Danfoss

Installation Guide

VLT®Safety Option MCB 152
VLT® AutomationDrive FC 302 and VLT® Decentral Drive FCD 302

Status | Quick Menu | Main Menu | Alarm Log

Back | Cancel | Info

On
Warn.
Alarm

OK

Hand On | Off | Auto On | Reset

VLT®
AutomationDrive

ENGINEERING
TOMORROW

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EU DECLARATION OF CONFORMITY
Danfoss A/S
Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter Options
Type designation(s):

Safety Option:	Product Safety Function:
MCB150 (order no.: 130b3280)	STO, SS1, SLS
MCB151 (order no.: 130b3290)	STO, SS1, SLS
MCB152 (order no.: 130B9860)	STO (PROFIsafe)

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EN61800-5-1 (2007)+A1:2017	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

Machinery Directive 2006/42/EC

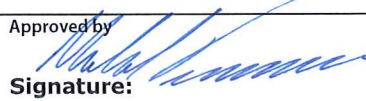| EN ISO 13849-1:2008	Safety of machinery – Safety related parts of control systems – Part 1: General principles for design.
EN 62061:2013	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN 61800-5-2:2008	Adjustable speed electrical power drive systems – Part 5-2: Safety requirement – Functional
EN 61508-1 to 7:2011	Functional safety of electrical/electronic/programmable electronic safety related systems – parts 1-7
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines – Part 1: General requirement.

RoHS Directive 2011/65/EU including amendment 2015/863.

EN63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

Date: 2020.09.15 Place of issue:	Issued by	Date: 2020.09.15 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Gert Kjær** **Title: Senior Director, GDE**	Graasten, DK	**Signature:** **Name: Michael Termansen** **Title: VP, PD Center Denmark**

Danfoss only vouches for the correctness of the English version of this declaration. In the event of the declaration being translated into any other language, the translator concerned shall be liable for the correctness of the translation

Contents

1 Introduction

1.1 Purpose of this Installation Guide

This manual provides information for safe installation and commissioning of a VLT® Safety Option MCB 152 for PROFIsafe communication

The Installation Guide is intended for use by qualified personnel only. Personnel must be familiar with the VLT® drive series.

Read and follow this Installation Guide before installation, and ensure that instructions for safe installation are observed. Always keep these instructions available with the drive.

1.2 Trademarks

VLT® is a registered trademark for Danfoss A/S.

1.3 Additional Resources

More information resources are available to understand advanced drive functions and programming.

- The VLT® AutomationDrive FC 301/FC 302 and the VLT® Decentral Drive FCD 302 Operating Guides provide information required to install and commission the drive for given applications.
- The VLT® PROFINET MCA 120 Installation Guide provides instructions on how to install the PROFINET option.
- VLT® Motion Control Tool MCT 10 Operating Guide describes how to configure the safety option via the MCT 10 Set-up Software.
- VLT® Frequency Converters Safe Torque Off Operating Guide describes the use of VLT® FC Series drives in functional safety applications.

Technical documentation for other product options is available at www.danfoss.com.

1.4 Document Version

This Installation Guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this manual is English.

Table 1: Document Version

Revision	Remarks
AN327351953089, version 0101	Now also available for VLT® Decentral Drive FCD 302. Changed from Operating Guide to Installation Guide.

1.5 Product Overview

1.5.1 Intended Use

VLT® Safety Option MCB 152 is designed to activate and deactivate safety functions of a drive through the PROFIsafe fieldbus. Using the fieldbus, requires the VLT® PROFINET MCA 120 option to be installed. The safety functions of the safety option are implemented according to EN IEC 61800-5-2.

The safety option:

- Activates safety functions on request.

- Sends status information to the safety control system via a connected PROFINET fieldbus.

- Activates the safe state when the option detects faults.

The safety control system:

- Activates safety functions via input on the safety option and/or via the safe fieldbus.

- Evaluates signals from safety devices, such as:

  - E-STOP push buttons

  - Non-contact magnetic switch

  - Interlocking switch

  - Light curtain devices

  The safety devices are connected to digital inputs of the safety option or digital input of the PLC.

- Provides safe connection between the safety option and a safety control system.

- Provides fault detection on the signal between a safety control system and the safety option at activation of safety functions (short across contacts, short circuit).
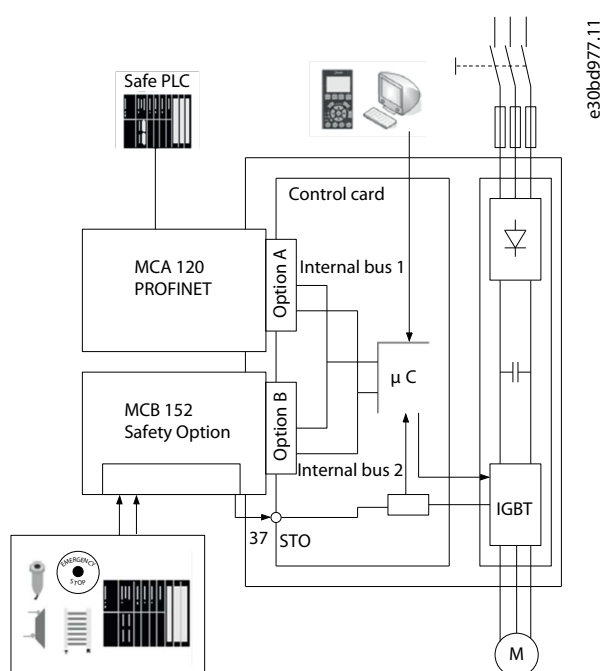
Illustration 1: FC 302 with VLT® Safety Option MCB 152 and Fieldbus Option

1.5.2 Unit Features

The safety option has the following features:

- Safety functions: Safe Torque Off (STO) in accordance with EN IEC 61800-5-2
- PROFIsafe version 2.4 communication
- Two dual-channel digital inputs:
  - Safety function activation
  - Monitoring
  - Configurable reset behavior (automatic or manual reset).
- LED status indication
- Supply voltage
  - Internally supplied by the drive
  - 24 V DC output for safety sensors available.
- Safe output S37

1.5.3   Items Supplied

- VLT® Safety Option MCB 152
- VLT® Safety Option MCB 152 Installation Guide

1.5.4   Compatible Drive Series

The VLT® Safety Option MCB 152 is a standard B option compatible with:

- VLT® AutomationDrive FC 302
- VLT® Decentral Drive FCD 302

1.5.5   Front View
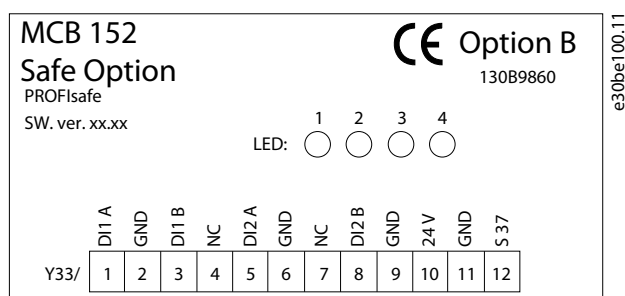
Illustration 2:   VLT® Safety Option MCB 152 Front View

1.5.6   Hardware and Software Requirements

The following software versions are required as a minimum when using VLT® Safety Option MCB 152:

- LCP software version 7.0
- VLT® AutomationDrive FC 302 firmware version 7.26
- VLT® Decentral Drive FCD 302 firmware version 8.23
- PROFINET software version 3.0
- VLT® Motion Control Tool MCT 10 software version 3.23. A license key is required to use the full set of features.

1.6 Compliance and Certifications

The VLT® Safety Option MCB 152 is certified for use in safety applications up to and including:

- SIL 2 according to EN IEC 61508 and EN IEC 62061
- Performance Level PL d.
- Category 3 according to EN ISO 13849-1

Safety requirements are based on the standards valid at the time of certification. The VLT® Safety Option MCB 152 is approved for use in safety-related applications where the de-energized state is considered to be the safe state. All examples related to I/O included in this manual are based on achieving de-energization as the safe state.

Approvals

The MCB 152 is tested and certified by PNO.

1.7 Disposal

	Do not dispose of equipment containing electrical components together with domestic waste. Collect it separately in accordance with local and currently valid legislation.

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

> ⚠ **DANGER** ⚠
>
> Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

> ⚠ **WARNING** ⚠
>
> Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

> ⚠ **CAUTION** ⚠
>
> Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

> **NOTICE**
>
> Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

The products must only be assembled, installed, programmed, commissioned, maintained, and decommissioned by persons with proven skills. Persons with proven skills:

- Are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plant, and machinery in accordance with the general standards and guidelines for safety technology.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in this manual and also the instructions given in the operating guide of the drive.
- Have good knowledge of the generic and specialist standards applicable to the specific application.

2.3 Responsibilities of Users of PDS(SR)

Context:

In EN ISO 12100, risk assessment is defined as an overall process comprising a risk analysis and a risk evaluation.

Procedure

1. Carry out a hazard and risk analysis of the application according to EN ISO 12100.
2. Identify safety functions required and allocate SIL or PLr to each of the functions.
3. Identify other subsystems and validate the signals and commands from those subsystems.
4. Design appropriate safety-related control systems (hardware, software, parameterization, and more).

2.4 Protective Measures

- Safety engineering systems may only be installed and commissioned by qualified and skilled personnel.

- Install the drive in an IP54 cabinet as per IEC 60529 or in equivalent environment. In special applications, a higher IP degree may be necessary.

- Ensure short-circuit protection of the cable between the safety option and the external safety device according to ISO 13849-2 table D.5. When external forces influence the motor axis (for example, suspended loads) extra measures (for example, a holding safety brake) are required to eliminate hazards.

2.5 Safety Precautions

⚠ WARNING ⚠

HIGH VOLTAGE

AC drives contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel must perform installation, start-up, and maintenance.

⚠ WARNING ⚠

UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

- Press [Off] on the LCP before programming parameters.

- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.

- Check that the drive, motor, and any driven equipment are in operational readiness.

⚠ WARNING ⚠

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.

- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.

- Wait for the capacitors to discharge fully. The minimum waiting time is specified in the table *Discharge time* and is also visible on the nameplate on top of the drive.

- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Table 2: Discharge Time, VLT® AutomationDrive FC 302

Voltage [V]	Minimum waiting time (minutes)					
	4	**7**	**15**	**20**	**30**	**40**
200–240	0.25–3.7 kW (0.34–5 hp)	–	5.5–37 kW (7.5–50 hp)	–	–	–
380–500	0.25–7.5 kW (0.34–10 hp)	–	11–75 kW (15–100 hp)	90–200 kW (150–350 hp)	250–500 kW (450–750 hp)	250–800 kW (450–1350 hp) 315–500 (500–750 hp)
400	–	–	–	90–315 kW (125–450 hp)	–	–
500	–	–	–	110–355 kW (150–450 hp)	–	–
525	–	–	–	55–315 kW (75–400 hp)	–	–
525–600	0.75–7.5 kW (1–10 hp)	–	11–75 kW (15–100 hp)	–	–	–
525–690	–	1.5–7.5 kW (2–10 hp)	11–75 kW (15–100 hp)	37–315 kW (50–450 hp)	355–1200 kW (450–1550 hp)	355–2000 kW (450–2050 hp) 355–710 kW (400–950 hp)
690	–	–	–	55–315 kW (75–400 hp)	–	–

Table 3: Discharge Time, VLT® Decentral Drive FCD 302

Voltage [V]	Minimum waiting time (minutes)		
	4	**7**	**15**
200–240	0.25–3.7 kW (0.34–5.0 hp)	–	5.5–37 kW (7.5–50 hp)
380–500	0.25–7.5 kW (0.34–10 hp)	–	11–75 kW (15–100 hp)
525–600	0.75–7.5 kW (1.0–10 hp)	–	11–75 kW (15–100 hp)
525–690	–	1.5–7.5 kW (2.0–10 hp)	11–75 kW (15–100 hp)

⚠ WARNING ⚠

UNINTENDED MOVEMENT

When external fores act on the motor, and unwanted movement, for example, caused by gravity, can cause a hazard. Failure to take extra measures for fall protection can result in death r serious injury.

- Equip the motor with fall protection, for example, extra mechanical brakes.

> ⚠ **WARNING** ⚠
>
> **EMERGENCY OFF**
>
> The STO function does not provide electrical safety, and is not sufficient to implement the Emergency-Off function as defined by EN 60204-1. Failure to implement the Emergency-Off function properly can result in death or serious injury.
>
> - Ensure safe isolation of electricity, for example, by installing an emergency stop contactor to disconnect mains.

> ⚠ **CAUTION** ⚠
>
> The operator or electrical installer is responsible for proper grounding and compliance with all applicable national and local safety regulations.

2.6 Risk Assessment

> **NOTICE**
>
> The safety option is intended to be part of the safety-related control system of a machine. Before installation, perform a risk assessment to determine whether the specifications of this safety option are suitable for all foreseeable operational and environmental characteristics for the system in which it will be installed.

The system user is responsible for:

- Set-up, safety rating, and validation of any actuators connected to the system.
- Completing a system-level risk assessment and reassessing the system anytime a change is made.
- Providing supposition (as needed for the application) that the system fulfills the requested safety rating.
- Project management and proof testing.
- Programming the application software and the safety option configurations in accordance with the information in this manual.
- Access to the control system.
- Access to the safety option customization (configuration changes).
- Analyzing all configuration settings and selecting the proper setting to achieve the required safety rating.

2.6.1 Validation of Performance Level

Check whether the required Performance Level "PLr", determined in the risk assessment, is achieved by the selected system for each safety sub-function used. Check the calculation using the SISTEMA SW Tool of IFA (Institute for Occupational Safety & Health). Danfoss provides a component library, which can be used for the calculation. Danfoss offers corresponding services to support the system check by calculation. The library can be downloaded from www.dguv.de.

If using another validation method for the performance level, use the characteristic safety values specified.

3 Functions

3.1 Safety Functions

International standards EN ISO 13850 and EN IEC 60204-1 specify the functional requirements and design principles of emergency stop devices.

In control systems where there is a risk of equipment damage or personal injury, safety-related parts of control systems (SRP/CS) are required to minimize the risk. SRP/CS include the following general components:
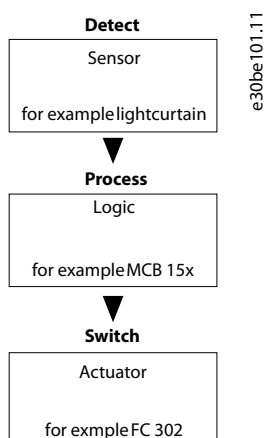
Illustration 5: Sensor-Logic-Actuator Safety Chain

Safety functions are defined based on both the application and the hazard. They are often specified in a Type C standard (a product standard), which provides precise specifications for special machines. If a C standard is not available, the macine designer defines the safety functions. Typical safety functions are described in more detail in EN ISO 13849-1, section 5, Specification of Safety Functions. The safety functions for drive systems are described in IEC 61800-5-2.

> # NOTICE
>
> When designing the machine application, consider timing and distance for a coast to stop (Stop Category 0 or Safe Torque Off (STO)). For more information regarding stop categories, refer to EN IEC 60204-1.

3.2 Safe Torque Off - STO

The safety function Safe Torque Off disconnects power to the motor. It is implemented via the shutdown path of the drive and the safe outputs of the safety option.

Features of the safety subfunction

- The motor becomes torque-free and no longer generates any hazardous movements.
- The safety function STO corresponds to a Category 0 stop (uncontrolled stop) in accordance with EN IEC 60204-1.
- The safety subfunction Safe Torque Off corresponds to a category 0 stop (uncontrolled stop) in accordance with EN IEC 60204-1.

Prerequisites for normal operation

- The fail-safe PLC has acknowledged operation of safety inputs.
- STO is not activated through the safe fieldbus.
- STO is not activated via inputs DI1 or DI2 if those inputs are configured.
- PROFIsafe communication is established and functional.
- The safety option detected no faults and there is no pending safety function.

When the prerequisites for normal operation are met, safe output S37 is active (signal 1, +24 V DC).

Safety function is activated in following cases

- An internal fault on the safety option.
- Power-up self-test (PUST).
- External faults at digital inputs.
- Changes in configuration via MCT 10 Safe Plug-in if the current drive is running.
- There is a 1/0 transition on a digital input or the STO signal through the safe fieldbus
- PROFIsafe communication is not established.

