

ACS 400

User's Manual

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

ABB Automation Inc.



ACS 400 AC Drives for Speed Control of AC Induction Motors

User's Manual

ACS400-US-04

3AUA489002B5310 R0101 Rev B

Effective: 01/16/01

Supersedes: 2/1/99

Safety



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



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



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



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



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



Warning! The ACS 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 ACS 100/140/400 units are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the units or an external supply.



Warning! The heat sink may reach a high temperature. See "Specifications" on page 21.

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

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

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

Unpacking the unit

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

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

Step by step instructions

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



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

- 1 **CHECK** the environment. See **A**
- 2 **MOUNT** the ACS 400 to the wall. See **B, C**
- 3 **REMOVE** the cover. See **D**
- 4 **ATTACH** a warning sticker
in the language of your choice. See **E, F**
- 5 **IDENTIFY** power and control terminals. See **E, I, J**
- 6 **CHECK** voltage supply. See **G, T**
- 7 **CHECK** the motor. See **L, T**
- 8 **CHECK** I/O jumpers J1 and J2. See **E, K, M**
- 9 **CONNECT** power terminals. See **E, J**
- 10 **CONNECT** control wires. See **J**
- 11 **REPLACE** the cover. See **N**
- 12 **TURN** the power on. See **O**

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

Reference Sections

A Installation Environment

Stationary Use

- Ambient temperature 32...104 °F (0...40 °C)
- Max. ambient temperature 122 °F (50 °C) if P_N and I₂ derated to 90%
- Installation altitude 0...3300 ft (1000 m) if P_N and I₂ 100%
- Installation altitude 3300...6600 ft (1000...2000 m) if P_N and I₂ derated 1% every 330 ft (100 m) above 3300 ft (1000 m)
- Relative humidity less than 95% (non-condensing)

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

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

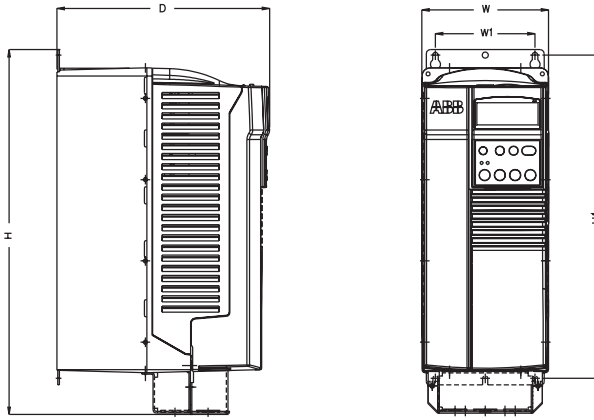
Storage and Transportation

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

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

B Dimensions (in/mm)

Units with IP 21/NEMA Type 1 Enclosures



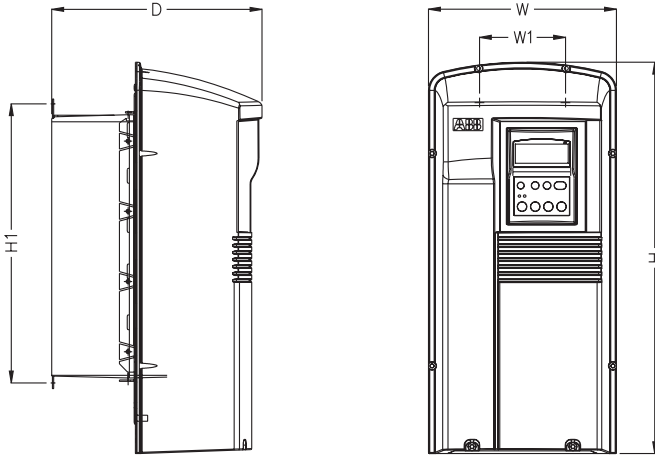
Dimensions Reference (in / mm)	Frame Size, IP21 / NEMA 1			
	R1	R2	R3	R4
W	4.92" / 125	4.92" / 125	7.99" / 203	7.98" / 203
W1	3.86" / 98	3.86" / 98	6.30" / 160	6.30" / 160
H	14.14" / 359	18.07" / 459	22.48" / 571	26.08" / 662
H1	12.52" / 318	16.42" / 417	20.79" / 528	24.38" / 619
D	8.24" / 209	8.71" / 221	9.77" / 248	11.07" / 281
Mass (lb / kg)	12.8 / 5.8	19.8 / 9	40.8 / 18.5	59.5 / 27

Figure 2 IP 21/NEMA Type 1 enclosures

A complete set of dimensional drawings for the NEMA Type 1 ACS 400 drives is located in "Appendix D" on page 167.

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

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




Dimensions Reference (in / mm)	Frame Size, IP54 / NEMA 12			
	R1	R2	R3	R4
W	8.43" / 214	8.43" / 214	10.09" / 256	10.09" / 256
W1	3.86" / 98	3.86" / 98	6.30" / 160	6.30" / 160
H	17.72" / 450	21.65" / 550	25.27" / 642	29.21" / 742
H1	12.52" / 318	16.42" / 417	20.79" / 528	24.38" / 619
D	9.43" / 240	9.96" / 253	11.00" / 280	12.28" / 312
Mass (lb / kg)	12.8 / 5.8	19.8 / 9	40.8 / 18.5	59.5 / 27

Figure 3 IP 54/NEMA Type 12 & 4 enclosures

A complete set of dimensional drawings for the NEMA Type 12 & 4 ACS 400 drives is located in "Appendix D" on page 167.

C Mounting the ACS 400 on a Wall

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

1

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

2

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

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

Figure 4 Removing the wall mounting template.

3

IP 21

Position the ACS 400 onto the mounting screws or bolts and securely tighten in all four corners.

Note! Lift the ACS 400 by its metal chassis.

Figure 5 Marking and drilling the mounting holes.

IP 54

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

Figure 6 Mounting type IP21 drives.

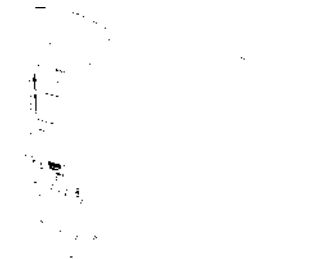


Figure 7 Mounting type IP54 drives.

D Removing the Cover

Opening frame size R1 and R2 units.

See Paragraph T for frame size assignments of type codes.

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

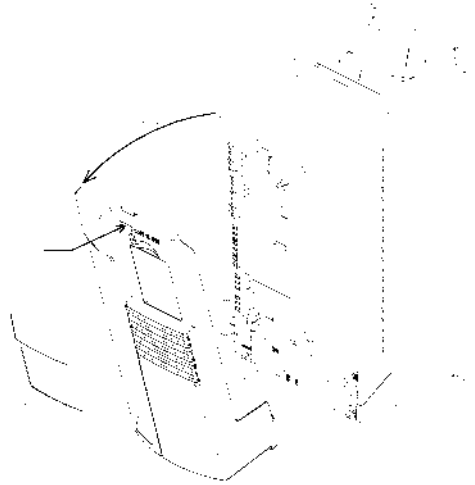


Figure 8 Opening the frame size R1 and R2 drives of type IP 21/NEMA Type 1.

Opening frame size R3 and R4 units.

See Paragraph T for frame size assignments of type codes.

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

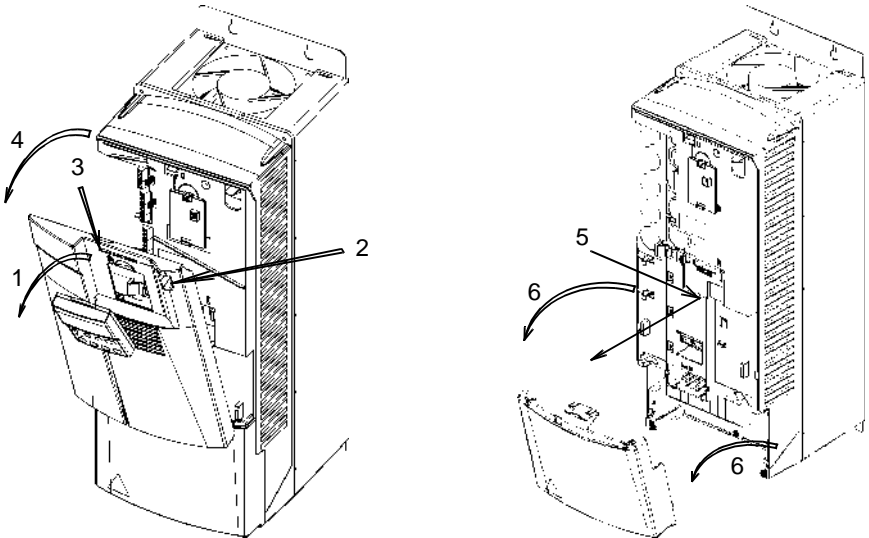


Figure 9 Opening the frame size R3 and R4 of type IP 21/NEMA Type 1.

IP 54/NEMA Type 12 & 4

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

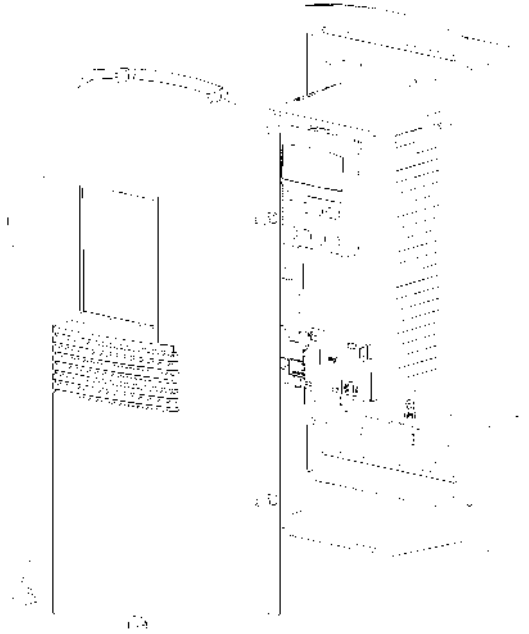


Figure 10 Opening type IP 54/NEMA Type 12 & 4 drives.

E Terminal Interface

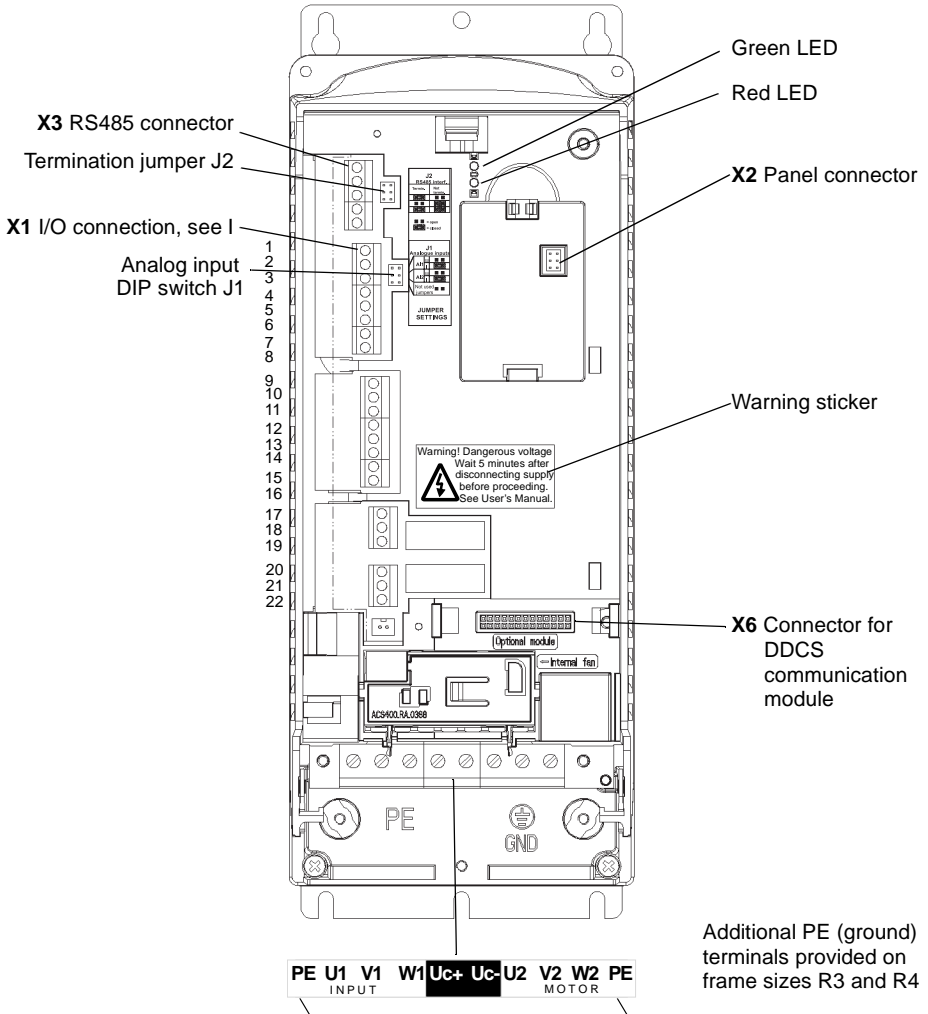


Figure 11 Terminal Interface.

F Attaching a Warning Sticker

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

G Type Code and Model Designation

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




ABB Industrial Products	Made in USA	U1	380...480 V	For more information see ACS400 User's LISTED 45Y1  IND. CONT. EQ  (EXCEPT 230 V)
Type	ACS401600432	U2	3 0 - 380...480 V	
Code	63996611	I_{1N}	6.2 A	
		I_{2N}	6.6 A	
Ser.no.	*1982800001*	f1	48...63 Hz	
		f2	0...250Hz	

Figure 12 ACS 400 type designation label.

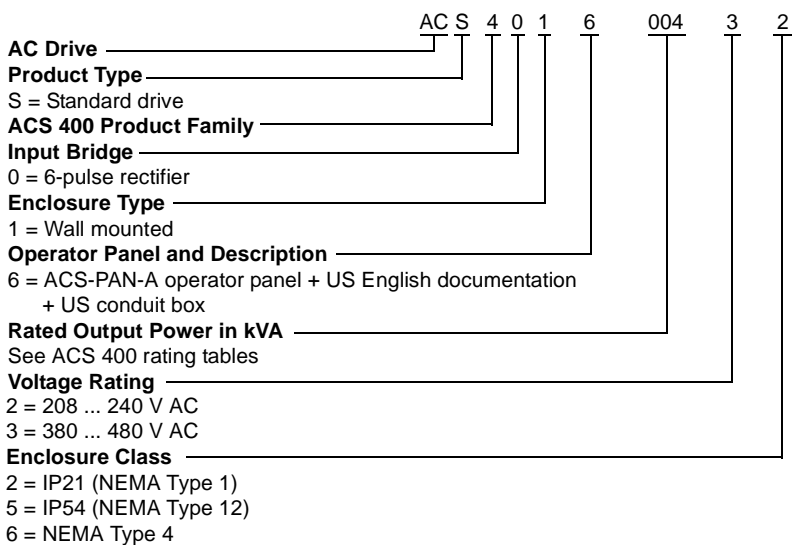


Figure 13 Type code key.

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

Type	ACS401600432		
Code	63996611	Ser.no.	*1982800001*

Figure 14 Serial number label.

H Floating Network

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

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

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

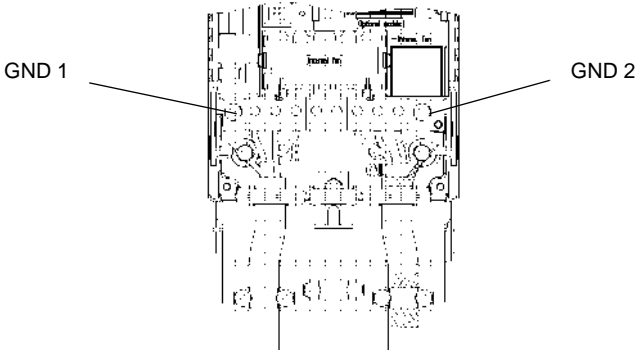


Figure 15 Removing the grounding screws from frame size R1 and R2 frequency converters.

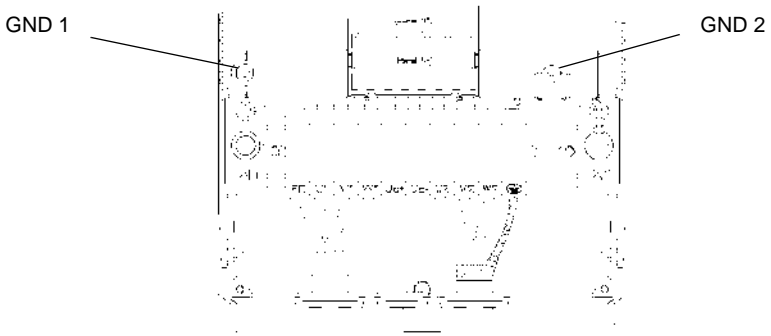


Figure 16 Removing the grounding screws from frame size R3 and R4 frequency converters.

I Installation of ACS 400 Conduit Box

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

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

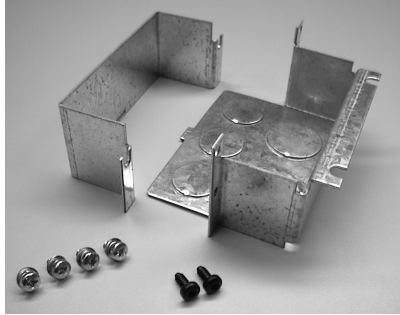


Figure 17 US conduit box installation kit. Your ACS 400 should include the parts shown above, the two (2) halves of the conduit box, four (4) screws with captive washers and two (2) self tapping screws.

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

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

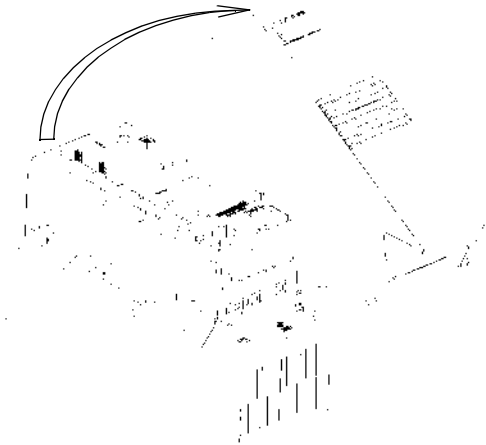


Figure 18 Removing the front cover.

IP 21 / NEMA Type 1.

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

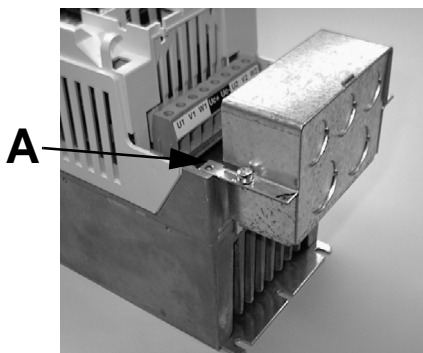


Figure 19 Positioning the conduit box for type IP 21 / NEMA Type 1 drives.

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

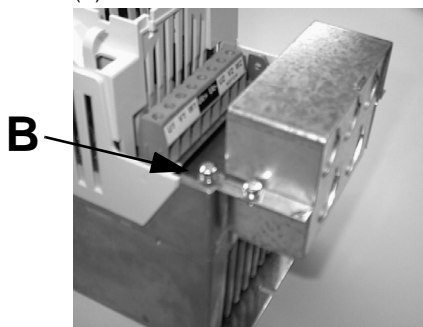


Figure 20 Conduit with top two screws installed.

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

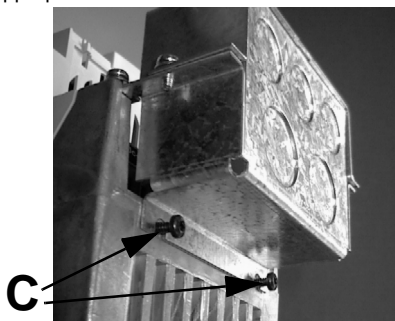


Figure 21 Conduit box with all screws inserted in the proper holes.

J Cable Connections

Table 4 Cable

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

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

Use shielded cable for control wiring.

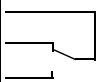
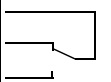
Use 60 °C rated power cable (75 °C if over 100 amps).

Refer to Section T “Specifications” on page 21 for current, ratings, fuse recommendations and the maximum wire size capacities and tightening torques for the terminals. The ACS 400 is suitable for use on a circuit capable of delivering not more than 65,000 RMS symmetrical amperes, 480 V maximum. The ACS 400 has an electronic motor protection feature that complies with the requirements of the National Electric Code (USA). When this feature is selected and properly adjusted, additional overload protection is not required unless more than one motor is connected to the drive or unless additional protection is required by applicable safety regulations. See parameters 3004, 3005, and 3006.

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

K Control Terminals

Main I/O terminal X1

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

Digital input impedance 1.5 k Ω .

Use multi-strand 0.5-1.5 mm² (20-16 AWG) wire.

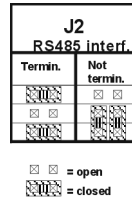
Note! For safety reasons the fault relay signals a “fault” when the ACS 400 is powered down.

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

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

RS485 terminal X3


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



L Motor

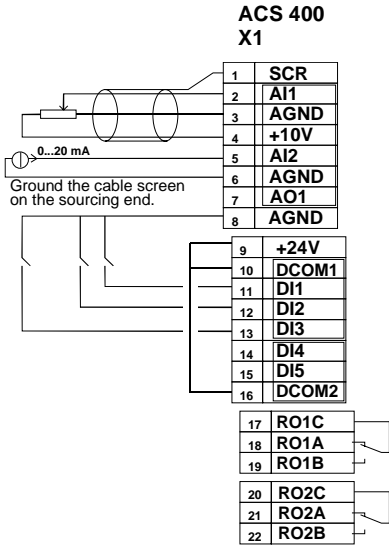
Check for motor compatibility. The motor must be a three-phase induction motor, with input voltage from 208 to 240 V for ACS401-XXXX-2-X or 380 to 480 V for ACS401-XXXX-3-X and f_N either 50 Hz or 60 Hz.

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

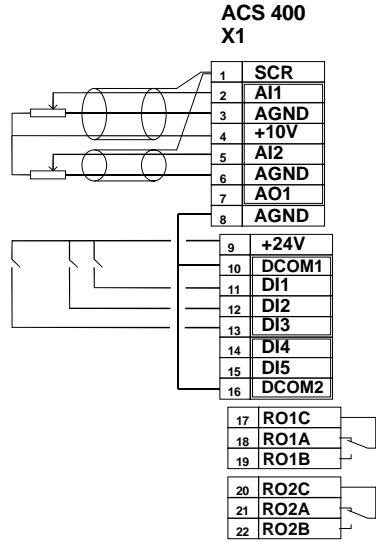
 **Warning!** Ensure the motor is compatible for use with the ACS 400. The ACS 400 must be installed by a competent person. **If in doubt, contact your local ABB sales or service office.**

M Connection Examples

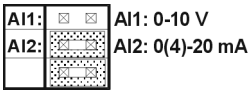
DI configuration for
NPN connection (sink)



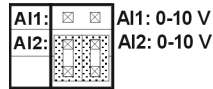
DI configuration for
PNP connection (source)



J1 Analog inputs

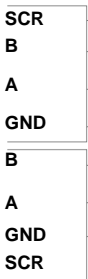


J1 Analog inputs



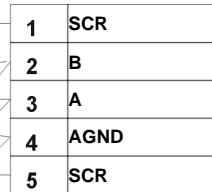
RS485 Multidrop application

Other Modbus Devices

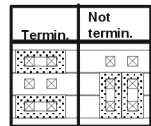


ACS 400

X3



J2 RS485 interf.



N Replacing the Cover

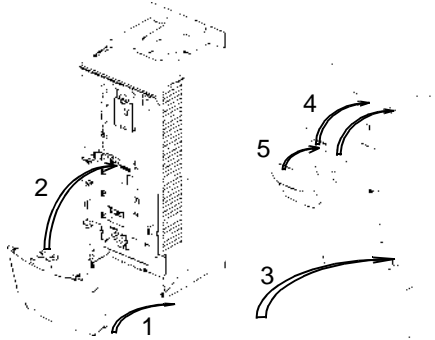
Do not turn the power on before replacing the front cover.

Replacing the front cover for IP21 / NEMA Type 1:

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

Replacing the front cover to IP 21/ NEMA Type 1 units from size ACS401x0163x and up.

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



Replacing the front cover for IP54 / NEMA Type 12:

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

O Applying Power

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

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

P Environmental Information

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

Q Protection Features

The ACS 400 has a number of protective features:

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

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

- For location of LEDs, see section E or, if an ACS-PAN-A control panel is connected, see “Programming” on page 25.

Red LED: off Green LED: blinking	ABNORMAL CONDITION
ABNORMAL CONDITION: <ul style="list-style-type: none"> • ACS 400 cannot fully follow control commands. • Blinking lasts 15 seconds. 	POSSIBLE CAUSES: <ul style="list-style-type: none"> • Acceleration or deceleration ramp is too fast in relation to load torque requirement • A momentary power interruption

Red LED: on Green LED: on	FAULT
ACTION: <ul style="list-style-type: none"> • Apply a stop signal to reset fault. • Apply a start signal to restart the drive. NOTE: If the drive fails to start, check that the input voltage is within the tolerance range.	POSSIBLE CAUSES: <ul style="list-style-type: none"> • Transient overcurrent • Over-/undervoltage • Overtemperature CHECK: <ul style="list-style-type: none"> • the supply line for disturbances. • the drive for mechanical problems that might cause overcurrent. • that the heat sink is clean.

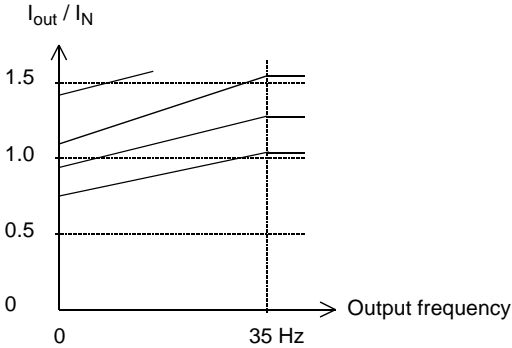
Red LED: blinking Green LED: on	FAULT
ACTION: <ul style="list-style-type: none"> • Turn the power off. • Wait for the LED's to turn off. • Turn the power back on. Caution! This action may start the drive.	POSSIBLE CAUSE: <ul style="list-style-type: none"> • Output ground fault • Short circuit • DC bus ripple too large CHECK: <ul style="list-style-type: none"> • the insulation in the motor circuit.

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

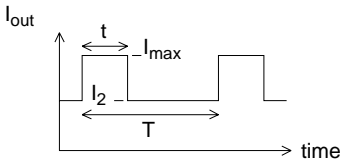
R Motor Overload Protection

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

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

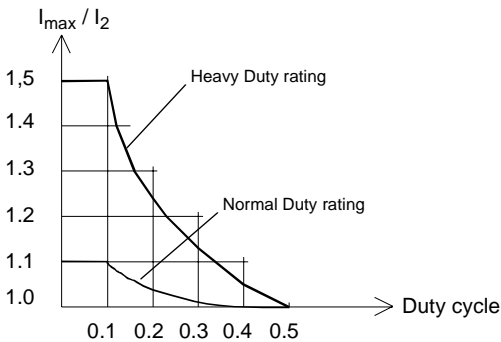


S Drive Overload Protection



Duty cycle = t/T

$T < 10$ min



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

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

T Specifications

Notes for the following tables are on page 23.

200 V Series										
3-Input 208 - 240V +/- 10% 50/60Hz	ACS401x	0004x	0005x	0006x	0009x	0011x	0016x	0020x	0030x	0041x
Frame Size	Unit	R1		R2		R3		R4		
Nominal Ratings (See G & M)										
Nominal motor P _N Normal Duty	kW Hp	2.2 3	4 5	5.5 7.5	7.5 10	11 15	15 20	18.5 25	22 30	30 40
Input Current I _{1N} 3~	A	10.0	15.7	22.7	29.0	43.4	55.8	70.3	82.7	107.2
Output Current I _{2N}	A	10.6	16.7	24.2	30.8	46.2	59.4	74.8	88	114
Max. Output Current I _{2Nmax}	A	11.7	18.4	26.6	33.9	50.8	65.3	82.3	96.8	125.4
Nominal motor P _N Heavy Duty	kW Hp	1.5 2	2.2 3	4 5	5.5 7.5	7.5 10	11 15	15 20	18.5 25	22 30
Input current I _{1NHD} 3~	A	7.1	10.0	15.7	22.8	29.0	43.6	56.0	70.5	83.0
Output Current I _{2NHD}	A	7.5	10.6	16.7	24.2	30.8	46.2	59.4	74.8	88
Max. Output current I _{2NHDmax}	A	11.3	15.9	25.1	36.3	46.2	69.3	89.1	112.2	132.0
Output Voltage U ₂	V	0 - U ₁								
Switching Frequency	kHz	4 (standard) 8 (Low Noise)**								
Protection Limits										
Overcurrent (peak)	A	31.4	44.3	69.8	101.2	128.7	142.3	196.0	279.8	367.8
Overvoltage: Running Start Inhibit	VDC VDC	421 VDC (1.3*U _{DC} Nominal @ 240 VAC input) 1.18 * U _{DC} Nominal @ 240 VAC								
Undervoltage: Running Start Inhibit	VDC VDC	182 VDC (0.65 * U _{DC} Nominal @ 208 VAC Input) 0.85 * U _{DC} Nominal @ 208 VAC								
Overtemperature	°C / °F	95° C / 203° F (Heat Sink)								
Max. Wire Sizes and Screw Torque of Connectors										
Power Terminals	mm ² / Nm / lb/in.	10, AWG6 (Stranded) / Torque 1.3 - 1.5 Nm / 11 - 13 lb/in.			10, AWG6 (Stranded) / Torque 1.3 - 1.5 Nm / 13 - 16 lb/in.		35, AWG2 (Stranded) / Torque 3.2 - 3.7 Nm / 28 - 32 lb/in.		35, AWG2 (Stranded) / Torque 3.2 - 3.7 Nm / 28 - 32 lb/in.	
Control Terminals	mm ²	0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm								
Line Fuse 3~	A	16	25	25	35	50	80	80	100	125
Bussmann Type		KTK-15	KTK-25	KTK-25	KTK-35	JJS-50	JJS-80	JJS-80	JJS-100	JJS-125
Power Losses										
Power Circuit	W	60	88	160	220	300	440	600	740	880
Control Circuit	W	6	6	6	6	6	6	6	6	6

400V Series

3~Input 380 - 480V +/- 10% 50/60Hz	ACS401x	0043x	0053x	0063x	0093x	0113x	0163x	0203x	0253x	0303x	0413x
Frame Size	Unit	R1			R2		R3		R4		
Nominal Ratings (See G)											
Nominal Motor P _N Normal Duty	Hp	3.0	5.0	7.5	10	15	20	25	30	40	50
Input Current I _{1NND}	A	6.2	8.3	11.1	14.8	21.5	29.0	35.0	41.0	56.0	68.0
Output Current I _{2NND}	A	6.6	8.8	11.6	15.3	23.0	30.0	38.0	44.0	59.0	72.0
Max. Output Current I _{2NNDmax} *	A	7.3	9.7	12.8	16.8	25.3	33	42	48	65	79
Nominal Motor P _N Heavy Duty	kW Hp	2.0	3.0	5.0	7.5	10	15	20	25	30	40
Input current I _{1N}	A	4.7	6.2	8.3	11.1	14.8	21.5	29	35	41	56
Output Current I _{2N}	A	4.9	6.6	7.7	11.6	15.3	23	30	38	44	59
Max. Output current I _{2Nmax} *	A	7.4	9.9	13.2	17.4	23	34	45	57	66	88
Output Voltage V ₂	V	0 - V ₁									
Switching Frequency	kHz	4 (Standard) 8 (Low Noise**)									
Protection Limits											
Overcurrent (peak)	A	20.3	27.5	37	48	64	76	99	125	145	195
Overvoltage: Running Start Inhibit	VDC VDC	842 (corresponds to 624 VAC input) 661 (in input voltage range 380-415 VAC) 765 (in input voltage range 440-480 VAC)									
Undervoltage: Running Start Inhibit	VDC VDC	333 (corresponds to 247 VAC input) 436 (in input voltage range 380-415 VAC) 505 (in input voltage range 440-480 VAC)									
Overtemperature	°C / °F	95° C / 203° F (Heat Sink)									
Max. Cable Length f _{SW} =4kHz****	m / ft.	100 / 320'			200 / 640'		200 / 640'		200 / 640'		
Max. wire sizes and screw torque of connectors											
Power terminals ***	mm ² / Nm / lb/in.	10, AWG6 (stranded) / Torque 1.3-1.5 Nm / 11 - 13 lb/in.					16, AWG4 (stranded) / Torque 1.5-1.8 Nm / 13 - 16 lb/in.		35, AWG2 (stranded) / Torque 3.2-3.7 Nm / 28 - 32 lb/in.		
Control terminals	mm ²	0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm									
Line fuse 3- ****	A	10	15	15	20	30	40	50	60	80	100
Bussman Fuse Type		KTK-10	KTK-15	KTK-15	KTK-20	KTK-30	JJS-40	JJS-50	JJS-60	JJS-80	JJS-100
Power losses											
Power circuit	W	90	120	170	230	330	450	560	660	900	1100
Control circuit	W	6	6	6	6	6	6	6	6	6	6

- * Power stages are designed for the continuous I_{2NND} current. These values are valid when the altitude is less than 3300 ft (1000 m) ASL. See S.
- ** Low noise setting programmable with optional control panel.
For ambient operating temperature 0...40°C, derate P_N and I_2 to 80%.
- *** Follow local rules for cable size; see J. Shielded motor cable is recommended.
- **** Fuse type: UL class CC or T (Bussman Type KTK or JJS).
Use 60°C rated power cable (75°C if T_{amb} above 45°C).
- ***** Maximum cable lengths listed are based on capacitive coupling between motor wires and from motor wires to ground. It may also be necessary to consider motor insulation requirements related to drive output dv/dt.

