ACH400

User's Manual

ACH 400 AC Drives for Speed Control of 50 to 100 Hp, 230 Volt and 60 to 400 Hp, 460 Volt AC Induction Motors

ABB Automation, Inc.

ACH 400 AC Drives for Speed Control of AC Induction Motors

User's Manual

ACH402-US-04

3AUA489002B4240 R0101 Rev E

Effective: 5/10/00

Supercedes: 8/1/99

Safety

Warning! Only a competent electrician should install the ACH 400.

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 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 ACH 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 **P**.

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

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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

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

Unpacking the unit

The ACH 400 is packaged with this User's Manual.

Step by step instructions

The installation of the ACH 400 has been broken down in a number of steps that are listed (See 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.**

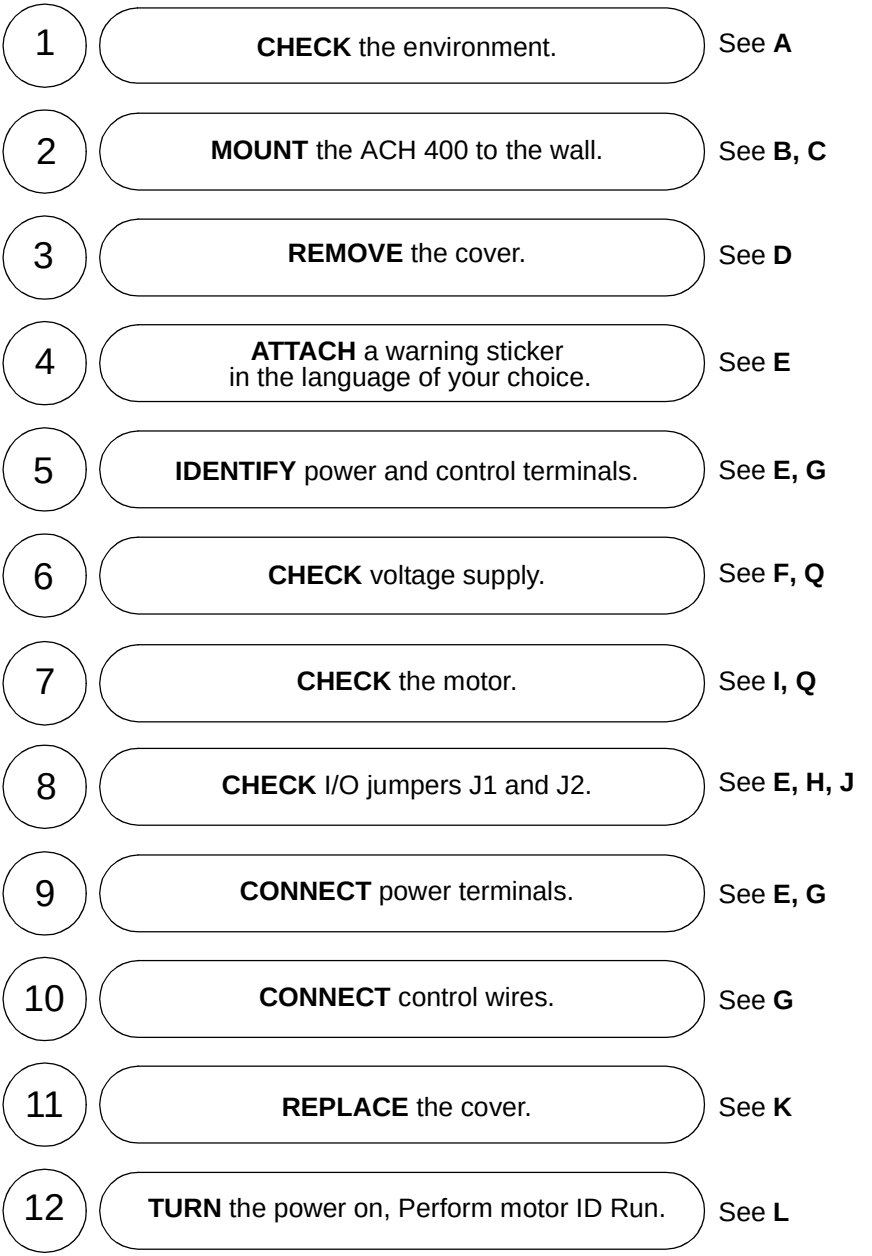


Figure 1 Step by step instructions for installing the ACH 400. The references after each step refer to one or more of the Reference Sections on the following pages in this manual.

Reference Sections

A Installation Environment

Stationary Use

- Ambient temperature 32…104°F (0...40°C)
- Max. ambient temperature 104°F (40°C)
- Installation altitude 0…3300 ft (1000 m) if P_N and I_2 are 100%
- Installation altitude 3300…6600 ft (1000...2000 m) if P_N and I_2 are 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 indoors in a heated, controlled environment that is suitable for the selected enclosure. Drives are available in either an IP21/NEMA Type 1, an IP54/NEMA Type 12, or a NEMA Type 4 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

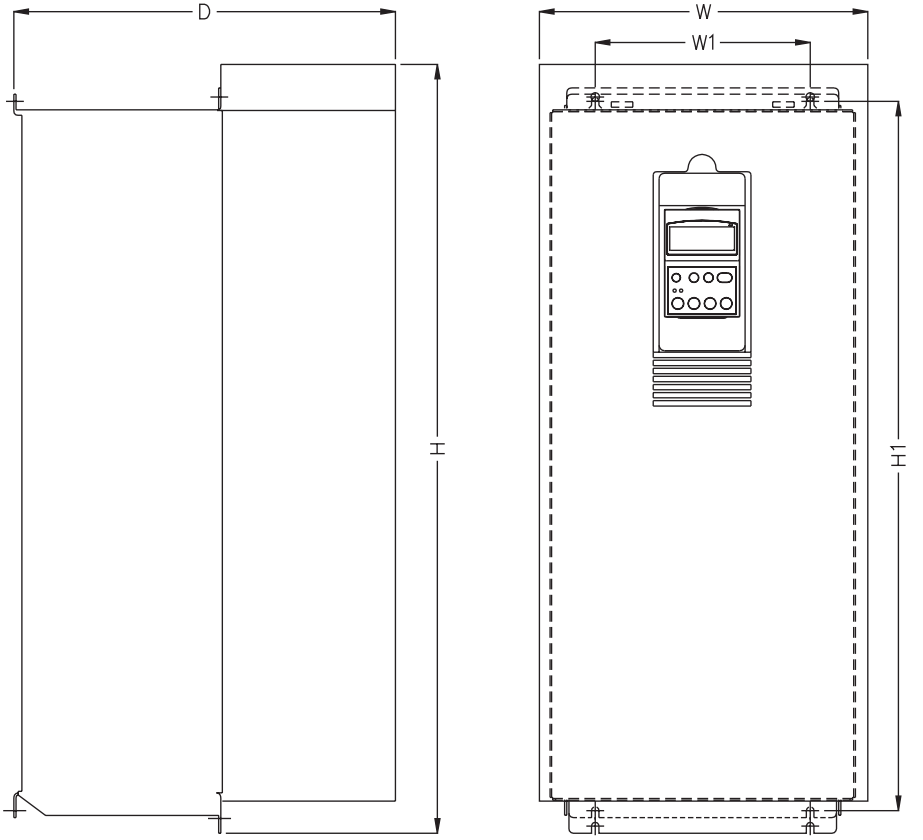
Storage Temperature - 40 ...+158°F (-40...+70°C)

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

B Dimensions

Complete dimensional drawings for the ACH 400 are located in “Appendix C” on page 133.

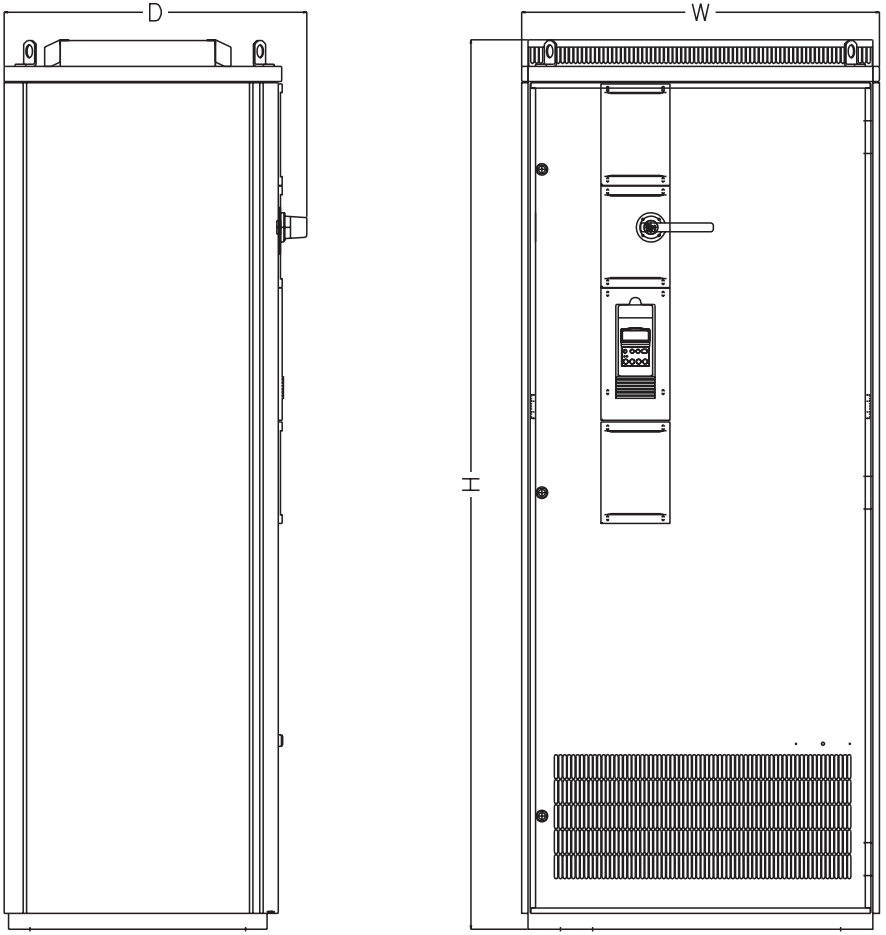
ACH 400 Frame Size R5-R7



Dimensions Reference (in/mm)	Frame Size, IP54/NEMA 12		
	R5	R6	R7
W	12.03/306	12.03/306	18.64/474
W1	7.87/200	7.87/200	12.60/320
H	28.16/715	28.16/715	31.44/799
H1	25.98/660	25.98/660	30.87/784
D	14.03/356	16.87/428	15.15/385
Mass (lb/kg)	77/35	110/50	194/88

Dimension Drawing – Frames R5, R6, & R7, NEMA 1 or NEMA 12

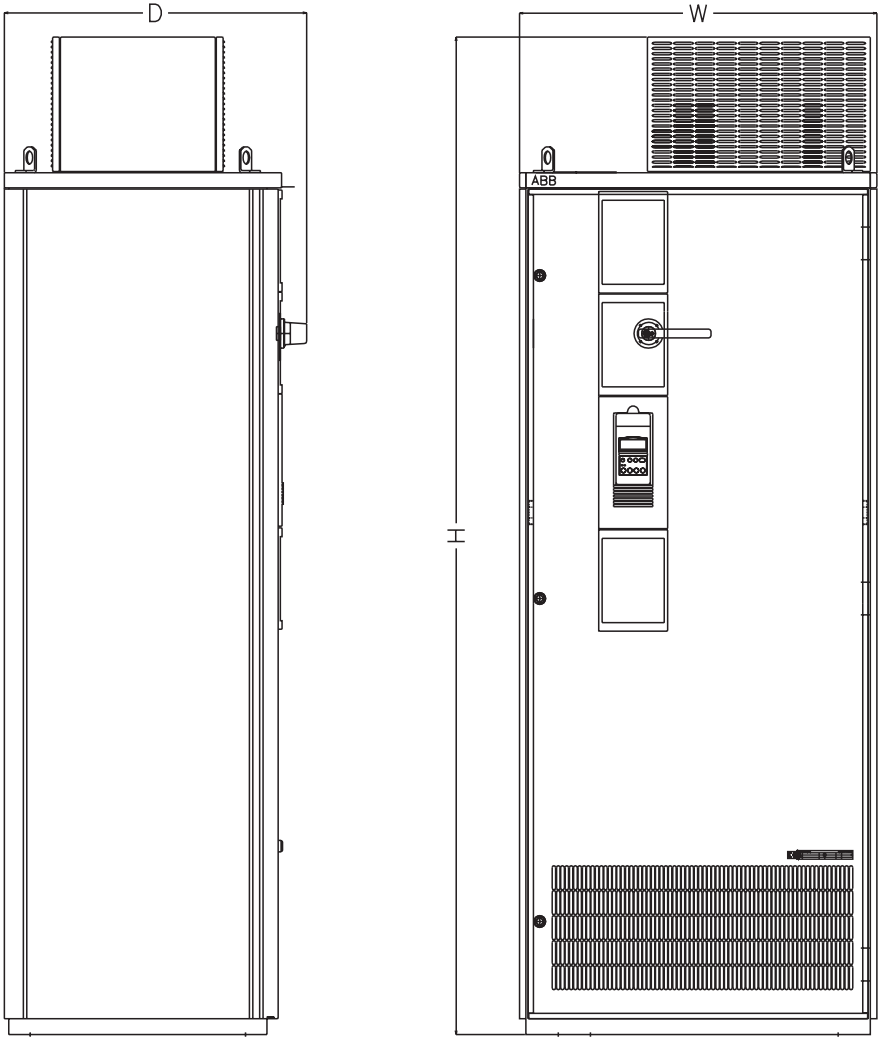
ACH 400 Frame Size NEMA Type 1 Enclosure, Frame Size R7- R9



Dimensions Reference (in/mm)	Frame Size, IP21/NEMA 1			
	R7	R8	R9	R7 W/BYP
W	32.68/830	32.68/830	32.68/830	32.68/830
H	81.22/2063	81.22/2063	81.22/2063	81.22/2063
D	27.64/702	27.64/702	27.64/702	27.64/702
Mass (lb/kg)	570/260	660/300	780/355	650/290

Dimension Drawing – Frame R8, NEMA 1 or NEMA 12

ACH 400 NEMA Type 12 Enclosure, Frame Size R7 - R9



Dimensions Reference (in/mm)	Frame Size, IP54/NEMA 12			
	R7	R8	R9	R7 W/BYP
W	32.68/830	32.68/830	32.68/830	32.68/830
H	91.20/2317	91.20/2317	91.20/2317	91.20/2317
D	27.64/702	27.64/702	27.64/702	27.64/702
Mass (lb/kg)	570/260	660/300	780/355	650/290

Dimension Drawing – Frame R9, NEMA 1 or NEMA 12

C Mounting the ACH 400 on a Wall

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

Appendix B contains detailed dimensional drawings showing the overall dimensions of the ACH 400 drives and the sizes and locations of the mounting bolt holes or slots. The drives have four mounting holes or slots as shown in Figure 2-1.

CAUTION! Lift the ACH 400 by its chassis and not by its cover. (Frame R7 has lifting lugs to allow the use of a suitable lifting device).

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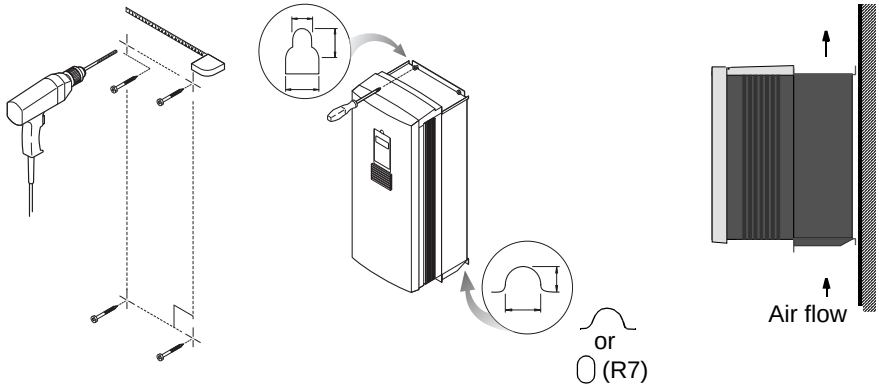

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1

The ACH 400 should only be mounted vertically on a smooth, solid surface, in an area 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.

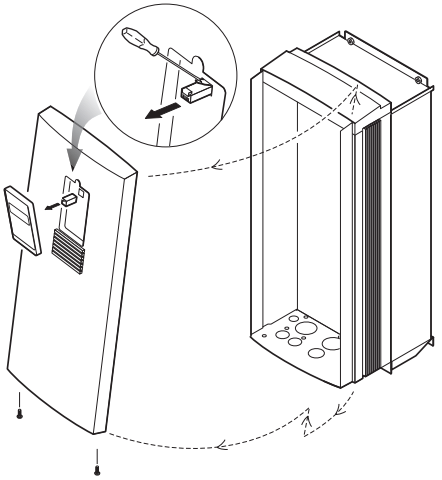
1 Mark the position of the mounting holes by measuring to the dimensions shown in the drawings or by using the drive as a template.
2 Drill and tap the holes.
3 Screw in four screws or affix nuts and bolts (depending on the mounting surface).

2

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.

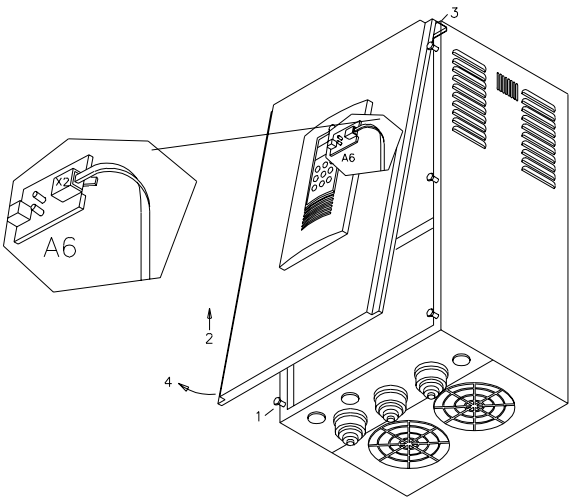
D Removing the Cover (Wall Mount Units - R5 to R7)



1. Remove the two screws at the lower front edge of the unit and remove the front cover by lifting it carefully from the bottom.
2. After connecting the input power, motor and control wiring, replace the cover as shown in this figure.

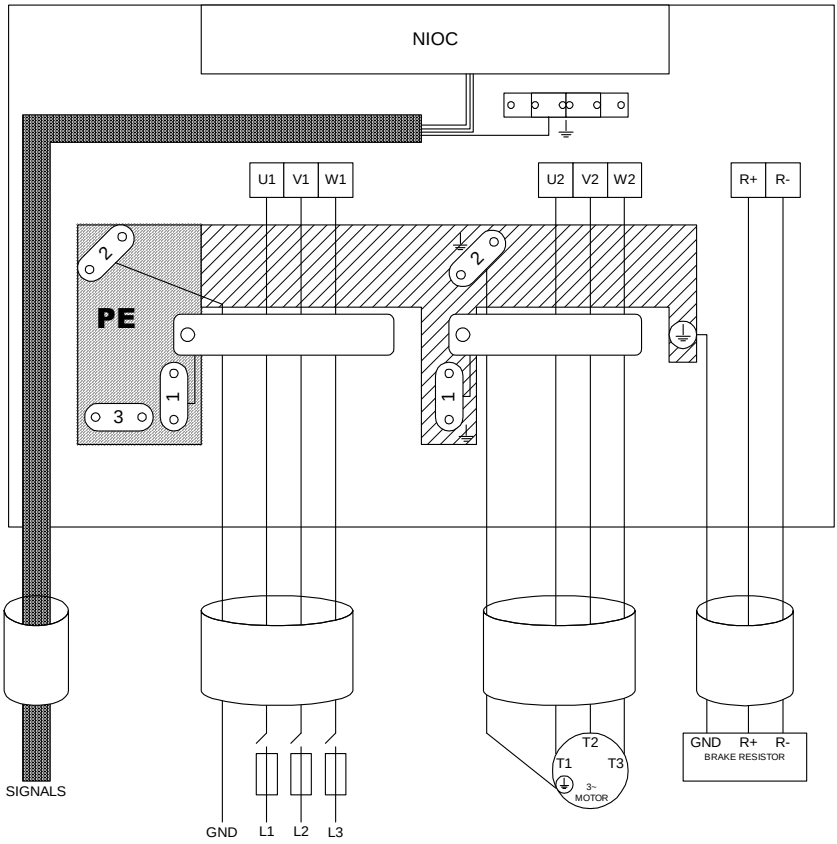
Frames R5 to R6: removal of the cover.

See Paragraph Q for frame size assignments of type codes.



Frame R7: Removal of the cover.

1. Loosen the cover screws.
2. Gently lift the cover upwards to release it from the screws.
   NOTE: Do not remove the cover until the phone cable is disconnected.
3. Leave the cover hanging by its upper edge.
4. Lift the lower edge of the cover to gain access to board A6. Disconnect the cable from connector X2.
5. Remove the cover.
6. After connecting the input power, motor and control cables, replace the front cover.



A view of the recommended wiring configuration.

Frame R7: Ring Lugs

E Terminal Interface

Figure 11 shows the control boards and the control terminal interface. Note that the control boards are mounted horizontally, as shown, in frames R5, R6 and R7 and vertically in frames R8 and R9.

Note! It is important to note the orientation of the terminal interface board when connecting jumpers into J1 and J2.

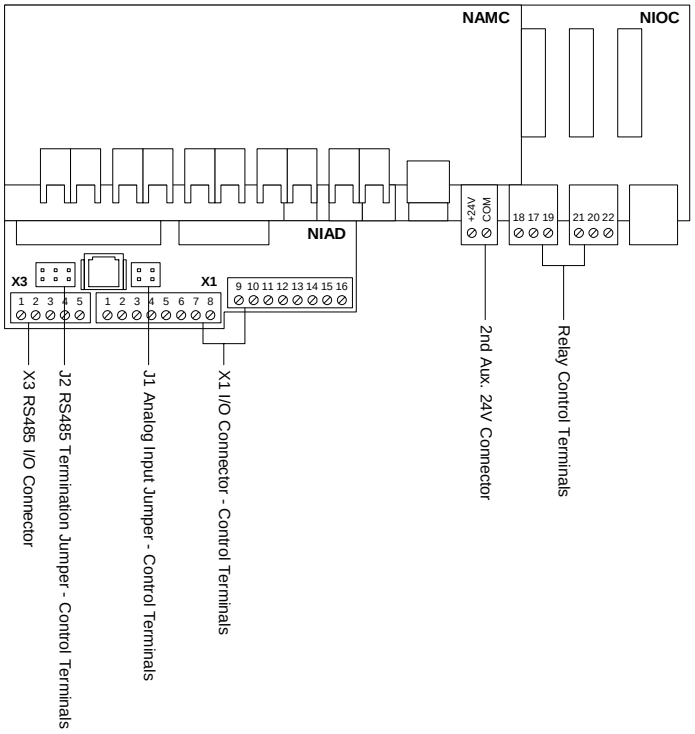


Figure 11 Terminal Interface.

F 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 c UL us IND. CONT. EQ
Code	**63996611**	**I1n**	4.7	
Ser.no.	*1982800001*	**I2n**	4.9	
		f1	48...63 Hz	
		f2	0...250Hz	

Figure 12 ACH 400 type designation label.

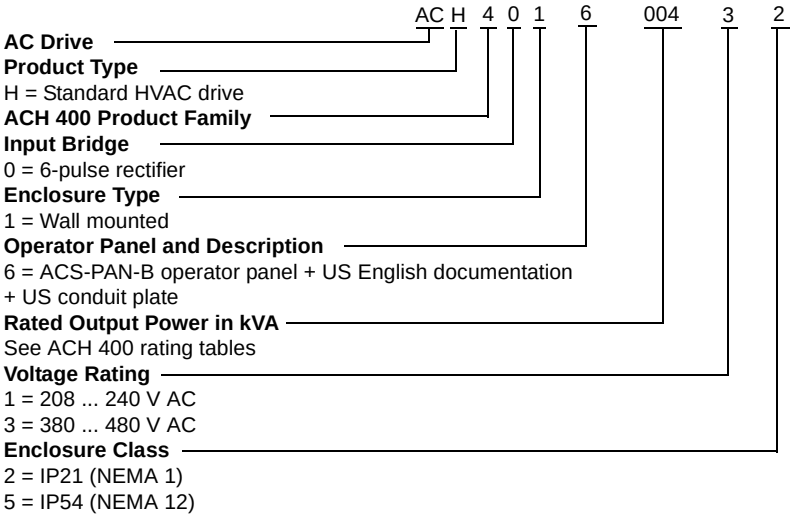


Figure 13 Type code key.