STO disables the control voltage of the drive output. This prevents the drive from generating the voltage required to rotate the motor (see illustration 6). STO is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety. STO should not be used as a control for starting and/or stopping the drive.
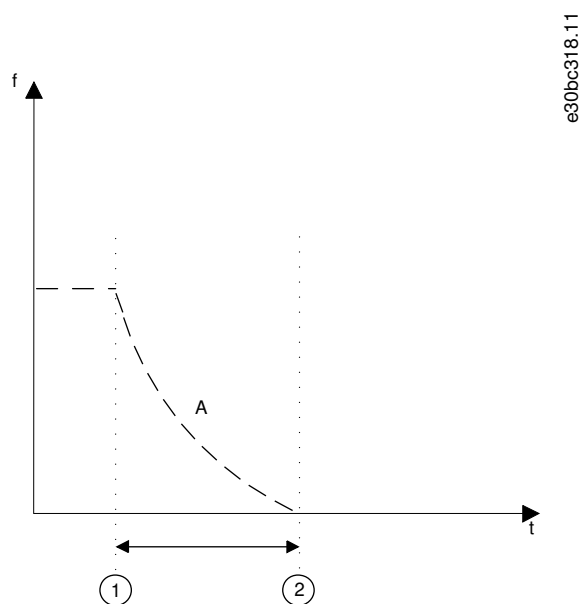
A	Actual frequency	**1**	Activation of STO
2	Motor standstill		

Illustration 6:   Safe Torque Off

3.3   Specification of Safety functions

The standards require a specification of functional requirements. The specification must contain details about each safety function that should be executed. Also define the:

- Necessary interfaces with other control functions.
- Required fault responses.
- Performance level required PLr or achievable SIL level.

3.4   Activation of Safety functions

- The safety functions are activated using the dual-channel safe inputs on the safety option or using the PROFIsafe communication.
- These inputs operate in accordance with the idle-current principle (activate when switching off). The safety control system activates the safety functions via a 1/0 transition.

3.5   Activation of STO from Multiple Sources

If multiple sources activate STO (via digital inputs and safe fieldbus), all sources must deactivate STO in the safety option to return to normal operation. After all sources deactivate STO, a reset of the safety option might be required depending on the settings of the digital inputs.

3.6   Functional Proof Tests

The functional safety standards require that functional proof tests are performed on the equipment used in the system. Proof tests are performed at user-defined intervals and depend on PFD and PFH values.

3.7   PFD and PFH Definitions

Safety-related systems can be classified as operating in either a low-demand mode or in a high-demand/continuous mode.

Low-demand mode

The frequency of demands for operation made on a safety-related system is maximum once per year. The SIL value for a low-demand safety-related system is directly related to order-of-magnitude ranges on its average probability of failure on demand (PFD).

High-demand/continuous mode

The frequency of operation made on a safety-related system is higher than once per year. The SIL value for a high-demand/continuous mode safety-related system is directly related to the probability of a dangerous failure per hour (PFH).

3.8   Internal Faults

Any internal fault in the safety option activates the safety function STO. The drive coasts the motor.

Internal faults always require a power cycle of the drive to reset the fault. Alternatively, use *parameter 42-90 Restart Safe Option* to restart the safety option after internal fault without power cycling the drive.

3.9 Inputs and Outputs

3.9.1 Allowed Sensor Types on Digital Inputs

The following list describes how digital inputs are activate depending on sensor types.

- NCNC: A digital input is active when there is 0 V at both channels of the input.
- Antivalent switches: A digital input is active only when there is 0 V at channel A and 24 V at channel B.
- NC: The functionality is similar to NCNC.

Sensors with 2 NO switches are not applicable.

The safe digital inputs are configured for both directly connecting safety sensors, for example emergency stop control devices or light curtains, and for connecting preprocessing safety relays, for example, safe controls. See examples of connecting the safe digital input, in accordance with EN ISO 13849-1 and EN IEC 62061 in 8.1 Connecting Safe Digital Inputs.

3.9.2 Inputs

The dual-channel digital inputs are used to activate the safety functions. 1 or both digital inputs can be disabled.

DI 1 can have 1 of the following functions:

- STO: Safe Torque Off.
- SO Mon: Safe option monitoring through the safe fieldbus.

DI2 can have 1 of the following functions:

- STO: Safe Torque Off.
- SO Mon: Safe option monitoring.
- Reset: Extra safe input to reset the safety option after a fault, or after deactivating a safety function on input DI1.

3.9.3 Safe Option Monitoring (SO Mon)

The PLC can use the digital inputs of the safety option as safe inputs. If a digital input is set to *Safe Option Monitoring (SO Mon)*, the safety option maintains all signal checks (discrepancy, and so on) on the digital inputs, but the safety option does not activate safety functions if a signal changes. All safety logic is carried out by the PLC.

3.9.4 Output

S37 is the safe, single-channel output that goes to the STO input of the drive. For information about the events that trigger STO, see 3.2 Safe Torque Off - STO.

3.9.5 Signal Filtering

If a sensor with NCNC or antivalent is selected, the safety option checks the signals of the safe digital input for consistency. If NCNC is selected, consistent signals at both inputs always assume the same signal state (high or low). If antivalent is selected, it checks the right state of each input.

With electromechanical sensors (for example, emergency stop buttons or door switches), the 2 sensor switches never switch at the same time (discrepancy). A long-term discrepancy points towards a fault in the wiring of a safe input, for example, a wire break. An

adjustable filter in the safety option prevents faults caused by temporary or short-term discrepancy. Within the filter tolerance time (*parameter 42-22 Discrepancy Time*), the safety option suppresses the discrepancy monitoring of the safe inputs.

If the signals have different levels after the discrepancy time expires, the option responds with an external error.

> **NOTICE**
>
> The discrepancy time does not extend the safety option response time. The safety option activates its safety -function when there is a signal transition on 1 of the 2 channels of a digital input.
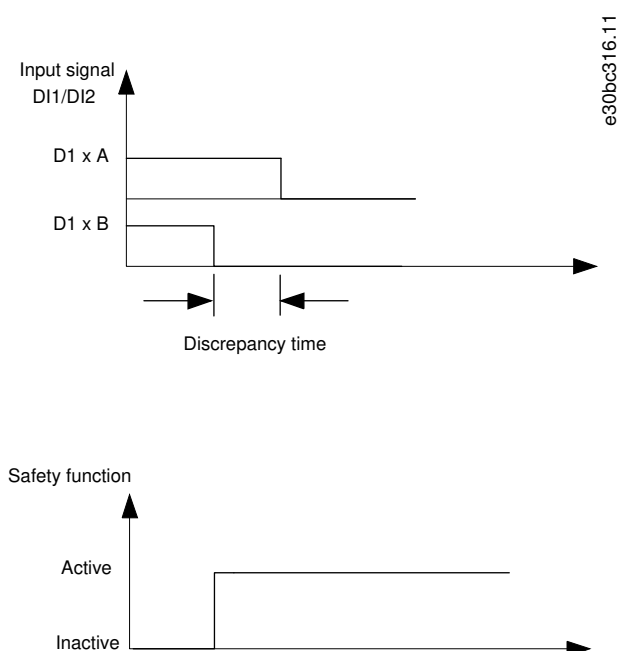
Illustration 7:   Discrepancy Time

3.9.6   Stable Signal Time from Safe Outputs

The safety option normally responds immediately to signal changes at its safe input DI1 or DI2. This response is not required in the following cases:

- When interconnecting the safe input of the option with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the option could respond.
- Several control modules test their safe outputs using test pulse pattern (on/off tests), to identify faults due to either short or cross circuiting. When interconnecting the safe input of the option with a safe output of a control module, the option could respond to these test signals.

A signal change during a test pulse pattern usually lasts 1 ms.

Under stable signal time, short pulses, which could lead to safety functions being incorrectly activated, can be filtered.

N O T I C E

The stable signal time extends the safety option response time. The safety option only activates the safety function after the response time has expired.

If the signal to the input on safety option is not stable, the option responds with an external fault after the stable signal time expires.

Definition of a Stable Signal

Following a change to the DI input signals, the option triggers an internal monitoring time. Use *parameter 42-23 Stable Signal Time* to select an appropriate stable signal time. A constant signal level is a high or a low state, at least for the time specified in *parameter 42-23 Stable Signal Time*.
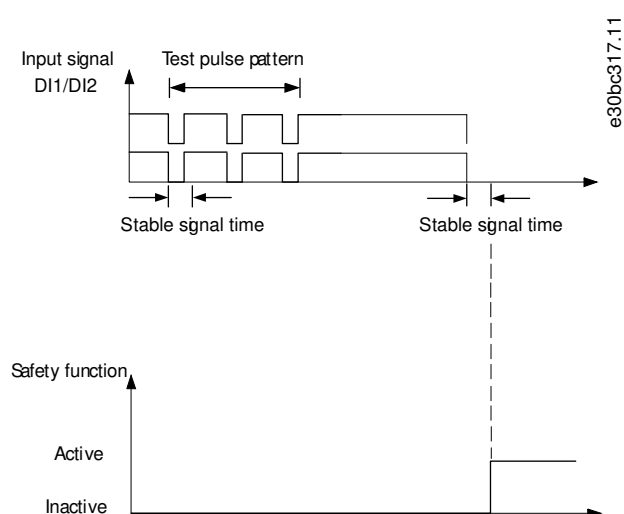
Illustration 8:   Filter for Suppressing Temporary Signal Changes

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4 Installation

4.1 Safety Instructions

> ⚠ **WARNING** ⚠
>
> **RISK OF DEATH OR INJURY**
>
> The AC drive contains high voltage when connected to AC mains supply, DC supply, or load sharing. Failure to follow the instructions in this warning may result in death or serious injury.
>
> - Before installation, disconnect the power supply voltage to the drive.
> - Switch off all dangerous voltages connected from external control circuits to the inputs and outputs of the drive.
> - Never install an option card into the drive during operation.
> - In addition to conventional installation tools, have the VLT® AutomationDrive FC 301/FC 302 Operating Guide or the VLT® Decentral Drive FCD 302 Operating Guide, and the VLT® Motion Control Tools MCT 10 Operating Guide available as they contain important information that is not included in this manual.

> ⚠ **WARNING** ⚠
>
> **ELECTRICAL HAZARD**
>
> Activation of STO does not provide electrical safety. The safety device connected to the dual-pole input of the safety option must fulfill the required safety level for the application for interrupting the voltage/current to the safety option. This is also valid for the connections between the safety option's safe output S37 and terminal 37 on the drive.
>
> - To connect the safety device correctly to the safety option, read and follow the instructions in this manual.

> **NOTICE**
>
> The safety option is exclusively intended for use in option slot B.

4.2 Installation Overview

This section contains the general overview of the installation and commissioning processes.

> **NOTICE**
>
> It is not possible to install the VLT® Safety Option MCB 152 into a VLT® Decentral Drive FCD 302. It is placed into the drive by factory. For VLT® Decentral Drive FCD 302, chapters 4.2 to 4.4 can be skipped.

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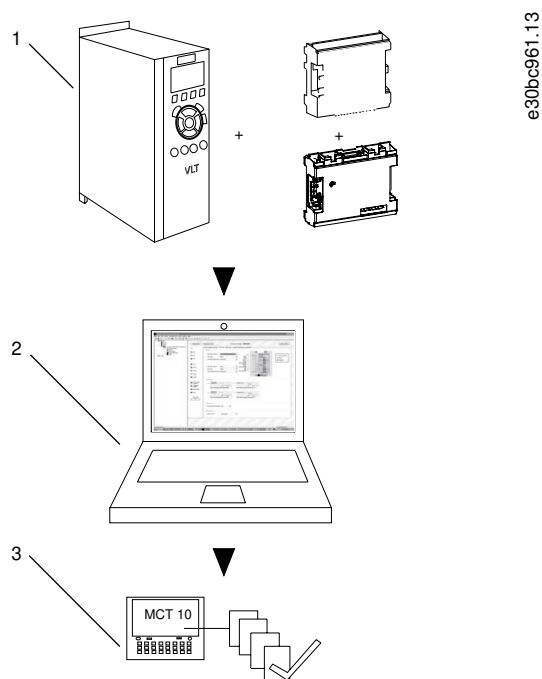
1	Install the safety option	**2**	Setup parameters
3	Commission		

Illustration 9:   Installation and Commissioning Overview

4.3 Installing the Option

Context:

> ### NOTICE
>
> Place the VLT® AutomationDrive FC 302 with safety option (including connection between S37 (Y30/12 or Y31/12) on VLT® Safety Option MCB 152 and X44/12 on the control card) in an IP54 enclosure as per IEC 60529.
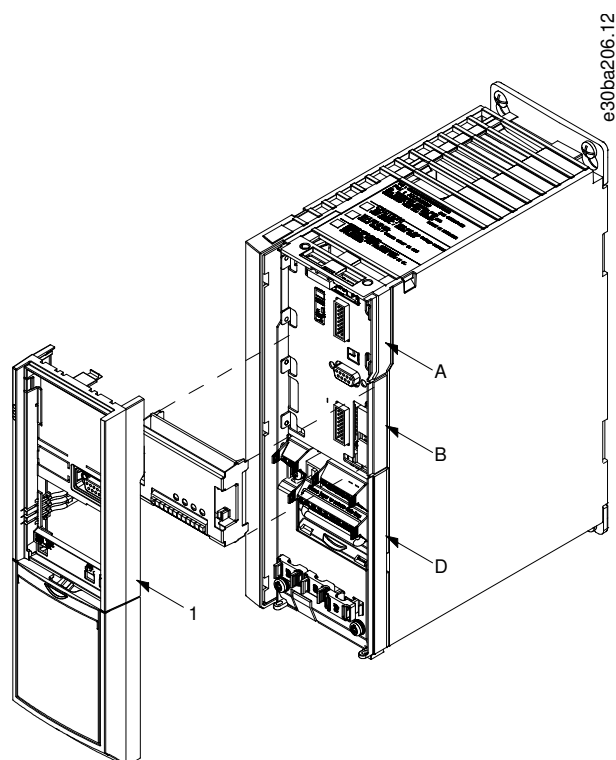
A	A-option slot	**B**	B-option slot
D	D-option slot	**1**	LCP frame

Illustration 10:   How to Fit the Safety Option

Procedure

1. Disconnect power from the drive.

2. Remove the LCP, the terminal cover, and the LCP frame from the drive.

3. Write down the serial number and order number of the safety option for use during the commissioning process.

4. Fit the safety option in slot B.

4.4 Electrical Installation

To ensure that the installation and wiring are EMC-compliant, read and follow the instructions in:

•   VLT® AutomationDrive FC 301/FC 302 Operating Guide.

•   VLT® Decentral Drive FCD 302 Operating Guide.

•   VLT® PROFINET MCA 120 Installation Guide.

4.4.1 Cabling Requirements

⚠ **C A U T I O N** ⚠

If a short circuit occurs, it is no longer possible to switch off the drive with terminal 37.

<div style="text-align:center">**NOTICE**</div>

All signals to the safety option must be PELV supplied and comply with EN IEC 60204.

Follow these guidelines to ensure proper wiring:
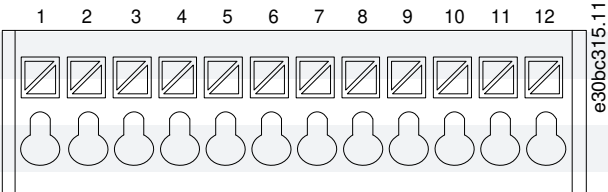
- Use appropriate wiring to prevent short circuits to a supply line or between the inputs.
- Use separate multi-core cable for supply voltage to avoid short circuits between the cable from the output (S37) and the 24 V DC supply line.
- Connect shields at both ends to the grounded enclosures through a good electrical connection and through a large surface area.
- Connect cable shields as close as possible to the cabinet cable entry.
- If possible, intermediate terminals should not interrupt cable shields.
- Retain cable shields for both power cables and data cables using the appropriate EMC clamps. Ensure that the shield connection for control cables has a low induction.

<div style="text-align:center">**NOTICE**</div>

If short circuits and cross circuits can be expected with safety-related signals, and if they are not detected by upstream devices, protected cable installation is required as per EN ISO 13849-2.

