

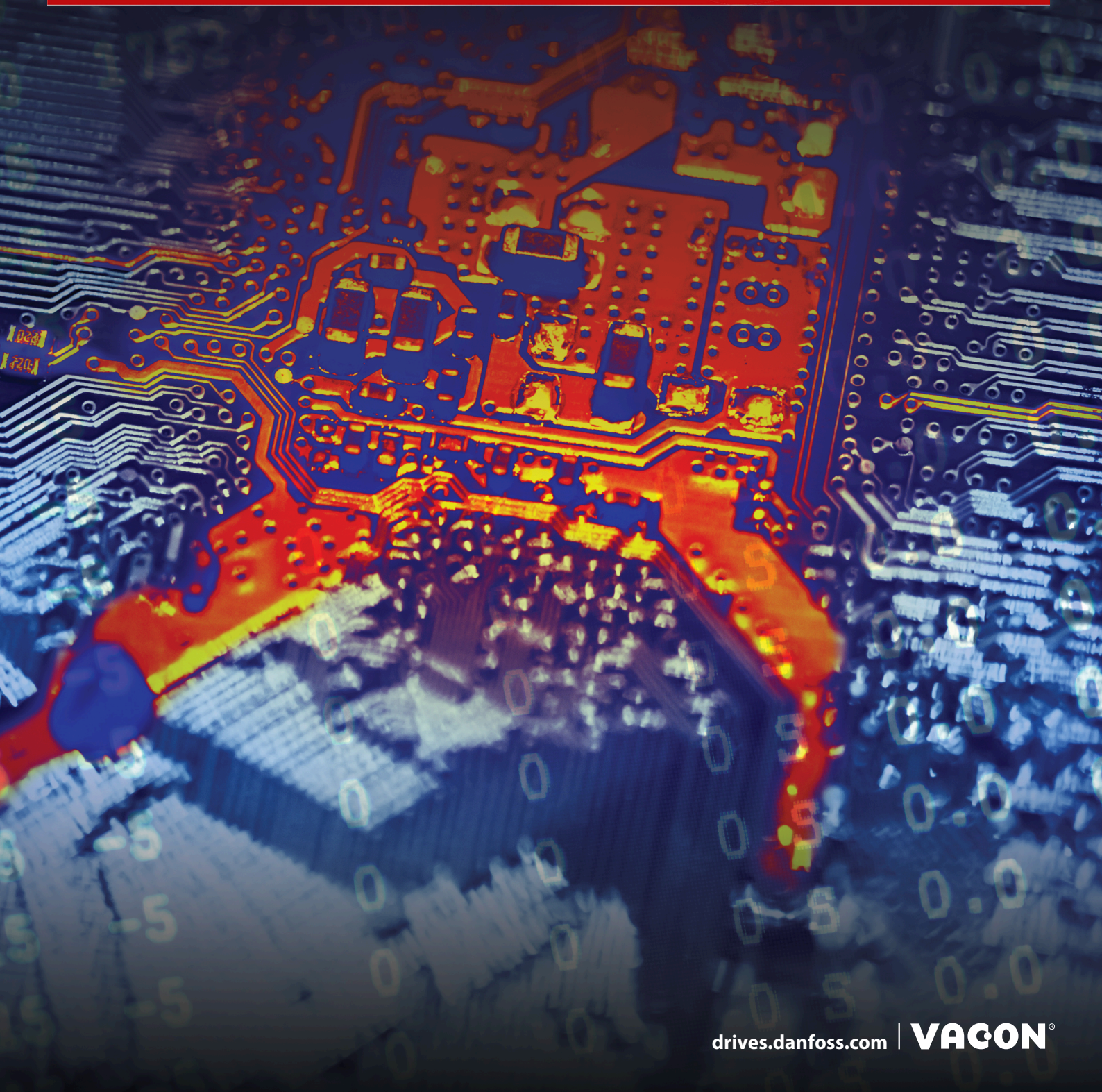
ENGINEERING
TOMORROW



Installation Guide

VACON® NXP Advanced Safety Options

OPTBL, OPTBM, OPTBN



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1 Introduction

1.1 Additional Resources

You can download the VACON® NXP Advanced Safety Options Operating Guide from the Danfoss website drives.danfoss.com/knowledge-center/technical-documentation/. It is necessary to read the Operating Guide to understand and design the safety system.

VACON® Safe can be downloaded from <https://www.danfoss.com/en/service-and-support/downloads/dds/vacon-safe/>.

The Commissioning report can be printed from the VACON® Safe tool with prefilled data. The Commissioning report can also be found as an appendix in the VACON® NXP Advanced Safety Options Operating Guide.

1.2 Manual and Version History

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

The original language of this manual is English.

Always make sure that you use the latest or correct revision of the manual when assessing the behavior of the Advanced safety option board.

Table 1: Manual and Version History

Manual version	Updates
DPD01919A	The first published version of this manual.
DPD01919B	<ul style="list-style-type: none"> Information on the manual added. Version history table added. Table linking option board names to option board codes. 3.4 General Information. Images edited. 3 Advanced Safety Option Variants. Warning added. 4.1 Installation Safety. Safety bypass procedure updated. 5.5 Bypassing Safety Features. Configuration example added. 5.6 Emergency Stop Using the STO Function. Other minor updates. Throughout the manual.
DPD01919C	<ul style="list-style-type: none"> NXP software information updated. 2.1 Requirements. Example configuration updated. 2.3 Using the Advanced Safety Option Board. Encoder terminal information updated. 3.2 Option Board OPTBM and 3.3 Option Board OPTBN. General information updated. 3.4 General Information. Option board installation instructions updated. 4.2 Installing the Option Board.
DPD01919D	<ul style="list-style-type: none"> PROFINET IO/PROFIsafe Certificate updated. 1.3 Approvals and Certificates. Changes in layout and structure.