G 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 Q
R+, R–	DC bus	For optional ACS-BRK braking resistor
X1 1 to 16	Control Wiring	Low voltage control – use shielded cable
X1 17 to 22	Control Wiring	Low voltage or 115 VAC
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 115 VAC control wiring separated from low voltage control wiring and power wiring.

Metallic conduit must be used for motor wiring unless armored cable is used. Where conduits must be coupled together, the joint must be bridged with a ground conductor bonded to the conduit on each side of the joint. The counduits must also be bonded to the drive enclosure. Do not run motor wiring from more than one drive in the same conduit.

Use shielded cable for control wiring.

Ampacity is based on 60°C rated power cable up to 100 Amps, 75°C over 100 Amps.

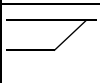
Refer to Section **Q** Specifications for current, ratings, fuse recommendations, maximum wire size capacities and tightening torques for the terminals. The ACH 400 is suitable for use on a circuit capable of delivering not more than 65,000 RMS symmetrical amperes, 480 V maximum. The ACH 400 has an electronic 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, 3006, 3007, and 3008.

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.

H 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. Default: 0 - 10 V (R_i = 200 kΩ) (J1:AI1 open) <=> 0 - f_{nom} frequency reference 0 - 20 mA (R_i = 500 Ω) (J1:AI1 closed) <=> 0 - f_{nom} frequency reference 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. 0 - 20 mA (R_i = 100 Ω) <=> 0 - f_{nom} frequency reference 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 < 700 Ω) <=>0-f_{nom} output frequency	
8	AGND	Analog input circuit common. (Connected internally to chassis ground through 1 MΩ.)	
9	24 V	+24 VDC source for digital inputs max 100 mA. Short circuit protected.	
10		No Connection.	
DI Configuration		To activate a digital input, there must be ≥+12 V (24 VDC source) applied to the inputs. The 24 V must be provided by the ACH 400 (X1:9) using the connection examples (see Section **J**).	
		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		No Connection.	
18	RO1		Relay output 1, programmable (default: fault => 17 connected to 18). 12 - 250 VAC / 30 VDC, 10 mA - 2 A
17	RO1		
19	RO1		
21	RO2		Relay output 2, programmable (default: running => 20 connected to 22). 12 - 250 VAC / 30 VDC, 10 mA - 2 A
20	RO2		
22	RO2		

Digital input impedance 1.5 kΩ.

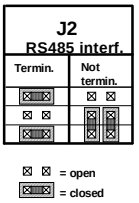
Use multi-strand 0.5 - 1.5 mm^2 (20 - 16 AWG) wire.

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

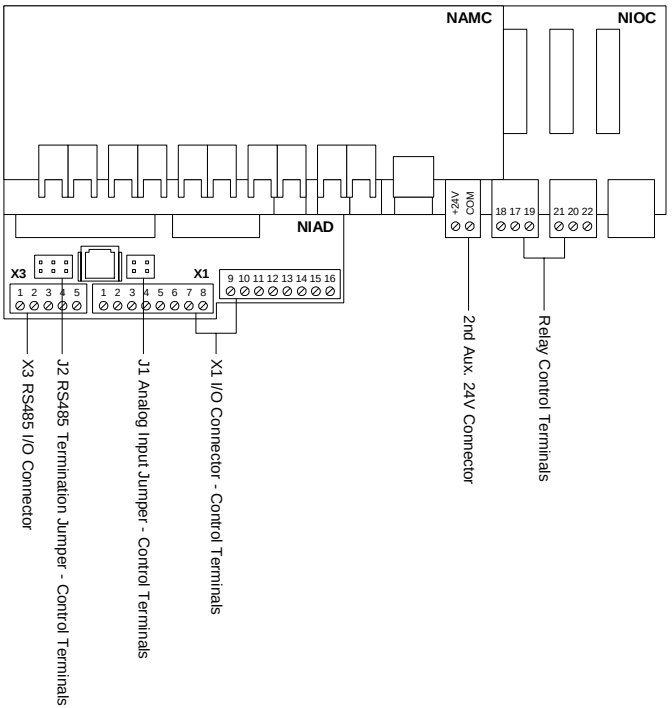
Note! Terminals 3, 6 and 8 are at the same potential.

RS485 terminal X3

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



Note! Ensure that the J2 switch is set for “Not Termin.” on the NIOC card!.



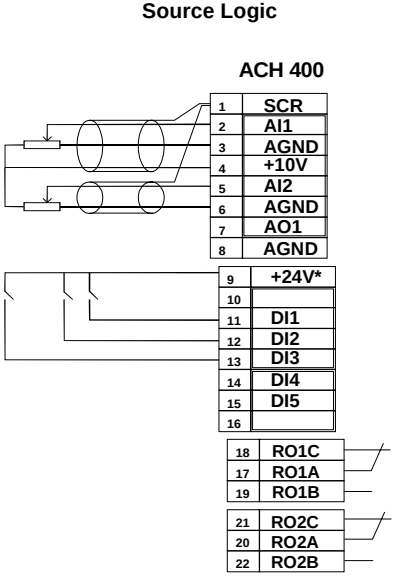
I Motor

Check for motor compatibility. The motor must be a three-phase induction motor, rated 200 to 240 V for ACH401-XXXX-1-X or 380 to 480 V for ACH401-XXXX-3-X and f_N either 50 Hz or 60 Hz.

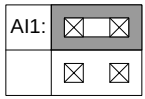
The motor’s nominal current, I_{N2}, must be less than the nominal output current of the ACH 400, I_2 (See Sections **F** and **Q**).

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.

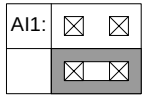
J Connection Examples



J1 Analog input
AI1: 0 (4) - 20 mA



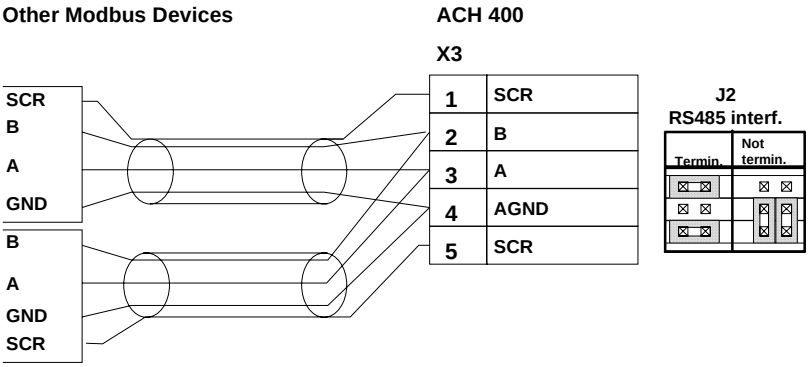
J1 Analog input
AI1: 0 - 10 V



Analog Input 2 (AI2:) is always configured for 0(4) - 20 mA input.

* Note that 24V COM is internally connected.

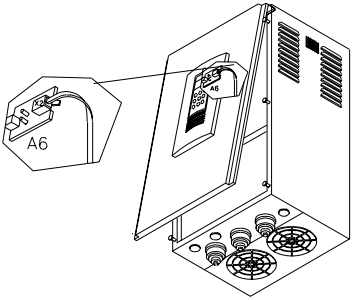
RS485 Multidrop application



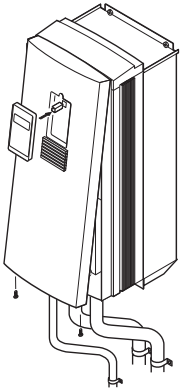
K Replacing the Cover (Wall Mount Units - R5 to R7)

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

Frame R7



Connect the Control Panel cable to the connector X2, and replace the front cover.



Replacing the front cover

Frames R5 to R6

1. Replace the front cover.
2. Replace the telephone connector.
3. Attach the Control Panel by first verifying that the connector is properly lined up with the port in the back of the control panel then gently pushing it down onto the connector in the recessed portion of the front cover.

L Applying Power

Once the unit has power, a motor ID Run must be performed (see “Perform Motor ID Run” on page 25).

Note! Before the drive can be used, a motor ID Run must be performed!

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

M Environmental Information

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

N Protection Features

The ACH 400 has a number of protective features:

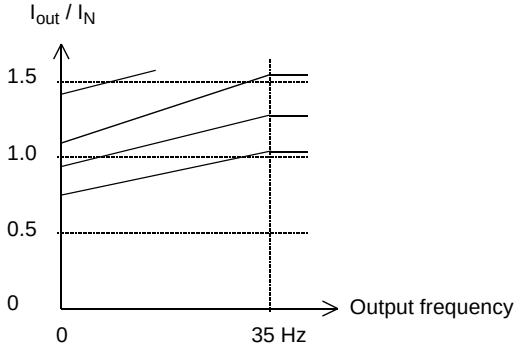
- Overcurrent
- Overvoltage
- Undervoltage
- Overtemperature
- Output ground fault
- Output short circuit
- Input phase loss (3~)
- I/O terminal short circuit protection
- Motor overload protection (see Section **O**)
- Output overload protection (see Section **P**)
- Stall protection
- Underload

Note! Whenever the ACH 400 detects a fault condition, the fault relay is activated. 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.

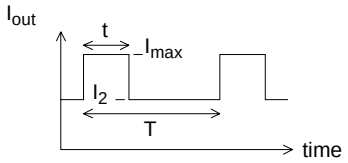
O Motor Overload Protection

If the motor current, I_{out}, exceeds the 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”.

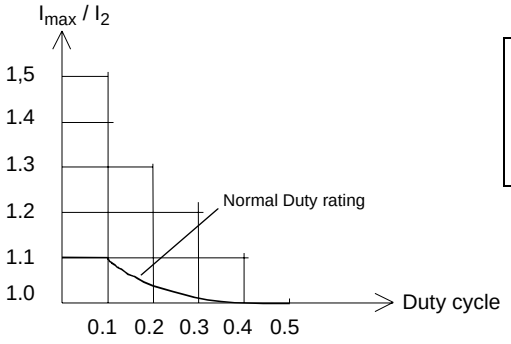


P Drive Overload Protection



Duty cycle = t/T

T < 10 min



Ambient temperature, θ_{amb} max. is 104°F (40°C).

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

Q Specifications

200 V series					
3~ Input U_1 200V - 240V ±10 % 50/60 Hz	**ACH401-**	**60601**	**60701**	**60801**	**61001**
Frame size		R6		R7	
Nominal ratings (See **F**)	Unit				
Nominal motor P_N Squared Torque	**Hp**	**50**	**60**	**75**	**100**
Input current I_{1N}	A	143	178	211	248
Output current I_{2N}	A	143	178	211	248
Max. output current I_{2Nmax}*	A	157	187	232	273
Output voltage U_2	U	0 - U_1			
Switching frequency	kHz	3kHz (Average)			
Protection limits	(See **N**)				
Overcurrent (peak)	A	228	286	340	384
Overvoltage: Running Start inhibit	 V DC V DC	 420 (corresponds to 285 VAC input) 390 (in input voltage range 276 VAC input)			
Undervoltage: Running Start inhibit	 V DC V DC	 200 (corresponds to 142 VAC input) 230 (in input voltage range 162 VAC input)			
Overtemperature	°C	115°C Warning, 125°C Trip			
Max. cable length f_{SW} = 3 kHz*****	m	300 m			
Max. wire sizes and screw torque of connectors					
Power terminals*** (One per phase)	mm^2 mm^2/AWG Nm/lbs-ft	70mm^2/AWG #00 8 Nm 5.9lbs ft		10mm (13/32”) bolts for attaching ring lugs (not furnished) 30Nm/22lbs ft	
Ground terminals (Two or more)	mm^2	70mm^2/AWG #00 30Nm/22lbs ft			
Control terminals	mm^2	0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm			
240 V	Hp	50	60	75	100
Line Fuse****	A A2s Bussmann No.	400 105000 170M3019	400 105000 170M3019	400 105000 170M3019	400 105000 170M3019
Power losses					
	W	2185	2950	3200	4300
	BTU/Hr	7500	10100	10900	14700

* Power stages are designed for the continuous I_{N2} current. These values are valid when the altitude is less than 3300 ft. (1000 m) above sea level. See R.

** Low noise setting is programmable with the optional control panel.

*** Follow local rules for cable sizes. Shielded motor cable is recommended.

**** These fuses are UL R/C (JFHR2)

*****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 ouput dv/dt.

Ampacity based on 60°C wire up to 100A and 75°C wire for 100A and above.

400 V series										
3~ Input U_1 380V - 480V ±10 % 50/60 Hz	**ACH401-**	**006031**	**007031**	**010031**	**012031**	**014031**	**ACH402 021031**	**ACH402 026031**	**ACH402 032031**	**ACH402 040031**
Frame size		R5	R6		R7		R8		R9	
Nominal ratings (See **F**)	Unit									
Nominal motor P_N Squared Torque	**Hp**	**60**	**75**	**100**	**125**	**150**	**200**	**250**	**300**	**400**
Input current I_{1N}	A	77	96	124	156	180	260	316	414	480
Output current I_{2N}	A	77	96	124	156	180	260	316	414	480
Max. output current I_{2Nmax}*	A	85	106	136	172	198	286	348	455	528
Output voltage V_2	V	0 - U_1								
Switching freq.	kHz	3 kHz (Average)								
Protection limits	(See **N**)									
Overcurrent (peak)	A	203	238	301	395	493	700	840	1050	1277
Overvoltage: Running Start inhibit	 V DC V DC	 842 (corresponds to 624 VAC input) 661 (corresponds to 380 - 415 VAC input) 765 (corresponds to 440 - 480 VAC input)								
Undervoltage: Running Start inhibit	 V DC V DC	 333 (corresponds to 247 VAC input) 436 (corresponds to 380 - 415 VAC input) 505 (corresponds to 440 - 480 VAC input)								
Overtemperature	°C	115°C Warning, 125°C Trip Inverter Module								
Max. cable length f_{SW} = 4 kHz*****	m	300 m								
Max. wire sizes and screw torque of connectors										
Power terminals*** (One per phase)	mm^2 mm^2/AWG Nm/lbs-ft	35mm^2/ AWG #2 8 Nm 5.9lbs ft	70mm^2/AWG #00 8 Nm 5.9lbs ft		10mm (13/32") bolts for attaching ring lugs (not furnished) 30Nm/ 22lbs ft		12mm (15/32") holes for bolting lugs to bus bar. NEMA two hole lugs (½" dia. & 1.75" on center) can be used. (Lugs not furnished)			
Ground terminals (Two or more)	mm^2	70mm^2/AWG #00 30Nm/22lbs ft					12mm (15/32") holes for attaching ring lugs. (Lugs not furnished).			
Control terminals	mm^2	0.5 - 1.5 (AWG20...AWG16) / Torque 0.4 Nm								
480 V	Hp	60	75	100	125	150	200	250	300	400
Line Fuse****	A A2s Bussmann No.	200 28000 170M 1370	200 28000 170M 1370	200 28000 170M 1370	400 105000 170M 3019	400 105000 170M 3019	550 190000 170M 5011	700 405000 170M 5013	700 405000 170M 5013	800 465000 170M 6012
Power losses										
	W	1880	2100	3000	3600	4200	6300	7800	9600	12000
	BTU/Hr	6150	7170	10200	12300	14300	21500	26600	32800	40900

* Power stages are designed for the continuous I_{N2} current. These values are valid when the altitude is less than 3300 ft. (1000 m) above sea level. See R.

** Low noise setting is programmable with the optional control panel.

*** Follow local rules for cable sizes. Shielded motor cable is recommended.

**** These fuses are UL R/C (JFHR2)

***** 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 ouput dv/dt.

Ampacity based on 60°C wire up to 100A and 75°C wire for 100A and above.

R Product Conformity

The ACH 400 complies with European requirements:

- Low Voltage Directive 73/23/EEC with amendments
- EMC Directive 89/336/EEC with amendments
- UL 508C

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 a safety related device mentioned in the Machinery Directive and related harmonized standards. The CDM/BDM/adjustable frequency drive can be considered a part of a 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.

S Accessories

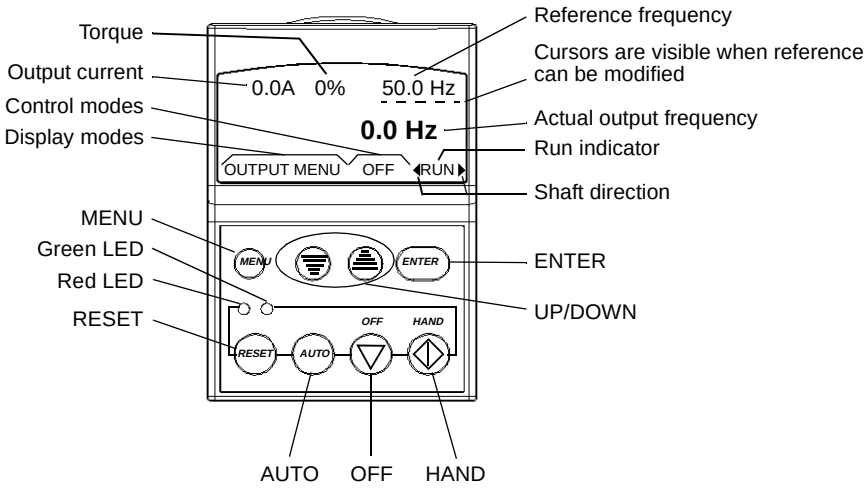
ACS-100/140/400-EXT
Extension cable kit for use with the control panel.

ACH 400 is supported by Drive*Ware*
Contact your local ABB sales office for details.

PROGRAMMING

ACS-PAN-B Control Panel

The ACS-PAN-B is an alphanumeric control panel with a backlit LCD display and multiple language capability. 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 > < RUN	• Drive is running and at set point • 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 shown in Figure 14. Whenever the MENU button is pressed and held, the control panel resumes this **OUTPUT** display.

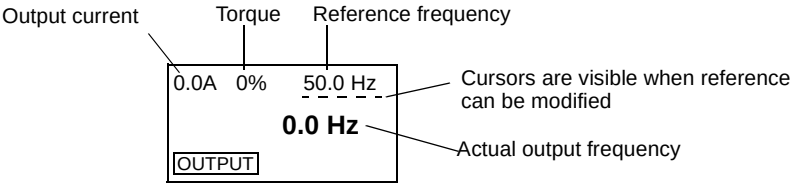


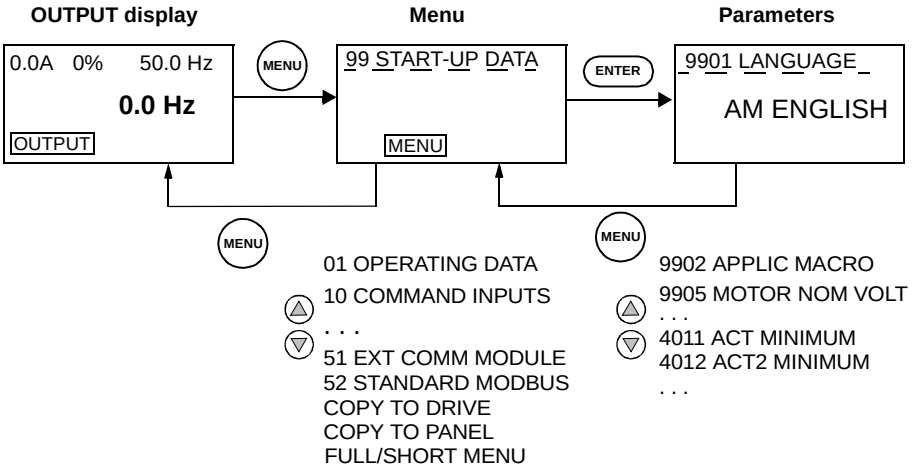
Figure 14 Output display variables.

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

Menu Structure

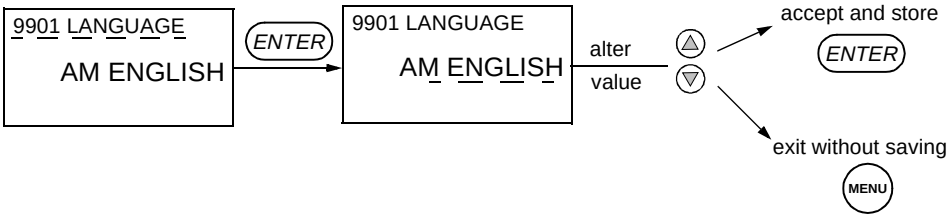
The ACH 400 has a large number of parameters. Of these, only the **basic parameters** are initially visible. See “Selecting Full Parameter Set” on page 26 for details on specifying the full parameter set.

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 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 RESET button.

Adjust the Panel Display Contrast

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

Perform Motor ID Run

A motor ID Run must be performed before the drive can be used. The proper procedure for setting up an ID Run is as follows:

Note! The motor must be connected to the drive's output before initiating an ID Run!

1) Enter the data from the motor's rating plate into parameter group 99. See "Group 99: Start-up Data" on page 47.

2) Once the data is entered, the drive's display will flash Warning 101 (ID MAGN REQ).

3) Make sure the Run Enable signal is present (Jumper 9 to 12).

4) Press the Hand (Start) button, the drive will output current to the motor for 20 seconds to one minute.

5) The drive will display Warning 102 (ID MAGN) during the ID Run.

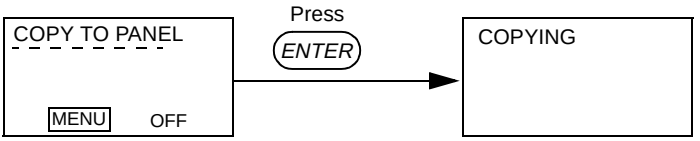
6) When the ID is complete, the drive display will stop displaying Warning 102 and shut off.

7) Enter the required macro and modify the drive's parameters as required.

Menu Functions

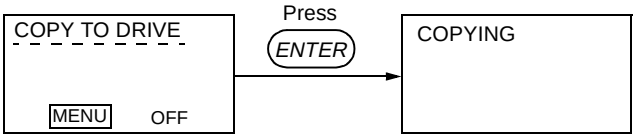
Use the UP/DOWN arrows to scroll through the Menu for the desired menu function, then press and hold ENTER until the display blinks to start the operation.

Copy Parameters from Drive to Panel (upload)



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

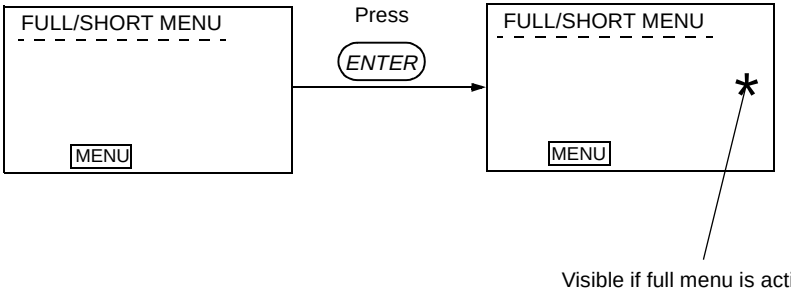
Copy Parameters from Panel to Drive (download) ONLY from R5-R9 drives to R5-R9 drives



Note! The drive must be OFF. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN) and the drive must be in the same macro as the original drive!

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 short parameter set.



Resetting the Drive from the Control Panel

When the ACS-PAN-B's red LED 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 (**LOC** or **REM**) 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.

Table 5 Alarms.