U Product Conformity

The ACS 400 complies with North American standard UL508C.

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

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

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

Note! See ACS 400 EMC instructions.

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

V Accessories

ACS-100/140/400-EXT

Extension cable kit for use with the control panel.

ACS400-IF11-3 through ACS400-IF41-3

RFI input filters.

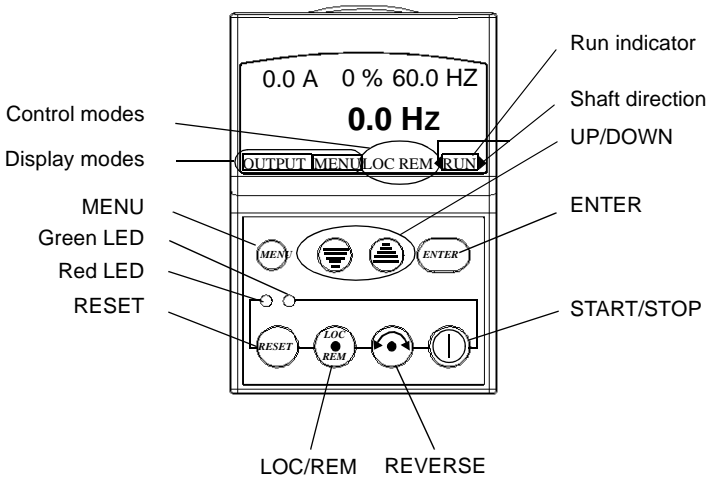
RS485/232 Adapter

DDCS Communication Module

PROGRAMMING

ACS-PAN-A Control Panel

ACS-PAN-A is an alphanumeric control panel with LCD display and multiple languages. The control panel can be connected to and detached from the converter at any time. The panel can be used to copy parameters to other ACS 400 converters with the same software revision (parameter 3301).



Control Modes

The very first time the drive is powered up, it is controlled from the Control Terminal Block X1 (remote control, **REM**). The ACS 400 is controlled from the control panel when the drive is in local control (**LOC**).

Switch to local control (**LOC**) by pressing and holding the LOC/REM button until first LOCAL CONTROL or later LOCAL, KEEP RUN is displayed:

- If the button is released while LOCAL CONTROL is displayed, the panel frequency reference is set to the current external reference and the drive is stopped.
- When LOCAL, KEEP RUN is displayed, the current run/stop status and the frequency reference are copied from the user I/O.

Start and stop the drive by pressing the START/STOP button.

Change the shaft direction by pressing the REVERSE button (parameter 1003 must be set to REQUEST).

Switch back to remote control (**REM**) by pressing and holding the LOC/REM button until REMOTE CONTROL is displayed.

Run Indication and Shaft Direction

RUN > < RUN	Drive is running and at setpoint Shaft direction is forward (>) or reverse (<)
RUN > (or < RUN) Arrow head blinking rapidly	Drive is running but not at setpoint.
> (or <) Arrow head blinking slowly	Drive is stopped.

Output Display

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

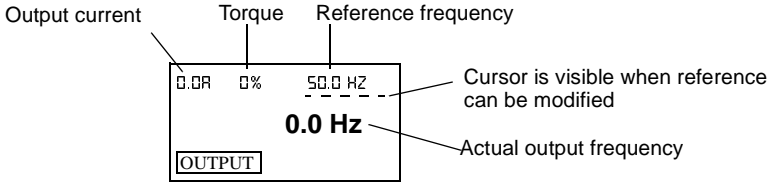


Figure 22 Output display variables.

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

The reference can be modified in local control mode, but also in remote control mode if the ACS 400 is programmed for that type of operation.

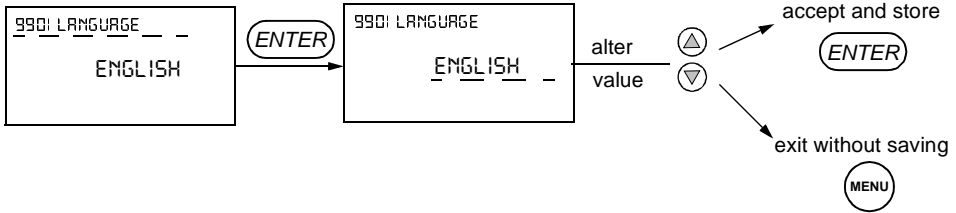
Menu Structure

ACS 400 has a large number of parameters. Of these, only the so-called **basic parameters** are initially visible. See "Selecting Full Parameter Set" on page 28 for details on specifying the full parameter set.

The menu consists of parameter groups and menu functions.

Setting Parameter Value

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



Note! In parameter set mode the cursor blinks when the parameter value is altered.

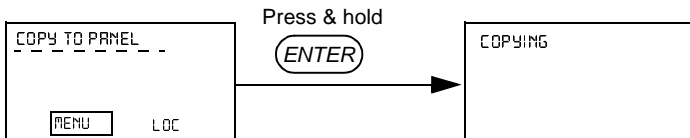
Note! To view the parameter default value in the parameter set mode, press the UP/DOWN buttons simultaneously.

Menu Functions

Scroll the Menu for desired menu function, then press and hold ENTER down until the display blinks to start the operation.

Note! Parameter copying does not affect all parameters. The excluded parameters are: 9901, 9905-9910, 1605, 1607, 5002, 5201 and all Group 51 parameters. See "ACS 400 Complete Parameter List" on page 65 for a description of these parameters.

Copy Parameters from Drive to Panel (upload)



Note! The drive must be stopped and in local control. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).

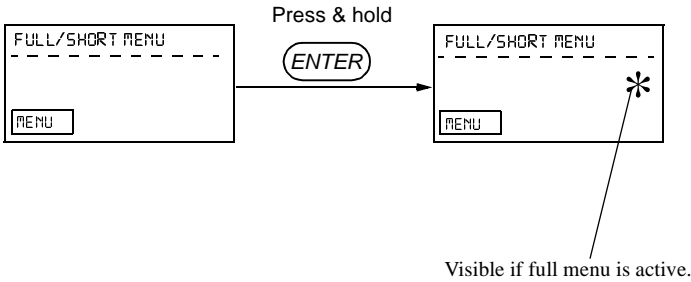
Copy Parameters from Panel to Drive (download)



Note! The drive must be stopped and in local control. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).

Selecting Full Parameter Set

Initially only the basic parameters are visible. When full Menu is active, an asterisk appears on the second row of the panel display in Menu. Activate this function again to resume the short Menu.



LED Indicators

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

Diagnostic displays

When the red LED of the ACS-PAN-A is on or blinking, a fault is active. The relevant fault message flashes in the panel display.

When the green LED of the ACS-PAN-A is blinking, an alarm is active. The relevant alarm message is shown in the panel display. Alarms 1-7 arise from button operation and the green LED does not blink for them.

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

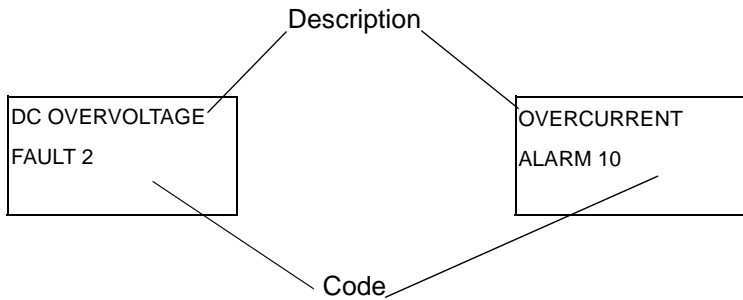


Figure 23 Fault and alarm messages

Refer to the "Programming" on page 25 section for a complete list of alarms and faults.

Resetting the Drive from the Control Panel

To reset a fault when the red LED is on, press the RESET button.

Caution! Resetting the fault may start the drive when in remote control.

To reset a fault when the red LED is blinking, turn the power off.

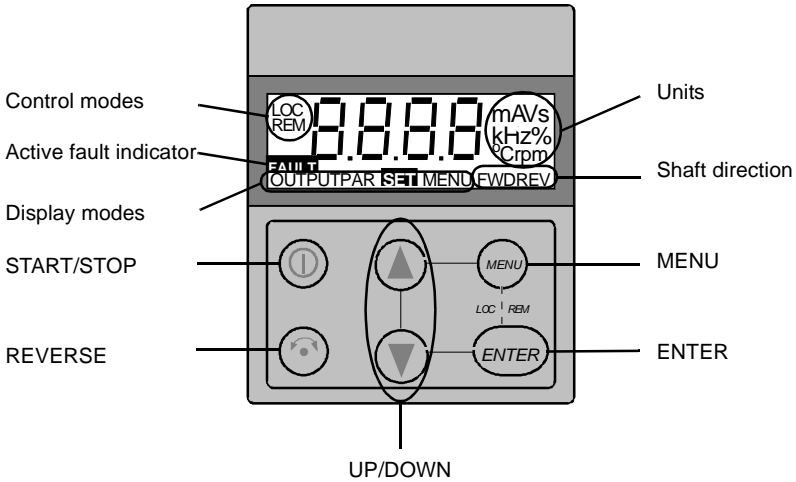
Caution! Turning the power on again may start the drive immediately.

Contrast Setting

Display contrast can be adjusted any time. Increase contrast by pressing and holding the ENTER and UP buttons. Decrease contrast by pressing and holding the ENTER and DOWN buttons. The buttons must be pressed simultaneously.

ACS100-PAN Control Panel

The control panel can be connected to and detached from the converter at any time.



Control Modes

The very first time the drive is powered up, it is controlled from the Control Terminals (remote control, **REM**). The ACS 400 is controlled from the control panel when the drive is in local control (**LOC**).

Switch to local control (**LOC**) by pressing and holding the MENU and ENTER buttons down simultaneously until first **Loc** or later **LCr** is displayed:

- If the buttons are released while **Loc** is displayed, the panel frequency reference is set to the current external reference and the drive is stopped.
- When **LCr** is displayed, the current run/stop status and the frequency reference are copied from the user I/O.

Start and stop the drive by pressing the START/STOP button.

Change the shaft direction by pressing the REVERSE button (parameter 1003 must be set to REQUEST).

Switch back to remote control (**REM**) by pressing and holding the MENU and ENTER buttons down simultaneously until **rE** is displayed.

Shaft Direction

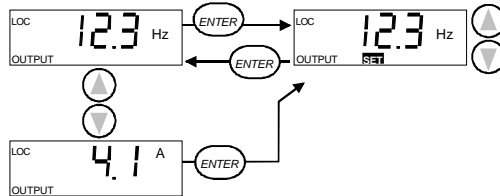
FWD / REV Visible	Shaft direction is forward / reverse Drive is running and at set point
FWD / REV Blinking rapidly	Drive is accelerating / decelerating.
FWD / REV Blinking slowly	Drive is stopped.

Output Display

When the control panel is powered up, the panel displays the actual output frequency. Whenever the MENU button is pressed and held, the control panel resumes this **OUTPUT** display.

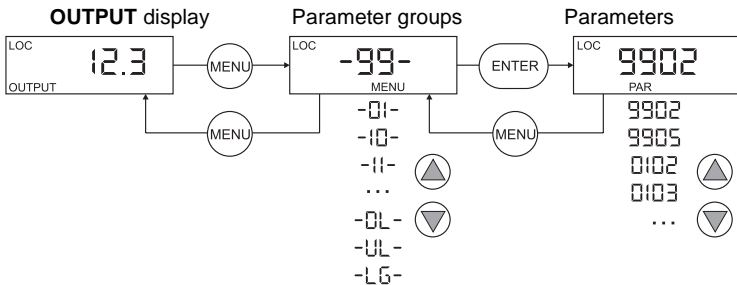
To toggle between output frequency and output current, press the UP or DOWN button.

To set the output frequency, press ENTER. Pressing the UP/DOWN buttons changes the reference immediately. Press ENTER again to return to **OUTPUT** display.



Menu Structure

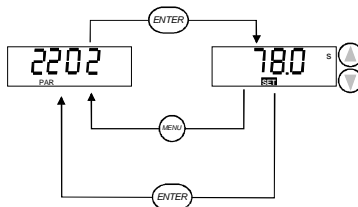
ACS 400 has a large number of parameters. Of these, only the so-called **basic parameters** are initially visible. The menu function -LG- is used to make the full parameter set visible.



Setting Parameter Value

Press ENTER to view the parameter value.

To set a new value, press and hold ENTER until **SET** is displayed.



Note! SET blinks if the parameter value is altered. SET is not displayed if the value cannot be altered.

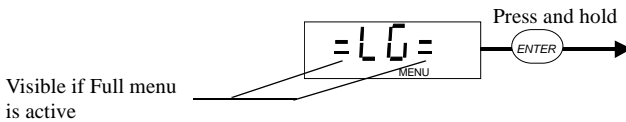
Note! To view the parameter default value, press the UP/DOWN buttons simultaneously.

Menu Functions

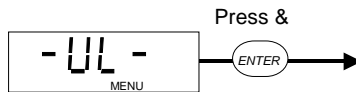
Scroll the Parameter groups for the desired menu function. Press and hold ENTER until the display blinks to start the function.

Note! Parameter copying does not affect all parameters. The excluded parameters are: 9901, 9905-9910, 1605, 1607, 5002, 5201 and all Group 51 parameters. See "ACS 400 Complete Parameter List" on page 65 for a description of these parameters.

Select between basic and full menu

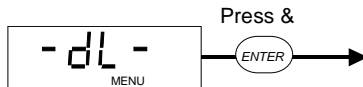


Copy parameters from panel to drive (upload)



Note! Drive must be stopped and in local control. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).

Copy parameters from drive to panel (download)



Note! Drive must be stopped and in local control. Parameter 1602 PARAMETER LOCK must be set to 1 (OPEN).

Diagnostic Displays

When the red LED of the ACS 400 is on or blinking, a fault is active. The relevant fault message flashes in the panel display.

When the green LED of the ACS 400 is blinking, an alarm is active. The relevant alarm message is shown in the panel display. Alarms 1-7 arise from button operation and green LED does not blink for them.

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

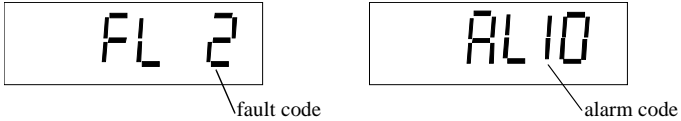


Figure 24 Fault and alarm messages.

Refer to the “Diagnostics” on page 35 section for a complete list of alarms and faults.

Resetting the Drive from the Control Panel

To reset a fault when the red LED is on, press the START/STOP button.

Caution! Resetting the fault 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.

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 the particular display. If the fault cannot be resolved using the given instructions, please 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 guarantee, endanger correct operation, and increase downtime and expense.

Alarm and Fault displays

The seven-segment display unit of ACS100-PAN indicates alarms and faults using codes "ALxx" or "FLxx", where xx is the corresponding alarm or fault code. The alphanumeric display of ACS-PAN control panel shows the alarm and fault codes together with a short message.

Alarms 1-7 arise from button operation. Green LED blinks for codes greater than or equal to 10. The faults are indicated by a red LED.

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

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

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

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

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

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. 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: <ul style="list-style-type: none"> 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 shaft direction is fixed by parameter 1003 DIRECTION. The drive is in remote control mode and START/STOP and REVERSE buttons are not followed.
6 *	PARAM/LOCAL LOCK	Control panel function is not allowed: <ul style="list-style-type: none"> 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 Standard Modbus Channel is lost. <ul style="list-style-type: none"> Check connections between the external control system and the ACS 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 ACS 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 <ul style="list-style-type: none"> - Drive is in local control mode (LOC is shown in the control panel display), or - Drive is in remote control mode (REM) and is parameterised 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 **	ACS400 OVERTEMP	ACS 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 ACS 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 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. <ul style="list-style-type: none"> • Check the status of the fieldbus adapter. Refer to the appropriate fieldbus adapter manual. • Check the DDCS option module and optical fibers. • Check 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 ACS 400 output current exceeds the ratings given in "Specifications" on page 21 of this manual.
27 *	AUTOMATIC RESET	ACS 400 is about to perform 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	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 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 ACS 400 cannot start any motor (when Autochange is used), or the ACS 400 cannot start the speed regulated motor (when Autochange is not used).

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

Note! Alarms (**) will be shown only if parameter 1608 DISPLAY ALARMS is set to 1 (YES)

Table 6 Faults.

Fault Code	Display	Description
1	OVERCURRENT	Output current is excessive. <ul style="list-style-type: none"> • 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 wrong.
2	DC OVERVOLTAGE	Intermediate circuit DC voltage is excessive. <ul style="list-style-type: none"> • Check the input power supply 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 underdimensioned
3	ACS400 OVERTEMP	ACS 400 heat sink temperature is excessive. Temperature trip limit is 95 °C. <ul style="list-style-type: none"> • Check air flow and fan operation. • Check motor power against unit power.
4 **	SHORT CIRCUIT	Fault current. Possible reasons for this fault are: <ul style="list-style-type: none"> • There is a short-circuit in the motor cable(s) or motor • Supply disturbances
5	OUTPUT OVERLOAD	Inverter overload condition. The ACS 400 output current exceeds the ratings given in "Specifications" on page 21 of this manual.
6	DC UNDERVOLTAGE	Intermediate circuit DC voltage is not sufficient. <ul style="list-style-type: none"> • Input power supply phase may be missing • Fuse may be blown
7	ANALOGUE INPUT 1	Analog input 1 loss. Analog input value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
8	ANALOGUE 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 ACS 400. Refer to parameters 3004 – 3008.
10	PANEL LOSS	Panel communication loss. Control panel is disconnected when the drive is receiving start, stop and direction commands from the panel. <ul style="list-style-type: none"> - 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 programmed 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: <ul style="list-style-type: none"> • MINIMUM AI1 > MAXIMUM AI1 (parameters 1301, 1302) • MINIMUM AI2 > MAXIMUM AI2 (parameters 1304, 1305) • MINIMUM FREQ > MAXIMUM FREQ (parameters 2007, 2008) • PFC block tries to use the I/O extension module (NDIO) but the DDCS link is not programmed properly
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 Standard Modbus Channel is lost. <ul style="list-style-type: none"> • Check connections between external control system and the ACS 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 EARTH FAULT	Ground fault. The load on the input power system is out of balance. <ul style="list-style-type: none"> • There may be a fault in the motor or motor cable. • Motor cable may be too long.

16 **	DC BUS RIPPLE	<ul style="list-style-type: none"> • Ripple voltages on the DC bus are too large. • Input power supply 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	<p>Problem with DDCS link.</p> <ul style="list-style-type: none"> • Check the DDCS option module and the optic fibres. • Check the status of the fieldbus adapter. Refer to appropriate fieldbus adapter manual. • Check connections between external control system and fieldbus adapter. • Alternatively, check the status of the IO extension modules (NDIO), required by PFC block. <p>Refer also to "DDCS Option Module Manual" and parameters 5004 – 5007.</p>
20 *	AI OUT OF RANGE	Analog input out of range. Check AI level.
21 - 26 **	HARDWARE ERROR	Hardware error. Contact factory.
Full display blinking (ACS100-PAN) "COMM LOSS" (ACS-PAN)		Serial link failure. Bad connection between the control panel and the ACS 400.

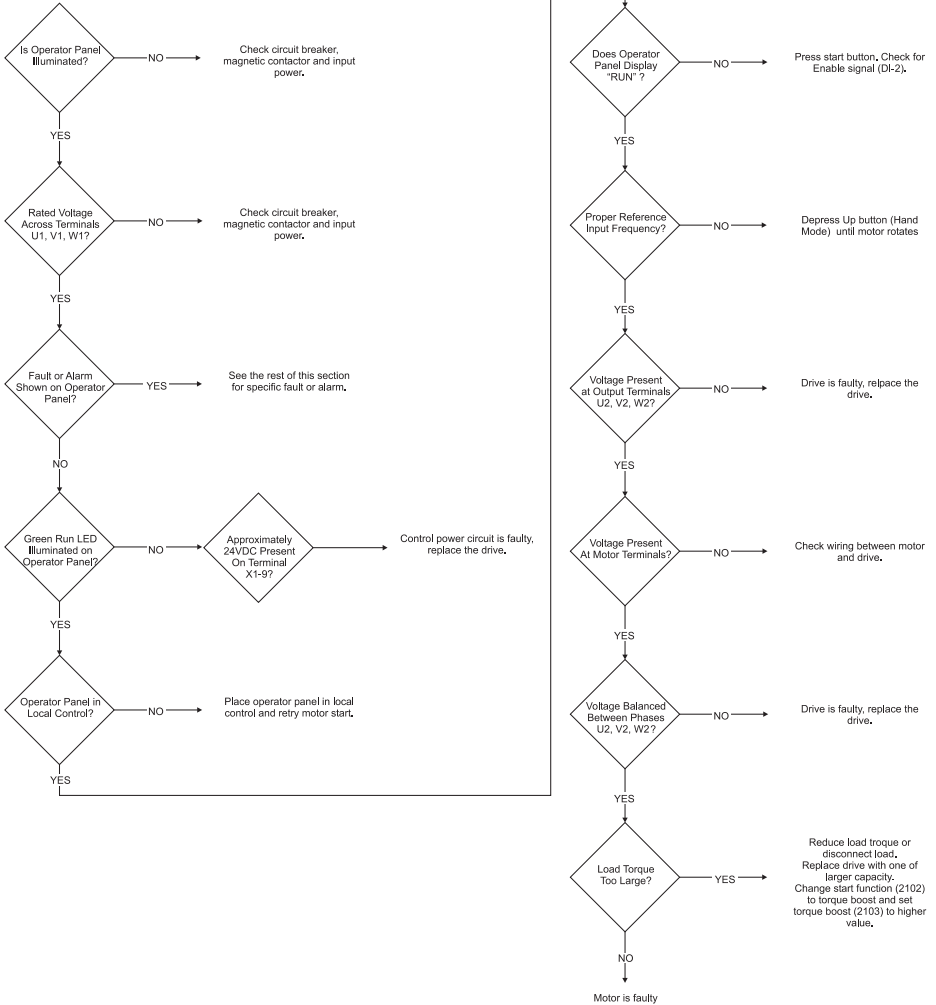
Note! These faults (**) are indicated by a red blinking LED and are reset by turning the power off for a while.

Troubleshooting Guide

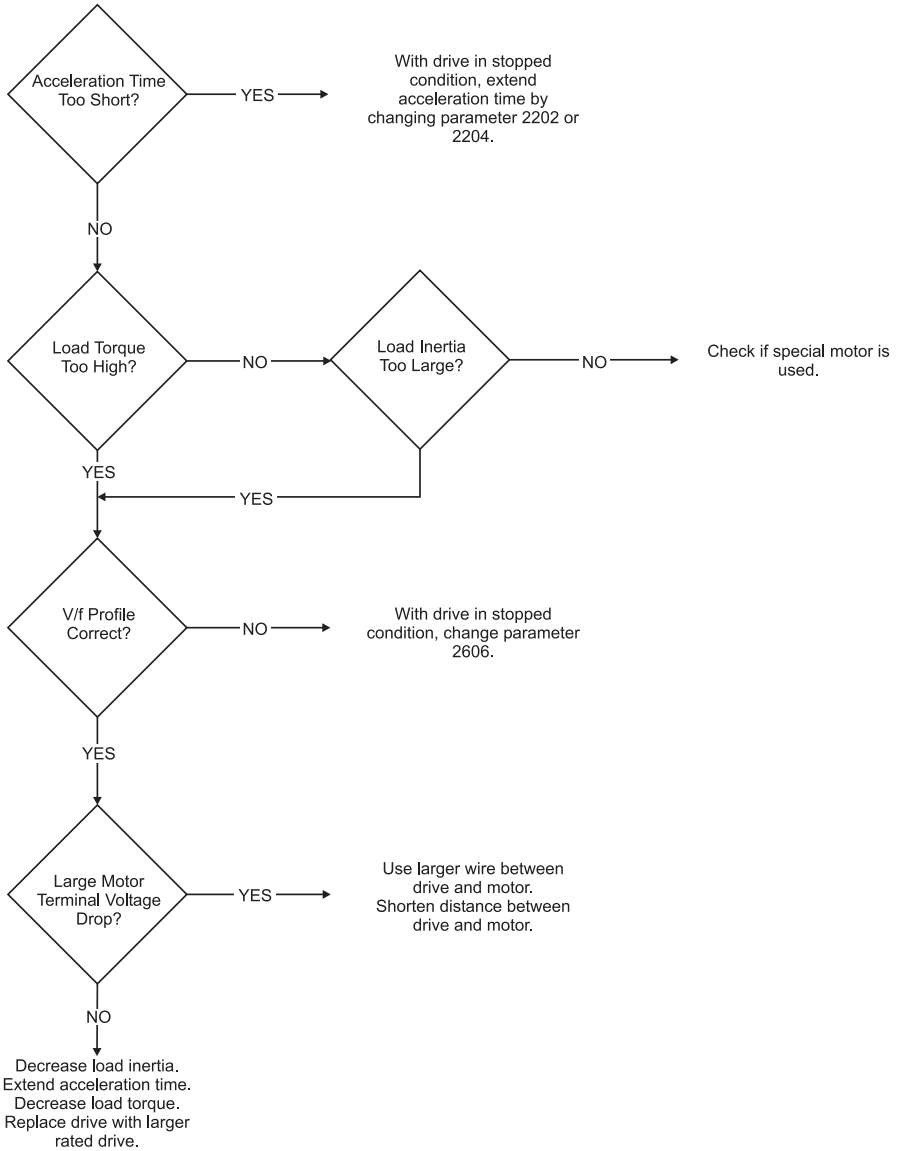
This section consists of a series of flowcharts to help determine the necessary corrective action for eight common problems that may occur during start-up of your ACS 400 drive.

