FLEX INTERFACES
FOR SYSTEM BUS

INDEX

1 SAFETY NOTES

WARNING: This symbol identifies information on practices, actions and circumstances which may result on injuries or harms to personnel, damage to the unit or economic loss.

Read this manual carefully and completely before installing, setting up and operating Flex Interfaces units.

These devices should only be used by qualified competent personnel.

If there are any doubts about safe use, the unit should be placed out of service to protect it against unintentional use.

Safe use must be assumed to be impossible if:

1. **there is visible damage to the unit**
2. **the unit is not operating (for example in the test)**
3. **the unit has suffered damage during the transport**

1.1. Notes for dielectric strength tests

WARNING: Dielectric strength tests on inputs and outputs of devices considered in this document are not permitted.

2 OVERVIEW

2.1. System description

Flex Interfeces are microprocessor-based devices for DIN-rail application, providing input / output digital and analog signals for carrying circuit breaker's trip unit information. In addition, they can be used for driving additional input signals coming from the field to the trip unit.

The Flex Interfeces family consists of accessory and system devices, according to the RS-485 bus they are connected to: the formers are linked to an internal (accessory) bus and communicate with a trip unit by means of MM030; the latters are connected to an external (system) bus, exchanging informations with a generic master unit.

While accessory Flex Interfeces have fixed communication parameters, that is baud rate and byte format, system devices are able to work with a variety of different settings, selectable through the dip-switches on the front.

Moreover, signallings on accessory units are pre-programmed through a rotary selector; in case of system units, these are fully programmable via Modbus Interface in order to fit user's specific requirements.

The present manual deals with system units only; references about accessory Flex Interfeces are listed in 2.2.

Different devices belong to the system Flex Interfeces family:

Device type	Features	Description
SD030 DO	8 digital outputs	Receives data from a generic master and actuates its digital outputs accordingly
SD030 AO	4 analog outputs	Receives data from a generic master and drives its analog outputs accordingly
SD030 MI	Mixed inputs: 2 analog inputs 2 digital inputs	Replays the status of its inputs upon master request
SD030 DI	8 digital inputs	Replays the status of its inputs upon master request
SD030 DX	Mixed input/output: 3 digital output 5 digital input	Actuates its outputs / replays the status of its inputs upon master request Manages circuit breakers

Table 1. Flex Interfeces units on system bus

Note 1: The main aim for SD030 DX units is to perform supervision function on circuit breakers (one of Isomax, Tmax, Emax or T7/X1); this specific functionality is described in a separated manual (see references in par. 2.2.)

Flex Interfaces are slave units; therefore, they must be connected to a master such as a PC, a PLC or a SCADA (Supervisory Control And Data Acquisition).

The total number of slaves on the System bus depends on the avalaibility of (logical) slave addresses.

Theorically, up to 247 different slave addresses are ready for use, but the number is limited by the physical layer chosen as communication channel, for example RS485 (see par. 8.4.).

The following figure shows a typical architecture involving:

- a generic system master
- a trip unit (Tmax, Emax or T7/X1 series)
- units from Flex Interfeces family

- generic slaves

Connections between different units are indicatory only; wirings must be carried out according to official ABB SACE documentation and to circuit diagrams in section 11

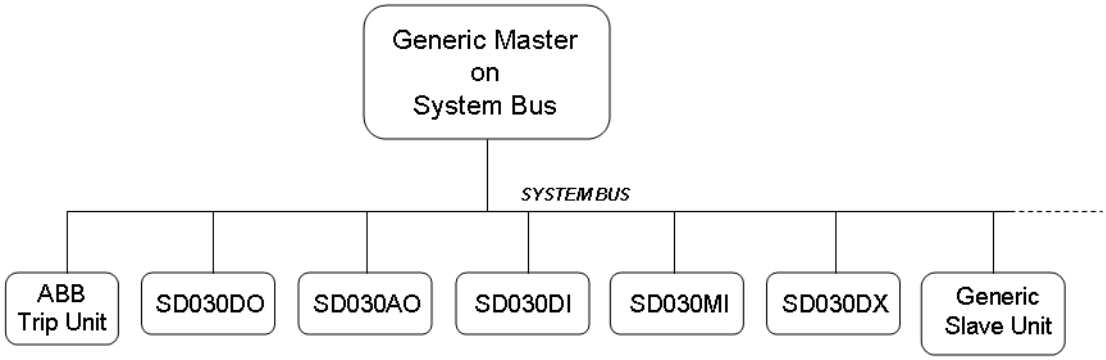

Figure 1. A typical architecture

2.2. References

The following document describes how to install, set-up and operate SD030 units.

For information about the trip units that can be interfaced with SD030 units, the following documents must be consulted:

- Instruction manual of trip unit PR121/P (doc. no. 1SDH000460R0002 for IEC version or doc. no. 1SDH000532R0002 for UL version)
- Instruction manual of trip unit PR122/P (doc. no. 1SDH000460R0002 for IEC version or doc. no. 1SDH000532R0002 for UL version)
- Instruction manual of trip unit PR123/P (doc. no. 1SDH000460R0002 for IEC version or doc. no. 1SDH000532R0002 for UL version)
- Instruction manual of trip unit PR222DS/PD (doc. no. 1SDH000436R0502 for IEC version or doc. no. 1SDH000549R0001 for UL version)
- Instruction manual of trip unit PR223DS (doc. no. 1SDH000479R0503)
- Instruction manual of trip unit PR223EF (doc. no. 1SDH000538R0002)
- Instruction manual of trip unit PR331/P (doc. no. 1SDH000587R0002)
- Instruction manual of trip unit PR332/P (doc. no. 1SDH000587R0002)
- Instruction manual of trip unit PR333/P (doc. no. 1SDH000587R0002)
- ABB SACE Tmax technical catalogue (doc. no. ISDC210015D0202)
- ABB SACE Emax technical catalogue (doc. no. 1SDC200006D0204)
- ABB SACE X1 technical catalogue (doc. no. 1SDC20009D0202)

For information about different Flex Interfaces devices, the following documents must be consulted:

- Instruction manual of Flex Interfaces for Accessory Bus (doc. no. 1SDH000622R0001)
- Instruction manual of HMI030 (doc. no. 1SDH000573R0001)
- Instruction manual of SD030 DX (doc. no. 1SDH000672R0001)
- Instruction manual of LD030 DO (doc. no. 1SDH000671R0001)

3 USER INTERFACE

3.1. System Flex Interfaces common features

This section deals with features that are common to all System Flex Interfaces, that is SD030 DO, SD030 AO, SD030 MI and SD030 DI.

3.1.1. Front view

The front panel of the System Flex Interfaces consists of:

- Test push-button
- 2 service LEDs
- 2 system bus LEDs
- channel LEDs (the number depends on the unit, see the specific section for details)
- an eight positions dip-switch for slave address selection
- 2 dip-switches to set communication parameters
- 2 terminal boxes

A picture for each System Flex Interfaces is found in the relevant paragraph.

3.1.2. Test push-button

Test push-button	Description
Pressed for 1 sec	Reset inputs / outputs and relevant LEDs Acquire the dip-switches position to take the new settings (baud rate, slave address, byte format)
Pressed for 5 sec	Execute self-test procedure (see par. 7.1.2.)

Table 2. Test push-button

3.1.3. LEDs meaning

After performing a test at start-up (see section 7 for additional informations), LEDs assume the following meaning:

Function	LED	Status	Meaning
Service	PWR	ON (Green)	Power supply voltage on
		OFF	Power supply voltage off
	WD	ON (Red)	Watchdog alarm: internal malfunction, the device is restarting
		OFF	Watchdog OK: device is working correctly
System bus	TX	ON (Yellow)	Data transmission on System bus
		OFF	No data transmission on System bus
	Fault	ON/Blink (Red)	Special condition / malfunction on System bus
		OFF	No special condition / malfunction on System bus
I/O channel	Depends on the unit, see relevant section	ON (Green)	Depends on the unit, see relevant section
		OFF	Depends on the unit, see relevant section

Table 3. LEDs behavior on System Flex Interfaces

3.1.3.1 Fault LED

Fault LED is used to signal many special conditions and malfunctions, as explained in the next table. In case of concurrent conditions / malfunctions, the one with the highest priority (i.e. the lowest priority number) will be signalled first.

Status	Signalling	Priority Number	Description
Fixed ON	Bus fault	7	Bus not connected or faulty
Pattern 2	Dip-switch position changed	9	Actual dip-switches position different from old one
Pattern 3	Dip-switch invalid	8	Dip-switches position not permitted: • slave address greater than 247 • baud rate set on n.u. configuration See 3.1.4. for detailed informations.
Pattern 7	Malfunction	4	Device is detecting a malfunction: • Power supply votage too low or too high • Internal malfunction
Pattern 8	Maintenance mode	1	Reserved to diagnostic purpose
Pattern 9	Maintenance mode	2	Reserved to diagnostic purpose
Pattern 10	Maintenance mode	3	Reserved to diagnostic purpose

Table 4. Fault LEDs behavior on System Flex Interfaces

Pattern x indicates that the LED periodically:

- Switches on and off x times.
- Stays off for a while.

The following example shows Pattern 3:

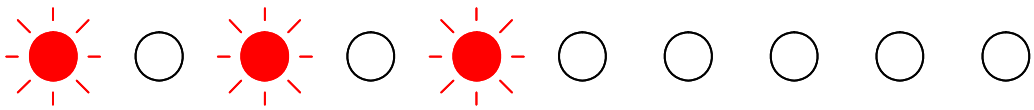

Figure 2. Example of LED pattern: Pattern 3

3.1.4. Dip-switches

The dip-switches placed on the front panel of System Flex Interfaces are used to set the slave address and the communication parameters.

Any change on the dip-switches become effective after the Test push-button is kept pressed for 1 second in order to reset the unit.

3.1.4.1 Slave address dip-switch

An eight positions dip-switch allows to set the slave address from 1 up to 247[1].

Note 2: Slave address 0 is not permitted; if the address dip-switches are all on 0 position, slave address and communication parameters will be remotely adjusted by the master unit.

The last valid settings are loaded in case no remote adjustement is performed.

If the user select an address outside the specified range, the unit will keep on using the last valid address and it will signal the anomaly by mean of the proper Fault LED pattern (see Table 4.).

1. Though there are up to 247 different logical addresses, only a few can be used, according to the physical layer that carries out communication. In case an address greater than 247 is set, unit will signal the incongruency by means of the FAULT led, see 3.1.3.1 .

3.1.4.2 Communication parameters dip-switches

There are two dip-switches to adjust the baud rate and two for the byte format. All available arrangements are displayed in Figure 3.

