ACH 400

# User's Manual

ACH 400 AC Drives for Speed Control
of 3 to 40 Hp, 230 Volt and
3 to 50 Hp, 460 Volt
AC Induction Motors

**ABB Automation Inc.**

# ACH 400 AC Drives for Speed Control of AC Induction Motors

## User's Manual

ACH400-US-04

3AUA489002B5311 R0101 Rev E

Effective: 5/15/00

Supersedes: 5/10/00

# Safety

**Warning!** The ACH 400 should ONLY be installed by a qualified electrician.

**Warning!** Dangerous voltages are present when input power is connected. Wait at least 5 minutes after disconnecting the supply before removing the cover. Measure the voltage at DC terminals ($U_{c+}$, $U_{c-}$) before servicing the unit. See Section **E**.

**Warning!** Even when the motor is stopped there are dangerous voltages present at Power Circuit terminals U1, V1, W1 and U2, V2, W2 and $U_{c+}$, $U_{c-}$.

**Warning!** Even when power is removed from the input terminals of the ACH 400, there may be dangerous external voltages at relay terminals RO1A, RO1B, RO1C, RO2A, RO2B, RO2C.

**Warning!** The ACH 400 is not a field repairable unit. Never attempt to repair a broken unit; contact the factory or your local Authorized Service Center for replacement.

**Warning!** The ACH 400 can start up automatically after an input voltage interruption if programmed for Automatic Restart after power outage.

**Warning!** When the control terminals of two or more ACH100/140/400 units are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the units or an external supply.

**Warning!** The heat sink may reach a high temperature. See Section “Drive Overload Protection” on page 20.

**Note!** For more technical information, contact the factory or your local ABB sales representative.

# Table of Contents

# Installation

Study these installation instructions carefully before proceeding. **Failure to observe the warnings and instructions may cause a malfunction or personal hazard.**

## Preparation before installation

To install the ACH 400 you need the following: screwdrivers, wire stripper, tape measure, 4 pieces of 5x12 mm screws or nuts and bolts (depending on the mounting surface), drill.

At this point it is a good idea to check the motor nameplate data and write down the following: supply voltage, nominal current, nominal frequency, and nominal speed.

## Unpacking the unit

The ACH 400 is packed with this User's Manual, Conduit Box, Warning Stickers, and a separate Installation Guide. The Installation Guide gives a summary of the installation instructions described here.

To help you mark the mounting holes for installation of your ACH 400, a Wall Mounting Template is drawn on the lid of the box. Remove the lid from the box and save it.

## Step by step instructions

The installation of the ACH 400 has been broken down in a number of steps that are listed on page 2. The steps must be carried out in the order shown. At the right of each step, reference is made to one or more Reference Sections on the following pages of this User's Manual. These sections give detailed information needed for the correct installation of the unit.

**Warning! Before you begin read all of the Safety instructions.**

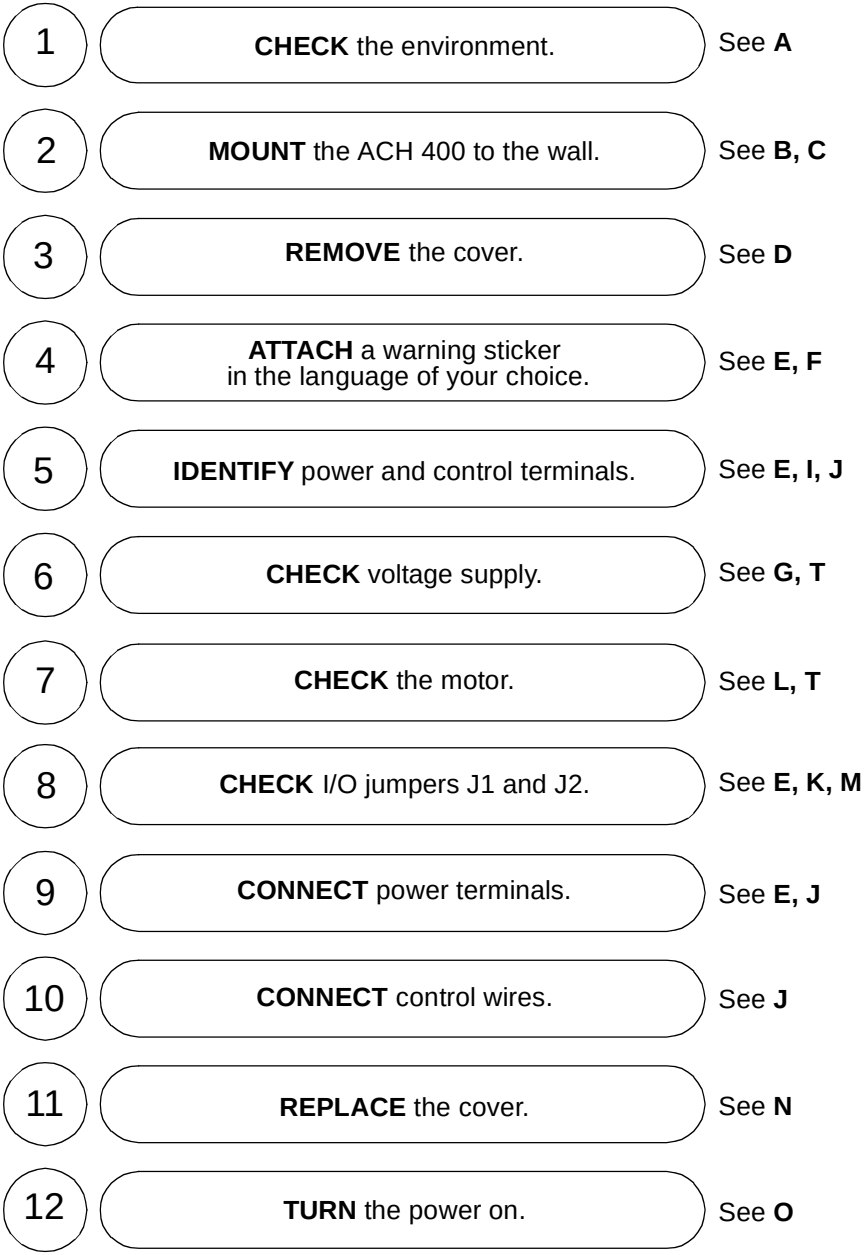



*Figure 1 Step by step instructions for installing the ACH 400. The references after each step refer to one or more of the Reference Sections on the following pages in this manual.*

# Reference Sections

# A Installation Environment

### Stationary Use

- Ambient temperature 32…104 °F (0...40 °C)
- Max. ambient temperature 122 °F (50 °C) if $P_N$ and $I_2$ derated to 90%
- Installation altitude 0…3300 ft (1000 m) if $P_N$ and $I_2$ 100%
- Installation altitude 3300…6600ft (1000...2000 m) if $P_N$ and $I_2$ derated 1% every 330 ft (100 m) above 3300 ft (1000 m)
- Relative humidity less than 95% (non-condensing)

The ACH 400 must be installed in a heated, indoor controlled environment that is suitable for the selected enclosure. Drives are available in either an IP21/NEMA Type 1 or an IP54/NEMA Type 12 enclosure. The drive must be protected from airborne dust, corrosive gases or liquids, and conductive contaminants such as condensation, carbon dust, and metallic particles.

The IP54/NEMA Type 12 enclosure provides protection from airborne dust and light sprays or splashing water from all directions.

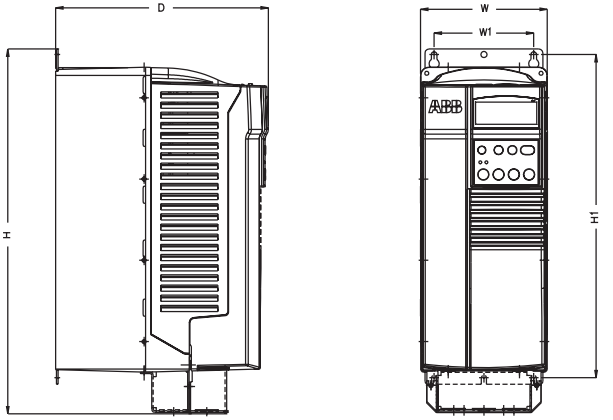
### Storage and Transportation

Storage Temperature -40 ...+158°F (-40...+70°C)

Transportation Temperature -40...+158°F (-40...+70°C)

# B Dimensions (in/mm)

### Units with IP 21/NEMA Type 1 Enclosures



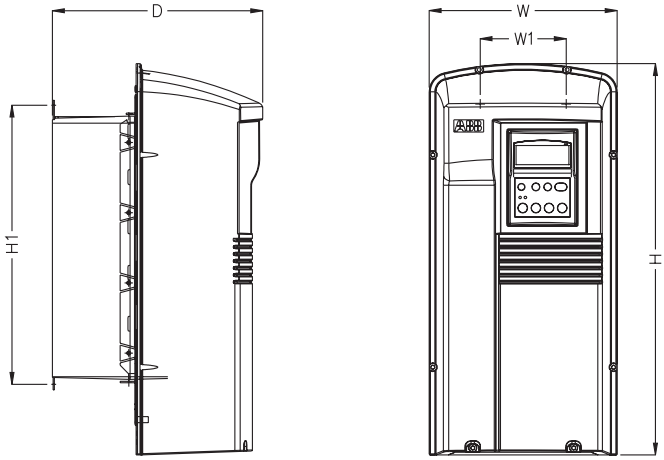

| Dimensions Reference (in/mm) | Frame Size, IP21/NEMA 1 | | | |
|---|---|---|---|---|
| | R1 | R2 | R3 | R4 |
| W | 4.72/120 | 4.96/126 | 7.99/203 | 7.98/203 |
| W1 | 3.86/98 | 3.86/98 | 3.86/98 | 3.86/98 |
| H | 14.14/359 | 18.07/459 | 22.48/571 | 26.08/662 |
| H1 | 12.52/318 | 16.42/417 | 20.79/528 | 24.38/619 |
| D | 8.24/209 | 8.71/221 | 9.77/248 | 11.07/281 |
| Mass (lb/kg) | 12.8/58 | 19.8/9 | 40.8/18.5 | 59.5/27 |

*Figure 2 IP 21/NEMA Type 1 enclosures*

A complete set of dimensional drawings for the NEMA Type 1 ACH 400 drives is located in “Appendix C” on page 133.

## Units with IP 54/NEMA Type 12 & NEMA Type 4 Enclosures

The IP 54/NEMA Type 12 & 4 protection class has a different outer plastic cover. The IP 54/NEMA Type 12 & 4 enclosures use the same internal plastic shell as the IP21 enclosure, but an internal fan is added to improve cooling. This structure increases the dimensions compared to the IP 21 enclosure, but does not require a de-rating.




| Dimensions Reference (in/mm) | Frame Size, IP54/NEMA 12 | | | |
|---|---|---|---|---|
| | R1 | R2 | R3 | R4 |
| W | 8.43/214 | 8.43/214 | 10.09/256 | 10.09/256 |
| W1 | 3.86/98 | 3.86/98 | 3.86/98 | 3.86/98 |
| H | 18.22/463 | 22.08/561 | 26.03/661 | 29.95/761 |
| H1 | 12.52/318 | 16.42/417 | 20.79/528 | 24.38/619 |
| D | 9.43/240 | 8.71/221 | 11.00/280 | 12.20/310 |
| Mass (lb/kg) | 12.8/5.8 | 19.8/9 | 40.8/18.5 | 59.5/27 |

*Figure 3 IP 54/NEMA Type 12 & 4 enclosures*

A complete set of dimensional drawings for the NEMA Type 12 & 4 ACH 400 drives is located in “Appendix C” on page 133.

## C Mounting the ACH 400 on a Wall

**Warning!** Before installing the ACH 400 ensure the input power supply to the drive is off.

### 1

The lid of the packing-box provides a Wall Mounting Template.
Remove the lid from the box.

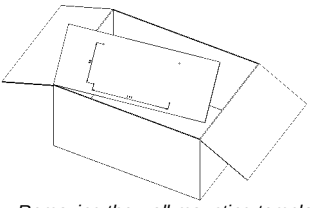


*Figure 4 Removing the wall mounting template.*

### 2

The ACH 400 should only be mounted vertically on a smooth, solid surface, free from heat, dampness, and condensation. Ensure minimum air flow gaps of 8 in (200 mm) above and below, and 2 in (50 mm) around the sides of the unit.

1 Using the mounting template, mark the position of the mounting holes.
2 Drill the holes.
3 Screw in four screws or affix nuts and bolts (depending on the mounting surface).

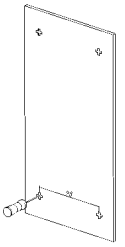


*Figure 5 Marking and drilling the mounting holes.*

### 3

**IP 21**
Position the ACH 400 onto the mounting screws or bolts and securely tighten in all four corners.

**Note! Lift the ACH 400 by its metal chassis.**

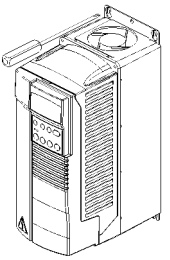


*Figure 6 Mounting type IP21 drives.*

**IP 54**
1 Remove the front cover, see Figure 10.
2 Remove the rubber plugs by pushing from outside.
3 Screw in the screws.
4 Replace the rubber plugs.

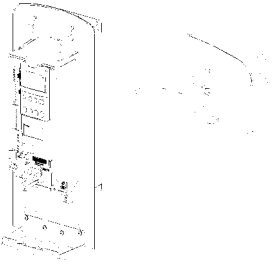


*Figure 7 Mounting type IP54 drives.*

## D Removing the Cover

Opening frame size R1 and R2 units.

See Paragraph T for frame size assignments of type codes.

1 Remove the control panel.
2 Press the retaining lever inside the hole located at the top of the drive.
3 Remove the cover.

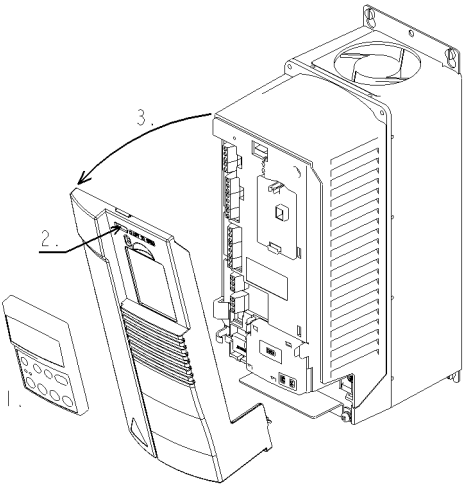
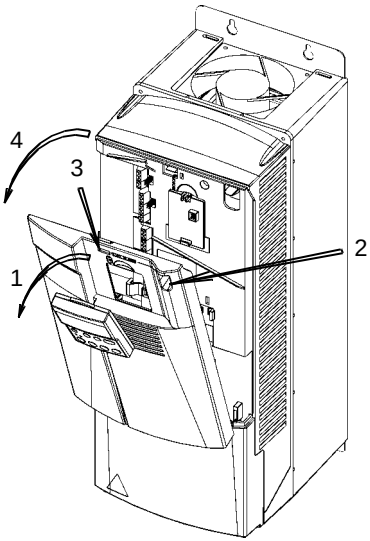


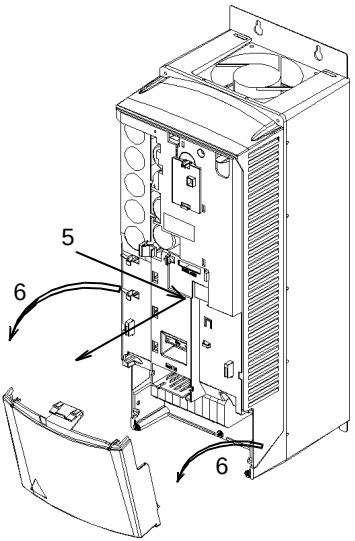

*Figure 8 Opening the frame size R1 and R2 drives of type IP 21/NEMA Type 1.*

Opening frame size R3 and R4 units.

See Paragraph T for frame size assignments of type codes.

1 Remove the control panel if needed.
2 Lift the retaining lever and simultaneously pull the upper front cover slightly.
3 Lift the other retaining lever with a screwdriver.
4 Open the upper part of the front cover and remove it.
5 Press the retaining lever and pull.




6 Remove the lower part of the front cover.

*Figure 9 Opening the frame size R3 and R4 of type IP 21/NEMA Type 1.*

IP 54/NEMA Type 12 & 4

1 Take the screws off.
2 Remove the front cover.
3 Remove panel if needed.

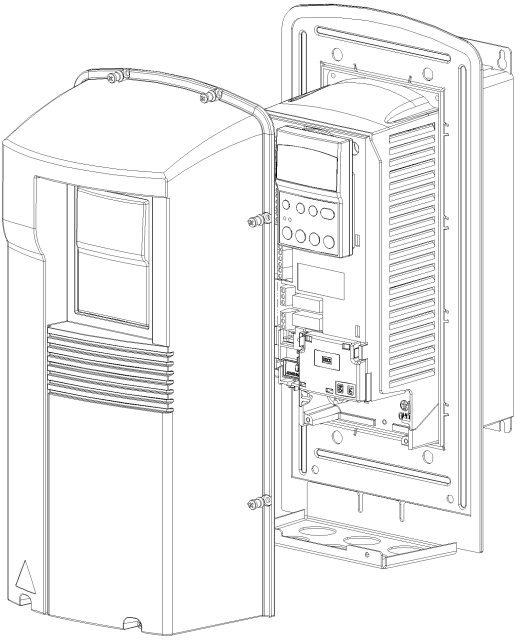


*Figure 10 Opening type IP 54/NEMA Type 12 & 4 drives.*

## E Terminal Interface

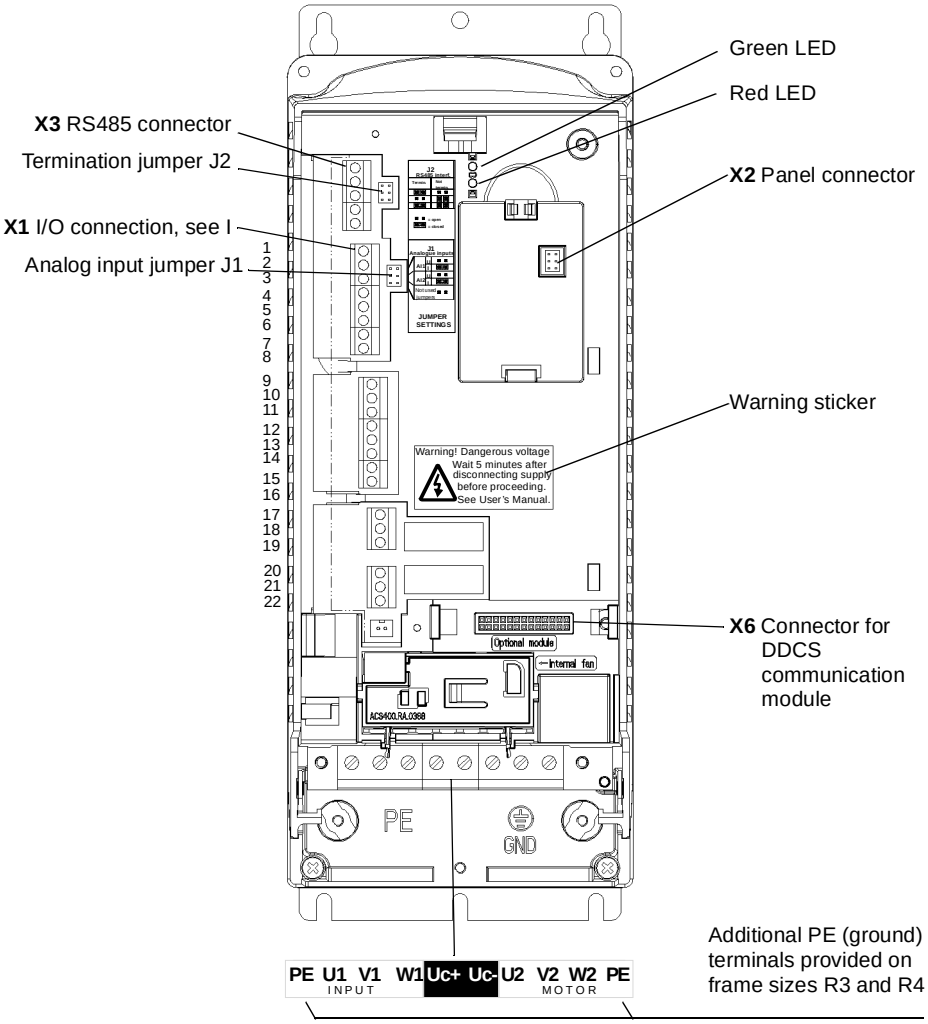



*Figure 11 Terminal Interface.*

## F Attaching a Warning Sticker

The contents of the packing box include warning stickers in different languages. Attach a warning sticker in the language of your choice on the inside plastic shell as indicated above.

## G Type Code and Model Designation

The Type Code Label is attached to the right side of the unit cover, on the heat sink.

| | | | | |
|---|---|---|---|---|
| **ABB Industrial Products** | **Made in USA** | **U1** | 380...480 V | For more information see ACH400 User's |
| **Type** | **ACH401600432** | **U2** | 3 0 - 380...480 V | LISTED 45Y1 |
| **Code** | **63996611** | $I_{1N}$ | 6.2 A | IND. CONT. EQ |
| **Ser.no.** | *1982800001* | $I_{2N}$ | 6.6 A | |
| | | **f1** | 48...63 Hz | |
| | | **f2** | 0...250Hz | *(EXCEPT 230 V)* |

*Figure 12 ACH 400 type designation label.*

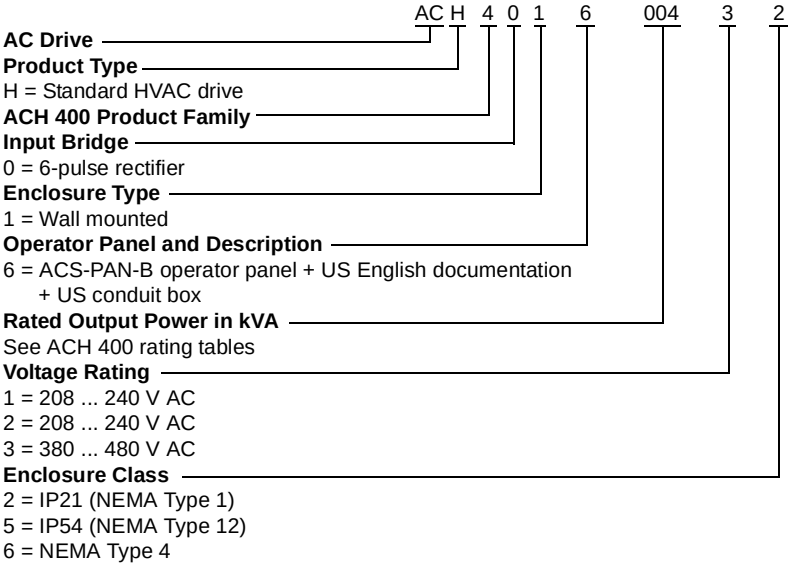



*Figure 13 Type code key.*

A Serial number label is attached on upper part of the chokeplate between mounting holes.

| | | | |
|---|---|---|---|
| **Type** | **ACH401600432** | | |
| **Code** | **63996611** | **Ser.no.** | ***1982800001*** |

*Figure 14 Serial number label.*

## H Floating Network

Make sure that no excessive emission is propagated to neighboring low voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, the supply transformer with static screening between the primary and secondary windings can be used.

**Note! Remove both grounding screws otherwise you may cause danger or damage the unit.** Location of the grounding screws is shown in Figure 15 and Figure 16.

**Note!** In IT networks do not use RFI filter. The input power becomes connected to ground through the filter capacitors. In floating networks this may cause danger or damage the unit.

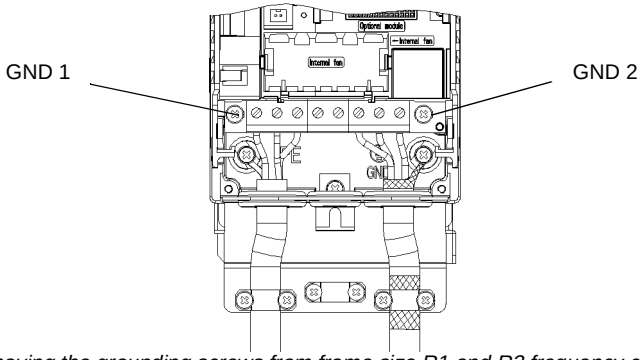



*Figure 15 Removing the grounding screws from frame size R1 and R2 frequency converters.*

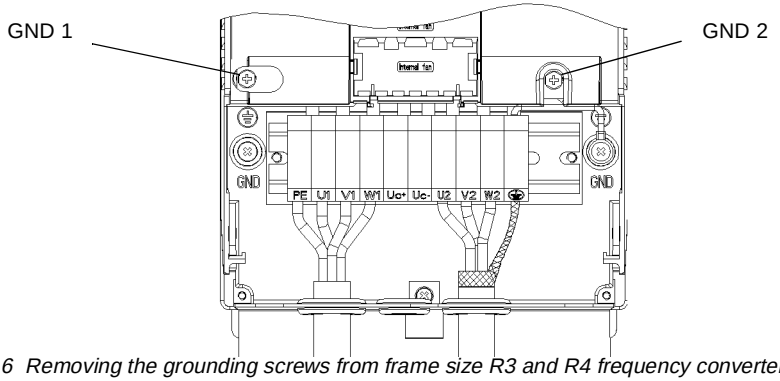



*Figure 16 Removing the grounding screws from frame size R3 and R4 frequency converters.*

# I Installation of ACH 400 Conduit Box

A package, containing one USA conduit box installation kit, is included with the ACH 400. Figures show conduit box installation. IEC conduit plate installation is not covered in the US manual for the ACH 400, please contact your local ABB representative for additional information regarding IEC installations.

For CE installation requirements, see ABB publication CE-US-02 “CE Council Directives and Variable Speed Drives.” Contact your local ABB representative for specific IEC installation instructions.

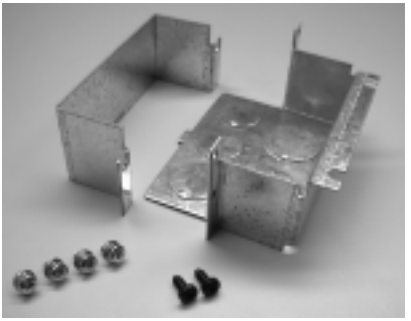


*Figure 17 US conduit box installation kit. Your ACH 400 should include the parts shown above, the 2 halves of the conduit box, 4 screws with captive washers and 2 self tapping screws.*

A different conduit arrangement, containing five screws and two cable clamp brackets, is included with the type IP 54 / NEMA Type 12 & 4 ACH 400 drives. NEMA Type 4 gland plates must be punched for conduit routing holes. In order to maintain the drive’s enclosure rating, use appropriate fittings for all conduit routing.

To open the front cover, see “Removing the Cover” on page 7.

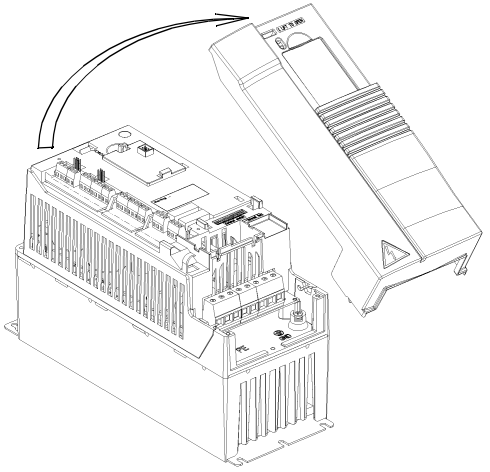


*Figure 18 Removing the front cover.*

**IP 21 / NEMA Type 1**.

Assemble the conduit box by mating the two conduit box halves and securing them with two of the supplied screws with captive washers (assembled box shown in Figure 19). After removing the cover from the drive, position the conduit box as shown below so the holes in the conduit box line up with the appropriate holes in the drive (A).

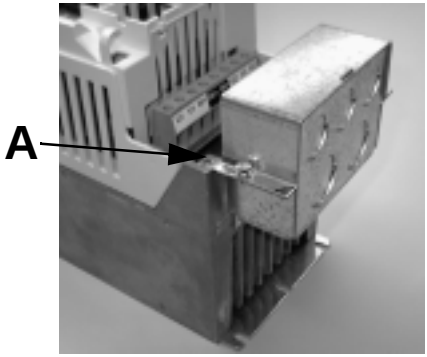



*Figure 19 Positioning the conduit box for type IP 21 / NEMA Type 1 drives.*

Insert the two screws with captive washers into the appropriate hole on each side of the conduit box on the front side of the drive (B).

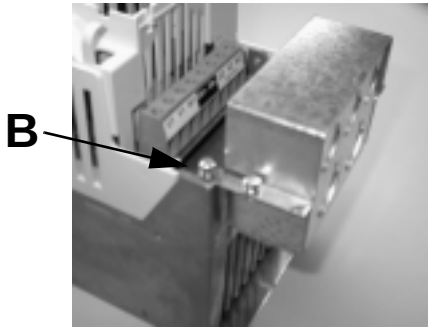



*Figure 20 Conduit with top two screws installed.*

Insert the two self-tapping screws into the two holes on the bottom of the drive (C) and tighten using a powered driver. Take care not to overtighten. Tighten the top two screws and use the supplied knockouts to route the appropriate cables.

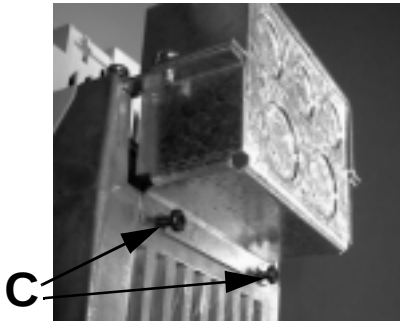



*Figure 21 Conduit box with all screws inserted in the proper holes.*

## J Cable Connections

*Table 4 Cable*

| Terminal | Description | Note |
|---|---|---|
| U1, V1, W1 | 3~ power supply input | Do not use 1~ supply! |
| PE | Protective Ground | Follow local rules for cable size. |
| U2, V2, W2 | Power output to motor | See T. |
| Uc+, Uc– | DC bus | For optional ACS-BRK braking unit. |
| X1 1 to 16 | Control Wiring | Low voltage control – use shielded cable |
| X1 17 to 22 | Control Wiring | Low voltage or 115VAC |
| X3 | RS485 Communications | Use shielded cable |

Follow local codes for cable size. To avoid electromagnetic interference, use separate conduits for input power wiring, motor wiring, control and communications wiring, and braking unit wiring. Keep these four classes of wiring separated in situations where the wiring is not enclosed in conduit. Also keep 115VAC control wiring separated from low voltage control wiring and power wiring.

Use shielded cable for control wiring.

Use 60 °C rated power cable (75 °C if ambient temperature exceeds 45 °C/113 °F).

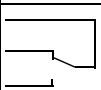
Refer to Section **T** Specifications for current, ratings, fuse recommendations and the maximum wire size capacities and tightening torques for the terminals. The ACH 400 is suitable for use on a circuit capable of delivering not more than 65,000 RMS symmetrical amperes, 480 V maximum. The ACH 400 has an electronic motor protection feature that complies with the requirements of the National Electric Code (USA). When this feature is selected and properly adjusted, additional overload protection is not required unless more than one motor is connected to the drive or unless additional protection is required by applicable safety regulations. See parameters 3004, 3005, and 3006.

For CE installation requirements, see ABB publication CE-US-02 “CE Council Directives and Variable Speed Drives.” Contact your local ABB representative for specific IEC installation instructions.

# K Control Terminals

**Main I/O terminal X1**

.

| X1 | Identification | Description | |
|---|---|---|---|
| 1 | SCR | Terminal for signal cable screen. (Connected internally to chassis ground.) | |
| 2 | AI 1 | Analog input channel 1, programmable.<br>Default: 0 - 10 V ($R_i$ = 200 kΩ) (J1:AI1 open) <=> 0 - $f_{nom}$ frequency reference<br>0 - 20 mA ($R_i$ = 500 Ω) (J1:AI1 closed) <=> 0 - $f_{nom}$ frequency reference<br>Resolution 0.1 % accuracy ±1 %. | |
| 3 | AGND | Analog input circuit common. (Connected internally to chassis ground through 1 MΩ.) | |
| 4 | 10 V | 10 V/10 mA reference voltage output for analog input potentiometer, accuracy ±2 %. | |
| 5 | AI 2 | Analog input channel 2, programmable.<br>Default: 0 - 20 mA ($R_i$ = 500 Ω) (J1:AI2 closed) <=> 0 - $f_{nom}$ frequency reference<br>0 - 10 V ($R_i$ = 200 kΩ) (J1:AI2 open) <=> 0 - $f_{nom}$ frequency reference<br>Resolution 0.1 % accuracy ±1 %. | |
| 6 | AGND | Analog input circuit common. (Connected internally to chassis ground through 1 MΩ.) | |
| 7 | AO1 | Analog output, programmable. Default: 0-20 mA (load < 500 Ω) <=>0-$f_{nom}$ output frequency | |
| 8 | AGND | Common for DI return signals. | |
| 9 | 24 V | Auxiliary voltage output 24 V DC / 250 mA (reference to AGND).<br>Short circuit protected. | |
| 10 | DCOM1 | Digital input common for DI1, DI2 and DI3. | |
| DI Configuration | | To activate a digital input, there must be ≥+10 V (or ≤-10 V) between that input and DCOM1. The 24 V may be provided by the ACH 400 (X1:9) using the connection examples (see Section **M**) or by an external 12-24 V source of either polarity. | |
| | | HVAC Hand-Auto Macro (8) (default) | |
| 11 | DI 1 | AUTO mode Start/Stop Close to start. Motor will ramp up to frequency reference. Open to stop. Motor will coast to stop. | |
| 12 | DI 2 | Run Enable: Close to enable | |
| 13 | DI 3 | Select constant speeds 1 to 7 | |
| 14 | DI 4 | Select constant speeds 1 to 7 | |
| 15 | DI 5 | Select constant speeds 1 to 7 | |
| 16 | DCOM2 | DCOM2 digital input common for DI4, DI5 | |
| 17 | RO1 |  | Relay output 1, programmable (default: fault => 17 connected to 18).<br>12 - 250 V AC / 30 V DC, 10 mA - 2 A |
| 18 | RO1 | | |
| 19 | RO1 | | |
| 20 | RO2 |  | Relay output 2, programmable (default: running => 20 connected to 22).<br>12 - 250 V AC / 30 V DC, 10 mA - 2 A |
| 21 | RO2 | | |
| 22 | RO2 | | |

Digital input impedance 1.5 kΩ.

Use multi-strand 0.5-1.5 $mm^2$ (20-16 AWG) wire.

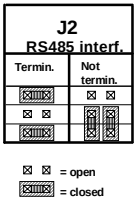
**Note! For safety reasons the fault relay signals a "fault" when the ACH 400 is powered down.**

**Note! DI 4 and 5 are electrically isolated from DI1, 2, and 3. To utilize DI4 and 5, a jumper must be connected. See section M for details.**

**Note! Terminals 3, 6 and 8 are at the same potential.**

**RS485 terminal X3**

| X3 | Description |
|---|---|
| 1 | Screen |
| 2 | B |
| 3 | A |
| 4 | AGND |
| 5 | Screen |




## L Motor

Check for motor compatibility. The motor must be a three-phase induction motor, with input voltage from 208 to 240 V for ACH401-XXXX-2-X or 380 to 480 V for ACH401-XXXX-3-X and $f_N$ either 50 Hz or 60 Hz.

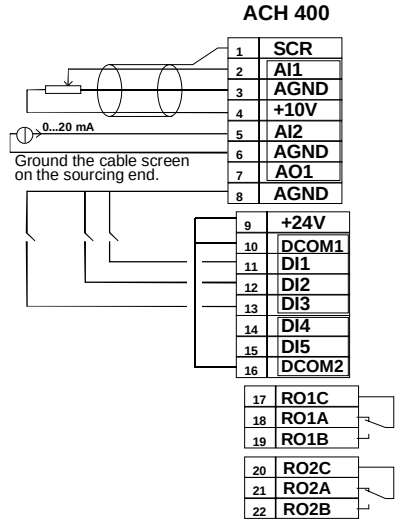
The motor nominal current must be less than the nominal output current of the ACH 400 (See Sections **G** and **T**).

**Warning!** Ensure the motor is compatible for use with the ACH 400. The ACH 400 must be installed by a competent person. **If in doubt, contact your local ABB sales or service office.**

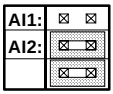
## M Connection Examples

DI configuration for

NPN connection (sink)




**J1 Analog inputs**

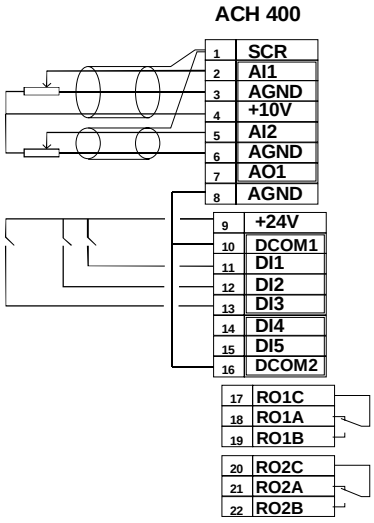



**AI1: 0-10 V**

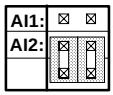
**AI2: 0(4)-20 mA**

DI configuration for

PNP connection (source)



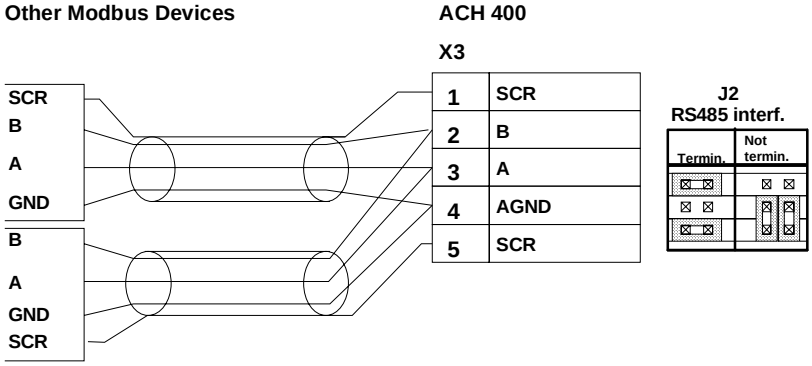

**J1 Analog inputs**




**AI1: 0-10 V**

**AI2: 0-10 V**

RS485 Multidrop application

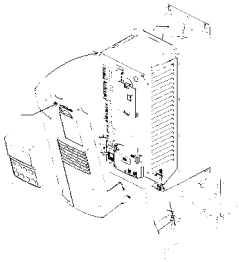


## N Replacing the Cover

Do not turn the power on before replacing the front cover.

