Bonfiglioli
Vectron

ACTIVE CUBE

Application manual – Crane drives
Brake control, load detection, anti-sway
Configurations 160, 260, 460 and 862

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We engineer dreams

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1 General Information about the Documentation

1.1 Instruction manuals

For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

Operating Instructions

The Operating Instructions document the complete functionality of the frequency inverter. The parameters required for special purposes, for adjustment to the application and the numerous additional functions are described in detail.

Application manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various topics in connection with the use of the frequency inverter is described in context with the specific application.

If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI.

The following instructions are available for the *ACTIVE CUBE* series:

ACTIVE CUBE Operating Instructions	Function of frequency inverter.
Quick Start Guide *ACTIVE CUBE*	Installation and commissioning Supplied with the device.
Manuals Communication interfaces	CM-CAN: CANopen manual CM-PDP-V1: Profibus DP-V1 manual CM-232/CM-485: VABus manual (serial protocol) CM-232/CM-485 Modbus: Modus ASCII and RTU manual CM-VABus/TCP: Ethernet Module CM-VABus/TCP CM-ModbusTCP: Ethernet Module CM-Modbus/TCP CM-EtherCAT®: Ethernet Module CM-EtherCAT® CM-ProfiNet: Ethernet Module CM-ProfiNet CM-EtherNet-I/P: Ethernet Module CM-EtherNet-I/P (i.V.)
Manuals Extension modules	EM-ABS-01: Absolute encoder module EM-ENC-01: Speed sensor (encoder) module EM-ENC-02: Speed sensor (encoder) module EM-ENC-03: Speed sensor (encoder) module EM-ENC-04: Speed sensor (encoder) module EM-ENC-05: Speed sensor (encoder) module EM-IO-01: Extension module for digital inputs/outputs EM-IO-02: Extension module for digital inputs/outputs EM-IO-03: Extension module for digital inputs/outputs EM-IO-04: Extension module for digital inputs/outputs EM-RES-01: Resolver module EM-RES-02: Resolver module EM-RES-03: Resolver module EM-SYS: System Bus module
Safe Torque Off (STO) manual	Safety function STO
Liquid Cooling - Complement to Operating Instructions	Properties specific to liquid cooled frequency inverters
Application manual "Parallel connection"	Parallel connection of Size 8 frequency inverters
PLC application manual	Logic linking of digital signals. Functions for analog signals such as comparisons and mathematical functions. Graphical support for programming with function blocks.
Application manual "Positioning"	Positioning functions of Configurations x40.
Application manual "Electronic gear"	Linking of at least 2 drives as electronic gear with Slave drive in Configuration x15 or x16.

The products for CANopen® communication comply with the specifications of the user organization CiA® (CAN in Automation).

The products for EtherCAT® communication comply with the specifications of the user organization ETG (EtherCAT Technology Group).

The present documentation was prepared with great care and it was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you face specific problems insufficiently addressed in the documentation, contact your local BONFIGLIOLI agent.
The present document's source language is English. Other language versions are translations.

1.2 This document

This documentation describes the frequency inverters of the *ACTIVE Cube* series. The modular hardware and software structure enables customer-specific adaptation of the frequency inverters. Applications with high functionality and dynamism requirements can be realized easily.
The Operating Instructions contain important information on the installation and the use of the product in its specified application range. Compliance with this user manual contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service live of the frequency inverter.
For this reason, make sure you read the Operating Instructions and this manual carefully.
IMPORTANT:
Compliance with the documentation is required to ensure safe operation of the frequency inverter. Bonfiglioli Vectron GmbH shall not be held liable for any damage caused by any non-compliance with the documentation.

For safe commissioning and operation of the ACU (ACTIVE Cube) series, the following documentation must be complied with:
- The Operating Instructions Document
- Application manual "Safe Torque Off ACU"

This documentation applies to the following frequency inverter series:
- ACTIVE Cube 210
- ACTIVE Cube 410
- ACTIVE Cube 510
- ACTIVE Cube 610

1.3 Warranty and liability

BONFIGLIOLI Vectron GmbH (hereinafter referred to as "manufacturer") notes that the contents of this Operating Instructions document do not form part of any previous or existing agreement, assurance or legal relationship between the manufacturer and the user of these Operating Instructions (hereinafter referred to as the "User"). Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.
The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without prior notice. The manufacturer assumes no responsibility to update these Operating Instructions. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.
In addition, the manufacturer excludes any warranty and disclaims all liability, including without limitation direct, indirect, special, punitive, incidental, exemplary or consequential damages arising out of or in connection with one or more of the following causes:
- inappropriate use of the frequency inverter,
- non-compliance with the instructions, warnings and prohibitions contained in the documentation,
- unauthorized modifications of the frequency inverter,
- insufficient monitoring of parts of the machine/plant which are subject to wear,
- repair work at the machine/plant not carried out properly or in time,
- catastrophes by external impact and Force Majeure.

1.4 Obligation

These Operating Instructions must be read before commissioning and complied with. Anybody entrusted with tasks in connection with the

- transport,
- assembly,
- installation of the frequency inverter and
- operation of the frequency inverter

must have read and understood the Operating Instructions and, in particular, the safety instructions in order to prevent personal and material losses.

1.5 Copyright

1.6 Storage

The documentation must be stored such that it is accessible to operating staff at all times. If the frequency inverter is sold on to other users, then the documentation must also be handed over.

1.7 Final decommissioning

After the end of product service life, the user/operator must take the device out of operation.

For more information about the decommissioning of the device refer to the applicable operating instructions document.

Disposal requirements under European Union WEEE regulations

The product is marked with the WEEE symbol shown below.

This product cannot be disposed as general household waste. Users responsible for the final disposal must make sure that it is carried out in accordance with the European Directive 2012/19/EU, where required, as well as the relative national transposition rules. Fulfil disposal also in according with any other legislation in force in the country.

2 General safety instructions and information on use

This chapter contains general safety instructions for the Operator and the Operating Staff. At the beginning of certain main chapters, some safety instructions are included which apply to all work described in the relevant chapter. Special work-specific safety instructions are provided before each safety-relevant work step.

2.1 Terminology

According to the documentation, different activities must be performed by certain persons with certain qualifications.
The groups of persons with the required qualification are defined as follows:

Operator

This is the entrepreneur/company who/which operates the frequency inverter and uses it as per the specifications or has it operated by qualified and instructed staff.

Operating staff

The term Operating Staff covers persons instructed by the Operator of the frequency inverter and assigned the task of operating the frequency inverter.

Skilled Personnel

The term Skilled Personnel covers staff that are assigned special tasks by the Operator of the frequency inverter, e.g. installation, maintenance and service/repair and troubleshooting. Based on their qualification and/or know-how, Skilled Personnel must be capable of identifying defects and assessing functions.

Qualified electrician

The term Qualified Electrician covers qualified and trained staff who has special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations, they must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

Instructed person

The term Instructed Person covers staff who was instructed and trained about/in the assigned tasks and the potential hazards that might result from inappropriate behavior. In addition, instructed persons must have been instructed in the required protection provisions, protective measures, the applicable directives, accident prevention regulations as well as the operating conditions and verified their qualification.

Expert

The term Expert covers qualified and trained staff who has special technical know-how and experience relating to frequency inverter. Experts must be familiar with the applicable government work safety directives, accident prevention regulations, guidelines and generally accepted rules of technology in order to assess the operationally safe condition of the frequency inverter.

2.2 Designated use

The frequency inverter is designed according to the state of the art and recognized safety regulations.
The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EC and DIN EN 60204-1.
The frequency inverters meet the requirements of the low voltage directive 2014/35/EU and DIN EN 61800-5-1. CE-labelling is based on these standards. Responsibility for compliance with the EMC Directive 2014/30/EU lies with the operator. Frequency inverters are only available at specialized dealers and are exclusively intended for commercial use as per EN 61000-3-2.
No capacitive loads may be connected to the frequency inverter.
The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with in any case.

2.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.

For, example, the machine/plant must not be operated

- by uninstructed staff,
- while it is not in perfect condition,
- without protection enclosure (e.g. covers),
- without safety equipment or with safety equipment deactivated,
- when general requirements, such as operating conditions and technical data, are not met.

The manufacturer shall not be held liable for any damage resulting from such misuse. The sole risk shall be borne by the operator.

Explosion protection

The frequency inverter is an IP 20 ingress protection rating device. For this reason, use of the device in explosive atmospheres is not permitted.

2.4 Residual risks

Residual risks are special hazards involved in handling of the frequency inverter which cannot be eliminated despite the safety-compliant design of the device. Residual risks are not obviously identifiable and can be a potential source of injury or a health hazard.

Typical residual hazards include:

- Electrical hazard
- Danger of contact with energized components due to a defect, opened covers or enclosures or improper working on electrical equipment.
- Danger of contact with energized components in frequency inverter if no external disconnection device was installed by the operator.

During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed to minimize electrical hazards.

When LEDs and other indicating elements on the frequency inverter go out, this does not necessarily mean that the device is deenergized. Before carrying out any Work at the device where contact with energized parts might be possible, it must be checked in any case, i.e. irrespective of the status of any indicating elements that may be installed, if the device is deenergized.

Charged capacitors in DC link

Sizes 1 through 7 (up to 160 kW): The DC-link may have dangerous voltage levels even up to 3 minutes after shutdown.

Size 7 and 8 (as from 160 kW): The DC-link may have dangerous voltage levels even up to 10 (in some configurations up to 25) minutes after shutdown. The valid waiting period is indicated on the device housing.

Electrostatic charging

Touching electronic components entails the risk of electrostatic discharges.

Thermal hazards

Risk of accidents by hot machine/plant surfaces, e.g. heat sink, transformer, fuse or sine filter.

Danger of equipment falling down/over, e.g. during transport

Center of gravity is not the middle of the electrical cabinet modules.

2.5 Safety and warning signs on frequency inverter

- Comply with all safety instructions and danger information provided on the frequency inverter.
- Safety information and warnings on the frequency inverter must not be removed.

2.6 Warning information and symbols used in the Operating Instructions

2.6.1 Hazard classes

The following hazard identifications and symbols are used to mark particularly important information:

DANGER

Identification of immediate threat holding a **high** risk of death or serious injury if not avoided.

WARNING

Identification of immediate threat holding a **medium** risk of death or serious injury if not avoided.

CAUTION

Identification of immediate threat holding a **low** risk of minor or moderate physical injury if not avoided.

NOTICE

Identification of a threat holding a risk of material damage if not avoided.

2.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hot surfaces
	Danger of crushing		

2.6.3 Prohibition signs

Symbol	Meaning
	No switching; it is forbidden to switch the machine/plant, assembly on

2.6.4 Personal safety equipment

Symbol	Meaning
	Wear body protection
	Wear ear protectors

2.6.5 Recycling

Symbol	Meaning
	Recycling, to avoid waste, collect all materials for reuse

2.6.6 Grounding symbol

Symbol	Meaning
	Ground connection

2.6.7 ESD symbol

Symbol	Meaning
	ESD: Electrostatic Sensitive Devices, i.e. components and assemblies sensitive to electrostatic energy

2.6.8 Information signs

Symbol	Meaning
	Tips and information making using the frequency inverter easier.

2.6.9 Font style in documentation

Example	Font style	Use
1234	bold	Representation of parameter numbers
Parameter	inclined, font: Times New Roman	Representation of parameter names
P.1234	bold	Representation of parameter numbers without name, e.g. in formulas
Q.1234	bold	Representation of source numbers

2.7 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation are accessible to the staff.
- An authorized person must ensure, before using the frequency inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the frequency inverter is used.
- For liquid cooled frequency inverters, comply with the cooling water guideline VGB-R 455 P.
- Any additional guidelines and directives that may be required additionally shall be defined by the operator of the machine/plant considering the operating environment.

2.8 Operator's general plant documentation

- In addition to the Operating Instructions, the operator should issue separate internal user manuals for the frequency inverter. The Operating Instructions of the frequency inverter must be included in the Operating Instructions of the whole plant.

2.9 Operator's/operating staff's responsibilities

2.9.1 Selection and qualification of staff

- Any work on the frequency inverter may only be carried out by skilled personnel. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility pertaining to all work on the frequency inverter clearly.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering.
- The operating staff must be trained for the relevant work to be performed.

2.9.2 General work safety

- In addition to the Operating Instructions of the machine/plant, any applicable legal or other regulations relating to accident prevention and environmental protection must be complied with. The staff must be instructed accordingly.
  Such regulations and/or requirements may include, for example, handling of hazardous media and materials or provision/use of personal protective equipment.
- In addition to this Operating Instructions, issue any additional directives that may be required to meet specific operating requirements, including supervision and reporting requirements, e.g. directives relating to work organization, workflow and employed staff.
- Unless approved of expressly by the manufacturer, do not modify the frequency inverter in any way, including addition of attachments or retrofits.
- Only use the frequency inverter if the rated connection and setup values specified by the manufacturer are met.

- Provide appropriate tools as may be required for performing all work on the frequency inverter properly.

2.9.3 Ear protectors

- The frequency inverter produces noise. Due to noise development, frequency inverters should only be installed in normally unstaffed areas.
- Noise emission in operation is < 85 dB(A) in the case of sizes 1 through 7.
- Noise emission in operation is approx. 86 dB(A) in the case of size 8. Ear protectors must be used when staying near the frequency inverter.

2.10 Organizational measures

2.10.1 General

- Train your staff in the handling and use of the frequency inverter and the machine/plant as well as the risks involved.
- Use of any individual parts or components of the frequency inverter in other parts of the operator's machine/plant is prohibited.
- Optional components for the frequency inverter must be used in accordance with their designated use and in compliance with the relevant documentation.

