Bonfiglioli
Vectron

# ACTIVE CUBE

Application Manual
Spindle firmware
Frequency inverter 230 V / 400 V


Bonfiglioli
Forever Forward

# 1 General Information about the Documentation

## 1.1 Instruction documents

For better clarity, the documentation is subdivided into documents of various types according to the customer-specific requirements pertaining to the product.

**Quick Start Guide**

The "Quick Start Guide" describes the basic steps required for mechanical and electrical installation of the product. The guided commissioning supports you in the selection of necessary parameters and the configuration of the product via the firmware running on the device and/or via the VPlus firmware installed on an external computer.

**Operating Instructions**

The "Operating Instructions" document describes the complete functionality of the product. It contains information about the commissioning and de-commissioning of the product and describes the most frequently used firmware parameters and basic application principles for the product. The "Operating Instructions" document also describes the troubleshooting and maintenance procedures.

**Application Manual**

The "Application Manual" supplements the documentation for purposeful installation and commissioning of the frequency inverter. The document describes the specific application of the product in a specific application environment.

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

## 1.2 This document

This document pertains to the extensions of the standard firmware 5.4.0.14 for spindle applications for devices of the ACU401 series and extensions of the standard firmware 7.0.1.0 for devices of the ACU410 series.

The extension for spindle applications is based on the software for ACU series frequency inverters. All standard features of the ACU are also available in the context of the spindle firmware. For the ACU standard features, please refer to the co-applicable Operating Instructions.

**IMPORTANT:**

**Compliance with the documentation is required to ensure safe operation of the frequency inverter. Bonfiglioli Vectron MDS GmbH shall not be held liable for any damage caused by any non-compliance with the documentation.**

In case any problems occur which are not covered by the documentation sufficiently, please contact the manufacturer.

For safe commissioning and operation of the ACU series, the following documentation must be complied with:

- This Operating Instructions document
- Application manual "Safety functions"

## 1.3 Warranty and liability

BONFIGLIOLI VECTRON GmbH (hereinafter referred to as "manufacturer") states 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 this document 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

This document 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 document and, in particular, the safety instructions in order to prevent personal and material losses.

## 1.5 Copyright

In accordance with applicable law any copyrights relating to this document shall remain with

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Germany

This document is intended for the operator of the frequency inverter. Any disclosure or copying of this document, exploitation and communication of its contents (as hardcopy or electronically) shall be forbidden, unless permitted expressly.

Any non-compliance will constitute an offense against the copyright law, the law against unfair competition and the German Civil Code and may result in claims for damages. All rights relating to patent, utility model or design registration reserved.

## 1.6 Storage

The documentation forms an integral part of the frequency inverter. It 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.

# 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

Throughout the documentation, the following terms shall be used to refer to the roles of persons and/or organizations as well as the described product/equipment:

**Manufacturer**

Bonfiglioli, being the company developing, producing and distributing the product described in this document shall be referred to as the "manufacturer".

**Product/device**

The term "product" and/or "device" is the specific piece of equipment described in this document as marketed by the manufacturer.

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" pertains to persons instructed by the operator of the device and assigned the task of operating the device.

**Skilled personnel**

The term "Skilled personnel" pertains to staff that are assigned special tasks by the operator of the device, 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" pertains to 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" pertains to staff instructed about and trained in the assigned tasks and the potential hazards that might result from inappropriate behaviour/use of the device. 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 must have verified their qualification.

**Expert**

The term "Expert" covers qualified and trained staff who has special technical know-how and experience relating to the device. 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 device.

## 2.2 Designated Use

The product is designed according to the state of the art and conforming to recognized safety regulations.

The products are electrical 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 products 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. The product is only available at specialized dealers and is intended exclusively for commercial use as per EN 61000-3-2.

No capacitive loads may be connected to the product.

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 product 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 minutes after shutdown.

**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 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 Information signs

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

### 2.6.3 Font style in documentation

| Example | Font style | Use |
|---|---|---|
| **1234** | bold | Representation of parameter numbers |
| *Parameter* | italic, 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 |
| • | Bullet point | Action instructions |
| – | Enumeration dash | Enumerations |
| 12345 | Courier New font | Representation of parameter values |

## 2.7 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.

## 2.8 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.

# 3 Introductory information about spindle applications

The configurations for spindle applications typically control milling machines with asynchronous machine (ASM) or permanent magnet synchronous machine (PMSM)

Operation is without encoder at high speeds. In order to enable finer setting of the speed controller when tools with large diameters are used, using an encoder is possible. When an encoder is used, the axle can be positioned for tool replacement.

For safe operation in the field weakening range, PMSM, require a brake chopper. Presence of a sufficiently dimensioned brake chopper is monitored by the spindle application automatically.

## 3.1 Configurations for spindle applications

For spindle applications, the following configurations are available:

- `804`: Spindle application with field-oriented speed control of asynchronous machine (ASM)
- `806`: Spindle application with field-oriented speed control of permanent magnet synchronous machine (PMSM)

Configurations `804` and `806` are based on Configurations `410` (open loop field-oriented control of asynchronous machine) and `610` (open loop field-oriented control of a synchronous machine, speed controlled).

This application manual describes the changes compared to the underlying configurations. For more information on Configurations `410` and `610`, please refer to the Operating Instructions of the ACU series of frequency inverters.

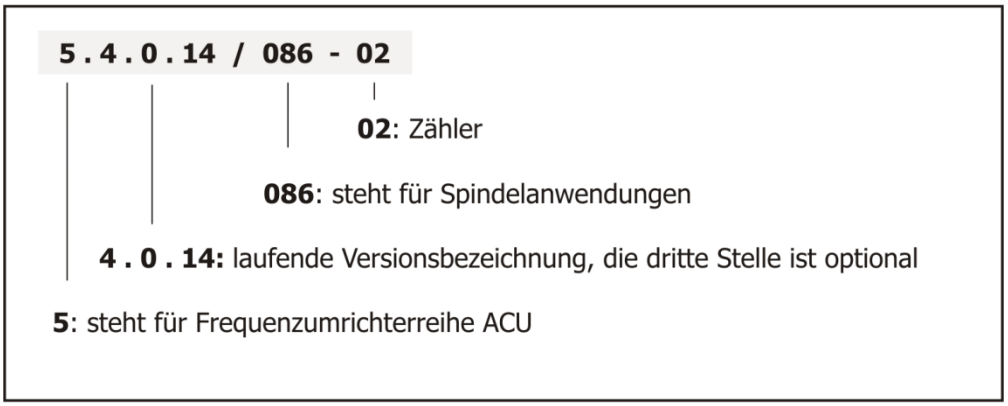
**In variance, for devices of the ACU410 series applies:**

For field weakening, the ACU410 spindle firmware in the configuration `5xx` behaves the same as ACU401 in configuration `806`. Also see chapter 4.4.

