EATON | Cutler-Hammer

Option Board OPTAF for SPX9000 Drives — Safe Disable & ATEX

User Manual

August 2007
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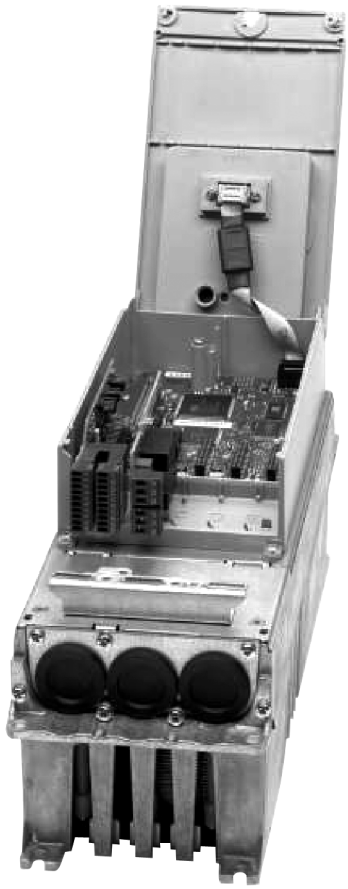

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Cover Photo: Cutler-Hammer® SPX9000 Drive with IP54 Enclosure.

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Safety

Definitions and Symbols

⚠ WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.

⚠

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous High Voltage

⚠ WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

Warnings and Cautions

⚠ WARNING

Internal components and circuit boards are at high potential when the drive is connected to the power source. This voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.

⚠ CAUTION

Make sure that the drive is switched OFF before an option or fieldbus board is changed or added.

⚠ CAUTION

The information in this manual provides guidance on the use of OPTAF option board for prevention of unexpected start-up of the motor. This information is ensured to be correct and in compliance with accepted practice and regulations at the time of writing. However, the end product/system designer is responsible for ensuring that the system is safe and in compliance with relevant regulations.

⚠ CAUTION

The OPTAF board and the Safe Disable function does not electrically isolate the drive output from the mains supply. If electrical work is to be carried out on the drive, the motor or the motor cabling, the drive has to be completely isolated from the mains supply, e.g. using an external approved isolator.

⚠ CAUTION

During maintenance breaks, or in case of service/repair the OPTAF board might have to be removed from its slot. After reconnecting the board ALWAYS make sure that the Safe Disable function is active and fully functional by testing it. See **Page 3-16**.

⚠ CAUTION

The thermistor function on OPTAF board with SPX9000 control is used to protect the overheating of motors in explosive atmosphere. The drive itself including OPTAF board can not be installed in explosive atmosphere.

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Chapter 1 — General

OPTAF Board

The OPTAF Option Board from Eaton's electrical business together with the SPX9000 control board provides the following functionalities with Eaton's Cutler-Hammer® SPX9000 drives.

- **Hardware-based Safe Disable to prevent torque on the motor shaft.** The hardware disable function is certified according to EN954-1, Cat 3. The Safe Disable function has been certified by BGIA (Berufsgenossenschaftliches Institut für Arbeitsschutz, Germany).
- **Overtemperature detection using thermistor.** It can be used as a tripping device for ATEX certified motors. The thermistor tripping function is certified by VTT (Technical Research Centre of Finland) according to ATEX directive 94/9/EC.

Both functions of the OPTAF board are described in this user manual.

The OPTAF option board also contains two programmable output relays. (**Note:** Output relays are not part of the Safe Disable function.)

OPTAF board can only be used with SPX9000 series drives (using SPX9000 control boards) and is installed in the B-slot of the control board.

⚠ WARNING

Internal components and circuit boards are at high potential when the drive is connected to the power source. This voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.

Safe Disable & ATEX Board Layout

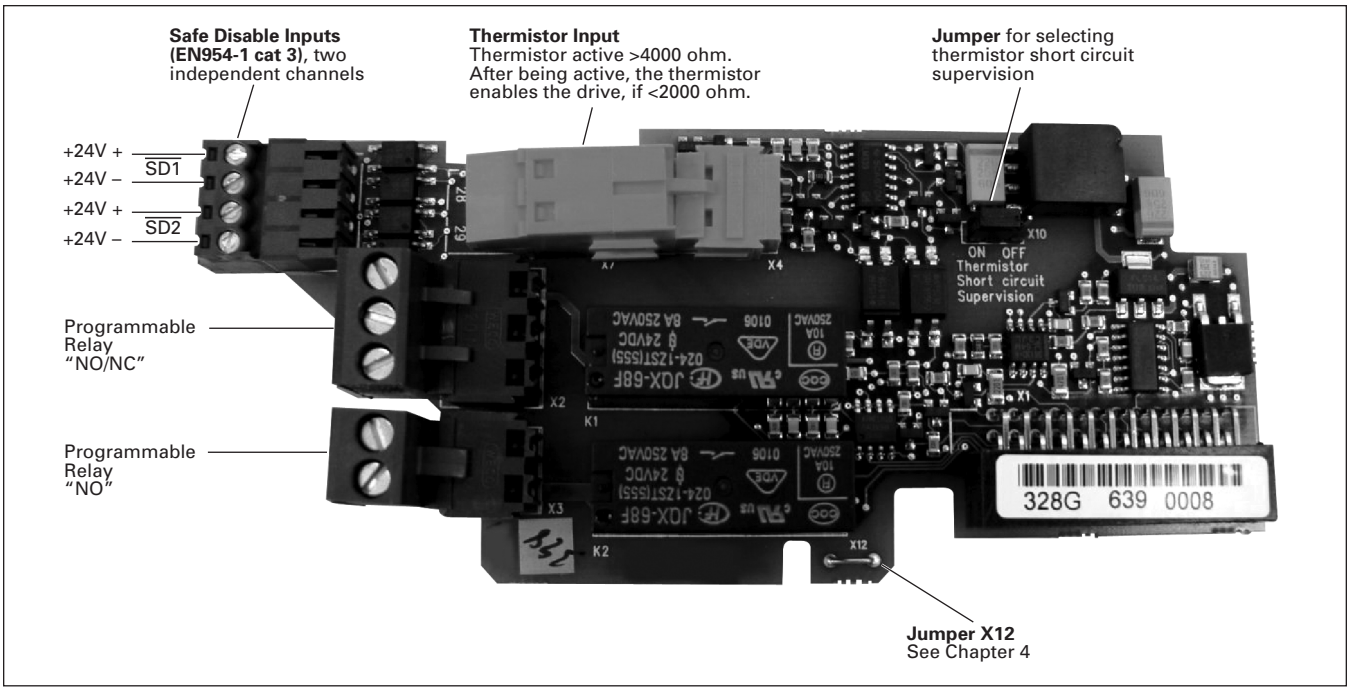

Figure 1-1: Layout of the OPTAF Board

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Chapter 2 — Installation

CAUTION

Make sure that the drive is switched OFF before an option or fieldbus board is changed or added.

Table 2-1: Installing the OPTAF Option Board

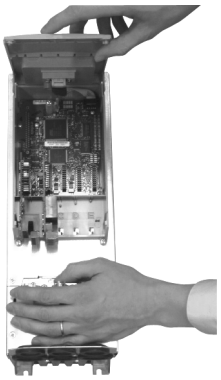
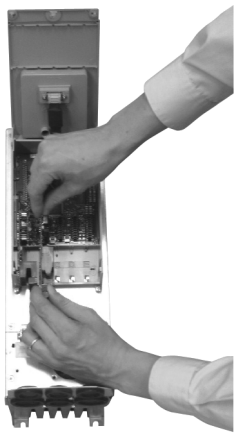
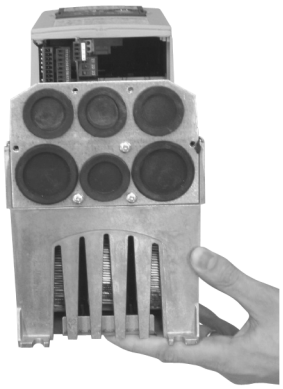
Item	Description	
A	SPX9000 drive with IP54 enclosure.	
B	Remove the main cover.	
C	Open the cover of the control unit.	