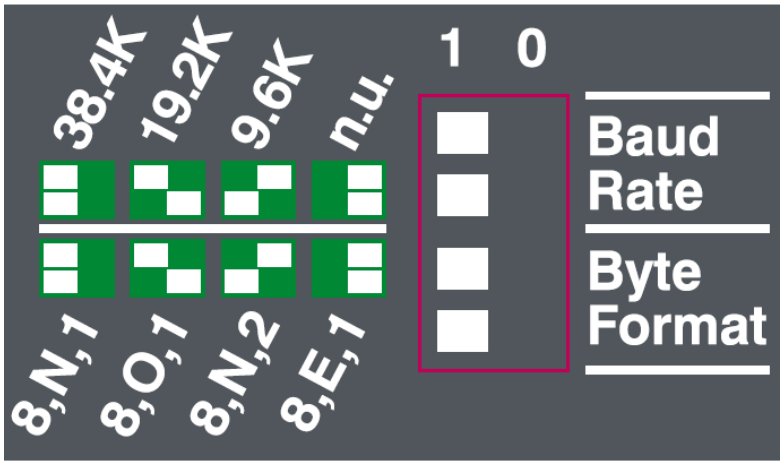

Figure 3. Available arrangements for communication parameters dip-switches

Note 3: The n.u. configuration (not used) considers a 19,2kbps baud rate by default. However, unit will signal the wrong dip-switch configuration by means of the FAULT led, see 3.1.3.1 .

3.2. SD030 DO

3.2.1. Front view

All the common features of System Flex Interfaces have been previously described in par. 3.1.1.

This section deals with the peculiarities of SD030 DO.

On the front panel of SD030 DO, 8 channel LEDs, one for each digital output, are present (see Figure 4.)

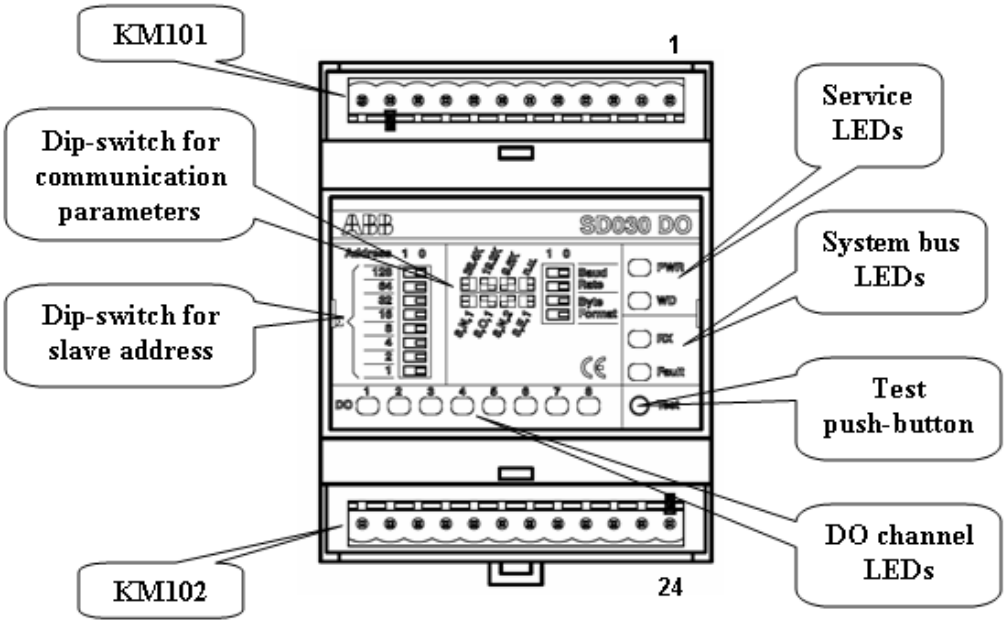

Figure 4. SD030 DO front view

3.2.2. Test push-button

See section 3.1.2.

3.2.3. LEDs meaning

See section 3.1.3.

3.2.3.1 Fault LED

See section 3.1.3.1

3.2.3.2 DO output channel

Each DO channel has its own LED to signal the status of the internal electro-mechanical relay. When the LED is on the relevant relay is closed, while the LED is off when the relevant relay is open.

Relay open	Relay closed
LED OFF	LED ON (Green)

Table 5. SD030 DO channel LEDs meaning

3.2.4. Dip-switches

See section 3.1.4.

3.2.5. Terminal boxes

The SD030 DO unit has two terminal boxes, KM101 and KM102 in Figure 4. , for external connection (auxiliary supply, communication bus, ...).

KM101 pin no.	Signal	Description
1	0V (Vaux)	Auxiliary power supply
2	24V (Vaux)	Auxiliary power supply
3	Earth	Protection earth
4	-	-
5 - 6	DO 4	Digital output channel 4
7 - 8	DO 3	Digital output channel 3
9 - 10	DO 2	Digital output channel 2
11 - 12	DO 1	Digital output channel 1

Table 6. KM101 terminal box for SD030 DO

KM102 pin no.	Signal	Description
13 - 14	DO 5	Digital output channel 5
15 - 16	DO 6	Digital output channel 6
17 - 18	DO 7	Digital output channel 7
19 - 20	DO 8	Digital output channel 8
21	-	-
22	Earth	Protection earth
23	BUSI-A	RS-485 Accessory bus
24	BUSI-B	RS-485 Accessory bus

Table 7. KM102 terminal box for SD030 DO

Connections must be performed according to sections 4.1. and 11 .

3.3. SD030 AO

3.3.1. Front view

All the common features of System Flex Interfaces have been previously described in par. 3.1.1.

This section deals with the peculiarities of SD030 AO.

On the front panel of SD030 AO, 4 channel LEDs, one for each analog output, are present (see Figure 5.).

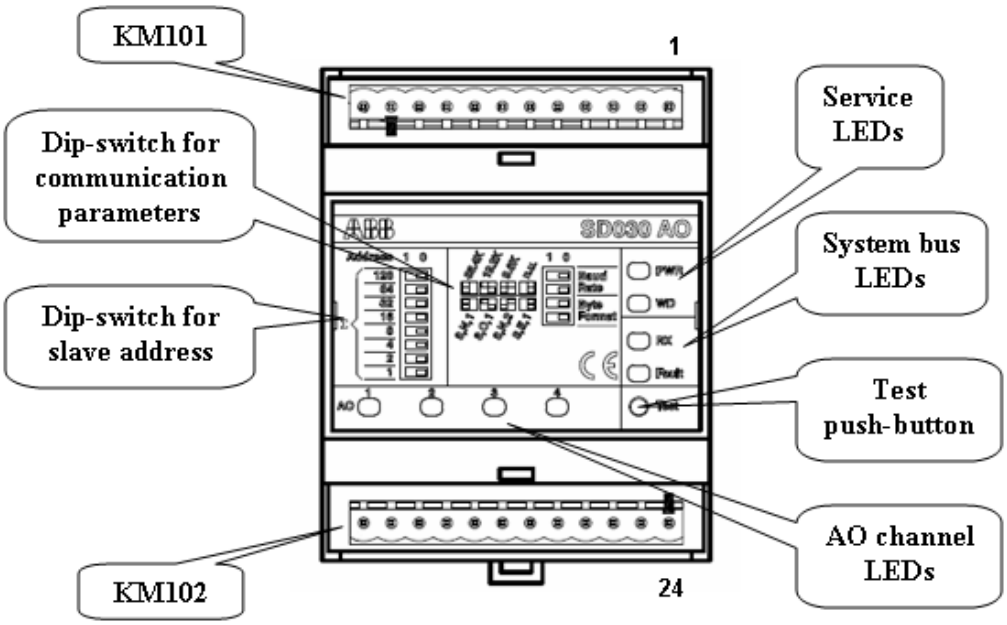

Figure 5. SD030 AO front view

3.3.2. Test push-button

See section 3.1.2.

3.3.3. LEDs meaning

See section 3.1.3.

3.3.3.1 Fault LED

See section 3.1.3.1

3.3.3.2 AO output channel

Each AO channel has its own LED, whose status depends on the value the channel is currently driving.

The output current can be defined among two different ranges:

- 0 ... 20mA
- 4 ... 20mA

However, the range is 4 ... 20mA by default.

A lower bound (LB) value and an upper bound (UB) value are also defined for each channel (see 8.1.3.).

The following table summarizes the channel LEDs behavior according to the relevant AO value.

AO value = LB	LB < AO value <= UB	AO value out of range		
		AO value < LB	AO value > UB	Unavailable value
LED OFF	LED ON (Green)	Pattern 1	Pattern 2	Pattern 3

Table 8. SD030 AO channel LEDs meaning

Each AO range, LB and UB can be configured independently by the others.

Note 4: The pattern value in table 8 stands for the number of blinkings performed by the LED in the outlined condition.

See Figure 2 for an example of pattern.

3.3.4. Dip-switches

See section 3.1.4.

3.3.5. Terminal boxes

The SD030 AO unit has two terminal boxes, KM101 and KM102 in Figure 5. , for external connection (auxiliary supply, communication bus, ...).

KM101 pin no.	Signal	Description
1	0V (Vaux)	Auxiliary power supply
2	24V (Vaux)	Auxiliary power supply
3	Earth	Protection earth
4-5-6	-	-
7 - 8	AO 2	Analog output channel 2
9-10	-	-
11 - 12	AO 1	Analog output channel 1

Table 9. KM101 terminal box for SD030 AO

KM102 pin no.	Signal	Description
13 - 14	AO 3	Analog output channel 3
15-16	-	-
17 - 18	AO 4	Analog output channel 4
19-20-21	-	-
22	Earth	Protection earth
23	BUSI-A	RS-485 Accessory bus
24	BUSI-B	RS-485 Accessory bus

Table 10. KM102 terminal box for SD030 AO

Connections must be performed according to sections 4.1. and 11 .

3.4. SD030 MI

3.4.1. Front view

All the common features of System Flex Interfaces have been previously described in par. 3.1.1.

This section deals with the peculiarities of SD030 MI.

On the front panel of SD030 MI, 4 channel LEDs, two for the analog inputs and two for the digital inputs, are present (see Figure 6.).

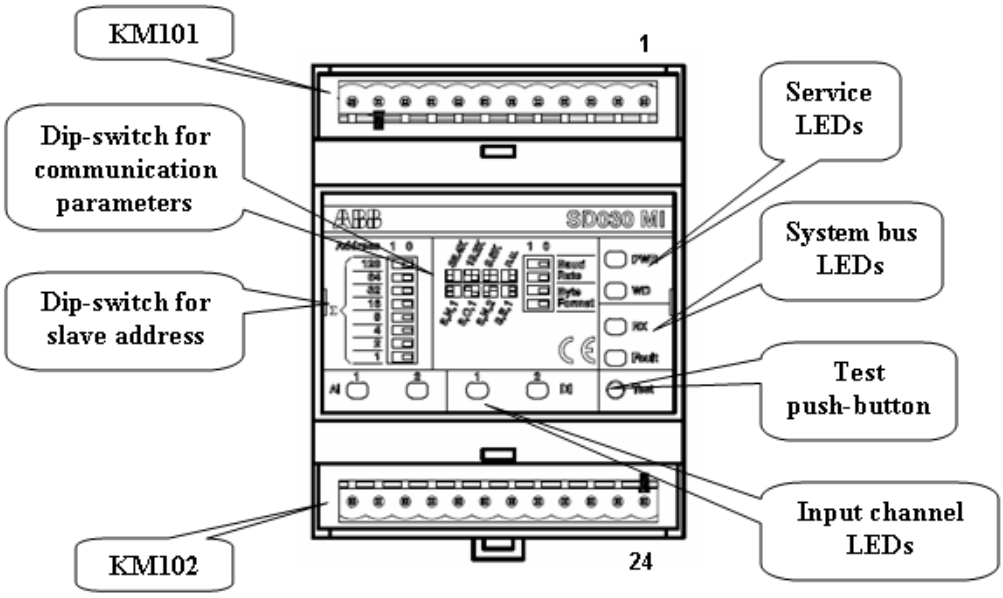

Figure 6. SD030 MI front view

3.4.2. Test push-button

See section 3.1.2.