## 3.2 Software identification

The software installed can be identified via Parameter *Inverter Software Version* **012** .

**Example for Software identifier:**



Further information about the software can be obtained via the following parameters:

| Parameter | |
|---|---|
| **No.** | **Identifier** |
| **000** | *Serial Number* |
| **001** | *Optional Modules* |
| **015** | *Copyright* |
| **028** | *Control Level* |
| **029** | *User Name* |
| **030** | *Configuration* |
| **033** | *Language* |

## 3.3 Operating characteristics

Parameter *Local Remote* **412** defines the operating characteristics and enables choosing control via contacts/control unit and/or the interface.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| **No.** | **Identifier** | | | |
| **412** | *Local Remote* | - | Selection | 44 - Ctrl. Cont.+KP, Dir. Cont.+KP |

**Operation Modes of Parameter 412**

| | |
|---|---|
| *0 - Control via Contacts* | Commands Start and Stop as well as definition of sense of rotation via digital signals. |
| *1 - Control via Statemachine* | Commands Start and Stop as well as definition of sense of rotation via DRIVECOM statemachine of communication interface. |
| *2 - Control via Remote-Contacts* | Commands Start and Stop as well as definition of sense of rotation via logic signals through the communication protocol |
| *3 - Ctrl. KP, direction Contacts* | Commands Start and Stop from the control unit, definition of sense of rotation via digital signals. |
| *4 - Ctrl. KP+Cont., direction Cont.* | Commands Start and Stop from the control unit or via digital signals, definition of sense of rotation only via digital signals. |
| *5 - Ctrl. 3-Wire, direction Cont.* | 3-wire; control of sense of rotation and the signal *Start 3-wire ctrl.* **87** via digital signals. |
| *13 - Control via KP, Direction KP* | Commands Start and Stop as well as definition of sense of rotation via control unit. |
| *14 - Control KP+Cont., Direction KP* | Commands Start and Stop via the control unit or digital signals, definition of sense of rotation only via control unit. |
| *20 - Control Contacts, Clockw.* | Commands Start and Stop via digital signals. Fixed definition of sense of rotation: clockwise only. |
| *23 - Control Keypad, Clockw.* | Commands Start and Stop via control unit. Fixed definition of sense of rotation: clockwise only. |
| *24 - C* | Commands Start and Stop via control unit or digital signals. Fixed definition of sense of rotation: clockwise only. |
| *30 - Control Contacts, Anticl.* | Commands Start and Stop via digital signals. Fixed definition of sense of rotation, anticlockwise rotation only. |
| *33 - Control Keypad, Anticl.* | Commands Start and Stop via control unit. Fixed definition of sense of rotation, anticlockwise rotation only. |
| *34 - Control Cont. + KP, Anticl.* | Commands Start and Stop via control unit or digital signals. Fixed definition of sense of rotation, anticlockwise rotation only. |
| *43 - Ctrl. KP, Dir. Cont. + KP* | Commands Start and Stop via control unit, Definition of sense of rotation via control unit or digital signals. |
| *44 - Ctrl. Cont.+KP, Dir. Cont.+KP* | Commands Start and Stop as well as definition of sense of rotation via control unit or via digital signals. |
| *46 - Ctrl. 3-Wire+KP, Dir. Cont.+KP* | 3-wire and control unit. Control of sense of rotation and signal *Start 3-Wire Ctrl* **87** via digital signals or control unit. |

## 3.4 Control inputs and outputs

**CAUTION**

**Live voltage**

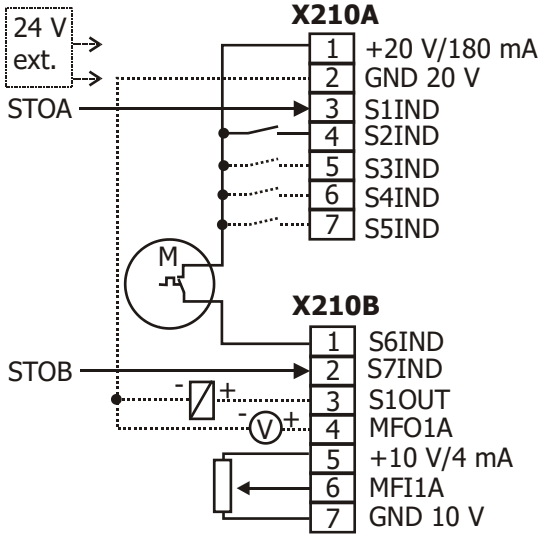
The control terminals may be energized.

- Connect the unit may only with the power supply switched off.
- Verify safe isolation from power supply.
- Switch off power supply before connecting or disconnecting the control inputs and outputs. Otherwise, components may be damaged.

**Control terminals**

The wiring diagram describes the default assignment of control terminals and functions. According to the requirements of the application, other functions can be assigned to the control terminals.

**Without encoder:**




| 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 thermal 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 |

**With encoder:**

An EM-ENCxx extension module for evaluation of encoder signals is required for operation with encoder.

For connection of the encoder, note the Operating Instructions of this extension module.

# 4 Start-up procedure

## 4.1 Turn mains voltage on

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 frequency inverter self-test is complete, the relay (X10) picks up and signals "no fault ".

