



**B&P** Elektromotoren

**VACON<sup>®</sup> 100 INDUSTRIAL**  
**VACON<sup>®</sup> 100 FLOW**  
**VACON<sup>®</sup> 100 HVAC**  
AC DRIVES

**OPTBJ**  
STO AND ATEX OPTION BOARD  
**SAFETY MANUAL**

**VACON<sup>®</sup>**

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**NOTE!** You can download the English and French product manuals with applicable safety, warning and caution information from <https://www.danfoss.com/en/service-and-support/>.

**REMARQUE** Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site <https://www.danfoss.com/en/service-and-support/>.

# 1. APPROVALS



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## EU DECLARATION OF CONFORMITY

**Danfoss A/S**  
Vacon Ltd

declares under our sole responsibility that the



Product name                      Vacon OPTBJ option board to be used with Vacon 100 family products  
Product identification            70CVB01380  
Product Safety Functions        Safe Torque Off (Specified in EN 61800-5-2)

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

Notified body that carried out the EC type examination:  
TÜV Rheinland Industrie Service GmbH (NB0035)  
Am Grauen Stein, 51105 Köln, Germany

The following standards and/or technical specifications referenced below were used:

- EN 61800-5-2:2007  
Adjustable speed electrical power drive systems, Part 5-2: Safety requirements – Functional
- EN 61800-5-1:2007 (only for LV Directive compliance)  
Adjustable speed electrical power drive systems, Part 5-2: Safety requirements - Electrical, thermal and energy
- EN 61800-3:2004/A1:2012 (only for EMC Directive compliance)  
Adjustable speed electrical power drive systems, Part 3: EMC requirements and specific test methods
- EN ISO 13849-1:2008 + AC:2009  
Safety of machinery - Safety-related parts of control systems –, Part 1: General principles for design
- EN 62061:2005 + AC:2010  
Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
- IEC 61508 Parts 1-7:2010  
Functional safety of electrical/electronic/programmable electronic safety-related systems
- EN 60204-1:2006 + A1:2009 + AC:2010 (in extracts)  
Safety of machinery – Electrical equipment of machines – Part 1: General requirements
- EN 61326-3-1:2008  
Electrical equipment for measurement, control and laboratory use – EMC, Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety).

Date 15-04-2016	Issued by Signature  Name: <b>Antti Vuola</b> Title: <b>Head of Standard Drives</b>	Date 15-04-2016	Approved by Signature  Name: <b>Timo Kasi</b> Title: <b>VP, Design Center Finland and Italy</b>
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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.

# EC Type-Examination Certificate



**Reg.-No.: 01/205/5216.03/20**

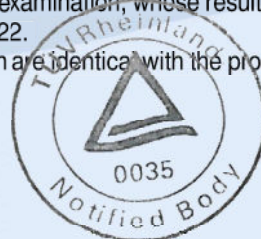
<b>Product tested</b>	Safety Function "Safe Torque Off (STO)" within Adjustable Frequency AC Drive	<b>Certificate holder</b>	Vacon PLC Runsorintie 7 65380 Vaasa Finland
<b>Type designation</b>	Vacon 100 AC Drive with OPTBJ (STO and ATEX option board): Frame Sizes MR4 to MR12, VACON 0100-3L-xxxx-y, Details see Revision List		
<b>Codes and standards</b>	EN 61800-5-2:2017 EN 61800-5-1:2007 + A1:2017 (in extracts) EN 61800-3:2018		EN ISO 13849-1:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 IEC 61508 Parts 1-7:2010
<b>Intended application</b>	The safety function "Safe Torque Off" complies with the requirements of the relevant standards (PL e / Cat. 3 acc. to EN ISO 13849-1, SIL CL 3 acc. to EN 61800-5-2 / EN 62061 / IEC 61508) and can be used in applications up to PL e acc. to EN ISO 13849-1 and SIL 3 acc. to EN 62061 / IEC 61508.		
<b>Specific requirements</b>	The instructions of the associated Installation and Operating Manual shall be considered.		

It is confirmed that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.

Valid until 2025-09-22

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/M 350.08/20 dated 2020-09-22.

This certificate is valid only for products which are identical with the product tested.



Köln, 2020-09-22

Notified Body for Machinery, NB 0035

*Jelena Stenzel*

Dipl.-Ing. Jelena Stenzel



1. **EU-TYPE EXAMINATION CERTIFICATE**
2. **Equipment or Protective System Intended for use in  
Potentially explosive atmospheres  
Directive 2014/34/EU**
3. Reference: **VTT 06 ATEX 048X Issue 4**
4. Equipment: **Thermal motor protection system for inverter drives**  
Certified types: **OPT-AF and OPT-BJ**
5. Manufactured by: **Vacon Ltd**
6. Address: **Runsorintie 7  
FI-65380 VAASA  
Finland**
7. This equipment or protective system and any acceptable variations thereto are specified in the schedule and possible supplement(s) to this Certificate and the documents therein referred to.
8. VTT Expert Services Ltd, notified body number 0537, in accordance with Article 21 of the Directive 2014/34/EU of February 2014, certifies that this equipment or protective system has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective system intended for use in potentially explosive atmospheres given in Annex II to the Directive.  
  
The examination and test results are recorded in confidential report no. VTT-S-05774-06.
9. Compliance with the Essential Health and Safety Requirements has been assured by using standards:


**EN ISO 13849-1 (2008) + AC:2009**  
**EN ISO 13849-2 (2013)**  
**EN 60079-14 (2014)**  
**EN 61508-1 (2010)**  
**EN 50495 (2010)**

- 
10. If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for safe use specified in the schedule to this certificate.
  11. This EC-Type examination certificate relates only to the design, examination and tests of the specified equipment or protective system in accordance to the directive 2014/34/EU. Further requirements of the Directive apply to the manufacturing process and supply of this equipment or protective system. These are not covered by this certificate.
  12. The marking of the equipment or protective system shall include the following:



**II (2) GD**

Espoo 28.4.2017  
**VTT Expert Services Ltd**



Juho Pörhönen  
Expert



Risto Sulonen  
Product Manager



SCHEDULE TO EU-TYPE  
EXAMINATION CERTIFICATE  
VTT 06 ATEX 048X Issue 4

1 (2)

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13. **Schedule**

14. **EU-TYPE EXAMINATION CERTIFICATE VTT 06 ATEX 048X Issue 4**

15. Description of Equipment

Thermal motor protection system consist one safe disable & ATEX option board with possibility to connect to temperature sensor (PTC). The temperature sensor is not included in this certificate. The ATEX safety function may be used with all Vacon 100 and NX drives.

Documents specifying the equipment:

OPT-AF: Prevention of Unexpected Start Up ; SC00328 J  
EC Type-Examination Certificate IFA1501228 (dated 2015-11-03) by IFA

OPT-BJ: STO option board; SC01380, rev C.01  
EC Type-Examination Certificate 01/205/5216.02/15 (dated 2015-09-22) by TÜV Rheinland

16. Report No. VTT-S-05774-06

17. Special conditions for safe use

The allowed ambient temperature range is -10°C...+50°C.

18. Essential Health and Safety Requirements

Assessment using standards referred in point 9 have confirmed compliance with the Directive 2014/34/EU, Annex II and in particular point 1.5. The device themselves are to be installed outside potentially explosive atmospheres (article 1, section (b) of the Directive).

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Certificate history

Issue	Date	Report No.	Comment
-	19.6.2006	VTT-S-05774-06	Prime certificate
Supplement 1 and 2	26.6.2008 and 6.4.2010		The introduction of new revisions and STO function
1	26.4.2012	968/M 350.00/12	The introduction of M-Platform STO-function and changing equipment name and type designation. Updating the certificate with the latest edition of relevant standards
2	9.7.2012	-	The introduction the old type OPT-AF in the scope of the certificate.
3	8.1.2016	-	Constraining the references only to ATEX-relevant documents
4	28.4.2017	-	Updating the certificate to refer the new directive 2014/34/EU and latest version of relevant standards. Special conditions for safe use changed

Espoo 28.4.2017  
**VTT Expert Services Ltd**



Juho Pörhönen  
 Expert



Risto Sulonen  
 Product Manager



## 2. GENERAL

This document covers OPTBJ option board 70CVB01380 (141X4029) revision D (or newer).

*Table 1. Version history of the manual*

Date	Revision	Updates
10/2020	G	<ul style="list-style-type: none"> <li>Updated EC Type-Examination Certificate</li> </ul>

**NOTE!** Designing of safety-related systems requires special knowledge and skills. Only qualified persons are permitted to install and set up the OPTBJ board.

This document covers the OPTBJ option board 70CVB01380 (141X4029) functionality together with VACON® 100 family Control board 70CVB01582 (141X4153).

The OPTBJ option board together with VACON® 100 family control board provides the following safety functions with VACON® 100 family products.

The following safety-related abbreviations and expressions have been used in this manual:

<b>SIL</b>	Safety Integrity Level
<b>PL</b>	Performance Level
<b>PFH</b>	Probability of a dangerous random hardware Failure per Hour
<b>Category</b>	Designated architecture for a safety function (from EN ISO 13849-1:2006)
<b>MTTF<sub>d</sub></b>	Mean time to dangerous failure
<b>DC<sub>avg</sub></b>	Average diagnostic coverage
<b>PFD<sub>avg</sub></b>	Average probability of (random hardware) failure on demand
<b>T<sub>M</sub></b>	Mission time
<b>Safety actuator</b>	Device that controls the safety-related signal lines. Can be, for example, emergency button, safety PLC, safety relay.
<b>OSSD</b>	Output Signal Switching Device, i.e. switch that controls the signal lines between actuator and the drive's signal input.

### Safe Torque Off (STO)

The hardware based 'Safe Torque Off' safety function prevents the drive from generating torque on the motor shaft. The STO safety function has been designed for use in accordance with the following standards:

- EN 61800-5-2 Safe Torque Off (STO) SIL3
- EN ISO 13849-1 PL"e" Category 3
- EN 62061: SILCL3
- IEC 61508: SIL3
- The function also corresponds to an uncontrolled stop in accordance with the stop category 0, EN 60204-1.
- The STO safety function has been certified by TÜV Rheinland

**NOTE!** The STO function is not the same as a prevention of unexpected start-up function. For fulfilling those requirements, additional external components are required according to appropriate standards and application requirements. Required external components may be for example:

- Appropriate lockable switch
- A safety relay providing a reset function

**NOTE!** The safety functions of OPTBJ do not comply with Emergency Switching Off according to EN 60204-1.

**NOTE!** Do not use the STO function as a standard stop function of the drive.

**NOTE!** In an IGBT fault situation, the shaft of a permanent magnet motor can rotate up to 180 degrees around the pole of the motor.

**NOTE!** If the pollution degree 2 cannot be guaranteed, use the IP54 protection class.



**CAUTION!** The OPTBJ board and its safety functions do not electrically isolate the drive output from the mains supply. If electrical work is to be carried out on the drive, the motor or the motor cabling, the drive has to be completely isolated from the mains supply, for example, using an external supply disconnecting switch. See, for example, EN60204-1 Chapter 6.5.

### Safe Stop 1 (SS1)

The SS1 safety function is realized in compliance with type C of the drives safety standard EN 61800-5-2 (Type C: "The PDS(SR) initiates the motor deceleration and initiates the STO function after an application specific time delay").

The SS1 safety function has been designed for use in accordance with the following standards:

- EN 61800-5-2 Safe Stop 1 (SS1) SIL2
- EN ISO 13849-1 PL"d" Category 3
- EN 62061: SILCL2
- IEC 61508: SIL2
- The function also corresponds to a controlled stop in accordance with the stop cat. 1, EN 60204-1.

### Motor Thermistor Over temperature protection (according to ATEX)

Overtemperature detection using thermistor. It can be used as a tripping device for ATEX certified motors.

The thermistor tripping function is certified by VTT\* according to ATEX directive 94/9/EC.

All safety functions of the OPTBJ board are described in this manual.

\* VTT = Technical Research Centre of Finland

## 2.1 REFERENCES

VACON® 100 family Installation and Application manuals are downloadable at <https://www.danfoss.com/en/service-and-support/>.

### 3. INSTALLATION OF OPTBJ BOARD

1

Open the cover of the AC drive.

M4x55

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The relay outputs and other I/O-terminals may have a dangerous control voltage present even when VACON® 100 family AC drive is disconnected from mains.