1.3 Approvals and Certificates

ZERTIFIKAT ◆ CERTIFICATE ◆ CERTIFICADO ◆ CERTIFIKAT ◆ 認証証書 ◆ CERTIFICATE ◆ ZERTIFIKAT

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CERTIFICATE

No. Z10 17 03 99224 001



Holder of Certificate: Vacon ltd
 Runsorintie 7
 65380 Vaasa
 FINLAND

Factory(ies): 98422

Certification Mark:



Product: Safety Related Programmable Electronic System
 Advanced Safety Option Card for
 Vacon NXP AC drive

Model(s): OPTBL, OPTBM, OPTBN

Parameters:
 Safety functions: STO, SBC, SS1, SS2, SOS,
 SLS, SMS, SSR, SSM
 Safety integrity: up to SIL 3

Tested according to:
 IEC 61508-1(ed.2)
 IEC 61508-2(ed.2)
 IEC 61508-3(ed.2)
 IEC 61508-4(ed.2)
 EN ISO 13849-1:2015 (up to PL e, Cat. 4)
 EN 61800-5-2:2007
 IEC 61511-1(ed.2)
 EN 62061:2005/A2:2015

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: SB90504T

Valid until: 2022-04-02

Peter Weiss
 Date, 2017-04-03 (Peter Weiss)



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TUV®

Illustration 1: TÜV Certificate

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Certificate

PROFIBUS Nutzerorganisation e.V. grants to

Vacon Ltd

Runsorintie 7, 65380 VAASA, FINLAND

the Certificate No: **Z20212** for the PROFIsafe Device:

Model Name: Vacon OPTEA, OPTBL, OPTBM, OPTBN Advanced Safety Option
 Order-Number: OPTBL, OPTBM, OPTBN
 Revision: SW/FW: V4.0.0; HW: 6
 Application CRC: Channel A: 0x84C3
 Channel B: 0xCB77

This certificate confirms that the product has successfully passed the certification tests with the following PROFIsafe scope:

PROFIsafe_V2 functionality on PROFINET IO

Test Report Number: PS127-2
 Authorized Test Laboratory: SIEMENS AG, Fürth, Germany

The tests were executed in accordance with the following documents:
 "PROFIsafe - Test Specification for F-Slaves, F-Devices, and F-Hosts, Version 2.1, March 2007".

This certificate is granted according to the document:
 "Framework for testing and certification of PROFIBUS and PROFINET products".

For all products that are placed in circulation by **March 19, 2023** the certificate is valid for life.

Karlsruhe, May 14, 2020

Board of PROFIBUS Nutzerorganisation e. V.

(Official in Charge)

(Karsten Schneider)

(Dr. Jörg Hähnliche)



Illustration 2: PROFINET IO/PROFIsafe Certificate



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Danfoss A/S

DK-6430 Nordborg
Denmark
CVR nr.: 20 16 57 15

Telephone: +45 7488 2222
Fax: +45 7449 0949

EU DECLARATION OF CONFORMITY

Danfoss A/S

Vacon Ltd

declares under our sole responsibility that the


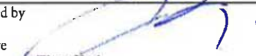
Product name VACON® Advanced Safety Options to be used in VACON® NXP AC drive
 Product identification OPTBL, OPTBM, OPTBN
 Product safety functions Safe Torque Off, Safe Stop 1, Safe Stop 2, Safe Operating Stop, Safe Brake Control, Safe Limited Speed, Safe Speed Range, Safe Acceleration Range, Safe Speed Monitor, Safe Direction, Safe Maximum Speed, Safe Quick Stop

fulfils all of the relevant safety component requirements of EC Machinery Directive 2006/42/EC.

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.

- EN ISO 13849-1:2015
Safety of machinery – Safety-related parts of the control systems – Part 1
- EN ISO 13849-2:2012
Safety of machinery – Safety-related parts of the control systems – Part 2
- IEC 61511-1: 2016
Functional safety - Safety instrumented systems for the process industry sector – Part 1
- EN 60204-1:2006
Safety of machinery – Electrical equipment of machines – Part 1
- EN 61800-5-2:2007
Adjustable speed electrical power drive systems – Part 5-2
- IEC 61508:2010
Functional safety of electrical/electronic/programmable electronic safety-related systems – Parts 1-3
- EN 62061:2005
Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems

Person authorised to compile the relevant technical documentation: Vacon Ltd, Runsonrintie 7, 65380 Vaasa, Finland.

Date & Place 17.2.2017 Vaasa	Issued by  Signature Name Pekka Alasaari Title Product Manager, Functional Safety	Date & Place 13.2.2017 Vaasa	Approved by  Signature Name Timo Kasi Title VP, Design Center Finland and Italy
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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.

ID No: DPD01918

Revision No: A

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Illustration 3: EC Declaration of Conformity

2 General information

2.1 Requirements

Table 2: Required Drive Component Versions

Component	Version	Comment
The control board of VACON® NXP AC drive	Hardware: VB00761 B (141L8026) or newer Software: NXP00002V198 or newer	
The STO and ATEX option board (OPTAF)	Hardware: VB00328 E (141L7786) or newer	Check the safety levels of STO in the product manual.

Table 3: The PC Tools that Can Be Used with the Option Board

PC tool	Version	Comment
NCDrive	2.0.29 or newer	Older versions than this can be used, but they do not show correctly the details of safety related faults.
VACON® Loader	1.1.12.0 or newer	The tool is used to update the option board firmware.
VACON® Safe	1.0.2.0 or newer	The tool is used to parameterize and monitor the option board.

