ABB drives

# User's manual
ACS320 drives (0.5 to 30 hp)


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# List of related manuals

| Drive manuals | Code (English) |
|---|---|
| *ACS320 drives (0.5 to 30 hp) user's manual* | 3AUA0000062599 |
| *ACS320 Short Form User's Manual* | 3AUA0000086933 |

| Option manuals and guides | |
|---|---|
| *MFDT-01 FlashDrop user's manual* | 3AFE68591074 |
| *MREL-01 output relay module user's manual* | 3AUA0000035974 |
| *MUL1-R1 installation instructions for ACS150, ACS310, ACS320, ACS350 and ACS355* | 3AFE68642868 |
| *MUL1-R3 installation instructions for ACS310, ACS320, ACS350 and ACS355* | 3AFE68643147 |
| *MUL1-R4 installation instructions for ACS310, ACS320, ACS350 and ACS355* | 3AUA0000025916 |
| *SREA-01 Ethernet adapter module quick start-up guide* | 3AUA0000042902 |
| *SREA-01 Ethernet adapter module user's manual* | 3AUA0000042896 |

| Maintenance manuals | |
|---|---|
| *Guide for capacitor reforming in ACS50, ACS55, ACS150, ACS310, ACS350, ACS355, ACS550, ACH550 and R1-R4 OINT-/SINT-boards* | 3AFE68735190 |

You can find manuals and other product documents in PDF format on the Internet. See section *Document library on the Internet* on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

# User’s manual

## ACS320 drives (0.5 to 30 hp)





3AUA0000062599 Rev D
EN
EFFECTIVE: 2014-06-30

# Table of contents

## *6. Electrical installation*



## *7. Installation checklist*

## 8. Start-up



## 9. Program features

## 10. Actual signals and parameters

## 11. Fieldbus control

## 12. Fault tracing



## 13. Maintenance and hardware diagnostics



## 14. Technical data

## *15. Dimension drawings*



## *16. Index*

## *Further information*

1

# Safety

## Contents of this chapter

The chapter contains safety instructions which you must follow when installing, operating and servicing the drive. If ignored, physical injury or death may follow, or damage may occur to the drive, motor or driven equipment. Read the safety instructions before you work on the drive.

## Use of warning symbols

Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment, and advise on how to avoid the danger. The following warning symbols are used in this manual:

**WARNING! Danger; electricity** warns of hazards from electricity which can cause physical injury and/or damage to the equipment.

**WARNING! General danger** warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment.

# Safety in installation and maintenance

These warnings are intended for all who work on the drive, motor cable or motor.

## Electrical safety

**WARNING!** If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.

- Only qualified electricians are allowed to install and maintain the drive!
- Never work on the drive, motor cable or motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
- Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that there is no voltage between the drive input phases U1, V1 and W1 and the ground.
- Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may carry dangerous voltage even when the input power of the drive is switched off.
- Do not make any insulation or voltage withstand tests on the drive.
- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system is connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive. See page *46*. **Note:** When the internal EMC filter is disconnected, the drive is not EMC compatible.
- Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged. See page *46*. **Note:** When the internal EMC filter is disconnected, the drive is not EMC compatible.
- All ACS320 Drive End Grounding screws are removed at the factory. See *Product overview* for location details.
- All ELV (extra low voltage) circuits connected to the drive must be used within a zone of equipotential bonding, in other words, within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by a proper factory grounding.

**Notes:**

- Even when the motor is stopped, dangerous voltage is present at the power circuit terminals U1, V1, W1 and U2, V2, W2.
- For more technical information, contact the factory or your local ABB sales representative.

### General safety

**WARNING!** If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.

- Never attempt to repair a malfunctioning drive; contact your local ABB representative or Authorized Service Center for service support.
- Make sure that dust from drilling does not enter the drive during the installation. Electrically conductive dust inside the drive may cause damage or lead to malfunction.
- Ensure sufficient cooling.

## Safe start-up and operation

These warnings are intended for all who plan the operation, start up or operate the drive.

### General safety

**WARNING!** If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.

- Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive. The drive can be adjusted to operate the motor at speeds above and below the speed provided by connecting the motor directly to the power line.
- Do not activate automatic fault reset functions if dangerous situations can occur. When activated, these functions will reset the drive and resume operation after a fault.
- Do not control the drive with an AC contactor or disconnecting device (disconnecting means); use the control panel start and stop keys and or external commands (I/O or fieldbus). The maximum allowed number of charging cycles of the DC capacitors (in other words, power-ups by applying power) is two per minute and the maximum total number of chargings is 15,000.

**Notes:**

- If an external source for start command is selected and it is ON, the drive will start immediately after an input voltage break or fault reset unless the drive is configured for 3-wire (a pulse) start/stop.
- When the control location is not set to local (LOC not shown on the display), the stop key on the control panel will not stop the drive. To stop the drive using the control panel, first press the LOC/REM key and then the stop key .

2

# Introduction to the manual

## Contents of this chapter

The chapter describes applicability, target audience and purpose of this manual. It describes the contents of this manual and refers to a list of related manuals for more information. The chapter also contains a flowchart of steps for checking the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual.

## Applicability

The manual is applicable to the ACS320 drive firmware version 4.03c or later. See parameter *3301 FIRMWARE* on page *200*.

## Target audience

The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

The manual is written for readers worldwide. Both SI and imperial units are shown. Special US instructions for installations in the United States are given.

## Purpose of the manual

This manual provides information needed for planning the installation, installing, commissioning, using and servicing the drive.

## Contents of this manual

The manual consists of the following chapters:

- *Safety* (page *15*) gives safety instructions you must follow when installing, commissioning, operating and servicing the drive.
- *Introduction to the manual* (this chapter, page *19*) describes applicability, target audience, purpose and contents of this manual. It also contains a quick installation and commissioning flowchart.
- *Operation principle and hardware description* (page *23*) describes the operation principle, layout, power connections and control interfaces, type designation label and type designation information in short.
- *Mechanical installation* (page *29*) tells how to check the installation site, unpack, check the delivery and install the drive mechanically.
- *Planning the electrical installation* (page *35*) tells how to check the compatibility of the motor and the drive and select cables, protections and cable routing.
- *Electrical installation* (page *45*) tells how to check the insulation of the assembly and the compatibility with IT (ungrounded) and corner grounded TN systems as well as connect power cables, control cables and embedded fieldbus.
- *Installation checklist* (page *55*) contains a checklist for checking the mechanical and electrical installation of the drive.
- *Start-up* (page *57*) tells how to start up the drive as well as how to start, stop, change the direction of the motor rotation and adjust the motor speed through the I/O interface. In addition, the chapter gives a brief description of each application macro together with a wiring diagram showing the default control connections. It also explains how to save a user macro and how to recall it.
- *Program features* (page *93*) describes program features with lists of related user settings, actual signals, and fault and alarm messages.
- *Actual signals and parameters* (page *133*) describes actual signals and parameters. It also lists the default values for the different macros.
- *Fieldbus control* (page *267*) tells how the drive can be controlled by external devices over a communication network using embedded fieldbus
- *Fault tracing* (page *339*) tells how to reset faults and view fault history. It lists all alarm and fault messages including the possible cause and corrective actions.
- *Maintenance and hardware diagnostics* (page *357*) contains preventive maintenance instructions and LED indicator descriptions.
- *Technical data* (page *363*) contains technical specifications of the drive, for example, ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE and other marks.
- *Dimension drawings* (page *379*) shows dimension drawings of the drive.

## Related documents

See *List of related manuals* on page *2*.

## Categorization by frame size

The ACS320 drive is manufactured in frame sizes R0…R4. Some instructions and other information which only concern certain frame sizes are marked with the symbol of the frame size (R0…R4). To identify the frame size of your drive, see the table in section *Ratings, types and voltages (for North American market)* on page *364* or in section *Ratings, types and voltages (for European market)* on page *365*.

# Quick installation and commissioning flowchart

| Task | See |
|---|---|
| Identify the frame size of your drive: R0…R4. | *Operation principle and hardware description*: *Type designation key* on page *27*<br>*Technical data*: *Ratings, types and voltages (for North American market)* on page *364* or in section *Ratings, types and voltages (for European market)* on page *365* |
| Plan the installation: select the cables, etc.<br>Check the ambient conditions, ratings and required cooling air flow. | *Planning the electrical installation* on page *35*<br>*Technical data* on page *363* |
| Unpack and check the drive. | *Mechanical installation: Checking the delivery* on page *31* |
| If the drive will be connected to an IT (ungrounded) or corner grounded system, check that the internal EMC filter is not connected. | *Operation principle and hardware description*: *Type designation key* on page *27*<br>*Electrical installation*: *Checking the compatibility with IT (ungrounded) and corner grounded TN systems* on page *46* |
| Install the drive on a wall or in a cabinet. | *Mechanical installation* on page *29* |
| Route the cables. | *Planning the electrical installation*: *Routing the cables* on page *41* |
| Check the insulation of the input cable and the motor and the motor cable. | *Electrical installation*: *Checking the insulation of the assembly* on page *45* |
| Connect the power cables. | *Electrical installation*: *Connecting the power cables* on page *47* |
| Connect the control cables. | *Electrical installation*: *Connecting the control cables* on page *49* |
| Check the installation. | *Installation checklist* on page *55* |
| Commission the drive. | *Start-up* on page *57* |

# 3

# Operation principle and hardware description

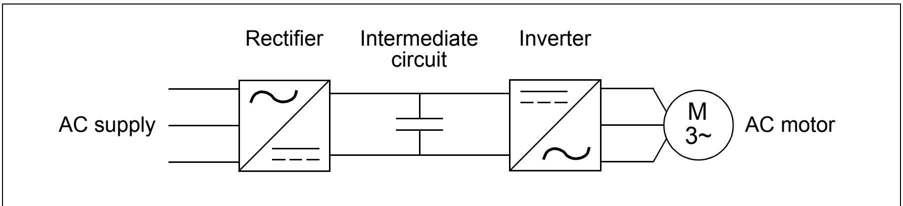
## Contents of this chapter

The chapter briefly describes the operation principle, layout, type designation label and type designation information. It also shows a general diagram of power connections and control interfaces.

## Operation principle

The ACS320 is a wall or cabinet mountable drive for controlling AC motors.

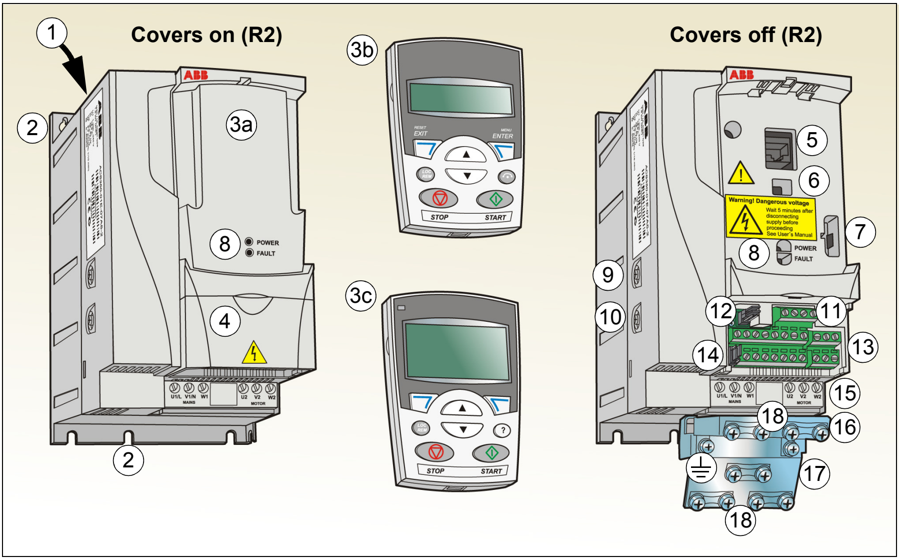
The figure below shows the simplified main circuit diagram of the drive. The rectifier converts three-phase AC voltage to DC voltage. The capacitor bank of the intermediate circuit stabilizes the DC voltage. The inverter converts the DC voltage back to AC voltage for the AC motor.



# Product overview

## Layout

The layout of the drive is presented below. The figure shows a frame size R2 drive. The construction of the different frame sizes R0…R4 varies to some extent.

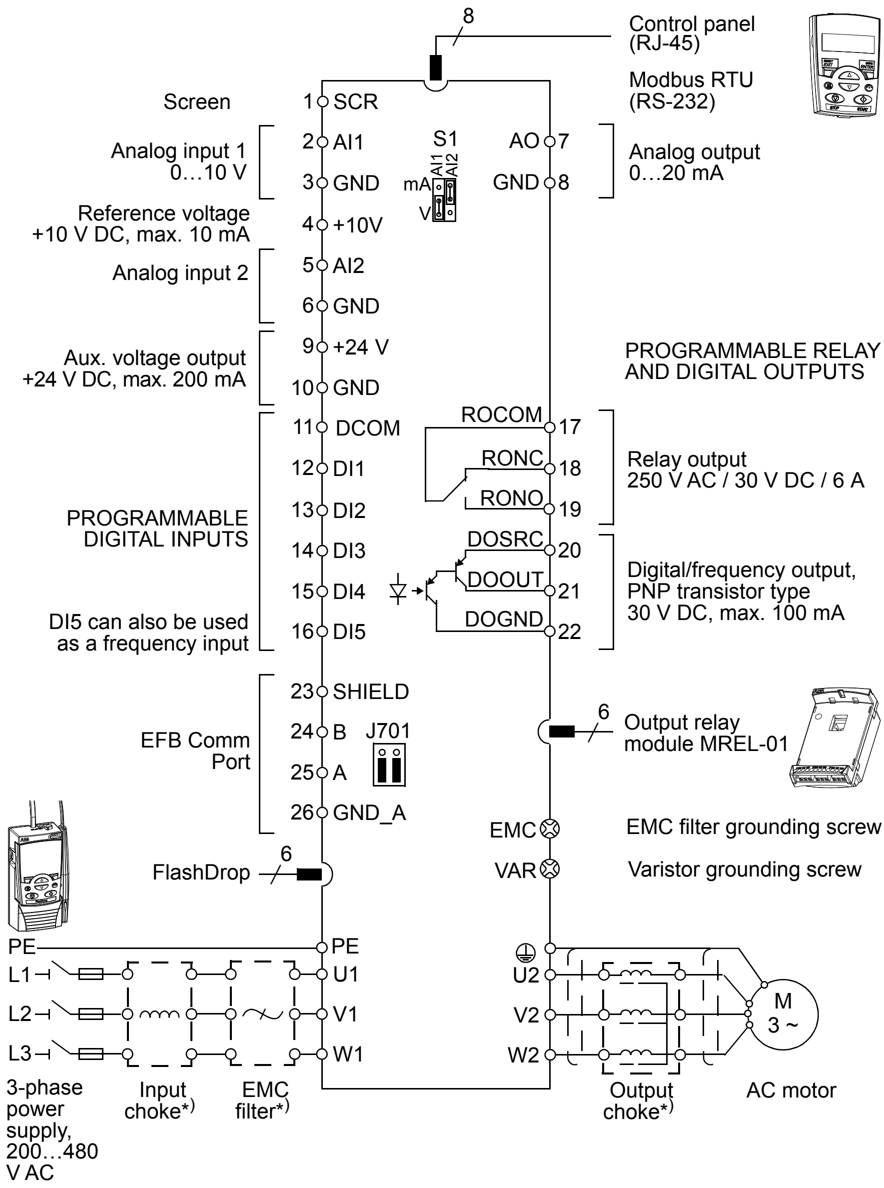



| | |
|---|---|
| 1 | Cooling outlet through top cover |
| 2 | Mounting holes |
| 3 | Panel cover (a) / Basic control panel (b) / Assistant control panel (c) |
| 4 | Terminal cover |
| 5 | Panel connection |
| 6 | Option connection |
| 7 | FlashDrop connection |
| 8 | Power OK and Fault LEDs. See section *LEDs* on page *361*. |

| | |
|---|---|
| 9 | EMC filter grounding screw (EMC). **Note:** The screw is on the front in frame size R4. |
| 10 | Varistor grounding screw (VAR) |
| 11 | RS-485 connection |
| 12 | Jumper J701 for connecting RS-485 termination resistor |
| 13 | I/O connections |
| 14 | Switch S1 for selecting voltage or current for analog inputs |
| 15 | Input power connection (U1, V1, W1) and motor connection (U2, V2, W2). (Braking chopper connection is disabled.) |
| 16 | I/O clamping plate |
| 17 | Clamping plate |
| 18 | Clamps |

## Power connections and control interfaces

The diagram gives an overview of connections. I/O connections are parameterable.

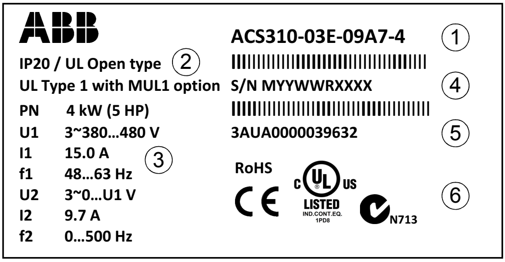



*) Optional, not provided with the drive.
**Note:** For 1-phase power supply, connect power to U1/L and V1/N terminals.

See *Application macros* on page *77* for I/O connections for the different macros and chapter *Electrical installation* on page *45* for installation in general.

## Type designation label

The type designation label is attached to the left side of the drive. An example label and explanation of the label contents are shown below.




| | |
|---|---|
| 1 | Type designation, see section *Type designation key* on page *27* |
| 2 | Degree of protection by enclosure (IP and UL/NEMA) |
| 3 | Nominal ratings, see section *Ratings, types and voltages (for North American market)* on page *364* or *Ratings, types and voltages (for European market)* on page *365*. |
| 4 | Serial number of format MYYWWRXXXX, where<br>M: Manufacturer<br>YY: 09, 10, 11, … for 2009, 2010, 2011, …<br>WW: 01, 02, 03, … for week 1, week 2, week 3, …<br>R: A, B, C, … for product revision number<br>XXXX: Integer starting every week from 0001 |
| 5 | ABB MRP code of the drive |
| 6 | CE marking and C-Tick, C-UL US and RoHS marks (the label of your drive shows the valid markings) |

# Type designation key

The type designation contains information on the specifications and configuration of the drive. You find the type designation on the type designation label attached to the drive. The first digits from the left express the basic configuration, for example ACS320-03U-09A7-4. The optional selections are given after that, separated by + signs, for example +J404. The explanations of the type designation selections are described below.

ACS320-03X-08A8-4+J404+...

**ACS320 product series**

**1-phase/3-phase**

01 = 1-phase input
03 = 3-phase input

**Configuration**

E = EMC filter connected, 50 Hz frequency
U = EMC filter disconnected, 60 Hz frequency

**Output current rating**

In format xxAy, where xx indicates the integer part and y the fractional part, eg, 08A8 means 8.8 A. For more information on ratings, types and voltages, see sections starting on page *363*.

**Input voltage range**

2 = 200 … 240 V AC
4 = 380 … 480 V AC

**Options**

J404 = ACS-CP-C basic control panel [1) 2)]
J400 = ACH-CP-B assistant control panel [1)]
R700 = ACS320 user's manual in English (3AUA0000062599 [EN])
E202 = Low harmonic RFI filter (available for European market only)

1) The ACS320 is compatible with panels that have the following panel revisions and panel firmware versions.

| Panel type | Type code | Panel revision | Panel firmware version |
|---|---|---|---|
| Basic control panel [2)] | ACS-CP-C | M or later | 1.13 or later |
| Assistant control panel | ACH-CP-B | X or later | 2.04 or later |

2) Available for North American market only.

4

# Mechanical installation

## Contents of this chapter

The chapter tells how to check the installation site, unpack, check the delivery and install the drive mechanically.

## Checking the installation site

The drive may be installed on the wall or in a cabinet. Check the enclosure requirements for the need to use the NEMA 1 option in wall installations (see chapter *Technical data* on page *363*.

The drive can be installed in three different ways, depending on the frame size:

a) back mounting (all frame sizes)

b) side mounting (frame sizes R0…R2)

c) DIN rail mounting (all frame sizes).

The drive must be installed in an upright position.

Check the installation site according to the requirements below. Refer to chapter *Dimension drawings* on page *379* for frame details.

### Requirements for the installation site

#### Operation conditions

See chapter *Technical data* on page *363* for the allowed operation conditions of the drive.

#### Wall

The wall should be as close to vertical and even as possible, of non-flammable material and strong enough to carry the weight of the drive.

### Floor

The floor/material below the installation should be non-flammable.

### Free space around the drive

The required free space for cooling above and below the drive is 75 mm (3 in). No free space is required on the sides of the drive, so drives can be installed side by side.

## Required tools

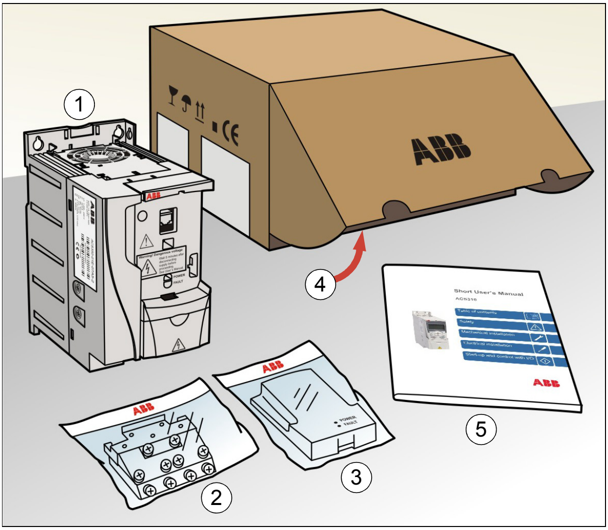
To install the drive, you need the following tools:

- screwdrivers (as appropriate for the mounting hardware used)
- wire stripper
- tape measure
- drill (if the drive will be installed with screws/bolts)
- mounting hardware: screws or bolts (if the drive will be installed with screws/bolts). For the number of screws/bolts, see *With screws* on page 32.

## Unpacking

The drive (1) is delivered in a package that also contains the following items (frame size R2 shown in the figure):

- plastic bag (2) including clamping plate (also used for I/O cables in frame sizes R3 and R4), I/O clamping plate (for frame sizes R0…R2), clamps and screws
- panel cover (3)
- mounting template, integrated into the package (4)
- user's manual (5)
- possible options.




## Checking the delivery

Check that there are no signs of damage. Notify the shipper immediately if damaged components are found.

Before attempting installation and operation, check the information on the type designation label of the drive to verify that the drive is of the correct type. See section *Type designation label* on page 26.

# Installing

The instructions in this manual cover drives with the IP20 degree of protection. To comply with NEMA 1, use the MUL-R1, MUL-R3 or MUL-R4 option kit, which is delivered with multilingual installation instructions (3AFE68642868, 3AFE68643147 or 3AUA0000025916, respectively).

## Install the drive

Install the drive with screws or on a DIN rail as appropriate.

**Note:** Make sure that dust from drilling does not enter the drive during the installation.

### With screws

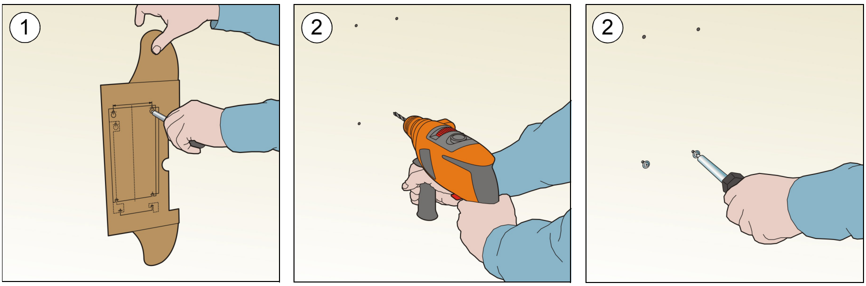
1. Mark the hole locations using for example the mounting template cut out from the package.

   The locations of the holes are also shown in the drawings in chapter *Dimension drawings* on page *379*. The number and location of the holes used depend on how the drive is installed:

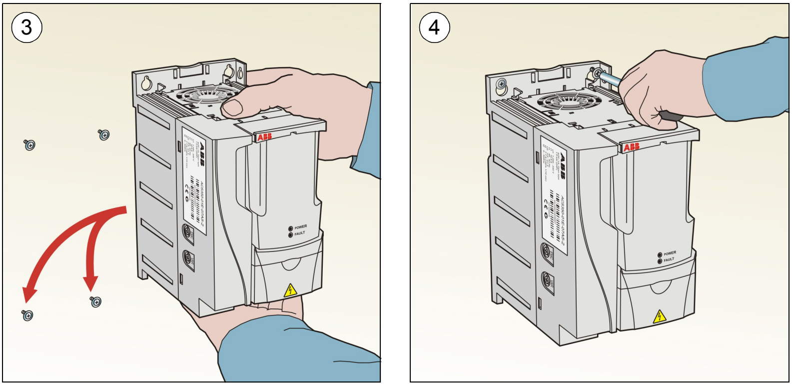
   a) back mounting (frame sizes R0…R4): four holes

   b) side mounting (frame sizes R0…R2): three holes; one of the bottom holes is located in the clamping plate.

2. Fix the screws or bolts to the marked locations.

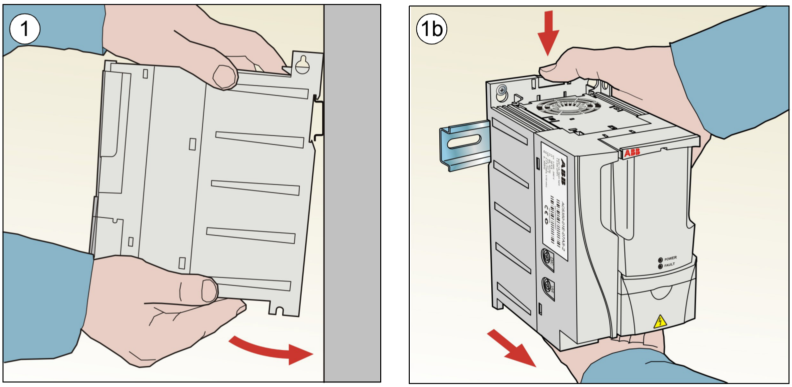


3. Position the drive onto the screws on the wall.
4. Tighten the screws in the wall securely.



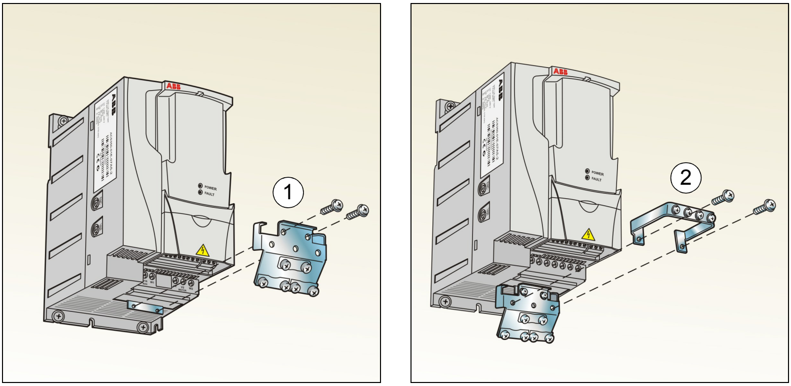

### On DIN rail

- Click the drive to the rail.
- To detach the drive, press the release lever on top of the drive (1b).



## Fasten clamping plates

1. Fasten the clamping plate to the plate at the bottom of the drive with the provided screws.
2. For frame sizes R0…R2, fasten the I/O clamping plate to the clamping plate with the provided screws.



5

# Planning the electrical installation

## Contents of this chapter

The chapter contains the instructions that you must follow when checking the compatibility of the motor and drive, and selecting cables, protections, cable routing and way of operation for the drive.

**Note:** The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

## Implementing the AC power line connection

See the requirements in section *Electric power network specification* on page *371*. Use a fixed connection to the AC power line.

**WARNING!** As the leakage current of the device typically exceeds 3.5 mA, a fixed installation is required according to IEC 61800-5-1.

# Selecting the supply disconnecting device (disconnecting means)

Install a hand-operated supply disconnecting device (disconnecting means) between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work.

## European union

To meet the European Union Directives, according to standard EN 60204-1, Safety of Machinery, the disconnecting device must be one of the following types:

- a switch-disconnector of utilization category AC-23B (EN 60947-3)
- a disconnector having an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
- a circuit breaker suitable for isolation in accordance with EN 60947-2.

## North America

The ACS320 drive does not include a disconnect device. A means to disconnect input power must be installed between the AC power source and the ACS320 drive. This branch circuit protection must:

- be sized to conform to applicable safety regulations, including but not limited to, both National and local electrical codes.
- be locked in an open position during installation and maintenance work.

The disconnect device must not be used to control the motor. Instead use the control panel, or commands to the I/O terminals for motor control.

## Other regions

The disconnecting device must conform to the applicable safety regulations.

# Checking the compatibility of the motor and drive

Check that the 3-phase AC induction motor and the drive are compatible according to the rating table in section *Ratings, types and voltages (for North American market)* on page *364* or in section *Ratings, types and voltages (for European market)* on page *365*. The table lists the typical motor power for each drive type.

# Selecting the power cables

## General rules

Dimension the input power and motor cables **according to local regulations**.

- The input power and the motor cables must be able to carry the corresponding load currents. See section *Ratings, types and voltages (for North American market)* on page *364* or in section *Ratings, types and voltages (for European market)* on page *365* for the rated currents.
- The cable must be rated for at least 70 °C maximum permissible temperature of the conductor in continuous use. For US, see section *Additional North American requirements* on page *39*.
- The conductivity of the PE conductor must be equal to that of the phase conductor (same cross-sectional area).
- 600 V AC cable is accepted for up to 500 V AC.
- Refer to chapter *Technical data* on page *363* for the EMC requirements.

A symmetrical shielded motor cable (see the figure below) must be used to meet the EMC requirements of the CE and C-Tick marks.

A four-conductor system is allowed for input cabling, but a shielded symmetrical cable is recommended.

Compared to a four-conductor system, the use of a symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as motor bearing currents and wear.

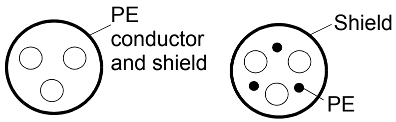
## Alternative power cable types

Power cable types that can be used with the drive are presented below.

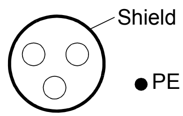
**Motor cables**

(recommended for input cables also)

Symmetrical shielded cable: three phase conductors, a concentric or otherwise symmetrically constructed PE conductor and a shield

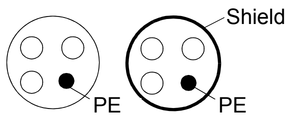



**Note:** A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.




**Allowed as input cables**

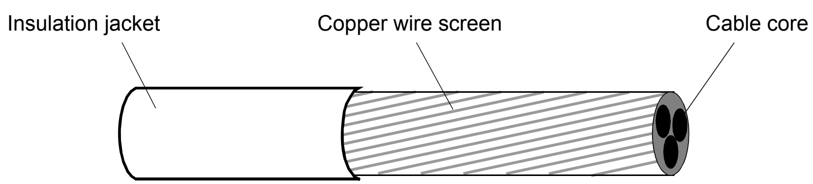
A four-conductor system: three phase conductors and a protective conductor




## Motor cable shield

To function as a protective conductor, the shield must have the same cross-sectional area as the phase conductors when they are made of the same metal.

To effectively suppress radiated and conducted radio-frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires. The better and tighter the shield, the lower the emission level and bearing currents.



## Additional North American requirements

Type MC continuous corrugated aluminium armor cable with symmetrical grounds or shielded power cable is recommended for the motor cables if metallic conduit is not used.

The power cables must be rated for 75 °C (167 °F).

### Conduit

Where conduits must be coupled together, bridge the joint with a ground conductor bonded to the conduit on each side of the joint. Bond the conduits also to the drive enclosure. Use separate conduits for input power, motor and control wiring. Do not run motor wiring from more than one drive in the same conduit.

### Armored cable / shielded power cable

Six-conductor (three phases and three ground) type MC continuous corrugated aluminium armor cable with symmetrical grounds is available from the following suppliers (trade names in parentheses):

- Anixter Wire & Cable (Philsheath)
- BICC General Corp (Philsheath)
- Rockbestos Co. (Gardex)
- Oaknite (CLX).

Shielded power cable is available from the following suppliers:

- Belden
- LAPPKABEL (ÖLFLEX)
- Pirelli.

# Selecting the control cables

## General rules

All analog control cables and the cable used for the frequency input must be shielded.

Use a double-shielded twisted pair cable (figure a, for example JAMAK by Draka NK Cables) for analog signals. Employ one individually shielded pair for each signal. Do not use common return for different analog signals.

A double-shielded cable is the best alternative for low-voltage digital signals, but a single-shielded or unshielded twisted multipair cable (figure b) is also usable. However, for frequency input, always use a shielded cable.


Double-shielded twisted multipair cable

Single-shielded twisted multipair cable

Run analog and digital signals in separate cables.

Relay-controlled signals, providing their voltage does not exceed 48 V, can be run in the same cables as digital input signals. It is recommended that the relay-controlled signals are run as twisted pairs.

Never mix 24 V DC and 115/230 V AC signals in the same cable.

## Relay cable

The cable type with braided metallic screen (for example ÖLFLEX by LAPPKABEL) has been tested and approved by ABB.

## Control panel cable

In remote use, the cable connecting the control panel to the drive must not exceed 3 m (10 ft). The cable type tested and approved by ABB is used in control panel option kits.

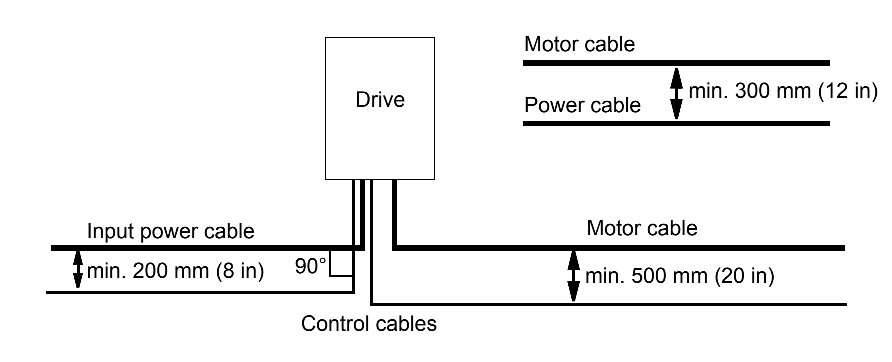
## Routing the cables

Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. It is recommended that the motor cable, input power cable and control cables are installed on separate trays. Avoid long parallel runs of motor cables with other cables to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.

Where control cables must cross power cables make sure that they are arranged at an angle as near to 90 degrees as possible.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminium tray systems can be used to improve local equalizing of potential.

A diagram of the cable routing is shown below.




### Control cable ducts

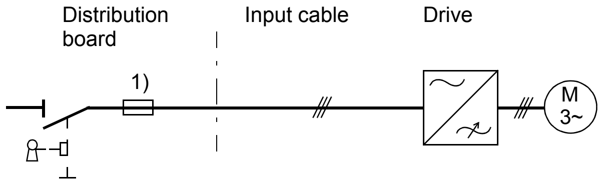

Not allowed unless the 24 V cable is insulated for 230 V or insulated with an insulation sleeving for 230 V.

Lead 24 V and 230 V control cables in separate ducts inside the cabinet.

# Protecting the drive, input power cable, motor and motor cable in short circuit situations and against thermal overload

## Protecting the drive and input power cable in short-circuit situations

Arrange the protection according to the following guidelines.

| Circuit diagram | Short-circuit protection |
|---|---|
|   | Protect the drive and input cable with fuses or ABB manual motor starter. |

Size the fuses according to instructions given in chapter *Technical data* on page *363*. The fuses will protect the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

## Protecting the motor and motor cable in short-circuit situations

The drive protects the motor and motor cable in a short-circuit situation when the motor cable is dimensioned according to the nominal current of the drive. No additional protection devices are needed.

## Protecting the drive, motor cable and input power cable against thermal overload

The drive protects itself and the input and motor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. No additional thermal protection devices are needed.

**WARNING!** If the drive is connected to multiple motors, a separate thermal overload switch or a circuit breaker must be used for protecting each cable and motor. These devices may require a separate fuse to cut off the short-circuit current.

## Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. It is also possible to connect a motor temperature measurement to the drive. The user can tune both the thermal model and the temperature measurement function further by parameters.

The most common temperature sensors are:

- motor sizes IEC180…225: thermal switch (for example Klixon)
- motor sizes IEC200…250 and larger: PTC or Pt100.

For more information on the thermal model, see section *Motor thermal protection* on page *112*. For more information on the temperature measurement function see section *Motor temperature measurement through the standard I/O* on page *121*.

## Using residual current devices (RCD) with the drive

ACS320-03x drives are suitable to be used with residual current devices of Type B. Other measures for protection in case of direct or indirect contact, such as separation from the environment by double or reinforced insulation or isolation from the supply system by a transformer, can also be applied.

## Implementing a bypass connection

**WARNING!** Never connect the supply power to the drive output terminals U2, V2 and W2. Power line voltage applied to the output can result in permanent damage to the drive.

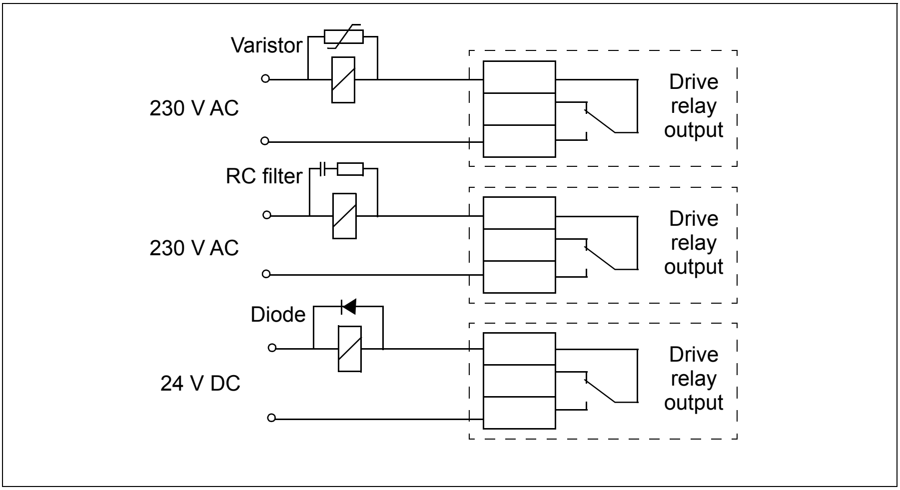
If frequent bypassing is required, employ mechanically connected switches or contactors to ensure that the motor terminals are not connected to the AC power line and drive output terminals simultaneously.

## Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off.

Equip inductive loads with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the EMC emission at switch-off. If not suppressed, the disturbances may connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible. Do not install protective components at the I/O terminal block.



6

# Electrical installation

## Contents of this chapter

The chapter tells how to check the insulation of the assembly and the compatibility with IT (ungrounded) and corner grounded TN systems as well as connect power cables, control cables and embedded fieldbus.

**WARNING!** Obey the safety instructions. See chapter *Safety* on page *15*. If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.
Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.

## Checking the insulation of the assembly

### Drive

Do not make any voltage tolerance or insulation resistance tests (for example hi-pot or megger) on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

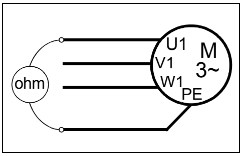
### Input power cable

Check the insulation of the input power cable according to local regulations before connecting to the drive.

### Motor and motor cable

Check the insulation of the motor and motor cable as follows:

1. Check that the motor cable is connected to the motor and disconnected from the drive output terminals U2, V2 and W2.
2. Measure the insulation resistance between each phase conductor and the Protective Earth (PE) conductor using a measuring voltage of 500 V DC. The insulation resistance of an ABB motor must exceed 10 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions.

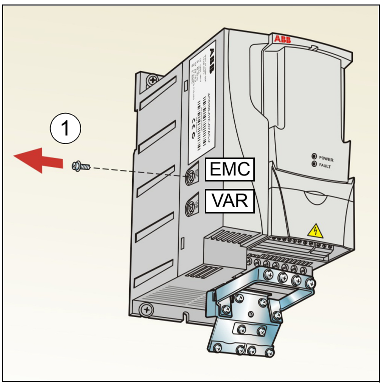



**Note:** Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.

## Checking the compatibility with IT (ungrounded) and corner grounded TN systems

**WARNING!** If a drive whose EMC filter is not disconnected is installed on an IT system (an ungrounded power system or a high resistance-grounded [over 30 ohms] power system), the system will be connected to ground potential through the EMC filter capacitors of the drive. This may cause danger or damage the drive. If a drive whose EMC filter is not disconnected is installed on a corner grounded TN system, the drive will be damaged.

1. If you have an IT (ungrounded) or corner grounded TN system, disconnect the internal EMC filter by removing the EMC screw. For 3-phase U-type drives (with type designation ACS320-03U-), the EMC screw is already removed at the factory and replaced by a plastic one.

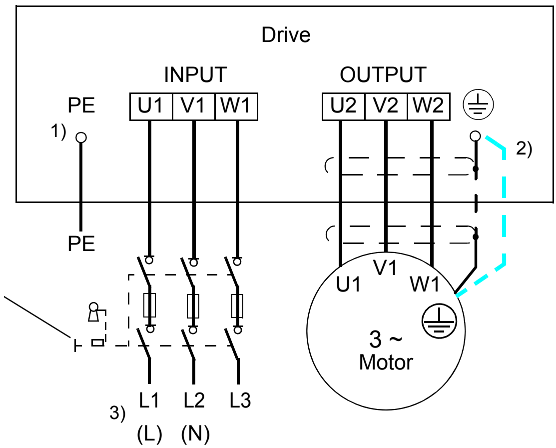



**Note:** In frame size R4 the EMC screw is located to the right of terminal W2.

# Connecting the power cables

## Connection diagram

For alternatives, see section *Selecting the supply disconnecting device (disconnecting means)* on page *36*.




1. Ground the other end of the PE conductor at the distribution board.
2. Use a separate grounding cable if the conductivity of the cable shield is insufficient (smaller than the conductivity of the phase conductor) and there is no symmetrically constructed grounding conductor in the cable. See section *Selecting the power cables* on page *37*.
3. L and N are connection markings for the 1-phase power supply.

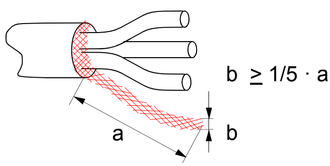
**Notes:**

- Do not use an asymmetrically constructed motor cable.
- If there is a symmetrically constructed grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends.
- Route the motor cable, input power cable and control cables separately. For more information, see section *Routing the cables* on page *41*.

### Grounding of the motor cable shield at the motor end

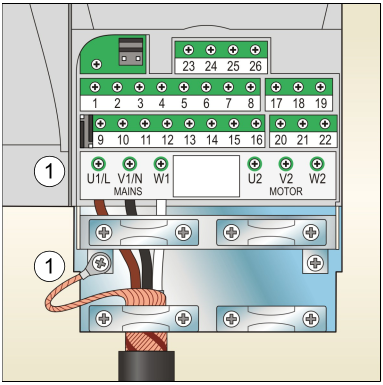
For minimum radio frequency interference:

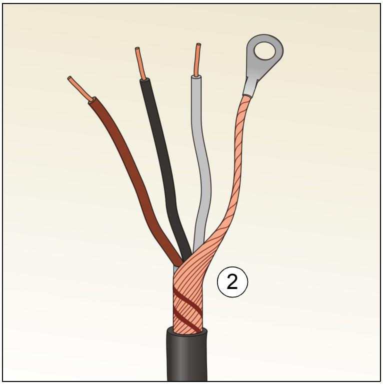
- ground the cable by twisting the shield as follows: flattened width ≥ 1/5 · length
- or ground the cable shield 360 degrees at the lead-through of the motor terminal box.

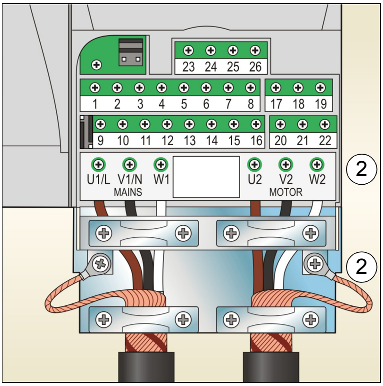


## Connection procedure

1. Fasten the grounding conductor (PE) of the input power cable under the grounding clamp. Connect the phase conductors to the U1, V1 and W1 terminals. Use a tightening torque of 0.8 N·m (7 in-lb) for frame sizes R0…R2, 1.7 N·m (15 in-lb) for R3, and 2.5 N·m (22 in-lb) for R4.
2. Strip the motor cable and twist the shield to form as short a pigtail as possible. Fasten the twisted shield under the grounding clamp. Connect the phase conductors to the U2, V2 and W2 terminals. Use a tightening torque of 0.8 N·m (7 in-lb) for frame sizes R0…R2, 1.7 N·m (15 in-lb) for R3, and 2.5 N·m (22 in-lb) for R4.
3. Secure the cables outside the drive mechanically.



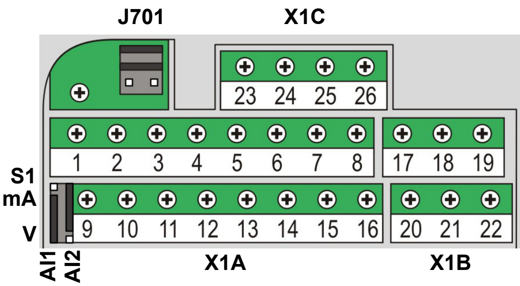



# Connecting the control cables

## I/O terminals

The figure below shows the I/O terminals. Tightening torque is 0.4 N·m / 3.5 in-lb.




**J701:** Connects 120 ohm termination resistor. See page *54*.

**S1:** Selects voltage or current as the signal types for analog inputs AI1 and AI2.

**X1A:**
1: SCR
2: AI1
3: GND
4: +10 V
5: AI2
6: GND
7: AO
8: GND
9: +24 V
10: GND
11: DCOM
12: DI1
13: DI2
14: DI3
15: DI4
16: DI5 digital or frequency input

**X1B:**
17: ROCOM
18: RONC
19: RONO
20: DOSRC
21: DOOUT
22: DOGND

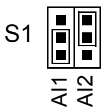
**X1C:**
23: SCR
24: B
25: A
26: GND_A

**WARNING!** All ELV (Extra Low Voltage) circuits connected to the drive must be used within a zone of equipotential bonding, in other words, within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by a proper factory grounding.

The terminals on the control board as well as on the optional modules attachable to the board fulfill the Protective Extra Low Voltage (PELV) requirements stated in EN 50178, provided that the external circuits connected to the terminals also fulfill the requirements and the installation site is below 2000 m (6562 ft).

### Voltage and current selection for analog inputs

Switch S1 selects voltage (0 [2]…10 V / -10…10 V) or current (0 [4]…20 mA / -20…20 mA) as the signal types for analog inputs AI1 and AI2. The factory settings are unipolar voltage for AI1 (0 [2]…10 V) and unipolar current for AI2 (0 [4]…20 mA), which correspond to the default usage in the application macros. The switch is located to the left of I/O terminal 9 (see the I/O terminal figure above).

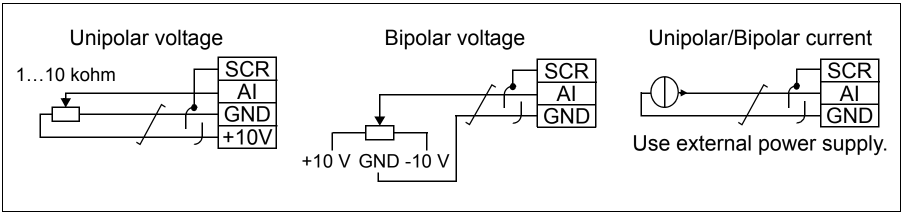



Top position: I (0 [4]…20 mA, default for AI2; or -20…20 mA)
Bottom position: U (0 [2]…10 V, default for AI1; or -10…10 V)

Permanently affix control cables with a minimum 1/4" spacing from power cables.

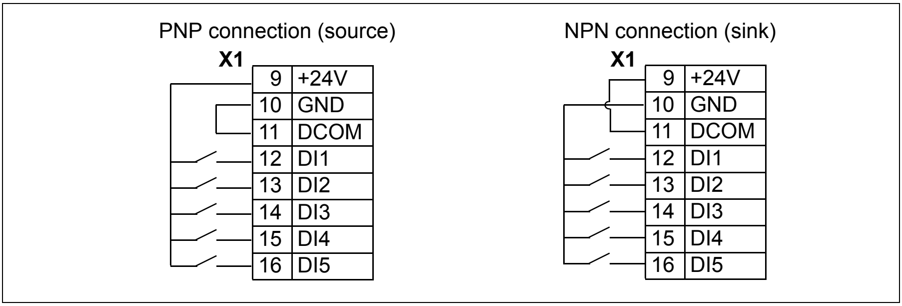
### Voltage and current connection for analog inputs

Bipolar voltage (-10…10 V) and current (-20…20 mA) are also possible. If a bipolar connection is used instead of a unipolar one, see section *Programmable analog inputs* on page *101* for how to set parameters accordingly.



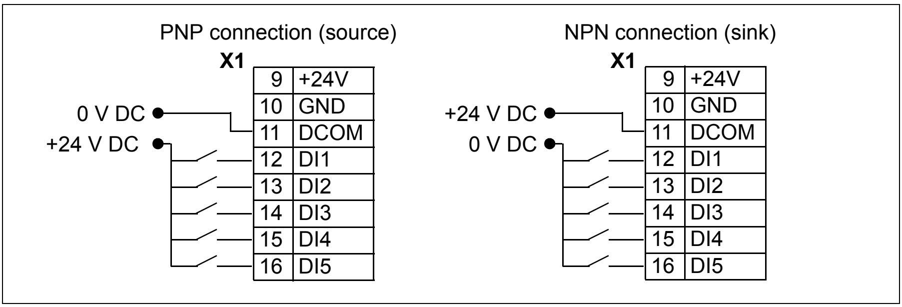

### PNP and NPN configuration for digital inputs

You can wire the digital input terminals in either a PNP or NPN configuration.




### External power supply for digital inputs

For using an external +24 V supply for the digital inputs, see the figure below.

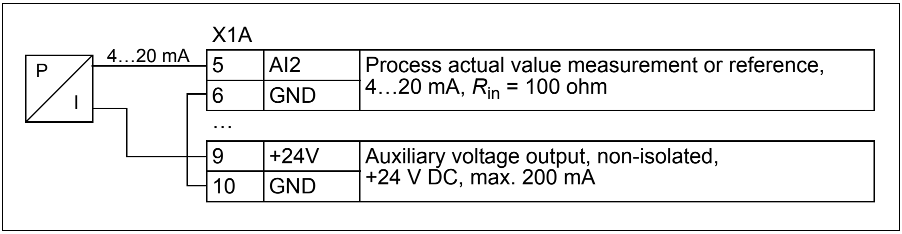


### Frequency input

If DI5 is used as a frequency input, see section *Frequency input* on page 105 for how to set parameters accordingly.

### Connection example of a two-wire sensor

HVAC default, supply fan, return fan, cooling tower fan, condenser, booster pumps, PFA control, internal timer, dual setpoint with PID, E-Clipse and dual setpoint with PID and constant speeds macros (see section *Application macros* on page 77) use analog input 2 (AI2). The macro wiring diagrams for these macros show the connection when a separately powered sensor is used. The figure below gives an example of a connection using a two-wire sensor.



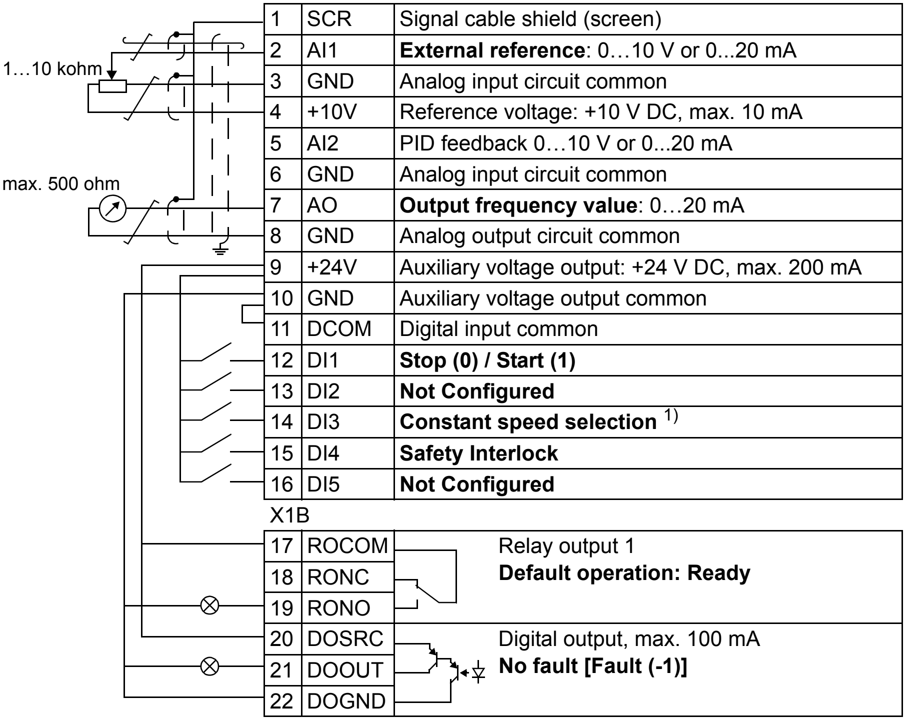

**Note:** The sensor is supplied through its current output. Thus the output signal must be 4…20 mA.

## Default I/O connection diagram

The default connection of the control signals depends on the application macro in use, which is selected with parameter *9902 APPLIC MACRO*.

The default macro is the HVAC Default. It provides a general purpose I/O configuration with three constant speeds. Parameter values are the default values given in section *Parameters in the short parameter view* on page *134*. For information on other macros, see section *Application macros* on page *77*.

The default I/O connections for the ABB standard macro are given in the figure below.




X1A

| | | |
|---|---|---|
| 1 | SCR | Signal cable shield (screen) |
| 2 | AI1 | **External reference**: 0…10 V or 0...20 mA |
| 3 | GND | Analog input circuit common |
| 4 | +10V | Reference voltage: +10 V DC, max. 10 mA |
| 5 | AI2 | PID feedback 0…10 V or 0...20 mA |
| 6 | GND | Analog input circuit common |
| 7 | AO | **Output frequency value**: 0…20 mA |
| 8 | GND | Analog output circuit common |
| 9 | +24V | Auxiliary voltage output: +24 V DC, max. 200 mA |
| 10 | GND | Auxiliary voltage output common |
| 11 | DCOM | Digital input common |
| 12 | DI1 | **Stop (0) / Start (1)** |
| 13 | DI2 | **Not Configured** |
| 14 | DI3 | **Constant speed selection** 1) |
| 15 | DI4 | **Safety Interlock** |
| 16 | DI5 | **Not Configured** |

X1B

| | | |
|---|---|---|
| 17 | ROCOM | Relay output 1<br>**Default operation: Ready** |
| 18 | RONC | |
| 19 | RONO | |
| 20 | DOSRC | Digital output, max. 100 mA<br>**No fault [Fault (-1)]** |
| 21 | DOOUT | |
| 22 | DOGND | |

1) See parameter *Group 12: Constant speeds*:

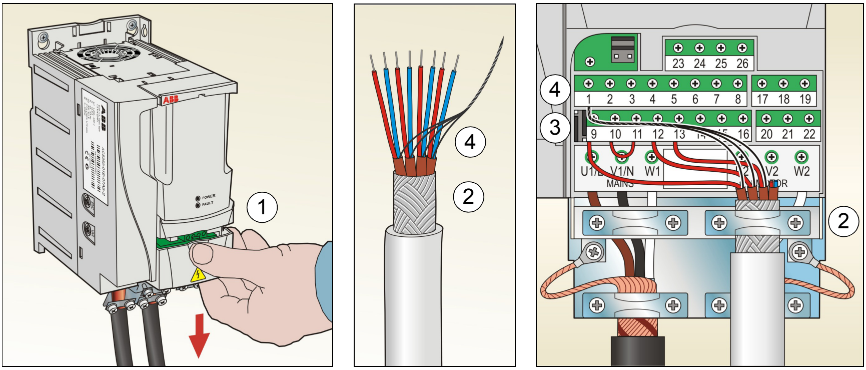
| DI3 | Operation (parameter) |
|---|---|
| 0 | Set speed through AI1 |
| 1 | Speed 1 (*1202*) |
| 0 | Speed 2 (*1203*) |
| 1 | Speed 3 (*1204*) |

2) 360 degree grounding under a clamp.

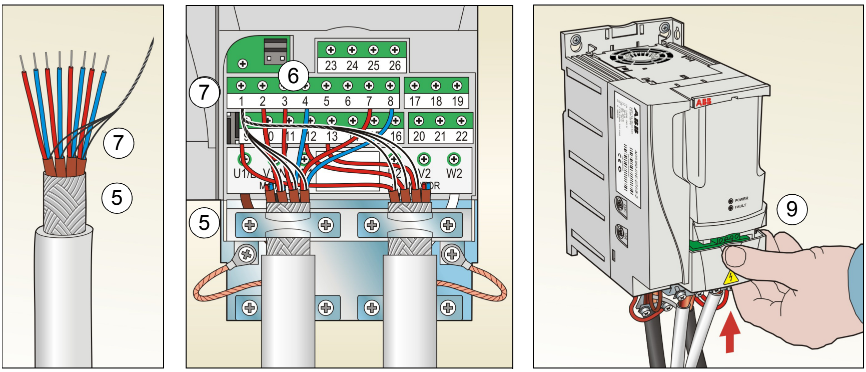
Tightening torque: 0.4 N·m (3.5 lbf·in).

## Connection procedure

1. Remove the terminal cover by simultaneously pushing the recess and sliding the cover off the frame.
2. *Digital signals*: Strip the outer insulation of the digital signal cable 360 degrees and ground the bare shield under the clamp.
3. Connect the conductors of the cable to the appropriate terminals. Use a tightening torque of 0.4 N·m (3.5 in-lb).
4. For double-shielded cables, twist also the grounding conductors of each pair in the cable together and connect the bundle to the SCR terminal (terminal 1).




5. *Analog signals*: Strip the outer insulation of the analog signal cable 360 degrees and ground the bare shield under the clamp.
6. Connect the conductors to the appropriate terminals. Use a tightening torque of 0.4 N·m (3.5 in-lb).
7. Twist the grounding conductors of each pair in the analog signal cable together and connect the bundle to the SCR terminal (terminal 1).
8. Secure all cables outside the drive mechanically.
9. Slide the terminal cover back in place.



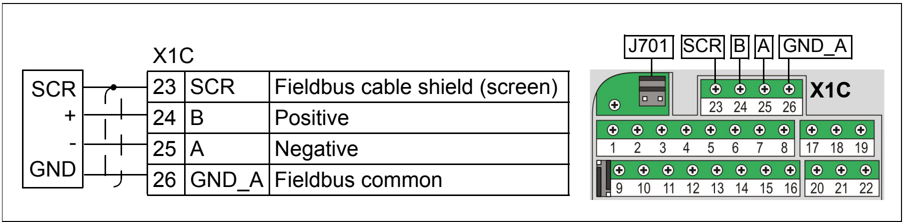
# Connecting the embedded fieldbus

Embedded fieldbus can be connected to the drive with RS-485 or RS-232.

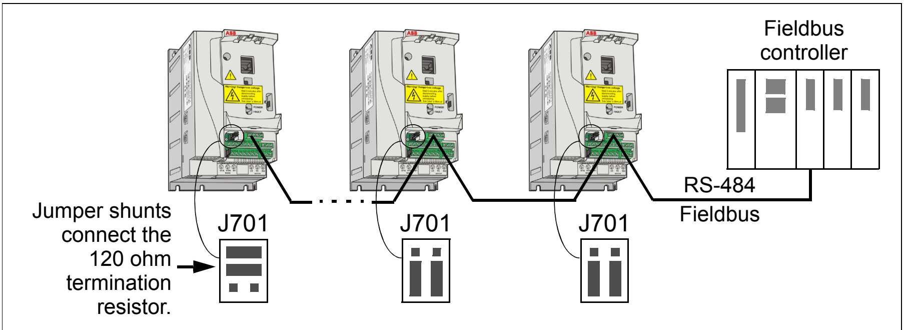
## Connection diagram

### RS-485

The figure below shows the fieldbus connection.

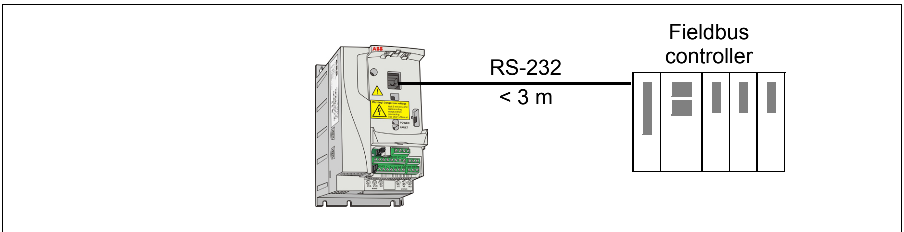



Terminate the RS-485 bus with a 120 ohm resistor at the end of the network by setting the jumper J701 shunts as in the figure below.




### RS-232

Plug a communication cable into the control panel connection X2. The cable must be shorter than 3 meters.



7

# Installation checklist

## Contents of this chapter

This chapter contains the task list to be followed after the mechanical and electrical installation before proceeding to starting up the drive.

## Checking the installation

Check the mechanical and electrical installation of the drive before start-up. Go through the checklist below together with another person. Read chapter *Safety* on page *15* of this manual before you work on the drive.

| | Check |
|---|---|
| **MECHANICAL INSTALLATION** | |
| ☐ | The ambient operating conditions are allowed. (See *Mechanical installation: Checking the installation site* on page *29* as well as *Technical data: Losses, cooling data and noise* on page *369* and *Ambient conditions* on page *374*.) |
| ☐ | The drive is fixed properly on an even vertical non-flammable wall. (See *Mechanical installation* on page *29.*) |
| ☐ | The cooling air will flow freely. (See *Mechanical installation*: *Free space around the drive* on page *30*.) |
| ☐ | The motor and the driven equipment are ready for start. (See *Planning the electrical installation*: *Checking the compatibility of the motor and drive* on page *36* as well as *Technical data: Motor connection data* on page *371*.) |
| **ELECTRICAL INSTALLATION** (See *Planning the electrical installation* on page *35* and *Electrical installation* on page *45.*) | |
| ☐ | For ungrounded and corner grounded systems: The internal EMC filter is disconnected (EMC screw removed). |
| ☐ | The capacitors are reformed if the drive has been stored over a year. |
| ☐ | The drive is grounded properly. |
| ☐ | The input power voltage matches the drive nominal input voltage. |

| | Check |
|---|---|
| ☐ | The input power connections at U1, V1 and W1 are OK and tightened with the correct torque. |
| ☐ | Appropriate input power fuses and disconnector are installed. |
| ☐ | The motor connections at U2, V2 and W2 are OK and tightened with the correct torque. |
| ☐ | The motor cable, input power cable and control cables are routed separately. |
| ☐ | Use wire ties to permanently affix control/communications wiring to the clamps provided to maintain a minimum 1/4" spacing from power wiring. |
| ☐ | The external control (I/O) connections are OK. |
| ☐ | The input power voltage cannot be applied to the output of the drive (with a bypass connection). |
| ☐ | Terminal cover and, for NEMA 1, hood and connection box, are in place. |

8

# Start-up

## Contents of this chapter

This chapter contains a brief description of the assistant (HVAC) control panel (operator keypad), start-up assistant and application selection.

This chapter also includes the application macros used for defining a group of parameters. Macros change a group of parameters to new, predefined values. Use macros to minimize the need for manual editing of parameters.

## HVAC control panel features

The ACS320 HVAC control panel (ACS-CP-B) features:


| | |
|---|---|
| 1 | Status LED (Green when normal, if flashing or red, see section *LEDs* on page *361*.) |
| 2 | Soft key 1 |
| 3 | Auto |
| 4 | Off |
| 5 | Up |
| 6 | Down |
| 7 | Soft key 2 |
| 8 | Help (always available) |
| 9 | Hand |

- Language selection for the display
- Drive connection that can be made or detached at any time
- Start-up assistant to facilitate drive commissioning
- Copy function for moving parameters to other ACS320 drives
- Backup function for saving parameter sets
- Context sensitive help
- Real-time clock

## General display features

*Soft key functions*

The soft key functions are defined by text displayed just above each key.

*Display contrast*

To adjust display contrast, simultaneously press  and  or , as appropriate.

*Macros*

**Note:** Selecting the appropriate macro should be part of the original system design, since the control wiring installed depends on the macro used.

1. Review the macro descriptions in section *Application macros* on page *77*. Use the macro that best fits system needs.
2. Edit parameter *9902 APPLIC MACRO* to select the appropriate macro. Use either of the following:
   - Use the Start-up assistant, which displays the macro selection immediately after motor parameter setup.
   - Refer to section *Parameters mode* on page *64* for parameter editing instructions.

*Turning - parameters*

The system can benefit from one or more of the ACS320 special features, and/or fine tuning.

1. Review the parameter descriptions in section *Parameter listing* starting on page *137*. Enable options and fine tune parameter values as appropriate for the system.
2. Edit parameters as appropriate.

### *Fault and alarm adjustments*

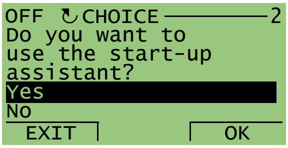
The drive can detect a wide variety of potential system problems. For example, initial system operation may generate faults of alarms that indicate set-up problems.

1. Faults and alarms are reported on the control panel with a number. Note the number reported.
2. Review the description provided for the reported fault/alarm:
   - Use the fault and alarm listings shown in chapter *Fault tracing* on *339*.
   - Press the help key (Assistant control panel only) while fault or alarm is displayed.
3. Adjust the system or parameters as appropriate.

# Start-up

Start-up can be performed in two ways:

- Using the Start-up assistant.



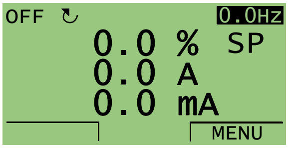
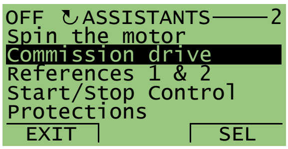
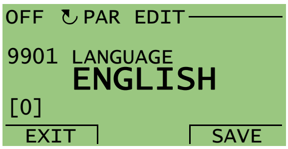

  See section *Start-up by using the Start-up assistant*.

- Changing the parameters individually.

  See section *Start-up by changing the parameters individually*.

## Start-up by using the Start-up assistant

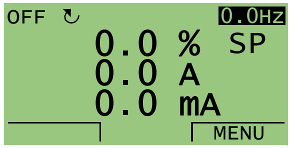
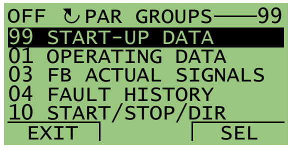
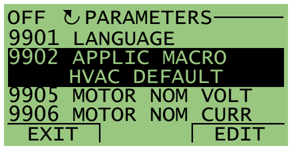
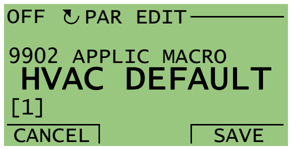
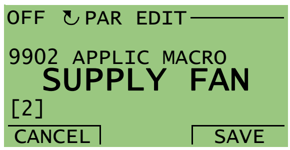
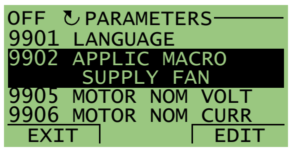
To start the Start-up assistant, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the main menu |  |   |
| **2** | Select ASSISTANTS with the Up/Down buttons and select ENTER. |  |   |
| **3** | Scroll to Commission drive with the Up/Down buttons. |  |   |
| **4** | Change the values suggested by the assistant to your preferences and then press SAVE after every change. |  |   |

The Start-up assistant will guide you through the start-up.

## Start-up by changing the parameters individually

To change the parameters, follow these steps:

<table>
<tr><td>1</td><td>Select MENU to enter the main menu.</td><td></td><td>
</td></tr>
<tr><td>2</td><td>Select PARAMETERS with the UP/DOWN buttons and select ENTER to select the Parameters mode.</td><td></td><td>
</td></tr>
<tr><td>3</td><td>Select the appropriate parameter group with the UP/DOWN buttons and select SEL</td><td></td><td>
</td></tr>
<tr><td>4</td><td>Select the appropriate parameter with the UP/DOWN buttons. Select EDIT to change the parameter value.</td><td></td><td>
</td></tr>
<tr><td>5</td><td>Press the UP/DOWN buttons to change the parameter value.</td><td></td><td>
</td></tr>
<tr><td>6</td><td>Select SAVE to store the modified value or select CANCEL to leave the set mode. Any modifications not saved are canceled.</td><td></td><td>
</td></tr>
<tr><td>7</td><td>Select EXIT to return to the listing of parameter groups, and again to return to the main menu.</td><td></td><td>
</td></tr>
</table>

To complete the control connections by manually entering the parameters, see section *Parameters mode* on page *64*.

For detailed hardware description, see the chapter *Technical data*.

**Notes:**

- The current parameter value appears below the highlighted parameter.
- To view the default parameter value, press the UP/DOWN buttons simultaneously.
- The most typical and necessary parameters to change belong to *Group 99: Start-up data*, *Group 10: Start/Stop/Dir*, *Group 11: Reference select*, *Group 20: Limits*, *Group 21: Start/Stop*, *Group 22: Accel/Decel*, *Group 30: Fault functions*, *Group 53: EFB protocol* and *Group 98: Options*.
- To restore the default factory settings, select the application macro HVAC default.

## Modes

The HVAC control panel has several different modes for configuring, operating and diagnosing the drive. The modes are:

- **Standard display mode –** Shows drive status information and operates the drive.
- **Parameters mode –** Edits parameter values individually.
- **Start-up assistant mode –** Guides the start-up and configuration.
- **Changed parameters mode –** Shows changed parameters.
- **Fault logger mode** – Shows the drive fault history.
- **Drive parameter backup mode –** Stores or uploads the parameters.
- **Clock set mode –** Sets the time and date for the drive.
- **I/O settings mode –** Checks and edits the I/O settings.
- **Alarm mode** – Reporting mode triggered by drive alarms.

### Standard display mode

Use the standard display mode to read information on the drive's status and to operate the drive. To reach the standard display mode, press EXIT until the LCD display shows status information as described below.

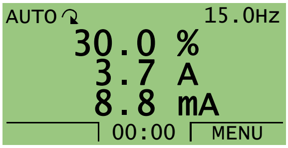
### *Status information*

**Top**. The top line of the LCD display shows the basic status information of the drive.

- HAND **–** Indicates that the drive control is local, that is, from the control panel.
- AUTO **–** Indicates that the drive control is remote, such as the basic I/O (X1) or fieldbus.
- OFF – Indicates that the drive control is local and stopped.
- **–** Indicates the drive and motor rotation status as follows:

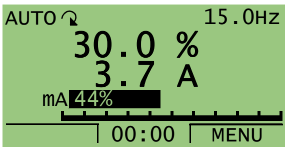
| Control panel display | Significance |
|---|---|
| Rotating arrow (clockwise or counterclockwise) | • Drive is running and at setpoint<br>• Shaft direction is forward or reverse |
| Rotating dotted arrow blinking | Drive is running but not at setpoint |
| Stationary dotted arrow | Start command is present, but motor is not running. For example, start enable is missing. |

- Upper right **–** shows the active reference.




**Middle**. Using *Group 34: Panel display*, the middle of the LCD display can be configured to display:

- One to three parameter values **–** The default display shows parameters *0103 OUTPUT FREQ* in percentages, *0104 CURRENT* in amperes and *0120 AI1* in milliamperes.
  - Use parameters *3401*, *3408*, and *3415* to select the parameters (from *Group 01: Operating data*) to display. Entering "parameter" 0100 results in no parameter displayed. For example, if *3401* = 0100 and *3415* = 0100, then only the parameter specified by *3408* appears in the Control panel display.
  - You can also scale each parameter in the display, for example, to convert the motor speed to a display of conveyor speed. Parameters *3402*…*3405* scale the parameter specified by *3401*, parameters *3409*…*3412* scale the parameter specified by *3408*, etc.
- A bar meter rather than one of the parameter values.
  - Enable bar graph displays using parameters *3404*, *3411* and *3418*.




**Bottom.** The bottom of the LCD display shows:

- Lower corners **–** show the functions currently assigned to the two soft keys.
- Lower middle **–** displays the current time (if configured to show the time).

*Operating the drive*

**AUTO/HAND –** The very first time the drive is powered up, it is in the auto control (AUTO) mode, and is controlled from the Control terminal block X1.

To switch to hand control (HAND) and control the drive using the control panel, press and hold the  or  button.

- Pressing the HAND button switches the drive to hand control while keeping the drive running.
- Pressing the OFF button switches to hand control and stops the drive.

To switch back to auto control (AUTO), press and hold the  button.

**Hand/Auto/Off –** To start the drive press the HAND or AUTO buttons, to stop the drive press the OFF button.

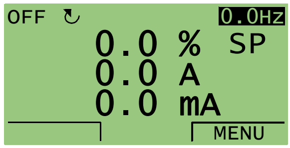
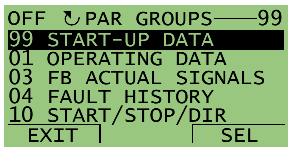
**Reference –** To modify the reference (only possible if the display in the upper right corner is in reverse video) press the UP or DOWN buttons (the reference changes immediately).

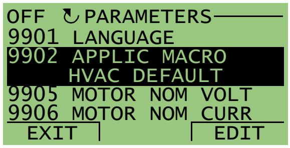
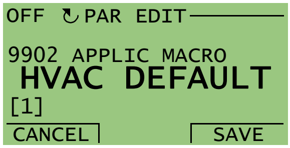
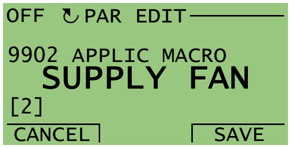
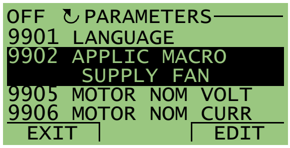
The reference can be modified in the local control mode, and can be parameterized (using *Group 11: Reference select*) to also allow modification in the remote control mode.

**Note:** The Start/Stop, Shaft direction and Reference functions are only valid in local control (LOC) mode.

## Parameters mode

To change the parameters, follow these steps:

| | | | |
|---|---|---|---|
| 1 | Select MENU to enter the main menu. |  |   |
| 2 | Select PARAMETERS with the UP/DOWN buttons, and select ENTER to select the Parameters mode. |  |   |
| 3 | Select the appropriate parameter group with the UP/DOWN buttons and select SEL |  |   |

| | | | |
|---|---|---|---|
| **4** | Select the appropriate parameter in a group with the UP/DOWN buttons. Select EDIT to change the parameter. |  |  |
| **5** | Press the UP/DOWN buttons to change the parameter value. |  |  |
| **6** | Select SAVE to store the modified value or select CANCEL to leave the set mode.<br>• Any modifications not saved are canceled.<br>• Each individual parameter setting is valid immediately after pressing SAVE. |  |  |
| **7** | Select EXIT to return to the listing of parameter groups, and again to return to the main menu. |  |  |

To complete the control connections by manually entering the parameters, see section *Parameters mode*.

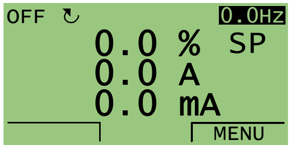
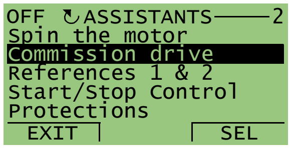
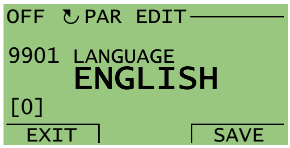
For detailed hardware description, see chapter *Dimension drawings*.

**Notes:**

- The current parameter value appears below the highlighted parameter.
- To view the default parameter value, press the UP/DOWN buttons simultaneously.
- The most typical and necessary parameters to change belong to *Group 99: Start-up data*, *Group 10: Start/Stop/Dir*, *Group 11: Reference select*, *Group 20: Limits*, *Group 21: Start/Stop*, *Group 22: Accel/Decel* and *Group 30: Fault functions*.
- To restore the default factory settings, select the application macro HVAC default.

## Start-up assistant mode

To start the Start-up assistant, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the main menu |  |  |
| **2** | Select ASSISTANTS with the Up/Down buttons and select ENTER. |  |  |
| **3** | Scroll to Commission drive with the Up/Down buttons and select SEL. |  |  |
| **4** | Change the values suggested by the assistant to your preferences and then press SAVE after every change. |  |  |

The Start-up assistant will guide you through the start-up.

The Start-up assistant guides you through the basic programming of a new drive. (Familiarize yourself with basic control panel operation and follow the steps outlined above.) At the first start, the drive automatically suggests entering the first task, language select.The assistant also checks the values entered to prevent entries that are out of range.

The Start-up assistant is divided into tasks. You may activate the tasks one after the other, as the Start-up assistant suggests, or independently.

**Note:** If you want to set the parameters independently, use the Parameters mode.

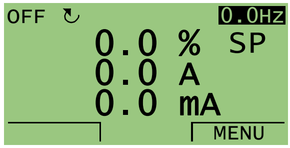
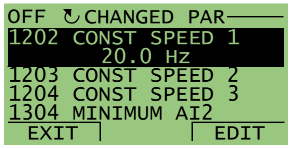
The order of tasks presented by the Start-up assistant depends on your entries. The following task list is typical.

| Task name | Description |
|---|---|
| Spin the motor | • Prompts for control panel display language selection.<br>• Prompts for motor data.<br>• Guides user through rotation check. |
| Commission drive | Prompts for motor data. |

| Task name | Description |
| --- | --- |
| References 1 & 2 | • Prompts for the source of speed references 1 and 2.<br>• Prompts for reference limits.<br>• Prompts for frequency (or speed) limits. |
| Start/Stop Control | • Prompts for the source for start and stop commands.<br>• Prompts for start and stop mode definition.<br>• Prompts for acceleration and deceleration times. |
| Protections | • Prompts for current and torque limits.<br>• Prompts for the use of Run enable and Start enable signals.<br>• Prompts for the use of emergency stop.<br>• Prompts for Fault function selection.<br>• Prompts for Auto reset functions selection. |
| Constant Speeds | • Prompts for the use of constant speeds.<br>• Prompts for constant speed values. |
| PID control | • Prompts for PID settings.<br>• Prompts for the source of process reference.<br>• Prompts for reference limits.<br>• Prompts for source, limits and units for the process actual value.<br>• Defines the use of Sleep function. |
| PID flow | • Prompts for the use of flow calculation.<br>• Prompts for units.<br>• Prompts for maximum flow.<br>• Prompts for transmitter signals. |
| Low Noise Set-up | • Prompts for switching frequency.<br>• Prompts for definition of Flux optimization.<br>• Prompts for the use of Critical speeds. |
| Panel Display | Prompts for display variable and unit settings. |
| Timed Functions | Prompts for the use of Timed functions. |
| Outputs | • Prompts for the signals indicated through the relay outputs.<br>• Prompts for signals indicated through the analog outputs AO1 and AO2. Sets the minimum, maximum, scaling and inversion values. |
| Serial Communication | • Prompts for communication settings.<br>• Prompts for control access settings. |

## Changed parameters mode

To view (and edit) a listing of all parameters that have been changed from macro default values, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the menu. |  |  |
| **2** | Select CHANGED PAR with the UP/DOWN buttons and select ENTER. |  |  |
| **3** | A list of changed parameters is displayed. Select EXIT to exit the parameters mode. |  |  |

## Fault logger mode

Use the Fault logger mode to see drive fault history, fault state details and help for the faults.

1. Select **FAULT LOGGER** in the MAIN MENU.
2. Press **ENTER** to see the latest faults (up to 10 faults, maximum).
3. Press **DETAIL** to see details for the selected fault.
   - Details are available for the three latest faults.
4. Press **DIAG** to see the help description for the fault. See chapter *Fault tracing*.

**Note:** If a power off occurs, only the three latest faults will remain (with details only in the first fault).

## Drive parameter backup mode

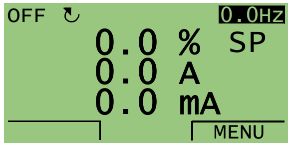
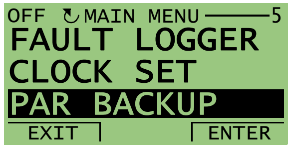
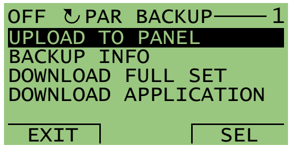
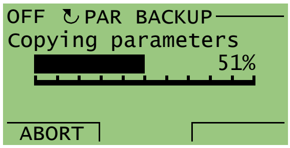
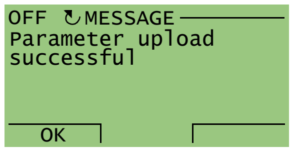
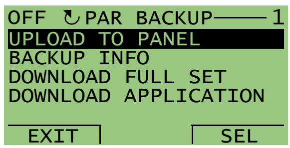
Use the parameter backup mode to export parameters from one drive to another. The parameters are uploaded from a drive to the control panel and downloaded from the control panel to another drive. Two options are available:

*Par backup mode*

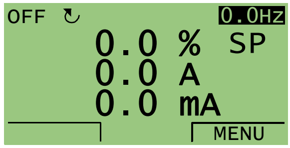
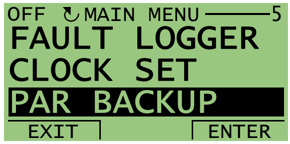
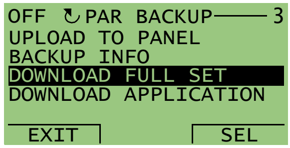
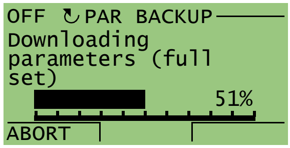
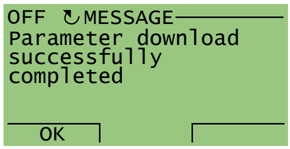
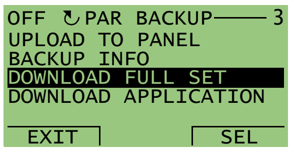
The Assistant control panel can store a full set of drive parameters.

The Par backup mode has these functions:

- **UPLOAD TO PANEL** – Copies all parameters from the drive to the Control panel. This includes user sets of parameters (if defined) and internal parameters. The Control panel memory is non-volatile and does not depend on the panel’s battery. To upload parameters to control panel, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the main menu. |  |  |
| **2** | Select PAR BACKUP with the UP/DOWN buttons and select ENTER. |  |  |
| **3** | Select UPLOAD TO PANEL and select SEL. |  |  |
| **4** | The “Copying parameters” text and a progress diagram is displayed. Select ABORT if you want to stop the process. |  |  |
| **5** | The “Parameter upload successful” text is displayed and the control panel returns to the PAR BACKUP menu. Select EXIT to return to the main menu. Now you can disconnect the panel. |  | <br> |

- **DOWNLOAD FULL SET** – Restores the full parameter set from the Control panel to the drive. Use this option to restore a drive, or to configure identical drives. This download does not include user sets of parameters.
  To download all parameters to drive, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the menu. |  |  |
| **2** | Select PAR BACKUP with the UP/DOWN buttons. |  |  |
| **3** | Scroll to DOWNLOAD FULL SET and select SEL. |  |  |
| **4** | The “Downloading parameters” text is displayed. Select ABORT if you want to stop the process. |  |  |
| **5** | After the download stops, the “Parameter download successfully completed” text is displayed and the control panel goes back to PAR BACKUP menu. Select EXIT to return to the main menu. |  | <br> |

**Note:** Download full set writes all parameters to the drive, including motor parameters. Only use this function to restore a drive, or to transfer parameters to systems that are identical to the original system.

- **Download application** – Copies a partial parameter set from the Control panel to a drive. The partial set does not include internal motor parameters, parameters *9905*…*9909*, *1605*, *1607*, *5201*, nor any *Group 53: EFB protocol* parameters. Use this option to transfer parameters to systems that use similar configurations – the drive and motor sizes do not need to be the same.
  To download application to drive, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the menu. |  | OFF ↻ 0.0Hz<br>0.0 % SP<br>0.0 A<br>0.0 mA<br>MENU |
| **2** | Select PAR BACKUP with the UP/DOWN buttons. |  | OFF ↻MAIN MENU 5<br>FAULT LOGGER<br>CLOCK SET<br>PAR BACKUP<br>EXIT ENTER |
| **3** | Scroll to DOWNLOAD APPLICATION and select SEL. |  | OFF ↻PAR BACKUP 4<br>UPLOAD TO PANEL<br>BACKUP INFO<br>DOWNLOAD FULL SET<br>DOWNLOAD APPLICATION<br>EXIT SEL |
| **4** | The “Downloading parameters” text is displayed. Select ABORT if you want to stop the process. |  | OFF ↻PAR BACKUP<br>Downloading<br>parameters<br>(application)<br>51%<br>ABORT |
| **5** | The “Parameter download successfully completed” is displayed and the control panel returns to PAR BACKUP menu. Select EXIT to return to the main menu. |  | OFF ↻MESSAGE<br>Parameter download<br>successfully<br>completed.<br>OK<br><br>OFF ↻PAR BACKUP 4<br>UPLOAD TO PANEL<br>BACKUP INFO<br>DOWNLOAD FULL SET<br>DOWNLOAD APPLICATION<br>EXIT SEL |

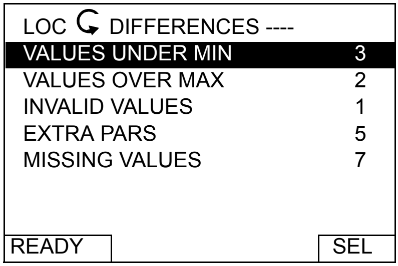
*Handling inexact downloads*

In some situations, an exact copy of the download is not appropriate for the target drive. Some examples:

- A download to an old drive specifies parameters/values that are not available on the old drive.
- A download (from an old drive) to a new drive does not have definitions for the new parameters – parameters that did not originally exist.

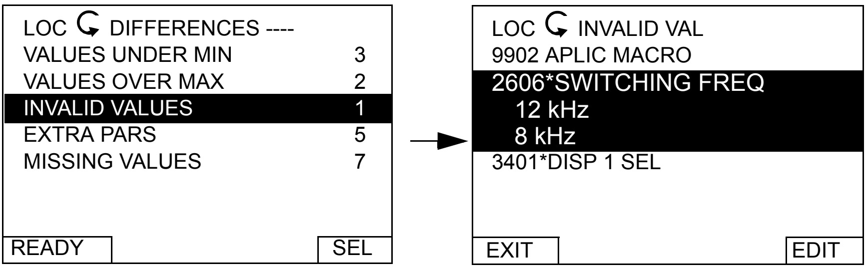
As a default, the control panel handles these situations by:

- Discarding parameters/values not available on the target drive.
- Using parameter default values when the download provides no values or invalid values.
- Providing a Differences List – A listing of the type and number of items that the target cannot accept exactly as specified.




You can either accept the default edits by pressing READY, or view and edit each item as follows:

1. Highlight an item type in the Differences List (left screen below) and press SEL to see the details for the selected type (right screen below).




In the above-right "details" screen:

- The first item that requires editing is automatically highlighted and includes details: In general, the first item listed in the details is the value defined by the backup file. The second item listed is the "default edit."
- For tracking purposes, an asterisk initially appears by each item. As edits are made, the asterisks disappear.

2. In the illustrated example, the backup specifies a switching frequency of 12 kHz, but the target drive is limited to 8 kHz.
3. Press EDIT to edit the parameter. The display is the target drive's standard edit screen for the selected parameter.

4. Highlight the desired value for the target drive.
5. Press SAVE to save setting.
6. Press EXIT to step back to the differences view and continue for each remaining exception.
7. When your editing is complete, press READY in the Differences List and then select “Yes, save parameters.”

*Download failures*

In some situations, the drive may be unable to accept a download. In those cases, the control panel display is: “Parameter download failed” plus one of the following causes:

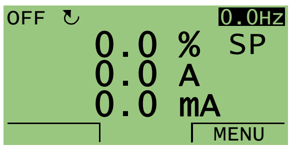
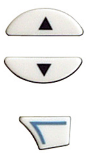
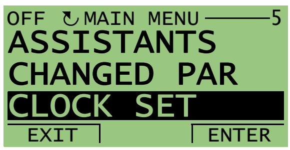
- Set not found – You are attempting to download a data set that was not defined in the backup. The remedy is to manually define the set, or upload the set from a drive that has the desired set definitions.
- Par lock – The remedy is to unlock the parameter set (parameter *1602 PARAMETER LOCK*).
- Incompatible drive/model – The remedy is to perform backups only between drives of the same type and the same model.
- Too many differences – The remedy is to manually define a new set, or upload the set from a drive that more closely resembles the target drive.

**Note:** If upload or download of parameters is aborted, the partial parameter set is not implemented.

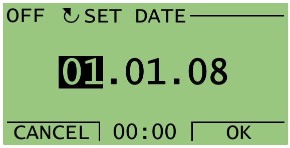
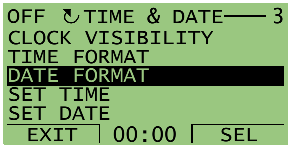
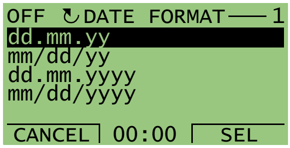
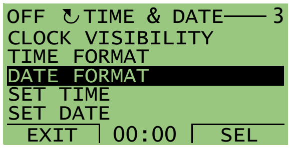
## Clock set mode

The clock set mode is used for setting the time and date for the internal clock of the drive. To use the timer functions of the drive, the internal clock has to be set first. Date is used to determine weekdays and is visible in Fault logs.

To set the clock, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the main menu. |  |  |
| **2** | Scroll to CLOCK SET with the UP/DOWN buttons and select ENTER to enter the Time & date mode. |  |  |

| | | | |
|---|---|---|---|
| **3** | Select CLOCK VISIBILITY with the UP/DOWN buttons and select SEL to change the visibility of the clock. |  | OFF ↻TIME & DATE 1<br>CLOCK VISIBILITY<br>TIME FORMAT<br>DATE FORMAT<br>SET TIME<br>SET DATE<br>EXIT SEL |
| **4** | Scroll to Show clock with the UP/DOWN buttons and select SEL to make the clock visible. |  | OFF ↻CLOCK VISIB 1<br>Show clock<br>Hide clock<br>EXIT SEL |
| **5** | Scroll to SET TIME with the UP/DOWN buttons and select SEL. |  | OFF ↻TIME & DATE 4<br>CLOCK VISIBILITY<br>TIME FORMAT<br>DATE FORMAT<br>SET TIME<br>SET DATE<br>EXIT SEL |
| **6** | Change the hours and minutes with the UP/DOWN buttons and select OK to save the values. The active value is displayed in inverted color. |  | OFF ↻SET TIME<br>00:00<br>CANCEL OK |
| **7** | Scroll to TIME FORMAT with the UP/DOWN buttons and select SEL. |  | OFF ↻TIME & DATE 2<br>CLOCK VISIBILITY<br>TIME FORMAT<br>DATE FORMAT<br>SET TIME<br>SET DATE<br>EXIT 00:00 SEL |
| **8** | The different formats are displayed. Select a format with the UP/DOWN buttons and select SEL to confirm the selection. |  | OFF ↻TIME FORMAT 1<br>24-hour<br>12-hour<br>CANCEL 00:00 SEL |
| **9** | Scroll to SET DATE with the UP/DOWN buttons and select SEL. |  | OFF ↻TIME & DATE 5<br>CLOCK VISIBILITY<br>TIME FORMAT<br>DATE FORMAT<br>SET TIME<br>SET DATE<br>EXIT 00:00 SEL |

| | | | |
|---|---|---|---|
| **10** | Change the days, months and year with the UP/DOWN buttons and select OK to save the values. The active value is displayed in inverted color. |  |  |
| **11** | Scroll to DATE FORMAT with the UP/DOWN buttons and select SEL. |  |  |
| **12** | The DATE FORMATS are displayed. Select a date format with the UP/DOWN buttons and select OK to confirm the selection. |  |  |
| **13** | Select EXIT twice to return to the main menu. |  |  |

## I/O settings mode

To view and edit the I/O settings, follow these steps:

| | | | |
|---|---|---|---|
| **1** | Select MENU to enter the main menu. | | OFF ↻ 0.0Hz<br>0.0 % SP<br>0.0 A<br>0.0 mA<br>MENU |
| **2** | Scroll to I/O SETTINGS with the UP/DOWN buttons and select ENTER. | | OFF ↻MAIN MENU 1<br>I/O SETTINGS<br>PARAMETERS<br>ASSISTANTS<br>EXIT ENTER |
| **3** | Scroll to the I/O setting you want to view with the UP/DOWN buttons and select SEL. | | OFF ↻I/O SETTINGS 1<br>DIGITAL INPUTS (DI)<br>ANALOG INPUTS (AI)<br>RELAY OUTPUTS (ROUT)<br>ANALOG OUTPUTS (AOUT)<br>PANEL<br>EXIT SEL |
| **4** | Select the setting you want to view with the UP/DOWN buttons and select EDIT. | | OFF ↻I/O SETTINGS<br>DI 1<br>1001:START/STOP (EI1)<br>1002:START/STOP (EI1)<br>EXIT EDIT |
| **5** | You can change the value with the UP/DOWN buttons and save it by selecting SAVE.<br>If you do not want to change the setting, select CANCEL. | | OFF ↻PAR EDIT<br>1001 EXT1 COMMANDS<br>DI1<br>[1]<br>CANCEL SAVE |
| **6** | Select EXIT to return to the main menu. | | OFF ↻I/O SETTINGS<br>DI 1<br>1001:START/STOP (EI1)<br>1002:START/STOP (EI1)<br>EXIT EDIT |

# Application macros

## Overview

Macros change a group of parameters to new, predefined values designed for specific applications. Use macros to minimize the need for manual editing of parameters. Selecting a macro sets all other parameters to their default values, except:

- *Group 99: Start-up data*
- *1602 PARAMETER LOCK*
- *1607 PARAM. SAVE*
- *3018 COMM FAULT FUNC* and *3019 COMM FAULT TIME*
- *9802 COMM PROT SEL*
- *Group 52: Panel comm* and *Group 53: EFB protocol*
- *Group 29: Maintenance trig*.

