Parameter	Value	
Settling time for full range change (resistive load, output signal within specified tolerance)	Typ. 5 ms	
Conversion error of the analog values caused by non-linearity, adjustment error at factory and resolution within the normal range	Typ.	±0.5 % of full scale at 25 °C
	Max.	±1 % of full scale (all ranges) at 0 °C...60 °C or EMC disturbance
Relationship between output signal and hex code	See table *Chapter 1.6.2.2.5.9.3 "Output ranges voltage and current" on page 519*	
Unused outputs	Can be left open-circuited	

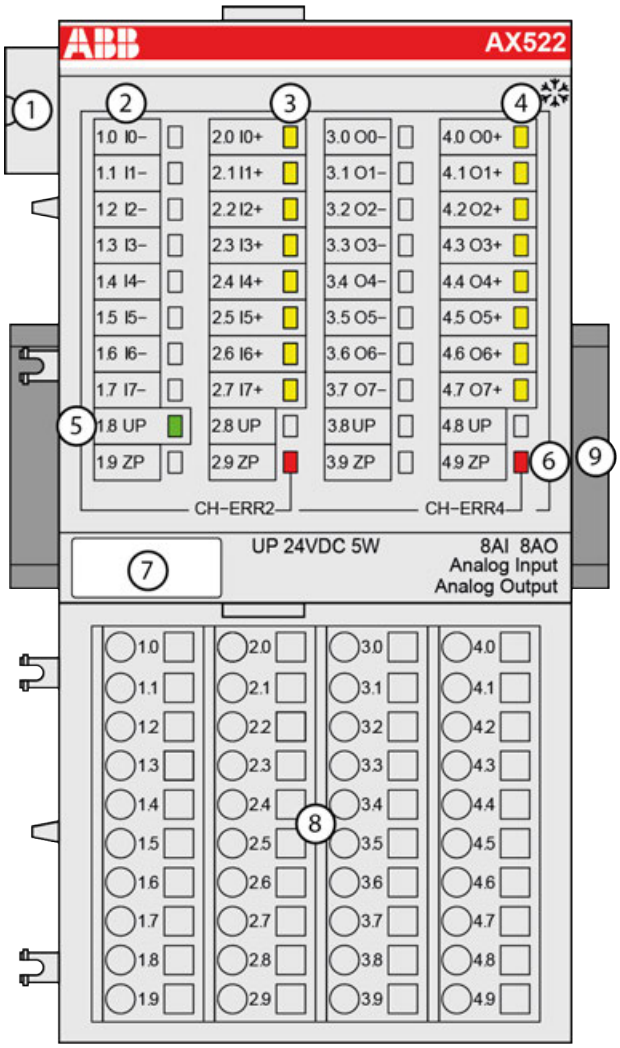
Ordering Data

Part no.	Description	Product life cycle phase *)
1SAP 250 100 R0001	AX521, analog input/output module, 4 AI, 4 AO, U/I/Pt100, 12 bits + sign, 2-wires	Active
1SAP 450 100 R0001	AX521-XC, analog input/output module, 4 AI, 4 AO, U/I/Pt100, 12 bits + sign, 2-wires, XC version	Active

**) Modules in lifecycle Classic are available from stock but not recommended for planning and commissioning of new installations.*

1.6.2.2.6 AX522 - Analog input/output module

- 8 configurable analog inputs (I0 to I7) in 1 group (1.0...2.7)
  Resolution 12 bits plus sign
- 8 configurable analog outputs (O0 to O7) in 1 group (3.0...4.7)
  Resolution 12 bits plus sign
- Module-wise galvanically isolated
- XC version for use in extreme ambient conditions available



1 I/O bus
2 Allocation between terminal number and signal name
3 8 yellow LEDs to display the signal states at the analog inputs (I0 - I7)
4 8 yellow LEDs to display the signal states at the analog outputs (O0 - O7)
5 1 green LED to display the state of the process supply voltage UP
6 2 red LEDs to display errors
7 Label
8 Terminal unit
9 DIN rail
Sign for XC version

Intended purpose

The device can be used as a decentralized I/O extension module for S500 communication iInterface modules (e. g. CI592-CS31, CI501-PNIO, CI541-DP, CI581-CN) or as a centralized extension module for AC500 CPUs.

Functionality

8 analog inputs (I0...I7), individually configurable for

- Unused (default setting)
- 0 V...10 V
- -10 V...+10 V
- 0 mA...20 mA

- 4 mA...20 mA
- Pt100, -50 °C...+400 °C (2-wire)
- Pt100, -50 °C...+400 °C (3-wire), requires 2 channels
- Pt100, -50 °C...+70 °C (2-wire)
- Pt100, -50 °C...+70 °C (3-wire), requires 2 channels
- Pt1000, -50 °C...+400 °C (2-wire)
- Pt1000, -50 °C...+400 °C (3-wire), requires 2 channels
- Ni1000, -50 °C...+150 °C (2-wire)
- Ni1000, -50 °C...+150 °C (3-wire), requires 2 channels
- 0 V...10 V with differential inputs, requires 2 channels
- -10 V...+10 V with differential inputs, requires 2 channels
- Digital signals (digital input)

4 analog outputs (O0...O3), individually configurable for

- Unused (default setting)
- -10 V...+10 V
- 0 mA...20 mA
- 4 mA...20 mA

4 analog outputs (O4...O7), individually configurable for

- Unused (default setting)
- -10 V...+10 V

Parameter		Value
Resolution of the analog channels		
	Voltage -10 V...+10 V	12 bits plus sign
	Voltage 0 V...10 V	12 bits
	Current 0 mA...20 mA, 4 mA...20 mA	12 bits
	Temperature	0.1 °C
LED displays		19 LEDs for signals and error messages
Internal power supply		Via the I/O bus interface (I/O bus)
External power supply		Via the terminals ZP and UP (process voltage 24 V DC)
Required terminal unit		TU515 or TU516 ↳ *Chapter 1.5.2 “TU515, TU516, TU541 and TU542 for I/O modules” on page 126*

Connections



For a detailed description of the mounting, disassembly and connection of the module, please refer to the System Assembly, Construction and Connection chapter ↳ *Chapter 2.6 “AC500 (Standard)” on page 971.*

The modules are plugged on an I/O terminal unit ↳ *Chapter 1.5.2 “TU515, TU516, TU541 and TU542 for I/O modules” on page 126*. Properly position the modules and press until they lock in place. The terminal units are mounted on a DIN rail or with 2 screws plus the additional accessory for wall mounting (TA526 ↳ *Chapter 1.8.2.6 “TA526 - Wall mounting accessory” on page 902*).

The connection of the I/O channels is carried out using the 40 terminals of the I/O terminal unit. I/O modules can be replaced without re-wiring the terminal units.

The terminals 1.8, 2.8, 3.8 and 4.8 as well as 1.9, 2.9,3.9 and 4.9 are electrically interconnected within the I/O terminal units and always have the same assignment, independent of the inserted module:

Terminals 1.8, 2.8, 3.8 and 4.8: process voltage UP = +24 V DC

Terminals 1.9, 2.9, 3.9 and 4.9: process voltage ZP = 0 V DC

The assignment of the other terminals:

Terminals	Signal	Description
1.0 to 1.7	I0- to I7-	Negative poles of the 8 analog inputs
2.0 to 2.7	I0+ to I7+	Positive poles of the 8 analog inputs
3.0 to 3.7	O0- to O7-	Negative poles of the 8 analog outputs
4.0 to 4.7	O0+ to O7+	Positive poles of the 8 analog outputs



The negative poles of the analog inputs are connected to each other to form an "Analog Ground" signal for the module.



The negative poles of the analog outputs are connected to each other to form an "Analog Ground" signal for the module.



There is no galvanic isolation between the analog circuitry and ZP/UP. Therefore, the analog sensors must be galvanically isolated in order to avoid loops via the ground potential or the supply voltage.



Because of their common reference potential, analog current inputs cannot be circuited in series, neither within the module nor with channels of other modules.



For the open-circuit detection (cut wire), each analog input channel is pulled up to "plus" by a high-resistance resistor. If nothing is connected, the maximum voltage will be read in then.