2.10.2 Use in combination with third-party products

- Please note that Bonfiglioli Vectron GmbH will not accept any responsibility for compatibility with third-party products (e.g. motors, cables or filters)..
- In order to enable optimum system compatibility Bonfiglioli Vectron GmbH offers components facilitating commissioning and providing optimum synchronization of the machine/plant parts in operation.
- If you use the frequency inverter in combination with third-party products, you do so at your own risk.

2.10.3 Handling and installation

- Do not commission any damaged or destroyed components.
- Prevent any mechanical overloading of the frequency inverter. Do not bend any components and never change the isolation distances.
- Do not touch any electronic construction elements and contacts. The frequency inverter is equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components will endanger the machine/plant safety and shall be considered as non-compliance with the applicable standards.
- Only install the frequency inverter in a suitable operating environment. The frequency inverter is exclusively designed for installation in industrial environments.
- If seals are removed from the case, this can result in the warranty becoming null and void.

2.10.4 Electrical connections

- The five safety rules must be complied with.
- Never touch live terminals. In sizes 1 through 7, the DC-link may have dangerous voltage levels up to 3 minutes after shutdown. In size 8, the DC-link may have dangerous voltage levels up to 10 (in some configurations up to 25) minutes after shutdown. The valid waiting period is indicated on the device housing.
- When performing any work on/with the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants of the country in which the frequency inverter is used.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
- Only connect the frequency inverter to suitable supply mains. The frequency inverter may be operated in TN, TT and IT grid types. Precautions must be taken for operation in IT grids, see Chapter 7 "Electrical installation". Operation in a corner-grounded TN grid shall not be permissible.

2.10.4.1 The five safety rules

When working on/in electrical plants, always follow the five safety rules:

- Disconnect
- Secure to prevent restarting
- check for absence of voltage,
- carry out earthing and short-circuiting
- cover or shield neighboring live parts

2.10.5 Safe operation

- During operation of the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to the applicable national and international safety directives.
- During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed. During operation, never open the machine/plant.
- No connection work shall be carried out while power supply is on.
- The machine/plant holds high voltage levels during operation, is equipped with rotating parts (fan) and has hot surfaces. Any unauthorized removal of covers, improper use, wrong installation or operation may result in serious injuries or material damage.
- Some components, e.g. the heat sink or braking resistor, may be hot even some time after the machine/plant was shut down. Don't touch any surfaces directly after shutdown. Wear safety gloves where necessary.
- The frequency inverter may hold dangerous voltage levels until the capacitor in the DC link is discharged. After shutdown, make sure that the equipment is deenergized in accordance with the safety rules before starting the work.
- In order to avoid accidents or damage, only skilled personnel and electricians may carry out the work such as installation, commissioning or setup.
- In the case of a defect of terminals and/or cables, immediately disconnect the frequency inverter from mains supply.
- Persons not familiar with the operation of the frequency inverter and children must not have access to the device.
- Do not bypass nor decommission any protective devices.
- The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.
- After a failure and restoration of the power supply, the motor may start unexpectedly if the AutoStart function is activated.
  If staff are endangered, a restart of the motor must be prevented by means of external circuitry.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable the safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.6 Maintenance and service/troubleshooting

- Visually inspect the frequency inverter when carrying out the required maintenance work and inspections at the machine/plant.
- Perform the maintenance work and inspections prescribed for the machine carefully, including the specifications on parts/equipment replacement.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering. Only use original spare parts.
- Unauthorized opening and improper interventions in the machine/plant can lead to personal injury or material damage. Any repair work may only be carried out by the manufacturer or persons approved/licensed by the manufacturer. Any repair work must be carried out by qualified electricians. Check protective equipment regularly.
- Before performing any maintenance work, the machine/plant must be disconnected from mains supply and secured against restarting. The five safety rules must be complied with.

2.10.7 Final decommissioning

Unless separate return or disposal agreements were made, recycle the disassembled frequency inverter components:

- Scrap metal materials
- Recycle plastic elements
- Sort and dispose of other component materials

Electric scrap, electronic components, lubricants and other utility materials must be treated as special waste and may only be disposed of by specialized companies.

In any case, comply with any applicable national disposal regulations as regards environmentally compatible disposal of the frequency inverter. For more details, contact the competent local authorities.

2.11 Safety Instructions on Function "Safe Torque Off" (STO)

The function „Safe Torque Off" (STO) is a functional safety feature, i.e. it protects staff from damage, provided that projecting, installation and operation are performed properly. This function does not disconnect the plant from power supply.

In order to disconnect the plant from power supply (e.g. for maintenance work), an "Emergency Stop" provision as per EN 60204 must be installed.

WARNING

Uncontrolled Starting

Improper installation of the safety circuitry may result in uncontrolled starting of the drive. This may cause death, serious injuries and significant material damage.

- Safety functions may only be installed and commissioned by skilled personnel.

The STO function is not suitable for emergency stop as per EN 60204. An emergency stop can be realized by installing a mains contactor.

An emergency stop according to EN 60204 must be functioning in all operation modes of the frequency inverter. Resetting of an emergency stop must not result in uncontrolled starting of the drive.

The drive is started again when the function STO is no longer required. In order to comply with EN 60204, it must be ensured by taking external measures that the drive does not start without prior confirmation.

Without a mechanical brake, the drive will not stop immediately but coast to a standstill. If this may result in personal or material damage, additional safety measures must be taken.

- If persons may be endangered after disconnection of the motor power supply by STO, access to the hazard areas must be prevented until the drive has stopped.
- Check the safety function at regular intervals according to the results of your risk analysis. Bonfiglioli Vectron GmbH recommends that the check be performed after one year, at the latest.

The STO function is fail-safe for one fault. However, on rare occasions, the occurrence of component defects may cause jerking of the motor shaft (max. 180°/pole pair, e. g. jerk by 90° with 4-pole motor, 180°/2).

- Check if this causes a dangerous movement of the machine.
- If the STO function is used, the special safety, installation and instructions on use instructions shall be complied with.

WARNING

Dangerous voltage!

The safety function "Safe Torque Off" may only be used if mechanical work is to be performed on the driven machines, not for work on live components.

After disconnection of an external DC 24 V power supply, the DC link of the frequency inverter is still connected to mains supply.

Even if power supply to the motor is disconnected, and the motor is coasting to a standstill or has already stopped, high voltages may still be present on the motor terminals.

Before working (e. g. maintenance) on live parts, the plant must always be disconnected from mains supply (main switch). This must be documented on the plant.

When the function "Safe Torque Off" is triggered, the motor is not isolated from the DC link of the frequency inverter. High voltage levels may be present at the motor.

- Do not touch live terminals.

The application manual "Safe Torque Off STO" must be complied with, particularly if the safety function described there is used.

3 Technical data

The technical data of the operating instructions refer to the reference operation point of the frequency inverter. The reference point of the frequency inverter is defined at the admissible mains voltage and at switching frequency of 2 kHz. This reference point is to be checked according to the requirements and redefined for the operating points of the application if needed.

3.1 Requirements

The functionality in the software configurations 160, 260 and 460 described in this application manual presupposes a distinct subset of the frequency inverters. The criteria for the design of the frequency inverter relevant for the applications are listed below.

Overload reserve

In these applications, in particular with high-quality hoist application, the frequency inverter is required to provide an increased overload reserve. The matching overload for 60 seconds are described in the corresponding operating instructions document.

Holding moment

The shifting between the raising and lowering operation must be done without the holding brake, with a low lowering speed required for the positioning. In addition, an increased holding moment is necessary in order to vent (open) and close the brake free of wear and tear. In the design of the drive system, the available reference current of the frequency inverter at a standstill (rotary frequency zero) must be taken into account.

Brake resistor

The generator operating point (braking operation) occurring in the applications in which energy flows back into the frequency inverter leads to an increasing of the DC link voltage. In order to limit the direct voltage, the frequency inverter adds an external brake resistor via the brake chopper transistor from a certain adjustable threshold value. The chopper transistor converts the excess energy into heat. The brake chopper transistor in the frequency inverter and the external resistor must be dimensioned according to the expected braking energy.

Absolute value sensor or incremental speed sensor

The software configurations described in the application manual differ in the controller structure and the resultant operational behavior. According to the requirements, sensor-less control (configuration 110), sensor-less field-oriented control (configuration 410) or field-oriented control with speed sensor (configuration 210) can be selected. Thanks to the modular hardware and software, the frequency inverters enable connection of the customary absolute value sensor or incremental speed sensors.

The present documentation was prepared with great care and it was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you face specific problems insufficiently addressed in the documentation, contact your local BONFIGLIOLI agent.

3.2 Control inputs and outputs

The control interfaces configuration described below applies to software configurations 160, 460 and 260, as well as 862.

4 Commissioning of the frequency inverter

4.1 Switch mains voltage on

WARNING

Danger from suspended loads

During guided commissioning the inverter may activate the crane/hoist. This can result in risk from suspended loads.

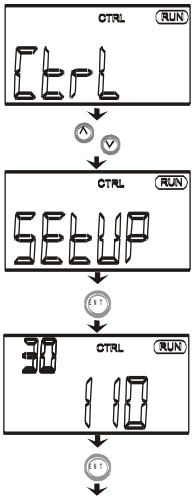
- Check the functionality of the extended brake control and the connection of the holding brake to the control terminals of the frequency inverter at the start of the commissioning. Execute the guided commissioning with the holding brake closed.

After completion of the installation work, make sure to check all control and power connections again before switching on the mains voltage. When all electrical connections are correct, make sure that the frequency inverter is not enabled (control inputs S1IND/STOA and S7IND/STOB open). After power-up, the frequency inverter carries out a self-test and the relay output (X10) reports "Fault".
After a few seconds, the self-test is complete, the relay (X10) picks up and signals "no fault ".
If the unit is in "as-delivered" condition or after resetting the unit to the Default settings, the guided commissioning procedure is started automatically. On the control unit, the "SetUP" menu from the menu branch CTRL is displayed.

4.2 Setup Using the Control Unit

The guided commissioning of the frequency inverter determines all parameter settings relevant to the required application. The available parameters were selected based on known standard drive applications. This facilitates the selection of the important parameters. After successful completion of the SETUP routine, the actual value *Actual Frequency* **241** from the VAL menu branch is displayed on the control unit. Now, the user should check whether further parameters are relevant for the application.

The guided commissioning contains the function for parameter identification. The parameters are determined by way of measurement and set accordingly. Guided commissioning must be carried out when the machine is cold, since a part of the machine data depends on the operating temperature.



When the unit is in "as-delivered" condition, the guided commissioning procedure is started automatically. After successful commissioning, the guided commissioning can be carried out again later via the sub-menu CTRL.

- Use the ENT key to switch to the CTRL sub-menu.
- In the CTRL sub-menu, select the menu item "SetUP" and confirm by pressing the ENT key.
- Use the ENT button to select parameter *Configuration* **30.**

The available configurations are displayed automatically depending on the selected *Control Level* **28**.

- Use the arrow keys to enter the number of the required configuration. (for a description of the configurations, refer to the following chapter)
  If the setup was changed, the hardware and software functionality will be configured. The message "SEtUP" is displayed again.
- Confirm this message by pressing the ENT key in order to continue the commissioning procedure.
- Switch to the next parameter.
- After initialization, confirm the selected configuration by pressing the ENT key.
- Continue the guided commissioning procedure according to the following chapters.

4.3 Configuration

Configuration **30** determines the assignment and basic function of the control inputs and outputs as well as the software functions. The software of the frequency inverter offers several configuration options. These differ with respect to the way in which the drive is controlled. Analog and digital inputs can be combined and complemented by optional communication protocols as further reference value sources. The Operating Instructions document describes the configurations and relevant parameters on the third *Control Level* **28** (Set parameter *Control Level* **28** to value `3`).

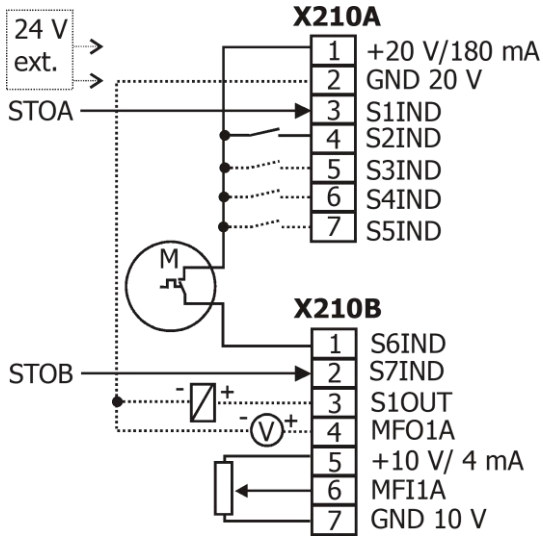
4.4 Setup with the control unit

The guided commissioning of the frequency inverter is described in the operating instructions among others for the configurations `110`, `210` and `410`. According to the operating instructions, the guided commissioning must be done while observing the safety information and further directives.

The guided commissioning contains the function for parameter identification. The parameters are determined by way of measurement and set accordingly. Guided commissioning must be carried out when the machine is cold, since a part of the machine data depends on the operating temperature.

4.4.1 Config 110 – Sensorless Control

Configuration 110 contains the functions for variable-speed control of a 3-phase machine in a wide range of standard applications. The motor speed is set according to the selected ratio of the reference frequency to the necessary voltage.