2

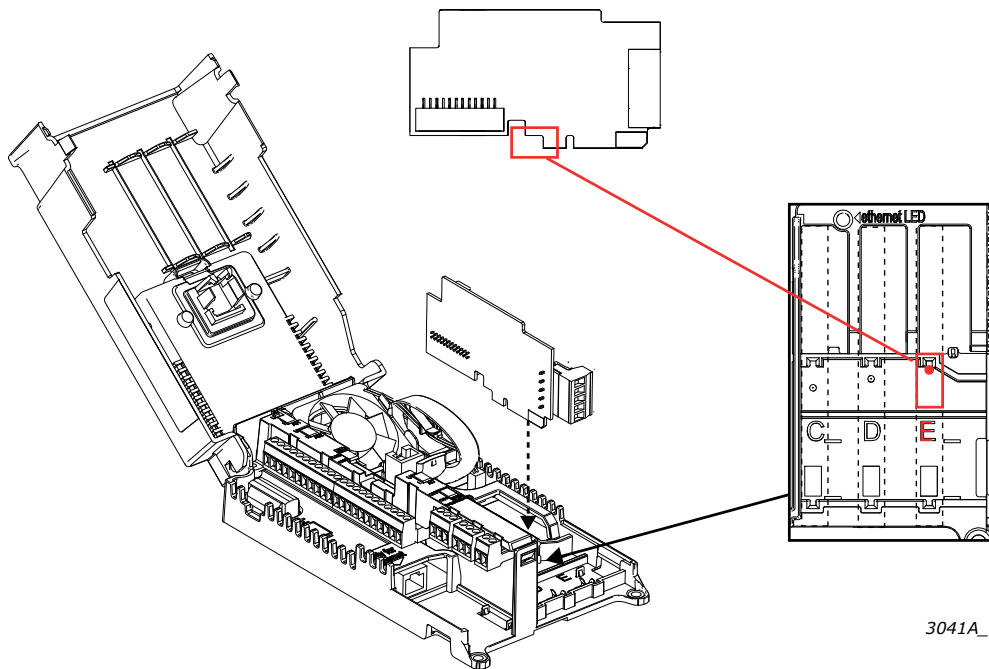
A B

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**NOTE:** Incompatible boards cannot be installed on VACON® 100 family AC drives. Boards that are compatible for VACON® 100 family AC drives have two codings that enable the placing of the board (see above): one for VACON® 100 family compatibility (**A**), and another for the slot-specific placing (**B**).

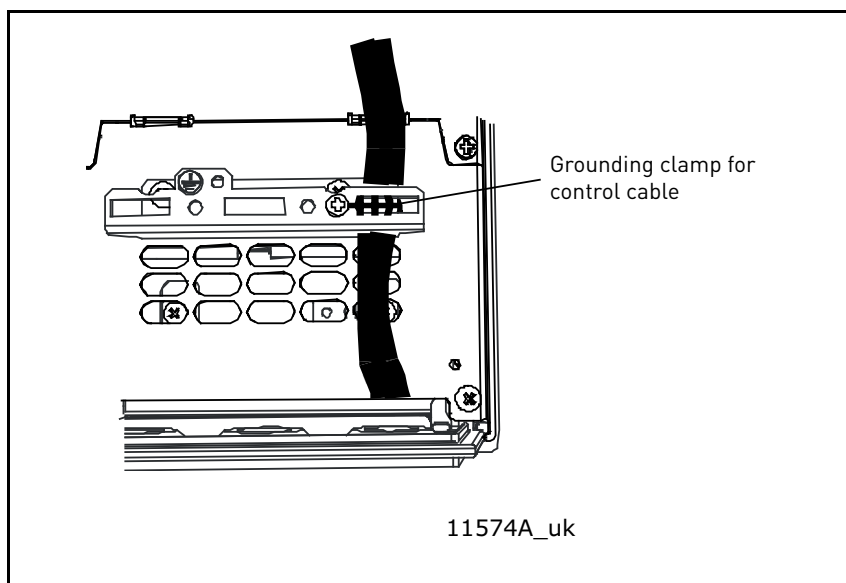
3

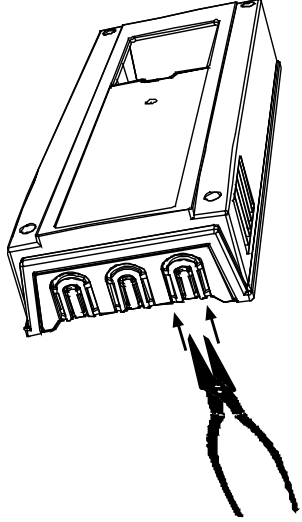
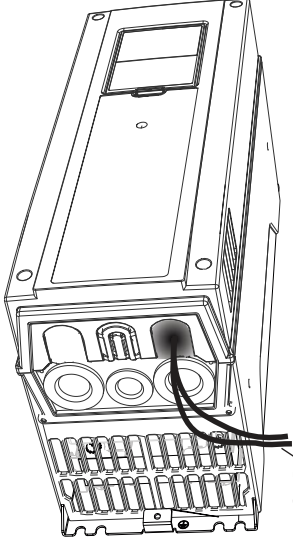
Open the inner cover to reveal the option board slots and install the OPTBJ board into slot **E**. Close the inner cover.  
**NOTE!** See Chapter 4.2 for the jumper settings!



4

If shielded cable is used, ground the shield of the OPTBJ cable to the frame of the drive by using the grounding clamp for control cable included in the delivery of the drive.  
**NOTE!** If shielded cable is used, grounding must be done according to best practice.



<h1>5</h1>	<p>Unless already done for the other control cables, cut free the opening on the AC drive cover for the OPTBJ cable (protection class IP21).</p> <p><b>NOTE:</b> Cut the opening on the side of the slot E!</p>	 <p style="text-align: right;">11576_00</p>
<h1>6</h1>	<p>Remount the AC drive cover and run the cable as shown in picture.</p> <p><b>NOTE:</b> When planning the cable runs, remember to keep the distance between OPTBJ cables and the motor cable at a minimum of 30 cm. It is recommended to route the OPTBJ cables away from the power cables as shown in the picture.</p>	 <p style="text-align: right;">11572_uk</p>

## 4. OPTBJ BOARD LAYOUT

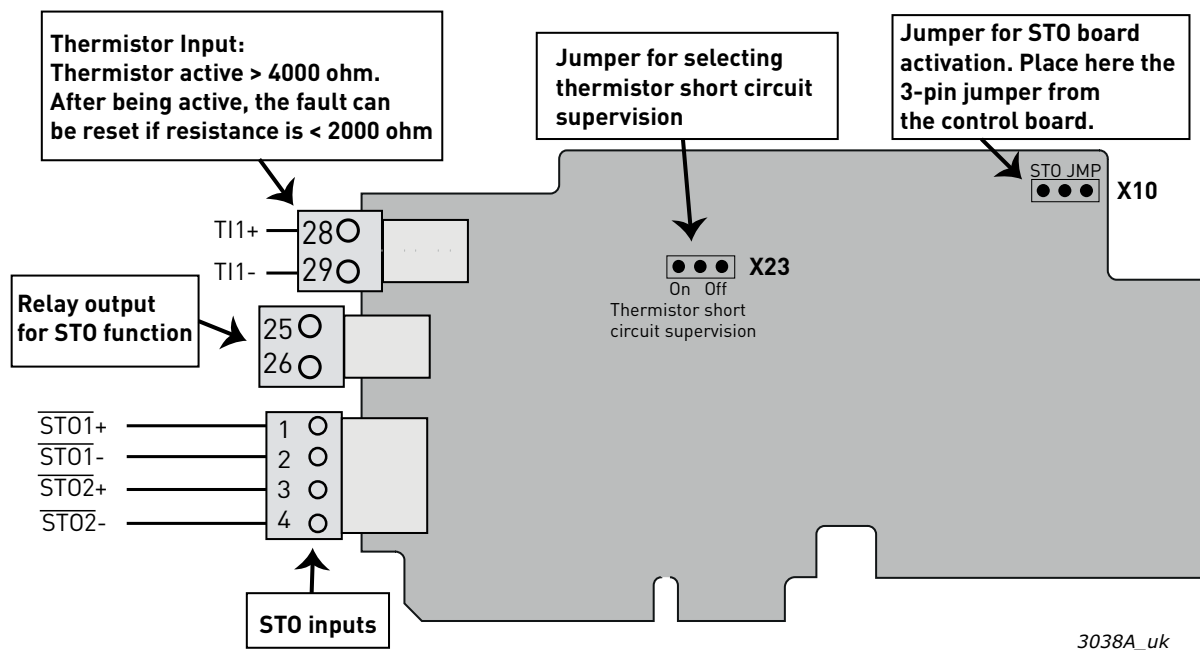


Figure 1. OPTBJ board layout

### 4.1 IDENTIFYING BOARD REVISION

The revision of OPTBJ board can be identified by checking the revision letter on the matrix bar code sticker. Revision letter is written after the board type code. For example, '70CVB01380 D' indicates that the board is of revision D. Some features may be introduced or changed during board updates.

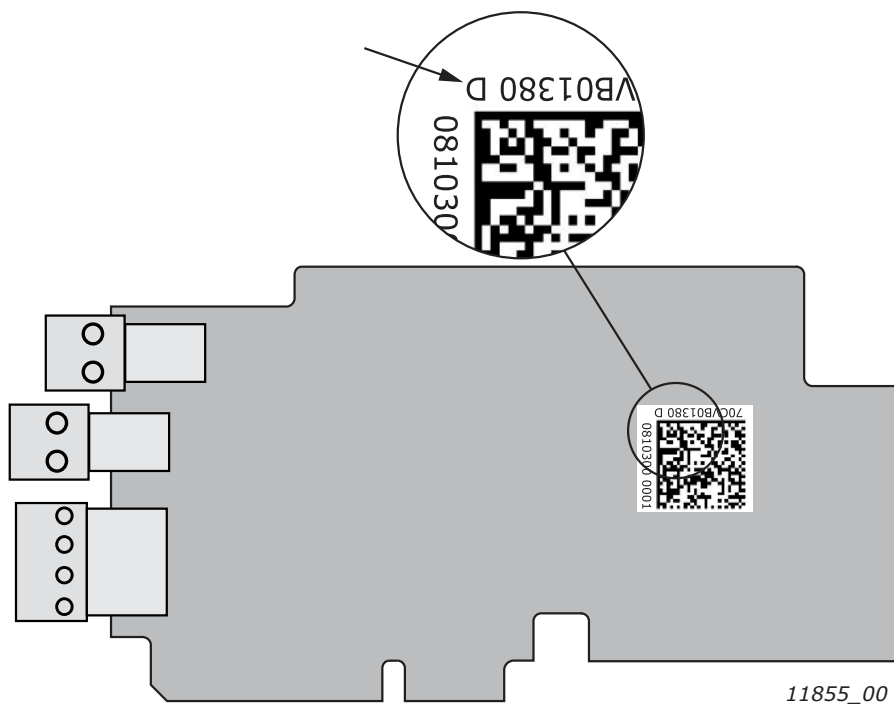
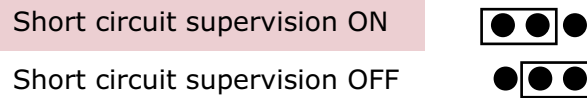


Figure 2. The board identification sticker on the OPTBJ board

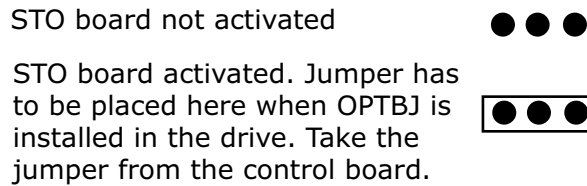
## 4.2 OPTBJ BOARD JUMPERS


There are two pin headers for jumpers on the OPTBJ option board. The jumper settings are described below:

### Jumper X23, short circuit supervision



### Jumper X10, STO board activation



 = Factory default

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Figure 3. OPTBJ board jumpers

To activate the OPTBJ board, you must take the three-pin jumper from the drive control board and place it to the OPTBJ board jumper X10. See the next chapter for more information.