3.4.3. LEDs meaning

See section 3.1.3.

3.4.3.1 Fault LED

See section 3.1.3.1

3.4.3.2 Input channel LEDs

Each DI and AI channel has its own LED, whose status depends on the value the channel is currently driving.

In the case of DI channels, the LED points out if a low input value (DI not active) or high input value (DI active) is detected, as explained in the following table.

NOT ACTIVE 0V < DI value < 4V	ACTIVE 15V < DI value < 24V
LED OFF	LED ON (Green)

Table 11. SD030 MI digital input channel LEDs meaning

The analog input current can be defined among two different ranges:

- 0 ... 20mA
- 4 ... 20mA (default)

A lower bound (LB) value and an upper bound (UB) value are also defined for each channel (see 8.1.4.)

The following table summarizes the channel LEDs behavior according to the relevant AI value.

AI value < 4mA	4mA < AI value <= 20mA	AI value > 20mA
LED OFF	LED ON (Green)	Pattern 2 (see Nota)

Table 12. SD030 MI analog input channel LEDs meaning

Note 5: The pattern value in table 12 stands for the number of blinkings performed by the LED in the outlined condition.

See Figure 2 for an example of pattern.

An histeresys has been performed in coincidence with 0, 4 and 20mA value, in order to avoid unwanted changing of the LED status produced by additional noise. The actual behavior is shown in Figure 7.

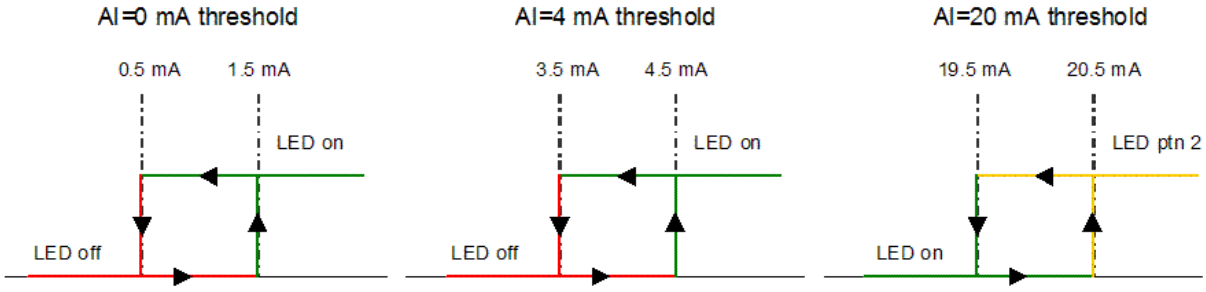

Figure 7. Histeresys at 0, 4 and 20mA input current

3.4.4. Dip-switches

See section 3.1.4.

3.4.5. Terminal boxes

The SD030 MI unit has two terminal boxes, KM101 and KM102 in Figure 6. , for external connections (auxiliary supply, communication bus, ...).

KM101 pin no.	Signal	Description
1	0V (Vaux)	Auxiliary power supply
2	24V (Vaux)	Auxiliary power supply
3	Earth	Protection earth
4-5-6	-	-
7 - 8	AI 2	Analog input channel 2
9-10	-	-
11 - 12	AI 1	Analog input channel 1

Table 13. KM101 terminal box for SD030 MI

KM102 pin no.	Signal	Description
13 - 14	DI 1	Digital input channel 1
15-16	-	-
17 - 18	DI 2	Digital input channel 2
19-20-21	-	-
22	Earth	Protection earth
23	BUSI-A	RS-485 Accessory bus
24	BUSI-B	RS-485 Accessory bus

Table 14. KM102 terminal box for SD030 MI

Connections must be performed according to sections 4.1. and 11 .

3.5. SD030 DI

3.5.1. Front view

All the common features of System Flex Interfaces have been previously described in par. 3.1.1.

This section deals with the peculiarities of SD030 MI.

On the front panel of SD030 DI, 8 channel LEDs, one for each digital input, are present (see Figure 8.).

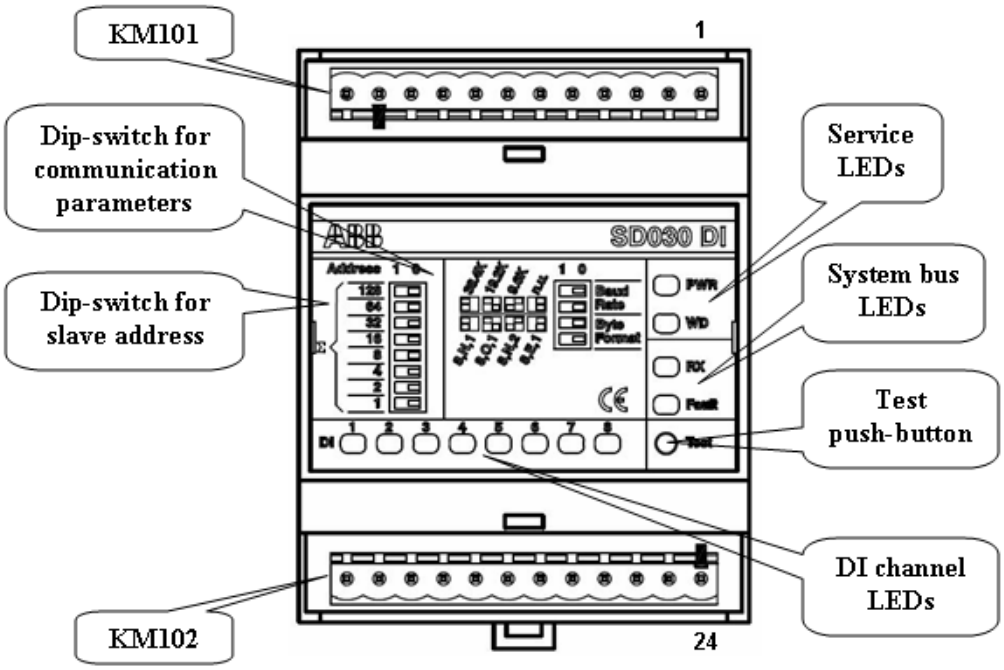

Figure 8. SD030 DI front view

3.5.2. Test push-button

See section 3.1.2.

3.5.3. LEDs meaning

See section 3.1.3.

3.5.3.1 Fault LED

See section 3.1.3.1

3.5.3.2 Fault LED

See section 3.1.3.1

3.5.3.3 Input channel LEDs

Each DI channel has its own LED, whose status depends on the value the channel is currently driving.

Each LED points out if a low input value (DI not active) or high input value (DI active) is detected, as explained in the following table.

NOT ACTIVE 0V < DI value < 4V	ACTIVE 15V < DI value < 24V
LED OFF	LED ON (Green)

Table 15. SD030 DI digital input channel LEDs meaning

3.5.4. Terminal boxes

The SD030 DI unit has two terminal boxes, KM101 and KM102 in Figure 8. , for external connections (auxiliary supply, communication bus, ...).

KM101 pin no.	Signal	Description
1	0V (Vaux)	Auxiliary power supply
2	24V (Vaux)	Auxiliary power supply
3	Earth	Protection earth
4	-	-
5-6	DI 4	Digital input channel 4
7 - 8	DI 3	Digital input channel 3
9-10	DI 2	Digital input channel 2
11 - 12	DI 1	Digital input channel 2

Table 16. KM101 terminal box for SD030 DI

KM102 pin no.	Signal	Description
13 - 14	DI 5	Digital input channel 5
15-16	DI 6	Digital input channel 6
17 - 18	DI 7	Digital input channel 7
19-20	DI 8	Digital input channel 8
21	-	-
22	Earth	Protection earth
23	BUSI-A	RS-485 Accessory bus
24	BUSI-B	RS-485 Accessory bus

Table 17. KM102 terminal box for SD030 DI

Connections must be performed according to sections 4.1. and 11 .

4 INSTALLATION

4.1. Installation instructions

Flex Interfeces units are mounted on standard 35 mm guide (DIN EN50022 type TS 35 x 15 mm), see Figure 18.

Make connections as indicated in sections 4.2. and 11 .

If Flex Interfeces are installed in enclosures near other devices generating electromagnetic fields (relays, transformers, motor controllers, ...), a proper shielding, grounding and other tricks should be considered to reduce unwanted effects, such as induced electrical noise on signal and power line.

An earth terminal is provided to connect the electronic circuit to the installation earth.

For the removable front connectors use shielded cables with conductors having a cross-section between 0.5 and 1.5 mm^2 (AWG 22 ... 14).

4.2. Connections

Carefully consider the relevant electrical diagram (see section 11 CIRCUIT DIAGRAMS) for the wiring of each terminal.

For the dedicated inputs and outputs, wirings different than that described in the official ABB SACE electrical diagram are not allowed.

The shield of the connecting cable for System bus must be connected to earth only in one point to avoid groung loop.

5 APPLICATION SCENARIOS

Flex Interfeces for System Bus are devices that can be used in a variety of application scenarios, interfaced with either PLC or SCADA or PC (equipped with an RS485 communication board), providing an intuitive and easy to use interface for carrying system information to distances up to 300 meters.

It is also possible to realize simple and inexpensive supervisor system architectures based on Flex Interfaces, acquiring real time data from the field, by means analog / digital inputs, and using digital / analog outputs to actuate electro-mechanical machines or visual and acustic devices or safety operations.

5.1. Digital Outputs

SD030 DO provides up to eight digital outputs with a normally open contact; each contact can be used by its own.

For example, DOs are used to drive either actuation mechanism, such as closing / opening coils (YC / YO) and command to reset the CB status after a trip (Trip Reset), or signalling devices, such as lamps, sirens and counter.