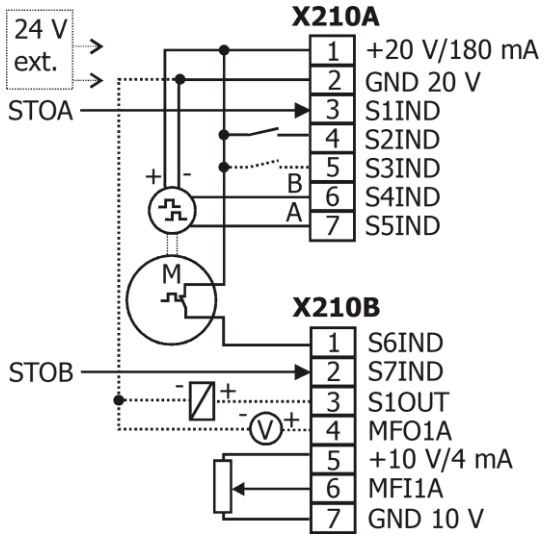
Control terminal X210A	
X210A.1	Voltage output +20 V or input for external power supply DC 24 V ±10%
X210A.2	GND 20 V/ GND 24 V (ext.)
X210A.3	Digital input STOA (1. shut-down path of STO safety function)
X210A.4	Start of clockwise operation
X210A.5	Start of anticlockwise operation
X210A.6	Data Set Change-Over 1
X210A.7	Data Set Change-Over 2

Control terminal X210B	
X210B.1	Motor therm. contact
X210B.2	Digital input STOA (2nd shut-down path of STO safety function)
X210B.3	Run Signal
X210B.4	Analog signal of actual frequency
X210B.5	Supply voltage +10 V for reference value potentiometer
X210B.6	Reference speed 0 ...+10 V
X210B.7	Ground 10 V

4.4.2 Config 210 – FOC, Speed Controlled

Control methods 2xx can be used with **HTL** encoders (with or without reference pulse) at basic device or an extension module.
In order to use control methods 2xx with **TTL** encoders, an extension module is required. An extension module EM-ABS for signal evaluation is required for operation with absolute encoders (Hiperface, EnDat2.1, SSI).

Configuration 210 contains the functions for speed-controlled, field-oriented control of a 3-phase machine with speed sensor feedback. The necessary speed sensor feedback results in a precise speed and torque performance.

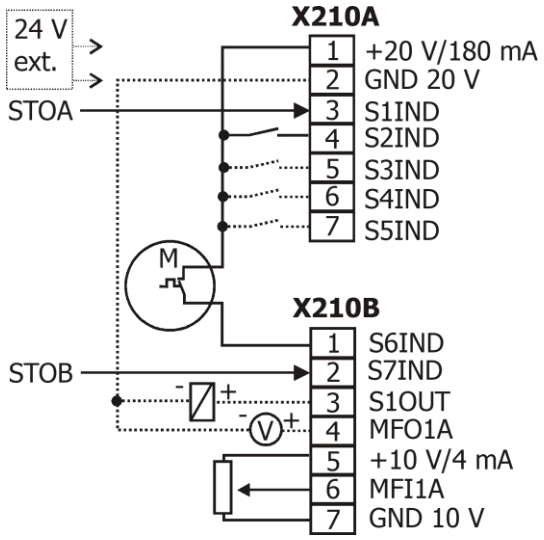


Control terminal X210A	
X210A.1	Voltage output +20 V or input for external power supply DC 24 V ±10%
X210A.2	GND 20 V/ GND 24 V (ext.)
X210A.3	Digital input **STOA** (1st shut-down path of STO safety function)
X210A.4	Start of clockwise operation
X210A.5	Start of anticlockwise operation
X210A.6	Speed sensor track B
X210A.7	Speed sensor track A

Control terminal X210B	
X210B.1	Motor therm. contact
X210B.2	Digital input **STOB** (2nd shut-down path of STO safety function)
X210B.3	Run Signal
X210B.4	Analog signal of actual frequency
X210B.5	Supply voltage +10 V for reference value potentiometer
X210B.6	Reference speed 0 ...+10V
X210B.7	Ground 10 V

4.4.3 Config 410 – Sensorless FOC

Configuration 410 contains the functions for sensorless, field-oriented control of an asynchronous machine. The current motor speed is determined from the present currents and voltages in combination with the machine parameters. Separate control of torque and flux-forming current enables a high drive dynamism at a high load moment.

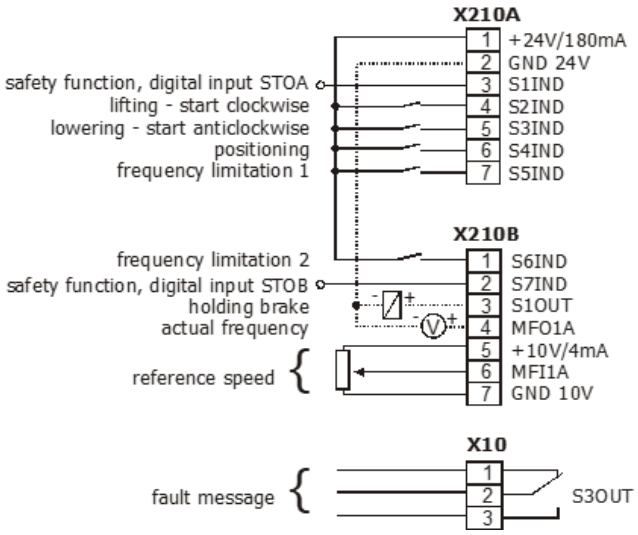


Control terminal X210A	
X210A.1	Voltage output +20 V or input for external power supply DC 24 V ±10%
X210A.2	GND 20 V/ GND 24 V (ext.)
X210A.3	Digital input **STOA** (1st shut-down path of STO safety function)
X210A.4	Start of clockwise operation
X210A.5	Start of anticlockwise operation
X210A.6	Data Set Change-Over 1
X210A.7	Data Set Change-Over 2

Control terminal X210B	
X210B.1	Motor therm. contact
X210B.2	Digital input **STOB** (2nd shut-down path of STO safety function)
X210B.3	Run Signal
X210B.4	Analog signal of actual frequency
X210B.5	Supply voltage +10 V for reference value potentiometer
X210B.6	Reference speed 0 ...+10 V
X210B.7	Ground 10 V

4.4.4 Config x60

The configurations 160, 260 and 460 extend the control functions of configurations 110, 210, 410.



The connection diagram describes the standard configuration of the control terminals. Adapt the connections as required in your application.
The control signals at the terminals X210A.6 and X210A.7 in the above connection diagram are linked with the software module for speed sensor evaluation in the configuration `260`.

4.4.5 Config 862

The configuration `862` extends the functions of configuration `260` by slewing application functions.
See chapter 8 for details.

5 Activation of holding brake

DANGER

Danger from suspended loads

Whenever a dysfunction of the brake control can lead to major damage, in particular injury or even death, a second independent device for engaging the brake must be implemented. It cannot be ruled out that, by damage to the frequency inverter, the brake is released although the frequency inverter has been switched off.

- Always install a redundant brake control device.

In some applications, for example hoist application, elevators or for some machine tools, activation of a holding brake demands an extended functionality for wear-free control of the brake.
In addition, some applications demand, according to directives, that the motor is electrically separated from the frequency inverter by a safety contactor at a standstill. These function modules of the software are activated by the configurations `160`, `260` or `460`, `560` and `862` to extend the control functions of configurations `110`, `210`, `410` and `510`.
The order of events during the start or stop process can be set with the help of the parameters described in the following chapters.

5.1 Digital outputs

NOTICE

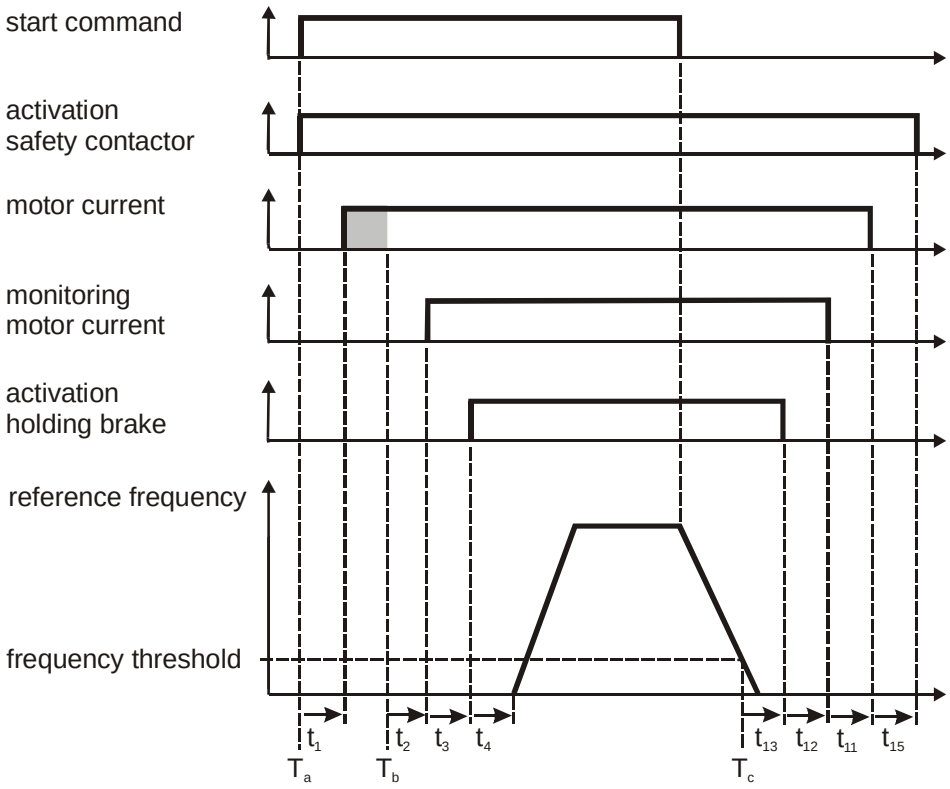
For safety reasons, the **inverted Operation mode** `141` is not available. In this operation mode, the brake is not released with the digital output active. For example, this would also be the case with a voltage-free frequency inverter or during the initialization phase.

The function "Brake open" in the operating modes `40` and `140` of the digital outputs enables activation of a corresponding unit via the digital control outputs. The function uses not only the control commands via the contact inputs but also the set starting and stopping behavior to control the parameterized digital output. These operating modes of the digital outputs are replaced by the Operation mode `41` for the extended brake control in configurations `160`, `260` and `460`.
The function for the activation of the safety switch is to be assigned to one of the digital control outputs with Operation mode `42`.

Operation mode	Function
41 - Brake open	The digital output becomes active (an open contact closes) when the brake is released.
42 - Safety contactor	The digital output becomes active when the frequency inverter is connected to the motor (safety contactor on).

5.2 Sequence control

The logic signals to start and stop the drive can be specified by various sources. The illustration shows the order of events during starting and stopping the drive with the time constants to be configured and the monitoring functionality to activate the safety switch and the holding brake.



Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
800	Time t1 – start of the current impression into the motor	0.0 s	200.0 s	0.0 s
801	Time t2 – start of the motor current monitoring	0.0 s	200.0 s	0.0 s
802	Time t3 – control signal to open the holding brake	0.0 s	200.0 s	0.0 s
803	Time t4 – acceleration of the drive	0.0 s	200.0 s	0.0 s
804	Time t11 – blocking the output signals	0.0 s	200.0 s	0.0 s
805	Time t12 – end of the current monitoring	0.0 s	200.0 s	0.0 s
806	Time t13 – control signal to close the holding brake	0.0 s	200.0 s	0.0 s
807	Time t15 – control signal to open the safety switch	0.0 s	200.0 s	0.0 s

The monitoring of the operation points to activate the holding brake and the safety switch can be set via trigger limits, the lower limit for the motor current monitoring with the *Monitoring current* **808** and the standstill detection with the *Frequency threshold* **809**. The setting is relative to the rated values of the motor and is to be selected by the set *Configuration* **30**.

5.2.1 Current monitoring

The monitoring of the motor current supplements the functionality for the activation of a holding brake. Applications demanding a holding brake accelerate the motor by the specific load behavior when the brake is opened.

The asynchronous motor must be supplied with sufficient current in all operation points in order to provide the necessary torque to avoid damage to property and persons. Possible reasons for a lack of torque on the motor shaft can be a defective motor, a lack of or incorrect motor connection, a defect in the frequency inverter or wrong parameterization. This is why the output current is monitored. If the absolute value of the output current drops below the set threshold *Monitoring current* **808**, the fault "F1310 minimum current monitoring" is triggered. In the event of a fault, the holding brake is closed and the safety switch opened by the frequency inverter or an external monitoring.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
808	Monitoring current	0.0 A	o·I_{FIN}	0.2 · I_R

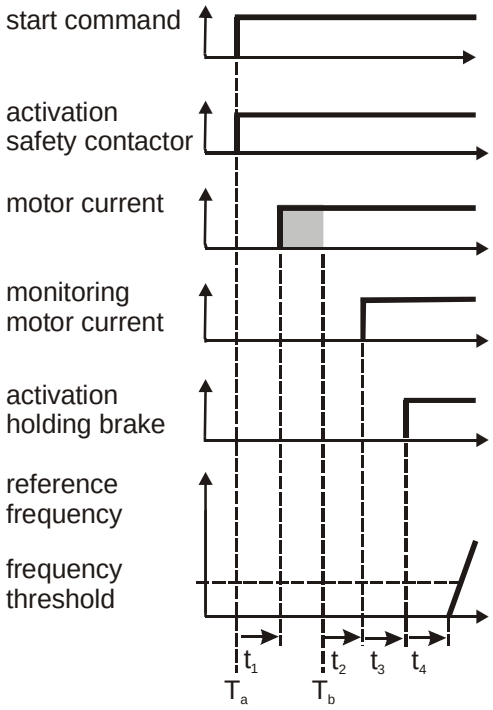
5.2.2 Frequency monitoring

The output frequency of the frequency inverter and the rotary frequency of the motor shaft vary as a function of the load point. The selected control functions and methods contain an estimate of the load point and thus the slip speed or a precise measurement thanks to a speed sensor feedback. The standstill of the drive can thus be determined precisely or also only estimated.
Reliable activation of the holding brake thus demands a *Frequency threshold* **809** relative to the *Maximum frequency* **419**, from which the time t_{13} for the closing of the holding brake is measured.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
809	*Frequency threshold*	0.0 %	100.0%	1.0 %

5.2.3 Starting the drive

The order of events until the actual start of the drive can be parameterized via various time constants.