4.4.2 Connector Pin Assignment

Table 4: Connector Pin Assignment, VLT® Safety Option MCB 152

Pin	Name	Description
1	DI1 A	Digital input 1 A channel
2	GND	Ground
3	DI1 B	Digital input 1 B channel
5	DI2 A	Digital input 2 A channel
6	GND	Ground
8	DI2 B	Digital input 2 B channel
9	GND	Ground
10	24 V	Power output
11	GND	Ground
12	S37	Safe output

4.4.3 Wiring Procedures

Procedure

1. Remove the jumper wire between control terminals 37 and 12/13 (24 V).

Cutting or breaking the jumper is not sufficient to avoid short-circuiting.
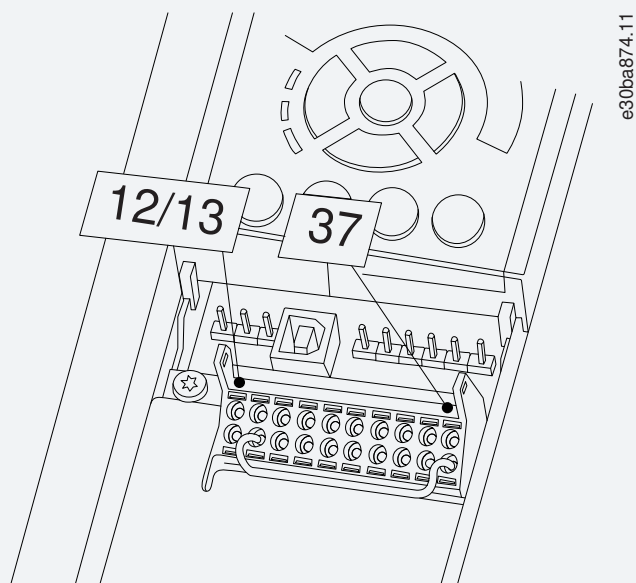
Illustration 12:   Jumper between Terminals 12/13 and 37 (VLT® AutomationDrive FC 302)
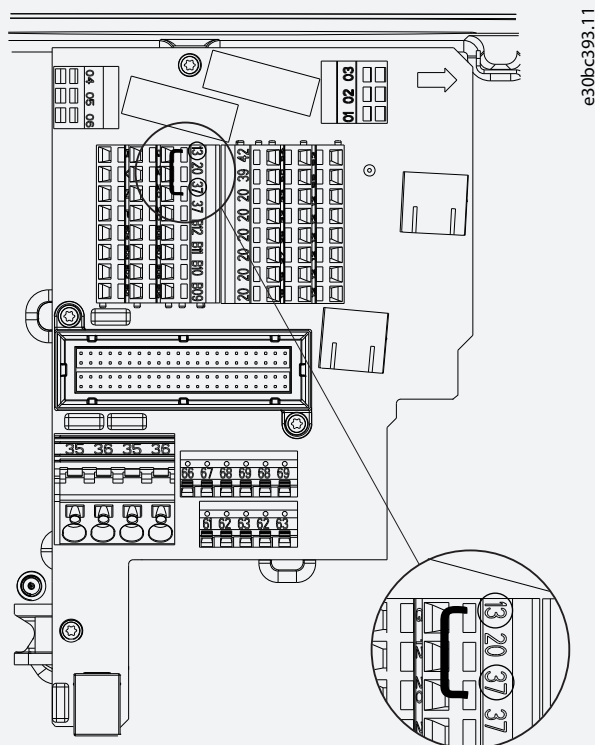
Illustration 13:   Jumper between Terminal 12/13 (24 V) and 37, VLT® Decentral Drive FCD 302

2. Connect the safe output S37 on the safety option to terminal 37 on the control card (maximum length of this wire is 100 mm (3.9 in)).

Illustration 14:   Connecting Control Wiring, Example Showing FC 302
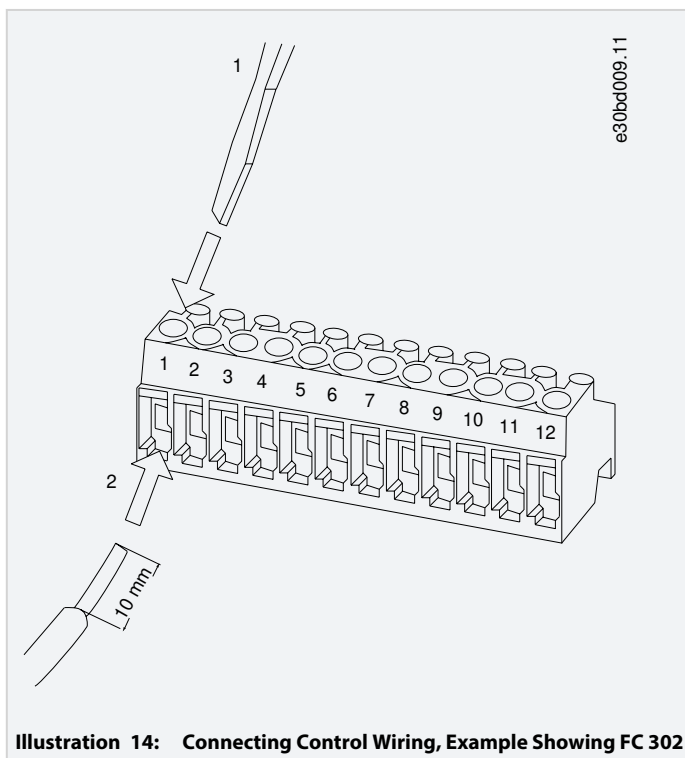
3. Connect the control cables to the safety option and relieve the cable by the enclosed cable strips. Follow the guidelines in 4.4.1 Cabling Requirements.
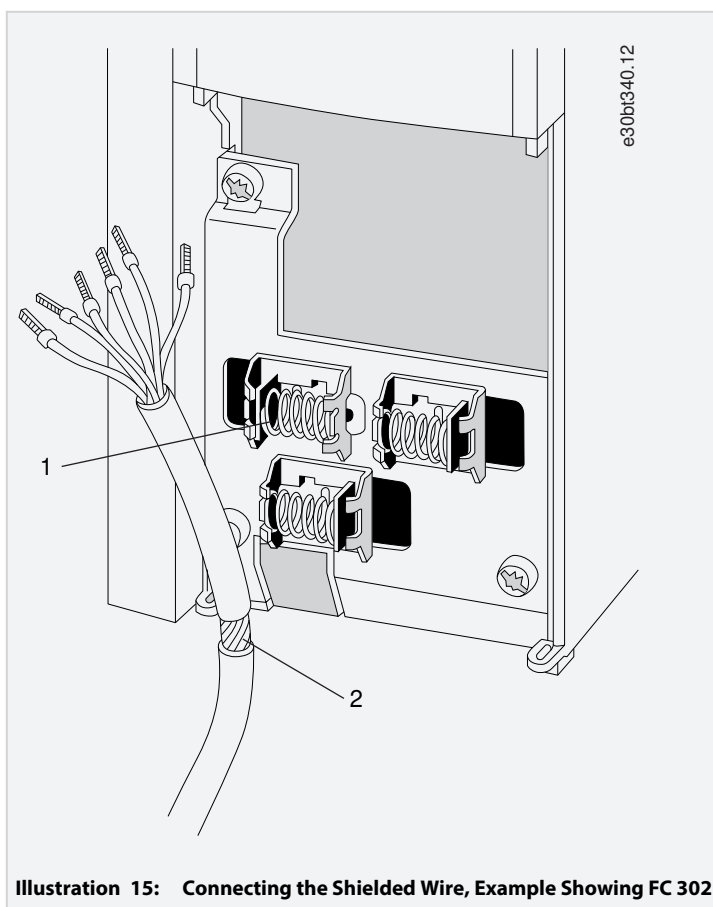
Illustration 15:   Connecting the Shielded Wire, Example Showing FC 302

4. Remove the knock-out in the extended LCP frame so that the option fits under the frame.

5. Fit the extended LCP frame and terminal cover.

6. Fit the LCP or blind cover in the extended LCP frame.

7. Connect power to the drive.

→ At the 1st power-up, the safety option is in blank initial state, and all safety parameters are at their default values.

4.4.4 Installation Checklist

Before completing installation of the unit, inspect the entire installation as described in:

- VLT® AutomationDrive FC 301/FC 302 Operating Guide
- VLT® Decentral Drive FCD 302 Operating Guide.

5 Commissioning

5.1 Before Commissioning

When commissioing/recommissioning:

- Secure the site in accordance with regulations (barrier, warnings, signs, and more). Only qualified personnel is allowed to commission/recommission the system.

- Refer to the guidelines, information, and specifications stated in the operating guide of the relevant programmable control system.

- Make sure that no personal injury and/or material damage can occur, even if the plant/machine moves unintentionally.

⚠ **C A U T I O N** ⚠

ELECTROSTATIC DISCHARGE

Electrostatic discharge can damage components.

- ˗ Ensure discharge before touching the safety option, for example by touching a grounded, conductive surface or by wearing a grounded armband.

⚠ **W A R N I N G** ⚠

RISK OF ELECTROCUTION

Wiring the electrical connections on the drive while voltage is applied can lead to death or serious injury.

- ˗ Switch off power.

- ˗ Make sure that the control cabinet is provided with an access lock or warning signs.

- ˗ DO NOT switch on voltage until the system is commissioned.

Refer to the VLT® AutomationDrive FC 301/FC 302 Operating Guide or the VLT® Decentral Drive FCD 302 Operating Guide for further information on the drive. Refer to the VLT® Motion Control Tool MCT 10 Operating Guide for further information on the Safe Plug-in.

5.2 Commissioning Procedure

Prerequisites:

The following components are required to perform the necessary steps for commissioning the safety option:

- Installation of MCT 10 Set-up Software version 4.40 or later.
- A connection between the PC and the control card of the drive.

N O T I C E

If RS485 is used, set the protocol for serial communication to *[0] FC-MC* in *parameter 8-30 Protocol* (only accessible through the LCP).

Procedure

1. Configure the safety option in the MCT 10 with Safe Plug-in. Ensure only to configure safety functions that are connected to the safety option inputs.

2. Ensure that the (serial number and order number of the safety option on the drive match the serial number *parameter 15-63 Option Serial No* and the order number in *parameer 15-62 Option Ordering No*. Use array index 1 to see the number related to the safety option.

3. Ensure that the drive is ready for commissioning (see VLT® AutomationDrive FC 301/FC 302 Operating Guide or the VLT® Decentral Drive FCD 302 Operating Guide).

5.3 Power-up/Self-test

Once the power supply has been applied to the drive, the drive automatically detects the safety option. During the start-up, the safety option performs a self-test. If the safety option is in blank initial state, the message *Safe Opt. Initialized - SO RESET requested* or *SO in Self-test* appears on the LCP. After the self-test, all LEDs light up according to the device status.

5.4 Commissioning in Online Mode

Context:

This procedure describes the example of the safety option commissioning procedure with VLT® Motion Control Tool MCT 10. In this example:

- A VLT® PROFINET MCA 120 option is installed in the drive and PROFIsafe communication is required for the application.

N O T I C E

If any errors occur while changing the password or after the approval step, the *Safe Plug-in* shows a notification with the error description.

N O T I C E

If STO is inactive (the drive is operational) when starting the customization process, the *Safe Plug-in* shows the *Confirmation Required* dialog box. This dialog box prompts the user to confirm that STO is activated during the commissioning.

Procedure

1. In MCT 10, establish a connection between the PC and the drive.

2. In MCT 10, select the *Safe Plug-in*.
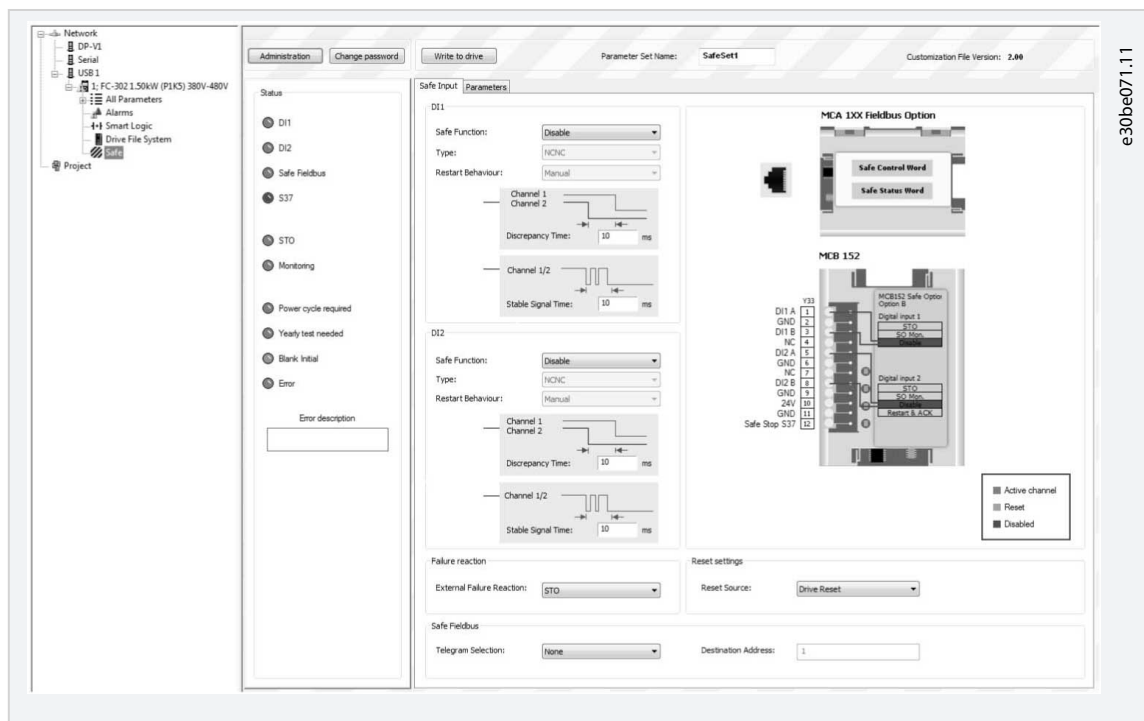
3. Select *PROFIsafe* in *Safe input⇒Telegram Selection* and enter the destination address in the *Destination Address* field.
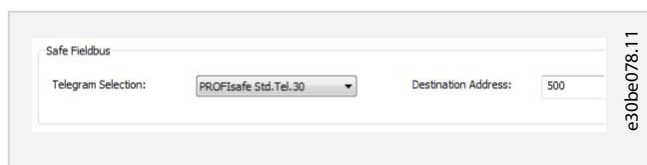
4. Select the appropriate safe function for digital input 1 in the DI1 group.
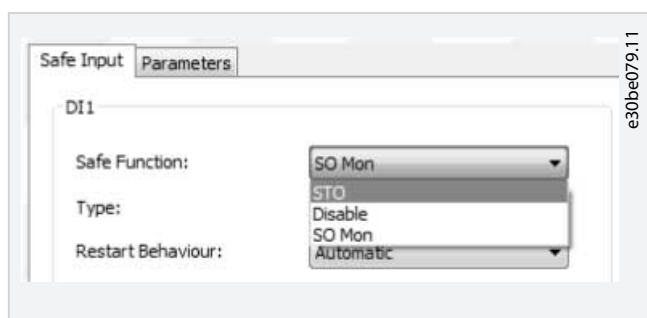
5. Make the other application-specific settings.