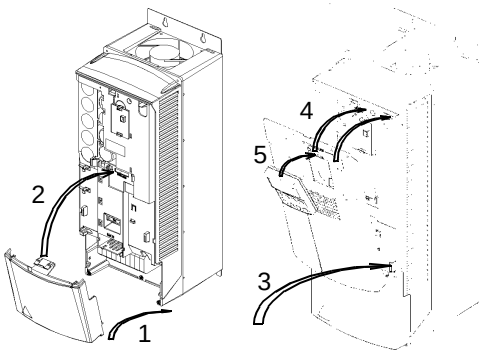
**Replacing the front cover for IP21 / NEMA Type 1:**

1. First locate the bottom mounting clips.
2. Click the retaining lever to its place.
3. Replace the control panel.



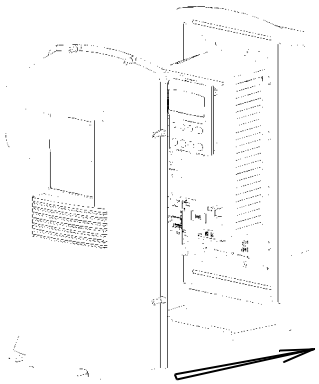
**Replacing the front cover to IP 21/ NEMA Type 1 units from size ACH401-x016-3-x and up.**

1. Hook the bottom end fingers of the lower part of the front cover.
2. Click the retaining lever to its place.
3. Hook the bottom end fingers.
4. Click the retaining levers into place.
5. Replace the control panel if available.




**Replacing the front cover for IP54 / NEMA Type 12:**

1. Replace the control panel.
2. Replace the front cover.
3. Carefully tighten the screws.



## O Applying Power

When power is applied to the ACH 400, the green LED comes on.

**Note! Before increasing motor speed, check that the motor is running in desired direction.**

## P Environmental Information

The package is made of corrugated cardboard and can be recycled.

## Q Protection Features

The ACH 400 has a number of protective features:

- Overcurrent
- Overvoltage
- Undervoltage
- Overtemperature
- Output ground fault
- Output short circuit
- Input phase loss (3~)
- I/O terminal short circuit protection
- Motor overload protection (see Section **R**)
- Output overload protection (see Section **S**)
- Stall protection
- Underload

The ACH 400 has the following LED alarm and fault indicators:

- For location of LEDs, see section E or if ACS-PAN-B control panel is connected, see the instructions on page 25.

| **Red LED: off**<br>**Green LED: blinking** | **ABNORMAL CONDITION** |
|---|---|
| **ABNORMAL CONDITION:**<br>• ACH 400 cannot fully follow control commands.<br>• Blinking lasts 15 seconds. | **POSSIBLE CAUSES:**<br>• Acceleration or deceleration ramp is too fast in relation to load torque requirement<br>• A momentary power interruption |

| **Red LED: on**<br>**Green LED: on** | **FAULT** |
|---|---|
| **ACTION:**<br>• Apply a stop signal to reset fault.<br>• Apply a start signal to restart the drive.<br><br>**NOTE:**<br>If the drive fails to start, check that the input voltage is within the tolerance range. | **POSSIBLE CAUSES:**<br>• Transient overcurrent<br>• Over-/undervoltage<br>• Overtemperature<br><br>**CHECK:**<br>• the supply line for disturbances.<br>• the drive for mechanical problems that might cause overcurrent.<br>• that the heat sink is clean. |

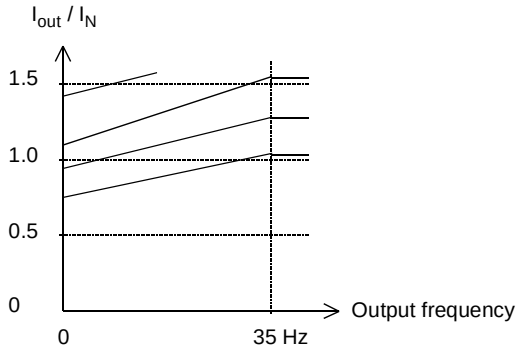
| **Red LED: blinking**<br>**Green LED: on** | **FAULT** |
|---|---|
| **ACTION:**<br>• Turn the power off.<br>• Wait for the LED's to turn off.<br>• Turn the power back on.<br><br>**Caution!** This action may start the drive. | **POSSIBLE CAUSE:**<br>• Output ground fault<br>• Short circuit<br>• DC bus ripple too large<br><br>**CHECK:**<br>• the insulation in the motor circuit. |

**Note! Whenever the ACH 400 detects a fault condition, the fault relay activates. The motor stops and the ACH 400 will wait to be reset. If the fault still persists and no external cause has been identified, contact your local ABB sales or service office.**

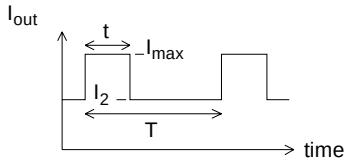
## R Motor Overload Protection

If the motor current $I_{out}$ exceeds nominal current $I_N$ of the motor for a prolonged period, the ACH 400 automatically protects the motor from overheating by tripping.

The trip time depends on the extent of the overload ($I_{out}$ / $I_N$), the output frequency and $f_{nom}$. Times given apply to a “cold start”.

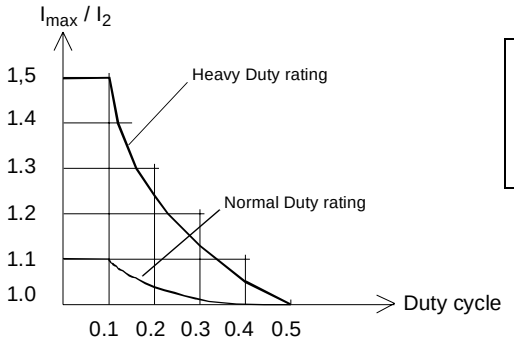



## S Drive Overload Protection




**Duty cycle = t/T**

**T < 10 min**




**Ambient temperature, $\theta_{amb}$ max. is 104 °F (40°C).**

**122 °F (50°C) is permissible, if $I_2$ is derated to 90%.**

## T Specifications

*Notes for the following tables are on page 23.*

| 200V Series | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3~Input 208 - 240V +/- 10% 50/60Hz | ACH401- | 60042 | 60052 | 60062 | 60092 | 60112 | 60162 | 60202 | 60302 | 60412 |
| Frame Size | | R1 | | R2 | | R3 | | R4 | | |
| Nominal Ratings (See G & M) | Unit | | | | | | | | | |
| Nominal Motor $P_N$ Squared Torque | kW<br>Hp | 2.2<br>3 | 4<br>5 | 5.5<br>7.5 | 7.5<br>10 | 11<br>15 | 15<br>20 | 18.5<br>25 | 22<br>30 | 30<br>40 |
| Input Current $I_{1NSQ}$ 3~ | A | 10.6 | 16.7 | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 114.0 |
| Output Current $I_{2NSQ}$ | A | 10.6 | 16.7 | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 114.0 |
| Max. Output Current $I_{2NSQmax}$ | A | 11.7 | 18.4 | 26.6 | 33.9 | 50.8 | 65.3 | 82.3 | 96.8 | 125.4 |
| Nominal Motor $P_N$ Constant Torque and Power | kW<br>Hp | 1.5<br>2 | 2.2<br>3 | 4<br>5 | 5.5<br>7.5 | 7.5<br>10 | 11<br>15 | 15<br>20 | 18.5<br>25 | 22<br>30 |
| Input current $I_{1N}$ 3~ | A | 7.5 | 10.6 | 16.7 | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 |
| Output Current $I_{2N}$ | A | 7.5 | 10.6 | 16.7 | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 |
| Max. Output current $I_{2Nmax}$ | A | 11.3 | 15.9 | 25.1 | 36.3 | 46.2 | 69.3 | 89.1 | 112.2 | 132.0 |
| Output Voltage $U_2$ | V | 0 - $U_1$ | | | | | | | | |
| Switching Frequency | kHz | 4 (Standard)<br>8 (Low Noise)** | | | | | | | | |
| Protection Limits | | | | | | | | | | |
| Overcurrent (peak) | A | 31.4 | 44.3 | 69.8 | 101.2 | 128.7 | 142.3 | 196.0 | 279.8 | 367.8 |
| Overvoltage:<br>Running<br>Start Inhibit | <br>VDC<br>VDC | 420 VDC (1.35*$U_{DC}$ Nominal @ 240 VAC input)<br>1.25 * $U_{DC}$ Nominal @ 240 VAC | | | | | | | | |
| Undervoltage:<br>Running<br>Start Inhibit | <br>VDC<br>VDC | 182 VDC (0.65 * $U_{DC}$ Nominal @ 208 VAC Input)<br>0.85 * $U_{DC}$ Nominal @ 208 VAC | | | | | | | | |
| Overtemperature | °C | 95 (Heat Sink) | | | | | | | | |
| Max. Wire Sizes and Screw Torque of Connectors | | | | | | | | | | |
| Power Terminals | $mm^2$ | 10, AWG6 (Stranded) / Torque 1.3 - 1.5 Nm | | 10, AWG6 (Stranded) / Torque 1.3 - 1.5 Nm | | 35, AWG2 (Stranded) / Torque 3.2 - 3.7 Nm | | 35, AWG2 (Stranded) / Torque 3.2 - 3.7 Nm | | |
| Control Terminals | $mm^2$ | 0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm | | | | | | | | |
| Line Fuse 3~ | A | 15 | 25 | 30 | 40 | 60 | 80 | 100 | 110 | 150 |
| Bussman Fuse Type | | KTK-15 | KTK-25 | KTK-30 | JJS-40 | JJS-60 | JJS-80 | JJS-100 | JJS-110 | JJS-150 |
| Power Losses | | | | | | | | | | |
| Power Circuit | W | 70 | 110 | 165 | 220 | 330 | 450 | 600 | 740 | 900 |
| Control Circuit | W | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |

| 400V Series | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3~Input 380 - 480V +/- 10% 50/60Hz | ACH401- | x00432 | x00532 | x00632 | x00932 | x01132 | x01632 | x02032 | x02532 | x03032 | x04132 |
| Frame Size | | R1 | | | R2 | | R3 | | R4 | | |
| Nominal Ratings (See G) | Unit | | | | | | | | | | |
| Nominal Motor $P_N$ Normal Duty | Hp | 3.0 | 5.0 | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 |
| Input Current $I_{1NND}$ | A | 6.2 | 8.3 | 11.1 | 14.8 | 21.5 | 29.0 | 35.0 | 41.0 | 56.0 | 68.0 |
| Output Current $I_{2NND}$ | A | 6.6 | 8.8 | 11.6 | 15.3 | 23.0 | 30.0 | 38.0 | 44.0 | 59.0 | 72.0 |
| Max. Output Current $I_{2NNDmax}$* | A | 7.3 | 9.7 | 12.8 | 16.8 | 25.3 | 33 | 42 | 48 | 65 | 79 |
| Nominal Motor $P_N$ Heavy Duty | kW<br>Hp | 2.0 | 3.0 | 5.0 | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 |
| Input current $I_{1N}$ | A | 4.7 | 6.2 | 8.3 | 11.1 | 14.8 | 21.5 | 29 | 35 | 41 | 56 |
| Output Current $I_{2N}$ | A | 4.9 | 6.6 | 7.7 | 11.6 | 15.3 | 23 | 30 | 38 | 44 | 59 |
| Max. Output current $I_{2Nmax}$* | A | 7.4 | 9.9 | 13.2 | 17.4 | 23 | 34 | 45 | 57 | 66 | 88 |
| Output Voltage $V_2$ | V | 0 - $V_1$ | | | | | | | | | |
| Switching Frequency | kHz | 4 (Standard)<br>8 (Low Noise**) | | | | | | | | | |
| Protection Limits | | | | | | | | | | | |
| Overcurrent (peak) | A | 20.3 | 27.5 | 37 | 48 | 64 | 76 | 99 | 125 | 145 | 195 |
| Overvoltage:<br>Running<br>Start Inhibit | <br>VDC<br>VDC | 842 (corresponds to 624 VAC input)<br>661 (in input voltage range 380-415 VAC)<br>765 (in input voltage range 440-480 VAC) | | | | | | | | | |
| Undervoltage:<br>Running<br>Start Inhibit | <br>VDC<br>VDC | 333 (corresponds to 247 VAC input)<br>436 (in input voltage range 380-415 VAC)<br>505 (in input voltage range 440-480 VAC) | | | | | | | | | |
| Overtemperature | °C | 95 (Heat Sink) | | | | | | | | | |
| Max. Cable Length $f_{SW}$=4kHz**** | m | 100 | | | 200 | | 200 | | 200 | | |
| Max. wire sizes and screw torque of connectors | | | | | | | | | | | |
| Power terminals *** | $mm^2$ | 10, AWG6 (stranded)/ Torque 1.3-1.5 Nm | | | | | 16, AWG4 (stranded) / Torque 1.5-1.8 Nm | | 35, AWG2 (stranded) / Torque 3.2-3.7 Nm | | |
| Control terminals | $mm^2$ | 0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm | | | | | | | | | |
| Line fuse 3~ **** | A | 10 | 15 | 15 | 20 | 30 | 40 | 50 | 60 | 80 | 100 |
| Bussman Fuse Type | | KTK-10 | KTK-15 | KTK-15 | KTK-20 | KTK-30 | JJS-40 | JJS-50 | JJS-60 | JJS-80 | JJS-100 |
| Power losses | | | | | | | | | | | |
| Power circuit | W | 90 | 120 | 170 | 230 | 330 | 450 | 560 | 660 | 900 | 1100 |
| Control circuit | W | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |

* Power stages are designed for the continuous $I_{2NND}$ current. These values are valid when the altitude is less than 3300 ft (1000 m) ASL. See S.

** Low noise setting programmable with optional control panel.
For ambient operating temperature 0...40°C, derate $P_N$ and $I_2$ to 80%.

*** Follow local rules for cable size; see J. Shielded motor cable is recommended.

**** Fuse type: UL class CC or T (Bussman Type KTK or JJS).
Use 60°C rated power cable (75°C if $T_{amb}$ above 45°C).

***** Maximum cable lengths listed are based on capacitive coupling between motor wires and from motor wires to ground. It may also be necessary to consider motor insulation requirements related to drive output dv/dt.

## U Product Conformity

The ACH 400 complies with North American standard UL508C.

The ACH 400 (400V Series) complies with European requirements:

- Low Voltage Directive 73/23/EEC with amendments
- EMC Directive 89/336/EEC with amendments

Corresponding declarations and a list of main standards are available on request.

**Note! See ACH 400 EMC instructions.**

An adjustable frequency drive and a Complete Drive Module (CDM) or a Basic Drive Module (BDM), as defined in IEC 61800-2, is not considered as a safety related device mentioned in the Machinery Directive and related harmonized standards. The CDM/BDM/adjustable frequency drive can be considered as a part of safety device if the specific function of the CDM/BDM/adjustable frequency drive fulfills the requirements of the particular safety standard. The specific function of the CDM/BDM/adjustable frequency drive and the related safety standard is mentioned in documentation of the equipment.

# V Accessories

**ACS-100/140/400-EXT**
Extension cable kit for use with the control panel.

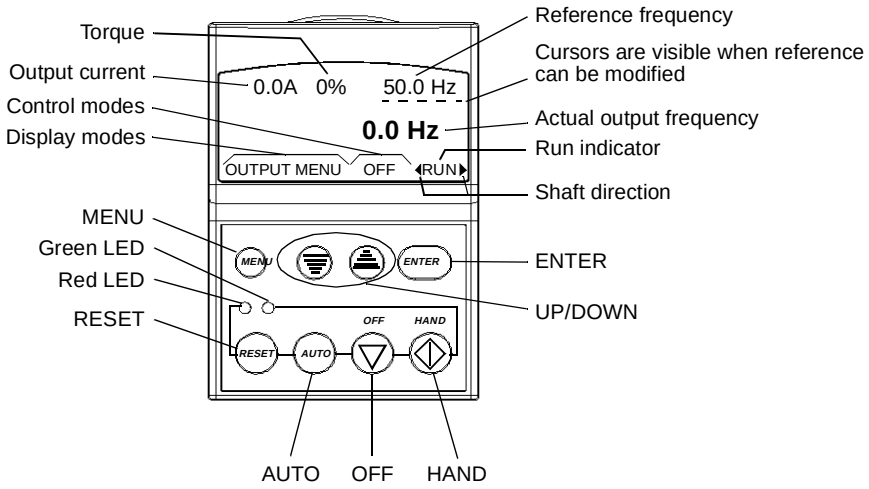
**ACS400-IF11-3 through ACS400-IF41-3**
RFI input filters.

**RS485/232 Adapter**

**DDCS Communication Module**

# Programming
# ACS-PAN-B Control Panel

The ACS-PAN-B is an alphanumeric control panel with a backlit LCD display and multiple languages. The control panel can be connected to and detached from the drive at any time. The panel can be used to copy parameters to other ACH 400 drives with the same software version (Parameter 3301).




## Control Modes

When the HAND key is pressed, the drive starts and the reference frequency can be modified by pressing the UP/DOWN keys. The HAND (keypad) control mode is indicated.

When the OFF key is pressed, the drive stops and the OFF control mode is indicated.

When the AUTO key is pressed, the AUTO mode is indicated. The drive can be started and stopped using whichever remote start/stop command has been configured, a contact closure applied to the Start/Stop input or a serial communication command. The drive speed is controlled by the external speed reference input or by the PID controller.

If the HAND key is pressed while the drive is running in the AUTO control mode, the drive continues to run without changing speed, but ceases to respond to external input or PID speed reference changes. (Bumpless transfer) The reference frequency can be modified by pressing the UP/DOWN keys.

If the AUTO key is pressed while the drive is running in the HAND control mode, the drive continues to run and follows the acceleration or deceleration control ramp to the speed set by the external input or PID speed reference. (Bumpless transfer)

**Run Indication and Shaft Direction**

| | |
|---|---|
| RUN ><br>< RUN | • Drive is running and at set point<br>• Shaft direction is forward (>) or reverse (<) |
| RUN > (or < RUN) Arrow head blinking rapidly | Drive is accelerating / decelerating. |
| > (or <) Arrow head blinking slowly | Drive is stopped. |

## Output Display

When the control panel is powered up, it displays a selection of actual values, as in Figure 22. Whenever the MENU button is pressed and held, the control panel resumes this **OUTPUT** display.

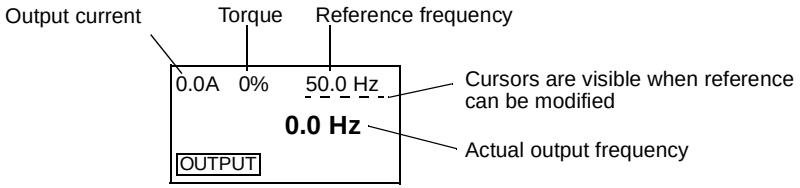


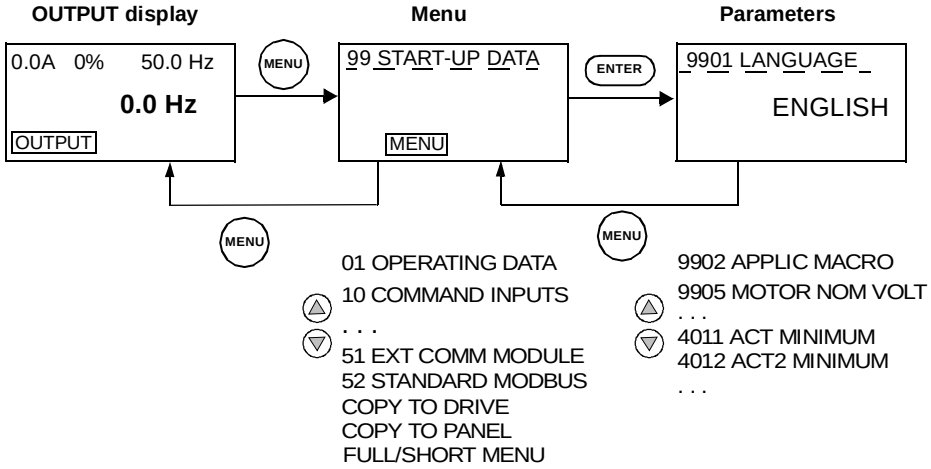

*Figure 22 Output display variables.*

The frequency reference can be modified using UP/DOWN buttons when it is underlined. Pressing UP or DOWN buttons changes the output immediately.

## Menu Structure

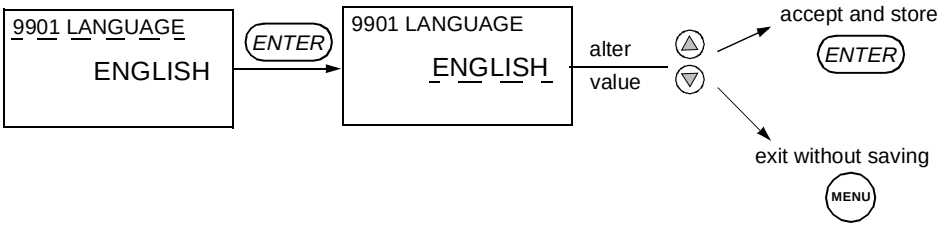
The ACH 400 has a large number of parameters. Of these, only the **basic parameters** are initially visible. See “Selecting Full Parameter Set” on page 28 for details on specifying the full parameter set.

The menu consists of parameter groups and menu functions.



## Setting Parameter Value

The parameter set mode is entered by pressing ENTER. In set mode, the value is underlined. The value is altered by using the UP/DOWN buttons. The modified value is stored by pressing ENTER. Modifications can be cancelled and set mode exited by pressing MENU.




**Note! In the parameter set mode, the cursors blink when the parameter value is altered.**

**Note! To view the parameter default value while in the parameter set mode, press the UP/DOWN buttons simultaneously.**

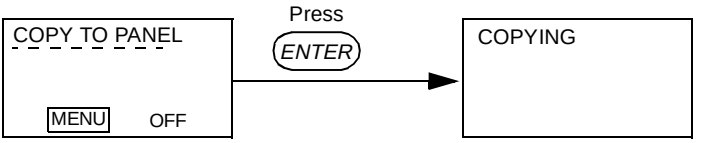
## Adjust the Panel Display Contrast

Simultaneously depressing the ENTER key and the UP/DOWN key will adjust the display contrast.

## Menu Functions

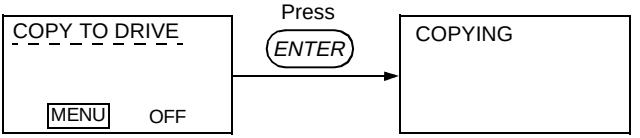
Use the UP/DOWN arrows to scroll through the Menu for the desired menu function, then press and hold ENTER down until the display blinks to start the operation.

### Copy Parameters from Drive to Panel (upload)




**Note! The drive must be OFF. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).**

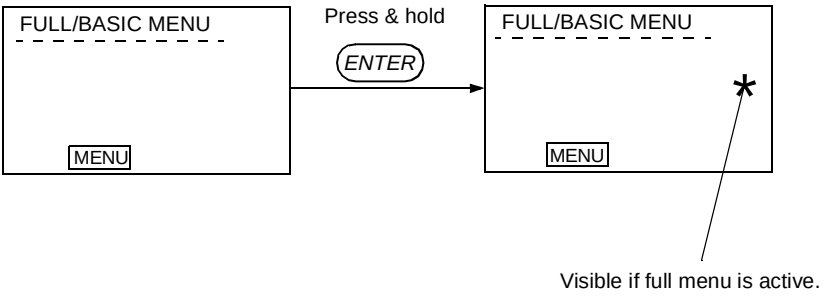
### Copy Parameters from Panel to Drive (download)




**Note! The drive must be OFF. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).**

### Selecting Full Parameter Set

Normally only the basic parameters are visible. When the full Menu is active, an asterisk appears in the second row of the panel display. Removal and reapplication of power automatically alters the menu to the basic parameter set..



## LED Indicators

| Red LED | Green LED | |
|---|---|---|
| OFF | ON | Power ON and drive is operating normally. |
| OFF | BLINKS | Alarm is active. |
| ON | ON | Fault is active. Drive can be reset from the control panel. |
| BLINKS | ON | Fault is active. Turn power off to reset the drive. |

## Resetting the Drive from the Control Panel

When the red LED of the ACS-PAN-B is on or blinking, a fault is active.

To reset a fault when the red LED is on, press the RESET button.
**Caution!** This may start the drive, when in remote control.

To reset a fault when the red LED is blinking, turn the power off.
**Caution!** Turning the power on again may start the drive immediately.

The relevant fault code (see Diagnostics) flashes in the panel display until the fault is reset or the display is “cleared”.

You can “clear” the display without resetting the fault by pressing any button.

**Note! If no other button is pressed within 15 seconds and the fault is still active, the fault code will be displayed again.**

After a power failure, the drive will revert to the same control mode (**Hand** or **Auto**) as before the power failure.

# Diagnostics

The ACS-PAN-B control panel displays the following alarm and fault messages.

Alarms AL1-7 arise from button operation. The green LED blinks for faults greater than AL7, indicating the ACH 400 cannot follow the control command.

*Table 5 Alarms.*

| Code | Message | Description |
|---|---|---|
| AL 1 | OPERATION FAILED | Parameter upload/download failed. |
| AL 2 | START ACTIVE | Operation not allowed while start is active. |
| AL 3 | LOCAL/REMOTE | Operation not allowed in current control mode (Local or Remote). |
| AL 5 | BUTTON DISABLED | Start/Stop/Direction or reference from control panel is not followed. Possible causes:<br>• Remote mode: parameters disable the buttons (see Appendix A).<br>• Local mode: START/STOP button interlocked from digital inputs.<br>• Local mode: Shaft direction is fixed by parameter 1003 DIRECTION. |
| AL 6 | PARAMETER LOCK | Operation not allowed. Parameter 1602 PARAMETER LOCK or 1605 LOCAL LOCK is active. |
| AL 7 | FACTORY MACRO | Use of factory macro disables operation. |
| AL10 | OVERCURRENT | Overcurrent controller active. |
| AL11 | OVERVOLTAGE | Overvoltage controller active. |
| AL12 | DC UNDERVOLTAGE | Undervoltage controller active. |
| AL13 | DIRECTION LOCK | Direction lock. See parameter 1003 DIRECTION. |
| AL14 | SERIAL COMM LOSS | Serial communication loss alarm. |
| AL15 | MODBUS EXCEPTION | Modbus exception response is sent through serial communication. |
| AL16 | AI1 LOSS | Analog input 1 loss. Analog input 1 value is less than MINIMUM AI1 (1301). See parameter 3001 AI<MIN FUNCTION. |
| AL17 | AI2 LOSS | Analog input 2 loss. Analog input 2 value is less than MINIMUM AI2 (1306). See parameter 3001 AI<MIN FUNCTION. |
| AL18 | PANEL LOSS | Panel loss. Panel is disconnected when Start/Stop/Dir or reference is coming from panel. See parameter 3002 and Appendix A. |
| AL19 | ACH400 OVERTEMP | Hardware overtemperature (at 95 % of the trip limit). |
| AL20 | MOTOR OVERTEMP | Motor overtemperature (at 95 % of the trip limit). |
| AL21 | UNDERLOAD | Motor underload alarm. |
| AL22 | MOTOR STALL | Stall alarm. |
| AL23 | DDCS COMM LOSS | DDCS link loss alarm. |
| AL24 | | Reserved. |
| AL25 | MANUAL OFF | Reference is not followed (1605 LOCAL LOCK=1). |
| AL26 | OUTPUT OVERLOAD | If the load is not reduced, the drive will soon trip due to OUTPUT OVERLOAD fault (FL5). |
| AL27 | AUTOMATIC RESET | The drive has stopped due to a fault but will attempt to restart automatically. See parameter Group 31. |
| AL28 | PID SLEEP ACTIVE | The PID sleep feature has stopped the drive. The drive will restart automatically if the PID wake-up conditions are satisfied. |

*Table 6 Faults.*

| Code | Message | Description |
|---|---|---|
| FL 1 | OVERCURRENT | Overcurrent:<br>• Possible mechanical problem.<br>• Acceleration and/or deceleration times may be too short.<br>• Power supply disturbances. |
| FL 2 | DC OVERVOLTAGE | DC overvoltage:<br>• Input voltage too high.<br>• Deceleration time may be too short. |
| FL 3 | ACH400 OVERTEMP | ACH 400 overtemperature:<br>• Ambient temperature too high.<br>• Severe overload. |
| FL 4 * | SHORT CIRCUIT | Fault current:<br>• Short circuit.<br>• Power supply disturbances. |
| FL 5 | OUTPUT OVERLOAD | Output overload. |
| FL 6 | DC UNDERVOLTAGE | DC undervoltage. |
| FL 7 | ANALOG INPUT 1 | Analog input 1 fault. Analog input 1 value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION. |
| FL 8 | ANALOG INPUT 2 | Analog input 2 fault. Analog input 2 value is less than MINIMUM AI2 (1304). See also parameter 3001 AI<MIN FUNCTION. |
| FL 9 | MOTOR OVERTEMP | Motor overtemperature. See parameters 3004-3008. |
| FL10 | PANEL LOSS | Panel loss. Panel is disconnected when Start/Stop/Dir or reference is coming from panel. See parameter 3002 and APPENDIX.<br>**Note!** If FL10 is active when the power is turned off, the ACH 400 will start in remote control (REM) when the power is turned back on. |
| FL11 | PARAMETERING | Parameters inconsistent. Possible fault situations:<br>• MINIMUM AI1 > MAXIMUM AI1 (parameters 1301 and 1302)<br>• MINIMUM AI2 > MAXIMUM AI2 (parameters 1304 and 1305)<br>• MINIMUM FREQ > MAXIMUM FREQ (parameters 2007 and 2008) |
| FL12 | MOTOR STALL | Motor stall. See parameter 3009 STALL FUNCTION. |
| FL13 | SERIAL COMM LOSS | Serial communication loss. |
| FL14 | EXTERNAL FAULT SIGNAL | External fault is active. See parameter 3003 EXTERNAL FAULT. |
| FL15 * | OUTPUT EARTH FAULT | Output ground fault. |
| FL16 * | DC BUS RIPPLE | DC bus ripple too high. Check power supply for phase loss or imbalance. |
| FL17 | UNDERLOAD | Underload. |
| FL18 | | Reserved. |
| FL19 | DDCS LINK | DDCS link fault. |
| FL20 - FL28 * | HARDWARE ERROR | Hardware error. Contact the factory. |
| "COMM LOSS" (ACS-PAN) Serial link failure. Bad connection between the control panel and the ACH 400. | | |

**Note! Faults (*) that are indicated by a red blinking LED are reset by turning the power off and on. Other faults are reset from the control panel. See parameter 1604 FAULT RESET SEL!**

# ACH 400 Basic Parameters

The ACH 400 has a large number of parameters. Of these, only the basic parameters are initially visible.

Setting up only a few basic parameters is sufficient in applications where the ACH 400's preprogrammed application macros can provide all desired functionality. For a full description of programmable features provided by the ACH 400, see "ACH 400 Complete Parameter List", starting on page 43.

The following table lists the basic parameters.

S = Parameters can be modified only when the drive is stopped.

| Code | Name | User | S |
|---|---|---|---|
| **Group 99<br>START-UP DATA** | | | |
| 9901 | **LANGUAGE**<br>Language selection.<br><br>0 = ENGLISH<br>1= ENGLISH (AM)<br>2 = GERMAN<br>3 = ITALIAN<br>4 = SPANISH<br>5 = PORTUGUESE<br>6 = DUTCH<br>7 = FRENCH<br>8 = DANISH<br>9 = FINNISH<br>10 = SWEDISH<br>11 = RUSSIAN<br>12 = (reserved) | | |
| 9902 | **APPLIC MACRO**<br>Selects application macro. Sets parameter values to their default values. Refer to "Application Macros", starting on page 37 for a detailed description of each macro.<br>0 = HVAC<br>1 = HVAC FL PNT<br>2 = HVAC PID<br>3 = HVAC PFC<br>Default value: 0 (HVAC) | | ✓ |
| 9905 | **MOTOR NOM VOLT**<br>Nominal motor voltage from the motor name plate. Range of this parameter depends on the type of the ACH 400.<br>Default value for 400 V unit: 400 V<br>200 V unit: 230 V | | ✓ |
| 9906 | **MOTOR NOM CURR**<br>Nominal motor current from the motor name plate. Values for this parameter range from 0.5* $I_N$ - 1.5* $I_N$, where $I_N$ is nominal current of the ACH 400.<br>Default value: $I_N$ | | ✓ |
| 9907 | **MOTOR NOM FREQ**<br>Nominal motor frequency from the motor name plate.<br>Range: 0 - 250 Hz<br>Default value: 50 Hz | | ✓ |

| Code | Name | User | S |
|---|---|---|---|
| 9908 | **MOTOR NOM SPEED**<br>Nominal motor speed from the motor name plate.<br><br>Range: 0 - 3600 rpm<br>Default: 1440 rpm | | ✓ |
| 9909 | **MOTOR NOM POWER**<br>Nominal motor power from the motor name plate.<br><br>Range: 0.1 - 100.0 kW<br>Default: 2.0 - 30.0 kW depending on the type of the frequency converter | | ✓ |
| 9910 | **MOTOR COS PHI**<br>Nominal motor cos phi from the motor name plate.<br><br>Range: 0.50 - 0.99<br>Default: 0.83 | | ✓ |
| **Group 01**<br>**OPERATING DATA** | | | |
| 0128 | **LAST FAULT**<br>Last recorded fault (0 = no fault). See “Diagnostics”, starting on page 31.<br>Can be cleared with the control panel by pressing the UP and DOWN buttons simultaneously when in parameter set mode. | | |
| **Group 10**<br>**COMMAND INPUTS** | | | |
| 1003 | **DIRECTION**<br>Rotation direction lock.<br><br>1 = FORWARD<br><br>2 = REVERSE<br><br>3 = REQUEST<br><br>If you select REQUEST, the direction is set according to the given direction command.<br>Default: 3 (REQUEST) or 1 (FORWARD) depending on the selected application macro. | | ✓ |
| **Group 11**<br>**REFERENCE SELECT** | | | |
| 1105 | **EXT REF1 MAX**<br>Maximum frequency reference in Hz.<br><br>Range: 0 - 250 Hz<br>Default value: 50 Hz or 52 Hz depending on the selected application macro. | | |
| **Group 12**<br>**CONSTANT SPEEDS** | | | |
| 1202 | **CONST SPEED 1**<br>Range for all constant speeds: 0 - 250.0 Hz<br><br>Default value: 5.0 Hz | | |
| 1203 | **CONST SPEED 2**<br>Default value: 10.0 Hz | | |
| 1204 | **CONST SPEED 3**<br>Default value: 15.0 Hz | | |

| Code | Name | User | S |
|---|---|---|---|
| **Group 13<br>ANALOG INPUTS** | | | |
| 1301 | **MINIMUM AI1**<br>Minimum value of AI1 in percent. Defines relative analog input value where the frequency reference reaches minimum value.<br><br>Range: 0 - 100 %<br>Default value: 0 % | | |
| **Group 15<br>ANALOG OUTPUT** | | | |
| 1503 | **AO CONTENT MAX**<br>Defines output frequency where analog output reaches 20 mA.<br><br>Default value: 50.0 Hz or 52 Hz depending on the selected application macro.<br><br>**Note!** Analog output content is programmable. Values given here are valid only if other analog output configuration parameters have not been modified. A description of all parameters is given in “ACH 400 Complete Parameter List” starting on page 43. | | |
| **Group 20<br>LIMITS** | | | |
| 2003 | **MAX CURRENT**<br>Maximum output current.<br><br>Range: 0.5* $I_N$ - 1.5...1.7* $I_N$ **, where $I_N$ is nominal current of the ACH 400.<br>Default value: 1.5 * $I_N$ | | |
| 2008 | **MAXIMUM FREQ**<br>Maximum output frequency.<br><br>Range: 0 - 250 Hz<br>Default value: 50 Hz or 52 Hz depending on the selected application macro. | | ✓ |

** The maximum factor depending on the type of the frequency converter at 4 kHz switching frequency.

The table continues on the next page.

| Code | Name | User | S |
|---|---|---|---|
| **Group 21 START/STOP** | | | |
| 2102 | **STOP FUNCTION**<br>Conditions during motor stopping.<br>1 = COAST<br>Motor coasts to stop.<br>2 = RAMP<br>Ramp deceleration as defined by the active deceleration time 2203 DECELER TIME 1 or 2205 DECELER TIME 2.<br>Default value: 1 (COAST) | | |
| **Group 22 ACCEL/DECER** | | | |
| 2202 | **ACCEL TIME 1**<br>Ramp 1: time from zero to maximum frequency (0 - MAXIMUM FREQ).<br>The range for all ramp time parameters is 0.1 - 1800 s.<br>Default value: 5.0 s | | |
| 2203 | **DECEL TIME 1**<br>Ramp 1: time from maximum to zero frequency (MAXIMUM FREQ - 0).<br>Default value: 5.0 s | | |
| 2204 | **ACCEL TIME 2**<br>Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ).<br>Default value: 60.0 s | | |
| 2205 | **DECEL TIME 2**<br>Ramp 2: time from maximum to zero frequency (MAXIMUM FREQ - 0).<br>Default value: 60.0 s | | |
| **Group 26 MOTOR CONTROL** | | | |
| 2606 | **U/f RATIO**<br>U/f below field weakening point.<br>1 = LINEAR<br>2 = SQUARE<br>LINEAR is preferred for constant torque applications. SQUARE is preferred for centrifugal pump and fan applications to increase motor efficiency and to reduce motor noise.<br>Default value: 1 (LINEAR) | | ✓ |
| **Group 33 INFORMATION** | | | |
| 3301 | **SW VERSION**<br>Software version code. | | |

S = Parameters can be modified only when the drive is stopped.