The inverter receives the start command via digital input or serial bus.
With the start command (time T_a) the safety contactor is switched without delay.
After *Time t1* **800** the magnetizing of the motor starts. If a safety contactor is used, this time must be set longer than its reaction time.
After the end of the magnetizing (time T_b) and the expiry of *Time t2* **801** the current monitoring is activated.
After *Time t3* **802** the signal for the release of the brake becomes active.
After *Time t4* **803** the drive starts. The reference speed is increased with the set ramp gradient. This time should be set to the reaction time when releasing the mechanical brake.

5.2.4 Stopping the drive

Stopping the drive down to standstill of the drive can be parameterized via various time constants. The parameterized *Stopping behavior* **630** as a function of the digital signals Start clockwise **STR** and Start Anti-clockwise **STL** is to be observed.

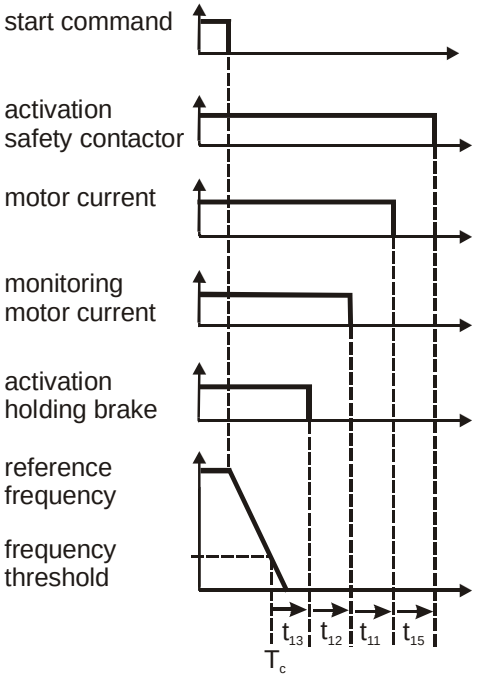
If the internal reference frequency (output of the ramp function) is smaller than the *Frequency threshold* **809** (time Tc), the sequence of the shutdown function starts. The percentage is set relative to *Maximum frequency* **419**.

After *Time t13* **806** the signal of the holding brake is deactivated. To reduce wear and tear, this time should be set in such a way that the drive is at a standstill before the brake closes.
If the signal is to be deactivated when the drive is still rotating, this time is to be set to zero and the *Frequency threshold* **809** increased if need be. A long reaction time of the mechanical brake in closing can thus be compensated.

After *Time t12* **805** the current monitoring is deactivated. This time constant should be at least equal to the reaction time of the mechanical brake in closing.

After *Time t11* **804** the power parts of the frequency inverter are blocked. The current in the motor goes to zero.

After *Time t15* **807** the signal to close the safety switch is deactivated. As the deceleration time of a relay is normally distinctly longer than the time needed for the current reduction, this time can remain at the figure zero (Default setting) in most cases.

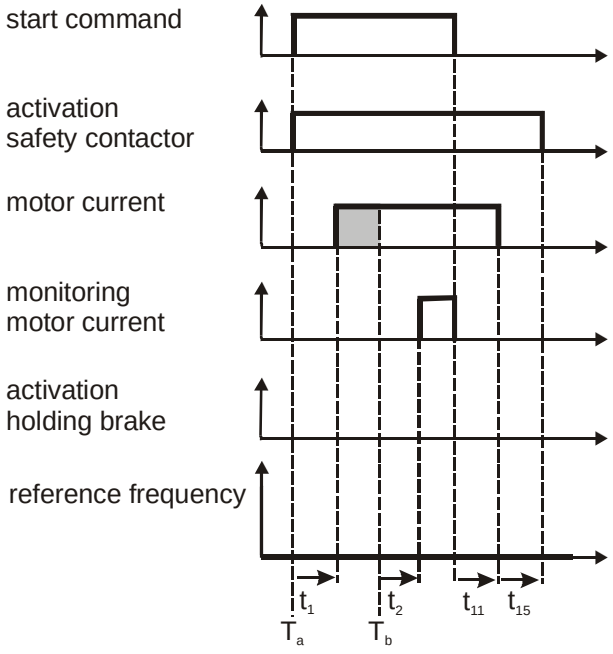


5.2.5 Interrupting the start or stop process

If the start command is deactivated again before the start sequence has been completed, the last step of the start sequence is canceled again immediately. After this, the sequence for stopping commences, starting with this condition.

Example:

If the start command is deactivated (current monitoring is active, waiting for the release of the brake) during the expiry of time t_3, the minimum current monitoring is deactivated straight away. After expiry of time t_{11} the power parts are blocked.
If a new start command is given before the sequence for stopping has ended, the last step of the sequence is canceled immediately. The described start sequence then commences, starting with this condition.



5.2.6 Occurrence of a malfunction

If the frequency inverter switches off due to a malfunction, the signals to release the brake and close the safety switch are deactivated immediately. After acknowledgment of the malfunction, the drive can be started again. The same steps take place as in the start process.

6 Load detection for hoist application and luffing jib cranes

The present documentation supplements the operating instructions for applications with an extended activation of a holding brake and the function for automatic load detection in hoist application and luffing jib cranes.
The application manual documents the additional functionality of the frequency inverters in the software configurations `260` and `460`. These configurations supplement the configurations `110`, `210` and `410`, which you can find details on in the operating instructions.

6.1 Load detection for hoist application

The function for load detection for hoist application is activated by the parameter *Operation mode LE* **822**. In the Default setting, the Load Estimate (LE) operating mode is set to zero, i.e. switched off. To activate the load detection for hoist application, operation mode `1` or `3` must be selected.

Operation mode		Function
1 -	Stat. Load estimate hoist application	The permitted maximum frequency will be adjusted by the detected load and the *I Limit Up* **818** and *I Limit Down* **824**. The current after the acceleration will be observed.
2 -	Stat. Load Estim. Special crane	Like 1 to start with. Then modification of the permitted maximum frequency, with the result that the adjustable maximum torque-forming reference currents of the parameters **819, 820** and **821** are complied with.
3 -	Dyn. Load estimate hoist application	The permitted maximum frequency will be adjusted by the detected load and the *I Limit Up* **818** and *I Limit Down* **824.** The current during the acceleration will be observed.
4 -	Dyn. Load Estim. Special crane	Like 3 to start with. Then modification of the permitted maximum frequency, with the result that the adjustable maximum torque-forming reference currents of the parameters **819, 820** and **821** are complied with.

For the load estimate, the *Mechanical time constant* **811** and the system constant *Turns per meter* **812** must be known. With the help of these parameter figures, the load estimate calculates the load in the lifting application during the acceleration. It is related to the rated torque of the machine and displayed by the actual figure *Estimated load* **243**.
In the basic speed area, the current load or torque relative to the rated torque is additionally displayed with the actual figure *Load* **242**. The permitted maximum speed is determined from the estimated load. The maximum speed can be scaled via three parameters.

- Parameter *I Limit Up* **818** and *I Limit Down* **824**.
  Current with which the load detection calculates the permitted maximum speed.
- Parameter *Pull-out torque at Fmax* **816**
  The pull-out torque relative to the rated torque of the asynchronous machine admissible at the maximum frequency.

6.1.1 Mechanical time constant

The *mechanical time constant* **811** is the time, which the drive needs to accelerate from a standstill to rated speed with rated current.
Neglecting the friction,

$$T = J \cdot \frac{d\omega}{dt}$$

T is the rated torque of the machine, J the entire mass moment of inertia of the drive.

$$dt = J \cdot \frac{d\omega}{T}$$

$$\frac{n}{60} \cdot 2 \cdot \pi = \omega$$

n is the no load speed of the machine, thus resulting in the mechanical time constant t_m:

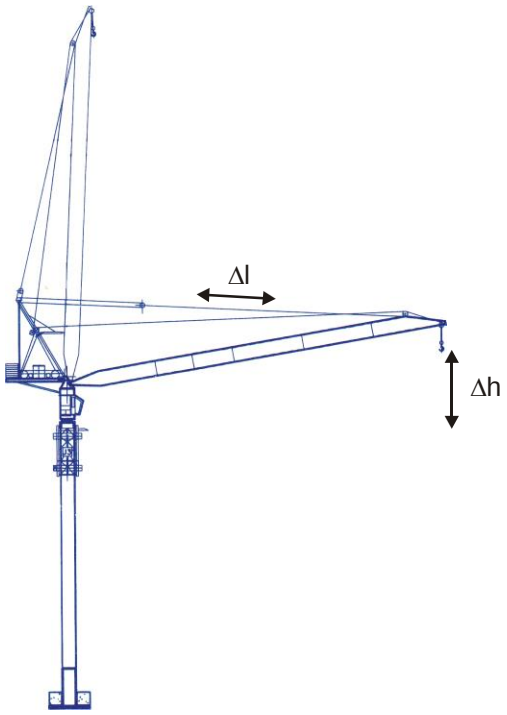
$$t_m = \frac{J \cdot n \cdot 2 \cdot \pi}{T \cdot 60}$$

If the entire mass moment of inertia J is not known exactly, the mechanical time constant t_m can also be determined by an acceleration test. For this, the plant constant *Turns per meter* **812** must be set first. After this, the lifting application is to be run without load at a constant speed (half the rated speed of the machine) (clockwise, lifting).
The actual value *Load* **242** is noted.
Now, the lifting application is accelerated from standstill with the *Acceleration (clockwise)* **420** required in operation to a speed above the rated speed of the machine (clockwise, lifting). Now, the actual value *Estimated load* **243** is evaluated.
If the value displayed for the estimated load is larger than the figure established before, the parameter value *mechanical time constant* **811** must be increased. In the opposite case, this figure must be reduced.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
811	*Mech. time constant*	0.000 s	65.000 s	0.190 s

6.1.2 Turns per meter

The number of mechanical turns of the motor per meter of lifting (Δh) must be input in lifting applications via the parameter *Turns/m* **812**.
For load estimation in a luffing jib crane, the number of mechanical turns of the motor for the alteration of length (Δl) of one meter of rope for the luffing jib must be input. In this, the step-down of the pulley must also be taken into account.



Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
812	*Turns/m*	0.01 U/m	650.00 U/m	20.00 U/m

6.1.3 Load estimate

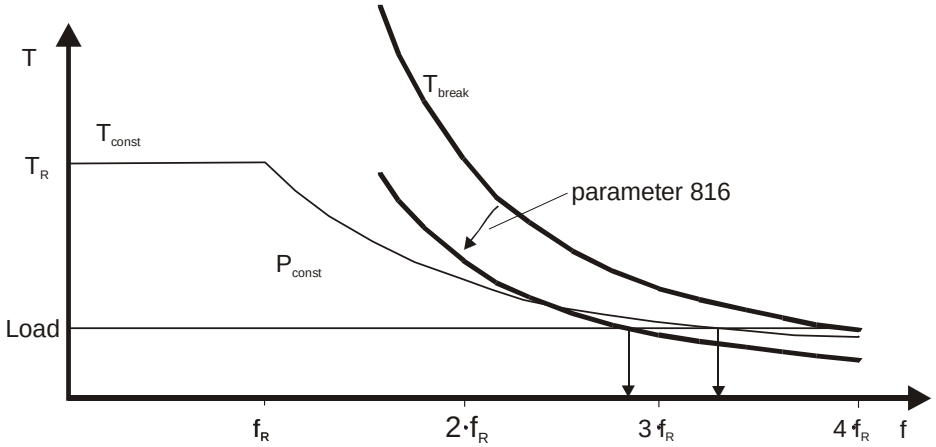
The load estimate is done in the basic speed area. In order to avoid faults at a standstill and very low speeds, the load estimate is only done above a rotary frequency limit, which can be set with the parameter *Fm lower value LE* **813**. The value is input in per cent and is relative to the rated frequency of the machine.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
813	*Fm lower value LE*	0 %	100 %	10 %

The load estimate starts above the rotary frequency given by the parameter Fm lower value LS 813. The maximum time of the load estimate can be set with the parameter *Max Time LE* **815**. If the set time expires or if the basic speed area is left, the determined value of *Load* **243** is displayed. From it, the maximum admissible speed is calculated.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
815	*Max time LE*	0.001 s	65.000 s	2.000 s

With a constant stator current, the torque of the asynchronous machine is constant in the basic speed area. Above it, it drops at 1/x, the output power remains constant. The pull-out torque (T_{break}) drops by $1/x^2$ in the field-weakening area. With the required stator current (Parameter *I Limit Up* **818** or *I Limit Down* **824**) the permitted rotary frequency is calculated from the P_{const} characteristic. In addition, the limitation of the maximum speed can be done with the pull-out torque, for which purpose a percentage relative to the rated torque is entered in parameter *Pull-out torque at Fmax* **816**, this torque being permitted at the *Maximum Frequency* **419**.
The permitted maximum speed is calculated in such a way that the characteristic given by the Parameter *Pull-out torque at Fmax* **816** is not exceeded.