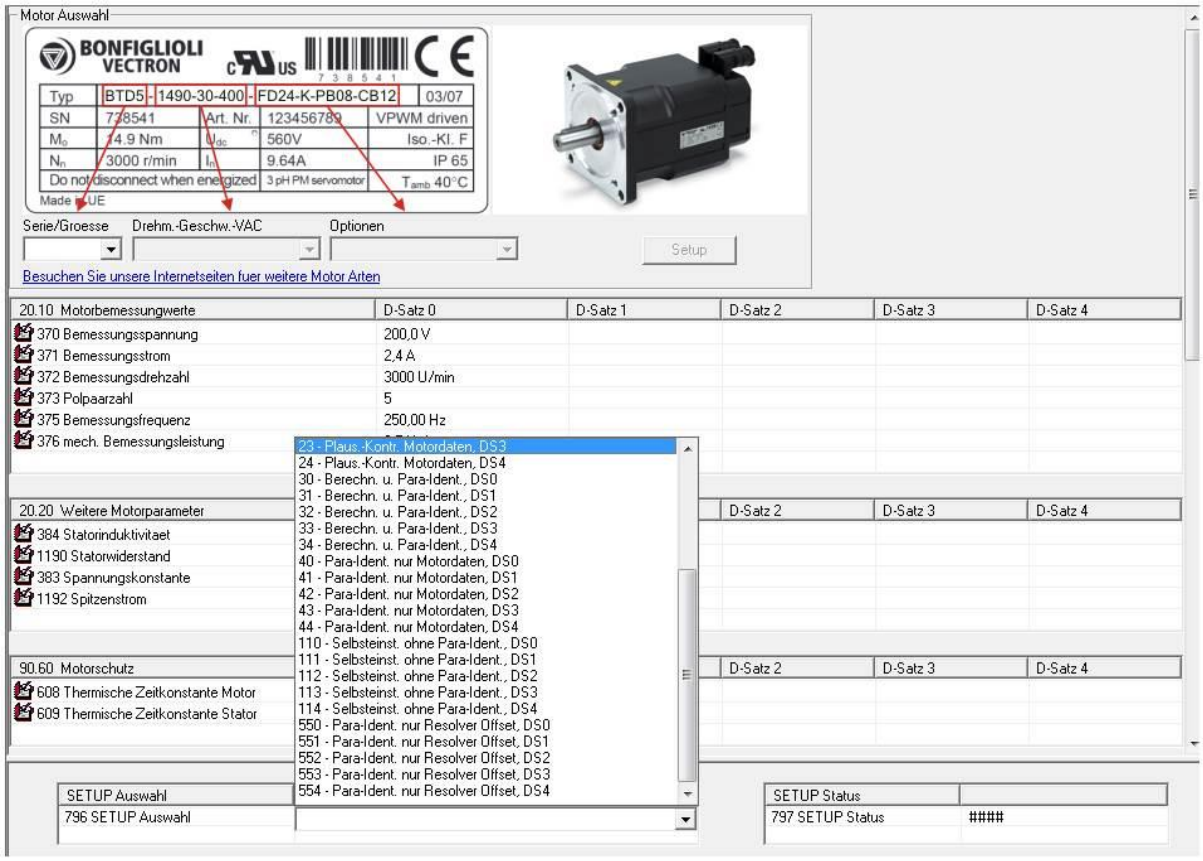
## 4.2 Motor setup

It is recommended that the setup be carried out using the VPlus software.

- Star Vplus "Inverter Manager".
- Via menu "Edit" / "Inverter Menu", start the setup window.
- In "Select motor" section, select the motor and check the preset motor ratings.

If the motor is not available in the list:

- enter the following motor ratings manually:
  - *Rated Voltage* **370**
  - *Rated Current* **371**
  - *Rated Speed* **372**
  - *No. of Pole Pairs* **373**
  - *Rated Frequency* **375**
  - *Rated Mech. Power* **376**
- For PMSM, enter additional motor parameters in section "20.20" if applicable.




- In the "SETUP Select" section, via Parameter *Setup Select* **796**, select the type of setup, e.g. "10-Complete Setup, DS0".

For self-setup, activate S1IND/STOA and S7IND/STOB release.

- Start setup.

After motor setup, the machine is set up for **open loop** operation.

## 4.3 Check speed sensors for sign error

After motor setup, sources *Actual Speed* **Q.441** and *Speed Sensor 2* **Q.430** should be compared using the VPlus Scope function. In this way a sign error in the speed sensors can be identified. If both sources (including the sign) have the same value, the sense of rotation is correct.

- If the two sources have different signs, invert the speed sensors.

## 4.4 For Configuration 806 / 5xx(PMSM): Self-configuration of resolver offset

During first commissioning, the position of the rotor winding of the resolver is adjusted to the rotor displacement angle of the synchronous motor by adjusting an offset. For operating a PMSM with resolver, the offset must be adjusted in order to obtain perfectly true running and a maximum torque.

**In variation, for devices of the ACU410 series applies:**

The spindle firmware applicable for ACU410 has the number **7.0.1.0/xxx-yy**.

- Select the configuration `5xx`.

**WARNING**

**Device damage**

When the frequency inverter is stopped in the field weakening process, the frequency inverter or other connected parts may be damaged, when no further measures are taken.

- Avoid excessive voltage using a sufficiently dimensioned brake chopper (BC).

To allow field weakening, **P.744** (*Ref. Isd Lower Limit*) must be parametrized with a negative value.

**WARNING**

**Device damage**

In the case of a fault, the device can be destroyed due to high dc link voltage during shutdown.

- To limit the dc link voltage in the case of a fault shutdown use a sufficiently dimensioned brake chopper!

**CAUTION**

**Operation disturbed**

If older vcb files are used (containing no field weakening in config. 5xx) internal links might be overwritten. The device then will not be working properly!

- Ensure the correct version of the VCB files. Config. 5xx must be included.

### 4.4.1 Safety measures before self-configuration of resolver offset

**WARNING**

**Risk of personal and machine damage**

In certain circumstances, the motor speed may reach high values.

- Before adjusting the resolver offset disconnect the motor from the load.
- To avoid damage, make the following settings.

- Turn off frequency inverter release via the digital inputs for controller release.
- If possible, uncouple the motor from the load so that the motor shaft turns freely.
- If uncoupling is not possible, make sure that the motor is loaded as little as possible.
- If installed, release the mechanical brake.
- Set the max. permissible output frequency of the frequency inverter to a low frequency value via parameter *Switch-Off Limit* **417**. Select the frequency value such that uncontrolled acceleration of the motor ("overspeeding") is detected at an early stage. This limitation is necessary in order to avoid personal and material damage.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **417** | *Frequency Switch-off Limit* | Hz | 0.00 .. 999.99 | 999.99 |

- Set parameter *Current Limit* **728** of the speed controller to a low current value (e.g. 10% of the rated motor current). In this way it is made sure that there are no excessive currents if the offset is set incorrectly.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **728** | *I limit* | A | 0.0 .. 6.0 | 6.0 |

### 4.4.2 Carrying out the self-setup

For self-setup of the resolver offset, a separate setup routine is available.

