



Smart
connections.

Operating manual

Functional Safety

INVEOR MP Modular / MPP

Legal notice

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General note on gender equality

KOSTAL is aware of how language impacts on gender equality and always makes an effort to reflect this in documentation. Nevertheless, for the sake of readability we are unable to use non-gender-specific terms throughout and use the masculine form instead.

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1. General information

Thank you for choosing an INVEOR drive controller from KOSTAL Industrie Elektrik GmbH & Co KG! Our INVEOR drive controller platform is designed to be universally usable with all common motor types.

If you have any technical questions, please call our central service hotline:

Tel.: +49 (0)2331 80 40-848

Monday to Friday: 7 am to 5 pm (UTC/GMT +1)

Fax: +49 (0)2331 80 40-602

E-mail: INVEOR-service@kostal.com

Website address

www.kostal-industrie-elektrik.com

1.1 Information about documentation

The following information explains how to navigate through the documentation.

This documentation is a supplementary operating manual for the INVEOR drive controller. It contains all important information required for "Functional Safety".

Please carefully read through the operating manual for the drive controller and the operating manual for functional safety. It contains important information for operating the INVEOR with "Functional Safety".

Then read this manual carefully in its entirety. It contains important information for operating the INVEOR.

We assume no liability for any damage resulting from non-observance of this manual.

This manual is a part of the product and should be stored in a safe place. It applies exclusively to the INVEOR from KOSTAL Industrie Elektrik GmbH & Co KG.

Provide the operator of the system with this manual so it is available when needed.

1.1.1 Other applicable documents

This refers to all manuals that describe how to operate the drive controller system and any other manuals for the equipment used. Download the 3D files (.stp) for INVEOR and adapter plates from www.kostal-industrie-elektrik.com.

A description of parameters is available for download (www.kostal-industrie-elektrik.com) for parameterising the drive controller system

In the download, you will find all the information required for correct parameterisation.

Designation
Operating manual for INVEOR drive controller

Table 1: Other applicable documents

1.1.2 Storing the documentation

Store this manual and all other applicable documents safely so they are available when needed.

1.2 Notes in this manual

1.2.1 Warnings

The warnings refer to life-threatening dangers. Serious injuries possibly resulting in death may occur.

Each warning consists of the following elements:

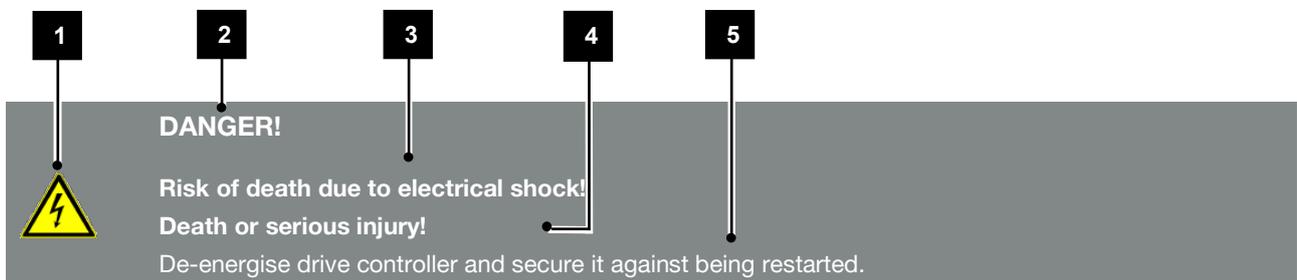


Fig. 1: Structure of the warnings

- 1** Warning symbol
- 2** Signal word
- 3** Type of danger and its source
- 4** Possible consequence(s) of failure to comply
- 5** Corrective actions

1	3	4	5	6	7	8	9	10	11	12	13	14
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1.2.2 Warning symbols used

Symbol	Meaning
	Danger
	Danger due to electrical shock and discharge
	Danger due to electromagnetic fields

Signal words

Signal words are used to identify the severity of the danger.

DANGER

Indicates a direct hazard with a high level of risk, which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazard with a moderate level of risk, which, if not avoided, will result in death or serious injury.

CAUTION

Indicates a hazard with a low level of risk, which, if not avoided, will result in minor or slight injury or property damage.

Information notes

Information notes contain important instructions for the installation and problem-free operation of the drive controller. These must be followed at all times. The information notes also point out that failure to observe instructions may result in damage to property or financial damages.

	<p>IMPORTANT INFORMATION</p> <p>The drive controller may only be assembled, operated, maintained and installed by trained and qualified staff.</p>
---	---

Fig.: 1 Example of an information note

2. General information

Symbols within the information notes

Symbol	Meaning
	Important information
	Damage to property possible

Other notes

Symbol	Meaning
	INFORMATION
	Enlarged view

2.1 Symbols used in this manual

Symbol	Meaning
1., 1., 3. ...	Consecutive steps in a handling instruction
	Effect of a handling instruction
	Final result of a handling instruction
	List

Fig.: 2 Symbols and icons used

Abbreviations used

Abbreviation	Explanation
Tab.	Table
Fig.	Figure
It.	Item
Ch.	Chapter

2.2 Labels on the drive controller

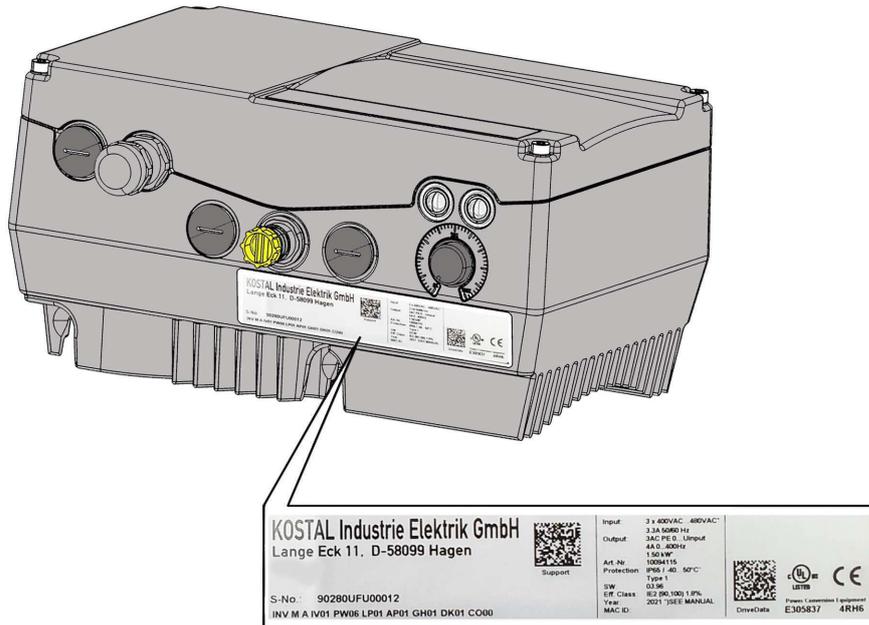


Fig.: 3 Labels on the drive controller

Signs and labels are applied to the housing of the drive controller. These signs and labels may not be altered or removed.

Symbol	Meaning	Symbol	Meaning
	Danger due to electrical shock and discharge		Additional earth connection
	Danger due to electrical shock and discharge. Wait two minutes (discharge time of the capacitors) after shut-down		Observe and read operating manual
	Device may not be disposed of with household waste! Observe the local application of disposal requirements		

2.3 Qualified staff

In the context of this operating manual, qualified staff are electronics specialists who are familiar with the installation, assembly, commissioning and operation of the drive controller and are aware of the dangers involved, and whose specialist training and knowledge of relevant standards and regulations provide them with the necessary abilities.

1	3	4	5	6	7	8	9	10	11	12	13	14
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2.4 Proper use

If the device is installed in a machine, drive controllers may not be commissioned (i.e. intended operation may not begin) until it has been determined that the machine complies with the regulations of EC Directive 2006/42/EC (Machinery Directive); DIN EN 60204-1; VDE 0113-1:2007-06 must be observed.

