming very quickly (> 9 ms). The pulse rate is calculated each time that **NoOfPulses** pulses are received. If not enough pulses have been received in the period **MaxTime** (normally 1 minute), the rate is calculated anyway.

You can configure the desired unit in the variable **TimeUnit**, in seconds. With e.g. **TimeUnit = 60**, the pulse rate is calculated as pulses/minute. Furthermore, this function can also automatically convert the values to application units. The pulse rate is multiplied with the value **Scale** before ***DI*Rate** is updated.

When pulse rate measuring is active, the input's status is **not** indicated in *DI* or ***DI*Raw**. If this is required, you must configure **Type** with a numerical value that activates the function. Note however, that if the pulse rate is high, this will put a great load on the EXOreal processor.

Function Diagram

Figure 35. The functions of a digital input shown schematically.



Configuration

A digital input has the following configuration attributes:

Attribute	Normal	Description
Type	**Normal**	Type of function for the digital input. Specified as one of the following alternatives: **Off [0], Normal [3], Run time Counter [83], Pulse Counter [16], Pulse Counter+Rate [144]**. Corresponds to the bits 0, 1, 4, 6 and 7 in the variable `DIMode`. Arbitrary combinations can be configured using a numerical value.
Invert Signal	**No**	Specifies if the signal will be inverted, i.e. a low signal to the hardware will be high in the software and vice versa.
Two Counters	**No**	Used when two variables are required, for pulse counting or run time logging, i.e. `DICount` and `DICount2`. Corresponds to bit #5 in the variable `DIMode`.
OnDelay	**0.0**	On-delay. Given in seconds in the interval 0.0 to 3000.0 seconds.
OffDelay	**0.0**	Off-delay. Given in seconds in the interval 0.0 to 3000.0 seconds.
TimeUnit	**3600**	Time unit for calculation of pulse speed or run time logging. Given in seconds in the interval 1 to 32000 seconds.
Scale (Advanced inputs)	**1.0**	Scaling factor for converting pulse counting and pulse speed measuring to application units.
NoOfPulses (Advanced inputs)	**1**	Number of pulses after which the pulse speed will be calculated and transferred. The period must, however, have been at least `1` second in duration. The number of pulses is given in the interval 0 to 250 pulses. **NoOfPulses = 0** means that the pulse speed is calculated solely by time, with the interval **MaxTime**.
MaxTime (Advanced inputs)	**60**	Maximum time allowed to elapse before the pulse speed will be calculated, even if not enough pulses have been received. Specified in seconds in the interval 1 to 32000 seconds.

Variables

A digital input has the following variables:

Type	Variable	Nor	Class	Description
L	*DI*	-	Read	The input's current value, <u>after</u> any on/off delays.
L	*DI*Raw	-	Read	The input's current value, <u>before</u> any on/off delays.
X	*DI*Mode	3	Param.	Configuration of the digital input's mode: Bit #0: The variable *DI* is active. Bit #1: The variable *DI*Raw is active. Bit #4: The variable *DI*Count is active. Bit #5: The variable *DI*Count2 is active. Bit #6: Type of counting in *DI*Count and *DI*Count2: 0 = Pulse counting, 1 = Run time logging (Advanced). Bit #7: The variable *DI*Rate is active (Advanced inputs).
R	*DI*OnDelay	0.0	Param.	On-delay. Specified in seconds in the interval 0.0 to 3000.0 seconds.
R	*DI*OffDelay	0.0	Param.	Off-delay. Specified in seconds in the interval 0.0 to 3000.0 seconds.
R	*DI*Count	0.0	R/W	Run-time or pulse counter, possibly converted to application unit.
R	*DI*Count2	0.0	R/W	Run-time or pulse counter, possibly converted to application unit.
R	*DI*TimeUnit	3600	Param.	Time unit for calculating pulse rate or run-time. Specified in seconds in the interval 1 to 32000 seconds.
R	*DI*Scale (Advanced inputs)	1.0	Param.	Scaling factor for converting pulse counting and pulse rate measuring to application unit.
R	*DI*Rate (Advanced inputs)	-	Read	Pulse rate, possibly converted to application unit.
X	*DI*NoOfPulses (Advanced inputs)	1	Param.	Number of pulses for which the pulse speed will be calculated and transferred. The period must, however, have been at least **1** second in duration. The number of pulses should be given in the interval 0 to 250 pulses. **NoOfPulses = 0** means that the pulse speed is calculated solely by time, with the interval **MaxTime**.
R	*DI*MaxTime (Advanced inputs)	60	Param.	Maximum time allowed to elapse before the pulse speed will be calculated, even if not enough pulses have been received. Specified in seconds in the interval 1 to 32000 seconds.

DI is the digital input's resource name, which normally is DO*p_r*, but this can freely be configured in PIFA I/O.
p is the PIFA's address, which is a numerical value from 0 to 31.
r is the resource's number in the PIFA, which is a numerical value from 1 and upwards.

Chapter 15 **Digital Outputs**

General

The standardized type of digital outputs has the following functions:

- Direct control of the output's mode.
- Configurable on/off delays, in the interval 0 to 30000 seconds, with indication of the output's momentary status (raw value).
- "Manual" control of the output's mode.
- Pulse proportioning, with the resolution 10 ms.
- Frequency generation, with the resolution 10 ms.
- Possibility to control pulse proportioning and frequency generation directly in application units (scaling).
- Configurable handling at power-up.
- Possibility to decide the signal's behavior if the PIFA loses contact with the processor.
- Overheating protection, which automatically disconnects the outputs before the electronics get overheated (only for certain models).

Function

With the configuration attribute **Type** you can choose the digital output's function mode.

In **Normal** mode, the output's value can be controlled directly with the variable *`DO`*. Changes can be delayed with the help of the attributes **OnDelay** and **OffDelay** respectively, which specify on/off delays in seconds in the interval 1 to 30000 seconds.

The output's mode can also be controlled *manually*, with the variable *`DO`*`ManAutoSelect`:

- When *`DO`*`ManAutoSelect = 2,` the mode is *automatic*, i.e. the output's mode is controlled by the variable *`DO`*, as described above.
- When *`DO`*`ManAutoSelect = 0` or `1` respectively, the output will be low or high respectively, irrespective of the value of *`DO`*.

For PIFA units with physical hand control switches, the output's mode can also be controlled manually. The function of the hand control switch is superior to its correspondence in the software (the variable *`DO`*`ManAutoSelect`). In these PIFA units, there is a variable, *`DO`*`ManAutoStatus`, specifying status for the digital output's hand control modes, from both a software and a hardware point of view:

- If the switch is in `Auto` mode, the configuration of *`DO`*`ManAutoSelect` is shown
- If the switch is not in `Auto`, the mode of the switch is shown.
- When *`DO`*`ManAutoStatus = 3` and `4` respectively, the output is low and high respectively.

For troubleshooting purposes, the output's momentary status (raw value) is indicated in the variable *`DO`*`Raw`.

The transfer time from the variable `DO` to the output's hardware in the PIFA is determined by the transfer between EXOreal and the PIFA, and by the internal handling in the PIFA (which is 10 ms).

Example: With 7 PIFA units, the total transfer time will be: 20 * 7 + 10 ms = 150 ms. This will apply if all the PIFA units have the same priority. If this is too slow, you can increase the priority for some PIFA units and decrease it for others.

Pulse Proportioning

A digital output can generate a pulse proportioning signal automatically. You get this by selecting **Type = Pulse Proportion**.

A pulse proportioning signal means that you generate a signal with a constant frequency, but with varying pulse lengths (the time when the output is high). The signal's resolution is 10 ms.

You control the proportioning with the variable ***DO*****`Pulse`** in percent (i.e. with the value 0–100). The period (the time between pulses) is configured with the attribute **PulseTime** in seconds, in the interval 0,01 to 300 seconds.

It is possible to control the proportioning with an application unit (instead of 0–100). The pulse proportioning (in percent) is then controlled by ***DO*****`Pulse`** * **Scale**.

When the pulse proportioning function is in use, the output's momentary status is **not** indicated in ***DO*****`Raw`**. If this is required, you must configure **Type** with a numerical value that activates the function. Note however, that if the pulse speed is high, this will put a great load on the EXOreal processor.

The signal can also be controlled *manually*, according to the below:

- ❑ When ***DO*****`ManAutoSelect = 2,`** the mode is *automatic*, i.e. the signal is controlled by the variable ***DO*****`Pulse`**, as described above.
- ❑ When ***DO*****`ManAutoSelect = 0,`** the output is low, irrespective of the value of ***DO*****`Pulse`**.
- ❑ When ***DO*****`ManAutoSelect = 1,`** the signal is instead controlled by the variable ***DO*****`ManPulse`**, possibly in an application unit if scaling is used.

Frequency Generation

A digital output can generate a frequency signal automatically. This is achieved by selecting **Type = Pulse Rate**.

Frequency generation means that a signal with constant pulse length (the time when the output is high), but with varying frequency is generated The signal's resolution is 10 ms.

The pulse speed is controlled by the variable ***DO*****`Pulse`** in periods/second (Hertz). The pulse length (the time when the output is high) is configured with the attribute **PulseTime** in seconds, in the interval 0.01 to 300 seconds.

It is possible to control the pulse speed with an application unit (instead of pulses/seconds). The pulse speed is then controlled by ***DO*****`Pulse`** * **Scale**.

During frequency generation, the output's momentary status is **not** indicated in ***DO*****`Raw`**. If this is required, you must configure **Type** with a numerical value that activates the function. Note however, that if the pulse speed is high, this will put a great load on the EXOreal processor.

You can also control the signal *manually*, according to the following:

- ❑ When ***DO*****`ManAutoSelect = 2,`** the mode is *automatic*, i.e. the signal is controlled by the variable ***DO*****`Pulse`** as described above.

- ❑ When ***DO*ManAutoSelect = 0,** the output will have the value 0 in application units.
- ❑ When ***DO*ManAutoSelect = 1,** the signal is instead controlled by the variable ***DO*ManPulse** in application units.

Power-up

During power-up, various things will happen depending on the PIFA's type of activation. The type of activation is configured individually for each PIFA in EXOflex I/O Tool.

Normally, automatic activation is used, which means that the outputs are kept low for the time specified by the attribute **PowerUpDelay**. When that time has elapsed, the output is immediately set to the value of the variable ***DO*** (without regard to **OnDelay**) or ***DO*Pulse**, depending on the type of function. Thereafter, it will function as usual.

The outputs are also kept low during manual activation and the whole PIFA ends up in passive mode. This state will persist until the application program "manually" activates the PIFA. When this happens, the output is immediately set to the value of the variable ***DO*** (without regard to **OnDelay** or **PowerUpDelay**) or ***DO*Pulse**. Thereafter, it will function as usual.

See also ***Run Modes*** on page 52.

Off-line Mode

PIFA units in expansion houses can lose contact with the EXOreal processor, if e.g. the cable between the expansion house and the processor house is damaged, or if the processor house loses power. Using the attribute **Off-line Action,** you can decide what will happen to the output when this occurs.

Using the configuration **Off-line Action = Set Signal Low**, the output is set low as soon as the contact is lost.

Normally you would use the configuration **Off-line Action = Keep Signal**. The output value current at the time of the loss of contact will instead remain on the output. For pulse proportioning or frequency outputs, this means that the output will continue to generate pulses on its own.

When contact is re-established, much the same will occur as during power-up, as described above.

See also ***Run Modes*** on page 52.

Overheating Protection

Certain PIFA models have digital outputs with automatic overheating protection, which automatically disconnects the outputs before the electronics get overheated. This applies to outputs of the type 24V DC.

The protection triggers when the temperature in the electronics rises above 74 ˚C and returns when it falls below 70˚C. The status for the protection is indicated in bit #0 in the variable **DO*p*SumStatus**, which is set when the protection is triggered. It will be reset when the protection returns.

Function Diagram

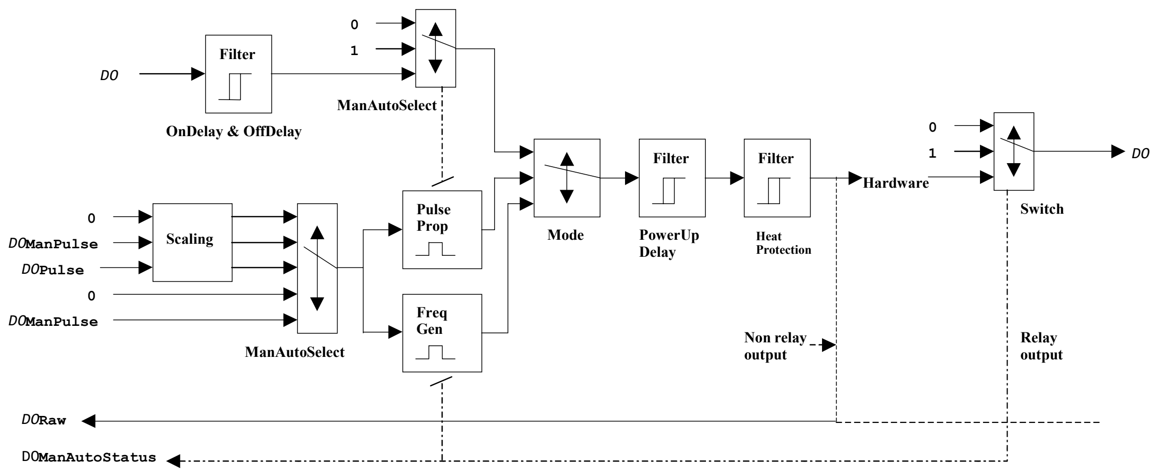


Figure 36. The functions of a digital output shown schematically.

Configuration

A digital output has the following configuration attributes:

Attribute	Normal	Description
Type	**Normal**	Type of function for the digital output. Uses one of the following alternatives: **Off [0]**, **Normal [5], Pulse Proportion [2], Pulse Rate [3]**. Corresponds to the bits 0-2 in the variable *DO*`Mode`. Arbitrary combinations can be configured using a numerical value.
OnDelay	**0**	On-delay. Specified in seconds in the interval 0 to 30000 seconds.
OffDelay	**0**	Off-delay. Specified in seconds in the interval 0 to 30000 seconds.
PowerUpDelay	**0**	Automatic on-delay during power-up. Specified in seconds in the interval 0 to 255 seconds.
Off-line Action	**Keep signal**	Determines what will happen to the output's value in off-line-mode. Specified by one of the following alternatives: **Keep signal [0]** or **Set signal low [128]**. Corresponds to bit #7 in the variable *DO*`Mode`.
Scale	**1.0**	Scaling factor for conversion to application unit.
PulseTime	**1.00**	Period for pulse proportioning or pulse length for frequency generation. Specified in seconds in the interval 0.01 to 300 seconds.

Variables

A digital output has the following variables:

Type	Variable	Nor	Class	Description
`L`	*DO*	`0`	Write	Controls the output's value.
`L`	*DO*`Raw`	`-`	Read	Indicates the output's momentary status.

X	*DO*Mode	1	Param.	Configuration of the digital output's mode: Bit #0-1: 00 = Inactive. 01 = Normal. 10 = Pulse proportioning. 11 = Frequency generation. Bit #2: The variable *DO*Raw is active. Bit #7: Behavior when switching to off-line mode: 0 = The output is retained, 1 = out-signal is set low.
X	*DO*ManAutoSelect	2	Param.	Determines mode for a "normal" output, as follows: 0 = Manual mode: Off- 1 = Manual mode: On. 2 = Automatic mode (normal run-mode). Determines mode for a "pulsed" output as follows: 0 = Manual mode: 0 in application units. 1 = Manual mode: Controlled by *DO*ManPulse in application units. 2 = Automatic mode: Controlled by *DO*Pulse in application units. 3 = Manual mode: 0 in engineering units. 4 = Manual mode: Controlled by *DO*ManPulse in engineering units.
X	*DO*ManAutoStatus	-	Read	**For PIFA with physical man/auto switches**. The variable specifies status for the digital output's ManAuto mode (**Off sw = 0, On sw = 1, Auto = 2, Off hw = 3, On hw = 4**).
R	*DO*OnDelay	0	Param.	On-delay in normal operation. Specified in seconds in the interval 0 to 30000 seconds.
R	*DO*OffDelay	0	Param.	Off-delay in normal operation. Specified in seconds in the interval 0 to 30000 seconds.
X	*DO*PowerUpDelay	0	Param.	On-delay after power-up (and a few other special cases). Specified in seconds, in the interval 0 to 255 seconds.
R	*DO*Pulse	0.0	Write	Controls frequency or pulse proportioning in automatic mode.
R	*DO*ManPulse	0.0	Write	Controls frequency or pulse proportioning in manual mode.
R	*DO*Scale	1.0	Param.	Scaling factor for conversion to application unit, for pulse proportioning or frequency generation.
R	*DO*PulseTime	1.00	Param.	Period for pulse proportioning or pulse length for frequency generation. Specified in seconds, in the interval 0.01 to 300 seconds.
X	DO*p*SumStatus	-	Read	Status summary for all digital outputs in the PIFA: Bit #0: Overheating protection triggered.

DO is the digital output's resource name, normally **DO***p_r*, but this can freely be configured in PIFA I/O.
p is the PIFA's address, which is a numerical value from 0 to 31.
r is the resource's number in the PIFA, which is a numerical value from 1 and upwards.

Chapter 16 **Analog Inputs**

General

The standardized types of analog outputs have the following functions:

- ❑ Modes for many different magnitudes and measurement ranges: Voltage, current and various temperature sensors, directly in engineering units.
- ❑ Built-in filter that filters out noise and hum.
- ❑ Configurable exponential filter for "softening up" the signal's movements
- ❑ Conversion of measured values to application units.
- ❑ Compensation for cable resistance for measuring of resistance and temperature.
- ❑ Configuration of signal behavior when outside the measurement range
- ❑ Priority specifications can be made for all inputs.

Function

With the configuration attribute **Type** you select the analog input's mode. The following magnitudes and measurement ranges can be selected: **0–10V, 0–200mV, 0–20mA, 0–2000Ω, Pt100 -50 to +15O°C, Pt100 0 to +600 °C, Pt1000, Ni1000** and **Ni1000 L&G**.

The input's level is continually indicated in the variable *AI*. The measured value always first passes a fast integration filter to filter out noise and hum. This filter cannot be configured. You can also filter the value through an exponential filter. The filter's time constant is configured with the attribute **FilterTime**. The time constant is equal to the time taken for the value after filtering to reach 63% of the final value when the input is changed in steps.

The value is presented directly in engineering units (according to **Type**) in the variable *AI*. You can however, let the analog input convert it to the required application unit automatically. You do this with the attributes **Scale** and **Offset** in the following way:

AI = (Measured value - **OffSet**) * **Scale**

From and including PIFAos 1.1, the scaling function can be selected with the attribute **Scaling Function**. There are two functions to choose between; the above and the following:

AI = (Measured value * **Scale**) + **OffSet**

For troubleshooting (or other purposes), the input's value is also indicated in the variable *AI***Raw** (the raw value) before it passes the exponential filter and is converted to application units.

Compensation for Wire Resistance

The analog input can automatically compensate for resistance in wires to temperature sensors. This is achieved by measuring the total resistance in both wires from the controller to the sensor and configuring the measured value directly in Ohm (Ω) in the attribute **WireRes**.

Measurement Range

Each function mode (as set in the configuration in **Type**) has a defined measurement range. Each physical input also has an *actual* measurement range that is somewhat greater, at both ends of the range. The actual measurement range differs from unit to unit, depending on what the electronics in the analog input can handle.

For example, an analog input with the mode 0-10 Volt, has an actual measurement range of -0.13 to +10.47 Volt. With the attributes **Enable Limiter** and **Allow NaN!**, you can decide how the value will be indicated in the variable `AI`, when the signal goes outside the measurement range.

If **Enable Limiter** is active, the signal is limited to the defined measurement range, even if the signal goes outside this. If the in-signal is e.g. 10.21 volt, the analog input will still give the value 10. If the function is not active, the value is indicated up to the limit of the actual measurement range. This limitation is performed before the value is sent to the exponential filter. The variable `AIRaw` always shows the actual measured value.

Using **Allow NaN!**, you can decide what will be indicated when the signal goes outside the actual measurement range. If the function is active, the variable `AI` = **`NaN!`** (*not-a-number*) is set when the signal is outside the actual measurement range. If the function is not active, the actual measurement range's limit is indicated instead.

Whatever the configuration is, the variable `AIStatus` always indicates if you are outside the measurement range, as follows:

Bit #	**Description**
0	The signal is outside the actual measurement range. Bit #1 indicates if the value is below or above the measurement range.
1	This bit is valid if bit #0 is set: 0 = The signal is below the actual measurement range. 1 = The signal is above the actual measurement range.
2	The signal is outside the defined measurement range, e.g. 0-10 Volt. Bit #3 indicates if the value is below or above the measurement range.
3	This bit is valid if bit #2 is set: 0 = The signal is below the defined measurement range (e.g. < 0 Volt). 1 = The signal is above the defined measurement range (e.g. > 10 Volt).

These bits can e.g. be connected to alarm points in the controller.

Priorities

In most PIFA units, much of the electronics are shared by all the analog inputs. The PIFA can therefore only measure the in-signal on one input at a time, which normally takes 28 ms. If you have e.g. 12 analog inputs, a new value from each analog input will be received with the interval 12 * 28 = 336 ms.

If this is too slow, you can increase the priority for some inputs and decrease it for others.