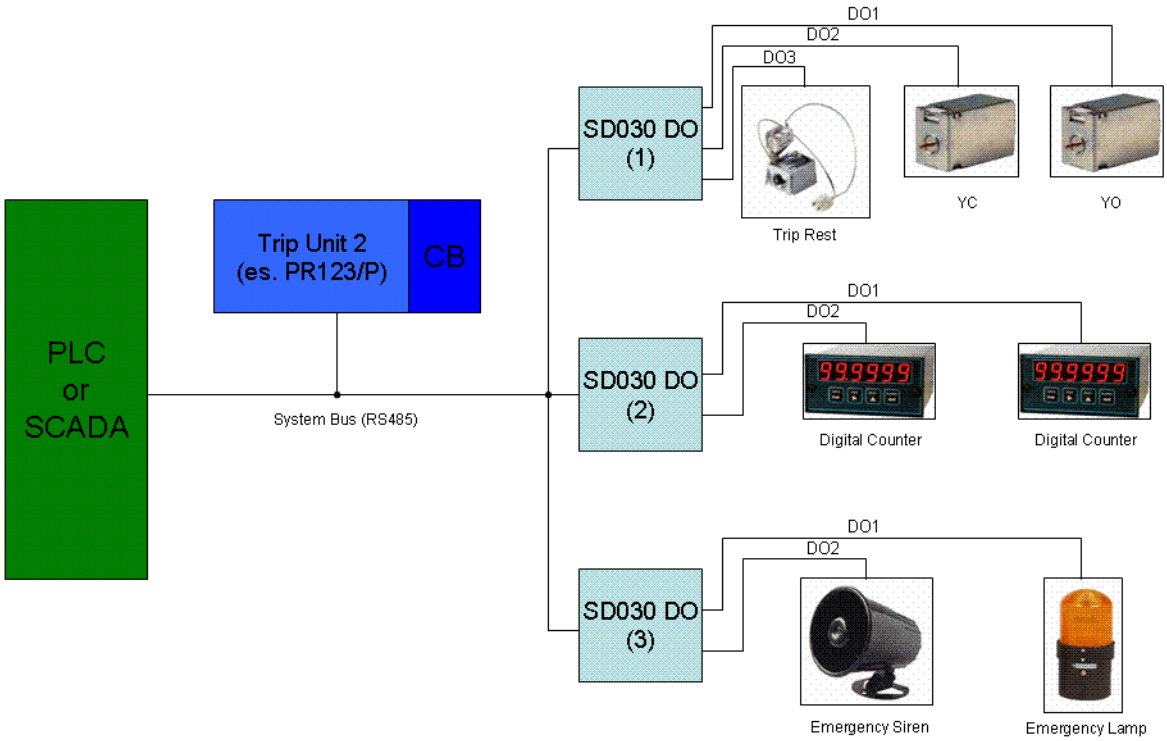

Figure 9. Example of application scenario with SD030 DO

5.2. Digital Inputs

By means the digital input of SD030 DI and SD030 MI units, user can read the operative status of a number of devices connected on the system bus, such as circuit breakers (CB open / close, CB inserted / isolated, spring charged / discharged and so on, as shown in the picture below) or standard safety devices (emergency buttons, flame sensors, infrared sensors, ...).

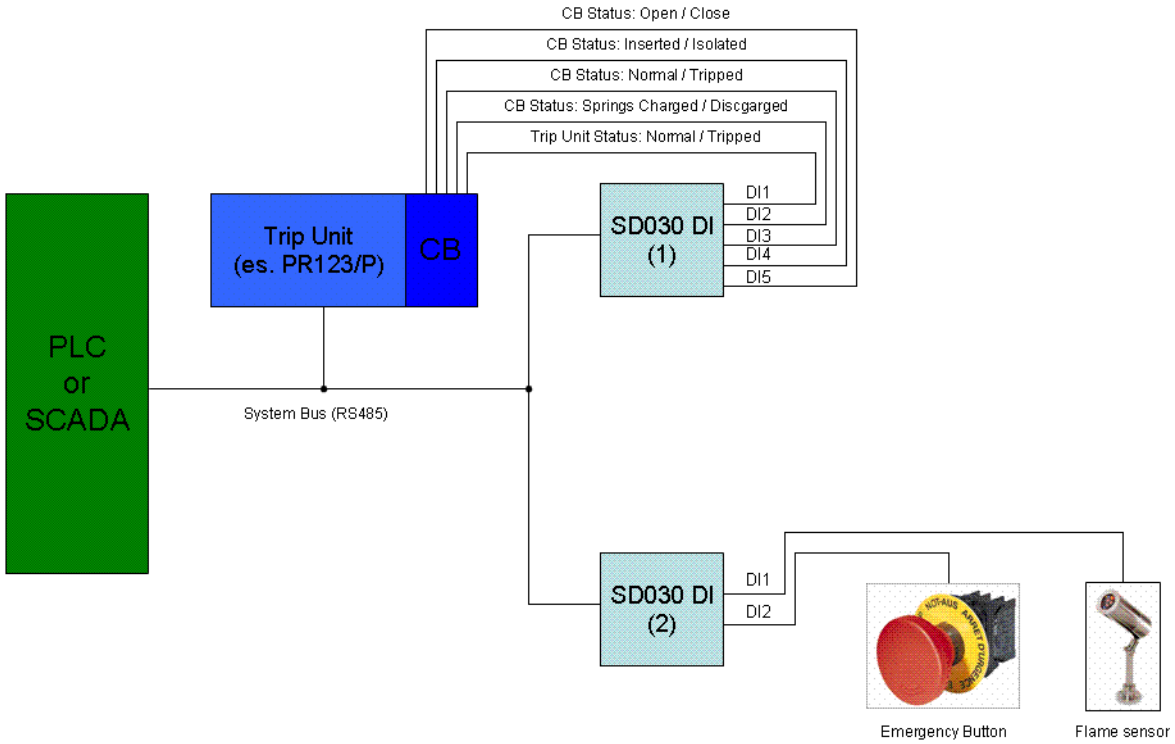

Figure 10. Example of application scenario with SD030 DI

5.3. Analog Output

SD030 AO allows to force an output current ranging from 4...20mA or 0...20mA to drive analog / digital counters and indicators.

In the following example, SD030 AOs are used to carry informations about currents, voltages and powers from a trip unit connected to the system to different analog indicators.

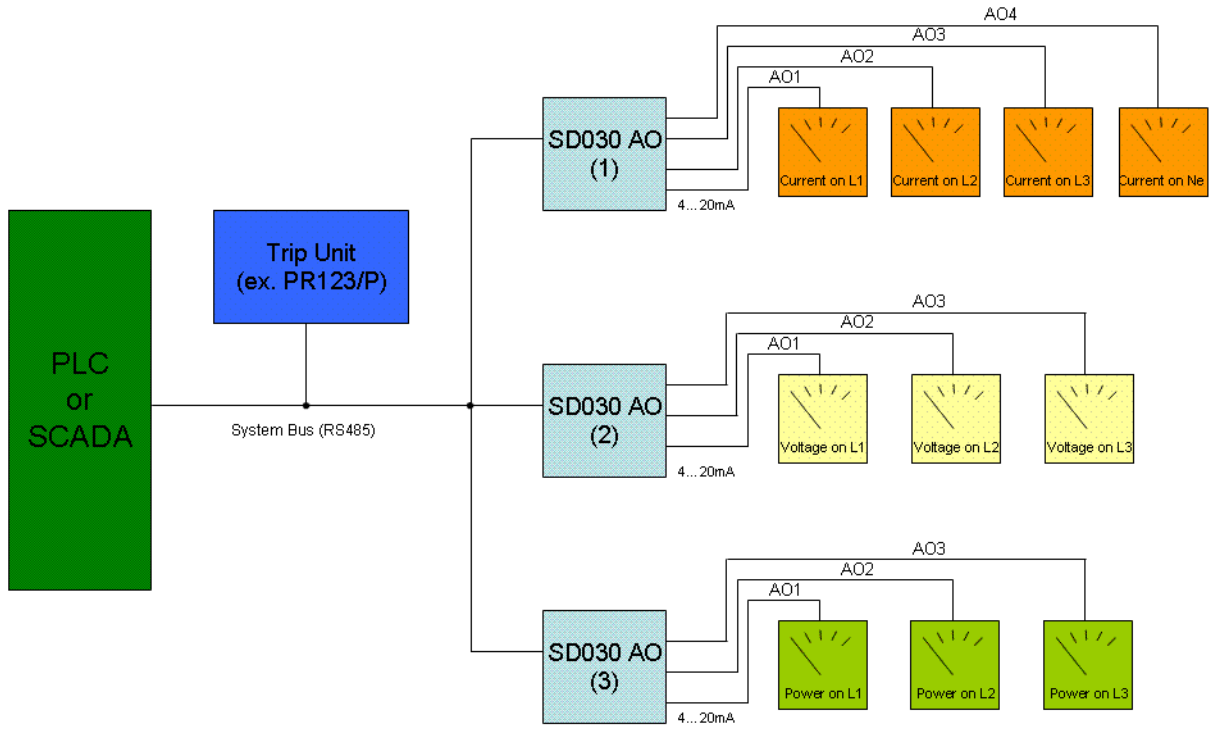

Figure 11. Example of application scenario with SD030 AO

5.4. Analog Input

Two analog inputs are provided by SD030 MI unit: they can be interfaced with a variety of devices with an output signal of 4...20mA (or 0...20mA), like temperature / humidity, pressure and many industrial sensors .

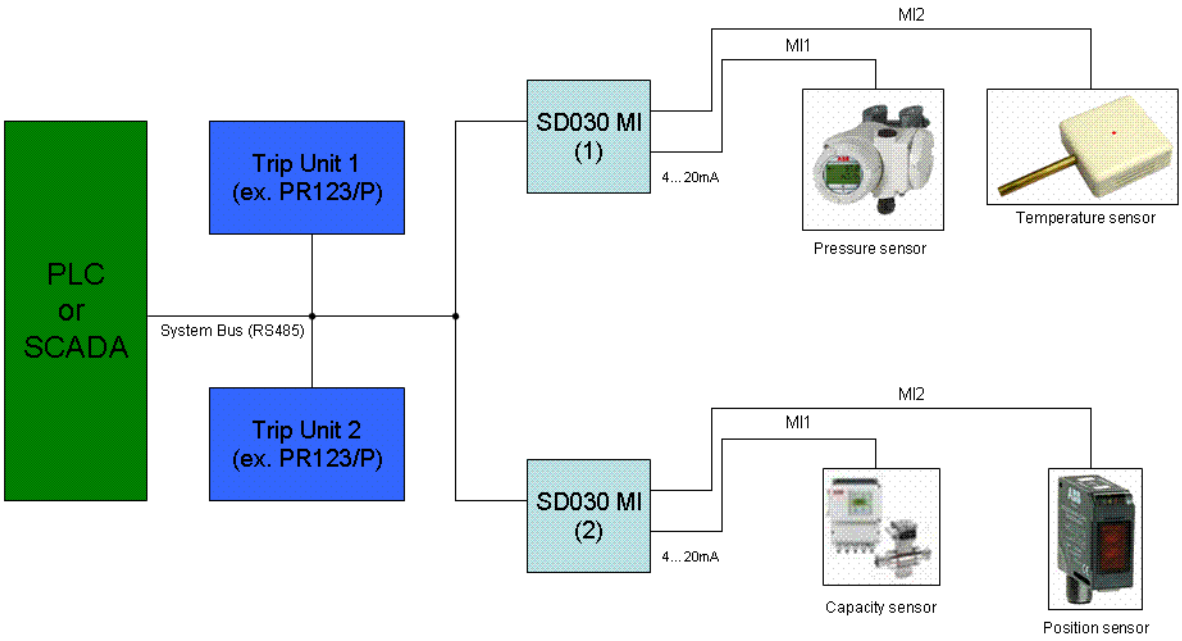

Figure 12. Example of application scenario with SD030 MI

6 DATA EXCHANGE ACTIVITY

6.1. SD030 DO

After the start up phase, SD030 DO is normally busy receiving periodic messages from the master that updates the status or the DO channels (output contact and relevant LED).

The signal associated with each single output contact is kept stable until the associated information (for example in the trip unit) changes.

The whole data exchange activity is signalled by the Accessory bus RX LEDs, which lights on when the device receives a message from the master.

