FLEX INTERFACES
FOR ACCESSORY BUS

CONTENTS

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 MM030 and 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

MM030 and Flex Interfaces provide a modular and easy-to-use system 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 Interfaces family is composed by accessory and system devices. This document describes only the devices that work in conjunction with the MM030, that is accessory devices.

The MM030 is a microprocessor-based device used to manage the information exchange between a trip unit and accessory Flex Interfaces.

It is provided with two different communication buses:

- Local bus, used for the connection with the trip unit (Tmax, Emax and T7/X1 series).
- Accessory bus, used for the connection with Flex Interfaces units.

MM030 unit gets data from the trip unit and dispatch them to the connected Flex Interfaces. Vice versa, in those scenarios that support this feature (see section 5), MM030 can get data from Flex Interfaces input channels and send it to the trip unit.

MM030 is able to automatically recognize the devices connected on the two buses and to establish the optimum data exchange sequence in order to get the highest transfer rate. This procedure is called 'Configuration' and it is initiated by pressing the Configuration push button (see section 6).

Accessory Flex Interfaces are microprocessor-based devices specifically designed to be connected to MM030 and provide input/output digital and analog signals.

Different devices belongs to accessory Flex Interfaces family:

Device type	Features	Description	Notes
AD030 DO	8 digital outputs	Receives data from MM030 and actuates its digital outputs accordingly	
AD030 AO	4 analog outputs	Receives data from MM030 and drives its analog outputs accordingly	
AD030 MI	Mixed inputs: 2 analog inputs 2 digital inputs	Replay the status of its inputs upon MM030 request	
HMI030	Human-machine interface	Visualizes data received from the MM030	Note 1: HMI030 can operate either connected directly to the trip unit or connected to the MM030. The operation mode must be properly configured (see the relevant documentation for details). Note 2: only HMI030 with software version equal or greater than 2.0 is supported.

Table 1. Flex Interfaces family of devices

An accessory device provides a rotary selector for choosing which trip unit data is associated with its inputs/outputs.

While only one trip unit can be connected to MM030 Local bus, more than one Flex Interfaces can be connected to MM030 Accessory bus.

In particular, the Flex Interfaces units should be of different device type or, if of the same device type, they should have different rotary selector position.

The total number, device type and relevant rotary selector position of the Flex Interfaces that can be connected to MM030 Accessory bus depends on the trip unit connected to MM030 Local bus and are defined in section 5.

The following figure shows a typical architecture involving:

- the trip unit (Tmax, Emax or T7/X1 series)
- the MM030 unit
- units from Flex Interfaces family

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 .

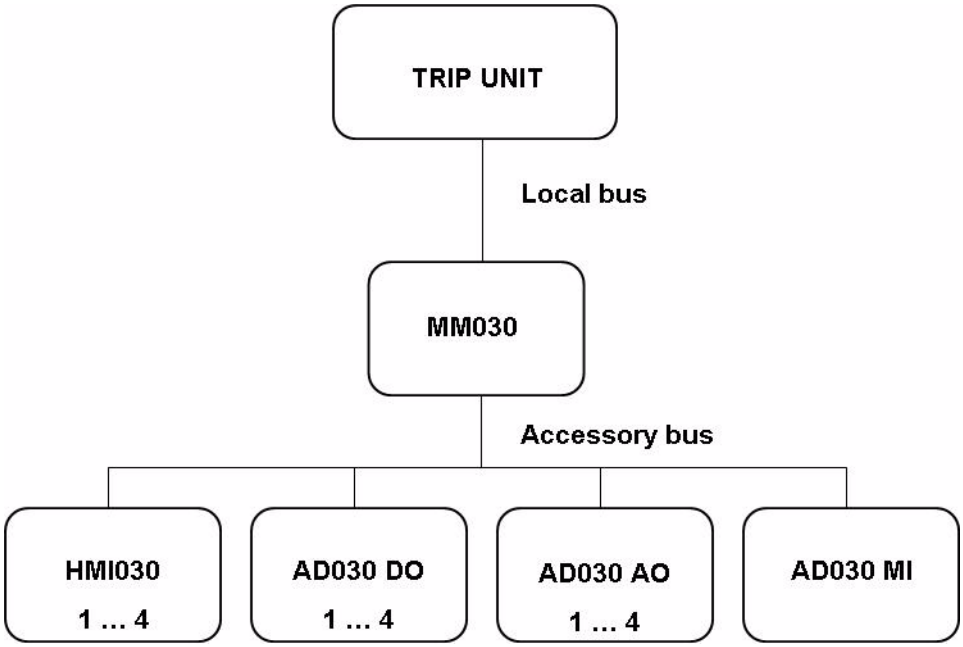

Figure 1. A typical architecture

2.2. References

The following document describes how to install, set-up and operate MM030 and AD030 XX units.

For information about the trip units that can be interfaced with MM030 unit, 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. ISDC210015D0201)
- ABB SACE Emax technical catalogue (doc. no. 1SDC200006D0201)
- ABB SACE T7/X1 technical catalogue (doc. no. 1SDC20009D0201)

For information about Flex Interfaces for System Bus and HMI030 the following documents must be consulted:

- Instruction manual of HMI030 (doc. no. 1SDH1000573R0001)
- Instruction manual of Flex Interfaces for System Bus (doc. no. 1SDH000649R001)

3 USER INTERFACE

3.1. MM030

3.1.1. Front view

The front panel of the MM030 unit consists of:

- 2 push-buttons
- 3 service LEDs
- 2 local bus LEDs
- 2 accessory bus LEDs
- 2 terminal boxes
- 1 maintenance serial port

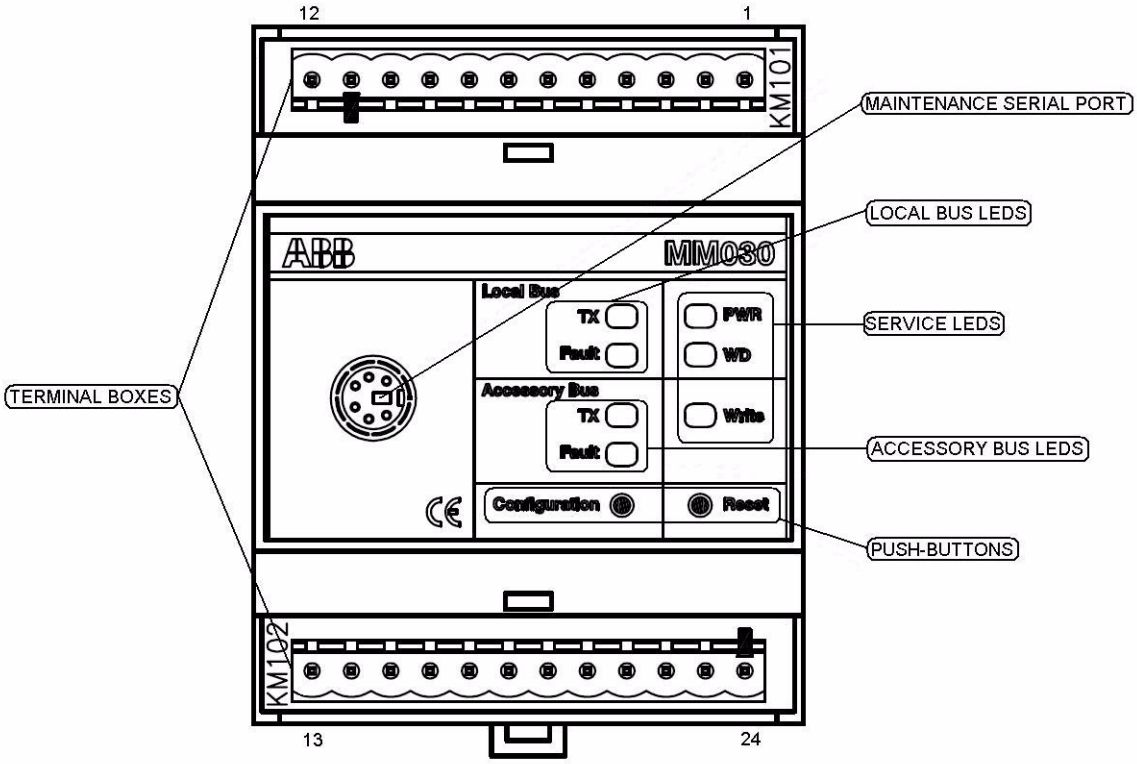

Figure 2. MM030 front view

3.1.2. Push-buttons

Push-buttons	Description
Reset	Performs the hardware reset
Configuration	Performs scan of Local and Accessory buses to recognize the devices connected

Table 2. MM030 push-buttons

3.1.3. LEDs meaning

After performing a test at start-up (see section 8.1.1.), the 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
	Write	ON (Red)	Internal memory writing
		OFF	No internal memory operations
Local bus	TX	ON (Yellow)	Data transmission on Local bus
		OFF	No data transmission on Local bus
	Fault	ON/Blink (Red)	Special condition / malfunction on Local bus
		OFF	No special condition / malfunction on Local bus
Accessory bus	TX	ON (Yellow)	Data transmission on Accessory bus
		OFF	No data transmission on Accessory bus
	Fault	ON/Blink (Red)	Special condition / malfunction on Accessory bus
		OFF	No special condition / malfunction on Accessory bus

Table 3. MM030 LEDs meaning

3.1.3.1 Fault LED

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

Status	Signalling	Priority	Description
Fixed ON	Bus fault	5	• Bus not connected or faulty • No device found on bus after configuration • All devices on bus disconnected
Pattern 1	Unconfigured	4	MM030 not yet configured
Pattern 2	Device disconnected	6	One or more (but not all) devices disconnected from bus
Pattern 3	Pattern not used	-	
Pattern 4	Unknown device	7	One or more unknown devices found during the configuration. Some examples: • Device with an ID not recognized by MM030 • Device connected to the wrong bus
Pattern 5	Unmanaged device	8	One or more devices have been recognized during the configuration but are not managed by MM030. Some examples: • Scenario different from the ones indicated in section 5 • Device with incorrect software version
Pattern 6	Possible device collision	9	Two or more Flex Interfaces configured with rotary selector in the same position

Status	Signalling	Priority	Description
Pattern 7	Malfunction	2	MM030 is detecting a malfunction: • Power supply votage too low or too high • Internal malfunction
Pattern 8	Maintenance mode	1	MM030 is in maintenance mode
Pattern 10	Internal memory error	3	MM030 internal memory is corrupted

Table 4. MM030 Fault LEDs meaning

Pattern x indicates that the LED periodically:

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

The following example shows Pattern 3:

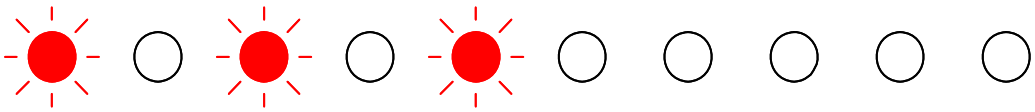

Figure 3. Pattern 3

3.1.4. Terminal boxes

The MM030 unit has two terminal boxes (KM101 and KM102 in Figure 2.)

KM101 pin no.	Signal	Description
1	0V (Vaux)	Auxiliary power supply
2	24V (Vaux)	Auxiliary power supply
3	-	-
4	Earth	Protection earth
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	BUSI-A1	RS485 Local bus
11	BUSI-B1	RS485 Local bus
12	Earth	Protection earth

Table 5. MM030 terminal box KM101

KM102 pin no.	Signal	Description
13	BUSI-A2	RS485 Accessory bus
14	BUSI-B2	RS485 Accessory bus
15	Earth	Protection earth
16	-	-
17	-	-
18	-	-
19	-	-
20	-	-
21	-	-
22	-	-
23	-	-
24	-	-

Table 6. MM030 terminal box KM102

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

3.1.5. Maintenance serial port

The MM030 unit has got a maintenance serial port on the front panel used to connect a personal computer.
The management of this port is reserved to ABB SACE skilled personnel.

WARNING: An incorrect use of this port can lead to a system block.

3.2. Common features of Accessory Devices

3.2.1. Front view

The following picture points out the features common to all accessory Flex Interfaces (except the rotary selector that is not present on AD030 MI, as shown in Figure 7.)

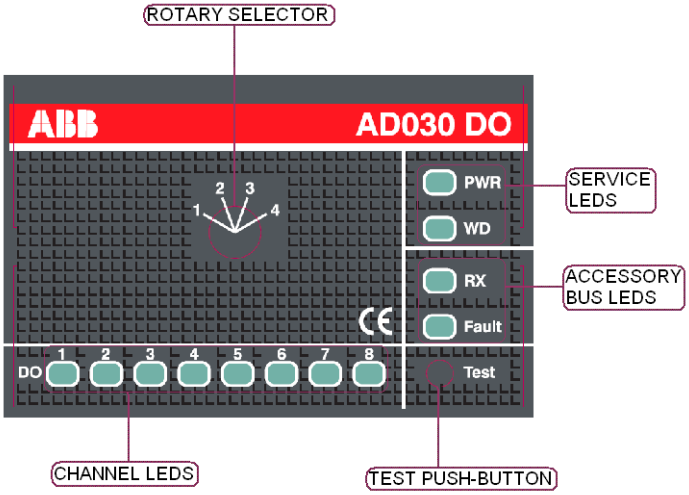

Figure 4. Front label of AD030 DO

3.2.2. Push-button

Push-button	Description
Test	• Pressed for at least 1 second (but less than 5 seconds): resets the output signals and the correspondent LEDS (see Note) • Pressed for at least 5 seconds: starts the self-test procedure • Pressed during start-up: puts the device into programmig mode

Table 7. Accessory Devices push-button

Note: Accessory Devices will keep the signalling of the last trip event if the trip unit is not reset.