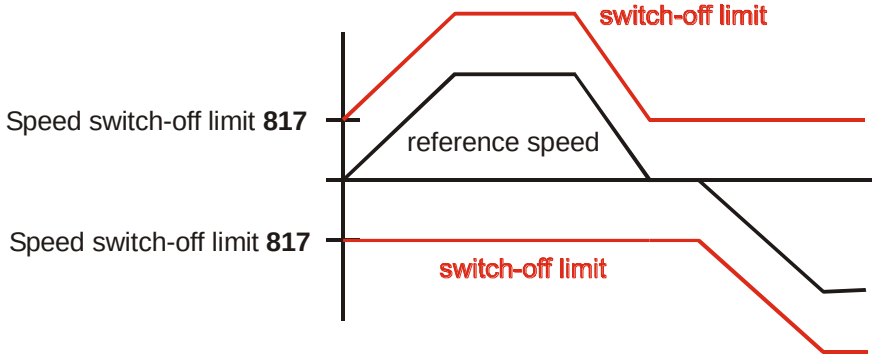


Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
816	*Pull-out torque at Fmax*	0 %	100 %	100 %

If the parameter *Operation mode LE* **822** is set to 1 or 2, the stationary end figure at the maximum frequency then allowed is used for the calculation.
If the parameter *Operation mode LE* **822** is set to 3 or 4, the additional torque for the acceleration is taken into account. As the deceleration is regarded as being particularly critical, the set *Deceleration Anti-clockwise* **423** is evaluated here.

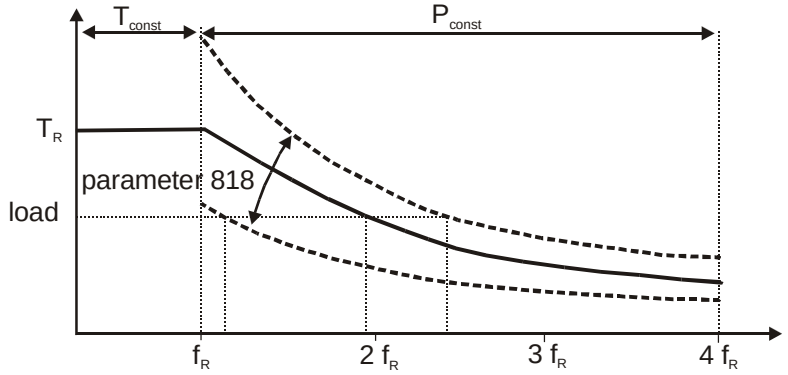
6.2 Speed switch-off limit

As an additional security element in the lowering of a load, a further monitoring has been implemented. The reference value of the speed is compared with the actual value of the speed. If the absolute value of the speed is larger than the actual speed by the value entered in the parameter *Speed switch-off limit* **817**, the fault "F1110 overspeed" is triggered.
If the direction of rotation deviates from the nominal direction, the fault is output as soon as the absolute value of the speed exceeds the adjustable threshold.



Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
817	*Speed switch-off limit*	0.00 Hz	599.00 Hz	10.00 Hz

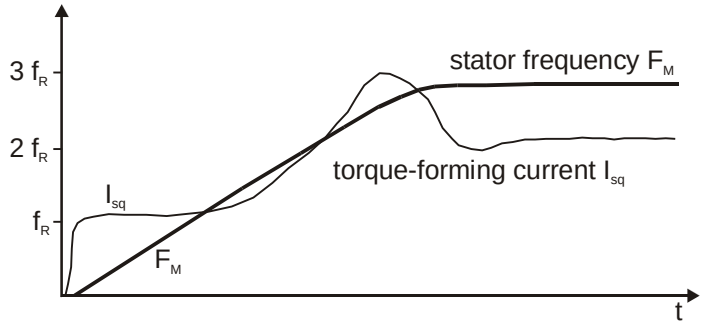
With the I limit parameter, the maximum permitted speed at the detected load is scaled.
If the value of the parameter *I Limit Up* **818** is increased, a larger maximum speed is permitted at the same load for the clockwise motor rotation.
If *I Limit Up* **818** is reduced, the maximum speed is reduced accordingly for the clockwise motor rotation. As a minimum, the rated speed is permitted.
The same applies for the parameter *I limit down* **824** for the counterclockwise rotation.



Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
818	*I limit up* (clockwise)	0.01 · I_{FIN}	3 · o · I_{FIN}	I_{FIN}
824	*I limit down* (counterclockwise)	0.01 · I_{FIN}	3 · o · I_{FIN}	I_{FIN}

If the parameter *Operation mode LE* **822** has been set to 1 or 2, the limit is the effective value of the stator current which sets after the acceleration at the permitted maximum speed.

The torque-forming current available in the acceleration phase is a function of the rated current and the torque of the asynchronous machine resulting from it.



If the parameter *Operation mode LE* **822** is set to 3 or 4, the additional current for the acceleration is taken into account. In this, the limit current is the effective value of the stator current which can be set for a short time during the set maximum acceleration. As the deceleration is regarded as being particularly critical, the set *Deceleration Anti-clockwise* **423** is taken into account here.

6.3 Load detection for luffing jib cranes

The function load detection for luffing jib cranes is activated by the parameter *Operation mode LE* **822**. In the Default setting, the *Load Estimate (LE)* operating mode is set to zero, i.e. switched off. To activate the load detection for luffing jib cranes, operation mode 2 or 4 must be selected.

Operation mode		Function
1 -	Stat. Load estimate hoist application	The permitted maximum frequency will be adjusted by the detected load and the *I Limit Up* **818** and *I Limit Down* **824**. The current after the acceleration will be observed.
2 -	Stat. Load Estim. Special crane	Like 1 to start with. Then modification of the permitted maximum frequency, with the result that the adjustable maximum torque-forming reference currents of the parameters **819, 820** and **821** are complied with.
3 -	Dyn. Load estimate hoist application	The permitted maximum frequency will be adjusted by the detected load and the *I Limit Up* **818** and *I Limit Down* **824.** The current during the acceleration will be observed.

4 -	Dyn. Load Estim. Special crane	Like 3 to start with. Then modification of the permitted maximum frequency, with the result that the adjustable maximum torque-forming reference currents of the parameters **819, 820** and **821** are complied with.

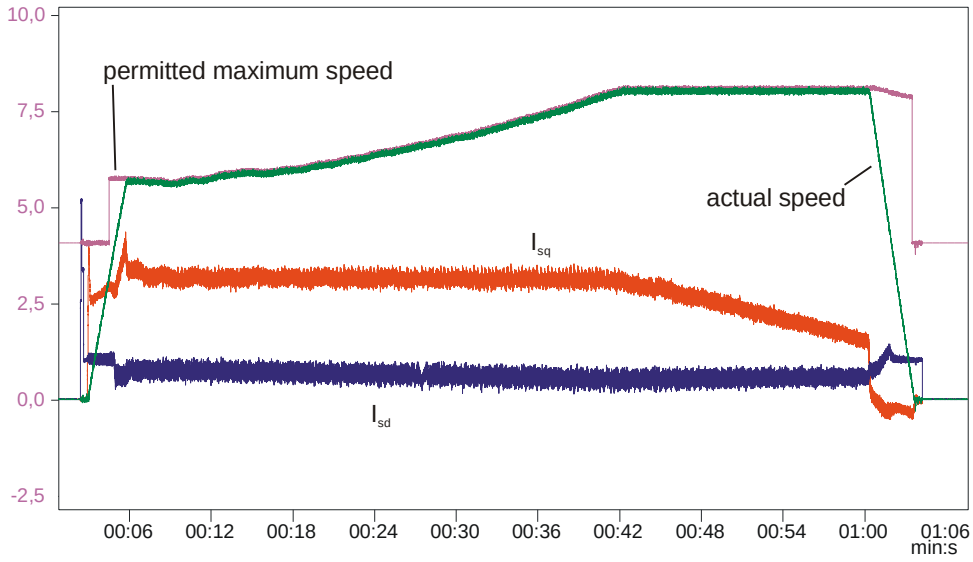
For the load estimate, the *Mechanical time constant* **811** and the system constant *Turns per meter* **812** must be known. With the help of these parameter figures, the load estimate calculates the sum of the loads in the lifting application (load of the luffing jib and load on the hook) during the acceleration. They are related to the rated torque of the machine and displayed as a percentage by the actual value *Load Estimate* **243**.
In the basic speed area, the current load and the torque relative to the rated torque are additionally displayed by the actual figure *Load* **242**. The permitted maximum speed is determined from the *estimated load*.
The maximum speed can be scaled via three parameters.

- Parameter *I Limit Up* **818** and *I Limit Down* **824**
  Current with which the load detection calculates the permitted maximum speed.
- Parameter *Pull-out torque at Fmax* **816**
  The pull-out torque relative to the rated torque of the asynchronous machine admissible at the maximum frequency.

After this, the permitted maximum speed is modified as a function of the position of the luffing jib.
The parameters *Mech. time constant* **811**, *Turns/m* **812**, *Fm lower value LE* **813**, *Max time LE* **815**, *Pull-out torque at Fmax* **816**, *Speed switch-off limit* **817** or *I Limit Up* **818** and *I Limit Down* **824** are parameterized in a way comparable with the described settings for the load detection for the hoist application.
In a crane with a luffing jib, the torque acting on the motor changes with the angle of the luffing jib. In order not to overload the motor in the field weakening area, the maximum permitted speed of the motor must therefore be adapted as a function of the angle of the luffing jib.
These settings for the luffing jib are to be done via the parameters described below: *Desired Isq up* **819**, *Desired Isq down at FsR* **820** and *Desired Isq down at Fmax* **821**.

6.3.1 Torque-forming current Isq

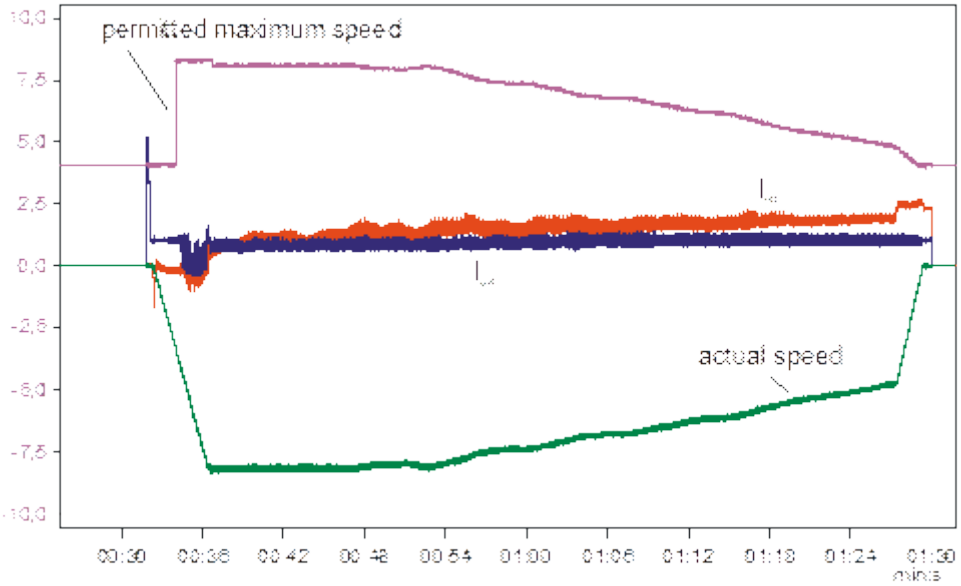
The maximum permitted speed during the lifting of the luffing jib is changed in such a way that the torque-forming current I_{sq} corresponds to the figure set with parameter *Desired Isq up* **819** in the field weakening area. The permitted maximum speed is a function of the angle of the luffing jib.



The rise of the torque-forming current I_{sq} at the 6 s point in time is needed for the acceleration.
If the value *Desired Isq up* **819** is increased, the absolute current value and the maximum permitted speed for the lifting of the luffing jib increase. If the value *Desired Isq up* **819** is reduced, both are reduced accordingly.
The effective value of the current is composed of the vector addition of *Isq* and *Isd*. If the effective value of the current is to be equal to the rated current during the lifting in stationary operation, the value in parameter **819** must be input some percent smaller than the rated current.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
819	*Desired Isq up*	0.01 · I_{FIN}	o · I_{FIN}	0.8 · I_{FIN}

During the lowering of the luffing jib, the machine works as a generator. Thanks to the properties of the machine, the frequency inverter and the mechanics, the effective value of the current is distinctly lower than in lifting, in particular in the field weakening area, with the same speed and load. If the speed is additionally increased, this leads to a further reduction of the current.
Two further parameters, with which the reference value for the torque-forming current Isq is stated in the lowering of the luffing jib arm, have been created for these operation points for the synchronization of the permitted maximum speed.
With the parameter *Desired Isq down at FsR* **820** the current is specified in the operation points with rated frequency.
With the parameter *Desired Isq down at Fmax* **821** the current at the frequency limit set with the parameter *Maximum Frequency* **419** is specified.
The reference value used for the calculation is subjected to linear interpolation within these frequency limits.



The permitted maximum speed is displayed in the above illustration with the negative speed in an anti-clockwise direction.
It can clearly be seen that the torque-forming current increases as the absolute value of the speed decreases.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
820	*Desired Isq down at FsR*	0.01 · I_{FIN}	o · I_{FIN}	0.80 · I_{FIN}
821	*Desired Isq down at Fmax*	0.01 · I_{FIN}	o · I_{FIN}	0.55 · I_{FIN}

6.4 Limitation of the speed by fixed frequencies

The maximum permitted speed can be limited by the parameters

- *Fixed Frequency 1* **480**,
- *Fixed Frequency 2* **481**,
- *Fixed Frequency 3* **482** and
- *Fixed Frequency 4* **483**.