Alarm Code	Display	Description
1 *	OPERATION FAILED	Parameter upload or download failed. The software versions of the drives may not be compatible. The software version can be seen from parameter 3301 SOFTWARE VERSION.
2 *	START ACTIVE	Control panel function is not allowed while start is active.
3 *	LOCAL/REMOTE	Control panel function is not allowed in current control mode (local or remote). Control mode is local when LOC is displayed and remote mode when REM is displayed on the control panel.
5 *	BUTTON DISABLED	Control panel function is denied for any of the following reasons: • START/STOP button is interlocked from digital input. This can happen with certain digital input configurations. Refer to chapter Application Macros. • REVERSE button is locked because the shaft direction is fixed by parameter 1003 DIRECTION. • The drive is in remote control mode and the START/STOP and REVERSE buttons are not followed.
6 *	PARAM/LOCAL LOCK	Control panel function is not allowed: • Parameter 1602 PARAMETER LOCK denies parameter editing. • Parameter 1605 LOCAL LOCK denies local control mode.
7 *	FACTORY MACRO	Control panel function is not allowed: Factory macro is selected and denies the parameter modifications. Factory macro is intended for applications where there is no control panel available.
10	OVERCURRENT	Overcurrent controller is active.
11	OVERVOLTAGE	Overvoltage controller is active.
12	DC UNDERVOLTAGE	Undervoltage controller is active.
13	DIRECTION LOCK	Rotation direction if fixed by parameter 1003 DIRECTION.
14	SERIAL COMM LOSS	Serial communication through the Standard Modbus Channel is lost. • Check connections between the external control system and the ACH 400. • Refer to parameters 5003 COMM FAULT TIME and 5004 COMM FAULT FUNC.
15 *	MODBUS EXCEPTION	Exception response is sent through Standard Modbus channel. The bus master may be sending queries which cannot be processed by the ACH 400. Refer to “Standard Serial Communication” section. Last three exception response codes are stored into parameters 5213 - 5215.
16	AI1 LOSS	Analog input 1 loss. Analog input 1 value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
17	AI2 LOSS	Analog input 2 loss. Analog input 2 value is less than MINIMUM AI2 (1306). See also parameter 3001 AI<MIN FUNCTION.
18	PANEL LOSS	Panel communication loss. Control panel is disconnected when - Drive is in local control mode (LOC is shown in the control panel display), or - Drive is in remote control mode (REM) and is configured to accept start/stop, direction or reference from the panel. Refer to parameters in groups 10 COMMAND INPUTS and 11 REFERENCE SELECT. See also parameter 3002 PANEL LOSS.
19	ACH400 OVERTEMP	ACH 400 overtemperature condition. This alarm is given when the temperature reaches 95% of the trip limit.

Alarm Code	Display	Description
20	MOTOR OVERTEMP	Motor overtemperature condition as estimated by the ACH 400. Refer to parameters 3004 – 3008.
21	UNDERLOAD	Motor load is too low. Check for a problem in the driven equipment. Refer to parameters 3013 – 3015.
22	MOTOR STALL	Motor is operating in the stall region. This may be caused by an excessive load or insufficient motor power. Refer to parameters 3009 – 3012.
23	DDCS COMM LOSS	DDCS communication loss has been detected. • Check the status of the fieldbus adapter. Refer to the appropriate fieldbus adapter manual. • Check the DDCS option module and optical fibers. • Check the connections between the external control system and fieldbus adapter. Refer to “DDCS Option module manual” and parameters 5003 – 5006.
24		Reserved.
25		Reserved.
26	OUTPUT OVERLOAD	Inverter overload condition. The ACH 400 output current exceeds the ratings given on page 18 of this manual.
27 *	AUTOMATIC RESET	ACH 400 is about to perform an automatic fault reset operation. As a result, the drive may start after the reset operation. Refer to parameter group 31 AUTOMATIC RESET.
28 *	PID SLEEP	The PID sleep function is active. The drive may accelerate when the PID sleep function is deactivated. Refer to parameters 4018 SLEEP SELECTION, 4013 PID SLEEP DELAY, 4014 PID SLEEP LEVEL and 4015 WAKE-UP LEVEL.
29 *	AUTOCHANGE	The autochange function of the Pump-Fan Control block is active. Refer to parameter group 81 PFC CONTROL and the appendix for more information.
30	INTERLOCK	Pump-Fan Control interlocks are active. The ACH 400 cannot start any motor (when Autochange is used), or the ACH 400 cannot start the speed regulated motor (when Autochange is not used).
101 *	ID MAGN REQ	The motor data has been entered or changed and the drive needs to perform a magnetizing ID Run. This is performed by ensuring the enable signal is present and by pressing the hand button. The motor needs to be connected to the drive for an ID Run.
102 *	ID MAGN	The drive is in the process of performing the ID Run on the motor.
103	GROUND FAULT	The drive has detected a ground fault condition.
104	COMM MODULE	The drive has lost communication with the communications module.

* This alarm will not cause relay output RO1 (RO2) to activate when the relay output is configured to indicate an alarm condition in general. (Parameter 1401 RELAY OUTPUT (1402 RELAY OUTPUT2) has value 5 (ALARM) or 13 (FLT/ALARM)).

Table 6 Faults.

Fault Code	Display	Description
1	OVERCURRENT	Output current is excessive. • Motor load may be too high. • Acceleration time may be too short (parameters 2201 ACCELER TIME 1 and 2203 ACCELER TIME 2). • Motor or motor cable is faulty or connected incorrectly.
2	DC OVERVOLTAGE	Intermediate circuit DC voltage is excessive. • Check main input power for static or transient overvoltages. • Deceleration time may be too short (parameters 2202 DECELER TIME 1 and 2204 DECELER TIME 2). • Brake chopper (if present) may be undersized.
3	ACH400 OVERTEMP	ACH 400 heat sink temperature is excessive. Temperature trip limit is 95°C (203°F). Ambient air inside the drive > 70°C. • Check air flow and fan operation. • Check motor power against unit power.
4 **	SHORT CIRCUIT	Fault current. Possible reasons for this fault are: • There is a short-circuit in the motor cable(s) or motor • Supply disturbances
5	OUTPUT OVERLOAD	Inverter overload condition. The ACH 400 output current exceeds the ratings given on page 18 of this manual.
6	DC UNDERVOLTAGE	Intermediate circuit DC voltage is not sufficient. • Main input power phase may be missing • Fuse may be blown
7	ANALOG INPUT 1	Analog input 1 loss. Analog input value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
8	ANALOG INPUT 2	Analog input 2 loss. Analog input value is less than MINIMUM AI2 (1306). See also parameter 3001 AI<MIN FUNCTION.
9	MOTOR OVERTEMP	Motor overtemperature condition as estimated by the ACH 400. Refer to parameters 3004 – 3008.
10	PANEL LOSS	Panel communication loss. The control panel is disconnected when the drive is receiving start, stop and direction commands from the panel. - Drive is in local control mode (LOC is shown in the control panel display), or - Drive is in remote control mode (REM is shown) and is configured to accept start/stop, direction or reference from the panel. Refer to parameters in groups 10 COMMAND INPUTS and 11 REFERENCE SELECT. See also parameter 3002 PANEL LOSS.
11	PARAMETERING	Parameter values are inconsistent: • MINIMUM AI1 > MAXIMUM AI1 (parameters 1301, 1302) • MINIMUM AI2 > MAXIMUM AI2 (parameters 1304, 1305) • MINIMUM FREQ > MAXIMUM FREQ (parameters 2007, 2008) • Motor data not entered before starting the drive.
12	MOTOR STALL	Motor stall. This may be caused by excessive load or insufficient motor power. Refer to parameters 3009 – 3012.
13	SERIAL COMM LOSS	Serial communication through the Standard Modbus Channel is lost. • Check the connections between the external control system and the ACH 400. • Refer to parameters 5003 COMM FAULT TIME and 5004 COMM FAULT FUNC.
14	EXTERNAL FAULT SIGNAL	External fault is active. See parameter 3003 EXTERNAL FAULT.
15 **	OUTPUT GROUND FAULT	Ground fault. The load on the incoming main input power system is out of balance. • There may be a fault in the motor or motor cable. • Motor cable may be too long.
16 **	DC BUS RIPPLE	• Ripple voltages on the DC bus are too large. • Main input power phase may be missing • Fuse may be blown

17	UNDERLOAD	Motor load is too low. Check for a problem in the driven equipment. Refer to parameters 3013 – 3015.
18		Reserved
19	DDCS LINK	Problem with DDCS link for IOC or NDIO. • Check the DDCS option module and the optic fibers. • Check the status of the IO extension modules (NDIO) required by the PFC block. Refer also to “DDCS Option Module Manual” and parameter 5004.
20 - 26 **	HARDWARE ERROR	Hardware error. Contact supplier.
Full display blinking (ACS100-PAN) “COMM LOSS” (ACS-PAN)		Serial link failure. Bad connection between the control panel and the ACH 400.
101	MOTOR PHASE	The drive has detected an open phase between the drive and the motor.
102	SUPPLY PHASE	The drive has detected a large ripple on the DC bus, indicating a loss of input phase.
103	ID MAGN FAILED	The drive was unable to perform the ID Run successfully. Check the motor parameters and the motor wiring then repeat the ID Run.
104	PPCC LINK	PPCC LINK code may indicate one of the following conditions: Indicates loss of communications between the NAMC and NINT boards. Check the fiber optic connection on channel INT on the AMC board. or Rate of rise of current too fast. Check the motor cabling for short circuits.
105	OVER FREQ	Output frequency too high.
106	SYSTEM FAULT	Contact ABB Service.
107	COMM MODULE	Communication with the communications module has been lost. Check the fiber optic connection on CH0 on the AMC board. Check the power supply connection to the communications module.

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" 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 START-UP DATA			
9901	**LANGUAGE** Language selection. 0 = ENGLISH 1= ENGLISH (AM) 2 = GERMAN 3 = ITALIAN 4 = SPANISH 5 = PORTUGUESE 6 = DUTCH 7 = FRENCH 8 = DANISH 9 = FINNISH 10 = SWEDISH 11 = RUSSIAN 12 = (reserved)		
9902	**APPLIC MACRO** Selects application macro. Sets parameter values to their default values. Refer to "Application Macros", starting page 37 for a detailed description of each macro. 0 = HVAC 1 = HAVC FL PNT 2 = HVAC PID 3 = HVAC PFC Default value: 0 (HVAC)		✓
9904	**MOTOR CONTROL MODE** Selects the motor control method. 0 = DTC 1 = SCALAR		
9905	**MOTOR NOM VOLT** Nominal motor voltage from the motor name plate. Range of this parameter depends on the type of the ACH 400.		✓
9906	**MOTOR NOM CURR** 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.		✓
9907	**MOTOR NOM FREQ** Nominal motor frequency from the motor name plate. Range: 0 - 250 Hz Default value: 60 Hz		✓
9908	**MOTOR NOM SPEED** Nominal motor speed from the motor name plate. Range: 0 - 3600 rpm		✓
9909	**MOTOR NOM POWER** Nominal motor power from the motor name plate. Range: 0.1 - 750 HP		✓

Code	Name	User	S
9910	**MOTOR COS PHI** Nominal motor cos phi from the motor name plate. Calculated by the drive during the Motor ID Run. Range: 0.50 - 0.99 Default: 0.83		✓
Group 01 **OPERATING DATA**			
0128	**LAST FAULT** Last recorded fault (0 = no fault). See “Diagnostics”, starting page 117. Can be cleared with the control panel by pressing the UP and DOWN buttons simultaneously when in parameter set mode.		
Group 10 **COMMAND INPUTS**			
1003	**DIRECTION** Rotation direction lock. 1 = FORWARD 2 = REVERSE 3 = REQUEST If you select REQUEST, the direction is set according to the given direction command. Default: 3 (REQUEST) or 1 (FORWARD) depending on the selected application macro.		✓
Group 11 **REFERENCE SELECT**			
1105	**EXT REF1 MAX** Maximum frequency reference in Hz. Range: 0 - 250 Hz Default value: 60 Hz or 62 Hz depending on the selected application macro.		
Group 12 **CONSTANT SPEEDS**			
1202	**CONST SPEED 1** Range for all constant speeds: 0 - 250.0 Hz Default value: 5.0 Hz		
1203	**CONST SPEED 2** Default value: 10.0 Hz		
1204	**CONST SPEED 3** Default value: 15.0 Hz		

Code	Name	User	S
Group 13 ANALOG INPUTS			
1301	**MINIMUM AI1** Minimum value of AI1 in percent. Defines relative analog input value where the frequency reference reaches minimum value. Range: 0 - 100 % Default value: 0 %		
Group 15 ANALOG OUTPUT			
1503	**AO CONTENT MAX** Defines output frequency where analog output reaches 20 mA. Default value: 60.0 (60 Hz) or 62.0 (62 Hz) depending on the selected application macro. **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 LIMITS			
2003	**MAX CURRENT** Maximum output current. Range: 0.5* I_N - 1.5...1.7* I_N **, where I_N is nominal current of the ACH 400. Default value: 1.5 * I_N		
2008	**MAXIMUM FREQ** Maximum output frequency. Range: 0 - 250 Hz Default value: 60 Hz or 62 Hz depending on the selected application macro.		✓

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

Group 21 START/STOP			
2102	**STOP FUNCTION** Conditions during motor stopping. 1 = COAST Motor coasts to stop. 2 = RAMP Ramp deceleration as defined by the active deceleration time 2203 DECELER TIME 1 or 2205 DECELER TIME 2. Default value: 1 (COAST)		
Group 22 ACCEL/DECEL			
2202	**ACCEL TIME 1** Ramp 1: time from zero to maximum frequency (0 - MAXIMUM FREQ). The range for all ramp time parameters is 0.1 - 1800 s. Default value: 5.0 s		
2203	**DECEL TIME 1** Ramp 1: time from maximum to zero frequency (MAXIMUM FREQ - 0). Default value: 5.0 s		
2204	**ACCEL TIME 2** Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ). Default value: 60.0 s		
2205	**DECEL TIME 2** Ramp 2: time from maximum to zero frequency (MAXIMUM FREQ - 0). Default value: 60.0 s		

Code	Name	User	S
Group 26 **MOTOR CONTROL**			
2606	**U/f RATIO** U/f below field weakening point. 1 = LINEAR 2 = SQUARE (FLUX OPTIMIZATION) 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. Default value: 2(SQUARE)		✓
Group 33 **INFORMATION**			
3301	**SW VERSION** 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 to be set during start-up. HVAC Hand/Auto Macro is the factory-set default macro.

Parameter Values

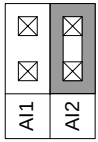
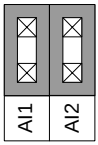
Selecting an application macro with parameter 9902 APPLIC MACRO will set all other parameters (except the language selection 9901, the parameter lock 1602 and groups 50 and 52 serial communication parameters) to their default values.

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

Connection Examples

Please note the following in the examples below:

- All the digital inputs are connected using negative (NPN) logic.
- The signal type of analog input is selected with V/I jumper J1.
- Analog reference AI2 is NOT configurable to a 0 - 10V input.

Frequency reference is provided with	V/I Jumper J1	
voltage signal (0 - 10 V)	open	
current signal (0 - 20 mA)	connected	

Note! J1 is shown as it appears when the control boards are mounted horizontally as they are in frames R5, R6 and R7, when the control boards are mounted vertically as they are in frames R8 and R9, J1 is turned 90 degrees counterclockwise.

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

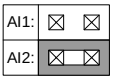
Input signals

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

Output signals

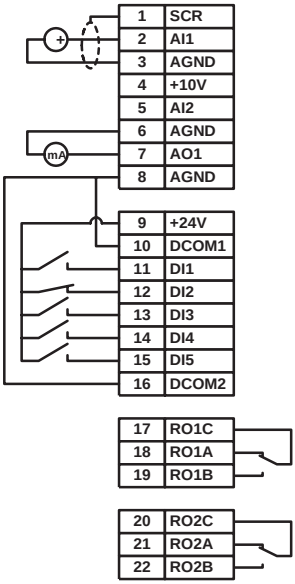
- Analog Output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

V/I jumper S1



0 - 10 V

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 default values:

9901 LANGUAGE	1 (ENGLISH US)	2101 START FUNCTION	2 (FLYING START)
9905 MOTOR NOM VOLT	230 V	2105 PREMAGN SEL	0 (NOT SEL)
9907 MOTOR NOM FREQ	60 Hz	2107 START INHIBIT	0 (OFF)
9908 MOTOR NOM SPEED	1 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 EXT1/EXT2 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	600 (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.

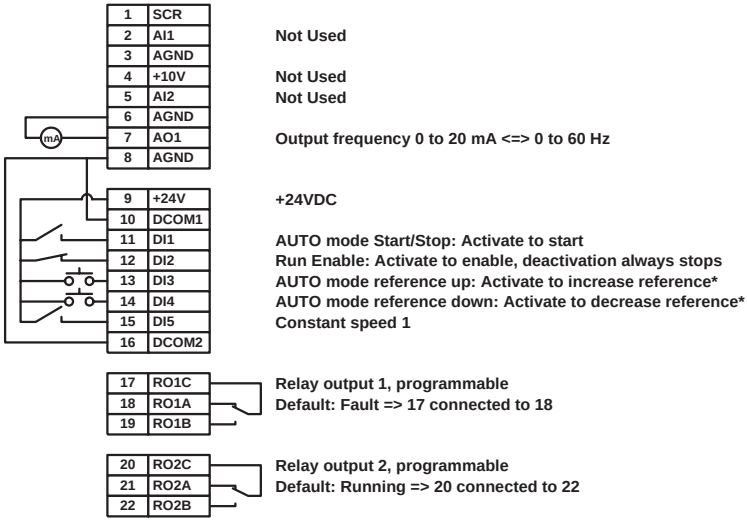
The value of parameter 9902 is HVAC FL PNT.

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 DI 3 and DI 4 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 default values:

9901 LANGUAGE	1 (ENGLISH US)	2101 START FUNCTION	2 (FLYING START)
9905 MOTOR NOM VOLT	230 V	2105 PREMAGN SEL	0 (NOT SEL)
9907 MOTOR NOM FREQ	60 Hz	2107 START INHIBIT	0 (OFF)
9908 MOTOR NOM SPEED	1 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 EXT1/EXT2 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	5 (DI5)	3106 AR UNDERVOLTAGE	1 (ENABLE)
1503 AO CONTENT MAX	600 (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.

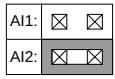
Input signals

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

Output signals

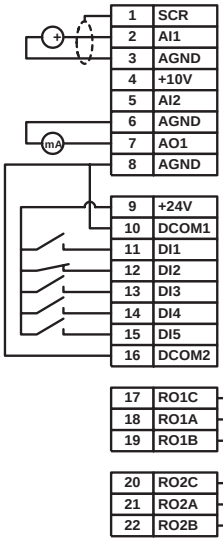
- Analog output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

V/I jumper S1



0 - 10 V

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 speed selections: 0 = open, 1 = connected

DI3	DI4	Output
0	0	Reference through AI1
1	0	Const speed 1 (1202)
0	1	Const speed 2 (1203)
1	1	Const speed 3 (1204)

Note! Constant speed selections are ignored while in PID control.

HVAC PID Control macro parameter default values

9901 LANGUAGE	1 (ENGLISH US)	2101 START FUNCTION	2 (FLYING START)
9905 MOTOR NOM VOLT	230 V	2105 PREMAGN SEL	0 (NOT SEL)
9907 MOTOR NOM FREQ	60 Hz	2107 START INHIBIT	0 (OFF)
9908 MOTOR NOM SPEED	1 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 EXT1/EXT2 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	1 (AI1)	3101 NR OF TRIALS	2
1201 CONST SPEED SEL	10 (DI3,4,5)	3106 AR UNDERVOLTAGE	1 (ENABLE)
1503 AO CONTENT MAX	600 (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.

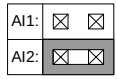
Input signals

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

Output signals

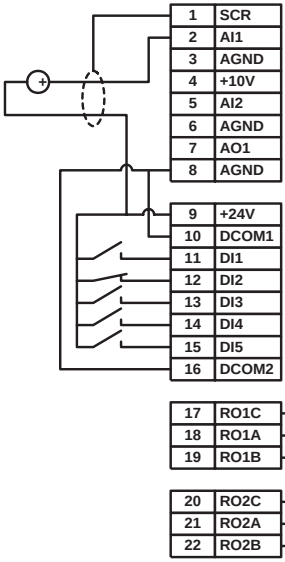
- Analog output AO: Freq
- Relay output 1: Fault
- Relay output 2: Running

V/I jumper S1



0 - 10 V

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

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

PFC parameter values:

9901 LANGUAGE	1 (ENGLISH US)	2101 START FUNCTION	2 (FLYING START)
9905 MOTOR NOM VOLT	230 V	2105 PREMAGN SEL	0 (NOT SEL)
9907 MOTOR NOM FREQ	60 Hz	2107 START INHIBIT	0 (OFF)
9908 MOTOR NOM SPEED	1 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	1 (DI1)	2203 ACCELER TIME 1	30 s
1003 DIRECTION	1 (FORWARD)	2603 IR COMPENSATION	0 V
1102 EXT1/EXT2 SEL	3 (DI3)	2606 U/F RATIO	2 (SQUARE)
1103 EXT REF1 SELECT	1 (AI1)	3001 AI<MIN FUNCTION	3 (LAST SPEED)
1105 EXT REF1 MAX	62 Hz	3008 BREAK POINT	15 Hz
1106 EXT REF2 SELECT	1 (AI1)	3101 NR OF TRIALS	2
1201 CONST SPEED SEL	0 (NOT SEL)	3106 AR UNDERVOLTAGE	1 (ENABLE)
1401 RELAY OUTPUT 1	PFC	2101 START FUNCTION	2 (FLYING START)
1402 RELAY OUTPUT 2	PFC	3107 AR AI<MIN	1 (ENABLE)
1503 AO CONTENT MAX	620 (62 Hz)	4001 PID GAIN	2.5
1601 RUN ENABLE	2 (DI2)	4002 PID INTEG TIME	3 s
1604 FAULT RESET SEL	0 (KEYPAD)	8120 INTERLOCKS	4 (DI4)
2008 MAXIMUM FREQ	62 Hz		

ACH 400 Complete Parameter List

Initially, only the basic parameters (shaded grey in Table 7) are visible. Use the appropriate control panel menu function 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	0 (ENGLISH)			
9902	APPLIC MACRO	0 - 4	1	0 (HVAC)		✓	
9904	MOTOR CONTROL MODE	0 - 1	1	0 (DTC)		✓	
9905	MOTOR NOM VOLT	208 - 500 V	-	230 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	60 Hz		✓	
9908	MOTOR NOM SPEED	0 - 3600 rpm	1 rpm	1440 rpm		✓	
9909	MOTOR NOM POWER	0.1 - 100 kW	0.1 kW	0 HP		✓	
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 %	-			
0127	PID ACT VALUE	0 - 100 %	0.1 %				
0128	LAST FAULT	0 - 26	1	0			
0129	PREVIOUS FAULT	0 - 26	1	0			

Code	Name	Range	Resolution	Default	User	S	M
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 %			
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			

Code	Name	Range	Resolution	Default	User	S	M
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			
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	0 (OFF)			
Group 22 ACCEL/DECEL							
2201	ACC/DEC 1/2 SEL	0 - 5	1	*		✓	✓
2202	ACCEL TIME 1	0.1 - 1800 s	0.1; 1 s	30 s			
2203	DECEL TIME 1	0.1 - 1800 s	0.1; 1 s	30 s			
2204	ACCEL TIME 2	0.1 - 1800 s	0.1; 1 s	60 s			
2205	DECEL 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			

Code	Name	Range	Resolution	Default	User	S	M
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 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	0 (NOT SEL)			
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	(CALCULATED)			
3006	MOT LOAD CURVE	50 - 150 %	1 %	100 %			
3007	ZERO SPEED LOAD	25 - 150 %	1 %	74 %			
3008	BREAK POINT	1 - 250 Hz	1 Hz	15 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	0.0 A			
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			
3016	MOTOR PHASE LOSS	0 - 1		0 (NO)			
3017	GROUND FAULT	0 - 1		1 (FAULT)			
Group 31 AUTOMATIC RESET							
3101	NR OF TRIALS	0 - 5	1	2			
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	1 (ENABLE)			
3107	AR AI<MIN	0 - 1	1	1 (ENABLE)			
Group 32 SUPERVISION							
3201	SUPERV 1 PARAM	102 - 137	1	103			
3202	SUPERV 1 LIM LO			0			
3203	SUPERV 1 LIM HI			0			
3204	SUPERV 2 PARAM	102 - 137	1	103			
3205	SUPERV 2 LIM LO			0			
3206	SUPERV 2 LIM HI			0			
Group 33 INFORMATION							
3301	SW VERSION	0.0.0.0 - f.f.f.f	-	-			

Code	Name	Range	Resolution	Default	User	S	M
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)			
Group 40 PID CONTROL							
4001	PID GAIN	0.1 - 100	0.1	*			✓
4002	PID INTEG TIME	0.1 - 320 s	0.1 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	2.5			
4102	PID INTEG TIME	0.1 - 320 s	0.1 s	3.0 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 %			

Code	Name	Range	Resolution	Default	User	S	M
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 %			
Group 50 COMMUNICATION							
5001	DDCS BIT RATE	1, 2, 4, 8	-	4 (4 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)		✓	
Group 51 EXT COMM MODULE							
5101-5115	FIELDBUSPAR1 - 15	-	-	-			
Group 52 SERIAL COMMUNICATIONS							
5201	STATION NUMBER						
5202	COMM SPEED						
5203	PARITY						
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	60Hz			
8110	START FREQ 2	0.0 - 250 Hz	0.1 Hz	60 Hz			
8111	START FREQ 3	0.0 - 250 Hz	0.1 Hz	60 Hz			
8112	LOW FREQ 1	0.0 - 250 Hz	0.1 Hz	30 Hz			
8113	LOW FREQ 2	0.0 - 250 Hz	0.1 Hz	30 Hz			
8114	LOW FREQ 3	0.0 - 250 Hz	0.1 Hz	30 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 %			
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** Language selection for the ACS-PAN-A control panel. 0 = ENGLISH 3 = ITALIAN 6 = DUTCH 9 = FINNISH 12 = (reserved) 1 = ENGLISH (AM) 4 = SPANISH 7 = FRENCH 10 = SWEDISH 2 = GERMAN 5 = PORTUGUESE 8 = DANISH 11 = RUSSIAN
9902	**APPLIC MACRO** 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 the available Application Macros. 0 = HVAC 1 = HVAC FL PNT 2 = HVAC PID 3 = HVAC PFC
9904	**MOTOR CONTROL MODE** Selects the motor control mode. 0 = DTC 1 = SCALAR Default selection is 0 (DTC).
9905	**MOTOR NOM VOLT** Nominal motor voltage from the motor rating plate. This parameter sets the maximum output voltage supplied to the motor by the ACH 400. MOTOR NOM FREQ sets the frequency at which the output voltage is equal to the MOTOR NOM VOLT. The ACH 400 cannot supply the motor with a voltage greater than the main input voltage. See Figure 15.
9906	**MOTOR NOM CURR** Nominal motor current from the motor rating plate. The allowed range is $0.5 \cdot I_N$ ... $1.5 \cdot I_N$ of ACH 400.
9907	**MOTOR NOM FREQ** Nominal motor frequency from the motor rating plate (field weakening point). See Figure 15.
9908	**MOTOR NOM SPEED** Nominal motor speed from the motor rating plate.
9909	**MOTOR NOM POWER** Nominal motor power from the motor rating plate.
9910	**MOTOR COS PHI** Nominal motor cos phi from the motor rating plate (This will be calculated if an ID Run is performed).