# Application Macros

Application Macros are preprogrammed parameter sets. They minimize the number of different parameters that need to be set during start-up. The Factory Macro is the factory-set default macro.

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**Note!** The Factory Macro is intended for applications where there is NO control panel available. It *should not be used* when a control panel is in use because macro dependent parameters cannot be set. With other macros, the control panel is needed.

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### Parameter Values

Selecting an application macro with parameter 9902 APPLIC MACRO will set all other parameters (except the group 99 Start-up Data parameters, the parameter lock 1602 and groups 50 - 52 serial communication parameters) to their default values.

Default values of certain parameters depend on the selected macro. These values are listed with the description of each macro. The default values for other parameters are given in “ACH 400 Complete Parameter List” starting on page 43.

### Connection Examples

In the following connection examples please note:

- All the digital inputs are connected using negative (NPN) logic.

## HVAC Hand-Auto Macro

This macro provides HAND control using the control panel and AUTO control using an external analog reference signal and an external start/stop contact closure.
The value of parameter 9902 is HVAC

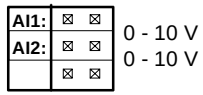
**Input signals**

- AUTO mode Start/Stop (DI1)
- AUTO mode Analog reference (AI1)
- Run Enable (DI2)
- Constant Speed 1 (DI3)

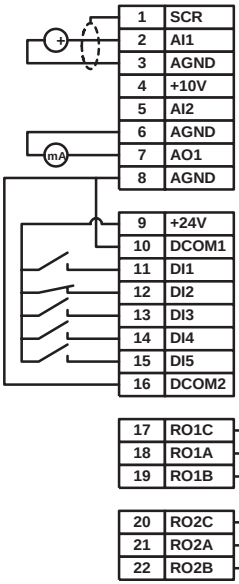
**Output signals**

- Analog Output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

**V/I jumper S1**




Insert jumper(s) for 0(4)-20 mA




**AUTO mode external reference 1: 0 to 10V <=> 0 to 60 Hz**

**Reference voltage 10VDC**
**Not used**

**Output frequency 0 to 20 mA <=> 0 to 60 Hz**

**+24VDC**

**AUTO mode Start/Stop: Activate to start**
**Run Enable: Activate to enable, deactivation always stops**
**Select constant speeds 1 to 7**
**Select constant speeds 1 to 7**
**Select constant speeds 1 to 7**

**Relay output 1, programmable**
**Default: Fault => 17 connected to 18**

**Relay output 2, programmable**
**Default: Running => 20 connected to 22**

HVAC Hand-Auto Macro parameter values:

| | | | |
|---|---|---|---|
| 9901 LANGUAGE | 1 (ENGLISH AM) | 2101 START FUNCTION | 1 (RAMP) |
| 9905 MOTOR NOM VOLT | 230/460 V | 2105 PREMAGN SEL | 0 (NOT SEL) |
| 9907 MOTOR NOM FREQ | 60 Hz | 2107 START INHIBIT | 0 (OFF) |
| 9908 MOTOR NOM SPEED | 1750 rpm | 2201 ACC/DEC 1/2 SEL | 0 (NOT SEL) |
| 1001 EXT 1 COMMANDS | 1 (DI1) | 2202 DECELER TIME 1 | 30 s |
| 1002 EXT 2 COMMANDS | 0 (NOT SEL) | 2203 ACCELER TIME 1 | 30 s |
| 1003 DIRECTION | 1 (FORWARD) | 2603 IR COMPENSATION | 0 V |
| 1102 EXT 1/EXT 2 SEL | 6 (EXT1) | 2606 U/F RATIO | 2 (SQUARE) |
| 1103 EXT REF1 SELECT | 1 (AI1) | 3001 AI<MIN FUNCTION | 0 (NOT SEL) |
| 1105 EXT REF1 MAX | 60 Hz | 3008 BREAK POINT | 15 Hz |
| 1106 EXT REF2 SELECT | 0 (KEYPAD) | 3101 NR OF TRIALS | 2 |
| 1201 CONST SPEED SEL | 10 (DI3, 4, 5) | 3106 AR UNDERVOLTAGE | 1 (ENABLE) |
| 1503 AO CONTENT MAX | 60 Hz | 3107 AR AI<MIN | 1 (ENABLE) |
| 1601 RUN ENABLE | 2 (DI2) | 4001 PID GAIN | 2.5 |
| 1604 FAULT RESET SEL | 0 (KEYPAD) | 4002 PID INTEG TIME | 3 s |
| 2008 MAXIMUM FREQ | 60 Hz | | |

## HVAC Floating Point Macro

This macro provides a cost-effective interface for PLCs that vary the speed of the drive using only digital signals.

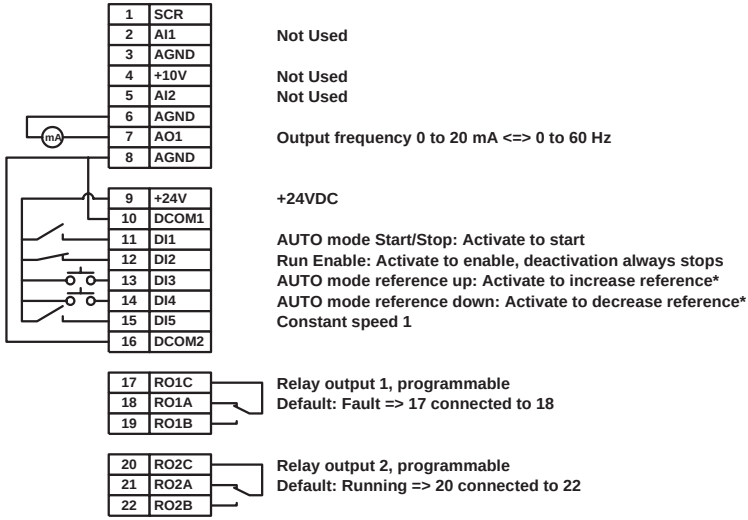
The value of parameter 9902 is HVAC FL PNT.

**Input signals**

- Start/Stop (DI1)
- Run Enable (DI2)
- Reference Up (DI3)
- Reference Down (DI4)
- Preset Speed Selection (DI5)

**Output signals**

- Analog output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running




***Note!**

- **If both DI3 and DI4 are active or inactive, reference is kept stable.**
- **Reference is stored during stop or power down condition.**
- **Analog reference is not followed when motor potentiometer is selected.**

HVAC Floating Point Macro parameter values:

| | | | |
|---|---|---|---|
| 9901 LANGUAGE | 1 (ENGLISH AM) | 2101 START FUNCTION | 1 (RAMP) |
| 9905 MOTOR NOM VOLT | 230/460 V | 2105 PREMAGN SEL | 0 (NOT SEL) |
| 9907 MOTOR NOM FREQ | 60 Hz | 2107 START INHIBIT | 0 (OFF) |
| 9908 MOTOR NOM SPEED | 1750 rpm | 2201 ACC/DEC 1/2 SEL | 0 (NOT SEL) |
| 1001 EXT 1 COMMANDS | 1 (DI1) | 2202 DECELER TIME 1 | 30 s |
| 1002 EXT 2 COMMANDS | 0 (NOT SEL) | 2203 ACCELER TIME 1 | 30 s |
| 1003 DIRECTION | 1 (FORWARD) | 2603 IR COMPENSATION | 0 V |
| 1102 EXT 1/EXT 2 SEL | 6 (EXT1) | 2606 U/F RATIO | 2 (SQUARE) |
| 1103 EXT REF1 SELECT | 6 (DI3U, 4D) | 3001 AI<MIN FUNCTION | 0 (NOT SEL) |
| 1105 EXT REF1 MAX | 60 Hz | 3008 BREAK POINT | 15 Hz |
| 1106 EXT REF2 SELECT | 0 (KEYPAD) | 3101 NR OF TRIALS | 2 |
| 1201 CONST SPEED SEL | 10 (DI5) | 3106 AR UNDERVOLTAGE | 1 (ENABLE) |
| 1503 AO CONTENT MAX | 60 Hz | 3107 AR AI<MIN | 1 (ENABLE) |
| 1601 RUN ENABLE | 2 (DI2) | 4001 PID GAIN | 2.5 |
| 1604 FAULT RESET SEL | 0 (KEYPAD) | 4002 PID INTEG TIME | 3 s |
| 2008 MAXIMUM FREQ | 60 Hz | | |

## HVAC PID Control Macro

This macro is intended for use with closed-loop control systems such as pressure control, flow control, etc. AUTO control regulates the process using an internal PID regulator with external analog reference and feedback signals and an external start/stop contact closure. The control panel is used for HAND control.

The value of parameter 9902 is HVAC PID.

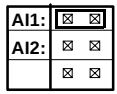
**Input signals**

- AUTO mode Start/Stop (DI1)
- PID Reference (KEYPAD)
- PID Actual Value (AI1)
- Run Enable (DI2)
- Constant Speed (DI3, 4, 5)

**Output signals**

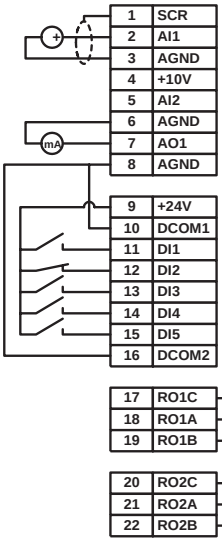
- Analog output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

**V/I jumper S1**




0(4) - 20 mA
0 - 10 V

Insert jumper(s) for 0(4)-20 mA




**Actual signal (transducer feedback): 0 to 20 mA (PID)**

**Reference voltage 10VDC**
**Not used**

**Output frequency 0 to 20 mA <=> 0 to 60 Hz**

**+24VDC**

**AUTO mode Start/Stop: Activate to start**
**Run Enable: Activate to enable, deactivation always stops**
**Select constant speeds 1 to 7 (** not with PID)**
**Select constant speeds 1 to 7 (** not with PID)**
**Select constant speeds 1 to 7 (** not with PID)**

**Relay output 1, programmable**
**Default: Fault => 17 connected to 18**

**Relay output 2, programmable**
**Default: Running => 20 connected to 22**

**Constant Speeds are ignored in PID Mode.
Constant Speed: 0=Open, 1=Connected

| DI3 | DI4 | Output |
|---|---|---|
| 0 | 0 | Keypad |
| 1 | 0 | Cnst Spd 1 (1202) |
| 0 | 1 | Cnst Spd 2 (1203) |
| 1 | 1 | Cnst Spd 2 (1204) |

HVAC PID Control Macro parameter values:

| | | | |
|---|---|---|---|
| 9901 LANGUAGE | 1 (ENGLISH AM) | 2101 START FUNCTION | 1 (RAMP) |
| 9905 MOTOR NOM VOLT | 230/460 V | 2105 PREMAGN SEL | 0 (NOT SEL) |
| 9907 MOTOR NOM FREQ | 60 Hz | 2107 START INHIBIT | 0 (OFF) |
| 9908 MOTOR NOM SPEED | 1750 rpm | 2201 ACC/DEC 1/2 SEL | 0 (NOT SEL) |
| 1001 EXT 1 COMMANDS | 0 (NOT SEL) | 2202 DECELER TIME 1 | 30 s |
| 1002 EXT 2 COMMANDS | 1 (DI1) | 2203 ACCELER TIME 1 | 30 s |
| 1003 DIRECTION | 1 (FORWARD) | 2603 IR COMPENSATION | 0 V |
| 1102 EXT 1/EXT 2 SEL | 7 (EXT2) | 2606 U/F RATIO | 2 (SQUARE) |
| 1103 EXT REF1 SELECT | 1 (AI1) | 3001 AI<MIN FUNCTION | 3 (LAST SPEED) |
| 1105 EXT REF1 MAX | 60 Hz | 3008 BREAK POINT | 15 Hz |
| 1106 EXT REF2 SELECT | 0 (KEYPAD) | 3101 NR OF TRIALS | 2 |
| 1201 CONST SPEED SEL | 10 (DI3, 4, 5) | 3106 AR UNDERVOLTAGE | 1 (ENABLE) |
| 1503 AO CONTENT MAX | 60 Hz | 3107 AR AI<MIN | 1 (ENABLE) |
| 1601 RUN ENABLE | 2 (DI2) | 4001 PID GAIN | 2.5 |
| 1604 FAULT RESET SEL | 0 (KEYPAD) | 4002 PID INTEG TIME | 3 s |
| 2008 MAXIMUM FREQ | 60 Hz | | |

## HVAC PFC Control Macro

This macro is intended for pump and fan control apllications.
The value of parameter 9902 is HVAC PFC.

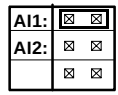
**Input signals**

- Start/Stop (DI1)
- Analog reference (KEYPAD)
- Actual Value (AI1)
- Control Location Selection (DI3)
- Run Enable (DI2)

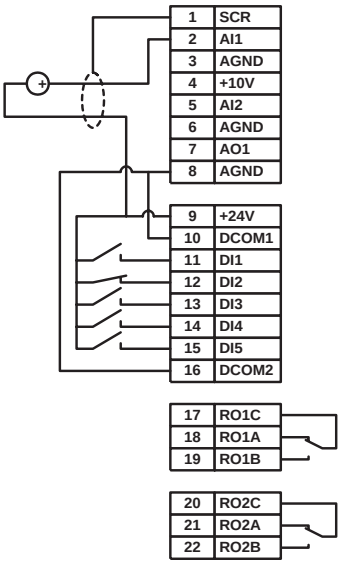
**Output signals**

- Analog output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

**V/I jumper S1**




0(4) - 20 mA
0 - 10 V




**Actual signal (transducer feedback): 0 to 20 mA (PID)**

**Reference voltage 10VDC**
**Not used**

**Output frequency 0 to 20 mA <=> 0 to 60 Hz**

**+24VDC**

**Start/Stop: Activate to start**
**Run Enable: Activate to enable, deactivation always stops**
**EXT1/EXT2 Selection: Activate to select PFC control**
**Interlock: Deactivation stops the drive**
**Interlock: Deactivation stops the constant speed motor**

**Relay output 1, programmable**
**Default: Speed regulated motor switched on**
**=> 17 connected to 18**

**Relay output 2, programmable**
**Default: Aux motor switched on**
**=> 20 connected to 22**

HVAC PFC Control Macro parameter values:

| | | | |
|---|---|---|---|
| 9901 LANGUAGE | 1 (ENGLISH AM) | 1604 FAULT RESET SEL | 0 (KEYPAD) |
| 9905 MOTOR NOM VOLT | 230/460 V | 2008 MAXIMUM FREQ | 62 Hz |
| 9907 MOTOR NOM FREQ | 60 Hz | 2101 START FUNCTION | 1 (RAMP) |
| 9908 MOTOR NOM SPEED | 1750 rpm | 2105 PREMAGN SEL | 0 (NOT SEL) |
| 1001 EXT 1 COMMANDS | 0 (NOT SEL) | 2201 ACC/DEC 1/2 SEL | 0 (NOT SEL) |
| 1002 EXT 2 COMMANDS | 1 (DI1) | 2202 DECELER TIME 1 | 30 s |
| 1003 DIRECTION | 1 (FORWARD) | 2203 ACCELER TIME 1 | 30 s |
| 1102 EXT 1/EXT 2 SEL | 7 (EXT2) | 2603 IR COMPENSATION | 0 V |
| 1103 EXT REF1 SELECT | 1 (AI1) | 2606 U/F RATIO | 2 (SQUARE) |
| 1105 EXT REF1 MAX | 62 Hz | 3001 AI<MIN FUNCTION | 3 (LAST SPEED) |
| 1106 EXT REF2 SELECT | 0 (KEYPAD) | 3008 BREAK POINT | 15 Hz |
| 1201 CONST SPEED SEL | 0 (NOT SEL) | 3101 NR OF TRIALS | 2 |
| 1401 RELAY OUTPUT 1 | 29 (PFC) | 3106 AR UNDERVOLTAGE | 1 (ENABLE) |
| 1402 RELAY OUTPUT 2 | 29 (PFC) | 3107 AR AI<MIN | 1 (ENABLE) |
| 1503 AO CONTENT MAX | 62 Hz | 4001 PID GAIN | 2.5 |
| 1601 RUN ENABLE | 2 (DI2) | 4002 PID INTEG TIME | 3 s |

# ACH 400 Complete Parameter List

Initially, only the so called basic parameters (shaded grey in Table 7) are visible. Use the appropriate menu function of the control panel to make the full parameter set visible.

S = Parameters can be modified only when the drive is stopped.
M = Default value depends on the selected macro (*).

*Table 7 Full parameter set.*

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| **Group 99 START-UP DATA** | | | | | | | |
| 9901 | LANGUAGE | 0 - 12 | 1 | 1 (ENGLISH AM) | | | |
| 9902 | APPLIC MACRO | 0 - 8 | 1 | 0 (HVAC) | | ✓ | |
| 9905 | MOTOR NOM VOLT | 200, 208, 220, 230, 240, 380, 400, 415, 440, 460, 480 V | - | 230 V / 400 V | | ✓ | |
| 9906 | MOTOR NOM CURR | $0.5*I_N$ - $1.5*I_N$ | 0.1 A | $1.0*I_N$ | | ✓ | |
| 9907 | MOTOR NOM FREQ | 0 - 250 Hz | 1 Hz | 50 Hz | | ✓ | |
| 9908 | MOTOR NOM SPEED | 0 - 3600 rpm | 1 rpm | 1440 rpm | | ✓ | |
| 9909 | MOTOR NOM POWER | 0.1 - 100 kW | 0.1 kW | 2 - 30 kW | | ✓ | |
| 9910 | MOTOR COS PHI | 0.50 - 0.99 | 0.01 | 0.83 | | ✓ | |
| **Group 01 OPERATING DATA** | | | | | | | |
| 0102 | SPEED | 0 - 9999 rpm | 1 rpm | - | | | |
| 0103 | OUTPUT FREQ | 0 - 250 Hz | 0.1 Hz | - | | | |
| 0104 | CURRENT | - | 0.1 A | - | | | |
| 0105 | TORQUE | - | 0.1 % | | | | |
| 0106 | POWER | - | 0.1 kW | - | | | |
| 0107 | DC BUS VOLTAGE | 0 - 999.9 V | 0.1 V | - | | | |
| 0109 | OUTPUT VOLTAGE | 0 - 480 V | 0.1 V | - | | | |
| 0110 | ACH400 TEMP | 0 - 150 °C | 0.1 °C | - | | | |
| 0111 | EXTERNAL REF 1 | 0 - 250 Hz | 0.1 Hz | - | | | |
| 0112 | EXTERNAL REF 2 | 0 - 100 % | 0.1 % | - | | | |
| 0113 | CTRL LOCATION | 0 - 2 | 1 | - | | | |
| 0114 | RUN TIME (R) | 0 - 9999 h | 1 h | - | | | |
| 0115 | kWh COUNTER (R) | 0 - 9999 kWh | 1 kWh | - | | | |
| 0116 | APPL BLK OUTPUT | 0 - 100 % | 0.1 % | - | | | |
| 0117 | DI1-DI4 STATUS | 0000 - 1111 (0 - 15 decimal) | 1 | - | | | |
| 0118 | AI1 | 0 - 100 % | 0.1 % | - | | | |
| 0119 | AI2 | 0 - 100 % | 0.1 % | - | | | |
| 0121 | DI5 & RELAYS | 0000 - 0111 (0 - 7 decimal) | 1 | - | | | |
| 0122 | AO | 0 - 20 mA | 0.1 mA | - | | | |
| 0124 | ACTUAL VALUE 1 | 0 - 100 % | 0.1 % | - | | | |
| 0125 | ACTUAL VALUE 2 | 0 - 100 % | 0.1 % | - | | | |
| 0126 | CONTROL DEV | -100 - 100 % | 0.1 % | - | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| 0127 | PID ACT VALUE | 0 - 100 % | 0.1 % | | | | |
| 0128 | LAST FAULT | 0 - 26 | 1 | 0 | | | |
| 0129 | PREVIOUS FAULT | 0 - 26 | 1 | 0 | | | |
| 0130 | OLDEST FAULT | 0 - 26 | 1 | 0 | | | |
| 0131 | SER LINK DATA 1 | 0 - 255 | 1 | | | | |
| 0132 | SER LINK DATA 2 | 0 - 255 | 1 | | | | |
| 0133 | SER LINK DATA 3 | 0 - 255 | 1 | | | | |
| 0134 | PROCESS VAR 1 | 0 - 65535 or -32768 - 32767 | 1 | | | | |
| 0135 | PROCESS VAR 2 | 0 - 65535 or -32768 - 32767 | 1 | | | | |
| 0136 | RUN TIME | 0.00 - 99.99 kh | 0.01 kh | | | | |
| 0137 | MWh COUNTER | 0 - 9999 MWh | 1 MWh | | | | |
| **Group 10 COMMAND INPUTS** | | | | | | | |
| 1001 | EXT1 COMMANDS | 0 - 10 | 1 | * | | ✓ | ✓ |
| 1002 | EXT2 COMMANDS | 0 - 10 | 1 | * | | ✓ | ✓ |
| 1003 | DIRECTION | 1 - 3 | 1 | * | | ✓ | ✓ |
| **Group 11 REFERENCE SELECT** | | | | | | | |
| 1101 | KEYPAD REF SEL | 1 - 2 | 1 | 1 (REF1 (Hz)) | | | |
| 1102 | EXT1/EXT2 SEL | 1 - 8 | 1 | * | | ✓ | ✓ |
| 1103 | EXT REF1 SELECT | 0 - 10 | 1 | * | | ✓ | ✓ |
| 1104 | EXT REF1 MIN | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| 1105 | EXT REF1 MAX | 0 - 250 Hz | 1 Hz | * | | | ✓ |
| 1106 | EXT REF2 SELECT | 0 - 10 | 1 | * | | ✓ | ✓ |
| 1107 | EXT REF2 MIN | 0 - 100 % | 1 % | 0 % | | | |
| 1108 | EXT REF2 MAX | 0 - 500 % | 1 % | 100 % | | | |
| **Group 12 CONSTANT SPEEDS** | | | | | | | |
| 1201 | CONST SPEED SEL | 0 - 10 | 1 | * | | ✓ | ✓ |
| 1202 | CONST SPEED 1 | 0 - 250 Hz | 0.1 Hz | 5 Hz | | | |
| 1203 | CONST SPEED 2 | 0 - 250 Hz | 0.1 Hz | 10 Hz | | | |
| 1204 | CONST SPEED 3 | 0 - 250 Hz | 0.1 Hz | 15 Hz | | | |
| 1205 | CONST SPEED 4 | 0 - 250 Hz | 0.1 Hz | 20 Hz | | | |
| 1206 | CONST SPEED 5 | 0 - 250 Hz | 0.1 Hz | 25 Hz | | | |
| 1207 | CONST SPEED 6 | 0 - 250 Hz | 0.1 Hz | 40 Hz | | | |
| 1208 | CONST SPEED 7 | 0 - 250 Hz | 0.1 Hz | 50 Hz | | | |
| **Group 13 ANALOG INPUTS** | | | | | | | |
| 1301 | MINIMUM AI1 | 0 - 100 % | 1 % | 0 % | | | |
| 1302 | MAXIMUM AI1 | 0 - 100 % | 1 % | 100 % | | | |
| 1303 | FILTER AI1 | 0 - 10 s | 0.1 s | 0.1 s | | | |
| 1304 | MINIMUM AI2 | 0 - 100 % | 1 % | 0 % | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| 1305 | MAXIMUM AI2 | 0 - 100 % | 1 % | 100 % | | | |
| 1306 | FILTER AI2 | 0 - 10 s | 0.1 s | 0.1 s | | | |
| **Group 14 RELAY OUTPUTS** | | | | | | | |
| 1401 | RELAY OUTPUT 1 | 0 - 31 | 1 | * | | ✓ | ✓ |
| 1402 | RELAY OUTPUT 2 | 0 - 31 | 1 | * | | ✓ | ✓ |
| 1403 | RELAY 1 ON DELAY | 0 - 3600 s | 0.1 s; 1 s | 0 s | | | |
| 1404 | RELAY 1 OFF DELAY | 0 - 3600 s | 0.1 s; 1 s | 0 s | | | |
| 1405 | RELAY 2 ON DELAY | 0 - 3600 s | 0.1 s; 1 s | 0 s | | | |
| 1406 | RELAY 2 OFF DELAY | 0 - 3600 s | 0.1 s; 1 s | 0 s | | | |
| **Group 15 ANALOG OUTPUT** | | | | | | | |
| 1501 | AO CONTENT | 102 - 137 | 1 | 103 | | | |
| 1502 | AO CONTENT MIN | | | 0.0 Hz | | | |
| 1503 | AO CONTENT MAX | | | * | | | ✓ |
| 1504 | MINIMUM AO | 0.0 - 20.0 mA | 0.1 mA | 0 mA | | | |
| 1505 | MAXIMUM AO | 0.0 - 20.0 mA | 0.1 mA | 20.0 mA | | | |
| 1506 | FILTER AO | 0 - 10 s | 0.1 s | 0.1 s | | | |
| **Group 16 SYSTEM CONTROLS** | | | | | | | |
| 1601 | RUN ENABLE | 0 - 6 | 1 | * | | ✓ | ✓ |
| 1602 | PARAMETER LOCK | 0 - 2 | 1 | 1 (OPEN) | | | |
| 1604 | FAULT RESET SEL | 0 - 7 | 1 | * | | ✓ | ✓ |
| 1605 | LOCAL LOCK | 0 - 1 | 1 | 0 (OPEN) | | | |
| 1607 | PARAM. SAVE | 0 - 1 | 1 | 0 (DONE) | | | |
| **Group 20 LIMITS** | | | | | | | |
| 2003 | MAX CURRENT | $0.5*I_N$ - $1.5...1.7*I_N$ | 0.1 A | $1.5*I_N$ | | | |
| 2005 | OVERVOLT CTRL | 0 - 1 | 1 | 1 (ENABLE) | | | |
| 2006 | UNDERVOLT CTRL | 0 - 2 | 1 | 1 (ENABLE TIME) | | | |
| 2007 | MINIMUM FREQ | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| 2008 | MAXIMUM FREQ | 0 - 250 Hz | 1 Hz | * | | ✓ | ✓ |
| **Group 21 START/STOP** | | | | | | | |
| 2101 | START FUNCTION | 1 - 4 | 1 | 1 (RAMP) | | ✓ | |
| 2102 | STOP FUNCTION | 1 - 2 | 1 | 1 (COAST) | | | |
| 2103 | TORQ BOOST CURR | $0.5*I_N$ - $1.5...1.7*I_N$ | 0.1 A | $1.2*I_N$ | | ✓ | |
| 2104 | STOP DC INJ TIME | 0 - 250 s | 0.1 s | 0 s | | | |
| 2105 | PREMAGN SEL | 0 - 6 | 1 | * | | ✓ | ✓ |
| 2106 | PREMAGN MAX TIME | 0.0 - 25.0 s | 0.1 s | 2.0 s | | | |
| 2107 | START INHIBIT | 0 - 1 | 1 | 1 (ON) | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| **Group 22 ACCEL/DECEL** | | | | | | | |
| 2201 | ACC/DEC 1/2 SEL | 0 - 5 | 1 | * | | ✓ | ✓ |
| 2202 | ACCELER TIME 1 | 0.1 - 1800 s | 0.1; 1 s | 30 s | | | |
| 2203 | DECELER TIME 1 | 0.1 - 1800 s | 0.1; 1 s | 30 s | | | |
| 2204 | ACCELER TIME 2 | 0.1 - 1800 s | 0.1; 1 s | 60 s | | | |
| 2205 | DECELER TIME 2 | 0.1 - 1800 s | 0.1; 1 s | 60 s | | | |
| 2206 | RAMP SHAPE | 0 - 3 | 1 | 0 (LINEAR) | | | |
| **Group 25 CRITICAL FREQ** | | | | | | | |
| 2501 | CRIT FREQ SEL | 0 - 1 | 1 | 0 (OFF) | | | |
| 2502 | CRIT FREQ 1 LO | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| 2503 | CRIT FREQ 1 HI | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| 2504 | CRIT FREQ 2 LO | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| 2505 | CRIT FREQ 2 HI | 0 - 250 Hz | 1 Hz | 0 Hz | | | |
| **Group 26 MOTOR CONTROL** | | | | | | | |
| 2603 | IR COMPENSATION | 0 - 30 V 200 V units<br>0 - 60 V 400 V units | 1 V | 10 V | | | |
| 2604 | IR COMP RANGE | 0 - 250 Hz | 1 Hz | 50 Hz | | | |
| 2605 | LOW NOISE | 0 - 1 | 1 | 0 (OFF) | | ✓ | |
| 2606 | U/f RATIO | 1 - 2 | 1 | 1 (LINEAR) | | ✓ | |
| 2607 | SLIP COMP RATIO | 0 - 250 % | 1 % | 0 % | | ✓ | |
| **Group 30 FAULT FUNCTIONS** | | | | | | | |
| 3001 | AI<MIN FUNCTION | 0 - 3 | 1 | 1 (FAULT) | | | |
| 3002 | PANEL LOSS | 1 - 3 | 1 | 1 (FAULT) | | | |
| 3003 | EXTERNAL FAULT | 0 - 5 | 1 | 0 (NOT SEL) | | | |
| 3004 | MOT THERM PROT | 0 - 2 | 1 | 1 (FAULT) | | | |
| 3005 | MOT THERM TIME | 256 - 9999 s | 1 s | 500 s | | | |
| 3006 | MOT LOAD CURVE | 50 - 150 % | 1 % | 100 % | | | |
| 3007 | ZERO SPEED LOAD | 25 - 150 % | 1 % | 70 % | | | |
| 3008 | BREAK POINT | 1 - 250 Hz | 1 Hz | 35 Hz | | | |
| 3009 | STALL FUNCTION | 0 - 2 | 1 | 0 (NOT SEL) | | | |
| 3010 | STALL CURRENT | $0.5*I_N$ - $1.5...1.7*I_N$ | 0.1 A | $1.2* I_N$ | | | |
| 3011 | STALL FREQ HI | 0.5 - 50 Hz | 0.1 Hz | 20 Hz | | | |
| 3012 | STALL TIME | 10...400 s | 1 s | 20 s | | | |
| 3013 | UNDERLOAD FUNC | 0 - 2 | 1 | 0 (NOT SEL) | | | |
| 3014 | UNDERLOAD TIME | 10...400 s | 1 s | 20 s | | | |
| 3015 | UNDERLOAD CURVE | 1 - 5 | 1 | 1 | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| **Group 31 AUTOMATIC RESET** | | | | | | | |
| 3101 | NR OF TRIALS | 0 - 5 | 1 | 0 | | | |
| 3102 | TRIAL TIME | 1.0 - 180.0 s | 0.1 s | 30 s | | | |
| 3103 | DELAY TIME | 0.0 - 3.0 s | 0.1 s | 0 s | | | |
| 3104 | AR OVERCURRENT | 0 - 1 | 1 | 0 (DISABLE) | | | |
| 3105 | AR OVERVOLTAGE | 0 - 1 | 1 | 0 (DISABLE) | | | |
| 3106 | AR UNDERVOLTAGE | 0 - 1 | 1 | 0 (DISABLE) | | | |
| 3107 | AR AI<MIN | 0 - 1 | 1 | 0 (DISABLE) | | | |
| **Group 32 SUPERVISION** | | | | | | | |
| 3201 | SUPERV 1 PARAM | 102 - 137 | 1 | 103 | | | |
| 3202 | SUPERV 1 LIM LO | | | 0.0 Hz | | | |
| 3203 | SUPERV 1 LIM HI | | | 0.0 Hz | | | |
| 3204 | SUPERV 2 PARAM | 102 - 137 | 1 | 103 | | | |
| 3205 | SUPERV 2 LIM LO | | | 0.0 Hz | | | |
| 3206 | SUPERV 2 LIM HI | | | 0.0 Hz | | | |
| **Group 33 INFORMATION** | | | | | | | |
| 3301 | SW VERSION | 0.0.0.0 - f.f.f.f | - | - | | | |
| 3302 | TEST DATE | yy.ww | - | - | | | |
| **Group 34 PROCESS VARIABLES** | | | | | | | |
| 3401 | DISPLAY SEL | 1 - 2 | 1 | 1(STANDARD) | | | |
| 3402 | P VAR 1 SEL | 102 - 137 | 1 | 104 | | | |
| 3403 | P VAR 1 MULTIP | 1 - 9999 | 1 | 1 | | | |
| 3404 | P VAR 1 DIVISOR | 1 - 9999 | 1 | 1 | | | |
| 3405 | P VAR 1 SCALING | 0 - 3 | 1 | 1 | | | |
| 3406 | P VAR 1 UNIT | 0 - 31 | 1 | 1 (A) | | | |
| 3407 | P VAR 2 SEL | 102 - 137 | 1 | 103 | | | |
| 3408 | P VAR 2 MULTIP | 1 - 9999 | 1 | 1 | | | |
| 3409 | P VAR 2 DIVISOR | 1 - 9999 | 1 | 1 | | | |
| 3410 | P VAR 2 SCALING | 0 - 3 | 1 | 1 | | | |
| 3411 | P VAR 2 UNIT | 0 - 31 | 1 | 3 (Hz) | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| **Group 40 PID CONTROL** | | | | | | | |
| 4001 | PID GAIN | 0.1 - 100 | 0.1 | 1.0 | | | ✓ |
| 4002 | PID INTEG TIME | 0.1 - 320 s | 0.1 s | 60 s | | | ✓ |
| 4003 | PID DERIV TIME | 0 - 10 s | 0.1 s | 0 s | | | |
| 4004 | PID DERIV FILTER | 0 - 10 s | 0.1 s | 1 s | | | |
| 4005 | ERROR VALUE INV | 0 - 1 | 1 | 0 (NO) | | | |
| 4006 | ACTUAL VAL SEL | 1 - 9 | 1 | 1 (ACT1) | | ✓ | |
| 4007 | ACT1 INPUT SEL | 1 - 2 | 1 | 2 (AI2) | | ✓ | |
| 4008 | ACT2 INPUT SEL | 1 - 2 | 1 | 2 (AI2) | | ✓ | |
| 4009 | ACT1 MINIMUM | 0 - 1000 % | 1 % | 0 % | | | |
| 4010 | ACT1 MAXIMUM | 0 - 1000 % | 1 % | 100 % | | | |
| 4011 | ACT2 MINIMUM | 0 - 1000 % | 1 % | 0 % | | | |
| 4012 | ACT2 MAXIMUM | 0 - 1000 % | 1 % | 100 % | | | |
| 4013 | PID SLEEP DELAY | 0.0 - 3600 s | 0.1; 1 s | 60 s | | | |
| 4014 | PID SLEEP LEVEL | 0.0 - 120 Hz | 0.1 Hz | 0 Hz | | | |
| 4015 | WAKE-UP LEVEL | 0.0 - 100 % | 0.1 % | 0 % | | | |
| 4016 | PID PARAM SET | 1 - 7 | 1 | 6 (SET 1) | | | |
| 4017 | WAKE-UP DELAY | 0 - 60 s | 0.01 s | 0.50 s | | | |
| 4018 | SLEEP SELECTION | 0 - 5 | 1 | 0 (INTERNAL) | | ✓ | |
| 4019 | SET POINT SEL | 1 - 2 | 1 | 2 (EXTERNAL) | | | |
| 4020 | INTERNAL SETPNT | 0.0 - 100.0 % | 0.1 % | 40 % | | | |
| **Group 41 PID CONTROL (2)** | | | | | | | |
| 4101 | PID GAIN | 0.1 - 100 | 0.1 | 1.0 | | | |
| 4102 | PID INTEG TIME | 0.1 - 320 s | 0.1 s | 60 s | | | |
| 4103 | PID DERIV TIME | 0 - 10 s | 0.1s | 0 s | | | |
| 4104 | PID DERIV FILTER | 0 - 10 s | 0.1 s | 1 s | | | |
| 4105 | ERROR VALUE INV | 0 - 1 | 1 | 0 (NO) | | | |
| 4106 | ACTUAL VAL SEL | 1 - 9 | 1 | 1 (ACT1) | | ✓ | |
| 4107 | ACT1 INPUT SEL | 1 - 2 | 1 | 2 (AI2) | | ✓ | |
| 4108 | ACT2 INPUT SEL | 1 - 2 | 1 | 2 (AI2) | | ✓ | |
| 4109 | ACT1 MINIMUM | 0 - 1000 % | 1 % | 0 % | | | |
| 4110 | ACT1 MAXIMUM | 0 - 1000 % | 1 % | 100 % | | | |
| 4111 | ACT2 MINIMUM | 0 - 1000 % | 1 % | 0 % | | | |
| 4112 | ACT2 MAXIMUM | 0 - 1000 % | 1 % | 100 % | | | |
| 4119 | SET POINT SEL | 1 - 2 | 1 | 2 (EXTERNAL) | | | |
| 4120 | INTERNAL SETPNT | 0.0 - 100.0 % | 0.1 % | 40.0 % | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| **Group 50 COMMUNICATION** | | | | | | | |
| 5001 | DDCS BIT RATE | 1, 2, 4, 8 | - | 1 (1 Mbits/s) | | ✓ | |
| 5002 | DDCS NODE NR | 1 - 254 | 1 | 1 | | ✓ | |
| 5003 | COMM FAULT TIME | 0.1 - 60 s | 0.1 s | 1 s | | | |
| 5004 | COMM FAULT FUNC | 0 - 3 | 1 | 0 (NOT SEL) | | | |
| 5005 | PROTOCOL SEL | 0 - 3 | 1 | 0 (NOT SEL) | | ✓ | |
| 5006 | COMM COMMANDS | 0 - 2 | 1 | 0 (NOT SEL) | | ✓ | |
| 5007 | DDCS BUS MODE | 1 - 2 | 1 | 1 (FIELDBUS) | | ✓ | |
| **Group 51 EXT COMM MODULE** | | | | | | | |
| 5101-5115 | FIELDBUSPAR1 - 15 | - | - | - | | | |
| **Group 52 STANDARD MODBUS** | | | | | | | |
| 5201 | STATION NUMBER | 1 - 247 | 1 | 1 | | | |
| 5202 | COMM SPEED | 3, 6, 12, 24,48, 96, 192 | - | 96 (9600 bits/s) | | | |
| 5203 | PARITY | 0 - 2 | 1 | 0 (NONE) | | | |
| 5206 | BAD MESSAGES | 0 - FFFF | 1 | - | | | |
| 5207 | GOOD MESSAGES | 0 - FFFF | 1 | - | | | |
| 5208 | BUFFER OVERRUNS | 0 - FFFF | 1 | - | | | |
| 5209 | FRAME ERRORS | 0 - FFFF | 1 | - | | | |
| 5210 | PARITY ERRORS | 0 - FFFF | 1 | - | | | |
| 5211 | CRC ERRORS | 0 - FFFF | 1 | - | | | |
| 5212 | BUSY ERRORS | 0 - FFFF | 1 | - | | | |
| 5213 | SER FAULT MEM 1 | 0 - 255 | 1 | - | | | |
| 5214 | SER FAULT MEM 2 | 0 - 255 | 1 | - | | | |
| 5215 | SER FAULT MEM 3 | 0 - 255 | 1 | - | | | |
| **Group 81 PFC CONTROL** | | | | | | | |
| 8103 | REFERENCE STEP 1 | 0.0 - 100 % | 0.1 % | 0 % | | | |
| 8104 | REFERENCE STEP 2 | 0.0 - 100 % | 0.1 % | 0 % | | | |
| 8105 | REFERENCE STEP 3 | 0.0 - 100 % | 0.1 % | 0 % | | | |
| 8109 | START FREQ 1 | 0.0 - 250 Hz | 0.1 Hz | 50Hz | | | |
| 8110 | START FREQ 2 | 0.0 - 250 Hz | 0.1 Hz | 50 Hz | | | |
| 8111 | START FREQ 3 | 0.0 - 250 Hz | 0.1 Hz | 50 Hz | | | |
| 8112 | LOW FREQ 1 | 0.0 - 250 Hz | 0.1 Hz | 25 Hz | | | |
| 8113 | LOW FREQ 2 | 0.0 - 250 Hz | 0.1 Hz | 25 Hz | | | |
| 8114 | LOW FREQ 3 | 0.0 - 250 Hz | 0.1 Hz | 25 Hz | | | |
| 8115 | AUX MOT START D | 0.0 - 3600 s | 0.1 s; 1 s | 5 s | | | |
| 8116 | AUX MOT STOP D. | 0.0 - 3600 s | 0.1 s; 1 s | 3 s | | | |
| 8117 | NR OF AUX MOT | 0 - 3 | 1 | 1 | | | |
| 8118 | AUTOCHNG INTERV | 0.0 - 336 h | 0.1 h | 0.0 h (NOT SEL) | | | |
| 8119 | AUTOCHNG LEVEL | 0.0 - 100.0 % | 0.1 % | 50 % | | | |

| Code | Name | Range | Resolution | Default | User | S | M |
|---|---|---|---|---|---|---|---|
| 8120 | INTERLOCKS | 0 - 6 | 1 | 4 (DI4) | | ✓ | |
| 8121 | REG BYPASS CTRL | 0 - 1 | 1 | 0 (NO) | | | |
| 8122 | PFC START DELAY | 0 - 10 s | 0.01 s | 0.5 s | | | |

* The maximum factor depending on the type of the frequency converter at 4 kHz switching frequency.