3.2.3. LEDs meaning

After performing a test at start-up (see section 8.1.1.), the 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

Function	LED	Status	Meaning
Accessory bus	RX	ON (Yellow)	The device receives a correct Modbus telegram
		OFF	No data reception
	Fault	ON/Blink (Red)	Special condition / malfunction
		OFF	No special condition / malfunction
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 8. Accessory Devices LEDs meaning

3.2.3.1 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 highest priority (lowest number) will be signalled first.

Fault LED	Signalling	Priority	Description
Fixed ON	Bus fault	3	The device has been configured but is not receiving telegrams by MM030
Pattern 1	Unconfigured	2	Device not yet configured by MM030
Pattern 2	Rotary switch moved	4	The device has been configured by MM030 but the rotary switch position has been moved. MM030 needs to be re-configured for considering the new rotary switch position, or the original rotary switch position needs to be restored.
Pattern 3	Rotary switch malfunction	5	The rotary switch position can't be defined clearly
Pattern 7	Malfunction	1	Device is detecting a malfunction: • Power supply votage too low or too high • Internal malfunction

Table 9. Accessory Devices Fault LED meaning

Pattern x indicates that the LED periodically:

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

See Figure 3. for an example.

3.2.3.2 Channel LEDs

Each input/output channel has its own LED to signal its status.

See device description for details.

3.2.4. Rotary selector

The rotary selector placed, if present, is used to determine the input/output profile, i.e. the set of information it exchanges with MM030 (see section 5).

3.3. AD030 DO

3.3.1. Front view

The front panel of the AD030 DO unit consists of:

- 1 push-button
- 2 service LEDs
- 2 accessory bus LEDs
- 8 channel LEDs
- 1 rotary selector
- 2 terminal boxes

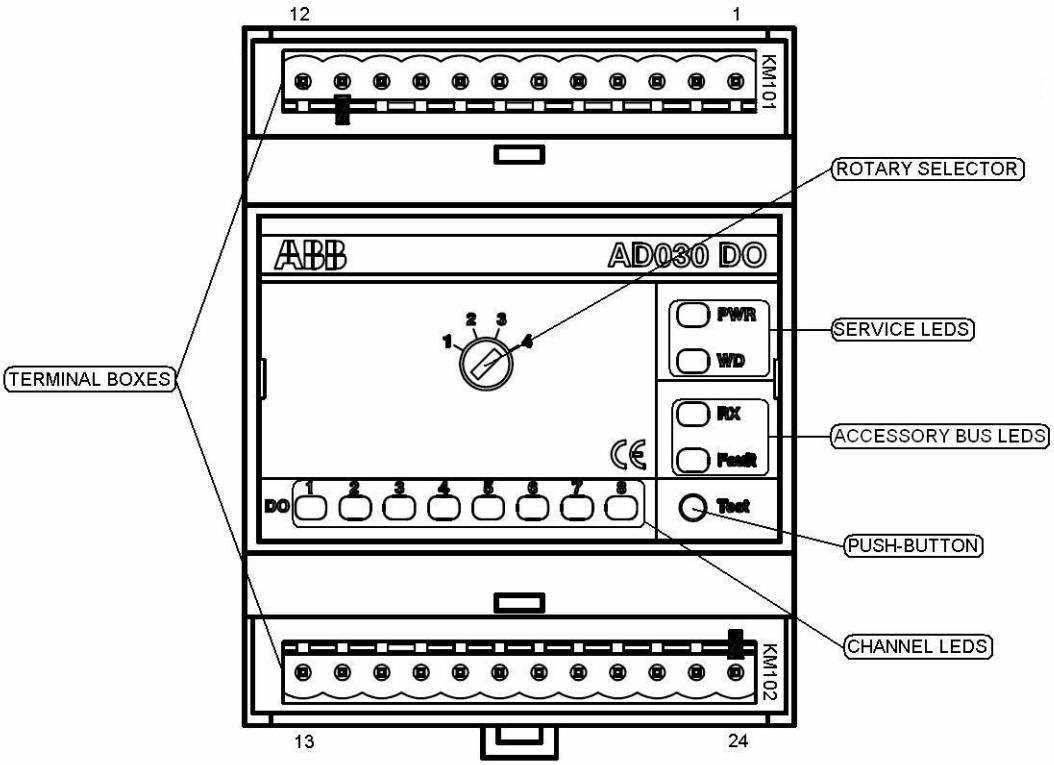

Figure 5. AD030 DO front view

3.3.2. Push-button

See section 3.2.2.

3.3.3. LEDs meaning

See section 3.2.3.

3.3.3.1 Fault LED

See section 3.2.3.1.

3.3.3.2 Channel LEDs

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 10. AD030 DO channel LEDs meaning

3.3.4. Rotary selector

See section 3.2.4.

3.3.5. Terminal boxes

The AD030 DO unit has two terminal boxes (KM101 and KM102 in Figure 5.)

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 11. AD030 DO terminal box KM101

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	RS485 Accessory bus
24	BUSI-B	RS485 Accessory bus

Table 12. AD030 DO terminal box KM102

3.4. AD030 AO unit

3.4.1. Front view

The front panel of the AD030 AO unit consists of:

- 1 push-button
- 2 service LEDs
- 2 accessory bus LEDs
- 4 channel LEDs
- 1 rotary selector
- 2 terminal boxes

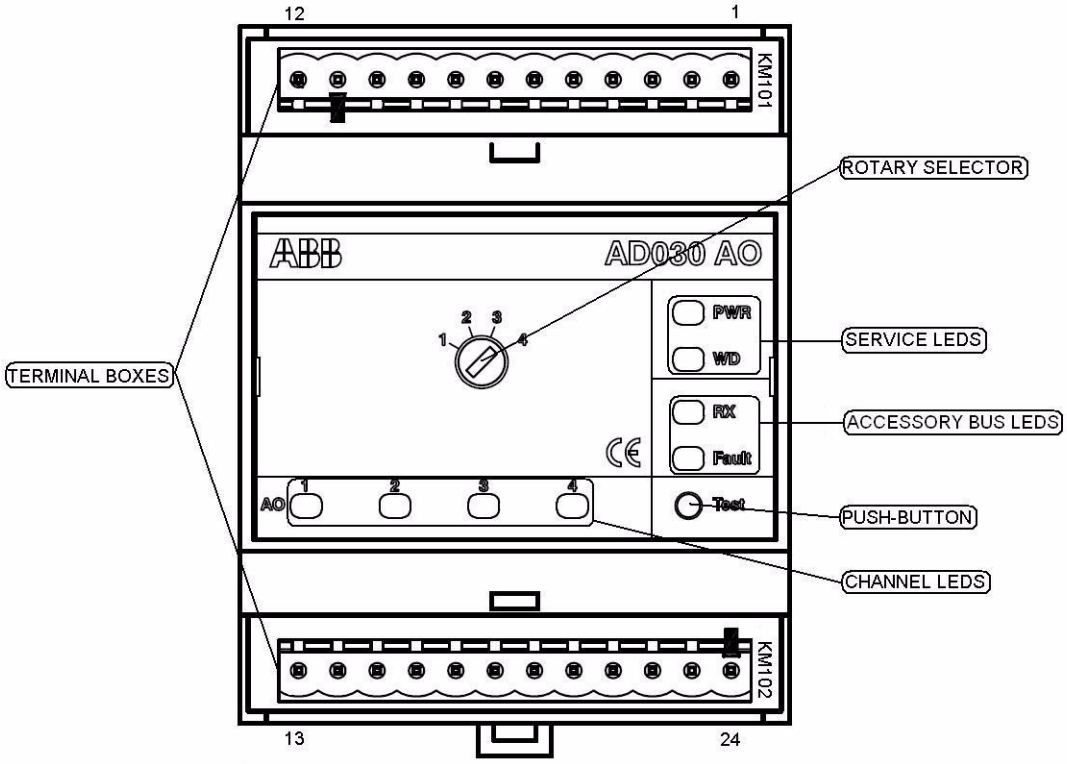

Figure 6. AD030 AO front view

3.4.2. Push-button

See section 3.2.2.

3.4.3. LEDs meaning

See section 3.2.3.

3.4.3.1 Fault LED

See section 3.2.3.1.

3.4.3.2 Channel LEDs

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

A lower bound (LB) value and an upper bound (UB) value are defined for each channel. LB and UB values depend on the application scenario the AD030 AO unit is performing (see section 5).

However, the range of the output current is 4 ... 20mA by default.

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 13. AD030 AO channel LEDs meaning

Pattern x is one of those specified for Fault LED of Accessory Devices in Table 9.

3.4.4. Rotary selector

See section 3.2.4.

3.4.5. Terminal boxes

The AD030 AO unit has two terminal boxes (KM101 and KM102 in Figure 6.)

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 14. AD030 AO terminal box KM101

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	RS485 Accessory bus
24	BUSI-B	RS485 Accessory bus

Table 15. AD030 AO terminal box KM102

3.5. AD030 MI unit

3.5.1. Front view

The front panel of the AD030 AO unit consists of:

- 1 push-button
- 2 service LEDs
- 2 accessory bus LEDs
- 4 channel LEDs
- 2 terminal boxes

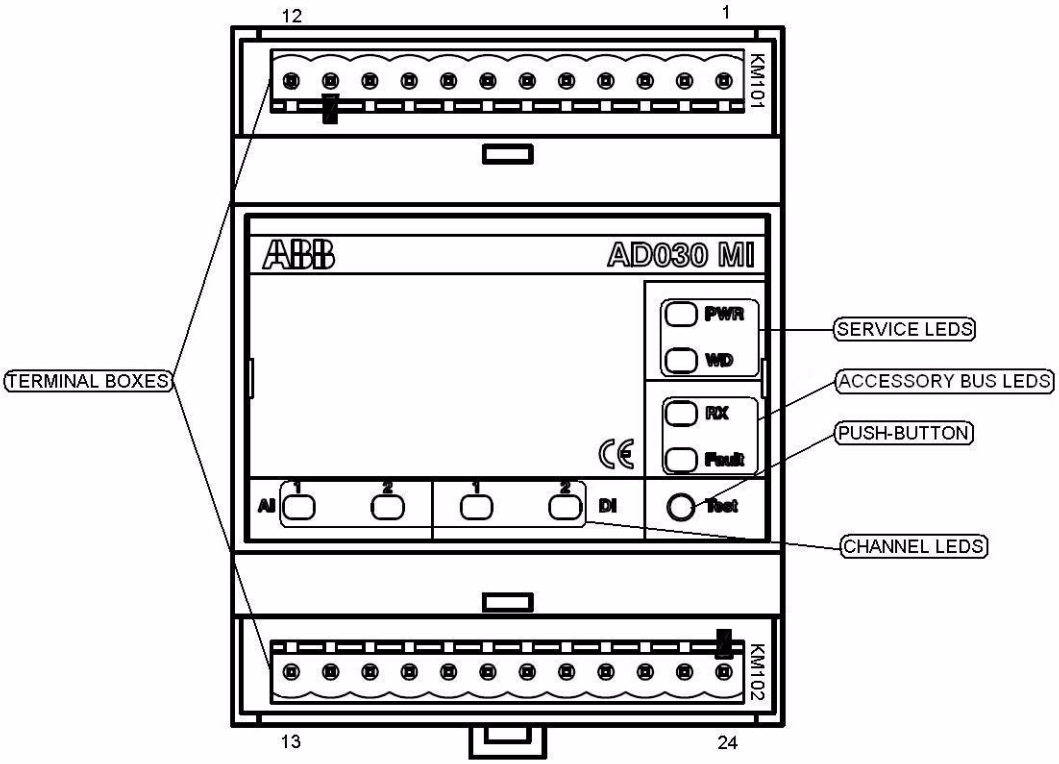

Figure 7. AD030 MI front view

3.5.2. Push-button

See section 3.2.2.

3.5.3. LEDs meaning

See section 3.2.3.

3.5.3.1 Fault LED

See section 3.2.3.1.

3.5.3.2 Channel LEDs

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

For the DI channels, the LED points out if a low or high voltage input value 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 16. AD030 MI digital input channel LEDs meaning

AI default range is 4 ... 20mA.

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

Table 17. AD030 MI analog input channel LEDs meaning

Pattern 2 is the same specified for Fault LED of Accessory Devices in Table 9.

An histeresys has been performed in coincidence with 4mA and 20mA value, in order to avoid unwanted changing of the LED status produced by additional noise. The actual behavior is shown in Figure 8.

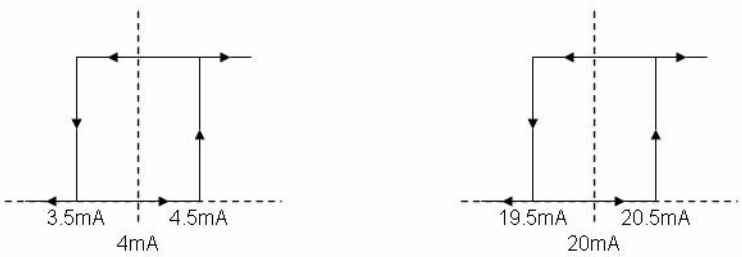

Figure 8. Histeresys on 4mA and 20mA AI value

3.5.4. Terminal boxes

The AD030 MI unit has two terminal boxes (KM101 and KM102 in Figure 7.)