The internal power supply voltage for the module's circuitry is carried out via the I/O bus (provided by a communication interface module or a CPU). Thus, the current consumption from 24 V DC power supply at the terminals L+/UP and M/ZP of the CPU/communication interface module increases by 2 mA per I/O module.

The external power supply connection is carried out via the UP (+24 V DC) and the ZP (0 V DC) terminals.

WARNING!

Removal/Insertion under power

Removal or insertion under power is only permissible under conditions described in Hot Swap chapter *Chapter 1.6 “I/O modules” on page 142*.

The devices are not designed for removal or insertion under power when Hot Swap conditions do not apply. Because of unforeseeable consequences, it is not allowed to plug or unplug devices with the power being ON.

Make sure that all voltage sources (supply and process voltage) are switched off before you

– connect or disconnect any signal or terminal block
– remove, mount or replace a module.

Disconnecting any powered devices while energized in a hazardous location could result in an electric arc, which could create a flammable ignition resulting in fire or explosion.

Make sure that power is removed and that the area has been thoroughly checked to ensure that flammable materials are not present prior to proceeding.

The devices must not be opened when in operation. The same applies to the network interfaces.

NOTICE!

Risk of damaging the PLC modules!

Overvoltages and short circuits might damage the PLC modules.

– Make sure that all voltage sources (supply voltage and process supply voltage) are switched off before you begin with operations on the system.
– Never connect any voltages or signals to reserved terminals (marked with ---). Reserved terminals may carry internal voltages.

Generally, analog signals must be laid in shielded cables. The cable shields must be grounded at both sides of the cables. In order to avoid unacceptable potential differences between different parts of the installation, low resistance equipotential bonding conductors must be laid.

Only for simple applications (low electromagnetic disturbances, no high requirement on precision), the shielding can also be omitted.

The following figure shows the connection of the I/O module.

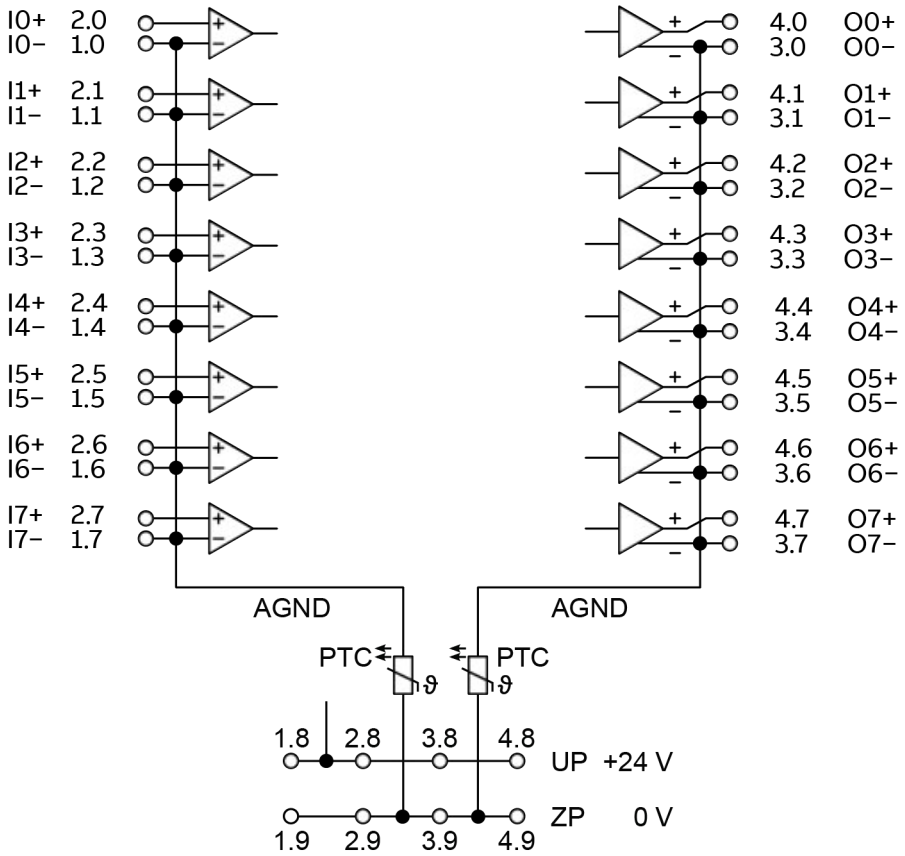


Fig. 62: 8 analog inputs and 8 analog outputs, individually configurable *Chapter 1.6.2.2.6.2 “Functionality” on page 524*

CAUTION!
By installing equipotential bonding conductors between the different parts of the system, it must be ensured that the potential difference between ZP and AGND never can exceed 1 V.

CAUTION!
The process supply voltage must be included in the grounding concept (e. g. grounding of the negative pole).

Connection of resistance thermometers in 2-wire configuration

When resistance thermometers (Pt100, Pt1000, Ni1000) are used, a constant current must flow through them to build the necessary voltage drop for the evaluation. For this, the I/O module provides a constant current source which is multiplexed over the 8 analog channels.

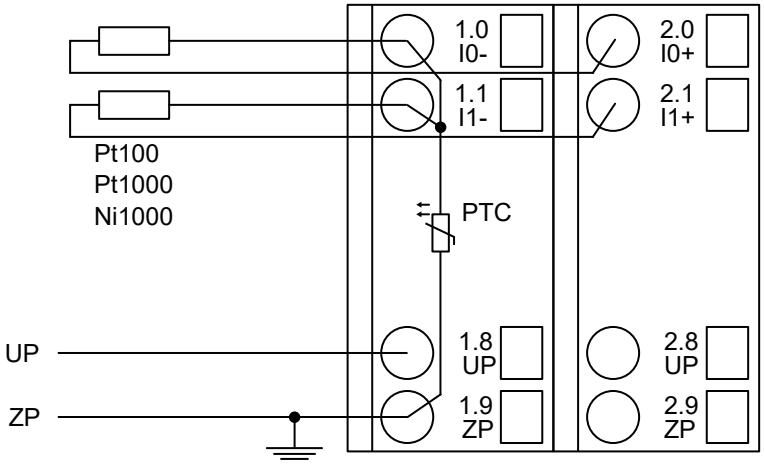


Fig. 63: Connection example

Pt100	-50 °C...+70 °C	2-wire configuration, one channel used
Pt100	-50 °C...+400 °C	2-wire configuration, one channel used
Pt1000	-50 °C...+400 °C	2-wire configuration, one channel used
Ni1000	-50 °C...+150 °C	2-wire configuration, one channel used

The I/O module performs a linearization of the resistance characteristic.

In order to avoid error messages from unused analog input channels, it is useful to configure them as "unused".

Connection of resistance thermometers in 3-wire configuration

When resistance thermometers (Pt100, Pt1000, Ni1000) are used, a constant current must flow through them to build the necessary voltage drop for the evaluation. For this, the I/O module provides a constant current source which is multiplexed over the max. 8 (depending on the configuration) analog channels.

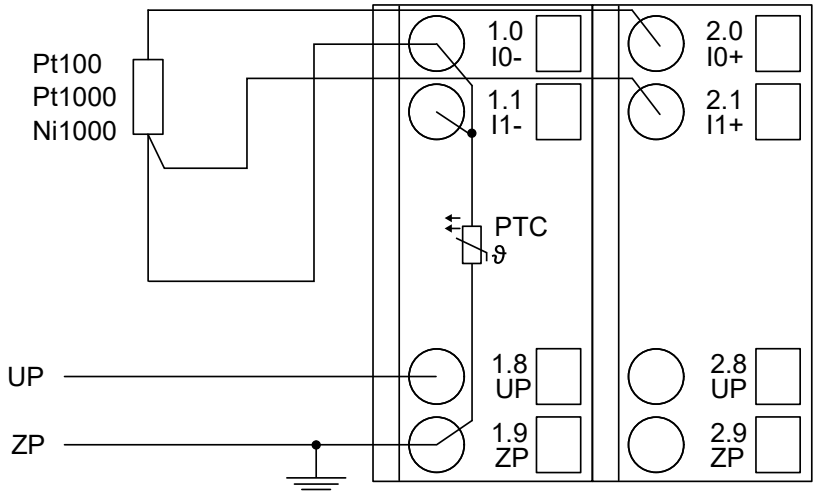


Fig. 64: Connection example

If several measuring points are adjacent to each other, only one return line is necessary. This saves wiring costs.