**NOTE!** If there are problems with the jumpers, see chapter 7.1!

### 4.3 STO JUMPER ON THE VACON® 100 FAMILY AC DRIVE

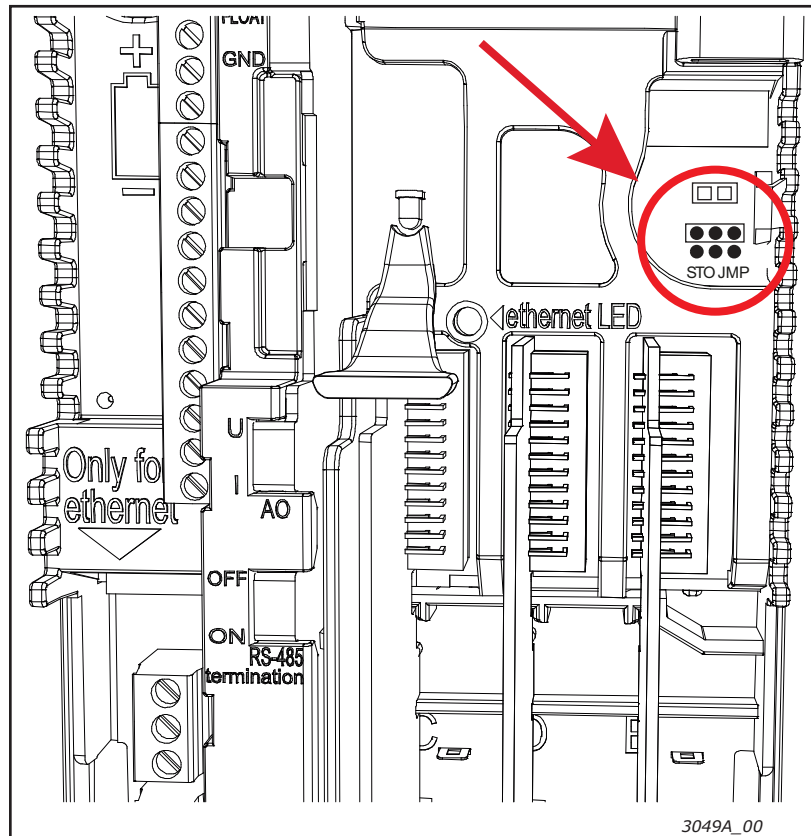
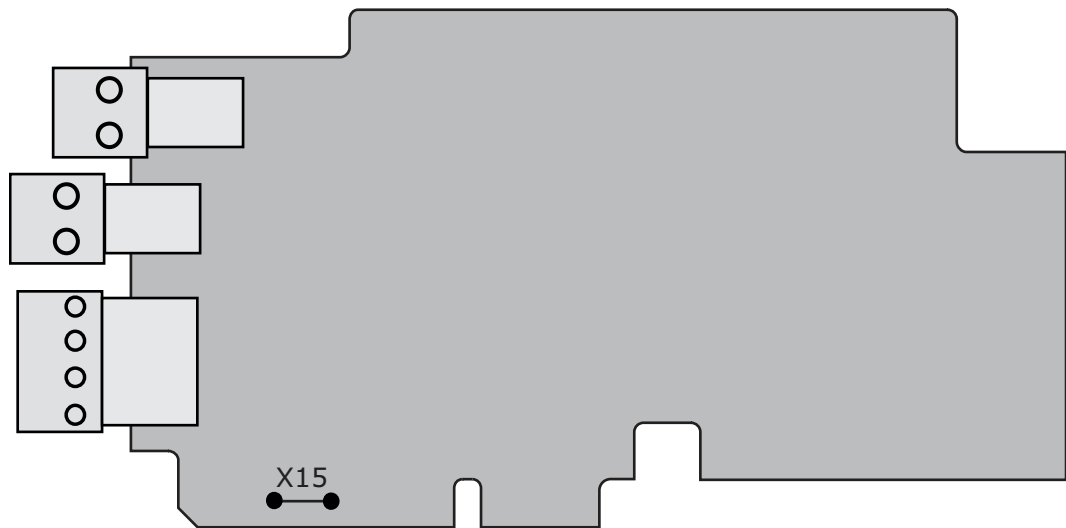


Figure 4. STO jumper location on VACON® 100 family AC drive. Open the main cover and the inner cover to reveal the jumper.



#### 4.4 CUTTABLE JUMPER TO SEPARATE CONTROL GROUND FROM PE



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Figure 5. Location of cuttable jumper X15

Normally when the OPTBJ board is installed on the drive, the AC drive's control ground is connected to PE (Protective Earth, drive's frame) through the OPTBJ board. Without the OPTBJ board, the control ground is connected to PE through high impedance. In some systems, the control ground may need to be separated from PE when the OPTBJ board is installed. Do not do this before consulting the Danfoss support personnel (contact the Danfoss local contacts at <http://drives.danfoss.com/danfoss-drives/local-contacts/>). If the jumper is cut, at least 1 mm of wire from X15 needs to be removed to ensure isolation.



**CAUTION!** Cutting this jumper should be done only when it is required by the system. After the jumper is cut, the drive's internal +24VDC can be used for external safety devices if fault exclusion in wiring 'Short circuit of any conductor to an exposed conductive part or earth or to the protective bonding conductor' according to EN ISO 13849-2 can be achieved.

## 5. STO AND SS1 SAFETY FUNCTIONS

The safety functions of the OPTBJ board, such as the technical principle and data, wiring examples and commissioning, will be described in this chapter.

**NOTE!** The use of STO, SS1 or other safety functions does not itself ensure safety. An overall risk evaluation is required in order to make sure that the commissioned system is safe. Safety devices like the OPTBJ board must be correctly incorporated into the entire system. The entire system must be designed in compliance with all relevant standards within the field of industry. Standards such as EN12100 Part 1, Part 2, & ISO 14121-1 provide methods for designing safe machinery and for carrying out a risk assessment.



**CAUTION!** The information in this manual provides guidance on the use of the safety functions that OPTBJ option board provides together with VACON® 100 family control board. This information is in compliance with accepted practice and regulations at the time of writing. However, the end product/system designer is responsible for ensuring that the system is safe and in compliance with relevant regulations.

### 5.1 SAFE TORQUE OFF (STO) PRINCIPLE

The STO safety function of the OPTBJ board allows the drive output to be disabled so that the drive cannot generate torque in the motor shaft. For STO, the OPTBJ board has two separate, galvanically isolated inputs  $\overline{STO1}$  and  $\overline{STO2}$ .

**NOTE!** To allow the drive to go to ready state, a voltage of +24V must be connected between the input terminals for both STO input channels. See chapter 5.3.5 for details.

The STO safety function is achieved by disabling the drive modulation. The drive modulation is disabled through two independent paths controlled by  $\overline{STO1}$  and  $\overline{STO2}$  so that a single fault in any of the safety related parts will not lead to the loss of the safety function. This is done by disabling the gate driver signal outputs to the driver electronics. The gate drive output signals control the IGBT module. When gate drive output signals are disabled, the drive will not generate torque in the motor shaft. See Figures 6 and 7.

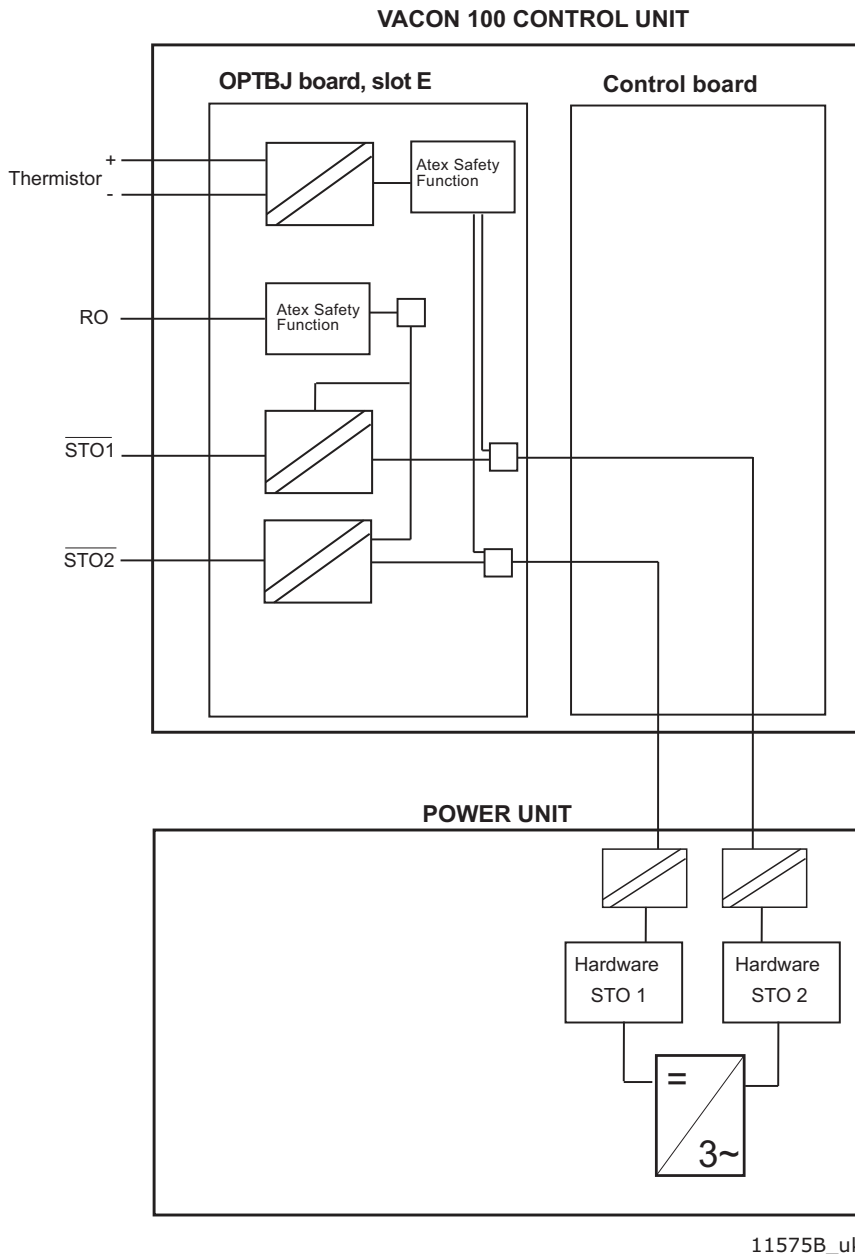
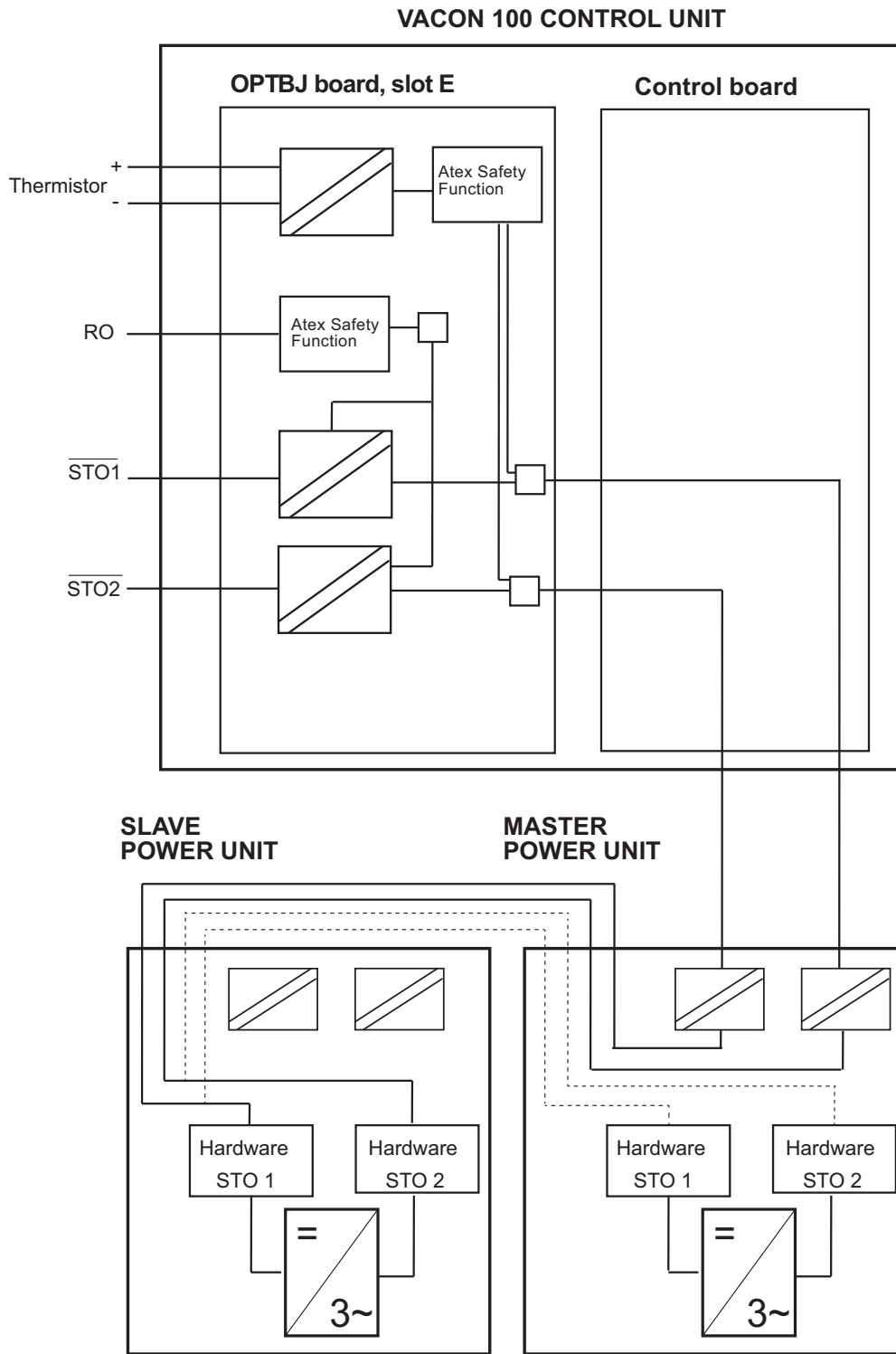