6. In the *Safe Plug-in*, click *Write to Drive*.

7. If the safety option is in blank initial state, it prompts for a new password.

    A In the *New password* dialog box, enter the current password (which is the default password - 12345678) and the new password - then click *OK*.
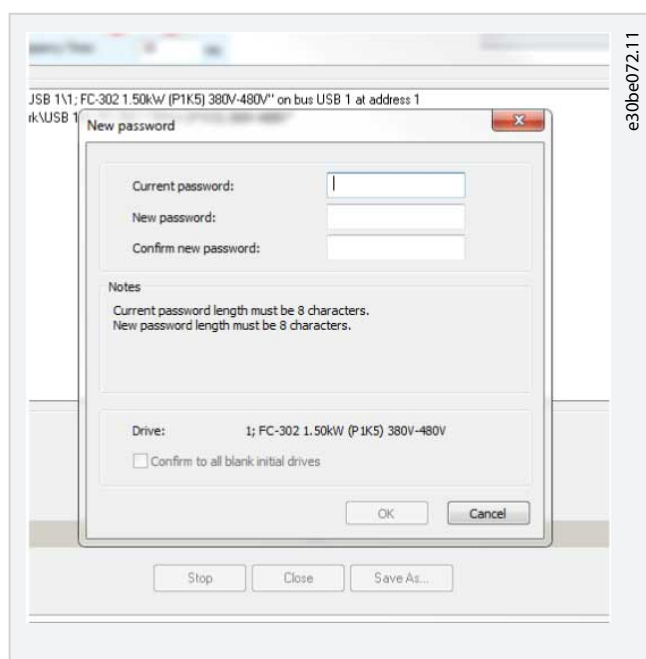
→ The *Safe Plug-in* shows the confirmation message.
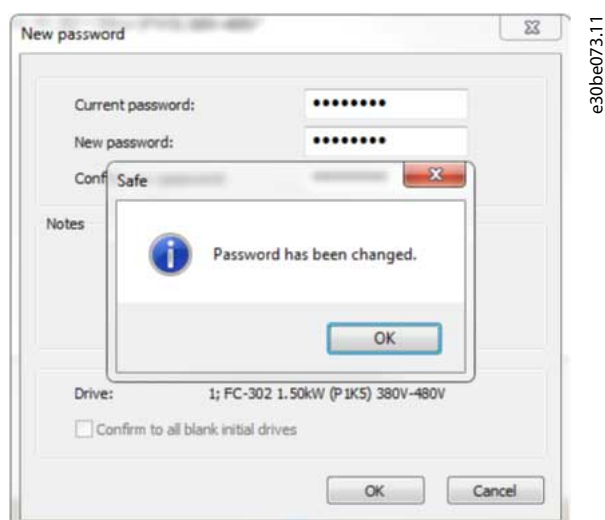
B Click *OK*.

8. In the *Confirm password* dialog box, enter the new safety option password and click *OK*.

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9. In the *Configuration Approval* dialog box, verify the safety configuration and click *Approve* to start writing the safety parameters.

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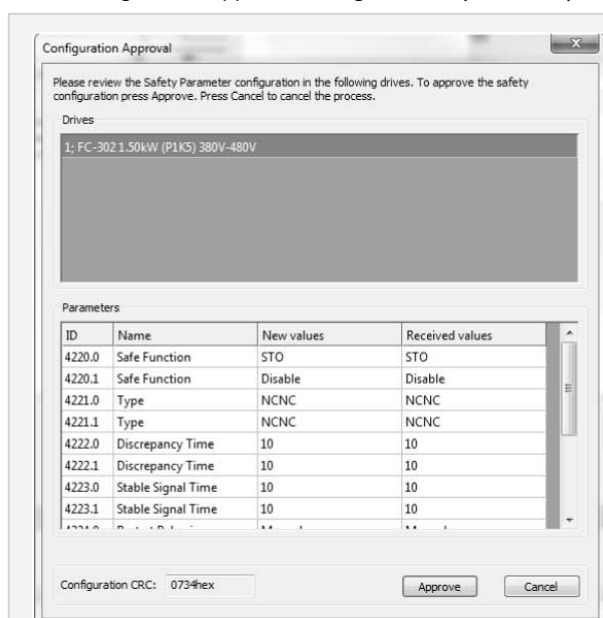
To abort the customization process and revert to the previous safety option state, click *Cancel*. The MCT 10 opens the *Writing Safety Parameters* dialog box.

e30be076.11
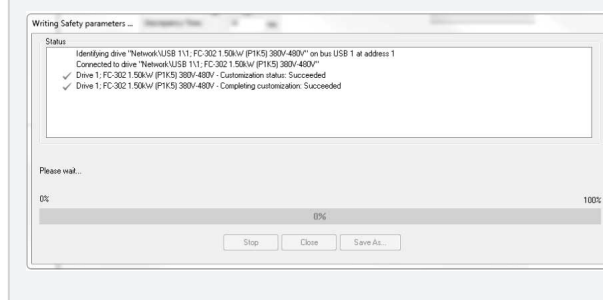
10. When the progress bar reaches 100%, the safety parameters are written.

11. The MCT 10 generates and opens the commissioning report.

12. Save and print the commissioning report. The report is required for future maintenance.

13. Close the commissioning report dialog box and the *Writing Safety Parameters* dialog box.

→ The safety option customization is now complete. A reset may be required depending on the safety option configuration. Up to 10 s may elapse before the safety option is ready for operation.

5.5 Commissioning Test

EN IEC 61508, EN IEC 62061 and EN ISO 13849 require that the final assembler of the machine validates the operation of the safety function with a commissioning test. The tests for the configured safety functions are described in the commissioning report generated by the MCT 10 *Safe Plug-in*. The commissioning test must be performed in the following cases:

• At initial start-up of the safety option.

• After any changes related to the safety function (wiring, components, parameter settings, and more).

• After any maintenance work related to the safety function.

The commissioning test for systems with safety functions is focused on:

• Validating the functionality of safety monitoring and stop functions configured in the drive system.

• Correct selection of the safety option parameter values.

• Examining the response of specific monitoring functions to the explicit input of values outside tolerance limits.

Perform the commissioning test based on the risk analysis. Adhere all applicable standards and regulations.

5.5.1 Performing the Commissioning Test

Prerequisites:

Ensure that the following preconditions are met:

- The drive must be wired properly. Refer to <u>4.4.3 Wiring Procedures</u>.
- All safety equipment such as protective monitoring devices, light barriers, or emergency stop switches are connected and ready for operation.
- All motor parameters and command parameters are set correctly in the drive.

Procedure

1. Use the VLT® Motion Control Tool MCT 10 software to generate the commissioning test report.

2. Follow the test sequence in the report to ensure proper functioning of the safety option.

3. Document each individual step of the test.

4. Note the checksum of the safety option parameters in the records.

5. Do not release the system unless it has successfully passed all individual steps of the test.

6. Restart the drive and check that the motor runs normally.

5.6 Operation

⚠ **WARNING** ⚠

UNINTENDED BEHAVIOR

Numerous stored data or settings control the behavior of the drive system. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions. Follow the instructions below to avoid risk of death, serious injury, or equipment damage.

- Do NOT operate the drive system with unknown settings or data.

- Verify that the stored data and settings are correct.

- When commissioning, carefully run tests for all operating states and potential error situations.

- Verify the functions after replacing the product and also after changing the settings or data.

- Only start the system if there are no persons or obstructions in the hazardous area.

Prerequisites for normal operation are:

- Commissioning is complete.
- The safety option contains the configuration data.
- The safety sub-functions have been tested.
- LED1, LED2, and LED4 are lit.

During operation:

- Any pulse edge change at the safety option safe input is monitored.
- The safety sub-functions are performed in accordance with the configuration.

5.7 Commissioning Setup Examples
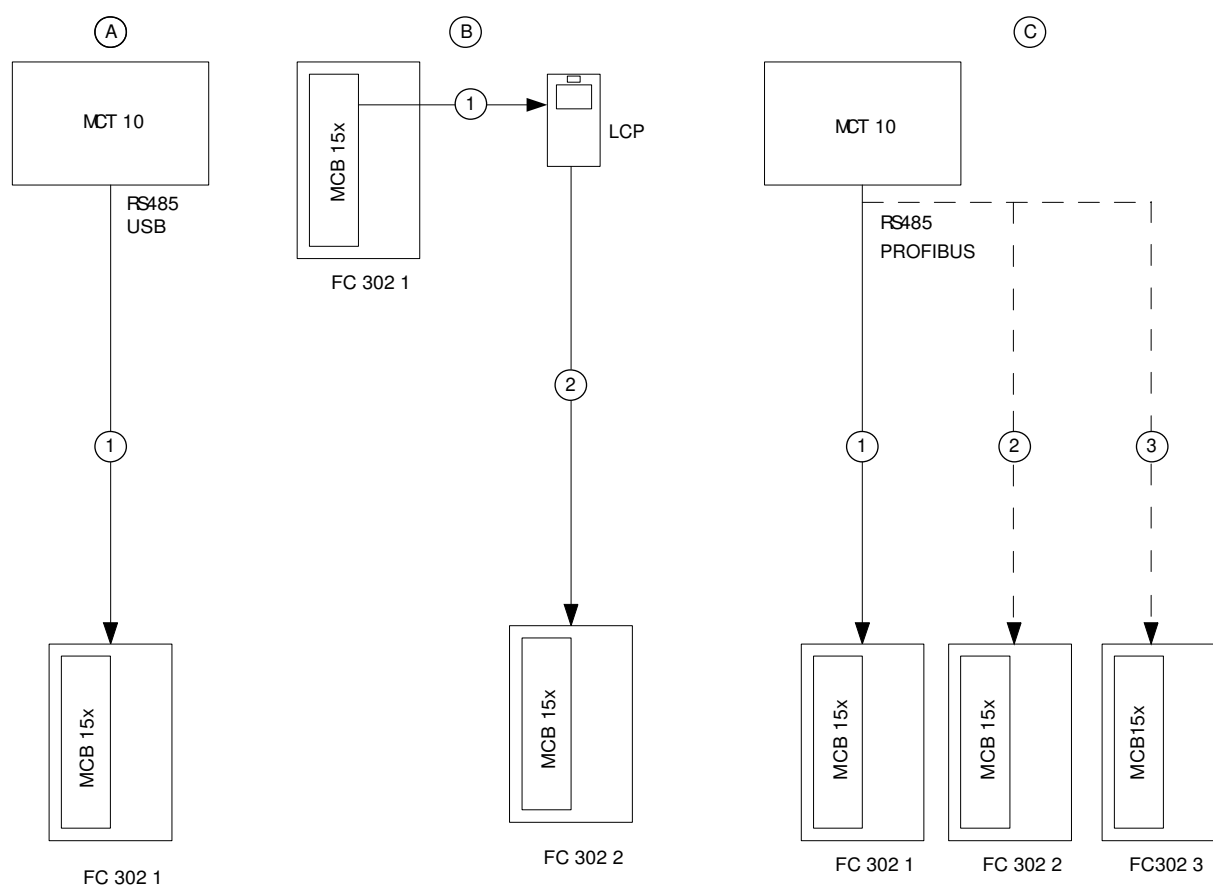
A	Commission is done between VLT® Motion Control Tool MCT 10 and the drive.	**B**	Safety parameters are copied from 1 drive to another via the *LCP Copy* function.
C	Safety options configured in a network using the MCT 10 software.		

Illustration 24: Commissioning Setup Examples

6 Configuring the Safety Option

6.1 PROFIsafe Configuration

6.1.1 Telegram Configuration

In *parameter 42-60 Telegram Selection*, select the safe fieldbus type and telegram standard that the safety option uses for communicating with the fail-safe PLC. VLT® Safety Option MCB 152 supports PROFIsafe standard telegram 30. If the parameter is set to *[0] None*, the safe fieldbus is disabled. In a PLC program, address the safety functions using bits and not bytes.

Byte 0 is PROFIdrive on PROFIsafe-specific and byte 1 is vendor-specific.

PROFIsafe control word (CTW)

Table 5: PROFIsafe Control Word (CTW)

Byte	Bit [1]	Name
0	0	STO
0	1–6	Not supported
0	7	INTERNAL_EVENT_ACK
1	0–7	Not supported

[1] *Bits that are not supported are set to 0.*

Bit 0, STO

Bit 00 = 0, Safe Torque Off (zero-active).

Bit 00 = 1, No Safe Torque Off.

Bit 7, INTERNAL_EVENT_ACK

When this bit changes its value from 1 to 0, the safety option gives an acknowledgment to the safety fault buffer. Fault entries in the safety fault buffer are shifted to the last acknowledged fault situation. Faults, which are still present or not acknowledgeable, appear again in the actual fault situation. For more information, refer to the PROFIdrive profile description at www.profibus.com.

PROFIsafe status word (STW)

Table 6: PROFIsafe Status Word (STW)

Byte	Bit [1]	Name
0	0	POWER_REMOVED
0	1–6	Not supported
0	7	INTERNAL_EVENT
1	0	Status DI 1
1	1	Status DI 2
1	2–7	Not supported

[1] *Bits that are not supported are set to 0.*

Byte 0, bit 0, POWER_REMOVED

Bit 00 = 0, Safe Torque Off inactive.

Bit 00 = 1, Safe Torque Off active.

Byte 0, bit 7, INTERNAL_EVENT

Bit 07 = 0, No safety fault.

Bit 07 = 1, Safety fault present.

Byte 1, bit 0, status DI 1

Bit 00 = 0, The digital input is active.

Bit 00 = 1, The digital input is inactive.

Byte 1, bit 1, status DI 2

Bit 01 = 0, The digital input is active.

Bit 01 = 1, The digital input is inactive.

To show the hex values of PROFIsafe status word and PROFIsafe control word on the LCP, use *parameter 42-83 Safe Status Word* and *parameter 42-82 Safe Control Word*. The hex values are used for debugging purpose or for transferring the safe control information to a non-safe control environment.

Safe fieldbus address

Set the safe fieldbus address in *parameter 42-61 Destination Address*. For PROFIsafe, the valid values are from 1–65535. This address must be unique in the network where PROFIsafe operates. The address should match the address specified in the PLC configuration.

6.1.2 Safety Functions Configuration

Use the VLT® Motion Control Tool MCT 10 Safe Plug-in for configuring the safety functions and to enable the PROFIsafe communication. For more information, refer to 5.4 Commissioning in Online Mode.

> **NOTICE**
>
> Always perform the required commissioning test. The commissioning test report is automatically generated via the Safe Plug-in in MCT 10 after writing the parameters to the safety option.

6.1.3 Password Protection

Use a password to protect the system configuration. A password must be entered only when changing safety option parameters (writing to option).

Default password is 12345678.

It is advised to change the safety option default password before downloading the parameter values of a safety option with factory settings. Only persons knowing the password can change the safety option parameter values.

N O T I C E

Any misuse of password may lead to severe safety problems.

N O T I C E

No password is required to access the commissioning parameters of the safety option. The password is required when the parameters must be downloaded to the option via *Write to Drive*.

The password must be of 8 characters and is case-sensitive. Alphanumeric characters and symbols are valid for password.

The safety option checks the parameter password entered. Use the menu item *Change Password* to change the safety option parameter password. Change the safety option password if there is any indication of manipulation.

6.1.3.1 Resetting the Password

Context:

N O T I C E

Resetting the password resets all option parameters to factory default.

Procedure

1. In the *Administration* menu, select *Reset*.
2. Checkmark *Yes, I want to reset Safe Option configuration in the drive*.
3. Enter the default password (12345678).
4. Click *Reset*.
5. On the prompt that appears, click *Yes*.
6. Change the safety option password.

6.2 Status over Fieldbus

The safety option status can be retrieved as part of the status word. Its behavior changes based on the selected control word profile.

In *parameter 8-13 Configurabnle Status Word STW*, select *[91] Safe Opt. Reset. req* and *[90] Safe Function active* to achieve the following:

- Indicate that a reset of the safety option is required. These signals are also available as DO outputs.
- Indicate that a safety function is active.

6.2.1 Safety Option Reset via Control Word

To reset the safety option using the control word, select *[3] Safe Option Reset* in *parameter 8-14 Configurable Control Word CTW*. This option is available only in bits 12–15 of *parameter 8-14 Configurable Control Word CTW*.

6.2.2 Safety Option Status

Parameter 42-80 Safe Option Status indicates the actual status (active safe function, any requests, and the error number) of the safety option and is accessible as a read-only parameter from any interface and is configurable as a read process data for a specific fieldbus.

NOTICE

Parameter 42-80 Safe Option Status shows only the active safety function.

Table 7: Status Bits for Safety Option Status

Bit	Description
0	Normal_up
1	PUST
2	STO active
3–6	Not applicable
7	Reserved for future safety functions
8	Safe output status
9	For internal use only. The safety option uses this bit to reset all safety parameters to default values.
10	Safe fieldbus acknowledge request
11	Int_fail
12	Reset required
13	Pending fail-safe state
14	Ext_fail
15	Safe function pending
16	General reset
17	Customization_confirmed
18	Customization_aborted
19	Customization_requested
20	Not applicable
21	PUST warning
22	DI_1_offline_warning
23	DI_2_offline_warning
24	Error code
25	Error code
26	Error code
27	Error code
28	Error code
29	Error code
30	Error code

Bit	Description
31	Error code

Bit 00, Safety function deactive/active

- Bit 00 = 1, Safety function, fail-safe reaction is active or pending, or warning is active.
- Bit 00 = 1, Normal operation.