2.2 Safety Levels of the Advanced Safety Option Board

- Safety integrity level: SIL 3
- Performance level: PL e
- Category: Cat 4

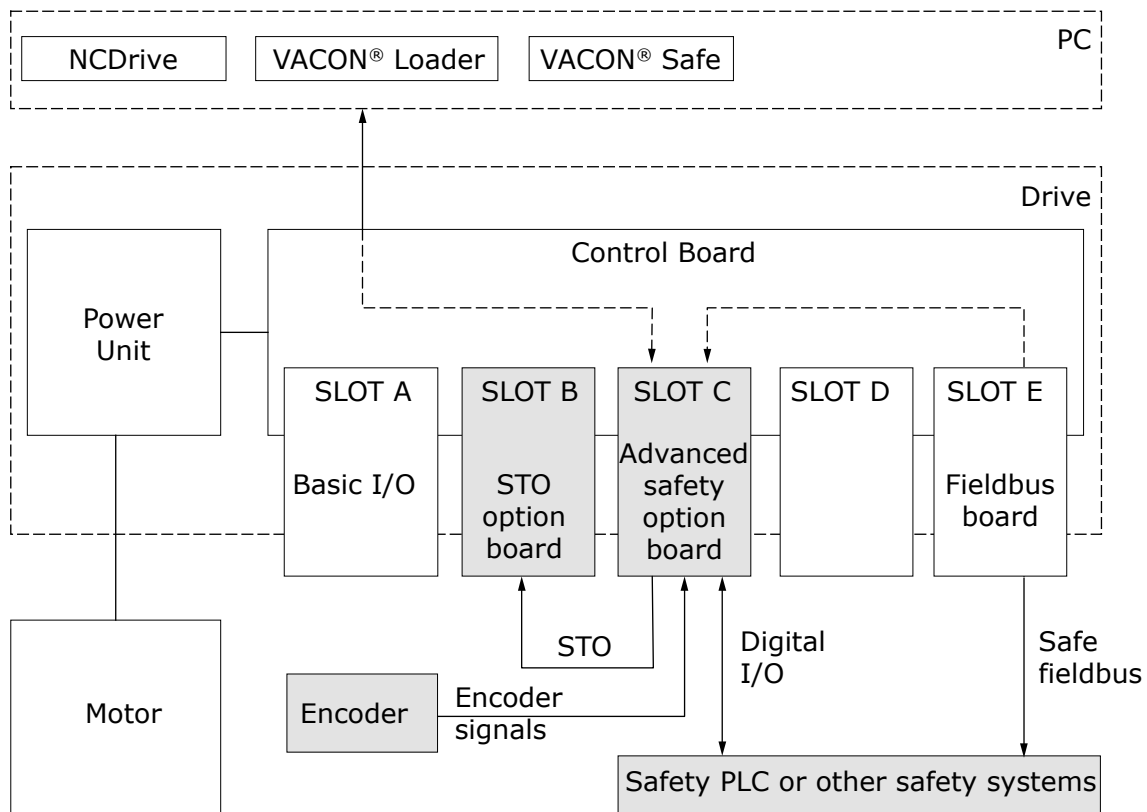
2.3 Using the Advanced Safety Option Board

The Advanced safety option board is used to implement safety functions in accordance with the standard EN IEC 61800-5-2. The option board handles the safe I/O and the monitoring of active safety functions. The option board does not handle the control of the AC drive. The AC drive can be controlled, for example, with the drive application, or the external process control system can give the speed reference to the AC drive.

The Advanced safety option board must be used with a subsystem that provides the STO function, it is not possible to use the Advanced safety option board alone. The STO function is provided, for example, by the OPTAF STO option board. To use the safety functions that do speed monitoring, an external speed sensor is necessary. The sensor can be a digital or an analog encoder or a digital proximity sensor.

When using a safe fieldbus, install an option board that supports the fieldbus.

The [Illustration 4](#) shows the configuration of the AC drive with the Advanced safety option board in slot C. The safe fieldbus and the closed-loop control are optional. The possible configuration and available features can depend on other option boards and their installation slots.



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Illustration 4: An example configuration of the VACON® NXP drive with the Advanced safety option board. The subsystems that handle safety actions are marked in gray.

The parameterization of the option board is done by selecting and editing the safety functions and features with the VACON® Safe tool.

3 Advanced Safety Option Variants

3.1 Option Board OPTBL

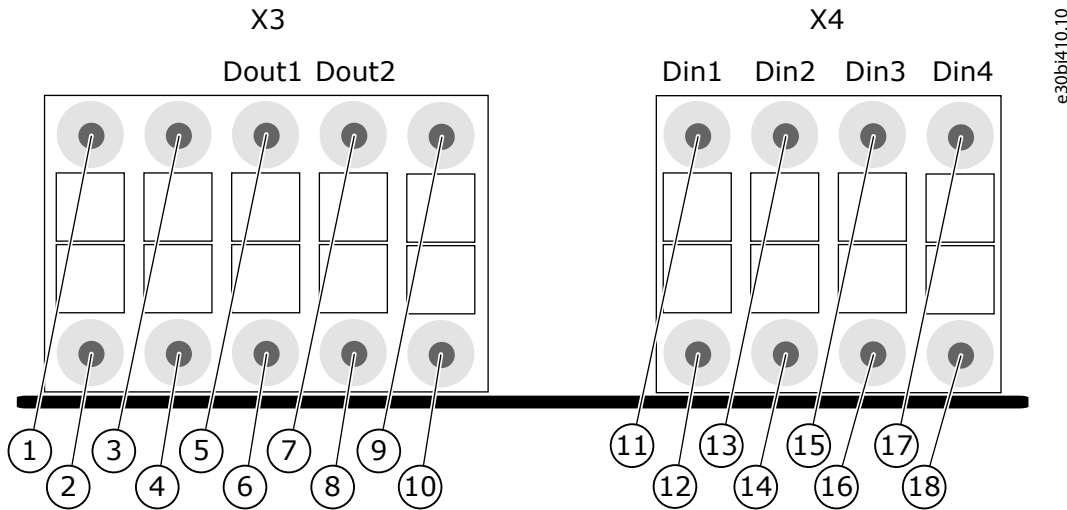


Illustration 5: The Terminals X3 and X4 of the OPTBL Option Board

1	STO 1. STO terminal 1 +24 V, to be connected to OP-TAF terminal SD1+.	10	GND.
2	STO 2. STO terminal 2 +24 V, to be connected to OP-TAF terminal SD2+.	11	Din 1A. Terminal A of digital input 1.
3	GND.	12	Din 1B. Terminal B of digital input 1.
4	GND.	13	Din 2A. Terminal A of digital input 2.
5	Dout 1A. Terminal A of digital output 1.	14	Din 2B. Terminal B of digital input 2.
6	Dout 1B. Terminal B of digital output 1.	15	Din 3A. Terminal A of digital input 3.
7	Dout 2A. Terminal A of digital output 2.	16	Din 3B. Terminal B of digital input 3.
8	Dout 2B. Terminal B of digital output 2.	17	Din 4A. Terminal A of digital input 4.
9	+24 V. +24 V supply for external logic.	18	Din 4B. Terminal B of digital input 4.