Figure 6. STO principle with OPTBJ board and VACON® 100 family control board MR4-10

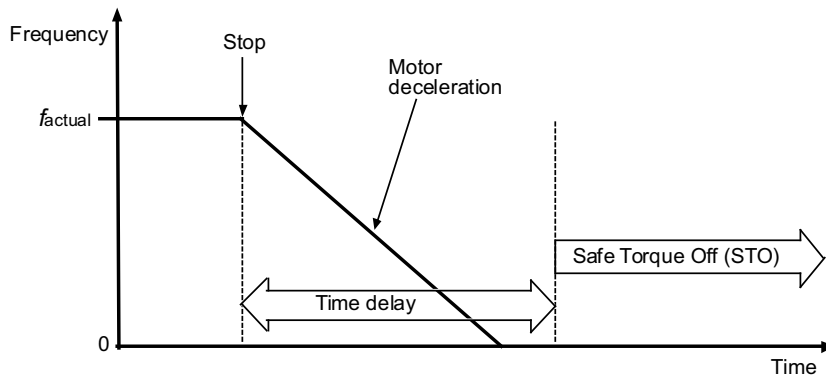


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Figure 7.STO principle with OPTBJ board and VACON® 100 family control board MR12

### 5.2 SAFE STOP 1 (SS1) PRINCIPLE

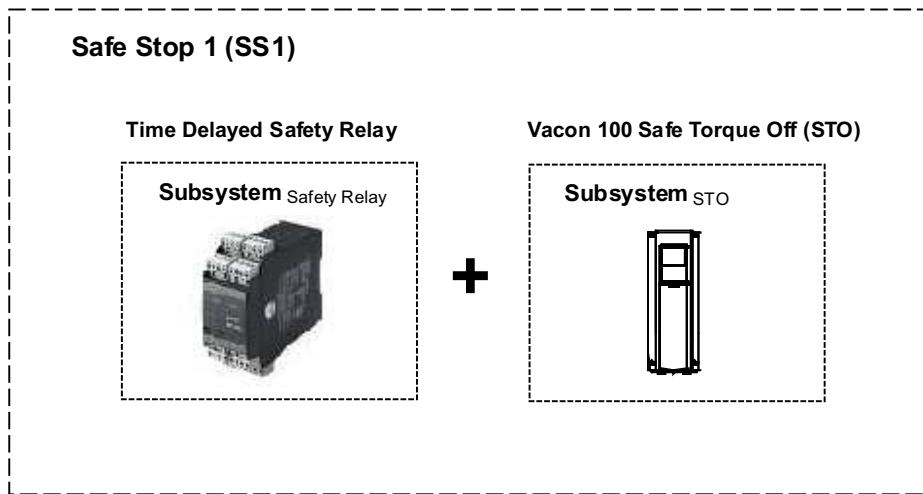
After a safe stop command the motor starts decelerating and SS1 safety function initiates the STO after a user set time delay.



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Figure 8. The principle of Safe Stop 1 (EN 61800-5-2, SS1 type c)

The Safe Stop 1 (SS1) safety function consists of two safety related subsystems, an external time delayed safety relay and the STO safety function. These two subsystems combined compose the Safe Stop 1 safety function as shown in Figure 9.

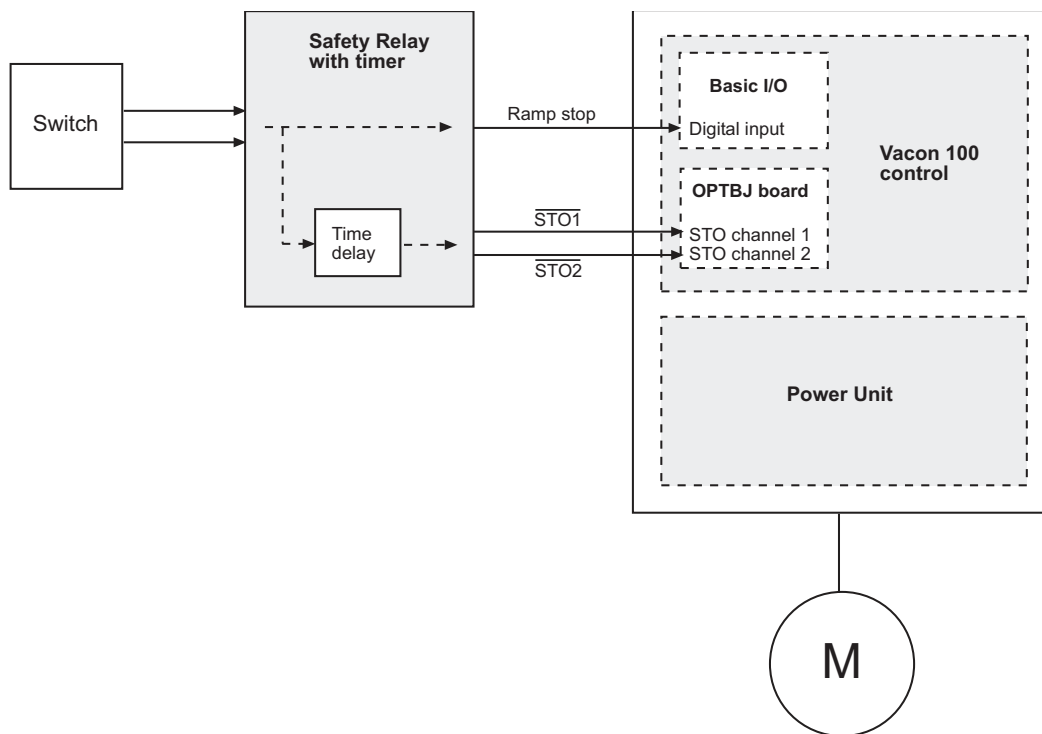


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Figure 9. Safe Stop 1 (SS1) safety function


Figure 10 shows the connection principle of Safe Stop 1 safety function, as specified in figure 8.


- The time delayed safety relay outputs are connected to the STO inputs.
- A separate digital output from the safety relay is connected to a general digital input of the VACON® 100 family AC drive. The general digital input must be programmed to execute the drive stop command and initiates the drive stop function without a time delay (must be set to "stop by ramp") and causes motor deceleration. If the SS1 behavior of Figure 8 is required then it must be ensured that the ramp stop is activated when the stop signal is received. It is the responsibility of the system designer to verify this. See Chapter 6.2 for the wiring and parametrization of Safe Stop 1.



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Figure 10. The connection principle of Safe Stop 1 (SS1)

	<p><b>CAUTION!</b> The system designer/user is responsible for understanding and setting the time delay of the safety relay, as it is process/machine dependent.</p> <ul style="list-style-type: none"> <li>• The time delay must be set to a greater value than the deceleration time of the drive*. The motor deceleration time is process/machine dependent.</li> <li>• The stop function of the drive needs to be correctly set for the process/machine. Activating the SS1 safety function must execute the configured stop in the drive. In the VACON® 100 default application software it is recommended to use the "Quick Stop" functionality for this purpose.</li> </ul> <p>* In case of a single fault the drive may not ramp down but is only put to STO mode after the configured time delay.</p>
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	<p><b>CAUTION!</b> The control place must be set according to the application requirements.</p>
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### 5.3 TECHNICAL DETAILS

#### 5.3.1 RESPONSE TIMES

Table 2. STO response times

Safety function	Activation time	De-activation time
Safe Torque Off (STO)	< 20 ms	500 ms

#### 5.3.2 INPUT VOLTAGE LEVELS

STO inputs fulfill the requirements for standard operating ranges for Type 2 digital inputs (current sinking), defined by IEC 61131-2 (2007). Reversed polarity applied on STO input terminals does not cause disabling of STO function.

The STO inputs of OPTBJ are OSSD tolerant. The operation of OPTBJ is not interfered by test pulses that are generated to the STO lines by the connected safety actuator as long as the test pulses fulfill certain requirements. See chapters 5.3.3 and 5.3.4 for details.

Table 3. Safe input data

Technical item or function	Minimum	Typical	Maximum
Input Voltage (logic 1)	11 V	24 V	30 V
Input Voltage (logic 0)	-3 V	0 V	5 V
Input Current (logic 1)	4.5 mA	7.5 mA	8 mA
Input Current (logic 0)			2.0 mA
Input Resistance	2.5 kΩ		
Galvanic Isolation	Yes		
Short circuit protected	Yes		
Active -> Inactive Debounce time		4 ms	9 ms
Allowed discrepancy time of physical inputs			500 ms

#### 5.3.3 EXTERNAL DARK TEST PULSE FILTERING CAPABILITY

To recognize the short circuits from STO lines to power supplies or ground, some safety PLCs test their outputs by pulsing the output from high to low level for short periods of time when STO is disabled. The pulses are known as 'dark test pulses'. To prevent these test pulses from causing false fault indications, these dark test pulses are filtered out by STO inputs on OPTBJ. If the input voltage-specific values for dark test pulse durations are exceeded, the drive may indicate STO diagnostics fault or STO may be activated. The used dark test pulse duration should always be shorter than the specified minimum pulse withstanding duration. Limits for the test pulse duration, frequency and period are given in Table 5. The filtering time is hardware-based and cannot be adjusted. External dark test pulse filtering is included on OPTBJ boards from revision D onwards. See chapter 4.1 for identifying the board revision.

Table 4. External dark test pulse filtering capability

Dark test pulse filtering capability	Minimum	Typical	Maximum
STO input voltage: 11 V	0 ms	0 ms	1 ms
STO input voltage: 24 V	4 ms	4 ms	7 ms
STO input voltage: 30 V	5 ms	6 ms	9 ms

Table 5. Pulse characteristics

Pulse characteristics	Dark test pulse	Light test pulse
Test pulse length	< 4 ms (24 V)	< 4 ms (24 V)
Period	> 20 ms	> 20 ms
Frequency	< 50 Hz	< 50 Hz

#### 5.3.4 EXTERNAL LIGHT TEST PULSE FILTERING CAPABILITY

To verify the switching capabilities of STO lines' switches, some safety actuators test their outputs by pulsing the output from low to high level for short periods of time when STO is enabled. The pulses are known as 'light test pulses'. Allowed pulse characteristics are introduced in Table 5 in Chapter 5.3.3.

To prevent the test pulses from causing false STO disactivation commands or false fault indications, the used connection must not create current path through STO inputs. Only connection example 1 is allowed. See the connection examples in chapter 6.1. Only one switch is allowed to be tested at a time.



**CAUTION!** When using other connection than "Connection example 1" with light test pulse function, forbidden pulse structure or by testing both switches (SW P & SW M) simultaneously, the drive may enter ready state even if STO should be activated. This may cause unintentional rotation of the motor shaft. See the connection examples in chapter 6.1.

#### 5.3.5 CONNECTIONS

In addition to the STO inputs, the board contains also a thermistor input. If the thermistor input is not used, it must be disabled. The thermistor input is disabled by making a short circuit to the terminals and setting the jumper X23 in "OFF" state. The thermistor input operation and instructions are presented in chapter 8.1.

Table 6. OPTBJ I/O terminals

Terminal	Technical information	
1	ST01+	Isolated STO input 1, +24V
2	ST01-	Virtual GND 1
3	ST02+	Isolated STO input 2, +24V
4	ST02-	Virtual GND 2
25	R01	Relay output 1 (NO) * Switching capacity: <ul style="list-style-type: none"> <li>• 24VDC/8A</li> <li>• 250VAC/8A</li> <li>• 125VDC/0.4A</li> </ul> Min. switching load: 5V/10mA
26	R02	
28	T11+	Thermistor input; $R_{trip} > 4.0 \text{ k}\Omega$ (PTC)
29	T11-	

\* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent the welding on the relay contacts.



Table 7. STO function truth table

$V_{STO1+} - V_{STO1-}$	$V_{STO2+} - V_{STO2-}$	STO state
0VDC	0VDC	STO active
24VDC	0VDC	STO diagnostic fault and STO activation. Fault is activated after inputs have been in different states for >500 ms.
0VDC	24VDC	STO diagnostic fault and STO activation. Fault is activated after inputs have been in different states for >500 ms.
24VDC	24VDC	STO inactive

**5.3.6 RELAY OUTPUT**

When the STO function is active, the relay output is closed. When the STO function is inactive the relay output is open. When STO function has detected a non-resettable diagnostics fault the relay output toggles at a frequency of one hertz.