- Start VPlus setup window, see Chapter 4.2 "Motor setup".
- Set Parameter *Voltage Constant* **383** to 0.0.
- Set Parameter *SETUP Select* **796** to Operation Mode "`55x - Para-Ident. Resolver Offset only, DSx`".
- Release brake, if applicable.

**WARNING**

**Risk of personal and machine damage**

In the case of an unfavorable or incorrect resolver angle, the machined can be accelerated unintentionally.

- Take appropriate safety measures, see Chapter 4.4.1 "Safety measures before self-configuration of resolver offset".

- Start setup.

The machine will turn slowly until the reference pulse is detected reliably. By test pulses, the resolver offset is determined and entered automatically in Parameter *Offset* **382**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **796** | *SETUP Select* | - | Selection | 0- Clear Status |
| **382** | *Offset* | deg | -360.0 .. 360.0 | 0.0 |
| **383** | *Voltage Constant* | mVmin | 0.0 .. 6500.0 | 0.0 |

Once the resolver offset has been set, the machine can be operated with speed sensor feedback.

### 4.4.3 Adjustment Parameter 383

In the self-setup, Parameter *Voltage Constant* **383** is determined from the rated voltage, the measured inductance and the measured stator resistance.

The voltage constant should be optimized after the setup in an open-circuit test (50% of rated speed):

- To that end, adjust Parameter *Voltage Constant* **383** in small steps until the actual value parameter *Rotor Flux* **225** displays value "101%" (±0,5%).

# 5 Operation

## 5.1 Permanent magnet synchronous machine (PMSM)

For ACU410/FW **7.0.1.0/xxx-yy**: the settings described below are carried out in configuration 5xx.

### 5.1.1 Operation without encoder

#### 5.1.1.1 Start

In order to prevent the machine from tilting, PMSM will always be started with current impression.

#### 5.1.1.2 Isd current

For operation in the basic speed range, impression of a small positive Isd current (10% of rated current) in the machine is recommended. Thus, current will be flowing, even in open-circuit state.

The SETUP will set Parameters *Ref. Isd Upper Limit* **743** and *Ref. Isd Lower Limit* **744** automatically to 10% of the rated current (Parameter **371**).

In the case of PMSM, the value entered in Parameter *Isd Reference Value* **743**.

| Parameter | | Unit | Setting range | Default settings |
|---|---|---|---|---|
| No. | Identifier | | | |
| **743** | *Ref. Isd Upper Limit* | A | 0.0 .. 6.0 | 0.0 |
| **744** | *Ref. Isd lower limit* | A | -3.0 .. 3.0 | 0.0 |

#### 5.1.1.3 Determination of the flux direction at startup

If the frequency inverter were started in sensor-less operation, there would be an alignment process of the PMSM at the impressed starting current, unless further measures are taken. Depending on inertia and attenuation, decreasing torsional vibrations would result from such an alignment process. To avoid this, the starting current is impressed in exactly the same direction as the flux when the frequency inverter is turned off. The angle is saved permanently to ensure it is not lost when mains power fails (Parameter *Operation Mode Search Run* **645** to "`0-Off`").

If it is not guaranteed that the machine has the same orientation during startup as during shutdown, the flux direction must be identified upon startup (Parameter *Operation Mode Search Run* **645** to "`20-Only Fluxdirection identification`"). The process will take approx. 35 ms.

If it is not guaranteed that the machine stands still upon startup, *Operation Mode Search Run* **645** must be set to "`10 …. 15-Quick Synchronisation…`". Here, it must be noted that only torsional frequencies up to approx. 200 Hz can be identified reliably.

Due to the search run (*Operation Mode Search Run* **645** to "`10 …. 15-Quick Synchronisation…`"), startup of the standing machine will be delayed additionally by approx. 150 ms.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **645** | *Operation Mode Search Run* | A | Selection | 0 - off |

**Operation Modes of Parameter 645**

| | |
|---|---|
| 0 - off | The synchronization to a rotating drive mechanism is deactivated. |
| 10 - Quick Synchronisation | An attempt is made to synchronize to the drive in positive direction (clockwise field of rotation) and in negative direction (anticlockwise field of rotation). |
| 11 - Quick Synch. acc. to Preset Value | The search direction is defined by the sign of the set point. If a positive set point (clockwise field of rotation) is entered, the search is in a positive direction (clockwise field of rotation), with a negative set point, the search is in a negative direction (anticlockwise field of rotation). |
| 14 - Quick Sync., Clockwise Only | Synchronization to the drive is only done in positive direction (clockwise field of rotation). |
| 15 - Quick Sync., Anti-clockwise Only | Synchronization to the drive is only done in negative direction (anticlockwise field of rotation). |
| 20 - Only Fluxdirection identification | Only the flux direction is identified for a synchronous motor (*Configuration* **30** = 806/5xx). The drive must be at a standstill. Synchronization to a turning drive is not possible. |
| 30 - Operation above Frequency Limit | Search run is carried out for a synchronous motor (*Configuration* **30** = 806/5xx). The search is continued until a torsional frequency is identified which is higher than the *Frequency Limit* **624**. If the stator frequency drops below the frequency limit, the search run is continued. This Operation Mode can be used for operation of synchronous motor in torque-controlled drives. Use in wind turbines is also possible. |

### 5.1.1.4 Operation with field weakening

The amount of the induced voltage and thus the stator voltage to be applied by the frequency inverter will increase in PMSM with the torsional frequency. The maximum torsional frequency of the PMSM is limited initially by the maximum output voltage of the frequency inverter.

The torsional frequency of the PMSM can be increased further if the effective field is weakened by superposition (field weakening). To that end, the modulation controller impresses a negative Isd current in the machine, once the frequency inverter reaches the modulation limit.

If the speed is increased beyond the rated speed as the result of field weakening, the open-circuit voltage of the machine will also increase with the speed.

**WARNING**

**Device damage**

When the frequency inverter is stopped in the field weakening process, the frequency inverter or other connected parts may be damaged, when no further measures are taken.

- Avoid excessive voltage using a sufficiently dimensioned brake chopper (BC).

To activate operation in the field weakening range, Parameter *Ref. Isd Lower Limit* **744** is set to a suitable negative value. This value **may never be** smaller than the negative rated current of the machine (Parameter *Rated Current* **371**) and only slightly higher than the negative rated current.