## Group 99: Start-up Data

The Start-up Data parameters are a special set of parameters for setting up the ACH 400 and for entering motor information.

| Code | Description |
|---|---|
| 9901 | **LANGUAGE**<br>Language selection for the ACS-PAN-A control panel.<br><br>0 = ENGLISH 3 = ITALIAN 6 = DUTCH 9 = FINNISH 12 = (reserved)<br>1 = ENGLISH (AM) 4 = SPANISH 7 = FRENCH 10 = SWEDISH<br>2 = GERMAN 5 = PORTUGUESE 8 = DANISH 11 = RUSSIAN |
| 9902 | **APPLIC MACRO**<br>Application macro selection. This parameter is used to select the Application Macro which will configure the ACH 400 for a particular application. Refer to “Application Macros”, starting page 37, for a list and description of available Application Macros.<br><br>0 = HVAC 1 = HVAC FL PNT 2 = HVAC PID 3 = HVAC PFC |
| 9905 | **MOTOR NOM VOLT**<br>Nominal motor voltage from motor rating plate. This parameter sets the maximum output voltage supplied to the motor by ACH 400. MOTOR NOM FREQ sets the frequency at which output voltage is equal to the MOTOR NOM VOLT. The ACH 400 cannot supply the motor with a voltage greater than the input voltage.<br>See Figure 23. |
| 9906 | **MOTOR NOM CURR**<br>Nominal motor current from rating plate. The allowed range is $0.5 \cdot I_N$ ... $1.5 \cdot I_N$ of ACH 400. |
| 9907 | **MOTOR NOM FREQ**<br>Nominal motor frequency from rating plate (field weakening point).<br>See Figure 23. |
| 9908 | **MOTOR NOM SPEED**<br>Nominal motor speed from rating plate. |
| 9909 | **MOTOR NOM POWER**<br>Nominal motor power from rating plate. |
| 9910 | **MOTOR COS PHI**<br>Nominal motor cos phi from rating plate. |

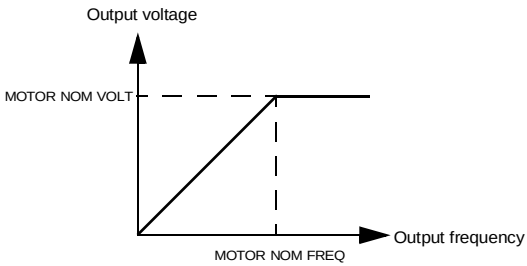
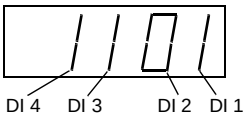
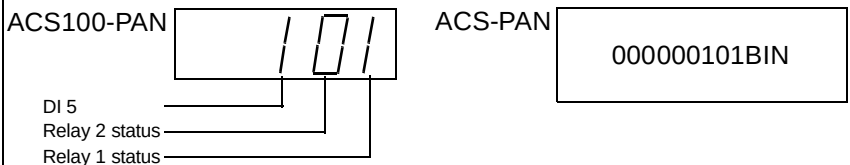



*Figure 23 Output voltage as a function of output frequency.*

## Group 01: Operating Data

This group contains drive operating data, including actual signals and fault memories. Actual Signal values are measured or calculated by the drive and they cannot be set by the user. Fault memories can be cleared by the user from the control panel.

| Code | Description |
|---|---|
| 0102 | **SPEED**<br>Displays the calculated speed of the motor (rpm). |
| 0103 | **OUTPUT FREQ**<br>Displays the frequency (Hz) applied to the motor. (Also shown in OUTPUT display.) |
| 0104 | **CURRENT**<br>Displays the motor current, as measured by the ACH 400.<br>(Also shown in OUTPUT display.) |
| 0105 | **TORQUE**<br>Output torque. Calculated value of torque on the motor shaft in % of motor nominal torque. |
| 0106 | **POWER**<br>Displays the measured motor power in kW.<br>**Note!** ACS100-PAN will not display the unit ("kW"). |
| 0107 | **DC BUS VOLTAGE**<br>Displays the DC bus voltage, as measured by the ACH 400. The voltage is displayed in Volts DC. |
| 0109 | **OUTPUT VOLTAGE**<br>Displays the voltage applied to the motor. |
| 0110 | **ACH 400 TEMP**<br>Displays the temperature of the ACH 400 heatsink in Centigrade. |
| 0111 | **EXTERNAL REF 1**<br>The value of external reference 1 in Hz. |
| 0112 | **EXTERNAL REF 2**<br>The value of external reference 2 in %. |
| 0113 | **CTRL LOCATION**<br>Displays the active control location. Alternatives are:<br>0 = LOCAL<br>1 = EXT1<br>2 = EXT2<br>See "Appendix A", starting page 123, for description of different control locations. |
| 0114 | **RUN TIME (R)**<br>Shows the total running time of the ACH 400 in hours (h). Can be **reset** by pressing UP and DOWN buttons simultaneously when in parameter set mode. |
| 0115 | **kWh COUNTER (R)**<br>Shows the counted kilowatt hours of ACH 400 in operation. Can be **reset** by pressing UP and DOWN buttons simultaneously when in parameter set mode. |
| 0116 | **APPL BLK OUTPUT**<br>The reference value in percent received from the application block. The value is from PID control or PFC control, depending on the selected macro. Otherwise the value is from 0112 EXT REF 2. |
| 0117 | **DI1-DI4 STATUS**<br>Status of the four digital inputs. Status is displayed as a binary number. If the input is activated, the display will indicate 1. If the input is deactivated, the display will be 0.<br>ACS100-PAN  ACS-PAN 000001101BIN<br>DI 4 DI 3 DI 2 DI 1 |

| Code | Description |
|---|---|
| 0118 | **AI1**<br>Relative value of analog input 1 displayed in %. |
| 0119 | **AI2**<br>Relative value of analog input 2 displayed in %. |
| 0121 | **DI5 & RELAYS**<br>Status of digital input 5 and relay outputs. 1 indicates that the relay is energized and 0 indicates that the relay is de-energized.<br>  |
| 0122 | **AO**<br>Value of analog output signal in milliamperes. |
| 0124 | **ACTUAL VALUE 1**<br>PID/PFC controller actual value 1 (ACT1), displayed in percent. |
| 0125 | **ACTUAL VALUE 2**<br>PID/PFC controller actual value 2 (ACT2), displayed in percent. |
| 0126 | **CONTROL DEV**<br>Displays the difference between the reference value and the actual value of the PID/PFC controller. |
| 0127 | **PID ACT VALUE**<br>Feedback signal (actual value) for PID/PFC controller. |
| 0128 | **LAST FAULT**<br>Last recorded fault (0=no fault). See “Diagnostics”, starting page 31.<br>Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode. |
| 0129 | **PREVIOUS FAULT**<br>Previous recorded fault. See “Diagnostics”, starting page 31.<br>Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode. |
| 0130 | **OLDEST FAULT**<br>Oldest recorded fault. See “Diagnostics”, starting page 31.<br>Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode. |
| 0131 | **SER LINK DATA 1**<br>Free data location that can be written from serial link. |
| 0132 | **SER LINK DATA 2**<br>Free data location that can be written from serial link. |
| 0133 | **SER LINK DATA 3**<br>Free data location that can be written from serial link. |
| 0134 | **PROCESS VAR 1**<br>Process variable 1, as selected by the parameters in group 34. |
| 0135 | **PROCESS VAR 2**<br>Process variable 2, as selected by the parameters in group 34. |
| 0136 | **RUN TIME**<br>Shows the total running time of ACH 400 in thousands of hours (kh). |
| 0137 | **MWh COUNTER**<br>Counts the megawatt hours of ACH 400 in operation. |

## Group 10: Command Inputs

Start, Stop and Direction commands can be given from the control panel or from two external locations (EXT1, EXT2). The selection between the two external locations is made with parameter 1102 EXT1/EXT2 SEL. For more information on control locations refer to “Appendix A”, starting page 123.

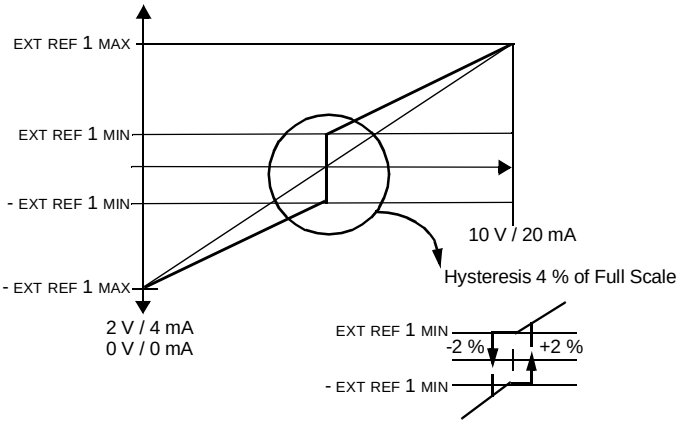
| Code | Description |
|---|---|
| 1001 | **EXT1 COMMANDS**<br>Defines the connections and the source of Start/Stop/Direction commands for External control location 1 (EXT1).<br><br>0 = NOT SEL<br>No Start/Stop/Direction command source for EXT1 is selected.<br><br>1 = DI1<br>Two-wire Start/Stop connected to digital input DI1. DI1 deactivated = Stop;<br>DI1 activated = Start. *<br><br>2 = DI1,2<br>Two-wire Start/Stop, Direction. Start/Stop is connected to digital input DI1 as above. Direction is connected to digital input DI2. DI2 deactivated = Forward; DI2 activated = Reverse. To control direction, value of parameter 1003 DIRECTION should be REQUEST.<br><br>3 = DI1P,2P<br>Three-wire Start/Stop. Start/Stop commands are given by means of momentary push-buttons (the P stands for “pulse”). The Start push-button is normally open, and connected to digital input DI1. The Stop push-button is normally closed, and connected to digital input DI2. Multiple Start push-buttons are connected in parallel; multiple Stop push-buttons are connected in series. *,**<br><br>4 = DI1P,2P,3<br>Three-wire Start/Stop, Direction. Start/Stop connected as with DI1P,2P. Direction is connected to digital input DI3. DI3 deactivated = Forward; DI3 activated = Reverse. To control Direction, value of parameter 1003 DIRECTION should be REQUEST. **<br><br>5 = DI1P,2P,3P<br>Start Forward, Start Reverse, and Stop. Start and Direction commands are given simultaneously with two separate momentary push-buttons (the P stands for “pulse”). The Stop push-button is normally closed, and connected to digital input DI3. The Start Forward and Start Reverse push-buttons are normally open, and connected to digital inputs DI1 and DI2 respectively. Multiple Start push-buttons are connected in parallel, and multiple Stop push-buttons are connected in series. To control direction, value of parameter 1003 DIRECTION should be REQUEST. **<br><br>6 = DI5<br>Two-wire Start/Stop, connected to digital input DI5. DI5 deactivated = Stop and DI5 activated = Start. *<br><br>7 = DI5,4<br>Two-wire Start/Stop/Direction. Start/Stop is connected to digital input DI5. Direction is connected to digital input DI4. DI4 deactivated = Forward and DI4 activated = Reverse. To control direction, value of parameter 1003 DIRECTION should be REQUEST.<br><br>8 = KEYPAD<br>The Start/Stop and Direction commands are given from the control panel when External control location 1 is active. To control direction, value of parameter 1003 DIRECTION should be REQUEST.<br><br>9 = DI1F,2R<br>Start forward command is given when DI1= activated and DI2= deactivated. Start reverse command is given if DI1 is deactivated and DI2 is activated. In other cases Stop command is given.<br><br>10 = COMM<br>The Start/Stop and Direction commands are given through serial communication.<br><br>***Note!** In cases 1, 3, 6 direction is set with parameter 1003 DIRECTION. Selecting value 3 (REQUEST) fixes direction to Forward.<br><br>****Note!** Stop signal must be activated before Start command can be given. |

| | |
|---|---|
| 1002 | **EXT2 COMMANDS**<br>Defines the connections and the source of Start, Stop and Direction commands for external control location 2 (EXT2).<br>Refer to parameter 1001 EXT1 COMMANDS above. |
| 1003 | **DIRECTION**<br>1 = FORWARD<br>2 = REVERSE<br>3 = REQUEST<br>Rotation direction lock. This parameter allows you to fix the direction of rotation of the motor to forward or reverse. If you select 3 (REQUEST), the direction is set according to the given direction command. |

## Group 11: Reference Select

Reference commands can be given from the control panel or from two external locations. The selection between the two external locations is made with parameter 1102 EXT1/EXT2 SEL. For more information on control locations, refer to “Appendix A”, starting page 123.

| Code | Description |
|---|---|
| 1101 | **KEYPAD REF SEL**<br>Selection of active control panel reference in local control mode.<br><br>1 = REF1 (Hz)<br>Control panel reference is given in Hz.<br><br>2 = REF2 (%)<br>Control panel reference is given as a percentage (%). |
| 1102 | **EXT1/EXT2 SEL**<br>Sets the input used for selecting the external control location, or fixes it to EXT1 or EXT2. The external control location of both Start/Stop/Direction commands and reference is determined by this parameter.<br><br>1...5 = DI1...DI5<br>External control location 1 or 2 is selected according to the state of the selected digital input (DI1 ... DI5), where deactivated = EXT1 and activated = EXT2.<br><br>6 = EXT1<br>External control location 1 (EXT1) is selected. The control signal sources for EXT1 are defined with parameter 1001 (Start/Stop/Direction commands) and parameter 1103 (reference).<br><br>7 = EXT2<br>External control location 2 (EXT2) is selected. The control signal sources for EXT2 are defined with parameter 1002 (Start/Stop/Direction commands) and parameter 1106 (reference).<br><br>8 = COMM<br>External control location 1 or 2 is chosen through serial communication. |

| | |
|---|---|
| 1103 | **EXT REF1 SELECT**<br>This parameter selects the signal source of external reference 1.<br><br>0 = KEYPAD<br>Reference is given from the control panel.<br><br>1 = AI 1<br>Reference is given through analog input 1.<br><br>2 = AI 2<br>Reference is given through analog input 2.<br><br>3 = AI1/JOYST; 4 = AI2/JOYST<br>Reference is given through analog input 1 (or 2 accordingly) configured for a joystick. The minimum input signal runs the drive at maximum reference in the reverse direction. The maximum input signal runs the drive at maximum reference in the forward direction (See Figure 24). See also parameter 1003 DIRECTION.<br><br>**Caution:** Minimum reference for joystick should be 0.3 V (0.6 mA) or higher. If a 0 ... 10 V signal is used, the ACH 400 will operate at maximum reference in the reverse direction if the control signal is lost. Set parameter 1301 MINIMUM AI1 to a value 3 % (corresponding 0.3 V) or higher, and parameter 3001 AI<MIN FUNCTION to 1 (FAULT), and the ACH 400 will stop in case the control signal is lost.<br><br>  <br><br><br>*Figure 24 Joystick control. Maximum for external reference 1 is set with Parameter 1105 and minimum with Parameter 1104.*<br><br>5 = DI3U,4D(R)<br>Speed reference is given through digital inputs as motor potentiometer control. Digital input DI3 increases the speed (the U stands for “up”), and digital input DI4 decreases the speed (the D stands for “down”). (R) indicates that the reference will be reset to zero when a Stop command is given. The rate of change of the reference signal is controlled by parameter 2204 ACCELER TIME 2.<br><br>6 = DI3U,4D<br>Same as above, except that the speed reference is not reset to zero on a Stop command. When the ACH 400 is started, the motor will ramp up at the selected acceleration rate to the stored reference.<br><br>7 = DI4U,5D<br>Same as above, except that the digital inputs in use are DI4 and DI5.<br><br>8 = COMM<br>The reference is given through serial communication.<br><br>9 = COMM + AI1<br>10 = COMM * AI1<br>The reference is given through serial communication. The analog input 1 signal is combined to the fieldbus reference (sum or multiplication). For more information, see chapter “Standard Serial Communication” on page 103. |

| | |
|---|---|
| 1104 | **EXT REF1 MIN**<br>Sets the minimum frequency reference for external reference 1 in Hz. When analog input signal is at minimum, external reference 1 equals to EXT REF1 MIN. See Figure 25 on page 58. |
| 1105 | **EXT REF1 MAX**<br>Sets the maximum frequency reference for external reference 1 in Hz. When analog input signal is at maximum, external reference 1 equals to EXT REF1 MAX. See Figure 25 on page 58. |
| 1106 | **EXT REF2 SELECT**<br>This parameter selects the signal source for external reference 2. The alternatives are the same as with external reference 1. |
| 1107 | **EXT REF2 MIN**<br>Sets the minimum reference in %. When analog input signal is at minimum value external reference 2 equals to EXT REF2 MIN. See Figure 25.<br>• If the PID Control or PFC macro is selected, this parameter sets the minimum process reference.<br>• If any other macro than PID is selected, this parameter sets the minimum frequency reference. This value is given as a percentage of the maximum frequency. |
| 1108 | **EXT REF2 MAX**<br>Sets the maximum reference in %. When analog input signal is at maximum, external reference 2 equals to EXT REF2 MAX. See Figure 25.<br>• If the PID Control or PFC macro is selected, this parameter sets the maximum process reference.<br>• If any other macro than PID Control is selected, this parameter sets the maximum frequency reference. This value is given as a percentage of the maximum frequency. |

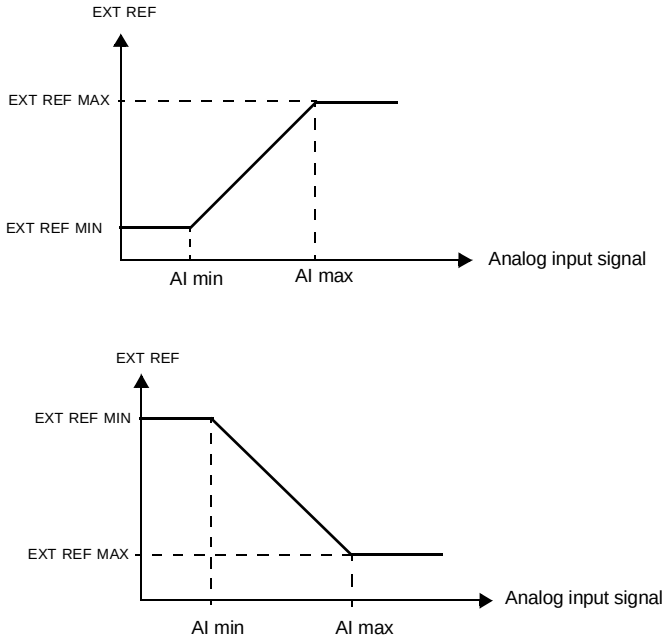



*Figure 25 Setting EXT REF MINIMUM and EXT REF MAXIMUM. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.*

## Group 12: Constant Speeds

The ACH 400 has 7 programmable constant speeds, ranging from 0 to 250 Hz. Negative speed values cannot be given for constant speeds.

Constant speed selections are ignored if the process PID reference is followed, the drive is in local control mode or PFC (Pump-Fan Control) is active.

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**Note!** Parameter 1208 CONST SPEED 7 also acts as a so-called fault speed which may be activated if the control signal is lost. Refer to parameter 3001 AI<MIN FUNCTION and parameter 3002 PANEL LOSS.

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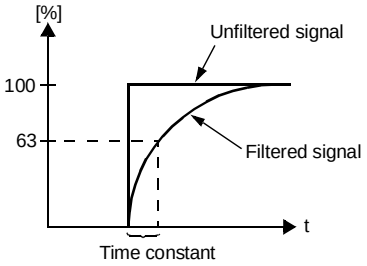
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>1201</td><td>CONST SPEED SEL<br>This parameter defines which digital inputs are used to select Constant Speeds.<br><br>0 = NOT SEL<br>Constant speed function disabled.<br><br>1...5 = DI1...DI5<br>Constant Speed 1 is selected with digital inputs DI1-DI5. Digital input activated = Constant Speed 1 activated.<br><br>6 = DI1,2<br>Three Constant Speeds (1 ... 3) are selected with two digital inputs.<br>Constant Speed selection with digital inputs DI1,2.<br><br>Table 8 Constant Speed selection with digital inputs DI1,2.<br><table><tr><th>DI 1</th><th>DI 2</th><th>Function</th></tr><tr><td>0</td><td>0</td><td>No constant speed</td></tr><tr><td>1</td><td>0</td><td>Constant speed 1 (1202)</td></tr><tr><td>0</td><td>1</td><td>Constant speed 2 (1203)</td></tr><tr><td>1</td><td>1</td><td>Constant speed 3 (1204)</td></tr></table>0 = DI deactivated, 1 = DI activated<br><br>7 = DI3,4<br>Three Constant Speeds (1 ... 3) are selected with two digital inputs as in DI1,2.<br><br>8 = DI4,5<br>Three Constant Speeds (1 ... 3) are selected with two digital inputs as in DI1,2.<br><br>9 = DI1,2,3<br>Seven Constant Speeds (1 ... 7) are selected with three digital inputs.<br><br>Table 9 Constant Speed selection with digital inputs DI1,2,3.<br><table><tr><th>DI 1</th><th>DI 2</th><th>DI 3</th><th>Function</th></tr><tr><td>0</td><td>0</td><td>0</td><td>No constant speed</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Constant speed 1 (1202)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Constant speed 2 (1203)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Constant speed 3 (1204)</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Constant speed 4 (1205)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Constant speed 5 (1206)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Constant speed 6 (1207)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Constant speed 7 (1208)</td></tr></table>0 = DI deactivated, 1 = DI activated<br><br>10 = DI3,4,5<br>Seven Constant Speeds (1 ... 7) are selected with three digital inputs as in DI1,2,3.</td></tr>
<tr><td>1202<br>-1208</td><td>CONST SPEED 1... CONST SPEED 7<br>Constant speeds 1-7.</td></tr>
</table>

## Group 13: Analog Inputs

| Code | Description |
|---|---|
| 1301 | **MINIMUM AI1**<br>Relative minimum value of AI1 (%). Value corresponds to minimum reference set by parameter 1104 EXT REF1 MIN or 1107 EXT REF2 MIN. Minimum AI cannot be greater than maximum AI.<br>See Figure 25 on page 58. |
| 1302 | **MAXIMUM AI1**<br>Maximum value of AI1 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX.<br>See Figure 25 on page 58. |
| 1303 | **FILTER AI1**<br>Filter time constant for analog input AI1. As the analog input value changes, 63 % of the change takes place within the time specified by this parameter.<br>**Note!** Even if you select 0 s for the filter time constant, the signal is still filtered with a time constant of 25 ms due to the signal interface hardware. This cannot be changed by any parameters.<br>  <br><br>*Figure 26 Filter time constant for analog input AI1.* |
| 1304 | **MINIMUM AI2**<br>Minimum value of AI2 (%). Value corresponds to minimum reference set by parameter 1104 EXT REF1 MIN or 1107 EXT REF2 MIN. Minimum AI cannot be greater than maximum AI. |
| 1305 | **MAXIMUM AI2**<br>Maximum value of AI2 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX. |
| 1306 | **FILTER AI2**<br>Filter time constant for AI2. Refer to parameter 1303 FILTER AI1. |

**Example.** To set the minimum allowed analog input value to 4 mA, value for parameter 1301 MINIMUM AI1 (1304 MINIMUM AI2) is calculated as follows:

Value (%) = Desired minimum value / Full range of the analog input * 100%

= 4 mA / 20 mA * 100%

= 20%.

**Note!** In addition to this parameter setting, the analog input must be configured for 0-20 mA current signal. Refer to section “Connection Examples” on page 17.

## Group 14: Relay Outputs

| Code | Description |
|---|---|
| 1401 | **RELAY OUTPUT 1**<br>Relay output 1 content.<br>Selects which information is indicated with relay output 1.<br>0 = NOT SEL<br>Relay is not used and is de-energized.<br>1 = READY<br>The ACH 400 is ready to function. The relay is energized unless no run enable signal is present or a fault exists and supply voltage is within range.<br>2 = RUN<br>Relay energized when the ACH 400 is running.<br>3 = FAULT (-1)<br>Relay energized when power is applied, and de-energized upon a fault trip.<br>4 = FAULT<br>Relay energized when a fault is active.<br>5 = ALARM<br>Relay energized when an alarm is active. To see which alarms cause the relay to energize, refer to section “Diagnostics” on page 31.<br>6 = REVERSED<br>Relay energized when motor rotates in reverse direction.<br>7 = SUPRV1 OVER<br>Relay energized when first supervised parameter (3201) exceeds the limit (3203). See “Group 32: Supervision”, starting page 77.<br>8 = SUPRV1 UNDER<br>Relay energized when first supervised parameter (3201) drops below the limit (3202). See “Group 32: Supervision”, starting page 77.<br>9 = SUPRV2 OVER<br>Relay energized when second supervised parameter (3204) exceeds the limit (3206). See “Group 32: Supervision”, starting page 77.<br>10 = SUPRV2 UNDER<br>Relay energized when second supervised parameter (3204) drops below the limit (3205). See “Group 32: Supervision”, starting page 77.<br>11 = AT SET POINT<br>Relay energized when output frequency is equal to reference frequency.<br>12 = FAULT (RST)<br>Relay energized when the ACH 400 is in a fault condition and will reset after the programmed autoreset delay (refer to parameter 3103 DELAY TIME).<br>13 = FLT/ALARM<br>Relay is energized when fault or alarm occurs. To see which alarms and faults cause the relay to energize, refer to section “Diagnostics” on page 31.<br>14 = EXT CONTROL<br>Relay is energized if external control is selected.<br>15 = REF 2 SEL<br>Relay is energized if EXT2 is selected.<br>16 = CONST FREQ<br>Relay is energized when a constant speed is selected.<br>17 = REF LOSS<br>Relay is energized when reference or active control place is lost.<br>18 = OVERCURRENT<br>Relay is energized when overcurrent alarm or fault appears.<br>19 = OVERVOLTAGE<br>Relay is energized when overvoltage alarm or fault appears.<br>20 = ACH400 TEMP<br>Relay is energized when ACH 400 overtemperature alarm or fault exists. |

| Code | Description |
|---|---|
| | 21 = ACH OVERLOAD<br>Relay is energized when ACH 400 overload alarm or fault exists.<br>22 = UNDERVOLTAGE<br>Relay is energized when undervoltage alarm or fault exists.<br>23 = AI1 LOSS<br>Relay is energized when AI1 signal is lost.<br>24 = AI2 LOSS<br>Relays energized when AI2 signal is lost.<br>25 = MOT OVR TEMP<br>Relay is energized when motor overtemperature alarm or fault exists.<br>26 = STALL<br>Relay is energized when stall alarm or fault exists.<br>27 = UNDERLOAD<br>Relay is energized when underload alarm or fault exists.<br>28 = PID SLEEP<br>Relay is energized when PID sleep function is active.<br>29 = PFC<br>Relay output is reserved for PFC control (Pump-Fan Control). This option should be selected only when PFC control macro is used.<br>30 = AUTOCHANGE<br>Relay is energized when PFC autochange operation is performed. This option should be selected only when PFC control macro is used.<br>31 = STARTED<br>Relay is energized when drive receives start command (even if Run Enable signal is not present). Relay is de-energized when stop command is received or fault occurs. |
| 1402 | **RELAY OUTPUT 2**<br>Relay output 2 content. Refer to parameter 1401 RELAY OUTPUT 1. |
| 1403 | **RO 1 ON DELAY**<br>Switch-on delay for relay 1. |
| 1404 | **RO 1 OFF DELAY**<br>Switch-off delay for relay 1 |
| 1405 | **RO 2 ON DELAY**<br>Switch-on delay for relay 2. |
| 1406 | **RO 2 OFF DELAY**<br>Switch-off delay for relay 2. |

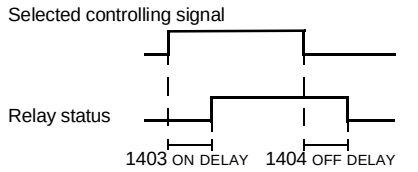



*Figure 27*

## Group 15: Analog Output

Analog output is used to output the value of any parameter of the Operating Data group (Group 1) as a current signal. Output current minimum and maximum values are configurable, as are the allowed minimum and maximum values for the observed parameter.

If analog output content maximum value (parameter 1503) is set to less than minimum value (parameter 1502), output current is inversely proportional to the value of the observed parameter.

| Code | Description |
|---|---|
| 1501 | **AO CONTENT**<br>Content for analog output. Number of any parameter of the Operating Data group (Group 01). |
| 1502 | **AO CONTENT MIN**<br>Analog output content minimum. Display depends on parameter 1501. |
| 1503 | **AO CONTENT MAX**<br>Analog output content maximum. Display depends on parameter 1501. |
| 1504 | **MINIMUM AO**<br>Minimum output current. |
| 1505 | **MAXIMUM AO**<br>Maximum output current. |
| 1506 | **AO FILTER**<br>Filter time constant for AO. |

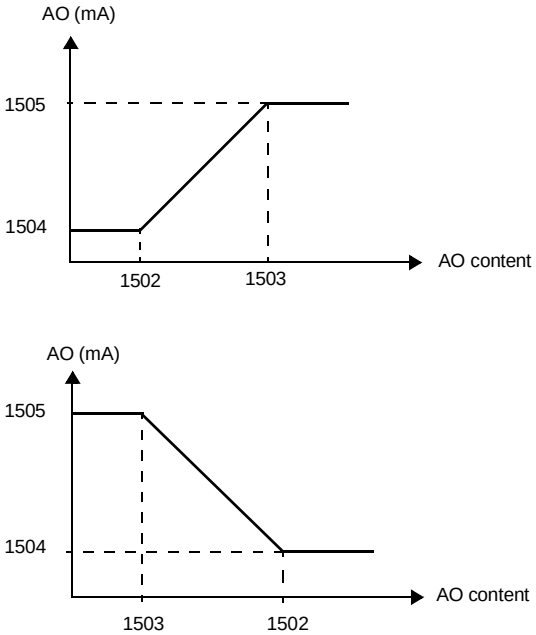



*Figure 28 Analog output scaling.*

## Group 16: System Controls

| Code | Description |
|---|---|
| 1601 | **RUN ENABLE**<br>Selects the source of the run enable signal.<br>0 = NOT SEL<br>The ACH 400 is ready to start without an external run enable signal.<br>1...5 = DI1 ... DI5<br>To activate the run enable signal, the selected digital input must be activated. If the voltage drops and deactivates the selected digital input, the ACH 400 will coast to stop and not start until the run enable signal resumes.<br>6 = COMM<br>The run enable signal is given through serial communication (Command Word bit #3). |
| 1602 | **PARAMETER LOCK**<br>Parameter lock for control panel.<br>0 = LOCKED<br>Parameter modification disabled.<br>1 = OPEN<br>Panel operations are allowed and parameter modification is enabled.<br>2 = NOT SAVED<br>Parameter values can be changed, but they are not stored in permanent memory.<br>**Note!** This parameter is not affected by macro selection.<br>**Note!** Parameter writes through Standard Modbus or DDCS channels are not affected by this parameter. |
| 1604 | **FAULT RESET SEL**<br>Fault reset source.<br>**Note!** Fault reset is always possible with control panel.<br>**Note!** Option 6 (START/STOP) should not be selected when start, stop and direction commands are given through serial communication.<br>0 = KEYPAD<br>Fault reset is executed from the control panel keypad.<br>1...5 = DI1 ... DI5<br>Fault reset is executed from a digital input. Reset is activated by deactivating the input.<br>6 = START/STOP<br>Fault reset is activated by Stop command.<br>7 = COMM<br>Fault reset is executed through serial communication. |
| 1605 | **LOCAL LOCK**<br>Local lock. When LOCAL LOCK is active (1=LOCKED), panel cannot change to local mode.<br>0 = OPEN<br>Control location can be changed from control panel.<br>1 = LOCKED<br>Panel cannot change to local mode.<br>**Note!** Option 1 LOCKED can be selected only in remote mode. |

| Code | Description |
|---|---|
| 1607 | **PARAM. SAVE**<br>Parameter save function. Selection 1 (SAVE...) saves all altered parameters to permanent memory. Value 0 (DONE) is displayed when all parameters are saved.<br>When parameters are altered through Standard Modbus or DDCS channels, altered values are not automatically saved to permanent memory. Instead, this parameter must be used.<br>0 = DONE<br>1 = SAVE…<br>**Note!** Parameter modifications done from the control panel are normally stored immediately to permanent memory. However, if 1602 PARAMETER LOCK is set to 2 (NOT SAVED), modifications done from the control panel are saved only if this parameter 1607 is used. |

## Group 20: Limits

| Code | Description |
|---|---|
| 2003 | **MAX CURRENT**<br>Maximum output current.<br>The maximum output current that the ACH 400 will supply to the motor. |
| 2005 | **OVERVOLT CTRL**<br>DC overvoltage controller enable.<br><br>Fast braking of a high inertia load causes the DC bus voltage to rise to the overvoltage control limit. To prevent the DC voltage from exceeding the limit, the overvoltage controller automatically decreases the braking torque by increasing output frequency.<br><br>**Caution!** If a braking chopper and a braking resistor are connected to the ACH 400, this parameter value must be set to 0 to ensure proper operation of the chopper.<br><br>0 = DISABLE<br><br>1 = ENABLE |
| 2006 | **UNDERVOLT CTRL**<br>DC undervoltage controller enable.<br><br>If the DC bus voltage drops due to loss of input power, the undervoltage controller will decrease the motor speed in order to keep the DC bus voltage above the lower limit. By decreasing the output frequency, the inertia of the load will cause regeneration back into the ACH 400, thus keeping the DC bus charged, and preventing an undervoltage trip. This will increase power loss ride-through on systems with a high inertia, such as a centrifuge or fan.<br><br>0 = DISABLE<br><br>1 = ENABLE (TIME)<br>Enable with 500 ms time limit for operation.<br><br>2 = ENABLE<br>Enable without time limit for operation. |
| 2007 | **MINIMUM FREQ**<br>Operating range minimum output frequency.<br><br>**Note!** Keep MINIMUM FREQ ≤ MAXIMUM FREQ. |
| 2008 | **MAXIMUM FREQ**<br>Operating range maximum output frequency. |

## Group 21: Start/Stop

ACH 400 supports several start and stop modes, including flying start and torque boosting at start. DC current can be injected either before the start command (premagnetizing) or automatically right after the start command (starting with DC hold).