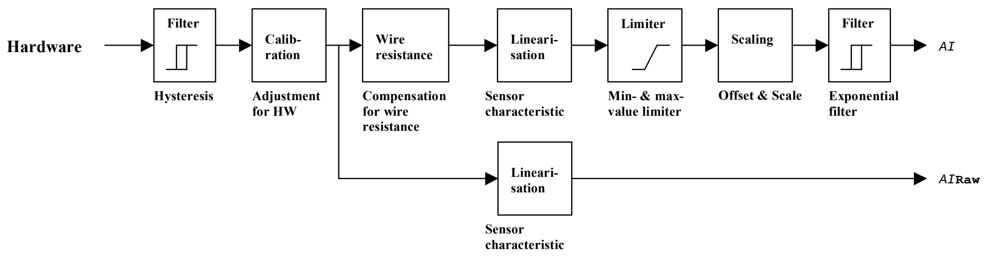
The priority is specified numerically, the value 1 is the highest priority. It is fairly complicated to calculate the interval for a certain input when priorities are stated in this way. However, it can be said that the interval for two inputs is inversely proportional to the relationship between their priorities, i.e. an input with priority 1 is 3 times as fast as an input with priority 3, which in turn is twice as fast as an input with priority 6, and so on.

The total time for transfer to the variable `AI` also depends on the transfer speed from the PIFA to EXOreal.

Example: With 7 PIFA units, the transfer time will be: 20 + 7*1.4 ms = 30 ms, which, in principle, is negligible in this context.

Function Diagram

Figure 37. The functions of an analog input shown schematically.



Configuration

An analog input has the following configuration attributes:

Attribute	Normal	Description
Type	**Normal**	Type of function for analog input. Specified with one of the following alternatives: **Off [0], 0–10V [9], 0–200mV [10], 0–20 mA [11], 0–2000 Ohms [4], Pt100 -50 to +15O°C [5], Pt100 0 to +600°C [12], Pt1000 [1], Ni1000 [8], Ni1000 L&G [2].**
Enable Limiter	**No**	Specifies if the value from the analog input will be limited to the defined measurement range (according to the configuration of **Type**). Corresponds to bit #6 in the variable `AIMode`.
Allow NaN!	**No**	Specifies if the value from the analog input will be *not-a-number* (`NaN!`) when the signal goes outside the actual measurement range. Corresponds to bit #7 in the variable `AIMode`.
Priority	**8**	The analog input's priority (i.e. how often its value is updated). Specified as a numerical value in the interval 1 to 32, where 1 is the highest priority.
WireRes	**0.00**	Wire resistance for measuring resistance and temperatures. Specified in Ohm in the interval 0.00 to 300.00 Ohm.
Scaling Function	**0**	The type of scaling function for converting measured value to application units is specified with one of the following alternatives: **(value-Offset)*Scale [0]**, **(value*Scale)+Offset [2]**.
Offset	**0.0**	Offset for converting measured values to application units.
Scale	**1.0**	Scaling factor for converting measured values to application units.
FilterTime	**0**	Time constant for exponential filter. The value **0** means that the filter is off. Specified in seconds in the interval 0 to 30000 seconds.

Variables

An analog input has the following variables:

Type	Variable	Nor	Class	Description
R	*AI*	**-**	Read	The input's current value, after any limiting, scaling, filtering, etc.
R	*AI***Raw**	**-**	Read	The input's current value, before any limiting, scaling, filtering, etc.
X	*AI***Type**	**9**	Param.	Configuration of the analog input's signal type: 0 = Inactive, 1 = Pt1000, 2 = Ni1000 L&G, 4 = 0–2000Ω, 5 = Pt100 -50 to +15O°C, 8 = Ni1000, 9 = 0–10 V, 10 = 0–200 mV, 11 = 0–20mA , 12 = Pt100 0 to +600°C.
X	*AI***Mode**	**1**	Param.	Configuration of the analog input's behavior: Bit #0: The variable *DI***Raw** is active. Bit #1: Alternative scaling function selected. Bit #6: The value is limited to the defined measurement range. Bit #7: The value will be **NaN!** outside the actual measurement range.
X	*AI***Status**	**0**	Read	The analog input's status: Bit #0: Signal is outside the actual measurement range. Bit #1: 0 = Below, 1 = Above the actual measurement range. Bit #2: Signal is outside the defined measurement range. Bit #3: 0 = Below, 1 = Above the defined measurement range.
X	*AI***Priority**	**8**	Param.	The analog input's priority (i.e. how often its value is updated).
R	*AI***WireRes**	**0.0**	Param.	Wire resistance for measuring resistances and temperatures. Specified in Ohms in the interval 0.00 to 300.00 Ohms.
R	*AI***Offset**	**0.0**	Param.	Offset for converting measured values to application units.
R	*AI***Scale**	**1.0**	Param.	Scaling factor for converting measured values to application units.
R	*AI***FilterTime**	**0**	Param.	Time constant for exponential filter. The value `0` means that the filter is off. Specified in seconds in the interval 0 to 30000 seconds.

AI is the digital output's resource name, normally **AI***p_r*, but this can freely be configured in PIFA I/O.
p is the PIFA's address, a numerical value from 0 to 31.
r is the resource's number in the PIFA, a numerical value from 1 and upwards.

Chapter 17 **Analog Outputs**

General

The standardized types of analog outputs have the following functions:

- ❑ Direct control of the output's mode.
- ❑ Control of the signal in application units.
- ❑ "Manual" control of the output's mode.
- ❑ Automatic, gradual rise when the signal changes.
- ❑ Configurable behavior for power-up.
- ❑ Possibility to specify the signal's behavior if the PIFA loses contact with the processor.

Function

The output's value is controlled directly with the variable *AO*, normally in engineering units. You can however, choose to control the signal in the desired application unit. This is done with the attributes **Scale** and **Offset** and is done in the following way:

Out-signal = (*AO* * **Scale**) + **Offset**

With the configuration attribute **Ramp,** you can configure an automatic, gradual rise of the out-signal. You specify how fast the out-signal shall change per second, always in engineering units.

You can also control the signal *manually*, according to the below:

- ❑ When *AO*`ManAutoSelect = 2`, the mode is *automatic*, i.e. the signal is controlled by the variable *AO,* as described above.
- ❑ When *AO*`ManAutoSelect = 0`, the output has the value 0 in application units.
- ❑ When *AO*`ManAutoSelect = 1`, the signal is instead controlled by the variable *AO*`Man`, in application units.

For troubleshooting, the output's momentary status (raw value) is indicated in the variable *AO*`Raw`, normally in application units. The raw value can be indicated in engineering units, by means of bit #2 in the variable *AO*`Mode`.

The transfer time from the variable *AO* to the output's hardware in the PIFA is determined by the transfer between EXOreal and the PIFA, and by the internal handling in the PIFA (which is 10 ms).

Example: With 7 PIFA units, the total transfer time will be: 20 * 7 + 10 ms = 150 ms. This will apply if all the PIFA units have the same priority. If this is too slow, you can increase the priority for some PIFA units and decrease it for others.

Power-up

During power-up, various things will happen depending on the PIFA's type of activation. The type of activation is configured individually for each PIFA in EXOflex I/O Tool.

Normally, automatic activation is used, which means that the outputs are kept low for the time specified by the attribute **PowerUpDelay**. When that time has elapsed, the output is set to the value of the variable *AO*. If **Ramp** is configured, the signal rises gradually to that level. Thereafter, it will function as usual.

The outputs are also kept low during manual activation and the whole PIFA ends up in passive mode. This state will persist until the application program "manually" activates the PIFA. When this happens, the output is set to the value of the variable *AO*. If **Ramp** is configured, the signal rises gradually to that level. Thereafter, it will function as usual.

See also ***Run Modes*** on page 52.

Off-line Mode

PIFA units in expansion houses can lose contact with EXOreal, if e.g. the cable between the expansion house and the processor house is damaged, or if the processor house loses power. Using the attribute **Off-line Action,** you can decide what will happen to the output when this occurs.

With the configuration **Off-line Action = Set Signal Low**, the output is set low as soon as contact is lost.

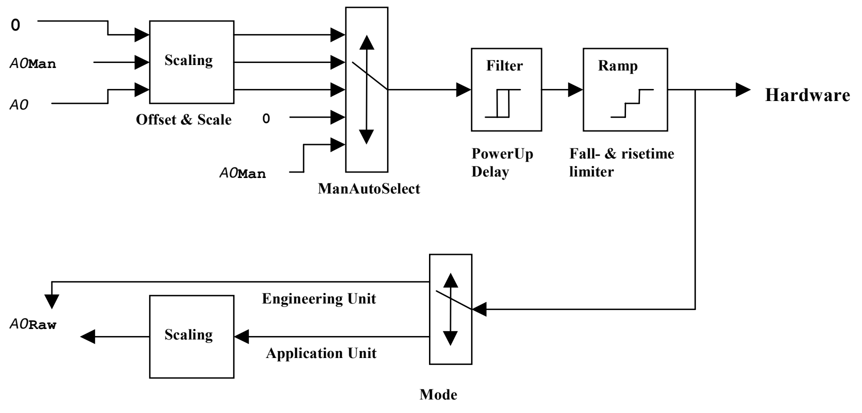
Normally you would use **Off-line Action = Keep Signal**. The out-signal value current at the time of the loss of contact will then instead remain on the output.

When contact is re-established, much the same will occur as during power-up, as described above.

See also ***Run Modes*** on page 52.

Function Diagram

Figure 38. The functions of an analog output shown schematically.



Configuration

An analog output has the following configuration attributes:

Attribute	Normal	Description
PowerUpDelay	**0**	Automatic on-delay at power-up. Specified in seconds in the interval 0 to 255 seconds.

Raw value Mode	**Application unit**	Sets the display mode for the *AO*`Raw` variable. One of the following alternatives can be set: **Off [0], Application unit [2], Engineering unit [6]**. Corresponds to bit #1 and bit #2 in the *AO*`Mode` variable.
Off-line Action	**Keep signal**	Determines what will happen with the output's value in off-line mode. Specified by one of the following alternatives: **Keep signal [0]** or **Set signal low [128]**. Corresponds to bit #7 in the variable *AO*`Mode`.
Offset	**0.0**	Offset for converting to application unit.
Scale	**1.0**	Scaling factor for converting to application unit.
Ramp	**0.00**	Maximum permitted change of out-signal per second, directly in engineering units.

Variables

An analog output has following variables:

Type	Variable	Nor	Class	Description
`L`	*AO*	`0`	Write	Controls the value of the output.
`L`	*AO*`Raw`	`-`	Read	Indicates the output's momentary status.
`X`	*AO*`Mode`	`3`	Param.	Configuration of the analog output's mode: Bit #0: The analog output is active. Bit #1: The variable *AI*`Raw` is active. Bit #2: Type of value in the variable *AO*`Raw.` 0 = Application units, 1= Engineering units. Bit #7: Behavior when going to off-line mode. 0 = Out-signal retained, 1 = The output is set low.
`X`	*AO*`ManAutoSelect`	`2`	Param.	Determines mode, as below: 0 = Manual mode: 0 in application units. 1 = Manual mode: Controlled by *AO*`Man` in application units. 2 = Automatic mode: Controlled by *AO* in application units. 3 = Manual mode: 0 in engineering units. 4 = Manual mode: Controlled by *AO*`Man` in engineering units.
`X`	*AO*`PowerUpDelay`	`0`	Param.	On-delay after power-up (and a few other special cases). Specified in seconds in the interval 0 to 255 seconds.
`R`	*AO*`Man`	`0.0`	Write	Controls the output's value in manual mode.
`R`	*AO*`Offset`	`0.0`	Param.	Offset for converting to application units.
`R`	*AO*`Scale`	`1.0`	Param.	Scaling factor for converting to application units.
`R`	*AO*`Ramp`	`0.00`	Param.	Maximum permitted change of out-signal per second, directly in engineering units.

AO is the analog output's resource name, normally **`AO`***p*_*r*, but this can freely be configured in PIFA I/O.
p is the PIFA's address, a numerical value from 0 to 31.
r is the resource's number in the PIFA, a numerical value from 1 and upwards.

Chapter 18 The External Display

The external display is an independent PIFA-unit, which connects to a processor house via the EFX-channel. It has the following resources:

- ❑ An LCD display with 2 x 20 characters, and software controlled background lighting and viewing angle. The display can show considerably more national characters than the model 5540 for Icelandic, French, Spanish, Italian, Turkish, etc. See below.
- ❑ 20 keys as opposed to 10 in the earlier system. All double functions on the keys have been removed. You then have the following keys **[0]** to **[9]**, **[↑]**, **[↓]**, **[←]**, **[→]**, **[+]**, **[-]**, **[↵]**, **[▲]**, **[.]** and **[C]**. The keys can also generate a click-sound when pressed.
- ❑ Built-in beeper.
- ❑ LED in the key **[↵]** (**`LED_Num`**) and a separate alarm LED **(`LED_Ala`)**. The counterparts to the LED's in the keys **[+]** and **[-]** have been removed. Also, there are a further two LED's indicating supply voltage and EFX-contact respectively.
- ❑ 2 general digital inputs.
- ❑ 1 general digital output with relay, for e.g. a lamp or external beeper.

The external display is a true EFX-PIFA, but to make it as compatible as possible with non-EXOflex-controllers, most of its functions are still exposed directly by EXOreal. The exceptions are the digital inputs and outputs, which are exposed as full EXOflex-resources, as described in Chapter 14 ***Digital Inputs*** and Chapter 15 ***Digital Outputs***

Only one external display can be connected at a time and it always has the address 0.

In normal applications, the external display is not handled directly in the application programs. Instead you use the ready-made controller functions **Display**, **Station Handler** and **Time Schedules Display**. See also Chapter 20 ***Applications***.

The Display

The display is handled as in non-EXOflex-controllers, i.e. with the EXOL instruction **`Print`** and the system variables **`CursorPos`**, **`DisplayMode`**, **`DispTimeOutLatch`**, **`DispTimeOut`** and **`DispAngle`**. See also the document *EXOreal*.

The character set however, does differ from non-EXOflex-controllers. There are considerably more national characters for various European languages. A complete table of these can be found in ***Character Sets*** on page 82.

Keypad

The keypad is handled as in non-EXOflex-controllers, i.e. primarily by the system variables **`Key_No`** and **`New_Key`**. There are however, several new keys. For each new key there is a new key code and a new system variable.

Using the system variable **`KeySound`** you can choose if the external display will emit a click-sound each time a key is pressed.

The new system variable **`DisplayInfo`** allows an application program to check which type of keypad the controller has.

Key Codes

The keys have the following codes:

Key	`Key_No`
[0]	48
[1]	49
[2]	50
[3]	51
[4]	52
[5]	53
[6]	54
[7]	55
[8]	56
[9]	57
[.]	46
[C]	27
[↵]	13
[↑]	30
[↓]	31
[←]	29
[→]	28
[+]	43
[-]	45
[▲]	7

System Variables

Type	Name	QPac	QLN	Cell	Nor	Ver	T	Description
X	`DisplayInfo`	`QDisp`	249	3	-	2.8	-	Information about the external display. Bit #0: Keypad type (0 = 10 keys, 1 = 20 keys).
X	`Key_No`	`QDisp`	249	31	-	2.0	-	Key code for latest key pressed
L	`New_Key`	`QDisp`	249	30	-	2.0	-	Set when a key is pressed
X	`KeySound`	`QDisp`	249	4	1	2.8	-	Type of key sound: 0 = None, 1 = Click
L	`Key_0`	`QDisp`	249	32	-	2.0	-	Indication for key **[0]**
L	`Key_1`	`QDisp`	249	33	-	2.0	-	Indication for key **[1]**
L	`Key_2`	`QDisp`	249	34	-	2.0	-	Indication for key **[2]**
L	`Key_3`	`QDisp`	249	35	-	2.0	-	Indication for key **[3]**
L	`Key_4`	`QDisp`	249	36	-	2.0	-	Indication for key **[4]**
L	`Key_5`	`QDisp`	249	37	-	2.0	-	Indication for key **[5]**
L	`Key_6`	`QDisp`	249	38	-	2.0	-	Indication for key **[6]**
L	`Key_7`	`QDisp`	249	39	-	2.0	-	Indication for key **[7]**
L	`Key_8`	`QDisp`	249	40	-	2.0	-	Indication for key **[8]**
L	`Key_9`	`QDisp`	249	41	-	2.0	-	Indication for key **[9]**
L	`Key_Dot`	`QDisp`	249	14	-	2.8	-	Indication for key **[.]**
L	`Key_Clr`	`QDisp`	249	15	-	2.8	-	Indication for key **[C]**

L	**`Key_Enter`**	**`QDisp`**	249	16	-	2.8	-	Indication for key [↵]
L	**`Key_Up`**	**`QDisp`**	249	17	-	2.8	-	Indication for key [↑]
L	**`Key_Down`**	**`QDisp`**	249	18	-	2.8	-	Indication for key [↓]
L	**`Key_Left`**	**`QDisp`**	249	19	-	2.8	-	Indication for key [←]
L	**`Key_Right`**	**`QDisp`**	249	20	-	2.8	-	Indication for key [→]
L	**`Key_Plus`**	**`QDisp`**	249	21	-	2.8	-	Indication for key [+]
L	**`Key_Minus`**	**`QDisp`**	249	22	-	2.8	-	Indication for key [-]
L	**`Key_Ala`**	**`QDisp`**	249	23	-	2.8	-	Indication for key [▲]

LEDs

The external display has only 2 LEDs that can be controlled from software: a red alarm LED and an LED in the enter key.

These can be controlled with the system variables **`LED_Ala`** and **`LED_Num`**, just as in non-EXOflex-controllers. These are however, not suitable for getting the LEDs to flash, as the transfer rate to the external display via the EFX-channel can be slightly too low in controllers with many PIFA-units.

There are therefore two new system variables **`LEDAlarm`** and **`LedEnter`** that also can be used for controlling the LEDs. Using these variables, you can let the external display do the flashing itself, without putting a load on the application program or the EFX-channel.

The variables can be used in the following ways:

`LedAlarm/Enter`	**Description**
0	The LED is off
1	The LED is on
2-10	The LED flashes at an interval specified by the value in number of 100 ms. An interval is a complete on/off-cycle!!
255	The LED is controlled by the variable **`Led_Ala`** or **`Led_Num`**.

System Variables

Type	Name	QPac	QLN	Cell	Nor	Ver	T	Description
L	**`LED_Ala`**	**`QDisp`**	249	42	0	2.0	-	Controls the alarm LED directly
L	**`LED_Num`**	**`QDisp`**	249	43	0	2.0	-	Controls the LED in the enter key directly
X	**`LedAlarm`**	**`QDisp`**	249	9	255	2.8	-	Advanced control of the alarm LED
X	**`LedEnter`**	**`QDisp`**	249	10	255	2.8	-	Advanced control of the LED in the enter key

Beeper

The beeper is handled as in non-EXOflex-controllers, i.e. with the system variables **`Beep`** and **`Beep_Mode`**. See also the document *EXOreal*.

Character Sets

n=	0	1	2	3	4	5	6	7	8	9
0*n*			CLS[2]							
1*n*						¤	►	◄		‼
2*n*	¶	§	-		↑	↓	→	←		
3*n*	▲	▼	Spc[1]	!	"	#	$	%	&	'
4*n*	(	)	*	+	,	-	.	/	0	1
5*n*	2	3	4	5	6	7	8	9	:	;
6*n*	<	=	>	?	@	A	B	C	D	E
7*n*	F	G	H	I	J	K	L	M	N	O
8*n*	P	Q	R	S	T	U	V	W	X	Y
9*n*	Z	[	\	]	^	_	`	a	b	c
10*n*	d	e	f	g	h	i	j	k	l	m
11*n*	n	o	p	q	r	s	t	u	v	w
12*n*	x	y	z	{	|	}	~	∆	Ç	ü
13*n*	é	â	ä	à	å	ç	ê	ë	è	ï
14*n*	î	ì	Ä	Å	É	æ	Æ	ô	ö	ò
15n	û	ù	ÿ	Ö	Ü	ø	£	Ø	₧	ƒ
16*n*	á	í	ó	ú	ñ	Ñ	ª	º	¿	®
17*n*		½	¼	¡	«	»				
18*n*		Á	Â	À	©					¢
19*n*	¥								ã	Ã
20*n*								¤	ð	Đ
21*n*	Ê	Ë	È	i	Í	Î	Ï			■
22*n*	■	¦	Ì	■	Ó	ß	Ô	Ò	õ	Õ
23*n*	µ	þ	Þ	Ú	Û	Ù	ý	Ý	ε	´
24*n*	‐	±	≥	≤	¶	§	÷	,	°	.
25*n*	.	^{1}	^{3}	^{2}	■					

[1] *SPC* = Blank space

[2] *CLS* = Clears the display

Chapter 19 TCP/IP

General

The TCP/IP PIFA-unit is a special PIFA intended for connection to an internal serial port in a processor house. Its task is to carry EXOline-messages in TCP/IP via a computer network, from one controller to another. The connection to the network is via twisted-pair Ethernet.

Communication is always between two or more TCP/IP PIFA-units. The transport via TCP/IP is invisible to the controller, as the communication is translated to and from ordinary serial communication for the controller.