Commissioning (i.e. beginning intended operation) is only permitted if the EMC Directive (2004/108/EC) is complied with.

The harmonised standards of DIN EN 50178; VDE 0160:1998-04 must be applied for this drive controller along with DIN EN 60439-1; VDE 0660-500:2005-01.

This drive controller may not be operated in areas where there is a danger of explosion!

Repairs may only be performed by authorised repair bodies.

Independent and unauthorised intervention may result in death, injury or property damage. The warranty provided by KOSTAL will be invalidated in such cases.

External mechanical loads such as stepping on the housing are not permitted.



IMPORTANT INFORMATION

Using drive units in equipment that is not fixed is considered as an exceptional environmental condition and is only permitted if allowed by the standards and guidelines applicable on site.

2.5 Responsibility

As a basic principle, electronic devices are not fail-safe. The operator and/or the contractor setting up the machine or system is responsible for ensuring that the drive switches to a safe state if the device fails.

The “Electrical equipment of machines” section in DIN EN 60204-1; VDE 0113-1:2007-06, “Safety of machinery” describes the safety requirements for electrical control units. These are provided for the safety of people and machines and must be observed in order to retain the functional capability of the machine or system.

An emergency stop feature does not necessarily result in the voltage supply to the drive being switched off. To avoid dangerous situations, it may be useful for individual drives to remain operational or for specific safety procedures to be initiated.

The effectiveness of emergency stop measures is evaluated by means of a risk assessment for the machine or system and its electrical equipment, and is determined by selecting a circuit category according to DIN EN 13849 “Safety of machinery – Safety-related parts of control systems”.

2.6 CE marking

With the CE marking, we, as the manufacturer of the device, confirm that the basic requirements of the following directive has been met:

- Directive on Electromagnetic Compatibility (Directive 2004/108/EC of the Council)

The declaration of conformity is available to download at <https://www.kostal-drives-technology.com/download>.

2.7 Abbreviations

All abbreviations used are listed in the following table:

Term	Definition
1oo2	"1 out of 2" structure according to IEC61508
STO	Safe Torque Off, safety function according to 61800-5-2, with which the commutation of the drive can be securely switched off.
SS1	Safe Stop 1 The SS1 safety function corresponds to an uncontrolled shut-down according to IEC 60204-1, stop category 1. In this case the drive controller does not securely monitor the motor delay or the motor speed.
IGBT	Insulated Gate Bipolar Transistor
Pulse block	Shut-down of the pulse pattern necessary for commutation by shutting down the driver supply
AOPD components	Active opto-electronic protective device
OSSD	Output Signal Switching Device: The part of the active opto-electric protective device (AOPD) that is connected to the machinery control system and is switched to OFF status when the sensor part is activated during correct operation.
DC	Diagnostic Coverage
SFF	Safe Failure Fraction
T	Lifetime
PL	Performance Level
PFH	Probability of a dangerous random hardware failure per hour
MTTFd	Mean Time to Failure
CCF	(also value) Common-Cause Failure
SRS	Safety Extra Low Voltage Safety Requirement Specification
PELV	Protected Extra Low Voltage Protected Extra Low Voltage
SELV	Safety Extra Low Voltage Safety Extra Low Voltage

Table 2: Abbreviations and terms

2.8 Certificate

EC Type-Examination Certificate





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ID 060000000

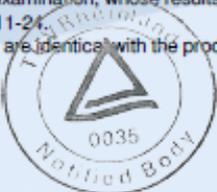
Reg.-No.: 01/205/5870.00/21

Product tested	Safety function "Safe Torque Off" (STO) (1-CH) within the Inverter Drives INVEOR MP Modular series	Certificate holder	KOSTAL Industrie Elektrik GmbH Lange Eck 11 58093 Hagen Germany								
Type designation	INVEOR MP Modular (Details see current Revision List)										
Codes and standards	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">EN 61800-5-2:2007</td> <td style="width: 50%;">EN ISO 13849-1:2015</td> </tr> <tr> <td>EN 61800-5-2:2017</td> <td>EN 62061:2005 + AC:2010 +</td> </tr> <tr> <td>EN 61800-5-1:2007 + A1: 2017, 4.3, 5.2.3.8, 5.2.6</td> <td>A1:2013 + A2:2015</td> </tr> <tr> <td></td> <td>EN 61508 Parts 1-7:2010</td> </tr> </table>			EN 61800-5-2:2007	EN ISO 13849-1:2015	EN 61800-5-2:2017	EN 62061:2005 + AC:2010 +	EN 61800-5-1:2007 + A1: 2017, 4.3, 5.2.3.8, 5.2.6	A1:2013 + A2:2015		EN 61508 Parts 1-7:2010
EN 61800-5-2:2007	EN ISO 13849-1:2015										
EN 61800-5-2:2017	EN 62061:2005 + AC:2010 +										
EN 61800-5-1:2007 + A1: 2017, 4.3, 5.2.3.8, 5.2.6	A1:2013 + A2:2015										
	EN 61508 Parts 1-7:2010										
Intended application	The safety function STO complies with the requirements of the relevant standards (SIL 1 / SILCL 1 acc. to EN 61800-5-2 / EN 61508 / EN 62061 and up to Cat. 1 / PL c acc. to EN ISO 13849-1 for DC=0%; SIL 2 / SILCL 2 acc. to EN 61800-5-2 / EN 61508 / EN 62061 and up to Cat. 2 / PL d acc. to EN ISO 13849-1 for DC=90%) and can be used in applications up to these safety levels.										
Specific requirements	The instructions of the associated Installation and Operating Manual shall be considered. In particular when used in Cat. 2 or SIL 2 an external diagnostic device with additional dynamic test is mandatory.										

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

Valid until 2026-11-25

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 2334.00/21 dated 2021-11-24.
This certificate is valid only for products which are identical with the product tested.



Köln, 2021-11-25

Notified Body for Machinery, NB 0035



Dipl.-Ing. Jelena Stenzel

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3. Safety

3.1 General safety instructions

See chapter 1.9 "Safety instructions" of the operating manual "INVEOR drive controller".

3.2 STO safety instructions

The safety instructions listed in the following are to be observed and obeyed strictly.

3.2.1 Protection from electric shock



IMPORTANT INFORMATION

No protection from electric shock is ensured by the STO status.



DANGER!

**Risk of death due to electrical shock!
Death or serious injury!**

De-energise the drive controller, determine that it is voltage-free and secure it against being restarted.

The following terminals may lead to dangerous currents even when the motor is not running:

- Supply terminals X1: L1, L2, L3
- Motor connection terminals X2: U, V, W

3.2.2 Protection from contamination



IMPORTANT INFORMATION

With open housing, contamination degree 2 must be observed in order to ensure the safety function.

3.2.3 Elimination of errors



IMPORTANT INFORMATION

The STO connection line must be shielded in order that the elimination of errors with regard to external voltage coupling may be applied.

3.2.4 Elimination of errors with regard to short circuit



IMPORTANT INFORMATION

With reference to the STO connection line, the "elimination of errors with regard to short circuit" is achieved in accordance with DIN EN 13849-2 in that a separate, shielded cable is used for each channel. Shielding is to be applied at both ends.

If only one shielded cable is used for both STO channels, a safety switch must be used to detect possible crossovers between the channels to comply with the "elimination of errors with regard to short circuit" in accordance with DIN EN 13849-2.

3.2.5 Visual inspection



IMPORTANT INFORMATION

All cables are to be inspected for correct wiring prior to commissioning.