For this, the parameter *Frequency upper limit source* **823** is to be set to the operation mode 110 – Limitation with FF.
If the additional limitation has been activated, the maximum frequency (maybe permitted by the load detection or its modification during the movement of a luffing jib) is limited to the current fixed frequency. The limitation is effective for both clockwise and anti-clockwise.

Operation mode		Function
0 -	Off	There is no additional speed limitation

110 -	Fixed limit	The selected fixed frequencies are taken into account for limitation

6.5 Temperature adjustment

The properties of the asynchronous machine change with the temperature and can be taken into account via a suitable measurement or estimate. Various methods and sources of actual values for temperature detection are to be selected via the parameter *Operation mode Temperature adjustment* **465**.
The parameter *Operation mode Temperature adjustment* **465** is pre-set to the operation mode 4-temperature estimate in the configurations `260` and `460`. In switching on, the temperature of the asynchronous machine is estimated and taken into account for correct calculation.
If this is not required, the parameter *Operation mode Temperature adjustment* **465** must be parameterized to the operation mode `0-Off`.

Operation mode	Function
0 - Off	The function is deactivated
1 - Temp. Detect. At AE1	Temperature synchronization (0 … 200°C => 0/2 … 10V), actual temperature value to multifunctional input 1
2 - Temp. Detect. At AE2	Temperature synchronization (0 … 200°C => 0/2 … 10V), actual temperature value to multifunctional input 2
3 - Temp. Detect. At AE3	Temperature synchronization (0 … 200°C => 0/2 … 10V), actual temperature value to multifunctional input 3
4 - Temperature estimate	Temperature synchronization by estimation
11 to 13	Operation modes 1 to 3 with the VECTRON extension temperature synchronization (-26.0 … 207.8°C => 0 … 10V)

The *Adjusting temperature* **467** is to be set to the temperature at which the optimization of the extended machine data has been carried out. The temperature can be read out via the actual value parameter *Winding temperature* **226** and can be used in the optimization for the parameter.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Default**
467	*Adjusting temperature*	-50.0 °C	300.0 °C	100.0 °C

7 Slewing application

The slewing application functions are available via the software configuration `862` (Setting in *Configuration* **30**).
The functions are as follows:

- Timers for reducing the peak torque
- Scaling of the gain of the speed controller
- Emergency movement in the case of encoder damage

7.1 Timers for reducing the peak torque

Target of the timers is to reduce the peak torques due to the elasticity of the tower during the change-over of the different speeds and amplifications until the speed of the motor becomes stable.
The timers are implemented via the Function Table with the Vtable.
With the Function Table the three commands of the Control Lever

- Start-Clockwise
- Start-Anticlockwise
- Data Set Change-Over 1

are delayed depending on the actual system status.

7.2 Emergency movement in the case of encoder damage

If the slewing is done by not a single motor but a group of motors it is still possible to operate in field oriented control in the case a motor is damaged and disconnected. The performance will be reduced accordingly. The slewing drive can still be used with **F**ield **O**rientated **C**ontrol with little reduction of the performance.
In the case of an encoder damage an emergency movement with reduced max speed (`10 Hz`) and acceleration ramps (`2 Hz/s`) is possible in Configuration `862`. The emergency operation is activated by parameter **876** – *SLC active*. The activation can be done by digital input for example. The Default setting is `7 – off`.
If SLC is activated the motor(s) are controlled via V/f control. All settings relevant for field oriented control are not used.
The V/f settings are set up during the auto tuning. To assure a proper operation during an encoder break down it is recommended to test the operation without encoder and control the pre-adjusted setting of the parameter *starting voltage* **600**.
The operation with reduced speed and acceleration deceleration ramps is not carried out automatically. It is mandatory to switch over in another data set where the fixed frequencies and ramps are set to reduced values that allow a safe operation. The data set change over digital input must be the same as the digital input set in **P.876**.
The encoder monitoring must be deactivated in the used data set by setting parameter **760** = `0 – Off`.

CAUTION

Overcurrent

If there is a motor current flowing while SLC is activated probably an overcurrent is generated.

- ONLY activate the SLC (Set EM-S1IND to HIGH (if **P.876** is set to `320 – EM-S1IND`)) if the motor current is zero.

7.3 Particularities of Encoder Monitoring for Slewing Crane

The circumstances indicating an encoder problem are not the same in configuration `862` (Slewing) in comparison to others.
Therefore is necessary to set a current threshold that activates an additional encoder monitoring. If **870** is set to zero the additional Encoder Monitoring is inactive.
The default value of **870** is 40 % of the nominal inverter current. During the setup **870** is set to 50 % of *rated machine current* **371**.
To prevent the error "`F1432 Encoder: Wrong Direction` the default value of **763** *Timeout: Direction fault* is set in configuration `862` to `10000 ms`.

8 Anti-Sway function

he anti-sway system is a solution dedicated to slewing drives mainly. However, it may also applied for trolley drives or portal cranes. The reason for the load oscillation resp. sway (the movement of the jib or external influences like wind) does not matter for the functionality. The anti-sway function can be used in configuration 862. The Anti-sway function works only with an encoder feedback. Sensorless anti-sway means in this context that no additional sensors like cameras or lasers are necessary.

8.1 Mode of Operation of Anti-Sway Function

The anti-sway system is developed for the slewing crane drive. The reason for the load oscillation (the movement of the jib or external influences like wind) does not matter for the functionality.
The anti-sway system works by obtaining the torque from the swaying load. Therefore, only
880 – *Mech. Time Constant* - has to be adjusted.
The anti-sway system generates a damping frequency. This damping frequency is filtered (**852 – 854** explained later) and scaled by a damping factor –
881 – *Anti-sway*. The default value is 25.00 %.
The damping frequency is then added to the output of the frequency ramp.

8.2 Adjustment of Anti-sway System

Mainly the *mechanical time constant* **880** and the *anti-sway* **881** have to be adapted. At first the *mechanical time constant* **880** should be adapted while the *anti-sway* **881** should remain on the default value of 0 %.
For a good behavior of the anti-sway system the speed controller has to minimize the speed error. To avoid an overshoot of the speed controller with the very big inertia of the jib the speed controller is set to a pure proportional speed controller.
Set:

- **721** – *Amplification 1* = 25,
- **722** - *integral Time 1* = 0 ms,
- **748** - *Backlash Damping* = 0 %.
- **738** – *Speed Control Switch-Over Limit* = 0 Hz.

The Acceleration has to be set to values the drive is able to follow.

- **420** – *Acceleration* =3 Hz/s
- **421** – *Deceleration* =7 Hz/s.

For a smooth behavior, set

- *Ramp Rise Time* (**430** and **432**) to 2000 ms,
- *Ramp Fall Time* (**431** and **433**) to 5000 ms.

8.2.1 Filter of the Anti-Sway System

The damping frequency is filtered with

- **882** – *Filter 1*,
- **883** – *Order Filter 1*
- **884** – *Filter 2*

882 – *Filter 1* – is the Time Constant of a PTx low-pass filter. The Time Constant is adjustable 2^0…2^{15} ms. The default value is 2^8 ms respectively 256 ms. The order of the filter is adjustable with
883 – *Order Filter 1* –3…7. The default value is 4.
With the ACU SW both parameters can be changed during the operation.
884 – *filter 2* – is mainly for a fast reaction against the wind. The Time Constant is adjustable form 2^0 ms to 2^{15} ms. The default value is 2^{14} ms respectively 16384 ms.

8.2.2 Limitation of the Output of Anti-Sway System

The output of the anti-sway system is a damping frequency. This damping frequency is limited with the
885 – *Fmax* - before it is added to the Ramp Output.
The default value is 2.00 Hz.
Additionally, the anti-sway system can be activated or deactivated with
886 – *Start Anti-sway*. The default value is 7 – Off.
For testing the anti-sway function it can be connected to an digital input, for example.

8.2.3 Parameters of Anti-Sway System

No.	Min.	Default	Max.	DS	Type	Description
877	- I-FUN[1]	0 A	I-FUN	4	int	Friction compensation constant
878	- I-FUN	0 A	I-FUN	4	int	Friction compensation proportional
879	0.00 Hz	0.10 Hz	10.00 Hz	4	long	Friction compensation linear
880	0.000 s	1.000 s	65.000 s	4	uint	Mech. Time Constant
881	0 %	0 %	250 %	4	int	Anti-sway
882	0 ms	250 ms	32000 ms	4	int	Time Constant PTy low Pass Filter
883	3	4	7	4	int	Order y from low Pass Filter 882
884	0 ms	16000 ms	32000 ms	4	int	Time Constant PT1 Filter
885	0.00 Hz	2.00 Hz	10.00 Hz	4	long	Fmax of Anti-sway
886	6	7 - Off	2416	4	int	Start Anti-sway

8.2.4 Adjustment of the Mechanical Time Constant

At first the speed controller has to be adjusted.

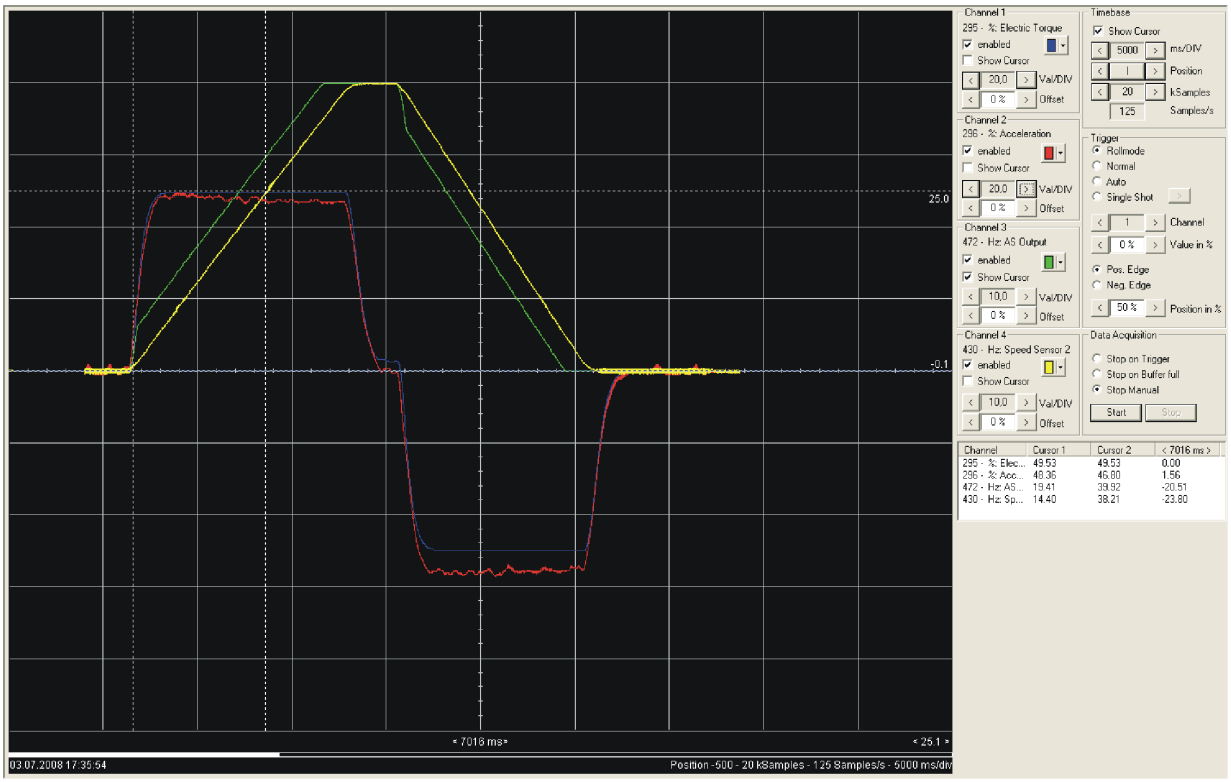


Figure 1: Adjustment of the Mechanical Time Constant.
Ideal behaviour at simulated Crane without swaying load.
The mechanical time constant is 7016 ms.
Green: AS Output (because 851 is 0 % AS Output is equal Ramp Output)
Yellow: Mechanical Speed
Blue: Electric Torque
Red: Acceleration Torque

To properly commission the anti-sway system in the condition of working properly, the value of the crane mechanical time constant and the friction effect on the movement has to be defined as input to the system.
The mechanical time constant is the time needed to reach, without load, the rated speed (of the motor) from standstill by applying the rated torque. That time is either given by the **manufacturer** or it is defined by **test**. See chapter 7.1.1 for more detail. In the latter case it is suggested to perform the following test, even if several variations can be used due to application limits:

– Half torque test (from standstill to ½ rated speed with no load and applying ½ rated torque)

[1] I-FUN: Inverter Nominal Current

- set frequency ramps (**P.420**, **P.421**) to values the crane cannot reach (to be sure no limitation will interfere)
- Apply 50% of rated torque limits (**P.730** and **P.731**, speed control parameters "862" configuration)
- Speed reference: fixed to the rated speed (**P.480** and **P.419**)
- Measuring the time needed to reach 50% of rated speed (motor)

In any case remember to put the frequency ramp values and torque limits back to the previous ones after this test.
During the previous test, check the precision of the used mechanical time constant value by monitoring through the Scope the graphs "acceleration torque" (Source 296) and "electric torque" (also called total torque: acceleration torque + frictions) (S 295).