- motor will not run, see page 41
- motor stalls during acceleration, see page 42
- overvoltage fault indication, see page 43
- overcurrent fault indication, see page 44
- overload fault indication, see page 45
- undervoltage fault indication, see page 46
- external fault indication, see page 47
- no operator panel display, see page 48

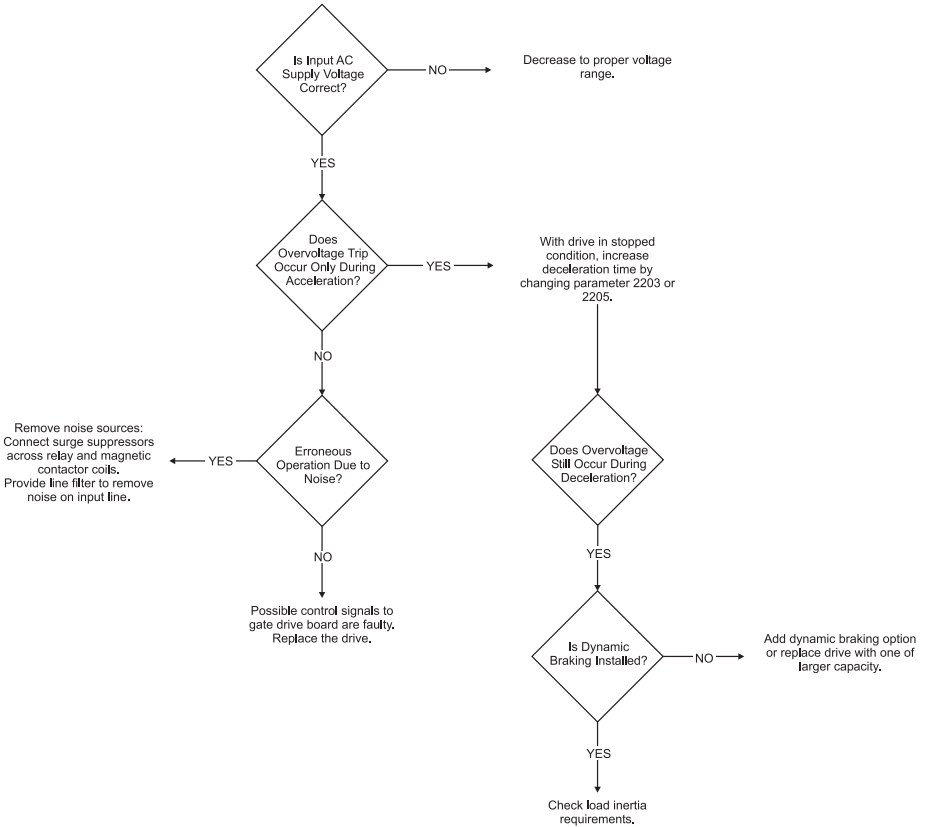
Motor Will Not Run



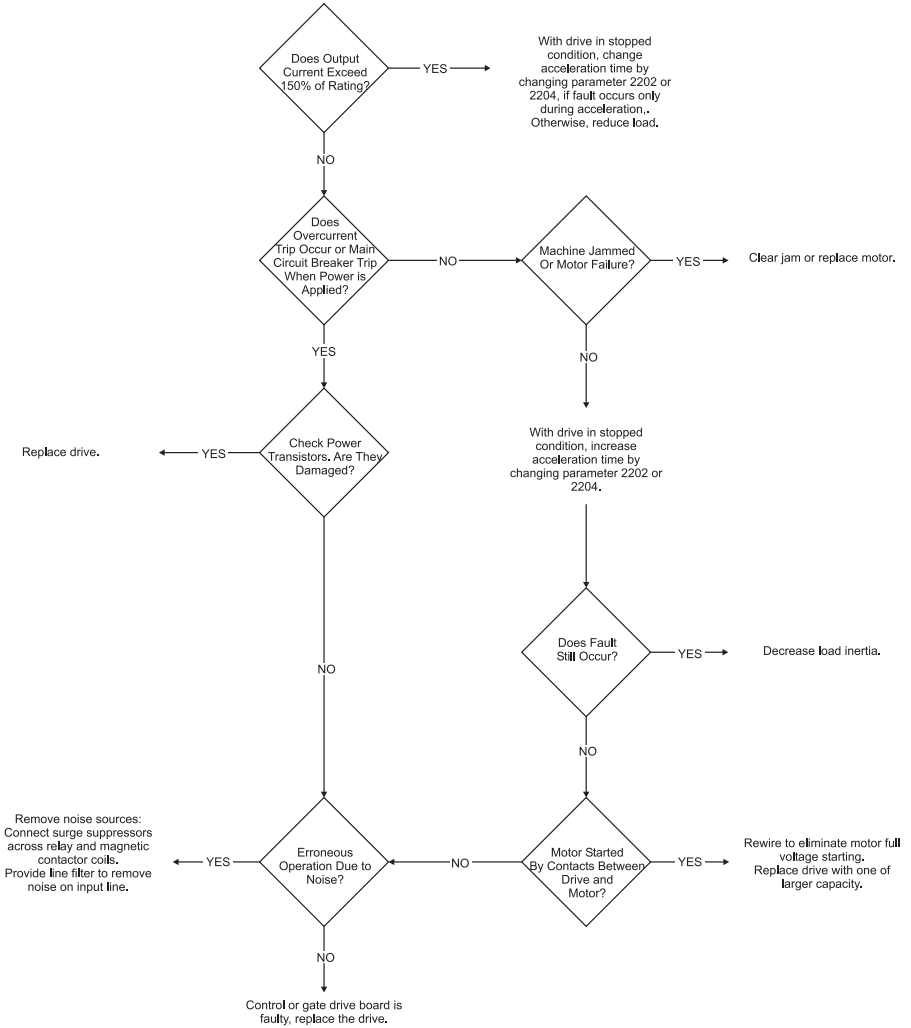
Motor Stalls during Acceleration



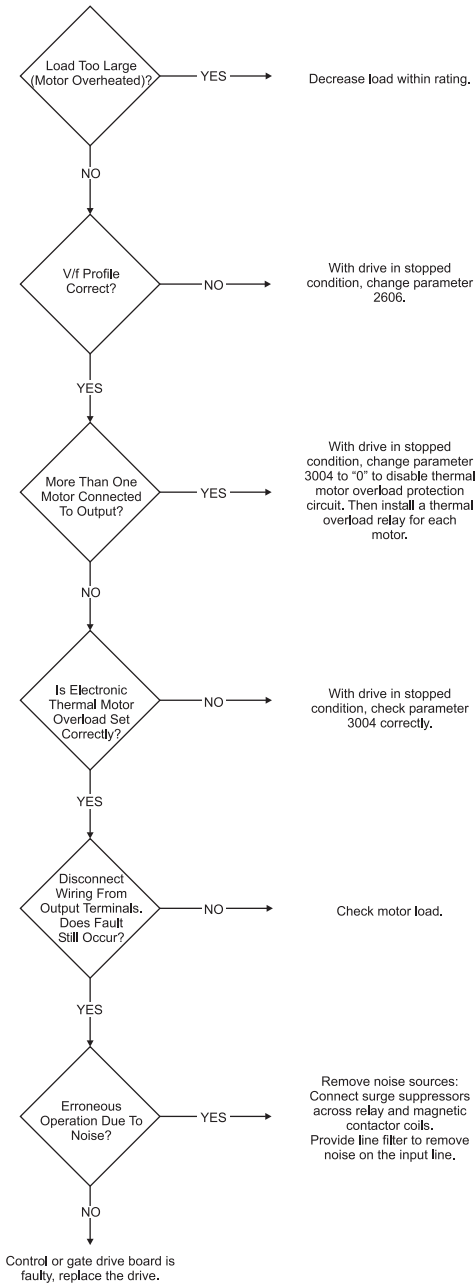
Overvoltage Fault Indication



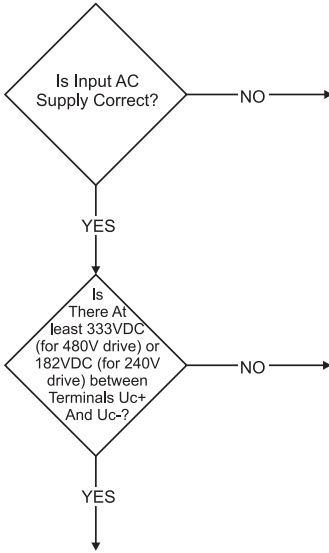
Overcurrent Fault Indication



Overload Fault Indication



Undervoltage Fault Indication

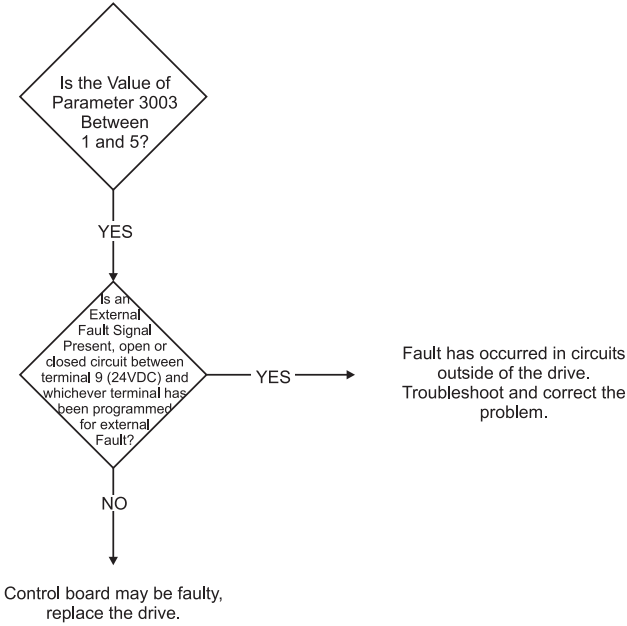


Increase voltage to within proper specifications. Check wiring between main switch and the drive. If fuse is blown, check all three phases.

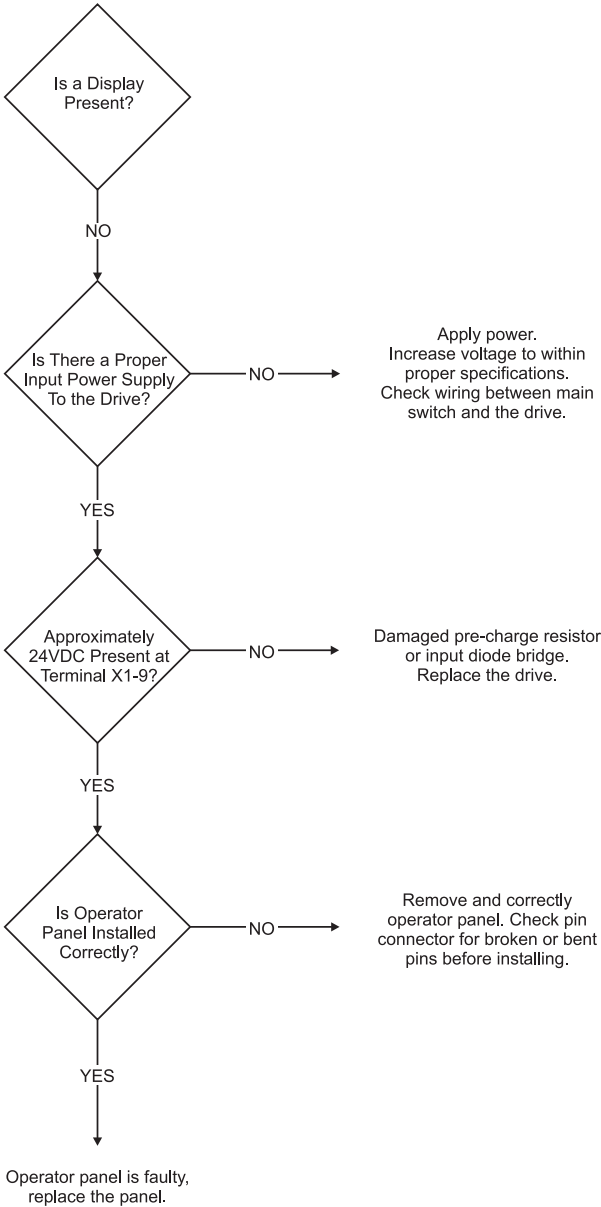
Damaged pre-charge resistor, input bridge or DC bus capacitor. Replace the drive.

Change:
Auto-reset time delay to 3 seconds.
Auto-reset attempts to 5.

External Fault Indication



No Operator Display



ACS 400 Basic Parameters

The ACS 400 has a large number of parameters. Of these, only the so-called basic parameters are initially visible.

Setting up only a few basic parameters is sufficient in applications where the preprogrammed application macros of the ACS 400 can provide all desired functionality. For a full description of the programmable features provided by the ACS 400, see "ACS 400 Complete Parameter List" on page 65.

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	<p>LANGUAGE Language selection.</p> <p>0 = ENGLISH 4 = SPANISH 8 = DANISH 12 = (reserved) 1 = ENGLISH (AM) 5 = PORTUGUESE 9 = FINNISH 2 = GERMAN 6 = DUTCH 10 = SWEDISH 3 = ITALIAN 7 = FRENCH 11 = RUSSIAN</p>		
9902	<p>APPLIC MACRO Selects application macro. Sets parameter values to their default values. Refer to CROSSREF for a detailed description of each macro.</p> <p>0 = FACTORY 1 = ABB STANDARD 2 = 3-WIRE 3 = ALTERNATE 4 = MOTOR POT 5 = HAND/AUTO 6 = PID CONTROL 7 = PREMAGN 8 = PFC CONTROL</p> <p>Default value: 0 (FACTORY MACRO)</p>		✓
9905	<p>MOTOR NOM VOLT Nominal motor voltage from motor name plate. Range of this parameter depends on the type of the ACS 400.</p> <p>Default value: 400 V unit: 460 V 200 V unit: 230 V</p>		✓
9906	<p>MOTOR NOM CURR Nominal motor current from motor name plate. Values for this parameter range from $0.5 \cdot I_N$ - $1.5 \cdot I_N$, where I_N is nominal current of the ACS 400.</p> <p>Default value: I_N</p>		✓
9907	<p>MOTOR NOM FREQ Nominal motor frequency from motor name plate.</p> <p>Range: 0 - 250 Hz Default value: 60 Hz</p>		✓

Code	Name	User	S
9908	MOTOR NOM SPEED Nominal motor speed from motor name plate. Range 0 - 3600 rpm Default: 1750 rpm		✓
9909	MOTOR NOM POWER Nominal motor power from name plate. Range: 0.1 - 134.1 HP Default: 3.0 - 50.0 HP depending on the type of the frequency converter		✓
9910	MOTOR COS PHI (POWER FACTOR) Nominal motor cos phi from name plate. Range: 0.50 - 0.99 Default: 0.83		✓
Group 01 OPERATING DATA			
0128	LAST FAULT Last recorded fault (0 = no fault). See "Diagnostics" on page 35. Can be cleared with the control panel by pressing the UP and DOWN buttons simultaneously while 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 per cent. Defines relative analog input value where 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 Hz or 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. Description of all parameters is given in "ACS 400 Complete Parameter List" on page 65.		
Group 20			
LIMITS			
2003	MAX CURRENT Maximum output current. Range: $0.5 \cdot I_N - 1.5 \dots 1.7 \cdot I_N$ **, where I_N is nominal current of the ACS 400. Default value: $1.5 \cdot I_N$		
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.

The table continues on the next page.

Code	Name	User	S
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			
ACCELER/DECELER			
2202	ACCELER TIME 1 Ramp 1: time from zero to maximum frequency (0 - MAXIMUM FREQ). Range for all ramp time parameters is 0.1 - 1800 s. Default value: 5.0 s		
2203	DECELER TIME 1 Ramp 1: time from maximum to zero frequency (MAXIMUM FREQ - 0). Default value: 5.0 s		
2204	ACCELER TIME 2 Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ). Default value: 60.0 s		
2205	DECELER TIME 2 Ramp 2: time from maximum to zero frequency (MAXIMUM FREQ - 0). Default value: 60.0 s		
Group 26			
MOTOR CONTROL			
2606	U/f RATIO U/f below field weakening point. 1 = LINEAR 2 = SQUARE 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: 1 (LINEAR)		✓
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. The Factory Macro is the factory-set default macro.

Note! The Factory Macro is intended for applications where there is NO control panel available. **If using the Factory Macro with control panel, note that the parameters whose value depend on digital input DI4 cannot be modified from the panel.**

Parameter Values

Selecting an application macro with parameter 9902 APPLIC MACRO will set all other parameters (except the group 99 Start-up Data parameters, the parameter lock 1602, the parameter save 1607 and groups 50 - 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 "ACS 400 Complete Parameter List" on page 65.

Connection Examples

In the following connection examples please note:

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

Application Macro Factory (0)

This macro is intended for applications where there is NO control panel available. It provides a general purpose 2-wire I/O configuration.

The value of parameter 9902 is 0 (FACTORY). DI4 is not connected.

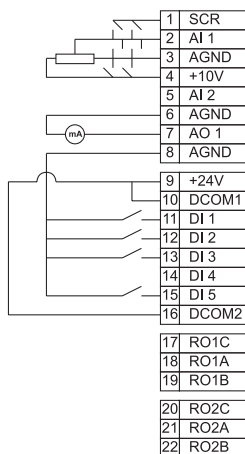
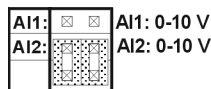
Input signals

- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Constant speed 1 (DI3)
- Ramp pair 1/2 selection (DI5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Start/Stop: Activate to start ACS400

Fwd/Rev: Activate to reverse rotation direction

Constant Speed 1: Default: 5 Hz

Leave unconnected!*

Ramp pair selection. Activate to select ramp pair 2.

Relay output 1, programmable

Default operation: **Fault** =>17 connected to 18

Relay output 2, programmable

Default operation: **Running** =>20 connected to 22

***Note!** DI 4 is used to configure ACS 400. It is read only once when power is connected. All parameters marked with * are determined by the DI4 input.

Factory (0) parameter values:

* 1001 EXT 1 COMMANDS	2 (DI1,2)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	6 (START/STOP)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	5 (DI5)
* 1201 CONST SPEED SEL	3 (DI3)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro Factory (1)

This macro is intended for applications where there is NO control panel available. It provides a general purpose 3-wire I/O configuration.

The value of parameter 9902 is 0 (FACTORY). DI 4 is connected.

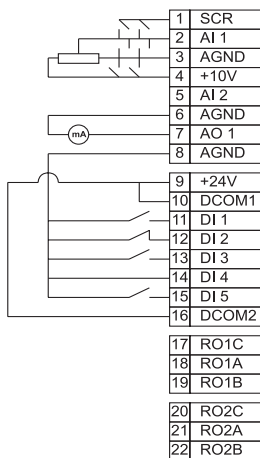
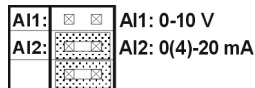
Input signals

- Start, stop and direction (DI1,2,3)
- Analog reference (AI1)
- Ramp pair 1/2 selection (DI5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Momentary activation with DI2 activated: **Start**

Momentary deactivation: **Stop**

Fwd/Rev: activate to reverse rotation direction

Has to be connected!*

Ramp pair selection. Activate to select ramp pair 2.

Relay output 1, programmable

Default operation: **Fault** => 17 connected to 18

Relay output 2, programmable

Default operation: **Running** => 20 connected to 22

***Note!** DI 4 is used to configure ACS 400. It is read only once when power is connected. All parameters marked with * are determined by the DI4 input.

Note! Stop input (DI2) deactivated: panel START/STOP button interlocked (local).

Factory (1) parameter values:

*	1001 EXT 1 COMMANDS	4 (DI1P,2P,P)	1402 RELAY OUTPUT 2	2 (RUN)
	1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
	1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
	1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	6 (START/STOP)
	1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
	1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
	1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	5 (DI5)
*	1201 CONST SPEED SEL	0 (NOT SEL)	4001 PID GAIN	1.0
	1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro ABB Standard

This general purpose macro is typical 2-wire I/O configuration. It gives two more preset speeds compared to Factory Macro (0).

The value of parameter 9902 is 1 (ABB STANDARD).

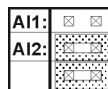
Input signals

- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Preset speed selection (DI3,4)
- Ramp pair 1/2 selection (DI5)

Output signals

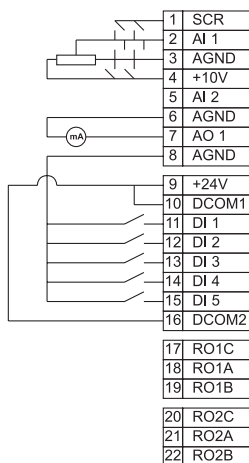
- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



AI1: 0-10 V

AI2: 0(4)-20 mA



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Start/Stop: Activate to start

Fwd/Rev: Activate to reverse rotation direction

Constant speed selection*

Constant speed selection*

Ramp pair selection. Activate to select ramp pair 2.

Relay output 1, programmable

Default operation: **Fault** => 17 connected to 18

Relay output 2, programmable

Default operation: **Running** => 20 connected to 22

*Constant speed selection: 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)

ABB Standard parameter values:

1001 EXT 1 COMMANDS	2 (DI1,2)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	5 (DI5)
1201 CONST SPEED SEL	7 (DI3,4)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro 3-wire

This macro is intended for those applications where the drive is controlled using momentary push-buttons. It gives two more preset speeds compared to Factory Macro (1) by using DI4 and DI5.

The value of parameter 9902 is 2 (3-WIRE).

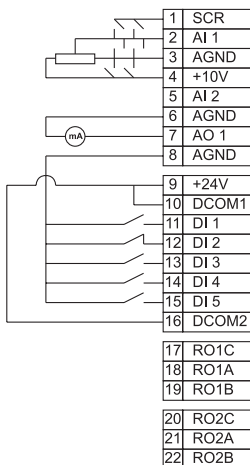
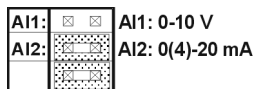
Input signals

- Start, stop and direction (DI1,2,3)
- Analog reference (AI1)
- Preset speed selection (DI4,5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Momentary activation with DI2 activated: **Start**
Momentary deactivation: **Stop**
Activate to reverse rotation: **Fwd/Rev**
Constant speed selection*
Constant speed selection*

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

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

*Constant speed selection: 0 = open, 1 = connected

DI4	DI5	Output
0	0	Reference through AI1
1	0	Constant speed 1 (1202)
0	1	Constant speed 2 (1203)
1	1	Constant speed 3 (1204)

Note! Stop input (DI2) deactivated: panel START/STOP button interlocked (local).

Application Macro 3-wire parameter values:

1001 EXT 1 COMMANDS	4 (DI1P,2P,3)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	8 (DI4,5)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro Alternate

This macro offers an I/O configuration that is adopted to a sequence of DI control signals used when alternating the direction of rotation of the drive.

The value of parameter 9902 is 3 (ALTERNATE).

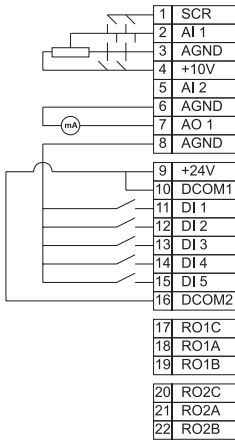
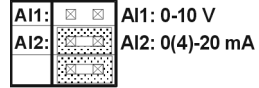
Input signals

- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Preset speed selection (DI3,4)
- Ramp pair 1/2 selection (DI5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V <=> 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA <=> 0...50 Hz

+24 VDC

Start fwd: If DI1 state is the same as DI2, drive stops

Start reverse

Constant Speed selection*

Constant Speed selection*

Ramp pair selection. Activate to select ramp pair 2.

Relay output 1, programmable

Default operation: **Fault** =>17 connected to 18

Relay output 2, programmable

Default operation: **Running** =>20 connected to 22

*Constant speed selection: 0 = open, 1 = connected

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

Application macro Alternate parameter values:

1001 EXT 1 COMMANDS	9 (DI1F,2R)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	5 (DI5)
1201 CONST SPEED SEL	7 (DI3,4)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro Motor Potentiometer

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 4 (MOTOR POT).

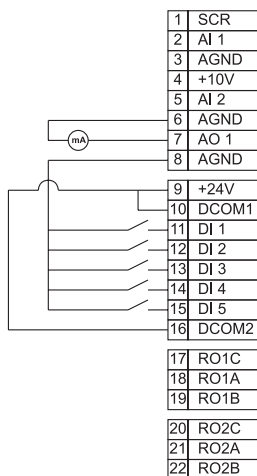
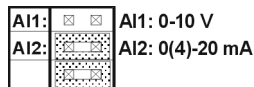
Input signals

- Start, stop and direction (DI1,2)
- Reference up (DI3)
- Reference down (DI4)
- Preset speed selection (DI5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Start/Stop: Activate to start.

Forward/Reverse: Activate to reverse rotation direction

Reference up: Activate to increase reference*

Reference down: Activate to decrease reference*

Constant speed 1

Relay output 1, programmable

Default operation: **Fault** => 17 connected to 18

Relay output 2, programmable

Default operation: **Running** => 20 connected to 22

*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.

Motor potentiometer parameter values:

1001 EXT 1 COMMANDS	2 (DI1,2)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	6 (DI3U,4D)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	5 (DI5)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro Hand - Auto

This macro offers an I/O configuration that is typically used in HVAC applications.

The value of parameter 9902 is 5 (HAND/AUTO).

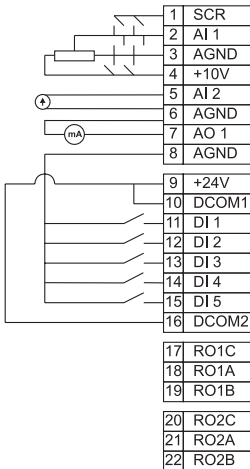
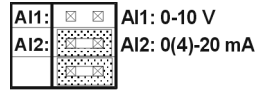
Input signals

- Start/stop (DI1,5) and rev (DI2,4)
- Two an. references (AI1,AI2)
- Control location selection (DI3)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz (**Hand Control**)

Reference voltage 10 VDC

External reference 2: 0...20 mA \Leftrightarrow 0...50 Hz (**Auto Control**)

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Start/Stop: Activate to start ACS 400 (**Hand**).

Forward/Reverse: Activate to reverse rotation direction (**Hand**)

EXT1/EXT2 Selection: Activate to select auto control

Forward/Reverse (Auto)

Start/Stop: Activate to start ACS 400 (**Auto**)

Relay output 1, programmable

Default operation: **Fault** => 17 connected to 18

Relay output 2, programmable

Default operation: **Running** => 20 connected to 22

Note! Parameter 2107 START INHIBIT should be 0 (OFF).

Hand-Auto parameter values:

1001 EXT 1 COMMANDS	2 (DI1,2)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	7 (DI5,4)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	3 (DI3)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	2 (AI2)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	0 (NOT SEL)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-1))	4002 PID INTEG TIME	60 s

Application Macro PID Control

This macro is intended for use with different closed-loop control systems such as pressure control, flow control, etc.

The value of parameter 9902 is 6 (PID CTRL).

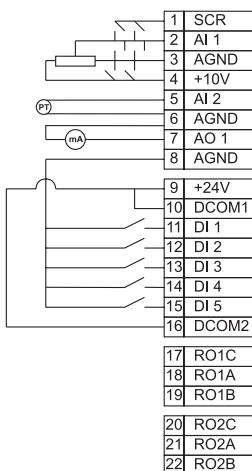
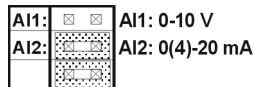
Input signals

- Start/stop (DI1,5)
- Analog reference (AI1)
- Actual value (AI2)
- Control location selection (DI2)
- Constant speed (DI3)
- Run enable (DI4)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



EXT1 (**Manual**) or EXT2 (**PID**) reference: 0...10 V

Reference voltage 10 VDC
Actual signal; 0...20 mA (**PID**)

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

- Start/Stop:** Activate to start ACS 400 (**Manual**).
- EXT1/EXT2 Selection:** Activate to select PID control
- Constant speed 1:** not used if PID control*
- Run enable:** deactivation always stops ACS 400
- Start/Stop:** Activate to start ACS 400 (**PID**)

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

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

Note!

* Constant speed is not considered while in PID control (PID).

Note! Parameter 2107 START INHIBIT should be 0 (OFF).

PID control parameters (group 40) do not belong to the Basic parameter set.

PID Control parameter values:

1001 EXT 1 COMMANDS	1 (DI1)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	6 (DI5)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	1 (FORWARD)	1601 RUN ENABLE	4 (DI4)
1102 EXT1/EXT2 SEL	2 (DI2)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	3 (DI3)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT(-1))	4002 PID INTEG TIME	60 s

Application Macro Premagnetize

This macro is intended for those applications where the drive must start very quickly. Building up the flux in the motor always takes time. With the Premagnetize Macro, this delay can be eliminated.

The value of parameter 9902 is 7 (PREMAGN).

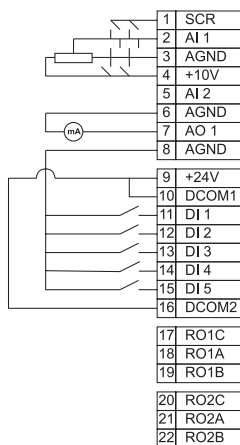
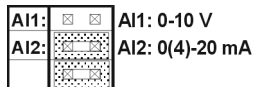
Input signals

- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Preset speed selection (DI3,4)
- Premagnetize (DI5)

Output signals

- An. output AO: Frequency
- Relay output 1: Fault
- Relay output 2: Running

Jumper Setting



External Reference 1: 0...10 V \Leftrightarrow 0...50 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA \Leftrightarrow 0...50 Hz

+24 VDC

Start/Stop: Active to start ACS 400
Fwd/Rev: Activate to reverse rotation
 Constant Speed selection*
 Constant Speed selection*
 Premagnetise: Activate to start premagnetising

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

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

*Constant speed selection: 0 = open, 1 = connected

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

Premagnetise parameter values:

1001 EXT 1 COMMANDS	2 (DI1,2)	1402 RELAY OUTPUT 2	2 (RUN)
1002 EXT 2 COMMANDS	0 (NOT SEL)	1503 AO CONTENT MAX	60 Hz
1003 DIRECTION	3 (REQUEST)	1601 RUN ENABLE	0 (NOT SEL)
1102 EXT1/EXT2 SEL	6 (EXT1)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	60 Hz
1105 EXT REF1 MAX	60 Hz	2105 PREMAGN SEL	5 (DI5)
1106 EXT REF2 SELECT	0 (KEYPAD)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	7 (DI3,4)	4001 PID GAIN	1.0
1401 RELAY OUTPUT 1	3 (FAULT (-))	4002 PID INTEG TIME	60 s

Application Macro PFC Control

This macro is intended for pump and fan control applications. For more information see "Appendix B" on page 157.

The value of parameter 9902 is 8 (PFC CONTROL).

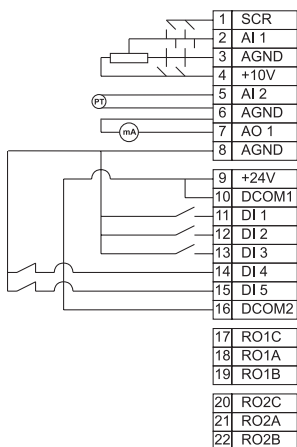
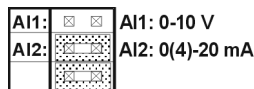
Input signals

- Start and stop (DI1)
- Analog reference (AI1)
- Actual value (AI2)
- Control location selection (DI3)
- Run enable (DI2)

Output signals

- An. output AO: Frequency
- Relay output 1: Speed regulated motor
- Relay output 2: Auxiliary motor

Jumper Setting



EXT1 (**Manual**) or EXT2 (**PID/PFC**) reference: 0...10 V

Reference voltage 10 VDC
Actual signal; 0...20 mA (**PID**)

Output frequency 0...20 mA \Leftrightarrow 0...52 Hz

+24 VDC

Start/Stop: Activate to start ACS 400.

Run enable: Deactivation always stops ACS 400

EXT1/EXT2 Selection: Activate to select PFC control

Interlock: Deactivation stops ACS 400

Interlock: Deactivation stops constant speed motor

Relay output 1, programmable

Default operation: **Speed regulated motor switched on**
=> 17 connected to 19

Relay output 2, programmable

Default operation: **Auxiliary motor switched on**
=> 20 connected to 22

Note! Parameter 2107 START INHIBIT should be 0 (OFF).

PFC parameter values:

1001 EXT 1 COMMANDS	1 (DI1)	1402 RELAY OUTPUT 2	29 (PFC)
1002 EXT 2 COMMANDS	1 (DI1)	1503 AO CONTENT MAX	62 Hz
1003 DIRECTION	1 (FORWARD)	1601 RUN ENABLE	2 (DI2)
1102 EXT1/EXT2 SEL	3 (DI3)	1604 FAULT RESET SEL	0 (KEYPAD)
1103 EXT REF1 SELECT	1 (AI1)	2008 MAXIMUM FREQ	62 Hz
1105 EXT REF1 MAX	62 Hz	2105 PREMAGN SEL	0 (NOT SEL)
1106 EXT REF2 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)
1201 CONST SPEED SEL	0 (NOT SEL)	4001 PID GAIN	2,5
1401 RELAY OUTPUT 1	29 (PFC)	4002 PID INTEG TIME	3 s

ACS 400 Complete Parameter List

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

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

M = Default value depends on the selected macro (*).