Table 2-1: Installing the OPTAF Option Board (Continued)

Item	Description	
D	Install OPTAF option board in slot B on the control board of the drive. Make sure that the grounding plate fits tightly in the clamp.	
E	Cable installation: Safe Disable function requires the use of cable sealing grommets or glands for all cables in the drive. The grommets or glands must be suitable for the type and amount of cables used and they will fulfill IP54 requirements. See the SPX9000 user manual for hole sizes for the power cables. The hole size is PG21 (28.3 mm) for the control cables. See **Page 3-12** for examples of cable sealing grommets or glands that can be used.	
F	Close the cover of the control unit and attach the main cover. Before attaching the main cover, check that the gasket of the cover is not damaged for IP54 units. Use a tightening torque of 0.9 – 1.1 Nm for the main cover screws.	

Chapter 3 — Safe Disable Function

The Safety Function of the OPTAF board, such as the technical principle and data, wiring examples and commissioning, will be described in this chapter.

Note: Designing of safety-related systems requires special knowledge and skills.

The use of Safe Disable and other similar applications does not itself ensure safety. An overall risk evaluation is required in order to make sure that the commissioned system is safe. Safety devices like the OPTAF board must be correctly incorporated into the entire system. The functionality of the OPTAF board is not necessarily suitable for all systems. The entire system must be designed in compliance with all relevant standards within the field of industry.

Standards such as EN12100 Part 1, Part 2, EN1050 and EN1088 provide methods for designing safe machinery and for carrying out a risk assessment.

⚠ CAUTION

The information in this manual provides guidance on the use of OPTAF option board for prevention of unexpected start-up of the motor. This information is ensured to be correct and in compliance with accepted practice and regulations at the time of writing. However, the end product/system designer is responsible for ensuring that the system is safe and in compliance with relevant regulations.

⚠ CAUTION

The OPTAF board and the Safe Disable function does not electrically isolate the drive output from the mains supply. If electrical work is to be carried out on the drive, the motor or the motor cabling, the drive has to be completely isolated from the mains supply, e.g. using an external approved isolator.

⚠ CAUTION

During maintenance breaks, or in case of service/repair the OPTAF board might have to be removed from its slot. After reconnecting the board ALWAYS make sure that the Safe Disable function is active and fully functional by testing it. See **Page 3-16**.

Hardware and Connections

The safe disable feature of the OPTAF board allows the drive output to be disabled so that the drive cannot generate torque in the motor shaft. The OPTAF board has two separate, galvanically isolated inputs SD1 and SD2 for the safe disable function.

Note: Both SD1 and SD2 inputs are normally closed for the drive to be in enable state.

The Safe Disable function is achieved by disabling the drive modulation. This is done by disabling the gate driver signal outputs to the driver electronics. The gate drive output signals control the IGBT module. When gate drive output signals are disabled, the drive will not generate torque in the motor shaft. See **Figure 3-1**.

The Safe Disable activation delay is <20 mS and when the drive is enabled again, there is a delay of 1 second before a valid start command can be given.

If either of the Safe Disable inputs is not connected to a +24V signal, the drive will not go to the RUN state.

In addition to the Safe Disable inputs, the board also contains a thermistor input. If the thermistor input is not used it must be disabled. The thermistor input is disabled by making a short circuit to the terminals and setting the jumper X10 to "OFF" state. The thermistor input operation and instructions are presented in **Chapter 4**.

Table 3-1: OPTAF I/O Terminals

Terminal		Parameter Reference on Keypad and Drive	Technical Information	
1	$\overline{\text{SD1}}$+	DigIN:**B.2**	Isolated **S**afe **D**isable input 1	+24V +-20% 10 – 15 mA
2	$\overline{\text{SD1}}$-		Virtual GND 1	
3	$\overline{\text{SD2}}$+	DigIN:**B.3**	Isolated **S**afe **D**isable input 2	+24V +-20% 10 – 15 mA
4	$\overline{\text{SD2}}$-		Virtual GND 2	
21 **22** **23**	RO1/normal closed RO1/common RO1/normal open	DigOUT:**B.1**	Relay output 1 (NO/NC) ① Switching capacity Min. switching load	 24V DC/8A 250V AC/8A 125V DC/0.4A 5V/10 mA
25 **26**	RO2/common RO2/normal open	DigOUT:**B.2**	Relay output 2 (NO) ① Switching capacity Min. switching load	 24V DC/8A 250V AC/8A 125V DC/0.4A 5V/10 mA
28 **29**	TI1+ TI1-	DigIN:**B.1**	Thermistor input; R_{trip} ≥4.0 kΩ (PTC)	

① If 230V AC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9.

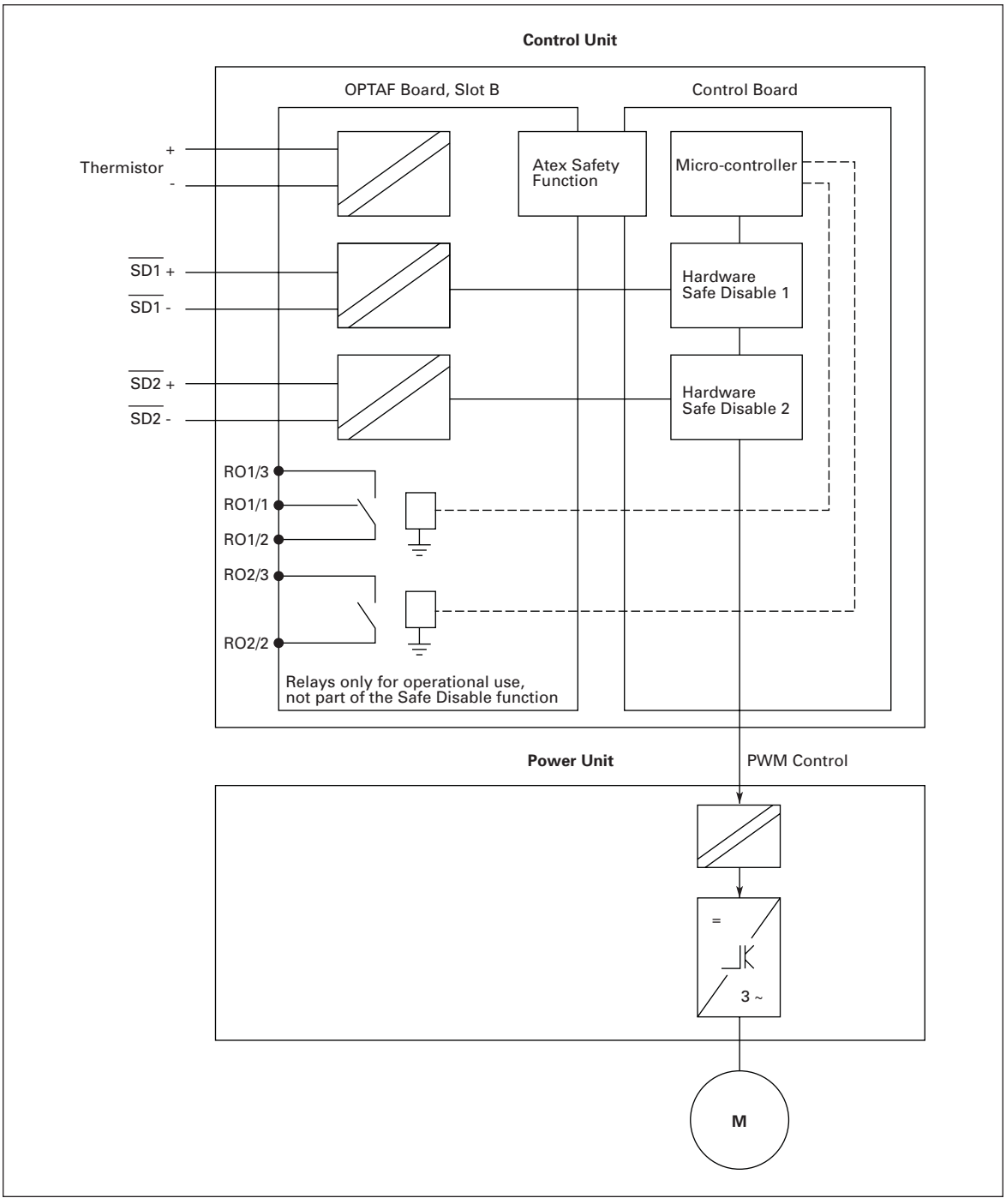


Figure 3-1: Safe Disable Principle in SPX9000 Drives with the OPTAF Board

Note: Both $\overline{SD1}$ and $\overline{SD2}$ inputs must be used to achieve EN 954-1 Category 3.

