SIEMENS

# SAPHIR
# ACX 32
# Hardware Description
## Basic Documentation

Revision 2.0
Controller Range ACX 32
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# 1 Foreword and Notes on Use

## 1.1 Foreword

Rising demands on building systems engineering and building management are reflected in increasing automation of building services. In the area of controls for the HVAC OEM business, the rising demands are being met with the new "SAPHIR" system, which will supersede the existing Siemens system "COMPAS" in the lower price/performance range.
The SAPHIR OEM primary controller is a powerful DDC compact controller that has been developed for use in HVAC applications.
It is optimized for the functional demands and geographical distribution of building services installations and has been designed for deployment in small systems, HVAC devices and local automation nodes within large buildings.
The SAPHIR **ACX 32** model was specifically designed to accommodate requests for more RAM storage and more analog outputs arising from the existing practical applications of SAPHIR **ACX 30**.

## 1.2 Notes on Use

This manual primarily addresses users of the SAPHIR OEM primary controller.
The main focus is on project engineering, installation and commissioning of the SAPHIR OEM primary controller.
For operation and planning of the SAPHIR OEM primary controller, please refer to the following manual:

- SAPHIR SACUS 32, User's Guide (Order No: CE2P3691en)

You can order this publication from SBT HVAC Products, Zug.

## 1.3 Abbreviations

| | |
|---|---|
| HVAC | **H**eating, **V**entilation, **A**ir-**C**onditioning |
| ADC | **A**nalog-to-**D**igital **C**onverter |
| NMI | **N**on-**M**askable **I**nterrupt |
| PWM | **P**ulse **W**idth **M**odulation |
| SPI | **S**erial **P**eripheral **I**nterface |
| MSR | **M**ess-**S**teuer-**R**egeltechnik (instrumentation and control) |
| ID | **Id**entification |
| HMI | **H**uman-**M**achine **I**nterface |
| DDC | **D**irect **D**igital **C**ontrol |

Passages introduced by this symbol indicate a warning to help prevent incorrect operation.


Passages introduced by this symbol indicate that the text must be read with special attention.

Paragraphs with this symbol provide tips.

## 1.4 Chapters in this Document

| | |
|---|---|
| Chapter 2 | This chapter contains a brief description of "SAPHIR". |
| Chapter 3 | This chapter provides configuration examples. |
| Chapter 4 | Describes the SAPHIR hardware. |
| Chapter 5 | Details of assembly, installation and setup guidelines. |

# 2 System Description

The following contains an overall description of a SAPHIR system.

## 2.1 General

The SAPHIR system comprises a basic device, operating system software for the basic device, and engineering software, as well as additional tools, such as SACUS or WEBCC, which provide for implementation of HVAC applications.

Two module slots, to which communication modules can be attached, provide extension possibilities. An external RS422 port to which external I/O modules can be connected provides an additional extension possibility.

This document describes the SAPHIR **ACX 32** hardware and operating system, as well as the system's setup and wiring.

Separate operation manuals describe the operating system software and the SAPRO 32 and SACUS 32 engineering software.

# 3 Planning Basis and System Design

## 3.1 SAPHIR ACX 32 System Design

The following provides a current list of the SAPHIR components:

| | |
|---|---|
| **ACX3x.xxx** | **SAPHIR controller** |
| ACX8x.xxx | SAPHIR HMI |
| ACX5x.xxx | SAPHIR communication cards |
| ACX4x.xxx | SAPHIR I/O expansion modules |
| ACX9x.xxx | SAPHIR plug-in terminal set |

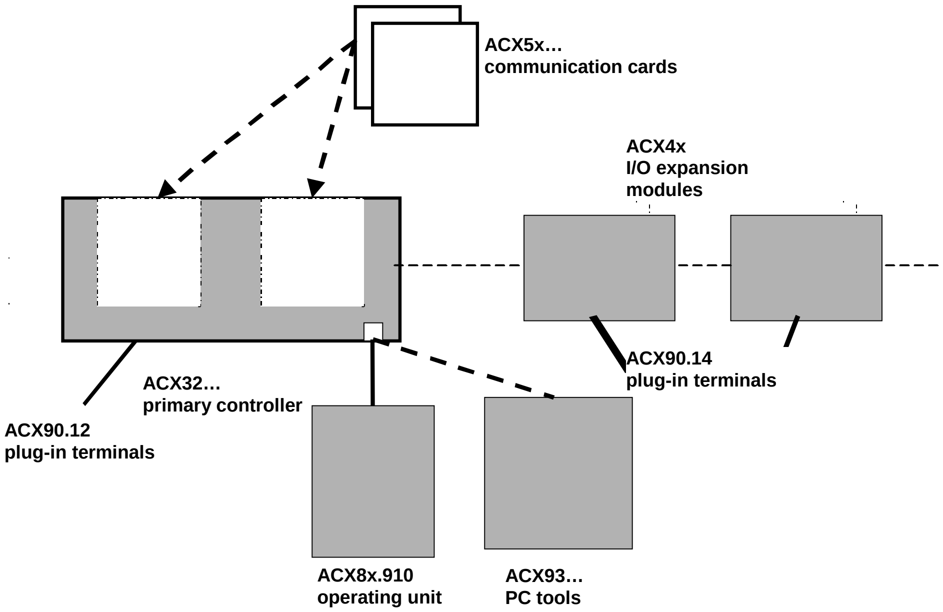


Figure 1: Block diagram with components

## 3.2 SAPHIR Tools

Description:

The following tools are required for engineering SAPHIR:

- SAPRO 32 — engineering tool with hardlock
- SACUS 32 — optional for parameterization and evaluation
- WEBCC — for generating web pages
- SAPHIR Scope — optional for parameterization and evaluation; includes UNICODE support (multilanguage)
- SAPHIR Loader — for downloading operating system updates to the controller
- Rainbow Loader — an HTML page that enables all project-specific data (MSR task, HMI templates and object handler languages) to be downloaded to the controller using Internet Explorer

# 4 Hardware

## 4.1 SAPHIR Control Assembly

### 4.1.1 Design

The SAPHIR control assembly comprises a motherboard and two different optional plug-in modules.

The motherboard is a 6-layer printed circuit board that contains all electronic components and connectors.

Communication connection solutions can be implemented on the modules. The motherboard has two 55-pin socket connectors for connecting the modules.

The motherboard is installed in a double sheet metal housing. The housing is designed for installation on a DIN top-hat rail or mounting plate.
The power supply and process signals are connected via plug-in terminals.