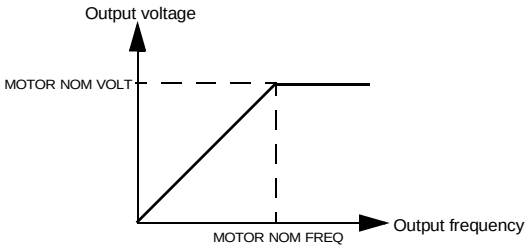
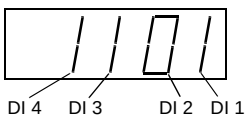
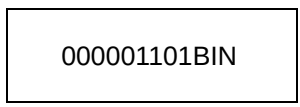
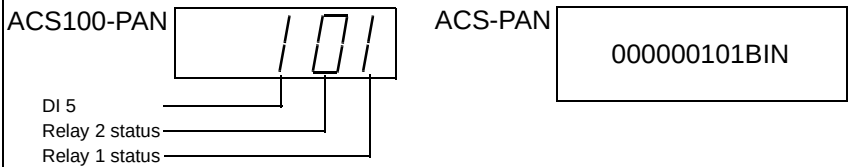


Figure 15 Output voltage as a function of output frequency.

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** Displays the calculated speed of the motor (rpm).
0103	**OUTPUT FREQ** Displays the frequency (Hz) applied to the motor. (Also shown in OUTPUT display.)
0104	**CURRENT** Displays the motor current, as measured by the ACH 400. (Also shown in OUTPUT display.)
0105	**TORQUE** Output torque. Calculated value of torque on the motor shaft in % of motor nominal torque.
0106	**POWER** Displays the measured motor power in kW. **Note!** ACH100-PAN will not display the unit (“kW”).
0107	**DC BUS VOLTAGE** Displays the DC bus voltage, as measured by the ACH 400. The voltage is displayed in Volts DC.
0109	**OUTPUT VOLTAGE** Displays the voltage applied to the motor.
0110	**ACH 400 TEMP** Displays the temperature of the ACH 400 heatsink in degrees Centigrade.
0111	**EXTERNAL REF 1** The value of external reference 1 in Hz.
0112	**EXTERNAL REF 2** The value of external reference 2 in %.
0113	**CTRL LOCATION** Displays the active control location. Alternatives are: 0 = LOCAL 1 = EXT1 2 = EXT2 See “Appendix A”, starting page 123, for description of different control locations.
0114	**RUN TIME (R)** Shows the total running time of the ACH 400 in hours (h). Can be **reset** by pressing the RESET button when in parameter set mode.
0115	**kWh COUNTER (R)** Shows the counted kilowatt hours of ACH 400 in operation. Can be **reset** by pressing the RESET button when in parameter set mode.
0116	**APPL BLK OUTPUT** The reference value in percent received from the application block. The value is from the PID or PFC control, depending on the selected macro. Otherwise the value is from 0112 EXT REF 2.
0117	**DI1-DI4 STATUS** 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. ACS100-PAN  ACS-PAN 
0118	**AI1** Relative value of analog input 1 displayed in %.

Code	Description
0119	**AI2** Relative value of analog input 2 displayed in %.
0121	**DI5 & RELAYS** Status of digital input 5 and relay outputs. 1 indicates that the relay is energized and 0 indicates that the relay is de-energized. 
0122	**AO** Value of analog output signal in milliamperes.
0124	**ACTUAL VALUE 1** PID/PFC controller actual value 1 (ACT1), displayed in percent.
0125	**ACTUAL VALUE 2** PID/PFC controller actual value 2 (ACT2), displayed in percent.
0126	**CONTROL DEV** Displays the difference between the reference value and the actual value of the PID/PFC controller.
0127	**PID ACT VALUE** Feedback signal (actual value) for the PID/PFC controller.
0128	**LAST FAULT** Last recorded fault (0=no fault). See “Diagnostics”, starting page 117. Can be cleared with the control panel by pressing the RESET button when in parameter set mode.
0129	**PREVIOUS FAULT** Previous recorded fault. See “Diagnostics”, starting page 117. Can be cleared with the control panel by pressing the RESET button when in parameter set mode.
0130	**OLDEST FAULT** Oldest recorded fault. See “Diagnostics”, starting page 117. Can be cleared with the control panel by pressing the RESET button when in parameter set mode.
0131	**SER LINK DATA 1** Free data location that can be written from a serial link.
0132	**SER LINK DATA 2** Free data location that can be written from a serial link.
0133	**SER LINK DATA 3** Free data location that can be written from a serial link.
0134	**PROCESS VAR 1** Process variable 1, as selected by the parameters in group 34.
0135	**PROCESS VAR 2** Process variable 2, as selected by the parameters in group 34.
0136	**RUN TIME** Shows the total running time of the ACH 400 in thousands of hours (kh).
0137	**MWh COUNTER** Counts the megawatt hours of the 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.

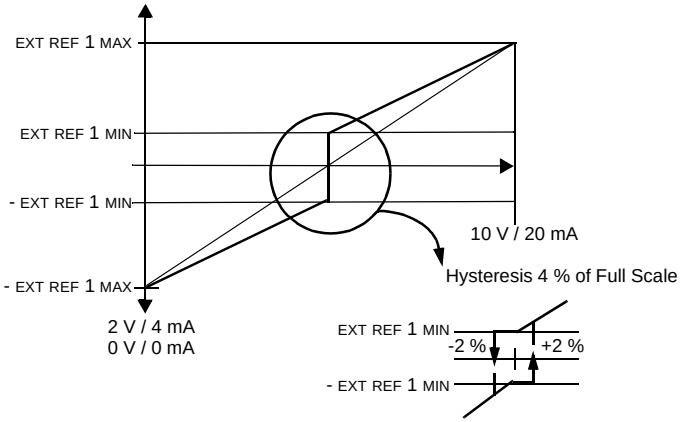
Code	Description
1001	**EXT1 COMMANDS** Defines the connections and the source of Start/Stop/Direction commands for External control location 1 (EXT1). 0 = NOT SEL No Start/Stop/Direction command source for EXT1 is selected. 1 = DI1 Two-wire Start/Stop connected to digital input DI1. DI1 deactivated = Stop; DI1 activated = Start. * 2 = DI1,2 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, the value for parameter 1003 DIRECTION should be REQUEST. 3 = DI1P,2P 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 is connected to digital input DI1. The Stop push-button is normally closed and is connected to digital input DI2. Multiple Start push-buttons are connected in parallel; multiple Stop push-buttons are connected in series. *,** 4 = DI1P,2P,3 Three-wire Start/Stop, Direction. Start/Stop is 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. ** 5 = DI1P,2P,3P 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, the value for parameter 1003 DIRECTION should be REQUEST. ** 6 = DI5 Two-wire Start/Stop, connected to digital input DI5. DI5 deactivated = Stop and DI5 activated = Start. * 7 = DI5,4 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, the value of parameter 1003 DIRECTION should be REQUEST. 8 = KEYPAD The Start/Stop and Direction commands are given from the control panel when External control location 1 is active. To control direction, the value for parameter 1003 DIRECTION should be REQUEST. 9 = DI1F,2R 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 a Stop command is given. 10 = COMM The Start/Stop and Direction commands are given through serial communication. ***Note!** In cases 1, 3, 6 direction is set with parameter 1003 DIRECTION. Selecting value 3 (REQUEST) fixes direction to Forward. ****Note!** Stop signal must be activated before Start command can be given.

1002	**EXT2 COMMANDS** Defines the connections and the source of Start, Stop and Direction commands for external control location 2 (EXT2). Refer to parameter 1001 EXT1 COMMANDS above.
1003	**DIRECTION** 1 = FORWARD 2 = REVERSE 3 = REQUEST Rotation direction lock. This parameter allows you to fix the motor's direction of rotation 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** Selection of the active control panel reference in local control mode. 1 = REF1 (Hz) Control panel reference is given in Hz. 2 = REF2 (%) Control panel reference is given as a percentage (%).
1102	**EXT1/EXT2 SEL** Sets the input used for selecting the external control location or fixes it to EXT1 or EXT2. The external control location of both the Start/Stop/Direction commands and reference is determined by this parameter. 1...5 = DI1...DI5 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. 6 = EXT1 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). 7 = EXT2 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). 8 = COMM External control location 1 or 2 is chosen through serial communication.

1103	**EXT REF1 SELECT** This parameter selects the signal source of external reference 1. 0 = KEYPAD Reference is given from the control panel. 1 = AI 1 Reference is given through analog input 1. 2 = AI 2 Reference is given through analog input 2. 3 = AI1/JOYST; 4 = AI2/JOYST 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 16). See also parameter 1003 DIRECTION. **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.  *Figure 16 Joystick control. Maximum for external reference 1 is set with Parameter 1105 and minimum with Parameter 1104.* 5 = DI3U,4D(R) 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. 6 = DI3U,4D 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. 7 = DI4U,5D Same as above, except that the digital inputs in use are DI4 and DI5. 8 = COMM The reference is given through serial communication. 9 = COMM + AI1 10 = COMM * AI1 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 97.

1104	**EXT REF1 MIN** Sets the minimum frequency reference for external reference 1 in Hz. When the analog input signal is at minimum, external reference 1 is equal to EXT REF1 MIN. See Figure 17 on page 56.
1105	**EXT REF1 MAX** Sets the maximum frequency reference for external reference 1 in Hz. When the analog input signal is at maximum, external reference 1 is equal to EXT REF1 MAX. See Figure 17 on page 56.
1106	**EXT REF2 SELECT** This parameter selects the signal source for external reference 2. The alternatives are the same as with external reference 1.
1107	**EXT REF2 MIN** Sets the minimum reference in %. When the analog input signal is at minimum value, external reference 2 equals to EXT REF2 MIN. See Figure 17. • If the PID Control or PFC macro is selected, this parameter sets the minimum process reference. • 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** Sets the maximum reference in %. When the analog input signal is at maximum value, external reference 2 equals to EXT REF2 MAX. See Figure 17. • If the PID Control or PFC macro is selected, this parameter sets the maximum process reference. • 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.

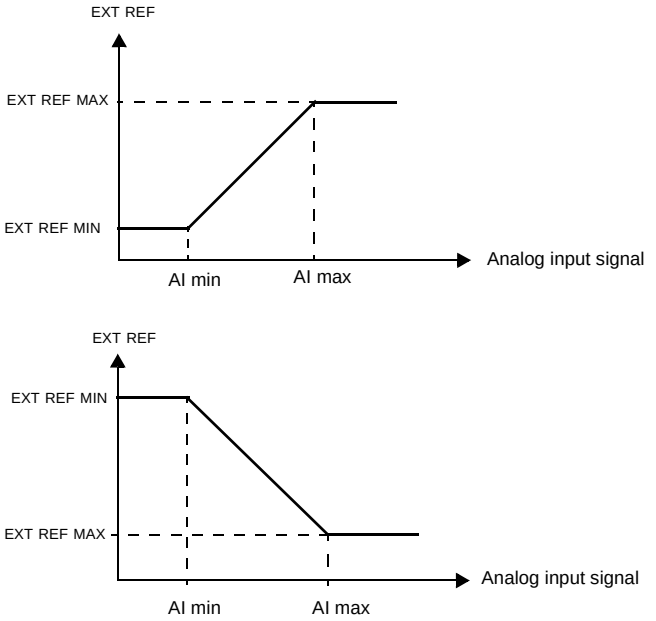


Figure 17 Setting EXT REF MINIMUM and EXT REF MAXIMUM. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.

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.

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

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>1201</td><td>CONST SPEED SEL
This parameter defines which digital inputs are used to select Constant Speeds.

0 = NOT SEL
Constant speed function disabled.

1...5 = DI1...DI5
Constant Speed 1 is selected with digital inputs DI1-DI5. Digital input activated = Constant Speed 1 activated.

6 = DI1,2
Three Constant Speeds (1 ... 3) are selected with two digital inputs.
Constant Speed selection with digital inputs DI1,2.

Table 8 Constant Speed selection with digital inputs DI1,2.
<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

7 = DI3,4
Three Constant Speeds (1 ... 3) are selected with two digital inputs as in DI1,2.

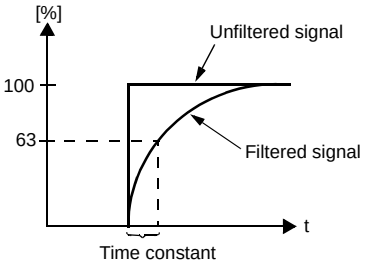
8 = DI4,5
Three Constant Speeds (1 ... 3) are selected with two digital inputs as in DI1,2.

9 = DI1,2,3
Seven Constant Speeds (1 ... 7) are selected with three digital inputs.

Table 9 Constant Speed selection with digital inputs DI1,2,3.
<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

10 = DI3,4,5
Seven Constant Speeds (1 ... 7) are selected with three digital inputs as in DI1,2,3.</td></tr>
<tr><td>1202
-1208</td><td>CONST SPEED 1... CONST SPEED 7
Constant speeds 1-7.</td></tr>
</table>

Group 13: Analog Inputs

Code	Description
1301	**MINIMUM AI1** 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. See Figure 17 on page 56.
1302	**MAXIMUM AI1** Maximum value of AI1 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX. See Figure 17 on page 56.
1303	**FILTER AI1** 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. **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.  *Figure 18 Filter time constant for analog input AI1.*
1304	**MINIMUM AI2** 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** Maximum value of AI2 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX.
1306	**FILTER AI2** 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 a 0(4) - 20 mA current signal. Refer to section “Connection Examples” on page 15.

Group 14: Relay Outputs

Code	Description
1401	**RELAY OUTPUT 1** Relay output 1 content. Selects which information is indicated with relay output 1. 0 = NOT SEL Relay is not used and is de-energized. 1 = READY 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. 2 = RUN Relay energized when the ACH 400 is running. 3 = FAULT (-1) Relay energized when power is applied, and de-energized upon a fault trip. 4 = FAULT Relay energized when a fault is active. 5 = ALARM Relay energized when an alarm is active. To see which alarms cause the relay to energize, refer to section “Diagnostics” on page 117. 6 = REVERSED Relay energized when motor rotates in reverse direction. 7 = SUPRV1 OVER Relay energized when first supervised parameter (3201) exceeds the limit (3203). See “Group 32: Supervision”, starting page 74. 8 = SUPRV1 UNDER Relay energized when first supervised parameter (3201) drops below the limit (3202). See “Group 32: Supervision”, starting page 74. 9 = SUPRV2 OVER Relay energized when second supervised parameter (3204) exceeds the limit (3206). See “Group 32: Supervision”, starting page 74. 10 = SUPRV2 UNDER Relay energized when second supervised parameter (3204) drops below the limit (3205). See “Group 32: Supervision”, starting page 74. 11 = AT SET POINT Relay energized when output frequency is equal to reference frequency. 12 = FAULT (RST) 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). 13 = FLT/ALARM 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 117. 14 = EXT CONTROL Relay is energized if external control is selected. 15 = REF 2 SEL Relay is energized if EXT2 is selected. 16 = CONST FREQ Relay is energized when a constant speed is selected. 17 = REF LOSS Relay is energized when reference or active control place is lost. 18 = OVERCURRENT Relay is energized when overcurrent alarm or fault appears. 19 = OVERVOLTAGE Relay is energized when overvoltage alarm or fault appears. 20 = ACH400 TEMP Relay is energized when ACH 400 overtemperature alarm or fault exists.

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

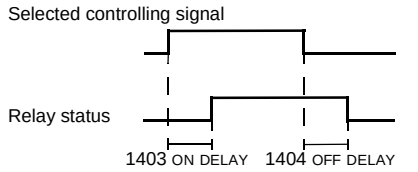


Figure 19

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

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

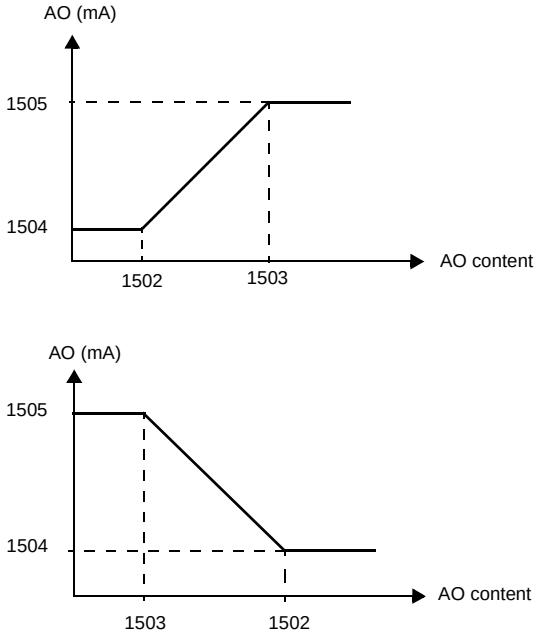


Figure 20 Analog output scaling.

Group 16: System Controls

Code	Description
1601	**RUN ENABLE** Selects the source of the run enable signal. 0 = NOT SEL The ACH 400 is ready to start without an external run enable signal. 1...5 = DI1 ... DI5 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. 6 = COMM The run enable signal is given through serial communication (Command Word bit #3).
1602	**PARAMETER LOCK** Parameter lock for control panel. 0 = LOCKED Parameter modification disabled. 1 = OPEN Panel operations are allowed and parameter modification is enabled. 2 = NOT SAVED (Not functional in R5-R9 units) **Note!** This parameter is not affected by macro selection. **Note!** Parameter writes through Standard Modbus or DDCS channels are not affected by this parameter.
1604	**FAULT RESET SEL** Fault reset source. **Note!** Fault reset is always possible with the control panel. **Note!** Option 6 (START/STOP) should not be selected when start, stop and direction commands are given through serial communication. 0 = KEYPAD Fault reset is executed from the control panel keypad. 1...5 = DI1 ... DI5 Fault reset is executed from a digital input. Reset is activated by deactivating the input. 6 = START/STOP Fault reset is activated by Stop command. 7 = COMM Fault reset is executed through serial communication.
1605	**LOCAL LOCK** Local lock. When LOCAL LOCK is active (1=LOCKED), panel cannot change to local mode. 0 = OPEN Control location can be changed from the control panel. 1 = LOCKED Panel cannot change to local mode. **Note!** Option 1 LOCKED can be selected only in remote mode.
1607	**PARAM. SAVE** Parameter save function. Selection 1 (SAVE...) saves all altered parameters to permanent memory. Value 0 (DONE) is displayed when all parameters are saved. 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. 0 = DONE 1 = SAVE…

Group 20: Limits

Code	Description
2003	**MAX CURRENT** Maximum output current. The maximum output current that the ACH 400 will supply to the motor.
2005	**OVERVOLT CTRL** DC overvoltage controller enable. 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. **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. 0 = DISABLE 1 = ENABLE
2006	**UNDERVOLT CTRL** DC undervoltage controller enable. 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 high inertia, such as a centrifuge or fan. 0 = DISABLE 1 = ENABLE (TIME) Enable with 500 ms time limit for operation. 2 = ENABLE Enable without time limit for operation.
2007	**MINIMUM FREQ** Operating range minimum output frequency. **Note!** Keep MINIMUM FREQ ≤ MAXIMUM FREQ.
2008	**MAXIMUM FREQ** 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 the drive is stopping by coasting, DC braking 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** Conditions during motor acceleration. 1 = RAMP Ramp acceleration as set. 2 = FLYING 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 for the correct output frequency. 3 = TORQUE BOOST No additional effect with DTC, Maximum torque is always acheived when required, acts the same as ramp start. 4 = FLY + BOOST Provides the same drive behavior as Flying Start.
2102	**STOP FUNCTION** Conditions during motor deceleration. 1 = COAST Motor coasts to stop. 2 = RAMP Ramp deceleration as defined by the active deceleration time 2203 DECELER TIME 1 or 2205 DECELER TIME 2.
2103	**TORQ BOOST CURR** No effect.
2104	**STOP DC INJ TIME** Applies a DC Hold after a ramp to stop.
2105	**PREMAGN SEL** Options 1- 5 select source for premagnetizing command. Option 6 selects start with DC hold. 0 = NOT SEL Premagnetizing not used. 1...5 = DI1...DI5 Premagnetizing command is received through a digital input. 6 = CONST Constant premagnetizing time after start command. Time is defined by parameter 2106 PREMAGN MAX TIME.
2106	**PREMAGN MAX TIME** Maximum premagnetizing time.

Code	Description
2107	**START INHIBIT** Start inhibit control. Start inhibit means that a pending start command is ignored when: • fault is reset, or • Run Enable activates while start command is active, or • mode change from local to remote takes place, or • mode change from remote to local takes place, or • from EXT1 to EXT2 takes place, or • from EXT2 to EXT1 takes place 0 = OFF 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. 1 = ON 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, reissue the 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 the pairs in run time through a digital input. The S curve of the ramps is adjustable.

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

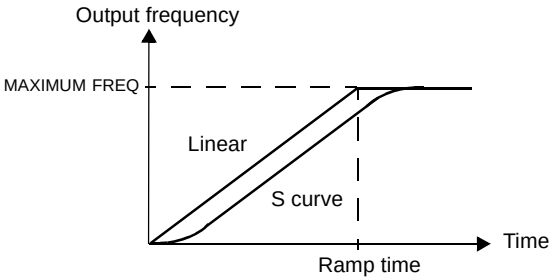


Figure 21 Definition of acceleration/deceleration ramp time.