3.2.6 Loss of the safety function



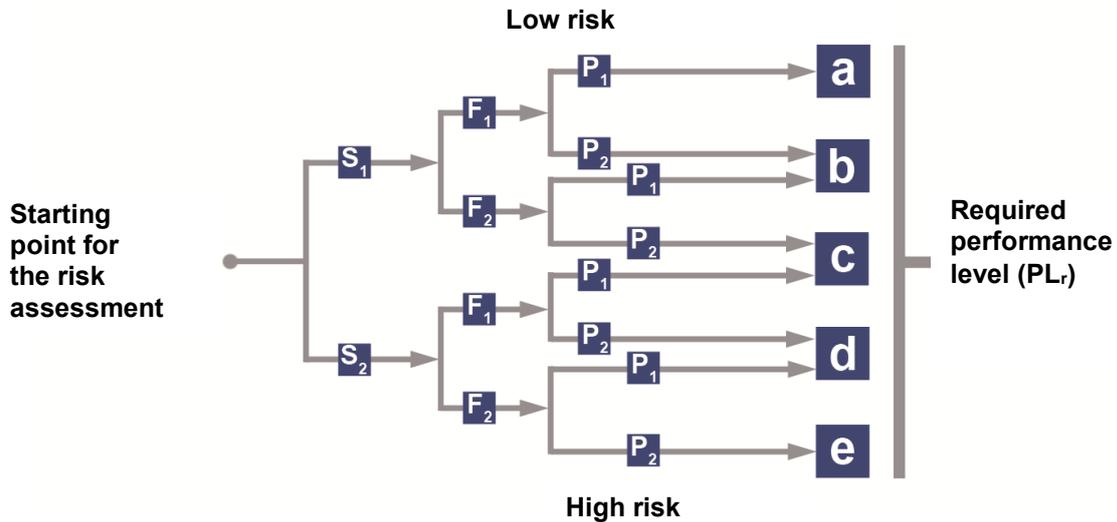
IMPORTANT INFORMATION

Permanent 24 V voltage to the STO inputs results in the loss of the safety function.

3.3 Safety classification / characteristic values

INVEOR drive controllers have been designed to take account of the standards named in the following chapters. The safety classification and the corresponding characteristic values are also found there.

3.3.1 Definition of the necessary performance levels (PL_r) according to EN ISO 13849-1



S - Severity of the injury

S₁ = slight injury (normally reversible)

S₂ = serious injury, (normally irreversible) including death

F - Frequency and/or duration of exposure to the hazard

F₁ = rare to frequently and/or short in duration

F₂ = frequently to continuously and/or long in duration

P - Possibilities for avoiding the hazard

P₁ = possible under certain conditions

P₂ = hardly possible

3.3.2 Classification IEC 60204-1

Three stop functions are named in the standard that are designated as categories 0 to 2. Categories 0 and 1 can be realised with INVEOR platform drive controllers with a pulse block.

Stop category-0

An uncontrolled shut-down through immediate interruption of the power supply to the machine drive elements (safety-related activation of the pulse block).

Stop category-1

Controlled shut-down. The power supply to the machine drive elements is initially maintained in order to achieve targeted shut-down. The power supply is interrupted following the standstill of the machine drive elements. (safety-related activation of the pulse block).



IMPORTANT INFORMATION

"Stop category-1 and 2" (SS1 and 2) is not supported by the drive controller.

1	3	4	5	6	7	8	9	10	11	12	13	14
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3.3.3 Classification IEC 61800-5-2

The following definitions describe the three types of safe stop function.

STO (Safe Torque Off)

No power is supplied to the motor that could cause rotation (or movement in the case of a linear motor). The drive controller supplies no power to the motor that could generate torque (or force in the case of a linear motor). This safety function corresponds to an uncontrolled shut-down according to IEC 60204-1, stop category 0.



IMPORTANT INFORMATION

This safety function can be used when it is necessary to shut off power in order to prevent an unexpected start.



IMPORTANT INFORMATION

Where there are external influences (e.g. falling of suspended loads), additional measures (e.g. mechanical braking), which must be designed to fail safe, may be necessary to prevent hazards.



IMPORTANT INFORMATION

In the STO status, the drive is not separated from the energy supply, as only the activation of the IGBTs is securely switched off.

Safe stop 1 and 2 (SS1 and SS2)

The SS1 and SS2 function is not supported.

Classification of one-channel EN 62061 without external diagnosis

The classification of the one-channel STO function without external diagnosis meets the following requirements:

Designation	Value	Explanation
Safety measure	Pulse block	---
SIL	1	Safety integrity level
PFH	2.50e-07	Probability of hazardous failures per hour
DC	0 [%]	Diagnosis coverage
SFF	50 %	Proportion of safe failures
T	20 years	Duration of usage

Table: Classification of one-channel EN 62061, without external testing

Classification of one-channel EN 62061 with external diagnosis

The classification of the one-channel STO function with external diagnosis meets the following requirements:

Designation	Value	Explanation
Safety measure	Pulse block	---
SIL	2	Safety integrity level
PFH	2.50e-08	Probability of hazardous failures per hour
DC	90 [%]	Diagnosis coverage
SFF	95 %	Proportion of safe failures
T	20 years	Duration of usage

Table: Classification of two-channel EN 62061 with external testing

1	3	4	5	6	7	8	9	10	11	12	13	14
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Classification of one-channel EN ISO 13849-1 without external diagnosis

The classification of the one-channel STO function without external diagnosis meets the following requirements:

Designation	Value	Explanation
Safety measure	Pulse block	---
PL	c	Performance level
Category	1	---
MTTFd	457 [a]	Mean time to failure (dangerous)
DC	0 [%]	Diagnosis coverage
T	20 years	Duration of usage
Max. diagnosis test interval	Once every 3 months	

Table: Classification of one-channel EN ISO 13849-1, without external testing

Classification of one-channel EN ISO 13849-1 with external diagnosis

The classification of the one-channel STO function with external diagnosis meets the following requirements:

Designation	Value	Explanation
Safety measure	Pulse block	---
PL	d	Performance level
Category	2	---
MTTFd	457 [a]	Mean time to failure (dangerous)
DC	90 [%]	Diagnosis coverage
T	20 years	Duration of usage
Max. diagnosis test interval	Once every 3 months	

Table: Classification two-channel EN ISO 13849-1 with external diagnosis



IMPORTANT INFORMATION

When an external control system carries out a test of the connection in the application 100 times more often than a "sharp" requirement of the STO function, SIL 2 and PL d are achieved.

4. Type key/scope of application

The INVEOR drive controller platform contains variants with and without safety function STO. These variants are clearly recognisable by the product key. The STO safety function cannot be retrofitted.

INVEOR MP Modular

Item designation for KOSTAL "INVEOR" MP Modular INV MPx VSxx IVxx PWxx LPxx APxx GHxx DKxx OAx IO1x COxx

Fig.: 4 Item designation (INVEOR MP Modular)

The following table provides an overview of devices with STO function:

INV	MPx	VS02	IV01	PWxx	LPxx	APxx	GHxx	DKxx	OAx	IO1x	COxx
INV	MPx	VS02	IV01	PWxx	LPxx	APxx	GHxx	DKxx	OAx	IO3x	COxx

INVEOR MPP

Item designation for KOSTAL "INVEOR" MPP INV MPx VSxx IVxx PWxx LPxx APxx GHxx DKxx OAx IO1x COxx
--

Fig.: 5 Item designation (INVEOR MP Modular)

The following table provides an overview of devices with STO function:

INV	MPP	VS03	IV01	PWxx	LPxx	APxx	GHxx	DKxx	OAx	IO1x	COxx
INV	MPP	VS03	IV01	PWxx	LPxx	APxx	GHxx	DKxx	OAx	IO3x	COxx

5. Technical data

5.1 Technical data, general

See chapter 8 "Technical data" of the operating manual "INVEOR drive controller".