Bit 01, Power up self test

- Bit 01 = 1, Safety option is in PUST state.

Bit 02, Safe Torque Off

- Bit 02 = 0, Safe Torque Off is not active.
- Bit 02 = 1, Safe Torque Off is active.

Bit 07

Reserved for future safety functions.

Bit 08

- Bit 08 = 0, Safe output at 24 V.
- Bit 08 = 1, Safe output at 0 V.

Bit 10

- Bit 10 = 0, No operator acknowledgment requested.
- Bit 10 = 1, Operator acknowledgment from fail-safe PLC requested.

Bit 11, Internal Error

- Bit 11 = 0, No internal error is active.
- Bit 11 = 1, An internal error is active.

Bit 12, Reset

- Bit 12 = 0, No safety option reset is required.
- Bit 12 = 1, A safety option reset is required.

Bit 13, Pending fail-safe state

- Bit 13 = 0, No pending fail-safe state.
- Bit 13 = 1, The safety option is in this state at each power-up.

Bit 14, External error

- Bit 14 = 0, No external error is active.
- Bit 14 = 1, An external error is active.

Bit 15, Safe function pending

- Bit 15 = 0, No safe function is pending.
- Bit 15 = 1, A safe function is pending.

Bit 16, General reset

- Bit 16 = 0, No change in state.
- Bit 16 = 1, A general reset is done.

Bit 17, Customization confirmed

- Bit 17 = 0, No change in state.
- Bit 17 = 1, Customization confirmed.

Bit 18, Customization aborted

- Bit 18 = 0, No change in state.
- Bit 18 = 1, Customization aborted.

Bit 19, Customization requested

- Bit 19 = 0, No change in state.
- Bit 19 = 1, Customization requested.

Bit 20, Suspension of speed monitoring

- Bit 20 = 0, No change in state.
- Bit 20 = 1, Suspension of speed monitoring - see error code.

Bit 21, Power up self test warning

- Bit 21 = 0, No change in state.
- Bit 21 = 1, A power-up self-test warning is issued.

Bit 22, Digital input 1 offline test warning

- Bit 22 = 0, No change in state.
- Bit 22 = 1, Digital input 1 offline test warning.

Bit 23, Digital input 2 offline test warning

- Bit 23 = 0, No change in state.
- Bit 23 = 1, Digital input 2 offline test warning.

Bits 24–31

These bits indicate a reason for internal or external errors. For more information, see the error codes.

Parameter 42-91 Safe Option Status 2 indicates which digital input of the safety option is activated, in pending state or in blank initial state.

Table 8: Status Bits for Safety Option Status 2

Bit	Description	State
0	DI 1 safety status	00 - Inactive
1		01 - Active
		10 - Pending
2	DI 1 safety status	00 - Inactive
3		01 - Active
		10 - Pending
4	Blank initial state	0 (inactive)/1 (active)
5	Safe fieldbus support	000 - No safe fieldbus supported
6		001 - PROFIsafe supported
7		
8	Safe function status on the fieldbus	0 - Deactivated
		1 - Activated
9–31	Not used	–

6.3 Reset Function

When the safety function is activated, reset the safety option. Depending on the configuration, the following sources can reset the safety option:

- The *[Reset]* key on the LCP or the digital input of the drive.
- The digital input on the safety option (DI2_A).
- The reset signal via the safe fieldbus.
- The automatic reset function.

Parameter 42-24 Restart Behavior determines whether the safety option restarts automatically or waits for a manual reset after the safety function was activated:

- Manual reset behavior - when the safety function is activated, the safety option requires a reset from a reset source before it can run again.
- Automatic reset behavior - when the safety function is activated, the safety option can run again when the condition that triggered the safety function ceases. This behavior is only valid for the digital input where this reset behavior is defined. For instance, if an external error occurs, a manual reset from the reset source is required regardless of the setting in *parameter 42-24 Restart Behavior*.

For more information, read the description of *parameter 42-31 Reset Source* and its options in CHAPTER 7.1 PARAMETER LIST.

6.3.1 Reset Input (DI2)

If manual reset is configured, wire the DI2A reset input terminal to a 24 V DC via an NO switch. The manual reset can also be used to reset external errors detected by the safety option.

6.4 Configuring PROFIsafe with Siemens Step 7

This section explains how to configure PROFIsafe communication between VLT® Safety Option MCB 152 and Siemens device in Siemens Step 7 environment.

6.4.1 Configuring the Hardware

Context:

Configure the PROFINET communication with the F-PLC using the VLT® PROFINET MCA 120 Installation Guide.

Procedure

1. In the panel in the right view, select *PROFINET IO⇒Additional Field Devices⇒Drives⇒VLT FC Series⇒Danfoss FC PN*.
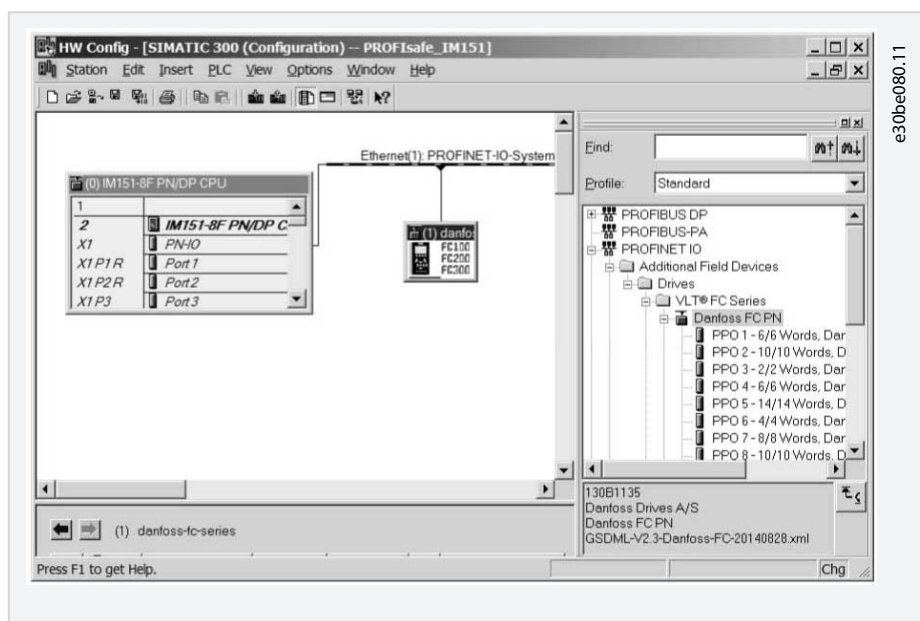
2. Drag the *Danfoss FC PN* module and drop it onto the PROFINET connection. STEP 7 sometimes requires to enter a password for this operation.

3. In the *Password for Safety Program* dialog box, enter the appropriate password.

4. To edit the Danfoss device properties, double-click the device.

5. In the *Device name* field, enter the same name as shown in *parameter 12-08 Host Name*.
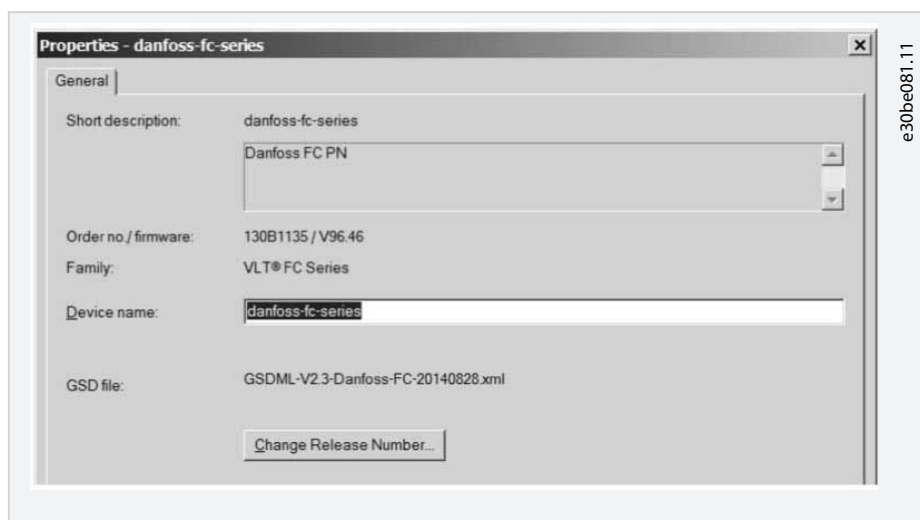
6. Select the module and add the following I/O protocol: *PROFIsafe 30 -6/6 Bytes, Standard Telegram 30*.

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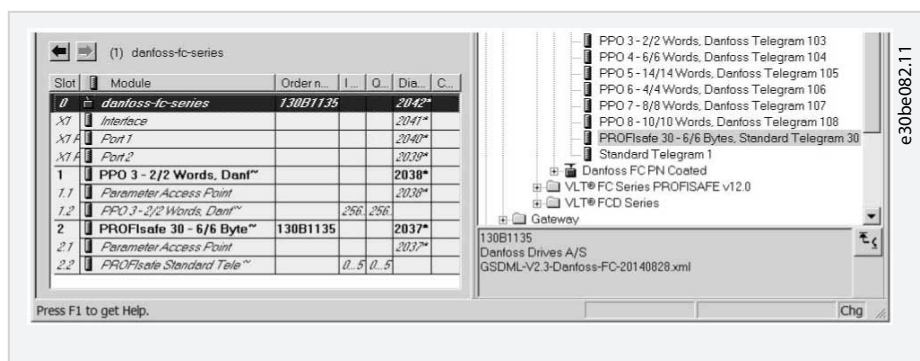
7. To edit the PROFIsafe settings, double-click *PROFIsafe Standard Telegram* at the bottom of the *HW Config* dialog box.

e30be083.11
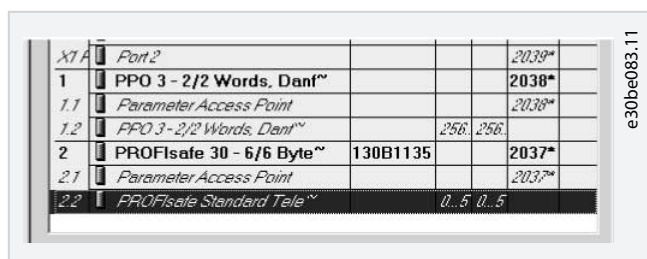
8. Select the *PROFIsafe* tab in the *Properties* dialog box.

e30be084.11
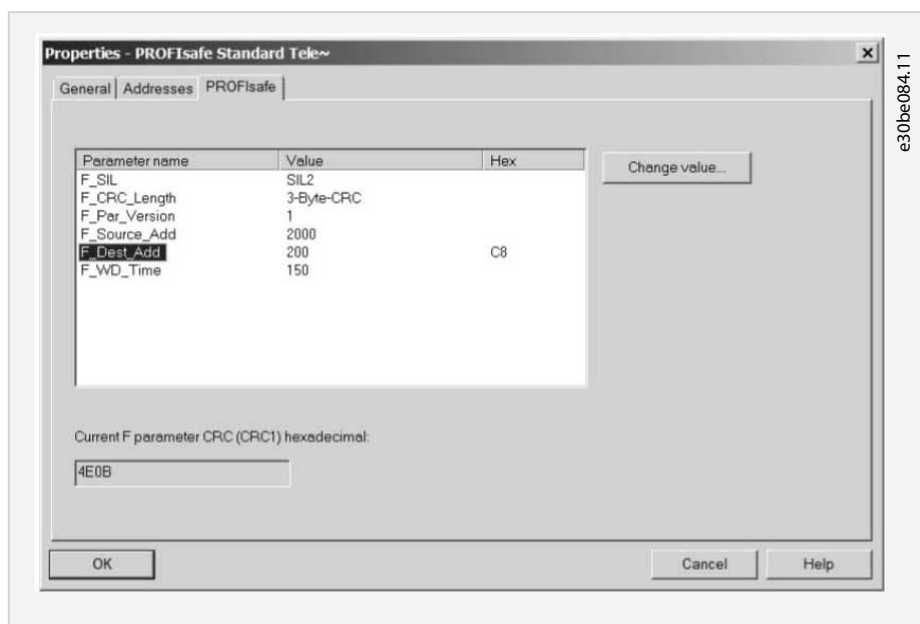
9. Edit the required settings.

The following 3 parameters can be changed, but normally it is only necessary to change the *F_Dest_Add* parameter:

- *F_Source_Add* - the PROFIsafe address of the PROFIsafe master.

- *F_Dest_Add* - the destination address of the safety option. This address must be the same as set in the VLT® Motion Control Tool MCT 10 software, *parameter 42-61 Destination Address*.

- *F_WD_Time* - the watchdog time for the PROFIsafe connection.

6.4.1.1 Watchdog Time

The watchdog time setting depends on the speed of the PROFINET connection and the number of devices.

- Valid range: 67–65535 ms
- Default value: 150 ms

If the safety option does not receive a new valid PROFIsafe telegram within this time, the safety option enters the safe state. The watchdog time is configured to a value that is long enough to avoid false alarms and short enough to detect errors in communication. The formula for calculating the minimum watchdog time:

F_WD_TIME = 2 x BT + HAT + DAT

- BT = Bus cycle time
- HAT = Host acknowledgment time
- DAT = Device acknowledgment time

Use the watchdog time to calculate the safety function response time (SFRT) for the system. For more information, see the PROFIsafe profile description at www.profibus.com.

6.5 Configuring PROFIsafe with Siemens TIA Portal

This section explains how to configure PROFIsafe communication between VLT® Safety Option MCB 152 and Siemens device with Siemens TIA Portal.

6.5.1 Configuring the Hardware

Context:

Configure the PROFINET communication with the F-PLC using the VLT® PROFINET MCA 120 Installation Guide.

Procedure

1. In the *Siemens TIA Portal*, select *Open the project view*.

2. Double-click *Devices and Networks*.

   → The *Hardware Configuration* dialog box opens.

3. Select the Danfoss device in the network view and drag it into the workspace.
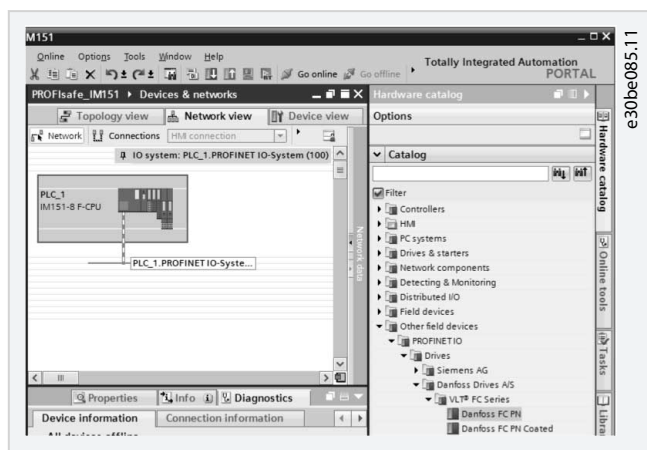
   → The project view shows the F-PLC and the Danfoss device.
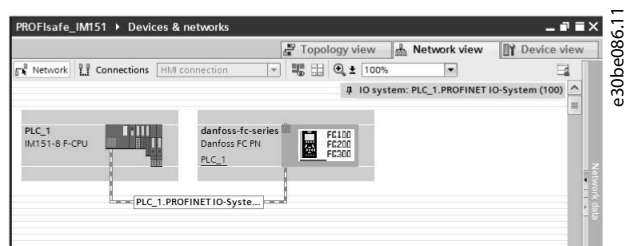
4. In the *Password for Safety Program* dialog box, enter the appropriate password.