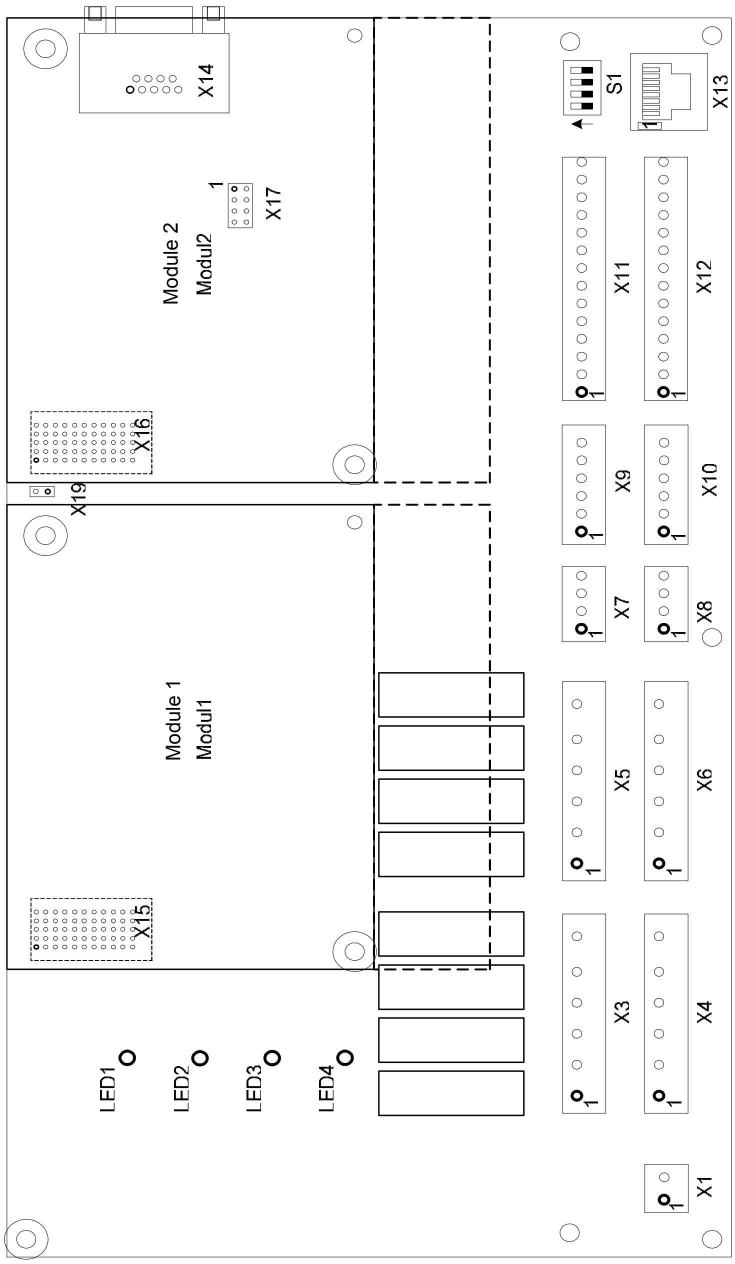


Figure 2: SAPHIR ACX 32 motherboard

## 4.1.2 Motherboard

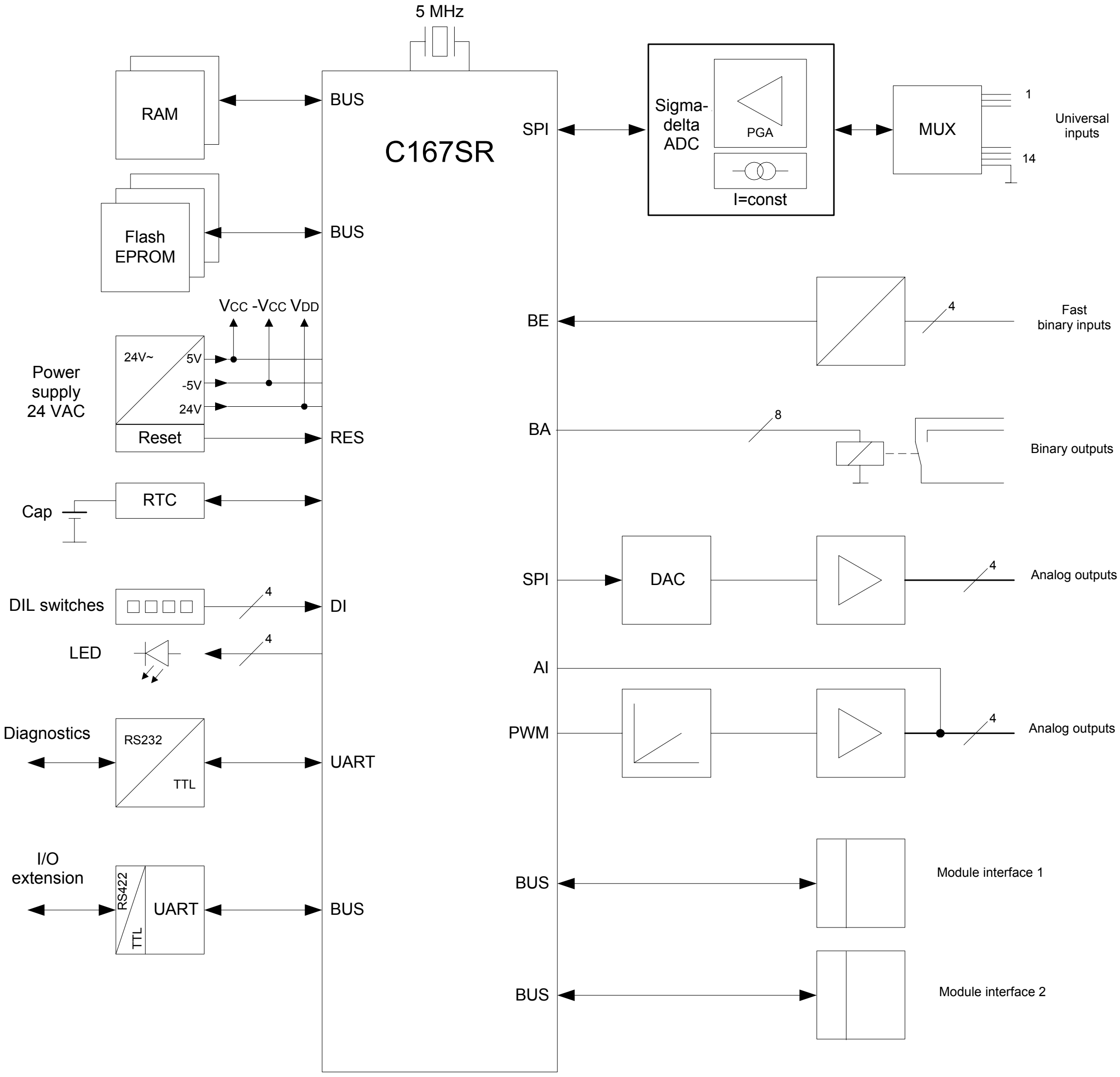


Figure 3: SAPHIR block diagram

## 4.2 Technical data

| | | |
|---|---|---|
| **General data** | Dimensions: | |
| | Overall device | 280 mm x 158 mm x 54 mm |
| | Motherboard | 280 mm x 150 mm, 6x multilayer |
| | Modules | 105 mm x 76 mm |
| | Weight | Approx. 1.3 kg |
| | Color | RAL 7016 (dark green) |
| | Attachment | Mounting on 35 x 7.5 mm DIN top-hat rail |
| | Supply voltage | 24 VAC (±15%) or 26…35 VDC |
| | Current consumption: | Approx. 0.3 A with full configuration |
| Interfaces: | Peripheral interfaces (X1…X12) | WAGO Cage Clamp terminal blocks |
| | Serial interface (X13) | 8-pin RJ45 jack |
| | External interface (X14) | 9-pin D-SUB jack |
| | Module interface (X15) | 55-pin, 5-row male connector |
| | Module interface (X16) | 55-pin, 5-row male connector |
| Memory: | Internal data memory | 1 Mbyte RAM<br>4 Mbyte flash<br>128 kbit EEPROM |
| Microcontroller: | CPU | C167SR-LM<br>16 bit (20 MHz) |
| Real-time clock: | | Buffered 2 days min.<br>Accuracy max. 10min/Year |

| | | |
|---|---|---|
| **Inputs and outputs** | | |
| Relay outputs BO1…BO8: | | 12…250 VAC, max. 2 A |
| | Load | Recommended min. 0.5 A, 12 VAC/VDC |
| | BA1…BA8: | Changeover |
| Universal inputs UI1…UI14: | All universal inputs with common reference | Ui = 0…10 V, non-floating |
| | Conversion time | Approx. 30 ms/analog input and approx. 12 ms/digital input |
| | Protective circuit | Up to +24 V without destruction |
| | Adjustable via software: | |
| | – Voltage | 0…10 V |
| | – Input impedance | Approx. 100 kΩ |
| | – Resolution | Up to 12 bit (default 10 bit) |
| | – Offset error | 0.2% |
| | – Gain error | ± 0.3% |
| | Current | 0…20 mA (via ext. 100 Ω shunt) |
| | – Resolution | 12 bit (default 10 bit) |
| | – Offset error | 0.5% |
| | – Gain error | ± 1% |
| | PT100 elements: | |
| | – Sensor current | 400 μA |
| | – Resolution | 0,1 K |
| | – Accuracy | ± 2 K |
| | PT100, NI1000 elements: | |
| | – Sensor current | 400 μA |
| | – Resolution | 0.1 K |
| | – Accuracy | ± 0.5 K |

| | | |
|---|---|---|
| | PTC, NTC thermistors: | |
| | – Sensor current | 400 µA |
| | – Temperature measurement | Up to approx. 4.5 kΩ resistance value (from 4.5 kΩ with parallel resistance) |
| | Digital input | External supply not possible. Voltage supplied by device; 24 V at max. 4.5 mA, non-floating, i.e. use floating contacts only! |
| | – Input frequency | Max. 2 Hz |
| Fast binary inputs BI1…BI4: | Digital input | External supply not possible. Voltage supplied by device; 24 V at max. 6 mA, non-floating, i.e. use floating contacts only! |
| | – Input frequency | Restricted to 50 Hz via software |
| Analog outputs AO1…AO4 (X9): | Output voltage | 0…10 V, non-floating |
| | – Linearity error | ± 2 LSB |
| | – Offset error | 0.1% |
| | – Gain error | Max. 0.5% |
| | – Resolution | 10 bit |
| | – Load current | 5 mA |
| | – Setting time | Approx. 60 ms |
| | – Protective circuit | Up to +24 V without destruction |
| Analog outputs AO5…AO8 (X10): | Output voltage | 0 .. 10 V, non-floating |
| | – Linearity error | ± 2 LSB |
| | – Offset error | 0.1% |
| | – Gain error | Max. 0.5% |
| | – Resolution | 12 bit |
| | – Load current | 5 mA |
| | – Setting time | Approx. 3 ms |
| | – Protective circuit | Up to +24 V without destruction |

**Environmental conditions**

| | |
|---|---|
| Air pressure: | |
| – Operation | Min. 700 hPa, corresponding to max. 3000 m AMSL |
| – Transport | Min. 260 hPa, corresponding to max. 10'000 m AMSL |
| Temperature: | |
| – Operation | 0…+50 °C |
| – Storage | -30…+70 °C |
| Humidity class | F as per DIN 40040 |
| Degree of protection | IP20 as per EN 60 529 |

**Type test reports**

| | |
|---|---|
| Mechanical strength: | DIN IEC 68-2-32 |
| EMC measurement: | Immunity as per IEC 801-3 class 3 as per EN 50081-1 and EN 50082-2 |
| Electric strength: | EN 50082-2 test of inputs and outputs at overvoltage of 24V passed, fire safety at 240 Veff is given |
| Vibration and shock test: | EN60068-2-27/31/32 as per test specifications DIN IEC 68-2-6 degree of severity SN29010, part 1, class 12 and 22, DIN IEC 68-2-27, 15g/11ms |
| Climatic test: | EN 60 068-2-14 |
| Storage temperature: | EN 60 068-2-1/2 |
| Humidity test: | DIN IEC 60 068-2-30 |
| Temperature-rise test: | EN 60 068-2-14 |

| | |
|---|---|
| Product safety | Automatic electrical controls for household and similar use EN 60 730-1 or IEC 60 730-1 |

# 4.3 Interfaces

## 4.3.1 RS232 Interface

For general service and diagnostic purposes, the RS232 interface is brought out to connector X13.