5.2 Technical data STO

	Size A				
Motor rating [kW]	0.55	0.75	1.1	1.5	2.2 LD
Ambient temperature	- 40 °C (non-condensing) to + 50 °C (without derating)				up to + 40 °C
	Size B				
Motor rating [kW]	2.2	3.0	4.0	5.5 LD	
Ambient temperature	- 40 °C (non-condensing) to + 50 °C (without derating)				up to + 40 °C
	Size C				
Motor rating [kW]	5.5	7.5	4.0	11 LD	
Ambient temperature	- 40 °C to + 50 °C > 50 °C (with derating)				up to + 40 °C
	Size D				
Motor rating [kW]	11	15	18.5	22	30 LD
Ambient temperature	- 40 °C to + 50 °C > 50 °C (with derating)				up to + 40 °C

	Sizes A-D
Storage temperature	- 40 °C...+ 85 °C

	Sizes A-D
Vibration resistance (DIN EN 60721-3-3)	3M7 (3g)

	Sizes A - C	Size D
Protection class [IPxy]	IP 65	IP 55

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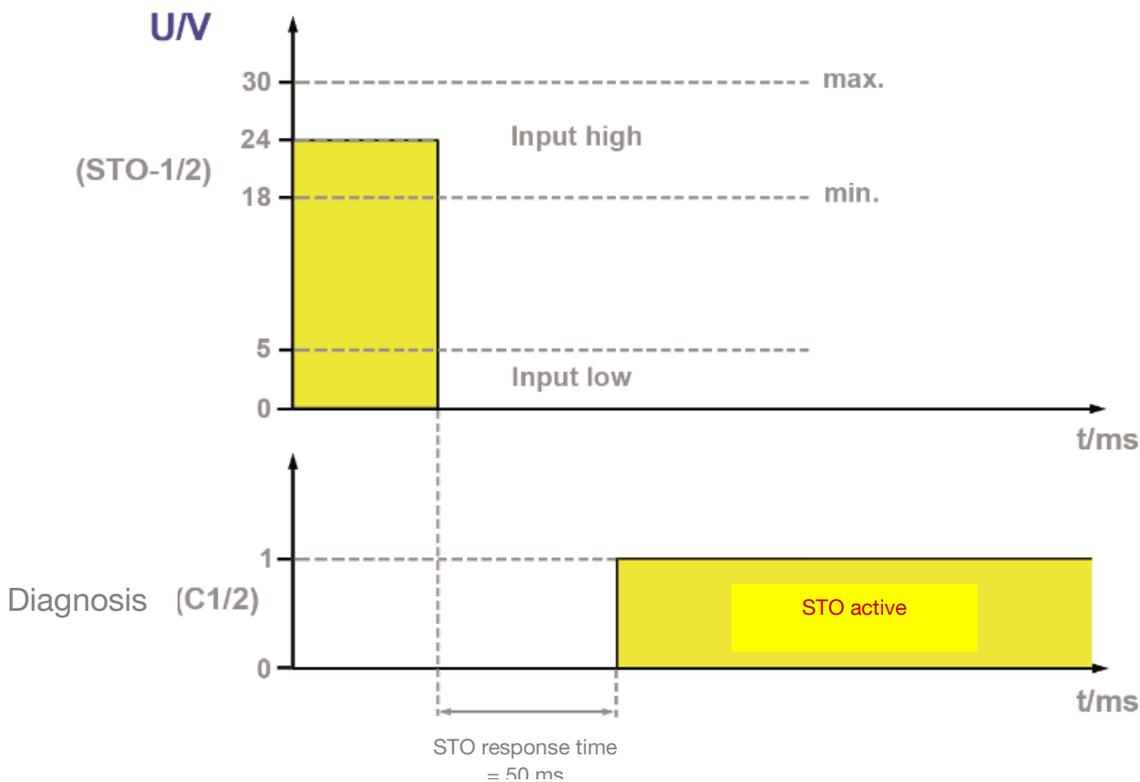
Continuation

Technical data STO

Designation	Value	Unit
STO max. response time	50	ms
PELV/SELV power supply for STO input voltage (rating)	24	VDC
PELV/SELV tolerance for STO input voltage (referring to rating)	± 25	%
Current consumption STO channel with rated voltage	Typ. 80	mA
Start-up peak current (2.5 ms)	500	mA
Compatibility: Max. OSSD pulse	1	ms
Compatibility: Min. OSSD pulse period time	10	ms
STO Input Low	0..5	V
STO Input High	18..30	V
STO Input High when operating with OSSD signals	19.2..30	V

Table: Technical data STO

The STO response time is the time between deactivation of the STO input signal and the definite fail-safe pulse block.



STO input



IMPORTANT INFORMATION

The maximum STO response time of 50 ms is to be taken into account when using the machine

6. Safety functions

In order to prevent the endangerment of people and the environment, as well as damage to material, it is necessary to be able to safely shut down machines in the event of a dangerous situation. To this purpose, the "safety variants" of the INVEOR platform are equipped with the safety function "Safe Torque Off" (STO).

In the following chapters, the principles of the STO safety functions and the fundamental parameter of response time are described and explained.

6.1 Operating modes

The STO function is effective at a higher level in all drive controller operating modes.

6.2 STO function (Safe Torque Off)

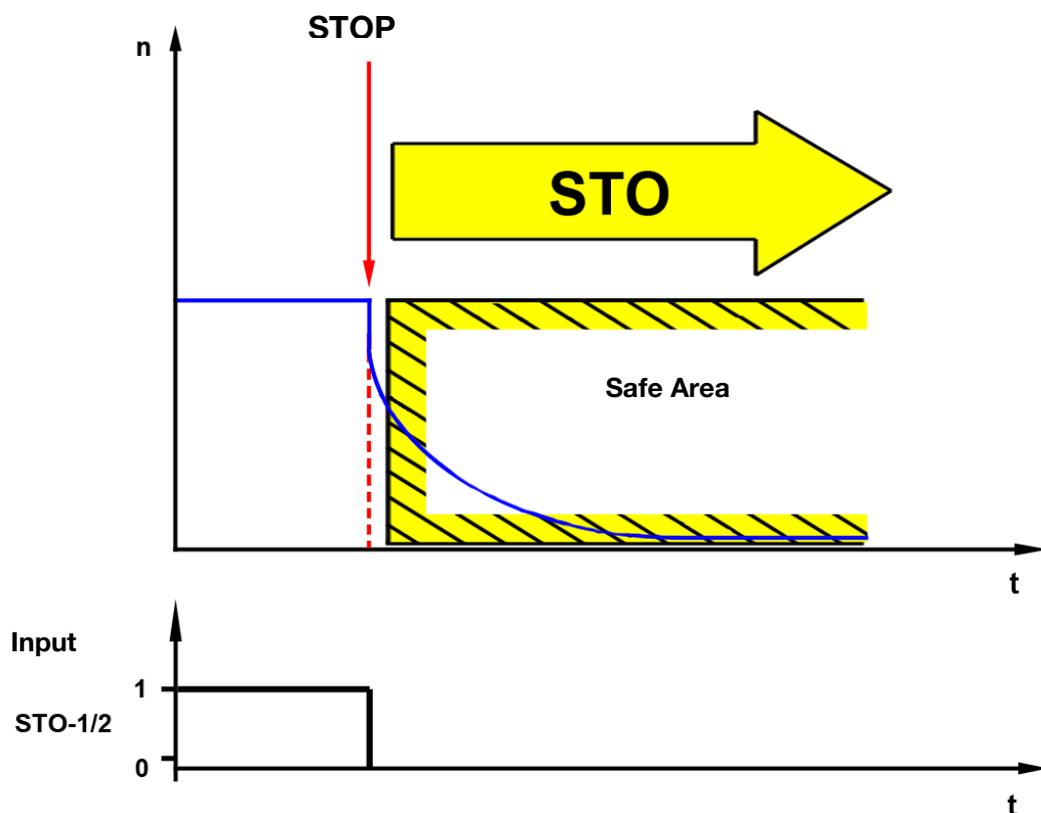


Fig.: 6 Safety function STO

A PELV/SELV 24V power supply must be provided for the STO control.