Table 7 Full parameter set.

Code	Name	Range	Resolution	Default	User	S	M
Group 99							
START-UP DATA							
9901	LANGUAGE	0 - 11	1	0 (ENGLISH)			
9902	APPLIC MACRO	0 - 13	1	0 (FACTORY)		✓	
9905	MOTOR NOM VOLT	200, 208, 220, 230, 240, 380, 400, 415, 440, 460, 480 V	-	230 V 460 V		✓	
9906	MOTOR NOM CURR	$0.5 \cdot I_N - 1.5 \cdot I_N$	0.1 A	$1.0 \cdot I_N$		✓	
9907	MOTOR NOM FREQ	0 - 250 Hz	1 Hz	60 Hz		✓	
9908	MOTOR NOM SPEED	0 - 3600 rpm	1 rpm	1750 rpm		✓	
9909	MOTOR NOM POWER	0.1 - 134 HP	0.1 HP	3 - 50 HP Size Dependent		✓	
9910	MOTOR COS PHI (MOTOR POWER FACTOR)	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	-100...100 %	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	ACS400 TEMP	0 - 300 °F	0.1 °F	-			
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 %	-			

Code	Name	Range	Resolution	Default	User	S	M
0125	ACTUAL VALUE 2	0 - 100 %	0.1 %	-			
0126	CONTROL DEV	-100 - 100 %	0.1 %	-			
0127	PID ACT VALUE	-100 - 100 %	0.1 %	-			
0128	LAST FAULT	0 - 26	1	-			
0129	PREVIOUS FAULT	0 - 26	1	-			
0130	OLDEST FAULT	0 - 26	1	-			
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	-	-	-			
0135	PROCESS VAR 2	-	-	-			
0136	RUN TIME	0.00 - 99.99 kh	0.01 kh	-			
0137	MWh COUNTER	0 - 9999 MWh	1 MWh	-			
Group 10							
COMMAND INPUTS							
1001	EXT1 COMMANDS	0 - 10	1	*		✓	✓
1002	EXT2 COMMANDS	0 - 10	1	*		✓	✓
1003	DIRECTION	1 - 3	1	*		✓	✓
Group 11							
REFERENCE SELECT							
1101	KEYPAD REF SEL	1 - 2	1	1 (REF1 (Hz))			
1102	EXT1/EXT2 SEL	1 - 8	1	*		✓	✓
1103	EXT REF1 SELECT	0 - 10	1	*		✓	✓
1104	EXT REF1 MIN	0 - 250 Hz	1 Hz	0 Hz			
1105	EXT REF1 MAX	0 - 250 Hz	1 Hz	*			✓
1106	EXT REF2 SELECT	0 - 10	1	*		✓	✓
1107	EXT REF2 MIN	0 - 100 %	1 %	0 %			
1108	EXT REF2 MAX	0 - 500 %	1 %	100 %			
Group 12							
CONSTANT SPEEDS							
1201	CONST SPEED SEL	0 - 10	1	*		✓	✓
1202	CONST SPEED 1	0 - 250 Hz	0.1 Hz	5 Hz			
1203	CONST SPEED 2	0 - 250 Hz	0.1 Hz	10 Hz			
1204	CONST SPEED 3	0 - 250 Hz	0.1 Hz	15 Hz			
1205	CONST SPEED 4	0 - 250 Hz	0.1 Hz	20 Hz			
1206	CONST SPEED 5	0 - 250 Hz	0.1 Hz	25 Hz			
1207	CONST SPEED 6	0 - 250 Hz	0.1 Hz	40 Hz			
1208	CONST SPEED 7	0 - 250 Hz	0.1 Hz	50 Hz			
Group 13							
ANALOG INPUTS							
1301	MINIMUM AI1	0 - 100 %	1 %	0 %			
1302	MAXIMUM AI1	0 - 100 %	1 %	100 %			
1303	FILTER AI1	0 - 10 s	0.1 s	0.1 s			
1304	MINIMUM AI2	0 - 100 %	1 %	0 %			

Code	Name	Range	Resolution	Default	User	S	M
1305	MAXIMUM AI2	0 - 100 %	1 %	100 %			
1306	FILTER AI2	0 - 10 s	0.1 s	0.1 s			
Group 14							
RELAY OUTPUTS							
1401	RELAY OUTPUT 1	0 - 31	1	*		✓	✓
1402	RELAY OUTPUT 2	0 - 31	1	*		✓	✓
1403	RELAY 1 ON DELAY	0 - 3600 s	0.1 s; 1 s	0 s			
1404	RELAY 1 OFF DELAY	0 - 3600 s	0.1 s; 1 s	0 s			
1405	RELAY 2 ON DELAY	0 - 3600 s	0.1 s; 1 s	0 s			
1406	RELAY 2 OFF DELAY	0 - 3600 s	0.1 s; 1 s	0 s			
Group 15							
ANALOG OUTPUT							
1501	AO CONTENT	102 - 137	1	103			
1502	AO CONTENT MIN	-	*	0.0 Hz			
1503	AO CONTENT MAX	-	*	*			✓
1504	MINIMUM AO	0.0 - 20.0 mA	0.1 mA	0 mA			
1505	MAXIMUM AO	0.0 - 20.0 mA	0.1 mA	20.0 mA			
1506	FILTER AO	0 - 10 s	0.1 s	0.1 s			
Group 16							
SYSTEM CONTROLS							
1601	RUN ENABLE	0 - 6	1	*		✓	✓
1602	PARAMETER LOCK	0 - 2	1	1 (OPEN)			
1604	FAULT RESET SEL	0 - 7	1	*		✓	✓
1605	LOCAL LOCK	0 - 1	1	0 (OPEN)			
1607	PARAM. SAVE	0 - 1	1	0 (DONE)			
1608	DISPLAY ALARMS	0-1	1	0 (NO)			
Group 20							
LIMITS							
2003	MAX CURRENT	$0.5 \cdot I_N - 1.5 \dots 1.7 \cdot I_N^{**}$	0.1 A	$1.5 \cdot I_N^{**}$			
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	$0.5 \cdot I_N - 1.5 \dots 1.7 \cdot I_N^{**}$	0.1 A	$1.2 \cdot I_N^{**}$		✓	
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 - 130.0 s	0.1 s	2.0 s			
2107	START INHIBIT	0 - 1	1	1 (ON)			

Code	Name	Range	Resolution	Default	User	S	M
Group 22							
ACCEL/DECEL							
2201	ACC/DEC 1/2 SEL	0 - 5	1	*		✓	✓
2202	ACCELER TIME 1	0.1 - 1800 s	0.1; 1 s	5 s			
2203	DECELER TIME 1	0.1 - 1800 s	0.1; 1 s	5 s			
2204	ACCELER TIME 2	0.1 - 1800 s	0.1; 1 s	60 s			
2205	DECELER TIME 2	0.1 - 1800 s	0.1; 1 s	60 s			
2206	RAMP SHAPE	0 - 3	1	0 (LINEAR)			
Group 25							
CRITICAL FREQ							
2501	CRIT FREQ SEL	0 - 1	1	0 (OFF)			
2502	CRIT FREQ 1 LO	0 - 250 Hz	1 Hz	0 Hz			
2503	CRIT FREQ 1 HI	0 - 250 Hz	1 Hz	0 Hz			
2504	CRIT FREQ 2 LO	0 - 250 Hz	1 Hz	0 Hz			
2505	CRIT FREQ 2 HI	0 - 250 Hz	1 Hz	0 Hz			
Group 26							
MOTOR CONTROL							
2603	IR COMPENSATION	0 - 60 V 400 V units	1 V	10 V			
2604	IR COMP RANGE	0 - 250 Hz	1 Hz	60 Hz			
2605	LOW NOISE	0 - 1	1	0 (OFF)		✓	
2606	U/f RATIO	1 - 2	1	1 (LINEAR)		✓	
2607	SLIP COMP RATIO	0 - 250 %	1 %	0 %		✓	
Group 30							
FAULT FUNCTIONS							
3001	AI<MIN FUNCTION	0 - 3	1	1 (FAULT)			
3002	PANEL LOSS	1 - 3	1	1 (FAULT)			
3003	EXTERNAL FAULT	0 - 5	1	0 (NOT SEL)			
3004	MOT THERM PROT	0 - 2	1	1 (FAULT)			
3005	MOT THERM TIME	256 - 9999 s	1 s	500 s			
3006	MOT LOAD CURVE	50 - 150 %	1 %	100 %			
3007	ZERO SPEED LOAD	25 - 150 %	1 %	70 %			
3008	BREAK POINT	1 - 250 Hz	1 Hz	35 Hz			
3009	STALL FUNCTION	0 - 2	1	0 (NOT SEL)			
3010	STALL CURRENT	$0.5 \cdot I_N - 1.5 \dots 1.7 \cdot I_N^{**}$	0.1 A	$1.2 \cdot I_N^{**}$			
3011	STALL FREQ HI	0.5 - 50 Hz	0.1 Hz	20 Hz			
3012	STALL TIME	10...400 s	1 s	20 s			
3013	UNDERLOAD FUNC	0 - 2	1	0 (NOT SEL)			
3014	UNDERLOAD TIME	10...400 s	1 s	20 s			
3015	UNDERLOAD CURVE	1 - 5	1	1			
3017	GROUND FAULT	1 - 2	1	1 (FAULT)			
3022	AI1 FLT LIMIT	0 - 100 %	1 %	0 %			
3023	AI2 FLT LIMIT	0 - 100 %	1 %	0 %			

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

Code	Name	Range	Resolution	Default	User	S	M
Group 40							
PID CONTROL							
4001	PID GAIN	0.1 - 100	0.1	*			✓
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	*			
4102	PID INTEG TIME	0.1 - 320 s	0.1 s	*			
4103	PID DERIV TIME	0 - 10 s	0.1s	0 s			
4104	PID DERIV FILTER	0 - 10 s	0.1 s	1 s			
4105	ERROR VALUE INV	0 - 1	1	0 (NO)			
4106	ACTUAL VAL SEL	1 - 9	1	1 (ACT1)		✓	
4107	ACT1 INPUT SEL	1 - 2	1	2 (AI2)		✓	
4108	ACT2 INPUT SEL	1 - 2	1	2 (AI2)		✓	
4109	ACT1 MINIMUM	0 - 1000 %	1 %	0 %			
4110	ACT1 MAXIMUM	0 - 1000 %	1 %	100 %			
4111	ACT2 MINIMUM	0 - 1000 %	1 %	0 %			
4112	ACT2 MAXIMUM	0 - 1000 %	1 %	100 %			
4119	SET POINT SEL	1 - 2	1	2 (EXTERNAL)			
4120	INTERNAL SETPNT	0.0 - 100.0 %	0.1 %	40.0 %			

Code	Name	Range	Resolution	Default	User	S	M
Group 50 COMMUNICATION							
5001	DDCS BIT RATE	1, 2, 4, 8	-	1 (1 Mbits/s)		✓	
5002	DDCS NODE NR	1 - 254	1	1		✓	
5003	COMM FAULT TIME	0.1 - 60 s	0.1 s	1 s			
5004	COMM FAULT FUNC	0 - 3	1	0 (NOT SEL)			
5005	PROTOCOL SEL	0 - 3	1	0 (NOT SEL)		✓	
5006	COMM COMMANDS	0 - 2	1	0 (NOT SEL)		✓	
5007	DDCS BUS MODE	1 - 2	1	1 (FIELD BUS)		✓	
5008	DDCS LINK CTRL	0 - 15	1	8			
5009	DDCS HW CONFIG	0 - 1	1	0 (RING)			
Group 51 EXT COMM MODULE							
5101-5115	FIELD BUS PAR 1 - 15	-	-	-			
Group 52 STANDARD MODBUS							
5201	STATION NUMBER	1 - 247	1	1			
5202	COMM SPEED	3, 6, 12, 24, 48, 96, 192	-	96 (9600 bits/s)			
5203	PARITY	0 - 2	1	0 (NONE)			
5206	BAD MESSAGES	0 - FFFF	1	-			
5207	GOOD MESSAGES	0 - FFFF	1	-			
5208	BUFFER OVERRUNS	0 - FFFF	1	-			
5209	FRAME ERRORS	0 - FFFF	1	-			
5210	PARITY ERRORS	0 - FFFF	1	-			
5211	CRC ERRORS	0 - FFFF	1	-			
5212	BUSY ERRORS	0 - FFFF	1	-			
5213	SER FAULT MEM 1	0 - 255	1	-			
5214	SER FAULT MEM 2	0 - 255	1	-			
5215	SER FAULT MEM 3	0 - 255	1	-			
Group 81 PFC CONTROL							
8103	REFERENCE STEP 1	0.0 - 100 %	0.1 %	0 %			
8104	REFERENCE STEP 2	0.0 - 100 %	0.1 %	0 %			
8105	REFERENCE STEP 3	0.0 - 100 %	0.1 %	0 %			
8109	START FREQ 1	0.0 - 250 Hz	0.1 Hz	60 Hz			
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			

Code	Name	Range	Resolution	Default	User	S	M
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 ACS 400 and for entering motor information.

Code	Description
9901	<p>LANGUAGE Language selection for the ACS-PAN-A control panel.</p> <p>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</p>
9902	<p>APPLIC MACRO Application macro selection. This parameter is used to select the Application Macro which will configure the ACS 400 for a particular application. Refer to "Application Macros" on page 53, for a list and description of available Application Macros.</p> <p>0 = FACTORY 2 = 3-WIRE 4 = MOTOR POT 6 = PID CONTROL 8 = PFC CONTROL 1 = ABB STANDARD 3 = ALTERNATE 5 = HAND/AUTO 7 = PREMAGN</p>
9905	<p>MOTOR NOM VOLT Nominal motor voltage from motor rating plate. This parameter sets the maximum output voltage supplied to the motor by the ACS 400. MOTOR NOM FREQ sets the frequency at which output voltage is equal to the MOTOR NOM VOLT. The ACS 400 cannot supply the motor with a voltage greater than the input supply voltage. See Figure 25.</p>
9906	<p>MOTOR NOM CURR Nominal motor current from motor nameplate. The allowed range is $0.5 \cdot I_N \dots 1.5 \cdot I_N$ of ACS 400.</p>
9907	<p>MOTOR NOM FREQ Nominal motor frequency from motor nameplate (field weakening point). See Figure 25.</p>
9908	<p>MOTOR NOM SPEED Nominal motor speed from motor nameplate.</p>
9909	<p>MOTOR NOM POWER Nominal motor power from motor nameplate.</p>
9910	<p>MOTOR COS PHI (MOTOR POWER FACTOR) Nominal motor cos phi from motor nameplate.</p>

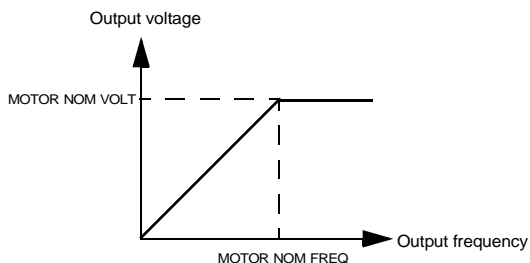
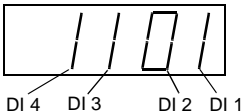
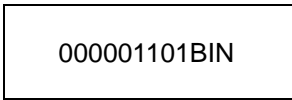


Figure 25 Output voltage as a function of output frequency.

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 ACS 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! ACS100-PAN will not display the unit ("kW").
0107	DC BUS VOLTAGE Displays the DC bus voltage, as measured by the ACS 400. The voltage is displayed in Volts DC.
0109	OUTPUT VOLTAGE Displays the voltage applied to the motor.
0110	ACS 400 TEMP Displays the temperature of the ACS 400 heatsink in degrees Fahrenheit.
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" on page 151, for description of different control locations.
0114	RUN TIME (R) Shows the total running time of the ACS 400 in hours (h). Can be reset by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0115	kWh COUNTER (R) Shows the counted kilowatt hours of the ACS 400 in operation. Can be reset by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0116	APPL BLK OUTPUT The reference value in percent received from the application block. The value is from PID control or PFC control, depending on the selected macro. Otherwise the value is from 0112 EXT REF 2.
0117	DI1-DI4 STATUS 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 

Code	Description
0118	AI1 Relative value of analog input 1 displayed in %.
0119	AI2 Relative value of analog input 2 displayed in %.
0121	<p>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.</p> <p>ACS100-PAN</p> <p>ACS-PAN</p> <p>00000101BIN</p> <p>DI 5 Relay 2 status Relay 1 status</p>
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 PID/PFC controller.
0128	LAST FAULT Last recorded fault (0=no fault). See "Diagnostics" on page 35. Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0129	PREVIOUS FAULT Previous recorded fault. See "Diagnostics" on page 35. Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0130	OLDEST FAULT Oldest recorded fault. See "Diagnostics" on page 35. Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0131	SER LINK DATA 1 Free data location that can be written from serial link.
0132	SER LINK DATA 2 Free data location that can be written from serial link.
0133	SER LINK DATA 3 Free data location that can be written from 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 ACS 400 in thousands of hours (kh).
0137	MWh COUNTER Counts the megawatt hours of ACS 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” on page 151.

Code	Description
1001	<p>EXT1 COMMANDS Defines the connections and the source of Start/Stop/Direction commands for External control location 1 (EXT1).</p> <p>0 = NOT SEL No Start/Stop/Direction command source for EXT1 is selected.</p> <p>1 = DI1 Two-wire Start/Stop connected to digital input DI1. DI1 deactivated = Stop; DI1 activated = Start. *</p> <p>2 = DI1,2 Three-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 of parameter 1003 DIRECTION should be REQUEST.</p> <p>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 connected to digital input DI1. The Stop push-button is normally closed, and connected to digital input DI2. Multiple Start push-buttons are connected in parallel; multiple Stop push-buttons are connected in series. *,**</p> <p>4 = DI1P,2P,3 Three-wire Start/Stop, Direction. Start/Stop connected as with DI1P,2P. Direction is connected to digital input DI3. DI3 deactivated = Forward; DI3 activated = Reverse. To control Direction, the value of parameter 1003 DIRECTION should be REQUEST. **</p> <p>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, value of parameter 1003 DIRECTION should be REQUEST. **</p> <p>6 = DI5 Two-wire Start/Stop, connected to digital input DI5. DI5 deactivated = Stop and DI5 activated = Start. *</p> <p>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.</p> <p>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 of parameter 1003 DIRECTION should be REQUEST.</p> <p>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 Stop command is given.</p> <p>10 = COMM The Start/Stop and Direction commands are given through serial communication.</p> <p>*Note! In cases 1, 3, 6 direction is set with parameter 1003 DIRECTION. Selecting value 3 (REQUEST) fixes the direction to Forward.</p> <p>**Note! The stop signal must be activated before a Start command can be given.</p>

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 direction of rotation of the motor to forward or reverse. If you select 3 (REQUEST), the direction is set according to the given direction command.

Group 11: Reference Select

Reference commands can be given from the control panel or from two external locations. The selection between the two external locations is made with parameter 1102 EXT1/EXT2 SEL. For more information on control locations, refer to "Appendix A" on page 151.

Code	Description
1101	<p>KEYPAD REF SEL Selection of active control panel reference in local control mode.</p> <p>1 = REF1 (Hz) Control panel reference is given in Hz.</p> <p>2 = REF2 (%) Control panel reference is given as a percentage (%).</p>
1102	<p>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 Start/Stop/Direction commands and reference is determined by this parameter.</p> <p>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.</p> <p>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).</p> <p>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).</p> <p>8 = COMM External control location 1 or 2 is chosen through serial communication.</p>

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 26). 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 ACS 400 will operate at maximum reference in the reverse direction if the control signal is lost. Set parameter 3022 AI1 FAULT LIMIT to a value 3 % or higher, and parameter 3023 AI2 FAULT LIMIT to 1 (FAULT), and the ACS 400 will stop in case the control signal is lost.

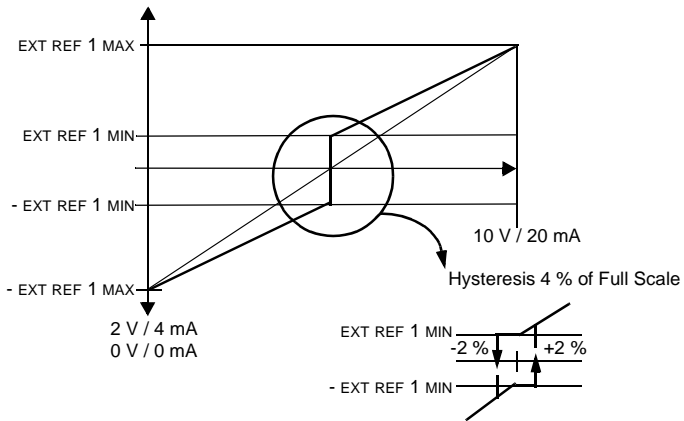


Figure 26 Joystick control. Maximum for external reference 1 is set with Parameter 1105 and minimum with Parameter 1104.

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 ACS 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, "Standard Serial Communication" on page 129.

Continued on next page

	<p>Continued from previous page</p> <p>11= DI3U, 4D (R,NC) 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. (NC) indicates that the reference is not copied when switching control locations, when switching back to a control location, the reference returns to the last value used for that control location.</p> <p>12= DI3U, 4D (NC) 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"). (NC) indicates that the reference is not copied when switching control locations, when switching back to a control location, the reference returns to the last value used for that control location.</p> <p>12= DI3U, 5D (NC) See description for 12. Digital input 5 decreases the speed.</p>
1104	<p>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 27 on page 80.</p>
1105	<p>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 27 on page 80.</p>
1106	<p>EXT REF2 SELECT This parameter selects the signal source for external reference 2. The alternatives are the same as with external reference 1, see 1103 EXT REF1 SELECT.</p>
1107	<p>EXT REF2 MIN Sets the minimum reference in %. When the analog input signal is at minimum, external reference 2 is equal to EXT REF2 MIN. See Figure 27 on page 80.</p> <ul style="list-style-type: none"> • 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	<p>EXT REF2 MAX Sets the maximum reference in %. When the analog input signal is at maximum, external reference 2 is equal to EXT REF2 MAX. See Figure 27 on page 80.</p> <ul style="list-style-type: none"> • If the PID Control or PFC macro is selected, this parameter sets the maximum process reference. • If any macro other than PID Control is selected, this parameter sets the maximum frequency reference. This value is given as a percentage of the maximum frequency.

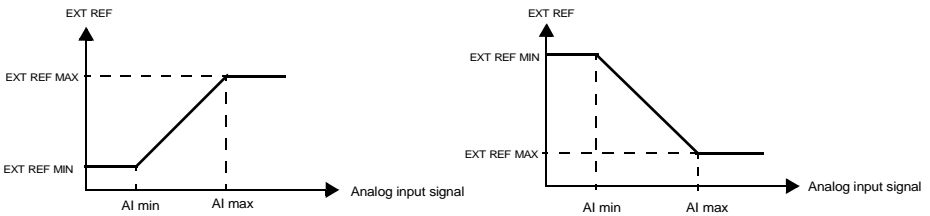


Figure 27 Setting EXT REF MINIMUM and EXT REF MAXIMUM. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.

Group 12: Constant Speeds

The ACS 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 so-called fault speed which may be activated if the control signal is lost. Refer to parameter 3001 AI<MIN FUNCTION and parameter 3002 PANEL LOSS.

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

Group 13: Analog Inputs

Code	Description
1301	<p>MINIMUM AI1 Relative minimum value of AI1 (%). This value corresponds to the minimum reference set by parameter 1104 EXT REF1 MIN or 1107 EXT REF2 MIN. Minimum AI cannot be greater than maximum AI. See Figure 27 on page 80.</p>
1302	<p>MAXIMUM AI1 Maximum value of AI1 (%). This value corresponds to the maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX. See Figure 27 on page 80.</p>
1303	<p>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.</p> <p>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.</p> <div style="text-align: center;"> </div> <p><i>Figure 28 Filter time constant for analog input AI1.</i></p>
1304	<p>MINIMUM AI2 Minimum value of AI2 (%). This 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.</p>
1305	<p>MAXIMUM AI2 Maximum value of AI2 (%). This value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX.</p>
1306	<p>FILTER AI2 Filter time constant for AI2. Refer to parameter 1303 FILTER AI1.</p>

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:

$$\begin{aligned}
 \text{Value (\%)} &= \text{Desired minimum value} / \text{Full range of the analog input} * 100\% \\
 &= 4 \text{ mA} / 20 \text{ mA} * 100\% \\
 &= 20\%.
 \end{aligned}$$

Note! In addition to this parameter setting, the analog input must be configured for 0-20 mA current signal. Refer to section CROSSREF.

Group 14: Relay Outputs

Code	Description
1401	<p>RELAY OUTPUT 1 Relay output 1 content. Selects which information is indicated with relay output 1.</p> <p>0 = NOT SEL Relay is not used and is de-energized.</p> <p>1 = READY The ACS 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.</p> <p>2 = RUN Relay energized when the ACS 400 is running.</p> <p>3 = FAULT (-1) Relay energized when power is applied, and de-energized upon a fault trip.</p> <p>4 = FAULT Relay energized when a fault is active.</p> <p>5 = ALARM Relay energized when an alarm is active. To see which alarms cause the relay to energize, "Diagnostics" on page 35.</p> <p>6 = REVERSED Relay energized when motor rotates in reverse direction.</p> <p>7 = SUPRV1 OVER Relay energized when first supervised parameter (3201) exceeds the limit (3203). See "Group 32: Supervision" on page 100.</p> <p>8 = SUPRV1 UNDER Relay energized when first supervised parameter (3201) drops below the limit (3202). See "Group 32: Supervision" on page 100.</p> <p>9 = SUPRV2 OVER Relay energized when second supervised parameter (3204) exceeds the limit (3206). See "Group 32: Supervision" on page 100.</p> <p>10 = SUPRV2 UNDER Relay energized when second supervised parameter (3204) drops below the limit (3205). See "Group 32: Supervision" on page 100.</p> <p>11 = AT SET POINT Relay energized when output frequency is equal to reference frequency.</p> <p>12 = FAULT (RST) Relay energized when the ACS 400 is in a fault condition and will reset after the programmed autoreset delay (refer to parameter 3103 DELAY TIME).</p> <p>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 35.</p> <p>14 = EXT CONTROL Relay is energized if external control is selected.</p> <p>15 = REF 2 SEL Relay is energized if EXT2 is selected.</p> <p>16 = CONST FREQ Relay is energized when a constant speed is selected.</p> <p>17 = REF LOSS Relay is energized when reference or active control place is lost.</p> <p>18 = OVERCURRENT Relay is energized when overcurrent alarm or fault appears.</p> <p>19 = OVERVOLTAGE Relay is energized when overvoltage alarm or fault appears.</p> <p>20 = ACS400 TEMP Relay is energized when ACS 400 overtemperature alarm or fault exists.</p>

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

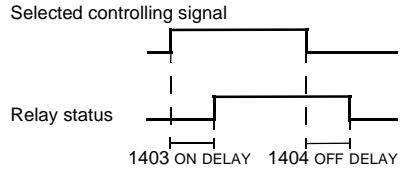


Figure 29

Group 15: Analog Output

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

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

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

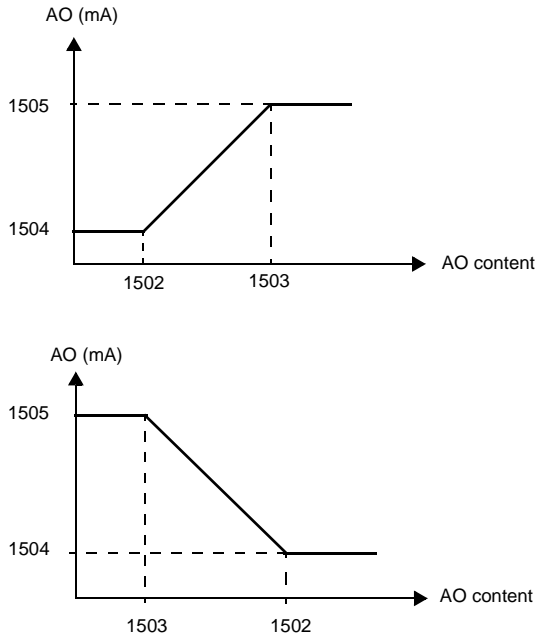


Figure 30 Analog output scaling.

Group 16: System Controls

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

Code	Description
1607	<p>PARAM. SAVE</p> <p>Parameter save function. Selection 1 (SAVE...) saves all altered parameters to permanent memory. Value 0 (DONE) is displayed when all parameter are saved.</p> <p>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.</p> <p>0 = DONE 1 = SAVE...</p> <p>Note! Parameter modifications done from the control panel are normally stored immediately to permanent memory. However, if 1602 PARAMETER LOCK is set to 2 (NOT SAVED), modifications done from the control panel are saved only if this parameter 1607 is used.</p>
1608	<p>DISPLAY ALARMS</p> <p>Controls the visibility of some of the alarms, see "Diagnostics" on page 35.</p> <p>1 = NO Some of the alarms are suppressed.</p> <p>2 = YES All of the alarms are enabled.</p>

Group 20: Limits

Code	Description
2003	<p>MAX CURRENT Maximum output current. The maximum output current that the ACS 400 will supply to the motor.</p>
2005	<p>OVERVOLT CTRL DC overvoltage controller enable.</p> <p>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 trip limit, the overvoltage controller automatically decreases the braking torque by increasing output frequency.</p> <p>Caution! If a braking chopper and a braking resistor are connected to the ACS 400, this parameter value must be set to 0 to ensure proper operation of the chopper.</p> <p>0 = DISABLE 1 = ENABLE</p>
2006	<p>UNDERVOLT CTRL DC undervoltage controller enable.</p> <p>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 ACS 400, thus keeping the DC bus charged, and preventing an undervoltage trip. This will increase power loss ride-through on systems with a high inertia, such as a centrifuge or a fan.</p> <p>0 = DISABLE 1 = ENABLE (TIME) Enable with 500 ms time limit for operation. 2 = ENABLE Enable without time limit for operation.</p>
2007	<p>MINIMUM FREQ Operating range minimum output frequency.</p> <p>Note! Keep MINIMUM FREQ ≤ MAXIMUM FREQ.</p>
2008	<p>MAXIMUM FREQ Operating range maximum output frequency.</p>

Group 21: Start/Stop

ACS 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 brake can be used.