**CAUTION**

**Magnets demagnetized**

If the value is set too high, the magnets might be demagnetized and the machine might be damaged.

- Ensure the correct values

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **744** | *Ref. Isd lower limit* | A | - $I_{FUN}$... $I_{FUN}$ | 0.0 |

## 5.1.2 Operation with encoder

### 5.1.2.1 Start

Upon first startup after return of mains power, the orientation of the machine is unknown, when a speed sensor is used. The orientation will only be clear once the reference pulse has been detected.

In order to enable field-oriented operation of a PMSM with speed sensor, the flux direction must either be known upon first startup after return of mains power or determined by means of the search run (*Operation Mode Search Run* **645**). When the speed sensor is used, field orientation takes place based on the identified mechanical orientation considering the resolver offset (Parameter **382**).

### 5.1.2.2 Speed sensor configuration

This software only supports operation with Speed Sensor 2 because Speed Sensor 1 has a lower input bandwidth.

- Set *Operation Mode Speed Sensor 2* **493** to "`1004 - Quadruple Evaluation w. Ref.-Pulse`" or "`1104 - Quad. Evaluation inv. w. Ref.-Pulse`".
- Enter *Division Marks* **494**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **493** | *Operation Mode Speed Sensor 2* | - | Selection | 0 - off |
| **494** | *Division Marks* | - | 1 .. 8192 | 1024 |

**Operation Modes of Parameter 493**

| | | | |
|---|---|---|---|
| 0 | - | off | Speed measurement not active |
| 4 | - | Quadruple Evaluation | Two-channel speed sensor with recognition of direction of rotation via track signals A and B; four signal edges are evaluated per division mark. |
| 104 | - | Quadruple Evaluation inverted | Like Operation Mode 4. The actual speed value is inverted (alternatively to the exchange of the track signals). |
| 1004 | - | Quadruple Evaluation w. Ref.-Pulse | Two-channel speed sensor with recognition of direction of rotation via track signals A and B; four signal edges are evaluated per division mark. The reference impulse is used for speed sensor monitoring. |
| 1104 | - | Quad. Evaluation inv. w. Ref.-Pulse | Like Operation Mode 1004. The actual speed value is inverted (alternatively to the exchange of the track signals). |

For speed sensor configuration, also refer to the documentation of the extension module used.

#### 5.1.2.3 Determination of the flux direction at startup

The flux direction of the machine is determined automatically in the following cases:

- when machine is restarted
- if machine was distorted.
- if power supply of the frequency inverter was interrupted.

When a speed sensor is used, the current orientation is determined using the captured speed sensor pulses based on the identified flux direction of the machine. Once the reference pulse was captured twice at the correct distance, the mechanical orientation of the machine is considered as known. In this way, field-oriented operation of the PMSM is possible using a speed sensor instead of a resolver.

- Set Parameter *Operation Mode Search Run* **645** to "`10 - Quick Synchronisation`", see Chapter 5.1.1.3 "Determination of the flux direction at startup".

#### 5.1.2.4 Adjustment of resolver offset

The flux direction identified upon startup has an uncertainty of some degrees. For exact field-orientation, it is recommended to adjust Parameter *Offset* **382**, like in the case of operation of PMSM with resolvers, see Chapter 4.4 "For Configuration 806 / 5xx(PMSM): Self-configuration of resolver offset".

In operation with speed sensor, the resolver offset is defined as the angle between zero pulse of the speed sensor and the flux direction. The offset is referred to the mechanical angle, not the electrical angle. For this reason, the maximum value should be 360°/number of pole pairs.

**WARNING**

**Personal and machine damage**

In the case of an unfavorable or incorrect resolver angle, the machined can be accelerated unintentionally.

- Take appropriate safety measures, see Chapter 4.4.1 "Safety measures before self-configuration of resolver offset".

#### 5.1.2.5 Act. speed source

Via Parameter *Actual Speed Source* **766**, the software enables selection of different actual speed sources for the speed controller.

With setting "`7 - Speed Sensor 2/Machine Model`", two actual speed sources can be combined. In this way, it is possible to switch from a high speed range in sensor-less field oriented operation to a lower speed range in speed sensor operation.

The switching limit between speed sensor and machine model is defined in this setting by Parameter *Frequency Limit* **624**, see Chapter 5.1.2.6 "Speed sensor monitoring".

The change to operation with speed sensor enables axle positioning in high-speed spindles for tool replacement.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **766** | *Act. speed source* | - | Selection | 3-Machine Model |

**Operation Modes of Parameter 766**

| | |
|---|---|
| 1 - Speed Sensor 1 | Actual speed of speed sensor 1 |
| 2 - Speed Sensor 2 | Actual speed of speed sensor 2 |
| 3 - Machine Model | Below the *Frequency Limit* **624**, impression of starting current (*Starting Current* **623**). Above the frequency limit, calculation of speed according to machine model (sensor-less field orientation). |
| 4 - Speedtracking EC 1 | Speed tracking Speed Sensor 1 |
| 5 - Speedtracking EC 2 | Speed tracking Speed Sensor 1 |
| 7 - Speed Sensor 2/Machine Model | Below the *Frequency Limit* **624** actual speed from Speed Sensor 2. Above the frequency limit, calculation of speed according to machine model (sensor-less field orientation). |

### 5.1.2.6 Speed sensor monitoring

In order to synchronize the machine orientation with the reference pulse, the speed sensor monitoring operation mode *Operation Mode* **760** must be set to "`2 - Error`" (default value).

In this setting, a wrong number of division marks is reported automatically and individual missing division marks are corrected using the reference pulse.

Monitoring is turned off above the *Frequency Limit* **624**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **760** | *Operation Mode* | - | 0-off<br>2-Error | 2-Error |
| **624** | *Frequency Limit* | Hz | 0.00 .. 999.99 | 2.60 |

### 5.1.2.7 Speed control with two operating ranges

Operation with Speed Sensor 2 at low torsional frequencies enables higher amplification of the speed controller for large inert tools.

In order to enable better adjustment of the properties of the speed controller at different speeds, it can be divided in two operating ranges with different amplifications and integral times, independent of the set actual speed source (see Chapter 5.1.2.5 "Act. speed source"):

- Amplification1/Integral Time1
- Amplification2/Integral Time2

The speed control changeover takes place at the torsional frequency set in Parameter *Speed Control Switch-Over Limit* **738**.