1	3	4	5	6	7	8	9	10	11	12	13	14
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6.3 STO function (Safe Torque Off)

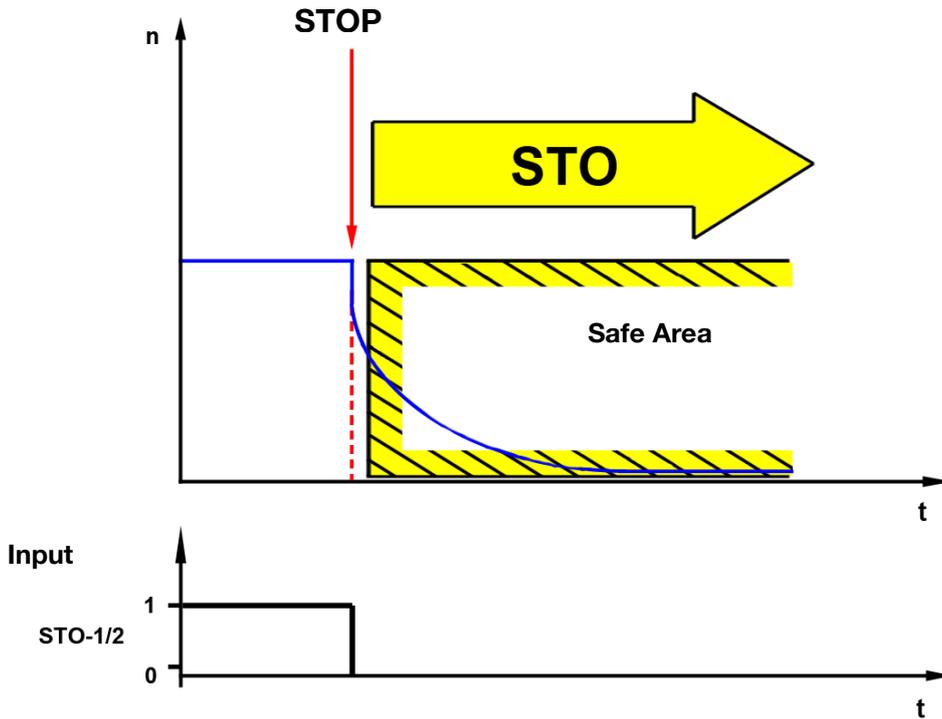


Fig.: 7 Safety function STO

A PELV/SELV 24V power supply must be provided for the STO control.



IMPORTANT INFORMATION

In the STO status, the drive controller and the motor are not separated from the energy supply, as only the commutation of the motor is switched off.

After the STO function is triggered, the drive is switched off (impulse block) and the drive control runs down without braking (when no brake has been activated).



IMPORTANT INFORMATION

The shut-down time must be considered in this application.

6.3.1 STO without external diagnosis

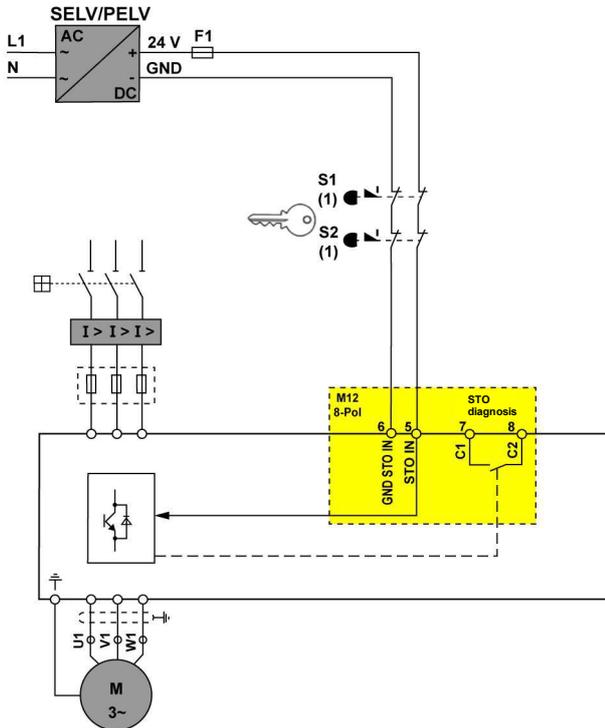


Fig.: 8 STO without external diagnosis

Category 1,

PL c according to EN ISO 13849-1

Level SIL 1 according to EN IEC 62061

Stop category 0

- (1) Emergency stop switch (S1): Request for a free-running stop and activation of the safety function "safe torque off".
- (2) Push button (S2): Resetting the OSSD switching device.

6.3.2 STO with external diagnosis

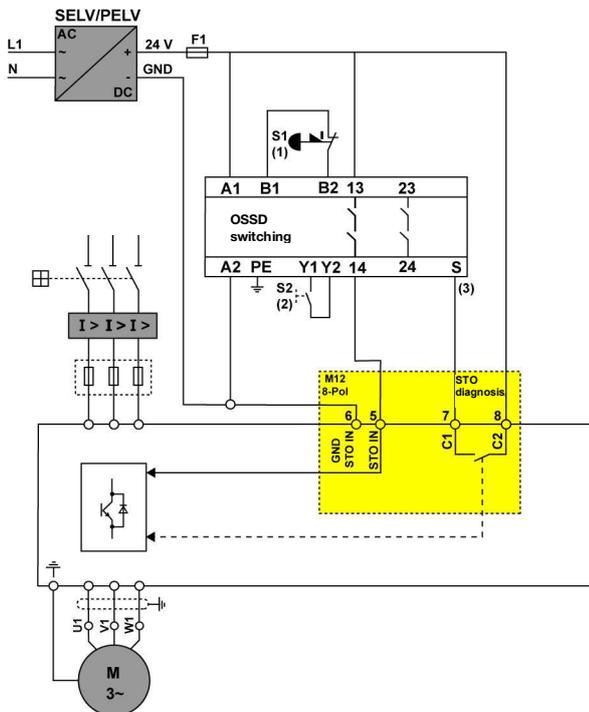


Fig.: 9 STO with external diagnosis

Category 2,

PL d according to EN ISO 13849-1

Level SIL 2 according to EN IEC 62061

Stop category 0

- (1) Emergency stop switch (S1): Request for a free-running stop and activation of the safety function "safe torque off".
- (2) Push button (S2): Resetting the OSSD switching device.
- (3) Response of safety branch for external control.

7. Application instructions - Safety

In order to clearly explain the wiring of the INVEOR frequency converter, the fundamental connection examples will be presented in the following chapters.

7.1 Restarting protection



IMPORTANT INFORMATION

In the event of dangerous loads having an external effect, a hazard can originate from the STO status when no further measures are taken.

In addition to the switching examples, the guidance on "Restarting" in the standards DIN EN ISO 13849-1 (BGIA Report 2/2008) and IEC 60204 should be followed.

The resetting of a safety requirement alone may not automatically result in the restarting of the drive. Restarting may only be made possible through a fault acknowledgement (manual reset) at the safety switching device.



IMPORTANT INFORMATION

With appropriate parameterisation, it is possible that the drive controller will start up automatically (see chapter 7).

7.2 External STO input voltage

A 24 V power supply that corresponds to the PELV or SELV provisions in accordance with EN 60204-1 must be used so that the electrical values for low voltage with safe separation cannot be exceeded in the STO function circuit.

The 24 V power supply used for the STO supply must be adequate for the grid-side voltage interruption defined in EN 60204-1.

7.3 Internal auxiliary voltage

The 24 V supply of the application circuit board is found on terminal **X5** in accordance with the SELV/PELV requirement and can be used as supply voltage for the STO channels. In this application case, a max. of 30 mA is available for additional external components.

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8. Parameterisation

See chapter 5 "Parameters" of the operating manual "INVEOR drive controller".

We recommend deactivating the "auto acknowledgement" of a fault (Parameter 1.181), as otherwise an immediate restart can occur as soon as the fault is no longer present.