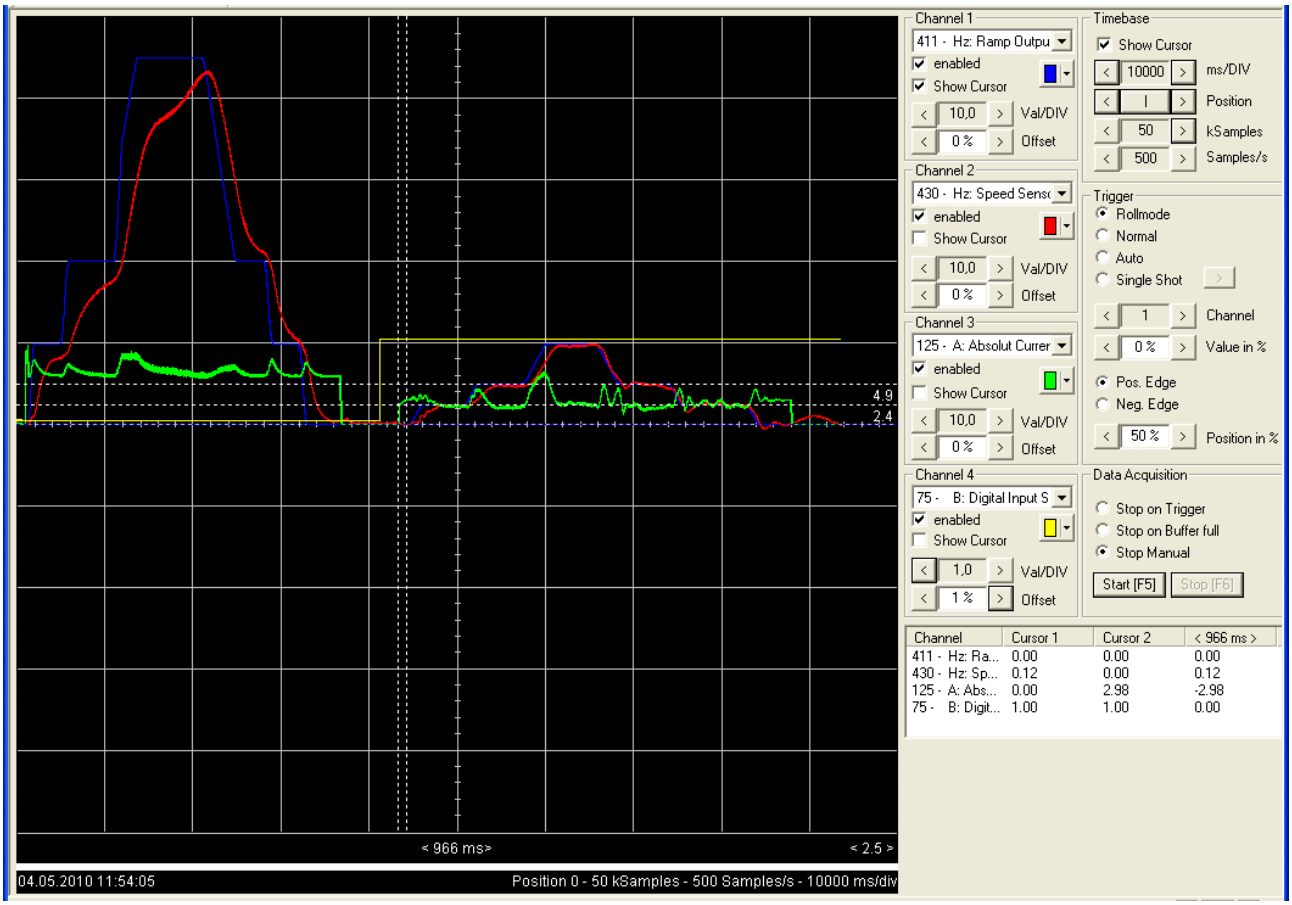


Fig. 6: Results with FOC Control (the first action) and the Emergency movement with SLC (the second action while Channel 4 is HIGH) at the Crane Simulation Test Bench
Channel 1: Ramp Output – the Reference for the Speed Controller
Channel 2. Speed
Channel 3. Absolute current
Channel 4. EM-S1IND – Emergency movement with SLC active

The two curves have to be very similar, if the acceleration torque is smaller than the electric torque the mechanical time constant has to be enlarge.
A too small mechanical time constant (for example 50% of the actual one) will cause at the end an insufficient damping of the load sway. If a too big mechanical time constant (for example 120 % of the actual one) is used, the anti-sway can lead to unacceptable vibrations. Therefore is suggested to start with smaller values of the mechanical time constant in case of doubt.
If during acceleration phase the acceleration torque (S 296) is a little bit smaller than electric torque and during deceleration it is a bit larger than electric torque (S 295), the friction is not compensated.
The compensation can be optimized using the following parameters: Friction Pre-control constant (**757**), *Friction Pre-control proportional* (**758**) and *Friction Pre-control linear* (**759**).

8.2.5 Further optimization of the Anti-sway System

- Using a pure proportional **speed controller** with high amplification (see Adjustment of Anti-sway System) may cause noises the controller may react to. In order to avoid this effect may be necessary to optimize the damping frequency filter see chapter Filter of the Anti-Sway System.

The filtered actual speed is monitored in the Scope via **source** 171.
The anti-sway system operation is affected by the load weight and the sway frequency. The configuration phase and first tests have to be performed with heavy load and long cable; with **lighter loads and shorter cables**, a different behavior may be noticed.
If the system does not work properly in this condition, change the anti-sway filter parameters **P.882** and **P.883**. Start reducing in small steps the time constant of filter 1 **P.882** or alternatively reduce the filter order **P.883**.
With these changes, it is necessary to re-optimise the damping factor **P.881** *Anti sway* in small steps of 5% while monitoring carefully the load sway.

- In order to avoid the wind impacting the load sway, adjust the *filter 2* **884** by reducing it in small steps. In addition to that, the amplification of the *speed controller* **721** can be increased.
  The operation of the load sway has to be verified after the changes.
- Depending of the construction of the crane, the damping speed may be limited quite often by *Fmax* **885** (See chapter Limitation of the Output of Anti-Sway System). This would be visible if during the sway compensation the drive speed reaches the limit set in **885**. If frequent limitations occur, enlarge *Fmax* in small steps until you reach the optimal behavior.
- To avoid the direct closing of the brake after decelerating the motors, you can change the brake control parameters (see chapter Sequence control) to higher values.

9 Sensorless hoist movement for emergency operation

In the case of an encoder break down the emergency operation function allows to operate the crane sensorless in configuration `260`. To avoid changing the inverter configuration to e.g. `460` a data set with according setting is used for the emergency operation. The activation of the emergency operation can either be activated by digital inputs changing the data set or by KP500 adjusting the following parameters.

873 *Emergency Operation without encoder* 0- Off / 1- on

874 *Data Set selection Emergency Operation*

Default: `4`

Defines the data set in which the settings for the emergency operation are made.

CAUTION

Note that operation without encoder probably will not have the same overload capacity as the operation with encoder.
It is mandatory to test the sensorless operation during commissioning and optimize it if necessary.

Recommended setting for emergency operation

Use e.g. data set 2:

- Set **P.766** to `3 - machine model` (This is mandatory)
- Set **P.874** to `2`
- If needed set a maximum speed for the emergency operation using **871** *Maximum Frequency 2* e.g. `15 Hz`.
- Set **P.875** to activate the use of maximum frequency. Set it e.g. to the same digital input that is necessary to switch over in the according data set. Or if the switch over is done by KP 500 set it to on and set it in the data sets that are not used for emergency operation to the same values as **419** *maximum frequency*. Please mind that the maximum Frequency 2 can be also used without the emergency operation mode.

No.	Min.	Default	Max.	DS	Type	Description
871	0,00 Hz	50.00 Hz	599.00 Hz	4	long	Maximum Frequency 2
873	0- Off	0 - Off	1 - On	1	int	Emergency Operation without encoder
874	1	4	4	1	int	Data Set Selection Emergency Operation
875	6	7 - Off	2416	1	int	Use Maximum Frequency 2

10 Error stopping behavior

CAUTION

Unwanted behavior

Wrong settings of the emergency ramps (**P.424** and **P.425**) can lead to unwanted behavior.

- Be cautious when setting the emergency ramps (**P.424** and **P.425**) to prevent unwanted behavior.

To reduce the stress of the tower before trips and to increase the lifetime, the stopping behavior for the error F0300 Overtemperature can be parameterized.
The following adjustments are possible.
889 *Shutdown with Emergency Stop by warning*.

P. 889	Function
0 - Off	Off
1 - Ti	Shutdown with Emergency Stop by warning Ti
10 - Tk	Shutdown with Emergency Stop by warning Tk
11 – Ti or Tk	Shutdown with Emergency Stop by warning Ti or Tk
100 - Ixt	Shutdown with Emergency Stop by warning Ixt
101 – Ti or Ixt	Shutdown with Emergency Stop by warning Ti or Ixt
110 – Tk or Ixt	Shutdown with Emergency Stop by warning Tk or Ixt
111 – Ti or Tk or Ixt	Shutdown with Emergency Stop by warning Ti or Tk or Ixt

No.	Min.	Default	Max.	DS	Type	Description
889	0- Off	0 - Off	111 – Ti...	1	int	Shutdown with Emergency Stop by warning

If one of the selected warnings is active, the drive will be decelerated with the emergency ramps **P.424** and **P.425** and then the error is generated and entered in the error protocol.
If the drive cannot decelerate to standstill before the overtemperature error F0300 is triggered, the drive is stopped immediately by triggering the corresponding error.

11 Encoder Filter

EC1 Filter time constant **1193** or *EC2/Resolver: Filter time constant* **1194** (only available if additional encoder / resolver module mounted) can be used in order to filter the speed of speed sensor 1. This filter can be used in situations where the speed sensor fluctuates (e.g. for mechanical reasons).
Bonfiglioli Vectron GmbH recommends changing the value in small steps and checking the individual results. Do not change the value in great steps.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1193	EC1 Filter time constant	0 us	32000 us	0 us

12 Unintended movement detection via Monitoring of Encoder Speed

The Parameter *Unintended movement: Timeout* (**P.898**) for the movement monitoring refers to the time period, during which the value set in *Unintended movement: Speed Switch-off Limit* (**P.897**) is exceeded by the value of **encoder speed that is set as actual speed source 766.** The default value is 100 ms.
If the value of **encoder speed** exceeds the parameterized value (**P.897**) for more than 100 ms, while the inverter is not released, the inverter shuts down with the fault message **„F1111 Unintended movement"**. If the timeout is set to 0 ms, the monitoring is deactivated.
The unintended movement *Activation delay* **899** starts as soon as the inverter is no longer released. Only after this delay has expired, the actual *Timeout* (**P.898**) starts. This allows preventing the execution of the switch-off in the case of an emergency shutdown (while drive is still running). If, after a longer standstill, the winch starts sliding, this is detected after the short timeout (**P.898**).

No.	Designation	Unit.	min.	max.	Default
897	Unintended movement: Speed Switch-off Limit	Hz	0.00	599.00	0.00
898	Unintended movement: Timeout	ms	0	10000	100
899	Unintended Movement: Activation Delay	ms	0	30000	1000

12.1 Low speed encoder monitoring

The method monitors the encoder used in the speed controller as source of the actual speed resp. the source assigned in **P.766**. If the machine model is used as speed source, this function is deactivated.
This method is applied, whenever the speed measured by the selected encoder is lower than the speed set in **P.896**.
The parameter *Movement Detection 2: Timeout* **895** for movement monitoring refers to the time period, during which the value set in *Movement Detection 2: Frequency Limit* (**P.896**) is exceeded by the value of the **monitored encoder**. The default value is 100 ms.
If the value of **monitored encoder** exceeds the parameterized value (**P.896**) for more than 100 ms, the inverter shuts down with the fault message **F1430 Encoder: no signal**. If the timeout is set to 0 ms, the monitoring is deactivated.
In conf. `862` (Slewing) the default value for **P.895** is set to `0 = off`.

No.	Designation	Unit.	min.	max.	Default
895	Movement Detection 2: Timeout	ms	0	10000	100
896	Movement Detection 2: Frequency Limit	Hz	1.00	20.00	2.00

Table 2.1: Movement monitoring after brake disengaged

13 Test Function

13.1 Earth fault and short circuit test

WARNING

Personal injury or material damage

Synchronous motors may move briefly while the test runs.

- Check if there is a potential for personal injury or material damage.
- Prevent access to hazard areas.

If a synchronous motor is connected: The test must not be started while the synchronous motor runs.

This test checks if there is an earth fault or a short-circuit against DC-link potential in the load (motor) or in the frequency inverter. This test can be carried out with or without load.
In this test, all six IGBTs (transistors) will be switched on briefly individually. No current may flow in this process even if the load is connected.