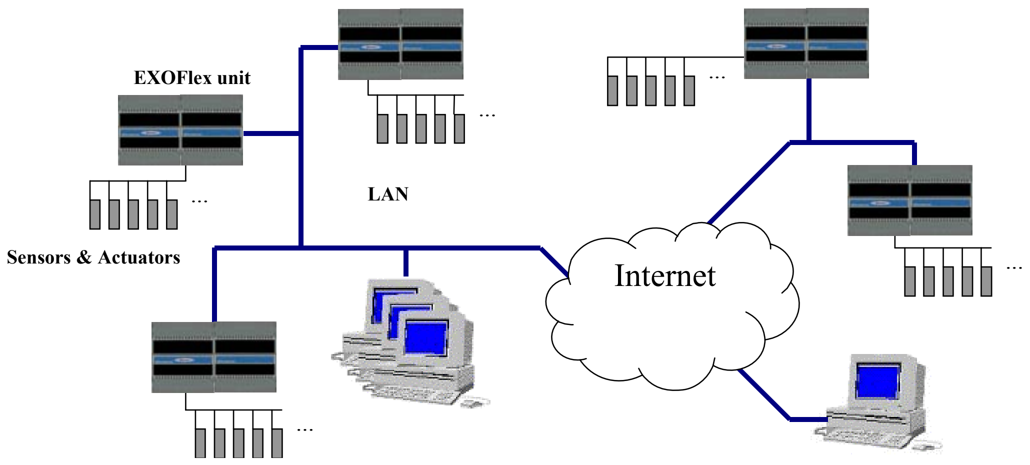
This means that ordinary computer networks, and even the Internet, can be used for communication between and with controllers.

By using TCP/IP PIFA's, systems can be spread over greater geographic areas with very simple resources. Exploiting the infrastructures already in use for ordinary computers reduces costs for installation.

The PIFA-unit can be used with most types of TCP/IP network, e.g. local area networks, the Internet, etc. It is not however suitable for use in dial-up TCP/IP networks. There are certain security functions that allow it to be used on the Internet, if there are no important security considerations.

Figure 39 shows an example of a system where the controllers communicate with each other with the help of TCP/IP PIFA-units.

Figure 39. System using Ethernet communication.



NetController

The TCP/IP PIFA can also communicate with a product from WHI, called the NetController. There is a special variant of the NetController that supports the EXOline-protocol in the same way as the TCP/IP PIFA.

TCP/IP Gateway

The TCP/IP PIFA can also be used in EXOflex-houses without processors, for creating a TCP/IP Gateway. This can be used independently for converting between EXOline and TCP/IP. See also ***TCP/IP Gateway*** on page 129

Network Construction

TCP/IP has no concept of master/slave and will, in principle, allow "everybody to communicate with everyone else". This cannot, however, be used to its full extent in the TCP/IP-PIFA-unit, as it is merely a *gateway,* i.e. a bridge between a TCP/IP network and serial communication.

A controller's serial port is always either a master or a slave, which is configured in EXOreal in the usual way. The TCP/IP PIFA-unit has no corresponding configuration, but detects itself how it is being used. All communication must go between a master-port and a slave port.

When constructing an ordinary EXOline-network with serial communication, you build a hierarchical network, with one controller at the top, a few more below, etc. This physical and logical structure is reflected in the controller's addresses (PLA and ELA), to allow configuration of *piping* through the controllers.

When building a network that uses TCP/IP-communication, it should be designed from the EXOline point of view, with no regard to how it is connected in the TCP/IP-network. You are then constructing a *logical* EXOline-structure, just as if ordinary serial communication was being used. The controllers' addresses, the ports' modes, *piping*, etc are configured in exactly the same way.

You can design the physical structure of the TCP/IP-network completely independently of the logical construction of the EXOline-network. In most cases, you **will not** be constructing TCP/IP-networks, but instead using an existing one for the communication between the controllers. There will then usually be a network supervisor who can help with information on how the TCP-IP PIFA-units should be configured.

Security

Security in this context means how to protect the system against network intruders. There are a few mechanisms in the TCP/IP PIFA-unit, which together provide moderate security.

If the TCP/IP PIFA-unit is only being used in a local network, but the network is also connected to the Internet, you can guard against unauthorized external access by using a firewall or a *proxy server*.

If the project will be using the Internet for communication, any firewalls must be open for this communication. It is, however, still possible to prevent the PIFA-units being configured externally through the firewall. In a TCP/IP PIFA that is connected to a slave port, it is also possible to configure it to only accept communication from the correct master.

Even if the above protective measures are not used, it will still not be easy for external "hackers" to do anything. Without EXOdesigner, an EXOflex-house with a TCP/IP PIFA, or a good knowledge of the EXO System, it will be extremely difficult to break in, due to the system's complexity. Furthermore, if the hacker wanted to do something "constructive", e.g. change a set-point value, he would also have to know something about the controller's project-software.

Performance

The TCP/IP PIFA is, as mentioned in the beginning of this chapter, a gateway that takes the information from a serial port and transports it over a network using the TCP and IP protocols. The TCP/IP PIFA is thus not only a physical converter, but also a protocol converter to a certain extent.

The protocol conversion results in a small delay, and therefore lower performance compared to a cable connection between two controllers. Which communication performance that is achieved also depends on delays and possible interferences in the network. In a normal office network the communication speed will be approximately halfway between a fixed 9600 bps cable connection and a 2400 modem connection.

If a master TCP/IP PIFA is used for communicating with more than 10 slave TCP/IP PIFA units, the communication speed is lowered further. In the worst case the speed drops to a level comparable to that of a 2400 bps modem connection.

I large systems with high demands for high communication speed, it may therefore be a good idea to have a master TCP/IP per 10 slave PIFA-units. This can be accomplished using multi drop between the PIFA units over Port 2 of the main processor. A more detailed description of how this is configured is given in the section ***Multidrop***.

Unreachable Controllers

Generally, an attempt to communicate with an unreachable or non-existing controller takes longer time than for a reachable controller. When communicating in a network the answer time to a computer can vary rather much, and also be quite long. To reduce the effect of unreachable controllers, the TCP/IP PIFA masks part of the processes taking place in the network from the station master .

There are two cases that yields somewhat varying results:

If the TCP/IP PIFA units connect with each other, but the controller on the slave side is not responding, the result will be as for an unreachable controller in an ordinarily connected fixed system.

If, on the other hand, the TCP/IP unit on the master side does not connect with the TCP/IP unit on the slave side, the result will be somewhat different. After the initial attempt at communicating with the unreachable station slave , it takes three seconds before the TCP/IP unit returns NoAnswer to the station master. The master TCP/IP PIFA unit continues to contact the slave TCP/IP PIFA unit in the background. The next time a message is sent to the same slave controller, NoAnswer is returned to the master controller as soon as it is clear that the connection with the slave PIFA unit is not established. After about a minute the TCP/IP PIFA unit stops trying to connect to the slave PIFA unit and the next communication attempt from the master will initiate a new 3 second delay followed by fast NoAnswer.

Considering that unreachable controllers affect the performance for the rest of the system in a negative way, it is important not to configure equipment into a project that is not installed and can be expected to answer. This means that non-existing substations should not be configured in line handlers and CCM.

Configuration

Each TCP/IP PIFA is connected to a serial port on a controller. A house can contain several controllers and each controller can have several serial ports. It is therefore possible to have several TCP/IP PIFA-units in a processor house, even this is seldom done.

The PIFA-units must first be added in EXOflex I/O Tool, in the usual way. To do the configuration, you then start the special TCP/IP PIFA Tool from EXOflex I/O.

The TCP/IP PIFA-unit has no contact with the controller in the house via EFX. The configuration is not loaded via the controller, as it is for other types of PIFA-unit. Instead, the configuration is loaded directly from the PC to the PIFA via the TCP/IP-network. For this to be possible, both must be connected to the same sub-net (or on separate sub-nets that are in contact with each other).

The actual configuration is done in **TCP/IP Tool** and saved (as usual) on the hard drive. The configuration can then be loaded to the PIFA at some later time.

To be able to configure the TCP/IP PIFA-units in a project, you must know something about TCP/IP-networks. A complete guide to TCP/IP networks is beyond the scope of this book, but a short introduction is provided below:

TCP/IP

All communicating units in a TCP/IP network are known as *nodes*, and all are equal. There is no concept of masters and slaves, or anything similar to it. In principle, all nodes can communicate with any other node. Each node must have a unique address, known as an IP-address, which is a 32-bit number. IP-addresses are always given as four integers between 0 and 255, separated by periods, e.g.: 192.168.1.10.

TCP/IP allows the connection of many small local networks (sub-nets) in larger networks. The Internet is the worlds largest TCP/IP-network, linking thousands of different sub-nets together. The traffic between these sub-nets is handles by *routers*. A router is a special unit with two or more TCP/IP-nodes, each of which can be connected to a sub-net. Traffic from one sub-net to another is received by a router, which works out the messages' destination by checking the IP-address contained in them. The messages are then forwarded to the destination by the router. In this way, nodes in one sub-net can communicate with others in other sub-nets, via one or more routers (and sub-nets). This is very similar to *piping* in EXOline-networks.

For all of this to work properly, the IP-addresses must be assigned systematically, so that all the nodes in a sub-net have IP-addresses where e.g. the first 24 bits are the same (the net-address). To define this, a *sub.net mask* is used. This sub-net mask is also a 32-bits number, written with four integers and periods. The bits in the sub-net mask that are set reveal that these are part of the net address, and the bits that are not set say that these are part of the node address. Nearly all sub-nets in use today have 24-bit net addresses, followed by 8-bit node addresses, which gives the sub-net mask 255.255.255.0.

Even if TCP/IP does not use the master/slave concept, it is common for network communication to be designed so that certain nodes provide services for other nodes. These are known as *servers* and *clients* respectively. When a client wants to contact a server, it must know the server's IP-address. As IP-addresses can be hard for people to remember, a system of names is used instead, which is known as DNS. This allows each node to use a name in plain language and each sub-net a. *sub-net name.* The names are registered manually in *DNS-servers*. When a client contacts a server, it first queries a DNS-server (or maybe several) to obtain the correct IP-address. The node name and sub-net name are usually written together and separated by periods. For example, in **`www.regin.se`** the node name is **`www`** and the domain name is **`regin.se`**.

IP-addresses can be assigned manually (with a fixed configuration) or dynamically, by a server in the network. The function for dynamically assigning addresses is called DHCP. If using dynamic IP-addresses for a server, the clients wanting to contact it must use names, as its IP-address is cannot be known in advance. In cases like this, a more advanced type of name-server, called DDNS must be used. This allows dynamic registration of the IP-address (by the server itself).

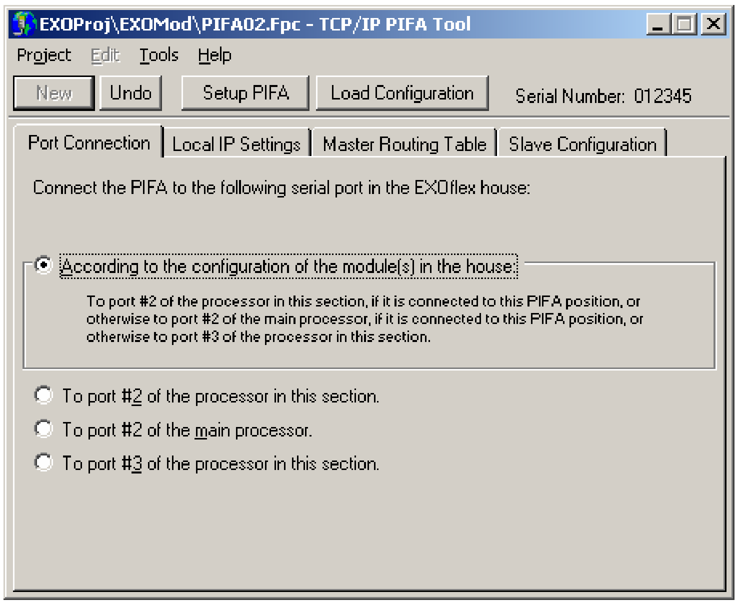
The configuration in TCP/IP PIFA Tool is divided into four different tabs, according to the following:

- ❑ **Port Connection**, for configuring the PIFA-unit's connection to the controller's serial port in the processor house.
- ❑ **Local IP Settings**, for configuring the PIFA's TCP/IP-settings.
- ❑ **Master Routing Table**, for configuring PIFA-units connected to an EXOline master-port.
- ❑ **Slave Configuration**, for configuring PIFA-units connected to an EXOline slave-port.

Port Connection

The **Port Connection** tab is used to configure the PIFA's connection to the controller's serial port in the processor house.

*Figure 40. The **Port Connection** tab.*



Serial Number: 012345

Connect the PIFA to the following serial port in the EXOflex house:

(●) According to the configuration of the module(s) in the house:

To port #2 of the processor in this section, if it is connected to this PIFA position, or otherwise to port #2 of the main processor, if it is connected to this PIFA position, or otherwise to port #3 of the processor in this section.

( ) To port #2 of the processor in this section.
( ) To port #2 of the main processor.
( ) To port #3 of the processor in this section.

The PIFA's connection to a serial port in the house can be controlled either by the controllers in the house or by the PIFA itself. Normally you would use the setting **According to the configuration of the controller(s) in the house**, whereby the connection is controlled by the controllers, according to the following rules:

- ❑ To port 2 on the processor in the same section as the PIFA, if it is connected to the PIFA-position in question (with **`Connect_Port_2`**).
- ❑ Otherwise to port 2 on the main processor (furthest to the left in the house), if it is connected to the PIFA-position in question (with **`Connect_Port_2`**).
- ❑ Otherwise to port 3, to the processor in the same section as the PIFA. This requires the PIFA to be in the PIFA-position "under" the processor.
- ❑ Otherwise not connected.

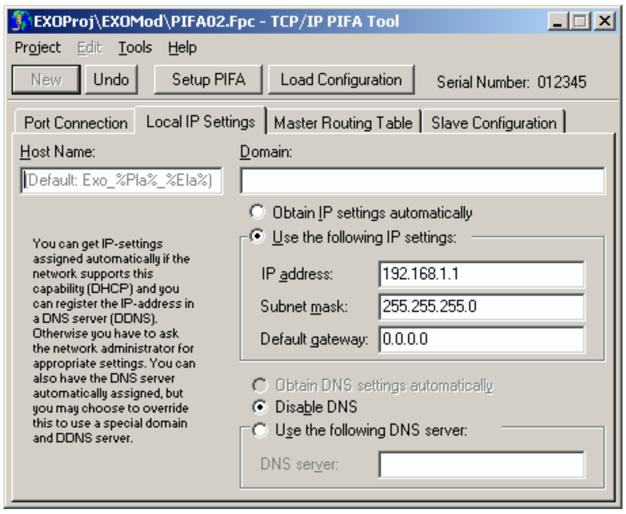
These rules are much the same as those for other types of communication PIFA-units.

It is important to keep in mind that the port corresponding to the criteria on top of the list will be selected if two criteria in the list above are fulfilled at the same time. If desired, the PIFA can be configured to connect to any port, irrespective of the controllers' configuration. This is particularly suitable if you want to reach a cold-started controller via the TCP/IP network.

Local IP Settings

The **Local IP Settings** tab is used to configure the PIFA's TCP/IP-settings.

*Figure 41. The **Local IP Settings** tab.*



EXOProj\EXOMod\PIFA02.Fpc - TCP/IP PIFA Tool

Project Edit Tools Help

New | Undo | Setup PIFA | Load Configuration | Serial Number: 012345

Port Connection | Local IP Settings | Master Routing Table | Slave Configuration

Host Name: (Default: Exo_%Pla%_%Ela%)

Domain:

You can get IP-settings assigned automatically if the network supports this capability (DHCP) and you can register the IP-address in a DNS server (DDNS). Otherwise you have to ask the network administrator for appropriate settings. You can also have the DNS server automatically assigned, but you may choose to override this to use a special domain and DDNS server.

○ Obtain IP settings automatically

● Use the following IP settings:

IP address: 192.168.1.1

Subnet mask: 255.255.255.0

Default gateway: 0.0.0.0

○ Obtain DNS settings automatically

● Disable DNS

○ Use the following DNS server:

DNS server:

TCP/IP PIFAos version 1.0 does not support DDNS, which means that most settings on this tab will not apply.

In practice, you must use manual IP-settings, which means that DNS-names will be of no use. In this case check the boxes for **Use the following IP settings** and **Disable DNS**. Then enter the PIFA's IP-address, the network's sub-net mask and the router's IP-address (**Default gateway**) manually.

In most cases, TCP/IP PIFA-units will be used in existing networks, where there will be staff administering the network. These parameters can then be obtained from the network supervisor. If you are building your own network, you should know enough about TCP/IP networks to be able to configure these parameters. In a small local network, you can e.g. use the addresses 192.168.1.0 to 192.168.1.255. The sub-net mask will then be 255.255.255.0.

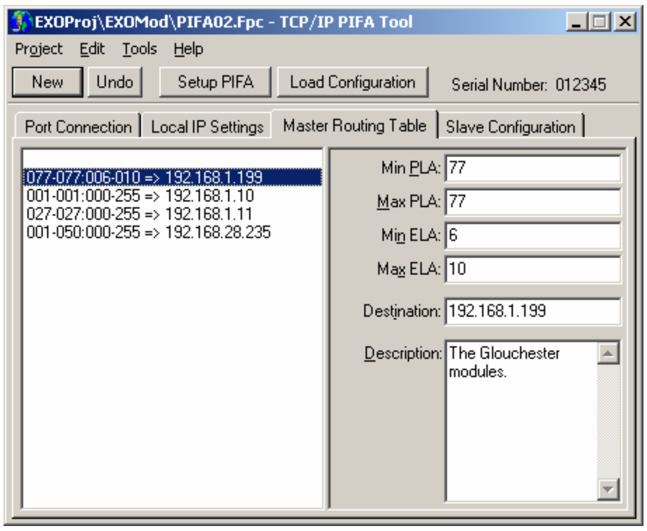
For **Default Gateway,** specify the router's address. If there is no router in the network, an unused address may be stated. The address 0.0.0.0. is not good to use since it may cause unnecessary broadcast traffic in the network.

Host Name and **Domain** can be configured, even if you are not using DNS. This will not fill any function in the system, but will act as a memory aid and as a plain language name.

Master Routing Table

The **Master Routing Table** tab is used to configure PIFA-units connected to an EXOline master-port.

*Figure 42. The **Master Routing Table** tab.*


EXOProj\EXOMod\PIFA02.Fpc - TCP/IP PIFA Tool
Project Edit Tools Help
New Undo Setup PIFA Load Configuration
Port Connection Local IP Settings Master Routing Table Slave Configuration

Serial Number: 012345

```
077-077:006-010 => 192.168.1.199
001-001:000-255 => 192.168.1.10
027-027:000-255 => 192.168.1.11
001-050:000-255 => 192.168.28.235
```

Min PLA: 77
Max PLA: 77
Min ELA: 6
Max ELA: 10
Destination: 192.168.1.199
Description: The Glouchester modules.

The PIFA receives EXOline-messages on its serial port from a controller in the house. It analyses the PLA and ELA in the EXOline-message and looks up the address in the *Master Routing* table. This will show which TCP/IP PIFA the message is destined for, in the form of an IP-address. The PIFA sends the message to the other specified PIFA, which receives it and converts it back to an EXOline-message and sends it to the connected controller in the processor house.

In the routing-table, each line contains an interval with PLA- and ELA-addresses. Each time the PIFA searches the table, it starts at the top and searches until it finds the line that fits the EXOline address in question. It is even permissible to configure this so that certain EXOline-addresses match several lines. The uppermost line that matches will then always be selected. An example of a routing table is shown below:

A Routing table for converting between EXOline- and IP-addresses.

Min-PLA	Max-PLA	Min-ELA	Max-ELA	Slave hostname
77	77	6	10	192.168.1.199
1	1	0	255	192.168.1.10
27	27	0	255	0.0.0.0
1	50	0	255	192.168.28.235
0	255	0	255	0.0.0.0

The table is read as follows:

- ❑ Communication to ELA 6 to 10 in station 77 will be sent to the IP-address 192.168.1.199.
- ❑ Communication to station 1 will be sent to the IP-address 192.168.1.10.
- ❑ Communication to station 27 is not forwarded.
- ❑ All other communication to stations 1–50 goes to the IP-address 192.168.28.235.
- ❑ All other communication is not forwarded.

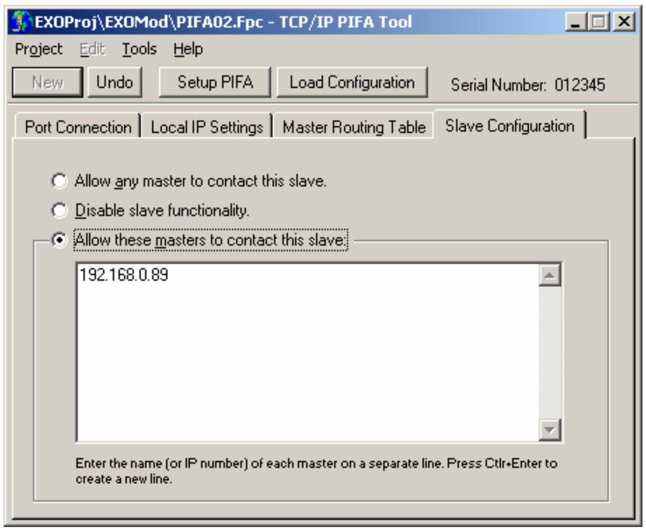
A TCP/IP PIFA master can communicate with an unlimited number of TCP/IP PIFA slaves. A master that is connected to more than 10 slaves will however have a significantly lower performance, since the memory in the master is not sufficient for keeping all the connections (*TCP/IP sessions*) running all the time.

We therefore recommend that you design communication units with a maximum of 10 TCP/IP-connected stations per line handler.