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 18. AD030 MI terminal box KM101

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	RS485 Accessory bus
24	BUSI-B	RS485 Accessory bus

Table 19. AD030 MI terminal box KM102

4 INSTALLATION

4.1. Installation instructions

MM030 and Flex Interfaces are mounted on standard 35 mm guide (DIN EN50022 type TS 35 x 15 mm), see 9.2. Figure 15.

Mount the MM030 unit in the electrical panel near the circuit breaker, then the Flex Interfaces near the MM030 unit.

Check that the units are correctly mounted on DIN rail.

Make connections as indicated in section 4.2. and section 11.

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

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

4.2. Connections

Carefully consider the relevant electrical diagram (par. 11) 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.

In MM030, the shield of the connecting cable for Local bus must be connected to earth in proximity of the trip unit, in case of PR121/P, PR331/P, PR122/P, PR332/P, PR123/P and PR333/P.

This is not necessary for PR222DS/PD, PR223EF and PR223DS.

5 APPLICATION SCENARIOS

An application scenario shows, for a given trip unit connected, which Flex Interfaces (type and rotary selector position) can be connected on the accessory bus. Furthermore, the set of information that will be exchanged among the devices is stated.

The following table sums up all the possible application scenarios. Further details are given in the next sections.

Flex Interfaces	rotary selector position	PR121/P PR331/P	PR122/P PR123/P PR332/P PR333/P	PR222DS/ PD	PR223EF	PR223DS
AD030 DO	1	yes	yes	yes	yes	yes
	2	yes	yes	yes	yes	yes
	3	yes	yes	yes	yes	yes
	4	yes	yes	-	yes	yes
AD030 AO	1	yes	yes	yes	yes	yes
	2	-	yes	-	yes	yes
	3	-	yes	-	-	yes
	4	-	yes	-	-	-
AD030 MI	fixed	yes	yes	-	-	-
HMI030	A	yes	yes	yes	yes	yes
	V	-	yes	-	yes	yes
	W	-	yes	-	-	yes
	A,V,W,...	yes	yes	yes	yes	yes

Table 20. Application scenarios: summary table

A dash (-) indicates a not allowed association.

Note: It is not allowed to have two or more Flex Interfaces of the same type with the same rotary selector position connected on the accessory bus.

5.1. Scenario with PR121/P and PR331/P

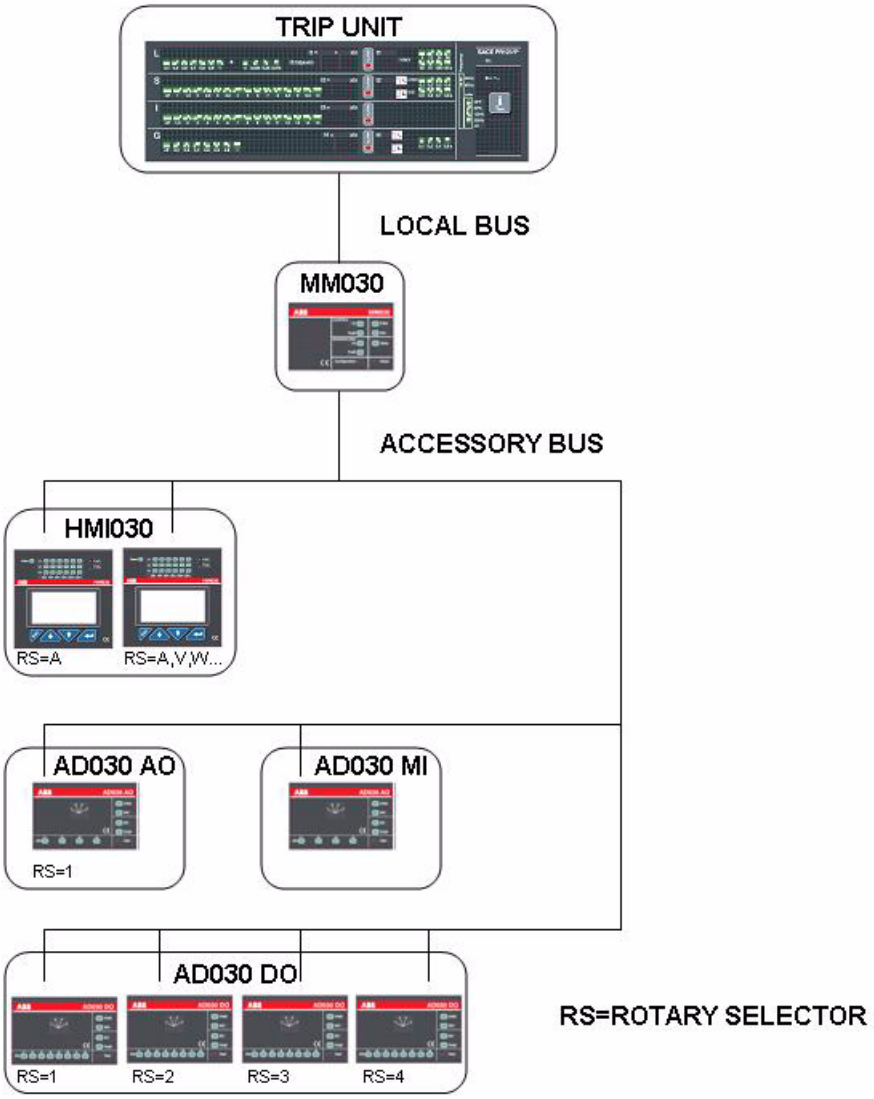

Figure 9. PR121/P and PR331/P application scenario

See section 11.1., section 11.2., section 11.4., section 11.5. circuit diagrams for connection instructions.

5.1.1. AD030 DO output profile

Up to 4 AD030 DO (rotary selector = 1, 2, 3, and 4) can be connected for signalling trip unit events.

Depending on the rotary selector position, AD030 DO will output the following information coming from the trip unit:

AD030 DO output profile with PR121/P				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	Any Alarm	Set by user
2	S Timing / Trip	S Timing	S/C Trip	Set by user
3	I Trip	Hardware Alarm	Hardware Alarm	Set by user
4	G Timing / Trip / G Alarm (blocked trip)	G Timing / G Alarm (blocked trip)	RTCC	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	L pre-alarm	L pre-alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Trip command fail (backup protection)	Trip command fail (backup protection)	Set by user

Table 21. Trip units events signalled by AD030 DO with PR121/P

AD030 DO output profile with PR331/P				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	Any Alarm	Set by user
2	S Timing / Trip	S Timing	S/C Trip	Set by user
3	I Trip	Hardware Alarm	Hardware Alarm	Set by user
4	G Timing / Trip / G Alarm (blocked trip)	G Timing / G Alarm (blocked trip)	G Timing	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	L pre-alarm	L pre-alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Trip command fail (backup protection)	Trip command fail (backup protection)	Set by user

Table 22. Trip units events signalled by AD030 DO with PR331/P

By default, DO 5 output channel is used to signal a bus malfuction condition; moreover, the relevant LED lights if bus stays inactive for more than 5 seconds.

Hardware Alarm with PR121/P and PR331/P		
1	Sensor Error on Phase 1	OR
2	Sensor Error on Phase 2	
3	Sensor Error on Phase 3	
4	Sensor Error on Neutral	
5	TC Error	
6	Rating Plug Error	
7	Key Plug Error	
8	Internal Error	

Table 23. Hardware Alarm signals for AD030 DO with PR121/P and PR331/P

S/C Trip - Short Circuit Trip with PR121/P		
1	S Trip	OR
2	I Trip	
3	Iinst Trip	

Table 24. S/C Trip signals for AD030 DO with PR121/P

RTCC - Ready To Close Contact with PR121/P		
1	No Alarm / Timing / Warning	AND
2	No Trip	
3	CB Open	
4	No Sensor Error on Phase 1	
5	No Sensor Error on Phase 2	
6	No Sensor Error on Phase 3	
7	No Sensor Error on Neutral	
8	No TC Error	
9	No Rating Plug Error	
10	No Key Plug Error	
11	No Internal Error	
12	No configuration Error	
13	No CB Status Error	
14	Spring Charged	

Table 25. RTCC signals for AD030 DO with PR121/P

Note: If an Undervoltage Release (UVR) is present, it is possible to complete the Ready To Close Contact by connecting the “contact for signalling undervoltage release de-energized” (the normally open one) in series with RTCC.

S/C Trip - Short Circuit Trip with PR331/P		
1	S Trip	OR
2	I Trip	
3	Iinst Trip	
4	MCR Trip	

Table 26. S/C Trip signals for AD030 DO with PR331/P

5.1.1.1 User-defined signalling

AD030 DO with rotary selector = 4 allows the user to select which trip unit events to output for every DO channel.

This is achieved by properly configuring the trip unit via SD-Pocket, SD-Testbus or PR010/T.

Every DO channel can be associated to one of the following trip unit events:

- None
- L pre-alarm
- L Timing
- S Timing
- L Trip
- G Trip
- S Trip
- I Trip
- Any Trip

- Any Alarm
- Custom

The last option allows to select more events and eventually combine them with and/or logic operations.

See the relevant trip unit user's manual for details.

5.1.2. AD030 AO and HMI030 output profile

PR121/P and PR331/P trip units perform current measuring function (ammeter), indeed one AD030 AO (rotary selector = 1) and two HMI030 (rotary selector = A and A,V,W,...) can be connected for showing currents.

The other rotary selector positions are not managed.

AD030 AO output profile with PR121/P and PR331/P				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	Current phase 1	Not managed	Not managed	Not managed
2	Current phase 2	Not managed	Not managed	Not managed
3	Current phase 3	Not managed	Not managed	Not managed
4	Current neutral	Not managed	Not managed	Not managed

Table 27. Trip unit measures signalled by AD030 AO with PR121/P and PR331/P

AD030 AO lower and upper bound values				
	Rotary selector 1	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
LB	0 A	-	-	-
UB	In (trip unit nominal current)	-	-	-

HMI030 output profile with PR121/P and PR331/P			
Rotary selector A	**Rotary selector V**	**Rotary selector W**	**Rotary selector A,V,W,...**
Currents	Not managed	Not managed	Currents Last trip information

Table 28. Trip unit measures showed by HMI030 with PR121/P and PR331/P

For detailed information about the measures shown by the HMI030 unit, please refer to the relevant user's manual.

5.1.3. AD030 MI input profile

An AD030 MI can be connected for acquiring external analog/digital signals that will be propagated to the trip unit.

The following table shows how each input channel can be used by the trip unit

AD030 MI input profile with PR121/P and PR331/P	
MI	**Trip unit behavior**
DI 1	Signals the status of the digital input
DI 2	Not supported
AI 1	Allows to define a threshold and signals if the analog input is under or over the threshold. In the latter case, generates an alarm condition.
AI 2	Not supported

Table 29. PR121/P and PR331/P behavior with AD030 MI

5.2. Scenario with PR122/P, PR123/P, PR332/P and PR333/P

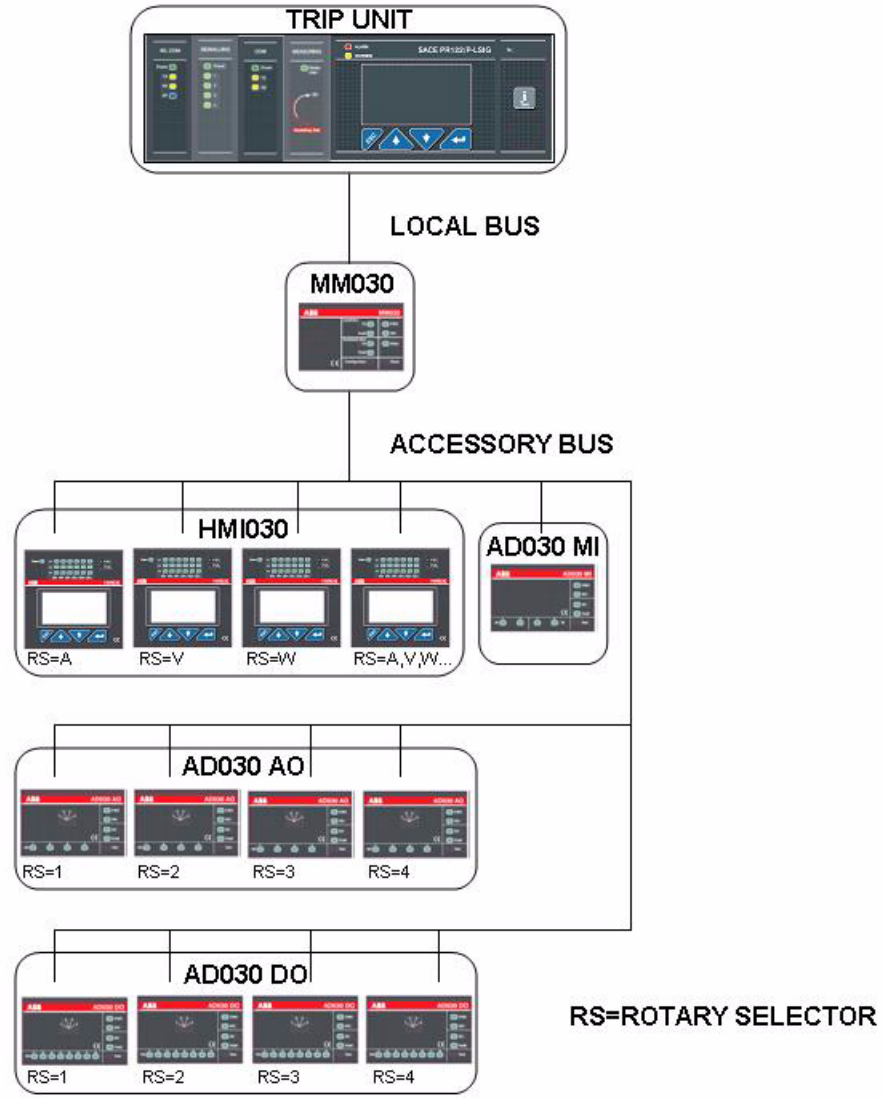

Figure 10. PR122/P, PR123/P, PR332/P and PR333/P application scenario

See section 11.1., section 11.2., section 11.3., section 11.4., section 11.5. circuit diagrams for connection instructions.