After selecting a macro, additional parameter changes can be made manually using the control panel.

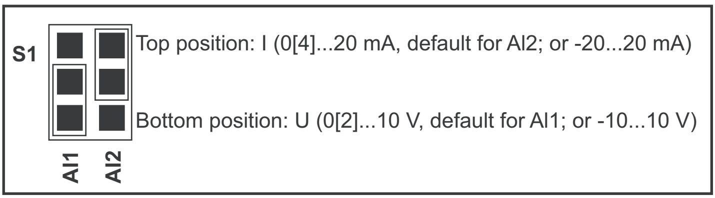
Application macros are enabled by setting the value for parameter *9902 APPLIC MACRO*. By default, HVAC default (value 1) is the enabled macro.

## General considerations

The following considerations apply for all macros:

- When using a direct speed reference in AUTO mode, connect the speed reference to analog input 1 (AI1), and provide the START command using digital input 1 (DI1). In HAND/OFF mode, the control panel provides the speed reference and START command.
- When using process PID, connect the feedback signal to analog input 2 (AI2). As a default, the control panel sets the Setpoint, but analog input 1 can be used as an alternate source. You can set up process PID using parameters (Group 40) or using the PID control assistant (recommended).

The S1 Jumpers are set for AI1 External Reference and PID Feedback as either 20 ma or 10 V.



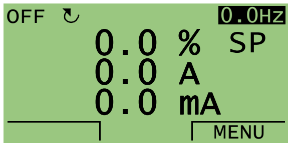
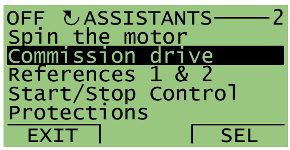
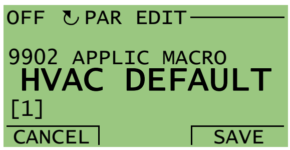
## Application / Macro listing

This section describes the following macros:

| 9902 value | Macro | | 9902 value | Macro |
|---|---|---|---|---|
| 1 | HVAC DEFAULT | | 8 | INT TIMER |
| 2 | SUPPLY FAN | | 9 | INT TIMER CS |
| 3 | RETURN FAN | | 10 | FLOATING PNT |
| 4 | CLNG TWR FAN | | 11 | DUAL SETPPID |
| 5 | CONDENSER | | 12 | DUAL SP PID WITH CS |
| 6 | BOOSTER PUMP | | 13 | E-BYPASS |
| 7 | PUMP ALTERNA | | 14 | HAND CONTROL |

## Selecting an application macro

To select a macro, follow these steps:

<table>
<tr><td>1</td><td>Select MENU to enter the main menu.</td><td></td><td></td></tr>
<tr><td>2</td><td>Select ASSISTANTS with the Up/Down buttons and select ENTER.</td><td></td><td></td></tr>
<tr><td>3</td><td>Scroll to Commission drive and select ENTER.</td><td></td><td></td></tr>
<tr><td>4</td><td>Select a macro with the Up/Down buttons and select SAVE.</td><td></td><td></td></tr>
</table>

## Restoring defaults

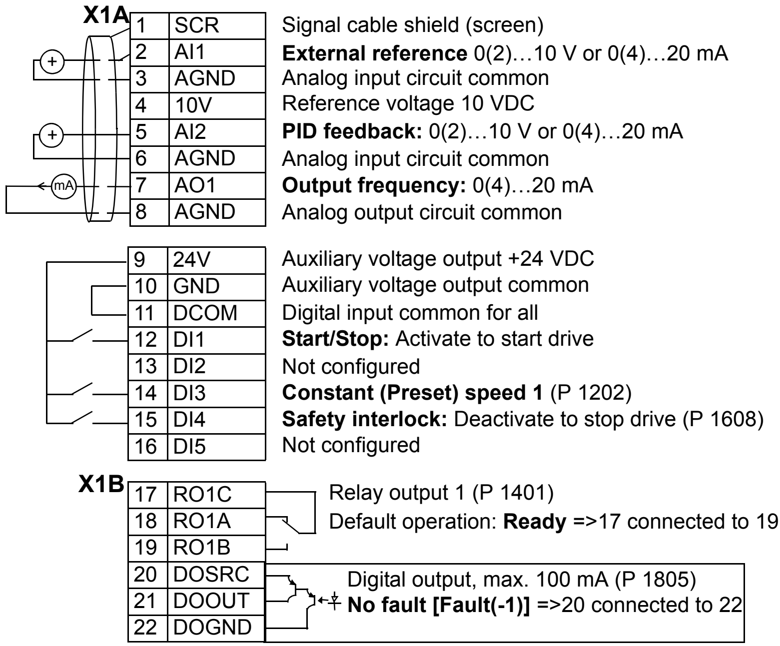
To restore the factory default settings, select application macro HVAC default.

## Control wiring

Each macro has specific requirements for control wiring. Specific wiring requirements are included with each macro description.

## HVAC default

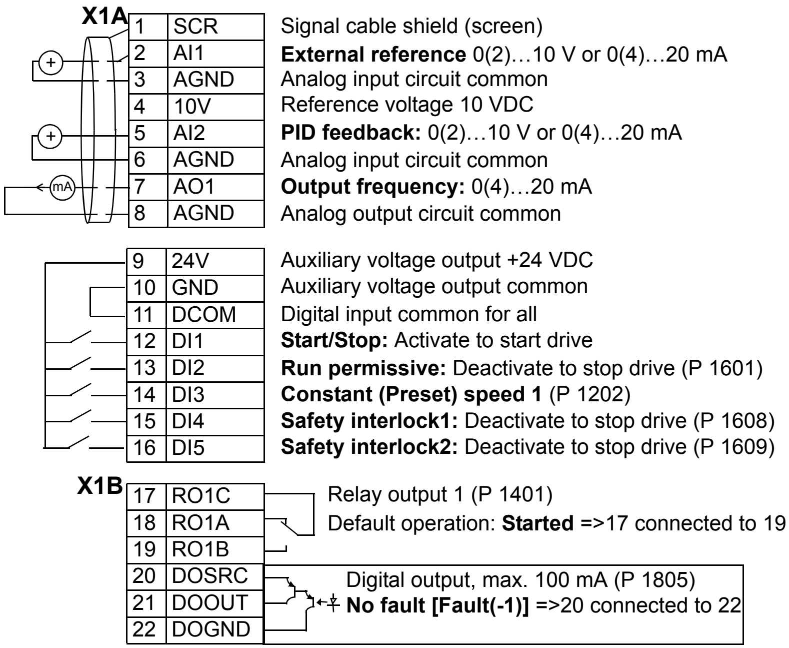
This macro provides the factory default parameter settings for the drive. Factory defaults can be restored at any time by setting parameter *9902 APPLIC MACRO* to 1. The diagram below shows typical wiring using this macro. When using direct speed reference in AUTO mode or process PID, see section *General considerations* on page *77*.




| | | |
|---|---|---|
| 1 | SCR | Signal cable shield (screen) |
| 2 | AI1 | **External reference** 0(2)…10 V or 0(4)…20 mA |
| 3 | AGND | Analog input circuit common |
| 4 | 10V | Reference voltage 10 VDC |
| 5 | AI2 | **PID feedback:** 0(2)…10 V or 0(4)…20 mA |
| 6 | AGND | Analog input circuit common |
| 7 | AO1 | **Output frequency:** 0(4)…20 mA |
| 8 | AGND | Analog output circuit common |
| 9 | 24V | Auxiliary voltage output +24 VDC |
| 10 | GND | Auxiliary voltage output common |
| 11 | DCOM | Digital input common for all |
| 12 | DI1 | **Start/Stop:** Activate to start drive |
| 13 | DI2 | Not configured |
| 14 | DI3 | **Constant (Preset) speed 1** (P 1202) |
| 15 | DI4 | **Safety interlock:** Deactivate to stop drive (P 1608) |
| 16 | DI5 | Not configured |
| 17 | RO1C | Relay output 1 (P 1401) |
| 18 | RO1A | Default operation: **Ready** =>17 connected to 19 |
| 19 | RO1B | |
| 20 | DOSRC | Digital output, max. 100 mA (P 1805) |
| 21 | DOOUT | **No fault [Fault(-1)]** =>20 connected to 22 |
| 22 | DOGND | |

## Supply fan

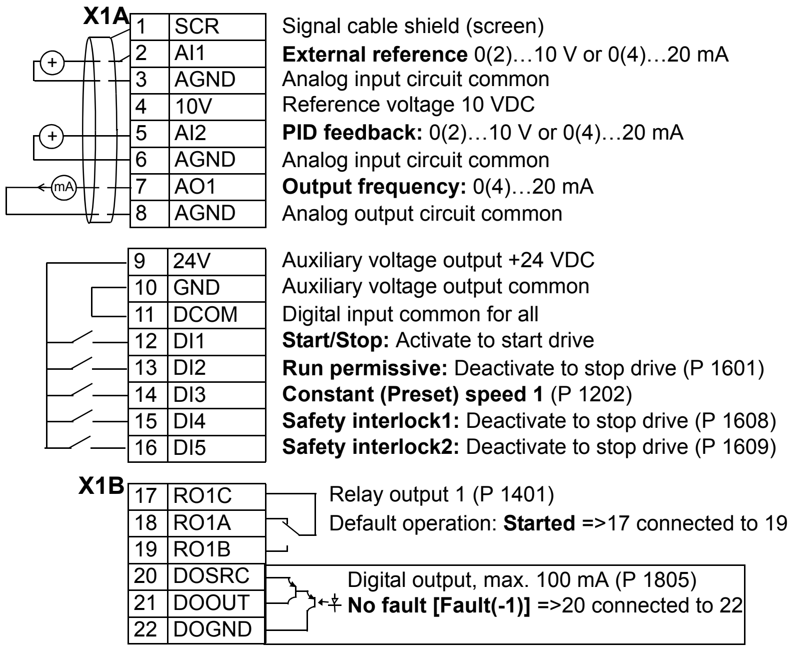
This macro configures for supply fan applications where the supply fan brings fresh air in according to signals received from a transducer. When using direct speed reference in AUTO mode or process PID, see *General considerations* on page *77*.




| **Parameters changed relative to HVAC default** | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 2 (SUPPLYFAN) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1401 | relay output 1 | 7 (STARTED) | 4001 | gain | 0.7 |
| 1601 | run enable | 2 (DI2) | 4002 | integration time | 10.0 s |
| 1609 | start enable 2 | 5 (DI5) | 4101 | gain | 1.0 |
| 2202 | acceler time 1 | 15.0 s | 4102 | integration time | 60.0 s |
| 2203 | deceler time 1 | 15.0 s | | | |

## Return fan

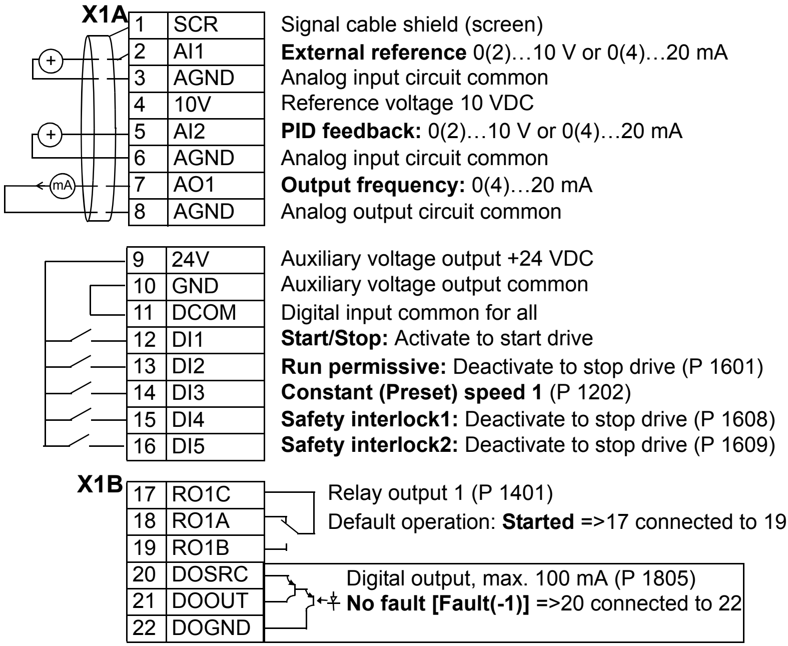
This macro configures for return fan applications where the return fan removes air according to signals received from a transducer. When using direct speed reference in AUTO mode or process PID, see *General considerations* on page *77*.




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 3 (RETURNFAN) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1401 | relay output 1 | 7 (STARTED) | 4001 | gain | 0.7 |
| 1601 | run enable | 2 (DI2) | 4002 | integration time | 10.0 s |
| 1609 | start enable 2 | 5 (DI5) | 4101 | gain | 1.0 |
| 2202 | acceler time 1 | 15.0 s | 4102 | integration time | 60.0 s |
| 2203 | deceler time 1 | 15.0 s | | | |

## Cooling tower fan

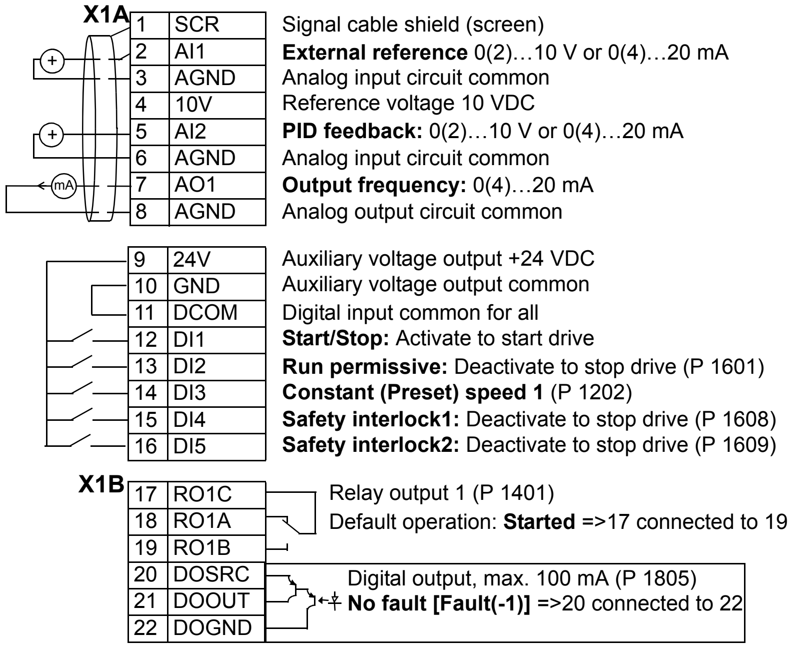
This macro configures for cooling tower fan applications where the fan speed is controlled according to the signals received from a transducer. When using direct speed reference in AUTO mode or process PID, see *General considerations* on page *77*.




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 4 (CLNGTWRFAN) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1401 | relay output 1 | 7 (STARTED) | 4101 | gain | 1.0 |
| 1601 | run enable | 2 (DI2) | 4102 | integration time | 60.0 s |
| 1609 | start enable 2 | 5 (DI5) | | | |

## Condenser

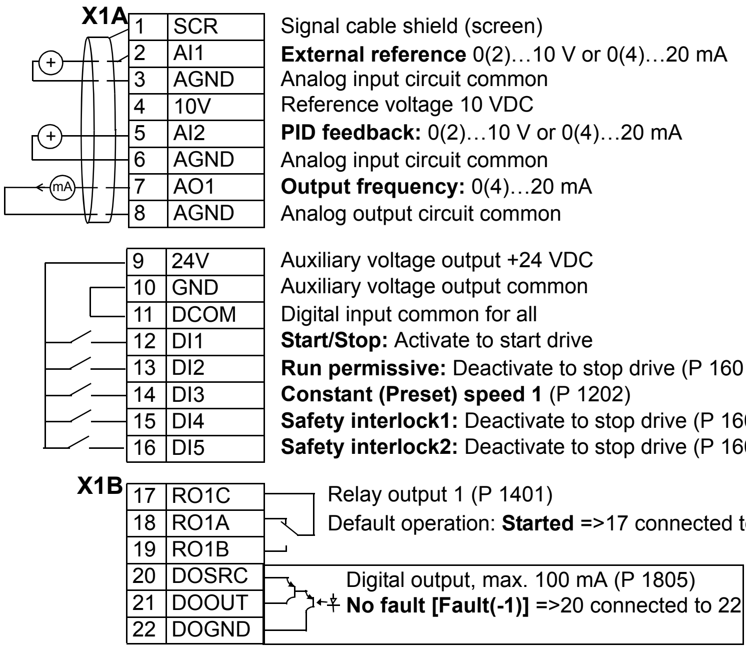
This macro configures for condenser and liquid cooler applications where fan speed is controlled according to signals received from a transducer. When using direct speed reference in AUTO mode or process PID, see *General considerations* on page *77*.




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 5 (CONDENSER) | 2203 | deceler time 1 | 10.0 s |
| 1401 | relay output 1 | 7 (STARTED) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1601 | run enable | 2 (DI2) | 4005 | error value inv | 1 (YES) |
| 1609 | start enable 2 | 5 (DI5) | 4101 | gain | 1.0 |
| 2202 | acceler time 1 | 10.0 s | 4102 | integration time | 60.0 s |

## Booster pump

This macro configures for booster pump applications where the pump speed is controlled according to a signal received from a transducer. When using direct speed reference in AUTO mode or process PID, see *General considerations* on page *77*.



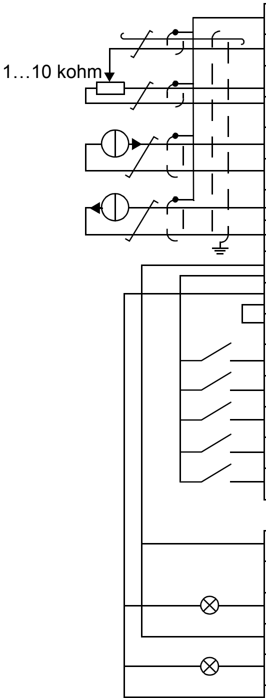

| **Parameters changed relative to HVAC default** | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 6 (BOOSTERPUMP) | 2203 | deceler time 1 | 5.0 s |
| 1401 | relay output 1 | 7 (STARTED) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1601 | run enable | 2 (DI2) | 4001 | gain | 1.0 |
| 1609 | start enable 2 | 5 (DI5) | 4002 | integration time | 60.0 s |
| 2202 | acceler time 1 | 5.0 s | | | |

# PFA control macro

This macro provides parameter settings for pump and fan alternation (PFA) applications. To enable the macro, set the value of parameter *9902 APPLIC MACRO* to 7 (PFA CONTROL).

**Note:** Parameter *2108 START INHIBIT* must remain in the default setting 0 (OFF).

## Default I/O connections




X1A

| | | |
|---|---|---|
| 1 | SCR | Signal cable shield (screen) |
| 2 | AI1 | **Ext. ref. 1 (Hand) / Ext. ref. 2 (PID/PFC)**: 0…10 V |
| 3 | GND | Analog input circuit common |
| 4 | +10V | Reference voltage: +10 V DC, max. 10 mA |
| 5 | AI2 | **Process actual value**: 4…20 mA |
| 6 | GND | Analog input circuit common |
| 7 | AO | **Output frequency value**: 0…20 mA |
| 8 | GND | Analog output circuit common |
| 9 | +24V | Auxiliary voltage output: +24 V DC, max. 200 mA |
| 10 | GND | Auxiliary voltage output common |
| 11 | DCOM | Digital input common |
| 12 | DI1 | **Stop (0) / Start (1) (Hand)** |
| 13 | DI2 | **Hand (0) / PID/PFC (1) control selection** |
| 14 | DI3 | **Interlock:** Deactivation always stops the drive |
| 15 | DI4 | **Interlock:** Deactivation stops constant speed motor |
| 16 | DI5 | **Stop (0) / Start (1) (PID/PFC)** |

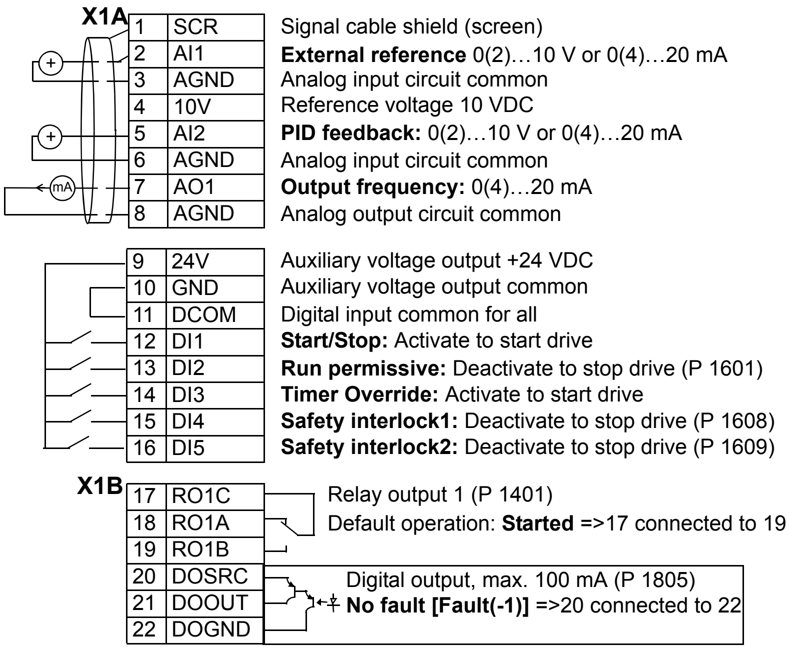
X1B

| | | |
|---|---|---|
| 17 | ROCOM | Relay output 1<br>**PFC** |
| 18 | RONC | |
| 19 | RONO | |
| 20 | DOSRC | Digital output, max. 100 mA<br>**No fault [Fault (-1)]** |
| 21 | DOOUT | |
| 22 | DOGND | |

## Internal timer

This macro configures for applications where a built-in timer starts and stops the motor. When the variable speed pump reaches a maximum speed limit, auxiliary pumps start as needed. When using direct speed reference in AUTO mode or process PID, see section *General considerations* on page *77*.

Momentarily activating digital input 3 (DI3) provides a boost function which operates the motor. See *Group 36: Timed functions* for more information on setting up timers.

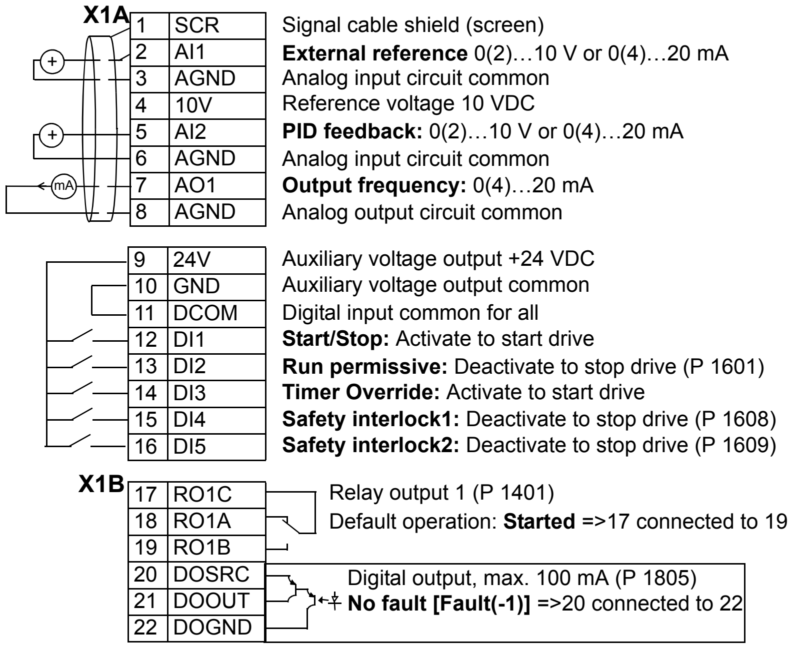



| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 8 (INT TIMER) | 1609 | start enable 2 | 5 (DI5) |
| 1001 | ext1 commands | 11 (TIMER1) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1002 | ext2 commands | 11 (TIMER1) | 3601 | timers enable | 1 (DI1) |
| 1201 | const speed sel | 0 (NOT SEL) | 3622 | boost sel | 3 (DI3) |
| 1401 | relay output 1 | 7 (STARTED) | 3626 | timer 1 src | 23 (B+P3+P2+P1) |
| 1601 | run enable | 2 (DI2) | | | |

## Internal timer with constant speeds / PRV

This macro configures for applications such as a timed powered roof ventilator (PRV) which alternates between two constant speeds (constant speed 1 and 2) based on a built-in timer.

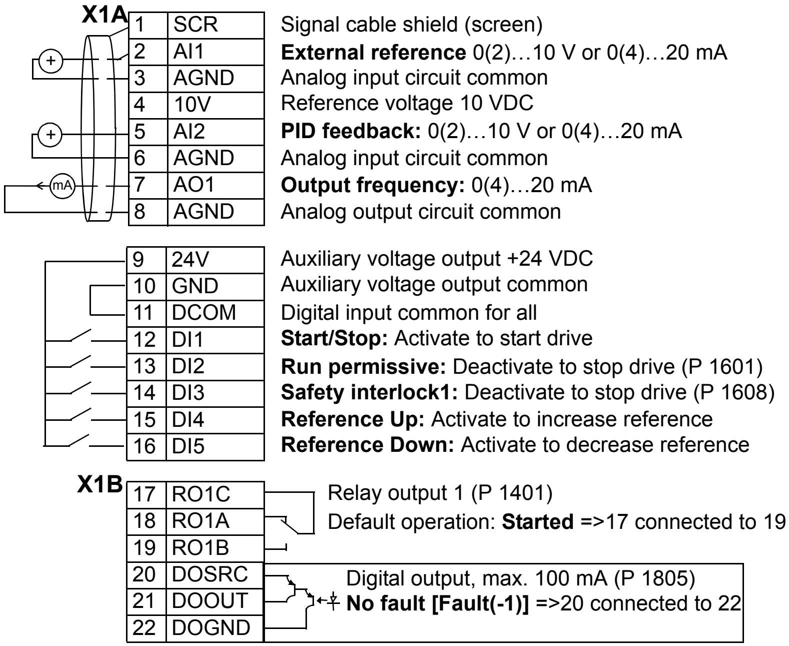
Momentarily activating digital input 3 (DI3) provides a boost function which operates the motor. See *Group 36: Timed functions* for more information on setting up timers.




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 9 (INT TIMER CS) | 3416 | signal 3 min | -200.0% |
| 1002 | ext2 commands | 0 (NOT SEL) | 3417 | signal 3 max | 200.0% |
| 1103 | ref1 sel | 0 (KEYPAD) | 3419 | output 3 dsp unit | 4 (%) |
| 1106 | ref3 sel | 2 (AI2) | 3420 | output 3 min | -200.0% |
| 1201 | const speed sel | 15 (TIMER1) | 3421 | output 3 max | 200.0% |
| 1301 | minimum ai1 | 0.0% | 3622 | boost sel | 3 (DI3) |
| 1401 | relay output 1 | 7 (STARTED) | 4001 | gain | 1.0 |
| 1601 | run enable | 2 (DI2) | 4002 | integration time | 60.0 s |
| 1609 | start enable 2 | 5 (DI5) | 4101 | gain | 1.0 |
| 3207 | superv 3 param | 0103 (OUTPUT FREQ) | 4102 | integration time | 60.0 s |
| 3415 | signal 3 param | 0105 (TORQUE) | 4110 | setpoint sel | 1 (AI1) |

## Floating point

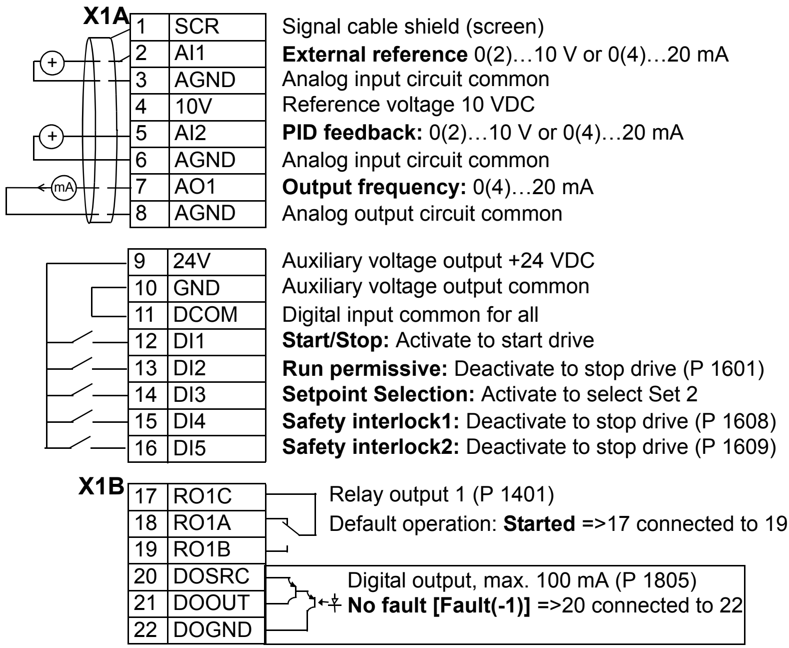
This application macro is for applications where speed reference needs to be controlled through digital inputs (DI4 & DI5). By activating digital input 4, the speed reference increases, by activating digital input 5, the speed reference decreases. If both digital inputs are active or inactive, the reference does not change.




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 10 (FLOATINGPNT) | 3416 | signal 3 min | -200.0% |
| 1103 | ref1 sel | 7 (DI5U, 6D) | 3417 | signal 3 max | 200.0% |
| 1401 | relay output 1 | 7 (STARTED) | 3419 | output 3 dsp unit | 4 (%) |
| 1601 | run enable | 2 (DI2) | 3420 | output 3 min | -200.0% |
| 3207 | superv 3 param | 0103 (OUTPUT FREQ) | 3421 | output 3 max | 200.0% |
| 3415 | signal 3 param | 0105 (TORQUE) | | | |

## Dual setpoint with PID

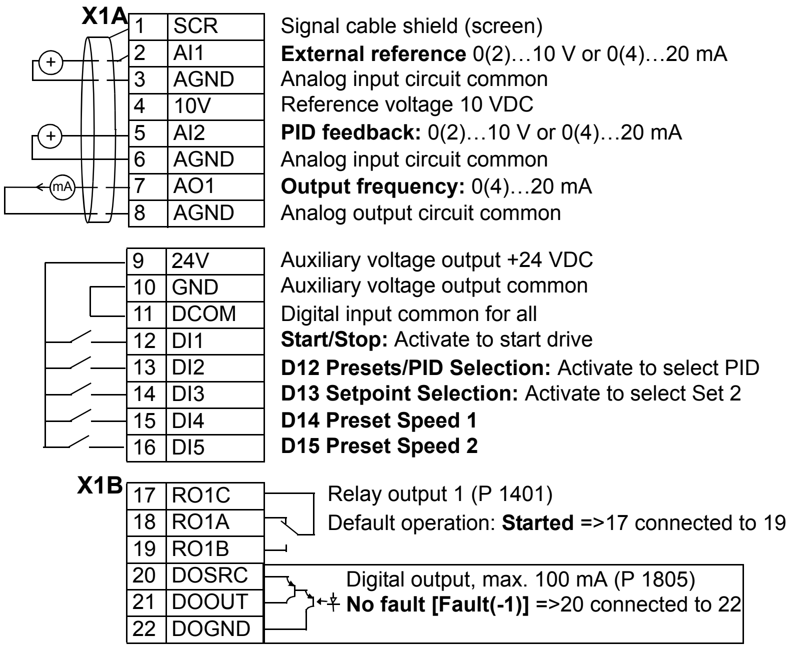
This macro configures for dual setpoint PID applications, where activating digital input 3 (DI3) changes the process PID controller's setpoint to another value. When using direct speed reference in AUTO mode or process PID, see section *General considerations* on page *77*. Set process PID setpoints (internal to the drive) using parameters 4011 (SET1) and 4111 (SET2).




| Parameters changed relative to HVAC default | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 11 (DUAL SETPNT) | 4010 | setpoint sel | 19 (INTERNAL) |
| 1201 | const speed sel | 0 (NOT SEL) | 4011 | internal setpnt | 50.0% |
| 1401 | relay output 1 | 7 (STARTED) | 4027 | pid 1 param set | 3 (DI3) |
| 1601 | run enable | 2 (DI2) | 4110 | setpoint sel | 19 (INTERNAL) |
| 1609 | start enable 2 | 5 (DI5) | 4111 | internal setpnt | 100.0% |
| 3207 | superv 3 param | 0103 (OUTPUT FREQ) | | | |

## Dual setpoint with PID and constant speeds

This macro configures for applications with 2 constant speeds, active PID and PID alternating between two setpoints using digital inputs. Set PID setpoints (internal to the drive) using parameters 4011 (SET1) and 4111 (SET2). The digital input DI3 selects the setpoints.




| Parameters changed relative to HVAC default | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 12 (DUAL SPNTCS) | 3207 | superv 3 param | 0103 (OUTPUT FREQ) |
| 1102 | ext1/ext2 sel | 2 (DI2) | 4001 | gain | 0.7 |
| 1201 | const speed sel | 11 (DI5, 6) | 4002 | integration time | 10.0 s |
| 1401 | relay output 1 | 7 (STARTED) | 4010 | setpoint sel | 19 (INTERNAL) |
| 1608 | start enable 1 | 0 (NOT SEL) | 4011 | internal setpnt | 50.0% |
| 2108 | start inhibit | 1 (ON) | 4027 | pid 1 param set | 3 (DI3) |
| 2202 | acceler time 1 | 10.0 s | 4101 | gain | 0.7 |
| 2203 | deceler time 1 | 10.0 s | 4102 | integration time | 10.0 s |
| 3105 | ar overvoltage | 0 (DISABLE) | 4110 | setpoint sel | 19 (INTERNAL) |
| 3107 | ar ai<min | 0 (DISABLE) | 4111 | internal setpnt | 100.0% |

## E-Clipse

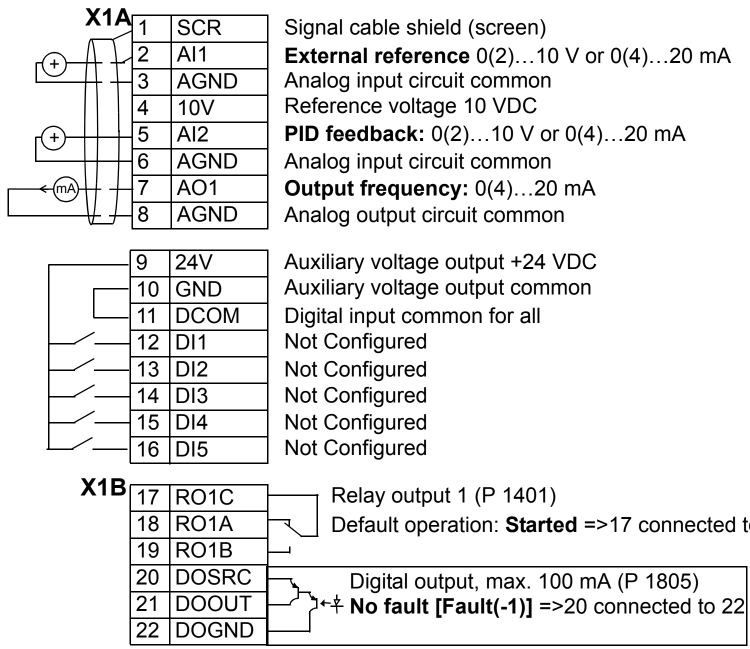
This macro configures for an E-Clipse Bypass device which can bypass the drive and connect the motor direct on-line. When using direct speed reference in AUTO mode or process PID, see section *General considerations* on page *77*.

| | | | |
|---|---|---|---|
| X1A | 1 | SCR | Signal cable shield (screen) |
| | 2 | AI1 | Not configured |
| | 3 | AGND | Analog input circuit common |
| | 4 | 10V | Reference voltage 10 VDC |
| | 5 | AI2 | Not configured |
| | 6 | AGND | Analog input circuit common |
| | 7 | AO1 | **Output frequency:** 0(4)…20 mA |
| | 8 | AGND | Analog output circuit common |
| | 9 | 24V | Auxiliary voltage output +24 VDC |
| | 10 | GND | Auxiliary voltage output common |
| | 11 | DCOM | Digital input common for all |
| | 12 | DI1 | Not configured |
| | 13 | DI2 | Not configured |
| | 14 | DI3 | Not configured |
| | 15 | DI4 | Not configured |
| | 16 | DI5 | Not configured |
| X1B | 17 | RO1C | Relay output 1 (P 1401)<br>Default operation: **Fault (-1)** =>20 connected to 22 |
| | 18 | RO1A | |
| | 19 | RO1B | |
| | 20 | RO2C | Digital output (P 1805)<br>Default operation: **Running** =>22 connected to 24 |
| | 21 | RO2A | |
| | 22 | RO2B | |

| Parameters changed relative to HVAC default | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Value** | **Parameter** | | **Value** |
| 9902 | applic macro | 15 (E-CLIPSE) | 5303 | efbbaud rate | 76.8 kb/s |
| 9802 | comm proto sel | 1 (STD MODBUS) | 5304 | efb parity | 2 (8 EVEN 1) |
| 1001 | ext1 commands | 10 (COMM) | 5305 | efb ctrl profile | 1 (DCU PROFILE) |
| 1002 | ext2 commands | 10 (COMM) | 5310 | efb par 10 | 103 |
| 1601 | run enable | 7 (COMM) | 5311 | efb par 11 | 104 |
| 1608 | start enable 1 | 7 (COMM) | | | |

## Hand control

This macro configures for drive control using only the control panel with no automated control. Typically, this is a temporary configuration used prior to control wiring.




| Parameters changed relative to HVAC default | | | |
|---|---|---|---|
| **Parameter** | **Value** | **Parameter** | **Value** |
| 9902 applic macro | 14 (HAND CONTROL) | 3415 signal 3 param | 100 (NOT SEL) |
| 1001 ext1 commands | 0 (NOT SEL) | 3416 signal 3 min | (-) |
| 1002 ext2 commands | 0 (NOT SEL) | 3417 signal 3 max | (-) |
| 1106 ref3 sel | 2 (AI2) | 3418 output 3 dsp form | (-) |
| 1201 const speed sel | 0 (NOT SEL) | 3419 output 3 dsp unit | (-) |
| 1301 minimum ai1 | 0.0% | 3420 output 3 min | (-) |
| 1304 minimum ai2 | 0.0% | 3421 output 3 max | (-) |
| 1401 relay output 1 | 7 (STARTED) | 4001 gain | 1.0 |
| 1504 minimum ao1 | 0.0mA | 4002 integration time | 60.0 s |
| 1510 minimum ao2 | 0.0mA | 4010 setpoint sel | 1 (AI1) |
| 1601 run enable | 2 (DI2) | 4101 gain | 1.0 |
| 1608 start enable 1 | 0 (NOT SEL) | 4102 integration time | 60.0 s |
| 2108 start inhibit | 1 (ON) | 4110 setpoint sel | 1 (AI1) |
| 3207 superv 3 param | 0103 (OUTPUT FREQ) | 4210 setpoint sel | 1 (AI1) |

9

# Program features

## Contents of this chapter

The chapter describes program features. For each feature, there is a list of related user settings, actual signals, and fault and alarm messages.

## Start-up assistant

### Introduction

The Start-up assistant (requires the Assistant control panel) guides the user through the start-up procedure, helping to enter the requested data (parameter values) to the drive. The Start-up assistant also checks that the entered values are valid, in other words, within the allowed range.

The Start-up assistant calls other assistants, each of which guides the user through the task of specifying a related parameter set. At the first start, the drive suggests entering the first task, Language select, automatically. The user may activate the tasks either one after the other as the Start-up assistant suggests, or independently. The user may also adjust the drive parameters in the conventional way without using the assistant at all.

## List of the tasks and the relevant drive parameters

Depending on the selection made in the Application task (parameter *9902 APPLIC MACRO*), the Start-up assistant decides which consequent tasks it suggests.

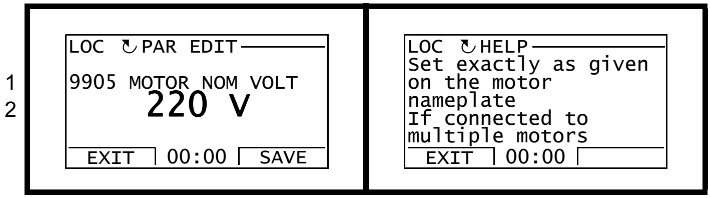
| Name | Description | Set parameters |
|---|---|---|
| **Language select** | Selecting the language | *9901* |
| **Motor set-up** | Setting the motor data | *9905…9909* |
| **Application** | Selecting the application macro | *9902*, parameters associated to the macro |
| **Option modules** | Activating the option modules | *Group 35: Motor temp meas*, *Group 52: Panel comm*, *9802* |
| **Speed control EXT1** | Selecting the source for the speed (output frequency) reference | *1103* |
| | (If AI1 is used: Setting analog input AI1 limits, scale, inversion) | (*1301…1303*, *3001*) |
| | Setting the reference limits | *1104*, *1105* |
| | Setting the frequency limits | *2007*, *2008* |
| | Setting the acceleration and deceleration times | *2202*, *2203* |
| **Speed control EXT2** | Selecting the source for the speed (output frequency) reference | *1106* |
| | (If AI1 is used: Setting analog input AI1 limits, scale, inversion) | (*1301…1303*, *3001*) |
| | Setting the reference limits | *1107*, *1108* |
| **PID control** | Selecting the source for the process reference | *1106* |
| | (If AI1 is used: Setting analog input AI1 limits, scale, inversion) | (*1301…1303*, *3001*) |
| | Setting the reference limits | *1107*, *1108* |
| | Setting the speed (reference) limits | *2007*, *2008* |
| | Setting the source and limits for the process actual value | *4016*, *4018*, *4019* |
| **Start/Stop control** | Selecting the source for start and stop signals of the two external control locations, EXT1 and EXT2 | *1001*, *1002* |
| | Selecting between EXT1 and EXT2 | *1002* |
| | Defining the direction control | *1003* |
| | Defining the start and stop modes | *2101…2103* |
| | Selecting the use of Run Enable signal | *1601* |
| **Protections** | Setting the current limits | *2003* |
| **Output signals** | Selecting the signals indicated through relay output RO | *Group 14: Relay outputs* |
| | Selecting the signals indicated through analog output AO | *Group 15: Analogue outputs* |
| | Setting the minimum, maximum, scaling and inversion | |

| **Name** | **Description** | **Set parameters** |
|---|---|---|
| **Timed functions** | Setting the timed functions | *Group 36: Timed functions* |
| | Selecting the timed start/stop control for external control locations EXT1 and EXT2 | *1001*, *1002* |
| | Selecting timed EXT1/EXT2 control | *1102* |
| | Activation of timed constant speed 1 | *1201* |
| | Selecting timed function status indicated through relay output RO | *1401* |
| | Selecting timed PID1 parameter set 1/2 control | *4027* |

## Contents of the assistant displays

There are two types of displays in the Start-up assistant: Main displays and the information displays. The main displays prompt the user to feed in information. The assistant steps through the main displays. The information displays contain help texts for the main displays. The figure below shows a typical example of both and explanations of the contents.

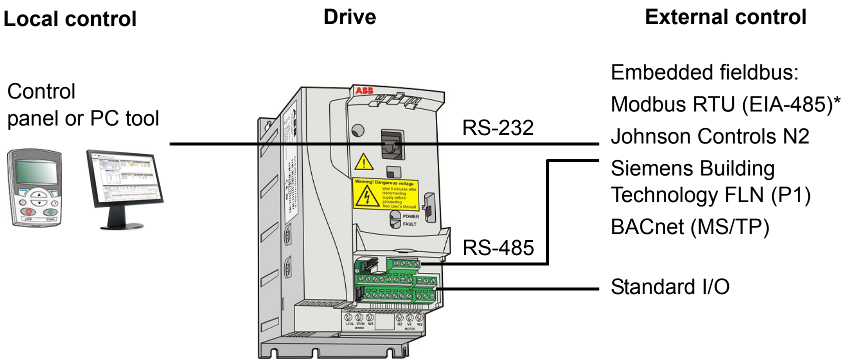
**Main display** **Information display**




| | | |
|---|---|---|
| 1 | Parameter | Help text … |
| 2 | Feed-in field | … help text continued |

# Local control vs. external control

The drive can receive start, stop and direction commands and reference values from the control panel or through digital and analog inputs. Embedded fieldbus enables control over an open fieldbus link. A PC equipped with DriveWindow Light PC tool can also control the drive.

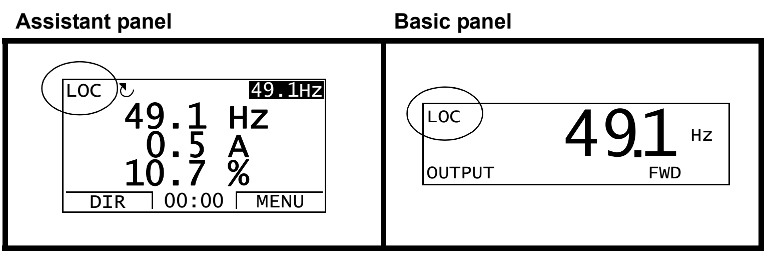



* With an SREA-01 Ethernet adapter module it is possible to use Modbus TCP/IP. For more information, see SREA-01 Ethernet Adapter Module User's Manual (3AUA0000042896 [English]).

**Note:** See section *System overview* on page *267*.

## Local control

The control commands are given from the control panel keypad when the drive is in local control. LOC indicates local control on the panel display.



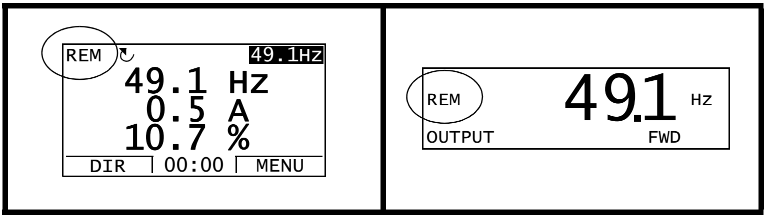

The control panel always overrides the external control signal sources when used in local mode.

## External control

When the drive is in external control, the commands are given through the standard I/O terminals (digital and analog inputs) and/or the fieldbus interface. In addition, it is also possible to set the control panel as the source for the external control.

External control is indicated with REM on the panel display.

**Assistant panel** **Basic panel**




The user can connect the control signals to two external control locations, EXT1 or EXT2. Depending on the user selection, either one is active at a time. This function operates on a 2 ms time level.

## Settings

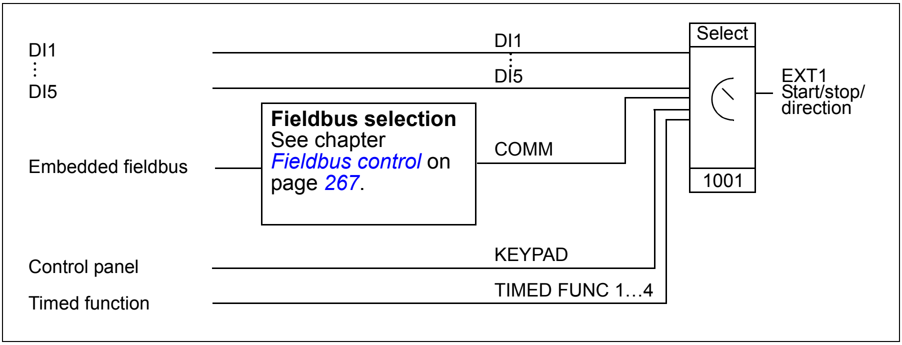
| Panel key | Additional information |
|---|---|
| LOC/REM | Selection between local and external control |
| **Parameter** | |
| *1102* | Selection between EXT1 and EXT2 |
| *1001*/*1002* | Start, stop, direction source for EXT1/EXT2 |
| *1103*/*1106* | Reference source for EXT1/EXT2 |

## Diagnostics

| Actual signals | Additional information |
|---|---|
| *0111*/*0112* | EXT1/EXT2 reference |

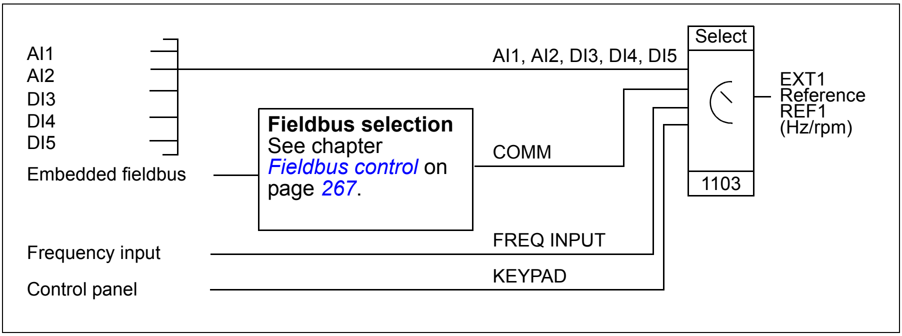
## Block diagram: Start, stop, direction source for EXT1

The figure below shows the parameters that select the interface for start, stop, and direction for external control location EXT1.




## Block diagram: Reference source for EXT1

The figure below shows the parameters that select the interface for the speed reference of external control location EXT1.



# Reference types and processing

The drive can accept a variety of references in addition to the conventional analog input and control panel signals.

- The drive reference can be given with two digital inputs: One digital input increases the speed, the other decreases it.
- The drive can form a reference out of two analog input signals by using mathematical functions: Addition, subtraction, multiplication and division.
- The drive can form a reference out of an analog input signal and a signal received through a serial communication interface by using mathematical functions: Addition and multiplication.
- The drive reference can be given with frequency input.

It is possible to scale the external reference so that the signal minimum and maximum values correspond to a speed other than the minimum and maximum speed limits.

## Settings

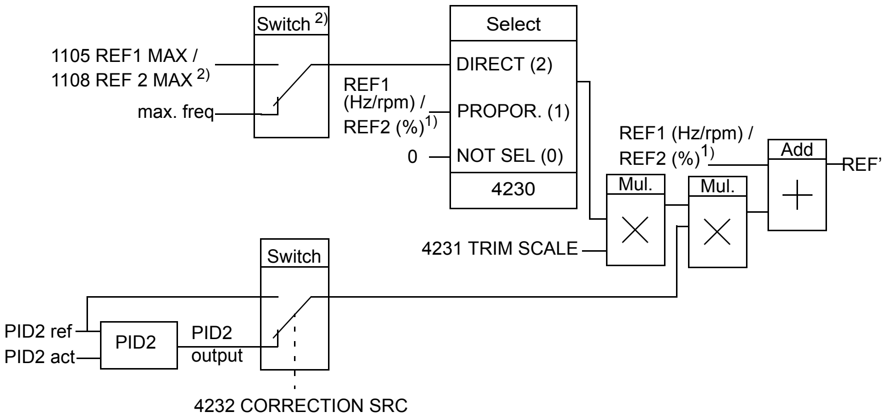
| **Parameter** | **Additional information** |
|---|---|
| *Group 11: Reference select* | External reference source, type and scaling |
| *Group 20: Limits* | Operating limits |
| *Group 22: Accel/Decel* | Speed reference acceleration/deceleration ramps |
| *Group 32: Supervision* | Reference supervision |

## Diagnostics

| **Actual signal** | **Additional information** |
|---|---|
| *0111*/*0112* | REF1/REF2 reference |
| *Group 03: FB actual signals* | References in different stages of the reference processing chain |

# Reference trimming

In reference trimming, the external reference is corrected depending on the measured value of a secondary application variable. The block diagram below illustrates the function.




REF1 (Hz/rpm) / REF2 (%) = The drive reference before trimming
REF' = The drive reference after trimming
max. freq = par. *2008* (or *2007* if the absolute value is greater)
PID2 ref = par. *4210*
PID2 act = par. *4214…4221*

[1] REF1 or REF2 depending on which is active. See parameter *1102*.

[2] When par. *4232* = PID2REF, the maximum trimming reference is defined by parameter *1105* when REF1 is active and by parameter *1108* when REF2 is active.
When par. *4232* = PID2 OUTPUT, the maximum trimming reference is defined by parameter *2008* value.

## Settings

| Parameter | Additional information |
|---|---|
| *1102* | REF1/2 selection |
| *4230* …*4232* | Trimming function settings |
| *4201 ... 4221*, *4228*, *4229* | PID control settings |
| *Group 20: Limits* | Drive operation limits |

## Programmable analog inputs

The drive has two programmable analog voltage/current inputs. The inputs can be inverted, filtered and the maximum and minimum values can be adjusted. The update cycle for the analog input is 8 ms (12 ms cycle once per second). The cycle time is shorter when information is transferred to the application program (8 ms -> 2 ms).

### Settings

| Parameter | Additional information |
| --- | --- |
| *Group 11: Reference select* | AI as reference source |
| *Group 13: Analogue inputs* | Analog input processing |
| *3001*, *3021*, *3022*, *3107* | AI loss supervision |
| *Group 35: Motor temp meas* | AI in motor temperature measurement |
| *Group 40: Process PID set 1* …*Group 42: Ext / Trim PID* | AI as PID process control reference or actual value source |
| *Group 44: Pump protection* | AI as pump protection measurement source |

### Diagnostics

| Actual signal | Additional information |
| --- | --- |
| *0120*, *0121* | Analog input values |
| *1401* | AI1/A2 signal loss |
| **Alarm** | |
| *AI1 LOSS* / *AI2 LOSS* | AI1/AI2 signal below AI1/AI2 FAULT LIMIT (*3021*/*3022*) |
| **Fault** | |
| *AI1 LOSS* / *AI2 LOSS* | AI1/AI2 signal below limit AI1/AI2 FAULT LIMIT (*3021*/*3022*) |
| *PAR AI SCALE* | Incorrect AI signal scaling (*1302* < *1301* or *1305* < *1304*) |

# Programmable analog output

One programmable current output (0 … 20 mA) is available. Analog output signal can be inverted, filtered and the maximum and minimum values can be adjusted. The analog output signals can be proportional to motor speed, output frequency, output current, motor torque, motor power, etc. The update cycle for the analog output is 2 ms.

It is also possible to write a value to an analog output through a serial communication link.

## Settings

| Parameter | Additional information |
|---|---|
| *Group 15: Analogue outputs* | AO value selection and processing |
| *Group 35: Motor temp meas* | AO in motor temperature measurement |

## Diagnostics

| Actual signal | Additional information |
|---|---|
| *0124* | AO value |
| **Fault** | |
| *PAR AO SCALE* | Incorrect AO signal scaling (*1503* < *1502*) |

# Programmable digital inputs

The drive has five programmable digital inputs. The update time for the digital inputs is 2 ms.

It is possible to delay the state change of digital inputs with delays defined in group *Group 18: Freq in & tran out*. This enables very simple program sequences by connecting several functions with the same physical wire, eg, to remove branches and leaves from a pipe by running the fan in reverse before normal operation.

One digital input (DI5) can be programmed as a frequency input. See section *Frequency input* on page *105*.

## Settings

| Parameter | Additional information |
|---|---|
| *Group 10: Start/Stop/Dir* | DI as start, stop, direction |
| *Group 11: Reference select* | DI in reference selection, or reference source |
| *Group 12: Constant speeds* | DI in constant speed selection |
| *Group 16: System controls* | DI as external Run Enable, fault reset or user macro change signal |
| *Group 18: Freq in & tran out* | Delays in DI state changes |
| *2109* | DI as external emergency stop command source |
| *2201* | DI as acceleration and deceleration ramp selection signal |
| *2209* | DI as zero ramp force signal |
| *3003* | DI as external fault source |
| *Group 35: Motor temp meas* | DI in motor temperature measurement |
| *3601* | DI as timed function enable signal source |
| *3622* | DI as booster activation signal source |
| *4010*/*4110*/*4210* | DI as PID controller reference signal source |
| *4022*/*4122* | DI as sleep function activation signal in PID1 |
| *4027* | DI as PID1 parameter set 1/2 selection signal source |
| *4034*/*4035* | DI as PID reference/output freezing source |
| *4039*/*4139* | DI as PID internal setpoint selection source |
| *4228* | DI as external PID2 function activation signal source |
| *4406*/*4414* | DI as connection signal source for pump inlet/outlet pressure switch |
| *4421* | DI as pipe fill enable source |
| *4601* | DI as pump clean trigger source |
| *6403* | DI as load analyzer logger reset source |
| *8120* | DI as PFA interlock source |

### Diagnostics

| Actual signal | Additional information |
| --- | --- |
| *0160* | DI status |
| *0414* | DI status at the time the latest fault occurred |

## Programmable relay output

The drive has one programmable relay output. It is possible to add three additional relay outputs with the optional MREL-0 relay output extension module. For more information, see *MREL-01 output relay module user's manual* (3AUA0000035974 [English]).

With a parameter setting it is possible to choose what information to indicate through the relay output: Ready, running, fault, alarm, etc. The update time for the relay output is 2 ms.

A value can be written to a relay output through a serial communication link.

### Settings

| Parameter | Additional information |
| --- | --- |
| *Group 14: Relay outputs* | RO value selections and operation times |

### Diagnostics

| Actual signal | Additional information |
| --- | --- |
| *0134* | RO Control Word through fieldbus control |
| *0162* | RO 1 status |
| *0173* | RO 2…4 status. With option MREL-01 only. |

# Frequency input

Digital input DI5 can be programmed as a frequency input. Frequency input (0…16000 Hz) can be used as external reference signal source. The update time for the frequency input is 50 ms. Update time is shorter when information is transferred to the application program (50 ms -> 2 ms).

## Settings

| **Parameter** | **Additional information** |
|---|---|
| *Group 18: Freq in & tran out* | Frequency input minimum and maximum values and filtering |
| *1103*/*1106* | External reference REF1/2 through frequency input |
| *4010*, *4110*, *4210* | Frequency input as PID reference source |

## Diagnostics

| **Actual signal** | **Additional information** |
|---|---|
| *0161* | Frequency input value |

# Transistor output

The drive has one programmable transistor output. The output can be used either as digital output or frequency output (0…16000 Hz). The update time for the transistor/frequency output is 2 ms.

## Settings

| **Parameter** | **Additional information** |
|---|---|
| *Group 18: Freq in & tran out* | Transistor output settings |

## Diagnostics

| **Actual signal** | **Additional information** |
|---|---|
| *0163* | Transistor output status |
| *0164* | Transistor output frequency |

# Actual signals

Several actual signals are available:

- Drive output frequency, current, voltage and power
- Motor speed and torque
- Intermediate circuit DC voltage
- Active control location (LOCAL, EXT1 or EXT2)
- Reference values
- Drive temperature
- Operating time counter (h), kWh counter
- Digital I/O and analog I/O status
- PID controller actual values.

Three signals can be shown simultaneously on the assistant control panel display (one signal on the basic panel display). It is also possible to read the values through the serial communication link or through the analog outputs.

## Settings

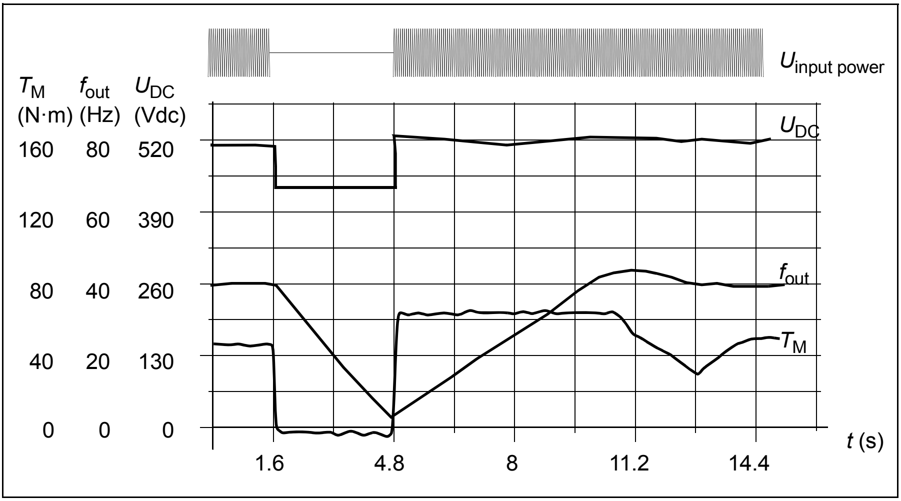
| Parameter | Additional information |
|---|---|
| *1501* | Selection of an actual signal to AO |
| *1801* | Selection of an actual signal to frequency output |
| *Group 32: Supervision* | Actual signal supervision |
| *Group 34: Panel display* | Selection of an actual signals to be displayed on the control panel |

## Diagnostics

| Actual signal | Additional information |
|---|---|
| *Group 01: Operating data* … *Group 04: Fault history* | Lists of actual signals |

# Power loss ride-through

If the incoming supply voltage is cut off, the drive will continue to operate by utilizing the kinetic energy of the rotating motor. The drive will be fully operational as long as the motor rotates and generates energy to the drive. The drive can continue the operation after the break if the main contactor remained closed.




$U_{DC}$ = Intermediate circuit voltage of the drive, $f_{out}$ = Output frequency of the drive, $T_M$ = Motor torque

Loss of supply voltage at nominal load ($f_{out}$ = 40 Hz). The intermediate circuit DC voltage drops to the minimum limit. The controller keeps the voltage steady as long as the input power is switched off. The drive runs the motor in generator mode. The motor speed falls but the drive is operational as long as the motor has enough kinetic energy.

## Settings

Parameter *2006 UNDERVOLT CTRL*

# DC magnetizing

When DC Magnetizing is activated, the drive automatically magnetizes the motor before starting. This feature guarantees the highest possible breakaway torque, up to 180% of the motor nominal torque. The Automatic Start feature and DC Magnetizing cannot be activated at the same time.

## Settings

Parameters *2101 START FUNCTION* and *2103 DC MAGN TIME*

# Maintenance trigger

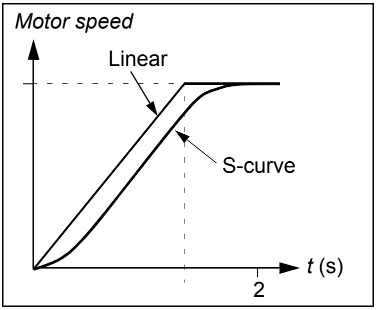
A maintenance trigger can be activated to show a notice on the panel display when, for example, drive power consumption has exceeded the defined trigger point.

## Settings

Parameter *Group 29: Maintenance trig*

# Acceleration and deceleration ramps

Two user-selectable acceleration and deceleration ramps are available. It is possible to adjust the acceleration/deceleration times and the ramp shape. Switching between the two ramps can be controlled via a digital input or fieldbus.




The available ramp shape alternatives are Linear and S-curve.

**Linear**: Suitable for drives requiring steady or slow acceleration/deceleration.

**S-curve**: Ideal for conveyors carrying fragile loads, or other applications where a smooth transition is required when changing the speed.

## Settings

Parameter *Group 22: Accel/Decel*

## Critical speeds

A Critical Speeds function is available for applications where it is necessary to avoid certain motor speeds (drive output frequencies) or speed bands (output frequency bands) because of, for example, mechanical resonance problems. The user can define three critical frequencies or frequency bands.

### Settings

Parameter *Group 25: Critical speeds*

## Constant speeds

It is possible to define seven positive constant speeds. Constant speeds are selected with digital inputs. Constant speed activation overrides the external speed reference.

Constant speed selections are ignored if

- PID reference is being followed, or
- drive is in local control mode.

This function operates on a 2 ms time level.

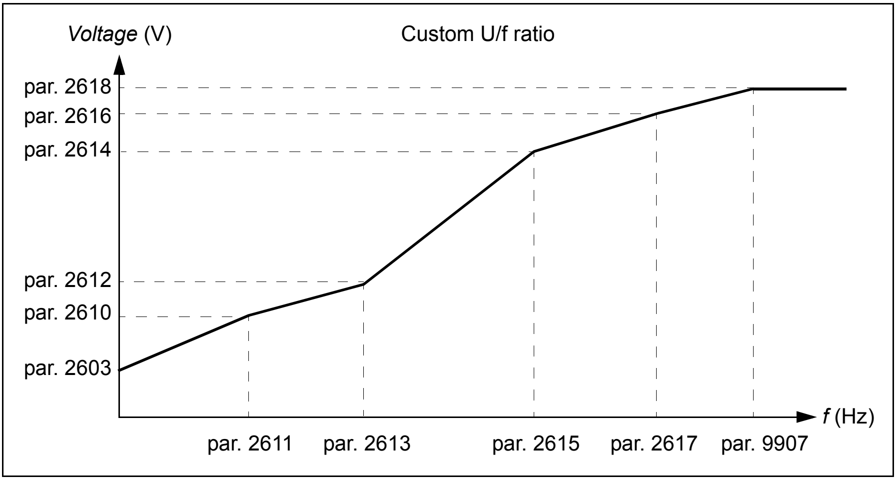
### Settings

Parameter *Group 12: Constant speeds*

Constant speed 7 (*1208 CONST SPEED 7*) is also used for fault functions. See parameter group *Group 30: Fault functions*.

# Custom U/f ratio

The user can define a U/f curve (output voltage as a function of frequency). This custom ratio is used only in special applications where linear and squared U/f ratio are not sufficient (eg, when motor break-away torque needs to be boosted).




**Note:** The voltage and the frequency points of the U/f curve must fulfill the following requirements:

*2610* < *2612* < *2614* < *2616* < *2618* and
*2611* < *2613* < *2615* < *2617* < *9907*

**WARNING!** High voltage at low frequencies may result in poor performance or motor damage (overheating).

## Settings

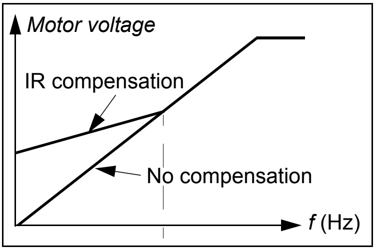
| Parameter | Additional information |
|---|---|
| *2605* | Custom U/f ratio activation |
| *2610…2618* | Custom U/f ratio settings |

## Diagnostics

| Fault | Additional information |
|---|---|
| *PAR CUSTOM U/F* | Incorrect U/f ratio |

# R compensation

When IR compensation is activated, the drive gives an extra voltage boost to the motor at low speeds. IR compensation is useful in applications that require high breakaway torque.




## Settings

Parameter *2603 IR COMP VOLT*

# Programmable protection functions

## AI<Min

AI<Min function defines the drive operation if an analog input signal falls below the set minimum limit.

### Settings

Parameters *3001 AI<MIN FUNCTION*, *3021 AI1 FAULT LIMIT* and *3022 AI2 FAULT LIMIT*

## Panel loss

The Panel loss function defines the operation of the drive if the control panel selected as control location for the drive stops communicating.

### Settings

Parameter *3002 PANEL COMM ERR*

## External fault

External faults (1 and 2) can be supervised by defining one digital input as a source for an external fault indication signal.

### Settings

Parameters *3003 EXTERNAL FAULT 1* and *3004 EXTERNAL FAULT 2*

## Stall protection

The drive protects the motor in a stall situation. It is possible to adjust the supervision limits (frequency, time) and choose how the drive reacts to the motor stall condition (alarm indication / fault indication & drive stop / no reaction).

### Settings

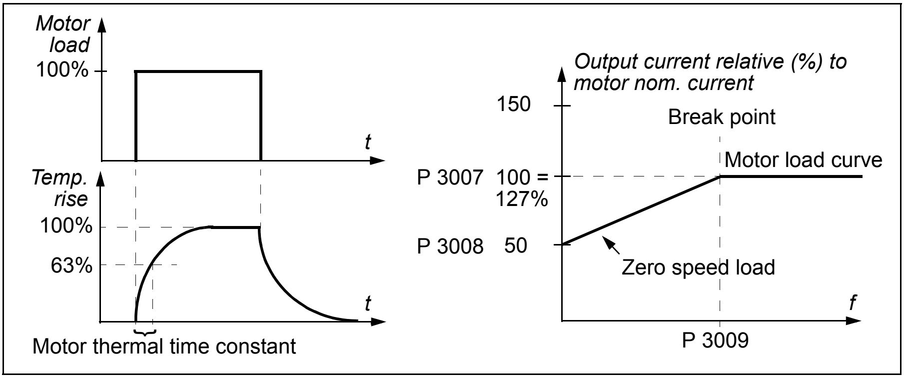
Parameters *3010 STALL FUNCTION*…*3012 STALL TIME*

## Motor thermal protection

The motor can be protected against overheating by activating the Motor thermal protection function.

The drive calculates the temperature of the motor on the basis of the following assumptions:

1. The motor is in the ambient temperature of 30 °C when power is applied to the drive.
2. Motor temperature is calculated using either the user-adjustable or automatically calculated motor thermal time constant and motor load curve (see the figures below). The load curve should be adjusted in case the ambient temperature exceeds 30 °C.




### Settings

Parameters *3005 MOT THERM PROT*…*3009 BREAK POINT FREQ*

**Note:** It is also possible to use the motor temperature measurement function. See section *Motor temperature measurement through the standard I/O* on page *121*.

## Earth fault protection

The Earth fault protection function detects ground faults in the motor or motor cable. The protection is active only during start.

A ground fault in the input power line does not activate the protection.

### Settings

Parameter *3017 EARTH FAULT*

## Incorrect wiring

Defines the operation when incorrect input power cable connection is detected.

**Settings**

Parameter *3023 WIRING FAULT*

# Preprogrammed faults

## Overcurrent

The overcurrent trip limit for the drive is 325% of the drive nominal current.

## DC overvoltage

The DC overvoltage trip limit is 420 V (for 200 V drives) and 840 V (for 400 V drives).

## DC undervoltage

The DC undervoltage trip limit is adaptive. See parameter *2006 UNDERVOLT CTRL*.

## Drive temperature

The drive supervises the IGBT temperature. There are two supervision limits: Alarm limit and fault trip limit.

## Short circuit

If a short circuit occurs, the drive will not start and a fault indication is given.

## Internal fault

If the drive detects an internal fault, the drive is stopped and a fault indication is given.

## Supply phase loss

If the drive detects supply phase loss (excessive DC voltage ripple), the drive is stopped and a fault indication is given.

# Operation limits

The drive has adjustable limits for output frequency, current (maximum) and DC voltage.

## Settings

Parameter *Group 20: Limits*

# Power limit

Power limitation is used to protect the input bridge and the DC intermediate circuit. If the maximum allowed power is exceeded, the drive torque is automatically limited. Maximum overload and continuous power limits depend on the drive hardware. For specific values, see chapter *Technical data* on page *363*.

# Automatic resets

The drive can automatically reset itself after overcurrent, overvoltage, undervoltage, external and “analog input below a minimum” faults. The Automatic Resets must be activated by the user.

## Settings

| Parameter | Additional information |
|---|---|
| *Group 31: Automatic reset* | Automatic reset settings |

## Diagnostics

| Alarm | Additional information |
|---|---|
| *AUTORESET* | Automatic reset alarm |

# Supervisions

The drive monitors whether certain user selectable variables are within the user-defined limits. The user may set limits for speed, current etc. The supervision status can be indicated through relay or digital output.

The supervision function outputs can be used for triggering some drive functionality (start/stop, sleep, pump cleaning).

The supervision functions operate on a 2 ms time level.

## Settings

Parameter group *Group 32: Supervision*

## Diagnostics

| Actual signal | Additional information |
|---|---|
| *1001*/*1002* | EXT1/EXT2 start/stop according to supervision functions |
| *1401* | Supervision status through RO 1 |
| *1402*/*1403*/*1410* | Supervision status through RO 2…4. With option MREL-01 only. |
| *1805* | Supervision status through DO |
| *4022*/*4122* | Sleep start according to supervision functions |
| *4601* | Pump clean trigger according to supervision functions |

# Parameter lock

The user can prevent parameter adjustment by activating the parameter lock.

## Settings

Parameters *1602 PARAMETER LOCK* and *1603 PASS CODE*

# PID control

There are two built-in PID controllers in the drive:

- Process PID (PID1) and
- External/Trim PID (PID2).

The PID controller can be used when the motor speed needs to be controlled based on process variables such as pressure, flow or temperature.

When the PID control is activated, a process reference (setpoint) is connected to the drive instead of a speed reference. An actual value (process feedback) is also brought back to the drive. The drive compares the reference and the actual values, and automatically adjusts the drive speed in order to keep the measured process quantity (actual value) at the desired level (reference).

The control operates on a 2 ms time level.

## Process controller PID1

PID1 has two separate sets of parameters (*Group 40: Process PID set 1*, *Group 41: Process PID set 2*). Selection between parameter sets 1 and 2 is defined by a parameter.

In most cases when there is only one transducer signal wired to the drive, only parameter set 1 is needed. Two different parameter sets (1 and 2) are used, eg, when the load of the motor changes considerably in time.

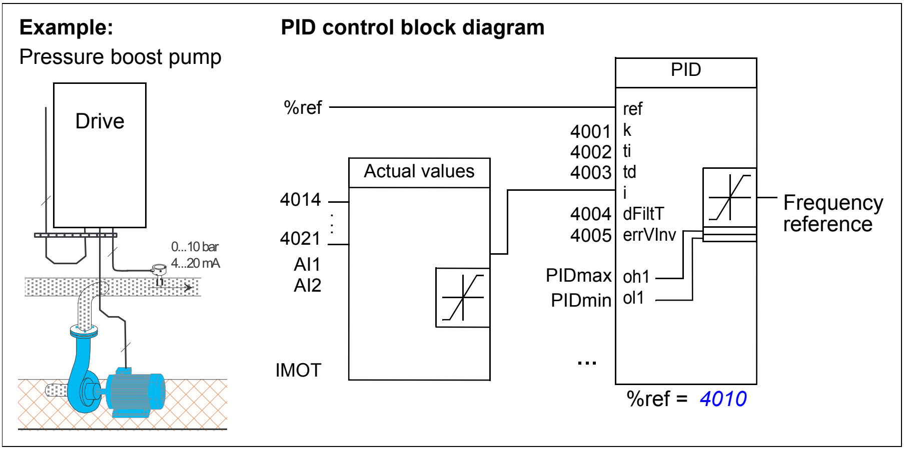
## External/Trim controller PID2

PID2 (*Group 42: Ext / Trim PID*) can be used in two different ways:

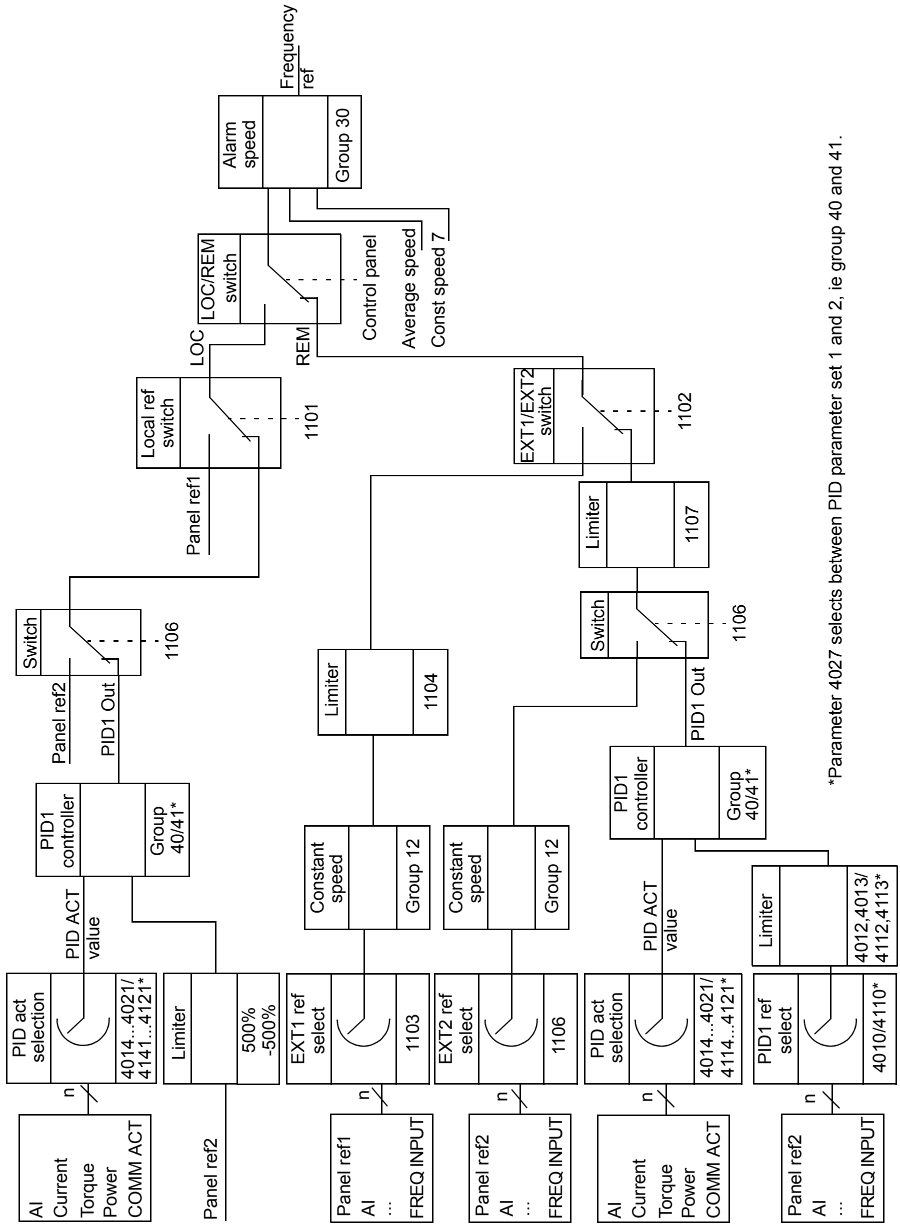
- External controller: Instead of using additional PID controller hardware, the user can connect PID2 output via drive analog output or fieldbus controller to control a field instrument like a damper or a valve.
- Trim controller: PID2 can be used to trim or fine tune the reference of the drive. See section *Reference trimming* on page *100*.

## Block diagrams

The figure below shows an application example: The controller adjusts the speed of a pressure boost pump according to the measured pressure and the set pressure reference.



The following figure presents the speed/scalar control block diagram for process controller PID1.



## Settings

| Parameter | Additional information |
|---|---|
| *1101* | Local control mode reference type selection |
| *1102* | EXT1/2 selection |
| *1106* | PID1 activation |
| *1107* | REF2 minimum limit |
| *1501* | PID2 output (external controller) connection to AO |
| *9902* | PID control macro selection |
| *Group 40: Process PID set 1…Group 41: Process PID set 2* | PID1 settings |
| *Group 42: Ext / Trim PID* | PID2 settings |

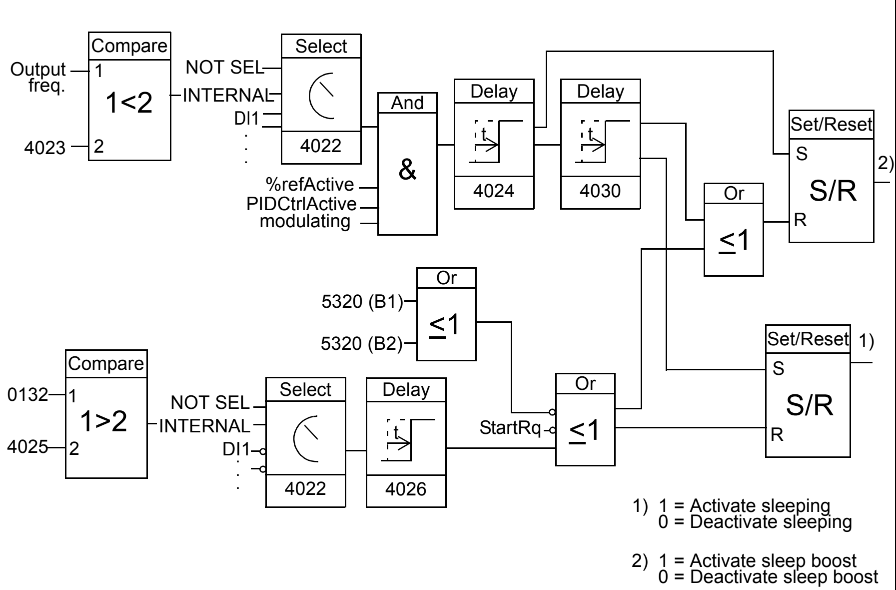
## Diagnostics

| Actual signal | Additional information |
|---|---|
| *0126*/*0127* | PID 1/2 output value |
| *0128*/*0129* | PID 1/2 setpoint value |
| *0130*/*0131* | PID 1/2 feedback value |
| *0132*/*0133* | PID 1/2 deviation |

## Sleep function for the process PID (PID1) control

The sleep function operates on a 2 ms time level.

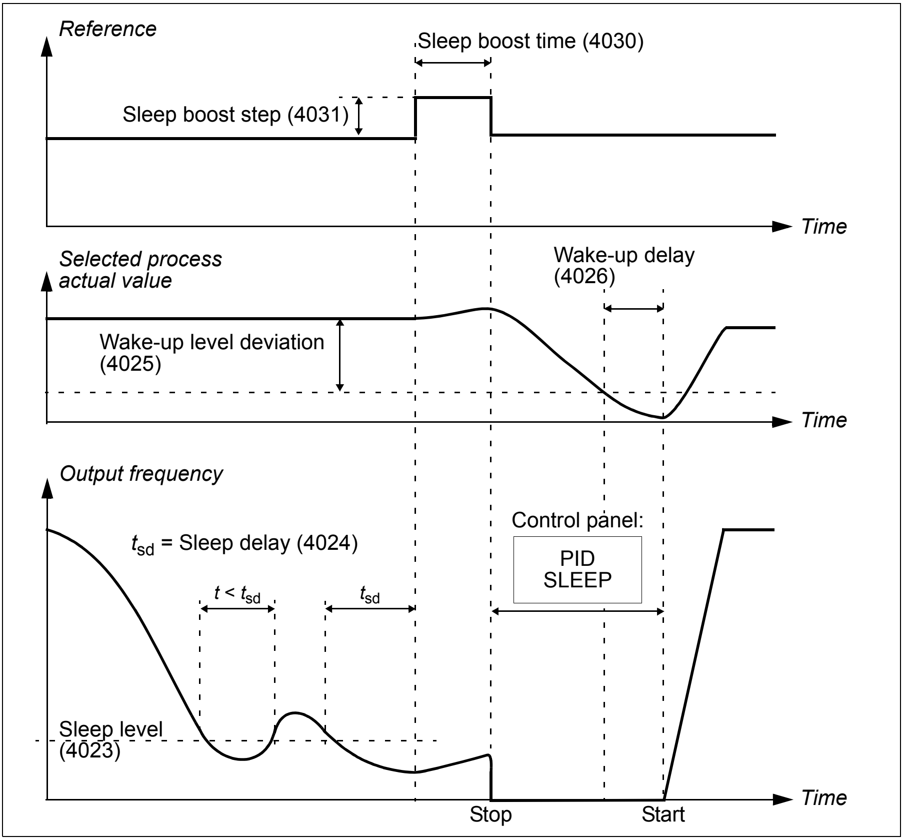
The block diagram below illustrates the sleep function enable/disable logic. The sleep function can be put into use only when the PID control is active.




Mot. speed: Actual speed of the motor
%refActive: The % reference (EXT REF2) is in use. See parameter *1102*.
PIDCtrlActive: *9902* is PID CTRL.
modulating: The inverter IGBT control is operating.

## Example

The time scheme below visualizes the operation of the sleep function.




Sleep function for a PID controlled pressure boost pump (when parameter *4022 SLEEP SELECTION* is set to INTERNAL): The water consumption falls at night. As a consequence, the PID process controller decreases the motor speed. However, due to natural losses in the pipes and the low efficiency of the centrifugal pump at low speeds, the motor does not stop but keeps rotating. The sleep function detects the slow rotation, and stops the unnecessary pumping after the sleep delay has passed. The drive shifts into sleep mode, still monitoring the pressure. The pumping restarts when the pressure falls under the allowed minimum level and the wake-up delay has passed.

### Settings

| Parameter | Additional information |
|---|---|
| *9902* | PID control activation |
| *4022…4026*, *4030*, *4031*, *4122…4126, 4130, 4131* | Sleep function settings |

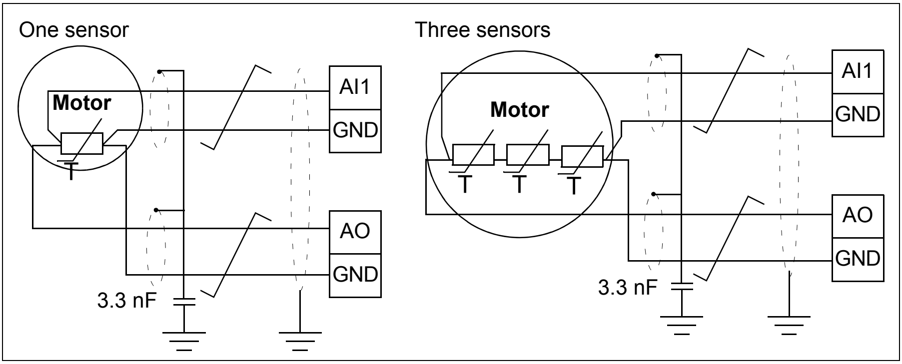
### Diagnostics

| Parameter | Additional information |
|---|---|
| *1401* | PID sleep function status through RO 1 |
| *1402*/*1403*/*1410* | PID sleep function status through RO 2…4. With option MREL-01 only. |
| **Alarm** | **Additional information** |
| *PID SLEEP* | Sleep mode |

## Motor temperature measurement through the standard I/O

This section describes the temperature measurement of one motor when the drive I/O terminals are used as the connection interface.

Motor temperature can be measured using PT100 or PTC sensors connected to analog input and output.



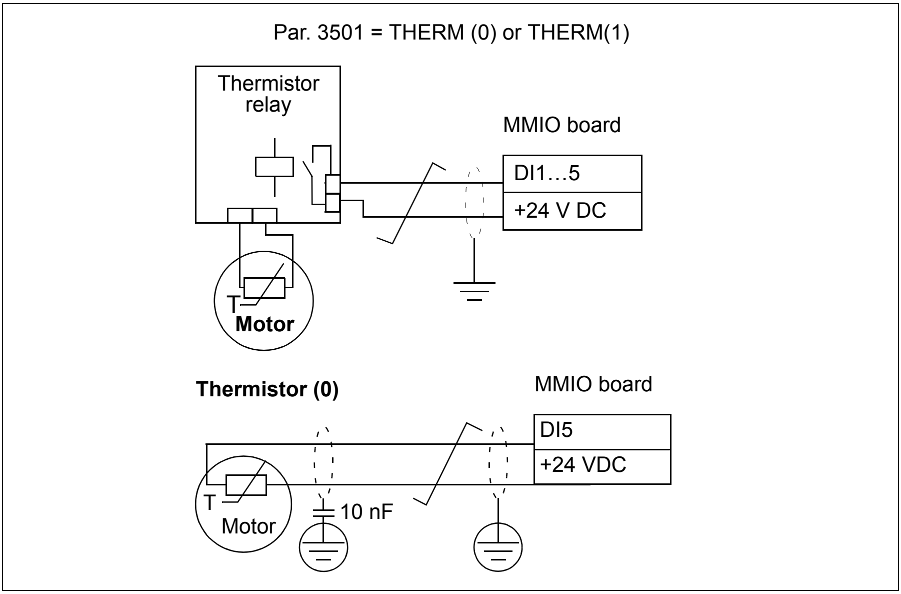

**WARNING!** According to IEC 664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. Reinforced insulation entails a clearance and creepage distance of 8 mm (400/500 V AC equipment).
If the assembly does not fulfill the requirement, the I/O board terminals must be protected against contact and they may not be connected to other equipment, or the temperature sensor must be isolated from the I/O terminals.

To fulfill the insulation requirement, connect a thermistor (and other similar components) to the drive's control terminals using any of these alternatives:

- Separate the thermistor from live parts of the motor with double reinforced insulation.
- Protect all circuits connected to the drive's digital and analog inputs. Protect against contact, and insulate from other low voltage circuits with basic insulation (rated for the same voltage level as the drive's main circuit).
- Use an external thermistor relay. The relay insulation must be rated for the same voltage level as the drive's main circuit.

The figure below shows alternate thermistor connections. At the motor end the cable shield should be grounded through a 10 nF capacitor. If this is not possible, leave the shield unconnected.

It is also possible to monitor motor temperature by connecting a PTC sensor and a thermistor relay between the +24 V DC voltage supply offered by the drive and a digital input. The figure below displays the connection.




For other faults, or for anticipating motor overheating using a model, see *Group 30: Fault functions*.

## Settings

| Parameter | Additional information |
|---|---|
| *Group 13: Analogue inputs* | Analog input settings |
| *Group 15: Analogue outputs* | Analog output settings |
| *Group 35: Motor temp meas* | Motor temperature measurement settings |
| **Other** | |
| At the motor end the cable shield should be grounded through a 10 nF capacitor. If this is not possible, the shield is to be left unconnected. | |

## Diagnostics

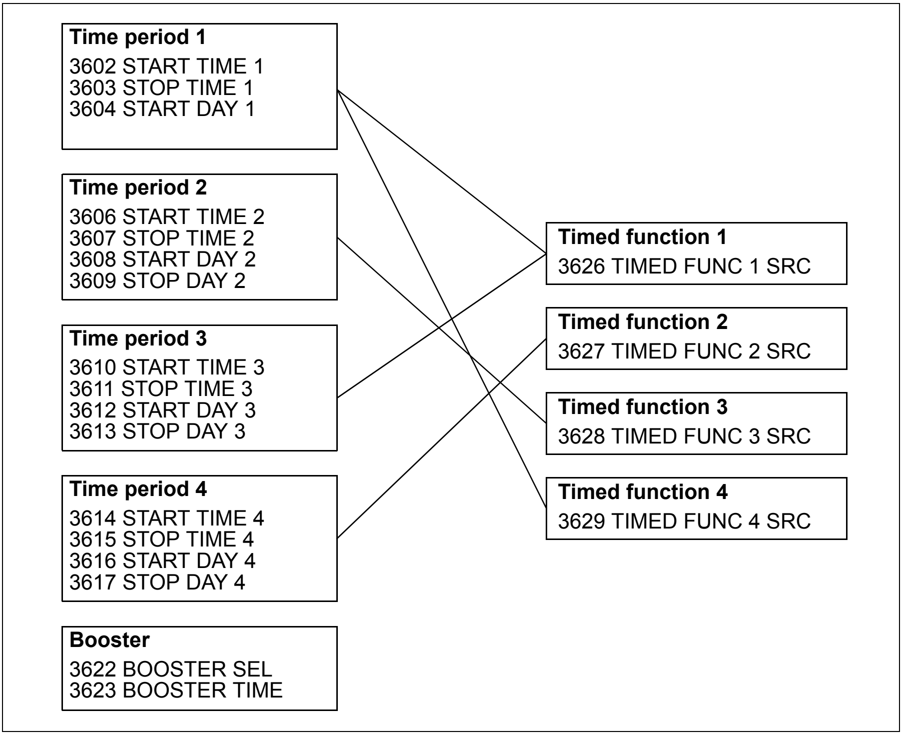
| Actual value | Additional information |
|---|---|
| *0145* | Motor temperature |
| **Alarm/Fault** | **Additional information** |
| *MOTOR TEMP/MOT OVERTEMP* | Excessive motor temp |

# Timed functions

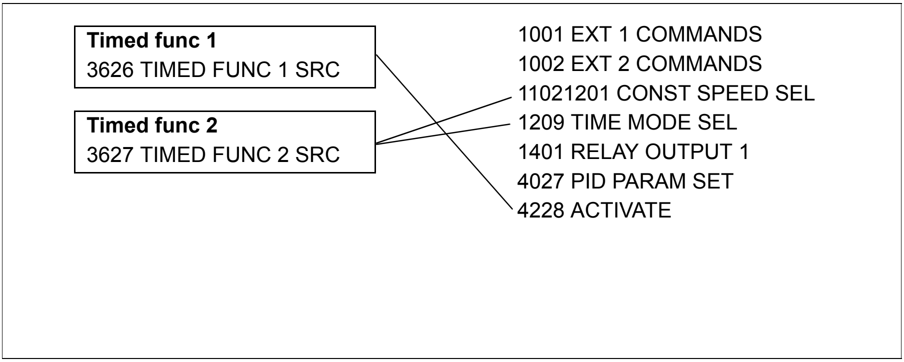
A variety of drive functions can be time controlled, eg start/stop and EXT1/EXT2 control. The drive offers

- four start and stop times (START TIME 1…4, STOP TIME 1…4)
- four start and stop days (START DAY 1…4, STOP DAY 1…4)
- four timed functions for collecting the selected time periods 1…4 together (TIMED FUNC 1…4)
- booster time (an additional booster time connected to timed functions).