**NOTE!** The ATEX input has no effect on the relay output.



**CAUTION!** The relay output is intended only for diagnostics of the STO function.



**CAUTION!** The relay output is a non-safety-related functionality.

## 5.3.7 SAFETY-RELATED DATA ACCORDING TO THE STANDARD

Table 8. Safe Torque Off (STO) safety-related data \*

	MR4 - MR10	MR12
<b>EN 61800-5-2:2007</b>	SIL 3 PFH = $4.12 \times 10^{-10}$ /hour HFT = 1	SIL 3 PFH = $4.30 \times 10^{-10}$ /hour HFT = 1
<b>EN 62061:2005</b>	SIL CL 3 PFH = $4.12 \times 10^{-10}$ /hour HFT = 1	SIL CL 3 PFH = $4.30 \times 10^{-10}$ /hour HFT = 1
<b>EN/ISO 13849-1:2006</b>	PL e MTTF <sub>d</sub> = 1700 years DC <sub>avg</sub> = medium Category 3	PL e MTTF <sub>d</sub> = 700 years DC <sub>avg</sub> = medium Category 3
<b>IEC 61508:2010, High Demand Mode</b>	SIL 3 PFH = $4.12 \times 10^{-10}$ /hour HFT = 1	SIL 3 PFH = $4.30 \times 10^{-10}$ /hour HFT = 1
<b>IEC 61508:2010, Low Demand Mode</b>	SIL 3 PFD <sub>AVG</sub> (T <sub>M</sub> ) = $3.59 \times 10^{-5}$ T <sub>M</sub> = 20 years HFT = 1	SIL 3 PFD <sub>AVG</sub> (T <sub>M</sub> ) = $3.76 \times 10^{-5}$ T <sub>M</sub> = 20 years HFT = 1

\* The values in the table above are worst case values and they are fulfilled with all board revisions.

If more detailed information is needed, contact Danfoss local contacts (<http://drives.danfoss.com/danfoss-drives/local-contacts/>) for support and details.

**Safe Stop (SS1) safety-related data**

**NOTE!** The following chapter is only an informative example of combining products.

The SS1 safety function consists of two subsystems with different safety-related data. The subsystem consisting of the time delayed safety relay is manufactured, for example, by PHOENIX CONTACT. The following types are available from this manufacturer:

- PSR-SCP-24DC/ESD/5X1/1X2/300 or
- PSR-SPP-24DC/ESD/5X1/1X2/300

See manufacturer user manual for more information regarding the time delayed safety relay.

PSR-SC/PP-24DC/ESD/5X1/1X2/300 safety-related data from user manual and certificate:

<b>IEC 61 508</b>	SIL 2
<b>EN 62061</b>	SIL CL 2
<b>DIN EN/ISO 13849-1</b>	PL d Category 3
<b>PFH</b>	$1.89 \cdot 10^{-9}$ /hour

Subsystem<sub>SafetyRelay</sub>

VACON® 100 STO safety-related data (MR4-MR10):

<b>EN 61800-5-2</b>	SIL 3
<b>EN 62061</b>	SIL CL 3
<b>IEC 61508</b>	SIL 3
<b>DIN EN/ISO 13849-1</b>	PL e Category 3
<b>PFH</b>	$4.12 \cdot 10^{-10}$ /hour

Subsystem<sub>VACON100STO</sub>

+

Safe Stop 1 (SS1) safety-related data:



<b>EN 61800-5-2</b>	SIL 2
<b>EN 62061</b>	SIL CL 2
<b>IEC 61508</b>	SIL 2
<b>DIN EN/ISO 13849-1</b>	PL d Category 3
<b>PFH</b>	$2.31 \cdot 10^{-9}$ /hour

When the two subsystems are combined, the maximum safety integrity level or performance level reached is the level of the lower subsystem.

- SIL 2 and PL d

The PFH value for a safety function of combined subsystems is the sum of all subsystems PFH values.  
 $PFH_{SS1} = PFH_{SafetyRelay} + PFH_{VACON100STO} = 1.89 \cdot 10^{-9} /hour + 4.12 \cdot 10^{-10} /hour = 2.31 \cdot 10^{-9} /hour$

- The result is within the requirements for SIL 2 and PL d.

## 6. COMMISSIONING

**NOTE!** The use of STO, SS1 or other safety functions does not itself ensure safety. Always make sure that the safety of the entire system is confirmed.

**NOTE!** The user is responsible for excluding faults in the external wiring.

### 6.1 GENERAL WIRING INSTRUCTIONS

- The wiring should be done according to the general wiring instructions for the specific product where OPTBJ is installed. See wiring examples in the figures 11, 12 and 13.
- If shielded cable is used, the shield must be connected to the drive's lid (PE) using a grounding clamp.
- EN 60204-1 part 13.5: The voltage drop from supply point to load must not exceed 5%.
- In practice, due to electromagnetic disturbances, the cable length should be limited to to max. 200 m when using shielded cable and to max. 50 m when using unshielded cable. In a noisy environment, the length of the cable could still be less in order to avoid unwanted tripping.
- Using unshielded cables is not allowed with some STO input configurations. Also some STO input connection options are not allowed to be used with certain safety actuator types. See Table 9 for details.
- The +24V power supply used for safety actuators may come from control board (e.g. drive's control connector pins 6 & 7) or it may also be external, earth fault and short circuit protected power supply.

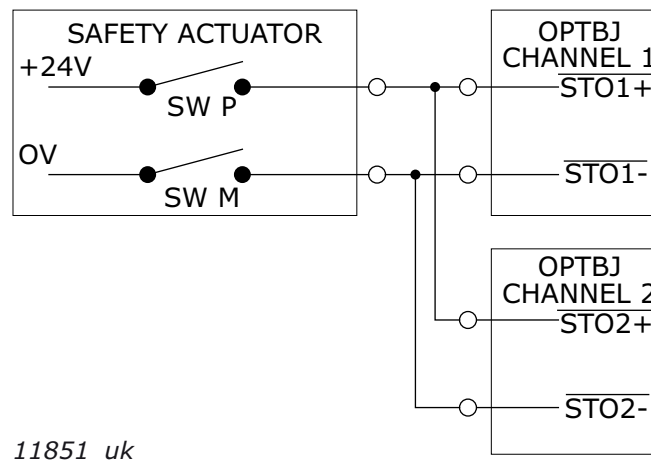
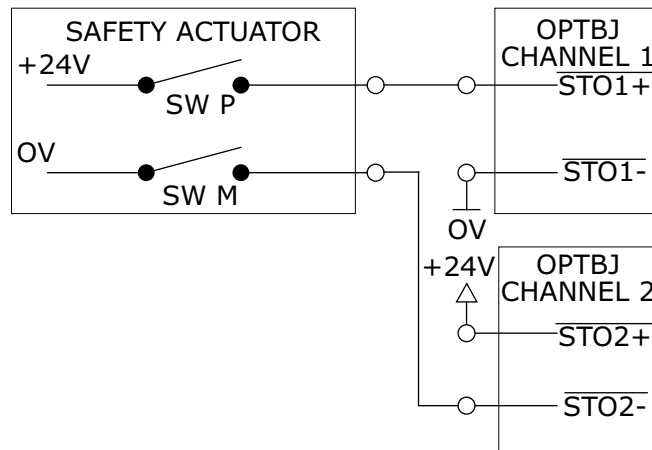
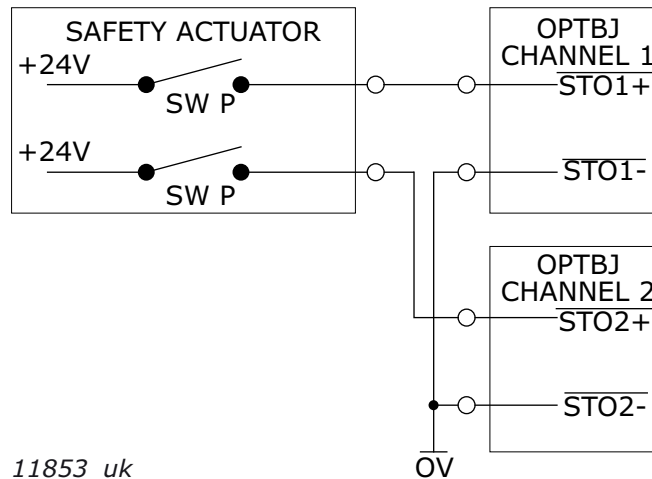


Figure 11. STO connection example 1



11852\_uk

Figure 12. STO connection example 2



11853\_uk

Figure 13. STO connection example 3

Cable recommendation:

<b>Type</b>	<p>For example one of the following:</p> <ul style="list-style-type: none"> <li>• 2x2x0.75mm<sup>2</sup> (18 AWG) low voltage cable with two individually shielded twisted pairs</li> <li>• 2x2x0.75mm<sup>2</sup> (18 AWG) low voltage, unshielded, twisted pair cable</li> <li>• two separate 2x0.75mm<sup>2</sup> (18 AWG) shielded or unshielded twisted pair cables.</li> </ul>
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See Table 9 for connections where shielded cable is required. In cases where the shield is marked as being required, use the shield to separate the STO input channels from each other as shown in Figure 14.

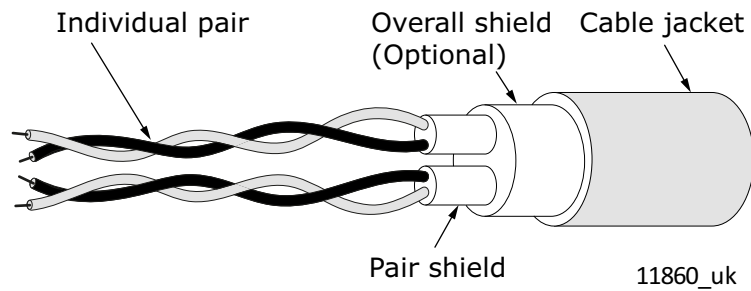


Figure 14. Structure of cable with two individually shielded twisted pairs

Table 9. Recommended maximum cable lengths

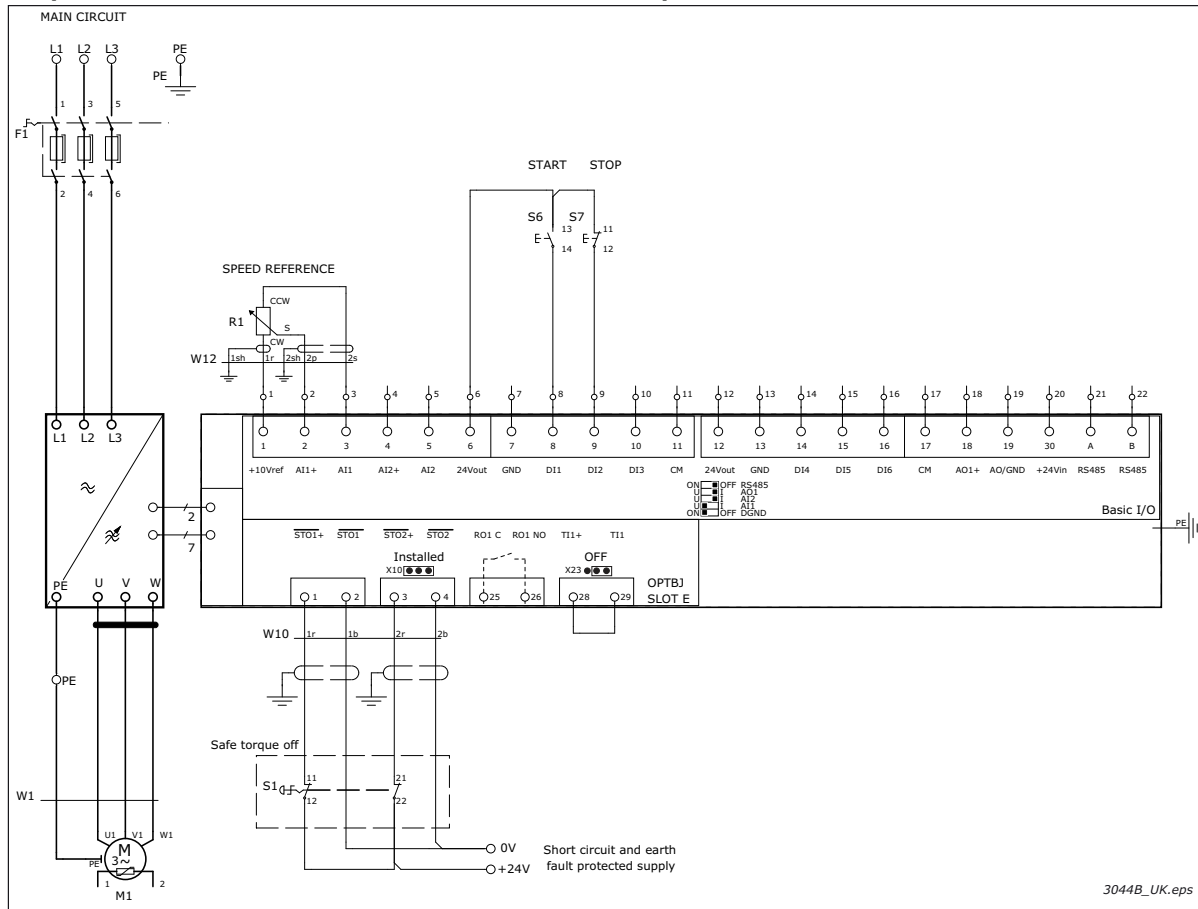
Safety actuator type	Diagnostics on safety actuator	Cable type	Used STO input connection		
			STO connection example 1	STO connection example 2	STO connection example 3
Undiagnosed safety actuator (i.e. emergency stop button or relay contact)	No diagnostics	Shielded	X	200 m	200 m
		Unshielded	X	30 m	X
Safety actuator with diagnosed outputs (i.e. safety PLC)	Outputs diagnosed using e.g. dark test pulse, light test pulse not used	Shielded	200 m	200 m	200 m
		Unshielded	30 m	30 m	X
	Outputs diagnosed using light test pulse	Shielded	200 m	X	X
		Unshielded	30 m	X	X

X = Not recommended due to causes of electromagnetic disturbances, safety actuator configuration or behavior in failure situations.