5.2.1. AD030 DO output profile

Up to 4 AD030 DO (rotary selector = 1, 2, 3, and 4) can be connected for signalling trip unit events.

Depending on the rotary selector position, AD030 DO will output the following information coming from the trip unit:

AD030 DO output profile with PR122/P and PR123/P				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	Any Alarm	Set by user
2	S Timing / Trip	S Timing	RTCC	Set by user
3	I Trip	Hardware Alarm	T Pre-Alarm	Set by user
4	G Timing / Trip / G Alarm (blocked trip)	Load LC1	UV Timing / UV Alarm (blocked trip)	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	Load LC2	L pre-alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Iw Warning	F out of range	Set by user

Table 30. Trip units events signalled by AD030 DO with PR122/P and PR123/P

AD030 DO output profile with PR332/P and PR333/P				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	Any Alarm	Set by user
2	S Timing / Trip	S Timing	S/C Trip	Set by user
3	I Trip	Hardware Alarm	T Pre-Alarm	Set by user
4	G Timing / Trip / G Alarm (blocked trip)	Load LC1	UV Timing / UV Alarm (blocked trip)	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	Load LC2	L pre-alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Iw Warning	F out of range	Set by user

Table 31. Trip units events signalled by AD030 DO with PR332/P and PR333/P

By default, DO 5 output channel is used to signal a bus malfuction condition; moreover, the relevant LED lights if bus stays inactive for more than 5 seconds.

Hardware Alarm with PR122/P, PR123/P and PR332/P, PR333/P		
1	Sensor Error on Phase 1	OR
2	Sensor Error on Phase 2	
3	Sensor Error on Phase 3	
4	Sensor Error on Neutral	
5	Sensor Error on External Toroid	
6	TC Error	
7	Rating Plug Error	
8	Key Plug Error	
9	Internal Error	

Table 32. Hardware Alarm signals for AD030 DO with PR122/P, PR123/P and PR332/P, PR333/P

RTCC - Ready To Close Contact with PR122/P, PR123/P		
1	No Alarm / Timing / Warning	AND
2	No Trip	
3	CB Open	
4	No Sensor Error on Phase 1	
5	No Sensor Error on Phase 2	
6	No Sensor Error on Phase 3	
7	No Sensor Error on Neutral	
8	No Sensor Error on External Toroid	
9	No TC Error	
10	No Rating Plug Error	
11	No Key Plug Error	
12	No Internal Error	
13	No configuration Error	
14	No CB Status Error	
15	CB Connected	
16	Spring Charged	

Table 33. RTCC signals for AD030 DO with PR122/P, PR123/P

Note: If an Undervoltage Release (UVR) is present, it is possible to complete the Ready To Close Contact by connecting the “contact for signalling undervoltage release deenergized” (the normally open one) in series with RTCC.

S/C Trip - Short Circuit Trip with PR332/P, PR333/P		
1	S Trip	OR
2	I Trip	
3	Iinst Trip	
4	MCR Trip	
5	D Trip (for PR333 only)	
6	S2 Trip (for PR333 only)	

Table 34. S/C Trip signals for AD030 DO with PR332/P, PR333/P

F out of range with PR122/P, PR123/P and PR332/P, PR333/P		
1	UF Alarm (blocked trip)	OR
2	OF Alarm (blocked trip)	
3	UF Timing	
4	OF Timing	

Table 35. F out of range signals for AD030 DO with PR122/P, Pr123/P and PR332/P, PR333/P

5.2.1.1 User-defined signalling

AD030 DO with rotary selector = 4 allows the user to select which trip unit events to output for every DO channel.

This is achieved by properly configuring the trip unit via its local display, SD-Pocket, SD-Testbus or PR010/T.

Figure 11. describes the procedure for setting up the user-defined signalling using the trip unit local display. First of all the ‘Settings --> Modules --> Local Bus Unit --> Presence’ should be set to ‘Present’. This will also allow the trip unit to signal a warning condition in case the communication between trip unit and MM030 is interrupted.

Then every DO channel can be associated to one of the following trip unit events:

- None
- L pre-alarm
- L Timing

- S Timing
- L Trip
- G Trip
- S Trip
- I Trip
- Any Trip
- Any Alarm
- Load LC1
- Load LC2
- Custom

The last option is available only if using SD-Pocket, SD-Testbus or PR010/T, it allows to select more events and eventually combine them with and/or logic operations.

See the relevant trip unit user's manual for details.

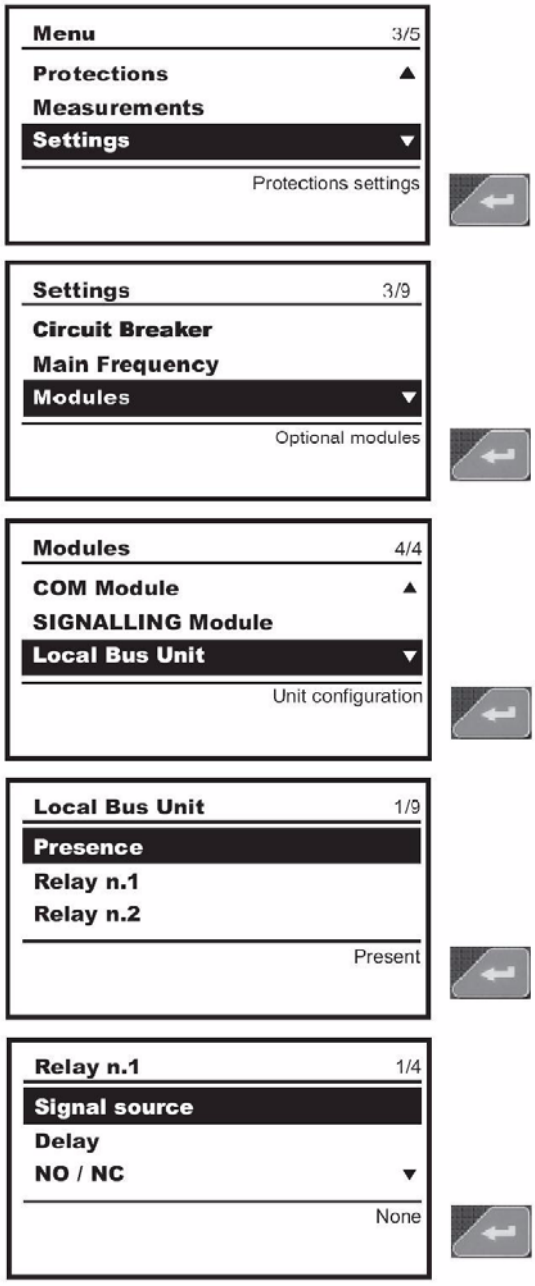

Figure 11. Trip unit local display menu for setting user-defined signalling

5.2.2. AD030 AO and HMI030 output profile

The PR122/P, PR123/P, PR332/P and PR333/P trip units perform current measuring function (ammeter). Besides, when the PR120/V or the PR330/V module are connected (optional for PR122/P and PR332/P respectively) additional measurements are available (voltages, powers, energies and more; see the relevant trip unit user's manual for details).

Indeed, up to 4 AD030 AO (rotary selector = 1, 2, 3, and 4) and up to 4 HMI030 (rotary selector = A, V, W, and A,V,W...) can be connected for showing/signalling measures.

AD030 AO output profile with PR122/P, PR123/P, PR332/P and PR333/P				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	Current phase 1	U12	Total active power	Total active energy

AD030 AO output profile with PR122/P, PR123/P, PR332/P and PR333/P				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
2	Current phase 2	U23	Total reactive power	Total reactive energy
3	Current phase 3	U31	Total apparent power	Total apparent energy
4	Current neutral	U1n	Power factor	Network frequency

AD030 AO lower and upper bound values					
	AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
LB	1	0 A	0 V	- In x Un x 10^{-3} (kW)	- In x Un x 24h x 10^{-3} (kWh)
	2			- In x Un x 10^{-3} (kVAR)	- In x Un x 24h x 10^{-3} (kVARh)
	3			- In x Un x 10^{-3} (kVA)	- In x Un x 24h x 10^{-3} (kVAh)
	4			- 1	0 Hz
UB	1	In (trip unit nominal current)	Un (trip unit nominal voltage)	In x Un x 10^{-3} (kW)	In x Un x 24h x 10^{-3} (kWh)
	2			In x Un x 10^{-3} (kVAR)	In x Un x 24h x 10^{-3} (kVARh)
	3			In x Un x 10^{-3} (kVA)	In x Un x 24h x 10^{-3} (kVAh)
	4			1	66 Hz

Table 36. Trip unit measures signalled by AD030 AO with PR122/P, PR123/P, PR332/P and PR333/P

HMI030 output profile with PR122/P, PR123/P, PR332/P and PR333/P			
Rotary selector A	**Rotary selector V**	**Rotary selector W**	**Rotary selector A,V,W,...**
Currents	Voltages	Powers	Currents Voltages Powers Energies Power factor Frequency Peak factors Last trip information

Table 37. Trip unit measures showed by HMI030 with PR122/P, PR123/P, PR332/P and PR333/P

For detailed information about the measures shown by the HMI030 unit, please refer to the relevant user's manual.

5.2.3. AD030 MI input profile

An AD030 MI can be connected for acquiring external analog/digital signals that will be propagated to the trip unit. The following table shows how each input channel can be used by the trip unit

AD030 MI input profile with PR122/P, PR123/P, PR332/P and PR333/P	
MI	**Trip unit behavior**
DI 1	Signals the status of the digital input
DI 2	Not supported
AI 1	Allows to define a threshold and signals if the analog input is under or over the threshold. In the latter case, generates an alarm condition.
AI 2	Not supported

Table 38. PR122/P, PR123/P, PR332/P and PR333/P behavior with AD030 MI

5.3. Scenario with PR222DS/PD

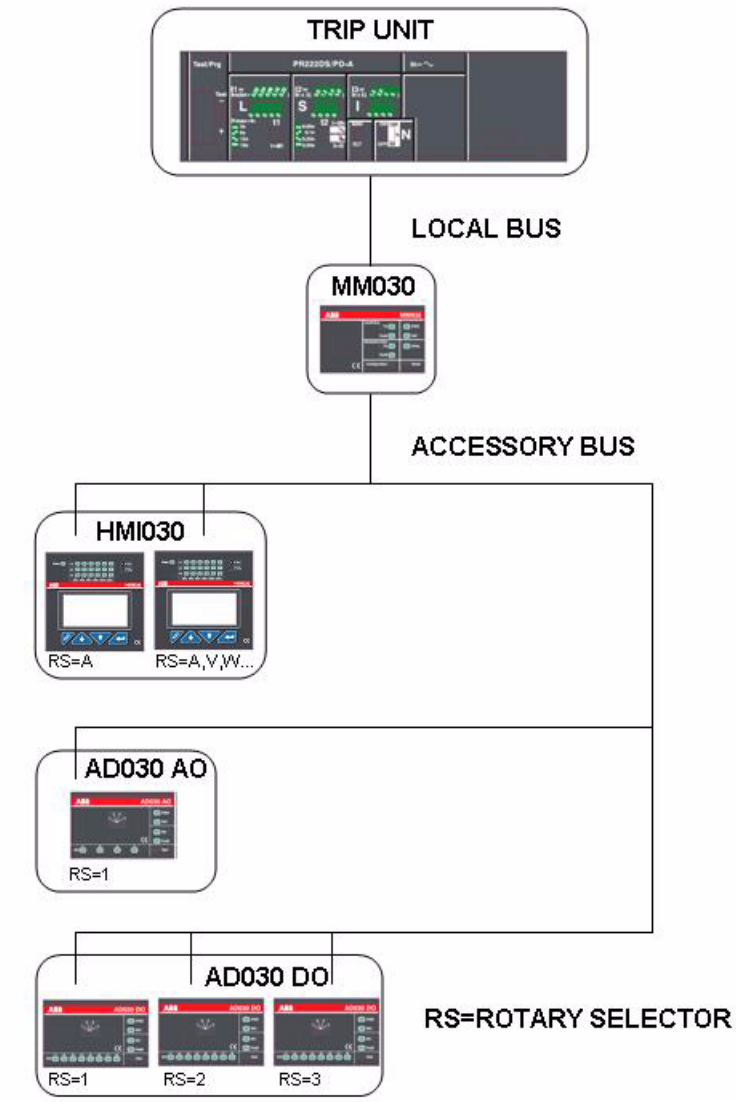

Figure 12. PR222DS/PD application scenario

See section 11.1., section 11.2., section 11.4., section 11.6. circuit diagrams to realize proper connections.

5.3.1. AD030 DO output profile

Up to 3 AD030 DO (rotary selector = 1, 2, and 3) can be connected for signalling trip unit events.