A timed function can be connected to multiple time periods:



A parameter which is triggered by a timed function can be connected to only one timed function at a time.




## Examples

Air conditioning is active on weekdays from 8:00 to 15:30 (8 a.m to 3:30 p.m) and on Sundays from 12:00 to 15:00 (12 to 3 p.m). By pressing the extension time switch, the air-conditioning is on for an extra hour.

| **Parameter** | **Setting** |
|---|---|
| *3601 TIMERS ENABLE* | DI1 |
| *3602 START TIME 1* | 08:00:00 |
| *3603 STOP TIME 1* | 15:30:00 |
| *3604 START DAY 1* | MONDAY |
| *3605 STOP DAY 1* | FRIDAY |
| *3606 START TIME 2* | 12:00:00 |
| *3607 STOP TIME 2* | 15:00:00 |
| *3608 START DAY 2* | SUNDAY |
| *3609 STOP DAY 2* | SUNDAY |
| *3623 BOOSTER TIME* | 01:00:00 |

## Settings

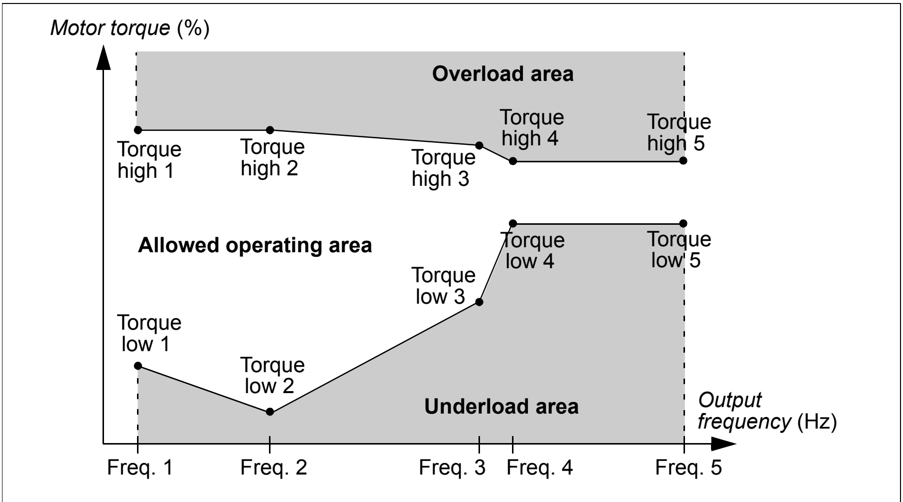
| **Parameter** | **Additional information** |
|---|---|
| *Group 36: Timed functions* | Timed functions settings |
| *1001*, *1002* | Timed start/stop control |
| *1102* | Timed EXT1/EXT2 selection |
| *1201* | Timed constant speed 1 activation |
| *1209* | Timed speed selection |
| *1401* | Timed function status indicated through relay output RO 1 |
| *1402*/*1403*/*1410* | Timed function status indicated through relay output RO 2…4. With option MREL-01 only. |

| Parameter | Additional information |
|---|---|
| *1805* | Timed function status indicated through digital output DO |
| *4027* | Timed PID1 parameter set 1/2 selection |
| *4228* | Timed external PID2 activation |

# User load curve

The user can specify a load curve (motor torque as a function of frequency) for supervision. The curve is defined by five points. Supervision can be set for the torque dropping below the underload curve, exceeding the overload curve, or both.

A fault is generated if the torque has been out of the allowed area for longer than the user-defined time limit. An alarm is generated if the torque has been out of the allowed area for longer than the half of the user-defined time limit.




## Settings

| Parameter | Additional information |
|---|---|
| *Group 37: User load curve* | User load curve settings |

### Diagnostics

| Actual signal | Additional information |
| --- | --- |
| *0105* | Motor torque |
| **Alarm** | |
| *USER LOAD CURVE* | Out of allowed area for longer than half of the defined time limit |
| **Fault** | |
| *USER LOAD CURVE* | Out of allowed area for longer than the defined time limit |
| *PAR USER LOAD C* | Incorrect user load curve parameter setting (*3704* > *3707* or *3707* > *3710* or *3710* > *3713* or *3713* > *3716* or *3705* > *3706* or *3708* > *3709* or *3711* > *3712* or *3714* > *3715* or *3717* > *3718*) |

## Energy optimizer

Energy optimizer optimizes the flux so that the total energy consumption and motor noise level are reduced when the drive operates below the nominal load. The total efficiency (motor and drive) can be improved by 1 … 10% depending on the load torque and speed.

### Settings

| Parameter | Additional information |
| --- | --- |
| *4501 ENERGY OPTIMIZER* | Energy optimizer enabling |

# Energy saving

Energy saving tools calculate energy saved in kWh and MWh, energy saved in local currency as well as reduction in $CO_2$ emission, all compared to the situation when the pump is connected directly to the supply.

Two actual signals, *0176 SAVED AMOUNT 1* and *0177 SAVED AMOUNT 2* are used to store the energy saved in local currency. To find out the total saved energy in currency units, add the value of signal *0177* multiplied by 1000 to the value of signal *0176*.

**Example:**
*0176 SAVED AMOUNT 1* = 123.4
*0177 SAVED AMOUNT 2* = 5
Total saved energy = 5 · 1000 + 123.4 = 5123.4 currency units.

**Note:** The values of saved energy parameters *0174 SAVED KWH*, *0175 SAVED MWH*, *0176 SAVED AMOUNT 1*, *0177 SAVED AMOUNT 2* and *0178 SAVED CO2* are derived from subtracting the drive's energy consumed from the direct-on-line (DOL) consumption calculated on the basis of parameter *4508 PUMP POWER*. As such, the accuracy of the values is dependent on the accuracy of the power estimate entered in that parameter.

## Settings

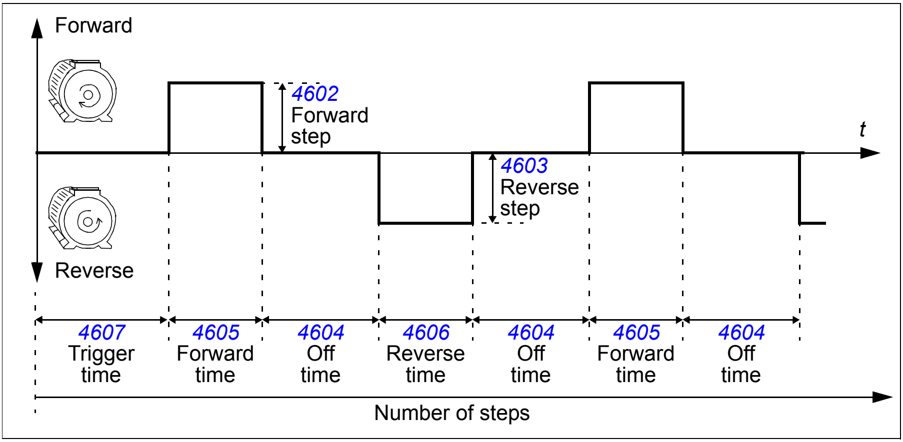
| Parameter | Additional information |
|---|---|
| *Group 45: Energy saving* | Energy saving settings |

## Diagnostics

| Actual signal | Additional information |
|---|---|
| *0174*/*0175* | Energy saved in kWh/Mwh |
| *0176*/*0177* | Energy saved in local currency |
| *0178* | Reduction in $CO_2$ emission |

## Pump cleaning

The Pump cleaning function can be used for preventing solids from building up on pump impellers. The function consists of a programmable sequence of forward and reverse runs of the pump (see the figure below), effectively shaking off any residue on the impeller. This is especially useful with booster and wastewater pumps.




The pump cleaning cycle can be activated at start-up, with a user-defined period, with a selectable digital input or by the Supervision function (for example triggered by the motor input current).

### Settings

| Parameter | Additional information |
|---|---|
| *Group 46: Pump cleaning* | Pump cleaning settings |
| *2205*/*2206* | Acceleration time 2 / Deceleration time 2 |

# Load analyzer

The load analyzer can be used for analyzing the customer's process and sizing the drive and the motor.

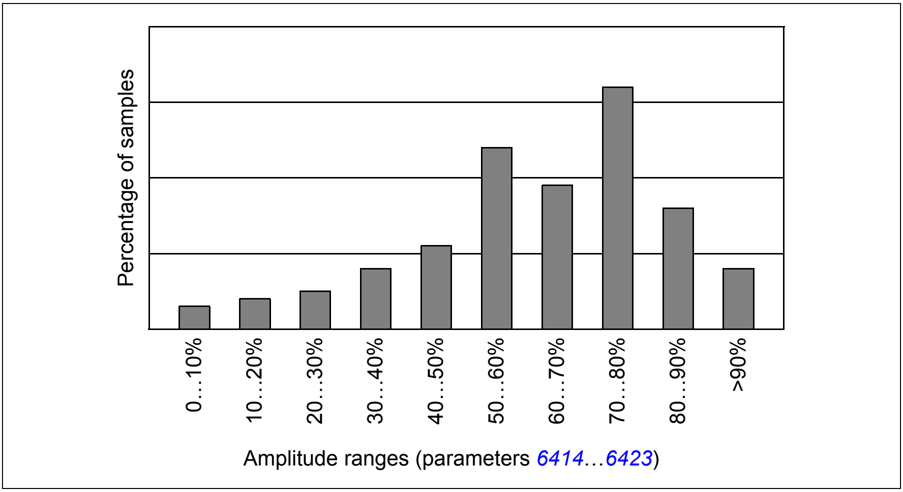
## Peak value logger

The user can select a signal (*Group 01: Operating data*) to be monitored by the peak value logger (PVL). The signal is sampled at 2 ms intervals when the drive is running. The logger records the peak (maximum) value of the signal along with the time the peak occurred, as well as output current, DC voltage and output frequency at the time of the peak.

## Amplitude loggers

The drive has two amplitude loggers.

For amplitude logger 2 (AL2), the user can select a signal (*Group 01: Operating data*) to be sampled at 200 ms intervals when the drive is running, and specify a value that corresponds to 100%. The collected samples are sorted into 10 read-only parameters according to their amplitude. Each parameter represents an amplitude range 10 percentage points wide, and displays the percentage of the collected samples that fall within that range.




Amplitude logger 1 (AL1) is fixed to monitor output current, and it cannot be reset. With amplitude logger 1, 100% corresponds to the nominal output current of the drive ($I_{2N}$).

The peak value logger and amplitude logger 2 can be reset by a user-defined method. They are also reset if either of the signals or the peak value filter time is changed.

### Settings

| Parameter | Additional information |
|---|---|
| *Group 64: Load analyzer*, parameters *6401*…*6405* | Load analyzer settings |

### Diagnostics

| Actual signal | Additional information |
|---|---|
| *Group 64: Load analyzer*, parameters *6406*…*6433* | Load analyzer results |

## PFA control
## (Requires use of MREL-01 option purchased separately)

### PFA control

The pump and fan alternation (PFA) control switches auxiliary pumps on and off as required by capacity changes. The Autochange function alternates between pumps to keep the duty times of the pumps equal. Interlocks function enables the drive to detect if any of the pumps are unavailable (for example, switched off for maintenance), in which case the next available pump is started instead.

The drive controls the motor of pump 1, varying the motor speed to control the pump capacity. This motor is the speed regulated motor.

Direct line connections power the motor of pump 2 and pump 3, etc. The drive switches pump 2 (and then pump 3, etc.) on and off as needed. These motors are auxiliary motors.

The drive PID control uses two signals: a process reference and an actual value feedback. The PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference.

When demand (defined by the process reference) exceeds the first motor’s capacity (user defined as a frequency limit), the PFA control automatically starts an auxiliary pump. The PFA control also reduces the speed of the first pump to account for the auxiliary pump’s addition to total output. Then, as before, the PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference. If demand continues to increase, the PFA control adds additional auxiliary pumps, using the same process.

When demand drops, such that the first pump speed falls below a minimum limit (user defined by a frequency limit), the PFA control automatically stops an auxiliary pump. The PFA control also increases the speed of the first pump to account for the auxiliary pump’s missing output.

An Interlock function (when enabled) identifies off-line (out of service) motors, and the PFA control skips to the next available motor in the sequence.

An Autochange function (when enabled and with the appropriate switchgear) equalizes duty time between the pump motors. Autochange periodically increments the position of each motor in the rotation – the speed regulated motor becomes the last auxiliary motor, the first auxiliary motor becomes the speed regulated motor, etc.

When the speed regulated motor reaches the full output, it is disconnected from the drive and switched to direct on-line connection, with a slight delay in between.

Auxiliary motor 2 is connected to drive output. After a slight delay the motor speed is increased to fulfill the pumping capacity needed.

Auxiliary motors 3 and 4 are started according to the same routine.

The motor stopping routine always follows the normal PFA routine.

## Settings

| Parameter | Additional information |
|---|---|
| *Group 14: Relay outputs* | Selections of relay outputs for starting and stopping of motors |
| *Group 44: Pump protection* | Pump protection (pressure monitoring) settings |
| *Group 81: PFA control* | PFA control settings |

## Diagnostics

| Actual signal | Additional information |
|---|---|
| *0116* | Application block output signal |
| *0162* | RO 1 status |
| *0173* | RO 2…4 status. With option MREL-01 only. |
| **Alarm** | |
| *AUTOCHANGE* | PFA autochange function active |
| *PFC I LOCK* | PFA interlocks active |
| *INLET LOW*, *INLET VERY LOW* | Pressure at pump/fan inlet too low |
| *OUTLET HIGH*, *OUTLET VERY HIGH* | Pressure at pump/fan outlet too high |
| **Fault** | **Additional information** |
| *PAR PFC REF NEG* | *2007* < 0 |
| *PAR PFA IO 1* | Not enough relays parameterized for the PFA control. Conflict between *Group 14: Relay outputs*, parameter *8117* and parameter *8118*. |
| *PAR PFC IO 2* | Parameter *8127* does not match the PFA motors in *Group 14: Relay outputs* and parameter *8118*. |
| *PAR PFC IO 3* | Allocation of a digital input (interlock) for each PFA motor not possible |
| *INLET LOW*, *INLET VERY LOW* | Pressure at pump/fan inlet too low |
| *OUTLET HIGH*, *OUTLET VERY HIGH* | Pressure at pump/fan outlet too high |

10

# Actual signals and parameters

## Contents of this chapter

The chapter describes the actual signals and parameters and gives the fieldbus equivalent values for each signal/parameter. It also contains a table of the default values for the different macros.

**Note:** When the control panel is in the short parameter view, in other words, when parameter *1611 PARAMETER VIEW* is set to 2 (SHORT VIEW), the control panel only shows a subset of all signals and parameters. The list of these signals and parameters starts on page *134*.

To be able to view all actual signals and parameters, set parameter *1611 PARAMETER VIEW* to 3 (LONG VIEW). The descriptions of parameters start on pages *137*.

## Terms and abbreviations

| Term | Definition |
|---|---|
| Actual signal | Signal measured or calculated by the drive. Can be monitored by the user. No user setting possible. *Group 01: Operating data*…*Group 04: Fault history* contain actual signals. |
| Def | Parameter default value |
| E | Refers to types 03E- with European parametrization |
| FbEq | Fieldbus equivalent: The scaling between the value and the integer used in serial communication. |
| Parameter | A user-adjustable operation instruction of the drive. *Group 10: Start/Stop/Dir*…*Group 98: Options* contain parameters.<br>**Note:** Parameter selections are shown on the Basic Control Panel as integer values. For example, parameter *1001 EXT1 COMMANDS* selection COMM is shown as value 10 (which is equal to the fieldbus equivalent FbEq). |
| U | Refers to types 03U- with US parametrization |

## Fieldbus equivalent

Example: If parameter *2008 MAXIMUM FREQ* (see page *180*) is set from an external control system, an integer value of 1 corresponds to 0.1 Hz. All the read and sent values are limited to 16 bits (-32768…32767).

## Actual signals in the short parameter view

| **Actual signals in the short parameter view** | | |
|---|---|---|
| **No. Name/Value** | **Description** | **FbEq** |
| **04 FAULT HISTORY** | Fault history (read-only). See *Group 04: Fault history* in the list of all parameters. | |
| 0401 LAST FAULT | Code of the latest fault. | 1 = 1 |

# Parameters in the short parameter view

| **Parameters in the short parameter view** | | | |
|---|---|---|---|
| **No.** | **Name/Value** | **Description** | **Default** |
| **11** | **REFERENCE SELECT** | Panel reference type, external control location selection and external reference sources and limits. See *Group 11: Reference select* in the list of all parameters. | |
| 1105 | REF1 MAX | Defines the maximum value for external reference REF1. | E: 50.0 Hz<br>U: 60.0 Hz |
| **12** | **CONSTANT SPEEDS** | Constant speed (drive output frequency) selection and values. See *Group 12: Constant speeds* in the list of all parameters. | |
| 1202 | CONST SPEED 1 | Defines constant drive output frequency 1. | E: 5.0 Hz<br>U: 6.0 Hz |
| 1203 | CONST SPEED 2 | Defines constant drive output frequency 2. | E: 10.0 Hz<br>U: 12.0 Hz |
| 1204 | CONST SPEED 3 | Defines constant drive output frequency 3. | E: 15.0 Hz<br>U: 18.0 Hz |
| **13** | **ANALOG INPUTS** | Analog input signal processing. See *Group 13: Analogue inputs* in the list of all parameters. | |
| 1301 | MINIMUM AI1 | Defines the minimum %-value that corresponds to minimum mA/(V) signal for analog input AI1. | 1.0% |
| **14** | **RELAY OUTPUTS** | Status information indicated through relay output, and relay operating delays. See *Group 14: Relay outputs* in the list of all parameters. | |
| 1401 | RELAY OUTPUT 1 | Selects a drive status indicated through relay output RO 1. | FAULT(-1) |
| **16** | **SYSTEM CONTROLS** | Parameter view, Run Enable, parameter lock etc. See *Group 16: System controls* in the list of all parameters. | |
| 1611 | PARAMETER VIEW | Selects the parameter view, in other words, which parameters are shown on the control panel. | SHORT VIEW |
| **20** | **LIMITS** | Drive operation limits. See *Group 20: Limits* in the list of all parameters. | |
| 2008 | MAXIMUM FREQ | Defines the maximum limit for the drive output frequency. | E: 50.0 Hz<br>U: 60.0 Hz |
| **21** | **START/STOP** | Start and stop modes of the motor. See *Group 21: Start/Stop* in the list of all parameters. | |
| 2102 | STOP FUNCTION | Selects the motor stop function. | COAST |
| **22** | **ACCEL/DECEL** | Acceleration and deceleration times. See *Group 22: Accel/Decel* in the list of all parameters. | |
| 2202 | ACCELER TIME 1 | Defines the acceleration time 1. | 5.0 s |
| 2203 | DECELER TIME 1 | Defines the deceleration time 1. | 5.0 s |

| Parameters in the short parameter view | | | |
|---|---|---|---|
| **No.** | **Name/Value** | **Description** | **Default** |
| **99 START-UP DATA** | | Language selection. Definition of motor set-up data. See *Group 99: Start-up data* in the list of all parameters. | |
| 9901 | LANGUAGE | Selects the display language. | ENGLISH |
| 9902 | APPLIC MACRO | Selects the application macro. | ABB STANDARD |
| 9905 | MOTOR NOM VOLT | Defines the nominal motor voltage. | 230 V (200 V units)<br>400 V (400 V E units)<br>460 V (400 V U units) |
| 9906 | MOTOR NOM CURR | Defines the nominal motor current. | $I_{2N}$ |
| 9907 | MOTOR NOM FREQ | Defines the nominal motor frequency. | E: 50.0 Hz<br>U: 60.0 Hz |
| 9908 | MOTOR NOM SPEED | Defines the nominal motor speed. | Type dependent |
| 9909 | MOTOR NOM POWER | Defines the nominal motor power. | $P_N$ |

# Parameter listing

Parameter data is specific to ACS320 firmware version 4.01C.

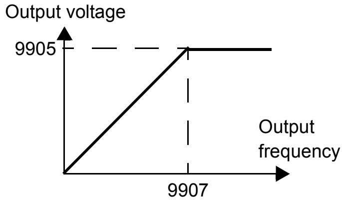
## Group 99: Start-up data

This group defines special Start-up data required to:

- set up the drive
- enter motor information.

**Note:** Parameters checked under the heading “S” can be modified only when the drive is stopped.

| Group 99: Start-up data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 9901 | **LANGUAGE**<br>Selects the display language.<br>0= ENGLISH, 1= ENGLISH (AM), 2= DEUTSCH, 3= ITALIANO<br>4= ESPAÑOL, 5= PORTUGUES, 6= NEDERLANDS, 7= FRANCAIS<br>8= DANSK, 9= SUOMI, 10= SVENSKA, 11= RUSSKI<br>12= POLSKI, 13= TÜRKCE, 14= CZECH, 15= MAGYAR<br>16= ELLINIKA, 17= CHINESE | **0...13** | **1** | **0** | |
| 9902 | **APPLIC MACRO**<br>Selects an application macro. Application macros automatically edit parameters to configure the ACS320 for a particular application. See *Application macros* for application macro descriptions.<br>1= HVAC DEFAULT, 2= SUPPLY FAN, 3= RETURN FAN, 4= CLNG TWR FAN<br>5= CONDENSER, 6= BOOSTER PUMP, 7= PUMP ALTERNA, 8= INT TIMER<br>9= INT TIMER CS, 10= FLOATING PNT, 11= DUAL SETPPID, 12= DL SP PID CS<br>13= E -BYPASS, 14= HAND CONTROL<br>31 = LOAD FD SETrontDrop parameter values as defined by the FlashDrop file. Parameter view is selected by parameter *1611 PARAMETER VIEW*.FlashDrop is an optional device for fast copying of parameters to unpowered drives. FlashDrop allows easy customization of the parameter list, for example, selected parameters can be hidden. For more information, see *MFDT-01 FlashDrop User’s Manual* [3AFE68591074 (English)].<br>-1 = USER S1 SAVE, -3 = USER S2 SAVE - With these it is possible to save two different user parameter sets into the drive permanent memory for later use. Each set contains parameter settings, including Group 99: START-UP DATA, and the results of the motor identification run.<br>0 = USER S1 LOAD, -2 = USER S2 LOAD- With these the user parameter sets can be taken back in use. | **-1...15** | **1** | **1** | ✓ |

| Group 99: Start-up data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 9905 | **MOTOR NOM VOLT** | **115 … 345 V (200 V, US)**<br>**230 … 690 V (400 V, US)**<br>**288 … 862 V (600 V, US)** | **1 V**<br>**1 V**<br>**1 V** | **230 V**<br>**460 V**<br>**575 V** | ✓ |
| | Defines the nominal motor voltage.<br>• Must equal the value on the motor rating plate.<br>• Sets the maximum drive output voltage supplied to the motor.<br>• Drive cannot supply the motor with a voltage greater than the mains voltage.<br><br> | | | | |
| 9906 | **MOTOR NOM CURR** | **$0.15*I_{2N}$ … $1.5*I_{2N}$** | **0.1 A** | **$1.5*I_{2N}$** | ✓ |
| | Defines the nominal motor current.<br>• Must equal the value on the motor rating plate. | | | | |
| 9907 | **MOTOR NOM FREQ** | **10.0 … 500 Hz** | **0.1 Hz** | **60 Hz (US)** | ✓ |
| | Defines the nominal motor frequency.<br>• Range: 10 … 500 Hz (typically 50 or 60 Hz)<br>• Sets the frequency at which output voltage equals parameter *9905 MOTOR NOM VOLT*<br>• Field weakening point = Norm freq * Supply Volt / Mot Nom Volt | | | | |
| 9908 | **MOTOR NOM SPEED** | **50 … 30000 rpm** | **1 rpm** | **Size dependent** | ✓ |
| | Defines the nominal motor speed.<br>• Must equal the value on the motor rating plate. | | | | |
| 9909 | **MOTOR NOM POWER** | **0.15 … $1.5*P_N$** | **0.1 Hp** | **0.2 HP (US)** | ✓ |
| | Defines the nominal motor power.<br>• Must equal the value on the motor rating plate. | | | | |
| 9914 | **PHASE INVERSION** | | | **NO** | ✓ |
| | Inverts two phases in the motor cable. This changes the direction of the motor rotation without having to exchange the positions of two motor cable phase conductors at the drive output terminals or at the motor connection box.<br>• NO – Phases not inverted.<br>• YES – Phases inverted. | | | | |

## Group 01: Operating data

This group contains drive operating data, including actual signals. The drive sets the values for actual signals, based on measurements or calculations. You cannot set these values.

| Group 01: Operating data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0101 | **SPEED & DIR** | **-30000...30000** | **1 rpm** | **-** | |
| | The calculated speed of the motor (rpm) & motor direction. | | | | |
| 0102 | **SPEED** | **0 … 30000 rpm** | **1 rpm** | **-** | |
| | The calculated speed of the motor (rpm). | | | | |
| 0103 | **OUTPUT FREQ** | **0.0 … 500.0 Hz** | **1Hz** | **-** | |
| | The frequency (Hz) applied to the motor. (Also shown by default in OUTPUT display.) | | | | |
| 0104 | **CURRENT** | **0.0 … 1.5*$I_{2N}$** | **0.1 A** | **-** | |
| | The motor current, as measured by the drive. (Also shown by default in OUTPUT display.) | | | | |
| 0105 | **TORQUE** | **-200% … 200%** | **0.1%** | **-** | |
| | Output torque. Calculated value of torque on motor shaft in % of motor nominal torque. | | | | |
| 0106 | **POWER** | **-1.5 … 1.5*$P_N$** | **0.1 kW** | **-** | |
| | The measured motor power in kW. | | | | |
| 0107 | **DC BUS VOLTAGE** | **0 V … 2.5*$V_{dN}$** | **1 V** | **-** | |
| | The DC bus voltage in VDC, as measured by the drive. | | | | |
| 0109 | **OUTPUT VOLTAGE** | **0 V … 2.0*$V_{dN}$** | **1 V** | **-** | |
| | The voltage applied to the motor. | | | | |
| 0110 | **DRIVE TEMP** | **0°C … 150°C** | **1°C** | **-** | |
| | The temperature of the drive power transistors in Celsius. | | | | |
| 0111 | **EXTERNAL REF 1** | **0 … 500 Hz** | **0.1 Hz** | **-** | |
| | External reference, REF1or Hz. | | | | |
| 0112 | **EXTERNAL REF 2** | **0% … 100%**<br>**(torque: 0% … 600%)** | **0.1%** | **-** | |
| | External reference, REF2, in % | | | | |
| 0113 | **CTRL LOCATION** | **0 … 2** | **1** | **-** | |
| | Active control location. Alternatives are:<br>0 = HAND<br>1 = EXT1<br>2 = EXT2 | | | | |
| 0114 | **RUN TIME (R)** | **0 … 65,535 h** | **1 h** | **0 h** | |
| | The drive's accumulated running time in hours (h).<br>• Can be **reset** by pressing UP and DOWN buttons simultaneously when in parameter set mode. | | | | |

| Group 01: Operating data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0115 | **KWH COUNTER (R)**<br>The drive's accumulated power consumption in kilowatt hours.<br>• Can be **reset** by pressing UP and DOWN buttons simultaneously when in parameter set mode. | **0 … 65,535 kWh** | **1 kWh** | **-** | |
| 0116 | **APPL BLK OUTPUT**<br>Application block output signal. Value is from either:<br>• PFA control, if PFA Control is active, or<br>• Parameter *0112 EXTERNAL REF 2*. | **0 … 100%**<br>**(torque: 0 … 600%)** | **0.1%** | **-** | |
| 0120 | **AI1**<br>Relative value of analog input 1 in %. | **0 … 100%** | **0.1%** | **-** | |
| 0121 | **AI2**<br>Relative value of analog input 2 in %. | **0 … 100%** | **0.1%** | **-** | |
| 0124 | **AO1**<br>The analog output 1 value in milliamperes. | **0 … 20 mA** | **0.1 mA** | **-** | |
| 0126 | **PID 1 OUTPUT**<br>The PID Controller 1 output value in %. | **-1000 … 1000%** | **0.1%** | **-** | |
| 0127 | **PID 2 OUTPUT**<br>The PID Controller 2 output value in %. | **-100 … 100%** | **0.1%** | **-** | |
| 0128 | **PID 1 SETPNT**<br>The PID 1 controller setpoint signal.<br>• Units and scale defined by PID parameters *4006*/4106 & *4007*/4107. | **-** | **-** | **-** | |
| 0129 | **PID 2 SETPNT**<br>The PID 2 controller setpoint signal.<br>• Units and scale defined by PID parameters 4206 & 4207. | **-** | **-** | **-** | |
| 0130 | **PID 1 FBK**<br>The PID 1 controller feedback signal.<br>• Units and scale defined by PID parameters *4006*/4106 & *4007*/4107. | **-** | **-** | **-** | |
| 0131 | **PID 2 FBK**<br>The PID 2 controller feedback signal.<br>• Units and scale defined by PID parameters 4206 & 4207. | **-** | **-** | **-** | |
| 0132 | **PID 1 DEVIATION**<br>The difference between the PID 1 controller reference value and actual value.<br>• Units and scale defined by PID parameters *4006*/4106 & *4007*/4107. | **-** | **-** | **-** | |
| 0133 | **PID 2 DEVIATION**<br>The difference between the PID 2 controller reference value and actual value.<br>• Units and scale defined by PID parameters 4206 & 4207. | **-** | **-** | **-** | |

| Group 01: Operating data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0134 | **COMM RO WORD** | **0...65535** | **1** | **0** | |
| | Free data location that can be written from serial link.<br>• Used for relay output control.<br>• See parameter 1401. | | | | |
| 0135 | **COMM VALUE 1** | **-32768 … +32767** | **1** | **0** | |
| | Free data location that can be written from serial link. | | | | |
| 0136 | **COMM VALUE 2** | **-32768 … +32767** | **1** | **0** | |
| | Free data location that can be written from serial link. | | | | |
| 0137 | **PROCESS VAR 1** | **-** | **1** | | |
| | Process variable 1<br>• Defined by parameters in *Group 34: Panel display*. | | | | |
| 0138 | **PROCESS VAR 2** | **-** | **1** | | |
| | Process variable 2<br>• Defined by parameters in *Group 34: Panel display*. | | | | |
| 0139 | **PROCESS VAR 3** | **-** | **1** | | |
| | Process variable 3<br>• Defined by parameters in *Group 34: Panel display*. | | | | |
| 0140 | **RUN TIME** | **0 … 499.99 kh** | **0.01 kh** | **0 kh** | |
| | The drive's accumulated running time in thousands of hours (kh). Cannot be reset. | | | | |
| 0141 | **MWH COUNTER** | **0 … 65535 MWh** | **1 MWh** | **-** | |
| | The drive's accumulated power consumption in megawatt hours. Cannot be reset | | | | |
| 0142 | **REVOLUTION CNTR** | **0 … 65535 Mrev** | **1** | **0** | |
| | The motor's accumulated revolutions in millions of revolutions. Can be reset by pressing the UP and DOWN keys simultaneously when in the Parameters mode. | | | | |
| 0143 | **DRIVE ON TIME HI** | **0 … 65535 days** | **1 day** | **0** | |
| | The drive's accumulated power-on-time in days. Cannot be reset. | | | | |
| 0144 | **DRIVE ON TIME LO** | **00.00.00 … 23:59:58** | **2 s** | **0** | |
| | The drive's accumulated power-on-time in 2 second ticks (30 ticks = 60 seconds).<br>• Shown in format hh.mm.ss.<br>• Cannot be reset. | | | | |
| 0145 | **MOTOR TEMP** | **-10...200 °C/<br>0...5000 Ohm /<br>0...1** | **1** | **0** | |
| | Motor temperature in Celsius / PTC resistance in Ohms.<br>• Applies only if motor temperature sensor is set up. See parameter *3501 SENSOR TYPE*. | | | | |
| 0158 | **PID COMM VALUE 1** | | | | |
| | Data received from fieldbus for PID control (PID1 and PID2). | | | | |

| Group 01: Operating data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0159 | **PID COMM VALUE 2**<br>Data received from fieldbus for PID control (PID1 and PID2). | | | | |
| 0160 | **DI 1-5 STATUS**<br>Status of digital inputs.<br>**Example:** 10000 = DI1 is on, DI2...DI5 are off. | | | | |
| 0161 | **PULSE INPUT FREQ**<br>Value of frequency input in Hz. | | **1 = 1 Hz** | | |
| 0162 | **RO STATUS**<br>Status of relay output 1.1 = RO is energized, 0 = RO is de-energized. | | **1 = 1** | | |
| 0163 | **TO STATUS**<br>Status of transistor output when transistor output is used as a digital output. | | **1 = 1** | | |
| 0164 | **TO FREQUENCY**<br>Transistor output frequency, when transistor output is used as a frequency output. | | **1 = 1 Hz** | | |
| 0173 | **RO 2-4 STATUS**<br>Status of the relays in the Relay Output Extension Module MREL-0. See *MREL-01 Relay Output Extension Module User's Manual* (3AUA0000035974 [English]).<br>**Example:** 100 = RO 2 is on, RO3 and RO 4 are off. | | | | |
| 0174 | **SAVED KWH**<br>Energy saved in kWh compared to the energy used when the load is connected directly to the supply. See the note on page *238*.<br>• The counter value is accumulated till it reaches 999.9 after which the counter rolls over and starts again from 0.0.<br>• Can be reset with parameter *4509 ENERGY RESET* (resets all energy calculators at the same time).<br>• See group *Group 45: Energy saving*. | **0.0 … 999.9 kWh** | | | |
| 0175 | **SAVED MWH**<br>Energy saved in MWh compared to the energy used when the load is connected directly to the supply. See the note on page *238*.<br>• The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0.<br>• Can be reset with parameter *4509 ENERGY RESET* (resets all energy calculators at the same time).<br>• See group *Group 45: Energy saving*. | **0 … 65535 MWh** | | | |

| Group 01: Operating data | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0176 | **SAVED AMOUNT 1** | **0.0 … 999.9** | | | |
| | Energy saved in local currency (remainder when the total saved energy is divided by 1000). See the note on page *238*.<br>• To find out the total saved energy in currency units, add the value of parameter *0177 SAVED AMOUNT 2* multiplied by 1000 to the value of parameter 0176.<br>**Example:**<br>0176 SAVED AMOUNT 1 = 123.4<br>0177 SAVED AMOUNT 2 = 5<br>Total saved energy = 5 * 1000 + 123.4 = 5123.4 currency units.<br>• The counter value is accumulated till it reaches 999.9 (the counter does not roll over).<br>• Can be reset with parameter *4509 ENERGY RESET* (resets all energy calculators at the same time).<br>• Local energy price is set with parameter *4502 ENERGY PRICE*.<br>• See group *Group 45: Energy saving*. | | | | |
| 0177 | **SAVED AMOUNT 2** | **0…65535** | | | |
| | Energy saved in local currency in thousand currency units. For example, value 5 means 5000 currency units. See the note on page *238*.<br>• The counter value is accumulated till it reaches 65535 (the counter does not roll over).<br>• See parameter *0176 SAVED AMOUNT 1*. | | | | |
| 0178 | **SAVED CO2** | **0 … 6553.5 tn** | | | |
| | Reduction on carbon dioxide emissions in tn. See the note on page *238*.<br>• The counter value is accumulated till it reaches 6553.5 (the counter does not roll over).<br>• Can be reset with parameter *4509 ENERGY RESET* (resets all energy calculators at the same time).<br>• CO2 conversion factor is set with parameter *4507 CO2 CONV FACTOR*.<br>• See group *Group 45: Energy saving*. | | | | |

## Group 03: FB actual signals

This group monitors fieldbus communications.

| Group 03: FB actual signals | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0301 | **FB CMD WORD 1** | - | - | - | |
| | Read-only copy of the Fieldbus command word 1.<br>• The fieldbus command is the principal means for controlling the drive from a fieldbus controller. The command consists of two Command words. Bit-coded instructions in the Command words switch the drive between states.<br>• To control the drive, using the Command words, an external location (EXT1 or EXT2) must be active and set to COMM. (See parameters *1001 EXT1 COMMANDS* and *1002 EXT2 COMMANDS*.)<br>• The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays as 0001. All zeros and a 1 in BIt 15 displays as 8000. | | | | |
| 0302 | **FB CMD WORD 2** | - | - | - | |
| | Read-only copy of the Fieldbus command word 2.<br>• See parameter *0301 FB CMD WORD 1*. | | | | |

| Bit # | 0301 FB CMD WORD 1 | 0302 FB CMD WORD 2 |
|---|---|---|
| 0 | STOP | FBLOCAL_CTL |
| 1 | START | FBLOCAL_REF |
| 2 | REVERSE | START_DISABLE1 |
| 3 | LOCAL | START_DISABLE2 |
| 4 | RESET | Reserved |
| 5 | EXT2 | Reserved |
| 6 | RUN_DISABLE | Reserved |
| 7 | STPMODE_R | Reserved |
| 8 | STPMODE_EM | Reserved |
| 9 | STPMODE_C | Reserved |
| 10 | RAMP_2 | Reserved |
| 11 | RAMP_OUT_0 | REF_CONST |
| 12 | RAMP_HOLD | REF_AVE |
| 13 | RAMP_IN_0 | LINK_ON |
| 14 | RREQ_LOCALLOC | REQ_STARTINH |
| 15 | TORQLIM2 | OFF_INTERLOCK |

| Group 03: FB actual signals | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0303 | **FB STS WORD 1** | - | 1 | - hex | |
| | Read-only copy of the Status word 1.<br>• The drive sends status information to the fieldbus controller. The status consists of two Status words. | | | | |
| 0304 | **FB STS WORD 2** | - | 1 | - hex | |
| | Read-only copy of the Status word 2.<br>• See parameter *0303 FB STS WORD 1*. | | | | |

| Bit # | 0303 STS CMD WORD 1 | 0304 FB STS WORD 2 |
|---|---|---|
| 0 | READY | ALARM |
| 1 | ENABLED | REQ_MAINT |
| 2 | STARTED | DIRLOCK |
| 3 | RUNNING | LOCALLOCK |
| 4 | ZERO_SPEED | CTL_MODE |
| 5 | ACCELERATE | Reserved |
| 6 | DECELERATE | Reserved |
| 7 | AT_SETPOINT | Reserved |
| 8 | LIMIT | Reserved |
| 9 | SUPERVISION | Reserved |
| 10 | REV_REF | REQ_CTL |
| 11 | REV_ACT | REQ_REF1 |
| 12 | PANEL_LOCAL | REQ_REF2 |
| 13 | FIELDBUS_LOCAL | REQ_REF2EXT |
| 14 | EXT2_ACT | ACK_STARTINH |
| 15 | FAULT | ACK_OFF_ILCK |

| Group 03: FB actual signals | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0305 | **FAULT WORD 1** | - | 1 | 0000 hex | |
| | Read-only copy of the Fault word 1.<br>• When a fault is active, the corresponding bit for the active fault is set in the Fault words.<br>• Each fault has a dedicated bit allocated within Fault words.<br>• See chapter *Fault tracing* on page *339* for a description of the faults.<br>The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays a 0001. All zeros and a 1 in Bit 15 displays as 8000. | | | | |

| Bit # | 0305 FAULT WORD 1 | 0306 FAULT WORD 2 | 0307 FAULT WORD 3 |
|---|---|---|---|
| 0 | OVERCURRENT | Reserved | EFB 1 |
| 1 | DC OVERVOLT | THERM FAIL | EFB 2 |
| 2 | DEV OVERTEMP | Reserved | EFB 3 |
| 3 | SHORT CIRC | Reserved | INCOMPATIBLE SW |
| 4 | Reserved | CURR MEAS | USER LOAD CURVE |
| 5 | DC UNDERVOLT | SUPPLY PHASE | UNKNOWN EXTENSION |
| 6 | AI1 LOSS | Reserved | INLET VERY LOW |
| 7 | AI2 LOSS | OVERSPEED | OUTLET VERY HIGH |
| 8 | MOT OVERTEMP | Reserved | INLET LOW |
| 9 | PANEL LOSS | DRIVE ID | OUTLET HIGH |
| 10 | Reserved | CONFIG FILE | System error |
| 11 | MOTOR STALL | SERIAL 1 ERR | System error |
| 12 | Reserved | EFB CON FILE | System error |
| 13 | EXT FLT 1 | FORCE TRIP | System error |
| 14 | EXT FLT 2 | MOTOR PHASE | System error |
| 15 | EARTH FAULT | OUTP WIRING | Parameter setting fault |

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 0306 | **FAULT WORD 2** | - | 1 | 0000 hex | |
| | A16-bit data word. For the possible causes and remedies and fieldbus equivalents, see chapter *Fault tracing* on page *339*. See parameter *0305 FAULT WORD 1*. | | | | |
| 0307 | **FAULT WORD 3** | - | 1 | 0000 hex | |
| | A16-bit data word. For the possible causes and remedies and fieldbus equivalents, see chapter *Fault tracing* on page *339*. See parameter *0305 FAULT WORD 1*. | | | | |

| Group 03: FB actual signals | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0308 | **ALARM WORD 1** | **-** | **1** | **0000 hex** | |

Read-only copy of the ALARM WORD 1.

- When a fault is active, the corresponding bit for the active fault is set in the Fault words.
- Each fault has a dedicated bit allocated within Fault words.
- Bits remain set until the whole alarm word is reset. (Reset by writing zero to the word).
- The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 correspond to 0001. All zeros and a 1 in Bit 15 correspond to 80000.

| Bit # | 0308 ALARM WORD 1 | 0309 ALARM WORD 2 |
|---|---|---|
| 0 | OVERCURRENT | OFF BUTTON |
| 1 | OVERVOLTAGE | PID SLEEP |
| 2 | UNDERVOLTAGE | Reserved |
| 3 | DIRLOCK | OVERRIDE |
| 4 | I/O COMM | START ENABLE 1 MISSING |
| 5 | AI1 LOSS | START ENABLE 2 MISSING |
| 6 | AI2 LOSS | EMERGENCY STOP |
| 7 | PANEL LOSS | Reserved |
| 8 | DEVICE OVERTEMP | FIRST START |
| 9 | MOT OVERTEMP | Reserved |
| 10 | UNDERLOAD | USER LOAD CURVE |
| 11 | MOTOR STALL | START DELAY |
| 12 | AUTORESET | Reserved |
| 13 | PFA AUTOCHANGE | INLET LOW |
| 14 | PFA INTERLOCK | INLET HIGH |
| 15 | Reserved | PIPE FILL |

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 0309 | **ALARM WORD 2** | **-** | **1** | **0000 hex** | |

Read-only copy of the ALARM WORD 3.

- See parameter *0308 ALARM WORD 1*.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 0310 | **ALARM WORD 3** | **-** | **1** | **0000 hex** | |

A 16-bit data word. For the possible causes and remedies and fieldbus equivalents, see chapter *Fault tracing* on page *339*.

An alarm can be reset by resetting the whole alarm word: Write zero to the word.

| Bit # | |
|---|---|
| 0 | INLET VERY LOW |
| 1 | OUTLET VERY HIGH |
| 2...15 | Reserved |

## Group 04: Fault history

This group stores a recent history of the faults reported by the drive.

| Group 04: Fault history | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0401 | **LAST FAULT** | **Fault code text** | **1** | **0** | |
| | 0 = Clear the fault history (on panel = NO RECORD).<br>n = Fault code of the last recorded fault.<br>• The fault code is displayed as a name. See chapter *Fault tracing* on page 339 for the fault codes and names. The fault name shown for this parameter may be shorter than the corresponding name in the fault listing, which shows the names as they are shown in the fault display. | | | | |
| 0402 | **FAULT TIME 1** | **Date dd.mm.yy / power-on days** | **1** | **0** | |
| | The day on which the last fault occurred. Either as:<br>• A date – if real time clock is operating.<br>• The number of days after power on – if real time clock is not used, or was not set. | | | | |
| 0403 | **FAULT TIME 2** | **Time hh:mm:ss** | **2 s** | **0** | |
| | The time at which the last fault occurred. Either as:<br>• Real time, in format hh:mm:ss – if real time clock is operating.<br>• The time since power on (less the whole days reported in parameter *0402 FAULT TIME 1*), in format hh:mm:ss – if real time clock is not used, or was not set.<br>Format on the basic control panel: Time elapsed after power-on in 2-second ticks (minus the whole days stated by signal *0402 FAULT TIME 1*). 30 ticks = 60 seconds. For example, value 514 equals 17 minutes and 8 seconds (= 514/30). | | | | |
| 0404 | **SPEED AT FLT** | **-** | **1 rpm** | **0** | |
| | The motor speed (rpm) at the time the last fault occurred. | | | | |
| 0405 | **FREQ AT FLT** | **-** | **0.1 Hz** | **0.0** | |
| | The frequency (Hz) at the time the last fault occurred. | | | | |
| 0406 | **VOLTAGE AT FLT** | **-** | **0.1 V** | **0.0** | |
| | The DC bus voltage (V) at the time the last fault occurred. | | | | |
| 0407 | **CURRENT AT FLT** | **-** | **0.1 A** | **0.0** | |
| | The motor current (A) at the time the last fault occurred. | | | | |
| 0408 | **TORQUE AT FLT** | **-** | **0.1%** | **0.0** | |
| | The motor torque (%) at the time the last fault occurred. | | | | |
| 0409 | **STATUS AT FLT** | **-** | **1** | **0000 hex** | |
| | The drive status (hex code word) at the time the last fault occurred. | | | | |
| 0412 | **PREVIOUS FAULT 1** | **Fault code text** | **1** | **0** | |
| | Fault code of the second last fault. Read-only | | | | |
| 0413 | **PREVIOUS FAULT 2** | **Fault code text** | **1** | **0** | |
| | Fault code of the third last fault. Read-only. | | | | |

| Group 04: Fault history | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 0414 | **DI 1-5 AT FLT**<br>Status of digital inputs DI1...5 at the time the latest fault occurred (binary).<br>**Example:** 10000 = DI1 is on, DI2...DI5 are off. | | | | |

## Group 10: Start/Stop/Dir

This group:

- Defines external sources (EXT1, and EXT2) for commands that enable start, stop and direction changes.
- Locks direction or enables direction control. To select between the two external locations use the next group, parameter *1102 EXT1/EXT2 SEL*.

| Group 10: Start/Stop/Dir | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1001 | **EXT1 COMMANDS** | **0...14** | **1** | **1** | ✓ |
| | Defines external control location 1 (EXT1) – the configuration of start, stop and direction commands.<br>0 = NOT SEL – No external start, stop and direction command source.<br>1 = DI1 – Two-wire Start/Stop.<br>• Start/Stop is through digital input DI1 (DI1 activated = Start; DI1 de-activated = Stop).<br>• Parameter *1003 DIRECTION* defines the direction. Selecting *1003* = 3 (request) is the same as 1003 = 1 (fwd).<br>2 = DI1, 2 – Two-wire Start/Stop, Direction.<br>• Start/Stop is through digital input DI1 (DI1 activated = Start; DI1 de-activated = Stop).<br>• Direction control (requires parameter *1003* = 3 (request)) is through digital input DI2 (DI2 activated = Reverse; de-activated = Forward).<br>3 = DI1P, 2P – Three-wire Start/Stop.<br>• Start/Stop commands are through momentary push-buttons (the P stands for “pulse”).<br>• Start is through a normally open push-button connected to digital input 1. In order to start the drive, the digital input 2 must be activated prior the pulse in 1.<br>• Connect multiple Start push-buttons in parallel.<br>• Stop is through a normally closed push-button connected to digital input 2.<br>• Connect multiple Stop push-buttons in series.<br>• Parameter *1003 DIRECTION* defines the direction. Selecting *1003* = 3 (REQUEST) is the same as *1003* = 1 (FWD).<br>4 = DI1P, 2P, 3 – Three-wire Start/Stop, Direction.<br>• Start/Stop commands are through momentary push-buttons, as described for DI1P, 2P.<br>• Direction control (requires parameter *1003* = 3 (REQUEST)) is through digital input DI3 (DI3 activated = Reverse; de-activated = Forward). | | | | |

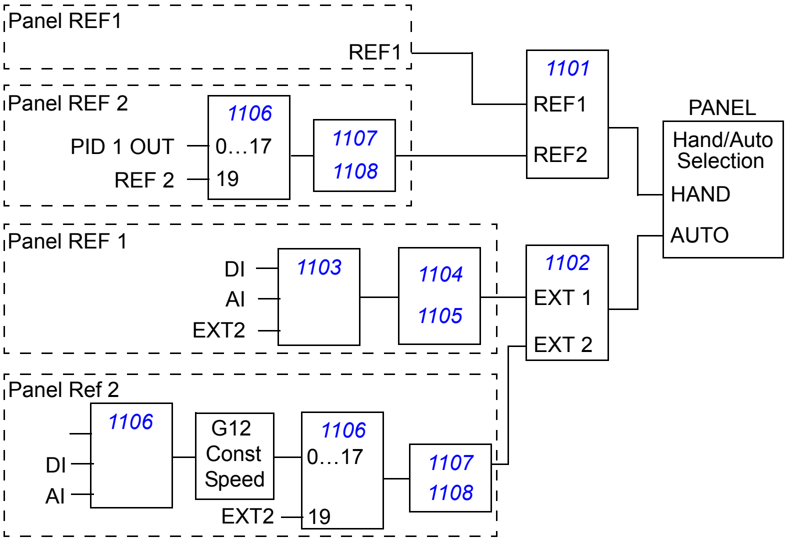
| Group 10: Start/Stop/Dir | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 5 = DI1P, 2P, 3P – Start Forward, Start Reverse, and Stop.<br>• Start and Direction commands are given simultaneously with two separate momentary push-buttons (the P stands for “pulse”).<br>• Start Forward command is through a normally open push-button connected to digital input DI1. To start the drive, the digital input DI3 must be activated during the pulse in DI1.<br>• Start Reverse command is through a normally open push-button connected to digital input DI2. To start the drive, the digital input DI3 must be activated prior the pulse in DI2.<br>• Connect multiple Start push-buttons in parallel.<br>• Stop is through a normally closed push-button connected to digital input DI3.<br>• Connect multiple Stop push-buttons in series.<br>• Requires parameter *1003* = 3 (REQUEST).<br>8 = KEYPAD – Control Panel.<br>• Start/Stop and Direction commands are through the control panel when EXT1 is active.<br>• Direction control requires parameter *1003* = 3 (REQUEST).<br>9 = DI1F, 2R – Start/Stop/Direction commands through DI1 and DI2 combinations.<br>• Start forward = DI1 activated and DI2 de-activated.<br>• Start reverse = DI1 de-activated and DI2 activated.<br>• Stop = both DI1 and DI2 activated, or both de-activated.<br>• Requires parameter *1003* = 3 (REQUEST).<br>10 = COMM – Assigns the fieldbus Command word as the source for the start/stop and direction commands.<br>• Bits 0,1, 2 of Command word 1 (parameter *0301 FB CMD WORD 1*) activates the start/stop and direction commands.<br>• See Fieldbus user’s manual for detailed instructions.<br>11 = TIMER 1 – Assigns Start/Stop control to Timer 1 (Timer activated = START; Timer de-activated = STOP). See *Group 36: Timed functions*.<br>12…14 = TIMER 2… 4 – Assigns Start/Stop control to Timer 2…4. See Timer Function 1 above.<br>20 = DI5 – Start and stop through digital input DI5. 0 = stop, 1 = start. Direction is fixed according to parameter *1003 DIRECTION* (setting REQUEST = FORWARD).<br>21 = DI5, 4 – Start and stop through digital input DI5. 0 = stop, 1 = start. Direction through digital input DI4. 0 = forward, 1 = reverse. To control direction, parameter *1003 DIRECTION* must be REQUEST.<br>27 = SUPRV1 OVER – Start when the value of supervision parameter 1 goes over the supervision high limit. Stop when the value goes below the low limit. See parameter *Group 32: Supervision*.<br>28 = SUPRV1 UNDER – Start when the value of the supervision parameter 1 goes below the supervision low limit. Stop when the value goes over the high limit. See parameter *Group 32: Supervision*.<br>29 = SUPRV2 OVER – See selection SUPRV1 OVER.<br>30 = SUPRV2 UNDER – See selection SUPRV1 UNDER.<br>31 = SUPRV3 OVER – See selection SUPRV1 OVER.<br>32 = SUPRV3 UNDER – See selection SUPRV1 UNDER.<br>33 = SUP1OVER+DI2 – Start and stop as for SUPRV1 OVER. Direction through digital input DI2. 0 = forward, 1 = reverse. To control direction, parameter *1003 DIRECTION* setting must be REQUEST.<br>34 = SUP1 UDR+DI2 – Start and stop as for SUPRV1 UNDER. Direction through digital input DI2. 0 = forward, 1 = reverse. To control direction, parameter *1003 DIRECTION* setting must be REQUEST. | | | | |

| Group 10: Start/Stop/Dir | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1002 | **EXT2 COMMANDS**<br>Defines external control location 2 (EXT2) – the configuration of start, stop and direction commands.<br>• See parameter *1001 EXT1 COMMANDS* above. | **0...14** | **1** | **1** | ✓ |
| 1003 | **DIRECTION**<br>Defines the control of motor rotation direction.<br>1 = FORWARD – Rotation is fixed in the forward direction.<br>2 = REVERSE – Rotation is fixed in the reverse direction.<br>3 = REQUEST – Rotation direction can be changed on command. | **1...3** | **1** | **1** | ✓ |

## Group 11: Reference select

This group defines:

- How the drive selects between command sources.
- Characteristics and sources for REF1 and REF2.



| Group 11: Reference select | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1101 | **KEYPAD REF SEL**<br>Selects the reference controlled in local control mode.<br>1 = REF1 (Hz/rpm) – Frequency reference in Hz.<br>2 = REF2 (%) – %-reference. | **1,2** | **1** | **1** | |
| 1102 | **EXT1/EXT2 SEL**<br>Defines the source for selecting between the two external control locations EXT1 or EXT2. Thus, defines the source for Start/Stop/Direction commands and reference signals.<br>0 = EXT1 – Selects external control location 1 (EXT1).<br>• See parameter *1001 EXT1 COMMANDS* for EXT1's Start/Stop/Dir definitions.<br>• See parameter *1103 REF1 SELECT* for EXT1's reference definitions.<br>1 = DI1 – Assigns control to EXT1 or EXT2 based on the state of DI1 (DI1 activated = EXT2; DI1 de-activated = EXT1).<br>2…5 = DI2…DI5 – Assigns control to EXT1 or EXT2 based on the state of the selected digital input. See DI1 above.<br>7 = EXT2 – Selects external control location 2 (EXT2).<br>• See parameter *1002 EXT2 COMMANDS* for EXT2's Start/Stop/Dir definitions.<br>• See parameter *1106 REF2 SELECT* for EXT2's reference definitions.<br>8 = COMM – Assigns control of the drive via external control location EXT1 or EXT2 based on the fieldbus control word.<br>• Bit 5 of the Command word 1 (parameter *0301 FB CMD WORD 1*) defines the active external control location (EXT1 or EXT2).<br>• See Fieldbus user's manual for detailed instructions.<br>9 = TIMER 1 – Assigns control to EXT1 or EXT2 based on the state of the Timer (Timer activated = EXT2; Timer de-activated = EXT1. See *Group 36: Timed functions*.<br>10…12 = TIMER 2… 4 – Assigns control to EXT1 or EXT2 based on the state of the Timer. See TIMER 1 above.<br>-1 = DI1(INV) – Assigns control to EXT1 or EXT2 based on the state of DI1 (DI1 activated = EXT1; DI1 de-activated = EXT2).<br>-2…-6 = DI2(INV)…DI6(INV) – Assigns control to EXT1 or EXT2 based on the state of the selected digital input. See DI1(INV) above. | **-6...12** | **1** | **0** | ✓ |

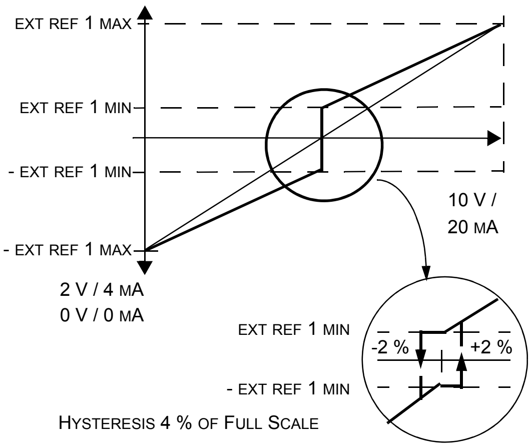
## Group 11: Reference select

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 1103 | **REF1 SELECT** | **0…21** | **1** | **1** | ✓ |

Selects the signal source for external reference REF1.

0 = KEYPAD – Defines the control panel as the reference source.
1 = AI1 – Defines analog input 1 (AI1) as the reference source.
2 = AI2 – Defines analog input 2 (AI2) as the reference source.
3 = AI1/JOYST – Defines analog input 1 (AI1), configured for joystick operation, as the reference source.

- The minimum input signal runs the drive at the maximum reference in the reverse direction. Define the minimum using parameter *1104 REF1 MIN*.
- The maximum input signal runs the drive at maximum reference in the forward direction. Define the maximum using parameter *1105 REF1 MAX*.
- Requires parameter *1103* = 3 (request).




⚠ **WARNING!** Because the low end of the reference range commands full reverse operation, do not use 0 V as the lower end of the reference range. Doing so means that if the control signal is lost (which is a 0 V input) the result is full reverse operation. Instead, use the following set-up so that loss of the analog input triggers a fault, stopping the drive:

- Set parameter *1301 MINIMUM AI1* (*1304 MINIMUM AI2*) at 20% (2 V or 4 mA).
- Set parameter *3021 AI1 FAULT LIMIT* to a value 5% or higher.
- Set parameter *3001 AI<MIN FUNCTION* to 1 (FAULT).

| Group 11: Reference select | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 4 = AI2/JOYST – Defines analog input 2 (AI2), configured for joystick operation, as the reference source.<br>• See above (AI1/JOYST) description.<br>5 = DI3U,4D(R) – Defines digital inputs as the speed reference source (motor potentiometer control).<br>• Digital input DI3 increases the speed (the U stands for “up”).<br>• Digital input DI4 decreases the speed (the D stands for “down”).<br>• Stop command resets the reference to zero (the R stands for “reset”).<br>• Parameter *2205 ACCELER TIME 2* controls the reference signal’s rate of change.<br>6 = DI3U,4D – Same as above (DI3U,4D(R)), except:<br>• A Stop command does not reset the reference to zero. The reference is stored.<br>• When the drive restarts, the motor ramps up (at the selected acceleration rate) to the stored reference.<br>8 = COMM – Defines the fieldbus as the reference source.<br>9 = COMM+AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog Input Reference Correction below.<br>10 = COMM*AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog Input Reference Correction below.<br>11 = DI3U, 4D(RNC) – Same as DI3U,4D(R) above, except that:<br>• Changing the control source (EXT1 TO EXT2, EXT2 TO EXT1, LOC TO REM) does not copy the reference.<br>12 = DI3U,4D(NC) – Same as DI3U,4D above, except that:<br>• Changing the control source (EXT1 TO EXT2, EXT2 TO EXT1, LOC TO REM) does not copy the reference.<br>14 = AI1+AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>15 = AI1*AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>16 = AI1-AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>17 = AI1/AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below. | | | | |

| Group 11: Reference select | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |

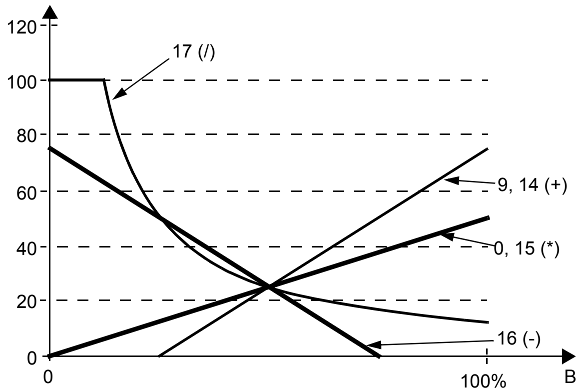
**Analog Input Reference Correction**

Parameter values 9, 10, and 14…17 use the formula in the following table.

| Value setting | Calculation of the AI reference |
|---|---|
| C + B | C value + (B value - 50% of reference value) |
| C * B | C value * (B value / 50% of reference value) |
| C - B | (C value + 50% of reference value) - B value |
| C / B | (C value * 50% of reference value) / B value |

Where:

- C = Main Reference value (= COMM for values 9, 10 and = 1 for values 14…17).
- B = Correcting reference (= AI1 for values 9, 10 and = AI2 for values 14…17).




**Example:**

The figure shows the reference source curves for value settings 9, 10, and 14…17, where:

- C = 25%.
- Parameter *4012 SETPOINT MIN* = 0.
- Parameter *4013 SETPOINT MAX* = 0.
- B varies along the horizontal axis.

REF1 SELECT

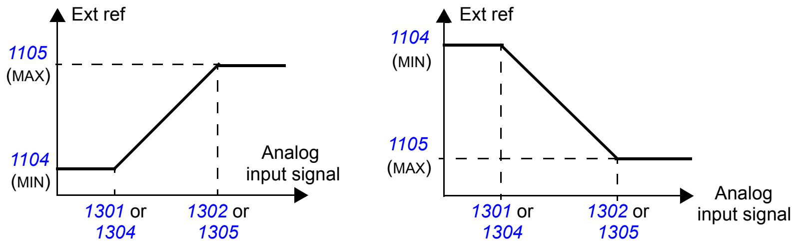
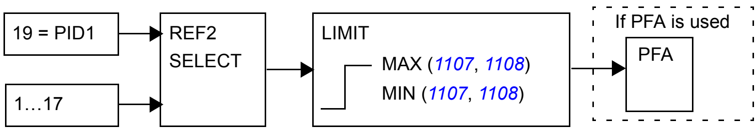
20 = KEYPAD(RNC) – Defines the control panel as the reference source. A Stop command resets the reference to zero (R stands for reset.). Changing the control source (EXT1 to EXT2, EXT2 to EXT1) does not copy the reference.

21 = KEYPAD(NC) – Defines the control panel as the reference source. A Stop command does not reset the reference to zero. The reference is stored. Changing the control source (EXT1 to EXT2, EXT2 to EXT1) does not copy the reference.

30 = DI4U,5D – See selection DI3U,4D.

31 = DI4U,5D(NC) – See selection DI3U,4D(NC).

32 = FREQ INPUT – Frequency input.

| Group 11: Reference select | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1104 | **REF1 MIN** | **0.0 … 500.0 Hz**<br>**0 … 30000 rpm** | **0.1 Hz**<br>**1 rpm** | **0.0 Hz**<br>**0 rpm** | |
| | Sets the minimum for external reference 1.<br>• The minimum analog input signal (as a percent of the full signal in volts or amps) corresponds to REF1 MIN in Hz/rpm.<br>• Parameter *1301 MINIMUM AI1* or *1304 MINIMUM AI2* sets the minimum analog input signal.<br>• These parameters (reference and analog min. and max. settings) provide scale and offset adjustment for the reference. | | | | |
| 1105 | **REF1 MAX** | **0.0 … 500.0 Hz**<br>**0 … 30000 rpm** | **0.1 Hz**<br>**1 rpm** | **60.0 Hz (US)**<br>**1800 rpm (US)** | |
| | Sets the maximum for external reference 1.<br>• The maximum analog input signal (as a percent of full the signal in volts or amps) corresponds to REF1 MAX in Hz/rpm.<br>• Parameter *1302 MAXIMUM AI1* or *1305 MAXIMUM AI2* sets the maximum analog input signal.<br> | | | | |
| 1106 | **REF2 SELECT** | **0...19** | **1** | **2** | ✓ |
| | Selects the signal source for external reference REF2.<br>0…17 – Same as for parameter *1103 REF1 SELECT*.19 = PID1OUT – The reference is taken from the PID1 output. See *Group 40: Process PID set 1* and *Group 41: Process PID set 2*.<br> | | | | |

| Group 11: Reference select | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1107 | **REF2 MIN** | **0.0 … 100.0% (torque: 0 … 600%)** | **0.1%** | **0.0%** | |
| | Sets the minimum for external reference 2.<br>• The minimum analog input signal (in volts or amps) corresponds to REF2 MIN in %.<br>• Parameter *1301 MINIMUM AI1* or *1304 MINIMUM AI2* sets the minimum analog input signal.<br>• This parameter sets the minimum frequency reference.<br>• The value is a percentage of the:<br>  • maximum frequency or speed<br>  • maximum process reference<br>  • nominal torque. | | | | |
| 1108 | **REF2 MAX** | **0.0 … 100.0% (torque: 0 … 600%)** | **0.1%** | **100.0%** | |
| | Sets the maximum for external reference 2.<br>• The maximum analog input signal (in volts or amps) corresponds to REF2 MAX in %.<br>• Parameter *1302 MAXIMUM AI1* or *1305 MAXIMUM AI2* sets the maximum analog input signal.<br>• This parameter sets the maximum frequency reference.<br>• The value is a percentage of the:<br>  • maximum frequency or speed<br>  • maximum process reference<br>  • nominal torque | | | | |

## Group 12: Constant speeds

This group defines a set of constant speeds. In general:

- You can program up to 7 constant speeds, ranging from 0 … 500 Hz or 0 … 30000 rpm.
- Values must be positive (No negative speed values for constant speeds).
- Constant speed selections are ignored if:
  - the torque control is active, or
  - the process PID reference is followed, or
  - the drive is in local control mode, or
  - PFA (Pump and fan alternation) is active

**Note:** Parameter *1208 CONST SPEED 7* acts also as a so-called fault speed which may be activated if the control signal is lost. For example, see parameters *3001 AI<MIN FUNCTION*, *3002 PANEL COMM ERR* and *3018 COMM FAULT FUNC*.

| Group 12: Constant speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1201 | **CONST SPEED SEL** | **-14…19** | **1** | **3** | ✓ |

Defines the digital inputs used to select Constant speeds. See general comments in the introduction.

0 = NOT SEL – Disables the constant speed function.

1 = DI1 – Selects Constant speed 1 with digital input 1.

- Digital input activated = Constant speed 1 activated.

2…5 = DI2…DI5 – Selects Constant speed 1 with digital input DI2…DI5. See above.

7 = DI1,2 – Selects one of three Constant speeds (1…3) using DI1 and DI2.

- Uses two digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):

| DI1 | DI2 | Function |
|---|---|---|
| 0 | 0 | No constant speed |
| 1 | 0 | Constant speed 1 (1202) |
| 0 | 1 | Constant speed 2 (1203) |
| 1 | 1 | Constant speed 3 (1204) |

- Can be set up as a so-called fault speed, which is activated if the control signal is lost. Refer to parameter *3001 AI<MIN FUNCTION* and parameter *3002 PANEL COMM ERR*.

8 = DI2,3 – Selects one of three Constant speeds (1…3) using DI2 and DI3.

- See above (DI1,2) for code.

9 = DI3,4 – Selects one of three Constant speeds (1…3) using DI3 and DI4.

- See above (DI1,2) for code.

10 = DI4,5 – Selects one of three Constant speeds (1…3) using 4 and 5.

- See above (DI1,2) for code.

12 = DI1,2,3 – Selects one of seven Constant speeds (1…7) using DI1, DI2 and DI3.

- Uses three digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):

| DI1 | DI2 | DI3 | Function |
|---|---|---|---|
| 0 | 0 | 0 | No constant speed |
| 1 | 0 | 0 | Constant speed 1 (1202) |
| 0 | 1 | 0 | Constant speed 2 (1203) |
| 1 | 1 | 0 | Constant speed 3 (1204) |
| 0 | 0 | 1 | Constant speed 4 (1205) |
| 1 | 0 | 1 | Constant speed 5 (1206) |
| 0 | 1 | 1 | Constant speed 6 (1207) |
| 1 | 1 | 1 | Constant speed 7 (1208) |

13 = DI3,4,5 – Selects one of seven Constant speeds (1…7) using DI3, DI4 and DI5.

- See above (DI1,2,3) for code.

| Group 12: Constant speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 15…18 = TIMER – Selects constant speed 1, constant speed 2 or the external reference depending on the state of, eg, timer 1 (if the parameter value is 15 = TIMER 1), timer 3 (if the parameter value is 17 = TIMER 3) etc, and the constant speed mode. See parameter *1209* and *Group 36: Timed functions*. | | | | |

| **1201 =** | **15** | **16** | **17** | **18** | **Reference** | |
|---|---|---|---|---|---|---|
| **Timer:** | **1** | **2** | **3** | **4** | **1209 = 1** | **1209 = 2** |
| **Timer State** | 0 | | | | External reference | Constant speed 1 |
| | 1 | | | | Constant speed 1 | Constant speed 2 |

19 = TIMER 1 & 2 – Selects a constant speed or the external reference depending on the state of timers 1 and 2 and the constant speed mode. See parameter *1209* and *Group 36: Timed functions*.

-1 = DI1(INV) – Selects Constant speed 1 with digital input DI1.

- Inverse operation: Digital input de-activated = Constant speed 1 activated.

-2 … - 5 = DI2(INV)…DI5(INV) – Selects Constant speed 1 with digital input. See above.

-7 = DI1,2(INV) – Selects one of three Constant speeds (1…3) using DI1 and DI2.

- Inverse operation uses two digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):

| DI1 | DI2 | Function |
|---|---|---|
| 1 | 1 | No constant speed |
| 0 | 1 | Constant speed 1 (1202) |
| 1 | 0 | Constant speed 2 (1203) |
| 0 | 0 | Constant speed 3 (1204) |

-8 = DI2,3(INV) – Selects one of three Constant speeds (1…3) using DI2 and DI3.

- See above (DI1,2(INV)) for code.

-9 = DI3,4(INV) – Selects one of three Constant speeds (1…3) using DI3 and DI4.

- See above (DI1,2(INV)) for code.

-10 = DI4,5(INV) – Selects one of three Constant speeds (1…3) using DI4 and DI5.

- See above (DI1,2(INV)) for code.

| Group 12: Constant speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | -12 = DI1,2,3(INV) – Selects one of seven constant speeds (1...7) using DI1, DI2 and DI3.<br>• Inverse operation uses three digital inputs, as defined below (0 = DI de-activated, 1 = DI activated): | | | | |

| DI1 | DI2 | DI3 | Function |
|---|---|---|---|
| 1 | 1 | 1 | No constant speed |
| 0 | 1 | 1 | Constant speed 1 (1202) |
| 1 | 0 | 1 | Constant speed 2 (1203) |
| 0 | 0 | 1 | Constant speed 3 (1204) |
| 1 | 1 | 0 | Constant speed 4 (1205) |
| 0 | 1 | 0 | Constant speed 5 (1206) |
| 1 | 0 | 0 | Constant speed 6 (1207) |
| 0 | 0 | 0 | Constant speed 7 (1208) |

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| | -13 = DI3,4,5(INV) – Selects one of seven constant speeds (1…3) using DI3, DI4 and DI5.<br>• See above (DI1,2,3(INV)) for code. | | | | |
| 1202 | **CONST SPEED 1**<br>Defines constant speed 1 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **6.0 (US)** | |
| 1203 | **CONST SPEED 2**<br>Defines constant speed 2 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **12.0** | |
| 1204 | **CONST SPEED 3**<br>Defines constant speed 3 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **18.0** | |
| 1205 | **CONST SPEED 4**<br>Defines constant speed 4 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **24.0** | |
| 1206 | **CONST SPEED 5**<br>Defines constant speed 5 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **30.0** | |
| 1207 | **CONST SPEED 6**<br>Defines constant speed 6 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **48.0** | |
| 1208 | **CONST SPEED 7**<br>Defines constant speed 7 (drive output frequency). | **0.0 … 500.0 Hz** | **0.1 Hz** | **60.0** | |

| Group 12: Constant speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1209 | **TIMED MODE SEL** | **1…2** | **1** | **2** | ✓ |
| | Defines timer activated, constant speed mode. Timer can be used to change between external reference and a maximum of three constant speeds, or to change between a maximum of 4 selectable speeds, in other words, constant speeds 1,2,3 and 4. | | | | |
| | 1 = EXT/CS1/2/3 – Selects an external speed when no timer is active, selects Constant speed 1 when Timer 1 is active, selects Constant speed 2 when Timer 2 is active and selects Constant speed 3 when both Timers 1 and 2 are active. | | | | |

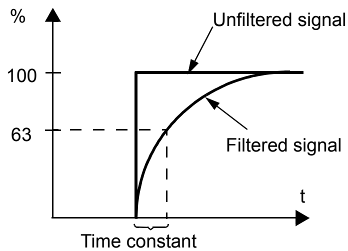
| TIMER1 | TIMER2 | Function |
|---|---|---|
| 0 | 0 | External reference |
| 1 | 0 | Constant speed 1 (1202) |
| 0 | 1 | Constant speed 2 (1203) |
| 1 | 1 | Constant speed 3 (1204) |

2 = CS1/2/3/4 – Selects Constant speed 1 when no timer is active, selects Constant speed 2 when Timer 1 is active, selects Constant speed 3 when Timer 2 is active, selects Constant speed 4 when both timers are active.

| TIMER1 | TIMER2 | Function |
|---|---|---|
| 0 | 0 | Constant speed 1 (1202) |
| 1 | 0 | Constant speed 2 (1203) |
| 0 | 1 | Constant speed 3 (1204) |
| 1 | 1 | Constant speed 4 (1205) |

## Group 13: Analogue inputs

This group defines the limits and the filtering for analog inputs.

| Group 13: Analogue inputs | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1301 | **MINIMUM AI1**<br>Defines the minimum value of the analog input.<br>• Define value as a percent of the full analog signal range. See example below.<br>• The minimum analog input signal corresponds to parameter *1104 REF1 MIN* or *1107 REF2 MIN*.<br>• MINIMUM AI cannot be greater than MAXIMUM AI.<br>• These parameters (reference and analog min. and max. settings) provide scale and offset adjustment for the reference.<br>• See figure at parameter *1104 REF1 MIN*.<br>**Example:** To set the minimum analog input value to 4 mA:<br>• Configure the analog input for 0 … 20 mA current signal.<br>• Calculate the minimum (4 mA) as a percent of full range (20 mA) = 4 mA / 20 mA * 100% = 20% | **0.0 … 100.0%** | **0.1%** | **20.0%** | |
| 1302 | **MAXIMUM AI1**<br>Defines the maximum value of the analog input.<br>• Define value as a percent of the full analog signal range.<br>• The maximum analog input signal corresponds to *1105 REF1 MAX* or *1108 REF2 MAX*.<br>• See figure at parameter *1104 REF1 MIN*. | **0.0 … 100.0%** | **0.1%** | **20.0%** | |
| 1303 | **FILTER AI1**<br>Defines the filter time constant for analog input 1 (AI1).<br>• The filtered signal reaches 63% of a step change within the time specified.<br><br> | **0.0 … 10.0 s** | **0.1 s** | **0.1 s** | |
| 1304 | **MINIMUM AI2**<br>Defines the minimum value of the analog input.<br>• See parameter *1301 MINIMUM AI1* above. | **0.0 … 100.0%** | **0.1%** | **20.0%** | |
| 1305 | **MAXIMUM AI2**<br>Defines the maximum value of the analog input.<br>• See parameter *1302 MAXIMUM AI1* above. | **0.0 … 100.0%** | **0.1%** | **100.0%** | |
| 1306 | **FILTER AI2**<br>Defines the filter time constant for analog input 2 (AI2).<br>• See parameter *1303 FILTER AI1* above | **0.0 … 10.0 s** | **0.1 s** | **0.1 s** | |

## Group 14: Relay outputs

This group defines the condition that activates each of the relay outputs.

| Group 14: Relay outputs | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1401 | **RELAY OUTPUT 1** | **0…45** | **1** | **1** | |
| | Defines the event or condition that activates relay 1 – what relay output 1 means.<br>0 = NOT SEL – Relay is not used and is de-energized.<br>1 = READY – Energize relay when drive is ready to function. Requires:<br>• Run enable signal present.<br>• No faults exist.<br>• Supply voltage is within range.<br>• Emergency Stop command is not on.<br>2 = RUN – Energize relay when the drive is running.<br>3 = FAULT (-1) – Energize relay when power is applied. De-energizes when a fault occurs.<br>4 = FAULT – Energize relay when a fault is active.<br>5 = ALARM – Energize relay when an alarm is active.<br>6 = REVERSED – Energize relay when motor rotates in reverse direction.<br>7 = STARTED – Energize relay when drive receives a start command (even if Run Enable signal is not present). De-energized relay when drive receives a stop command or a fault occurs.<br>8 = SUPRV1 OVER – Energize relay when first supervised parameter (*3201*) exceeds the limit (*3203*).<br>• See *Group 32: Supervision* starting on page *198*.<br>9 = SUPRV1 UNDER – Energize relay when first supervised parameter (*3201*) drops below the limit (*3202*).<br>• See *Group 32: Supervision* starting on page *198*.<br>10 = SUPRV2 OVER – Energize relay when second supervised parameter (*3204*) exceeds the limit (*3206*).<br>• See *Group 32: Supervision* starting on page *198*.<br>11 = SUPRV2 UNDER – Energize relay when second supervised parameter (*3204*) drops below the limit (*3205*).<br>• See *Group 32: Supervision* starting on page *198*.<br>12 = SUPRV3 OVER – Energize relay when third supervised parameter (*3207*) exceeds the limit (*3209*).<br>• See *Group 32: Supervision* starting on page *198*.<br>13 = SUPRV3 UNDER – Energize relay when third supervised parameter (*3207*) drops below the limit (*3208*).<br>• See *Group 32: Supervision* starting on page *198*.<br>14 = AT SET POINT – Energize relay when the output frequency is equal to the reference frequency.<br>15 = FAULT (RST) – Energize relay when the drive is in a fault condition and will reset after the programmed auto-reset delay.<br>• See parameter *3103 DELAY TIME*.<br>16 = FLT/ALARM – Energize relay when fault or alarm occurs.<br>17 = EXT CTRL – Energize relay when external control is selected.<br>18 = REF 2 SEL – Energize relay when EXT2 is selected.<br>19 = CONST FREQ– Energize relay when a constant speed is selected. | | | | |

| Group 14: Relay outputs | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 20 = REF LOSS – Energize relay when reference or active control place is lost.<br>21 = OVERCURRENT – Energize relay when an overcurrent alarm or fault occurs.<br>22 = OVERVOLTAGE – Energize relay when an overvoltage alarm or fault occurs.<br>23 = DRIVE TEMP – Energize relay when a drive overtemperature alarm or fault occurs.<br>24 = UNDERVOLTAGE – Energize relay when an undervoltage alarm or fault occurs.<br>25 = AI1 LOSS – Energize relay when AI1 signal is lost.<br>26 = AI2 LOSS – Energize relay when AI2 signal is lost.<br>27 = MOTOR TEMP – Energize relay when a motor overtemperature alarm or fault occurs.<br>28 = STALL – Energize relay when a stall alarm or fault exists.<br>30 = PID SLEEP – Energize relay when the PID sleep function is active.<br>31 = PFA – Use relay to start/stop motor in PFA control (See *Group 81: PFA control*).<br>• Use this option only when PFA control is used.<br>• Selection activated / deactivated when drive is not running.<br>32 = AUTOCHANGE – Energize relay when the PFA autochange operation is performed.<br>• Use this option only when PFA control is used.<br>33 = FLUX READY – Energize relay when the motor is magnetized and able to supply nominal torque (motor has reached nominal magnetizing).<br>34 = USER MACRO S2 – Energize relay when User Parameter Set 2 is active.<br>35 = COMM – Energize relay based on input from fieldbus communication.<br>• Fieldbus writes binary code in parameter *0134 COMM RO WORD* that can energizes relay 1…relay 4 according to the following: | | | | |

| Parameter 0134 | Binary | RO4 | RO3 | RO2 | RO1 |
|---|---|---|---|---|---|
| 0 | 000000 | 0 | 0 | 0 | 0 |
| 1 | 000001 | 0 | 0 | 0 | 1 |
| 2 | 000010 | 0 | 0 | 1 | 0 |
| 3 | 000011 | 0 | 0 | 1 | 1 |
| 4 | 000100 | 0 | 1 | 0 | 0 |
| 5…62 | … | … | … | … | … |
| 63 | 111111 | 1 | 1 | 1 | 1 |

• 0 = De-energize relay, 1 = Energize relay.

## Group 14: Relay outputs

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|

36 = COMM(-1) – Energize relay based on input from fieldbus communication.

- Fieldbus writes binary code in parameter 0134 that can energizes relay 1…relay 4 according to the following:

| Parameter 0134 | Binary | RO4 | RO3 | RO2 | RO1 |
|---|---|---|---|---|---|
| 0 | 000000 | 1 | 1 | 1 | 1 |
| 1 | 000001 | 1 | 1 | 1 | 0 |
| 2 | 000010 | 1 | 1 | 0 | 1 |
| 3 | 000011 | 1 | 1 | 0 | 0 |
| 4 | 000100 | 1 | 0 | 1 | 1 |
| 5…62 | … | … | … | … | … |
| 63 | 111111 | 0 | 0 | 0 | 0 |

- 0 = De-energize relay, 1 = Energize relay.

37 = TIMER 1 – Energize relay when timer 1 is activated. See *Group 36: Timed functions*.

38…40 = TIMER 2…4 – Energize relay when Timer 2…4 is active. See TIMER 1 above.

41 = MNT TRIG FAN – Energize relay when cooling fan counter is triggered. See *Group 29: Maintenance trig*.

42 = MNT TRIG REV – Energize relay when revolutions counter is triggered. See *Group 29: Maintenance trig*.

43 = MNT TRIG RUN – Energize relay when run time counter is triggered. See *Group 29: Maintenance trig*.

44 = MNT TRIG MWH – Energize relay when power consumption counter is triggered. See *Group 29: Maintenance trig*.

45 = OVERRIDE – Energize relay when override is activated.

46 = START DELAY– Energize relay when a start delay is active.

47 = USER LOAD C – Energize relay when a user load curve fault or alarm occurs.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 1402 | **RELAY OUTPUT 2** | **0…45** | **1** | **2** | |

Defines the event or condition that activates relay 2 – what relay output 2 means.

- See parameter *1401 RELAY OUTPUT 1* (Relay Output 2 only with MREL-01).

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 1403 | **RELAY OUTPUT 3** | **0…45** | **1** | **2** | |

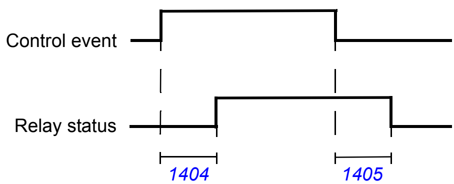
Defines the event or condition that activates relay 3 – what relay output 3 means.

- See parameter *1401 RELAY OUTPUT 1* (Relay Output 3 only with MREL-01).

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 1404 | **RO 1 ON DELAY** | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |

Defines the switch-on delay for relay 1.

- On / off delays are ignored when relay output of parameter *1401 RELAY OUTPUT 1* is set to PFA.

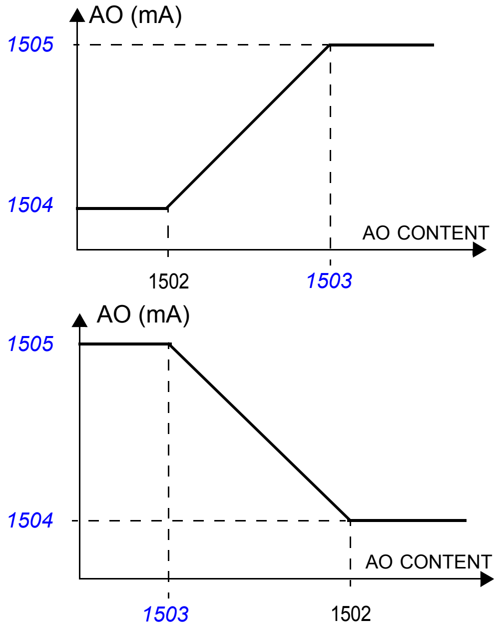


| Group 14: Relay outputs | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1405 | **RO 1 OFF DELAY**<br>Defines the switch-off delay for relay 1.<br>• On / off delays are ignored when relay output of parameter *1401 RELAY OUTPUT 1* is set to PFA. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1406 | **RO 2 ON DELAY**<br>Defines the switch-on delay for relay 2.<br>• See parameter *1404 RO 1 ON DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1407 | **RO 2 OFF DELAY**<br>Defines the switch-on delay for relay 2.<br>• See parameter *1405 RO 1 OFF DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1408 | **RO 3 ON DELAY**<br>Defines the switch-on delay for relay 3.<br>• See parameter *1404 RO 1 ON DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1409 | **RO 3 OFF DELAY**<br>Switch-off delay for relay 3.<br>• See parameter *1405 RO 1 OFF DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1410 | **RELAY OUTPUT 4**<br>Defines the event or condition that activates relay 4 – what relay output 4 means.<br>• See parameter *1401 RELAY OUTPUT 1*. | **0…45** | **1** | **0** | |
| 1413 | **RO 4 ON DELAY**<br>Defines the switch-on delay for relay 4.<br>• See parameter *1404 RO 1 ON DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |
| 1414 | **RO 4 OFF DELAY**<br>Defines the switch-off delay for relay 4.<br>• See parameter *1405 RO 1 OFF DELAY*. | **0.0 … 3600.0 s** | **0.1 s** | **0.0 s** | |

## Group 15: Analogue outputs

This group defines the drive's analog (current signal) outputs. The drive's analog outputs can be:

- Any parameter of *Group 01: Operating data*.
- Limited to programmable minimum and maximum values of output current.
- Scaled (and/or inverted) by defining the minimum and maximum values of the source parameter (or content). Defining an maximum value (parameter *1503 AO1 CONTENT MAX*) that is less than the content minimum value (parameter *1502 AO1 CONTENT MIN*) results in an inverted output.
- Filtered.

| Group 15: Analogue outputs | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1501 | **AO1 CONTENT SEL** | **x…x** | **1** | **103** | |
| | Connects a drive signal to analog output AO.<br>• Parameter index in *Group 01: Operating data*. For example, 102 = *0102 SPEED*. | | | | |
| 1502 | **AO1 CONTENT MIN** | **Depends on selection** | **-** | **0.0 Hz** | |
| | Sets the minimum content value.<br>• Content is the parameter selected by parameter *1501 AO1 CONTENT SEL*.<br>• Minimum value refers to the minimum content value that will be converted to an analog output.<br>• These parameters (content and current min. and max. settings) provide scale and offset adjustment for the output. See the figure.<br><br> | | | | |
| 1503 | **AO1 CONTENT MAX** | **Depends on selection** | **-** | **60.0 Hz** | |
| | Sets the maximum content value<br>• Content is the parameter selected by parameter *1501 AO1 CONTENT SEL*.<br>• Maximum value refers to the maximum content value that will be converted to an analog output. | | | | |
| 1504 | **MINIMUM AO1** | **0.0 … 20.0 mA** | **0.1 mA** | **4.0 mA** | |
| | Sets the minimum output current. | | | | |
| 1505 | **MAXIMUM AO1** | **0.0 … 20.0 mA** | **0.1 mA** | **2.0 mA** | |
| | Sets the maximum output current. | | | | |
| 1506 | **FILTER AO1** | **0 … 10 s** | **0.1 s** | **0.1 s** | |
| | Defines the filter time constant for AO1.<br>• The filtered signal reaches 63% of a step change within the time specified.<br>• See the figure in parameter *1303 FILTER AI1*. | | | | |

## Group 16: System controls

This group defines a variety of system level locks, resets and enables.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 1601 | **RUN ENABLE** | **-6…7** | **1** | **0** | ✓ |
| | Selects the source of the run enable signal.<br>0 = NOT SEL – Allows the drive to start without an external run enable signal.<br>1 = DI1 – Defines digital input DI1 as the run enable signal.<br>• This digital input must be activated for run enable.<br>• If the voltage drops and de-activates this digital input, the drive will coast to stop and not start until the run enable signal resumes.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the run enable signal.<br>• See DI1 above.<br>7 = COMM – Assigns the fieldbus Command word as the source for the run enable signal.<br>• Bit 6 of the Command word 1 (parameter *0301 FB CMD WORD 1*) activates the run disable signal.<br>• See fieldbus user's manual for detailed instructions.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as the run enable signal.<br>• This digital input must be de-activated for run enable.<br>• If this digital input activates, the drive will coast to stop and not start until the run enable signal resumes.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the run enable signal.<br>• See DI1(INV) above. | | | | |
| 1602 | **PARAMETER LOCK** | **0…2** | **1** | **1** | |
| | Determines if the control panel can change parameter values.<br>• This lock does not limit parameter changes made by macros.<br>• This lock does not limit parameter changes written by fieldbus inputs.<br>• This parameter value can be changed only if the correct pass code is entered. See parameter *1603 PASS CODE*.<br>0 = LOCKED – You cannot use the control panel to change parameter values.<br>• The lock can be opened by entering the valid pass code to parameter *1603 PASS CODE*.<br>1 = OPEN – You can use the control panel to change parameter values.<br>2 = NOT SAVED – You can use the control panel to change parameter values, but they are not stored in permanent memory.<br>• Set parameter *1607 PARAM. SAVE* to 1 (SAVE) to store changed parameter values to memory. | | | | |
| 1603 | **PASS CODE** | **0…65535** | **1** | **0** | |
| | Entering the correct pass code allows you to change the parameter lock.<br>• See parameter *1602 PARAMETER LOCK* above.<br>• Code 358 allows you to change the value of the parameter *1602 PARAMETER LOCK* once.<br>This entry reverts back to 0 automatically. | | | | |

| Group 16: System controls | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1604 | **FAULT RESET SEL** | **-6…8** | **1** | **0** | |
| | Selects the source for the fault reset signal. The signal resets the drive after a fault trip if the cause of the fault no longer exists.<br>0 = KEYPAD – Defines the control panel as the only fault reset source.<br>• Fault reset is always possible with control panel.<br>1 = DI1 – Defines digital input DI1 as a fault reset source.<br>• Activating the digital input resets the drive.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as a fault reset source.<br>• See DI1 above.<br>7 = START/STOP – Defines the Stop command as a fault reset source.<br>• Do not use this option when fieldbus communication provides the start, stop and direction commands.<br>8 = COMM – Defines the fieldbus as a fault reset source.<br>• The Command word is supplied through fieldbus communication.<br>• The bit 4 of the Command word 1 (parameter *0301 FB CMD WORD 1*) resets the drive.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as a fault reset source.<br>• De-activating the digital input resets the drive.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as a fault reset source.<br>• See DI1(INV) above. | | | | |

| Group 16: System controls | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1605 | **USER PAR SET CHG** | **-6…6** | **1** | **0** | |
| | Defines control for changing the user parameter set.<br>• See parameter *9902 APPLIC MACRO*.<br>• The drive must be stopped to change User parameter sets.<br>• During a change, the drive will not start.<br>**Note:** Always save the User parameter set after changing any parameter settings, or performing a motor identification.<br>• Whenever the power is cycled, or parameter *9902 APPLIC MACRO* is changed, the drive loads the last settings saved. Any unsaved changes to a user parameter set are lost.<br>**Note:** The value of this parameter (1605) is not included in the User parameter sets, and does not change if User parameter sets change.<br>**Note:** You can use a relay output to supervise the selection of User parameter set 2.<br>• See parameter 1401.<br>0 = NOT SEL – Defines the control panel (using parameter *9902 APPLIC MACRO*) as the only control for changing User parameter sets.<br>1 = DI1 – Defines digital input 1 as a control for changing User parameter sets.<br>• The drive loads User parameter set 1 on the falling edge of the digital input.<br>• The drive loads User parameter set 2 on the rising edge of the digital input.<br>• The User parameter set changes only when the drive is stopped.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as a control for changing User parameter sets.<br>• See DI1 above.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as a control for changing User parameter sets.<br>• The drive loads User parameter set 1 on the rising edge of the digital input.<br>• The drive loads User parameter set2 on the falling edge of the digital input.<br>• The User parameter set changes only when the drive is stopped.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as a control for changing User parameter sets.<br>• See DI1(INV) above. | | | | |

| Group 16: System controls | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1606 | **LOCAL LOCK** | **-6…8** | **1** | **0** | |
| | Defines control for the use of the HAND mode. The HAND mode allows drive control from the control panel.<br>• When LOCAL LOCK is active, the control panel cannot change to HAND mode.<br>0 = NOT SEL – Disables the lock. The control panel can select HAND and control the drive.<br>**Note:** The OFF key always stops the drive, regardless of the parameter 1606 LOCAL LOCK value. If LOCAL LOCK is active and the drive is in the AUTO mode when the OFF key is pressed, the drive remains in the AUTO mode but coasts to stop and shows alarm 2017 OFF BUTTON on the control panel display. (This alarm is shown on the control panel only; it is not indicated by relay outputs.) Press the AUTO key to restart the drive.<br>**Note:** If the drive is in the OFF or HAND mode and LOCAL LOCK is activated (eg, from the control panel or through a digital input), control from the control panel is still possible until the drive is set to the AUTO mode. It is not until then that LOCAL LOCK becomes effective, disabling changing from the AUTO mode to the OFF or HAND mode by pressing the OFF or HAND key.<br>1 = DI1 – Defines digital input 1 as the control for setting the local lock.<br>• Activating the digital input locks out local control.<br>• De-activating the digital input enable the HAND selection.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for setting the local lock.<br>• See DI1 above.<br>7 = ON – Sets the lock. The control panel cannot select HAND, and cannot control the drive.<br>8 = COMM – Defines bit 14 of the Command word 1 as the control for setting the local lock.<br>• Command word is supplied through fieldbus communication.<br>• Command word is parameter *0301 FB CMD WORD 1*.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for setting the local lock.<br>• De-activating the digital input locks out local control.<br>• Activating the digital input enable the HAND selection.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for setting the local lock.<br>• See DI1(INV) above. | | | | |
| 1607 | **PARAM. SAVE** | **0, 1** | **1** | **0** | |
| | Saves all altered parameters to permanent memory.<br>• Parameters altered through a fieldbus are not automatically saved to permanent memory. To save, you must use this parameter.<br>• If parameter *1602 PARAMETER LOCK* = 2 (NOT SAVED), parameters altered from the control panel are not saved. To save, you must use this parameter.<br>• If parameter *1602 PARAMETER LOCK* = 1 (OPEN), parameters altered from the control panel are stored immediately to permanent memory.<br>0 = DONE – Value changes automatically when all parameters are saved.<br>1 = SAVE… – Saves altered parameters to permanent memory. | | | | |

| Group 16: System controls | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1608 | **START ENABLE 1** | **-6…7** | **1** | **4** | |

Selects the source of the start enable 1 signal.