- The value set in Parameter *Speed Control Switch-Over Limit* **738** should be at least 10% smaller than the *Frequency Limit* **624**.
- Optimize *Amplification 1* **721** and *Integral Time 1* **722** for operation with speed controller.
- Optimize *Amplification 2* **723** and *Integral Time 2* **724** for sensor-less operation.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **738** | *Speed Control Switch-Over Limit* | Hz | 0.00 .. 999.99 | 55.00 |
| **721** | *Amplification 1* | - | 0.00 .. 500.00 | 5.00 |
| **722** | *Integral Time 1* | ms | 0 .. 60000 | 91 |
| **723** | *Amplification 2* | - | 0.00 .. 500.00 | 5.00 |
| **724** | *Integral Time 2* | ms | 0 .. 60000 | 182 |

### 5.1.3 Brake chopper monitoring

For PMSMs operating in the field weakening range, a sufficiently dimensioned brake chopper is required to prevent frequency inverter damage in case of a shutdown.

In operation in the field weakening range, it will be checked before any current impression of the spindle if a brake chopper is available and has a sufficiently low resistance.

For testing, the brake chopper is switched on for some ms and the response of the DC-link voltage is evaluated. If the DC-link voltage, within some ms after the brake chopper was switched on, has not dropped compared to the value before the bake chopper was switched on by the value set in Parameter *Trigger Limit BC-Test* **820**, the error "`F1427 braking resistor not connected`" will be generated. The monitoring process will take 12 ms.

The function is started automatically as soon as a negative current value is entered in Configuration `806/5xx` in Parameter *Ref. Isd Lower Limit* **744**, see Chapter 5.1.1.4 "Operation with field weakening". It is enough if there is a negative value in one of the four data sets.

Monitoring of the brake chopper can be modified or deactivated via Parameter *Trigger Limit BC-Test* **820**. If the parameter has value "`0.0 V`", the monitoring function is off.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **820** | *Trigger Limit BC-Test* | V | 0.0 .. 100.0 | 7.0 |

### 5.1.4 Detection of spindle with inverse behavior

During setup, a PMSM with an angle deviating by 180 degrees (electrical) can be identified as an inverse machine. Such machines are typically PMSM with buried magnets.

For identification, a part of the flux direction identification normally carried out upon startup of a standing machine (depending on setting of Parameter **645**, see Chapter 5.1.1.3 "Determination of the flux direction at startup") is carried out during parameter identification.

Parameter *Estimation of flux-direction - inverted* **644** is set as follows depending on the identified machine:

- "0-Off" when a "normal" machine is identified
- "1-On" when a "inverse" machine is identified

If, for example, reliable identification is not possible due to rotation of the machine during parameter identification, Parameter **644** will remain unchanged.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **644** | *estimation of flux-direction - inverted* | - | 0-Off<br>1-On | 0-Off |

## 5.2 Asynchronous machine (ASM) – Configuration 804

### 5.2.1 Operation without encoder

In sensor-less operation, the spindle application uses Configuration `410` (default sensor-less control) for asynchronous motors.

### 5.2.2 Operation with encoder

As regards the changeover between field orientation with Speed Sensor 2 and sensor-less operation, the ASM behavior is analogous with the PMSM. However, identification of the flux direction upon start and setting of a resolver offset are not required in the case of an ASM.

#### 5.2.2.1 Act. speed source

The actual speed source is selected via Parameter *Actual Speed Source* **766**, see Chapter 5.1.2.5 "Act. speed source".

#### 5.2.2.2 Speed sensor monitoring

Speed sensor monitoring is switched on by setting "`2 - Error`" of Parameter *Operation Mode* **760**, see Chapter 5.1.2.6 "Speed sensor monitoring".

#### 5.2.2.3 Limit for changeover of speed control

The speed control changeover takes place at the torsional frequency set in Parameter *Speed Control Switchover Limit* **738** , see Chapter 5.1.2.7 "Speed control ".

## 5.3 Only ACU410: overmodulation for conf. 1xx

This function optimizes the behavior of the Vf characteristic to operate ASM spindles at very high rotation frequencies and with field weakening factors.

In the Vf characteristic set **P.404** to `1`. Field orientation does not change.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **750** | *Reference modulation* | % | 3…104.5 | 104.5 |

With **P.750** the behavior of the overmodulation can be adjusted.

With **P.750** reduced to 100 % max., the output voltage is strictly sinusoidal and the stator currents are hardly distorted even in the field weakening range.

With the default 104.5 % a compromise is set between maximum output voltage in the field weakening and still tolerable distortions.

## 5.4 Only ACU410: Stall-Mode

For the function stall mode three parameters with four data sets each are created: (P.835, P.836 und P.837).

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **835** | *Current limit accelerate* | A | c…10* ü·$I_{FUN}$ | -0,1 |
| **836** | *Current limit constant profile* | A | -0,1…10* ü·$I_{FUN}$ | -0,1 |
| **837** | *Current limit decelerate* | A | -0,1…10* ü·$I_{FUN}$ | -0,1 |

With default `-0.1 A` additional current limits are deactivated individually.

In the field weakening range these additional current limits are reduced proportionally to (rated frequency/Stator frequency)².

For the Stall Mode function the current limit value controller muss der Stromgrenzwertregler eingeschaltet sein (**P.610** – `Operation mode current limit value controller = 1 - On`).

The "normal" current limit (**P.613**) is still active.

This means the current limit value controller operates with the minimum of the "normal" current limit (**P.613**) and the active current limits of **P.835**, **P.836**, **P.837** (considering (rated frequency/Stator frequency)² of course).

The new effective current limit is available in the scope function under the source **9192** (Max current of the limit value controller in stall mode).

The *Current limit constant profile* (**P.836**) is employed, if the *Max. Control Deviation* (**P.549**) is undershot.

**CAUTION**

**Operation malfunction**

It is important to set the new resulting max. current of the limit value controller (source **9192**) higher than the required magnetization current of the spindle in all operation points. If this condition is not met, the current value limit controller cannot work properly or might even reverse the type of operation (the machine accelerates instead of decelerating!).

- Ensure the correct parametrization.

To avoid this state, a test can be carried out according to the following list, albeit using much slower ramps. Then, the resulting current (as this is just the magnetization current) must always be smaller than **Q.9192** (Channel 4).