Wiring Examples

Example 1

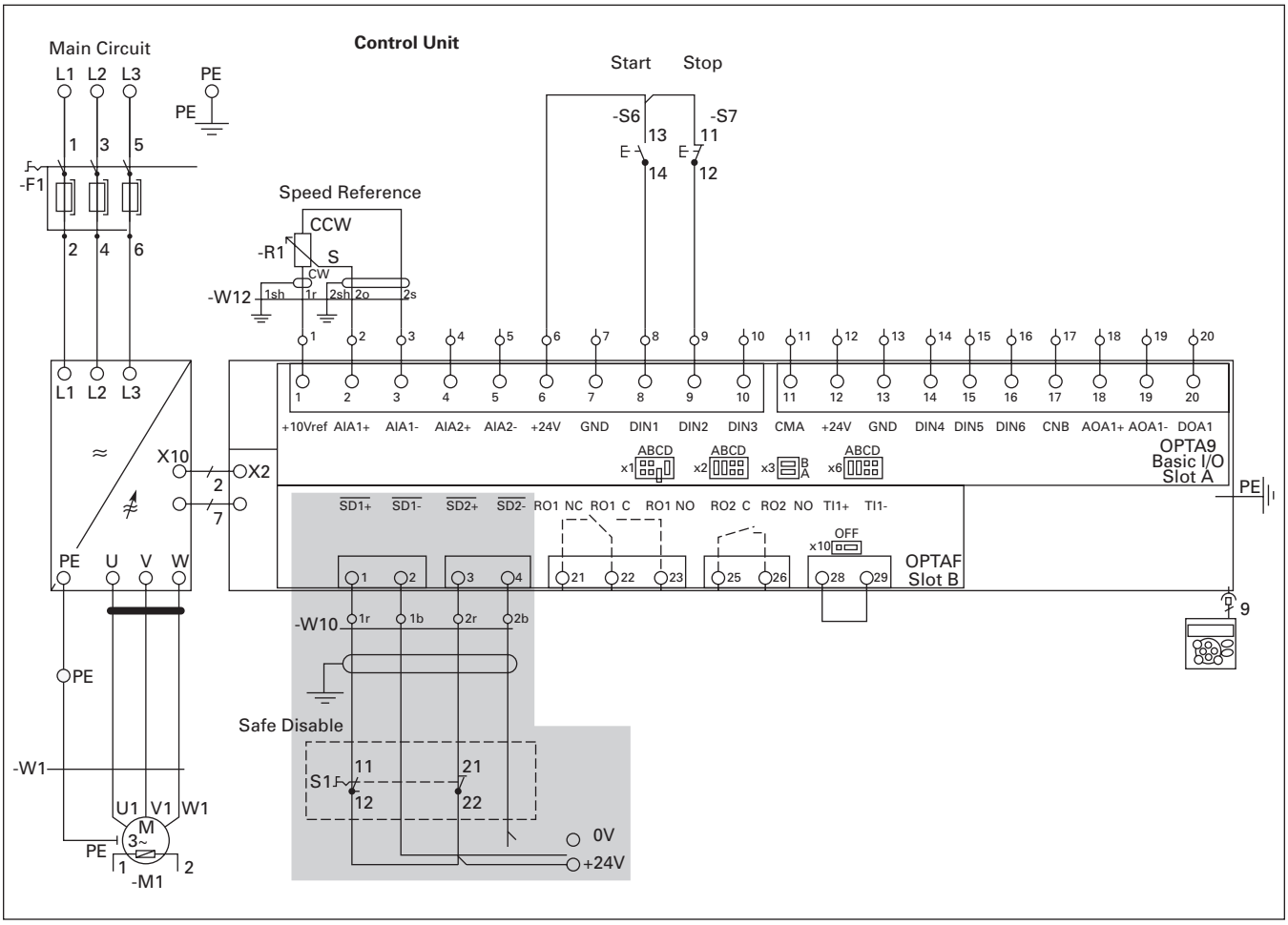


Figure 3-2: Example 1, Safe Disable without Reset

Figure 3-2 shows a connection example of OPTAF board for Safe Disable function without reset. The switch S1 is connected with 4 wires to the OPTAF board as shown above.

The power supply to S1 may come from OPTA9 board (connector pins 6 and 7 in **Figure 3-2**) or it may also be external.

When the switch S1 is activated (contacts open), the drive will go to Safe Disable state and motor (if running) will stop by coasting. The drive will generate the warning "A30 Safe Disable".

When switch S1 is released (contacts closed), the drive returns to the ready state. The motor can then be run with a valid start command.

Note: All SPX9000 series drives containing the Safe Disable board are programmed to accept only edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

Example 2

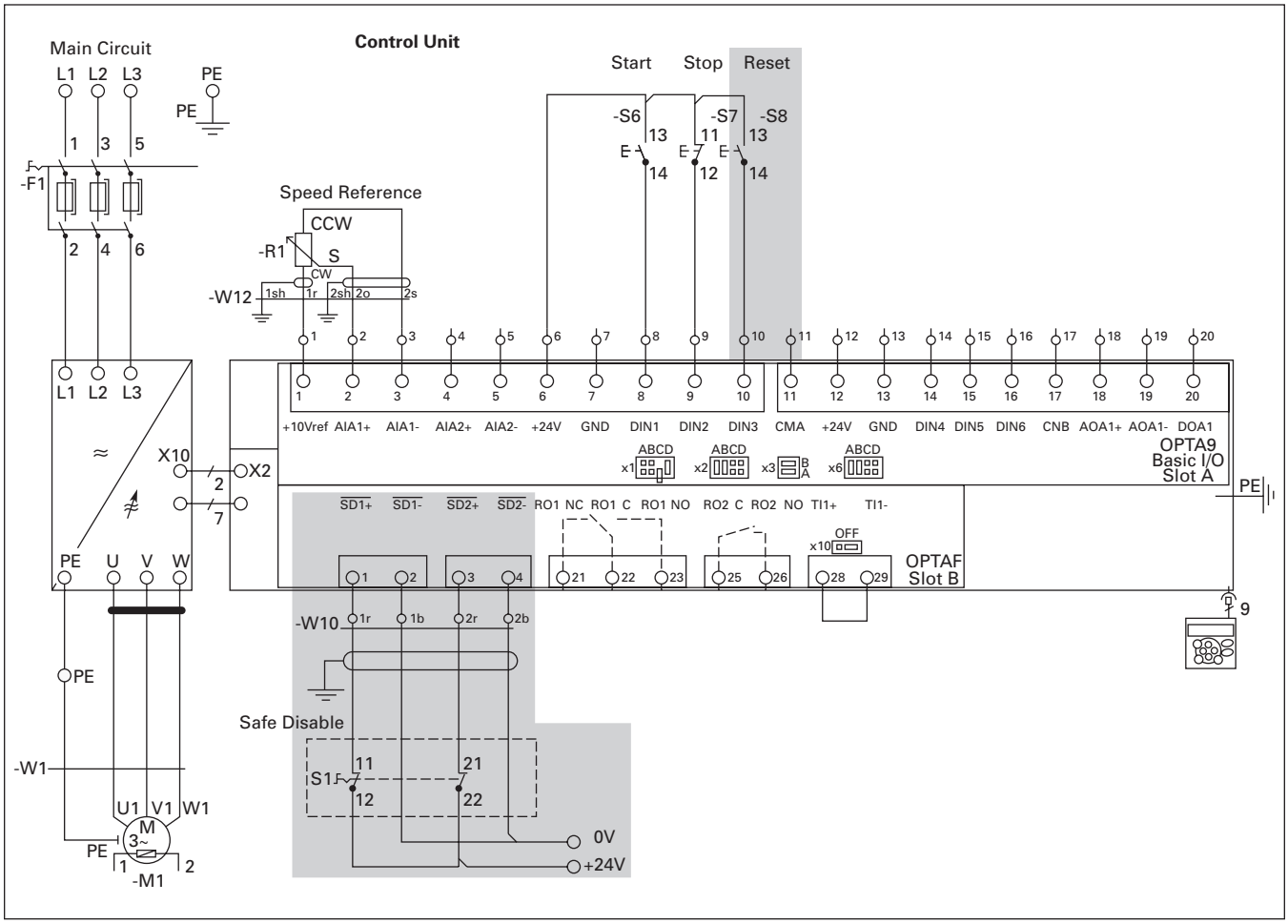


Figure 3-3: Example 2, Safe Disable with Reset

Figure 3-3 shows a connection example of OPTAF board for Safe Disable function with reset. The switch S1 is connected with 4 wires to the OPTAF board as shown above. The digital input 3 (DIN3), for example, is wired for the fault reset function. The reset function can be programmed to any of the available digital inputs. The drive must be programmed to generate a fault in Safe Disable state.