**Note:** Start enable functionality **differs** from the run enable functionality.

0 = NOT SEL – Allows the drive to start without an external start enable signal.

1 = DI1 – Defines digital input DI1 as the start enable 1 signal.

- This digital input must be activated for start enable 1 signal.
- If the voltage drops and de-activates this digital input, the drive will coast to stop and show alarm *2021 START ENABLE 1 MISSING* on panel display. The drive will not start until start enable 1 signal resumes.

2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the start enable 1 signal.

- See DI1 above.

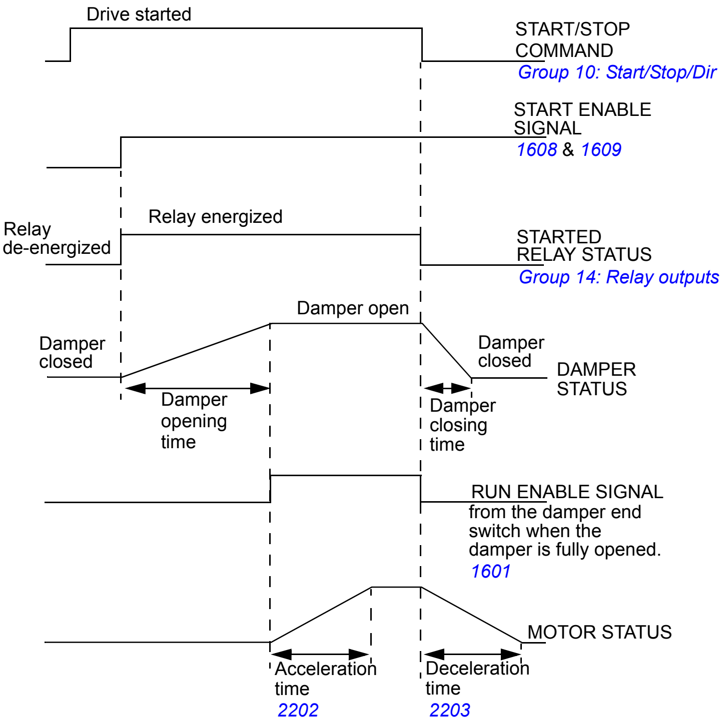
7 = COMM – Assigns the fieldbus Command word as the source for the start enable 1 signal.

- Bit 2 of the Command word 2 (parameter *0302 FB CMD WORD 2*) activates the start disable 1 signal.
- See fieldbus user's manual for detailed instructions.

-1 = DI1(INV) – Defines an inverted digital input DI1 as the start enable 1 signal.

-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the start enable 1 signal.

- See DI1(INV) above.



| Group 16: System controls | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1609 | **START ENABLE 2** | **-6…7** | **1** | **0** | |
| | Selects the source of the start enable 2 signal.<br>**Note:** Start enable functionality differs from the run enable functionality.<br>0 = NOT SEL – Allows the drive to start without an external start enable signal.<br>1 = DI1 – Defines digital input DI1 as the start enable 2 signal. This digital input must be activated for start enable 2 signal. If the voltage drops and de-activates this digital input, the drive will coast to stop and show alarm *2022 START ENABLE 2 MISSING* on the panel display. The drive will not start until start enable 2 signal resumes.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the start enable 2 signal. See DI1 above.<br>7 = COMM – Assigns the fieldbus Command word as the source for the start enable 2 signal. Bit 3 of the Command word 2 (parameter *0302*) activates the start disable 2 signal. See fieldbus user's manual for detailed instructions.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the start enable 2 signal.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the start enable 2 signal.<br>• See DI1(INV) above. | | | | |
| 1610 | **DISPLAY ALARMS** | **0, 1** | **1** | **1** | |
| | Controls the visibility of the following alarms:<br>• *2001 OVERCURRENT*<br>• *2002 OVERVOLTAGE*<br>• *2003 UNDERVOLTAGE*<br>• *2009 DEVICE OVERTEMP*.<br>For more information, see chapter *Fault tracing*.<br>0 = NO – The above alarms are suppressed.<br>1 = YES – All of the above alarms are enabled. | | | | |
| 1611 | **PARAMETER VIEW** | **1…3** | **1** | **2** | |
| | Selects the parameter view, in other words, which parameters are shown.<br>**Note:** This parameter is visible only when it is activated by the optional FlashDrop device. The FlashDrop is designed for fast copying of parameters to unpowered drives. It allows fast customization of the parameter list, for example, selected parameters can be hidden. For more information, see *MFDT-01 FlashDrop User's Manual* [3AFE68591074 (English)].<br>FlashDrop parameter values are activated by setting parameter *9902 APPLIC MACRO* to 31 (LOAD FD SET.<br>1 = FLASHDROP – FlashDrop parameter list is shown. Does not include short parameter list. Parameters that are hidden by the FlashDrop device are not visible.<br>2 = SHORT VIEW – Shows only a subset of all signals and parameters<br>3 = LONG VIEW – Shows all signals and parameters. | | | | |

## Group 17: Override

This group defines the source for the override activation signal, the override speed/ frequency and pass code and how the override is enabled and disabled.

When override DI is activated, the drive stops and then accelerates to the preset speed or frequency. When the DI is deactivated the drive stops and reboots. If the start command, run enable and start enables are active in the AUTO mode the drive starts automatically and continues normally after override mode. In the HAND mode the drive returns to OFF mode.

When override is active:

- Drive runs at preset speed.
- Drive ignores all keypad commands.
- Drive ignores all commands from communication links.
- Drive ignores all digital inputs except override activation/deactivation, RUN ENABLE and START ENABLE.
- Drive displays alarm message *2020 OVERRIDE*.

The following faults are ignored:

| | |
|---|---|
| 3 | DEV OVERTEMP |
| 5 | OVERLOAD |
| 6 | DC UNDERVOLT |
| 7 | AI1 LOSS |
| 8 | AI2 LOSS |
| 9 | MOT OVERTEMP |
| 10 | PANEL LOSS |
| 12 | MOTOR STALL |
| 14 | EXT FAULT 1 |
| 15 | EXT FAULT 2 |
| 17 | UNDERLOAD |
| 18 | THERM FAIL |
| 21 | CURR MEAS |
| 22 | SUPPLY PHASE |
| 24 | OVERSPEED |
| 28 | SERIAL 1 ERR |
| 29 | EFB CON FILE |
| 30 | FORCE TRIP |
| 31 | EFB 1 |

| | |
|---|---|
| 32 | EFB 2 |
| 33 | EFB 3 |
| 34 | MOTOR PHASE |
| 1001 | PAR PFA REF NEG |
| 1002 | PAR PFC IOCONF |
| 1003 | PAR AI SCALE |
| 1004 | PAR AO SCALE |
| 1006 | PAR EXT RO |
| 1007 | PAR FIELDBUS MISSING |
| 1008 | PAR PFA MODE |

*Commissioning the override mode*

1. Enter the parameters in all groups as needed, except *Group 17: Override*.
2. Select the digital input that will activate the override mode (parameter *1701 OVERRIDE SEL*).
3. Enter the frequency reference for the override mode with parameter *1702 OVERRIDE FREQ*.
4. Enter the pass code (358) at parameter *1704 OVERR PASS CODE*.
5. Enable the override mode with parameter *1705 OVERRIDE*.

*Changing the override parameters*

1. If override mode is already enabled, disable it:
   - Enter the pass code (358) at parameter *1704 OVERR PASS CODE*.
   - Disable the override mode with parameter *1705 OVERRIDE*.
2. If needed, load the override parameter set with parameter *9902 APPLIC MACRO*.
3. Change the parameters as needed, except *Group 17: Override*.
4. Select the digital input that will activate the override mode (parameter *1701 OVERRIDE SEL*).
5. Enter the frequency reference for the override mode with parameter *1702 OVERRIDE FREQ*.
6. Enter the pass code (358) at parameter *1704 OVERR PASS CODE*.
7. Enable the override mode with parameter *1705 OVERRIDE*. The drive replaces the override parameter set with new values of all parameters.

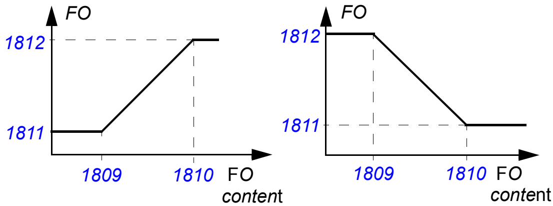
| Group 17: Override | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1701 | **OVERRIDE SEL** | **-6…6** | **1** | **0** | |
| | Selects the source of the override activation signal.<br>0 = NOT SEL – Override activation signal not selected.<br>1 = DI1 – Defines digital input DI1 as the override activation signal.<br>• This digital input must be activated for override activation signal.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the override activation signal.<br>• See DI1 above.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the override activation signal.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the override activation signal.<br>• See DI1(INV) above. | | | | |
| 1702 | **OVERRIDE FREQ** | **-500 … 500 Hz** | **0.1** | **0.0** | |
| | Defines a preset frequency for the override. | | | | |
| 1704 | **OVERR PASS CODE** | **0…65535** | **1** | **0** | |
| | Entering the correct override pass code unlocks parameter *1705 OVERRIDE* for one change.<br>• Enter the pass code always before changing the value of the parameter *1705*.<br>• The pass code is 358.<br>• The entry reverts back to zero automatically. | | | | |
| 1705 | **OVERRIDE** | **0…1** | **1** | **0** | |
| | Selects whether the override is enabled or disabled.<br>0 = OFF – Override disabled.<br>1 = ON – Override enabled.<br>• When enabled, the drive stores the values of all parameters into an override parameter set (see parameter *9902 APPLIC MACRO*) and the parameters in *Group 17: Override* will be write protected (except parameter *1704 OVERR PASS CODE*). To change the other parameters in *Group 17: Override*, override has to be disabled. | | | | |
| 1706 | **OVERRIDE DIR** | | | | |
| | Selects the source of the override direction signal.<br>0 = FORWARD – Assigns forward as the override direction.<br>1 = DI1 – Defines digital input 1 as the override direction signal.<br>• Activating the digital input selects the forward direction.<br>• De-activating the digital input selects the reverse direction.<br>2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the override direction signal. See DI1 above.<br>7 = REVERSE – Assigns reverse as the override direction.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the override direction signal.<br>• De-activating the digital input selects the forward direction.<br>• Activating the digital input selects the reverse direction.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the override direction signal.<br>• See DI1(INV) above. | | | | |

| Group 17: Override | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1707 | **OVERRIDE REF** | | | | |
| | Selects the source of the override reference.<br>1 = CONSTANT – Selects a preset frequency or speed for the override. The frequency value is defined by parameter *1702 OVERRIDE FREQ*.<br>2 = PID – The reference is taken from the PID output, see group *Group 40: Process PID set 1*.<br>**Note:** The following conditions must be met when using PID in the override mode:<br>• PID1 setpoint (parameter *4010 SET POINT SEL*) can be either A1, A2 OR INTERNAL PID1 parameter set 1 must be active (parameter *4027 PID 1 PARAM SET* = set 1).<br>• Override direction (parameter *1706 OVERRIDE DIR*) can be either 0 = forward or 7 = reverse. | | | | |

## Group 18: Freq in & tran out

This group defines the frequency input and transistor output signal processing.

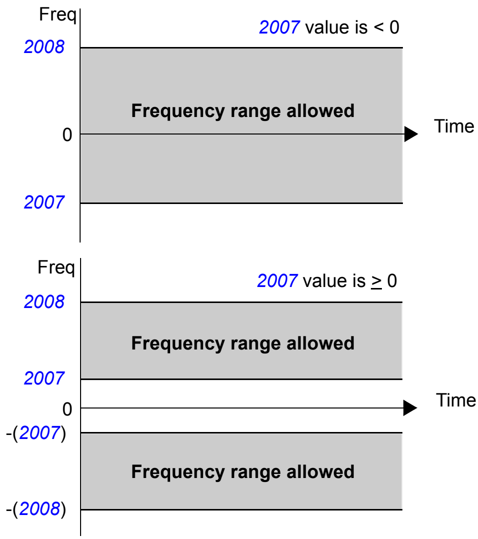
| Group 18: Freq in & tran out | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1801 | **FREQ INPUT MIN** | **0 … 16000 Hz** | **1 =1 Hz** | **0 Hz** | |
| | Defines the minimum input value when DI5 is used as a frequency input. See section *Frequency input* on page *105*. | | | | |
| 1802 | **FREQ INPUT MAX** | **0 … 16000 Hz** | **1 =1 Hz** | **1000 Hz** | |
| | Defines the maximum input value when DI5 is used as a frequency input. See section *Frequency input* on page *105*. | | | | |
| 1803 | **FILTER FREQ IN** | **0.0 … 10.0 s** | **1 = 0.1 s** | **0.1 s** | |
| | Defines the filter time constant for frequency input, ie the time within 63% of a step change is reached. See section *Frequency input* on page *105*. | | | | |
| 1804 | **TO MODE** | | | **DIGITAL** | |
| | Selects the operation mode for the transistor output TO. See section *Transistor output* on page *105*.<br>0 = DIGITAL – Transistor output is used as a digital output DO.<br>1 = FREQUENCY – Transistor output is used as a frequency output FO. | | | | |
| 1805 | **DO SIGNAL** | | | **FAULT (-1)** | |
| | Selects a drive status indicated through digital output DO. See parameter *1401 RELAY OUTPUT 1*. | | | | |
| 1806 | **DO ON DELAY** | **0.0 … 3600.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the operation delay for digital output DO. | | | | |
| 1807 | **DO OFF DELAY** | **0.0 … 3600.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the release delay for digital output DO. | | | | |
| 1808 | **FO CONTENT SEL** | **x…x** | | **104** | |
| | Selects a drive signal to be connected to frequency output FO. Parameter index in *Group 01: Operating data*, for example, 102 = 0102 SPEED. | | | | |

| Group 18: Freq in & tran out | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1809 | **FO CONTENT MIN** | **x…x** | **-** | **-** | |
| | Defines the minimum frequency output FO signal value. Signal is selected with parameter *1808 FO CONTENT SEL*.<br>FO minimum and maximum correspond to *1811 MINIMUM FO* and *1812 MAXIMUM FO* settings as follows:<br><br><br>Setting range depends on parameter *1808 FO CONTENT SEL* setting. | | | | |
| 1810 | **FO CONTENT MAX** | **x…x** | **-** | **-** | |
| | Defines the maximum frequency output FO signal value. Signal is selected with parameter *1808 FO CONTENT SEL*. See parameter *1809 FO CONTENT MIN*.<br>Setting range depends on parameter *1808 FO CONTENT SEL* setting. | | | | |
| 1811 | **MINIMUM FO** | **10 … 16000 Hz** | **1 = 1 Hz** | **10 Hz** | |
| | Defines the minimum value for frequency output FO. See parameter *1809 FO CONTENT MIN*. | | | | |
| 1812 | **MAXIMUM FO** | **10 … 16000 Hz** | **1 = 1 Hz** | **10 Hz** | |
| | Defines the maximum value for frequency output FO. See parameter *1809 FO CONTENT MIN*. | | | | |
| 1813 | **FILTER FO** | **0.0 … 10.0 s** | **1 = 0.1 s** | **0.1 s** | |
| | Defines the filter time constant for frequency output FO, ie, the time within 63% of a step change is reached. | | | | |
| 1814 | **DI 1 ON DELAY** | **0.0 … 3600.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the delay from the signal change to the change of the digital input DI to the ON state. | | | | |
| 1815 | **DI 1 OFF DELAY** | **0.0 … 3600.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the delay from the signal change to the change of the digital input DI to the OFF state. | | | | |
| 1816 | **DI 2 ON DELAY** | | | **0.0 s** | |
| | See parameter *1814 DI 1 ON DELAY*. | | | | |
| 1817 | **DI 2 OFF DELAY** | | | **0.0 s** | |
| | See parameter *1815 DI 1 OFF DELAY*. | | | | |
| 1818 | **DI 3 ON DELAY** | | | **0.0 s** | |
| | See parameter *1814 DI 1 ON DELAY*. | | | | |
| 1819 | **DI 3 OFF DELAY** | | | **0.0 s** | |
| | See parameter *1815 DI 1 OFF DELAY*. | | | | |

| Group 18: Freq in & tran out | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 1820 | **DI 4 ON DELAY**<br>See parameter *1814 DI 1 ON DELAY*. | | | **0.0 s** | |
| 1821 | **DI 4 OFF DELAY**<br>See parameter *1815 DI 1 OFF DELAY*. | | | **0.0 s** | |
| 1822 | **DI 5 ON DELAY**<br>See parameter *1814 DI 1 ON DELAY*. | | | **0.0 s** | |
| 1823 | **DI 5 OFF DELAY**<br>See parameter *1815 DI 1 OFF DELAY*. | | | **0.0 s** | |

## Group 20: Limits

This group defines minimum and maximum limits to follow in driving the motor – speed, frequency, current, torque, etc.

| Group 20: Limits | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2003 | **MAX CURRENT** | **0.0 … 1.1 * $I_{2N}$** | **0.1 A** | **1.1 * $I_{2N}$** | ✓ |
| | Defines the maximum output current (A) supplied by the drive to the motor. | | | | |
| 2006 | **UNDERVOLT CTRL** | **0…2** | **1** | **1** | |
| | Sets the DC undervoltage controller on or off. When on:<br>• If the DC bus voltage drops due to loss of input power, the undervoltage controller decreases the motor speed in order to keep the DC bus voltage above the lower limit.<br>• When the motor speed decreases, the inertia of the load causes regeneration back into the drive, keeping the DC bus charged, and preventing an undervoltage trip.<br>• The DC undervoltage controller increases power loss ride-through on systems with a high inertia, such as a centrifuge or a fan.<br>0 = DISABLE – Disables controller.<br>1 = ENABLE (TIME) – Enables controller with 500 ms time limit for operation.<br>2 = ENABLE – Enables controlled without maximum time limit for operation. | | | | |
| 2007 | **MINIMUM FREQ** | **-500.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | ✓ |
| | Defines the minimum limit for the drive output frequency.<br>• A positive or zero minimum speed frequency defines two ranges, one positive and one negative.<br>• A negative minimum speed frequency defines one speed range. See figure.<br>**Note:** Keep MINIMUM FREQ≤ MAXIMUM FREQ.<br> | | | | |
| 2008 | **MAXIMUM FREQ** | **0.0 … 500.0 Hz** | **0.1 Hz** | **60.0 Hz (US)** | ✓ |
| | Defines the maximum limit for the drive output frequency. | | | | |

## Group 21: Start/Stop

This group defines how the motor starts and stops. The drive supports several start and stop modes.

| Group 21: Start/Stop | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2101 | **START FUNCTION**<br>Selects the motor start method.<br>1 = AUTO – The drive starts the motor instantly from zero frequency. If flying start is required, use selection SCAN START.<br>2 = DC MAGN – The drive pre-magnetizes the motor with DC current before the start. The pre-magnetizing time is defined by parameter *2103 DC MAGN TIME*.<br>**Note:** Starting to a rotating machine is not possible when DC MAGN is selected.<br>**WARNING!** The drive will start after the set pre-magnetizing time has passed even if the motor magnetization is not completed. Ensure always in applications where a full break-away torque is essential, that the constant magnetizing time is long enough to allow generation of full magnetization and torque.<br>4 = TORQ BOOST – Torque boost should be selected if a high break-away torque is required.<br>The drive pre-magnetizes the motor with DC current before the start. The pre-magnetizing time is defined by parameter *2103 DC MAGN TIME*.<br>Torque boost is applied at start. Torque boost is stopped when output frequency exceeds 20 Hz or when it is equal to the reference value. See parameter *2110 TORQ BOOST CURR*.<br>**Note:** Starting to a rotating machine is not possible when TORQ BOOST is selected.<br>**WARNING!** The drive will start after the set pre-magnetizing time has passed although the motor magnetization is not completed. Ensure always in applications where a full break-away torque is essential, that the constant magnetizing time is long enough to allow generation of full magnetization and torque.<br>6 = SCAN START – Frequency scanning flying start (starting the drive connected to a rotating machine). Based on frequency scanning (interval *2008 MAXIMUM FREQ*…*2007 MINIMUM FREQ*) to identify the frequency. If frequency identification fails, DC magnetization is used (see selection DC MAGN).<br>7 = SCAN + BOOST – Combines scanning start (starting the drive connected to a rotating machine) and torque boost. See selections SCANSTART and TORQ BOOST. If frequency identification fails, torque boost is used. | **1…8** | **1** | **1** | |
| 2102 | **STOP FUNCTION**<br>Selects the motor stop method.<br>1 = COAST – Selects cutting off the motor power as the stop method. The motor coasts to stop.<br>2 = RAMP – Selects using a deceleration ramp<br>• Deceleration ramp is defined by *2203 DECELER TIME 1* or *2206 DECELER TIME 2* (whichever is active). | **1, 2** | **1** | **1** | |

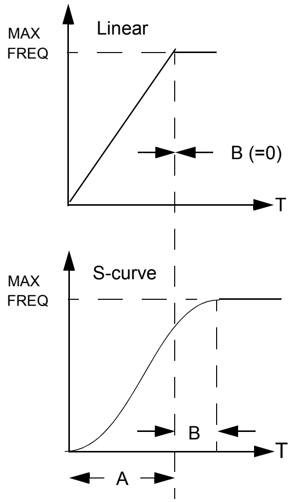
| Group 21: Start/Stop | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2103 | **DC MAGN TIME** | **0.00 … 10.00 s** | **0.01 s** | **0.30 s** | |
| | Defines the pre-magnetizing time for the DC Magnetizing start mode.<br>• Use parameter *2101 START FUNCTION* to select the start mode.<br>• After the start command, the drive pre-magnetizes the motor for the time defined here, and then starts the motor.<br>• Set the pre-magnetizing time just long enough to allow full motor magnetization. Too long a time heats the motor excessively. | | | | |
| 2106 | **DC CURR REF** | **0 … 100%** | **1%** | **30%** | |
| | Defines the DC current control reference as a percentage of parameter *9906 MOTOR NOM CURR*. | | | | |
| 2107 | **DC BRAKE TIME** | **0 … 250 s** | **0.1 s** | **0 s** | |
| | Defines the DC brake time. | | | | |
| 2108 | **START INHIBIT** | **0, 1** | **1** | **0** | ✓ |
| | Sets the Start inhibit function on or off. If the drive is not actively started and running, the Start inhibit function ignores a pending start command in any of the following situations and a new start command is required:<br>• Fault is reset.<br>• Run enable (parameter *1601 RUN ENABLE*) activates while start command is active.<br>• Mode changes from local to remote.<br>• Control switches from EXT1 to EXT2Control switches from EXT2 toEXT1.<br>0 = OFF – Disables the Start inhibit function.<br>1 = ON – Enables the Start inhibit function. | | | | |
| 2109 | **EMERG STOP SEL** | **-6…6** | **1** | **0** | |
| | Defines control of the Emergency stop command. When activated:<br>• Emergency stop decelerates the motor using the emergency stop ramp (parameter *2208 EMERG DEC TIME*).<br>• Requires an external stop command and removal of the emergency stop command before drive can restart.<br>0 = NOT SEL – Disables the Emergency stop function through digital inputs.<br>1 = DI1 – Defines digital input 1 as the control for Emergency stop command.<br>• Activating the digital input issues an Emergency stop command.<br>• De-activating the digital input removes the Emergency stop command.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for Emergency stop command.<br>• See DI1 above.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for Emergency stop command.<br>• De-activating the digital input issues an Emergency stop command.<br>• Activating the digital input removes the Emergency stop command.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for Emergency stop command.<br>• See DI1(INV) above. | | | | |

| Group 21: Start/Stop | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2110 | **TORQ BOOST CURR**<br>Sets the maximum supplied current during torque boost.<br>• See parameter *2101 START FUNCTION*. | **15 … 300%** | **1** | **100%** | |
| 2113 | **START DELAY**<br>Defines the Start delay. After the conditions for start have been fulfilled, the drive waits until the delay has elapsed and then starts the motor. Start delay can be used with all start modes.<br>• If START DELAY = zero, the delay is disabled.<br>• During the Start delay, alarm 2028 START DELAY is shown. | | | | |

## Group 22: Accel/Decel

This group defines ramps that control the rate of acceleration and deceleration. You define these ramps as a pair, one for acceleration and one for deceleration. You can define two pairs of ramps and use a digital input to select one or the other pair.

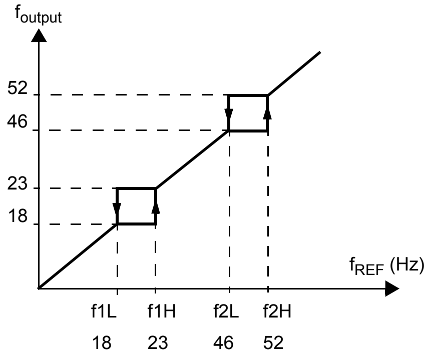
| Group 22: Accel/Decel | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2201 | **ACC/DEC 1/2 SEL**<br>Defines control for selection of acceleration/deceleration ramps.<br>• Ramps are defined in pairs, one each for acceleration and deceleration.<br>• See below for the ramp definition parameters.<br>0 = NOT SEL – Disables selection, the first ramp pair is used.<br>1 = DI1 – Defines digital input 1 as the control for ramp pair selection.<br>• Activating the digital input selects ramp pair 2.<br>• De-activating the digital input selects ramp pair 1.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for ramp pair selection.<br>• See DI1 above.<br>7 = COMM – Defines serial communication as the control for ramp pair selection.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as the control for ramp pair selection.<br>• De-activating the digital input selects ramp pair 2<br>• Activating the digital input selects ramp pair 1.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for ramp pair selection.<br>• See DI1(INV) above. | **-6…7** | **1** | **0** | |
| 2202 | **ACCELER TIME 1**<br>Sets the acceleration time for zero to maximum frequency for ramp pair 1. See A in the figure with parameter *2204 RAMP SHAPE 1*.<br>• Actual acceleration time also depends on parameter *2204 RAMP SHAPE 1*.<br>• See parameter *2008 MAXIMUM FREQ*. | **0.0 … 1800.0 s** | **0.1 s** | **30.0 s** | |

| Group 22: Accel/Decel | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2203 | **DECELER TIME 1** | **0.0 … 1800.0 s** | **0.1 s** | **30.0 s** | |
| | Sets the deceleration time for maximum frequency to zero for ramp pair 1.<br>• Actual deceleration time also depends on parameter *2204 RAMP SHAPE 1*.<br>• See parameter *2008 MAXIMUM FREQ*. | | | | |
| 2204 | **RAMP SHAPE 1** | **0 … 1000.0 s** | **0.1 s** | **0.0** | |
| | Selects the shape of the acceleration/deceleration ramp for ramp pair 1. See B in the figure.<br>• Shape is defined as a ramp, unless additional time is specified here to reach the maximum frequency. A longer time provides a softer transition at each end of the slope. The shape becomes an s-curve.<br>• Rule of thumb: 1/5 is a suitable relation between the ramp shape time and the acceleration ramp time.<br>0.0 = LINEAR – Specifies linear acceleration/deceleration ramps for ramp pair 1.<br>0.1…1000.0 – Specifies s-curve acceleration/deceleration ramps for ramp pair 1.<br><br><br>A = *2202*<br>B = *2204* | | | | |
| 2205 | **ACCELER TIME 2** | **0.0 … 1800.0 s** | **0.1 s** | **60.0 s** | |
| | Sets the acceleration time (s) for zero to maximum frequency for ramp pair 2. See parameter *2202 ACCELER TIME 1*. | | | | |
| 2206 | **DECELER TIME 2** | **0.0 … 1800.0 s** | **0.1 s** | **60.0 s** | |
| | Sets the deceleration time for maximum frequency to zero for ramp pair 2. See parameter *2203 DECELER TIME 1*. | | | | |
| 2207 | **RAMP SHAPE 2** | **0 … 1000.0 s** | **0.1 s** | **0.0** | |
| | Selects the shape of the acceleration/deceleration ramp for ramp pair 2. See parameter *2204 RAMP SHAPE 1*. | | | | |
| 2208 | **EMERG DEC TIME** | **0.0 … 1800 s** | **0.1 s** | **1.0 s** | |
| | Sets the deceleration time for maximum frequency to zero for an emergency.<br>• See parameter *2109 EMERG STOP SEL*.<br>• Ramp is linear. | | | | |

| Group 22: Accel/Decel | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2209 | **RAMP INPUT 0** | **-6…6** | **1** | **0** | |
| | Defines control for forcing the ramp input to 0.<br>0 = NOT SEL – Not selected.<br>1 = DI1 – Defines digital input 1 as the control for forcing the ramp input to 0.<br>• Activating the digital input forces ramp input to 0. Ramp output will ramp to 0 according to the currently used ramp time, after which it will stay at 0.<br>• De-activating the digital input: ramp resumes normal operation.<br>2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for forcing the ramp input to 0.<br>• See DI1 above.<br>7 = COMM – Defines bit 13 of the Command word 1 as the control for forcing the speed to 0.<br>• Command word is supplied through fieldbus communication.<br>• Command word is parameter *0301*.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for forcing the ramp input to 0.<br>• De-activating the digital input forces ramp input to 0.<br>• Activating the digital input: ramp resumes normal operation.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for forcing the ramp function generator input to 0.<br>• See DI1(INV) above. | | | | |

## Group 25: Critical speeds

This group defines up to three critical speeds or ranges of speeds that are to be avoided due, for example, to mechanical resonance problems at certain speeds.

| Group 25: Critical speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2501 | **CRIT SPEED SEL**<br>Sets the critical speeds function on or off. The critical speed function avoids specific speed ranges.<br>0 = OFF – Disables the critical speeds function.<br>1 = ON – Enables the critical speeds function.<br>Example: To avoid speeds at which a fan system vibrates badly:<br>• Determine problem speed ranges. Assume they are found to be: 18…23 Hz and 46…52 Hz.<br>• Set 2501 CRIT SPEED SEL = 1.<br>• Set *2502 CRIT SPEED 1 LO* = 18 Hz.<br>• Set *2503 CRIT SPEED 1 HI* = 23 Hz.<br>• Set *2504 CRIT SPEED 2 LO* = 46 Hz.<br>• Set *2505 CRIT SPEED 2 HI* = 52 Hz.<br><br> | **0, 1** | **1** | **0** | |
| 2502 | **CRIT SPEED 1 LO**<br>Sets the minimum limit for critical speed range 1.<br>• Value must be less than or equal to *2503 CRIT SPEED 1 HI*.<br>• Units are rpm. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |
| 2503 | **CRIT SPEED 1 HI**<br>Sets the maximum limit for critical speed range 1.<br>• Value must be greater than or equal to *2502 CRIT SPEED 1 LO*.<br>• Units are rpm. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |
| 2504 | **CRIT SPEED 2 LO**<br>Sets the minimum limit for critical speed range 2.<br>• See parameter *2502 CRIT SPEED 1 LO*. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |
| 2505 | **CRIT SPEED 2 HI**<br>Sets the maximum limit for critical speed range 2.<br>• See parameter *2503 CRIT SPEED 1 HI*. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |
| 2506 | **CRIT SPEED 3 LO**<br>Sets the minimum limit for critical speed range 3.<br>• See parameter *2502 CRIT SPEED 1 LO*. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |

| Group 25: Critical speeds | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2507 | **CRIT SPEED 3 HI**<br>Sets the maximum limit for critical speed range 3.<br>• See parameter *2503 CRIT SPEED 1 HI*. | **0.0 … 500.0 Hz** | **0.1 Hz** | **0.0 Hz** | |

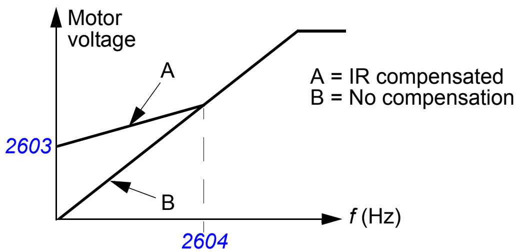
## Group 26: Motor control

This group provides controls for fine-tuning the motor control.

| Group 26: Motor control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2603 | **IR COMP VOLT**<br>Sets the IR compensation voltage used for 0 Hz.<br>• Keep IR compensation as low as possible to prevent overheating.<br>• Typical IR compensation values are: | **0 … 100 V** | **1 V** | **size dependent** | |

Typical IR compensation values:

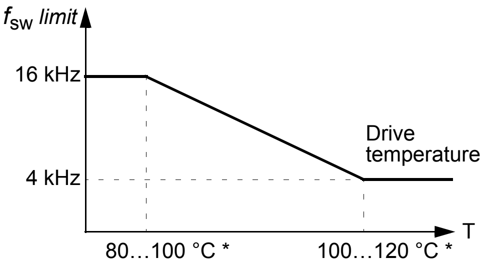
| $P_N$ (kW) | 0.37 | 0.75 | 2.2 | 4.0 | 7.5 |
|---|---|---|---|---|---|
| **200…240** V units | | | | | |
| IR comp (V) | 8.4 | 7.7 | 5.6 | 8.4 | N/A |
| **380…480** V units | | | | | |
| IR comp (V) | 14 | 14 | 5.6 | 8.4 | 7 |




IR compensation

• When enabled, IR compensation provides an extra voltage boost to the motor at low speeds. Use IR compensation, for example, in applications that require a high breakaway torque.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 2604 | **IR COMP FREQ**<br>Sets the frequency at which IR compensation is 0 V (in % of motor frequency). | **0 … 100%** | **1** | **80%** | |
| 2605 | **U/F RATIO**<br>Selects the form for the U/f (voltage to frequency) ratio below field weakening point.<br>1 = LINEAR – Preferred for constant torque applications.<br>2 = SQUARED – Preferred for centrifugal pump and fan applications. (SQUARED is more silent for most operating frequencies.) | **1, 2** | **1** | **2** | |

| Group 26: Motor control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2606 | **SWITCHING FREQ** | **1, 4, 8, 12, 16 kHz** | **-** | **4 kHz** | |
| | Defines the switching frequency of the drive. Higher switching frequency results in lower acoustic noise in the motor. See also parameter *2207 SWITCH FREQ CTRL* and section *Switching frequency derating*, I2N and ILD (= all currents) on page *366*.<br>In multimotor systems, do not change the switching frequency from the default value. | | | | |
| 2607 | **SWITCH FREQ CTRL** | **0, 1** | **-** | **1** | |
| | Activates the switching frequency control. When active, the selection of parameter *2606 SWITCHING FREQ* is limited when the drive internal temperature increases. See the figure below. This function allows the highest possible switching frequency at a specific operation point.<br>Higher switching frequency results in lower acoustic noise in the motor, but higher internal losses.<br><br>* Temperature depends on the drive output frequency.<br>1 = ON – Active.<br>2 = ON (LOAD) – Switching frequency can adapt to loading instead of limiting the output current. This allows maximum loading with all switching frequency selections. The drive automatically decreases the actual switching frequency if loading is too high for the selected switching frequency. | | | | |
| 2608 | **SLIP COMP RATIO** | **0 … 200%** | **1** | **0** | |
| | Defines the slip gain for the motor slip compensation control. 100% means full slip compensation, 0% means no slip compensation. Other values can be used if a static speed error is detected despite the full slip compensation.<br>**Example:** 35 Hz constant speed reference is given to the drive. Despite the full slip compensation (SLIP COMP RATIO = 100%), a manual tachometer measurement from the motor axis gives a speed value of 34 Hz. The static speed error is 35 Hz - 34 Hz = 1 Hz. To compensate the error, the slip gain should be increased.<br>0 = No slip compensation.<br>1…200 = Slip gain. | | | | |

| Group 26: Motor control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2609 | **NOISE SMOOTHING** | **0, 1** | **1** | **0** | |
| | Enables the noise smoothing function. Noise smoothing distributes the acoustic motor noise over a range of frequencies instead of a single tonal frequency resulting in lower peak noise intensity. A random component with an average of 0 Hz is added to the switching frequency set by parameter *2206 SWITCHING FREQ*.<br>**Note:** This parameter has no effect if parameter *2206* = 16kHz.<br>0 = DISABLE<br>1 = ENABLE | | | | |
| 2610 | **USER DEFINED U1** | **0 … 120% of $U_N$ V** | **1 = 1 V** | **19% of $U_N$** | |
| | Defines the first voltage point of the custom U/f curve at the frequency defined by parameter *2611 USER DEFINED F1*. See section *Custom U/f ratio* on page *110*. | | | | |
| 2611 | **USER DEFINED F1** | **0.0 … 500.0 Hz** | **1 = 0.1 Hz** | **10.0 Hz** | |
| | Defines the first frequency point of the custom U/f curve. | | | | |
| 2612 | **USER DEFINED U2** | **0 … 120% of $U_N$ V** | **1 = 1 V** | **38% of $U_N$** | |
| | Defines the second voltage point of the custom U/f curve at the frequency defined by parameter *2613 USER DEFINED F2*. See section *Custom U/f ratio* on page *110*. | | | | |
| 2613 | **USER DEFINED F2** | **0.0 … 500.0 Hz** | **1 = 0.1 Hz** | **20.0 Hz** | |
| | Defines the second frequency point of the custom U/f curve. | | | | |
| 2614 | **USER DEFINED U3** | **0 … 120% of $U_N$ V** | **1 = 1 V** | **47.5% of $U_N$** | |
| | Defines the third voltage point of the custom U/f curve at the frequency defined by parameter *2615 USER DEFINED F3*. See section *Custom U/f ratio* on page *110*. | | | | |
| 2615 | **USER DEFINED F3** | **0.0 … 500.0 Hz** | **1 = 0.1 Hz** | **25.0 Hz** | |
| | Defines the third frequency point of the custom U/f curve. | | | | |
| 2616 | **USER DEFINED U4** | **0 … 120% of $U_N$ V** | **1 = 1 V** | **76% of $U_N$** | |
| | Defines the fourth voltage point of the custom U/f curve at the frequency defined by parameter *2617 USER DEFINED F4*. See section *Custom U/f ratio* on page *110*. | | | | |
| 2617 | **USER DEFINED F4** | **0.0 … 500.0 Hz** | **1 = 0.1 Hz** | **40.0 Hz** | |
| | Defines the fourth frequency point of the custom U/f curve. | | | | |
| 2618 | **FW VOLTAGE** | **0 … 120% of $U_N$ V** | **1 = 1 V** | **95% of $U_N$** | |
| | Defines the voltage of the U/f curve when frequency is equal to or exceeds the motor nominal frequency (*9907 MOTOR NOM FREQ*). See section *Custom U/f ratio* on page *110*. | | | | |
| 2619 | **DC STABILISER** | | | | |
| | Enables or disables the DC voltage stabilizer. The DC stabilizer is used in scalar control mode to prevent possible voltage oscillations in the drive DC bus caused by motor load or weak supply network. In case of voltage variation the drive tunes the frequency reference to stabilize the DC bus voltage and therefore the load torque oscillation.<br>0 = DISABLE – Disables DC stabilizer.<br>1 = ENABLE – Enables DC stabilizer. | | | | |

## Group 29: Maintenance trig

This group contains usage levels and trigger points. When usage reaches the set trigger point, a notice is displayed on the control panel signals that maintenance is due.

| Group 29: Maintenance trig | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2901 | **COOLING FAN TRIG** | **0.0 … 6553.5 kh** | **0.1 kh** | **0.0** | |
| | Defines the trigger point for the drive cooling fan run time counter. Value is compared to parameter *2902 COOLING FAN ACT*.<br>• Time. If parameter value is set to zero, the trigger is disabled.<br>0.0 = NOT SEL | | | | |
| 2902 | **COOLING FAN ACT** | **0.0 … 6553.5 kh** | **0.1 kh** | **0.0** | |
| | Defines the actual value for the cooling fan run time counter. When parameter *2901 COOLING FAN TRIG* has been set to a non zero value, the counter starts. When the actual value of the counter exceeds the value defined by parameter *2901*, a maintenance notice is displayed on the panel.<br>• Time. Parameter is reset by writing 0.0 to it. | | | | |
| 2903 | **REVOLUTION TRIG** | **0 … 65535 MRev** | **1 MRev** | **0** | |
| | Defines the trigger point for the motor revolution counter. Value is compared to parameter *2904 REVOLUTION ACT* value.<br>• Millions of revolutions. If parameter value is set to zero, the trigger is disabled.<br>0.0 = NOT SEL | | | | |
| 2904 | **REVOLUTION ACT** | **0 … 65535 MRev** | **1 MRev** | **0** | |
| | Defines the actual value for the motor revolution counter. When parameter *2903 REVOLUTION TRIG* has been set to a non zero value, the counter starts. When the actual value of the counter exceeds the value defined by parameter *2903*, a maintenance notice is displayed on the panel.<br>• Millions of revolutions. Parameter is reset by setting it to zero. | | | | |
| 2905 | **RUN TIME TRIG** | **0.0 … 6553.5 kh** | **0.1 kh** | **0.0** | |
| | Defines the trigger point for the drive run time counter. Value is compared to the value of parameter *2906 RUN TIME ACT*.<br>• Time. If parameter value is set to zero, the trigger is disabled.<br>0.0 = NOT SEL | | | | |
| 2906 | **RUN TIME ACT** | **0.0 … 6553.5 kh** | **0.1 kh** | **0.0** | |
| | Defines the actual value for the drive run time counter. When parameter *2905 RUN TIME TRIG* has been set to a non zero value, the counter starts. When the actual value of the counter exceeds the value defined by parameter *2905*, a maintenance notice is displayed on the panel.<br>• Time. Parameter is reset by setting it to zero. | | | | |

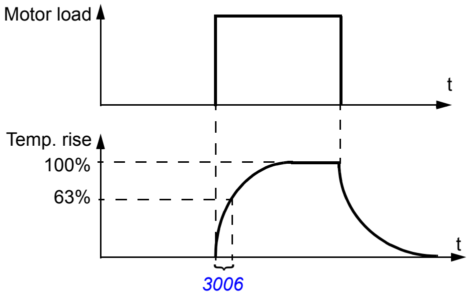
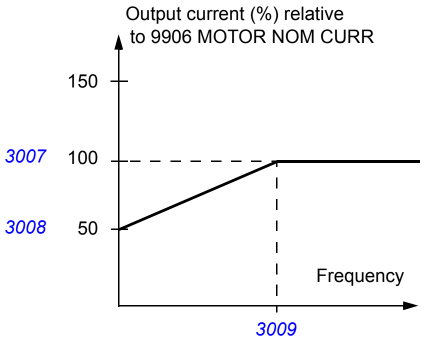
| Group 29: Maintenance trig | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 2907 | **USER MWh TRIG** | **0.0 … 6553.5 MWh** | **0.1 MWh** | **0.0** | |
| | Defines the trigger point for the drive power consumption counter. Value is compared to the value of parameter *2908 USER MWh ACT*.<br>• Megawatt hours. If parameter value is set to zero, the trigger is disabled.<br>0.0 = NOT SEL | | | | |
| 2908 | **USER MWh ACT** | **0.0 … 6553.5 MWh** | **0.1 MWh** | **0.0** | |
| | Defines the actual value of the drive power consumption counter. When parameter *2907 USER MWh TRIG* has been set to a non zero value, the counter starts. When the actual value of the counter exceeds the value defined by parameter *2907*, a maintenance notice is displayed on the panel.<br>• Megawatt hours. Parameter is reset by setting it to zero. | | | | |

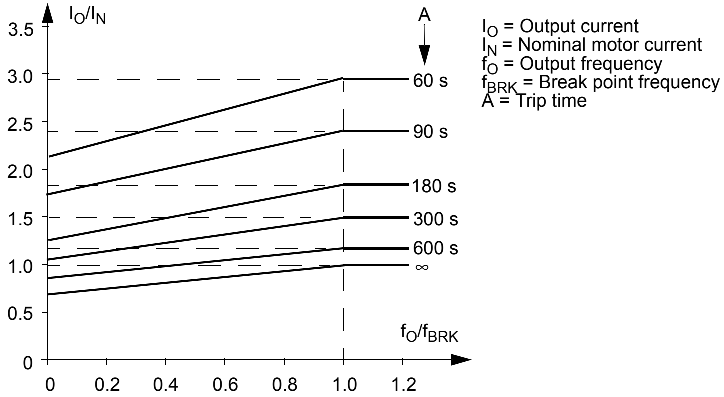
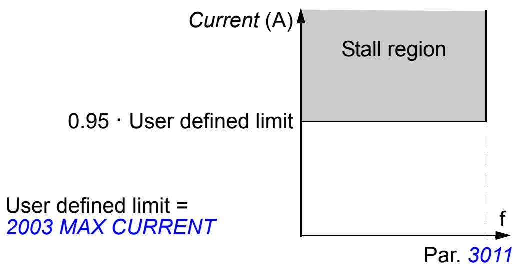
## Group 30: Fault functions

This group defines situations that the drive should recognize as potential faults and defines how the drive should respond if the fault is detected.

| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3001 | **AI<MIN FUNCTION** | **0…3** | **1** | **0** | |
| | Defines the drive response if the analog input (AI) signal drops below the fault limits and is used:<br>• as the active reference source (*Group 11: Reference select*)<br>• as the Process or External PID controllers' feedback or setpoint source (*Group 40: Process PID set 1*, *Group 41: Process PID set 2* or *Group 42: Ext / Trim PID*) and the corresponding PID controller is active.<br>*3021 AI1 FAULT LIMIT* and *3022 AI2 FAULT LIMIT* set the minimum limits.<br>0 = NOT SEL – No response.<br>1 = FAULT – Displays a fault (*0007 AI1 LOSS* or *0008 AI2 LOSS*) and the drive coasts to a stop.<br>2 = CONST SP 7 – Displays a warning (*2006 AI1 LOSS* or *2007 AI2 LOSS*) and sets speed using *1208 CONST SPEED 7*.<br>3 = LAST SPEED – Displays a warning (*2006 AI1 LOSS* or *2007 AI2 LOSS*) and sets speed using the last operating level. This value is the average speed over the last 10 seconds.<br>**WARNING!** If you select CONST SP7 or LAST SPEED, make sure that continued operation is safe when the analog input signal is lost. | | | | |

| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3002 | **PANEL COMM ERR**<br>Defines the drive response to a control panel communication error.<br>**Note:** When either of the two external control locations are active, and start, stop and/or direction are through the control panel – *1001 EXT1 COMMANDS* / *1002 EXT2 COMMANDS* = 8 (KEYPAD) – the drive follows the speed reference according to the configuration of the external control locations, instead of the value of the last speed or parameter *1208 CONST SPEED 7*.<br>1 = FAULT – Displays a fault (10, PANEL LOSS) and the drive coasts to stop.<br>2 = CONST SP 7 – Displays a warning *2008 PANEL LOSS* and sets speed using *1208 CONST SPEED 7*.<br>3 = LAST SPEED – Displays a warning *2008 PANEL LOSS* and sets speed using the last operating level. This value is the average speed over the last 10 seconds.<br>**WARNING!** If you select CONST SP7 or LAST SPEED, make sure that continued operation is safe when the control panel communication is lost. | **1…3** | **1** | **1** | |
| 3003 | **EXTERNAL FAULT 1**<br>Defines the External Fault 1 signal input and the drive response to an external fault.<br>0 = NOT SEL – External fault signal is not used.<br>1 = DI1 – Defines digital input 1 as the external fault input.<br>• Activating the digital input indicates a fault. The drive displays fault *0014 EXT FAULT 1* and the drive coasts to stop.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the external fault input.<br>• See DI1 above.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as the external fault input.<br>• De-activating the digital input indicates a fault. The drive displays fault *0014 EXT FAULT 1* and the drive coasts to stop.<br>-2…-5 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI5 as the external fault input.<br>• See DI1(INV) above. | **-6…6** | **1** | **0** | |
| 3004 | **EXTERNAL FAULT 2**<br>Defines the External fault 2 signal input and the drive response to an external fault.<br>• See parameter *3003 EXTERNAL FAULT 1* above. | **-6…6** | **1** | **0** | |
| 3005 | **MOT THERM PROT**<br>Defines the drive response to motor overheating.<br>0 = NOT SEL – No response and/or motor thermal protection not set up.<br>1 = FAULT – When the calculated motor temperature exceeds 90 °C (194 °F), displays alarm *2010 MOTOR TEMP*. When the calculated motor temperature exceeds 110 °C (230 °F) displays fault *0009 MOT OVERTEMP* and the drive coasts to stop.<br>**Note:** Because the motor thermal protection has memory retention, do not shut down the drive when fault *0009 MOT OVERTEMP* occurs. If you shut down the drive, the drive does not reset the fault. The drive resets the fault as soon as the motor temperature has lowered enough.<br>2 = ALARM – When the calculated motor temperature exceeds 90 °C (194 °F), displays alarm *2010 MOTOR TEMP*. | **0, 2** | **1** | **1** | |

| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3006 | **MOT THERM TIME** | **256 … 9999 s** | **1** | **1050 s** | |
| | Sets the motor thermal time constant for the motor temperature model.<br>• This is the time required for the motor to reach 63% of the final temperature with steady load.<br>• For thermal protection according to UL requirements for NEMA class motors, use the rule of thumb: MOTOR THERM TIME equals 35 times t6, where t6 (in seconds) is specified by the motor manufacturer as the time that the motor can safely operate at six times its rated current.<br>• The thermal time for a Class 10 trip curve is 350 s, for a Class 20 trip curve 700 s, and for a Class 30 trip curve 1050 s.<br> | | | | |
| 3007 | **MOT LOAD CURVE** | **50 … 150%** | **1** | **100%** | |
| | Sets the maximum allowable operating load of the motor.<br>• With the default value 100%, motor overload protection is functioning when the constant current exceeds 127% of the parameter *9906 MOTOR NOM CURR* value.<br>• The default overloadability is at the same level as what motor manufacturer's typically allow in the 30 °C (86 °F) ambient temperature and 1000m (3300 ft) altitude. When the ambient temperature exceeds 30 °C (86 °F) or the installation altitude is over 1000m (3300 ft), decrease the parameter 3007 value according to the motor manufacturer's recommendation.<br><br>**Example:** If the constant protection level needs to be 115% of the motor nominal current, set parameter *3007 MOT LOAD CURVE* value to 91% (=115/127*100%). | | | | |
| 3008 | **ZERO SPEED LOAD** | **25 … 150%** | **1** | **70%** | |
| | Defines the load curve together with parameters *3007 MOT LOAD CURVE* and *3009 BREAK POINT FREQ*.<br>25%…150% = Allowed continuous motor load at zero speed in percent of the nominal motor current. | | | | |

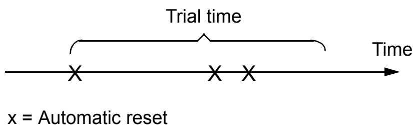
| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3009 | **BREAK POINT FREQ**<br>Defines the load curve together with parameters *3007 MOT LOAD CURVE* and *3009 BREAK POINT FREQ*.<br>**Example:** Thermal protection trip times when parameters *3006 MOT THERM TIME*, *3007 MOT LOAD CURVE* and *3008 ZERO SPEED LOAD* have default values.<br> | **1 … 250 Hz** | **1** | **35 Hz** | |
| 3010 | **STALL FUNCTION**<br>Selects how the drive reacts to a motor stall condition. The protection wakes up if the drive has operated in a stall region (see the figure below) longer than the time set by parameter *3012 STALL TIME*.<br><br>0 = NOT SEL – Protection is inactive.<br>1 = FAULT – Drive trips on fault *0012 MOTOR STALL* and the motor coasts to stop.<br>2 = ALARM – Drive generates alarm *2012 MOTOR STALL*. | **0…2** | **1** | **35 Hz** | |
| 3011 | **STALL FREQUENCY**<br>This parameter sets the frequency value for the Stall function. Refer to the figure above. | **0.5 … 50.0 Hz** | **0.1 Hz** | **20.0 Hz** | |
| 3012 | **STALL TIME**<br>This parameter sets the time value for the Stall function. | **10 … 400 s** | **1 s** | **20 s** | |

| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3016 | **SUPPLY PHASE**<br>Selects how the drive reacts to a supply phase loss, in other words, when the DC voltage ripple is excessive.<br>0 = FAULT – Drive trips on fault *SUPPLY PHASE* and the motor coasts to stop when the DC voltage ripple exceeds 14% of the nominal DC voltage.<br>1 = LIMIT/ALARM – Drive output current is limited and alarm *INPUT PHASE LOSS* is generated when the DC voltage ripple exceeds 14% of the nominal DC voltage. There is a 10 s delay between the activation of the alarm and the output current limitation. The current is limited until the DC voltage ripple drops under the ripple limit.<br>2 = ALARM – Drive generates alarm *INPUT PHASE LOSS* when the DC ripple exceeds 14% of the nominal DC voltage. | | | | |
| 3017 | **EARTH FAULT**<br>Defines the drive response if the drive detects a ground fault in the motor or motor cables. The drive monitors for ground faults while the drive is running, and while the drive is not running. Also see parameter *3023 WIRING FAULT*.<br>0 = DISABLE – No drive response to ground faults.<br>1 = ENABLE – Ground faults display fault *0016 EARTH FAULT*, and (if running) the drive coasts to stop. | **0…1** | **1** | **1** | |
| 3018 | **COMM FAULT FUNC**<br>Defines the drive response if the fieldbus communication is lost. The time delay is defined by parameter *3019 COMM FAULT TIME*.<br>0 = NOT SEL – No response.<br>1 = FAULT – Displays fault *0028 SERIAL 1 ERR* and the drive coasts to stop.<br>2 = CONST SP 7 – Displays warning *2005 IO COMM* and sets speed using parameter *1208 CONST SPEED 7*. This “alarm speed” remains active until the fieldbus writes a new reference value.<br>3 = LAST SPEED – Displays warning *2005 IO COMM* and sets speed using the last operating level. This value is the average speed over the last 10 seconds. This “alarm speed” remains active until the fieldbus writes a new reference value.<br>⚠ **WARNING!** If you select CONST SP7, or LAST SPEED, make sure that continued operation is safe when fieldbus communication is lost. | **0…3** | **1** | **0** | |
| 3019 | **COMM FAULT TIME**<br>Sets the communication fault time used with parameter *3018 COMM FAULT FUNC*.<br>• Brief interruptions in the fieldbus communication are not treated as faults if they are less than the COMM FAULT TIME value. | **0.0 … 600.0 s** | **0.1 s** | **10.0 s** | |
| 3021 | **AI1 FAULT LIMIT**<br>Sets a fault level for analog input 1. See parameter *3001 AI<MIN FUNCTION*.<br>Do not set this limit below the level defined by parameter *1301 MINIMUM AI1*.<br>• Value in percent of the full signal range. | **0.0 … 100.0%** | **0.1%** | **0.0%** | |
| 3022 | **AI2 FAULT LIMIT**<br>Sets a fault level for analog input 2. See parameter *3001 AI<MIN FUNCTION*.<br>Do not set this limit below the level defined by parameter *1304 MINIMUM AI2*.<br>• Value in percent of the full signal range. | **0.0 … 100.0%** | **0.1%** | **0.0%** | |

| Group 30: Fault functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3023 | **WIRING FAULT** | **0, 1** | **1** | **1** | |
| | Selects how the drive reacts when incorrect input power and motor cable connection is detected (ie, the input power cable is connected to the motor connection of the drive).<br>0 = DISABLE – No action.<br>1 = ENABLE – The drive trips on fault *0035 OUTP WIRING*. | | | | |

## Group 31: Automatic reset

This group defines conditions for automatic resets. An automatic reset occurs after a particular fault is detected. The drive holds for a set delay time, then automatically restarts. You can limit the number of resets in a specified time period, and you can set up automatic resets for a variety of faults.

| Group 31: Automatic reset | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3101 | **NUMBER OF TRIALS** | **0…5** | **1** | **5** | |
| | Sets the number of allowed automatic resets within a trial period defined by parameter *3102 TRIAL TIME*.<br>• If the number of automatic resets exceeds this limit (within the trial time), the drive prevents additional automatic resets and remains stopped.<br><br>• Starting then requires a successful reset performed from the control panel or from a source selected by parameter *1604 FAULT RESET SEL*.<br>**Example:** Three faults have occurred in the trial time. The last is reset only if the value for parameter *3101 NUMBER OF TRIALS* is 3 or more. | | | | |
| 3102 | **TRIAL TIME** | **1.0 … 600.0 s** | **0.1 s** | **30.0 s** | |
| | Sets the time period used for counting and limiting the number of resets.<br>• See parameter *3101 NUMBER OF TRIALS*. | | | | |
| 3103 | **DELAY TIME** | **0.0 … 120.0 s** | **0.1 s** | **0.5 s** | |
| | Sets the delay time between a fault detection and attempted drive restart.<br>• If DELAY TIME = zero, the drive resets immediately. | | | | |
| 3104 | **AR OVERCURRENT** | **0, 1** | **1** | **0** | |
| | Sets the automatic reset for the overcurrent function on or off.<br>0 = DISABLE – Disables automatic reset.<br>1 = ENABLE – Enables automatic reset.<br>• Automatically resets fault *0001 OVERCURRENT* after the delay set by parameter *3103 DELAY TIME*, and the drive resumes normal operation. | | | | |

| Group 31: Automatic reset | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3105 | **AR OVERVOLTAGE**<br>Sets the automatic reset for the intermediate link overvoltage function on or off.<br>0 = DISABLE – Disables automatic reset.<br>1 = ENABLE – Enables automatic reset.<br>• Automatically resets fault *0002 DC OVERVOLT* after the delay set by parameter *3103 DELAY TIME*, and the drive resumes normal operation. | **0, 1** | **1** | **1** | |
| 3106 | **AR UNDERVOLTAGE**<br>Sets the automatic reset for the intermediate link undervoltage function on or off.<br>0 = DISABLE – Disables automatic reset.<br>1 = ENABLE – Enables automatic reset.<br>• Automatically resets the fault *0006 DC UNDERVOLT* after the delay set by parameter *3103 DELAY TIME*, and the drive resumes normal operation. | **0, 1** | **1** | **1** | |
| 3107 | **AR AI<MIN**<br>Sets the automatic reset for the analog input less than minimum value function on or off.<br>0 = DISABLE – Disables automatic reset.<br>1 = ENABLE – Enables automatic reset.<br>• Automatically resets fault faults *0007 AI1 LOSS* and *0008 AI2 LOSS* after the delay set by parameter *3103 DELAY TIME*, and the drive resumes normal operation.<br>**WARNING!** When the analog input signal is restored, the drive may restart, even after a long stop. Make sure that automatic, long delayed starts will not cause physical injury and/or damage equipment. | **0, 1** | **1** | **1** | |
| 3108 | **AR EXTERNAL FLT**<br>Sets the automatic reset for external faults function on or off.<br>0 = DISABLE – Disables automatic reset.<br>1 = ENABLE – Enables automatic reset.<br>• Automatically resets the fault (*0014 EXT FAULT 1* or *0015 EXT FAULT 2*) after the delay set by parameter *3103 DELAY TIME*, and the drive resumes normal operation. | **0, 1** | **1** | **1** | |

## Group 32: Supervision

This group defines supervision for up to three signals from *Group 01: Operating data*. Supervision monitors a specified parameter and energizes a relay output if the parameter passes a defined limit. Use *Group 14: Relay outputs*, to define the relay and whether the relay activates when the signal is too low or too high.

| Group 32: Supervision | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3201 | **SUPERV 1 PARAM** | **101…199** | **1** | **103** | |

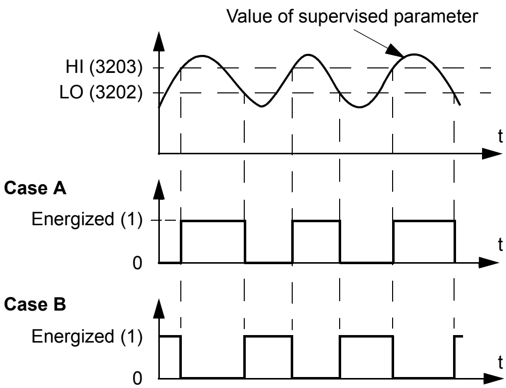
Selects the first supervised parameter.

- Must be a parameter number from *Group 01: Operating data*.
- If the supervised parameter passes a limit, a relay output is energized.
- The supervision limits are defined in this group.
- The relay outputs are defined in *Group 14: Relay outputs* (definition also specifies which supervision limit is monitored).

**LO ≤ HI**

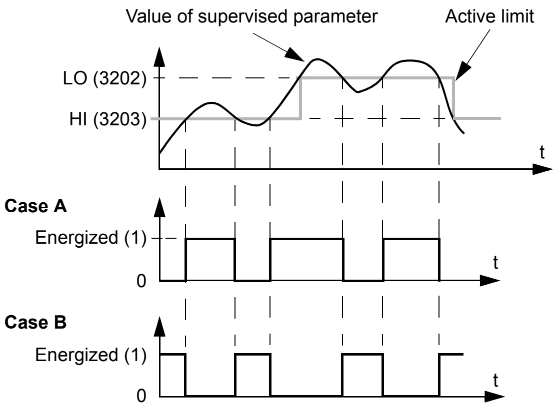
Operating data supervision using relay outputs, when LO ≤ HI.

- Case A = Parameter *1401 RELAY OUTPUT 1* (or *1402 RELAY OUTPUT 2*, etc.) value is SUPRV1 OVER or SUPRV 2 OVER. Use for monitoring when/if the supervised signal exceeds a given limit. The relay remains active until the supervised value drops below the low limit.




- Case B = Parameter *1401 RELAY OUTPUT 1* (or *1402 RELAY OUTPUT 2*, etc.) value is SUPRV 1 UNDER or SUPRV 2 UNDER. Use for monitoring when/if the supervised signal falls below a given limit. The relay remains active until the supervised value rises above the high limit.

**Note:** Case LO ≤ HI represents a normal hysteresis.

| Group 32: Supervision | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | **LO > HI**<br>Operating data supervision using relay outputs, when LO > HI.<br>The lowest limit (HI *3203*) is active initially, and remains active until the supervised parameter goes above the highest limit (LO *3202*), making that limit the active limit. That limit remains active until the supervised parameter goes below the lowest limit (HI *3203*), making that limit active.<br><br>• Case A = Parameter *1401 RELAY OUTPUT 1* (or *1402 RELAY OUTPUT 2*, etc.) value is SUPRV1 OVER or SUPRV2 OVER. Initially the relay is de-energized. It is energized whenever the supervised parameter goes above the active limit.<br>• Case B = Parameter *1401 RELAY OUTPUT 1* (or *1402 RELAY OUTPUT 2*, etc.) value is SUPRV1 UNDER or SUPRV2 UNDER. Initially the relay is energized. It is de-energized whenever the supervised parameter goes below the active limit.<br>**Note:** Case LO > HI represents a special hysteresis with two separate supervision limits. | | | | |
| 3202 | **SUPERV 1 LIM LO**<br>Sets the low limit for the first supervised parameter. See parameter *3201 SUPERV 1 PARAM* above. Supervision wakes up if the value is below the limit. | **Depends on selection** | **-** | **60.0 Hz** | |
| 3203 | **SUPERV 1 LIM HI**<br>Sets the high limit for the first supervised parameter. See parameter *3201 SUPERV 1 PARAM* above. Supervision wakes up if the value is above the limit. | **Depends on selection** | **-** | **60.0 Hz** | |
| 3204 | **SUPERV 2 PARAM**<br>Selects the second supervised parameter. See parameter *3201 SUPERV 1 PARAM* above. | **101…199** | **1** | **104** | |
| 3205 | **SUPERV 2 LIM LO**<br>Sets the low limit for the second supervised parameter. See parameter *3204 SUPERV 2 PARAM* above. Supervision wakes up if the value is below the limit. | **Depends on selection** | | **4.5 A** | |
| 3206 | **SUPERV 2 LIM HI**<br>Sets the high limit for the second supervised parameter. See parameter *3204 SUPERV 2 PARAM* above. Supervision wakes up if the value is above the limit. | **Depends on selection** | | **4.5 A** | |
| 3207 | **SUPERV 3 PARAM**<br>Selects the third supervised parameter. See parameter *3201 SUPERV 1 PARAM* above. | **101…199** | **1** | **105** | |

| Group 32: Supervision | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3208 | **SUPERV 3 LIM LO** | **Depends on selection** | | **100.0%** | |
| | Sets the low limit for the third supervised parameter. See parameter *3207 SUPERV 3 PARAM* above. Supervision wakes up if the value is below the limit. | | | | |
| 3209 | **SUPERV 3 LIM HI** | **Depends on selection** | | **100.0%** | |
| | Sets the high limit for the third supervised parameter. See parameter *3207 SUPERV 3 PARAM* above. Supervision wakes up if the value is above the limit. | | | | |

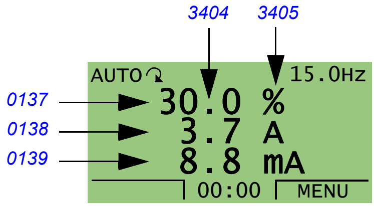
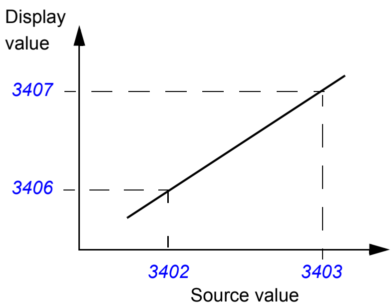
## Group 33: Information

This group provides access to information about the drive's current programs: versions and test date.

| Group 33: Information | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3301 | **FIRMWARE** | **10000…FFFF hex** | **1** | **Firmware ver.** | |
| | Contains the version of the drive's firmware. | | | | |
| 3302 | **LOADING PACKAGE** | **0000…FFFF hex** | **1** | **0** | |
| | Contains the version of the loading package. | | | | |
| 3303 | **TEST DATE** | **yy.ww** | **1** | **0** | |
| | Contains the test date (yy.ww). | | | | |
| 3304 | **DRIVE RATING** | **-** | **-** | **-** | |
| | Indicates the drive's current and voltage rating. The format is XXXY hex, where:<br>• XXX =The nominal current rating of the drive in amps. If present, an "A" indicates a decimal point in the rating for the current. For example XXX = 9A8 indicates a nominal current rating of 9.8 amperes.<br>• Y = The voltage rating of the drive, where Y = :<br>  • 2 indicates a 200…240 Volt rating.<br>  • 4 indicates a 380…480 Volt rating.<br>  • 6 indicates a 500…600 Volt rating. | | | | |
| 3305 | **PARAMETER TABLE** | **0000…FFFF hex** | | | |
| | Contains the parameter table version of the drive's firmware. | | | | |

## Group 34: Panel display

This group defines the content for control panel display (middle area), when the control panel is in the Output mode.

| Group 34: Panel display | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3401 | **SIGNAL1 PARAM** | **100…178** | **1** | **103** | |
| | Selects the first parameter (by number) displayed on the control panel.<br>• Definitions in this group define display content when the control panel is in the Output mode.<br>• Any *Group 01: Operating data* parameter number can be selected.<br>• Using the following parameters, the display value can be scaled, converted to convenient units, and/or displayed as a bar graph.<br>• The figure identifies selections made by parameters in this group.<br><br>100 = not selected – First parameter not displayed.<br>101…199 = Displays parameter 0101…0199. If parameter does not exist, the display shows “n.a.”. | | | | |
| 3402 | **SIGNAL1 MIN** | **Depends on selection** | | **0.0 Hz** | |
| | Defines the minimum expected value for the first display parameter.<br>Use parameters 3402, *3403*, *3406*, and *3407*, for example to convert a Group 01 parameter, such as *0102 SPEED* (in rpm) to the speed of a conveyor driven by the motor (in ft/min). For such a conversion, the source values in the figure are the min. and max. motor speed, and the display values are the corresponding min. and max. conveyor speed. Use parameter *3405* to select the proper units for the display.<br><br>**Note:** Selecting units does not convert values. | | | | |
| 3403 | **SIGNAL1 MAX** | **Depends on selection** | **-** | **600.0 Hz** | |
| | Defines the maximum expected value for the first display parameter.<br>**Note:** Parameter is not effective if parameter *3404 OUTPUT1 DSP FORM* = 9 (DIRECT). | | | | |

## Group 34: Panel display

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 3404 | **OUTPUT1 DSP FORM** | **0…9** | **1** | **9** | |

Defines the decimal point location for the first display parameter.

1…7 – Defines the decimal point location.
- Enter the number of digits desired to the right of the decimal point.
- See table for example using pi (3.14159).

8 = BAR METER – Specifies a bar meter display.

9 = DIRECT – Decimal point location and units of measure are identical to the source signal. See *Group 01: Operating data* parameter listing for resolution (which indicates the decimal point location) and the units of measure.

| 3404 value | Display | Range |
|---|---|---|
| 0 | ± 3 | -32768…+32767 (Signed) |
| 1 | ± 3.1 | |
| 2 | ± 3.14 | |
| 3 | ± 3.142 | |
| 4 | 3 | 0…65535 (Unsigned) |
| 5 | 3.1 | |
| 6 | 3.14 | |
| 7 | 3.142 | |

**Note:** Parameters *3402*, *3403* and *3405…3407* are not effective.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 3405 | **OUTPUT1 UNIT** | **0…127** | **1** | **4** | |

Selects the units used with the first display parameter.

**Note:** Parameter is not effective if parameter *3404 OUTPUT1 DSP FORM* = 9 (DIRECT).

| | | | | | |
|---|---|---|---|---|---|
| 0 = NOT SEL | 12 = mV | 24 = GPM | 36 = l/s | 48 = gal/m | 60 = ft wg |
| 1 = A | 13 = kW | 25 = PSI | 37 = l/min | 49 = gal/h | 61 = lbsi |
| 2 = V | 14 = W | 26 = CFM | 38 = l/h | 50 = $ft^3$/s | 62 = ms |
| 3 = Hz | 15 = kWh | 27 = ft | 39 = $m^3$/s | 51 = $ft^3$/m | 63 = Mrev |
| 4 = % | 16 = °F | 28 = MGD | 40 = $m^3$/m | 52 = $ft^3$/h | 64 = d |
| 5 = s | 17 = hp | 29 = inHg | 41 = kg/s | 53 = lb/s | 65 = inWC |
| 6 = h | 18 = MWh | 30 = FPM | 42 = kg/m | 54 = lb/m | 66 = m/min |
| 7 = rpm | 19 = m/s | 31 = kb/s | 43 = kg/h | 55 = lb/h | 67 = Nm |
| 8 = kh | 20 = $m^3$/h | 32 = kHz | 44 = mbar | 56 = FPS | 68 = $Km^3$/h |
| 9 = °C | 21 = $dm^3$/s | 33 = Ohm | 45 = Pa | 57 = ft/s | |
| 10 = lb ft | 22 = bar | 34 = ppm | 46 = GPS | 58 = $inH_2O$ | |
| 11 = mA | 23 = kPa | 35 = pps | 47 = gal/s | 59 = in wg | |
| 117 = %ref | 119 = %dev | 121 = % SP | 123 = Iout | 125 = Fout | 127 = Vdc |
| 118 = %act | 120 = % LD | 122 = %FBK | 124 = Vout | 126 = Tout | |

The following units are useful for the bar display:

117 = %ref, 118 = %ac, 119 = %dev, 120 = % LD, 121 =% SP, 122 = %FBK, 123 = Iout, 124 = Vout, 125 = Fout, 126 = Tout, 127 = Vdc.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 3406 | **OUTPUT1 MIN** | **Depends on selection** | **1** | **-** | |

Sets the minimum value displayed for the first display parameter.

**Note:** Parameter is not effective if parameter *3404 OUTPUT1 DSP FORM* = 9 (DIRECT).

| Group 34: Panel display | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3407 | **OUTPUT1 MAX** | **Depends on selection** | **1** | **-** | |
| | Sets the maximum value displayed for the first display parameter.<br>**Note:** Parameter is not effective if parameter *3404 OUTPUT1 DSP FORM* = 9 (DIRECT). | | | | |
| 3408 | **SIGNAL2 PARAM** | **100…178** | **1** | **104** | |
| | Selects the second parameter (by number) displayed on the control panel. See parameter *3401 SIGNAL1 PARAM*. | | | | |
| 3409 | **SIGNAL2 MIN** | **Depends on selection** | **1** | **-** | |
| | Defines the minimum expected value for the second display parameter. See parameter *3402 SIGNAL1 MIN*. | | | | |
| 3410 | **SIGNAL2 MAX** | **Depends on selection** | **1** | **-** | |
| | Defines the maximum expected value for the second display parameter. See parameter *3403 SIGNAL1 MAX*. | | | | |
| 3411 | **OUTPUT2 DSP FORM** | **0…9** | **1** | **-** | |
| | Defines the decimal point location for the second display parameter. See parameter *3404 OUTPUT1 DSP FORM*. | | | | |
| 3412 | **OUTPUT2 UNIT** | **0…127** | **1** | **1** | |
| | Selects the units used with the second display parameter. See parameter *3405 OUTPUT1 UNIT*. | | | | |
| 3413 | **OUTPUT2 MIN** | **Depends on selection** | **1** | **-** | |
| | Sets the minimum value displayed for the second display parameter. See parameter *3406 OUTPUT1 MIN*. | | | | |
| 3414 | **OUTPUT2 MAX** | **Depends on selection** | **1** | **-** | |
| | Sets the maximum value displayed for the second display parameter. See parameter *3407 OUTPUT1 MAX*. | | | | |
| 3415 | **SIGNAL3 PARAM** | **100…178** | **1** | **120** | |
| | Selects the third parameter (by number) displayed on the control panel. See parameter *3401 SIGNAL1 PARAM*. | | | | |
| 3416 | **SIGNAL3 MIN** | **Depends on selection** | **1** | **-** | |
| | Defines the minimum expected value for the third display parameter. See parameter *3402 SIGNAL1 MIN*. | | | | |
| 3417 | **SIGNAL3 MAX** | **Depends on selection** | **1** | **-** | |
| | Defines the maximum expected value for the third display parameter. See parameter *3403 SIGNAL1 MAX*. | | | | |
| 3418 | **OUTPUT 3 DSP FORM** | **0…9** | **1** | **1** | |
| | Defines the decimal point location for the third display parameter. See parameter *3404 OUTPUT1 DSP FORM*. | | | | |

| Group 34: Panel display | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3419 | **OUTPUT3 UNIT** | **-128…127** | **1** | **11** | |
| | Selects the units used with the third display parameter. See parameter *3405 OUTPUT1 UNIT*. | | | | |
| 3420 | **OUTPUT3 MIN** | **Depends on selection** | **1** | **-** | |
| | Sets the minimum value displayed for the third display parameter. See parameter *3406 OUTPUT1 MIN*. | | | | |
| 3421 | **OUTPUT3 MAX** | **Depends on selection** | **1** | **-** | |
| | Sets the maximum value displayed for the third display parameter. See parameter *3407 OUTPUT1 MAX*. | | | | |

## Group 35: Motor temp meas

| Group 35: Motor temp meas | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3501 | **SENSOR TYPE** | **0…6** | **1** | **0** | |

Activates the motor temperature measurement function and selects the sensor type. See also parameter *Group 15: Analogue outputs*.

0 = NONE – Function is inactive.

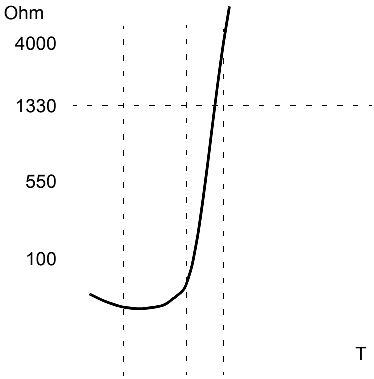
1 = 1 x PT100 – Function is active. The temperature is measured with one Pt100 sensor. Analog output AO feeds constant current through the sensor. The sensor resistance increases as the motor temperature rises, as does the voltage over the sensor. The temperature measurement function reads the voltage through analog input AI1/2 and converts it to degrees centigrade.

2 = 2 x PT100 – Function is active. The temperature is measured using two Pt100 sensors. See selection 1 x PT100 above.

3 = 3 x PT100 – Function is active. The temperature is measured using three Pt100 sensors. See selection 1 x PT100 above.

4 = PTC – Function is active. The temperature is supervised using one PTC sensor. Analog output AO feeds constant current through the sensor. The resistance of the sensor increases sharply as the motor temperature rises over the PTC reference temperature (Tref), as does the voltage over the resistor. The temperature measurement function reads the voltage through analog input AI1/2 and converts it into ohms. The figure on the right-hand side shows typical PTC sensor resistance values as a function of the motor operating temperature.

| Temperature | Resistance |
|---|---|
| Normal | 0 … 1.5 kohm |
| Excessive | ≥ 4 kohm |




5 = THERM (0) – Function is active. The motor temperature is monitored using a PTC sensor (see selection PTC) connected to a drive through a normally closed thermistor relay connected to a digital input. 0 = motor overtemperature.

6 = THERM (1) – Function is active. The motor temperature is monitored using a PTC sensor (see selection PTC) connected to a drive through a normally open thermistor relay connected to a digital input. 1 = motor overtemperature.

See the figures in section *Motor temperature measurement through the standard I/O*.

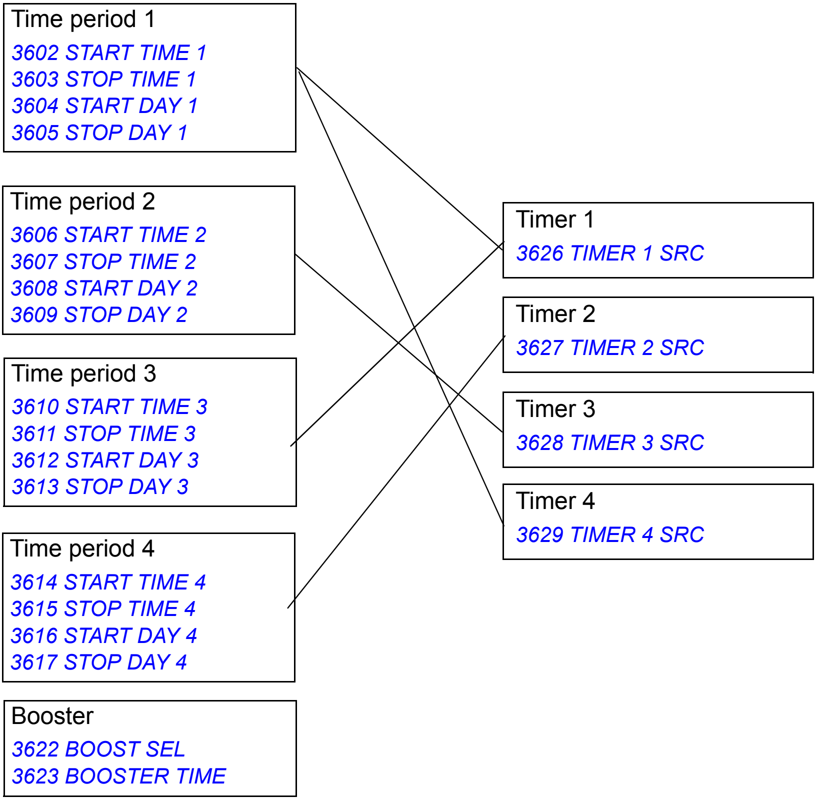
| Group 35: Motor temp meas | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3502 | **INPUT SELECTION** | **1…7** | **1** | **1** | |
| | Selects the source for the motor temperature measurement signal.<br>1 = AI1 – Analog input AI1. Used when Pt100 or PTC sensor is selected for the temperature measurement.<br>2 = AI2 – Analog input AI2. Used when Pt100 or PTC sensor is selected for the temperature measurement.<br>3 = DI1 – Digital input DI1. Used when the value of parameter *3501 SENSOR TYPE* is set to THERM(0)/THERM(1).<br>4 = DI2 – Digital input DI2. Used when parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1).<br>5 = DI3 – Digital input DI3. Used when parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1).<br>6 = DI4 – Digital input DI4. Used when parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1).<br>7 = DI5 – Digital input DI5. Used when parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1). | | | | |
| 3503 | **ALARM LIMIT** | **x…x** | **1** | **0** | |
| | Defines the alarm limit for motor temperature measurement. Alarm *2010 MOTOR TEMP* indication is given when the limit is exceeded. When parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1): 1 = alarm. | | | | |
| 3504 | **FAULT LIMIT** | **x…x** | **1** | **0** | |
| | Defines the fault trip limit for motor temperature measurement. The drive trips on fault *0009 MOT OVERTEMP* when the limit is exceeded. When parameter *3501 SENSOR TYPE* value is set to THERM(0)/THERM(1): 1 = fault. | | | | |
| 3505 | **AO EXCITATION** | | | **0** | |
| | Enables current feed from analog output AO. The parameter setting overrides the settings in *Group 15: Analogue outputs*.<br>• With PTC the output current is 1.6 mA.<br>• With Pt 100 the output current is 9.1 mA.<br>0 = DISABLE<br>1 = ENABLE | | | | |

## Group 36: Timed functions

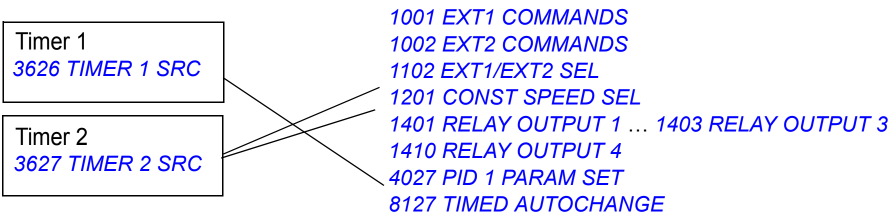
This group defines the timed functions. The timed functions include:

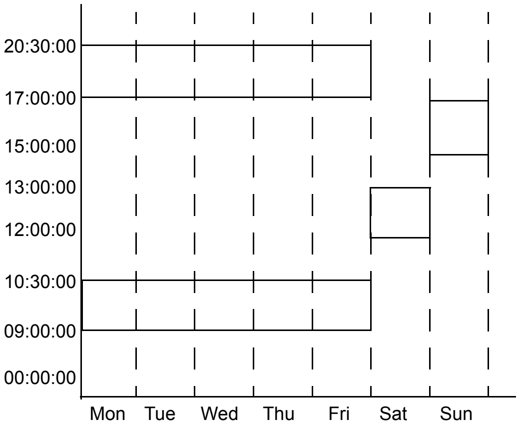
- four daily start and stop times
- four weekly start, stop and boost times
- four timers for collecting selected periods together.

A timer can be connected to multiple time periods and a time period can be in multiple timers.

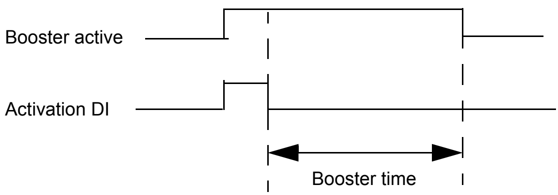



A parameter can be connected to only one timer.



| Group 36: Timed functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3601 | **TIMERS ENABLE** | **-6…7** | **1** | **0** | |
| | Selects the source for the timer enable signal.<br>0 = NOT SEL – Timed functions are disabled.<br>1 = DI1 – Defines digital input DI1 as the timed function enable signal.<br>• The digital input must be activated for timed functions enable.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the timed function enable signal.<br>7 = ACTIVE – Timed functions are enabled.<br>11…15 = DI1 CMODE…DI5 CMODE – Timed function enabled on the rising edge of DI1. Timed function is in a continuous mode, in which the start date can be different from the stop date.<br>17 = CONT MODE – Timed function enabled in a continuous mode, in which the start date can be different from the stop date.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the timed function enable signal.<br>• This digital input must be de-activated for timed function enable.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the timed function enable signal.<br>-11…-15 = DI1(INV) CM…DI5(INV) CM – Timed function enabled on the falling edge of DI1. Timed function is in a continuous mode, in which the start date can be different from the stop date. | | | | |
| 3602 | **START TIME 1** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines the daily start time.<br>• The time can be changed in steps of 2 seconds.<br>• If parameter value is 07:00:00, then the period will be activated at 7 a.m.<br>• The figure shows multiple periods on different weekdays.<br>When editing parameters to set times:<br>• Use arrow keys to select desired hour setting.<br>• Press NEXT to advance to minutes.<br>• Use arrow keys to select desired minutes setting.<br>• Press NEXT to advance to minutes.<br>• Use arrow keys to select desired seconds setting.<br>• Press SAVE.<br><br> | | | | |
| 3603 | **STOP TIME 1** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines the daily stop time.<br>• The time can be changed in steps of 2 seconds.<br>• If the parameter value is 09:00:00, then the period will be deactivated at 9 a.m. | | | | |

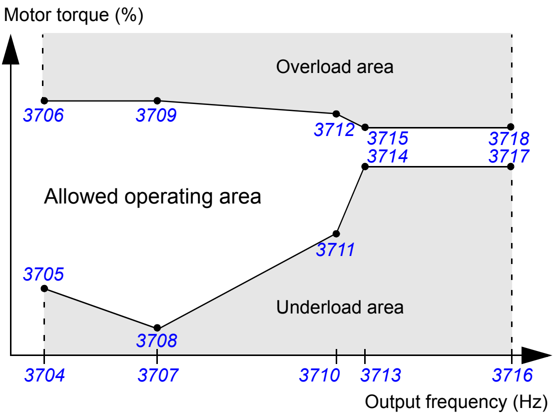
| Group 36: Timed functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3604 | **START DAY 1** | **1…7** | **1** | **1** | |
| | Defines the weekly start day.<br>1 = MONDAY…7 = SUNDAY.<br>• If parameter value is 1, then period 1 weekly is active from Monday midnight (00:00:00). | | | | |
| 3605 | **STOP DAY 1** | **1…7** | **1** | **1** | |
| | Defines weekly stop day.<br>1 = MONDAY…7 = SUNDAY.<br>• If parameter value is 5, then timer 1 weekly will be deactivated on Friday midnight (23:59:58). | | | | |
| 3606 | **START TIME 2** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 2 daily start time.<br>• See parameter *3602 START TIME 1*. | | | | |
| 3607 | **STOP TIME 2** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 2 daily stop time.<br>• See parameter *3603 STOP TIME 1*. | | | | |
| 3608 | **START DAY 2** | **1…7** | **1** | **1** | |
| | Defines timer 2 weekly start day.<br>• See parameter *3604 START DAY 1*. | | | | |
| 3609 | **STOP DAY 2** | **1…7** | **1** | **1** | |
| | Defines timer 2 weekly stop day.<br>• See parameter *3605 STOP DAY 1*. | | | | |
| 3610 | **START TIME 3** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 3 daily start time.<br>• See parameter *3602 START TIME 1*. | | | | |
| 3611 | **STOP TIME 3** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 3 daily stop time.<br>• See parameter *3603 STOP TIME 1*. | | | | |
| 3612 | **START DAY 3** | **1…7** | **1** | **1** | |
| | Defines timer 3 weekly start day.<br>• See parameter *3604 START DAY 1*. | | | | |
| 3613 | **STOP DAY 3** | **1…7** | **1** | **1** | |
| | Defines timer 3 weekly stop day.<br>• See parameter *3605 STOP DAY 1*. | | | | |
| 3614 | **START TIME 4** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 4 daily start time.<br>• See parameter *3602 START TIME 1*. | | | | |
| 3615 | **STOP TIME 4** | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |
| | Defines timer 4 daily stop time.<br>• See parameter *3603 STOP TIME 1*. | | | | |

| Group 36: Timed functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3616 | **START DAY 4**<br>Defines timer 4 weekly start day.<br>• See parameter *3604 START DAY 1*. | **1…7** | **1** | **1** | |
| 3617 | **STOP DAY 4**<br>Defines timer 4 weekly stop day.<br>• See parameter *3605 STOP DAY 1*. | **1…7** | **1** | **1** | |
| 3622 | **BOOST SEL**<br>Selects the source for the booster signal.<br>0 = NOT SEL – Booster signal is disabled.<br>1 = DI1 – Defines DI1 as the booster signal.<br>2…5 = DI2…DI5 – Defines DI2…DI5 as the booster signal.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the booster signal.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the booster signal. | **-6…6** | **1** | **0** | |
| 3623 | **BOOSTER TIME**<br>Defines the booster ON time. Time is started when booster sel signal is released. If parameter range is 01:30:00, then booster is active for 1 hour and 30 minutes after activation DI is released.<br> | **00:00:00 … 23:59:58** | **2 s** | **12:00:00** | |

| Group 36: Timed functions | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3626 | **TIMER 1 SRC**<br>Defines the time periods used by the timer.<br>0 = NOT SEL- No timers have been selected.<br>1 = P1 – Time Period 1 selected in the timer.<br>2 = P2 – Time Period 2 selected in the timer.<br>3 = P1+P2 – Time Periods 1 and 2 selected in the timer.<br>4 = P3 – Time Period 3 selected in the timer.<br>5 = P1+P3 – Time Periods 1 and 3 selected in the timer.<br>6 = P2+P3 – Time Periods 2 and 3 selected in the timer.<br>7 = P1+P2+P3 – Time Periods 1, 2 and 3 selected in the timer.<br>8 = P4 – Time Period 4 selected in the timer.<br>9 = P1+P4 – Time Periods 4 and 1 selected in the timer.<br>10 = P2+P4 – Time Periods 4 and 2 selected in the timer.<br>11 = P1+P2+P4 – Time Periods 4, 2 and 1 selected in the timer.<br>12 = P3+P4 – Time Periods 4 and 3 selected in the timer.<br>13 = P1+P3+P4 – Time Periods 4, 3 and 1 selected in the timer.<br>14 = P2+P3+P4 – Time Periods 4, 3 and 2 selected in the timer.<br>15 = P1+P2+P3+P4 – Time Periods 4, 3, 2 and 1 selected in the timer.<br>16 = BOOST – Booster selected in the timer.<br>17 = P1+B – Booster and Time Period 1 selected in the timer.<br>18 = P2+B – Booster and Time Period 2 selected in the timer.<br>19 = P1+P2 B – Booster and Time Periods 1 and 2 selected in the timer.<br>20 = P3+B – Booster and Time Period 3 selected in the timer function.<br>21 = P1+P3+B – Booster and Time Period 3 and 1 selected in the timer.<br>22 = P2+P3+B – Booster and Time Periods 3 and 2 selected in the timer.<br>23 = P1+P2+P3+B – Booster and Time Periods 3, 2 and 1 selected in the timer.<br>24 = P4+B – Booster and Time Periods 4 selected in the timer.<br>25 = P1+P4+B – Booster and Time Period 4 and Timer 1 selected in the timer.<br>26 = P2+P4+B – Booster and Time Period 4 and 2 selected in the timer.<br>27 = P1+P2+P4+B – Booster and Time Periods 4, 2 and 1 selected in the timer.<br>28 = P3+P4+B – Booster and Time Periods 4 and 3.<br>29 = P1+P3+P4+B – Booster and Time Periods 4, 3 and 1 selected in the timer.<br>30 = P2+P3+P4+B – Booster and Time Periods 4, 3 and 2 selected.<br>31 = P1+2+3+4+B – Booster and Time Periods 4, 3, 2 and 1 selected. | **0…31** | **1** | **0** | |
| 3627 | **TIMER 2 SRC**<br>See parameter 3626. | **0…31** | **1** | **0** | |
| 3628 | **TIMER 3 SRC**<br>See parameter 3626. | **0…31** | **1** | **0** | |
| 3629 | **TIMER 4 SRC**<br>See parameter 3626. | **0…31** | **1** | **0** | |

## Group 37: User load curve

This new group defines supervision of user adjustable load curves (motor torque as a function of frequency). The curve is defined by five points. - The function replaces deleted underload parameters 3013…3015

| Group 37: User load curve | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3701 | **USER LOAD C MODE**<br>Supervision mode for the user adjustable load curves. This functionality replaces the former underload supervision in *Group 30: Fault functions*.<br>0 = NOT SEL – Supervision is not active.<br>1 = UNDERLOAD – Supervision for the torque dropping below the underload curve.<br>2 = OVERLOAD – Supervision for the torque exceeding the overload curve.<br>3 = BOTH – Supervision for the torque dropping below the underload curve or exceeding the overload curve.<br><br> | **0...3** | **1** | **0** | |
| 3702 | **USER LOAD C FUNC**<br>Action wanted during load supervision.<br>1 = FAULT – A fault is generated when the condition defined by *3701 USER LOAD C MODE* has been valid longer than the time set by *3703 USER LOAD C TIME*.<br>2 = ALARM – An alarm is generated when the condition defined by *3701 USER LOAD C MODE* has been valid longer than half of the time defined by *3703 USER LOAD C TIME*. | **1, 2** | **1** | **1** | |
| 3703 | **USER LOAD C TIME**<br>Defines the time limit for generating a fault. Half of this time is used as the limit for generating an alarm. | **10 … 400 s** | | **20 s** | |
| 3704 | **LOAD FREQ 1**<br>Defines the frequency value of the first curve definition point. Must be smaller than *3707 LOAD FREQ 2*. | **0 … 500 Hz** | | **5 Hz** | |
| 3705 | **LOAD TORQ LOW 1**<br>Defines the torque value of the first underload curve definition point. Must be smaller than *3706 LOAD TORQ HIGH 1*. | **0 … 600%** | | **10%** | |
| 3706 | **LOAD TORQ HIGH 1**<br>Defines the torque value of the first overload curve definition point. | **0 … 600%** | | **300%** | |

| Group 37: User load curve | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 3707 | **LOAD FREQ 2** | **0 … 500 Hz** | | **25%** | |
| | Defines the frequency value of the second curve definition point. Must be smaller than *3710 LOAD FREQ 3*. | | | | |
| 3708 | **LOAD TORQ LOW 2** | **0 … 600%** | | **15%** | |
| | Defines the torque value of the second underload curve definition point. Must be smaller than *3709 LOAD TORQ HIGH 2*. | | | | |
| 3709 | **LOAD TORQ HIGH 2** | **0 … 600%** | | **300%** | |
| | Defines the torque value of the second overload curve definition point. | | | | |
| 3710 | **LOAD FREQ 3** | **0 … 500 Hz** | | **43 Hz** | |
| | Defines the frequency value of the third load curve definition point. | | | | |
| 3711 | **LOAD TORQ LOW 3** | **0 … 600%** | | **25%** | |
| | Defines the torque value of the third underload curve definition point. Must be smaller than *3712 LOAD TORQ HIGH 3*. | | | | |
| 3712 | **LOAD TORQ HIGH 3** | **0 … 600%** | | **300%** | |
| | Defines the torque value of the third overload curve definition point. | | | | |
| 3713 | **LOAD FREQ 4** | **0 … 500 Hz** | | **50 Hz** | |
| | Defines the frequency value of the fourth load curve definition point. | | | | |
| 3714 | **LOAD TORQ LOW 4** | **0 … 600%** | | **30%** | |
| | Defines the torque value of the fourth underload curve definition point. Must be smaller than *3715 LOAD TORQ HIGH 4*. | | | | |
| 3715 | **LOAD TORQ HIGH 4** | **0 … 600%** | | **300%** | |
| | Defines the torque overvalue of the fourth load curve definition point. | | | | |
| 3716 | **LOAD FREQ 5** | **0 … 500 Hz** | | **500 Hz** | |
| | Defines the frequency value of fifth load curve definition point. | | | | |
| 3717 | **LOAD TORQ LOW 5** | **0 … 600%** | | **30%** | |
| | Defines the torque value of the fifth underload curve definition point. Must be smaller than *3718 LOAD TORQ HIGH 5*. | | | | |
| 3718 | **LOAD TORQ HIGH 5** | **0 … 600%** | | **300%** | |
| | Defines the torque value of the fifth overload curve definition point. | | | | |

## Group 40: Process PID set 1

This group defines a set of parameters used with the Process PID (PID1) controller.