Channel 4: Source **9192** - Maximalstrom des Grenzwertregler bei Stall-Mode

Die Stromgrenzen des Stromgrenzwertreglers sind eingestellt auf:

**P.613** – *Current limit* 25 A

**P.835** – *Current limit accelerate* 150 A

**P.836** – *Current limit constant profile* 100 A

**P.837** – *Current limit decelerate* 120 A

The *rated frequency* (**P.375**) is 216 Hz.

## 5.5 Only ACU410: Auto-Reset

The auto-reset function allows to acknowledge an error automatically. When an error occurs the output stages are deactivated for several 100 ms. The inverter then synchronizes with the drive in order to shut the drive down and to be able to switch off the output stages.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **840** | *Operation mode Auto-reset* | - | 0…1 | 1 Auto-reset shutdown |

Even with active auto-reset function a possible fault is protocoled in the error protocol. If, with the auto-reset function activated, a fault cannot be automatically acknowledged within 5 s, the auto-reset function is halted and the initial fault must be acknowledged manually. The spindle then coasts to stop "normally".

In order to synchronize the inverter after a fault switch-off, the search run is used (**P.645** – *operation mode search run*). If the search run is deactivated (**P.645** set to 0 – off) the "slow" search run is used automatically instead of "Quick sync".

The search run starts with the maximum frequency parametrized (**P.419**) – According to the rotation direction before the fault switch-off.

The search run function must be completed within 15 s. Otherwise, the initial fault is signaled and the spindle coasts to stop "normally".

**NOTICE**

If the *search run* (**P.645**) is parameterized to "Quick sync" (MO 1x), a spindle can be synced only up to a rotation frequency of approx. 200 Hz.

## 5.6 Axle positioning

In operation with speed sensor 2 (with reference pulse), axle positioning is possible. Speed sensor 1 is not suitable for axle positioning due to the lower bandwidth of the inputs.

With axle positioning, the machine is stopped in an adjustable mechanical orientation. In this way, automatic tool replacement is possible even in spindles with positive-locking tool holding fixture.

Axle positioning is triggered depending on the setting of Parameter *Start Positioning of Axle* **037**. Parameter *Reference orientation* **469** enables definition of any mechanical angle for axle positioning.

Axle positioning will not start before the frequency set in Parameter *Positioning Frequency* **471** is reached. If, upon release of axle positioning, the current torsional frequency is higher than the positioning frequency, it will be reduced using a simple ramp function (without rounding) until it is below the positioning frequency.

Axle positioning by the position controller is done at the time constant set in Parameter *time constant positioning contr.* **479**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **037** | *Start Positioning of Axle* | - | Selection | 75 – S6IND |
| **469** | *Reference orientation* | Degrees | 0.0 .. 359.9 | 0.0 |
| **471** | *Positioning Frequency* | Hz | 1.00 .. 50.00 | 50.00 |
| **479** | *time constant positioning contr.* | ms | 1.00 .. 9999.99 | 20.00 |

### 5.6.1 Identification of reference point position

When the frequency inverter is switched on during commissioning, the current position of the spindle is identified by a search mode. The search mode continues for three revolutions at the set frequency *Reference Profile Frequency* **809**. As soon as the reference signal was recognized twice, the drive is positioned to the *Reference orientation* **469**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **809** | *Reference Profile Frequency* | Hz | 0.00 .. 50.00 | 1.00 |

If the motor has already turned before release of axle positioning, the frequency inverter knows the position of the reference point. In this case, positioning is carried out based on the *Reference orientation* **469** without search mode.

### 5.6.2 Definition of sense of rotation for axle positioning

Parameter *Operation Mode Homing* **810** defines the sense of rotation for positioning at standstill and the homing operation after start of the inverter.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **810** | *Operation Mode Homing* | - | Selection | 0 - Opt |

**Operation Modes of Parameter 810**

| | |
|---|---|
| 0 - Opt | Optimized direction The direction of the homing operation corresponds to the identified sense of rotation. In the case of a standing machine, the positioning operation starts with clockwise rotation. |
| 1 - Clockwise | Clockwise rotation. Homing and positioning will always start with clockwise rotation in the case of a standing machine. |
| 2 - Anticlockwise | Anticlockwise operation Homing and positioning will always start with anticlockwise rotation in the case of a standing machine. |

### 5.6.3 Status message "Target Position Reached"

Status message "`60-Target Position reached`" or *Target Position Reached* **Q.282** of the Scope function is set directly in the case of the "`POS OK`" signal, but canceled after a delay in the case of the "`POS not OK`" signal. The delay can be parameterized via *Delay: Signal POS OK* **800**.

When the position was already reached, but is no longer in the range defined by Parameter *Max positional error* **472**, error "`F1426 positioning: position fault`" is output (*Delay: Error POS not OK* **801**). If **801** is 0, the error will not be generated.

Error "`No encoder signal - F1430`" in the case of tool replacement with blocked spindle after distortion by application of the brake is suppressed in the encoder monitor when status message "`60-Target Position Reached`" is set.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| **No.** | **Identifier** | | | |
| **800** | *Delay: Signal POS OK* | ms | 0 .. 65000 | 0 |
| **801** | *Delay: Error POS not OK* | ms | 0 .. 65000 | 0 |
| **472** | *Max positional error* | Degrees | 0.1 .. 90.0 | 3.0 |

Status message "60-Target Position Reached" or *Target Position Reached* **Q.282** of the Scope function is also set if *Start Positioning of Axle* **037** has value "`7 - OFF`", but the target position was reached. However, the drive must still be powered for this.

As long as the position error is within the permissible limits and the amount of the torsional frequency is < 1 Hz, the procedure is as described above. If *Start Positioning of Axle* **037** has value "`7 - OFF`" and the reference speed is not zero, status message "`60-Target Position Reached`" or. **Q.282** will be canceled immediately regardless of the position error.

### 5.6.4 Sources of axle positioning

For the Scope function, sources *Position (error)* **Q.296** in degrees (maximal 360 Grad) and *Target Position Reached* **Q.282** are made available.

Angle [degrees]
**Q.296** *Position (Error)* (max. 360 degrees)

**Boolean values**
**Q.282** *Target Position Reached*

### 5.6.5 Actual value parameter 805

Actual value parameter *Position of Axle* **805** shows the angle of the axle referred to the reference pulse. Values in the range from 0.0° to 359.9° are displayed. After switch-on, value -1.0° will be displayed until three zero pulsed are captured at the right distance.