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

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

Code	Description
2107	<p>START INHIBIT</p> <p>Start inhibit control. Start inhibit means that a pending start command is ignored when:</p> <ul style="list-style-type: none"> • 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 • when switching from EXT1 to EXT2 takes place, or • when switching from EXT2 to EXT1 takes place <p>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.</p> <p>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, give start command anew.</p>

Group 22: Accel/Decel

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

Code	Description
2201	<p>ACC/DEC 1/2 SEL Selects the source for the ramp pair selection signal.</p> <p>0 = NOT SEL The first ramp pair is used (ACCELER TIME 1/DECELER TIME 1).</p> <p>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.</p>
2202	<p>ACCELER TIME 1 Ramp 1: time from zero to maximum frequency (0 - MAXIMUM FREQ).</p>
2203	<p>DECELER TIME 1 Ramp 1: time from maximum frequency to zero (MAXIMUM FREQ - 0).</p>
2204	<p>ACCELER TIME 2 Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ).</p>
2205	<p>DECELER TIME 2 Ramp 2: time from maximum frequency to zero (MAXIMUM FREQ - 0).</p>
2206	<p>RAMP SHAPE Acceleration/deceleration ramp shape selection</p> <p>0 = LINEAR 1 = FAST S CURVE 2 = MEDIUM S CRV 3 = SLOW S CURVE</p>

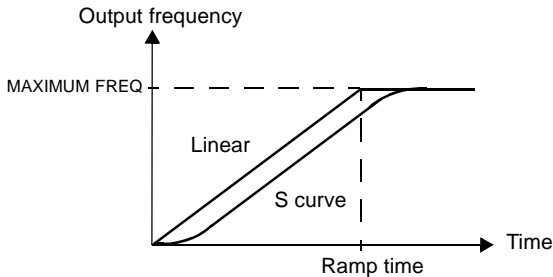


Figure 31 Definition of acceleration/deceleration ramp time.

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 ACS 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

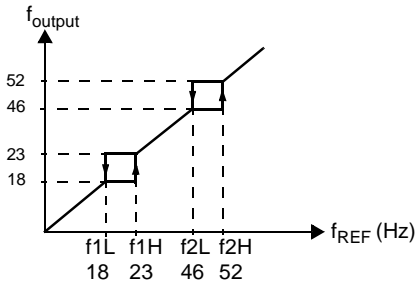


Figure 32 Example of critical frequencies setting in a fan system with bad vibrations at frequency ranges 18 Hz to 23 Hz and 46 Hz to 52 Hz.

Group 26: Motor Control

Code	Description																		
2603	<p>IR COMPENSATION IR compensation voltage at 0 Hz.</p> <p>Note! IR compensation should be kept as low as possible to prevent overheating. Refer to Table 10.</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="6">400 V Units</th> </tr> <tr> <th>P_N / kW</th> <td>3</td> <td>7.5</td> <td>15</td> <td>22</td> <td>37</td> </tr> <tr> <th>IR comp / V</th> <td>21</td> <td>18</td> <td>15</td> <td>12</td> <td>10</td> </tr> </thead></table> <p style="text-align: right;"><i>Table 10 Typical IR compensation values.</i></p>	400 V Units						P _N / kW	3	7.5	15	22	37	IR comp / V	21	18	15	12	10
400 V Units																			
P _N / kW	3	7.5	15	22	37														
IR comp / V	21	18	15	12	10														
2604	<p>IR COMP RANGE IR compensation range. Defines frequency after which IR compensation is 0 V.</p>																		
2605	<p>LOW NOISE Motor acoustical noise option.</p> <p>0 = OFF Standard (switching frequency 4 kHz).</p> <p>1 = ON(1) Low noise (switching frequency 8 kHz).</p> <p>Note! When the low noise setting is used, the maximum loadability of the ACS 400 is I₂ at 30 °C ambient temperature or 0.8 * I₂ at 40 °C.</p>																		
2606	<p>U/f RATIO U/f ratio below field weakening point.</p> <p>1 = LINEAR 2 = SQUARE</p> <p>Linear is preferred for constant torque applications, Square for centrifugal pump and fan applications. (Square is more silent for most operating frequencies.)</p>																		
2607	<p>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.</p>																		

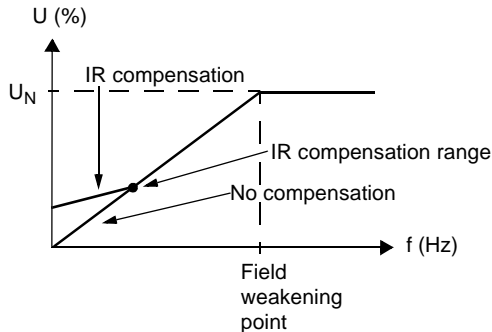


Figure 33 Operation of IR compensation

Group 30: Fault Functions

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

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

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

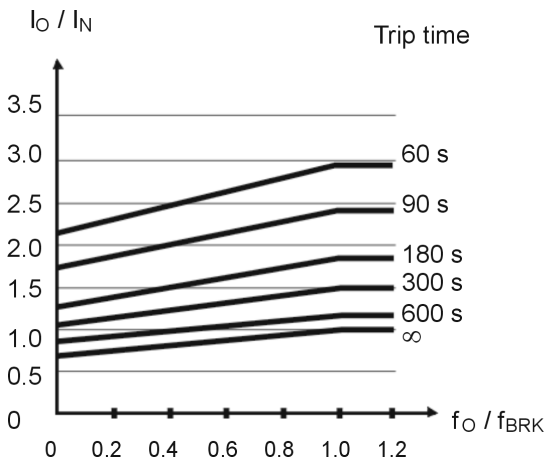
Stall protection (parameters 3009 - 3012) includes parameters for stall frequency, stall time and current.

Code	Description
3001	<p>AI<MIN FUNCTION Operation in case of AI signal drops below fault limit 3022 AI1 FLT LIMIT or 3023 AI2 FLT LIMIT.</p> <p>0 = NOT SEL No operation.</p> <p>1 = FAULT A fault indication is displayed and the ACS 400 coasts to stop.</p> <p>2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.</p> <p>3 = LAST SPEED A warning indication is displayed and the speed is set to the level at which the ACS 400 was last operating. This value is determined by the average speed over the last 10 seconds.</p> <p>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.</p>
3002	<p>PANEL LOSS Operation in case of control panel loss fault.</p> <p>1 = FAULT A fault indication is displayed and the ACS 400 coasts to stop.</p> <p>2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.</p> <p>3 = LAST SPEED A warning indication is displayed and the speed is set to the level at which the ACS 400 was last operating. This value is determined by the average speed over the last 10 seconds.</p> <p>Caution: If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case the panel is lost.</p>
3003	<p>EXTERNAL FAULT External fault input selection.</p> <p>0 = NOT SEL External fault signal is not used.</p> <p>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 ACS 400 is stopped and the motor coasts to stop and fault indication is displayed.</p>

Code	Description
3004	<p>MOT THERM PROT Motor overtemperature function. This parameter defines the operation of the motor thermal protection function which protects the motor from overheating.</p> <p>0 = NOT SEL 1 = FAULT Displays a warning indication at the warning level (97.5 % of the nominal value). Displays a fault indication when the motor temperature reaches the 100 % level. The ACS 400 coasts to stop.</p> <p>2 = WARNING A warning indication is displayed when the motor temperature reaches the warning level (95 % of the nominal value).</p>
3005	<p>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 34 shows motor thermal time definition.</p> <p>If thermal protection according to UL requirements for NEMA class motors is desired, use this rule of thumb - MOTOR THERM TIME equals 35 times t_6 (t_6 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.</p> <div data-bbox="312 602 801 899" data-label="Figure"> </div> <p><i>Figure 34 Motor thermal time.</i></p>
3006	<p>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.</p> <div data-bbox="231 1114 944 1425" data-label="Figure"> </div> <p><i>Figure 35 Motor load curve.</i></p>

Code	Description
3007	<p>ZERO SPEED LOAD This parameter defines the maximum allowable current at zero speed relative to 9906 MOTOR NOM CURR. Refer to Figure 35.</p>
3008	<p>BREAK POINT Break point of motor load curve. Refer to Figure 35 for an example of a motor load curve. See Figure 37.</p>
3009	<p>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 36.</p> <p>0 = NOT SEL Stall protection is not used.</p> <p>1 = FAULT When the protection is activated the ACS 400 coasts to stop. Fault indication is displayed.</p> <p>2 = WARNING A warning indication is displayed. The indication disappears in half the time set by parameter 3012 STALL TIME.</p> <div style="text-align: center;"> </div> <p><i>Figure 36 Motor stall protection.</i></p>
3010	<p>STALL CURRENT Current limit for stall protection. Refer to Figure 36.</p>
3011	<p>STALL FREQ HI This parameter sets the frequency value for the stall function. Refer to Figure 36.</p>
3012	<p>STALL TIME This parameter sets the time value for the stall function.</p>
3013	<p>UNDERLOAD FUNCTION Removal of motor load may indicate a process malfunction. The protection is activated if:</p> <ul style="list-style-type: none"> • 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. <p>0 = NOT SEL Underload protection is not used.</p> <p>1 = FAULT When the protection is activated the ACS 400 coasts to stop. Fault indication is displayed.</p> <p>2 = WARNING A warning indication is displayed.</p>
3014	<p>UNDERLOAD TIME Time limit for underload protection.</p>

Code	Description
3015	UNDERLOAD CURVE This parameter provides five selectable curves shown in Figure 38. 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.
3017	GROUND FAULT This parameter defines operation in case of ground fault is detected in the motor or in the motor cable. 1 = FAULT A fault indication is displayed and the ACS 400 coasts to stop. 2 = NO The fault indicator is suppressed and the ACS 400 continues operation normally.
3022	AI1 FLT LIMIT Fault level for analog input 1 supervision. See parameter 3001 AI<MIN FUNCTION.
3023	AI2 FLT LIMIT Fault level for analog input 2 supervision. See parameter 3001 AI<MIN FUNCTION.



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

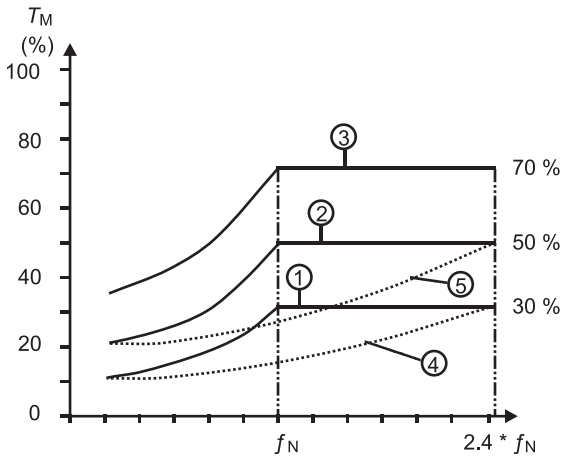


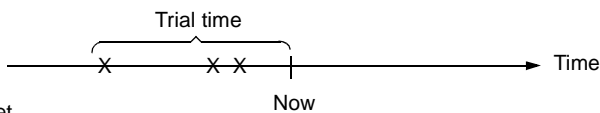
Figure 38 Underload curve types. T_M nominal torque of the motor, f_N nominal frequency of the motor.

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 stop when the analog input signal is restored. Ensure that the use of this feature will not cause physical injury and/or damage equipment.

Code	Description
3101	NR OF TRIALS Sets the number of allowed autoresets within a certain time. The time is defined with parameter 3102 TRIAL TIME. The ACS 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 ACS 400 will wait after a fault occurs before attempting to reset. If set to zero, the ACS 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, and the ACS 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, and the ACS 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 ACS 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.



x = Automatic reset

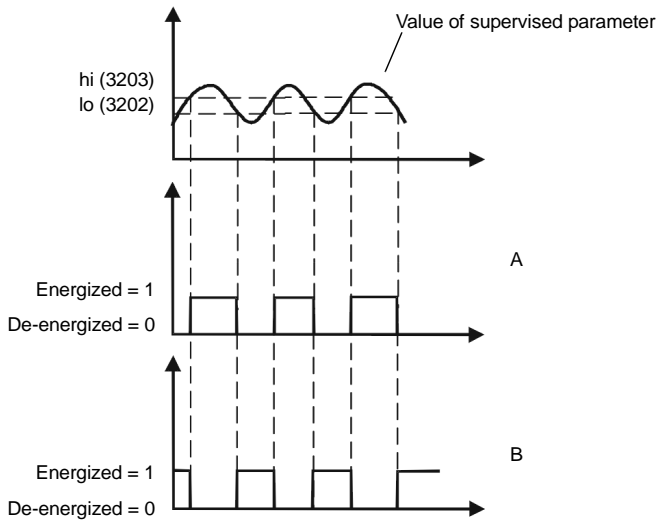
Now

Figure 39 Operation of automatic reset function. In this example, if the fault occurs at the moment "Now", it is automatically reset if parameter 3101 NR OF TRIALS value is greater than or equal to 4.

Group 32: Supervision

Parameters of this group are used together with relay output parameters 1401 RELAY OUTPUT 1 and 1402 RELAY OUTPUT 2. Any two parameters of the Operating Data Group (Group 1) can be supervised. Relays can be configured to be energized when the values of the supervised parameters 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. Display of this parameter depends on the selected supervised parameter (3201).
3203	SUPERV 1 LIM HI First supervision limit high. Display of this parameter depends on the selected supervised parameter (3201).
3204	SUPERV 2 PARAM Second supervised parameter number of the Operating Data group (Group 01).
3205	SUPERV 2 LIM LO Second supervision limit low. Display of this parameter depends on the selected supervised parameter (3204).
3206	SUPERV 2 LIM HI Second supervision limit high. Display of this parameter depends on the selected supervised parameter (3204).



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

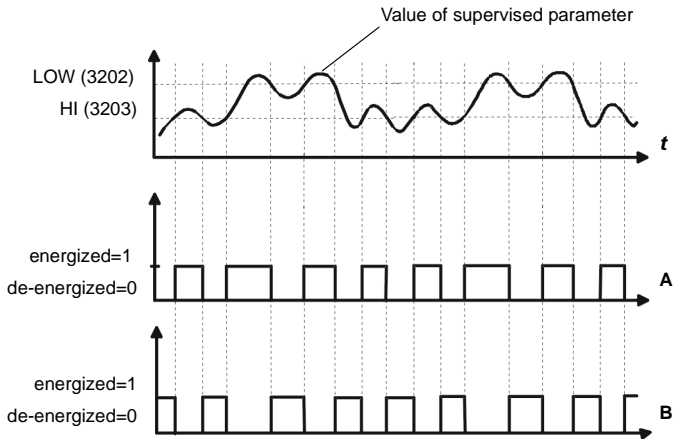
B = Parameter 1401 RELAY OUTPUT 1 (1402 RELAY OUTPUT 2) value is SUPRV1 UNDER or SUPRV2 UNDER

Note! Case $LOW \leq HIGH$ represents a normal hysteresis.

Case A: Is for monitoring when/if the supervised signal exceeds a given limit.

Case B: Is for monitoring when/if the supervised signal falls below a given limit.

Figure 40 Operating data supervision using relay outputs, when $LOW \leq HIGH$.



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

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

Note! Case LOW>HIGH represents a special hysteresis with two separate supervision limits. Depending on whether the supervised signal has gone below value HIGH (3203) or above value LOW (3202), determines which limit is being used. Initially HIGH is used, until the signal goes above value LOW. After this the limit used is LOW, until the signal goes back below value HIGH.

A = Initially the relay is de-energized.

B = Initially the relay is energized.

Figure 41 Operating data supervision using relay outputs, when LOW>HIGH.

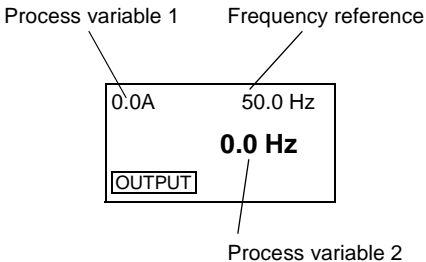
Group 33: Information

Code	Description
3301	SW VERSION Software version.
3302	TEST DATE Displays the test date of the ACS 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.

Code	Description										
3401	<p>DISPLAY SEL Selects displayed variables for the output display of the ACS-PAN control panel.</p> <p>1 = STANDARD Panel displays standard variables.</p> <p>2 = PROCESS VAR Panel displays process variables. See Figure 42.</p>										
	 <p>Figure 42 ACS-PAN output display when process variable display is selected.</p>										
3402	<p>P VAR 1 SEL Selection of process variable 1. Number of any parameter of the group 1 OPERATING DATA.</p>										
3403	<p>P VAR 1 MULTIP Process variable 1 multiplier.</p>										
3404	<p>P VAR 1 DIVISOR Process variable 1 divider.</p>										
3405	<p>P VAR 1 SCALING Decimal point location of process variable 1, when displayed. Refer to Figure 43.</p> <table border="1" data-bbox="561 1008 884 1170"> <thead> <tr> <th>Value</th> <th>Display</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Figure 43 Display with different decimal point locations when calculated value is 125.</p>	Value	Display	0	125	1	12.5	2	1.25	3	0.125
Value	Display										
0	125										
1	12.5										
2	1.25										
3	0.125										
3406	<p>P VAR 1 UNIT Process variable unit.</p> <p>0 = NOT SEL 4 = % 8 = kh 12 = mV 16 = °F 20 = m³/h 24 = GPM 28 = MGD 1 = A 5 = s 9 = °C 13 = kW 17 = hp 21 = dm³/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</p>										

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 $\pi \times 0.1$ m/s line speed, or approximately 0.314 m/s, is:

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

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.

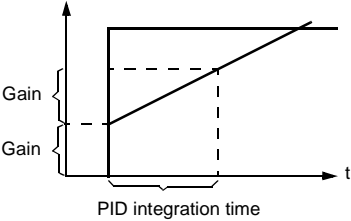
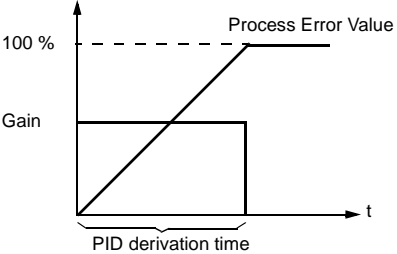
Group 40: PID Control

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

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

CROSSREF shows the connections of internal signals when the PID Control macro is selected.

Code	Description
4001	<p>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 %.</p>
4002	<p>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. Integration time 1 s denotes that a 100 % change is achieved in 1 s.</p> 
4003	<p>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.</p> 

Code	Description
4004	<p>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.</p>
4005	<p>ERROR VALUE INV Process error value inversion. Normally, a decrease in feedback signal causes an increase in drive speed. If a decrease in feedback signal is desired to cause a decrease in speed, set ERROR VALUE INV to 1 (YES).</p> <p>0 = NO 1 = YES</p>
4006	<p>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 source for actual value 2 is selected by parameter 4008.</p> <p>1 = ACT1 Actual value 1 is used as the feedback signal.</p> <p>2 = ACT1-ACT2 Difference of actual values 1 and 2 is used as the feedback signal.</p> <p>3 = ACT1+ACT2 Sum of actual values 1 and 2.</p> <p>4 = ACT1*ACT2 Product of actual values 1 and 2.</p> <p>5 = ACT1/ACT2 Quotient of actual values 1 and 2.</p> <p>6 = MIN (A1, A2) Smaller of actual values 1 and 2.</p> <p>7 = MAX (A1, A2) Greater of actual values 1 and 2.</p> <p>8 = sqrt (A1-A2) Square root of difference of actual values 1 and 2.</p> <p>9 = sqA1 + sqA2 Sum of square roots of actual values 1 and 2.</p>
4007	<p>ACT1 INPUT SEL Source for actual value 1 (ACT1).</p> <p>1 = AI 1 Analogue input 1 is used as actual value 1.</p> <p>2 = AI 2 Analogue input 2 is used as actual value 1.</p>
4008	<p>ACT2 INPUT SEL Source for actual value 2 (ACT2).</p> <p>1 = AI 1 Analog input 1 is used as actual value 2.</p> <p>2 = AI 2 Analog input 2 is used as actual value 2.</p>

Code	Description
4009	ACT1 MINIMUM Minimum value for actual value 1 (ACT1). Refer to Figure 44 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 44 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.

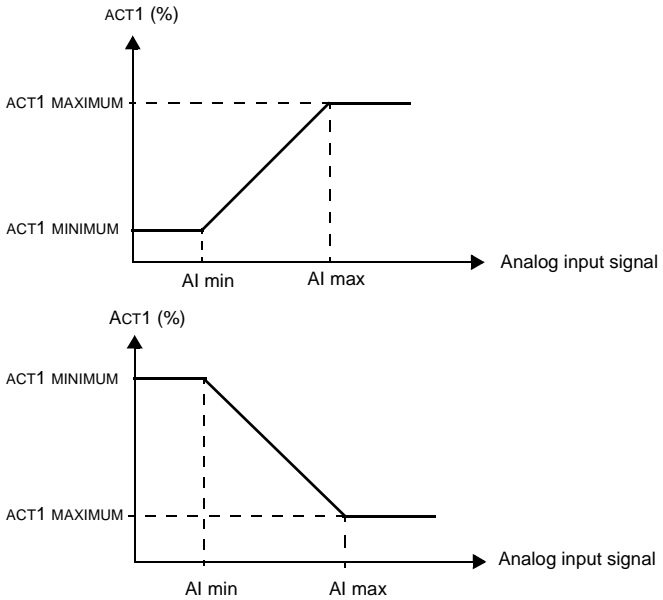


Figure 44 Actual value scaling. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.

Code	Description
4013	<p>PID SLEEP DELAY Time delay for the sleep function, see Figure 45. If the ACS 400 output frequency is below a set level (parameter 4014 SLEEP LEVEL) longer than PID SLEEP DELAY, ACS 400 is stopped. Alarm 28 is displayed when PID sleep is active.</p>
4014	<p>PID SLEEP LEVEL Level for activation of sleep function, see Figure 45. When the ACS 400 output frequency falls below the sleep level, the sleep delay counter is started. When the ACS 400 output frequency rises above the sleep level, the sleep delay counter is reset.</p>
4015	<p>WAKE-UP LEVEL Level for deactivation of sleep function. This parameter sets a process actual value limit for the sleep function (see Figure 45). The limit floats with the process reference.</p> <p>Non-inverted error value (parameter 4005 = 0) Applied wake-up level is according to the following formula: Limit = parameter 1107 + parameter 4015 * (set point - parameter 1107) / (parameter 1108 - parameter 1107)</p> <p>When the actual value is less than or equal to this value, the sleep function is de-activated. See Figure 46 and Figure 48.</p> <p>Inverted error value (parameter 4005 = 1) Applied wake-up level is according to the following formula: Limit = parameter 1108 + parameter 4015 * (parameter 1108 - setpoint) / (parameter 1108 - parameter 1107)</p> <p>When the actual value is higher than or equal to this value, the sleep function is de-activated. See Figure 47 and Figure 49.</p>
4016	<p>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.</p> <p>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.</p> <p>6 = SET 1 PID parameter set 1 is active.</p> <p>7 = SET 2 PID parameter set 2 is active.</p>
4017	<p>WAKE-UP DELAY Delay for deactivation of PID sleep function. Refer to parameter 4015 WAKE-UP LEVEL and Figure 45.</p>
4018	<p>SLEEP SELECTION PID sleep function control.</p> <p>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.</p> <p>1...5 = DI1...DI5 Sleep state is activated and deactivated using a digital input.</p>

Code	Description
4019	<p>SET POINT SEL Set point selection. Defines the reference signal source for the PID controller.</p> <p>Note! When PID regulator is by-passed (parameter 8121 REG BYPASS CTRL), this parameter has no significance.</p> <p>1 = INTERNAL Process reference is a constant value set with parameter 4020 INTERNAL SETPNT.</p> <p>2 = EXTERNAL Process reference is read from a source defined with parameter 1106 EXT REF2 SELECT. The ACS 400 must be in remote mode (REM is shown on control panel display).*</p> <p>* Process reference to PID controller can also be given from the control panel in local mode (LOC is shown on control panel display) if the panel reference is given as percentage, i.e. value of parameter 1101 KEYPAD REF SEL = 2 (REF2 (%)).</p>
4020	<p>INTERNAL SETPNT Sets a constant process reference (%) for the PID controller. PID controller follows this reference if parameter 4019 SET POINT SEL is set to 1 (INTERNAL).</p>

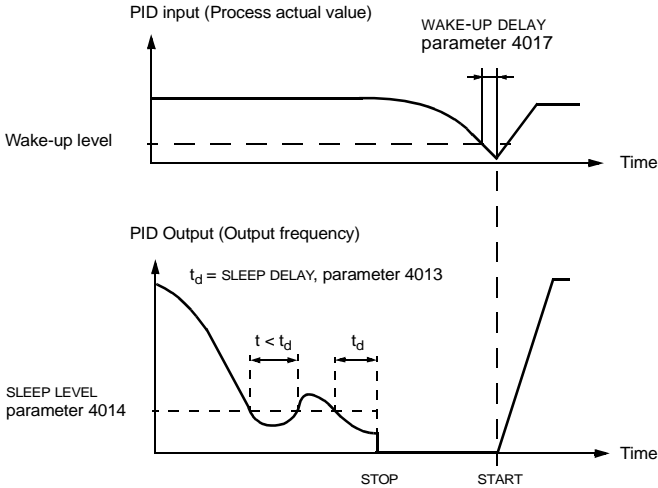


Figure 45 Sleep function operation.

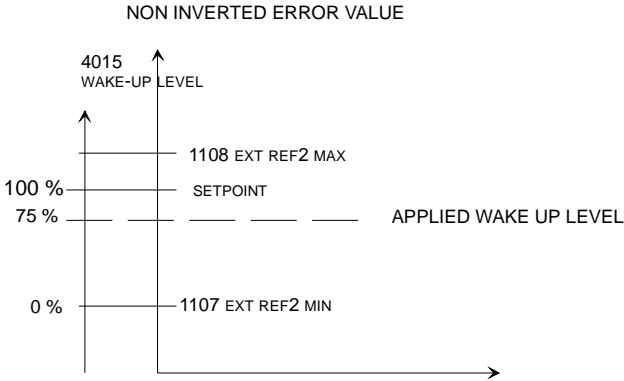


Figure 46 Example of how the applied wake-up level floats with the set point, here parameter 4015 WAKE-UP LEVEL equals to 75 %, PID control non-inverted case.

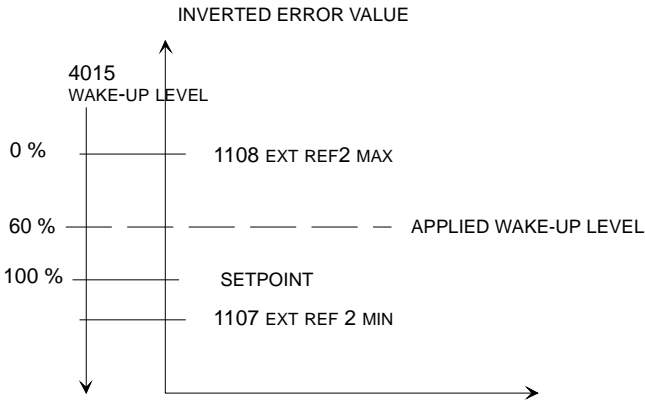


Figure 47 Example of how applied wake-up level floats with the set point, here parameter 4015 WAKE-UP LEVEL equals to 60 %, PID control inverted case.

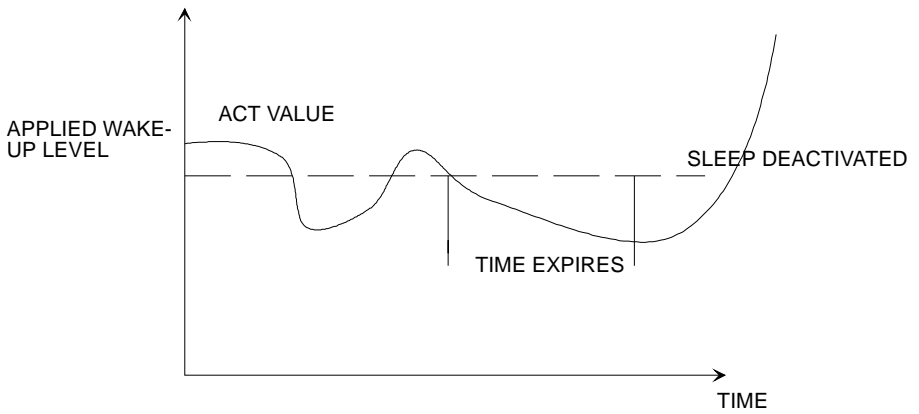


Figure 48 Wake-up level operation with non-inverted error value.

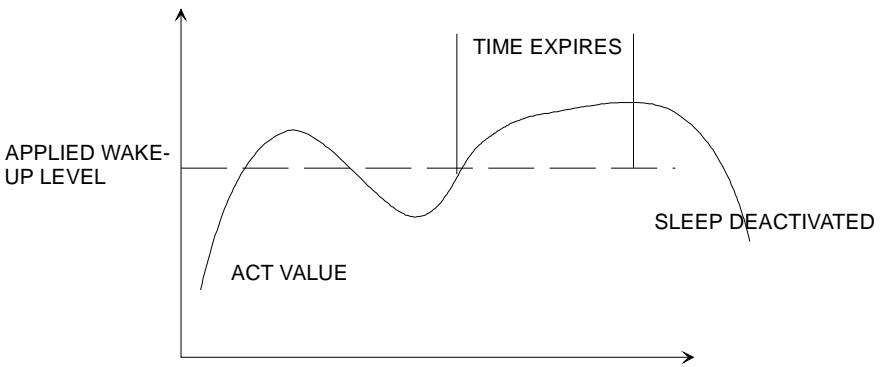


Figure 49 Wake-up level operation with inverted error value.

Group 41: PID Control (2)

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

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

Group 50: Communication

Parameters of this group define some general communication settings. Parameters 5001-5002 and 5007-5009 are used only if the DDCS option module is installed.

Code	Description
5001	<p>DDCS BIT RATE DDCS link baud rate in Mbits/s.</p>
5002	<p>DDCS NODE NR DDCS link node number.</p>
5003	<p>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.</p>
5004	<p>COMM FAULT FUNC Communication fault function. This applies both to standard Modbus and DDCS link.</p> <p>0 = NOT SEL No operation.</p> <p>1 = FAULT A fault indication is displayed and the ACS 400 coasts to stop.</p> <p>2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7.</p> <p>3 = LAST SPEED A warning indication is displayed and the speed is set to the level at which the ACS 400 was last operating. This value is determined by the average speed over the last 10 seconds.</p> <p>Caution: If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation in case communication is lost.</p>
5005	<p>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.</p> <p>0 = NOT SEL No serial communication is active.</p> <p>1 = DDCS DDCS serial communication is active.</p> <p>2 = STD MODBUS Standard Modbus protocol is active.</p> <p>3 = STD MDB+DDCS Both standard Modbus and DDCS are active.</p>
5006	<p>COMM COMMANDS The commands source protocol selection. Although the ACS 400 can communicate simultaneously via several serial communication channels, the controlling commands - start, stop, direction and reference - can be received only from a single communication channel, selectable by this parameter.</p> <p>0 = NOT SEL Controlling commands are not received via serial communication.</p> <p>1 = STD MODBUS Controlling commands can be received through Channel 1 standard Modbus protocol.</p> <p>2 = DDCS Controlling commands can be received through the DDCS link.</p>

Code	Description
5007	<p>DDCS BUS MODE Sets the operation mode of the DDCS link.</p> <p>1=FIELDBUS Fieldbus adapter is used in DDCS link. (The ACS 400 acts as the slave station on the DDCS link).</p> <p>2=IO EXTENSION Input/output extension module (type name NDIO) is used on DDCS link. The ACS 400 acts as the master station on the DDCS link, and is capable of controlling the digital inputs and outputs of the extension module.</p> <p>Note! Value 2 (IO EXTENSION) should be used only when the PFC (Pump-Fan Control) macro is selected.</p>
5008	<p>DDCS LINK CTRL Controls the light intensity in the DDCS link. The higher the value the higher the intensity.</p>
5009	<p>DDCS HW CONFIG HW configuration of the DDCS link.</p> <p>0 = STAR Star configuration, DDCS regeneration is off.</p> <p>1 = RING DDCS link forms an optical ring, DDCS regeneration is on.</p>

Group 51: Ext Comm Module

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

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

Group 52: Standard Modbus

The ACS 400 can be connected to Modbus fieldbus system. Parameters of this group are used to set up station number, communication speed and parity. Parameters 5206 - 5215 are diagnostic counters that can be used to debug the fieldbus system. Refer to “Standard Serial Communication” on page 129 for more information.