With the 3-wire configuration, two adjacent analog channels belong together (e.g. the channels 0 and 1). In this case, both channels are configured according to the desired operating mode. The lower address must be the even address (channel 0), the next higher address must be the odd address (channel 1).

The constant current of one channel flows through the resistance thermometer. The constant current of the other channel flows through one of the cores. The module calculates the measured value from the two voltage drops and stores it under the input with the higher channel number (e.g. I1).

In order to keep measuring errors as small as possible, it is necessary to have all the involved conductors in the same cable. All the conductors must have the same cross section.

Pt100	-50 °C...+70 °C	3-wire configuration, two channels used
Pt100	-50 °C...+400 °C	3-wire configuration, two channels used
Pt1000	-50 °C...+400 °C	3-wire configuration, two channels used
Ni1000	-50 °C...+150 °C	3-wire configuration, two channels used

The I/O module performs a linearization of the resistance characteristic.

In order to avoid error messages from unused analog input channels, it is useful to configure them as "unused".

Connection of active-type analog sensors (Voltage) with galvanically isolated power supply

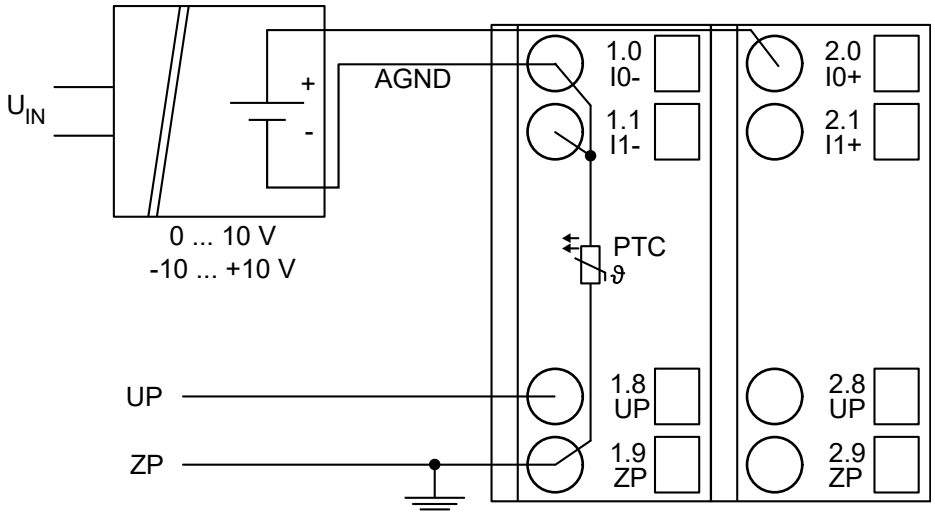


Fig. 65: Connection example

By connecting the sensor's negative pole of the output voltage to AGND, the galvanically isolated voltage source of the sensor is referred to ZP.

The following measuring ranges can be configured for AX521 *Chapter 1.6.2.2.5.6 “Parameterization” on page 511* and for AX522 *Chapter 1.6.2.2.6.6 “Parameterization” on page 536*:

Voltage	0 V...10 V	1 channel used
Voltage	-10 V...+10 V	1 channel used

In order to avoid error messages or long processing times, it is useful to configure unused analog input channels as "unused".

Connection of active-type analog sensors (Current) with galvanically isolated power supply

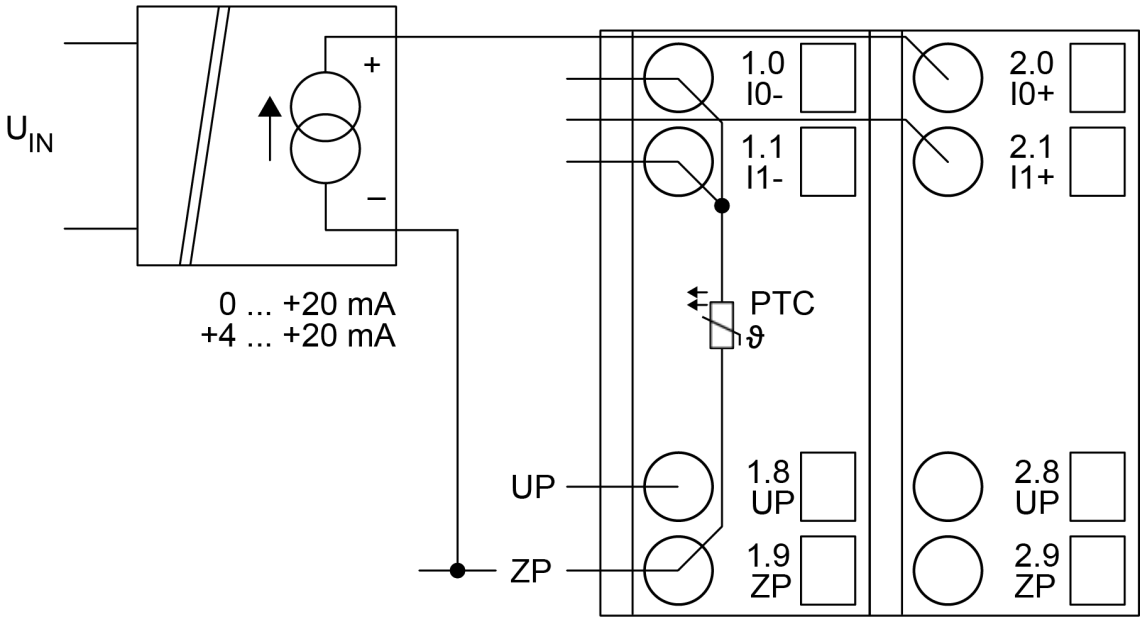


Fig. 66: Connection example

Current	0 mA...20 mA	1 channel used
Current	4 mA...20 mA	1 channel used

Unused input channels can be left open-circuited, because they are of low resistance.

Connection of active-type analog sensors (Voltage) with no galvanically isolated power supply

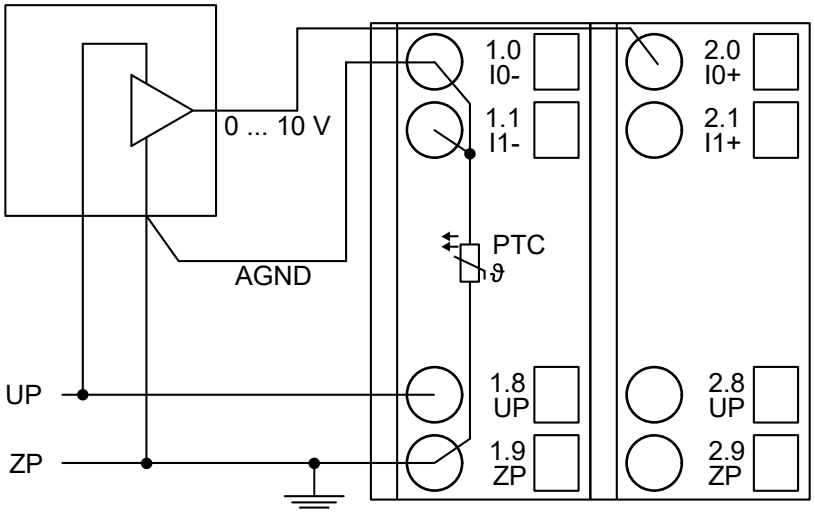


Fig. 67: Connection example

CAUTION!
The potential difference between AGND and ZP at the module must not be greater than 1V, not even in case of long lines (see figure Terminal Assignment).

If AGND does not get connected to ZP, the sensor current flows to ZP via the AGND line. The measuring signal is distorted, as a very small current flows through the voltage line. The total current through the PTC should not exceed 50 mA. This measuring method is therefore only suitable for short lines and small sensor currents. If there are bigger distances, the difference measuring method should be applied.

Voltage	0 V...10 V	1 channel used
Voltage	-10 V...+10 V *)	1 channel used

*) if the sensor can provide this signal range

In order to avoid error messages or long processing times, it is useful to configure unused analog input channels as "unused".