The power supply to S1 may come from OPTA9 board (connector pins 6 and 7 in **Figure 3-3**) or it may also be external.

When the switch S1 is activated (contacts open), the drive will go to Safe Disable state and motor (if running) will stop by coasting. The drive will generate the warning "F30 Safe Disable".

To start the motor operation again, the following sequence is performed.

- Release switch S1 (contacts closed). The hardware is now enabled but the drive continues to display the fault "F30 Safe Disable".
- Acknowledge the releasing of switch by edge sensitive reset function. The drive returns to the ready state.
- Giving a valid start command will start running the motor.

Note: All SPX9000 series drives containing the Safe Disable board are programmed to accept only edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

Example 3

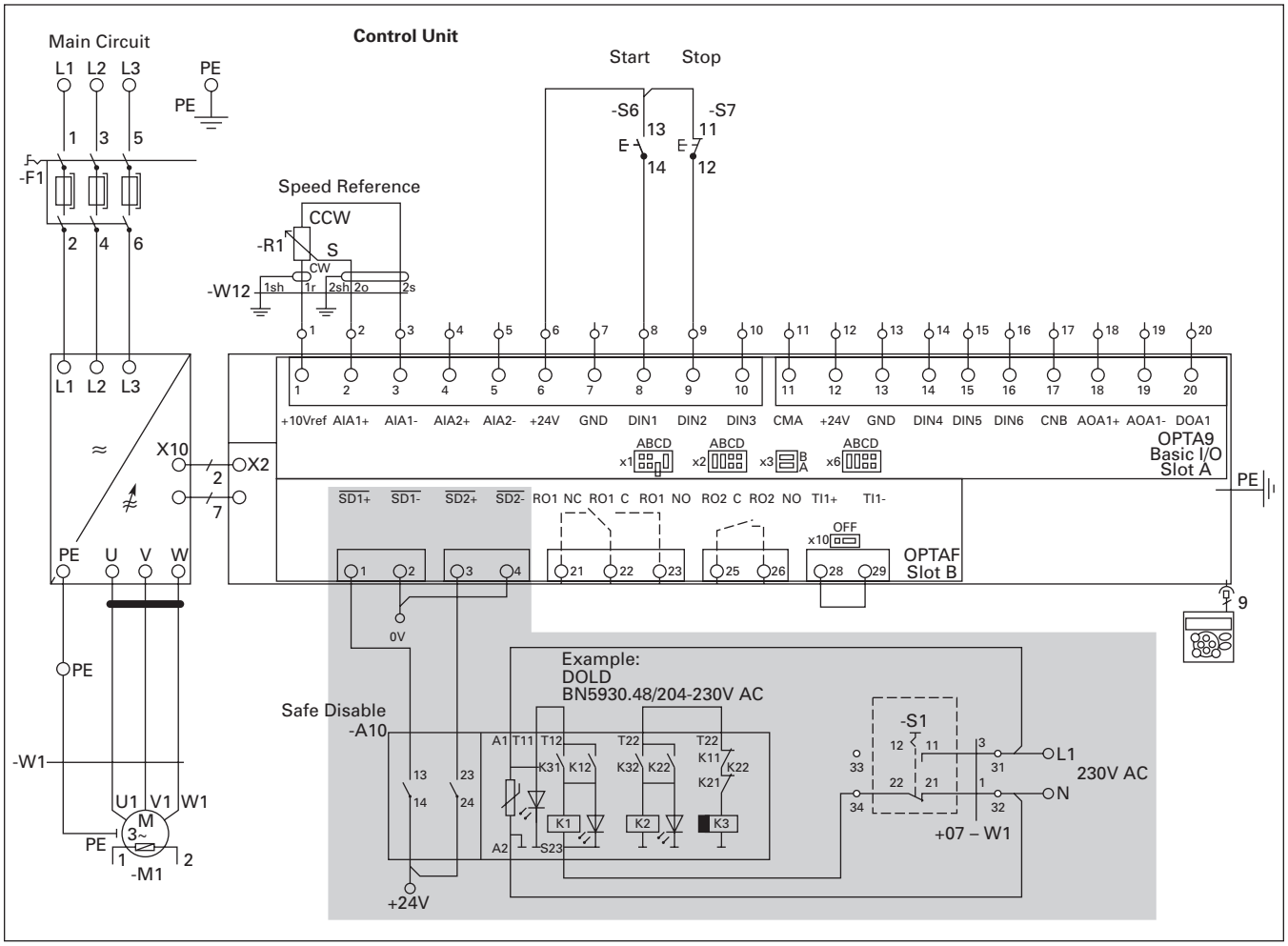


Figure 3-4: Example 3, Safe Disable without Reset and with External Safety Relay Module

Figure 3-4 shows a connection example of OPTAF board for Safe Disable function with external safety relay module and without reset.

External safety relay module is connected to the switch S1. The used power supply to switch S1 is 230V AC as an example. The safety relay module is connected to OPTAF board with 4 wires as shown in **Figure 3-4**.

When the switch S1 is activated (contacts open), the drive will go to Safe Disable state and motor (if running) will stop by coasting. The drive will generate the warning “A30 Safe Disable”.

When switch S1 is released (contacts closed), the drive returns to the ready state. The motor can then be run with a valid start command.

More information regarding the safety relay module may be found from the safety relay documentation.

Note: All SPX9000 series drives containing the Safe Disable board are programmed to accept only edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

Examples 4 and 5

Examples 4 and 5 differ from the previous examples. The Safe Disable inputs on the OPTAF board are connected with 2 wires only, from a safety relay or directly from the switch. In a design using 2 wires instead of 4, fault exclusion for the cable connected to the drive is required. If no safety relay is used (as in example 5), fault exclusion for the switch is required. The standard ISO 13849-2 defines methods for excluding faults related to the cables and switches in order for the system to meet the requirements for EN 954-1 category 3.