## 6.2 WIRING EXAMPLES

The examples in this chapter show the basic principles for wiring OPTBJ board. Local standards and regulations should be always followed in the final design.

### Example 1: OPTBJ board without reset for Safe Torque Off (STO)



The figure above shows a connection example of OPTBJ board for Safe Torque Off safety function without reset. The switch S1 is connected with 4 wires to the OPTBJ board as shown above.

When the switch S1 is activated (contacts open), the drive goes to STO state and motor (if running) will stop by coasting. If STO fault action is parameterized as "Alarm", the drive indicates: "30 Safe torque off". Regardless of the parameterization, activation of STO function causes a coasting stop for motor.

To allow the returning of the drive to ready state without a reset after S1 is deactivated (contacts closed), STO Fault action must be parameterized as "Alarm". See application manual for related parameters.

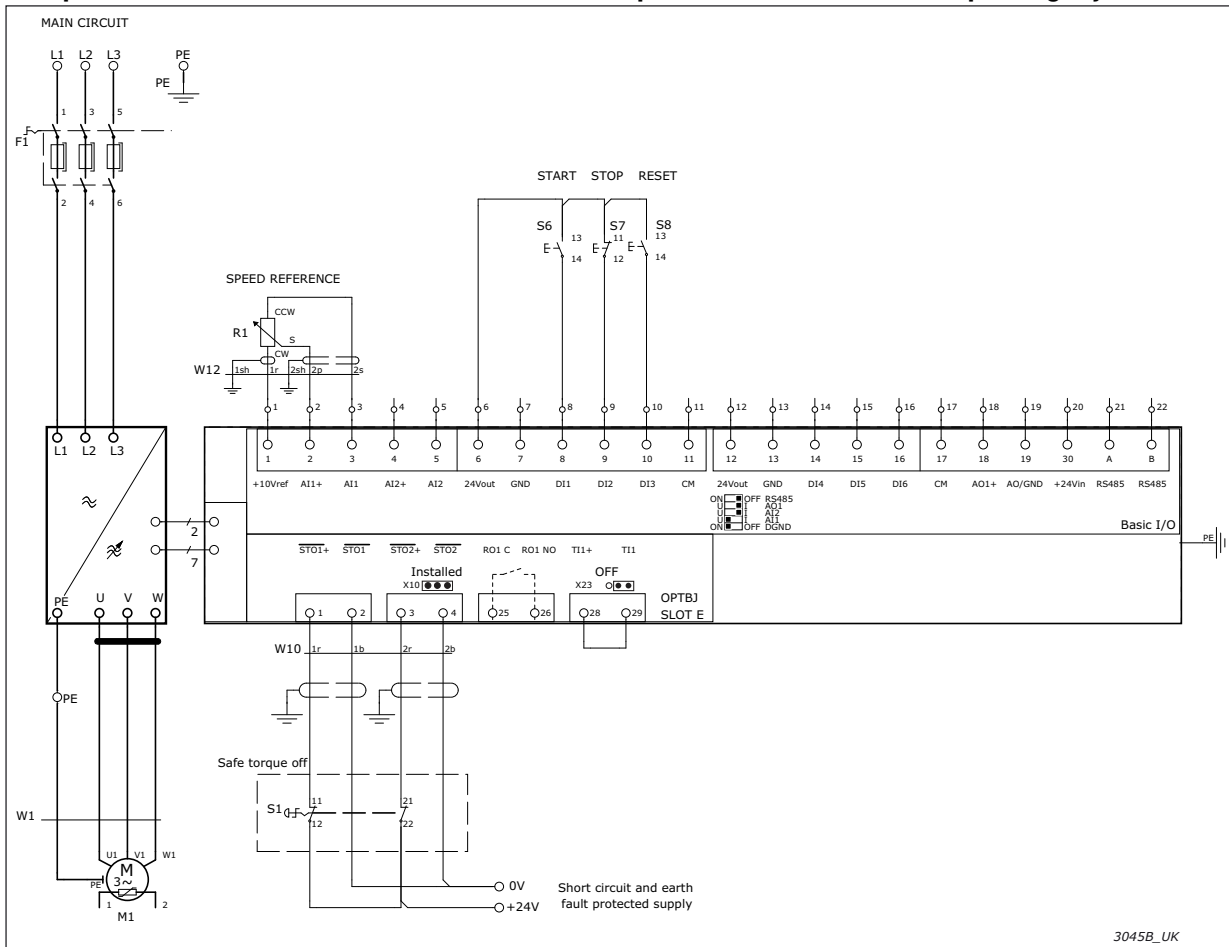
To start the motor operation again, the following sequence is performed.

- Release the switch S1 (contacts closed). The hardware is now enabled and the drive returns to ready state.
- Giving a valid start command starts running the motor.

**NOTE!** According to EN 60204-1 (Safety of machinery - Electrical equipment of machines), the re-setting of the emergency stop request (e.g. releasing of emergency stop button) must not restart the drive.

**NOTE!** The VACON® 100 default application software uses edge-sensitive start as a default start command. With the edge-sensitive start command, deactivating the STO does not cause immediate start.

**Example 2: OPTBJ board with reset for Safe Torque Off or EN 60204-1 stop category 0.**



The figure above presents a connection example of OPTBJ board for STO safety function with reset. The switch S1 is connected with 4 wires to the OPTBJ board as shown above. The digital input 3 (DIN3), for example, is wired for the fault reset function. The reset function (not part of any safety function) can be programmed to any of the available digital inputs.

To prevent starting the motor without reset, STO fault action has to be parameterized as "Fault". See application manual for related parameters.

When the switch S1 is activated (contacts open), the drive goes to STO state and motor (if running) stops by coasting. The drive indicates: "30 SafeTorqueOff".

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

- Release the switch S1 (contacts closed). The hardware is now enabled but the drive continues to display the fault "30 SafeTorqueOff".
- Acknowledge the releasing of switch by edge sensitive reset function. The drive returns to the ready state.
- Giving a valid start command starts running the motor.

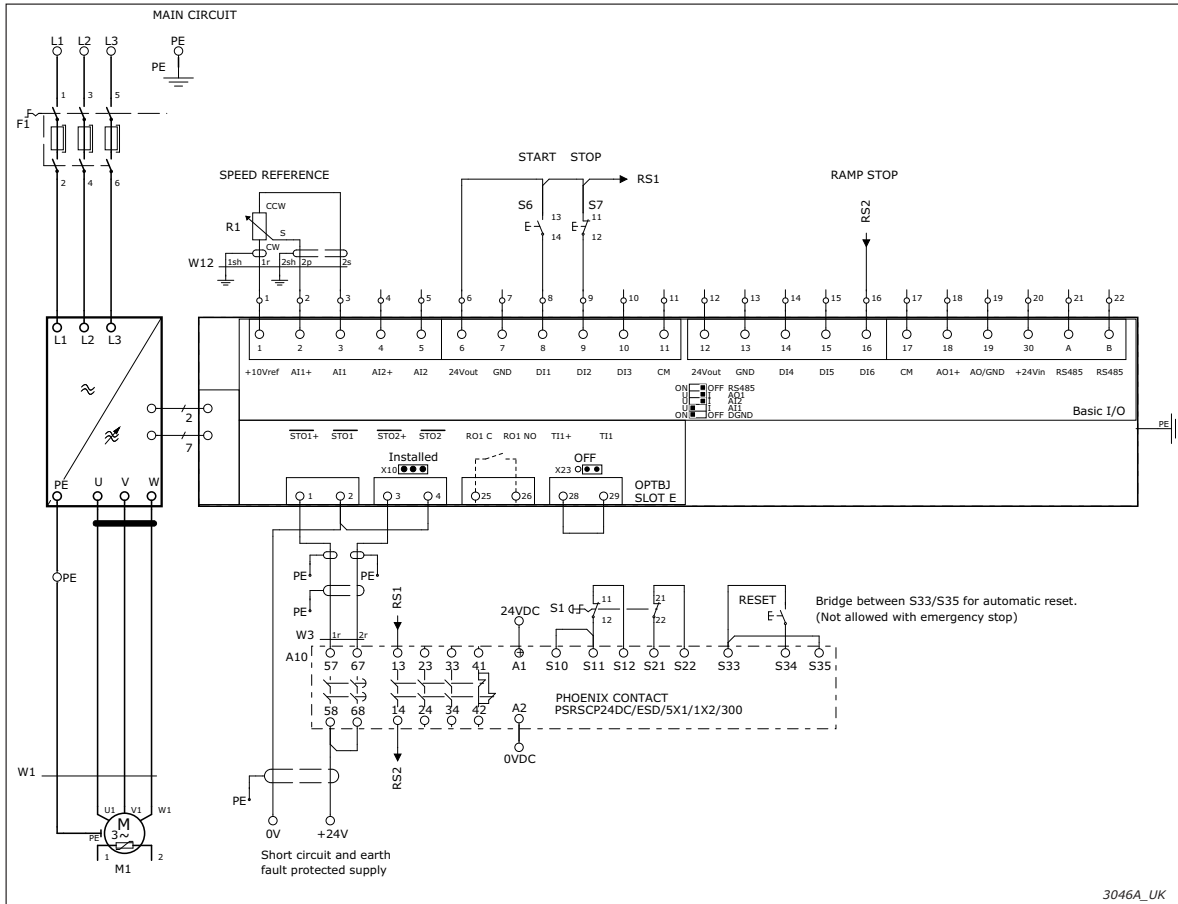
**NOTE!** According to EN 60204-1 (Safety of machinery - Electrical equipment of machines), the re-setting of the emergency stop request (e.g. releasing of emergency stop button) must not restart the drive.

**NOTE!** The VACON® 100 default application software uses edge-sensitive start as a default start command. With the edge-sensitive start command, deactivating the STO does not cause immediate start.

**NOTE!** For EN 60204-1 emergency stop according to stop category 0, use the emergency stop button.



**Example 3: OPTBJ board with SS1 and safety reset or EN 60204-1 stop category 1.**



The figure above presents a connection example of OPTBJ board for SS1 safety function with external safety relay module and with safety reset.

The external safety relay module is connected to the switch S1. The used power supply to switch S1 is 230 VAC as an example. The safety relay module is connected to OPTBJ board with 4 wires as shown in Figure above.

To configure the drive to perform the fast deceleration with a ramp, it is recommended to use Quick Stop -function that is activated by digital input, for example DI6 as in Example 3 above. See the application manual for correct parametrization of Quick Stop -function.

When the switch S1 is activated (contacts open), the drive starts ramping down the output frequency until the delay of the safety relay has passed. After safety relay time delay, the drive goes to STO state. If the motor is still running, it stops by coasting. If STO fault action is parameterized as "Alarm", the drive indicates: "30 Safe torque off". Regardless of the parameterization, activation of STO function causes a coasting stop for motor.

To allow the returning of the drive to ready state after S1 is deactivated (contacts closed) and safety relay is resetted, STO Fault action needs to be parameterized as "Alarm". If STO Fault action is parameterized as "Fault", also the drive needs to be reset to allow ready state. See application manual for related parameters.

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

- Release the switch S1 (contacts closed). The hardware is now enabled and the drive returns to ready state. An alarm indication for STO activation is displayed if STO Fault action is parameterized as "Alarm".
- Acknowledge the releasing of switch by resetting the safety relay. The drive returns to the ready state.
- Giving a valid start command starts running the motor

More information on the safety relay module may be found in the safety relay documentation.

**NOTE!** According to EN 60204-1 (Safety of machinery - Electrical equipment of machines), the re-setting of the emergency stop request (e.g. releasing of emergency stop button) must not restart the drive.

**NOTE!** The VACON<sup>®</sup> 100 default application software uses edge-sensitive start as a default start command. With the edge-sensitive start command, deactivating the STO does not cause immediate start.