Connection of passive-type analog sensors (Current)

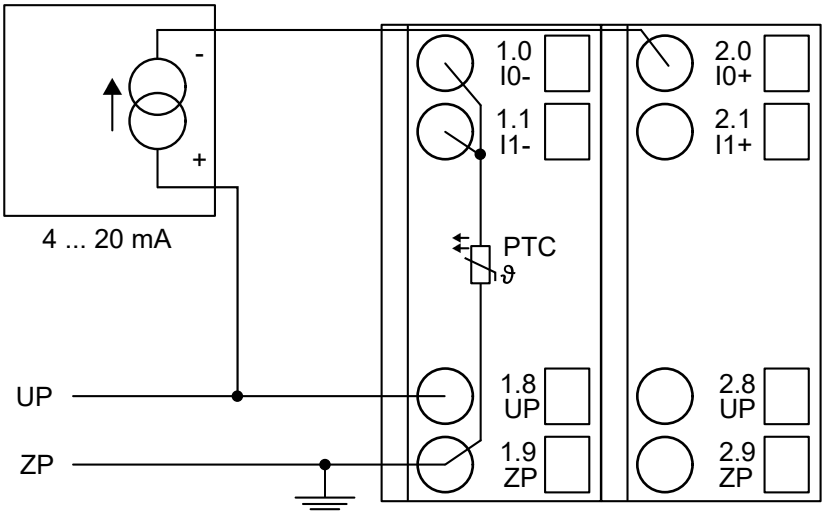


Fig. 68: Connection example

Current	4 mA...20 mA	1 channel used

CAUTION!
If, during initialization, an analog current sensor supplies more than 25 mA for more than 1 second to an analog input, this input is switched off by the module (input protection). In such cases, it is recommended to protect the analog input by a 10-volt Zener diode (in parallel to I+ and I-). But, in general, sensors with fast initialization or without current peaks higher than 25 mA are preferrable.

Unused input channels can be left open-circuited because they are of low resistance.

Connection of active-type analog sensors (Voltage) to differential inputs

Differential inputs are very useful if analog sensors are used which are remotely non-isolated (e.g. the minus terminal is remotely grounded).

The use of differential inputs helps to considerably increase the measuring accuracy and to avoid ground loops.

With differential input configurations, two adjacent analog channels belong together (e.g. the channels 0 and 1). In this case, both channels are configured according to the desired operating mode. The lower address must be the even address (channel 0), the next higher address must be the odd address (channel 1). The converted analog value is available at the higher address (channel 1).

The analog value is calculated by subtraction of the input value with the higher address from the input value of the lower address.

The converted analog value is available at the odd channel (higher address).

CAUTION!
The ground potential at the sensors must not have too large a potential difference with respect to ZP (max. ±1 V within the full signal range). Otherwise, problems may occur concerning the common-mode input voltages of the involved analog inputs.

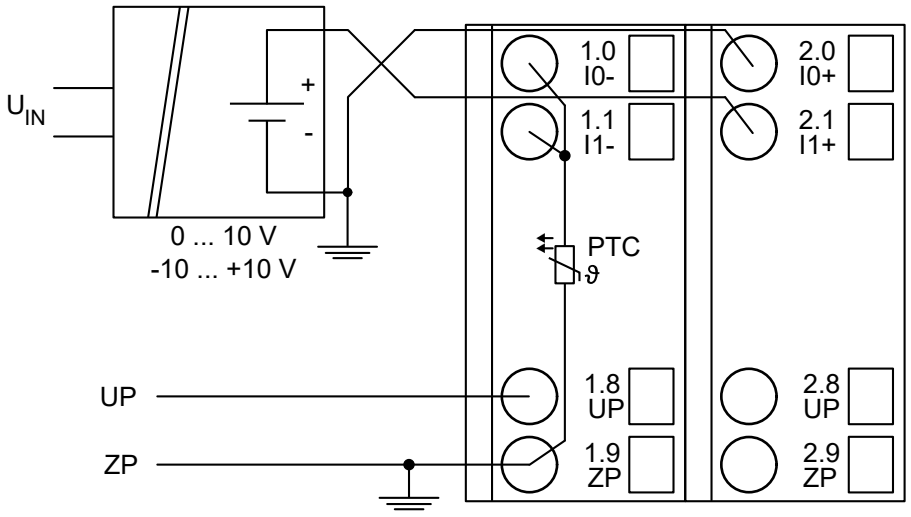


Fig. 69: Connection example

The negative pole of the sensor must be grounded next to the sensor.

Voltage	0 V...10 V	with differential inputs, 2 channels used
Voltage	-10 V...+10 V	with differential inputs, 2 channels used

In order to avoid error messages or long processing times, it is useful to configure unused analog input channels as "unused".

Use of analog inputs as digital inputs

Several (or all) analog inputs can be configured as digital inputs. The inputs are not galvanically isolated against the other analog channels.

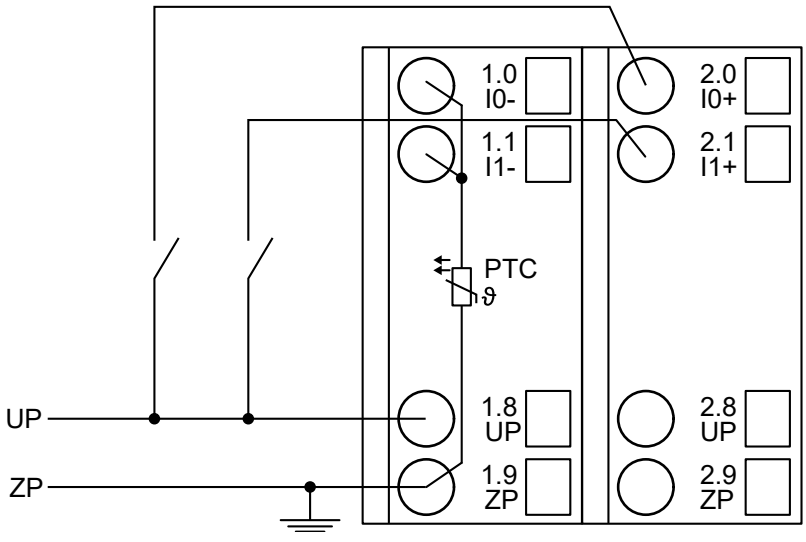


Fig. 70: Connection example

Digital input	24 V	1 channel used
Effect of incorrect input terminal connection		Wrong or no signal detected, no damage up to 35 V

Connection of analog output loads (Voltage, current)

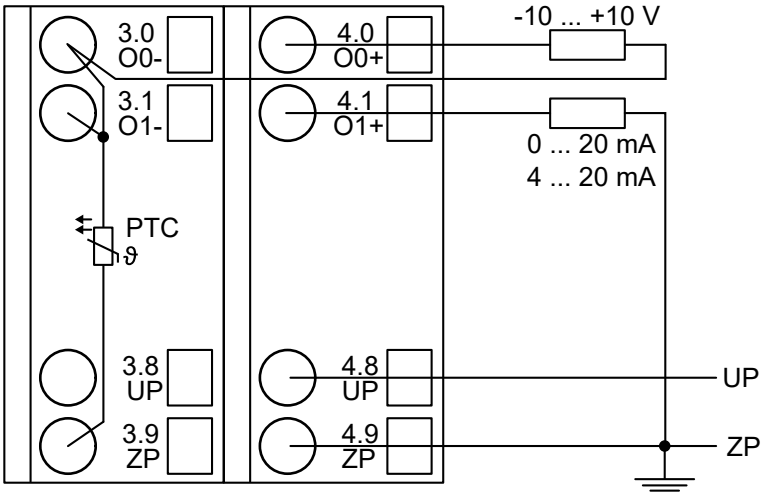


Fig. 71: Connection example

Voltage	-10 V...+10 V	Load max. ±10 mA	1 channel used
Current	0 mA...20 mA	Load 0 Ω...500 Ω	1 channel used
Current	4 mA...20 mA	Load 0 Ω...500 Ω	1 channel used

Only the channels 0...3 can be configured as current output (0 mA...20 mA or 4 mA...20 mA).

Unused analog outputs can be left open-circuited.