3.2 Option Board OPTBM

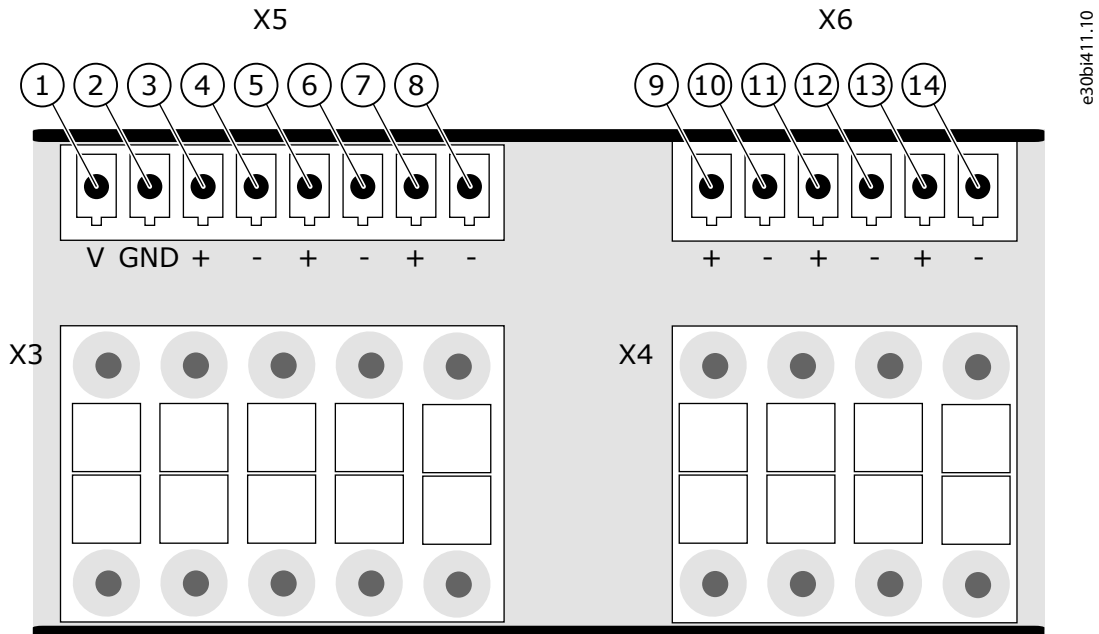
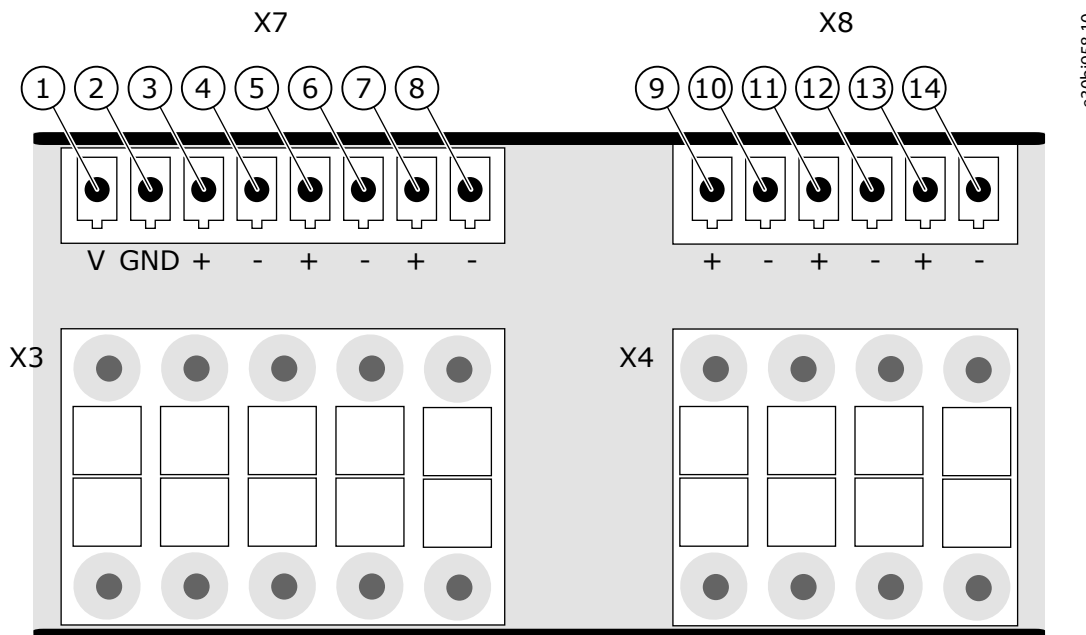


Illustration 6: The Terminals X5 and X6 of the Digital Pulse Type Encoder Interface Board

1	Configurable encoder voltage.	8	Z-. Reference signal, optional.
2	GND.	9	A+. Unmodified encoder signal loopback.
3	A+. Terminal A of digital pulse signal.	10	A-. Unmodified encoder signal loopback.
4	A-. Terminal A of digital pulse signal.	11	B+. Unmodified encoder signal loopback.
5	B+. Terminal B of digital pulse signal.	12	B-. Unmodified encoder signal loopback.
6	B-. Terminal B of digital pulse signal.	13	Z+. Unmodified encoder signal loopback.
7	Z+. Reference signal, optional.	14	Z-. Unmodified encoder signal loopback.

The OPTBM option board is similar to the OPTBL option board, but in addition, the OPTBM option board has a digital pulse TTL/HTL type encoder interface board attached to it.

3.3 Option Board OPTBN



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Illustration 7: The Terminals X7 and X8 of the Sin/Cos Type Encoder Interface Board

1	Encoder voltage. Selectable encoder voltage.	8	Z-. Reference signal, optional.
2	GND.	9	Sin+. Unmodified encoder signal loopback.
3	Sin+. Sinus terminal of analog pulse signal.	10	Sin-. Unmodified encoder signal loopback.
4	Sin-. Sinus terminal of analog pulse signal.	11	Cos+. Unmodified encoder signal loopback.
5	Cos+. Cosine terminal of analog pulse signal.	12	Cos-. Unmodified encoder signal loopback.
6	Cos-. Cosine terminal of analog pulse signal.	13	Z+. Unmodified encoder signal loopback.
7	Z+. Reference signal, optional.	14	Z-. Unmodified encoder signal loopback.

The OPTBN option board is similar to the OPTBL option board, but in addition, the OPTBN option board has a Sin/Cos type encoder interface board attached to it.

3.4 General Information

Newer versions of the Advanced Safety Option have extended slot compatibility. The table [Table 4](#) describes the supported slots for different revisions of the option board. The compatibility is determined by the revision of the board 70CVB01938 (141X4588). See [Illustration 8](#) for the location of the revision information.