6.1.1. Bus fault

By default, the DO 5 output channel is used to signal a bus inactivity condition. If communication between the device and the master is not present for more than 5 seconds:

- DO5 relay will go in closed state and the relevant LED will be ON
- All the other relays will go in open state and the relevant LEDs will be OFF
- The Fault LED will signal the Bus fault condition

It is possible to define the wanted behavior for each DO separately by sending a Modbus query in the proper registers (see Modbus map on section 10.3. for details).

6.2. SD030 AO

After the start up phase, SD030 AO is normally busy receiving periodic messages from the master that updates the values output by the AO channels.

The signal associated with each output channel varies accordingly to the associated measure.

The whole data exchange activity is signalled by the Accessory bus RX LEDs, which lights on when the device receives a message from the master.

6.2.1. Bus fault

If communication between the device and the master is not present for more than 5 seconds:

- All the AO channels will output the lower bound (LB) value and the relevant LEDs will be OFF
- The Fault LED will signal the Bus fault condition

6.3. SD030 DI

After the start up phase, SD030 DI is normally busy answering to the periodic message requests from the master, relative to the status of the input channels.

The whole data exchange activity is signalled by the Accessory bus RX LEDs, which lights on when the device receives a message from the master.

6.3.1. Bus fault

If communication between the device and the master is not present for more than 5 seconds:

- The Fault LED will signal the Bus fault condition

6.4. SD030 MI

After the start up phase, SD030 MI is normally busy answering to the periodic message requests from the master, relative to the status of the input channels.

The whole data exchange activity is signalled by the Accessory bus RX LEDs, which lights on when the device receives a message from the master.

6.4.1. Bus fault

If communication between the device and the master is not present for more than 5 seconds:

- The Fault LED will signal the Bus fault condition

7 OTHER OPERATIONS

7.1. General

At the start-up of the SD030 units, a procedure is immediately performed to verify that all LEDs work correctly:

- WD LED turns on
- all remanent LEDs turn on
- all LEDs but PWR switch off

Different procedure can be initiate by means of the Test push-button of SD030, as explained in Table 2.

7.1.1. Reset

The reset procedure is executed when the Test push-button is pressed for about 1 sec:

all I/O channels became inactive and relevant LEDs are switched off.

After reset, the position of the dip-switches is updated, if different settings have been applied.

7.1.2. Self-test

The self-test procedure is executed by Flex Interfeces units if the Test push-button on the front panel is kept pressed for about 5 sec:

- all LEDs lights in succession and are kept on for about 1 second; then they are turned off simultaneously
- all I/O channels are activated and deactivated, while relevant LEDs are switched on and off

The procedure ends when the PWR LED is permanently ON.

This test helps to check if:

- the device operates correctly during initialization
- LEDs switch on and off correctly
- I/O channels work properly

Note 6: Unit reset is automatically carried out before self-test took place.

8 TECHNICAL CHARACTERISTICS

8.1. Electrical characteristics

Effective operation	Max 10 s after the power on
Electromagnetic compatibility	IEC 61947-2 IEC 60533

Table 18. Electrical characteristcs of system Flex Interfeces

Contact ABB SACE for informations about the ESD compliance standards.

8.1.1. Auxiliary power supply

The Flex Interfeces units must be powered by an auxiliary supply.

Characteristics	SD030 AO, SD030 MI, SD030 DI	SD030 DO
Supply voltage	24 Vdc ± 20%	24 Vdc ± 20%
Maximum ripple	± 5%	± 5%
Nominal power @ 24 Vdc	2 W	4 W (all relays active)

Table 19. Auxiliary supply for system Flex Interfeces

Since the auxiliary voltage must be isolated from the ground, it is necessary to use 'galvanically separeted converters', conforming to IEC standard 60950 (UL 1950) or equivalent IEC 60364-41, in order to guarantee a common mode current or a leakage current (as defined in IEC 478/1), not greater than 3.5mA.

8.1.2. SD030 DO internal relays characteristics

The digital output channels have a normally open contact connected to the terminal box and are independent by each other. The following table sums up the main characteristics of the relay used for each channel.

Load	Resistance Load (cos ϕ = 1)
Type	Monostable SPDT
Max breaking capacity	150 W, 2000 VA
Max breaking voltage	30 Vdc, 250 Vac
Max breaking current	5 A @ 30 Vdc 8 A @ 250 Vac

Table 20. Characteristics of SD030 DO relays

8.1.3. SD030 AO channel characteristics

AOs are non isolated analog output channels, able to drive a current signal in the specified range with a resolution of 12bits and an accuracy of 1% at least.

User can select the output range to be:

- 0 ... 20mA
- 4 ... 20mA (default)

by means of a dedicated Modbus Telegram (see 10).

The maximum current managed by each AO channel is 25mA.

It is possible to set lower bound (LB) and upper bound (UB) values too: the LB must be associated to the AO minimum physical level depending on the selected output range.

Example 1: Set the AO1 output range to 0...20mA

Addr	Function	Register Address		Register Value		Crc	
AA	06h	04	B0	00	00	ch	cl

Example 2: Set the AO1 Lower Bound to 4mA

Addr	Function	Starting Address		Number of Registers		Byte Count	First Register value		Second Register value		Crc	
AA	10h	04	BA	00	02	04	00	00	00	00	ch	cl

Note 7: AA represents the slave address of the Flex Interfeces (see 3.1.4.1)
ch, cl represent the bytes used for Cyclic Redundancy Check (CRC)

Examples of permitted configurations are depicted hereafter.

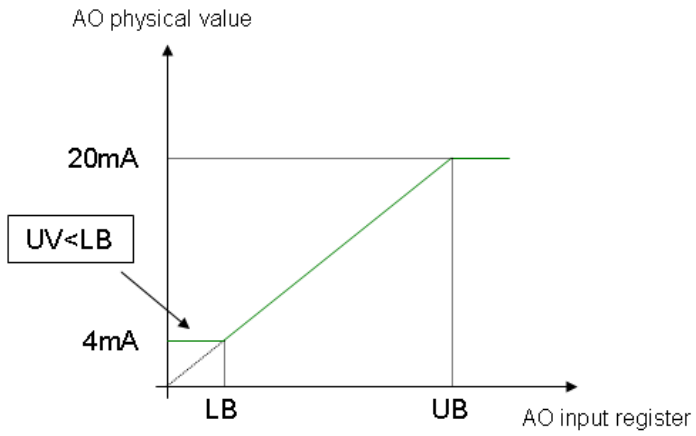

Figure 13. 4...20mA AO characteristic

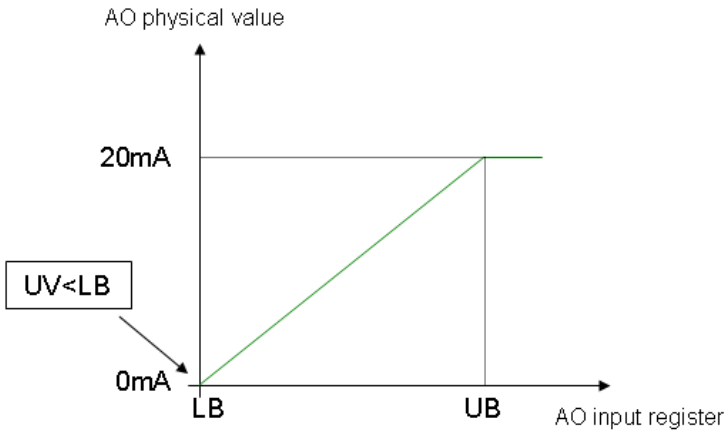

Figure 14. 0...20mA AO characteristic

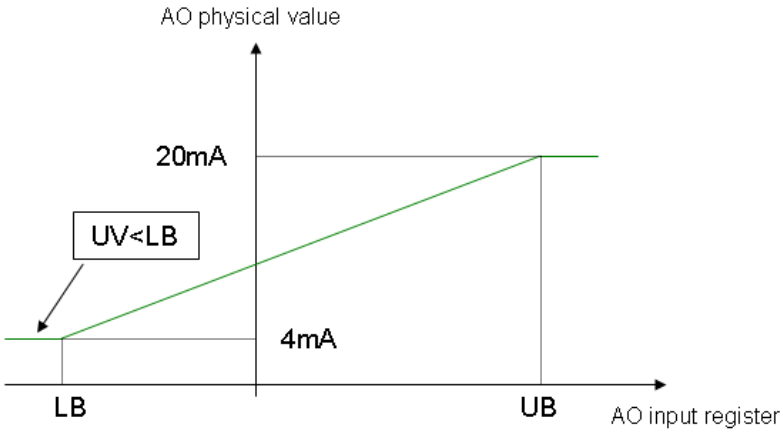

Figure 15. Example of AO characteristic with 4...20mA range and negative LB

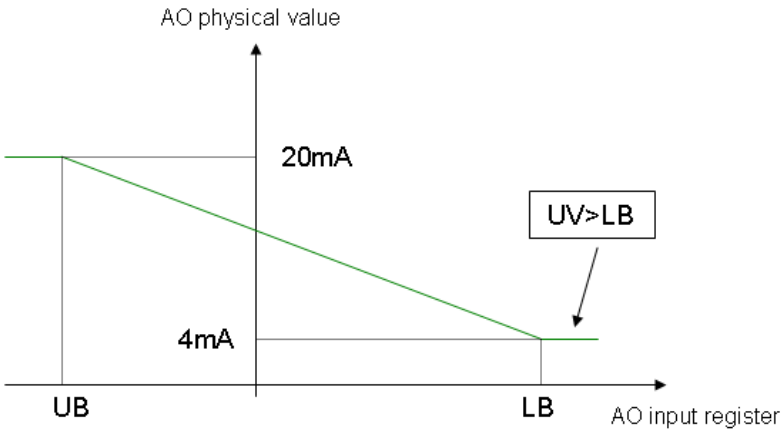

Figure 16. Example of AO characteristic with 4...20mA range and UB lower than LB

Note 8: UV means unavailable value.

The behavior of each channel is signalled by means of the relevant LED, as explained in Table 8.

8.1.4. SD030 MI channel characteristics

The digital input channels support a voltage signal in the range 0V ... 24V where:

- the range 0V ... 4V will be seen as a not active digital signal (binary 0)
- the range 15V ... 24 V will be seen as an active digital signal (binary 1)
- the range 5V ... 15V will as an undetermined digital signal

The analog input channels support a current signal in the specified range with a resolution of 12bits and an accuracy of 1% at least. The value that will be transmitted to the trip unit will be the engineering value multiplied by 1000 (4mA --> 4000, 20mA --> 20000).

User can select the input range to be:

- 0 ... 20mA
- 4 ... 20mA (default)

by means of a dedicated Modbus Telegram (see 10).

It is possible to set lower bound (LB) and upper bound (UB) values too.

The maximum current managed by each AI channel is limited to 25mA.