DC hold can be used when stopping the drive with ramp. If drive is stopping by coasting, DC brake can be used.

**Note!** Too long a DC injection time or premagn max time causes the motor to heat up.

| Code | Description |
|---|---|
| 2101 | **START FUNCTION**<br>Conditions during motor acceleration.<br><br>1 = RAMP<br>Ramp acceleration as set.<br><br>2 = FLYING<br>Flying start. Use this setting if the motor is already rotating and the drive will start smoothly at the current frequency. The drive will automatically search the correct output frequency.<br><br>3 = TORQUE BOOST<br>Automatic torque boost might be necessary in drives with high starting torque. Torque boost is only applied at start. Boosting is stopped when output frequency exceeds 20 Hz or when output frequency is equal to reference. See also parameter 2103 TORQ BOOST CURR.<br><br>4 = FLY + BOOST<br>Activates both the flying start and torque boost.<br><br>**Note!** If torque boost is used the switching frequency is always 4 kHz. In this case parameter 2605 LOW NOISE is ignored. |
| 2102 | **STOP FUNCTION**<br>Conditions during motor deceleration.<br><br>1 = COAST<br>Motor coasts to stop.<br><br>2 = RAMP<br>Ramp deceleration as defined by the active deceleration time 2203 DECELER TIME 1 or 2205 DECELER TIME 2. |
| 2103 | **TORQ BOOST CURR**<br>Maximum supplied current during torque boost. See also parameter 2101 START FUNCTION. |
| 2104 | **STOP DC INJ TIME**<br>DC injection time after modulation has stopped. If 2102 STOP FUNCTION is 1 (COAST), the ACH 400 uses DC braking. If 2102 STOP FUNCTION is 2 (RAMP), ACH 400 uses DC hold after ramp. |
| 2105 | **PREMAGN SEL**<br>Options 1- 5 select source for premagnetizing command. Option 6 selects start with DC hold.<br><br>0 = NOT SEL<br>Premagnetizing not used.<br><br>1...5 = DI1...DI5<br>Premagnetizing command is received through a digital input.<br><br>6 = CONST<br>Constant premagnetizing time after start command. Time is defined by parameter 2106 PREMAGN MAX TIME. |
| 2106 | **PREMAGN MAX TIME**<br>Maximum premagnetizing time. |

| Code | Description |
|---|---|
| 2107 | **START INHIBIT**<br>Start inhibit control. Start inhibit means that a pending start command is ignored when:<br>• fault is reset, or<br>• Run Enable activates while start command is active, or<br>• mode change from local to remote takes place, or<br>• mode change from remote to local takes place, o<br>• from EXT1 to EXT2 takes place, or<br>• from EXT2 to EXT1 takes place<br>0 = OFF<br>Start inhibit control disabled. Drive will start after fault is reset, Run Enable is activated or mode is changed while there is a pending start command.<br>1 = ON<br>Start inhibit control enabled. Drive will not start after fault is reset, Run Enable is activated or mode is changed. In order to start the drive again, you must enter a new start command. |

## Group 22: Accel/Decel

Two acceleration/deceleration ramp pairs can be used. If both ramp pairs are used, selection can be made between these in run time through a digital input. The S curve of the ramps is adjustable.

| Code | Description |
|---|---|
| 2201 | **ACC/DEC 1/2 SEL**<br>Selects the source for the ramp pair selection signal.<br><br>0 = NOT SEL<br>The first ramp pair is used (ACCELER TIME 1/DECELER TIME 1).<br><br>1...5 = DI1...DI5<br>Ramp pair selection is done through a digital input (DI1 to DI5).<br>Digital input deactivated = Ramp pair 1 (ACCELER TIME 1/DECELER TIME 1) is used.<br>Digital input activated = Ramp pair 2 (ACCELER TIME 2/DECELER TIME 2) is used. |
| 2202 | **ACCEL TIME 1**<br>Ramp 1: time from zero to maximum frequency (0 - MAXIMUM FREQ). |
| 2203 | **DECEL TIME 1**<br>Ramp 1: time from maximum frequency to zero (MAXIMUM FREQ - 0). |
| 2204 | **ACCEL TIME 2**<br>Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ). |
| 2205 | **DECEL TIME 2**<br>Ramp 2: time from maximum frequency to zero (MAXIMUM FREQ - 0). |
| 2206 | **RAMP SHAPE**<br>Acceleration/deceleration ramp shape selection<br><br>0 = LINEAR<br>1 = FAST S CURVE<br>2 = MEDIUM S CRV<br>3 = SLOW S CURVE |

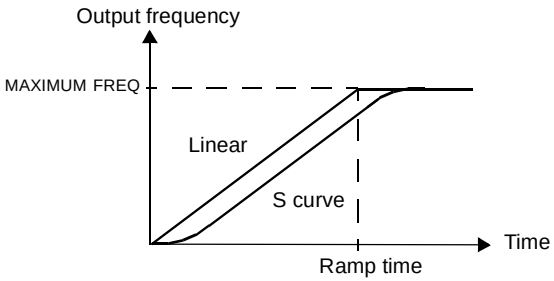



*Figure 29 Definition of acceleration/deceleration ramp time.*

## Group 25: Critical Freq

In some mechanical systems, certain speed ranges can cause resonance problems. With this parameter group, it is possible to set up to two different speed ranges that the ACH 400 will skip over.

| Code | Description |
|---|---|
| 2501 | **CRIT FREQ SEL**<br>Critical frequencies activation.<br><br>0 = OFF<br>1 = ON |
| 2502 | **CRIT FREQ 1 LO**<br>Critical frequency 1 start.<br><br>**Note!** If LOW > HI, no critical frequency lock-out will happen. |
| 2503 | **CRIT FREQ 1 HI**<br>Critical frequency 1 end. |
| 2504 | **CRIT FREQ 2 LO**<br>Critical frequency 2 start. |
| 2505 | **CRIT FREQ 2 HI**<br>Critical frequency 2 end.<br><br>**Note!** If LOW > HI, no critical frequency lock-out will happen. |

**Example**: A fan system vibrates badly from 18 Hz to 23 Hz and from 46 Hz to 52 Hz. Set the parameters as follows:

CRIT FREQ 1 LO = 18 Hz and CRIT FREQ 1 HI = 23 Hz

CRIT FREQ 2 LO = 46 Hz and CRIT FREQ 2 HI = 52 Hz

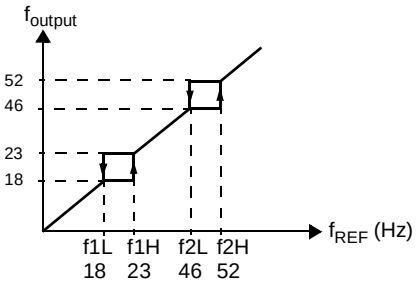



*Figure 30 Example of critical frequencies setting in a fan system with bad vibrations at frequency ranges 18 Hz to 23 Hz and 46 Hz to 52 Hz.*

## Group 26: Motor Control

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>2603</td><td>IR COMPENSATION<br>IR compensation voltage at 0 Hz.<br><br>Note! IR compensation should be kept as low as possible to prevent overheating. Refer to Table 10.<br><br>Table 10 Typical IR compensation values.<br><table><tr><th colspan="6">400 V Units</th></tr><tr><td>$P_N$ / kW</td><td>3</td><td>7.5</td><td>15</td><td>22</td><td>37</td></tr><tr><td>IR comp / V</td><td>21</td><td>18</td><td>15</td><td>12</td><td>10</td></tr></table></td></tr>
<tr><td>2604</td><td>IR COMP RANGE<br>IR compensation range. Defines frequency after which IR compensation is 0 V.</td></tr>
<tr><td>2605</td><td>LOW NOISE<br>Motor acoustical noise option.<br><br>0 = OFF<br>Standard (switching frequency 4 kHz).<br><br>1 = ON(1)<br>Low noise (switching frequency 8 kHz).<br><br>Note! When the low noise setting is used, the maximum loadability of the ACH 400 is $I_2$ at 30 °C ambient temperature or 0.8 * $I_2$ at 40 °C.</td></tr>
<tr><td>2606</td><td>U/f RATIO<br>U/f ratio below field weakening point.<br><br>1 = LINEAR<br>2 = SQUARE<br><br>Linear is preferred for constant torque applications, Square for centrifugal pump and fan applications. (Square is more silent for most operating frequencies.)</td></tr>
<tr><td>2607</td><td>SLIP COMP RATIO<br>A squirrel-cage motor will slip under load. The slip can be compensated by increasing the frequency as the motor torque increases. This parameter defines the gain for the slip. 100 % means full slip compensation; 0 % means no slip compensation.</td></tr>
</table>

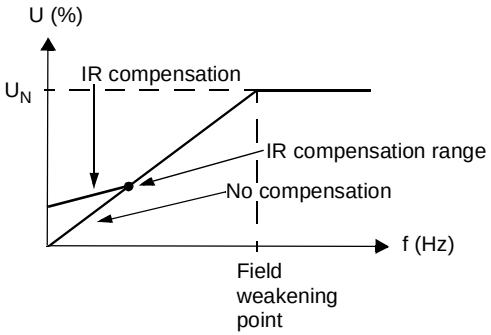



*Figure 31 Operation of IR compensation*

## Group 30: Fault Functions

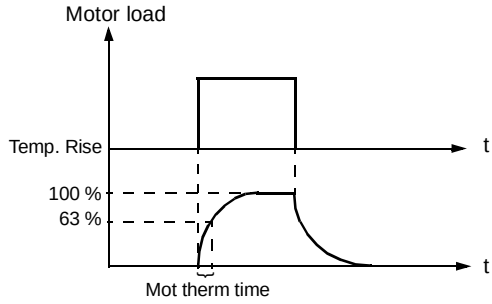
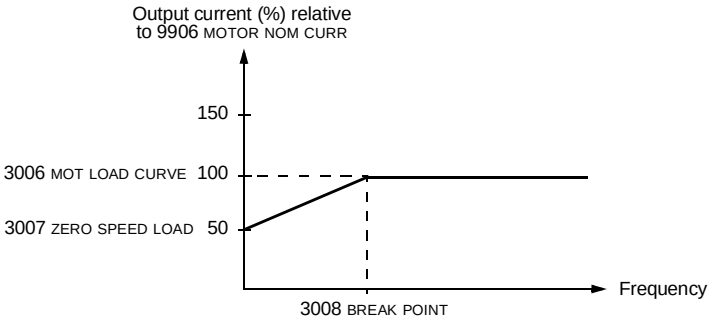
ACH 400 can be configured to respond as desired to certain abnormal external conditions: analog input fault, external fault signal and panel loss.

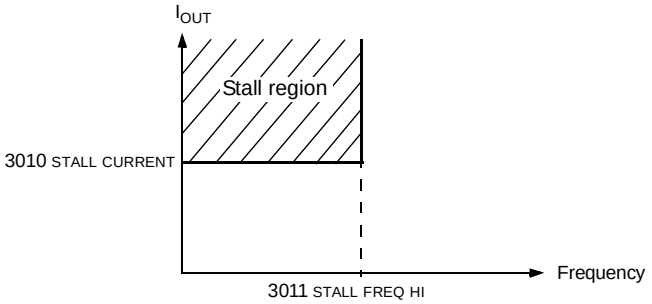
In these cases, the drive can either continue operation at current speed or at a set constant speed while showing an alarm, ignore the condition, or trip on a fault and stop.

Motor thermal protection parameters 3004 - 3008 provide a means of adjusting the motor load curve. For example, limiting the load near zero speed might be necessary if the motor does not have a cooling fan.

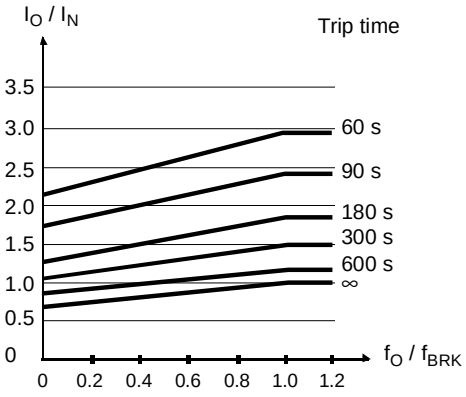
Stall protection (parameters 3009 - 3012) includes parameters for stall frequency, stall time and current.

| Code | Description |
|---|---|
| 3001 | **AI<MIN FUNCTION**<br>Operation in case of AI signal drops below minimum limit.<br><br>0 = NOT SEL<br>No operation.<br><br>1 = FAULT<br>A fault indication is displayed and the ACH 400 coasts to stop.<br><br>2 = CONST SP 7<br>A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.<br><br>3 = LAST SPEED<br>A warning indication is displayed and the speed is set to the level at which the ACH 400 was last operating. This value is determined by the average speed over the last 10 seconds.<br><br>**Caution:** If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case the analog input signal is lost. |
| 3002 | **PANEL LOSS**<br>Operation in case of control panel loss fault.<br><br>1 = FAULT<br>A fault indication is displayed and the ACH 400 coasts to stop.<br><br>2 = CONST SP 7<br>A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.<br><br>3 = LAST SPEED<br>A warning indication is displayed and the speed is set to the level at which the ACH 400 was last operating. This value is determined by the average speed over the last 10 seconds.<br><br>**Caution:** If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case the panel is lost. |
| 3003 | **EXTERNAL FAULT**<br>External fault input selection.<br><br>0 = NOT SEL<br>External fault signal is not used.<br><br>1...5 = DI1...DI5<br>This selection defines the digital input used for an external fault signal. If an external fault occurs, i.e. digital input is deactivated, the ACH 400 is stopped, the motor coasts to stop and a fault indication is displayed. |

| Code | Description |
|---|---|
| 3004 | **MOT THERM PROT**<br>Motor overtemperature function. This parameter defines the operation of the motor thermal protection function which protects the motor from overheating.<br><br>0 = NOT SEL<br><br>1 = FAULT<br>Displays a warning indication at the warning level (95 % of the nominal value). Displays a fault indication when the motor temperature reaches the 100 % level. The ACH 400 coasts to stop.<br><br>2 = WARNING<br>A warning indication is displayed when the motor temperature reaches the warning level (95 % of the nominal value). |
| 3005 | **MOT THERM TIME**<br>Time for 63 % temperature rise. This is the time within which the motor temperature reaches 63 % of the final temperature rise. Figure 32 shows motor thermal time definition.<br>If thermal protection according to UL requirements for NEMA class motors is desired, use this rule of thumb - MOTOR THERM TIME equals 35 times t6 (t6 in seconds is the time that the motor can safely operate at six times its rated current, given by the motor manufacturer). 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><br>  <br><br>*Figure 32 Motor thermal time.* |
| 3006 | **MOT LOAD CURVE**<br>Motor current maximum limit. MOTOR LOAD CURVE sets the maximum allowable operating load of the motor. When set to 100 %, the maximum allowable load is equal to the value of Start-up Data parameter 9906 MOTOR NOM CURRENT. The load curve level should be adjusted if the ambient temperature differs from the nominal value.<br><br>  <br><br>*Figure 33 Motor load curve.* |

| Code | Description |
|---|---|
| 3007 | **ZERO SPEED LOAD**<br>This parameter defines the maximum allowable current at zero speed relative to 9906 MOTOR NOM CURR. Refer to Figure 33. |
| 3008 | **BREAK POINT**<br>Break point of motor load curve. Refer to Figure 33 for an example of a motor load curve. See Figure 35. |
| 3009 | **STALL FUNCTION**<br>This parameter defines the operation of the stall protection. The protection is activated if the output current becomes too high compared to output frequency, refer to Figure 34.<br><br>0 = NOT SEL<br>Stall protection is not used.<br><br>1 = FAULT<br>When the protection is activated the ACH 400 coasts to stop. Fault indication is displayed.<br><br>2 = WARNING<br>A warning indication is displayed. The indication disappears in half the time set by parameter 3012 STALL TIME.<br><br>  <br><br>*Figure 34 Motor stall protection.* |
| 3010 | **STALL CURRENT**<br>Current limit for stall protection. Refer to Figure 34. |
| 3011 | **STALL FREQ HI**<br>This parameter sets the frequency value for the stall function.<br>Refer to Figure 34. |
| 3012 | **STALL TIME**<br>This parameter sets the time value for the stall function. |
| 3013 | **UNDERLOAD FUNCTION**<br>Removal of motor load may indicate a process malfunction. The protection is activated if:<br>• The motor torque drops below the load curve selected by parameter 3015 UNDERLOAD CURVE.<br>• This condition has lasted longer than the time set by parameter 3014 UNDERLOAD TIME.<br>• Output frequency is higher than 10 % of the nominal frequency of the motor and higher than 5 Hz.<br><br>0 = NOT SEL<br>Underload protection is not used.<br><br>1 = FAULT<br>When the protection is activated the ACH 400 coasts to stop. Fault indication is displayed.<br><br>2 = WARNING<br>A warning indication is displayed. |
| 3014 | **UNDERLOAD TIME**<br>Time limit for underload protection. |

| Code | Description |
|---|---|
| 3015 | **UNDERLOAD CURVE**<br>This parameter provides five selectable curves shown in Figure 36. If the load drops below the set curve for longer than the time set by parameter 3014, the underload protection is activated. Curves 1...3 reach maximum at the motor rated frequency set by parameter 9907 MOTOR NOM FREQ. |




$I_O$ = output current
$I_N$ = nominal current of the motor
$f_O$ = output frequency
$f_{BRK}$ = break point frequency (parameter 3008 BREAK POINT)

*Figure 35 Thermal protection trip times when parameters 3005 MOT THERM TIME, 3006 MOT LOAD CURVE and 3007 ZERO SPEED LOAD have default values.*

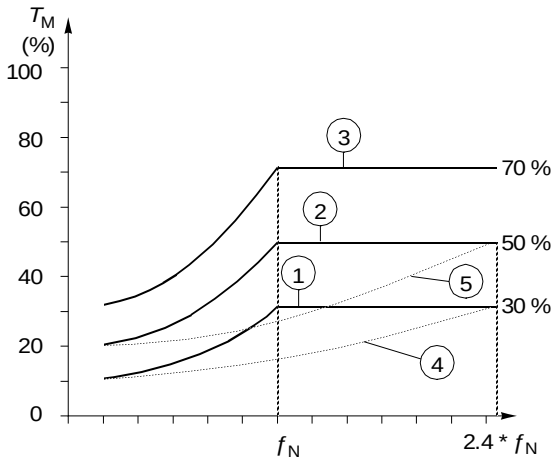



*Figure 36 Underload curve types. $T_M$ nominal torque of the motor, $f_N$ nominal frequency of the motor.*

## Group 31: Automatic Reset

The automatic reset system can be used for resetting overcurrent, overvoltage, undervoltage and analog input loss faults automatically. Number of allowed automatic reset operations within a certain time is selectable.

**Warning!** If parameter 3107 AR AI<MIN is enabled, the drive may restart even after a long stop when the analog input signal is restored. Ensure that the use of this feature will not cause physical injury and/or damage equipment.

| Code | Description |
|---|---|
| 3101 | **NR OF TRIALS**<br>Sets the number of allowed autoresets within a certain time. The time is defined with parameter 3102 TRIAL TIME. The ACH 400 prevents additional autoresets and remains stopped until a successful reset is performed from the control panel or from a place selected by parameter 1604 FAULT RESET SEL. |
| 3102 | **TRIAL TIME**<br>The time within which a limited number of fault autoresets is allowed. The allowed number of faults per this time period is given with parameter 3101 NR OF TRIALS. |
| 3103 | **DELAY TIME**<br>This parameter sets the time that the ACH 400 will wait after a fault occurs before attempting to reset. If set to zero, the ACH 400 will reset immediately. |
| 3104 | **AR OVERCURRENT**<br>0 = DISABLE<br>1 = ENABLE<br>If 1 is selected, the fault (motor overcurrent) is reset automatically after the delay set by parameter 3103, and the ACH 400 resumes normal operation. |
| 3105 | **AR OVERVOLTAGE**<br>0 = DISABLE<br>1 = ENABLE<br>If 1 is selected, the fault (DC bus overvoltage) is reset automatically after the delay set by parameter 3103, and the ACH 400 resumes normal operation. |
| 3106 | **AR UNDERVOLTAGE**<br>0 = DISABLE<br>1 = ENABLE<br>If 1 is selected, the fault (DC bus undervoltage) is reset automatically after the delay set by parameter 3103 DELAY TIME, and the ACH 400 resumes normal operation. |
| 3107 | **AR AI<MIN**<br>0 = DISABLE<br>1 = ENABLE<br>If 1 is selected, the fault (analog input signal under minimum level) is reset automatically after the delay set by parameter 3103 DELAY TIME. |

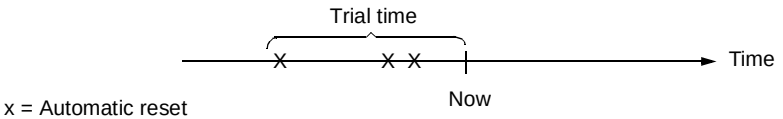
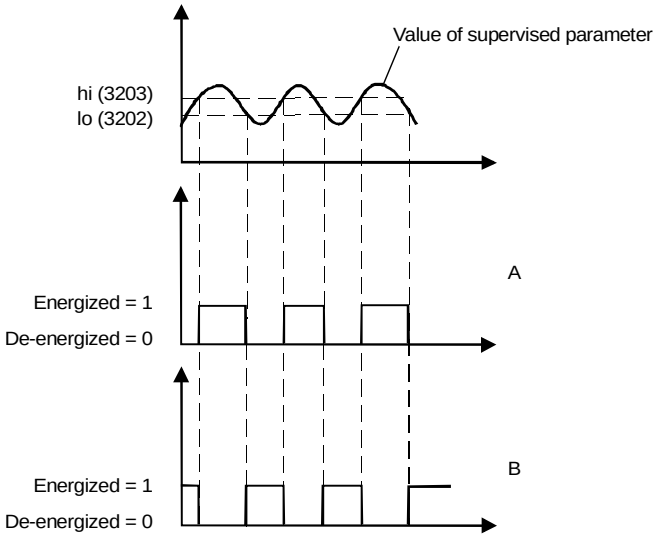



*Figure 37 Operation of automatic reset function. In this example, if the fault occurs at the moment "Now", it is automatically reset if parameter 3101 NR OF TRIALS value is greater than or equal to 4.*

## Group 32: Supervision

Parameters of this group are used together with relay output parameters 1401 RELAY OUTPUT 1 and 1402 RELAY OUTPUT 2. Any two parameters of the Operating Data group (Group 1) can be supervised. Relays can be configured to be energized when the values of supervised parameters are either too low or too high.

| Code | Description |
|---|---|
| 3201 | **SUPERV 1 PARAM**<br>First supervised parameter number of the Operating Data group (Group 01). |
| 3202 | **SUPERV 1 LIM LO**<br>First supervision limit low. Display of this parameter depends on selected supervised parameter (3201). |
| 3203 | **SUPERV 1 LIM HI**<br>First supervision limit high. Display of this parameter depends on selected supervised parameter (3201). |
| 3204 | **SUPERV 2 PARAM**<br>Second supervised parameter number of the Operating Data group (Group 01). |
| 3205 | **SUPERV 2 LIM LO**<br>Second supervision limit low. Display of this parameter depends on selected supervised parameter (3204). |
| 3206 | **SUPERV 2 LIM HI**<br>Second supervision limit high. Display of this parameter depends on selected supervised parameter (3204). |




A = Parameter 1401 RELAY OUTPUT 1 (1402 RELAY OUTPUT 2) value is SUPRV1 OVER or SUPRV2 OVER

B = Parameter 1401 RELAY OUTPUT 1 (1402 RELAY OUTPUT 2) value is SUPRV1 UNDER or SUPRV2 UNDER

*Figure 38 Operating data supervision using relay outputs.*

## Group 33: Information

| Code | Description |
|---|---|
| 3301 | **SW VERSION**<br>Software version. |
| 3302 | **TEST DATE**<br>Displays the test date of the ACH 400 (yy.ww). |

## Group 34: Process Variables

Parameters of this group can be used to create custom process variables. Values of process variables can be seen in parameters 0134 PROCESS VAR 1 and 0135 PROCESS VAR 2 AND optionally in the ACS-PAN output display. Value is calculated by taking given parameter from the operating data group (Group 1), and multiplying and dividing it with given coefficients. The unit and number of decimal digits is configurable.

See example below.

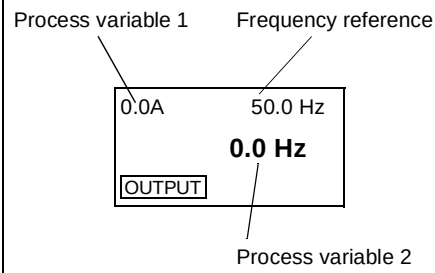
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>3401</td><td>DISPLAY SEL<br>Selects displayed variables for the output display of the ACS-PAN control panel.<br><br>1 = STANDARD<br>Panel displays standard variables.<br><br>2 = PROCESS VAR<br>Panel displays process variables. See Figure 39.<br><br> 

Figure 39 ACS-PAN output display when process variable display is selected.</td></tr>
<tr><td>3402</td><td>P VAR 1 SEL<br>Selection of process variable 1. Number of any parameter of the group 1 OPERATING DATA.</td></tr>
<tr><td>3403</td><td>P VAR 1 MULTIP<br>Process variable 1 multiplier.</td></tr>
<tr><td>3404</td><td>P VAR 1 DIVISOR<br>Process variable 1 divider.</td></tr>
<tr><td>3405</td><td>P VAR 1 SCALING<br>Decimal point location of process variable 1, when displayed. Refer to Figure 40.<br><br><table><tr><th>Value</th><th>Display</th></tr><tr><td>0</td><td>125</td></tr><tr><td>1</td><td>12.5</td></tr><tr><td>2</td><td>1.25</td></tr><tr><td>3</td><td>0.125</td></tr></table>Figure 40 Display with different decimal point locations when calculated value is 125.</td></tr>
<tr><td>3406</td><td>P VAR 1 UNIT<br>Process variable unit.<br><br>0 = NOT SEL 4 = % 8 = kh 12 = mV 16 = °F 20 = $m^3/h$ 24 = GPM 28 = MGD<br>1 = A 5 = s 9 = °C 13 = kW 17 = hp 21 = $dm^3/s$ 25 = PSI 29 = inHg<br>2 = V 6 = h 10 = lb ft 14 = W 18 = MWh 22 = bar 26 = CFM 30 = FPM<br>3 = Hz 7 = rpm 11 = mA 15 = kWh 19 = m/s 23 = kPa 27 = ft 31 = Cst</td></tr>
<tr><td>3407</td><td>P VAR 2 SEL<br>Selection of process variable 2. Number of any parameter of the group 1 OPERATING DATA.</td></tr>
</table>

| Code | Description |
|---|---|
| 3408 | **P VAR 2 MULTIP**<br>Process variable 2 multiplier. |
| 3409 | **P VAR 2 DIVISOR**<br>Process variable 2 divider. |
| 3410 | **P VAR 2 SCALING**<br>Decimal point location of process variable 2, when displayed. |
| 3411 | **P VAR 2 UNIT**<br>Process variable 2 unit. See parameter 3406. |

**Example**. Assume that a two pole motor is directly connected to a roll 0.1 m in diameter and the line speed is to be displayed in m/s. The following settings are then needed:

3401 DISPLAY SEL = 2 (PROCESS VAR)
3402 P VAR 1 SEL = 0103 (OUTPUT FREQ)
3406 P VAR 1 UNIT = 19 (m/s)

Since 1 Hz output equals 1 rev/s, equals PI * 0.1 m/s line speed, or approximately 0.314 m/s, is:

$$\text{line speed} = \frac{\text{output freq} * 314}{1000} \text{ m/s}$$

Select:

3403 P VAR 1 MULTIP = 314
3404 P VAR 1 DIVISOR = 1000

Since variable 0103 OUTPUT FREQ is displayed with 0.1 Hz resolution, it is internally scaled so that value 10 represents 1 Hz. Therefore 3405 P VAR 1 SCALING = 1 must be selected.

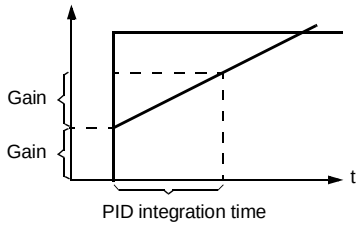
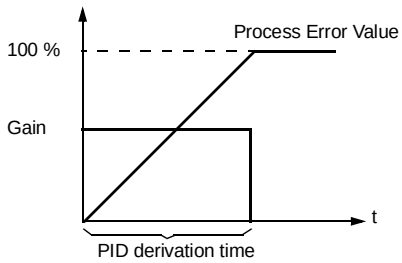
## Group 40: PID Control

The PID Control Macro allows the ACH 400 to take a reference signal (setpoint) and an actual signal (feedback), and automatically adjust the speed of the drive to match the actual signal to the reference.

There are two PID parameter sets (group 40 for set 1 parameters and group 41 for set 2 parameters). Normally only set 1 parameters are used. Set 2 parameters can be taken in use by parameter 4016 PID PARAM SET. Selection between parameter sets can be done eg. through a digital input.

PID sleep function can be used to stop the regulation when the output of the PID controller falls below preset limit. Regulation is resumed when the process actual value falls below preset limit. Alternatively, sleep function can be activated and deactivated through a digital input.

Figure 55 on page 127 (Appendix A) shows the connections of internal signals when the PID Control macro is selected.

| Code | Description |
|---|---|
| 4001 | **PID GAIN**<br>This parameter defines the gain of the PID Controller. The setting range is 0.1... 100.<br>If you select 1, a 10 % change in error value causes the PID Controller output to change by 10 %. |
| 4002 | **PID INTEG TIME**<br>PID controller integration time. Defined as the time in which the maximum output is achieved if a constant error value exists and the gain is 1. Integration time 1 s denotes that a 100 % change is achieved in 1 s.<br>  |
| 4003 | **PID DERIV TIME**<br>PID controller derivation time. If the process error value changes linearly, D part adds a constant value into the PID controller output. The derivative is filtered with a 1-pole filter. The time constant of the filter is defined by parameter 4004 PID DERIV FILTER.<br>  |

| Code | Description |
|---|---|
| 4004 | **PID DERIV FILTER**<br>Time constant for the filter of D part. By increasing the filter time constant it is possible to smooth the effect of the D part and suppress noise. |
| 4005 | **ERROR VALUE INV**<br>Process error value inversion. Normally, a decrease in feedback signal causes an increase in drive speed. If a decrease in feedback signal is desired to cause a decrease in speed, set ERROR VALUE INV to 1 (YES).<br>0 = NO<br>1 = YES |
| 4006 | **ACTUAL VAL SEL**<br>PID controller feedback (actual) signal selection. Feedback signal can be a combination of two actual values ACT1 and ACT2. Source for actual value 1 is selected by parameter 4007 and source for actual value 2 is selected by parameter 4008.<br>1 = ACT1<br>Actual value 1 is used as the feedback signal.<br>2 = ACT1-ACT2<br>Difference of actual values 1 and 2 is used as the feedback signal.<br>3 = ACT1+ACT2<br>Sum of actual values 1 and 2.<br>4 = ACT1*ACT2<br>Product of actual values 1 and 2.<br>5 = ACT1/ACT2<br>Quotient of actual values 1 and 2.<br>6 = MIN (A1, A2)<br>Smaller of actual values 1 and 2.<br>7 = MAX (A1, A2)<br>Greater of actual values 1 and 2.<br>8 = sqrt (A1-A2)<br>Square root of difference of actual values 1 and 2.<br>9 = sqA1 + sqA2<br>Sum of square roots of actual values 1 and 2. |
| 4007 | **ACT1 INPUT SEL**<br>Source for actual value 1 (ACT1).<br>1 = AI 1<br>Analog input 1 is used as actual value 1.<br>2 = AI 2<br>Analog input 2 is used as actual value 1. |
| 4008 | **ACT2 INPUT SEL**<br>Source for actual value 2 (ACT2).<br>1 = AI 1<br>Analog input 1 is used as actual value 2.<br>2 = AI 2<br>Analog input 2 is used as actual value 2. |

| Code | Description |
|---|---|
| 4009 | **ACT1 MINIMUM**<br>Minimum value for actual value 1 (ACT1). Refer to Figure 41 and to Group 13 parameters for analog input minimum and maximum settings. |
| 4010 | **ACT1 MAXIMUM**<br>Maximum value for actual value 1 (ACT1). Refer to Figure 41 and to Group 13 parameters for analog input minimum and maximum settings. |
| 4011 | **ACT2 MINIMUM**<br>Minimum value for actual value 2 (ACT2). Refer to parameter 4009. |
| 4012 | **ACT2 MAXIMUM**<br>Maximum value for actual value 2 (ACT2). Refer to parameter 4010. |

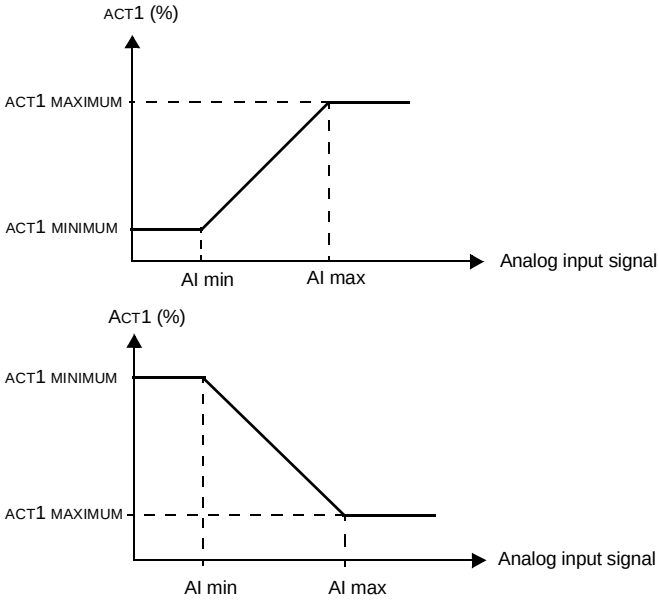



*Figure 41 Actual value scaling. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.*

| Code | Description |
|---|---|
| 4013 | **PID SLEEP DELAY**<br>Time delay for the sleep function, see Figure 42. If the ACH 400 output frequency is below a set level (parameter 4014 SLEEP LEVEL) longer than PID SLEEP DELAY, ACH 400 is stopped.<br>Alarm 28 is displayed when PID sleep is active. |
| 4014 | **PID SLEEP LEVEL**<br>Level for activation of sleep function, see Figure 42. When the ACH 400 output frequency falls below the sleep level, the sleep delay counter is started. When the ACH 400 output frequency rises above the sleep level, the sleep delay counter is reset. |
| 4015 | **WAKE-UP LEVEL**<br>Level for deactivation of sleep function. This parameter sets a process actual value limit for the sleep function (see Figure 42). The limit floats with the process reference.<br>The limit is calculated as follows:<br>limit = process reference * 4015 WAKE-UP LEVEL / 100<br>When sleep function is active, normal operation is resumed when the process actual value goes below this limit, and stays below the limit for at least the time period set by parameter 4017 WAKE-UP DELAY.<br>**Note!** Wake-up level comparison is also inverted when error value is inverted using parameter 4005 ERROR VALUE INV. |
| 4016 | **PID PARAM SET**<br>PID parameter set selection. When set 1 is selected, parameters 4001-4012 and 4019-4020 are used. When set 2 is selected, parameters 4101-4112 and 4119-4120 are used.<br>1...5 = DI1...DI5<br>PID parameter set is selected through a digital input (DI1...DI5). Parameter set 1 is used when the digital input is not active. Parameter set 2 is used when the digital input is active.<br>6 = SET 1<br>PID parameter set 1 is active.<br>7 = SET 2<br>PID parameter set 2 is active. |
| 4017 | **WAKE-UP DELAY**<br>Delay for deactivation of PID sleep function. Refer to parameter 4015 WAKE-UP LEVEL and Figure 42. |
| 4018 | **SLEEP SELECTION**<br>PID sleep function control.<br>0 = INTERNAL<br>When INTERNAL is selected, the sleep state is controlled by the output frequency, process reference and process actual value. Refer to parameters 4015 WAKE-UP LEVEL and 4014 PID SLEEP LEVEL.<br>1...5 = DI1...DI5<br>Sleep state is activated and deactivated using a digital input. |
| 4019 | **SET POINT SEL**<br>Set point selection. Defines the reference signal source for the PID controller.<br>**Note!** When PID regulator is by-passed (parameter 8121 REG BYPASS CTRL), this parameter has no significance.<br>1 = INTERNAL<br>Process reference is a constant value set with parameter 4020 INTERNAL SETPNT.<br>2 = EXTERNAL<br>Process reference is read from a source defined with parameter 1106 EXT REF2 SELECT. The ACH 400 must be in remote mode (REM is shown on control panel display).*<br>* Process reference to PID controller can also be given from the control panel in local mode (LOC is shown on control panel display) if the panel reference is given as percentage, i.e. value of parameter 1101 KEYPAD REF SEL = 2 (REF2 (%)). |
| 4020 | **INTERNAL SETPNT**<br>Sets a constant process reference (%) for the PID controller. PID controller follows this reference if parameter 4019 SET POINT SEL is set to 1 (INTERNAL). |

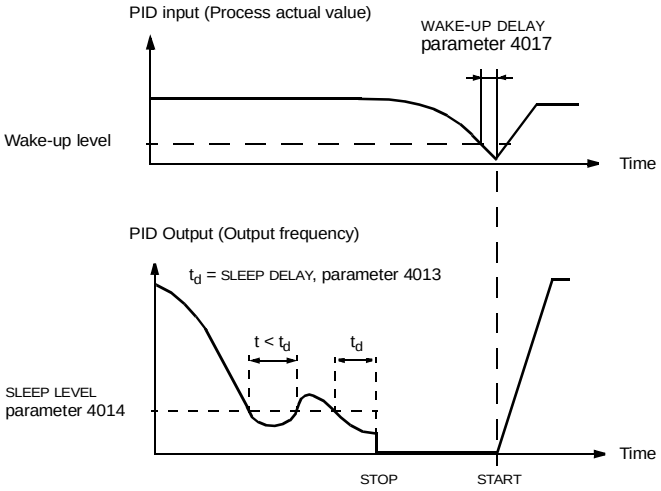



*Figure 42 Sleep function operation.*

## Group 41: PID Control (2)

Parameters of this group belong to PID parameter set 2. The operation of parameters 4101 - 4112, 4119 - 4120 is analogous with set 1 parameters 4001 - 4012, 4019 - 4020.