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

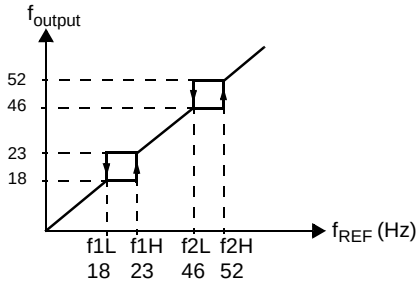


Figure 22 Example of critical frequencies setting in a fan system with bad vibrations at frequency ranges 18 Hz to 23 Hz and 46 Hz to 52 Hz.

Group 26: Motor Control

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>2603</td><td>IR COMPENSATION
IR compensation voltage at 0 Hz.

Note! IR compensation should be kept as low as possible to prevent overheating. Refer to Table 10.

Only functional when SCALAR mode is selected.

Table 10 Typical IR compensation values.
<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
IR compensation range. Defines frequency after which IR compensation is 0 V.</td></tr>
<tr><td>2605</td><td>LOW NOISE
Motor acoustical noise option.

0 = OFF (N/A)

Switching frequency is not adjustable.</td></tr>
<tr><td>2606</td><td>U/f RATIO
U/f ratio below field weakening point.

1 = LINEAR
2 = SQUARE (FLUX OPTIMIZATION)

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
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>

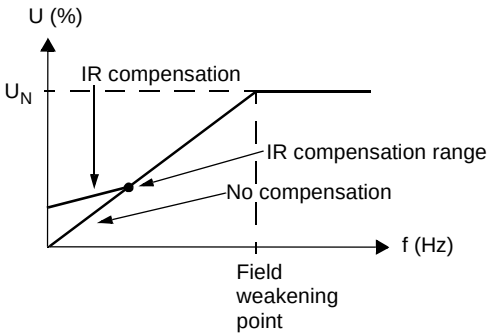


Figure 23 Operation of IR compensation

Group 30: Fault Functions

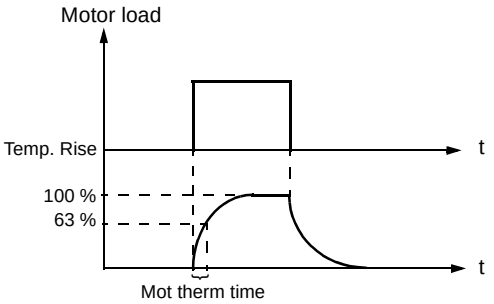
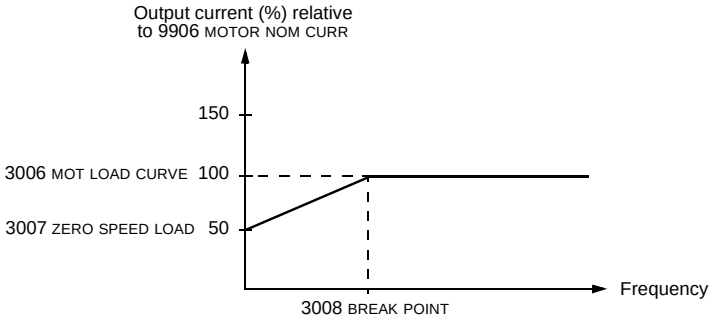
ACH 400 can be configured to respond as desired to certain abnormal external conditions: analog input fault, external fault signal and panel loss.

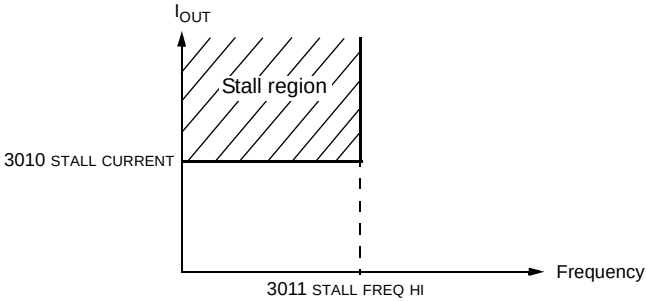
In these cases, the drive can either continue operation at its current speed, continue operation at a set constant speed while showing an alarm, ignore the condition, or trip on a fault and stop.

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.

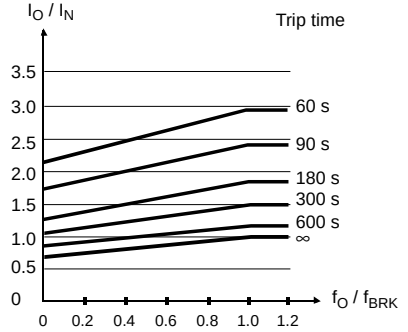
Stall protection (parameters 3009 - 3012) includes parameters for stall frequency, stall time and current.

Code	Description
3001	**AI<MIN FUNCTION** Operation in case the AI signal drops below the minimum limit. 0 = NOT SEL No operation. 1 = FAULT A fault indication is displayed and the ACH 400 coasts to stop. 2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7. 3 = LAST SPEED 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. **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** Operation in case of control panel loss fault. 1 = FAULT A fault indication is displayed and the ACH 400 coasts to stop. 2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7. 3 = LAST SPEED 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. **Caution:** If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case the connection to the panel is lost.
3003	**EXTERNAL FAULT** External fault input selection. 0 = NOT SEL External fault signal is not used. 1...5 = DI1...DI5 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 and the motor coasts to stop and fault indication is displayed.

Code	Description
3004	**MOT THERM PROT** Motor overtemperature function. This parameter defines the operation of the motor thermal protection function which protects the motor from overheating. 0 = NOT SEL 1 = FAULT 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. 2 = WARNING A warning indication is displayed when the motor temperature reaches the warning level (95 % of the nominal value).
3005	**MOT THERM TIME** Time for 63 % temperature rise. This is the time within which the motor temperature reaches 63 % of the final temperature rise. Figure 24 shows motor thermal time definition. 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.  *Figure 24 Motor thermal time.*
3006	**MOT LOAD CURVE** 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.  *Figure 25 Motor load curve.*

Code	Description
3007	**ZERO SPEED LOAD** This parameter defines the maximum allowable current at zero speed relative to 9906 MOTOR NOM CURR. Refer to Figure 25.
3008	**BREAK POINT** Break point of the motor load curve. Refer to Figure 25 for an example of a motor load curve. See Figure 27.
3009	**STALL FUNCTION** This parameter defines the operation of the stall protection. The protection is activated if the output current becomes too high compared to the output frequency, refer to Figure 26. 0 = NOT SEL Stall protection is not used. 1 = FAULT When the protection is activated, the ACH 400 coasts to stop. Fault indication is displayed. 2 = WARNING A warning indication is displayed. The indication disappears in half the time set by parameter 3012 STALL TIME.  *Figure 26 Motor stall protection.*
3010	**STALL CURRENT** Current limit for stall protection. Refer to Figure 26.
3011	**STALL FREQ HI** This parameter sets the frequency value for the stall function. Refer to Figure 26.
3012	**STALL TIME** This parameter sets the time value for the stall function.
3013	**UNDERLOAD FUNCTION** Removal of motor load may indicate a process malfunction. The protection is activated if: • The motor torque drops below the load curve selected by parameter 3015 UNDERLOAD CURVE. • This condition has lasted longer than the time set by parameter 3014 UNDERLOAD TIME. • Output frequency is higher than 10 % of the nominal frequency of the motor and higher than 5 Hz. 0 = NOT SEL Underload protection is not used. 1 = FAULT When the protection is activated the ACH 400 coasts to stop and a fault indication is displayed. 2 = WARNING A warning indication is displayed.
3014	**UNDERLOAD TIME** Time limit for underload protection.

Code	Description
3015	**UNDERLOAD CURVE** This parameter provides five selectable curves shown in Figure 28. 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.
3016	**MOTOR PHASE LOSS** This parameter determines if the drive will detect a loss of motor phase. 0 = NO 1 = FAULT
3017	**GROUND FAULT** 0 = WARNING 1 = FAULT



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

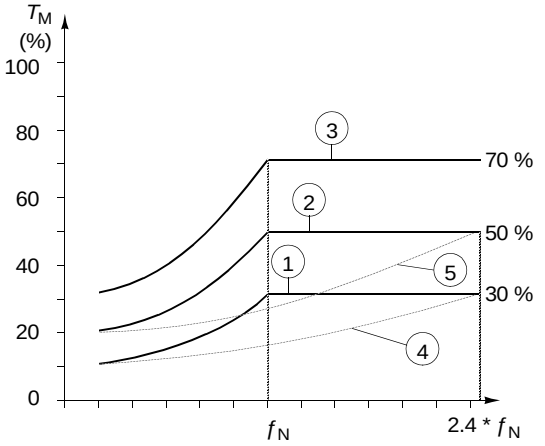


Figure 28 Underload curve types. T_M nominal torque of the motor, f_N nominal frequency of the motor.

Group 31: Automatic Reset

The automatic reset system can be used for resetting overcurrent, overvoltage, undervoltage and analog input loss faults automatically. The 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 stoppage 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** 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** 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** 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** 0 = DISABLE 1 = ENABLE If 1 is selected, the fault (motor overcurrent) is reset automatically after the delay set by parameter 3103 DELAY TIME, and the ACH 400 resumes normal operation.
3105	**AR OVERVOLTAGE** 0 = DISABLE 1 = ENABLE If 1 is selected, the fault (DC bus overvoltage) is reset automatically after the delay set by parameter 3103 DELAY TIME, and the ACH 400 resumes normal operation.
3106	**AR UNDERVOLTAGE** 0 = DISABLE 1 = ENABLE 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** 0 = DISABLE 1 = ENABLE If 1 is selected, the fault (analog input signal under minimum level) is reset automatically after the delay set by parameter 3103 DELAY TIME.

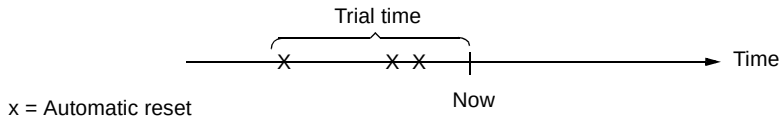
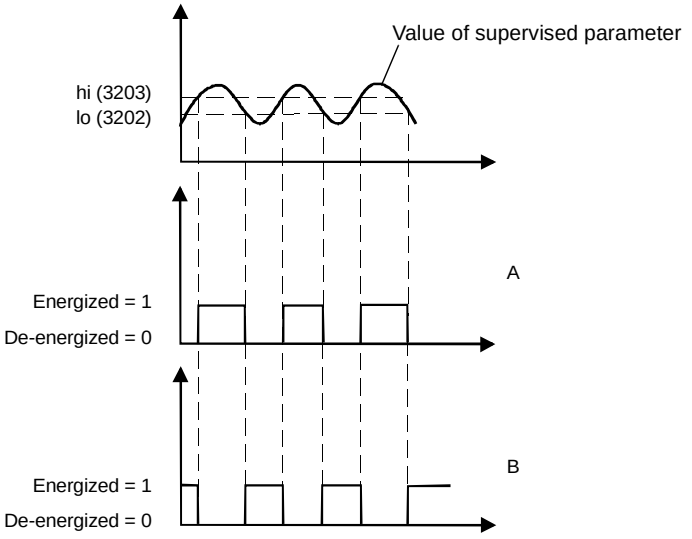


Figure 29 Operation of automatic reset function. In this example, if the fault occurs at the moment "Now", it is automatically reset if parameter 3101 NR OF TRIALS value is greater than or equal to 4.

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 supervised parameters' values are either too low or too high.

Code	Description
3201	**SUPERV 1 PARAM** First supervised parameter number of the Operating Data group (Group 01).
3202	**SUPERV 1 LIM LO** First supervision limit low.
3203	**SUPERV 1 LIM HI** First supervision limit high.
3204	**SUPERV 2 PARAM** Second supervised parameter number of the Operating Data group (Group 01).
3205	**SUPERV 2 LIM LO** Second supervision limit low.
3206	**SUPERV 2 LIM HI** Second supervision limit high.



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 30 Operating data supervision using relay outputs.

Group 33: Information

Code	Description
3301	**SW VERSION** Software version.
3302	**TEST DATE** 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
Selects displayed variables for the output display of the ACS-PAN control panel.

1 = STANDARD
Panel displays standard variables.

2 = PROCESS VAR
Panel displays process variables. See Figure 31.

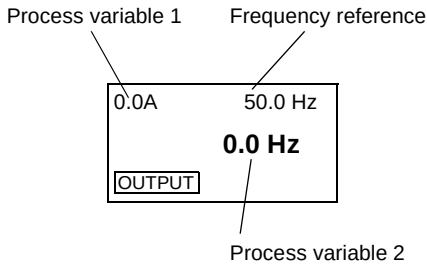
 

Figure 31 ACS-PAN output display when the process variable display is selected.</td></tr>
<tr><td>3402</td><td>P VAR 1 SEL
Selection of process variable 1. Number of any parameter of the group 1 OPERATING DATA.</td></tr>
<tr><td>3403</td><td>P VAR 1 MULTIP
Process variable 1 multiplier.</td></tr>
<tr><td>3404</td><td>P VAR 1 DIVISOR
Process variable 1 divider.</td></tr>
<tr><td>3405</td><td>P VAR 1 SCALING
Decimal point location of process variable 1, when displayed. Refer to Figure 32.

<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 32 Display with different decimal point locations when calculated value is 125.</td></tr>
<tr><td>3406</td><td>P VAR 1 UNIT
Process variable unit.

0 = NOT SEL | 4 = % | 8 = kh | 12 = mV | 16 = °F | 20 = m^3/h | 24 = GPM | 28 = MGD
1 = A | 5 = s | 9 = °C | 13 = kW | 17 = hp | 21 = dm^3/s | 25 = PSI | 29 = inHg
2 = V | 6 = h | 10 = lb ft | 14 = W | 18 = MWh | 22 = bar | 26 = CFM | 30 = FPM
3 = Hz | 7 = rpm | 11 = mA | 15 = kWh | 19 = m/s | 23 = kPa | 27 = ft | 31 = Cst</td></tr>
</table>

Code	Description
3407	**P VAR 2 SEL** Selection of process variable 2. Number of any parameter of the group 1 OPERATING DATA.
3408	**P VAR 2 MULTIP** Process variable 2 multiplier.
3409	**P VAR 2 DIVISOR** Process variable 2 divider.
3410	**P VAR 2 SCALING** Decimal point location of process variable 2, when displayed.
3411	**P VAR 2 UNIT** 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.

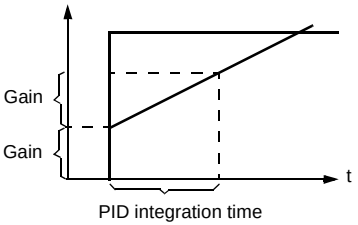
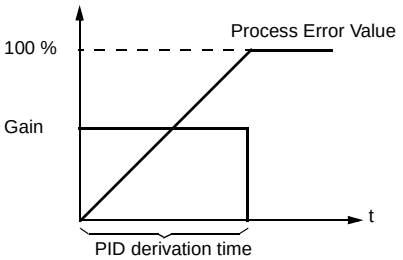
Group 40: PID Control

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 accomplished through a digital input.

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

Figure 47 on page 127 (Appendix A) shows the connections of internal signals when the PID Control macro is selected.

Code	Description
4001	**PID GAIN** This parameter defines the gain of the PID Controller. The setting range is 0.1... 100. If you select 1, a 10 % change in error value causes the PID Controller output to change by 10 %.
4002	**PID INTEG TIME** 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. An integration time of 1 s would exhibit a 100 % change in 1 s. 
4003	**PID DERIV TIME** 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. 

Code	Description
4004	**PID DERIV FILTER** 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** Process error value inversion. Normally, a decrease in the 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). 0 = NO 1 = YES
4006	**ACTUAL VAL SEL** PID controller feedback (actual) signal selection. The feedback signal can be a combination of two actual values ACT1 and ACT2. The source for actual value 1 is selected by parameter 4007 and the source for actual value 2 is selected by parameter 4008. 1 = ACT1 Actual value 1 is used as the feedback signal. 2 = ACT1-ACT2 Difference of actual values 1 and 2 is used as the feedback signal. 3 = ACT1+ACT2 Sum of actual values 1 and 2. 4 = ACT1*ACT2 Product of actual values 1 and 2. 5 = ACT1/ACT2 Quotient of actual values 1 and 2. 6 = MIN (A1, A2) Smaller of actual values 1 and 2. 7 = MAX (A1, A2) Greater of actual values 1 and 2. 8 = sqrt (A1-A2) Square root of difference of actual values 1 and 2. 9 = sqA1 + sqA2 Sum of square roots of actual values 1 and 2.
4007	**ACT1 INPUT SEL** Source for actual value 1 (ACT1). 1 = AI 1 Analog input 1 is used as actual value 1. 2 = AI 2 Analog input 2 is used as actual value 1.
4008	**ACT2 INPUT SEL** Source for actual value 2 (ACT2). 1 = AI 1 Analog input 1 is used as actual value 2. 2 = AI 2 Analog input 2 is used as actual value 2.

Code	Description
4009	**ACT1 MINIMUM** Minimum value for actual value 1 (ACT1). Refer to Figure 33 and to Group 13 parameters for analog input minimum and maximum settings.
4010	**ACT1 MAXIMUM** Maximum value for actual value 1 (ACT1). Refer to Figure 33 and to Group 13 parameters for analog input minimum and maximum settings.
4011	**ACT2 MINIMUM** Minimum value for actual value 2 (ACT2). Refer to parameter 4009.
4012	**ACT2 MAXIMUM** Maximum value for actual value 2 (ACT2). Refer to parameter 4010.

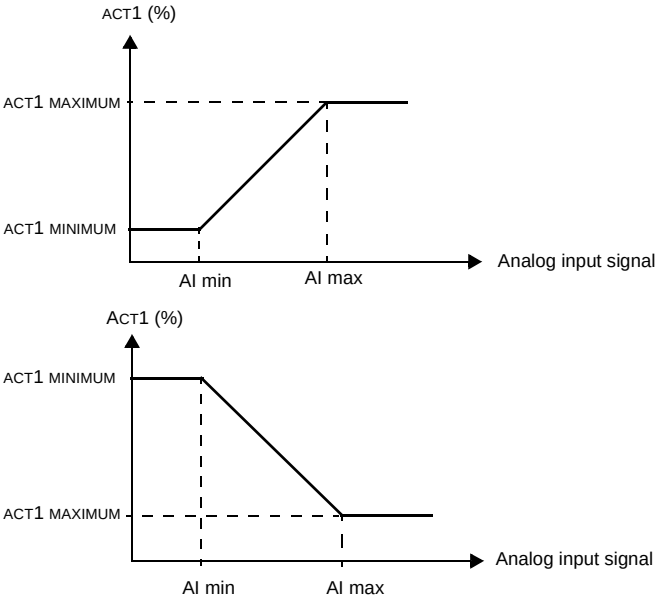


Figure 33 Actual value scaling. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on which analog input is used.

Code	Description
4013	**PID SLEEP DELAY** Time delay for the sleep function, see Figure 34. If the ACH 400 output frequency is below a set level (parameter 4014 SLEEP LEVEL) longer than PID SLEEP DELAY, the ACH 400 is stopped. Alarm 28 is displayed when PID sleep is active.
4014	**PID SLEEP LEVEL** Level for activation of sleep function, see Figure 34. 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** Level for deactivation of sleep function. This parameter sets a process actual value limit for the sleep function (see Figure 34). The limit floats with the process reference. The limit is calculated as follows: limit = process reference * 4015 WAKE-UP LEVEL / 100 When the 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. **Note!** Wake-up level comparison is also inverted when the error value is inverted using parameter 4005 ERROR VALUE INV.
4016	**PID PARAM SET** 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. 1...5 = DI1...DI5 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. 6 = SET 1 PID parameter set 1 is active. 7 = SET 2 PID parameter set 2 is active.
4017	**WAKE-UP DELAY** Delay for deactivation of PID sleep function. Refer to parameter 4015 WAKE-UP LEVEL and Figure 34.
4018	**SLEEP SELECTION** PID sleep function control. 0 = INTERNAL 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. 1...5 = DI1...DI5 Sleep state is activated and deactivated using a digital input.
4019	**SET POINT SEL** Set point selection. Defines the reference signal source for the PID controller. **Note!** When the PID regulator is by-passed (parameter 8121 REG BYPASS CTRL), this parameter has no significance. 1 = INTERNAL Process reference is a constant value set with parameter 4020 INTERNAL SETPNT. 2 = EXTERNAL 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).* * Process reference to the 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** Sets a constant process reference (%) for the PID controller. The PID controller follows this reference if parameter 4019 SET POINT SEL is set to 1 (INTERNAL).

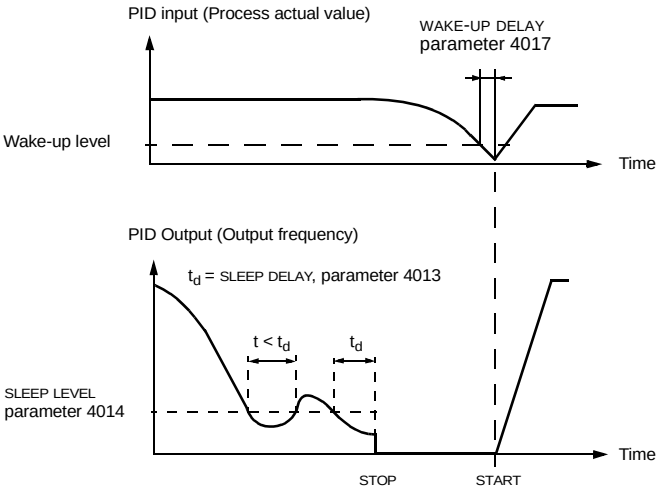


Figure 34 Sleep function operation.

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 to 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 a DDCS option module is installed.

Code	Description
5001	**DDCS BIT RATE** DDCS link baud rate in Mbits/s.
5002	**DDCS NODE NR** DDCS link node number.
5003	**COMM FAULT TIME** Communication time out delay. This applies both to standard Modbus and DDCS link. 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** Communication fault function. This applies both to standard Modbus and DDCS link. 0 = NOT SEL No operation. 1 = FAULT A fault indication is displayed and the ACH 400 coasts to stop. 2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7. 3 = LAST SPEED 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. **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** Defines what communication protocols are used. Options 1 (DDCS) and 3 (STD MDB+DDCS) should be selected only if a DDCS communication module is installed. 0 = NOT SEL No serial communication is active. 1 = DDCS DDCS serial communication is active. 2 = STD MODBUS Standard Modbus protocol is active. 3 = STD MDB+DDCS Both standard Modbus and DDCS are active.
5006	**COMM COMMANDS** 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 only be received from a single communication channel, selectable by this parameter. 0 = NOT SEL Controlling commands are not received via serial communication. 1 = STD MODBUS Controlling commands can be received through Channel 1 standard Modbus protocol. 2 = DDCS Controlling commands can be received through the DDCS link.

Group 51: Ext Comm Module

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

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>5101</td><td>FIELDBUSPAR 1
Parameter 1 of communication module on the DDCS link. Value reflects the type of the connected communication module.

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
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 a 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 97 for more information.

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

Code	Description
5201	**STATION NUMBER** Sets the slave number for the ACH 400 in a Modbus network. Range: 1 - 247
5202	**COMM SPEED** Defines the communication speed of the ACH 400 in bits per second (bits/s). 6 = 600 bits/s 12 = 1200 bits/s 24 = 2400 bits/s 48 = 4800 bits/s 96 = 9600 bits/s
5203	**PARITY** 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. 0 = NONE 1 = EVEN 2 = ODD

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** 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 %. **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. At low water consumption levels, 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, the other pump. 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 with the increasing pumping capacity. The reference steps compensate the growing pressure loss and prevent the pressure drop at the end of the pipe.
8104	**REFERENCE STEP 2** 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** 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** Sets a frequency limit. See Figure 35 on page 88. 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. After the first auxiliary motor is started, ACH 400 output frequency is decreased by value (8109 START FREQ 1 - 8112 LOW FREQ 1). **Note!** Start Frequency 1 should be within limits 8112 LOW FREQ 1 and 2008 MAXIMUM FREQ -1.
8110	**START FREQ 2** Sets a frequency limit (see Figure 35). 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. After the second auxiliary motor is started, ACH 400 output frequency is decreased by value (8110 START FREQ 2 - 8113 LOW FREQ 2). **Note!** Start Frequency 2 should be within limits 8112 LOW FREQ 2 and 2008 MAXIMUM FREQ -1.
8111	**START FREQ 3** Sets a frequency limit (see Figure 35). 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. After the third auxiliary motor is started, ACH 400 output frequency is decreased by value (8111 START FREQ 3 - 8114 LOW FREQ 3). **Note!** Start Frequency 3 should be within limits 8112 LOW FREQ 3 and 2008 MAXIMUM FREQ -1.