8.1 STO

The restart protection (not safety-related, parameter 1.132) should under no circumstances be deactivated, as otherwise an immediate restart can occur when the STO voltage is activated.

9. Diagnosis

The status of the STO function is signalled with the help of a potential-free diagnosis contact that is locked in the safe status. The two-channel, deactivated impulse block is thus displayed. This contact can be used as a response to a higher level control unit.

9.1 Diagnosis safety function

STO 1	Contact	Note
Off	closed	STO channel not supplied: STO active
On	open	STO channel supplied: Operation possible

Table 3: Diagnosis overview of diagnosis contact



IMPORTANT INFORMATION

- The maximum delay time between the activation of the safety function by the input-side safety device and the closing of the contact is 50 ms.
- This reaction time is to be observed when using the machine and configured in accordance with the external fault diagnosis.

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9.1.1 Carrying out external diagnosis

An external diagnosis is necessary in order to achieve diagnosis coverage of 90% and the resulting safety parameters. The diagnosis contact is monitored for plausibility in accordance with the statuses of the STO inputs. This means that, for STO channels that are not supplied, the internal diagnosis relay short-circuits the contacts C1 and C2 (normally open contact). As soon as the STO channel is supplied with 24 V, the relay deactivates and the contacts C1 and C2 are interrupted. Carry out a diagnosis prior to every start-up of the motor.

9.1.2 External dynamic test

An external dynamic test is necessary in order to achieve diagnosis coverage of 90% and the resulting safety parameters. The STO channel is supplied with all possible logical statuses and the expected status of the diagnosis relay is queried before each motor activation is enabled.

Process:

1. STO1 not supplied with 24 V => Relay is closed
2. STO1 supplied with 24 V => Relay opens
3. STO1 supplied with 24 V => Motor can be activated

With this the dynamic test is concluded and the motor can be started.



IMPORTANT INFORMATION

- During the dynamic test, the response times of the STO circuit are to be considered:
Delay of the diagnosis relay max. 50 ms
- The maximum test interval is 1 year.

10. Terminal assignment

10.1 Connection diagram (IO module option) INVEOR MP Modular

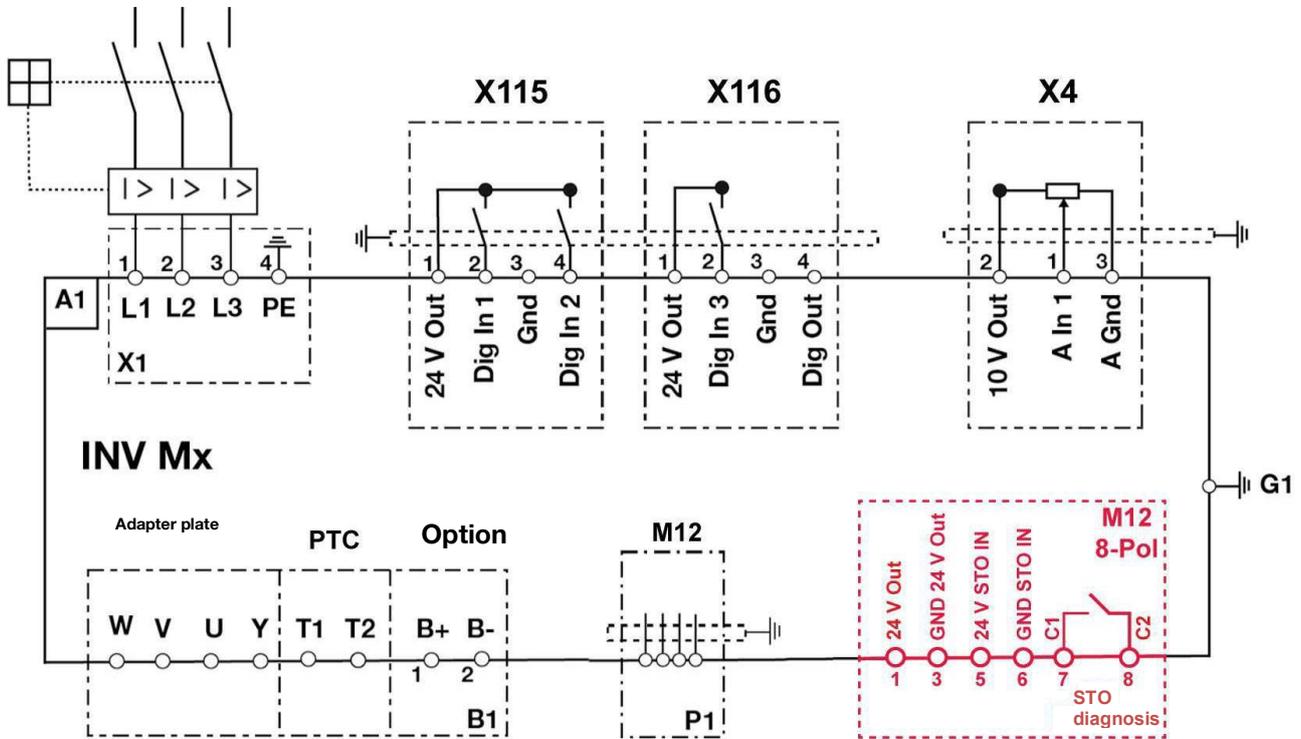


Fig.: 10 Connection diagram (IO module option)

Characters	Explanation
A1	Drive controller type: INV Mx IV01 (3 x 400 V AC)
B1	Connection for external brake resistor (option)
G1	M6 grounding screw (connection for residual currents > 3.5 mA)
P1	RS485 programming interface (M12 plug)
X4	Internal potentiometer / analogue input 1
Q1	Motor protection switch or load break switch (optional)
X1	Mains terminals
X15 – X16	Digital inputs and outputs
M12 8-pin	Digital inputs and outputs for "functional safety" (option)

The drive controller is ready once a 3 x 400 VAC mains supply has been activated (on terminals L1 to L3) or a 565 V DC mains supply has been activated (on terminals L1 and L3).

1	3	4	5	6	7	8	9	10	11	12	13	14
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10.2 Connection diagram INVEOR MPP

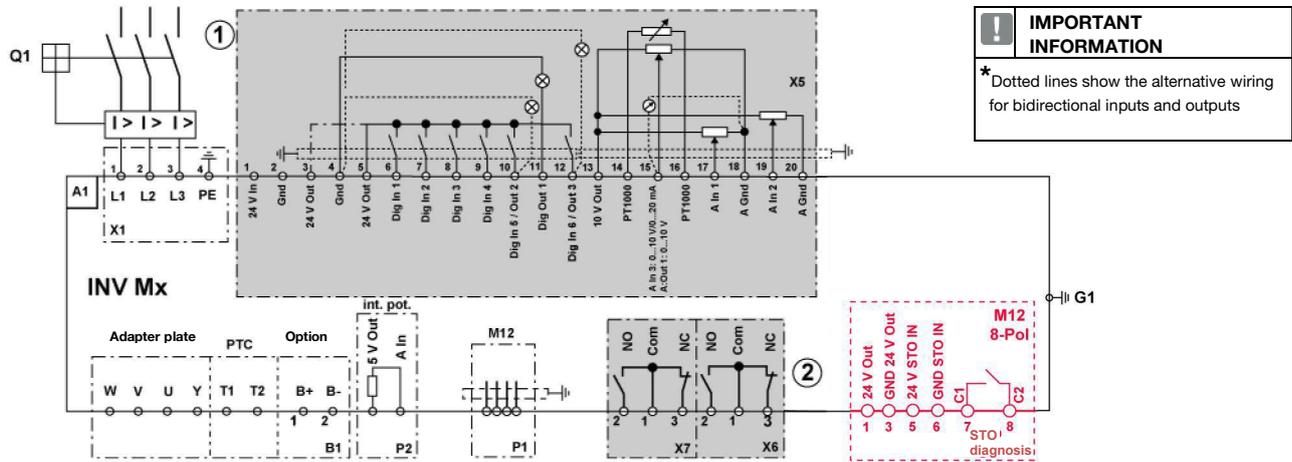


Fig. 11: Connection diagram

Characters	Explanation
A1	Drive controller type: INV MPPx
B1	Connection for external brake resistor (option)
G1	M6 grounding screw (connection for residual currents > 3.5 mA)
P1	RS485 programming interface (M12 plug)
P2	Internal potentiometer
Q1	Motor protection switch or load break switch (optional)
X1	Mains terminals
X5 – X7	Digital/analogue inputs and outputs
M12 8-pin	Digital inputs and outputs for "functional safety" (option)

The drive controller is ready once a 3 x 400 V AC mains supply has been activated (on terminals L1 to L3) or a DC mains supply has been activated (on terminals L1 and L3).