Internal data exchange

Digital inputs (bytes)	0
Digital outputs (bytes)	0
Counter input data (words)	8
Counter output data (words)	8

I/O configuration

The module does not store configuration data itself. It gets its parameterization data from the master device of the I/O bus (CPU or communication interface module) during power-up of the system.

Hence, replacing I/O modules is possible without any re-parameterization via software.

Parameterization

Firmware version	Configuration
Firmware version > V2.0.0	The arrangement of the parameter data is performed by Control Builder Plus/ Automation Builder software.

The parameter data directly influences the functionality of modules.

For non-standard applications, it is necessary to adapt the parameters to your system configuration.

Module: Module slot address: Y = 1...10

For non-standard applications, it is necessary to adapt the parameters to your system configuration.

Module slot address: Y = 1...7

No.	Name	Value	Internal value	Internal value, type	Default	Min.	Max.	EDS Slot/ Index
1	Module ID	Internal	1500 [1)]	Word	1500 0x05dc	0	65535	0x0Y01
2	Ignore module [2)]	No Yes	0 1	Byte	No 0x00			not for FBP
3	Parameter length in bytes	Internal	37	Byte	37-CPU 37-FBP	0	255	0x0Y02
4	Check supply	Off On	0 1	Byte	On 0x01	0	1	0x0Y03
5	Analog data format	Default	0	Byte	Default 0x00			0x0Y04
6	Behaviour of outputs at communication errors	Off Last value Substitute value	0 1+(n*5) 2+(n*5), n ≤ 2	Byte	Off 0x00	0	2	0x0Y05
7	Channel configuration Input channel 0	See *Table 111 "Channel configuration [2)]" on page 538*		Byte	Default 0x00	0	19	0x0Y06
8	Channel monitoring Input channel 0	See *Table 112 "Channel monitoring [3)]" on page 539*		Byte	Default 0x00	0	3	0x0Y07

No.	Name	Value	Internal value	Internal value, type	Default	Min.	Max.	EDS Slot/ Index
9 to 22	Channel configuration and channel monitoring of the input channels 1 to 7	See *Table 111 “Channel configuration 2)” on page 538* and *Table 112 “Channel monitoring 3)” on page 539*		Byte Byte	Default 0x00 0x00	0 0	19 3	0x0Y08 to 0x0Y15
23	Channel configuration Output channel 0	See *Table 111 “Channel configuration 2)” on page 538*		Byte	Default 0x00	0	130	0x0Y16
24	Channel monitoring Output channel 0	See *Table 112 “Channel monitoring 3)” on page 539*		Byte	Default 0x00	0	3	0x0Y17
25	Substitute value Output channel 0	only valid for output channel 0	0...0xffff	Word	Default 0x0000	0	65535	0x0Y18
26 to 31	Channel configuration and channel monitoring of the output channels 1 to 3	See *Table 111 “Channel configuration 2)” on page 538* and *Table 112 “Channel monitoring 3)” on page 539*		Byte Byte	Default 0x00 0x00	0 0	130 3	0x0Y19 to 0x0Y1E
32	Channel configuration Output channel 4	See *Table 111 “Channel configuration 2)” on page 538*		Byte	Default 0x00	0	128	0x0Y1F

No.	Name	Value	Internal value	Internal value, type	Default	Min.	Max.	EDS Slot/ Index
33	Channel monitoring Output channel 4	See *Table 112 “Channel monitoring 3)” on page 539*		Byte	Default 0x00	0	3	0x0Y20
34 to 39	Channel configuration and channel monitoring of the output channels 5 to 7	See *Table 111 “Channel configuration 2)” on page 538* and *Table 112 “Channel monitoring 3)” on page 539*		Byte Byte	Default 0x00 0x00	0 0	128 3	0x0Y21 to 0x0Y26

1) With CS31 and addresses less than 70 and FBP, the value is increased by 1

2) Not with FBP

GSD file:

Ext_User_Prm_Data_Len =	24
Ext_User_Prm_Data_Const(0) =	0x05, 0xe2, 0x15, \ 0x01, 0x00, 0x00 \ 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, \ 0x00, 0x00, 0x00, 0x00, \ 0x00, 0x00, 0x00, 0x00, 0x00, 0x00;

Table 110: Input channel (4x)

No.	Name	Internal value, type	Default
1	Channel configuration see table 2)	Byte	0 0x00 see table 2)
2	Channel monitoring see table 3)	Byte	0 0x00 see table 3)

Table 111: Channel configuration 2)

Internal value	Operating modes of the analog inputs, individually configurable
0	Unused (default)
1	Analog input 0 V...10 V
2	Digital input
3	Analog input 0 mA...20 mA

Internal value	Operating modes of the analog inputs, individually configurable
4	Analog input 4 mA...20 mA
5	Analog input -10 V...+10 V
8	Analog input Pt100, -50 °C...+400 °C (2-wire)
9	Analog input Pt100, -50 °C...+400 °C (3-wire), requires 2 channels *)
10	Analog input 0...10 V via differential inputs, requires 2 channels *)
11	Analog input -10 V...+10 V via differential inputs, requires 2 channels *)
14	Analog input Pt100, -50 °C...+70 °C (2-wire)
15	Analog input Pt100, -50 °C...+70 °C (3-wire), requires 2 channels *)
16	Analog input Pt1000, -50 °C...+400 °C (2-wire)
17	Analog input Pt1000, -50 °C...+400 °C (3-wire), requires 2 channels *)
18	Analog input Ni1000, -50 °C...+150 °C (2-wire)
19	Analog input Ni1000, -50 °C...+150 °C (3-wire), requires 2 channels *)
	*) In the operating modes with 3-wire configuration or with differential inputs, two adjacent analog inputs belong together (e.g. the channels 0 and 1). In these cases, both channels are configured in the desired operating mode. The lower address must be the even address (channel 0). The next higher address must be the odd address (channel 1). The converted analog value is available at the higher address (channel 1).

Table 112: Channel monitoring [3])

Internal value	Monitoring
0	Plausibility, open-circuit (broken wire) and short circuit
3	No monitoring

Table 113: Output channel 0 (1 channel)

No.	Name	Value	Internal value	Internal value, type	Default
1	Channel configuration	see table [4])	see table [4])	Byte	see table [4])
2	Channel monitoring	see table [5])	see table [5])	Byte	see table [5])
3	Substitute value see table [6])	0...65535	0... 0xffff	Word	0

Table 114: Output channels 1...3 (3x)

No.	Name	Internal value, type
1	Channel configuration see table [4])	Byte
2	Channel monitoring see table [6])	Byte

Table 115: Channel configuration [4])

Internal value	Operating modes of the analog outputs, individually configurable
0	Unused (default)
128	Analog output -10 V...+10 V
129	Analog output 0 mA...20 mA (not with the channels 4...7 and 12...15)
130	Analog output 4 mA...20 mA (not with the channels 4...7 and 12...15)

Table 116: Channel monitoring [5])

Internal value	Monitoring
0	Plausibility, open circuit (broken wire) and short circuit (default)
3	No monitoring

Table 117: Substitute value [6])

Intended behaviour of output channel when the control system stops	Required setting of the module parameter "Behaviour of outputs in case of a communication error"	Required setting of the channel parameter "Substitute value"
Output OFF	Off	0
Last value infinite	Last value	0
Last value for 5 s and then turn off	Last value 5 sec	0
Last value for 10 s and then turn off	Last value 10 sec	0
Substitute value infinite	Substitute value	Depending on configuration
Substitute value for 5 s and then turn off	Substitute value 5 sec	Depending on configuration
Substitute value for 10 s and then turn off	Substitute value 10 sec	Depending on configuration

Diagnosis

Table 118: Possible diagnosis of I/O channels

Output range	Condition	
	Output value in the PLC underflow	Output value in the PLC overflow
0..20 mA	Error identifier = 7	Error identifier = 4
4..20 mA		
-10..+10 V		

Input range	Condition			
	Short circuit	Wire break	Input value under-flow	Input value over-flow
0..20 mA	no diagnosis possible	no diagnosis possible	no diagnosis possible	Error identifier = 48
4..20 mA	Error identifier = 7	Error identifier = 7	Error identifier = 7	Error identifier = 48
-10..+10 V	no diagnosis possible	Error identifier = 48	Error identifier = 7	Error identifier = 48