Slave Configuration

The **Slave Configuration** tab is for configuring PIFA-units connected to an EXOline slave port.

*Figure 43. The **Slave Configuration** tab.*


EXOProj\EXOMod\PIFA02.Fpc - TCP/IP PIFA Tool
Project Edit Tools Help
New Undo Setup PIFA Load Configuration
Port Connection Local IP Settings Master Routing Table Slave Configuration

Serial Number: 012345

( ) Allow any master to contact this slave.
( ) Disable slave functionality.
[✓ Allow these masters to contact this slave:]

192.168.0.89

Enter the name (or IP number) of each master on a separate line. Press Ctlr+Enter to create a new line.

There is no particular configuration of the PIFA necessary for it to be connected to an EXOline slave port.

There is however, a function for limiting which TCP/IP PIFA-unit(s) can communicate with this slave port. Simply enter the IP-numbers for the permitted master-TCP/IP PIFA-units.

The purpose of this is to prevent unauthorized communication with the connected slave port via the TCP/IP PIFA.

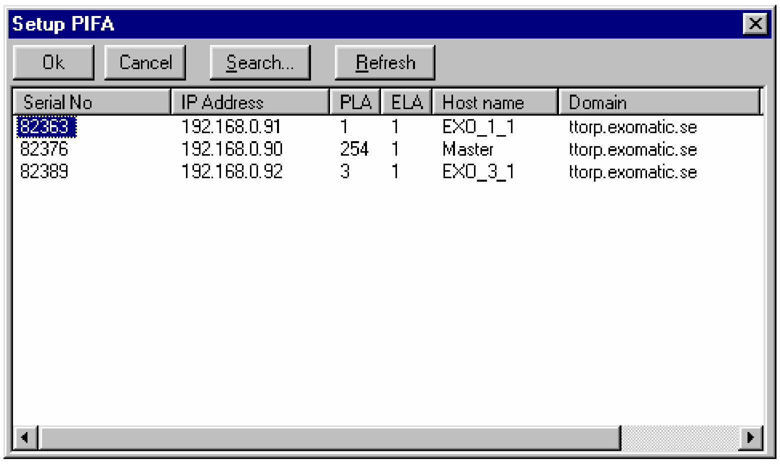
Load the Configuration

The configuration is loaded directly from the **TCP/IP Tool,** via the network to the PIFA. Before loading the configuration to the PIFA, you must run *Setup* on the PIFA. This is because you must select the correct PIFA-unit to load the configuration to.

Run Setup on the PIFA

This is done with the command **Setup PIFA** in **TCP/IP PIFA Tool**. The command opens a window that shows a list of all the TCP/IP PIFA-units in the same local network (sub-net) as the computer.

Figure 44. The Setup window.



Serial No	IP Address	PLA	ELA	Host name	Domain
82363	192.168.0.91	1	1	EXO_1_1	ttorp.exomatic.se
82376	192.168.0.90	254	1	Master	ttorp.exomatic.se
82389	192.168.0.92	3	1	EXO_3_1	ttorp.exomatic.se

When doing this out in the actual installation, it can be a good idea to take your own hub with you. This is to allow you to connect to the client's network, as there will often be a network socket intended for connecting the controller. Connect the hub to the network socket and then connect the laptop PC and TCP/IP PIFA to the hub's ports. When the configuration is complete, the hub is disconnected and the TCP/IP PIFA is connected directly to the network socket.

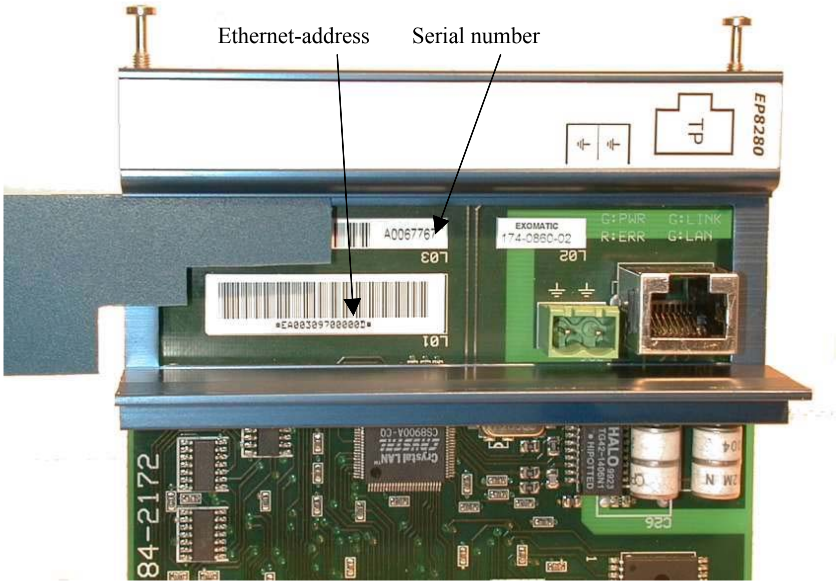
The window shows the PIFA-units' serial numbers and current IP-settings. Their Ethernet-addresses can be seen by scrolling to the right.

The serial number is an ordinary five or six figure number. All components manufactured by Regin receive a unique serial number. The Ethernet-address is a 48-bit address, unique amongst all Ethernet units produced (worldwide).

The PIFA's Ethernet-address is noted on the lower barcode label behind the plate covering the part of the PIFA not used for contacts. See the figure below. When the PIFA is not mounted in a house, the covering plate can be moved to the side to reveal the PIFA's Ethernet-address and serial number.

When a configuration is tied to a PIFA-unit, the unit's serial number is displayed in the upper right corner of TCP/IP PIFA Tool.

Figure 45. The Ethernet-address and serial number.



Select the correct PIFA and click **Ok**. The parameters on the **Local IP Settings** tab are then loaded to the PIFA. The PIFA's serial number is also saved in the unit's configuration, which the tool saves to the hard drive. The serial number is then used by the tool when loading configurations etc.

If the TCP/IP PIFA unit is to be used as a slave and only uses the default configuration under the tab "Slave Configuration", you only need to do "Setup PIFA" on the PIFA unit.

If a TCP/IP PIFA is moved to another controller, or if the IP-address is changed etc, Setup must be run again. You will then see the previous TCP/IP-settings in the window. In this case the PIFA setup can even be done from another network (via routers). Press the **Search** button in the setup window and specify the <u>current</u> IP-address. If the tool finds the PIFA it will be shown in the list.

Setup can also be done from another sub-net, if the PIFA already has an IP-address loaded. Click the **Search** button and enter its current IP-address and it will appear in the list.

Load the Configuration

When the PIFA has been set up, the configuration can be loaded to it with the command **Load Configuration** in TCP/IP **Tool**. The tool uses the (saved) serial number from when Setup was used to identify the PIFA.

The configuration can be loaded from any network that can contact the PIFA via routers, but only as long as the IP-address has not been changed. If it has changed, Setup will need to be done again.

You might want to configure your PIFA-units before going to the customer's installation. Usually, the customer uses other series of IP-addresses than the ones used for your own office. In order to solve this problem, you can change network configuration in the computer running TCP/IP PIFA Tool to one similar to the one that the PIFA-unit will have in the installation. The IP-address, which is selected in the same sub-net as the PIFA-unit, should be different than the PIFA-unit's configuration. Depending on the network services installed in the computer, and their configuration, it might happen that the configuration still cannot be loaded to the PIFA-unit. The reason may then be settings in proxy-clients, dialed-up networks etc.

In order to make it possible to perform **Load Configuration** on a TCP/IP PIFA the computer that loads the configuration and the TCP/IP PIFA unit <u>must</u> be correctly configured for the network they are connected to. This means that an installer's portable computer probably is not correctly configured for the client's network. To be able to upload the configuration, the settings on the portable computer must be changed so they fit the client's network. That **Setup PIFA** works does <u>not</u> mean that **Load Configuration** works. **Setup PIFA** is designed to work even if the network settings in the PIFA unit are erroneous.

Set the Processor's Address

If the controller is completely unconfigured ("cold-started"), it will have the address 254:30. The correct address must be set before the program can be loaded. This is normally done with the command **Reset Controller** in e.g. Project Builder.

This can however, be difficult to do via the TCP/IP PIFA-unit, as the routing table in the master is hardly likely to be configured for sending EXOline-messages with the address 254:30 to just that PIFA. You should therefore set the controller's address locally, by connecting the computer directly to one of its serial ports.

It is however, still possible to cool start a controller via TCP/IP-PIFA-units, with no problems.

Loading the Operating System

You can load the TCP/IP PIFA's operating system with **TCP/IP PIFA Tool**. This is done with the command **Load PIFAos**. The command first displays a message showing the revisions of both the current operating system and the one about to be loaded.

For this to work, you must first have run setup on the PIFA. The tool uses the (saved) serial number from when Setup was used to identify the PIFA. Any configuration for the PIFA will be preserved when reloading the operating system.

The operating system can be loaded from any network that can contact the PIFA via routers, but only as long as the IP-address has not been changed. If it has changed, Setup will need to be done again.

From and including version 1.0-1-03 of EP8280-PIFAos, the PIFA-units' error handling has been redesigned to also manage upgrades under difficult network conditions.

If the operating system in the PIFA-unit is older than version 1.0-1-03, we recommend you to do the upgrade in an "isolated network", where only the PIFA-unit and the computer loading the configuration are connected. This mainly applies to networks with a high load where the built-in error handling can restart the PIFA-unit during upgrade at network load peaks.

If TCP/IP PIFA Tool would report that the upgrade failed, it is important not to break the current to the PIFA-unit but to retry to carry through the upgrade. TCP/IP PIFA Tool will retry automatically, but will give up after three attempts.

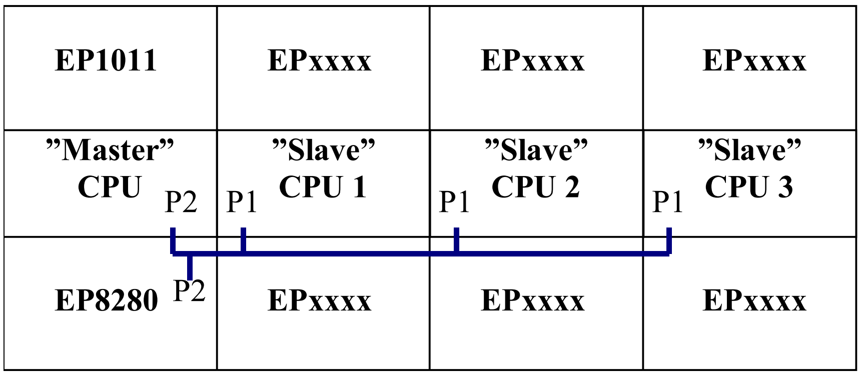
If the PIFA-unit would be restarted or without current during upgrade, the PIFA-unit will stop functioning and has to be sent to Regin for reprogramming.

Advanced Applications

Multidrop

The TCP/IP PIFA supports multidrop on the main processor's port 2 internally in an EXOflex-housing. Consequently, the PIFA-unit can be connected to the main processor's port 2 with slave processors in the same house.

Figure 46. Multidrop on the main processor's port 2.



For this type of configuration, it is important that the slave processors' piping settings are made in such a way that they do not overlap the PLA- and ELA-ranges defined in the PIFA-unit's routing table. The TCP/IP PIFA uses its routing table correspondingly to how the EXOreal-processor uses the variables Max_ELA, Max_PLA, Min_ELA and Min_PLA.

The TCP/IP PIFA can also be used for multidrop applications with port 2 on the main processor and other communication units. With the TCP/IP PIFA is is possible to manually, using the configuration tool, choose which port the PIFA should connect to.

The configuration of a system where the communication PIFA is used in a multidrop application together with the TCP/IP PIFA is done in the following way: The communication PIFA unit is configured as usual by choosing **Connect to PIFA** in Controller System Tool. In the configuration of the TCP/IP PIFA, the setting **To port #2 of the main processor** on the tab **Port Connection** is chosen.

The same configuration can also be done with two TCP/IP PIFA units instead of a communication PIFA and a TCP/IP PIFA. It is important that the posts in the routing table of the TCP/IP PIFA are not overlapping the routing range that has been configured in controllers connecting to the main processor's port 2.

The same multidrop functionality can be used by the PIFA-unit in TCP/IP Gateway version, se ***TCP/IP Gateway***, page 129.

TCP/IP PIFA units with serial numbers lower than A0070240 do not support connection to the main processor's port 2 and can therefore not be used for multidrop applications in an EXOflex housing. The support for the main processor's port 2 in these PIFA units is missing in the hardware.

PIFA units without previous support for multidrop on EXOline when the PIFA is included in a TCP/IP Gateway can, however, be made to support multidrop on EXOline by a software upgrade to EP8280 PIFAos version 1.0-1-00 or later.

Multimaster

The multimaster function opens new communication possibilities in the EXO system. For example can a separate controller be connected that handles varible transfers between the controllers in parallel with the rest of the communication. However, this requires an extra TCP/IP PIFA and a CPU in the communications unit, but will, especially in large systems, increase the communication speed between EXO4 and the controllers.

TCP/IP PIFA units that are used as slaves can handle tha communication with several master controllers at the same time. If two station masters simultaneously each send a question to the station slave, one of the controllers answers will be slightly delayed, while the message from the other station master is being processed. This means that the number of messages per second from one of the masters will be somewhat lower than had it been alone. The total number of messages per second will however increase since the slave recieves the next message from the queue as soon as it has processed the previous message.

Firewalls

To communicate via TCP/IP PIFA-units through a firewall, it must be configured for that purpose. A firewall is a unit that only allows TCP/IP-communication on certain *port numbers* and not on others. TCP/IP-ports work as separate communication channels between two nodes. The TCP/IP PIFA-units use separate ports for operation and configuration, as described below:

Type of Communication	Port number	Protocol
Normal operational traffic.	26486	TCP
Configuration, i.e. the commands **Setup PIFA, Load Configuration** and **Load PIFAos**.	26487	TCP, UDP

Hardware Interface

The TCP/IP PIFA has two connections to the outside world. The first is an RJ-45 contact for connecting to Ethernet via a TP-cable (10base-T). The other is a two-pole Phoenix-plinth for connection to protective earth, which is necessary for the function of the equipment's lightning protection.

See also *Error! Reference source not found.* on page **Error! Bookmark not defined.**.

Chapter 20 **Applications**

Controller Objects

When using an EXOflex-controller, you first add the PIFA-units with EXOflex I/O Tool and then use PIFA I/O Tool to configure names and properties for your resources (inputs and outputs). If you want to e.g. connect an analog input to an outside temperature sensor, give that analog input the name **`Outtemp`** in PIFA I/O and configure the sensor type, filtering factor etc. In your object, you then connect the variable **`Outtemp`** directly to e.g. a regulator object. This procedure is the same for other inputs and outputs.

This means that you do not have to use special input and output objects when programming EXOflex-controllers, thus reducing the number of objects in a controller.

It will be easier to re-use ready configured objects if you use a standard form for your resource names. You might have e.g. configured sets of objects for different types of ventilation aggregates. All you would then have to do would be to configure your inputs and outputs in PIFA I/O.

Display

The external display in the EXOflex-system has more keys than non-EXOflex-controllers. Normally you do not program the display handling directly, but instead use the ready-made controller functions in EXOdesigner.

For this to work, you must use new versions of the affected controller functions. EXOflex requires the following versions:

- ❑ Dialog 3.3
- ❑ Station Handle Program 3.3
- ❑ Time Dialog Program 2.0

For configuration purposes, the new versions are identical to their predecessors. It is only the user interface seen in run time that has been changed.

The new versions of the controller function are general, and can well be used even in non-EXOflex-controllers.

Display

In normal move-mode, things work much the same as before, but with the new keys.

The greatest difference is in how maneuvers are performed. Earlier, there were two different maneuver-modes: input-mode and increase/decrease-mode. These have now been merged into one general change-mode, with the following advantages.

The entering of numerical values is now much freer, i.e. you can enter any amount of digits and place the decimal point where you like. You can also choose whether to edit the existing value **[↵]** or enter a completely new one **[C]**. When entering a value, you can delete characters one by one if you make a mistake **[C]** and you can move around freely with the arrow keys. The entry process can be cancelled at any time by a long **[C]**.

As before, you can step the value up **[+]** or down **[-]**. Earlier, you always had to step the final digit in the value, but now you step the digit at the cursor, which can be freely moved back and forth with the arrow keys.

Station Handler

Station Handler handles the display of alarms on the external display.

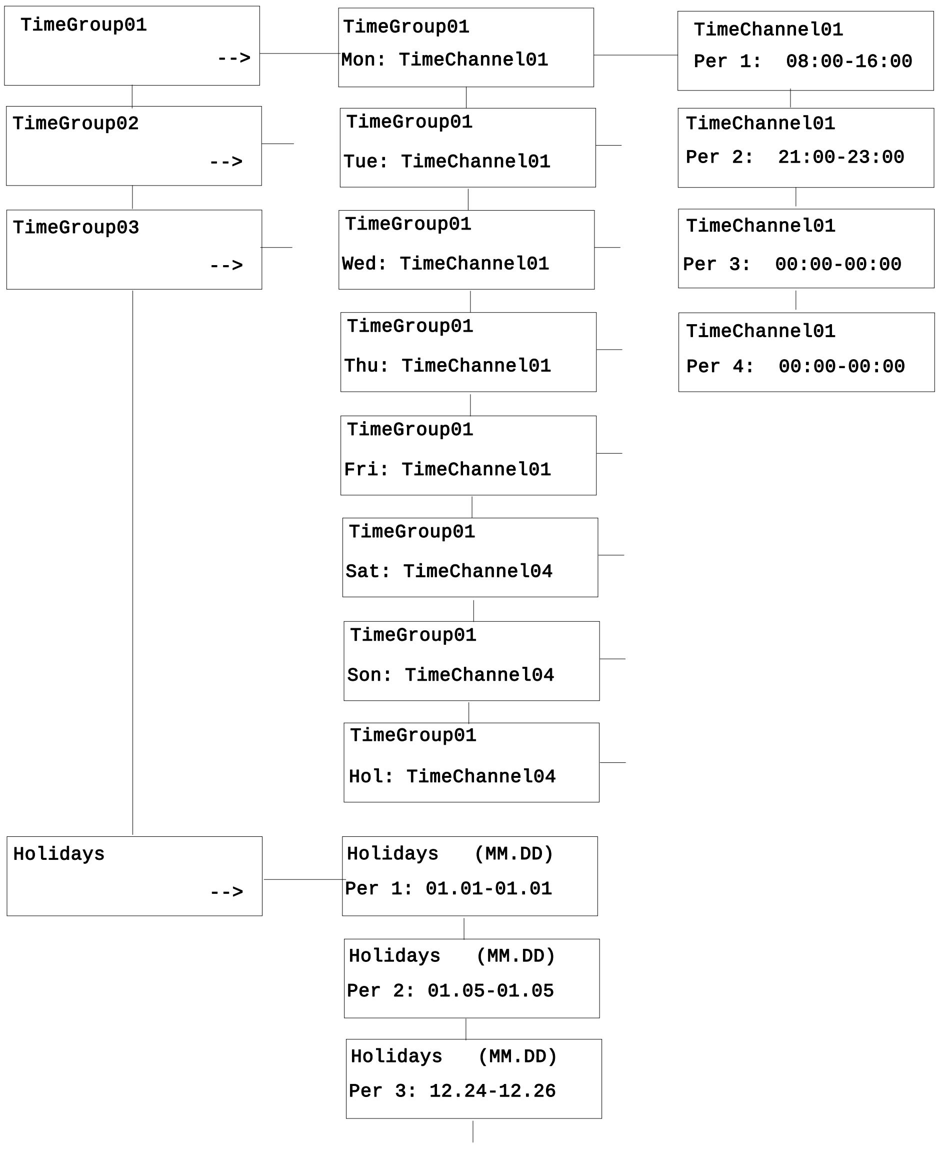
You move around, as before, with the keys **[↑]**, **[↓]**, **[←]**. To acknowledge press **[↵]**, to block/unblock press **[C]**.

It is also now possible to use alarm texts of more than 20 characters. The text can be scrolled with the key **[→]**.

Time Schedules Display

Time Schedules Display handles the larger keypad in the same way as Display during maneuvers. Furthermore, the program uses a completely new structure for the dialog boxes. This new structure should be easier to learn and more like Display's structure. This version can also be used in non EXOflex-controllers, with the new structure.

See the example below.


TimeGroup01 -->
TimeGroup02 -->
TimeGroup03 -->
Holidays -->
TimeGroup01 Mon: TimeChannel01
TimeGroup01 Tue: TimeChannel01
TimeGroup01 Wed: TimeChannel01
TimeGroup01 Thu: TimeChannel01
TimeGroup01 Fri: TimeChannel01
TimeGroup01 Sat: TimeChannel04
TimeGroup01 Son: TimeChannel04
TimeGroup01 Hol: TimeChannel04
Holidays (MM.DD) Per 1: 01.01-01.01
Holidays (MM.DD) Per 2: 01.05-01.05
Holidays (MM.DD) Per 3: 12.24-12.26
TimeChannel01 Per 1: 08:00-16:00
TimeChannel01 Per 2: 21:00-23:00
TimeChannel01 Per 3: 00:00-00:00
TimeChannel01 Per 4: 00:00-00:00

Limitations

Performance

EXOflex-controllers have exactly the same performance as all other EXO controllers with the 22 MHz processor. It is true that EXOreal itself does not need to handle the hardware resources directly, but only indirectly via the EFX-channel. The handling of the EFX-channel however, puts about the same load on the controller as hardware resources in e.g. the model 5540.