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

Code	Description								
5201	<p>STATION NUMBER Sets the slave number for the ACS 400 in Modbus network. Range: 1 - 247</p>								
5202	<p>COMM SPEED Defines the communication speed of the ACS 400 in bits per second (bits/s).</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">3 = 300 bits/s</td> <td style="width: 50%;">48 = 4800 bits/s</td> </tr> <tr> <td>6 = 600 bits/s</td> <td>96 = 9600 bits/s</td> </tr> <tr> <td>12 = 1200 bits/s</td> <td>192 = 19200 bits/s</td> </tr> <tr> <td>24 = 2400 bits/s</td> <td></td> </tr> </table>	3 = 300 bits/s	48 = 4800 bits/s	6 = 600 bits/s	96 = 9600 bits/s	12 = 1200 bits/s	192 = 19200 bits/s	24 = 2400 bits/s	
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5203	<p>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.</p> <p>0 = NONE 1 = EVEN 2 = ODD</p>								
5206	<p>BAD MESSAGES This diagnostics counter increases by one every time the ACS 400 finds any kind of communication error. During normal operation, this counter rarely increases.</p>								
5207	<p>GOOD MESSAGES This diagnostics counter increases by one every time a valid Modbus message has been received by the ACS 400. During normal operation, this counter is increasing constantly.</p>								
5208	<p>BUFFER OVERRUNS Longest possible message length for the ACS 400 is 32 bytes. If a message exceeding 32 bytes is received, this diagnostic counter increases by one every time a character which cannot be placed in the buffer is received.</p>								
5209	<p>FRAME ERRORS This diagnostic counter increases by one every time a character with a framing error is received from the bus.</p> <ul style="list-style-type: none"> • Communication speed settings of the devices connected in the bus differ. • Ambient noise levels may be too high. 								
5210	<p>PARITY ERRORS This diagnostic counter increases by one every time a character with a parity error is received from the bus.</p> <ul style="list-style-type: none"> • Parity settings of the devices connected on the bus differ. • Ambient noise levels may be too high. 								

Code	Description
5211	CRC ERRORS This diagnostic counter increases by one every time a message with a CRC error is received. <ul style="list-style-type: none"> • Ambient noise levels may be too high. • CRC calculation is not performed correctly.
5212	BUSY ERRORS This diagnostic counter increases by one every time the ACS 400 receives a character from the bus while it is still processing the previous message. <ul style="list-style-type: none"> • There might be two stations with the same station number. • Ambient noise levels may be too high.
5213	SER FAULT MEM 1 Last Modbus exception code sent.
5214	SER FAULT MEM 2 Previous Modbus exception code sent.
5215	SER FAULT MEM 3 Oldest Modbus exception code sent.

Group 81: PFC Control

Parameters for Pump-Fan Control (PFC). “Appendix B” on page 157 gives detailed information on PFC. “Application Macros” on page 53 describes the default signal connections.

Code	Description
8103	<p>REFERENCE STEP 1 Sets a percentage value that is added to the process reference when <u>at least one</u> auxiliary (constant speed) motor is running. Default value is 0 %.</p> <p>Example: An ACS 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.</p> <p>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.</p> <p>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.</p>
8104	<p>REFERENCE STEP 2 Sets a percentage value that is added to the process reference when <u>at least two</u> auxiliary (constant speed) motors are running. Default value is 0 %. See parameter 8103 REFERENCE STEP1</p>
8105	<p>REFERENCE STEP 3 Sets a percentage value that is added to the process reference when <u>at least three</u> auxiliary (constant speed) motors are running. Default value is 0 %. See parameter 8103 REFERENCE STEP1.</p>
8109	<p>START FREQ 1 Sets a frequency limit. See Figure 50 on page 120. When ACS 400 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.</p> <p>After the first auxiliary motor is started, ACS 400 output frequency is decreased by value (8109 START FREQ 1 - 8112 LOW FREQ 1).</p> <p>Note! Start Frequency 1 should be within limits 8112 LOW FREQ 1 and 2008 MAXIMUM FREQ -1.</p>
8110	<p>START FREQ 2 Sets a frequency limit (see Figure 50). When the ACS 400 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.</p> <p>After the second auxiliary motor is started, the ACS 400 output frequency is decreased by value (8110 START FREQ 2 - 8113 LOW FREQ 2).</p> <p>Note! Start Frequency 2 should be within limits 8112 LOW FREQ 2 and 2008 MAXIMUM FREQ -1.</p>
8111	<p>START FREQ 3 Sets a frequency limit (see Figure 50). When the ACS 400 output frequency exceeds the 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.</p> <p>After the third auxiliary motor is started, the ACS 400 output frequency is decreased by value (8111 START FREQ 3 - 8114 LOW FREQ 3).</p> <p>Note! Start Frequency 3 should be within limits 8112 LOW FREQ 3 and 2008 MAXIMUM FREQ -1.</p>

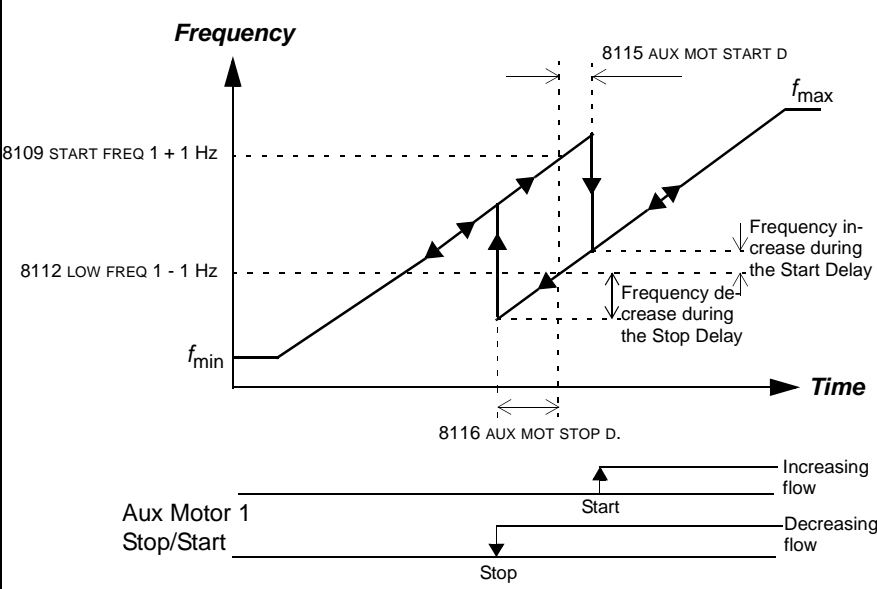
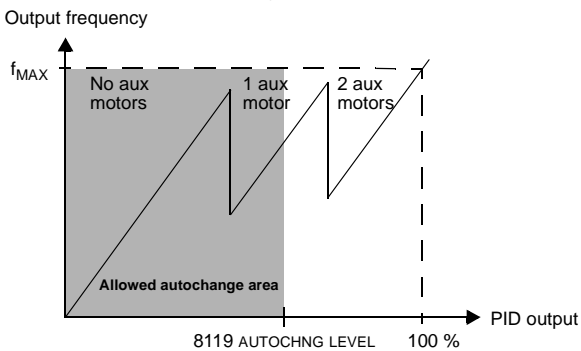
Code	Description
8112	<p>LOW FREQ 1</p> <p>Sets a frequency limit (see Figure 50). When the ACS 400's output frequency falls below the value (8112 LOW FREQ 1 - 1 Hz) and one auxiliary motor is running, the Stop Delay counter is started. When the time set with parameter 8116 AUX MOT STOP D. is elapsed and if the output frequency is still below the value (8112 LOW FREQ 1 + 1 Hz), the first auxiliary motor is stopped.</p> <p>After the auxiliary motor is stopped, the ACS 400's output frequency is increased by the value (8109 START FREQ 1 - 8112 LOW FREQ 1).</p> <p>Note! Low Frequency 1 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 1.</p>
8113	<p>LOW FREQ 2</p> <p>Sets a frequency limit (see Figure 50). When the ACS 400's output frequency falls below the 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.</p> <p>After the auxiliary motor is stopped, the ACS 400's output frequency is increased by a value (8110 START FREQ 2 - 8113 LOW FREQ 2).</p> <p>Note! Low Frequency 2 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 2</p>
8114	<p>LOW FREQ 3</p> <p>Sets a frequency limit (see Figure 50). When the ACS 400's output frequency falls below a value (8114 LOW FREQ 3 - 1 Hz) and three auxiliary motors are running a Stop Delay counter is started. When the time set with parameter 8116 AUX MOT STOP D. is elapsed and if the output frequency is still below the value (8114 LOW FREQ 3 + 1 Hz), the third auxiliary motor is stopped.</p> <p>After the auxiliary motor is stopped, ACS 400 output frequency is increased by value (8111 START FREQ 3 - 8114 LOW FREQ 3).</p> <p>Note! Low Frequency 3 should be within limits 2007 MINIMUM FREQ +1 and 8109 START FREQ 3.</p>
8115	<p>AUX MOT START D</p> <p>Sets the Start Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 and Figure 50 for more information.</p>
8116	<p>AUX MOT STOP D.</p> <p>Sets the Stop Delay for the auxiliary motors. See parameter 8112 LOW FREQ 1 for more information.</p>  <p>Aux Motor 1 Start/Stop</p> <p>Increasing flow Decreasing flow</p> <p>Start Stop</p>

Figure 50 Start Frequency, Low Frequency, Start Delay and Stop Delay.

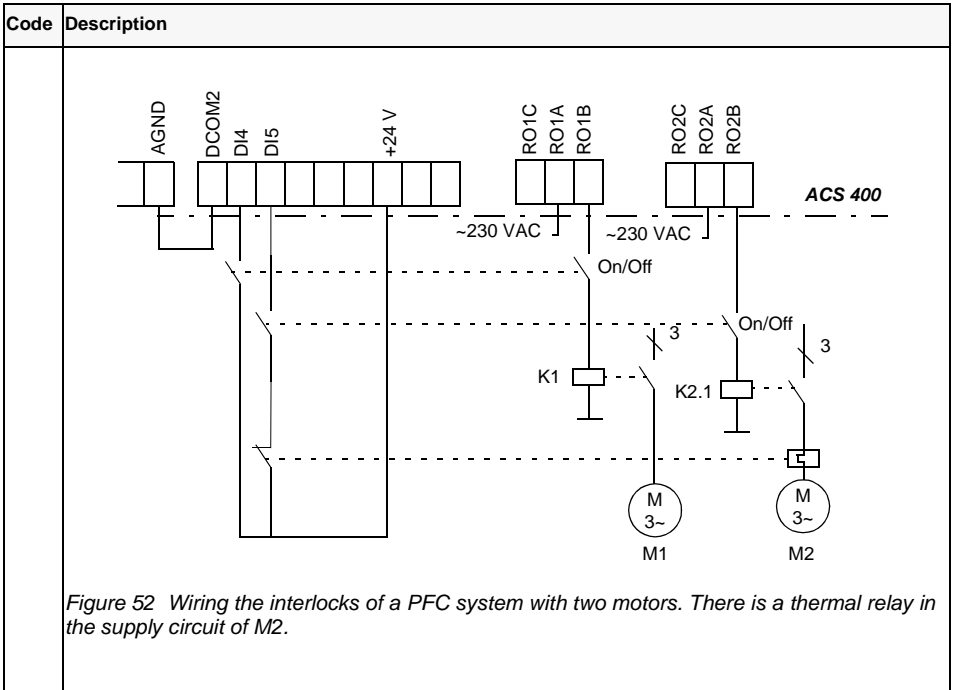
Code	Description																																																
8117	<p>NR OF AUX MOT Sets the number of auxiliary motors.</p> <p>Relay outputs</p> <p>Start/stop signals for the auxiliary motors are given through relay outputs. In addition, one relay output is used to connect the speed regulated motor to the ACS 400.</p> <p>ACS 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).</p> <p>ACS 400 relay output 1 is used for Pump and Fan motor control if the value of 1401 RELAY OUTPUT 1 is 29 (PFC). Relay output 2 is used for Pump and Fan motor control if the value of 1402 RELAY OUTPUT 2 is 29 (PFC).</p> <p>Table 12 depicts the use of relay outputs for different settings of parameters 1401 and 1402. If Autochange function is not used, first relay output configured for PFC use controls the speed regulated motor. If Autochange function is used, the ACS 400 Autochange logic assigns the relay outputs to corresponding motors (of which one is speed controlled).</p> <p><i>Table 12 Usage of relay outputs. Relay output configuration is set by parameters 1401, 1402 and 8117. Number of relay outputs needed depends on the number of auxiliary motors. For example, if the number of auxiliary motors is 2, total of three relay outputs (motors 1,2 and 3) are needed. x = Any setting other than 29 (PFC).</i></p> <table border="1"> <thead> <tr> <th colspan="2">Parameter setting</th> <th colspan="2">ACS 400 relays</th> <th colspan="2">NDIO module 1 (Module node number = 5)</th> <th colspan="2">NDIO module 2 (Module node number = 6)</th> </tr> <tr> <th>1401 RELAY OUTPUT 1</th> <th>1402 RELAY OUTPUT 2</th> <th>Relay output RO1 function</th> <th>Relay output RO2 function</th> <th>NDIO relay output 1 function</th> <th>NDIO relay output 2 function</th> <th>NDIO relay output 1 function</th> <th>NDIO relay output 2 function</th> </tr> </thead> <tbody> <tr> <td>29 (PFC)</td> <td>29 (PFC)</td> <td>Motor 1 start/stop</td> <td>Motor 2 start/stop</td> <td>Motor 3 start/stop</td> <td>Motor 4 start/stop</td> <td>Not used</td> <td>Not used</td> </tr> <tr> <td>29 (PFC)</td> <td>x</td> <td>Motor 1 start/stop</td> <td>e.g. Fault</td> <td>Motor 2 start/stop</td> <td>Motor 3 start/stop</td> <td>Motor 4 start/stop</td> <td>Not used</td> </tr> <tr> <td>x</td> <td>29 (PFC)</td> <td>e.g. Fault</td> <td>Motor 1 start/stop</td> <td>Motor 2 start/stop</td> <td>Motor 3 start/stop</td> <td>Motor 4 start/stop</td> <td>Not used</td> </tr> <tr> <td>x</td> <td>x</td> <td>e.g. Run</td> <td>e.g. Fault</td> <td>Motor 1 start/stop</td> <td>Motor 2 start/stop</td> <td>Motor 3 start/stop</td> <td>Motor 4 start/stop</td> </tr> </tbody> </table>	Parameter setting		ACS 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
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8118	<p>AUTOCHNG INTERV Sets the interval for the Autochange function. The time is counted only when the ACS 400 Start signal is on. See parameter 8119 AUTOCHNG LEVEL for information on the operation of the Autochange.</p> <p>0.0 = NOT SEL</p> <p>This setting switches off the Autochange function.</p> <p>Note! The ACS 400 always coasts to stop when autochange is performed.</p> <p>Warning! If the Autochange function is used, the Interlocks must be in use. In the Autochange system there is a contactor between the ACS 400's output terminals and the speed controlled motor. The contactor is damaged if opened without first interrupting the ACS 400 inverter bridge switching. The inverter switching is interrupted when the Interlock is switched off and the ACS 400 coasts to stop.</p>																																																

Code	Description
8119	<p>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.</p>  <p><i>Figure 51 Autochange level.</i></p> <p>Autochange operation</p> <p>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 ACS 400 as well as direct on line. The starting order of the motors is changed when Autochange is done.</p> <p>To use the Autochange function, an external alternation switchgear is needed. Refer to “Appendix B” on page 157 for more information. When Autochange is used, the interlocks (parameter 8120) must also be taken into use.</p> <p>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.</p> <p>Autochange operation is as follows:</p> <ol style="list-style-type: none"> 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 ACS 400. 5. Time set with parameter 8122 PFC START DELAY is waited. 6. Speed controlled motor starts. If a constant speed motor was stopped in Step 3, one more motor is connected direct on-line by switching on the contactor of that motor. After this step the same number of motors is running as before the Autochange. 7. Normal PFC operation continues. <p>As an example, the starting order in a three motor system 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...)</p> <p>If some motors in the system are interlocked, the Autochange logic skips them. If all interlocks are active and no motor can be started, an interlock alarm (Alarm 30) is displayed.</p> <p>Note! The ACS 400 always coasts to stop when autochange is performed.</p> <p>Note! Autochange can also occur during PID sleep.</p> <p>Note! When the ACS 400’s power supply is switched off, the values of the starting order counter and Autochange Interval counter are stored in the permanent memory. The counters continue from the stored values after the power supply is switched on again.</p>

Code	Description																																																
8120	<p>INTERLOCKS Controls the use of the Interlock function.</p> <p>Warning! If the Autochange function is used, the Interlocks must also be taken into use (see parameter 8118 AUTOCHNG INTERV).</p> <p>0 = NOT SEL No Interlocks function is in use. All digital inputs are available for other purposes.</p> <p>1 = DI1 Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to the following table.</p> <table border="1" data-bbox="193 410 969 857"> <thead> <tr> <th colspan="4" data-bbox="193 410 969 451">Interlock signals</th> </tr> <tr> <th data-bbox="193 451 388 516">No of aux. motors (param. 8117)</th> <th data-bbox="388 451 583 516">ACS 400 digital inputs</th> <th data-bbox="583 451 774 516">NDIO module 1</th> <th data-bbox="774 451 969 516">NDIO module 2</th> </tr> </thead> <tbody> <tr> <td data-bbox="193 516 388 570">0</td> <td data-bbox="388 516 583 570">DI1: Motor 1 DI2-DI5 free</td> <td data-bbox="583 516 774 570">Not used</td> <td data-bbox="774 516 969 570">Not used</td> </tr> <tr> <td data-bbox="193 570 388 646">1</td> <td data-bbox="388 570 583 646">DI1: Motor 1 DI2: Motor 2 DI3-DI5 free</td> <td data-bbox="583 570 774 646"></td> <td data-bbox="774 570 969 646"></td> </tr> <tr> <td data-bbox="193 646 388 740">2</td> <td data-bbox="388 646 583 740">DI1: Motor 1 DI2: Motor 2 DI3: Motor 3 DI4-DI5 free</td> <td data-bbox="583 646 774 740"></td> <td data-bbox="774 646 969 740"></td> </tr> <tr> <td data-bbox="193 740 388 857">3</td> <td data-bbox="388 740 583 857">DI1: Motor 1 DI2: Motor 2 DI3: Motor 3 DI4: Motor 4 DI5 free</td> <td data-bbox="583 740 774 857"></td> <td data-bbox="774 740 969 857"></td> </tr> </tbody> </table> <p>2 = DI2 Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to the following table.</p> <table border="1" data-bbox="193 987 969 1498"> <thead> <tr> <th colspan="4" data-bbox="193 987 969 1027">Interlock signals</th> </tr> <tr> <th data-bbox="193 1027 388 1092">No of aux. motors (param. 8117)</th> <th data-bbox="388 1027 583 1092">ACS 400 digital inputs</th> <th data-bbox="583 1027 774 1092">NDIO module 1</th> <th data-bbox="774 1027 969 1092">NDIO module 2</th> </tr> </thead> <tbody> <tr> <td data-bbox="193 1092 388 1169">0</td> <td data-bbox="388 1092 583 1169">DI1: free DI2: Motor 1 DI3-DI5 free</td> <td data-bbox="583 1092 774 1169">Not used</td> <td data-bbox="774 1092 969 1169">Not used</td> </tr> <tr> <td data-bbox="193 1169 388 1263">1</td> <td data-bbox="388 1169 583 1263">DI1: free DI2: Motor 1 DI3: Motor 2 DI4-DI5 free</td> <td data-bbox="583 1169 774 1263"></td> <td data-bbox="774 1169 969 1263"></td> </tr> <tr> <td data-bbox="193 1263 388 1378">2</td> <td data-bbox="388 1263 583 1378">DI1: free DI2: Motor 1 DI3: Motor 2 DI4: Motor 3 DI5: free</td> <td data-bbox="583 1263 774 1378"></td> <td data-bbox="774 1263 969 1378"></td> </tr> <tr> <td data-bbox="193 1378 388 1498">3</td> <td data-bbox="388 1378 583 1498">DI1: free DI2: Motor 1 DI3: Motor 2 DI4: Motor 3 DI5: Motor 4</td> <td data-bbox="583 1378 774 1498"></td> <td data-bbox="774 1378 969 1498"></td> </tr> </tbody> </table>	Interlock signals				No of aux. motors (param. 8117)	ACS 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			Interlock signals				No of aux. motors (param. 8117)	ACS 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		
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3	DI1-DI2: free DI3: Motor 1 DI4: Motor 2 DI5: Motor 3	DI1: Motor 4 DI2: Unused	Not used																																														
	Interlock signals																																																
No of aux. motors (param. 8117)	ACS 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																																																
	<p data-bbox="139 152 990 212">5 = DI5 Interlocks function is in use. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to the following table.</p> <table border="1" data-bbox="195 261 969 578"> <thead> <tr> <th data-bbox="195 261 389 298"></th> <th colspan="3" data-bbox="392 261 969 298">Interlock signals</th> </tr> <tr> <th data-bbox="195 303 389 363">No of aux. motors (param. 8117)</th> <th data-bbox="392 303 583 363">ACS 400 digital inputs</th> <th data-bbox="586 303 774 363">NDIO module 1</th> <th data-bbox="777 303 969 363">NDIO module 2</th> </tr> </thead> <tbody> <tr> <td data-bbox="195 368 389 418">0</td> <td data-bbox="392 368 583 418">DI1-DI4: free DI5: Motor 1</td> <td data-bbox="586 368 774 418">Not used</td> <td data-bbox="777 368 969 418">Not used</td> </tr> <tr> <td data-bbox="195 423 389 474">1</td> <td data-bbox="392 423 583 474">DI1-DI4: free DI5: Motor 1</td> <td data-bbox="586 423 774 474">DI1: Motor 2 DI2: Unused</td> <td data-bbox="777 423 969 474">Not used</td> </tr> <tr> <td data-bbox="195 479 389 529">2</td> <td data-bbox="392 479 583 529">DI1-DI4: free DI5: Motor 1</td> <td data-bbox="586 479 774 529">DI1: Motor 2 DI2: Motor 3</td> <td data-bbox="777 479 969 529">Not used</td> </tr> <tr> <td data-bbox="195 534 389 578">3</td> <td data-bbox="392 534 583 578">DI1-DI4: free DI5: Motor 1</td> <td data-bbox="586 534 774 578">DI1: Motor 2 DI2: Motor 3</td> <td data-bbox="777 534 969 578">DI1: Motor 4 DI2: Unused</td> </tr> </tbody> </table> <p data-bbox="139 618 1021 678">6 = EXTERNAL IO Interlocks function is in use. All interlock signals are taken through external I/O modules. Depending on the number of motors, the digital inputs are reserved for the interlock signals according to the following table.</p> <table border="1" data-bbox="195 724 969 1040"> <thead> <tr> <th data-bbox="195 724 389 761"></th> <th colspan="3" data-bbox="392 724 969 761">Interlock signals</th> </tr> <tr> <th data-bbox="195 766 389 826">No of aux. Motors (param. 8117)</th> <th data-bbox="392 766 583 826">ACS 400 digital inputs</th> <th data-bbox="586 766 774 826">NDIO module 1</th> <th data-bbox="777 766 969 826">NDIO module 2</th> </tr> </thead> <tbody> <tr> <td data-bbox="195 831 389 881">0</td> <td data-bbox="392 831 583 881">DI1-DI5: free</td> <td data-bbox="586 831 774 881">DI1: Motor 1 DI2: Unused</td> <td data-bbox="777 831 969 881">Not used</td> </tr> <tr> <td data-bbox="195 886 389 937">1</td> <td data-bbox="392 886 583 937">DI1-DI5: free</td> <td data-bbox="586 886 774 937">DI1: Motor 1 DI2: Motor 2</td> <td data-bbox="777 886 969 937">Not used</td> </tr> <tr> <td data-bbox="195 941 389 992">2</td> <td data-bbox="392 941 583 992">DI1-DI5: free</td> <td data-bbox="586 941 774 992">DI1: Motor 1 DI2: Motor 2</td> <td data-bbox="777 941 969 992">DI1: Motor 3 DI2: Unused</td> </tr> <tr> <td data-bbox="195 997 389 1040">3</td> <td data-bbox="392 997 583 1040">DI1-DI5: free</td> <td data-bbox="586 997 774 1040">DI1: Motor 1 DI2: Motor 2</td> <td data-bbox="777 997 969 1040">DI1: Motor 3 DI2: Motor 4</td> </tr> </tbody> </table> <p data-bbox="139 1089 1021 1149">Interlock signals are active low, i.e. an interlock is active when the corresponding interlock signal is absent. If a start command is given when the interlock signal of the speed regulated motor is active, the ACS 400 will not start, and will show alarm 30 (INTERLOCK) on the control panel.</p> <p data-bbox="139 1159 543 1180">Each Interlock circuit should be wired as follows:</p> <ol data-bbox="139 1190 1021 1304" style="list-style-type: none"> <li data-bbox="139 1190 1021 1250">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. <li data-bbox="139 1260 1021 1304">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. 		Interlock signals			No of aux. motors (param. 8117)	ACS 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		Interlock signals			No of aux. Motors (param. 8117)	ACS 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
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0	DI1-DI4: free DI5: Motor 1	Not used	Not used																																														
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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																																														



Code	Description
8121	<p>REG BYPASS CTRL</p> <p>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 53 and Figure 54.</p> <p>0 = NO Process PID regulator is in use.</p> <p>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.</p> <div data-bbox="221 394 923 813" data-label="Diagram"> </div> <p>Figure 53 Regulator bypass control. The capacity of the pumping station (outlet flow) follows the measured inlet flow.</p> <div data-bbox="221 927 976 1404" data-label="Figure"> <p>a: No auxiliary motors running b: One auxiliary motor running c: Two auxiliary motors running</p> </div> <p>Figure 54 The relation between the control signal and the frequency of the controlled motor in a three-motor system.</p>

Code	Description
8122	<p data-bbox="108 149 281 170">PFC START DELAY</p> <p data-bbox="108 172 771 193">Sets the start delay for all the motors in the system. The delay works as follows:</p> <ol data-bbox="108 199 970 302" style="list-style-type: none"><li data-bbox="108 199 970 245">1. The contactor that connects the speed regulated motor to the ACS 400 is switched on (by a ACS 400 relay output).<li data-bbox="108 250 348 271">2. PFC Start Delay is waited.<li data-bbox="108 276 948 302">3. Speed regulated motor is energized and normal PFC operation starts. Auxiliary motors are started. <p data-bbox="108 308 998 396">Caution! There should always be PFC Start Delay 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 ACS 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 ACS 400 inverter starts switching.</p>

Standard Serial Communication

Overview

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

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

Optional serial communication features

The ACS 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.

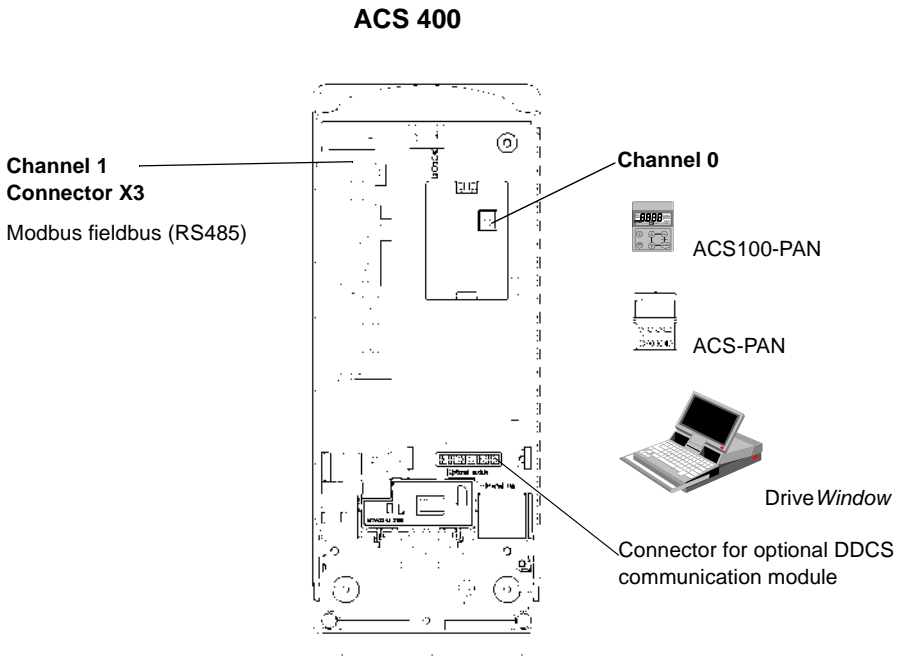


Figure 55 Standard serial communication features of ACS 400.

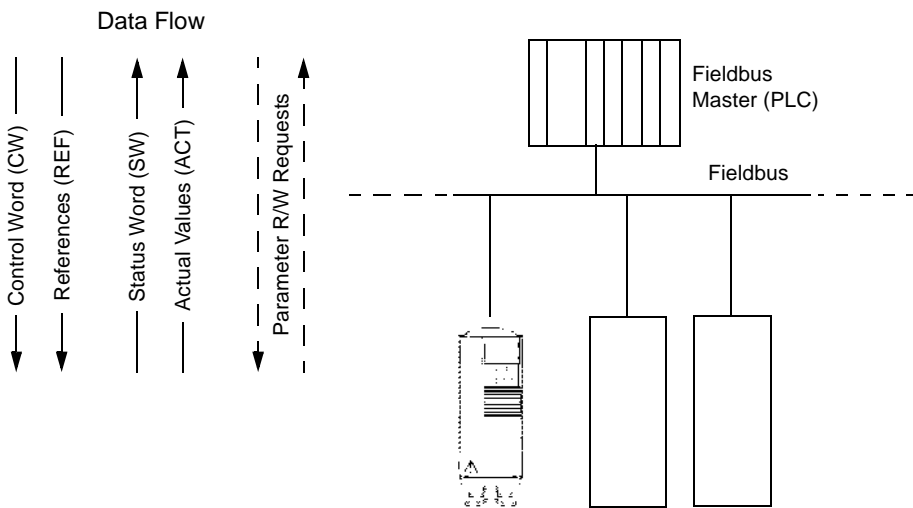


Figure 56 Structure of a fieldbus system.