Depending on the rotary selector position, AD030 DO will output the following information coming from the trip unit:

AD030 DO output profile with PR222DS/PD				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	L Trip	Not managed
2	S Timing / Trip	S Timing	S Trip	Not managed
3	I Trip	Any Alarm	I Trip	Not managed
4	G Timing / Trip	G Timing	G Trip	Not managed
5	Bus KO	Bus KO	Bus KO	Not managed
6	L pre-alarm	L pre-alarm	Any Alarm	Not managed
7	Any Trip	Any Trip	Any Trip	Not managed
8	Trip command fail (backup protection)	Trip command fail (backup protection)	Trip command fail (backup protection)	Not managed

Table 39. Trip units events signalled by AD030 DO with PR222DS/PD

AD030 DO with rotary selector position = 4 is not managed.

By default, DO 5 output channel is used to signal a bus malfuction condition; moreover, the relevant LED lights if bus stays inactive for more than 5 seconds.

5.3.2. AD030 AO and HMI030 output profile

The PR222DS/PD trip unit performs current measuring function (ammeter), indeed one AD030 AO (rotary selector = 1) and two HMI030 (rotary selector = A and A,V,W,...) can be connected for showing currents.

The other rotary selector positions are not managed.

AD030 AO output profile with PR222DS/PD				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	Current phase 1	Not managed	Not managed	Not managed
2	Current phase 2	Not managed	Not managed	Not managed
3	Current phase 3	Not managed	Not managed	Not managed
4	Current neutral	Not managed	Not managed	Not managed

AD030 AO lower and upper bound values				
	Rotary selector 1	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
LB	0 A	-	-	-
UB	In (trip unit nominal current)	-	-	-

Table 40. Trip unit measures signalled by AD030 AO with PR222DS/PD

HMI030 unit with PR222DS/PD			
Rotary selector A	**Rotary selector V**	**Rotary selector W**	**Rotary selector A,V,W,...**
Currents	Not managed	Not managed	Currents Last trip information

Table 41. Trip unit measerues showed by HMI030 with PR222DS/PD

For detailed information about the measures shown by the HMI030 unit, please refer to the relevant user's manual.

5.3.3. AD030 MI input profile

AD030 MI is not managed.

5.4. Scenario with PR223EF

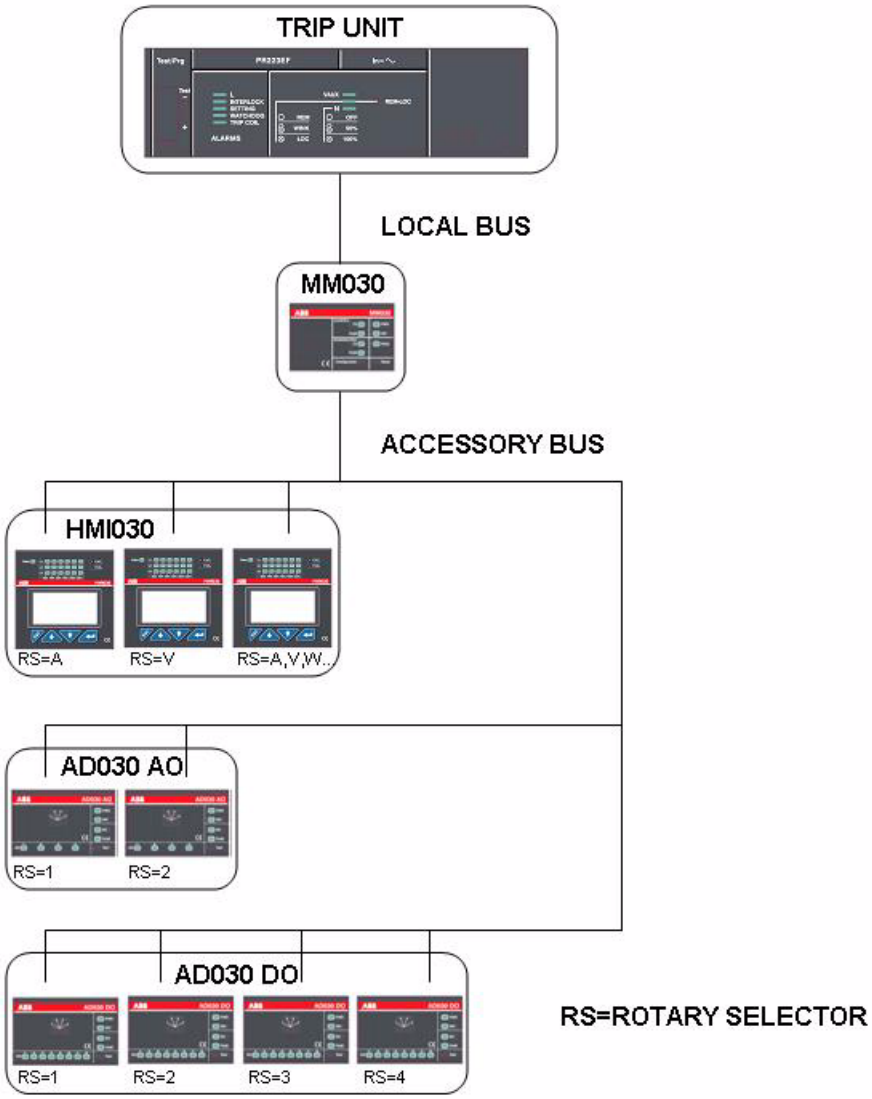

Figure 13. PR223EF application scenario

See section 11.1., section 11.2., section 11.4., section 11.6. circuit diagrams to realize proper connections.

5.4.1. AD030 DO output profile

Up to 4 AD030 DO (rotary selector = 1, 2, 3, and 4) can be connected for signalling trip unit events.

Depending on the rotary selector position, AD030 DO will output the following information coming from the trip unit:

AD030 DO output profile with PR223EF				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / Trip	L Timing	L Trip	Set by user
2	S Timing/ Trip	S Timing	S Trip	Set by user
3	I Trip / EF Trip	Interlock Alarm	I Trip	Set by user
4	G Timing / Trip	G Timing	G Trip	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	L pre-alarm	Any Alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Trip command fail (backup protection)	Trip command fail (backup protection)	Set by user

Table 42. Trip units events signalled by AD030 DO with PR223EF

By default, DO 5 output channel is used to signal a bus malfuction condition; moreover, the relevant LED lights if bus stays inactive for more than 5 seconds.

5.4.1.1 User-defined signalling

AD030 DO with rotary selector = 4 allows the user to select which trip unit events to output for every DO channel.

This is achieved by properly configuring the trip unit via SD-Pocker, Sd-Testbus or PR010/T.

Every DO channel can be associated to one of the following trip unit events:

- None
- Parameters changed
- Test unit connected
- Test unit not connected
- CB Tripped
- CB Closed
- CB Open
- CB status undefined
- CB status defined
- Trip command fail
- Local operating mode
- Remote operating mode
- Any alarm
- L pre-alarm
- L Timing
- S Timing
- G Timing
- EF Alarm
- EF Interlocked
- S Interlocked
- G Interlocked
- Interlocking fault uplink
- Interlocking fault downlink
- SOS requested
- Trip Coil Alarm
- MOE-E Over Temperature Alarm
- Frequency Alarm
- Any Trip

- L Tripped
- S Tripped
- I Tripped
- Iinst Tripped
- G Tripped
- EF Tripped
- SOS Trip
- Trip reset event
- Vaux present
- Vaux absent
- MOE-E present
- MOE-E absent
- Clock failure

See the relevant trip unit user's manual for details.

5.4.2. AD030 AO and HMI030 output profile

The PR223EF trip unit performs current measuring function (ammeter). Besides, when the VM210 module is connected additional measurements are available (voltages and more; see the relevant trip unit user's manual for details).

Indeed, up to 2 AD030 AO (rotary selector = 1 and 2) and up to 3 HMI030 (rotary selector = A, V, and A,V,W...) can be connected for showing/signalling measures.

AD030 AO output profile with PR223EF				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	Current phase 1	U12	Not managed	Not managed
2	Current phase 2	U23	Not managed	Not managed
3	Current phase 3	U31	Not managed	Not managed
4	Current neutral	U1n	Not managed	Not managed

AD030 AO lower and upper bound values				
	Rotary selector 1	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
LB	0 A	0 V	-	-
UB	In (trip unit nominal current)	Un (trip unit nominal voltage)	-	-

Table 43. Trip unit measures signalled by AD030 AO with PR223EF

HMI030 output profile with PR223EF			
Rotary selector A	**Rotary selector V**	**Rotary selector W**	**Rotary selector A,V,W,...**
Currents	Voltages	Not managed	Currents Voltages Power factor Frequency Peak factors Last trip information

Table 44. Trip unit measures showed by HMI030 with PR223EF

For detailed information about the measures shown by the HMI030 unit, please refer to the relevant user's manual.

5.4.3. AD030 MI input profile

AD030 MI is not managed.

5.5. Scenario with PR223DS

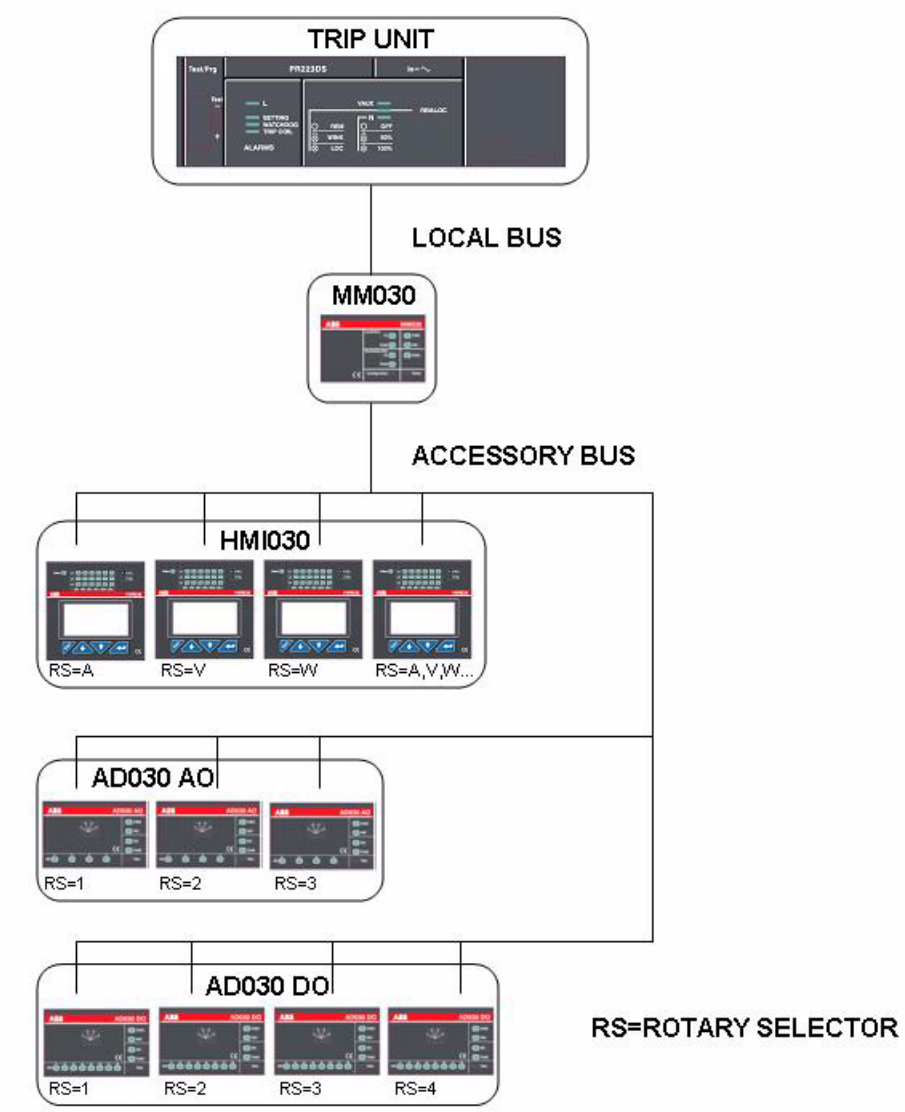

Figure 14. PR223DS application scenario

See section 11.1., section 11.2., section 11.4., section 11.6. circuit diagrams to realize proper connections.

5.5.1. AD030 DO output profile

Up to 4 AD030 DO (rotary selector = 1, 2, 3, and 4) can be connected for signalling trip unit events.

Depending on the rotary selector position, AD030 DO will output the following information coming from the trip unit:

AD030 DO output profile with PR223DS				
DO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	L Timing / TripTrip	L Timing	L Trip	Set by user
2	S Timing/ Trip	S Timing	S Trip	Set by user
3	I Trip	L pre-alarm	I Trip	Set by user
4	G Timing / Trip	G Timing	G Trip	Set by user
5	Bus KO	Bus KO	Bus KO	Bus KO
6	L pre-alarm	Any Alarm	Any Alarm	Set by user
7	Any Trip	Any Trip	Any Trip	Set by user
8	Trip command fail (backup protection)	Trip command fail (backup protection)	Trip command fail (backup protection)	Set by user

Table 45. Trip units events signalled by AD030 DO with PR223DS

By default, DO 5 output channel is used to signal a bus malfuction condition; moreover, the relevant LED lights if bus stays inactive for more than 5 seconds.

5.5.1.1 User-defined signalling

AD030 DO with rotary selector = 4 allows the user to select which trip unit events to output for every DO channel.

This is achieved by properly configuring the trip unit via SD-Pocker, Sd-Testbus or PR010/T.