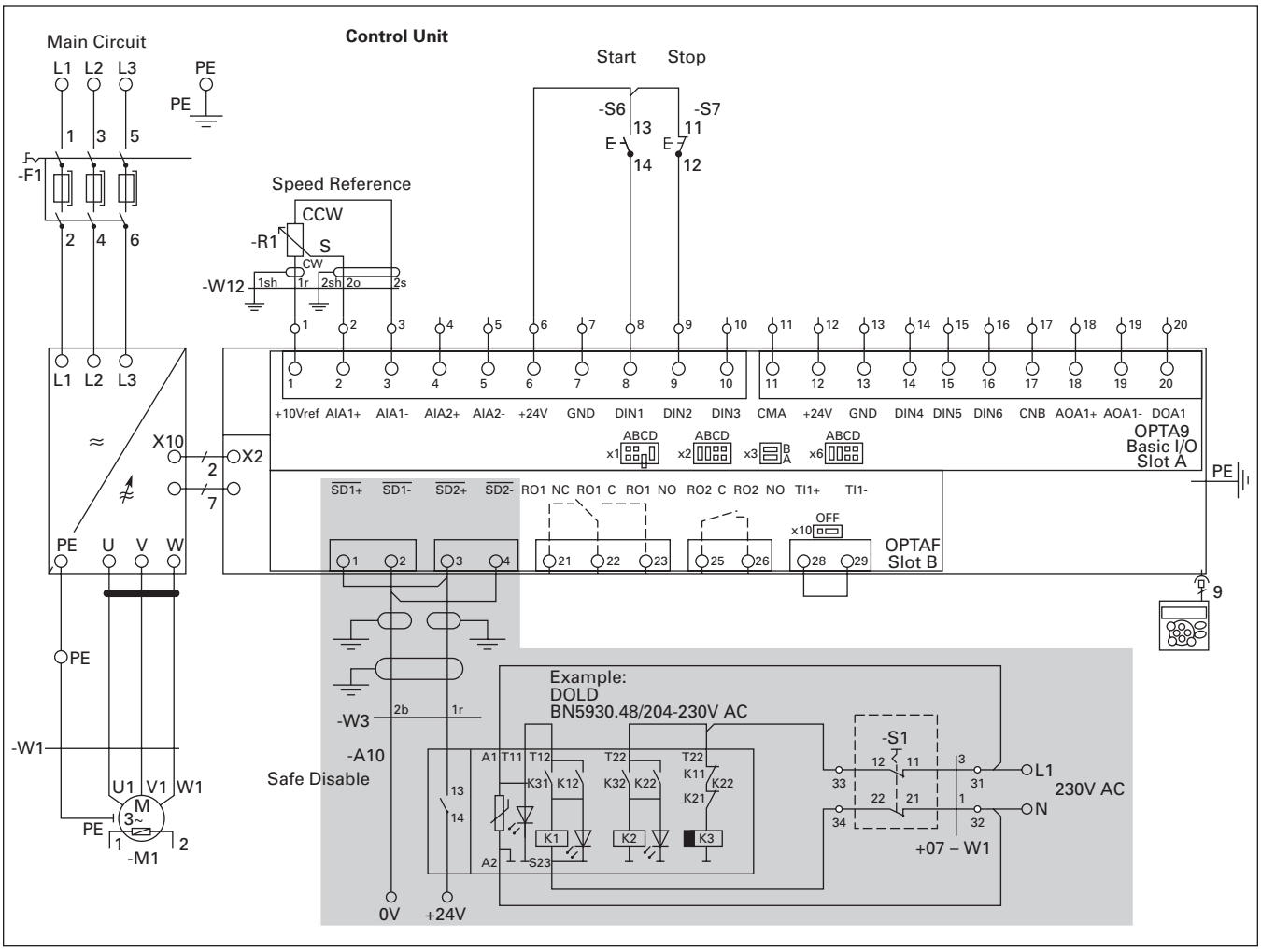


Figure 3-5: Example 4, Safe Disable Application with Safety Relay Connected to Switch S1 and Only 2 Wires Coming to the Drive from the Safety Relay

When the switch S1 is activated (contacts open), the drive will go to Safe Disable state and the motor (if running) will stop by coasting. The drive will generate the warning "A30 Safe Disable".

When switch S1 is released (contacts closed), the drive returns to the ready state. The motor can then be run with a valid start command.

More information regarding the safety relay module may be found from safety relay documentation.

Note: All SPX9000 series drives containing the Safe Disable board are programmed to accept only edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

With an application as shown in **Figure 3-5**, fault exclusion for the cable connected to the drive is required.

Fault Exclusions for the Cable Connected to the Drive

For the cable, the faults that must be considered and the ways they can be excluded are listed below, taken from ISO 13849-2 table D4:

- Short-circuit between any two conductors

  Fault exclusion: Short-circuits between conductors which are (one of these methods is required):

  – individually shielded with earth connection (shown in the **Figure 3-5**), or

  – separate multicore cable, or

  – permanently connected (fixed) and protected against external damage, e.g. by cable ducting, shielding, or

  – within an electrical enclosure (see Remark 1)

- Short-circuit of any conductor to an exposed conductive part or to earth or to the protective bonding conductor

  Fault exclusion: Short-circuits between conductors which are within an electrical enclosure (see Remark 1)

- Open-circuit of any conductor
  No fault exclusion required

  Remarks:
  1) Provided that both the conductors and enclosure meet the appropriate requirements (see EN 60204-1 [IEC 60204-1]).

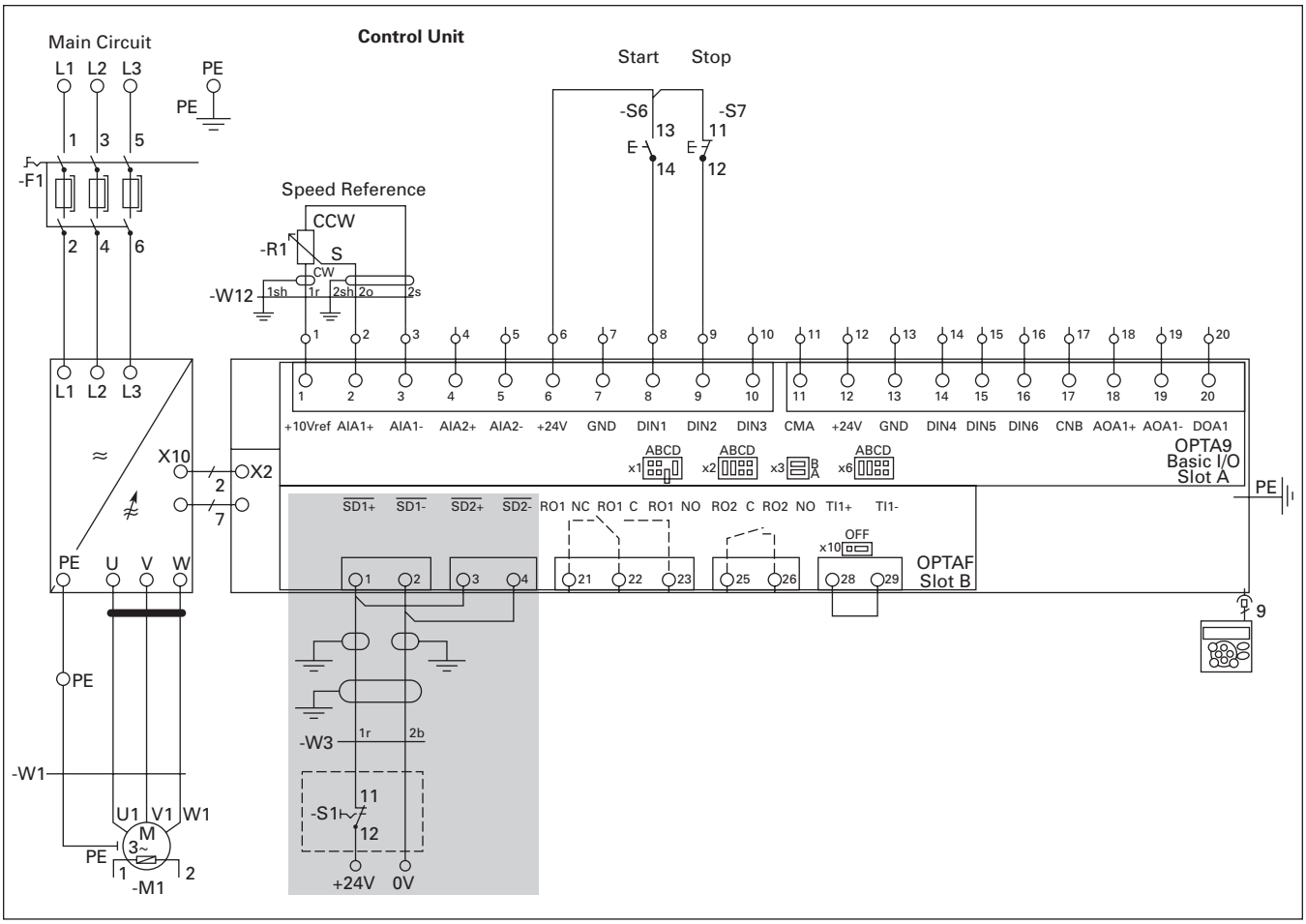


Figure 3-6: Example 5, Safe Disable Application with One Switch and Only 2 Wires Coming to the Drive

When the switch S1 is activated (contacts open), the drive will go to Safe Disable state and motor (if running) will stop by coasting. The drive will generate the warning "A30 Safe Disable".

When switch S1 is released (contacts closed), the drive returns to the ready state. The motor can then be run with a valid start command.

Note: All SPX9000 series drives containing the Safe Disable board are programmed to accept only edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

With an application as shown in **Figure 3-6**, fault exclusion for the cable is required and also a fault exclusion for the switch is necessary. The fault exclusion for the cable is described on **Page 3-9**.

Fault Exclusions for the Switch Connected to the Drive

For the switch, the electrical faults that must be considered and the ways they can be excluded are listed below, taken from ISO 13849-2 Table D8:

- Contact will not close
  No fault exclusion required
- Contact will not open

  Fault exclusion:

  – Contacts have to be in accordance with EN 60947-5-1:1997 (IEC 60947-5-1:1997), annex K.
- Short-circuit between adjacent contacts insulated from each other

  Fault exclusion:

  – Short-circuit can be excluded for switches in accordance with EN 60947-5-1:1997 (IEC 60947-5-1:1997) (see Remark 2)
- Simultaneous short-circuit between three terminals of changeover contacts

  Fault exclusion:

  – Simultaneous short-circuit can be excluded for switches in accordance with EN 60947-5-1:1997 (IEC 60947-5-1:1997) (see Remark 2)

  Remarks:
  2) Conductive parts which become loose should not be able to bridge the insulation between contacts.

The mechanical part of the switch must also be considered and it always depends on the application used. There are no general fault exclusion methods for the mechanical part of the switch described in ISO 13849-2. The designer has to consider all possible fault situations and their exclusions.