Code	Description
8112	**LOW FREQ 1** Sets a frequency limit (see Figure 35). 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. After the auxiliary motor is stopped, ACH 400 output frequency is increased by value (8109 START FREQ 1 - 8112 LOW FREQ 1). **Note!** Low Frequency 1 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 1.
8113	**LOW FREQ 2** Sets a frequency limit (see Figure 35). 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. After the auxiliary motor is stopped, ACH 400 output frequency is increased by a value (8110 START FREQ 2 - 8113 LOW FREQ 2). **Note!** Low Frequency 2 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 2
8114	**LOW FREQ 3** Sets a frequency limit (see Figure 35). When the ACH 400's output frequency falls below value (8114 LOW FREQ 3 - 1 Hz) and three 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 (8114 LOW FREQ 3 + 1 Hz), the third auxiliary motor is stopped. After the auxiliary motor is stopped, ACH 400 output frequency is increased by value (8111 START FREQ 3 - 8114 LOW FREQ 3). **Note!** Low Frequency 3 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 3.
8115	**AUX MOT START D** Sets the Start Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 and Figure 35 for more information.
8116	**AUX MOT STOP D.** Sets the Stop Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 for more information.

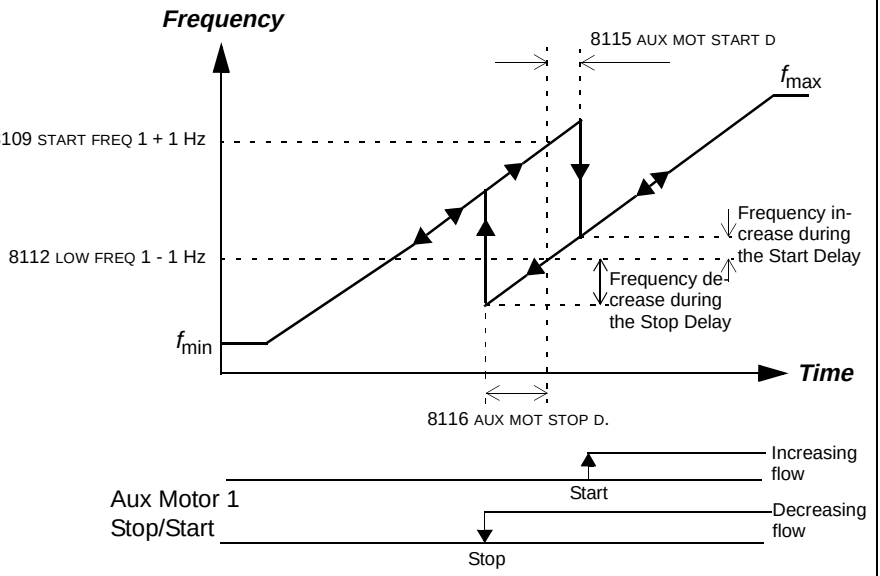


Figure 35 Start Frequency, Low Frequency, Start Delay and Stop Delay.

Code	Description
8117	**NR OF AUX MOT** 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 the value for 1401 RELAY OUTPUT 1 is 29 (PFC). Relay output 2 is used for Pump and Fan motor control if the value for 1402 RELAY OUTPUT 2 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 the 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. The 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

	NOTE: If the number of auxilliary motors require NDIO modules which have not yet been connected, the drive will fault on FAULT 19 DDCS LINK.
8118	**AUTOCHNG INTERV** 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. 0.0 = NOT SEL This setting switches off the Autochange function. **Note!** The ACH 400 always coasts to stop when autochange is performed. **Warning!** If the Autochange function is used, the Interlocks must be in use. In an 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** 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.

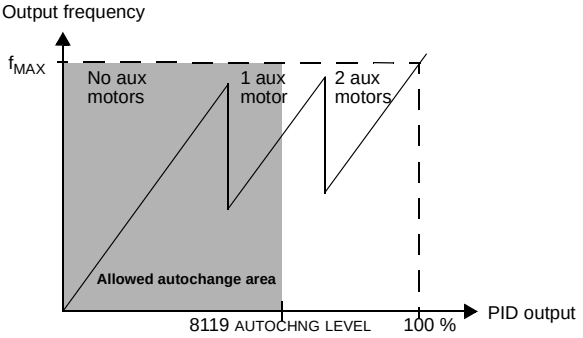


Figure 36 Autochange level.

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 motors' starting order is changed when the Autochange is complete.

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 the 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. Wait for time set with parameter 8122 PFC START DELAY.
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 as 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, the 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 the ACH 400's power supply is switched off, the values of the starting order counter and Autochange Interval counter are stored in permanent memory. The counters continue from the stored values after the power supply is switched on again.

Code	Description
8120	**INTERLOCKS** Controls the use of the Interlock function. **Warning!** If the Autochange function is used, the Interlocks must also be taken into use (see parameter 8118 AUTOCHNG INTERV). 0 = NOT SEL No Interlock function is in use. All digital inputs are available for other purposes. 1 = DI1 Interlock function is in use. Depending on the number of motors, digital inputs are reserved for the interlock signals according to the following table.

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

2 = DI2
Interlock function is in use. Depending on the number of motors, digital inputs are reserved for the interlock signals according to the following table.

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

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

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

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

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

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

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

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

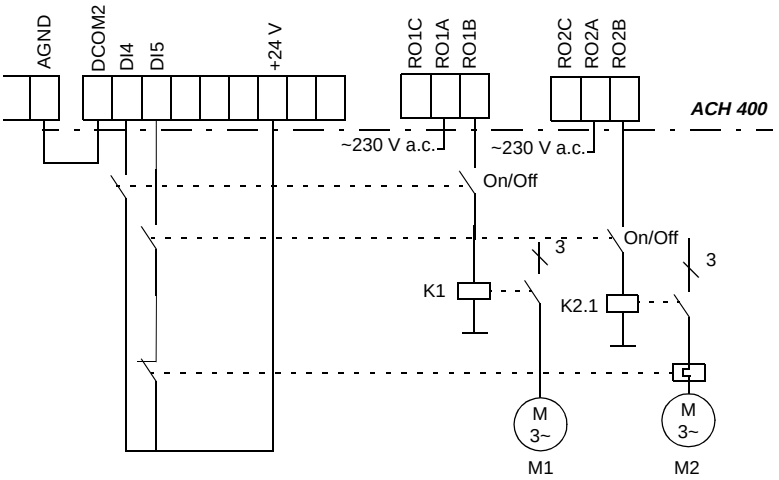
	Interlock signals		
No of aux. Motors (param. 8117)	**ACH 400 digital inputs**	**NDIO module 1**	**NDIO module 2**
0	DI1-DI5: free	DI1: Motor 1 DI2: Unused	Not used
1	DI1-DI5: free	DI1: Motor 1 DI2: Motor 2	Not used
2	DI1-DI5: free	DI1: Motor 1 DI2: Motor 2	DI1: Motor 3 DI2: Unused
3	DI1-DI5: free	DI1: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

Interlock signals are active low, i.e. interlock is active when 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 display 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
	 *Figure 37 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** Regulator by-pass control provides a simple control mechanism without a PID regulator. By-pass control is needed in special applications only. Examples are given in Figure 38 and Figure 39. 0 = NO The process PID regulator is in use. 1 = YES 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.

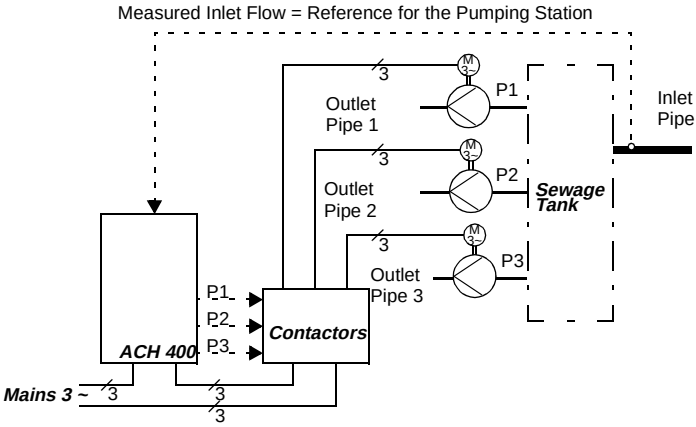
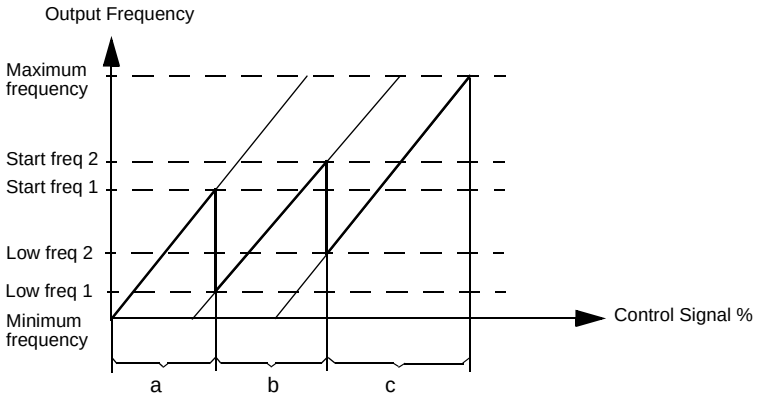


Figure 38 Regulator bypass control. The capacity of the pumping station (outlet flow) follows the measured inlet flow.



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

Figure 39 The relation between the control signal and the frequency of the controlled motor in a three-motor system.

Code	Description
8122	**PFC START DELAY** Sets the start delay for all the motors in the system. The delay works as follows: 1. The contactor that connects the speed regulated motor to the ACH 400 is switched on (by a ACH 400 relay output). 2. PFC Start Delay is waited. 3. Speed regulated motor is energized and normal PFC operation starts. Auxiliary motors are started. **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. The communication settings for Channel 1 can be configured by the user. To control the ACH 400 via Modbus, the ACH 400 must be configured to accept control commands and/or frequency references from Channel 1. Channel 0 is reserved for the ACS-PAN drive control panel and for the Drive*Window* PC tool.

Optional serial communication features

The ACH 400 can also be connected to a 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 supplier.

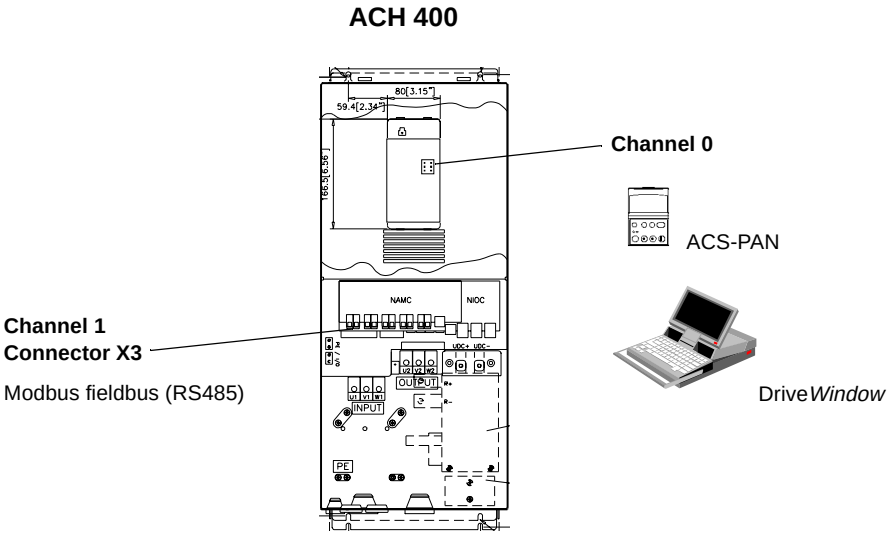


Figure 40 Standard serial communication features of ACH 400.

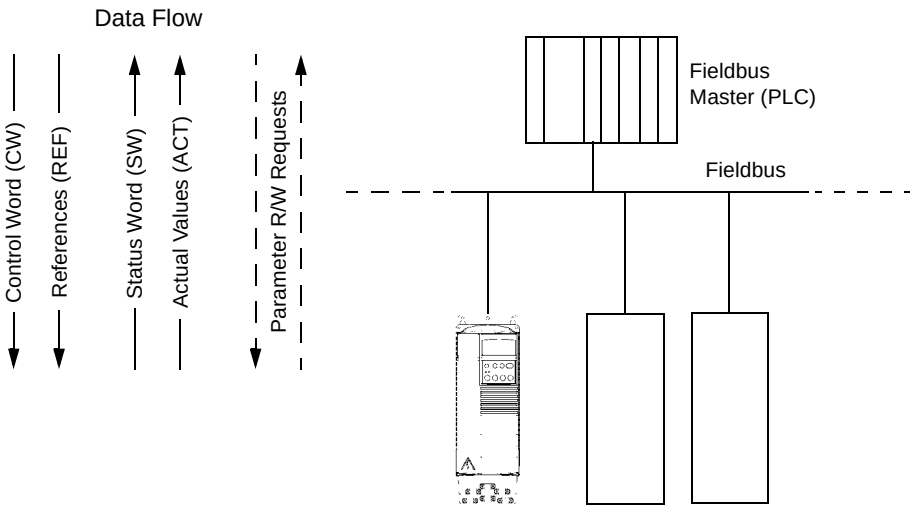


Figure 41 Structure of a fieldbus system.

Grounding and Termination

RS485 Bus

The RS485 network should not be directly grounded at any point. All the devices on the network should be properly grounded using their corresponding gounding terminals.

As always, the grounding wires should not form any closed loops, and all the devices should be connected 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.

The termination should not be done on the intermediate stations on the network as shown in Figure 42.

Figure 42 Termination for the RS485 link.

The connections may only be made with the drive disconnected from the power source.

Activating Modbus Protocol

As a factory setting, Channel 1 is not operational. To activate standard Modbus protocol for Channel 1, set parameter 5005 PROTOCOL SEL to 2 (STD MODBUS).

After this single modification, the ACH 400 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 ACH 400 for more sophisticated communication and control.

Table 13 Default communication settings of Channel 1.

Station number	Communication speed	Parity bit	Stop bits	Number of data bits
1	9600 bps	none	two	8

Note! Protocol must be reactivated after the communication settings are changed.

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 the 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 the parameters and their alternative settings is given in the “ACH 400 Complete Parameter List” on page 43.

Table 14 Communication parameters.

Code	Parameter Name	Alternative Settings	Default Setting	Function/Information
Group 52 STANDARD MODBUS				
5201	STATION NUMBER	1 - 247	1	Slave number for the ACH 400 in the Modbus network.
5202	COMM SPEED	3 = 300 bps ... 96 = 9600 bps	96 (9600 bits/s)	Communication speed.
5203	PARITY	0 = NONE 1 = EVEN 2 = ODD	0 (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	0 = NOT SEL 1 = FAULT 2 = CONST SP 7 3 = LAST SPEED	0 (NOT SEL)	Operation in case communication with the master device is lost.
5005	PROTOCOL SEL	0 = NOT SEL 1 = DDCS 2 = STD MODBUS 3 = STD MDB+DDCS	0 (NOT SEL)	Communication protocol 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 configured to accept control commands and/or frequency references from this channel and the ACH 400 must be in remote control.

The necessary parameters and their usage are listed in Table 15. Note especially, that 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 is given in chapter “ACH 400 Complete Parameter List” starting 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 COMMAND	0 = NOT SEL 1 = STD MODBUS, 2 = DDCS	1 (STD MODBUS)	Defines the serial communication channel for the controlling commands (start, stop, direction and reference). Must be set to 1 (STD MODBUS).
Group 10 COMMAND INPUTS				
1001	EXT1 COMMANDS	0 = NOT SEL 1 = DI1 ... 10 = COMM	10 (COMM)	Enables the Control Word (except bit 11) when EXT1 is selected as the control location.
1002	EXT2 COMMANDS	0 = NOT SEL 1 = DI1 ... 10 = COMM	10 (COMM)	Enables the Control Word (except bit 11) when EXT2 is selected as the control location.
1003	DIRECTION	1 = FORWARD 2 = REVERSE 3 = REQUEST	3 (REQUEST)	Enables rotation direction control as defined by parameters 1001 and 1002.
Group 11 REFERENCE SELECT				
1102	EXT1/EXT2 SEL	1 = DI1 ... 8 = COMM	8 (COMM)	Enables external control location EXT1/ EXT2 selection by Control Word bit 11.
1103	EXT REF1 SELECT	0 = KEYPAD 1 = AI1 ... 8 = COMM 9 = COMM+AI1 10 = COMM*AI1	8 (COMM), 9 (COMM+AI1) or 10 (COMM*AI1)	Fieldbus reference 1 is used when EXT1 is selected as the control location. See section References below for information on the alternative settings.
1106	EXT REF2 SELECT	0 = KEYPAD 1 = AI1 ... 8 = COMM 9 = COMM+AI1 10 = COMM*AI1	8 (COMM), 9 (COMM+AI1) or 10 (COMM*AI1)	Fieldbus reference 2 is used when EXT2 is selected as the control location. See section References below for information on the alternative settings.

Code	Parameter Name	Alternative Settings	Setting for Standard Modbus	Function/Information
Group 16 SYSTEM CONTROLS				
1601	RUN ENABLE	0 = NOT SEL 1...5 = DI1 ... DI5 6 = COMM	6 (COMM)	The run enable signal is given through serial communication (Control Word bit 3).
1604	FAULT RESET SEL	0 = KEYPAD ONLY 1...5 = DI1 ... DI5 6 = START/STOP 7 = COMM	7 (COMM)	Fault reset is executed through serial communication (Control Word bit 7).

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 the parameters in group 32 SUPERVISION.

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

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

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	0 = NOT SEL ... 7 = SUPRV1 OVER 8 = SUPRV1 UNDER 9 = SUPRV2 OVER 10 = SUPRV2 UNDER ... 31 = STARTED	e.g. 7 (SUPERV1 OVER)	Relay output 1 function. 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. 7 (SUPERV1 OVER)	Relay output 2 function. See above.
Group 32 SUPERVISION				
3201	SUPERV 1 PARAM	102 - 137	e.g. 131 (SERIAL LINK DATA 1)	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 (SERIAL LINK DATA 2)	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.
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) is reached when value 255 written to parameter 133.

Communication

This chapter describes the Modbus communication on ACH 400 drives.

Introduction to Modbus

Modbus is a serial, asynchronous protocol. The Modbus protocol does not specify the physical interface. The typical physical interface 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 ABB supplier 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 predefined 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 only allow zero writes (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).

Note! Parameter writes through Channel 1 (Standard Modbus) are always volatile i.e. modified values are not automatically stored to permanent memory. Parameter 1607 PARAM. SAVE can be used to save all altered values.

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 18. In this table GG is the group number, and PP is the parameter number within the group.

Table 18 Parameter mapping.

4GGPP	GG	PP
40001 – 40006	00 DRIVE CONTROL REGISTERS	01 CONTROL WORD 02 REFERENCE 1 03 REFERENCE 2 04 STATUS WORD 05 ACTUAL VALUE 1 06 ACTUAL VALUE 2
40102 – 40130	01 OPERATING DATA	02 SPEED … 30 OLDEST FAULT
41001 – 41003	10 COMMAND INPUTS	01 EXT1 COMMANDS 02 EXT2 COMMANDS 03 DIRECTION
41101 – 41108	11 REFERENCE SELECT	01 KEYPAD REF SEL … 08 CONST SPEED 7
…	…	…
49901 – 49908	99 START-UP DATA	02 APPLIC MACRO … 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 19.

Table 19 Exception codes.

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

Function Codes

The ACH 400 supports the Modbus function codes given in Table 20. If any other function codes are used, the ACH 400 returns an exception response with error code 01 (illegal function).

Table 20 Function codes.

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

The Control Word and the Status Word

Holding registers: 40001 (Control Word), 40004 (Status Word)

The Control Word (CW) is the principal means for controlling the drive from a fieldbus system. It is effective when

- The drive is in external (remote) control and the controlling commands are received through a serial communication channel (set by parameters 1001 EXT1 COMMANDS, 1002 EXT2 COMMANDS and 1102 EXT1/EXT2 SEL), and
- The serial communication channel that is used for the controlling is Standard Modbus. Parameter 5006 COMM COMMANDS is set to 1 (STD MODBUS).

The Control Word (detailed in Table 21) is sent by the fieldbus master station to the drive. The drive switches between its states according to the bit-coded instructions of the Control Word. See the state machine on page 114.

The Status Word (SW) is a word containing status information, sent by the drive to the master station. The composition of the Status Word is explained in Table 23.

Note! Operation of Control Word and Status Word conforms to ABB Drives Profile with the exception of Control Word bit #10 (REMOTE_CMD), which is not used by the ACH 400.

Table 21 The Control Word. See also the state machine on page 114.

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. 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 also 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. 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

Example on Using the Control Word

The following example shows how to use the Control Word to start the drive. When the power is connected for the first time, the state of the drive (see the state machine in Figure 43) is NOT READY TO SWITCH ON. The Control Word is used to step through the state machine states until OPERATING state is reached, meaning that the drive is running and is following the given reference.

Table 22 Using the Control Word.

	Control Word Value	Description
Step 1	CW = 0000 0000 0000 0110 bit 15 bit 0	When this value is written, the drive state changes to READY TO SWITCH ON.
Step 2		Wait at least 100 ms before proceeding.
Step 3	CW = 0000 0000 0000 0111	When this value is written, the drive state changes to READY TO OPERATE.
Step 4	CW = 0000 0000 0000 1111	When this value is written, the drive starts, but will not accelerate. The drive state changes to OPERATION ENABLED.
Step 5	CW = 0000 0000 0010 1111	When this value is written, the ramp function generator (RFG) output is released. The drive state changes to RFG: ACCELERATOR ENABLED.
Step 6	CW = 0000 0000 0110 1111	When this value is written, the ramp function generator (RFG) input is released. The drive state changes to OPERATING. Drive will accelerate to the given reference and will follow the reference.

This example assumes that the ACH 400 is in remote control, that external control location 1 (EXT1) is the active control location (as selected by parameter 1102), and that EXT1 start and stop commands are received through serial communication (parameter 1001).

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	Alarm is active. See the Diagnostics section for a list of relevant alarms.
	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

References

References are 16-bit words comprised of 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 value.

Reference 1

Holding Register: 40002

Reference 1 can be used as the frequency reference REF1 for the ACH 400. 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. 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 Scaling

Fieldbus references are scaled as follows:

Reference 1: 20000 ≙ EXT REF1 MAX (Hz, parameter 1105). Scaling Parameter 1104 EXT REF1 MIN is not used.

Reference 2: 10000 ≙ EXT REF2 MAX (%, parameter 1108). Scaling Parameter 1107 EXT REF2 MIN is not used.

Fieldbus Reference

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 following table explains these selections. Note that the analog input value is a percentage value (0-100 %) which can be seen in parameter 0118 AI1.

Table 24 Correcting the fieldbus reference through analog input.

Parameter Setting	Effect of AI1 Value on Fieldbus Reference
COMM	None
COMM+AI1	Corrected fieldbus reference = given fieldbus reference + analog input AI1 value
COMM*AI1	Corrected fieldbus reference = given fieldbus reference * analog input AI1 value / 100

Example of the effect of AI1 value on fieldbus reference.

Assume that 2008 MAXIMUM FREQ = 50 Hz

Assume that fieldbus reference 1 is 5000 (corresponding to 25 % of full scale) and voltage at AI1 is 3 V (corresponding to 30 % of full scale).

1 If setting COMM+AI1 is used, then the corrected fieldbus reference is 25 % + 30 % = 55 % or 27.5 Hz.
2 If setting COMM*AI1 is used, then the corrected fieldbus reference is 25 % * 30 % / 100 % = 7.5 % or 3.75 Hz.