Grounding and Termination

RS485 Bus

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

As always, the grounding wires should not form any closed loops, and all the devices should be earthed to a common ground.

The RS485 network must be terminated using $120\ \Omega$ resistors at both ends of the network. Use DIP switch to connect or disconnect the termination resistors.

The termination should not be done on the intermediate stations on the network as shown in Figure 57.



Figure 57 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 ACS 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 ACS 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 parameters in groups 50 COMMUNICATION and 52 STANDARD MODBUS.

The default communication settings for Channel 1 are listed in Table 13. To be able to communicate with the master device, the ACS 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 "ACS 400 Complete Parameter List" on page 65.

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 ACS 400 in Modbus network.
5202	COMM SPEED	3 = 300 bps ... 192 = 19200 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 ACS 400 drive can receive control information from multiple sources, including digital I/O, analog I/O, keypad, and Modbus fieldbus.

To control the ACS 400 via the serial communication channel 1 (Modbus fieldbus), it must be programmed to accept control commands and/or frequency references from this channel. In addition, ACS 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 “ACS 400 Complete Parameter List” on page 65.

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 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 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 control location. See section References below for information on the alternative settings.

Code	Parameter Name	Alternative Settings	Setting for Standard Modbus	Function/Information
1106	EXT REF2 SELECT	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 control location. See section References below for information on the alternative settings.
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 serial communication channel 1.

Relay outputs can be controlled in the following way:

Step 1: Configure the ACS 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 to supervised parameter (131-133) *some* value that is either above or below the given supervision limits.

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

Refer to Table 17 for information on analog output control.

Table 16 Relay output control.

Code	Parameter Name	Alternative Settings	Setting for Standard Modbus	Function/Information
Group 01				
OPERATING DATA				
0131	SER LINK DATA 1	0 - 255	-	Controlling data for the relay outputs.
0132	SER LINK DATA 2	0 - 255	-	

Code	Parameter Name	Alternative Settings	Setting for Standard Modbus	Function/Information
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 (SUPRV1 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 (SUPRV1 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) reached when value 255 is written to parameter 133.

Diagnostic Counters

Diagnostic counters can be used for debugging the Modbus system.

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

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

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

Table 18

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

Communication

This chapter describes the Modbus communication on ACS 400 drives.

Introduction to Modbus

Modbus is a serial, asynchronous protocol. The Modbus protocol does not specify the physical interface. 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 ACS 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 ACS 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 ACS 400 parameter grouping.

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

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 4xxx area so that:

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

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

Table 19 Parameter mapping.

4GGPP	GG	PP
40001 – 40006	00 Drive control registers	01 Control word 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 ACS 400 supports the standard Modbus exception codes. These are shown in Table 20.

Table 20 Exception codes.

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

Function Codes

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

Table 21 Function codes.

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

The Control Word 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 serial communication channel (set by parameters 1001 EXT1 COMMANDS, 1002 EXT2 COMMANDS and 1102 EXT1/EXT2 SEL), and
- 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 22) 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 also state machine on CROSSREF.

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 24.

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 ACS 400.

Table 22 The Control Word. See also the state machine in Figure 58 on page 147.

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 58) is NOT READY TO SWITCH ON. Control Word is used to step through the state machine states until OPERATING state is reached, meaning that the drive is running and follows the given reference.

Table 23 Using the Control Word.

	Control Word Value	Description
Step 1	CW = 0000 0000 0000 0110 <div style="display: flex; justify-content: space-around; width: 100px;"> <div style="text-align: center;"> bit 15</div> <div style="text-align: center;"> bit 0</div> </div>	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. 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. 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. The drive will accelerate to the given reference and will follow the reference.

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

Table 24 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 (<i>OPERATION INHIBITED</i>)
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 ACS 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 ACS 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: $20000 \hat{=} \text{EXT REF1 MAX (Hz, parameter 1105)}$. Scaling Parameter 1104 EXT REF1 MIN is not used.

Reference 2: $10000 \hat{=} \text{EXT REF2 MAX (\%, parameter 1108)}$. 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. When the analog input is 50 %, the correction is 0. When the input is <50 % (>50 %), the correction reduces (respectively increases) the reference used.

Table 25 Correcting the fieldbus reference through analog input.

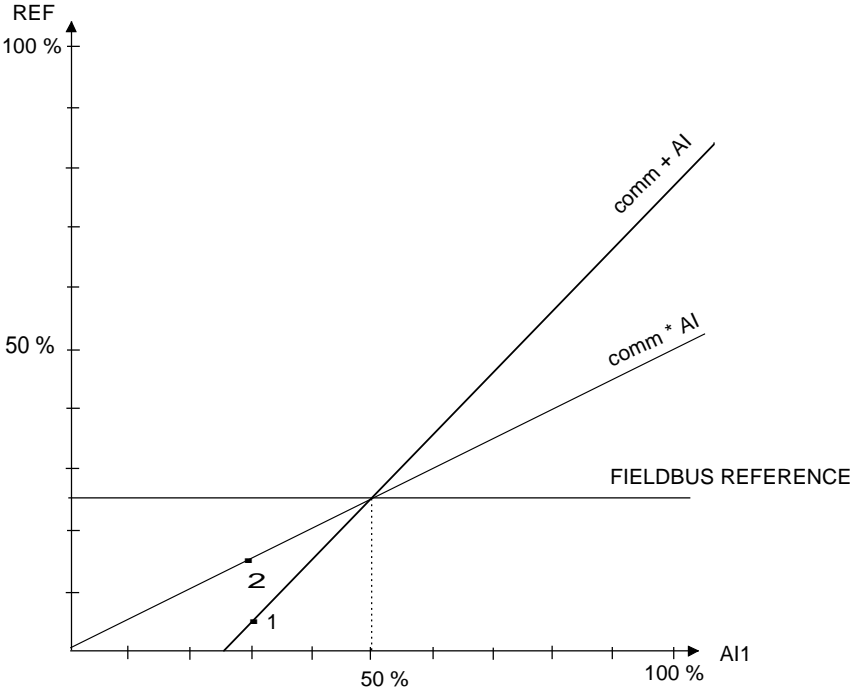
Parameter Setting	Effect of AI1 Value on Fieldbus Reference
COMM	None
COMM+AI1	Corrected fieldbus reference = given fieldbus reference + analog input AI1 value
COMM*AI1	Corrected fieldbus reference = given fieldbus reference * analog input AI1 value / 50 %

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 $25 \% + 30 \% - 50 \% = 5 \%$ or 2.5 Hz.
2. If setting $COMM*AI1$ is used, then the corrected fieldbus reference is $25 \% * 30 \% / 50 \% = 15 \%$ or 7.5 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

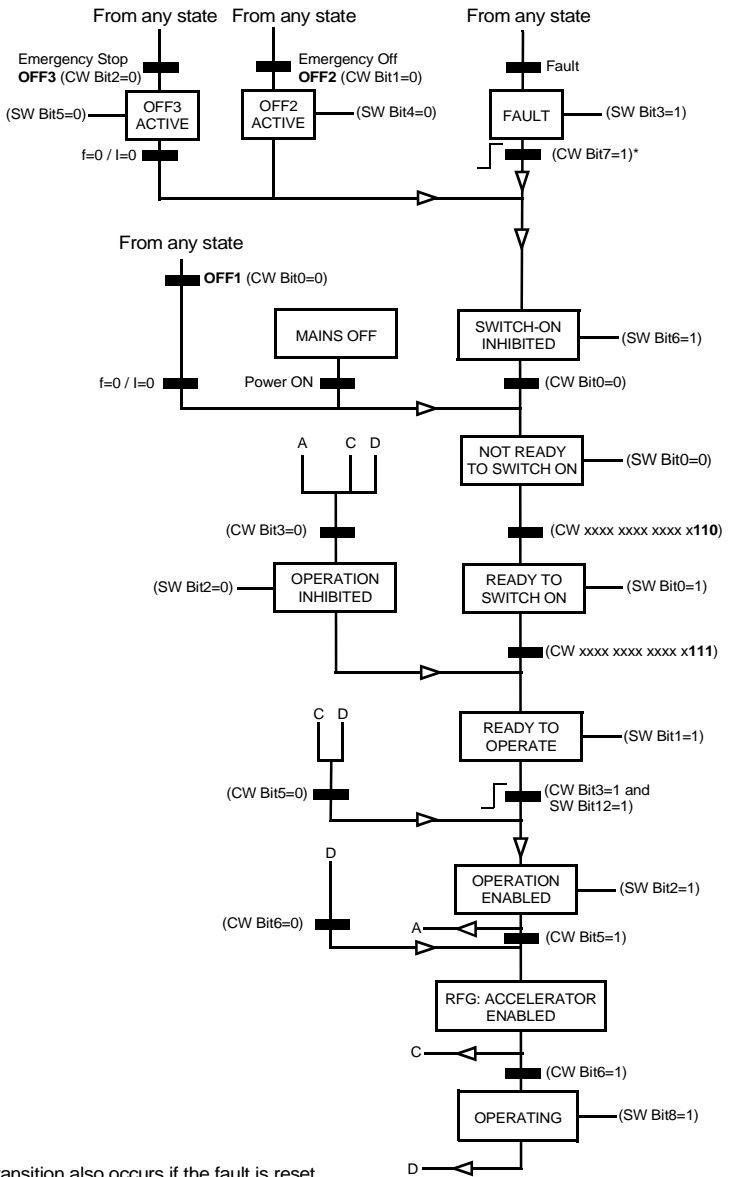
Holding Register: 40005

Actual output frequency. Scaling: $5000 \hat{=} 50$ Hz.

Actual Value 2

Holding Register: 40006

Actual output current. Scaling: $10 \hat{=} 1$ A.



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

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

Figure 58 The state machine for evaluation of start and stop signals.

Fault and Alarm Status

The ACS 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 read-only type; however, both alarm words can be reset by writing a zero to them.

Table 26 Fault and alarm status words.

Code	Name	Description
301	MAIN COMMAND WORD	Read-only copy of the Control Word. See page 141.
302	MAIN STATUS WORD	Read-only copy of the Status Word. See page 143.
305	FAULT WORD 1	Fault information. When a fault is active, the corresponding bit is set. Bit descriptions are given in Table 27.
306	FAULT WORD 2	Fault information. When a fault is active, the corresponding bit is set. Bit descriptions are given in Table 27.
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 28.
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 28.

Table 27 Bit descriptions for fault words 1 and 2. See also 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	ACS 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 28 Bit descriptions for ALARM WORD 1 and ALARM WORD 2. See also 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	ACS 400 overtemperature	
10	Motor overtemperature	
11	Underload	
12	Motor stall alarm	
13	DDCS link	
14	Reserved	
15	Reserved	

Appendix A

Local Control vs. Remote Control

The ACS 400 can be controlled from two remote control locations or from the control panel. Figure 59 below shows the ACS 400 control locations.

The selection between local control (**LOC**) and remote control (**REM**) is 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.

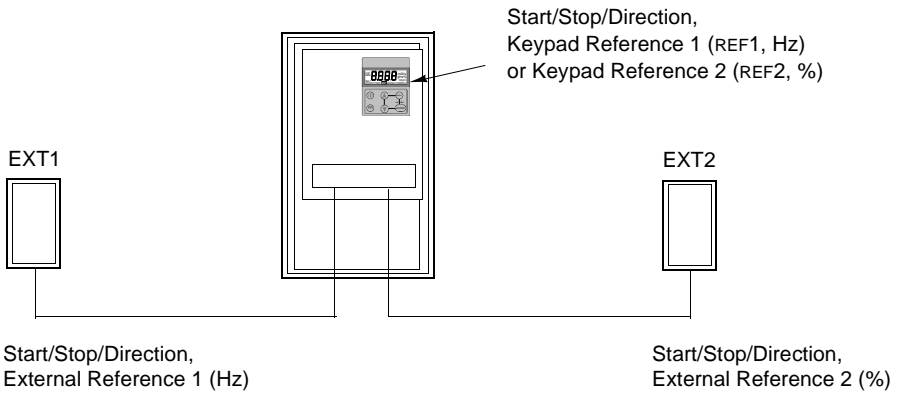


Figure 59 Control locations.

Local Control

The control commands are given explicitly from the control panel when the ACS 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 ACS 400 in Hz. If REF2 (%) is selected, the reference is given in per cent.

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

Remote Control

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

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

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

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

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

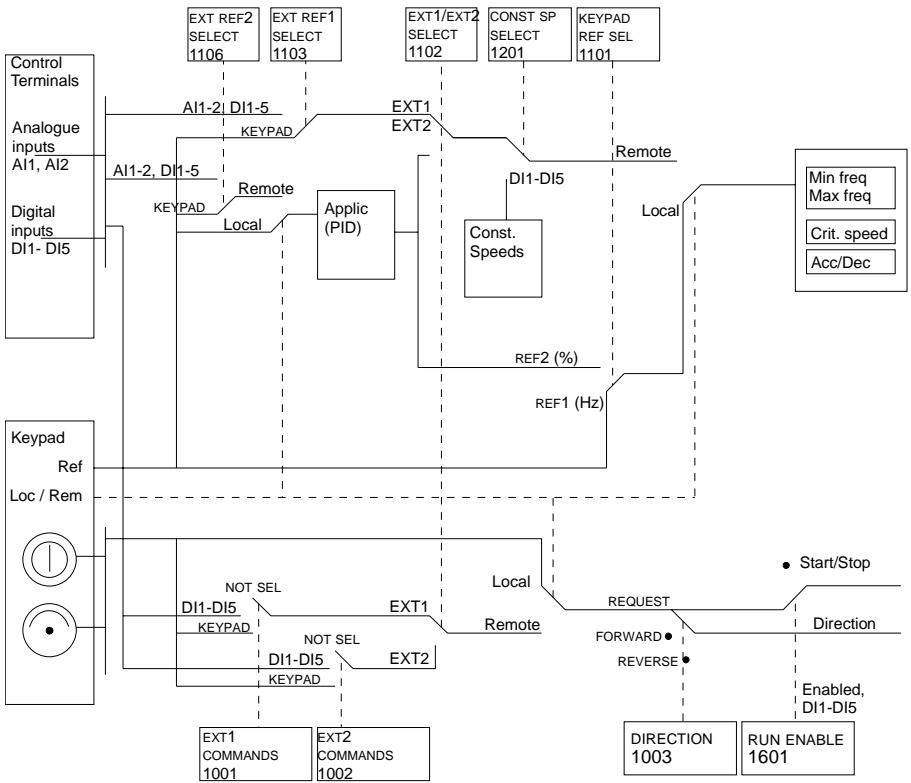


Figure 60 Selecting control location and control source.

Internal Signal Connections for the Macros

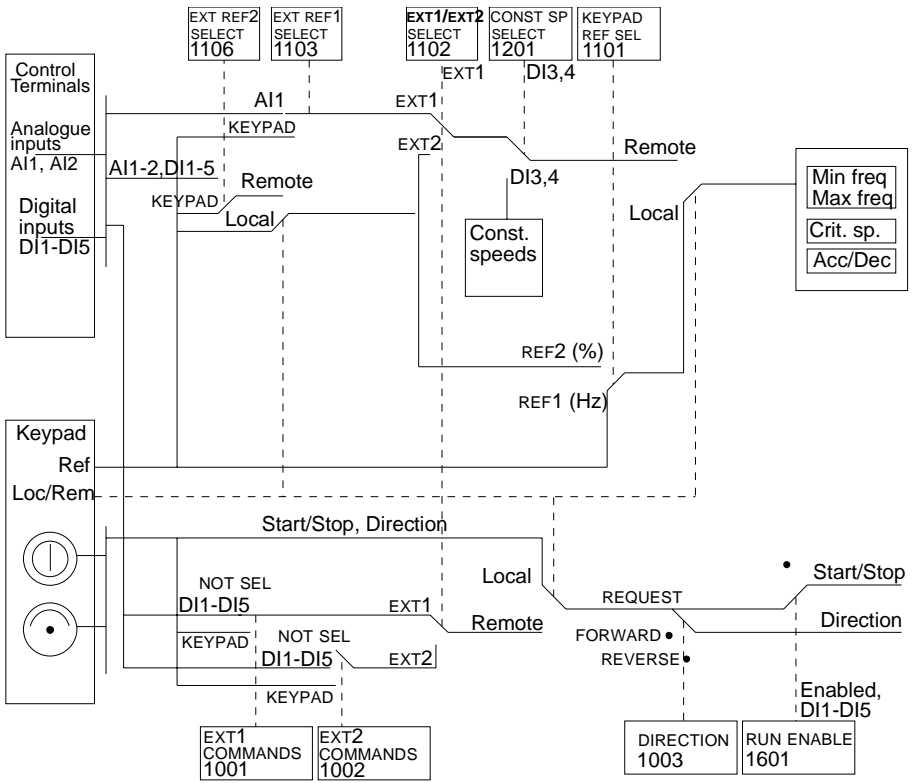


Figure 61 The control signal connections of the ABB Standard, Alternate and Premagnetize macros.

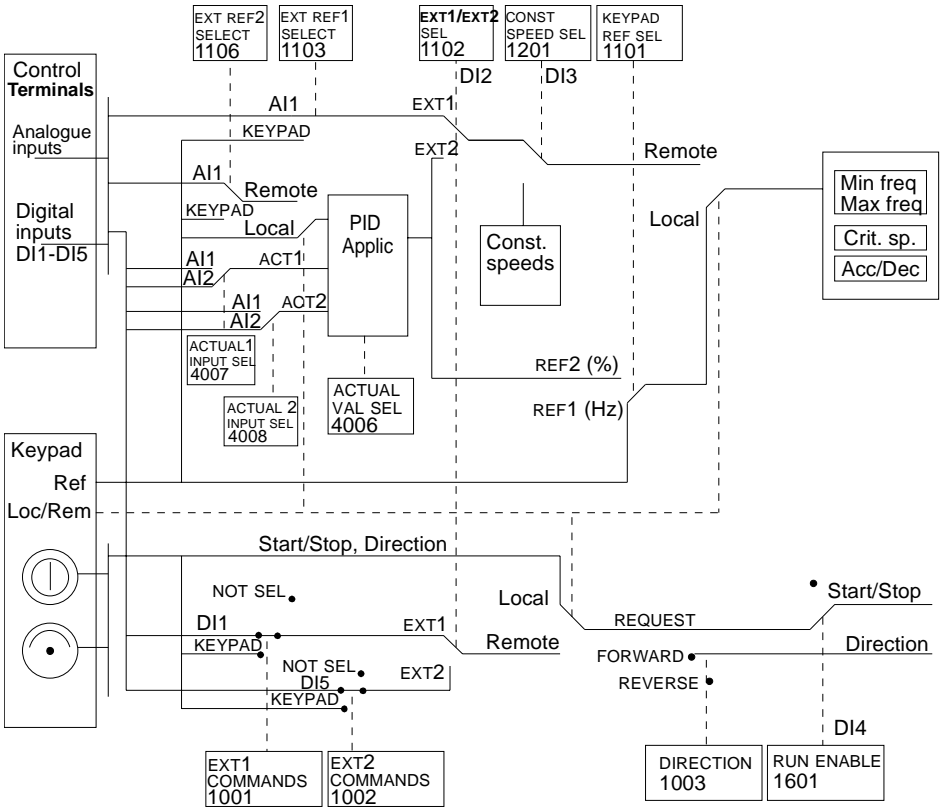


Figure 62 The control signal connections of the PID Control macro.

Appendix B

ACS 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 of pump no. 1 is connected to the ACS 400. The capacity of the pump is controlled by varying the motor speed.
- The motor of pump no. 2 is connected direct on-line. The pump can be switched on and off by the ACS 400 when necessary.
- The process reference and actual value are fed to the ACS 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 ACS 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. Thus 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 bypass, see parameter group 40, 41 and 81 parameter descriptions.

As default when PFC macro is selected, the ACS 400 receives the 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). A Run Enable signal is received through the digital input 2 and the 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 ACS 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.

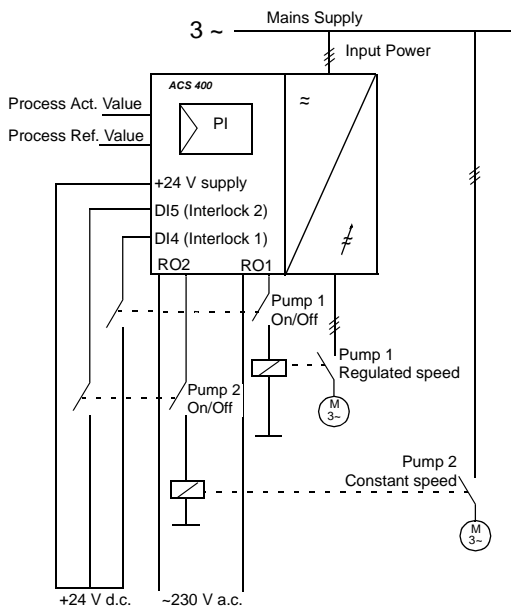


Figure 63 Operation Diagram for the Pump and Fan Control (PFC) Macro. With the default settings, automatic pump alternation is not in use.

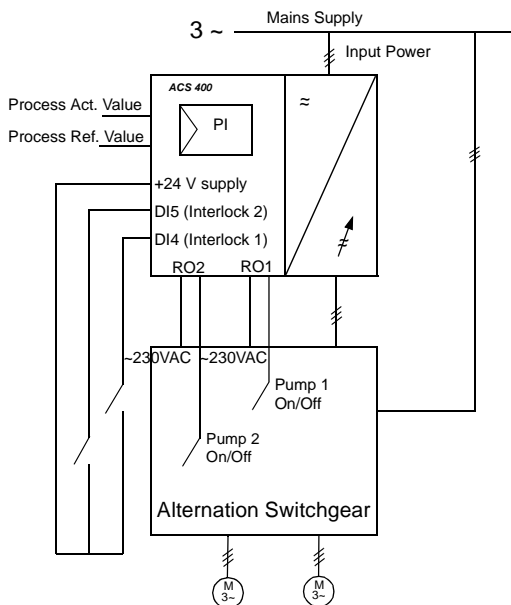


Figure 64 In this example the automatic pump alternation is in use.

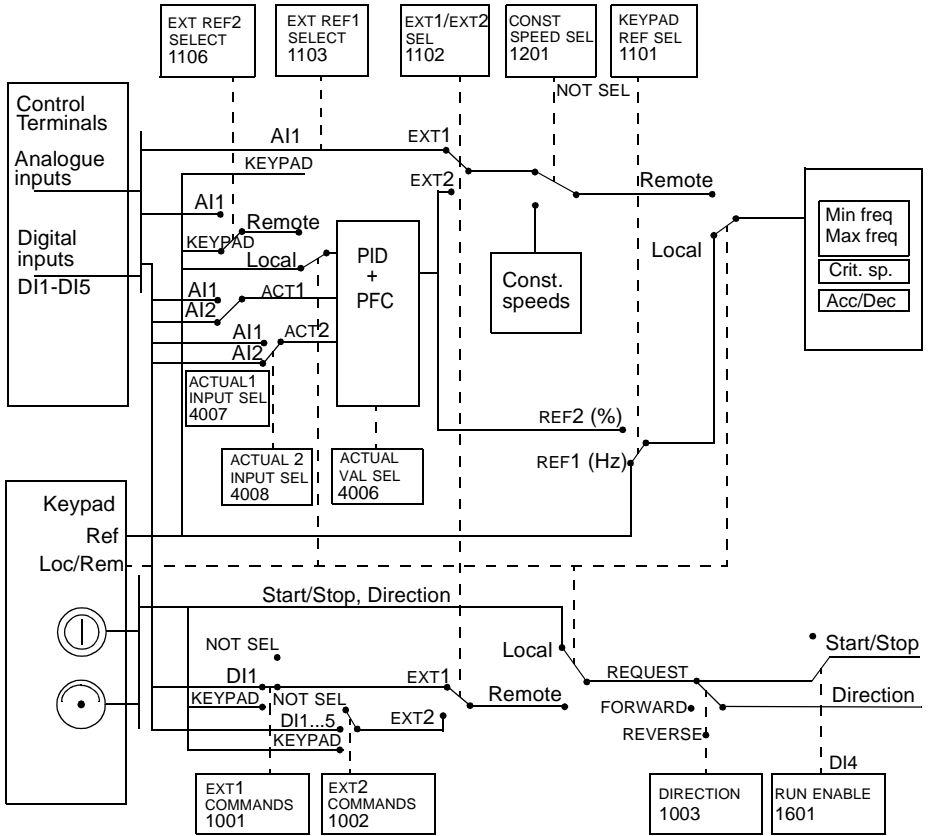


Figure 65 The control signal connections of the Pump and Fan Control (PFC) macro.

PID Controller

The ACS 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 regulation when the output of the PID controller falls below preset limit; recovery when the process actual value falls below the 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 ACS 400 has two programmable relay outputs. Relay output 1 and 2 operation is configured by parameters 1401 RELAY OUTPUT 1 and 1402 RELAY OUTPUT 2. 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 ACS 400

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

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

I/O extension modules are connected to the ACS 400 via a DDCS fiber optic link. An optional DDCS communication module is needed to use DDCS.

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 ACS 400 and NDIO modules is set up as follows:

- Set the module node numbers using the DIP switches located inside the modules. Refer to 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 NDIO modules.
- Activate DDCS protocol by setting parameter 5005 PROTOCOL SEL to 1 (DDCS).
- Tell the ACS 400 that extended I/O is used by setting parameter 5007 DDCS BUS MODE to 2 (EXTENDED IO). Communication between the ACS 400 and the NDIO module(s) is now operating.

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 ACS 400. Contact your nearest ABB supplier for more information.

Appendix C

ACS 400 EMC Instructions

Mandatory Installation Instruction According to the EMC Directive for type ACS 400 frequency converters

Follow the instructions given in the ACS 400 User's Manual and the instructions delivered with different accessories.

CE Marking

A CE mark is attached to ACS 400 frequency converters to verify that the unit follows the provisions of the European Low Voltage and EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC and Directive 89/336/EEC, as amended by 93/68/EEC).

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used in European Economic Area. The EMC product standard EN 61800-3 covers the requirements stated for frequency converters. ACS 400 frequency converters comply with the requirements stated in EN 61800-3 for Second Environment and First Environment, restricted distribution.

Product standard EN 61800-3 (Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods) defines **First Environment** as environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low voltage power supply network which supplies buildings used for domestic purposes.

Second Environment includes establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes. With ACS 400, no RFI filter is needed in Second Environment.

C-Tick Marking

A C-tick mark is attached to the ACS 400 frequency converters to verify that the unit follows the provisions of the Australian Statutory Rules No 294, 1996, Radiocommunication (Compliance Labelling - Incidental Emissions) Notice and the Radiocommunication Act, 1989, and the Radiocommunication Regulations, 1993, of New Zealand.

The statutory rules defines the essential requirements for emissions of electrical equipment used in Australia and New Zealand. The standard AS/NZS 2064, 1997, Limits and methods of measurement of electronic disturbance characteristics of industrial, scientific and medical (ISM) radiofrequency equipment, covers the detailed requirements for three-phase frequency converter.

The frequency converter ACS 400 comply with the AS/NZS 2064, 1997, limits for class A equipment. Class A equipment is suitable for use in all establishments other than domestic and those directly connected to a low voltage network which supplies buildings used for domestic purposes. The compliance is valid with the following provisions:

- The frequency converter is equipped with RFI-filter.
- The motor and control cables are chosen as specified in this manual.
- The installation rules of this manual are followed.

Cabling Instructions

Keep individual unscreened wires between the cable clamps and the screw terminals as short as possible. Route control cables away from power cables.

Mains Cable

A four conductor cable (three phase with protective earth) is recommended for the mains cabling. Shielding is not necessary. Dimension the cables and fuses in accordance with the input current. Always pay attention to local legislation when sizing the cables and fuses.

The mains input connectors are at the bottom of the converter unit. Mains cable routing must be done so that the distance from the sides of the converter is at least 20 cm to avoid excessive radiation to the mains cable. In the case of shielded cable, twist the cable screen wires together into a bundle not longer than five times its width and connect to the PE terminal of the converter. (Or PE terminal of input filter, if present.)

Motor Cable

The motor cable must be a symmetrical three conductor cable with a concentric PE conductor or a four conductor cable with a concentric shield, however, a symmetrical constructed PE conductor is always recommended. Minimum requirement for the motor cable screen is presented in Figure 66.

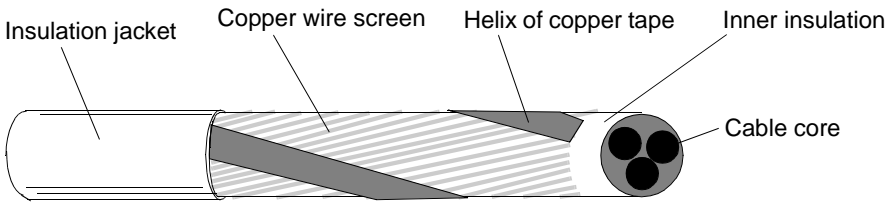


Figure 66 Minimum requirement for motor cable screen (e.g. MCMK, NK Cables).

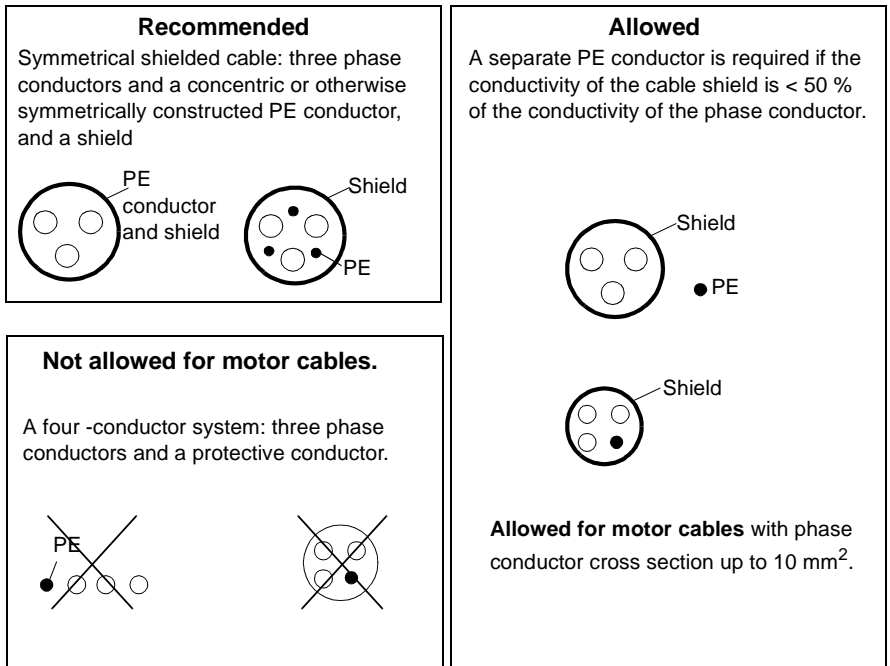


Figure 67 Cable recommendations and restrictions.