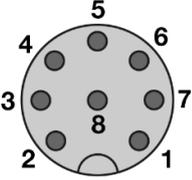
The drive controller can also be started up by connecting an external 24 V voltage.

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10.3 Terminal assignment M12 8-pin

The 8-pin M12 plug serves as the input-end connection for electro-mechanical and electronic safety switching devices.

In addition to the safety-related input, signalling contacts are available on the contacts of the 8-pin M12 plug with pins 7 and 8 (diagnosis).

Terminal assignment M12 8-pin			
	8-pin M12 flanged bush A-coded with yellow insert		
	Pin	Assignment	
	1	INVEOR 24 V voltage output	INVEOR 24 V voltage output
	2	n. c.	Not used
	3	GND OUT INVEOR	INVEOR GND voltage output
	4	n. c.	Not used
	5	24 V STO IN	Control input for the STO function 0 V/24 V
	6	GND STO IN	Reference potential STO (0 V)
	7	Signalling contact C1	Normally open contact for response of STO to external control system (diagnosis)
	8	Signalling contact C2	Normally open contact for response of STO to external control system (diagnosis)

11. Installation/disassembly/commissioning

In this document, the installation and disassembly instructions as well as the information concerning commissioning refer only to functional safety.

11.1 Installation

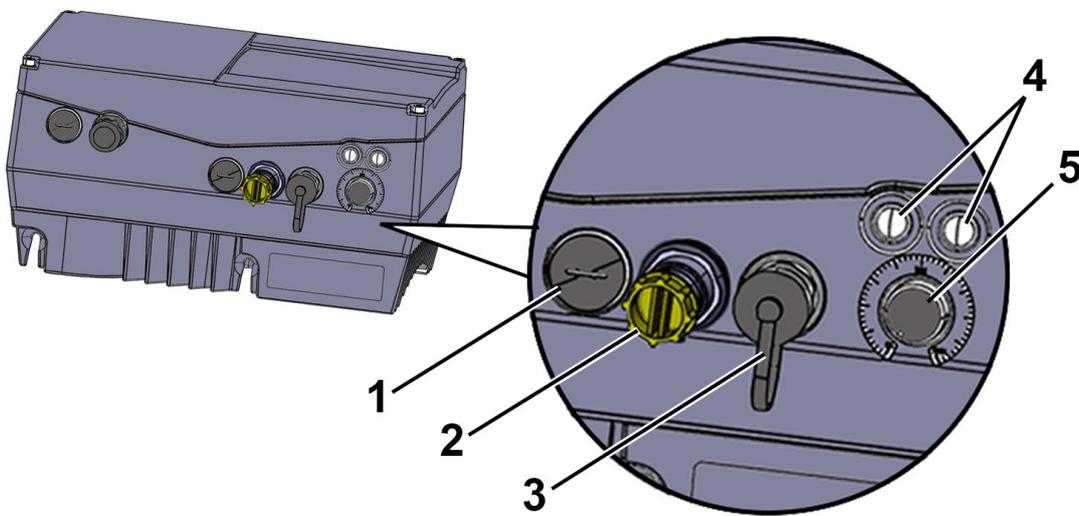
See chapter 1 "General information" of the operating manual "INVEOR MP Modular drive controller".



IMPORTANT INFORMATION

With open housing, contamination degree 2 must be observed in order to ensure the safety function.

11.1.1 Connections



A picture with STO, 8-pin as an example (item 2)

Fig.: 12 Connections assy A

Connections	
1	Blind plug
2	"Functional safety (FuSa / STO)" connection
3	"MMI" connection
4	LED error messages (see chapter 12.3 "Fault display")
5	Potentiometer

11.2 STO connection cable

With reference to the STO connection cable, the "elimination of errors with regard to short circuit" is achieved in accordance with DIN EN 13849-2, as a separate, shielded cable is used for each channel. Shielding is to be applied at both ends.

If only one shielded cable is used for both STO channels, a safety switch must be used to detect possible crossovers between the channels to comply with the "elimination of errors with regard to short circuit".

The maximum cable length for the connection of the STO channels is 30m.

The cable cross-section is to be designed in such a way to ensure the required minimum input voltage of 18 V or 19.2 V during operation with OSSD signals.

11.3 Disassembly

See chapter 1 "General information" of the operating manual "INVEOR drive controller".

11.4 Commissioning

See chapter 1 "General information" of the operating manual "INVEOR drive controller".

The procedure is described as a flow chart in chapter 15.3.

11.4.1 STO validation

In the context of commissioning, it is absolutely necessary to request the STO function of the drive controller in order to ensure problem-free function.

To this purpose the STO function is requested with running motor. The motor must then run down.

The diagnosis function must also be checked. See chapter 8.1.

12. Dealing with malfunctions

12.1 Error detection and troubleshooting

This chapter contains the following:

- a list of the LED flash codes for error recognition
- a description of error recognition using PC tools
- a list of errors and system errors
- notes on error detection with the MMI

12.2 Malfunction overview

The driver controller shuts down if an error occurs. Consult the flash code table / PC tool for the corresponding error numbers.



DANGER!

**Risk of death due to electrical shock!
Death or serious injury!**

De-energise the drive controller, determine that it is voltage-free and secure it against being restarted.

If damaged parts or components need replacing, only ever replace with original parts.



Danger due to electrical shock and discharge. Wait two minutes (discharge time of the capacitors) after shut-down.



IMPORTANT INFORMATION

Error messages can only be acknowledged once the error has been remedied.

Error messages can be acknowledged as follows:

- digital input (can be programmed)
- using MMI (handheld controller)
- auto acknowledgement (parameter 1.181, page 89)
- switch device off and on again

via fieldbus (CANOpen, Profibus DP, EtherCAT)

A list of possible fault messages can be found in chapter 6.2 of the operating manual for the INVEOR drive controller.

12.3 Fault display

When an error occurs, the LEDs on the drive control display a flashing code that allows the errors to be diagnosed.

The following table contains an overview:

Red LED	Green LED	State
		Boot loader active (flashing in turn)
		Operational (STO channels are not supplied with 24 V)
		Operation / Ready (STO channels are supplied with 24 V)
		Warning
		Error
		Identification of motor data
		Initialisation
		Firmware update
		Bus error operation
		Bus error ready for operation

Tab. 1: LED flash codes

Key			
	LED off		LED on
	LED flashing		LED flashing quickly

12.4 Fault-finding and troubleshooting

Utilise the operating manual of the INVEOR sizes A - D for assistance in fault-finding and troubleshooting. See chapter 6.2 "List of faults and system errors" of the operating manual "INVEOR drive controller".

13. Maintenance

See chapter 1 "General information" of the operating manual "INVEOR drive controller".

13.1 Safety function

The STO function is requested when the motor is running. The motor must then run down.

In accordance with the selected safety application (also see chapter 5), the correct functionality of the diagnosis or of the dynamic test must also be documented.

13.2 Checklist for maintenance

See chapter 1 "General information" of the operating manual "INVEOR drive controller".