Every DO channel can be associated to one of the following trip unit events:

- None
- Parameters changed
- Test unit connected
- Test unit not connected
- CB Tripped
- CB Closed
- CB Open
- CB status undefined
- CB status defined
- Trip command fail
- Local operating mode
- Remote operating mode
- Any alarm
- L pre-alarm
- L Timing
- S Timing
- G Timing
- Trip Coil Alarm
- MOE-E Over Temperature Alarm
- Frequency Alarm
- Any Trip
- L Tripped
- S Tripped
- I Tripped
- Iinst Tripped
- G Tripped
- Trip reset event
- Vaux present

- Vaux absent
- MOE-E present
- MOE-E absent
- Clock failure

See the relevant trip unit user's manual for details.

5.5.2. AD030 AO and HMI030 output profile

The PR223DS trip unit performs a current measuring function (ammeter).

When the optional VM210 module is connected additional measurements are available (voltages, powers, energies and more; see the relevant trip unit user's manual for details).

Up to 4 HMI030 (rotary selector = 'A', 'V', 'W', and 'A,V,W...') and up to 3 AD030 AO (rotary selector = 1, 2 and 3) can be connected for showing/signalling measures.

AD030 AO output profile with PR223DS				
AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
1	Current phase 1	U12	Total active power	Not managed
2	Current phase 2	U23	Total reactive power	Not managed
3	Current phase 3	U31	Total apparent power	Not managed
4	Current neutral	U1n	Power factor	Not managed

AD030 AO lower and upper bound values					
	AO	**Rotary selector 1**	**Rotary selector 2**	**Rotary selector 3**	**Rotary selector 4**
LB	1	0 A	0 V	- In x Un (kW)	-
	2			- In x Un (kVAR)	-
	3			- In x Un (kVA)	-
	4			- 1	-
UB	1	In (trip unit nominal current)	Un (trip unit nominal voltage)	In x Un x 10^{-3} (kW)	-
	2			In x Un x 10^{-3} (kVAR)	-
	3			In x Un x 10^{-3} (kVA)	-
	4			1	-

Table 46. Trip unit measures signalled by AD030 AO with PR223DS

HMI030 outout profile with PR223DS			
Rotary selector A	**Rotary selector V**	**Rotary selector W**	**Rotary selector W**
Currents	Voltages	Powers	Currents Voltages Powers Energies Power factor Frequency Peak factors Last trip information

Table 47. Trip unit measures showed by HMI030 with PR223DS

For detailed information about the measures shown by the HMI030 unit, please refer to the relevant user's manual.

5.5.3. AD030 MI input profile

AD030 MI is not managed.

6 CONFIGURATION

Configuration is the mandatory operation to perform for setting-up MM030 and Flex Interfaces system.

During the configuration procedure the MM030 executes the following actions:

- Scan the local and accessory buses
- Find and recognize the trip unit and Flex Interfaces connected
- Freeze the Flex Interfaces with their current rotary selector position
- Schedule data exchange activities
- Store the list of found devices in permanent memory
- Begin data exchange

Configuration is a procedure that involves both MM030 and Flex Interfaces.

6.1. Start a new configuration

After all devices are properly installed as explained in section 11, the auxiliary power supply can be provided.

If MM030 unit has never been configured before (or its configuration has been delete, see section 6.4.), it will signal the Unconfigured condition by lighting the Fault LEDs on the front panel as in Table 4.

If a previous configuration procedure is in execution, press the Reset push-button.

MM030 is able to detect the communication parameters (address, baud rate and similar) used by the devices connected on both buses. Therefore no special setting is requested by the user.

Press the MM030 'Configuration' push-button for at least 1 second.

Configuration procedure is now started.

During the configuration procedure the MM030 Fault LEDs keep on signalling the Unconfigured condition, but the local and accessory bus TX LEDs signal bus activity.

Note: During configuration a further pressure of the 'Configuration' push-button is ignored. If you need to re-start the configuration procedure press the 'Reset' push-button.

As soon as the configuration is started, the Flex Interfaces connected are unfreezed to reset the configuration parameters in use up to now. This is evident in AD030 XX unit, whose LEDS switch all on for 1 second, and in HMI030 units, whose displays turns off and then slowly turns on again.

It is possible that, at a certain point, one of the two MM030 TX LEDs stops blinking while the other keeps on signalling bus activity. This is due to the fact that the scan is over only for one bus, while is still proceeding on the other bus.

Note: The configuration procedure may last for minutes. The worst case occurs when there are no devices connected on Local bus: the MM030 will take about 5 minutes before finishing the procedure and signalling bus fault on both buses.

When the Configuration procedure is ended, the MM030 stops signalling the Unconfigured condition.

6.2. Outcomes of the configuration

Depending on the results of the bus scan, the configuration procedure may end with different outcomes.

It is possible to have an idea of what happened by firstly looking at the Fault LEDs in MM030.

The LEDs in the slave devices (trip unit or Flex Interfaces) can be analysed afterwards for finding out the exact devices that eventually generated a problem.

The following table sums up all the possible outcomes (see section 3.1.3. for details about the LEDs meaning).

Condition	MM030 Fault LED	Description
All devices OK	OFF	All devices connected on the given bus have been recognized. Data exchange activity is started. Here is a summary of the status of all LEDs for this condition: • PWR LED ON (Green) • WD LED OFF • Write LED OFF • TX LEDs blink (Yellow) • FAULT LEDs OFF
Bus fault	ON	MM030 was not able to find any device on the given bus. This can happen on: • only one bus • on both buses In both cases, normally no data exchange activity can be initiated and the TX LEDs are OFF.
Unknown device	Pattern 4	MM030 has found a device on the given bus, but this device is unknown. This can be due to: • Device ID not recognized • Device connected on the wrong bus (for example trip unit connected to Accessory bus and/or Flex Interfaces connected to Local bus) It is possible to detect which devices (trip unit and/or Flex Interfaces) generated the problems by: • Identifying the bus (looking at which MM030 Fault LED is blinking) • Identifying the devices, connected on that bus, that still signal the Unconfigured condition or that do not show bus activity If the device unknown is the trip unit , normally no data exchange activity can be initiated and the TX LEDs are OFF. If the device unknown is a Flex Interfaces, it is possible that the trip unit and other Flex Interfaces have been correctly recognized. In this case there can be data exchange and the TX LEDs signals bus activity.
Unmanaged device	Pattern 5	MM030 has found a device on the given bus, it has recognized it, but this device is unmanaged. This can be due to: • Device does not fit into one of the application scenarios described in section 5. • Device has a software version not managed • Device can't be associated with any other device for data exchange (for example: a trip unit has been found, but no Flex Interfaces have been found) • Device connected on the wrong bus (for example trip unit connected to Accessory bus and/or Flex Interfaces connected to Local bus) and/or bus wires inverted It is possible to detect which devices (trip unit and/or Flex Interfaces) generated the problems by: • Identifying the bus (looking at which MM030 Fault LED is blinking) • Identifying the devices, connected on that bus, that still signal the Unconfigured condition or that do not show bus activity If the device unmanaged is the trip unit , normally no data exchange activity can be initiated and the TX LEDs are OFF. If the device unmanaged is one or more Flex Interfaces, it is possible that the trip unit and other Flex Interfaces have been correctly recognized. In this case there can be data exchange and the TX LEDs signals bus activity.

Condition	MM030 Fault LED	Description
Possible device collision	Pattern 6	MM030 has found a possible device collision on the given bus. This can be due to: • Two or more Flex Interfaces with the same rotary selector position • Two or more trip units with the same slave address Note that also communication errors due to noise disturbs along the buses may generate this outcome. This is the case if one more HMI030 is set for not communication with MM030 ('MM030 = no')

Table 48. Outcomes after configuration procedure

6.3. Save and restore a configuration

When MM030 is configured, it automatically stores the list of the devices found and the outcomes of the scan into its permanent memory.

It is possible for MM030 to automatically restore the configuration when there is a power-up after a reset or a power shut-down. Hence, if all the conditions are satisfied, MM030 will re-start autonomously the data exchange.

6.4. Delete a configuration

The procedure to put MM030 and Flex Interfaces to the Unconfigured state is:

- Press the 'Configuration' push-button
- Press the 'Reset' push button before the Configuration procedure ends

6.5. Re-configuration

If MM030 is already configured, it is possible to re-configure it by pressing the 'Configuration' push-botton (unless the configuration procedure is going on, see section 6.1., or MM030 is in Maintenance mode).

This can be required when:

- A new device has been connected (in order to include it into the data exchange activity)
- A device has been eliminated (in order to stop MM030 querying it for reconnection, see section 7.1.1.)
- A Flex Interfaces rotary selector position have been modified (in order to evaluate the new scenario)
- A trip unit communication parameters have been modified (in order to resume the communication with it)

7 DATA EXCHANGE ACTIVITY

7.1. MM030

After the configuration procedure succeded, MM030 is normally busy performing a periodic data exchange activity with the connected devices.

The data exchange is optimised in order to guarantee the highest transfer rate and propagate the information from/to trip unit and Flex Interfaces as fast as possible.

The activity is organised on an priority basis: channels with higher prioriy are refreshed more frequently.

The following table shows the default priority policy used:

Priority	Exchange channel	
	from	to
High	AD030 MI	trip unit
Medium	trip unit	AD030 DO
Low	trip unit	AD030 AO and HMI

Table 49. Data exchange priorities

The refresh rate of a single device depends and the total number and type of devices connected to MM030.

The whole data exchange activity is signalled by the Local and Accessory bus TX LEDs, which light on when a message is being transmitted on the relevant bus.

7.1.1. Management of disconnected devices

If during normal data exchange one or more devices are disconnected (voluntarily or as a consequence of a fault) MM030 alerts the user with the Fault LEDs, according to the following outcomes:

Outcome	MM030 Fault LED	Description
Bus fault	ON	All devices on the given bus are disconnected, or MM030 gets no responses from the bus.
One or more (bur not all) devices disconnected	Pattern 2	One or more devices on the given bus are disconnected, but there is still data exchange activity with other devices.

Table 50. Outcomes due to device disconnection

MM030 will stop data exchange activity with the disconnected devices. This may cause also the stop of data exchange activity with other devices, directly associated with the disconnected ones. For example, if a trip unit is disconnected also the data exchange with all the Flex Interfaces will stop.

MM030 will periodically query the disconnected devices to check if they are reconnected (heart-beat check). If this is the case, the data exchange activity with them will be restored.

In order to stop MM030 from querying the disconnected device, a new configuration procedure is required.

MM030 will consider a device disconnected (and will apply the same policy for reconnection described above) even if the communication with the device generates error (for example due to noises on the communication bus).

7.2. AD030 DO

After the configuration procedure succeded, AD030 DO is normally busy receiving periodic messages from MM030 that update 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 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 MM030.

7.2.1. Bus fault

By default, the DO 5 output channel is used to signal a bus inactivity condition. If communication between the device and the MM030 is not present for more than 5 seconds:

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

7.3. AD030 AO

After the configuration procedure AD030 AO is normally busy receiving periodic messages from MM030 that update the values output by the AO channels.

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

The whole data exchange activity is signalled by the Accessory bus RX LEDs, which lights on when the device receives a message from MM030.

7.3.1. Bus fault

If communication between the device and the MM030 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

7.4. AD030 MI

After the configuration procedure AD030 MI is normally busy answering to the periodic message requests from MM030, 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 MM030.

7.4.1. Bus fault

If communication between the device and the MM030 is not present for more than 5 seconds:

- The Fault LED will signal the Bus fault condition

8 OTHER OPERATIONS

8.1. General

8.1.1. Self-test

The self-test procedure is executed by the MM030 and Flex Interfaces units immediately after the power on: all the LEDs are turned and kept on for about 1 second; then they are turned off simultaneously.

The procedure ends when the PWR LED is permanently ON.

This test helps to:

- Check the device operates correctly during initialization
- Check the LEDs switch on and off correctly

8.2. MM030

8.2.1. Reset

It is possible to reset the MM030 unit by pushing the 'Reset' push-button on the front panel (see par 3.1).

The optical signals can't be manually reset since they always reflect the internal status of the MM030 unit.

8.2.2. Malfunction conditions

MM030 can face the following malfunction conditions:

Condition	MM030 Fault LEDs (both)	Description
Malfunction	Pattern 7	MM030 detects a malfunction. This can be due to: • Supply voltage too high or too low • Internal malfunction
Internal memory error	Pattern 10	MM030 internal memory is corrupted. Contact ABB Service.

Table 51. MM030 malfunction conditions

8.3. Accessory Devices

8.3.1. Test

It is impossible to execute the AD030 test procedure pressing the Test Push button on the front panel.

9 TECHNICAL CHARACTERISTICS

9.1. Electrical characteristics

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

Table 52. Electrical characteristcs of MM030 and accessory Flex Interfaces

9.1.1. Auxiliary power supply

The MM030 and Flex Interfaces units must be powered by an auxiliary supply.

Characteristics	MM030	AD030 AO, AD030 MI	AD030 DO
Supply voltage	24 Vdc ± 20% ± 5%		
Maximum ripple			
Nominal power @ 24 Vdc	2.5 W	2 W	4 W (all relays active)

Table 53. Auxiliary supply for MM030 and accessory Flex Interfaces

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.

9.1.2. AD030 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.

Type	Monostable SPDT
Max breaking capacity	150 W / 250 VA (resistive load)
Max breaking voltage	300 Vdc / 250 Vac
Max breaking current	5 A @ 30 Vdc (resistive load) 8 A @ 250 Vac(resistive load)

Table 54. Characteristics of AD030 DO relays

9.1.3. AD030 AO channel characteristics

AOs are non isolated analog output channels, able to drive a current signal in the range of 4 ... 20mA with a resolution of 12bit (11bit for the data and 1bit for the sign) and an accuracy of 1% at least.