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

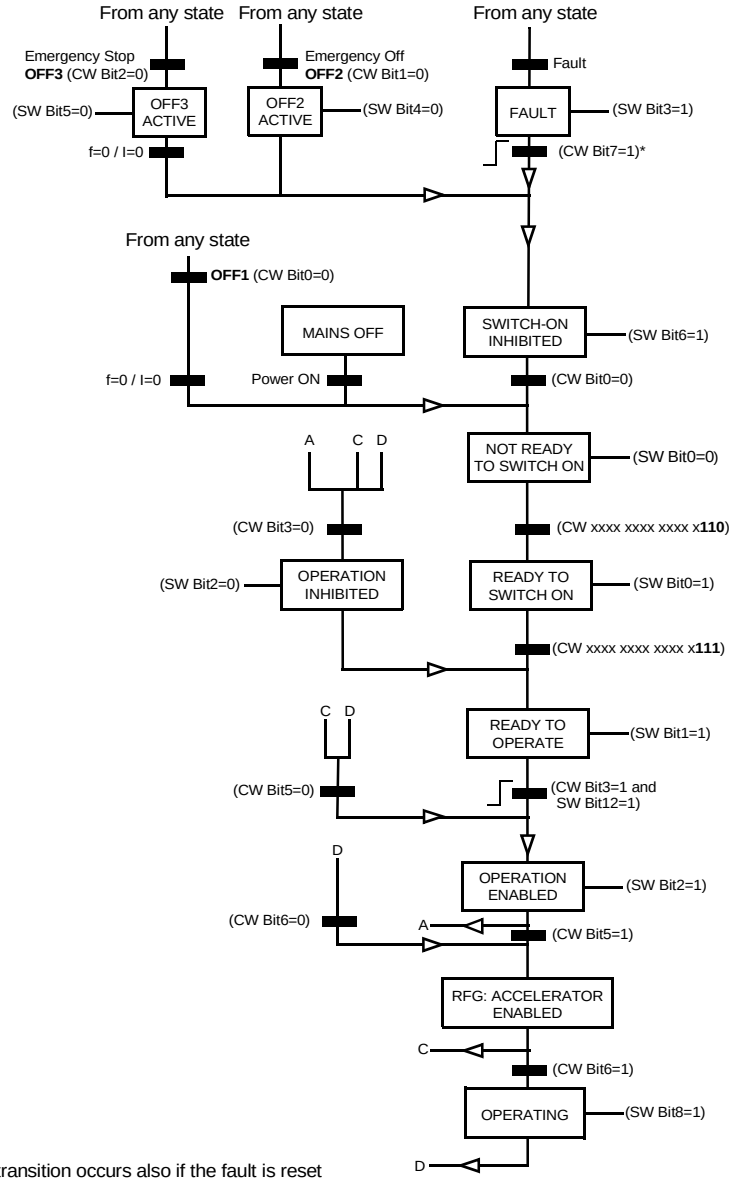
Holding Register: 40005

Actual output frequency. Scaling: 5000 ≙ 50 Hz.

Actual Value 2

Holding Register: 40006

Actual output current. Scaling: 10 ≙ 1 A.



*This state transition occurs also 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 43 The state machine for evaluation of start and stop signals.

Fault and Alarm Status

The ACH 400 provides fault and alarm status words for the external control system. These data words are accessible only through the serial communication link but not from the control panel.

Fault and alarm status words are located in parameter group 3. The group also contains copies of the Control Word and Status Word. Group 3 parameters are of the read-only type; however, both alarm words can be reset by writing a zero to them.

Table 25 Fault and alarm status words.

Code	Name	Description
301	MAIN COMMAND WORD	Read-only copy of the Control Word. See page 109.
302	MAIN STATUS WORD	Read-only copy of the Status Word. See page 111.
305	FAULT WORD 1	Fault information. When a fault is active, the corresponding bit is set. Bit descriptions are given in Table 26.
306	FAULT WORD 2	Fault information. When a fault is active, the corresponding bit is set. Bit descriptions are given in Table 26.
308	ALARM WORD 1	Alarm information. When an alarm is active, the corresponding bit is set. Bits remain set until the whole alarm word is reset by writing 0 to it. See Table 27.
309	ALARM WORD 2	Alarm information. When an alarm is active, the corresponding bit is set. Bits remain set until the whole alarm word is reset by writing 0 to it. See Table 27.

Table 26 Bit descriptions for fault words 1 and 2. See the Diagnostics section for more information about faults and fault codes.

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 Bit descriptions for ALARM WORD 1 and ALARM WORD 2. See the Diagnostics section for more information about alarms and alarm codes.

Bit #	Alarm Word 1	Alarm Word 2
0	Overcurrent controller alarm	Overload alarm
1	Overvoltage controller alarm	Autoreset alarm
2	Undervoltage controller alarm	PID sleep alarm
3	Direction lock alarm	PFC autochange alarm
4	Serial communication loss	PFC interlock alarm
5	Modbus exception	Reserved
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	

Diagnostics

General

This chapter describes the various diagnostic displays of the ACS-PAN and ACS100-PAN control panels and lists the most common causes for each particular display. If the fault cannot be rectified using the given instructions, contact an ABB service representative.

Caution! Do not attempt any measurement, parts replacement or other service procedure not described in this manual. Such action will void the warrantee, endanger correct operation, and increase downtime and expense.

Alarm and Fault displays

The alphanumeric display of the ACS-PAN control panel shows the alarm and fault codes together with a short message.

Alarms 1-7 arise from button operation.

The alarm and fault messages disappear when the control panel's MENU, ENTER or arrow buttons are pressed. The message will reappear after a few seconds if the keypad is not touched and the alarm or fault is still active.

The last three fault codes are stored into parameters 0128 - 0130. These fault memories can be cleared from the control panel by pressing the UP and DOWN buttons simultaneously while in parameter set mode.

Fault Resetting

Faults (indicated by a red static LED) can be reset either from the control panel, by digital input or serial communication, or by switching the supply voltage off for a while. When the fault has been removed, the motor can be started.

The ACH 400 can be configured to automatically reset certain faults. Refer to parameter group 31 AUTOMATIC RESET.

Warning! If an external source for a start command is selected and it is active, the ACH 400 may start immediately after the fault is reset.

Warning! All electrical installation and maintenance work described in this chapter should only be performed by a qualified electrician. The Safety Instructions on the first pages of this manual must be followed.

Table 28 Alarms

Alarm Code	Display	Description
1 *	OPERATION FAILED	Parameter upload or download failed. The software versions of the drives may not be compatible. The software version can be seen from parameter 3301 SOFTWARE VERSION.
2 *	START ACTIVE	Control panel function is not allowed while start is active.
3 *	LOCAL/REMOTE	Control panel function is not allowed in current control mode (local or remote). Control mode is local when LOC is displayed and remote mode when REM is displayed on the control panel.
5 *	BUTTON DISABLED	Control panel function is denied for any of the following reasons: • START/STOP button is interlocked from digital input. This can happen with certain digital input configurations. Refer to chapter Application Macros. • REVERSE button is locked because the shaft direction is fixed by parameter 1003 DIRECTION. • The drive is in remote control mode and the START/STOP and REVERSE buttons are not followed.
6 *	PARAM/LOCAL LOCK	Control panel function is not allowed: • Parameter 1602 PARAMETER LOCK denies parameter editing. • Parameter 1605 LOCAL LOCK denies local control mode.
7 *	FACTORY MACRO	Control panel function is not allowed: Factory macro is selected and denies the parameter modifications. Factory macro is intended for applications where there is no control panel available.
10	OVERCURRENT	Overcurrent controller is active.
11	OVERVOLTAGE	Overvoltage controller is active.
12	DC UNDERVOLTAGE	Undervoltage controller is active.
13	DIRECTION LOCK	Rotation direction if fixed by parameter 1003 DIRECTION.
14	SERIAL COMM LOSS	Serial communication through the Standard Modbus Channel is lost. • Check connections between the external control system and the ACH 400. • Refer to parameters 5003 COMM FAULT TIME and 5004 COMM FAULT FUNC.
15 *	MODBUS EXCEPTION	Exception response is sent through Standard Modbus channel. The bus master may be sending queries which cannot be processed by the ACH 400. Refer to “Standard Serial Communication” section. Last three exception response codes are stored into parameters 5213 - 5215.
16	AI1 LOSS	Analog input 1 loss. Analog input 1 value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
17	AI2 LOSS	Analog input 2 loss. Analog input 2 value is less than MINIMUM AI2 (1306). See also parameter 3001 AI<MIN FUNCTION.
18	PANEL LOSS	Panel communication loss. Control panel is disconnected when - Drive is in local control mode (LOC is shown in the control panel display), or - Drive is in remote control mode (REM) and is configured to accept start/stop, direction or reference from the panel. Refer to parameters in groups 10 COMMAND INPUTS and 11 REFERENCE SELECT. See also parameter 3002 PANEL LOSS.
19	ACH400 OVERTEMP	ACH 400 overtemperature condition. This alarm is given when the temperature reaches 95% of the trip limit.
20	MOTOR OVERTEMP	Motor overtemperature condition as estimated by the ACH 400. Refer to parameters 3004 – 3008.
21	UNDERLOAD	Motor load is too low. Check for a problem in the driven equipment. Refer to parameters 3013 – 3015.
22	MOTOR STALL	Motor is operating in the stall region. This may be caused by an excessive load or insufficient motor power. Refer to parameters 3009 – 3012.

Alarm Code	Display	Description
23	DDCS COMM LOSS	DDCS communication loss has been detected. • Check the status of the fieldbus adapter. Refer to the appropriate fieldbus adapter manual. • Check the DDCS option module and optical fibers. • Check the connections between the external control system and fieldbus adapter. Refer to “DDCS Option module manual” and parameters 5003 – 5006.
24		Reserved.
25		Reserved.
26	OUTPUT OVERLOAD	Inverter overload condition. The ACH 400 output current exceeds the ratings given on page 18 of this manual.
27 *	AUTOMATIC RESET	ACH 400 is about to perform an automatic fault reset operation. As a result, the drive may start after the reset operation. Refer to parameter group 31 AUTOMATIC RESET.
28 *	PID SLEEP	The PID sleep function is active. The drive may accelerate when the PID sleep function is deactivated. Refer to parameters 4018 SLEEP SELECTION, 4013 PID SLEEP DELAY, 4014 PID SLEEP LEVEL and 4015 WAKE-UP LEVEL.
29 *	AUTOCHANGE	The autochange function of the Pump-Fan Control block is active. Refer to parameter group 81 PFC CONTROL and the appendix for more information.
30	INTERLOCK	Pump-Fan Control interlocks are active. The ACH 400 cannot start any motor (when Autochange is used), or the ACH 400 cannot start the speed regulated motor (when Autochange is not used).
101 *	ID MAGN REQ	The motor data has been entered or changed and the drive needs to perform a magnetizing ID Run. This is performed by ensuring the enable signal is present and by pressing the hand button. The motor needs to be connected to the drive for an ID Run.
102 *	ID MAGN	The drive is in the process of performing the ID Run on the motor.
103	GROUND FAULT	The drive has detected a ground fault condition.
104	COMM MODULE	The drive has lost communication with the communications module.

* This alarm will not cause relay output RO1 (RO2) to activate when the relay output is configured to indicate an alarm condition in general. (Parameter 1401 RELAY OUTPUT 1 (1402 RELAY OUTPUT 2) has value 5 (ALARM) or 13 (FLT/ALARM)).

Table 29 Faults.

Fault Code	Display	Description
1	OVERCURRENT	Output current is excessive. • Motor load may be too high. • Acceleration time may be too short (parameters 2201 ACCELER TIME 1 and 2203 ACCELER TIME 2). • Motor or motor cable is faulty or connected incorrectly.
2	DC OVERVOLTAGE	Intermediate circuit DC voltage is excessive. • Check main input power for static or transient overvoltages. • Deceleration time may be too short (parameters 2202 DECELER TIME 1 and 2204 DECELER TIME 2). • Brake chopper (if present) may be undersized.
3	ACH400 OVERTEMP	ACH 400 heat sink temperature is excessive. Temperature trip limit is 95°C (203°F). Ambient air inside the drive > 70°C. • Check air flow and fan operation. • Check motor power against unit power.
4 **	SHORT CIRCUIT	Fault current. Possible reasons for this fault are: • There is a short-circuit in the motor cable(s) or motor • Supply disturbances
5	OUTPUT OVERLOAD	Inverter overload condition. The ACH 400 output current exceeds the ratings given on page 18 of this manual.
6	DC UNDERVOLTAGE	Intermediate circuit DC voltage is not sufficient. • Main input power phase may be missing • Fuse may be blown
7	ANALOG INPUT 1	Analog input 1 loss. Analog input value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
8	ANALOG INPUT 2	Analog input 2 loss. Analog input value is less than MINIMUM AI2 (1306). See also parameter 3001 AI<MIN FUNCTION.
9	MOTOR OVERTEMP	Motor overtemperature condition as estimated by the ACH 400. Refer to parameters 3004 – 3008.
10	PANEL LOSS	Panel communication loss. The control panel is disconnected when the drive is receiving start, stop and direction commands from the panel. - Drive is in local control mode (LOC is shown in the control panel display), or - Drive is in remote control mode (REM is shown) and is configured to accept start/stop, direction or reference from the panel. Refer to parameters in groups 10 COMMAND INPUTS and 11 REFERENCE SELECT. See also parameter 3002 PANEL LOSS.
11	PARAMETERING	Parameter values are inconsistent: • MINIMUM AI1 > MAXIMUM AI1 (parameters 1301, 1302) • MINIMUM AI2 > MAXIMUM AI2 (parameters 1304, 1305) • MINIMUM FREQ > MAXIMUM FREQ (parameters 2007, 2008) • Motor data not entered before starting the drive.
12	MOTOR STALL	Motor stall. This may be caused by excessive load or insufficient motor power. Refer to parameters 3009 – 3012.
13	SERIAL COMM LOSS	Serial communication through the Standard Modbus Channel is lost. • Check the connections between the external control system and the ACH 400. • Refer to parameters 5003 COMM FAULT TIME and 5004 COMM FAULT FUNC.
14	EXTERNAL FAULT SIGNAL	External fault is active. See parameter 3003 EXTERNAL FAULT.
15 **	OUTPUT GROUND FAULT	Ground fault. The load on the incoming main input power system is out of balance. • There may be a fault in the motor or motor cable. • Motor cable may be too long.

16 **	DC BUS RIPPLE	• Ripple voltages on the DC bus are too large. • Main input power phase may be missing • Fuse may be blown
17	UNDERLOAD	Motor load is too low. Check for a problem in the driven equipment. Refer to parameters 3013 – 3015.
18		Reserved
19	DDCS LINK	Problem with DDCS link for IOC or NDIO. • Check the DDCS option module and the optic fibers. • Check the status of the IO extension modules (NDIO) required by the PFC block. Refer also to “DDCS Option Module Manual” and parameter 5004.
20 - 26 **	HARDWARE ERROR	Hardware error. Contact supplier.
Full display blinking (ACS100-PAN) “COMM LOSS” (ACS-PAN)		Serial link failure. Bad connection between the control panel and the ACH 400.
101	MOTOR PHASE	The drive has detected an open phase between the drive and the motor.
102	SUPPLY PHASE	The drive has detected a large ripple on the DC bus, indicating a loss of input phase.
103	ID MAGN FAILED	The drive was unable to perform the ID Run successfully. Check the motor parameters and the motor wiring then repeat the ID Run.
104	PPCC LINK	PPCC LINK code may indicate one of the following conditions: Indicates loss of communications between the NAMC and NINT boards. Check the fiber optic connection on channel INT on the AMC board. or Rate of rise of current too fast. Check the motor cabling for short circuits.
105	OVER FREQ	Output frequency too high.
106	SYSTEM FAULT	Contact supplier.
107	COMM MODULE	Communication with the communications module has been lost. Check the fiber optic connection on CH0 on the AMC board. Check the power supply connection to the communications module.

Appendix A

Local Control vs. Remote Control

The ACH 400 can be controlled from two remote control locations or from the control panel. Figure 44 below shows the ACH 400 control locations.

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

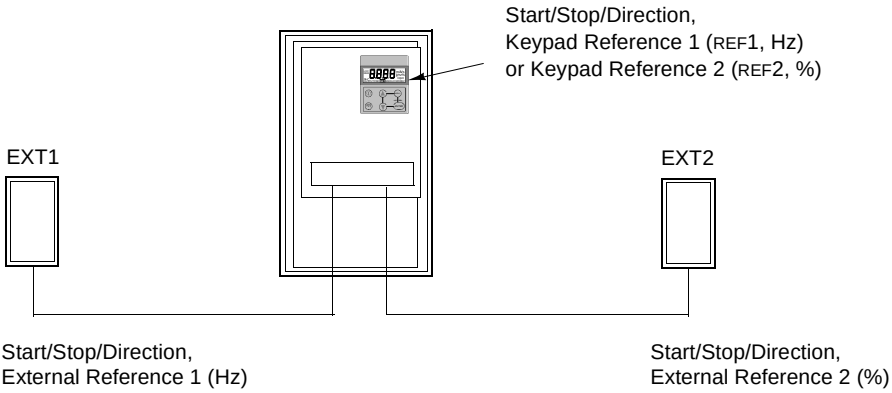


Figure 44 Control locations.

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 the PID Control or PFC 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 the value for 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 or 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).

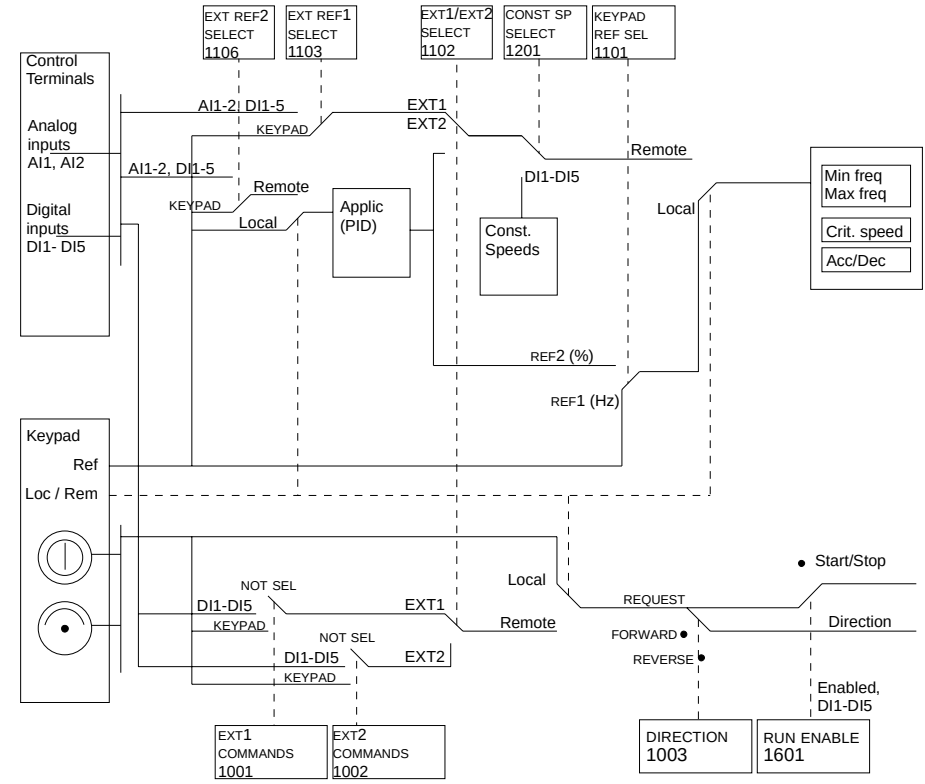


Figure 45 Selecting control location and control source.

Internal Signal Connections for the Macros

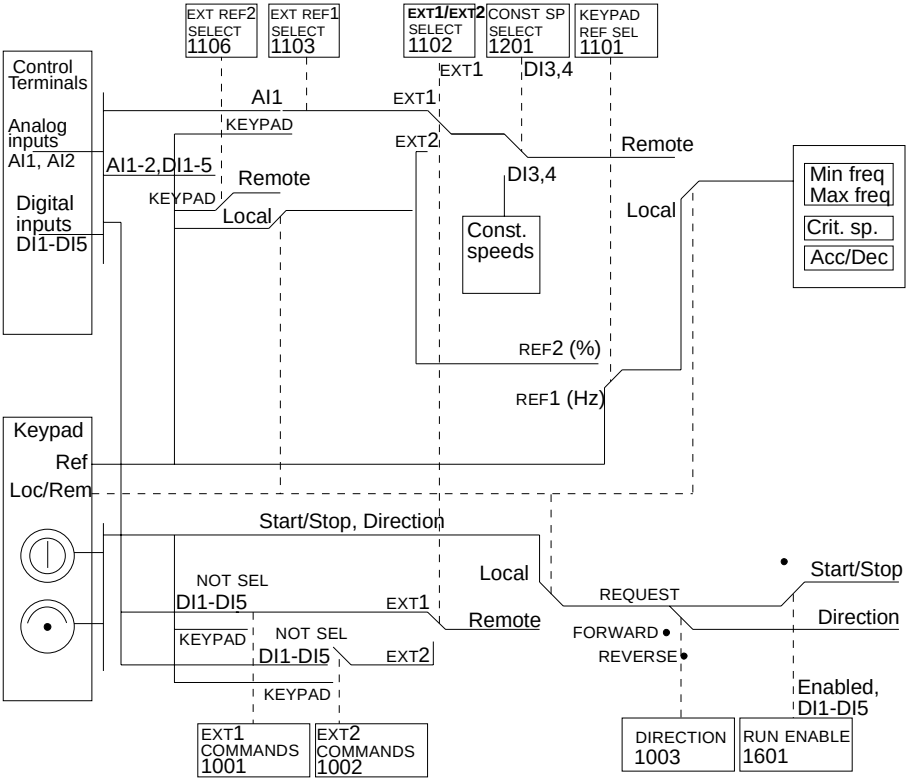


Figure 46 The control signal connections of the ABB Standard, Alternate and Premagnetize macros.

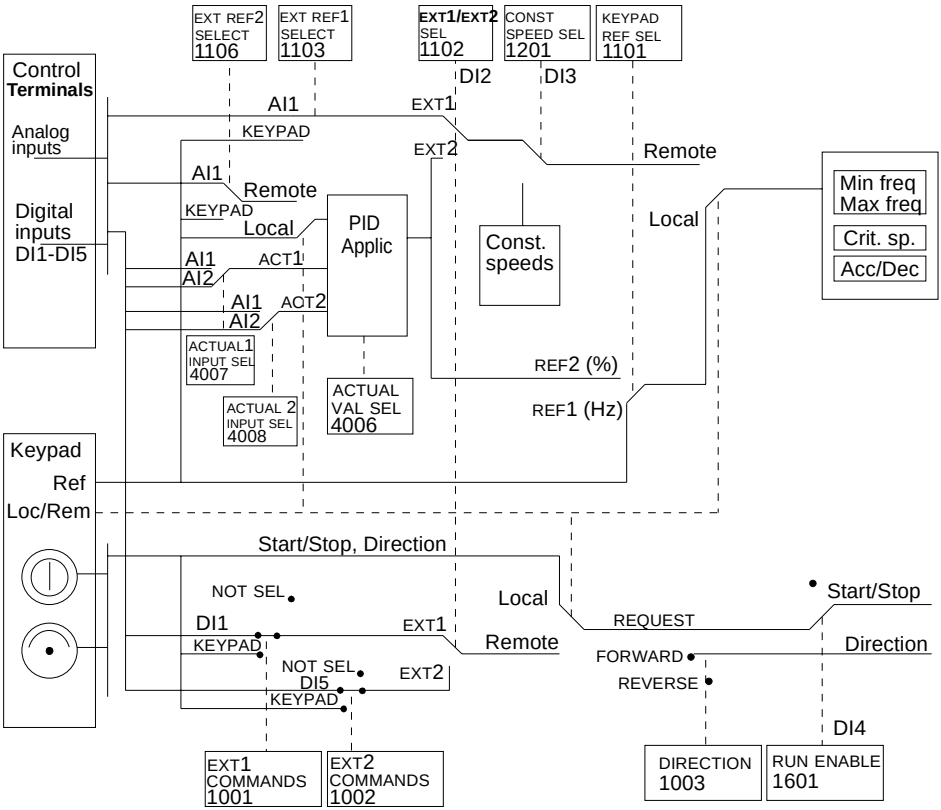


Figure 47 The control signal connections of the PID Control macro.

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.