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14.1 Appendix: Commissioning

14.1.1 Quick-start guide for asynchronous motors

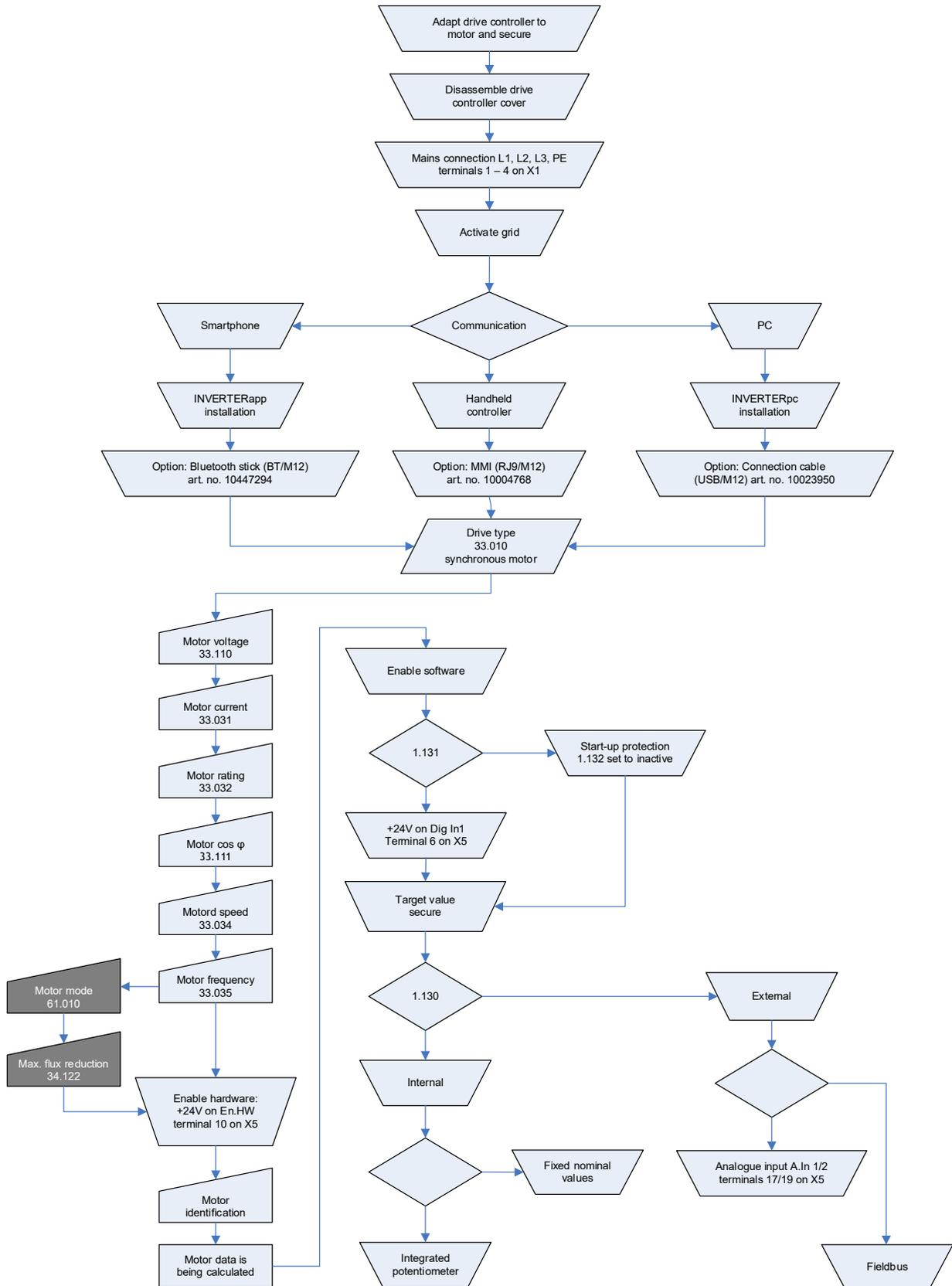


Fig.: 13 Block diagram for quick start for ASM

14.1.2 Quickstart guide for synchronous motors

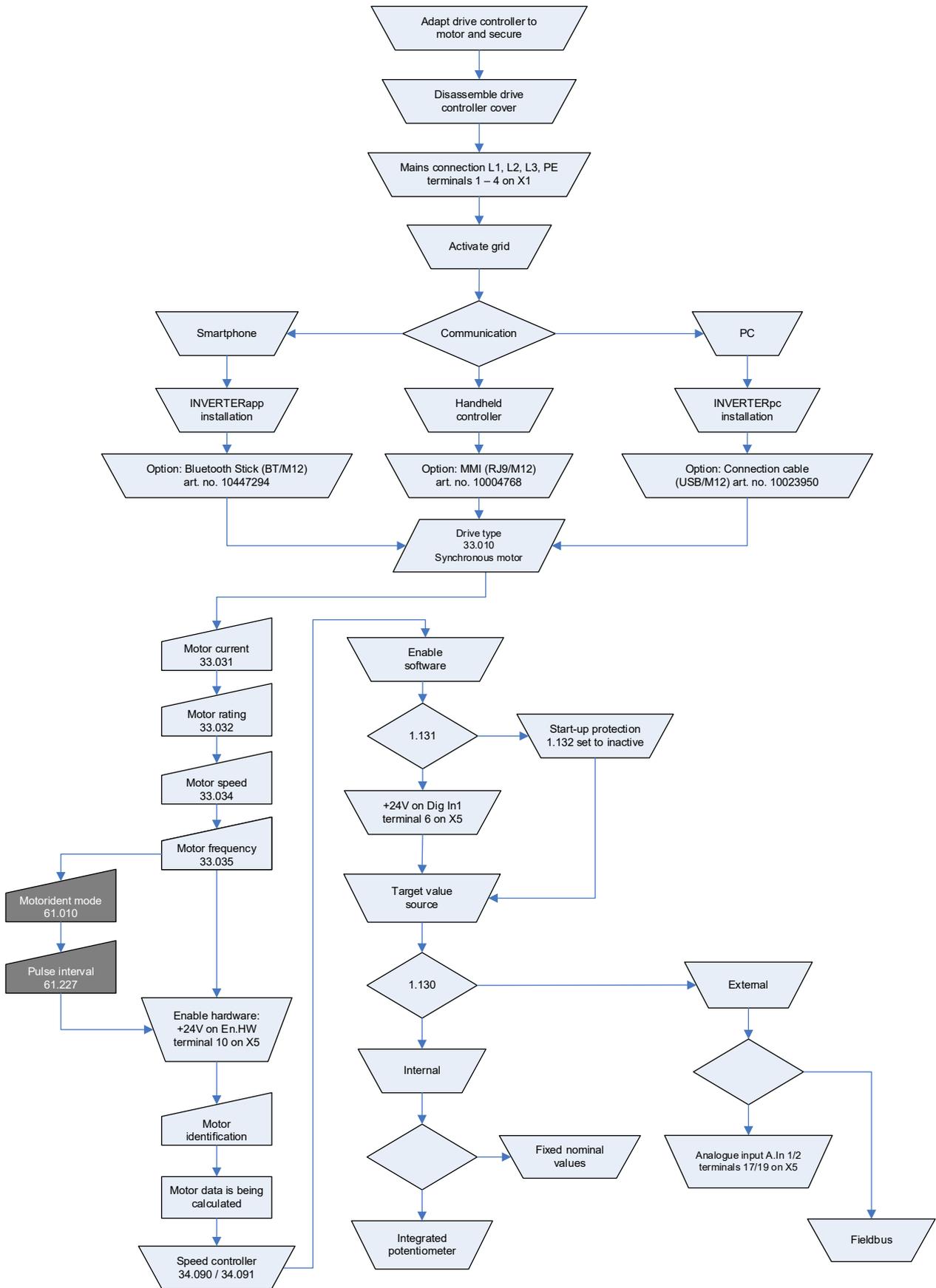


Fig.: 14 Block diagram for PMSM and SynRN quick commissioning

Notes

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