Table 4: Supported Slots of the Revisions of the Option Board

Option board revision (70CVB01938, 141X4588)	Slot C	Slot D	Slot E
C, E	-	Yes	-
F	Yes	Yes	Yes

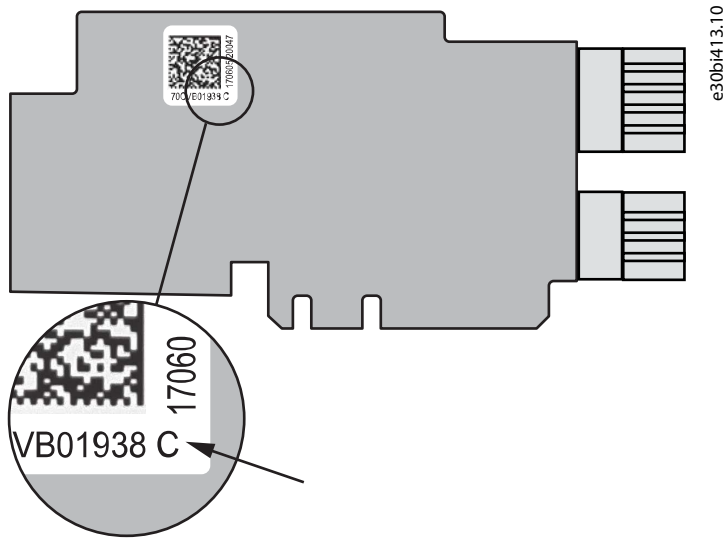


Illustration 8: The Board Identification Sticker on the Advanced Safety Option Board

4 Installation

4.1 Installation Safety

Read these warnings before starting the installation of the option board.

⚠ WARNING ⚠

SHOCK HAZARD FROM CONTROL TERMINALS

The control terminals can have a dangerous voltage also when the drive is disconnected from mains. A contact with this voltage can lead to injury.

- Make sure that there is no voltage in the control terminals before touching the control terminals.

⚠ CAUTION ⚠

DAMAGE TO OPTION BOARDS

Do not install, remove, or replace option boards on the drive when the power is on. Doing this can cause damage to the boards.

- Switch off the AC drive before installing, removing, or replacing option boards on the drive.

NOTICE

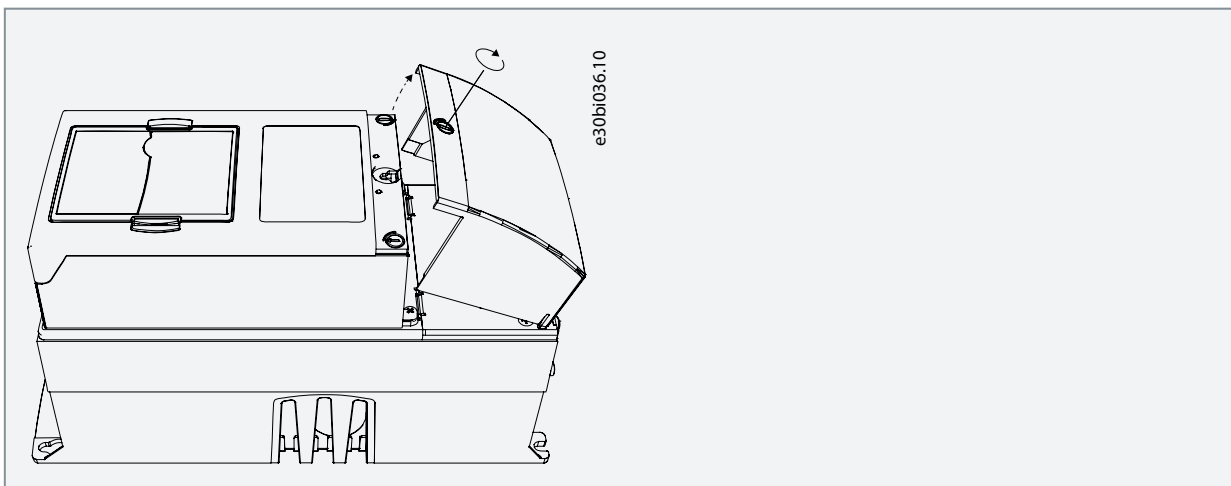
Measure or do a check of the encoder supply voltage of the encoder interface board before connecting a new encoder. It is possible that the encoder supply voltage was set to a higher voltage than what is supported by the new encoder. An incorrect encoder supply voltage can damage the equipment.

4.2 Installing the Option Board

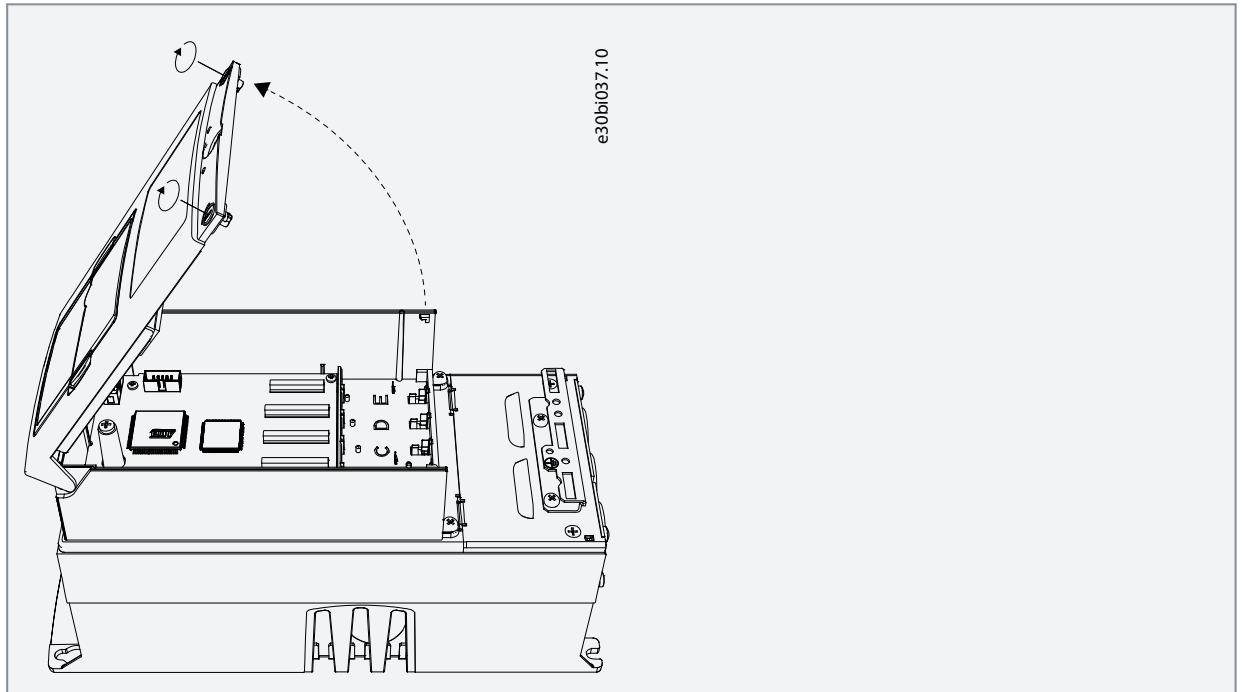
This topic gives instructions for installing the option board in VACON® NXP, FR4–FR9.