The general rule for cable screen effectiveness is: the better and tighter the screen of the cable, the lower the radiated emission level. Example of an effective construction is presented in Figure 68.

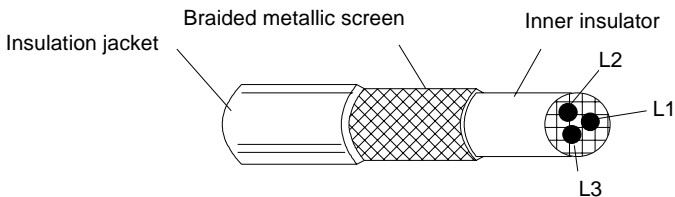


Figure 68 Effective motor cable screen (e.g. Ölflex-Servo-FD 780 CP, Lappkabel or MCCMK, NK Cables).

Clamp the cable shield into the gland plate at the converter end and twist the cable screen wires together into a bundle not longer than five times its width and connect it to the terminal marked \perp (at the bottom right-hand corner of the converter), if you are using cable without a separate PE conductor.

At the motor end the motor cable screen must be earthed 360 degrees with an EMC cable gland (e.g. ZEMREX SCG Screened cable glands) or the screen wires must be twisted together into a bundle not longer than five times its width and connected to the PE terminal of the motor.

Control Cables

Control cables must be multi-core cables with a braided copper wire screen.

The screen must be twisted together into a bundle not longer than five times its width and connected to terminal X1:1 (digital and analogue I/O) or X3.1 or X3.5 (RS485).

Route the control cables as far away as possible from the mains and motor cables (at least 20 cm). Where control cables must cross power cables make sure they are at an angle as near 90 degrees as possible. Also the cable routing must be done so that the distance from the sides of the converter is at least 20 cm to avoid excessive radiation to the cable.

A double shielded twisted pair cable is recommended for the analogue signals. Employ one individually shielded pair for each signal. Do not use common return for different analogue signals.

A double shielded cable is the best alternative for low voltage digital signals but single shielded twisted multipair cable is also usable (see Figure 69).

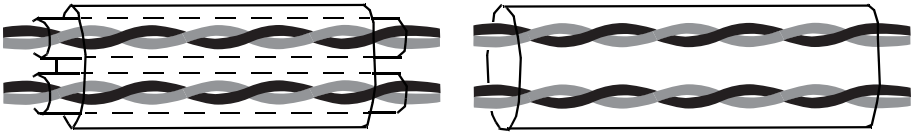


Figure 69 A double shielded twisted pair cable on the left and a single shielded twisted multipair cable on the right.

The analogue and digital input signals should be run in separate, screened cables.

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

Never mix 24 VDC and 115/230 VAC signals in the same cable.

Note! When the overriding control equipment and the ACS 400 are installed inside the same cabinet, these recommendations might be overly cautious. If the customer plans to test the entire installation, there is an opportunity to save some costs by relaxing these recommendations, for example by using unshielded cable for the digital inputs. But the customer must verify this.

Control Panel Cable

If the control panel is connected to the converter with a cable, use only the panel extension cable provided with the option package PEC-98-0008. Follow the instructions delivered with the option package.

Route the control panel cable as far away as possible from the mains and motor cables (at least 20 cm). Also the cable routing must be done so that the distance from the sides of the converter is at least 20 cm to avoid excessive radiation to the cable.

Additional Instructions to Comply with EN61800-3, First Environment, Restricted Distribution, and AS/NZS 2064, 1997, Class A

Always use an optional RFI filter as specified in Table 29 and follow the instructions in the filter package for all cable screen connections.

The motor cable lengths have to be limited as specified in Table 29 and the cable must have effective screen according to Figure 68. At the motor end, the cable screen must be earthed 360 degrees with an EMC cable gland (e.g. Zemrex SCG screened cable glands).

Table 29 Maximum motor cable lengths with input filters ACS400-IF11-3... ACS400-IF41-3 and switching frequency 4 kHz or 8 kHz .

Converter Type	Filter	Switching Frequency	
		4 kHz	8 kHz
ACS/ACH 401-x004-3-x	ACS400-IF11-3	100 m	-
	ACS400-IF22-3	10 m	10 m
ACS/ACH 401-x005-3-x	ACS400-IF11-3	100 m	-
	ACS400-IF22-3	10 m	10 m
ACS/ACH 401-x006-3-x	ACS400-IF11-3	100 m	-
	ACS400-IF22-3	10 m	10 m
ACS/ACH 401-x009-3-x	ACS400-IF21-3	100 m	100 m
	ACS400-IF22-3	10 m	10 m
ACS/ACH 401-x011-3-x	ACS400-IF21-3	100 m	100 m
	ACS400-IF22-3	10 m	10 m
ACS/ACH 401-x016-3-x	ACS400-IF31-3	100 m	100 m
ACS/ACH 401-x020-3-x	ACS400-IF31-3	100 m	100 m
ACS/ACH 401-x025-3-x	ACS400-IF41-3	100 m	100 m
ACS/ACH 401-x030-3-x	ACS400-IF41-3	100 m	100 m
ACS/ACH 401-x041-3-x	ACS400-IF41-3	100 m	100 m

Conducted emission with input filters ACS400-IF11-3 and ACS400-IF21-3 complies with the limits for unrestricted distribution class in First Environment as specified in EN61800-3 (EN50081-1) provided that maximum motor cable length is 30 m and switching frequency 4 kHz.

Line Current Harmonics

The current harmonic levels under rated load conditions are available on request.

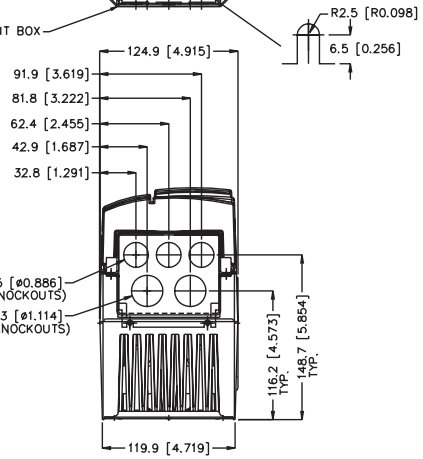
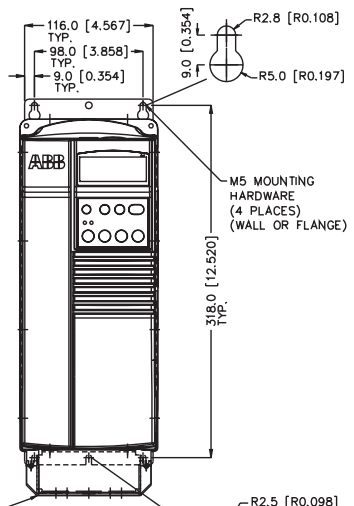
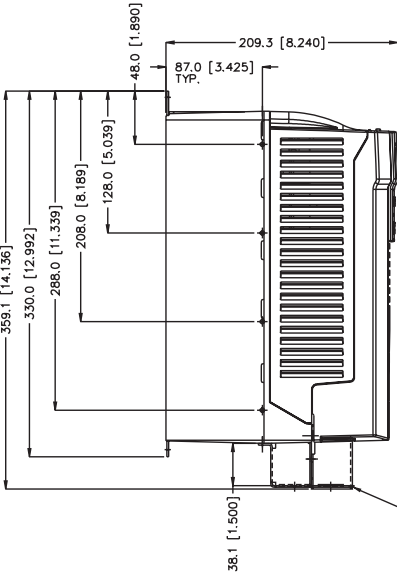
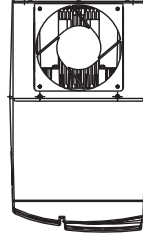
Distribution Networks Isolated from Earth

Input filters designed for ACS 400 cannot be used in an isolated, or high impedance earthed industrial distribution networks.

Appendix D

ACS 400 Dimensional Drawings

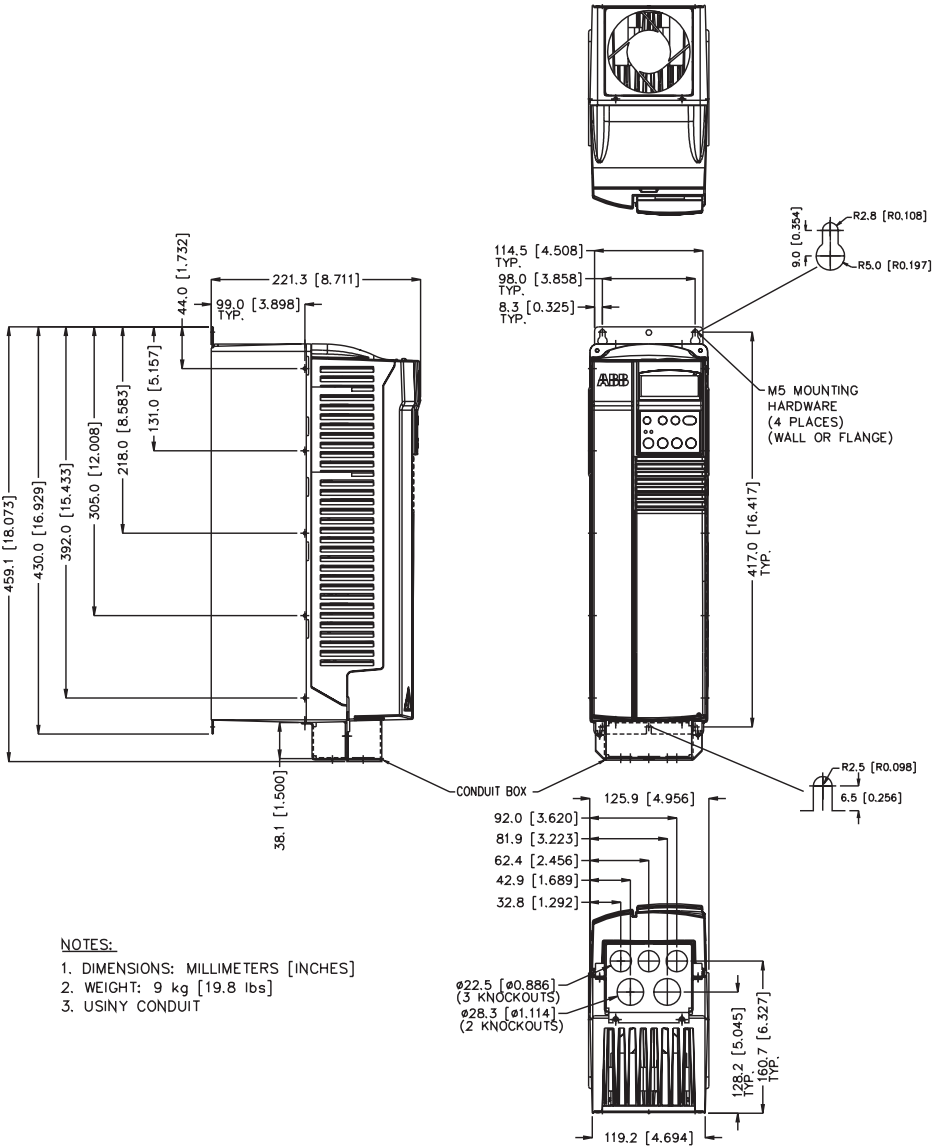
ACS 400 NEMA Type 1 Enclosure, R1 Frame Size



NOTES:

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

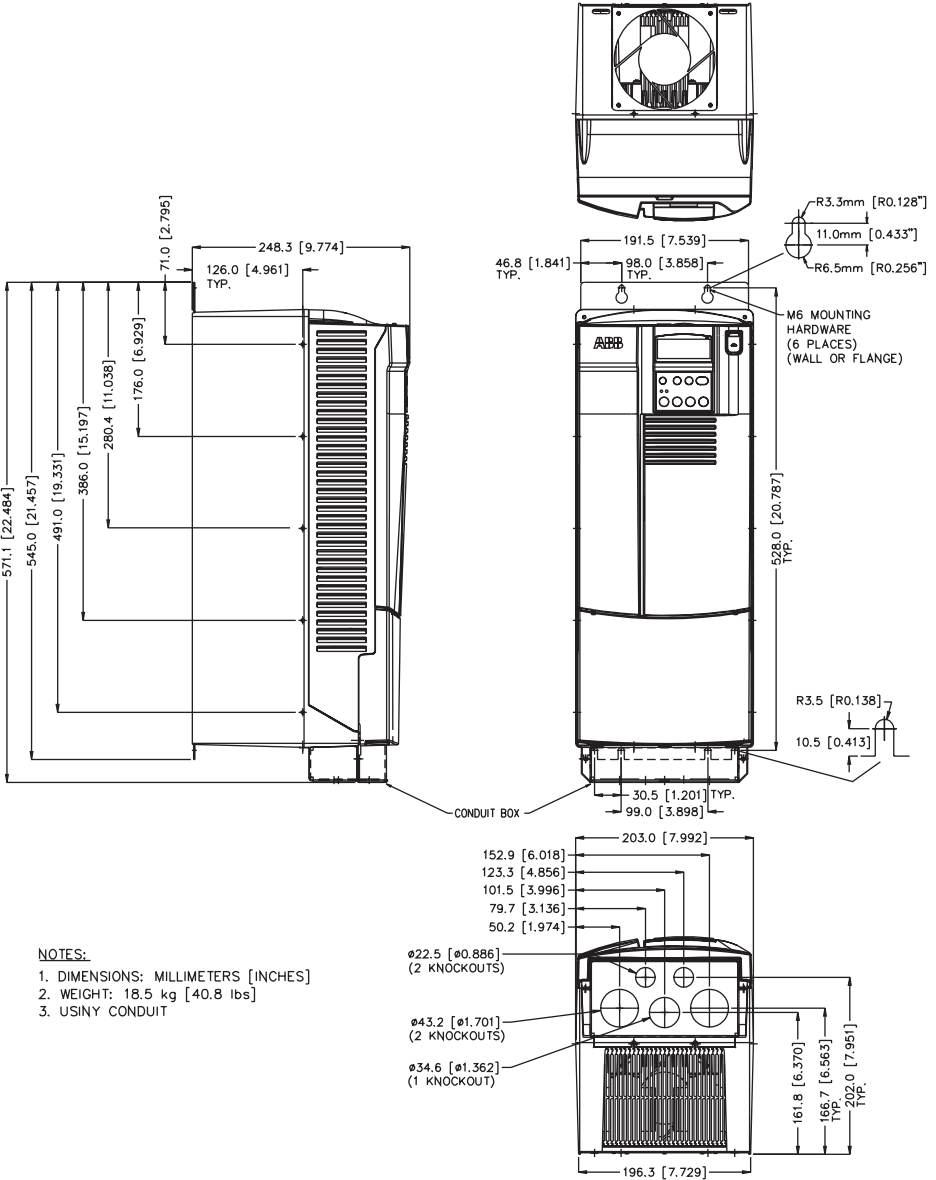
ACS 400 NEMA Type 1 Enclosure, R2 Frame Size



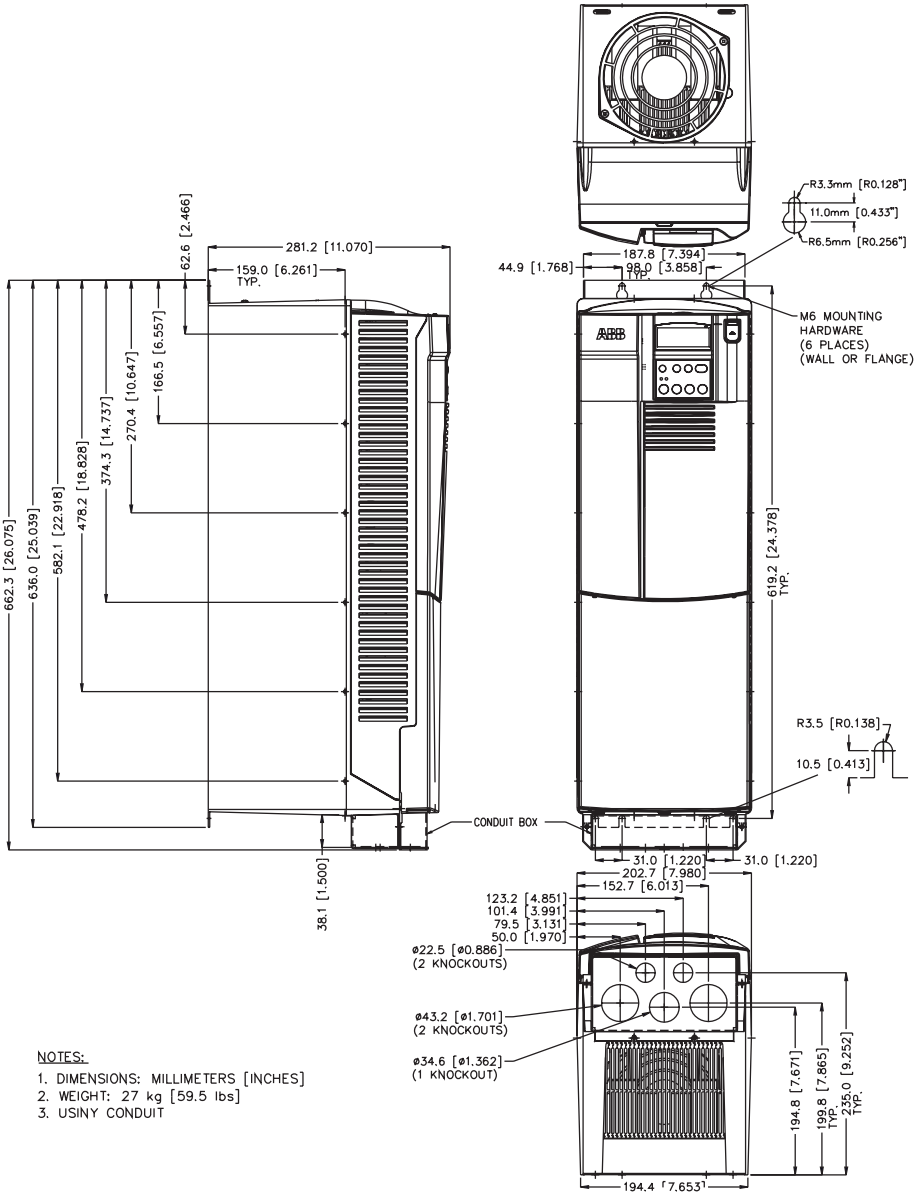
NOTES:

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

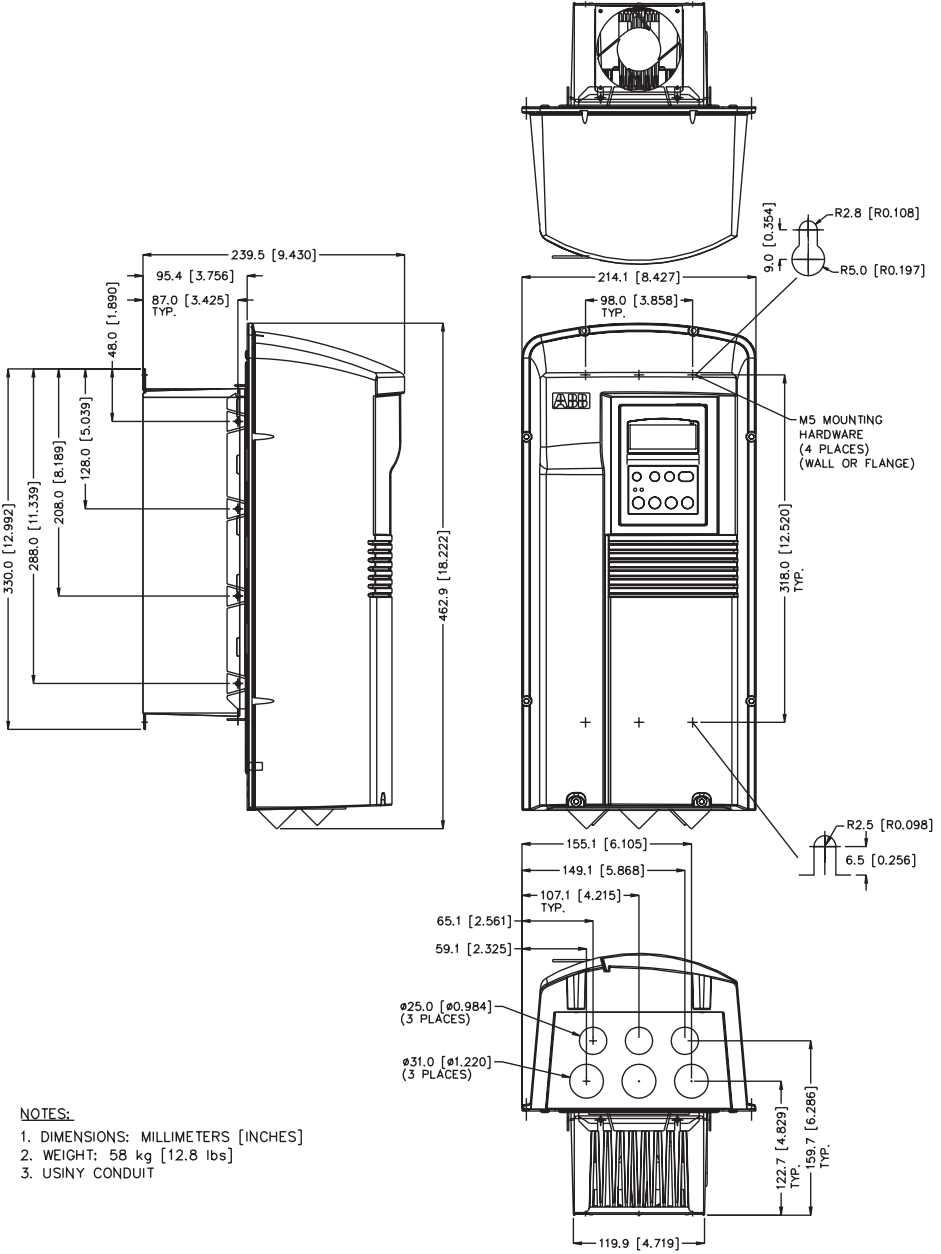
ACS 400 NEMA Type 1 Enclosure, R3 Frame Size



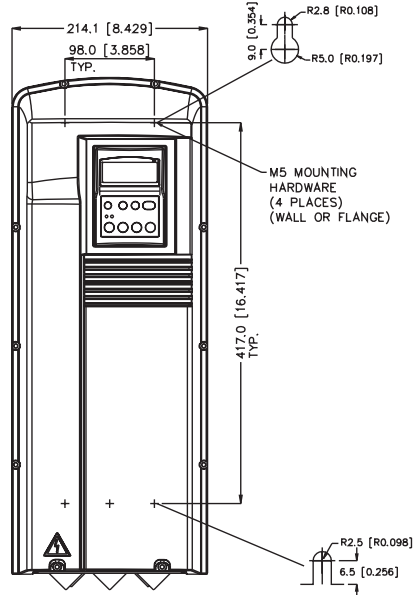
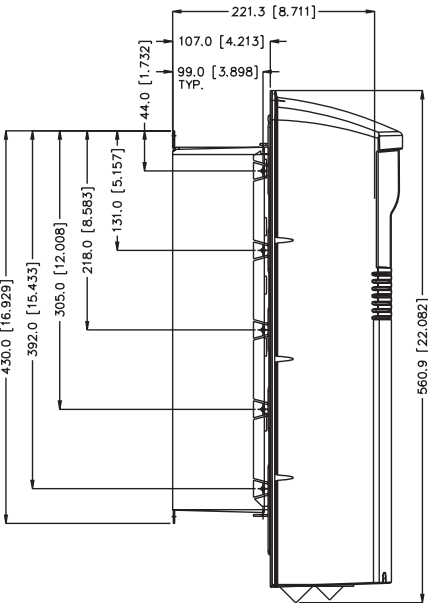
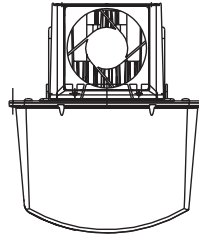
ACS 400 NEMA Type 1 Enclosure, R4 Frame Size



ACS 400 NEMA Type 12 & 4 Enclosure, R1 Frame Size

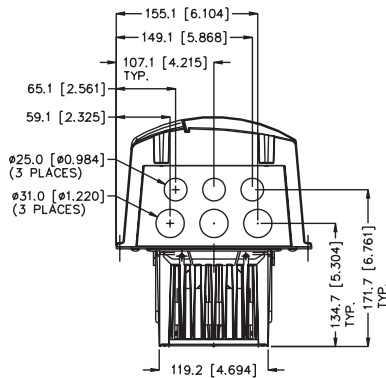


ACS 400 NEMA 12 & 4 Enclosure, R2 Frame Size

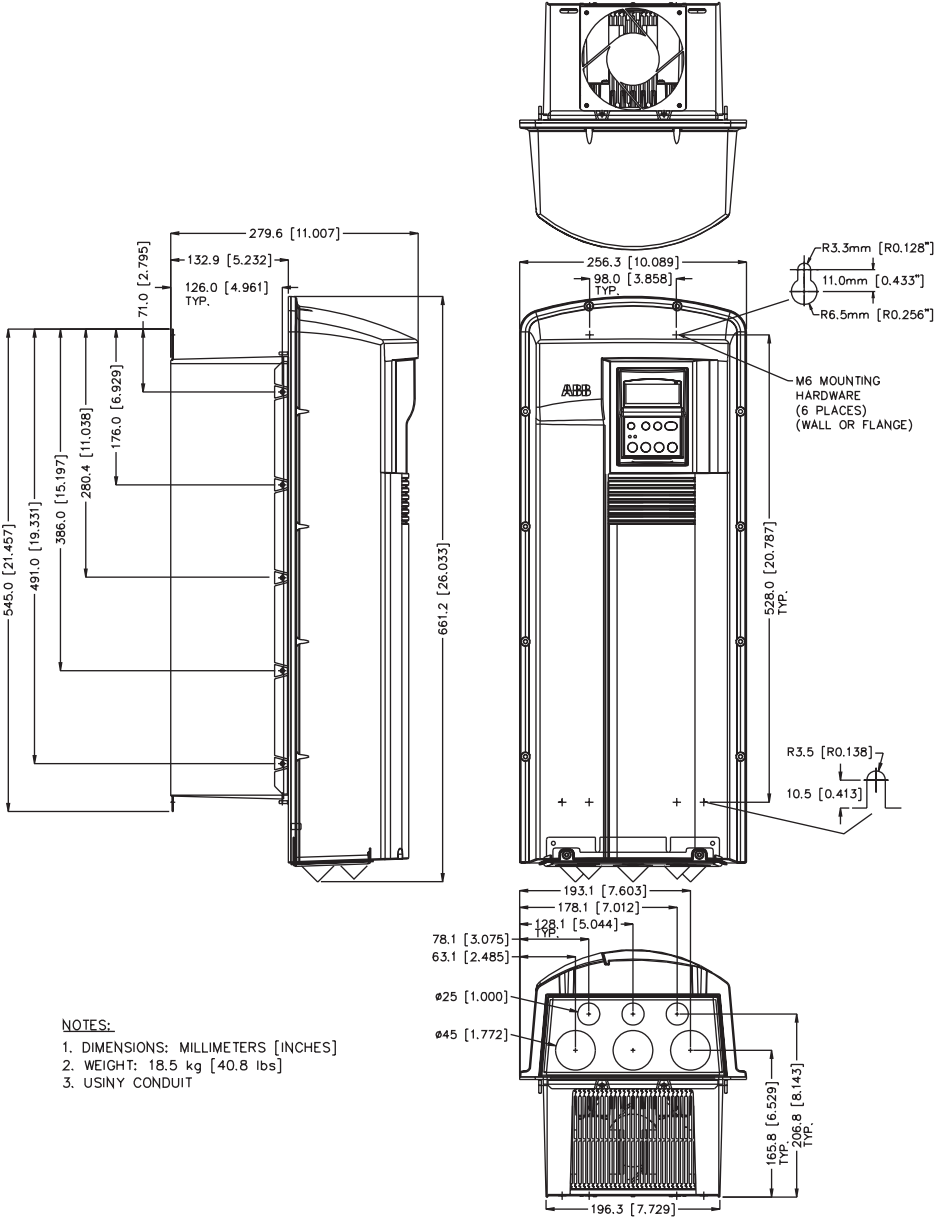


NOTES:

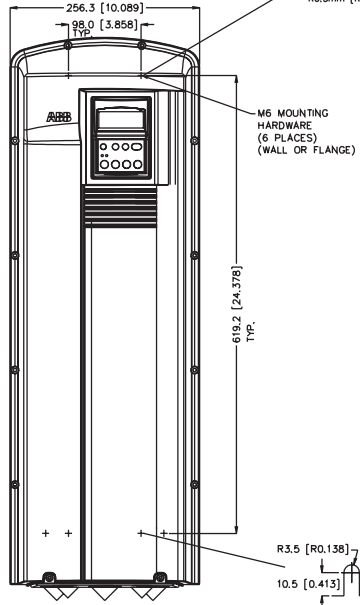
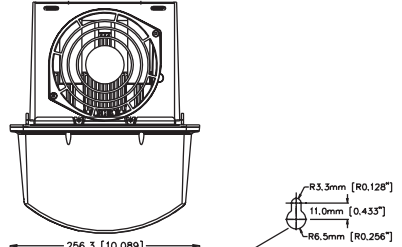
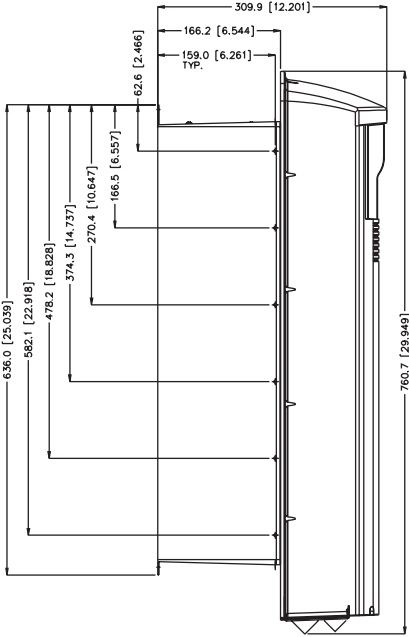
1. DIMENSIONS: MILLIMETERS [INCHES]
2. WEIGHT: 9 kg [19.8 lbs]
3. USINY CONDUIT



ACS 400 NEMA Type 12 & 4, R3 Frame Size



ACS 400 NEMA Type 12 & 4, R4 Frame Size



NOTES:

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

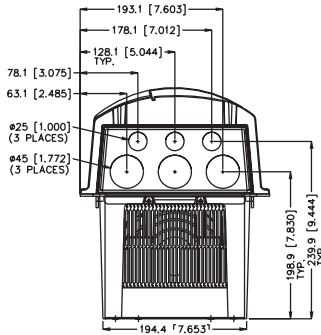




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ACS400-US-04
3AUA489002B5310 R0101 Rev B
Effective: 01/16/01
Supercedes: 2/1/99