The free processor capacity available for application programs is therefore approximately the same in an EXOflex-controller as in model 5540. The PIFA-units however, contain many functions that need to be done in the application programs in other models. In applications where the PIFA-units' extra functions are required, you will thus have more processor capacity available to the rest of the application.

Furthermore, EXOreal 2.8 has somewhat better performance than earlier versions when handling **long** VPacs and BPacs. This improvement applies to all models.

Memory

EXOflex controllers have 512 kByte of expanded memory, of which 480 kB can be used to its limits.

The general limits (for all models) are otherwise:

Tasks: Maximum 15, consisting of 256 segments each.

DPacs: Maximum 62, consisting of 256 segments each.

Texts: Max 240 (possibly fewer if the texts are very long).

The number of DPacs is enough for all normal applications, even if you put a great many functions in a controller.

The limitations on the Tasks are probably not a problem either. The greatest likelihood of running into problems is when programming controllers with Controller Objects and using large numbers of functions. One (unsatisfactory) solution might be to spread the functions over more Tasks.

Texts

The most important limitation is the one for Texts. The maximum of 240 texts must be shared by a number of different controller functions. See below:

Station controllers

In station controllers it is normally the following programs that will be working together.

- ❑ **Alarms and Events**, needs a text for each alarm point. If the alarm will **only be** shown in EXO4, you can do without text in the controller.
- ❑ **Station Handler**, needs 10 texts.
- ❑ **Time Schedules Display**, needs 3 texts, plus a text for each time object.
- ❑ **Display**, needs 4 texts plus a text for each alternative in dialog boxes using text swapping functions. The static texts can be placed in BPacs (Large Storage).

Central controllers

In central controllers the following programs will normally be present.

- ❑ **CCP**, needs 11 texts plus one text per modem-dialed station (for telephone numbers).

- ❑ **Alarms and Events**, with one text for each station using alarms for unreachable stations. If the alarm is **only** shown in EXO4, you can do without texts in the controller.
- ❑ **Pager/SMS**, needs 43 texts, plus one text per station (i.e. the stations' name in plain text)

Log Channels

The number of log channels is limited to 96 per controller. There are no plans for increasing this amount in the foreseeable future.

Alarm Points

The number of alarm points is limited to 250 per controller. If you need alarm texts in the controller, the limit will be even lower. See ***Texts*** above.

This will not be increased in the foreseeable future

Multi-processor Houses

If, in a processor house, you get problems with one of the limitations mentioned above, your first thought might be to install some more processors. This, however, cannot be done all that easily, as programs you will be using cannot interact between controllers as might be desired.

Houses with several processors are, as far as software is concerned, exactly the same as several separate controllers.

Part IV **Specifications**

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Part IV **Specifications**

Enclosure Specifications

Houses

An EXOflex house can be divided into its aluminum and plastic components.

Plastic Components

The plastic components are of injection-molded, flame-resistant ABS plastic. The flame resistance is to class V0, which means that the plastic will self-extinguish in the case of fire.

Aluminum Components

The aluminum components are of extrusion-pressed anodized aluminum. The anodization has good resistance to light and chemicals.

Sealing

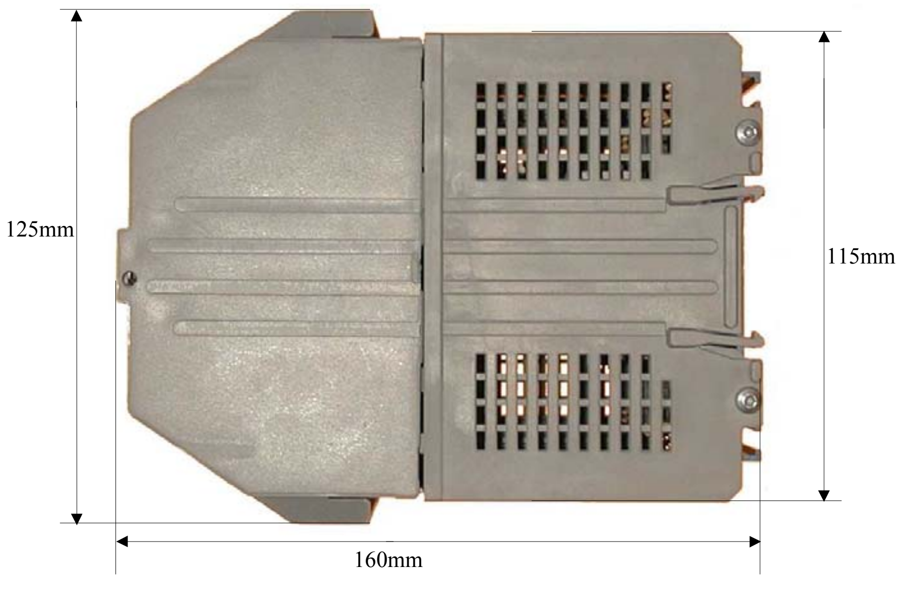
The casing sealing is to class IP30, i.e. it is intended for cabinet mounting

External Display

Refer to the external display specifications.

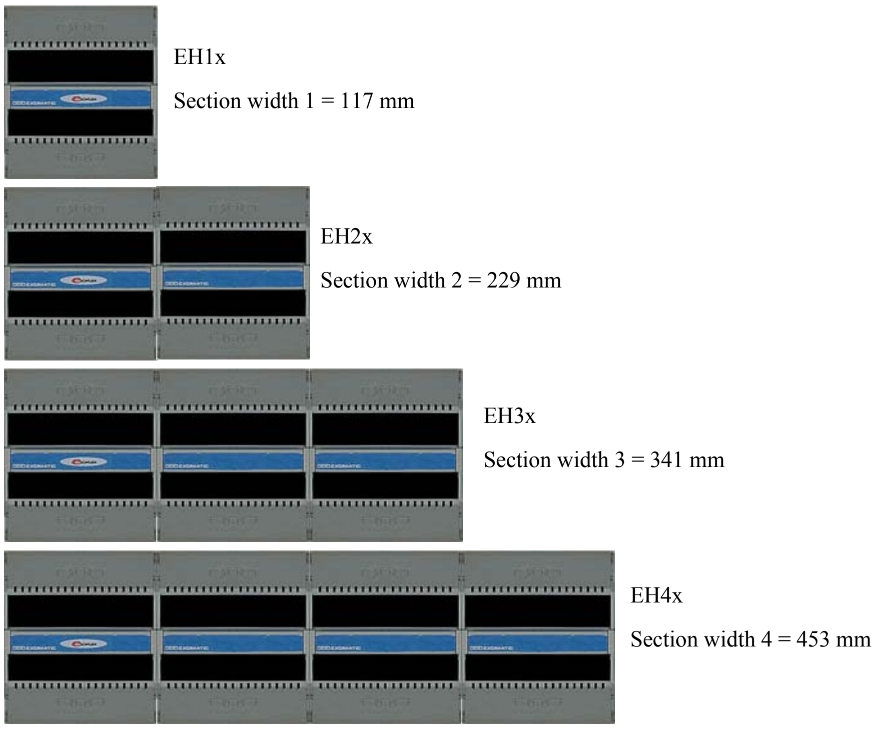
Dimensions

Figure 47. A side-view of the EXOflex house, with dimensions.



Section Widths

Figure 48. Section widths



Environment Specifications

EXOflex-units may be used under the following conditions:

Operating temperature	0 to +50^{o}C
Storage temperature	-20 to +70^{o}C
Humidity (non-condensing)	max 95 %
Above sea level	max 2000 m

Processor Specifications, ECX1

The processor function is built on two circuit boards, one of which contains an EXOreal processor and the other an EFX processor. The EXOreal processor handles EXOL application code and external serial communication via Port 1-3. The EFX processor is responsible for the exchange of data between the EXOreal processor and PIFA-units via the EFX channel. Port 1 has its physical output on the EPU's power-PIFA, whilst Ports 2-3 have theirs on special communication PIFA-units, the type EP8102.

The EFX-processor is responsible for the exchange of data between the EXOreal-processor and PIFA-units via the EFX-channel. The EFX-channel has built-in error handling with a CRC-16 check sum.

Specifications

CPU-board

Operating system	EXOreal
CPU	C515C
ROM-memory with EXOreal operating system	64 kB
Conventional RAM memory	32 kB
Expanded RAM memory	512 kB (480 kB can currently be used)
Battery backup of RAM, RTC	5 years with one processor installed
Battery monitoring	LED + software accessible
EEPROM with factory settings	2 kB
Real-time clock (RTC)	±30 sec./month.
Port 1	RxD, TxD, RTS (E-signal)
Port 2	RxD, TxD, RTS, CTS
Port 3	RxD, TxD, RTS, CTS, RI, DCD, DTR, CTS

The battery is located on the power PIFA. A backup capacitor on the CPU board retains the contents of the memory for at least 30 minutes when the unit is not powered.

EFX-board

Operating system	EFXos
CPU	C515C
EFX-channel	RS485/115200bps
ROM-memory with EFX operating system	64 kB
Dual port RAM	2 kB

Internal Power Consumption CPU + EFX

5 V	100 mA

General PIFA Specifications

This chapter provides a general overview of the PIFA-units currently available.

What is there to choose from?

The following overview is a list of PIFA-units. Detailed descriptions can be found in product sheets, which are available from our web site http://www.regin.se.. Other units may exist. Please contact your nearest supplier or AB Regin for information on the current range.

Model Number	Description
EP1004	Power PIFA for extender
EP1011	Main Power PIFA
EP2032	32 DI Multifunction PIFA
EP3016	16 DO Multifunction PIFA
EP4024	16 DI / 8 DO mixed Multifunction PIFA
EP5012	12 AI Multisensor PIFA
EP5112	12 AI Multisensor PIFA
EP6012	12 AO Voltage Multifunction PIFA
EP7218	12 AI / 6 AO mixed Multifunction PIFA
EP7408	8 Mixed I/O PIFA
EP7416	16 Mixed I/O PIFA
EP7601/EX7601	Access Control PIFA/Unit
EP8101	Basic Serial PIFA
EP8102	Dual Basic Serial PIFA
EP8210	EXOlon PIFA
EP8280	TCP/IP PIFA (replaced by EP8282)
EP8282	TCP/IP PIFA
ED9200	External Display
Modem 9011	PTT Modem (Option 9011)
Model 9035	Battery Charger/UPS (Option 9035)
EP0000	Blind PIFA

PIFA-positions

PIFA-units can generally be mounted in any of the compartments in an EXOflex house, although there are certain exceptions. A power PIFA must **always** be present and must **always** be mounted in position 1. The same position designation is used even when the house is mounted vertically, which makes it possible to refer to e.g. position 1 with no risk of being misunderstood. See also Chapter 9 ***Commissioning*** for more information about positions.

Common Properties for PIFA-units

- ❑ The power supply to the parts of the PIFA closest to the process is always external, although there are certain exceptions, e.g. the TCP/IP PIFA.
- ❑ The process connections on an individual PIFA-unit are, viewed as a group, galvanically isolated from the internal control logic circuits by a special protective barrier, which is bridged by an opto-coupler, relays etc. The isolation from other circuits can be retained by using a separate power supply.
- ❑ Each process connection has active transient protection, which is led to a special EMI earth (disturbance protection earth) or in some cases to protective earth.
- ❑ Calibration parameters for analog inputs etc, are stored in the PIFA-units' EEPROM, which is not dependent on a power supply. PIFA-units can thus easily be replaced.
- ❑ Connections are usually made on plug-in screw connectors of the Phönix brand, although there are exceptions for certain communication ports.

Communication Ports

See the specifications for each respective PIFA for more information about that particular model.

Ports 1, 2 and 3

- ❑ All standard ports, ports 1, 2 and 3 have selectable physical interfaces in the form of EXOline, hlEXOline or RS232 as standard. See also Chapter 13 ***Communication***.
- ❑ Port 3 has a full set of control signal for RS232 and advanced modem support, whilst the other ports have a limited set, as described below. Port 3 can also be fitted with an option card, which further increases the freedom of choice for this interface. See also Chapter 27 ***Options***.
- ❑ hlEXOline is obtained by changing a jumper setting on the power-PIFA.
- ❑ The RS232 interface is selected via the hardware if you connect the signal SEL1, 2, 3 to GND1, GND2, GND3 for the respective port.

Electrical Specifications

Type	EXOline (RS485), hlEXOline or RS232
standard	EXOline
Speed	configurable, max 19200 bps,
standard	9600 bps
Galvanic isolation from the rest of the electronics, common mode voltage	max 250 V

Port 1

Control signals, RS232	RxD, TxD and RTS
Control signals, RS485	E
Connector EXOline and hlEXOline	Terminal block
Connector RS232	RJ45

Port 2

Control signals, RS232	RxD, TxD, RTS and CTS
Control signals, RS485	E
Connector EXOline, hlEXOline and RS232	Terminal block

Port 3

Control signals, RS232	RxD, TxD, RTS, CTS, DTR, DSR, RI and DCD
Control signals, RS485	E
Connector EXOline, hlEXOline and RS232	Terminal block

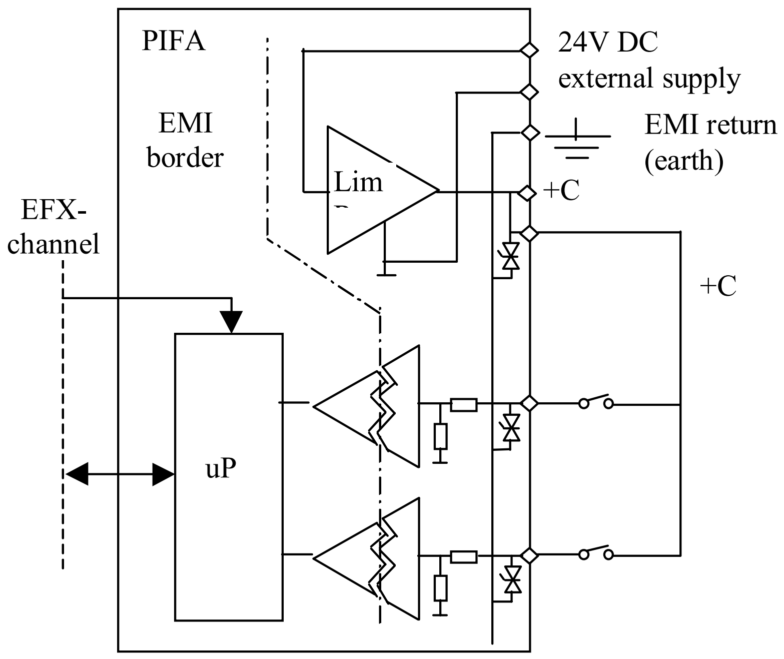
EFX channel (internal)

Type	RS485
Communication speed	115200 bps

Standard 24 V DC DI

Please see the specifications for each respective PIFA for more information about that particular model.

Figure 49. Block diagram for a standard digital input.



Properties

- ❑ This type of input is used for reading off floating (potential free) contacts and are active high.
- ❑ A yellow LED for each input shows its current status.
- ❑ The EFX channel is used to connect the PIFA-unit to the processor (not applicable for EP1011).

Process Connections

- ❑ The external contact's one end is connected to the input and the other to **+C**. The **+C** output is current limited and short circuit proof.
- ❑ EMI earth <u>must</u> be connected to the earth rail or equivalent, to prevent disturbances.
- ❑ The power supply's 0V connection must also be grounded. This is normally done at the power unit's 0V output.

Electrical Specifications

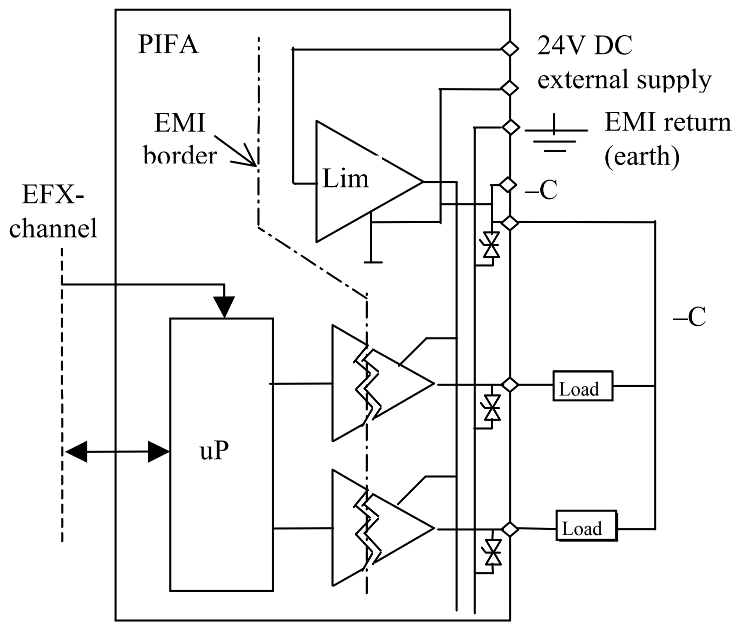
Digital Inputs, Type DC

Logic 0	0 to 5 V
input current at 0 V	0 mA
input resistance	5,7 kOhm
Logic 1	11 to 30 V
input current at +24 V	4 mA
Shortest pulse length for detection, software type ***normal***	9ms (not applicable for EP1011)
Shortest pulse length for detection, software type ***advanced***	4,5ms (not applicable for EP1011)

Standard 24 V DC DO

Please see the specifications for each respective PIFA for more information about that particular model.

Figure 50. Block diagram for a standard digital output.



Properties

- ❑ This type of current source output is mainly constructed for use with DC-relays, lamps and the like.
- ❑ The outputs' driving stage is powered from the external supply
- ❑ Each output is current limited, short circuit protected and has overheat protection. Apart from the current limiting for each individual output, there is also total limiting for all of the outputs together. See **Lim** in the illustration above.
- ❑ A yellow LED for each output shows its status.

Process Connections

- ❑ An external load is connected between the output and **-C**.
- ❑ The EMI earth must be connected to the earth rail or equivalent, to protect against disturbances.
- ❑ The 0V connection must also be grounded. This is normally done at the power unit's negative pole.

Electrical Specifications

Digital Outputs, Type DC

Type..current source
Current is fed from the PIFA-unit's power supply connection
Output voltage at logical zero..max 2 V/12 uA
Output current at +24 V (source)
  max continuous load per output..min 400 mA
  max continuous load per output at max. 30°C run temp ....min 500 mA
  max transient load (20 ms) ....min 1 A

Multisensor AI

See the specifications for each respective PIFA for more information about that particular model.

Properties

- ❑ This type of input is mainly intended for use with sensors using voltage outputs and resistance elements for measuring temperature, pressure, flow, etc. Certain models also have a 0-20 mA input.

Process Connections

- ❑ Voltage signals are connected between the input and **Agnd**.
- ❑ The cable screen is connected to the connector **SCR**.
- ❑ The EMI earth must be connected to the earth rail or equivalent, to prevent disturbances.
- ❑ The 0V connection must also be grounded. This is normally done at the power unit's negative pole.
- ❑ The **+C** output is always current limited. External transmitters for 4-20mA can be powered from a **+C** output. A fast fuse should be fitted in serial with the transmitter to protect the input from short circuits in the transmitter.
- ❑ For PIFA-models in the range 0–20 mA, the current shunt resistor is activated by software-controlled electronic circuits. The shunt resistor has an active current limiter that limits the current to approximately 25mA. However, the input voltage must not exceed 12V on the input, as each input also has active transient protection that activates at this voltage level.

All analog inputs have active transient protection that activates at an in-voltage of >12 V. This means that if you mistakenly allow 24 V on an input for longer than approx. 0.5 seconds the input will be permanently damaged and the guarantee will not be valid!

If you connect an active transmitter (4–20 mA) and power it with 12 V, the analog input will not be damaged if the transmitter is mistakenly short-circuited.

Standard AO

See the specifications for each particular PIFA for more information about that particular model.

Properties

- ❑ Each output is current limited and short circuit proof.
- ❑ This type of output is mainly intended for use with damper motors, shunt valves, frequency inverters and other analog actuators for 0–10 V.

Process Connections

- ❑ Normal, high-ohm loads are connected between the output and **AGnd**. Other types of loads for special applications with low-ohm loads are best connected between the output and 24Vminus.

- The EMI earth <u>must</u> be connected to the earth rail or equivalent, to prevent disturbances.
- The 0V connection must also be earthed. This is normally done at the power unit's negative pole.
- Cable screens can be connected to the connector **SCR** (if present).

Model Modem 9011 - PTT Modem

Introduction

Modem 9011 has the following main functions:

- V.22bis/V.22/V.21 and BELL 212A/103 compatible design with automatic detection of data communication standard.
- Operate in character asynchronous mode.
- Includes an advanced "**AT**" command interpreter compatible with 2400 bit/s industry standard products.
- Includes non-volatile memory to store user configurations.
- Adaptive equalization for optimum performance over all lines.
- Dynamic range from -3 to -45 dBm.
- Call progress, carrier and answer tone detectors providing intelligent dialing functions.
- Built-in speaker for easier error detection.
- DTMF and CCITT guard tone generators.
- High reliability in real life operation.
- CE-marked according to the European R&TTE Directive for use in Belgium, Denmark, Finland, France, Germany, Holland, Norway, Sweden and the U.K.

Modem 9011 is a high performance, 2400 bit/s intelligent modem for use in dial-up telephone network applications in EXO installations. It is 100 % compatible with the EXOmodem 9010, with one exception: The 9011 modem does not include the capability to make pulse dialing.