Table 119: Content of diagnosis messages

E1...E4	d1	d2	d3	d4	Identifier 000...063	AC500 display	<– Display in	
Class	Comp	Dev	Mod	Ch	Err	PS501 PLC browser		
Byte 6 Bit 6...7	-	Byte 3	Byte 4	Byte 5	Byte 6 Bit 0...5	FBP diag-nosis block		
Class	Interface	Device	Module	Channel	Error Identifier	Error message		Remedy
	[1])	[2])	[3])	[4])				
Module error								
3	14	1...10	31	31	19	Checksum error in the I/O module		Replace I/O module
	11 / 12	ADR	1...10					
3	14	1...10	31	31	3	Timeout in the I/O module		Replace I/O module
	11 / 12	ADR	1...10					
3	14	1...10	31	31	40	Different hard-/firm-ware versions in the module		Replace I/O module
	11 / 12	ADR	1...10					
3	14	1...10	31	31	43	Internal error in the module		Replace I/O module
	11 / 12	ADR	1...10					
3	14	1...10	31	31	36	Internal data exchange failure		Replace I/O module
	11 / 12	ADR	1...10					
3	14	1...10	31	31	9	Overflow diagnosis buffer		New start
	11 / 12	ADR	1...10					
3	14	1...10	31	31	26	Parameter error		Check master
	11 / 12	ADR	1...10					
3	14	1...10	31	31	11	Process voltage too low		Check process voltage
	11 / 12	ADR	1...10					
4	14	1...10	31	31	45	Process voltage is switched off (ON –> OFF)		Process voltage ON
	11 / 12	ADR	1...10					
Channel error								
				AX521	AX522			

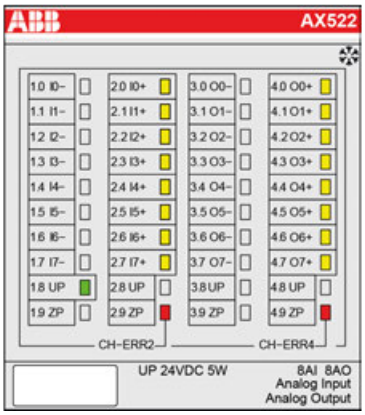
E1...E4	**d1**	**d2**	**d3**	**d4**		**Identifier 000...063**	**AC500 display**	**<– Display in**
Class	**Comp**	**Dev**	**Mod**	**Ch**		**Err**	**PS501 PLC browser**	
Byte 6 Bit 6...7	**-**	**Byte 3**	**Byte 4**	**Byte 5**		**Byte 6 Bit 0...5**	**FBP diag-nosis block**	
Class	**Interface**	**Device**	**Module**	**Channel**		**Error Identifier**	**Error message**	**Remedy**
	[1])	**[2])**	**[3])**	**[4])**				
4	14	1...10	1	0...3	0...7	48	Analog value over-flow or broken wire at an analog input	Check input value or terminal
	11 / 12	ADR	1...10					
4	14	1...10	1	0...3	0...7	7	Analog value under-flow at an analog input	Check input value
	11 / 12	ADR	1...10					
4	14	1...10	1	0...3	0...7	47	Short circuit at an analog input	Check terminal
	11 / 12	ADR	1...10					
4	14	1...10	3	4...7	8...15	4	Analog value over-flow at an analog output	Check output value
	11 / 12	ADR	1...10					
4	14	1...10	3	4...7	8...15	7	Analog value under-flow at an analog output	Check output value
	11 / 12	ADR	1...10					

Remarks:

[1])	In AC500, the following interface identifier applies: 14 = I/O bus, 11 = COM1 (e.g. CS31 bus), 12 = COM2. The FBP diagnosis block does not contain this identifier.
[2])	With "Device" the following allocation applies: 31 = module itself, 1...10 = expansion module 1...10, ADR = hardware address (e.g. of the DC551)
[3])	With "Module" the following allocation applies depending on the master: Module error: I/O bus or FBP: 31 = module itself; COM1/COM2: 1...10 = expansion 1...10 Channel error: I/O bus or FBP = module type (1 = AI, 3 = AO); COM1/COM2: 1...10 = expansion 1...10
[4])	In case of module errors, with channel "31 = Module itself" is output.

State LEDs

During the power ON procedure, the module initializes automatically. All LEDs (except the channel LEDs) are ON during this time.

LED		State	Color	LED = OFF	LED = ON	LED flashes
	Inputs I0...I7	Analog input	Yellow	Input is OFF	Input is ON (brightness depends on the value of the analog signal)	--
	Outputs O0...O7	Analog output	Yellow	Output is OFF	Output is ON (brightness depends on the value of the analog signal)	--
	UP	Process voltage 24 V DC via terminal	Green	Process voltage is missing	Process voltage OK	--
	CH-ERR2	Channel error, error messages in groups (analog inputs or outputs combined into the groups 2 and 4)	Red	No error or process voltage is missing	Severe error within the corresponding group	Error on one channel of the group
	CH-ERR4		Red			
	CH-ERR *)	Module error	Red	--	Internal error	--
	*) Both LEDs (CH-ERR2 and CH-ERR4) light up together					

Measuring ranges

Input ranges of voltage, current and digital input

The represented resolution corresponds to 16 bits.

Range	0...10 V	-10...+10 V	0...20 mA	4...20 mA	Digital input	Digital value	
						Decimal	Hex.
Overflow	>11.7589	>11.7589	>23.5178	>22.8142		32767	7FFF
Measured value too high	11.7589 . . 10.0004	11.7589 : 10.0004	23.5178 : 20.0007	22.8142 : 20.0006		32511 : 27649	7EFF : 6C01
Normal range Normal range or measured value too low	10.0000 . . 0.0004	10.0000 : 0.0004	20.0000 : 0.0007	20.0000 : 4.0006	ON	27648 : 1	6C00 : 0001
		0.0000	0	4	OFF	0	0000
	0.0000	-0.0004 : :		3.9994		-1 -4864 -6912	FFFF ED00 E500

Range	0...10 V	-10...+10 V	0...20 mA	4...20 mA	Digital input	Digital value	
						Decimal	Hex.
	-0.0004 : -1.7593	: -10.0000				: -27648	: 9400
Meas-ured value too low		-10.0004 : -11.7589				-27649 : -32512	93FF : 8100
Under-flow	<-1.7593	<-11.7589	<0.0000	<1.1858		-32768	8000

Input ranges resistance temperature detector

Range	Pt100 / Pt 1000 -50...70 °C	Pt100 / Pt1000 -50...400 °C	Ni1000 -50...150 °C	Digital value	
				Decimal	Hex.
Overflow	> 80.0 °C	> 450.0 °C	> 160.0 °C	32767	7FFF
Measured value too high		450.0 °C : 400.1 °C		4500 : 4001	1194 : 0FA1
			160.0 °C : 150.1 °C	1600 : 1501	0640 : 05DD
	80.0 °C : 70.1 °C			800 : 701	0320 : 02BD
Normal range	: : 70.0 °C : 0.1 °C	400.0 °C : : 0.1 °C	: 150.0 °C : : 0.1 °C	4000 1500 700 : 1	0FA0 05DC 02BC : 0001
	0.0 °C	0.0 °C	0.0 °C	0	0000
	-0.1 °C : -50.0 °C	-0.1 °C : -50.0 °C	-0.1 °C : -50.0 °C	-1 : -500	FFFF : FE0C
Measured value too low	-50.1 °C : -60.0 °C	-50.1 °C : -60.0 °C	-50.1 °C : -60.0 °C	-501 : -600	FE0B : FDA8
Underflow	< -60.0 °C	< -60.0 °C	< -60.0 °C	-32768	8000

Output ranges voltage and current

The represented resolution corresponds to 16 bits.