In addition to software loading functions, such as the bootstrap loader, operating system loading and MSR tasks, the RS232 interface is also used to connect an external monitoring and operator unit.
In order to supply the external HMI, a 12 V supply voltage is brought out to the X13 connector. The voltage is short-circuit proof.

**Pin assignment**

Connector: X13
Type: 8-pin RJ45

| Pin No. | Signal |
|---|---|
| 1 | GND |
| 2 | RxD |
| 3 | RTS |
| 4 | TxD |
| 5 | CTS |
| 6 | +12V |
| 7 | +12V |
| 8 | GND |

### 4.3.2 External Communication Interface

In case the number of data points in the ACX32 controller is insufficient for a given application, an additional, external communication interface provides for connection of external slave I/O modules.
The interface is physically configured as an RS422 bus interface on D-SUB jack X14. The signal lines are terminated internally with 120 Ω.

The overall system comprises an ACX32 master and up to 15 slave I/O modules (see section 5.3.10 for an example).

The following can currently be connected as slave modules:

- ACX42.12: 4 relay outputs, 12 universal inputs
- ACX41.08: 8 relay outputs
- ACX32: As slave

**Pin assignment**

Connector: X14
Type: 9-pin D-SUB jack

| Pin No. | Signal |
|---|---|
| 1 | – |
| 2 | TxD+ |
| 3 | RxD+ |
| 4 | – |
| 5 | GND |
| 6 | – |
| 7 | TxD- |
| 8 | RxD- |
| 9 | – |

⚠ If 2 ACX32s are interconnected as **master and slave**, the **signals must be crossed over**, i.e. signal from pin no. 2 to 3, and from pin no. 7 to 8 (refer to section 5.3.10)!

### 4.3.3 Module Interface

In order to implement communication application solutions, SAPHIR has two equivalent module slots, which makes it very versatile with regard to connectivity, and enables it to operate with a number of different communication busses.

The two module interfaces are connected directly to the microcontroller's data/address/control bus.
The modules' hardware identifiers are read via an ID signal. This enables the operating system software to automatically identify the inserted modules and start the respective drivers.

As an additional power supply, the rectified 24 VAC prime power is brought out to the module connector.

**Pin assignment**

The modules are connected using the X15 and X16 55-pin male connectors.

Module connector X15:

| Pin No. | X15A | X15B | X15C | X15D | X15E |
|---|---|---|---|---|---|
| 1 | +5 V | +5 V | +5 V | +5 V | +5 V |
| 2 | GND | GND | GND | GND | GND |
| 3 | D0 | D1 | D2 | D3 | D4 |
| 4 | D5 | D6 | D7 | D8 | D9 |
| 5 | D10 | D11 | D12 | D13 | D14 |
| 6 | D15 | A1 | A2 | A3 | A4 |
| 7 | A5 | A6 | A7 | A8 | A9 |
| 8 | A10 | A11 | A12 | A13 | A14 |
| 9 | WR_N | SWRES_N | RD_N | READY_N | ID (P3.6) |
| 10 | ALE | HWRES_N | CS_N | I/O_0 (P2.9) | I/O_1 (P2.10) |
| 11 | +26…35 V | +26…35 V | +26…35 V | +26…35 V | +26…35 V |

Module connector X16:

| Pin No. | X16A | X16B | X16C | X16D | X16E |
|---|---|---|---|---|---|
| 1 | +5 V | +5 V | +5 V | +5 V | +5 V |
| 2 | GND | GND | GND | GND | GND |
| 3 | D0 | D1 | D2 | D3 | D4 |
| 4 | D5 | D6 | D7 | D8 | D9 |
| 5 | D10 | D11 | D12 | D13 | D14 |
| 6 | D15 | A1 | A2 | A3 | A4 |
| 7 | A5 | A6 | A7 | A8 | A9 |
| 8 | A10 | A11 | A12 | A13 | A14 |
| 9 | WR_N | SWRES_N | RD_N | READY_N | ID (P3.6) |
| 10 | ALE | HWRES_N | CS_N | I/O_2 (P2.11) | I/O_3 (P2.12) |
| 11 | +26…35 V | +26…35 V | +26…35 V | +26…35 V | +26…35 V |

# 4.4 Inputs and Outputs

## 4.4.1 Relay Outputs

8 DC-decoupled relay outputs BO1…BO8 provide for potential-free control of process operations (motors, actuators, lamps etc).

The digital outputs are designed as floating relay contacts. The contacts support a load of 230 VAC and a maximum of 2 A.
The relays are arranged in two groups:
- BO1…BO4 changeover
- BO5…BO8 changeover

**Use only 1 working voltage within each group**: 230 VAC or safety extra-low voltage. **Mixing within one group is not permitted!**

*Recommendation:* minimum relay loading is recommended:
- 230 VAC ±20%: 5 mA
- 24 VAC ±20%: 20 mA
- 5 VDC: 100 mA

The relays are controlled directly via the controller's I/O ports.

| Relay output | I/O port pins |
|---|---|
| BO1 | P2.0 |
| BO2 | P2.1 |
| BO3 | P2.2 |
| BO4 | P2.3 |
| BO5 | P2.4 |
| BO6 | P2.5 |
| BO7 | P2.6 |
| BO8 | P2.7 |

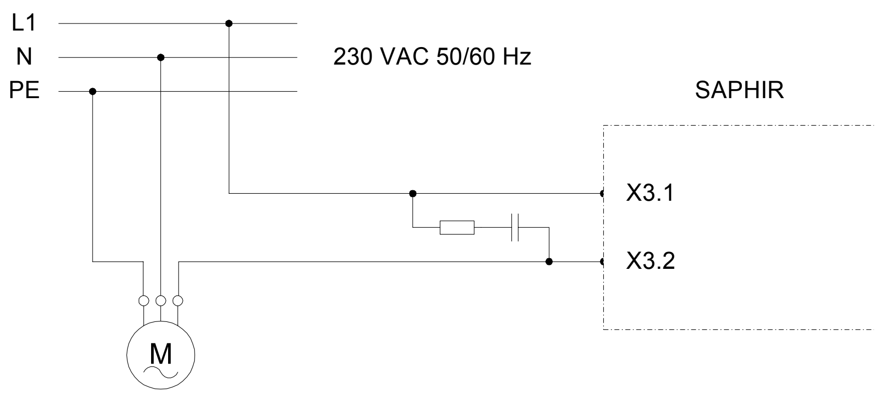


Figure 4: Relay output connection

Any **suppressor circuit, interference suppression** etc. must be provided **externally** according to the application!

Cables

The cross-section of the connecting wires should not exceed 2,5 mm² because of the Cage Clamp terminals.

### 4.4.2 Fast Binary Inputs

The four fast binary inputs BI1…BI4 are used to interrogate switching states, and for counting switching pulses at a maximum switching frequency of 50 Hz.
These inputs are connected directly to interrupt-generating ports of the microcontroller. This provides for a quick reaction to signal changes.

Only floating contacts must be connected to the binary inputs. The contacts are interrogated with approx. 24 V / 6 mA. The counter frequency is restricted to approx. 50 Hz via the software.

| Binary input | Input |
|---|---|
| BI1 | P2.13 |
| BI2 | P2.14 |
| BI3 | P8.2 |
| BI4 | P8.3 |

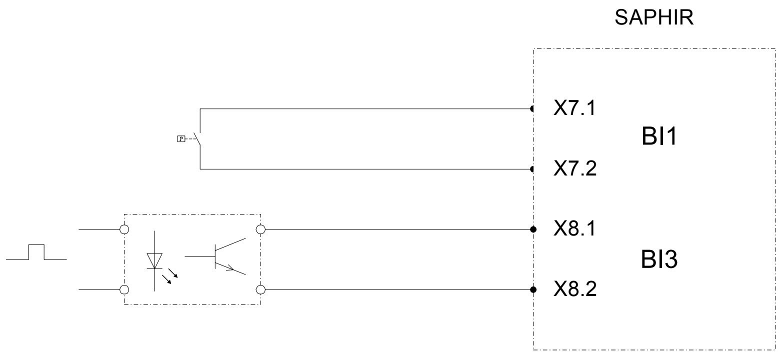


Figure 5: Binary input connection

Cables

The cross-section of the connecting wires should not exceed 1.5 mm² because of the Cage Clamp terminals.