**NOTE!** For EN 60204-1 emergency stop according to stop category1, use emergency stop button.

### 6.3 PARAMETERIZATION OF STO FUNCTIONALITY

STO functionality is based on hardware, and cannot be bypassed by parameterization. Activating either or both of STO input channels by applying logical '0' causes a coasting stop for the motor and prevents the restart. The additional actions such as generating fault or alarm from STO activation or driving the STO state to an output can be parameterized. See application manual for the related parameters.

Table 10. Parameter description for STO fault parameter

Index	Parameter	Min	Max	Default	ID	Description
P3.9.1.14 (INDUS- TRIAL / FLOW)	STO Fault	No Action	Fault, Coast	Fault, Coast	775	<ul style="list-style-type: none"> <li>• <b>No Action:</b> Activating STO causes motor to stop by coasting and 'Not ready' state. Drive returns to 'Ready' state as soon as STO is deactivated. No indication of STO activation is displayed.</li> <li>• <b>Alarm:</b> Activating STO causes motor to stop by coasting and 'Not ready' state. Alarm is displayed, but drive returns to 'Ready' state as soon as STO is deactivated.</li> <li>• <b>Fault, Coast:</b> Activating STO causes motor to stop by coasting and 'Fault' state. STO needs to be deactivated and fault reset before drive returns to 'Ready' state.</li> </ul>
P3.9.29 (HVAC)						

#### 6.4 CHECKLIST FOR COMMISSIONING THE OPTBJ BOARD

Nr	Step	Yes	No
1	Has a risk assessment of the system been carried out to ensure that using the OPTBJ board Safe Torque Off (STO) or Safe Stop 1 (SS1) safety function is safe and according to the local regulations ?		
2	Does the assessment include an examination of whether using external devices such as a mechanical brake is required ?		
3	Has the switch S1 been chosen according to the required safety performance target (SIL or PL) set during the risk evaluation?		
4	Is the switch S1 required to be lockable or otherwise secured in the OFF position?		
5	Is it ensured that color coding and marking of the switch S1 is in accordance with the intended use?		
6	Is the external power of the switch S1 protected (according to EN 60204-1) against supply earth fault and short circuit?		
7	The shaft of a permanent magnet motor might in an IGBT fault situation rotate up to 180 degrees around the pole of the motor. Has it been ensured that the system is designed in such a way that the this can be accepted?		
8	Has the STO jumper configuration been done according to the instructions in this manual?		
9	Has the STO input wiring been done according to examples?		
10	Have process requirements (including deceleration time) been considered for correct execution of Safe Stop 1 (SS1) safety function and are the corresponding settings done?		
11	Is there a risk of conductive contamination (e.g. conductive dust) in the environment?		
12	If pollution degree 2 cannot be guaranteed, IP54 protection class must be used.		
13	Have the User's Manual instructions for the specific product been followed?		
14	Does the system need a safety certified prevention of unexpected start-up? The safety function has to be provided by an external safety relay.		
15	Has the system been designed in such a way that activating (enabling) the drive through STO inputs will not lead to an unexpected start of the drive?		
16	Have only approved units and parts been used?		
17	Is the VACON <sup>®</sup> 100 family control board 70CVB01582 (141X4153)? (See the sticker on the VACON <sup>®</sup> 100 family control board, or "Drive Info" in VACON <sup>®</sup> Live)		
18	Is the VACON <sup>®</sup> 100 system software version FW0072V002, or newer? (Check the system software version on the keypad or in VACON <sup>®</sup> Live)		
19	Has a routine been set up to ensure that the functionality of the safety functions is being checked at regular intervals?		
20	Has this manual been read, understood and followed carefully?		
21	Have the STO and SS1 safety functions been tested properly according to Chapter 6.5?		

## 6.5 TESTING THE SAFE TORQUE OFF (STO) OR SAFE STOP 1 (SS1) SAFETY FUNCTIONS

**NOTE!** Before testing the STO or SS1 safety functions, make sure that the checklist (Chapter 6.2) is inspected and completed.

**NOTE!** After connecting the board ALWAYS make sure that the STO or SS1 safety functions are working properly by testing them before operating the system.

**NOTE!** Concerning the SS1 safety function, make sure by testing that the drive's stop by ramp function is working in accordance with the process requirements.

**NOTE!** If the STO safety function is used in a low-demand operating mode, it must be tested periodically at least once a year.

When the STO safety function is activated, a code: Fault 30 "SafeTorqueOff " appears on the control keypad display. This indicates that the STO safety function is active. After STO has been deactivated, the fault remains active until the fault is acknowledged.

## 7. MAINTENANCE



**CAUTION!** If any service or repair is to be conducted on the drive installed with OPTBJ board please follow the check list given in Chapter 6.2.



**CAUTION!** During maintenance breaks, or in case of service/repair, the OPTBJ board might have to be removed from its slot. After reconnecting the board, ALWAYS make sure that the STO or SS1 safety functions are active and fully functional by testing them. See Chapter 6.5.

### 7.1 FAULTS RELATED TO THE SAFE TORQUE OFF (STO) OR SAFE STOP 1 (SS1) SAFETY FUNCTIONS

The table below shows the normal fault, generated when STO safety function is active:

Fault code	Fault	ID	Explanation	Correcting measures
30	SafeTorqueOff	530	STO activated through the OPTBJ option board	STO function activated. Drive is in safe state

The table below shows faults that may be generated from the software part that monitors the hardware related to the STO safety function. If some of the faults listed below occur, DO NOT reset the fault:

Fault code	Fault	ID	Explanation	Correcting measures
30	Safety configuration	500	STO jumper is installed on the control board.	<ul style="list-style-type: none"> <li>Remove the STO jumper from the control board. See ch. 3.1 and 3.1.1</li> </ul>
30	Safety configuration	501	More than one OPTBJ option board detected in the drive.	<ul style="list-style-type: none"> <li>Only one OPTBJ board is supported by the drive. Remove other OPTBJ boards from the drive, except from slot E.</li> </ul>
30	Safety configuration	502	OPTBJ option board installed to a wrong slot.	<ul style="list-style-type: none"> <li>OPTBJ option board can only be installed to slot E. Install the board to slot E.</li> </ul>
30	Safety configuration	503	STO jumper missing from the control board.	<ul style="list-style-type: none"> <li>Install the STO jumper to the control board, when the OPTBJ board has been removed from the drive. See ch. 3.1 and 3.1.1</li> </ul>
30	Safety configuration	504	Problem detected in STO jumper installation on the control board.	<ul style="list-style-type: none"> <li>Check the installation of the STO jumper on the control board. See ch. 3.1 and 3.1.1.</li> </ul>
30	Safety configuration	505	Problem detected in STO jumper installation on the OPTBJ board.	<ul style="list-style-type: none"> <li>Check the installation of STO jumper switch on the OPTBJ board. See ch. 3.1 and 3.1.1</li> </ul>
30	Safety configuration	506	Communication has been failed between the control board and OPTBJ option board.	<ul style="list-style-type: none"> <li>Check the installation of the OPTBJ board.</li> <li>Restart the drive.</li> <li>Change the OPTBJ board if necessary.</li> <li>Should the fault re-occur, contact the distributor near to you.</li> </ul>

Fault code	Fault	ID	Explanation	Correcting measures
30	Safety configuration	507	The hardware does not support the OPTBJ board.	<ul style="list-style-type: none"> <li>Restart the drive.</li> <li>Should the fault re-occur, contact the distributor near to you.</li> </ul>
30	Safety diagnostics	520	There is a diagnostic failure in the STO safety function. This fault occurs when the STO inputs are in a different state for more than 500 ms.	<ul style="list-style-type: none"> <li>Restart the drive.</li> <li>If the restart does not help, check the wiring: Both STO input channels of OPTBJ need to be on the same state, i.e. safety device controlling the inputs needs to feed or cut power from both <math>STO1</math> and <math>STO2</math> channels simultaneously.</li> <li>If the inputs are on the same state and the fault re-occurs, replace the OPTBJ board.</li> <li>Should the fault re-occur, contact the distributor near to you. Deliver the fault report to the distributor, see fault details for more information.</li> </ul>
30	Safety diagnostics	521	Atex-thermistor diagnostic fault.	<ul style="list-style-type: none"> <li>Restart the drive.</li> <li>If the restart does not help, change the OPTBJ board.</li> <li>Should the fault re-occur, contact the distributor near to you</li> </ul>
30	Safety diagnostics	522	Atex-thermistor short-circuit.	<ul style="list-style-type: none"> <li>Check the connection of the Atex-thermistor</li> <li>Check the thermistor</li> <li>Restart the drive.</li> <li>If the restart does not help, change the OPTBJ board.</li> <li>Should the fault re-occur, contact the distributor near to you</li> </ul>
30	Safety diagnostics	523	Problem occurred in internal safety circuit	<ul style="list-style-type: none"> <li>Reset the drive and restart. If the fault reoccurs contact your nearest distributor.</li> </ul>
30	Safety diagnostics	524	Overvoltage detected in safety option board	<ul style="list-style-type: none"> <li>Reset the drive and restart. If the fault reoccurs contact your nearest distributor.</li> </ul>
30	Safety diagnostics	525	Undervoltage detected in safety option board	<ul style="list-style-type: none"> <li>Reset the drive and restart. If the fault reoccurs contact your nearest distributor.</li> </ul>
30	Safety diagnostics	526	Internal failure detected in safety option board CPU or memory handling	<ul style="list-style-type: none"> <li>Reset the drive and restart. If the fault reoccurs contact your nearest distributor.</li> </ul>
30	Safety diagnostics	527	Internal failure detected in safety function	<ul style="list-style-type: none"> <li>Reset the drive and restart. If the fault reoccurs contact your nearest distributor.</li> </ul>

## 8. THERMISTOR FUNCTION (ATEX)

The thermistor overtemperature supervision is designed in accordance with ATEX directive 94/9/EC. It is approved by VTT Finland for group II (certificate nr. VTT 06 ATEX 048X), category (2) in the 'G' area (area in which potentially explosive gas, vapor, mist or air mixtures are present) and 'D' area (area with combustible dust). The "X" in the certificate number refers to special conditions for safe use. See the conditions in the last note in this page.



0537



II (2) GD

It can be used as an overtemperature tripping device for motors in explosive area (EX motors).

**NOTE!** The OPTBJ board also contains the Safe Torque Off (STO) safety function. When STO is not intended to be used, inputs  $\overline{\text{STO1+}}$ (OPTBJ:1),  $\overline{\text{STO2+}}$ (OPTBJ:3) are to be connected to +24V (for example, pin 6 in VACON<sup>®</sup> 100 family control board).  $\overline{\text{STO1-}}$ (OPTBJ:2).  $\overline{\text{STO2-}}$  (OPTBJ:4) are to be connected to GND (for example, pin 7 or 13 on VACON<sup>®</sup> 100 family control board).

**NOTE!** Safety devices like the OPTBJ board must be correctly incorporated into the entire system. The functionality of the OPTBJ board is not necessarily suitable for all systems. The entire system must be designed in compliance with all relevant standards within the field of industry.

	<p><b>CAUTION!</b> The information in this manual provides guidance on the use of thermistor function for protecting overheating of motors in explosive atmosphere. However, the end product/system designer is responsible for ensuring that the system is safe and in compliance with relevant regulations.</p>
	<p><b>CAUTION!</b> During maintenance breaks, or in case of service/repair the OPTBJ board might have to be removed from its slot. After reconnecting the board ALWAYS make sure that the thermistor function is working correctly by testing it.</p>
	<p><b>CAUTION!</b> The thermistor function on OPTBJ board with VACON<sup>®</sup> 100 family control is used to protect the overheating of motors in explosive atmosphere. The drive itself including OPTBJ board can not be installed in explosive atmosphere.</p>

**NOTE!** The special conditions required for safe use (X in the certificate number): This function can be used with Exe-, Exd-, and ExnA- type of motors. In case of Exe-, and ExnA- motors, the end user has to confirm that the installation of the measurement circuit is done according to area classification. For example, in the Exe- and ExnA- motors, the PTC sensors must be certified together with the motor according to the requirements of the type of protection. The allowed ambient temperature range for the drive is -10°C...+50°C.





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**EU DECLARATION OF CONFORMITY**

**Danfoss A/S**

**Vacon Ltd**

declares under our sole responsibility that the

Product name                      Vacon OPTBJ option board to be used with Vacon 100 family products  
Product identification            70CVB01380



Marking of the equipment       II (2) GD

has been designed in conformity with the requirements of the Council directive for explosive atmospheres, 94/9/EC of March 1994 (until April 19th, 2016), 2014/34/EU (from April 20th, 2016) according to following standards.