5. Assign the name to the Danfoss device. The name must be the same is shown in *parameter 12-08 Host Name*.
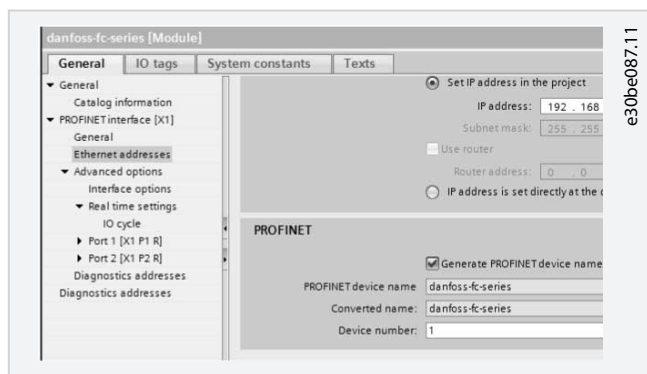
6. Select the following I/O protocol: *PROFIsafe 30 -6/6 Bytes, Standard Telegram 30*.
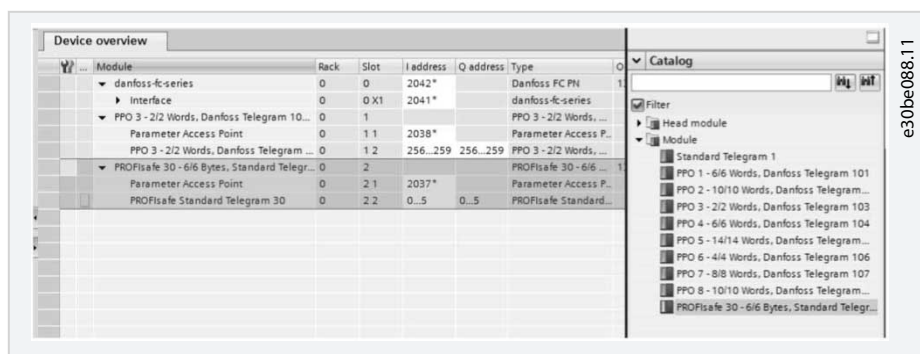
7. Edit the required PROFIsafe settings under the *Properties* tab.
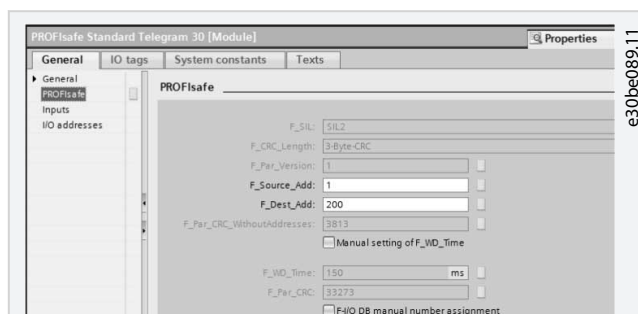
The following 3 parameters can be changed, but normally it is only necessary to change the *F_Dest_Add* parameter:

- *F_Source_Add* - the PROFIsafe address of the PROFIsafe master.
- *F_Dest_Add* - the destination address of the safety option. This address must be the same as set in the VLT® Motion Control Tool MCT 10 software, *parameter 42-61 Destination Address*.
- *F_WD_Time* - the watchdog time for the PROFIsafe connection. This setting depends on the speed of the PROFINET connection and the number of slaves.

6.5.2 Programming Safety Functions with Siemens Step 7 and TIA Portal

Refer to the Siemens documentation for more information on distributed safety. Refer to the following documentation for information on how to use safety inputs and outputs for passivation and reintegration.

- *Industrial Software SIMATIC Safety - Configuring and Programming*. Programming and Operating Manual.
- *Fail-safe Controllers SIMATIC Safety Integrated*. Emergency Stop with Acknowledgment in Category 4 according to EN 954-1.
- *Fail-safe Controllers SIMATIC Safety Integrated*. Passivation and Reintegration of F-I/O considering as example the ET 200S.

7 Parameter Setup

7.1 About Safety Parameters

This section describes the safety option parameters.

Use VLT® Motion Control Tool MCT 10 to configure the safety functions supported in VLT® Safety Option MCB 152.

Safety parameters have the following properties:

- The safety option stores 2 separate copies of the safety parameters.
- During start-up, a cyclic redundancy check (CRC) sum over the safety parameters is calculated and checked. The safety option stores parameters in the non-volatile memory. To see the CRC value on the LCP, add *parameter 42-35 S-CRC Value* to the LCP small display line.

A reset of the safety parameters to the blank initial state can be executed via MCT 10.

7.2 Parameter Lists

All safety parameters, except *parameter 42-90 Restart Safe Option*, can only be read from the LCP (but not changed). Use the VLT® Motion Control Tool MCT 10 Safe Plug-in to change the parameter values.

Refer to VLT® AutomationDrive FC 301/FC 302 Programming Guide for general information about usage of conversion index and data type.

7.2.1 Parameter Group 42-2* Safe Input

Table 9: 42-2* Safe Input

Parameter	Options/ valid range	Default value	Description	Conversion index	Data type
42-20 Safe Function	[0] STO [5] Disable [8] SO Mon	[5] Disable	Select the safety function that the safety option activates when the safe input is active. *[0] STO* - the safety option activates STO. *[5] Disable* - the safety option ignores the current safe input. *[8] SO Mon* - the safety option monitors all activity on the current safe input, but does not activate safety functions. The safety option transmits the information to the PLC and the PLC handles the safety logic. This parameter is an array with 2 elements. Element 0 contains DI1 settings and element 1 - DI2 settings.	–	u_int8
42-21 Type	[0] NCNC [1] Antivalent [2] NC	[0] NCNC	Select the safe input type. • *[0] NCNC*: A digital input is active when there is 0 V at both channels of the input. • *[1] Antivalent*: A digital input is active only when there is 0 V at channel A and 24 V at channel B. • *[2] NC*: The functionality is similar to NCNC. For more information, see 3.9.1 Allowed Sensor Types on Digital Inputs.	–	u_int8

Parame-ter	Options/valid range	De-fault value	Description	Con-ver-sion index	Data type
42-22 Discrep-ancy Time	0–5000 ms	10 ms	Enter the maximum time in ms allowed for differences between input channels. This parameter helps to prevent errors caused by temporary discrepancy.	-3	u_int16
42-23 Stable Signal Time	0–5000 ms	10 ms	Enter the stable signal time in ms. The stable signal time is the period where the VLT® Safety Option MCB 152 suppresses temporary signal changes at its safety inputs. This functionality prevents the MCB 152 from reacting to short test pulses from external modules or sensors.	-3	u_int16
42-24 Re-start Be-havior	*[0] Manual* *[1] Automatic*	*[0] Manual*	Select whether the safety option restarts automatically or waits for a manual reset after the safety function was activated via a digital input. *[0] Manual* - when the safety function is activated via a safe input, the safety option requires a reset from a reset source before it can run again. *[1] Automatic* - when the safety function is activated, the safety option can run again when the condition that triggered the safety function ceases.	–	u_int8

7.2.2 Parameter Group 42-3* General

Table 10: 42-3* General

Parameter	Options/valid range	Default value	Description	Con-ver-sion index	Data type
42-30 Exter-nal Failure Reaction	*[0] STO*	*[0] STO*	Select a safety function that is executed if an external error oc-curs.	–	u_int8

Parameter	Options/valid range	Default value	Description	Con-version index	Data type
42-31 Reset Source	*[0] Drive Reset* *[1] Drive Safe Reset* *[2] Safe Option DI2_A*	*[0] Drive Reset*	Select the source that triggers the safety option reset. *[0] Drive Reset* - the reset sources are: • The [Reset] key on the LCP. • The drive digital input. • The reset signal via a fieldbus. If there is an active alarm on the drive, the 1st reset signal resets the drive, and the 2nd signal resets the safety option. *[1] Drive Safe Reset* - the reset sources are: • The digital input of the drive. Select option *[100] Safe Option Reset* on 1 of the digital inputs for this source type to work. • The reset signal via a fieldbus. For the fieldbus reset to work, set *parameter 8-14 Configurable Control Word CTW* to *[3] Safe Option Reset*. The reset signal resets only the safety option. *[2] Safe Option DI2_A* - the reset source is the digital input DI2_A on the safety option. The reset signal resets only the safety option.	–	u_int8
42-33 Param-eter Set Name	Visible string, length: 8	SafeSet 1	Enter the name of the parameter set (8 characters). Use this parameter to identify the safety configurations.	–	Visible-string

7.2.3 Parameter Group 42-6* Safe Fieldbus

Table 11: 42-6-* Safe Fieldbus

Parame-ter	Options/ valid range	De-fault value	Description	Con-ver-sion index	Data type
42-60 Tele-gram Se-lection	*[0] None* *[1] PROFI-dafe Std. Tel. 30*	*[0] None*	Select the safe fieldbus type and the telegram standard for the VLT® Safety Option MCB 152. *[0] None* - the safe fieldbus communication is disabled. *[1] PROFIsafe Std. Tel. 30* - the PROFIsafe communication is enabled. The telegram standard is *PROFIsafe Std. Tel. 30*. For more information, see 6.1.1 Telegram Configuration. If fieldbus communication is enabled, and if the reset signal comes via the fieldbus, this parameter also defines whether only the safety option or also the drive is reset.	–	u_int8

Parame-ter	Options/ valid range	De-fault value	Description	Con-ver-sion index	Data type
42-61 Des-tination Address	1–65535	1	Enter the safe fieldbus destination address within the safe network. This address must be unique in the network where PROFIsafe oper-ates. The address should match the address specified in the PLC soft-ware.	–	u_int16

7.2.4 Parameter Group 42-8* Status

Table 12: 42-8* Status

Parameter	Options/valid range	Default value	Description	Con-ver-sion index	Data type
42-80 Safe Op-tion Status	0 - 0xFFFFFFFF	0	Shows the status word of the VLT® Safety Option MCB 152 as a hexadecimal value. For more information, see 6.2 Sta-tus over Fieldbus.	0	u_int32
42-81 Safe Op-tion Status 2	0 - 0x7FFFFFFF	0	Shows the status 2 word of the VLT® Safety Option MCB 152 as a hexadecimal value. For more information, see 6.2 Status over Fieldbus.	0	u_int32
42-82 Safe Control Word	0 - 0xFFFFFFFF	0	Shows the safe control word as a hexadecimal value.	–	u_int32
42-83 Safe Status Word	0 - 0xFFFFFFFF	0	Shows the safe status word as a hexadecimal value.	–	u_int32
42-85 Active Safe Func.	*[0] STO* *[10] None*	*[10] None*	Shows the currently active safety function. Use *parameter 0-20 Display Line 1.1 Small* to *parameter 0-22 Display Line 1.3 Small* to show the function on the LCP.	–	u_int8
42-86 Safe Op-tion Info	Safe Option Messages, String Length 25	0	Shows information about the safety option. The LCP can show this parameter in the large display line. Can be selec-ted in *parameter 0-23 Display Line 2 Large* and *parameter 0-24 Display Line 3 Large*.	0	Visible-String
42-87 Time Until Manual Test	0–8761 h	8761 h	Shows the remaining time in hours until yearly test has to be performed. • [0] indicates PUST warning. • [1] indicates speed suspension warning (Not used for MCB 152). • [2] indicates DI1 offline test required. • [3] indicates DI2 offline test required.	0	u_int16

Parameter	Options/valid range	Default value	Description	Conversion index	Data type
42-88 Supported Customization File Version	0.00–99.99	2.00	Shows the maximum supported configuration file version (CfgFileVers): • [0] – the maximum version supported by the safe system (drive with the safety option). • [1] – the maximum version supported by the safety option. • [2] – the maximum version supported by the control card.	-2	u-int16
42-89 Customization File Version	0.00–99.99	2.00	Shows the currently used customization file version.	-2	u_int16

7.2.5 Parameter Group 42-9* Special

Table 13: 42-9* Special

Parameter	Options/valid range	Default value	Description	Conversion index	Data type
42-90 Restart Safe Option	[0] No [1] Yes	[0] No	Select *[1] Yes* to restart the VLT® Safety Option MCB 152 without power cycling the drive. When the safe fieldbus is enabled, the communication option is also restarted.	–	u_int8

7.2.6 Parameter Group 600-** PROFIsafe

> **N O T I C E**
>
> Parameter group 600-** PROFIsafe is only visible in VLT® Motion Control Tool MCT 10.

Table 14: 600- PROFIsafe**

Parameter	Options/valid range	Default value	Description	Conversion index	Data type
600-44 Fault Message Counter	0–65535	0	Shows the number of error messages shown since the last reset.	–	u_int16
600-52 Fault Situation Counter	0–1000	0	Shows the number of error situations shown since the last reset.	–	u_int16

7.2.7   Parameter Group 0-6* Password

Table 15: 0-6* Password

Parameter	Options/valid range	Default value	Description	Conversion index	Data type
0-68 Safety Parameter Password	0–9999	300	Enter the password that protects the safety parameters.	–	u_int16
0-69 Password Protection of Safety Parameters	*[0] Disabled* *[1] Enabled*	*[0] Disabled*	Enable the password that protects the safety parameters.	–	u_int8

8 Application Examples

8.1 Connecting Safe Digital Inputs

This section contains examples of connecting the fail-safe digital input according to EN ISO 13849-1 and EN IEC 62061. The examples apply in cases where all components are installed in a control cabinet.
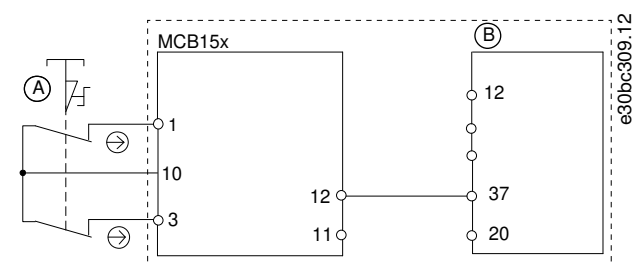
A	2-channel emergency stop switch	**B**	Drive

Illustration 29: Connecting a Sensor, Push Button, or Limit Switch

Connecting an electronic sensor
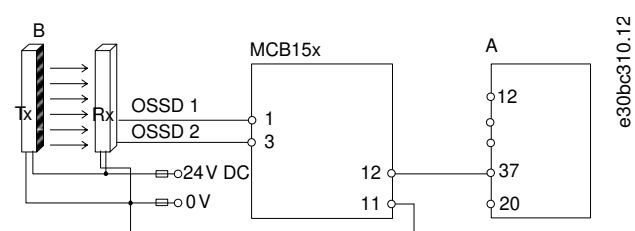
A	Drive	**B**	Light curtain

Illustration 30: Connecting an Electronic Sensor, for example a Safety Light Curtain

Connecting an antivalent sensor
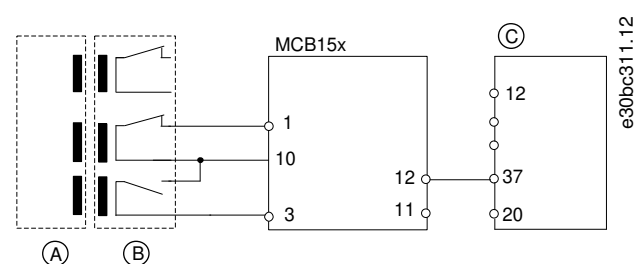
A	Actuator	**B**	Switch
C	Drive		

Illustration 31: Connecting 1 NO/1 NC Sensor, for Example Magnetic Switch

Connecting a digital output module
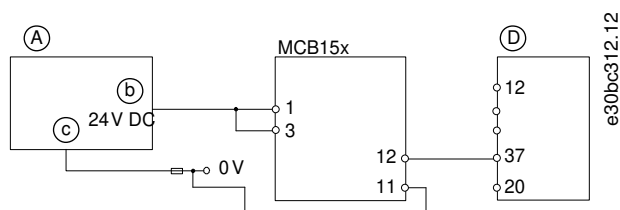
A	Safety PLC	**B**	Safety output
C	GND	**D**	Drive

Illustration 32: Connecting a Digital Output Module, for Example Safety PLC

NOTICE

The safety level is downgraded when inputs are used a 1 channel only.

Connecting a sensor, for example a 1-channel emergency stop push button
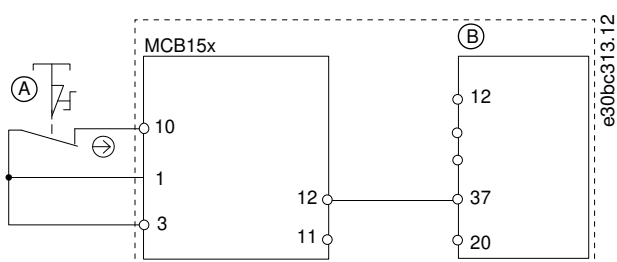
Illustration 33: Connecting a Sensor, for Example 1-channel Emergency Stop Mushroom Push Button or Limit Switch

NOTICE

All equipment used must be suitable for the selected category/PL or SIL.