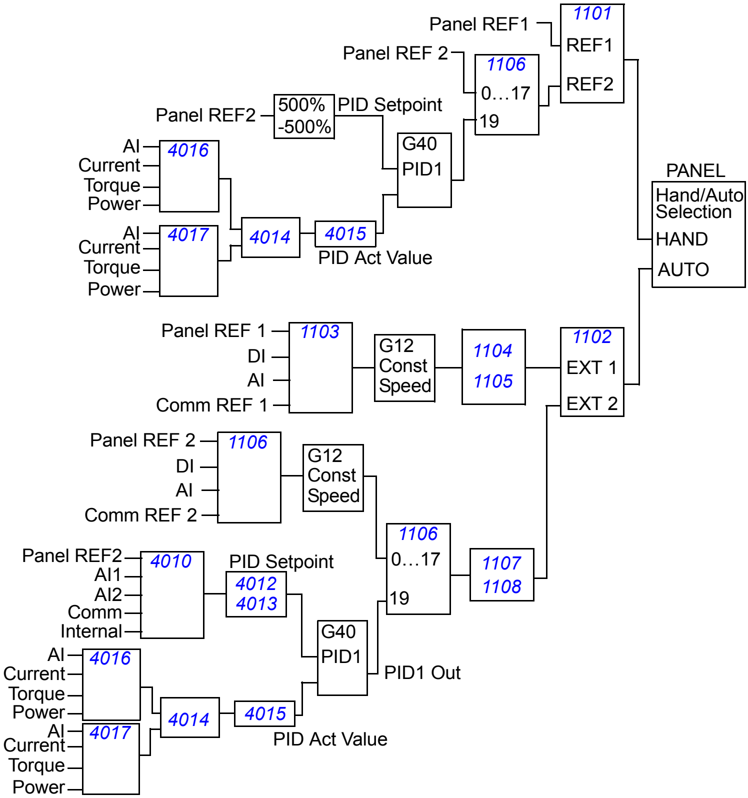
Typically only parameters in this group are needed.

### PID controller – basic set-up

In PID control mode, the drive compares a reference signal (setpoint) to an actual signal (feedback), and automatically adjusts the speed of the drive to match the two signals. The difference between the two signals is the error value.

Typically PID control mode is used, when the speed of a fan or pump needs to be controlled based on pressure, flow or temperature. In most cases – when there is only 1 transducer signal wired to the drive – only parameter group 40 is needed.

A schematic of setpoint/feedback signal flow using parameter group 40 is presented below.




**Note:** To activate and use the PID controller, parameter *1106 REF2 SELECT* must be set to value 19.

### PID controller – advanced

ACS320 has 2 separate PID controllers:

- Process PID (PID1)
- External PID (PID2).

Process PID (PID1) has 2 separate sets of parameters:

- Process PID (PID1) SET1, defined in *Group 40: Process PID set 1*
- Process PID (PID1) SET2, defined in *Group 41: Process PID set 2*.

You can select between the 2 different sets by using parameter *4027 PID 1 PARAM SET*.

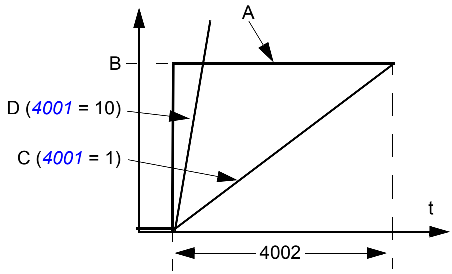
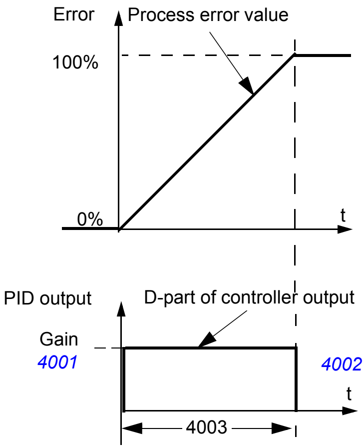
Typically two different PID controller sets are used when the load of the motor changes considerably from one situation to another.

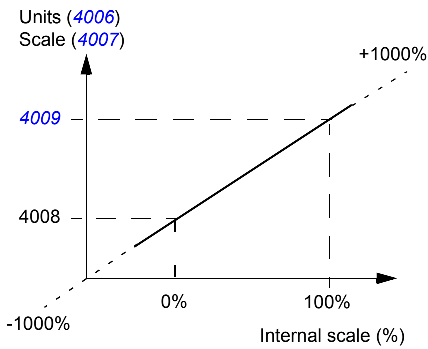
You can use External PID (PID2), defined in *Group 42: Ext / Trim PID*, in 2 different ways:

- Instead of using additional PID controller hardware, you can set outputs of the ACS320 to control a field instrument like a damper or a valve. In this case, set Parameter 4230 to value 0. (0 is the default value.)
- You can use External PID (PID2) as an additional PID controller to Process PID (PID1) to trim or fine-tune the speed of the ACS320.

An example of the trimming is a return fan that follows the speed of the supply fan. As the return fan needs to run faster or slower then the supply fan in order to create under- or overpressure, correction factors to the supply fan speed are needed. Use External PID (PID2) in the return fan drive to provide these corrections.

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4001 | **GAIN** | **0.1 … 100.0** | **0.1** | **2.5** | |
| | Defines the PID controller's gain.<br>• At 0.1, the PID controller output changes one-tenth as much as the error value.<br>• At 100, the PID controller output changes one hundred times as much as the error value.<br>Use the proportional gain and integration time values to adjust the responsiveness of the system.<br>• Low value for proportional gain and a high value for integral time ensures stable operation, but provides sluggish response.<br>If the proportional gain value is too large or the integral time too short, the system can become unstable.<br>**Procedure:**<br>• Initially, set:<br>  • 4001 GAIN = 0.1.<br>  • *4002 INTEGRATION TIME* = 20 seconds.<br>• Start the system and see if it reaches the setpoint quickly while maintaining stable operation. If not, increase GAIN (4001) until the actual signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation.<br>• Reduce GAIN (4001) until the oscillation stops.<br>• Set GAIN (4001) to 0.4 to 0.6 times the above value.<br>• Decrease the *INTEGRATION TIME* (*4002*) until the feedback signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation.<br>• Increase *INTEGRATION TIME* (*4002*) until the oscillation stops.<br>• Set *INTEGRATION TIME* (*4002*) to 1.15 to 1.5 times the above value.<br>• If the feedback signal contains high frequency noise, increase the value of Parameter *1303 FILTER AI1* or *1306 FILTER AI2* until the noise is filtered from the signal. | | | | |

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4002 | **INTEGRATION TIME** | **0.0 … 3600.0 s** | **0.1 s** | **3.0 s** | |
| | Defines the PID controller's integration time.<br>Integration time is, by definition, is the time required to increase the output by the error value:<br>• Error value is constant and 100%.<br>• Gain = 1.<br>• Integration time of 1 second denotes that a 100% change is achieved in 1 second.<br>0.0 = NOT SEL Disables integration (I-part of controller).<br>0.1 … 3600.0 = Integration time (seconds).<br><br>A = Error<br>B = Error value step<br>C = Controller output with Gain = 1<br>D = Controller output with Gain = 10<br>See parameter *4001 GAIN* for adjustment procedure. | | | | |
| 4003 | **DERIVATION TIME** | **0.0 … 10.0 s** | **0.1 s** | **0.0 s** | |
| | Defines the PID controller's derivation time.<br>• You can add the derivative of the error to the PID controller output. The derivative is the error value's rate of change. For example, if the process error value changes linearly, the derivative is a constant added to the PID controller output.<br>• Error-derivative is filtered with a 1-pole filter. The time constant of the filter is defined by parameter *4004 PID DERIV FILTER*.<br>0.0 = NOT SEL Disables the error-derivative part of the PID controller output<br>0.1 … 10.0 = Derivation time (seconds)<br> | | | | |
| 4004 | **PID DERIV FILTER** | **0.0 … 10.0 s** | **0.1 s** | **0.1 s** | |
| | Defines the filter time constant for the error-derivative part of the PID controller output.<br>• Before being added to the PID controller output, the error-derivative is filtered with a 1-pole filter.<br>• Increasing the filter time smooths the error-derivative, reducing noise.<br>0.0 = NOT SEL Disables the error-derivative filter.<br>0.1 … 10.0 = Filter time constant (seconds). | | | | |

<table>
<tr><th colspan="6">Group 40: Process PID set 1</th></tr>
<tr><th>Code</th><th>Description</th><th>Range</th><th>Resolution</th><th>Default</th><th>S</th></tr>
<tr><td>4005</td><td>ERROR VALUE INV</td><td>0, 1</td><td>-</td><td>0</td><td></td></tr>
<tr><td></td><td colspan="5">Selects either a normal or inverted relationship between the feedback signal and the drive speed.<br>0 = NO – Normal, a decrease in feedback signal increases drive speed. Error = Ref - Fbk<br>1 = YES – Inverted, a decrease in feedback signal decreases drive speed. Error = Fbk - Ref</td></tr>
<tr><td>4006</td><td>UNITS</td><td>0…31</td><td>-</td><td>4</td><td></td></tr>
<tr><td></td><td colspan="5">Selects the unit for the PID controller actual values. (PID1 parameters 0128, 0130, and 0132).<br>• See parameter 3405 OUTPUT1 UNIT for list of available units.</td></tr>
<tr><td>4007</td><td>UNIT SCALE</td><td>0…4</td><td>1</td><td>1</td><td></td></tr>
<tr><td></td><td colspan="5">Defines the decimal point location in PID controller actual values.<br>• Enter the decimal point location counting in from the right of the entry.<br>• See table for example using pi (3.14159).
<table>
<tr><th>4007 value</th><th>Entry</th><th>Display</th></tr>
<tr><td>0</td><td>0003</td><td>3</td></tr>
<tr><td>1</td><td>0031</td><td>3.1</td></tr>
<tr><td>2</td><td>0314</td><td>3.14</td></tr>
<tr><td>3</td><td>3142</td><td>3.142</td></tr>
</table></td></tr>
<tr><td>4008</td><td>0 % VALUE</td><td>-1000.0 … 1000.0%</td><td>0.1%</td><td>0.0%</td><td></td></tr>
<tr><td></td><td colspan="5">Defines (together with the next parameter) the scaling applied to the PID controller's actual values (PID1 parameters 0128, 0130, and 0132).<br>• Units and scale are defined by parameters 4006 UNITS and 4007 UNIT SCALE.

</td></tr>
<tr><td>4009</td><td>100 % VALUE</td><td>-1000.0 … 1000.0%</td><td>0.1%</td><td>100%</td><td></td></tr>
<tr><td></td><td colspan="5">Defines (together with the previous parameter) the scaling applied to the PID controller's actual values.<br>• Units and scale are defined by parameters 4006 UNITS and 4007 UNIT SCALE.</td></tr>
</table>

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4010 | **SET POINT SEL** | **0...19** | **1** | **0** | ✓ |
| | Defines the reference signal source for the PID controller.<br>• Parameter has no significance when the PID regulator is by-passed (see parameter *8121 REG BYPASS CTRL*).<br>0 = KEYPAD – Control panel provides reference.<br>1 = AI1 – Analog input 1 provides reference.<br>2 = AI2 – Analog input 2 provides reference.<br>8 = COMM – Fieldbus provides reference.<br>9 = COMM+AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog Input Reference Correction below.<br>10 = COMM*AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog Input Reference Correction below.<br>11 = DI3U, 4D(RNC) – Digital inputs, acting as a motor potentiometer control, provide reference.<br>• DI3 increases the speed (the U stands for “up”)<br>• DI4 decreases the reference (the D stands for “down”).<br>• Parameter *2205 ACCELER TIME 2* controls the reference signal’s rate of change.<br>• R = Stop command resets the reference to zero.<br>• NC = Reference value is not copied.<br>12 = DI3U, 4D(NC) – Same as DI3U, 4D(RNC) above, except:<br>• Stop command does not reset reference to zero. At restart the motor ramps up, at the selected acceleration rate, to the stored reference.<br>14 = AI1+AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>15 = AI1*AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>16 = AI1-AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>17 = AI1/AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog Input Reference Correction below.<br>19 = INTERNAL – A constant value set using parameter 4011 provides reference. | | | | |

**Group 40: Process PID set 1**

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|

Analog input reference correction

Parameter values 9, 10, and 14…17 use the formula in the following table.

| Value Setting | AI reference is calculated as following: |
|---|---|
| C + B | C value + (B value - 50% of reference value) |
| C * B | C value * (B value / 50% of reference value) |
| C - B | (C value + 50% of reference value) - B value |
| C / B | (C value * 50% of reference value) / B value |

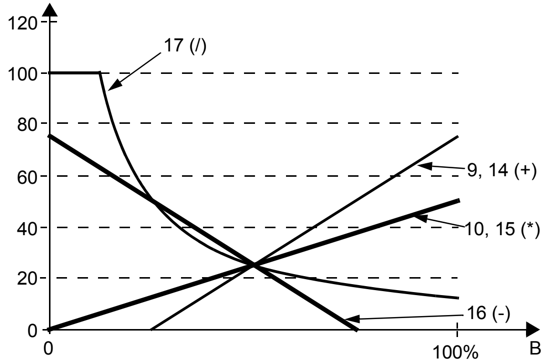
Where:

- C = Main Reference value (= COMM for values 9, 10 and = AI1 for values 14…17).
- B = Correcting reference (= AI1 for values 9, 10 and = AI2 for values 14…17).

**Example:**

The figure shows the reference source curves for value settings 9, 10, and 14…17, where:

- C = 25%.
- Parameter *4012 SETPOINT MIN* = 0.
- Parameter *4013 SETPOINT MAX* = 0.
- B varies along the horizontal axis.



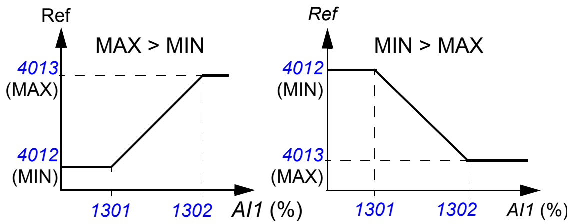

31 = DI4U, 5D(NC) – See selection DI3U,4D(NC).

32 = FREQ INPUT – Frequency limit.

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 4011 | **INTERNAL SETPNT** | **-1000.0 … 1000.0%** | **0.1%** | **40.0%** | |

Selects a constant value as a process PID controller reference, when parameter *4010 SET POINT SEL* value is set to INTERNAL.

- Unit and range depend on the unit and scale defined by parameters *4006 UNITS* and *4007 UNIT SCALE*.

<table>
<tr><th colspan="6">Group 40: Process PID set 1</th></tr>
<tr><th>Code</th><th>Description</th><th>Range</th><th>Resolution</th><th>Default</th><th>S</th></tr>
<tr><td rowspan="2">4012</td><td>SETPOINT MIN</td><td>-500.0 … 500.0%</td><td>0.1%</td><td>0.0%</td><td></td></tr>
<tr><td colspan="5">Defines the minimum value for the selected PID reference signal source. See parameter 4010 SET POINT SEL. Value in percent.<br>Example: Analog input AI1 is selected as the PID reference source (value of parameter 4010 is AI1). The reference minimum and maximum correspond to the 1301 MINIMUM AI1 and 1302 MAXIMUM AI1 settings as follows.<br>


</td></tr>
<tr><td rowspan="2">4013</td><td>SETPOINT MAX</td><td>-500.0 … 500.0%</td><td>0.1%</td><td>100.0%</td><td></td></tr>
<tr><td colspan="5">Defines the maximum value for the selected PID reference signal source. See parameters 4010 SET POINT SEL and 4012 SETPOINT MIN. Value in percent.</td></tr>
<tr><td rowspan="2">4014</td><td>FBK SEL</td><td>1…10</td><td>1</td><td>1</td><td></td></tr>
<tr><td colspan="5">Defines the PID controller feedback (actual signal).<br>• You can define a combination of two actual values (ACT1 and ACT2) as the feedback signal.<br>• Use parameter 4016 ACT1 INPUT to define the source for actual value 1 (ACT1).<br>• Use parameter 4017 ACT2 INPUT to define the source for actual value 2 (ACT2).<br>1 = ACT1 – Actual value 1 (ACT1) provides the feedback signal.<br>2 = ACT1-ACT2 – ACT1 minus ACT2 provides the feedback signal.<br>3 = ACT1+ACT2 – ACT1 plus ACT2 provides the feedback signal.<br>4 = ACT1*ACT – ACT1 times ACT2 provides the feedback signal.<br>5 = ACT1/ACT2 – ACT1 divided by ACT2 provides the feedback signal.<br>6 = MIN (ACT1, 2) – The smaller of ACT1 or ACT2 provides the feedback signal.<br>7 = MAX (ACT1, 2) – The greater of ACT1 or ACT2 provides the feedback signal.<br>8 = sqrt(ACT1-2) – Square root of the value for ACT1 minus ACT2 provides the feedback signal.<br>9 = sqA1 + sqA2 – Square root of ACT1 plus the square root of ACT2 provides the feedback signal.<br>10 = sqrt(ACT1) – Square root of ACT1 provides the feedback signal.<br>11 = COMM FBK 1 – Signal 0158 PID COMM VALUE 1 provides the feedback signal.<br>12 = COMM FBK 2 – Signal 0159 PID COMM VALUE 2 provides the feedback signal.<br>13 = AVE(ACT1,2) – The average of ACT1 and ACT2 provides the feedback signal.</td></tr>
</table>

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4015 | **FBK MULTIPLIER**<br>Defines an extra multiplier for the PID FBK value defined by parameter *4014 FBK SEL*.<br>• Used mainly in applications where the flow is calculated from the pressure difference.<br>0 = NOT SELECTED.<br>-32.768…32.767 = Multiplier applied to the signal defined by parameter *4014 FBK SEL*.<br><br>**Example:** $FBK = Multiplier \times \sqrt{A1 - A2}$ | **-32.768…32.767** | **0.001** | **0** | |
| 4016 | **ACT1 INPUT**<br>Defines the source for actual value 1 (ACT1).<br>1 = AI 1 – Uses analog input 1 for ACT1.<br>2 = AI 2 – Uses analog input 2 for ACT1.<br>3 = CURRENT – Uses current for ACT1, scaled so:<br>• Min ACT1 = 0 current<br>• Max ACT1 = 2 x nominal current<br>4 = TORQUE – Uses torque for ACT1, scaled so:<br>• Min ACT1= -2 x nominal torque<br>• Max ACT1 = 2 x nominal torque<br>5 = POWER – Uses power for ACT1, scaled so:<br>• Min ACT1 = -2 x nominal power<br>• Max ACT1 = 2 x nominal power<br>6 = COMM ACT 1 – Uses value of signal *0158 PID COMM VALUE 1* for ACT1.<br>7 = COMM ACT 2 – Uses value of signal *0159 PID COMM VALUE 2* for ACT1.<br>8 = FREQ INPUT | **1…5** | **1** | **2** | ✓ |
| 4017 | **ACT2 INPUT**<br>Defines the source for actual value 2 (ACT2).<br>1 = AI 1 – Uses analog input 1 for ACT2.<br>2 = AI 2 – Uses analog input 2 for ACT2.<br>3 = CURRENT – Uses current for ACT2, scaled so:<br>• Min ACT2 = 0 current<br>• Max ACT2 = 2 x nominal current<br>4 = TORQUE – Uses torque for ACT2, scaled so:<br>• Min ACT2 = -2 x nominal torque<br>• Max ACT2 = 2 x nominal torque<br>5 = POWER – Uses power for ACT2, scaled so:<br>• Min ACT2 = -2 x nominal power<br>• Max ACT2 = 2 x nominal power<br>6 = COMM ACT 1 – Uses value of signal *0158 PID COMM VALUE 1* for ACT2.<br>7 = COMM ACT 2 – Uses value of signal *0159 PID COMM VALUE 2* for ACT2.<br>8 = FREQ INPUT – Frequency input. | **1…5** | **1** | **2** | ✓ |

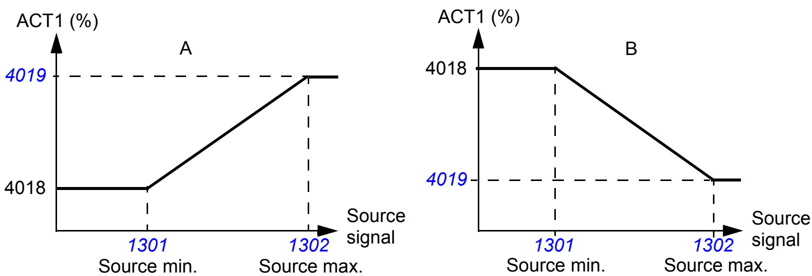
## Group 40: Process PID set 1

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 4018 | **ACT1 MINIMUM** | **-1000 … 1000%** | **1%** | **0%** | |

- Sets the minimum value for ACT1.
- Scales the source signal used as the actual value ACT1 (defined by parameter *4016 ACT1 INPUT* ACT1 INPUT). For parameter *4016* values 6 (COMM ACT 1) and 7 (COMM ACT 2) scaling is not done.

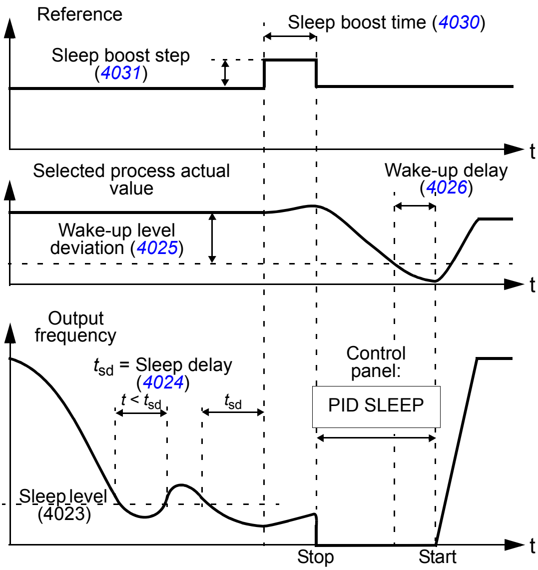
| Par. 4016 | Source | Source min. | Source max. |
|---|---|---|---|
| 1 | Analog input 1 | 1301 MINIMUM AI1 | 1302 MAXIMUM AI1 |
| 2 | Analog input 2 | 1304 MINIMUM AI2 | 1305 MAXIMUM AI2 |
| 3 | Current | 0 | 2 · nominal current |
| 4 | Torque | -2 · nominal torque | 2 · nominal torque |
| 5 | Power | -2 · nominal power | 2 · nominal power |

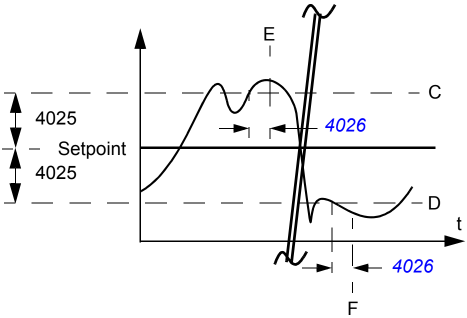
- See the figure below: A= Normal; B = Inversion (ACT1 MINIMUM > ACT1 MAXIMUM)

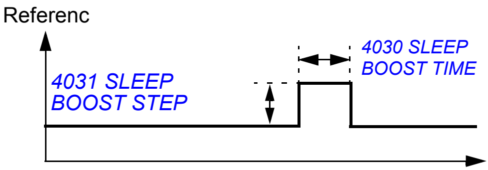



| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 4019 | **ACT1 MAXIMUM**<br>Sets the maximum value for ACT1.<br>• See *4018 ACT1 MINIMUM*. | **-1000 … 1000%** | **1%** | **100%** | |
| 4020 | **ACT2 MINIMUM**<br>Sets the minimum value for ACT2.<br>• See *4018 ACT1 MINIMUM*. | **-1000 … 1000%** | **1%** | **0%** | |
| 4021 | **ACT2 MAXIMUM**<br>Sets the maximum value for ACT2.<br>• See *4018 ACT1 MINIMUM*. | **-1000 … 1000%** | **1%** | **100%** | |

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4022 | **SLEEP SELECTION** | **-6…7** | **-** | **0** | |
| | Defines the control for the PID sleep function.<br>0 = NOT SEL – Disables the PID sleep control function.<br>1 = DI1 – Defines digital input 1 as the control for the PID sleep function.<br>• Activating the digital input activates the sleep function.<br>• De-activating the digital input restores PID control.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for the PID sleep function.<br>• See DI1 above.<br>9…11 = SUPRV1 UNDER…SUPRV3 UNDER – The function is activated when parameter *3201 SUPERV 1 PARAM* stays over the high limit defined by parameter *3203 SUPERV 1 LIM HI*.<br>The internal sleep criteria set by parameters *4023 PID SLEEP LEVEL* and *4025 WAKE-UP DEV* are not effective. The sleep start and stop delay parameters *4024 PID SLEEP DELAY* and *4026 WAKE-UP DELAY* are effective.<br>7 = INTERNAL – Defines the output rpm/frequency, process reference, and process actual value as the control for the PID sleep function. Refer to parameters *4025 WAKE-UP DEV* and *4023 PID SLEEP LEVEL*.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for the PID sleep function.<br>• De-activating the digital input activates the sleep function.<br>• Activating the digital input restores PID control.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for the PID sleep function.<br>• See DI1(INV) above.<br>-9…-11 = SUPRV1 UNDER…SUPRV3 UNDER – The function is activated when parameter *3201 SUPERV 1 PARAM* stays below the low limit defined by parameter *3202 SUPERV 1 LIM LO*.<br>The internal sleep criteria set by parameters *4023 PID SLEEP LEVEL* and *4025 WAKE-UP DEV* are not effective. The sleep start and stop delay parameters 4*4024 PID SLEEP DELAY* and *4026 WAKE-UP DELAY* are effective. | | | | |

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4023 | **PID SLEEP LEVEL** | **0.0 … 120.0 Hz /<br>0 … 7200 rpm** | **0.1 Hz /<br>1 rpm** | **0.0 Hz** | |
| | Sets the motor speed / frequency that enables the PID sleep function – a motor speed / frequency below this level, for at least the time period *4024 PID SLEEP DELAY* enables the PID sleep function (stopping the drive).<br>• Requires *4022* = 7 INTERNAL.<br>• See figure: A = PID output level; B = PID process feedback.<br> | | | | |
| 4024 | **PID SLEEP DELAY** | **0.0 … 3600.0 s** | **0.1 s** | **60.0 s** | |
| | Defines the delay for the sleep start function. See parameter *4023 PID SLEEP LEVEL*. When the motor speed falls below the sleep level, the counter starts. When the motor speed exceeds the sleep level, the counter is reset.<br>• See *4023 PID SLEEP LEVEL* above. | | | | |

<table>
<tr><th colspan="6">Group 40: Process PID set 1</th></tr>
<tr><th>Code</th><th>Description</th><th>Range</th><th>Resolution</th><th>Default</th><th>S</th></tr>
<tr><td>4025</td><td>WAKE-UP DEV</td><td>0.0 … 1000%</td><td>0.1</td><td>0.0</td><td></td></tr>
<tr><td></td><td colspan="5">Defines the wake-up deviation – a deviation from the setpoint greater than this value, for at least the time period 4026 WAKE-UP DELAY, re-starts the PID controller.<br>
• Parameters 4006 UNITS and 4007 UNIT SCALE define the units and scale.<br>
• Parameter 4005 ERROR VALUE INV = 0,<br>Wake-up level = Setpoint – Wake-up deviation.<br>
• Parameter 4005 ERROR VALUE INV = 1,<br>Wake-up level = Setpoint + Wake-up deviation.<br>
• Wake-up level can be above or below setpoint.<br>
<br>
<br>
See the figure:<br>
• C = Wake-up level when parameter 4005 ERROR VALUE INV = 1<br>
• D = Wake-up level when parameter 4005 ERROR VALUE INV = 0<br>
• E = Feedback is above wake-up level and lasts longer than 4026 WAKE-UP DELAY – PID function wakes up.<br>
• F = Feedback is below wake-up level and lasts longer than 4026 WAKE-UP DELAY – PID function wakes up.</td></tr>
<tr><td>4026</td><td>WAKE-UP DELAY</td><td>0.00 … 60.00 s</td><td>0.01 s</td><td>0.50 s</td><td></td></tr>
<tr><td></td><td colspan="5">Defines the wake-up delay –<br>
a deviation from the setpoint greater than 4025 WAKE-UP DEV, for at least this time period re-starts the PID controller.<br>
• See 4023 PID SLEEP LEVEL above.</td></tr>
</table>

| **Group 40: Process PID set 1** | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4027 | **PID 1 PARAM SET** | **-6…11** | **1** | **0** | |
| | Defines how selections are made between PID set 1 and PID set 2.<br>PID parameter set selection. When set 1 is selected, parameters *4001*…*4026* are used.<br>When set 2 is selected, parameters *4001*…*4026* are used.<br>0 = SET 1 – PID set 1 (parameters *4001*…*4026*) is active.<br>1 = DI1 – Defines digital input 1 as the control for PID set selection.<br>• Activating the digital input selects PID set 2.<br>• De-activating the digital input selects PID set 1.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for PID set selection.<br>• See DI1 above.<br>7 = SET 2 – PID set 2 (parameters 4101…4126) is active.<br>8…11 = TIMER 1…4 – Defines the Timer as the control for the PID set selection (Timer de-activated = PID set 1; Timer activated = PID set 2)<br>See parameter *Group 36: Timed functions*.<br>-1 = DI1(INV) – Defines an inverted digital input 1 as the control for PID set selection.<br>• Activating the digital input selects PID set 1.<br>• De-activating the digital input selects PID set 2.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for PID set selection.<br>• See DI1(INV) above. | | | | |
| 4028 | **PID OUT MIN** | **-500.0 … 500.0%** | **1 = 0.1%** | **-100.0%** | |
| | Defines the minimum value of PID output. | | | | |
| 4029 | **PID OUT MAX** | **-500.0 … 500.0%** | **1 = 0.1%** | **-100.0%** | |
| | Defines the maximum value of PID output. | | | | |
| 4030 | **SLEEP BOOST TIME** | **0.0 … 3600.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the boost time for the sleep boost step. See parameter *4031 SLEEP BOOST STEP*.<br> | | | | |
| 4031 | **SLEEP BOOST STEP** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | When the drive is entering sleep mode, the reference (PID setpoint) is increased by this percentage for the time defined by parameter *4030 SLEEP BOOST TIME*. | | | | |
| 4032 | **PID REF ACC TIME** | **0.0 … 1800.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the time for the reference (PID setpoint) increase from 0 to 100%.<br>**Note:** Parameters *4032*…*4036* are active even if the process PID set 2 (*Group 41: Process PID set 2*) is used. Acceleration time | | | | |

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4033 | **PID REF DEC TIME** | **0.0 … 1800.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the time for the reference (PID setpoint) decrease from 100 to 0%. | | | | |
| 4034 | **PID REF FREEZE** | | | **NOT SEL** | |
| | Freezes the input (reference, PID setpoint) of the process PID controller.<br>0 = NOT SEL – Not selected<br>1 = DI1 – Reference is frozen on the rising edge of digital input DI1.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1.<br>-1 = DI1(INV) – Reference is frozen on the falling edge of digital input DI1.<br>-2 = DI2(INV) – See selection DI1(INV).<br>-3 = DI3(INV) – See selection DI1(INV).<br>-4 = DI4(INV) – See selection DI1(INV).<br>-5 = DI5(INV) – See selection DI1(INV). | | | | |
| 4035 | **PID OUT FREEZE** | | | **NOT SEL** | |
| | Freezes the output of the process PID controller.<br>0 = NOT SEL – Not selected<br>1 = DI1 – Output is frozen on the rising edge of digital input DI1<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1.<br>-1 = DI1(INV) – Output is frozen on the falling edge of digital input DI1.<br>-2 = DI2(INV) – See selection DI1(INV).<br>-3 = DI3(INV) – See selection DI1(INV).<br>-4 = DI4(INV) – See selection DI1(INV).<br>-5 = DI5(INV) – See selection DI1(INV). | | | | |
| 4036 | **INTERNAL SETPNT2** | **-100.0 … 100.0%** | **1 = 0.1%** | **40.0%** | |
| | Selects a constant value as the process PID controller reference, which becomes active when parameter *4010 SET POINT SEL* value is set to INTERNAL and setpoint 2 is selected with the input defined by parameter *4039 INT SETPNT SEL*. Value in percent. | | | | |
| 4037 | **INTERNAL SETPNT3** | **-100.0 … 100.0%** | **1 = 0.1%** | **40.0%** | |
| | Selects a constant value as the process PID controller reference, which becomes active when parameter *4010 SET POINT SEL* value is set to INTERNAL and setpoint 3 is selected with the input defined by parameter *4039 INT SETPNT SEL*. Value in percent. | | | | |
| 4038 | **INTERNAL SETPNT4** | **-100.0 … 100.0%** | **1 = 0.1%** | **40.0%** | |
| | Selects a constant value as the process PID controller reference, which becomes active when parameter *4010 SET POINT SEL* value is set to INTERNAL and setpoint 4 is selected with the input defined by parameter *4039 INT SETPNT SEL*. Value in percent. | | | | |

| Group 40: Process PID set 1 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4039 | **INT SETPNT SEL** | | | **NOT SEL** | |
| | Selects the source for the selection of the internal setpoint used as the process PID controller reference when parameter *4010 SET POINT SEL* value is set to INTERNAL.<br>**Example:**<br>*4010 SET POINT SEL* = INTERNAL<br>*4039 INT SETPNT SEL* = DI2<br>Digital input DI2 = 1<br>-> *4012 SETPOINT MIN* is used as the reference.<br>0 = NOT SEL – *4011 INTERNAL SETPNT* is used as the reference.<br>1 = DI1<br>0 = *4011 INTERNAL SETPNT* is used.<br>1 = *4036 INTERNAL SETPNT2* is used.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1.<br>7 = DI1,2 – Selects with digital inputs DI1 and DI2 which internal setpoint is used as the reference. 1 = DI active, 0 = DI inactive. | | | | |

| DI1 | DI2 | Internal setpoint selected |
|---|---|---|
| 0 | 0 | *4011 INTERNAL SETPNT* |
| 1 | 0 | *4036 INTERNAL SETPNT2* |
| 0 | 1 | *4037 INTERNAL SETPNT3* |
| 1 | 1 | *4038 INTERNAL SETPNT4* |

8 = DI2,3 – See selection DI1,2.
9 = DI3,4 – See selection DI1,2.
10 = DI4,5 – See selection DI1,2.
15 = TIMED FUNC 1
  0 = *4011 INTERNAL SETPNT* is used.
  1 = *4036 INTERNAL SETPNT2* is used.
16 = TIMED FUNC 2 – See selection TIMED FUNC 1.
17= TIMED FUNC 3 – See selection TIMED FUNC 1.
18= TIMED FUNC 4 – See selection TIMED FUNC 1.
19 = TIMED FUN1&2 – Selects with TIMED FUNC 1 and TIMED FUNC 2 which internal setpoint is used as the reference. 1 = timed function active, 0 = timed function inactive.

| TIMED FUNC 1 | TIMED FUNC 2 | Internal setpoint selected |
|---|---|---|
| 0 | 0 | *4011 INTERNAL SETPNT* |
| 1 | 0 | *4036 INTERNAL SETPNT2* |
| 0 | 1 | *4037 INTERNAL SETPNT3* |
| 1 | 1 | *4038 INTERNAL SETPNT4* |

## Group 41: Process PID set 2

This group defines second set of parameters used with the Process PID (PID1) controller.

The operation of parameters *4101 ... 4139* is analogous with Process PID set 1 (PID1) parameters *4001*…*4039*.

PID parameter set 2 can be selected by parameter *4027 PID 1 PARAM SET*.

| Group 41: Process PID set 2 | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4101 … 4139 | See parameters *4001*…*4039*. | | | | |

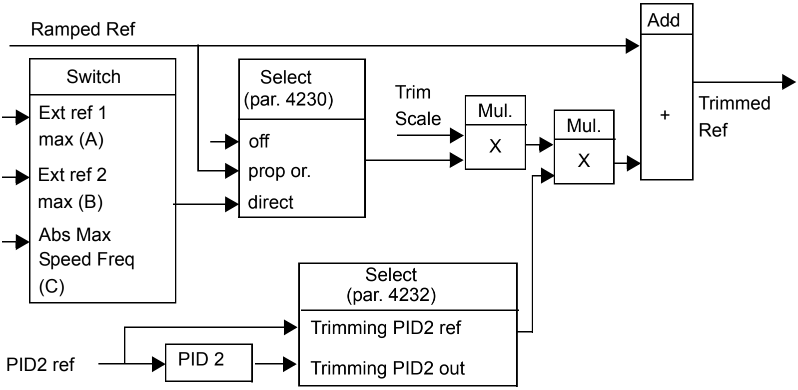
## Group 42: Ext / Trim PID

This group defines the parameters used for the second PID controller (PID2) of ACS320.

The operation of parameters *4201 ... 4221* is analogous with Process PID set 1 (PID1) parameters *4001*…*4039*.

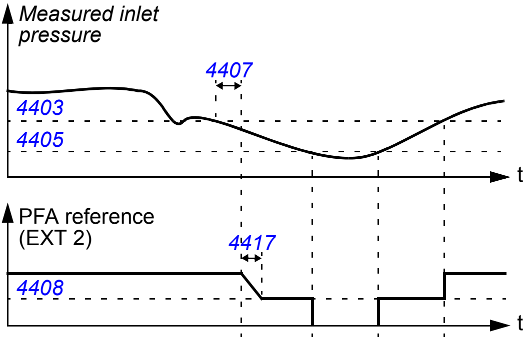
| Group 42: Ext / Trim PID | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4201 … 4221 | See parameters *4001*…*4021*. | | | | |

| Group 42: Ext / Trim PID | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4228 | **ACTIVATE** | **-6…12** | **-** | **1** | |
| | Defines the source for enabling the external PID function.<br>• Requires parameter *4230 TRIM MODE* = 0 NOT SEL.<br>0 = NOT SEL – Disables external PID control.<br>1 = DI1 – Defines digital input 1 as the control for enabling external PID control.<br>• Activating the digital input enables external PID control.<br>• De-activating the digital input disables external PID control.<br>2…5 = DI2…DI5 – Defines digital input DI2…DI5 as the control for enabling external PID control.<br>• See DI1 above.<br>7 = DRIVE RUN – Defines the start command as the control for enabling external PID control.<br>• Activating the start command (drive is running) enables external PID control.<br>8 = ON – Defines the power-on as the control for enabling external PID control.<br>• Activating power to the drive enables external PID control.<br>9…12 = TIMER 1…4 – Defines the Timer as the control for enabling external PID control (Timer active enables external PID control).<br>• See parameter *Group 36: Timed functions*.<br>-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for enabling external PID control.<br>• Activating the digital input disables external PID control.<br>• De-activating the digital input enables external PID control.<br>-2…-5 = DI2(INV)…DI5(INV) – Defines an inverted digital input DI2…DI5 as the control for enabling external PID control.<br>• See DI1(INV) above. | | | | |
| 4229 | **OFFSET** | **0.0 … 100.0%** | **0.1%** | **0.0%** | |
| | Defines the offset for the PID output.<br>• When PID is activated, output starts from this value.<br>• When PID is deactivated, output resets to this value.<br>• Parameter is not active when parameter *4230 TRIM MODE* not = 0 (trim mode is not active). | | | | |
| 4230 | **TRIM MODE** | **0…2** | **1** | **0** | |
| | Selects the type of trim, if any. Using the trim it is possible to combine a corrective factor to the drive reference.<br>0 = NOT SEL – Disables the trim function.<br>1 = PROPORTIONAL – Adds a trim factor that is proportional to the rpm/Hz reference.<br>2 = DIRECT – Adds a trim factor based on the control loop's maximum limit. | | | | |
| 4231 | **TRIM SCALE** | **-100.0 … 100.0%** | **0.1%** | **0.0%** | |
| | Defines the multiplier (as a percent, plus or minus) used in the trim mode. | | | | |

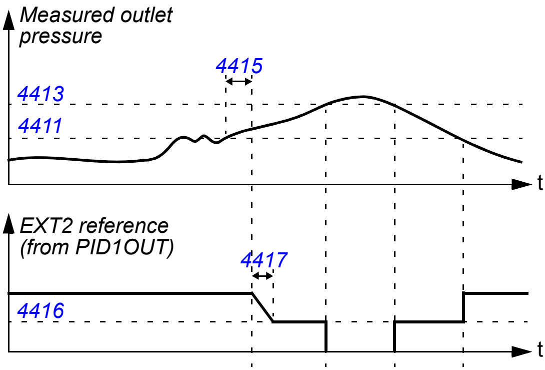
| Group 42: Ext / Trim PID | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4232 | **CORRECTION SRC** | **1…2** | **1** | **1** | |
| | Defines the trimming reference for the correction source.<br>1 = PID2 REF – Uses appropriate REF MAX (SWITCH A OR B)<br>• *1105 REF1 MAX* when REF1 is active (A).<br>• *1108 REF2 MAX* when REF2 is active (B).<br>2 = PID2 OUTPUT – Uses the absolute maximum speed or frequency (Switch C).<br> | | | | |

## Group 44: Pump protection

This group defines the parameters used for the set-up of pump protection.

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4401 | **INLET PROT CTRL** | | | **NOT SEL** | |
| | Enables, and selects the mode of, the primary supervision of pump/fan inlet pressure.<br>**Note:** Inlet protection is active only when the active reference is PID.<br>0 = NOT SEL – Primary inlet pressure supervision not used.<br>1 = ALARM – Detection of low inlet pressure generates an alarm on the control panel display.<br>2 = PROTECT – Detection of low inlet pressure generates an alarm on the control panel display. The output of the PI controller is ramped down (according to parameter *4417 PID OUT DEC TIME*) to the forced reference (set by parameter *4008 INLET FORCED REF*). The drive will revert to the original reference if the pressure subsequently exceeds the supervision level.<br><br>The diagram describes the inlet pressure supervision function.<br>3 = FAULT – Detection of low inlet pressure trips the drive on a fault. | | | | |
| 4402 | **AI MEASURE INLET** | | | **NOT SEL** | |
| | Selects the analog input for pump/fan inlet pressure supervision.<br>0 = NOT SEL – No analog input selected.<br>1 = AI1 – Pump/fan inlet pressure monitored through analog input AI1.<br>2 = AI2 – See selection AI1. | | | | |
| 4403 | **AI IN LOW LEVEL** | **0.00 … 100.00%** | **1 = 0.01%** | **0.00%** | |
| | Sets the supervision limit for the primary inlet pressure measurement. If the value of the selected input falls below this limit, the action defined by parameter *4401 INLET PROT CTRL* is taken after the delay set by parameter *4407 INLET CTRL DLY* expires. The range corresponds to 0…10 V or 0…20 mA on the analog input. With a bipolar input, the absolute input value is considered. | | | | |
| 4404 | **VERY LOW CTRL** | | | **NOT SEL** | |
| | Enables, and selects the mode of, the secondary inlet pressure supervision function. The function uses the analog input selected by parameter *4402 AI MEASURE INLET*.<br>0 = NOT SEL – Secondary inlet pressure supervision not used.<br>1 = STOP – Detection of very low inlet pressure stops the drive. The drive will start again if the pressure exceeds the supervision level.<br>2 = FAULT – Detection of very low inlet pressure trips the drive on a fault. | | | | |

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4405 | **AI IN VERY LOW** | **0.00 … 100.00%** | **1 = 0.01%** | **0.00%** | |
| | Supervision level for the secondary inlet pressure monitoring function. See parameter *4401 INLET PROT CTRL*. Supervision level. | | | | |
| 4406 | **DI STATUS INLET** | | | **NOT SEL** | |
| | Selects the digital input for connection of a pressure switch at the pump/fan inlet. The “normal” state is 1 (active). If the selected input switches to 0 (inactive), the action defined by parameter *4401 INLET PROT CTRL* is executed after the delay set by parameter *4407 INLET CTRL DLY* expires.<br>0 = NOT SEL – No digital input selected.<br>1 = DI1 – Pump/fan inlet pressure monitored through digital input DI1.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1. | | | | |
| 4407 | **INLET CTRL DLY** | **0.1 … 1800.0 s** | **1 = 0.1 s** | **60.0 s** | |
| | Sets the delay after which the action defined by parameter *4401 INLET PROT CTRL* is taken on detection of low inlet pressure. | | | | |
| 4408 | **INLET FORCED REF** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | This reference is used after detection of low inlet pressure. See parameter *4401 INLET PROT CTRL*.<br>⚠ **WARNING!** Make sure that it is safe to continue operation using this reference. | | | | |

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4409 | **OUTLET PROT CTRL**<br>Enables, and selects the mode of, the primary supervision of pump/fan outlet pressure.<br>**Note:** Outlet protection is active only when the active reference is PID.<br>0 = NOT SEL – Primary outlet pressure supervision not used.<br>1 = ALARM – Detection of high outlet pressure produces an alarm on the control panel display.<br>2 = PROTECT – Detection of high outlet pressure produces an alarm on the control panel display. The output of the PI controller is ramped down (according to parameter *4417 PID OUT DEC TIME*) to the forced reference (set by parameter *4416 OUTLET FORCED REF*). The drive will revert to the original reference if the pressure subsequently falls below the supervision level.<br>The following diagram describes the outlet pressure supervision function.<br><br><br>3 = FAULT – Detection of high outlet pressure trips the drive on a fault. | | | **NOT SEL** | |
| 4410 | **AI MEAS OUTLET**<br>Selects the analog input for pump/fan outlet pressure supervision.<br>0 = NOT SEL – No analog input selected.<br>1 = AI1 – Pump/fan outlet pressure monitored through analog input AI1.<br>2 = AI2 – See selection AI1. | | | **NOT SEL** | |
| 4411 | **AI OUT HI LEVEL**<br>Sets the supervision limit for the primary outlet pressure measurement. If the value of the selected analog input exceeds this limit, the action defined by parameter *4409 OUTLET PROT CTRL* is taken after a delay set with parameter *4415 OUTLET CTRL DLY* expires. Supervision level | **0.00 … 100.00%** | **1 = 0.01%** | **100.00%** | |
| 4412 | **VERY HIGH CTRL**<br>Enables, and selects the mode of, the secondary outlet pressure supervision function. The function uses the analog input selected by parameter *4410 AI MEAS OUTLET*.<br>0 = NOT SEL – Secondary outlet pressure monitoring not used.<br>1 = STOP – Detection of very high outlet pressure stops the drive. The drive will start again if the pressure falls below the supervision level.<br>2 = FAULT – Detection of very high outlet pressure trips the drive on a fault. | | | **NOT SEL** | |
| 4413 | **AI OUT VERY HIGH**<br>Supervision level for secondary outlet pressure monitoring function. See parameter *4409 OUTLET PROT CTRL*. Supervision level | **0.00 … 100.00%** | **1 = 0.01%** | **100.00%** | |

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4414 | **DI STATUS OUTLET** | | | **NOT SEL** | |
| | Selects the digital input for connection of a pressure switch at the pump/fan outlet. The "normal" state is 1 (active). If the selected input switches to 0 (inactive), the action defined by parameter *4409 OUTLET PROT CTRL* is taken after a delay set by parameter *4415 OUTLET CTRL DLY* expires.<br>0 = NOT SEL – No digital input selected.<br>1 = DI1 – Pump/fan outlet pressure monitored through digital input DI1.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1. | | | | |
| 4415 | **OUTLET CTRL DLY** | **0.1 … 1800.0 s** | **1 = 0.1 s** | **60.0 s** | |
| | Sets the delay after which the action defined by parameter *4409 OUTLET PROT CTRL* is taken on detection of high outlet pressure. | | | | |
| 4416 | **OUTLET FORCED REF** | **0.00 … 100.00%** | **1 = 0.01%** | **0.0%** | |
| | This reference is used after detection of high outlet pressure. See parameter *4409 OUTLET PROT CTRL*.<br>**WARNING!** Make sure that it is safe to continue operation using this reference. | | | | |
| 4417 | **PID OUT DEC TIME** | **0.0 … 3800.0 s** | **1 = 0.1 s** | **60.0 s** | |
| | PI controller ramp-down time. See selection PROTECT for parameters *4401 INLET PROT CTRL* and *4409 OUTLET PROT CTRL*. | | | | |
| 4418 | **APPL PROFILE CTL** | | | **NOT SEL** | |
| | Parameters *4418 APPL PROFILE CTL* to *4420 PROF LIMIT ON DLY* provide the Application profile protection feature, based on long-term monitoring of an internal status signal. If the selected signal exceeds (and remains above) the supervision limit for a longer time than the set delay (parameter *4420 PROF LIMIT ON DLY*), the internal status signal "PROFILE HIGH" is set to 1. The signal can be directed to a relay output (see parameter *Group 14: Relay outputs*).<br>0 = NOT SEL – Not selected.<br>1 = CONTROL DEV1 – Signal *0126 PID 1 OUTPUT* is monitored and compared to parameter *4419 PROFILE OUTP LIM*. Monitoring the deviation between the reference and the actual value gives an indication of the general condition of the pump, piping and valves.<br>2 = CONTROL DEV2 – Signal *0127 PID 2 OUTPUT* is monitored and compared to parameter *4419 PROFILE OUTP LIM*. Monitoring the deviation between the reference and the actual value gives an indication of the general condition of the pump, piping and valves.<br>3 = APPL OUTPUT – Signal *0116 APPL BLK OUTPUT* is monitored and compared to parameter *4419 PROFILE OUTP LIM*. The signal constantly remaining at 100% may indicate a leak in the output piping. | | | | |
| 4419 | **PROFILE OUTP LIM** | **-500.0 … 500.0%** | **1 = 0.1%** | **100.0%** | |
| | Supervision limit for the Application profile protection. | | | | |
| 4420 | **PROF LIMIT ON DLY** | **0.00 … 100.00 h** | **1 = 0.01 h** | **0.00 h** | |
| | Delay time for the Application profile protection. | | | | |

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4421 | **PIPEFILL ENABLE** | | | **NOT SEL** | |
| | Enables the Precharge function, which calculates reference steps.<br>0 = NOT SEL – Not enabled.<br>1 = DI1 – When DI1 is active (1), the Precharge function is active when the drive is started. If DI1 becomes inactive (0) before the Precharge function is finished, normal PID control is enabled.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1.<br>7 = ACTIVE – The Precharge function is active at every start-up.<br>-1 = DI1(INV) – When DI1 is inactive (0), the Precharge function is active when the drive is started. If DI1 becomes active (1) before the Precharge function is finished, normal PID control is enabled.<br>-2 = DI2(INV) – See selection DI1(INV).<br>-3 = DI3(INV) – See selection DI1(INV).<br>-4 = DI4(INV) – See selection DI1(INV).<br>-5 = DI5(INV) – See selection DI1(INV). | | | | |
| 4422 | **PIPEFILL STEP** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Defines the speed step used in the Precharge function. The PID reference ramp time is specified by parameter *4032 PID REF ACC TIME*.<br>The speed step is added to the reference after the time defined by parameter *4424 ACT CHANGE DELAY* has elapsed and the change in feedback defined by parameter *4423 REQ ACT CHANGE* has not been reached.<br>• Speed step in percent of the maximum speed output | | | | |
| 4423 | **REQ ACT CHANGE** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Defines the requested change in process feedback during the time that is set by parameter *4424 ACT CHANGE DELAY*.<br>If the requested change in the feedback is not reached, *4422 PIPEFILL STEP* is added to the speed reference.<br>• Value in percent of the maximum speed. | | | | |
| 4424 | **ACT CHANGE DELAY** | **0.1 … 6000.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the time that is waited after the feedback value is compared with the old feedback value.<br>If parameter *4423 REQ ACT CHANGE* is measured in the feedback value, the speed reference stays as it is. If REQ ACT CHANGE is not seen in the feedback value, the value of parameter *4422 PIPEFILL STEP* is added to the speed reference. | | | | |
| 4425 | **PID ENABLE DEV** | **0.0 … 100.0%** | **1 = 0.1%** | **0.1%** | |
| | Defines the level when the Precharge function is disabled and PID is enabled. When the level is reached, PID is enabled. PID is executed as parameterized. If reference ramp times are set, they are used.<br>• Value in percent of the maximum feedback. | | | | |

| Group 44: Pump protection | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4426 | **PIPEFILL TIMEOUT** | **1 … 60000 s** | **1 = 1 s** | **NOT SEL** | |
| | Defines the maximum time the Precharge function is allowed to operate. If this time elapses, PID is preset and PID is allowed to run as it is parameterized – with or without reference ramps.<br>0 = NOT SEL - 1…60000 s: Max. Precharge operating time | | | | |

## Group 45: Energy saving

This group defines the set-up for calculation and optimization of energy savings.

**Note:** The values of saved energy parameters *0174 SAVED KWH*, *0175 SAVED MWH*, *0176 SAVED AMOUNT 1*, *0177 SAVED AMOUNT 2* and *0178 SAVED CO2* are derived from subtracting the drive's energy consumed from the direct-on-line (DOL) consumption calculated on the basis of parameter *4508 PUMP POWER*. As such, the accuracy of the values is dependent on the accuracy of the power estimate entered in that parameter.

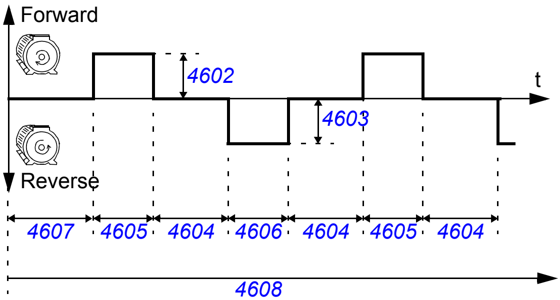
| Group 45: Energy saving | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4501 | **ENERGY OPTIMIZER** | | | **OFF** | |
| | Enables or disables the energy optimizer, which optimizes the flux so that the total energy consumption and motor noise level are reduced when the drive operates below the nominal load. The total efficiency (motor and drive) can be improved by 1…10% depending on load torque and speed.<br>0 = OFF – Disabled.<br>1 = ON – Enabled. | | | | |
| 4502 | **ENERGY PRICE** | **0.00 … 655.35** | **1 = 0.1 (Currency)** | **0.00 (Currency)** | |
| | Price of energy per kWh. Used for reference when energy savings are calculated. See parameters *0174 SAVED KWH*, *0175 SAVED MWH*, *0176 SAVED AMOUNT 1*, *0177 SAVED AMOUNT 2* and *0178 SAVED CO2* (reduction in carbon dioxide emissions in tn). | | | | |
| 4507 | **CO2 CONV FACTOR** | **0.0 … 655.35 tn/MWh** | **1 = 0.1 tn/MWh** | **0.5 tn/MWh** | |
| | Conversion factor for converting energy into CO2 emissions (kg/kWh or tn/MWh). Used for multiplying the saved energy in MWh to calculate the value of parameter *0178 SAVED CO2* (reduction in carbon dioxide emissions in tn). | | | | |
| 4508 | **PUMP POWER** | **0.0 … 1000.0%** | **1 = 0.1%** | **100.0%** | |
| | Pump power when connected directly to supply (DOL). Used for reference when energy savings are calculated. See parameters *0174 SAVED KWH*, *0175 SAVED MWH*, *0176 SAVED AMOUNT 1*, *0177 SAVED AMOUNT 2* and *0178 SAVED CO2*.<br>It is possible to use this parameter as the reference power also for other applications than pumps. The reference power can also be some other constant power than a motor connected directly on-line. | | | | |

| Group 45: Energy saving | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 4509 | **ENERGY RESET** | | | **DONE** | |
| | Resets energy calculators *0174 SAVED KWH*, *0175 SAVED MWH*, *0176 SAVED AMOUNT 1*, *0177 SAVED AMOUNT 2* and *0178 SAVED CO2*.<br>0 = DONE – Reset not requested (normal operation).<br>1 = RESET – Reset energy counters. The value reverts automatically to DONE. | | | | |

## Group 46: Pump cleaning

This group defines the set-up for pump cleaning.

<table>
<tr><th colspan="6">Group 46: Pump cleaning</th></tr>
<tr><th>Code</th><th>Description</th><th>Range</th><th>Resolution</th><th>Default</th><th>S</th></tr>
<tr><td>4601</td><td>PUMP CLEAN TRIG</td><td></td><td></td><td>NOT SEL</td><td></td></tr>
<tr><td></td><td colspan="5">
Defines how the Pump cleaning function is triggered. The pump cleaning sequence consists of forward and reverse “steps”.




**WARNING!** Before enabling the Pump cleaning function ensure it is safe to perform the Pump cleaning sequence with the connected equipment.

**Notes:**

- The Pump cleaning function overrides parameter *1003 DIRECTION*.
- The Pump cleaning function observes the maximum forward and reverse frequencies (parameters *2007 MINIMUM FREQ* and *2008 MAXIMUM FREQ*).
- The Pump cleaning function always uses acceleration time 2 (parameter *2205 ACCELER TIME 2*) and deceleration time 2 (parameter *2006 UNDERVOLT CTRL*).
- The drive must be started and its Run enable signal must be present before the Pump cleaning function sequence can start.

0 = NOT SEL – No triggering source defined.<br>
1 = DI1 – Trigger on the rising edge of digital input DI1.<br>
2 = DI2 – See selection DI1.<br>
3 = DI3 – See selection DI1.<br>
4 = DI4 – See selection DI1.<br>
5 = DI5 – See selection DI1.
</td></tr>
</table>

| Group 46: Pump cleaning | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 7 = DI1/SUP1OVR – Enable on the rising edge of digital input DI1, trigger on SUPRV1 OVER (parameter *1401 RELAY OUTPUT 1*). See parameter *Group 32: Supervision*.<br>8 = DI2/SUP1OVR – See selection DI1/SUP1OVR.<br>9 = DI3/SUP1OVR – See selection DI1/SUP1OVR.<br>10 = DI4/SUP1OVR – See selection DI1/SUP1OVR.<br>11 = DI5/SUP1OVR – See selection DI1/SUP1OVR.<br>12 = SUPRV1 OVER – Trigger on SUPRV1 OVER (parameter *1401 RELAY OUTPUT 1*). See parameter *Group 32: Supervision*.<br>13 = DRIVE START – Trigger when the drive receives a start command.<br>14 = TIMER TRIG – Pump cleaning sequence is started periodically at intervals defined by parameter *4607 TRIG TIME*.<br>-1 = DI1(INV) – Trigger on the falling edge of digital input DI1.<br>-2 = DI2(INV) – See selection DI1(INV).<br>-3 = DI3(INV) – See selection DI1(INV).<br>-4 = DI4(INV) – See selection DI1(INV).<br>-5 = DI5(INV) – See selection DI1(INV).<br>-7 = DI1(INV)S1O – Enable on the falling edge of digital input DI1, trigger on SUPRV1 OVER (parameter *1401 RELAY OUTPUT 1*). See parameter *Group 32: Supervision*.<br>-8 = DI2(INV)S1O – See selection DI1(INV)S1O.<br>-9 = DI3(INV)S1O – See selection DI1(INV)S1O.<br>-10 = DI4(INV)S1O – See selection DI1(INV)S1O.<br>-11 = DI5(INV)S1O – See selection DI1(INV)S1O. | | | | |
| 4602 | **FWD STEP** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Defines the forward step frequency for the pump cleaning sequence in percent of the nominal motor frequency (parameter *9907 MOTOR NOM FREQ*). | | | | |
| 4603 | **REV STEP** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Defines the reverse step frequency for the pump cleaning sequence in percent of the nominal motor frequency (parameter *9907 MOTOR NOM FREQ*). | | | | |
| 4604 | **OFF TIME** | **0.0 … 1000.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the length of the interval between forward and reverse steps in the pump cleaning sequence in seconds. | | | | |
| 4605 | **FWD TIME** | **0.0 … 1000.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the duration of each forward step in the pump cleaning sequence in seconds. | | | | |
| 4606 | **REV TIME** | **0.0 … 1000.0 s** | **1 = 0.1 s** | **0.0 s** | |
| | Defines the duration of each reverse step in the pump cleaning sequence in seconds. | | | | |
| 4607 | **TRIG TIME** | **0.0 … 200.0 h** | **1 = 0.1 h** | **0.0 h** | |
| | Defines the time for setting TIMER TRIG of parameter *4601 PUMP CLEAN TRIG*. | | | | |
| 4608 | **COUNT** | **0…100** | **1 = 1** | **0** | |
| | Number of steps to be performed in the pump cleaning sequence. | | | | |

## Group 52: Panel comm

This group defines the communication settings for the control panel port on the drive. Normally, when using the supplied control panel, there is no need to change settings in this group.

In this group, parameter modifications take effect on the next power-up.

| Group 52: Panel comm | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 5201 | **STATION ID** | **1…247** | **1** | **1** | |
| | Defines the address of the drive. Two units with the same address are not allowed on-line.<br>• Range: 1…247 | | | | |
| 5202 | **BAUD RATE** | **9.6 … 115.2 kbits/s** | **-** | **9.6 kbits/s** | |
| | Defines the transfer rate of the link.<br>9.6<br>19.2<br>38.4<br>57.6<br>115.2 | | | | |
| 5203 | **PARITY** | **0…3** | **1** | **0** | |
| | Defines the use of parity and stop bit(s). The same setting must be used in all on-line stations.<br>0 = 8N1 – 8 data bits, no parity, one stop bit.<br>1 = 8N2 – 8 data bits, no parity, two stop bits.<br>2 = 8E1 – 8 data bits, even parity indication bit, one stop bit.<br>3 = 8O1 – 8 data bits, odd parity indication bit, one stop bit. | | | | |
| 5204 | **OK MESSAGES** | **0…65535** | **1** | **-** | |
| | Number of valid messages received by the drive. During normal operation, this number increases constantly. | | | | |
| 5205 | **PARITY ERRORS** | **0…65535** | **1** | **-** | |
| | Number of characters with a parity error received from the Modbus link. If the number is high, check that the parity settings of the devices connected on the bus are the same.<br>**Note:** High electromagnetic noise levels generate errors. | | | | |
| 5206 | **FRAME ERRORS** | **0…65535** | **1** | **-** | |
| | Number of characters with a framing error received by the Modbus link. If the number is high, check that the communication speed settings of the devices connected on the bus are the same.<br>**Note:** High electromagnetic noise levels generate errors. | | | | |
| 5207 | **BUFFER OVERRUNS** | **0…65535** | **1** | **-** | |
| | Number of characters which overflow the buffer, in other words, number of characters which exceed the maximum message length, 128 bytes. | | | | |

| Group 52: Panel comm | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 5208 | **CRC ERRORS** | **0…65535** | **1** | **-** | |
| | Number of messages with a CRC (cyclic redundancy check) error received by the drive. If the number is high, check CRC calculation for possible errors.<br>**Note:** High electromagnetic noise levels generate errors. | | | | |

## Group 53: EFB protocol

This group defines set-up variables used for an embedded fieldbus (EFB) communication protocol. Refer to communication protocol documentation for more information on these parameters.

| Group 53: EFB protocol | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 5301 | **EFB PROTOCOL ID** | **0000 … FFFF hex** | **1** | **0000 hex** | |
| | Contains the identification and program revision of the protocol.<br>**Note:** You can reset this parameter only with parameter *9802 COMM PROT SEL*.<br>• Format XXYY hex, where XX = protocol ID and YY = program revision of the protocol. | | | | |
| 5302 | **EFB STATION ID** | **0…65535** | **1** | **1** | ✓ |
| | Defines the address of the device. Two units with the same address are not allowed on-line. | | | | |
| 5303 | **EFB BAUD RATE** | **1.2 … 76.8 kbits/s** | **-** | **9.6 kbits/s** | |
| | Defines the transfer rate of the link.<br>1.2 kbits/s<br>2.4 kbits/s<br>4.8 kbits/s<br>9.6 kbits/s<br>19.2 kbits/s<br>38.4 kbits/s<br>57.6 kbits/s<br>76.8 kbits/s | | | | |
| 5304 | **EFB PARITY** | **0…3** | | **0** | |
| | Defines the use of parity and stop bit(s) and the data length. The same setting must be used in all on-line stations.<br>0 = 8 NONE 1 – 8 data bits, no parity, one stop bit.<br>1 = 8 NONE 2 – 8 data bits, no parity, two stop bits.<br>2 = 8 EVEN 1 – 8 data bits, even parity, one stop bit.<br>3 = 8 ODD 1 – 8 data bits, odd parity, one stop bit. | | | | |

| Group 53: EFB protocol | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 5305 | **EFB CTRL PROFILE** | **0…2** | **1** | **0** | |
| | Selects the communication profile. See section *Communication profiles* on page *319*.<br>0 = ABB DRV LIM – Operation of Control/Status words conforms to ABB Drives Profile.<br>1 = DCU PROFILE – Operation of Control/Status words conforms to 32-bit DCU Profile.<br>2 = ABB DRV FULL – Operation of Control/Status words conforms to ABB Drives Profile. | | | | |
| 5306 | **EFB OK MESSAGES** | **0…65535** | **1** | **0** | |
| | Number of valid messages received by the drive. During normal operation, this number increases constantly. | | | | |
| 5307 | **EFB CRC ERRORS** | **0…65535** | **1** | **0** | |
| | Number of messages with a CRC (cyclic redundancy check) error received by the drive. If the number is high, check CRC calculation for possible errors.<br>**Note:** High electromagnetic noise levels generate errors. | | | | |
| 5308 | **EFB UART ERRORS** | **0…65535** | **1** | **0** | |
| | Number of messages with a character error received by the drive. | | | | |
| 5309 | **EFB STATUS** | **0…7** | **1** | **0** | |
| | Status of the EFB protocol.<br>0 = IDLE – EFB protocol is configured, but not receiving any messages.<br>1 = EXECUT INIT – EFB protocol is initializing.<br>2 = TIME OUT – A time-out has occurred in the communication between the network master and the EFB protocol.<br>3 = CONFIG ERROR – EFB protocol has a configuration error.<br>4 = OFF-LINE – EFB protocol is receiving messages that are NOT addressed to this drive.<br>5 = ON-LINE – EFB protocol is receiving messages that are addressed to this drive.<br>6 = RESET– EFB protocol is performing a hardware reset.<br>7 = LISTEN ONLY – EFB protocol is in listen-only mode. | | | | |
| 5310…<br>5320 | **EFB PAR 10…EFB PAR 20** | **0…65535** | **1** | **Protocol dep.** | |

## Group 64: Load analyzer

This group defines the settings for the load analyzing function for peak value and amplitude. See section *Load analyzer* on page *130*.

| Group 64: Load analyzer | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 6401 | **PVL SIGNAL** | **x…x** | | **103** | |
| | Defines the signal logged for peak value. Parameter index in *Group 01: Operating data*. For example, 102 = *0102 SPEED*. | | | | |
| 6402 | **PVL FILTER TIME** | **0.0 … 120.0 s** | **1 = 0.1 s** | **0.1 s** | |
| | Defines the filter time for peak value logging. Filter time | | | | |

| Group 64: Load analyzer | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 6403 | **LOGGERS RESET**<br>Defines the source for the reset of loggers.<br>0 = NOT SEL – No reset selected.<br>1 = DI1 – Reset loggers on the rising edge of DI1.<br>2 = DI2 – See selection DI1.<br>3 = DI3 – See selection DI1.<br>4 = DI4 – See selection DI1.<br>5 = DI5 – See selection DI1.<br>7 = RESET – Reset loggers. Parameter is set to NOT SEL.<br>-1 = DI1(INV) – Reset loggers on the falling edge of DI1.<br>-2 = DI2(INV) – See selection DI1(INV).<br>-3 = DI3(INV) – See selection DI1(INV).<br>-4 = DI4(INV) – See selection DI1(INV).<br>-5 = DI5(INV) – See selection DI1(INV). | | | **NOT SEL** | |
| 6404 | **AL2 SIGNAL**<br>Defines the signal logged for amplitude logger 2. Parameter index in *Group 01: Operating data*. For example, 102 = *0102 SPEED*. | **x…x** | | **103** | |
| 6405 | **AL2 SIGNAL BASE**<br>Defines the base value from which the percentage distribution is calculated. Representation and default value depends on the signal selected with parameter *6404 AL2 SIGNAL*. | **-** | | **-** | |
| 6406 | **PEAK VALUE**<br>Detected peak value of the signal selected with parameter *6401 PVL SIGNAL*. | **-** | | **-** | |
| 6407 | **PEAK TIME 1**<br>Date of the peak value detection. Day on which the peak value was detected.<br>Format: Date if the real time clock is operating. / The number of days elapsed after the power-on if the real time clock is not used, or was not set. | **0 … 65535 d** | **1 = 1 d** | **0 d** | |
| 6408 | **PEAK TIME 2**<br>Time of the peak value detection. | **00:00:00 … 23:59:58** | | **00:00:00** | |
| 6409 | **CURRENT AT PEAK**<br>Current at the moment of the peak value | **0.0 … 6553.5 A** | **1 = 0.1 A** | **0.0 A** | |
| 6410 | **UDC AT PEAK**<br>DC voltage at the moment of the peak value | **0 … 65535 V** | **1 = 1 V** | **0 V** | |
| 6411 | **FREQ AT PEAK**<br>Output frequency at the moment of the peak value | **0.0 … 6553.5 Hz** | **1 = 0.1 Hz** | **0.0 Hz** | |
| 6412 | **TIME OF RESET 1**<br>Last reset date of the peak logger and amplitude logger 2. Day of the last reset.<br>Format: Date if the real time clock is operating. / Number of days elapsed after the power-on if the real time clock is not used, or was not set. | **0 … 65535 d** | **1 = 1 d** | **0 d** | |
| 6413 | **TIME OF RESET 2**<br>Last reset time of the peak logger and amplitude logger 2. | **00:00:00 … 23:59:58** | | **00:00:00** | |

| Group 64: Load analyzer | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 6414 | **AL1RANGE0TO10** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 0…10% distribution | | | | |
| 6415 | **AL1RANGE10TO20** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 10…20% distribution | | | | |
| 6416 | **AL1RANGE20TO30** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 20…30% distribution | | | | |
| 6417 | **AL1RANGE30TO40** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 30…40% distribution | | | | |
| 6418 | **AL1RANGE40TO50** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6419 | **AL1RANGE50TO60** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6420 | **AL1RANGE60TO70** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6421 | **AL1RANGE70TO80** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6422 | **AL1RANGE80TO90** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6423 | **AL1RANGE90TO** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 1 (current in percent of nominal current) 40…50% distribution | | | | |
| 6424 | **AL2RANGE0TO10** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 0…10% distribution | | | | |
| 6425 | **AL2RANGE10TO20** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 10…20% distribution | | | | |
| 6426 | **AL2RANGE20TO30** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 20…30% distribution | | | | |
| 6427 | **AL2RANGE30TO40** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 30…40% distribution | | | | |
| 6428 | **AL2RANGE40TO50** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 40…50% distribution | | | | |
| 6429 | **AL2RANGE50TO60** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 50…60% distribution | | | | |
| 6430 | **AL2RANGE60TO70** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 60…70% distribution | | | | |
| 6431 | **AL2RANGE70TO80** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 70…80% distribution | | | | |
| 6432 | **AL2RANGE80TO90** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 80…90% distribution | | | | |

| Group 64: Load analyzer | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 6433 | **AL2RANGE90TO** | **0.0 … 100.0%** | **1 = 0.1%** | **0.0%** | |
| | Amplitude logger 2 (selection with parameter *6404*) 90…100% distribution | | | | |

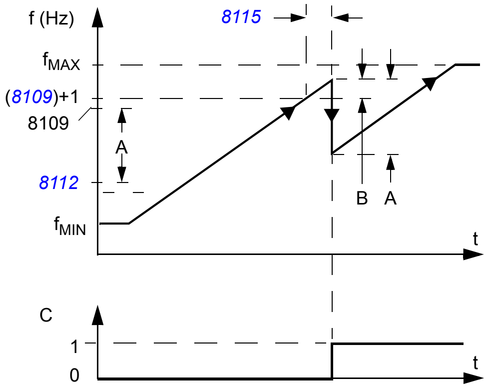
## Group 81: PFA control

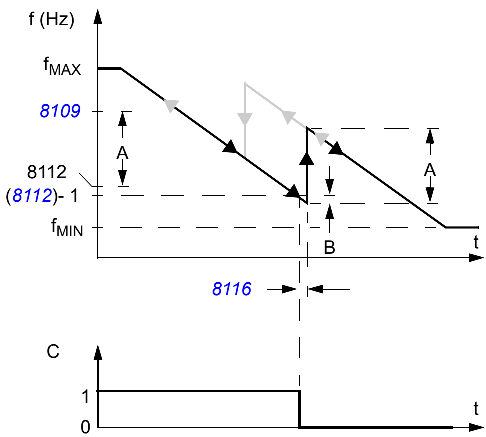
This group defines a Pump and Fan Alternation (PFA) mode of operation. The major features of PFA are:

- The ACS320 controls the motor of pump no. 1, varying the motor speed to control the pump capacity. This motor is the speed regulated motor.
- Direct line connections power the motor of pump no. 2 and pump no. 3, etc. The ACS320 switches pump no. 2 (and then pump no. 3, etc.) on and off as needed. These motors are auxiliary motors. Use of the MREL-01 relay output module is required for control of pump no. 2 and no. 3.
- The ACS320 PID control uses two signals: a process reference and an actual value feedback. The PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference.
- When demand (defined by the process reference) exceeds the first motor’s capacity (user defined as a frequency limit), the PFA automatically starts an auxiliary pump. The PFA also reduces the speed of the first pump to account for the auxiliary pump’s addition to total output. Then, as before, the PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference. If demand continues to increase, PFA adds additional auxiliary pumps, using the same process.
- When demand drops, such that the first pump speed falls below a minimum limit (user defined by a frequency limit), the PFA automatically stops an auxiliary pump. The PFA also increases the speed of the first pump to account for the auxiliary pump’s missing output.
- An Interlock function (when enabled) identifies off-line (out of service) motors, and the PFA skips to the next available motor in the sequence.

An Autochange function (when enabled and with the appropriate switchgear) equalizes duty time between the pump motors. Autochange periodically increments the position of each motor in the rotation – the speed regulated motor becomes the last auxiliary motor, the first auxiliary motor becomes the speed regulated motor, etc.

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8103 | **REFERENCE STEP 1** | **0.0 … 100.0%** | **0.1%** | **0.0%** | |
| | Sets a percentage value that is added to the process reference.<br>• Applies only when at least one auxiliary (constant speed) motor is running.<br>• Default value is 0%.<br>**Example:** An ACS320 operates three parallel pumps that maintain water pressure in a pipe.<br>• Parameter *4011 INTERNAL SETPNT* sets a constant pressure reference that controls the pressure in the pipe.<br>• The speed regulated pump operates alone at low water consumption levels.<br>• As water consumption increases, first one constant speed pump operates, then, the second.<br>• As flow increases, the pressure at the output end of the pipe drops relative to the pressure measured at the input end. As auxiliary motors step in to increase the flow, the adjustments below correct the reference to more closely match the output pressure.<br>• When the first auxiliary pump operates, increase the reference with parameter 8103 REFERENCE STEP 1.<br>• When both auxiliary pumps operate, increase the reference with parameter 8103 REFERENCE STEP 1 + parameter *8104 REFERENCE STEP 2*.<br>• When three auxiliary pumps operate, increase the reference with parameter 8103 REFERENCE STEP 1 + parameter *8104 REFERENCE STEP 2* + parameter *8105 REFERENCE STEP 3*. | | | | |
| 8104 | **REFERENCE STEP 2** | **0.0 … 100.0%** | **0.1%** | **0.0%** | |
| | Sets a percentage value that is added to the process reference.<br>• Applies only when at least two auxiliary (constant speed) motors are running.<br>• See parameter *8103 REFERENCE STEP 1*. | | | | |
| 8105 | **REFERENCE STEP 3** | **0.0 … 100.0%** | **0.1%** | **0.0%** | |
| | Sets a percentage value that is added to the process reference.<br>• Applies only when at least three auxiliary (constant speed) motors are running.<br>• See parameter *8103 REFERENCE STEP 1*. | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8109 | **START FREQ 1** | **0.0 … 500.0 Hz** | **0.1 Hz** | **60.0** | |
| | Sets the frequency limit used to start the first auxiliary motor. The first auxiliary motor starts if:<br>• No auxiliary motors are running.<br>• ACS320 output frequency exceeds the limit: 8109 START FREQ 1 + 1 Hz.<br>• Output frequency stays above a relaxed limit (8109 START FREQ 1 - 1 Hz) for at least the time: *8115 AUX MOT START D*.<br>After the first auxiliary motor starts:<br>• Output frequency decreases by the value = (8109 START FREQ 1) - (*8112 LOW FREQ 1*).<br><br><br>• In effect, the output of the speed regulated motor drops to compensate for the input from the auxiliary motor.<br>See the figure, where:<br>A = (8109 START FREQ 1) - (*8112 LOW FREQ 1*)<br>B = Output frequency increase during the start delay.<br>C = Diagram showing auxiliary motor's run status as frequency increases (1 = On).<br>**Note:** 8109 START FREQ 1 value must be between:<br>• *8112 LOW FREQ 1*<br>• (*2008 MAXIMUM FREQ*) -1. | | | | |
| 8110 | **START FREQ 2** | **0.0 … 500.0 Hz** | **0.1 Hz** | **60.0** | |
| | Sets the frequency limit used to start the second auxiliary motor.<br>• See parameter *8109 START FREQ 1* for a complete description of the operation.<br>The second auxiliary motor starts if:<br>• One auxiliary motor is running.<br>• ACS320 output frequency exceeds the limit: 8110 START FREQ 2 + 1.<br>• Output frequency stays above the relaxed limit (8110 START FREQ 2 - 1 Hz) for at least the time: *8115 AUX MOT START D*. | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8111 | **START FREQ 3** | **0.0 … 500.0 Hz** | **0.1 Hz** | **60.0** | |
| | Sets the frequency limit used to start the third auxiliary motor.<br>• See parameter *8109 START FREQ 1* 1for a complete description of the operation.<br>The third auxiliary motor starts if:<br>• Two auxiliary motors are running.<br>• ACS320 output frequency exceeds the limit: 8111 START FREQ 3 + 1 Hz.<br>• Output frequency stays above the relaxed limit (8111 START FREQ 3 - 1 Hz) for at least the time: *8115 AUX MOT START D*. | | | | |
| 8112 | **LOW FREQ 1** | **0.0 … 500.0 Hz** | **0.1 Hz** | **25.0** | |
| | Sets the frequency limit used to stop the first auxiliary motor. The first auxiliary motor stops if:<br>• First auxiliary motor is running alone.<br>• ACS320 output frequency drops below the limit: 8112 LOW FREQ 1 - 1.<br>• Output frequency stays below the relaxed limit (8112 LOW FREQ 1 + 1 Hz) for at least the time: *8116 AUX MOT STOP D*.<br>After the first auxiliary motor stops:<br>• Output frequency increases by the value = (*8109 START FREQ 1*) - (8112 LOW FREQ 1).<br><br><br>• In effect, the output of the speed regulated motor increases to compensate for the loss of the auxiliary motor.<br>See the figure, where:<br>• A = (*8109 START FREQ 1*) - (8112 LOW FREQ 1)<br>• B = Output frequency decrease during the stop delay.<br>• C = Diagram showing auxiliary motor's run status as frequency decreases (1 = On).<br>• Grey path = Shows hysteresis – if time is reversed, the path backwards is not the same. For details on the path for starting, see the diagram at *8109 START FREQ 1*.<br>**Note:** Low Frequency 1 value must be between:<br>• (*2007 MINIMUM FREQ*).<br>• *8109 START FREQ 1* | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8113 | **LOW FREQ 2** | **0.0 … 500.0 Hz** | **0.1 Hz** | **25.0** | |
| | Sets the frequency limit used to stop the second auxiliary motor.<br>• See *8112 LOW FREQ 1* for a complete description of the operation.<br>The second auxiliary motor stops if:<br>• Two auxiliary motors are running.<br>• Drive output frequency drops below the limit: 8113 LOW FREQ 2 - 1.<br>• Output frequency stays below the relaxed limit (8113 LOW FREQ 2 + 1 Hz) for at least the time: *8116 AUX MOT STOP D*. | | | | |
| 8114 | **LOW FREQ 3** | **0.0 … 500.0 Hz** | **0.1 Hz** | **25.0** | |
| | Sets the frequency limit used to stop the third auxiliary motor.<br>• See *8112 LOW FREQ 1* for a complete description of the operation.<br>The third auxiliary motor stops if:<br>• Three auxiliary motors are running.<br>• ACS320 output frequency drops below the limit: 8114 LOW FREQ 3 - 1.<br>• Output frequency stays below the relaxed limit (8114 LOW FREQ 3 + 1 Hz) for at least the time: *8116 AUX MOT STOP D*. | | | | |
| 8115 | **AUX MOT START D** | **0.0 … 3600.0 s** | **0.1 s; 1 s** | **5.0 s** | |
| | Sets the Start delay for the auxiliary motors.<br>• The output frequency must remain above the start frequency limit (parameter *8109*, *8110*, or *8111*) for this time period before the auxiliary motor starts.<br>• See *8109 START FREQ 1* for a complete description of the operation. | | | | |
| 8116 | **AUX MOT STOP D** | **0.0 … 3600.0 s** | **0.1 s; 1 s** | **3.0 s** | |
| | Sets the Stop delay for the auxiliary motors.<br>• The output frequency must remain below the low frequency limit (parameter *8112*, *8113*, or *8114*) for this time period before the auxiliary motor stops.<br>• See *8112 LOW FREQ 1* for a complete description of the operation. | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8117 | **NR OF AUX MOT** | **0…4 (5 with TO)** | **1 = 1** | **1** | ✓ |

Sets the number of auxiliary motors. Each auxiliary motor requires a relay output, which the drive uses to send start/stop signals.

The Autochange function, if used, requires an additional relay output for the speed regulated motor.

The following describes the set-up of the required relay outputs.

**Relay outputs**

As noted above, each auxiliary motor requires a relay output, which the drive uses to send start/stop signals. The following describes how the drive keeps track of motors and relays.

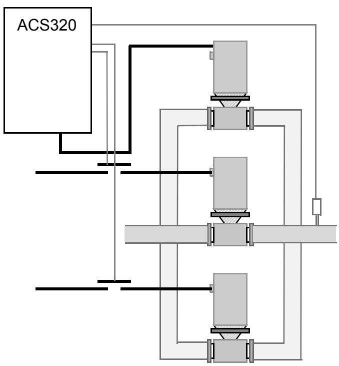
The drive provides one relay output RO1. An external relay output module can be added to provide relay outputs RO2…RO4.

**Note:** If five auxiliary motors are used (Autochange disabled), use transistor output TO in addition to relay outputs RO1…RO4. Note that max. voltage at TO is 30 V DC.

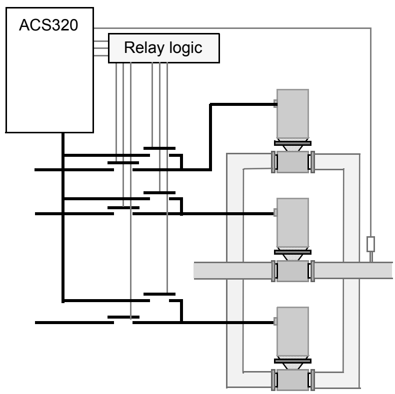
Parameters *1401*…*1403* and *1410* define, respectively, how relays RO1…RO4 are used – the parameter value 31 (PFA) defines the relay as used for PFA.

The drive assigns auxiliary motors to relays in ascending order. If the Autochange function is disabled, the first auxiliary motor is the one connected to the first relay with a parameter setting = 31 (PFA), and so on.

If the Autochange function is used, the assignments rotate. Initially, the speed regulated motor is the one connected to the first relay with a parameter setting = 31 (PFA), the first auxiliary motor is the one connected to the second relay with a parameter setting = 31 (PFA), and so on. The fourth auxiliary motor uses the same reference step, low frequency and start frequency values as the third auxiliary motor. Number of auxiliary motors.




Standard PFC mode




PFC with Autochange mode

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |

The table below shows the PFA motor assignments for some typical settings in the relay output parameters (*1401*…*1403* and *1410*), where the settings are either = 31 (), or =X (anything but 31), and where the Autochange function is disabled (*8118 AUTOCHNG INTERV* = 0).

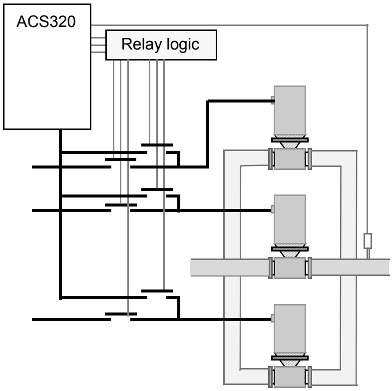
| Parameter setting | | | | | Relay assignment | | | |
|---|---|---|---|---|---|---|---|---|
| 1401 | 1402 | 1403 | 1410 | 8117 | Autochange disabled | | | |
| | | | | | RO1 | RO2 | RO3 | RO4 |
| 31 | X | X | X | 1 | Aux. | X | X | X |
| 31 | 31 | X | X | 2 | Aux. | Aux. | X | X |
| 31 | 31 | 31 | X | 3 | Aux. | Aux. | Aux. | X |
| X | 31 | 31 | X | 2 | X | Aux. | Aux. | X |
| 31 | 31 | X | X | 1* | Aux. | Aux. | X | X |

* = One additional relay output for the PFC that is in use. One motor is in "sleep" when the other is rotating.