It includes a complete "AT" command and feature set compatible with industry standard products. Its operating modes are compatible with CCITT V.22bis, V.22 and V.21 as well as BELL 212A and 103 data communication standards. The modem may only be used in ***EXO Processor controllers*** (see price-list).

The 9011 modem has been designed for high reliability in real life operation surrounded by noise, interfering equipment and sometimes even thunderstorms generating high voltages and transients. This has been accomplished by a careful component selection and by good layout practice. Critical components in the line interface are chosen to withstand 4kV isolation voltage between the line and the internal logic. Surge arrestors and a gas discharge tube positioned on the motherboard close to the line inlet takes care of both fast transients and high voltages with a high energy content.

Specifications

Power Supply

Internal

Internal Power Consumption

5 V	140 mA
12 V	10 mA
-12 V	10 mA

Other Parameters

Modulation	CCITT V.22bis, V.22, and V.21 Bell 212A and 103,
Dial-up	Tone signals, DTMF
Transmission	Asynchronous
Insulation between line and internal circuits	4 kV
Settings	AT commands
Line	two-wire dial-up

Line Interface	plug-in screw connector
transmit level	-13 dBm
impedance	600 Ohm
reception level	down to –43 dBm

Standard	TBR21

Function

Models **3397, 5540** and the **EXOflex series** etc. have an internal slot for optional functions like the **Modem 9011** card. The modem is controlled from the EXOreal Processor and its **Port 3**.

In **EXOflex** the modem is normally positioned in the lower **Option position** in **section 1** together with a Basic or Dual Basic Serial PIFA like EP8101 or EP8102 and a Processor. Also the lower Option positions in section 2, 3 or 4 may be used. This requires an additional Processor and a Serial PIFA per modem in each section.

When commanded from an ***EXO Processor controller*** the modem will automatically perform a complete handshake as defined by the V.22bis, V.22, V21 or BELL 212A/103 standards to connect with a remote modem.

The modem includes an "**AT**" command interpreter which is compatible with the **Hayes 2400 Smartmodem** command set. Also see section ***Hayes Commands***.

The modem includes internal non-volatile memory to store the current "**AT**" command configuration etc.

Settings of Speed and Format

Settings for speed and format are carried out automatically. The modem corrects itself for speed, number of data bits and parity each time an **AT** command is sent.

In transparent mode (data mode) the modem handles a total of 9, 10 or 11 bits as shown below:

S1--D1--D2--D3--D4--D5--D6--D7--S2	7 data bits without Parity
S1--D1--D2--D3--D4--D5--D6--D7--PB--S2	7 data bits with Parity
S1--D1--D2--D3--D4--D5--D6--D7--D8--S2	8 data bits without Parity
S1--D1--D2--D3--D4--D5--D6--D7--D8--PB--S2	8 data bits with Parity

In command mode result codes, if activated, will be shown in the following format:

S1--D1--D2--D3--D4--D5--D6--D7--D8--S2	8 data bits without Parity.

Note:

S1 =	start bit
D1-D8 =	data bits
PB =	parity bit
S2 =	stop bit

Parity can be **EVEN**, **ODD**, **MARK** or **SPACE.**

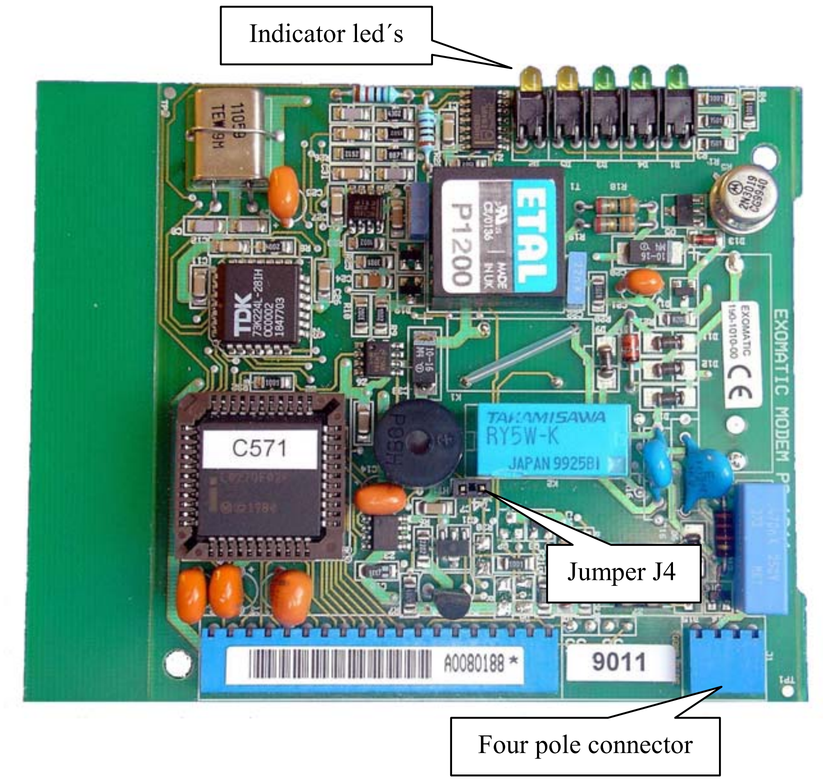
Hardware Preparations and Installation

Normally no preparations are necessary, but the following steps may be considered

For how to install and remove the modem, see Chapter 25 ***Installing Processors and Option Cards***.

- ❑ If no speaker function is desired, disconnect jumper J4. See Figure 51 below.

Figure 51. Modem 9011 with cut-off edges



Jumper J4	Description
Jumper off	Speaker is electrically disconnected
Jumper on	Speaker is electrically connected

1 = Connected jumper

- ❑ Insert the Modem 9011 PCB in the **Option slot**

Observe that Modem 9011 with cut-off edges only fits into EXOflex. For other models, e.g. 5540, the cut-off edges must be cut before mounting.

Connections and Wiring

Connect the incoming telephone line to terminal **R (Ring)** and **T (Tip)** on the controller. If for any reason the modem does not react to ring signals, outputs **A** and **A1** can further connect the telephone line to a telephone etc, if desired. Connector marked with earth symbol (⏚) must be connected to a nearby ground bar or similar with a heavy wire in order to bypass transients.

The table below also shows which pins to connect to in a standard 6 pole RJ12 plug.

Modem 9011 Connector	**Function**	**Connect to:**	**RJ12 plug**	
				UK
R	Ring	Analog PSTN	3 (or 4)	2 (or 5)
T	Tip	Analog PSTN	4 (or 3)	5 (or 2)
A	Secondary Ring	Phone		
A1	Secondary Tip	Phone		
⏚	Transient ground	Ground bar		

The Modem 9011 connector symbols, R, T, A and A1, correspond to the ones on the serial ports on e.g. EP8101 and EP8102.

EXOreal and Modem 9011

With **EXOapt 2001** or later and Controller System Tool (in EXOdesigner) you can easily configure whether *Port 3* shall be connected to the internal or to the external *Port 3* connector.

Changing Register Settings in Modem 9011

This is advanced information and normally not necessary to read when using Modem 9011 in normal applications.

By using a standard terminal emulator programin a PC, it is easy to change modem register settings for **external** modems. When using **Modem 9011**, which does not have an RS232 interface, the procedure described below can be used.

Add a procedure Task according to the following example:

```
{ TASK
  Name = ProcedureTask
  TLN = PROC
}

{ QPac
  SLib:\QSystem
  SLib:\QCom
  SLib:\QDisp
}

{ VPac
}

{ Const
  l false = 0
  l true = 1
  x Qcom_Ln              = 248   ; VLn for Qcom
    x Baud_Port_base     = 41    ; Cn for Baud_Port_1
    x Mode_port_base     = 0     ; Cn for Mode_port_1
    x Format_Port_Base   = 35    ; Cn for Format_Port_1
    x BinMode_base       = 47    ; Cn for BinMode_Port_1
    x StartChar_base     = 24    ; Cn for StartChar_Port_1
    x EndChar_base       = 27    ; Cn for EndChar_Port_1
    x BinLength_base     = 30    ; Cn for BinLength_Port_1
    x TimeOut_base       = 38    ; Cn for TimeOut_Port_1
    x CharTimeOut_base   = 8     ; Cn for CharTimeOut_Port_

}

{ Locals
  l lv1
  x xv1
}

{ Text
  Reg:\Texts
}
```

```
{ Code
;---------------------------------------------------------------------------
DEFSTAT BinaryInit x xv1

      bit( Format_Port_3, 4 ) = 1    ; 8 data bits
      bit( Format_Port_3, 5 ) = 0    ; Parity off
      bit( Format_Port_3, 6 ) = 1    ; Parity ODD

      ; Set binary mode (Start at SOM and terminate after timeout)
      sxv( Qcom_Ln, BinMode_Base-1+xv1 ) = 0

      ; Set start of message character...
      sxv( Qcom_Ln, StartChar_Base-1+xv1 ) = 13

      ; Set binary message length...
      sxv( Qcom_Ln, BinLength_Base-1+xv1 ) = 100

      ; Set the timeout...
      sxv( Qcom_Ln, TimeOut_base-1+xv1 ) = 20              ; x 64 ms
      siv( Qcom_Ln, CharTimeOut_base+(xv1-1)*2 ) = 100     ; x 4 ms

      ; Set port mode to MASTER...
      sxv( QCom_Ln, Mode_Port_Base+xv1-1 ) = 1

      bit( Signal_Port_3, 0) = 1  ; Set DTR high

       Delay 11  ; Wait for a second

ENDSTAT l lv1
;---------------------------------------------------------------------------

DEFSTAT BinaryTerminate x xv1

      bit( Format_Port_3, 4 ) = 1    ; 8 data bits
      bit( Format_Port_3, 5 ) = 1    ; Parity on
      bit( Format_Port_3, 6 ) = 1    ; Parity ODD

ENDSTAT l lv1
;---------------------------------------------------------------------------
DEFSTAT Speak2Modem $ Binary$

  ; Add Linefeed to the command...
  $ Binary$ = Binary$ + CHR(13)
  $ Binary$ = InOut$( 3, Binary$ )
  l lv1 = not cmp$( "" = Binary$ )

ENDSTAT $ Binary$, l lv1
;---------------------------------------------------------------------------
------
}
```

Now you have the procedures necessary to communicate to the modem.

Add a Task that uses the procedures above, according to the following example:

```
{ Task
...
}
...
{ Text
  Reg:\Texts
}
...
{ Code
...
  ; Initiate Port #3 for Hayes command mode...
  BinaryInit X 3

  ; Send some AT command to the modem...
  Speak2Modem $ "ATX3&W" \ $ AnswerString

  ; Now the answer is available in the string 'AnswerString'

  ; Set Port #3 back to transparent mode...
  BinaryTerminate X 3
...
}
```

The string **`AnswerString`** must be defined in **`Texts.Txe`**.

Hayes Commands

The modem is controlled with **AT** commands according to **Extended Hayes**. All commands are preceded by **[`AT`**, with a few exceptions described further below. The modem has an input buffer of 40 characters for these commands.

Some commands have parameters associated with them. If you use one of those commands without parameter, this will be similar to a parameter of **`0`**. For example **`ATE`** is equivalent to **`ATE0`**.

After a command sequence of 40 characters (or less), the sequence is executed with **[Return]**. When the modem has executed the response, it sends an **OK** response. Note that the EXO modem is set up to not respond. See the **`Q1`** command.

The escape sequence +++ (see sections ***Register S2*** and ***Register S12***) is used to control the modem in data mode without disconnecting the line. When in command mode the modem can be reconfigurated as desired. After reconfiguration you type **`ATO`** to go back to data mode.

AT Commands Supported

Note:

s	=	string
n	=	0-255 decimal
x	=	Boolean
0/1	=	false/true

Command	Options	Default
`A/`	Repeats last command line	N/A
`A`	Answer	N/A
`Bx`	BELL/CCITT=1/0 answer tone @ 1200 (N/A @ 2400)	0
`DS=n`	Dial string specified by n, n = 0-3	*n* = 0
`Ex`	Command echo, 0/1 = OFF/ON	0
`Hn`	Hook status, 0/1 = ON/OFF	N/A
`Ln`	Speaker volume, (0)1/2/3 med/med/med, supports only one volume	2
`Mn`	Speaker, 0/1/2/3 = control (see ***Table 8***)	1
`On`	Online, 0/1/2/3 = online/retrain/no retrain (see ***Table 9***)	N/A
`P`	Not supported	
`Qx`	Quiet result, 0/1 1-quiet	1
`R`	Reverse originate	N/A
`Sn=n`	Set S register (see ***Table 2***)	N/A
`Sn=?`	Return value in register n (see ***Table 2***)	N/A
`T`	Touch tone dial	Pulse
`Vx`	Verbose result, 0/1 = ON/OFF	1
`Xn`	Result code, 0/1/2/3/4 (see ***Table 1***)	4
`Yx`	Enable long space disconnect, 1 = enable	0
`Zx`	Restore from Non-Volatile Memory, x = 0 or 1	N/A
`&Cx`	Carrier detect override, 0/1 = ALWAYS ON/NORMAL	1
`&Dn`	DTR Mode, 0/1/2/3 (see ***Table 10***)	3
`&F`	Restore to factory configuration	N/A
`&Gn`	CCITT guard tone, 0/1/2 = OFF/1800/550	2
`&J`	Auxiliary relay control, **may not be changed!**	1
`&Mn`	Async only, (see ***Table 11***)	0
`&Qx`	Same as &M	0
`&Rx`	Enable RTS/CTS	0
`&Sx`	DSR override, 0/1 = US/UK	0
`&V`	View active configuration and user files	N/A
`&Wx`	Write current configuration to NVRAM x = 0 or 1	0
`&Yx`	Designate default user profile Z0 or Z1	N/A
`&Zn=s`	Store a telephone number n = 0-3	N/A

Factory Configuration

B0 E0 L2 M1 P Q1 V1 X4 Y0 &C1 &D3 &G2 &J1 &M0 &P0 &R0 &S0 &T5 &X0

If the NOVRAM has not been initialized it may be necessary to Power Down/Power Up and type **`AT&F&W<cr>`** to properly initialize modem state.

Dial String Arguments

,	Delay 2 sec
;	Return to Command
@	Silent Answer during 5 sec during a period of S/sec
s	Dial Stored Number
!	Flash, Corresponds to the R button in most countries, Breaks the line in 90 ms
W	Wait for Tone
R	Reverse Mode

Please Observe So-called blind dialing, using the comma (**,**) character instead of the wait (**W**) character in the dial string, is not allowed.

Table 1: Result Codes

Xn	Vocal/Numeric Result Code
`X0`	OK/0, CONNECT/1, RING/2, NO CARRIER/3, ERROR/4
`X1`	All functions of X0 + CONNECT (RATE)/1 = 300, 5 = 1200, 10 = 2400
`X2`	All functions of X1 + NO DIAL TONE /6
`X3`	All functions of X1 + BUSY/7
`X4`	All functions of X3 + NO DIAL TONE /6

Table 2: S Registers Supported

Sn	Function	Units	Default
`S0`[2]	Answer on ring	No of rings	000
`S1`	Ring counter	No of rings up to 8	000
`S2`	Escape code	ASCII CHR$()	043
`S3`	Carriage return	ASCII CHR$()	013
`S4`	Line feed	ASCII CHR$()	010
`S5`	Backspace	ASCII CHR$()	008
`S6`	Wait for dial tone	Seconds	002
`S7`	Wait for carrier	Seconds	030
`S8`	Pause time	Seconds	002
`S9`	Carrier valid	100 milliseconds	006
`S10`	Carrier drop out	100 milliseconds	014
`S11`	DTMF tone duration	1 millisecond	070
`S12`	Escape guard time	20 milliseconds	050
`S13`	Unused		N/A
`*S14`[2]	Bitmapped register	Decimal 0-255, See Table 3	140
`S15`	Unused		N/A
`S16`	Test register	Decimal #	000
`S18`	Test timer	Decimal 0-255	000
`S19`	Unused		N/A
`S20`	Unused		N/A
`*S21`[2]	Bitmapped register	Decimal 0-255 See Table 4	057
`*S22`[2]	Bitmapped register	Decimal 0-255, See Table 5	118
`*S23`[2]	Bitmapped register	Decimal 0-255, See Table 6	166

S24	Unused		N/A
S25[2]	DTR delay	10 milliseconds	005
S26[2]	CTS delay	10 milliseconds	001
***S27**[2]	Bitmapped register	Decimal 0-255, See Table 7	000

* The bitmapped register functions are equivalent to normal "**AT**" command modem registers.

[2] Stored in NVRAM with **&W** command.

Table 3 to 7 are bitmapped registers. The different bit values for all registers are written on table rows and each default bit value is marked bold.

Table 3: Register S14 140Dec 8C Hex

Register S14 is an option register.

Bit	Bit value	Description
0	**0**	**reserved**
	1	reserved
1	**0**	**off**
Echo on/off, En	1	on
2	0	on
Answer codes,Qx	**1**	**off**
3	0	on (digits)
Verbose result, Vx	**1**	**off (characters)**
4	**0**	**Accept commands**
	1	No accept of commands
5	**0**	**Tone**
Dialing method, T, P	1	Pulse (not supported)
6	**0**	**reserved**
	1	reserved
7	0	Originating
A and D..	**1**	**Answering**

Table 4: Register S21   57Dec   39 Hex

Register for control of signals etc.

Bit	Bit value	Description
0	0	RJ-11/41S/45S
Telco jack, &Jx	**1**	**RJ-12/13**
1	**0**	**reserved**
	1	reserved
2	**0**	**CTS activates after RTS with a delay of S26 seconds and goes active directly after RTS**
Enable CTS/RTS, &Rx	1	CTS always active when carrier is present.
4,3	0,0	The modem do not care about DTR.
	0,1	The modem goes ON.
	1,0	The modem goes on hook when DTR goes inactive.
DTR mode, &Dx	**1,1**	**The modem is restarted when DTR goes inactive.**
5	0	DCD always active.
Carrier detect, &Cx	**1**	**DCD is active if carrier present.**
6	**0**	**DSR always active.**
DSR override	1	DSR active when modem in data mode.
7	**0**	**No**
Enable Long space disconnect	1	Yes

Bit 0 must always be 1 (RJ-12/13).

Table 5: Register S22   76Hex   118 Dec

This register controls speaker, answer codes etc. In some countries the speaker may not be used due to local regulations regarding how the speaker volume must be controlled. In such cases the speaker must be disconnected from the modem.

Bit	Bit value	Description
1,0	0,0	medium
	0,1	medium
	1,0	**medium**
Speaker volume, Ln	1,1	medium
3,2	0,0	Off
	0,1	**Connected until carrier detected**
	1,0	Always on
Speaker control, Mn	1,1	ON until carrier detected but not during dialing
6,5,4	0,0,0	X0, (see ***Table 1***), Result codes
	1,0,0	X1
	1,0,1	X2
	1,1,0	X3
Result codes, Xn	**1,1,1**	**X4**
7	**0**	**Make/break ratio 39/61 (US, Canada, Sweden etc) Not supported!**
Pulse dialing, &P	1	Make/break ratio 33/67**.. Not supported!**

Table 6: Register S23   A7 Hex   167 Dec

This register is used for setting terminal speed etc.

Bit	Bit value	Description
0	0	Remote digital loopback request accepted
RDL, &T4, &T5	**1**	**Remote digital loopback request not accepted**
3,2,1	0,0,0	0 to 300 bps, See also ***Settings of Speed and Format***
	0,1,0	1200 bps
Terminal speed	**0,1,1**	**2400 bps**
5,4	0,0	Even
	0,1	Space
	1,0	**Odd**
Parity	1,1	Mark/No parity
7,6	0,0	No guard tones
	0,1	550 Hz guard tone
	1,0	**1800 guard tone**
Guard tones	1.1	Reserved

Table 7: Register S27   0

This register is used for options.

Bit	Bit value	Description
0	**0,0**	**Only &M0 implemented**
	0,1	Not used
	1,0	Not used
Sync mode	1,1	Not used
2	**0**	
Reserved	1	
3	**0**	
Reserved	1	
5,4	**0,0**	
	0,1	
	1,0	
Reserved	1,1	
6	**0**	**CCITT**
BELL/CCITT	1	BELL
7	**0**	
Reserved	1	

Table 8: Speaker Modes

Mn	Speaker Mode
M0	Speaker off
M1	Speaker on during connect only
M2	Speaker on always
M3	Speaker on during call progress

Table 9: O Modes

On	Online/Retrain Modes
O0	Return online
O1	Return online with retrain
O2	Enable automatic retrain (default)
O3	Disable automatic retrain

Table 10: DTR Modes

&Dn	DTR Mode
&D0	Ignore DTR.
&D1	Go to command state if ON to OFF detected.
&D2	Go to command state and disabled auto answer if ON to OFF detected.
&D3	Initialize modem with NVRAM if ON to OFF detected.

Part V Examples of Complete EXOflex-units

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Part V **Examples of Complete EXOflex-units**

Chapter 21 **Complete EXOflex-units**

General

Complete EXOflex-units, containing the required PIFA-units, can easily be ordered. All that is needed is a simple description stating the size of the house, which positions the units should be mounted in and which base address should be used. If no base address is given, the standard value 0 will be used.

If any PIFA positions are left vacant, these will be fitted with a blind PIFA.

TCP/IP Gateway

TCP/IP Gateway EX8282 is described in a product sheet.