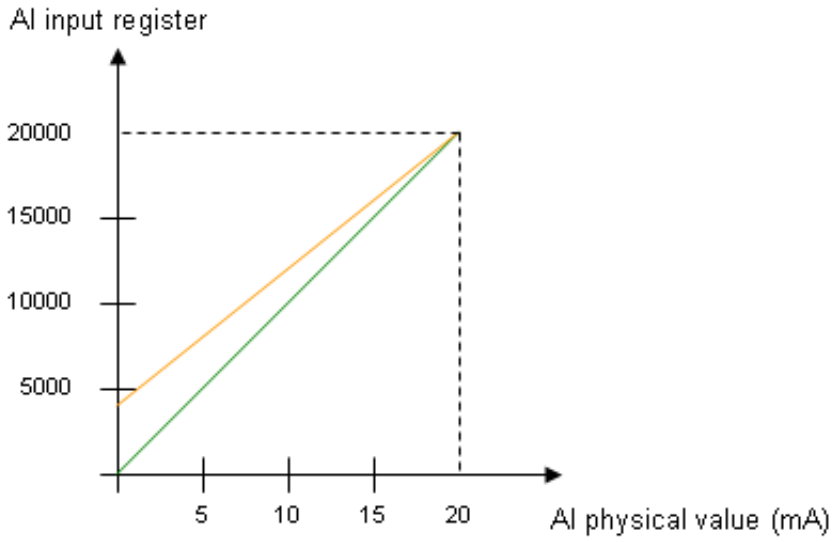

Figure 17. AI channel characteristics: 0 ... 20mA and 4 ... 20mA

8.1.5. SD030 DI channel characteristics

The digital input channels support a voltage signal in the range 0V ... 24V where:

- the range 0V ... 4V will be seen as a not active digital singal (binary 0)
- the range 15V ... 24 V will be seen as an active digital signal (binary 1)
- the range 5V ... 15V will as an undetermined digital signal

8.2. Mechanical characteristic

The same box is used for all the system Flex Interfeces.

Characteristic	Description
Case	Self-extinguish Noryl resin
Protection degree	IP20
Dimensions	see Figure 18.
Weight	100 g
Connectors	2 x 12 ways removables connectors (with screw terminals)

Table 21. Mechanical characteristics of system Flex Interfeces

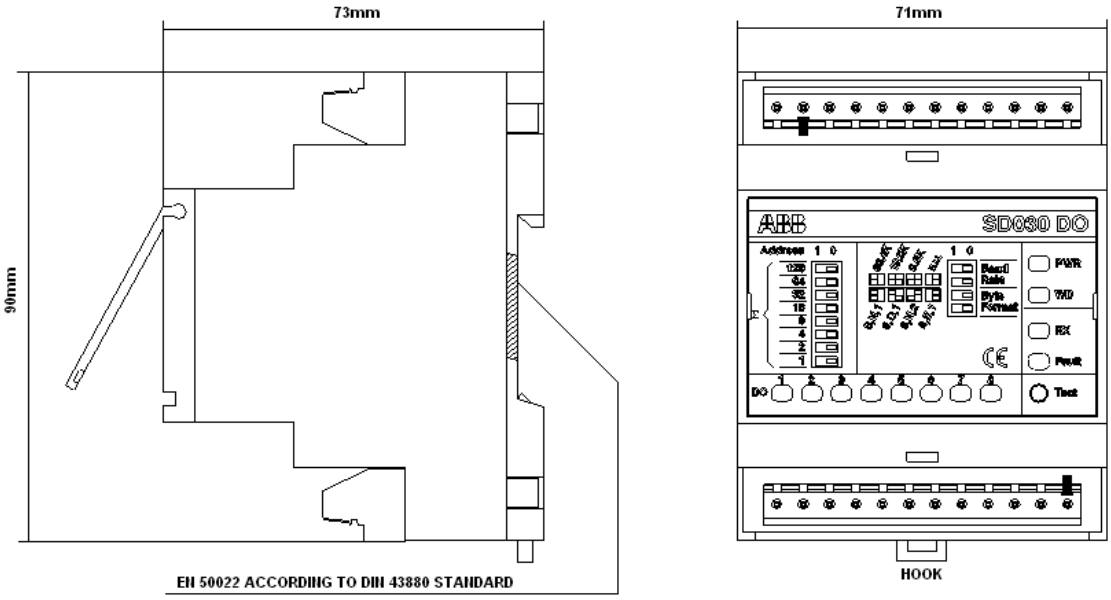

Figure 18. System Flex Interfeces dimensions

8.3. Environmental conditions

Characteristic	System Flex Interfeces
Operating environmental temperature	-25 °C ... +70 °C
Storage temperature	-40 °C ... +90 °C
Relative humidity	5% ... 98% with condensation (with coating)
Atmospheric pressure	1 bar, 0 m ... 2000 m

Table 22. Environmental conditions

8.4. RS-485 bus

The Flex Interfeces for System Bus units have got one serial bus used to communicate with other devices of the system.

It uses RS-485 as physical layer.

Each RS-485 channel is optically isolated and it is possible to connect at most 32 devices (using 32 different addresses from 1 to 247).

The connecting cable must be Belden 3105 with 120 Ohm characteristic impedence, or similar. Therefore, a 120 Ohm terminal resistor must be used.

The maximum length of the System bus is 300 m. In case of lot of stub connections, the bus length decreases accordingly.

9 TROUBLESHOOTING

The following table sums up a number of typical operational situations useful to understand and solve possible faults and malfunctions.

Note 9: Before consulting the following table, check the LEDs status on the front panel of the connected devices, as described in section 3.1.3. , 3.2.3. , 3.3.3. , 3.4.3.

Wait for the end of the start up phase if the system has just been powered up.

Situation	Possible causes	Suggestions
Flex Interfaces does not turn on	Auxiliary voltage not present	• Check auxiliary supply connection • Check if the value of auxiliary supply is in the range specified in 8.1.
Flex Interface does not communicate	System malfunctioning (RX LED is blinking)	• Check the system
	Device malfunctioning (RX LED is OFF): • System bus disconnected or not properly connected • Wrong communication parameters • Wrong dip switch position • Slave address collision	• Check connections • Check communication parameters on system bus (see Modbus register 1028-1031) • Check the dip switch position (see Modbus register 504) • Check if there are not two or more devices on the system bus with the same address
WD LED is ON or blinking	Device malfunctioning	Contact ABB technical support
DO unexpected behavior or actuation failure	• Wrong Modbus command • DO disconnected or not properly connected • Internal malfunction or fault condition • Different output mode • Bus fault • Different SW version	• Check the Modbus query • Check connections • Check the LED behavior according to 3.1.3. • Check the DO output mode in Modbus register 406 • Check the DOs behavior on bus fault (see Modbus registers 402 and 404) • Check the SW version on Modbus register 701
MI / DI unexpected behavior	• DI / MI disconnected or not properly connected • Internal malfunction or fault condition • Input level out of acceptable range • AI level different from the expected one • AI not properly calibrated • Different SW version	• Check connections • Check the LED behavior according to 3.1.3. • Check the input level according to 8.1.5. and 8.1.4. • Check the AI type in Modbus registers 1240-1241 • Check calibration offset in Modbus registers 1250-1251 • Check the SW version on Modbus register 701

Situation	Possible causes	Suggestions
AO unexpected behavior	• Wrong Modbus command • AO disconnected or not properly connected • Internal malfunction or fault condition • Output level different from the expected one • AO not properly calibrated • Different SW version	• Check the Modbus query • Check connections • Check the LED behavior according to 3.1.3. • Check the AO type according to Modbus register 1200-1203 • Check calibration offset in Modbus registers 1228-1231 • Check the SW version on Modbus register 701

Table 23. Troubleshooting for System Flex Interfaces

If the previous list does not solve the problem and/or if you suspect that any device is faulty, malfunctioning or has generated unexpected behavior, we recommend you to follow the instructions below:

- Prepare a brief description of the problem ecountered
- Note down the serial number of the unit
- Send all the information gathered, together with your application circuit diagram, to the nearest ABB technical support

10 MODBUS MAP for Flex Interfeces

10.1. Modbus function formats

10.1.1.Available Modbus Function

Function Code	Description	Applicable to
03 (03h)	Read Holding Registers	SD030 DO SD030 AO SD030 MI
04 (04h)	Read Input Registers	SD030 DO SD030 AO SD030 DI SD030 MI
06 (06h)	Write Single Register	SD030 DO SD030 AO SD030 MI
16 (10h)	Write Multiple Registers	SD030 DO SD030 AO SD030 MI

10.1.2.Function 03 (03h): Read Holding Registers

Query:

Addr	Function	Starting address		Number of Registers		Crc	
AA	03h	High	Low	High	Low	ch	cl

Response:

Addr	Function	Byte count	Register Value		Register Value		...	Crc	
AA	03h	nn	High	Low	High	Low	...	ch	cl

10.1.3.Function 04 (04h): Read Input Registers

Query:

Addr	Function	Starting address		No. of Inputs Registers		Crc	
AA	04h	High	Low	High	Low	ch	cl

Response:

Addr	Function	Byte count	Input Register		Input Register		...	Crc	
AA	04h	nn	High	Low	High	Low	...	ch	cl

10.1.4.Function 06 (06h): Write Single Register

Query:

Addr	Function	Register Address		Register Value		Crc	
AA	06h	High	Low	High	Low	ch	cl

Response (query echo):

Addr	Function	Register Address		Register Value		Crc	
AA	06h	High	Low	High	Low	ch	cl

10.1.5.Function 16 (10h): Write Multiple Registers

Query:

Addr	Function	Starting Address		Number of Registers		Byte Count	Register value		Register value		...	Crc	
AA	10h	High	Low	High	Low	nn	High	Low	High	Low	...	ch	cl

Response:

Addr	Function	Starting Address		Number of Registers		Crc	
AA	10h	High	Low	High	Low	ch	cl

Note 10: The lenght of all queries must be compliant with the maximum value allowable for Modbus messages (256 byte).