The table below shows the PFA motor assignments for some typical settings in the relay output parameters (*1401*…*1403* and *1410*), where the settings are either = 31 (), or =X (anything but 31), and where the Autochange function is enabled (*8118 AUTOCHNG INTERV* > 0).

| Parameter setting | | | | | Relay assignment | | | |
|---|---|---|---|---|---|---|---|---|
| 1401 | 1402 | 1403 | 1410 | 8117 | Autochange enabled | | | |
| | | | | | RO1 | RO2 | RO3 | RO4 |
| 31 | 31 | X | X | 1 | PFA | PFA | X | X |
| 31 | 31 | 31 | X | 2 | PFA | PFA | PFA | X |
| X | 31 | 31 | X | 1 | X | PFA | PFA | X |
| 31 | 31 | X | X | 0** | PFA | PFA | X | X |

** = No auxiliary motors, but the Autochange function is in use. Working as a standard PID-control.

<table>
<tr><th colspan="6">Group 81: PFA control</th></tr>
<tr><th>Code</th><th>Description</th><th>Range</th><th>Resolution</th><th>Default</th><th>S</th></tr>
<tr><td>8118</td><td>AUTOCHNG INTERV</td><td>0.1 … 336.0 h</td><td>1 = 0.1 h</td><td>NOT SEL</td><td></td></tr>
<tr><td></td><td colspan="5">
Controls operation of the Autochange function and sets the interval between changes.<br>
The Autochange time interval only applies to the time when the speed regulated motor is running.<br>
See parameter 8119 AUTOCHNG LEVEL for an overview of the Autochange function.<br>
The drive always coasts to stop when the Autochange function is performed. The Autochange enabled selection requires parameter 8120 INTERLOCKS > 0.<br>
⚠ WARNING! When enabled, the Autochange function requires the interlocks (8120 INTERLOCKS > 0) enabled. During the Autochange function the power output is interrupted and the drive coasts to stop, preventing damage to the contacts.<br>


PFC with Autochange mode<br>
-0.1 = TEST MODE – Forces the interval to value 36…48 s.<br>
0.0 = NOT SEL – Disables the Autochange function.<br>
The operating time interval (the time when the start signal is on) between automatic motor changes.
</td></tr>
</table>

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8119 | **AUTOCHNG LEVEL** | **0.0 … 100.0%** | **0.1%** | **50.0%** | |

Sets an upper limit, as a percent of output capacity, for the autochange logic. When the output from the PID/PFA control block exceeds this limit, the Autochange function is prevented. For example, use this parameter to deny the Autochange function when the Pump-Fan system is operating near maximum capacity.

**Autochange overview**

The purpose of the autochange operation is to equalize duty time between multiple motors used in a system. At each autochange operation:

- A different motor takes a turn connected to the ACS320 output – the speed regulated motor.
- The starting order of the other motors rotates.

The Autochange function requires:

- External switchgear for changing the drive's output power connections.
- Parameter *8120 INTERLOCKS* = value > 0.

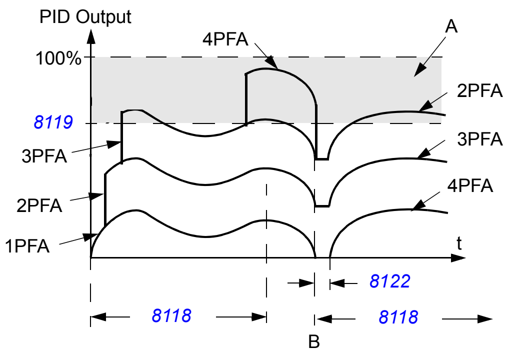
The Autochange function is performed when:

- The running time since the previous autochange operation reaches the time set by *8118 AUTOCHNG INTERV*.
- The PFA input is below the level set by this parameter, *8119 AUTOCHNG LEVEL*.

**Note:** The ACS320 always coasts to stop when autochange operation is performed.

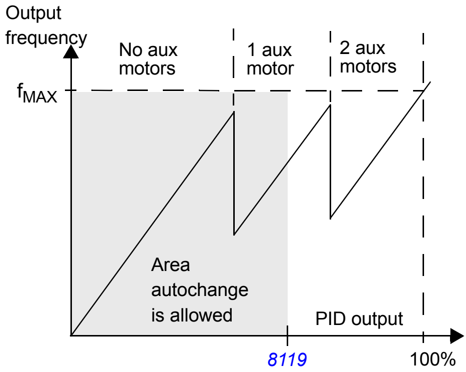
In an autochange operation, the Autochange function does all of the following (see the figure below):

- Initiates a change when the running time, since the last autochange operation, reaches *8118 AUTOCHNG INTERV*, and PFA input is below limit 8119 AUTOCHNG LEVEL.
- Stops the speed regulated motor.
- Switches off the contactor of the speed regulated motor.
- Increments the starting order counter, to change the starting order for the motors.




A = Area above *8119 AUTOCHNG LEVEL* – autochange operation not allowed.
B = Autochange operation occurs.
1PFA, etc. = PID output associated with each motor.

- Identifies the next motor in line to be the speed regulated motor.
- Switches off the above motor's contactor, if the motor was running. Any other running motors are not interrupted.
- Switches on the contactor of the new speed regulated motor. The autochange switchgear connects this motor to the ACS320 power output.
- Delays motor start for the time *8122 PFA START DELAY*.

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | • Starts the speed regulated motor.<br>• Identifies the next constant speed motor in the rotation.<br>• Switches the above motor on, but only if the new speed regulated motor had been running (as a constant speed motor) – This step keeps an equal number of motors running before and after autochange operation.<br>• Continues with a normal PFA operation.<br>**Starting order counter**<br>The operation of the starting-order counter:<br>• The relay output parameter definitions (*1401*…*1403* and *1410*) establish the initial motor sequence. (The lowest parameter number with a value 31 (PFA) identifies the relay connected to 1PFA, the first motor, and so on.)<br>• Initially, 1PFA = speed regulated motor, 2PFA = 1st auxiliary motor, etc.<br><br><br>• The first autochange operation shifts the sequence to: 2PFA = speed regulated motor, 3PFA = 1st auxiliary motor, …, 1PFA = last auxiliary motor.<br>• The next autochange operation shifts the sequence again, and so on.<br>• If the autochange operation cannot start a needed motor because all inactive motors are interlocked, the drive displays an alarm (*2015 PFC I LOCK*).<br>• When the ACS320 power supply is switched off, the counter preserves the current autochange rotation positions in permanent memory. When power is restored, the autochange rotation starts at the position stored in memory.<br>• If the PFA relay configuration is changed (or if the PFA enable value is changed), the rotation is reset. (See the first bullet above.) | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8120 | **INTERLOCKS** | **0…6** | **1** | **4** | |
| | Defines operation of the Interlock function. When the Interlock function is enabled:<br>• An interlock is active when its command signal is absent.<br>• An interlock is inactive when its command signal is present.<br>The drive will not start if a start command occurs when the speed regulated motor's interlock is active – the control panel displays alarm *2015 PFC I LOCK*.<br>Wire each Interlock circuit as follows:<br>• Wire a contact of the motor's On/Off switch to the Interlock circuit – the drive's PFA logic can then recognize that the motor is switched off, and start the next available motor.<br>• Wire a contact of the motor thermal relay (or other protective device in the motor circuit) to the Interlock input – the drive's PFA logic can then recognize that a motor fault is activated and stop the motor.<br>0 = NOT SEL – Disables the Interlock function. All digital inputs are available for other purposes.<br>• Requires parameter *8118 AUTOCHNG INTERV* = 0 (The Autochange function must be disabled if the Interlock function is disabled.)<br>1 = DI1 – Enables the Interlock function, and assigns a digital input (starting with DI1) to the interlock signal for each PFA relay. These assignments are defined in the following table and depend on:<br>The number of PFA relays (number of parameters *1401*…*1403* and *1410*) with value = 31 (PFA)<br>The Autochange function status (disabled if *8118 AUTOCHNG INTERV* = 0, and otherwise enabled). | | | | |

| No. PFA relays | Autochange disabled (8118) | Autochange enabled (8118) |
|---|---|---|
| 0 | DI1: Speed Reg Motor<br>DI2…DI5: Free | Not allowed |
| 1 | DI1: Speed Reg Motor<br>DI2: First PFA Relay<br>DI3…DI5: Free | DI1: First PFA Relay<br>DI2…DI5: Free |
| 2 | DI1: Speed Reg Motor<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4…DI5: Free | DI1: First PFA Relay<br>DI2: Second PFA Relay<br>DI3…DI5: Free |
| 3 | DI1: Speed Reg Motor<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4: Third PFA Relay<br>DI5…DI5: Free | DI1: First PFA Relay<br>DI2: Second PFA Relay<br>DI3: Third PFA Relay<br>DI4…DI5: Free |
| 4 | DI1: Speed Reg Motor<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4: Third PFA Relay<br>DI5: Fourth PFA Relay | DI1: First PFA Relay<br>DI2: Second PFA Relay<br>DI3: Third PFA Relay<br>DI4: Fourth PFA Relay<br>DI5…DI5: Free |

**Note:** MREL-01 required for PFA relays 2, 3 and 4.

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | 2 = DI2 – Enables the Interlock function, and assigns a digital input (starting with DI2) to the interlock signal for each PFA relay. These assignments are defined in the following table and depend on:<br>• The number of PFA relays (number of parameters *1401*…*1403* and *1410*) with value = 31 (PFA).<br>• The Autochange function status (disabled if *8118 AUTOCHNG INTERV* = 0, and otherwise enabled). | | | | |

| No. PFA relays | Autochange disabled (8118) | Autochange enabled (8118) |
|---|---|---|
| 0 | DI1: Free<br>DI2: Speed Reg Motor<br>DI3…DI5: Free | Not allowed |
| 1 | DI1: Free<br>DI2: Speed Reg Motor<br>DI3: First PFA Relay<br>DI4…DI5: Free | DI1: Free<br>DI2: First PFA Relay<br>DI3…DI5: Free |
| 2 | DI1: Free<br>DI2: Speed Reg Motor<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5…DI5: Free | DI1: Free<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4…DI5: Free |
| 3 | DI1: Free<br>DI2: Speed Reg Motor<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5: Third PFA Relay | DI1: Free<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4: Third PFA Relay<br>DI5…DI5: Free |
| 4 | DI1: Free<br>DI2: Speed Reg Motor<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5: Third PFA Relay | DI1: Free<br>DI2: First PFA Relay<br>DI3: Second PFA Relay<br>DI4: Third PFA Relay<br>DI5: Fourth PFA Relay |

**Note:** MREL-01 required for PFA relays 2, 3 and 4.

3 = DI3 – Enables the Interlocks function, and assigns a digital input (starting with DI3) to the interlock signal for each PFA relay. These assignments are defined in the following table and depend on:

- The number of PFA relays (number of parameters *1401*…*1403* and *1410*) with value = 31 (PFA).
- The Autochange function status (disabled if *8118 AUTOCHNG INTERV* = 0, and otherwise enabled).

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| Code | Description | Range | Resolution | Default | S |

| No. PFA relays | Autochange disabled (8118) | Autochange enabled (8118) |
|---|---|---|
| 0 | DI1…DI2: Free<br>DI3: Speed Reg Motor<br>DI4…DI5: Free | Not allowed |
| 1 | DI1…DI2: Free<br>DI3: Speed Reg Motor<br>DI4: First PFA Relay<br>DI5…DI5: Free | DI1…DI2: Free<br>DI3: First PFA Relay<br>DI4…DI5: Free |
| 2 | DI1…DI2: Free<br>DI3: Speed Reg Motor<br>DI4: First PFA Relay<br>DI5: Second PFA Relay | DI1…DI2: Free<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5…DI5: Free |
| 3 | DI1…DI2: Free<br>DI3: Speed Reg Motor<br>DI4: First PFA Relay<br>DI5: Second PFA Relay | DI1…DI2: Free<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5: Third PFA Relay |
| 4 | Not allowed | DI1…DI2: Free<br>DI3: First PFA Relay<br>DI4: Second PFA Relay<br>DI5: Third PFA Relay |

**Note:** MREL-01 required for PFA relays 2, 3 and 4.

4 = DI4 – Enables the Interlock function, and assigns a digital input (starting with DI4) to the interlock signal for each PFA relay. These assignments are defined in the following table and depend on:

- The number of PFA relays (number of parameters *1401*…*1403* and *1410*) with value = 31 (PFA).
- The Autochange function status (disabled if *8118 AUTOCHNG INTERV* = 0)

| No. PFA relays | Autochange disabled (8118) | Autochange enabled (8118) |
|---|---|---|
| 0 | DI1…DI3: Free<br>DI4: Speed Reg Motor<br>DI5…DI5: Free | Not allowed |
| 1 | DI1…DI3: Free<br>DI4: Speed Reg Motor<br>DI5: First PFA Relay | DI1…DI3: Free<br>DI4: First PFA Relay<br>DI5…DI5: Free |
| 2 | DI1…DI3: Free<br>DI4: Speed Reg Motor<br>DI5: First PFA Relay | DI1…DI3: Free<br>DI4: First PFA Relay<br>DI5: Second PFA Relay |
| 3 | Not allowed | DI1…DI3: Free<br>DI4: First PFA Relay<br>DI5: Second PFA Relay |
| 4 | Not allowed | Not allowed |

## Group 81: PFA control

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| | 5 = DI5 – Enables the Interlock function, and assigns a digital input (starting with DI5) to the interlock signal for each PFA relay. These assignments are defined in the following table and depend on:<br>• The number of PFA relays (number of parameters *1401*…*1403* and *1410*) with value = 31 (PFA).<br>• The Autochange function status (disabled if *8118 AUTOCHNG INTERV* = 0, and otherwise enabled). | | | | |

| No. PFA relays | Autochange disabled (8118) | Autochange enabled (8118) |
|---|---|---|
| 0 | DI1…DI4: Free<br>DI5: Speed Reg Motor | Not allowed |
| 1 | DI1…DI4: Free<br>DI5: Speed Reg Motor | DI1…DI4: Free<br>DI5: First PFA Relay |
| 2 | Not allowed | DI1…DI4: Free<br>DI5: First PFA Relay |
| 3…5 | Not allowed | Not allowed |

| Code | Description | Range | Resolution | Default | S |
|---|---|---|---|---|---|
| 8121 | **REG BYPASS CTRL** | **0…1** | **1** | **0** | |

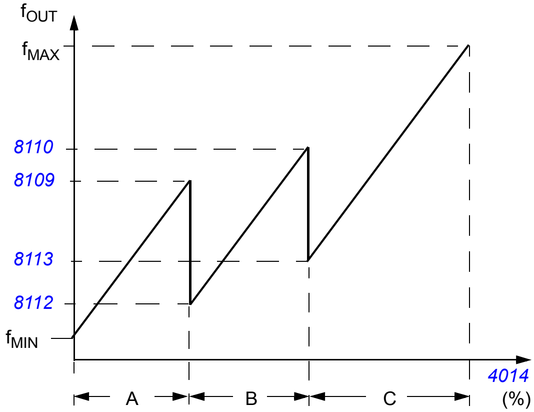
Selects the Regulator by-pass control. When enabled, the Regulator by-pass control provides a simple control mechanism without a PID regulator.

- Use the Regulator by-pass control only in special applications.

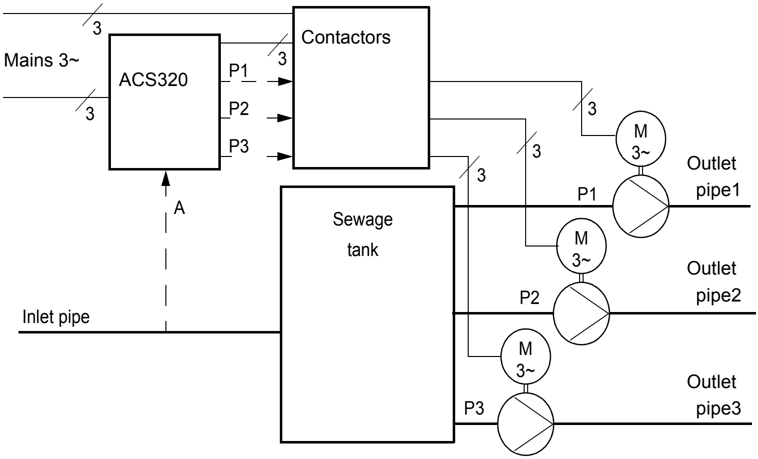
0 = NO – Disables the Regulator by-pass control. The drive uses the normal PFA reference: *1106 REF2 SELECT*.

1 = YES – Enables the Regulator by-pass control.

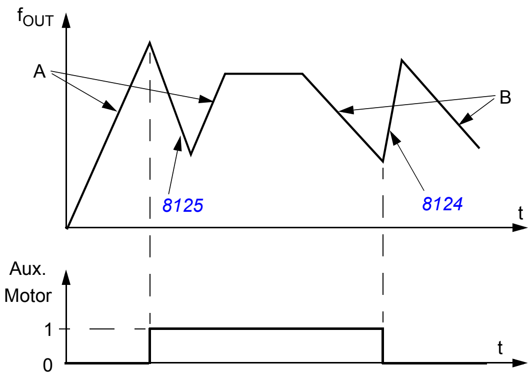
- The process PID regulator is bypassed.
  Actual value of PID is used as the PFA reference (input). Normally EXT REF2 is used as the PFA reference.
- The drive uses the feedback signal defined by *4014 FBK SEL* (or 4114) for the PFA frequency reference.
- The figure shows the relation between the control signal *4014 FBK SEL* (or 4114) and the speed regulated motor's frequency in a three-motor system.




A = No auxiliary motors running
B = One auxiliary motor running
C = Two auxiliary motors running

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| | **Example:** In the diagram below, the pumping station's outlet flow is controlled by the measured inlet flow (A).<br> | | | | |
| 8122 | **PFA START DELAY** | **0.00 … 10.00 s** | **0.01 s** | **0.50 s** | |
| | Sets the start delay for speed regulated motors in the system. Using the delay, the drive works as follows:<br>• Switches on the contactor of the speed regulated motor – connecting the motor to the drive power output.<br>• Delays motor start for the time 8122 PFA START DELAY.<br>• Starts the speed regulated motor.<br>• Starts auxiliary motors. See parameter *8115 AUX MOT START D* for delay.<br>Warning! Motors equipped with star-delta starters require a PFA start delay.<br>• After the drive relay output switches a motor On, the star-delta starter must switch to the star-connection and then back to the delta-connection before the drive applies power.<br>• So, the PFA start delay must be longer than the time setting of the star-delta starter. | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8123 | **PFA ENABLE** | **0…1** | **-** | **0** | ✓ |
| | Sets the start delay for speed regulated motors in the system. Using the delay, the drive works as follows:<br>• Switches on the contactor of the speed regulated motor – connecting the motor to the drive power output.<br>• Delays motor start for the time *8122 PFA START DELAY*.<br>• Starts the speed regulated motor.<br>• Starts auxiliary motors. See parameter *8115 AUX MOT START D* for delay.<br>⚠ **WARNING!** Motors equipped with star-delta starters require a PFA start delay.<br>•After the drive relay output switches a motor On, the star-delta starter must switch to the star-connection and then back to the delta-connection before the drive applies power.<br>• So, the PFA start delay must be longer than the time setting of the star-delta starter.<br>1 = ACTIVE – PFA control enabled.<br>2 = SPFC ACTIVE – SPFC control enabled. The soft pump and fan control is used for alternation applications where lower pressure peaks are desirable when a new auxiliary motor is started. | | | | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8124 | **ACC IN AUX STOP**<br>Sets the PFA acceleration time for a zero-to-maximum frequency ramp. This PFA acceleration ramp:<br>• Applies to the speed regulated motor, when an auxiliary motor is switched off.<br>• Replaces the acceleration ramp defined in Group 22: Accel / Decel.<br>• Applies only until the output of the regulated motor increases by an amount equal to the output of the switched off auxiliary motor. Then the acceleration ramp defined in Group 22: Accel / Decel applies.<br>0 = NOT SEL<br>0.1…1800 = Activates this function using the value entered as the acceleration time.<br><br>• A = speed regulated motor accelerating using *Group 22: Accel/Decel* parameters (*2202* or *2205*).<br>• B = speed regulated motor decelerating using *Group 22: Accel/Decel* parameters (*2203* or *2206*).<br>• At aux. motor start, speed regulated motor decelerates using parameter *8125 DEC IN AUX START*.At aux. motor stop, speed regulated motor accelerates using parameter *8124 ACC IN AUX STOP*. | **0.0 … 1800.0 s** | **0.1 s** | **0.0** | |
| 8125 | **DEC IN AUX START**<br>Sets the PFA deceleration time for a maximum-to-zero frequency ramp. This PFA deceleration ramp:<br>• Applies to the speed regulated motor, when an auxiliary motor is switched on.<br>• Replaces the deceleration ramp defined in *Group 22: Accel/Decel*.<br>• Applies only until the output of the regulated motor decreases by an amount equal to the output of the auxiliary motor. Then the deceleration ramp defined in *Group 22: Accel/Decel* applies.<br>0 = NOT SEL<br>0.1…1800 = Activates this function using the value entered as the acceleration time. | **0.0 … 1800.0 s** | **0.1 s** | **0.0** | |

| Group 81: PFA control | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 8126 | **TIMED AUTOCHANGE**<br>Sets the Autochange function with timer. When enables, the Autochange function is controlled with the timer functions.<br>0 = NOT SEL.<br>1 = TIMER 1 – Enables the Autochange function when Timer 1 is active.<br>2…4 TIMER 2…4 – Enables the Autochange function when Timer 2…4 is active. | **0…4** | **1** | **0** | |
| 8127 | **MOTORS**<br>Sets the actual number of PFA controlled motors (maximum 6 motors, 1 speed regulated, 3 connected direct-on-line and 3 spare motors).<br>• This value includes also the speed regulated motor.<br>• This value must be compatible with number of relays allocated to PFA if the Autochange function is used.<br>• If Autochange function is not used, the speed regulated motor does not need to have a relay output allocated to PFA but it needs to be included in this value. | **0…7** | **1** | **0** | ✓ |
| 8128 | **AUX START ORDER**<br>Sets the start order of the auxiliary motors.<br>1 = EVEN RUNTIME – Time sharing is active. Evens out the cumulative run time of the auxiliary motors. The start order depends on the run times: The auxiliary motor whose cumulative run time is shortest is started first, then the motor whose cumulative run time is the second shortest etc. When the demand drops, the first motor to be stopped is the one whose cumulative run time is longest.<br>2 = RELAY ORDER – The start order is fixed to be the order of the relays. | | | | |

## Group 98: Options

This group configures for options, in particular, enabling serial communication with the drive.

| Group 98: Options | | | | | |
|---|---|---|---|---|---|
| **Code** | **Description** | **Range** | **Resolution** | **Default** | **S** |
| 9802 | **COMM PROT SEL**<br>Selects the communication protocol.<br>0 = NOT SEL – No communication protocol selected.<br>1 = STD MODBUS – The drive communicates with Modbus via the RS485 channel (X1-communications, terminal).<br>• See also *Group 53: EFB protocol*.<br>2 = N2 – Enables fieldbus communication with the drive using Metasys N2 protocol via the RS485 serial link (X1-communications terminal).<br>3 = FLN – Enables fieldbus communication with the drive using FLN protocol via the RS485 serial link (X1-communications terminal).<br>5 = BACNET – Enables fieldbus communication with the drive using BACnet protocol via the RS485 serial link (X1-communications terminal).<br>10 = MODBUS RS232 | **0…5** | **1** | **0** | |

# Default values with different macros

When application macro is changed (*9902 APPLIC MACRO*), the software updates the parameter values to their default values. The table below shows the parameter default values for different macros. For other parameters, the default values are the same for all macros. See the parameter list starting on page *137*.

| Index | Name/ Selection | HVAC DEFAULT | SUPPLY FAN | RETURN FAN | CLNG TWR FAN | CONDENSER | BOOSTER PUMP | PUMP ALTERNA |
|---|---|---|---|---|---|---|---|---|
| *9902* | *APPLIC MACRO* | 1 = HVAC DEFAULT | 2 = SUPPLY FAN | 3 = RETURN FAN | 4 = CLNG TWR FAN | 5 = CONDENSER | 6 = BOOSTER PUMP | 7 = PUMP ALTERNA |
| *1001* | *EXT1 COMMANDS* | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 |
| *1002* | *EXT2 COMMANDS* | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 |
| *1003* | *DIRECTION* | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD |
| *1102* | *EXT1/EXT2 SEL* | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 |
| *1103* | *REF1 SELECT* | 1 = AI1 | 1 = AI1 | 1 = AI1 | 1 = AI1 | 1 = AI1 | 1 = AI1 | 1 = AI1 |
| *1106* | *REF2 SELECT* | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT |
| *1201* | *CONST SPEED SEL* | 3 = DI3 | 3 = DI3 | 3 = DI3 | 3 = DI3 | 3 = DI3 | 3 = DI3 | 0 = NOT SEL |
| *1304* | *MINIMUM AI2* | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% |
| *1401* | *RELAY OUTPUT 1* | 1 = READY | 7 = STARTED | 7 = STARTED | 1 = READY | 1 = READY | 1 = READY | 31 = PFA |
| *1601* | *RUN ENABLE* | 0 = NOT SEL | 2 = DI2 | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL |
| *1805* | *DO SIGNAL* | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN |
| *2008* | *MAXIMUM FREQ* | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz |
| *2201* | *ACC/DEC 1/2 SEL* | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL |
| *2202* | *ACCELER TIME 1* | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 10.0 s | 10.0 s |
| *2203* | *DECELER TIME 1* | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 10.0 s | 10.0 s |
| *3019* | *COMM FAULT TIME* | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s |
| *4001* | *GAIN* | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| *4002* | *INTEGRATION TIME* | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s |
| 4101 | GAIN | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| 4102 | INTEGRATION TIME | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 60.0 s | 3.0 s | 3.0 s |
| *8116* | *AUX MOT STOP D* | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s |
| *8118* | *AUTOCHNG INTERV* | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL |
| *8123* | *PFA ENABLE* | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 1 = ACTIVE |

| Index | Name/ Selection | INT TIMER | INT TIMER CS | FLOATING PNT | DUAL SETPPID | DL SP PID CS | E-BYPASS | HAND CONTROL |
|---|---|---|---|---|---|---|---|---|
| *9902* | *APPLIC MACRO* | 8 = INT TIMER | 9 = INT TIMER CS | 10 = FLOATING PNT | 11 = DUAL SETPPID | 12 = DL SP PID CS | 13 = BYPASS | 14 = HAND CONTROL |
| *1001* | *EXT1 COMMANDS* | 11 = TIMER 1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 0 = NOT SEL |
| *1002* | *EXT2 COMMANDS* | 1 = TIMER 1 | 0 = NOT SEL | 1 = DI1 | 1 = DI1 | 1 = DI1 | 1 = DI1 | 0 = NOT SEL |
| *1003* | *DIRECTION* | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD | 1 = FORWARD |
| *1102* | *EXT1/EXT2 SEL* | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 0 = EXT1 | 2 = DI2 | 0 = EXT1 | 0 = EXT1 |
| *1103* | *REF1 SELECT* | 1 = AI1 | 0 = KEYPAD | 30 = DI4U,5D | 1 = AI1 | 1 = AI1 | 1 = AI1 | 1 = AI1 |
| *1106* | *REF2 SELECT* | 19 = PID1OUT | 2 = AI2 | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 19 = PID1OUT | 2 = AI2 |
| *1201* | *CONST SPEED SEL* | 0 = NOT SEL | 15 = TIMER 1 | 3 = DI3 | 0 = NOT SEL | 10 = DI4,5 | 0 = NOT SEL | 0 = NOT SEL |
| *1304* | *MINIMUM AI2* | 20.0% | 20% | 20% | 20.0% | 20.0% | 20.0% | 20.0% |
| *1401* | *RELAY OUTPUT 1* | 7 = STARTED | 7 = STARTED | 7 = STARTED | 7 = STARTED | 1 = READY | 7 = STARTED | 1 = READY |
| *1601* | *RUN ENABLE* | 2 = DI2 | 2 = DI2 | 2 = DI2 | 2 = DI2 | 0 = NOT SEL | 2 = DI2 | 0 = NOT SEL |
| *1805* | *DO SIGNAL* | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN | 2 = RUN |
| *2008* | *MAXIMUM FREQ* | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz | 50.0 Hz |
| *2201* | *ACC/DEC 1/2 SEL* | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL |
| *2202* | *ACCELER TIME 1* | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s |
| *2203* | *DECELER TIME 1* | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s | 30.0 s |
| *3019* | *COMM FAULT TIME* | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s | 10.0 s |
| *4001* | *GAIN* | 2.5 | 1.0 | 2.5 | 2.5 | 2.5 | 2.5 | 1.0 |
| *4002* | *INTEGRATION TIME* | 3.0 s | 60.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 60.0 s |
| 4101 | GAIN | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| 4102 | INTEGRATION TIME | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s |
| *8116* | *AUX MOT STOP D* | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s | 3.0 s |
| *8118* | *AUTOCHNG INTERV* | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL | 0.0 = NOT SEL |
| *8123* | *PFA ENABLE* | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL | 0 = NOT SEL |

11

# Fieldbus control

## Contents of this chapter

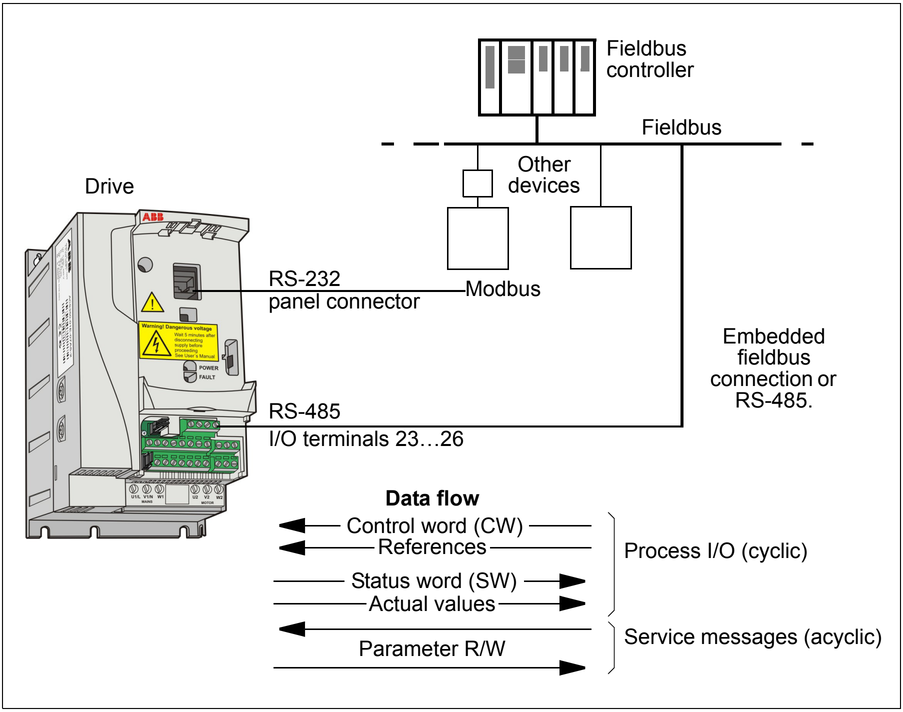
The chapter describes how the drive can be controlled by external devices over a communication network using embedded fieldbus.

## System overview

The drive can be connected to an external control system via embedded fieldbus. The embedded fieldbus supports Modbus RTU, BACnet®, Metasys® N2 and APOGEE® FLN protocols.

Embedded fieldbus connection is either RS-232 (control panel connector X2) or RS-485 (I/O terminals 23…26). The maximum length of the communication cable with RS-232 is restricted to 3 meters.

RS-232 is designed for a point-to-point application (a single master controlling one slave). RS-485 is designed for a multipoint application (a single master controlling one or more slaves).




The drive can be set to receive all of its control information through the fieldbus interface, or the control can be distributed between the fieldbus interface and other available sources, for example, digital and analog inputs.

## Control interface

In general, the basic control interface between the fieldbus system and the drive consists of:

| Protocol | Control Interface | Reference for more information |
|---|---|---|
| Modbus | • Output Words<br>– Control word<br>– Reference1<br>– Reference2<br>• Input Words<br>– Status word<br>– Actual value 1<br>– Actual value 2<br>– Actual value 3<br>– Actual value 4<br>– Actual value 5<br>– Actual value 6<br>– Actual value 7<br>– Actual value 8 | The content of these words is defined by profiles. For details on the profiles used, see *ABB control profiles technical data* |
| N2 | • Binary output objects<br>• Analog output objects<br>• Binary input objects<br>• Analog input objects | *N2 protocol technical data* |
| FLN | • Binary output points<br>• Analog output points<br>• Binary input points<br>• Analog input points | *FLN protocol technical data* |
| BACnet | • Device management<br>• Binary output objects<br>• Analog output objects<br>• Binary input objects<br>• Analog input objects | *BACnet protocol technical data* |

**Note:** The words “output” and “input” are used as seen from the fieldbus controller point of view. For example an output describes data flow from the fieldbus controller to the drive and appears as an input from the drive point of view.

# Planning

Network planning should address the following questions:

- What types and quantities of devices must be connected to the network?
- What control information must be sent down to the drives?
- What feedback information must be sent from the drives to the controlling system?

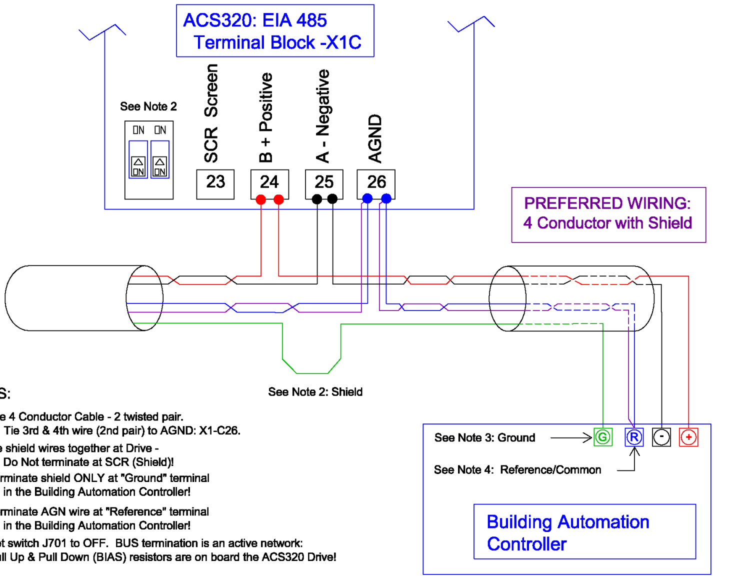
## Mechanical and electrical installation – EFB

**WARNING!** Connections should be made only while the drive is disconnected from the power source.

Drive terminals 23…26 are for RS485 communications.

- Use Belden 9842 or equivalent. Belden 9842 is a dual twisted, shielded pair cable with a wave impedance of 120 Ω.
- Use one of these twisted shielded pairs for the RS485 link. Use this pair to connect all A (-) terminals together and all B (+) terminals together.
- Use one of the wires in the other pair for the logical ground (terminal 26), leaving one wire unused.
- Do not directly ground the RS485 network at any point. Ground all devices on the network using their corresponding grounding terminals.
- As always, the grounding wires should not form any closed loops, and all the devices should be grounded to a common ground.
- Connect the RS485 link in a daisy-chained bus, without dropout lines.
- To reduce noise on the network, terminate the RS485 network using 120 Ω resistors at both ends of the network. Use the DIP switch to connect or disconnect the termination resistors. See following wiring diagram.
- For configuration information see the following:
  - below.
  - *Activate drive control functions – EFB* on page *275*.
  - The appropriate EFB protocol specific technical data. For example, *Modbus protocol technical data* on page *318*.

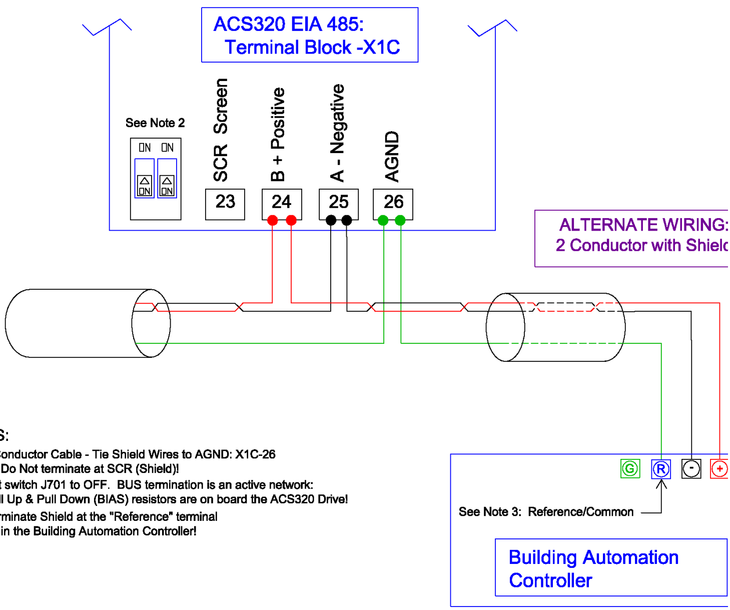
## Preferred Wiring Diagram




NOTES:

1. Use 4 Conductor Cable - 2 twisted pair.
   Tie 3rd & 4th wire (2nd pair) to AGND: X1-C26.
2. Tie shield wires together at Drive -
   Do Not terminate at SCR (Shield)!
3. Terminate shield ONLY at "Ground" terminal
   in the Building Automation Controller!
4. Terminate AGN wire at "Reference" terminal
   in the Building Automation Controller!
5. Set switch J701 to OFF. BUS termination is an active network:
   Pull Up & Pull Down (BIAS) resistors are on board the ACS320 Drive!

## Alternate Wiring Diagram




NOTES:

1. 2 Conductor Cable - Tie Shield Wires to AGND: X1C-26
   Do Not terminate at SCR (Shield)!
2. Set switch J701 to OFF. BUS termination is an active network:
   Pull Up & Pull Down (BIAS) resistors are on board the ACS320 Drive!
3. Terminate Shield at the "Reference" terminal
   in the Building Automation Controller!

# Communication set-up – EFB

## Serial communication selection

To activate the serial communication, set parameter *9802 COMM PROT SEL* =

- 1 (STD MODBUS)
- 2 (N2)
- 3 (FLN)
- 5 (BACNET).

**Note:** If you cannot see the desired selection on the panel, your drive does not have that protocol software in the application memory.

## Serial communication configuration

Setting parameter *9802 COMM PROT SEL* automatically sets the appropriate default values in parameters that define the communication process. These parameters and descriptions are defined below. In particular, note that the station Id may require adjustment.

| Code | Description | EFB Protocol Reference | | | |
|---|---|---|---|---|---|
| | | Modbus | N2 | FLN | BACnet |
| *5301* | *EFB PROTOCOL ID*<br>Contains the identification and program revision of the protocol. | Do not edit. Any non-zero value entered for parameter *9802 COMM PROT SEL*, sets this parameter automatically. The format is: XXYY, where xx = protocol ID, and YY = program revision. | | | |
| *5302* | *EFB STATION ID*<br>Defines the node address of the RS485 link. | Set each drive on the network with a unique value for this parameter.<br>When this protocol is selected, the default value for this parameter is: 1<br>**Note:** For a new address to take affect, the drive power must be cycled **OR** 5302 must first be set to 0 before selecting a new address. Leaving 5302 = 0 places the RS485 channel in reset, disabling communication. | | | Sets MS/TP MAC ID. A temporary value of 0 places the protocol channel in reset. |

| Code | Description | EFB Protocol Reference | | | |
|---|---|---|---|---|---|
| | | Modbus | N2 | FLN | BACnet |
| *5303* | *EFB BAUD RATE*<br>Defines the communication speed of the RS485 link in kbits per second (kbits/s).<br>1.2 kbits/s<br>2.4 kbits/s<br>4.8 kbits/s<br>9.6 kbits/s<br>19.2 kbits/s<br>38.4 kbits/s<br>57.6 kbits/s<br>76.8 kbits/s | When this protocol is selected, the default value for this parameter is<br>9.6 | 9.6 | 4.8 | When this protocol is selected, the default value for this parameter is: 38400. |
| *5304* | *EFB PARITY*<br>Defines the data length, parity and stop bits to be used with the RS485 link communication.<br>The same settings must be used in all on-line stations.<br>0 = 8N1 – 8 data bits, No parity, one stop bit.<br>1 = 8N2 – 8 data bits, No parity, two stop bits.<br>2 = 8E1 – 8 data bits, Even parity, one stop bit.<br>3 = 8O1 – 8 data bits, Odd parity, one stop bit. | When this protocol is selected, the default value for this parameter is: 1 | When this protocol is selected, the default value for this parameter is: 0 | | Sets MS/TP character format. |
| *5305* | *EFB CTRL PROFILE*<br>Selects the communication profile used by the EFB protocol.<br>0 = ABB DRV LIM – Operation of Control/Status Words conform to ABB Drives Profile, as used in ACH400.<br>1 = DCU PROFILE – Operation of Control/Status Words conform to 32-bit DCU Profile.<br>2 = ABB DRV FULL – Operation of Control/Status Words conform to ABB Drives Profile, as used in ACH600/800. | When this protocol is selected, the default value for this parameter is: 0 | N/A. When this protocol is selected, the default value for this parameter is: 0.<br>Changing the value for this parameter has no affect on this protocol’s behavior. | | |

<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Description</th><th colspan="4">EFB Protocol Reference</th></tr>
<tr><th>Modbus</th><th>N2</th><th>FLN</th><th>BACnet</th></tr>
<tr><td rowspan="2">5310</td><td rowspan="2">EFB PAR10</td><td rowspan="2">Not used for Comm setup.</td><td colspan="3">Sets them response turnaround time in milliseconds. When this protocol is selected, the default value is:</td></tr>
<tr><td>3 msec.</td><td>0 msec.</td><td>5 msec.</td></tr>
<tr><td>5311</td><td>EFB PAR11</td><td colspan="3">Not used for Comm setup.</td><td>This parameter, together with parameter 5317, sets BACnet Device Object Instance IDs:<br>• For the range 1 to 65,535: This parameter sets the ID directly (5317 must be 0). For example, the following values set the ID to 49134: 5311 = 49134 and 5317 = 0.<br>• For IDs > 65,335: The ID equals 5311’s value plus 10,000 times 5317’s value. For example, the following values set the ID to 71234: 5311 = 1234 and 5317 = 7.</td></tr>
<tr><td>5312</td><td>EFB PAR12</td><td colspan="3">Not used for Comm setup.</td><td>This parameter sets the BACnet Device Object Max Info Frames Property.</td></tr>
<tr><td>5313</td><td>EFB PAR13</td><td colspan="3">Not used for Comm setup.</td><td>This parameter sets the BACnet Device Object Max Master Property.</td></tr>
<tr><td>5314</td><td>EFB PAR14</td><td colspan="4">Not used for Comm setup.</td></tr>
<tr><td>5315</td><td>EFB PAR15</td><td colspan="4">Not used for Comm setup.</td></tr>
<tr><td>5316</td><td>EFB PAR 16</td><td colspan="3">Not used for Comm setup.</td><td>This parameter indicates the count of MS/TP tokens passed to this drive.</td></tr>
<tr><td>5317</td><td>EFB PAR17</td><td colspan="3"></td><td>This parameter works with parameter 5311 to set BACnet Device Object Instance IDs. See parameter 5311.</td></tr>
</table>

**Note:** After any changes to the communication settings, protocol must be reactivated by either cycling the drive power, or by clearing and then restoring the station Id (5302) or use Reinitialize Device Service.

# Activate drive control functions – EFB

## Controlling the drive

Fieldbus control of various drive functions requires configuration to:

- Tell the drive to accept fieldbus control of the function.
- Define as a fieldbus input, any drive data required for control.
- Define as a fieldbus output, any control data required by the drive.

The following sections describe, at a general level, the configuration required for each control function. For the protocol-specific details, see the document supplied with the FBA module.

## Start/Stop direction control

Using the fieldbus for start/stop/direction control of the drive requires:

- Drive parameter values set as defined below.
- Fieldbus controller supplied command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

| Drive Parameter | | Value | Description | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus[1] | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1001 | EXT1 COMMANDS | 10 (COMM) | Start/Stop by fieldbus with Ext1 selected. | 40001 bits 0…3 | 40031 bits 0, 1 | BO1 | 24 | BV10 |
| 1002 | EXT2 COMMANDS | 10 (COMM) | Start/Stop by fieldbus with Ext2 selected. | 40001 bits 0…3 | 40031 bits 0, 1 | BO1 | 24 | BV10 |
| 1003 | DIRECTION | 3 (REQUEST) | Direction by fieldbus. | 4002/ 4003[2] | 40031 bit 3 | BO2 | 22 | BV11 |

1.For Modbus, the protocol reference can depend on the profile used, hence two columns in these tables. One column refers to the ABB Drives profile, selected when parameter *5305* = 0 (ABB DRV LIM) or *5305* = 2 (ABB DRV FULL). The other column refers to the DCU profile selected when parameter *5305* = 1 (DCU PROFILE). See section *ABB control profiles technical data*.

2.The reference provides direction control – a negative reference provides reverse rotation.

## Input reference select

Using the fieldbus to provide input references to the drive requires:

- Drive parameter values set as defined below.
- Fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1102 | EXT1/ EXT2 SEL | 8 (COMM) | Reference set selection by fieldbus. | 40001 bit 11 | 40031 bit 5 | BO5 | 26 | BV13 |
| 1103 | REF1 SEL | 8 (COMM) | Input reference 1 by fieldbus. | 40002 | | AO1 | 60 | AV16 |
| 1106 | REF2 SEL | 8 (COMM) | Input reference 2 by fieldbus. | 40003 | | AO2 | 61 | AV17 |

*Reference scaling*

Where required, REFERENCES can be scaled. See the following, as appropriate:

- Modbus Register *40002* in the *Modbus protocol technical data* section.
- *Reference scaling* in the *ABB control profiles technical data* section.
- *N2 analog output objects* in the *N2 protocol technical data* section.
- The slope of points 60 and 61 in the *FLN protocol technical data* section.

## Miscellaneous drive control

**Note:** The user should change only the parameters for the functions you wish to control vial fieldbus. All other parameters should typically remain at factory default. For simple start/stop and speed reference fieldbus control, only parameters *1001 EXT1 COMMANDS* and *1103 REF1 SELECT* need to be changed to COMM.

Using the fieldbus for miscellaneous drive control requires:

- Drive parameter values set as defined below.
- Fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1601 | RUN ENABLE | 7 (COMM) | Run enable by fieldbus. (Not recommended[1]) | 40001 bit 3 | 40031 bit 6 (inverted) | BO4 | 35 | BV12 |

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1604 | FAULT RESET SEL | 8 (COMM) | Fault reset by fieldbus. | 40001 bit 7 | 40031 bit 4 | BO6 | 94 | BV14 |
| 1606 | LOCAL LOCK | 8 (COMM) | Source for local lock selection is the fieldbus. | Does not apply | 40031 bit 14 | | | |
| 1607 | PARAM SAVE | 1 (SAVE) | Saves altered parameters to memory (then value returns to 0). | 41607 | 40032 bit 2 | BO18 | N/A[1] | |
| 1608 | START ENABLE 1 | 7 (COMM) | Source for start enable 1 is the fieldbus Command word. (Not recommended)[1] | Does not apply. | 40032 bit 2 | | | BV20 |
| 1609 | START ENABLE 2 | 7 (COMM) | Source for start enable 2 is the fieldbus Command word. (Not recommended)[1] | | 40032 bit 3 | | | BV21 |
| 2013 | MIN TORQUE SEL | 7 (COMM) | Source for minimum torque selection is the fieldbus. | | 40031 bit 15 | | | |
| 2014 | MAX TORQUE SEL | 7 (COMM) | Source for maximum torque selection is the fieldbus. | | | | | |
| 2201 | ACC/DEC 1/2 SEL | 7 (COMM) | Source for ramp pair selection is the fieldbus. | | 40031 bit 10 | | | |

1.ABB recommends hard wiring run permissive and safeties.

## Relay output control

Using the fieldbus for relay output control requires:

- Drive parameter values set as defined below.
- Fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1401 | RELAY OUTPUT 1 | 35 (COMM) | Relay Output 1 controlled by fieldbus. | 40134 bit 0 or 00033 | | BO7 | 40 | BO0 |

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1402[1] | RELAY OUTPUT 2 | 35 (COMM) | Relay Output 2 controlled by fieldbus. | 40134 bit 1 or 00034 | | BO8 | 41 | BO1 |
| 1403[1] | RELAY OUTPUT 3 | 35 (COMM) | Relay Output 3 controlled by fieldbus. | 40134 bit 2 or 00035 | | BO9 | 42 | BO2 |
| 1410[1] | RELAY OUTPUT 4 | 35 (COMM) | Relay Output 4 controlled by fieldbus. | 40134 bit 3 or 00036 | | BO10 | 43 | BO3 |

1. More than 1 relay requires the addition of a relay extension module.

**For example:** To control relays 1 and 2 using serial communication:
Set parameters *1401 RELAY OUTPUT 1* and *1402 RELAY OUTPUT 2* = 35 (COMM).

Then, for example using N2:

- To turn Relay 1 On: Force object B07 to On.
- To turn Relay 2 On: Force object B08 to On.
- To turn both Relay 1 and 2 On: Force objects B07 and B08 On.

**Note:** Relay status feedback occurs without configuration as defined below.

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 0122 | RO 1-3 STATUS | Relay 1…3 status. | 40122 | 0122 | | BI4…BI6 | 76…78 | BI0…BI2 |
| 0123 | RO 4 STATUS | Relay 4 status. | 40123 | 0123 | | BI7 | 79 | BI3 |

## Analog output control

Using the fieldbus for analog output control requires:

- Drive parameter values set as defined below.
- Fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

| Drive Parameter | | Value | Setting | Protocol Reference | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Modbus | | N2 | FLN | BACnet |
| | | | | abb drv | dcu profile | | | |
| 1501 | AO1 CONTENT SEL | 135 (COMM VALUE 1) | Analog Output 1 controlled by writing to parameter 0135. | – | | – | – | – |
| 0135 | COMM VALUE 1 | – | | 40135 | | AO14 | 46 | AO0 |

## PID control setpoint source

Use the following settings to select the fieldbus as the setpoint source for PID loops:

| Drive Parameter | | Value | Setting | Protocol Reference: Modbus abb drv | Modbus dcu profile | N2 | FLN | BACnet |
|---|---|---|---|---|---|---|---|---|
| 4010 | SET POINT SEL (Set 1) | 8 (COMM VALUE 1)<br>9 (COMM + AI1)<br>10 (COMM*AI1) | Setpoint is either:<br>Input Reference 2 (+/-/* AI1). Control requires parameter 1106 value = comm.<br>Process PID setpoint. Control requires parameter 1106 value = pid1 out and parameter 4010 value = comm. | 40003 | | AO2 | 61 | AV17 |
| 4110 | SET POINT SEL (Set 2) | | | | | | | |
| 4210 | SET POINT SEL (Ext/Trim) | | | | | | | |

## Communication fault

When using fieldbus control, specify the drive's action if serial communication is lost.

| Drive Parameter | | Value | Description |
|---|---|---|---|
| 3018 | COMM FAULT FUNC | 0 (NOT SEL))<br>1 (FAULT)<br>2 (CONST SP7)<br>3 (LAST SPEED) | Set for appropriate drive response. |
| 3019 | COMM FAULT TIME | Set time delay before acting on a communication loss. | |

# Feedback from the drive – EFB

## Pre-defined feedback

Inputs to the controller (drive outputs) have pre-defined meanings established by the protocol. This feedback does not require drive configuration. The following table lists a sample of feedback data. For a complete listing, see input word/point/object listings in the technical data for the appropriate protocol starting on *284*.

| Drive Parameter | | Protocol Reference | | | |
|---|---|---|---|---|---|
| | | Modbus | N2 | FLN | BACnet |
| 0102 | SPEED | 40102 | AI3 | 5 | AV0 |
| 0103 | FREQ OUTPUT | 40103 | AI1 | 2 | AV1 |
| 0104 | CURRENT | 40104 | AI4 | 6 | AV4 |
| 0105 | TORQUE | 40105 | AI5 | 7 | AV5 |
| 0106 | POWER | 40106 | AI6 | 8 | AV6 |
| 0107 | DC BUS VOLT | 40107 | AI11 | 13 | AV2 |
| 0109 | OUTPUT VOLTAGE | 40109 | AI12 | 14 | AV3 |
| 0115 | KWH COUNTER | 40115 | AI8 | 10 | AV8 |
| 0118 | DI1-3 STATUS – bit 1 (DI3) | 40118 | BI10, BI11, BI12, | 70, 71, 72 | BI6, BI7, BI8 |
| 0122 | RO1-3 STATUS | 40122 | BI4, BI5, BI6 | 76, 77, 78 | BI0, BI1, BI2 |
| 0301 | FB STATUS WORD – bit 0 (STOP) | 40301 bit 0 | BI1 | 23 | BV0 |
| 0301 | FB STATUS WORD – bit 2 (REV) | 40301 bit 2 | BI2 | 21 | BV1 |

**Note:** With Modbus, any parameter can be accessed using the format: 4 followed by the parameter number.

## Mailbox Read/Write

The ACS320 provides a "Mailbox" function to access parameters that have not been pre-defined by the protocol. Using mailbox, any drive parameter can be identified and read. Mailbox can also be used to adjust parameter settings by writing a value to any parameter identified. The following table describes the use of this function.

| Name | Description | Protocol Reference | | | |
|---|---|---|---|---|---|
| | | Modbus[1] | N2 | FLN | BACnet |
| Mailbox Parameter | Enter the number of the drive parameter to access. | Does not apply. | AO19 | 95 | AV25 |
| Mailbox Data | Contains the parameter value after a read, or enter the desired parameter value for a write. | | AO20 | 96 | AV26 |
| Mailbox Read | A binary value triggers a read – the value of the "Mailbox Parameter" appears in "Mailbox data". | | BO19 | 97 | BV15 |
| Mailbox Write | A binary value triggers a write – the drive value for the "Mailbox Parameter" changes to the value in "Mailbox data". | | BO20 | 98 | BV16 |

1.As noted above, Modbus provides direct access to all parameters using the format: 4 followed by the parameter number.

## Actual value scaling

The scaling of actual values can be protocol dependent. In general, for Actual values, scale the feedback integer using the parameter's resolution. (See section *Parameter listing* for parameter resolutions.) For example:

| Feedback Integer | Parameter Resolution | (Feedback Integer) * (Parameter Resolution) = Scaled Value |
|---|---|---|
| 1 | 0.1 mA | 1 * 0.1 mA = 0.1 mA |
| 10 | 0.1% | 10 * 0.1% = 1% |

Where parameters are in percent, section *Parameter listing* specifies what parameter corresponds to 100%. In such cases, to convert from percent to engineering units, multiply by the value of the parameter that defines 100% and divide by 100%. For example:

| Feedback Integer | Parameter Resolution | Value of the Parameter that defines 100% | (Feedback Integer) * (Parameter Resolution) * (Value of 100% Ref.) / 100% = Scaled Value |
|---|---|---|---|
| 10 | 0.1% | 1800 rpm[1] | 10 * 0.1% * 1800 RPM / 100% = 18 rpm |
| 100 | 0.1% | 600 Hz[2] | 100 * 0.1% * 600 Hz / 100% = 60 Hz |

1. Assuming, for the sake of this example, that the Actual value uses parameter *9908 MOTOR NOM SPEED* as the 100% reference, and that 9908 = 1800 rpm.

2. Assuming, for the sake of this example, that the Actual value uses parameter *9907 MOTOR NOM FREQ* as the 100% reference, and that 9907 = 6.00 Hz.

Although Actual value scaling could differ from the above for the N2 and FLN protocols, it currently does not. To confirm, see the following sections, as appropriate:

- *N2 analog input objects* in the *N2 protocol technical data* section.
- *Scaling drive feedback values* in the *FLN protocol technical data* section.

Scaling does not apply for the BACnet protocol.

# Diagnostics – EFB

## Fault queue for drive diagnostics

For general ACS320 diagnostics information, see section *LEDs*. The three most recent ACS320 faults are reported to the fieldbus as defined below.

| Drive Parameter | | Protocol Reference | | | |
|---|---|---|---|---|---|
| | | Modbus | N2 | FLN | BACnet |
| 0401 | Last Fault | 40401 | 17 | 90 | AV18 |
| 0412 | Previous Fault 1 | 40402 | 18 | 91 | AV19 |
| 0413 | Previous Fault 2 | 40403 | 19 | 92 | AV20 |

## Serial communication diagnostics

Network problems can be caused by multiple sources. Some of these sources are:

- Loose connections
- Incorrect wiring (including swapped wires)
- Bad grounding
- Duplicate station numbers
- Incorrect setup of drives or other devices on the network

The major diagnostic features for fault tracing on an EFB network include *Group 53: EFB protocol* parameters *5306*…*5309*. Section *Parameter listing* describes these parameters in detail.

## Diagnostic situations

The sub-sections below describe various diagnostic situations – the problem symptoms and corrective actions.

### *Normal operation*

During normal network operation, *5306*…*5309* parameter values act as follows at each drive:

- *5306 EFB OK MESSAGES* advances (advances for each application message properly received and addressed to this drive).
- *5307 EFB CRC ERRORS* does not advance at all (advances when an invalid message CRC is received).

- *5308 EFB UART ERRORS* does not advance at all (advances when character format errors are detected, such as parity or framing errors).
- *5309 EFB STATUS* value varies depending on network traffic.
- BACnet protocol: 5316 EFB PAR 16 (MS/TP token counter) advances for each token passed to this drive. (Does not apply for other protocols.)

*Loss of communication*

The AC320 behavior, if communication is lost, was configured in *Communication fault*. The parameters are *3018 COMM FAULT FUNC* and *3019 COMM FAULT TIME*. Section *Parameter listing* describes these parameter.

*No master station on line*

If no master station is on line: Neither the *EFB OK MESSAGES* nor the errors (*5307 EFB CRC ERRORS* and *5308 EFB UART ERRORS*) increase on any of the stations.

To correct:

- Check that a network master is connected and properly programmed on the network.
- Verify that the cable is connected, and is not cut or short circuited.

*Duplicate stations*

If two or more stations have duplicate numbers:

- Two or more drives cannot be addressed.
- Every time there is a read or write to one particular station, the value for *5307 EFB CRC ERRORS* or *5308 EFB UART ERRORS* advances.

To correct: Check all station numbers and edit conflicting values.

*Swapped wires*

If the communication wires are swapped (terminal A on one drive is connected to terminal B on another):

- The value of *5306 EFB OK MESSAGES* does not advance.
- The values of *5307 EFB CRC ERRORS* and *5308 EFB UART ERRORS* are advancing.

To correct: Check that the EIA-485 lines are not swapped.

*Fault 28 – Serial 1 Err*

If the drive's control panel shows fault *0028 SERIAL 1 ERR*, check for either of the following:

- The master system is down. To correct, resolve problem with master system.
- The communication connection is bad. To correct, check communication connection at the drive.

- The time-out selection for the drive is too short for the given installation. The master is not polling the drive within the specified time-out delay. To correct, increase the time set by parameter *3019 COMM FAULT TIME*.

*Fault 31 – EFB1*

For BACnet: If the drive's control panel shows fault *0031 EFB 1*, the drive has an invalid Device Object Instance ID. To correct, use parameters 5311 and 5317 and establish a unique drive ID that is in the range 1 to 4,194,303.

*Faults 31…33 – EFB1…EFB3*

Except as noted above, these three EFB fault codes (*0031 EFB 1*…*0033 EFB 3*) are not used.

*Intermittent off-line occurrences*

The problems described above are the most common problems encountered with ACS320 serial communication. Intermittent problems might also be caused by:

- Marginally loose connections,
- Wear on wires caused by equipment vibrations,
- Insufficient grounding and shielding on both the devices and on the communication cables.

# N2 protocol technical data

## Overview

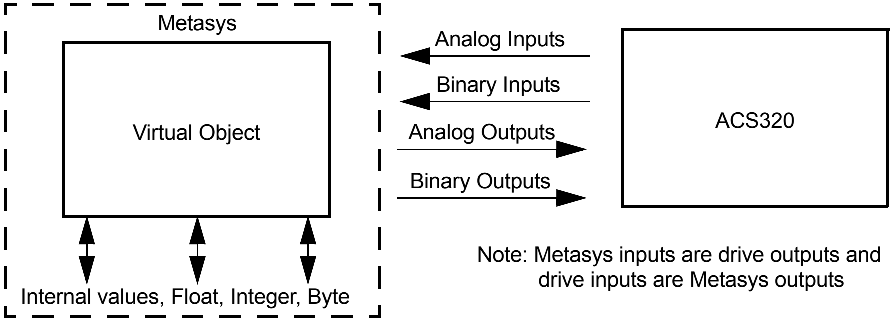
The N2 fieldbus connection to the ACS320 drives is based on an industry standard RS-485 physical interface. The N2 fieldbus protocol is a master-slave type, serial communication protocol, used by the Johnson Controls Metasys® system. In the Metasys architecture the N2 fieldbus connects object interfaces and remote controllers to Network Control Units (NCUs).

The N2 fieldbus can also be used to connect ACS320 drives to the Metasys Companion product line.

This section describes the use of the N2 fieldbus with the ACS320 drives' connection and does not describe the protocol in detail.

*Supported features*

In the N2 fieldbus protocol the ACS320 drive appears as a “virtual object”.




A virtual object is made up of:

- Analog Inputs
- Binary Inputs
- Analog Outputs
- Binary Outputs
- Internal values for Floating point, Integer, and Byte values.

The ACS320 drive does not support N2 fieldbus communication “internal values”.

All of the Analog and Binary I/O objects are listed below, starting with *N2 analog input objects* below.

**Analog input** – The analog input objects support the following features:

- Analog Input actual value in engineering units
- Low Alarm limit
- Low Warning limit
- High Warning limit
- High Alarm limit
- Differential value for the hysteresis of the Alarms and Warnings
- Change of State (COS) enabled
- Alarm Enabled
- Warning Enabled
- Override value is received, but there is no action taken.

**Binary input** – The binary input objects support the following features:

- Binary Input actual value
- Normal / Alarm state specification
- Alarm Enabled

- Change of State (COS) enabled
- Override value is received, but there is no action taken.

**Analog output** – The analog output objects support the following features:

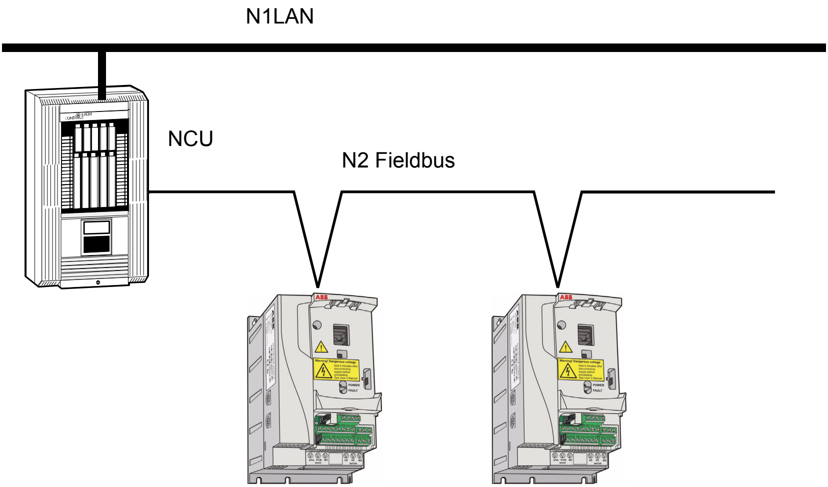
- Analog Output value in engineering units
- Override value is used to change the Analog Output value. It is not possible to return to the previous value by removing the override. The override feature is used only to change the value.

**Binary output** – The binary output objects support the following features:

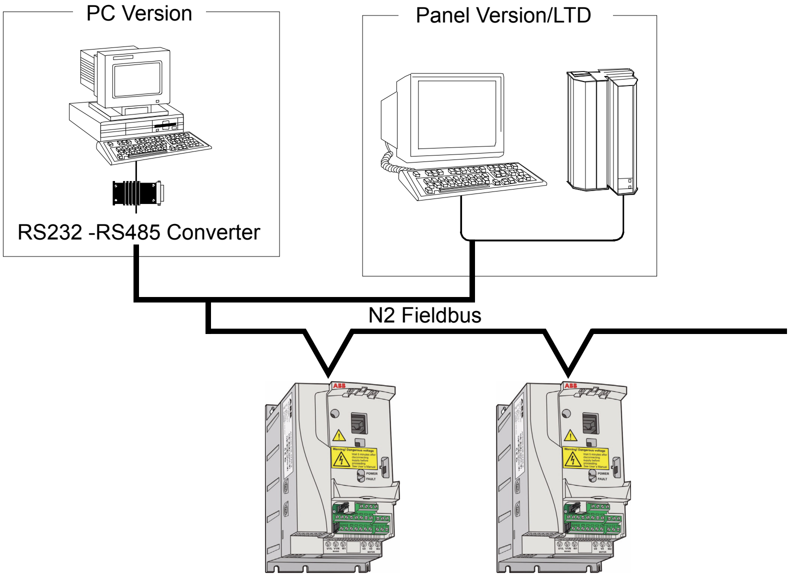
- Binary Output value
- Override value is used to change the Binary Output value. It is not possible to return to the previous value by removing the override. The override feature is used only to change the value.

*Metasys integration*

The following diagram shows the drives' integration to the Johnson Controls Metasys system.



The following diagram shows the drives' integration to the Johnson Controls Metasys Companion system.




On the N2 fieldbus each ACS320 drive can be accessed by the full complement of Metasys FMS features, including Change-of-State (COS) monitoring, alarm notification, scheduling, trend, and totalization.

On one N2 fieldbus segment there can be up to 32 nodes while integrating ACS320 drives with Johnson Controls Metasys.

*Drive device type*

For the Metasys and Metasys Companion products, the device type for the ACS320 drive is VND.

## N2 analog input objects

The following table lists the N2 analog Input objects defined for the ACS320 drive.

| **N2 Analog Inputs:** | | | | | |
|---|---|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Scale Factor** | **Units** | **Range** |
| AI1 | OUTPUT FREQUENCY | 0103 | 10 | Hz | 0…250 |
| AI2 | RATED SPEED | Note 1 | 10 | % | 0 …100 |
| AI3 | SPEED | 0102 | 1 | rpm | 0 …9999 |
| AI4 | CURRENT | 0104 | 10 | A | 0…9999 |
| AI5 | TORQUE | 0105 | 10 | % | -200…200 |
| AI6 | POWER | 0106 | 10 | kW | 0…9999 |

| N2 Analog Inputs: | | | | | |
|---|---|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Scale Factor** | **Units** | **Range** |
| AI7 | DRIVE TEMPERATURE | 0110 | 10 | °C | 0 …125 |
| AI8 | KILOWATT HOURS | 0115 | 1 | kWh | 0…65535 |
| AI9 | MEGAWATT HOURS | 0141 | 1 | MWh | 0…65535 |
| AI10 | RUN TIME | 0114 | 1 | H | 0…65535 |
| AI11 | DC BUS VOLTAGE | 0107 | 1 | V | 0…999 |
| AI12 | OUTPUT VOLTAGE | 0109 | 1 | V | 0…999 |
| AI13 | PRC PID FEEDBACK | 0130 | 10 | % | 0…100 |
| AI14 | PRC PID DEVIATION | 0132 | 10 | % | 0…100 |
| AI15 | EXT PID FEEDBACK | 0131 | 10 | % | 0…100 |
| AI16 | EXT PID DEVIATION | 0133 | 10 | % | 0…100 |
| AI17 | LAST FAULT | 0401 | 1 | | fault code |
| AI18 | PREV FAULT | 0402 | 1 | | fault code |
| AI19 | OLDEST FAULT | 0403 | 1 | | fault code |
| AI20 | AI 1 ACTUAL | 0120 | 10 | % | 0…100 |
| AI21 | AI 2 ACTUAL | 0121 | 10 | % | 0…100 |
| AI22 | AO 1 ACTUAL | 0124 | 10 | mA | 0…20 |
| AI24 | MOTOR TEMP | 0145 | 1 | °C | 0…200 |
| AI25 | REVOLUTION CNT | 0142 | 1 | MREV | 0…32767 |

1. RATED SPEED is a percent of maximum frequency (parameter 2008) if the drive is in scalar mode, and is a percent of maximum speed (parameter 2002) in speed mode.

## N2 binary input objects

The following table lists the N2 binary input objects defined for the ACS320 drive.

| N2 Binary Inputs: | | | |
|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Range** |
| BI1 | STOP/RUN | Status Word | 0 = Stop, 1 = Drive Running |
| BI2 | FORWARD/REVERSE | Status Word | 0 = Forward, 1 = Reverse |
| BI3 | FAULT STATUS | Status Word | 0 = OK, 1 = Drive Fault |
| BI4 | RELAY 1 STATUS | 0122 (bit mask 04) | 0 = Off, 1 = On |
| BI5 | RELAY 2 STATUS | 0122 (bit mask 02) | 0 = Off, 1 = On[1] |
| BI6 | RELAY 3 STATUS | 0122 (bit mask 01) | 0 = Off, 1 = On[1] |
| BI7 | RELAY 4 STATUS | 0123 (bit mask 04) | 0 = Off, 1 = On[1] |
| BI10 | INPUT 1 STATUS | 0118 (bit mask 04) | 0 = Off, 1 = On |
| BI11 | INPUT 2 STATUS | 0118 (bit mask 02) | 0 = Off, 1 = On |
| BI12 | INPUT 3 STATUS | 0118 (bit mask 01) | 0 = Off, 1 = On |
| BI13 | INPUT 4 STATUS | 0119 (bit mask 04) | 0 = Off, 1 = On |
| BI14 | INPUT 5 STATUS | 0119 (bit mask 02) | 0 = Off, 1 = On |
| BI16 | EXTERNAL 2 SELECT | Status Word | 0 = EXT1 = EXT2 |
| BI17 | HAND/AUTO | Status Word | 0 = AUTO, 1 = HAND |

| N2 Binary Inputs: | | | |
|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Range** |
| BI18 | ALARM | Status Word | 0 = OK, 1 = ALARM |
| BI19 | MAINTENANCE REQ | Status Word | 0 = OK, 1 = MAINT REQ |
| BI20 | DRIVE READY | Status Word | 0 = Not Ready, 1 = Ready |
| BI21 | AT SETPOINT | Status Word | 0 = No, 1 = At Setpoint |
| BI22 | RUN ENABLED | Status Word | 0 = Not Enabled, 1 = Enabled |
| BI23 | N2 LOCAL MODE | Status Word | 0 = Auto, 1 = N2 Local |
| BI24 | N2 CONTROL SRC | Status Word | 0 = No, 1 = Yes |
| BI25 | N2 REF1 SRC | Status Word | 0 = No, 1 = Yes |
| BI26 | N2 REF2 SRC | Status Word | 0 = No, 1 = Yes |

1.Require optional MREL relay output card.

## N2 analog output objects

The following table lists the N2 analog output objects defined for the ACS320 drive.

| N2 Analog Outputs: | | | | | |
|---|---|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Scale Factor** | **Units** | **Range** |
| AO1 | REFERENCE 1 | Reference 1 | 10 | % | 0…100 |
| AO2 | REFERENCE 2 | Reference 2 | 10 | % | 0…100 |
| AO3 | ACCEL TIME 1 | 2202 | 10 | s | 0.1…1800 |
| AO4 | DECEL TIME 1 | 2203 | 10 | s | 0.1…1800 |
| AO5 | CURRENT LIMIT | 2003 | 10 | A | 0…1.3*$I_{2N}$ |
| AO6 | PID1-CONT GAIN | 4001 | 10 | % | 0.1…100 |
| AO7 | PID1-CONT I-TIME | 4002 | 10 | s | 0.1…600 |
| AO8 | PID1-CONT D-TIME | 4003 | 10 | s | 0…10 |
| AO9 | PID1-CONT D FILTER | 4004 | 10 | s | 0…10 |
| AO10 | PID2-CONT GAIN | 4101 | 10 | % | 0.1…100 |
| AO11 | PID2-CONT I-TIME | 4102 | 10 | s | 0.1…600 |
| AO12 | PID2-CONT D-TIME | 4103 | 10 | s | 0…10 |
| AO13 | PID2-CONT D FILTER | 4104 | 10 | s | 0…10 |
| AO14 | COMMAND AO 1 | 135 | 10 | % | 0…100 |
| AO16 | EXT PID SETPOINT | 4211 | 10 | % | 0…100 |
| AO17 | SPD OUT MIN | 2001/2007 | 10 | % | 0…200 |
| AO18 | SPD OUT MAX | 2002/2008 | 10 | % | 0…200 |
| A019 | MAILBOX PARAMETER | | 1 | | 0…65535 |
| A020 | MAILBOX DATA | | 1 | | 0…65535 |

## N2 binary output objects

The following table lists the N2 binary output objects defined for the ACS320 drive.

| N2 Binary Outputs: | | | |
|---|---|---|---|
| **Number** | **Object** | **Drive Parameter** | **Range** |
| BO1 | STOP/START | Command word | 0 = Stop, 1 = Start to Speed |
| BO2 | FORWARD/REVERSE | Command word | 0 = Forward, 1 = Reverse |
| BO3 | PANEL LOCK | Command word | 0 = Open, 1 = Locked |
| BO4 | RUN ENABLE | Command word | 0 = Enable, 1 = Disable |
| BO5 | REF1/REF2 SELECT | Command word | 0 = Ref1, 1 = Ref2 |
| BO6 | FAULT RESET | Command word | Change 0 -> 1 Resets |
| BO7 | COMMAND RO 1 | 134 (bit mask 01) | 0 = Off, 1 = On |
| BO8 | COMMAND RO 2 | 134 (bit mask 02) | 0 = Off, 1 = On[1] |
| BO9 | COMMAND RO 3 | 134 (bit mask 04) | 0 = Off, 1 = On[1] |
| BO10 | COMMAND RO 4 | 134 (bit mask 08) | 0 = Off, 1 = On[1] |
| BO13 | RESET RUN TIME | 114 (indirectly) | 0 = N/A, 1 = On (Reset Run Time) |
| BO14 | RESET KWH COUNT | 115 (indirectly) | 0 = N/A, 1 = On (Reset kWh Count) |
| BO15 | PRC PID SELECT | 4027 (indirectly) | 0 = SET2, 1 = SET2 |
| BO16 | N2 LOCAL CTL[2] | Command word | 0 = Auto, 1 = N2 |
| BO17 | N2 LOCAL REF[2] | Command word | 0 = Auto, 1 = N2 |
| BO18 | SAVE PARAMETERS | 1607 (indirectly) | 0 = N/A, 1 = On (Save Parameters) |
| B019 | READ MAILBOX | | 0 = No, 1 = Yes |
| B020 | WRITE MAILBOX | | 0 = No, 1 = Yes |

1.Requires optional MREL relay output card.

2.N2 LOCAL CTL and N2 LOCAL REF have priority over drive input terminals. Use these binary outputs for temporary N2 control of the drive when COMM is not the selected control source.

## DDL file for NCU

The listing below is the Data Definition Language (DDL) file for ACS320 drives used with the Network Control Units.

This listing is useful when defining drive I/O objects to the Network Controller Units.

Below is the ACS320.DDL file listing.

```
***************************************************************
*  ABB Drives, ACS 320 Variable Frequency Drive
***************************************************************
CSMODEL "ACS_320","VND"

AITITLE "Analog_Inputs"
BITITLE "Binary_Inputs"
AOTITLE "Analog_Outputs"
BOTITLE "Binary_Outputs"

CSAI "AI1",N,N,"FREQ_ACT","Hz"
CSAI "AI2",N,N,"PCT_ACT","%"
```

```
CSAI "AI3",N,N,"SPEED","RPM"
CSAI "AI4",N,N,"CURRENT","A"
CSAI "AI5",N,N,"TORQUE","%"
CSAI "AI6",N,N,"POWER","kW"
CSAI "AI7",N,N,"DRV_TEMP","°C"
CSAI "AI8",N,N,"ENERGY_k","kWh"
CSAI "AI9",N,N,"ENERGY_M","MWh"
CSAI "AI10",N,N,"RUN_TIME","H"
CSAI "AI11",N,N,"DC_VOLT","V"
CSAI "AI12",N,N,"VOLT_ACT","V"
CSAI "AI13",N,N,"PID1_ACT","%"
CSAI "AI14",N,N,"PID2_DEV","%"
CSAI "AI15",N,N,"PID2_ACT","%"
CSAI "AI16",N,N,"PID2_DEV","%"
CSAI "AI17",N,N,"LAST_FLT","Code"
CSAI "AI18",N,N,"PREV_FLT","Code"
CSAI "AI19",N,N,"1ST_FLT","Code"
CSAI "AI20",N,N,"AI_1_ACT","%"
CSAI "AI21",N,N,"AI_2_ACT","%"
CSAI "AI22",N,N,"AO_1_ACT","mA"
CSAI "AI24",N,N,"MTR_TEMP","°C"
CSAI "AI25",N,N,"REVL_CNT",""

CSBI "BI1",N,N,"STOP/RUN","STOP","RUN"
CSBI "BI2",N,N,"FWD/REV","FWD","REV"
CSBI "BI3",N,N,"FAULT","OK","FLT"
CSBI "BI4",N,N,"RELAY_1","OFF","ON"
CSBI "BI5",N,N,"RELAY_2","OFF","ON"
CSBI "BI6",N,N,"RELAY_3","OFF","ON"
CSBI "BI7",N,N,"RELAY_4","OFF","ON"
CSBI "BI10",N,N,"INPUT_1","OFF","ON"
CSBI "BI11",N,N,"INPUT_2","OFF","ON"
CSBI "BI12",N,N,"INPUT_3","OFF","ON"
CSBI "BI13",N,N,"INPUT_4","OFF","ON"
CSBI "BI14",N,N,"INPUT_5","OFF","ON"
CSBI "BI16",N,N,"EXT1/2","EXT1","EXT2"
CSBI "BI17",N,N,"HND/AUTO","HAND","AUTO"
CSBI "BI18",N,N,"ALARM","OFF","ON"
CSBI "BI19",N,N,"MNTNCE_R","OFF","ON"
CSBI "BI20",N,N,"DRV_REDY","NO","YES"
CSBI "BI21",N,N,"AT_SETPT","NO","YES"
CSBI "BI22",N,N,"RUN_ENAB","NO","YES"
CSBI "BI23",N,N,"N2_LOC_M","AUTO","N2_L"
CSBI "BI24",N,N,"N2_CTRL","NO","YES"
CSBI "BI25",N,N,"N2_R1SRC","NO","YES"
CSBI "BI26",N,N,"N2_R2SRC","NO","YES"
CSAO "AO1",Y,Y,"REF_1","%"
CSAO "AO2",Y,Y,"REF_2","%"
CSAO "AO3",Y,Y,"ACCEL_1","s"
CSAO "AO4",Y,Y,"DECEL_1","s"
CSAO "AO5",Y,Y,"CURR_LIM","A"
```

```
CSAO "AO6",Y,Y,"PID1_GN","%"
CSAO "AO7",Y,Y,"PID1_I","s"
CSAO "AO8",Y,Y,"PID1_D","s"
CSAO "AO9",Y,Y,"PID1_FLT","s"
CSAO "AO10",Y,Y,PID2_GN","%"
CSAO "AO11",Y,Y,"PID2_I","s"
CSAO "AO12",Y,Y,"PID2_D","s"
CSAO "AO13",Y,Y,"PID2_FLT","s"
CSAO "AO14",Y,Y,"CMD_AO_1","%"
CSAO "AO16",Y,Y,"PI2_STPT","%"
CSAO "AO17",Y,Y,"MIN_SPD","%"
CSAO "AO18",Y,Y,"MAX_SPD","%"
CSAO "AO19",Y,Y,"MB_PARAM",""
CSAO "AO20",Y,Y,"MB_DATA",""
CSBO "BO1",Y,Y,"START","STOP","START"
CSBO "BO2",Y,Y,"REVERSE","FWD","REV"
CSBO "BO3",Y,Y,"PAN_LOCK","OPEN","LOCKED"
CSBO "BO4",Y,Y,"RUN_ENAB","DISABLE","ENABLE"
CSBO "BO5",Y,Y,"R1/2_SEL","EXT_1","EXT_2"
CSBO "BO6",Y,Y,"FLT_RSET","-","RESET"
CSBO "BO7",Y,Y,"CMD_RO_1","OFF","ON"
CSBO "BO8",Y,Y,"CMD_RO_2","OFF","ON"
CSBO "BO9",Y,Y,"CMD_RO_3","OFF","ON"
CSBO "BO10",Y,Y,"CMD_RO_4","OFF","ON"
CSBO "BO13",Y,Y,"RST_RTIM","OFF","RESET"
CSBO "BO14",Y,Y,"RST_KWH","OFF","RESET"
CSBO "BO15",Y,Y,"PID_SEL","SET1","SET2"
CSBO "BO16",Y,Y,"N2_LOC_C","AUTO","N2"
CSBO "BO17",Y,Y,"N2_LOC_R","EUTO","N2"
CSBO "BO18",Y,Y,"SAV_PRMS","OFF","SAVE"
CSBO "BO19",Y,Y,"READ_MB","NO","READ"
CSBO "BO20",Y,Y,"WRITE_MB","NO","WRITE"
```

# FLN protocol technical data

## Overview

The FLN fieldbus connection to the ACS320 drives is based on an industry standard RS-485 physical interface. The FLN (Floor Level Network) fieldbus protocol is a serial communication protocol, used by the Siemens APOGEE® system. The ACS320 interface is specified in Siemens application xxxx.

*Supported features*

The ACS320 supports all required FLN features.

## Reports

The ACS320 provides seven pre-defined reports. Using a report request generated from the FLN fieldbus controller, select one of the following sets of points. By providing views of selected points, these reports are often easier to work with than views of the full point database.

*ABB ACS320*

| FLN ABB drive report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 01 | LAO | CTLR ADDRESS | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 02 | LAO | APPLICATION | |
| 20 | LAO | OVRD TIME | |
| 29 | LDO | DAY.NIGHT | |

*Startup*

| FLN start-up report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 21 | LDI | FWD.REV | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 22 | LDO | CMD FWD.REV | |
| 23 | LDI | STOP.RUN | |
| 24 | LDO | CMD STP.STRT | |
| 25 | LDI | EXT1.2 ACT | |
| 26 | LDO | EXT1.2 CMD | |
| 34 | LDI | ENA.DIS ACT | |
| 35 | LDO | ENA.DIS CMD | |
| 36 | LDI | FLN LOC ACT | |
| 60 | LAO | INPUT REF1 | |
| 61 | LAO | INPUT REF2 | |
| 68 | LDO | FLN LOC CTL | |
| 69 | LDO | FLN LOC REF | |
| 94 | LDO | RESET FAULT | |

*Overview*

| FLN overview report | | | |
|---|---|---|---|
| **Point** | | **Subpoint name** | **Data** |
| **#** | **Type** | | |
| 03 | LAI | FREQ OUTPUT | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 04 | LAI | PCT OUTPUT | |
| 05 | LAI | SPEED | |
| 06 | LAI | CURRENT | |
| 07 | LAI | TORQUE | |
| 08 | LAI | POWER | |
| 09 | LAI | DRIVE TEMP | |
| 10 | LAI | DRIVE KWH | |
| 11 | LAI | DRIVE MWH | |
| 12 | LAI | RUN TIME | |
| 13 | LAI | DC BUS VOLT | |
| 14 | LAI | OUTPUT VOLT | |
| 17 | LAI | MOTOR TEMP | |
| 18 | LAI | MREV COUNTER | |
| 21 | LDI | FWD.REV | |
| 23 | LDI | STOP.RUN | |
| 25 | LDI | EXT1.2 ACT | |
| 27 | LDI | DRIVE READY | |
| 28 | LDI | AT SETPOINT | |
| 33 | LDI | HANDAUTO ACT | |
| 34 | LDI | ENA.DIS ACT | |
| 36 | LDI | FLN LOC ACT | |

*Drive I/O*

| FLN drive I/O report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 40 | LDO | RO 1 COMMAND | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 41 | LDO | RO 2 COMMAND | |
| 42 | LDO | RO 3 COMMAND | |
| 43 | LDO | RO 4 COMMAND | |
| 46 | LAO | AO 1 COMMAND | |
| 70 | LDI | DI 1 ACTUAL | |
| 71 | LDI | DI 2 ACTUAL | |
| 72 | LDI | DI 3 ACTUAL | |
| 73 | LDI | DI 4 ACTUAL | |
| 74 | LDI | DI 5 ACTUAL | |
| 76 | LDI | RO 1 ACTUAL | |
| 77 | LDI | RO 2 ACTUAL | |
| 78 | LDI | RO 3 ACTUAL | |
| 79 | LDI | RO 4 ACTUAL | |

*Drive Config*

| FLN drive config. report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 30 | LAO | CURRENT LIM | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 31 | LAO | ACCEL TIME 1 | |
| 32 | LAO | DECEL TIME 1 | |
| 48 | LDO | RST RUN TIME | |
| 49 | LDO | RESET KWH | |
| 59 | LDO | LOCK PANEL | |
| 66 | LDO | SPD OUT MIN | |
| 67 | LDO | SPD OUT MAX | |
| 95 | LAO | MBOX PARAM | |
| 96 | LAO | MBOX DATA | |
| 97 | LDO | MBOX READ | |
| 98 | LDO | MBOX WRITE | |

*Process PID*

| FLN process PID report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 15 | LAI | PRC PID FBCK | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 16 | LAI | PRC PID DEV | |
| 50 | LAO | PRC PID GAIN | |
| 51 | LAO | PRC PID ITIM | |
| 52 | LAO | PRC PID DTIM | |
| 53 | LAO | PRC PID DFIL | |
| 54 | LDO | PRC PID SEL | |
| 60 | LAO | INPUT REF1 | |
| 61 | LAO | INPUT REF2 | |
| 82 | LAI | AI 1 ACTUAL | |
| 83 | LAI | AI 2 ACTUAL | |
| 84 | LAI | AO 1 ACTUAL | |

*External PID*

| FLN external PID report | | | |
|---|---|---|---|
| Point | | Subpoint name | Data |
| # | Type | | |
| 55 | LAO | EXT PID GAIN | Each host FLN application (for example, CIS or Insight) controls both the particular data reported for each point, and the report format. |
| 56 | LAO | EXT PID ITIM | |
| 57 | LAO | EXT PID DTIM | |
| 58 | LAO | EXT PID DFIL | |
| 62 | LAO | EXT PID STPT | |
| 63 | LAI | EXT PID FBCK | |
| 64 | LAI | EXT PID DEV | |
| 82 | LAI | AI 1 ACTUAL | |
| 83 | LAI | AI 2 ACTUAL | |
| 84 | LAI | AO 1 ACTUAL | |

## Scaling drive feedback values

Feedback values are provided with units of percent, where 0% and 100% correspond to the range of the sensor being used to measure the control variable. These points have default units in Hz. If other units are required:

- Unbundle these points with appropriate slopes and intercepts.
- The new intercept equals the lowest value of the desired range.

- Calculate the new slope as follows:

$$\text{New Slope} = \frac{\text{(Desired Range, ie, high - low values) x (Slope of Existing Point)}}{\text{Range of Existing Point}}$$

$$= \frac{\text{(60 Hz - 0 Hz) x (0.01)}}{\text{100\% - 0\%}} = 0.006$$

*Example* – You are controlling water temperature from a cooling tower using the ACS320 to control a fan. The temperature sensor has a range of 30 to 250 degrees Fahrenheit.

To unbundle the setpoint (INPUT REF 2), for commanding in degrees Fahrenheit, where 0…60 Hz is equal to 30…250° F:

New Intercept = 30 (the temperature that corresponds to 0%)

$$\text{New Slope} = \frac{\text{(Desired Range) x (Slope of Existing Point)}}{\text{Range of Existing Point}}$$

$$= \frac{\text{(250° F - 30° F) x (0.1)}}{\text{100\% - 0\%}} = 0.22$$

To unbundle the feedback (PRC PID FBCK) for monitoring in degrees Fahrenheit:

New Intercept = 30

$$\text{New Slope} = \frac{\text{(Desired Range) x (Slope of Existing Point)}}{\text{Range of Existing Point}}$$

$$= \frac{\text{(250° F - 30° F) x (0.01)}}{\text{100\% - 0\%}} = 0.022$$

## Loop gains

PRC PID GAIN (Point 50) and PRC PID ITIM (Point 51) are PID parameters similar to the P and I gains in the APOGEE TECs. Because the ABB PI loop and the Siemens loop are structured differently, there is no a one-to-one correspondence between the gains. The following formulas allow translation from ABB gains to Siemens gains and vice versa:

- To convert from ABB PI gains to Siemens P and I gains:

$$\text{P GAIN}_{\text{Siemens}} = \text{PI GAIN}_{\text{ABB}} \text{ x } 0.0015$$

$$\text{I GAIN}_{\text{Siemens}} = \frac{\text{PI GAIN}_{\text{ABB}}}{\text{PI GAIN}_{\text{ABB}}} \text{ x } 0.0015$$

- To convert from Siemens P and I gains to ABB PI gains:

$$\text{P GAIN}_{\text{ABB}} = \text{PI GAIN}_{\text{Siemens}} \text{ x } 667$$

$$\text{I GAIN}_{\text{ABB}} = \frac{\text{PI GAIN}_{\text{Siemens}}}{\text{PI GAIN}_{\text{Siemens}}} \text{ x } 667$$

## Point database

The following table lists the point database for FLN / ACS320 (Application 2762).

| FLN Point Database | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Point** | | **Subpoint Name** | **Factory Default** | **Engr. Units** | **Slope** | **Intercept** | **On Text** | **Off Text** |
| **#** | **Type** | | **(SI Units)** | | | | | |
| 01 | LAO | CTLR ADDRESS | 99 | - | 1 | 0 | - | - |
| 02 | LAO | APPLICATION | 2734 | - | 1 | | - | - |
| {03} | LAI | FREQ OUTPUT | 0 | Hz | 0.1 | 0 | - | - |
| {04} | LAI | PCT OUTPUT | 0 | PCT | 0.1 | 0 | - | - |
| {05} | LAI | SPEED | 0 | RPM | 1 | 0 | - | - |
| {06} | LAI | CURRENT | 0 | A | 0.1 | | - | - |
| {07} | LAI | TORQUE | 0 | PCT | 0.1 | -200 | - | - |
| {08} | LAI | POWER | 0<br>(0) | HP<br>(KW) | 0.134<br>0.1 | 0<br>0 | - | - |
| {09} | LAI | DRIVE TEMP | 77<br>(25) | °F<br>(°C) | 0.18<br>(0.1) | 32<br>0 | - | - |
| {10} | LAI | DRIVE KWH | 0 | KWH | 1 | | - | - |
| {11} | LAI | DRIVE MWH | 0 | MWH | 1 | | - | - |
| {12} | LAI | RUN TIME | 0 | HRS | 1 | | - | - |
| {13} | LAI | DC BUS VOLT | 0 | V | 1 | | - | - |
| {14} | LAI | OUTPUT VOLT | 0 | V | 1 | | - | - |
| {15} | LAI | PRC PID FBCK | 0 | PCT | 0.1 | | - | - |
| {16} | LAI | PRC PID DEV | 0 | PCT | 0.1 | | - | - |
| {17} | LAI | MOTOR TEMP | 77(25) | °F (°C) | 1.8 (1) | 32 0 | - | - |
| {18} | LAI | MREV COUNTER | 0 | MREV | 1 | 0 | - | - |
| 20 | LAO | OVRD TIME | 1 | hrs | 1 | 0 | - | - |
| {21} | LDI | FWD.REV | FWD | - | 1 | 0 | REV | FWD |
| {22} | LDO | CMD FWD.REV | FWD | - | 1 | 0 | REV | FWD |
| {23} | LDI | STOP.RUN | STOP | - | 1 | 0 | RUN | STOP |
| {24} | LDO | CMD STP.STRT | STOP | - | 1 | 0 | RUN | STOP |
| {25} | LDI | EXT1.2 ACT | EXT1 | - | 1 | 0 | EXT2 | EXT1 |
| {26} | LDO | EXT1.2 CMD | EXT1 | - | 1 | 0 | EXT2 | EXT1 |
| {27} | LDI | DRIVE READY | NOTRDY | - | 1 | 0 | READY | NOTRDY |

| FLN Point Database | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Point | | Subpoint Name | Factory Default | Engr. Units | Slope | Intercept | On Text | Off Text |
| # | Type | | (SI Units) | | | | | |
| {28} | LDI | AT SETPOINT | NO | - | 1 | 0 | YES | NO |
| {29} | LDO | DAY.NIGHT | DAY | - | 1 | 0 | NIGHT | DAY |
| 30 | LAO | CURRENT LIM | 0 | A | 0.1 | 0 | - | - |
| 31 | LAO | ACCEL TIME 1 | 300 | sec | 0.1 | 0 | - | - |
| 32 | LAO | DECEL TIME 1 | 300 | sec | 0.1 | 0 | - | - |
| {33} | LDI | HANDAUTO ACT | AUTO | - | 1 | 0 | HAND | AUTO |
| {34} | LDI | ENA.DIS ACT | DISABL | - | 1 | 0 | ENABLE | DISABL |
| {35} | LDO | ENA.DIS CMD | DISABL | - | 1 | 0 | ENABLE | DISABL |
| {36} | LDI | FLN LOC ACT | AUTO | - | 1 | 0 | FLN | AUTO |
| {37} | LDI | CTL SRC | NO | - | 1 | 0 | YES | NO |
| {38} | LDI | FLN REF1 SRC | NO | - | 1 | 0 | YES | NO |
| {39} | LDI | FLN REF2 SRC | NO | - | 1 | 0 | YES | NO |
| {40} | LDO | RO 1 COMMAND | OFF | - | 1 | 0 | ON | OFF |
| {41} | LDO | RO 2 COMMAND | OFF | - | 1 | 0 | ON | OFF |
| {42} | LDO | RO 3 COMMAND | OFF | - | 1 | 0 | ON | OFF |
| {43} | LDO | RO 4 COMMAND | OFF | - | 1 | 0 | ON | OFF |
| {46} | LAO | AO 1 COMMAND | PCT | PCT | 0.1 | 0 | - | - |
| 48 | LDO | RST RUN TIME | NO | - | 1 | 0 | RESET | NO |
| 49 | LDO | RESET KWH | NO | - | 1 | 0 | RESET | NO |
| 50 | LAO | PRC PID GAIN | 10 | PCT | 0.1 | 0 | - | - |
| 51 | LAO | PRC PID ITIM | 600 | SEC | 0.1 | 0 | - | - |
| 52 | LAO | PRC PID DTIM | 0 | SEC | 0.1 | 0 | - | - |
| 53 | LAO | PRC PID DFIL | 10 | SEC | 0.1 | 0 | - | - |
| 54 | LDO | PRC PID SEL | SET1 | - | 1 | 0 | SET2 | SET1 |
| 55 | LAO | EXT PID GAIN | 10 | PCT | 0.1 | 0 | - | - |
| 56 | LAO | EXT PID ITIM | 600 | SEC | 0.1 | 0 | - | - |
| 57 | LAO | EXT PID DTIM | 0 | SEC | 0.1 | 0 | - | - |
| 58 | LAO | EXT PID DFIL | 10 | SEC | 0.1 | 0 | - | - |
| 59 | LDO | LOCK PANEL | UNLOCK | - | 1 | 0 | LOCK | UNLOCK |
| {60} | LAO | INPUT REF1 | 0 | PCT | 0.1 | 0 | - | - |
| {61} | LAO | INPUT REF2 | 0 | PCT | 0.1 | 0 | - | - |
| {62} | LAO | EXT PID STPT | 0 | PCT | 0.1 | 0 | - | - |
| {63} | LAI | EXT PID FBCK | 0 | PCT | 0.1 | 0 | - | - |
| {64} | LAI | EXT PID DEV | 0 | PCT | 0.1 | 0 | - | - |

| FLN Point Database | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Point | | Subpoint Name | Factory Default | Engr. Units | Slope | Intercept | On Text | Off Text |
| # | Type | | (SI Units) | | | | | |
| 66 | LDO | SPD OUT MIN | 0 | PCT | 0.1 | 0 | - | - |
| 67 | LDO | SPD OUT MAX | 1000 | PCT | 0.1 | 0 | - | - |
| {68} | LDO | FLN LOC CTL | AUTO | - | 1 | 0 | FLN | AUTO |
| {69} | LDO | FLN LOC REF | AUTO | - | 1 | 0 | FLN | AUTO |
| {70} | LDI | DI 1 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {71} | LDI | DI 2 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {72} | LDI | DI 3 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {73} | LDI | DI 4 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {74} | LDI | DI 5 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {76} | LDI | RO 1 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {77} | LDI | RO 2 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {78} | LDI | RO 3 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {79} | LDI | RO 4 ACTUAL | OFF | - | 1 | 0 | ON | OFF |
| {82} | LAI | AI 1 ACTUAL | 0 | PCT | 0.1 | 0 | - | - |
| {83} | LAI | AI 2 ACTUAL | 0 | PCT | 0.1 | 0 | - | - |
| {84} | LAI | AO 1 ACTUAL | 0 | MA | 0.1 | 0 | - | - |
| {86} | LDI | OK.ALARM | OK | - | 1 | 0 | ALARM | OK |
| {87} | LDI | OK.MAINT | OK | - | 1 | 0 | MAINT | OK |
| {88} | LAI | ALARM WORD 1 | - | - | 1 | 0 | - | - |
| {89} | LAI | ALARM WORD 2 | - | - | 1 | 0 | - | - |
| {90} | LAI | LAST FAULT | - | - | 1 | 0 | - | - |
| {91} | LAI | PREV FAULT 1 | - | - | 1 | 0 | - | - |
| {92} | LAI | PREV FAULT 2 | - | - | 1 | 0 | - | - |
| {93} | LDI | OK.FAULT | OK | - | 1 | 0 | FAULT | OK |
| {94} | LDO | RESET FAULT | NO | - | 1 | 0 | RESET | NO |
| {95} | LAO | MBOX PARAM | - | - | 1 | 0 | - | - |
| {96} | LAO | MBOX DATA | - | - | 1 | 0 | - | - |
| {97} | LDO | MBOX READ | DONE | - | 1 | 0 | READ | DONE |
| {98} | LDO | MBOX WRITE | DONE | - | 1 | 0 | WRITE | DONE |
| {99} | LAO | ERROR STATUS | - | - | 1 | 0 | - | - |

a.Points not listed are not used in this application.

b.A single value in a column means that the value is the same in English units and in SI units.

c.Point numbers that appear in brackets { } may be unbundled at the field panel.