Commissioning

Note: The use of Safe Disable and other similar applications does not itself ensure safety. Always make sure that the safety of the entire system is confirmed. Also see the warnings on **Page 3-1**.

General Wiring Instructions

- The wiring should be done according to the general wiring instructions for the specific product where OPTAF is installed.
- Shielded cable is required for connecting the OPTAF board.
- EN 60204-1 part 13.5: The voltage drop from supply point to load should not exceed 5%.
- In practice, due to electromagnetic disturbances, the cable length should be limited to 200m max. In a noisy environment, the length of the cable could be even less than 200m.

Table 3-2: Example of Cable Types

Name	Conductors	Manufacturer
KJAAM	2 x (2 + 1) x 0.5 mm^2	Reka
JAMMAK	2 x (2 + 1) x 0.5 mm^2	Draka NK Cables Oy
RFA-HF(i)	2 x (2 + 1) x 0.5 mm^2	Helkama
LiYDY-CY TP	2 x (2 + 1) x 0.5 mm^2	SAB Bröckskes

Examples of Cable Sealing Grommets or Glands

Below you can see examples of cable sealing grommets or glands. Refer to the listed manufacturers or corresponding manufacturers for more information on correct types that are suitable for the hole and cable diameter:

Figure 3-7: VET Membrane Glands from Oy Mar-Con Polymers Ltd.

Figure 3-8: Cable Gland, Polystyrene from WISKA Hoppmann & Mulsow GmbH, Cable Accessory Systems

Figure 3-9: QUIXX Membrane for Several Cables from WISKA Hoppmann & Mulsow GmbH, Cable Accessory Systems
Note: A metric to PG adapter is needed.

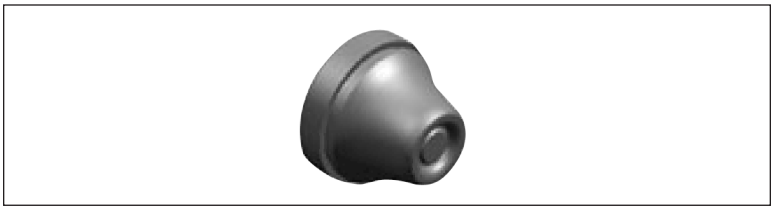


Figure 3-10: SNAP-PG Cable Grommet from A. Vogt GmbH & Co. KG (Gummivogt).

Figure 3-11: UNI Dicht Cable Glands for Multiple Cables from PFLITSCH GmbH

Figure 3-12: Cable Gland Model "PERFECT" with Multiple Sealing Insert from Jacob GmbH

Checklist for Commissioning the OPT-AF Board

The minimum steps required during connection of the Safe Disable function of the OPTAF board are shown in the checklist below. For ATEX related issues see the ATEX section.

Table 3-3: Checklist for Commissioning the Safe Disable Function

Step	Description	No	Yes
1	Has a risk assessment of the system been carried out to ensure that using the OPTAF board Safe Disable function is safe and according to local regulations?		
2	Does the assessment include an examination of whether using external devices such as a mechanical brake is required?		
3	Is the S1 switch EN954-1 Cat 3 compliant? **OR** Is the S1 switch an electromechanical switch with contacts that are in accordance with EN60947-5-1:1997 annex K?		
4	Is the reset function edge sensitive? If a reset function is used with Safe Disable it must be edge sensitive.		
5	The shaft of a permanent magnet motor might in an IGBT fault situation rotate up to 360 degrees/pole of the motor. Has it been ensured that the system is designed in such a way that this is acceptable?		
6	Is the enclosure class of the control unit, where the OPTAF board is installed, at least IP54? According to ISO13849-2 and table D5, PCBs containing safety related functions require a fault exclusion for short-circuit between two adjacent pads/tracks. This is realized with IP54 enclosure.		
7	Have the User Manual instructions for the specific product, on EMC compliant cabling been followed?		
8	Has the system been designed in such a way that activating (enabling) the drive through Safe Disable inputs will not lead to an unexpected start of the drive?		
9	Has this manual been read, understood and followed carefully?		
10	Have only approved units and parts been used?		
11	Is the SPX9000 control board VB00561 revision H, or newer? (See the sticker on the SPX9000 control board.)		
12	Is the SPX9000 system software version SPX00032V012.VCN, or newer?		
13	Has a routine been set up to ensure that the functionality of the safety function is being checked at regular intervals?		

Programming the Drive for the Safe Disable Function

There are no parameters for the Safe Disable function itself.

Faults Related to the Safe Disable Function

Table 3-4 shows the normal warning/alarm, generated when Safe Disable is active.

Table 3-4: Warning/Alarm Indicating that Safe Disable Function Is Active

Fault Code	Warning	Subcode	Possible Cause	Correcting Measures
30	**Safe Disable**	1	Safe Disable inputs $\overline{SD1}$ & $\overline{SD2}$ are activated through the OPTAF option board.	

Table 3-5 shows faults that may be generated from the software part that monitors the hardware related to the Safe Disable function. If some of the faults mentioned in this table occur, the fault may NOT be reset.

Table 3-5: Single Hardware Problems Detected in the Safe Disable Function

Fault Code	Fault	Subcode	Possible Cause	Correcting Measures
8	**System Fault**	30	Safe Disable inputs are in different state. Not allowed according to EN954-1 category 3. This fault occurs when the SD inputs are in different state more than 5 seconds.	– Check the S1 switch. – Check the cabling to the OPTAF board. – Single hardware problem possible in either OPTAF board *or SPX9000 control board*.
8	**System Fault**	31	Thermistor short circuit detected.	– Correct the cabling. – Check the jumper for the thermistor short circuit supervision, if thermistor function is not used, and the thermistor input is short circuited.
8	**System Fault**	32	OPTAF board has been removed.	– Do not remove the OPTAF board once it has been recognized by the software. **NOTE: There is only one method to clear this fault. By writing "OPTAF Removed" to "1" and then back to "0" again. This variable is found from the "System Menu" "Security" (6.5.5).**
8	**System Fault**	33	OPTAF board EEPROM error (checksum, not answering…)	– Change the OPTAF board.
8	**System Fault**	34 – 36	OPTAF supply voltage hardware problem detected.	– Change the OPTAF board.
8	**System Fault**	37 – 40	Single hardware problem detected in Safe Disable inputs.	– Change the OPTAF board *or the SPX9000 control board*.
8	**System Fault**	41 – 43	Single hardware problem detected in the thermistor input.	– Change the OPTAF board.
8	**System Fault**	44 – 46	Single hardware problem detected in Safe Disable inputs or in the thermistor input.	– Change the OPTAF board *or the SPX9000 control board*.
8	**System Fault**	47	OPTAF board mounted in old SPX9000 control board not equipped with Safe Disable function.	– Change the SPX9000 control board to VB00561, rev. H or newer.

Testing the Safe Disable Function

Note: After connecting the board ALWAYS make sure that the Safe Disable function is active by testing it before operating the system.

Note: Before testing the safe disable function, make sure that the checklist (**Table 3-3**) is inspected and completed.

When the Safe Disable function is activated with the switch S1, a code: A30 “Safe Disable” appears on the control keypad display. This indicates that the Safe Disable function is active. When releasing switch S1, the warning remains active for 10 seconds.

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Chapter 4 — Thermistor Function (ATEX)

The thermistor overtemperature supervision is designed in accordance with ATEX directive 94/9/EC. It is approved by VTT Finland for group II, category (2) in the "G" area (area in which potentially explosive gas, vapor, mist or air mixtures are present) and D area (area with combustible dust).

CE 0537 Ex II (2) GD

It can be used as an overtemperature tripping device for motors in explosive area (EX motors) in addition to thermal overload protection available in the drive.

Note: The OPTAF board also contains the Safe Disable functionality. When Safe Disable is not intended to be used, inputs SD1+(OPTAF: 1), SD2+(OPTAF:3) are to be connected to +24V (e.g. OPTA1:6) & SD1-(OPTAF:2). SD2- (OPTAF:4) are to be connected to GND (for e.g. OPTA1:7).

Note: Safety devices like the OPTAF board must be correctly incorporated into the entire system. The functionality of the OPTAF board is not necessarily suitable for all systems. The entire system must be designed in compliance with all relevant standards within the field of industry. Maximum SIL capability of this function in the drive is SIL1.