NOTICE

Use of a 1-channel E-stop switch provides no input redundancy and no ability for the safety option to monitor for input short circuits. One-channel E-stop switches used with a safety option are suitable only for category 2 applications, per EN ISO 13849-1 PL c or SIL1.

When a 1-channel E-stop is used, guard against failure modes that can result in an unsafe condition. An example of an unsafe condition could be the failure of the contact to a short circuit condition. A switch with positive opening operation should be used to reduce the possibility of a failure of the switch to open. A short-circuit failure results in loss of switching function. This failure can occur from a short across the switch contacts, a short across the wires connected to the switch between the switch and the safety option, or a short to a secondary source of power. To reduce these risks, physically separate the wires from each other and from other sources of power (for example, in separate wire ways or conduit). According to the definition of European standard EN ISO 13849-1, a 1-channel E-stop could be used in applications where PL c or less (b or a) has been determined via a risk-assessment procedure.

Multiple drives in a daisy chain

Illustration 34:   Example of Multiple Drives in Daisy Chain

Up to 3 drives may be connected in a daisy chain. Total cable length must not exceed 30 m (98.4 ft).

9 Maintenance, Diagnostics, and Troubleshooting

9.1 Maintenance and Service

⚠ **C A U T I O N** ⚠

FIRMWARE MODIFICATIONS

Only Danfoss is authorized to change the firmware. If other parties change the firmware, the warranty expires. Furthermore, Danfoss cannot be held liable for any consequences that changes may have on the functional safety.
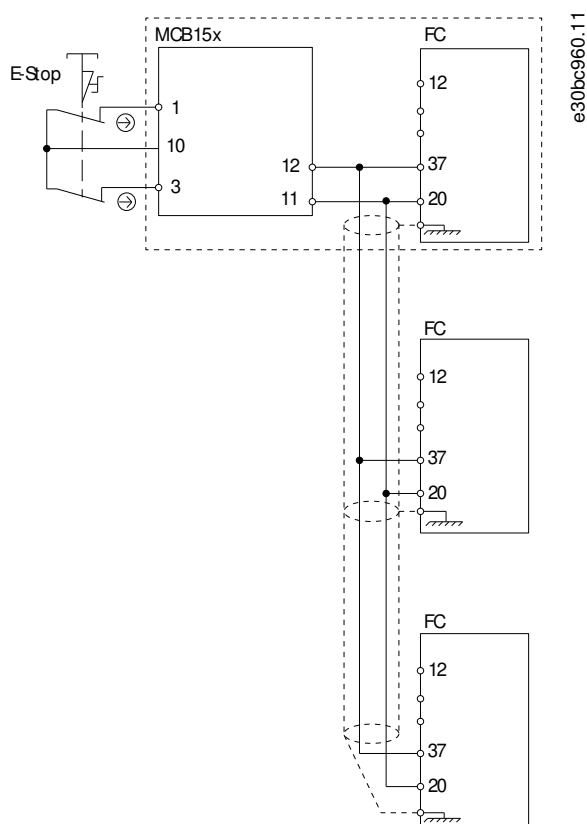

N O T I C E

UPDATES TO FIRMWARE

Contact Danfoss to get a firmware update.

⚠ **C A U T I O N** ⚠

MODIFICATIONS TO THE UNIT

Only Danfoss is allowed to make hardware modifications of the safety option. If other parties change the unit, the warranty expires. Furthermore, Danfoss cannot be held liable for any consequences the changes may have on the functional safety.

⚠ **C A U T I O N** ⚠

SERVICING

Once a year, check that the safety option functions properly to ensure the safety of the machine. Perform the check by testing the safety function and by power cycling the options used in the safety chain.

9.1.1 Yearly Test

According to EN ISO 13849-1, EN IEC 62061, and EN IEC 61508, the safety-relevant circuits of the safety option must be tested regularly to ensure correct functioning. It is required for PL d or SIL2 to conduct a functional test every 12 months to detect any failure or malfunction of the STO functionality. For lower PL or SIL, it is a recommendation. After the power supply has been connected, the safety option checks its circuits to switch off the torque each time the STO function is selected. The safety option monitors the regular test interval of its safety-relevant circuits using a time module.

After 1 year in operation, the drive shows a message telling to perform a yearly test. The following types of yearly tests exist:

- DI1 yearly test: Test only the activation of DI1. No power cycling is required. When DI1 is set to *Disabled*, no test is required.

- DI2 yearly test: Test only the activation of DI2. No power cycling is required. When DI2 is set to *Disabled*, no test is required.

- PUST yearly test: Power cycle the drive, set *parameter 42-90 Restart Safe Option* to *[1] YES* for restarting the safety option, or trigger an external error and press [RESET].

9.2   Repair and Troubleshooting

> ### ⚠ WARNING ⚠
>
> **ELECTRICAL SHOCK HAZARD**
>
> AC drives contain high voltage when connected to AC mains input, DC supply, or load sharing. Having non-qualified personnel doing repair or troubleshooting can result in death or serious injury.
>
> - Always disconnect mains supply to the drive before removing the safety option.
>
> - Only qualified personnel are allowed to troubleshoot on the safety option

Only Danfoss is allowed to repair the safety option. A defect option must be shipped to Danfoss.

9.2.1   Removing the Safety Option (FC 302 only)

Context:

> ### NOTICE
>
> If the safety option is not in the blank initial state when it is removed, the drive trips with *Alarm 84*. To prevent this behavior, set the option to blank initial state before removing it. This can be done by resetting the safety option via VLT® Motion Control Tool MCT 10. For more information, see 6.1.3 Password Protection.

> ### NOTICE
>
> If the drive detects a change in the hardware configuration, the LCP shows *Alarm 67, Option changed* after a power-up. This situation can occur after installing or removing an option, or if an option is defective.

> ### NOTICE
>
> If *parameter 14-89 Option Detection* is set to *[0] Protect Option Config.*, and the drive detects a change in the configuration, the drive trips with *Alarm 88, Option Detection* after a start-up. This behavior prevents any unintended parameter changes. To avoid alarm 88, set *parameter 14-89 Option Detection* to *[1] Enable Option Change*.

Prerequisites:

Before removing the safety option, save all parameters of the safety option and device settings using 1 of the following ways:

- Use MCT 10 Set-up Software, see VLT® Motion Control Tool MCT 10 Operating Guide.

- Execute the LCP copy operation by selecting *[1] All to LCP* in *parameter 0-50 LCP Copy*. This operation duplicates the existing parameter settings.

Procedure

1. Disconnect all power supplies before removing the option.

2. Verify that no voltage is present.

3. Remove the safety option according to the instructions in the *Installation* chapter in VLT® AutomationDrive FC 301/FC 302 Operating Guide or in VLT® Decentral Drive FCD 302 Operating Guide.

> ### NOTICE
>
> If the removed safety option is installed in another drive, the drive issues a warning. The user can then select the safety configuration from either the drive or from the safety option.

9.2.2 Replacing the Safety Option (FC 302 only)

> ### ⚠ WARNING ⚠
>
> **ELECTRICAL SHOCK HAZARD**
>
> AC drives contain high voltage when connected to AC mains input, DC supply, or load sharing. Having non-qualified personnel replacing the safety option can result in death or serious injury.
>
> - Always disconnect mains supply to the drive before removing the safety option.
>
> - Only qualified personnel are allowed to remove the safety option.

When replacing the safety option, note the following:

- If the firmware version has changed, configured functions and stated parameters may no longer be supported, or may have been modified. Adapt the configuration in VLT® Motion Control Tool MCT 10.

Use 1 of the following ways to program the safety option after replacement:

- Reset the safety option to blank initial state as described in VLT® Motion Control Tool MCT Operating Guide and reprogram the safety option using MCT 10 as on the 1st commissioning. See 5.1 Before Commissioning and 5.2 Commissioning Procedure.

- Use the parameter mismatch functionality to use an existing parameter set with the new safety option.

- Copy the safe parameters using the graphical LCP, INSERT XREF TO 9.2.4 COPYING SAFE PARAMETER CONFIG

> ### NOTICE
>
> Protect the safety parameter configuration from changes using the password protection. For example, the changes may occur when there is a parameter mismatch, or when copying the parameters via LCP. *Parameter 0-68 Safety Parameters Password* and *parameter 0-69 Password Protection of Safety Parameters* allow configuring the safety parameter password protection. This protection is different from the password that MCT 10 uses. For more information, see 7.2 Parameter Lists.

> ### NOTICE
>
> If the safety option is replaced with a different safety option model, for example, if VLT® Safety Option MCB 152 is replaced with a VLT® Safety Option MCB 150 or vice versa, the drive trips with *Alarm 67, Option Change* or *Alarm 88, Option Detection*. For more information, see 9.2.1 Removing the Safety Option (FC 302 only).

9.2.3   Mismatch of Safety Option Parameters (FC 302 only)

At each power-up, the parameter mismatch functionality checks if the safety parameters in the drive and the safety option are different. If there is a difference, for example after a replacement of the safety option, it is possible to select 1 of the valid detected safety parameter configurations using the *SO Param. Selection* form on the LCP.
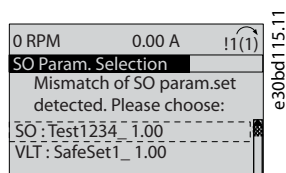

Illustration 35:   SO Param. Selection Form

After selecting 1 of the parameter sets, the set is written to the safety option. During this process, the safety option saves a checksum along with the parameter set, which allows identifying the duplicated safety option parameters. The LCP messages guide through the parameter transfer.

9.2.3.1   Transferring Parameter

Context:

Follow this procedure when replacing the safety option, assuming that the safety parameters in the drive have the correct values.

Procedure

1. Select *VLT*.

2. If configured, enter the password for the safety option configuration that is being copied. See the description of *parameter 0-68 Safety Parameters Password* and *parameter 0-69 Password Protection of Safety Parameters* in 7.2.7 Parameter Group 0-6* Password.

3. The LCP shows the *SO Data Confirmation* message.

4. Press *OK* to overwrite the safety parameters in the safety option.

5. Depending on the actual safety parameter configuration, a reset signal to the safety option can be required. For information about the reset functionality, see 6.3 Reset Function.

6. Perform the commissioning test to ensure that the correct safety parameter configuration is transferred to the safety option. See 5.5 Commissioning Test. Use the commissioning test report for the safety parameter configuration that is being transferred.

   If replacing the drive, use the same functionality and select *SO* in step 1 instead of *VLT*.

9.2.4   Copying Safe Parameter Configuration

Context:

The drive allows copying safety parameters via the LCP. This functionality allows setting up a different drive with the exact same safety parameter configuration without using VLT® Motion Control Tool MCA 10.

Follow this procedure to copy a predefined safety parameter configuration from 1 drive to another.

Procedure

1. In *parameter 0-50 LCP Copy*, select *[1] All to LCP*.

2. Monitor the upload process on the progress bar.

3. Install the LCP with all the copied parameters on the drive that needs to be updated.

4. Select 1 of the following options:

   [2] All from LCP in *parameter 0-50 LCP Copy*, to copy all drive parameters, including the safety parameters.

   [9] Safety Par. from LCP in *parameter 0-50 LCP Copy*, to copy only the safety parameter configuration.

5. Continue with steps 2–6 in 9.2.3.1 Transferring Parameter to finish the safety parameter copy process.

Example:

Refer to 5.7 Commissioning Setup Examples to see an example of a commissioning setup with LCP copying.

9.3 Error Conditions

The VLT® Safety Option MCB 152 differentiates between the following error types:

- Internal errors
- External errors

Table 16: Error Types

Error type	Description	Effect on the system	Reset condition
Internal error	Severe exceptional error caused by the program run in the safety option. Cyclic program sequence is no longer possible for safety-related reasons. The system enters the defined safe state.	Output S37 is switched off.	Reset possible by power cycling the drive or by restarting the safety option via *parameter 42-90 Restart Safe Option*.
External error	Functional error caused by an external process. Both systems continue to run cyclically and serve all requests from the communication interfaces. Sensing of the external process is also maintained. The system enters the defined safe state.	Output S37 is switched off.	Apply a reset signal to the safety option via input DI2, the [Reset] key, or via fieldbus. For information about the reset functionality, see 6.3 Reset Function.

9.3.1 Error Descriptions

Table 17: Errors 72–76

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4

Error number	Description			LED indications		
72	Internal error: Processor error. Reaction: STO	–	Perform 1 of the following actions: • Power cycle the drive. • Restart the safety option via *parameter 42-90 Restart Safe Option*. • If the problem persists, contact Danfoss.	Status of LED1 and LED2 depends on the safety function state assigned to DI1 and DI2.	If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise, LED3 is off.	Red constant.
73	Internal error: Safe output switch 1. Reaction: STO					
74	Internal error: Safe output switch 2. Reaction: STO					
75	Internal error: DI2 in PUST. Reaction: STO	• Safety input connected to DI2 has illegal signal levels. • Sensor is broken.	• Check that the configuration of DI2, *parameter 42-21 Type*, is set correctly or that the connected sensor is installed according to specification. • Extend the discrepancy time on the safe input using the VLT® Motion Control MCT 10 Safe Plug-in.			
76	Internal error: DI1 in PUST. Reaction: STO.	• Safety input connected to DI1 has illegal signal level. • Sensor is broken.	• Check that the configuration of DI1 (*parameter 42-21 Type*, sub-index [0]) is set correctly or that the connected sensor is installed according to specification. • Extend the discrepancy time on the safe input using the VLT® Motion Control Tool MCT 10 Safe Plug-in.			

Table 18: Errors 77–83

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4
77	Internal error: Fail-safe data CRC mismatch. Reaction: STO.	The CRC of the safety option does not match the stored CRC value on the drive.	Configure the safety option with MCT 10 Safe Plug-in or by CRC select/LCP copy	Status of LED1 and LED2 depends on the safety unction state assigned to DI1 and DI2.		If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise, LED3 is off.	Red constant.
78	Internal error: S1 S2 Communication Channel. Reaction: STO.	Severe exceptional error caused by the program run in the safety option.	Perform 1 of the following actions: • Power cycle the drive. • Restart the safety option via *parameter 42-90 Restart Safe Option*. • If the problem persists, contact Danfoss.				
80	Internal error: No CAN communication. Reaction: STO.						
81	Internal error: Undervoltage Vuc1. Reaction: STO.						
82	Internal error: Overvoltage Vuc1. Reaction: STO.						
83	Internal error: Undervoltage 24 V IO. Reaction: STO.						

Table 19: Errors 84–89

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4
84	Internal error: Overvoltage 24 V IO. Reaction: STO.	Severe exceptional error caused by the program run in the safety option.	Perform 1 of the following actions: • Power cycle the drive. • Restart the safety option via *parameter 42-90 Restart Safe Option*. • If the problem persists, contact Danfoss.	Status of LED1 and LED2 depends on the safety unction state assigned to DI1 and DI2.		If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise, LED3 is off.	Red constant.
85	Internal error: Undervoltage Vuc2. Reaction: STO.						
86	Internal error: Overvoltage Vuc2. Reaction: STO.						
87	Internal error: Undervoltage int5v. Reaction: STO.						
88	Internal error: Overvoltage int5v. Reaction: STO.						
89	Internal error: Memory error S2. Reaction: STO.						

Table 20: Errors 90–96

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4

Error number	Description			LED indications		
90	Internal error: Memory error S1. Reaction: STO.	Severe exceptional error caused by the program run in the safety option.	Perform 1 of the following actions: • Power cycle the drive. • Restart the safety option via *parameter 42-90 Restart Safe Option*. • If the problem persists, contact Danfoss.	Status of LED1 and LED2 depends on the safety unction state assigned to DI1 and DI2.	If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise, LED3 is off.	Red constant.
91	Internal error: Undervoltage Vuc2 PLL. Reaction: STO.					
92	Internal error: Overvoltage Vuc2 PLL. Reaction: STO.					
93	Internal error: Undervoltage Vuc2 Core. Reaction: STO.					
94	Internal error: Overvoltage Vuc2 Core. Reaction: STO.					
95	Internal error: Undervoltage Vuc2 SDRAM. Reaction: STO.					
96	Internal error: Overvoltage Vuc2 SDRAM. Reaction: STO.					