Range	-10...+10 V	0...20 mA	4...20 mA	Digital value	
				Decimal	Hex.
Overflow	0 V	0 mA	0 mA	> 32511	> 7EFF
Value too high	11.7589 V : 10.0004 V	23.5178 mA : 20.0007 mA	22.8142 mA : 20.0006 mA	32511 : 27649	7EFF : 6C01
Normal range	10.0000 V : 0.0004 V	20.0000 mA : 0.0007 mA	20.0000 mA : 4.0006 mA	27648 : 1	6C00 : 0001
	0.0000 V	0.0000 mA	4.0000 mA	0	0000
	-0.0004 V : -10.0000 V	0 mA : 0 mA	3.9994 mA 0 mA 0 mA	-1 -6912 -27648	FFFF E500 9400
Value too low	-10.0004 V : -11.7589 V	0 mA : 0 mA	0 mA : 0 mA	-27649 : -32512	93FF : 8100
Underflow	0 V	0 mA	0 mA	< -32512	< 8100

Technical data

The system data of AC500 and S500 *Chapter 2.6.1 “System data AC500” on page 971* are applicable to the standard version.

The system data of AC500-XC *Chapter 2.7.1 “System data AC500-XC” on page 1023* are applicable to the XC version.

Only additional details are therefore documented below.

The technical data are also applicable to the XC version.

Parameter		Value
Process voltage		
	Connections	Terminals 1.8, 2.8, 3.8 and 4.8 for +24 V (UP) as well as 1.9, 2.9, 3.9 and 4.9 for 0 V (ZP)
	Rated value	24 V DC
	Max. ripple	5 %
	Protection against reversed voltage	Yes
	Rated protection fuse on UP	10 A fast
	Galvanic isolation	Yes, per module
Current consumption		
	From 24 V DC power supply at the terminals UP/L+ and ZP/M of the CPU/communication interface module	Ca. 2 mA
	From UP at normal operation	0.15 A + output loads
Inrush current from UP (at power up)		0.020 A^2s

Parameter	Value
Max. length of analog cables, conductor cross section > 0.14 mm²	100 m
Weight	300 g
Mounting position	Horizontal or vertical with derating (output load reduced to 50 % at 40 °C per group)
Cooling	The natural convection cooling must not be hindered by cable ducts or other parts in the switchgear cabinet.

NOTICE!

Attention:

All I/O channels (digital and analog) are protected against reverse polarity, reverse supply, short circuit and continuous overvoltage up to 30 V DC.

Technical data of the analog inputs

Parameter	Value	
Number of channels per module	8	
Distribution of channels into groups	1 group of 8 channels	
Connections of the channels I0- to I7-	Terminals 1.0 to 1.7	
Connections of the channels I0+ to I7+	Terminals 2.0 to 2.3	
Input type	Bipolar (not with current or Pt100/Pt1000/Ni1000)	
Galvanic isolation	Against internal supply and other modules	
Configurability	0 V...10 V, -10 V...+10 V, 0 mA...20 mA, 4 mA...20 mA, Pt100/1000, Ni1000 (each input can be configured individually)	
Channel input resistance	Voltage: > 100 kΩ Current: ca. 330 Ω	
Time constant of the input filter	Voltage: 100 µs current: 100 µs	
Indication of the input signals	One LED per channel	
Conversion cycle	2 ms (for 8 inputs + 8 outputs), with Pt/Ni... 1 s	
Resolution	Range 0 V...10 V: 12 bits Range -10 V...+10 V: 12 bits + sign Range 0 mA...20 mA: 12 bits Range 4 mA...20 mA: 12 bits	
Conversion error of the analog values caused by non-linearity, adjustment error at factory and resolution within the normal range	Typ.	±0.5 % of full scale at 25 °C
	Max.	±1 % of full scale (all ranges) at 0 °C...60 °C or EMC disturbance
Unused voltage inputs	Are configured as "unused"	

Parameter	Value
Unused current inputs	Have a low resistance, can be left open-circuited
Overvoltage protection	Yes

Technical data of the analog inputs, if used as digital Inputs

Parameter		Value
Number of channels per module		Max. 8
Distribution of channels into groups		1 group of 8 channels
Connections of the channels I0+ to I7+		Terminals 2.0 to 2.7
Reference potential for the inputs		Terminals 1.9, 2.9, 3.9 and 4.9 (ZP)
Input signal delay		Typ. 8 ms, configurable from 0.1 to 32 ms
Indication of the input signals		1 LED per channel
Input signal voltage		24 V DC
	Signal 0	-30 V...+5 V
	Undefined signal	+5 V...+13 V
	Signal 1	+13 V...+30 V
Input current per channel		
	Input voltage +24 V	Typ. 7 mA
	Input voltage +5 V	Typ. 1.4 mA
	Input voltage +15 V	Typ. 4.3 mA
	Input voltage +30 V	< 9 mA
Input resistance		Ca. 3.5 kΩ

Technical data of the analog outputs

Parameter		Value
Number of channels per module		8, all channels for voltage, the first 4 channels also for current
Distribution of channels into groups		1 group of 8 channels
	Channels O0-...O7-	Terminals 3.0...3.7
	Channels O0+...O7+	Terminals 4.0...4.7
Output type		Bipolar with voltage, unipolar with current
Galvanic isolation		Against internal supply and other modules
Configurability		-10 V...+10 V, 0 mA...20 mA, 4 mA...20 mA (each output can be configured individually), current outputs only channels 0...3
Output resistance (load), as current output		0 Ω...500 Ω
Output loadability, as voltage output		Max. ±10 mA
Indication of the output signals		One LED per channel
Resolution		12 bits (+ sign)

Parameter	Value	
Settling time for full range change (resistive load, output signal within specified tolerance)	Typ. 5 ms	
Conversion error of the analog values caused by non-linearity, adjustment error at factory and resolution within the normal range	Typ.	±0.5 % of full scale at 25 °C
	Max.	±1 % of full scale (all ranges) at 0 °C...60 °C or EMC disturbance
Relationship between output signal and hex code	See table, *Chapter 1.6.2.2.6.9.3 “Output ranges voltage and current” on page 544*	
Unused outputs	Can be left open-circuited	

Ordering data

Part no.	Description	Product life cycle phase *)
1SAP 250 000 R0001	AX522, analog input/output module, 8 AI, 8 AO, U/I/Pt100, 12 bits + sign, 2-wires	Active
1SAP 450 000 R0001	AX522-XC, analog input/output module, 8 AI, 8 AO, U/I/Pt100, 12 bits + sign, 2-wires, XC version	Active

**) Modules in lifecycle Classic are available from stock but not recommended for planning and commissioning of new installations.*

1.6.3 Digital/Analog I/O modules

1.6.3.1 S500

1.6.3.1.1 DA501 - Digital/Analog input/output module

- 16 digital inputs 24 V DC
- 8 configurable digital inputs/outputs 24 V DC, 0.5 A max.
- 4 analog inputs, voltage, current and RTD.
  Resolution 12 bits plus sign
- 2 analog outputs, voltage and current
  Resolution 12 bits plus sign
- Fast counter

- Module-wise galvanically isolated
- XC version for use in extreme ambient conditions available

NOTICE!
Improper voltage level or frequency range which cause damage of AC inputs:
– AC voltage above 264 V
– Frenquency below 47 Hz or above 62.4 Hz

NOTICE!
Improper connection leads cause overtemperature on terminals.
PLC modules may be destroyed by using wrong cable type, wire size and cable temperature classification.

Parameter		Value
Temperature		
	Operating	0 °C...+60 °C: Horizontal mounting of modules. 0 °C...+40 °C: Vertical mounting of modules. Output load reduced to 50 % per group.
	Storage	-40 °C...+70 °C
	Transport	-40 °C...+70 °C
Humidity		Max. 95 %, without condensation
Air pressure		
	Operating	> 800 hPa / < 2000 m
	Storage	> 660 hPa / < 3500 m
Ingress protection		IP20

2.6.1.2 Creepage distances and clearances

The creepage distances and clearances meet the requirements of the overvoltage category II, pollution degree 2.