### 4.4.3 Analog Outputs

**PWM analog outputs**

The 4 PWM analog outputs AO1…AO4 are implemented via the controller's internal PWM outputs.
The PWM signal is converted to the analog range of 0…10 VAC via an RC element and an amplifier module. A feedback circuit connecting the analog outputs to the controller's internal analog inputs is used to calibrate the outputs.

The PWM analog outputs have the following features:

- AO1...AO4 produce voltages between 0...+10 VDC
- Maximum load current 5 mA
- 10 bit resolution
- Voltage outputs are short-circuit proof.
- The setting time is typically 60 ms.
- The AO… are non-floating.
- Protective circuit: up to +24 V without destruction
- Maximum load impedance: 2 kΩ

| Analog output | PWM output | Analog input |
|---|---|---|
| AO1 | P7.0 | P5.0 |
| AO2 | P7.1 | P5.1 |
| AO3 | P7.2 | P5.2 |
| AO4 | P7.3 | P5.3 |

**DAC analog outputs**

The 4 DAC analog outputs AO5…AO8 are implemented via a quad DAC.
The 2.5 V output signal is converted to the analog range of 0…10 VAC via an amplifier module.

The DAC analog outputs have the following features:

- AO5...AO8 produce voltages between 0...+10 VDC
- Maximum load current 5 mA
- 12 bit resolution
- Voltage outputs are short-circuit proof.
- The setting time is typically 3 ms (software reaction time).
- The AO… are non-floating.
- Protective circuit: up to +24 V without destruction
- Maximum load impedance: 2 kΩ

| Analog output | DAC output |
|---|---|
| AO5 | A |
| AO6 | B |
| AO7 | C |
| AO8 | D |

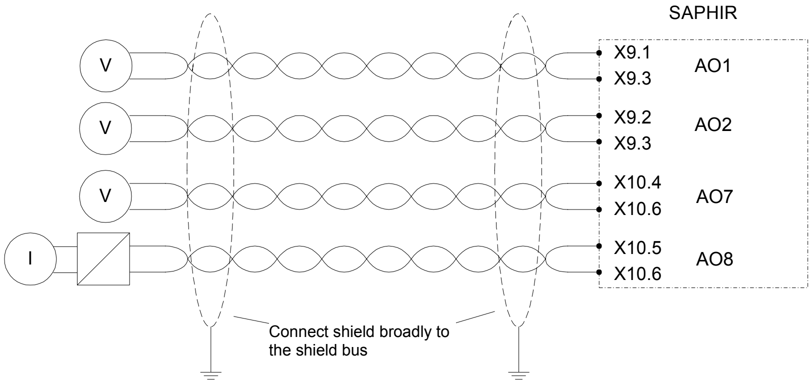


Figure 6: Analog output connection

Cables

The cross-section of the connecting wires should not exceed 1.5 mm² because of the Cage Clamp terminals.

**EMC measures**

Use shielded cables as signal cables. Each analog output should be connected to a twisted pair.
The shield must be connected broadly to a shield bus in front of the SAPHIR unit.

### 4.4.4 Universal Inputs

The central element of the universal inputs is a sigma-delta ADC. One of the 14 universal inputs is connected to the ADC via a multiplexer and analog switch. A scan list defined via the software determines the processing sequence.
The 14 universal inputs UI1...UI14 have a common reference point and are electrically connected to the SAPHIR unit.

Each input is configurable as follows via the software:

- 0…10 V voltage input
- 0…20 mA / 4…20 mA current input (only via external 100 Ω shunt)
- Temperature Ni1000, Pt1000, Pt100 (with approx. 400 μA sensor current)
- Temperature NTC, PTC (up to approx. 4.5 kΩ, from then on with external shunt resistor)
- Digital input (24 V, max. 4.5 mA)

An analog input signal is converted in approx. 30 ms. When configured as a digital input, the conversion time is reduced to approx. 12 ms. In the worst case, the conversion time for all 14 universal inputs is approx. 420 ms.
The universal inputs are controlled via multiplexers.

Refer to the SAPHIR circuit diagrams for detailed information on the control of the multiplexers and analog switches according to input configuration.

Cables

The cross-section of the connecting wires should not exceed 1.5 mm² because of the Cage Clamp terminals.

**EMC measures**

With the exception of the digital input, only shielded, twisted pair signal cables should be used as connecting wires. Each universal input should be connected to a twisted pair.
Observe the following in the case of three-wire connected, active transducers:

- The transducer should be connected via two twisted pairs. One conductor pair is used for the power supply, the other for the signal, but the ground is removed at the transducer.

The shield must be connected broadly to a shield bus in front of the SAPHIR unit.

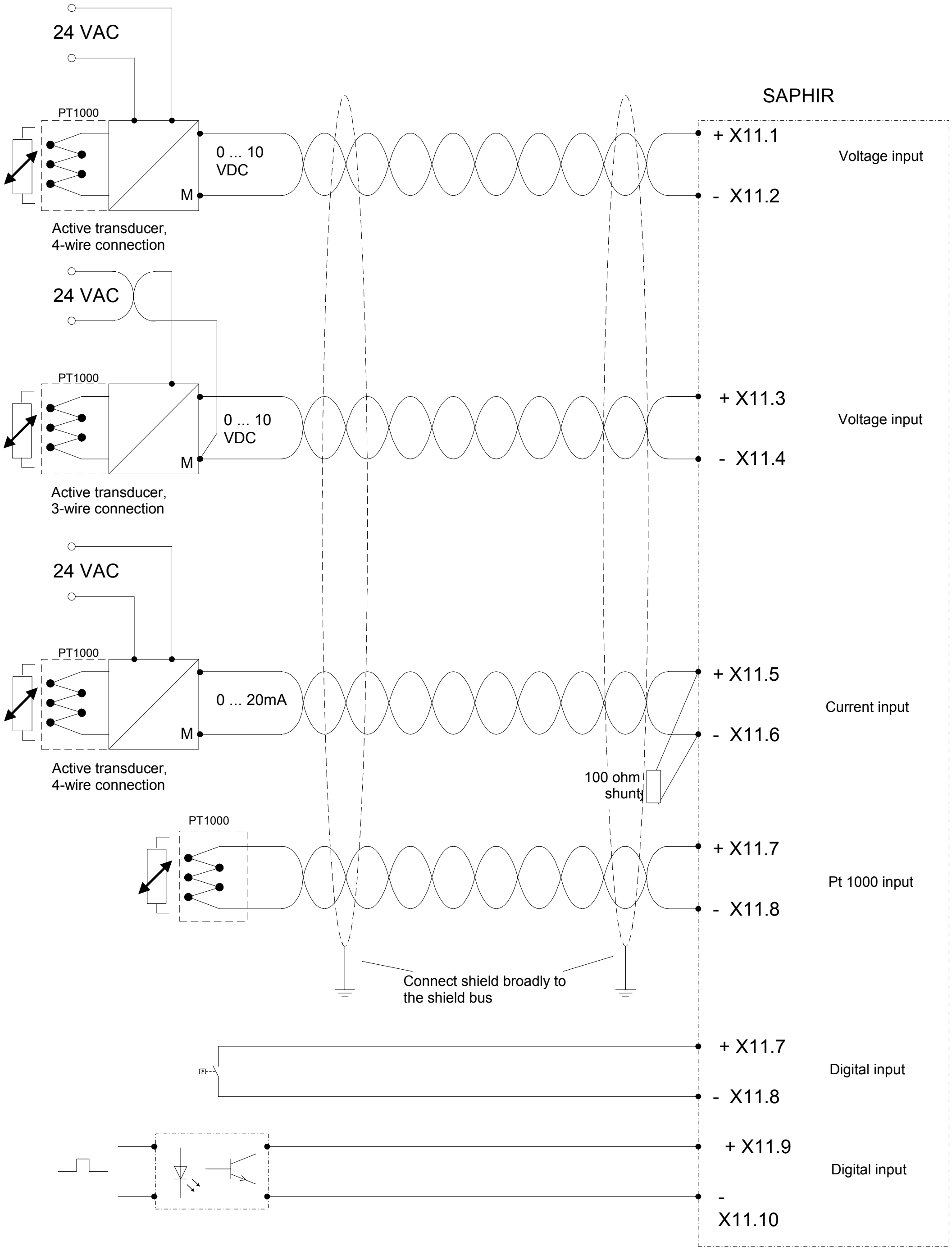


Figure 7: Universal input connection

**Voltage input** Voltage inputs process 0...+10 VDC signals.

Electrical values

| | |
|---|---|
| Input voltage: | U = 0…10 VDC |
| Input impedance: | approx. 100 kΩ |
| Resolution: | up to 12 bit (default 10 bit) |

**Current input** In the case of current inputs, a 100 Ω shunt must be connected externally in parallel to the universal input. Current measurement is performed indirectly via a voltage measurement across the shunt.