The behavior of each channel is signalled by means of the relevant LED, as explained in Table 13.

9.1.4. AD030 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 singal (binary 0)
- the range 15V ... 24 V will be seen as an active digital signal (binary 1)
- the range 5V ... 15V will be seen as an undetermined digital signal

The analog input channels support a current signal in the range 4mA ... 20mA with a resolution of 12bit (11bit for the data and 1bit for the sign) 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).

9.2. Mechanical characteristic

The same box is used for the MM030, AD030 DO, AD030 A0 and AD030 MI.

Characteristic	MM030 and AD030 units
Case	Self-extinguish Noryl resin
Protection degree	IP20
Dimensions	see Figure 15.
Weight	100 g

Table 55. Mechanical characteristics of MM030 and accessory Flex Interfaces

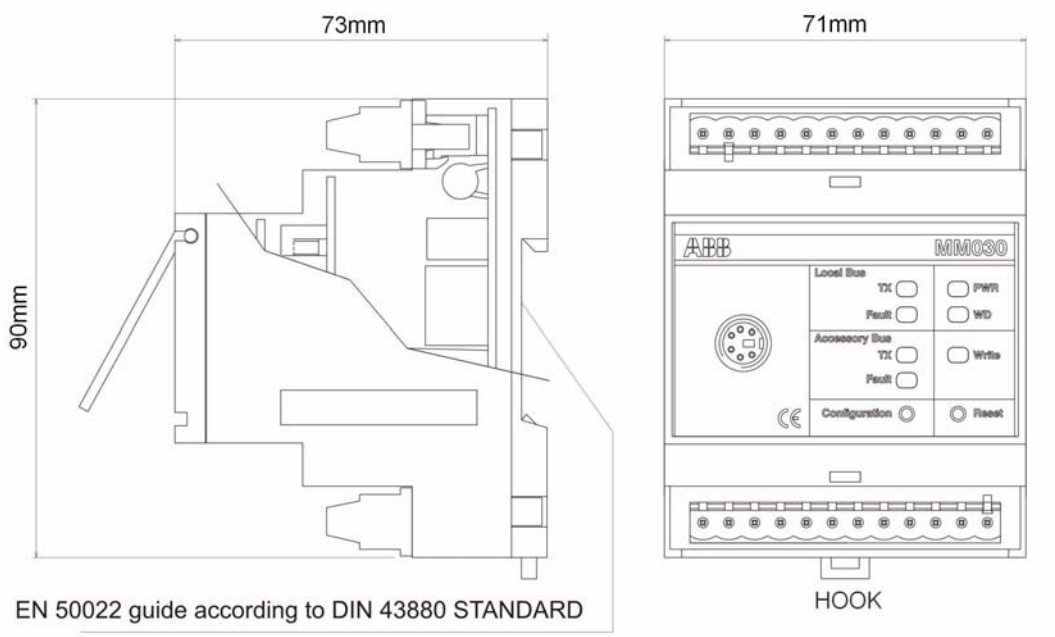

Figure 15. MM030 and Accessory Devices dimensions

9.3. Environmental conditions

Characteristic	MM030 - AD030 DO	HMI030
Operating environmental temperature	-25 °C ... +70 °C	-20 °C ... +70 °C
Storage temperature	-40 °C ... +90 °C	-30 °C ... +80 °C
Relative humidity	5% ... 98% with condensation (with coating)	
Atmospheric pressure	1 bar, 0 m ... 2000 m	

Table 56. Environmental conditions

9.4. Communication buses

The MM030 unit has got two serial buses used to communicate with other devices:

- the local bus connects the MM030 unit to the trip unit[1]
- the accessory bus connects the MM030 unit to the modules from the Flex Interfaces family.

Both buses use RS485 as physical layer.

Each RS485 channel is optically isolated and it is possible to connect at most 32 devices.

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

The maximum length of the connection between MM030 and trip unit depends on the latter, see the table below.

Trip unit	MM030 to trip unit connection cable lenght
PR12x/P	15 m
PR33x/P	15 m
PR222DS/PD	200 m
PR223EF/DS	200 m

Table 57. Connection lenght of MM030 to different trip units

1. PR222DS/PD, PR223EF and PR223DS trip unit dont' have the local bus so they must be connected to MM030 by the system bus.

10 TROUBLESHOOTING

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

Note: Before consulting the following table, check the LEDs on the front panel of the connected devices (wait for the start up phase to end if the system has just been powered up); see section 3.1.3., section 3.2.3., section 6.2. and section 8.2.2.

Situation	Possible causes	Suggestions
MM030 does not exchange data: (TX and RX LEDs are off most of the time)	Auxiliary voltage not present	Restore supply voltage
	MM030 not configured	Start MM030 configuration (see section 6.1.)
	One or more HMI030 set for not communicating with MM030 ('MM030 = no')	Set all connected HMI030 for communicating with MM030 ('MM030 = yes')
	Impossible to communicate with trip unit: • Local bus disconnected or not properly connected • Connected trip unit not recognized by MM030	• Check connections • Connect a managed trip unit (see section 5)
	Impossible to communicate with Flex Interfaces units: • Accessory bus disconnected or not properly connected • No Flex Interfaces unit recognized by MM030	• Check connections • Connect a managed Flex Interfaces (see section 5)
One or more (but not all) Flex Interfaces do not exchange data (RX LEDS is off most of the time)	Auxiliary voltage not present	Restore supply voltage
	Flex Interfaces is not configured	(Re)Configure MM030
	Flex Interfaces disconnected or not properly connected	Check connections
	Unknown device	• Check the Flex Interfaces are connected to the Accessory bus • Check the Flex Interfaces are supported (see section 5)
	Unmanaged device	Check the connected Flex Interfaces and their rotary selector position. They should fall into one of the connection scenarios in section 5
	Possible device collision	• Check that Flex Interfaces of the same device type (for example AD030 DO) have different rotary selector position. • Check all connected HMI030 are set for communicating with MM030 ('MM030 = yes')
Flex Interfaces signals bus fault	Flex Interfaces connection with MM030 interrupted or disturbed	Check connections between MM030 and Flex Interfaces
	MM030 Local bus fault	Check connections between MM030 and trip unit
After resetting AD030 DO, the DO channels keep the same values	Trip unit has not been reset after a trip event has occurred	Reset the trip unit (see the relevant user's manual)
	The condition associated with the DO channels is still present	Expected behavior