⚠ CAUTION

The information in this manual provides guidance on the use of thermistor function for protecting overheating of motors in explosive atmosphere. This information is ensured to be correct and in compliance with accepted practice and regulations at the time of writing. However, the end product/system designer is responsible for ensuring that the system is safe and in compliance with relevant regulations.

⚠ CAUTION

During maintenance breaks, or in case of service/repair the OPTAF board might have to be removed from its slot. After reconnecting the board ALWAYS make sure that the thermistor function is working correctly by testing it.

⚠ CAUTION

The thermistor function on OPTAF board with SPX9000 control is used to protect the overheating of motors in explosive atmosphere. The drive itself including OPTAF board can not be installed in explosive atmosphere.

Note: This function can be used with Exe-, Exd-, and ExnA- type of motors. In case of Exe-, and ExnA- motors, the end user has to confirm that the installation of the measurement circuit is done according to area classification. E.g. in Exe- and ExnA- motors PTC sensors shall be certified together with the motor according to the requirements of the type of protection. The allowed ambient temperature range is -10°C – +50°C.

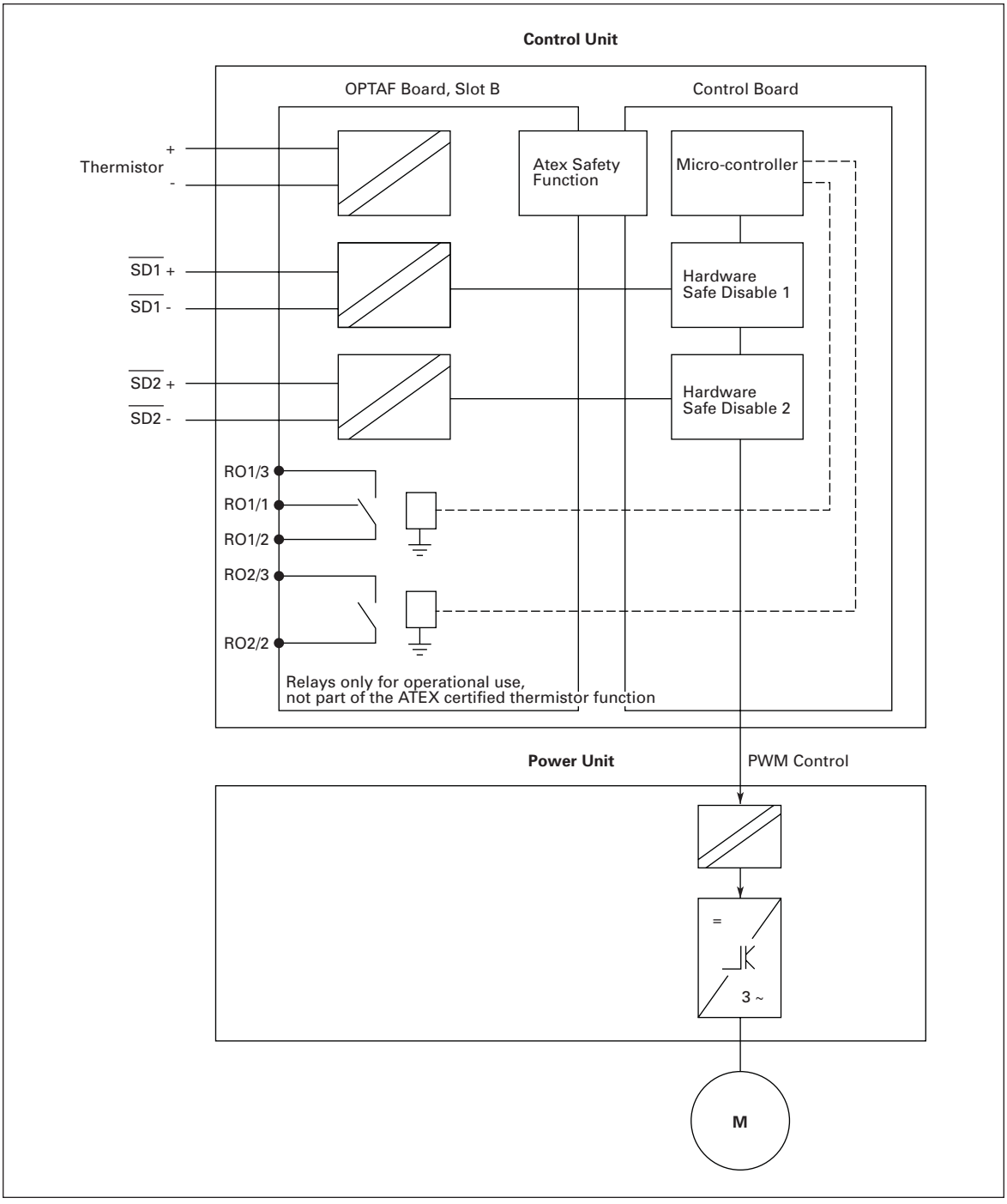

Figure 4-1: Thermistor Function Principle in SPX9000 Drive with the OPTAF Board

Hardware and Connections

Table 4-1: OPTAF I/O Terminals

Terminal		Parameter Reference on Keypad and Drive	Technical Information	
1	$\overline{\text{SD1}}$+	DigIN:**B.2**	Isolated **S**afe **D**isable input 1	+24V +-20% 10 – 15 mA
2	$\overline{\text{SD1}}$-		Virtual GND 1	
3	$\overline{\text{SD2}}$+	DigIN:**B.3**	Isolated **S**afe **D**isable input 2	+24V +-20% 10 – 15 mA
4	$\overline{\text{SD2}}$-		Virtual GND 2	
21 **22** **23**	RO1/normal closed RO1/common RO1/normal open	DigOUT:**B.1**	Relay output 1 (NO/NC) ① Switching capacity Min. switching load	 24V DC/8A 250V AC/8A 125V DC/0.4A 5V/10 mA
25 **26**	RO2/common RO2/normal open	DigOUT:**B.2**	Relay output 2 (NO) ① Switching capacity Min. switching load	 24V DC/8A 250V AC/8A 125V DC/0.4A 5V/10 mA
28 **29**	TI1+ TI1-	DigIN:**B.1**	Thermistor input; R_{trip} ≥4.0 kΩ (PTC) Max. voltage = 10V Max. current = 6.7 mA Ambient temperature range -10°C to 50°C	

① If 230V AC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9.

The thermistor (PTC) is connected between the terminals 28(TI1+) and 29(TI1-) of the OPTAF board. The optocoupler isolates the thermistor inputs from the control board potential.

The overtemperature is detected by hardware on the OPTAF board. See temperature versus resistance curve in **Figure 4-2**.

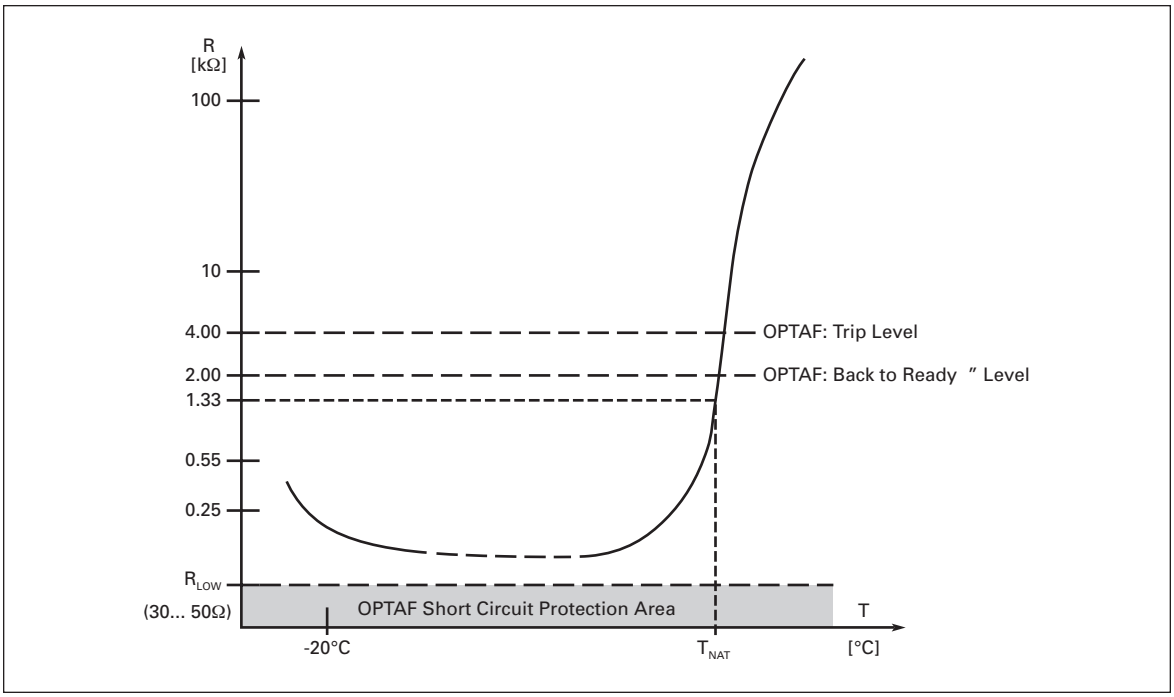

Figure 4-2: Typical Characteristics of a Motor Protection Sensor as Specified in DIN 44081/DIN 440

Commissioning

Note: Installation, testing and service work on the OPTAF board must be performed only by authorized professionals.