PID parameter set 2 can be selected by parameter 4016 PID PARAM SET.

## Group 50: Communication

Parameters of this group define some general communication settings. Parameters 5001-5002 and 5007 are used only if DDCS option module is installed.

| Code | Description |
|---|---|
| 5001 | **DDCS BIT RATE**<br>DDCS link baud rate in Mbits/s. |
| 5002 | **DDCS NODE NR**<br>DDCS link node number. |
| 5003 | **COMM FAULT TIME**<br>Communication time out delay. This applies both to standard Modbus and DDCS link.<br>When communication loss supervision is activated by parameter 5004 COMM FAULT FUNC, the bus master must write Control Word, Reference 1 or Reference 2 periodically. The maximum period is set by this parameter. |
| 5004 | **COMM FAULT FUNC**<br>Communication fault function. This applies both to standard Modbus and DDCS link.<br>0 = NOT SEL<br>No operation.<br>1 = FAULT<br>A fault indication is displayed and the ACH 400 coasts to stop.<br>2 = CONST SP 7<br>A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.<br>3 = LAST SPEED<br>A warning indication is displayed and the speed is set to the level at which the ACH 400 was last operating. This value is determined by the average speed over the last 10 seconds.<br>**Caution:** If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case communication is lost. |
| 5005 | **PROTOCOL SEL**<br>Defines what communication protocols are used. Options 1 (DDCS) and 3 (STD MDB+DDCS) should be selected only if DDCS communication module is installed.<br>0 = NOT SEL<br>No serial communication is active.<br>1 = DDCS<br>DDCS serial communication is active.<br>2 = STD MODBUS<br>Standard Modbus protocol is active.<br>3 = STD MDB+DDCS<br>Both standard Modbus and DDCS are active. |
| 5006 | **COMM COMMANDS**<br>The commands source protocol selection. Although the ACH 400 can communicate simultaneously via several serial communication channels, the controlling commands - start, stop, direction and reference - can be received only from a single communication channel, selectable by this parameter.<br>0 = NOT SEL<br>Controlling commands are not received via serial communication.<br>1 = STD MODBUS<br>Controlling commands can be received through Channel 1 standard Modbus protocol.<br>2 = DDCS<br>Controlling commands can be received through the DDCS link. |

| Code | Description |
|---|---|
| 5007 | **DDCS BUS MODE**<br>Sets the operation mode of the DDCS link.<br><br>1=FIELDBUS<br>Fieldbus adapter is used in DDCS link. (The ACH 400 acts as the slave station on the DDCS link).<br><br>2=IO EXTENSION<br>Input/output extension module (type name NDIO) is used on DDCS link. The ACH 400 acts as the master station on the DDCS link, and is capable of controlling the digital inputs and outputs of the extension module.<br><br>**Note!** Value 2 (IO EXTENSION) should be used only when PFC (Pump-Fan Control) macro is selected. |

## Group 51: Ext Comm Module

Parameters of this group need to be adjusted only when an external fieldbus communication module is installed. Refer to communication module documentation for more information on these parameters.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>5101</td><td>FIELDBUSPAR 1<br>Parameter 1 of communication module on the DDCS link. Value reflects the type of the connected communication module.<br><br>Table 11 List of module types.
<table>
<tr><th>Value</th><th>Module type</th></tr>
<tr><td>0</td><td>No module connected.</td></tr>
<tr><td>1</td><td>NPBA Profibus</td></tr>
<tr><td>2</td><td>NMBA Modbus</td></tr>
<tr><td>3</td><td>NIBA Interbus-S</td></tr>
<tr><td>4</td><td>NCSA CS31 bus</td></tr>
<tr><td>5</td><td>NCAN CANopen</td></tr>
<tr><td>6</td><td>NDNA DeviceNet</td></tr>
<tr><td>7</td><td>NLON LONWORKS</td></tr>
<tr><td>8</td><td>NMBP Modbus+</td></tr>
<tr><td>9</td><td>Others</td></tr>
</table></td></tr>
<tr><td>5102 - 5115</td><td>FIELDBUSPAR 2 - FIELDBUSPAR 15<br>Refer to communication module documentation for more information on these parameters.</td></tr>
</table>

## Group 52: Standard Modbus

The ACH 400 can be connected to Modbus fieldbus system. Parameters of this group are used to set up station number, communication speed and parity. Parameters 5206 - 5215 are diagnostic counters that can be used to debug the fieldbus system. Refer to “Standard Serial Communication” on page 103 for more information.

Modifications of parameters in this group take effect on the next power-up.

| Code | Description |
|---|---|
| 5201 | **STATION NUMBER**<br>Sets the slave number for the ACH 400 in Modbus network.<br><br>Range: 1 - 247 |
| 5202 | **COMM SPEED**<br>Defines the communication speed of the ACH 400 in bits per second (bits/s).<br><br>3 = 300 bits/s<br>6 = 600 bits/s<br>12 = 1200 bits/s<br>24 = 2400 bits/s<br>48 = 4800 bits/s<br>96 = 9600 bits/s<br>192 = 19200 bits/s |
| 5203 | **PARITY**<br>Defines the parity to be used with the Modbus communication. Parameter also defines the number of stop bits. With Modbus communication, the number of stop bits is 2 with no parity bit, and 1 with even or odd parity.<br><br>0 = NONE<br>1 = EVEN<br>2 = ODD |
| 5206 | **BAD MESSAGES**<br>This diagnostics counter increases by one every time the ACH 400 finds any kind of communication error. During normal operation, this counter hardly ever increases. |
| 5207 | **GOOD MESSAGES**<br>This diagnostics counter increases by one every time a valid Modbus message has been received by the ACH 400. During normal operation, this counter is increasing constantly. |
| 5208 | **BUFFER OVERRUNS**<br>Longest possible message length for the ACH 400 is 32 bytes. If a message exceeding 32 bytes is received, this diagnostic counter increases by one every time a character which cannot be placed in the buffer is received. |
| 5209 | **FRAME ERRORS**<br>This diagnostic counter increases by one every time when a character with a framing error is received from the bus.<br>• Communication speed settings of the devices connected in the bus differ.<br>• Ambient noise levels may be too high. |
| 5210 | **PARITY ERRORS**<br>This diagnostic counter increases by one every time when a character with a parity error is received from the bus.<br>• Parity settings of the devices connected on the bus differ.<br>• Ambient noise levels may be too high. |

| Code | Description |
|---|---|
| 5211 | **CRC ERRORS**<br>This diagnostic counter increases by one every time when a message with a CRC error is received.<br>• Ambient noise levels may be too high.<br>• CRC calculation is not performed correctly. |
| 5212 | **BUSY ERRORS**<br>This diagnostic counter increases by one every time the ACH 400 receives a character from the bus while it is still processing the previous message.<br>• There might be two stations with the same station number.<br>• Ambient noise levels may be too high. |
| 5213 | **SER FAULT MEM 1**<br>Last Modbus exception code sent. |
| 5214 | **SER FAULT MEM 2**<br>Previous Modbus exception code sent. |
| 5215 | **SER FAULT MEM 3**<br>Oldest Modbus exception code sent. |

## Group 81: PFC Control

Parameters for Pump-Fan Control (PFC). Appendix B gives detailed information on PFC. Chapter Application Macros describes the default signal connections.

| Code | Description |
|---|---|
| 8103 | **REFERENCE STEP 1**<br>Sets a percentage value that is added to the process reference when at least one auxiliary (constant speed) motor is running. Default value is 0 %.<br>**Example:** An ACH 400 operates three parallel pumps that pump water to a pipe. The pressure in the pipe is controlled. The constant pressure reference is set by parameter 4020 INTERNAL SETPNT.<br>At low water consumption level only the speed regulated pump is run. When water consumption increases, constant speed pumps are started; first one pump, and if the demand is still growing, also the other pump.<br>When water flow increases, the pressure loss increases between the beginning (measurement site) and the end of the pipe. By setting suitable reference steps (parameters 8103 REFERENCE STEP1 and 8104 REFERENCE STEP2) the process reference is increased along the increasing pumping capacity. The reference steps compensate the growing pressure loss and prevent the pressure fall at the end of the pipe. |
| 8104 | **REFERENCE STEP 2**<br>Sets a percentage value that is added to the process reference when at least two auxiliary (constant speed) motors are running. Default value is 0 %. See parameter 8103 REFERENCE STEP1 |
| 8105 | **REFERENCE STEP 3**<br>Sets a percentage value that is added to the process reference when at least three auxiliary (constant speed) motors are running. Default value is 0 %. See parameter 8103 REFERENCE STEP1. |
| 8109 | **START FREQ 1**<br>Sets a frequency limit. See Figure 43 on page 93. When the ACH 400's output frequency exceeds value (8109 START FREQ 1 + 1 Hz) and no auxiliary motors are running, the Start Delay counter is started. When the time set with parameter 8115 AUX MOT START D is elapsed and if the output frequency is still above value (8109 START FREQ 1 - 1 Hz), the first auxiliary motor is started.<br>After the first auxiliary motor is started, the ACH 400's output frequency is decreased by value (8109 START FREQ 1 - 8112 LOW FREQ 1).<br>**Note!** Start Frequency 1 should be within limits 8112 LOW FREQ 1 and 2008 MAXIMUM FREQ -1. |
| 8110 | **START FREQ 2**<br>Sets a frequency limit (see Figure 43 ). When the ACH 400's output frequency exceeds value (8110 START FREQ 2 + 1 Hz) and one auxiliary motor is running, the Start Delay counter is started. When the time set with parameter 8115 AUX MOT START D is elapsed and if the output frequency is still above value (8110 START FREQ 2 - 1 Hz), the second auxiliary motor is started.<br>After the second auxiliary motor is started, the ACH 400's output frequency is decreased by value (8110 START FREQ 2 - 8113 LOW FREQ 2).<br>**Note!** Start Frequency 2 should be within limits 8112 LOW FREQ 2 and 2008 MAXIMUM FREQ -1. |
| 8111 | **START FREQ 3**<br>Sets a frequency limit (see Figure 43). When the ACH 400's output frequency exceeds value (8111 START FREQ 3 + 1 Hz) and two auxiliary motors are running, the Start Delay counter is started. When the time set with parameter 8115 AUX MOT START D is elapsed and if the output frequency is still above value (8111 START FREQ 3 - 1 Hz), the third auxiliary motor is started.<br>After the third auxiliary motor is started, the ACH 400's output frequency is decreased by value (8111 START FREQ 3 - 8114 LOW FREQ 3).<br>**Note!** Start Frequency 3 should be within limits 8112 LOW FREQ 3 and 2008 MAXIMUM FREQ -1. |

| Code | Description |
|---|---|
| 8112 | **LOW FREQ 1**<br>Sets a frequency limit (see Figure 43). When the ACH 400's output frequency falls below value (8112 LOW FREQ 1 - 1 Hz) and one auxiliary motor is running, the Stop Delay counter is started. When the time set with parameter 8116 AUX MOT STOP D. is elapsed and if the output frequency is still below value (8112 LOW FREQ 1 + 1 Hz), the first auxiliary motor is stopped.<br>After the auxiliary motor is stopped, the ACH 400's output frequency is increased by value (8109 START FREQ 1 - 8112 LOW FREQ 1).<br>**Note!** Low Frequency 1 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 1. |
| 8113 | **LOW FREQ 2**<br>Sets a frequency limit (see Figure 43). When the ACH 400's output frequency falls below value (8113 LOW FREQ 2 - 1 Hz) and two auxiliary motors are running, the Stop Delay counter is started. When the time set with parameter 8116 AUX MOT STOP D. is elapsed and if the output frequency is still below value (8113 LOW FREQ 2 + 1 Hz), the second auxiliary motor is stopped.<br>After the auxiliary motor is stopped, the ACH 400's output frequency is increased by a value (8110 START FREQ 2 - 8113 LOW FREQ 2).<br>**Note!** Low Frequency 2 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 2 |
| 8114 | **LOW FREQ 3**<br>Sets a frequency limit (see Figure 43). When the ACH 400's output frequency falls below value (8114 LOW FREQ 3 - 1 Hz) and three auxiliary motors are running a Stop Delay counter is started. When the time set with parameter 8116 AUX MOT STOP D. is elapsed and if the output frequency is still below value (8114 LOW FREQ 3 + 1 Hz), the third auxiliary motor is stopped.<br>After the auxiliary motor is stopped, the ACH 400's output frequency is increased by value (8111 START FREQ 3 - 8114 LOW FREQ 3).<br>**Note!** Low Frequency 3 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 3. |
| 8115 | **AUX MOT START D**<br>Sets the Start Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 and Figure 43 for more information. |
| 8116 | **AUX MOT STOP D.**<br>Sets the Stop Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 for more information. |

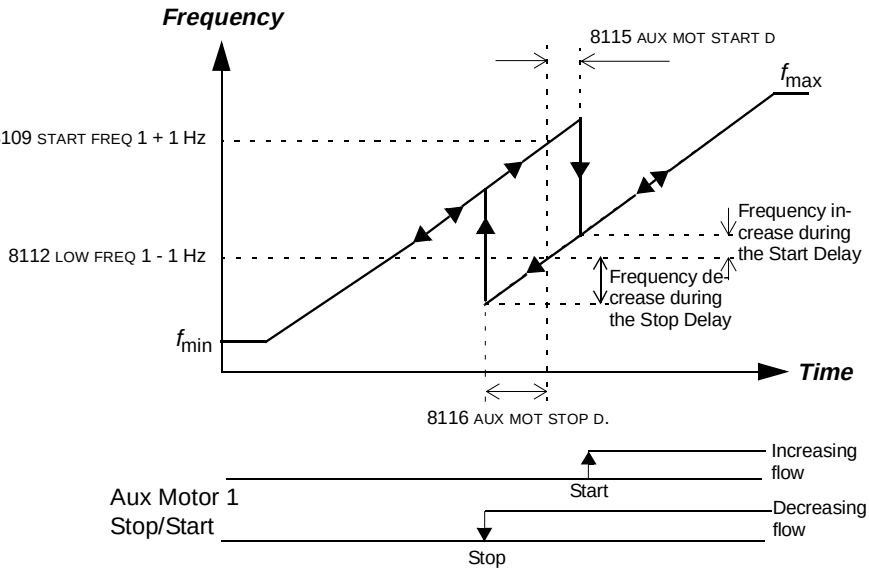



*Figure 43 Start Frequency, Low Frequency, Start Delay and Stop Delay.*

| Code | Description |
|---|---|
| 8117 | **NR OF AUX MOT**<br>Sets the number of auxiliary motors. |

## Relay outputs

Start/stop signals for the auxiliary motors are given through relay outputs. In addition, one relay output is used to connect the speed regulated motor to the ACH 400.

ACH 400 relay outputs RO1 and RO2 can be used to control the motors. It is also possible to use up to two optional external digital input/output modules (NDIO).

ACH 400 relay output 1 is used for Pump and Fan motor control if 1401 RELAY OUTPUT 1 value is 29 (PFC). Relay output 2 is used for Pump and Fan motor control if 1402 RELAY OUTPUT 2 value is 29 (PFC).

Table 12 depicts the use of relay outputs for different settings of parameters 1401 and 1402. If the Autochange function is not used, the first relay output configured for PFC use controls the speed regulated motor. If Autochange function is used, the ACH 400 Autochange logic assigns the relay outputs to corresponding motors (of which one is speed controlled).

*Table 12 Usage of relay outputs. Relay output configuration is set by parameters 1401, 1402 and 8117. Number of relay outputs needed depends on the number of auxiliary motors. For example, if the number of auxiliary motors is 2, a total of three relay outputs (motors 1,2 and 3) are needed. x = Any other setting than 29 (PFC).*

| Parameter setting | | ACH 400 relays | | NDIO module 1 (Module node number = 5) | | NDIO module 2 (Module node number = 6) | |
|---|---|---|---|---|---|---|---|
| 1401 RELAY OUTPUT 1 | 1402 RELAY OUTPUT 2 | Relay output RO1 function | Relay output RO2 function | NDIO relay output 1 function | NDIO relay output 2 function | NDIO relay output 1 function | NDIO relay output 2 function |
| 29 (PFC) | 29 (PFC) | Motor 1 start/stop | Motor 2 start/stop | Motor 3 start/stop | Motor 4 start/stop | Not used | Not used |
| 29 (PFC) | x | Motor 1 start/stop | e.g. Fault | Motor 2 start/stop | Motor 3 start/stop | Motor 4 start/stop | Not used |
| x | 29 (PFC) | e.g. Fault | Motor 1 start/stop | Motor 2 start/stop | Motor 3 start/stop | Motor 4 start/stop | Not used |
| x | x | e.g. Run | e.g. Fault | Motor 1 start/stop | Motor 2 start/stop | Motor 3 start/stop | Motor 4 start/stop |

| | |
|---|---|
| 8118 | **AUTOCHNG INTERV**<br>Sets the interval for the Autochange function. The time is counted only when the ACH 400 Start signal is on. See parameter 8119 AUTOCHNG LEVEL for information on the operation of the Autochange.<br>0.0 = NOT SEL<br>This setting switches off the Autochange function.<br>**Note!** The ACH 400 always coasts to stop when autochange is performed.<br>**Warning!** If the Autochange function is used, the Interlocks must be in use. In Autochange system there is a contactor between the ACH 400 output terminals and the speed controlled motor. The contactor is damaged if opened without first interrupting the ACH 400 inverter bridge switching. The inverter switching is interrupted when the Interlock is switched off and the ACH 400 coasts to stop. |

| Code | Description |
|---|---|
| 8119 | **AUTOCHNG LEVEL**<br>Sets the operation limit for the Autochange logic. This parameter can be used to deny Autochange when the Pump-Fan system is operating near maximum capacity. When the output from the PID/PFC control block exceeds the level set by this parameter, Autochange operation is not possible. |

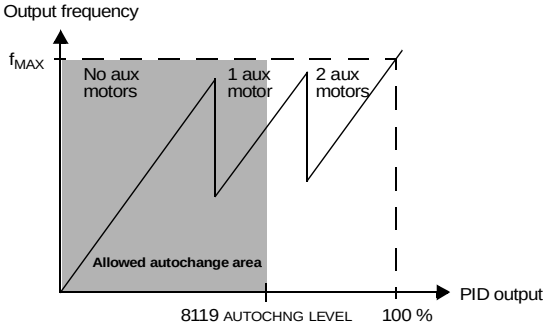



*Figure 44 Autochange level.*

## Autochange operation

The purpose of the Autochange operation is to ensure equal duty time for all the motors. Each motor in the system will in its turn be connected to the ACH 400 as well as direct on line. The starting order of the motors is changed when Autochange is done.

To use the Autochange function, an external alternation switchgear is needed. Refer to Appendix B for more information. When Autochange is used, the interlocks (parameter 8120) must also be taken into use.

The Autochange is performed when the Autochange Interval (parameter 8118) is elapsed from the previous autochange and the output from PFC is below the level set by this parameter.

Autochange operation is as follows:

1. The speed controlled motor stops. The contactor of the speed controlled motor is switched off.
2. The starting order is changed (the starting order counter steps onward).
3. The contactor of the motor that will be the new speed controlled motor is switched off (if the motor is running). If other motors are running, they will not be interrupted.
4. The contactor of the new speed controlled motor is switched on. The autochange switchgear connects this motor to the ACH 400.
5. Time set with parameter 8122 PFC START DELAY is waited.
6. Speed controlled motor starts. If a constant speed motor was stopped in Step 3, one more motor is connected direct on-line by switching on the contactor of that motor. After this step the same number of motors is running than before the Autochange.
7. Normal PFC operation continues.

As an example, in a three motor system the starting order is changed as follows:

First start: Motor no. 1, motor no. 2, motor no. 3.

Second start: Motor no. 2, motor no. 3, motor no. 1.

Third start: Motor no. 3, motor no. 1, motor no. 2. (etc...)

If some motors in the system are interlocked, the Autochange logic skips them. If all interlocks are active and no motor can be started, interlock alarm (Alarm 30) is displayed.

**Note!** The ACH 400 always coasts to stop when autochange is performed.

**Note!** Autochange can also occur during PID sleep.

**Note!** When ACH 400 power supply is switched off, the values of the starting order counter and Autochange Interval counter are stored in the permanent memory. The counters continue from the stored values after the power supply is switched on again.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>8120</td><td>
INTERLOCKS<br>
Controls the use of the Interlock function.<br><br>
Warning! If the Autochange function is used, the Interlocks are also used (see parameter 8118 AUTOCHNG INTERV).<br><br>
0 = NOT SEL<br>
No Interlocks function is in use. All digital inputs are available for other purposes.<br><br>
1 = DI1<br>
Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table.<br><br>
<table>
<tr><th></th><th colspan="3">Interlock signals</th></tr>
<tr><th>No of aux. motors (param. 8117)</th><th>ACH 400 digital inputs</th><th>NDIO module 1</th><th>NDIO module 2</th></tr>
<tr><td>0</td><td>DI1: Motor 1<br>DI2-DI5 free</td><td>Not used</td><td>Not used</td></tr>
<tr><td>1</td><td>DI1: Motor 1<br>DI2: Motor 2<br>DI3-DI5 free</td><td></td><td></td></tr>
<tr><td>2</td><td>DI1: Motor 1<br>DI2: Motor 2<br>DI3: Motor 3<br>DI4-DI5 free</td><td></td><td></td></tr>
<tr><td>3</td><td>DI1: Motor 1<br>DI2: Motor 2<br>DI3: Motor 3<br>DI4: Motor 4<br>DI5 free</td><td></td><td></td></tr>
</table>
2 = DI2<br>
Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table.<br><br>
<table>
<tr><th></th><th colspan="3">Interlock signals</th></tr>
<tr><th>No of aux. motors (param. 8117)</th><th>ACH 400 digital inputs</th><th>NDIO module 1</th><th>NDIO module 2</th></tr>
<tr><td>0</td><td>DI1: free<br>DI2: Motor 1<br>DI3-DI5 free</td><td>Not used</td><td>Not used</td></tr>
<tr><td>1</td><td>DI1: free<br>DI2: Motor 1<br>DI3: Motor 2<br>DI4-DI5 free</td><td></td><td></td></tr>
<tr><td>2</td><td>DI1: free<br>DI2: Motor 1<br>DI3: Motor 2<br>DI4: Motor 3<br>DI5: free</td><td></td><td></td></tr>
<tr><td>3</td><td>DI1: free<br>DI2: Motor 1<br>DI3: Motor 2<br>DI4: Motor 3<br>DI5: Motor 4</td><td></td><td></td></tr>
</table>
</td></tr>
</table>

| Code | Description |
|---|---|

3 = DI3
Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table.

| | Interlock signals | | |
|---|---|---|---|
| **No of aux. motors (param. 8117)** | **ACH 400 digital inputs** | **NDIO module 1** | **NDIO module 2** |
| 0 | DI1-DI2: free<br>DI3: Motor 1<br>DI4-DI5 free | Not used | Not used |
| 1 | DI1-DI2: free<br>DI3: Motor 1<br>DI4: Motor 2<br>DI5: free | | |
| 2 | DI1-DI2: free<br>DI3: Motor 1<br>DI4: Motor 2<br>DI5: Motor 3 | | |
| 3 | DI1-DI2: free<br>DI3: Motor 1<br>DI4: Motor 2<br>DI5: Motor 3 | DI1: Motor 4<br>DI2: Unused | Not used |

4 = DI4
Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table.

| | Interlock signals | | |
|---|---|---|---|
| **No of aux. motors (param. 8117)** | **ACH 400 digital inputs** | **NDIO module 1** | **NDIO module 2** |
| 0 | DI1-DI3: free<br>DI4: Motor 1<br>DI5 free | Not used | Not used |
| 1 | DI1-DI3: free<br>DI4: Motor 1<br>DI5: Motor 2 | | |
| 2 | DI1-DI3: free<br>DI4: Motor 1<br>DI5: Motor 2 | DI1: Motor 3<br>DI2: unused | |
| 3 | DI1-DI3: free<br>DI4: Motor 1<br>DI5: Motor 2 | DI1: Motor 3<br>DI2: Motor 4 | Not used |

| Code | Description |
|---|---|
| | 5 = DI5<br>Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table. |

| | Interlock signals | | |
|---|---|---|---|
| **No of aux. motors (param. 8117)** | **ACH 400 digital inputs** | **NDIO module 1** | **NDIO module 2** |
| 0 | DI1-DI4: free<br>DI5: Motor 1 | Not used | Not used |
| 1 | DI1-DI4: free<br>DI5: Motor 1 | DI1: Motor 2<br>DI2: Unused | Not used |
| 2 | DI1-DI4: free<br>DI5: Motor 1 | DI1: Motor 2<br>DI2: Motor 3 | Not used |
| 3 | DI1-DI4: free<br>DI5: Motor 1 | DI1: Motor 2<br>DI2: Motor 3 | DI1: Motor 4<br>DI2: Unused |

6 = EXTERNAL IO
Interlocks function is in use. All interlock signals are taken through external I/O modules. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to following table.

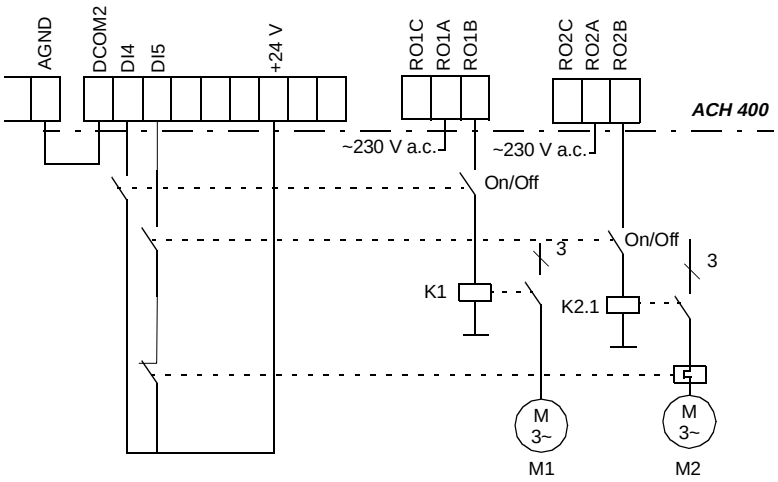
| | Interlock signals | | |
|---|---|---|---|
| **No of aux. Motors (param. 8117)** | **ACH 400 digital inputs** | **NDIO module 1** | **NDIO module 2** |
| 0 | DI1-DI5: free | DI1: Motor 1<br>DI2: Unused | Not used |
| 1 | DI1-DI5: free | DI1: Motor 1<br>DI2: Motor 2 | Not used |
| 2 | DI1-DI5: free | DI1: Motor 1<br>DI2: Motor 2 | DI1: Motor 3<br>DI2: Unused |
| 3 | DI1-DI5: free | DI1: Motor 1<br>DI2: Motor 2 | DI1: Motor 3<br>DI2: Motor 4 |

Interlock signals are active low, i.e. interlock is active when the corresponding interlock signal is absent. If a start command is given when the interlock signal of the speed regulated motor is active, the ACH 400 will not start, and will show alarm 30 (INTERLOCK) on the control panel.

Each Interlock circuit should be wired as follows:

1. A contact of the On/Off switch of the motor must be wired to the Interlock circuit. PFC logic detects if a motor is switched off. The logic does not try to start the switched-off motor; the next available motor is started instead.

2. A contact of the motor thermal relay (or another protective device in the motor circuit) must be wired to the Interlock input. PFC logic detects if the thermal relay is activated. The motor is stopped.

| Code | Description |
|---|---|
| |  <br>*Figure 45 Wiring the interlocks of a PFC system with two motors. There is a thermal relay in the supply circuit of M2.* |

| Code | Description |
|---|---|
| 8121 | **REG BYPASS CTRL**<br>Regulator bypass control provides a simple control mechanism without a PID regulator. Bypass control is needed in special applications only. Example is given in Figure 46 and Figure 47.<br>0 = NO<br>Process PID regulator is in use.<br>1 = YES<br>The process PID regulator is bypassed. The signal connected to the PID Controller actual value pin (parameter 4006 ACTUAL VAL SEL) is used as the PFC frequency reference. The automatic start and stop of constant speed motors is referred to this actual value signal instead of the output of the PID regulator. |

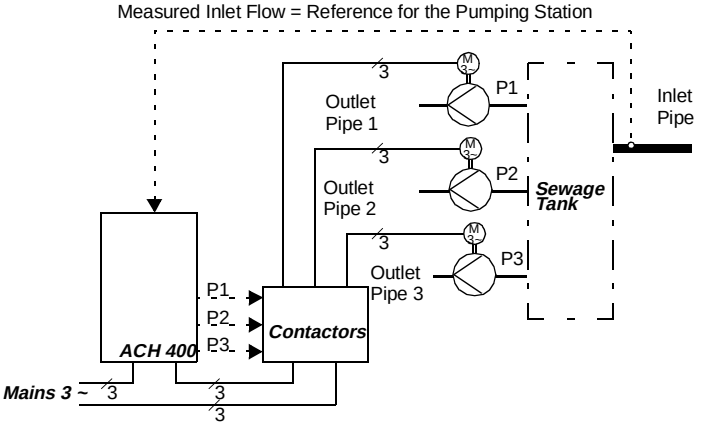
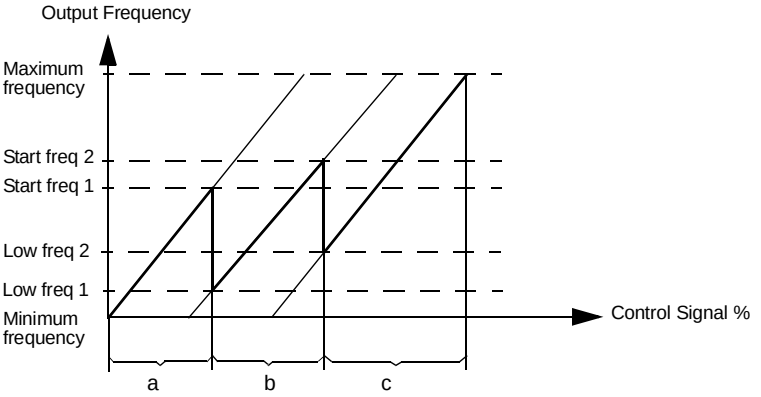



*Figure 46 Regulator bypass control. The capacity of the pumping station (outlet flow) follows the measured inlet flow.*




a: No auxiliary motors running
b: One auxiliary motor running
c: Two auxiliary motors running

*Figure 47 The relation between the control signal and the frequency of the controlled motor in a three-motor system.*

| Code | Description |
|---|---|
| 8122 | **PFC START DELAY**<br>Sets the start delay for all the motors in the system. The delay works as follows:<br>1. The contactor that connects the speed regulated motor to ACH 400 is switched on (by a ACH 400 relay output).<br>2. PFC Start Delay is waited.<br>3. Speed regulated motor is energized and normal PFC operation starts. Auxiliary motors are started.<br>**Caution!** The PFC Start Delay should always be set if the motors are equipped with star-delta starters. The PFC Start Delay must be set longer than the time setting of the star-delta starter: After the motor is switched on by the relay output of the ACH 400 there must be enough time for the star-delta starter to first switch to star-connection and then back to delta-connection before the ACH 400 inverter starts switching. |

# Standard Serial Communication

## Overview

The ACH 400 can be connected to an external control system using the standard Modbus fieldbus connection.

The ACH 400 can receive all of its control information either from the Modbus fieldbus, or the control can be distributed between the fieldbus and other available control locations, e.g. digital/ analog inputs and the drive control panel.

The ACH 400 has two serial communication channels (or ports), Channel 0 and Channel 1. Channel 1 is the standard Modbus fieldbus connection. Communication settings of Channel 1 can be configured by the user. To control the ACH 400 via Modbus, the ACH 400 must be programmed to accept control commands and/or frequency references from Channel 1. Channel 0 is reserved for drive control panels ACS-PAN-B and ACS100-PAN, and for the Drive*Window* PC tool.

**Optional serial communication features**

The ACH400 can also be connected to number of other fieldbuses using special fieldbus adapter modules. These adapters are connected using an optical DDCS link (DDCS=Distributed Drives Control System). For more information on these options, contact your local ABB sales office.

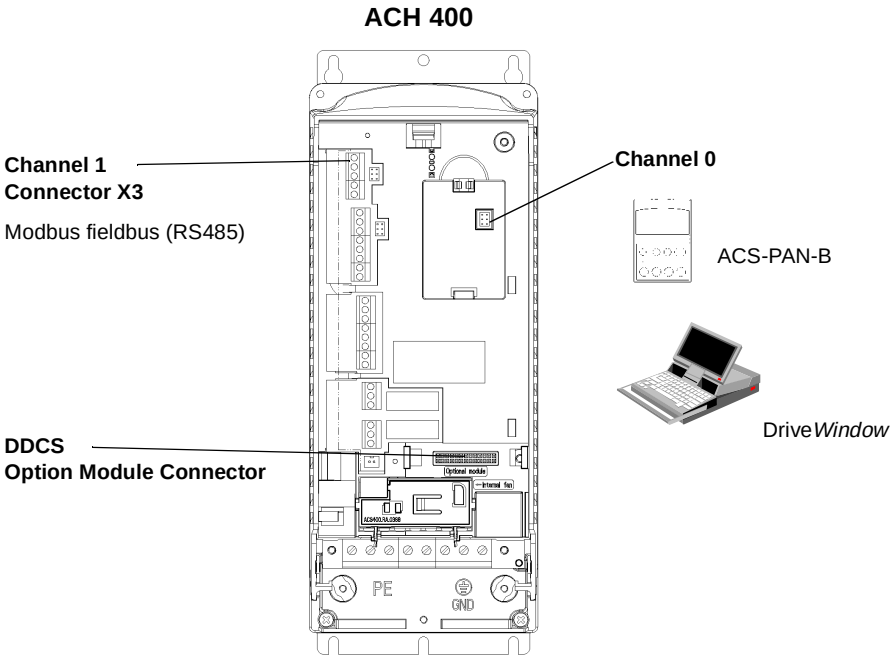



*Figure 48 Standard serial communication features of the ACH 400.*

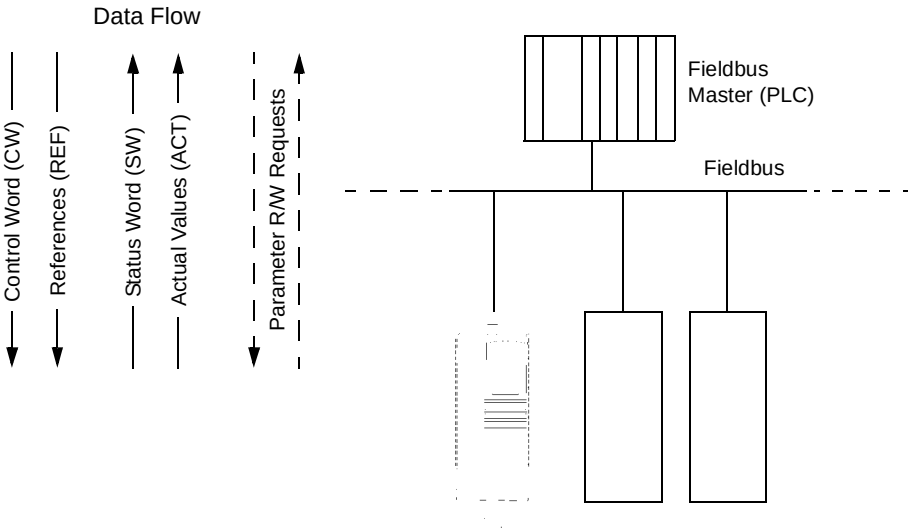



*Figure 49 Structure of a fieldbus system.*

## Grounding and Termination

### RS485 Bus

The RS485 network should not be directly grounded at any point. All the devices on the network should be well grounded 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.