Part VI Maintenance and Service

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Part VI **Maintenance and Service**

Chapter 22 **Changing the Battery**

When the battery indicator on the power-PIFA is lit, the battery for backup of program memory and the real-time clock has become too weak. The battery is on the power-PIFA and is replaced as described below. A backup capacitor on the processor card saves the memory and keeps the clock running for at least 30 minutes after the power-PIFA is removed. Thus, if battery replacement takes less than 30 minutes there will be no need to reload the program, and the clock will continue to run normally.

The replacement battery must be of the type CR2032.

This procedure requires knowledge of proper ESD protection, i.e. an earthed wrist band must be used!

Figure 52. The EP1011 and its battery.

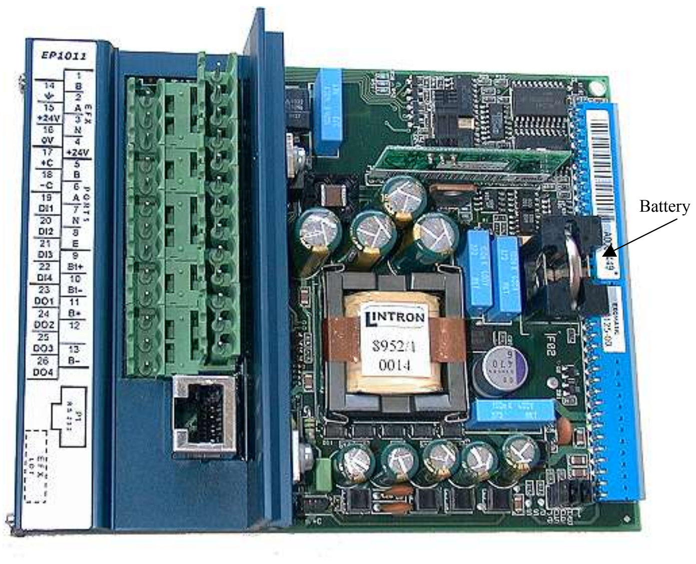


Figure 53. Grip the battery firmly on both sides.

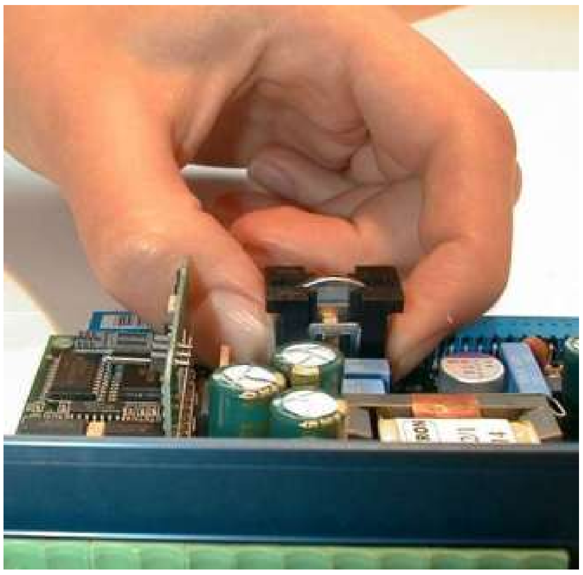


Figure 54. Squeeze the battery until it rises from its holder.

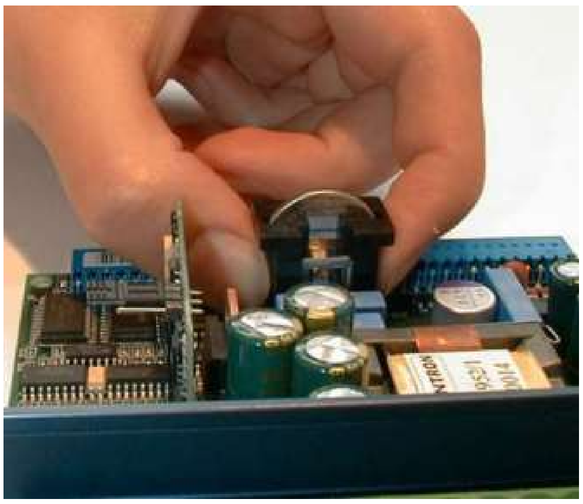


Figure 55. Remove the battery.

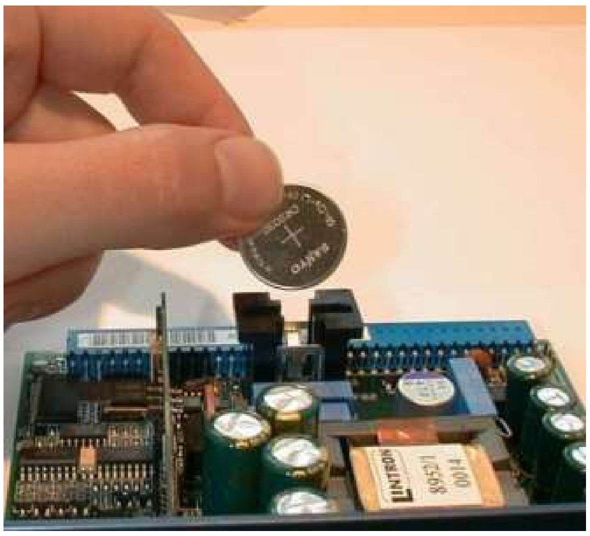
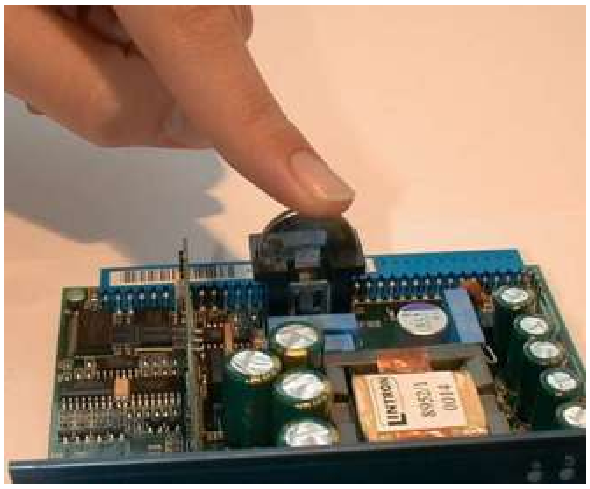


Figure 56. Press the new battery firmly down into place. Note that to preserve correct polarity, the battery can only be inserted the "right way round".



Chapter 23 Resetting The Program Memory

To reset the processor's program memory, use a reset jumper in the section where the processor is mounted.

The 2-section base circuit board in the example below has two reset jumpers, one for each section. As only section 1 has a processor, this jumper that will be used here.

An ESD-earthed wristband must be used for this procedure.

Figure 57. A 2-section base circuit board with reset jumpers.

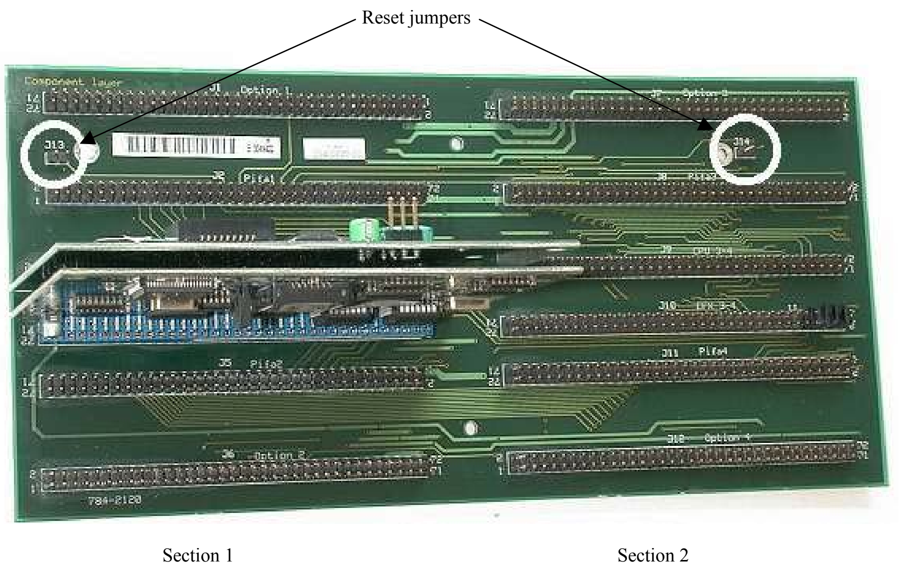
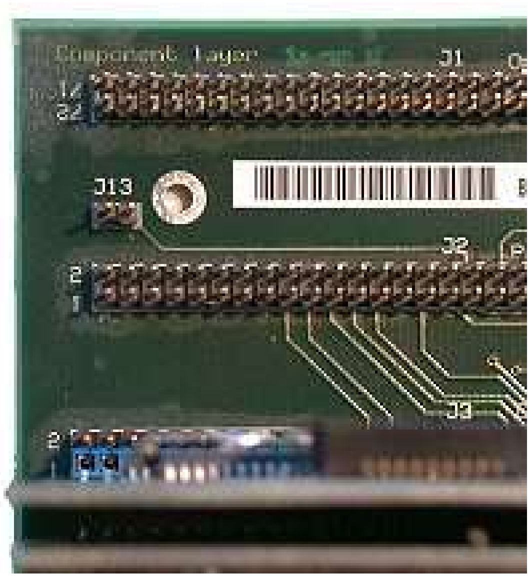
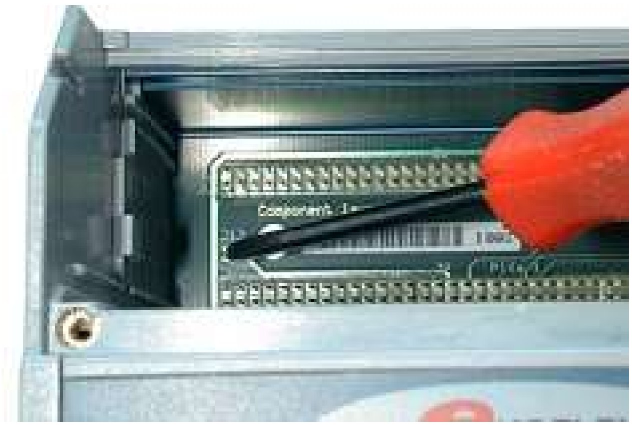


Figure 58. A close-up of the reset jumper in section 1.



To get at the jumper on the base board, remove the PIFA-unit in the section in question. Reset the jumper with e.g. a screwdriver.

Figure 59. Reset with a screwdriver.



Chapter 24 **Changing the PROM**

This procedure may only be carried out by qualified resellers and requires knowledge of secure ESD handling, i.e. an earthed wristband must be used !

First disconnect the power supply to the unit.

To change the PROM on the CPU card or EFX card, the PIFA-units and the shell in the section affected must first be removed. See ***Removing the Shell*** on page 139.

Remove the PROM from its holder using the special PROM tool. This tool can be ordered from AB Regin, along with the new PROM revision.

Note that the PROM has a beveled edge that must be matched to the PROM socket's own edge.

The PROM on a PIFA-unit is replaced in the same way (but without removing the shell).

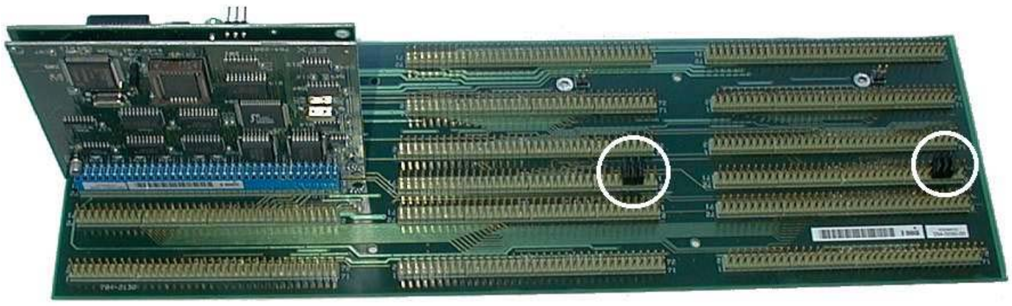
Chapter 25 Installing Processors and Option Cards

This procedure may only be performed by a qualified reseller and requires knowledge of ESD-protection. An earthed wristband must be used !

To supplement a house with one or more extra processors (CPU card + EFX card) or option cards, the house must first be dismantled and the affected PIFA-units and plastic shell removed. See ***Removing the Shell*** on page 139.

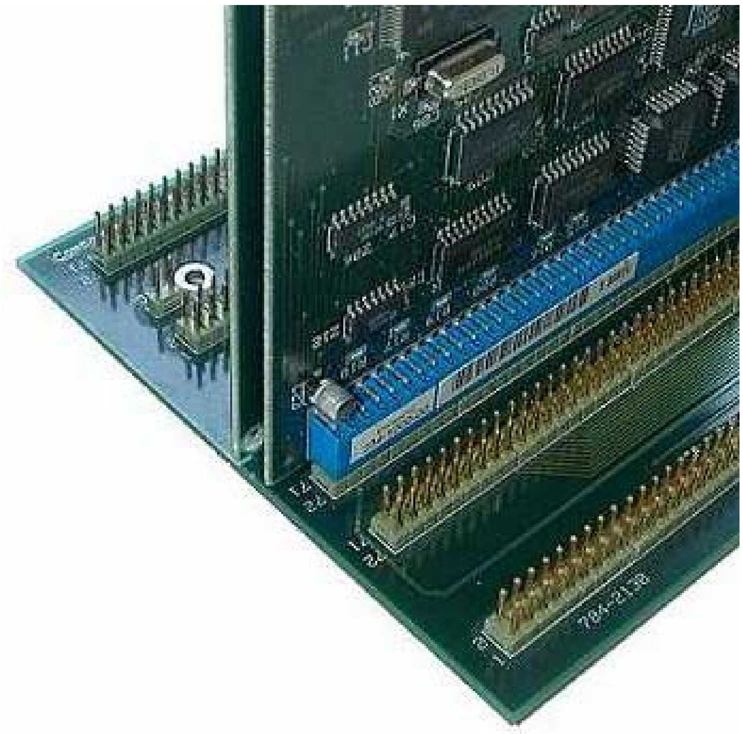
To fit new processors, the jumper switches in the sections on the base circuit board where they will be placed must be removed. These are located, in the example below, on sections 2 and 3, and also on section 4 on a 4-section base board (but they are never present on section 1 in a processor house).

Figure 60. 3-section base board with EFX-jumpers.



The figure below shows where on the base board the processor circuit boards are fitted.

Figure 61. CPU & EFX card in section 1.

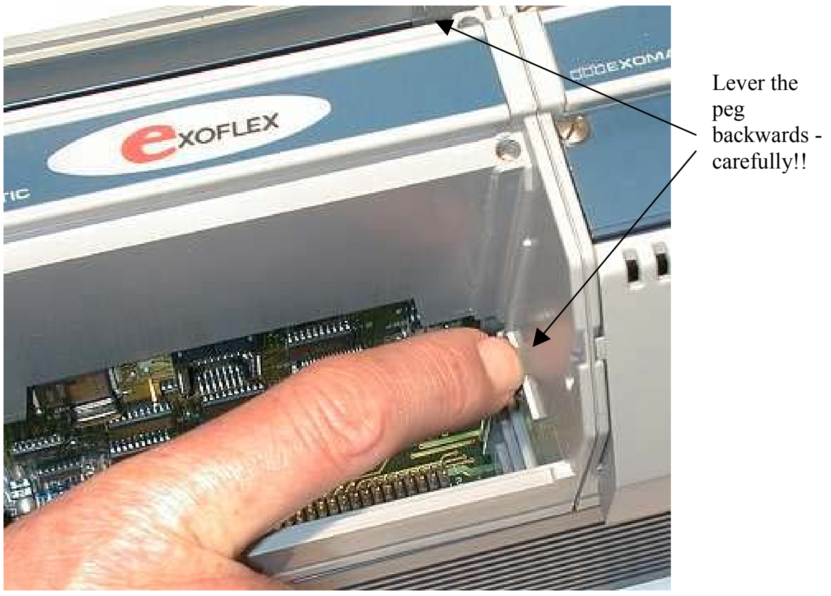


Removing the Shell

After extracting the PIFA-units, lever the pegs on the shell carefully backwards (max 1mm) on each side of the middle section as in Figure 62.

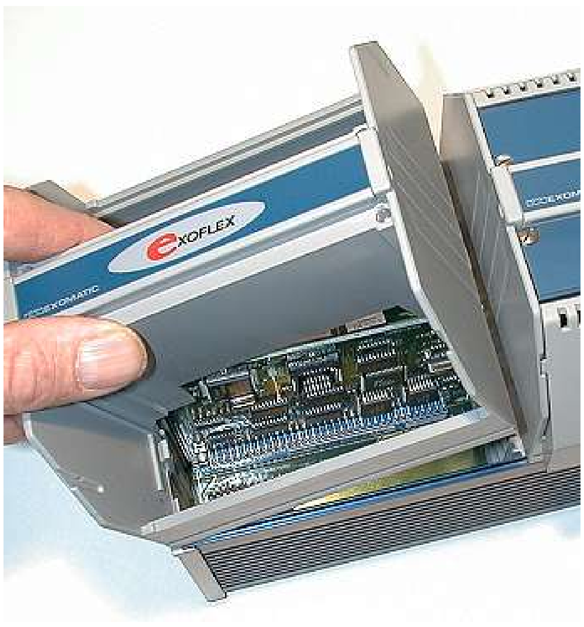
At the same time, lift the shell up and the pegs will release. Excessive force is **not** necessary!

Figure 62. The pegs for releasing the shell.



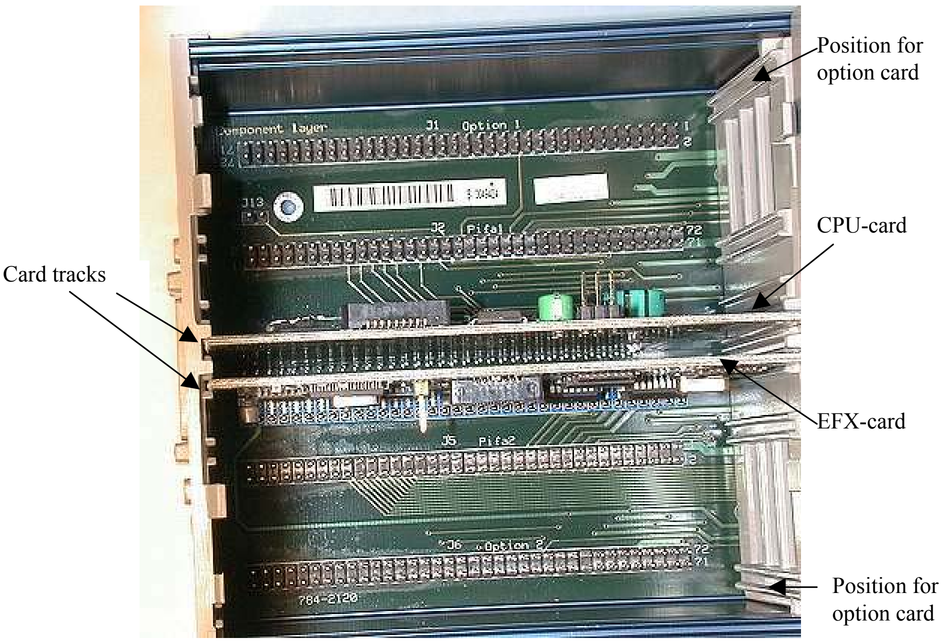
Carefully lift the shell off.

Figure 63. Removing the shell.



Fit the new cards as described below.

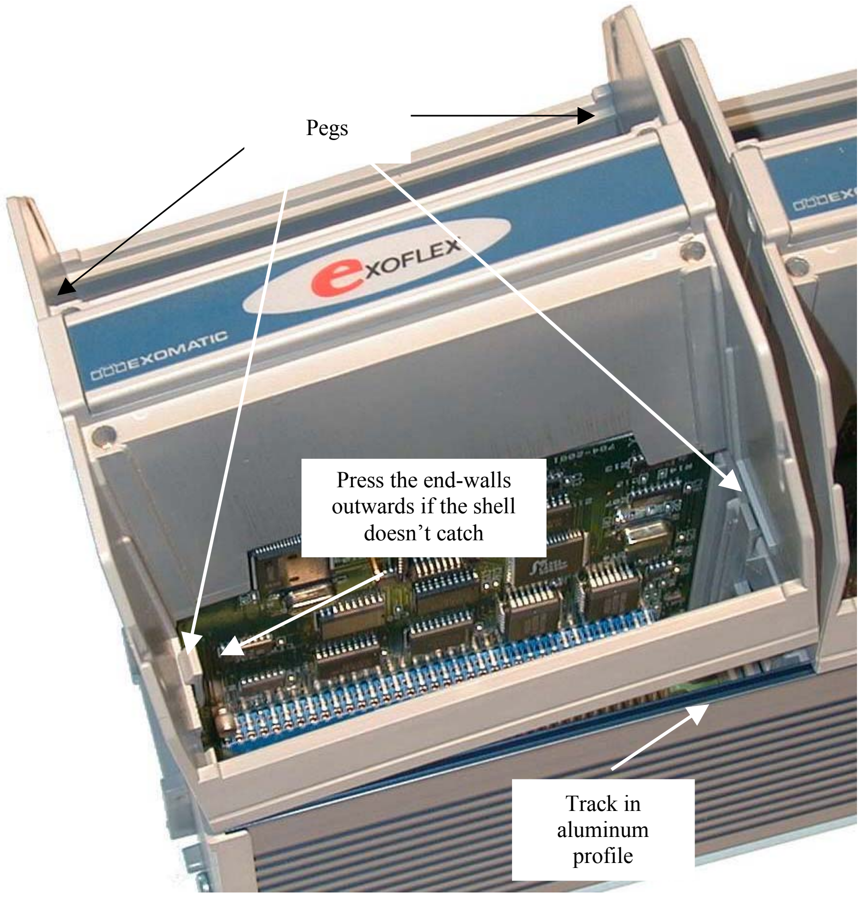
Figure 64. The CPU & EXF-cards and option positions in section 1.