Electrical values

| | |
|---|---|
| Input current: | I = 0…20 mADC (4…20 mADC) |
| Input impedance: | 100 Ω |
| Resolution: | up to 12 bit (default 10 bit) |

**Temperature input** Temperature inputs provide for connection of passive, temperature-dependent resistors with a resistance value of approx. 4.5 kΩ, such as Pt1000/Pt100/Ni1000 elements and NTC/PTC elements.

Temperature measurement is performed indirectly via resistance measurement. The temperature value is determined in the software via resistance/temperature characteristics.

Electrical values

| | |
|---|---|
| Sensor current: | I = 400 μA |
| Measuring range: | 0…approx. 4.5 kΩ |
| Resolution: | up to 12 bit (default 10 bit) |

**Digital input** Digital inputs are used to interrogate static switching states. The maximum input frequency must not exceed 2 Hz.

Only floating contacts must be connected. The contacts are interrogated with approx. 24 V / 4.5 mA.

## 4.5 Real-Time Clock

SAPHIR is equipped with a real-time clock. It supports the following functions:

- Time indication in hours/minutes/seconds
- Calendar with leap-year
- Manual winter/summer time changeover
- Day of week

The real-time clock is buffered against power failure for at least two days. The clock information is retained during this period.

Afterwards, the clock must be set manually (via HMI or PC).

## 4.6 Indications and Switches

### 4.6.1 Light-Emitting Diodes (LEDs)

The SAPHIR unit is equipped with four LEDs for optical status indication.

The LEDs are controlled via an external port that is addressed by the microcontroller's chip select signal (CS2).

| LED name | LED color | Port |
|---|---|---|
| CTRL (LED1) | Green | Bit 0 |
| FAULT (LED2) | Red | Bit 2 |
| COM (LED3) | Green | Bit 4 |
| OK (LED4) | Green | Bit 7 |

**Indication meanings:** The functionality of the LEDs is briefly described here.

**–** Individual ACX32: Application with an ACX32 with no communication card (RCC) installed.

| Operating state | LED indication |
|---|---|
| Normal status | CTRL flashes green<br>OK flashes green at high frequency<br>FAULT is off<br>COM is off |
| Task stopped | CTRL is off<br>OK flashes green at high frequency<br>FAULT is permanently red<br>COM is off |

**–** ACX32 master: Master-slave application with a communication card (RCC) installed.

| LED | Operating state |
|---|---|
| CTRL | **Application program running**:<br>If the application is running properly, the LED changes its status at every cycle. This means high to very high frequency flashing with small applications, and low-frequency flashing with large applications. |
| FAULT | **Only on if an error is present**:<br>• If FAULT is on, and CTRL and OK are flashing, there is a hardware fault in the I/O peripherals.<br>• If FAULT is on, and OK is not flashing, there is a problem with the entire controller.<br>Please inform Support of the LED status! |
| COM | **Communication active**:<br>Only if an RCC card is installed, this LED flashes during message traffic. |
| OK | **Controller operational**:<br>Controller life sign; must flash rapidly |

| Operating state | LED indication |
|---|---|
| Normal status | CTRL flashes green<br>OK flashes green at high frequency<br>FAULT is off<br>COM indicates RCC message traffic |
| Task stopped | CTRL is off<br>OK flashes at high frequency<br>FAULT is permanently red<br>COM is off |
| I/O error | CTRL flashes<br>OK flashes at high frequency<br>FAULT is permanently red<br>COM indicates RCC message traffic |
| Controller error | FAULT is permanently red!<br>No other LED is on or flashing.<br>Inform Support of the LED status! |

**–** ACX32 slave

| LED | Operating state |
|---|---|
| CTRL | **ACX32 is running as an I/O extension**:<br>Flashes at 1-second intervals to indicate that the controller is being used as an I/O extension. |
| FAULT | **Only on in case of a communication disturbance**:<br>• If FAULT is on, and COM is off, a communication disturbance is present.<br>• If FAULT is on, and COM is flashing, a hardware fault is present. |
| COM | **Communication active**:<br>Indicates the message traffic with the master. The LED changes it's status when the slave is addressed by the master. |
| OK | **Controller operational**:<br>Controller life sign; must flash rapidly |

| Operating state | LED indication |
|---|---|
| Normal status | CTRL flashes green slowly<br>OK flashes green at high frequency<br>FAULT is off<br>COM indicates message traffic with the master |
| No communication | CTRL flashes slowly<br>OK flashes at high frequency<br>FAULT is permanently red<br>COM is off |
| I/O error | CTRL flashes slowly<br>OK flashes at high frequency<br>FAULT is permanently red<br>COM indicates message traffic with the master |
| Controller error | FAULT is permanently red!<br>No other LED is on or flashing.<br>Inform Support of the LED status! |

### 4.6.2 DIL Switches

A 4x DIL switch is installed on the SAPHIR unit.

The ON position of a switch supplies the "0" state at the corresponding port pin.

The DIL switches are read via port P5 of the controller.

| DIL switch S6 | Input |
|---|---|
| Bit 0 | P5.4 |
| Bit 1 | P5.5 |
| Bit 2 | P5.6 |
| Bit 3 | P5.7 |

### 4.6.3 Bridges

The bootstrap loader is activated via bridge X19. The bridge must be inserted before the SAPHIR unit is powered up (see Fig. 2).
As long as bridge X19 is inserted, the operating system cannot boot, and all LED's are on!

STOP

4x bridge module X17 on the SAPHIR unit is used to set various software modes (see also Fig. 2).
The bridges are read directly by the controller port. An inserted bridge supplies a "0" at the corresponding port pin.
X17 1/2 is to Bridge, if the Saphir is used as a Slave.
X17 3/4 not used
X17 5/6 not used
X17 7/8 at the left Site, is to Stop the Task.

# 4.7 Supply Voltages

The SAPHIR unit is supplied with 24 VAC (±15%) or 26…35 VDC via plug-in terminal strip X1 (terminals X1.1 and X1.2).

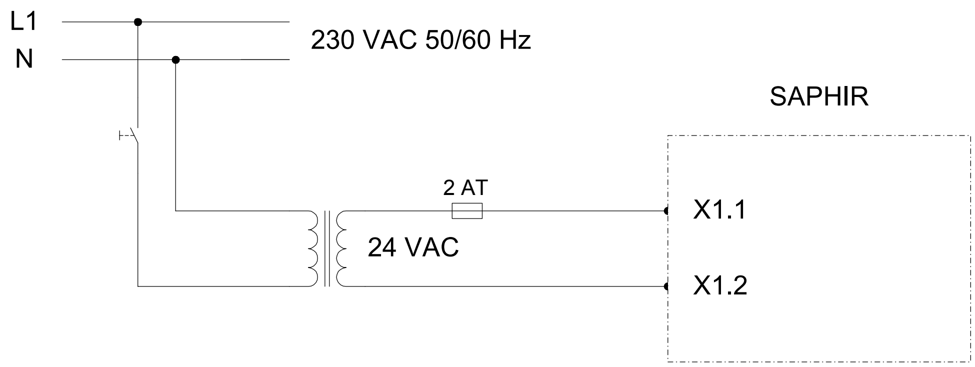


Figure 8: Transformer connection

**A supply voltage > 29 VAC can destroy the unit!**

**The power supply of the SAPHIR unit must not be grounded!**

**Transformer data**

| | |
|---|---|
| Primary voltage: | 230 V |
| Secondary voltage: | 24 V |
| Power: | 15 VA |
| Secondary protection: | 2 A, slow |

Primary side protection can be provided by a motor circuit-breaker or circuit breaker terminal.

Electrical values

| | |
|---|---|
| Supply voltage: | 24 VAC, ±15%, 50/60 Hz or<br>26 V...35 VDC |
| Current consumption: | approx. 0.3 A with full configuration |

Cables

The cross-section of the connecting wires should not exceed 1.5 mm² because of the Cage Clamp terminals.

Grounding

The SAPHIR housing is grounded at the central earth connection point via a mounting lug with a conductor cross-section > 10 mm² (copper conductor).

The transformer must not be used to supply any additional devices other than the SAPHIR unit (e.g. control valves, damper actuators etc).

Any other necessary supply voltages are generated via rectifiers and DC/DC converters in the device. The supply voltages for the microcontroller are monitored via the software.

The supply voltage low limit is monitored via a comparator. If it falls below the tolerance of -15 %, an NMI is generated in the controller.