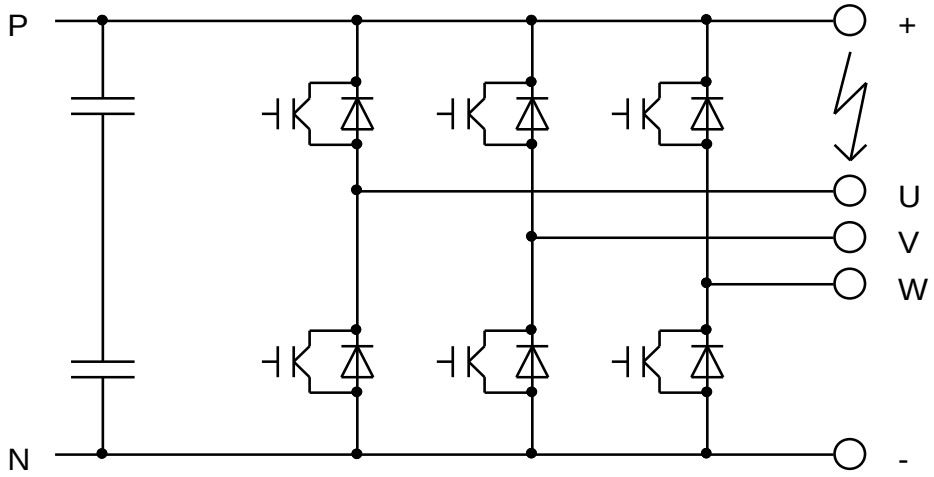


Fig. 13.1: Inverter with short circuit between positive DC link potential and line U

If, for example, there is a short-circuit between the positive DC-link potential (P or +) and branch U (see illustration), the test would be stopped and error "T0104 earth /P-U fault" would be displayed. This may either be a "hard" short-circuit or a "soft" short-circuit, i.e. a short-circuit with a relatively high resistance. Short-circuits which don't trigger a hardware overcurrent circuit break, but cause a current which is 10 % greater than the rated current peak value are signalled as earth faults.
If an error is signalled during a test with connected load, the test should be repeated without connected load, in order to find out if the device or the load is defective.
If an error is only signalled while the load is connected, it is an earth fault in the load or - if the DC-link terminals are assigned - possibly a short-circuit between a load branch and a DC-link potential.
If an error is also signalled while the load terminals are not assigned, there is a short-circuit in the device or an IGBT is defective. In the case of a defective IGBT or a short-circuit in the device, the error will be signalled in several branches while the load is connected, as the current can also flow via the load. In this case, only the messages generated while the load is not connected may be considered.
Non-switching IGBTs or non-functioning current measurements will not be detected by this test. In this case existing errors which would normally be identified by this test might not be detected.

Message	Meaning
T0001	Stop. Test stopped by user.
T0002 permanent error	There is a non-acknowledgeable error, no (fur-ther) test is possible.
T0003 STO	STO Signals missing.
T0010 Istart <> 0	Current flow when applying zero voltage, no (fur-ther) test possible.
Abort by User	The test has been aborted by the user.
Abort no STO	The test is aborted because STO has been opened after the start of test.
T1 Failed	Test finished. An error was detected.
T1 OK	Test finished without error.
T0101 Ground / N – U hard	short circuit between phase U and the negative DC link potential or PE detected.
T0102 Ground / N – V hard	short circuit between phase V and the negative DC link potential or PE detected.
T0103 Ground / N – W hard	short circuit between phase W and the negative DC link potential or PE detected.

Message	Meaning
T0104 Ground / P – U hard	short circuit between phase U and the positive DC link potential or PE detected.
T0105 Ground / P – V hard	short circuit between phase V and the positive DC link potential or PE detected.
T0106 Ground / P – W hard	short circuit between phase W and the positive DC link potential or PE detected.

Table 13.1: Possible error messages of the device test

13.2 Operation of the Test Function

The test must not be started, while the motor is magnetized and rotating. This causes voltages at the motor connectors which disturb the test. If a permanent magnet synchronous motor is used, a standstill of the motor is necessary for the test.

WARNING

Personal injury or material damage

Synchronous motors may move briefly while the test runs.

- Check if there is a potential for personal injury or material damage.
- Prevent access to hazard areas.

CAUTION

Load safety

Dangerous state due to negligence possible.

- Double-check if the external brakes are engaged when the motor is deactivated.

13.2.1 Operation via Vplus

The test function is only available for inverters of size 3 or higher.
The device test can be started via the control software VPlus by parameter **1011** *Start device Test*. Table 13.2 lists the options of Parameter **P.1011**. Parameter **1012** "*Status Device Test*" shows the status of the device test and messages generated during the test. In Table 13.1 the possible messages are listed.

1011 Start device Test	Function
0 – Clear status	Deletes the messages generated during the test.
1 – Continue	Continues the current test after a message
2 – Cancel	Stops the current test.
11 – Start device test	Starts earth fault and short-circuit test.

Table 13.2: Options of Parameter 1011

The device tests can be started by selecting of `11 - Start device test`. During the test the digital inputs STOA and STOB must be set. If this is not the case, "T0003 STO" is displayed on the keypad to indicate that the STO-signal is missing.
2 - Cancel can be used to stop a running test at any time. The message " T0011 Abort by User" is then reported. When STO signal is disabled during the test, the test will be aborted and the message "T0012 Abort no STO" is displayed. After the test is completed without error, "T1 OK" is displayed. The message can be acknowledged with 1 – Continue or 2 - Cancel and the inverter resets. When the message is not acknowledged, the inverter is automatically reset 10 seconds after the message was displayed.
If an error occurs during the test, it will be reported by an error with text from table 13.1. After an error, the test can be resumed with 1 – Continue or can be left with 2 - Cancel. When the test is finished "T0013 T1 Failed" is display. If this message is not acknowledged by the user, the inverter is automatically reset 10 seconds later.
When the error "T0010 Istart <> 0" is displayed after the start of the test, a current is measured with no IGBT switched on. Then no further test is possible. Hence after the acknowledgement of this error the test is aborted and "T0013 T1 Failed" is displayed.

13.2.2 Operation via Key Pad

The device tests can be started from the key pad by selecting "TEST" in the CTRL menu.
The enter key is used to start the test. During the test the digital inputs STOA and STOB must be set. If this is not the case, "STO" is displayed on the key pad to indicate that the STO-signal is missing.

The esc key can be used to stop a running test at any time. The message "abort" is then reported. When STO is disabled during the test, the test will be aborted and the message "noStO" is displayed. After the test is completed without error, "1.good" is displayed. This message can be acknowledged by pressing the Enter or ESC key. After that the inverter generates a reset. When no button is pressed the inverter is reset automatically 10 seconds after the message was displayed.
If an error occurs during the test, it will be reported by an error number from table 13.1. The error text will not be displayed. After an error, the test can be resumed with the enter key or can be left with the ESC key. When the test is finished "1.fail" is display. If his message is not acknowledged by the user, the inverter is automatically reset 10 seconds later.
When the error "t0010" is displayed after the start of the test, a current is measured with no IGBT switched on. Then no further test is possible. Therefore, after the acknowledgement of this error, the test is aborted and "1.fail" is displayed.

NOTICE

The test function is only available with inverters of size 3 or higher.

14 Mode "Slinging"

For hoist applications (configuration 260 / 460) it might be necessary to move the motor slower and to decrease the slope of acc/dec ramps when the rope is without tension. For this reason, the inverter provides the function slinging mode which allows to use four different speeds and acc/dec ramps for clockwise and anticlockwise operation.
The slinging mode is activated by the parameter **861** *Start slinging mode*. The start is freely programmable and can be set for example to a digital input.
To apply the speeds and ramps the following parameters need to be set up accordingly. New parameters and their ranges are the following.

No.	Min.	Default	Max.	DS	Type	Description
861	6	7 - Off	2416	1	int	Start Slinging Mode
862	0.00 Hz	2.00 Hz	599.00 Hz	4	long	Slinging Frequency 1
863	0.00 Hz	4.00 Hz	599.00 Hz	4	long	Slinging Frequency 2
864	0.00 Hz	6.00 Hz	599.00 Hz	4	long	Slinging Frequency 3
865	0.00 Hz	8.00 Hz	599.00 Hz	4	long	Slinging Frequency 4
866	0.01 Hz/s	5.00 Hz/s	9999.99 Hz/s	4	long	Slinging Acceleration (Clockwise)
867	0.01 Hz/s	5.00 Hz/s	9999.99 Hz/s	4	long	Slinging Deceleration (Clockwise)
868	0.01 Hz/s	5.00 Hz/s	9999.99 Hz/s	4	long	Slinging Acceleration Anticlockwise
869	0.01 Hz/s	5.00 Hz/s	9999.99 Hz/s	4	long	Slinging Deceleration Anticlockwise

To switch between the different speeds use the normal procedure with the F*ixed Frequency change over* parameters **66** and **67**.
Please mind that the settings of the ramps are not considered in the case of an emergency stop.

15 Parameter list

The parameter list is structured according to the menu branches of the operating unit. For better clarity, the parameters have been marked with pictograms:

- The parameter is available in the four data sets
- ☑ The parameter value is set by the SET-UP routine
- ⊗ This parameter cannot be written in the operation of the frequency inverter.

15.1 Actual value menu (VAL)

Actual values of the system				
No.	**Description**	**Unit**	**Display range**	**Chapter**
242	*Load*	%	0.0 ... 999.9	6.1
243	*Estimated load*	%	0.0 ... 999.9	6.1

15.2 Parameter menu (PARA)

	No.	Description	Unit	Range	Chapter
		Temperature adjustment			
	465	*Operation mode*	-	Selection	6.5
	467	*Adjusting temperature*	°C	-50.0 ... 300.0	6.5
		Brake control			
	800	*Time t1*	s	0.0 ... 20.0	5.2
	801	*Time t2*	s	0.0 ... 20.0	5.2
	802	*Time t3*	s	0.0 ... 20.0	5.2
	803	*Time t4*	s	0.0 ... 20.0	5.2
	804	*Time t11*	s	0.0 ... 20.0	5.2
	805	*Time t12*	s	0.0 ... 20.0	5.2
	806	*Time t13*	s	0.0 ... 20.0	5.2
	807	*Time t15*	s	0.0 ... 20.0	5.2
	808	*Monitoring current*	A	0.0 ... o·I_{FIN}	5.2.1
	809	*Frequency threshold*	%	0.0 ... 100.0	5.2.2
		Load estimation			
	811	*Mech. time constant*	s	0.000 ... 65.000	6.1.1
	812	*Turn/m*	U/m	0.01 ... 650.00	6.1.2
	813	*Fm lower value LE*	%	0 ... 100	6.1.3
	815	*Max time LE*	s	0.001 ... 65.000	6.1.3
	816	*Pull-out torque at Fmax*	%	0 ... 100	6.1.3
	817	*Speed switch-off Limit*	Hz	0.00 ... 599.00	6.1.3
	818	*I Limit Up*	A	0.01·I_{FIN} ... 3·o·I_{FIN}	6.1.3
	819	*Desired Isq up*	A	0.01·I_{FIN} ... o·I_{FIN}	6.3.1
	820	*Desired Isq down at FsR*	A	0.01·I_{FIN} ... o·I_{FIN}	6.3.1
	821	*Desired Isq down at Fmax*	A	0.01·I_{FIN} ... o·I_{FIN}	6.3.1
	822	*Operation mode LE*	-	Selection	6.1
	823	*Frequency Upper Limit Source*	-	Selection	6.4
	824	*I Limit Down*	A	0.01·I_{FIN} ... 3·o·I_{FIN}	6.1.3
	757	*Friction Pre-Control constant*	A	-I_{FIN} ... I_{FIN}	8.2.4
	758	*Friction Pre-Control proportional*	A	-I_{FIN} ... I_{FIN}	8.2.4
	759	*Friction Pre-Control linear*	Hz	0.00 ... 10.00	8.2.4
	861	*Start Slinging Mode*	-	Selection	14
	862	*Slinging Frequency 1*	Hz	0.00 ... 599.00	14
	863	*Slinging Frequency 2*	Hz	0.00 ... 599.00	14
	864	*Slinging Frequency 3*	Hz	0.00 ... 599.00	14
	865	*Slinging Frequency 4*	Hz	0.00 ... 599.00	14
	866	*Slinging Acceleration (Clockwise)*	Hz/s	0.01 ... 9999.99	14
	867	*Slinging Deceleration (Clockwise)*	Hz/s	0.01 ... 9999.99	14
	868	*Slinging Acceleration Anticlockwise*	Hz/s	0.01 ... 9999.99	14
	869	*Slinging Deceleration Anticlockwise*	Hz/s	0.01 ... 9999.99	14
	870	*Encoder - Monitoring Current*	A	0 ... 6	7.3
	871	*Maximum Frequency 2*		0,00 Hz	9
	873	*Emergency Operation without encoder*		0- Off	9
	874	*Data Set selection Emergency Operation*		1	9

No.	Description	Unit	Range	Chapter
875	*Use Maximum Frequency 2*		6	9
876	*SLC active*	-	Selection	7.2
877	*Friction Pre-Control constant*	A	- I-FUN[2] ... I-FUN	8.2.3
878	*Friction Pre-Control proportional*	A	- I-FUN ... I-FUN	8.2.3
879	*Friction Pre-Control linear*	Hz	0.00 ... 10.00	8.2.3
880	*Mech. Time Constant*	s	0.000 ... 65.000	8.2.3
881	*Anti Sway*	%	0 ... 250	8.2.3
882	*Time Constant PTy low Pass Filter*	ms	0 ... 32000	8.2.3
883	*Order y from low Pass Filter P. 882*	-	3 ... 7	8.2.3
884	*Time Constant PT1 Filter*	ms	0 ... 32000	8.2.3
885	*Fmax of Anti Sway*	Hz	0.00 ... 10.00	8.2.3
886	*Start Anti Sway*	-	Selection	8.2.3
889	*Shutdown with Emergency Stop by warning*	-	Selection	10
895	*Movement Detection 2: Timeout*	ms	0 ... 10000	12.1
896	*Movement Detection 2: Frequency Limit*	Hz	1.00 ... 20.00	12.1
897	*Unintended movement: Speed Switch-off Limit*	Hz	0.00 ... 599.00	12
898	*Unintended movement: Timeout*	ms	0 ... 10000	12
899	*Unintended Movement: Activation Delay*	ms	0 ... 30000	12

[2] I-FUN: Inverter Nominal Current

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