Legenda: AA= slave address (1...247)

cl = CRC low byte

ch = CRC high byte

10.2. Exception responses

10.2.1.Illegal function

Addr	Function	Exception code	Crc		When...
AA	Function +80h	01	ch	cl	Device does not support the received fucntion code

10.2.2.Illegal data address

Addr	Function	Exception code	Crc		When...
AA	Function +80h	02	ch	cl	• Starting address is 9999 (standard addressing type) • Starting address is outside a map section (ABB Sace addressing type) • Starting address not defined • Strating address not supported by function

10.2.3.Illegal data value

Addr	Function	Exception code	Crc		When...
AA	Function +80h	03	ch	cl	• The message is too long • The number of items is not in range (=0 or >max number of items) • Byte counts is different form the expected value • The whole query requested buffer (starting address + number of items) does not belong to a device map buffer • Command value different from “1”

10.2.4.Slave device failure

Addr	Function	Exception code	Crc		When...
AA	Function +80h	04	ch	cl	• Data with congruency byte not valid

10.2.5.Slave device busy

Addr	Function	Exception code	Crc		When...
AA	Function +80h	06	ch	cl	• EEPROM busy • Commands inhibition

10.3. Modbus Map

Relative Address-1	Modbus Type: Analog Input	Modbus Type: Analog Output
	Function: 4	Function: 3, 6, 16
0÷1	Communication statistics	Commands (see Table 26.)
2÷4		
6÷13	DO number of operations counters	
20÷27		DO Open Command
30÷37		DO Close Command
40÷47	AO values	AO values
100	Wink status	
102	DO status	
104	DI status	
106÷109	AI value	
110	AI status	
400	Bus Inactivity Time	Bus Inactivity Time
402	Signal Bus Fault with DO5	Signal Bus Fault with DO5
404	DOs behavior on Bus Fault	DOs behavior on Bus Fault
406	DO Output Mode	DO Output Mode
504	Dip Switches	
506	Power Supply Value	
700	Slave ID	
701	SW version	
703	Product Execution	
704÷711	Device Serial Number	
1028÷1031	Communication parameters	
1084÷1088	Tag Name	Tag Name
1089÷1093	User Data	User Data
1095	Date of Installation	Date of Installation
1096	Date of Test	
1200÷1203	AO type	AO type
1204÷1211	AO Lower Bound	AO Lower Bound
1212÷1219	AO Upper Bound	AO Upper Bound
1220÷1227	AO unavailable value	AO unavailable value
1228÷1231	AO calibration offset	
1240÷1241	AI type	AI type
1242÷1245	AI Lower Bound	AI Lower Bound
1246÷1249	AI Upper Bound	AI Upper Bound
1250÷1251	AI calibration offset	
1254	Upper Bound Multiplier	Upper Bound Multiplier

Table 24. Flex Interfeces Modbus Map

Rel addr-1	No. of item	Reg Name	Range	Default	Note	SD030 DO	SD030 AO	SD030 DI	SD030 MI
0	1	No. of received messages	0÷65535	-		x	x	x	x
1	1	No. of received messages with CRC error	0÷65535	-		x	x	x	x
2	1	No. of responses	0÷65535	-		x	x	x	x
3	1	No. of slave busy responses	0÷65535	-		x	x	x	x
4	1	No. of exception responses	0÷65535	-		x	x	x	x
6	1	DO1 no. of operations	0÷65535	-		x			
7	1	DO2 no. of operations	0÷65535	-		x			
8	1	DO3 no. of operations	0÷65535	-		x			
9	1	DO4 no. of operations	0÷65535	-		x			
10	1	DO5 no. of operations	0÷65535	-		x			
11	1	DO6 no. of operations	0÷65535	-		x			
12	1	DO7 no. of operations	0÷65535	-		x			
13	1	DO8 no. of operations	0÷65535	-		x			
20	1	DO1 Open Command	0÷1	-	1=open DO1	x			
21	1	DO2 Open Command	0÷1	-	1=open DO2	x			
22	1	DO3 Open Command	0÷1	-	1=open DO3	x			
23	1	DO4 Open Command	0÷1	-	1=open DO4	x			
24	1	DO5 Open Command	0÷1	-	1=open DO5	x			
25	1	DO6 Open Command	0÷1	-	1=open DO6	x			
26	1	DO7 Open Command	0÷1	-	1=open DO7	x			
27	1	DO8 Open Command	0÷1	-	1=open DO8	x			
30	1	DO1 Close Command	0÷1	-	1=close DO1	x			
31	1	DO2 Close Command	0÷1	-	1=close DO2	x			
32	1	DO3 Close Command	0÷1	-	1=close DO3	x			
33	1	DO4 Close Command	0÷1	-	1=close DO4	x			
34	1	DO5 Close Command	0÷1	-	1=close DO5	x			
35	1	DO6 Close Command	0÷1	-	1=close DO6	x			
36	1	DO7 Close Command	0÷1	-	1=close DO7	x			
37	1	DO8 Close Command	0÷1	-	1=close DO8	x			
40	2	AO1 value	$0\div2^{32}-1$	0	Signed value		x		
42	2	AO2 value	$0\div2^{32}-1$	0	Signed value		x		
44	2	AO3 value	$0\div2^{32}-1$	0	Signed value		x		
46	2	AO4 value	$0\div2^{32}-1$	0	Signed value		x		
100	1	Wink status	0÷1	0	0=Wink Off 1=Wink On	x	x	x	x
102	1	DO status	0÷255	-	Bit No. / Bit=0 / Bit=1				
					0 / DO1 open / DO1 close	x			
					1 / DO2 open / DO2 close	x			
					2 / DO3 open / DO3 close	x			
					3 / DO4 open / DO4 close	x			
					4 / DO5 open / DO5 close	x			
					5 / DO6 open / DO6 close	x			
					6 / DO7 open / DO7 close	x			
					7 / DO8 open / DO8 close	x			
					8÷15 / n.u. / n.u.				

Rel addr-1	No. of item	Reg Name	Range	Default	Note			SD030 DO	SD030 AO	SD030 DI	SD030 MI
104	1	DI status	0÷255	-	Bit No.	Bit=0	Bit=1				
					0	DI1 open	DI1 close			x	x
					1	DI2 open	DI2 close			x	x
					2	DI3 open	DI3 close			x	
					3	DI4 open	DI4 close			x	
					4	DI5 open	DI5 close			x	
					5	DI6 open	DI6 close			x	
					6	DI7 open	DI7 close			x	
					7	DI8 open	DI8 close			x	
					8÷15	n.u.	n.u.				
106	2	AI1 value	$0÷2^{32}$-1	-	Signed value						x
108	2	AI2 value	$0÷2^{32}$-1	-	Signed value						x
110	1	AI status	0÷65535	-	Bit No.	Bit=0	Bit=1				
					0	-	AI1 under load				x
					1	-	AI1 over load				x
					2	-	AI2 under load				x
					3	-	AI2 over load				x
					4÷15	n.u.	n.u.				
400	1	Bus Inactivity Time	0÷60	5	Seconds to detect inactivity on bus			x	x	x	x
402	1	Signal Bus Fault with DO5	0÷1	0	0=DO5 normal 1=DO5 on bus fault			x			
404	1	Outputs behavior on Bus Fault	0÷1	0	0=Reset Output state 1=Keep Output state			x	x		
406	1	DO Output Mode	0÷255	-	Bit No.	Bit=0	Bit=1				
					0	DO1 normal	DO1 latched	x			
					1	DO2 normal	DO2 latched	x			
					2	DO3 normal	DO3 latched	x			
					3	DO4 normal	DO4 latched	x			
					4	DO5 normal	DO5 latched	x			
					5	DO6 normal	DO6 latched	x			
					6	DO7 normal	DO7 latched	x			
					7	DO8 normal	DO8 latched	x			
					8÷15	n.u.	n.u.				
504	1	Dip Switches	0÷65535	-				x	x	x	x
506	1	Power Supply value	0÷65535	-	Value of supply voltage in mV			x	x	x	x
700	1	Slave ID	100÷104	-	100=SD030 DO 101=SD030 AO 102=SD030 DI 103=SD030 DX 104=SD030 MI			x	x	x	x
701	1	SW version	0÷65535	-	MSB=Mayor version LSB=Minor version			x	x	x	x
703	1	Product Execution	0÷9	0	0=undefined 4=SD030 DO 5=SD030 AO 6=SD030 DI 8=SD030 MI			x	x	x	x
704	8	Device Serial Number	16 char	“00000000ABB SACE”	1 byte for each character			x	x	x	x
1028	1	Slave Address	0÷247	-				x	x	x	x
1029	1	Addressing type	0	0	0=standard			x	x	x	x

Rel addr-1	No. of item	Reg Name	Range	Default	Note	SD030 DO	SD030 AO	SD030 DI	SD030 MI
1030	1	Baud rate	0÷2	Dip depending	0=9600 1=19200 2=38400	x	x	x	x
1031	1	Byte Format	0÷3	Dip depending	0=”E,8,1” 1=O,8,1” 2=”N,8,2” 3=”N,8,1”	x	x	x	x
1084	5	Tag Name	10 char	“CB.Name”	1 byte for each character	x	x	x	x
1089	5	User Data	10 char	“User.Data”	1 byte for each character	x	x	x	x
1095	1	Date of Installation	0÷65535	0	Number of days passed since 31 December 1999	x	x	x	x
1096	1	Date of Test	0÷65535	0	Number of days passed since 31 December 1999	x	x	x	x
1200	1	AO1 type	0÷1	1	0=0...20mA 1=4...20mA		x		
1201	1	AO2 type	0÷1	1	0=0...20mA 1=4...20mA		x		
1202	1	AO3 type	0÷1	1	0=0...20mA 1=4...20mA		x		
1203	1	AO4 type	0÷1	1	0=0...20mA 1=4...20mA		x		
1204	2	AO1 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value		x		
1206	2	AO2 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value		x		
1208	2	AO3 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value		x		
1210	2	AO4 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value		x		
1212	2	AO1 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value		x		
1214	2	AO2 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value		x		
1216	2	AO3 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value		x		
1218	2	AO4 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value		x		
1220	2	AO1 unavailable value	$0 \div 2^{32}-1$	0xFFFFFFFF	Unsigned value		x		
1222	2	AO2 unavailable value	$0 \div 2^{32}-1$	0xFFFFFFFF	Unsigned value		x		
1224	2	AO3 unavailable value	$0 \div 2^{32}-1$	0xFFFFFFFF	Unsigned value		x		
1226	2	AO4 unavailable value	$0 \div 2^{32}-1$	0xFFFFFFFF	Unsigned value		x		
1228	1	AO1 calibration offset	0÷65535	0	Signed value		x		
1229	1	AO2 calibration offset	0÷65535	0	Signed value		x		
1230	1	AO3 calibration offset	0÷65535	0	Signed value		x		
1231	1	AO4 calibration offset	0÷65535	0	Signed value		x		
1240	1	AI1 type	0÷1	1	0=0...20mA 1=4...20mA				x
1241	1	AI2 type	0÷1	1	0=0...20mA 1=4...20mA				x
1242	2	AI1 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value				x
1244	2	AI2 Lower Bound	$0 \div 2^{32}-1$	4000	Signed value				x
1246	2	AI1 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value				x
1248	2	AI2 Upper Bound	$0 \div 2^{32}-1$	20000	Signed value				x
1250	1	AI1 calibration offset	0÷65535	0	Signed value				x
1251	1	AI2 calibration offset	0÷65535	0	Signed value				x
1254	1	Upper bound multiplier	0÷65535	100	Unsigned value		x		

Table 25. Modbus registers for SD030 DO, AO, DI, MI units

10.3.1.Commands registers

Value	Command type (address=0)	Parameter (address=1)	SD030 DO	SD030 AO	SD030 DI	SD030 MI
0	Dummy	Don't care	x	x	x	x
1	Electronic self-test	Don't care	x	x	x	x
2	Reset Signals	Don't care	x	x		
3	Reset Communication statistics	Don't care	x	x	x	x
4÷10	n.u.	-				
11	Wink	0=Wink Off 1=Wink On	x	x	x	x