Procedure

1. In FR5–FR9, open the cover of the AC drive.
2. In FR4, remove the cable cover.

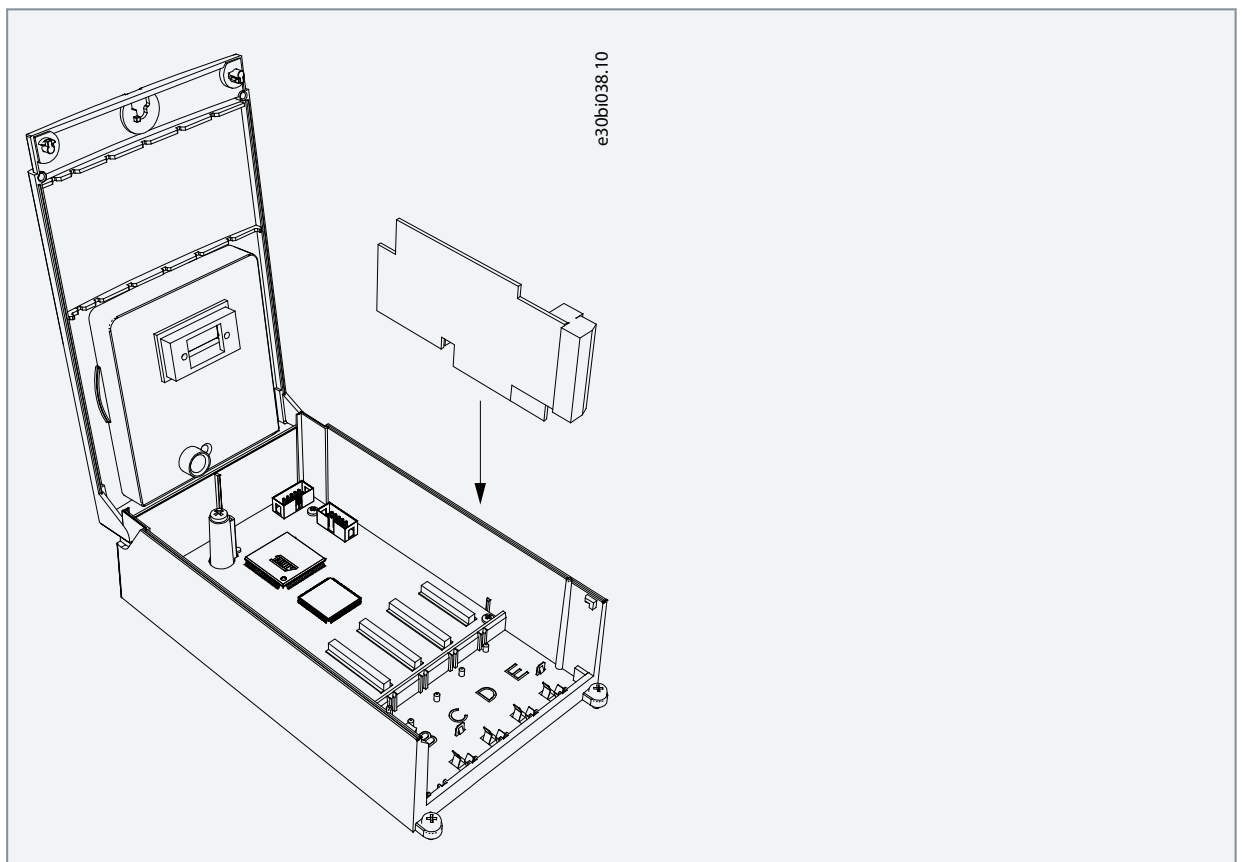


3. Open the cover of the control unit.



4. Install the option board into the slot C, D, or E on the control board of the AC drive. Make sure that the grounding plate fits tightly in the clamp.

The board revision can affect the applicable installation slot.



5. In IP21, cut free the opening on the cover of the AC drive for the fieldbus cable.
6. Install the cables.
7. Close the cover of the control unit and attach the cable cover.

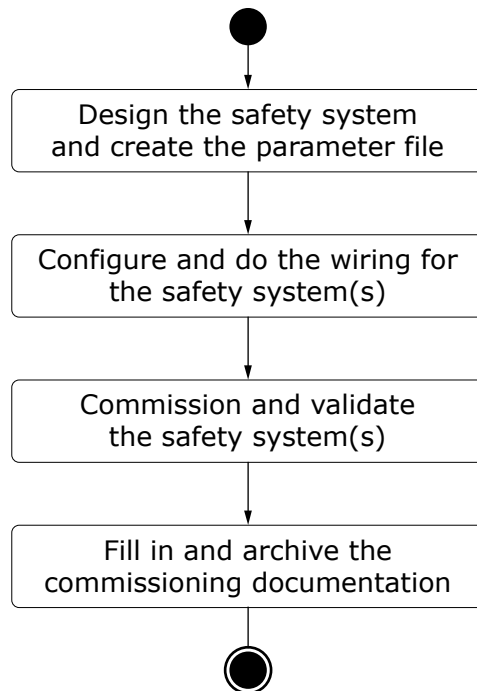
5 Commissioning

5.1 Preparing for Commissioning

The information in this chapter is also included in the Commissioning report.