The RS485 network must be terminated using 120 Ω resistors at both ends of the network. Use jumper J2 to connect or disconnect the termination resistors.

Termination should not be done on the intermediate stations. See Figure 50 for the proper method of termination.


*Figure 50 Termination for the RS485 link.*

**Warning! The connections should only be made with the drive disconnected from the power source.**

## Activating Modbus protocol

The factory setting for Channel 1 is not enabled. To enable standard Modbus protocol for Channel 1, set parameter 5005 PROTOCOL SEL to 2 (STD MODBUS).

After this parameter change, the ACH400 is ready to communicate via Channel 1 using the default communication settings (given in Table 13), making parameter read and write possible.

The following sections describe how to configure the ACH400 for more sophisticated communication and control.

*Table 13 Default communication settings of the Channel 1.*

| Station number | Communication speed | Parity bit | Stop bits |
|---|---|---|---|
| 1 | 9600 bps | none | two |

## Communication settings

Communication settings define the communication speed, parity checking, number of stop bits and fault functions. These settings for Channel 1 are defined using parameters in groups 50 COMMUNICATION and 52 STANDARD MODBUS.

Default communication settings for Channel 1 are listed in Table 13. To be able to communicate with the master device, the ACH 400 must use the same communication speed and parity settings as the master.

Further information on all parameters and their alternative settings is given in under “ACH 400 Complete Parameter List” on page 43.

*Table 14 Communication parameters.*

| Code | Name | Range | Default | User | Function/Information |
|---|---|---|---|---|---|
| **Group 52 STANDARD MODBUS** | | | | | |
| 5201 | STATION NUMBER | 1 - 247 | 1 | | Slave number for ACH 400 in Modbus network. |
| 5202 | COMM SPEED | 300,...,19200 bps | 9600 bits/s | | Communication speed. |
| 5203 | PARITY | NONE,EVEN,ODD | NONE | | Parity and stop bit setting. |
| **Group 50 COMMUNICATION** | | | | | |
| 5003 | COMM FAULT TIME | 0.1 - 60.0 s | 1.0 s | | Time limit for communication loss detection. |
| 5004 | COMM FAULT FUNC | NOT SEL, FAULT, CONST SP 7, LAST SPEED | NOT SEL | | Operation in case communication with the master device is lost. |
| 5005 | PROTOCOL SEL | NOT SEL, DDCS, STD MODBUS, STD MDB+DDCS | NOT SEL | | Communication protocols selection. Normally must be set to STD MODBUS. |

## Control Locations

The ACH 400 drive can receive control information from multiple sources, including digital I/O, analog I/O, keypad, and Modbus fieldbus.

To control the ACH 400 via the serial communication channel 1 (Modbus fieldbus), it must be programmed to accept control commands and/or frequency references from this channel. To accept control from serial communications, ACH 400 must be in remote control.

The necessary parameters and their usage are listed in Table 15. Before any control commands can be given through serial communication channel 1, parameter 5006 COMM COMMANDS value must be set to STD MODBUS.

Further information on all the parameters and their alternative settings can be found under “ACH 400 Complete Parameter List” on page 43.

*Table 15 Parameters for control command source selection.*

| Code | Parameter Name | Alternative Settings | Setting for Standard Modbus | Function/Information |
|---|---|---|---|---|
| **Group 50 COMMUNICATION** | | | | |
| 5006 | COMM COMMANDS | NOT SEL,<br>STD MODBUS,<br>DDCS | STD MODBUS | Defines the source for serial communication commands in general. |
| **Group 10 COMMAND INPUTS** | | | | |
| 1001 | EXT1 COMMANDS | NOT SEL<br>DI1<br>...<br>COMM | COMM | Enables the Control Word (except bit 11) when EXT1 is selected as control location. |
| 1002 | EXT2 COMMANDS | NOT SEL<br>DI1<br>...<br>COMM | COMM | Enables the Control Word (except bit 11) when EXT2 is selected as control location. |
| 1003 | DIRECTION | FORWARD<br>REVERSE<br>REQUEST | REQUEST | Enables rotation direction control as defined by parameters 1001 and 1002. |
| **Group 11 REFERENCE SELECT** | | | | |
| 1102 | EXT1/EXT2 SEL | DI1<br>...<br>COMM | COMM | Enables external control location EXT1/ EXT2 selection by Control Word bit 11. |
| 1103 | EXT REF1 SELECT | KEYPAD<br>AI1<br>...<br>COMM<br>COMM+AI1<br>COMM*AI1 | COMM,<br>COMM+AI1<br>or<br>COMM*AI1 | Fieldbus reference 1 is used when EXT1 is selected as control location. See section References below for information on the alternative settings. |

| Code | Parameter Name | Alternative Settings | Setting for Standard Modbus | Function/Information |
|---|---|---|---|---|
| 1106 | EXT REF2 SELECT | KEYPAD<br>AI1<br>...<br>COMM<br>COMM+AI1<br>COMM*AI1 | COMM,<br>COMM+AI1<br>or<br>COMM*AI1 | Fieldbus reference 2 is used when EXT2 is selected as control location. See section References below for information on the alternative settings. |
| **Group 16<br>SYSTEM CONTROLS** | | | | |
| 1601 | RUN ENABLE | NOT SEL<br>DI1...DI5<br>COMM | COMM | Selects the source of the run enable signal. |
| 1604 | FAULT RESET SEL | KEYPAD ONLY<br>DI1...DI5<br>START/STOP<br>COMM | COMM | Fault reset source<br>**Note! Fault reset is always possible with conrol panel.** |

## Output signal source selection

It is possible to control both the relay outputs 1 and 2, as well as the analog output from the serial communication channel 1.

Relay outputs can be controlled in the following way:

Step 1: Configure the ACH 400 to *supervise* the value of any of the parameters 131-133 using parameters in group 32 SUPERVISION.

Step 2: Configure a relay output 1 or 2 to respond to the status of one of the supervised parameter.

The selected relay can now be turned on or off by writing to supervised parameter (131-133) *some* value that is either above or below the given supervision limits.

Refer to Table 16 for more information on required parameter settings. With the given settings, writing any value 100 - 255 to parameter 131 SER LINK DATA 1 causes the relay output 1 to *activate*. Writing any value 0 - 99 to parameter 131 causes the relay output 1 to *deactivate*.

Refer to Table 17 for information on analog output control.

*Table 16 Relay output control.*

| Code | Parameter Name | Alternative Settings | Setting for Standard Modbus | Function/Information |
|---|---|---|---|---|
| **Group 01 OPERATING DATA** | | | | |
| 0131 | SER LINK DATA 1 | 0 - 255 | - | Controlling data for the relay outputs. |
| 0132 | SER LINK DATA 2 | 0 - 255 | - | |
| **Group 14 RELAY OUTPUTS** | | | | |
| 1401 | RELAY OUTPUT 1 | NOT SEL<br>...<br>SUPRV1 OVER<br>SUPRV1 UNDER<br>SUPRV2 OVER<br>SUPRV2 UNDER<br>...<br>UNDERLOAD | e.g. SUPERV1 OVER | Relay output 1 function.<br>With the given setting, the relay 1 is activated when supervised parameter 1 (given by parameter 3201) is above the limit given by parameter 3203. |
| 1402 | RELAY OUTPUT 2 | As above | e.g. SUPERV1 OVER | Relay output 2 function.<br>See above. |
| **Group 32 SUPERVISION** | | | | |
| 3201 | SUPERV 1 PARAM | 102 - 137 | e.g. 131 | Number of supervised parameter 1. Any parameter of the group 1 OPERATING DATA. |
| 3202 | SUPERV 1 LIM LO | 0 - 255 | e.g. 100 | Lower supervision limit for supervised parameter 1. |
| 3203 | SUPERV 1 LIM HI | 0 - 255 | e.g. 100 | Upper supervision limit for supervised parameter 1. |
| 3204 | SUPERV 2 PARAM | 102 - 137 | e.g. 132 | Number of supervised parameter 1. Any parameter of the group 1 OPERATING DATA. |
| 3205 | SUPERV 2 LIM LO | 0 - 255 | e.g. 100 | Lower supervision limit for supervised parameter 2. |

| Code | Parameter Name | Alternative Settings | Setting for Standard Modbus | Function/Information |
|---|---|---|---|---|
| 3206 | SUPERV 2 LIM HI | 0 - 255 | e.g. 100 | Upper supervision limit for supervised parameter 2. |

*Table 17 Analog output control.*

| Code | Parameter Name | Alternative Settings | Setting for Standard Modbus | Function/Information |
|---|---|---|---|---|
| **Group 01 OPERATING DATA** | | | | |
| 0133 | SER LINK DATA 3 | 0 - 255 | - | Controlling data for the analog output. |
| **Group 15 ANALOG OUTPUT** | | | | |
| 1501 | AO CONTENT | 102 - 137 | e.g. 133 | Directs the contents of parameter 133 to the analog output. |
| 1503 | AO CONTENT MAX | | 255 | Analog output scaling: upper limit (20 mA) reached when value 255 written to parameter 133. |

## Diagnostic Counters

Diagnostic counters can be used for debugging the Modbus system.

Counters will roll over from 65535 to 0. The counter values are stored to permanent memory when power is disconnected.

Counters can be reset from the control panel by pressing the UP and DOWN buttons simultaneously when in parameter set mode, or by writing zero from the serial communication channel 1.

**Note! Parameters 5206 - 5212 are displayed in hexadecimal format by the control panel.**

*Table 18*

| Code | Name | Range | User |
|---|---|---|---|
| **Group 52 STANDARD MODBUS** | | | |
| 5206 | BAD MESSAGES | 0 - 65535 | |
| 5207 | GOOD MESSAGES | 0 - 65535 | |
| 5208 | BUFFER OVERRUNS | 0 - 65535 | |
| 5209 | FRAME ERRORS | 0 - 65535 | |
| 5210 | PARITY ERRORS | 0 - 65535 | |
| 5211 | CRC ERRORS | 0 - 65535 | |
| 5212 | BUSY ERRORS | 0 - 65535 | |
| 5213 | SER FAULT MEM 1 | 0 - 3 | |
| 5214 | SER FAULT MEM 1 | 0 - 3 | |
| 5215 | SER FAULT MEM 3 | 0 - 3 | |

# Communication

This chapter describes the Modbus communication for the ACH 400 drive.

## Introduction to Modbus

Modbus is a serial, asynchronous protocol. The Modbus protocol does not specify the physical interface. The typical physical interface for Modbus communication is RS485.

Modbus is designed for integration with Modicon PLCs or other automation devices, and the services closely correspond to the PLC architecture. The ACH 400 drive 'looks like' a Modicon PLC on the network.

If detailed information regarding the Modicon Modbus protocol is required, contact your local ABB sales office for a copy of the Modbus Protocol Guide.

## Register Read and Write

The ACH 400 has all drive parameter, control and status information mapped into a 4xxxx register area. This holding register area can be read from an external device, and an external device can modify the register values by writing to them.

There are no setup parameters for mapping the data to the 4xxxx register. The mapping is pre-defined and corresponds directly to the ACH 400 parameter grouping.

All parameters are available for both reading and writing. The parameter writes are verified for correct value and for valid register addresses. Some parameters never allow writes (including Group 1 actual values), some allow only zero write (including Group 1 fault memories), some parameters allow write only when the drive is stopped (including Group 99 setup variables), and some can be modified at any time (including e.g. Group 22 acceleration and deceleration ramp times).

## Register Mapping

The drive parameters are mapped to the 4xxxx area so that:

- 40001 – 40099 are reserved for drive control registers
- 40101 – 40199 is reserved for the actual values (parameter group 1)
- 40201 – 40299 is reserved for parameter group 2
- 40301 – 40399 is reserved for fault and alarm information
- … other parameter groups
- 49901 – 49999 is reserved for the start-up data

Register addresses 4GGPP are shown in Table 19. In this table GG is the group number, and PP is the parameter number within the group

*Table 19 Parameter mapping.*

| 4GGPP | GG | PP |
|---|---|---|
| 40001 – 40006 | 00 Drive control registers | 01 Control word<br>02 Reference 1<br>03 Reference 2<br>04 Status word<br>05 Actual value 1<br>06 Actual value 2 |
| 40102 – 40130 | 01 OPERATING DATA | 02 SPEED<br>…<br>30 OLDEST FAULT |
| 41001 – 41003 | 10 COMMAND INPUTS | 01 EXT1 COMMANDS<br>02 EXT2 COMMANDS<br>03 DIRECTION |
| 41101 – 41108 | 11 REFERENCE SELECT | 01 KEYPAD REF SEL<br>…<br>08 CONST SPEED 7 |
| … | … | … |
| 49901 – 49908 | 99 START-UP DATA | 02 APPLIC MACRO<br>…<br>08 MOTOR NOM SPEED |

The register addresses between the groups are invalid. No reads or writes are allowed for these addresses. If there is an attempt to read or write outside the parameter addresses, the Modbus interface will return an exception code to the controller.

## Exception Codes

The ACH 400 supports the standard Modbus exception codes. These are shown in Table 20.

*Table 20 Exception codes.*

| Code | Name | Meaning |
|---|---|---|
| 01 | ILLEGAL FUNCTION | The function code received in the query is not an allowable action for the slave.<br>ACH 400 : Unsupported Command. |
| 02 | ILLEGAL DATA ADDRESS | The data address received in the query is not an allowable address for the slave.<br>ACH 400 : Address outside groups |
| 03 | ILLEGAL DATA VALUE | A value contained in the query data field is not an allowable value for the slave.<br>ACH 400 : Value outside min-max limits<br>ACH 400 : Parameter is read-only<br>ACH 400 : Message is too long<br>ACH 400 : Parameter write not allowed when start is active<br>ACH 400 : Parameter write not allowed when factory macro is selected |

## Function Codes

The ACH 400 supports the Modbus function codes given in Table 21. If any other function codes are used the ACH 400 returns an exception response with error code 01 (illegal function).

*Table 21 Function codes.*

| Code | Description |
|---|---|
| 03 | Read holding registers |
| 06 | Preset single register |
| 16 (10 Hex) | Preset multiple registers |

## The Control Word

Holding register: 40001

The Control Word is the principal means for controlling the ACH 400 from a fieldbus system. It is sent by the fieldbus master station to the drive. The ACH 400 switches between its states according to the bit-coded instructions on the Control Word.

**Note! In order to use Control Word the drive must be configured to receive control commands from the serial communication channel. Refer to "Control Locations" on page 108.**

The contents of the Control Word is presented in the following table. The text in *italics* refers to the states in Figure 51.

*Table 22 The Control Word.*

| Bit | Value | Description |
|---|---|---|
| 0 | 1 | Enter ***READY TO OPERATE*** |
| | 0 | Emergency OFF. Ramp to stop according to parameter 2203 DECELER TIME 1. Enter ***OFF1 ACTIVE***; proceed to ***READY TO SWITCH ON*** unless other interlocks (OFF2, OFF3) are active. |
| 1 | 1 | Continue operation (OFF2 inactive) |
| | 0 | Emergency OFF, coast to stop.<br>Enter ***OFF2 ACTIVE***, proceed to ***SWITCH-ON INHIBITED***. |
| 2 | 1 | Continue operation (OFF3 inactive) |
| | 0 | Emergency stop. Drive ramps to stop according to parameter 2205 DECELER TIME 2. Enter ***OFF3 ACTIVE***; proceed to ***SWITCH-ON INHIBITED***. |
| 3 | 0 -1 | Enter ***OPERATION ENABLED*** Note that the Run enable signal must be present on a digital input – see parameter 1601 RUN ENABLE. |
| | 0 | Inhibit operation. Enter ***OPERATION INHIBITED*** |
| 4 | | Unused. |
| 5 | 1 | Normal operation.<br>Enter ***RAMP FUNCTION GENERATOR: ACCELERATOR ENABLED*** |
| | 0 | Halt ramping (Ramp Function Generator output held) |
| 6 | 1 | Normal operation. Enter ***OPERATING*** |
| | 0 | Force Ramp Function Generator input to zero. |
| 7 | 0 - 1 | Fault reset (enter ***SWITCH-ON INHIBITED***) |
| | 0 | (Continue normal operation) |
| 8 to 10 | | Unused |
| 11 | 1 | Select external control location 2 (EXT2) |
| | 0 | Select external control location 1 (EXT1) |
| 12 to 15 | | Unused |

**Note! Control and status word operation conforms to ABB Drives Profile with the exception of bit#10 (REMOTE_CMD) which is not used by the ACH 400.**

## References

References are 16-bit words containing a sign bit and a 15-bit integer. A negative reference (indicating reversed direction of rotation) is formed by calculating the two's complement from the corresponding positive reference.

### Reference 1

Holding Register: 40002

Reference 1 can be used as the frequency reference REF1 for the ACH 400. Scaling: 20000 ≙ EXT REF1 MAX (Hz, parameter 1105). Scaling Parameter 1104 EXT REF1 MIN is not used.

The signal source of external reference 1 (REF1) must be set to COMM and external control location 1 (EXT1) must be activated. Refer to parameters 1103 EXT REF 1 SELECT and 1102 EXT1/EXT2 SEL.

### Reference 2

Holding Register: 40003

Reference 2 can be used as the frequency reference REF2 for the ACH 400. Scaling: 10000 ≙ EXT REF2 MAX (%, parameter 1108). Scaling Parameter 1107 EXT REF2 MIN is not used.

The signal source of external reference 2 REF2 must be set to COMM and External control location 2 (EXT2) must be activated. Refer to parameters 1106 EXT REF 2 SELECT and 1102 EXT1/EXT2 SEL.

### Fieldbus Reference Selection and Correction

Fieldbus reference is selected by setting a Reference selection parameter 1103 EXT REF1 SELECT or 1106 EXT REF2 SELECT to COMM, COMM+AI1 or COMM*AI1. The latter two enable correction of the fieldbus reference using Analog input AI1.

## The Status Word

Holding Register: 40004

The Status Word is a read-only word containing information of the ACH 400 status.

The contents of Status Word is presented in the following table. The text in italics refers to the states in Figure 51.

*Table 23 The Status Word.*

| Bit | Value | Description |
|---|---|---|
| 0 | 1 | ***READY TO SWITCH ON*** |
| | 0 | ***NOT READY TO SWITCH ON*** |
| 1 | 1 | ***READY TO OPERATE*** |
| | 0 | ***OFF1 ACTIVE*** |
| 2 | 1 | ***OPERATION ENABLED*** |
| | 0 | Not ready (*OPERATION INHIBITED*) |
| 3 | 0 - 1 | ***FAULT*** |
| | 0 | No fault |
| 4 | 1 | OFF2 inactive |
| | 0 | ***OFF2 ACTIVE*** |
| 5 | 1 | ***OFF3*** inactive |
| | 0 | ***OFF3 ACTIVE*** |
| 6 | 1 | ***SWITCH-ON INHIBITED*** |
| | 0 | |
| 7 | 1 | Any alarm except AL1-AL7, AL15, AL27, and AL28. |
| | 0 | No alarm |
| 8 | 1 | ***OPERATING.*** Actual value equals reference value (= is within tolerance limits). |
| | 0 | Actual value differs from reference value (= is outside tolerance limits) |
| 9 | 1 | Drive control location: REMOTE |
| | 0 | Drive control location: LOCAL |
| 10 | 1 | The value of first supervised parameter equals to or is greater than supervision limit. Refer to Group 32 Supervision. |
| | 0 | The value of first supervised parameter is below supervision limit |
| 11 | 1 | External control location 2 (EXT2) selected |
| | 0 | External control location 1 (EXT1) selected |
| 12 | 1 | Run Enable signal received |
| | 0 | No Run Enable signal received |
| 13 to 15 | | Unused |

## Actual Values

Actual values are read-only values containing information on the operation of the drive. Actual values are 16-bit words containing a sign bit and a 15-bit integer. A negative value is given as two's complement of the corresponding positive value.

**Actual Value 1**

Holding Register: 40005

Actual output frequency. Scaling: 5000 ≙ 50 Hz.

**Actual Value 2**

Holding Register: 40006

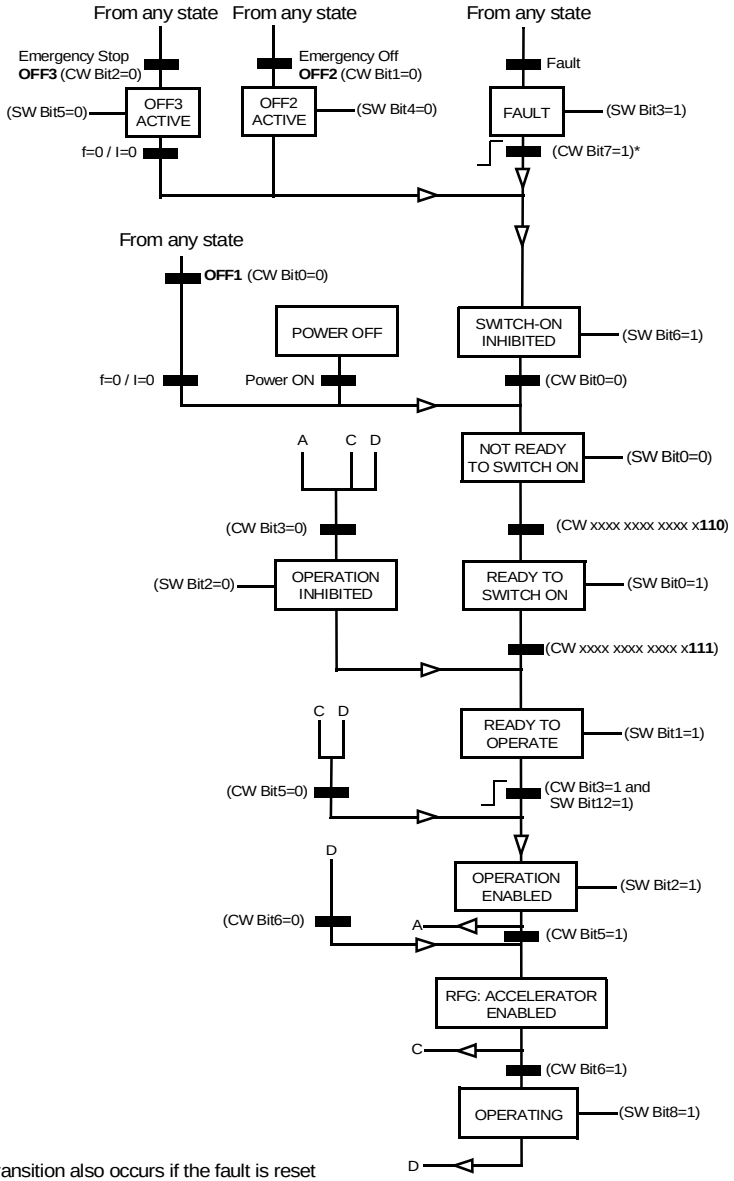
Actual output current. Scaling: 10 ≙ 1 A.

## Example

The following example shows how to use the Control Word to start the drive. When the power is connected, the state machine state is NOT READY TO SWITCH ON.

*Table 24 Using the Control Word.*

| | Control Word Value | Description |
|---|---|---|
| **Step 1** | CW = 0000 0000 0000 0110<br>bit 15 bit 0 | When this value is written, state machine state changes to READY TO SWITCH ON. |
| **Step 2** | CW = 0000 0000 0000 0111 | When this value is written, state machine state changes to READY TO OPERATE. |
| **Step 3** | CW = 0000 0000 0000 1111 | When this value is written, the drive starts, but will not accelerate. State machine state changes to OPERATION ENABLED. |
| **Step 4** | CW = 0000 0000 0001 1111 | When this value is written, the ramp function generator (RFG) output is released. State machine state changes to RFG: ACCELERATOR ENABLED |
| **Step 5** | CW = 0000 0000 0011 1111 | When this value is written, the ramp function generator (RFG) input is released. Drive will accelerate to the given reference. State machine state changes to OPERATING. |




*This state transition also occurs if the fault is reset from any other source (e.g. digital input).

State
CW = Control Word
SW = Status Word
I = Output current
f = Output frequency
RFG = Ramp Function Generator

*Figure 51 The state machine for evaluation of start and stop signals.*

## Fault and Alarm Status

The ACH 400 provides fault and alarm status words that are accessible only from the serial communication link (not from the control panel).

These status words are located in place of parameter group 3 (Modbus holding registers 40301-40309). These registers also contain copies of the Control Word (40001) and Status Word (40004).

Registers 40301-40309 are generally read-only type; however, alarm words can be reset by writing zero into the register. Table 25 lists the fault and alarm words.

*Table 25 Fault and alarm status words.*

| No | Name | Description |
|---|---|---|
| 40301 | MAIN CONTROL WORD | Read-only copy of the Control Word (40001). See page 116. |
| 40302 | MAIN STATUS WORD | Read-only copy of the Status Word (40004). See page 118. |
| 40305 | FAULT WORD 1 | Fault information. When a fault is active corresponding bit is set. Bit descriptions are given in Table 26. |
| 40306 | FAULT WORD 2 | Fault information. When a fault is active corresponding bit is set. Bit descriptions are given in Table 26. |
| 40308 | ALARM WORD 1 | Alarm information. When an alarm is active corresponding bit is set. Bits remain set until whole alarm word is reset by writing 0 to it.See Table 27. |
| 40309 | ALARM WORD 2 | Alarm information. When an alarm is active corresponding bit is set. Bits remain set until whole alarm word is reset by writing 0 to it.See Table 27. |

*Table 26 Bit descriptions for fault words 1 and 2.*

| Bit # | Fault Word 1 | Fault Word 2 |
|---|---|---|
| **0** | Overcurrent | Underload |
| **1** | DC overvoltage | Reserved |
| **2** | ACH 400 overtemperature | DDCS link |
| **3** | Fault current | Reserved |
| **4** | Output overload | |
| **5** | DC undervoltage | |
| **6** | Analog input 1 fault | |
| **7** | Analog input 2 fault | |
| **8** | Motor overtemperature | Hardware error |
| **9** | Panel loss | |
| **10** | Parameters inconsistent | |
| **11** | DC bus ripple too large | |
| **12** | Motor stall | |
| **13** | Serial communication loss | |
| **14** | External fault | |
| **15** | Output ground fault | |

*Table 27 ALARM WORD 1 bit descriptions.*

| Bit # | ALARM WORD 1 |
|---|---|
| **0** | Overcurrent controller alarm |
| **1** | Overvoltage controller alarm |
| **2** | Undervoltage controller alarm |
| **3** | Direction lock alarm |
| **4** | Serial communication loss |
| **5** | Modbus exception generated locally |
| **6** | Analog input 1 loss |
| **7** | Analog input 2 loss |
| **8** | Panel loss |
| **9** | ACH 400 overtemperature |
| **10** | Motor overtemperature |
| **11** | Underload |
| **12** | Motor stall alarm |
| **13** | DDCS link |
| **14** | Reserved |
| **15** | Reserved |

# Appendix A
## Local Control vs. Remote Control

The ACH 400 can be controlled from two remote control locations or from the control panel. Figure 52 below shows the ACH 400 control locations.

The selection between local control (**LOC**) and remote control (**REM**) can be achieved by pushing the MENU and ENTER buttons simultaneously when the ACS100-PAN is used, and by pushing the LOC/REM button when ACS-PAN-B is used.

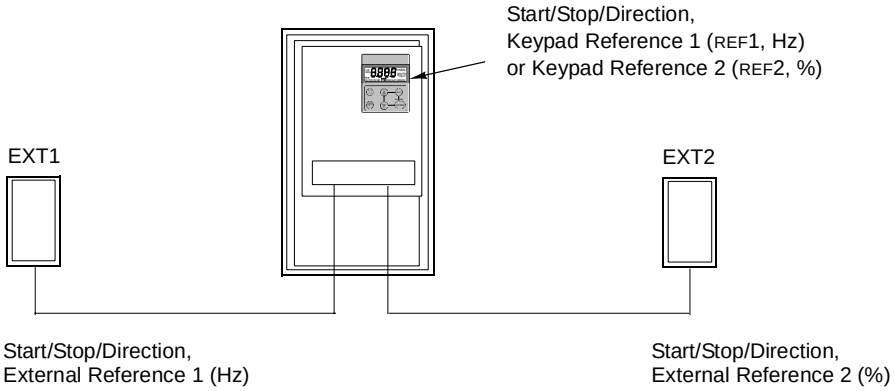



*Figure 52 Control locations.*

## Local Control

The control commands are given explicitly from the control panel when the ACH 400 is in local control.

Parameter 1101 KEYPAD REF SEL is used to select keypad reference, which can be either REF1 (Hz) or REF2 (%). If REF1 (Hz) is selected, the type of reference is frequency and it is given to the ACH 400 in Hz. If REF2 (%) is selected, the reference is given in percent.

If PID Control macro is used, reference REF2 is fed directly to the PID controller as a percentage. Otherwise, reference REF2 (%) is converted to a frequency so that 100 % corresponds to MAXIMUM FREQ (parameter 2008).

## Remote Control

When the ACH 400 is in remote control (**REM**), the commands are given primarily through digital and analog inputs, although commands can also be given through the control panel or serial communication.

Parameter 1102 EXT1/EXT2 SELECT selects between the two external control locations EXT1 and EXT2.

For EXT1, the source of the Start/Stop/Direction commands is defined by parameter 1001 EXT1 COMMANDS, and the reference source is defined by parameter 1103 EXT REF1 SELECT. External reference 1 is always a frequency reference.

For EXT2, the source of the Start/Stop/Direction commands is defined by parameter 1002 EXT2 COMMANDS, and the reference source is defined by parameter 1106 EXT REF2 SELECT. External reference 2 can be a frequency reference, or a process reference, depending on the application macro selected.

In remote control, constant speed operation can be programmed by parameter 1201 CONST SPEED SEL. Digital inputs can be used to select between the external frequency reference and seven configurable constant speeds (1202 CONST SPEED 1... 1208 CONST SPEED 7).

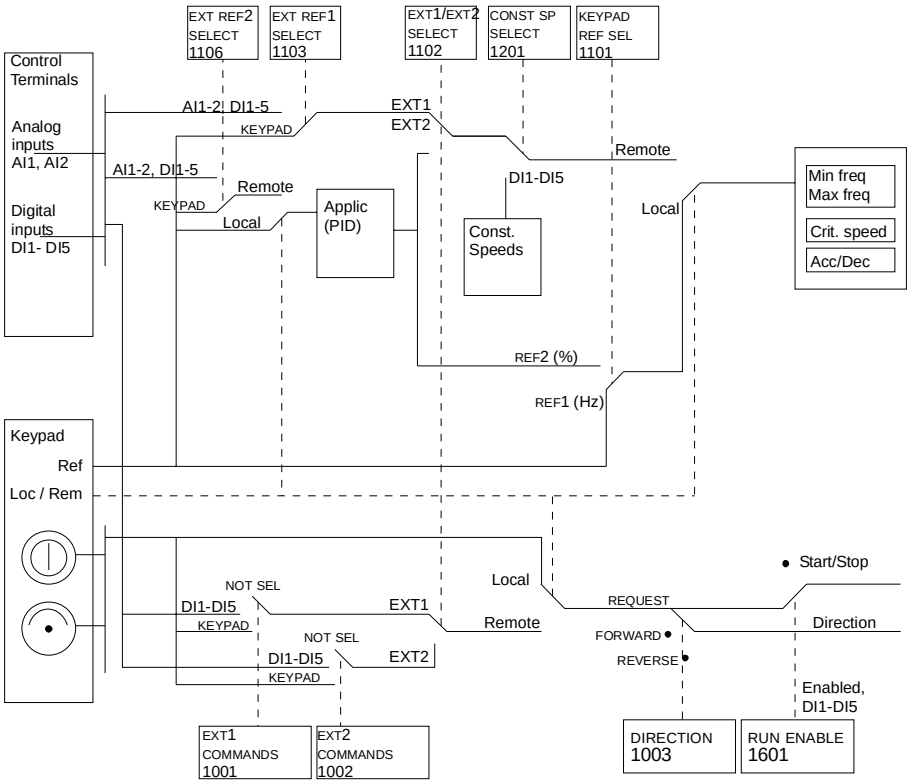



*Figure 53 Selecting control location and control source.*

## Internal Signal Connections for the Macros

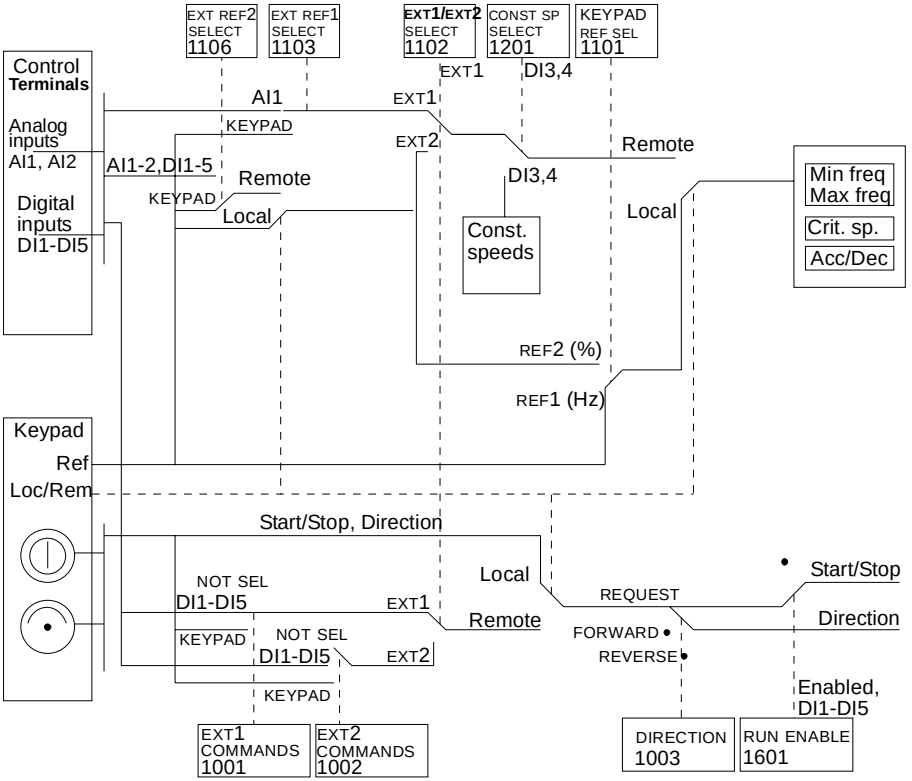



*Figure 54 The control signal connections of the ABB Standard, Alternate and Premagnetize macros.*

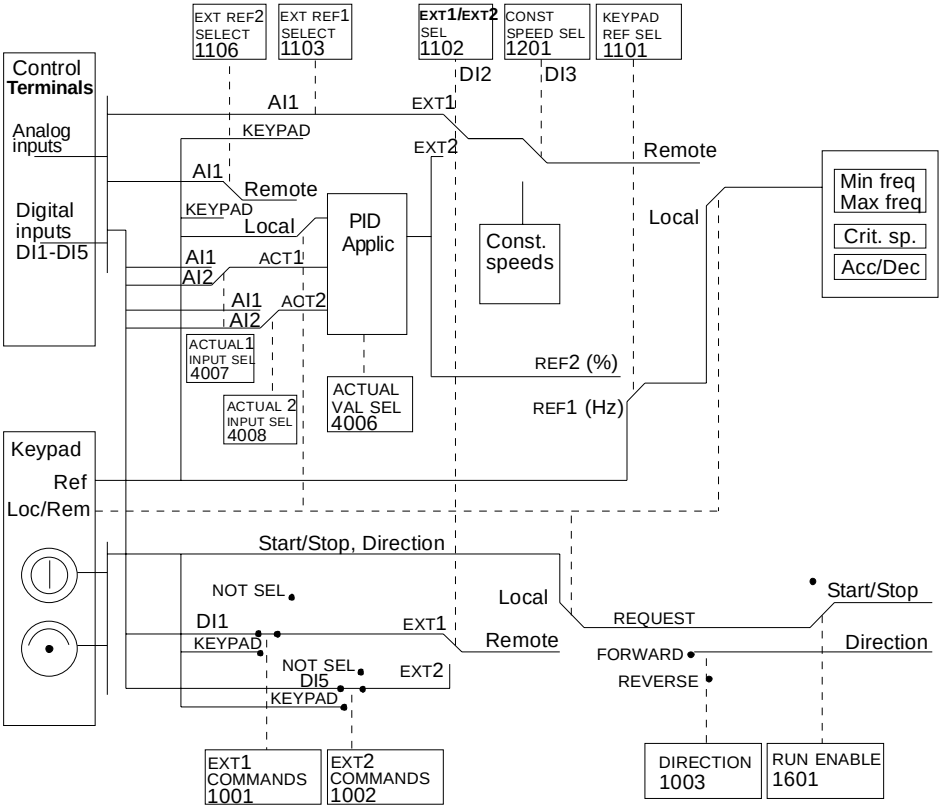



*Figure 55 The control signal connections of the PID Control macro.*

# Appendix B
# ACH 400 Pump and Fan Control (PFC) Macro

## Introduction

The Pump and Fan Control (PFC) macro can operate a pump (or fan or compressor) station with one to four parallel pumps. The control principle of a two-pump station is as follows:

- The motor for pump no. 1 is connected to the ACH 400. The capacity of the pump is controlled by varying the motor speed.
- The motor for pump no. 2 is connected direct on-line. The pump can be switched on and off by the ACH 400 when necessary.
- The process reference and actual value are fed to the ACH 400 PID controller. The PID controller adjusts the speed (frequency) of the first pump such that the process actual value follows the reference. When the frequency reference of the process PID controller exceeds the limit set by the user, the PFC macro automatically starts the second pump. When the frequency falls below the limit set by the user, the PFC macro automatically stops the second pump.
- Using the digital inputs of the ACH 400, an interlocking function can be implemented; the PFC macro detects if a pump is switched off and starts the other pump instead.
- The PFC macro makes automatic pump alternation possible. Each pump can be run with an equal duty time. For more information on the alternation system and the other useful features such as Sleep function, Constant reference value, Reference steps and Regulator by-pass, see the parameter descriptions for parameter groups 40, 41 and 81.