### 4.7.1 5V Logic Supply

This is produced from the supply voltage after rectification and smoothing via a DC/DC converter. A reset generator monitors the voltage; it is triggered at a voltage of approx. 4.55 V at which it generates a reset.

### 4.7.2 30 VDC supply

This is produced directly from the supply voltage after rectification and smoothing. Since the voltage is not controlled, it can vary in a range of approx. 26...35 V.

The voltage is used to supply the binary inputs/outputs and the complete analog section. It is also brought out to module connectors X15 and X16.
The analog voltage value can be acquired via controller input AN14 (port pin P5.14).

### 4.7.3 12 V Output

In order to supply the external HMI, a 12 VDC supply voltage is generated from the rectified 24 VAC via an in-phase regulator.
The 12 V output is monitored to approx. 10 V via a comparator.
The comparator output can be interrogated via the software through controller input AN15 (port pin P5.15).
Additionally, the analog value of the 12 V supply can be acquired via controller input AN13 (port pin P5.13).

The 12 VDC supply voltage output has the following features:

- Maximum load current 50 mA
- The 12 V output is short-circuit proof.

The 12 V supply voltage is brought out to connector X13.

| Connector X13 | 12 V output |
|---|---|
| X13.6; X13.7 | +12 V |
| X13.1; X13.8 | GND |

# 5 Assembly, Installation and Setup Guidelines

## 5.1 General Setup Notes

With the use of electronic components in automation, increasing attention must be paid to electromagnetic immunity. Typical sources of interference noise such as relays, fluorescent lamps, converters, HF generators, commutator rotors and switching controllers generate high-frequency signals that are injected directly, inductively or capacitively into the module where they can disturb or even destroy it.

Observe the following points with regard to the installation of electronic components in field panels:

- Use a galvanized assembly plate to ground racks, mains filters, shield busses and other components.
- Keep grounding connections broad and short.
- Attach shielded cables broadly to the shield bus.
- Route circuits with a high interference potential separately.
- Connect relays with freewheeling diodes or RC elements.
- Keep the wiring of modules with strong interference emissions physically separate from the module.
- Use filters positioned as close as possible to the field panel inlet to reduce mains interference.
- Ground power supplies via ground terminal as close as possible to the module using the 0 V connection.
- Install input terminals and shield busses directly at the field panel's cable inlet.
- Where not directly welded together, establish a broad electrical contact between all field panel parts, or assemble with contact washers.
- Use two-end shield connection (to ground) always with a bonding conductor.

Additionally, the following general rules should be observed during installation and commissioning:

☝ The devices are equipped with components that are sensitive to electrostatic discharge. Therefore, the usual precautions for electrostatic sensitive devices (ESD) should be taken.

☝ Printed circuit boards must not be removed from the device.

☝ Devices must not come into contact with charged or chargeable objects. Use approved tools only.

☝ The following is not permitted with voltage applied:
  - Removal and insertion of plug-in cables
  - Changing of bridges and components
  - Removal and insertion of communication modules

STOP Devices must only be transported in their original packaging (or in suitable ESD packaging)!

Any manipulation of the device beyond the appropriate proper operation and installation voids all warranties.

## 5.2 SAPHIR ACX32

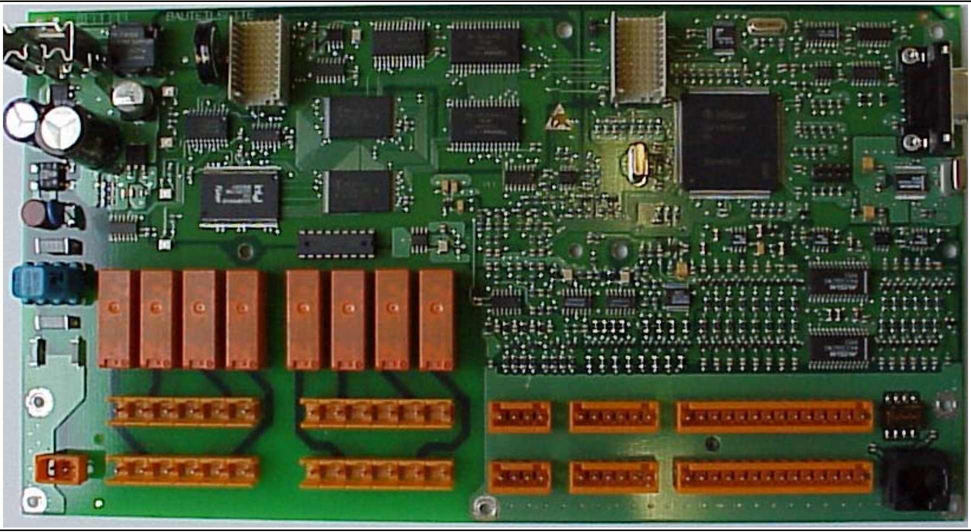

Figure 9: SAPHIR ACX32...

**Accidental connection of voltages greater than AC 29 V (e.g. AC 240 V) to the low-voltage connections will destroy the device.**

STOP

The connection sequence of the SAPHIR device is as follows:
**First connect the peripheral signals, then the power supply.**

**In order to protect against accidental contact with relay connections at voltages of $U_{eff}$ > 42 V, the device must be installed in an enclosure (preferably a control panel). It must be impossible to open the enclosure without the aid of a key or tool.**

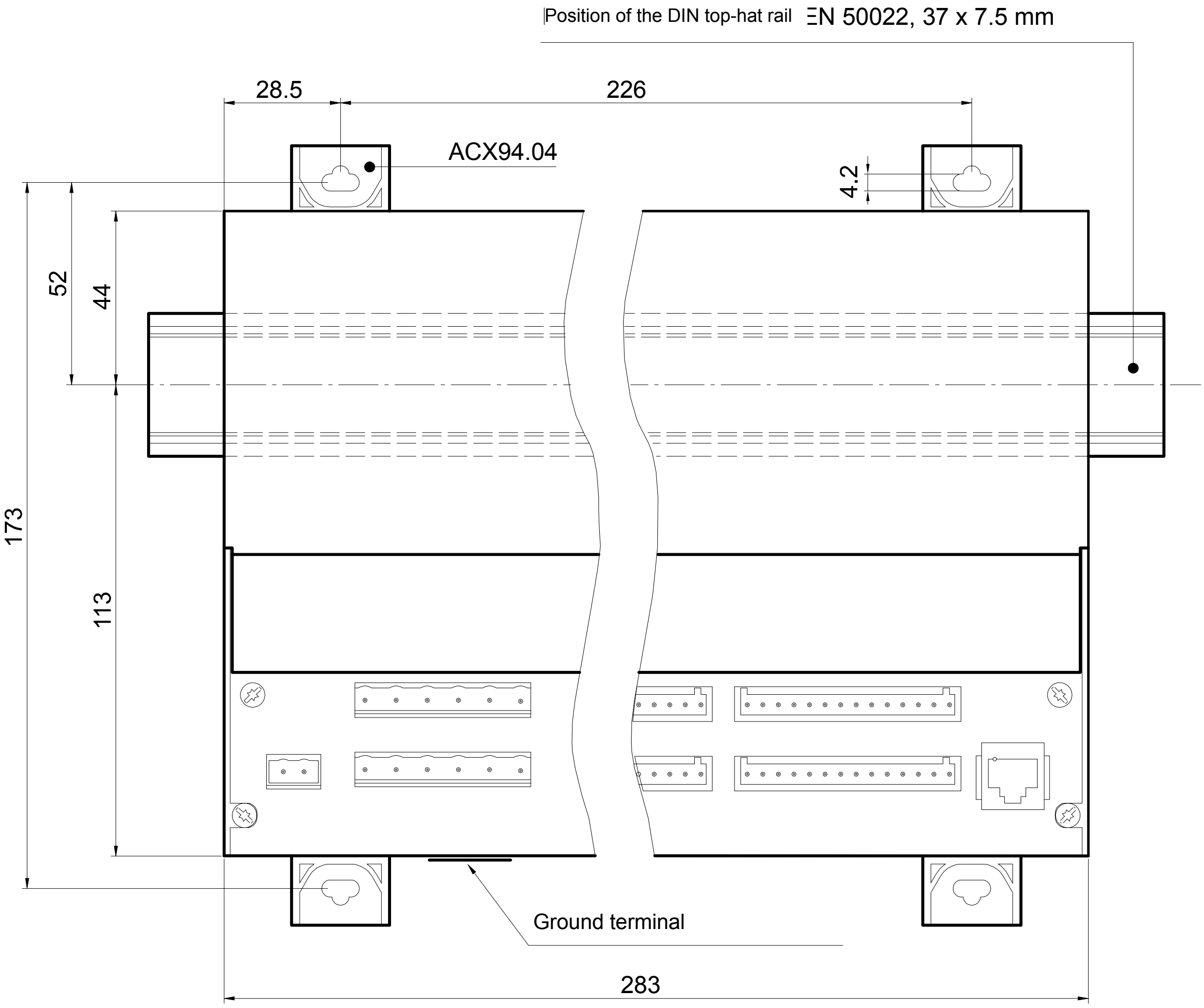


Figure 10: Snap-in mounting of unit ACX32... on a top-hat rail using ACX94.04

### 5.2.1 Behavior in the Event of Malfunction

Check the following in case of malfunction:

- 24 V power supply
- Correct connection of plug-in cables
- Correct connection of peripheral devices
- Watchdog error occurred?
- Diagnostics via LEDs on device front (see section 4.6.1)

If the malfunction cannot be corrected in this way, exchange the device and return it to the manufacturer's facility.