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

11 CIRCUIT DIAGRAMS

11.1.AD030 DO

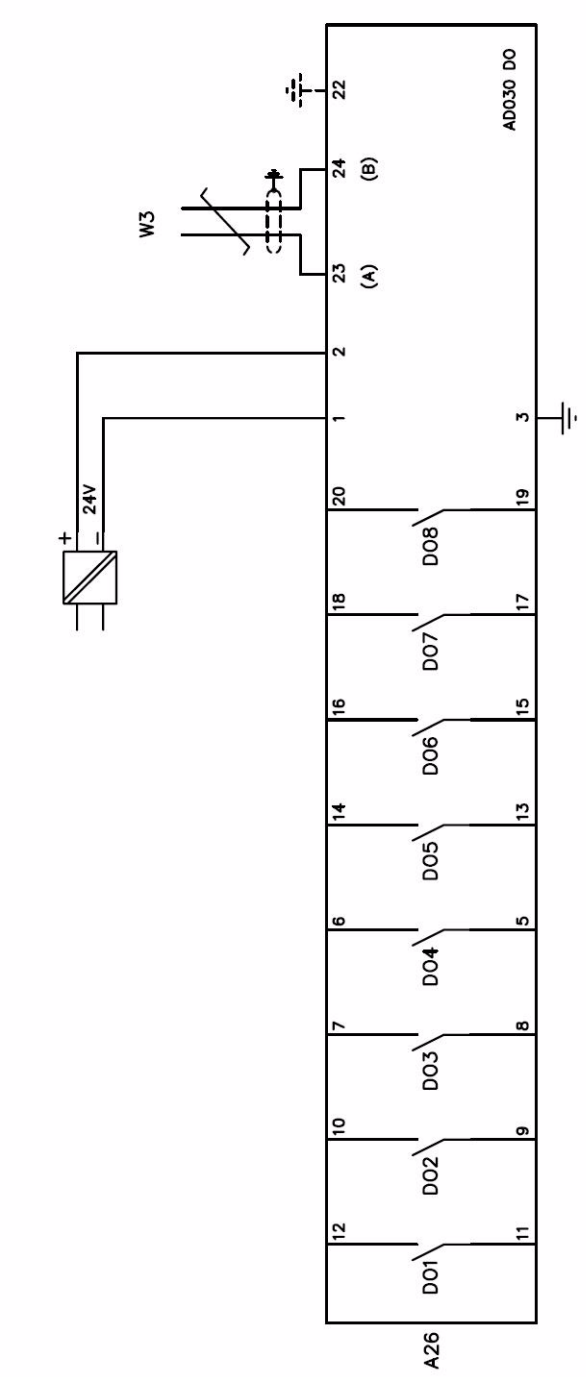

Figure 16. AD030 DO circuit diagram

11.2.AD030 AO

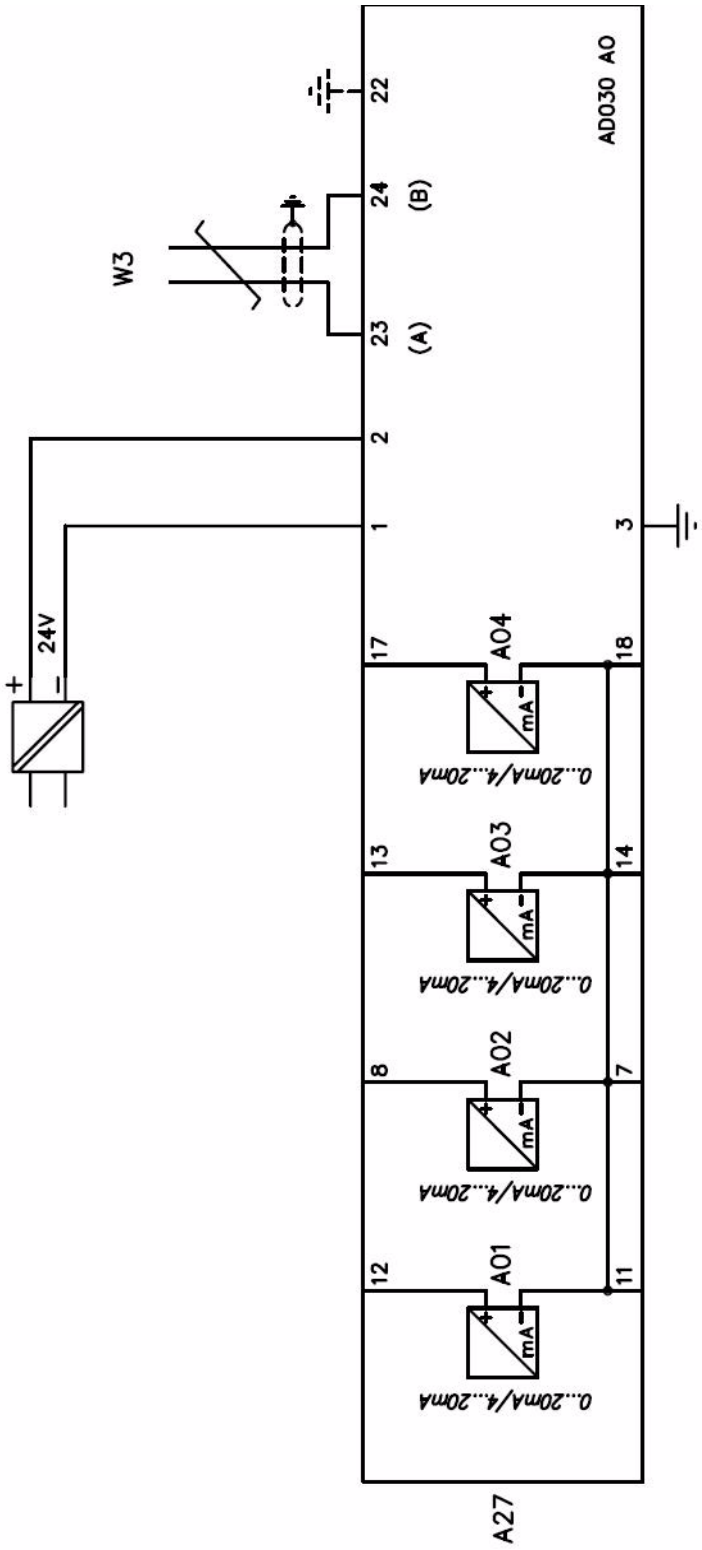

Figure 17. AD030 AO circuit diagram

11.3.AD030 MI

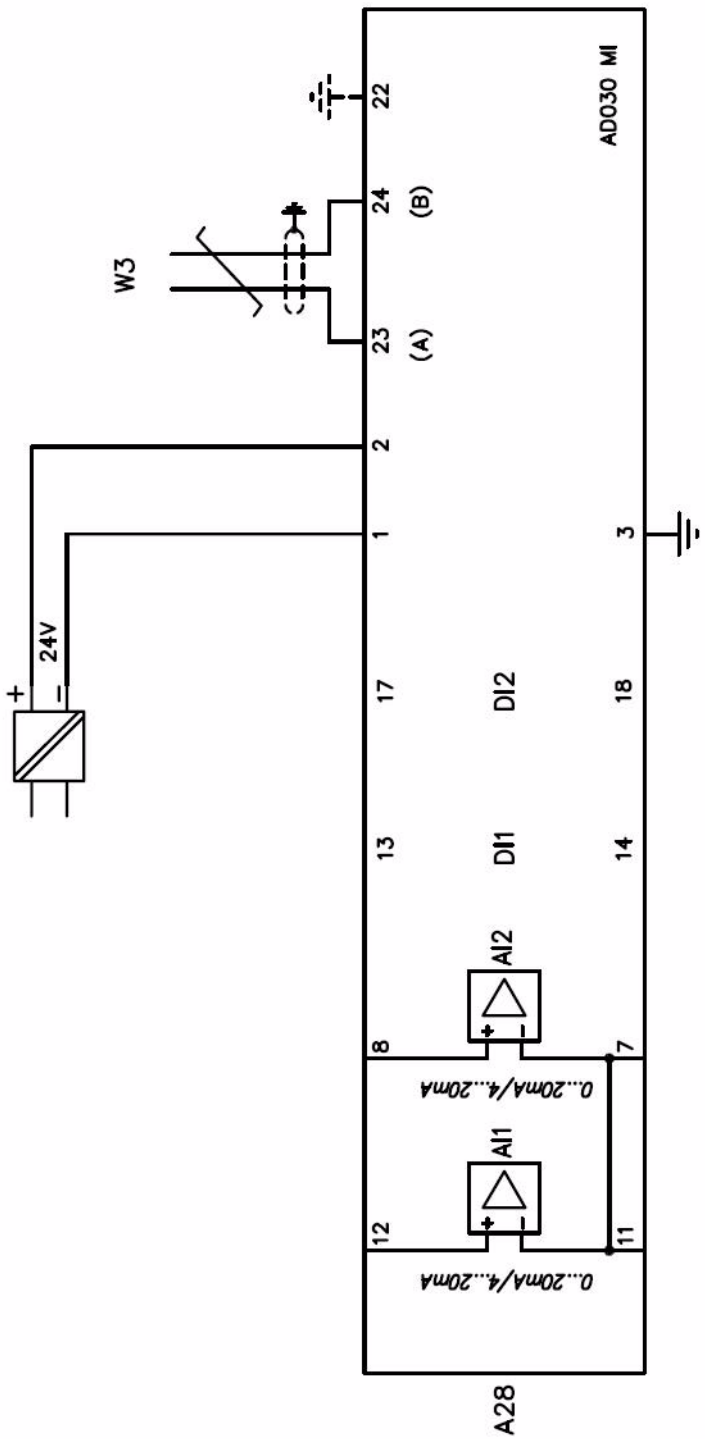

Figure 18. AD030 MI circuit diagram

11.4.HMI030

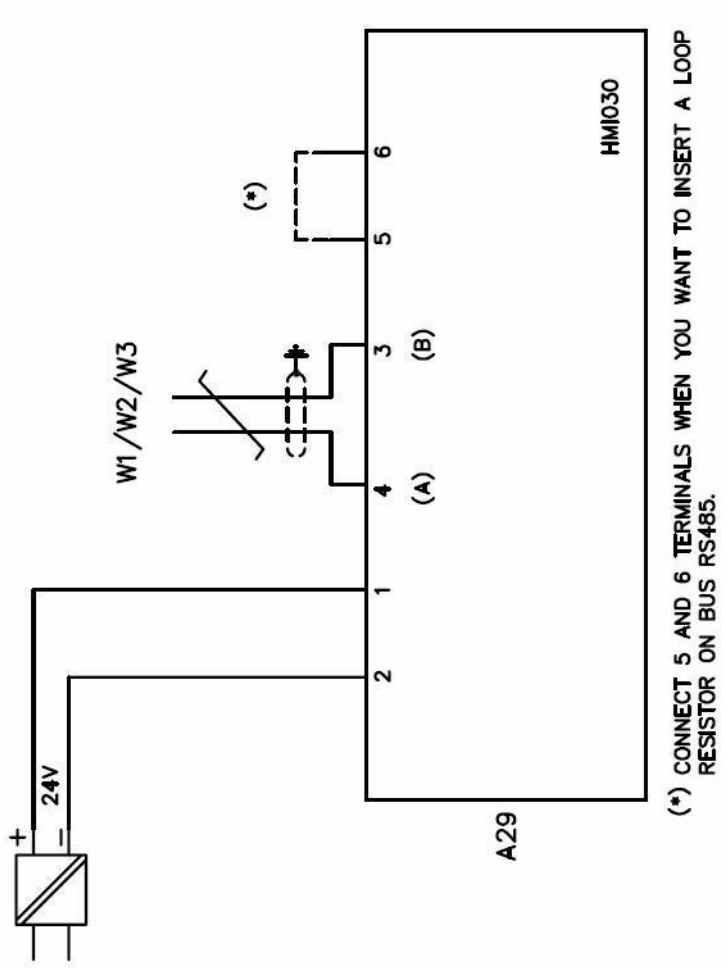

Figure 19. HMI030 circuit diagram

11.5.MM030 with PR12x/P and PR33x/P trip units

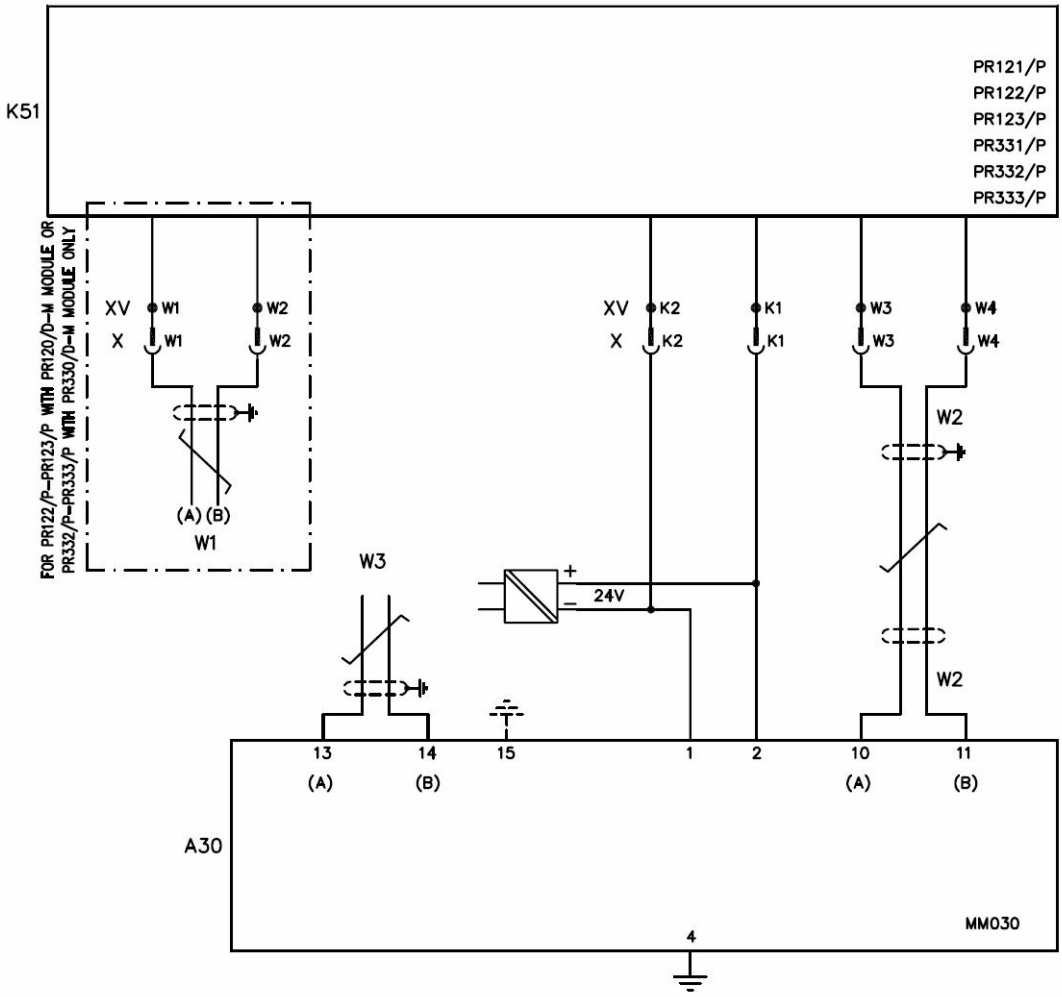

Figure 20. MM030 with PR12x/P,PR33x/P trip units circuit diagram

11.6.MM030 with PR222DS/PD, PR223EF, PR223DS trip units

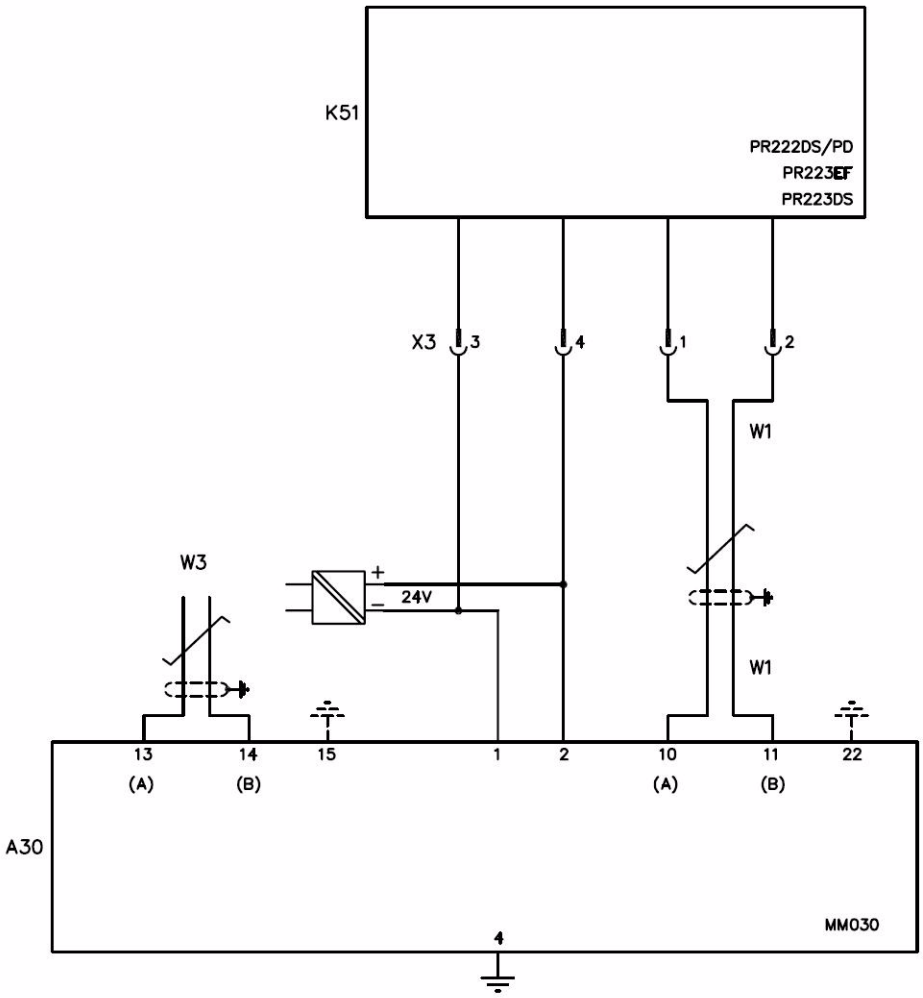

Figure 21. MM030 with PR222DS/PD and PR223 trip units circuit diagram

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

Caption	Description
A26	Unit type AD030 DO with 8 digital outputs to connect to Accessory Bus
A27	Unit type AD030 AO with 4 analog outputs to connect to Accessory Bus
A28	Unit type AD030 MI with 2 digital inputs and 2 analog inputs to connect to Accessory Bus
A29	Unit type HMI030 for remote display on Accessory Bus
A30	Unit type MM030 (master-master) for connection of a trip unit on Accessory Bus
AI	Analog Inputs
AO	Analog Outputs
DO	Digital Outputs
K51	Trip unit
W3	Accessory Bus

Table 58. Description of electrical diagrams captions

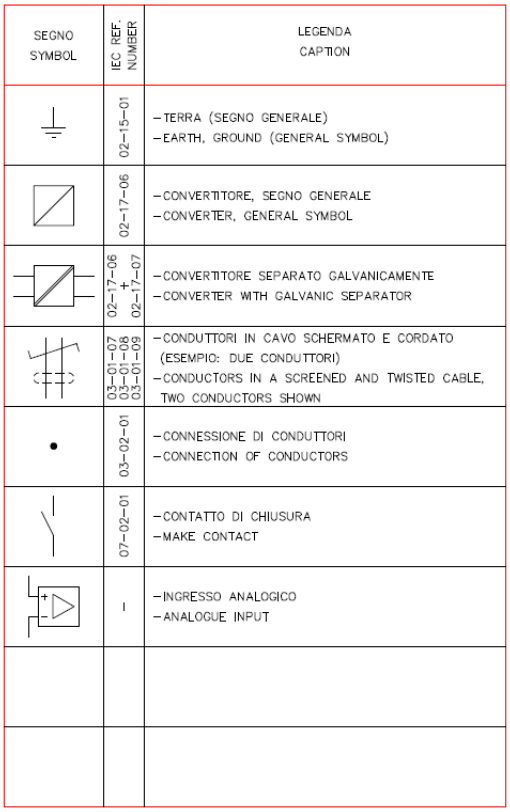

Figure 22. Graphical symbols used in circuit diagrams