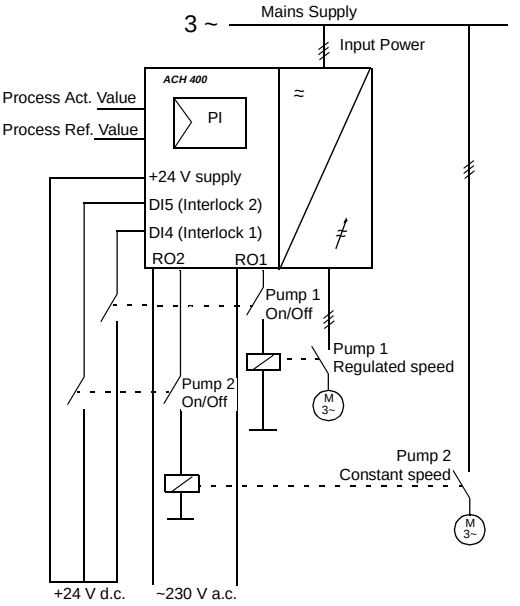


Figure 48 Operation Diagram for the Pump and Fan Control (PFC) Macro. With the default settings, automatic pump alternation is not in use.

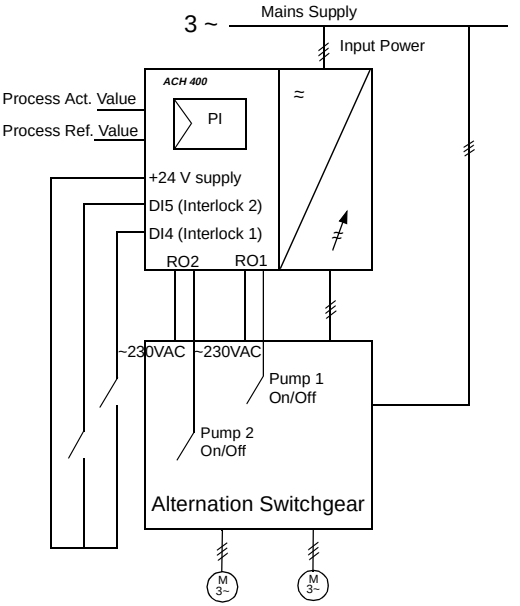


Figure 49 In this example the automatic pump alternation is in use.

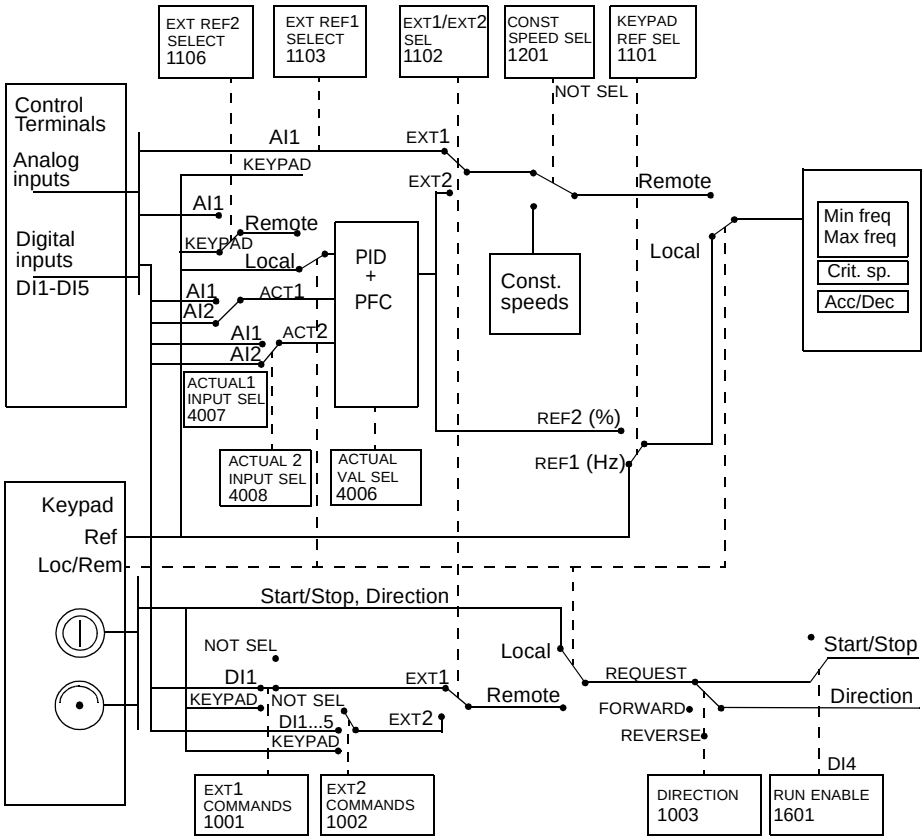


Figure 50 The control signal connections of the Pump and Fan Control (PFC) macro.

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 pre-set 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:

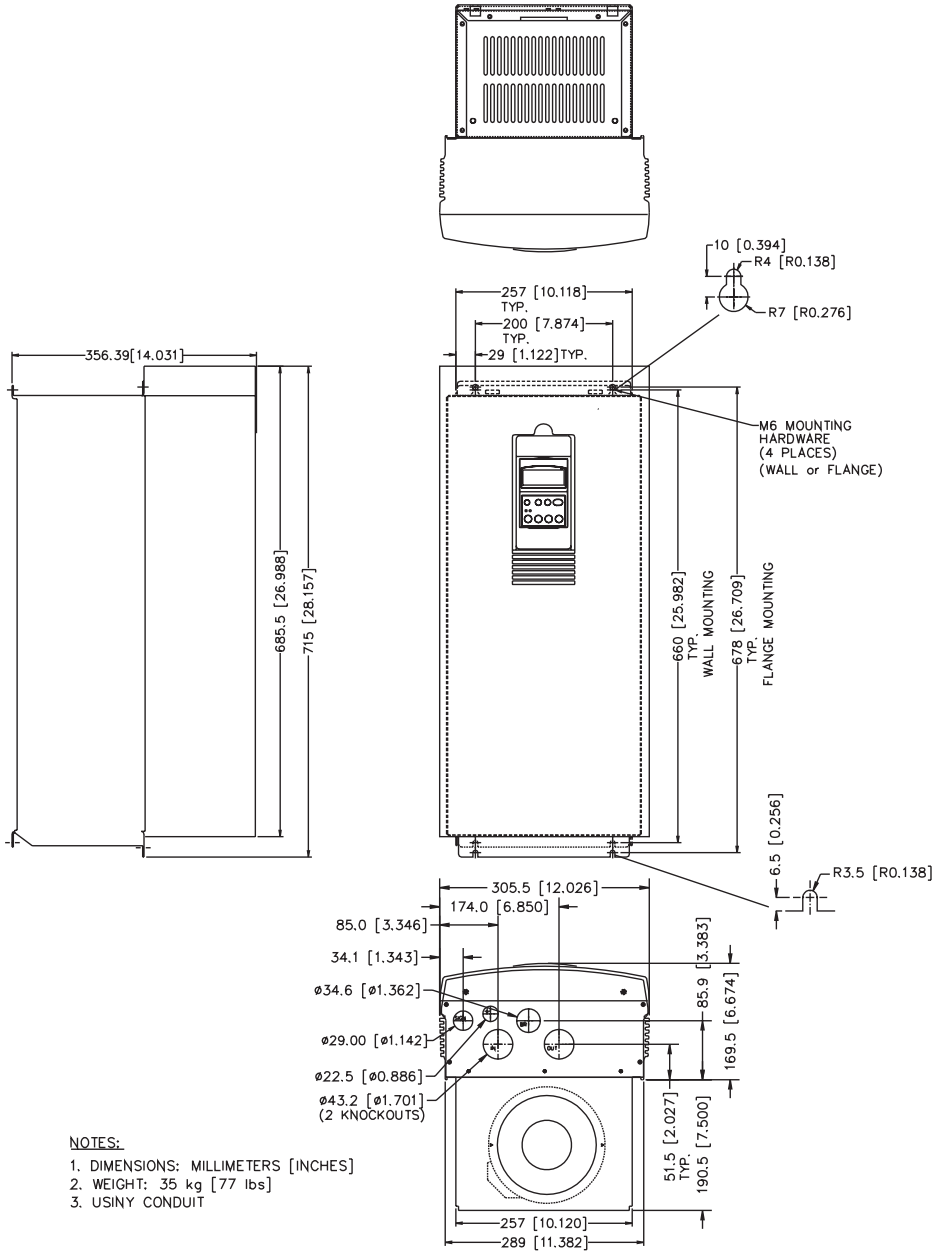
- Set the module node numbers using the DIP switches located inside the modules. Refer to the NDIO module manual for details. Module node number must be 5 if only one NDIO module is used. Node numbers must be 5 and 6 if two NDIO modules are used.
- Connect power to the NDIO modules.

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

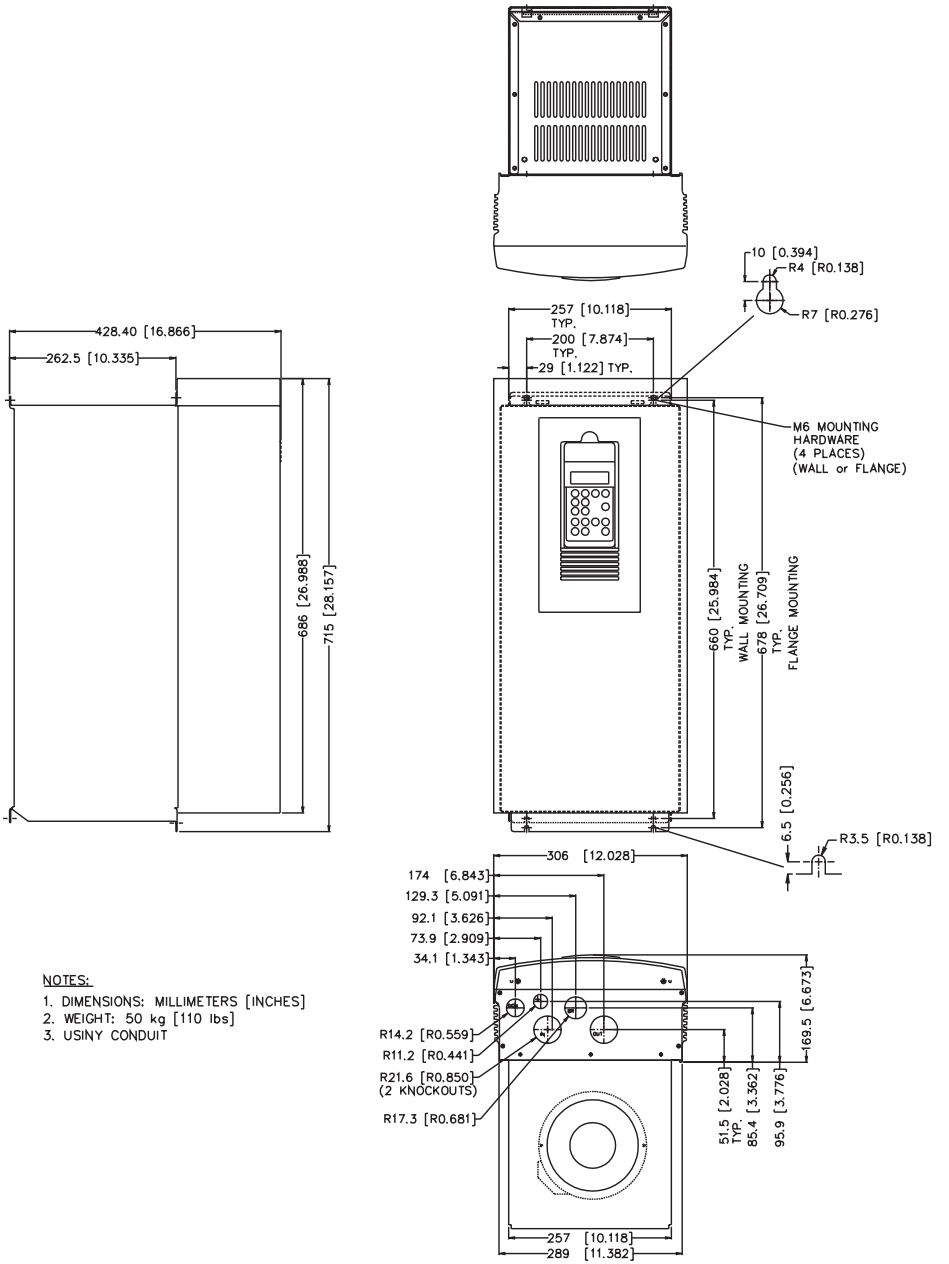
ACH 400 NEMA Type 1 or Type 12 Enclosure, R5 Frame Size



NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 35 kg [77 lbs]
3. USINY CONDUIT

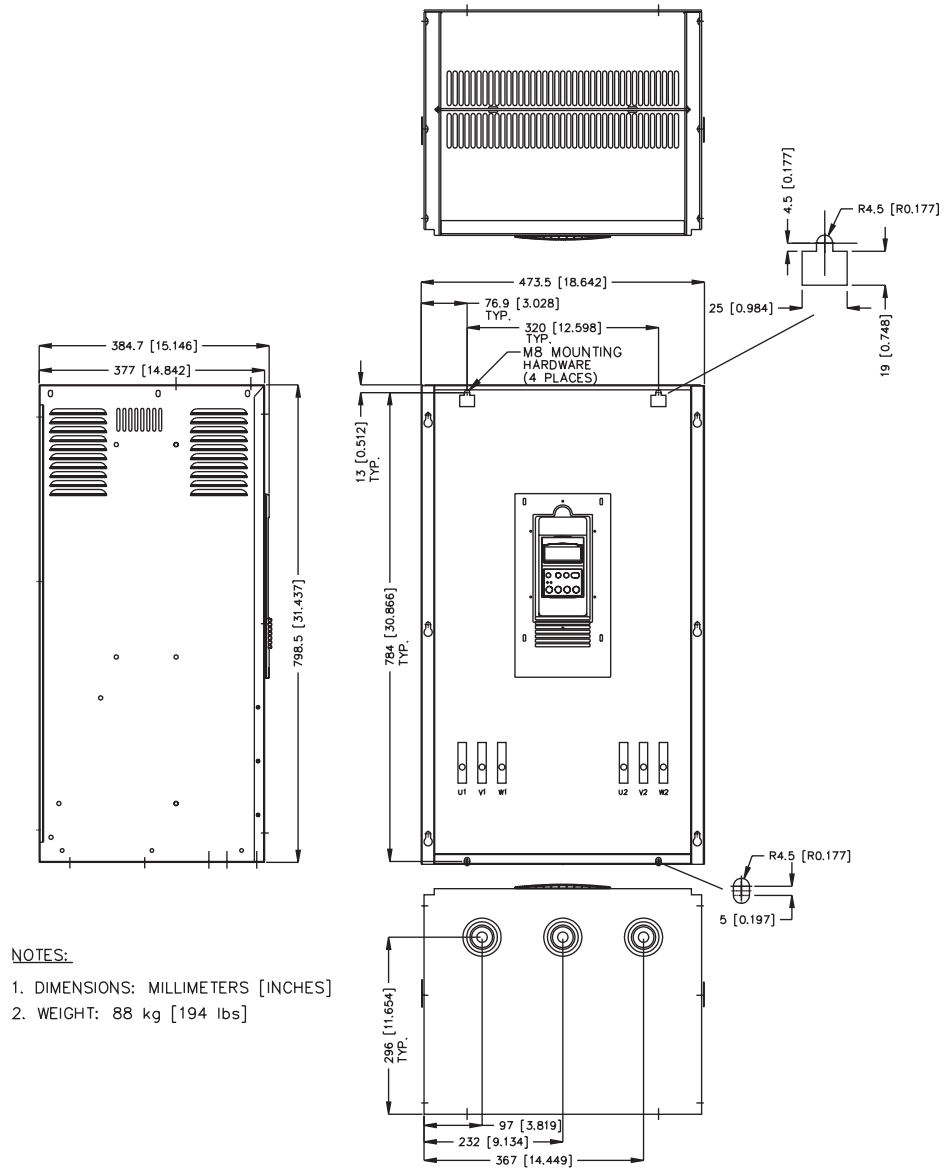
ACH 400 NEMA Type 1 or Type 12 Enclosure, R6 Frame Size



NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 50 kg [110 lbs]
3. USINY CONDUIT

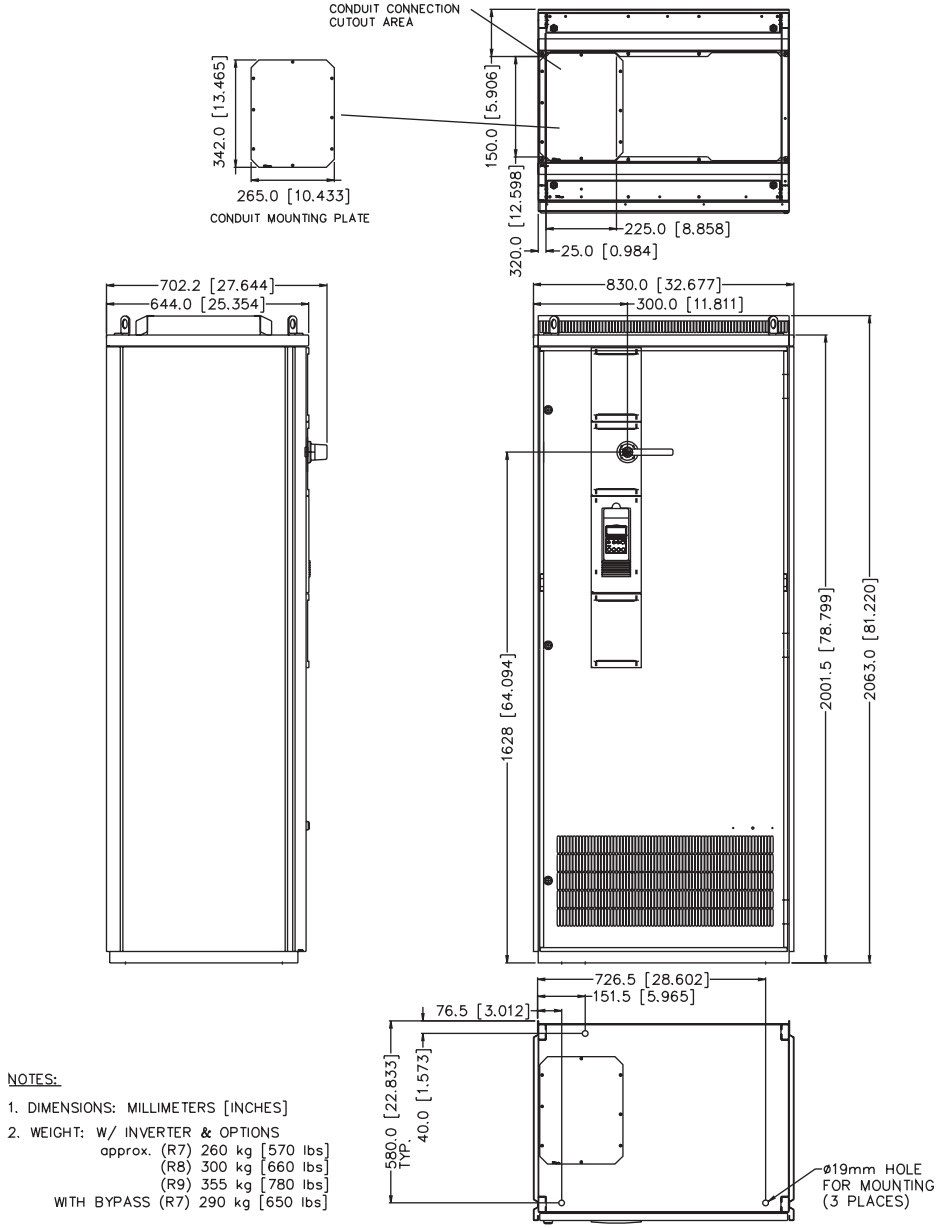
ACH 400 NEMA Type 1 or Type 12 Enclosure, R7 Frame Size



NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 88 kg [194 lbs]

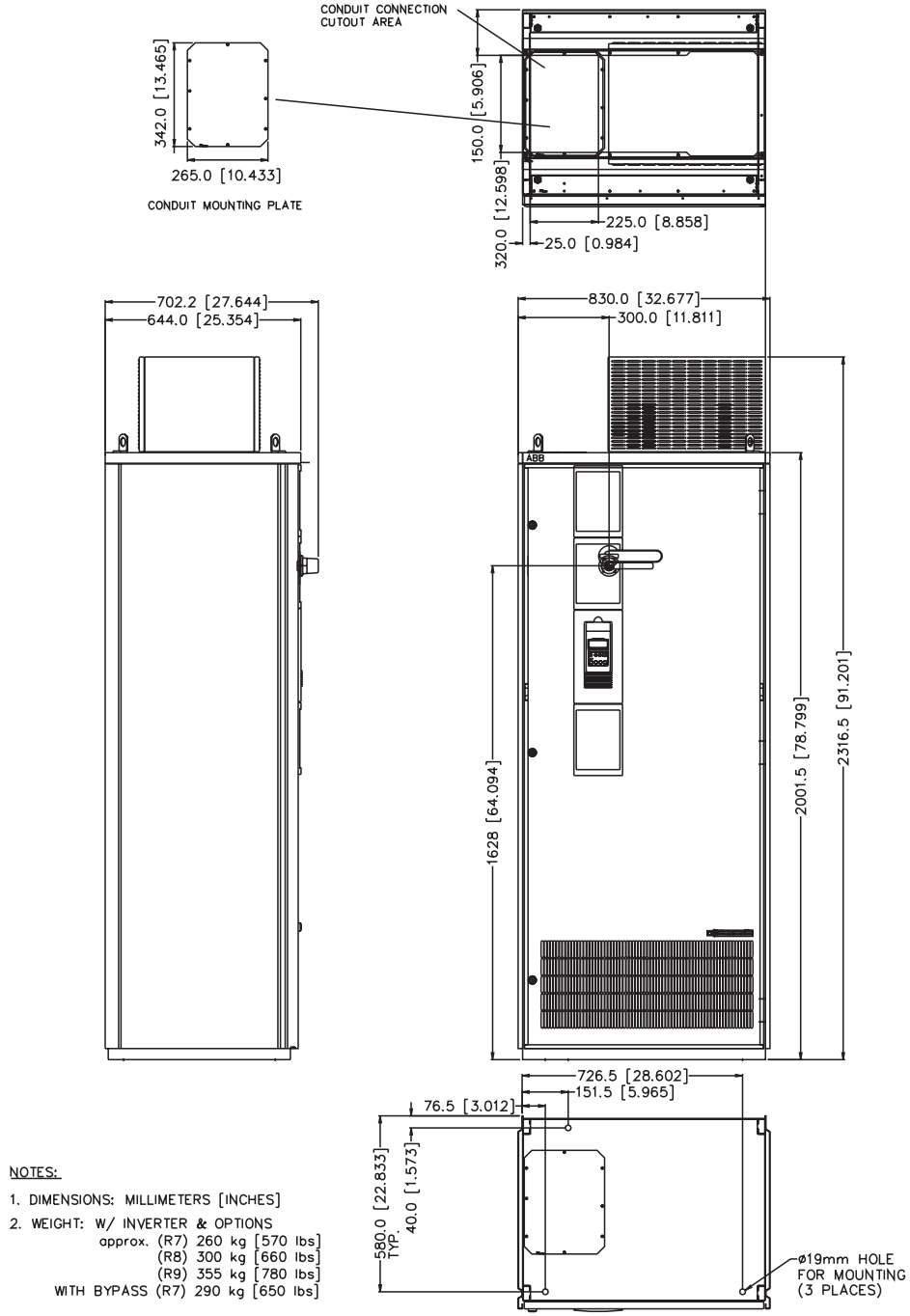
ACH 400 NEMA Type 1 Enclosure, R7 - R9 Frame Size



NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: W/ INVERTER & OPTIONS
   approx. (R7) 260 kg [570 lbs]
   (R8) 300 kg [660 lbs]
   (R9) 355 kg [780 lbs]
   WITH BYPASS (R7) 290 kg [650 lbs]

ACH 400 NEMA Type 12 Enclosure, R7 - R9 Frame Size



NOTES:

1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: W/ INVERTER & OPTIONS
   approx. (R7) 260 kg [570 lbs]
   (R8) 300 kg [660 lbs]
   (R9) 355 kg [780 lbs]
   WITH BYPASS (R7) 290 kg [650 lbs]

ACH402-US-04
3AUA489002B4240 R0101 Rev E
Effective: 5/10/00
Supercedes: 8/1/99

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