2.6.1.3 Insulation test voltages, routine test

According to EN 61131-2

Parameter	Value	
230 V circuits against other circuitry	2500 V	1.2/50 µs
120 V circuits against other circuitry	1500 V	1.2/50 µs
120 V...240 V circuits against other circuitry	2500 V	1.2/50 µs
24 V circuits (supply, 24 V inputs/outputs, analog inputs/outputs), if they are galvanically isolated against other circuitry	500 V	1.2/50 µs

Table 200: Immunity against the influence of radiated (CW radiated), according to IEC 61000-4-3, zone B, criterion A

Parameter	Value
Test field strength	10 V/m

Table 201: Immunity against fast transient interference voltages (burst), according to IEC 61000-4-4, zone B, criterion B

Parameter	Value
Supply voltage units (DC)	2 kV
Supply voltage units (AC)	2 kV
Digital inputs/outputs (24 V DC)	1 kV
Digital inputs/outputs (120 V AC...240 V AC)	2 kV
Analog inputs/outputs	1 kV
CS31 bus	1 kV
Serial RS-485 interfaces (COM)	1 kV
Serial RS-232 interfaces (COM, not for PM55x and PM56x)	1 kV
Ethernet	1 kV
I/O supply (DC-out)	1 kV

Table 202: Immunity against the influence of line-conducted interferences (CW conducted), according to IEC 61000-4-6, zone B, criterion A

Parameter		Value
Test voltage		3V zone B, 10 V is also met.
High energy surges		According to IEC 61000-4-5, zone B, criterion B
	Power supply DC	1 kV CM / 0.5 kV DM [2])
	DC I/O supply	0.5 kV CM / 0.5 kV DM [2])
	Communication Lines, shielded	1 kV CM [2])
	AC I/O unshielded [3])	2 kV CM / 1 kV DM [2])
	I/O analog, I/O DC unshielded [3])	1 kV CM / 0.5 kV DM [2])
Radiation (radio disturbance)		According to IEC 55011, group 1, class A

[2]) CM = Common Mode, DM = Differential Mode

[3]) When DC I/O inputs are used with AC voltage, external filters limiting high energy surges to 1 kV CM / 0.5 DM are required to meet requirements according IEC 61131-2.

2.6.1.6 Mechanical data

Parameter	Value
Mounting	Horizontal
Degree of protection	IP 20
Housing	Classification V-2 according to UL 94

Parameter	Value
Vibration resistance acc. to EN 61131-2	all three axes 2 Hz...8.4 Hz, continuous 3.5 mm 8.4 Hz...150 Hz, continuous 1 g (higher values on request)
Shock test	All three axes 15 g, 11 ms, half-sinusoidal
Mounting of the modules:	
DIN rail according to DIN EN 50022	35 mm, depth 7.5 mm or 15 mm
Mounting with screws	Screws with a diameter of 4 mm
Fastening torque	1.2 Nm

2.6.1.7 Approvals and certifications

Information on approvals and certificates can be found in the corresponding chapter of the *Main catalog, PLC Automation*.

2.6.2 Mechanical dimensions

2.6.2.1 Switchgear cabinet assembly



Information on EMC-conforming assembly and construction is provided within the overall functions section ↳ Chapter 2.4.4 “EMC-conforming assembly and construction” on page 918.

PLC enclosure



NOTICE!

PLC damage due to wrong enclosures

Due to their construction (degree of protection IP 20 according to EN 60529) and their connection technology, the devices are suitable only for operation in enclosed switchgear cabinets.

To protect PLCs against:

- unauthorized access,
- dusting and pollution,
- moisture and wetness and
- mechanical damage,

switchgear cabinet IP54 for common dry factory floor environment is suitable.

Maintain spacing from:

- enclosure walls
- wireways
- adjacent equipment

Allow a minimum of 20 mm clearance on all sides. This provides ventilation and galvanic isolation.

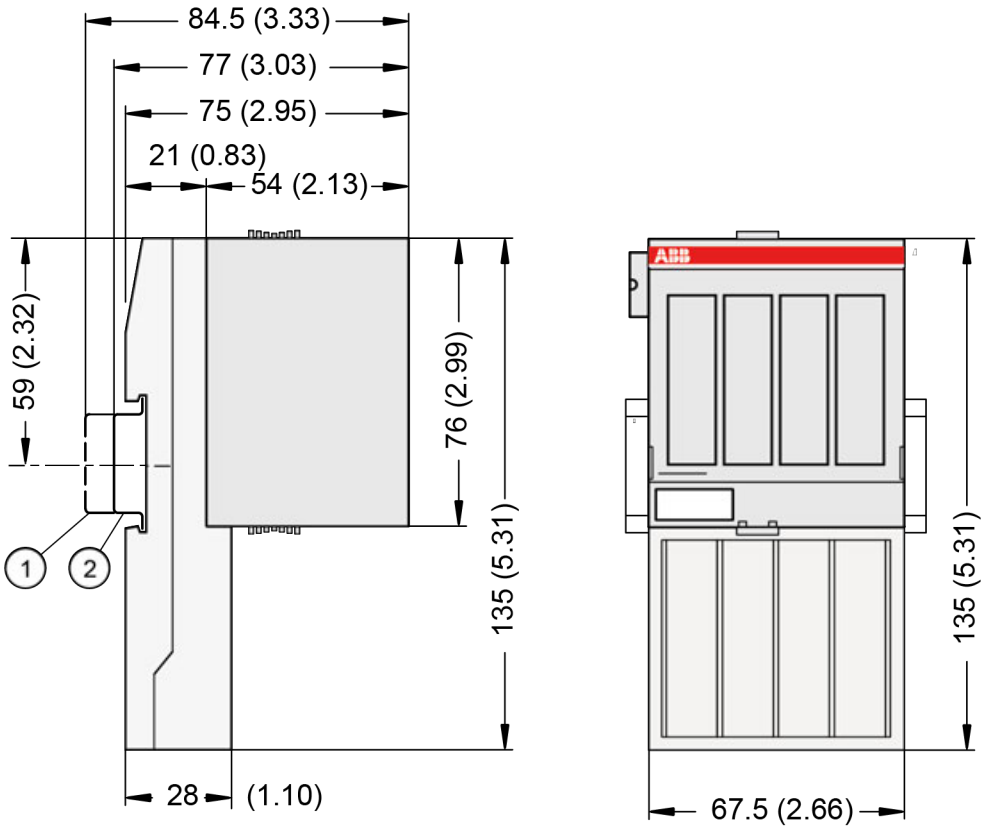


Fig. 185: Terminal units and S500 modules, side view and front view

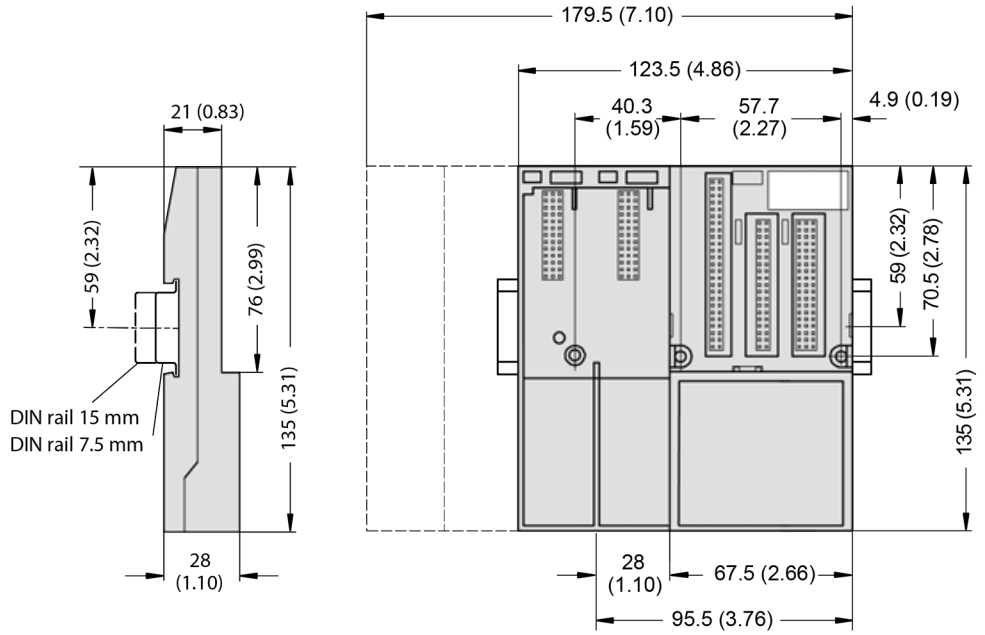


Fig. 186: Terminal base (for comparison)

All dimensions are in mm (in.). Hole spacing tolerance: ±0.4 mm (0.016 in.)