### 5.2.2 Connectors

WAGO Cage Clamp female connectors are provided for connection of the power supply and peripheral signals to the SAPHIR unit.

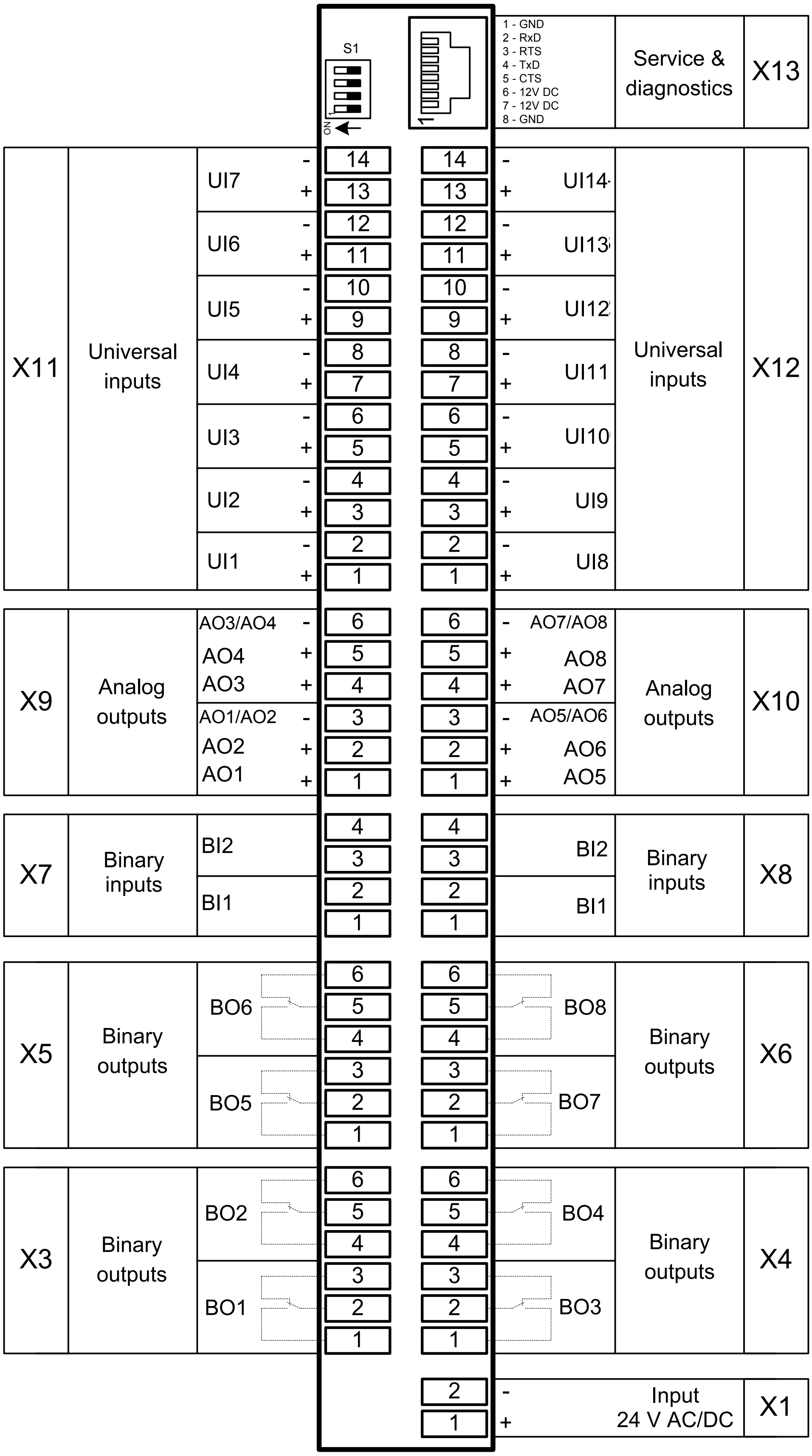


Figure 11: Connector assignment

**WAGO peripheral connectors**

Ordering data: Cage Clamp equipment

| Connector | Contact spacing in mm | Conductor cross section in mm² | Order number | |
|---|---|---|---|---|
| | | | without strain relief | with strain relief |
| X1 | 5.08 | 0.08…2.5 | 231-302/026-000 | /032-000 |
| X3,X4,X5,X6 | 7.62 | 0.08…2.5 | 231-706/026-000 | /034-000 |
| X7,X8 | 3.81 | 0.08…1.5 | 734-204 | /033-000 |
| X9,X10 | 3.81 | 0.08…1.5 | 734-206 | /033-000 |
| X11,X12 | 3.81 | 0.08…1.5 | 734-214 | /035-000 |

Figure 12: Ordering data

The service and diagnostics interface is adapted via an RJ45 connector.
The SDL plug connector system by AMP can be used, for example.

## 5.3 Wiring Examples

### 5.3.1 Basic Wiring of SAPHIR

The following illustration shows a wiring example of the SAPHIR unit.

The 24 VAC supply voltages for the SAPHIR unit and the active transmitters/sensors must be generated via a transformer with two **separate windings** (short circuit hazard). Alternatively, two 24 V transformers can be used.

### 20 VA power supply

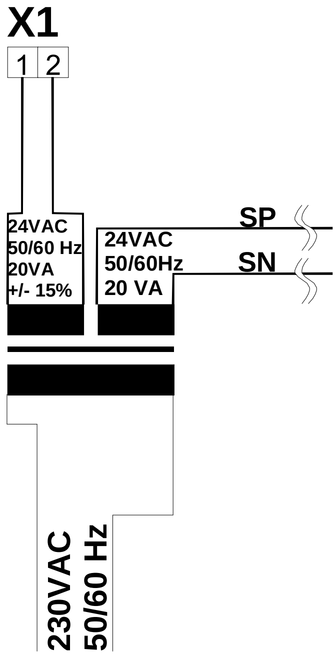


Figure 13: Basic power supply wiring

### 5.3.2 SAPHIR with Digital Outputs

Wiring example with relay outputs:

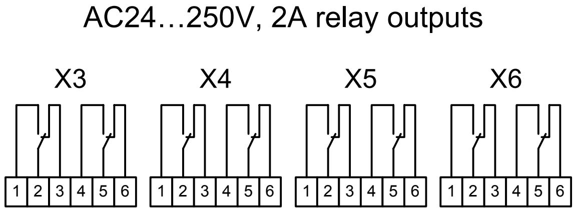


Figure 14: Relay outputs

⚠ Any **suppressor circuit, interference suppression** etc. must be provided **externally** according to the application!

### 5.3.3 SAPHIR with Fast Counter Inputs

Wiring example with the digital inputs configured as fast counter inputs (max. 50 Hz).

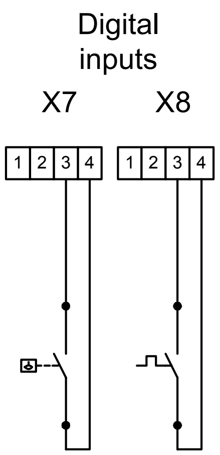


Figure 15: Fast counter inputs

### 5.3.4 SAPHIR with Analog Outputs

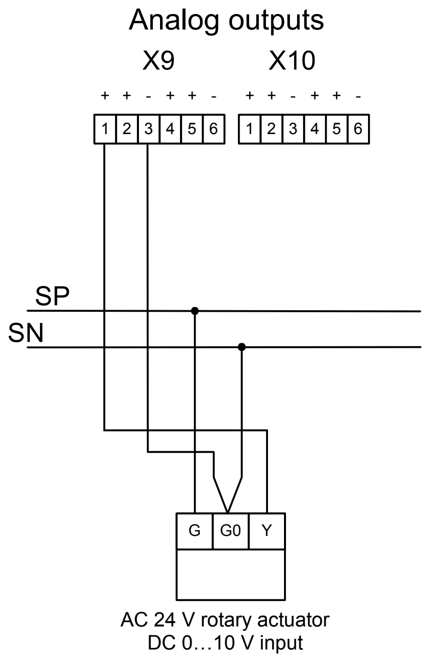


Figure 16: Analog outputs

### 5.3.5 SAPHIR with Passive Sensor

Wiring example with Ni1000, Pt1000 or Pt100 configured as a passive sensor.