The Commissioning report lists relevant instructions for commissioning the option board. The Commissioning report can be printed from the VACON® Safe tool with prefilled data or downloaded from the Danfoss website. The Commissioning report can also be found as an appendix in the VACON® NXP Advanced Safety Options Operating Guide.

If it is possible, commission the AC drive first without the Advanced safety option board to make sure that your process is operational.



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Illustration 9: Preparing and Commissioning a Safety System that Includes the Advanced Safety Option Board

5.2 Procedures Before the First Start-up of the System with the Option

Procedure

1. Read the Advanced safety option board Operating Guide and the Commissioning report and apply their instructions in the commissioning plan.
2. Read the operating guide of the AC drive.
3. Refer to the user guide of other subsystems connected to the commissioned drive system.
4. Define the parameter file for the Advanced safety option board.
5. Make sure that the hardware and configuration are correct, and that the software is correct in the components of the AC drive and its subsystems.
6. Make sure that the information of the commissioned AC drive matches the information in the commissioning plan and the Commissioning report.
7. Make sure that the connections between different systems have been checked and are ready to be used.
8. Make sure that the area affected by the commissioned systems is free and secure for the commissioning.
9. Make sure that no danger can be caused to personnel if the system has been configured incorrectly and behaves unexpectedly.
10. Make sure that the AC drive is correctly parameterized and commissioned for use.
 - a. The motor parameters have been set.
 - b. The identification run has been done. Preferred identification type: identification with run or encoder ID run.
 - c. The fieldbus connection can be established. If a fieldbus is used.
11. Have a computer available with software to control and parameterize the AC drive and the option boards, and to store test logs and parameters.
12. Have the Commissioning report available.

13. Document the deviations compared to expected results during the commissioning and testing procedures. Do not release the system for use if any unacceptable deviations exist.

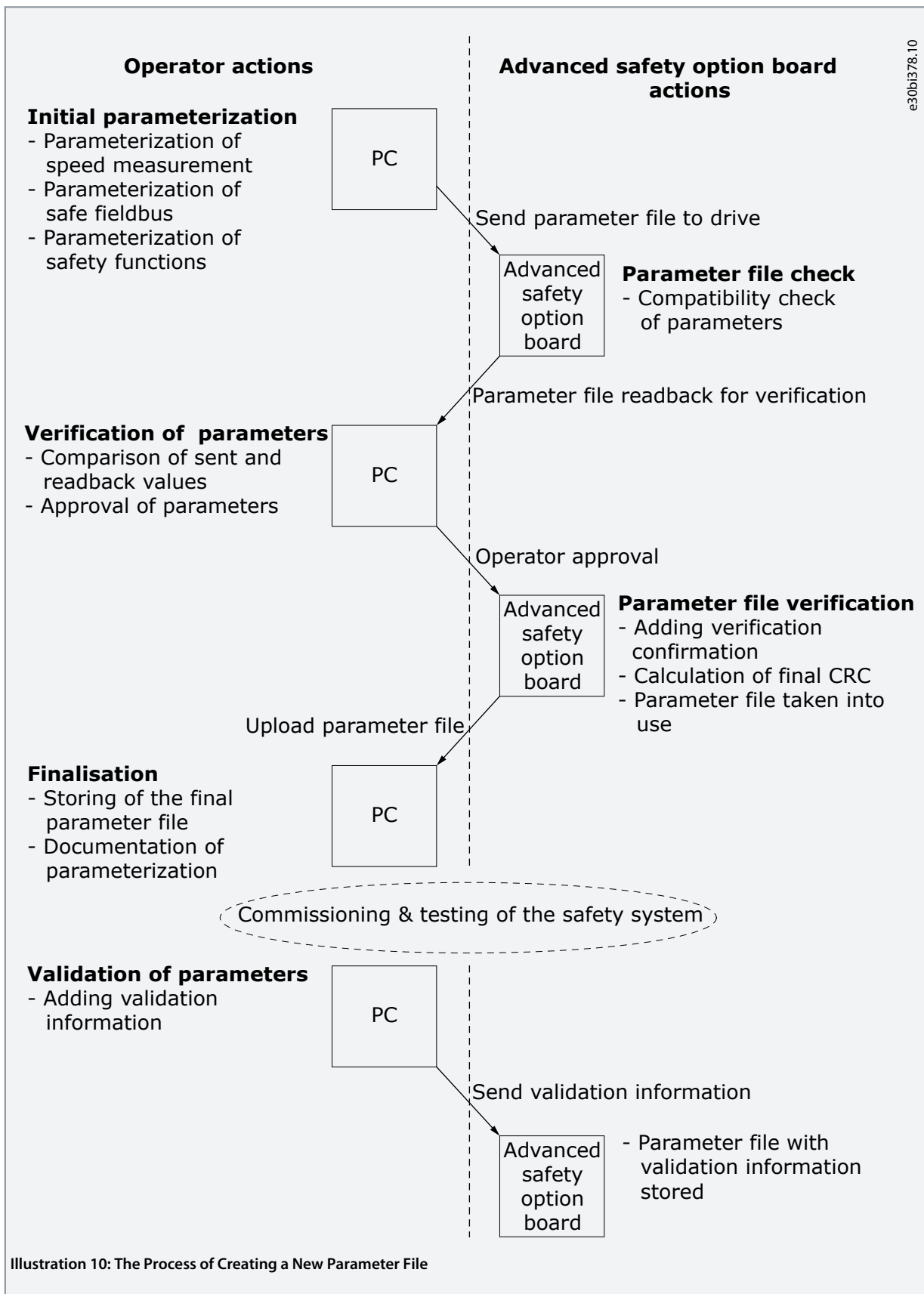
5.3 Setting the Parameters

Use the VACON® Safe tool to parameterize the Advanced safety option board. The parameterization process of the Advanced safety option board has 4 steps.

Procedure

1. To select the desired safety functions and features, go to "Select functions" in the PC tool.
2. Go to "Adjust parameters" in the PC tool.
3. Verify the transfer of parameters to the option board. Go to "Verify and Approve".

4. Validate the parameter file by going to "Validate".



5.4 Doing the First Start-up After the Installation of the Option Board

The information in this chapter is also included in the Commissioning report. After the option board is installed in the AC drive, do these steps.