Note: Do not perform any repair work on the OPTAF board.

General Wiring Instructions

The thermistor connection must be done using a separate control cable. Do not use wires belonging to the motor supply cables or any other main circuit cables. It is recommended that a shielded control cable is used.

Table 4-2: Maximum Cable Lengths

	Maximum Cable Length without Short Circuit Monitoring X10: OFF	**Maximum Cable Length with Short Circuit Monitoring X10: ON**
≥ 1.5 sq mm	4920 feet (approx. 1500m)	820 feet (approx. 250m)

Note: Eaton recommends testing the ATEX functionality using thermistor input on OPTAF board periodically (typically once a year). For testing, the thermistor connection to the OPTAF board is disconnected. The drive ready signal goes low (green LED on the keypad goes OFF). Check for the corresponding warning or fault indication in the drive according to the parameter setting explained below.

Parameter Setting for ATEX Function

In case of overtemperature, the drive modulation is disabled. The drive will no longer feed energy to the motor which prevents further overheating. See **Figure 4-1**.

When the drive is connected to the main power and the motor temperature is within overtemperature limits, the drive goes to ready state. The motor may start in the presence of start command from a selected control place.

If the motor temperature is above the overtemperature limits, fault/warning (F29) thermistor is activated depending on the programming in the application.

The application programming for the thermistor fault is as follows in factory applications.

Table 4-3: Thermistor Fault Parameter

Code	**Parameter**	**Default**	**ID**	**Note**
P2.7.21	Response to Thermistor Fault	2	732	0 = No Response 1 = Warning 2 = Fault according to Stop Mode ① 3 = Fault, stop by coasting

① With OPTAF board according to ATEX directive 94/9/EC (i.e jumper X12 not cut), response to thermistor fault = 2 is always same as response to thermistor fault = 3, i.e. stop by coasting.

When the resistance of the thermistor mounted in the motor goes above 4 kΩ due to motor overheating, the drive modulation is disabled within 20 mS. Fault F29 or warning A29 is generated in the drive according to the above-mentioned programming.

According to the curve, when the temperature falls below 2 kΩ (see **Figure 4-2**), the drive can be restarted by giving a valid start command.

The thermistor fault configuration causes the following reactions:

- Response to thermistor fault = No action. No warning/fault is generated in case of overtemperature. The drive goes to run disable mode. The drive can be restarted when temperature is normalized by giving a valid start command.
- Response to thermistor fault = Warning. A29 is generated in case of overtemperature. The drive goes to run disable mode. The drive can be restarted when temperature is normalized by giving a valid start command when the drive has returned to ready state.
- Response to thermistor fault = Fault. F29 is generated in case of overtemperature and the drive goes to run disable mode. When the temperature is normalized, a reset command is needed before the drive can be restarted. The drive returns to ready state. A valid start command is then needed to restart the drive.

Note: All SPX9000 series drives containing the OPTAF board are programmed to accept only an edge sensitive start command for a valid start. To start the motor operation, a new start command is required after the drive returns to ready state.

Short Circuit Monitoring

The thermistor inputs TI1+ and TI1- are monitored for short circuit. If a short circuit is detected, the drive modulation is disabled within 20 mS, F8 system fault (subcode 31) is generated. When the short circuit has been removed, the drive can be reset only after power recycles to the SPX9000 control board.

The short circuit monitoring can be enabled or disabled using the jumper X10 in ON or OFF position respectively. The jumper is set in ON position by factory default.

⚠ IMPORTANT

For the functionality of OPTAF board according to ATEX directive 94/9/EC, **check that jumper X12 is not damaged or cut**. Also set the parameter Expander Boards/Slot B/"Therm Trip (HW)" to "ON".

Exceptional Use of Thermistor Function on OPTAF Board
(Similar to OPTA3, Not in Compliance with ATEX Directive 94/9/EC)

In systems where the drive detects the overtemperature of the motor through a thermistor input, there might be a need of running down the whole system in a controlled way or continue running the motor. In these cases the thermistor input must not cause an immediate stop of the drive. To achieve this functionality, the following actions must be carried out:

- Cut the jumper X12 on OPTAF board.
- Set the jumper X10 to OFF position (short circuit monitoring disabled).
- Set the parameter Expander Boards/Slot B/"Therm Trip (HW)" to "Off".

⚠ WARNING

When the jumper X12 is cut, the OPTAF board is no longer valid for use in an environment that requires a certified overheating protection device according to the ATEX directive 94/9/EC.

Table 4-4: OPTAF Board Parameter

Code	Parameter	Default	Note
P7.2.1.1	Therm Trip (HW)	"On"	**Correct settings:** – Jumper X12 not cut and this board parameter "On" (for ATEX) – Jumper X12 cut and this board parameter "Off" (for **no** ATEX and similar to OPTA3) **Wrong settings:** – If jumper X12 is cut and this board parameter is "On", thermistor trip will cause unresettable System Fault 8, subcode 41. – If jumper X12 is not cut and this board parameter is "Off", thermistor trip will cause unresettable System Fault 8, subcode 48.

Fault Diagnosis

The table below shows the normal fault/warning generated when thermistor input is active.

Table 4-5: Fault/Warning Indicating that the Thermistor Is Active

Fault Code	Fault/Warning	Subcode	Possible Cause	Correcting Measures
29	**Thermistor**	1	Thermistor input is activated (> 4 kΩ) on the OPTAF option board.	The resistance of thermistor input must go below 2 kΩ to be able to restart the drive.

The table below shows faults that may be generated from the software that monitors the hardware related to the Safe Disable and thermistor function. If some of the faults mentioned in this table occur, the fault may NOT be reset.

Table 4-6: Faults Related to the Safe Disable and Thermistor Function

Fault Code	Fault/Warning	Subcode	Possible Cause	Correcting Measures
8	**System Fault**	30	Safe Disable inputs are in different state. Not allowed according to EN954-1 category 3. This fault occurs when the SD inputs are in different state more than 5 seconds.	– Check the S1 switch. – Check the cabling to the OPTAF board. – Single hardware problem possible in either OPTAF board *or SPX9000 control board*.
8	**System Fault**	31	Thermistor short circuit detected.	– Correct the cabling. – Check the jumper for the thermistor short circuit supervision, if thermistor function is not used, and the thermistor input is short circuited.
8	**System Fault**	32	OPTAF board has been removed.	– Do not remove the OPTAF board once it has been recognized by the software. **NOTE: There is only one method to clear this fault. By writing "OPTAF Removed" to "1" and then back to "0" again. This variable is found from the "System Menu" "Security" (6.5.5).**
8	**System Fault**	33	OPTAF board EEPROM error (checksum, not answering…)	– Change the OPTAF board.
8	**System Fault**	34 – 36	OPTAF supply voltage hardware problem detected.	– Change the OPTAF board.
8	**System Fault**	37 – 40	Single hardware problem detected in Safe Disable inputs.	– Change the OPTAF board *or the SPX9000 control board*.
8	**System Fault**	41 – 43	Single hardware problem detected in the thermistor input.	– Change the OPTAF board.
8	**System Fault**	44 – 46	Single hardware problem detected in Safe Disable inputs or in the thermistor input.	– Change the OPTAF board *or the SPX9000 control board*.
8	**System Fault**	47	OPTAF board mounted in old SPX9000 control board not equipped with Safe Disable function.	– Change the SPX9000 control board to VB00561, rev. H or newer.
8	**System Fault**	48	Parameter Expander boards/ SlotB/Therm Trip(HW) is set to OFF even if the jumper X12 is not cut.	– Correct the parameter according to the jumper settings.

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Company Information

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