Table 21: Errors 98–113

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4
98	Internal error: Invalid customization file version. Reaction: STO.	Version of customisation file of safety option stored in EEPROM does not match the customisation file supported by the SW version of safety option.	Do a new configuration with MCT 10 safe plug-in which supports the SW version of safety option.	Status of LED 1 and LED2 depends on the safety function state assigned to DI1 and DI2.		If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise LED3 is off.	Red constant
100	Internal error: Invalid fieldbus option. Reaction: STO	The current fieldbus option is not supported.	Make sure that the fieldbus option meets the software version requirements. An update of the fieldbus option software may be required.				
101	Internal error: PSD hard error. Reaction: STO.	There is an error in PSD hardware.	Perform 1 of the following actions: • Power cycle the drive. • Restart the safety option via *parameter 42-90 Restart Safe Option*. • If the problem persists, contact Danfoss.				
113	External error DI1. Reaction: STO.	• Safety input connected to DI1 has illegal signal level. • Sensor is broken.	• Check that the configuration of DI1 (*parameter 42-21 Type*, subindex [0]) is set correctly or that the connected sensor is installed according to specification. • Extend the discrepancy time for DI1 using the VLT® Motion Control Tool MCT 10 Safe Plug-in.	Red constant	Status depends on the safety function state assigned to DI2.		Red flashing, cycle (on 500 ms, off 500 ms).

Table 22: Errors 114–121

Error number	Description			LED indications			
		Reason	Action	LED1	LED2	LED3	LED4
114	External error DI2. Reaction: STO	• Safety input connected to DI2 has illegal signal level. • Sensor is broken.	• Check that the configuration of DI1 (*parameter 42-21 Type*, subindex [0]) is set correctly or that the connected sensor is installed according to specification. • Extend the discrepancy time for DI1 using the VLT® Motion Control Tool MCT 10 Safe Plug-in.	Status depends on the safety function state assigned to DI1.	Red constant.	If safe fieldbus is enabled, the status of LED3 depends on the safe fieldbus status. Otherwise LED3 is off.	Red flashing, cycle (on 500 ms, off 500 ms).
119	External error: Safe fieldbus destination address mismatch. Reaction: STO.	The destination address on the safe fieldbus is invalid.	Make sure that the addresses on the PLC and the safety option match.	Status of LED 1 and LED2 depends on safety function state assigned to DI1 and DI2.		Red flashing (500 ms on/off).	
120	External error: Safe fieldbus telegram mismatch. Reaction: STO.	Safe fieldbus telegram is invalid.	Check the telegram format settings in the fail-safe PLC and the safety option.				
121	PROFIsafe configuration error. Reaction: STO.	PROFIsafe configuration is invalid.	Check the settings of the safety option and the PLC.				

9.4 LCP Messages

Any errors on the safety option are indicated on the drive.

The following options are available for detailed diagnostics and error detection:

• LEDs on the front of the safety option provide information on operating states. The LEDs indicate the status of the option, that is active safety functions, failures, and warnings, if any.

• LCP texts or info via bus show the status of the safety functions, for example, STO.

The following messages are shown in online mode in the VLT® Motion Control Tool MCT 10:

- Status of the safety option.
- Internal and external errors and the corresponding troubleshooting tips.

To configure the LCP to show the safety option-specific information, use the parameters in *parameter group 0-2* LCP Display*.

Parameter 0-20 Display Line 1.1 Small to *parameter 0-22 Display Line 1.3 Small* have the following options:

- *Parameter 42-82 Safe Control Word*
- *Parameter 42-83 Safe Status Word*
- *Parameter 42-85 Active Safe Func*

Parameter 0-23 Display Line 2 Large and *parameter 0-24 Display Line 3 Large* have the following options:

- *Parameter 42-82 Safe Control Word*
- *Parameter 42-83 Safe Status Word*
- *Parameter 42-86 Safe Option Info*

9.4.1 LCP Status Messages

This section describes the LCP status messages related to the VLT® Safety Option MCB 152. The set of messages differs depending on whether or not a safe fieldbus is enabled. Messages, which are shown regardless of the safe fieldbus state, are shown in table 23. Messages, which are only shown when the safe fieldbus is disabled, are shown in table 24.

Table 23: LCP Messages

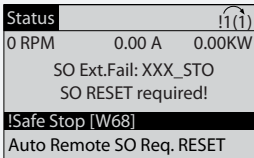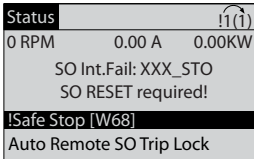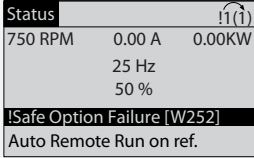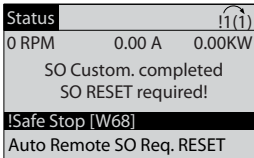| LCP Message	Description
Status !1(1) e30be090.11 0 RPM 0.00 A 0.00KW 0.0 Hz 50.0 % !Safe Stop [W68] Auto Remote Coast	The safety function was activated via a digital input or via PROFIsafe.
Status !1(1) e30be091.11 0 RPM 0.00 A 0.00KW Safe Func. Pending SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET	The source that triggered the safety condition has ceased, but the safety option is waiting for the reset signal to continue normal operation. The LCP shows this message only if the manual restart behavior is selected for the digital input. The LCP does not show this message when the PROFIsafe control word activates the safety function, since the PROFIsafe configuration uses automatic restart behavior.
Status !1(1) e30be092.11 0 RPM 0.00 A 0.00KW SO General Reset SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET	The LCP shows this message after resetting the safety option with VLT® Motion Control Tool MCT 10. After the reset, the safety option is set to blank initial state. For more information, see 6.1.3 Password Protection.

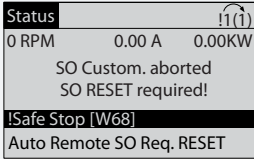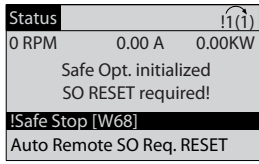| LCP Message	Description
Status !1(1) e30be093.11 0 RPM 0.00 A 0.00KW SO Ext.Fail: XXX_STO SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET	The LCP shows this message when the safety option detects an external error. The LCP shows the error number. For information about the errors and possible solutions, see 9.3.1 Error Descriptions. To resume normal operation, ensure that the source of the error has ceased and reset the safety option.
Status !1(1) e30be094.11 0 RPM 0.00 A 0.00KW SO Int.Fail: XXX_STO SO RESET required! !Safe Stop [W68] Auto Remote SO Trip Lock	The LCP shows this message when the safety option detects an internal error. The LCP shows the error number. For information about the errors and possible solutions, see 9.3.1 Error Descriptions. To resume normal operation, ensure that the source of the error has ceased and power cycle the safety option.
Status !1(1) e30be095.11 750 RPM 0.00 A 0.00KW 25 Hz 50 % !Safe Option Failure [W252] Auto Remote Run on ref.	The LCP shows this message when the safety option detects an issue and cannot handle the issue as an internal or external error. A manual user action is required in this situation. This situation can occur in the following cases: • PUST (power up self-test) timer has expired (*parameter 42-87 Time Until Manual Test* index [0]). To resume normal operation, power cycle the safety option (power cycle the drive, restart the safety option via *parameter 42-90 Restart Safe Option*, or trigger an external error and press [Reset]. • DI1 offline timer has expired (*parameter 42-87 Time Until Manual Test* index [2]). Test DI1 by activating it. • DI2 offline timer has expired (*parameter 42-87 Time Until Manual Test* index [3]). Test DI2 by activating it. To configure the LCP to show a dedicated message for each warning, select *parameter 42-86 Safe Option Info* in *parameter 0-23 Display Line 2 Large* or in *parameter 0-24 Display Line 3 Large*.

Table 24: LCP Messages, Safe Fieldbus Disabled

LCP Message	Description
Status !1(1) e30be096.11 0 RPM 0.00 A 0.00KW SO Custom. completed SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET	The safety option customization with MCT 10 is completed. Reset the safety option to start the normal operation.
Status !1(1) e30be097.11 0 RPM 0.00 A 0.00KW SO Custom. aborted SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET	The safety option customization with MCT 10 was aborted. The safety option uses the previous configuration. Reset the safety option to start the normal operation.

LCP Message	Description
Status !1(1) 0 RPM 0.00 A 0.00KW Safe Opt. initialized SO RESET required! !Safe Stop [W68] Auto Remote SO Req. RESET e30be098.11	The safety option was powered up. After the power up self-test (PUST), the safety option requests a reset.

NOTICE

When the safety option indicates an error or warning, the LCP shows the warning Safe Option Failure [W252] if the warning is not overwritten by a higher priority alarm. As a possible solution, check the connection between the safety option terminal S12 and terminal 37 on the control card.

10 Specifications

10.1 Consumption

Power consumption	2 W (equivalent power consumption related to VDD)
Current consumption VCC (5 V)	<200 mA
Current consumption VDD (24 V)	<25 mA

10.2 Inputs

10.2.1 Digital Inputs

Number of digital inputs	4 (2x2-channel digital safety input)
Input voltage range	0–24 V DC
Input voltage range, logic 0	<5 V DC
Input voltage range, logic 1	>12 V DC
Input voltage (maximum)	28 V DC
Input current (minimum)	6 mA @V_{in}=24 V (inrush current 12 mA peak)
Input resistance	Approximately 4 kΩ
Galvanic isolation	No
Short-circuit proof	Yes
Input pulse recognition time (minimum)	3 ms
Discrepancy time	9 ms
Cable length	<30 m (98.4 ft) (shielded or unshielded cable), >30 m (98.4 ft) (shielded cable)

10.3 Output

10.3.1 Digital Output (Safe Output)

Number of outputs	1
Output voltage low	<2 V DC
Output voltage high	>19.5 V DC
Output voltage (maximum)	24.5 V DC
Nominal output current (@24 V)	<100 mA
Nominal output current (@0 V)	<0.5 mA
Galvanic isolation	No
Diagnostic test pulse	300 µs
Short-circuit proof	Yes
Cable length	<30 m (98.4 ft) (shielded cable)

10.3.2 24 V Supply Output

Supply voltage	24 V DC (voltage tolerance: +0.5 V DC to -4.5 V DC)
Maximum output current	150 mA

Short-circuit proof	Yes
Cable length	<30 m (98.4 ft) (shielded or unshielded cable), >30 m (98.4 ft) (shielded cable)

10.4 Other Specifications

10.4.1 Connector Cable Dimensions

Connector cable dimensions	0.75 mm^2/18 AWG, AEH without plastic collar in accordance with DIN 46228/1

10.4.2 Reset Characteristics

Manual reset time	≤5 ms (safety option), ≤5 ms (drive), ≤10 ms (fieldbus)
Manual reset pulse time	10 µs (safety option and drive)
Automatic reset time	≤4 ms
Start-up reset time	≤5 s (*parameter 42-90 Restart Safe Option*)

10.4.3 Response Time

Input to output response time [1]	≤2 ms
Cross fault detection time	≤3 ms (@activated output)
Minimum PROFIsafe watchdog time	67 ms
STO through PROFIsafe	23 ms
PROFIsafe version 2.4 supported	Yes
PROFIdrive version 3.00.4 supported	Yes

[1] *The response times are valid for VLT® Safety Option MCB 152 only and do not include the STO of the drive in use. The user is responsible for calculating the total safety metrics/values of the system.*

10.4.4 Safety Characteristic Data

> **NOTICE**
>
> The safety-related characteristic data are valid for all safety functions. When calculating the safety characteristic data, consider all units used within a safety function.

Table 25: European Directives

Name of directive	Number/Description
Machinery Directive (2006/42/EC)	EN ISO 13849-1
	EN IEC 62061
	EN IEC 61800-5-2

Name of directive	Number/Description
EMC Directive (2014/30/EU)	EN 50011 EN 61000-6-3 EN 61800-3
Low Voltage Directive (2014/35/EC)	EN 50178 EN 61800-5-1

Table 26: Safety Standards

Name of standard	Number/description
Safety of Machinery	EN ISO 13849-1 IEC 62061 IEC 60204-1
Functional Safety	IEC 61508-1 to -7 IEC 61800-5-2 IEC 61784-3

Table 27: Safety Function

IEC 61800-5-2	IEC 60204-1
Safe Torque Off (STO)	Stop Category 0

> **N O T I C E**
>
> The data in table 28 is valid for VLT® Safety Option MCB 152 only and does not include the STO of the drive in use. The user is responsible for calculating the total safety metrics/values of the system.

Table 28: Safety Performance

Name of performance	Type/description
Safety Integrity Level	SIL 2 SIL CL2
HFT (IEC 61508)	Hardware Fault Tolerance = 1
Subsystem classification	Type B
Probability of dangerous failure per hour	PFH: 1,52 e-8
Probability of dangerous failure on demand	PFD: 1,33 e-3
Category	Cat 3
Performance level	PL d (cat 3)

Name of performance	Type/description
Mean time to dangerous failure of each channel	MTTFd: 245 years (High)
Average diagnostic coverage	DC_{ave}: 86% (Low)
Safe failure fraction	SFF: 90%
Proof test interval	20 years

11 Appendix

11.1 Abbreviations

Abbreviation	Description
Cat.	Category (EN ISO 13849-1).
CCF	Common cause failure (IEC 61508, IEC 62061, EN 61511-1, EN ISO 13849-1).
CCW	Counterclockwise.
CW	Clockwise.
DC	Diagnostic coverage (EN ISO 13849-1, IEC 62061 (IEC61508-2)).
DIx	DI1: Digital input 1. DI2: Digital input 2.
EMC	Electromagnetic compatibility.
F-DIO	Fail-safe digital input and output.
F-PLC	Fail-safe PLC
GSD	General station description. A GSD file contains characteristics of an I/O device.
MFFT/MTTFd	Mean time to failure/mean time to dangerous failure (EN ISO 13849-1).
OSSD	Output signal switching device (EN 61496-1).
PDS(SR)	Power drive system (safety related).
PELV	Protective extra low voltage, low voltage with isolation. For more information: IEC 60364-4-41 or IEC 60204-1.
PFD	Probability of failure on demand (IEC 61508, IEC 62061).
PFH	Probability of failure per hour (IEC 61508, IEC 62061).
PLC	Programmable logic controller.
PSD	PROFIsafe driver.
PUST	Power up self-test. Internal self-test on the safety option.
SF	Safe function.
SIL	Safety integrity level (IEC 61508, IEC 61800-5-2, IEC 62061).
SO	Safety option.
SRECS	Safety-related electrical control system (IEC 62061).
SRP/CS	Safety-related part of control systems (EN ISO 13849-1).

Abbreviation	Description
STO	Safe Torque Off.
TIA	Totally integrated automation.
TM	Mission time (EN ISO 13849-1).

11.2 Conventions

- Numbered lists indicate procedures.
- Bulleted and dashed lists indicate listings of other information where the order of the information is not relevant.
- Bolded text indicates highlighting and section headings.
- Italicized text indicates the following:
  - Cross-reference.
  - Link.
  - Footnote.
  - Parameter name.
  - Parameter option.
  - Parameter group name.
  - Alarms/warnings.
- All dimensions in drawings are in metric values (imperial values in brackets).
- An asterisk (*) indicates the default setting of a parameter.

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Glossary - VLT® Safety Option MCB 152

B

Blank initial state

The blank initial state is the state of the safety option when it leaves the factory with default settings.

D

Degree of protection

The degree of protection is a standardized specification for electrical equipment that describes the protection against the ingress of foreign objects and water (for example, IP20).

E

Error

Discrepancy between a computed, observed, or measured value or condition and the specified or theoretically correct value or condition.

Error class

Classification of errors into groups. The different error classes allow for specific responses to errors, for example by severity.

F

Fatal error

If a fatal error occurs, the product is no longer able to control the motor so that the power stage must be immediately disabled.

P

Parameter

Device data and values that can be read and set (to a certain extent) by the user.

PL/Performance level

Discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions (EN ISO 13849-1).

R

RS485

Fieldbus interface as per EIA-422/485 Bus Description, which enables serial data transmission with multiple devices.

S

Safe state

If a safe state fault is detected, the safety option goes into safe state. This includes faults related to integrity of hardware and firmware.

STO - Safe Torque Off

Safety function in accordance with EN IEC 61800-5-2, prevents torque from being generated by the motor. This function is integrated within the drive as a standard.

W

Warning

If the term is used outside the context of safety instructions, a warning alerts to a potential problem that was detected by a monitoring function. A

warning is not an error and does not cause a transition of the operating state.

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