As a default when the PFC macro is selected, the ACH 400 receives process reference (setpoint) through analog input 1, process actual value through analog input 2 and Start/Stop commands through digital input 1. The interlocks are connected to digital input 4 (speed regulated motor) and digital input 5 (constant speed motor). The Run Enable signal is received through the digital input 2 and PFC control is activated/deactivated through the digital input 3. The default output signal is given through the analog output (frequency).

Normally the automatic Pump and Fan Control is bypassed when the ACH 400 is in local control (LOC is shown on the control panel display). In this case, the process PID controller is not in use and the constant speed motors are not started. However, by selecting value 2 (REF2 (%)) for parameter 1101 KEYPAD REF SEL, PFC reference can be given from the control panel in local control.

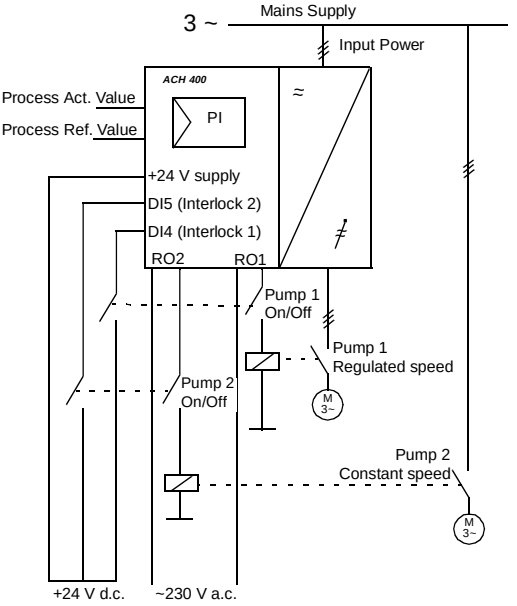



*Figure 56 Operation Diagram for the Pump and Fan Control (PFC) Macro. With the default settings, automatic pump alternation is not in use.*

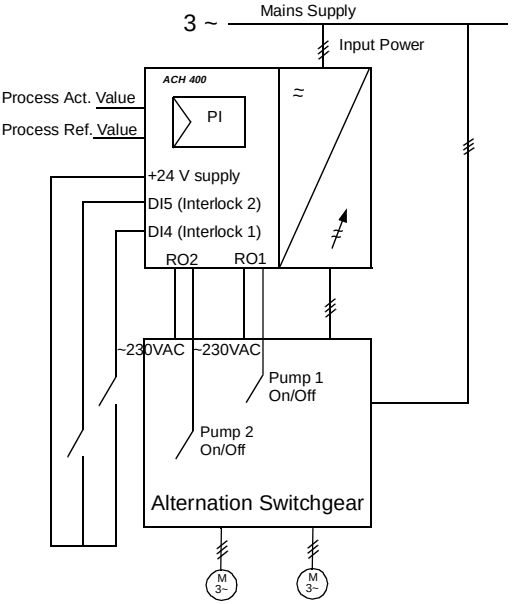



*Figure 57 In this example the automatic pump alternation is in use.*

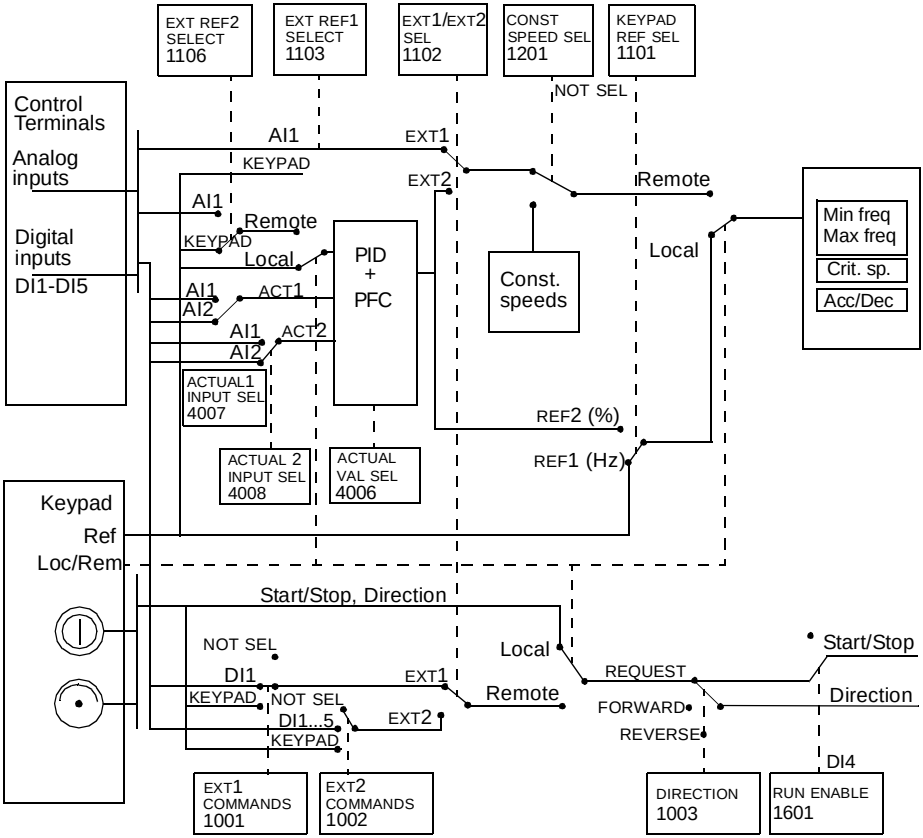



*Figure 58 The control signal connections of the Pump and Fan Control (PFC) macro.*

## PID Controller

The ACH 400 has an internal PID controller which is in use when the PFC control macro is selected. Key features of the PID controller are:

- PID sleep function to stop the regulation when the output of the PID controller falls below a preset limit; recovery when the process actual value falls below preset limit.
- Programmable sleep and wake-up delays. Sleep mode can also be activated through a digital input.
- Two PID parameter sets, selectable through a digital input.
- PID controller parameters are in groups 40 and 41.

## Relay Outputs

The ACH 400 has two programmable relay outputs. Operation of relay output 1 and 2 is configured by parameters 1401 RELAY OUTPUT 1 and 1402 RELAY OUTPUT 2, respectively. Value 29 (PFC) allocates the relay output for the Pump and Fan Control block. This is the default setting for both relay outputs when the PFC macro is selected.

## Adding More I/O to the ACH 400

When Pump and Fan control is used, the ACH 400 is capable of using optional I/O extension modules (NDIO). These modules provide additional relay outputs and digital inputs. I/O extension is needed:

- When the standard relay outputs of the ACH 400 (RO1 and RO2) are needed for other purposes and/or the number of auxiliary motors is large, and
- When the standard digital inputs of the ACH 400 (DI1 - DI5) are needed for other purposes and/or the number of interlock signals (auxiliary motors) is large.

I/O extension modules are connected to the ACH 400 via a DDCS fiber optic link on CH1 in series with the NIOC board.

There can be either one or two NDIO modules on the DDCS link. Each NDIO module contains two digital inputs and two relay outputs.

## Setting up NDIO modules

Refer to the Installation and Start-up Guide of the NDIO module for installation instructions. After installation, the communication between the ACH 400 and NDIO modules is set up as follows:

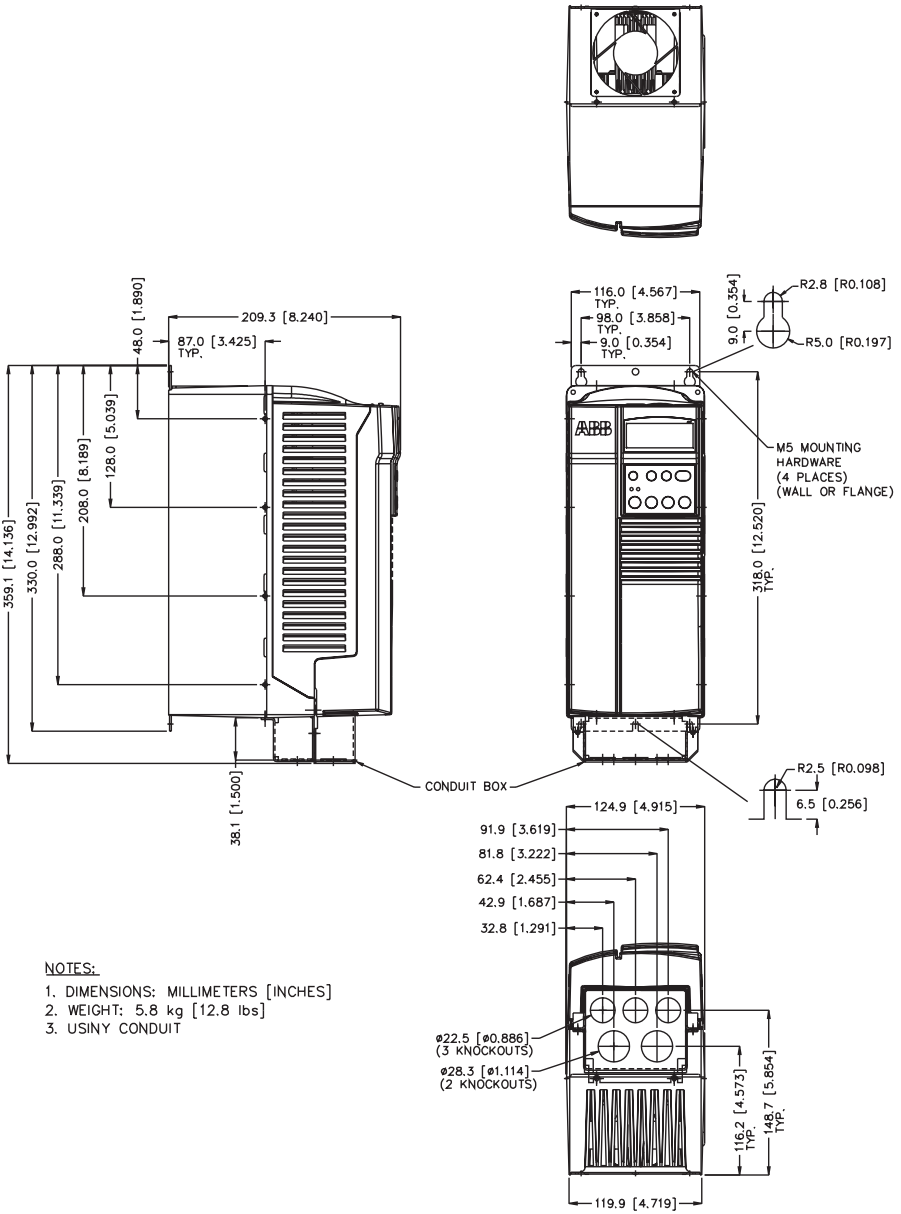
- Set the module node numbers using the DIP switches located inside the modules. Refer to the NDIO module manual for details. Module node number must be 5 if only one NDIO module is used. Node numbers must be 5 and 6 if two NDIO modules are used.
- Connect power to the NDIO modules.

## Alternation Switchgear

PFC autochange operation (set by parameters 8118 AUTOCHNG INTERV and 8119 AUTOCHNG LEVEL) requires dedicated alternation switchgear which is controlled through the relay outputs of the ACH 400. Contact your nearest ABB supplier for more information.

# Appendix C
## ACH 400 Dimensional Drawings

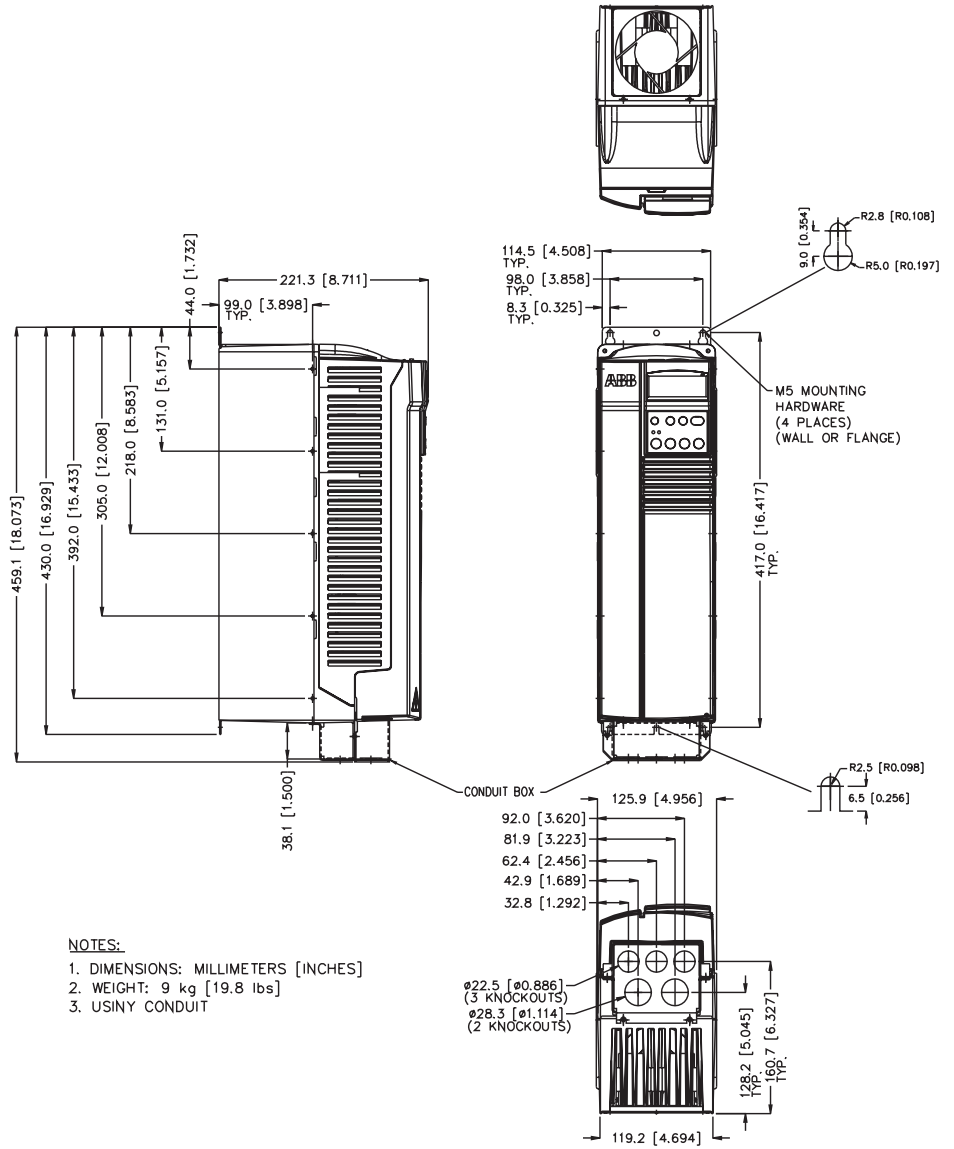
### ACH 400 NEMA Type 1 Enclosure, R1 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 5.8 kg [12.8 lbs]
3. USINY CONDUIT

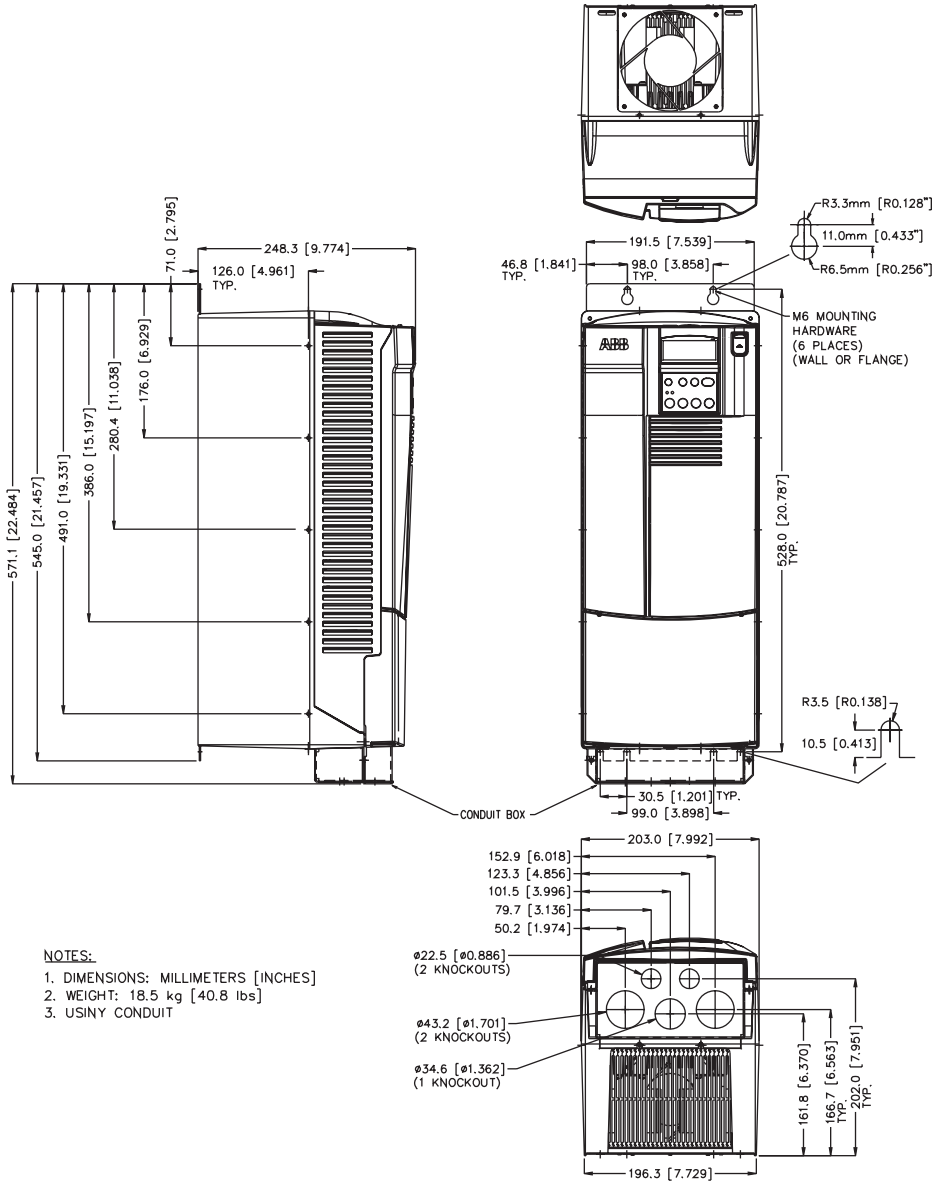
## ACH 400 NEMA Type 1 Enclosure, R2 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 9 kg [19.8 lbs]
3. USINY CONDUIT

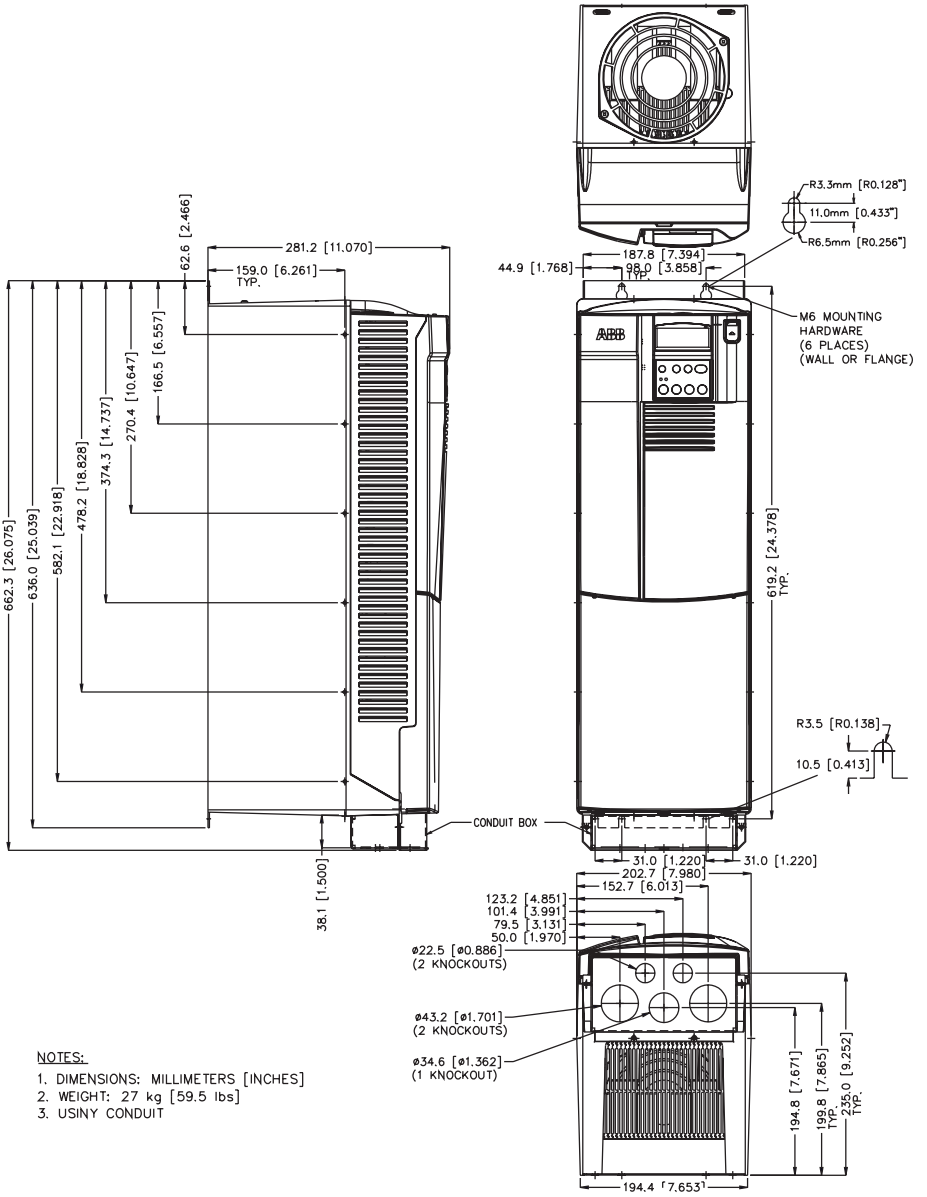
## ACH 400 NEMA Type 1 Enclosure, R3 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 18.5 kg [40.8 lbs]
3. USINY CONDUIT

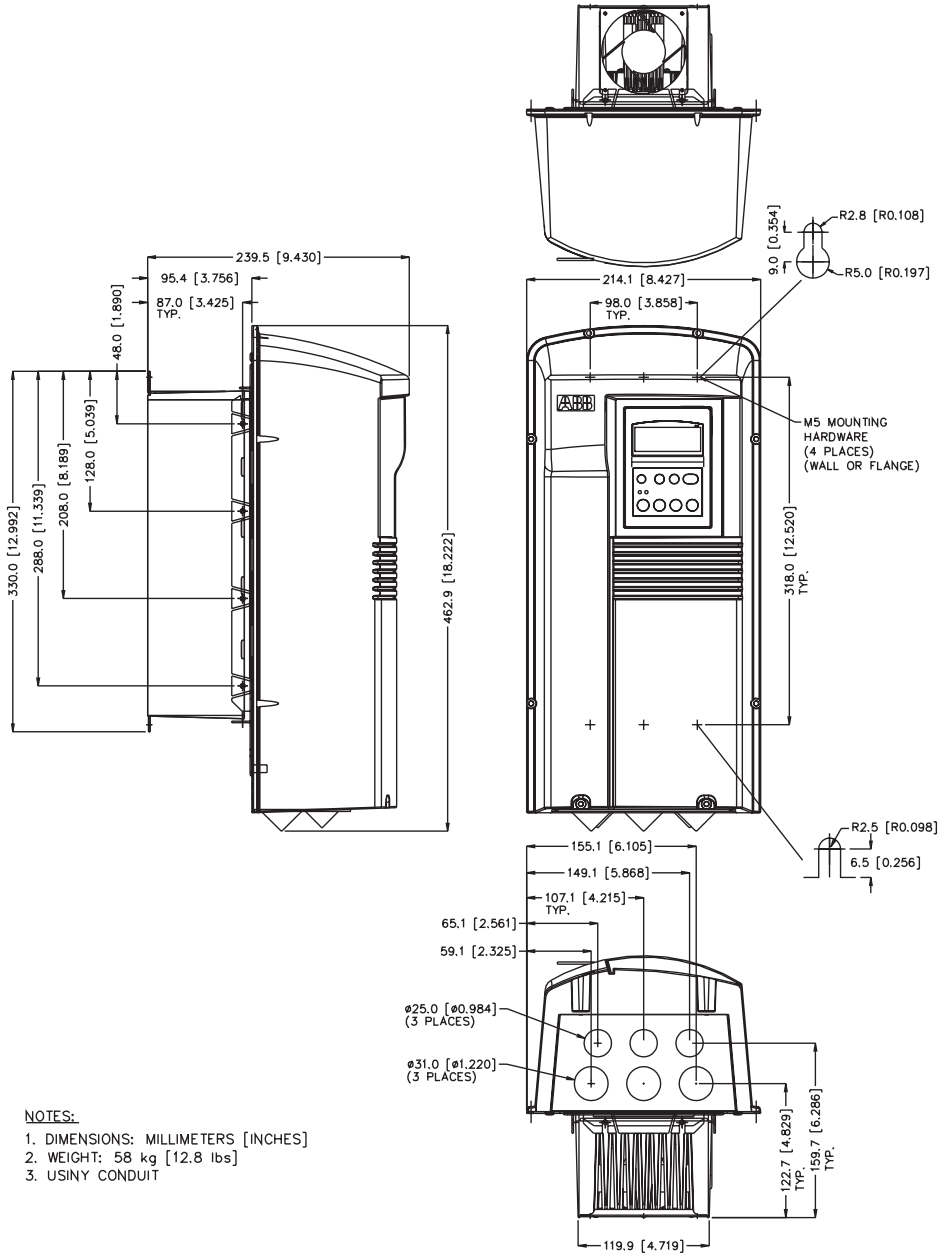
## ACH 400 NEMA Type 1 Enclosure, R4 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 27 kg [59.5 lbs]
3. USINY CONDUIT

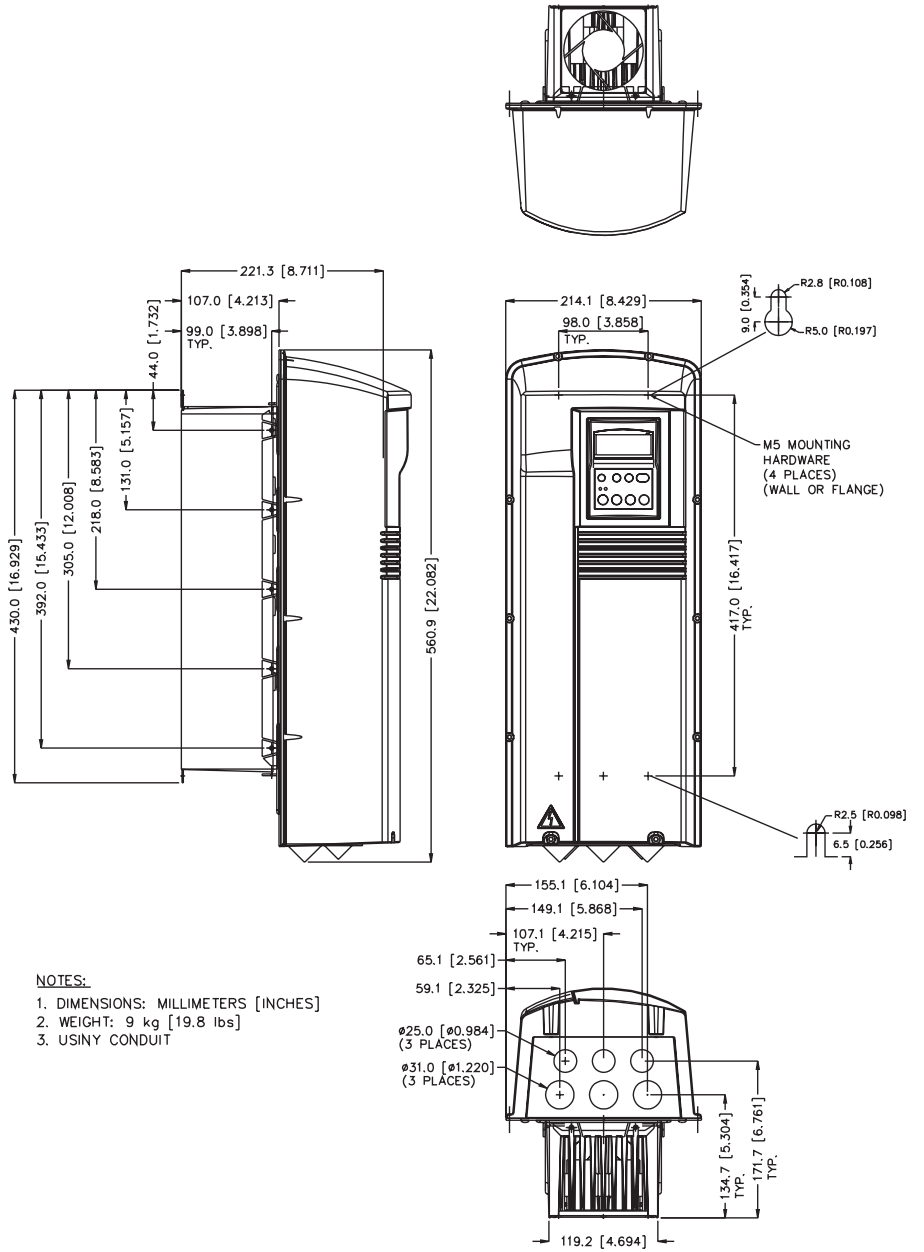
## ACH 400 NEMA Type 12 & 4 Enclosure, R1 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 58 kg [12.8 lbs]
3. USINY CONDUIT

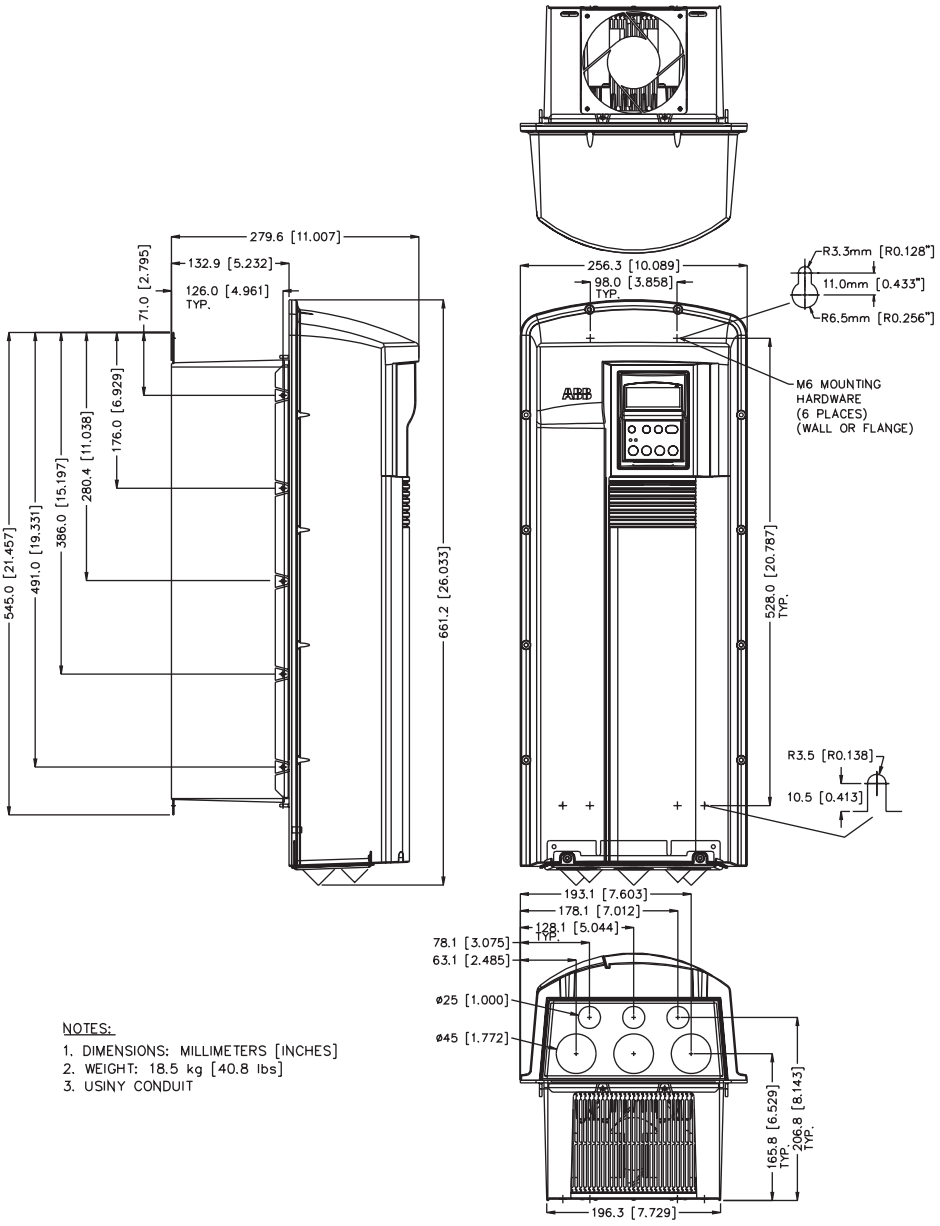
## ACH 400 NEMA 12 & 4 Enclosure, R2 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 9 kg [19.8 lbs]
3. USINY CONDUIT

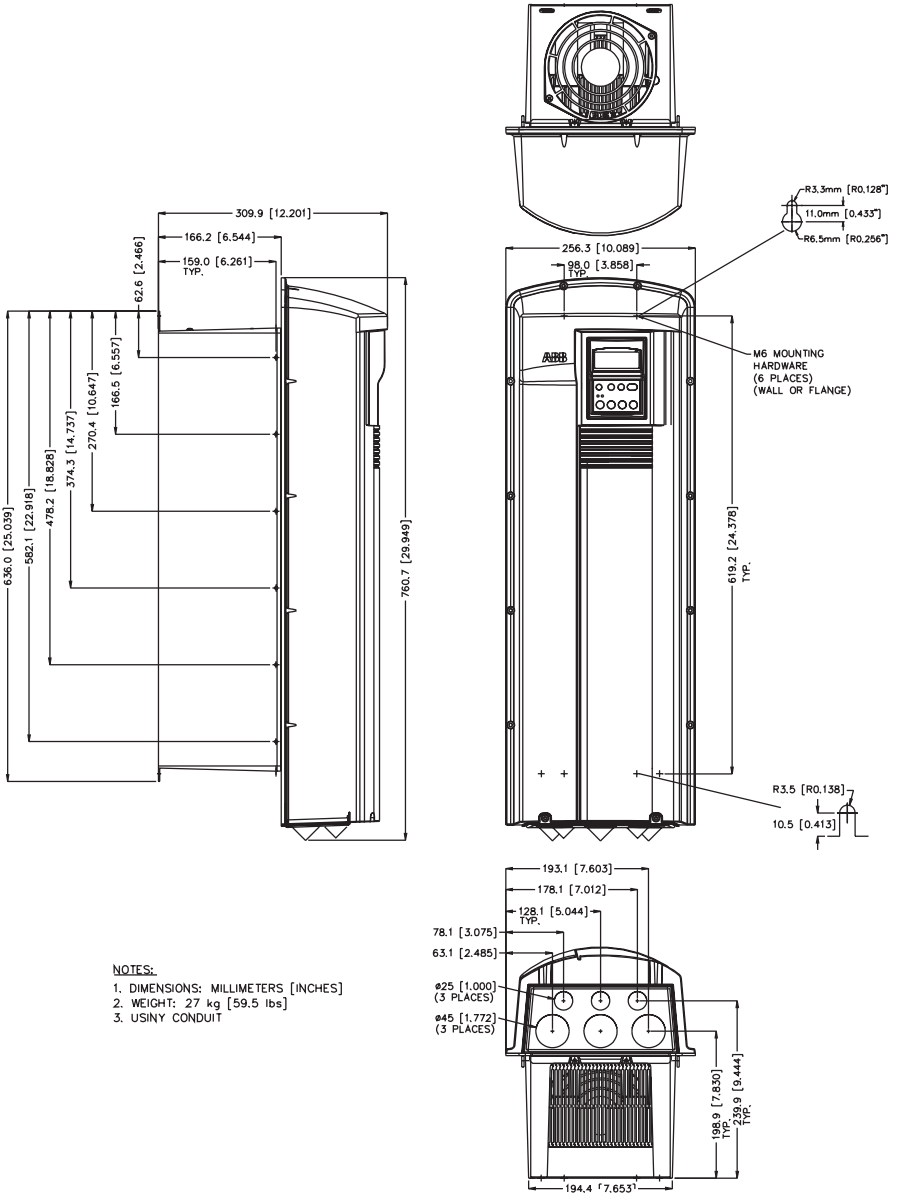
## ACH 400 NEMA Type 12 & 4, R3 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 18.5 kg [40.8 lbs]
3. USINY CONDUIT

## ACH 400 NEMA Type 12 & 4, R4 Frame Size




NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 27 kg [59.5 lbs]
3. USINY CONDUIT

ACH400-US-04
3AUA489002B5311 R0101 Rev E
Effective: 5/15/00
Supercedes: 5/10/00

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