## Detailed point descriptions

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| Point | | Description | Drive Parameter |
| 1 | CTRL ADDRESS | The FLN address of the drive. It can be set by FLN and by the panel. | 5302 |
| 2 | APPLICATION | The Application ID for FLN on the ACS320. This ID is assigned by Siemens for each unique application. It correlates directly to a particular point list approved at the time of release. Therefore, this point list shall remain fixed once approval is granted. Any changes to the point list shall require a new Application ID and re-approval by Siemens. The Application ID assigned to ACS320 is 2934. | |
| 3 | FREQ OUTPUT | The output frequency applied to the motor, in Hertz. | 0103 |
| 4 | PCT OUTPUT | The ratio of output frequency or speed to the corresponding maximum rating, depending on control mode.<br>For scalar mode, it is the ratio of Output Frequency (parameter 0103) to Maximum Frequency (parameter 2008).<br>For speed mode, it is the ratio Speed (parameter 0102) to Maximum Speed (2002). | None. This ratio is calculated by the FLN application. |
| 5 | SPEED | The calculated speed of the motor, in RPM. | 0102 |
| 6 | CURRENT | The measured output current. | 0104 |
| 7 | TORQUE | The calculated output torque of the motor as a percentage of nominal torque. | 0105 |
| 8 | POWER | The measured output power in KW. The FLN point definition also supports horsepower by selecting English units. | 0106 |
| | DRIVE TEMP | The measured heatsink temperature, in ° C. The FLN point definition also supports ° F by selecting English units. | 0110 |
| 10 | DRIVE KWH | The drive's cumulative power consumption in kilowatt-hours. This value may be reset by commanding FLN point 49, RESET KWH. | 0115 |
| 11 | DRIVE MWH | The drive's cumulative power consumption in megawatt hours. This value cannot be reset. | 0141 |
| 12 | RUN TIME | The drive's cumulative run time in hours. This value may be reset by commanding FLN point 48, RESET RUN TIME. | 0114 |
| 13 | DC BUS VOLT | The DC bus voltage level of the drive. | 0107 |
| 14 | OUTPUT VOLT | The AC output voltage applied to the motor. | 0109 |
| 15 | PRC PID FBCK | The Process PID feedback signal. | 0130 |
| 16 | PRC PID DEV | The deviation of the Process PID output signal from its setpoint. | 0132 |
| 17 | MOTOR TEMP | The measured motor temperature as set up in Group 35. | 0145 |
| 18 | ROTATION CNT | The motor's cumulative revolution count, in mega-revolutions. | 0142 |
| 19 | N/A | | |

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| **Point** | | **Description** | **Drive Parameter** |
| 20 | OVRD TIME | 1 of the 5 mandatory FLN points required for compatibility with Siemens control systems. It has no functionality in the drive application. | None |
| 21 | FWD.REV ACT | Indicates the rotational direction of the motor, regardless of control source (1 = REV, 0 = FWD). | |
| 22 | FWD.REV CMD | Commanded by FLN to change the rotational direction of the drive.<br>Parameter 1001 must be set to COMM for FLN to control the direction of the motor by EXT1.<br>Parameter 1002 must be set to COMM for FLN to control the direction of the motor by EXT2. | |
| 23 | RUN.STOP ACT | Indicates the drive's run status, regardless of control source (1 = RUN, 0 = STOP). | |
| 24 | RUN.STOP CMD | Commanded by FLN to start the drive.<br>Parameter 1001 must be set to COMM for FLN to control the run state of the drive by EXT1.<br>Parameter 1002 must be set to COMM for FLN to have this control. | |
| 25 | EXT1.2 ACT | Indicates whether External 1 or External 2 is the active control source (1 = EXT2, 0 = EXT1). | |
| 26 | EXT1.2 CMD | Commanded by FLN to select External 1 or External 2 as the active control source (1 = EXT2, 0 = EXT1).<br>Parameter 1102 must be set to COMM for FLN to have this control. | |
| 27 | DRIVE READY | Indicates the drive is ready to accept a run command (1 = READY, 0 = NOTRDY). | |
| 28 | AT SETPOINT | Indicates the drive has reached its commanded setpoint (1 = YES, 0 = NO) | |
| 29 | DAY.NIGHT | 1 of the 5 mandatory FLN points required for compatibility with Siemens control systems. It has no functionality in the drive application. | None |
| 30 | CURRENT LIM | Sets the output current limit of the drive. | 2003 |
| 31 | ACCEL TIME 1 | Sets the acceleration time for Ramp 1. | 2202 |
| 32 | DECEL TIME 1 | Sets the deceleration time for Ramp 1. | 2203 |
| 33 | HANDAUTO ACT | Indicates whether the drive is in Hand or Auto control (1 = HAND, 0 = AUTO). | |
| 34 | ENA.DIS ACT | Indicates the status of the Run Enable command, regardless of its source (1 = ENABLE, 0 = DISABL). | |
| 35 | ENA.DIS CMD | Commanded by FLN to assert the Run Enable command (1 = ENABLE, 0 = DISABL).<br>Parameter 1601 must be set to COMM for FLN to have this control. | |
| 36 | FLN LOC ACT | Indicates if the drive has been placed in “FLN LOCAL” mode by commanding either point 68 (FLN LOC CTL) or point 69 (FLN LOC REF). Commanding either of these points to FLN (1) “steals” control from its normal source and places in under FLN control.<br>Note that the HAND mode of the panel has priority over FLN local control. | |

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| Point | | Description | Drive Parameter |
| 37 | FLN CTL SRC | Indicates if FLN is a source for control inputs (1 = YES, 0 = NO).<br>Note that this status point is true if any of the following control inputs are from FLN: Run/Stop, Ext1/2 Select or Run Enable. | |
| 38 | FLN REF1 SRC | Indicates if FLN is the source for speed reference 1 (1 = YES, 0 = NO). | |
| 39 | FLN REF2 SRC | Indicates if FLN is the source for speed reference 2 (1 = YES, 0 = NO). | |
| 40 | RO1 COMMAND | Controls the output state of Relay 1.<br>Parameter 1401 must be set to COMM for FLN to have this control (1 = ON, 0 = OFF). | 0134, bit 0 |
| 41 | RO2 COMMAND | Controls the output state of Relay 2. Access to relay 2 requires ACS320 option MREL.<br>Parameter 1402 must be set to COMM for FLN to have this control (1 = ON, 0 = OFF). | 0134, bit 1 |
| 42 | RO3 COMMAND | Controls the output state of Relay 3. Access to relay 3 requires ACS320 option MREL.<br>Parameter 1403 must be set to COMM for FLN to have this control (1 = ON, 0 = OFF). | 0134, bit 2 |
| 43 | RO4 COMMAND | Controls the output state of Relay 4. Access to relay 4 require ACS320 option MREL.<br>Parameter 1410 must be set to COMM for FLN to have this control (1 = ON, 0 = OFF). | 0134, bit 3 |
| 46 | AO1 COMMAND | Controls Analog Output 1.<br>Parameter 1501 must be set to this value for FLN to have this control. | 0135 (COMM VALUE 1) |
| 48 | RESET RUN TIME | Commanded by FLN to reset the cumulative run timer (1 = RESET, 0 = NO).<br>The control input is rising-edge sensitive, so, once the command is issued, this point automatically returns to its inactive state. This “momentary” operation avoids any need for an explicit command to clear the point before a subsequent reset can be issued. | |
| 49 | RESET KWH | Commanded by FLN to reset the cumulative kilowatt-hour counter (1 = RESET, 0 = NO).<br>The control input is rising-edge sensitive, so, once the command is issued, this point automatically returns to its inactive state. This “momentary” operation avoids any need for an explicit command to clear the point before a subsequent reset can be issued. | |
| 50 | PRC PID GAIN | Sets the proportional gain of the active Process PID set, as selected by Point 54, PRC PID SEL (1 = SET2, 0 = SET1). | 4001 (SET1)<br>4101 (SET2) |
| 51 | PRC PID ITIM | Sets the integration time of the active Process PID set, as selected by Point 54, PRC PID SEL (1 = SET2, 0 = SET1). | 4002 (SET1)<br>4102 (SET2) |
| 52 | PRC PID DTIM | Sets the derivation time of the active Process PID set, as selected by Point 54, PRC PID SEL (1 = SET2, 0 = SET1). | 4001 (SET1)<br>4101 (SET2) |

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| **Point** | | **Description** | **Drive Parameter** |
| 53 | PRC PID DFIL | Sets the time constant for the error-derivative of the active Process PID set, as selected by Point 54, PRC PID SEL (1 = SET2, 0 = SET1). | 4004 (SET1)<br>4104 (SET2) |
| 54 | PRC PID SEL | Selects the active Process PID set (1 = SET2, 0 = SET1). | 4027 |
| 55 | EXT PID GAIN | Sets the proportional gain of the External PID controller. | 4201 |
| 56 | EXT PID ITIM | Sets the integration time of the External PID controller. | 4202 |
| 57 | EXT PID DTIM | Sets the derivation time of the External PID controller. | 4203 |
| 58 | EXT PID DFIL | Sets the time constant for the error-derivative of the External PID controller. | 4204 |
| 59 | LOCK PANEL | Command by FLN to lock the panel and prevent parameter changes (1 = LOCK, 0 = UNLOCK). | 1602 |
| 60 | INPUT REF 1 | Sets Input Reference 1.<br>Parameter 1102 must be set to COMM for FLN to control this value. | |
| 61 | INPUT REF 2 | Sets Input Reference 2.<br>Parameter 1106 must be set to COMM for FLN to control this value. | |
| 62 | EXT PID STPT | The setpoint for the External PID controller.<br>The function of this point requires parameter 4210, PID Setpoint Select, to be set to 19 (Internal). | 4211 |
| 63 | EXT PID FBCK | The External PID feedback signal. | 0131 |
| 64 | EXT PID DEV | The deviation of the External PID output signal from its setpoint. | 0133 |
| 65 | N/A | | |
| 66 | SPD OUT MIN | Sets the minimum output speed of the drive as a percentage of the motor nominal rating. | 2007 (SCALAR)<br>2001 (SPEED) |
| 67 | SPD OUT MAX | Sets the maximum output speed of the drive as a percentage of the motor nominal rating. | 2008 (SCALAR)<br>2002 (SPEED) |
| 68 | FLN LOC CTL | Commanded by FLN to temporarily “steal” start/stop control of the drive from its normal source and place it under FLN control. This functionality is analogous to placing the drive in HAND mode at the panel, with the control being taken by FLN instead. HAND mode at the panel has priority over this point. Thus, this point is only effective in temporarily taking control from the digital inputs or some other internal control functionality. | |
| 69 | FLN LOC REF | Commanded by FLN to temporarily “steal” input reference control of the drive from its normal source and place it under FLN control. This functionality is analogous to placing the drive in HAND mode at the panel, with the reference control being taken by FLN instead. HAND mode at the panel has priority over this point. Thus, this point is only effective in temporarily taking control from the analog inputs or some other internal control functionality. | |
| 70 | DI 1 ACTUAL | Indicates the status of Digital Input 1 (1 = ON, 0 = OFF). | 0118, bit 2 |

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| Point | | Description | Drive Parameter |
| 71 | DI 2 ACTUAL | Indicates the status of Digital Input 2 (1 = ON, 0 = OFF). | 0118, bit 1 |
| 72 | DI 3 ACTUAL | Indicates the status of Digital Input 3 (1 = ON, 0 = OFF). | 0118, bit 0 |
| 73 | DI 4 ACTUAL | Indicates the status of Digital Input 4 (1 = ON, 0 = OFF). | 0119, bit 2 |
| 74 | DI 5 ACTUAL | Indicates the status of Digital Input 5 (1 = ON, 0 = OFF). | 0119, bit 1 |
| 76 | RO 1 ACTUAL | Indicates the status of Relay Output 1 (1 = ON, 0 = OFF). | 0122, bit 2 |
| 77 | RO 2 ACTUAL | Indicates the status of Relay Output 2 (1 = ON, 0 = OFF). | 0122, bit 1 |
| 78 | RO 3 ACTUAL | Indicates the status of Relay Output 3 (1 = ON, 0 = OFF). | 0122, bit 0 |
| 79 | RO 4 ACTUAL | Indicates the status of Relay Output 4 (1 = ON, 0 = OFF). | 0123, bit 2 |
| 82 | AI 1 ACTUAL | Indicates the input level of Analog Input 1. | 0120 |
| 83 | AI 2 ACTUAL | Indicates the input level of Analog Input 2. | 0121 |
| 84 | AO 1 ACTUAL | Indicates the output level of Analog Output 1. | 0124 |
| 86 | OK.ALARM | Indicates the current alarm state of the drive (1 = ALARM, 0 = OK). | |
| 87 | OK.MAINT | Indicates the current maintenance state of the drive (1 = MAINT, 0 = OK).<br>Maintenance triggers are configured in drive parameter Group 29. | |
| 88 | ALARM WORD1 | This point is a bit-field indicating active alarms in the drive. | 0308 |
| 89 | ALARM WORD2 | This point is a bit-field indicating active alarms in the drive. | 0309 |
| 90 | LAST FAULT | This point is first in the drive's fault log and indicates the most recent fault declared. | 0401 |
| 91 | PREV FAULT 1 | This point is second in the drive's fault log and indicates the previous fault declared. | 0412 |
| 92 | PREV FAULT 2 | This point is last in the drive's fault log and indicates the oldest fault in the log. | 0413 |
| 93 | OK.FAULT | Indicates the current fault state of the drive (1 = FAULT, 0 = OK). | |
| 94 | RESET FAULT | Command by FLN to reset a faulted drive (1 = RESET, 0 = NO).<br>Parameter 1604 must be set to COMM for FLN to control this state.<br>The control input is rising-edge sensitive, so, once the command is issued, this point automatically returns to its inactive state. This “momentary” operation avoids any need for an explicit command to clear the point before a subsequent reset can be issued. | |
| 95 | MBOX PARAM | Sets the parameter to be used by the mailbox function. | |
| 96 | MBOX DATA | Sets or indicates the data value of the mailbox function. | |
| 97 | MBOX READ | Command by FLN to read the parameter value specified by Point 95, MBOX PARAM. The parameter value is returned in Point 96, MBOX DATA.<br>The control input is rising-edge sensitive, so, once the command is issued, this point automatically returns to its inactive state. This “momentary” operation avoids any need for an explicit command to clear the point before a subsequent reset can be issued. | |

| FLN Detailed Point Descriptions | | | |
|---|---|---|---|
| Point | | Description | Drive Parameter |
| 98 | MBOX WRITE | Command by FLN to write the data value specified by Point 96, MBOX DATA, to the parameter value specified by Point 95, MBOX PARAM.<br>The control input is rising-edge sensitive, so, once the command is issued, this point automatically returns to its inactive state. This “momentary” operation avoids any need for an explicit command to clear the point before a subsequent reset can be issued. | |
| 99 | ERROR STATUS | 1 of the 5 mandatory FLN points required for compatibility with Siemens control systems. It has no functionality in the drive application. | None |

# BACnet protocol technical data

## Binary input object instance summary

The following table summarizes the Binary input objects supported:

| Instance ID | Object Name | Description | Active/Inactive Text | Present Value Access Type |
|---|---|---|---|---|
| BI0 | RO 1 ACT | This object indicates the status of Relay Output 1. | ON/OFF | R |
| BI1 | RO 2 ACT | This object indicates the status of Relay Output 2 (requires MREL-01 option). | ON/OFF | R |
| BI2 | RO 3 ACT | This object indicates the status of Relay Output 3 (requires MREL-01 option). | ON/OFF | R |
| BI3 | RO 4 ACT | This object indicates the status of Relay Output 4 (requires MREL-01 option). | ON/OFF | R |
| BI6 | DI 1 ACT | This object indicates the status of Digital Input 1. | ON/OFF | R |
| BI7 | DI 2 ACT | This object indicates the status of Digital Input 2. | ON/OFF | R |
| BI8 | DI 3 ACT | This object indicates the status of Digital Input 3. | ON/OFF | R |
| BI9 | DI 4 ACT | This object indicates the status of Digital Input 4. | ON/OFF | R |
| BI10 | DI 5 ACT | This object indicates the status of Digital Input 5. | ON/OFF | R |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## Binary output object instance summary

The following table summarizes the Binary output objects supported:

| Instance ID | Object Name | Description | Active/Inactive Text | Present Value Access Type |
|---|---|---|---|---|
| BO0 | RO1 COMMAND | This object controls the output state of Relay 1. This control requires that parameter *1401* value = COMM. | ON/OFF | C |
| BO1 | RO2 COMMAND | This object controls the output state of Relay 2. This control requires that parameter *1402* value = COMM (also requires MREL-01 option). | ON/OFF | C |
| BO2 | RO3 COMMAND | This object controls the output state of Relay 3. This control requires that parameter *1403* value = COMM (also requires MREL-01 option). | ON/OFF | C |
| BO3 | RO4 COMMAND | This object controls the output state of Relay 4. This control requires that parameter *1410* value = COMM (also requires MREL-01 option). | ON/OFF | C |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## Binary value object instance summary

The following table summarizes the Binary value objects supported:

| Instance ID | Object Name | Description | Active/Inactive Text | Present Value Access Type |
|---|---|---|---|---|
| BV0 | RUN/STOP ACT | This object indicates the drive Run Status, regardless of the control source. | RUN/STOP | R |
| BV1 | FWD/REV ACT | This object indicates the motor's rotation direction, regardless of the control source. | REV/FWD | R |
| BV2 | FAULT ACT | this object indicates the drive's fault status. | FAULT/OK | R |
| BV3 | EXT 1/2 ACT | This object indicates which control source is active: External 1 or External 2. | EXT2/EXT1 | R |
| BV4 | HAND/AUTO ACT | This object indicates whether the drive is under Hand or Auto control. | HAND/AUTO | R |
| BV5 | ALARM ACT | This object indicates the drive's alarm status. | ALARM/OK | R |
| BV6 | MAINT REQ | This object indicates the drive's maintenance status. Refer to *Group 29: Maintenance trig*. | MAINT/OK | R |

| Instance ID | Object Name | Description | Active/Inactive Text | Present Value Access Type |
|---|---|---|---|---|
| BV7 | DRIVE READY | This object indicates whether the drive is ready to accept a run command. | READY/NOT READY | R |
| BV8 | AT SETPOINT | This object indicates whether the drive is at the commanded setpoint. | YES/NO | R |
| BV9 | RUN ENA ACT | This object indicates the Run Enable command status, regardless of the control source. | ENABLE/DISABLE | R |
| BV10 | RUN/STOP CMD | This object commands a drive start. Control requires either:<br>Parameter *1001* value = COMM for control by EXT1 or<br>Parameter *1002* value = COMM for control by EXT2. | RUN/STOP | C |
| BV11 | FWD/REV CMD | This object commands a motor rotation direction change. Control requires *1003* = REQUEST and either:<br>Parameter *1001* value = COMM for control by EXT1 or<br>Parameter *1002* value = COMM for control by EXT2. | REV/FWD | C |
| BV12 | RUN ENA CMD | This object commands Run Enable. Control requires parameter *1601* value = COMM. | ENABLE/DISABLE | C |
| BV13 | EXT 1/2 CMD | This object selects ext1 or ext2 as the active control source. Control requires parameter *1102* value = COMM. | EXT2/EXT1 | C |
| BV14 | FAULT RESET | This object resets a faulted drive. The command is rising-edge triggered. Control requires parameter *1604* value = COMM. | RESET/NO | C |
| BV15 | MBOX READ | This object reads a parameter (defined by AV25 MBOX PARAM) and returns it in AV26 MBOX DATA. | READ/RESET | W |
| BV16 | MBOX WRITE | This object writes the data value specified by AV26, MBOX DATA, to a parameter (defined by AV25, MBOX PARAM). | WRITE/RESET | W |

| Instance ID | Object Name | Description | Active/Inactive Text | Present Value Access Type |
|---|---|---|---|---|
| BV17 | LOCK PANEL | This object locks the panel and prevents parameter changes. The corresponding drive parameter is *1602*. | LOCK/UNLOCK | W |
| BV18 | CTL OVERRIDE CMD | This object commands the drive into BACnet Control Override. In this mode, BACnet takes drive control from the normal source. However, the control panel's HAND mode has priority over BACnet Control Override. | ON/OFF | C |
| BV19 | CTL OVERRIDE ACT | This object indicates whether the drive is in BACnet Control Override. (See BV18.) | ON/OFF | R |
| BV20 | START ENABLE 1 | This object commands start enable1. Control requires par. *1608* value = COMM. | ENABLE/DISABLE | C |
| BV21 | START ENABLE 2 | This object commands start enable1. Control requires par. *1609* value = COMM. | ENABLE/DISABLE | C |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## Analog input object instance summary

The following table summarizes the Analog input objects supported:

| Instance ID | Object Name | Description | Units | Present Value Access Type |
|---|---|---|---|---|
| AI0 | ANALOG INPUT 1 | This object indicates the value of Analog Input 1. The corresponding drive parameter is *0120*. | Percent | R |
| AI1 | ANALOG INPUT 2 | This object indicates the value of Analog Input 2. The corresponding drive parameter is *0121*. | Percent | R |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## Analog output object instance summary

The following table summarizes the Analog output objects supported:

| Instance ID | Object Name | Description | Units | Present Value Access Type |
|---|---|---|---|---|
| AO0 | AO 1 COMMAND | This object controls Analog Output 1. The corresponding drive parameter is *0135 COMM VALUE 1*. Control requires parameter *1501* value = 135. | Percent | C |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## Analog value object instance summary

The following table summarizes the Analog value objects supported:

| Instance ID | Object Name | Description | Units | Present Value Access Type |
|---|---|---|---|---|
| AV0 | OUTPUT SPEED | This object indicates the calculated motor speed in RPM. The corresponding drive parameter is *0102*. | RPM | R |
| AV1 | OUTPUT FREQ | This object indicates the output frequency applied to the motor in Hz. The corresponding drive parameter is *0103*. | Hertz | R |
| AV2 | DC BUS VOLT | This object indicates the drive's DC bus voltage level. The corresponding drive parameter is *0107*. | Volts | R |
| AV3 | OUTPUT VOLT | This object indicates the AC output voltage applied to the motor. The corresponding drive parameter is *0109*. | Volts | R |
| AV4 | CURRENT | This object indicates the measured output current. The corresponding drive parameter is *0104*. | Amps | R |
| AV5 | TORQUE | This object indicates the calculated motor output torque as a percentage of nominal torque. The corresponding drive parameter is *0105*. | Percent | R |
| AV6 | POWER | This object indicates the measured output power in kW. The corresponding drive parameter is *0106*. | Kilowatts | R |
| AV7 | DRIVE TEMP | This object indicates the measured heatsink temperature in °C. The corresponding drive parameter is *0110*. | °C | R |
| AV8 | KWH (R) | This object indicates, in kW hours, the drive's accumulated energy usage since the last reset. The value can be reset to zero. The corresponding drive parameter is *0115*. | kWh | W |
| AV9 | KWH (NR) | This object indicates the drive's accumulated energy usage in kW hours. The value cannot be reset. | kWh | R |

| Instance ID | Object Name | Description | Units | Present Value Access Type |
|---|---|---|---|---|
| AV10 | PRC PID FBCK | This object is the Process PID feedback signal. The corresponding drive parameter is *0130*. | Percent | R |
| AV11 | PRC PID DEV | This object is the Process PID output signal's deviation from its setpoint. The corresponding drive parameter is *0132*. | Percent | R |
| AV12 | EXT PID FBCK | This object is the External PID feedback signal. The corresponding drive parameter is *0131*. | Percent | R |
| AV13 | EXT PID DEV | This object is the External PID output signal's deviation from its setpoint. The corresponding drive parameter is *0133*. | Percent | R |
| AV14 | RUN TIME (R) | This object indicates, in hours, the drive's accumulated run time since the last reset. The value can be reset to zero. The corresponding drive parameter is *0114*. | Hours | W |
| AV15 | MOTOR TEMP | This object indicates the drive's motor temperature, as set up in *Group 35: Motor temp meas*. The corresponding drive parameter is *0145*. | °C | R |
| AV16 | INPUT REF 1 | This object sets Input Reference 1. Control requires parameter *1103* value = COMM. | Percent | C |
| AV17 | INPUT REF 2 | This object sets either:<br>Input Reference 2. Control requires parameter *1106* value = COMM.<br>Process PID setpoint. Control requires parameter *1106* value = PID1 OUT and parameter *4010* value = COMM. | Percent | C |
| AV18 | LAST FLT | This object indicates the most recent fault entered in the drive's fault log. The corresponding drive parameter is *0401*. | None | R |
| AV19 | PREV FLT 1 | This object indicates the second most recent fault entered in the drive's fault log. The corresponding drive parameter is *0412*. | None | R |
| AV20 | PREV FLT 2 | This object indicates the third most recent fault entered in the drive's fault log. The corresponding drive parameter is *0413*. | None | R |
| AV21 | AO 1 ACT | This object indicates Analog Output 1's level. The corresponding drive parameter is *0124*. | Milliamps | R |
| AV23 | ACCEL1 TIME | This object sets the Ramp1 acceleration time. The corresponding drive parameter is *2202*. | Seconds | W |
| AV24 | DECEL1 TIME | This object sets the Ramp1 deceleration time. The corresponding drive parameter is *2203*. | Seconds | W |
| AV25 | MBOX PARAM | This object defines the parameter to be read or written to by the mailbox function. See BV15 and BV16. | None | W |

| Instance ID | Object Name | Description | Units | Present Value Access Type |
|---|---|---|---|---|
| AV26 | MBOX DATA | This object holds the mailbox function's parameter value – a value that was read, or is to be written. See BV15 and BV16. | None | W |
| AV27 | EXT PID STPT | This object sets the External PID controller setpoint. The corresponding drive parameter is 4211. Control requires parameter 4210,value = 19 (. | Percent | C |

**Note:** For Present Value Access Types, R = Read-only, W = Writeable, C = Commandable. Commandable values support priority arrays & relinquish defaults.

## BACnet quick-start sequence

The following steps summarize the process for enabling and configuring BACnet on the ACS320:

1. Enable BACnet protocol: Set drive parameter *9802 COMM PROT SEL* = BACNET (5).

   **Note:** If you cannot see the desired selection on the panel, your drive does not have that protocol software in the application memory.

   - To confirm this selection, read drive parameter *5301 EFB PROTOCOL ID*. It should read x5xx (where "x" is any value).
2. Place the BACnet channel in "reset": Set drive parameter *5302 EFB STATION ID* = 0.
   - This setting holds the BACnet communication channel in reset while remaining settings are completed.
3. Define the MS/TP baud rate.
   - Set drive parameter *5303 EFB BAUD RATE* = appropriate value.
4. Define the Device Object Instance ID.
   - To define a specific device object instance value, use drive parameters 5311 and 5317 (object instance values must be unique and in the range 1 to 4,194,303).
   - To use the drive's MS/TP MAC ID as the device object instance value, set drive parameter 5311 and 5317 = 0.
5. Define a unique MS/TP MAC ID. Set drive parameter *5302 EFB STATION ID* = appropriate value.
   - Once this parameter is set to a non-zero value, current BACnet settings are "latched" and used for communication until the channel is reset.
   - In order to participate in MS/TP token passing, the MAC ID used must be within the limits defined by other masters' "Max Master" property.

6. Confirm proper BACnet communication.
   - When BACnet communication is operating properly, drive parameter 5316 EFB PAR 16 (the MS/TP token counter), should be continually increasing.
   - Drive parameter *5306 EFB UART ERRORS*, should be stable.

## Protocol implementation conformance statement (PICS)

*PICS summary*

**BACnet Standard Device Profile.** This version of ACS320 BACnet fully conforms to the 'Application-Specific Controller' standard device profile (B-ASC).

**Services Supported.** The following services are supported by the ACS320:

- I-Am (Response to Who-Is, also broadcast on power-up & other reset)
- I-Have (Response to Who-Has)
- ReadProperty
- WriteProperty
- DeviceCommunicationControl
- ReinitializeDevice.

**Data Link Layer.** The ACS320 implements MS/TP (Master) Data Link Layer. All standard MS/TP baud rates are supported (9600, 19200, 38400 & 76800).

**MAC ID / Device Object Instance.** The ACS320 supports separate MAC ID and Device Object Instance parameters:

- Set the MAC ID using drive parameter *5302 EFB STATION ID*. Default: 5302 = 1.
- Set the Device Object Instance ID using drive parameters 5311 and 5317. Default: Both 5311 and 5317 = 0, which causes the MAC ID to “double” as the Device Object Instance. For Device Object Instance values not linked to the MAC ID, set ID values using 5311 and 5317:
  - For IDs in the range 1 to 65,535: Parameter 5311sets the ID directly (5317 must be 0). For example, the following values set the ID to 49,134:
    5311 = 49134 and 5317 = 0.
  - For IDs > 65,335: The ID equals 5311’s value plus 10,000 times 5317’s value. For example, the following values set the ID to 71,234:
    5311 = 1234 and 5317 = 7.

**Max Info Frames Property.** Configure the Device Object Max Info Frames property using drive parameter 5312. Default: 5312 = 1.

**Max Master Property.** Configure the Device Object Max Master property using drive parameter 5313. Default: 5313 = 127.

*MS/TP Token Counter*

Parameter 5316 stores the count of MS/TP tokens passed to the associated node.

## Statement

This statement is part of this Standard and is required for its use.

| BACnet Protocol Implementation Conformance Statement | |
|---|---|
| **Date:** | February 2013 |
| **Vendor Name:** | ABB, Inc |
| **Product Name:** | Low Voltage AC Motor Drive |
| **Product Model Number:** | ACS320 |
| **Applications Software Version:** | 403C |
| **Firmware Revision:** | 0526 |
| **BACnet Protocol Revision:** | 7 |
| **Product Description:** | The ACS320 is a high-performance adjustable frequency drive specifically designed for commercial automation applications. This product supports native BACnet, connecting directly to the MS/TP LAN. All standard MS/TP baud rates are supported, as well as master mode functionality. Over BACnet, the drive can be fully controlled as a standard adjustable frequency drive. In addition, up to 16 configurable I/O ports are available over BACnet for user applications. |
| **BACnet Standardized Device Profile (Annex L):** | ☐ BACnet Operator Workstation (B-OWS)<br>☐ BACnet Building Controller (B-BC)<br>☐ BACnet Advanced Application Controller (B-AAC)<br>☒ BACnet Application Specific Controller (B-ASC)<br>☐ BACnet Smart Sensor (B-SS)<br>☐ BACnet Smart Actuator (B-SA) |
| **List all BACnet Interoperability Building Blocks Supported (Annex K):** | DS-RP-B, DS-WP-B, DM-DDB-B, DM-DOB-B, DM-DCC-B, DM-RD-B. |
| **Segmentation Capability:** | ☐ Segmented requests supported. Window Size ____<br>☐ Segmented responses supported. Window Size ____ |

| BACnet Protocol Implementation Conformance Statement | |
|---|---|
| **Standard Object Types Supported:**<br>An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:<br>1. Whether objects of this type are dynamically creatable using the CreateObject service<br>2. Whether objects of this type are dynamically detectable using the DeleteObject service<br>3. List of the optional properties supported<br>4. List of all properties that are writable where not otherwise required by this standard<br>5. List of proprietary properties and for each its property identifier, datatype, and meaning<br>6. List of any property range restrictions | See table at *Object/Property support matrix* on page *317*. |
| **Data Link Layer Options:** | ☐ BACnet IP, (Annex J)<br>☐ BACnet IP, (Annex J), Foreign Device<br>☐ ISO 8802-3, Ethernet (Clause 7)<br>☐ ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)<br>☐ ANSI/ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s) ___<br>☒ MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800<br>☐ MS/TP slave (Clause 9), baud rate(s): ___<br>☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s): ___<br>☐ Point-To-Point, modem, (Clause 10), baud rate(s): ___<br>☐ LonTalk, (Clause 11), medium: ___________<br>☐ Other: ___________ |
| **Device Address Binding:**<br>Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) | ☐ Yes<br>☒ No |
| **Networking Options:** | ☐ Router, Clause 6 - List all routing configurations, eg, ARCNET-Ethernet, Ethernet-MS/TP, etc.<br>☐ Annex H, BACnet Tunneling Router over IP<br>☐ BACnet/IP Broadcast Management Device (BBMD) |
| **Does the BBMD support registrations by Foreign Devices?** | ☐ Yes<br>☐ No |

| BACnet Protocol Implementation Conformance Statement | |
|---|---|
| **Character Sets Supported:** Indicating support for multiple character sets does not imply that they can all be supported simultaneously. | ☒ ANSI X3.4<br>☐ IBM™/Microsoft™ DBCS<br>☐ ISO 8859-1<br>☐ ISO 10646 (UCS-2)<br>☐ ISO 10646 (UCS-4)<br>☐ JIS C 6226 |
| **If this product is a communication gateway, describe the types of non-BACnet equipment/network(s) that the gateway supports:** | |

# BACnet object definitions

## Object/Property support matrix

The following table summarizes the object types/properties supported:

| Property | Object Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | Device | Binary Input | Binary Output | Binary Value | Analog Input | Analog Output | Analog Value |
| Object Identifier | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Object Name | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Object Type | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| System Status | ✓ | | | | | | |
| Vendor Name | ✓ | | | | | | |
| Vendor Identifier | ✓ | | | | | | |
| Model Name | ✓ | | | | | | |
| Firmware Revision | ✓ | | | | | | |
| Appl Software Revision | ✓ | | | | | | |
| Protocol Version | ✓ | | | | | | |
| Protocol Revision | ✓ | | | | | | |
| Services Supported | ✓ | | | | | | |
| Object Types Supported | ✓ | | | | | | |
| Object List | ✓ | | | | | | |
| Max APDU Length | ✓ | | | | | | |
| Segmentation Support | ✓ | | | | | | |
| APDU Timeout | ✓ | | | | | | |
| Number APDU Retries | ✓ | | | | | | |
| Max Master | ✓ | | | | | | |
| Max Info Frames | ✓ | | | | | | |
| Device Address Binding | ✓ | | | | | | |
| Database Revision | ✓ | | | | | | |
| Present Value | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Property | Object Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | Device | Binary Input | Binary Output | Binary Value | Analog Input | Analog Output | Analog Value |
| Status Flags | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Event State | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Out-of-Service | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Units | | | | | ✓ | ✓ | ✓ |
| Priority Array | | | ✓ | ✓ * | | ✓ | ✓ * |
| Relinquish Default | | | ✓ | ✓ * | | ✓ | ✓ * |
| Polarity | | ✓ | ✓ | | | | |
| Active Text | | ✓ | ✓ | ✓ | | | |
| Inactive Text | | ✓ | ✓ | ✓ | | | |

* For commandable values only.

# Modbus protocol technical data

## Overview

The Modbus® protocol was introduced by Modicon, Inc. for use in control environments featuring Modicon programmable controllers. Due to its ease of use and implementation, this common PLC language was quickly adopted as a de-facto standard for integration of a wide variety of master controllers and slave devices.

Modbus is a serial, asynchronous protocol. Transactions are half-duplex, featuring a single Master controlling one or more Slaves. While RS232 can be used for point-to-point communication between a single Master and a single Slave, a more common implementation features a multi-drop RS485 network with a single Master controlling multiple Slaves. The ACS320 features RS485 for its Modbus physical interface.

### RTU

The Modbus specification defines two distinct transmission modes: ASCII and RTU. The ACS320 supports RTU only.

### Feature summary

The following Modbus function codes are supported by the ACS320.

| Function | Code (Hex) | Description |
|---|---|---|
| Read Coil Status | 0x01 | Read discrete output status. For the ACS320, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (eg, RO1=Coil 33). |
| Read Discrete Input Status | 0x02 | Read discrete inputs status. For the ACS320, the individual bits of the status word are mapped to Inputs 1…16 or 1…32, depending on the active profile. Terminal inputs are mapped sequentially beginning with Input 33 (eg, DI1=Input 33). |

| Function | Code (Hex) | Description |
|---|---|---|
| Read Multiple Holding Registers | 0x03 | Read multiple holding registers. For the ACS320, the entire parameter set is mapped as holding registers, as well as command, status and reference values. |
| Read Multiple Input Registers | 0x04 | Read multiple input registers. For the ACS320, the 2 analog input channels are mapped as input registers 1 & 2. |
| Force Single Coil | 0x05 | Write a single discrete output. For the ACS320, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (eg, RO1=Coil 33). |
| Write Single Holding Register | 0x06 | Write single holding register. For the ACS320, the entire parameter set is mapped as holding registers, as well as command, status and reference values. |
| Diagnostics | 0x08 | Perform Modbus diagnostics. Subcodes for Query (0x00), Restart (0x01) & Listen Only (0x04) are supported. |
| Force Multiple Coils | 0x0F | Write multiple discrete outputs. For the ACS320, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (eg, RO1=Coil 33). |
| Write Multiple Holding Registers | 0x10 | Write multiple holding registers. For the ACS320, the entire parameter set is mapped as holding registers, as well as command, status and reference values. |
| Read/Write Multiple Holding Registers | 0x17 | This function combines functions 0x03 and 0x10 into a single command. |

### Mapping summary

The following table summarizes the mapping between the ACS320 (parameters and I/0) and Modbus reference space. For details, see section *Modbus addressing* below.

| ACS320 | Modbus Reference | Supported Function Codes |
|---|---|---|
| • Control Bits<br>• Relay Outputs | Coils(0xxxx) | • 01 – Read Coil Status<br>• 05 – Force Single Coil<br>• 15 – Force Multiple Coils |
| • Status Bits<br>• Discrete Inputs | Discrete Inputs(1xxxx) | • 02 – Read Input Status |
| • Analog Inputs | Input Registers(3xxxxx) | • 04 – Read Input Registers |
| • Parameters<br>• Control/Status Words<br>• References | Holding Registers(4xxxx) | • 03 – Read 4X Registers<br>• 06 – Preset Single 4X Register<br>• 16 – Preset Multiple 4X Registers<br>• 23 – Read/Write 4X Registers |

### Communication profiles

When communicating by Modbus, the ACS320 supports multiple profiles for control and status information. Parameter *5305 EFB CTRL PROFILE* selects the profile used.

- ABB DRV LIM – This profile is based on the PROFIBUS interface, and is discussed in detail in the following sections.

- DCU PROFILE – Another profile is called the DCU PROFILE profile. It extends the control and status interface to 32 bits, and is the internal interface between the main drive application and the embedded fieldbus environment.
- ABB DRV FULL – This profile is also based on the PROFIBUS interface, and supports two control word bits not supported by the ABB DRV LIM profile.

## Modbus addressing

With Modbus, each function code implies access to a specific Modbus reference set. Thus, the leading digit is not included in the address field of a Modbus message.

**Note:** The drive supports the zero-based addressing of the Modbus specification. Holding register 40002 is addressed as 0001 in a Modbus message. Similarly, coil 33 is addressed as 0032 in a Modbus message.

Refer again to section *Mapping summary* above. The following sections describe, in detail, the mapping to each Modbus reference set.

**0xxxx Mapping – Modbus Coils.** The drive maps the following information to the 0xxxx Modbus set called Modbus Coils:

- Bit-wise map of the CONTROL WORD (selected using parameter *5305 EFB CTRL PROFILE*). The first 32 coils are reserved for this purpose.
- Relay output states, numbered sequentially beginning with coil 00033.

The following table summarizes the 0xxxx reference set:

| Modbus Ref. | Internal Location (All Profiles) | (5305 = 0) | (5305 = 1) | (5305 = 2) |
|---|---|---|---|---|
| **0**0001 | – Bit 0 | OFF1* | STOP | OFF1* |
| **0**0002 | – Bit 1 | OFF2* | START | OFF2* |
| **0**0003 | – Bit 2 | OFF3* | REVERSE | OFF3* |
| **0**0004 | – Bit 3 | START | LOCAL | START |
| **0**0005 | – Bit 4 | N/A | RESET | RAMP_OUT_ZERO* |
| **0**0006 | – Bit 5 | RAMP_HOLD* | EXT2 | RAMP_HOLD* |
| **0**0007 | – Bit 6 | RAMP_IN_ZERO* | RUN_DISABLE | RAMP_IN_ZERO* |
| **0**0008 | – Bit 7 | RESET | STPMODE_R | RESET |
| **0**0009 | – Bit 8 | N/A | STPMODE_EM | N/A |
| **0**0010 | – Bit 9 | N/A | STPMODE_C | N/A |
| **0**0011 | – Bit 10 | N/A | RAMP_2 | REMOTE_CMD* |
| **0**0012 | – Bit 11 | EXT2 | RAMP_OUT_0 | EXT2 |
| **0**0013 | – Bit 12 | N/A | RAMP_HOLD | N/A |
| **0**0014 | – Bit 13 | N/A | RAMP_IN_0 | N/A |
| **0**0015 | – Bit 14 | N/A | REQ_LOCALLOCK | N/A |
| **0**0016 | – Bit 15 | N/A | TORQLIM2 | N/A |

| Modbus Ref. | Internal Location (All Profiles) | (5305 = 0) | (5305 = 1) | (5305 = 2) |
|---|---|---|---|---|
| 00017 | – Bit 16 | Does not apply | FBLOCAL_CTL | Does not apply |
| 00018 | – Bit 17 | | FBLOCAL_REF | |
| 00019 | – Bit 18 | | START_DISABLE1 | |
| 00020 | – Bit 19 | | START_DISABLE2 | |
| 00021… 00032 | Reserved | Reserved | Reserved | Reserved |
| 00033 | relay output 1 | Relay Output 1 | Relay Output 1 | Relay Output 1 |
| 00034 | relay output 2 | Relay Output 2 | Relay Output 2 | Relay Output 2 |
| 00035 | relay output 3 | Relay Output 3 | Relay Output 3 | Relay Output 3 |
| 00036 | relay output 4 | Relay Output 4 | Relay Output 4 | Relay Output 4 |

* = Active low

For the 0xxxx registers:

- Status is always readable.
- Forcing is allowed by user configuration of the drive for fieldbus control.
- Additional relay outputs are added sequentially.

The drive supports the following Modbus function codes for coils:

| Function Code | Description |
|---|---|
| 01 | Read coil status |
| 05 | Force single coil |
| 15 (0x0F Hex) | Force multiple coils |

**1xxxx Mapping – Modbus Discrete Inputs.** The drive maps the following information to the 1xxxx Modbus set called Modbus Discrete Inputs:

- Bit-wise map of the STATUS WORD (selected using parameter *5305 EFB CTRL PROFILE*). The first 32 inputs are reserved for this purpose.
- Discrete hardware inputs, numbered sequentially beginning with input 33.

The following table summarizes the 1xxxx reference set:

| Modbus Ref. | Internal Location (All Profiles) | (5305 = 0 or 2) | (5305 = 1) |
|---|---|---|---|
| 10001 | – Bit 0 | RDY_ON | READY |
| 10002 | – Bit 1 | RDY_RUN | ENABLED |
| 10003 | – Bit 2 | RDY_REF | STARTED |
| 10004 | – Bit 3 | TRIPPED | RUNNING |
| 10005 | – Bit 4 | OFF_2_STA* | ZERO_SPEED |
| 10006 | – Bit 5 | OFF_3_STA* | ACCELERATE |
| 10007 | – Bit 6 | SWC_ON_INHIB | DECELERATE |
| 10008 | – Bit 7 | ALARM | AT_SETPOINT |
| 10009 | – Bit 8 | AT_SETPOINT | LIMIT |

| Modbus Ref. | Internal Location (All Profiles) | (5305 = 0 or 2) | (5305 = 1) |
|---|---|---|---|
| 10010 | – Bit 9 | REMOTE | SUPERVISION |
| 10011 | – Bit 10 | ABOVE_LIMIT | REV_REF |
| 10012 | – Bit 11 | EXT2 | REV_ACT |
| 10013 | – Bit 12 | RUN_ENABLE | PANEL_LOCAL |
| 10014 | – Bit 13 | N/A | FIELDBUS_LOCAL |
| 10015 | – Bit 14 | N/A | EXT2_ACT |
| 10016 | – Bit 15 | N/A | FAULT |
| 10017 | – Bit 16 | Reserved | ALARM |
| 10018 | – Bit 17 | Reserved | REQ_MAINT |
| 10019 | – Bit 18 | Reserved | DIRLOCK |
| 10020 | – Bit 19 | Reserved | LOCALLOCK |
| 10021 | – Bit 20 | Reserved | CTL_MODE |
| 10022 | – Bit 21 | Reserved | Reserved |
| 10023 | – Bit 22 | Reserved | Reserved |
| 10024 | – Bit 23 | Reserved | Reserved |
| 10025 | – Bit 24 | Reserved | Reserved |
| 10026 | – Bit 25 | Reserved | Reserved |
| 10027 | – Bit 26 | Reserved | REQ_CTL |
| 10028 | – Bit 27 | Reserved | REQ_REF1 |
| 10029 | – Bit 28 | Reserved | REQ_REF2 |
| 10030 | – Bit 29 | Reserved | REQ_REF2EXT |
| 10031 | – Bit 30 | Reserved | ACK_STARTINH |
| 10032 | – Bit 31 | Reserved | ACK_OFF_ILCK |
| 10033 | | DI1 | DI1 |
| 10034 | | DI2 | DI2 |
| 10035 | | DI3 | DI3 |
| 10036 | | DI4 | DI4 |
| 10037 | | DI5 | DI5 |

* = Active low

For the 1xxxx registers:

- Additional discrete inputs are added sequentially.

The drive supports the following Modbus function codes for discrete inputs:

| Function Code | Description |
|---|---|
| 02 | Read input status |

**3xxxx Mapping – Modbus Inputs.** The drive maps the following information to the 3xxxx Modbus addresses called Modbus input registers:

- Any user defined analog inputs.

The following table summarizes the input registers:

| Modbus Reference | Internal Location (All Profiles) | Remarks |
|---|---|---|
| **3**0001 | ai1 | This register shall report the level of Analog Input 1 (0…100%). |
| **3**0002 | ai2 | This register shall report the level of Analog Input 2 (0…100%). |

The drive supports the following Modbus function codes for 3xxxx registers:

| Function Code | Description |
|---|---|
| 04 | Read 3xxxx input status |

**4xxxx Register Mapping.** The drive maps its parameters and other data to the 4xxxx holding registers as follows:

- 40001…40099 map to drive control and actual values. These registers are described in the table below.
- 40101…49999 map to drive parameters 0101…9999. Register addresses that do not correspond to drive parameters are invalid. If there is an attempt to read or write outside the parameter addresses, the Modbus interface returns an exception code to the controller.

The following table summarizes the 4xxxx drive control registers 40001…40099 (for 4xxxx registers above 40099, see the drive parameter list, for example, 40102 is parameter *0102*):

| Modbus Register | | Access | Remarks |
|---|---|---|---|
| **4**0001 | | R/W | Maps directly to the profile CSupported only if 5305 = 0 or 2 (ABB Drives profile). Parameter 5319 holds a copy in hex format. |
| **4**0002 | Reference 1 | R/W | Range = 0…+20000 (scaled to 0…1105 REF1 MAX, or<br>-20000…0 (scaled to 1105 REF1 MAX…0). |
| **4**0003 | Reference 2 | R/W | Range = 0…+10000 (scaled to 0…1108 REF2 MAX, or<br>-10000…0 (scaled to 1108 REF2 MAX…0). |
| **4**0004 | | R | Maps directly to the profile SSupported only if 5305 = 0 or 2 (ABB Drives profile). Parameter 5320 holds a copy in hex format. |
| **4**0005 | Actual 1<br>(select using 5310) | R | By default, stores a copy of 0103 OUTPUT FREQ. Use parameter 5310 to select a different actual value for this register. |
| **4**0006 | Actual 2<br>(select using 5311) | R | By default, stores a copy of 0104 CURRENT. Use parameter 5311 to select a different actual value for this register. |
| **4**0007 | Actual 3<br>(select using 5312) | R | By default, stores nothing. Use parameter 5312 to select an actual value for this register. |
| **4**0008 | Actual 4<br>(select by 5313) | R | By default, stores nothing. Use parameter 5313 to select an actual value for this register. |
| **4**0009 | Actual 5<br>(select using 5314) | R | By default, stores nothing. Use parameter 5314 to select an actual value for this register. |

| Modbus Register | | Access | Remarks |
|---|---|---|---|
| 40010 | Actual 6<br>(select using 5315) | R | By default, stores nothing. Use parameter 5315 to select an actual value for this register. |
| 40011 | Actual 7<br>(select using 5316) | R | By default, stores nothing. Use parameter 5316 to select an actual value for this register. |
| 40012 | Actual 8<br>(select using 5317) | R | By default, stores nothing. Use parameter 5317 to select an actual value for this register. |
| 40031 | LSW | R/W | Maps directly to the Least Significant Word of the DCU profile‘s CONTROL WORD. Supported only if 5305 = 1.<br>See parameter 0301. |
| 40032 | MSW | R | Maps directly to the Most Significant Word of the DCU profile‘s CONTROL WORD. Supported only if 5305 = 1.<br>See parameter 0302. |
| 40033 | LSW | R | Maps directly to the Least Significant Word of the DCU profile‘s CONTROL WORD. Supported only if 5305 = 1.<br>See parameter 0303. |
| 40034 | MSW | R | Maps directly to the Most Significant Word of the DCU profile‘s CONTROL WORD. Supported only if 5305 = 1.<br>See parameter 0304. |

For the Modbus protocol, drive parameters in group 53 report the parameter mapping to 4xxxx Registers.

| Code | Description |
|---|---|
| 5310 | EFB PAR 10<br>Specifies the parameter mapped to Modbus register 40005. |
| 5311 | EFB PAR 11<br>Specifies the parameter mapped to Modbus register 40006. |
| 5312 | EFB PAR 12<br>Specifies the parameter mapped to Modbus register 40007. |
| 5313 | EFB PAR 13<br>Specifies the parameter mapped to Modbus register 40008. |
| 5314 | EFB PAR 14<br>Specifies the parameter mapped to Modbus register 40009. |
| 5315 | EFB PAR 15<br>Specifies the parameter mapped to Modbus register 40010. |
| 5316 | EFB PAR 16<br>Specifies the parameter mapped to Modbus register 40011. |
| 5317 | EFB PAR 17<br>Specifies the parameter mapped to Modbus register 40012. |
| 5318 | Reserved. |
| 5319 | EFB PAR 19<br>Holds a copy (in hex) of the CONTROL WORD, Modbus register 40001. |
| 5320 | EFB PAR 20<br>Holds a copy (in hex) of the STATUS WORD, Modbus register 40004. |

Except where restricted by the drive, all parameters are available for both reading and writing. The parameter writes are verified for the correct value, and for a valid register addresses.

**Note:** Parameter writes through standard Modbus are always volatile, in other words, modified values are not automatically stored to permanent memory. Use parameter *1607 PARAM. SAVE* to save all altered values.

The drive supports the following Modbus function codes for 4xxxx registers:

| Function Code | Description |
|---|---|
| 03 | Read holding 4xxxx registers |
| 06 | Preset single 4xxxx register |
| 16 (0x10 Hex) | Preset multiple 4xxxx registers |
| 23 (0x17 Hex) | Read/write 4xxxx registers |

### *Actual values*

The contents of the register addresses 40005…40012 are actual values and are:

- Specified using parameters 5310…5317.
- Read-only values containing information on the operation of the drive.
- 16-bit words containing a sign bit and a 15-bit integer.
- When negative values, written as the two's complement of the corresponding positive value.
- Scaled as described earlier in *Actual value scaling*.

### *Exception codes*

Exception codes are serial communication responses from the drive. The drive supports the standard Modbus exception codes defined below.

| Exception Code | Name | Meaning |
|---|---|---|
| 01 | | Unsupported command |
| 02 | | The data address received in the query is not allowable. It is not a defined parameter/group. |
| 03 | | A value contained in the query data field is not an allowable value for the drive, because it is one of the following:<br>Outside min. or max. limits.<br>Parameter is read-only.<br>Message is too long.<br>Parameter write not allowed when start is active.<br>Parameter write not allowed when factory macro is selected. |

# ABB control profiles technical data

## Overview

*ABB Drives profile*

The ABB Drives profile provides a standard profile that can be used on multiple protocols, including Modbus and the protocols available on the FBA module. Two implementations of the ABB Drives profile are available:

- ABB DRV FULL – This implementation standardizes the control interface with ACS600 and ACS800 drives.
- ABB DRV LIM – This implementation standardizes the control interface with ACH400 drives. This implementation does not support two control word bits supported by ABB DRV FULL.

Except as noted, the following “ABB Drives profile” descriptions apply to both implementations.

*DCU profile*

The DCU profile extends the control and status interface to 32 bits, and is the internal interface between the main drive application and the embedded fieldbus environment.

Control word

The CONTROL WORD is the principal means for controlling the drive from a fieldbus system. The fieldbus master station sends the CONTROL WORD to the drive. The drive switches between states according to the bit-coded instructions in the CONTROL WORD. Using the CONTROL WORD (ABB Drives profile version) requires that:

- The drive is in remote (REM) control.
- The serial communication channel is defined as the source for controlling commands (set using parameters *1001 EXT1 COMMANDS*, *1002 EXT2 COMMANDS* and *1102 EXT1/EXT2 SEL*).
- The serial communication channel used is configured to use an ABB control profile. For example, to use the control profile ABB DRV FULL, requires both parameter *9802 COMM PROT SEL* = 1 (STD MODBUS), and parameter *5305 EFB CTRL PROFILE* = 2 (ABB DRV FULL).

### *ABB Drives profile*

The following table and the state diagram later in this sub-section describe the CONTROL WORD content for the ABB Drives profile.

| ABB Drives Profile (EFB) CONTROL WORD | | | | |
|---|---|---|---|---|
| **Bit** | **Name** | **Value** | **Commanded State** | **Comments** |
| 0 | OFF1 CONTROL | 1 | READY TO OPERATE | Enter READY TO OPERATE. |
| | | 0 | EMERGENCY OFF | Drive ramps to stop according to currently active deceleration ramp (2203 or 2205)<br>Normal command sequence:<br>• Enter OFF1 ACTIVE.<br>• Proceed to READY TO SWITCH ON, unless other interlocks (OFF2, OFF3) are active. |
| 1 | OFF2 CONTROL | 1 | OPERATING | Continue operation (OFF2 inactive) |
| | | 0 | EMERGENCY OFF | Drive coasts to stop.<br>Normal command sequence:<br>• Enter OFF2 ACTIVE.<br>• Proceed to SWITCHON INHIBITED. |
| 2 | OFF3 CONTROL | 1 | OPERATING | Continue operation (OFF3 inactive) |
| | | 0 | EMERGENCY STOP | Drive stops within in time specified by parameter 2208.<br>Normal command sequence:<br>• Enter OFF3 active.<br>• Proceed to switch on inhibited.<br>⚠ **WARNING!** Be sure motor and driven equipment can be stopped using this mode. |
| 3 | INHIBIT OPERATION | 1 | OPERATION ENABLED | Enter OPERATION ENABLED (Note the Run enable signal must be active. See parameter 1601. If parameter 1601 is set to COMM, this bit also actives the Run Enable signal.) |
| | | 0 | OPERATION INHIBITED | Inhibit operation. Enter OPERATION INHIBITED. |
| 4 | Unused (ABB DRV LIM) | | | |
| | RAMP_OUT_ ZERO (ABB DRV FULL) | 1 | NORMAL OPERATION | Enter RAMP FUNCTION GENERATOR: ACCELERATION ENABLED. |
| | | 0 | RFG OUT ZERO | Force ramp function generator output to Zero. Drive ramps to stop (current and DC voltage limits in force). |
| 5 | RAMP_HOLD | 1 | RFG OUT ENABLED | Enable ramp function.<br>Enter RAMP FUNCTION GENERATOR: ACCELERATION ENABLED. |
| | | 0 | RFG OUT HOLD | Halt ramping (Ramp Function Generator output held) |

| ABB Drives Profile (EFB) CONTROL WORD | | | | |
|---|---|---|---|---|
| **Bit** | **Name** | **Value** | **Commanded State** | **Comments** |
| 6 | RAMP_IN_ ZERO | 1 | RFG INPUT ENABLED | Normal operation. Enter OPERATING. |
| | | 0 | RFG INPUT ZERO | Force Ramp Function Generator input to zero. |
| 7 | RESET | 0=>1 | RESET | Fault reset if an active fault exists (Enter SWITCH-ON INHIBITED). Effective if 1604 = COMM. |
| | | 0 | OPERATING | Continue normal operation |
| 8…9 | Unused | | | |
| 10 | Unused (ABB DRV LIM) | | | |
| | REMOTE_CMD (ABB DRV FULL) | 1 | | Fieldbus control enabled. |
| | | 0 | | • CW ≠ 0 or Ref ≠ 0: Retain last CW and Ref.<br>• CW = 0 and Ref = 0: Fieldbus control enabled.<br>• Ref and deceleration/acceleration ramp are locked. |
| 11 | EXT CTRL LOC | 1 | EXT2 SELECT | Select external control location 2 (EXT2). Effective if 1102 = COMM. |
| | | 0 | EXT1 SELECT | Select external control location 1 (EXT1). Effective if 1102 = COMM. |
| 12…15 | Unused | | | |

### DCU profile

The following tables describe the CONTROL WORD content for the DCU profile.

| DCU Profile CONTROL WORD (See Parameter 0301) | | | | |
|---|---|---|---|---|
| **Bit** | **Name** | **Value** | **Command/Req.** | **Comments** |
| 0 | STOP | 1 | Stop | Stops according to either the stop mode parameter or the stop mode requests (bits 7 and 8).<br>Simultaneous STOP and START commands result in a stop command. |
| | | 0 | (no op) | |
| 1 | START | 1 | Start | |
| | | 0 | (no op) | |
| 2 | REVERSE | 1 | Reverse direction | This bit XOR'd with the sign of the reference defines direction. |
| | | 0 | Forward direction | |
| 3 | LOCAL | 1 | Local mode | When the fieldbus sets this bit, it steals control and the drive moves to fieldbus local control mode. |
| | | 0 | External mode | |
| 4 | RESET | -> 1 | Reset | Edge sensitive. |
| | | other | (no op) | |
| 5 | EXT2 | 1 | Switch to | |
| | | 0 | Switch to | |
| 6 | RUN_DISABLE | 1 | Run disable | Inverted run enable. |
| | | 0 | Run enable on | |

| DCU Profile CONTROL WORD (See Parameter 0301) | | | | |
|---|---|---|---|---|
| **Bit** | **Name** | **Value** | **Command/Req.** | **Comments** |
| 7 | STPMODE_R | 1 | Normal ramp stop mode | |
| | | 0 | (no op) | |
| 8 | STPMODE_EM | 1 | Emergency ramp stop mode | |
| | | 0 | (no op) | |
| 9 | STPMODE_C | 1 | Coast stop mode | |
| | | 0 | (no op) | |
| 10 | RAMP_2 | 1 | Ramp pair 2 | |
| | | 0 | Ramp pair 1 | |
| 11 | RAMP_OUT_0 | 1 | Ramp output to 0 | |
| | | 0 | (no op) | |
| 12 | RAMP_HOLD | 1 | Ramp freeze | |
| | | 0 | (no op) | |
| 13 | RAMP_IN_0 | 1 | Ramp input to 0 | |
| | | 0 | (no op) | |
| 14 | RREQ_LOCALLOC | 1 | Local mode lock | In lock, the drive will not switch to local mode. |
| | | 0 | (no op) | |
| 15 | TORQLIM2 | 1 | Torque limit pair 2 | |
| | | 0 | Torque limit pair 1 | |

| DCU Profile CONTROL WORD (See Parameter 0302) | | | | |
|---|---|---|---|---|
| **Bit** | **Name** | **Value** | **Function** | **Comments** |
| 16…26 | Reserved | | | |
| 27 | REF_CONST | 1 | Constant speed ref. | These bits are only for supervision purposes. |
| | | 0 | (no op) | |
| 28 | REF_AVE | 1 | Average speed ref. | |
| | | 0 | (no op) | |
| 29 | LINK_ON | 1 | Master is detected in link | |
| | | 0 | Link is down | |
| 30 | REQ_STARTINH | 1 | Start inhibit request is pending | |
| | | 0 | Start inhibit request is OFF | |
| 31 | OFF_INTERLOCK | 1 | Panel OFF button pressed | For the control panel (or PC tool) this is the OFF button interlock. |
| | | 0 | (no op) | |

## Status word

The contents of the STATUS WORD is status information, sent by the drive to the master station.

*ABB Drives profile*

The following table and the state diagram later in this sub-section describe the status word content for the ABB Drives profile.

| ABB Drives Profile (EFB) STATUS WORD | | | |
|---|---|---|---|
| **Bit** | **Name** | **Value** | **Description (Correspond to states/boxes in the state diagram)** |
| 0 | RDY_ON | 1 | READY TO SWITCH ON |
| | | 0 | NOT READY TO SWITCH ON |
| 1 | RDY_RUN | 1 | READY TO OPERATE |
| | | 0 | OFF1 ACTIVE |
| 2 | RDY_REF | 1 | OPERATION ENABLED |
| | | 0 | OPERATION INHIBITED |
| 3 | TRIPPED | 0…1 | FAULT |
| | | 0 | No fault |
| 4 | OFF_2_STA | 1 | OFF2 INACTIVE |
| | | 0 | OFF2 ACTIVE |
| 5 | OFF_3_STA | 1 | OFF3 INACTIVE |
| | | 0 | OFF3 ACTIVE |
| 6 | SWC_ON_INHIB | 1 | SWITCH-ON INHIBIT ACTIVE |
| | | 0 | SWITCH-ON INHIBIT NOT ACTIVE |
| 7 | ALARM | 1 | Warning/alarm (See chapter *Fault tracing* section for details on alarms.) |
| | | 0 | No warning/alarm |
| 8 | AT_SETPOINT | 1 | OPERATING. Actual value equals (within tolerance limits) the reference value. |
| | | 0 | Actual value is outside tolerance limits (not equal to reference value). |
| 9 | REMOTE | 1 | Drive control location: REMOTE (EXT1 or EXT2) |
| | | 0 | Drive control location: LOCAL |
| 10 | ABOVE_LIMIT | 1 | Supervised parameter's value ≥ supervision high limit.<br>Bit remains "1" until supervised parameter's value < supervision low limit.<br>See *Group 32: Supervision*. |
| | | 0 | Supervised parameter's value < supervision low limit.<br>Bit remains "0" until supervised parameter's value > supervision high limit.<br>See *Group 32: Supervision*. |

| ABB Drives Profile (EFB) STATUS WORD | | | |
|---|---|---|---|
| **Bit** | **Name** | **Value** | **Description (Correspond to states/boxes in the state diagram)** |
| 11 | EXT CTRL LOC | 1 | External control location 2 (EXT2) selected |
| | | 0 | External control location 1 (EXT1) selected |
| 12 | EXT RUN ENABLE | 1 | External Run Enable signal received |
| | | 0 | No External Run Enable signal received |
| 13… 15 | Unused | | |

*DCU profile*

The following tables describe the STATUS WORD content for the DCU profile.

| DCU Profile STATUS WORD (See Parameter 0303) | | | |
|---|---|---|---|
| **Bit** | **Name** | **Value** | **Status** |
| 0 | READY | 1 | Drive is ready to receive start command. |
| | | 0 | Drive is not ready. |
| 1 | ENABLED | 1 | External run enable signal received. |
| | | 0 | No external run enable signal received. |
| 2 | STARTED | 1 | Drive has received start command. |
| | | 0 | Drive has not received start command. |
| 3 | RUNNING | 1 | Drive is modulating. |
| | | 0 | Drive is not modulating. |
| 4 | ZERO_SPEED | 1 | Drive is at zero speed. |
| | | 0 | Drive has not reached zero speed. |
| 5 | ACCELERATE | 1 | Drive is accelerating. |
| | | 0 | Drive is not accelerating. |
| 6 | DECELERATE | 1 | Drive is decelerating. |
| | | 0 | Drive is not decelerating. |
| 7 | AT_SETPOINT | 1 | Drive is at setpoint. |
| | | 0 | Drive has not reached setpoint. |
| 8 | LIMIT | 1 | Operation is limited by Group 20 settings. |
| | | 0 | Operation is within Group 20 settings. |
| 9 | SUPERVISION | 1 | A supervised parameter (Group 32) is outside its limits. |
| | | 0 | All supervised parameters are within limits. |
| 10 | REV_REF | 1 | Drive reference is in reverse direction. |
| | | 0 | Drive reference is in forward direction. |
| 11 | REV_ACT | 1 | Drive is running in reverse direction. |
| | | 0 | Drive is running in forward direction. |
| 12 | PANEL_LOCAL | 1 | Control is in control panel (or PC tool) local mode. |
| | | 0 | Control is not in control panel local mode. |
| 13 | FIELDBUS_LOCAL | 1 | Control is in fieldbus local mode (steals control panel local). |
| | | 0 | Control is not in fieldbus local mode. |

| DCU Profile STATUS WORD (See Parameter 0303) | | | |
|---|---|---|---|
| **Bit** | **Name** | **Value** | **Status** |
| 14 | EXT2_ACT | 1 | Control is in the EXT2 mode. |
| | | 0 | Control is in the EXT1 mode. |
| 15 | FAULT | 1 | Drive is in a fault state. |
| | | 0 | Drive is not in a fault state. |

| DCU Profile STATUS WORD (See Parameter 0304) | | | |
|---|---|---|---|
| **Bit** | **Name** | **Value** | **Status** |
| 16 | ALARM | 1 | An alarm is on. |
| | | 0 | No alarms are on. |
| 17 | REQ_MAINT | 1 | A maintenance request is pending. |
| | | 0 | No maintenance request is pending. |
| 18 | DIRLOCK | 1 | Direction lock is ON. (Direction change is locked out.) |
| | | 0 | Direction lock is OFF. |
| 19 | LOCALLOCK | 1 | Local mode lock is ON. (Local mode is locked out.) |
| | | 0 | Local mode lock is OFF. |
| 20 | CTL_MODE | 1 | Drive is in vector control mode. |
| | | 0 | Drive is in scalar control mode. |
| 21…25 | Reserved | | |
| 26 | REQ_CTL | 1 | Copy the control word |
| | | 0 | (no op) |
| 27 | REQ_REF1 | 1 | Reference 1 requested in this channel. |
| | | 0 | Reference 1 is not requested in this channel. |
| 28 | REQ_REF2 | 1 | Reference 2 requested in this channel. |
| | | 0 | Reference 2 is not requested in this channel. |
| 29 | REQ_REF2EXT | 1 | External PID reference 2 requested in this channel. |
| | | 0 | External PID reference 2 is not requested in this channel. |
| 30 | ACK_STARTINH | 1 | A start inhibit from this channel is granted. |
| | | 0 | A start inhibit from this channel is not granted. |
| 31 | ACK_OFF_ILCK | 1 | Start inhibit due to OFF button |
| | | 0 | Normal operation |

## State diagram

*ABB Drives profile*

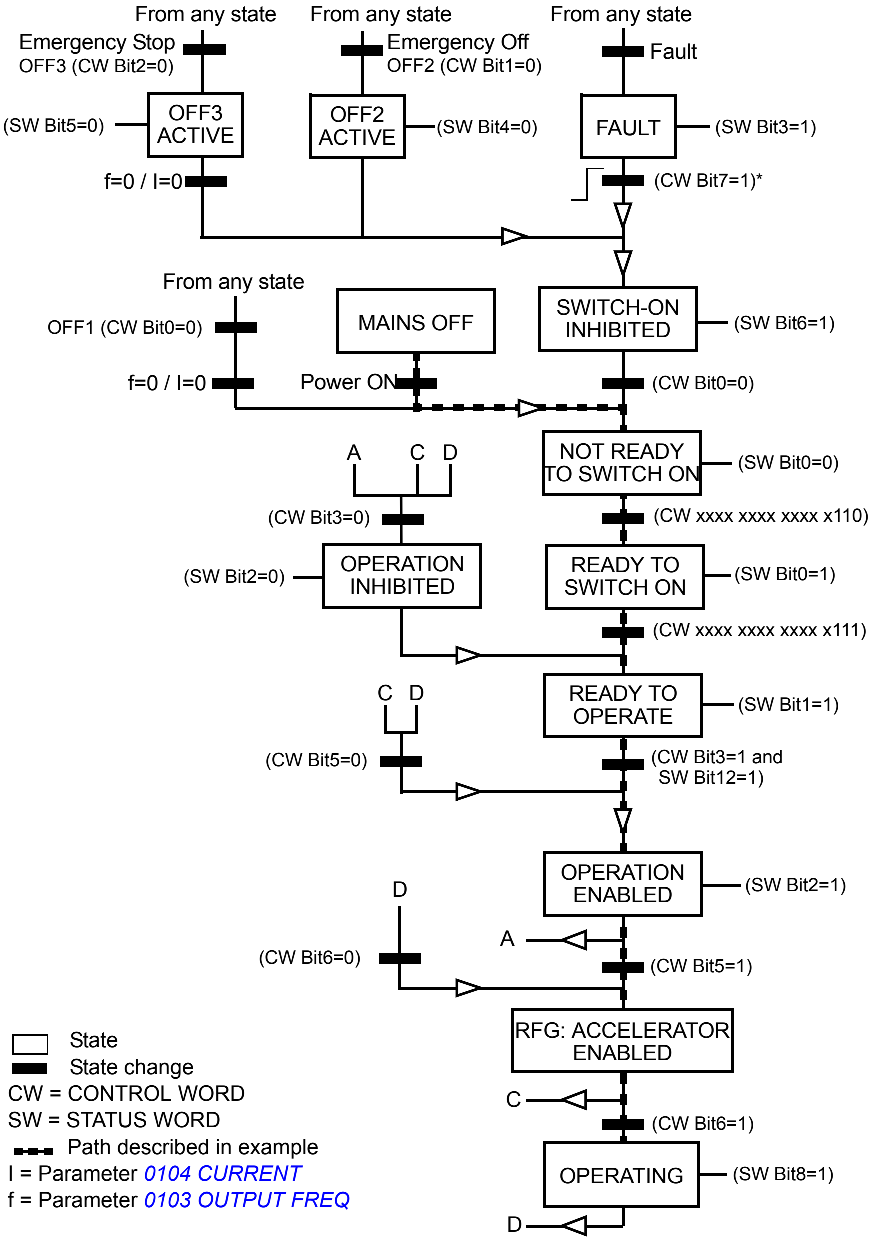
To illustrate the operation of the state diagram, the following example (ABB DRV LIM implementation of the ABB Drives profile) uses the control word to start the drive:

- First, the requirements for using the CONTROL WORD must be met. See above.
- When the power is first connected, the state of the drive is not ready to switch on. See dotted lined path ( ▬▬▬ ) in the state diagram below.

- Use the CONTROL WORD to step through the state machine states until the OPERATING state is reached, meaning that the drive is running and follows the given reference. See table below.

| **Step** | CONTROL WORD **Value** | **Description** |
|---|---|---|
| 1 | CW = 0000 0000 0000 0110<br>bit 15 ... bit 0 | This CW value changes the drive state to READY TO SWITCH ON. |
| 2 | | Wait at least 100 ms before proceeding. |
| 3 | CW = 0000 0000 0000 0111 | This CW value changes the drive state to READY TO OPERATE. |
| 4 | CW = 0000 0000 0000 1111 | This CW value changes the drive state to OPERATION ENABLED. The drive starts, but will not accelerate. |
| 5 | CW = 0000 0000 0010 1111 | This CW value releases the ramp function generator (RFG) output, and changes the drive state to RFG: ACCELERATOR ENABLED. |
| 6 | CW = 0000 0000 0110 1111 | This CW value releases the ramp function generator (RFG) output, and changes the drive state to OPERATING. The drive accelerates to the given reference and follows the reference. |

The state diagram below describes the start-stop function of CONTROL WORD (CW) and STATUS WORD (SW) bits for the ABB Drives profile.




*This state transition also occurs if the fault is reset from any other source (eg, digital input).

## Reference scaling

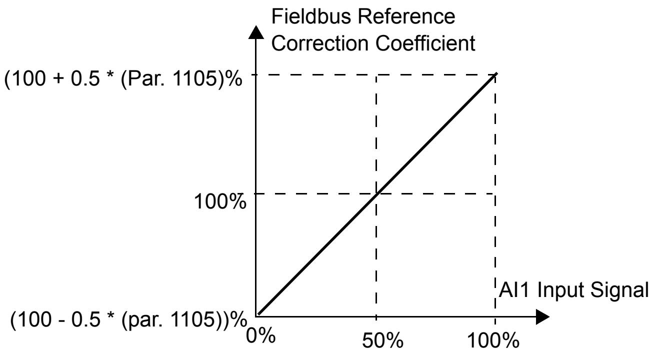
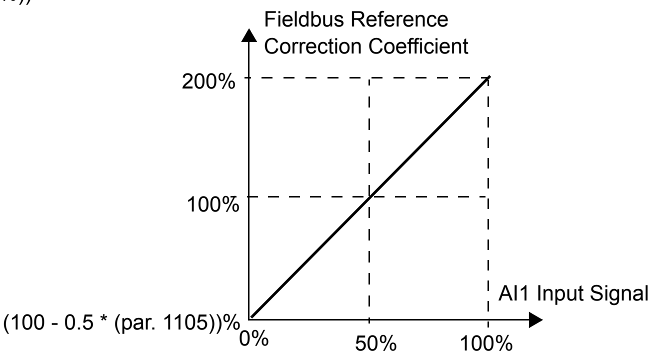
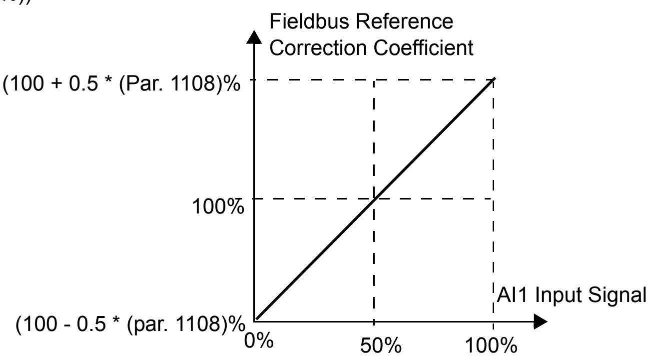
*ABB Drives and DCU profiles*

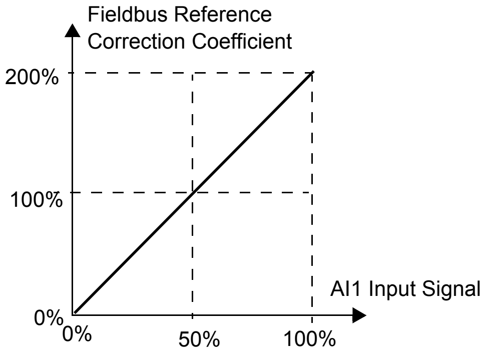
The following table describes REFERENCE scaling for the ABB Drives profile.

| ABB Drives and DCU Profiles | | | | |
|---|---|---|---|---|
| **Reference** | **Range** | **Reference Type** | **Scaling** | **Remarks** |
| REF1 | -32767 … +32767 | Speed or frequency | -20000 = -**(par. 1105)**<br>0 = 0<br>+20000 = **(par. 1105)**<br>(20000 corresponds to 100%) | Final reference limited by 1104/1105. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency). |
| REF2 | -32767 … +32767 | Speed or frequency | -10000 = -**(par. 1108)**<br>0 = 0<br>+10000 = **(par. 1108)**<br>(10000 corresponds to 100%) | Final reference limited by 1107/1108. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency). |
| | | Torque | -10000 = -**(par. 1108)**<br>0 = 0<br>+10000 = **(par. 1108)**<br>(10000 corresponds to 100%) | Final reference limited by 2015/2017 (torque1) or 2016/2018 (torque2). |
| | | PID Reference | -10000 = -**(par. 1108)**<br>0 = 0<br>+10000 = **(par. 1108)**<br>(10000 corresponds to 100%) | Final reference limited by 4012/4013 (PID set1) or 4112/4113 (PID set2). |

**Note:** The setting of parameter *1104 REF1 MIN* and *1107 REF2 MIN* has no effect on the scaling of references.

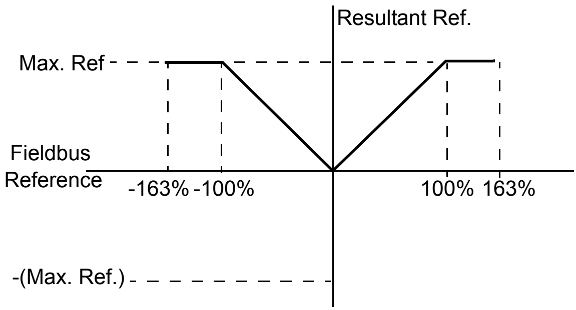
When parameter *1103 REF1 SELECT* or *1106 REF2 SELECT* is set to COMM+AI1 or COMM*AI1, the reference is scaled as follows:

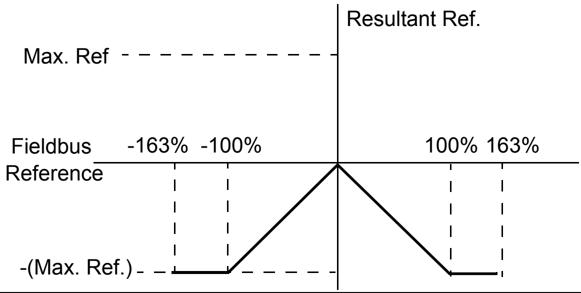
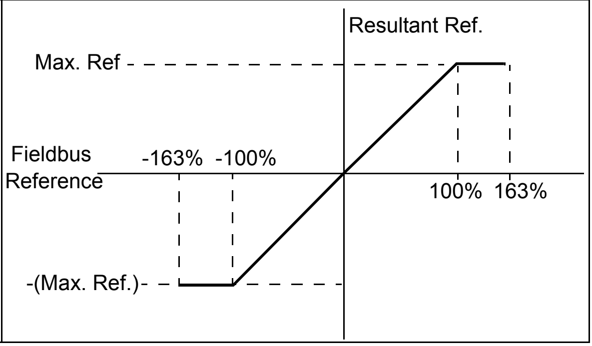
<table>
<tr><th colspan="3">ABB Drives and DCU Profiles</th></tr>
<tr><th>Reference</th><th>Value Setting</th><th>AI Reference Scaling</th></tr>
<tr><td>REF1</td><td></td><td>))

</td></tr>
<tr><td>REF1</td><td></td><td>%))

</td></tr>
<tr><td>REF2</td><td></td><td>%))

</td></tr>
</table>

| ABB Drives and DCU Profiles | | |
|---|---|---|
| **Reference** | **Value Setting** | **AI Reference Scaling** |
| REF2 | | %))  |

*Reference handling*

Use *Group 10: Start/Stop/Dir* parameters to configure for control of rotation direction for each control location (EXT1 and EXT2). The following diagrams illustrate how *Group 10: Start/Stop/Dir* parameters and the sign of the fieldbus reference interact to produce REFERENCE values (REF1 and REF2). Note, fieldbus references are bipolar, that is they can be positive or negative.

| ABB Drives Profile | | |
|---|---|---|
| **Parameter** | **Value Setting** | **AI Reference Scaling** |
| 1003 | 1 () |  |

| ABB Drives Profile | | |
|---|---|---|
| **Parameter** | **Value Setting** | **AI Reference Scaling** |
| 1003 | 2 () |  |
| 1003 | 3 (request) |  |

12

# Fault tracing

## Contents of this chapter

The chapter tells how to reset faults and view fault history. It also lists all alarm and fault messages including the possible cause and corrective actions.

## Safety

**WARNING!** Only qualified electricians are allowed to maintain the drive. Read the safety instructions in chapter *Safety* on page *15* before you work on the drive.

## Alarm and fault indications

Fault is indicated with a red LED. See section *LEDs* on page *361*.

An alarm or fault message on the panel display indicates abnormal drive status. Using the information given in this chapter most alarm and fault causes can be identified and corrected. If not, contact an ABB representative.

The four digit code number in parenthesis after the fault is for the fieldbus communication. (See chapter *Fieldbus control* on page *267*.)

## How to reset

The drive can be reset either by pressing the keypad key RESET EXIT (Basic Control Panel) or RESET (Assistant Control Panel), through digital input or fieldbus, or by switching the supply voltage off for a while. The source for the fault reset signal is selected by parameter *1604 FAULT RESET SEL*. When the fault has been removed, the motor can be restarted.

## Fault history

When a fault is detected, it is stored in the Fault history. The latest faults are stored together with the time stamp.

Parameters *0401 LAST FAULT*, *0412 PREVIOUS FAULT 1* and *0413 PREVIOUS FAULT 2* store the most recent faults. Parameters *0404*…*0409* show drive operation data at the time the latest fault occurred. The Assistant control panel provides additional information about the fault history. See section *Fault logger mode* on page *68* for more information.

## Alarm messages generated by the drive

| CODE | ALARM | CAUSE | WHAT TO DO |
|---|---|---|---|
| 2001 | OVERCURRENT<br>*0308* bit 0<br>(programmable fault function *1610*) | Output current limit controller is active. | Check motor load.<br>Check acceleration time (*2202* and *2205*).<br>Check motor and motor cable (including phasing).<br>Check ambient conditions. Load capacity decreases if installation site ambient temperature exceeds 40 °C. See section *Derating* on page *366*. |
| 2002 | OVERVOLTAGE<br>*0308* bit 1<br>(programmable fault function *1610*) | DC overvoltage controller is active. | Check deceleration time (*2203* and *2206*).<br>Check input power line for static or transient overvoltage. |
| 2003 | UNDERVOLTAGE<br>*0308* bit 2<br>(programmable fault function *1610*) | DC undervoltage controller is active. | Check input power supply. |
| 2004 | DIR LOCK<br>*0308* bit 3 | Change of direction is not allowed. | Check the settings of parameter *1003 DIRECTION*. |
| 2005 | IO COMM<br>*0308* bit 4<br>(programmable fault function *3018*, *3019*) | Fieldbus communication break | Check status of fieldbus communication. See chapter *Fieldbus control* on page *267*.<br>Check fault function parameter settings.<br>Check connections.<br>Check if master can communicate. |
| 2006 | AI1 LOSS<br>*0308* bit 5<br>(programmable fault function *3001*, *3021*) | Analog input AI1 signal has fallen below limit defined by parameter *3021 AI1 FAULT LIMIT*. | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections. |
| 2007 | AI2 LOSS<br>*0308* bit 6<br>(programmable fault function *3001*, *3021*) | Analog input AI2 signal has fallen below limit defined by parameter *3022 AI2 FAULT LIMIT*. | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections. |
| 2008 | PANEL LOSS<br>*0308* bit 7<br>(programmable fault function *3002*) | Control panel selected as active control location for drive has ceased communicating. | Check panel connection.<br>Check fault function parameters.<br>Check control panel connector. Refit control panel in mounting platform.<br>If drive is in external control mode (REM) and is set to accept start/stop, direction commands or references via control panel:<br>Check *Group 10: Start/Stop/Dir* and *Group 11: Reference select* settings. |

| CODE | ALARM | CAUSE | WHAT TO DO |
|---|---|---|---|
| 2009 | DEVICE OVERTEMP<br>0308 bit 8 | Drive IGBT temperature is excessive. Alarm limit is 120 °C. | Check ambient conditions. See also section *Derating* on page *366*.<br>Check air flow and fan operation.<br>Check motor power against unit power. |
| 2010 | MOTOR TEMP<br>0305 bit 9<br>(programmable fault function *3005*…*3009* / *3503*) | Motor temperature is too high (or appears to be too high) due to excessive load, insufficient motor power, inadequate cooling or incorrect start-up data. | Check motor ratings, load and cooling.<br>Check start-up data.<br>Check fault function parameters. |
| | | Measured motor temperature has exceeded alarm limit set by parameter *3503 ALARM LIMIT*. | Check value of alarm limit.<br>Check that actual number of sensors corresponds to value set by parameter (*2501 SENSOR TYPE*).<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc. |
| 2012 | MOTOR STALL<br>0308 bit 11<br>(programmable fault function *3010*…*3012*) | Motor is operating in stall region due to, eg, excessive load or insufficient motor power. | Check motor load and drive ratings.<br>Check fault function parameters. |
| 2013 1) | AUTORESET<br>0308 bit 12 | Automatic reset alarm | Check parameter *Group 31: Automatic reset* settings. |
| 2014 1) | AUTOCHANGE<br>0308 bit 13 | PFA autochange function is active. | See parameter *Group 81: PFA control*, section  on page *92*. |
| 2015 | PFC I LOCK<br>0308 bit 14 | PFA interlocks are active. | Drive cannot start<br>• any motor (when Autochange is used)<br>• the speed regulated motor (when Autochange is not used).<br>See parameter group *Group 81: PFA control*. |
| 2018 1) | PID SLEEP<br>3009 bit 1 | Sleep function has entered sleeping mode. | See parameter *Group 40: Process PID set 1*…*Group 41: Process PID set 2*. |
| 2020 | OVERRIDE | Override mode is activated. See *Group 17: Override*. | See sections *Commissioning the override mode* and *Changing the override parameters*. |
| 2021 | START ENABLE 1 MISSING<br>3009 bit 4 | No Start Enable 1 signal received | Check parameter *1608 START ENABLE 1*settings.<br>Check digital input connections.<br>Check fieldbus communication settings. |

| CODE | ALARM | CAUSE | WHAT TO DO |
|---|---|---|---|
| 2022 | START ENABLE 2 MISSING<br>*3009* bit 5 | No Start Enable 2 signal received | Check parameter *1609 START ENABLE 2* settings.<br>Check digital input connections.<br>Check fieldbus communication settings. |
| 2023 | EMERGENCY STOP<br>*3009* bit 6 | Drive has received emergency stop command and ramps to stop according to ramp time defined by parameter *2208 EMERG DEC TIME*. | Check that it is safe to continue operation.<br>Return emergency stop push button to normal position. |
| 2025 | FIRST START<br>*3009* bit 8 | Motor identification magnetization is on. This alarm belongs to normal start-up procedure. | Wait until drive indicates that motor identification is completed. |
| 2026 | INPUT PHASE LOSS<br>*3009* bit 9<br>(programmable fault function *3016*) | Intermediate circuit DC voltage is oscillating due to missing input power line phase or blown fuse.<br>Alarm is generated when DC voltage ripple exceeds 14% of nominal DC voltage. | Check input power line fuses.<br>Check for input power supply imbalance.<br>Check fault function parameters. |
| 2027 | USER LOAD CURVE<br>*3009* bit 10 | Condition defined by *3701 USER LOAD C MODE* has been valid longer than half of the time set by *3703 USER LOAD C TIME*. | See parameter *Group 37: User load curve*. |
| 2028 | START DELAY<br>*3009* bit 11 | Start delay in progress | See parameter *2113 START DELAY*. |
| 2030 | INLET LOW<br>*3009* bit 13 | Pressure at pump/fan inlet too low | Check for a closed valve on the inlet side of the pump/fan.<br>Check piping for leaks.<br>See parameter *Group 44: Pump protection*. |
| 2031 | OUTLET HIGH<br>*3009* bit 14 | Pressure at pump/fan outlet too high | Check piping for blocks.<br>See parameter *Group 44: Pump protection*. |
| 2032 | PIPE FILL<br>*3009* bit 15 | Pipe fill in progress | See parameters *4421*…*4426*. |
| 2033 | INLET VERY LOW<br>*0310* bit 0 | Pressure at pump/fan inlet too low | Check for a closed valve on the inlet side of the pump/fan.<br>Check piping for leaks.<br>See parameter *Group 44: Pump protection*. |

| CODE | ALARM | CAUSE | WHAT TO DO |
|---|---|---|---|
| 2034 | OUTLET VERY HIGH<br>*0310* bit 1 | Pressure at pump/fan outlet too high | Check piping for blocks.<br>See parameter *Group 44: Pump protection*. |

1) Even when the relay output is configured to indicate alarm conditions (eg, parameter *1401 RELAY OUTPUT 1* = 5 (ALARM) or 16 (FLT/ALARM)), this alarm is not indicated by a relay output.