The positions described above are also found in the other sections.

Center the shell relative to the tracks in the aluminum profile. Press the shell down so that it "clicks" into place. You will also hear a click when it is correctly positioned. You may need to press the end-walls outwards slightly, to get the shell to click into place. The CPU and EFX cards must also be correctly positioned so as to fit in the cavity on the inside of the shell.

Figure 65. Replacing the shell.



Pegs
Press the end-walls outwards if the shell doesn't catch
Track in aluminum profile

Part VII **Appendix**

Table of contents

Part VII **Appendix**

Chapter 26 Modems

Telephone Line Modems

Telephone modems may be used in two different ways:

- ❑ permanently leased lines
- ❑ dial-up connections

Dial up operation uses a *Hayes Compatible* modem.

The **EXO** system requires a modem with the particular characteristics as listed below:

- ❑ Standard Hayes compatible modem.
- ❑ 11 bit communication format including start/stop bit and odd parity.
- ❑ Integrated EEPROM for new set-up storage and reloading after power outages.
- ❑ Others, such as DCD timing.

Internal Modem

The **EXO** modem **Modem 9011 (and 9010)** is specially designed for EXO controllers and is intended for dial-up connections. See further chapter ***Model Modem 9011 - PTT Modem***.

The modem is installed at the internal option's position under a Processor where it occupies Port 3. For connection to the telecommunication network, PIFA 8101/02 is used in combination with the modem.

External Modem

If an external modem is required, Regin recommends Westermo's TD-32 model for dialed-up lines.

The modem can be used for EXO controllers since it can transfer the parity bit of the EXOline protocol.

For information on Westermo resellers, please visit the Westermo website :
www.westermo.se

It can replace/be combined with Selic 243 (or 241) for communication with 2400 bps. It can also be used for communication at higher speeds, e.g. 9 600 bps.

The settings are made with a command string which is sent to the modem and stored in its EEPROM.

This can be done by connecting the modem to the serial port on a computer and sending the command string with a normal terminal program, which is included in Windows 2000 for instance. You can also ask Westermo to make the settings in the modem before delivery.

For communication with 2 400 bps (V.22bis), the following command string is used:

```
AT&FS0=0S30=90&S0&C1&D3L3%E0&K0F5\N1&W
```

For communication with higher speeds, for instance 9 600 bps (V.32bis), the following command string is used:

```
AT&FS0=0S30=90&S0&C1&D3L3%E0&K0\N1&W
```

Radio Modems

By operating in the low-power band (0,5W, 420–470MHz) this type of modem may be used in most European countries without an operating license. The operating distance is between 2 and 5 km depending on the type of antenna and the features of the landscape.

Chapter 27 **Options**

The options listed below are available as plug-in cards for the option position in an EXOflex house. See Chapter 3 ***EPU Internal System Design*** and Chapter 26 ***Modems.***

The physical connection to these options are made via connectors on a communication PIFA, e.g. EP8102.

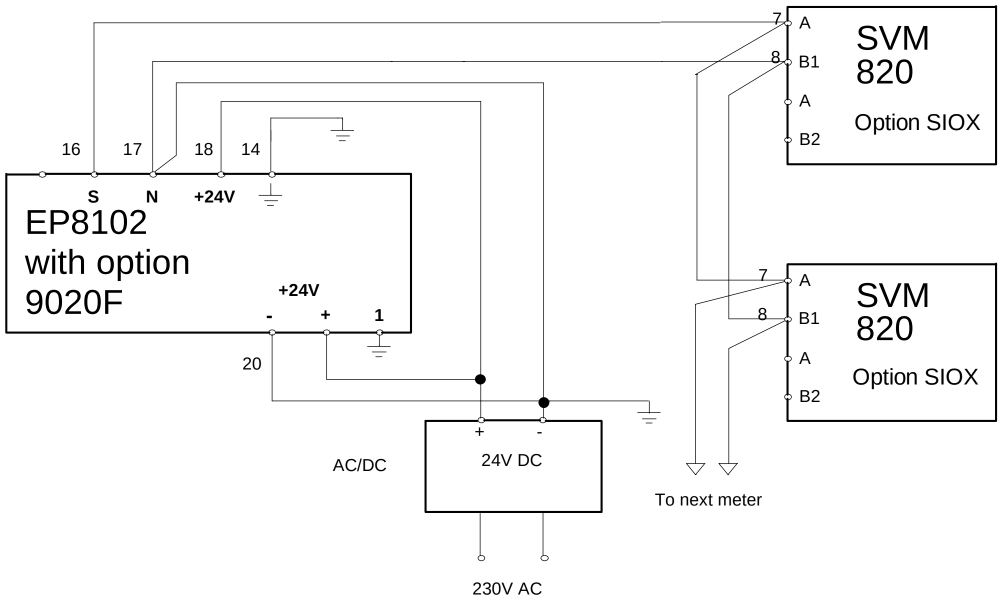
Option 9020F

Option 9020F is a plug-in card for serial communication on the SIOX bus, typically for certain types of meters.

The cable should not be longer than 2000 meters for 300 bps communication speed or 1000 meters at 1200 bps, when used with EXO controllers. The bus should not normally be terminated.

Up to 20 units with SIOX interface can be hooked up to an EXO unit with this option.

Figure 66. A connection between an EP8102 and SVM 820 with SIOX interface.



Option 9015

Option 9015 is a plug-in card for serial communication in Foxboro applications. This interface has <u>no</u> galvanic isolation from the rest of the internal electronics. The maximum cable length is 3 meters and it is important that the cable is placed away from power cables. See also the Foxboro manual.

Option 9011

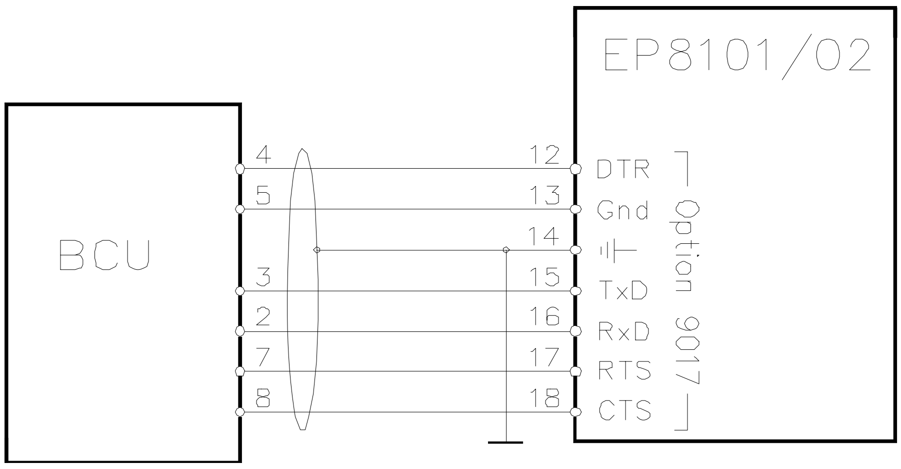
Option 9011 (Modem 9011) is a plug-in card for serial communication via dial-up telephone lines. See also chapter ***Model Modem 9011 - PTT Modem***.

Option 9017, EIB

Option 9017 is a plug-in card for serial communication on the EIB bus. This interface has no galvanic isolation from the rest of the internal electronics. The maximum cable length is 3 meters and it is important that the cable is placed away from power cables. See also the EIB manual.

The figure below illustrates the connection of an EIB bus connector, BCU, to EP8101/02. The DTR output on EP8101/02 cannot be controlled from software but is internally connected to +12V.

Figure 67.



Option 9035

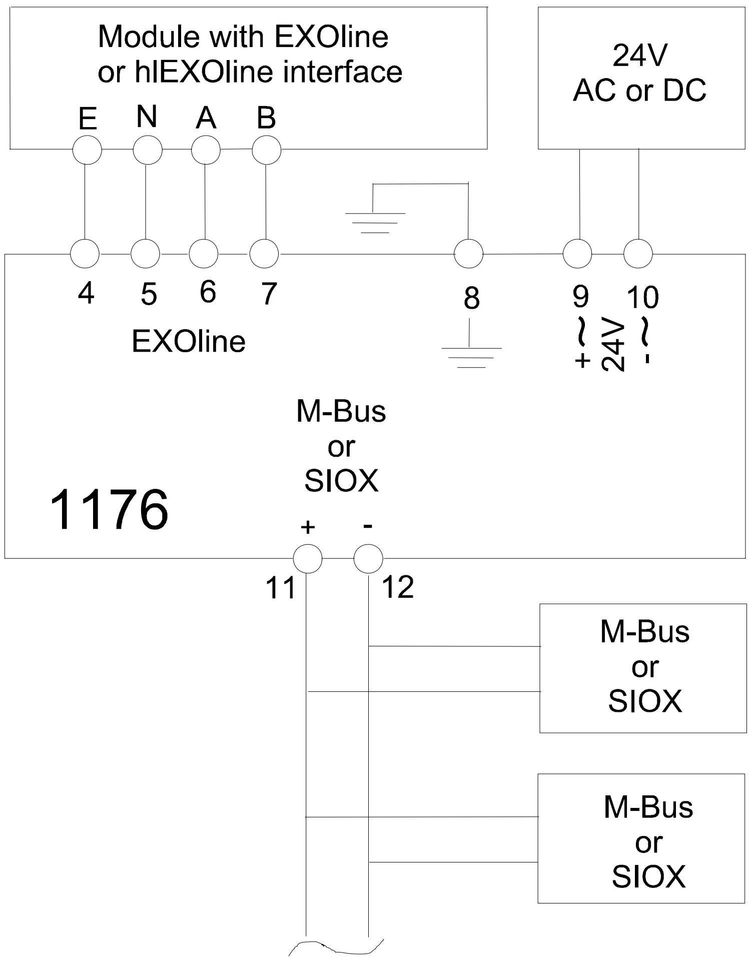
Option 9035 (Battery Charger/UPS) is a plug-in card for battery charging and reserve power, which is connected to an externally connected lead acid battery. See section *Error! Reference source not found.*.

M-Bus

Model 1176 is an independent unit using the M-Bus interface.

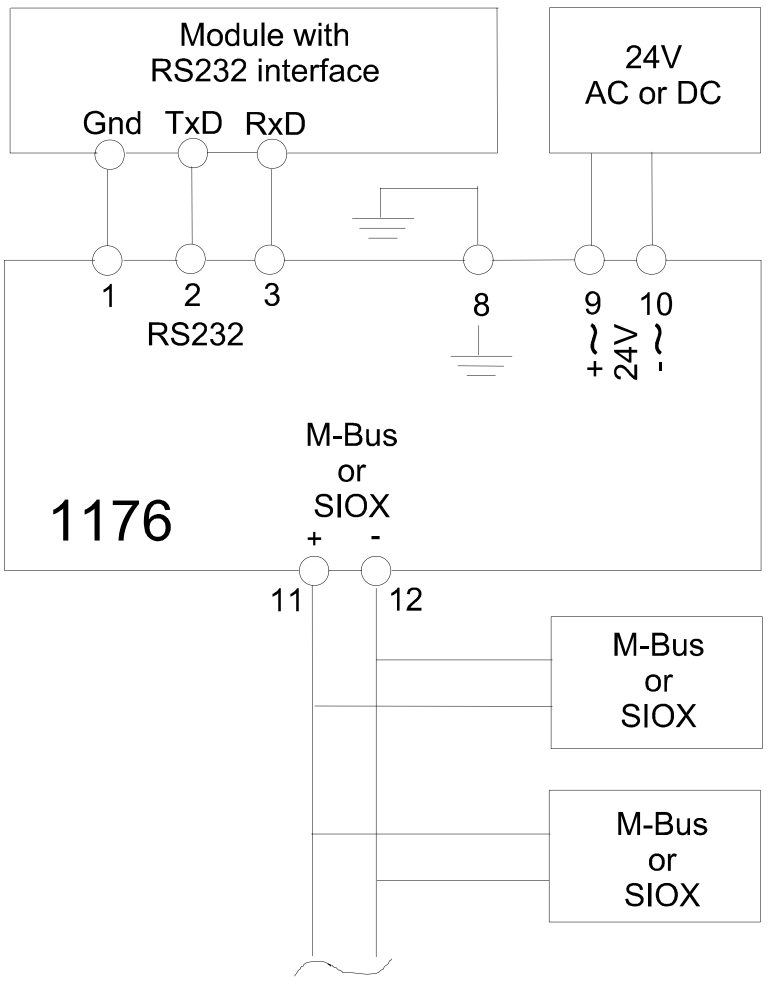
Model 1176 Connections

Figure 68. Shows how to connect the 1176 to a controller with the EXOline or hlEXOline interface.



RS232

Figure 69. Shows how model 1176 is connected to a controller with the RS232 interface.



For further information, see separate datasheet for Model 1176.

Chapter 28 **Interference**

All installations are subject to interference from other electrical systems, radio sources and from lightning. Depending on the intensity of the disturbances and the system design this may cause:

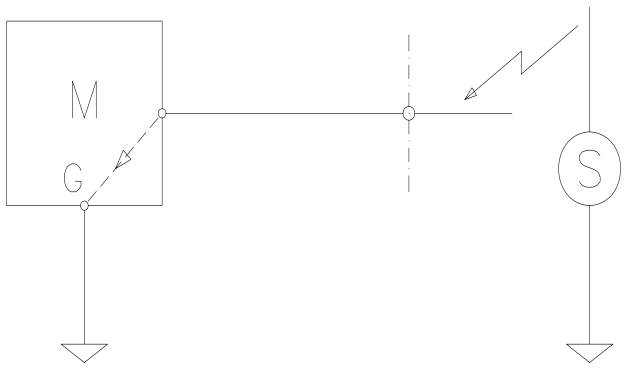
- ❑ temporary errors in measurements or signals
- ❑ temporary program errors
- ❑ permanent program errors
- ❑ hardware malfunction

All **EXO** products, hardware as well as software, are designed to operate flawlessly even in the presence of interference. However In spite of all precautions, there is always a threshold above which problems will arise. This threshold depends to a large extent on how the electrical installation in a cabinet is carried out, e.g. on grounding and cable positioning. Great improvements are possible by following a couple of simple rules.

See figure below for a description of how disturbances work.

Disturbances are very high frequency pulses, which are most easily visualized as energy packages. Due to the high frequencies, very large voltages are produced even on short wires when the package passes. High voltages are also carried to adjacent conductors.

Figure 70. Route of disturbance through controller.

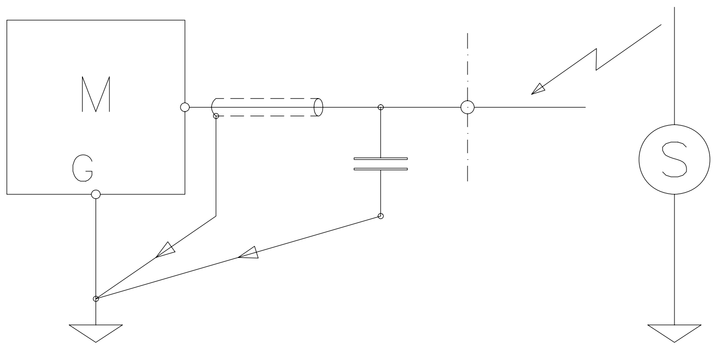


Assume a disturbance source ***S*** that injects an energy package into a conductor. The package is in most cases injected relative to earth. The package travels along the line to return to earth. If it passes inside the controller it creates internal voltages in its path and in other nearby conductors, due to inductive and capacitive coupling. It also passes through the ground wire, which puts a voltage on the ground terminal which then sends energy into other wires connected to the controller and produces voltages in other inputs.

It is obvious from Figure 71 that the correct remedy is to create a path for the disturbance package, directly to the cabinet's earth.

All controllers contain internal, protective circuits connected to one of the ground terminals of the controller. If this terminal is tied with a heavy wire to the ground rail, an incoming disturbance will pass to ground with very little effect on the rest of the controller. A short, screened cable used inside the cabinet with the screen connected directly to the ground rail will provide great improvements in the threshold voltage. Likewise, if a special protective circuit is deemed necessary, it is important that it be positioned close to the cable entry in the cabinet. It is also important that its ground terminal is connected with a short wire to the ground rail. See the figure below.

Figure 71. Route for diversion of disturbance when protected.



If our rules for grounding and cabinet layout are followed, the protection provided will be quite sufficient for most practical installations. It is only in cases where cables run outside buildings and are exposed to possible lightning, or are situated close to power cables for long distances, that a more extensive protection, such as screened cables and separate protection circuits, is required.

Chapter 29 The EMC and LVD Directive

Background

As of January 1st 1996, all electric/electronic products must be CE marked on delivery from the manufacturer and they must comply with certain requirements specified in the **EMC** and **LVD Directives.** The Directives are issued by the EU commission.

The **EMC** (**E**lectro**M**agnetic **C**ompatibility) directive describes the ability of a product to operate satisfactorily within its environment without disturbances. The **LVD** (**L**ow **V**oltage **D**irective) directive concerns electrical safety.

The EMC and LVD directives apply to **all** electric/electronic apparatus, systems and installations.

For Regin, the directives mean that every single product must comply with a number of standards, and that a declaration of conformity is issued for each product.

Declaration of Conformity

Electromagnetic Compatibility, EMC

Units specified in this manual are CE marked and approved according to the following Generic EMC standards:

- ❑ Immunity: EN 50082-2
- ❑ Emission: ED9200 (External Display) and EX7601 fulfill the requirements of EN 50081-1 and the rest of the units fulfill the EN 50081-2 requirements.

Low-Voltage Directive, LVD

Units specified in this manual are CE marked and approved according to the following safety standards:

- ❑ Safety, EN 61010-1

Also parts regarding insulation requirements in the EN60950 standard are applicable and approved of.

Note that external power supplies generating 24V DC for EXO controllers must be CE marked as SELV, safety extra low voltage, or PELV, protected extra low voltage, power supplies.

Note that the LVD is only applicable to products which are connected to 50VAC or 75VDC or higher.

Chapter 30 **Glossary of Terms**

Activation type	Decides how a PIFA will be activated after power cuts and other errors. There are two alternatives: Automatic or manual (by the application program).
Active mode	Normal mode for a PIFA, when all its functions are running normally.
Base address	The part of a PIFA's address that depends on the expansion house. The PIFA-address is calculated by adding the base address to the PIFA's position address.
Configuration data	A BPac containing configuration for PIFA-units with dynamic variables set. Transferred to the PIFA very early in the synchronization phase.
Control variable	Variable in the processor used to control and indicate a PIFA's function.
CPU-card	The printed circuit board that contains the EXOreal-CPU, amongst other things.
EEU	EXO Expansion Unit. Expansion house with PIFA-units. Connects to an EPU via the EFX-channel.
EFX	The communication channel between a controller and its PIFA-units.
EFX-channel	Another term for *EFX*.
EFX-card	Printed circuit board containing the EFX-CPU, amongst other things.
EFXos	The operating system in the EFX-CPU
EFXP	The application protocol for EFX.
EFXT	The transport protocol for EFX.
EPU	EXO Process Unit. Combination of a Processor Unit and its Expansion Units which together constitute a process station.
EXOreal	The operating system in the controller's CPU.
Expansion unit	Expansion house with PIFA-units which is connected via the EFX-channel to a Processor Unit.
Expansion house	House with no processor or PIFA-units.
External display	External display in the form of a PIFA, which is connected to a Processor Unit via the EFX-channel.
Main processor	The processor furthest to the left in a house with several processors.
Controller	A logical concept that means (exactly) one processor and all of its PIFA's.
Parameter variable	Variable transferred from a processor to a PIFA, with low priority.
Passive mode	Special mode for a PIFA, when in principle all of its functions are active, but the outputs are not updated. Used at start-up when contact with the controller is not working etc.
PIFA	A node connected to a controller via EFX. Can be completely independent or partly built-in
PIFA-address	A PIFA's address on the EFX-channel. For house-PIFA's this is calculated by adding the house's base address to the PIFA's position address.

PIFAos	The operating system in an intelligent PIFA that communicates with the processor via EFX.
Position address	The part of a PIFA’s address that depends on the position in the house. The PIFA-address is calculated by adding the house’s base address to the position address.
Processor	A physical concept that describes the central functions in a controller, i.e. the CPU and EFX-cards together.
Processor unit	House with processor and PIFA-units.
Processor house	House with processor, but no PIFA-units.
Program	A number of EXOL-files in the controller that comprise the actual application.
Read variable	Variable whose value is transferred from a PIFA to the processor.
Resource	Smallest functional peripheral unit in a controller, e.g. an analog input or a display.
Resource attribute	Software property for a resource.
Resource name	The resource’s name in the software.
Resource type	Standardized classification for resources with the same function.
Section	Part of a house, with space for 2 PIFA-units.
Station	Logical concept that covers one or more controllers (and computers) organized in a functional group. There are process stations and computer station.
Write variable	Variable that is transferred from a processor to a PIFA, with high priority.

Part VIII **Index**

Part IX Regin Resellers

For information on Regin Resellers, please visit the Regin Website:

www.regin.se