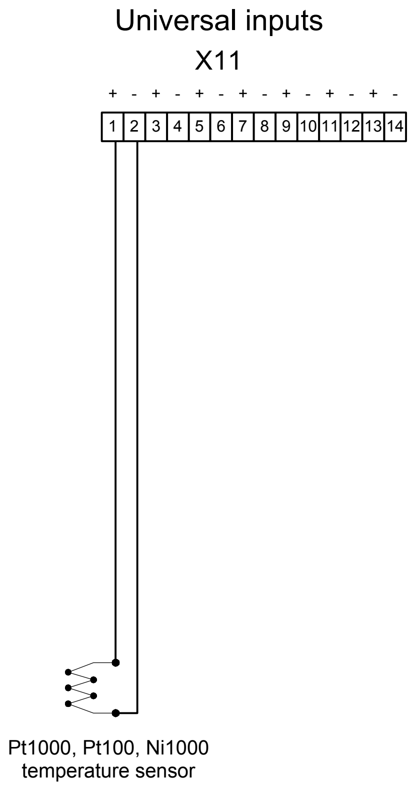


Figure 17: Passive sensor

## 5.3.6 SAPHIR with Temperature Sensor

Wiring example with NTC or PTC temperature sensor.
An NTC/PTC sensor is connected to universal input UI11 (X12.7, X12.8).
Above a resistance value of approx. 4.5 kΩ, an external shunt resistor must be connected.

Inquire first whether an NTC/PTC sensor characteristic has been implemented in the software.

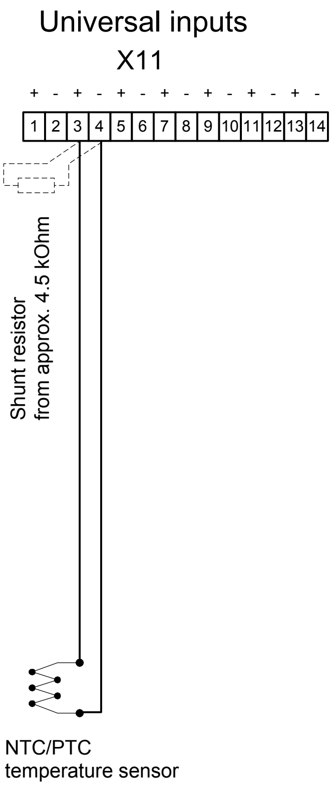


Figure 18: Temperature sensor

## 5.3.7 SAPHIR with Active Sensor

Wiring example with an active sensor with 0…20 mA or 4…20 mA output signal.
An active sensor with a 0…20 mA current output is connected to universal input UI3 (X11.5, X11.6). For this purpose, a 100 Ω shunt resistor must be connected in parallel to the input. The accuracy of the current input is largely determined by the accuracy of the shunt resistor. A resistor with a tolerance of 0.1 % is recommended.

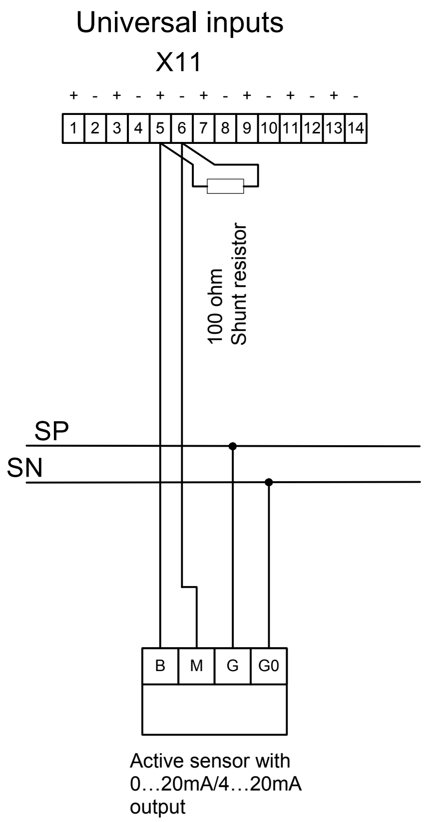


Figure 19: Active sensor with max. 20 mA output signal

### 5.3.8 SAPHIR with Active Sensor

Wiring example with an active sensor with DC 0…10 V output signal.

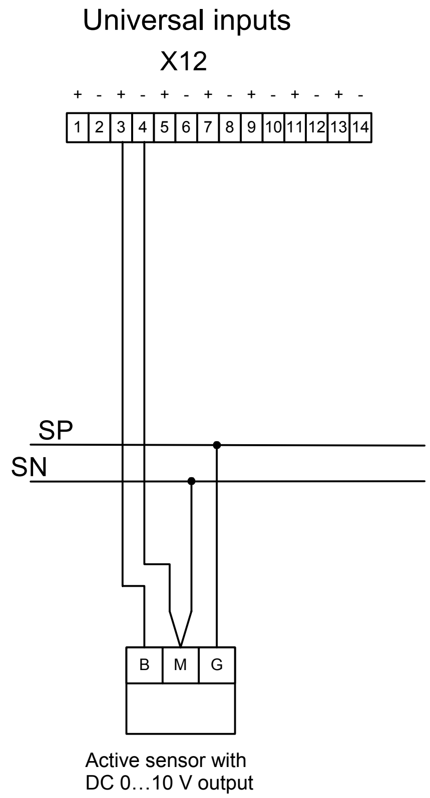


Figure 20: Active sensor with DC 10 V output signal

### 5.3.9 SAPHIR with Digital Input

Wiring example with 2 digital inputs, e.g. status signal.

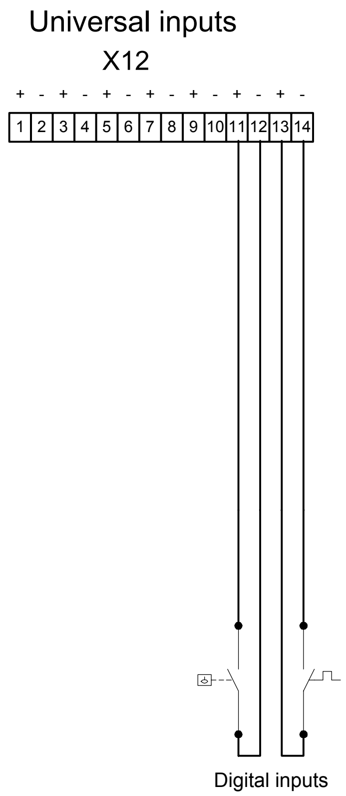


Figure 21: Digital inputs

## 5.3.10 SAPHIR with Slave Modules

Wiring example of ACX32 master and AXC42.12 or ACX41.08:

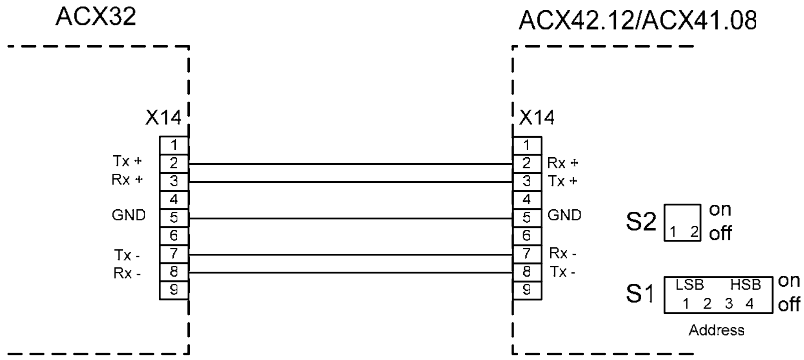


Figure 22: ACX32 master and I/O extension

**DIL switches:**

- S1 Defines address of the slave (0 = OFF / 1 = ON)
- S2 Termination of the last slave:
  For the last slave module of the connected slaves
  **both DIL switches of S2 have to be fixed to ON position!**

Wiring example of ACX32 master and AXC32 slave:

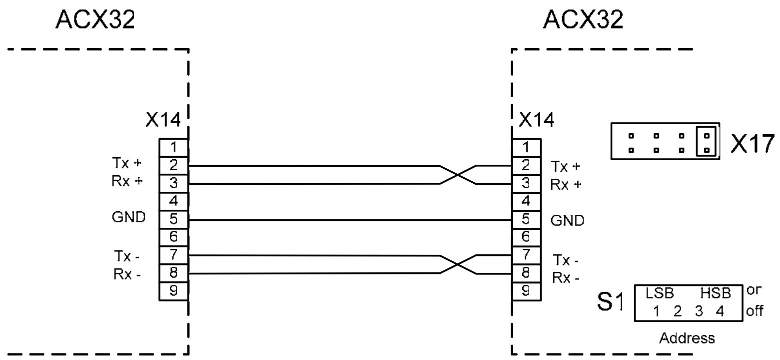


Figure 23: ACX32 master and slave

**Dil Switch and Bridge Module:**

- S1 Defines address of the slave (0 = OFF / 1 = ON)
- X17 If ACX32 controller is used as slave:
  to set the software mode of AXC32 for slave
  **at bridge module X17/1-2 an inserted bridge all to the right has to be!**

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