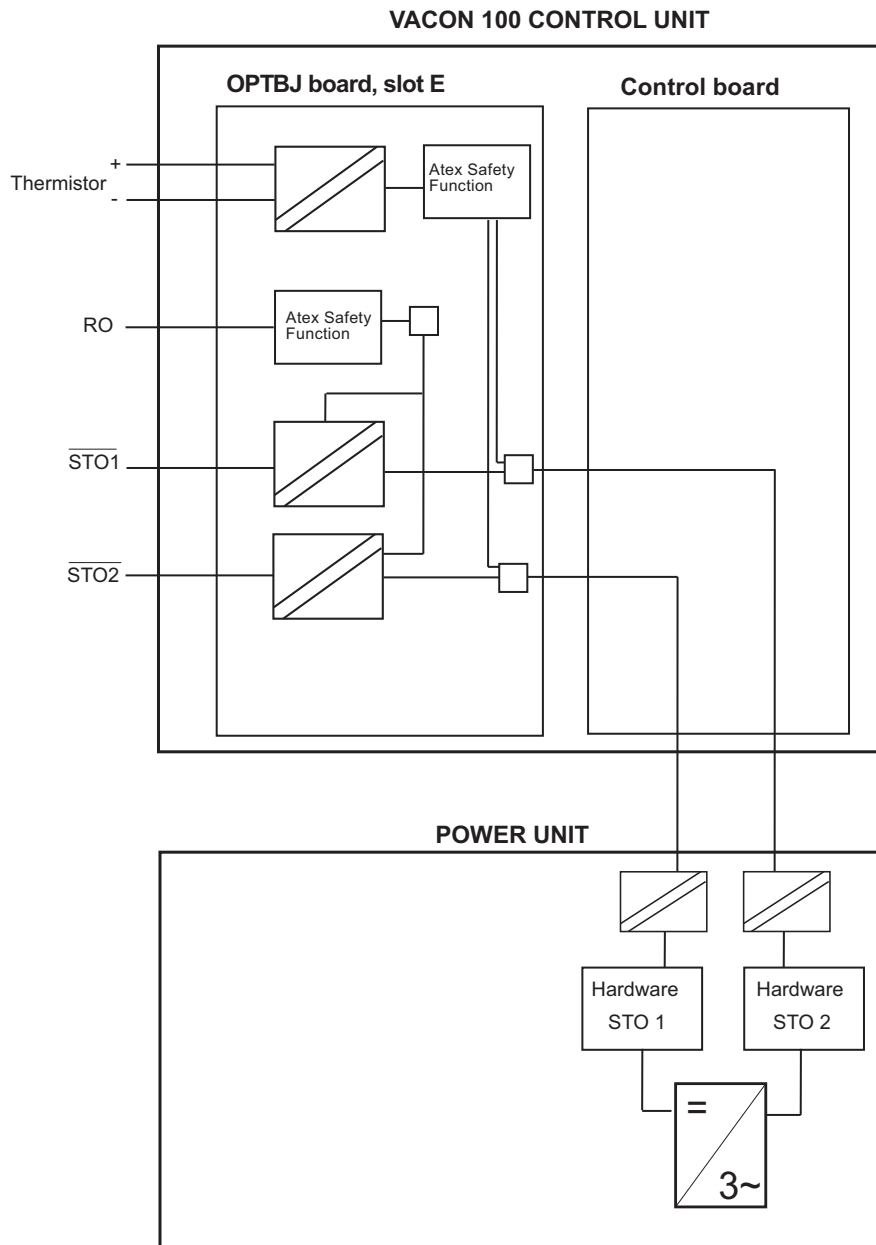
- EN ISO 13849-1 (2006)  
Safety of machinery – safety-related parts of the control systems. Part 1: General principles for design
- EN ISO 13849-2 (2003)  
Safety of machinery – safety-related parts of the control systems. Part 2: Validation
- EN 60079-14 (2007)  
Electrical apparatus for explosive gas atmospheres.  
Part 14: Electrical installations in hazardous area (other than mines).
- EN 61508-3(2010)  
Functional safety of electrical/electronic/programmable electronic safety- related systems – Part3:  
Software requirements
- EN ISO/IEC 80079-34 (2011)  
Explosive atmospheres – Part 34: Application of quality systems for equipment manufacture.
- EN 50495 (2010)  
Safety devices for ignition prevention.

VTT Industrial Systems, Electrical Ex apparatus, the Notified Body having identification number 0537, has assessed the conformity of thermal motor protection system and has issued the certificate VTT 06 ATEX 048X.

It is ensured through internal measures and quality control that the product conforms at all times to the requirements of the current Directive and the relevant standards.

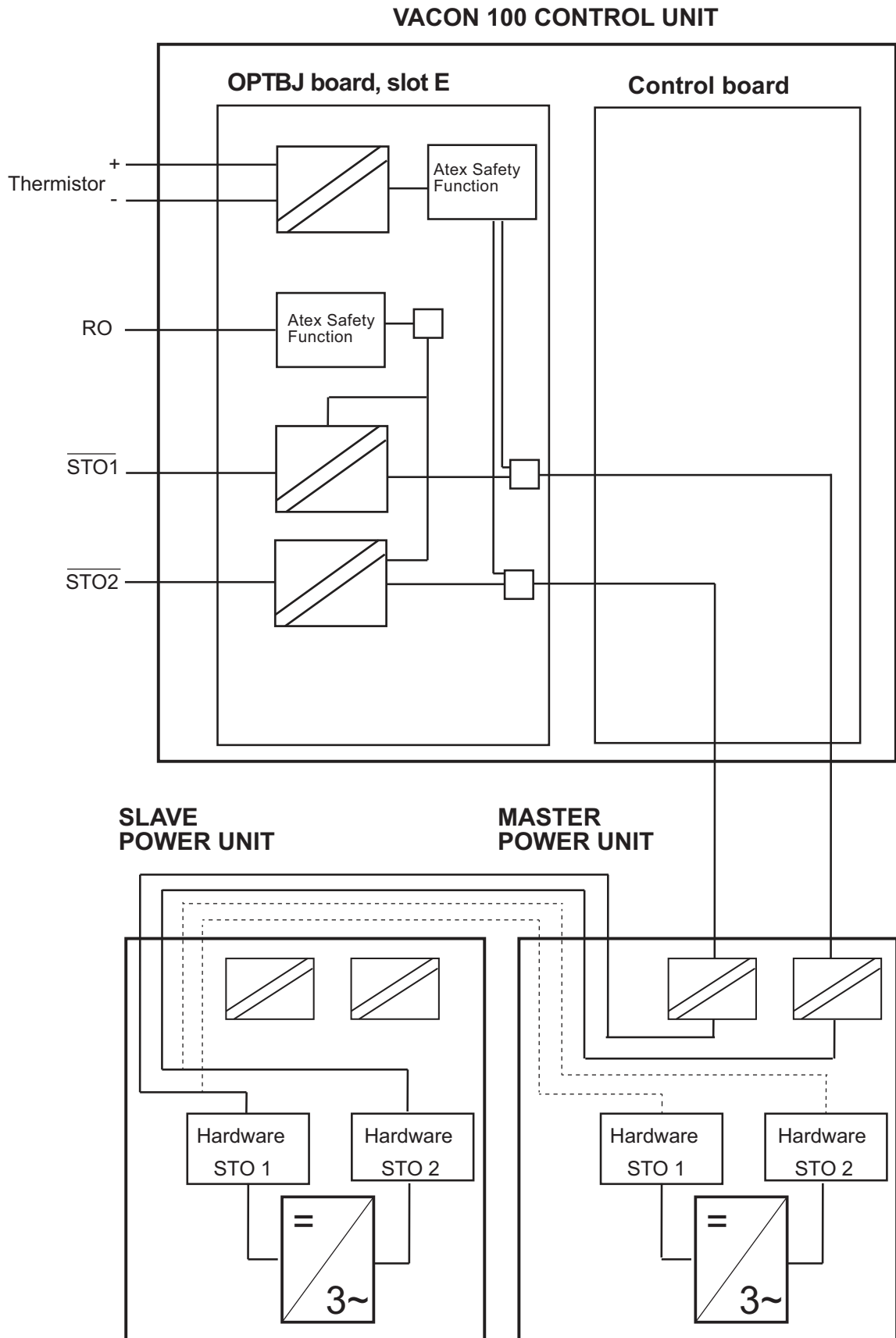
Date 15-04-2016	Issued by Signature  Name: <b>Antti Vuola</b> Title: <b>Head of Standard drives</b>	Date 15-04-2016	Approved by Signature  Name: <b>Timo Kasi</b> Title: <b>VP, Design Center Finland and Italy</b>
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Danfoss only vouches for the correctness 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.



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Figure 15. Thermistor function principle in VACON® 100 family AC drive with the OPTBJ board, MR4-10



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Figure 16. STO principle with OPTBJ board and VACON<sup>®</sup> 100 family control board MR12

## 8.1 TECHNICAL DATA

### 8.1.1 FUNCTIONAL DESCRIPTION

The thermistor supervision circuit of the OPTBJ board is designed to provide a reliable way of disabling the drive modulation in case there is an overtemperature at the motor thermistor(s).

By disabling the drive modulation, the feeding of the energy to the motor is prevented and a further heating up of the motor due to this is avoided.

The thermistor supervision circuit meets the requirements in the ATEX directive by directly activating the "STO" safety function of the VACON® 100 family (See Figure 15) and thus provides a reliable, software and parameter independent way of preventing the energy supply to the motor.

### 8.1.2 HARDWARE AND CONNECTIONS

See Chapter 5.3.5.

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

\* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent the welding on the relay contacts.

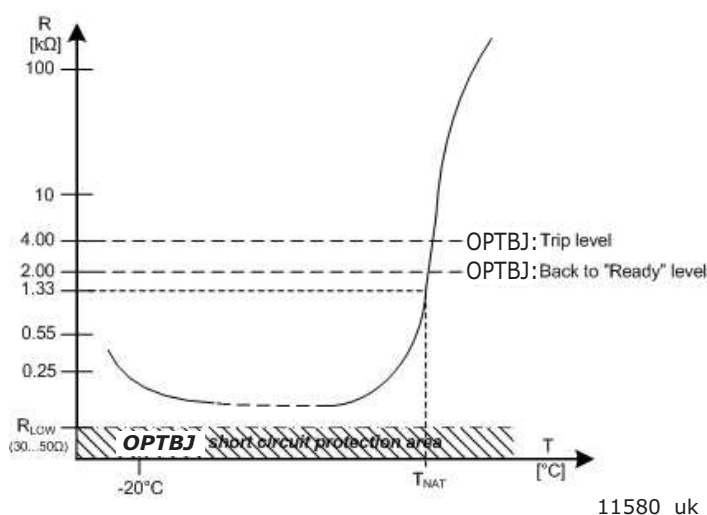


Figure 17. Typical characteristics of a motor-protection sensor as specified in DIN 44081/DIN 440

### 8.1.3 ATEX FUNCTION

When drive is connected to the main power and if the motor temperature is below overtemperature limits (see Figure 17), the drive goes to ready state. The motor may start after a valid start command.

If the motor temperature is above the overtemperature limits (see Figure 17), fault 29 (Atex thermistor) is activated.

When the resistance of the thermistor(s) mounted in the motor goes above 4 kΩ due to motor overheating, the drive modulation is disabled within 20ms.

According to Figure 17, when the temperature falls below 2 kΩ, the thermistor function allows fault reset and entering to ready state.

### 8.1.4 SHORT CIRCUIT MONITORING

The thermistor inputs TI1+ and TI1- are monitored for short circuit. If a short circuit is detected, the drive modulation is disabled within 20ms, Fault 30, Safety diagnostic (subcode 522) is generated. When the short circuit has been removed, the drive can be reset only after restarting the drive.

The short circuit monitoring can be enabled or disabled using the jumper X23 in ON or OFF position respectively. The jumper is set in ON position by factory default.

## 8.2 COMMISSIONING

**NOTE!** Installation, testing and service work on the OPTBJ board can be performed only by qualified persons.

**NOTE!** It is not allowed to perform any repair work on the OPTBJ board. Return faulty boards to the manufacturer for analysis.

**NOTE!** It is recommended to test the ATEX functionality using thermistor input on OPTBJ board periodically (typically once a year). For testing, activate the thermistor functionality (e.g. remove ATEX-thermistor plug from the OPTBJ board). The drive enters to fault state and indicates fault 29 (Atex-thermistor fault, subcode 280).

### 8.2.1 GENERAL WIRING INSTRUCTIONS

The thermistor connection must be done using a separate control cable. It is not allowed to use wires belonging the motor supply cables or any other main circuit cables. A shielded control cable must be used. See also Chapter 3.

	Maximum cable length without short circuit monitoring. Shield must be connected to the drive's lid (PE). X23 : OFF	Maximum cable length with short circuit monitoring. X23 : ON
>= 1.5 sq mm	1500 meters	250 meters

### 8.2.2 FAULT DIAGNOSIS OF THERMISTOR FUNCTION

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

Fault code	Fault	ID	Explanation	Correcting measures
29	Atex-thermistor	280	Atex-thermistor has detected overtemperature.	The resistance of thermistor input must go below 2 kΩ to be able to restart the drive.

See the fault table in chapter 7.1.



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