Table 26. Modbus command operations

11 CIRCUIT DIAGRAMS

11.1. SD030 DO

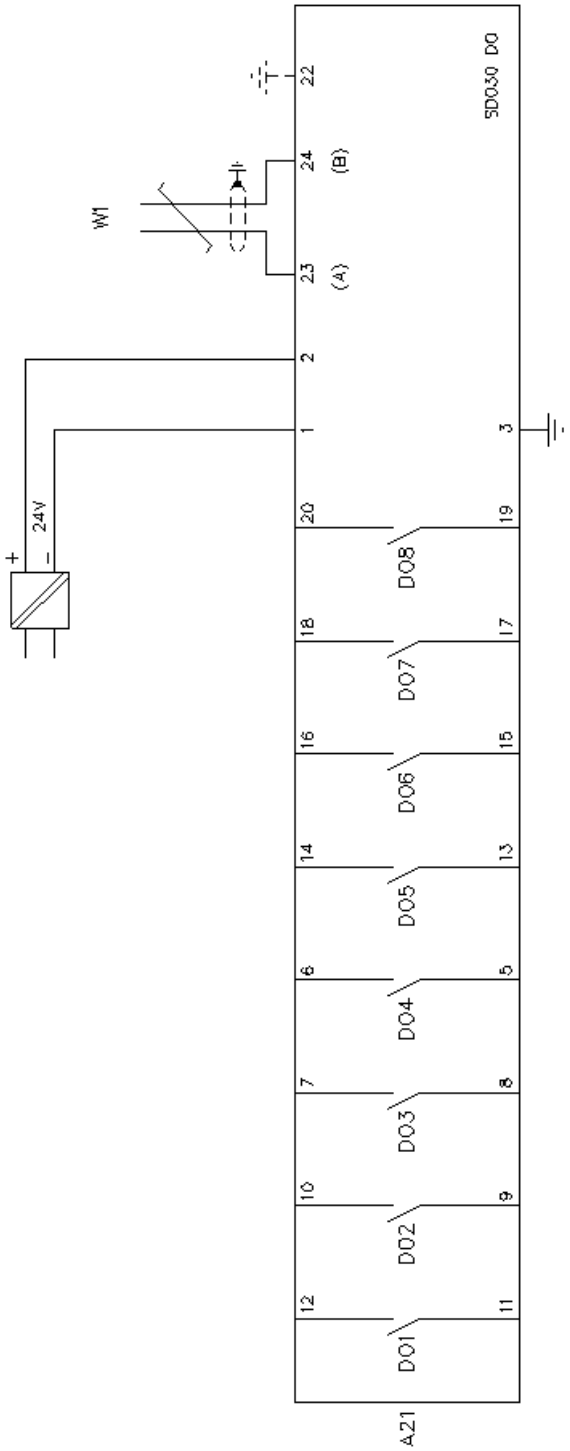

Figure 19. SD030 DO circuit diagram

11.2. SD030 AO

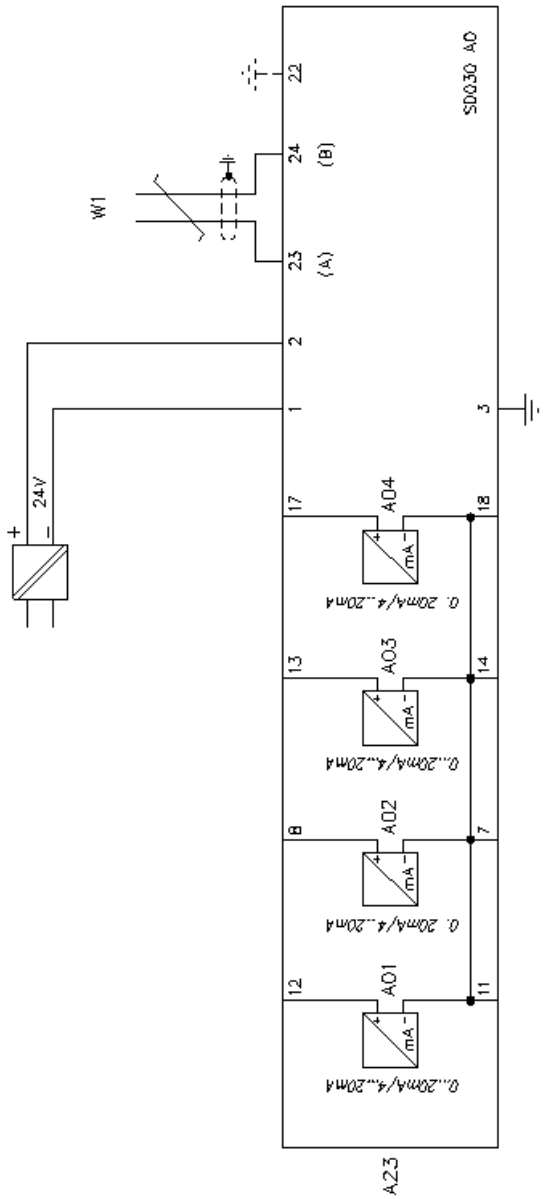

Figure 20. SD030 AO circuit diagram

11.3. SD030 MI

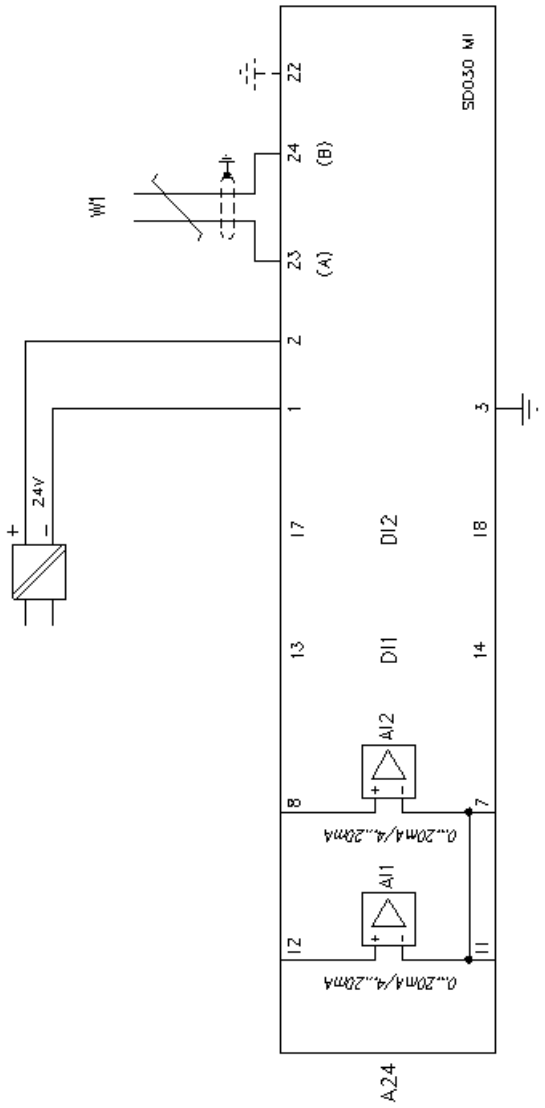

Figure 21. SD030 MI circuit diagram

11.4. SD030 DI

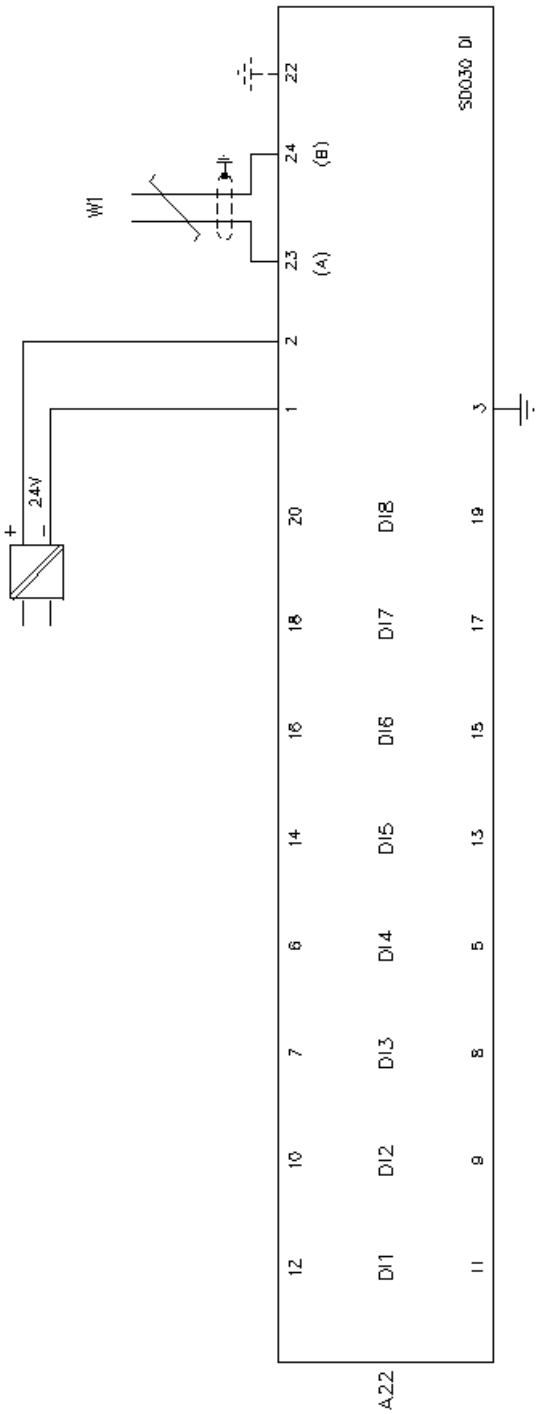

Figure 22. SD030 DI circuit diagram

11.5. Graphical symbols for electrical diagrams (617 IEC standards)

Caption	Description
A21	Unit type SD030 DO with 8 digital outputs to connect to System Bus
A22	Unit type SD030 DI with 8 digital inputs to connect to System Bus
A23	Unit type SD030 AO with 4 analog outputs to connect to System Bus
A24	Unit typeSD030 MI with 2 digital inputs and 2 analog inputs to connect to System Bus
A25	Unit type SD030 DX with 5 digital inputs and 3 digital outputs to connect a circuit breaker without dialogue unit to System Bus
AI	Analog Inputs
AO	Analog Outputs
DO	Digital Outputs
DX	Digital Outputs/Inputs
MI	Mixed Inputs
K51	Trip unit
W1	System Bus (Modbus generic bus)

Table 27. Description of electrical diagrams captions

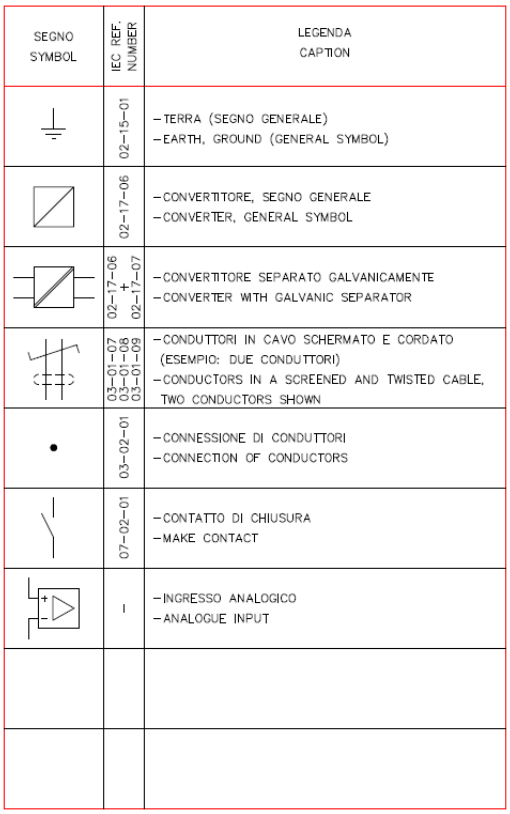

Figure 23. Graphical symbols used in circuit diagrams