## 5.7 Control of acceleration ramps via digital input

### 5.7.1 Switching ramp mode on or off

Acceleration ramps can be selected via a digital input. This function is switched on or off via Parameter *Ramp Mode* **830**.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **830** | *Ramp Mode* | - | Selection | 0 – Acc./Dec. clockwise/anticlockwise |

**Operation Modes of Parameter 830**

| | | |
|---|---|---|
| 0 | - Acc./Dec. clockwise/anticlockwise | Ramp mode is switched off. Acceleration and Deceleration are controlled - depending on the sense of rotation – by Parameters:<br>*Acceleration Clockwise* **420**<br>*Deceleration Clockwise***421**<br>*Acceleration Anticlockwise***422**<br>*Deceleration Anticlockwise* **423**<br>The digital source selected in Parameter **831** is not evaluated. |
| 1 | - Acc. 2/dec. 2 | Ramp mode is switched on. Depending on the value of the digital source selected in Parameter **831**, the parameters for anticlockwise rotation or the parameters for clockwise operation are used for acceleration and deceleration, see 5.7.3 "Evaluation of digital input". |

### 5.7.2 Selection of digital source

The digital source is selected via Parameter *Acc. 2/Dec. 2* **831**. All standard digital sources are available.

| Parameter | | Unit | Setting range | Default |
|---|---|---|---|---|
| No. | Identifier | | | |
| **831** | *Acc. 2/dec. 2* | - | Selection | |

### 5.7.3 Evaluation of digital input

The current value of the digital input determines which parameter for acceleration and deceleration is used for both senses of rotation:

| | |
|---|---|
| FALSE: | Parameters *Acceleration Clockwise* **420** and *Deceleration (Clockwise)* **421** are used for clockwise and anticlockwise operation. |
| TRUE: | Parameters *Acceleration Anticlockwise* **422** and *Deceleration Anticlockwise* **423** are used for clockwise and anticlockwise operation. |

# 6 Overview of sources

The output values of the spindle function modules are available at the following sources:

**Frequency value [$s^{-1}$]**

**Q.441** – *Actual Speed*

**Q.443** – *Speed Sensor 2*

**Boolean values**

**Q.282** - *Target Position Reached*

**Q.296** - *Position (Error)*

# 7 Actual values

| Actual value parameters | | | |
|---|---|---|---|
| **No.** | **Description** | **Unit** | **Chapter** |
| 225 | Rotor Flux | % | 4.4.3 |
| 805 | Position of Axle | Degrees | 5.6.5 |

# 8 Parameter

The parameter is available in the four data sets

| Parameter | | | | | |
|---|---|---|---|---|---|
| **No.** | **Description** | **Unit** | **Setting range** | **Default** | **Chapter** |
| 037 | Start Positioning of Axle | - | Selection | 75 – S6IND | 5.3 |
| 382 | Offset | deg | -360.0 .. 360.0 | 0.0 | 4.4 |
| 383 | Voltage Constant* | mVmin | 0.0 .. 6500.0 | 0.0 | 4.4.3 |
| 412 | Local/Remote | - | Selection | 44 – Ctrl. Cont.+KP, Dir. Cont.+KP | 3.3 |
| 417 | Frequency Switch-off Limit | Hz | 0.00 .. 999.99 | 999.99 | 4.4.1 |
| 469 | Reference orientation | Degrees | 0.0 .. 359.9 | 0.0 | 5.3 |
| 471 | Positioning Frequency | Hz | 1.00 .. 50.00 | 50.00 | 5.3 |
| 472 | Max positional error | Degrees | 0.1 .. 90.0 | 3.0 | 5.6.3 |
| 479 | time constant positioning contr. | ms | 1.00 .. 9999.99 | 20.00 | 5.3 |
| 493 | Operation Mode Speed Sensor 2 | - | Selection | 0 - off | 5.1.2.2 |
| 494 | Division Marks | - | 1 .. 8192 | 1024 | 5.1.2.2 |
| 624 | Frequency Limit | Hz | 0.00 .. 999.99 | 2.60 | 5.1.2.6 |
| 644 | estimation of flux-direction - inverted* | - | 0-Off<br>1-On | 0-Off | 5.1.4 |
| 645 | Operation Mode Search Run | - | Selection | 0 - off | 5.1.1.3 |
| 721 | Amplification 1 | - | 0.00 .. 500.00 | 5.00 | 5.1.2.7 |
| 722 | Integral Time 1 | ms | 0 .. 60000 | 91 | 5.1.2.7 |
| 723 | Amplification 2 | - | 0.00 .. 500.00 | 5.00 | 5.1.2.7 |
| 724 | Integral Time 2 | ms | 0 .. 60000 | 182 | 5.1.2.7 |
| 728 | Current Limit | A | 0.0 .. 6.0 | 6.0 | 4.4.1 |
| 738 | Operation Mode | Hz | 0.00 .. 999.99 | 55.00 | 5.1.2.7 |
| 743 | Ref. Isd Upper Limit | A | 0.0 .. 6.0 | 0.0 | 5.1.1.2 |
| 744 | Ref. Isd lower limit | A | -3.0 .. 3.0 | 0.0 | 5.1.1.2 |
| 760 | Operation mode | - | 0-off<br>2-Error | 2-Error | 5.1.2.6 |
| 766 | Act. speed source | - | Selection | 3-Machine Model | 5.1.2.5 |
| 800 | Delay: Signal POS OK | ms | 0 .. 65000 | 0 | 5.6.3 |
| 801 | Delay: Error POS not OK | ms | 0 .. 65000 | 0 | 5.6.3 |
| 809 | Reference Profile Frequency | Hz | 0.00 .. 50.00 | 1.00 | 5.6.1 |
| 810 | Operation Mode Homing | - | Selection | 0 - Opt | 5.6.2 |
| 820 | Trigger Limit BC-Test* | V | 0.0 .. 100.0 | 7.0 | 5.1.3 |
| 830 | Ramp Mode | - | Selection | 0 – Acc./Dec. clockwise/anticlockwise | 5.7.1 |
| 831 | Acc. 2/dec. 2 active | - | Selection | | 5.7.2 |
| 840 | | | | | |

*For PMSM only

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