Procedure

1. Power up the AC drive.
 - a. The drive shows the fault F38 DeviceAdded (example: slot D, subcode 1 if Advanced safety option is installed in slot D). The actual faults shown depend on the configuration used during the previous start-up if other changes have also been made.
 - b. If the option board was already installed and tested at the factory, the fault is not shown.
 - c. Other faults are also shown: the warning for Safe Torque Off (F30, subcode: 1) and the fault for Safety System (F20 SafetySystem, source: 82 - Plaus. check, fault number: 3). Fault F20 indicates that the option board has no valid parameter file.
2. Reset the faults.
 - a. The drive is not ready. The warning F30 SafeTorqueOff is shown.
 - b. If the option board has been used in a previous configuration, it is possible that it has a valid parameter file already. In this case, the drive may be in READY state.
 - c. The faults that are shown and their type (Fault or Alarm) depend on the settings of the AC drive.
 - d. STO state can also be seen from the STO board diagnostic relay output.
3. Parameterize the option board using the VACON® Safe tool.
 - a. After parameterization the fault F20 (source: 82, fault number: 3) no longer appears. Depending on the parameterized safety functions and the state of the option board inputs, different safety functions can be reported as requested or reached.
 - b. The fault F20 (source: 243 - drive conf, fault number: 2) appears. The fault indicates that the parameter file is not tested and validated.
4. Print the prefilled Commissioning report from the VACON® Safe tool or save the report in digital form.
5. Test the safe fieldbus, or if a safe fieldbus is not used, the relevant safety functions.

5.4.1 Commissioning Check List

Table 5: Commissioning Check List

Step	Commissioning action	Yes	No
1	The correct installation of the option board has been verified and documented.		
2	The option board has been parameterized with the intended configuration.		

To commission the different safety functions, see the Commissioning report of the option board.

5.5 Bypassing Safety Features

⚠ D A N G E R ⚠

BYPASS HAZARD
 When the Advanced safety option board is bypassed, it does not provide any safety functions.

- Consider carefully before bypassing the Advanced safety option board.

N O T I C E

While not strictly required, it is recommended to return the parameter P7.4.1.2.1 to its default value "Default" after the commissioning activities.

If the Advanced safety option board is installed in the AC drive with an STO board and the AC drive itself has not been commissioned, it may be preferable to bypass the safety functions of the Advanced safety option to make the commissioning simpler. To bypass the safety functions of the Advanced safety option, do these steps.

Procedure

1. Disconnect the STO outputs of the Advanced safety option board if they are connected. Leave the outputs disconnected.

2. Connect the STO request input of the STO board to terminals +24 V and GND so that the STO function is disabled.
3. Power up the AC drive.
4. Set the parameter P7.4.1.2.1 in the expander board menu to value "Warning" to deactivate the drive response to faults reported by the Advanced safety option.
5. Reset the faults.
 - a. The AC drive should be in the READY state.

5.6 Emergency Stop Using the STO Function

This is an example configuration for realizing emergency stop according to IEC-60204-1 using the STO function in the Advanced safety option board OPTBL and the STO option board OPTAF. The drive reset is used to clear the faults and to deactivate the STO function after violations and faults. The STO function is set to the manual acknowledgment mode.

Depending on the result of the risk and hazard analysis, you can use the safe external acknowledgment signal 1) or the non-safe drive acknowledgment 2). The case in [Illustration 11](#) has safe external acknowledgment.

The STO request is assigned to Digital Input 1 of the Advanced safety option board. External acknowledgment signal is assigned to Digital input 2. No speed measurement is needed or considered for this configuration.

Table 6: Configuration in OPTBL. Used Safety Functions: STO

STO parameters	Value
Acknowledgment Mode (STO)	Manual

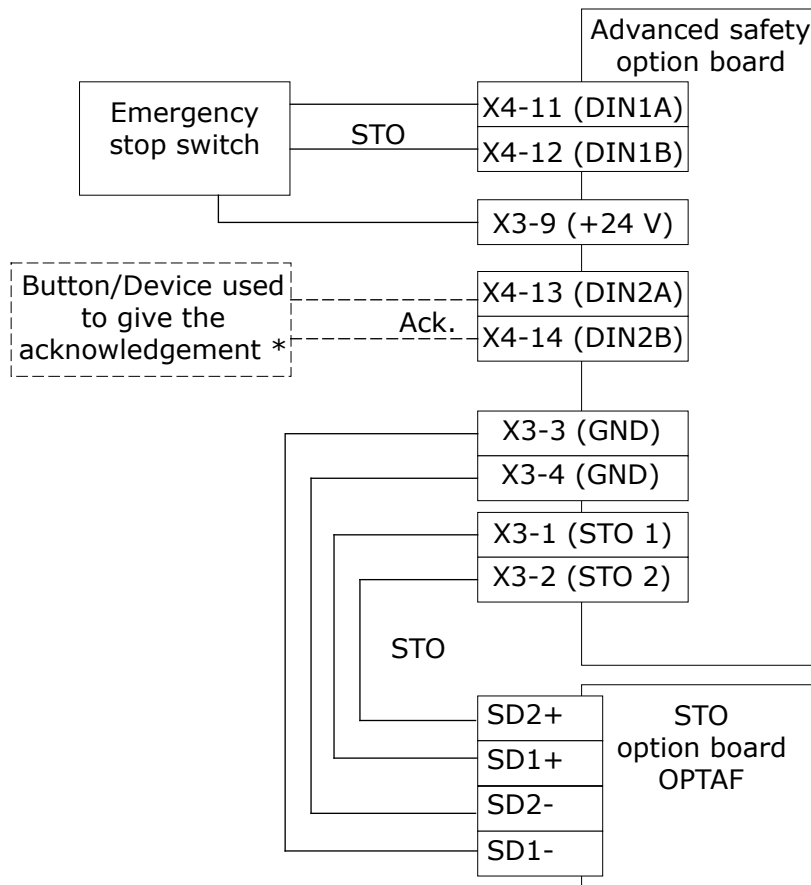
Table 7: Input/Output Parameters

Input/output parameters	Value
Digital Input 1	STO
Digital Input 2	Acknowledgment 1)

Table 8: General Parameters

General parameters	Value
Drive Reset	Enabled
Drive Acknowledgment	Enabled 2) Disabled 1)

1) and 2) indicate alternative options. Use values marked with the same number.



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Illustration 11: Emergency Stop Configuration with the STO Function and Safe Acknowledgment

* = For some devices used for acknowledgment, additional wiring is required.

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Runsorintie 7
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