## Alarms generated by the Basic control panel

The Basic control panel indicates control panel alarms with a code, A5xxx.

| ALARM CODE | CAUSE | WHAT TO DO |
|---|---|---|
| 5001 | Drive is not responding. | Check panel connection. |
| 5002 | Incompatible communication profile | Contact your local ABB representative. |
| 5010 | Corrupted panel parameter backup file | Retry parameter upload.<br>Retry parameter download. |
| 5011 | Drive is controlled from another source. | Change drive control to local control mode. |
| 5012 | Direction of rotation is locked. | Enable change of direction. See parameter *1003 DIRECTION*. |
| 5013 | Panel control is disabled because start inhibit is active. | Start from the panel is not possible. Reset the emergency stop command or remove the 3-wire stop command before starting from the panel.<br>See parameters *1001 EXT1 COMMANDS*, *1002 EXT2 COMMANDS* and *2109 EMERG STOP SEL*. |
| 5014 | Panel control is disabled because of drive fault. | Reset drive fault and retry. |
| 5015 | Panel control is disabled because local control mode lock is active. | Deactivate local control mode lock and retry. See parameter *1606 LOCAL LOCK*. |
| 5018 | Parameter default value is not found. | Contact your local ABB representative. |
| 5019 | Writing non-zero parameter value is prohibited. | Only parameter reset is allowed. |
| 5020 | Parameter or parameter group does not exist or parameter value is inconsistent. | Contact your local ABB representative. |
| 5021 | Parameter or parameter group is hidden. | Contact your local ABB representative. |
| 5022 | Parameter is write protected. | Parameter value is read-only and cannot be changed. |
| 5023 | Parameter change is not allowed, when drive is running. | Stop drive and change parameter value. |
| 5024 | Drive is executing task. | Wait until task is completed. |
| 5025 | Software is being uploaded or downloaded. | Wait until upload/download is complete. |
| 5026 | Value is at or below minimum limit. | Contact your local ABB representative. |
| 5027 | Value is at or above maximum limit. | Contact your local ABB representative. |
| 5028 | Invalid value | Contact your local ABB representative. |
| 5029 | Memory is not ready. | Retry. |

| ALARM CODE | CAUSE | WHAT TO DO |
|---|---|---|
| 5030 | Invalid request | Contact your local ABB representative. |
| 5031 | Drive is not ready for operation, eg due to low DC voltage. | Check input power supply. |
| 5032 | Parameter error | Contact your local ABB representative. |
| 5040 | Parameter download error. Selected parameter set is not in current parameter backup file. | Perform upload function before download. |
| 5041 | Parameter backup file does not fit into memory. | Contact your local ABB representative. |
| 5042 | Parameter download error. Selected parameter set is not in current parameter backup file. | Perform upload function before download. |
| 5043 | No start inhibit | |
| 5044 | Parameter backup file restoring error | Check that file is compatible with drive. |
| 5050 | Parameter upload aborted | Retry parameter upload. |
| 5051 | File error | Contact your local ABB representative. |
| 5052 | Parameter upload has failed. | Retry parameter upload. |
| 5060 | Parameter download aborted | Retry parameter download. |
| 5062 | Parameter download has failed. | Retry parameter download. |
| 5070 | Panel backup memory write error | Contact your local ABB representative. |
| 5071 | Panel backup memory read error | Contact your local ABB representative. |
| 5080 | Operation is not allowed because drive is not in local control mode. | Switch to local control mode. |
| 5081 | Operation is not allowed because of active fault. | Check cause of fault and reset fault. |
| 5083 | Operation is not allowed because parameter lock is on. | Check parameter *1602 PARAMETER LOCK* setting. |
| 5084 | Operation is not allowed because drive is performing task. | Wait until task is completed and retry. |
| 5085 | Parameter download from source to destination drive has failed. | Check that source and destination drive types are same, ie, ACS320. See the type designation label of the drive. |
| 5086 | Parameter download from source to destination drive has failed. | Check that source and destination drive type designations are the same. See type designation labels of the drives. |

| ALARM CODE | CAUSE | WHAT TO DO |
| --- | --- | --- |
| 5087 | Parameter download from source to destination drive has failed because parameter sets are incompatible. | Check that source and destination drive information are same. See parameters in *Group 33: Information*. |
| 5088 | Operation has failed because of drive memory error. | Contact your local ABB representative. |
| 5089 | Download has failed because of CRC error. | Contact your local ABB representative. |
| 5090 | Download has failed because of data processing error. | Contact your local ABB representative. |
| 5091 | Operation has failed because of parameter error. | Contact your local ABB representative. |
| 5092 | Parameter download from source to destination drive has failed because parameter sets are incompatible. | Check that source and destination drive information are same. See parameters in *Group 33: Information*. |

## Fault messages generated by the drive

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 0001 | OVERCURRENT<br>(2310)<br>*0305* bit 0 | Output current has exceeded trip level. | Check motor load.<br>Check acceleration time (*2202* and *2505*).<br>Check motor and motor cable (including phasing).<br>Check ambient conditions. Load capacity decreases if installation site ambient temperature exceeds 40 °C. See section *Derating* on page *366*. |
| 0002 | DC OVERVOLT<br>(3210)<br>*0305* bit 1 | Excessive intermediate circuit DC voltage. DC overvoltage trip limit is 420 V for 200 V drives and 840 V for 400 V drives. | Check that overvoltage controller is on.<br>Check input power line for static or transient overvoltage.<br>Check deceleration time (*2203*, *2206*). |
| 0003 | DEV OVERTEMP<br>(4210)<br>*0305* bit 2 | Drive IGBT temperature is excessive. Fault trip limit is 135 °C. | Check ambient conditions. See also section *Derating* on page *366*.<br>Check air flow and fan operation.<br>Check motor power against unit power. |
| 0004 | SHORT CIRC<br>(2340)<br>*0305* bit 3 | Short circuit in motor cable(s) or motor | Check motor and motor cable. |
| 0006 | DC UNDERVOLT<br>(3220)<br>*0305* bit 5 | Intermediate circuit DC voltage is not sufficient due to missing input power line phase, blown fuse, rectifier bridge internal fault or too low input power. | Check that undervoltage controller is on (parameter *2006 UNDERVOLT CTRL*).<br>Check input power supply and fuses. |
| 0007 | AI1 LOSS<br>(8110)<br>*0305* bit 6<br>(programmable fault function *3001*, *3021*) | Analog input AI1 signal has fallen below limit defined by parameter *3021 AI1 FAULT LIMIT*. | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections. |
| 0008 | AI2 LOSS<br>(8110)<br>*0305* bit 7<br>(programmable fault function *3001*, *3022*) | Analog input AI2 signal has fallen below limit defined by parameter *3022 AI2 FAULT LIMIT*. | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections. |

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 0009 | MOT OVERTEMP<br>(4310)<br>*0305* bit 8<br>(programmable fault function *0305…3009* / *3504*) | Motor temperature is too high (or appears to be too high) due to excessive load, insufficient motor power, inadequate cooling or incorrect start-up data. | Check motor ratings, load and cooling.<br>Check start-up data.<br>Check fault function parameters. |
| | | Measured motor temperature has exceeded fault limit set by parameter *3504 FAULT LIMIT*. | Check value of fault limit.<br>Check that actual number of sensors corresponds to value set by parameter *3501 SENSOR TYPE*.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc. |
| 0010 | PANEL LOSS<br>(5300)<br>*0305* bit 9<br>(programmable fault function *3002*) | Control panel selected as active control location for drive has ceased communicating. | Check panel connection.<br>Check fault function parameters.<br>Check control panel connector.<br>Refit control panel in mounting platform.<br>If drive is in external control mode (REM) and is set to accept start/stop, direction commands or references via control panel:<br>Check *Group 10: Start/Stop/Dir* and *Group 11: Reference select* settings. |
| 0012 | MOTOR STALL<br>(7121)<br>*0305* bit 11<br>(programmable fault function *3010…3012*) | Motor is operating in stall region due to eg excessive load or insufficient motor power. | Check motor load and drive ratings.<br>Check fault function parameters. |
| 0014 | EXT FAULT 1<br>(9000)<br>*0305* bit 13<br>(programmable fault function *3003*) | External fault 1 | Check external devices for faults.<br>Check parameter *3003 EXTERNAL FAULT 1* setting. |
| 0015 | EXT FAULT 2<br>(9001)<br>*0305* bit 14<br>(programmable fault function *3004*) | External fault 2 | Check external devices for faults.<br>Check parameter *3004 EXTERNAL FAULT 2* setting. |
| 0016 | EARTH FAULT<br>(2330)<br>*0305* bit 15<br>(programmable fault function *3017*) | Drive has detected a ground fault in motor or motor cable. | Check motor.<br>Check fault function parameters.<br>Check motor cable. Motor cable length must not exceed maximum specifications. See section *Motor connection data* on page *371*. |

| CODE | FAULT | CAUSE | WHAT TO DO |
| --- | --- | --- | --- |
| 0018 | THERM FAIL<br>(5210)<br>*0306* bit 1 | Drive internal fault. Thermistor used for drive internal temperature measurement is open or short-circuited. | Contact your local ABB representative. |
| 0021 | CURR MEAS<br>(2211)<br>*0306* bit 4 | Drive internal fault. Current measurement is out of range. | Contact your local ABB representative. |
| 0022 | SUPPLY PHASE<br>(3130)<br>*0306* bit 5 | Intermediate circuit DC voltage is oscillating due to missing input power line phase or blown fuse.<br>Trip occurs when DC voltage ripple exceeds 14% of nominal DC voltage. | Check input power line fuses.<br>Check for input power supply imbalance.<br>Check fault function parameters. |
| 0024 | OVERSPEED<br>(7310)<br>*0306* bit 7 | Motor is turning faster than highest allowed speed due to incorrectly set minimum/maximum speed.<br>Operating range limits are set by parameters *2007 MINIMUM FO* and *2008 MAXIMUM FO*. | Check minimum/maximum frequency settings.<br>Check adequacy of motor braking torque. |
| 0026 | DRIVE ID<br>(5400)<br>*0306* bit 9 | Internal drive ID fault | Contact your local ABB representative. |
| 0027 | CONFIG FILE<br>(630F)<br>*0306* bit 10 | Internal configuration file error | Contact your local ABB representative. |
| 0028 | SERIAL 1 ERR<br>(7510)<br>*0306* bit 11<br>(programmable fault function *3018*, *3019*) | Fieldbus communication break | Check status of fieldbus communication. See chapter *Fieldbus control* on page *267*.<br>Check fault function parameter settings.<br>Check connections.<br>Check if master can communicate. |
| 0029 | EFB CON FILE<br>(6306)<br>*0306* bit 12 | Configuration file reading error | Contact your local ABB representative. |
| 0030 | FORCE TRIP<br>(FF90)<br>*0306* bit 13 | Trip command received from fieldbus | See appropriate communication module manual. |

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 0031 | EFB 1<br>(FF92)<br>*0307* bit 0 | Error from the embedded fieldbus (EFB) protocol application. The meaning is protocol dependent. | See chapter *Fieldbus control* on page *267*. |
| 0032 | EFB 2<br>(FF93)<br>*0307* bit 1 | | |
| 0033 | EFB 3<br>(FF94)<br>*0307* bit 2 | | |
| 0034 | MOTOR PHASE<br>(FF56)<br>*0306* bit 14 | Motor circuit fault due to missing motor phase or motor thermistor relay (used in motor temperature measurement) fault. | Check motor and motor cable.<br>Check motor thermistor relay (if used). |
| 0035 | OUTP WIRING<br>(FF95)<br>*0306* bit 15<br>(programmable fault function *3023*) | Incorrect input power and motor cable connection (ie input power cable is connected to drive motor connection).<br>The fault can be erroneously declared if the input power is a delta grounded system and the motor cable capacitance is large. This fault can be disabled using parameter *3023 WIRING FAULT*. | Check input power connections.<br>Check fault function parameters. |
| 0036 | INCOMPATIBLE SW<br>(630F)<br>*0307* bit 3 | Loaded software is not compatible. | Contact your local ABB representative. |
| 0038 | USER LOAD CURVE<br>(FF6B)<br>*0307* bit 4 | Condition defined by *3701 USER LOAD C MODE* has been valid longer than the time set by *3703 USER LOAD C TIME*. | See parameter *Group 37: User load curve*. |
| 0039 | UNKNOWN EXTENSION<br>(7086)<br>*0307* bit 5 | Option module not supported by the drive firmware is connected to the drive. | Check connections. |
| 0040 | INLET VERY LOW<br>(8A81)<br>*0307* bit 6 | Pressure at pump/fan inlet too low | Check for a closed valve on the inlet side of the pump/fan.<br>Check piping for leaks.<br>See parameter *Group 44: Pump protection*. |

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 0041 | OUTLET VERY HIGH<br>(8A83)<br>*0307* bit 7 | Pressure at pump/fan outlet too high | Check piping for blocks.<br>See parameter *Group 44: Pump protection*. |
| 0042 | INLET LOW<br>(8A80)<br>*0307* bit 8 | Pressure at pump/fan inlet too low | Check for a closed valve on the inlet side of the pump/fan.<br>Check piping for leaks.<br>See parameter *Group 44: Pump protection*. |
| 0043 | OUTLET HIGH<br>(8A82)<br>*0307* bit 9 | Pressure at pump/fan outlet too high | Check piping for blocks.<br>See parameter *Group 44: Pump protection*. |
| 0101 | SERF CORRUPT<br>(FF55)<br>*0307* bit 14 | Drive internal error | Write down fault code and contact your local ABB representative. |
| 0103 | SERF MACRO<br>(FF55)<br>*0307* bit 14 | | |
| 0201 | DSP T1 OVERLOAD<br>(6100)<br>*0307* bit 13 | | |
| 0202 | DSP T2 OVERLOAD<br>(6100)<br>*0307* bit 13 | | |
| 0203 | DSP T3 OVERLOAD<br>(6100)<br>*0307* bit 13 | | |
| 0204 | DSP STACK ERROR<br>(6100)<br>*0307* bit 12 | | |
| 0206 | CB ID ERROR<br>(5000)<br>*0307* bit 11 | | |
| 1000 | PAR HZRPM<br>(6320)<br>*0307* bit 15 | Incorrect frequency limit parameter setting | Check parameter settings. Check that following applies:<br>• *2007 MINIMUM FO* < *2008 MAXIMUM FO*<br>• *2007 MINIMUM FO* / *9907 MOTOR NOM FREQ* and *2008 MAXIMUM FO* / *9907 MOTOR NOM FREQ* are within range. |

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 1001 | PAR PFC REF NEG (6320)<br>*0307* bit 15 | Incorrect PFA parameters | Check parameter *Group 81: PFA control* settings. Check that following applies:<br>• *2007 MINIMUM FO* > 0 when *8123* is ACTIVE or SPFC ACTIVE. |
| 1003 | PAR AI SCALE (6320)<br>*0307* bit 15 | Incorrect analog input AI signal scaling | Check parameter *Group 13: Analogue inputs* settings. Check that following applies:<br>• *1301 MINIMUM AI1* < *1302 MAXIMUM AI1*<br>• *1304 MINIMUM AI2* < *1305 MAXIMUM AI2*. |
| 1004 | PAR AO SCALE (6320)<br>*0307* bit 15 | Incorrect analog output AO signal scaling | Check parameter *Group 15: Analogue outputs* settings. Check that following applies:<br>• *1504 MINIMUM AO1* < *1505 MAXIMUM AO1*. |
| 1005 | PAR PCU 2 (6320)<br>*0307* bit 15 | Incorrect motor nominal power setting | Check parameter *9909* setting.<br>Following must apply:<br>• 1.1 < (*9906 MOTOR NOM CURR* * *9905 MOTOR NOM VOLT* * 1.73 / $P_N$) < 3.0<br>where $P_N$ = 1000 * *9909 MOTOR NOM POWER* (if units are in kW) or $P_N$ = 746 * *9909 MOTOR NOM POWER* (if units are in hp). |
| 1006 | PAR EXT RO (6320)<br>*0307* bit 15 | Incorrect extension relay output parameters. | Check parameter settings. Check that following applies:<br>• Relay Output Extension Module MREL-0 is connected to the drive.<br>• *1402…1403 RELAY OUTPUT 2…RELAY OUTPUT 3* and *1410 RELAY OUTPUT 4* have non-zero values.<br>See *MREL-01 Relay Output Extension Module User's Manual* (3AUA0000035974 [English]). |
| 1007 | PAR FBUSMISS (6320)<br>*0307* bit 15 | Fieldbus control has not been activated. | Check fieldbus parameter settings. |
| 1009 | PAR PCU 1 (6320)<br>*0307* bit 15 | Incorrect motor nominal speed/frequency setting | Check parameter settings. Following must apply:<br>• 1 < (60 * *9907 MOTOR NOM FREQ*/ *9908 MOTOR NOM SPEED*) < 16<br>• 0.8 < *9908 MOTOR NOM SPEED* / (120 **9907 MOTOR NOM FREQ* / Motor poles) < 0.992 |

| CODE | FAULT | CAUSE | WHAT TO DO |
|---|---|---|---|
| 1012 | PAR PFA IO 1 (6320) *0307* bit 15 | I/O configuration for PFA not complete | Check parameter settings. Following must apply:<br>• There are enough relays parameterized for PFA.<br>• No conflict exists between parameter *Group 14: Relay outputs*, parameter *8117 NR OF AUX MOT* and parameter *8118 AUTOCHNG INTERV*. |
| 1013 | PAR PFC IO 2 (6320) *0307* bit 15 | I/O configuration for PFA not complete | Check parameter settings. Following must apply:<br>• The actual number of PFA motors (parameter *8127 MOTORS*) matches the PFA motors in parameter *Group 14: Relay outputs* and parameter *8118 AUTOCHNG INTERV*. |
| 1014 | PAR PFC IO 3 (6320) *0307* bit 15 | I/O configuration for PFA not complete. The drive is unable to allocate a digital input (interlock) for each PFA motor. | See parameters *8120 INTERLOCKS* and *8127 MOTORS*. |
| 1015 | PAR CUSTOM U/F (6320) *0307* bit 15 | Incorrect voltage to frequency (U/f) ratio voltage setting. | Check parameter *2610 USER DEFINED U1*…*2617 USER DEFINED F4* settings. |
| 1017 | PAR SETUP 1 (6320) *0307* bit 15 | It is not allowed to use frequency input signal and frequency output signal simultaneously. | Disable frequency output or frequency input:<br>• change transistor output to digital mode (value of parameter *1804 TO MODE* = DIGITAL), or<br>• change frequency input selection to other value in parameters *Group 11: Reference select*, *Group 40: Process PID set 1*, *Group 41: Process PID set 2* and *Group 42: Ext / Trim PID*. |
| 1026 | PAR USER LOAD C (6320) *0307* bit 15 | Incorrect user load curve parameter setting | Check parameter settings. Following must apply:<br>• *3704 LOAD FREQ 1* ≤ *3707 LOAD FREQ 2* ≤ *3710 LOAD FREQ 3* ≤ *3713 LOAD FREQ 4* ≤ *3716 LOAD FREQ 5*<br>• *3705 LOAD TORQ LOW 1* < *3706 LOAD TORQ HIGH 1*<br>• *3708 LOAD TORQ LOW 2* < *3709 LOAD TORQ HIGH 2*<br>• *3711 LOAD TORQ LOW 3* < *3712 LOAD TORQ HIGH 3*<br>• *3714 LOAD TORQ LOW 4* < *3715 LOAD TORQ HIGH 4*<br>• *3717 LOAD TORQ LOW 5* < *3718 LOAD TORQ HIGH 5*. |

## Embedded fieldbus faults

Embedded fieldbus faults can be traced by monitoring group *Group 53: EFB protocol* parameters. See also fault/alarm *SERIAL 1 ERR*.

### No master device

If there is no master device on line, parameter *5306 EFB OK MESSAGES* and *5307 EFB CRC ERRORS* values remain unchanged.

What to do:

- Check that the network master is connected and properly configured.
- Check the cable connection.

### Same device address

If two or more devices have the same address, parameter *5307 EFB CRC ERRORS* value increases with every read/write command.

What to do:

- Check the device addresses. No two devices on line may have the same address.

### Incorrect wiring

If the communication wires are swapped (terminal A on one device is connected to terminal B on another device), parameter *5306 EFB OK MESSAGES* value remains unchanged and parameter *5307 EFB CRC ERRORS* increases.

What to do:

- Check the RS-232/485 interface connection.

13

# Maintenance and hardware diagnostics

## Contents of this chapter

The chapter contains preventive maintenance instructions and LED indicator descriptions.

## Maintenance intervals

If installed in an appropriate environment, the drive requires very little maintenance. The table lists the routine maintenance intervals recommended by ABB Drives.

| Maintenance | Interval | Instruction |
|---|---|---|
| Reforming of capacitors | Every year when stored | See *Capacitors* on page *360*. |
| Check of dustiness, corrosion and temperature | Every year | |
| Replacement of the cooling fan (frame sizes R1…R4) | Every three years | See *Cooling fan* on page *358*. |
| Check and tightening of the power terminals | Every six years | See *Power connections* on page *360*. |
| Replacement of the battery in the Assistant Control Panel | Every ten years | See *Changing the battery in the Assistant control panel* on page *360*. |

Consult your local ABB Service representative for more details on the maintenance. On the Internet, go to http://www.abb.com/drives and select *Drive Services – Maintenance and Field Services*.

# Cooling fan

The life span of the drive’s cooling fan depends on the drive usage and ambient temperature.

When the Assistant control panel is in use, the Notice Handler Assistant informs when the definable value of the operating hour counter is reached (see parameter *2901 COOLING FAN TRIG*). This information can also be passed to the relay output (see parameter *1401 RELAY OUTPUT 1*) regardless of the used panel type.

Fan failure can be predicted by the increasing noise from the fan bearings. If the drive is operated in a critical part of a process, fan replacement is recommended once these symptoms start appearing. Replacement fans are available from ABB Drives. Do not use other than ABB specified spare parts.

## Replacing the cooling fan (frame sizes R1…R4)

Only frame sizes R1…R4 include a fan; frame size R0 has natural cooling.

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**WARNING!** Obey the safety instructions. See chapter *Safety* on page *15*. If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.

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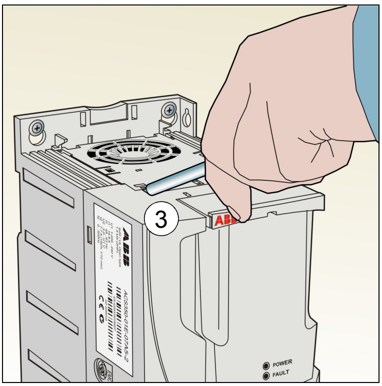
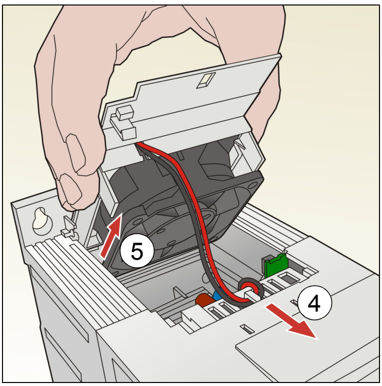
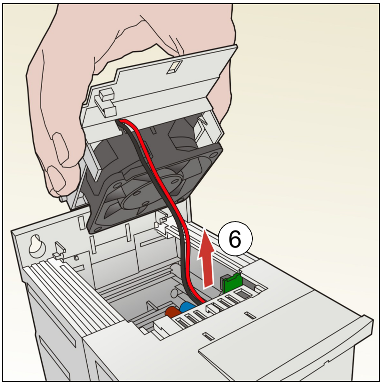
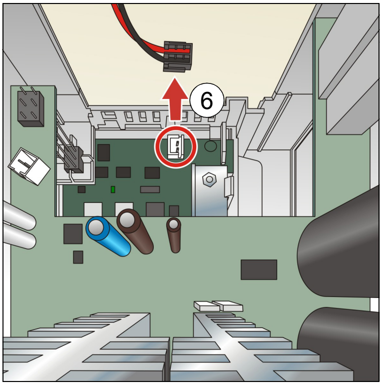
1. Stop the drive and disconnect it from the power line. Wait for five minutes to let the drive DC capacitors discharge. Make sure that there is no voltage present. Measure by a multimeter (impedance at least 1 Mohm) the voltage between the input terminals and ground and the output terminals and ground.
2. Remove the hood if the drive has the NEMA 1 option.
3. Lever the fan holder off the drive frame with, for example, a screwdriver.
4. Free the fan cable from the clip in the drive frame.
5. Lift the holder from the hinges.



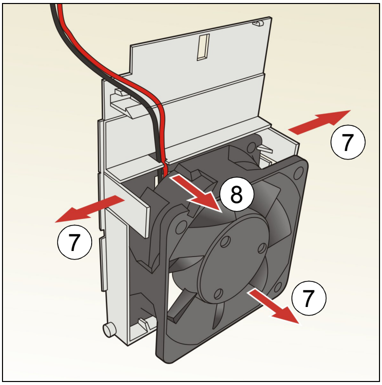



6. Disconnect the fan cable. The figure below on the right shows the location of the fan cable connector in frame size R2. The inside views in different frame sizes are not identical, but the fan cable connector is always on the control board that is against the front of the drive.




7. Free the fan cable from the clip in the fan holder.
8. Remove the fan from the holder.




9. Install the new fan in reverse order.
10. Restore power.

# Capacitors

## Reforming the capacitors

The capacitors must be reformed if the drive has been stored for a year. See section *Type designation label* on page *26* for how to find out the manufacturing time from the serial number. For information on reforming the capacitors, refer to *Guide for Capacitor Reforming in ACS50, ACS55, ACS150, ACS310, ACS320, ACS350, ACS550 and ACH550* (3AFE68735190 [English]), available on the Internet (go to http://www.abb.com and enter the code in the Search field).

# Power connections

**WARNING!** Obey the safety instructions. See chapter *Safety* on page *15*. If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrician, do not do electrical work.

1. Stop the drive and disconnect it from the power line. Wait for five minutes to let the drive DC capacitors discharge. Make sure that there is no voltage present. Measure by a multimeter (impedance at least 1 Mohm) the voltage between the input terminals and ground and the output terminals and ground.
2. Check the tightness of the power cable connections. Use the tightening torques given in section *Terminal and lead-through data for the power cables* on page *371*.
3. Restore power.

# Control panel

## Cleaning the control panel

Use a soft damp cloth to clean the control panel. Avoid harsh cleaners which could scratch the display window.

## Changing the battery in the Assistant control panel

A battery is only used in Assistant control panels that have the clock function available and enabled. The battery keeps the clock operating in memory during power interruptions.

The expected life for the battery is greater than ten years. To remove the battery, use a coin to rotate the battery holder on the back of the control panel. Replace the battery with type CR2032.

**Note:** The battery is NOT required for any control panel or drive functions, except the clock.

## LEDs

There is a green and a red LED on the front of the drive. They are visible through the panel cover but invisible if a control panel is attached to the drive. The Assistant control panel has one LED. The table below describes the LED indications.

| Where | LED off | LED lit and steady | | LED blinking | |
|---|---|---|---|---|---|
| On the front of the drive.<br>If a control panel is attached to the drive, switch to remote control (otherwise a fault will be generated), and then remove the panel to be able to see the LEDs. | No power | Green | Power supply on the board OK | Green | Drive in an alarm state |
| | | Red | Drive in a fault state. To reset the fault, press RESET from the control panel or switch off the drive power. | Red | Drive in a fault state. To reset the fault, switch off the drive power. |
| At the top left corner of the Assistant Control Panel | Panel has no power or no drive connection. | Green | Drive in a normal state | Green | Drive in an alarm state |
| | | Red | Drive in a fault state. To reset the fault, press RESET from the control panel or switch off the drive power. | Red | - |

14

# Technical data

## Contents of this chapter

The chapter contains the technical specifications of the drive, for example, ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE and other marks.

# Ratings, types and voltages (for North American market)

| Type Code | Ratings | | | | | Frame Size |
|---|---|---|---|---|---|---|
| | Input | | Output | | | |
| | Nominal without Reactor A | Nominal with 5% Reactor A | Continuous @ 50C, 10% Overload 1) A | Continuous @ 40C, 0% Overload A | Instantaneous Peak 2) A | |
| **1-phase supply voltage 200 - 240 V units (Confirm output ratings meet motor requirements)** | | | | | | |
| ACS320-01U-02A4-2 | 6.1 | N/A | 2.3 | 2.4 | 4.0 | R0 |
| ACS320-01U-04A7-2 | 11.4 | N/A | 4.5 | 4.7 | 7.9 | R1 |
| ACS320-01U-06A7-2 | 16.1 | N/A | 6.5 | 6.7 | 11.4 | R1 |
| ACS320-01U-07A5-2 | 16.8 | N/A | 7.2 | 7.5 | 12.6 | R2 |
| ACS320-01U-09A8-2 | 21.0 | N/A | 9.4 | 9.8 | 16.5 | R2 |
| **3-phase supply voltage 200 - 240 V units** | | | | | | |
| ACS320-03U-02A6-2 | 4.7 | 2.6 | 2.4 | 2.6 | 4.2 | R0 |
| ACS320-03U-03A9-2 | 6.7 | 3.9 | 3.5 | 3.9 | 6.1 | R0 |
| ACS320-03U-05A2-2 | 8.4 | 5.2 | 4.7 | 5.2 | 8.2 | R1 |
| ACS320-03U-07A4-2 | 13.0 | 7.4 | 6.7 | 7.4 | 11.7 | R1 |
| ACS320-03U-08A3-2 | 13.2 | 8.3 | 7.5 | 8.3 | 13.1 | R1 |
| ACS320-03U-10A8-2 | 15.7 | 10.8 | 9.8 | 10.8 | 17.2 | R2 |
| ACS320-03U-14A6-2 | 23.9 | 14.6 | 13.3 | 14.6 | 23.3 | R2 |
| ACS320-03U-19A4-2 | 27.3 | 19.4 | 17.6 | 19.4 | 30.8 | R2 |
| ACS320-03U-26A8-2 | 45 | 26.8 | 24.4 | 26.8 | 42.7 | R3 |
| ACS320-03U-34A1-2 | 55 | 34.1 | 31.0 | 34.1 | 54.3 | R4 |
| ACS320-03U-50A8-2 | 76 | 50.8 | 46.2 | 50.8 | 80.9 | R4 |
| **3-phase supply voltage 380 - 480 V units** | | | | | | |
| ACS320-03U-01A2-4 | 2.2 | 1.2 | 1.1 | 1.2 | 2.1 | R0 |
| ACS320-03U-01A9-4 | 3.6 | 1.9 | 1.7 | 1.9 | 3.3 | R0 |
| ACS320-03U-02A4-4 | 4.1 | 2.4 | 2.2 | 2.4 | 4.2 | R1 |
| ACS320-03U-03A3-4 | 6.0 | 3.3 | 3.0 | 3.3 | 5.8 | R1 |
| ACS320-03U-04A1-4 | 6.9 | 4.1 | 3.7 | 4.1 | 7.2 | R1 |
| ACS320-03U-05A6-4 | 9.6 | 5.6 | 5.1 | 5.6 | 9.8 | R1 |
| ACS320-03U-07A3-4 | 11.6 | 7.3 | 6.6 | 7.3 | 12.8 | R1 |
| ACS320-03U-08A8-4 | 13.6 | 8.8 | 8.0 | 8.8 | 15.4 | R1 |
| ACS320-03U-12A5-4 | 18.8 | 12.5 | 11.4 | 12.5 | 21.9 | R3 |
| ACS320-03U-15A6-4 | 22.1 | 15.6 | 14.2 | 15.6 | 27.3 | R3 |
| ACS320-03U-23A1-4 | 30.9 | 23.1 | 21.0 | 23.1 | 40.4 | R3 |
| ACS320-03U-31A0-4 | 52.0 | 31.0 | 28.2 | 31 | 54.3 | R4 |
| ACS320-03U-38A0-4 | 61.0 | 38.0 | 34.5 | 38 | 66.5 | R4 |
| ACS320-03U-44A0-4 | 67.0 | 44.0 | 40.0 | 44 | 77.0 | R4 |

1) Overloadability for one minute every ten minutes.
2) Instantaneous peak current for two seconds every ten minutes.

## Definition

**R0…R4** ACS320 is manufactured in frame sizes R0…R4. Some instructions and other information that only concern certain frame sizes are marked with the symbol of the frame size (R0…R4)

## Ratings, types and voltages (for European market)

| Type | Input 2) | Input 2) with 5% choke | Output | | | | | Frame size |
|---|---|---|---|---|---|---|---|---|
| ACS320-03E 1) | $I_{1N}$ | $I_{1N}$ | $I_{LD}$ | $I_{2N}$ | $I_{2max}$ | $P_N$ | | |
| | A | A | A | A | A | kW | hp | |
| **3-phase $U_N$ = 380…480 V** (380, 400, 415, 440, 460, 480 V) 3) | | | | | | | | |
| 03E-01A2-4 | 2.2 | 1.1 | 1.1 | 1.2 | 2.1 | 0.37 | 0.5 | R0 |
| 03E-01A9-4 | 3.6 | 1.8 | 1.7 | 1.9 | 3.3 | 0.55 | 0.75 | R0 |
| 03E-02A4-4 | 4.1 | 2.3 | 2.2 | 2.4 | 4.2 | 0.75 | 1 | R1 |
| 03E-03A3-4 | 6.0 | 3.1 | 3.0 | 3.3 | 5.8 | 1.1 | 1.5 | R1 |
| 03E-04A1-4 | 6.9 | 3.5 | 3.7 | 4.1 | 7.2 | 1.5 | 2 | R1 |
| 03E-05A6-4 | 10 | 4.8 | 5.1 | 5.6 | 9.8 | 2.2 | 3 | R1 |
| 03E-07A3-4 | 12 | 6.1 | 6.6 | 7.3 | 12.8 | 3 | 3 | R1 |
| 03E-08A8-4 | 14 | 7.7 | 8.0 | 8.8 | 15.4 | 4 | 5 | R1 |

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1) E = EMC filter connected (metal EMC filter screw installed)

2) Input current depends on the supply network, line inductance and load motor. With 5% choke values can be met by ABB CHK-xx or typical 5% chokes.

### Definitions

| | |
|---|---|
| $I_{1N}$ | continuous rms input current (for dimensioning cables and fuses) at ambient temperature of +40 °C (104 °F). |
| $I_{LD}$ | continuous output current at max ambient temperature of +50 °C (122 °F). 10% overloadability for one minute every ten minutes. |
| $I_{2N}$ | maximum continuous output current at ambient temperature of +40 °C (104 °F). No overloadability, derating 1% for every additional 1 °C up to 50 °C (122 °F). |
| $I_{2max}$ | maximum instantaneous output current. Available for two seconds every ten minutes at start-up, or as long as allowed by the drive temperature. |
| $P_N$ | typical motor power. The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole motors. |
| **R0…R4** | ACS320 is manufactured in frame sizes R0…R4. Some instructions and other information that only concern certain frame sizes are marked with the symbol of the frame size (R0…R4). |

### Sizing

The current ratings are the same regardless of the supply voltage within one voltage range. To achieve typical motor power, the rated current of the drive must be higher than or equal to the rated motor current.

**Note 1:** The maximum allowed motor shaft power is limited to 1.5 · $P_N$ (where $P_N$ = typical motor power). If the limit is exceeded, motor torque and current are automatically restricted. The function protects the input bridge of the drive against overload.

**Note 2:** The ratings apply at ambient temperature of 40 °C (104 °F) for $I_{2N}$ and 50 °C (122 °F) for $I_{LD}$.

In multimotor systems, the drive output current rating $I_{LD}$ must be equal to or greater than the calculated sum of the input currents of all motors.

## Derating

The load capacity decreases if the installation site ambient temperature exceeds 40 °C (104 °F) or if the altitude exceeds 1000 meters (3300 ft).

### Temperature derating

In the temperature range +40 °C…+50 °C (+104 °F…+122 °F), the rated output current is decreased by 1% for every additional 1 °C (1.8 °F). The output current is calculated by multiplying the current given in the rating table by the derating factor.

**Example:** If the ambient temperature is 50 °C (+122 °F), the derating factor is $100\% - 1\,\frac{\%}{°C} \cdot 10\,°C = 90\%$ or 0.90. The output current is then $0.90 \cdot I_{2N}$ (where $I_{2N}$ = continuous output at 40 °C, 0% overload)

### Altitude derating

In altitudes 1000…2000 m (3300…6600 ft) above sea level, the derating is 1% for every 100 m (330 ft).

### Switching frequency derating

Derate according to the switching frequency used (see parameter *2606 SWITCHING FREQ*) as follows:

| Switching frequency | Drive voltage rating | |
|---|---|---|
| | $U_N$ = 200…240 V | $U_N$ = 380…480 V |
| **4 kHz** | No derating | No derating |
| **8 kHz** | Derate $I_{2N}$ to 90%. | Derate $I_{2N}$ to 75% for R0 or to 80% for R1…R4. |
| **12 kHz** | Derate $I_{2N}$ to 80%. | Derate $I_{2N}$ to 50% for R0 or to 65% for R1…R4 and derate maximum ambient temperature to 30 °C (86 °F). |
| **16 kHz** | Derate $I_{2N}$ to 75%. | Derate $I_{2N}$ to 50% and derate maximum ambient temperature to 30 °C (86 °F). |

$I_{2N}$ = continuous output at 40 °C, 0% overload.

## Power cable sizes and fuses

Cable dimensioning for rated input currents is shown in the table below together with the corresponding fuse types for short-circuit protection of the input power cable. **The rated fuse currents given in the table are the maximal for the mentioned fuse types.** If smaller fuse ratings are used, check that the fuse rms current rating is larger than the rated input current given in section *Ratings, types and voltages (for North American market)* on page *364* or in section *Ratings, types and voltages (for European market)* on page *365*. If 150% output power is needed, multiply input current by 1.5. See also section *Selecting the power cables* on page *37*.

**Check that the operating time of the fuse is below 0.5 seconds**. The operating time depends on the fuse type, the supply network impedance as well as the cross-sectional area, material and length of the supply cable. In case the 0.5 seconds operating time is exceeded with the gG or T fuses, ultra rapid (aR) fuses will in most cases reduce the operating time to an acceptable level.

**Notes:**

- Do not use larger fuses.
- Choose the correct fuse size according to the actual input current which depends on the input line voltage and the input choke selection.
- Other fuse types can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in this table.

| Type Code | Fuses | | Size of copper conductor in cablings | | | | | |
|---|---|---|---|---|---|---|---|---|
| | gG | UL Class T or CC (600 V) | Supply (U1, V1, W2) | | Motor (U2, V2, W3) | | PE | |
| | A | A | mm² | AWG | mm² | AWG | mm² | AWG |
| **1-phase supply voltage 200 - 240 V units** | | | | | | | | |
| ACS320-01U-02A4-2 | 10 | 10 | 2.5 | 14 | 0.75 | 18 | 2.5 | 14 |
| ACS320-01U-04A7-2 | 16 | 20 | 2.5 | 14 | 0.75 | 18 | 2.5 | 14 |
| ACS320-01U-06A7-2 | 16/20*) | 25 | 2.5 | 10 | 1.5 | 14 | 2.5 | 10 |
| ACS320-01U-07A5-2 | 20/25*) | 30 | 2.5 | 10 | 1.5 | 14 | 2.5 | 10 |
| ACS320-01U-09A8-2 | 25/35*) | 35 | 6 | 10 | 2.5 | 12 | 6 | 10 |
| **3-phase supply voltage 200 - 240 V units** | | | | | | | | |
| ACS320-03U-02A6-2 | 10 | 10 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |
| ACS320-03U-03A9-2 | 10 | 10 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |
| ACS320-03U-05A2-2 | 10 | 15 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |
| ACS320-03U-07A4-2 | 16 | 15 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-08A3-2 | 16 | 15 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-10A8-2 | 16 | 20 | 2.5 | 12 | 2.5 | 12 | 2.5 | 12 |
| ACS320-03U-14A6-2 | 25 | 30 | 6 | 10 | 6 | 10 | 6 | 10 |
| ACS320-03U-19A4-2 | 25 | 35 | 6 | 10 | 6 | 10 | 6 | 10 |
| ACS320-03U-26A8-2 | 63 | 60 | 10 | 8 | 10 | 8 | 10 | 8 |
| ACS320-03U-34A1-2 | 80 | 80 | 16 | 6 | 16 | 6 | 16 | 6 |
| ACS320-03U-50A8-2 | 100 | 100 | 25 | 2 | 25 | 2 | 16 | 4 |
| **3-phase supply voltage 380 - 480 V units** | | | | | | | | |
| ACS320-03U-01A2-4 | 10 | 10 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |
| ACS320-03U-01A9-4 | 10 | 10 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |

| Type Code | Fuses | | Size of copper conductor in cablings | | | | | |
|---|---|---|---|---|---|---|---|---|
| | gG | UL Class T or CC (600 V) | Supply (U1, V1, W2) | | Motor (U2, V2, W3) | | PE | |
| | A | A | mm$^2$ | AWG | mm$^2$ | AWG | mm$^2$ | AWG |
| ACS320-03U-02A4-4 | 10 | 10 | 2.5 | 14 | 1.5 | 14 | 2.5 | 14 |
| ACS320-03U-03A3-4 | 10 | 10 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-04A1-4 | 16 | 15 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-05A6-4 | 16 | 15 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-07A3-4 | 16 | 20 | 2.5 | 12 | 1.5 | 14 | 2.5 | 12 |
| ACS320-03U-08A8-4 | 20 | 25 | 2.5 | 12 | 2.5 | 12 | 2.5 | 12 |
| ACS320-03U-12A5-4 | 25 | 30 | 6 | 10 | 6 | 10 | 6 | 10 |
| ACS320-03U-15A6-4 | 35 | 35 | 6 | 8 | 6 | 8 | 6 | 8 |
| ACS320-03U-23A1-4 | 50 | 50 | 10 | 8 | 10 | 8 | 10 | 8 |
| ACS320-03U-31A0-4 | 80 | 80 | 16 | 6 | 16 | 6 | 16 | 6 |
| ACS320-03U-38A0-4 | 100 | 100 | 25 | 4 | 16 | 4 | 16 | 4 |
| ACS320-03U-44A0-4 | 100 | 100 | 25 | 4 | 25 | 4 | 16 | 4 |

*) If 150% output is needed use the larger fuse alternative.

# Dimensions, weights and free space requirements

## Dimensions and weights

| Frame size | Dimensions and weights | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IP20 (cabinet) / UL open | | | | | | | | | | | |
| | H1 | | H2 | | H3 | | W | | D | | Weight | |
| | mm | in | mm | in | mm | in | mm | in | mm | in | kg | lb |
| R0 | 169 | 6.65 | 202 | 7.95 | 239 | 9.41 | 70 | 2.76 | 161 | 6.34 | 1.2 | 2.6 |
| R1 | 169 | 6.65 | 202 | 7.95 | 239 | 9.41 | 70 | 2.76 | 161 | 6.34 | 1.4 | 3.1 |
| R2 | 169 | 6.65 | 202 | 7.95 | 239 | 9.41 | 105 | 4.13 | 165 | 6.50 | 1.8 | 4.0 |
| R3 | 169 | 6.65 | 202 | 7.95 | 236 | 9.29 | 169 | 6.65 | 169 | 6.65 | 2.9 | 6.4 |
| R4 | 181 | 7.13 | 202 | 7.95 | 244 | 9.61 | 260 | 10.24 | 169 | 6.65 | 5.1 | 11.2 |

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| Frame size | Dimensions and weights | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IP20 / NEMA 1 | | | | | | | | | |
| | H4 | | H5 | | W | | D | | Weight | |
| | mm | in | mm | in | mm | in | mm | in | kg | lb |
| R0 | 257 | 10.12 | 280 | 11.02 | 70 | 2.76 | 169 | 6.65 | 1.6 | 3.5 |
| R1 | 257 | 10.12 | 280 | 11.02 | 70 | 2.76 | 169 | 6.65 | 1.8 | 4.0 |
| R2 | 257 | 10.12 | 282 | 11.10 | 105 | 4.13 | 169 | 6.65 | 2.2 | 4.9 |
| R3 | 260 | 10.24 | 299 | 11.77 | 169 | 6.65 | 177 | 6.97 | 3.5 | 7.7 |
| R4 | 270 | 10.63 | 320 | 12.60 | 260 | 10.24 | 177 | 6.97 | 5.7 | 12.6 |

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**Symbols**
**IP20 (cabinet) / UL open**
**H1** height without fastenings and clamping plate

**H2** height with fastenings, without clamping plate
**H3** height with fastenings and clamping plate
**IP20 / NEMA 1**
**H4** height with fastenings and connection box
**H5** height with fastenings, connection box and hood

### Free space requirements

| Frame size | Free space required | | | | | |
|---|---|---|---|---|---|---|
| | Above | | Below | | On the sides | |
| | mm | in | mm | in | mm | in |
| R0…R4 | 75 | 3 | 75 | 3 | 0 | 0 |

## Losses, cooling data and noise

### Losses and cooling data

Frame size R0 has natural convection cooling. Frame sizes R1…R4 are provided with an internal fan. The air flow direction is from bottom to top.

The table below specifies the heat dissipation in the main circuit at nominal load and in the control circuit with minimum load (I/O and panel not in use) and maximum load (all digital inputs in the on state and the panel, fieldbus and fan in use). The total heat dissipation is the sum of the heat dissipation in the main and control circuits.

| Type Code | Heat dissipation | | | | | | Air flow | |
|---|---|---|---|---|---|---|---|---|
| | Main circuit | | Control circuit | | | | | |
| | Rated current | | Min | | Max | | | |
| | W | BTU/Hr | W | BTU/Hr | W | BTU/Hr | $m^3/h$ | $ft^3/min$ |
| **1-phase supply voltage 200 - 240 V units** | | | | | | | | |
| ACS320-01U-02A4-2 | 19 | 65 | 6.1 | 21 | 22.7 | 78 | - | - |
| ACS320-01U-04A7-2 | 38 | 130 | 9.5 | 32 | 26.4 | 90 | 24 | 14 |
| ACS320-01U-06A7-2 | 60 | 205 | 9.5 | 32 | 26.4 | 90 | 24 | 14 |
| ACS320-01U-07A5-2 | 62 | 212 | 10.5 | 36 | 27.5 | 94 | 21 | 12 |
| ACS320-01U-09A8-2 | 83 | 283 | 10.5 | 36 | 27.5 | 94 | 21 | 12 |
| **3-phase supply voltage 200 - 240 V units** | | | | | | | | |
| ACS320-03U-02A6-2 | 19 | 65 | 6.1 | 21 | 22.7 | 78 | - | - |
| ACS320-03U-03A9-2 | 31 | 106 | 6.1 | 21 | 22.7 | 78 | - | - |
| ACS320-03U-05A2-2 | 38 | 130 | 9.5 | 32 | 26.4 | 90 | 24 | 14 |
| ACS320-03U-07A4-2 | 60 | 205 | 9.5 | 32 | 26.4 | 90 | 24 | 14 |
| ACS320-03U-08A3-2 | 62 | 212 | 9.5 | 32 | 26.4 | 90 | 21 | 12 |
| ACS320-03U-10A8-2 | 83 | 283 | 10.5 | 36 | 27.5 | 94 | 21 | 12 |
| ACS320-03U-14A6-2 | 112 | 383 | 10.5 | 36 | 27.5 | 94 | 52 | 31 |
| ACS320-03U-19A4-2 | 152 | 519 | 10.5 | 36 | 27.5 | 94 | 52 | 31 |
| ACS320-03U-26A8-2 | 250 | 854 | 16.6 | 57 | 35.4 | 121 | 71 | 42 |
| ACS320-03U-34A1-2 | 270 | 922 | 33.4 | 114 | 57.8 | 197 | 96 | 57 |

| Type Code | Heat dissipation | | | | | | Air flow | |
|---|---|---|---|---|---|---|---|---|
| | Main circuit | | Control circuit | | | | | |
| | Rated current | | Min | | Max | | | |
| | W | BTU/Hr | W | BTU/Hr | W | BTU/Hr | $m^3/h$ | $ft^3/min$ |
| ACS320-03U-50A8-2 | 430 | 1469 | 33.4 | 114 | 57.8 | 197 | 96 | 57 |
| **3-phase supply voltage 380 - 480 V units** | | | | | | | | |
| ACS320-03U-01A2-4 | 11 | 38 | 6.6 | 23 | 24.4 | 83 | - | - |
| ACS320-03U-01A9-4 | 16 | 55 | 6.6 | 23 | 24.4 | 83 | - | - |
| ACS320-03U-02A4-4 | 21 | 72 | 9.8 | 33 | 28.7 | 98 | 13 | 8 |
| ACS320-03U-03A3-4 | 31 | 106 | 9.8 | 33 | 28.7 | 98 | 13 | 8 |
| ACS320-03U-04A1-4 | 40 | 137 | 9.8 | 33 | 28.7 | 98 | 13 | 8 |
| ACS320-03U-05A6-4 | 61 | 208 | 9.8 | 33 | 28.7 | 98 | 19 | 11 |
| ACS320-03U-07A3-4 | 74 | 253 | 14.1 | 48 | 32.7 | 112 | 24 | 14 |
| ACS320-03U-08A8-4 | 94 | 321 | 14.1 | 48 | 32.7 | 112 | 24 | 14 |
| ACS320-03U-12A5-4 | 130 | 444 | 12.0 | 41 | 31.2 | 107 | 52 | 31 |
| ACS320-03U-15A6-4 | 173 | 591 | 12.0 | 41 | 31.2 | 107 | 52 | 31 |
| ACS320-03U-23A1-4 | 266 | 908 | 16.6 | 57 | 35.4 | 121 | 71 | 42 |
| ACS320-03U-31A0-4 | 350 | 1195 | 33.4 | 114 | 57.8 | 197 | 96 | 57 |
| ACS320-03U-38A0-4 | 440 | 1503 | 33.4 | 114 | 57.8 | 197 | 96 | 57 |
| ACS320-03U-44A0-4 | 530 | 1810 | 33.4 | 114 | 57.8 | 197 | 96 | 57 |

## Noise

| Frame size | Noise level |
|---|---|
| | dBA |
| R0 | <30 |
| R1 | 50…62 |
| R2 | 50…62 |
| R3 | 50…62 |
| R4 | <62 |

## Terminal and lead-through data for the power cables

| Frame size | Max. cable diameter for NEMA 1 | | U1, V1, W1, U2, V2, W2 | | | | PE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | U1, V1, W1, U2, V2, W2 | | Max. terminal size flexible/rigid | | Tightening torque | | Max. clamp size solid or stranded | | Tightening torque | |
| | mm | in | $mm^2$ | AWG | N·m | lbf·in | $mm^2$ | AWG | N·m | lbf·in |
| R0 | 16 | 0.63 | 4.0/6.0 | 10 | 0.8 | 7 | 25 | 3 | 1.2 | 11 |
| R1 | 16 | 0.63 | 4.0/6.0 | 10 | 0.8 | 7 | 25 | 3 | 1.2 | 11 |
| R2 | 16 | 0.63 | 4.0/6.0 | 10 | 0.8 | 7 | 25 | 3 | 1.2 | 11 |
| R3 | 29 | 1.14 | 10.0/16.0 | 6 | 1.7 | 15 | 25 | 3 | 1.2 | 11 |
| R4 | 35 | 1.38 | 25.0/35.0 | 2 | 2.5 | 22 | 25 | 3 | 1.2 | 11 |

## Terminal and lead-through data for the control cables

| Conductor size | | | | | | Tightening torque | |
|---|---|---|---|---|---|---|---|
| Solid or stranded | | Stranded, with ferrule without plastic sleeve | | Stranded, with ferrule with plastic sleeve | | | |
| Min/Max | Min/Max | Min/Max | Min/Max | Min/Max | Min/Max | | |
| $mm^2$ | AWG | $mm^2$ | AWG | $mm^2$ | AWG | N·m | lbf·in |
| 0.14/1.5 | 26/16 | 0.25/1.5 | 23/16 | 0.25/1.5 | 23/16 | 0.4 | 3.5 |

## Electric power network specification

| | |
|---|---|
| **Voltage ($U_1$)** | 200/208/220/230/240 V AC 1-phase for 200 V AC drives<br>200/208/220/230/240 V AC 3-phase for 200 V AC drives<br>380/400/415/440/460/480 V AC 3-phase for 400 V AC drives<br>±10% variation from converter nominal voltage is allowed as default. |
| **Short-circuit capacity** | Maximum allowed prospective short-circuit current at the input power connection as defined in IEC 60439-1 is 100 kA. The drive is suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes at the drive maximum rated voltage. |
| **Frequency** | 50/60 Hz ± 5%, maximum rate of change 17%/s |
| **Imbalance** | Max. ±3% of nominal phase to phase input voltage |

## Motor connection data

| | |
|---|---|
| **Voltage ($U_2$)** | 0 to $U_1$, 3-phase symmetrical, $U_{max}$ at the field weakening point |
| **Short-circuit protection (IEC 61800-5-1, UL 508C)** | The motor output is short-circuit proof by IEC 61800-5-1 and UL 508C. |
| **Frequency** | 0…500 Hz |
| **Frequency resolution** | 0.01 Hz |
| **Current** | See section *Ratings, types and voltages (for North American market)* on page *364* or *Ratings, types and voltages (for European market)* on page *365*. |
| **Power limit** | $1.5 \cdot P_N$ |

| | |
|---|---|
| **Field weakening point** | 10…500 Hz |
| **Switching frequency** | 4, 8, 12 or 16 kHz |
| **Maximum recommended motor cable length** | R0: 30 m (100 ft), R1…R4: 50 m (165 ft)<br>With output chokes the motor cable length may be extended to 60 m (195 ft) for R0 and 100 m (330 ft) for R1…R4. |

To comply with the European EMC Directive, use the cable lengths specified in the table below for 4 kHz switching frequency. The lengths are given for using the drive with the internal EMC filter or an optional external EMC filter.

| 4 kHz switching frequency | Internal EMC filter | Optional external EMC filter |
|---|---|---|
| **Second environment (category C3 [1])** | 30 m (100 ft) | 30 m (100 ft) minimum |
| **First environment (category C2 [1])** | - | 30 m (100 ft) |

[1] See the new terms in section *Definitions* on page 376.

## Control connection data

| | | | |
|---|---|---|---|
| **Analog inputs X1A: 2 and 5** | Voltage signal, | unipolar | 0 (2)…10 V, $R_{in}$ > 312 kohm |
| | | bipolar | -10…10 V, $R_{in}$ > 312 kohm |
| | Current signal, | unipolar | 0 (4)…20 mA, $R_{in}$ = 100 ohm |
| | | bipolar | -20…20 mA, $R_{in}$ = 100 ohm |
| | Potentiometer reference value (X1A: 4) | | 10 V ± 1%, max. 10 mA, $R$ < 10 kohm |
| | Resolution | | 0.1% |
| | Accuracy | | ±1% |
| **Analog output X1A: 7** | | | 0 (4)…20 mA, load < 500 ohm |
| **Auxiliary voltage X1A: 9** | | | 24 V DC ± 10%, max. 200 mA |
| **Digital inputs X1A: 12…16 (frequency input X1A: 16)** | Voltage | | 12…24 V DC with internal or external supply |
| | Type | | PNP and NPN |
| | Frequency input | | Pulse train 0…16 kHz (X1A: 16 only) |
| | Input impedance | | 2.4 kohm |
| **Relay output X1B: 17…19** | Type | | NO + NC |
| | Max. switching voltage | | 250 V AC / 30 V DC |
| | Max. switching current | | 0.5 A / 30 V DC; 5 A / 230 V AC |
| | Max. continuous current | | 2 A rms |
| **Digital output X1B: 20…21** | Type | | Transistor output PNP |
| | Max. switching voltage | | 30 V DC |
| | Max. switching current | | 100 mA / 30 V DC, short-circuit protected |
| | Frequency | | 10 Hz …16 kHz |
| | Resolution | | 1 Hz |
| | Accuracy | | 0.2% |
| **RS-485 interface X1C: 23…26** | Cable | | Shielded twisted pair, impedance 100…150 ohm |
| | Termination | | Daisy chained bus without drop out lines |
| | Isolation | | Bus interface isolated from the drive |
| | Transfer rate | | 1.2…76.8 kbit/s |
| | Communication type | | Serial, asynchronous, half duplex |
| | Protocol | | Modbus |

## Clearance and creepage distance

The clearance and creepage distance between I/O connections and mains circuit is 5.5 mm, which guarantees safety insulation of overvoltage category 3 (IEC 60664-1).

## Efficiency

Approximately 95 to 98% at nominal power level, depending on the drive size and options

## Degrees of protection

IP20 (cabinet installation) / UL open: Standard enclosure. The drive must be installed in a cabinet to fulfil the requirements for shielding from contact.

IP20 / NEMA 1: Achieved with an option kit including a hood and a connection box.

# Ambient conditions

Environmental limits for the drive are given below. The drive is to be used in a heated indoor controlled environment.

| | **Operation** installed for stationary use | **Storage** in the protective package | **Transportation** in the protective package |
|---|---|---|---|
| **Installation site altitude** | 0 to 2000 m (6600 ft) above sea level (above 1000 m [3300 ft], see section *Derating* on page *366*) | - | - |
| **Air temperature** | -10 to +50 °C (14 to 122 °F). No frost allowed. See section *Derating* on page *366*. | -40 to +70 °C (-40 to +158 °F) | -40 to +70 °C (-40 to +158 °F) |
| **Relative humidity** | 0 to 95% | Max. 95% | Max. 95% |
| | No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases. | | |
| **Contamination levels (IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1)** | No conductive dust allowed. | | |
| | According to IEC 60721-3-3, chemical gases: Class 3C2 solid particles: Class 3S2. The drive must be installed in clean air according to enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust. | According to IEC 60721-3-1, chemical gases: Class 1C2 solid particles: Class 1S2 | According to IEC 60721-3-2, chemical gases: Class 2C2 solid particles: Class 2S2 |
| **Sinusoidal vibration (IEC 60721-3-3)** | Tested according to IEC 60721-3-3, mechanical conditions: Class 3M4 2…9 Hz, 3.0 mm (0.12 in) 9…200 Hz, 10 $m/s^2$ (33 $ft/s^2$) | - | - |
| **Shock (IEC 60068-2-27, ISTA 1A)** | Not allowed during operation. | According to ISTA 1A. Max. 100 $m/s^2$ (330 $ft/s^2$), 11 ms. | According to ISTA 1A. Max. 100 $m/s^2$ (330 $ft/s^2$), 11 ms. |
| **Free fall** | Not allowed | 76 cm (30 in) | 76 cm (30 in) |

## Materials

| | |
|---|---|
| **Drive enclosure** | • PC/ABS 2 mm, PC+10%GF 2.5…3 mm and PA66+25%GF 1.5 mm, all in color NCS 1502-Y (RAL 9002 / PMS 420 C)<br>• hot-dip zinc coated steel sheet 1.5 mm, thickness of coating 20 micrometers<br>• extruded aluminium AlSi. |
| **Package** | Corrugated cardboard. |
| **Disposal** | The drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks.<br>If recycling is not feasible, all parts excluding electrolytic capacitors and printed circuit boards can be landfilled. The DC capacitors contain electrolyte, which is classified as hazardous waste within the EU. They must be removed and handled according to local regulations.<br>For further information on environmental aspects and more detailed recycling instructions, please contact your local ABB distributor. |

## Applicable standards

| | |
|---|---|
| | The drive complies with the following standards: |
| • **IEC/EN 61800-5-1: 2003** | Electrical, thermal and functional safety requirements for adjustable frequency a.c. power drives |
| • **IEC/EN 60204-1: 2006** | Safety of machinery. Electrical equipment of machines. Part 1: General requirements. *Provisions for compliance:* The final assembler of the machine is responsible for installing<br>- an emergency-stop device<br>- a supply disconnecting device. |
| • **IEC/EN 61800-3: 2004** | Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods |
| • **UL 508C** | UL Standard for Safety, Power Conversion Equipment, third edition |

# CE marking

The CE mark is attached to the drive to verify that the drive follows the provisions of the European Low Voltage and EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC, and Directive 2004/108/EC).

## Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004) covers requirements stated for drives. See section *Compliance with EN 61800-3:2004* on page *376*.

# Compliance with EN 61800-3:2004

## Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

*First environment* includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

*Second environment* includes establishments connected to a network not directly supplying domestic premises.

*Drive of category C2:* drive of rated voltage less than 1000 V and intended to be installed and commissioned only by a professional when used in the first environment.

**Note:** A professional is a person or organization having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

Category C2 has the same EMC emission limits as the earlier class first environment restricted distribution. EMC standard IEC/EN 61800-3 does not any more restrict the distribution of the drive, but the using, installation and commissioning are defined.

*Drive of category C3:* drive of rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.

Category C3 has the same EMC emission limits as the earlier class second environment unrestricted distribution.

## Category C2

The emission limits are complied with the following provisions:

1. The optional EMC filter is selected according to the ABB documentation and installed as specified in the EMC filter manual.

2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. Motor cable length maximum 30 m (100 ft) with 4 kHz switching frequency.

**Note:** In a domestic environment, this product may cause radio inference, in which case supplementary mitigation measures may be required.

### Category C3

The immunity performance of the drive complies with the demands of IEC/EN 61800-3, second environment (see page *376* for IEC/EN 61800-3 definitions).

The emission limits are complied with the following provisions:

1. The internal EMC filter is connected (the metal screw at EMC is in place) or the optional EMC filter is installed.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. With the internal EMC filter: motor cable length 30 m (100 ft) with 4 kHz switching frequency.

**Notes:**

- A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.
- It is not allowed to install a drive with the internal EMC filter connected on IT (ungrounded) systems. The supply network becomes connected to ground potential through the EMC filter capacitors which may cause danger or damage the drive.
- It is not allowed to install a drive with the internal EMC filter connected on a corner grounded TN system as this would damage the drive.

## UL marking

See the type designation label for the valid markings of your drive.

The UL mark is attached to the drive to verify that it meets UL requirements.

### UL checklist

**Input power connection** – See section *Electric power network specification* on page *371*.

**Disconnecting device (disconnecting means)** – See *Selecting the supply disconnecting device (disconnecting means)* on page *36*.

**Ambient conditions** – The drives are to be used in a heated indoor controlled environment. See section *Ambient conditions* on page *374* for specific limits.

**Input cable fuses** – For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any applicable local codes. To fulfill this requirement, use the UL classified fuses given in section *Power cable sizes and fuses* on page *367*.

For installation in Canada, branch circuit protection must be provided in accordance with Canadian Electrical Code and any applicable provincial codes. To fulfill this requirement, use the UL classified fuses given in section *Power cable sizes and fuses* on page *367*.

**Power cable selection** – See section *Selecting the power cables* on page *37*.

**Power cable connections** – For the connection diagram and tightening torques, see section *Connecting the power cables* on page *47*.

**Overload protection** – The drive provides overload protection in accordance with the National Electrical Code (US).

## C-Tick marking

See the type designation label for the valid markings of your drive.

C-Tick marking is required in Australia and New Zealand. A C-Tick mark is attached to the drive to verify compliance with the relevant standard (IEC 61800-3:2004 – Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods), mandated by the Trans-Tasman Electromagnetic Compatibility Scheme.

The Trans-Tasman Electromagnetic Compatibility Scheme (EMCS) was introduced by the Australian Communication Authority (ACA) and the Radio Spectrum Management Group (RSM) of the New Zealand Ministry of Economic Development (NZMED) in November 2001. The aim of the scheme is to protect the radio frequency spectrum by introducing technical limits for emission from electrical/electronic products.

For fulfilling the requirements of the standard, see section *Compliance with EN 61800-3:2004* on page *376*.

## RoHS marking

The RoHS mark is attached to the drive to verify that drive follows the provisions of the European RoHS Directive. RoHS = the restriction of the use of certain hazardous substances in electrical and electronic equipment.

15

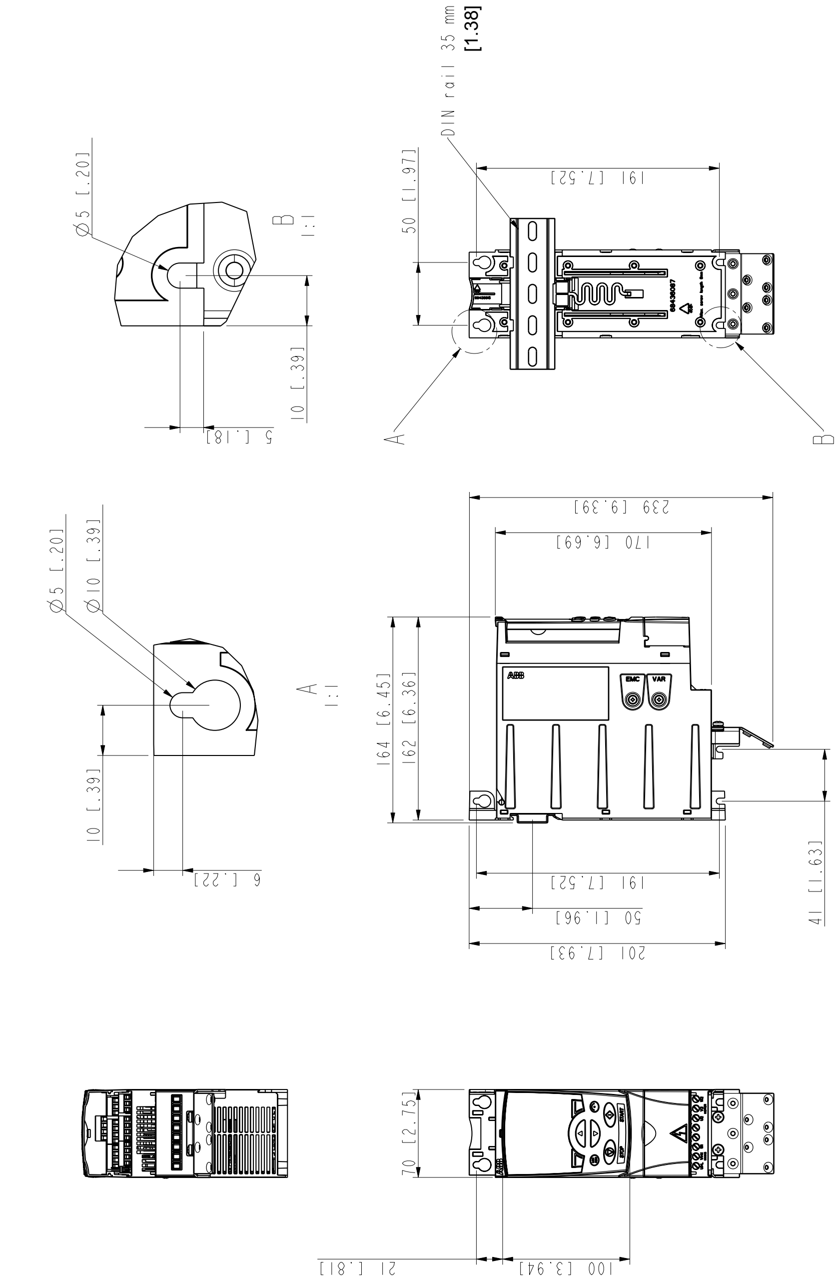
# Dimension drawings

## Contents of this chapter

This chapter contains the dimension drawings of the ACS320. The dimensions are given in millimeters and [inches].

## Frame sizes R0 and R1, IP20 (cabinet installation) / UL open

R1 and R0 are identical except for the fan at the top of R1.

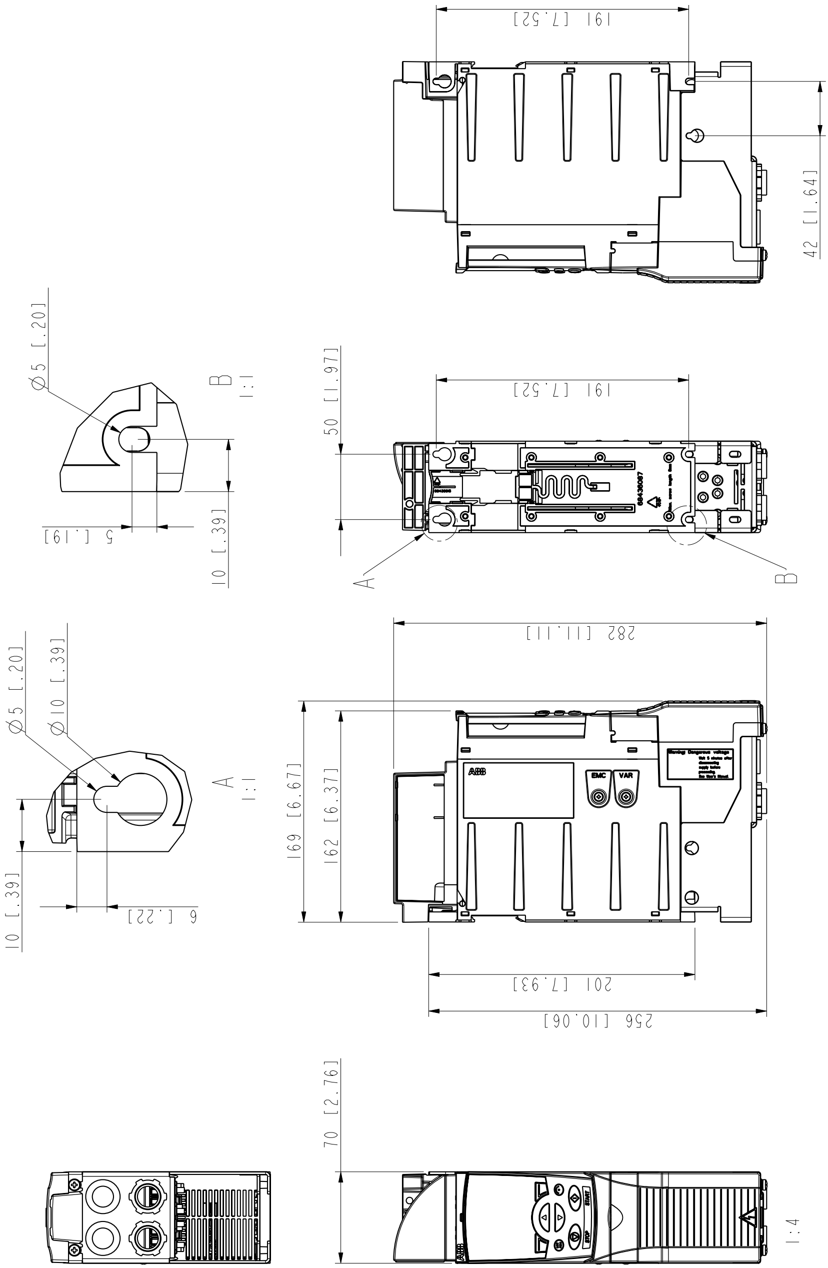



3AUA0000050967-A

Frame sizes R0 and R1, IP20 (cabinet installation) / UL open

## Frame sizes R0 and R1, IP20 / NEMA 1

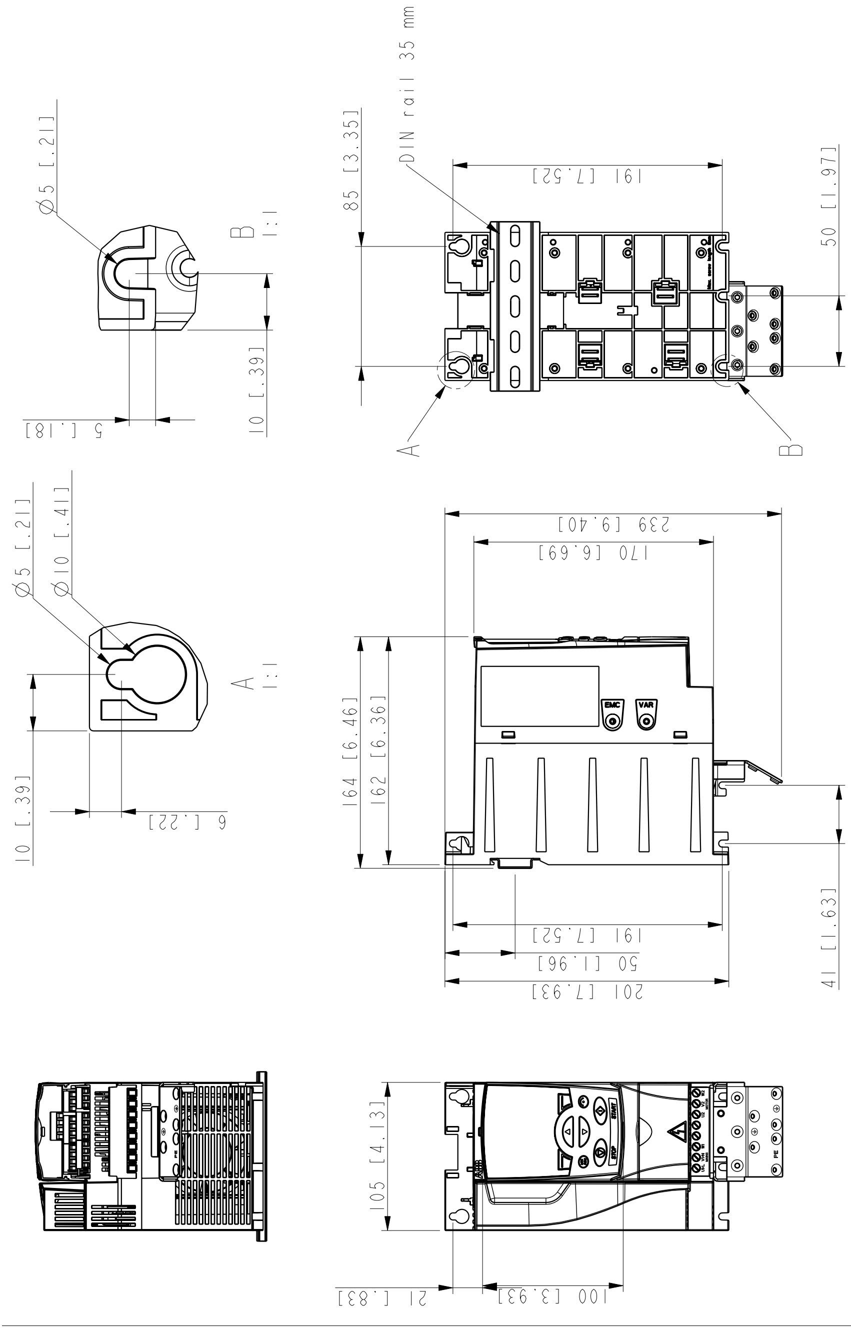
R1 and R0 are identical except for the fan at the top of R1.




Frame sizes R0 and R1, IP20 / NEMA 1

3AUA0000051086-A

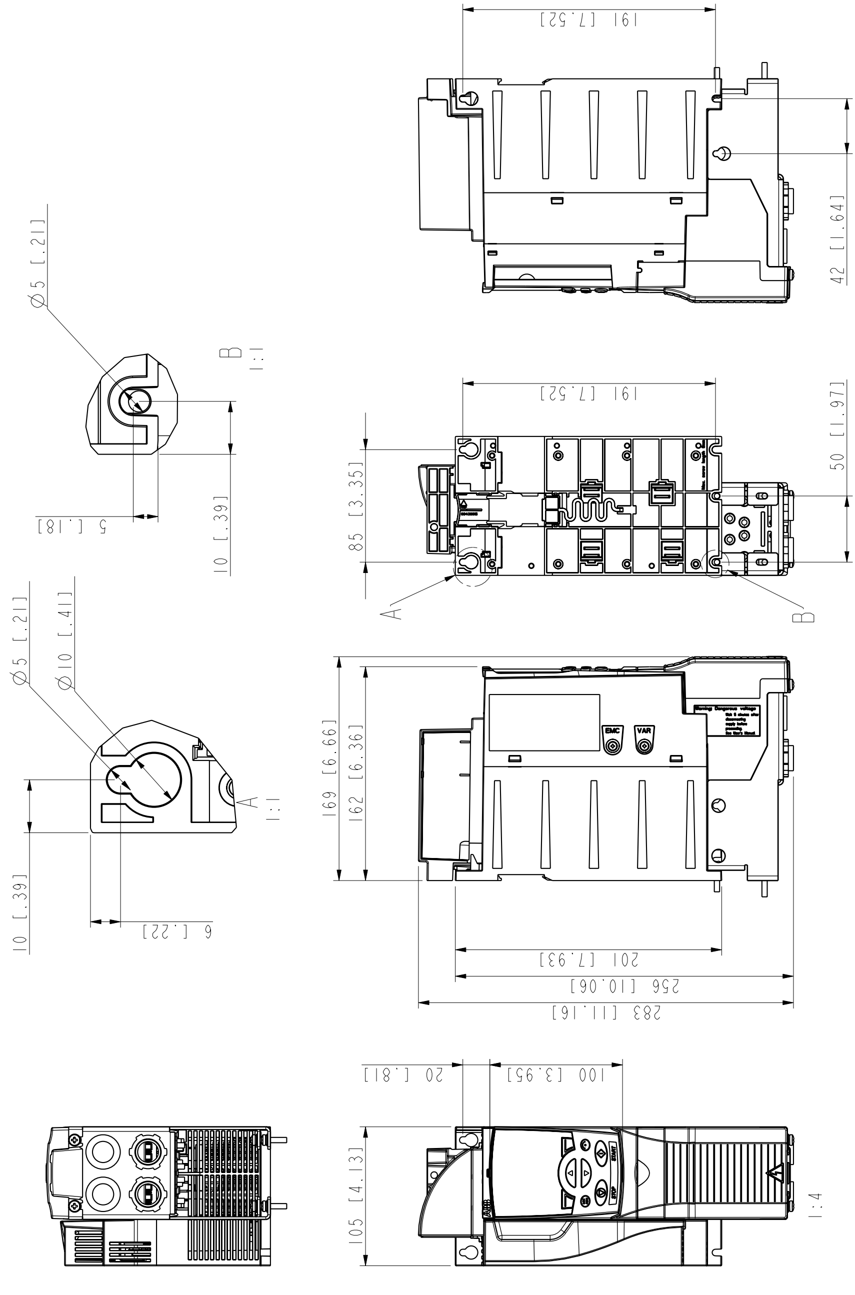
## Frame size R2, IP20 (cabinet installation) / UL open




*Frame size R2, IP20 (cabinet installation) / UL open*

3AUA0000051090-A

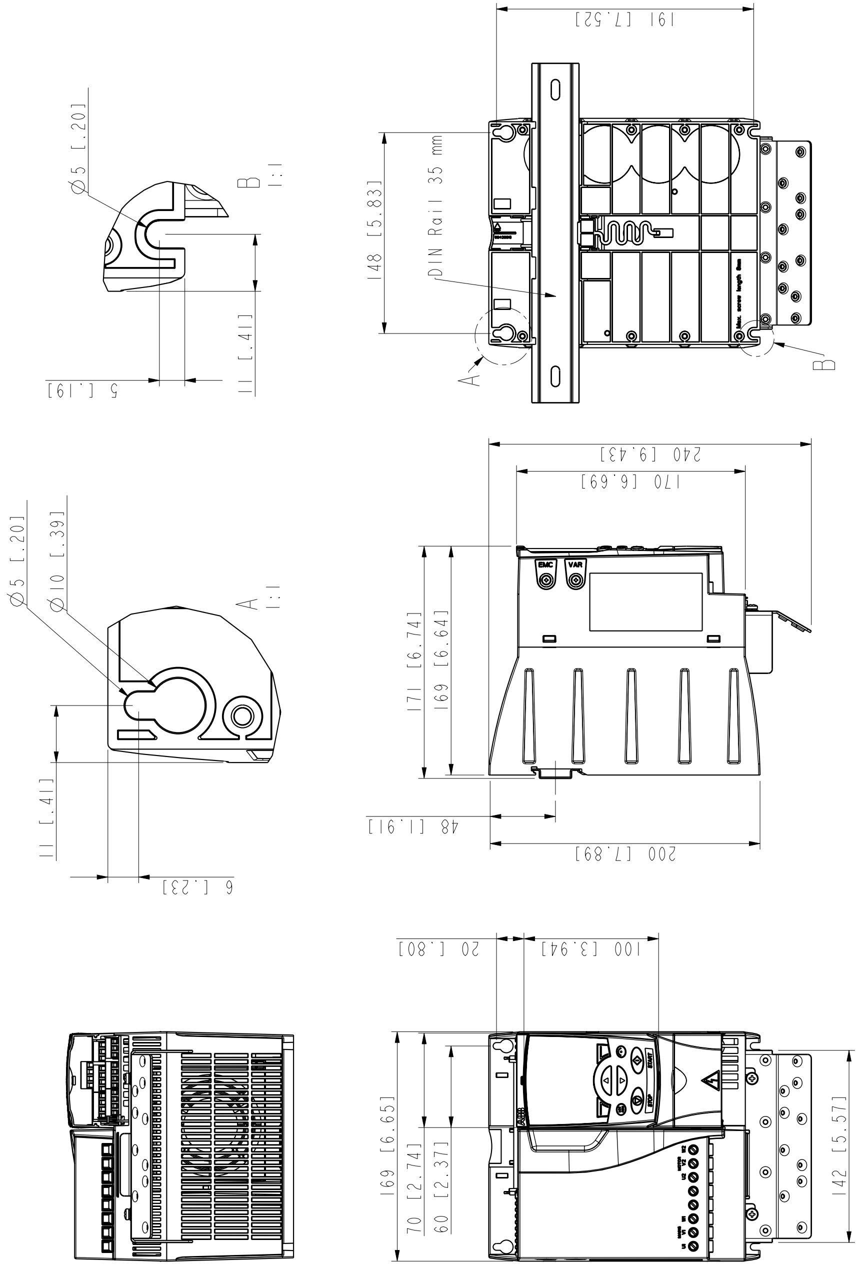
# Frame size R2, NEMA 1




*Frame size R2, IP20 / NEMA 1*

3AUA0000051097-A

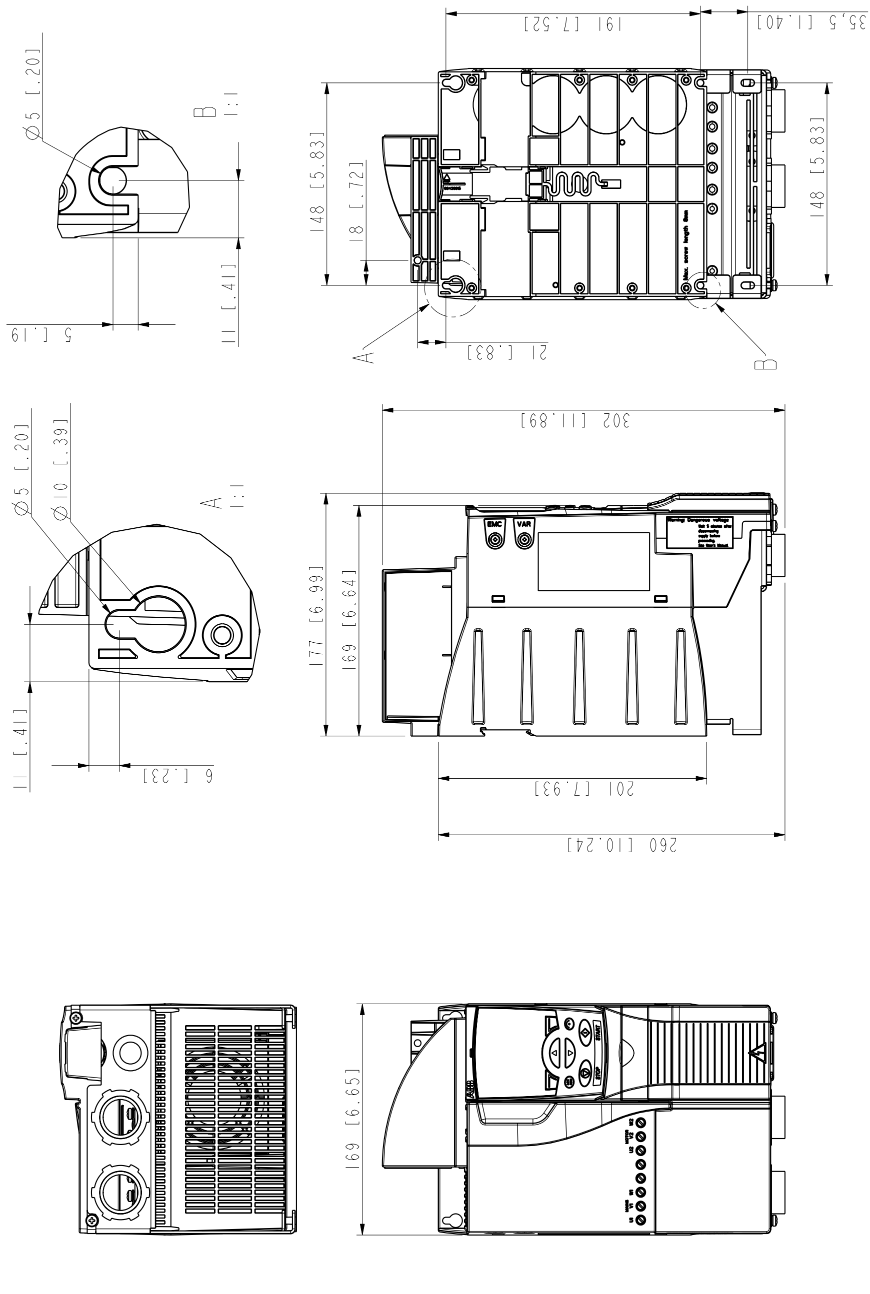
# Frame size R3, IP20 (cabinet installation) / UL open




*Frame size R3, IP20 (cabinet installation) / UL open*

3AUA0000051109-A

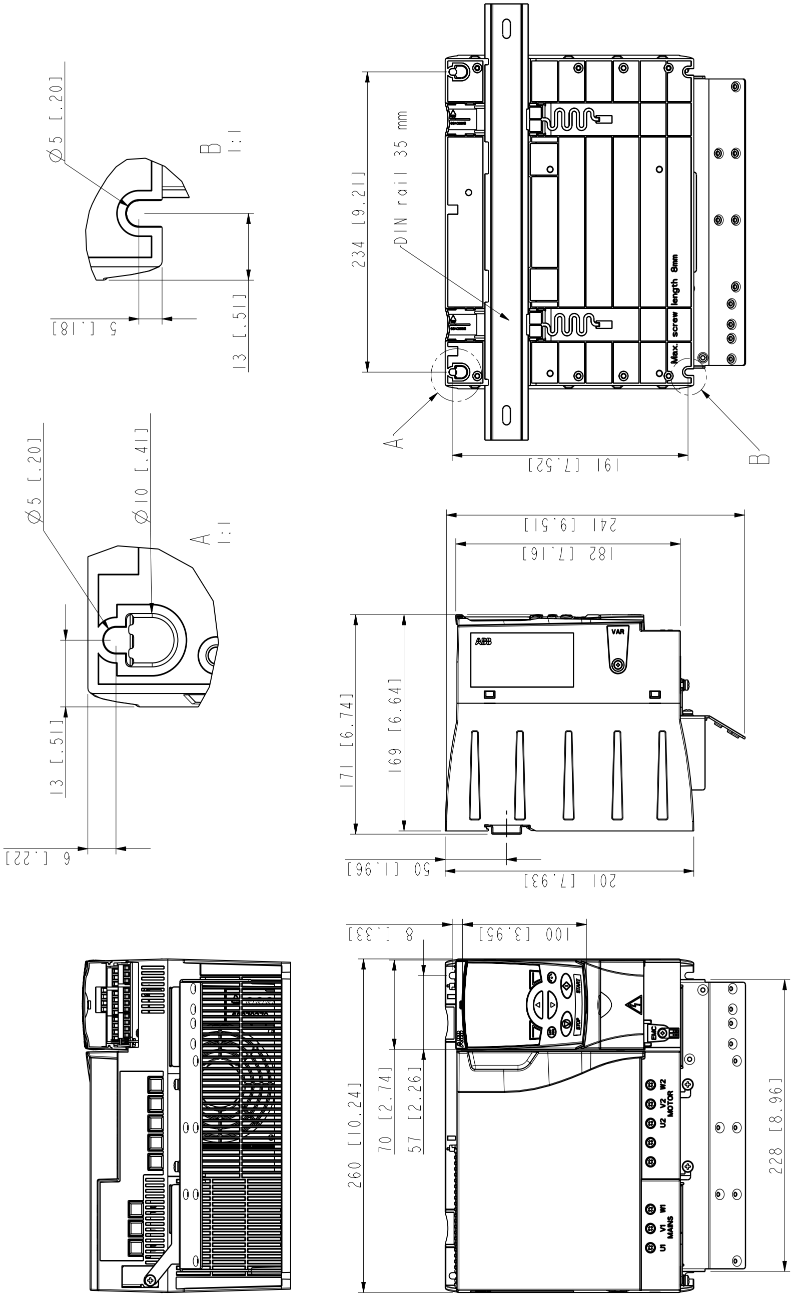
# Frame size R3, NEMA 1




Frame size R3, IP20 / NEMA 1

3AUA0000051118-A

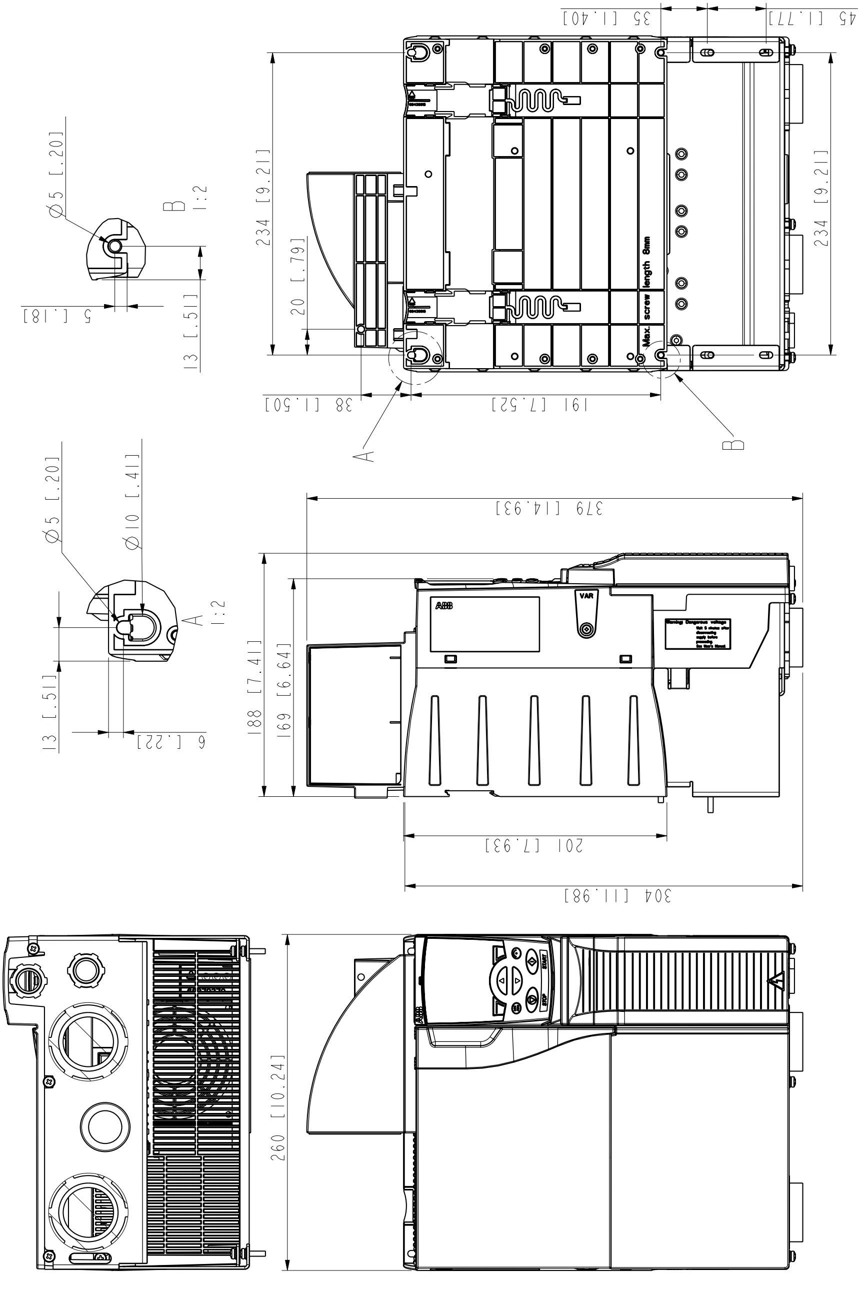
## Frame size R4, IP20 (cabinet installation) / UL open




*Frame size R4, IP20 (cabinet installation) / UL open*

3AUA0000051130-A

# Frame size R4, NEMA 1




Frame size R4, IP20 / NEMA 1

3AUA0000051133-A

# Index

## C

## D

## E

## F

## K



## L



## M

## R

## S

## T

## U

# Further information

## Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

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3AUA0000062599 Rev D (EN) EFFECTIVE: 2014-06-30

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